



NE290D: Special Topics in Nuclear History, Politics, and Futures

Early Manhattan Project

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January 19, 2021 – W5L9



Introduction

Agenda

- ▶ Guest Speaker
Sara Schreiber
- ▶ Final Project
Discussion
- ▶ 1942-1943 Early
Manhattan
Project

W5L9 Learning Outcomes

- ▶ Recall the major historical milestones in the investigation of nuclear weapons and describe the experiments that led to them.
- ▶ Organize the events on a timeline.
- ▶ Draw connections between the developments in 20th century physics and latter Manhattan project.

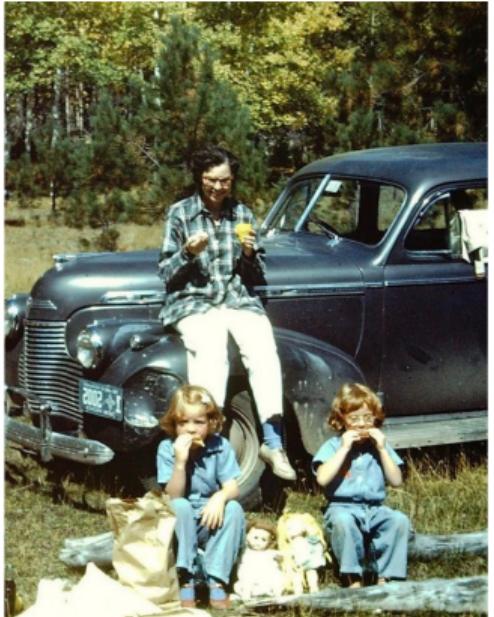
Guest Sara Schreiber



¹ https://www.oregonlive.com/history/2017/11/oregons_secrective_and_indispensible.html

² <https://www.nytimes.com/1998/12/31/us/re-schreiber-88-nuclear-bomb-physicist.html>

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Final Project Discussion

Option 1

Historical answers to modern problems.

With your newfound understanding of nuclear history and its impact across the 20th century, consider a problem facing the nuclear community that transcends a scientist, technical, economic, security-driven, etc., propose a solution to the present, for the future, based on the past. Write up your solution as a paper for one of the journals discussed.

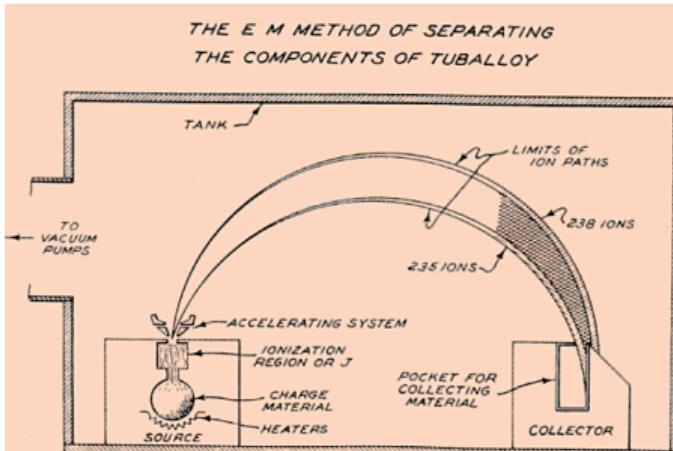
Option 2

Tell me a nuclear bedtime story.

Given our discussions of the weaving of history, science, literature, and its impact on society, consider either adapting a work of literature to fit the scope of an important historical event in nuclear physics, nuclear engineering, or national defense such that a reader would be compelled to consider the weight or your theme.

1942-1943 Early Manhattan Project

1942 Sept 13: The S-1 Executive Committee recommends building a pilot plant based on Ernest O. Lawrence's cyclotrons to separate uranium isotopes in Tennessee.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1942 Sept 17: Col. Leslie Groves is notified that his assignment overseas has been cancelled and that he command the Manhattan Engineer District.

- ▶ Previous assignment had required overseeing ten billion dollars' worth of construction projects, including the construction of the Pentagon.
- ▶ 1942 Sept 18: Groves buys 1250 tons of high quality Belgian Congo uranium ore stored on Staten Island.
- ▶ 1942 Sept 19: Groves selects Oak Ridge, TN as the site for the pilot plant. He buys Site X, 52,000 acres of land on the Clinch River. Preliminary construction work begins soon after.



¹<https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1942 Sept 17: Col. Leslie Groves is notified that his assignment overseas has been cancelled and that he command the Manhattan Engineer District.

- ▶ 1942 Sept 19: Groves' insistence the Manhattan Project is granted approval by the War Production Board to use the highest emergency procurement priority in existence (AAA) when needed.
- ▶ 1942 Sep 23: Col. Leslie Groves is promoted to Brigadier General.
- ▶ 1942 Oct: Groves puts DuPont in charge of the plutonium production project.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

"First, General Groves is the biggest S.O.B. I have ever worked for. He is most demanding. He is most critical. He is always a driver, never a praiser. He is abrasive and sarcastic. He disregards all normal organizational channels. He is extremely intelligent. He has the guts to make difficult, timely decisions. He is the most egotistical man I know. He knows he is right and so sticks by his decision. He abounds with energy and expects everyone to work as hard or even harder than he does. Although he gave me great responsibility and adequate authority to carry out his mission-type orders, he constantly meddled with my subordinates. However, to compensate for that he had a small staff, which meant that we were not subject to the usual staff-type heckling. He ruthlessly protected the overall project from other government agency interference, which made my task easier. He seldom accepted other agency cooperation and then only on his own terms. During the war and since I have had the opportunity to meet many of our most outstanding leaders in the Army, Navy and Air Force as well as many of our outstanding scientific, engineering and industrial leaders. And in summary, if I had to do my part of the atomic bomb project over again and had the privilege of picking my boss I would pick General Groves."

¹ Nichols, Kenneth David. "The road to Trinity." (1987).

1942-1943 Early Manhattan Project

1942 Oct: Conant recommends to Bush that information exchange with Britain, already largely one-way (UK → US), be sharply restricted.

- ▶ Bush passes this recommendation to President Roosevelt. As a result the US loses access to British work in gaseous diffusion, which seriously delays successful plant completion.
- ▶ Centrifuge separation is abandoned due to technical problems.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1942 Oct 5: Groves visits the Met Lab and meets the key scientists, including J. Robert Oppenheimer.

- ▶ He orders key engineering decisions for plutonium production, under debate for months, be made in 5 days.
- ▶ 1942 Oct 15: Groves asks Oppenheimer to head Project Y, planned to be the new central laboratory for weapon physics research and design.
- ▶ 1942 Oct 19: Bush approves Oppenheimer appointment.
- ▶ 1942 Nov 25: Groves selects Los Alamos, NM as the site for a scientific research laboratory. Oppenheimer is selected as laboratory director.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project



¹ <https://www.atomicheritage.org/history/civilian-displacement-los-alamos-nm>



1942-1943 Early Manhattan Project



Gamma Building —

A Building — Administration headquarters
B Building — Laboratory and office space
D Building —
E Building —
G Buildings —

H Building — Administration headquarters
K Building —
M Building — Boiler House No. 1
P Building —
Q Building — Health group headquarters
R Building —

S Building — Technical warehouse
T Building — Original Administration building
U Building — Electronics
V Building — Shops
W Building — Van de Graff accelerator
X Building (not shown) — Cyclotron

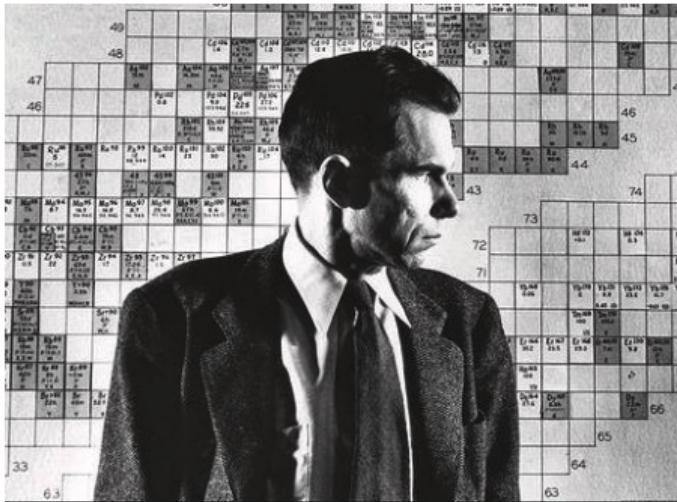
Y Building — Physics laboratory
Z Building — Cockcroft-Walton accelerator
Boiler House No 2 —

¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1942 Nov 3: Glenn Seaborg reports that due to plutonium's high alpha activity, slight amounts of light element impurities can cause a serious problem with neutron emission from alpha → n reactions.

- ▶ This issue caused major concern with many project leaders, including Groves and Conant, not only due to its own significance, but because it raised apprehension about the impact of other unexplored phenomena.
- ▶ This issue later became moot due to the problems with Pu-240 contamination. Later in the month the Lewis Committee is formed to review progress and make recommendations.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1942 Dec 1: After 17 days of work,
Fermi's group completes Chicago Pile-1.

- ▶ It contains 36.6 metric tons of uranium oxide, 5.6 metric tons of uranium metal, and 350 metric tons of graphite.
- ▶ Construction is halted sooner than planned when Fermi projects that a critical configuration has been reached.
- ▶ 1942 Dec 2: At 3:49 p.m., CP-1 goes critical.
- ▶ It demonstrates a k value of 1.0006, and is allowed to reach a thermal output of 0.5 watts (ultimately it operates at 200 watts maximum).
- ▶ This is the first sustained nuclear fission chain-reaction.



¹ <https://www.atomicheritage.org/history/timeline>



1942-1943 Early Manhattan Project



1942-1943 Early Manhattan Project



1942-1943 Early Manhattan Project



1942-1943 Early Manhattan Project

1943 Feb: The Soviet Union secretly launches its own atomic program under the direction of Igor Kurchatov.

- ▶ The program was extremely limited throughout the war and included no more than fifty personnel.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1943 Mar 27: Richard Tolman writes J. Robert Oppenheimer about using explosives to collapse a shell into a critical mass.

- ▶ This is the earliest surviving reference to the idea of implosion (although this term was not used).
- ▶ 1943 April: Seth Neddermeyer begins research on implosion, seeking to compress hollow metal assemblies.
- ▶ 1943 April: By the end of the March planning sessions, the necessity of including ordnance development activity at Los Alamos was apparent. This greatly expanded the scope of work undertaken at the laboratory to engineering development, and eventually acting as prime contractor for weapon production, and manufacturer of key weapon components.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1943 April: Hans Bethe is selected over Edward Teller to head the theoretical division.

- ▶ Teller is soon placed in charge of lower priority research on fusion weapons.

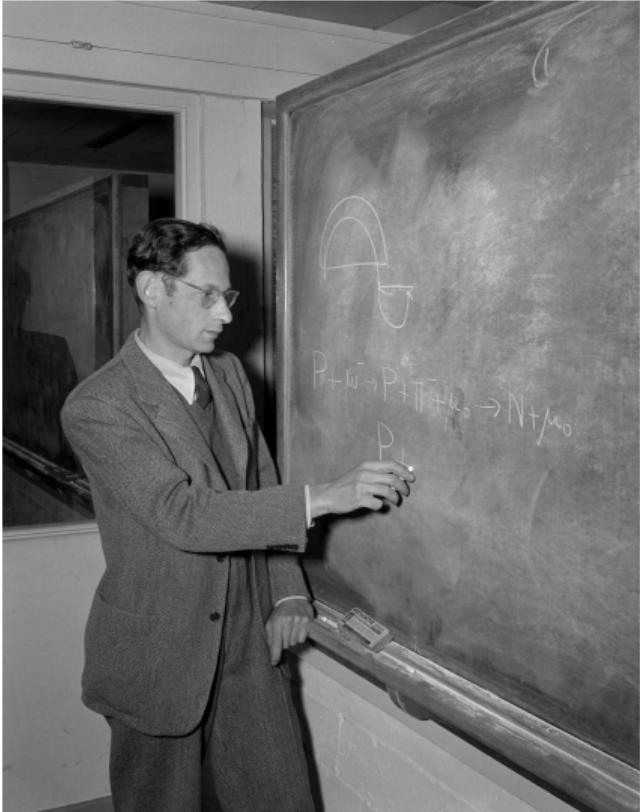


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1942-1943 Early Manhattan Project

1943 April: Los Alamos provides its scientists introductory lectures on nuclear physics and bomb design.

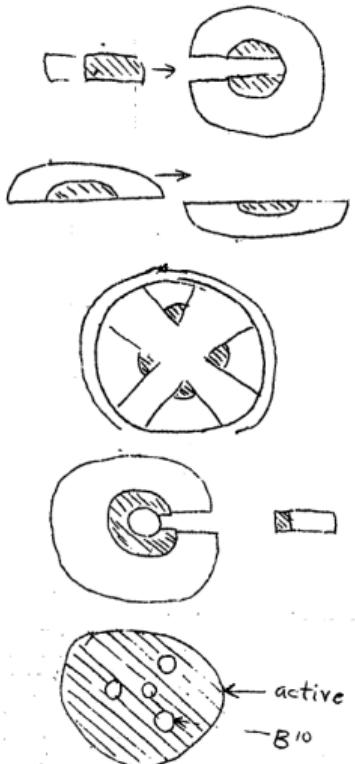
- ▶ 1943 May 10: The Los Alamos, NM review committee approves the laboratory's research program.



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1942-1943 Early Manhattan Project

The Los Alamos Primer

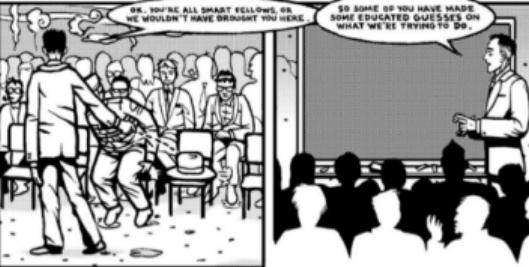


The Los Alamos Primer

- [1. Object](#)
- [2. Energy of Fission Process](#)
- [3. Fast Neutron Chain Reaction](#)
- [4. Fission Cross-sections](#)
- [5. Neutron Spectrum](#)
- [6. Neutron Number](#)
- [7. Neutron Capture](#)
- [8. Why Ordinary U Is Safe](#)
- [9. Material 49](#)
- [10. Simplest Estimate of Minimum Size of Bomb](#)
- [11. Effect of Tamper](#)
- [12. Damage](#)
- [13. Efficiency](#)
- [14. Effect of Tamper on Efficiency](#)
- [15. Detonation](#)
- [16. Probability of Predetonation](#)
- [17. Fizzes](#)
- [18. Detonating Source](#)
- [19. Neutron Background](#)
- [20. Shooting](#)
- [21. Autocatalytic Methods](#)
- [22. Conclusion](#)



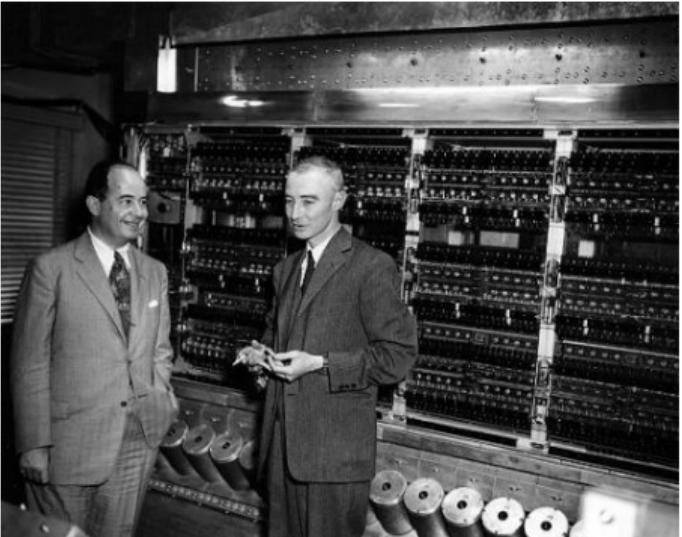
1942-1943 Early Manhattan Project



1942-1943 Early Manhattan Project

1943 Sept 20: John von Neumann arrives on a visit to Los Alamos

- ▶ He points out the potential for high compression from implosion.
- ▶ This is a clear advantage for the technique which would make a bomb more efficient, and require a smaller critical mass.
- ▶ Teller and Bethe begin investigating the subject theoretically, Oppenheimer and Groves become very interested in its potential, and efforts to accelerate the program begin.
- ▶ John von Neumann agrees to work on the physics of implosion in his spare time.



¹<https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1943 Oct: Project Alberta, the full scale atomic bomb delivery program, begins.

- ▶ Norman Ramsey appointed to select and modify aircraft for delivering atomic bombs.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1943 Oct 4: DuPont engineers release reactor design drawings for the first Hanford, WA plutonium production pile, 100-B, allowing construction to begin.

- ▶ 1943 Oct 10: Site preparation starts for the B-100 plutonium production reactor, B Reactor, at Hanford, WA.
- ▶ 1943 Oct 21: First concrete is poured for the K-25 Plant building at Oak Ridge, TN.

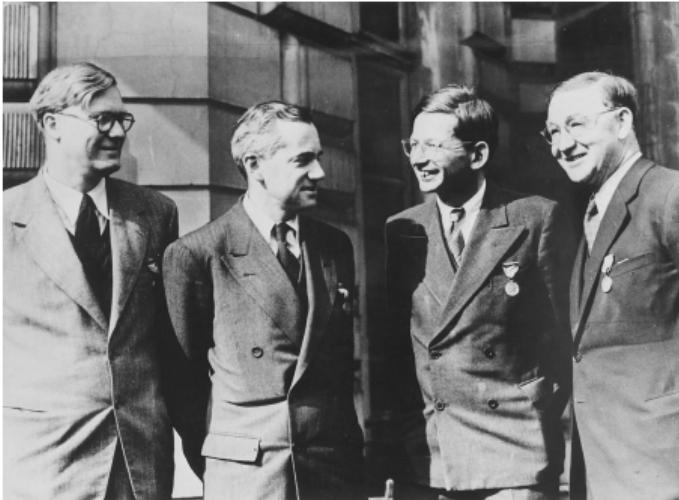


¹<https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1943 Nov: The top experts in England on fission weapons, many former members of the MAUD committee, depart England for the US to assist the atomic bomb project.

- ▶ Included are Niels Bohr, Otto Frisch, Rudolf Peierls, James Chadwick, William Penney, George Placzek, Philip B. Moon, James Tuck, Egon Bretscher, and Klaus Fuchs.

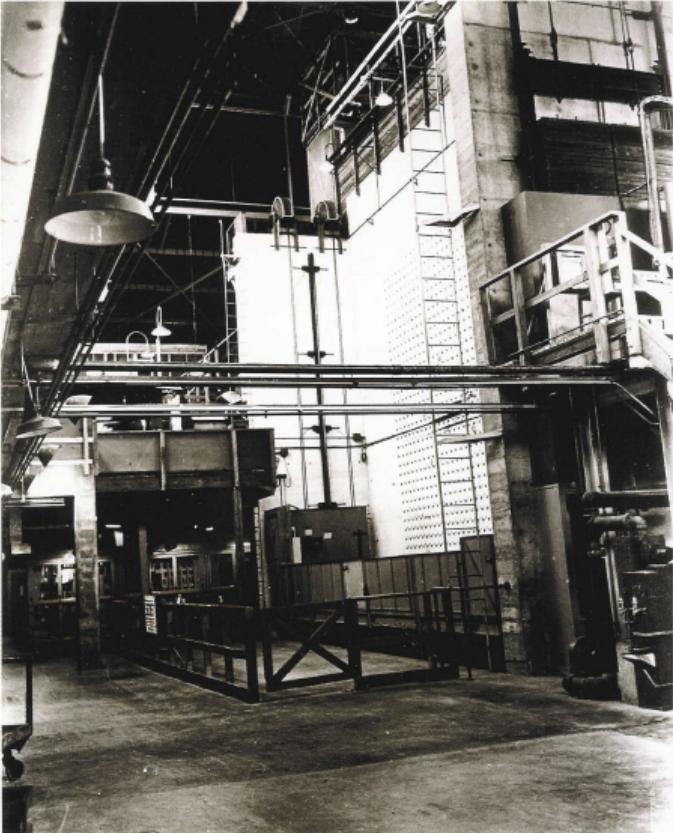


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1942-1943 Early Manhattan Project

1943 Nov 4: The X-10 Graphite Reactor pile goes critical at Oak Ridge, TN.

- ▶ This air-cooled experimental pile begins producing the first substantial (gram) amounts of plutonium to assist research into its properties.
- ▶ The world supply of plutonium at this time is 2.5 mg, produced by cyclotrons.
- ▶ Also, a Manhattan Project Governing Board meeting approves an ambitious implosion research program, intended to develop it to the point of usability in six months.
- ▶ 1943 Dec: Chemical separation of reactor-produced plutonium begins, using fuel from the X-10 Graphite Reactor pile.



¹ <https://www.atomicheritage.org/history/timeline>

1942-1943 Early Manhattan Project

1943 Dec: Emilio Segre measures the spontaneous fission rate of U-235 at Los Alamos, NM

- ▶ He finds it lower than expected. This allows a substantial reduction in performance of the planned gun assembly method for uranium.



¹ <https://www.atomicheritage.org/history/timeline>