



Why the Nazis Lost the Race for the Atom Bomb

Murray Perl

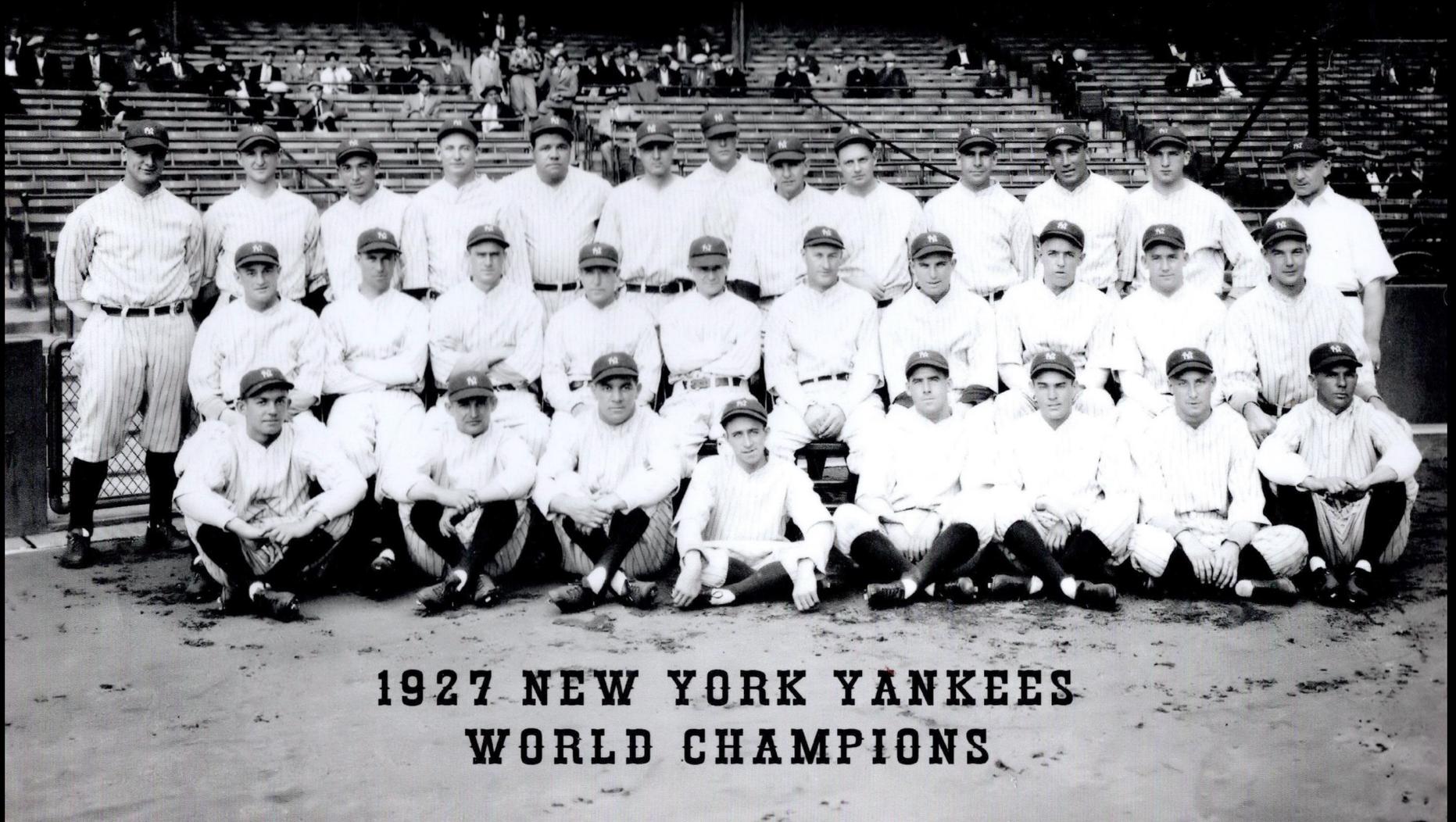
in 1900 quantum (nuclear) physics began in Germany with Max Plank's discovery that energy is radiated from atoms in packets called quanta.



Gottingen University in Germany soon became the epicenter of quantum physics research in the early decades of the 20th century



1927 Yankees dominated baseball
“Murderer’s Row” lineup



**1927 NEW YORK YANKEES
WORLD CHAMPIONS**

Germany 1927: The Golden Age of Quantum Physics



German scientists dominated the list of Nobel Prize winners in science in the early 20th century

1. Ernst Boris Chain*, Physiology or Medicine, 1945
2. Otto Hahn, Chemistry, 1944
3. Otto Stern*, Physics, 1943
4. Adolf Butenandt, Chemistry, 1939
5. Gerhard Domagk, Physiology or Medicine, 1939
6. Richard Kuhn, Chemistry, 1938
7. Otto Loewi*, Physiology or Medicine, 1936
8. Hans Spemann, Physiology or Medicine, 1935
9. Werner Karl Heisenberg, Physics, 1932
10. Otto Heinrich Warburg, Physiology or Medicine, 1931
11. Carl Bosch, Chemistry, 1931
12. Friedrich Bergius, Chemistry, 1931
13. Hans Fischer, Chemistry, 1930
14. Hans von Euler-Chelpin*, Chemistry, 1929
15. Adolf Otto Reinhold Windaus, Chemistry, 1928
16. Heinrich Otto Wieland, Chemistry, 1927
17. James Franck, Physics, 1925
18. Gustav Ludwig Hertz, Physics, 1925
19. Otto Fritz Meyerhof, Physiology or Medicine, 1922
20. Albert Einstein, Physics, 1921
21. Walther Nernst, Chemistry, 1920
22. Johannes Stark, Physics, 1919
23. Fritz Haber, Chemistry, 1918
24. Max Karl Ernst Ludwig Planck, Physics, 1918
25. Richard Willstätter, Chemistry, 1915
26. Max von Laue, Physics, 1914
27. Wilhelm Wien, Physics, 1911
28. Otto Wallach, Chemistry, 1910
29. Albrecht Kossel, Physiology or Medicine, 1910
30. Karl Ferdinand Braun, Physics, 1909
31. Wilhelm Ostwald, *born in Russia, now Latvia*, Chemistry, 1909
32. Paul Ehrlich, Physiology or Medicine, 1908
33. Eduard Buchner, Chemistry, 1907
34. Robert Koch, Physiology or Medicine, 1905
35. Philipp Lenard, Physics, 1905
36. Adolf von Baeyer, Chemistry, 1905
37. Hermann Emil Fischer, Chemistry, 1902
38. Emil Adolf von Behring, Physiology or Medicine, 1901
39. Wilhelm Conrad Röntgen, Physics, 1901

Robert Oppenheimer received his doctorate in Quantum Physics from Gottingen University in Germany in 1926



1938: Otto Hahn and Lise Mietner discovered the nuclear fission of uranium at the Kaiser Wilhelm University



With such a great head start in nuclear physics how did the Nazis lose the race to build the atom bomb?

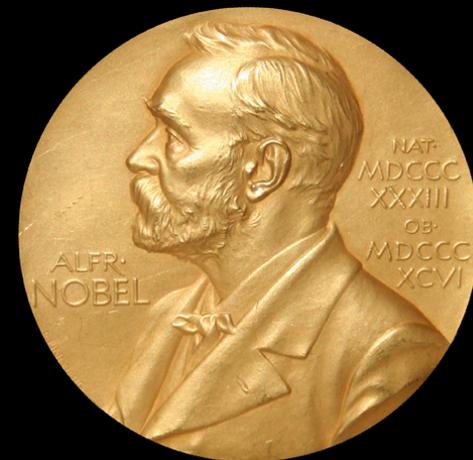
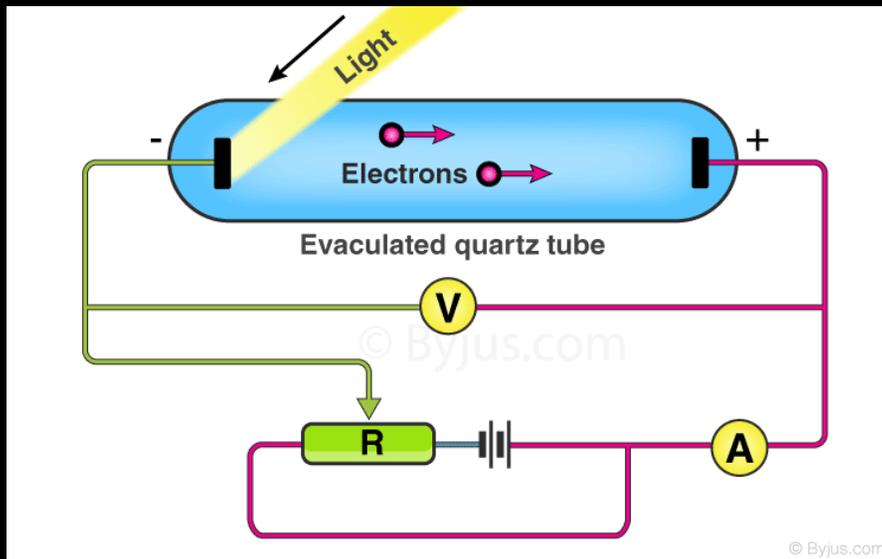


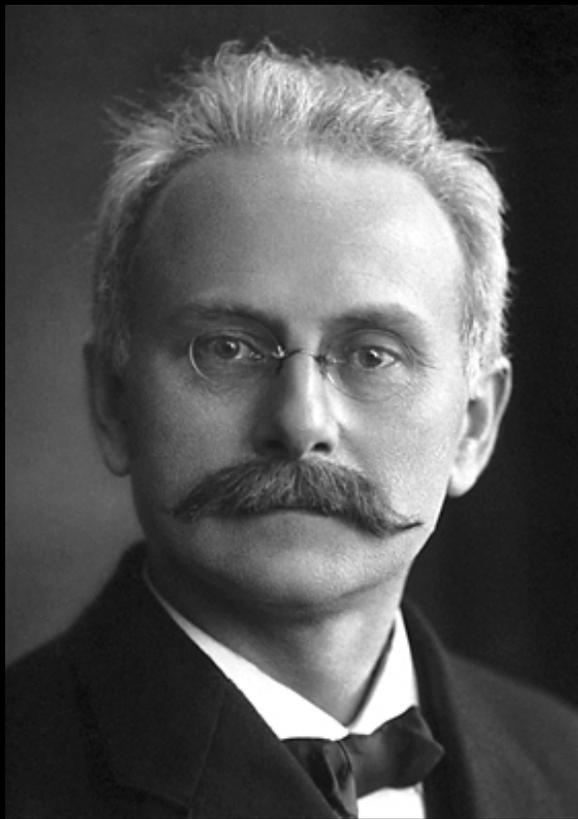
The answer is complicated

1. Professional jealousy
2. Brain drain

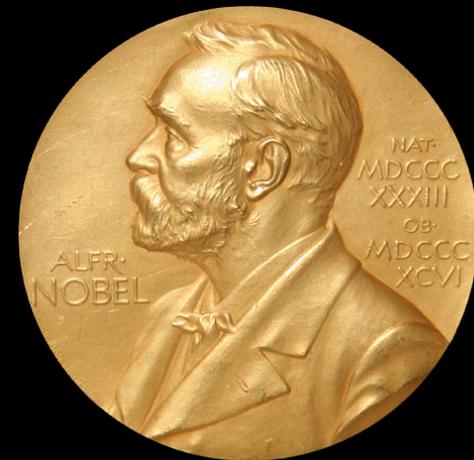
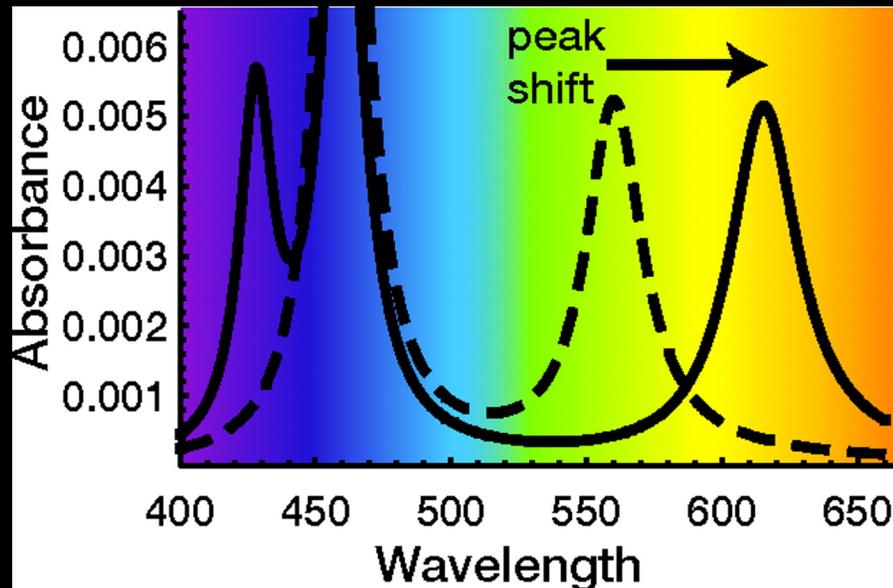


In 1905 German physicist Philipp Lenard won the Nobel Prize for the discovery of the photoelectric effect while experimenting in his laboratory





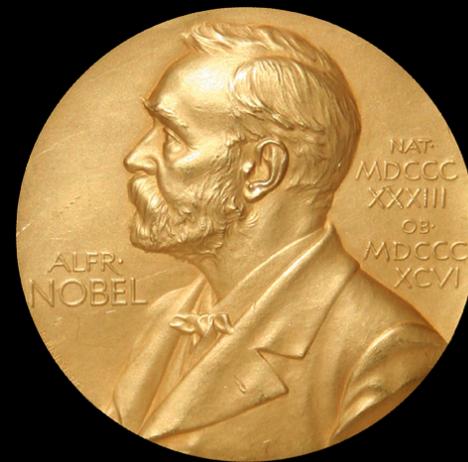
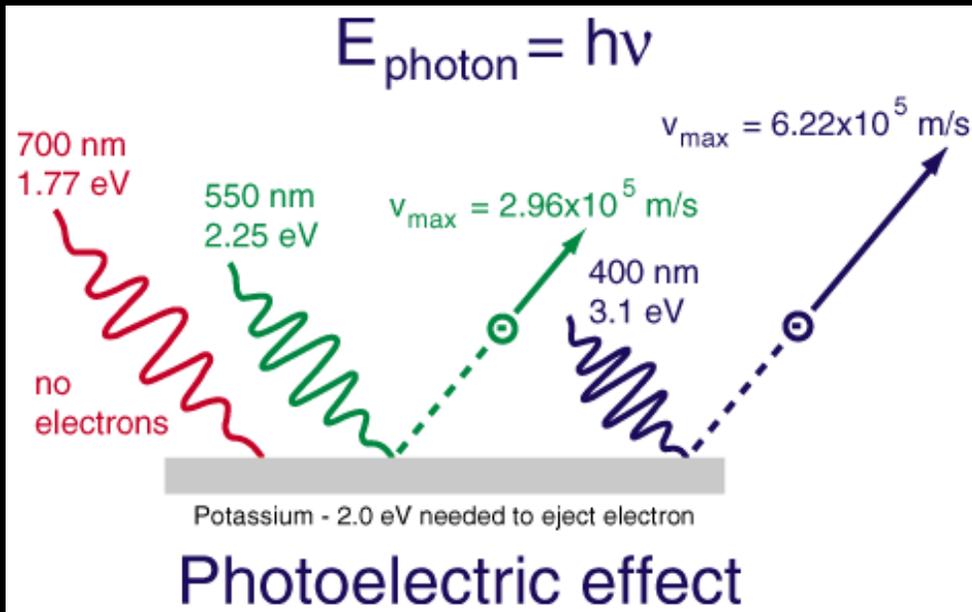
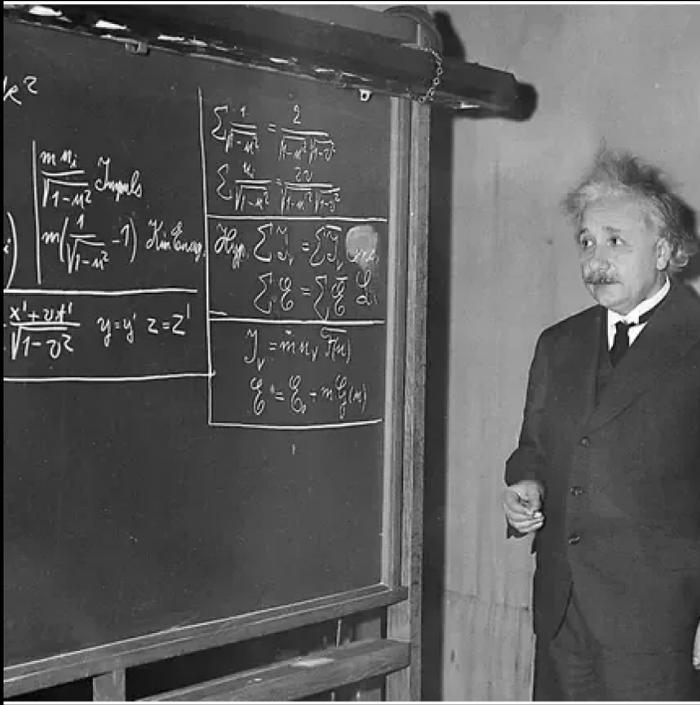
In 1919 Johannes Stark won the Nobel Prize for discovering that an electric field would cause splitting of the lines in the spectrum of light emitted by a luminous substance; the phenomenon is called the Stark effect.



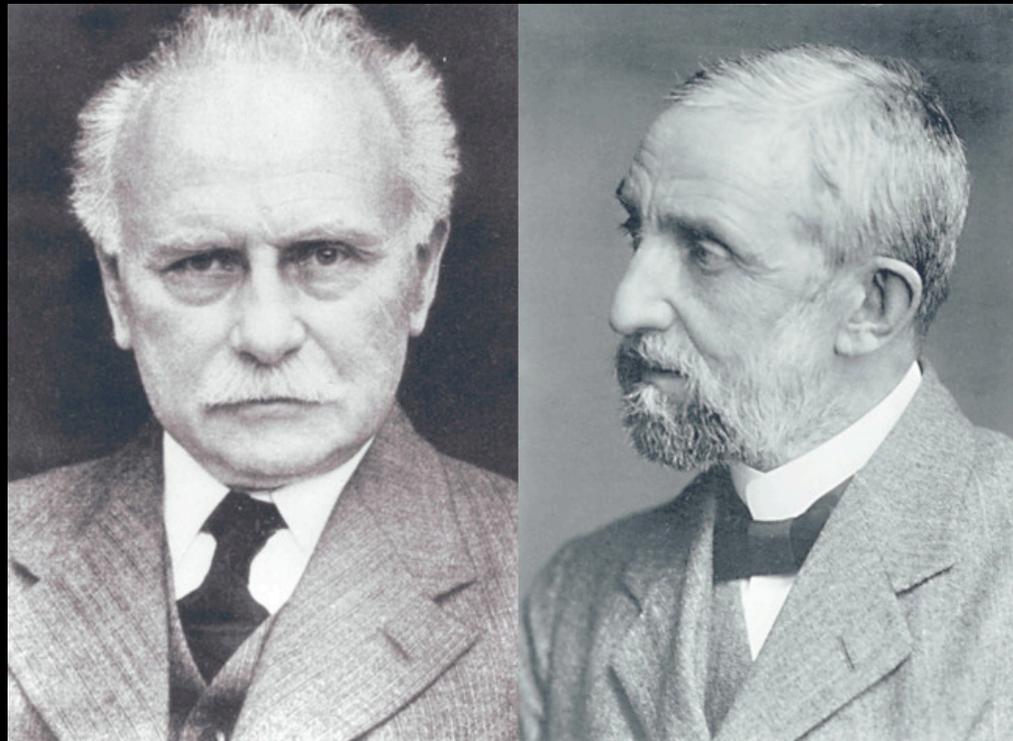
Stark and Lenard were seen as celebrities and hailed in intellectual social circles in Germany



Albert Einstein used quantum theory to contradict Lenard's and Stark's explanation for their experimental results. In 1921 he won the Nobel Prize for his explanation of the photo-electric effect.



Stark and Lenard felt humiliated and resented Einstein. Einstein showed that they did not understand the science behind their work. They also felt that they did the experimental work and Einstein got the Nobel Prize. They called quantum physics “*Juden Physics*” as opposed to “*Deutsche Physics*”

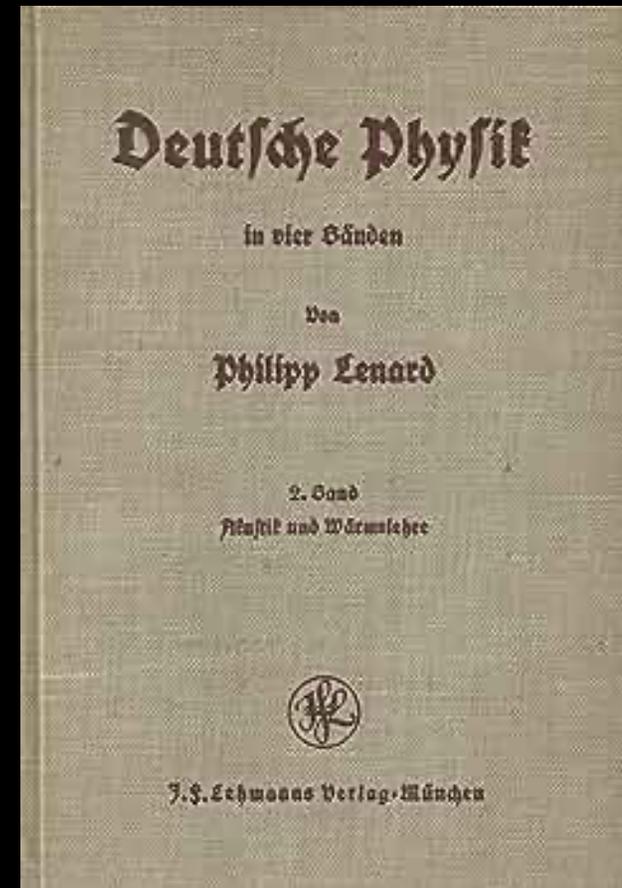


Johannes
Stark

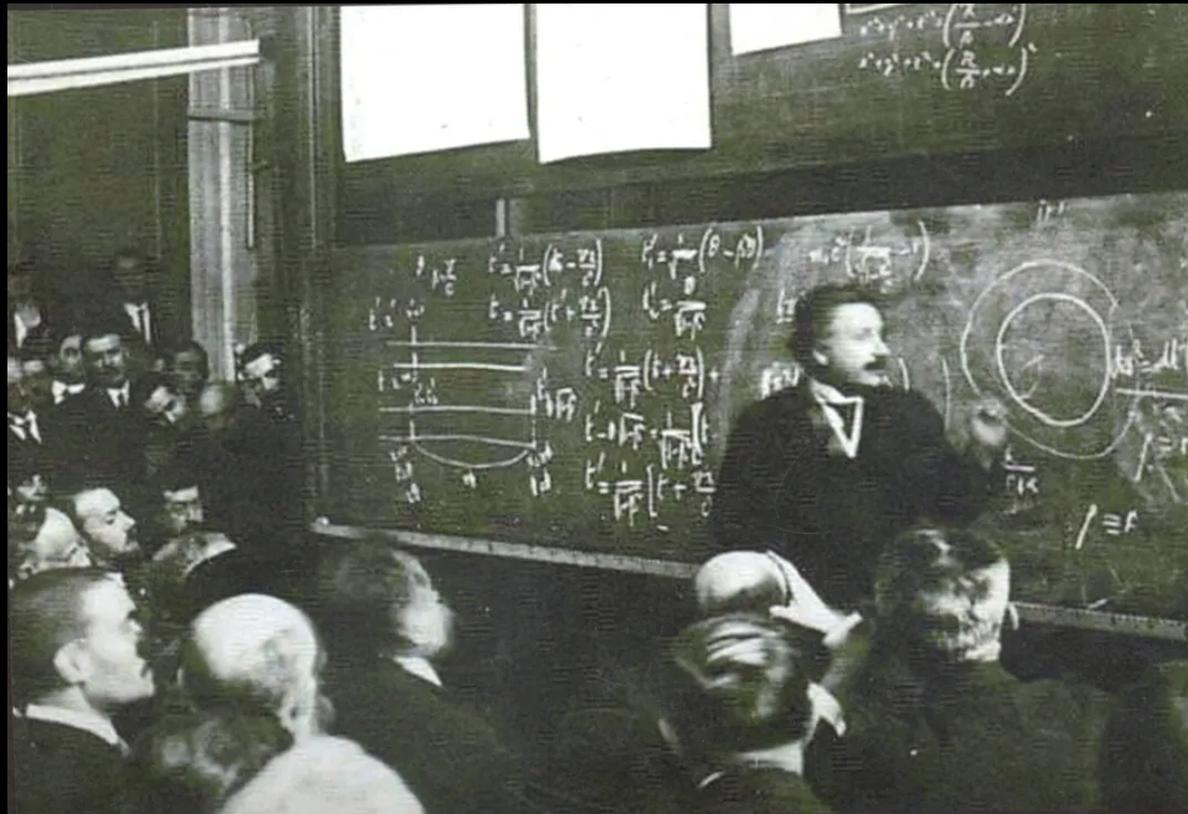
Philipp
Lenard

Deutsche Physik is based on laboratory observations,
while *Juden Physik* is theoretical physics

“*Juden Physics*” (Quantum physics) was removed from German schools and German physics text books only contained “*Deutsche Physics*” (German Physics)



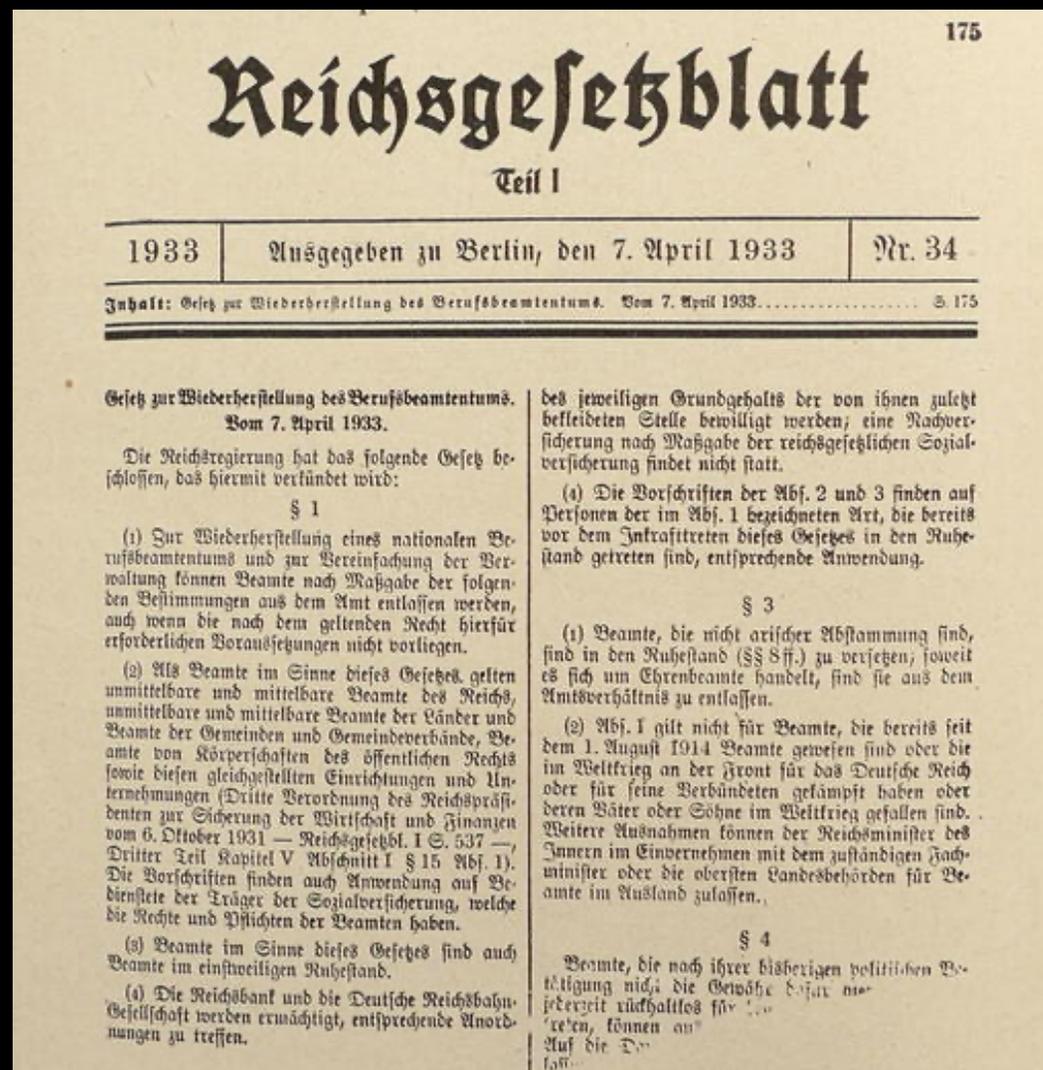
Stark's supporters heckled Einstein and disrupted his lectures



April 1933, Adolph Hitler was named Chancellor of Germany



The Nazi-controlled Reichstag passed the 'The Law for the Restoration of the Professional Civil Service' preventing Jews from employment as teachers, doctors, lawyers or any other form of civil service.



Max Plank, Nobel Prize winner and president of the Kaiser Wilhelm Institute, met with the new German Reichchancellor Adolph Hitler.

Plank told Hitler that “forcing Jewish scientists to emigrate would cripple German science, and the benefits of their work would go to foreign countries that were not necessarily favorably disposed toward Germany.”



Max Plank



Adolph Hitler

Hitler responded; "Our national policies will not be revoked or modified. Even for scientists. If the dismissal of Jewish scientists means the annihilation of contemporary German science, then we shall do without science for a few years!"

Reichchancellor Adolf Hitler



Stark led the movement to cut funding for the study of quantum physics German universities.



Physics books containing references to Einstein, relativity, or quantum mechanics, were burned along with other books by Jewish authors.

In 1935 Nazis passed the Nuremberg Race Laws removing citizenship and all employment rights from Jews.

Over 100 scientists and university professors fled Germany, among them were twelve Nobel prize winning physicists.

Reichstag Takes More Rights Away From German Jews

Hitler Relegates Race
To Place It Held in
Middle Ages

CITIZENSHIP DENIED GROUP

NURNBERG, Germany, Sept. 16 (AP)—The reichstag of Adolf Hitler Monday relegated Jews in the Germany of the future to their position during the middle ages.

They may not become citizens, intermarry with Aryans, nor even employ Aryan servant girls under 45 years of age.

The third reich of the future, by unanimous decision of the 600 Hitler followers who make up the reichstag, will be one in which Aryan citizens who "by their attitude indicate they are willing and fit to serve faithfully the people and the reich" will be sep-

Aviation Hails Sohn As Pioneer

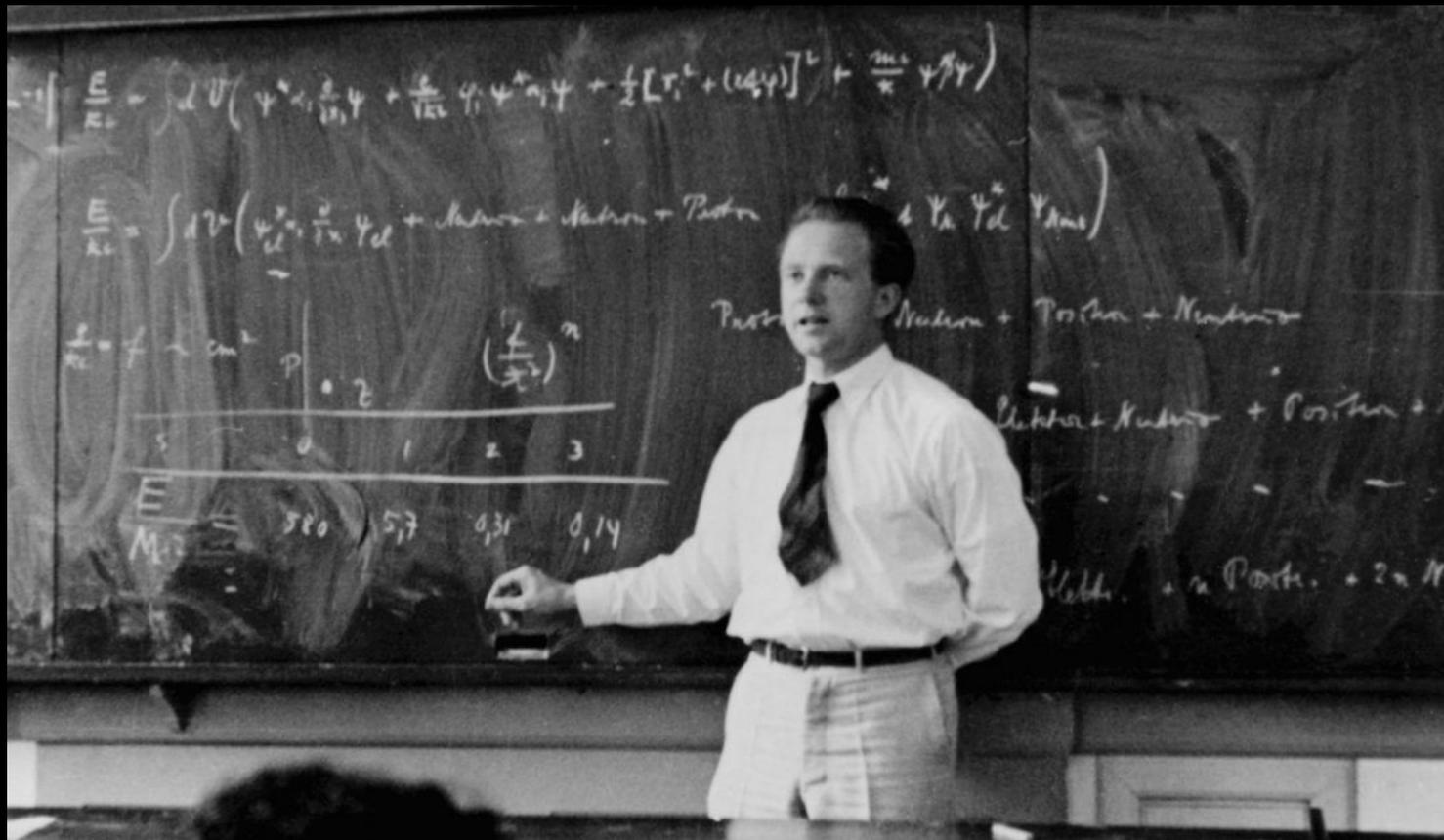
DETROIT, Sept. 16 (INS)

THE feat of Clem Sohn, young Lansing parachute jumper in soaring in the air on his "bat wings," Monday led to a prediction by world famous aviators that still more marvelous developments than those to date could be expected in the airplane industry.

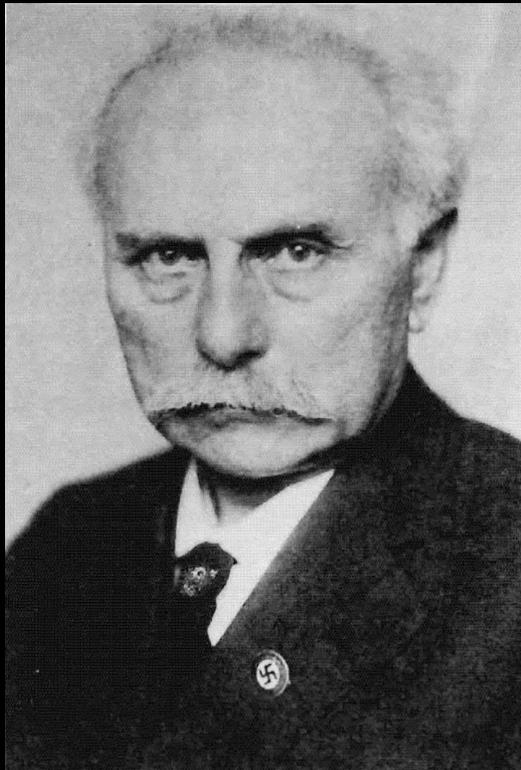
To the thousands that watched young Sohn bail out of an airplane at a height of 5,000 feet and then "float" to an altitude of 800 feet on his wings before he opened his para-



Werner Heisenberg was a Physics prodigy. At the age of 23 he published his theory of quantum mechanics (the Heisenberg Uncertainty Principle). He was presented the Nobel Prize in 1932

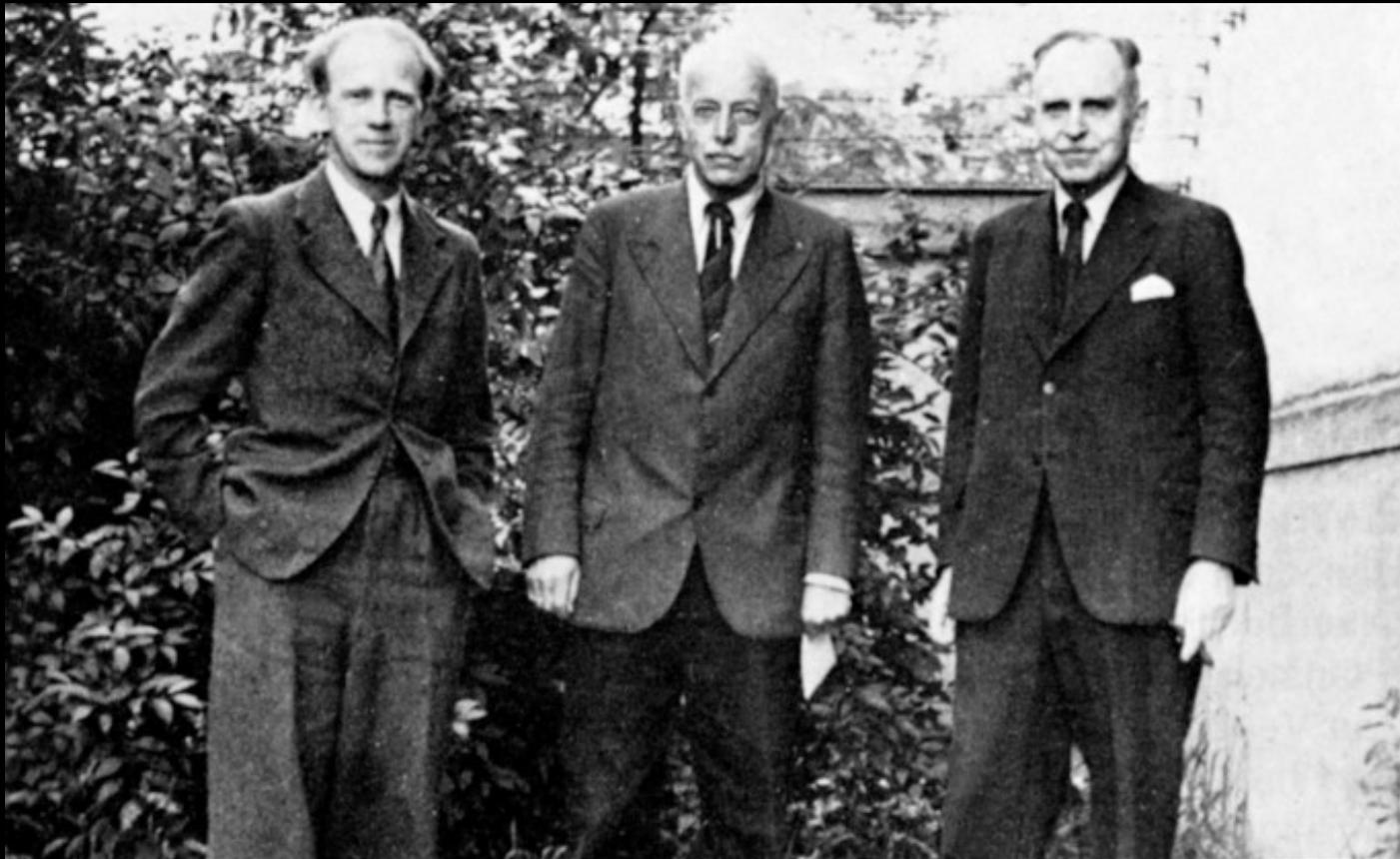


Johannes Stark resented the meteoric rise of the young Heisenberg to fame, and condemned him for his support of the “Jewish” theory of relativity



In 1937 he authored an article entitled
“White Jews in Science”
in the *Schwatze Korps*, the official newspaper of the SS

Hiesenberg was suspended from his chairmanship of the Physics Department at Heidelberg University and was investigated by the Gestapo.



An appeal from Heisenberg's mother to Heinrich Himmler's mother finally exonerated Heisenberg



*"Esteemed Professor Heisenberg
...I have had your case examined with
particular care and scrutiny, since you
were recommended to me by my family.
I am happy to be able to inform you
today that I do not approve of the
offensive article by the Schwarzes Korps
and that I have put a stop to any further
attack on you.....*

*With friendly greetings and
Heil Hitler!*

Yours

H. Himmler"

"Heinrich Himmler: Letter to Werner
Heisenberg",
July 21, 1938

Even though Heisenberg was exonerated by Himmler, the science associated with quantum physics was not looked upon favorably by the Nazi high command





In 1939 Albert Speer, the Nazi armament minister, formed a commission to investigate the development of an atomic weapon. A group of scientist, headed by Werner Heisenberg, formed the “Uranium Club” to work on the project.

The Uranium Club



The German scientists of the Uranium Club worked individually, sometimes competitively, on the Nazi nuclear project. Their Research was carried out in university labs. They had no specialized laboratories or production facilities.

Speier pitched the program to Hitler who was biased against quantum physics and was skeptical about the weapon potential of atomic energy.

Hitler approved funding to continue at the laboratory scale but not at an industrial scale.

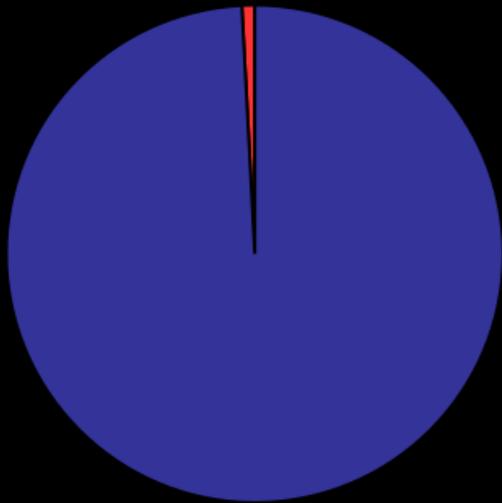


3. The difficulty producing fissile material

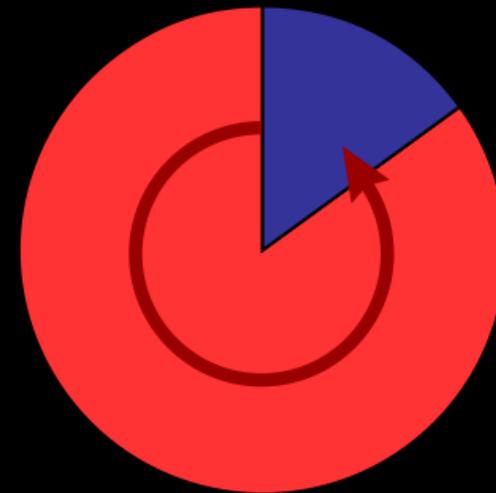
In 1940 Germany invaded Belgium and confiscated their uranium supply from the Belgian Congo.



Natural uranium is U-238. Fissile uranium is U-235, a rare isotope that occurs in .7% of natural uranium. In every 1000lbs. of uranium U-238 only 7 lbs. will be U-235

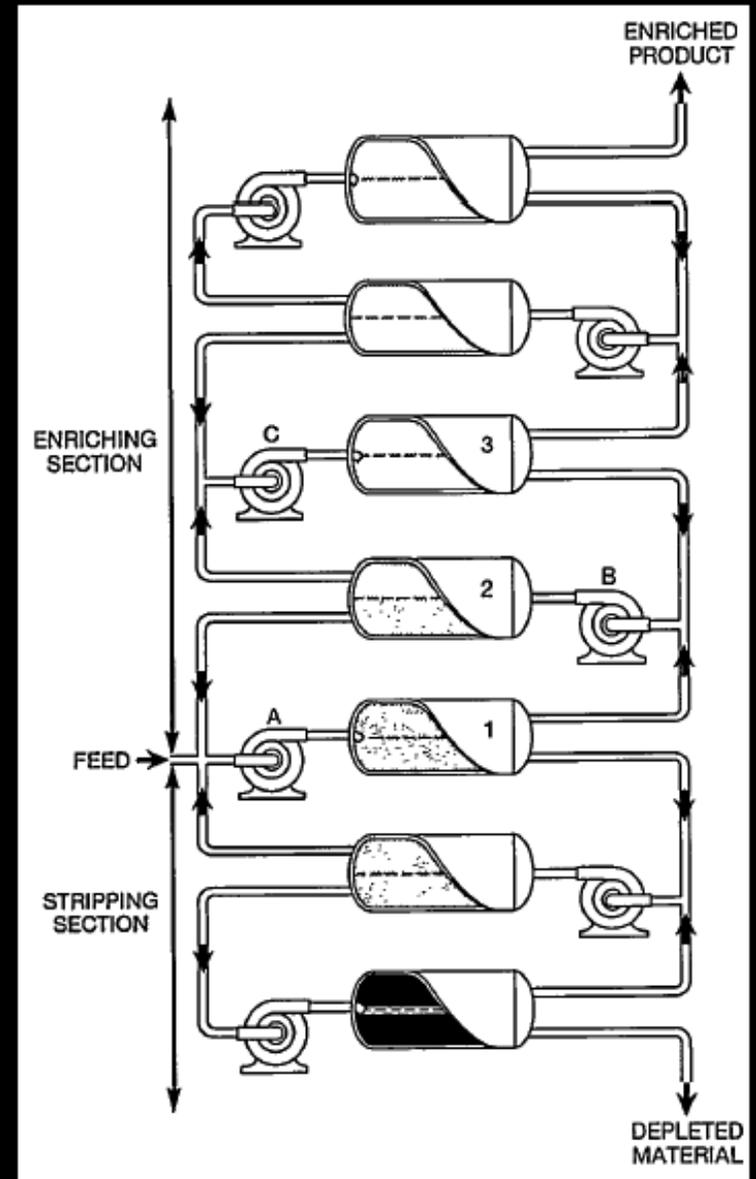
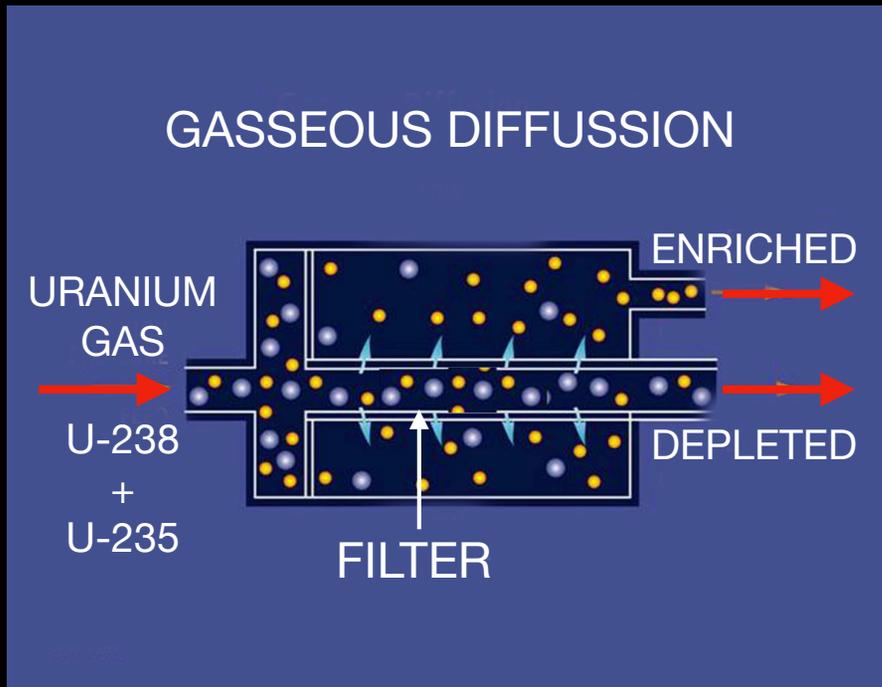


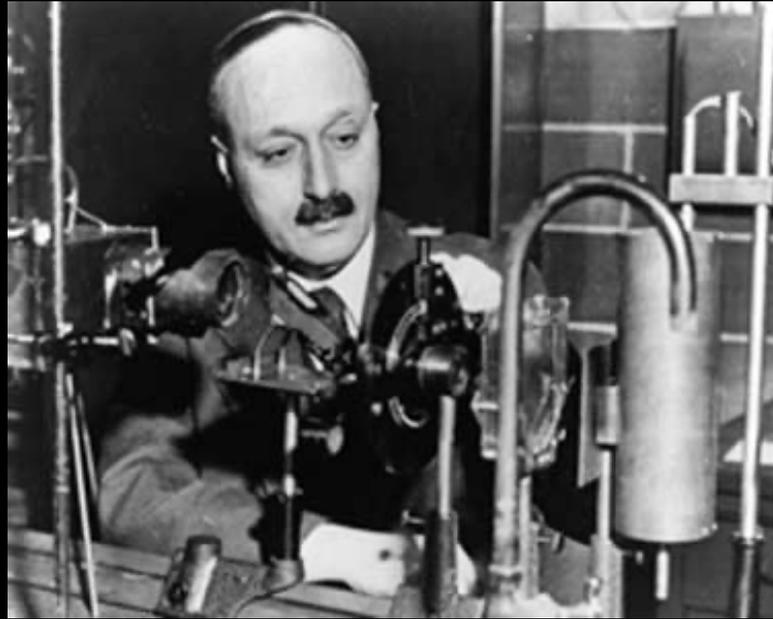
Natural Uranium
U-238 99.2%
U-235 0.7%



Highly-enriched Uranium
(Weapons Grade)
U-235 >85%

Uranium enrichment by gaseous diffusion





Gustav Hertz was Germany's leading researcher of gaseous diffusion. But Hertz's uncle, the famous Heinrich Hertz, was Jewish. As a result, Gustav was forced out of his position as head of the physics department at Berlin Technical College. This set back fissile uranium (U-235) production for the Nazi nuclear program.

Remember filling the glasses with marbles
in the Oppenheimer movie?

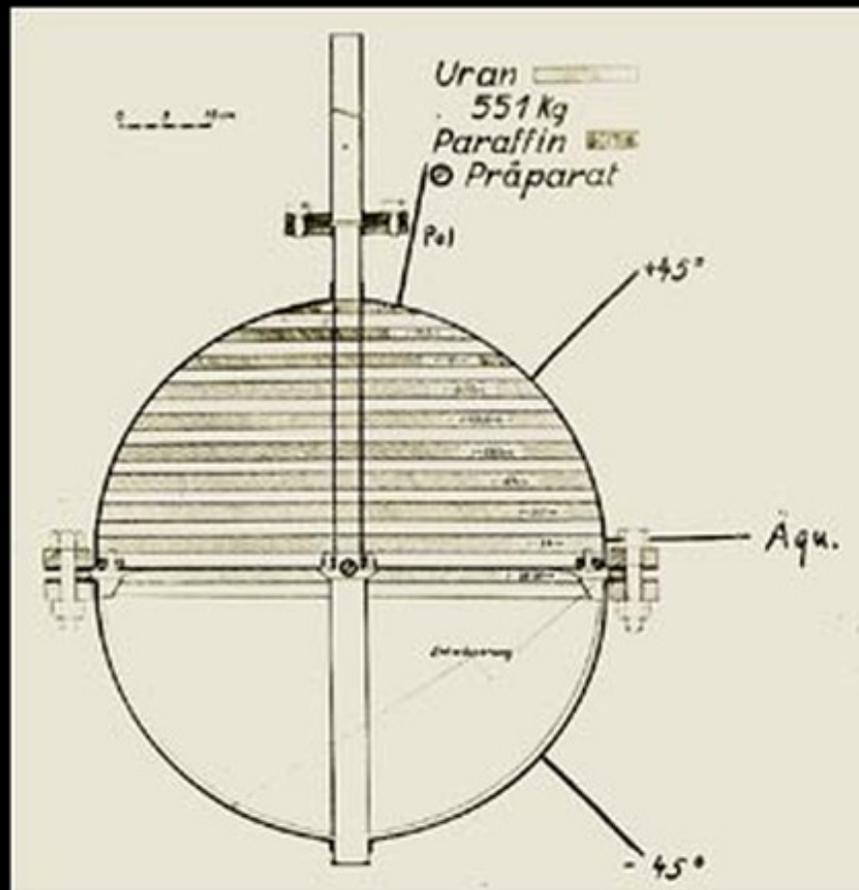
Uranium-235



Plutonium



Plutonium is produced as a by-product in a nuclear reactor. Germany was never able to produce a functioning nuclear reactor before the war ended



Without a nuclear reactor, Nazi Germany could not produce plutonium. They were forced to produce a relatively large amount of U235

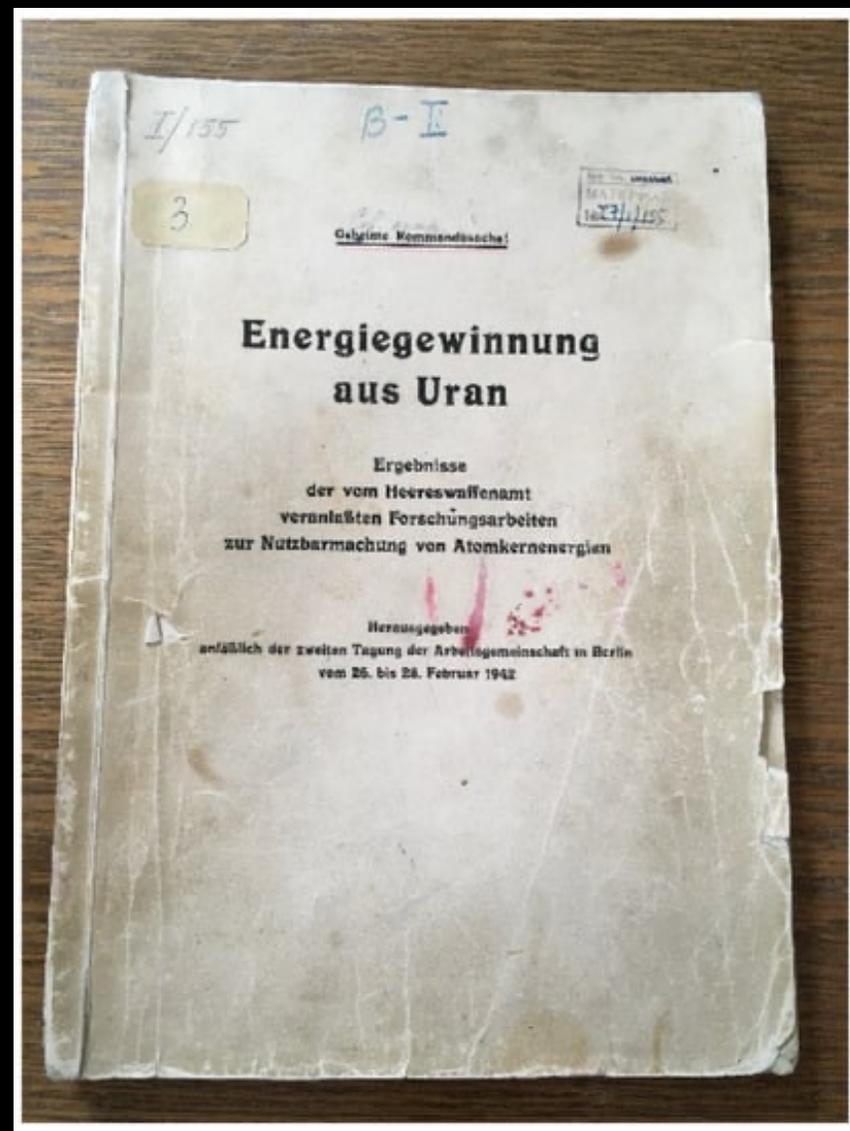
Uranium-235



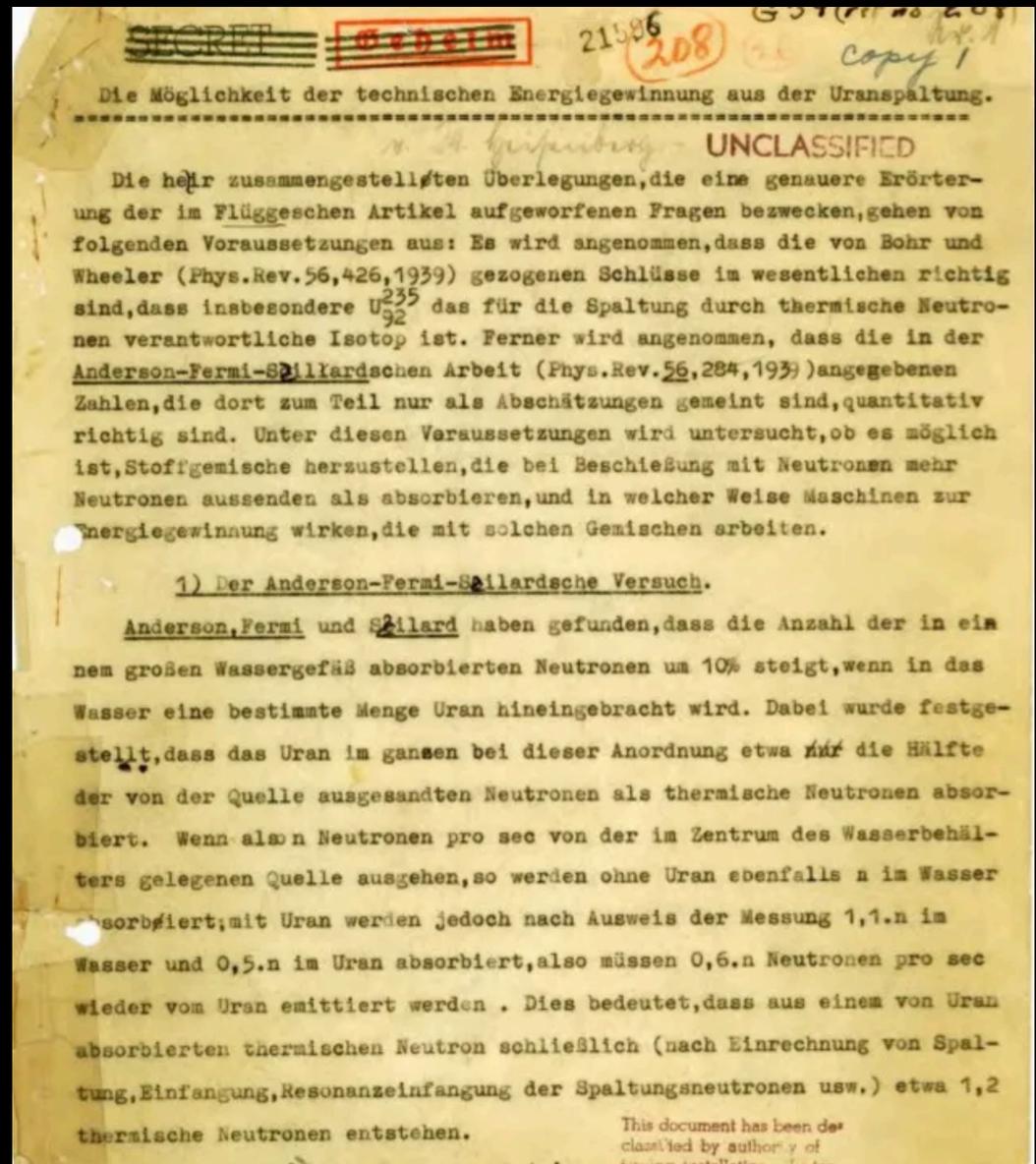
Plutonium



In 1942 Albert Speer pressed the Uranium Club for a timeline for the production a nuclear weapon. The scientists submitted a report to Speer summarizing the progress of the atomic bomb project



Heisenberg
mistakenly calculated
that they would need
more than a ton of
pure U-235 for a
nuclear bomb. He
wrote that it would
take 3-4 years to
produce that much
U-235.

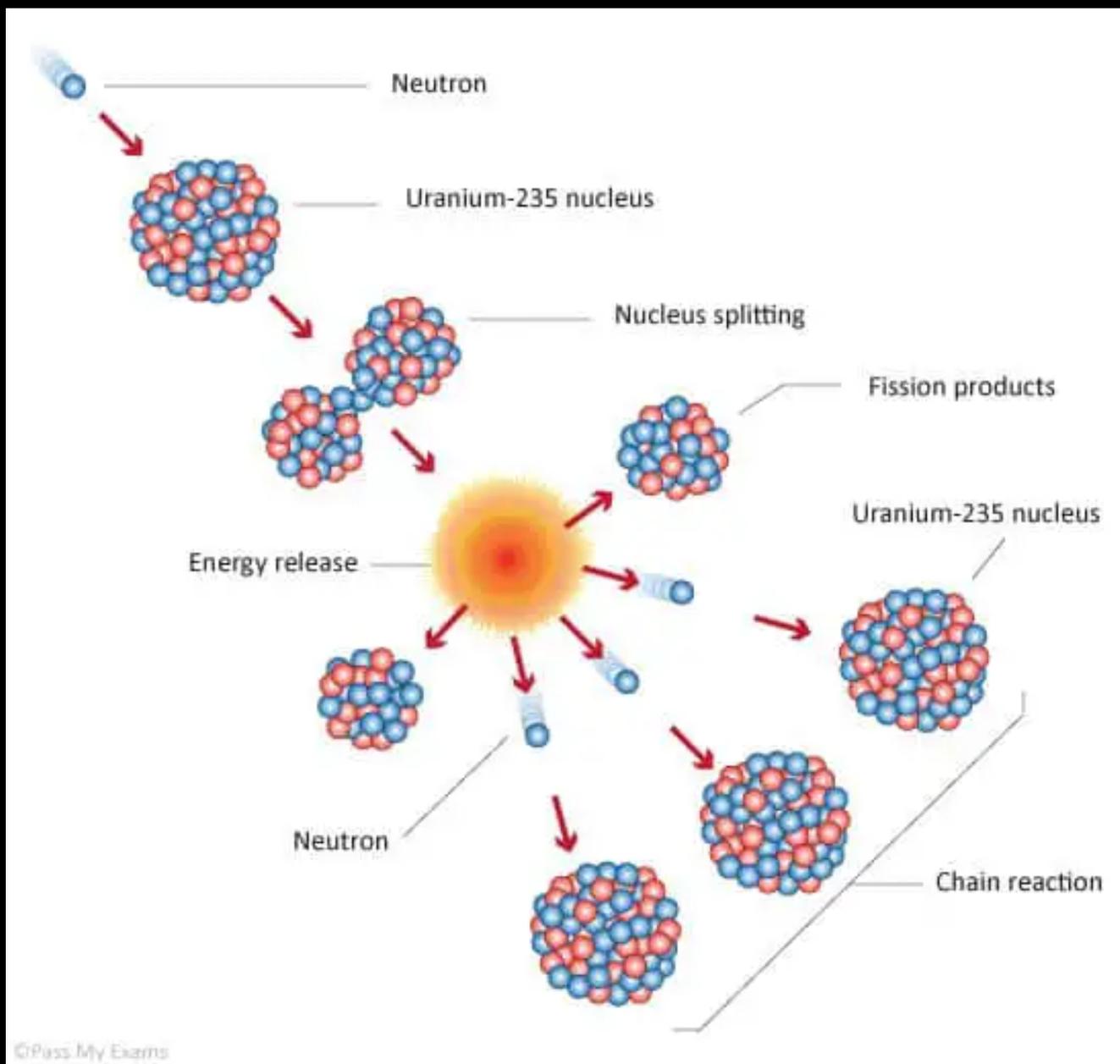


Hitler felt that the war would be over by then and gave the program a low priority



4. The wrong choice of moderator
5. Allied military action

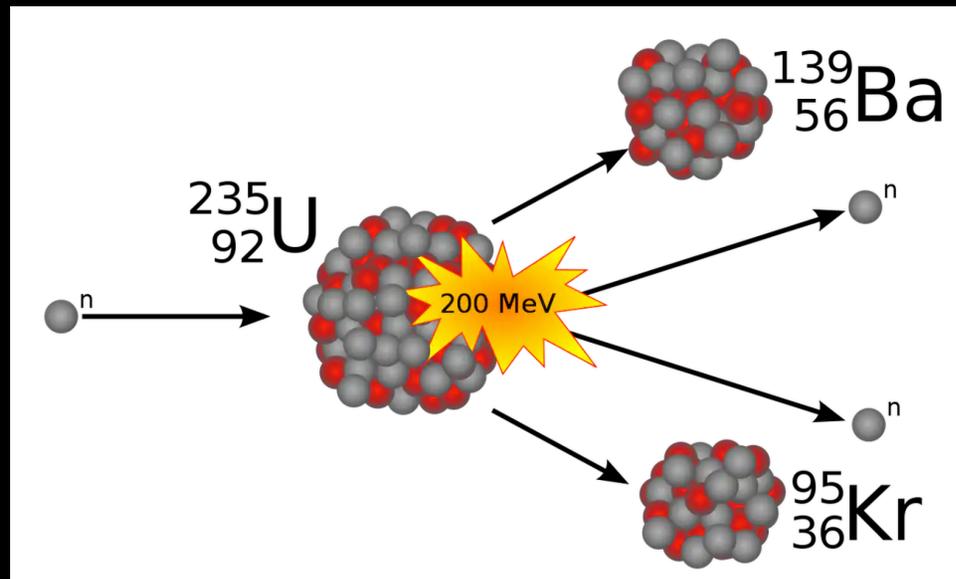
Nuclear Chain Reaction



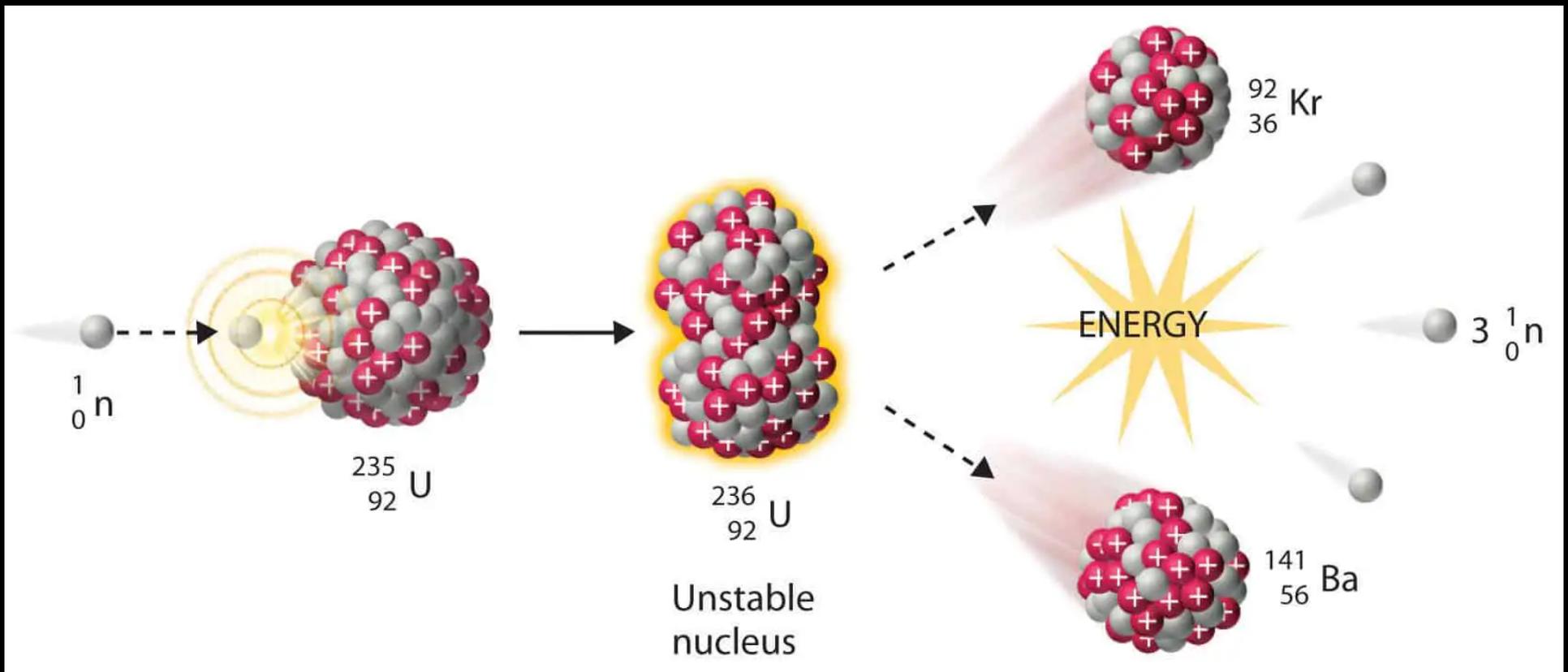


In 1934 Enrico Fermi bombarded elements with neutrons. He discovered that slowing down the neutrons in a chain reaction by surrounding them with paraffin increased the amount of nuclear fission.

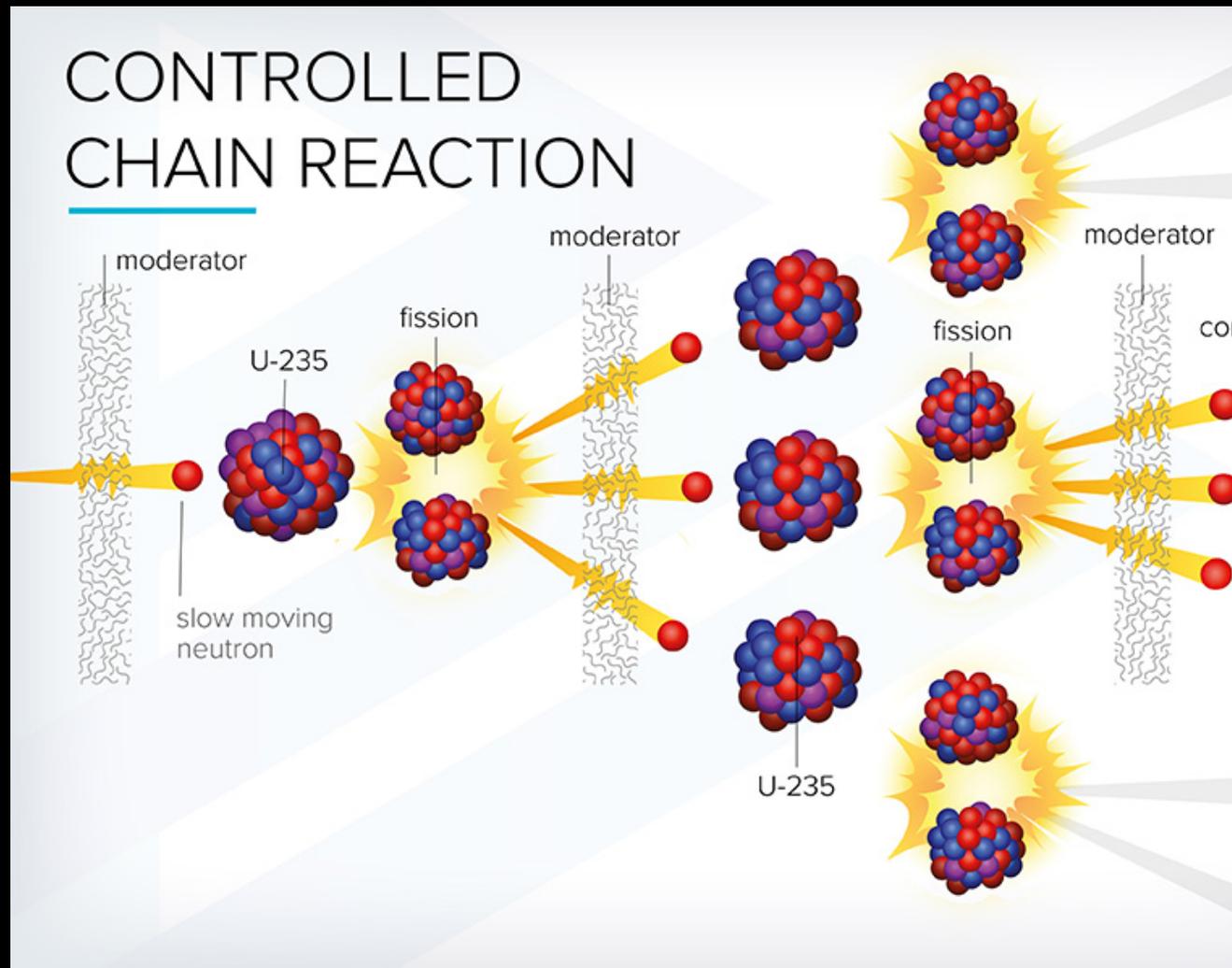
Lise Meitner hypothesized that nuclear fission is not like a pool break



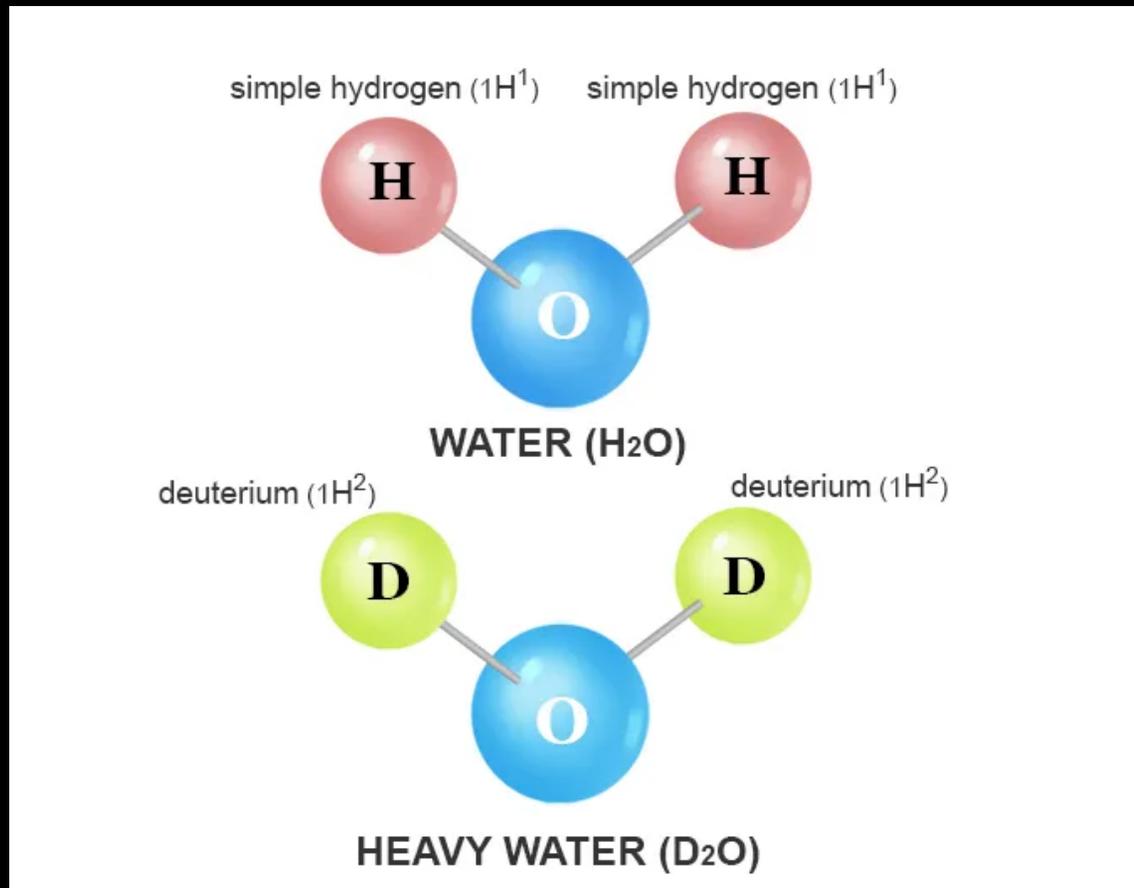
She proposed that the neutron hitting the uranium was absorbed, forming an unstable nucleus. The unstable nucleus then split into two stable atoms and emitted three excess neutrons.



Slow neutrons are more effective in maintaining a nuclear reaction than fast neutrons. A moderator is a substance that slows neutrons.

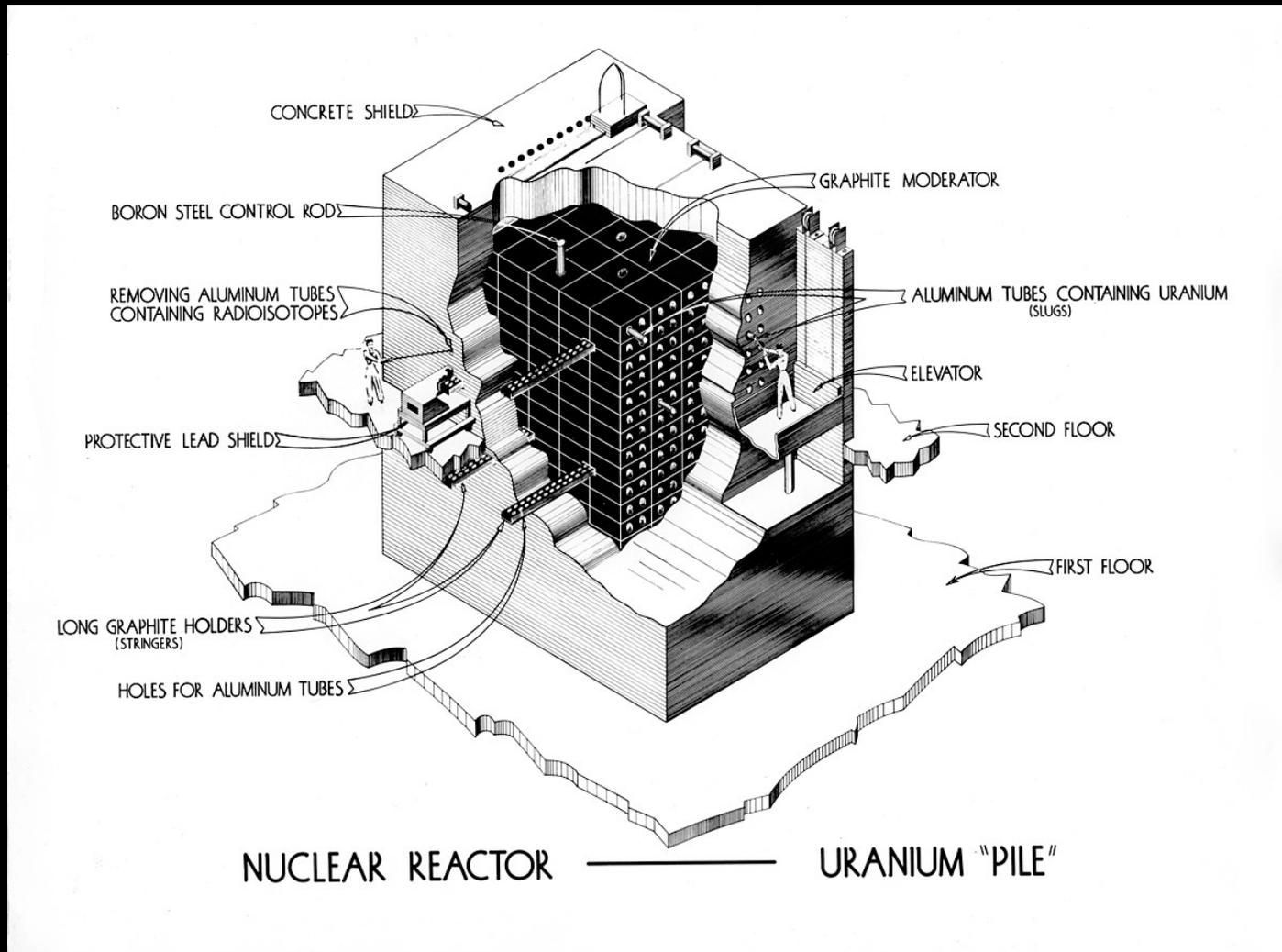


One way to slow down neutrons is using heavy water as a moderator



Heavy water is extremely rare in nature and is expensive to produce by electrolysis

Another way to slow down neutrons is to use graphite blocks as a moderator



German scientists rejected graphite as a moderator because it appeared to block the path of neutrons. They chose to use heavy water instead.



Heavy water is extremely rare in nature but can be manufactured at very slowly

The Nazi plan for a reactor involved suspending blocks of U-235 in a pool of heavy water.

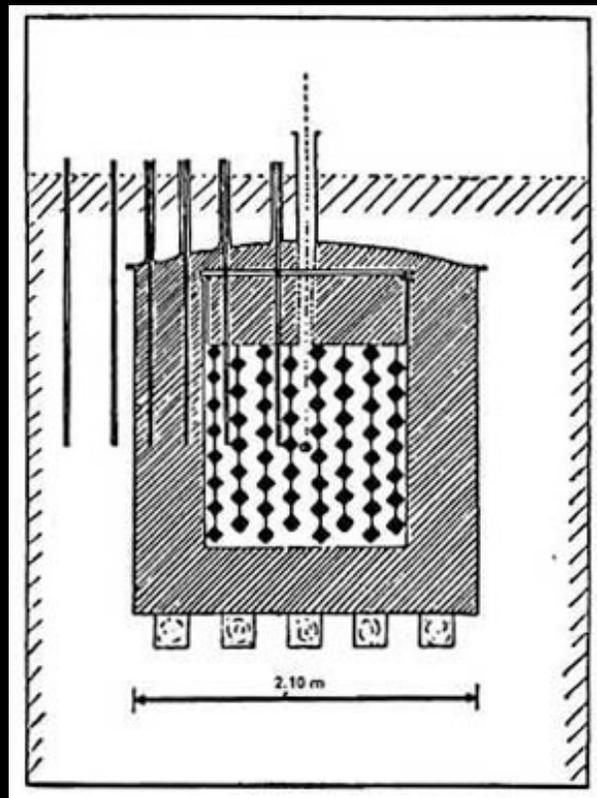


Diagram of Nazi nuclear reactor Museum model of proposed Nazi reactor

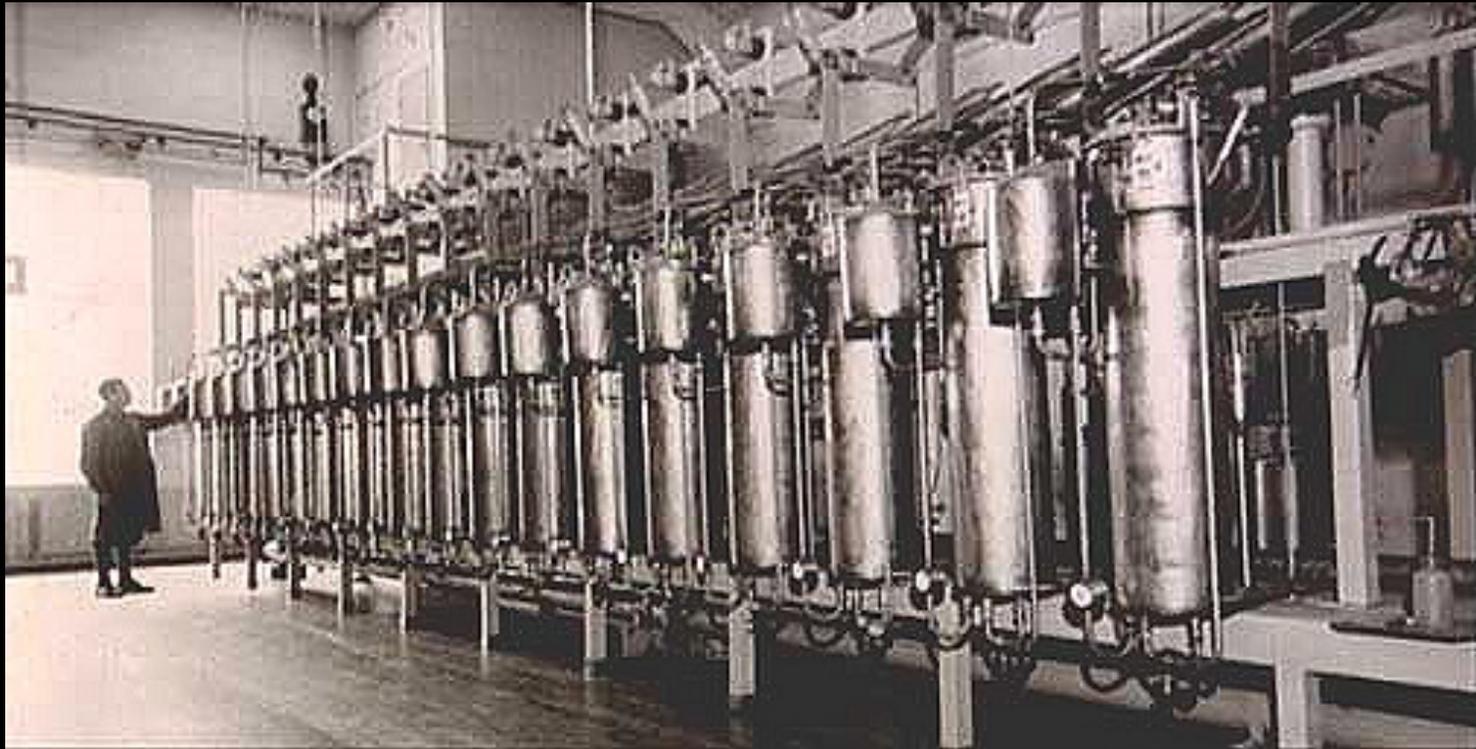


In 1940 the Nazis invaded Norway and took over the Vemork hydroelectric plant, the only plant in Europe producing heavy water.

The heavy water plant was a fortress-like building on a remote mountainside



Electrolysis was used in the plant to slowly create heavy water at a rate of 10Kg per month



In February 1943 nine Norwegian commandos trained by British Special Operations were dropped into Norway to sabotage the Vermok heavy water facility.



Their attack disrupted heavy water production in the plant for six months

The Nazis rebuilt the plant and resumed heavy water production.



In 1944 American B-17s attacked the plant.

The air raid destroyed the plant and heavy water production ceased.

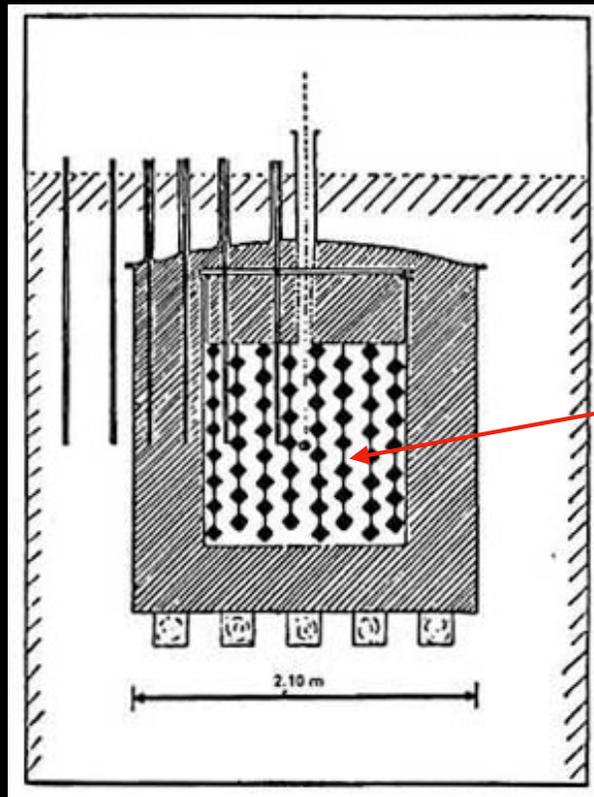


The Nazis attempted to transport the remaining heavy water stored in the plant on a ferry.



The ferry was blown up by Norwegian partisans.

Without heavy water, the German plan for a nuclear reactor was disrupted



heavy water

6. Hitler's preference for wonder weapons

Hitler was not impressed by the report from the Uranium Club and biased against the science of nuclear physics. He preferred to invest wartime resources in Wundrewaffe (Wonder Weapons).



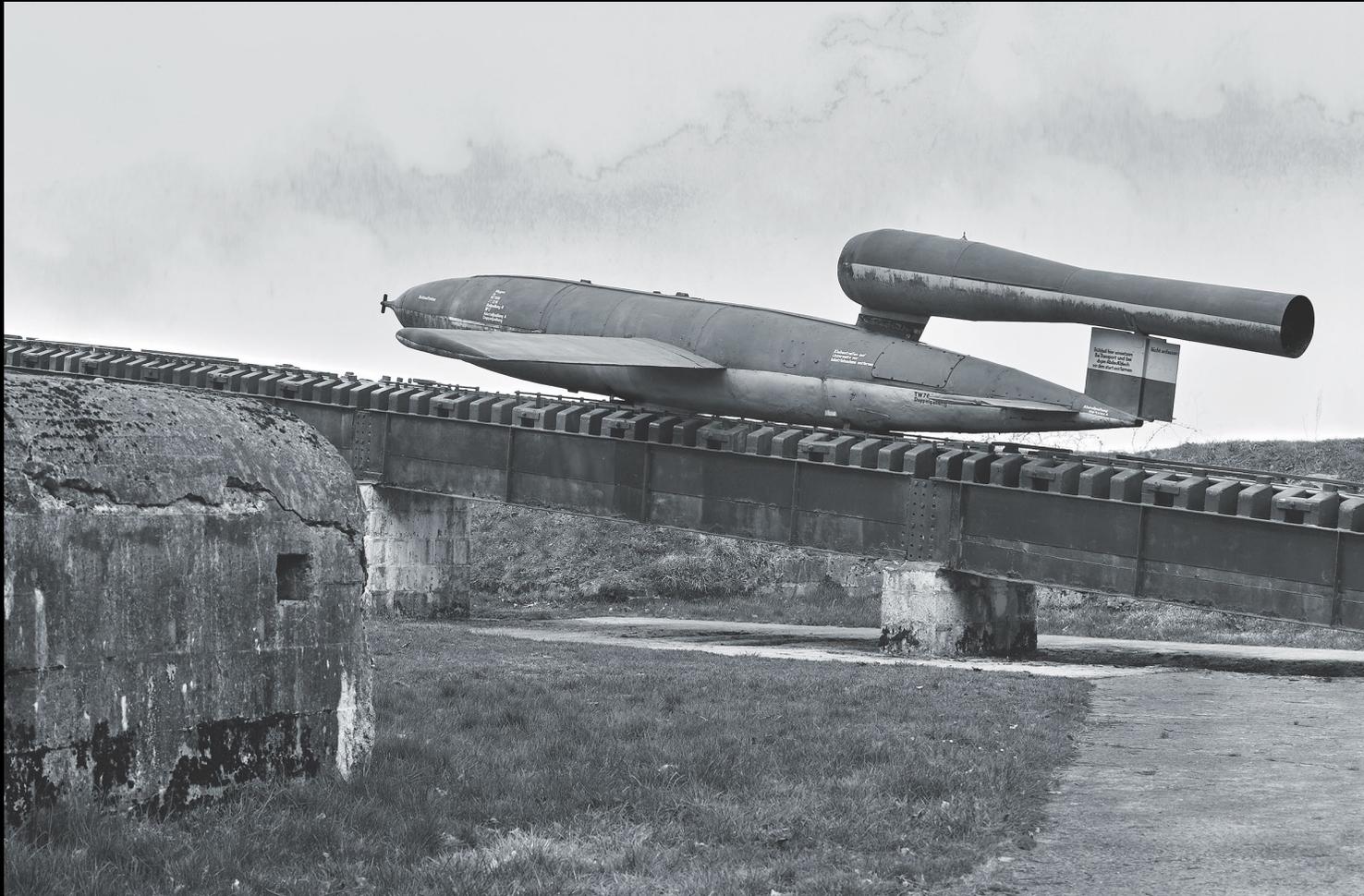
Hitler believed that German scientists should work on jets and rockets



Messerschmitt ME-262 swept wing jet fighter



Messerschmitt ME-263 Komet
Rocket powered interceptor



V-1 pulse jet cruise missile

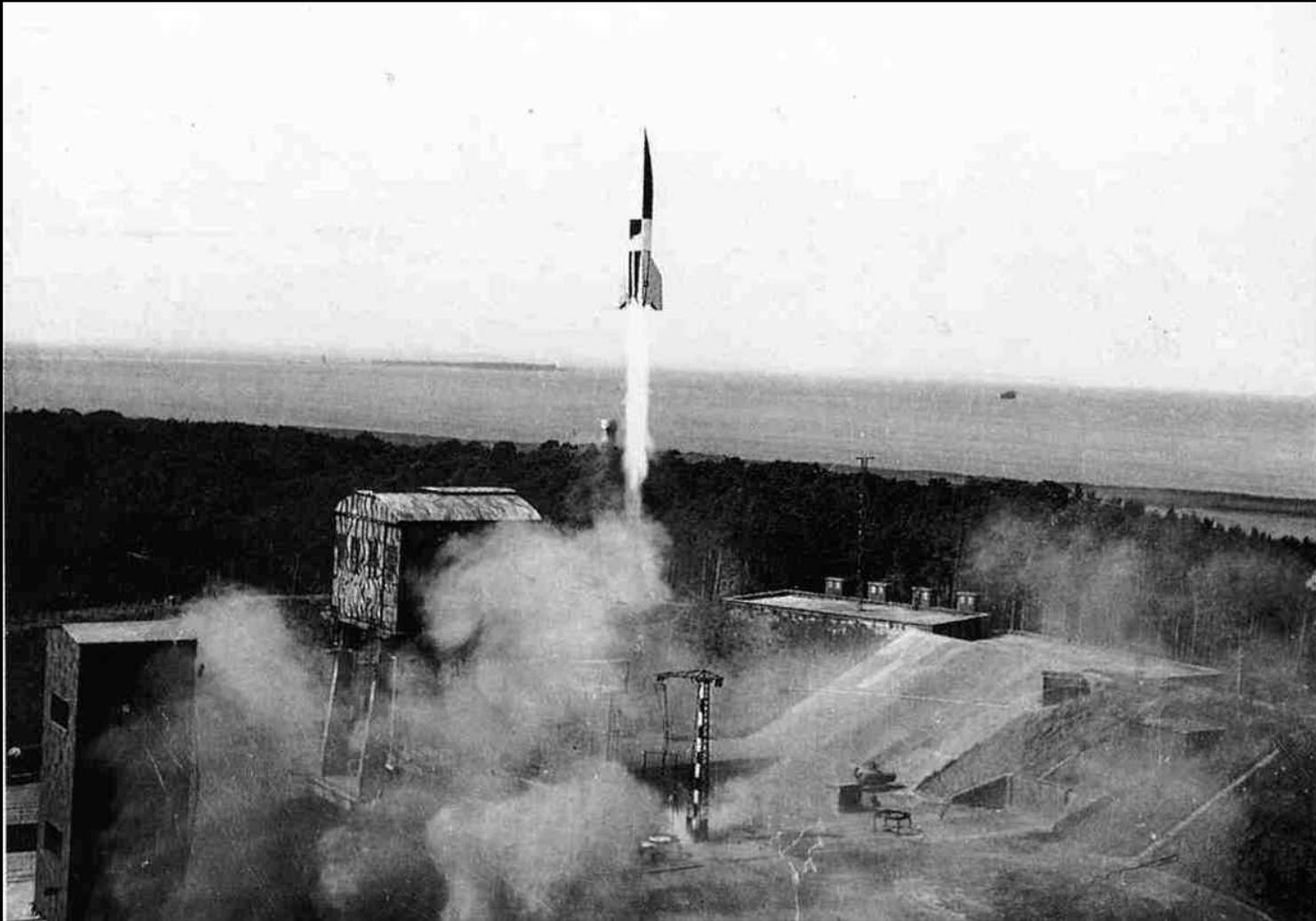
Hitler's favorite scientist was Werner Von Braun,
head of the V-2 Ballistic Rocket program





V2 Ballistic Missile

1400 V-2 rockets were fired at London.

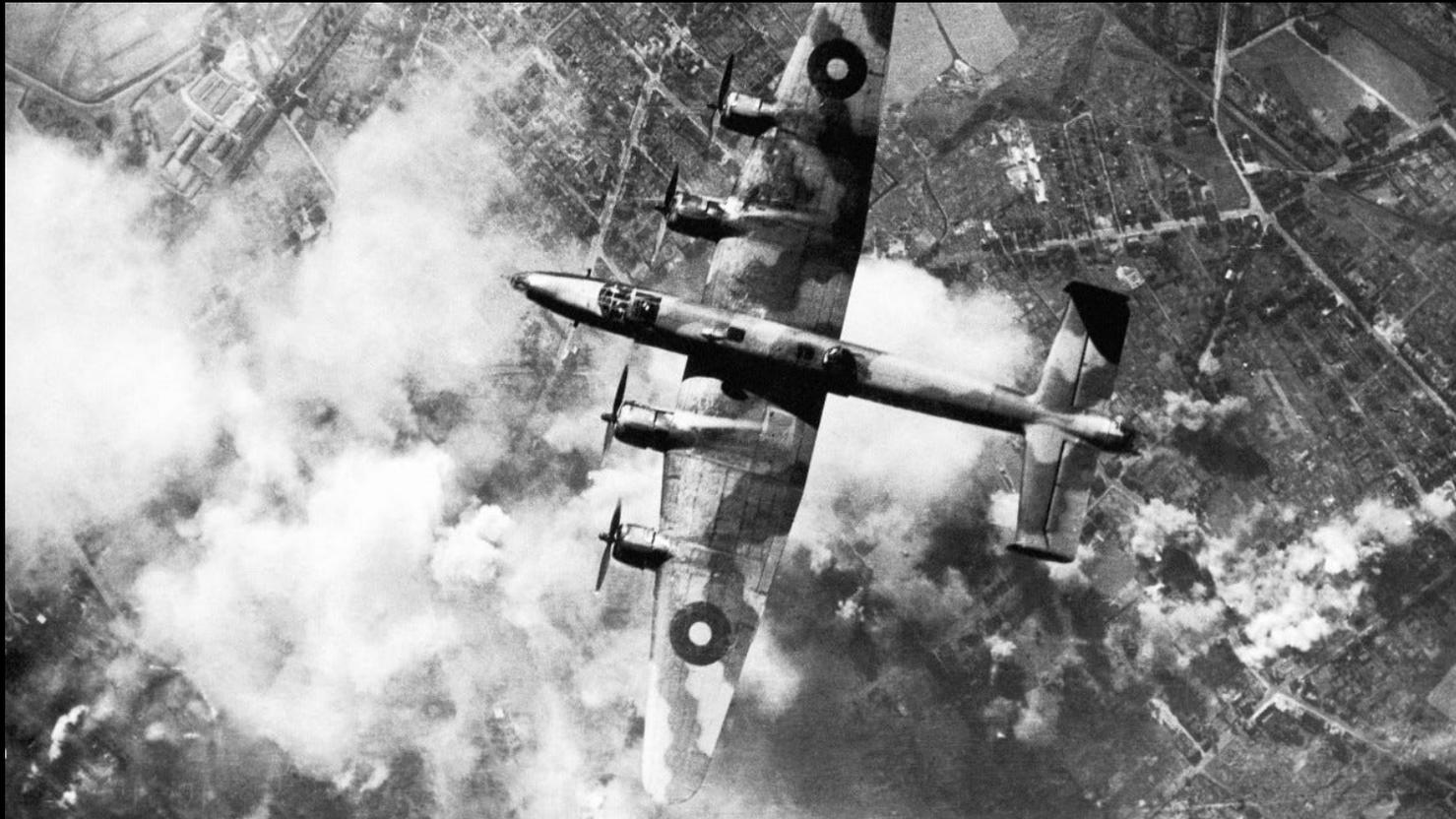


They were very expensive to produce

The V-2s were produced in a factory in Peenemunde Germany



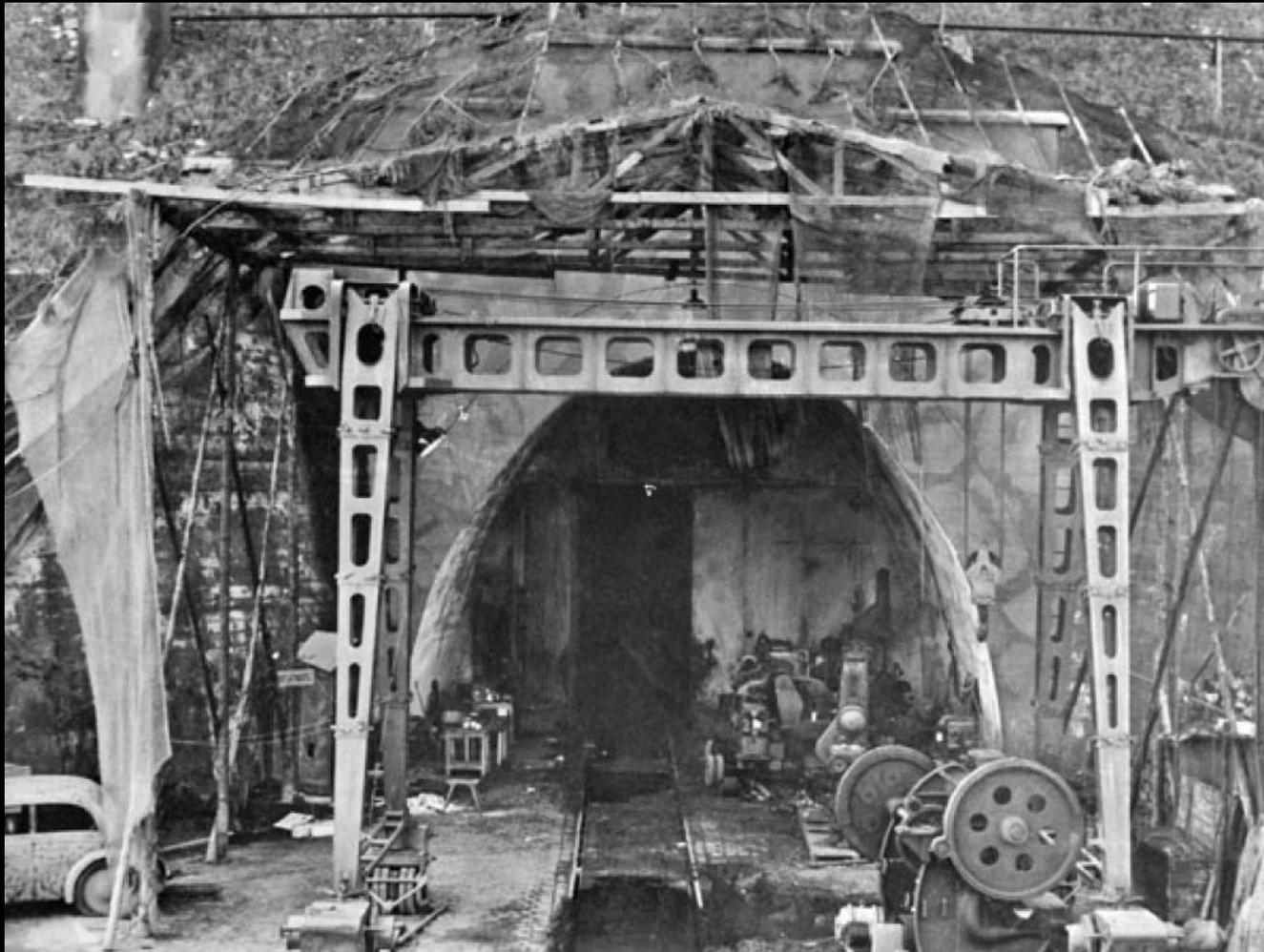
In 1943 600 British bombers bombed the V-2 assembly plant in Peenemunde



40 of the bombers were shot down
but the facility was destroyed



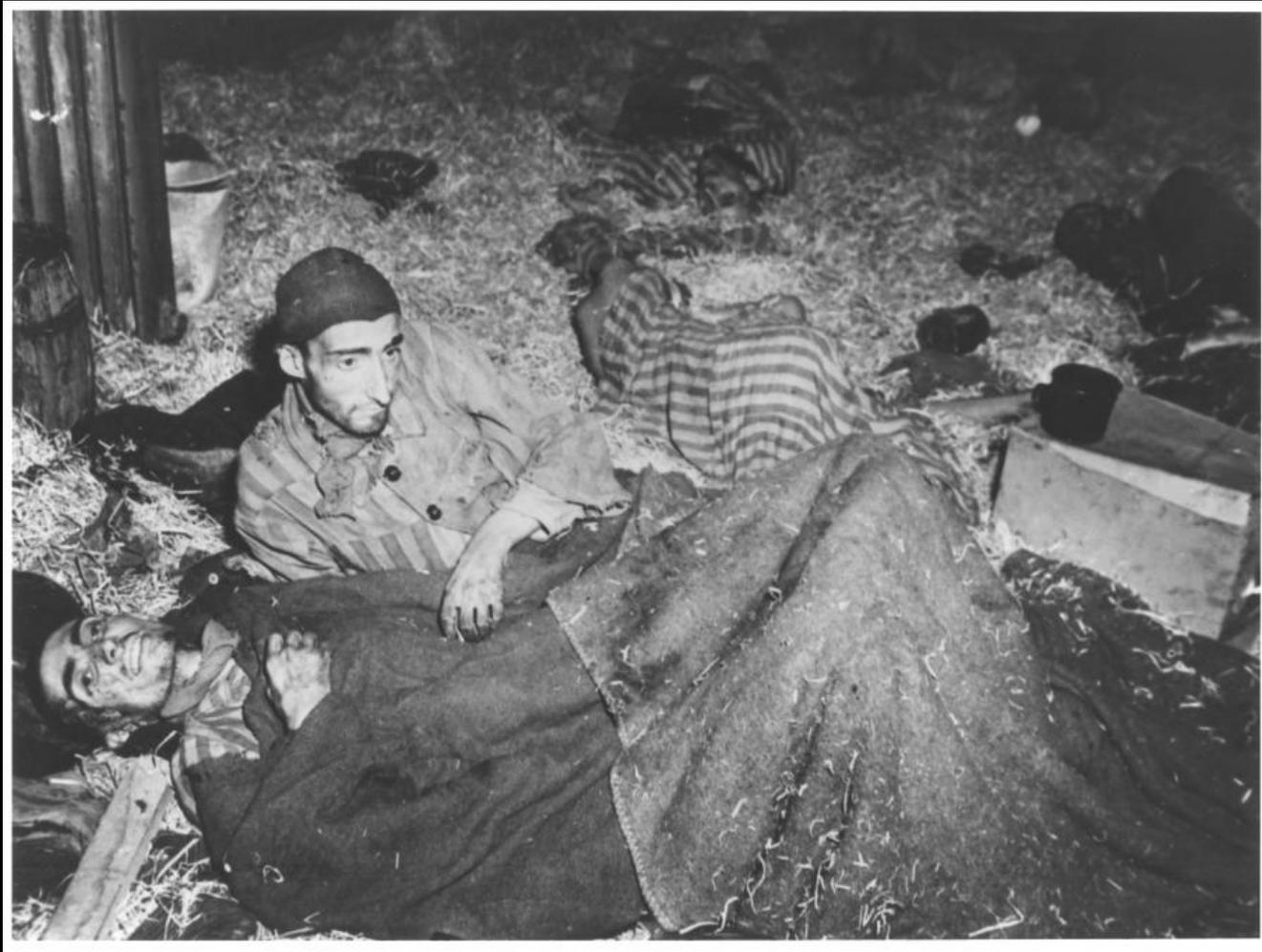
This Forced the Germans to move V-2 production to the underground Mittelwerk factory. Assembly was done by forced laborers from concentration camps.



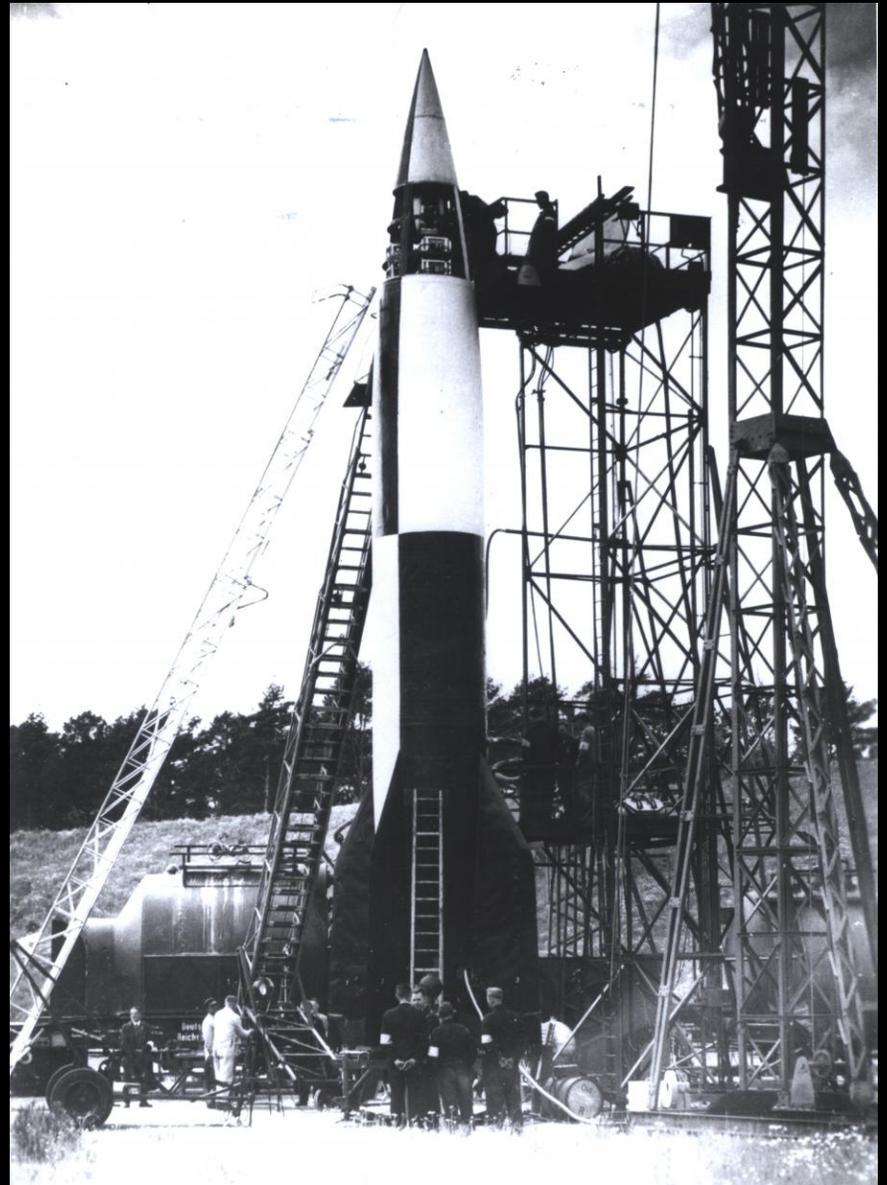
More prisoners died working in the underground factory than the V2 rockets killed in England



When the US Army liberated the town of Nordhausen they found hundreds of sick, starving prisoners abandoned in the factory tunnels



The cost of the Hitler's V-2 program was \$2 Billion 1944 dollars, comparable to the cost of the American atom bomb Project.

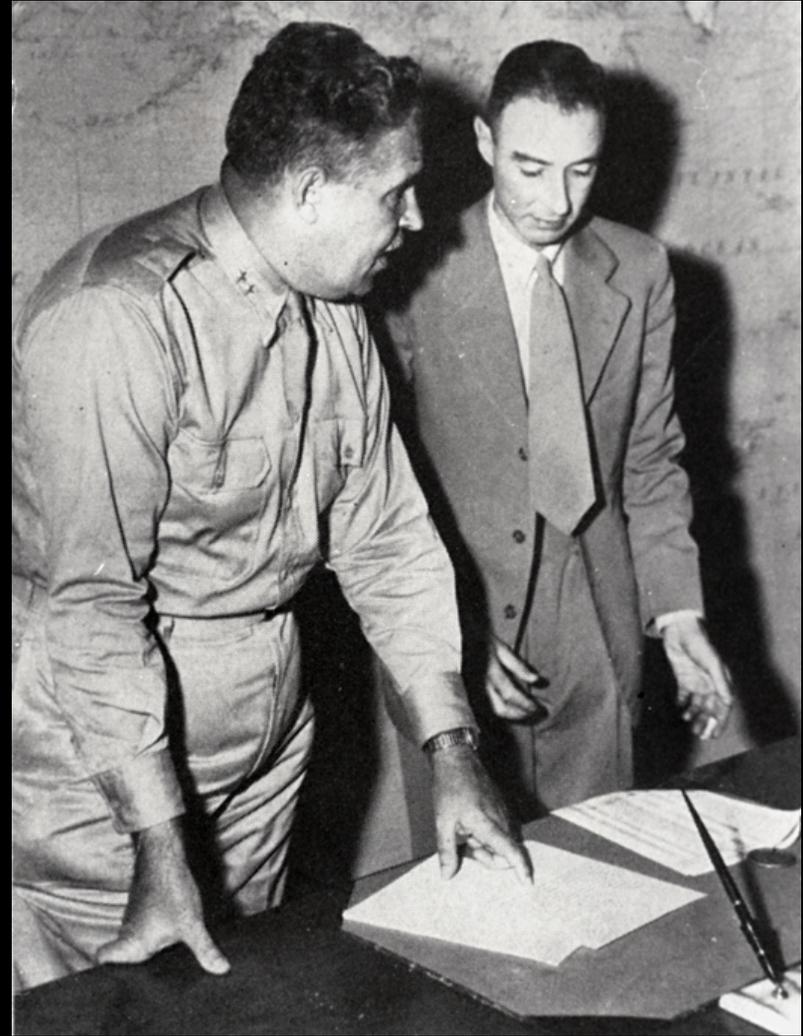


Meanwhile, in the US....



In 1939 Leo Szilard visited Albert Einstein and told him that the were Nazis developing an atomic bomb. They sent a letter to President Roosevelt warning that a nuclear chain reaction could be used to make a powerful bomb, and cautioned that Germany might be the first to do so.

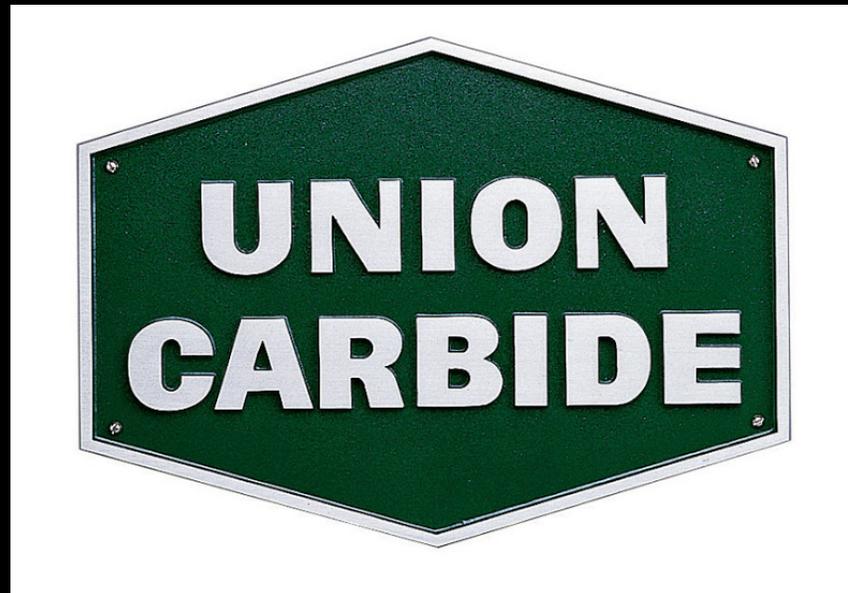
A month later Roosevelt authorized the “Manhattan Project”. The US Army ordered General Leslie Groves and Physicist Robert Oppenheimer to coordinate a combined military and scientific bomb development program.



While General Groves directed the development of the Manhattan Project infrastructure, Robert Oppenheimer organized the scientific research. Oppenheimer assigned each scientist to a specific project based on their area of expertise and managed their diverse egos and personalities.



Leo Szilard found that natural graphite contained minute quantities boron that degraded graphite's ability to act as a moderator. He worked with Union Carbide to develop a purified form of graphite which was used as a moderator in the American nuclear reactor.



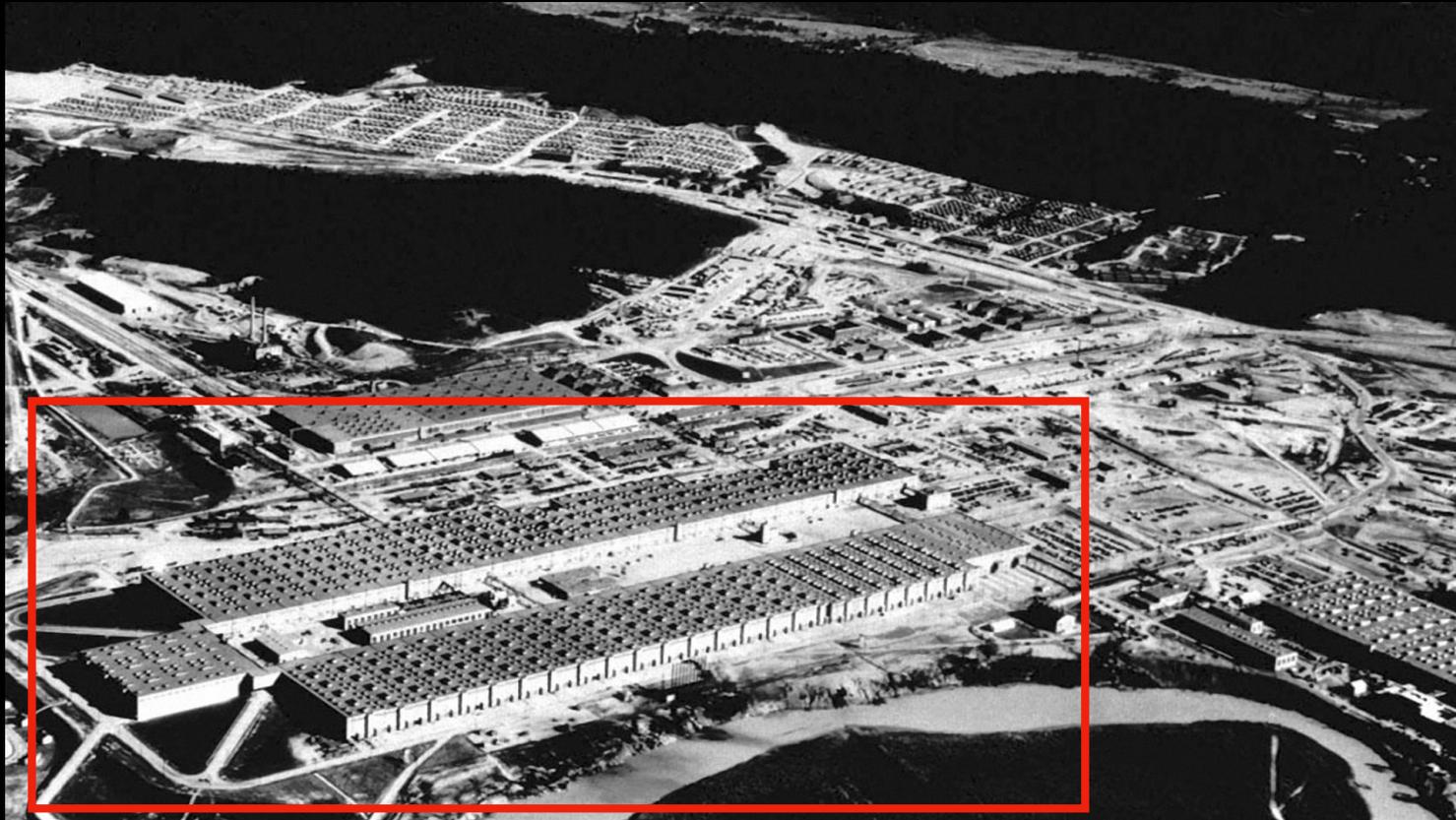
In 1942 Enrico Fermi and Leo Szilard built the first nuclear reactor under the stands at the University of Chicago using blocks of purified graphite as a moderator



By 1944, the Project cost \$2 billion and employed 129,000 people at 20 different locations

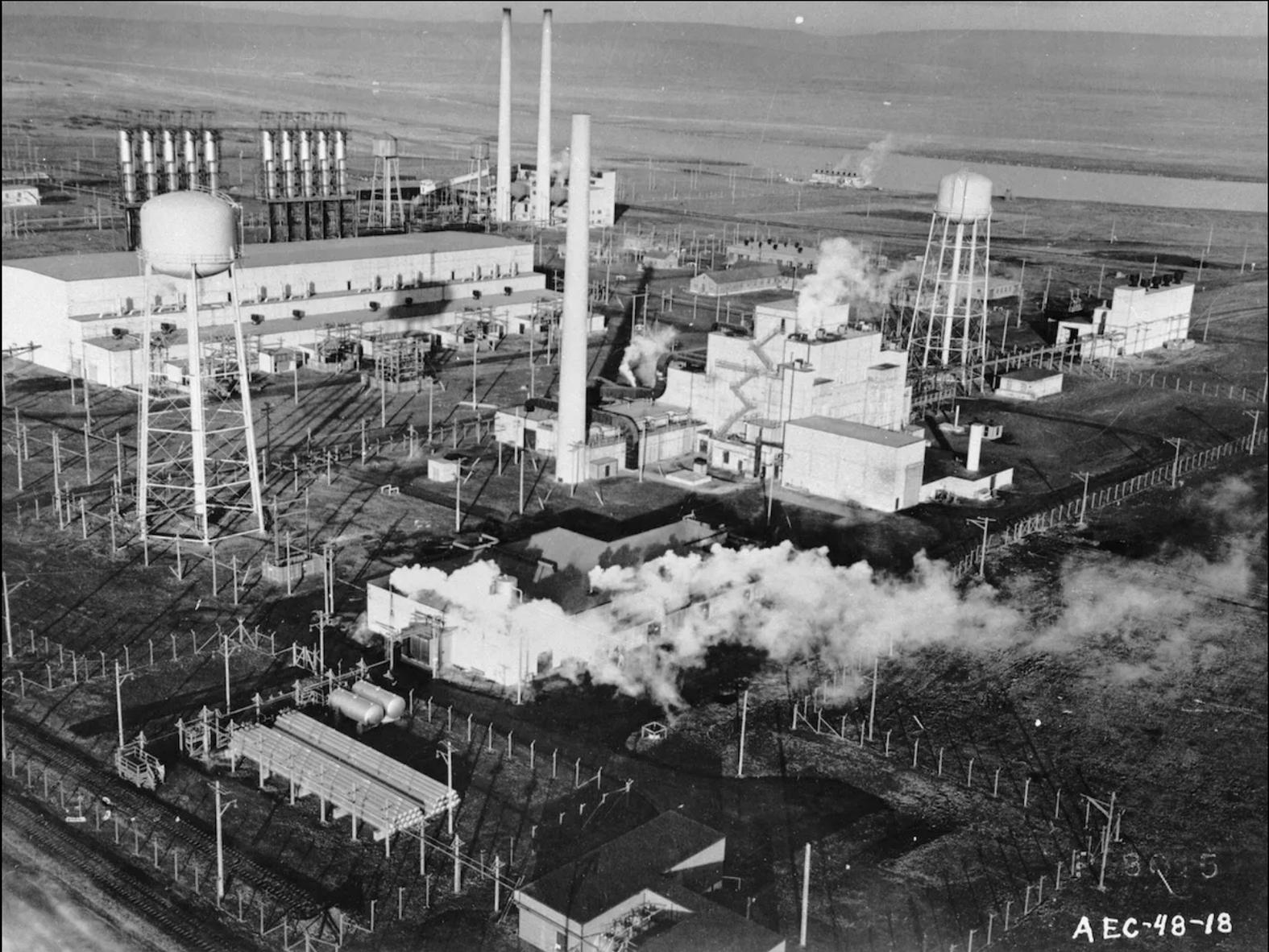


They built a uranium processing facility for separating U-235 from U-238 in Oak Ridge Tennessee

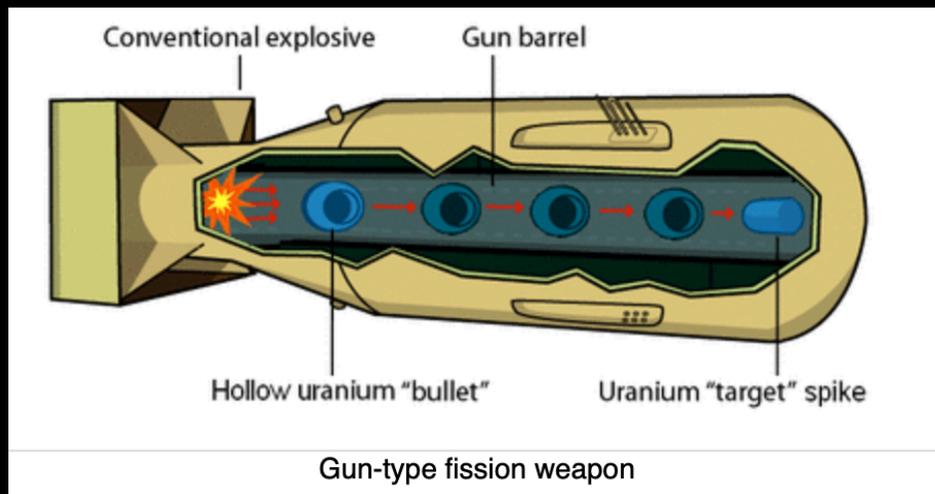


This was the largest building in the world. 2 million square feet, a half mile long and 1000 feet wide.
The site was half the size of Rhode Island.

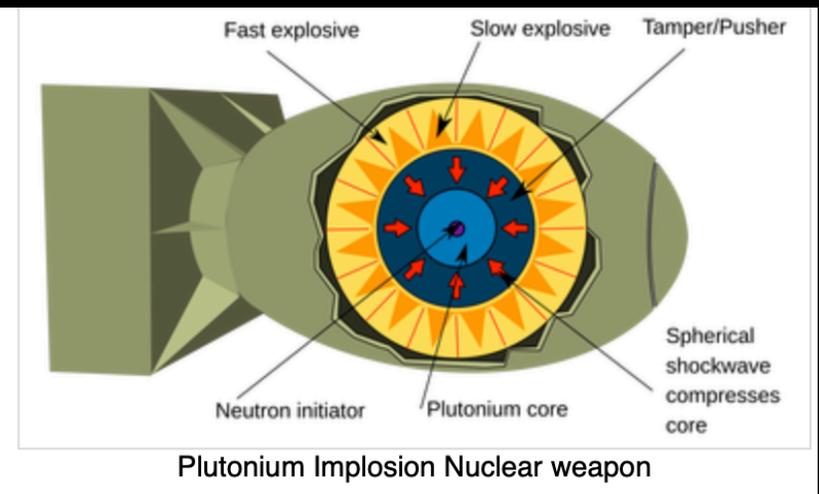
A nuclear reactor was built in Hanford
Washington to produce plutonium



By 1945 the Manhattan Project produced two types of bombs, a uranium bomb dropped on Hiroshima and a plutonium bomb dropped on Nagasaki



Uranium Bomb
"Little Boy"



Plutonium Bomb
"Fat Man"

Conclusion



While Nazi jet and rocket projects were more advanced than Allied efforts, they also proved to be indecisive militarily. The result of all the wonder weapons was that the Reich wasted a lot of money and technical expertise to develop and produce exotic devices that yielded little strategic advantage.

Had Germany produced just a few atomic bombs before the end of the war, instead of the thousands of V-1 and V-2 rockets they lobbed on Britain, the course of history would have been different.



The Alsos Mission

The Alsos Mission



General Groves sent a special army unit to accompany the Allied invasion of Europe. The unit's mission was to capture key German scientists and research documents before the Russians got to them.

By June 1945 the Alsos team captured ten of the scientist of the Uranium Club.



The captured German scientists were interned in Farm Hall near Manchester, England. Their rooms were bugged and their conversations were secretly recorded over six months.



What the allies learned from the Farm Hall tapes:

- The German Scientists didn't believe that the Americans scientists had created a bomb.
- There was little respect for American science. They were surprised that the Americans were capable of producing the bomb.
- They realized that the American scientists worked cooperatively while German scientist worked individually or were competitive with each other.
- They were impressed by the scale of the Manhattan project and blamed their government for not making a large resource commitment.

Let's summarize why the Nazi atomic weapons project failed

- Germany suffered from a critical brain drain produced by Jewish scientists escaping Nazi anti-Semitism.
- Hitler's antipathy towards quantum physics prevented a large investment of funds or research into atomic weapons.
- The Allied bombing of Nazi facilities and factories disrupted research and production.
- The pursuit of expensive advanced weapons systems drained Nazi resources.
- Allied motivation, organizational and production ability outmatched Germany's.

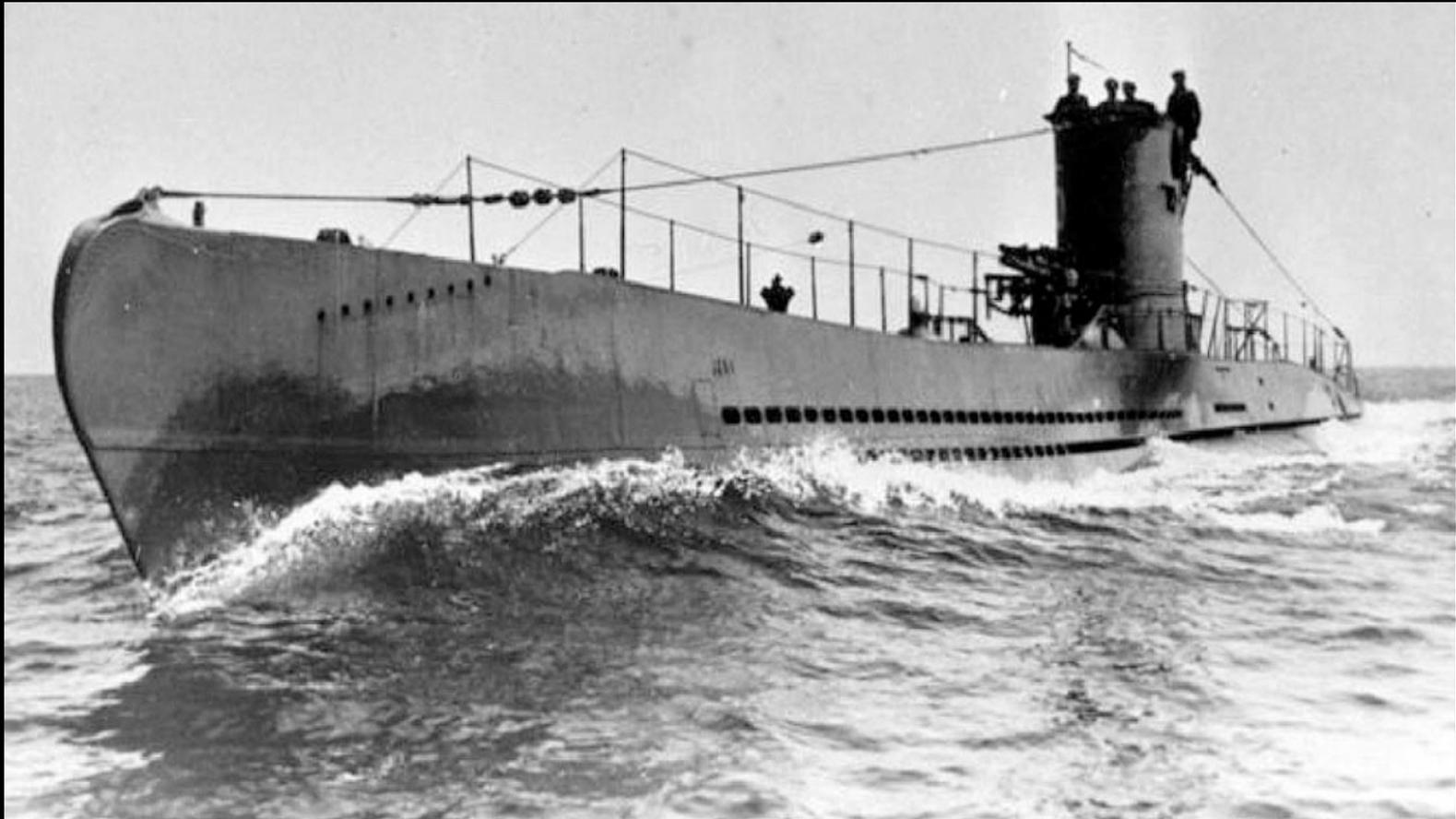
Mistakes made by Nazi scientists:

- They chose heavy water rather than graphite for a moderator.
- They miscalculated of the critical mass necessary to achieve fission in a U-235 bomb.
- They underestimated the difficulty of separating the U-235 from the U-238.
- They never produced a nuclear reactor necessary to produce plutonium.

Epilogue

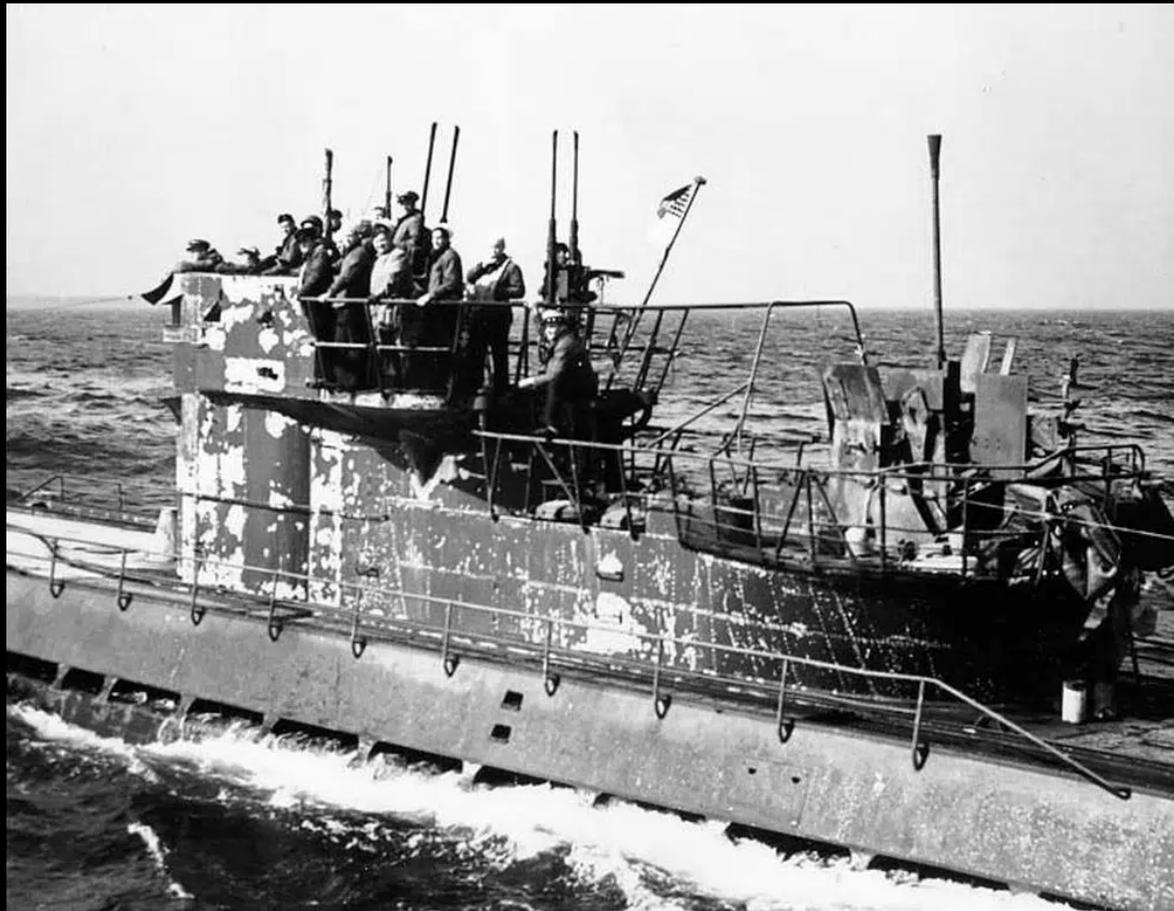
In April 1945 the German mine laying submarine U-234 sailed from Norway bound for Japan on her first and only mission.





On May 10th, 1945 the U-234 received a broadcast announcing Hitler's death. Admiral Karl Dönitz ordered all U-boats to surrender immediately to Allied forces.

The U-234 surfaced and surrendered to the Navy destroyer, USS Sumpter. The U-Boat was boarded by marines, and diverted to Portsmouth, New Hampshire



Inside the sub's hold they found the fuselage of a Messerschmit Me-263, engineering drawings of jet engines, and 80 lead cylinders containing 560kg of uranium oxide being shipped to Japan. Two Japanese officers on board had committed suicide.



The U-Boat Commander surrenders to Marines in Portsmouth



After his capture, Heisenberg took credit for preventing the Nazis from producing an atomic weapon. He claimed that he deliberately over-estimated the amount of the uranium required to build a bomb to discourage the Nazis from pursuing their nuclear program.



New York Times September 1, 1992

Home > News > History

Secret documents reveal Germans tested nuclear bomb in 1944 as doodlebugs pounded London

DOCUMENTS unearthed in an American archive suggest that Nazi Germany may have tested an operational nuclear bomb before the end of the Second World War.

By **ALLAN HALL IN BERLIN**

00:00, Thu, Feb 23, 2017 | UPDATED: 10:56, Thu, Feb 23, 2017



Documents suggest Nazi Germany tested an operational nuclear bomb

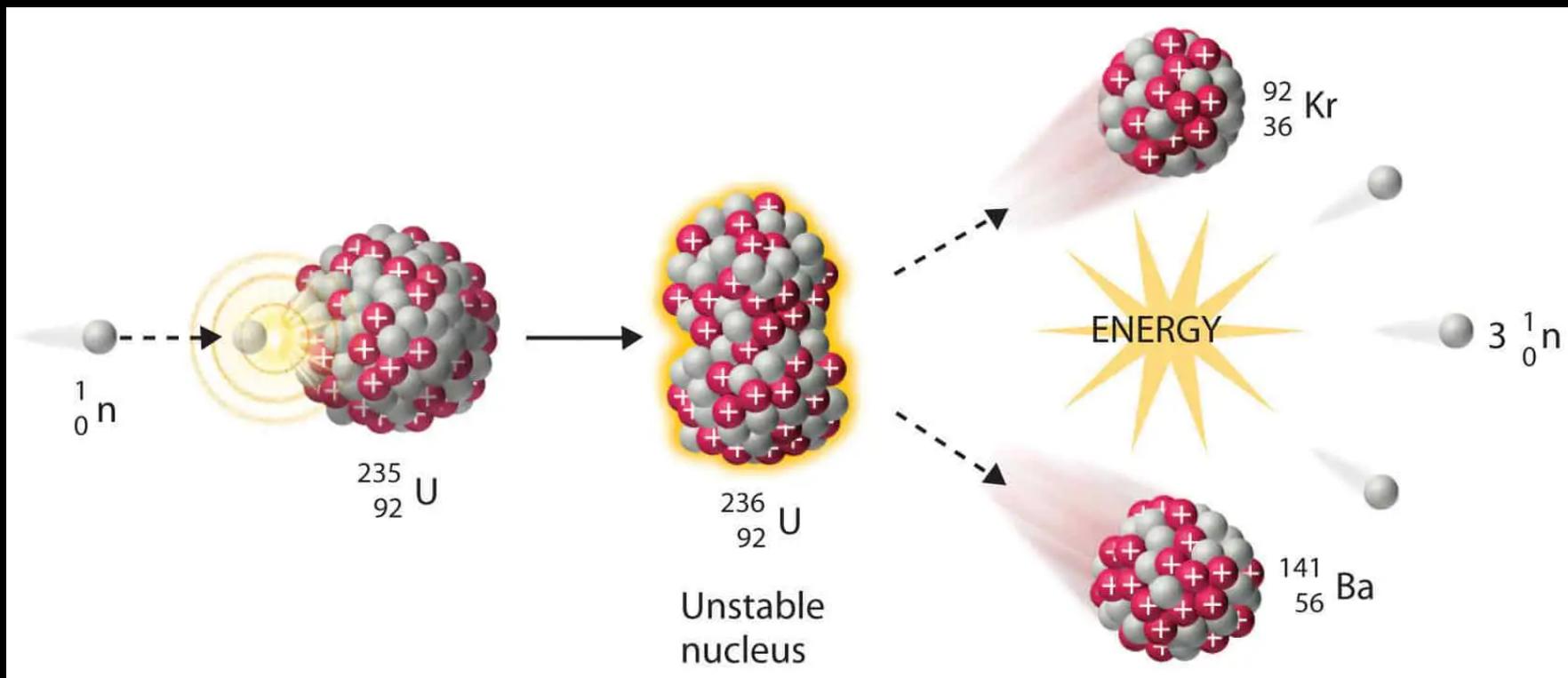
Questions?
Comments?



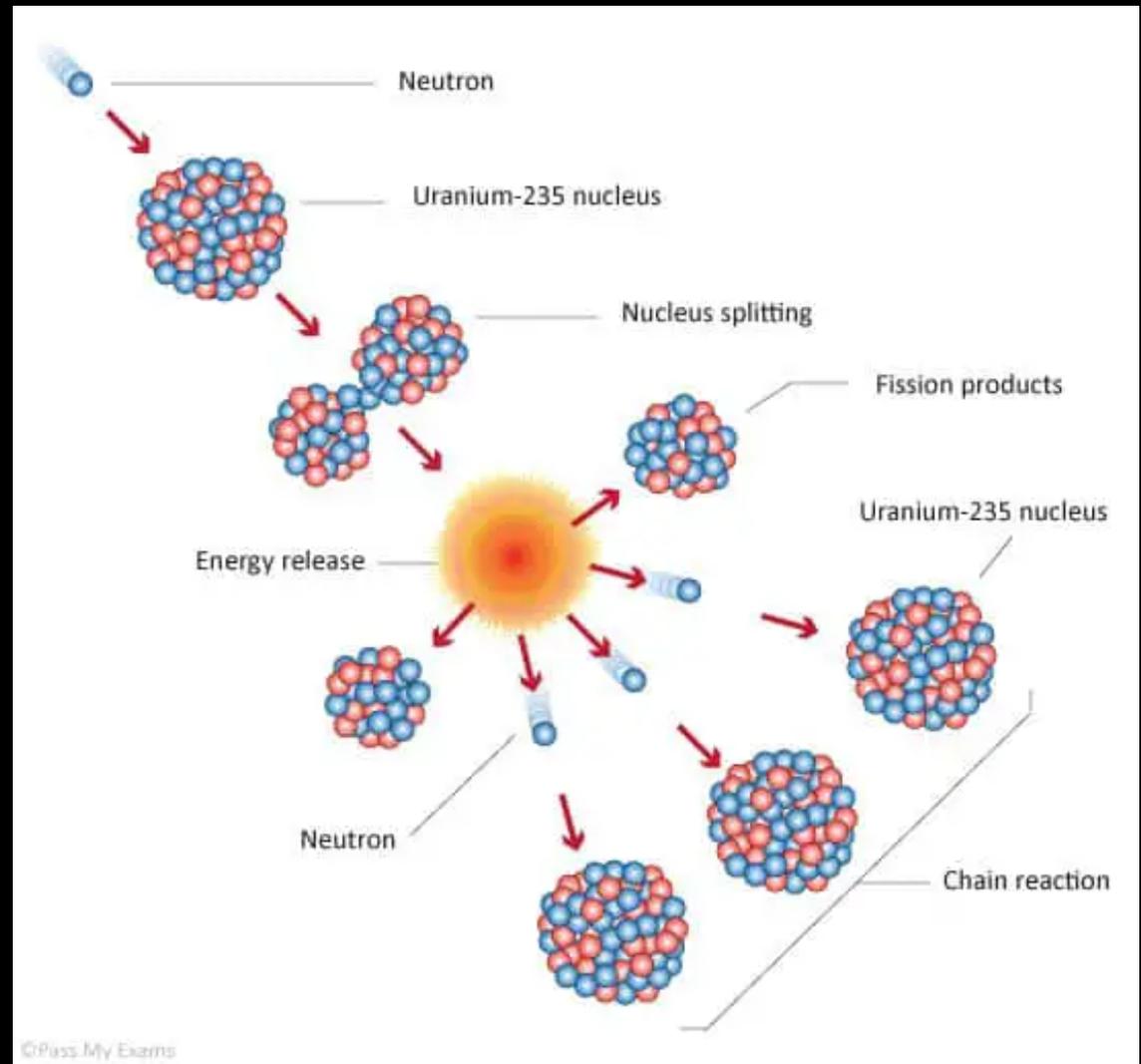




In 1938 Otto Hahn and Lise Meitner
discovered nuclear fission



Leo Szilard realized if fission emits neutrons, then neutrons from the fission of one nucleus could cause the fission of another nucleus causing a chain reaction potentially releasing an enormous amount of energy



Chain reaction

In 1940 the Nazis invaded Belgium and took over their uranium mines in the Congo for their nuclear program

