The German Nuclear Reactor at Haigerloch

Science History Tour 2004 and Norway 2007

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Haigerloch castle and castle church
Haigerloch Castle and Castle Church
• Nuclear fission was discovered in Germany in 1938-1939 through the work of Otto Hahn, Fritz Strassmen, Lise Meitner, and Otto Robert Frisch (following up on work done by Enrico Fermi). By the beginning of World War II the scientific community was well aware of the early German lead in this area of nuclear physics.
• When World War II began, the experiments were declared secret. They were turned over to the Army Weapons Office in Berlin and were looked after by Kurt Diebner, who got the Kaiser Wilhelm Institute for Physics involved in these experiments. Early on, Werner Heisenberg directed their work.
• By 1943, the air raids on Berlin were becoming so intense that work became impossible there. An area was sought which was still relatively safe from air attacks.

• South-West-Germany had largely been spared from such attacks so far. It was also foreseen that in the event of occupation, hardly any Soviet troops would penetrate into this area.

• Walter Gerlach, who studied physics in Tübingen and had been professor there, recalled the area around Hechingen and Haigerloch. He proposed building a laboratory within a bunker in the narrow limestone valley of the Eyach-River, since it was considered safer from air raids. During their visit to Haigerloch, it was pure coincidence that caused the scientists to find the rockhewn beer cellar of the "Schwanen Inn" and they could rent it for their work.
View of castle church and location of Atomkeller Museum
Entrance to Atomkeller Museum
Model of Atomkeller with photographs
Construction of the reactor
The Atomkeller Museum
The reactor was located in a concrete cylinder.
During its operation, normal water was between the outer concrete shell and the inner aluminum shell.
The normal water was primarily used for cooling purposes.
The aluminum container had a diameter of 210 cm and a height of 210 cm, and contained another vessel made of magnesium.
The space between the two vessels was filled with a 40 cm layer of graphitic carbon bricks having a total weight of about 10 tons.
These rectangular bricks were also placed both at the bottom and in the lid to provide an external shield which prevented the escape of neutrons generated during the fission process.

The 664 uranium blocks attached to the lid were then lowered into the inner magnesium vessel. Subsequently, the lid was bolted onto the reactor.
Heavy water storage containers

Control rods

Reactor model
• The reactor experiment, known as the "B8 Experiment” was carried out at the end of March and the beginning of April, 1945.

• The reactor never became critical. A functioning nuclear reactor would have had to be about 1.5 times the size of this reactor and would require additional quantities of both heavy water and uranium blocks.

• Shortly after conducting the last experiment, Haigerloch, located within the French zone of occupation, was occupied by a special American Task Force. This was the so-called "ALSOS-Mission".

• A goal of the ALSOS mission was that none of Germany's nuclear materials and absolutely none of the German scientists could be allowed to fall into Russia's hands.
• Colonel Boris T. Pash, the commander of the ALSOS unit, seized the atomic physics laboratory took the scientists, including Otto Hahn, Carl von Weizacker, and Max von Laue, prisoner in their offices and private homes at Hechingen.

• The American Forces dismantled the facilities in the cellar and took them to the US.

• The American Forces had been ordered to blow up the cellar. The then parish priest took Colonel Pash into the baroque Schloßkirche (castle church) directly above the cellar, and explained that the destruction of the cellar would also mean the destruction of the church. Knowing this, the Americans confined themselves to limited demolition operations in the cellar.

Soldiers of the ALSOS mission with uranium cubes recovered from burial in a nearby field. Somewhere between 1.5 and 2 tons of metallic uranium cubes from the nuclear pile were found.

Remains of outer reaction vessel, blown up by Allied forces.
A modern analysis of a fuel cube from the German nuclear reactor

A 2015 nuclear forensic investigation of uranium from the German nuclear reactor by Maria Wallenius and colleagues from the European Commission’s Institute for Transuranium Elements determined that the uranium came from Czechoslovakia.

By measuring the ratios of various uranium isotopes $^{234}\text{U}$, $^{235}\text{U}$, $^{236}\text{U}$, and $^{238}\text{U}$, they determined that the samples were not enriched with $^{235}\text{U}$, making it unlikely that the Nazi scientists would have been able to sustain a nuclear chain reaction.

Dr. Klaus Mayer, Dr. Maria Wallenius, Dr. Klaus Lützenkirchen, Joan Horta, Adrian Nicholl, Gert Rasmussen, Pieter van Belle, Dr. Zsolt Varga, Dr. Razvan Buda, Dr. Nicole Erdmann, Prof. Dr. Jens-Volker Kratz, Prof. Dr. Norbert Trautmann, Prof. L. Keith Fifield, Dr. Stephen G. Tims, Dr. Michaela B. Fröhlich, Dr. Peter Steier, *Uranium from German Nuclear Power Projects of the 1940s— A Nuclear Forensic Investigation*, *Angew. Chem. Int. Ed.* 2015, DOI:10.1002/anie.201504874
The Heavy Water Factory at Telemark
Norsk Hydro's plant at Rjukan

Originally built to produce hydrogen, by water electrolysis, for production of ammonia for fertilizer.
The Norsk Hydro power station today
The bridge to the Norsk Hydro power station
Today, the power plant contains the Norsk Industrial Worker Museum
The turbine room with a preserved German motorcycle with sidecar
Visual model of the water wheel part of a turbine
The generator model, on the left, and an actual generator, below.
• In the electrolysis of water, there was always some remaining water that was not hydrolyzed

• Harold Urey discovered deuterium in 1931 and was later able to concentrate it in water.

• Gilbert Newton Lewis isolated the first sample of pure heavy water by electrolysis in 1933

• 1934, at Vemork, Norsk Hydro built the first commercial plant specifically to produce heavy water
The Nazis took control of the Norsk Hydro plant in 1940. They expanded the number of electrolytic cells from nine to 18, doubling the plant's production of heavy water.
15 December 1942 communication of commandos being air dropped for raid on Norsk Hydro plant

10 March 1943 communication of congratulations for 28 February 1943 raid
The British short-wave transmitter used during the heavy water sabotage.
Model of an electrolysis cell used to make hydrogen (Norse Resistance Museum, Oslo).

Heavy water requires more energy to electrolyze, thus it always remained behind in the electrolysis vessel.

The small labeled “box” on the bottom half of the reactor represents the charge set by the Norse Resistance to blow up the reactor.
Model showing 28 February, 1943 raid by resistance fighters setting explosive charges on heavy water reactors. The plant was back in production in April 1943. (Norse Hydro Museum)
The train yard at Lake Tinnsjø, Telemark, Norway
The Hydro, a ferry carrying heavy water across Lake Tinnsjø was sabotaged on 20 February, 1944
The Ammonia, sister ferry to the Hydro, still sits on Lake Tinnsjø, Telemark, Norway
Recovered heavy water barrel from Lake Tinnsjø.
The Heros of Telemark