RUSSIAN FEDERATION

NOMINATION MATERIALS

ASTRONOMICAL OBSERVATORIES OF KAZAN FEDERAL UNIVERSITY

Volume 5

Property management plan

2022

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ASTRONOMICAL OBSERVATORIES
OF KAZAN FEDERAL UNIVERSITY

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1. PROPERTY DESCRIPTION

The Astronomical Observatories of Kazan Federal University comprise the building of Kazan City Observatory (001) and a complex of Suburban Engelhardt Astronomical Observatory (002) with their historic buildings, museum expositions, a cultural and presentation complex Planetarium and the Astropark. The former is located in the central part of Kazan, the latter – in Zelenodolsk district of the Republic of Tatarstan, in the northeast of the European part of the Russian Federation.

The astronomical sites submitted for inscription in the UNESCO World Heritage List are a composite nomination that includes several components: Kazan City Observatory (19th century), located as part of the University ensemble in the historical centre of Kazan, and Engelhardt Astronomical Observatory (1901), specifically designed for large-scale observations and research in the conditions most suitable for night observations (out of town, 94 m above sea level) and located in Zelenodolsk municipal district of the Republic of Tatarstan, 24 km west of Kazan.

The Astronomical Observatories of Kazan Federal University are the only preserved site in the world that contains evidence of the gradual emergence and development of astronomical science in the world for almost 200 years, which has become the greatest contribution to the study and exploration of space in human history. The research once started in the era of optical instruments in the City Observatory, continued in the Suburban Observatory, and today is carried out with advanced space research instruments. Each stage of the research is recorded with extant scientific instruments.

The Astronomical Observatories are of global value as historic and cultural monuments, advanced centres for the development of astronomical science which carried out innovative and technological breakthroughs in the 19th-20th centuries in the Russian Empire, the USSR, the Russian Federation, Eastern Europe and Eurasia; today, they continue to expand the horizons of national, European and world science.

Both urban and suburban sites are part of Kazan Federal University, which has had different names at different times but has kept the continuity of its scientific, educational, and training activities. Since its creation in 1804 by Emperor Alexander I and until the February Revolution of 1917, it was known as Kazan Imperial University. In 1918, Kazan Federal University was transformed into «Kazan State University». After the death of V. Lenin, the university was named in his honour — Ulyanov-Lenin Kazan State University under the decree of the USSR Central Executive Committee of January 26, 1924. This name was officially approved by the Presidium of the Central Executive Committee on June 29, 1925. Due to the awards, in 1955, the university was renamed into Ulyanov-Lenin Kazan State University of the Order of the Red Banner of Labour, and since 1979 it was called Ulyanov-Lenin Kazan State University of the Order of Lenin and the Order of the Red Banner of Labour. From the early 1990s to 2010, the University was called 'Ulyanov-Lenin Kazan State University (KSU). Then, D. Medvedev, by the Decree of the President of Russia of October 21, 2009, approved the establishment of Kazan (Volga Region) Federal University. It became the successor of Kazan State University. The sites of Kazan Federal University are monuments of federal significance, and since 1997 Kazan Federal University has been an especially valuable cultural heritage site of the Russian Federation.

The Astronomical Observatories of Kazan Federal University represent a single space-time architectural complex specializing in astronomical observations and research from 1814 to the present. The desire to improve the quality of scientific astronomical research with the development of technical progress in the cities and towns of the Russian Empire at the turn of the 19th and 20th centuries and the increase in their illumination at night led to the creation of

a suburban part of the observatory with a cultural landscape park in the vicinity of Kazan.

The Astronomical Observatories of Kazan Federal University nominated for inscription on the UNESCO World Cultural and Natural Heritage List comprise:

City Astronomical Observatory (001):

1. The building of the Astronomical Observatory located on the Vienna meridian circle (1837) and unique authentic 19th-century instruments.

Engelhardt Astronomical Observatory Complex (002):

1. The main administrative building, 1899-1901
2. Observatory with the refractor and the meridian circle pavilions, 1899-1901
3. Southern Mark – the tomb
4. Northern Mark
5. Heliometer Pavilion
6. AZT-14 telescope pavilion, 1950s
7. Library, 1930s
8. Meteor Department pavilion, 1950s
9. Instruments of the 19th–20th centuries
10. Necropolis

The nominated properties are directly related to OUV events. The creation of the Fundamental Celestial Coordinate System makes it possible to clarify the astronomical constants and to solve the fundamental, cosmological questions of the origin and evolution of the Universe; on the other hand, the accumulation of data on the Sun allows a deeper understanding of the processes occurring on the Sun and other stars, and predicts solar activity, which has a direct impact on the evolution of civilization on Earth.

Thus, the Observatories of Kazan Federal University is a triad of spiritual unity of the historical and cultural heritage, science and life, which testifies to its sacralization.

Monuments of Kazan City Observatory (001)

1. The building of the Astronomical Observatory located on the Vienna meridian circle (1837)

2. Unique authentic instruments of the 19th century.

Kazan City Observatory is a part of Kazan (Volga Region) Federal University located downtown on Kremlevskaya Street. The Observatory is located on the University campus to the west of its main building. A wide passage leads to the Observatory from the main gate of the University campus connecting it with Kremlevskaya Street. There is a courtyard passage to the left of the Observatory starting at the side gates that open to Universitetskaya Street. The passage is located behind the main building of the campus parallel to Kremlevskaya Street. Thus, the location of Kazan City Observatory within the university campus is marked by the intersection of two important communications and is one of its compositional dominants.

The construction of the Astronomical Observatory designed by M. Korinfsky started on October 5, 1833; it was completed in 1833-1837. It has a symmetrical composition and a complex plan configuration. The Observatory was built of bricks with the southwestern part of the building lying on a terrace-like white-stone foundation. The two-storey northeastern part of the rectangular building is covered with a gable roof cut in the centre with a skylight above the inner spiral staircase. The layout of the ground and first floors of the northeastern part are practically similar.

The building of the Kazan Astronomical Observatory has a symmetrical composition and a complex plan configuration. The northeastern part of the building is rectangular in shape. This two-storey part houses the entrance with the lobby and the workrooms. An additional entrance is located on the left-side facade. The peculiarity of the southeastern facade of the rectangular volume of the Observatory is the asymmetry of the entrance. location It is dis-

placed on the facade to the left. The southwestern part of the building is a ring segment with the ends protruding beyond the rectangular volume. Above them, on a flat roof, there are round and multifaceted towers with rotating domes. The roof decks around the side towers are fenced with balusters. The tower at the southern end of the semicircular protrusion of the building has a cylindrical shape and a hemispherical opening dome. The tower at the western end has an octagonal timber cladding that conceals the dome and is surrounded by a timber lattice parapet. The main facade of the building, oriented to the southwest, has a semicircular concave shape. This part of the building used to locate the main hall which was intended for receiving visitors and storing portable instruments.

The hall opens onto a terrace with a wide staircase leading to the garden. Due to the rather steep relief, the terrace of the main façade has slightly sloping retaining walls and is fenced with a baluster parapet. From the main hall one could get into the Eastern hall, intended for observing stars in the 1st vertical, and the Western hall – for observing stars in the meridian. The halls have a cylindrical shape, partly protruding from the side facades of the Observatory. The two corner rooms adjoin these halls on each side, above which the side towers are located. The central octahedral tower with a wooden superstructure with a sliding vaulted roof is installed above the main hall along the longitudinal axis of the building. Around the tower intended for the refractor, a wooden circular balcony on brackets was built, also surrounded by a wooden lattice fence. In the arched part of the building, all rooms are double-height, i.e. designed in the form of a high floor, the rooms of which are illuminated by two rows of windows. The facades of the northeastern rectangular part of the building are designed ascetically and have practically no detail. The main attention in the design of the facades is paid to the curved south-western part of the building. The attic floor of the building with rooms over which towers with domes are installed is separated from the main floor by a dividing cornice with a frieze decorated with metopes. The second dividing cornice runs over the rectangular windows and is cut by semicircular archivolts arranged over small semicircular windows of the second light. The central part of the main façade with three entrance doors and high arched windows on the sides is distinguished by twin pilasters. The semicircular projections of round halls protruding on the western and eastern facades have a similar design. The facades of Kazan City Observatory are designed in late Russian classicism.

The southwestern part of the building is a wide arc with a flat roof and the ends protruding beyond the rectangular volume. Above them, on a flat roof designed in the form of a terrace, there are round and multifaceted towers with sliding domes. The tower at the southern end of the terrace has a cylindrical shape and a hemispherical opening dome. The tower at the western end has an octagonal timber cladding that conceals the dome and is surrounded by a timber lattice parapet. The terraces on the roof, surrounded by a balustrade, are divided by a large octahedral volume of the central room with eight arches joining in the centre above it. An octahedral platform with a rotating dodecahedral wooden drum with a sliding vault rests on them, under which a large refractor is located.

Around the refractor tower, a wooden circular balcony on curved brackets was built; it is also surrounded by a wooden lattice fence. It can be reached via a wooden ladder from the south terrace. This entire 5.50 m high timber structure is installed on an octagonal brick central volume, from which there are exits to flat roof terraces. Such a volumetric design of the building determined the semicircular concave shape of the main facade of the building opening to the south-west. The arcuate south-western part of the building, in contrast to the two-storey north-eastern part, is one-storey and double-height.

There is a basement for household needs under the building. The entrance to it is on the northwest side of the building. The entrance to the Observatory is on the northeastern facade from the side of the en-

trance from the main gate of the university campus. Visitors enter a double-height lobby that occupies the northern corner of the ground floor. To the right of the entrance to the lobby there is a wide three-flight staircase with winding steps on the corner platforms. Service premises are located to the left of the entrance. Behind them is a hall, which can also be accessed through a door on the east side facade of the building. There is also a two-flight staircase to the first floor. Through the wall, this staircase is adjoined by a round spiral cast-iron staircase leading upward and illuminated from above by a conical-shaped skylight. The metal frame of the lantern, resting on a cylindrical brick trunk with a spiral staircase, solved not only the problem of lighting the staircase inside the building, but was also a modern architectural technique at the time of construction. From the walk-through room, connected with the vestibule and a spiral staircase, one gets into the library hall with a semicircular wall, along which historical cabinets with scientific literature are placed. The library is connected with a square hall, where the Department of Astronomy is now located. The library and this hall were connected by doors with an arched part of the building, where in the centre there was a double-height rectangular hall, on the sides of which circular halls were symmetrically located. Half of their cylindrical volumes, they protrude beyond the arcuate part of the Observatory and are illuminated from this side by rectangular windows and semicircular openings over them.

The central hall together with the circular halls and square end rooms are found in this part of the building with a concave southwest facade. The central double-height hall is covered with a cylindrical vault and is illuminated by two rows of openings located one above the other: three glass doors and semicircular windows above them. This room was intended for receiving visitors and storing portable instruments, and is now used for training sessions. The main hall is connected with the Eastern circular hall, which was intended for observing the stars in the first vertical, and a similar Western hall, where observations of the stars in the meridian were carried out. These halls are adjoined by square end rooms on each side, over which the side domes of the Observatory protrude on the flat roof. Heavy brick columns of a unique design, 180 cm in diameter, were built in the middle of these rooms. The inner part of the columns was made hollow and covered with dry sand. This design made it possible to dampen the vibration that occurred when horse-drawn vehicles moved along the cobblestone streets near the Observatory. This made it possible to achieve greater stability of the equipment installed under the side domes and the accuracy of measurements and research. Three high doors lead from the central hall to the terrace encircling the arched part of the building on the southwest side. A wide staircase goes down from the terrace to the garden built on a slope with a height difference from 74.80 to 67.00, i.e. 7.8 metres. Due to a rather steep relief, the terrace of the main façade has slightly sloping retaining walls 180 cm high and is fenced with a baluster parapet.

The interiors of the City Astronomical Observatory have remained practically unchanged. In the interior of the double-height lobby, a large-scale three-flight staircase with winding steps on the turning platforms has been preserved. The supporting structures of the stair spans are massive curved stringers. The upper landing and steps of the stairs are covered with cast iron plates bolted to the structures and painted. Wooden chiseled balusters are used in the staircase railings. Authentic bookcases, a worktable and benches have been preserved in the library. Some of the halls have preserved Dutch ovens covered with white majolica tiles (Academician N. Sakhibullin's office, 1st floor). In connection with the implementation of steam heating with piping and the installation of batteries in the 1960s, some ovens were dismantled in the Observatory, the location of which can be determined by the existing niches in the walls. The main hall with exits to the terrace has practically not changed, only the oven has been dismantled. Along the walls of the hall, the original cabinets with authentic astronomical small-sized equipment have been preserved. The cylindrical double-height halls had vaulted ceilings; today

there are stretch flat ceilings. The building is decorated with a spiral staircase with triangular steps of a slotted geometric pattern; it is made from cast iron. The riser plates are decorated with cut-out floral ornaments. The staircase railings have pseudo-gothic motives. The low conical dome above the staircase has a second row of glazing inside a metal frame with square cells. The wooden staircases, leading after the spiral staircase through the inner rooms to the terraces and the main dome, have fences made of thin carved balusters.

The facades of the northeastern rectangular part of the building are ascetic in design and have practically no detail. According to the design, the rectangular windows of this part of the building have no platbands. On the northeastern facade of the Observatory, facing the main gate of the University campus, there is a high, blank attic that hides the gable roof. There is a relief inscription in Latin numerals MDCCC20THXVIII on the facade of the attic. The main attention in the design of the facades is paid to the south-western part of the building. The attic on the main façade is separated from the main floor by a dividing cornice with a frieze decorated with metopes. The second dividing cornice runs over rectangular windows and is cut by semicircular archivolts arranged over small semicircular double-height windows. The central part of the main façade with three entrance doors and high arched windows on the sides is marked with paired Doric pilasters. The semicircular protrusions of the round halls of the western and eastern facades are similarly decorated. Balusters are used in the fences of the roof terraces of the Observatory. The facades of the building of Kazan City Observatory are designed in late Russian classicism.

For almost 200 years the teaching of astronomy has not stopped in the City Observatory. To this day training sessions have been held there; the instruments used by the outstanding astronomers of Kazan Federal University of the 19th-20th centuries are still part of the educational process. They are used both in teaching the history of astronomy and in explaining the basic principles of astronomical observation, which conveys the spirit of continuity in the teaching of theoretical and practical astronomy for almost 200 years.

Instruments, located in the City Astronomical Observatory, borrowed from the funds of the University History Museum

1. Dollond Sundial, England (late 18th-early 19th centuries)

The sundial is mounted on a large flat round base with three adjustable legs. In the centre of the base there is a silvery compass with levels. The compass is surrounded by a silver ring with days and months marked on the inner circle and 360 degrees graduated around the outer circumference with each quadrant additionally marked «watch faster» and «watch slower». To set the required position, the device is rotated along its axis with the help of a brass knob installed between the months «Sept» and «Oct». Two pillars are fixed on the rotating base to maintain the main ring with a smaller ring and a flat oval metal element inside. The inner ring rotates outward in a right angled position from the main ring and has 24 hour markings (two sets I-XII) on one side and along the inner edge. The flat oval metal element has a sliding metal segment with a tiny hole. On one side of the element, days and months are marked, on the other, the constellations. The outer ring is graduated with 360 degrees on one side. The outer ring has two holes to be used when comparing with the sun. There is a small brass knob below the main ring used for rotating the inner and outer rings inside the main ring. 'Dollond London' is written at the base.

2. The star globe with two telescopes (Professor Bohme and M. Reitter), Austria (19th century)

The star globe with two telescopes stands on a massive cast-iron base with three brass, height-adjustable legs. The globe is yellowish with black traced constellations. A brass ring runs along the orbit of the

globe, with two brass telescopes located on the sides (original optics). The globe can be adjusted in height, rotated on its axis and tilted. At the base of the globe there is a graduated brass ring indicating the inventor and manufacturer «PATENT DES PROF.BOHM», «M.REITTER IN INSBRUCK №96» and indicating the morning stars – «VORMITTAG», and the evening stars – «NACHMITTAG». With the help of the graduated ring, you can determine the angle of a star. The surface of the globe has some parts lost; the base of a numeral is red.

3. Ney's universal instrument, Russian Empire (mid-19th century)

It is a versatile tool with dimensions: 60x50x42 cm. The device stands on three sharp brass legs, adjustable in height (the legs have additional flat tablets). The diameter of the device frame is 31 cm. The tube has one axis (hollow) directed from east to west; star rays are reflected into it with the help of a prism. The telescope is 'broken', i.e. the two halves make a 90° angle at the junction of one tube and the other; there is a prism in a square box. At the end of the central tube, 1 weight is fixed; a level is fixed above the central tube. At one end of the axis there is an eyepiece through which observations are carried out. With its help, the climax of the stars is recorded if their right ascension and declination is known. It has one limb; it is small with a silver stripe with graduations along the edge. There is also a graduated strip along the frame of the device. The graduated stripes are equipped with additional microscopes. An additional telescope with the inscription «Utzschneiden und Fraunhofer in Munchen» is fixed under the frame of the device. On the frame of the device there is an inscription "Ney in Kazan No.1".

4. The demonstration model of the Moon, Germany (1907-1908)

The demonstration model of the Moon (12 cm in diameter) was made from the photographs of Dr. F.S. Archenhold and E. Lehr (Archenhold Observatory in Berlin-Treptow). Its dimensions are 18x18x3 cm. The model has the shape of a hemisphere made of gypsum and is fixed in a recess in a cardboard base covered with blue velvet. There is an inscription in German along the edge of the gypsum. In the corners there are four brass decorative ornaments in the form of volumetric pins. On the back of the model there is an original hanging loop, as well as a printed text in German about the demo model itself, how and from what it was made, on what basis.

5. An astronomical instrument (late 19th century)

It is a transit instrument with an eccentric tube and a vertical limb; its design allows it to perpendicularly transfer the tube onto the additional pillars.

Unlike a multi-purpose instrument, it does not have a horizontal limb and is not suitable for horizontal angular measurements.

It functionally corresponds to the Bordo vertical circle. The inscription "A gift of A.M. Kovalko, 1901». Dimensions: 46x106x84cm. No optics. Tube length – 84 cm. Frame diameter – 44 cm. Limb diameter – 41 cm.

6. Reichenbach's universal instrument, Germany (early 19th century)

Reichenbach's universal instrument is an astronomical device with three massive, bronze, brass-plated, arc-shaped, adjustable legs. Dimensions: 62x39x38 cm. The tube rotates both around the horizontal and around the vertical axis. Large, wheel-like circles (limbs) with silver graduations are visible on these axes. Small microscopes with low magnification are directed at the limbs (some are missing), which make it possible to clearly see the divisions on the limbs. At the universal instrument's level, there is also a horizontal graduated silver stripe. There used to be levels (missing) on the universal instrument frame. They were used to position the universal instrument strictly in a horizontal plane by turning the supporting adjusting screws. Weights are fixed on the tube from below and from above.

The universal instrument is used for measuring the horizontal coordinates of a star with an accuracy of seconds – its azimuth and zenith distance or height. There is an inscription «Utzschneiden und Fraunhofer in Munchen» on the tube. The lenses are original. There are inscriptions "Andreas Taworskie", "H.K. polyt institut in Wiene» on the frame of the instrument.

7. Repsold's universal instrument (mid-19th century)

Repsold's universal instrument is an astronomical instrument with three massive bronze legs covered with brass. It was produced by A. & G. Repsold company, Germany, Hamburg. Dimensions: 57x45x56 cm. The tube rotates both around the horizontal and around the vertical axis. The device is equipped with two large limbs with silver graduations. Additional telescopes are directed at the limbs, allowing a clearer view of the divisions on the limbs. The frame (standing on the legs) also has a graduated silver strip equipped with microscopes. The instrument's level is fixed in a special glass compartment above the side tube. The device has one massive weight at the end of the central telescope.

The universal instrument is used for measuring the horizontal coordinates of a star with an accuracy of seconds, such as its azimuth and zenith distance or height. The eyepiece bears the inscription «A & G Repsold Hamburg, 1857».

It is also functionally close to the vertical circle – a clear priority of vertical (astronomical) measurements.

8. Kippregel (late 19th century)

The device is fixed on a ruler-shaped base which is 51 cm long. Dimensions: 30x51x14 cm. There is an inscription "V.T.Otd. Gl. sht. 1891 No. 224" on the base. Also, on one side of the base there is a scale in the shape of a table, numbered vertically and horizontally from 0 to 10. The scale is horizontally divided into 4 parts and numbered from 1 to 4. Optics is available. There is a level on the base. A medium-sized limb has a graduated band around the circumference on one side and on the other from 0 to 60 and from 0.350 to 310. There used to be additional microscopes around the circumference of the limb; they are now lost. There is damage and corrosion to the metal.

9. A universal instrument (19th century)

A universal instrument (matt brass). Dimensions: 32x40x34 cm. The instrument stands on three brass legs, adjustable in height and graduated from 0 to 100. The tube has one axis (hollow), directed from east to west; star rays are reflected into it with the help of a prism. The telescope is 'broken', i.e. the two halves make a 90° angle at the junction of one tube and the other; there is a prism in a square box. At the end of the central tube, two weights are fixed. At one end of the axis there is an eyepiece through which observations are carried out. There is one limb; it is small with a silver stripe with graduations along the edge. There is also a graduated strip along the frame of the device. Additional microscopes are directed at the graduated strips – 4 pcs.

It is clear that it was primarily used to measure horizontal angles (the horizontal limb has a much larger diameter; it has 4 reference microscopes instead of 2).

11. An astronomical instrument (late 19th century)

An astronomical instrument lies on a cast-iron frame with three brass legs, adjustable in height. Dimensions: 35x27x51 cm. The instrument rotates on its axis. The device has two graduated brass limbs. The brass is painted black. There is a compass and a level on top of the instrument. At the end of the telescope there is a metal box with a sloping top, with two rectangular holes covered with mica plates. The front part for the 'artificial horizon' was used in astronomy (mercury was poured, such a 'mercury mirror' kept horizontal when tilted).

12. Struve Uno Wilhelm Pohrt's Heliotrope (mid-19th century)

It is an astronomical instrument with three adjustable brass legs. It has a brass graduated limb with an arrow. There is an inscription (partially readable) "Pohrt in Pulkowa" on the limb. There is a rectangular plate on the frame that moves along it.

The laboratory building (the building of the former Littrow Observatory)

The one-storey extended building is located parallel to the building of the Astronomical Observatory. Basically, this building was built at the end of the 18th century and was part of Prince Tenishev's estate. It was located on the very edge of the slope at the western border of the estate garden and consisted of two rooms covered with vaults with strippings and was covered with a hipped roof. This building was used for household purposes. There were kept garden tools and seeds. The initial inspection of the building was carried out by one of the employees who concluded that the building was dilapidated [ORRK KFU. No. 3971. L. 62. Plan of the building projected for reconstruction under the KU observatory. 1812]. Obviously, Littrow did not agree with this conclusion and designed a project to adapt it to a small observatory. A wooden room was built over one half of this building.

The second half of the building served as an open terrace on which a small wooden pavilion with a sliding roof was installed [RGIA. F. 733. Op. 39. D. 156. L. 6. Plan of the first observatory of Kazan Federal University, Professor Littrow. 1814]. In 1814, after the reconstruction, Littrow adapted this building for astronomical observations. Above the building there was erected a tower for the equatorial, a span for the meridian circle and a small room with a retractable roof for small instruments. The brick walls of the building were plastered and whitewashed. The rectangular windows were set into flat arched niches. In general, the building, in accordance with its original purpose, is devoid of any other decorative elements. Over time, the building of the Littrow Observatory fell into disrepair; in 1822, before the implementation of Pyatnitsky's general plan, the Observatory was temporarily housed in the wooden gallery of the building that was previously Spizharnaya's residential building. At that time, this gallery was part of Ivan Simonov's apartment. The Observatory was located there before the construction of the main building. The property is an authentic building associated with the development of astronomy in our region. Later, a similar volume was added to the building from the northeastern side, and the building acquired a modern look.

The monuments of Engelhardt Astronomical Observatory (002)

1. The main administrative building, 1899-1901

2. Observatory with the refractor and the meridian circle pavilions, 1899-1901

3. Southern Mark – the tomb

4. Northern Mark

5. Heliometer pavilion

6. AZT-14 telescope pavilion, 1950s

7. Library, 1930s

8. Meteor Department pavilion, 1950s

9. Instruments of the 19th–20th centuries

10. Necropolis

The construction of the Suburban Observatory was a new stage in both the development of science and the architecture of scientific complexes. Creating an Astropark – a unique socio-cultural space built in a natural landscape environment – was innovative for its time and expressed advanced scientific thought. The Astropark, designed as a single concept, combines astronomical instruments, architectural constructions, a science laboratory and a living environment within the natural landscape. The scientific and daily lives of the staff and residents of the suburban observatory were devoted to astronomical research.

The complex is located on the edge of a high plateau above the Volga River, 24 km away from the historical centre of Kazan. The complex includes the observatory building with the pavilions of the refractor placed in the centre of the site, the meridian circle

and the Marks (adjustment of the meridian circle), the Heliometer Pavilion, the Meteor Department, the library, and the administrative building. The Refractor Pavilion, the Observatory building, the meridian circle pavilion along the west-east axis and the perpendicular set by the Northern and Southern Marks create a conceptual and compositional framework to which all other components of the complex are subordinated. The large structures are distributed around the perimeter of the vast clearing, with smaller instrument pavilions clustered in the centre. A straight main avenue that is lined with tall lime trees and parallel to the west-east axis connects the central clearing with the gates of the main entrance. Between the gate and the central clearing, on the north side of the alley, there is the main building surrounded by tall lime trees, oaks, and fir trees. According to the composition of the complex, the Planetarium building is placed at the end of the perspective in the north-south direction, set by the direction of the meridian circle to the Marks. The Complex of the Engelhardt Suburban Observatory of Kazan Federal University was built in 1898-1901. The plot of the state-owned Krasnogorsko-Turin dacha, selected for construction, was located 24 km from Kazan, not far from Lavrentevo railway station (renamed soon after the construction into Observatory station).

The architectural ensemble and instruments of the Suburban Observatory

The architecture of the complex is designed in neoclassical forms. The asymmetrical composition of the buildings and structures is ascribed to Art Nouveau. At the same time, the decorative design of the facades and interiors is based on classicism, order system, classical proportions, and attempt for harmony. The characteristic decorations are rustication, pilasters, stylised triglyphs and architectural pediments. Founded on its heritage, the largest movement in architecture was Russian Neoclassicism. The architecture of Engelhardt Astronomical Observatory marked a rediscovery of classicist architectural values, typical for the turn of the 19th-20th centuries. Its design was inspired by the magnificent Empire style of the Kazan Federal University, and Kazan City Observatory.

The Main Administrative Building

There is an elegant two-storey stone administrative building of early neoclassical style close to the gate. It was built in 1899-1901 by architect F. Malinovsky. It originally housed a library, computing rooms and living quarters; currently, it houses the director's office, administrative offices, laboratories, computing services and research staff offices. The observatory is a rectangular two-storey building with two asymmetrical risalites flanking the main facade. The right-hand larger risalite with three window axes is accented by an elaborate attic with a triangular pediment. The central axis of the risalite is accentuated with a small wall set-back. The main entrance is shifted to the left of the central axis of the risalite. The shift of the accents to the right side of the building, with orientation to the main entrance, is presupposed by the overall composition of the entire complex. The left risalite of two window axes is completed with a small attic. The walls of the ground floor are rusticated, the corners and wall setbacks of the first floor are decorated with pilasters. There are several entrances to the building. All of them are decorated with small porches and wrought iron gable roofs with triangular pediments. The interior has fully preserved the original layout, elements of interior decoration, cookers, furnishings and part of the archive as well as D. Dubyago's study with memorial furniture, custom-made cabinets and a bust of V. Engelhardt by Dresden sculptor Selmar Werner.

The Observatory building with pavilions for refractors and the meridian circle was erected at the same time as the main building in 1899-1901 by the

design of F. Malinovsky. It is a one-storey brick building, with its longitudinal axis oriented in an east-west direction. In its central part, it has two computing halls located symmetrically on the sides of the main entrance. In the west, there is an adjacent tower for the 12-inch Engelhardt Equatorial Telescope, and in the east, there is the meridian circle Pavilion. The total length is 40 m. The height of the tower to the top of the dome is 11 m, the central part is 6 m high and the Meridian Hall is 7 m high. The main entrance is centrally located, opening with double doors to the north and south. The facade entrance is embellished with a risalite and an attic. The corners of the risalite are accentuated by wide pilasters. The glazed wooden entrance doors are framed by a semi-circular portal: a deep arched niche with a profiled archivolt on the imposts supported by three-quarter columns. The flat frieze shows «1901» as the date of construction. In the interiors, the entrance has retained its original finish. The centred foyer is covered by a cross vault supported by circular columns. The ceilings of the computing halls are decorated with profiled cornices. The original panelled doors and pedestals for portable tools have been preserved.

The main instrument of Engelhardt Astronomical Observatory was a **12-inch Engelhardt refractor** made by Grubb in 1875. In the Suburban Observatory, the 12-inch equatorial went into operation in February 1901. The refractor has a doublet lens of 12 inches (30 cm) in diameter. The focal length is 3.85 metres. Its cast-iron pedestal takes the form of a hollow parallelepiped truncated in its upper part by a plane, perpendicular to the celestial axis. The instrument is equipped with a clockwork mechanism with approximately one and a half hours of wind up. A fine Repsold filar micrometre with mechanical registration of the drum reading made it possible to make accurate observations. The first observation with the equatorial, according to the wish of V. Engelhardt, was made by D. Dubyago.

The purpose of the refractor is to observe the positions of minor planets, comets, faint variable stars, binary stars. The refractor was therefore used to observe the brightness of variable stars and the positions of minor planets and comets. They carried out major astrometric work, apart from minor astrophysical work (photographing, observing the Sun, etc.). In particular, Dmitry Dubyago, in the early 1890s observed the 16P/Brooks comet, the minor planet Diana, and the Perseids in 1893. Yakov Kornukh-Trotsky observed the Solar eclipse, the satellites of Jupiter and lunar occultations since 1890. During the post-war period, the scientific work in the Astronomical Observatory was determined by the instruments available then – the meridian circle, the refractor and the heliometer. That equipment mainly mapped out the astrometric nature of the observatory. A small astrograph in combination with a 6» comet seeker and a 12» refractor showed significant results, especially in the class of eclipsing binaries. Ivan Dyukov performed over 1,700 observations of minor planets with a 12-inch refractor. After returning from the war, Konstantin Kostylev started photoelectric observations of variable stars with a Grubbé refractor. He set up the equipment and commissioned an electrophotometer for the refractor, which Mikhail Lavrov later used to observe variable stars. In 1965, the 12» Grubbe refractor was reconstructed into a 16» astrograph. The visual lens was replaced by another photographic lens (D=400cm, F=3780mm), the tube was changed, and the clock mechanism was improved. Subsequently, the scientists carried out several observations to determine ephemeris time and evaluated the possibility of applying it for the analysis of the selenodesy reference coordinate systems using the pictures of the Moon obtained with the refractor.

The equatorial tower is surrounded by a small balcony with a wrought iron lattice. The refractor pole foundation is not connected to the tower walls and is buried at 3 metres. The rotating dome with 6.6 m in diameter is made of wood and upholstered with iron, moving on rollers that run on two pairs of rails. It has a single one-metre wide observation slot, closed by two hatches. The dome was made according to the drawings of Gustav Heide in Patsig workshop, Dresden, commissioned by D. Dubyago specifically for the Suburban Observatory building. The original

structure of the tower and dome, the wrought iron staircase with wooden steps have been preserved to this day. The mechanisms for opening and turning the dome are in good working order.

To the west, the Observatory building is connected to the **meridian hall pavilion** by a small passageway. The sliding shell of the Meridian Hall, which was specially designed by Professor Schleier, was commissioned from Franz Mozentin's company (Leipzig). The walls and roof of the Meridian Hall are made of galvanised corrugated iron produced at the Corrugated Iron and Galvanizing Plant of Wilhelm Tilmans in Pruszkow (near Warsaw). A double shell with a 0.4 m air layer enables rapid equalizing of the indoor and outdoor temperatures, making the structure one-of-a-kind. Special fans were installed to circulate the air. The roof of the pavilion is sliding. There are 1.2m wide astrohatches on the south and north sides of the pavilion. The foundation for the tool support posts is a concrete slab that is 3 metres below floor level. A brick parallelepiped with a height of 2.5 metres is erected on it. Inside, there are pillars that rise 2 metres above the floor of the hall and are isolated from the rest of the foundation and floor by glycerine. The distance between them is 1.1 metres. To protect against heat, the tool itself is placed in a wooden sliding house. A mercury horizon is installed on a separate post isolated from the foundation and floor with glycerine. All the original designs and opening mechanisms have been preserved in good working condition.

The meridian circle of the Observatory was made in 1845 in Hamburg by the famous astronomical instrument designer, Repsold. This Circle was commissioned by the Kazan Astronomical Observatory to replace the Vienna meridian circle, which was severely damaged during the great fire of 24 August 1842 in Kazan and could not be restored. The Repsold meridian circle was brought to Kazan Observatory in 1847 by M. Lyapunov. In 1895, an impersonal micrometre with a micrometre in declination was purchased for it. In 1900, all parts of the instrument were sent to Repsold for rebuilding, except the circles, since they were of excellent quality. Repsold had the axes reworked, the cube drilled, the accuracy of the declination setting improved, and a new level for the horizontal axis was made to modernise the circle. Also, 4 new micrometric microscopes were made to avoid shifting the microscopes when rearranging the instruments, and a new microscope with support was made. In the workshops, they installed counterbalance circuits, attached three wire-nets to the lens to reduce the brightness of stars, and adapted the equipment to electric lighting. After restoration, in 1902, the meridian circle was brought to the Engelhardt Observatory, but due to damp conditions in the Meridian Hall it was finally installed in the autumn of 1903.

The meridian circle is installed in a corrugated galvanised iron pavilion. The walls of the hall are double, with an air gap of 0.4 metres. Special fans have been adapted to circulate the air. The roof of the pavilion is sliding. There are 1.2m wide astrohatches on the south and north sides of the pavilion. The height of the room is 6 metres. The foundation for the supporting pillars of the tool is a concrete slab located at a depth of 3 metres below the ground level. A brick parallelepiped with a height of 2.5 metres was erected on it. Inside, there are the pillars that rise 2 metres above the floor of the hall and are isolated from the rest of the foundation and floor by glycerine. The distance between them is 1.1 metres. To protect against heat, the tool is placed in a wooden sliding house. A mercury horizon is installed on a separate post isolated from the foundation and floor with glycerine.

The diameter of the meridian circle lens is 135 mm, the focal length is 195 cm. There are four eyepieces with 120x, 150x, 190x and 250x magnification. The circles are arranged symmetrically on both sides of the pipe – a two-minute main circle and a ten-minute supplementary circle. The scale is printed on a silver strip. The accuracy of the graduation is of high quality. There are wooden handles in the form of circles on either side of the tube to operate the appliance. The fixing screws are located in the eyepiece section of the telescope. For the convenience of observation, there is an adjustable rail-mounted chair. To

study the horizontal flecture of the meridian circle tube, they installed small horizontal collimators with 11-cm lenses of 165-cm focal length on special pillars in front of the hatches, 1.5 metres away from the pavilion. In 1920, the meridian circle was removed, and the timber cladding of the pillars was replaced with cement cladding. In 1923, the meridian circle was thoroughly cleaned and installed. In 1924, the mercury horizon was adjusted, and the lighting of the telescope was put in order.

The meridian circle of the Astronomical Observatory was used to determine the coordinates of the stars on the celestial sphere. Measuring star positions in the sky is the foundation of all astronomy. The catalogues derived from these observations are essential in determining the exact time, geographical coordinates on the earth's surface, in drawing geographical maps in navigation, topography and geodesy, in studying the Earth's rotation, the structure of the Galaxy, etc.

Mikhail Grachev started systematic observations on the meridian circle at the Engelhardt Observatory in 1903. His purpose was to study the tool. In 1909, he began observations of a large series of stars between 5.5 and 6.5 of magnitude. Within 10 years he made about 10,000 observations. Later, Ivan Dyukov joined the observations and started working on the international program. Engelhardt Astronomical Observatory further participated in all collective observational work, such as the compilation of the 'Catalogue of Geodesic Stars', which is part of the programme to determine the geographical coordinates of triangulation points. It was the first major collective work of the USSR astronomers. A. Dyukov and L. Agafonova carried out observations and their processing before all other participants of this collective work and the results were published in 1943 in the Proceedings of the Astronomical Observatory of Kazan Federal University.

Engelhardt Astronomical Observatory took an active part in the international work on the Compiled Catalogue of Fundamental Faint Stars (FKSZ in Russian). Three stages of work were carried out: determination of differential and absolute declination for the Compiled Catalogue of Fundamental Faint Stars and observation of declination of the Fundamental Catalogue. Later on, both the differential and absolute catalogues of the Compiled Catalogue of Fundamental Faint Stars of Engelhardt Astronomical Observatory were used to compile the Preliminary Fundamental Catalogue of Faint Stars (PFKSZ). A. Nefedyeva became the main observer on the Meridian circle. She carried out significant research on anomalous refraction due to the tilt of the air layers. She used the observations on the meridian circle. This instrument has also been used to measure the coordinates of the major planets, and to determine the declination of Mercury, Venus, Mars, Jupiter and Saturn. All the results have been published.

During these extensive observation programmes, the meridian circle was modernised. Instead of the visual microscopes for measuring the limb, cameras of the original design, which smoothly work at all air temperatures, were installed. This upgrade increased the efficiency of the observer by several times and made the observation process much easier. A semi-automatic electronic computer was designed to measure the graduations. Around 100,000 measurements of the declination of stars and planets have been made on the meridian circle. The research carried out on the tool has shown that the instrumental variations have remained virtually unchanged within 120 years, except for the tube flecture, with its minor changes after the telescope maintenance check-up. The Repsold meridian circle in the Engelhardt Observatory is fully authentic, still a fully functional instrument and of great historical value.

There are **two Marks** connected to the meridian circle, each 130m away from the centre of the mercury horizon. They were constructed in 1904-1905 and are necessary for the alignment of the meridian circle. To the north, in the direction of the meridian, there is a small **Northern Mark** pavilion, built of galvanised corrugated iron, the same as the meridian circle pavilion. The marks themselves are iron planks with a square side of 35 cm. The copper plates measuring 12 cmx22 cm and 0.5

cm thick are screwed onto them. There is a 1.5 mm hole in this board. When illuminated by an electric bulb, it gives an artificial star of 2 seconds in diameter, which is easy to observe at a distance of 147.6 metres from the instrument. Both marks are positioned at the altitude of 90 degrees from the instrument, and the mark line deviates from the meridian by about 0.2 seconds. To observe the marks, there is an additional movable lens in the eyepiece section of the tube.

Due to the lowering of the natural terrain, the **Southern Mark** was raised by 5.5 metres onto an artificial mound. Inside there was a brick vault, intended by the creators of the suburban observatory D. Dubyago and V. Engelhardt, for their future burial. In 1904 – 1905, a chapel-like mark topped the hill by the K. Mufke project. The South Mark is not only an astronomical point but also a tomb – the only one of its kind in the world, a unique architectural structure. The pavilion on top of the mound is built as a small chapel in the Russian-Byzantine style. The walls of the chapel are made of galvanized corrugated iron. The hip roof is topped with a bulbous cupola on a round light tholobate. At the base of the tholobate, there is a row of corbel arches with additional ventilation holes, protected by a grille with a cut-out pattern. The skirt of the cupola and the eaves are decorated with a cut-out pattern. The facades are embellished with metal profiled cornices with overlay details as stars and acanthus leaves. The front door and porch are arranged on the east side. The entrance portal is decorated with intricate floral ornamentation. A metal door with overlay is decorated with a Greek cross in the centre, ornate wrought-iron strap hinges and a door lock with a handle. All decorative finishing of the facades is made of iron with different techniques: cutting, shaping, drawing, forging; and preserved in the original design. The crypt in the chapel contains the graves of D.Dubyago and V.Engelhardt, reburied in 2014 from Dresden (Germany).

The heliometer is a unique instrument of Engelhardt Astronomical Observatory, the only heliometer telescope in the world that currently operates. This is one of the first heliometers made at Repsold manufacture; Repsold was a famous producer of astronomical equipment. It was manufactured in Hamburg in 1874. Originally the telescope was made to observe Venus passing across the solar disk. But after applying the Kazan heliometer during the expedition to Chita in 1874, it was installed at the city observatory in 1891, where A. Krasnov mainly observed the Mösting crater in order to study the physical libration of the Moon. Subsequently, in 1908, the heliometer was installed at the suburban observatory in a specially constructed round brick pavilion of 3.6 m in diameter, with a rotating spherical dome. The cylindrical pavilion is placed on a high basement. The facades are decorated with semicircular niches located at the cardinal points, flanked by paired pilasters. The entrance is decorated with a small projection and pilasters at the corners. A wrought-iron staircase leads to the entrance. The dome is made of ship steel and sheathed with 1 mm thick galvanized sheet metal with an insulating cardboard layer on the inside. The inner diameter of the room is 3.6 metres. For observations there is a hatch in the dome with a sector opening to one side. The dome is rotated mechanically. The heliometer is installed on a brick pillar; the lower part of it is laid out in a stone basement 2.6 metres deep. The pillar has a cylindrical shape with vents inside. This shape of the pillar allows stabilizing the instrument, which is important in positional observations.

The Kazan heliometer is one of the devices of a new type, with some major constructive improvements: the halves of the lens move symmetrically in opposite directions along the cylindrical surface, its radius is equal to the focal length of the lens; there is no lateral displacement of the eyepiece; the whole pipe, together with the objective box, rotates along the positional angle as a single piece; readings of objective scales and the positioning circle are made with the use of long-focus microscopes directly from the eyepiece end of the tube. The dimensions of the instrument are characterized as follows: lens diameter – 106 mm, focal length – 1590 mm. The position of the instrument is quite stable due to the original design of the heliometer pillar. The important quali-

ty is its resistance to temperature fluctuations. It does not require frequent refocusing and bringing the focal scale to a constant reading, since observations are carried out with a constant focus. The optical part of the instrument is also of a high quality. The images of stars are obtained in the form of short light strokes (which is normal for heliometers located by their elongation perpendicular to the cut line of the lens halves). Moving the lens halves, the stars are arranged in a straight line, which should be parallel to the thread of the cross in the field of view of the pipe. The cross of its threads is strictly parallel to the cut line of the lens halves, and the other one is perpendicular to it.

The heliometer is one of the most accurate and, at the same time, the most complex astronomical instruments. It is difficult to use it for observations because of the special observation methods being applied due to the original design of the instrument. The lens of the heliometer is cut diametrically into two halves, moving relatively one to the other, which makes it possible to measure large arcs in the sky.

The rotation and shape of the Moon are a matter of special interest for the Engelhardt Observatory. Since the libration effect in the rotational motion of the Moon was theoretically predicted, the efforts of astronomers were directed towards determination of the physical libration parametres through observations that could characterize the dynamic nature of our natural satellite. Kazan heliometric observation series are the longest ones in the world and have fundamental importance for the study of libration and the shape of the Moon. The first series of observations were carried out by A. Krasnov (1895-1898) and A. Mikhailovsky (1899-1905). The observations were pretty scarce and handled poorly. In 1910 T. Banakhevich started observations at the Engelhardt Observatory. That series of observations was carried out from 1910 to 1915 and processed by A. Yakovkin. Due to those observations and their complete and comprehensive processing, the accurate data on the Moon's rotation were obtained. From 1916 to 1931, heliometric observations were continued by A. Yakovkin, followed by I. Belkovich, A. Nefediev, A. Mamakov, Yu. Nefediev. Since then, the telescope has been used for many more observations than any other similar instruments in other observatories. Determination of the Moon rotation parametres and its coordinates, as well as solution of selenodetic issues, are associated with the observation of the lunar edge, which is uneven due to a number of mountains and lowlands on the Moon. These irregularities introduce systematic errors in observations and distort the results. A. Nefediev developed a method and built maps of the lunar relief based on the extensive observations of the Moon carried out with the Kazan heliometer for fifty years.

In 1967-1969, the instrument was subjected to restoration works that included installation of photographic microscopes on it in order to register the readings of the positioning circle and scales, as well as a number of other design improvements that were made. As a result, the accuracy of the scale readings significantly increased and, in particular, the accuracy of the positioning circle readings. The process of reading registration was significantly simplified. Now it is possible to measure not only angular distances, but also positional angles with high accuracy. The mechanism that moves the heliometer in terms of distances, consists of a handwheel located at the eyepiece end of the tube, and a mechanical drive that displaces the sliders of the lens halves. The mechanical ratio of the drive is selected so one turn of the handwheel corresponds to the relative displacement of the lens halves by 180". In practice, the inclination of the halves may change due to incomplete contact of the guide surfaces of the slider and the objective box; or due to insufficiently rigid attachment of the lenses and the lens halves in the frames or the attachment of the frames to the sliders. These causes can be eliminated by careful tool adjustments. In 1968, a precise mechanism for micrometer rotation of the pipe along the positional angle was installed. The displacement value of the halves of the heliometer objective is determined by the scales installed on the sliders. Nickel silver scales were made for the instrument. The distance between the marks was the same – 0.4 mm. Each scale has 151 lines of the

same length: on one scale the line length is 0.7, on the other – 1.0 mm. The strokes are digitized in five divisions and are not more than 6 microns thick. A thorough study of the instrument shows that it can be successfully used now to measure the distances between lunar craters and the positional angles of craters, binary stars, as well as deal with other tasks.

When measuring positional angles, the images of objects are placed in the plane of the sky so that the straight line connecting their centres turns out to be parallel to the thread of the cross, which runs parallel to the line of optical centres of the lens halves. The images are set to parallelism by turning the pipe along the positional angle using a micrometer mechanism. The optics of the instrument provides guidance along the positional angle with an accuracy of two times less than when measuring distances. To reach the accuracy when measuring the positional angles of lunar craters, it is necessary to use a mechanism that can be rotated about the collimation axis with an accuracy of at least 20 arc seconds. Before those improvements it was impossible to make accurate measurements of position angles.

The observations performed with the Kazan heliometer are widely known. Those research data were fundamental for the foundation of the astronomical school that was aimed at studying the Moon rotation. The scientific material obtained with Engelhardt Astronomical Observatory heliometer over a period of more than a century is a significant contribution to astronomical science. And if we take into account that such observations have long been discontinued everywhere because of their complexity, it becomes obvious what a fundamental importance the heliometric observations in Engelhardt Astronomical Observatory have.

The mirror telescope AZT-14 was purchased by Engelhardt Astronomical Observatory in 1966. The astrophysical research work was carried out at Engelhardt Astronomical Observatory in the 1930-ies. Dark eclipsing variables became the main topic of that research. The study of those stars was one of the main sources of information about the most important physical characteristics of celestial objects: their size, mass, density, atmosphere, etc. The photometric study of such binary systems is the fundamental research that resulted in the derivation of their physical characteristics. That research work at Engelhardt Astronomical Observatory was initiated by D. Martynov and V. Krat.

Numerous methods were used to study variable stars: visual, photographic, and the most effective, electrophotometric ones. In 1946, an electrophotometer mounted on a 12-inch refractor was installed at the observatory; it became the key instrument for variable stars observations. The power supply and registration units were later improved by K. Kostylev. The development of astronomy in the middle of the 20th century required more and more sophisticated instruments for observations. In the 1960s, Engelhardt Astronomical Observatory received the opportunity to acquire modern telescopes. The telescope AST-452 used for stellar astronomical research, and AZT-14 – for electrophotometric studies of dark eclipsing variables, were installed.

The AZT-14 mirror telescope was manufactured at the Leningrad Optical and Mechanical Plant. The optical design of the telescope is a classic version of the Cassegrain system. This system is often applied on small and medium-sized reflectors, where instead of the telescopic one, meaning the application of the eyepiece after the Cassegrain focus, some kind of receiver of the star radiation is placed. In this case it is the diaphragm of the electrophotometer.

Major characteristics of the telescope:
Light hole (lens) – 480 mm
Main mirror diameter – 530 mm
Telescope focal length – 7715 mm
Relative aperture (lumens) – 1:16
Field of view – 27 minutes of angles

A refractor guide with a lens of 130 mm in diameter is installed parallel to the main tube of the telescope. The focal length of the guide is 1954 mm. The relative aperture is 1:15.

The magnification of the image in the eyepiece of the guide is achieved due to the use of interchangeable eyepieces from 50 to 280 times. The field of view

is equipped with illumination and eyepiece micrometres. A small wide-angle tube is rigidly attached to the guide's tube – a finder with a 75 mm objective lens that allows the astronomer to orientate on the celestial sphere. Three tubes – the main tube of the telescope, the guide and the finder are coaxial. If the observed object is in the centre of the finder, then, accordingly, it will be visible both in the field of view of the guide and in the focus of the telescope where the radiation receiver is installed.

The telescope mount is parallax (or equatorial). It is typical for astronomical observations when the object of observation continuously moves with the rotation of the firmament. This rotation is eminently uniform. Therefore, the installation of the telescope must be very stable: an axis is mounted on a powerful stone pillar, rotating parallel to the polar (or clockwise) axis. In perpendicular to it, i.e. parallel to the plane of the celestial equator, the declination axis is attached, the telescope tube and (on the other side of the pillar) the counterweight are mounted on it. The ability to rotate the tube clockwise and the declination axes allow you to direct the instrument to any point in the sky where the observed object is located. The declination circle with a scale of 1 degree is located on the axis of declination near the tube. The hour circle is mounted on the polar axis of the telescope. Its value is 1 minute. Both circles are equipped with mounting screws and limb lights. The telescope is equipped with a temperature compensator, which should resist the instrument's focus against temperature fluctuations in the range from –20 to +20 degrees C.

The AZT-14 telescope is installed in a specially built two-story brick pavilion with a rotating dome. A one-storey cubic building under a pitched roof adjoins a low cylindrical tower with a hemispherical dome on the north side. Simplified architectural forms and details are used in the design of the facades borrowed from the earlier structures of the complex: the corners are accented with large stylized rustication, simple cornices without profiles, the division of the tower with flat blades, arched windows and shallow niches – square and with arched ends. The dome rotation is provided by the electric drive or, if necessary, manually. The dome has an observation hatch, which can be opened by means of a mechanical drive when rotating the handle. A one-story heated room is attached to the pavilion, where the auxiliary equipment associated with the radiation receiver is installed. The instrument is placed on a massive stone pillar that runs through the entire pavilion and is buried 2.5 metres into the ground. The total length of the foundation is 6 metres. A wooden staircase leads from the first to the second floor. Electrophotometres were improved to serve as radiation detectors. Already in the 1970s it became clear that the accuracy of photoelectric photometry is unmatched. The electrophotometer became the only photometric instrument used to observe individual celestial objects, providing less accurate, but more massive photometric determinations based on photoelectric brightness standards for the share of photography.

By the time AZT-14 was installed, the design of Engelhardt Astronomical Observatory electrophotometer had changed. A new power supply and registration units with EPG – 09 were installed. The filters were replaced with the ones recommended for the international Morgan-Johnson system. The installation and adjustment of the photometer was performed by Y. Shabalov. Regular observations at the telescope began in 1971, when high-speed FEU-79 was purchased. The main observers at AZT-14 were Y. Shabalov, R. Botsula, M. Lavrov, N. Lavrov, R. Shaimukhametov. In addition to the traditional programmes aimed at observing dark eclipsing variables, other programmes such as the covering of stars by the Moon, observations of planets and large asteroids were also carried out. One of the latest designs of the AZT-14 telescope high-speed electrophotometer operates according to the following scheme: radiation from a celestial object recorded by the PMT in photons is received by the photon counter in the form of separate signals with an interval equal to the step of the internal time scale. The time counter is linked through the radio receiver to the external time scale; it begins to generate millisecond pulses – the internal time scale is set. The signals from the star are

tied to the time scale and displayed on a computer monitor, recorded on a printed tape.

Over the last 10 years, the AZT-14 telescope was modernized. This telescope was equipped with modern receivers, universal optical correctors, modern fiber-optic cable networks, the corresponding active network equipment, productive workstations and software, server equipment and digital measuring systems. In order to solve educational and practical problems in the field of CCD photometry, a CCD photometer was equipped with a set of universal adapters – all these allows to study both the technical characteristics of the CCD receivers (chips) from different international manufacturers, and the photometric properties as a system, using various CCD-matrices, such as S1C and CSDU285 made by domestic manufacturers, Alta U9000 from Apogee instruments inc., ST-10 from SBIG inc. and others, as well as carry out the work in the field of stellar CCD photometry, in particular, the processes of light curves obtaining, reducing to the standard Johnson photometric system, processing optical data using specialized software such as Midas, Maxim DI, etc. This complex of information and technical systems is controlled from a specialized centre located in a separate room equipped with climate control systems and stabilized power supply for telescopes actuators, separate power distribution networks and ground loops for measuring, computing complexes processing, servers, as well as communication facilities, data transmission by means of GPS and GLONASS navigation systems, as well as time synchronization of the entire complex. The parametres of automated thermoregulation, ventilation, dew point control in the dome space, overpressure control, air cleaning supplied to the mirrors and receivers of the telescope are displayed on the monitor at the workstation in the appropriate graphical form and archived. Particular attention is paid to the development and implementation of the appropriate software, elaboration of USNO 2 catalogs filling, etc. The created automated system operates under real time conditions, and the catalog filling process is carried out according to the positions of stars up to magnitude 19. In general, the work that was done to modernize the park of observational instruments made it possible to start photometric observations, process observations, obtain light curves of variable stars and analyze the corresponding processes in the celestial sphere, which, in its turn, allowed Engelhardt Astronomical Observatory to take part in joint research projects, including international ones. In particular, in order to solve the problem of spatial orientation of the International Orbital Astrophysical Observatory "Spectrum-UF" complex, manufactured by S. Lavochkin scientific and production association, was solved together with specialists and developers of scientific equipment from the Institute of Astronomy of the Russian Academy of Sciences, who carried out test observations of sky regions on the AZT-14 telescope in order to develop the algorithms for the alignment and orientation of the telescope during its operation in the orbit.

In addition, the most modern telescopes acquired at different times, such as Zenith telescope, Heide astrograph, Maksutov system meniscus telescope and AFR are also located at Engelhardt Astronomical Observatory**.**

TELESCOPE ZENITH ZTL-180

The Soviet Latitude Service and the Central Bureau at the Poltava Gravimetric Observatory were founded in May 1953. The instruments at the newly created service needed updating, so the Leningrad Optical and Mechanical Plant, in cooperation with the Pulkovo astronomers and scientists of the State Astronomical Institute, developed and manufactured a large high-aperture and wide-angle telescope Zenith ZTL-180, 9 pieces. The diameter of the objective aperture of the new telescope is 180 mm, the focal length is 2360 mm, the pitch of the MICROMETER screw is 0.28 mm. One of those new telescopes was obtained by the Engelhardt Observatory in 1956. In the second half of 1957,

ZTL-180 was used for observations of a four-group program. The wide field of view of the ZTL-180 (1 degree 45 minutes), as well as the ability to obtain the highly accurate data of the propeller turnover measurements on wide scale pairs allowed it to conduct observations for a long time without changing the program. This technical quality is very important for pole secular and earth axis motion studies. From August 1957 all scheduled observations of the latitude variability in Engelhardt Astronomical Observatory were carried out only with the ZTL-180. The new telescope Zenith was equipped with cameras for taking micrometer readings and level measurements. For many years, this technique has been operating, making observations easier and more comfortable. Engelhardt Astronomical Observatory became the base station of the Soviet Latitude Service. International cooperation was also very important. For several decades (until 1988), the results of observations were regularly sent to the International Pole Motion Service (IMDP), centreed in Mitsuzawa (Japan), as well as to the International Time Bureau (BIE), centreed in Paris (France). The observational data from all participating stations were regularly published in the monthly bulletins and annual reports of these services.

HEYDE ASTROGRAPH

The first astrograph appeared at Engelhardt Astronomical Observatory (EAO) in 1914. It was manufactured by Heyde in Dresden. The astrograph lens turned out to be of poor quality, so it was replaced with another one with the same parametres of the Petzval system Astrotriplet with a diameter of D = 120 mm and a focal length of F = 530 mm (Baranov V.A. EAO // 1937, Volume 1, issue 1. – 24 p.).

Minor planets were first observed on this astrograph – A. Yakovkin carried out a large series of spectral observations of the Novaya Eagle in 1918. (D. Martynov, Astronomy at Kazan Federal University in 1920s // 1983, Historical and astronomical research – issue 16 – p. 413-435). In 1933 – 1934 N. Chudovichev received 1125 expositions of U Cepheus (N. Chudovichev, Photometric observations of U Cepheus system // Bulletin of EAO – no.17, p. 3-40). S. Nekrasov, N. Chudovichev and Sh. Khabibullin photographed Moscow sites for variable stars studies. Over 1,000 images were taken. (D. Martynov. EAO in 1901-1951 // 1951, Bulletin of EAO, no. 27 -p.5-26). In the early 1950s, the telescope optics were replaced with another optical device (D = 200 mm, F = 1200 mm). The pipe was made at the EAO workshop. In the period from 1949 to 1971, the scientists of the EAO B. Kadomsky, N. Lavrova and others continued collecting images of Moscow sites for the study of variable stars on Heide astrograph. In 1959 N. Rizvanov received a number of comet images 1959 (c): (N. Rizvanov Observations of the comet in 1959 (c) at the EAO // 1960, Astr. Circus. – no. 208 – p.7.).

Heide astrograph has a leading tube (guide) and a lens with a diameter of D = 110 mm. The guide has an eyepiece micrometer with threads to control the guiding process during observations. In addition, the telescope is equipped with a finder for rough guidance to the investigated area of the celestial sphere. The astrograph tube is mounted on a classical (German) parallax mount, which has two axes: the hour (polar) and the declination axis with circles divided into degrees and their fractions. These circles are designed to guide the tube into the observed area. A pipe with a lens is attached to one side of the declination axis, on the other side, it has screw threads, metal discs – the counterweights are screwed on it to compensate for the weight of the pipe so that the pipe on the clockwise axis equilibrates. The pipe also carries the weight that is able to move along the pipe. This achieves the equilibrium position of the pipe on the declination axis. The mount has two fasteners to fix the pipe in a required position on the declination axis and on the clockwise axis that is to fix the direction of the pipe to a given point in the celestial sphere. The clock mechanism rotates the pipe at the

speed of the Earth's rotation around its axis. It can compensate for the daily rotation of the Earth. The clock mechanism on the Heide astrograph consists of a synchronous electric motor powered by a current source with a star frequency of 50 Hz multiplied by 1.002738.

The clock mechanism does not compensate for the daily rotation of the Earth accurately enough, and also due to the influence of refraction on this process, it is necessary to correct the direction of the pipe from time to time during observations. It can be achieved with the help of special guiding devices. They can be operated manually or be automated. The size of the cassettes for photographic plates are 130×180 mm. At present, the telescope is mainly used for practical training of students at the Astronomy Department of Kazan Federal University. Since the photographic observations are no longer carried out, due to the fact that the corresponding manufacturers have ceased to produce astronomical types of photographic plates, a photo camera is attached to the cassette part of the telescope in order to take the images of some individual objects: comets, nebulae, etc. on 36 mm film. The telescope is installed in a brick pavilion with a roof consisting of two parts that can roll back to the east and west, respectively.

MENISCUS TELESCOPE

The Maksutov system photographic mirror telescope – AST-452 – was installed at Engelhardt Astronomical Observatory in 1963. The optical scheme of the telescope is a classic version of the optical meniscus system, developed by the designer of astronomical technology, Corresponding Member of the USSR Academy of Sciences D.D. Maksutov. Although he designed and proposed a large number of systems, it is meniscus telescopes that are associated with his name. Such telescopes are compact, have a closed tube and high image quality. The telescope was manufactured in Kazan at the optical-mechanical plant in Derbyshki by special order.

The telescope is attached to a meniscus, a field-straightening lens, and three objective prisms. All of them are made of uviol glass. This allows spectral and photometric observations in close ultraviolet light up to 3400 angstroms. The telescope meniscus aperture and the main mirror diametres are 350mm and 490 mm respectively.

The telescope can operate in two optical schemes.
Main focus: meniscus diameter 350mm
Focal length: 1200 mm
Mirror diameter: 490 mm
Lens Aperture: 1: 3.5
View field: 4 degrees 14 min.
Linear field size: 90 mm
Scale: 2.82 arcmin in 1 mm.

In Newtonian focus: focal length – 1200 mm
View field: 2 degrees 50 min.
Linear field size: 60 mm

The meniscus telescope is installed in a specially built two-story brick pavilion. With the help of a mechanical manual drive the roof of the pavilion moves apart in two halves to the east and west. The instrument is installed on a massive stone pillar, buried 2.5 metres into the soil and extending upward to a total height of 6 metres. On the ground floor of the pavilion, to the left, there is a heated room, where a quartz generator and automatics that control the telescope are located. To the left of the entrance there is an unheated auxiliary room for reloading photographic plates, which takes place in complete darkness.

On the first floor, where two stairwells lead, there is a meniscus telescope and a telescope control panel. The form of equatorial mounting of the telescope is a forked design, which is most popular for medium to small size reflectors. The telescope tube is located inside the fork, and when the instrument is directed into the circumpolar region, the entire lower part of the tube is covered by the fork. This greatly facilitates observation in this region of the sky. The declination circles are located on either side of the telescope tube on the fork. They have fastening handles, two on each circle, above and below for the convenience of the observer. The right ascension circle is located at

the base of the fork on the polar axis of the telescope. There are also fixing handles on both sides of the circle. A circle in right ascension covers 24 hours and circles in declination are from + 90 to -90 degrees.

A refractor guide with a focal length of 1300 mm and a relative aperture of 1:10.5 is mounted parallel to the main tube of the telescope. Inlet diameter is 140 mm. Maximum field of view is 50 min. The guide is equipped with removable eyepieces. The guide's view field has a cross of threads and an illumination, as well as an eyepiece micrometer. On the other side of the telescope tube there is an auxiliary wide-angle tube – a finder for orientation in the sky. If the desired object of observation falls into the centre of the finder, then, accordingly, it will be visible in the guide and in the focus of the telescope.

The telescope is driven by a synchronous motor powered by a polished quartz crystal oscillator to obtain a frequency that allows the telescope to rotate in sidereal time. The motors are driven from the control panel or by means of a manual key. The control panel located next to the telescope is intended for remote control, as well as for automatically setting the coordinates of the selected object of observation. It is equipped with scales for setting coordinates. The division of the remote-control scales is 1 minute.

After setting the specified coordinates, the observer, by pressing a button on the remote control, gives a command to the device, and the telescope is set to the centre of the selected area. The accuracy of the installation is such that the guiding object is in the guide's field of view. The remote control has a device for automatically opening and closing the shutter. In addition to the stationary control panel, there is also a manual control panel – a handbrake, on which there are buttons for controlling the telescope for declination and right ascension (with three speeds of movement) – for guiding, a button for opening and closing the shutter, and a backlight.

Photographing is carried out on octagonal photographic plates (9x9 mm) with cut corners. The cutter is made in the machine shop of Engelhardt Astronomical Observatory. A cassette was also attached to the telescope, making it possible to work with 35 mm perforated photographic film. The cassette holds 1.65 m of film. Working area of the cassette is 25 x 60 mm.

A cassette with a plate or a film is inserted into a special cassette chamber located inside the instrument tube. It is designed so that the cassette is in focus of the telescope. To obtain observational material in the international photometric system, various combinations of photographic plates and filters were used. The filter is placed between the cracker (telescope shutter) and the cassette knod. Accordingly, it is necessary to change the focus of the telescope using a drum with scale marks, located near the cassette device. The exact position of the focus is determined experimentally depending on temperature and filter. Processing of the obtained observational material takes place in laboratory conditions. The resolving power of the telescope is 6-7 arc seconds. The telescope's permeable power is 16 magnitudes in 40 minutes of exposure without a filter, and on fresh plates, 13 magnitudes are obtained in three minutes of exposure.

The telescope is equipped with three objective prisms with refractive angles of 35, 15, and 2 degrees and dispersions of 125 A/mm, 300 A/mm and 10,000 A/mm, respectively. In the spectra of stars of spectral Class A 0, obtained with a 35-degree prism, 13 Balmer series lines are well traced. Objective prisms are mounted on the telescope tube in front of the lens using brackets fixed on the roof of the pavilion. One or another objective prism is set for a whole cycle of observations. The observational material obtained with the meniscus telescope was used for stellar and astronomical research in the Galaxy, the structure and evolution of which still remains one of the important problems of modern astronomy. Only comprehensive studies in the entire range of wavelengths available for observation will allow studying the properties and evolution of large galactic formations and tracing the interaction of their individual components, such as stars, gas-dust clouds, and will also help to reveal the galactic structure.

The telescope was equipped with a programme of photometric and spectrophotometric studies in

selected areas of the celestial sphere. The work plan included the study of the spatial distribution of stars of various spectral and luminosity classes, as well as of interstellar absorbing matter in the directions of these regions for studying the Galaxy structure at the most remote possible distances. Along with work on the structure of the Galaxy, individual objects such as New and Supernova stars, comets, quasars were also investigated, and observation of small bodies of the solar system was carried out. Most of the photographic plates were obtained in the international photometric system. On the basis of the obtained observational material, catalogs of more than 20,000 stellar magnitudes, colour indices and spectral types have been compiled. A model of the two-arm structure of the Galaxy was proposed. Qualitative and quantitative spectral classifications of stars were developed from the plates obtained with objective prisms.

The glass library of Engelhardt Astronomical Observatory contains about 5,000 photographic plates obtained with a meniscus telescope. They cover almost the entire northern hemisphere from –20 to +87 degrees. The main observers at the telescope were L. Urasin, S. Tokhtasev, I. Dubyago, S. Fomin, L. Markova. Observations were carried out, according to the adopted program, in shifts throughout the night. The results of the work are presented in papers (more than 300), reported at astronomical conferences and international symposia. At present, the telescope is mainly used for practical training for students of the Astronomy Department of Kazan Federal University.

MINI MEGATORTORA

The optical wide-field monitoring system for the celestial sphere "Mini-MegaTORTORA" of Engelhardt Astronomical Observatory (installed in the North Caucasus, but the control centre is located in Engelhardt Astronomical Observatory), has ensured the detection and study of high-rate phenomena of previously unknown localization in outer and deep space. The main method of obtaining information is wide-angle optical monitoring of the celestial sphere with high temporal resolution. The monitoring process realizes the main task – the detection of new and the study of already known non-stationary objects of various nature and localization. For the first time, a continuously updated dynamic picture of both outer and deep space with a subsecond time resolution was obtained. To carry out continuous observations of this kind, a robotic multichannel (9 lenses) optical complex with a total field of view of about 900 square degrees and a time resolution of 0.1 seconds has been created. Such a complex accumulates information about all stationary and transient (in time and space) sources of optical radiation localized in the celestial hemisphere (20,000 sq. deg.), with brightness up to 17.5 magnitude. In addition, on the basis of the considered wide-angle monitoring system (by means of hardware-software integration and modernization of the wide-field meniscus telescope AZT-14), Engelhardt Astronomical Observatory has created a unified complex for monitoring and on-line analysis of observed events, equipped with an appropriate situational IT centre (with a display system, processing and storage of the obtained observational data).

Library

The library building is located on the eastern side of the central observation glade. It closes the perspective of the main alley. The beautiful stone building with columns was built in the early 1930s presumably by the I. Bruno project, in place of two pavilions of the passage instrument. It is a one-story, square building. The main entrance, highlighted by a two-column portico in antae, is located on the eastern facade facing the main entrance to the observatory complex. The triangular tympanum of the pedi-

ment has a semicircular window. On the right side of the northern facade there is a service entrance with a two-column portico of the Tuscan order. High arched windows are framed with profiled platbands. The lower part of the walls is decorated with horizontal rustication. The building is crowned with a profiled cornice with stylized mutulae. A low attic is laid out along the perimeter of the roof. The library's classical style develops the neoclassical theme inherent in the original design of the ensemble. The library has about 100,000 units of storage. It was based on the libraries of V. Engelhardt, A. Kowalski, D. Dubyago, M. Grachev, in which there are rare copies of books autographed by famous astronomers. The glass library of the observatory contains over 12,000 photographic plates.

Meteor Department pavilion

The Meteor Department pavilion was built in the 1950s. A one-story building, the entrance to which is located along the axis of the longitudinal eastern facade and is highlighted by a small projection, completed by a two-stage rectangular attic. Rusty blades, united at the top by a smooth frieze, divide the facade into three parts. The corners of the risalit are accentuated by rusticated pilasters. The building is illuminated by large rectangular windows without platbands. The attic is decorated with a row of square battlements and flat rectangular niches.

Necropolis

The necropolis is located in the southern part of the site, at the foot of a hill with a southern mark. The burials of Vasily Engelhardt (1828 – 1915) and Dmitry Dubyago (1849-1918) are in a tomb under the southern mark. A brick tomb with two burial chambers is hidden in the hill. A hill with a tomb and a mark-chapel above them was erected in 1904-1905. According to the will of the suburban Astronomical Observatory founders, D. Dubyago and V. Engelhardt, they were to be buried in this tomb. D. Dubyago was buried in the crypt in accordance with his will. As a result of the outbreak of World War I with Germany and the subsequent revolution, it was impossible to transport the body of V. Engelhardt, who died in Dresden in 1915 to Engelhardt Astronomical Observatory immediately. His ashes were transported from Dresden and reburied in a tomb under the southern mark in 2014. Dubyago and Engelhardt gave their names to the lunar craters.

The graves of prominent scientists, directors of Engelhardt Astronomical Observatory, are located on the southern side of the hill with the burials of V. Engelhardt and D. Dubyago.

The grave of A. Dubyago. Alexander Dmitrievich Dubyago (1903-1959) – Doctor of Physical and Mathematical Sciences, Professor of the Astronomy Department (1948-1954), Director of Engelhardt Astronomical Observatory (1954-1958). In honour of A. Dubyago, a lunar crater, a minor planet and a comet are named.

The grave of M. Grachev. Mikhail Avramievich Grachev (1866-1925) – Master of Astronomy and Geodesy, Professor of Kazan Federal University, Director of Engelhardt Astronomical Observatory (1919 – 1925).

The grave of I. Dyukov. Ivan Dyukov (1888 – 1961) – Doctor of Physical and Mathematical Sciences, Honored Worker of the TASSR and the RSFSR, Vice-Rector of Kazan State University (1941-1952), Director of Engelhardt Astronomical Observatory (1942 – 1958).

The grave of A. Nefediev. Anatoly Nefediev (1910 – 1976) – professor at Kazan State University, Director of Engelhardt Astronomical Observatory (1942 – 1958). In 2009, the International Astronomical Union named the crater on the far side of the moon after A. Nefediev.

Residential building of the director of the Observatory

It was built in 1908 by the project of F. Malinovsky. It is located symmetrically to the main building relative to the main alley, on the south side. This is a one-story wooden house, rectangular in plan, with three entrances, under a hipped roof. In the centre above the roof there is a small turret with a pitched roof and two wooden spiers. The wooden frame is sheathed on the outside with a board. The facades are decorated in the neo-Russian style, one of the brightest trends in national modernity. Window frames are decorated with multi-tiered saw-thread carvings. A wide overlaid frieze is made using the same saw-thread technique. A cantilever canopy over the main entrance with a high triangular pediment, "sun" and a wooden spire creates the image of a Russian tower. This theme is continued by two side porches with awnings on carved wooden posts. The house was inhabited by the directors and researchers of the observatory, and it currently remains residential.

Residential building for employees

It was built in 1915. Located in the park, north of the main building. A one-story log house, rectangular in plan, with a boardwalk on the north side, under a hipped roof. The walls of the log house are from the outside without cladding. The windows are decorated with joinery platbands, as well as corner paneling. The entrance, located on the east side, is decorated with a wooden porch. The house, built for the staff of the observatory continues to be residential, successively retaining its original function.

Thus, the beautiful architecture in combination with the landscape and astronomical instruments allow to carry out the astronomical research at the most modern level, contributing to the world astronomical science. The fundamental coordinate system was created, as well as the catalogues of faint stars (CFS), AGK, FKSZ, etc. were obtained. The longest observation series in Russia were obtained on the heliometer, the unique observations of the Moon with stars were carried out, and catalogues of lunar craters were compiled. The refractor was used to determine the coordinates of the solar system bodies. The astrophysical department of Engelhardt Astronomical Observatory studies the structure of the interstellar medium and the structure of the Galaxy. The catalogues of spectral values and colour indices for more than 30 000 stars have been developed. In 1932, the observatory was selected to become the centre for the study of variable stars. Activities of international importance are carried out in the Meteor Department of the Observatory.

2. ATTRIBUTES OF OUTSTANDING UNIVERSAL VALUE

This chapter focuses on Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University. A statement of this is provided below, followed by a table that reflects various components of Outstanding Universal Value Statement and their specific linkage. The property is quite extensive and includes various territories, buildings and instruments reflecting the development of scientific thought in the field of astronomy.

Brief summary

The Astronomical Observatories of Kazan Federal University possess Outstanding Universal Value for several reasons.

1. The Observatories of Kazan Federal University are a vivid representative of the general historical evolution of the phenomenon of the development of observatories, both urban and suburban, in a new environment for themselves. They contribute to the essence of science, history and culture because they are modifications in new historical, cultural and natural conditions.

2. The Observatories of Kazan Federal University are outstanding evidence of the development of the classical optical astronomical paradigm. This growth is supported by Kazan Federal University scientists, by the change of scientific codes and identities, by a gradual transition from positional astronomy to astrophysics, and by its climax in a certain period of its evolution in time and space.

3. The Observatories of Kazan Federal University are the most vivid illustration of an independent optical observatory, a category that is insufficiently represented in the World Heritage List. Most of the observatories are presented in the framework of larger nominations, only the Jodrell Bank Observatory and the Jantar Mantar are presented as independent objects. However, they represent a radio-astronomy observatory and an observatory of the pre-optical period, respectively. The observatories of the optical period on the UNESCO List include the Greenwich Royal Observatory, the Tartu Observatory, and the Pulkovo Observatory, included as part of the larger nominations. Therefore, the Observatories of Kazan Federal University will become the first observatories of the optical observation period included as independent objects.

4. The preservation of the characteristic features and attributes indicates that the observatories at Kazan Federal University are a striking example of authentic objects of the mid-19 – early 20 centuries with their genesis, historical stratification and continuity in the development of science and technology.

5. Architecture, good preservation, integrity, unique authentic tooling of the 19th -20th centuries allow us to identify the key attributes of Outstanding Universal Value and features associated with the inclusion of the site of science and technology into urban life.

6. The territory of the Astropark, the Planetarium at Engelhardt Astronomical Observatory, the ongoing classes with authentic instruments allow to popularize science among the younger generation, plunge into the great discoveries made by outstanding scientists of Kazan Federal University, and provide the continuity in the development of science in the 19th-21th centuries.

7. The Observatories of Kazan Federal University are a remarkable example of a specific cultural landscape that synthesizes landscape architecture, astronomical tools and perpetuation of historical memory and symbiosis between European, Russian and Eastern (Tatar) cultures, a symbiosis between man and nature, architecture, and culture.

8. The Astronomical Observatories of Kazan Federal University and their sites are a repository of traces of the incessant scientific, historical, cultural, architectural, spiritual evolution, which accumulates different epochs – optical, astrophysical, radio astronomy and ultramodern periods of astronomical observations. It also includes the features of Russian history and culture as manifestations of the outstanding historical and cultural continuity.

9. It includes significant intangible values related to important historical events and persons, world-class breakthrough scientific discoveries, publications, symbolic characteristics, valuable traditions and images.

Kazan City Observatory building has a unique identity, determined by an extraordinary space-planning solution, verified proportions in the golden ratio and a combination of dome-tower completions characteristic of this type of structures during the Russian classicism period in the first third of

the 19th century. All these components of the Kazan Astronomical Observatory, combined with the peculiar landscape and urban planning conditions of its location in the historical environment of a large Russian-Euro-Asian city, are of global importance from the point of view of world heritage.

The uniqueness of Engelhardt Astronomical Observatory is associated with the creation of an advanced Astropark for its time – a unique space organised to put science at the centre of the focus of every day of the life of its employees and their families, who also lived in certain periods of its history on this territory, who developed certain mental and ideological attitudes associated with this territory by spiritual ties, which contributed to the fact that during the revolutions, two world wars, lack of money and chaos of the 1990s, only devotion to astronomical science, love and loyalty to the territory of the Astropark, which has become the home of many astronomers, who saved it from looting, destruction and desolation and passed it on to new generations in the integrity and authenticity of its attributes.

Criterion (I)

The Astronomical Observatories of Kazan Federal University are an outstanding example of the outstanding scientific and technological achievement that has revolutionized the understanding of space and the universe. The Observatories as a 'collective instrument' are a masterpiece of the human creative genius of N. Lobachevsky, I. Simonov and other scientists, showcasing revolutionary advances in culture, science, engineering and technology. They are vivid evidence of the emergence and development of optical astronomy, astrophysics and space geodesy, which had an important impact on the development of the sciences related to the Earth and the universe, spiritual and material culture of the vast geocultural region of Eurasia.

The Astronomical Observatories of Kazan Federal University are the property that embodies a continuous thread of history, culture, science and technology resulting from its pioneering work in the development of astronomy, astrophysics, space geodesy in the 19th – 20th centuries to the present day.

The creation of the easternmost observatory in the world and the first university observatory in Russia in 1837 marked a new stage in the development of astronomy and laid the foundations for the creation of a new scientific school. The personality and role of its founder J. Littrow is exceptional not only in laying the foundations of its operation, but it was he who prepared and attracted to its work such outstanding scientists as I. Simonov and N. Lobachevsky, M. Kowalski, as well as the astronomers who worked after them and made new world discoveries. International scientific relations are of great importance in the 20th century for modern astronomical research, for the introduction of new methods and technologies carried out by scientists of Kazan Federal University in collaboration with the International Astronomical Union.

The outstanding value of the Kazan Astronomical Observatories is evidenced by their importance as a unique universal centre of scientific, educational and cultural life, a place of preservation of scientific traditions and innovation in engineering and technology, as an outstanding monument of science, that creates a special spirit of the territory.

Thanks to the international scientific team of astronomers working at Kazan Federal University the Observatories have been successfully functioning and contributed hugely to the development of optical astronomy, astrophysics, and geodesy. These people, who had a significant influence on world development, believed in the importance of astronomical science, its role in the study of celestial objects, space exploration and first human spaceflight.

Justification for Criterion I

The founder of the oldest department of astronomy in Russia, Joseph Littrow, the ideological inspirer of creating the observatory, initially made observations in temporary buildings of the first observatory (1814), waiting for the allocated funding. Ivan Simonov was directed by the trustee of the Kazan educational district, Mikhail Musin-Pushkin to design the permanent building of the observatory and take the lead with its construction. It re-energised developing an astronomical school in Kazan and in Europe, introducing practical knowledge and skills for the university students who had already been studying theoretical astronomy. It is interesting to know that in 1836, when the building was in a basic condition, Kazan was visited by Emperor Nicholas I. Temporary floors were laid in the observatory, and the Tsar could have enough time to admire the city and its surroundings from the upper terrace. . The result of this visit was an additional allocation of 15,000 rubles for the purchase of tools.

According to the initial plan of Simonov, on the roof of the building where a spiral staircase leads from the inner room, there was not supposed to be a large mobile tower, because Kazan Federal University did not hope to get a large refractor soon, but Nicholas I, while getting acquainted with the plan of the Kazan Federal University observatory, in his own hand wrote on the report: "A tower must be like in Derpt (nowadays Estonian Tartu)" and added a significant amount of money from the state treasury to the cost estimates The construction of this and the other two small towers were commissioned to the university mechanic Ney, a student of the famous Reichenbach, invited from Germany in 1829 by Simonov on the recommendation of Littrow. According to the report of the Kazan Federal University Construction Committee, the total amount of construction of the observatory cost 78,790 rubles 53.75 kopecks in banknotes, or 22,511 rubles 58 kopecks in silver. Simultaneously with the construction of the observatory, a 9-inch refractor was commissioned in 1835 at the Fraunhofer workshop (Munich, Germany). It was ready in August 1837 and a year later it was finally installed in the main mobile tower. Simonov went to St. Petersburg in September 1837 to receive the refractor. Having received it from Germany, Simonov drove the lens himself and sent the refractor with a special official. This refractor was then one of the few outstanding instruments and cost the treasury 36,000 rubles in banknotes, and for the 15,000 rubles allocated by Emperor Nicholas I, 4 more large instruments were purchased.

The Kazan Federal University Observatory in its construction and equipment is on a par with the best observatories in Europe. Until 1840, Simonov was its only observer, combining numerous observations with a large teaching load, because astronomy at Kazan Federal University then "was taught in a very wide range." According to Dmitry Dubyago, "in general, following the life of this remarkable person, one involuntarily marvels at the diversity of his scientific studies, which is shown both by his works on pure mathematics, astronomy, magnetism, etc., and an extraordinary zeal for making observations. He writes, for example, that he made hourly meteorological observations day and night, forcing him to wake up hourly during sleep: once – for 60 days (!), another time – for 30 days. And he did not miss a single hour (!). Similarly, without anybody's help, he observed changes in magnetic declination many times for 44 hours at a time".

In 1819, Simonov was invited as an astronomer to the famous round-the-world expedition of Faddey Bellingshausen and Mikhail Lazarev, culminating in the discovery of a new continent, Antarctica. Simonov was the first Russian astronomer to travel around the world and observe the stars of the Southern Hemisphere, which are not visible in Russia, and determine the geographical coordinates of the South Pole of the Earth. During the expedition, being the only scientist among its members, Simonov headed all scientific work: he conducted geographical, meteorological, ethnographic, and zoological observations, collected and brought

from the countries of the Southern Hemisphere rich natural-historical collections, which today are part of the unique astronomical, historical and ethnographic collections of the museums of Kazan Federal University. (ORRK KFU. 7579 ed. khr.). Tools of labour, weapons, mantles of the island peoples of the Southern Hemisphere became the first exhibits of the zoological office of Kazan Federal University in 1821.

Moreover, "while sailing in the course of determining the geographic latitudes of various locations, I. Simonov invented a new astronomical reflective instrument necessary in tropical climates", was written in the Echo Vekov journal.

Faddey Bellingshausen later wrote that, when in 1824, while organizing a new expedition on the "Smirny" sloop, he proposed the candidacy of I. Simonov: "I willingly wish... to have employees of this class of people from Kazan Federal University more preferable to others because of the feeling of respect for the dignity of the University, which was left in me by Mr. Professor Simonov with his excellent merits and diligence" (ORRK KFU. 4690/3 ed. khr. 1823 g.).

In February, 1821, (when the ships were still sailing), the Kazansky Vestnik published excerpts from his observations. In 1822, in Kazan, in a separate brochure was published Simonov's speech, which he made at the University: "A word about the success of the voyages of "Vostok "and" Mirny" sloops round the world and especially in the South Arctic Sea in 1819, 1820 and 1821" (ORRK KFU. 4532 ed.khr, 4533 ed.khr). It was soon published in Europe in German and French. Simonov, in his diary, was the first to tell Russian and foreign researchers about the geographical discoveries made by the expedition, while Bellingshausen's full report on the Antarctic expedition was published only in 1831 – 10 years after the expedition.

Simonov prepared his astronomical observations for publication, then he published them in 1823 in the Kazan Federal University Printing House under the title "Determination of the geographical position of the anchorage sites of "Vostok"and" Mirny" sloops". In the preface, he wrote that this information would be "interesting and useful in relation to astronomy and geography, bring glory to Kazan Federal University, making it a participant in the studies of European scientists..." (ORRK KFU. 4016 ed. khr.). In 1832, this essay was republished and sent to the Academy of Sciences, higher educational institutions of Russia and gymnasiums of the Kazan educational district.

Simonov's observations made during the trip to the South Pole were of great practical importance for navigators and were significant for a number of areas of scientific knowledge.

Simonov's duties on this expedition included getting a fix on the location of the newly discovered islands. One of them subsequently was named in his honour (by the way, the name was suggested by F. Bellingshausen, the head of the expedition). Discovered on August 19(31), 1820, Simonov (Tuvana-Itolo) island is an uninhabited island in the Pacific Ocean, south of the Fiji archipelago (21 ° 2'55'' S and 178° 46'23 "E), today belongs to the UK. Its length is 1.85 km, width is about 1 km. The Simonov glacier (in Norwegian - Simonovbreen) on the Antarctic island of Peter I is also named in honor of the Kazan astronomer.

Ivan Simonov began teaching at university in 1814 after conferring upon him the title of the adjunct of the physical and mathematical sciences. From 1814 to 1816 he taught practical astronomy, as well as geodesy under the general supervision of J. Littrow. After his departure, Simonov was entrusted with the teaching of practical astronomy, teaching students to work on instruments and maintaining a journal of observations At 22, after conferring the title of extraordinary professor I. Simonov also began to teach theoretical astronomy. In the absence of I. Simonov's teaching of astronomy at the university did not stop. Lectures were given by Lobachevsky, who until the end of his life retained his love of astronomy and, as a rector, contributed a lot to its development at the university.

Deeply penetrating into the very origins of space doctrine, N. Lobachevsky created a new geometry,

which later was given his name. It was a bold step into a still unexplored area: Lobachevsky's ideas contradicted spatial experience familiar to researchers. On February 7, 1826, he submitted his essay "A Concise Presentation of the Principles of Geometry with a Rigorous Proof of the Parallel Theorem" to the Physics and Mathematics Department of Kazan Federal University; on February 11, reviewers were appointed, and on February 12, he read his discourse at Department meeting. N. Lobachevsky was rightly compared with Columbus – the discoverer of new lands and with Copernicus, who transformed contemporaries' views on the Universe, depriving the Earth of its privileged immobile position in the centre of the world.

Interestingly, the scientist's new ideas in the field of mathematics were based on deep knowledge of astronomy and wide experience of observations, through which, as he noted, he proved his mathematical theories. N. Lobachevsky in his work "On the Principles of Geometry" (1829), his first published work on non-Euclidean geometry, clearly stated that the fifth postulate cannot be proved on the basis of other statements of Euclidean geometry, and that the assumption of a postulate opposite to that of Euclidean allows one to construct a geometry as meaningful and free of contradictions as Euclidean.

Lobachevsky died unrecognized, only 10-12 years before the triumph of his ideas. Soon the situation in science changed radically. The studies of Beltrami (1868), Klein (1871), Poincaré (1883), and others played an important role in the recognition of Lobachevsky's works. The appearance of the Klein model proved that N. Lobachevsky's geometry is also consistent, as well as Euclidean. The idea that there is a full-fledged alternative to Euclidean geometry made a huge impression on the scientific world and gave impetus to other innovative ideas in mathematics and physics. In particular, Lobachevsky's geometry had a decisive influence on the appearance of Riemannian geometry, Felix Klein's "Erlangen programme" and the general theory of axiomatic systems. It also turned out that the relationship between space and time, discovered by Lorentz, Poincaré, Einstein and Minkowski and described in the framework of the special theory of relativity, is directly related to the geometry of N. Lobachevsky. For instance, calculations of modern synchrophasotron rely on the formulas of Lobachevsky's geometry.

Nikolai Lobachevsky obtained a number of valuable results in other branches of mathematics. So, in algebra, he developed, independently of Dendelen, a method for the approximate solution of equations, in mathematical analysis he obtained a number of subtle theorems on trigonometric series, clarified the concept of a continuous function, gave a criterion for the convergence of series, etc. The basis of these achievements lay in his knowledge of astronomy.

In 1847, I. Simonov was approved as Rector of the University. Therefore, in 1850, Marian Kowalski (1821-1884), invited from the Pulkovo Observatory, was appointed an associate professor in the department of astronomy. Kowalski created new methods of calculating the orbits of minor planets and binary stars, remarkable in their idea. He offered the first hypothesis about the rotation of our system. But his most important work, On the Laws of the Own Motions of the Stars of the Bradley Catalogue, is devoted to solving a very difficult problem, the study of the proper motions of stars. It developed and applied a new method for determining the motion of the solar system in space. Criticising Medler's hypothesis about the existence of a dynamic centre of the Galaxy in the Pleiades cluster, M. Kowalski received its scientific proof and is now known as the Kowalski-Erie method.

M. Kowalski proved that stars form a single system without any body with a giant mass in the centre, discovered a decrease in the proper motions of stars with their approach to the middle line of the Milky Way. In addition, he offered a mathematical formulation of the problem of galactic rotation, the existence of which was finally established only in 1927, and someone thoroughly refuted the theory of the central position of the Sun in the Galaxy. In 1852-1856, the scientist developed a theory of Neptune's movement taking into account long-term perturbations from Uranus, Saturn, and Jupiter. He studied one

of the main problems of celestial mechanics which is the problem of laying out a series of perturbation function that determines the magnitude of mutual perturbations of celestial objects. M. Kowalski also developed the theory of solar and lunar eclipses and proposed a convenient method of computing beforehand the lunar occultations.

In 1872, M. Kowalski developed an original theory of refraction and proposed the best method of that time for determining the orbits of binary stars from observations, which has not lost its significance today. At Kazan Observatory, M. Kowalski observed stellar positions and compiled a catalogue of more than 4,200 stars in the AG zone from +75 to +80 (with a stellar magnitude of up to 9.5 m). He was one of the founders of the Russian Astronomical Society, a member of many Russian and international scientific societies. Craters on the Moon and Mars are named in honour of Kowalski. Moreover, M. Kowalski conducted extensive teaching work and contributed to the promotion of astronomical science among young people and the scientific community of that time.

Another bright personality who contributed to the development of astronomical science was a graduate of Kazan Federal University M. Gusev, one of the pioneers in astrophysics, who later became director of the Vilna Observatory. He was the first in Russia to apply the photographic method to the study of celestial phenomena, in particular, the surfaces of the Sun and the Moon, and organised a photographic service for observing sunspots. The first astrophysicist of Russia, Matvey Gusev also made a significant contribution to the study of the moon shape, using a mathematical method based on accurate measurement of lunar photographs. He established the elongation of the moon shape in the direction toward the Earth One of the craters of Mars is named in his honour, in which, by the way, in 2004 Mars rover Spirit landed and carried out some interesting studies.

In 1850-1854, student Ilia Ulyanov, the future father of Vladimir Lenin, took an active part in the work of the Department of Astronomy. As a student, he defended his thesis "Determination of the orbit of Klinkerfus comet", which received a very flattering review by M. Kowalski "Ulyanov comprehended the essence of astronomical observations, which, as you know, often require special considerations and techniques."

The final formation of the Kazan Astronomical School is associated with the name of Dmitry Dubyago (1849-1918), who was appointed professor of astronomy in Kazan and director of the City Observatory after the death of M. Kowalski on May 28, 1884. The period of the direction of D. Dubyago is a turning point in the work of the Kazan Astronomical Observatory. The impossibility of an isolated productive work of the Observatory without constant communication with other observatories of the world was recognized by the builder-director professor I. Simonov. He began to establish such a connection in his trips abroad, and professor M. Kowalski continued this line by participating in international zone observations. The project was completed by D. Dubyago, who compiled a catalogue of the coordinates of 4,281 stars, based on observations of Kazan astronomers conducted in 1869-1892. He also began observing the Moon covering the stars, measuring the position of the Mösting Alunar crater, studying the Moon movement and libration, continued the study of variations in the latitude of Kazan begun by M. Kowalski. D. Dubyago managed to strengthen and expand ties with other astronomical institutions of the world. Kazan Observatory was included in the planned international work. The world astronomical community saw that Kazan Federal University has an astronomical school and talented scientists.

D. Dubyago widely opened the doors of the Observatory to talented young people. Before D.I. Dubyago, the Observatory had remained a closed institution, to which only a few privileged persons had access and they did not use the tools to their fullest extent. At that time, the observatory had a refractor, a meridian circle, a transit instrument, and a heliometer. The staff comprised the director, the only practising astronomer, P. Poretsky and a supernumerary assistant, A. Kowalski. D. Dubyago

felt compelled to break that vicious circle around the Astronomical Observatory and make it accessible to all wishing to engage in observational astronomy. Therefore, Dubyago considered attracting talented youth to astronomical observations as a matter of paramount importance. A private associate professor and two assistants were introduced into the staff of the department to assist in the teaching and observing process: Alexander Krasnov, Mikhail Grachev, Yakov Kornukh-Trotsky, and Grachev. The transit instrument was put into operation, and the heliometer started observing the physical libration of the Moon. These observations were performed by Alexander Krasnov (1866-1911), the pioneer of heliometric measurements in Russia, who from 1895 to 1898 performed 112 measurements of the lunar crater Mösting A. In 1898, A. Krasnov was invited to Warsaw as a professor of astronomy, where he founded the Warsaw Astronomical Observatory. His name was given to a crater on the surface of the Moon.

There was a further unification of the young scientific forces around the observatory. Graduates of this school not only expanded the creative work of Kazan Observatory but also joined the ranks of scientists of other observatories. The increase in staff allowed expanding the observations of the site. Observations develop, and the same is going on with research; a computer bureau is being created at the observatory, a systematic publication of scientific papers is being organized. From 1893, these works began to appear under the general title "Proceedings of the Astronomical Observatory of Kazan Federal University, published by Professor D. Dubyago, director of the observatory". There were 26 issues of "Proceedings" during his time. From February 23, 1885, a clock showing the exact Kazan average time was displayed in the window of the department. For more than half a century, Kazan had synchronised their clocks upon it: as signals of the exact time did not exist then.

From 1892 to 1901, Kazan Observatory carried out pioneering observations on the variability of latitude. Processing of these observations showed that the latitude of the Kazan Astronomical Observatory varied up to 0.5 " This corresponds to the pole moving on the Earth's surface by only 16 m. The high accuracy achieved while doing this indicates the good quality of the transit instrument, the excellent skills of the observers, and the large number of observations made. In Moscow, systematic observations of the variability of latitude were started in the same year as in Kazan, and at the Pulkovo Observatory, it was done 12 years later.

In addition, D. Dubyago contributed to providing a scientific and literary base for research. He understood that effective research work could be carried out only when supported by a good library. The funding of the Observatory was limited, and it was impossible to purchase all the necessary books. At the beginning of the directorship of D. Dubyago, the library of Kazan City Astronomical Observatory was in its infancy. There were only 875 books, odd and random. The task was to create a library corresponding to the scientific tasks of the Astronomical Observatory and to make the flow of books into it continuous and systematic. Therefore, in the absence of funding D. Dubyago proposed an original and effective idea: all observatories to start the exchange of publications. Thus, on January 1, 1917, the library had already had 9,000 volumes.

Diverse scientific discoveries made due to the magnificent intellectual, scientific potential, charismatic and strong-willed personalities of N. Lobachevsky, I. Simonov, M. Kowalski, D. Dubyago and others made a huge contribution to the development of world astronomical science. The masterpiece of the human genius of Kazan astronomers was not only the City Astronomical Observatory but also the second one, built in 1901 out of town to exclude exposure to the light of the central part of the city, which began to interfere with work of the City observatory. Handing over to Kazan Federal University the unique instruments of his private observatory in Dresden in 1897 by the famous Russian astronomer Vasily Engelhardt was the impetus for creating the observatory. So, the Grubb refractor, owned by V. Engelhardt, in the 1880s was one of the best in Germany, and by the end of the 1890s, when Engelhardt decided to retire,

it was a wanted acquisition for any observatory. Many observatories of Germany and Russia claimed these instruments, but V. Engelhardt bequeathed them to Kazan Federal University. Such personal factors as friendship with D. Dubyago gave a new impetus to the development of science.

V. Engelhardt wished that his observatory, which had arisen on German soil, would return to the bosom of his motherland, Russia, and be used in the best way. Initially, he thought of transferring his observatory to one of the southern Russian universities. Initially, he thought of transferring his observatory to one of the southern Russian universities. But, in the end, his choice settled on Kazan Federal University, where his friend Dmitry Dubyago worked. D. Dubyago often complained in letters and at face-to-face meetings in Dresden to a friend about severe inconvenience when observing at an City observatory located in the courtyard of the university in the centre of Kazan. Undoubtedly, the friendship with Dmitry Dubyago played a decisive role in the fact that it was Kazan Federal University that Engelhardt decided to transfer all the equipment to his observatory. Although the climate of the Volga region was not very favourable to accurate astronomical measurements, Vasily Engelhardt believed that in the friendly hands his observatory would be reborn in the best way. Thus, Engelhardt transferred all his instruments, library and all property (subsequently) to the full disposal of Kazan Federal University. D. Dubyago understood that this was a serious argument in favour of applying for the construction of a new observatory, quite remote from the city.

On August 29, 1897, V. Engelhardt, with the help of D. Dubyago, turns to the Kazan Federal University Council with a petition to accept from him the most important instruments of his observatory as a gift: 12" Grubb equatorial, 6" equat-comet finder, 4" small comet finder, Bamberg transit instrument, Fennel universal instrument, Knoblich clock and Tide watches and many other small instruments and devices, as well as his rather significant library of up to 2,000 volumes. The gift, of course, was gratefully accepted, and already in December, astronomical instruments in twenty boxes arrived in Kazan. In the summer of 1898, the request of D. Dubyago at the higher instances for the release of funds for the construction of a new observatory and the allotment of land was granted. Vasily Engelhardt did not stop at that point. Later, by the will, after his death, he and all his property, tangible and intangible, together with capital, with few exceptions, was transferred to Kazan Federal University so that his observatory in its new place would be provided with funds for further development. Until the end of his days, Vasily Engelhardt took the most passionate part in the construction of a new observatory at Kazan Federal University. The observatory was named in honour of V. Engelhardt.

Rashid Sunyaev's name is widely known in the whole world. He is the great son of the Tatar people, a member of the Russian and Tatarstan Academy of Sciences, a member of the Academies of Sciences of Europe, America, Germany, Great Britain, Holland and dozens of international and national astronomical unions. He has been awarded more than 15 world and national prizes The Sunyaev-Zeldovich effect, the Sunyaev-Titarchuk formula, the theory of Sunyaev and Shakura and many other scientific discoveries testify to his human genius. Since his student years, R. Sunyaev cooperates with scientists of Kazan Federal University. He is an honorary professor of this university respected in Russia and the world. He is an active participant in the international project of the 1.5-meter Russian-Turkish telescope of Kazan Federal University, installed in the mountains of Turkey. This modern observatory continues the traditions of the Kazan Astronomical School. Launched on July 13, 2019, by the State Corporation Roscosmos, Russian-German X-ray Observatory "Spectrum-X-Ray-Gamma" will allow our astronomers to discover and explore new galaxy clusters, neutron stars and much more.

Another example of a masterpiece of human genius is the Maksutov telescope developed and put into operation at the suburban observatory. The tel-

escope was able to obtain a huge photographic and spectral material, which helped to study the structure of the Galaxy's arms. Along with the work on the structure of the Galaxy, such random objects as New and Supernovae stars, comets, quasars were investigated, and a Small Bodies observation service was arranged.

Criterion (II)

The Astronomical Observatories of Kazan Federal University are a unique example of a scientific and cultural space where phasing, evolution and continuity in architecture, culture, and astronomical studies are concentrated. It reveals important changes in human values in the period of the 19th-early 21st centuries, as well as changes in cultural environment, technology, art, environmental design and city structure of both the particular geocultural region and the world. They are vivid evidence of the synthesis of scientific and cultural traditions, mutual influence of human values and mutual enrichment of cultures.

Creating modern observatory complexes, tooling them up with the latest astronomical equipment and technology contributed to the expansion of scientific research of Russian, Eurasian and world astronomy.

Owing to the preserved physical evidence on the example of Kazan Federal University Observatories, we see the only fully preserved in the world authentic and integral complexes of objects demonstrating the stages transition from traditional optical astronomy of the 19th century to modern forms of conducting astronomical research. Events at all stages of this period took place within the boundaries of the Observatory complexes of Kazan Federal University, with many of their earliest features or their locations being preserved and recognizable. Each element of the Observatory in authentic architectural objects, devices, archival and library materials fully reveals important stages in the history of understanding of our place in the Universe in scientific research over the past two hundred years.

Each of the stages in the history of Kazan Observatory recorded significant changes in the development of "big science" and was characterized by a leap in the scale of projects, a parallel leap in funding and in the number of collaborating scientists and engineers. The formed architectural landscape spaces of Observatory complexes are the most obvious and striking feature of the nominated site. The landscape type and the connections between buildings and structures reveal important events in the development of science at the sites themselves, and are evidence of these significant stages in the history of mankind. The Observatory of Kazan Federal University is an outstanding technological ensemble illustrating the emergence and subsequent development of astronomy over two centuries and several generations of outstanding scientists who made world discoveries. The sites are unique in the combination of their innovative role and continuous scientific research conducted from 1814 to the present day, and physical evidence of all these stages is preserved up to this day.

The periods of creation, development and transformation of Observatories at Kazan Federal University mark significant shifts in the paradigm of astronomical research in world science. In their development they reflect changes in the scientific thought of Kazan Federal University Observatory. They reveal the spectra of advanced scientific, cultural approaches to the perception of beauty, which are expressed in peculiarities of the architectural solutions of science buildings, landscape solutions within the city boundaries and the forest countryside, in the features of the tools and furniture used in the premises.

The uniqueness of the surviving complexes of Kazan Federal University is determined, on the one

hand, by their universality for their time, and on the other hand by their exclusivity, characterized by the fact that they are the only objects in the world that preserve architectural, instrumental, functional continuity throughout the entire period of their existence and authenticity in all key elements of their manifestations.

Justification for criterion II

The place and role of Kazan Astronomical Observatories in the Volga-Ural region, in the Russian and world-historical, cultural, spiritual and scientific heritage are unique and hold a special place. As the analysis shows there were some prerequisites for the observatories constructions such as the historical and cultural development of the region and the peoples inhabiting it, the development of Kazan Federal University as one of the drivers of socio-economic, political and cultural development of society.

In the 19th – early 21st centuries, a modern geopolitical and civilizational space of exceptional importance in the history of Russia's interstate relations with the states of Europe, Asia and America formed and developed in the region. The Volga-Ural region has become a frontier at the junction of various socio-cultural platforms The communities that lived here had common and special historical and cultural characteristics and symbols that are of great importance for the peoples of the modern Russian Federation. The historical and architectural complex of the Kazan Kremlin, the Bulgarian Historical and Archaeological Complex, the Assumption Cathedral and the Monastery of the Island-Town of Sviyazhsk, which have become the world cultural heritage and are included in the UNESCO World Heritage List, have become the unique evidence of multinational and intercultural interaction and dialogue.

It is not only the important changes of human values within cultural transformation, the development of architecture, technology, environmental and urban design that Kazan Astronomical Observatories herald but also a unique identifier of the historical, cultural and scientific heritage of Russia, Tatarstan and an important prerequisite for the first-ever man in the space, the role of science and technology, their continuity in development. The Astronomical Observatories have played an important role in the promotion of astronomical science to the east, the graduates work in the largest observatories in Europe and Asia. The Astronomical Observatories of Kazan Federal University with a wide range of research in various fields of astronomy show important changes in the development of science and technology in Eastern Europe and Eurasia for over 200 years. They not only develop and improve the level of scientific and astronomical knowledge but also cooperate closely with the countries of Western Europe on issues of science, technology, culture, which also contribute to the development of society in other areas.

For the Russian Empire, the first third of the 19th century was the period of formation of Kazan Federal University. A common trend in the development of the university was the establishment of the Department of Astronomy and Astronomical Observatories. This was a manifestation of an awareness of the importance of scientific and astronomical observations in the Euro-Asian expanses of the Russian Empire at the state level. The construction of an Astronomical Observatory in Kazan – in the east of Europe – showed important changes in Russian society, contributing to the development of science and technology against unprecedented innovative development of the architectural and urban planning of Kazan. At that time they designed and built the architectural ensemble of Kazan Federal University in an unprecedentedly short time. It was an integral scientific and educational complex equipped with all necessary tools, built in the classicism style, which was innovative for Russia. It was the manifestation of the most important changes in Russian society and the awareness of universal values despite the terrible anachronism of the Russian Empire state system, the serfdom. In less than 30 years, serfdom would disappear, and the University

and the Observatory would contribute to the further progress of science and society.

Constructing the Astronomical Observatory in classicism style was a significant stage in the development of the world design and construction of astronomical observatories. The special location in the cityscape and the peculiar space-planning decision determine the uniqueness and Outstanding Universal Value of the city observatory. The dominance of its main facade, which opened onto the lower part of the city, embellished by the garden and park area on the hillside of the university ensemble, was an advanced decision in urban design. The observatory building on the top of the hill could be observed from different points of the slope base as the most important part of the university ensemble. It served as an identifier of the importance of astronomical science in the 19th century.

At the end of the 19th and beginning of the 20th century the formation of a complex of buildings of the suburban Astronomical Observatory which was not just "built-in" the surrounding landscape, but transformed it making a landscape garden, contributing to the formation of a new phenomenon within a European tradition towards the architecture of scientific complexes – the Astropark, putting Engelhardt Astronomical Observatory on a par with the advanced observatories of that time both in architecture and the advanced level of equipment. The ensemble of the Suburban Observatory includes the main building with a refractor telescope, an administrative building, pavilions for various types of telescopes, the Northern Mark, the Southern Mark with a tomb, which implies the idea of "consecrating" the astronomical heritage already laid down at the foundation of the observatory vividly illustrates the neoclassical traditions in architecture and is unique from the point of view of the cultural landscape.

The main research line at Engelhardt Astronomical Observatory is to explore the coordinate and time issues of astronomy and geodesy, to identify the exact positions of stars and to catalogue stellar positions, to observe and specify the figures and orbits of the bodies of the solar system, to identify galactic parametres, to study astronomical instrumentation and the history of astronomy. The contribution of the Astronomical Observatories of Kazan Federal University is 18 high-precision meridian and photographic catalogues of the positions of stars (including IRSC, Photographic Sky Survey, Catalogue of Weak Fundamental Stars, Photographic Catalogue, Catalogue of Weak Stars, etc.).

Since the first years, the Astronomy Department has contributed to the development of world scientific thought. The discoveries of talented scientists and astronomers are sometimes ahead of the scientific philosophy of their time. Being the only scientist in the round-the-world expedition of Bellingshausen and Lazarev, I. Simonov (1819-1821) determined the sloops' coordinates, thereby largely contributing to the discovery of a new continent – Antarctica and the South Pole, which was a great world achievement. In the middle of the 19th century, M. Kowalski first expressed the idea of our Galaxy rotation. He explained it with his observations and it was confirmed by later observations in 1927. He was also the first to determine the exact orbit of the planet Neptune, discovered a few years earlier. D. Dubyago was the first to organize the Moon observations, which are continuing to the present day. This is the only such long-term series of observations of the Moon in the world. A great contribution to the study of the Moon was made by A. Nefedyev, who was the first to create a map of the Moon marginal zone, which is important for space research. For the same purposes, Sh. Khabibullin was the first to propose an inventive method for determining the coordinates of craters on the Moon surface. He was also the first in the world to create a nonlinear theory of the Moon and planets. The works of A. Dubyago on the theory of comet motion are world-renowned. Even before the launch of the first satellite, Sh. Khabibullin developed a method of determining the location on the Moon. Yu. Nefedyev was the first in the world to offer a precision approach and landing system of spacecraft on the Moon surface. O. Belkovich first in Russia developed a model of the distribution of meteoric matter

in near-Earth space. The model is extremely important for ensuring the safety of astronauts.

World achievements in the field of astrophysics have also been made in the observatory. The work of D. Martynov about the correlation between period and spectrum in eclipsing variables (1937) initiated a new worldwide approach to the study of the components of close binary systems. N. Sakhibullin first applied a new method of stellar atmosphere analysis, which allowed to explain many physical processes in stellar atmospheres that cannot be interpreted by traditional methods. L. Mashonkina used this method to reveal the chemical evolution of our Galaxy. V. Shimansky and N.Sakhibullin developed a method for modelling the analysis of atmospheres with X-ray or ultraviolet irradiation, that was applied to the analysis of several classes of close binary star systems. Over the two latest decades, Kazan astrophysicists (I. Bikmaev and his colleagues) were invited to participate in major international space programmes "INTEGRAL", "PLANK" and "SRG". The Kazan astronomers, using the Kazan telescope with a diameter of 1.5 metres, provided optical support for unique objects in the Universe (supermassive black holes, neutron stars, distant galaxy clusters, supernovae). I. Bikmaev and his colleagues were first in Russia to discover an exoplanet – a planet orbiting a giant star.

In the field of space geodesy the scientists have first investigated the ways to build models of the gravitational fields of the Earth, the Moon and Mars relying on measurements between artificial satellites of these bodies, as well as onboard measurements of the second derivatives of the gravitational potential (R. Kashcheev).

The team under the guidance of R. Zagretdinov conducted a study of the impact of the man-made processes related to the active oil-field development on the geodynamic and seismic activity of this geocultural region.

Observing the changes in values that follow the cultural shifts in architecture and technology, environmental and urban design in the world, the City Observatory continues to perform educational functions. It houses the Department of Astronomy and Space Geodesy and KFU classrooms. In the Observatory, during the scheduled classes and under the guidance of teachers of the department, the students are taught to work with the telescopes installed in towers and with other instruments reflecting the historical stages of the astronomy evolution in the 19th – early 20th centuries. Both urban and suburban Observatories still perform their initial scientific and educational function. This helps to preserve the spirit of the place and the authenticity of the building.

The observatories of Kazan Federal University represent the value of world significance as historical and cultural monuments, advanced development centres of astronomical science in Europe, the Russian Empire, the USSR and the Russian Federation. They possessed the best world technologies of their time and helped in the implementation of innovative and informational scientific breakthroughs in the 19th and 20th centuries. The observatories of Kazan Federal University remain active at the present time and continue scientific research. The recognition of the value is confirmed by the fact that the architectural ensemble of Kazan Federal University, located in the centre of Kazan, is an site of cultural heritage of federal significance, and Kazan Federal University itself has been classified as a particularly valuable site of cultural heritage of the people of the Russian Federation since 1997. The complex of Suburban Engelhardt Astronomical Observatory is also under state protection as a cultural heritage site. Both observatories are unique monuments of science and technology. The activity of these sites with a wide range of studies in various fields of astronomy demonstrates important changes in the development of science and technology in Eastern Europe and Eurasia as a whole for more than 200 years. Achievements, research, discoveries of these observatories illustrate not only the development and improvement of the level of scientific and astronomical knowledge in Russia, but also the world astronomical science, architecture, construction technologies, culture. It manifests that the processes of development of Russian science belong to a single world scientific and cultural space. An analysis of the architecture of Western European and Russian observatories showed that in the first third of the 19th century

there was a new stage in the development of this type of buildings and architectural complexes in functional and stylistic terms. Kazan Urban Astronomical Observatory, built in the style of Russian classicism, reflected a new stage in the development of the architecture of observatories in Europe and Russia, as a type of structure with a specific purpose. Kazan Urban Astronomical Observatory played an important role in the promotion of astronomical science in the Eurasian space in the 19th century. Organisation and construction of the observatory in the structure of the ensemble of Kazan Federal University, instalment of the latest astronomical instruments of the time, N. Lobachevsky's contribution to astronomical research, as well as to the construction of the observatory building, contributed to the development of research of Russian, European and world astronomy in general.

Criterion (IV)

The Kazan Federal University Observatories are a unique example of buildings of classical and neoclassical architecture in conjunction with a technological ensemble in the form of a toolkit, as well as a landscape, aimed at astronomical research and discoveries and illustrating more than 200 years of human history. The design and construction of buildings of Kazan Astronomical Observatories in the style of classicism and neoclassicism, the Astropark and the planetarium are a significant stage in the development of European and world construction of astronomical observatories. The special location within the ensemble of Kazan Federal University, historical and cultural landscapes, and unique architectural and lay-out solutions determine the uniqueness and characteristic features of Outstanding Universal Value.

The use of unique engineering solutions in the construction of pavilions for placement of astronomical instruments, the transformation of a natural landscape into a park ensemble, simultaneously serving as an astronomical instrument and a memorial to its creators, makes the City and Engelhardt Astronomical Observatory a unique monument that combines architecture, landscape art, engineering thought, philosophy and science, the genius locus of this place.

Justification for criterion IV

Unique buildings and constructions of the 19th – early 20th centuries on the territory of both the City Observatory and the Suburban Observatory, preserved in the integrity and unity of their attributes, are an example of an outstanding architectural and technological ensemble that illustrates a significant period in the history of astronomical science development, which laid the foundation for the exploration of outer space, the discovery of new planets and galaxies. Well-arranged architectural solutions, resulting from the requirements for astronomical observatories functioning, contributed to the correct placement of volumetric tools in the buildings of observatories, while ensuring the maximum accuracy of the conducted research, functionality and scientists' consummate professionalism. The university ensemble and the Astronomical Observatory construction reflected the most important stage of innovative and fundamental transformation of the post-Medieval irregular Kazan planning pattern into regular, and mainly wooden building – into stone building in the style of classicism.

In general, the symmetrical proposal of the university complex architectural and spatial organization was the most advanced and contemporary at that time. The Astronomical Observatory placement on the high Kremlin hill shoulder to the west of the University buildings with a conscious change in the original University ensemble symmetrical pattern contributed to the elucidation of its unique ap-

pearance in the city space. The City Astronomical Observatory building has become one of the key identifiers of the university ensemble in Kazan historical building. Among Western European and Russian observatories, Kazan Observatory possesses, in one respect, typological characteristic features in common with them (the presence of special rotating towers and opening domes), and, per contra, characteristic compositional and space-planning features that identify it as a unique site.

The architecture of the City Kazan Federal University observatory is an example of a perfectly preserved original shaped authentic building of the 19th century with the main facade oriented to the south-west with halls located in it along a concave arc. From the main hall there is an exit to the terrace encircling the half of the Astronomical Observatory. The main hall was intended for the reception of visitors and storage of portable tools, the eastern hall was intended for observing the stars in the 1st vertical, and the western hall – in the meridian. Two corner rooms with stone pillars carrying small towers on the roof and transmitting the load to special foundations adjoined these halls on each side. Now these halls have become classrooms. Consequently, students feel the spirit of a two-century history of astronomical observations and discoveries made within the walls of Kazan Observatory. On the roof of the building in a large movable tower there is a 9-inch Fraunhofer refractor (1837, Munich). This refractor was among the most outstanding tools at that time. The funds allocated by Emperor Nicholas I of Russia were used to purchase 4 other important astronomical tools.

The Observatory of Kazan Federal University in its architecture, structure and equipment stood on a par with the best observatories in Europe, Asia and America as far back as the first half of the 19th century. Observatories in Europe at that time had the status of a royal, state, university or private institution.

The construction of the Suburban Observatory became a new phase in both the development of science and the architecture of scientific complexes with the creation of public Astropark – a unique and advanced for its time space organised with one goal – to put science in the focus of everyday life of its employees and their families, who also lived in the park territory during certain periods of its history. Astronomical architectural sites of Engelhardt Astronomical Observatory – buildings, its territory, a scientific site in an organic connection with the surrounding landscape and habitat, represent a single ensemble (complex), which has an Outstanding Universal Value of cultural, architectural and scientific significance for the history of the eastern European region in the 19th-21st centuries.

The nominated Astronomical Observatories also demonstrate the creation and development of a typology of original architectural forms in Russia, Eastern Europe and Eurasia in general, namely large forms (original structures of buildings and complexes for astronomical and technological purposes) and small architectural forms (astronomical pavilions, towers, foundations, tools) in astronomy. The activities of the Astronomical Observatories played a significant role in the development of navigation, mapping and the economic development of Russian regions.

The nominated sites are associated with events of Outstanding Universal Value. The creation of a celestial Fundamental Coordinate System allowed to specify astronomical constants and solve fundamental, cosmological issues of the emergence and evolution of the Universe; then again the accumulation of data on the Sun allowed a deeper understanding of the processes occurring on the Sun and other stars and helped to predict solar activity which had a direct impact on the process of evolution of civilization on Earth.

The astronomers of Kazan Observatory made scientific breakthroughs decades ahead of their time. Thus, the famous scientist, mathematician, one of the founders of non-Euclidean geometry (a masterpiece of human genius), rector of Kazan Imperial University N. Lobachevsky (1827-1845) being both fond of and professionally engaged in astronomy, in his printed report on a trip to Penza after observing the complete eclipse of the Sun (July 26, 1842) de-

veloped ideas about the possibility of the dual nature of light almost a century ahead of his era. Light is both the vibration of the ether and the movement of the smallest particles. That expedition marked the beginning of many subsequent trips of Kazan scientists to observe total solar eclipses.

Studies of the Moon shape, its liberation and the creation of a nonlinear theory of its motion (professors Sh. Khabibullin and N. Rizvanov) are the main achievements of the Kazan selenodesy group. Even before the satellite launch, a method for locating the position on the Moon was developed. Important discoveries in the Galaxy structure were made and a new Double stars method was developed to determine its structure. And the method of studying dark nebulae proposed by the Kazan professor was included in the textbooks on stellar astronomy as the Khabibullin method. A new scientific direction appeared at the Department of Astronomy and Space Geodesy – research in the field of theoretical astrophysics. In these works, the stellar atmosphere modeling method was applied for star spectra interpretation. Later, Professor N. Sakhibullin implemented a new modeling method that does not use the traditional assumption and the meeting of local thermodynamic equilibrium states in stellar atmospheres. This allowed him to explain some of the stars' spectra features that could not be interpreted with the traditional approach. In the 1990s, associate professor L. Mashonkina, using this method, managed to reveal the particularities in the chemical evolution of matter in our Galaxy.

The modeling method was extended to other astronomical objects, for example, to accretion disks (by V. Suleimanov). This method has revealed the differences between the disk's atmospheres and the star's atmospheres. It was used to simulate the X-ray spectra of quasars and determine their masses. At the Astronomical Observatory a computer programme for calculating models of atmospheres and emission spectra of very hot up to a million degrees) white dwarfs was developed by V. Suleimanov together with N. Sakhibullin and A. Ibragimov. Its application made it possible to determine the physical and atmosphere parametres of a number of super soft X-ray sources, including those discovered by the space observatory Chandra in the galaxy M81 (together with NASA scientists).

Developing and expanding, the observatories continued to make a huge contribution to the study and solution of such topical astrophysical and general scientific problems as the evolution of the Universe and the origin of chemical elements. For this, information, which could only be obtained from the stars' study, was sorely needed. Most of the Universe's visible mass is concentrated in stars, and from this point of view, stars are the main space objects. A very important and, in most cases, the only source of information about physical processes on stars is their radiation. Radiation from a star in a wide spectral range, from far ultraviolet range to infra-red range, forms in a thin surface layer called the star's atmosphere. The astronomer of Kazan Federal University N. Sakhibullin in the early 1970s was the first in the former USSR to implement a new approach to the star spectra analysis based on the rejection of the local thermodynamic equilibrium hypothesis. non-LTE task – multi-parameter and non-linear Therefore, although most spectroscopists recognize the importance of taking deviations from LTE into account when determining the physical parametres of stars, so far the non-LTE approach has been mastered only in a few astrophysical centres in the world: in Germany, France, the USA, Italy, Japan, Ukraine, and Russia – only at Kazan Federal University. Sakhibullin also was the first in the USSR to analyze the spectral lines of MgII, CII, CIII, and CIV in hot stars. For the first time, the kinetic equilibrium of the CIII ion was considered and the mechanism of the appearance of emission in the infrared lines of this ion was explained.

In the second half of the 20th century, the leading scientific school of the Russian Federation, Physics of Stellar Atmospheres (Prof. N. Sakhibullin), was established at KFU based on the experience of international cooperation with astrophysicists from the USA and the Netherlands. Under his direction, the exploration was expatiate to the absorptions of other

atoms and ions and to the stars in a wide range of parametres (with effective temperatures from 5000 K to 55000 K). The emission origin mechanism in the NIV 4057 A line for the stars of spectral class O was explored (by L. Mashonkina), the problem of Na excess of F supergiants was studied (by N. Sahibullin in cooperation with the scientists of the Crimea astrophysical observatory), the mechanism of super ionization and enforcement of the lines FeI in the spectrum of solar burst was explored (by N. Sahibullin and U. Bayazitov).

Further, the emphasis was placed on the study of the cool stars spectra with parametres close to solar. And in this field, the Kazan group has taken a leading position in the world: For the first time, methods for analyzing the kinetic equilibrium of ions SrII, NdII и EuII-III in stellar atmospheres, the mechanisms of deviations from LTE in 12 atoms and ions have been studied. Kazan astrophysicists have carried out about a third of the original non-LTE studies in the world for solar-type stars, and no less than half of such studies for metal-deficient stars. Non-LTE calculations were used to determine the abundances of lithium, magnesium, potassium and other chemical elements in cool dwarf stars. It is shown that taking into account the non-LTE effects makes it possible to increase the accuracy of the results and to confirm the previously discovered evolutionary regularities in the behavior of these elements' abundances at a higher level of reliability. These data served as observational constraints for models of the Galaxy chemical evolution. The works on determining the abundances of barium and europium and the ratios of even and odd barium isotopes abundances in stars of different populations of the Galaxy have been widely recognized by Russian and foreign scientists. Due to the high accuracy of abundance determination (at least 0.1 dex), achieved by the use of a non-LTE approach, for the first time, a different behavior of the ratios [Eu/Ba] and [Eu/Fe] with metallicity was found in the stars of the halo, thick and thin disks, which indicates a different chemical history of these types of galactic population. From these results it follows that during the epoch of the formation of the stellar population of the halo and thick disk, the r-process dominated the synthesis of heavy elements; however, the production of barium in the s-process began before the formation of the thick disk, and during the active star formation phase in the thick disk, the proportion of s-process increased from 30% to 50%; before the formation of a thin disk, there was a delay in star formation, and the jumps magnitudes in the ratios [Eu/Ba] and [Eu/Fe] serve as an observational constraint on the duration of this intermediate phase in the Galaxy evolution.. These studies were carried out in close cooperation with colleagues from the Institute of Astronomy and Astrophysics, Ludwig Maximilian University of Munich

Later, the range of objects under study was expanded: the accumulated experience in stellar atmospheres modeling and the developed techniques for the perceptive analysis of star spectra were applied to stars in binary systems, where one of the components is a highly evolved object and the interaction of the components causes complex physical processes on their surfaces or even leads to the accretion disk formation around one of the stars.

An original technique for modeling the stars' atmospheres irradiated by X-ray and ultraviolet radiation of the second component in a binary system has been implemented due to the full account of opacity sources, the inclusion of convection, and the use of a non-LTE approach when considering the spectral lines formation, it does not concede the world's best research works in this area, and in some respects even surpasses them. A technique for calculating synthetic spectra of close binary systems (CBS) has been developed. For the first time, the formation of the NaI and CaII lines in atmospheres with X-ray irradiation was considered in the absence of the LTE hypothesis. These techniques have been applied to study pre-cataclysmic variable stars in order to determine their fundamental parametres. Observational material was obtained with the 6-m telescope of the SAO RAS (stars spectra) and the Kazan 1.5-metre telescope RTT-1500 (photometric observations).

The successes of observational and theoretical astrophysics in recent decades have made it possible to come to the understanding that the most powerful source of energy in space is accretion of matter onto compact relativistic objects – white dwarfs, neutron stars, and black holes. In the process of close binary systems evolution, the stages of matter exchange are inevitable, leading to accretion, and their study is crucial for understanding the physics and evolution of close binary stars. At the Kazan Federal University, an original technique for modeling the accretion disk atmosphere around a star and calculating the outgoing radiation, based on combining the theory of disk accretion with relativistic corrections and techniques used in the theory of stellar atmospheres, was developed. Its distinctive feature is a complete and strict account of opacity sources, the effects of finite thickness, ionization and the effects of external irradiation. The technique was applied to study cataclysmic variable stars, X-ray novae and other systems with accretion disks.

Works on super soft X-ray sources have been widely recognized by Russian and foreign scientists. These are close binary systems with a white dwarf and a secondary star overfilling its Roche lobe. The accretion rate in such systems is so high (~ 10-7 solar masses per year) that thermonuclear burning of hydrogen occurs on the surface of white dwarfs in a quasi-stationary mode and without significant envelope expansion. The effective temperature of the white dwarf envelope is very high (100,000 – 1,000,000 K), and it itself is a source of high-luminosity soft X-ray radiation. The emission from such a white dwarf is calculated using a stellar atmosphere model. For the first time in Russia, the atmosphere models of such hot white dwarfs were created at KFU. Their distinctive feature is that they take into account the contribution of a large number of spectral lines to opacity. An extensive grid of such atmospheres' emission spectra was used both for the analysis of archived (ROSAT satellite) X-ray observations of super soft sources, and for the analysis of newly discovered sources of this type in the M81 galaxy by X-ray observatory Chandra. Analysis of observations using theoretically calculated spectra made it possible to determine the effective temperature of the sources, their sizes and masses. When analyzing the optical radiation of super soft sources, it was found that the observed high ratio of optical to X-ray luminosity can only be explained by the conversion of soft X-ray radiation into optical radiation upon irradiation of a geometrically thick accretion disk surrounding a white dwarf. However, detailed modeling of the accretion disk irradiated atmosphere showed that the efficiency of processing soft X-ray radiation into optical radiation is low (~ 7 – 10%) Therefore, to increase the processing efficiency, a scheme of multiple re-emission in the system of gas clouds above the accretion disk near its outer edge was proposed.

New hopes of Kazan astrophysicists lie in the 1.5-m telescope RTT150. Even the first observations carried out in 2002 showed their very good quality, and the telescope was included in the implementation of international observational programmes.

The 1.5-metre optical telescope RTT150 was manufactured by order of Kazan Federal University at AO LOMO company (St. Petersburg) in the late 1990s. A distinctive feature of modern ground-based telescopes is the necessity to install them in places with the best weather conditions and to equip them with modern scientific equipment for a detailed analysis of starlight collected by telescope mirrors. In connection with these features, the RTT150 telescope was installed on the territory of TÜBİTAK National Observatory – in a place with one of the world's best astroclimate for continental zones, and for several years work has been carried out to equip the telescope with modern light detectors and spectral equipment. The installation of a large-format charge-coupled device matrix of 2048 x 2048 elements, cooled to minus 60 degrees Celsius, made it possible to obtain images of such faint objects in the celestial sphere, the light from which came to us from the depths of the Universe for several billion years. High photometric accuracy, determined by the high qualities of the atmosphere, light detector and telescope optics, made it possible to formulate and solve problems of revealing subtle reflection effects in

close binary systems, details of matter flowing from one star to another through a fast-rotating gas disk surrounding a white dwarf or a relativistic component in system. Such photometric observations with the RTT150 telescope significantly enhanced the reliability effects of numerical calculations performed within the framework of the Scientific School's developed methodology. In 2003 the first high-resolution spectra were obtained using the RTT150 telescope Coude Echelle spectrometer created by the observatory staff members. The abovementioned spectrometer is located in a special thermostated room inside the telescope building and is intended for a detailed study of stellar atmospheres by analyzing the intensities and profiles of spectral lines. Currently, this tool is the third tool of this class in Russia (the first two are used in the 1-m telescope of the SAO RAS and the 2-m telescope of the Terskol peak Observatory in the North Caucasus). Apparently, nowadays in Russia only the Kazan group has appropriate observational facilities and theoretical developments in the field of studying stellar atmospheres in one research group as its distinctive feature.

Today, the traditional Kazan astronomy directions continue to develop: astrometry, selenodesy, celestial mechanics, and astrophysical research, which occupy an important place among the other directions. Staff members of the Department of Astronomy and Space Geodesy are also members of the International Astronomical Union and the European Astronomical Society. Due to the fact that a qualified team on modern methods of analyzing stellar atmospheres was formed in Kazan, on the initiative of the Astronomical Council of the Russian Academy of Sciences, the Laboratory and Working Group "Stellar atmospheres", which united the efforts of all specialists and various scientists of Russia, was created on this team basis at Kazan Federal University. This group, chaired by Professor N. Sakhibullin for almost 20 years, organized scientific conferences almost every year (some of them were held in Kazan). Several staff members were awarded the State Prize of the Republic of Tatarstan (N. Sakhibullin, I. Bikmaev, V. Shimansky, R. Gumerov). The Belopolsky Prize of the Russian Academy of Sciences was received by Professor N. Sakhibullin for the study of stellar atmospheres by the non-LTE method. He and Professor I. Bikmaev received awards from the International Academic Publishing Company (IAIK) for the best articles in astrophysics. Associate professor V. Shimansky received the Zavoisky Award. The staff members have repeatedly won grants from the German Astronomical Society, the Russian Foundation for Basic Research, the Leading Scientific Schools of Russia program, etc. The team of KFU astronomers was awarded the State Prize of the Republic of Tatarstan (N. Sakhibullin, I. Bikmaev, R. Gumerov, V. Shimansky, N. Rizvanov). N. Sakhibullin was elected an academician of the Academy of Sciences of the Republic of Tatarstan, and I. Bikmaev was elected a corresponding member of the Academy of Sciences of the Republic of Tatarstan.

The staff members' high qualification in the field of observational astrophysics drew the attention of the international scientific community, as a result of which the team received an invitation to participate in a number of international space experiments (INTEGRAL and PLANK). Participation in these experiments made it possible to carry out optical identification of powerful gamma-ray bursts and galaxy clusters discovered by these satellites.

In 2019, a new international satellite Spektr-RG (SRG) was launched with the purpose to create a three-dimensional map of the Universe, observations and research for which are carried out directly with the use of ultra-modern equipment in the historical building of Kazan City observatory on the19th century tables. This example, like many others, represents the link of times, historical continuity in the development of science and technology.

The observatory is an educational centre where excursions are held annually for school students, teachers, Russian and international scientific community, and tourists from all over the world.

The important role of Kazan astronomy is recognized by the world astronomical community. The Kazan City Astronomical Observatory (1837) is included in the List of the International Astronomical Union under reference number 135, and the

Engelhardt Astronomical Observatory (1901) is included in the list under reference number 136 (G. Wolfschmidt, 2020). The discoveries of the Kazan astronomers of the 19th – 20th centuries became part of world astronomy history, the results of the research of the Department of Astronomy and Space Geodesy staff members in the 21st century won various international diplomas and awards.

Integrity

The complex of Kazan Federal University Astronomical Observatories is an integral ensemble of astronomical science development in this geocultural region. Having begun its history in the 19th century as a university building for astronomical needs, with the rapid development of science at the beginning of the 20th century, the main body of research was moved out of city, far from the noisy and bright, even at night, large provincial city, a whole astronomical complex was built in accordance with the latest architecture, landscape and technology standards. Both the City observatory building and the complex of the Suburban Observatory buildings have remained unchanged. In 2013 the modern scientific, educational and entertainment complex Kazan Planetarium and public Astropark, located outside the nominated territory, within the buffer zone of Engelhardt Astronomical Observatory.

All tangible properties are within the boundaries of the site. The nominated property belongs exclusively to Kazan Federal University, and the boundaries of the site are clearly defined in the land titles. The property is generally in good condition. The buildings on the property are in good condition, and the ongoing research, educational and museum use of telescopes has ensured that the integrity and functionality of the property's most iconic elements have been preserved. Potential adverse consequences are generally easy to eliminate, since the observatory has strong protection because of the property rights, as well as titles of protection in accordance with the laws of the participating country. All material elements and attributes required to express the Applicant's Outstanding Universal Value are within its boundaries. The property belongs exclusively to Kazan Federal University. The property of the university is clearly indicated in the title deeds for the land. Buffer zones are determined by the boundaries of the historical territories of the complexes, established in the certificates of the land cadastre with the definition of the intended use. Since it was founded about 200 years ago, this facility has been used continuously. While this led to some modification and re-profiling, which is typical of the research site – it ensured that the buildings and telescopes were kept in good condition. They are maximally protected in accordance with the planning rules. Some work is required to preserve buildings and devices, "equipollent" replacement of parts, for example, replacement of rusted metal elements of devices, which is provided for by the site maintenance and restoration procedures.

The integrity of the Astronomical Observatories complex and the preservation of the attributes expressing their Outstanding Universal Value are ensured by the established property boundaries and their buffer zone. The boundaries of the City and the Suburban observatories cover a sufficient area. The buffer zone boundaries are set to cover all important viewpoints and prevent the possibility of multi-storey construction, which could disrupt the visual perception of objects. Thanks to the protective measures implemented in the 20th – early 21st centuries, the creation of a museum, Kazan Planetarium and Astropark aimed both at the presentation and promotion of Astronomy as an important scientific discipline and world discoveries made in these buildings. The state of their preservation and astronomical tools is good.

The authenticity and integrity of the observatories is ensured by republican and federal legislation. Kazan Federal University was included in the

State Register of Especially Valuable Property of the People of the Russian Federation by the Decree of the President of the Russian Federation. The complex of Astronomical Observatories has been preserved in its historical and landscape environment. The context of the City Astronomical Observatory is supported by the ensemble of Kazan Federal University, the first building of the Littrow Observatory, buildings or structures that were built in the same time period or in close succession – the Main Building, the Rector's House (nowadays it is the Lobachevsky Museum), the Scientific Library, the Anatomical Theater, and buildings that appeared later, which are genuine evidence of the time.

Buildings and structures of Engelhardt Astronomical Observatory are in a natural environment that emphasizes their role, significance and function. At the same time, City and Suburban Observatories retain their compositional place and role in the architectural and landscape concept, which is inextricably linked with the sacred meaning of the Engelhardt Observatory. On the territory and in the premises of the Observatories, current repair work and improvement were carried out, aimed at preserving the main idea of scientists, architects, expressed in architectural, urban planning and landscape forms, set of instruments and equipment incepted by its creators. The restoration of buildings and structures, and landscaping has been planned and has already started. The applied methods take into account all international requirements to ensure the maintenance of values and the preservation of monuments and equipment. The preservation of integrity is facilitated by the legal consolidation of the boundaries of the nominated territory, plots, the status of cultural heritage sites given to them, and the approval of the boundaries of the buffer zone. This border, on the basis of visual connections, includes the surrounding historical, cultural and natural landscape context.

The above measures allow covering the entire territory, attributes, elements, values, viewpoints and perspectives, large multi-storey buildings and violations of the historical visual perception of sites. The complex is a federal property, and all the attributes and characteristics expressing Outstanding Universal Value are located on the territory, they have not suffered any serious damage, have not lost their value.

Authenticity

The buildings complex of the City and Suburban Observatories are genuine sites of cultural heritage, have not suffered any serious damage, have not lost their characteristic features and attributes, which indicates that they express Outstanding Universal Value and inalienable properties of these monuments. The buildings are unique examples of classical and neoclassical architecture and their elements: high artistry, stylistic and compositional unity, architectural expression of both facades and small forms, urban planning and landscape significance, a kind of space-planning and spatial concept, well subordinated to the functional purpose of buildings and astronomical instruments – have been completely preserved. Together with the interiors, buildings and devices are a unique testimony to the architectural and technological schools of the West and the East and an example of the spread of architectural and scientific traditions in the east of Eurasia. Buildings and equipment reflect scientific and technical inquiries and discoveries, aesthetic principles and views, the continuity of generations of scientists and scientific life. The presence of monuments and attractions with historical and architectural merit and originality, as well as the highest concentration of historical, cultural and scientific and technological events here, the unity of tangible and intangible heritage, the preservation of the "genius locus" ("spirit of the place") testify to the special status of Astronomical Observatories that have the characteristics of Outstanding Universal Value.

The main buildings of Kazan Observatory and Engelhardt Astronomical Observatory have a high degree of authenticity and the preservation of the original forms and contents of the sites. The scientific community has sufficient documentary evidence of the design, creation and condition of properties in different periods of their existence. The authentic tools, with which scientists of the 19th and 20th centuries made observations and discoveries that were revolutionary for their time and still remain unique and relevant,are still used both for the education of bachelors, masters, postgraduate students and for conducting fundamental research by eminent scientists. To ensure its preservation, part of the equipment and tools of the 19th century was donated to the Lobachevsky Museum, where they are exhibited. In this museum there are guided tours, which allow to get acquainted with the unique authentic tools of a high level of preservation and study the history of Astronomy development in Kazan as well as the contribution of Kazan scientists to Russian and world astronomical science.

The building of the City Observatory has authentic bookshelves and a table of the 19th century, made to order specifically for Kazan observatory. [A systematic catalogue of books on astronomy and geodesy belonging to the Imperial Kazan Federal University, 1890-1911]. The bookshelves contain a unique library with authentic books of the 19th-20th centuries, mostly in German, as well as in Russian, French and English, some of them exist in a unique copy. In addition, on the shelves there are the observation logs of Kazan scientists, dating back to 1814. Their authenticity is evidenced from an impressive body of accompanying documentation, including numerous international research papers, a variety of archives and a huge number of archival media reports. The contribution of this site to astronomy has been widely documented in the scientific literature from its inception to the present day.

The level of preservation of the 19th-century instruments is unique, both in the City and Suburban Observatories. Their use continues for educational purposes, transmitting the spirit of succession between the distinguished astronomers of the 19th and 20th centuries and the new generation of student astronomers. The telescope pavilions are in good condition, the mechanism for opening the shutters for observation and rotation of the telescope works properly. Nevertheless, the authentic knob, with the rotation of which the shutters were opened manually, in the 20th century was replaced by a mechanism but the elements of the knob are still preserved.

Works on conservation and maintenance were carried out on the architectural monuments belonging to both observatories, in the building of Engelhardt Astronomical Observatory a museum dedicated to the history of the Kazan astronomical school was created. The attributes intrinsic to the complex of the Astronomical Observatories, including form and design, building materials and substances, use and function, location and environment, etc., are ensured by meeting the necessary requirements for conservation and maintenance. In terms of the degree of development, the buildings of the City Observatory and Engelhardt Astronomical Observatory belong to the historical urban landscape and are part of Kazan Federal University ensemble and a naturally developing landscape with a forest environment.

The authenticity of the Astronomical Observatories of Kazan Federal University is confirmed by the combination of the following attributes.

– form and design

In its preserved form, the complex of buildings of Astronomical Observatories of Kazan Federal University is an example of classical and neoclassical architectural traditions in the east of Eurasia. The appearance of buildings, details of facades and premises, astronomical instruments practically did not change. Historical and architectural monuments that are part of the ensemble of the university and the landscape-natural environment of Engelhardt Astronomical Observatory are also preserved. The Planetarium and scientific presentation complex, opened in 2013, correspond to the shape and landscape of the Engelgradt Observatory and are aimed at the sustainable development of this territory.

– material and substances

The complex of City and Suburban Observatories has been preserved in original materials: brick, metal, wood. Only these materials are used during the conservation, repair and restoration work.

– use and function

The historical purpose of the Astronomical Observatories is preserved to this day – they are used for scientific, educational and cultural purposes. Buildings and equipment are used to teach undergraduate, graduate and post-graduate students, they are integral part of scientific life. They are closely related to the emergence and development of radio astronomy, astrophysics and observatories in the North Caucasus and Turkey in the second half of the 20th and early 21st centuries, to continuation of scientific networking with scientists from Germany and other countries of Europe, America and Asia, international projects Spectrum-Roentgen-Gamma (SRG), Integral, Plank, etc.

The history of Observatories, outstanding scholars, scientific and technological discoveries of the Earth, space and the universe and world-class achievements, as well as the sites that make up the historical, cultural and landscape-natural context have been embodied in the permanent exposition of the Lobachevsky Museum, the History Museum of Kazan Federal University, Engelhardt Astronomical Observatory, Planetarium and scientific presentation complex. They represent more than 200-year history of astronomy, space and the universe studies in the east of Eurasia and its evolution in all its diversity in the Russian and world context.

The objectives of the expositions are to reveal and actualize the phenomenon of science and education, the role of Kazan Federal University in the socio-economic development of the East of Eurasia and the geocultural region, astronomy in Russia and the world, the discovery of Antarctica, the exploration of space, the Moon, and mankind reaching beyond the Earth, to form a sense of pride and represent the scientific heritage associated with the history and culture of Kazan, Tatarstan and Russia.

traditions, techniques and management systems

The building of the City Observatory, created in the first half of the 19th century, as well as the complex of the Engelhardt Suburban Observatory, established and at the end of the 19th and beginning of the 20th century, were part of Kazan Federal University from the very beginning and remain its subdivision within the Institute of Physics of Kazan Federal University to this day. Traditions of the university observatory are few in the world and testify to the continuation and development of science at the university, which allow opening new horizons of Russian and world astronomy and space.

The historical, cultural and scientific significance of the Astronomical Observatories of Kazan Federal University was recognized at all stages of its history in the period of the Russian Empire, the USSR and the Russian Federation, the International Astronomical Union. This was enshrined in legislation and contributed to the conduct of research and repair and restoration work, the creation of the Planetarium of Kazan Federal University and the development of excursion activities. They are the monuments of federal significance, and Kazan Federal University is a particularly valuable site of the peoples of the Russian Federation.

– location and environment

The building of the City Observatory is located in the centre of Kazan, 1.5 km from the historical and architectural complex of the Kazan Kremlin, inscribed on to the UNESCO World Heritage List in 2000. Together with the architectural and urban planning ensemble of Kazan Federal University, they formed a unique historical and cultural landscape with expressiveness and architectural context. The building is an architectural dominant of the lower part of the city of Kazan. Kremlevskaya Street, which connects Kazan Federal University and the Kremlin, has been pre-

served since the middle of the 16th century and together with the monuments of the 18th – early 20th century form a stable plan for the upper part of the historical centre of Kazan. Landscape and natural environment of Engelhardt Astronomical Observatory, built in a wooded area like an English landscape park, has expressiveness and, in combination with buildings, an intimate context of the intertwined architecture and nature.

– language and other forms of intangible heritage

The Astronomical Observatories of Kazan Federal University are the place where astronomical science and its traditions were born in the east of Eurasia. It is the place where promising scientific domains were determined, discoveries of the Russian and world level were made, a communal "temple" of the science of astronomy was founded. The real embodiment of sites, instruments and scientific discoveries and ideas made with their help are reflected in numerous monographs, articles, publications, popular science works, radio and television programmes, photographs and other forms that emphasize and reveal the attributes of Outstanding Universal Value. The environment of the observatories is a complex cultural and natural phenomenon endowed with unique historical, architectural and landscape-ecological advantages, including static (historical, architectural, cultural, technical and technological monuments) and dynamic manifestations of scientific and cultural life, which are closely connected. The territory and sites are reflected in literary, cinematic, autobiographical and other works.

Intangible attribute elements (scientific records, images, oral histories, etc.) are available regardless of terrain boundaries. They provide an independent international validation of attributes expressing Outstanding Universal Value. The territory allotted for the international educational student laboratory in the Engelhard Suburban Observatory, located in the buffer zone on the site belonging to Kazan Federal University, reflects the involvement of its international scientific and educational space, the importance of this place for astronomy and astrogeodesy. The land on which the laboratory is located belongs to Kazan Federal University and is included in the buffer zone of the nominated site. The Observatories of Kazan Federal University within the boundaries of the sites encompass a full set of functions and processes that convey the significance of the site.

– spirit and emotions

Astronomical Observatories of Kazan Federal University, together with the historical, cultural, architectural and landscape environment are of value for science and culture, as a place from which the development of astronomy in the east of Russia and Eurasia began. The value lies in the fact that a sacred space of friendship, commitment to science and its achievements has been created. An important memorial value, emphasizing Outstanding Universal Value of Astronomical Observatories, is the life and work of the great scientists J. Littrow and N. Lobachevsky, I. Simonova, M. Kowalski, D. Dubyago and many others, their scientific discoveries, the friendship of D. Dubyago and V. Engelhardt, embodied in buildings, equipment, material sponsorship, their ashes and burial almost a hundred years later, a sculptural composition that perpetuates historical memory. A significant number of scientists are reflected in memorial plaques on the buildings of observatories, in the historical and architectural monuments of the university ensemble, closely associated with the discoveries of scientists from Kazan Federal University, the discovery of ruthenium, Chemical, Oriental, Medical, Law and other scientific schools. All this wide range of phenomena was extremely concentrated on a small piece of land, which disposes any person to think about the role of science and culture.

Protection and management requirements

Astronomical observatories of Kazan Federal University are legally protected in accordance with the Resolution of the Council of Ministers of the RSFSR "On further improvement of the protection of cultural monuments in the RSFSR" №1327 of August 30, 1960 and the Resolution of the Cabinet of Ministers of the Republic of Tatarstan "On the inclusion of additionally identified properties in the State Protective Registers of monuments of history, urban planning and architecture of republican significance and the transfer of historical and cultural monuments to operational administration by the Principal Directorate of State Control over the Protection and Use of Monuments of History and Culture of the Republic of Tatarstan" №318 of June 4, 2001.

The City Observatory is included in the protected zone of the Kazan Federal University complex of the 18th – 19th centuries and it is part of the project of the protection zones of the Kazan Kremlin in accordance with the Order of the Ministry of Culture of the Russian Federation No. 845 dated July 28, 2020. Boundaries and the use mode of the territory of the cultural heritage site "Engelhardt Astronomical Observatory. Complex", dating back to the end of the 19th – 20th centuries approved by the Order No. 100-P issued by the Committee of the Republic of Tatarstan for the Protection of Cultural Heritage Sites, dated May 19, 2021. In accordance with the Order, the plot of land with cadastral number 16: 20: 035201: 15 used by Kazan Federal University for the placement of Engelhardt Astronomical Observatory, is classified as a cultural heritage site.

The legal and institutional framework for effective protection and management of the property is established by legal and regulatory acts of the Russian Federation and the Republic of Tatarstan. The status of monuments of federal significance under state protection and a particularly valuable property of the cultural heritage of the peoples of the Russian Federation made it possible to preserve the Astronomical Observatories of Kazan Federal University in good condition. To preserve the attributes of observatories and their historical and cultural surroundings, buffer zones have been allocated. The property is managed and operates on the basis of the interaction of the concerned parties system stated in the Management Plan with the consideration of the Strategy for the Conservation and Use of Astronomical Observatory Complexes of Kazan Federal University, intended to last until 2043.

In the property management process, the emphasis is on the preservation, scientific conservation and research of the Astronomical Observatories of Kazan Federal University, the organization of museums, the harmonious combination of nominated territories and tourist attractions, effective risk management, interaction with the local community in order to preserve all the characteristics of the property, its integrity and authenticity. To prevent potential threats to the preservation of Astronomical Observatories, any new projects within the buffer zone are carefully analyzed and evaluated for the impact on property's Outstanding Universal Value.

The regulation of urban planning and economic activities within the specified boundaries is an essential condition for the preservation of Outstanding Universal Value of a World Heritage site. Urban planning and economic activities should be carried out taking into account the fact that this territory is located in the zone of historical, cultural, visual and emotional influence of a unique historical, architectural and scientific complex.

In order to ensure the preservation and the most complete disclosure of Outstanding Universal Value of the World Heritage site, the Management Plan also assumes the Plans for the Territorial Development of Zelenodolsk district of the Republic of Tatarstan and the general plans of individual settlements.

The buffer zone of the Astronomical Observatories provides the necessary conditions for the environment protection and the surrounding landscape. Buffer zone of City Astronomical Observatory has an area of 6.80 hectares and buffer zone of Engelhardt Astronomical Observatory has an area of 436.84 hectares. They are designed considering visual connections to and from the site.

Buffer zone for nomination components

001 – Kazan City Astronomical Observatory

Textual description of the boundary of the buffer zone of the nominated site.

The boundary of the area of the buffer zone of the nominated site passes from point 1 at 202.41m to point 2 (azimuth 54°32'50.68") towards the north-east; from point 2 at 274.07m to point 3 (azimuth 111°53'07.80") towards the east; from point 3 at 76.79m to point 4 (azimuth 192°43'10.24") towards the south; from point 4 at 38.17m to point 5 (azimuth 225°06'37.79") towards the south-west; from point 5 at 31.19 m to point 6 (azimuth 230°02'19.67") in a south-west direction; from point 6 at 97.08 m to point 7 (azimuth 234°58'54.80") in a south-west direction; from point 7 at 321.31 m to point 1 (azimuth 296°11'31.85") in a north-west direction.

The buffer zone of the City Astronomical Observatory of Kazan Federal University covers the boundaries of Kazan Federal University ensemble, which is included in the State Protection Register of Monuments of Federal Significance and is a particularly valuable property of the cultural heritage of the peoples of the Russian Federation. It is in the historical part of Kazan, on the same axis and near the World Heritage Site "Historical and Architectural Ensemble of the Kazan Kremlin". The axis of the interconnection between the two sites is the oldest communication of Kazan – Kremlevskaya Street.

The Kazan Federal University ensemble occupies one of the central city quarters, the borders of which are the red lines of the streets. The south-western ensemble border runs along the red line of Professora Nuzhina (Profsoyuznaya) Street before crossing Universitetskaya Street and Astronomicheskaya Street, along the front border (turning points № 15-1-2-3); the north-western border – along the Astronomicheskaya Street before the intersection with Kremlevskaya Street and Professora Nuzhina Street, along the red line, along the front border (turning points № 3-4-5); the north-eastern border runs along Kremlevskaya Street before crossing Astronomicheskaya Street and Universitetskaya Street, along the red line, along the front border (turning points № 5-6-7-8); the south-eastern border runs along Universitetskaya Street before crossing Kremlevskaya Street and Professora Nuzhina Street, along the red line, along the front border (turning points № 15-14-13-12-11-10-9-8).

The territory of the University campus ensemble has a difficult terrain, due to its location on the top of a hill with the southwest slope. The Observatory building is located at an elevation of 77.5 m. Middle elevation of Professora Nuzhina Street is 64 m. The height difference in the opposite boundaries of the university ensemble territory along the axis of the Observatory is 13.5 m, the City Observatory is set on the edge of a hill at its highest point. This building setting results from the fact that the sky horizon was not closed by urban buildings located below the relief, and this fact ensured a high quality of sky observations for a sufficiently long period of time.

As required by the Operational Guidelines for the Implementation of the 1972 UNESCO Convention, the buffer zone should include the immediate surroundings of the nominated site, important perspectives (landscapes) and other areas or attributes that are functionally important to the property and its protection. The City Astronomical Observatory buffer zone includes the University campus complex within the quarter along the red lines of Kremlevskaya, Astronomicheskaya, Universitetskaya and Professora Nuzhina (Profsoyuznaya) streets. At the same time, the quarter building opposite the University campus, including Lobachevsky Park, is of great importance for preserving the perception of the Astronomical Observatory building. The building from the side of Astronomicheskaya and Professora Nuzhina streets is of particular importance. Historically, the location of the observatory on a high open point in the western part of the University campus made the visual perception of the Observatory building from these streets complete and most advantageous. This was facilitated by the lack of building in the University campus along the base

of the hill along Professora Nuzhina Street and on the slope on Astronomicheskaya Street. The corner square, formed at the intersection of Astronomicheskaya Street (turns into Lobachevskogo Street) and Kremlevskaya Street is of great importance. It includes areas in front of the high-rise building of the Institute of Physics, in front of the Alexander Butlerov Institute of Chemistry and N. Lobachevsky Park. From various viewpoints of this square the Observatory in the structure of the University ensemble is clearly visible

002 – Engelhardt Astronomical Observatory

The Kazan Federal University Astronomical Observatory, built in 1899-1901, is located 24 km from Kazan on the site of Krasnogorsk-Turinsky forest estate and 2 km from Lavrentievo Railway Station (renamed as Observatory Railway Station shortly after its construction). Visually, the territory of the Observatory complex is hidden behind the tall vegetation of the forest. The towers of the telescopes, the domes and the hill with the southern tomb chapel are small in height. They are the local dominants of the complex.

The principle of 'dissolution' in the natural landscape was laid down initially in the construction project by the architect F. Malinovsky. On the 1910 plan, compiled by the land surveyor E. Gornostaev, vegetation with paths and a path network was displayed in detail. The surrounding "deciduous forest with single oaks" smoothly joins the landscape "park with single oaks"; the park and the forest do not have a distinct border.

The boundaries of the territory of the cultural heritage property of regional significance, Engelhardt Astronomical Observatory, have not been defined. The boundaries of the territory of the property are proposed to be determined in accordance with the cadastral boundaries of Engelhardt Astronomical Observatory, as historically established taking the interest of new owners into account. In accordance with the Russian law, buffer zones are established for the cultural heritage properties if their cultural zones have not been defined. This measure ensures the safety of the cultural heritage properties as well as their composition and specific features (panoramas). Within the boundaries of the buffer zones, the construction of capital facilities or their reconstruction connected with a change in their parametres (height, number of floors, area), with the exception of the construction and reconstruction of linear facilities, is prohibited. The buffer zones of the ensembles and complexes must be established 200 m from the boundaries of the cultural heritage property.

However, taking into account the requirements of the Operational Guidelines for the Application of the 1972 UNESCO Convention which states that the buffer zone should include the immediate surroundings of the nominated property, important features (landscapes) and other territories or attributes that are functionally important for the property and its protection, it is proposed to expand the Observatory buffer zone to the south up to the foot of the hill and to the west to the clearing. It is proposed to extend the buffer zone to the foot of the hill in the south, from the north– up to the borders of Orekhovka village. On the eastern and western sides, the border of the buffer zone is delineated by a radius distance equal to the distance to Orekhovka village. The territory of the buffer zone includes the areas of the Aishinsky district forestry of the Forest Fund of the Russian Federation, the territory of the Student training base of the practice of the Department of Geophysics of the KFU, the landfill of the problematic radio astronomy laboratory and the scientific and educational base of the Department of Oil and Gas Geology of the KFU, the territory of Oktyabrsky village, Zelenodolsk district of the Republic of Tatarstan. The buffer zone regime implements requirements for ensuring environmental conditions for the operation of highly sensitive equipment, compliance with the astroclimate: the maximum possible purity, smoke resistant atmosphere, minimal background illumination during observation hours, minimal microseismic influence on instruments and registration equipment. It is prohibited: flights of aircraft and drones, decorative lighting of buildings and installation of street lamps without protective caps; exceeding the level of radio interference; allocation of

new land plots for temporary and permanent construction, as well as for the installation of cellular base stations; hosting mass cultural and entertainment events. It is allowed: wood harvesting; harvesting and collection of non-wood forest resources; harvesting of food forest resources and collection of medicinal plants; carrying out activities in the field of hunting; farming; construction, reconstruction, operation of linear objects that do not create radio interference; carrying out research activities, educational activities; recreational activities; cultivation of forest fruit, berry, ornamental plants, medicinal plants; cultivation of planting material of forest plants (seedlings); geological exploration and mining of minerals; construction and operation of water reservoirs and other artificial water bodies, as well as hydraulic structures; religious activities; other types defined in accordance with part 2 of Article 6 of the Forest Code of the Russian Federation.

Description of the boundary of the buffer zone of the nominated site.

The boundary of the buffer zone of the nominated site passes from point 1 at 128.18 m to point 2 (azimuth 258°21'52.62") in a south-west direction; from point 2 at 185.28 m to point 3 (azimuth 235°26'23.38") towards the south-west; from point 3 at 141.33 m to point 4 (azimuth 233°57'16.53") towards the south-west; from point 4 at 40.66 m to point 5 (azimuth 292°51'56.35") in a west direction; from point 5 at 804.09 m to point 6 (azimuth 282°06'21.34") in a westward direction; from point 6 at 73.3 m to point 7 (azimuth 327°51'14.84") in a north-western direction; from point 7 at 103.81 m to point 8 (azimuth 320°01'40.20") in a north-western direction; from point 8 at 69.57 m to point 9 (azimuth 334°30'41.36") towards the north; from point 9 at 91.0 m to point 10 (azimuth 341°43'58.75") in a northward direction; from point 10 at 98.79 m to point 11 (azimuth 348°07'57.52") towards the north; from point 11 at 108.08 m to point 12 (azimuth 351°48'12.82") in a northward direction; from point 12 at 93.62 m to point 13 (azimuth 7°06'18.55") towards the north; from point 13 at 95.89 m to point 14 (azimuth 15°41'53.87") in a northward direction; from point 14 at 157.33 m to point 15 (azimuth 26°04'00.26") towards the north; from point 15 at 137.0 m to point 16 (azimuth 31°26'57.69") towards the north; from point 16 at 178.82 m to point 17 (azimuth 46°09'12.38") towards the north; from point 17 at 198.67 m to point 18 (azimuth 53°22'33.55") towards the north-east; from point 18 at 179.55 m to point 19 (azimuth 63°17'46.24") towards the north-east; from point 19 at 138.35 m to point 20 (azimuth 63°45'10.48") in a north-eastern direction; from point 20 at 496.62 m to point 21 (azimuth 93°48'58.41") towards the east; from point 21 at 308.82 m to point 22 (azimuth 54°17'12.31") towards the north; from point 22 at 13.92 m to point 23 (azimuth 341°40'09.57") towards the north; from point 23 at 133.39 m to point 24 (azimuth 52°40'45.72") towards the north; from point 24 at 398.49 m to point 25 (azimuth 98°23'46.26") towards the east; from point 25 at 710.2 m to point 26 (azimuth 98°28'07.91") towards the east; from point 26 at 296.27 m to point 27 (azimuth 247°45'39.71") towards the south-west; from point 27 at 175.77 m to point 28 (azimuth 98°48'17,50") towards the east; from point 28 at 64.85 m to point 29 (azimuth 98°48'21,10") towards the east; from point 29 at 25.4 m to point 30 (azimuth 176°48'34.68") towards the south; from point 30 at 107.05 m to point 31 (azimuth 120°43'27.49") towards the south; from point 31 at 136.37 m to point 32 (azimuth 129°59'03.78") towards the south; from point 32 at 109.05 m to point 33 (azimuth 136°32'44.83") towards the south; from point 33 at 130.66 m to point 34 (azimuth 143°08'28.70") towards the south; from point 34 at 157.18 m to point 35 (azimuth 156°13'40.14") towards the south; from point 35 at 95,79 m to point 36 (azimuth 166°10'47,32") towards the south; from point 36 at 179,18 m to point 37 (azimuth 180°25'28,46") towards the south; from point 37 at 121,1 m to point 38 (azimuth 193°47'50,19") towards the south; from point 38 at 113,06 m to point 39 (azimuth 202°35'43",38) in the direction of the south; from point 39 at 216,52 m to point 40 (azimuth 216°46'57,58") in the di-

rection of the south; from point 40 at 247,86 m to point 41 (azimuth 267°39'53,38") in the direction of the west; from point 41 at 422.44 m to point 42 (azimuth 215°52'29.20") in a south-western direction; from point 42 at 60.59 m to point 43 (azimuth 108°50'21".93) in a south-eastern direction; from point 43 at 249.84 m to point 44 (azimuth 250°36'49.03") towards the south-west; from point 44 at 216.5 m to point 45 (azimuth 256°01'28.93") towards the south-west; from point 45 at153.88 m to point 46 (azimuth 6°02'05".09) towards the north; from point 46 at 46.81 m to point 47 (azimuth 254°46'01.29") towards the south-west; from point 47 at 42.83 m to point 48 (azimuth 2°50'00.70") towards the north; from point 48 at 105,72 m to point 49 (azimuth 249°25'00,14") in a south-western direction; from point 49 at 86,06 m to point 50 (azimuth 267°13'59,97") in a western direction; from point 50 at 114.1 m to point 51 (azimuth 3°12'47",86) in the direction of the north; from point 51 at 17.04 m to point 52 (azimuth 39°19'55.13") towards the north; from point 52 at 23.0 m to point 53 (azimuth 345°43'48.16") in the direction of the north; from point 53 at 168.28 m to point 54 (azimuth 5°37'31.09") towards the north; from point 54 at 25.57 m to point 55 (azimuth 277°09'20.62") towards the west; from point 55 at 230.77 m to point 56 (azimuth 5°45'11".84) towards the north; from point 56 at 35.29 m to point 57 (azimuth 84°17'09.27") towards the east; from point 57 at 16,49 m to point 58 (azimuth 79°58'10.16") towards the east; from point 58 at 16.19 m to point 59 (azimuth 337°30'35.05") towards the north; from point 59 at 19.06 m to point 60 (azimuth 270°03'28.89") towards the west; from point 60 at 19,22 m to point 61 (azimuth 343°36'23,82") towards the north; from point 61 at 76,33 m to point 62 (azimuth 267°05'57,56") towards the west; from point 62 at 115,52 m to point 63 (azimuth 261°19'57,21") towards the west; from point 63 at 36.81 m to point 64 (azimuth 277°30'40.61") towards the west; from point 64 at 123.11 m to point 65 (azimuth 213°15'25.32") towards the south; from point 65 at 137.22 m to point 1 (azimuth 287°31'48.61") towards the north-west.

The developed philosophy of the Management Plan of the nominated UNESCO World Heritage Site proceeds from the need to maximize the preservation of Outstanding Universal Value of the site. Kazan City Observatory and the Engelhardt Suburban Observatory played an important part in the development of optical astronomy in Eastern Europe in the 19th-early 20th centuries.

The strategy of the Management Plan involves the identification and preservation of cultural heritage in all areas of the proposed World Heritage site and its buffer zone, ensuring the competent organization of the territory, based on its cultural, landscape and functional features.

The philosophy of the Management Plan assumes that the preservation and presentation of the nominated World Heritage site will become a factor for the sustainable development of this territory and providing dynamic socio-economic functions. In terms of management, the Astronomical Observatories of Kazan Federal University are considered as a modern scientific, educational, museum and spiritual complex. At the same time, the local community continues to function, taking into account certain encumbrances associated with the surrounding nature (for a suburban observatory), for which the maintenance of new functions will become the basis for employment and providing a decent level and quality of life.

The creation of a museum system will also reduce the threat of anthropogenic pressure on monuments, distribute visitors evenly on the territory and avoid excessive loads on key properties. This creates the prerequisites for a more effective organization of tourist services, stimulating the development of tourist infrastructure, quantitative and qualitative tourist services.

In accordance with the philosophy of the Management Plan, the main strategic goals are 1. preservation of Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University; 2. providing opportunity for sustainable development; 3. promotion of the site and involving local population in achieving public consensus on the conservation and usage of the property nominated for the World Heritage List. The following tasks are also defined: 1. management and protection; 2. restoration; 3. research 4. involvement of the local community;

5. promotion of the property; 6) sustainable development of the infrastructure.

The Astronomical Observatories of Kazan Federal University have their own governing body (administration of the facility), namely the Department of Astrophysics and Space Geodesy of the Institute of Physics of Kazan Federal University, which has a full range of scientific specialists in various fields of astronomy, astrophysics and space geodesy. The administration is divided into four main departments: Department of Astronomy and Space Geodesy, Engelhardt Astronomical Observatory, North Caucasian Astronomical Station KFU (AS KFU) and Telescope AZT-22 (RTT-150). The administration of the site reports to the administration of Kazan Federal University and the Ministry of Science and Higher Education of the Russian Federation. The funding available for this site is sufficient and used for research and adequate protection and conservation.

Outstanding Universal Value	Attributes	S (Site) BZ (Buffer zone)
«represents an exemplar of human creative genius»	The use of the unique instruments as well as the process of creating the celestial Fundamental Coordinate System and the study of the Sun together with many other studies took place in the buildings of Kazan City Observatory and Engelhardt Astronomical Observatory.	S
«demonstrates important changes in human values with the development of technology»	Unique authentic instruments of the 19th century. (Merz refractor made by Fraunhofer (D = 9-inches, F = 4 meters) (1838); Repsold heliometer; George Dollond tube; Vienna meridian circle; equatorial; a large transit instrument; a precise time clock (in operation since February 23, 1885). Instruments of the 19th century. Engelhardt Astronomical Observatory	S
«a typical example of a typical building, architectural or technological ensemble or landscape that illustrates a significant period in human history»	The building of the Astronomical Observatory on the Vienna meridian circle (1837); Monuments of Engelhardt Astronomical Observatory: 1. Main Administrative Building of the EAO; 2. The main building of the EAO; 3. The EAO library building; 4. Heliometer pavilion; 5. Southern Mark– tomb; 6. Northern Mark;	S
«directly related to events (results) of Outstanding Universal Value»	Such outstanding scientists as Joseph Johann Littrow (1781-1840), Ivan Simonov (1794-1855), Nikolai Lobachevsky (1792-1856), Mikhail Lyapunov (1820-1868), Marian Kowalski (1821-1884), Dmitry Dubyago (1849-1918) and many others worked in the buildings of Kazan City Observatory and Engelhardt Astronomical Observatory and used the unique instruments	S

3. PRESERVATION LEVEL

The Astronomical Observatories of Kazan Federal University are distinguished by a high level of preservation. The unique heritage property and its multifaceted assets are under state protection. Conservation measures are carried out in accordance with international standards and with respect for monuments.

A comparative analysis of the architecture of the observatory buildings in Kazan and other Russian and European cities showed that in the first third of the 19th century there was a new stage in the development of this type of buildings in functional and stylistic aspects. The building designs provided the exact orientation of the facility in relation to the cardinal points for the correct installation of astronomical telescopes and other instruments. Observatories, as a rule, were separate buildings as part of a complex. More rarely, they were built as an extension to a building (which was an educational facility, palace, mansion, etc.). Large observatories had a complex spatial planning solution. To accommodate large instruments, separate round or six to eight-sided buildings were built, covered with a hemispherical dome with sliding and rotating parts. In university observatories in the first third of the 19th century, domed towers were installed on the roofs. Moreover, although they were small, among them we can find observatories with a peculiar space-planning solution, which makes them unique objects. The distinct example is the Observatory of Kazan Federal University with a high degree of authenticity, since it has not undergone reconstruction and restoration after military destruction or other changes. At the same time, most of the buildings of European and Russian observatories during their history have undergone several reconstructions with the expansion or extension of premises and additional storeys. In the first half of the 19th century, most of the observatories in Europe and Russia were built in the style of classicism. In the second half of the 19th century, the architecture of the observatories had all of the characteristics of classical eclecticism, which was superseded by neoclassicism, neo-renaissance with the motives of rationalist modernism at the beginning of the 20th century. In comparison to observatory buildings in Western Europe and Russia, Kazan Observatory has, on the one hand, common features (as rotating towers and sliding domes), and, on the other hand, peculiar compositional and space-planning features intrinsic to a unique site.

The Suburban Engelhardt Observatory, among the neoclassical complexes, occupies a special place as an example of a unique cultural landscape, the first example of an observatory park, as an independent genre dating back to the ideas of the Enlightenment, embodied in the architectural forms of an English landscape park with classical buildings.

Topics of research in the 19th century were positional astronomy with meridian circles for compiling star catalogues, celestial mechanics and timekeeping, especially for navigation, and surveying. In 1803, Johann Georg Repsold (1770-1830) invented the first modern meridian circle (in Göttingen Observatory since 1818). Repsold's workshop, founded in Hamburg in 1799, developed as "Adolf & Georg Repsold" (1830 to 1867) and as "A. Repsold & Sons" (1867 to 1919) and delivered astronomical instruments to observatories all over the world. In Engelhardt Astronomical Observatory (1901) in Kazan there is a meridian circle, made by Repsold in 1845. This circle was commissioned for Kazan Astronomical Observatory to replace the Vienna meridian circle, which was severely damaged during a terrible fire on August 24, 1842 in Kazan and could not be restored. Mikhail Lyapunov brought Repsold's meridian circle to Kazan Observatory in 1847. In 1895, an impersonal micrometer with a micrometer in inclination was purchased.

In 1900, all the instruments were sent to Repsold for remake, except for the circles, because they were of excellent quality. To modernize the circle, Repsold produced new axes refinement, drilled a

cube, improved precision in inclination, and produced a new level for the horizontal axis. In addition, 4 new microscopes – micrometres – were made to avoid rearrangement of the microscopes when repositioning the tool and a new microscope with support was installed. In the workshops counterbalance circuits were installed, three wire works were attached to the lens to reduce the brightness of stars, and the equipment was adapted to electric lighting.

After the remake, the meridian circle was brought to the Engelhardt Observatory in 1902 and finally installed in 1903 in the pavilion made of corrugated zinc-coated iron. The double walls of the hall have an air layer of 0.4 metres. Special fans were installed for air circulation. The roof of the pavilion is sliding. Observation hatches of 1.2 metres are located on the south and north sides of the hall. The height of the room is 6 metres. The foundation for the supporting pillars of the instrument is a concrete slab, located at a depth of 3 metres under the soil. A brick parallelepipedon 2.5 metres high was erected on top of it. Inside it, there are the poles, which rise above the floor of the hall by 2 metres and are isolated from the rest of the foundation and the floor with glycerine. The distance between them is 1.1 metres. The tool itself is kept in a wooden sliding container in order to protect against the heat. On a separate pole, isolated from the foundation and the floor with glycerin, there is a mercury horizon.

The diameter of the meridian circle lens is 135 mm and the focal length is 195 cm. There are four eyepieces with magnification of 120x, 150x, 190x and 250x. Symmetrically on both sides of the tube, there are 2 circles – the main 2-minute circle and the additional 10-minute circle. The scale is applied on the silver strip. The precision of the scale is of high quality. On both sides of the pipe, there are wooden handles in the form of circles for device control. Fixing screws are located in the ocular part of the telescope. There is a special chair on rails moving upwards, where an observer can take a comfortable position for observation.

Around the meridian circle there are two marks, each of them is 130 metres away from the centre of the mercury horizon. Due to the declension of the landscape, the southern mark had to be raised to a height of 5.5 metres by filling a burial mound. Pavilion of the southern mark built in the Pseudo-Byzantine style is also a chapel that houses a tomb. The northern mark is located on the other side of the meridian hall near the lake of the premises. The marks themselves are iron planks with a square side of 35 cm. The planks have copper plates screwed on them that measure 12 x 22 cm and are 0.5 cm thick. The hole in the plank is 1.5 mm, lit by an electric light bulb. It gives the mark artificial star of 2 seconds in diameter, which is easy to observe at a distance of 147.6 metres from the instrument. Both marks are precisely located at the colatitude of 90 degrees from the instrument and the line of the marks deviates from the meridian by about 0.2 seconds. In order to observe the marks in the ocular part of the tube there is an additional movable lens.

To study the horizontal bending of the meridian circle pipe, small horizontal collimators with 11 cm lenses and 165 cm focal length were installed in front of the hatches at a distance of 1.5 metres from the pavilion on special poles.

In 1920, the meridian circle was removed, and the wooden lining of the poles was replaced by cement lining. In 1923, the meridian circle was thoroughly cleaned and installed. In 1924, the mercury horizon was adjusted, and the telescope lighting was put in order.

The coordinates of stars on the celestial sphere were located on the meridian circle of Engelhardt Astronomical Observatory. Precise measurements of the positions of stars in the sky are the basis and foundation of astronomy. Catalogues, published as a result of these observations, are necessary in determining the exact time, geographical coordinates on the Earth's surface, in the preparation of geographical maps in navigation, topography and geodesy, the study of the rotation of the Earth, the structure of the Galaxy, etc.

Mikhail Grachev started systematic observations on the meridian circle at the Engelhardt Observatory in 1903 with the aim of studying the instrument. In 1909, he began observations of a large number of stars between 5.5 and 6.5 of magnitude. Within 10 years he made about 10,000 observations. Later, Ivan Dyukov joined the observations and started working on the international program. Then Engelhardt Astronomical Observatory participated in all collective observation works, such as the compilation of the "Catalogue of geodesic stars", included in the programmes to determine the geographical coordinates of triangulation points. It was the first major collective work of the USSR astronomers. I. Dyukov and L. Agafonova carried out observations and their processing before all other participants of this collective work. The results of this work were published in 1943 in the journals of Kazan Federal University Astronomical Observatory.

Engelhardt Astronomical Observatory took an active part in the international work on compilation of the Fundamental Catalogue of Weak Stars (FCWC). Three stages of work were carried out: differential and absolute determination of declination of the FCWC and observation of declination of the general catalog. Later on, both the differential and absolute catalogues of Engelhardt Astronomical Observatory were used in the preparation of the "Preliminary Fundamental Catalogue of Weak Stars". A. Nefedyeva became the main observer on the meridian circle. She carried out a significant research of the anomalous refraction due to the inclination of air layers in the Engelhardt Observatory. She used the observations on the meridian circle. The coordinates of large planets were also measured with this instrument and the declensions of Mercury, Venus, Mars, Jupiter and Saturn were determined. All the results have been published.

During these extensive observation programmes, the meridian circle was brought up to date. Instead of visual microscopes for measuring the limb, cameras of the original design, which work smoothly at all air temperatures, were installed. This modernization increased the efficiency of the observer by several times and made the observation process much easier. A semi-automatic electronic computer was designed to measure limb dashes. About 100,000 measurements of the declensions of stars and planets were made on the meridian circle. Conducted research of the instrument showed that the errors for 120 years of work did not change significantly, except for the tube bending, changing slightly after the telescope maintenance check-up.

The Repsold meridian circle in the Engelhardt Observatory is fully authentic, still a fully functional instrument and of great historical and cultural value. This instrument is a great example of the way people can trace the history of evolution of an authentic instrument – a masterpiece of human genius of Repsold, as well as the evolution of optical astronomy for two centuries.

In addition to the meridian circle, Engelhardt Astronomical Observatory also has other instruments that are unique in their historical value: an azimuth mark, a remarkable heliometer (Repsold, 1874), a 68-mm-transit instrument (Carl Bamberg, Berlin), a universal instrument (Fennel of Vienna), chronometres (Knoblich, Hamburg), astronomical pendulum clocks (Tiede, Berlin), and a chronograph (Fuess, Berlin). The Grubb refractor, owned by Engelhardt in the 1880s, was one of the best in Germany. By the end of 90-s, when Engelhardt decided to retire, it was a desirable instrument for any observatory of the world. Many observatories in Germany and Russia claimed these instruments, but Engelhardt bequeathed them to Kazan Federal University.

We can also find Repsold's meridian circles in the observatories in La Plata (Argentina), Rio de Janeiro (Brazil), Naval Observatory in Washington, D.C. (the USA), as well as in Lisbon (Portugal), Brussels (Belgium), Strasbourg (France), Konkoly (Hungary) or Pulkovo (Russia). In Hamburg Observatory there is a 19 cm meridian circle (f = 2.3 m), made by A. Repsold & Sons (Hamburg, 1909).

The 19th century unique authentic tools at Kazan Federal University observatories, perfectly preserved and still used both in education and observations, which have been tested for centuries and have already proven their effectiveness and relevance today, can be compared in their parametres, importance, contribution to science, authenticity, integrity and state of conservation with the instruments of astronomical observatories in Hamburg, Konkoly and La Plata.

During the preparation for the 200th anniversary of the Kazan Federal University in 2004, a number of tasks were identified. The Institute of Giproniiaviaprom developed design and estimate documents and carried out a significant amount of repair and restoration work on the buildings of the Astronomical Observatories and objects that support Outstanding Universal Value. The work was financed from the federal budget and the budget of Tatarstan. In 2010 and 2021, repair and conservation work were carried out with whitewashing of the outer walls, restoration of the interiors, landscaping of the garden on the hillside south of the Observatory terrace.

As for the instrumentation, after the fire of 1842, three large instruments (refractor, equatorial and large passage instrument) were sent to Pulkovo for repair. The Vienna meridian circle could not be restored and it was decided to order a new one from the German master Repsold. Other tools were transferred to mechanic Ney, and the construction committee of Kazan Federal University took over the repair of the building. The tools were fixed in two years. In 1847 the observatory began to function again. In 1905 the heliometer was sent to the Repsold Company in Hamburg for preventive maintenance. After the instrument was returned to Kazan in 1908, it was installed in the suburban Engelhardt Observatory. In 1950 at the Department of Astronomy the refractor tower was overhauled. The top wooden part was made anew. The refractor was disassembled and reassembled during the repair.

The complex of buildings of Engelhardt Astronomical Observatory was constructed later, in the late 19th – early 20th centuries. The chronicle of threats and changes in their history in more detail: in October 1918, battles of the Russian Civil War took place near the Engelhardt Observatory, but no damage was inflicted to the buildings and instruments of the observatory. Commander of the Volga left-bank troops of the Red Army Alekseev issued a safe conduct to the Observatory and set up an armed checkpoint. On April 13, 1934 the People's Commissar of Education of the RSFSR A. Bubnov signed an order for the overhaul of Engelhardt Astronomical Observatory. On March 17, 1935, the Presidium of the Central Executive Committee of the Tatar Autonomous Soviet Socialist Republic made a decision to build (complete) a seismic basement at the Observatory. On January 30, 1942, a fire broke out in the engine room of the Astronomical Observatory and destroyed the room itself and the equipment located there. In 1958, an 8-apartment building was commissioned at Engelhardt Astronomical Observatory. In 2009, before the International Conference "Astronomy and the World Heritage: Through Time and Continents" (Kazan, August 19-24, 2009), a large-scale renovation of the Engelhardt Observatory was carried out: the largest operating visual telescope – refractor was revived, modern security and communication systems were laid, the territory was landscaped, a sundial was built to facilitate guided tourism, the observatory was equipped with a solar telescope with a blocking filter BF 0.5 – 0.8 A., the museum exhibition was staged. In 2013, a modern educational and entertainment complex of the Planetarium of Kazan Federal University and an Astropark, located outside the nominated territory, in the buffer zone of the facility, were opened for visitors. The visual perception of the site has not changed.

4. MANAGEMENT

Successful property management requires knowledge of the management context, which includes political, economic and social aspects. When developing an effective management system, it is important to consider various aspects. In the end, they will draw up a structure into which the management plan is embedded.

Political and governance aspects

The Astronomical Observatories of Kazan Federal University are located in the Republic of Tatarstan, which is a federal educational institution of the Russian Federation.

The site is regulated by two legal systems, namely the Russian system, as well as the legislation of Tatarstan. As a consequence, the site itself and its buffer zone are protected at two different levels. Several residential buildings within the boundaries of Engelhardt Astronomical Observatory are private property.

The regional coordinating body is the Committee of the Republic of Tatarstan for the Protection of Cultural Heritage Sites, the Ministry of Education and Science of the Republic of Tatarstan and the expert group of the Republican Foundation for the Revival of Historical and Cultural Monuments. At the federal level, the key bodies responsible for the preservation of the historical and cultural heritage are the Commission for UNESCO of the Ministry of Foreign Affairs of the Russian Federation, the Ministry of Culture of the Russian Federation, and the Ministry of Science and Higher Education of the Russian Federation.

The Astronomical Observatories of Kazan Federal University have their own governing body (administration of the facility), namely the Department of Astrophysics and Space Geodesy of the Institute of Physics of Kazan Federal University, which has a full range of scientific specialists in various fields of astronomy, astrophysics and space geodesy. The administration is divided into four main departments: the Department of Astronomy and Space Geodesy, Engelhardt Astronomical Observatory, North Caucasian Astronomical Station KFU (AS KFU) and Telescope AZT-22 (RTT-150). The administration of the site reports to the administration of Kazan Federal University and the Ministry of Science and Higher Education of the Russian Federation. The funding available for this site is sufficient and used for research and adequate protection and conservation.

Social and economic aspects

The Republic of Tatarstan has a well-developed economy, which is based mainly on the availability of rich natural resources, industrial and agricultural production. The Astronomical Observatories of Kazan Federal University are located in the northwestern part of Tatarstan along the Volga River, in the historical centre and in the outskirts of Kazan, in Zelenodolsk municipal district.

Kazan is the capital of the Republic of Tatarstan and one of the most ancient cities in Russia. Kazan is located on the left bank of the Volga River in the place where the Kazanka River flows into it. Ancient Kazan, which celebrated its millennium in 2005, is often called the third capital of Russia. This city, one of the ten largest in the country, has earned the reputation of the fastest growing tourist destination, which is visited by more than

3.5 million tourists annually. Kazan is a big city, the territory is conditionally divided into two parts: historical and modern. The old quarters are located in the central, Vakhitovsky district. It is here that the pride of the Republic of Tatarstan is located – the Kazan Kremlin, which is included in the UNESCO World Heritage List, as well as the Old Tatar Sloboda, the favorite pedestrian streets – Bauman street and Kremlevskaya Street, old mosques and Orthodox churches, as well as theaters and museums.

Kazan is a youth city, a scientific and educational centre. In 2013, Kazan hosted the World Student Universiade; in 2019 the city greeted the participants of the "WorldSkills" – World Competition in Professional Skills. Many sports, cultural, scientific, political and other events are held in the city. In 2022, the 45th session of the UNESCO World Heritage Committee will be held there.

The opportunity to obtain an affordable and high-quality higher education attracts nonresident and foreign applicants to the capital of Tatarstan. Prospective students can choose any of 29 universities (13 state, 9 commercial, 7 branches of universities), as well as 34 professional educational institutions. One of the oldest universities in the country is Kazan (Volga Region) Federal University, founded in 1804 and famous for its scientific schools.

Kazan's leadership in the economic sphere is clearly visible. The capital of Tatarstan is at the forefront in investment and construction in the Volga region, in the provision of modern shopping centres and in the total capital of its own banks in Russia. The city is home to Russia's largest high-tech Technopark "IT Park", as well as one of the largest technoparks in Europe – "Idea".

Oktyabrsky village of Zelenodolsk municipal district of the Republic of Tatarstan is located in the immediate vicinity of Engelhardt Astronomical Observatory, commonly called the Observatory village by locals. The number of residents in 2017 is 3243 people. Founded in 1919 as a farm, Oktyabrsky village is located in a beautiful picturesque place. On the north side a mixed forest stretches for many kilometres. From the south is the left bank of the Volga with numerous bays rich in various fish and green islands. Railways and highways reliably connect the villagers with Kazan, Zelenodolsk and other settlements where the local population comes to work. Here, in 1918, in unsuitable premises a tuberculosis dispensary was opened, now the Republican Children's Tuberculosis Sanatorium "Observatory". In the same years, a dairy farm was built from the ship-repair paratroopers' workshops, at present the 2nd branch of the Yudinsky poultry farm is located here. The main transformation of the village in the social life of the population fell out for 1985-1999, when a typical rural school for 464 pupils, a rural house of culture, a kindergarten, an outpatient clinic, and shops were built on the territory of the village. Asphalted roads have been built, and the new residential buildings – a 36-apartment building and a 118-apartment building. Reconstruction of power grids with an increase in transformer substations was carried out. A 9-kilometer supply gas pipeline, street gas pipelines have been built, Oktyabrsky village and Orekhovka village are fully gasified. A mosque was built; the construction of a church is completed. The central square has been improved; a monument to the fallen soldiers of the Great Patriotic War has been erected. All the solemn events held in the village take place here.

5. SWOT-ANALYSIS

	Contribute to goal achievement	**Prevent goal achievement**
Internal factors	Strengths	Weaknesses
External factors	Opportunities	Threats

Strengths	**Weaknesses**	**Opportunities**	**Threats**
Management and protection			
Legally protected since 1960 and 2001. Currently the property has an advanced management system with its own administration and more than 20 employees.	The legal protection of the property should be increased. It should also cover the buffer zones. Given the strong dependence on higher-level government agencies, the property's administration is limited in decision-making.	An increase in the number of young heritage specialists and professional training will allow the property to continuously improve its management and monitoring systems. Fundraising events will attract additional sponsors.	There is a risk of communication difficulties between the property administration and the authorities, as well as within the property administration itself. Due to the lack of legal protection, the buffer zones are vulnerable in their development.
Restoration			
The World Heritage property enjoys interest and support from various political and educational institutions. The Committee of the Republic of Tatarstan for the Protection of Cultural Heritage Sites and the Kazan Federal University are directly involved in the protection and preservation of the property.	Conservation and restoration work was often carried out extensively in conjunction with anniversaries and other memorable dates. The sites require a more painstaking and thoughtful approach	The organization of specific conservation and study workshops together with the Astrophysics and Space Geodesy Department of the Institute of Physics (Kazan Federal University) with the availability of experts and qualified personnel makes it possible to create an effective conservation and maintenance plan that can become a leading model for the entire World Heritage property. The residents can be trained to ensure more efficient and faster conservation.	Lack of an overall conservation and maintenance strategy can result in the permanent loss of the property's identity and directly affect the property's OUV attributes.

Research			
The World Heritage property has the highest scientific and educational value in the area of World Heritage, astronomy and the history of the region. The property gives a unique understanding of the development of scientific thought in the field of astronomy and special scientific civil architecture.	The building of the Astronomical Observatory on the Vienna meridian circle in the central part of the city, completed by 1837, suffered from a large city fire on August 24, 1842. The building committee of Kazan Federal University was engaged in the repair of the building. The instruments were repaired two years later. In 1847, the Observatory began to function again. By the end of the 19th century, the problem of the need to transfer the main astronomical research to the countryside as a result of dust, soot, lighting, buildings under construction covering the horizon, became more acute – such were the costs of urbanization of a large university provincial city of the Russian Empire. The complex of buildings of Engelhardt Astronomical Observatory – buildings of the late 19th – early 20th centuries. In October 1918, next to the Engelhardt Observatory, battles of the Civil War were fought, but no damage was caused to the buildings and instruments of the Observatory – the commander of the left-bank troops of the Red Army Alekseev issued a security sheet to the Observatory and set up guards. On January 30, 1942, a fire broke out in the engine room of the Astronomical Observatory, it destroyed the room itself and the equipment located in it. In the 1990s, due to political and economic changes in the country, it was more about the survival of the World Heritage property and their employees, who were forced to personally protect the astronomical instruments from hunters for non-ferrous metals.	The World Heritage property has the potential to generate consistent and fundamental scientific knowledge in astronomy. For example, a unique instrument of Engelhardt Astronomical Observatory – the world's only currently operating heliometer – provides a unique opportunity to understand the importance of the existing and ongoing development of scientific thought within the walls of the World Heritage property.	There is a risk that the continued use of the 19th-century instruments that have not been restored for a long time and the continuing urbanization towards Suburban Engelhardt Astronomical Observatory is able to change the delicate matter of the scientific process that has developed over two centuries within the walls of the World Heritage property.

Attracting the residents			
The local community has been represented by the members of the administration of the site and its employees and their descendants for more than 100 years of the existence of the Suburban Observatory. The local Orthodox Russian and Muslim Tatar populations have a centuries-old tradition of peaceful coexistence and cultural exchange and are proud of their common heritage. The main area of their residence is the neighboring village of Oktyabrsky, aka «Observatory».	The traditional vertical approach to management requires revising and increasing the toolbox of decision-making processes by the residents who are not involved in the management of the site.	The increase in the number of tourists generates more income for local businesses and also provides an opportunity for new business start-ups. Community members interact with visitors and thereby contribute to strengthening mutual understanding and increasing the value of the property.	The potential lack of government support will prevent the attraction of economically or socially vulnerable members of the community. At the same time, the expansion of various local businesses can lead to the commercialization of the property and its reputation.
Explanation of content and promotion			
Currently, various sources for explaining the content have been created and are used, including the Museum of the History of Astronomy, and the Planetarium and Astropark. The administration of the site is ready to integrate new technologies and innovative methods to maximize the presentation of the facility.	The property requires a strategic approach to its interpretation. Limited availability of information for international visitors.	The property can become a world leader in promoting cultural diversity and preserving the UNESCO World Heritage. It can become one of the most attractive heritage properties in Russia for both scientists, children and tourists, including foreign visitors.	There is a need for clear guarantees of financial resources in the future, since this could jeopardize the implementation of educational and awareness-raising programmes of the property. There is a risk associated with tourism that could damage the property as well as an increase in discontent among the residents.
Sustainable infrastructure development			
Strong political, social, scientific and financial support for infrastructure development.	The property is expanding, becoming more complex, the number of visitors is increasing every year. It is required to find a balance between development and conservation. Expanding urbanization may hinder this.	The creation of a new and modern infrastructure guarantees a gentle inspection of the property without compromising the heritage assets. This could become a role model not only for the region, but for the whole world.	Development can affect the environment. The desire to provide the necessary infrastructure to meet the visitor's needs as soon as possible can conflict with a sustainable and more cautious approach.

6. GENERAL CONCEPT

The overall concept was formulated on the basis of the SWOT-analysis and the report of Outstanding Universal Value. It serves as a general guide to the management procedures of the Astronomical Observatories of Kazan Federal University.

The World Heritage property – the Astronomical Observatories of Kazan Federal University – is a unique and authentic evidence of the triumph of scientific astronomical thought for more than 200 years. The attributes of its Outstanding Universal Value are well reflected and preserved for present and future generations. The Astronomical Observatories of Kazan Federal University are a recognized international center of excellence in astronomical research, conservation and sustainable heritage management. The property is truly a pleasant and accessible place for everyone. Its scientific and educational capabilities are fully implemented and are aimed at promoting the socio-economic development of the region and for the benefit of its local community.

The Astronomical Observatories of Kazan Federal University are an ensemble of civil, scientific architecture and contain unique scientific instruments of the 19th century. Scientific astronomical activity at the Observatories was of a constant progressive nature. The contribution of Kazan astronomers to science is generally recognized and undeniable. The special pride of the astronomers of Kazan is the research in the field of the creation of the celestial Fundamental Coordinate System and the study of the Sun, carried out within the walls of the Astronomical Observatories of Kazan Federal University and on unique scientific instruments of the 19th century.

The property has great scientific potential. Scientific research in the buildings of the Astronomical Observatories of Kazan Federal University, using unique scientific instruments of the 19th century, continues and is in demand by the Russian and world scientific community. All-Russian and international scientific conferences held on the basis of the Astronomical Observatories of the Kazan Federal University are of a permanent nature. International experts are invited to determine the best ways and methods to protect and preserve the various attributes of Outstanding Universal Value. As its popularity grows, the number of visitors increases. While this provides new economic opportunities for the local population, the property administration faces challenges in terms of infrastructure and property presentation.

7. STRATEGY OF THE MANAGEMENT PLAN OF THE NOMINATED WORLD HERITAGE PROPERTY «ASTRONOMICAL OBSERVATORIES OF KAZAN FEDERAL UNIVERSITY» (2023-2043)

7.1 Philosophy of the Strategy and Management Plan with the main provisions

The developed philosophy of the Management Plan of the nominated UNESCO World Heritage Site proceeds from the need to maximize the preservation of Outstanding Universal Value of the site. Kazan City Observatory and the Engelhardt Suburban Observatory played an important part in the development of optical astronomy in Eastern Europe in the 19th-early 20th centuries.

The impulse laid here gave impetus to the development of modern astronomy. The discovery of new objects, black holes, the compilation of X-ray maps of the sky thanks to the participation of Kazan astronomers in the international Russian-German project, in which the ART-XC telescopes (Russia) and eROSITA (Germany) aboard the Spectrum-RG orbital observatory review the entire sky in X-ray radiation – all this

indicates the continuation of the development of optical astronomy. The SRG Observatory for the first time in the history of space research in our country was launched at the second point of Lagrange, 1.5 million km from the Earth, three to four times further than the orbit of the Moon. At this point, the forces of attraction of the observatory to the Sun and Earth are compared with the centrifugal force of its rotation around the Sun. The main task of the observatory is to build the world's most sensitive map of the entire sky in X-rays and create a catalog of X-ray sources containing data on the nature of millions of previously unknown astronomical objects. Kazan professors of astrophysics, together with students and graduate students at Kazan Federal University are remotely involved in the processing and analysis of the sky map from special equipment installed in the City Observatory.

Joint research of eminent scientists and a new generation of Kazan students, transfer of best practices and continuity in scientific traditions are also an integral part of the historical evolution of the development of astronomical science in the observatories of Kazan Federal University. The Kazan Federal Uni versity Astronomical Observatories became a turning-point in the history of the study of the Moon, which made a huge contribution to expanding mankind's knowledge of the Earth's satellite, without which modern lunar research would be impossible. Its purpose is to search for signs of life on this celestial object. In recent years, the renewed interest in the Moon inspired. The Moon is not just a mere supplier of raw material of the Earth used to produce helium. Scientists are exploring the potential of the Moon and the beginnings of life on it. There would not be a single lunar programme without the cartography of the Moon, created during two centuries of continuous observations. Many craters on the Moon are named in honour of the outstanding scientists of Kazan Federal University – N. Lobachevsky, M. Kowalski, D. Dubyago, A. Yakovkin, A. Krasnov, I. Littrow, I. Belkovich, T. Banakhevich, A. Nefedyeva, which was the world recognition of their contribution to the world astronomical science. Flights into space became possible thanks to the genius of human scientific thought, including the astronomers of Kazan Federal University.

Created in the observatories of Kazan Federal University, the celestial Fundamental Coordinate System, which can help to clarify astronomical constants and solve fundamental, cosmological issues of the appearance and evolution of the Universe, since 1935 began to be used as the basis of the coordinate system for astronomical and geodetic work around the world. Studies of the Sun, carried out mainly on the Repsold heliometers in the two KFU observatories, make it possible to understand better the processes taking place on the Sun and other stars and predict solar activity, which has a direct impact on the evolution of civilization on the Earth. The data obtained from long-term observations at many observatories on the structure, composition and evolution of the Sun, the impact of solar activity on the Earth, including data collected at Kazan observatories in more than two hundred years, currently provide the opportunity to conduct the Solar Weather service necessary for the activities of Earth civilization. And the instrument, located in Engelhardt Astronomical Observatory, is currently the only active heliometer telescope in the world. In addition, the breakthrough studies by Kazan astronomers were made in the field of comet and meteor astronomy, astrometry, selenodesy, photographic astronomy, and astrophysics. The discovery of Antarctica and its first scientific research was carried out by the astronomer, professor, rector of Kazan Federal University I. Simonov, the only scientist in the circumnavigation led by Lazarev-Bellingshausen. Kazan Federal University was founded as a centre and a touch point between the East and the West. Kazan Observatory in the 19th century was the easternmost observatory in Europe. It was a kind of counterpoint on the "silk road" of astronomy from East to West. The Suburban Observatory was a symbol of unity of science and the unique advanced tools for its time (according to the configuration of the best in the Russian Empire and one of the advanced in Eastern Europe), authentic and magnificently preserved today, and the surrounding landscape, unique

nature with relict and rare tree species, a number of neoclassical complexes occupying a special place as an example of a unique cultural landscape, the first example of an observatory park, as an independent genre dating back to the ideas of the Enlightenment, embodied in the architectural forms of an English garden landscape with classical buildings. When founding the Suburban Observatory, its "fathers" D. Dubyago and V. Engelhardt laid the plan for memorizing themselves and their deeds. There was a place in the Southern Mark for the burial of two best friends, whose will was fulfilled by his descendants. In the case of V. Engelhardt, whose immediate burial after death was prevented by the First World War, his last will was executed in 2014, when the ashes of the astronomer were transferred from Dresden to the place of rest in the tomb next to his lifetime friend D. Dubyago. Thus, the Suburban Observatory is a triad of spiritual unity of life, science and cultural heritage "Instrument – Grave – Monument".

The Astronomical Observatories of Kazan Federal University are of great value from a scientific, historical, architectural, museum and spiritual point of view and in connection with the unique preservation of architectural monuments, authentic instruments, and artifacts. The potential of the historical and cultural heritage of The Astronomical Observatories of Kazan Federal University as a historical centre at the junction of the East and the West, the "silk route" of astronomy associated with the breakthrough events in world astronomical science of the 19th-21st centuries, is comparable to the potential of the leading objects from the UNESCO World Heritage List. In this regard, the philosophy of the Management Plan involves identification and preservation of the cultural heritage in all sections of the World Heritage Site and its buffer zone, ensuring the competent management of the territory, based on its cultural, landscape and functional characteristics. The philosophy of the Management Plan implies that the preservation and presentation of the nominated World Heritage Site will become a factor aimed at the sustainable development of this territory and give it dynamic socio-economic functions. The Astronomical Observatories of Kazan Federal University in terms of management are considered as a modern scientific, educational, museum and spiritual complex. At the same time, the local community continues to function, considering certain burdens associated with the environment (for the suburban observatory), for which servicing new functions will become the basis of employment and achieving a decent standard and quality of life. The Management Plan outlines further work on restoration, scientific study of architectural monuments, preservation of authentic tools, elimination of risk factors for their existence, scientific and educational activities related to the popularization of astronomy.

It is proposed to form new museum capabilities of the City Observatory, which is part of the ensemble of Kazan Federal University, included in the List of Sites of the Outstanding Value of the Peoples of the Russian Federation, and the Suburban Observatory with the Planetarium which is an educational and entertainment complex.

The implementation of the planned activities will allow the Astronomical Observatories to stand out with an original museum offer, create museums that have no analogues in the country, and which will be able to determine its scientific museum specialization and attractiveness.

Due to the fact that the main function of Kazan City Observatory is currently educational, it is a training centre for bachelor's, master's and postgraduate students of the university, a place where theoretical, practical, as well as historical knowledge about the development of astronomical science is transferred, the key object in terms of creating museum expositions will be the Suburban Observatory, which serves as a citadel of practical astronomy and has the educational potential to popularize astronomy among a wide range of visitors and tourists.

The creation of a museum system will also reduce the threat of anthropogenic pressure on monuments, distribute visitors evenly on the territory and avoid excessive loads on key objects. This creates the prerequisites for a more effective organization of tourist services, stimulating the development of tourist infrastructure, quantitative and qualitative tourist ser-

vices. The strategy of the Management Plan is also focused on the idea that the historical, cultural and scientific heritage is a special and important social and economic resource, it should become the basis of a special branch of specialization of Kazan Federal University, a local municipality, and become the basis for sustainable development of the territory.

The diverse activities of Engelhardt Astronomical Observatory and the associated development of tourism, various service organizations and social infrastructure sectors can bring a significant effect. The assessment of the planned activities allows us to speak about a high social impact. It is connected, first of all, with the development of culture and tourism, public spaces, the preservation and revival of spirituality, the improvement of the ecological situation, the preservation of the historical and cultural landscape environment, the dissemination of scientific knowledge and the improvement of education, enlightenment, etc.

The creation of new workplaces plays a special role. All these factors become the basis for ensuring consent on the territory of the municipality. The main directions of the Management Plan of the Astronomical Observatories for 2023-2043 are:

– a description of the existing protection system of the nominated site on the basis of legislative, administrative and other methods of state and public protection;

– analysis of the range of stakeholders in relation to the use and sustainable development of the site;

– the required state of preservation of the nominated site;

– the management system of Kazan Federal University Astronomical Observatories with the introduction of tools for achieving public agreement;

– organizational management scheme, monitoring and ensuring the implementation of the Observatory Management Plan;

– action plan within the framework of 6 strategic objectives and directions of the Management Plan.

According to the philosophy of the Strategy of the Management Plan, the main strategic objectives are:

1. Preservation of Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University.

2. Providing opportunity for sustainable development.

3. Promotion of the site and involving local population in achieving public consensus on the conservation and usage of the property nominated for the World Heritage List.

The following tasks are also to be defined:

1. Management and protection;
2. Restoration;
3. Research;
4. Involvement of the local community;
5. Promotion of the property;
6. Sustainable development of the infrastructure.

Specific directions for the implementation of strategic goals and objectives are determined based on the analysis of the current situation, the analysis of possible risks, as well as on the basis of the common strategic approaches to the World Heritage Site.

Activities are identified within each field, including the priority ones aimed at eliminating possible threats to the state of components of the nominated site, the Astronomical Observatories of Kazan Federal University, and ensuring the necessary conditions for its existence. Each direction is presented in the form of a specific system of projects and activities.

7.2. Strategic goal 1. Preservation of Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University

The main objective of the Management Plan for the Astronomical Observatories of Kazan Federal University is to preserve Outstanding Universal Value of the site to be included in the World Heritage List. The implementation of this objective is associated with solving a number of tasks to preserve the architectural and picturesque heritage of the Astronomical Observatories of Kazan Federal University and their surroundings, as well as to preserve and maintain the historical and cultural landscape. These objectives can

be successfully reached only by transition from the protection of a single monument to the preservation of the cultural and natural heritage as a whole, with minimal interference in the landscape environment and with careful preservation of the masterpiece in the traditional environment.

To achieve the main objective, it is necessary to solve the following tasks:

1. To conduct scientific research in order to organize an effective management system to protect and preserve the attributes of Outstanding Universal Value of the nominated site and monitoring of their condition.

2. To restore and conserve of the Astronomical Observatories of Kazan Federal University.

3. To preserve the movable property of the sites.

4. To preserve and regenerate historical buildings and cultural landscape, which is important for the preservation of Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University.

5. To preserve other cultural heritage sites (architectural monuments) on the territory of the City Astronomical Observatory and Suburban Engelhardt Astronomical Observatory (buffer zones of the site to be inscribed on the World Heritage List).

6. To ensure safety and security of the sites and reduce the risks of their destruction and loss.

a) Carrying out scientific research of the Astronomical Observatories of Kazan Federal University in order to effectively provide the control system for protection and preservation of the attributes of Outstanding Universal Value of the nominated property and provision of the monitoring of its state

Measures to preserve Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University and their study are included in the programme of comprehensive study of the Astronomical Observatories of Kazan Federal University and scientific heritage of Kazan. The study of the territory surrounding the Astronomical Observatories of Kazan Federal University is an important condition for development, which is determined by international requirements for the preservation of World Heritage sites. The relevance of the programme is defined by the need for a more complete disclosure of the historical and cultural potential of the Astronomical Observatories of Kazan Federal University based on the materials of recent research. The results of the studies can be brought to the scientific community and leading experts through publications and discussions at scientific forums. It is important to popularize sites of the cultural and scientific heritage of Kazan both in Russia and abroad using traditional and modern methods of transmitting information.

An important condition for these studies is the formulation of appropriate recommendations and regulations to ensure the preservation of sites of cultural and scientific heritage during the restoration work, museum activities, scientific, administrative, social and other activities. For a comprehensive study, it is necessary to involve a wide range of specialists in various scientific disciplines: historians, architects, art historians, restorers, cultural scientists, museum experts, astronomers, astrophysicists, surveyors, specialists in the protection of cultural and natural heritage, using data obtained by natural scientific methods.

The main objects of study and preservation on the territory of the Kazan Federal University and Zelenodolsk district are the City and the Suburban Observatories, respectively, the components of the site to be included on the World Heritage List.

The main directions for research on astronomical observatories are the following:

1. Comprehensive historical research, including identification and study of new archival materials and sources, comprehensive historical-archival, architectural, source studies, historiographic, art history, cultural studies and comparative analysis.

2. Assessment of the current state and development of measures for the preservation of the Astronomical Observatories based on complex interdisciplinary historical, archaeological and natural science research and obtaining new data on the construction time, materials and construction technologies.

This research involves:

- the study of tools and equipment in order to clarify their characteristics and reveal potential threats and risks to their condition;
- the study of buildings, pavilions of observatories to reveal potential threats and risks and determine the best conditions for the preservation of architectural structures and unique equipment and tools, as well as furniture of the 19th century (tables, bookcases);
- the study of temperature and humidity conditions in observatories.

A set of measures has been identified and is being implemented to study the design features of the Astronomical Observatories:

- condition of foundations,
- condition of walls and roof,
- condition of the internal supporting structures of the buildings of the City Observatory, the main and administrative buildings of the suburban observatory, the wooden house of D. Dubyago and telescope pavilions, etc.

Special attention is paid to the study of the temperature and humidity conditions in these buildings and the organization of continuous monitoring of temperature and humidity. Interdisciplinary comprehensive research work includes the study of the soil, buildings, temperature and humidity conditions of the monuments, continuous monitoring of the natural environment and cultural landscape, the level of groundwater, the state of the enclosing structures of the Observatories.

Research works also include technological research using non-destructive methods and high-tech equipment and are carried out on the basis of research and conservation laboratories of the Kazan Federal University, the Institute of Restoration (Moscow) and other leading centres in Russia and abroad.

A complex of interdisciplinary methods based on the widespread use of non-destructive study methods improves the quality and results of restoration research. The combination of these methods for studying the preservation of architectural structures, large equipment (refractors, heliometer, etc.) and small instruments for astronomical observations and research, furniture of the 19th century, expands the understanding of the integrity and authenticity of the site, revealing new aspects of its Outstanding Universal Value. This programme creates conditions for the formation of a new stage in understanding the role and place of the Astronomical Observatories of Kazan Federal University in the Russian and world cultures.

An automated computer system is being developed to systematize and record the results of all research works, to create a system for monitoring the current state of the Astronomical Observatories of Kazan Federal University.

The development of an automated system will result in the creation of a unified information system, which includes the following modules:

1. Visualization of the nominated site by creating its 3D model.

2. Historical and graphic reconstruction of the City Observatory and the suburban observatory complex, reconstruction of architectural changes to the site and restoration works.

3. Real-time monitoring of the state of astronomical observatories and recording of conditions.

4. Registration and storage of research samples of the nominated site.

5. Registration and storage of research and analysis results.

6. Storage of archival documents.

7. Organization of multi-user access to databases.

b) Conservation and restoration of the Astronomical Observatories of Kazan Federal University

The main method of protecting a monument is conservation aimed at ensuring optimal conditions for the operation of the site, identifying and eliminating the causes of possible violations of brickwork and other structures, the state of instruments. The comprehensive preventive maintenance system is based on the results of years-long research and experience in preservation activity.

The system of comprehensive preventive maintenance includes:

1. Comprehensive monitoring of the condition of Kazan Federal University Astronomical Observatories including:

- monitoring of destruction caused by water and wind erosion, mechanical impact, etc.;
- monitoring of biodeterioration to identify foci and causes of biological damage to the site;
- monitoring of the technical condition of the Astronomical Observatories of Kazan Federal University, which allows to identify existing and possible damage to elements and structures of the site.

Relevant methods and modern high-tech equipment for non-destructive testing (acoustic detector, electronic tacheometer) are used to monitor the condition of the site.

2. Preventive maintenance and preservation of the site, including:

- elimination of the causes of physical and biological destruction of the property of cultural and scientific heritage;
- elimination of leaks from roofs and other parts of buildings;
- indoor microclimate control.

The main task in providing preventive maintenance is to ensure the continuity of measures.

3. Collection and storage of information about the nominated site carried out by scholars and specialists in the relevant area and collected and stored in the administration offices of the Kazan Federal University and the Committee of the Republic of Tatarstan for Protection of Cultural Heritage – the state body of the Republic of Tatarstan responsible for protection of cultural heritage. The programme for conservation of the interior of the Astronomical Observatories of Kazan Federal University also involves several technical and organizational measures. Current, annual and long-term plans for preventive, repair and restoration work are based on monitoring of changes in the state of the Astronomical Observatories throughout the year.

The restoration of the Astronomical Observatories is considered as a forced and exceptional measure aimed at preserving and revealing the aesthetic and historical value of the site. The decision on restoration is made by the state bodies for protection of monuments on the basis of decision of the expert commission responsible for restoration.

The restoration of the Astronomical Observatories is based on international charters, standards and management guidelines for cultural heritage sites:

1. The *Convention concerning the Protection of the World Cultural and Natural Heritage*

2. The Venice Charter for the Conservation and Restoration of Monuments and Sites (1964)

3. UNESCO Recommendation Concerning the Safeguarding and Contemporary Role of Historic Areas (1976)

4. The Nara Document on Authenticity (1994)

In restoration work preference should be given to traditional materials and technologies. Any element introduced into monuments during restoration should be marked so that it can be easily identified in the future.

During the restoration of Astronomical observatories special attention is paid to monitoring of the restoration process:

- the quality of the restoration work must be continuously monitored by the author of the project, representatives of the KFU administration, the directorate of Engelhardt Astronomical Observatory, the Department of Astronomy and Space Geodesy and state supervisory authorities;

- to monitor the restoration process all available methods, including high-tech methods, should be used: geodetic control, technological control over the condition of materials, etc.;
- all elements taken from the site to be included on the World Heritage List should be included in a databank;
- information on the available restoration materials should be included in a special database;
- in the course of restoration work, the state of each element, the technology of its restoration and other data should be described in detail and registered in a special journal;
- continuous technological monitoring must be carried out during the restoration work on the territory of the Astronomical Observatories of Kazan Federal University.

c) Preservation of movable property

The funds of Engelhardt Astronomical Observatory and the City Astronomical Observatory include research papers, photographs, documents, rare books, furniture of the 19th century. As of January 1, 2021 the number of exhibits in the main fund of the Museum of History of Kazan Federal University, which are directly related to the astronomical heritage, amount to 17 unique instruments of the 18th-early 20th centuries.

A part of the exhibits is kept in the Museum of History of Kazan Federal University, another – in the museum and in the funds of Engelhardt Astronomical Observatory and in the City Astronomical Observatory at the Department of Astronomy and Space Geodesy of the Institute of Physics of KFU. The museum is responsible for identification, registration, storage, safety, study, publishing museum items and collections and for providing access to them.

The creation of a museum of science "From the past to the future" in the palace of science and technology "UNIGRAD" on the territory of Suburban Engelhardt Astronomical Observatory will allow to make an exposition that will precede a visit to the observatory and the Planetarium. The exposition will acquaint visitors with the history of the construction of the City Observatory and the Suburban Observatory complex, the development of astronomy in Kazan, Russia and in the world, unique scientific equipment of the 19th and 20th centuries (including operating equipment), a retrospective series of technology of the 20th century (cameras, television and radio sets), interactive exhibits and achievements of KFU in astrophysics and cosmology.

Thus, the visitors of the museum will get important information about the Astronomical Observatories of Kazan Federal University and will not spend much time on instructions in the museum of the main building of Engelhardt Astronomical Observatory. This will solve a problem associated with organizing visits to historic buildings on the territory of the suburban observatory complex, reduce the time of visit and allow keeping the temperature and humidity regime.

The main task for the coming years is to organize activities to accelerate the formation of the museum fund, to make this process systematic and science based. The acquisition of museum objects and collections is carried out using both budget and extra-budget sources, including through more active work of museums with individuals and legal entities who can donate items and collections to museums.

The main priorities for ensuring the safety of museum objects and collections are:

- the formation of a special fund, involving storage of the movable museum objects that make up and emphasize Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University.
- creation and implementation of a unified information system for monitoring the condition and use of museum objects and collections;
- systematic formation of databases and maintaining up-to-date and complete data;

- development and implementation of systems for security marking and labeling of museum objects, as well as making electronic copies of the main documents and museum records;
- development and use of modern preservation and security systems (monitoring and maintenance of temperature, humidity and light conditions, monitoring and ensuring microbiological and entomological safety, anti-terrorist, anti-criminal and fire safety);
- ensuring the use of different security systems on the territory of the Astronomical Observatories;
- development of anti-crisis plans and emergency instructions.

The Museum Fund provides methodological support for registration and storage of the museum objects and collections. In current conditions, the preservation of museum funds requires an effective combination of the latest research, conservation and restoration methods. Restoration allows not only to preserve the site, but also to reveal its historical, cultural, scientific and artistic significance.

The priority directions of conservation and restoration of museum exhibits are:

- training of restorers (higher specialized education, advanced training, internships);
- technological equipment of restoration rooms;
- scientific support for the restoration of museum objects;
- creation of the depository;
- development of preventive conservation of objects, which in many cases allows avoiding restoration.

The field laboratory of the Institute of Archeology, which has great restoration capabilities and work experience, cooperation of the Kazan (Volga Region) Federal University with the International Astronomical Union, Kazan State University of Architecture and Engineering, and cooperation of astronomers of Kazan Federal University with leading world scientific centres, professors and astronomers allows to consider Astronomical Observatories as a new regional centre for practical astronomy and to consider this area of activity of the museum with partner organizations as one of the most promising.

d) Preservation and regeneration of the historical environment and cultural landscape

The preservation of Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University, the garden and the park complex of the Suburban Observatory requires a landscape approach. The preservation of the site and its perception should be carried out only in accordance with its cultural and landscape complex. The complex, in which natural and historical components, elements of tangible and intangible heritage are organically connected with each other, for the Astronomical Observatories of Kazan Federal University in the narrow sense is represented by the entire territory of Kazan Federal University ensemble (in the central part of Kazan) and the entire complex of buildings of the Suburban Observatory with the garden and park zone, and in the broad sense – the territory and water area within the boundaries of the buffer zone.

In this aspect, the objective of the Management Plan is to develop mechanisms to ensure the preservation of the authenticity and integrity of not only the buildings of the observatories, but also the cultural and natural landscape of the Kazan Federal University and Oktyabrsky village, regeneration of the historical and cultural environment. The territory of Kazan and Zelenodolsky district is characterized by many historical architectural sites that form their cultural space and emphasize Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University. These are monuments of science, history and culture, the territory of the future Astropark, areas of the natural, historical and cultural landscape.

Moreover, the property "The Assumption Cathedral and the Monastery of the Island-Town

of Sviyazhsk" (Zelenodolsky district) was inscribed in the World Heritage List in 2017. After the restoration and subsequent turning of the Astronomical Observatories into museums, they will become significant museum and touristic sites.

An important condition for further development of the City Observatory, and what is especially important from the point of view of the cultural and natural landscape, Suburban Engelhardt Astronomical Observatory, is the study and regeneration of the historical landscape with the elaboration of mechanisms for its preservation.

To uphold the integrity and authenticity of Engelhardt Astronomical Observatory, the urban cultural landscape and that of the Astropark, in particular, the monuments of historically valuable environment, differentiated regimes have been developed on the territory of the Astropark.

The subzones have been distinguished by planning and morphological features.

The subzone A is the subzone of the highest concentration of cultural heritage sites. This is the territory of Kazan Federal University ensemble and the complex of buildings of the Suburban Observatory. The former includes the main building (1822-1825) designed by architect P. Pyatnitsky and a complex of buildings in the courtyard of the Kazan Federal University designed by architect M. Korinfsky: the buildings of the Scientific Library, the Physics and Chemistry laboratories, the building of the Anatomical Theatre, the Astronomical Observatory and the Littrow Observatory. Among them are:

- The Ensemble of Ulyanov-Lenin Kazan State University – an ensemble of federal significance (register number 161620773750006)
- The Complex of Kazan Federal University – an ensemble of regional significance (register number 161720964290005)
- The Rector's House of Kazan Federal University, in which N. Lobachevsky lived from 1827 to 1846 – a monument of regional significance (register number 161610773760005).

The latter includes the administrative building of Engelhardt Astronomical Observatory, the main building of Engelhardt Astronomical Observatory with the Meridian Circle Pavilion, Engelhardt Astronomical Observatory Library Building, the Heliometer Pavilion, the South Mark-tomb, the Northern Mark, the necropolis where prominent astronomers of Kazan Federal University are buried, 2 telescope pavilions, the building of the Meteor Department, the Planetarium, and infrastructure facilities.

The cultural heritage site of regional significance "Engelhardt Astronomical Observatory, late 19th-20th centuries. A Complex" which includes: "The main building, 1899-1901", "The Heliometer pavilion, 1899-1901", "The library, 1930s", "The Observatory with a refractor pavilion, 1899-1901", and "The necropolis with the graves of the Engelhardt Observatory directors: D. Dubyago (1849-1918), A. Dubyago (1903-1959), M. Grachev (1866-1925), I. Dyukov (1888-1961), A. Nefediev (1910-1961), were adopted for protection by the Resolution of the Cabinet of Ministers of the Republic of Tatarstan of 04.06.2001 No. 318.

Subzone B – the territory of the buffer zone.

Subzones are allocated to differentiate the regimes of maintenance and use of land, corresponding to the regimes and regulations established in accordance with the current national urban planning and monument protection legislation. The Management Plan regulates the development of Oktyabrsky village. The organization of an effective management system for the protection and preservation of the attributes of Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University is carried out through the regulation of the buffer zone regimes in accordance with international and national legislation. To preserve the cultural landscape, the Management Plan includes measures to study the natural heritage of the territory of Oktyabrsky village and the buffer zones of the Astronomical Observatories of Kazan Federal University.

e) System of measures to reduce the risks of disasters

Principles of protection

Two main categories of risks are identified for the property nominated for inscription in the World Heritage List:

- risks related to possible natural and biological factors of the physical destruction of the site to be included on the World Heritage List;
- risks caused by the activity of various members of modern society, whose interests are directly related to the Astronomical Observatories or concern them.

Risk management is associated with monitoring and regular analysis of the control process. The peculiarities of the Astronomical Observatories and their cultural landscape that determine the choice of measures for their protection are:

- the location of the Suburban Observatory complex in the forest and the possible deforestation of relict trees and rare vegetation species;
- the necessity of protection against various types of external impact and destruction;
- severe weather and climatic conditions of monuments and their protecting equipment usage;
- vulnerability of the landscape environment;
- seasonality of the tourist flow with a peak in summer.

The main principles of the Astronomical Observatories properties are:

- systematization of all threats and appropriate systematization of the site protection measures;
- prevention of threat possibility;
- the taken measures should correspond to the tasks of protection: the used means and methods should be reasonably sufficient and distributed in accordance with the probability of threats and the importance of the protected area;
- a combination of personnel actions and effective technical means should correspond to the aims of protection. Long-term planning and readiness for various threats are necessary aspects of the Management Plan for the Astronomical Observatories and their cultural landscape to ensure a high level of security of the site relative to possible threats.

In addition to the measures to protect the historical and cultural environment and the cultural landscape of the nominated property (see paragraph 4.6), special nature studies were conducted to identify dangerous and unfavorable natural processes in the buffer zone of the nominated property.

Fire safety

Planning of actions in case of fire in the buildings of the Kazan Federal University and Oktyabrsky village is extremely important. The legislation of Russia and the Republic of Tatarstan guarantees the protection of architectural monuments, museums and museum buildings, as well as residential buildings on the territory of the village. A fire prevention plan has been drawn up and approved in the museums in the main building of the Kazan Federal University and on the territory of Engelhardt Astronomical Observatory.

The buildings of the Astronomical Observatories, the museums, the exhibition halls, the storage facilities, the conference centres, the hotels, the cafes and other facilities have local fire extinguishing plans.

The fire station for the City Observatory is a 5-minute drive from the Kazan Federal University (Vakhitovsky district fire station number 68 is located in the Kazan Kremlin). The fire station for the suburban observatory is located in Zelenodolsk, a 30-minute drive from the suburban observatory (fire station number 53, Zelenodolsk, 52 Tchaikovsky Str.). Fire departments inspect the Kazan Federal University complex and Engelhardt Astronomical Observatory once a year and draw up instructions for the implementation of fire-fighting measures. The Fire Department recognises the value of the monument structures, documentary archives and books, and has a special procedure for combating fire and epidemic disease outbreaks. All monuments have a security and fire alarm system

controlled by the security console of each monument separately.

The following additional fire protection is provided at the sites:

- the City and the Suburban Observatories, the Museum of Astronomy, the Planetarium are equipped with powder fire extinguishers and fire plugs.
- Museum depository: gas fire extinguishing system in the storage facilities.

The museum, the buildings of the Astronomical Observatories and other buildings are under the jurisdiction of the *Occupational Safety and Health* Department of the Ministry of Education and Science of the Republic of Tatarstan, the Ministry of Culture of the Republic of Tatarstan, the Ministry of Higher Education and Science of the Russian Federation, municipality of Zelenodolsk district, which conduct regular fire drills.

Terrorism and serious incidents

The Ministry of Internal Affairs of the Russian Federation for the Republic of Tatarstan and its unit in Zelenodolsk district are responsible for the consequences of terrorist acts and other serious incidents. Together with the Ministry of Civil Defense and Emergency Situations of the Republic of Tatarstan and the Ministry of Health of the Republic of Tatarstan and their departments, alternative emergency plans and special plans for eliminating consequences related to the educational buildings of Kazan Federal University, including the Astronomical Observatories, museums and other monuments have been developed.

Vandalism, theft and unintentional damage

Vandalism, theft and unintentional damage are considered critical aspects in managing the site. The Astronomical Observatories of Kazan Federal University are equipped with security and fire alarms and other security facilities. At the Department of Astronomy and Space Geodesy, the Department of Radio Astronomy in the City Astronomical Observatory, at the Museum of the History of Astronomy, the Museum of the History of Kazan Federal University, in the exhibition halls, the fund depository, in the expositions and other rooms where movable artifacts are stored, their preservation is ensured in accordance with the national legislation on registration and storage of museum objects. All instruments, rare books, furniture of the 19th century and other movable values are cataloged and numbered. Museum items containing precious stones and metals have special records and special measures are provided for their preservation: safes, safe rooms with sealing, burglar alarms and video surveillance.

All the buildings are equipped with a burglar alarm system. Video surveillance and anti-vandal materials are used near and inside the monuments, near the stands with presentations and other technical and informational multimedia equipment. To prevent theft and vandalism security measures have been improved. Since museums and monuments are visited by many tourists, these measures can be adjusted in the Management Plan. The "Fund Management" section provides the main management priorities for the preservation of museum objects and collections for the next 20 years. An important aspect in this regard is the creation of virtual museums, exhibitions and expositions, excluding the possibility of vandalism and theft.

Anthropogenic pressure

The task of reducing the anthropogenic impact on the nominated property is one of the most important for the protection of monuments. The Management Plan provides continuous improvement of visitor flow control which includes:

- excursion guidance of tourist groups and tourist visits to museum expositions and exhibitions (the guides are responsible for monitoring the implementation of visiting rules on the territory of Suburban Engelhardt Astronomical Observatory and its facilities, including the Planetarium);
- distribution of museum caretakers in exhibition halls, interiors and places of active visits of

monuments on the territory of the Suburban Observatory;
- implementation of fire supervision (prohibition of smoking and making open fires);
- security, police control over public order and preventive measures against unauthorized and illegal actions;
- anti-terrorist measures, especially in situations involving mass visits to the site on weekends and holidays.

The Management Plan provides the calculated (permissible) anthropogenic pressure on the territory, monuments and natural landscape of Sviyazhsk, as well as the assessment of anthropogenic impact which will allow adjusting visiting modes and time of the territory.

New properties are planned to be added to the category of museum facilities on the territory of the Astropark, which will allow to avoid the accumulation of tourists near the historical buildings of the suburban observatory and other most interesting monuments of science, history and culture, the memorial complex (Southern Mark and the necropolis) and relatively evenly distribute them over the territory of the suburban observatory complex. The introduction of new (additional) and auxiliary excursion routes for tourists and visitors will relieve the tourist flow at the main (most visited) properties of the complex.

In promoting the concept of sustainable tourism, we pay special attention to calculating the maximum anthropogenic pressure on the territory of the suburban observatory (since the City Observatory is an educational building, retaining its original educational function and is not a place for excursion tours) and its separate nominated parts.

The maximum anthropogenic pressure on Engelhardt Astronomical Observatory.

A comfortable visit to the Museum of the History of Astronomy can be carried out by a group of less than 15 people. A full coverage of Engelhardt Astronomical Observatory and scientific discoveries takes about 20 minutes, taking into account the way to the main building of the observatory and the way back this time increases to 30 minutes. Due to the small capacity of this museum, a Planetarium is functioning on the territory of the Astropark and a memorial room of D. Dubyago is planned to be opened in the administrative building of the observatory (with the preserved unchanged furnishings, furnishings of the director's office and personal belongings of the founder of the suburban library) and a museum in the House of Science.

The limitation of the maximum number of visitors to the main building and the administrative building of the suburban observatory to 15-20 people will keep the temperature and humidity conditions at the facilities, elements of their exterior and interior and also increase the number of repeated visits to the place of interest which has an important marketing effect to attract tourists.

Reducing the consequences of accidents and natural disasters

The problem of natural disasters, floods and others is perceived as a large-scale problem, therefore, the programmes of the Ministry of Civil Defense and Emergency Situations of the Republic of Tatarstan provide for measures to reduce its consequences.

7.3. Strategic goal 2. Providing opportunity for sustainable development

To achieve goal of creation of conditions for sustainable development of infrastructure and the surrounding area" it is necessary to solve the following tasks:

1. To organize the effective use of the potential of the Astronomical Observatories through the development of the Museum of History of Kazan Federal University, the Department of Astronomy and Space

Geodesy, the Department of Radio Astronomy, the suburban Engelhardt Observatory;

2. To form a mechanism of managing tourist flows;

3. To create conditions for the development of the local community;

4. To popularize and promote the property nominated for the World Heritage List.

a) Organization of effective use of the scientific, historical and cultural potential of the Astronomical Observatories of Kazan Federal University

The development of infrastructure and territory around the property nominated for the World Heritage List is supposed to be carried out based on a landscape approach. The consistent implementation of this principle will make it possible to restore the historical environment and develop the necessary infrastructure using only traditional, historically grounded forms, as well as the historical environment, planning and cultural landscape.

The system of planned measures is designed to expand the range of services related to the presentation of the Astronomical Observatories and improve its quality, ensure the safety of cultural and natural heritage sites, and significantly improve the social and economic situation in the territory.

The Management Plan supposes the following development of the territory:

- the entire territory of the property nominated to the World Heritage List and its buffer zone will be considered as a complex cultural and landscape facility, which includes both architectural and scientific monuments, and historical buildings of later periods, natural sites;
- for the purposes of the presentation a museum complex of several display spaces is planned to be made, with a subsequent tourist route through the exposition of astronomical research instruments (a sort of open-air museum); the system of various museums will make it possible to fairly evenly distribute visitors across the territory of the museum-reserve and avoid excessive pressure on key historic sites;
- the restoration of the historical environment will also require the creation of a modern infrastructure that ensures the preservation and presentation of the Astronomical Observatories of the Kazan Federal University and other heritage sites, comfortable living conditions for the local population and the provision of services in accordance with modern requirements and standards.

The restoration of the historical landscape environment and, moreover, the initiation of modern infrastructure elements should be carried out based on local projects, undergo extensive discussion and approval, including international discussion.

Any new project related to the buffer zone of a World Heritage-nominated property and the surrounding area must go through public debate and undergo an impact assessment of Outstanding Universal Value and surrounding landscape impact assessment procedure, as recommended by ICOMOS, in order not to cause harm to integrity and authenticity of the Astronomical Observatories of Kazan Federal University.

b) Functional zoning of the territory as a condition for sustainable development of the property nominated for the World Heritage List

Functional zoning is one of the tools for sustainable development, preservation of the cultural heritage of the territory of the City Observatory and the suburban Engelhardt Observatory, the integrity of cultural and landscape complexes and the appearance of a historical place, as well as the presentation and use of historical and cultural potential. It is intended to ensure the preservation of monuments in

its historical and landscape environment, as well as to correctly outline the main directions for using the territory.

Functional zoning of the Suburban Engelhardt Observatory is built on the basis of the characteristics of the historical, architectural, scientific and natural heritage of the area, as well as cultural and landscape features. When determining the boundaries of functional zones, in addition to cultural and landscape zoning, the following factors were considered:

- analysis of the development of the planning structure of Oktyabrsky village,
- analysis of the development (the value and the prevailing type of monuments were taken into account),
- features of the tasks of heritage preservation,
- promising areas of museum development,
- social factors of the development of the territory.

In total, on the territory of the Suburban Engelhardt Observatory it is advisable to distinguish the following functional zones:

- the historical part of the territory,
- learning zone;
- the sports and recreation zone;
- the residential zone;
- the practice zone.

Historical zone. In the historical zone there is an administrative building, the main building of the observatory, the Mark-tomb – the burial place of V. Engelhardt and D. Dubyago, the building of the scientific library, the pavilion of the AZT-14 telescope, the pavilion of the Heide telescope, the pavilion of the heliometer telescope, the sundial, the pavilion of the meniscus telescope, the pavilion of the solar telescope, the building of the meteor department.

Learning zone. The Learning Zone includes the Planetarium building, the UNIGRAD Science and Technology Palace and an open-air exhibition of scientific instruments. In the palace of science and technology UNIGRAD on the 1st floor, the museum of science "From the past to the future" is planned to be placed. It will be a science museum with interactive elements. Its exposition will feature scientific equipment of the 19th and 20th centuries (working scientific installations), a retrospective series of 20th century technology (cameras, televisions, radios), interactive exhibits – "how it works", "what things devices allow you to see", "physics and chemistry inside a person", an exhibition of KFU achievements in the field of astrophysics and cosmology.

On the 2nd floor there will be a transformer conference room, circle rooms ("Make a telescope yourself", "Underwater drones"), premises for the preparation and storage of exhibits, office premises. The conference hall is organized for a permanent lecture hall with physical experiments (50 people), a weekend lecture on topical science topics (100 people), plenary and sectional sessions of scientific conferences (200 people), the behavior of mobile exhibitions of scientific equipment and technology in cooperation with famous museums such as the Polytechnic Museum and private collectors, art exhibitions, exhibitions of children's art.

Sports and recreation zone. Since the territory of the suburban observatory has historically developed as a place of science and life of astronomers, during the twentieth century employees of the observatory with their families organized sports grounds for children and their family members. According to the recollections of the older generation of astronomers-employees of Engelhardt Astronomical Observatory volleyball and football grounds were located here. Thus, it is natural to include a sports zone in the complex to maintain tradition in the life of the observatory's researchers.

A volleyball court, a tennis court, Lake "Glasses", a ski and bicycle rental point, an artificial bike path, a ski track and an attraction "Rope Park" are planned in the sports and recreation area.

Residential Zone. The residential area is supposed to accommodate a hotel with a canteen and office premises for students to stay during practical training, accommodation for tourists (mainly schoolchildren), participants in astronomical clubs, gatherings of astronomy enthusiasts, par-

ticipants in scientific schools and conferences; car parking; utility yard; boiler room; garage; tent camp.

Practice Zone. Throughout the history of the Suburban Observatory, scientific observations of students and graduate students of Kazan Federal University, summer practice were held here. However, the living conditions of the students were extremely modest. In this connection, the development plan of the territory provides both a dedicated area for conducting field practices for students in the practice area and improving living conditions with the construction of a student hostel in the residential zone.

c) Strategy for the formation of the museum sphere

Due to the large increase in the number of visitors, in order to preserve the authenticity and integrity of the properties of scientific and cultural heritage, a special programme for the formation of the museum infrastructure is being implemented. Within its framework, the following properties have been restored and opened since 2010. The main museum is the exhibition hall dedicated to 200 years of astronomy development, located in the main building of Engelhardt Astronomical Observatory affecting the development of astronomical science at Kazan Federal University in the 19th-20th centuries.

A memorial room for the founder of the suburban observatory D. Dubyago is planned to be created in the administrative building.

The Leonov Planetarium is located at a distance from the historical zone. The mission of the planetarium is to revive people's interest in astronomy, astronautics, science and technology, thereby contributing to the development of science in general. The planetarium has collected the best world experience and knowledge about equipping planetariums. 22 planetariums around the world were examples and guides for the creation of a new, modern, technologically advanced planetarium.

Kazan Planetarium is the only planetarium in Russia created at a higher educational institution – this is an indicator that the Kazan (Volga Region) Federal University is one of the most advanced educational institutions not only in Russia, but also in the world.

An important part of property management is turning the property into a museum and the creation of museums in order to popularize and present the property. The strategy for the development of museum and tourist activities is aimed at a broad presentation of the historical, cultural and spiritual potential of the Astronomical Observatories of Kazan Federal University, the diversity of the heritage of this place, its development as a historical centre of astronomy, the intersection of cultures and civilizations.

The creation of conditions for the sustainable development of a site nominated for the World Heritage List requires special principles of museum management. In this regard, turning such a complex property into a museum presupposes the following fundamental approaches:

- an integrated approach to turning heritage into a museum, in which, along with movable monuments, immovable monuments (individual buildings, its complexes) are preserved and turned into museums, natural and historical and cultural territories are turned into museums);
- a spatial approach of turning heritage into a museum, in which the entire historical space becomes a museum, that is, along with the traditional type of museum, an open-air museum is formed, which is largely related to the status of a scientific structure;
- the creation of a varied museum and tourist offer, which will allow to disperse visitors to different facilities on the territory of the Suburban Observatory and will be aimed at reducing the anthropogenic pressure on historical buildings and other key areas of the historical territory.

This approach to the development of the museum space is intended to ensure the organiza-

tion of a careful visit to the property nominated for the World Heritage List, and also to provide additional knowledge and impressions of the observatory and at the same time to avoid excessive loads on the main monuments of science, history and culture.

In terms of presentation and popularization of the Astronomical Observatories of Kazan Federal University and other monuments that make up the attributes and characteristics of Outstanding Universal Value of the nominated property, the following are especially important:

- Multifunctional exhibition pavilion of Kazan Federal University scientific and educational centre in the field of natural sciences and astrophysics "Astropark",
- Planetarium,
- Palace of Science and Technology "UNIGRAD",
- Exhibition of scientific instruments in the open air.

d) Strategy for sustainable development of tourism on the territory of the property nominated for the World Heritage List

Threats to a World Heritage Site Nominated by Tourism Development

The optimal mechanism for the development of the territory and the local community without harm to the site nominated to the World Heritage is to create conditions for sustainable tourism development. However, the current trends in tourism development clearly indicate the constant increase of tourist pressure on the site and the extreme unevenness of the tourist flow during the seasons of the year. Because of the educational process in the building of the City Observatory, excursions are not conducted directly in the building.

Information about the building of the City Observatory is included in the excursion tour around the territory of the courtyard of Kazan Federal University, conducted both for students and tourists in Kazan. The building of the City Observatory itself is subject to the anthropogenic impact of the flow of bachelors, masters and graduate students, employees of the departments of astronomy and space geodesy and radio astronomy.

The average number of visitors to the Engelhardt Suburban Astronomical Observatory is 28,000 people a year. In general, over the past four years, the attendance of the Observatory has increased considerably.

This situation is aggravated by the extremely uneven load on the suburban observatory complex throughout the year. So, according to the sale of museum tickets, only a few thousand people come to the museum in the winter months, and in summer the attendance doubles. In order to evenly distribute the seasonal load, an action plan has been developed for the winter months, first connected with the load on museum properties. During the summer period, as already mentioned, the load will be distributed through the development of museum and tourist and recreational offers.

Basic principles of tourist development of the territory

According to a marketing research conducted by the Austrian consulting company Kohl & Partners, the most promising types of tourism for development in the Republic of Tatarstan are: cultural, educational, scientific, active, ecological.

On the territory of Engelhardt Astronomical Observatory, the following types of activities for visitors are carried out:

- KFU Planetarium programmes;
- excursions to Engelhardt Astronomical Observatory;

- field practices for KFU students;
- health programmes for KFU students and employees (Ski base);
- international astronomical schools, all-Russian and international conferences and symposia organized by KFU;
- events dedicated to significant dates in the field of astronomy and cosmonautics;
- a number of educational programmes to involve young people in the study of Earth and space sciences, popularize the achievements of Russian astronomers and cosmonauts, preparation and testing of educational materials and methods;
- interactive events in natural science and engineering, including and primarily in the field of astronomy and the use of the results of space activities.

Besides the Astronomical Observatories of Kazan Federal University, along with UNESCO World Heritage sites – the ancient city of Bolgar, the Kazan Kremlin and the Assumption Cathedral and the monastery of the island-city of Sviyazhsk are part of the international project "The Great Silk Route", implemented with the support of the Ministry of Culture of the Russian Federation and the Interparliamentary Assembly of the Commonwealth of Independent States. The Silk Road project is a route uniting 6 regions of the Russian Federation (the republics of Dagestan, Kalmykia, Karachay-Cherkessia, Tatarstan, Altai Territory and Astrakhan Region) and the countries of the Commonwealth of Independent States located at the intersection of trade routes.

In order to develop the concept of sustainable tourism and reduce the impact of negative factors of anthropogenic pressure from an increase in the tourist flow on the territory of the suburban observatory, the project of the tourist and recreational cluster "Observatory" involves the development of tourist infrastructure not on the territory of the nominated property and its buffer zone, but outside it – in area of the federal highway M7, ski sports and recreation complex "Kazan", country club "Sviyaga". The creation and development of facilities of the tourist and recreational cluster at the same time will contribute to the popularization of cultural heritage sites. The availability of facilities will be ensured by the location of the main tourist infrastructure near the federal highway M7 (Moscow-Ufa).

While developing the tourist potential of the Astronomical Observatories and increasing the flow of tourists, we take into account the need to limit the land transport load on the tourist destination. In this regard, in 2023, it is planned to build an intercepting parking lot for vehicles with the delivery of tourists by shuttles to the entrance zone of the suburban observatory using an ecological gas engine or electric drive. The development of railway communication will have a positive impact on limiting the traffic load on the observatory.

Currently, there is a positive trend in the Republic of Tatarstan that the growth in the expansion of tourist services and income from the tourism sector is ahead of the growth in tourist flows. An increase in income from the tourism sector on the territory of separate sites of the complex will stimulate tourists to visit a larger number of sites of the observatory complex. Additional sources of income for the Observatory will be provided by the tourist catering services, sales of souvenirs, exhibitions and sales of scientific exhibits and other additional services.

The factors that will lead to a significant outstripping of the growth of income from the tourism sector in comparison with the growth of the tourist flow, as well as the development of "sustainable" and "high-quality" tourism in the territory of the nominated object, we include:

1. Introduction of a special booking system for visiting the facilities "Planetarium", "UNIGRAD", the Museum of the History of Astronomy;

2. Raising the level of public catering enterprises, as well as its status from "cafe" to "restaurant";

3. Conducting exclusive master classes, interactive programmes for students of a scientific nature;

4. Organization of "ecological" routes through the territory of the Astropark.

5. Development of a system of events aimed at maintaining the uniqueness of the place, and events that emphasize Outstanding Universal Value: – theater festivals, night observations of the starry sky, concerts, gastronomic festivals, individual trips aimed at studying optical astronomy, space geodesy, radio astronomy, art residences, scientific seminars and conferences.

6. Organization of events aimed at revealing the value of the architecture of observatories and its significance in the context of the history of Russian and world science, art and culture (exhibitions, installations, educational events).

7. Strengthening the work of marketing tools to attract tourist flow to the territory of the Observatory cluster, and not to the nominated property itself.

A strategy for sustainable tourism should take maximum account of the necessity to preserve the integrity and authenticity of a property nominated for the World Heritage List and its historical surroundings, as well as the interests of the tourism market. The developed tourism strategy is based on the marketing research of the target audience, on the calculations of the maximum permissible anthropogenic pressure on the observatory and the historical landscape. These activities are a priority at the moment.

The main principles of tourism development on the territory of the suburban observatory are:

- the development of such areas of tourism activities that meet the objectives of preserving the Astronomical Observatories and its Outstanding Universal Value and excludes any possible negative impact;
- interaction and cooperation with all parties concerned, development of mechanisms to maintain stability of the situation, reduce risks for a property nominated to the World Heritage List;
- stimulation and encouragement of the development of forms of tourist activity that contribute to the restoration of the historical landscape and natural ecosystem, the preservation and development of traditional material and non-material culture culture;
- a positive impact on the local community as an environment-forming factor and as a factor in improving conditions and living standards through the creation of new jobs.

To solve the problems of presentation and popularization of the monuments of Sviyazhsk, the prerequisites were created for organizing the following types of tourism:

- scientific and congress tourism;
- cultural and educational tourism,
- ecological tourism,
- event tourism.

Also, children's tourism programmes and cultural and educational trips are being formed in order to increase the educational level of adolescents and young people and develop the youth local history movement. These programmes are closely related to the issues of school education and patriotic education. The observatory's own tourist product is actively being formed and the organization of tourist and excursion services is provided in cooperation with tourist companies in the domestic and international tourist markets.

Development of modern methods of museum display and multimedia means and technologies require to use. In order to achieve the maximum "museum-exposition" effect, the Management Plan provides that sightseers and tourists will be able to observe both scientific instruments in museum expositions, and "living" tools of an open-air museum with the opportunity to touch science. This will not only give them new information, but will also strengthen their sense of involvement in history and science, give an idea of the very process of astronomical observations, of the work of astronomers. For schoolchildren and students, the exploring of these monuments has been introduced into the lessons of history, physics, the volunteer movement in order to give not an abstract, but a specific idea on the history of the development of science in the region, the significance of astronomical monuments.

Its own information resource (Internet support, booklets and guidebooks, a hotel booking system) is subject to improvements, which will allow the

Observatory to independently go to tourism fairs, including international ones.

The most important component of the tourist structure should be a visit centre, which also performs information, organizational and service functions. The centre will allow the tourist to receive information about all the components of the regional tourist product (museums and other attractions, hotels, restaurants, entertainment, folk crafts, transport, etc.), provide the tourist with information and local history literature, tourist maps, as well as video and audio recordings , information and souvenir CDs, etc. It will also carry out the function of booking hotels and other accommodation, both in the Republic of Tatarstan and on the further route, ordering excursions and transport.

Management of visits to the Astronomical Observatories of Kazan Federal University

The Management Plan outlines measures to protect the World Heritage site from the potential negative impact of tourism. They include a variety of means:

- the introduction of restrictions on the use of transport and travel through the territory of Engelhardt Astronomical Observatory;
- the establishment of security regimes on the territory of the observatory complex, prohibiting the unauthorized arrangement of recreation sites, setting up camps, setting up tents;
- organization and control of the admission of visitors to the territory of Engelhardt Astronomical Observatory (through the system of organized entrance to the territory from the parking lot of vehicles, as well as through the services of the visit centre);
- development and introduction of visiting modes for separate monuments and museum and exhibition expositions located in them, including restrictions on visiting time and the limit of people staying in them at the same time;
- prohibiting visitors' presence at museum expositions located at separate monuments in case of unfavorable weather conditions (rain, snowfall, etc.) to prevent a possible drop in temperature and humidity, negative impact on the interiors of buildings.

The following preventive measures are planned to reduce anthropogenic pressure:

- performing calculations of the permissible anthropogenic pressure on the properties of Engelhardt Astronomical Observatory and its landscape environment, considering the functional zoning of the territory
- creation of an extensive system of museum expositions, allowing to redistribute the anthropogenic pressure over the territory of the Observatory;
- redistribution of anthropogenic pressure throughout the calendar year through the development of a system of presentation events.

A hotel for students doing practical work at the observatory is planned to be built. However, the further development of hotel facilities on the territory of Engelhardt Astronomical Observatory will practically not take place (the Management Plan provides for the maximum expansion of the capacity of the hotel chain). This will be one of the factors of limiting the intense anthropogenic pressure connected with the development of tourism.

Environmental protection

The factor of threat to the natural environment of the suburban observatory is human economic activity connected with pollution of natural environment, as well as with violation of town planning regulations and land use.

Activities for the preservation of the natural environment of a property nominated for the World Heritage List include:

- study of the natural complex under the programme of long-term monitoring studies of bi-

odiversity, ecosystems and landscapes; research is carried out by specialists of the Kazan Federal University, their recommendations become the basis for planning practical events;
- monitoring studies of the state of the environment (air, water, soil); carried out by local specialists of the sanitary and epidemiological service under a special programme of quarterly monitoring of maximum permissible substances, during which measurements of substances polluting the atmosphere, chemical analysis of water and sources of drinking water are made;
- daily meteorological observations;
- seasonal preventive measures to ensure the environmental safety of visitors, employees and local residents (acaricidal treatment of the territory in spring, deratization treatment in spring and autumn);
- control, including a quarterly chemical analysis of water from water supply systems; control over subsoil use; control of emissions of pollutants into the atmosphere;
- recycling of production and consumption waste.

The Management Plan also outlines the following engineering measures:
- reconstruction of utilities and wastewater treatment and sewerage systems;
- modernization of the waste management system (collection, sorting, disposal and storage) on the territory of the observatory and the buffer zone.

Important events in the environmental protection system are systematic educational work in the field of ecology and nature protection, including lectures and briefings, preparation of exhibitions and popular science publications, as well as the organization of environmental events with the participation of the local population.

Social and economic development of the territory

Preservation and presentation of Astronomical Observatories is a strategic direction for the development of the local social and economic complex

The nomination of the Astronomical Observatories of Kazan Federal University to the World Heritage List and the preparatory work carried out in connection with this allows us to set the following strategic task: the scientific heritage is a special and very important economic resource, it can and should become the basis of a special branch of specialization of the Observatory, Oktyabrsky village, it should become one of the promising areas of development of the local economy.

Also, this resource has a significant social and economic impact on the territory of Zelenodolsk district, where the buffer zone of the suburban observatory is located. The growing activity of the Observatory administration on the presentation and popularization of the property nominated for the World Heritage List, and the related development of the sphere of culture, tourism, service institutions and social infrastructure sectors can bring a significant economic effect due to the emergence of new sources of investment and providing a district budget, due to the new employment prospects.

The general orientation of the planned activities enables us to speak about high social benefits and social efficiency. It is connected primarily with the development of science, culture, maintenance of spiritual life, improvement of the ecological situation and preservation of the historical and cultural environment, improvement of education process, environmental education, etc.

At the same time the new circumstances of economic development also carry potential threats: – intensive development of activities that do not properly reveal Outstanding Universal Value of the property, but are designed for an average consumer and are carried out according to standard impersonal schemes.

The Management Plan in this situation is based on the following principles:

- if issues related to the development of the socio-economic complex arise, the main priority is not economic facilities, but the preservation of Outstanding Universal Value of the property Astronomical Observatories of Kazan Federal University;
- any new project related to the buffer zone of a property nominated for the World Heritage List and nearby territories must, at the preliminary design stage, go through the procedure for performing an impact assessment on Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University and the surrounding landscape in accordance with the recommendations of UNESCO so as not to harm the integrity and authenticity of the property;
- one of the priorities of the development of the social and economic complex is the creation of conditions for the development of the local community.

7.4. Strategic goal 3. Promotion of the site and involving local population in achieving public consensus on the conservation and usage of the property nominated for the World Heritage List

a) Interaction with the local population and creating conditions for the development of the local community

The Management Plan assumes active participation of the local population. Currently Oktyabrsky village is home to 3,234 people, on the territory of Engelhardt Astronomical Observatory 67 people live. The property has a significant impact on the economy and social complex of Oktyabrsky village.

It is important to emphasize that some of Engelhardt Astronomical Observatory staff are reside in the village. Thus, the nominated World Heritage site plays an important role in providing employment to the locals, enabling local professionals to have access to decent employment and stay in the region.

In summer a temporary increase in the staff of the museum is required in order to ensure the overall workload on serving tourists. This results in more employment (both in Oktyabrsky village and in the regional centre and other settlements of Zelenodolsk district due to the restoration and construction work, expansion of tourist services, etc.). It is also important to note that the most attractive moment for tourism and tourist trade is the purchase of a product created at the Observatory; this purchase is part of the tourist experience.

b) Raising awareness of the local community

To preserve the Astronomical Observatory of Kazan Federal University and to achieve public consent it is necessary to establish constant information process of the local community of Oktyabrsky village about the activities of Engelhardt Astronomical Observatory, students and employees of KFU about the City Observatory, scientific symposia, conferences, practical observations, projects for the development and presentation of nomination components, and projects for the development of social infrastructure in its buffer zones.

KFU plans its activities as an organization open to society (the system for raising awareness of the local community about development plans includes both passive forms (transmission of information, organization of exhibitions and other events) and active (discussions, reports, participation of local residents in the activities of the museum, in joint projects).

Characteristics of the local community

Engelhardt Astronomical Observatory is located in Zelenodolsk district of the Republic of Tatarstan. The total population of Zelenodolsk district was 165.9 thousand people in 2020, of which almost 60% is rural population. The population is stable. The centre of Zelenodolsk district is the city of Zelenodolsk, the fifth largest city in Tatarstan. In Zelenodolsk district there is a UNESCO World Heritage site "The Assumption Cathedral and the Monastery of the Island-Town of Sviyazhsk", included in the List in 2017. In the immediate vicinity of Engelhardt Astronomical Observatory, there is Oktyabrsky village, formed in 1919. The area of settlements that make up Oktyabrsky village is 270 ha. On the east side, Oktyabrsky village borders on the city of Kazan; on the southwest it borders on Vasilyevo village; on the north-west it borders on Novopolskoye village. The population (January 1, 2021) is 3,234 people. There are the following facilities in Oktyabrsky village: the local affiliate of the State Healthcare Institution "Republican Clinical Anti-Tuberculosis Dispensary" – "Children's Tuberculosis Sanatorium", Oktyabrsky affiliate of the polyclinic of "Vasilyevskaya District Hospital", Observatory secondary school, Kindergarten No. 5 "Belochka", a rural House of Culture, a village library, St. Vladimir's Church, a mosque, a branch of PJSC Sberbank of Russia Additional Office No. 8610/0555, a Russian Post Office, a hairdresser's, a pharmacy, a car service, a gas station, more than 10 trading facilities.

Engelhardt Astronomical Observatory is located on the territory of Oktyabrsky village. Therefore, the policy of its social and economic development, as well as construction and housing improvement are essential for the preservation and presentation of Outstanding Universal Value of the nominated property.

The development of the territories surrounding the nominated property is carried out according to the Spatial Planning Schemes. Zelenodolsk district was introduced to the scheme with Engelhardt Astronomical Observatory, and Kazan – with Kazan Observatory, on the territories of which the buffer zone sections are located, in the 2000s. This is the main document that defines the directions and parametres of the region's development, construction, land use, social and economic indicators. However it is necessary to adjust the territorial planning schemes for these areas, taking into account the new circumstances of the development of the area, namely: the inclusion of the Astronomical Observatories of Kazan Federal University in the World Heritage List, as well as measures to preserve the integrity and authenticity of sites and its cultural landscape.

This document will gain legal force after its final development, passing public hearings and approval at the level of the Government of the Republic of Tatarstan. The planning document should be developed jointly with the administration of Kazan Federal University and become an effective tool for preserving the authenticity and integrity of the nominated property.

Beginning with the preparation of materials for the nomination of the Astronomical Observatories and later, in the process of developing the Management Plan, meetings were held with the local population, with heads of local organizations and institutions in order to clarify their interests and needs, as well as possible participation in the activities of the Management Plan of the nominated object. A survey was conducted to identify the opinions and interests of various concerned groups.

One the important things to attract the local community is to introduce the principles of dialogue, cohabitation, popularization of the system of traditions and values in culture, education and science and apply them in the policies of federal, republican and local authorities. In the Management Plan a separate section is devoted to this issue, aimed at implementing the measures proposed in 2010 by the United Nations to bring cultures closer together and correct inappropriate cultural values, stereotypes and perceptions.

It is expected that with the inscription of Engelhardt Astronomical Observatory as part of the nomination "The Astronomical Observatories of Kazan Federal University" in the UNESCO List, the local population will be able to improve their living and employment conditions due to the active development of the Suburban Observatory complex, its preparation and inscription into the World Heritage List. Moreover, the interest in visiting this property will increase significantly.

Other concerned parties

In addition to the local community, there are other parties interested in using the area. Interaction with municipal authorities (they are Zelenodolsk district and Oktyabrsky village) is established in terms of compliance with legislation on the protection of cultural heritage sites, prevention of illegal construction and unauthorized archaeological work.

One of the private houses in the buffer zone of Engelhardt Astronomical Observatory is the house of the Deputy Minister of Finance of the Russian Federation – A. Lavrov who is aware of the protection legislation and complies with all its requirements.

This allows the nominated properties to defend the interests of protection and rational use of monuments of history and culture, science and technology, to coordinate legislative decisions. An important aspect of cooperation between the local authorities and the administration of the Kazan Federal University and Engelhardt Astronomical Observatory is the housing improvement of nearby settlements and the conducting mass local and external public events.

Tourists and sightseers represent the largest group of visitors of Engelhardt Astronomical Observatory. In 2020, their total number was more than 20,000 people. The main purpose of the trip is to acquaint visitors with the outstanding architectural and scientific monuments of the observatory and visit museum expositions. Due to the development programme of Engelhardt Astronomical Observatory and the planned new museum sites, its attendance will grow at a significant rate. The growth in attendance creates a high load, although the traffic indicators have not yet reached its limit values. The maximum load on Engelhardt Astronomical Observatory and sustainability of the cultural landscape is roughly estimated at up to 500 thousand people per year. However, it is important to take into account that the main recreational pressure on the historical territory occurs mainly within four months (from June to September). Currently Engelhardt Astronomical Observatory is having a hard time coping with this peak load during the summer and fall months.

The load on the territory is also very uneven. Tourists and excursion groups explore a very small part of the territory of the Astronomical Observatory. The greatest recreational load is experienced by the Museum of the History of Astronomy and the Planetarium.

In the daytime up to 500 visitors from various regions of Russia and foreign countries are marked here. After including the property in the World Heritage List, the estimated load will be 2 thousand tourists. It is a very serious and in fact critical load for natural landscapes and sites of cultural heritage; in such a situation, the anthropogenic pressure on local cultural and natural complexes increases significantly. With regard to the territory development program, zoning of the territory is planned in order to distribute the flows more evenly. A Unigrad house of science, sports and residential zones reduce this load.

In order to prevent the risks of the influence of anthropogenic pressure, studies of the recreational load on certain parts of the island are already being carried out, a study of the state of natural and cultural landscapes and present tourist flow. On this basis, optimization will be developed, and the redistribution of extreme tourist loads to certain territories of Engelhardt Astronomical Observatory will be carried out.

It should be noted that there is a positive example of state and private partnership on the territory of Engelhardt Astronomical Observatory. Thus, entrepreneur V. Sosyuk, an enthusiast of astronomy, at his own expense restored the pavilions of telescopes and the AZT-14 telescope for the younger generation. He himself is also engaged in observational astronomy with the AZT-14 telescope.

c) Scheme of the implementation of the Management Plan for the Astronomical Observatories of Kazan Federal University

Monitoring is an integral part of the state protection of cultural heritage sites. It is carried out in accordance with the Decree of the Government of the Russian Federation of 05.07.2001, No. 504 "On all-Russian monitoring of the state and use of historical and cultural monuments, items of the museum fund of the Russian Federation, documents of library funds, archival funds of the Russian Federation, as well as film funds", and in the order, determined by the Order of the Ministry of Culture of the Russian Federation dated May 28, 2002, No. 848.

Monitoring tasks are:

- registration of historical and cultural sites, which are under the state protection;
- inventory of movable property objects of historical and cultural value, which are an integral part of immovable monuments of history and culture;
- prevention of damage to historical and cultural sites;
- prevention of illegal (unauthorized) construction in the zones of protection of historical and cultural sites;
- control over the work on repair, restoration, conservation, reconstruction and adaptation of historical and cultural sites;
- supervision over compliance by users (owners) with the rules for the use of historical and cultural sites, in accordance with the current legislation on the protection of historical and cultural sites;
- making informed decisions on the effective use of historical and cultural sites;
- coordination of financing aimed at preservation of historical and cultural sites;
- formation and maintenance of the state information resource on the state of historical and cultural sites.

Key indicators for assessing the state of conservation of the site:

- ensuring legal protection of the site;
- the efficiency of the facility management system;
- indicators of the facility security system;
- indicators of the quality of restoration work;
- the level of promotion of the object's value and anthropogenic load on the site;
- the state of the natural environment of the site;
- the state of the buffer zone;
- raising awareness of the local community and reaching public agreement on the conservation and sustainable development of the nominated site;
- management of museum funds;
- risk management.

The system of activities for the implementation of the Management Plan for the site nominated on the UNESCO World Heritage List

№	Projects, events	Budget and source	Executor	Time frame
1. Preservation of Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University				
1.1.	The study of buildings of the City and Suburban Astronomical Observatories and their foundations using non-destructive methods.	Federal budget, budget of the Republic of Tatarstan	Institute of Archeology of the Academy of Sciences of the Republic of Tatarstan, Kazan (Volga Region) Federal University	2024–2026
1.2.	The study of the territory of the City and Suburban Astronomical Observatories using non-destructive methods (geological, aerospace and magnetic methods) and archaeological excavations	Budget of the Republic of Tatarstan	Kazan (Volga Region) Federal University, Institute of Archeology of the Academy of Sciences of the Republic of Tatarstan	2023–2026
1.3.	The assessment of the current state and the development of measures for the City and Suburban Astronomical Observatories preservation based on complex interdisciplinary historical, archaeological and natural science research to determine the construction time, materials and construction technologies.	Federal budget, budget of the Republic of Tatarstan	Kazan (Volga Region) Federal University, Institute of Archeology of the Academy of Sciences of the Republic of Tatarstan	2023–2028
1.3.1.	The study of astronomical tools in order to clarify their characteristics and identify potential threats and risks to their state.	Federal budget, budget of the Republic of Tatarstan	Scientific subdivisions of the Kazan (Volga Region) Federal University	2024–2026
1.3.2	The study of buildings of the City and Suburban Astronomical Observatories (the main administrative building and the building of the observatory with a refractor pavilion) in order to identify potential threats and risks and determine the best conditions for the preservation of the buildings.	Federal budget, budget of the Republic of Tatarstan	Scientific subdivisions of the Kazan (Volga Region) Federal University	2024–2026
1.4.	Implementation of computer technologies for mapping the state of instrumentation, observatory buildings (City Observatory, Littrow Observatory, Suburban Observatory building with a refractor pavilion, administrative building of a suburban observatory, telescope pavilions, meteor department pavilion) and their surroundings	Federal budget	Kazan (Volga Region) Federal University	2025–2028

№	Projects, events	Budget and source	Executor	Time frame
1.5.	Monitoring the observatory buildings state (City Observatory, Littrow Observatory, Suburban Observatory building with a refractor pavilion, administrative building of a suburban observatory, telescope pavilions, meteor department pavilion), the state of instrumentation and the formation of information database	Federal budget	Kazan (Volga Region) Federal University	Permanently
1.6.	Conducting comprehensive historical research including identification and study of new archival materials and sources; architectural, source studies, historiographical, fine art, cultural studies and comparative analysis	Federal budget	Kazan (Volga Region) Federal University, Institute of Archeology of the Academy of Sciences of the Republic of Tatarstan	2023–2038
2. Conservation and restoration of the Astronomical Observatories				
2.1.	Works on conservation of observatory buildings and strengthening of their condition: – work to improve the condition of foundations, – works to improve the condition of walls and roofs, – works to improve the condition of the internal load-bearing structures of buildings	Federal budget, Republican budget	Kazan (Volga Region) Federal University	2023–2026
2.2.	Accounting and storage of research samples, creation of a databank of recovered samples and a databank of ongoing restoration and conservation work	Federal budget	State Committee for the Protection of Cultural Heritage Sitets of the Republic of Tatarstan, Kazan (Volga Region) Federal University	2023–2038
3. Preservation of movable property				
3.1.	Organization of the Astronomy Museum in the Suburban Engelhardt Observatory (preceding the visit by tourists and excursionists to the observatory with the refractor pavilion)	Federal budget	Kazan (Volga Region) Federal University	2024–20

№	Projects, events	Budget and source	Executor	Time frame
4. Preservation of the historical and cultural environment				
4.1.	Implementation of functional zoning of Engelhardt Astronomical Observatory territory and the establishment of clear modes of use of each functional area	Republican budget	State Committee for the Protection of Cultural Heritage Sites of the Republic of Tatarstan, Kazan (Volga Region) Federal University	2023–2024
4.2.	Approval of the procedure for the reconstruction of residential buildings	Republican budget	State Committee for the Protection of Cultural Heritage Sites of the Republic of Tatarstan, Ministry of Construction, Architecture and housing and communal services of the Republic Tatarstan, Kazan (Volga Region) Federal University	2023–2024
5. Organization of effective use of the site nominated to the World Heritage List				
5.1.	Implementation of a system management measures for organizing the modern structure of museum services for visitors	Federal budget	Kazan (Volga Region) Federal University	2023–2024
5.2.	Organization of an exhibition of scientific instruments in the presentation complex	Federal budget	Ministry of Culture of the Republic of Tatarstan, Kazan (Volga Region) Federal University	2023–2026
5.3.	Organization of the Science Museum «From the Past to the Future» in the UNIGRAD Palace of Science and Technology	Federal budget	Ministry of Culture of the Republic of Tatarstan, Kazan (Volga Region) Federal University	2023–2026
5.4.	Creation of a digital space observatory «Space Digital Observatory»	Federal budget, Republican budget	Kazan (Volga Region) Federal University	2023–2028
5.5.	Creation of a digital system base for the study and development of natural resources on the bodies of the solar system	Federal budget	Kazan (Volga Region) Federal University	2023–2028

№	Projects, events	Budget and source	Executor	Time frame
5.6.	Creation of the Centre for the Study of Near and Deep Space, which will include: 1) a radio telescope with a diameter of 13 meters for radio interferometry with very long observation bases (VLOB); 2) a complex of optical telescopes with a lens diameter of 0.6 meters for carrying out paired synchronous observations equipped with a spectrograph, a CCD photometer; 3) quantum-optical system (QOS) «Sazhen-TM» for work on refining the elements of satellite orbits, including work on supporting the GLONASS system; 4) network for optical wide-field sky survey and space debris scanning based on sets of two scanners «Mini-MegaTortor».	Federal budget	Kazan (Volga Region) Federal University	2023–2028
5.7.	Development of the Roskosmos metrological testing ground for work with navigation equipment based on observations of the GLONASS satellite constellation	Federal budget	Kazan (Volga Region) Federal University	2023–2028
5.8.	Development of a practice base in the field of astronomy, ground and space geodesy, topography, radiophysics and radio astronomy for KFU students; year-round for nonresident participants	Federal budget	Kazan (Volga Region) Federal University	2023–2028
5.9.	Development of a seismology centre based on a seismic basement 10 meters deep with tiltmeters and seismographs to study the tectonic dynamics of the Republic of Tatarstan	Federal budget	Kazan (Volga Region) Federal University	2023–2028
5.10.	Development of an innovative Astropark as the basis for the priority area of space research at Kazan Federal University	Federal budget	Kazan (Volga Region) Federal University	2023–2028
5.11.	Annual events: International School-Conference «PROCosmos and Space Science»	Federal budget	Kazan (Volga Region) Federal University	2023–2028
5.12.	Creation of the gravimetry centre of the world gravimetric network	Federal budget	Kazan (Volga Region) Federal University	2023–2028
5.13.	Creation of a carbon landfill site and its control centre	Federal budget	Kazan (Volga Region) Federal University	2025–2029

№	Projects, events	Budget and source	Executor	Time frame
5.14.	Creation of the Scientific Council of the Planetarium and its educational development	Federal budget	Kazan (Volga Region) Federal University	2023–2028
5.15	Creation of the Centre for Earth Remote Sensing Using Modern Radiometric Methods	Federal budget	Kazan (Volga Region) Federal University	2023–2032
5.16	Creation of a Consortium for the development of KFU Astropark in the global scientific and information space with the involvement of world-renowned scientists with high rating indicators	Federal budget	Kazan (Volga Region) Federal University	2023–2032
5.17	Establishment of the Centre for Astronomical Knowledge	Federal budget	Kazan (Volga Region) Federal University	2023–2032
5.18	Formation and development of a common research infrastructure of the EAO and the National Library of Science «radiophysical testing ground»	Federal budget	Kazan (Volga Region) Federal University	2023–2032
5.19	Turning other historic buildings and monuments of the Suburban Engelhardt Observatory into museums as required	Federal budget	Ministry of Culture of the Republic of Tatarstan, Kazan (Volga Region) Federal University	2028–2043
6. Ensuring sustainable tourism development				
6.1.	Development of a new concept for tourist development of Engelhardt Astronomical Observatory and neighboring to the Republic of Tatarstan territories	Republican budget	Ministry of Culture of the Republic of Tatarstan, State Committee of the Republic of Tatarstan on tourism, Kazan (Volga Region) Federal University	2024–2025
6.2.	Marketing research of the target audience for the development of tourism at the World Heritage site	Federal budget	Ministry of Culture of the Republic of Tatarstan, State Committee of the Republic of Tatarstan on tourism, Kazan (Volga Region) Federal University	2023–2025

№	Projects, events	Budget and source	Executor	Time frame
6.3.	Conducting research on the maximum permissible anthropogenic and recreational loads at the World Heritage site and in its buffer zone	Republican budget	Ministry of Culture of the Republic of Tatarstan, State Committee of the Republic of Tatarstan on tourism, Kazan (Volga Region) Federal University	Realization in 2024, actualization based on the practice of 2025–2026
6.4.	Organization of a new parking zone on the territory of Oktyabrsky village	Republican budget, private investor funds	Ministry of Transport and Roads of the Republic of Tatarstan	2024–2027
6.5.	Providing the administration of the Engelhardt Observatory with electric transport for the carriage of passengers from the parking place to the territory of the observatory	Republican budget	Ministry of Culture of the Republic of Tatarstan, State Committee of the Republic of Tatarstan on tourism, Kazan (Volga Region) Federal University	2023–2026
7. Environmental protection				
7.1.	Organization of waste disposal activities	Republican budget	Ministry of Ecology and Natural Resources of the Republic of Tatarstan, Zelenodolsk municipality, Kazan (Volga Region) Federal University	2024–2025
7.2.	Reconstruction of utilities and cleaning systems	Federal budget	Ministry of Construction, Architecture and Housing and Communal Services of the Republic of Tatarstan, Zelenodolsk municipality, Kazan (Volga Region) Federal University	2023–2026
7.3.	Environmental monitoring	Federal budget	Kazan (Volga Region) Federal University with the experts involvement	2023–2043

№	Projects, events	Budget and source	Executor	Time frame
7.4.	Environmental education of the residents	Federal budget	Kazan (Volga Region) Federal University, Ministry of Ecology and Natural Resources of the Republic of Tatarstan	Permanently
8. Socio-economic development of the territory				
8.1.	Plans correction for territorial development of Zelenodolsk district of the Republic of Tatarstan considering the buffer zone modes of the Suburban Engelhardt Observatory	Republican budget, municipal budget	Ministry of Construction, Architecture and Housing and Communal Services of the Republic of Tatarstan, Zelenodolsk municipality	Development in 2024
8.2.	Development of Oktyabrsky village infrastructure to meet the needs of visitors coming to the nominated World Heritage site	Republican budget, municipal budget, private investors, administration of Oktyabrsky village	Ministry of Construction, Architecture and Housing and Communal Services of the Republic of Tatarstan,	2025–2026
8.3.	Stimulating the attraction of museum workers and creative intelligentsia to permanent residence in Zelenodolsk district	Republican budget, private investors	Ministry of Culture of the Republic of Tatarstan, Zelenodolsk municipalit	Program development in 2023 Implementation: 2024–2028
9. Local community development				
9.1.	Developing an awareness raising program for local community on Outstanding Universal Value in the Plan of World Heritage site management, land use and management rules	Federal budget	Kazan (Volga Region) Federal University	2016–2018
9.2.	Conducting a sociological survey of the residents of Oktyabrsky village, Zelenodolsky district, living within the buffer zone of the nominated World Heritage site	Federal budget	Kazan (Volga Region) Federal University, Zelenodolsk municipality	2024–2025

№	Projects, events	Budget and source	Executor	Time frame
10. Popularization and promotion of the site nominated for the World Heritage List				
10.1	Scientific and popularization activities to promote the Astronomical Observatories of Kazan Federal University	Federal budget	Academy of Sciences of the Republic of Tatarstan, Kazan (Volga Region) Federal University, Ministry of Culture of the Republic of Tatarstan, State Committee of the Republic of Tatarstan on tourism, scientists and public figures	Permanently
10.2	Activities to promote the historical, cultural, scientific and artistic value of the Astronomical Observatories of Kazan Federal University	Federal budget	Ministry of Culture of the Republic of Tatarstan, Kazan (Volga Region) Federal University, scientists and public figures	Permanently
10.3	Organization of a wide range of events and projects at the regional, interregional and international levels (international conferences, seminars, meetings, etc.)	Federal budget, investor funds	Academy of Sciences of the Republic of Tatarstan, Kazan (Volga Region) Federal University,	Permanently
10.4	Specialized publishing activities and creation of electronic publications and sites for the promotion of cultural and scientific heritage of the Astronomical Observatories of Kazan Federal University	Federal budget, investor funds	Kazan (Volga Region) Federal University	2023–2043
11. Stakeholder Engagement				
11.1	Conclusion of agreements on joint partnership activities under the Management Plan with various stakeholders (municipalities management, interested departments and institutions, business entities, religious, public organizations)	–	Kazan (Volga Region) Federal University	Permanently
11.2	Conclusion of specific contracts for the provision of work or services for the needs of the Astronomical Observatories of Kazan Federal University (with organizations, institutions, individuals)	Federal budget	Kazan (Volga Region) Federal University	2023–2038

d) Resource support of the property Management Plan

Human resourcing

The research and educational centre "Resource Centre "The World Cultural Heritage" is a structural unit of the Higher School of History and Cultural Heritage of the Institute of International Relations of Kazan Federal University. Together with the Department of the World Cultural Heritage of Kazan Federal University this centre organizes advanced training programmes for employees of the Astronomical Observatories that include the efficient management and protective measures designed for the cultural heritage sites and developed on the basis of international and Russian experience, as well as the experience gained at UNESCO sites located in the Republic of Tatarstan (the Kazan Kremlin, Bolgar, Sviyazhsk). The employees of the museum and the main structural units of Engelhardt Astronomical Observatory and the City Astronomical Observatory regularly participate in advanced training related to the issues of organization and management of cultural heritage sites, arranged by the Department of the World Cultural Heritage and the Resource Centre.

Kazan Federal University has bachelor's programmes for the training of historians, archaeologists, ethnologists, culturologists, museologists, regional experts and international specialists. In addition together with the University of Cottbus (Federal Republic of Germany) training is being conducted on the master's programme "Management of cultural heritage" that combines specialists-bachelors of the above areas prepares narrow specialists in the field of protection and management of cultural heritage to work both at properties included in the UNESCO Cultural Heritage List (3 of them are located in the Republic of Tatarstan, the remaining 27 in various regions of the Russian Federation), and in museums, historical and cultural monuments of federal, regional and local significance. The key teachers of this programme are members of the regional and all-Russian affiliates of ICOMOS-Russia, the head and members of the Volga affiliate of the UNESCO Chair for the preservation of architectural and urban planning monuments, candidates and doctors of historical sciences, art history, cultural studies, archaeologists, restorers, specialists in the field of international relations. Among them there are such names as A. Sitdikov – Director of the Institute of Archeology of the Academy of Sciences of the Republic of Tatarstan, Dean of the Higher School of Historical Sciences and World Cultural Heritage, R. Valeev – Vice-President of the Russian Affiliate of ICOMOS, Head of the Volga Affiliate of the UNESCO Chair for the Preservation of Architectural and Urban Monuments, Deputy Director of the Institute of International Relations, R. Khairutdinov – Director of the Institute of International Relations of the Kazan Federal University, Director of the ANO "Institute of Cultural Heritage" (since 2004), Chairman of the Heraldic Council under the President of the Republic of Tatarstan (since 2006), Chairman of the Council of the Department of the Russian Historical Society in Kazan (since 2013). All of them took an active part in the work of the expert council of the Republican Foundation for the Revival of Historical and Cultural Monuments, responsible for the inclusion of the Bulgarian Historical and Archaeological Complex and the Assumption Cathedral and the Monastery of the Island-City of Sviyazhsk in the UNESCO World Heritage List in 2014 and 2017. They monitored the implementation of the Management Plan for these sites, as well as key scientists did who participated in the development of the dossier and the Management Plan both for these nominations and for the Kazan Kremlin which was included in the World Heritage List in 2000.

Besides that, in 2019, the National Committee of ICOMOS-Russia signed a Memorandum of Understanding with the Greek National Committee. According to this Memorandum, it is planned to implement exchange programmes on protection

of cultural heritage for students of Kazan Federal University and the National Technical University of Athens; currently, unfortunately, these programmes are forcedly postponed due to the pandemic.

In addition to KFU, Kazan State University of Architecture and Civil Engineering have special programmes for the restoration of cultural heritage, Kazan State Institute of Culture provide programmes for museology and the protection of cultural heritage.

Kazan Observatory performs educational functions. It houses the Department of Astronomy and Space Geodesy and classrooms. In order to reduce the anthropogenic pressure on the historic building, excursions are not conducted. To direct the tourist flow into an organized channel, to reduce the negative impact on the construction of the 19th century, to ensure its safety, part of the equipment and tools was transferred to the Museum of the History of KFU where organized excursions are held and in addition to the history of the life and work of the great mathematician and the rector of the university, you can get acquainted with unique authentic tools of a high level of preservation and to study the history of the development of astronomy in Kazan and the contribution of Kazan scientists to domestic and world astronomical science.

The building of the City Observatory houses the 19th-century instruments used in teaching history of astronomy – the Fraunhofer Merz Refractor; the Repsold heliometer; the George Dollond telescope; Vienna meridian circle; equatorial; a large travel instrument, as well as an accurate time clock. Other instruments of the 19th century are stored in the Museum of the History of Astronomy in the suburban observatory, as well as in separate pavilions on the territory of the Astropark – pavilions for the Heide telescope, heliometer, meniscus telescope, solar telescope – and are used in teaching and, in some cases, during practice and field research. Also students undergo practical training using telescopes of the 20th century, like AZT-14. In addition students use modern equipment located in both city and suburban observatories. Such a combination of old and modern tools allows you to feel respect for the history and spirit of astronomical science, touch the things which the great scientists of Kazan Federal University used in the past, contributes to the preservation of the spirit of the place – the genius locus – of observatories, while making it possible to use the most advanced technologies of modern science.

The average number of visitors to Suburban Engelhardt Astronomical Observatory is more than 20,000 people a year. Statistics is collected by the observatory administration.

Attendance at Engelhardt Astronomical Observatory and the KFU Planetarium:

In 2019:

KFU Planetarium – 26,554 people

Engelhardt Astronomical Observatory – 2,032 people

In total in 2019 – 28,586 people.

In 2020:

KFU Planetarium – 8,830 people

Engelhardt Astronomical Observatory – 1,500 people

In total in 2020 – 10,330 people, taking into account the fact that from March 19 to August 31, 2020 Engelhardt Astronomical Observatory and the KFU Planetarium were closed due to COVID-19.

In 2021:

KFU Planetarium – 22,866 people

Engelhardt Astronomical Observatory – 1,680 people

In total in 2021 (03.01.2021 – 30.11.2021) – 24,546 people.

In total from 2019 to November 2021, Engelhardt Astronomical Observatory and the KFU Planetarium were visited by 63,462 people.

On the territory of Engelhardt Astronomical Observatory visitors are offered the following services:

- Guided tours of Engelhardt Astronomical Observatory including a visit to the museum exposition (both in Russian and English): the history of the Kazan Astronomical School, the history of Engelhardt Astronomical Observatory,

acquaintance with astronomical instruments, telescopes and the principles of its work.

- Educational programmes in astronomy and natural science in the KFU Planetarium (both in Russian and English): specialized programmes, including visual observations through telescopes, specialized programmes for preschool children, conducting thematic sessions, astronomical lectures on the dome of the Planetarium, demonstration of spherical films on astronomy and natural history, interactive excursions to the exhibits of the Planetarium. ·
- Field practical work for students
- Recreational activities for KFU students and employees
- Parking
- In the pavilion located next to the Planetarium building a cafe, a toilet (you can also visit a toilet in the Planetarium building), a souvenir shop is planned to be placed
- Multifunctional exhibition pavilion of the KFU scientific and educational centre in the field of natural sciences and astrophysics "Astropark".

The programme of excursion to the KFU Planetarium in Suburban Engelhardt Astronomical Observatory

The standard excursion programme lasts one and a half hours. It consists of three parts: an interactive tour in the hall of the Planetarium (acquaintance with the exhibits), an astronomical lecture on the dome of the Planetarium and a spherical film. The excursion starts with an interactive tour in the lobby where visitors get acquainted with the exhibits of the Planetarium. The guides tell about famous astronauts and their records, about the nature of the planets and levitation, demonstrate the work of the Tesla coil. The visitors can learn many informative and interesting things during the excursions, for example how to recharge with "cosmic energy" from meteorites presented in the Planetarium. Then the excursion continues in the "Star Hall" for 83 visitors with a dome diameter of 15 m and a dome slope of 10 degrees. On the dome there is the optical-mechanical projector MEGASTAR, made in Japan, which creates the illusion of a night sky and reproduces with great accuracy the position and movement of stars and planets at any latitude, at any moment of the past, present or future. Up to 10 million stars can be seen with this system. The digital system DomeSky is also used here for the demonstration of spherical films. There are more than 20 films in the library. The planetarium conducts educational classes in various sections of astronomy and natural science. The lecturers highlight interesting events in these areas. The visitors can talk to the lecturer, ask questions and watch different films. Exciting programmes for preschool children are held on Sundays. The KFU Planetarium also holds the stargazing nights ("Night show"). This is an expanded programme that includes visual observations using telescopes. But such observations are possible only when the sky is clear. Stargazing nights are announced in advance; the date and time of the event are appointed taking into account the weather conditions. The KFU Planetarium programmes are aimed at different age groups.

Excursion programme to Engelhardt Astronomical Observatory

The programme includes:

1. Sightseeing tour on the territory of Observatory.

2. Demonstration of the principles of a sundial and an armillary sphere operation.

3. Museum exposition: the history of the Kazan Astronomical School; the history of the Astronomical Observatory; demonstration of old telescopes and tools.

Duration: 80 minutes

Engelhardt Astronomical Observatory has a special atmosphere. You can plunge into the past, getting acquainted with the history of astronomy, the Astronomical Observatory, with the destinies of famous scientists, admiring the architecture of ancient buildings. Then you find yourself in the modern hall of the Planetarium with high-tech equipment, thanks to which you can plunge into the world of space, so distant and alluring. On clear nights, you can take

part in observations through different telescopes of the Observatory. You can see the collection of ancient astronomical instruments, learn their history and principles of operation, get acquainted with the modern telescopes and the results of observations using them. You will have the opportunity to listen to popular science lectures on astronomy, as well as witness unique cosmic phenomena in the past, present and future. Fascinating spherical films await you in the "Star Hall" of the Planetarium. The complex of Engelhardt Astronomical Observatory and the KFU Planetarium is a scientific, cultural and educational centre.

Multifunctional pavilion of KFU Scientific and educational centre of Natural Sciences and Astrophysics "Astropark"

The main facilities and elements:

1. An interactive corridor "Interplanetary station" – the main hall entrance for visitors.

A multimedia installation for thematic exhibitions and Astronomy "immersion" of visitors. Lighting is used for creating an image of a space station there, monitors and projectors for broadcasting video information.

2. The main interactive hall

• Permanent active exhibits: the "Vostok" launch vehicle/carrier rocket model (scale 1:20), the GLONASS-K spacecraft model (scale 1:10), the Spektr-Roentgen-Gamma spacecraft model (scale 1:10), a space suit, an element of the spacecraft to be launched, physical experimental installations (a Foucault pendulum, etc.). The list is being supplemented.

• A multimedia installation for thematic exhibitions. Lighting is used for organizing and zoning the exhibition space, interactive panels for navigating the exhibition, monitors and projectors for broadcasting video information. It is planned to hold the following thematic exhibitions (turnover approximately once a month):

1. Lunar program. Development of lunar mineral reserves
2. X-ray Astrophysics.
3. Black holes and white dwarfs
4. Evolution of stars: from birth to death
5. The emergence of life on Earth – a cosmic factor.
6. Solar system – do we all know about it?
7. Gravity and its role in the formation of the structure of the Universe.
8. Space technologies and their "terrestrial" applications.
9. Temperature in Space: cold or hot?
10. Evolution of living matter.

The zone of interactive toys and constructors for children

3. Multifunctional conference hall

A hall for classes, seminars, lectures for students; for meetings, conferences, symposia and workshops

In the hall along the non-transformable walls, a permanent exhibition of minerals (terrestrial and cosmic), exhibits of the KFU Zoological Museum is supposed to be held.

The hall can also be used to continue thematic exhibitions from the main hall facilities.

Supplementary elements:

– visitors welcome area
– hot meals cafeteria
– cloakroom
– toilets
– storage facilities for temporary exhibits storage and students geodetic practice tools
– server room
– security room

A creative concept design of the exhibition pavilion on the territory of the Engelhardt Observatory

The exhibition pavilion on the territory of the Engelhardt Observatory is designed to show visitors in a spectacular form the history of mankind space exploration, to interest them in modern Astronomy issues, to answer the questions about the origin, laws and structure of the Universe, Near Space and the Solar System in order to popularize science among younger people.

The interior space of the exhibition pavilion is divided into 6 (six) zones:

1) The Entrance area. Hall No. 1. The Space station greenhouse

The first hall of the pavilion – the foyer / entrance area – is designed as a greenhouse on the space station. A visitor finds himself in the imaginary area of a spaceship, far from humanity's cradle – the Earth of the Solar System.

There are terrestrial plants in stylized flasks, growing in zero gravity on the imaginary space station. The Visitor is impressed by the futuristic spirally twisted stems of plants.

The Visitor of the Kazan Federal University suburban Observatory exhibition pavilion is an imaginary space traveller of the distant future. He was born and raised on a space station in deep space. He is invited to find out where humanity appeared, where it came from, when and how it became interested in studying space outside of its cradle planet, what methods were used to explore Space.

A circular LED lamp is located on the top of the hall centre. It visually collects the space and intuitively guides the Visitor to the Portal – the passage to the next halls of the exhibition. There visitors can discover the whole history of the space study and exploration – from the first astronomical observations to space flights.

2) The Portal. The passage to the exhibition halls

The corridor connecting the pavilion halls is made in the shape of a space-time portal. The futuristic design of the portal corridor is supported by LED luminous arches.

Visitors do not stop in the corridor, they just pass it. However, the guides pay attention to information about the great personalities who revealed the secrets of the Universe to mankind.

Using projection of "cosmic particles" onto the corridor walls, visitors create portraits of great cosmologists, astrophysicists, astronomers, physicists and ancient scientists, who discovered the basic principles of the luminaries movement and cosmic laws.

The portraits appear in the reverse chronological order: first, visitors are shown modern scientists – from hypothetical Stephen Hawking (the information highlighting his contribution to Astrophysics is also given), from Einstein to Newton, then to medieval scientists, including the scientists of the Islamic Middle Ages (the information highlighting their contribution to the development of Astronomy is presented). Luminous particles are creating/composing images of Arab Astronomical treatises. Then goes al-Biruni and his conjecture about the elliptical planets movement trajectory in the Solar System – and finally Ptolemy and other Ancient scientists appear.

Thus, the Visitor hypothetically moves back in time – to the origins of Astronomy on Earth. This artistic path leads to the second hall of the pavilion – the Cromlech Hall.

3) Hall number 2. The Cromlech (Stonehenge)

In this hall, it is planned to familiarize the Visitor with the history of human Celestial objects observation, the first steps of mankind in the space study, the birth and development of Astronomy.

The showcases of the hall look like/resemble a circular megalithic structure – the Cromlech – "Stones" displayed in a circle. Cromlechs are the first stone paleo-Observatories of mankind.

Above the Cromlech there will be the planets of the Solar system installation, visually uniting all circular showcases.

The first showcase in a circle will imitate a stone. Glass dioramas, depicting the first observations of stars' movement in the sky that people made, will

be cut into the "stone". In the background, in the aperture/opening of the megalithic construction, the Visitor can observe the movement of heavenly bodies. A light system on the opposite wall is used to show the movement of the Sun, the brightest planets in the sky, etc.

The next showcase of the Cromlech will be decorated with elements of an antique column. It will tell the stories about ancient astronomers and their great discoveries. This section is devoted to the emergence and development of Optics – the branch of Physics and represents the first optical telescopes and ancient mathematical astronomical treatises.

The third showcase will imitate an Astronomy medieval tower. The next in a circle will look like a modern Observatory or resemble steps of a modern spacecraft. This section will represent radio telescopes, space telescopes, satellites, etc.

Originals/Real objects – old and modern optical telescopes – will be installed along the whole perimeter of the hall. Small-scale exhibits and reduced scale models of various astronomical inventions are displayed inside the showcases – "the Cromlech stones".

And in the hall centre – in the middle of the circle of showcases "the Cromlech" – it is possible to install an air lock of a spacecraft – as a symbol of the next step in the Universe exploration – men spacecraft ***exit for*** a spacewalk.

And thus, we pass from the primary ArcheoAstronomy to the Astronomy of the future. The last "stone" of the Cromlech is planned to have a futuristic design, for example transparent. This last part of the story about Astronomy and the history of its development indicates the issues astronomers of the future will face; the tasks today's astrophysicists are facing nowadays, the mysteries of the Universe have not been solved yet and are still waiting for their researchers.

Therefore, having walked around in the circle and familiarize himself with the history of the study of mankind, the Visitor leaves the second hall through the Portal to the next one – Krugorama (Circular view).

4) Hall number 3. Krugorama (Circular view)

The Krugorama Hall is a circular video hall in which 360-degree films can be shown on a circular rear projection screen.

The circular panorama film is dedicated to the theory of the origin of the Universe, stars, planets and planetary systems, as well as the origin of life on Earth.

Humanity has always been interested in the question: Are we alone in the Universe? Is there life on other planets? What kind of life forms can be there? What is the probability that there are other intelligent beings in the Universe?

In order to try to answer these questions, we first study life on our home planet – Earth – the cradle of humanity. How did life emerge on our planet? How was it developing? How did the whole innumerable variety of plants, fungi, insects, birds and animals appeared from the primordial protozoa. How did a Man appear? Why exactly did he become the crown of creation, the pinnacle of evolution? And how, in his evolution, the Man went beyond the framework of the planet offered to him for living and turned his gaze to the Cosmos and began to study it – and, what is more important, to explore! He designated himself not only the Master of the Earth planet, but also a citizen of the entire Cosmos.

After the Krugorama Hall, the Visitor returns through the portal back to the first hall – the Greenhouse of the space station. He began his excursion into the history of the study of space by mankind and completes his acquaintance with the display of the exhibition pavilion there.

5) classroom

6) cloakroom

The project for the development of the Astropark territory assumes the allocation of several semantic zones for better organization of space and infrastructure in order to reduce the negative anthropogenic impact on historical sites and regulate the tourist flow. Therefore, it is planned to allocate the historical part of the territory, zones of knowledge, sports and recreation, a residential zone and a practice zone.

The main administrative building of Engelhardt Astronomical Observatory, the main building of Engelhardt Astronomical Observatory, the tomb – the burial place of V. Engelhardt and D. Dubyago, Engelhardt Astronomical Observatory library building, the AZT-14 telescope pavilion, the Heide telescope pavilion, the heliometer telescope pavilion, the sundial, the meniscus telescope pavilion, the solar telescope pavilion, the meteor department building.

The Knowledge Zone contains the Planetarium building, the Science and Technology Palace "UNIGRAD" and an open-air exhibition of scientific instruments. On the ground floor of the Palace of Science and Technology "UNIGRAD", it is planned to place the museum of science "From the past to the future". It will be a science museum with elements of interactivity. Its display will feature scientific equipment of the 19th and 20th centuries. (working scientific installations), a retrospective series of 20th century technology. (cameras, televisions, radios), interactive exhibits – "how it works", "what devices allow you to see", "physics and chemistry inside a person", an exhibition of KFU achievements in the field of Astrophysics and Cosmology. On the 1st floor, there will be a transformer conference hall, club rooms ("Make a telescope yourself", "Underwater drones"), rooms for the exhibits preparation and storage, offices. The conference hall is constructed for several purposes: permanent lectures and physical labs (experiments) (50 people); a weekend lyceum on science topics (100 people); plenary and sectional sessions of scientific conferences (200 people); mobile exhibitions of scientific equipment and technology in cooperation with famous museums such as the Polytechnic Museum and private collectors); art exhibitions, children's crafts.

A volleyball court, a tennis court, Lake "Points", a ski and bicycle rental point, a bike path, a ski track and a "Rope Park" are planned in the sports and recreation area.

The residential area is supposed to accommodate a hotel for students with a canteen and office premises for students to stay during practical training, accommodation for tourists (mainly schoolchildren), astronomical club participants, Astronomy amateurs' meetings, scientific schools and conferences participants; car parking; a utility yard; a boiler room; a garage; a tent camp.

In the practice zone, a special area for students' field practice will be provided.

Financial resources

Certain funds are available to protect and manage the site on the annual basis, including overhaul and maintenance, security, utility expenses and salary fund.

657,187.7 thousand rubles (about 8,940.1 thousand US dollars) were allocated for the maintenance, protection and management of the City and Suburban Astronomical Observatories of the Kazan Federal University in the period from 2011 to 2021. In 2015, 152,099.4 thousand rubles (about 2,069.1 thousand US dollars) were allocated for the maintenance, protection and management of the site, in 2016 – 11,478.0 thousand rubles (about 156.1 thousand US dollars), in 2017 – 15,474.8 thousand rubles (about 210.5 thousand US dollars), in 2018 – 17,639.1 thousand rubles (about 239.9 thousand US dollars), in 2019 – 17,309.5 thousand rubles (about 235.5 thousand US dollars), in 2020 – 37,917.5 thousand rubles (about 515.8 thousand US dollars), in 2021 – 114,758.8 thousand rubles (about 1,561.1 thousand US dollars). In total, 366,677.2 thousand rubles (about 4,988.1 thousand US dollars) were allocated for the maintenance, protection and management of the site in 2015–2021.

In accordance with the UNESCO Thematic Initiative on Astronomy and World Heritage implemented since 2003, which purpose is to identify and preserve objects related to astronomy and of historical and cultural significance, the scientific community of Kazan Federal University began to conduct

research work to collect material about the astronomical heritage of Kazan. In 2009 the International Conference "Astronomy and World Heritage: Across Time and Continents" was held.

In 2019, the International Forum "Astronomy and World Heritage" was organized. Within the framework of the forum there were several events organized: International Scientific and Practical Conference "Historical, Cultural and Scientific Heritage of Astronomical Observatories: Formation of Outstanding Universal Value of Properties", an International Round Table with the participation of UNESCO experts and IAS on technical and methodological issues of preparation of the nomination dossier "Astronomical Observatories of Kazan Federal University", youth models of the UN and UNESCO. The budget for the events was 6 million roubles. (81.6 thousand US dollars).

In April 2021, the International Round Table "Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University" was held with the participation of representatives of the UNESCO World Heritage Centre (A. Balsamo, M. Bushenaki), ICOMOS, IAS and the world's leading astronomers.

In November 2021, an International Conference is planned to be held to determine Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University and to discuss the best world experience in the protection, identification, preservation and popularization of scientific heritage sites.

In accordance with the Decree of the President of the Republic of Tatarstan and the Resolution of the Cabinet of Ministers of the Republic of Tatarstan, a financial roadmap has been determined. According to it 15.0 million roubles for writing and supporting the nomination, publishing nomination materials (about 204.1 thousand US dollars) and 8.0 million rubles for promoting the nomination, publishing presentation materials and preparing the Management Plan (about 108.8 thousand US dollars) (in accordance with the exchange rate of $ 1 = 73.15 roubles as of December 16, 2021) are planned to allocate.

According to the Order of the President of the Republic of Tatarstan R.N. Minnikhanov in November 2021, 16 million rubles (217,6 thousand US dollars) are planned to allocate for scientific events to identify Outstanding Universal Value of the Astronomical Observatories of Kazan Federal University and conduct research to monitor the state of the components of the nomination.

8. MANAGEMENT PLAN OF THE WORLD CULTURAL HERITAGE PROPERTY "THE ASTRONOMICAL OBSERVATORIES OF KAZAN FEDERAL UNIVERSITY" (2023-2027)

8.1. General provisions

The developed Management Plan of the nominated UNESCO World Heritage Site proceeds from the need to maximize the preservation of Outstanding Universal Value of the sites – Kazan City Observatory and the Engelhardt Suburban Observatory. The strategy of the Management Plan involves identification and preservation of cultural heritage in all areas of the proposed World Heritage Site and its buffer zone, ensuring the competent organization of the territory, based on its cultural, landscape and functional features.

The Management Plan assumes that the preservation and presentation of the nominated World Heritage Site will become a factor for the sustainable development of this territory and providing dynamic socio-economic functions. In terms of management,

the Astronomical Observatories of Kazan Federal University are considered as a modern scientific, educational, museum and spiritual complex. At the same time, the local community continues to function, taking into account certain encumbrances associated with the surrounding nature (for a suburban observatory), for which the maintenance of new functions will become the basis for employment and providing a decent level and quality of life.

The Management Plan outlines further work on restoration, scientific research of architectural monuments, preservation of authentic instruments, elimination of risk factors, scientific and educational activities related to the popularization of astronomy. It is proposed to create new museum opportunities for the City Observatory, which is part of the ensemble of Kazan Federal University, included in the List of Highly Valuable Properties of the Peoples of the Russian Federation, and the Suburban Observatory with its educational complex Planetarium.

The creation of a museum system will also reduce the threat of anthropogenic pressure on monuments, distribute visitors evenly on the territory and avoid excessive loads on key properties. This creates the prerequisites for a more effective organization of tourist services, stimulating the development of tourist infrastructure, quantitative and qualitative tourist services.

At the time of submission of the nominee dossier for the site, the main aspects of the Management Plan had been established and a number of key measures in the field of coordination and management of assets were identified, as well as the need to continue research, preservation and management of architectural sites and scientific astronomical instruments.

These measures provide that future research will focus on important aspects of the development of the site and the formation of its unique features. They will be based on non-destructive research methods, including technologies and methods used in basic and applied science. The Management Plan should be complete and regularly updated to ensure that the best available techniques and practices are used for managing the facility.

8.2. STRATEGIC OBJECTIVES

The development of the Management Plan of nominated site for the World Heritage List "The Astronomical Observatories of Kazan Federal University" began in 2020 by order of the State Committee of the Republic of Tatarstan for the Protection of Cultural Heritage in accordance with the UNESCO Guidelines for the Implementation of the Convention on the Protection of World Heritage and the recommendations of the World Heritage Committee.

The main developers of the Management Plan are:

- Republican Fund of Cultural and Historical M onuments Revival;
- Kazan (Volga Region) Federal University;
- Khalikov Institute of Archeology of the Academy of Sciences of the Republic of Tatarstan;
- Volga Branch of the Department of UNESCO.

In the course of the work, a detailed analysis of the situation was carried out, a large number of events were held, including stakeholders, and significant material was collected. The terms of implementation of the Management Plan are calculated for the period from 2023 to 2043, with the allocation of the priority period – 2023-2027, which coincides with the period of 6-year reporting on World Heritage sites.

During the development of the Plan, the following activities were held:

- meetings of the Republican Fund "Revival" and the International Scientific and Methodological Expert Council,
- scientific symposia,
- International Conference "Astronomy and the World Heritage: Through Time and Continents";
- the International Forum "Astronomy and the World Heritage";

- the International Scientific and Practical Conference "Historical, cultural and scientific heritage of the Astronomical Observatories: formation of Outstanding Universal Value of sites";
- the International round table discussion "The Astronomical Observatories of Kazan Federal University in world culture and science";
- seminars, working meetings, workshops with representatives of institutional structures and stakeholders, as well as international organizations in the field of cultural heritage preservation.

The results of the work on the Management Plan were tested at international and regional scientific and practical conferences. Specialists of the Ministry of Culture of the Russian Federation, Russian and international specialists in the field of protection of cultural heritage regularly got acquainted with the preparation of the nominated site and participated in the discussion of essential issues. The astronomical community of the Russian Federation and representatives of many foreign countries expressed their full support to the developers, helped with practical advice at conferences, symposia, forums and round tables.

8.3 STRATEGIC OBJECTIVE 1: MANAGEMENT AND PROTECTION

Establishing clear responsibilities and decision-making mechanisms, providing legal and de facto protection for all attributes of Outstanding Universal Value within the property and its buffer zone:

a. Appointment of a local coordinator responsible for the implementation of the management plan and periodic reporting to UNESCO;

b. Ensuring regular monitoring of the World Heritage property and developing accurate indicators to regularly assess the quality of management processes;

c. Clearly delineating the boundaries of the property, as well as its buffer zone in all zoning and land-use plans;

d. Developing accurate guidance on development decision-making processes, conducting appropriate training seminars for property managers, as well as stakeholders from the municipality and administration of the institution.

The first strategic objective is called "Management and Protection" and is dedicated to the property management system, monitoring of procedures and legal protection mechanisms. It aims to improve them by ensuring a sustainable allocation of funding and resources, and is presented in a block, fully developed in accordance with the adopted Management Plan. In addition, the strategy aims to strengthen the current legal protections of the buffer zone, as well as to prevent extensive restoration and inappropriate infrastructure development that could jeopardize the site itself and its OUV. This objective also includes educational activities to give administrative staff and government agencies an understanding of the importance of the requirements for protecting the World Heritage of the Astronomical Observatories of Kazan Federal University. In addition, quality control procedures are introduced to implement a management system through the implementation of monitoring and evaluation procedures.

8.4. STRATEGIC OBJECTIVE 2: RESTORATION

The main method of protecting a monument is conservation aimed at ensuring optimal conditions for the operation of the site, identifying and eliminating the causes of possible violations of brickwork and other structures, the state of instruments. The comprehensive preventive maintenance system is based on the results of years-long research and experience in preservation activity.

The system of comprehensive preventive maintenance involves:

1. Comprehensive monitoring of the condition of Kazan Federal University Astronomical Observatories including:

- monitoring of destruction caused by water and wind erosion, mechanical impact, etc.;
- monitoring of biodeterioration to identify foci and causes of biological damage to the site;
- monitoring of the technical condition of the Astronomical Observatories of Kazan Federal University, which allows to identify existing and possible damage to elements and structures of the site.

Relevant methods and modern high-tech equipment for non-destructive testing (acoustic detector, electronic tacheometer) are used to monitor the condition of the site.

2. Preventive maintenance and preservation of the site, including:

- elimination of the causes of physical and biological destruction of the property of cultural and scientific heritage;
- elimination of leaks from roofs and other parts of buildings;
- indoor microclimate control.

The main task in providing preventive maintenance is to ensure the continuity of measures.

3. Collection and storage of information about the nominated site carried out by scholars and specialists in the relevant area and collected and stored in the administration offices of the Kazan Federal University and the Committee of the Republic of Tatarstan for Protection of Cultural Heritage – the state body of the Republic of Tatarstan responsible for protection of cultural heritage. The programme for conservation of the interior of the Astronomical Observatories of Kazan Federal University also involves a number of technical and organizational measures. Current, annual and long-term plans for preventive, repair and restoration work are based on monitoring of changes in the state of the Astronomical Observatories throughout the year.

The restoration of the Astronomical Observatories is considered as a forced and exceptional measure aimed at preserving and revealing the aesthetic and historical value of the site. The decision on restoration is made by the state bodies for protection of monuments on the basis of decision of the expert commission responsible for restoration.

The restoration of the Astronomical Observatories is based on international charters, standards and management guidelines for cultural heritage sites:

- The *Convention concerning the Protection of the World Cultural and Natural Heritage*,
- The Venice Charter for the Conservation and Restoration of Monuments and Sites, 1964,
- UNESCO Recommendation Concerning the Safeguarding and Contemporary Role of Historic Areas, 1976,
- The Nara *Document on Authenticity*, 1994.

In restoration work preference should be given to traditional materials and technologies. Any element introduced into monuments during restoration should be marked so that it can be easily identified in the future. During the restoration of the Astronomical Observatories special attention is paid to monitoring of the restoration process:

- the quality of the restoration work must be continuously monitored by the author of the project, representatives of the KFU administration, the directorate of Engelhardt Astronomical Observatory, the Department of Astronomy and Space Geodesy and state supervisory authorities;
- to monitor the restoration process all available methods, including high-tech methods, should be used: geodetic control, technological control over the condition of materials, etc.;
- all elements taken from the site to be included on the World Heritage List should be included in a databank;
- information on the available restoration materials should be included in a special database;
- in the course of restoration work, the state of each element, the technology of its restoration and other data should be described in detail and registered in a special journal;
- continuous technological monitoring must be carried out during the restoration work on the territory of the Astronomical Observatories of Kazan Federal University.

8.5. STRATEGIC OBJECTIVE 3: RESEARCH

To increase knowledge and understanding of the uniqueness of the property and, in particular, architectural monuments and scientific astronomical instruments by means of:

a. creating a multifaceted research strategy, research taking into account astronomical, architectural and historical assets;

b. conducting comprehensive scientific research;

c. developing means for adequate storage and complex archival solutions of the richest written astronomical heritage;

d. disseminating knowledge and providing access to reports and publications related to astronomy and the history of science.

The strategic objective relates to research, ongoing and planned astronomical observations and historical research to be carried out within the property and its buffer zone. The strategy seeks to create a multi-faceted and comprehensive research agenda that can help identify potential areas for future research. Particular attention is paid to the study of underwater astronomical objects. In addition, attention is paid to the requirements of the World Heritage Committee for the creation of a comprehensive archive, which should contain all data and reports in a single dedicated location near the property. The creation of an archive, together with the translation of sources on astronomical research, contributes to the availability of these data for future research and the dissemination of scientific knowledge.

8.6. STRATEGIC OBJECTIVE 4: INVOLVEMENT OF THE LOCAL COMMUNITY

To promote local community's participation in the World Heritage property, raise a sense of conservation and contribute to socio-economic development by:

a. raising awareness among community members of the importance of protecting World Heritage and integrating them into decision-making processes;

b. providing opportunities for local businesses and initiatives;

c. honoring the World Heritage property as a temple of science and a place for the concentration and production of scientific knowledge.

The Community Engagement Strategy focuses on methods and activities to involve local communities in the management and protection of World Heritage. This strategy aims to maximize community participation by supporting local businesses, stimulating volunteerism and attracting young people. In this way, it aims to strengthen ties with the local community and inspires a desire to maintain, which is necessary for successful governance of the World Heritage property. At the same time, this strategy emphasizes the special role of the World Heritage for social and economic development. It aims to engage the community, explore the heritage and values that relate to the property, its history and its historical environment, thus transforming the site into a vibrant place for scientific and popular science exchanges and meetings.

8.7. STRATEGIC OBJECTIVE 5: PROMOTION OF THE PROPERTY

To formalise and convey the outstanding universal value of the World Heritage Site by offering visitors an enjoyable and informative journey into the history of the Astronomical Observatories of Kazan Federal University certain measures are envisaged:

a. Interpretation into different languages in order to increase the satisfaction of visiting a World Heritage site;

b. Providing excursions of excellent quality and continually improving services;

c. Maximising the educational potential of the facility;

d. Developing communication channels to attract different groups of visitors.

The promotion strategy appeals to the means of interpretation and the provision of appropriate services to visitors. This provides a framework for pursuing the benefits of World Heritage in view of its learning potential. Given the ongoing commitment to pass on World Heritage to future generations, this strategy seeks to define principles for interpreting and communicating the exceptional value of the Astronomical Observatories of Kazan Federal University to a wide audience, thereby encouraging understanding and building a sense of responsibility towards heritage conservation.

8.8. STRATEGIC OBJECTIVE 6: SUSTAINABLE DEVELOPMENT OF THE INFRASTRUCTURE.

To renew the existing infrastructure with due care, taking into account all attributes of the property reflecting OUV, and implementing the following measures for the needs of scientists, students and visitors by:

a. installing essential amenities in strategic locations;

b. designing routes for visitors, for a pleasant and easy access to property;

c. creating a system for managing the flow of visitors during tourist scientific and educational visits.

The sixth strategic objective is dedicated to the sustainable and environmentally friendly development of the property's infrastructure. The Astronomical Observatories of Kazan Federal University have become more and more famous over the past years, and the number of visitors is constantly growing. Despite the first steps taken to enhance the visitor experience and create the first sibling structures, the facility is not yet fully equipped with all the amenities it needs. The strategy recommends the creation of some of them, and also proposes strategic measures for the sustainable development of the infrastructure of the property. It is necessary to develop and implement a network of routes for visitors. The importance of this aspect increases during school holidays, as the number of visitors reaches high numbers. The flow of visitors should be organized in such a way as to avoid bottlenecks and long waiting times. Any new development is proposed in terms of management and concerns not only architectural monuments, but also unique scientific astronomical instruments, and also implies respect for the environment.

9. REFERENCES

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