The Microscope and the Tower

Ernst Ruska had a mission: an electron microscope with atomic resolution. He constructed his first one shortly after completing his studies. It showed things only 15 times larger than they really were. By the end of his professional career, he had built an apparatus at the Max Planck Society's Fritz Haber Institute that could magnify up to 800,000 times. In recognition of this, he was awarded the Nobel Prize in physics in 1986.

This, perhaps, was the secret of his success: In an interview, the then 80-year-old Ernst Ruska related: "I always forced my 'genius' to begin working at 7:30 a.m." For a very practical reason: "Things flow better when the head of a research department gets to work at the same time as the head of the workshop, rather than not starting until 9:30." This was the lesson he had learned after 20 years of working in the industrial world, and another 20 years at a Max Planck Society institute.

During his career, Ruska had a great deal to do with workshops – early on, for instance, as a member of Max Knoll's team at the Institute of High Voltage in Berlin, where he worked to improve cathode ray oscillographs, also known as Braun tubes. Ruska started there in 1928 when he was just 22 years old. He had just completed his intermediate examination in electrical engineering in Munich and continued his studies at the Technical University of Berlin. He made good use of the freedom that Knoll allowed his students: during the course of his undergraduate work, he succeeded, in 1926, in proving for the first time the theory proposed by physicist Hans Busch. Busch had shown that the magnetic field of a coil focused electrons. These could thus be used to create quasi-optical images – using a magnetic coil as a lens.

Even though Ernst Ruska assembled quite a bit of his apparatuses himself, he did need to rely on the help of tradesmen – and he selected the most able ones he could find. "For example, there was a mechanic in Zehlendorf," as Ruska related in the above-mentioned interview, "who could solder iron to brass vacuum-tight – not a common thing back then. Of course, I transported all of the pieces for my new coils to this guy in Zehlendorf." Also at 7:30 in the morning, when necessary.

Turning knobs is a job for an expert: Ernst Ruska adjusts the Super Microscope 100 that Siemens produced in 1949.

Early in 1931, Ruska and Knoll came up with the idea of using a second lens to further magnify the electron image created with the first lens. Ruska, who had since completed his degree, drew up plans for such a two-step device, and in March 1931, the prototype of an electron microscope was completed. With its 15-fold magnification, it was far from being able to compete with the best light microscopes of the day, which were able to magnify 2,000 times. However, Ruska's apparatus was proof that such an electron microscope could actually work.

Ernst Ruska then made a truly high-resolution electron microscope the subject of his doctoral thesis. For this, he and his fellow doctoral candidate Bodo von Borries developed iron-shrouded magnetic coils with a short focal length. The invention of these lenses earned Ruska his doctorate in 1934 – and each scientist a sum of 2,590 deutschmarks when they later sold the patents for the coil to Siemens.

But he had not yet achieved his goal, so Ruska pursued his research further at the Institute of High Voltage at the Technical College in Neubabelsberg. There, he designed a transmission electron microscope (TEM) that he equipped with the new lenses. Ruska optimistically predicted that this microscope would magnify 12,000 times – a virtually unimaginable figure back then. The first TEM was finished a few weeks later. Ruska had used as many parts as possible from his previous microscope column, which by then was already more than two years old.

The first image was produced on September 25, 1933 and showed a carbonized cotton thread – magnified around 8,000 times. Even though that wasn't quite the intended goal, the TEM nevertheless proved to already be much better than a light microscope. During the next few years, Ruska developed TV tubes for a Berlin-based company. It wasn't until 1937 that von Borries and Ruska were able to begin work on developing a TEM that would allow mass production. In 1939, one of the first "Siemens Super Microscopes," as the devices were now called, was turned over to Ernst's younger brother. Helmut Ruska conducted research at Siemens to determine how the TEM could be used for biology and medicine – a job that literally kept him in the dark. For the most part, he had to investigate the biological compounds at night since, during the day, the engineers immediately set about implementing the practical suggestions for improvement resulting from his experiments. Their devices caused the building to vibrate so strongly that Helmut Ruska, who worked in the basement, would have seen only blurred images. However, thanks to his night work, Ruska and a handful of colleagues were able, in 1940, to present the first fruits of their labors using the new microscope in the German magazine Die Naturwissenschaften: images of a bacteriophage, a bacteria-eating virus.

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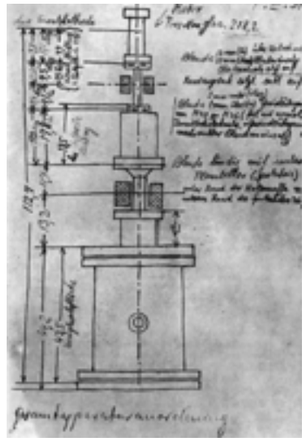
RIAS Berlin on Oct. 18, 1986 about Ernst Ruska's Nobel Prize

It came as a complete surprise. Not a single word had leaked out to the outside world from the secluded meeting of the Prize Committee in Stockholm. Then, last Wednesday, shortly after 12:00 p.m., it was time. Among the three chosen physicists, a name popped up that hit like a bomb: Ernst Ruska. A man who has resided in this city for six decades, and who has almost reached the biblical age of 80. A researcher who has become an institution in Berlin, but who, in the last few years, has withdrawn from all public life. The reactions have ranged from a rather rude "Oh, is he still alive?" to the well intended: "Didn't he already win that prize a long time ago?"

After the end of the war – the old Siemens works had been dismantled – the rebuilding of the department for electron optics in Siemensstadt in Berlin was begun in 1945. There, Ernst Ruska immediately set to work designing a new electron microscope – the Super Microscope 100. There were already a number of orders for this 100-kilovolt instrument, and Siemens delivered the first devices in 1949. This was followed in 1954 by the Elmiskop I, a high-resolution electromagnetic transmission microscope – by far the most successful development. By 1965, Siemens had sold around 1,000 of these instruments, which boasted a resolution of 0.8 nanometers. However, the company subsequently commissioned only minimal research in the area of electron microscopy. Apparently those in charge were satisfied to simply sell the devices that had already been developed.

That wasn't enough for Ernst Ruska: he wanted to construct an electron microscope with atomic resolution – and he searched for an institute that was, first and foremost, devoted to basic research. The Berlin-based Fritz Haber Institute of the Max Planck Society seemed to be just the right place. After all, he had already been heading a research group devoted to basic research and electron microscopy there since 1948. His brother Helmut also headed a group for micromorphology at the same institute. As the Max Planck Society believed that the high-resolution electron microscope held great potential for various scientific disciplines, Ernst Ruska was given with the opportunity to expand his group. He was made a Scientific Member at the Fritz Haber Institute in 1954 and named Director of the Institute for Electron Microscopy three years later. The scientist then accepted an appointment at the Technical University of Berlin in 1959, and he had also been teaching at the Freie Universität since 1949. Ruska's institute, located on the grounds of the Fritz Haber Institute, was given its own building in 1963, which was supplemented with another new building between 1972 and 1974.



Worthy of a Nobel Prize: A sketch of the first electron microscope from March 9, 1931.

This second building was christened the Ernst-Ruska-Bau in 1986 and is bounded by two high towers that served a special purpose: inside them, Ruska and his team were able to mount electron microscopes either on a suspended or stationary pendulum base. In this way, the scientists could protect the electron microscope from vibration and shocks. This was an important factor, as they had long been able to achieve the highest resolution only when the device chanced to not be subjected to vibrations.

During this time, Ruska's team worked hard on the resolution: The researchers optimized, among other things, the form of the magnetic lenses, intensified the brightness of the electron gun, increased the luminosity of the monitor and improved the magnetic shield against stray fields – all of which brought them closer to achieving resolution in the atomic range. Only the problem of vibrations still prevented a breakthrough. In 1969, several of Ruska's colleagues even proposed relocating the Institute for Electron Microscopy to an area where neither traffic nor industry could disturb the operation – like the Black Forest.

But Ernst Ruska was strictly against such plans. He wanted to achieve the highest TEM resolution in normal, imperfect surroundings. The scientists were finally able to accomplish this thanks to the pendulum bases in the two towers. Ruska himself inaugurated the new building shortly before retiring with emeritus status in 1974. His group was now constructing electron microscopes here that magnified objects up to 800,000 times.

Twelve years later, in December 1986, Ernst Ruska was awarded the Nobel Prize in physics – together with the inventors of the scanning tunneling microscope, Gerd Binnig and Heinrich Rohrer. According to the Swedish Academy of Sciences, "The significance of the electron microscope in different fields of science such as biology and medicine is now fully established: it is one of the most important inventions of this century. Its development began with work carried out by Ruska as a young student at the Berlin Technical University at the end of the 1920s." Ernst Ruska died in Berlin in 1988. On December 25, 2006, he would have celebrated his 100th birthday.

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