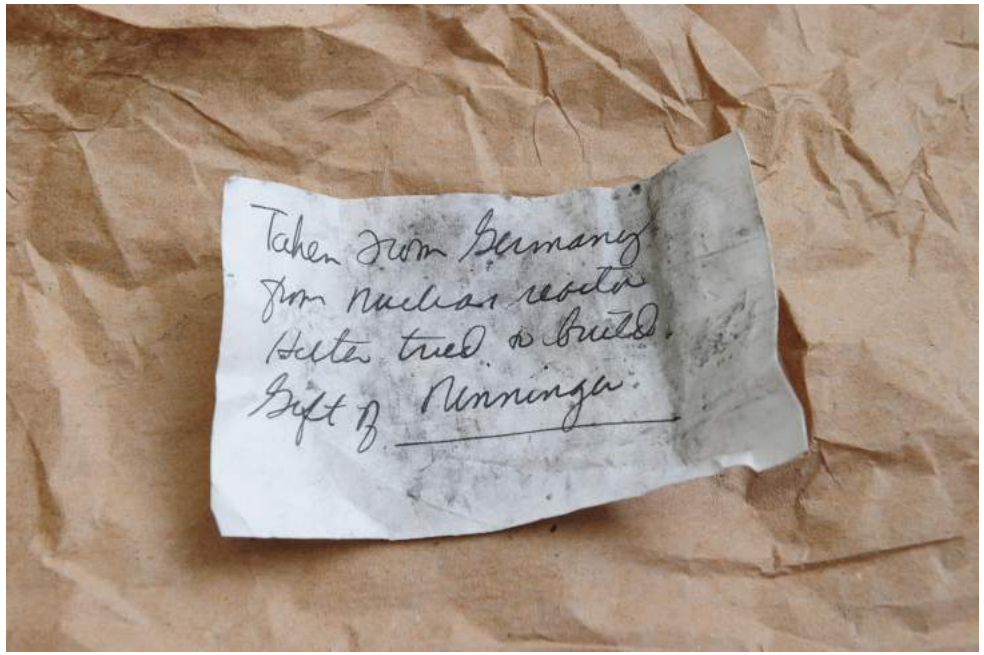
The Alsos Mission and the German Nuclear Program

Dr. Miriam Hiebert

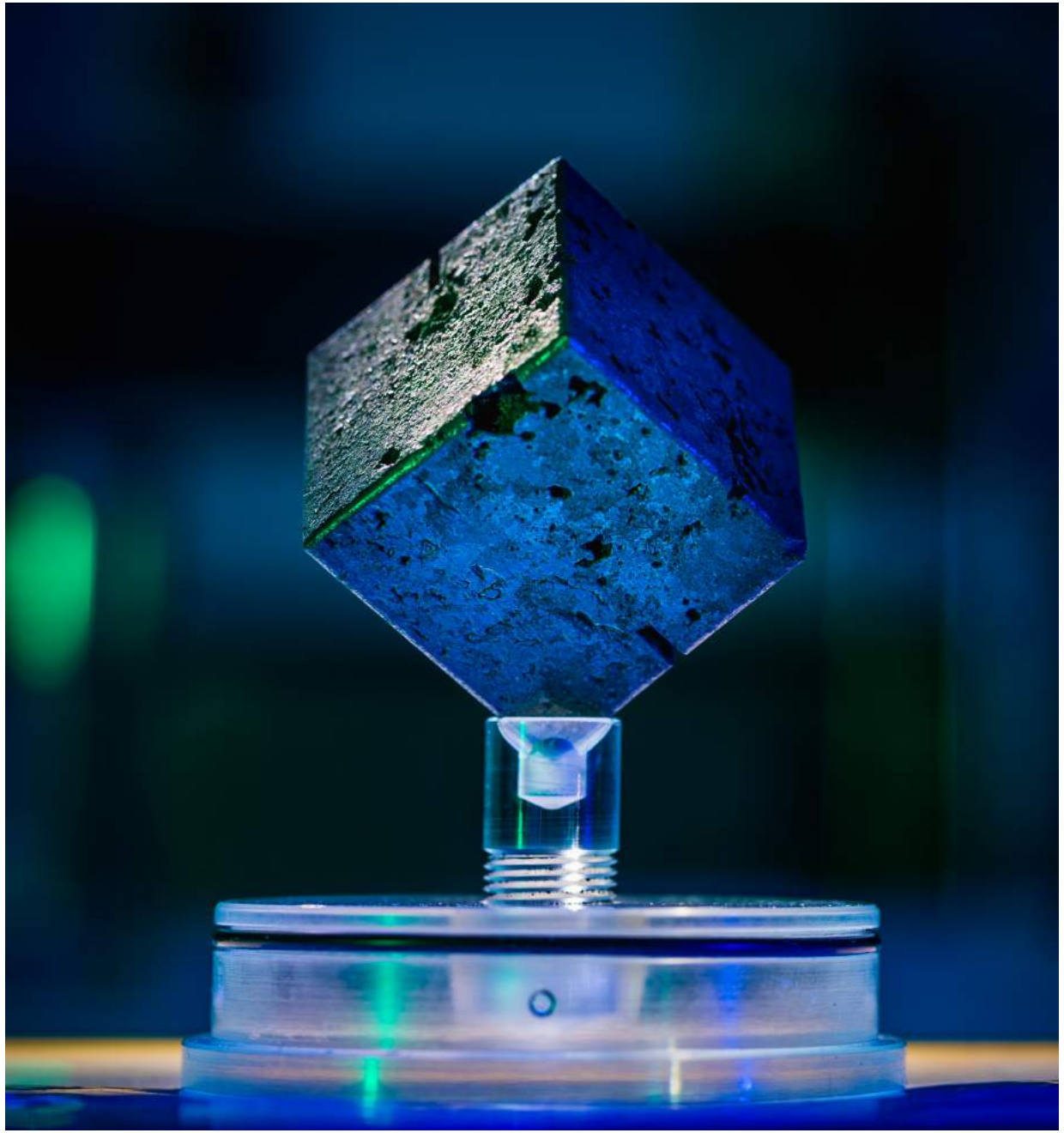
2/18/2021

The Cube

- Received as a gift in August of 2012
  - Anonymous benefactor



"Taken from Germany from nuclear reactor Hitler tried to build. Gift of Ninninger."



1938, December

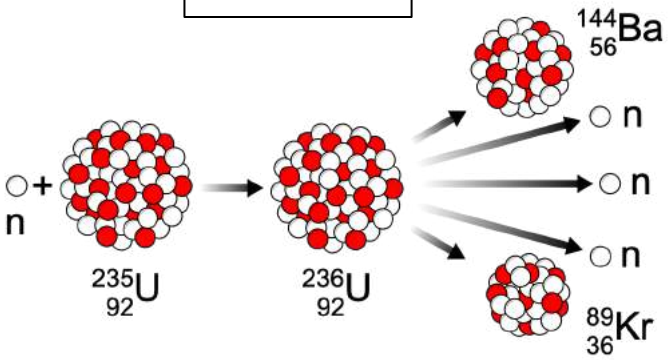
Lise Meitner et al interpret fission

1939, 1 August

Germany declares war on Poland

1939, 1 September

Einstein Letter to FDR



1941, 7 December

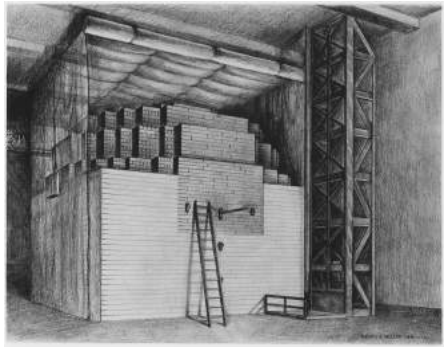
Pearl Harbor

1941, 18 December

Inaugural Meeting of the Manhattan Project

1942, 2 December

Chicago Pile 1



1945, 8 May

Germany surrenders

1945, 16 July

Trinity Test

1945, 6 and 9 August

Hiroshima and Nagasaki

The Alsos Mission

The Manhattan Project

- The U.S. effort to build the first nuclear weapon was headed by General Leslie R. Groves.
  - Project cost $2 billion dollars and employed 600,000 people

- The U.S. assumed that Germany would be well on the way to making their own nuclear weapon

- As Germany began to fall – no nuclear weapon had appeared
  - Wanted any information/materials
  - Prevent USSR access

The Alsos Mission

Top Secret military intelligence mission tasked with acquiring information about the German scientific progress in all fields, with particular focus on the progress of the nuclear program.

Intelligence Lead:
Col. John Lansdale

Military Lead:
Col. Boris T. Pash

Scientific Lead:
Samuel Goudsmit

John Lansdale Jr. and Manhattan Project Security

- John Lansdale volunteered for service in the Military Intelligence Division
  - First Lieutenant under General Strong, Deputy Chief of Staff for Intelligence (G-2)
- Originally tasked with processing reports of Nazi and Soviet threats to military assets
  - Worry over “fifth column” interference from both
  - Little evidence was given in these reports
  - Few options available for how to neutralize potential threats

John Lansdale Jr.
Intelligence Chief – Alsos Mission

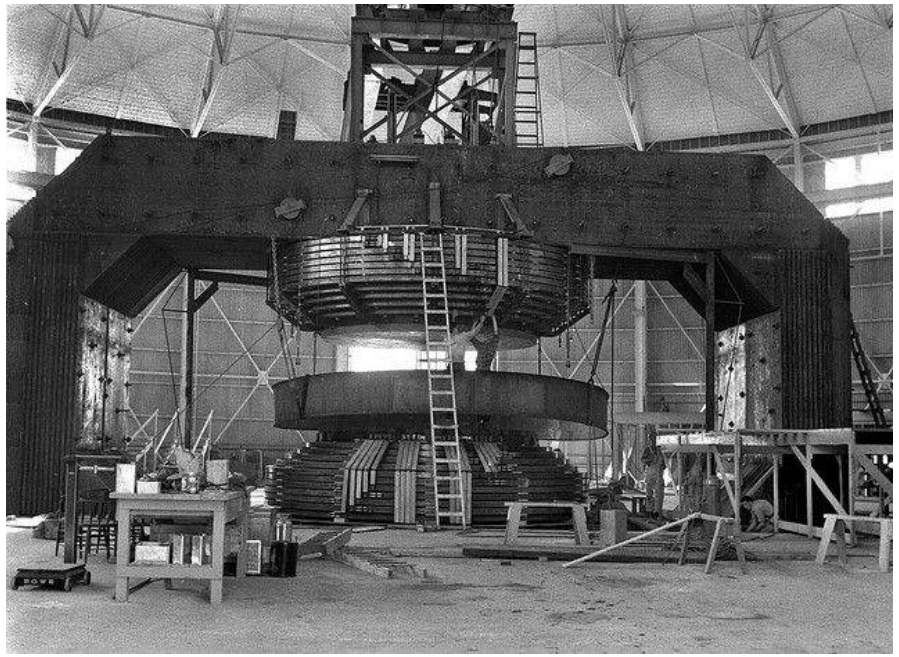
The Berkeley Incident

- The University of California at Berkeley was established as a center of nuclear research
  - Ernest Lawrence
  - Robert Oppenheimer
- Lawrence was building a 184” cyclotron
  - U isotope separation experiments
- Security concerns:
  - Soviet infiltration/interference
  - Scientists not taking security seriously
- Lansdale was sent to CA to investigate

What Lansdale Found at Berkeley

- Virtually no security at the lab

- Lansdale walked from the center of campus to the cyclotron lab
  - Passed through two open gates – “Blind Road – No Visitors”
  - Plans laying out on benches (Lansdale “stole” some of these)
  - Construction manager spoke with him at length
    - **“They are trying to break the uranium atom”**



What Lansdale Found at Berkeley

- Rampant gossip at the faculty club

- Lawrence and his colleagues ate lunch at the “physicist’s table” at the faculty club
- Lansdale spoke with as many of these men as possible
  - Learned almost everything about the cyclotron and its intended purpose.
  - Only a Dr. Donald Cooksey showed any hesitation in talking

The Berkeley Incident

- Lansdale returned to Washington to report to James B. Conant.
  - They decided that Lansdale would return in uniform and try to impress upon the scientists, the importance of secrecy

- Berkeley continued to be closely monitored by Western Defense Command

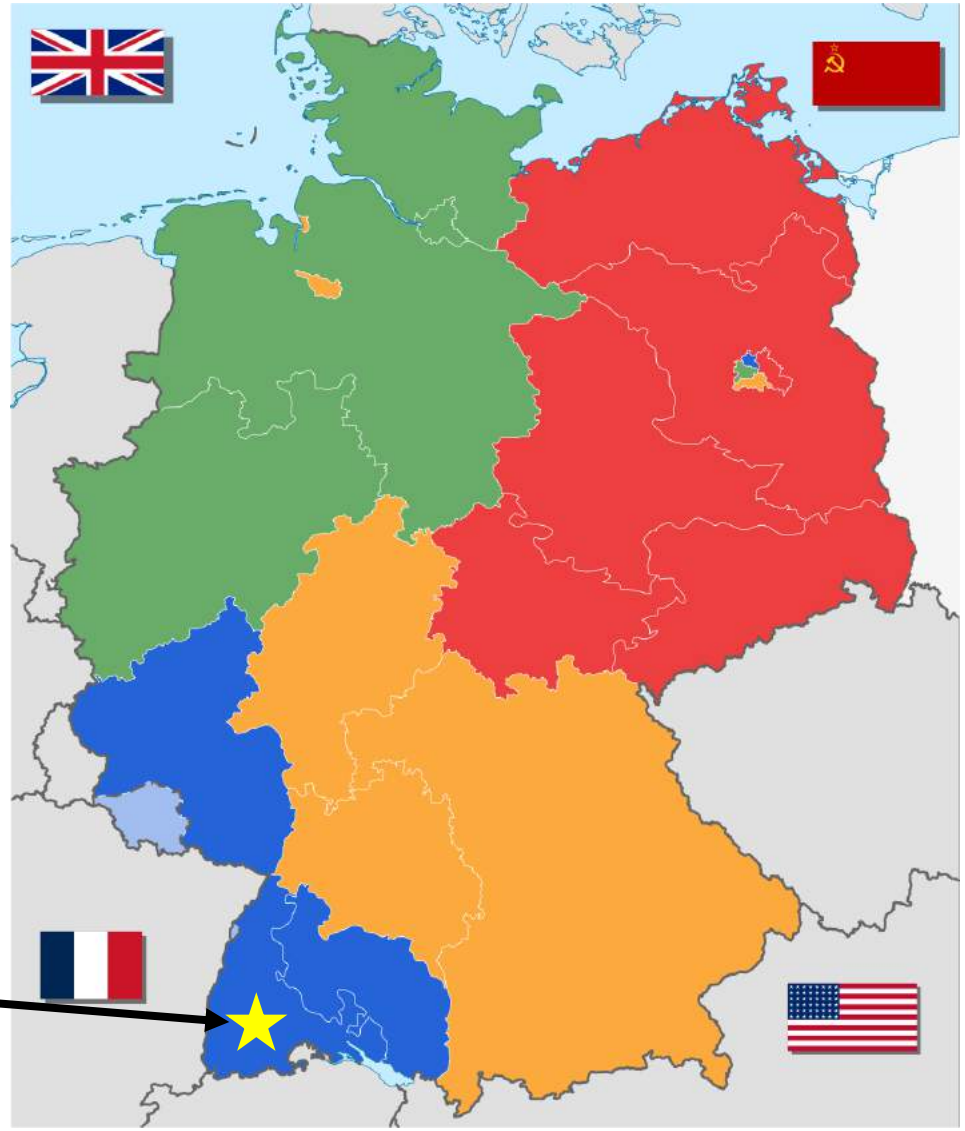
- Lansdale's exposure to the Project made him the ideal man to head up security for the Manhattan Project when it was transferred to Gen. Groves.
  - **Lansdale was the man who made Alsos happen…**

Boris Pash and the Western Defense Command

- Born in San Francisco – raised in Russia
  - Father was important in Russian Orthodox Church
- Fought against the Communists during the Russian Revolution
  - Moved back to US when Bolsheviks took over
  - HATED Communists
- Enlisted in Army in 1940
  - Posted to Western Defense Command (San Francisco)
  - Investigations into USSR espionage
- Met Lansdale during Berkeley investigations
  - **Chosen to head Alsos Missions in Italy and Germany**

Soviet Threat to the Alsos Mission

- Soviets had claim to large sections of Germany as the Third Reich fell
- It was deemed imperative that Alsos obtained info on German nuclear progress FIRST
  - Moved along with the front through Germany
- Haigerloch was in the French area
  - Concerns about French/Soviet ties
  - Operation BIG

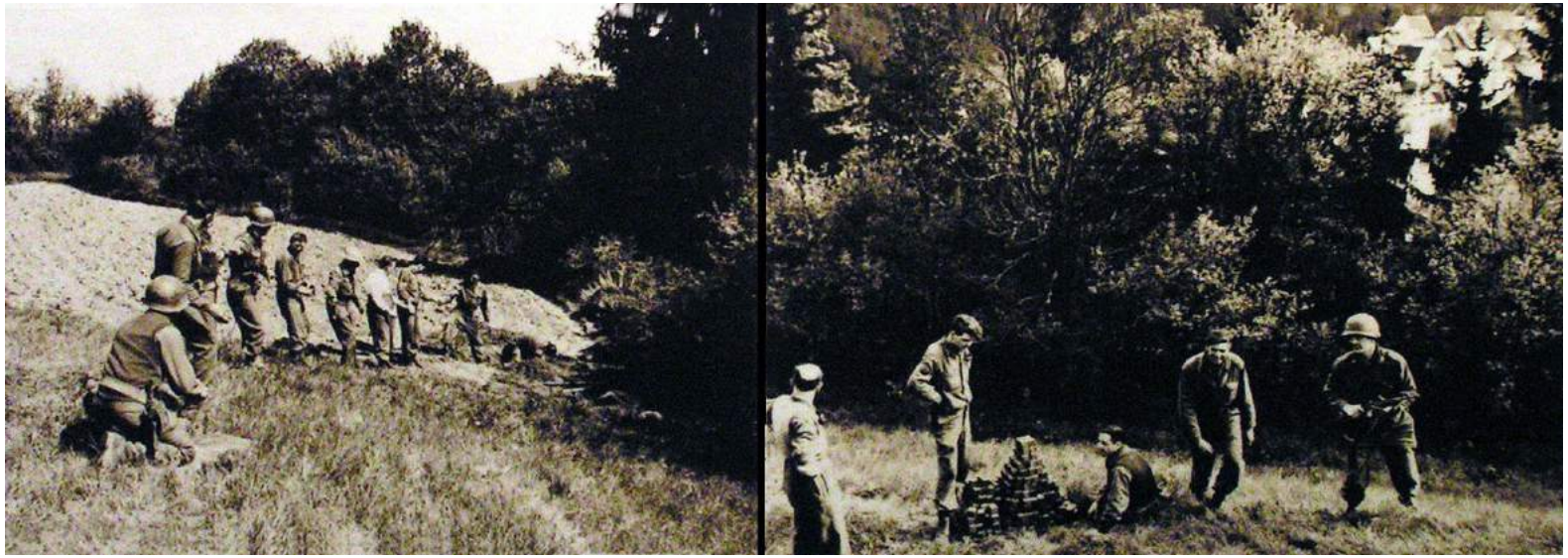


Frederic Joliot-Curie and French Science

- Son-in-law of Marie Curie (Irene)
  - Prominent physicist in his own right
- Was among the first to verify Hahn and Strassman's results and recognized potential of atomic energy
  - Smuggled documents and heavy water to England at start of the war.
  - Stayed in France out to sense of duty the national physics reputation
- Extremely political…
  - Joined the French Communist Party during the war and worked with the French Resistance
    - Communist affiliations made him a perceived threat – Alsos target
  - ”Science is not national, but international”

Alsos and the Cubes

April 27, 1945



What Happened Next?

- *"Skillful questioning of the German scientists by Goudsmit and his associates finally disclosed the hiding place of the heavy water and uranium and, on April 26, the heavy water was removed from the cellar of an old mill near Haigerloch and sent back to Paris.* ***About one and a half tons of the small metallic uranium cubes were dug up from a plowed field just outside of the town. These, too, were quickly dispatched to Paris. Both [heavy] water and uranium were then shipped to the US, to be disposed of by the Combined Development Trust. (CDT).*** *"* *(Now It Can Be Told,* page 242)

Combined Development Trust

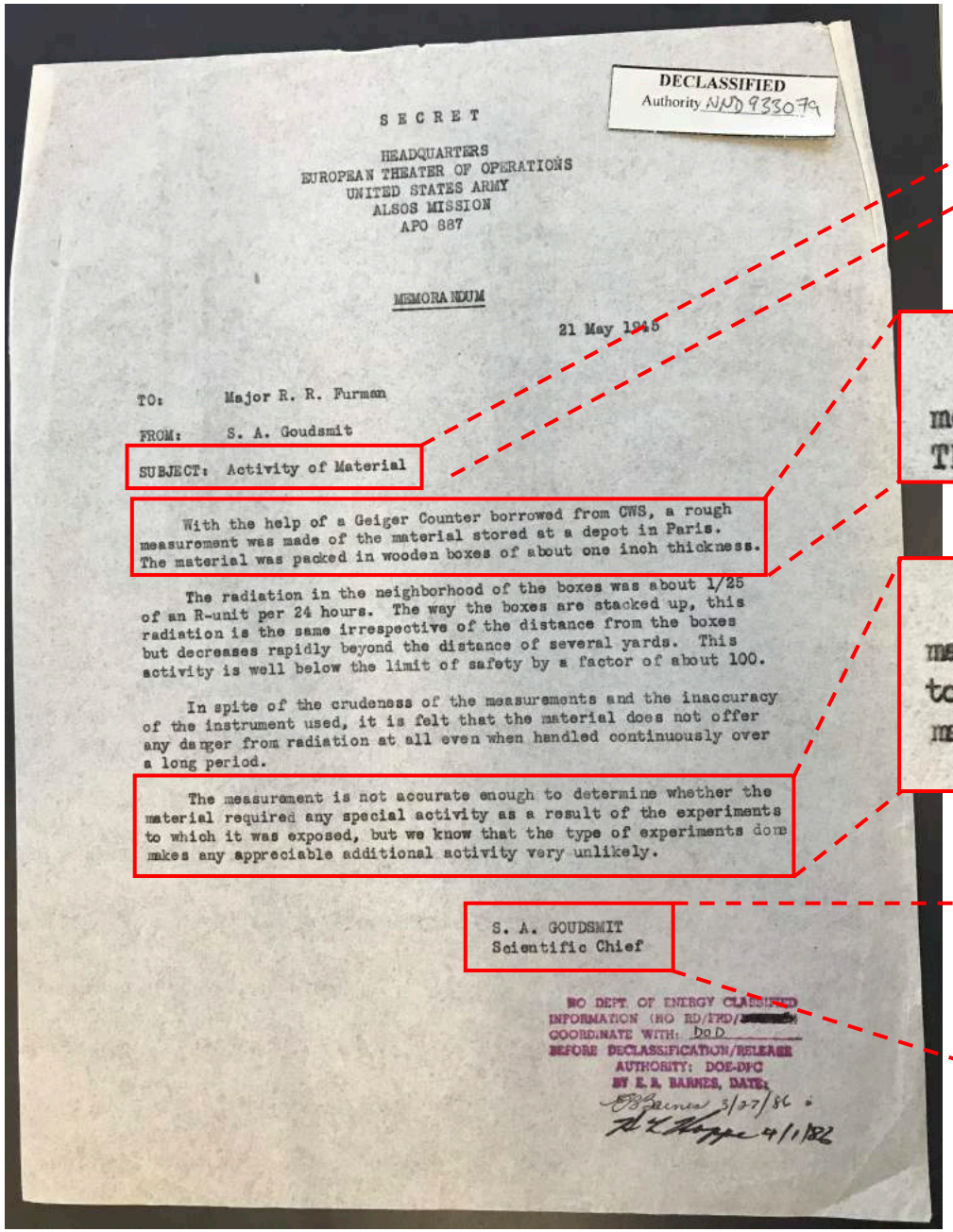
Espionage

Pre-war collaboration

Concern over possible ties to USSR

Espionage

Joliot a suspected informant risk



DECLASSIFIED
Authority NND 933079

SECRET

HEADQUARTERS
EUROPEAN THEATER OF OPERATIONS
UNITED STATES ARMY
ALSOS MISSION
APO 887

MEMORANDUM

21 May 1945

TO: Major R. R. Furman

FROM: S. A. Goudsmit

SUBJECT: Activity of Material

With the help of a Geiger Counter borrowed from CWS, a rough measurement was made of the material stored at a depot in Paris. The material was packed in wooden boxes of about one inch thickness.

The radiation in the neighborhood of the boxes was about 1/25 of an R-unit per 24 hours. The way the boxes are stacked up, this radiation is the same irrespective of the distance from the boxes but decreases rapidly beyond the distance of several yards. This activity is well below the limit of safety by a factor of about 100.

In spite of the crudeness of the measurements and the inaccuracy of the instrument used, it is felt that the material does not offer any danger from radiation at all even when handled continuously over a long period.

The measurement is not accurate enough to determine whether the material required any special activity as a result of the experiments to which it was exposed, but we know that the type of experiments done makes any appreciable additional activity very unlikely.

S. A. GOUDSMIT
Scientific Chief

NO DEPT. OF ENERGY CLASSIFIED INFORMATION (NO RD/FRD/[redacted])
COORDINATE WITH: DoD
BEFORE DECLASSIFICATION/RELEASE
AUTHORITY: DOE-DFC
BY E.B. BARNES, DATE:
E B Barnes 3/27/86
H K Hoppe 4/1/86

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S. A. GOUDSMIT
Scientific Chief

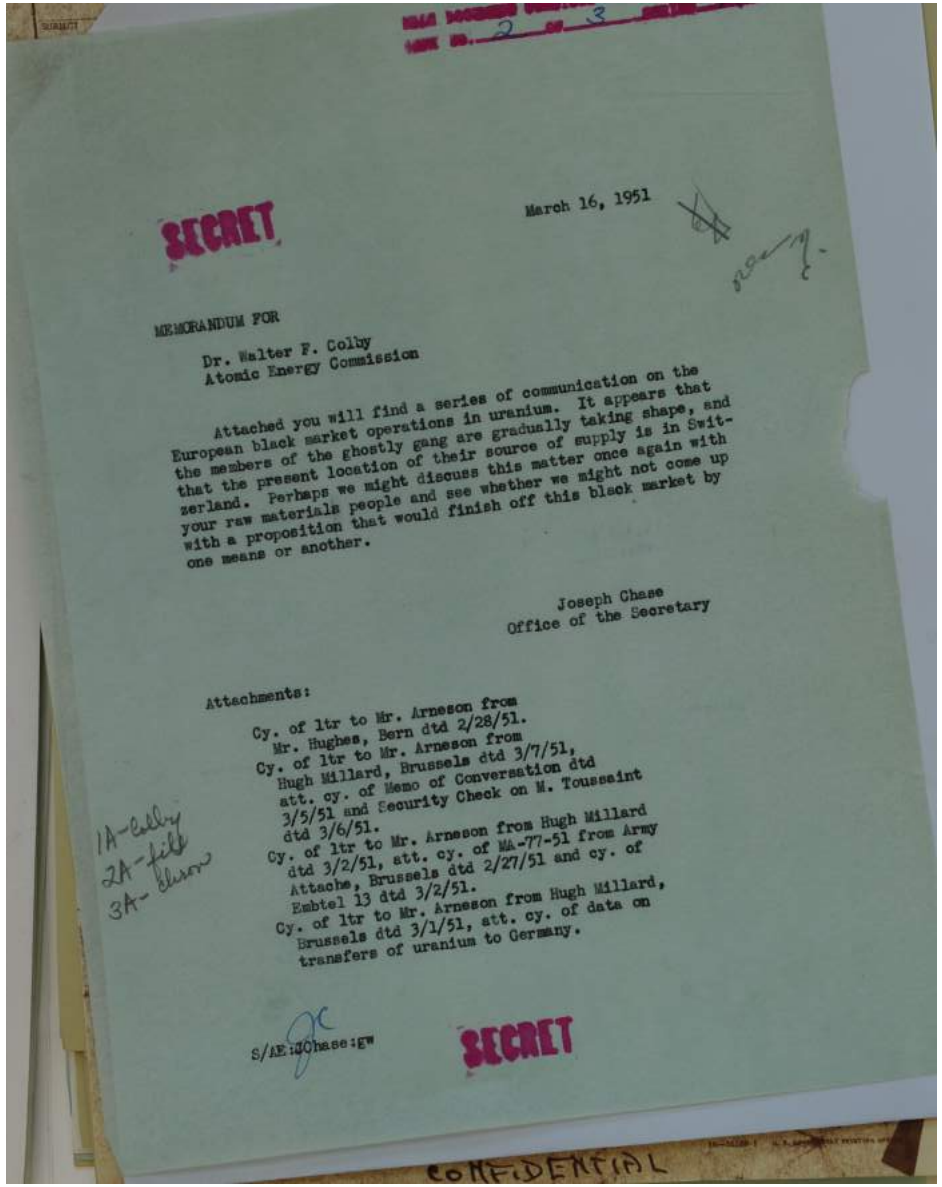
Cubes in Post-War Europe

- ~ 400 cubes escaped capture by Alsos and fueled a black market 1948-1953
  - Alsos was aware of the pile but it was not evacuated
    - Several Alsos Mission members took “souvenirs” from this pile

→This means there was enough Uranium for a self-sustaining pile in Germany, had they been in the same location

- This led to an intriguing tale of smugglers, con-artists, and “jobbers”

A Ghostly Gang



SECRET

March 16, 1951

MEMORANDUM FOR

Dr. Walter F. Colby
Atomic Energy Commission

Attached you will find a series of communication on the European black market operations in uranium. It appears that the members of the ghostly gang are gradually taking shape, and that the present location of their source of supply is in Switzerland. Perhaps we might discuss this matter once again with your raw materials people and see whether we might not come up with a proposition that would finish off this black market by one means or another.

Joseph Chase
Office of the Secretary

Attachments:

Cy. of ltr to Mr. Arneson from Mr. Hughes, Bern dtd 2/28/51.
Cy. of ltr to Mr. Arneson from Hugh Millard, Brussels dtd 3/7/51, att. cy. of Memo of Conversation dtd 3/5/51 and Security Check on M. Tousseint dtd 3/6/51.
Cy. of ltr to Mr. Arneson from Hugh Millard dtd 3/2/51, att. cy. of MA-77-51 from Army Attache, Brussels dtd 2/27/51 and cy. of Embtel 13 dtd 3/2/51.
Cy. of ltr to Mr. Arneson from Hugh Millard, Brussels dtd 3/1/51, att. cy. of data on transfers of uranium to Germany.

1A-Colby
2A-file
3A-Olson

S/AE:JChase:gw

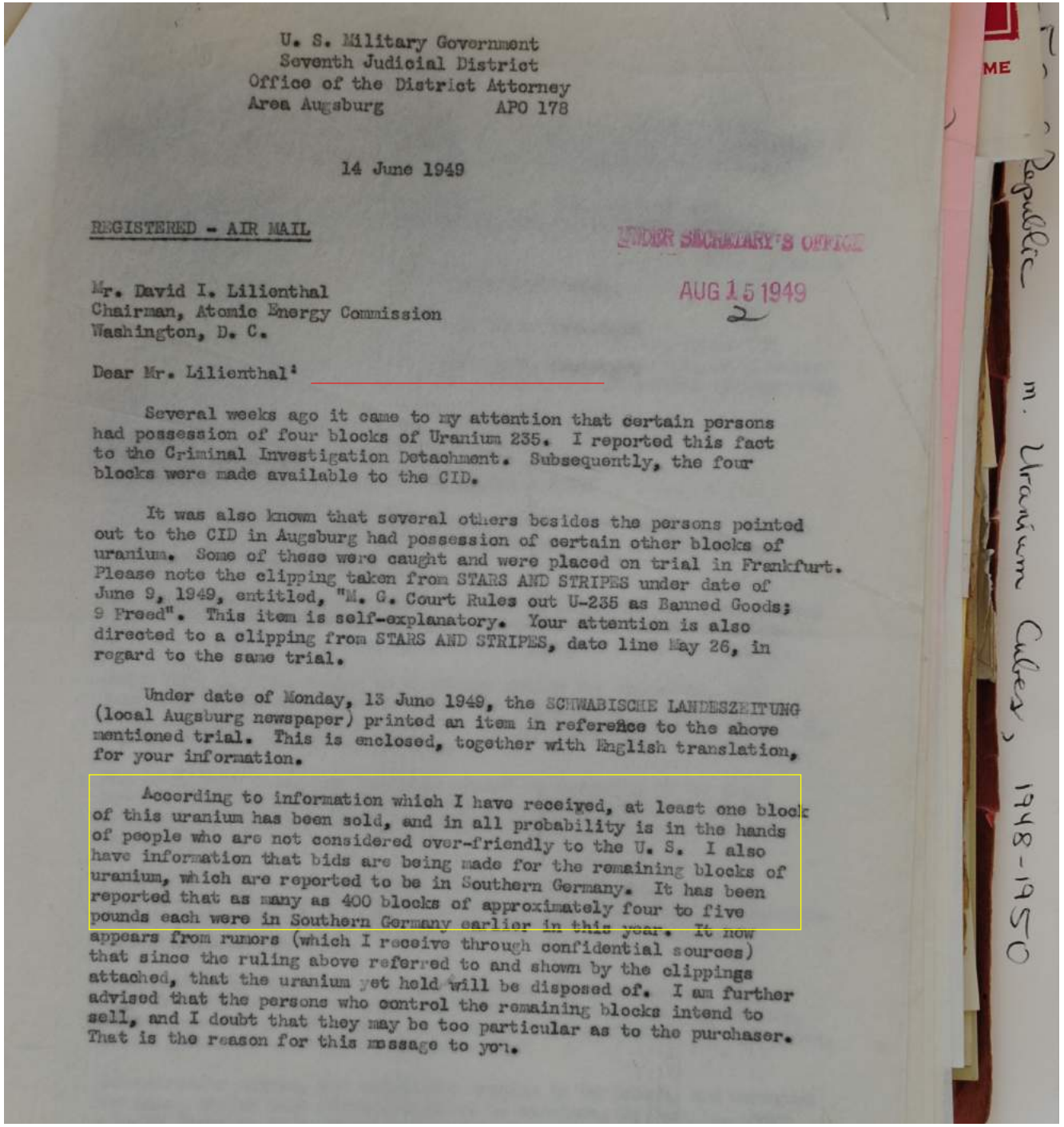
SECRET

CONFIDENTIAL

Memos/Letters at Nat. Archives:

German High Command, AEC, and OSS: a "*ghostly gang was gradually taking shape*" peddling uranium metal, in the form of 5x5x5 cm cubes of approximately 2.3 kg each.

It was rumored that a cache of uranium metal cubes were circulating on the black market and intelligence officials were chasing them, one cube at a time.



U. S. Military Government
Seventh Judicial District
Office of the District Attorney
Area Augsburg APO 178

14 June 1949

REGISTERED - AIR MAIL

UNDER SECRETARY'S OFFICE
AUG 15 1949

Mr. David I. Lilienthal
Chairman, Atomic Energy Commission
Washington, D. C.

Dear Mr. Lilienthal:

Several weeks ago it came to my attention that certain persons had possession of four blocks of Uranium 235. I reported this fact to the Criminal Investigation Detachment. Subsequently, the four blocks were made available to the CID.

It was also known that several others besides the persons pointed out to the CID in Augsburg had possession of certain other blocks of uranium. Some of these were caught and were placed on trial in Frankfurt. Please note the clipping taken from STARS AND STRIPES under date of June 9, 1949, entitled, "M. G. Court Rules out U-235 as Banned Goods; 9 Freed". This item is self-explanatory. Your attention is also directed to a clipping from STARS AND STRIPES, date line May 26, in regard to the same trial.

Under date of Monday, 13 June 1949, the SCHWABISCHE LANDESZEITUNG (local Augsburg newspaper) printed an item in reference to the above mentioned trial. This is enclosed, together with English translation, for your information.

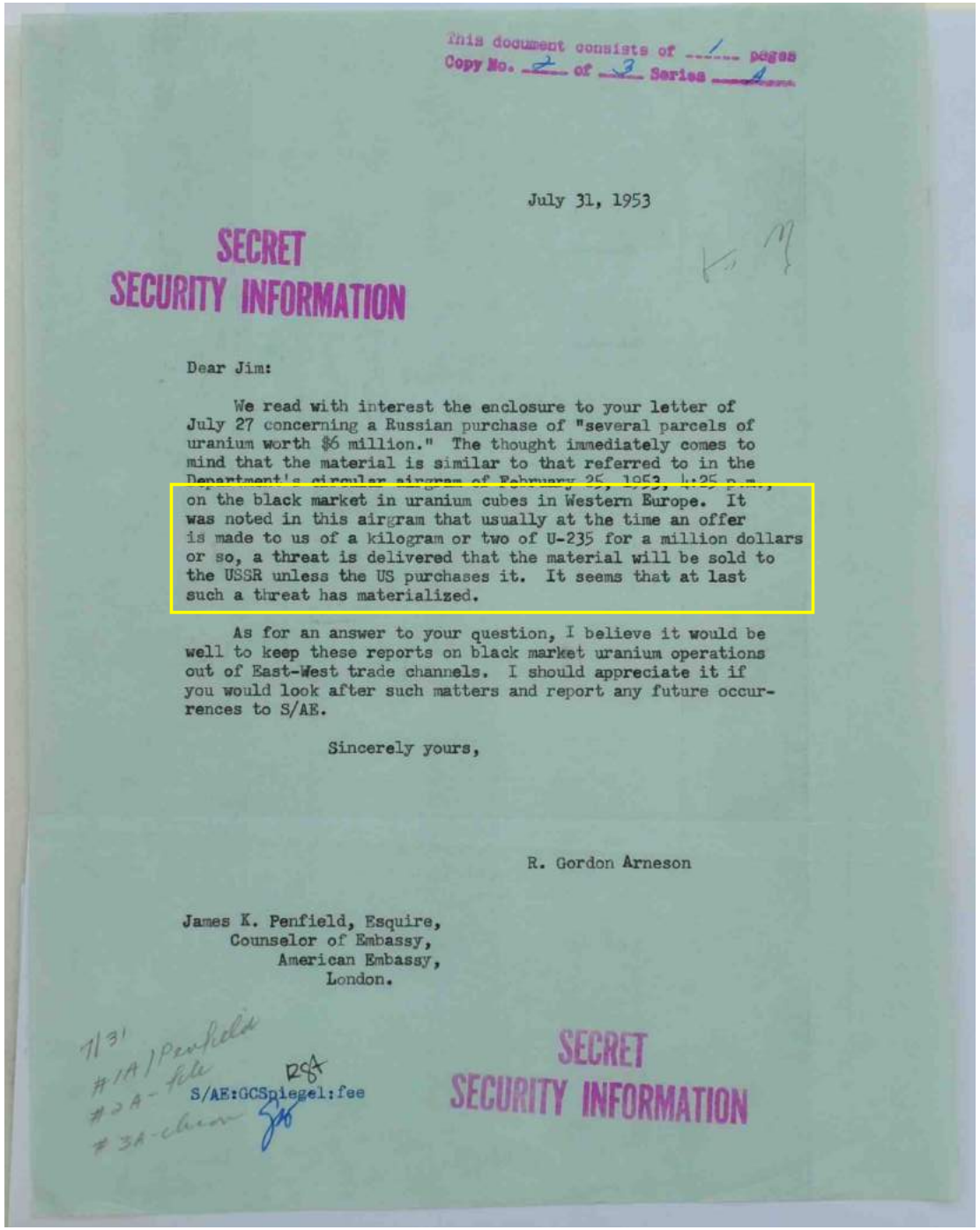
According to information which I have received, at least one block of this uranium has been sold, and in all probability is in the hands of people who are not considered over-friendly to the U. S. I also have information that bids are being made for the remaining blocks of uranium, which are reported to be in Southern Germany. It has been reported that as many as 400 blocks of approximately four to five pounds each were in Southern Germany earlier in this year. It now appears from rumors (which I receive through confidential sources) that since the ruling above referred to and shown by the clippings attached, that the uranium yet held will be disposed of. I am further advised that the persons who control the remaining blocks intend to sell, and I doubt that they may be too particular as to the purchaser. That is the reason for this message to you.

Republic m. Uranium Cubes, 1948-1950

"According to information which I have received, at least one block of this uranium has been sold, and in all probability is ***in the hands of people who are not considered over-friendly to the U.S****. I also have information that bids are being made for the remaining blocks of uranium which are reported to be in Southern Germany. It has been reported that as many as 400 blocks of approximately four to five pounds each were in Southern Germany earlier this year."*

What happened to the ~400 cubes?

"It was noted in this airgram that usually at the time an offer is made to us of a kilogram or two of U-235 for a million dollars or so, ***a threat is delivered that the material will be sold to the USSR unless the US purchases it. It seems at last, such a threat has materialized."***



This document consists of 1 pages
Copy No. 2 of 3 Series A

July 31, 1953

SECRET
SECURITY INFORMATION

Dear Jim:

We read with interest the enclosure to your letter of July 27 concerning a Russian purchase of "several parcels of uranium worth $6 million." The thought immediately comes to mind that the material is similar to that referred to in the Department's circular airgram of February 25, 1953, 4:25 p.m., on the black market in uranium cubes in Western Europe. It was noted in this airgram that usually at the time an offer is made to us of a kilogram or two of U-235 for a million dollars or so, a threat is delivered that the material will be sold to the USSR unless the US purchases it. It seems that at last such a threat has materialized.

As for an answer to your question, I believe it would be well to keep these reports on black market uranium operations out of East-West trade channels. I should appreciate it if you would look after such matters and report any future occurrences to S/AE.

Sincerely yours,

R. Gordon Arneson

James K. Penfield, Esquire,
Counselor of Embassy,
American Embassy,
London.

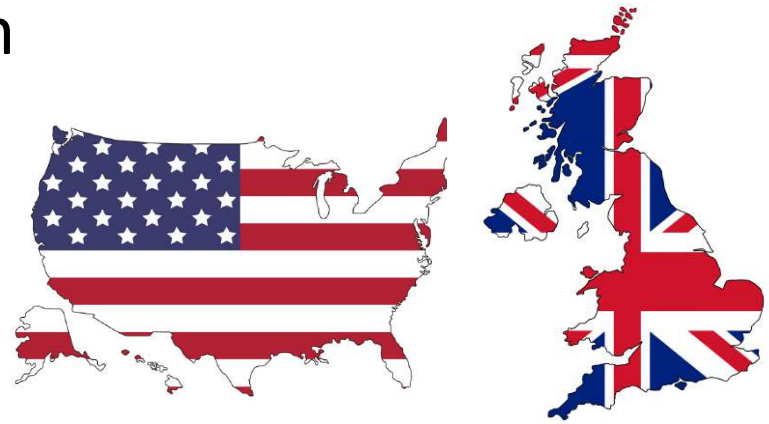
7/31
#1A/Penfield
#2A-file
#3A-chron

S/AE:GCSpiegel:fee

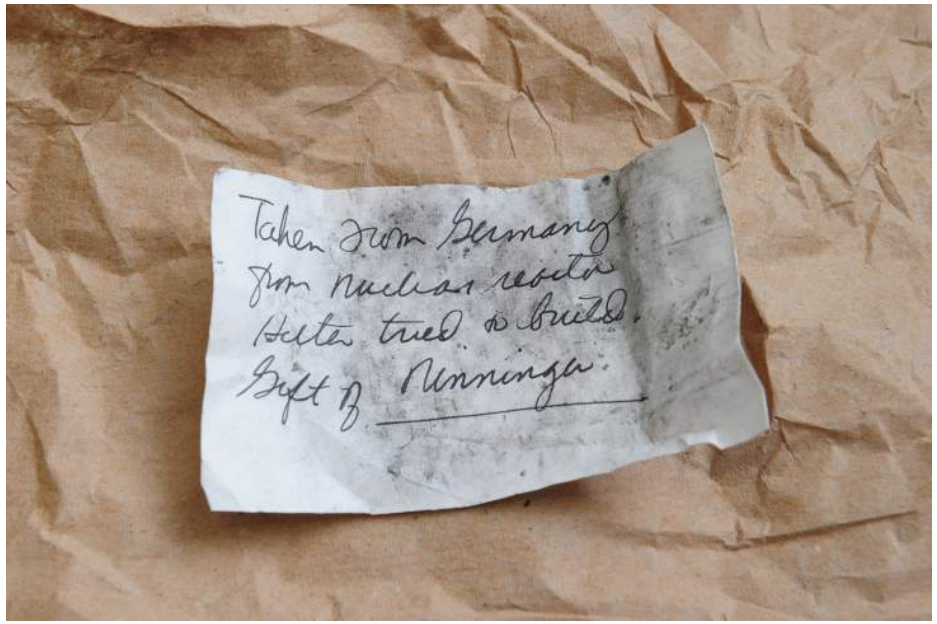
SECRET
SECURITY INFORMATION

The Combined Development Trust

- Purchasing agreement between the US and UK
  - Corner the international market for uranium and **prevent USSR from acquiring too much of the material**
  - Set up as a trust to avoid reporting requirements
  - Millions of dollars - channeled through Grove's personal bank account
- Murray Hill Area – code name for the MED division responsible for gathering intelligence on uranium sources
  - Source of Tim's cube

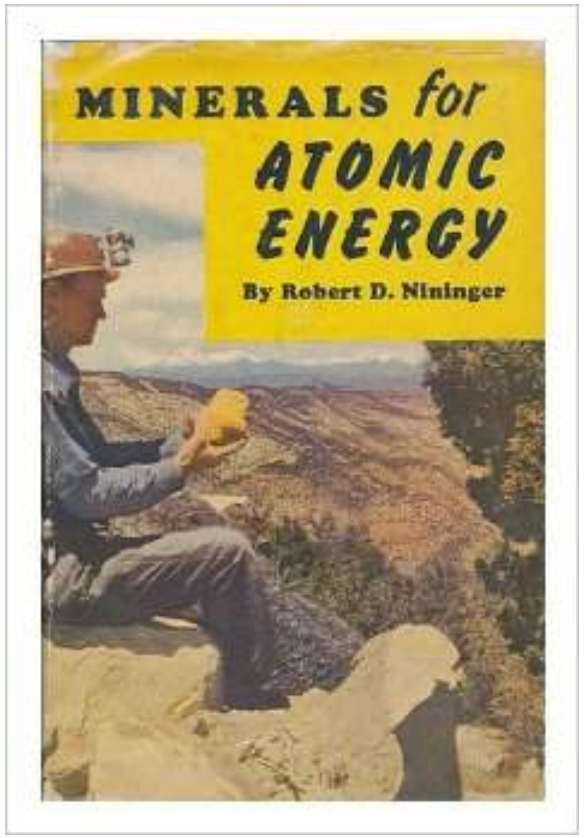


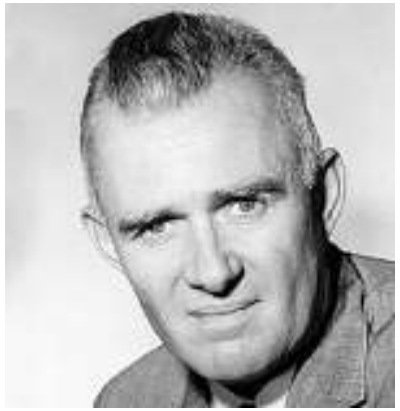
The Nininger Cube – Came With A Note:



Paper reads: "Taken from Germany from nuclear reactor Hitler tried to build. Gift of Ninninger "

Who is **Ninninger** ? Robert D **Nininger.**





WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
MADISON SQUARE AREA
P. O. BOX 42
STATION F
NEW YORK 16, N. Y.

IN REPLY
REFER TO
EIDM AE-1 MH-224

24 February 1945

Murray Hill Area

Harrison

man 321.02 (Mininger, Robert D.)
X 140.2 (Gen)

RECEIVED
FEB 2 6 1945
U.S. ENGINEER OFFICE
MANHATTAN DISTRICT
CAMBRIDGE, TENN.

Subject: Property Accountability.

To: The District Engineer, Manhattan District, Oak Ridge, Tennessee.

1. Reference is made to District Circular Letter (Prop. & Whse. 45-3) dated 9 February 1945.

2. Robert D. Mininger, 2nd Lt., C.E., O-1116686, has been appointed Accountable Property Officer for the Murray Hill Area effective 1 March 1945. This is an initial appointment and not a change in property accountable officers.

3. It is requested that a District Office Special Order be issued confirming this appointment.

PAUL L. GUARIN
Lt. Col., Corps of Engineers
Area Engineer

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY

PERSONNEL
OFFICERS 1
ENL. 0
P 1
S P 0
C A F 5
C P C 0
MISCL. 0
VAC. 2
TOTAL 13

AREA ENGINEER
P.L. GUARIN, Lt. Col., C.E.
1 Clerk-Stenographer CAF-5

DEPUTY AREA ENGINEER
H. D. Keiser, Major, C. E.

TECHNICAL REVIEW AND INSPECTION BRANCH
Dr. G. C. Selfridge, P-6, Chief
Dr. George W. Bain, P-6, Asst.
1 Clerk-Stenographer CAF-4

1. Physically inspects field work performed by the Contractor, as required and directed by the Area Engineer.
2. Reviews, appraises, and correlates all reports submitted by the Contractor, covering work accomplished under the contract.
3. Reviews currently the individual interim reports submitted by the Contractor's field and research personnel on jobs in progress.
4. Provides technical advice to the Area Engineer, as required.

EXECUTIVE BRANCH
H. D. Keiser, Major, C.E., Chief
R. D. Nininger, 2nd Lt., C.E., Asst.*
1 Clerk-Stenographer CAF-4

1. Develops and maintains all features of control involved in the functioning of the Area office.
2. Reviews all proposed contracts.
3. Reviews project planning and project programs.
4. Reviews project budget estimates.
5. Prepares monthly progress reports and special reports.
6. Coordinates all features of the Area office work.
7. Reviews proposals to acquire mineral leases and other mineral rights.
8. Serves as liaison with the Contractor and all outside interests.
9. Reviews Contractor's deferment requests.
10. Reviews Contractor's salary recommendations.
11. Handles air travel and air express priorities.
12. Provides for and maintains protective security.
13. Performs functions pertaining to labor relations.
14. Handles all Area matters pertaining to patents.

* Recommended for promotion to 1st Lt. on 27 July 1944.

ADMINISTRATIVE BRANCH
E. C. Smith, CAF-9, Chief
1 Administrative Asst., CAF-7 (vacant)
1 Clerk-Stenographer CAF-4 (vacant)

1. Performs Government auditing functions and handles all other fiscal matters. Serves as liaison with Contractor on all fiscal matters.
2. Handles mail and records.
3. Maintains property accounts.
4. Handles clerical features of official travel by personnel and obtains space for railway travel.
5. Obtains procurement priorities.
6. Exercises administrative supervision of civilian personnel.
7. Handles all matters pertaining to safety.
8. Prepares miscellaneous administrative reports required by higher authority and maintains administrative records.
9. Handles War Bond program.

GRAND JUNCTION, COLO.
Frank J. Belina, P-5, Chief*
1 Clerk-Stenographer CAF-4*

1. Physically inspects field work performed by Contractor in the Colorado Plateau Region.
2. Reviews, appraises, and correlates all reports, programs, and recommendations submitted by Contractor covering work in the Colorado Plateau Region.
3. Reviews and advises Area Engineer on Contractor's proposals to acquire mineral rights in the Colorado Plateau Region.
4. Serves as liaison with Contractor's field organization in the Colorado Plateau Region.

* Attached to Colorado Area for administrative supervision only.

ORGANIZATION CHART
MANHATTAN DISTRICT

UNIT Murray Hill Area
SUBMITTED Paul P. Guarin DATE1 Apr. 1945
RECOMMENDED _____ DATE _____
APPROVED _____ DATE 5/8/45

SHEET NO 1 OF 1 SHEETS

DECLASSIFIED
Authority NND 73274

EXECUTIVE BRANCH

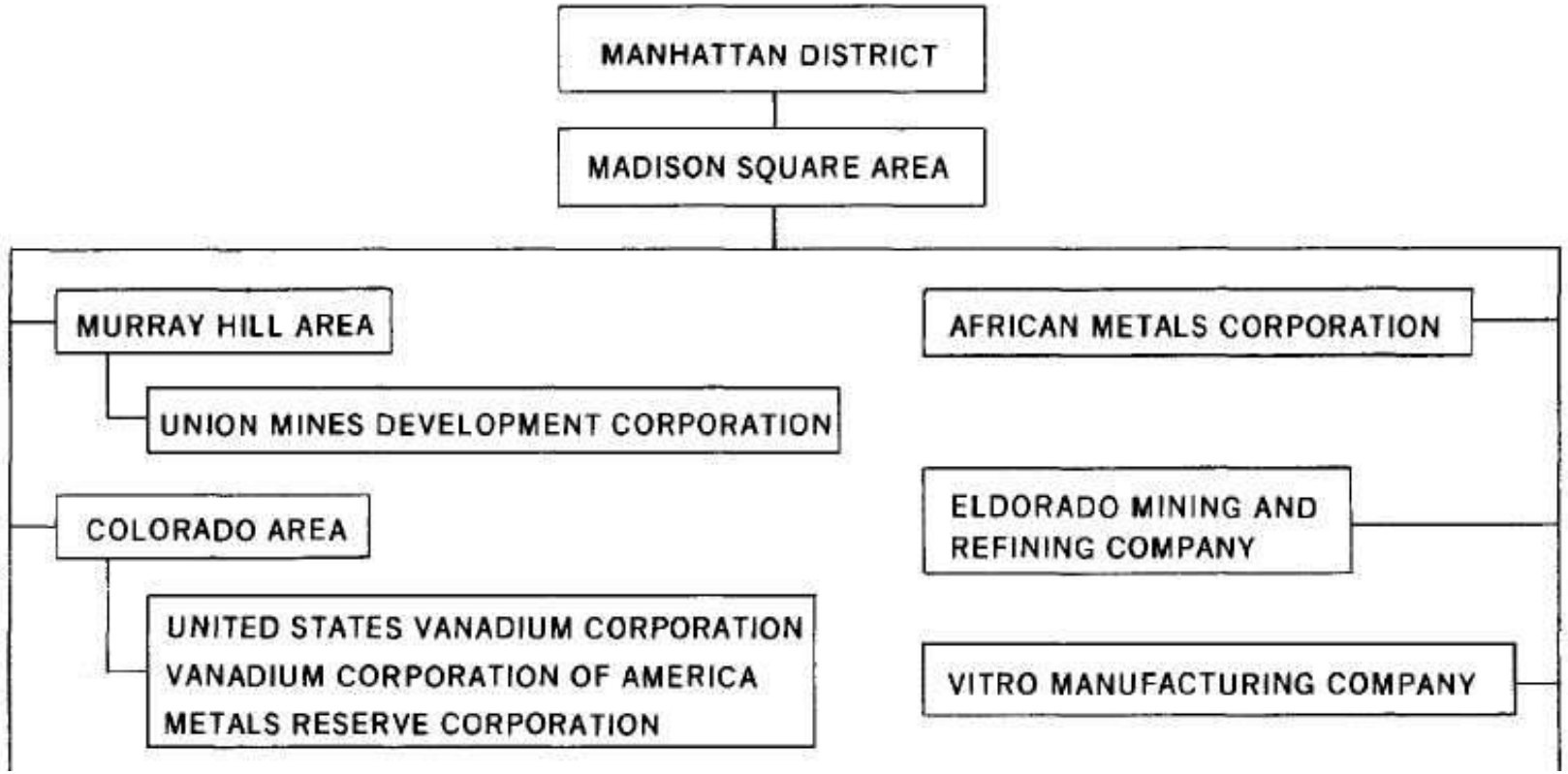
H. D. Keiser, Major, C.E., Chief
R. D. Nininger, 2nd Lt., C.E., Asst.*
1 Clerk-Stenographer CAF-4

Area Engineer: P.L. Guarin

G.C. Selfridge
G.W. Bain
H.D. Keiser
R.D. Nininger
E.C. Smith
F.J. Belina

Murray Hill Area – Part of the Uranium Procurement Network

CHART 4—FEED MATERIALS NETWORK, JANUARY 1945



*Given the focus of the Area, it is likely that the cubes were shipped to the Murray Hill Area from Paris

Murray Hill Area

- Groves felt it was necessary to investigate new sources of uranium around the world
  - Relying only on the Congo was logistically complicated.
    - Just getting bags for shipping from India proved difficult
  - Contracted with Union Carbide and Carbon to make a study of all the literature on the worlds geography
  - Study needed to happen fast
    - “I wanted a man who was experienced in the oil industry feeling that he would be used to making quick conclusive decisions, based, if necessary, on very limited information”
- Chose Paul Guarin
  - Mechanical engineer – worked in Texas oil industry
  - “Chosen because he was not a joiner” no frats, no Elk Lodge, Knights of Columbus etc.
- Aided by a small team
  - Selfridge (Amherst)
  - Bain (Utah)
  - Nininger

Securing New Uranium Sources

- George Bain had a nose for uranium
  - Found a significant (millions of dollars worth) of overlooked uranium in South Africa
  - Believed that uranium should be found in monazite sands with thorium – also proved correct
- Colorado was determined to be a source of domestic uranium
- Congolese uranium was purchased through the Belgian government
  - Paying for it was a problem…
  - Guarin visited - driveway was paved with higher grade uranium than the best in North America
- Arctic Circle and Ontario - Eldorado Mining Company
- Brazil – sands

The German Nuclear Program…

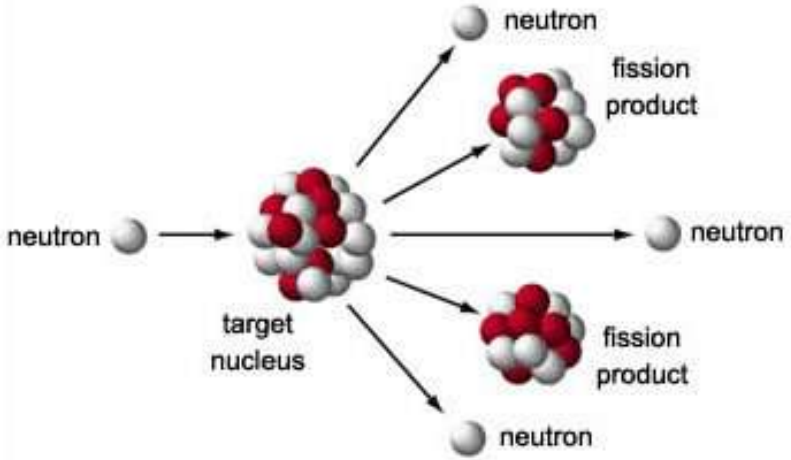
The Kaiser Wilhelm Institute

- Founded in 1911 to promote the natural sciences in Germany
- Sub-divided into 29 “Institutes”
  - KWI for Physics – founded in 1917
  - KWI for Chemistry – founded in 1911
  - But also: KWI for Leather Research, KWI for Cell Physiology, KWI for Vine Breeding…
  - KWI for Anthropology, Human Heredity and Eugenics – founded in 1926
    - Human experimentation on concentration camp prisoners

Jewish Physicists and the Intellectual Migration

- Anti-Semitic sentiments and policy in Germany:
- “Jewish Science”
  - Physics theories and principles that had been developed by Jewish scientists (e.g. relativity)
  - Teaching/studying were grounds for suspicion
  - Kind of necessary for nuclear physics work…
- Removal of Jews from academic positions
  - Numerous Jewish scientists fled Europe for the US.
  - Niels Bohr, Albert Einstein, Enrico Fermi, Wolfgang Pauli, etc..
  - Jewish scientists played a massive role in the Manhattan Project.
- *Germany was left with a reduced scientific population*…

Lise Meitner and the Discovery of Fission



- Born 1878 in Vienna, Austria
- PhD in physics in 1905
  - First woman at the University of Vienna and the second in the WORLD.
- Kaiser Wilhelm Institute of Chemistry
  - Fled Germany 1938
- Otto Hahn and Fritz Strassman…
  - Neutron bombardment experiments of uranium
  - Christmas letter asking for help

Werner Heisenberg

- Born 1901 in Würzburg
- Ph.D. in physics from University of Munich 1923
- 1924-1925 worked with Niels Bohr in Copenhagen
  - Quantum Mechanics
  - 1932: Nobel Prize
- Germany's "Golden Boy" of physics
  - "the most dangerous possible German in the field because of his brain power" - James Chadwick
- American friends begged him to take a job in the US
  - Refused, saying he wanted to be around to maintain/rebuild the reputation of German physics
- THEORETICIAN

Kurt Diebner

- Born in 1905 in eastern Germany
- Ph.D. in physics from Martin Luther University (Halle) in 1932
- Began working/consulting for government (Nazi) labs
  - Advisor on nuclear physics to the Reich Ministry of Defense and the Army Ordinance Office
- A “good Nazi” who was *not* viewed as part of the academic science community.
- “Second – rater”
- Tapped to organize the preliminary work on nuclear weapons
- EXPERIMENTALIST

The Uranium Club

- Also began with a letter..
  - Dated April 24, 1939 from Harteck and Groth to Eric Schumann (head of weapons research - German Army Weapons Bureau)
  - Discussed possible new explosive technology…
  - Schumann is skeptical – but brings it to Kurt Diebner

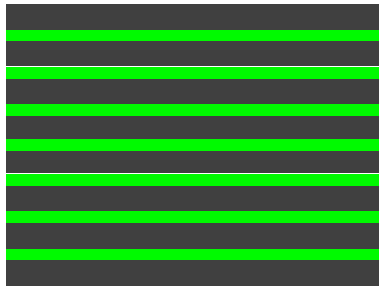
- Diebner immediately establishes a research effort – **The Uranium Club**
  - Issued military orders to nuclear scientists to attend planning sessions in Berlin
  - Weapons Bureau takes over KWIP and appoints Diebner as Director

Initial Efforts

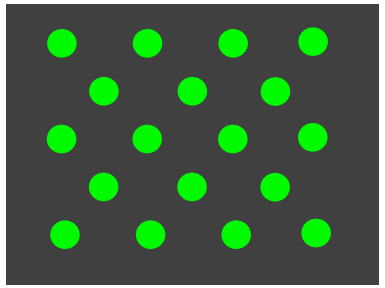
- Heisenberg quickly produced two reports discussing the feasibility of nuclear reactors and explosives
  1. Postulated that both heavy water and graphite could work as moderators
  2. Developed a theoretical design for a *layered* reactor
  3. Determined that U^{235} enrichment was necessary for a smaller reactor and likely the only way to make an explosive
- Made several technical errors:
  1. Critical mass – prohibitively big, especially for plane-delivered bomb.
  2. Graphite wouldn't work (didn't measure clean graphite) – **stuck with heavy water** (also von Weizsäcker, Bothe)
  3. Layers as superior design.

Early Experiments

- Focused on addressing technical problems while they waited for U and D_2O supplies:
  - Isotope separations
  - Geometry and size of a critical reactor



Layers
(Heisenberg)

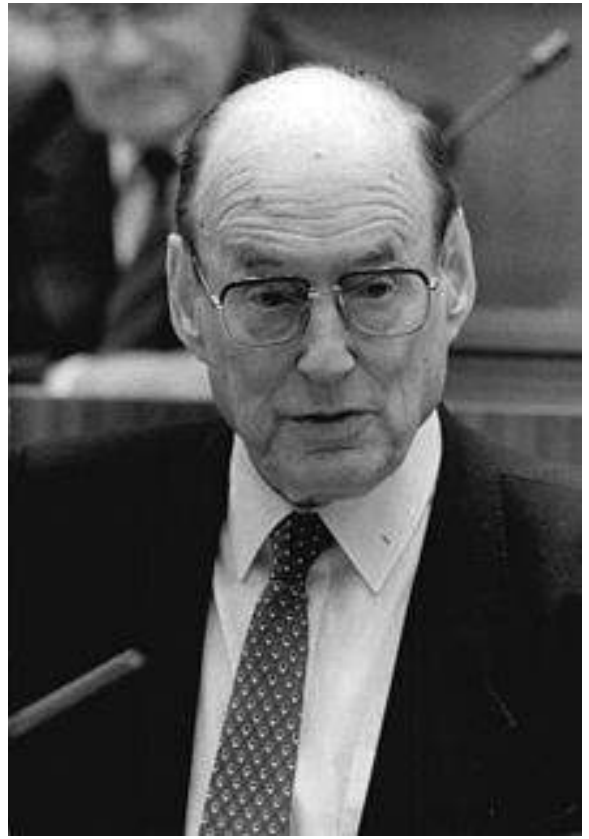


“Spheres”
(Diebner)

- Two main reactor-oriented groups:
  - Heisenberg at Leipzig University
  - Diebner at KWIP in Berlin
    - The scientists working at KWIP (Wirtz and von Weizsacker) regarded Diebner as a “second rater” – consulted with Heisenberg

Manfred von Ardenne and the Post Office

- Technician, inventor, and private scientist
  - Very good at building scientific apparatus
  - No formal degrees - not considered a true “scientists” by Heisenberg et al
- Established a private laboratory Berlin–Lichterfelde
  - Invented the Scanning Electron Microscope
- Discovered that the Post Office had a lot of money for research
  - Obtained funding for nuclear physics research and isotope separation
  - Fritz Houtermans working in this lab reported the possible production of plutonium from a reactor in August 1941



Autumn of 1941

- By this time Germany had:
  - Basic theory of chain reaction ✓
  - Backing of the Army ✓
  - Plutonium alternative ✓
  - Neutron multiplication ✓

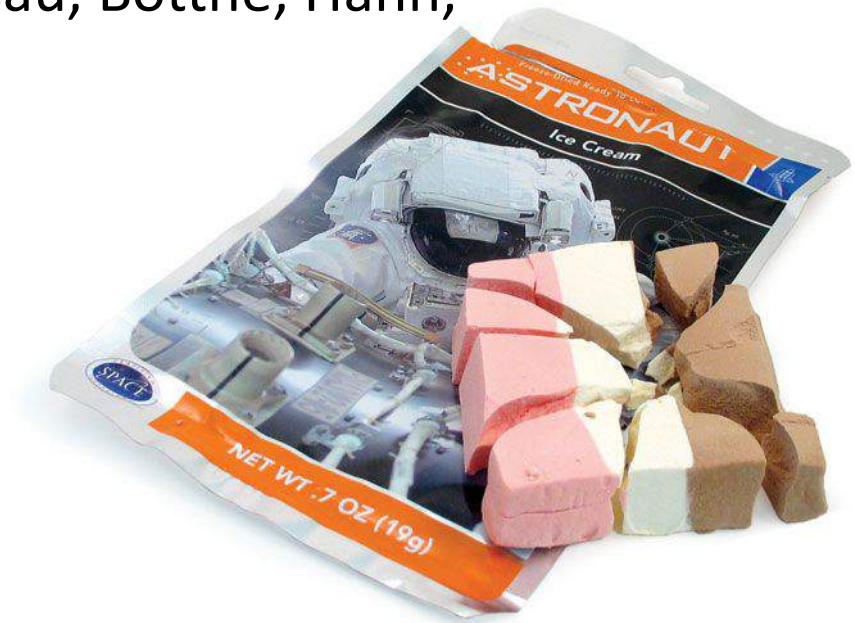
- Seemed on track for a reactor and possible eventual explosive
  - Germany had invaded the Soviet Union in the summer of 1941
  - By winter, resources had began to tighten ⇢ move to a focus on projects that could produce an immediate result.
    - “only if a certainty exists of attaining an application in the foreseeable future”.
- Heisenberg et al could make no guarantees

Shifting Control - 1942

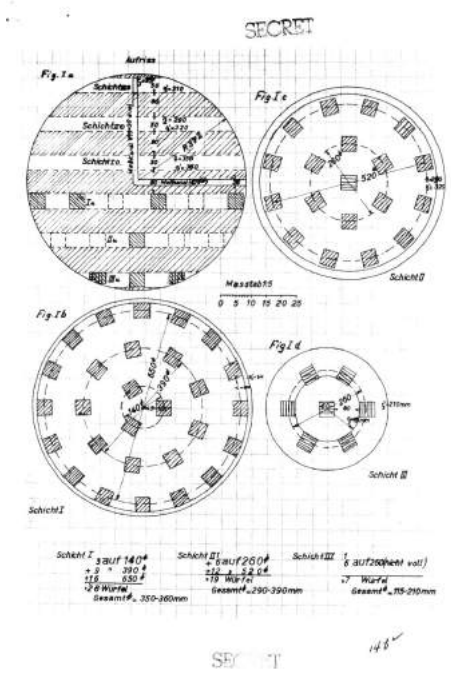
- February 1942 – Nazi Army relinquishes control of nuclear research program
  - No longer centralized…
  - Diebner moves his work to Gottow
  - Heisenberg is made Director of the KWIP
- Walther Gerlach is appointed to oversee the different branches of the project
- 1942 Bagge (Berlin) Clausius and Dickel (Munich) were working on isotope separation
  - little success

Boring Talks and Bad Food…

- Heisenberg needed funding/government backing for the experiments in Berlin
  - “went about it in a typical German way” – Samuel Goudsmit
  - Organized a meeting with eight talks (Schumann, Esau, Botthe, Hahn, Heisenberg etc.)
    - Invited upper-levels of Nazi regime
    - Presented very high-level physics
    - Served *versuchsessen* or experimental frozen food
    - Himmler rsvp’ed that he “unfortunately had to be out of town that day” – no one showed up…



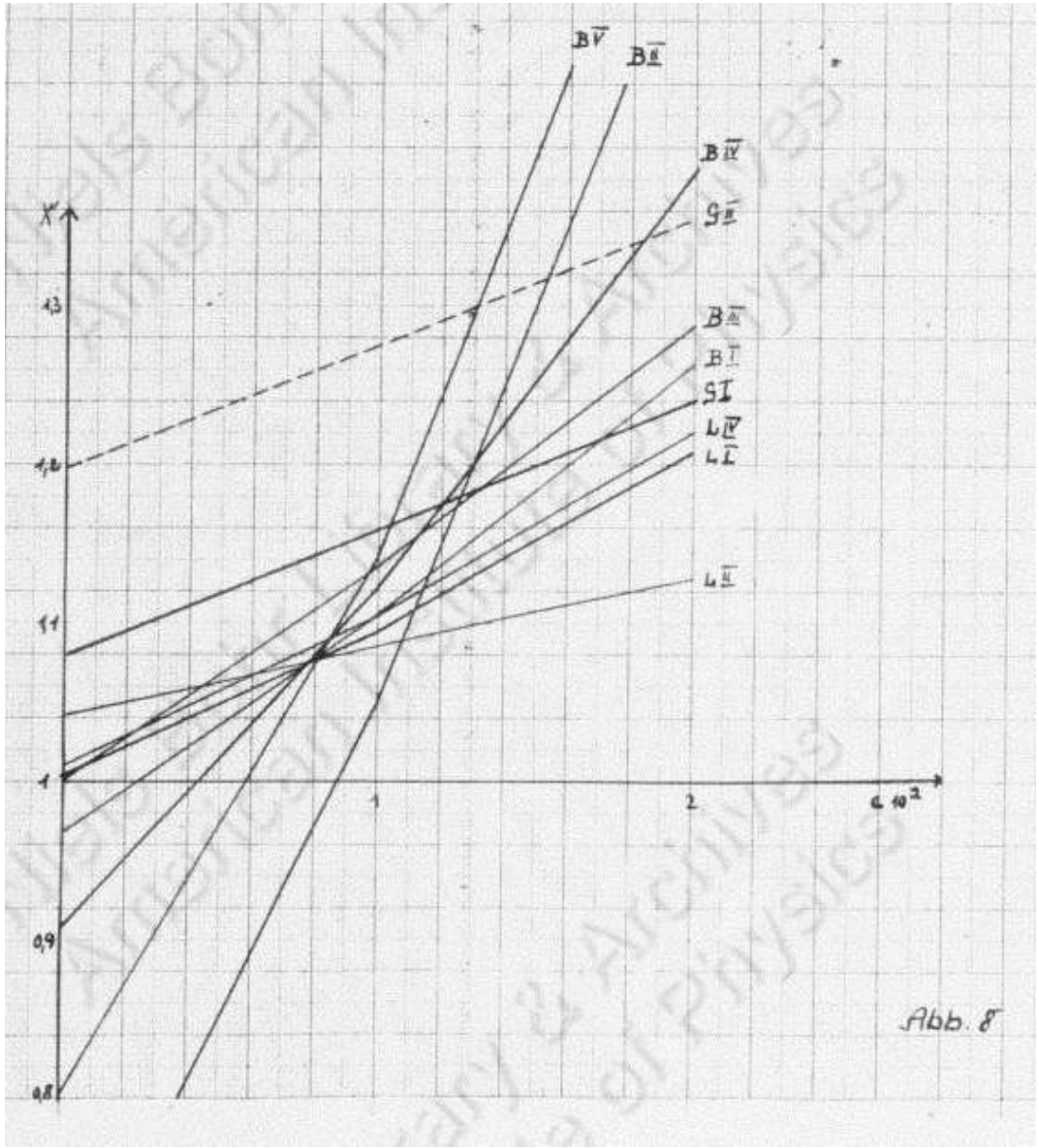
Liepzig		
Heisenberg		
D_2O		
Concentric spherical shells		
I	paraffin	Oxide powder
II	D_2O (164 kg)	Oxide (142 kg)
III	D_2O (164 kg)	Metal powder (108 kg)
IV	D_2O (164 kg)	Metal powder (755 kg)



Berlin		
Initially Diebner – then primarily Heisenberg		
Paraffin		
Horizontal layers		
I	paraffin	Oxide
II	paraffin	Oxide
III	paraffin (44 kg)	Metal powder (551 kg)
IV	paraffin (37 kg)	Metal powder (740 kg)
V	paraffin (12.5 kg)	Metal powder (864 kg)
VI a	D_2O (1.5 tons)	Plates (2.12 tons)
VI b	D_2O (1.5 tons)	Plates (1.25 tons)
VI c	D_2O (1.5 tons)	Plates (0.89 tons)
VI d	D_2O (1.5 tons)	Plates (1.7 tons)
VII	D_2O (1.5 tons)	Plates (1.25 tons)
VIII	D_2O (1.5 tons)	**Cubes** (1.5 tons)

Gottow		
Diebner (starting 1942)		
Paraffin and D_2O		
Cubes		
I	paraffin	Oxide **cubes**
II	D_2O ice	Metal **cubes**
III	D_2O	Metal **cubes**

Approaching Criticality (1/M)



$M = 1/(1-k_{eff})$

Relocation and Final Experiments

- Diebner's cube-based reactors showed promise (1943)
  - Heisenberg insisted that the plates were still the way to go (cost the project a year)
  - End of 1944 – Heisenberg had his plates cut into cubes…
- Mid 1944 Allied bombing of Berlin increased..
  - All research is ordered to leave Berlin area

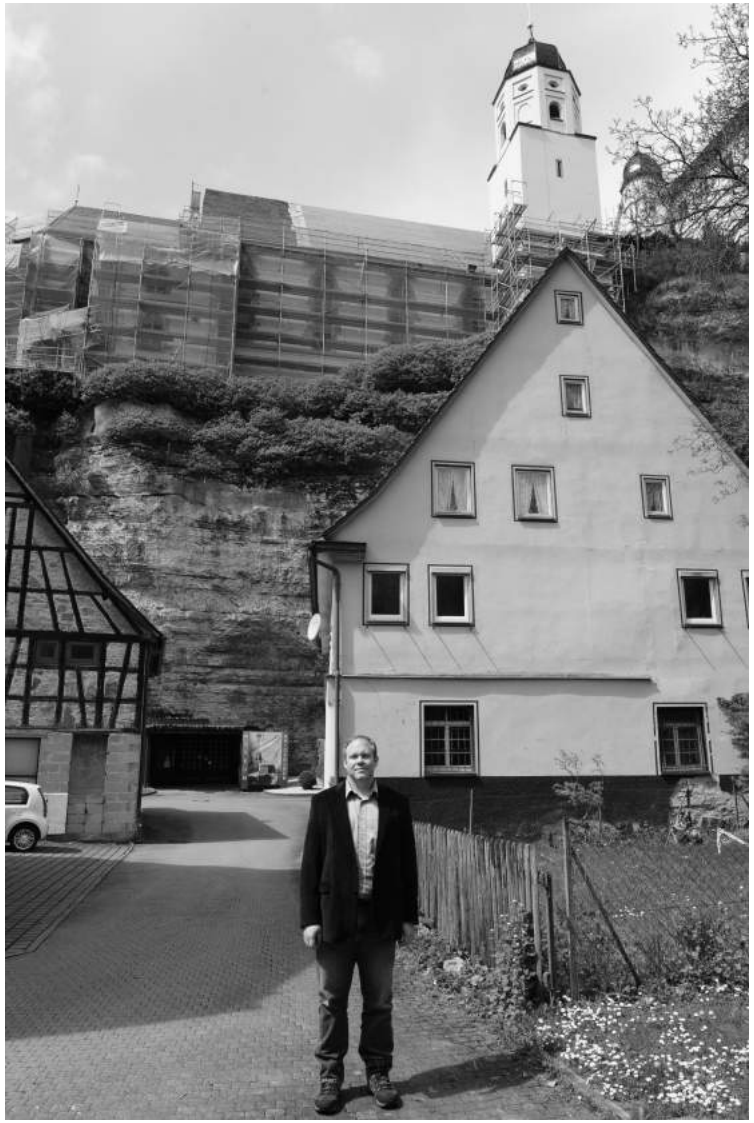
    KWIP ⇢ Haigerloch and Hechingen

    KWIC ⇢ Tailfingen

    Diebner ⇢ Stadtlim

The “Lab” in Haigerloch

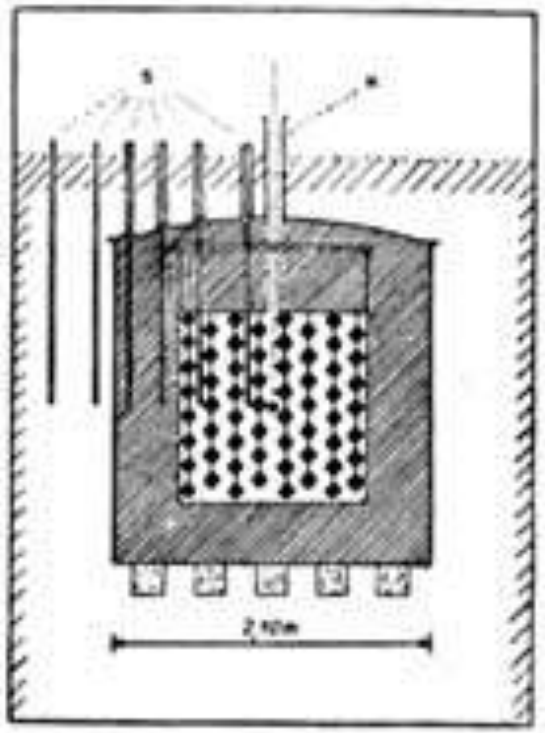
April 27,1945

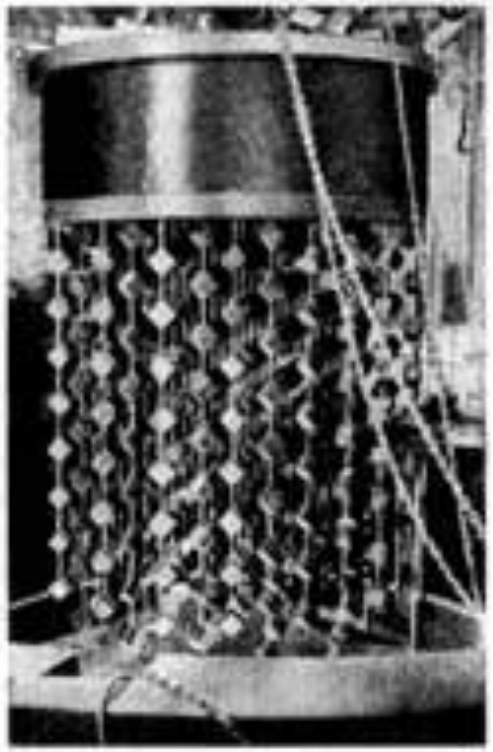


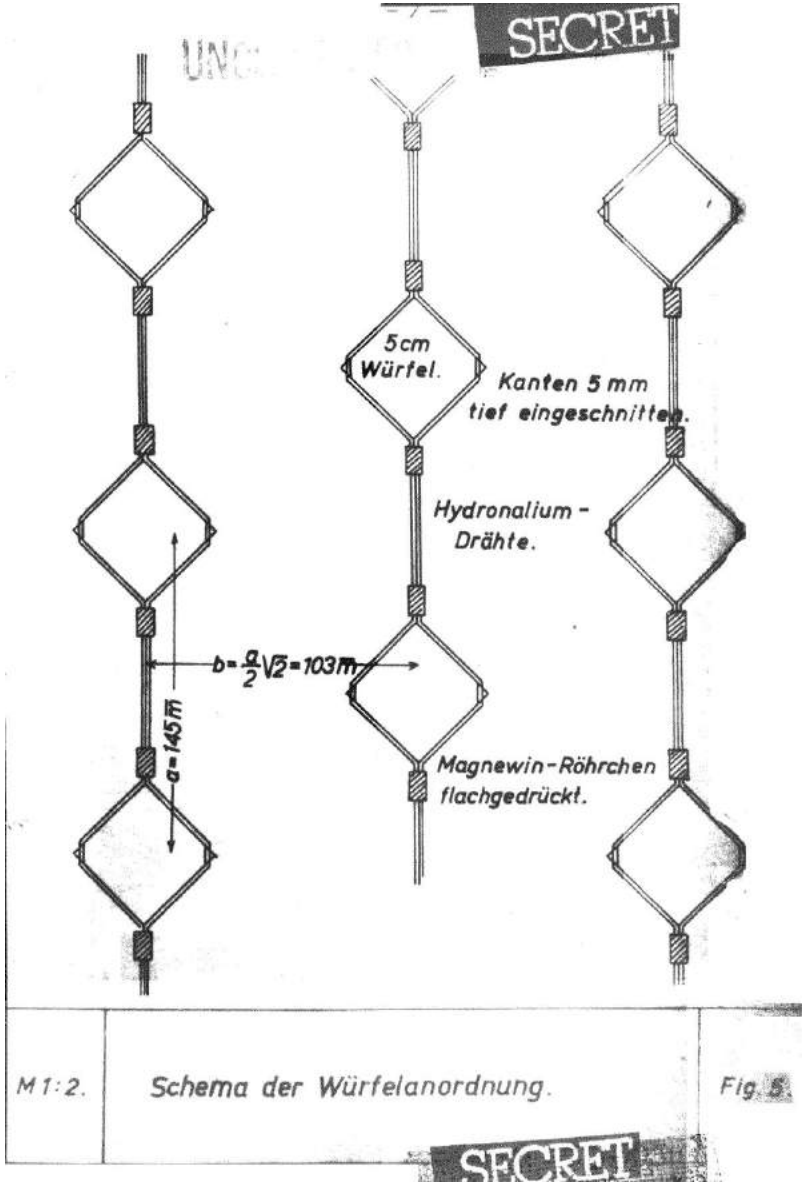
April 27, 2015

The Last Experiment: BVIII

- 664 Uranium Cubes
  - 5cm cubes suspended in heavy water.

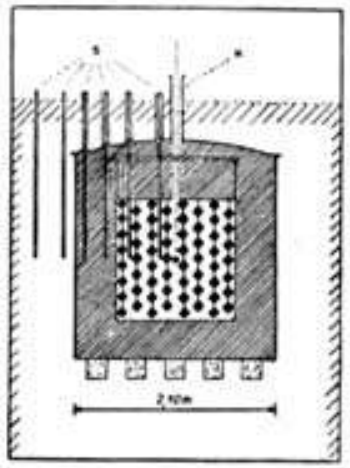


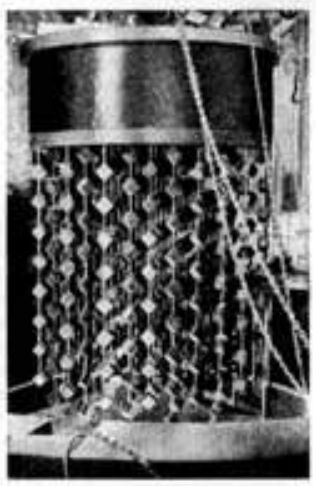




How close did the Germans get?

A 2009 MCNP5 study of the B-VIII reactor by Grasso, Oppici, Rocchi, and Sumini.





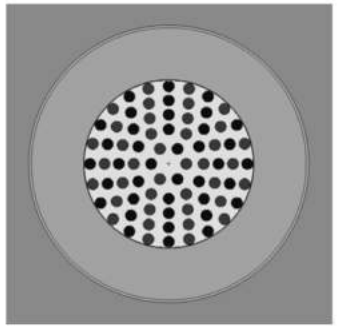


Fig. 5. Horizontal (*left*) and vertical (*right*) cross sections at the central plane of the B-VIII reactor, as simulated by the MCNP code for Model C and as rendered by VISED software.

Model	Graphite purity	Graphite density (g/cm^3)
A	Pure graphite	2.2
B	Graphite with 1 ppm Boron	1.8
C	Natural graphite	1.8

Table 4. The results of the MCNP simulations for the effective neutron-multiplication constants k_{eff}, their standard deviations (SD), their corresponding neutron-multiplication factors M, the neutron mean-free-paths (mfp) in centimeters over the entire reactor, and the average prompt neutron lifetimes (l) in seconds for Models A, B, and C.

Model	k_{eff}	SD	M	mfp (cm)	l (s)
A	0.89454	0.00013	9.482	2.28	5.6530×10^{-4}
B	0.86831	0.00013	7.593	2.28	4.8395×10^{-4}
C	0.85748	0.00013	7.016	2.28	4.1184×10^{-4}

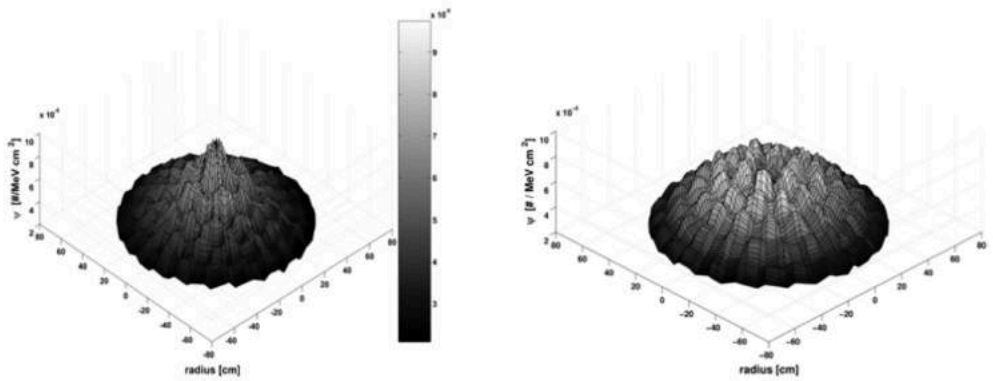
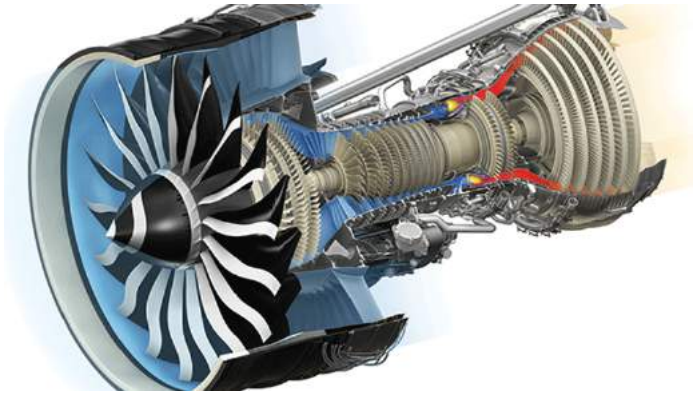


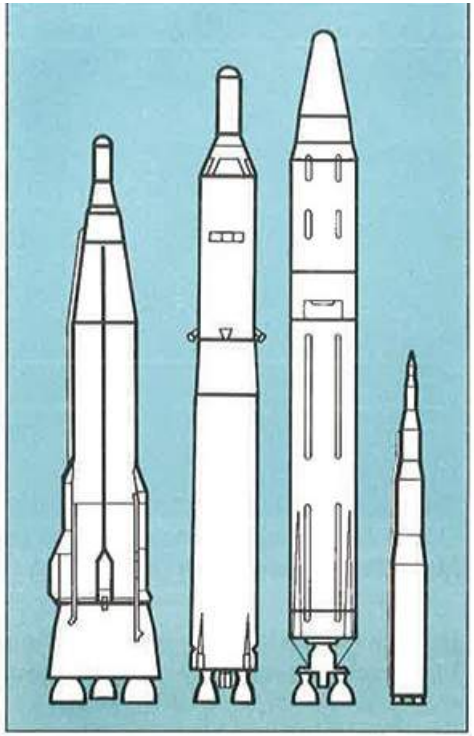
Fig. 7. The radial spatial profile of the neutron-flux distribution Φ *versus* neutron energy E at a horizontal central plane in the B-VIII reactor for thermal neutrons of energies up to 0.625 eV (*left*) and for fast neutrons of energies above 0.625 eV (*right*), as obtained with the MESHTAL feature of the MCNP5 code.

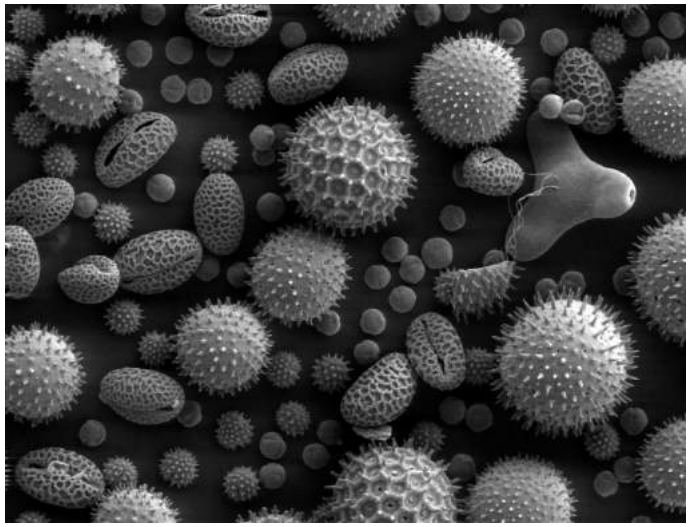
→ Needed ~ 50% (300) more U cubes

Nazi Scientific Developments

- *Fission…*
- Television
- Jet engines
- Intercontinental ballistic missals
- Electron microscope
- Pesticides
- Magnetic tape audio recording
- Cancer research (acknowledged link between cancer and smoking/asbestos/carcinogenic dyes)





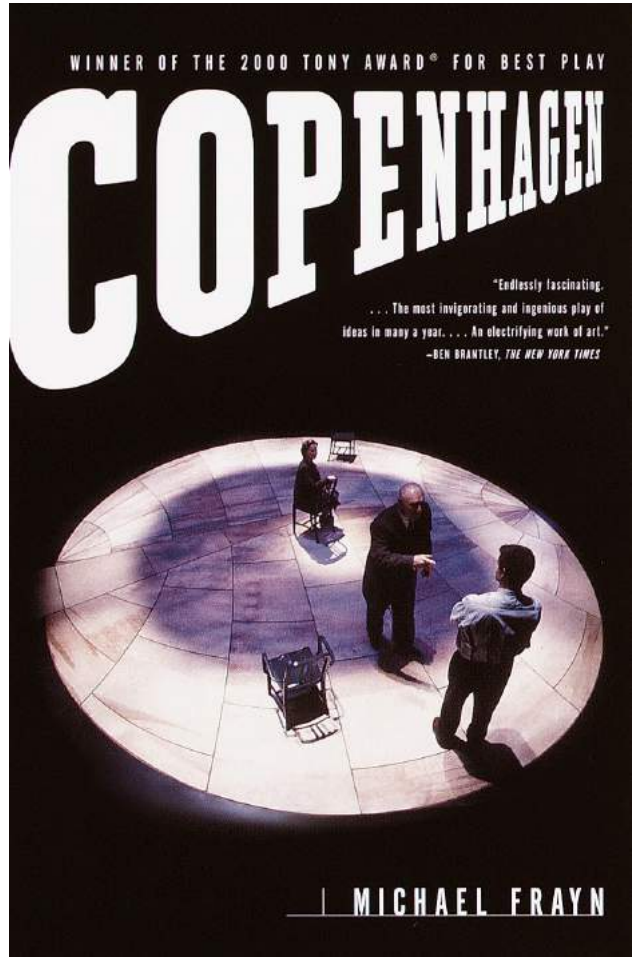


What Happened?

- Speculation about the actual motives of the German scientists…
  - Miscalculation? Sabotage? Lack of resources?
  - Visit to Copenhagen to see Bohr (1941)

- Three real options:
  1. Work for the Nazi (willingly or unwillingly)
  2. Refuse to cooperate
  3. Comply while working to sabotage the project…

- What was in it for them?
  - Regime recognition
  - Funding
    - "…for the first time in a decade the government was willing to give money for physics and we were going to make best use of it." W. Heisenberg
  - Draft deferments
  - Interesting research
  - Potential for international prestige
- Believed themselves to be far ahead of Allies until August 6, 1945…



The Farm Hall Recordings: Aug 6th, 1945

The "Guests:" Otto Hahn, Max von Laue, Walther Gerlach, Werner Heisenberg, Paul Harteck, Carl Friedrich von Weizacker, Karl Wirtz, Erich Bagge, Horst Korsching, Kurt Diebner

Hahn: I don't believe it.

Heisenberg: All I can suggest is that some dilettante in America who knows nothing about it has bluffed them in saying if you drop this is has the equivalent of 20 thousand tons of high explosive and in reality it doesn't work at all.

Hahn: At any rate Heisenberg you are just a second rater and you may as well pack up.

Heisenberg: I quite agree.

Hahn: They are fifty years further advanced than us.

Heisenberg: I don't believe a word of the whole thing.

Where did they go wrong?

1. Anti-Semitism and loss of intellectual capital
   - Xenophobia
2. Ineffectual communication with government
3. Distrust of science in Nazi regime…
4. No real industrial support
   - “the attitude was too academic and for the development of modern physics one needed that marriage with industry” –Samuel Goudsmit
5. Crippling divisiveness amongst the scientists
   - Academic elitism
   - Deference to Heisenberg rather than collaborative effort

Acknowledgements

- National Museum of Nuclear Science and History
- Clay Perkins for providing travel funds
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- Shane Bell of National Archives, Atlanta
- Niels Bohr Library, AIP in College Park
- Posthumously Robert D. Ninninger
- Dieter Hoffman of KWI in Berlin
- Roger Meade of LANL
- Richard Rhodes, support and social capital
- Sally Lansdale and Chloe Pitard