

Splitting Atoms in a Beer Cellar

The **Kaiser Wilhelm Institute for Physics** in Berlin opened its doors a century ago. One of its future directors was Werner Heisenberg, the father of quantum mechanics. In February 1945, he and his colleagues gathered in Haigerloch in the Württemberg region of Germany. There, in a secret cellar in a cave, the researchers embarked on a daring experiment.

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Berlin, February 23, 1945: A truck convoy sets out in the bombed-out capital. It is carrying one and a half tons each of uranium cubes and heavy water, and ten tons of graphite blocks. Its destination is the small town of Haigerloch in Württemberg. Far away from the devastation of the Berlin bombing raids, scientists there are hoping to trigger a nuclear chain reaction. The project is headed by Werner Heisenberg, who was appointed Director of the Kaiser Wilhelm Institute (KWI) for Physics two and a half years prior.

The KWI for Physics in Berlin was opened during the First World War, on October 1, 1917. Originally, it was supposed to be dedicated to the young, burgeoning field of quantum physics. At the time, the field of quantum research consisted of little more than a jumble of data and theories relating to Planck's energy quantum, the details of which, however, were still rather hazy. In order to move forward, it was decided to create a think tank and bring together the best minds in the field. No one seemed better suited to serve as its director than Albert Einstein.

The concept of the new research facility was revolutionary in that, unlike at other such establishments, no actual experiments were planned. Instead, a six-member board proposed projects that were then reviewed by a board of trustees and, with funding from the Kaiser Wilhelm Society, were delegated to external institutes. As no laboratories were required, the institute was able to do without a dedicated building, and instead opened its first premises at Haberlandstrasse 5 in Schöneberg – Einstein's home address.

The idea worked at first, and several projects were successfully completed. However, Einstein's enthusiasm concerning his new role was muted. He hated the bureaucracy his position entailed, and he had no knack for bringing researchers together and kick-starting projects. Einstein was and remained a brilliant lone wolf.

In July 1922, he therefore decided to provisionally relinquish directorship of the Institute to fellow physicist Max von Laue.



A scientist with a flash of inspiration: 23-year-old Werner Heisenberg created the foundations of quantum mechanics while at a health resort in Heligoland.

He himself planned to travel for an indefinite period. When he returned to Berlin the following year as a Nobel laureate, he passed the scepter to Laue for good. Officially, however, Einstein remained on the books as director until 1932.

Max von Laue set out to reorganize the Institute from the ground up and secure its future competitiveness, and it was set to finally get a dedicated building. The money was provided by the American Rockefeller Foundation. Then the Nazis came to power in early 1933 and brought things to a sudden standstill. Leading scientists, including Albert Einstein, emigrated. Under these circumstances, Laue presumably lost the desire to run the Institute. In the end, the director's post was transferred to Dutchman Peter Debye, who had previously been working in Leipzig.

The official inauguration of the new Institute building in Berlin-Dahlem took place on May 30, 1938. Above the entrance stood the words "Max Planck Institute." The scientists in Berlin chose this name to commemorate the outgoing president of the Kaiser Wilhelm Society. The authorities were not pleased; Planck, after all, was a Nazi opponent. Nevertheless, the name remained. What would the Rockefeller Foundation have thought if the name had been changed? The KWI for Physics was thus the very first Max Planck Institute, pre-dating the foundation of the Max Planck Society by a decade.

The Second World War broke out on September 1, 1939 and the Institute was placed under the command of the German Army Ordnance Department the following year. A project that was unofficially known as the "Uranium Club" was launched to explore the possibilities of nuclear fission, which Otto Hahn and Fritz Strassmann had discovered at the KWI for Chemistry in December 1938. Barred from leading a war project as a foreigner, Director Debye was asked to take on German citizenship. He refused and was banned from the Institute, making Werner Heisenberg the lead scientist of the Uranium Club.

Heisenberg, who was born in 1901, had a brilliant career behind him. Based on his outstanding performance in secondary

school, he was granted a scholarship by the Maximilianeum Foundation for gifted students and completed his studies in just three years. He wrote his doctoral dissertation at the age of 22 and became the youngest professor in Germany at the age of 26 – despite nearly failing his doctoral examination. He was flummoxed by, among other things, a question about the resolution of the microscope.

In the spring of 1925, however, he came up with an idea that more than made up for this slip-up. At the age of 23, he was plagued by hay fever and travelled to Heligoland for treatment. One night he had a sudden flash of inspiration that led to the development of quantum mechanics and that would earn him the 1932 Nobel Prize in Physics.

So Heisenberg and his colleagues were working on nuclear fission during the Second World War. The group also included such famous physicists as Walther Bothe, Hans Geiger, Otto Hahn and Carl Friedrich von Weizsäcker. By then it was known that, under certain conditions, uranium nuclei can be split by neutron bombardment to release, not just energy, but also other neutrons, which in turn could split more uranium nuclei. The physicists envisioned a self-sustaining chain reaction that could be harnessed to create a “uranium burner” to obtain energy – or a bomb.

In the course of their work, however, they realized that an atomic bomb couldn't be built that quickly. Some historians assume that Heisenberg delayed the project to prevent the Nazis from getting their hands on a nuclear weapon. Others believe that he and his colleagues simply failed in their endeavor. In any

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Europe's most advanced power plant – a top-secret nuclear reactor consisting of uranium cubes, heavy water and graphite cladding – was built in the Prussian town of Haigerloch in an environment that was a mixture of Freischütz, Faust and James Bond.

case, the German Army Ordnance Department eventually lost interest and returned the KWI for Physics to the Kaiser Wilhelm Society in 1942. The uranium experiments were continued, but now with a view to realizing a “uranium machine.”

The biggest experiment to date, known as B8, was planned for January 1945. Everything had been prepared in the bunker in Berlin: heavy water had arrived from Norway and uranium ore from Bohemia. But the Russian troops were closing in, and in the end, the scientists deemed it too risky. In the face of constant air raids, parts of the Institute had already been relocated to Hechingen in Württemberg. Now the uranium experiment was to be relocated as well.

Some 15 kilometers from Hechingen lies the idyllic town of Haigerloch. The center is dominated by a massive cliff on which



Where it all took place: The beer cellar of the former Schwanenwirt pub in Haigerloch is now home to a replica of the legendary B8 experiment.

the castle church stands. At the foot of the cliff, directly below the church, is a cellar where the innkeeper of the Schwanenwirt pub stored his beer – the perfect location for the nuclear researchers.

A lease was soon signed with the innkeeper for 100 reichsmarks per month. The supplies were removed, a hole blasted into the ground and the facility constructed. Finally, at the end of February, everything was ready: the material had arrived from Berlin and the experiment could begin.

In greatly simplified terms, the reactor consisted of 664 uranium cubes that measured five centimeters on each edge and that were attached to chains in the lid. The cubes were immersed in a graphite-clad magnesium tank set in a concrete pit and filled with heavy water. The neutron source could be introduced via a tube in the lid. The researchers recorded the neutron proliferation at periodic intervals. A large increase would indicate that the reactor had reached a critical state and that the goal of a self-sustaining chain reaction had been achieved, in which case the experiment would be stopped.

But it never got that far. The neutrons multiplied, but without reaching the critical point. Werner Heisenberg calculated that they would need around 50 percent more uranium and heavy water. Due to the war, however, there was no prospect of receiving the necessary supplies.

Instead, a special US unit arrived in Haigerloch on April 23, 1945 and discovered the cellar. All traces of the experiment had been provisionally removed and the uranium cubes buried in a field near the castle. The scientists were arrested. The Allies captured Heisenberg, who had fled by bicycle, at his family home at Lake Walchen in Upper Bavaria. He and his colleagues spent the following months interned at Farm Hall in England.

The Americans were ordered to blow up the cave cellar, but the courageous town pastor forbade it. He showed the commanding officer the almost 350-year-old church above them with all its art treasures. The Americans then settled for a smaller, pro forma detonation. The church remained intact. Today, a museum in the Haigerloch cave cellar commemorates the former hub of German nuclear research.

After the war, the KWI for Physics was rebuilt in Göttingen. In 1948, it officially became a Max Planck Institute. Ten years later, the facility relocated to Munich. Werner Heisenberg remained Director for almost 30 years. He died in Munich in 1976.