EINSTEINTURM SOLAR OBSERVATORY

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The Einstein Tower, designed by the Berlin architect Erich Mendelsohn (1857-1953) and built in the early 1920s, is an astrophysical observatory and a masterpiece of the history of modern architecture in Germany (Figure 1 and 2).

Figure 1 – Einstein Tower Solar Observatory.

The building was first conceived in 1917. It was built from 1919 to 1921 and became operational in 1924. It is still a working solar observatory today as part of the Leibniz Institute for Astrophysics of Potsdam. Light from the telescope is directed down through the shaft to the basement where the instruments and laboratory are located.

The exterior is in concrete, but due to construction problems with the complex design and shortages from the war, much of the building was made in brick, covered with stucco. This caused many problems. Extensive repair work had to be done only five years after the initial construction, overseen by Mendelsohn himself. Since then numerous renovations have been done periodically.

The building was heavily damaged by Allied bombing during World War II. It underwent a full renovation in 1999, for its 75th anniversary. It is often cited as one of the landmarks of expressionist architecture.

Figure 2 - Einstein Tower Solar Observatory.

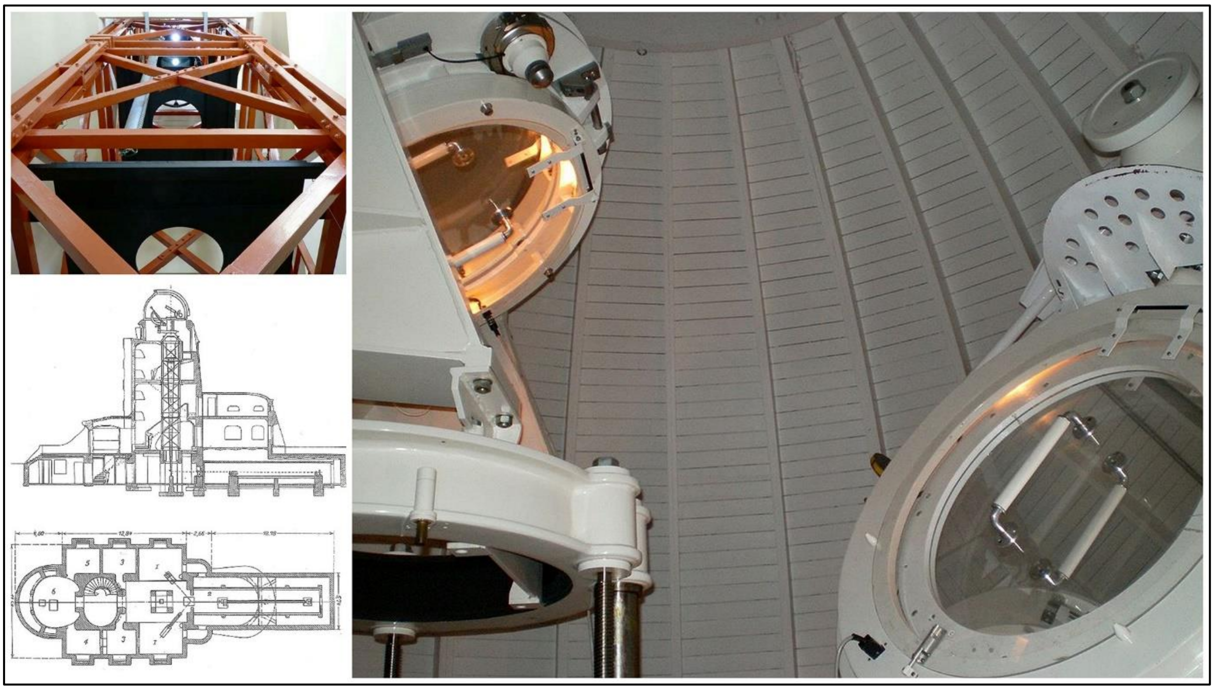

Figure 3 - Einstein Tower Solar Observatory. Wooden support structure and coelostat. Denker, C. *et al.* (2016).

The Einstein Tower consists of two wooden platforms, each 6 m high, placed one above the other. The telescope has an objective of 60 cm diameter and 14 m of focal length. Laboratories for observations and measurements are located at the base of the tower. A rotating mirror directs the sunlight to the spectrograph laboratory located in the basement. It is here that the light is split up into its spectral components and analysed (Figure 3).

Originally built for high-resolution spectroscopy and for measuring the gravitational redshift, research shifted over the years to studies of the active Sun and its magnetic field. Nowadays, telescope and spectrographs are used for research and development, testing instruments and in particular polarization optics for advanced instrumentation deployed at major European and international astronomical and solar telescopes. In addition, the Einstein Tower is used for educating and training of the next generation astrophysicists as well as for education and public outreach activities directed to the public[1].

A fire during the restoration of the Einstein Tower on 1998 January 6 led to significant damages to the wooden support structure and the telescope itself. The mechanical mounts of the coelostat mirrors and the entrance aperture had to be cleaned of soot and other remnants of the fire. On July 27, 1999 the Einstein Tower resumed operations.

The tower telescopes at the Mt. Wilson Observatory in California were the inspiration for the Einstein Tower. This was the first solar tower telescope built in Europe. The telescope is protected by a wooden dome with a diameter of 4.5 m. The exterior of the dome is protected by sheet metal. Two plane coelostat mirrors with an aperture of 60 cm catch the sunlight at a height of 15 m above ground and direct the light beam vertically into the tower. The main mirror has a parallactic mount, which can be rotated in azimuth preserving its parallactic orientation. This prevents vignetting by the shadow casted by the secondary mirror and its mount. Height and tilt of the secondary mirror are adjustable to accommodate the Sun's changing zenith distance over the course of a year and the azimuth angle of the main mirror. The original silver-coated 85-cm coelostat mirrors were replaced in the mid-fifties by 60-cm aluminium-coated glass mirrors. Since 1993 Zerodur mirrors were installed minimizing deformations under heat load. A doublet objective lens with a diameter of 60 cm and a focal length of 1400 cm, forms a solar image with 13 cm diameter in the optical laboratory, located in the basement of the building.

Figure 4- Wooden structure supporting the coelostat and the 60 cm doublet lens with focus gearing mechanism. Denker, C. *et al.* (2016).

The telescope is installed on two stacked wooden towers with a separate foundation to insulate the telescope from the wind buffeting the building and vibrations caused by people moving inside the building or outside traffic. Ball and socket joints between foundation, wooden towers, and telescope

[1] Denker, C. *et al.* (2016). Solar Physics at the Einstein Tower. *Astronomische Nachrichten*, 23 September 2016.

mount further reduce propagation of vibrations. The low heat expansion coefficient of wood also minimizes thermal expansion and thus focus drifts over the day. The lens mount is attached to three threaded rods for focusing. The vertical lifting distance is more than a meter in both directions, conveniently placing the focal plane where required for different set-ups in the optical laboratory (Figure 4).

The two spectrographs of the Einstein Tower are in the southern part of the basement. These spectrographs are equipped with different gratings (420mm X 320mm and 320mm X 220 mm). An Alta F9000 CCD camera[2] was installed in 2016 for recording high-resolution spectrographs (Figure 5).

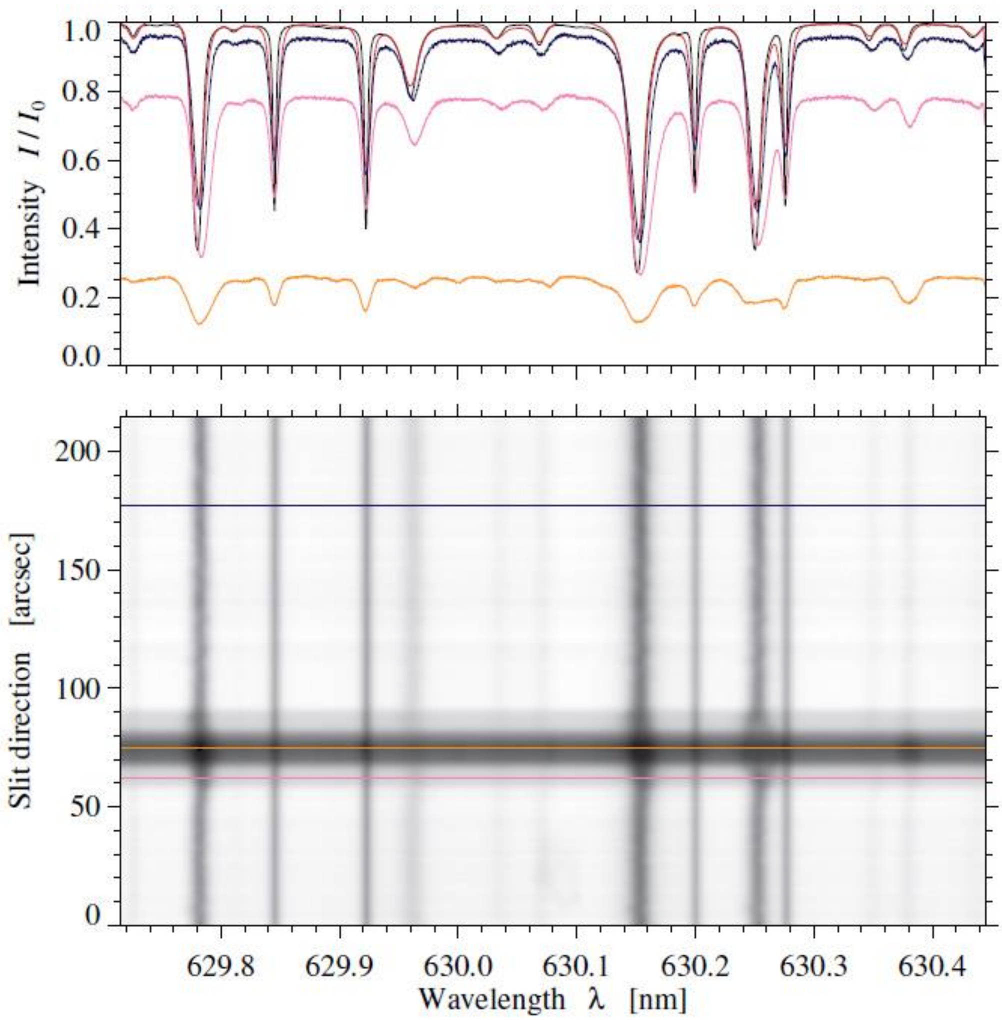

Figure 5- Spectrum of a sunspot (630.2 nm) observed in April 29, 2016. Denker, C. *et al.* (2016).

[2] The Alta F9000 uses a very large format 9.3-megapixel full frame sensor with anti-blooming gates (3056x3056 36.7x36.7 mm), ideal for applications requiring large field of view. Cooling down to 45 °C below ambient results in a low dark current. These features combine to make the Alta F9000 an ideal solution for applications requiring both a large field of view and optimal signal to noise ratio.

The solar disk at prime focus has a diameter of 13 cm. Large format photographic plates were used before the digital age (until the late eighties) (Figure 6). 3000 full-disk images exist in the photographi archive of the Einsteinturm (1943 to mid-1980).

Many research projects were realized in the Einsteinturm Solar Observatory. These include solar instrumentation and spectroscopic studies mainly. An important Education and public outreach programme are also under way. The observatory is home to the German Research Centre for Geosciences and the Potsdam Institute for Climate Impact Research. Remote stations of the Alfred Wegener Institute for Polar and Marine Research and the German Metrological Office are also located in the observatory grounds.

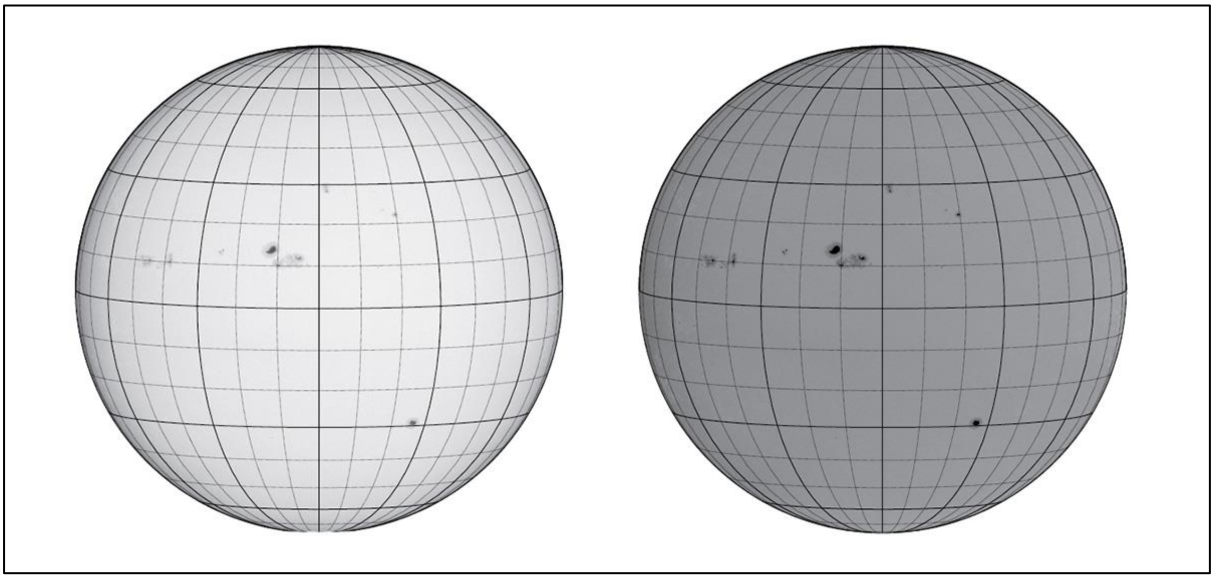

Figure 6- Analogic Full Disk Solar image on July 17, 1947. Denker, C. *et al.* (2016).

Sources:

Denker, C. *et al.* (2016). Solar Physics at the Einstein Tower. *Astronomische Nachrichten*, 23 September 2016.

https://www.aip.de/en/institute/locations/einstein-tower/

http://www3.astronomicalheritage.org/images/astronomicalheritage.org/thematic-study/ch12cs5.pdf

http://architecture-history.org/architects/architects/MENDELSOHN/OBJECTS/1919-1921,%20Einstein%20Tower,Teltower%20Vorstadt,%20Germany.html