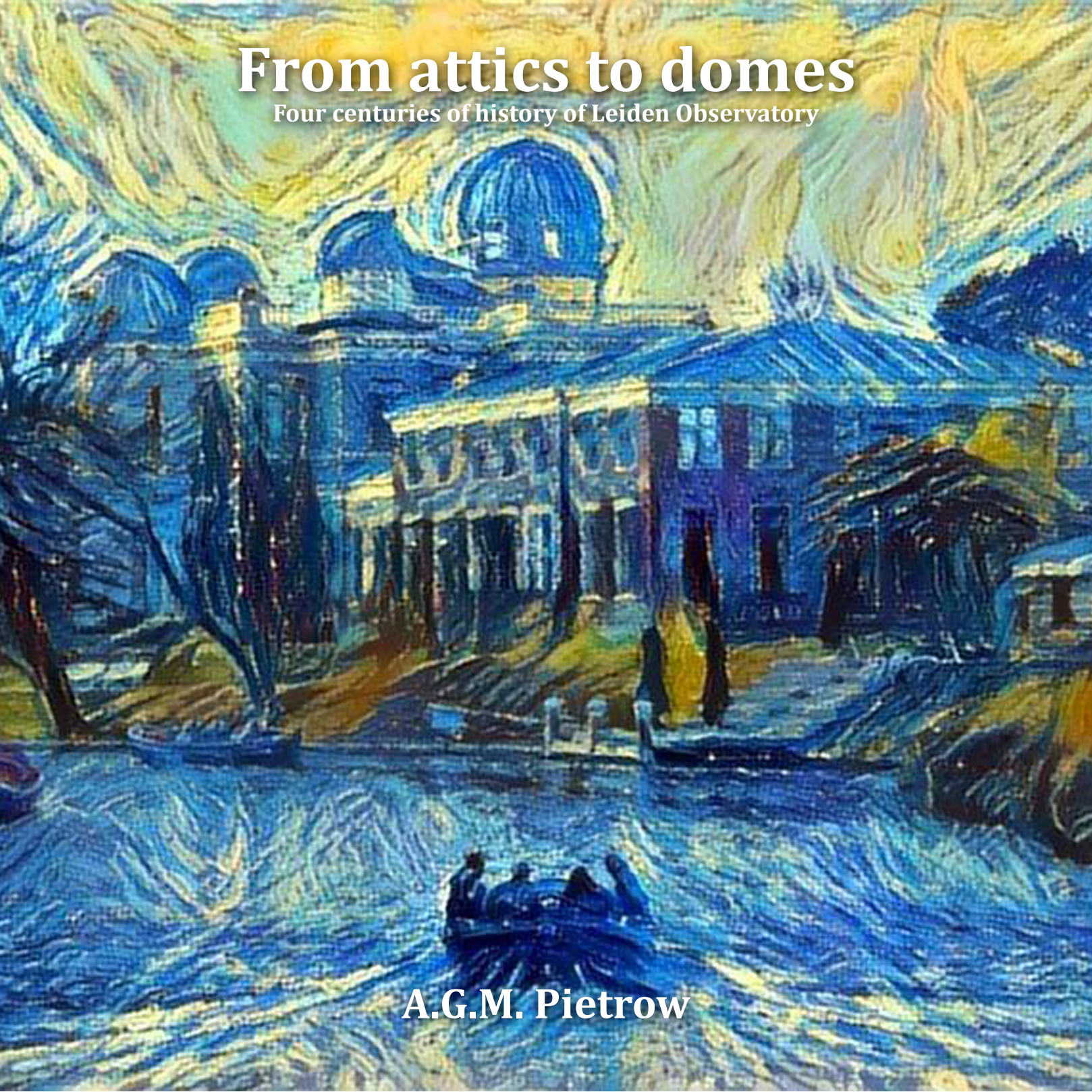


From attics to domes

Four centuries of history of Leiden Observatory



A.G.M. Pietrow

Author:

Alexander G.M. Pietrow

Acknowledgements

The information inside this book is a short overview of years of research by generations of astronomers and astronomy enthusiasts who grew fascinated by the building and its history. It would not be possible to write this book without the input, help and support of these people be it personally or through their writings or proofreads of this book. For this reason I would like to extend special thanks to;

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A picture of the Old Observatory by Gilles Otten that was turned into a Van Gogh style image by Alex using Ostagram.ru.

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This work has been published to commemorate the 25th anniversary of the Leidsch Astronomisch Dispuut 'F. Kaiser' and the Vereniging Oud Sterrewachters



25 years of Kaiser

Dear reader,

This year it is exactly a quarter of a century ago that the student association for astronomers 'Dispuut Kaiser' was founded. Together with the V-OS, which also celebrates a lustrum this year, we decided to go all out on the celebration of this memorable fact: together with all generations of Leiden astronomers, at this beautiful historical location with which we all feel a special connection, and in which Astronomy in Leiden has grown to a formidable size.

For 25 years now, our association has been there for the observatory. Our goal is to organize all kinds of activities to offer students something extra, and to connect students of all ages with each other. Bachelor students, Master students, PhD students, and of course the staff members: everyone is welcome at our activities.

From Astronomy lunch lectures, observing nights and visits to an observatory or museum to fun social activities such as movie nights, laser tag in the Snellius building and the annual football tournament (where there's always a team of professors participating). There's something for everyone.

In addition, we are frequently involved in public activities at the Old Observatory. As a student, you can come to us to become a professional tour guide, or an custodian in the visitor center in the basement of the building. In both cases, you learn to handle the four antique telescopes that this building houses (about which you can read everything in this booklet!), and you get the chance to share your passion for Astronomy with a wide audience. We provide regular guided tours, as well as tours for major public events, such as the 'Museumnacht' and the 'Nacht van Kunst en Kennis'. As board of Dispuut Kaiser, we are also involved in the organisation of these events.

The author of this booklet, Alex Pietrow, is a former board member of Dispuut Kaiser, and has always been very committed to it, as well as to the Old Observatory itself. His passion for its history and its instruments come together in the text you now hold your hands. I wish you a lot of fun reading it! And pay some special attention to the chapter about Frederik Kaiser, whose name our association proudly bears.

On to the next 25 years!

On behalf of the Board of L.A.D. 'F.Kaiser':

Kira Strelow



That special bond with Leiden Observatory

In 2018 the Vereniging van Oud-Sterrewachters (VOS) has existed for 20 years. A moment that we do not want to pass unnoticed. We therefore celebrate this lustrum together with the Kaiser-fraternity, which has been around for 25 years. Where alumni, students and staff members of all years can meet and share their memories on that special bond with Leiden Observatory. A place where they have studied, conducted or supported research.

That time has left a lasting impression on many alumni, due to the special combination of its small scale, top level research, exciting observations on remote mountain peaks or even on the Old Observatory. The VOS wants to keep these good memories alive by maintaining close contact with today's Sterrewachters. This is done with inspiring lectures on current astronomical research, visits to astronomical institutes and social events.

In addition, the VOS offers plenty of room to exchange experiences from life after the Sterrewacht. And these are many, as Sterrewacht alumni are known to arrive at a large variety of positions in- and outside of astronomy. As a result many work experiences can be shared with younger alumni in the form of mentorships. Or annual meetings take place at special locations such as an abbey, a museum or at...

...the Old Leiden Observatory, a special place that many alumni are still connected to. E.g. as an active member of the group that oversees the telescope maintenance. Or as a writer of this nice booklet about her rich history, as Alex Pietrow did. We are very grateful to him for this and are pleased that we can offer this special anniversary gift. We wish you much pleasure reading and hopefully see you soon!

On behalf of the VOS Board,

Niels van Weeren
Chairman



Snell's Quadrant and the birth of Leiden Observatory

Astronomy has been part of the curriculum at Leiden University since it first opened its doors in 1575. Not as a separate subject as it is today, but instead as a purely theoretical part of the study of mathematics, particularly geometry, where students would calculate angles between stars as exercises. It wasn't until 1633 that this changed, when Professor Jacobus Golius obtained two large quadrants from the widow of his predecessor, Professor Willebrord Snell. Golius sold the best of the two to the university and let them install it on the roof of the Academy building to allow for practical measurements of the stars in the sky. With that, he unwittingly set the first step on the long road of the Leiden observatory. This was a very bare-bones observatory, as for the first few months it stood on the roof completely unprotected from the elements. This was eventually remedied by building a dome around it. Like before, the quadrant was not used for science, but rather as a practical assignment for students to practice their geometry.

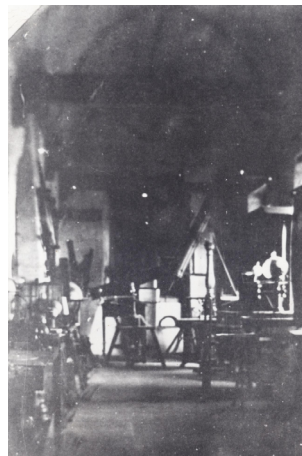
The situation did not change much during the following five decades, until the platform was expanded with a second dome in 1689, this time with a telescope. It was around this time that the science started to become more serious and measurements were taken to improve astronomical knowledge, not just mathematics. However, like the rest of the university, the observatory



was a public place. This meant that the observers on the roof were often interrupted by curious passers-by who made it very hard to take proper measurements. This was worse during special astronomical occurrences like meteor showers or when comets passed. The roof would be full of people who demanded a look

▼ Sketch of Leiden Observatory on top of the academy building from 1633 to 1689

▼ Inside the building 1857.

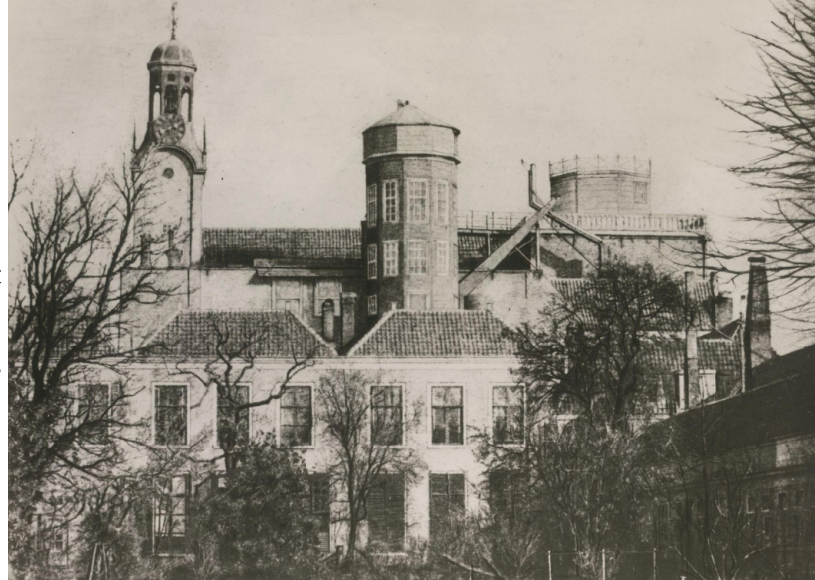


through the telescope. This, accompanied by a lack of funds, good equipment and the constant vibrations from the clock made it very hard for anyone to seriously pursue astronomy in Leiden. Unfortunately, the observatory stayed in this state for almost 200 years. As expected from this description, at this time, astronomy in Leiden was not a serious competitor to foreign observatories. In various diaries, we can read that the domes were not suited for professional use and that there was a great shortage of staff, instruments and workspace. A good example can be found in the diary of French astronomer, Jérôme Lalande, who simply wrote: 'I saw neither astronomer nor instruments that can be cited.'

The lack of a proper observatory was a great source of irritation for the directors of the observatory throughout the years. A few times plans were made to build a new observatory and raise Dutch astronomy to an international level. Unfortunately, these plans always ran into financial problems and eventually resulted in

only minor improvements of the observatory on the academy building. It wasn't until the bold actions of Frederik Kaiser that this all changed.

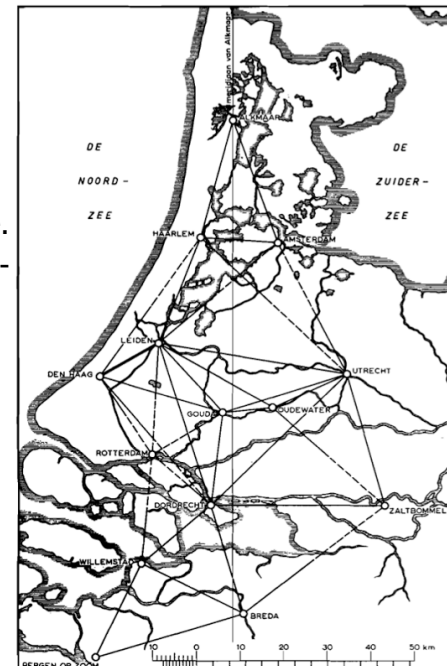
▼ *The observatory on top of the academy building in 1859.*



Anecdote

Snell's quadrant had been used to make a very accurate map of the Netherlands before it came into Golius' possession. This was done by dragging it to the top of church towers all over the Netherlands and measuring the angle between two or more other towers in the distance. With this information, it was possible to calculate the length of all triangles by just measuring the distance between two points. This allowed him to make the world's most accurate map, and furthermore, Snell used these measurements to make the first calculation of the diameter of the world since the time of the ancient Greeks. This same method was used to map France, reducing its estimated size by over 20%. King Louis XIV is said to have remarked that he lost more land to astronomers than all of his enemies combined.

▼ *Snells map of The Netherlands.*



Frederik Kaiser, the father of Leiden Astronomy

Frederik Kaiser was born on the 10th of June 1808 in Amsterdam to a family of German immigrants. At age 17, he moved to Leiden to live with his uncle Johan Fredrik Keyser, who was a math and astronomy lecturer. Under his uncle's guidance, Kaiser's love for science, and primarily astronomy, flourished. At age 18, Kaiser got a job as observer at Leiden observatory. Around the same time, Professor Uylenbroek was appointed as head of the astronomy department and immediately took control of the place. Uylenbroek did not trust Kaiser with the instruments and often said that he did not consider him the right man for the job. However, due to Kaiser's connections, he could not fire him. He therefore did his best to make him miserable by watching his every move and setting very strict and unreasonable rules. For instance, Kaiser was not allowed inside the observatory if Uylenbroek was not present.

For over 10 years, Kaiser had to endure this treatment under Uylenbroek's strict rule, but eventually he did manage to even the score with help of Halley's Comet. Kaiser had predicted its return and position very precisely and knew exactly where it would appear in the sky. Not wanting to work with the antiquated materials at the observatory or wanting to deal with Uylenbroek, he decided to set up his own observatory. Kaiser borrowed a telescope from a friend who was an amateur astronomer and made a small hole in the roof of his house by removing a few roof tiles. With this setup completed, he sent out many invitations to all who wanted to see it. This worked brilliantly as he got a steady stream of visitors such as various professors and even the Minister of Foreign Affairs. This display sent a very strong message about the state of the observatory and its management. Change was finally coming.



In 1837, Uylenbroek became the head of the Physics department and became too busy for his old job, therefore Kaiser was named head of the observatory, finally getting the freedom that he so desired. When taking inventory, Kaiser wrote that he was shocked at the state in which the observatory and its instruments were left, lamenting the waste of good telescopes that had become useless due to poor maintenance.

He advocated for a new observatory, with his main motivation being that he wanted astronomy in Leiden to compete with other facilities in the world. In 1853, the plans for the new Sonnenborgh observatory in Utrecht were announced which motivated him even more to achieve this. For Kaiser, it was unthinkable that Utrecht would become the Dutch center of astronomy instead of Leiden! After some lobbying and personal audiences with members of the 'Tweede Kamer', he soon convinced them that building a new

observatory in Leiden was crucial for the scientific community in the country. He had studied the plans of most major observatories and used the general setup of the big 1839 Imperial Observatory in St. Petersburg as his model. This had a central main building, flanked by two wings connected by large rooms housing meridian instruments. On the roof of the main building are two domes with mountings which are structurally separate from the main building itself. He wanted an observatory like this, but smaller. One year later, he published his plans in a book; 'De Inrigting der Sterrewachten, beschreven naar de Sterrewacht op den heuvel Pulkova en het ontwerp eener Sterrewacht voor de Hoogeschool te Leiden' where he explained that he wanted to copy the Pulkova observatory.

This new observatory would cost an estimated 112,500 guildens (equal to roughly €2.5 million in today's currency), six times more than the recently funded Sonnenborgh observatory. This, coupled with the fact that Kaiser's design was basically a palace, did not motivate the government. They much preferred modesty in plans over extravagance and were about to decline the proposal. However, Kaiser anticipated this and did not sit idly while waiting for a reply: instead

he used his communication talents to gather 26,000 guildens using crowdfunding, the sale of popular science books and other outreach activities. This was about one quarter of the needed sum and more than the Utrecht observatory had cost in total. This, combined with his silver tongue, was enough to convince the government to fund the observatory in 1857. Kaiser had won.

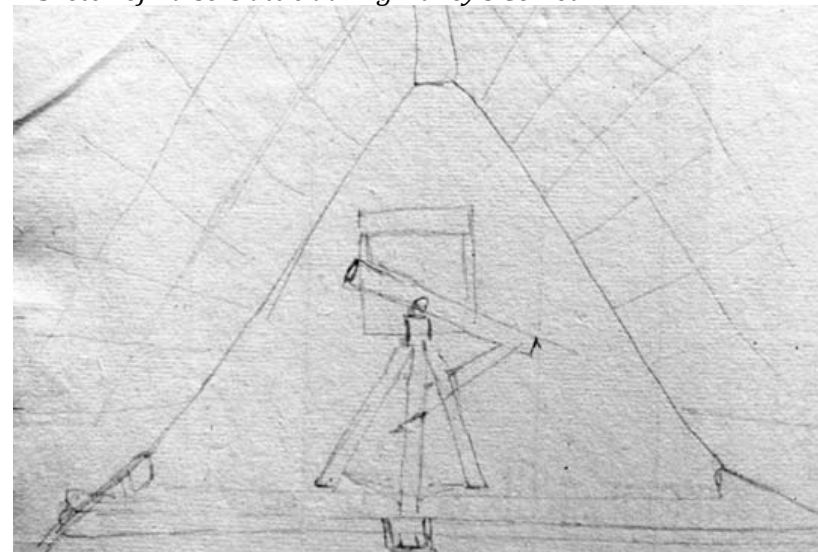
Kaiser's house in what is now called the 'Kaiserstreet'. The ground floor of the building is now part of a restaurant called 'Verboden Toegang'.



▼ *Observatory of Pulkova in Russia.*



▼ *Sketch of Kaisers attic during Halley's Comet.*



Kaisers new observatory

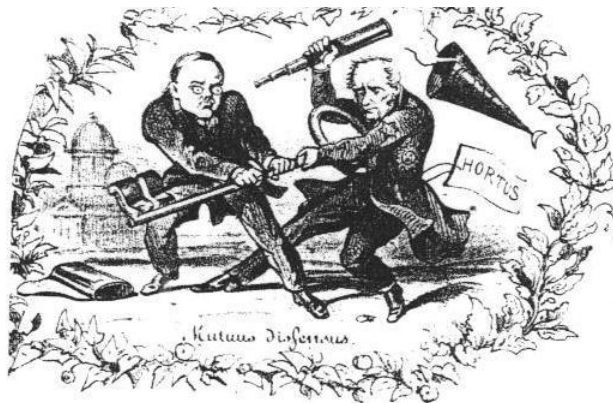
Now that it was agreed that there would be an observatory in Leiden, the next question was where to build it? Originally, he had his eye on a patch of land at the beginning of the Haagweg, where Theater Ins Blau is now situated. This was an ideal spot as it was far enough from the city to not be affected by light pollution. However, this plan was short lived due to the immense cost of the land, so an alternative had to be found. In hindsight, it was very fortunate for Kaiser and astronomy in Leiden that this happened as the city had built a railway right next to this potential location in 1878 of the observatory. The vibrations of passing trains would have made the new observatory about as useless as the one on the roof of the academy building.

Kaiser's second choice was eventually found by looking at land that was already owned by the university, as this was therefore free to build on. He quickly narrowed it down to the bastion in the bottom west corner of the inner city. This patch of land was perfect: it was owned by the University and was far enough from other buildings to not be affected by light pollution. The only problem was that it was part of the Hortus Botanicus. (The university's botanical garden)

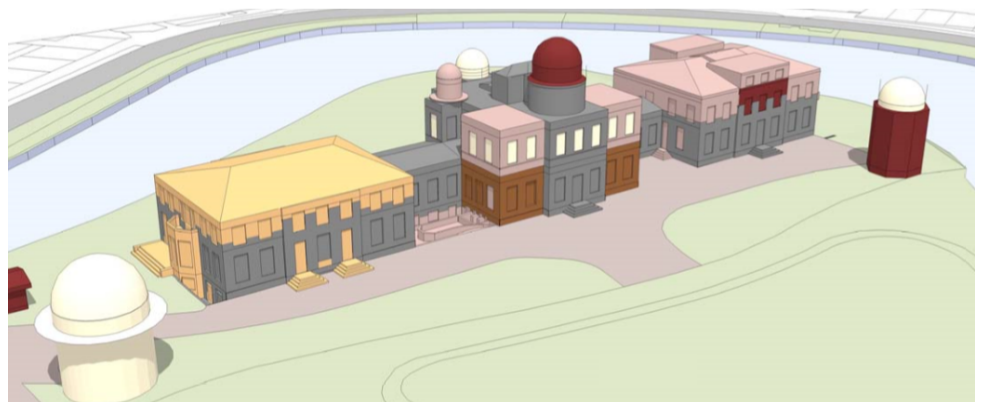
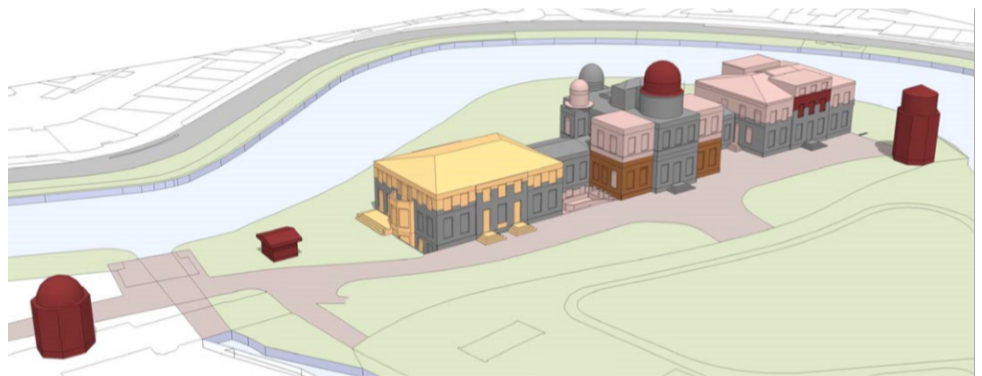
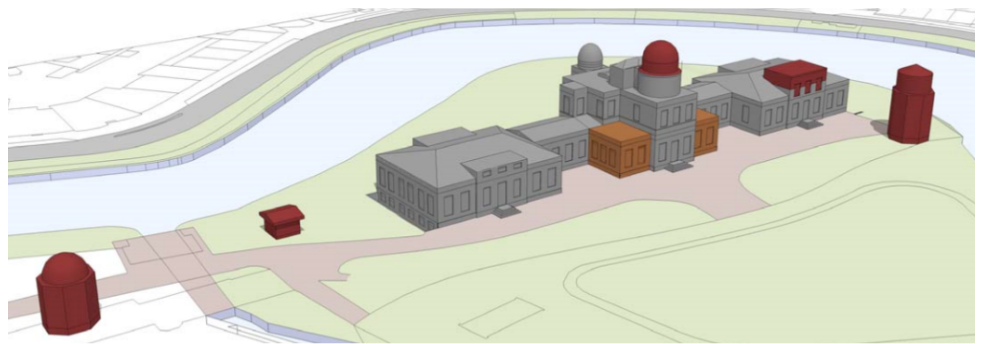
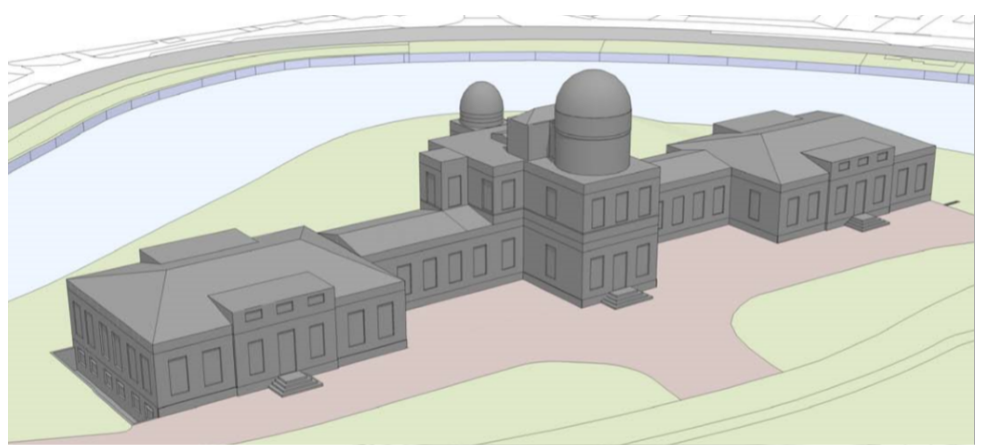
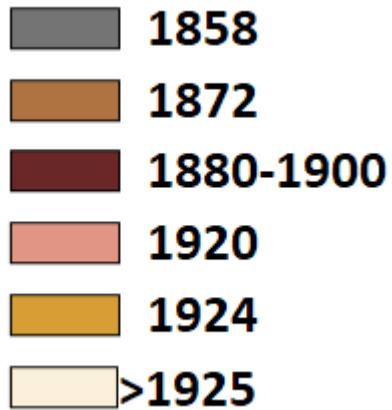
When suggesting his plan to the university board, Kaiser was met with general approval, except from the curators of the Hortus Botanicus, who protested fiercely against losing a quarter of their garden. This problem was solved by Kaiser in a rather unorthodox way. In 1857, he became rector magnificus of the university to gain more leverage in the matter. Coincidentally Professor W.H. de Vriese, his biggest opponent, left that same year to do research in the Dutch Indies. This left the much younger and less experienced W.F.R. Suringar as the head of the Hortus Botanicus, who was easily passed by the much more experienced Kaiser who was acting both as the director of the Observatory and as the rector magnificus.

The construction of the observatory began in October 1758 and was completed in 1860. It was designed by the king's architect, H.F.H.N Camp (who also designed the Kamerlingh Onnes Laboratory), and cost a total of 131,845 gulden (roughly €3 million in 2017). This was all the money that Kaiser had for the new building, and because of that, it took over a year until the first new instrument could be installed. The new observatory was finally complete. Kaiser had pulled an incredible feat which would be hard to copy even today. However, he was still not content with the facilities and kept expanding the building over the years. To Suringar's annoyance, he even commented that he wished that he had taken more land from the Hortus, as he barely had enough as it was. He did not mean to insult Suringar, but simply failed to see how herbalism could bear any kind importance next to astronomy. After Kaiser, the building continued to be expanded by his successors, who made sure that the observatory stayed competitive and state of the art. Originally, the building consisted of a central section, where the observatory was housed, and two wings for the staff. The west wing was the director's private residence and the remainder of the staff lived in the east wing. When the observatory grew, staff members also moved into regular houses along the street the observatory was on. The telescopes too have expanded beyond the building itself, as two towers were added to house the growing institute.

▼ *Caricature of Kaiser and Suringar fighting over land.*



Building stages of Old Observatory



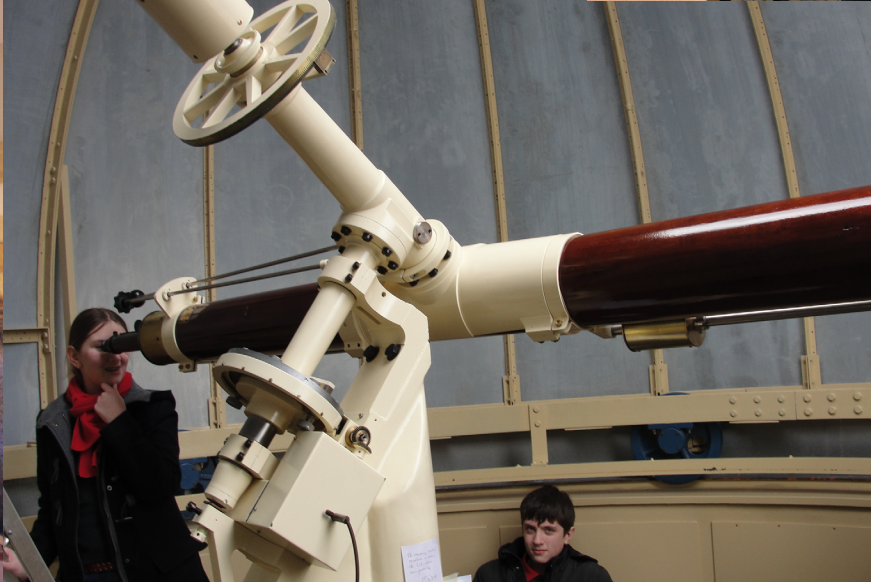
Four pannels showing the evolution of the Old Observatory throughout the years. The different colors stand for different periods in time. Remarkable is how the eastern most tower got moved in 1925 because a newly built flat blocked too much sky.



Telescopes

The Old Observatory has a large collection of telescopes. These vary from the large, permanently set up telescopes in the domes to small portable ones that are currently in storage. We will give a short description of the seven most important public instruments in the following chapters.

At the top of each section, some technical specifications will be provided for those who are interested. These will contain the diameter of the entrance aperture and the focal length.



6" Merz-refractor

D=16.6cm, f=225,0 cm, piles=16

The oldest telescope of the Old Observatory can be found in the south dome on the roof of the Old Observatory. It is simply called the '6-inch' due to the diameter of its lens being 6 Parisian inches (16.6 cm). The telescope was manufactured in 1838 in the Optical-Mechanical Institute of Fraunhofer, Utzschneider and Reichenbach in Munich by Georg Merz and was bought by Frederik Kaiser in the same year.

Scientific instruments were a lot simpler in those days. From Kaiser's notes, we learn that it arrived in five crates on the 18th of October at 9 o'clock in the morning, and that with the help of his son, Pieter-Jan Kaiser, the telescope was assembled in the main dome of the observatory on the roof of the academy building and ready for use by 1 pm on the same day. It stood there as Kaiser's private instrument until it was moved to the 'new' observatory in 1861.

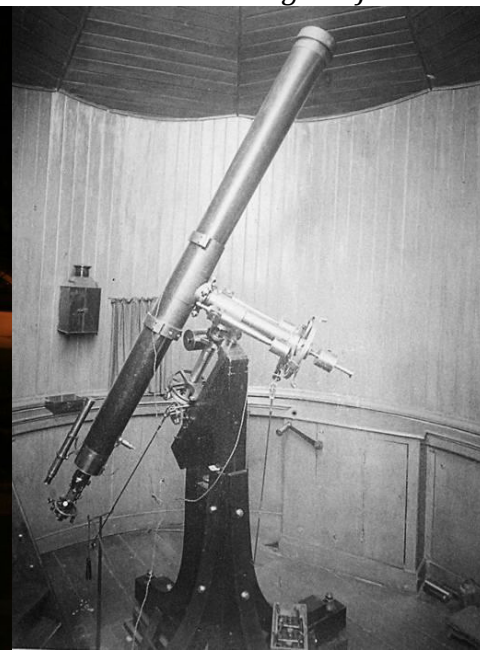
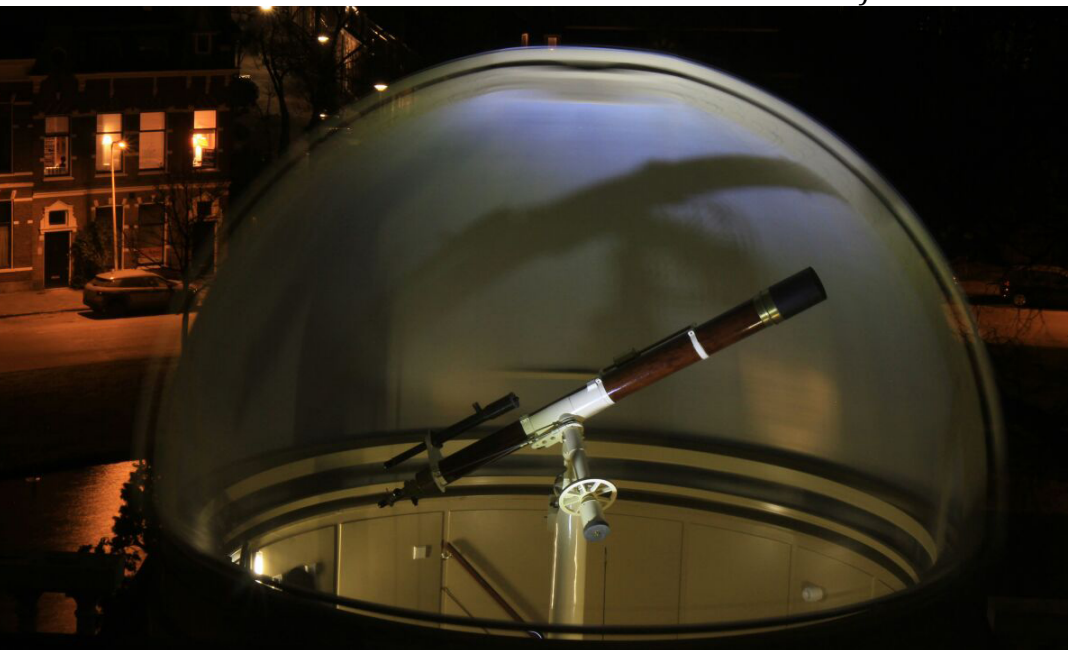
The tube of the telescope is made from pine wood and covered with mahogany, normal building materials in the early nineteenth century. Not many of these tele-

scopes still function because these tubes bend relatively easily when housed in a humid environment. We have managed to keep our telescope in perfect condition thanks to the careful maintenance it has received from the astronomy department while still in use, and by the Werkgroep Leidse Sterrewacht after that. Because of this, it is still an excellent telescope for observing and a favorite amongst many of the current users for observing the planets and the Moon.

Anecdote

The telescope used to be fully made from wood, but now brandishes a sturdy metal leg. This is because in 1931, the telescope was found on the ground with a broken leg. Miraculously, the telescope itself was undamaged. It is said that this is because an unknown astronomer kicked it when clouds ruined his observations. The leg was later replaced with a metal one so that anyone kicking it now will break their foot rather than the telescope.

Picture from 1908 with the 6-inch and its original foot. ▼



10" Repsold-refractor

D=26.6 cm, f=399.5 cm, piles =81

Inside the biggest dome of the Old Observatory, on the north side of the roof, we find the telescope named the '10-inch.' This refractor was bought in 1885 to replace the older '7 inch' telescope that was originally housed in this dome. The telescope was manufactured by the firm Repsold und Söhne who were housed in Hamburg. What makes this telescope unique is that the lens was bought from Alvan Clark & Sons in the United States. This kind of collaboration was unheard of in these days as the German optical industry controlled the European market. Nevertheless, the two came together perfectly and gave Leiden Observatory what was then considered the best telescope in the Netherlands.

It was primarily used for observations of double stars. The diameter of the lens is 1 millimeter larger than the 1845 10-inch Mertz refractor in Museum Sonnenborgh in Utrecht. This is because Paris inches were used rather than German inches. It is unknown if this was done intentionally to get the record of the Netherlands biggest telescope.

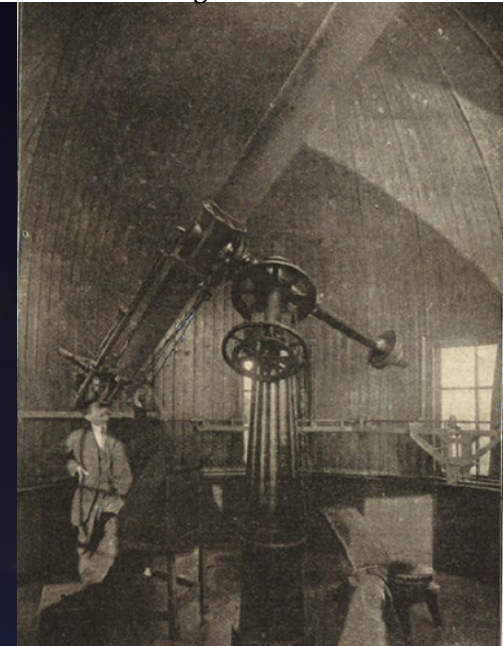
Unlike the 6-inch telescope, the 10-inch has hardly changed over the years. The biggest alteration is that a second, smaller guidescope was added so that the main tube could be used for photography. Besides that, the telescope was electrified in the 20th century to track more accurately. Originally, tracking was achieved by use of a pulley-weight system, not unlike that in an old grandfather clock.

Anecdote

In the dome of the 10", we can find an old observing chair. This chair is called the 'Einstein Chair.' It owes its name to the famous physicist Albert Einstein, who sat in it during one of his visits to his good friend and colleague, Willem de Sitter. (Director of the Old Observatory from 1918-1934).



Newspaper photo from 1917. Einstein's chair is visible in the lower right corner. ▼



The Astrograph

Primary lens: $d=33\text{cm}$, $f=524\text{ cm}$, secondary lens: $d=18\text{cm}$, $f=524$

The largest telescope of the observatory is housed in the east tower in front of the Old Observatory. This is a 13-inch refractor, which is the largest lensed telescope of the Netherlands. It was bought by the Dutch government in 1897 for one of the Dutch astronomy institutes and eventually given to Leiden because director Van de Sande Bakhuyzen said that there was a dome ready and waiting for it. This was not the case, but one was built within the year. If not for this daring bluff, the telescope would probably have gone to the astronomical institute in Groningen that had no telescopes at that time.

The Astrograph is a photographic telescope that was specially designed to map the skies for a worldwide project called Carte du Ciel (literally, 'Map of the Sky'). This French led project enlisted the help of over twenty observatories around the world and sold them these specialised telescopes. Over the years that the project took place, more than 20,000 astronomical photographs were taken, making it one of the largest collaborations in science until recent times. Unfortunately, the project failed miserably as there weren't enough people to analyze the plates, and because the observations heavily interfered with other work that had to be done. Leiden never participated in this project due to the telescope arriving late and taking a while to set up. Identical twins of this telescope can still be found in Paris, the Vatican,

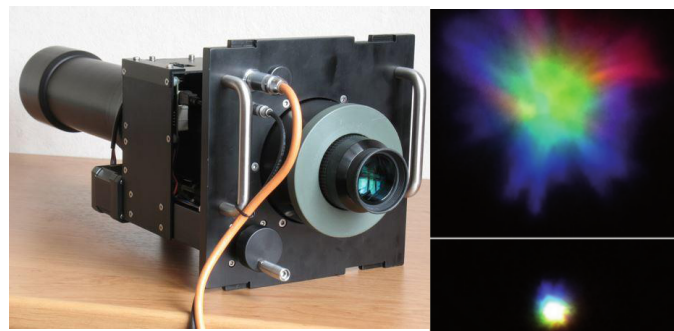


Sydney, Cape Town and several other observatories. However, the Leiden astrograph is 1.5 times larger than the rest by request of Van de Sande Bakhuyzen.

The astronomers that made these photographs had

a hard job as it could take up to several hours for one picture to be made. In theory, all that needed to be done was opening the shutter and waiting, but in practice, the telescope moved slightly due to the wind, vibrations and temperature changes. All these movements had to be counteracted manually, and therefore the astronomer had to be active the entire time. This was a very hard job, especially in the winter when it was cold. One of the hardships that the astronomers often encountered was that their eyebrow would freeze to the brass eyepiece because they kept their head so still for a long time.

These days, we do not use photographic plates when observing through this telescope. Instead, the amateur astronomers of the Werkgroep Leidse Sterrewacht built a color corrector that can be inserted into the hole for photographic plates. This was necessary because the telescope was designed to focus only blue light correctly, as the photographic plates it was originally intended for were only sensitive to blue light. So, if one looked through this telescope with the naked eye without this corrector, it would be impossible to get a sharp image. This is illustrated perfectly in a before and after image of the star Arcturus.



Anecdote

This telescope is mostly kept in its original state and can be operated without electricity. There is also still a small stash of blank photographic plates close by. This is done so that the telescope can be used at any time for 'Astronomical emergencies.'

The Zunderman Reflector

Nasmyth-Coudé design, $d=48\text{cm}$, $f=663\text{ cm}$

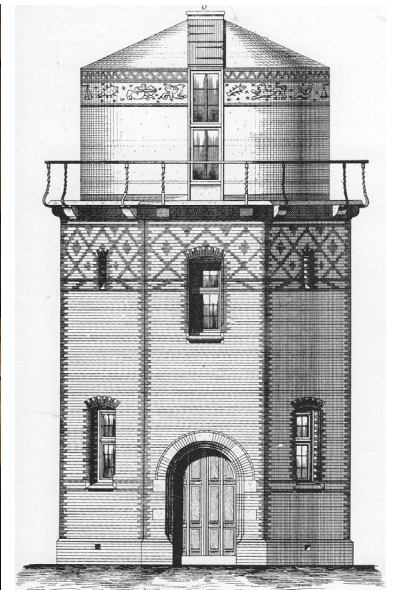
The Zunderman reflector was built in 1939 in Leiden by the chief instrument maker, H. Zunderman, and is the only academically used telescope that was made in Leiden. However, it could not remain in its dome for long as it had to be dismantled at the beginning of the second world war because the Germans were interested in the design. All important pieces were given to astronomers and other employees who hid them in their basements, rendering it useless to the Germans. After the war, all the pieces were miraculously still accounted for. The telescope was rebuilt in 1947 and worked like it did before its disassembly. However, not much research has been done with the telescope after that, as bigger and better telescopes were being built in darker locations like South Africa, the Canary Islands and the Atacama Desert in Chile. The telescope is still one of the largest reflectors in the Netherlands because of this.

The Zunderman is housed in the 1878 Heliometer Tower, which is in front of the Old Observatory on the west side. The tower was designed by the famous architect, P.J.H. Cuypers (Most well-known for the Rijksmuseum and Central Station in Amsterdam). It

was originally meant for the Merz Heliometer, but this instrument had grown obsolete before the tower was finished. Part of why the construction took so long was because of a disagreement between Cuypers and Professor Van de Sande Bakhuyzen. Cuypers had designed the tower with the zodiac depicted on it and the director was absolutely opposed to that. He did not want astrology to be mixed with astronomy. In the end, Van Sande Bakhuyzen got his way and the images never made it onto the final construction, something that Cuypers was not happy with. Something comparable has happened recently, where the architect of the new apartments on the beginning of the Sterrenwachtlaan incorporated the zodiac in his design. Unfortunately, here the architect did get his way and the images remained.

Anecdote

Astronomers using the telescope often wore an old Russian pilot suit from WWI to keep warm. This allowed them to observe comfortably.



The Huygens aerial telescope

$D=10\text{cm}$, $f=400\text{cm}$

During special occasions, like open days, one can find a green mast with a small brass tube on top of it behind the Old Observatory. This is the world's only working replica of a Huygens aerial telescope. Modelled after a design by Christiaan Huygens from 1683, this telescope is made in a very unconventional way. Instead of having a long tube, it consists of two lenses and a 4-meter long cord. When used properly, one can align the two lenses perfectly by exerting the proper tension on the cord.

Huygens invented this kind of telescope because in his time it was very hard to make good lenses, especially with short focal lengths. Huygens was not deterred by this and instead used this to his advantage. He made lenses that had very long focuses and a brilliant quality. This was a victory, but the next hurdle was to make telescope tubes of this length that didn't buckle under their own weight and were light enough to move around. Huygens again solved this by turning the problem into an advantage: he made telescopes without tubes. The telescopes became immensely popular upon their introduction, with most large observatories in the world buying one of at least 30 meters. Due to their size, these telescopes were very hard to use, and usually required a small army of assistants to aid the observer. And more often than not, a special structure was needed to hang up the primary lens. One can see an example of such structure on this engraving of the Paris Observatory from the early 1700s.

Aerial telescopes quickly dropped in popularity as in the beginning of the 18th century, reflecting telescopes started to gain ground due to their compact design and strong magnification. The final blow to these telescopes came in the late 1750s when a new breakthrough in lens manufacturing allowed for very good lenses with a short focal length, removing any need for Huygens' invention. Sadly, these telescopes were quickly removed due to their difficulty of operation. These days, only parts of the construction can be found in museums and historical observatories but no working models remain. This replica is therefore the world's only working Huygens telescope.

This telescope was funded by Hans de Rijk, with the money that he won with the 2008 'NWO oeuvreprijs' for his exceptional scientific communication. It was manufactured by the Leidse Instrumentmakers School and unveiled in May 2014 by Professor Vincent Icke during the first edition of the annual 'Kaiser Lente Lezingen' (Kaiser spring lectures).

Anecdote

Adrien Auzout, a fellow of the Royal Society of London, was so impressed with Huygens' design that he proposed to make one that was 1000 ft (304m) long. He would then use this telescope to observe animals on the Moon. Sadly, this telescope was never built, nor have any animals been found.



The Heliostat

$D=10\text{cm}$, $f=100\text{m}$, Schiefspiegler design

The Heliostat is a solar telescope, designed specifically to track the sun and project a 90-cm image of it on the wall inside the Old Observatory visitors center. The light travels from the roof through the old chimney of the director's office to the visitors center down below.

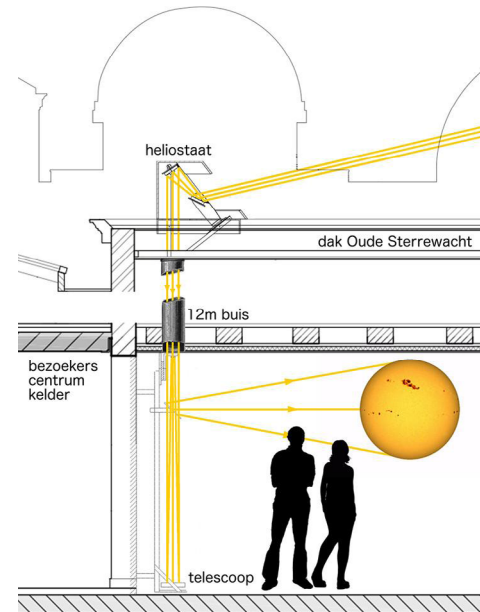
This telescope was initiated in 2014 by the committee working on the new exhibition, mainly since in March of 2015, an 84% solar eclipse would take place in the Netherlands. To raise the money in time, it was decided to use crowdfunding, which worked fantastically. The required €20,000 was raised within a month and building could commence. The telescope could be used for the eclipse since a bare bones approach was used, and only the crucial elements were installed at first. Later, a dome and other protective elements were added and the telescope was officially unveiled by the Rector Magnificus, Professor Stolker just in time for the Mercury transit of May 2016. Ever since, the telescope has projected a solar image on a wall in the visitor's center whenever the weather permits.

After the telescope was completed, two students decided to expand upon it as part of their bachelor research project. This resulted in a spectrograph that can measure

the Sun's rotation when placed on one of the edges by using the Doppler effect. This instrument is now used for student practicals and is in ongoing development for public use.

Anecdote

The designer of the dome lovingly called it a 'motor helmet,' due to the unorthodox shape. However, to his dismay, the name that stuck was the 'Baby carriage.'



The Meteoroscope

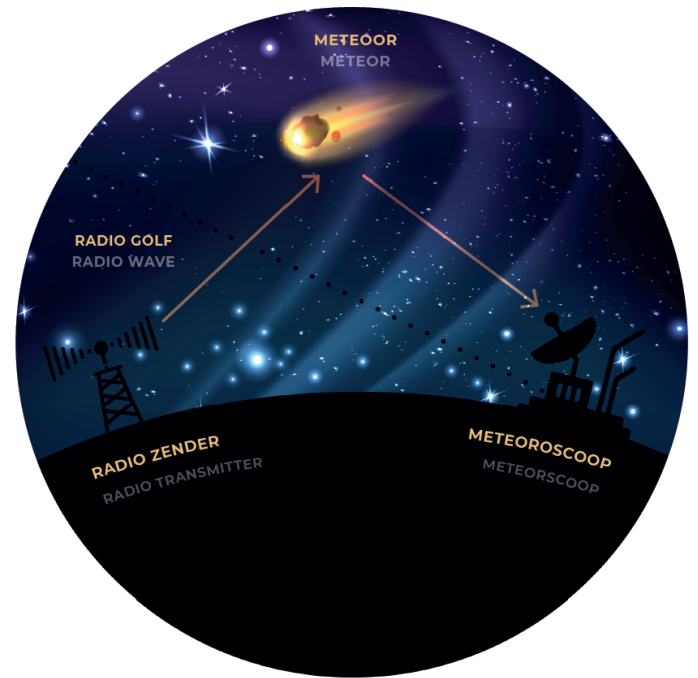
Frequency= 143.050MHz, Antenna= 2 element Yagi

The meteoroscope is not a traditional telescope like the others in this list. Instead, it is a radio antenna that is aimed to the south. It is calibrated to listen to the Graves radar in Dijon, France. This radar is aimed at the sky and emits a strong radio signal at 143.050MHz. It is designed to detect satellites and determine their orbital parameters and is turned on 24/7. This would mean that we would hear a constant beep in our setup, but Dijon is so far away that it is behind the curvature of the Earth, making it impossible to detect directly, giving a net zero signal when listening to it. However, when a meteor flies across the sky above the area between us and Dijon, the radar's radio waves will reflect off the ionized tail of the meteor into our antenna, letting us hear the signal of the radar for a short while.

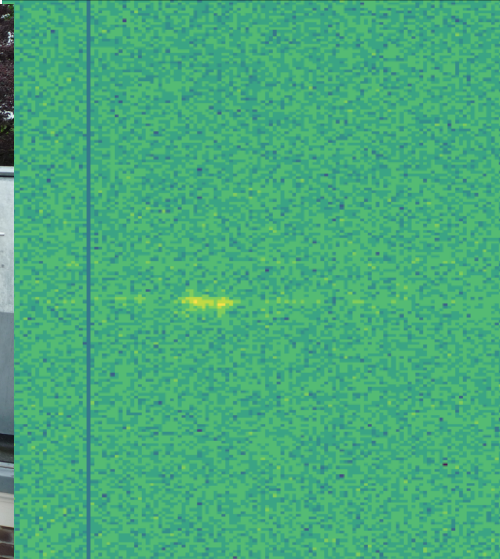
In the visitors' center, this signal has been visualised on a screen where we can see a scanline moving down and plotting the most recent measurement. Roughly once every five minutes, a small meteor can be seen as a blip on the screen.

The meteoroscope was first proposed in 2009 during the planning for the restoration. It took until 2015 for the project to pick up speed again, when a group of astron-

omy students and radio amateurs decided together that more radio astronomy should be done at the Old Observatory, as the field was largely invented by professors Oort and Van der Hulst in this very building.



A typical signal reflected by a meteor as seen on the meteoroscope ▼



The Renovation

In 1974, the astronomers moved to the Huygens building in the Leiden Bioscience Park where they still can be found today. This first move was against their will and was part of a larger effort by the university to move all exact sciences out of the inner city and bring them together in the Bioscience Park.

The astronomy department is still one of the best in the world and has many big researchers and discoveries attached to it. Currently, Leiden Observatory is doing cutting edge research in the fields of exoplanets, galaxies, cosmology and astronomical instrumentation.

Meanwhile, the Old Observatory building was given to the biology department as a temporary location until the new biology building could be built. However, this new building never eventuated due to budget cuts. The short stay soon turned into 10 years, which turned to 15 and so on until almost 35 years had passed. During this time, neither the biology department nor the university spent any money on the upkeep of the 'temporary' building, letting it slowly wither away. Eventually, hard hats needed to be worn in certain parts of the building, the cellar was flooded most of the time and the banisters would fall from the roof when the wind blew too hard. Multiple attempts had been made to start renovations since the nineties but with little result. The building was even entered as a competitor for the 2007 BankGiro

Loterij Restauratie program. A show where monuments would 'battle' for one million euro for restorations. Unfortunately, the observatory did not win and the money went to the windmill of Goidschalxoord. So, the deterioration continued and in 2008, a decision was required to either renovate or completely demolish it.

Fortunately, the university decided on the former and made plans for renovations. Part of this was paid by selling the land east of the observatory to the city to build apartments, the rest came from the university and a 3-million-euro subsidy given by Ronald Plasterk, then Minister of Education, Culture and Science. Together, this was enough to pay for the 15-million-euro renovation which began on April 6th, 2009.



The project was led by the architectural firm Veldman | Rietbroek | Smit and was very thorough. Almost the entire roof was replaced, together with many floors and all the domes. Both the interior and exterior walls were completely replastered and painted. Wiring and plumbing was completely replaced and the layout of the rooms was changed by adding and removing walls to create rooms of the desired size. More extravagant things were also added like restoration of a giant stained glass window in the ceiling of the director's wing and hand painted marble on the walls of the central building. A new basement was dug out to create space to make the visitors' center. The telescopes themselves were also restored by the Leidse Instrument-makers School.

Two years later, on the 26th of October 2011, the renovations were complete and the building was opened to the public once more. It was opened by Halbe Zijlstra, then Minister of Education, Culture and Science. The building won the national architecture prize in the same year. For over 150 years, the observatory has weathered the ups and downs of Leiden astronomy, and hopefully it will continue to do so for 150 more.

The observatory is now a part of the law faculty, serving as a lecture location. The newly excavated basement is a visitors center that can be reached via the Hortus Botanicus while the domes received museal status and can be visited during a guided tour.

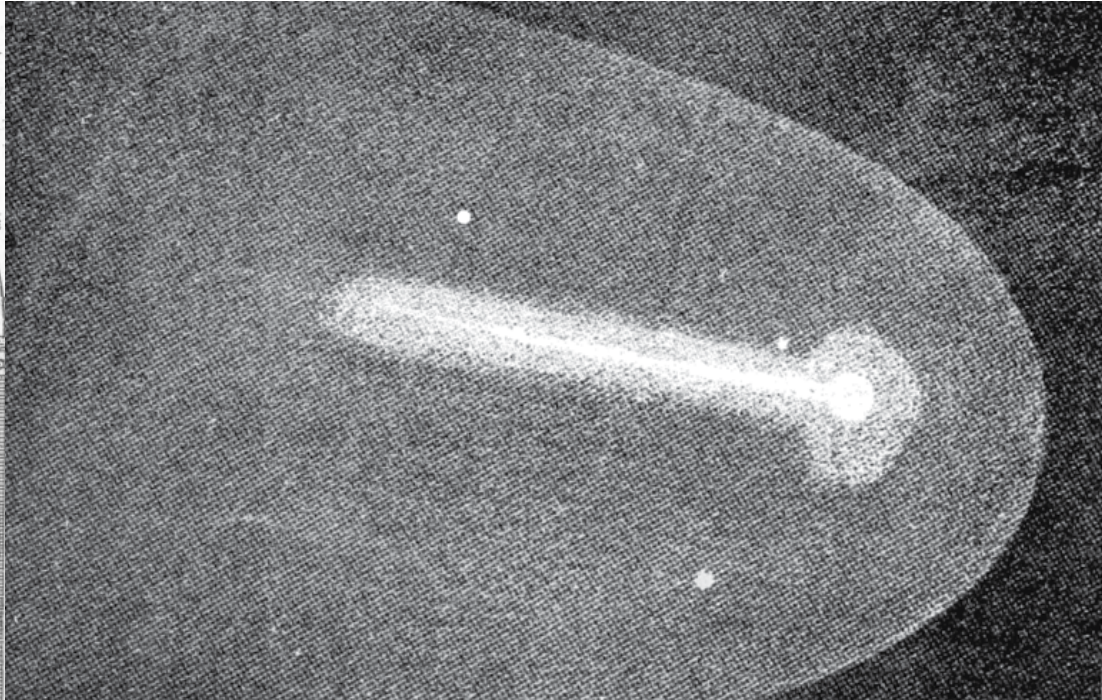
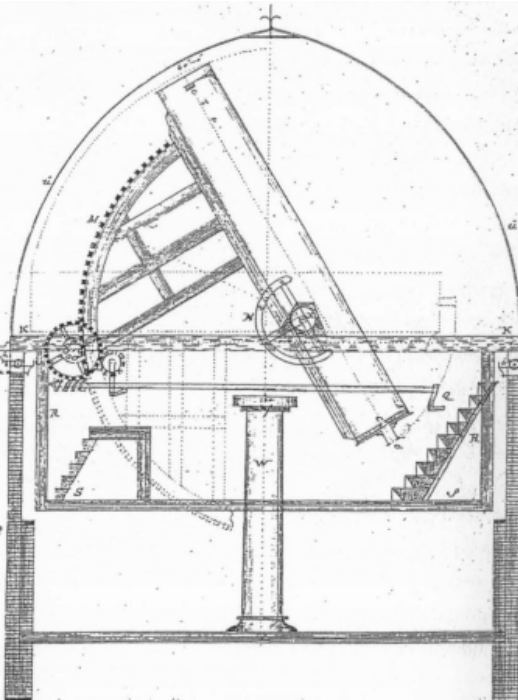


Timeline

- 1575 - Willem van Oranje establishes Leiden university.
- 1617 - Triangulation of the Netherlands with Snells Quadrant.
- 1629 - Jacob Golius becomes Professor of Mathematics and Arabic.
- 1633 - Snells Quadrant is sold to the University by Golius and is mounted on the roof.
Several months later a dome is built.
- 1689 - A second dome is built.
- 1717 - Willem Jacob 's Gravensande becomes first to get the title of Professor
of Astronomy.
- 1817 - Roof gets remodelled, two new domes built.
- 1823 - Reflector made by Roelofs and Rienks gets installed in the large dome. This is a present from
King Willem I. Unfortunately the telescope is poorly made and does not work.
- 1835 - Kaiser observes Halley's comet from his attic.
- 1837 - Kaiser becomes director of the observatory.
- 1838 - Domes get replaced.
- 1838 - 6-inch telescope acquired.
- 1845 - Kaiser sells the Roelofs and Rienks telescope for scrap after the death of King Willem I. The
parts get recognised and the astronomy department falls out of favor with the royal family.

▼ *Drawing of the telescope by Roelofs and Rienks.*

▼ *Halley's comet in 1835 drawn by Herschel.*



Timeline

- 1857 - Kaiser becomes rector magnificus.
- 1861 - Kaiser's new observatory is opened.
- 1872 - Kaiser dies, H.G. v.d. Sande Bakhuyzen becomes director.
- 1885 - 10-inch telescope acquired.
- 1898 - The photographic telescope is acquired.
- 1908 - E. F. v.d. Sande Bakhuyzen becomes director.
- 1918 - Willem de Sitter becomes director.
- 1935 - Enjar Hertzsprung becomes director.
- 1937 - Zunderman reflector is built but cannot be used until 1947 due to the war.
- 1945 - J. Oort becomes director.
- 1970 - H. van de Hulst becomes director
- 1974 - Astronomers move to new building at the edge of the city and Biology moves into the observatory.
- 2007 - Observatory competes in the BankGiro Loterij show for restoration, but does not win.
- 2009 - Restauration started.
- 2011 - Restauration completed and the law faculty moves in to use the building for classes.
- 2016 - Heliostat completed.
- 2018 - Meteoroscope completed.



Poster from the 2007 BankGiro Loterij campaign, asking people to ► vote for the Old Observatory.

▼ Directors of the Old Observatory after Kaiser. From left to right. H.G. Van de Sande Bakhuyzen. E.F. Van de Sande Bakhuyzen, W. de Sitter, E. Hertzsprung, J. Oort, H. van de Hulst.

