WHAT'S NEW IN FUSION

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SESSION 2

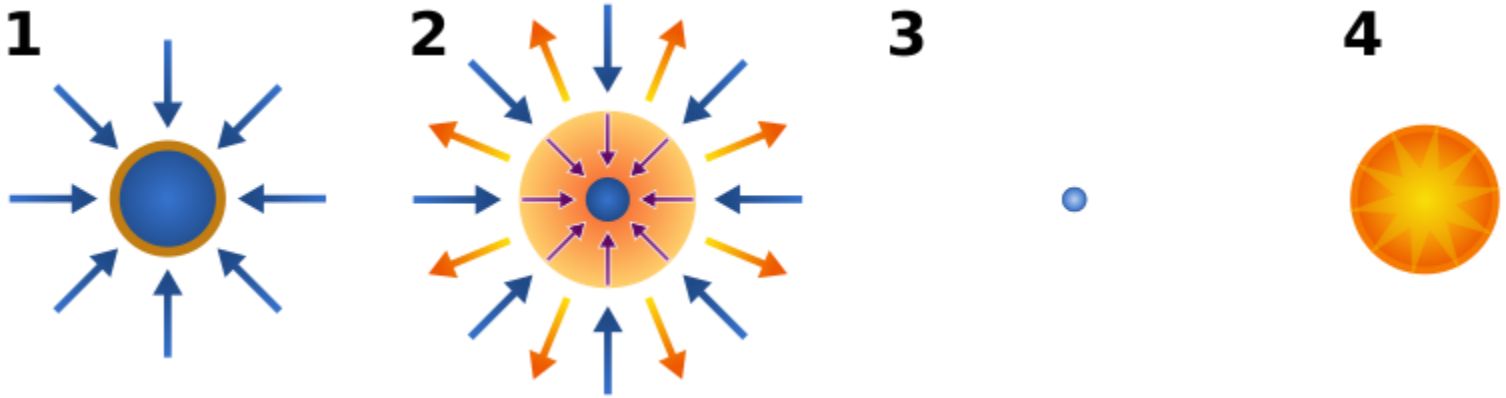
Inertial Confinement Fusion Concepts

- 25% of fusion companies are pursuing inertial confinement fusion engines
- 50% of these companies are using lasers for inertial confinement
- Research is difficult due to laser power required
- Still the only technique which has demonstrated net energy from fusion

INERTIAL FUSION FUEL PELLET

https://upload.wikimedia.org/wikipedia/commons/b/b8/Fusion_microcapsule.jpg

DT FUEL PELLET IMPLOSION



https://upload.wikimedia.org/wikipedia/commons/thumb/1/17/Inertial_confinement_fusion.svg/1200px-Inertial_confinement_fusion.svg.png?20230810173354

LASER FUSION HOHLRAUM

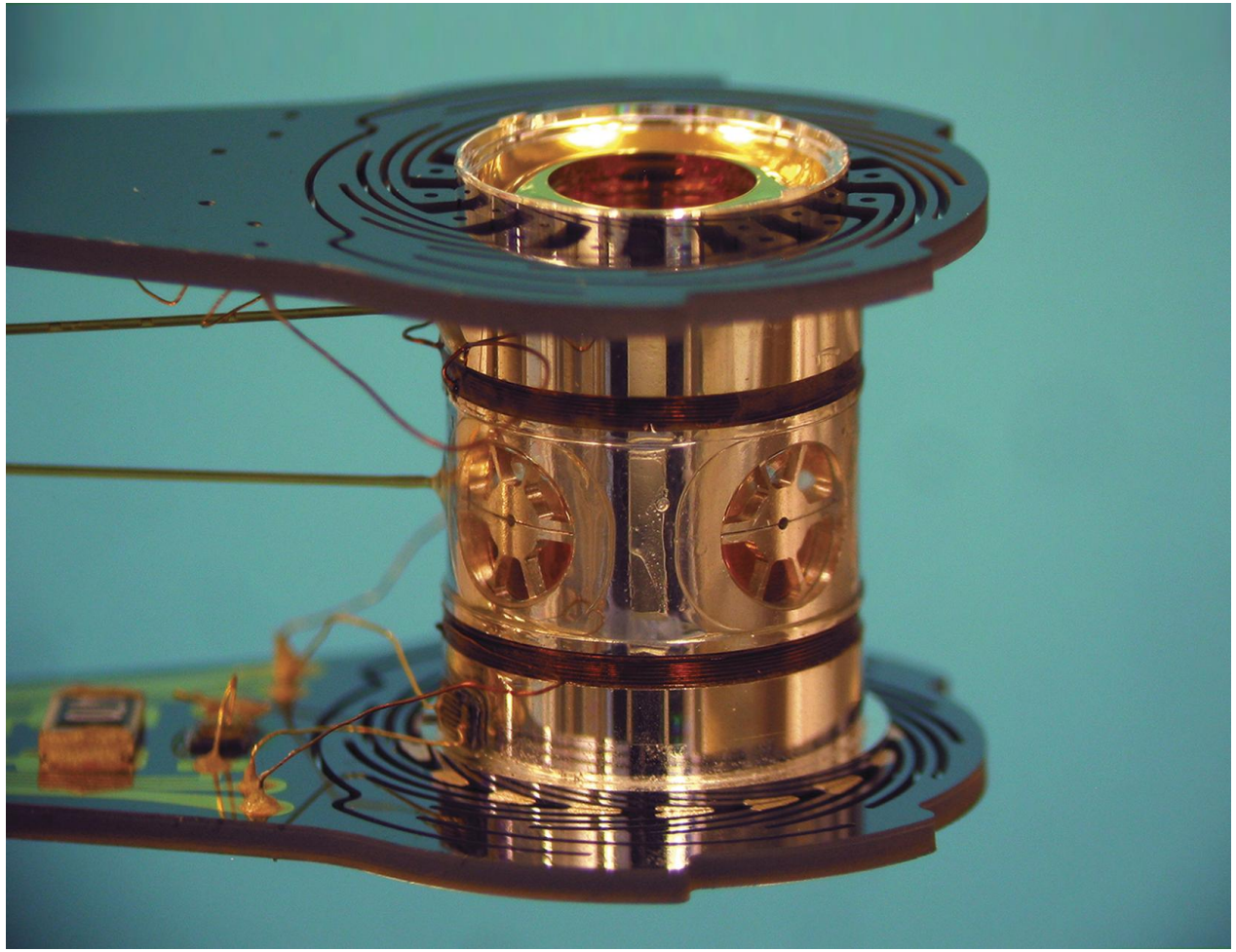
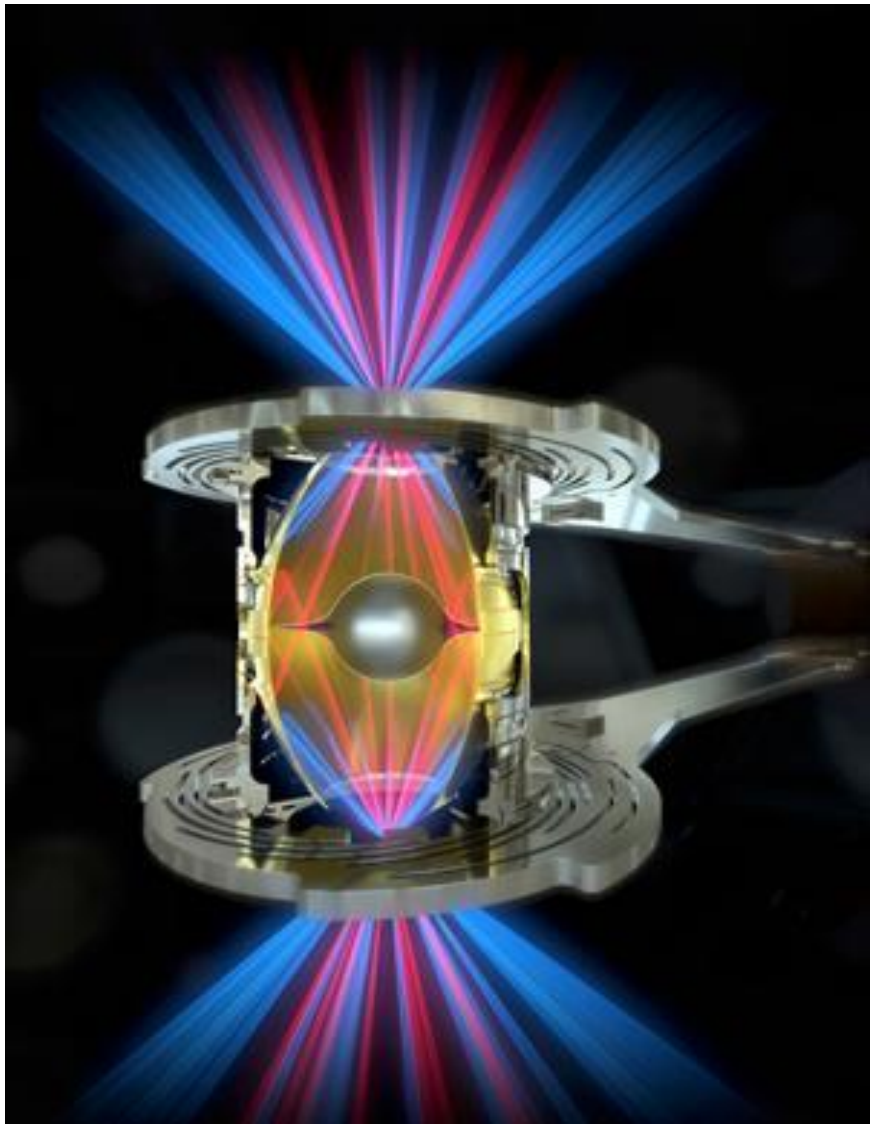


Image: © LLNL. The Age of Ignition, LLNL-BR-857901. *NIF Hohlraum: A metallic case called a hohlraum holds the fuel capsule for NIF experiments. Target handling systems precisely position the target and freeze it to cryogenic temperatures (18 kelvins, or -427 degrees Fahrenheit) so that a fusion reaction is more easily achieved.* Lawrence Livermore National Laboratory (CC BY-NC-SA 4.0) [Accessed: July 18, 2025]

INSIDE THE HOHLRAUM



https://lasers.llnl.gov/sites/lasers/files/styles/scaled_300w/public/2021-05/fusion-hohlraum.jpg?itok=k4nvc8lk

PELLET IMPLOSION

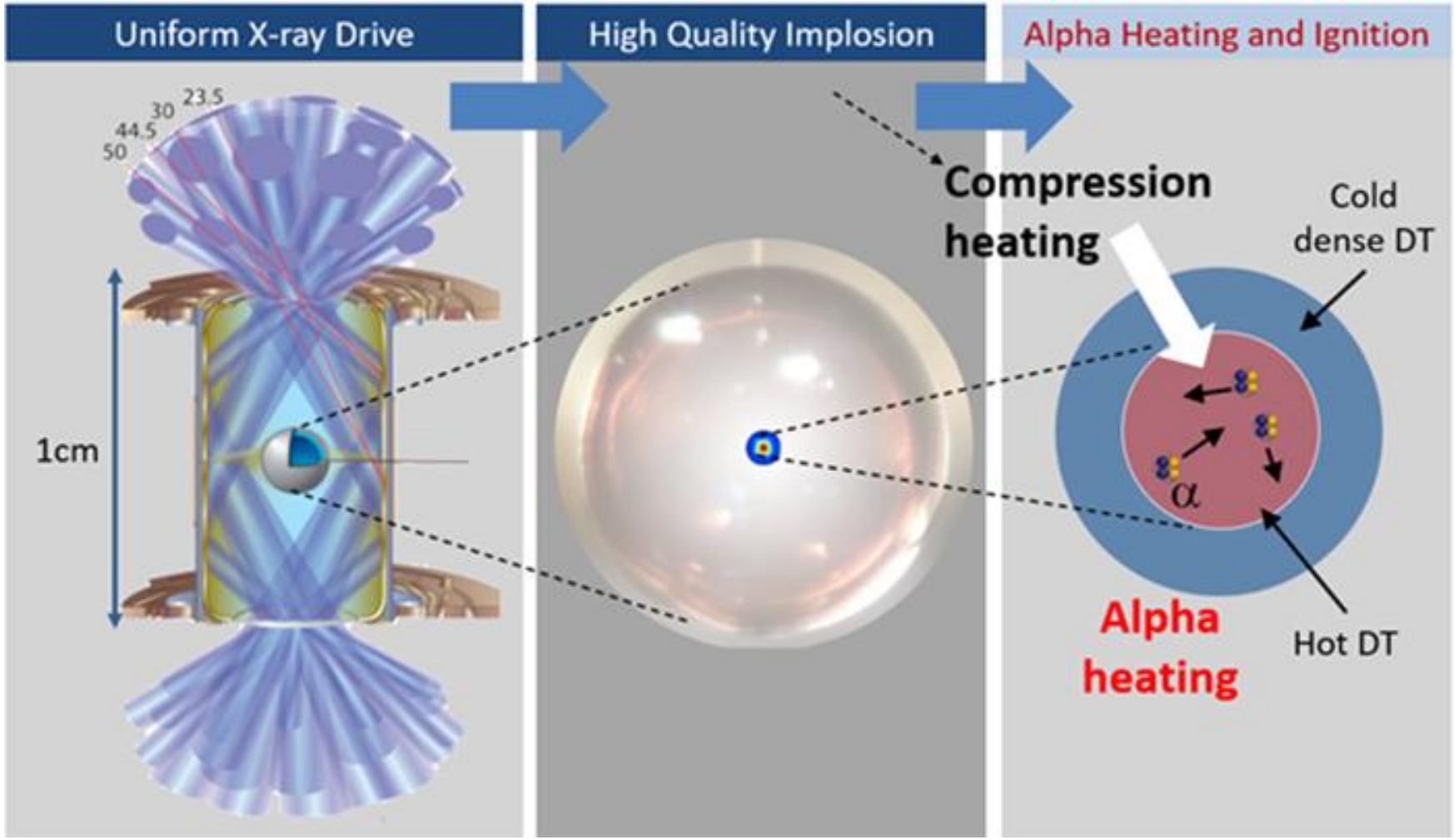


Image: © LLNL. The Age of Ignition, LLNL-BR-857901. *Illustration of alpha heating in a standard NIF target*. Lawrence Livermore National Laboratory (CC BY-NC-SA 4.0) [Accessed: July 21, 2025]

LASER PULSE SHAPE

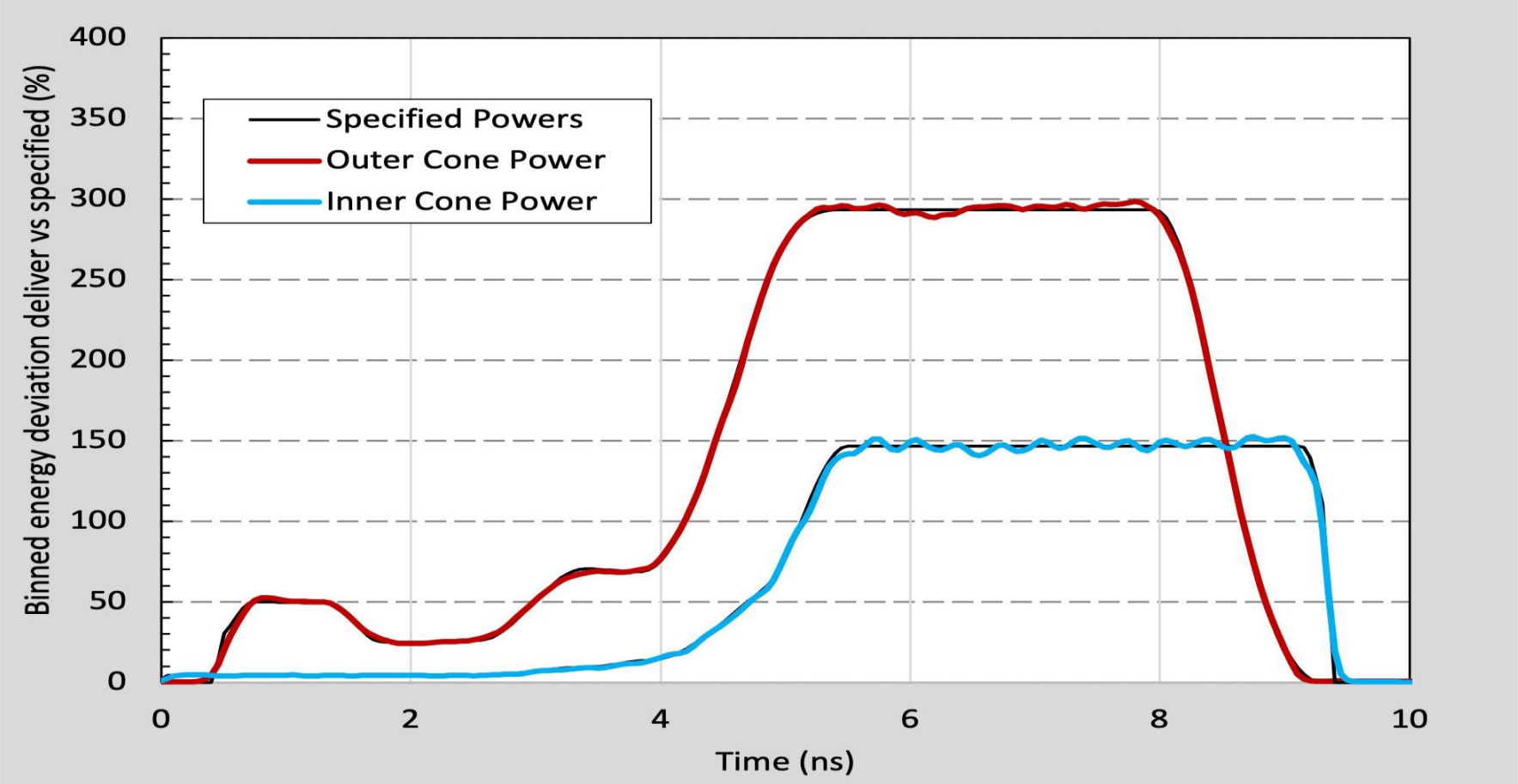
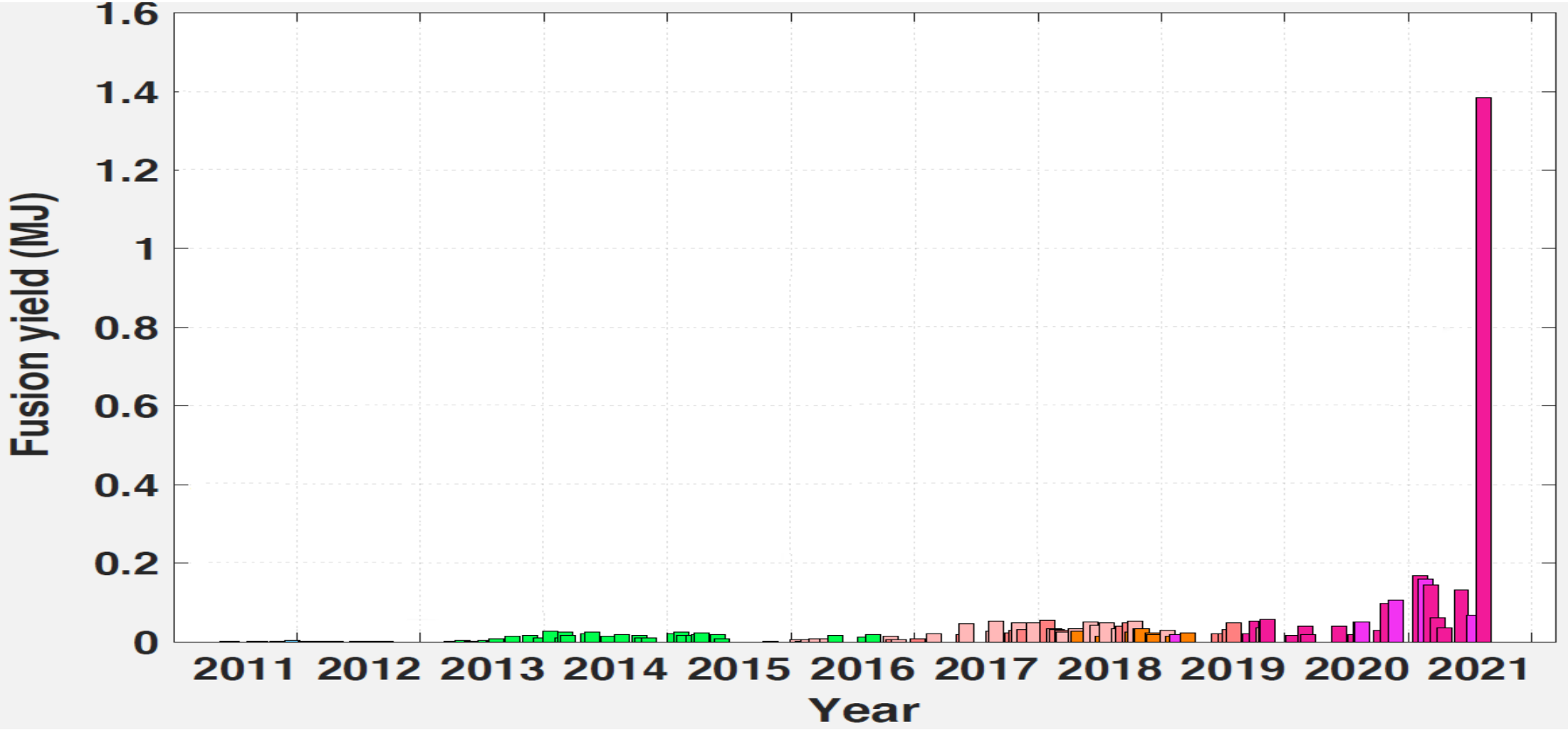


Image: © LLNL. The Age of Ignition, LLNL-BR-857901. *To provide the laser energy conditions required for ignition for the Dec. 5, 2022, shot, NIF's laser system was able to meet the requests of experimental designers within a pointing accuracy level of 50 microns and a timing level of 30 picoseconds (trillionths of a second). The red line shows the pulse for outer cone beams and the blue line shows the pulse for beams aimed at the inner cone.* Lawrence Livermore National Laboratory (CC BY-NC-SA 4.0) [Accessed: July 18, 2025]

NEVER GIVE UP

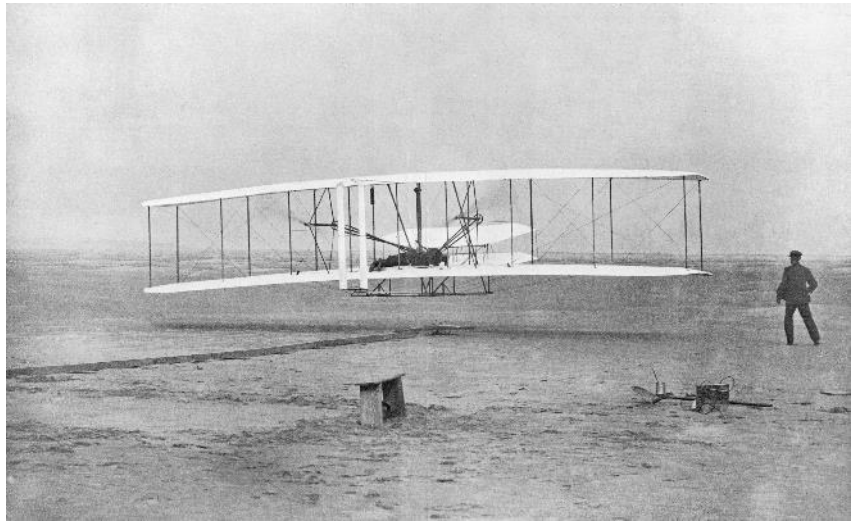


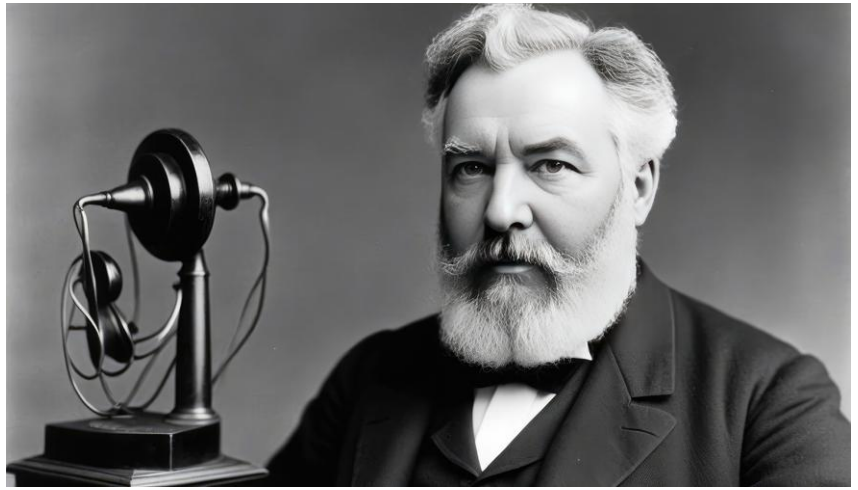
By Livermore National Laboratory – ;"The threshold of ignition on the NIF and laying the path towards Inertial Fusion Energy (IFE"; Presentation by Dr. Tammy Ma, 2021 Fusion Power Associates Meeting, Washington DC, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=117558501

LASER FUSION BREAKTHROUGH

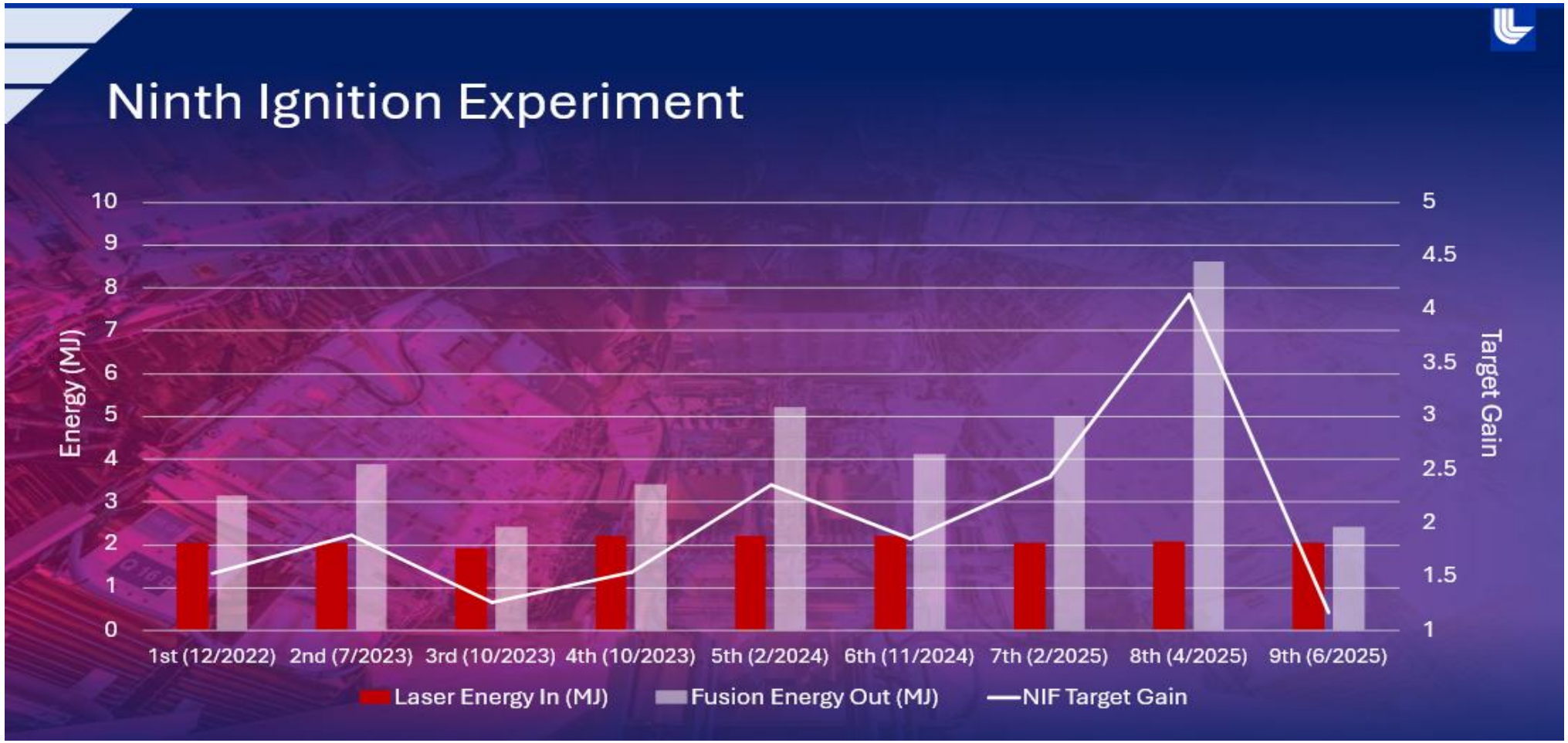
- December 5, 2022
  - 2.05 MJ laser energy delivered
  - 3.15 MJ fusion energy generated
  - Scientific gain (Q) of 1.5

https://lasers.llnl.gov/sites/lasers/files/2023-06/_Q9A8873-lg.jpg



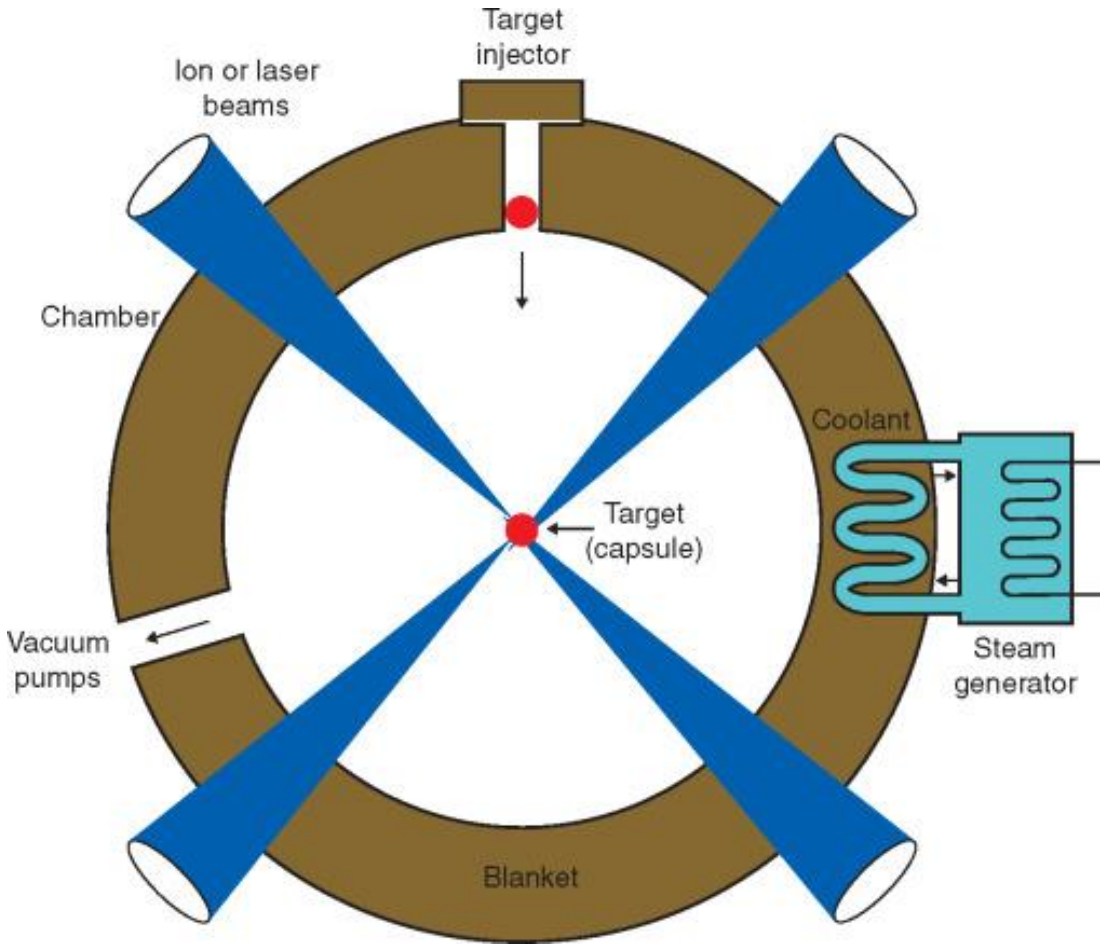


NATIONAL IGNITION FACILITY TESTS



https://lasers.llnl.gov/sites/lasers/files/2025-07/ninth-ignition_0.jpg

INERTIAL CONFINEMENT



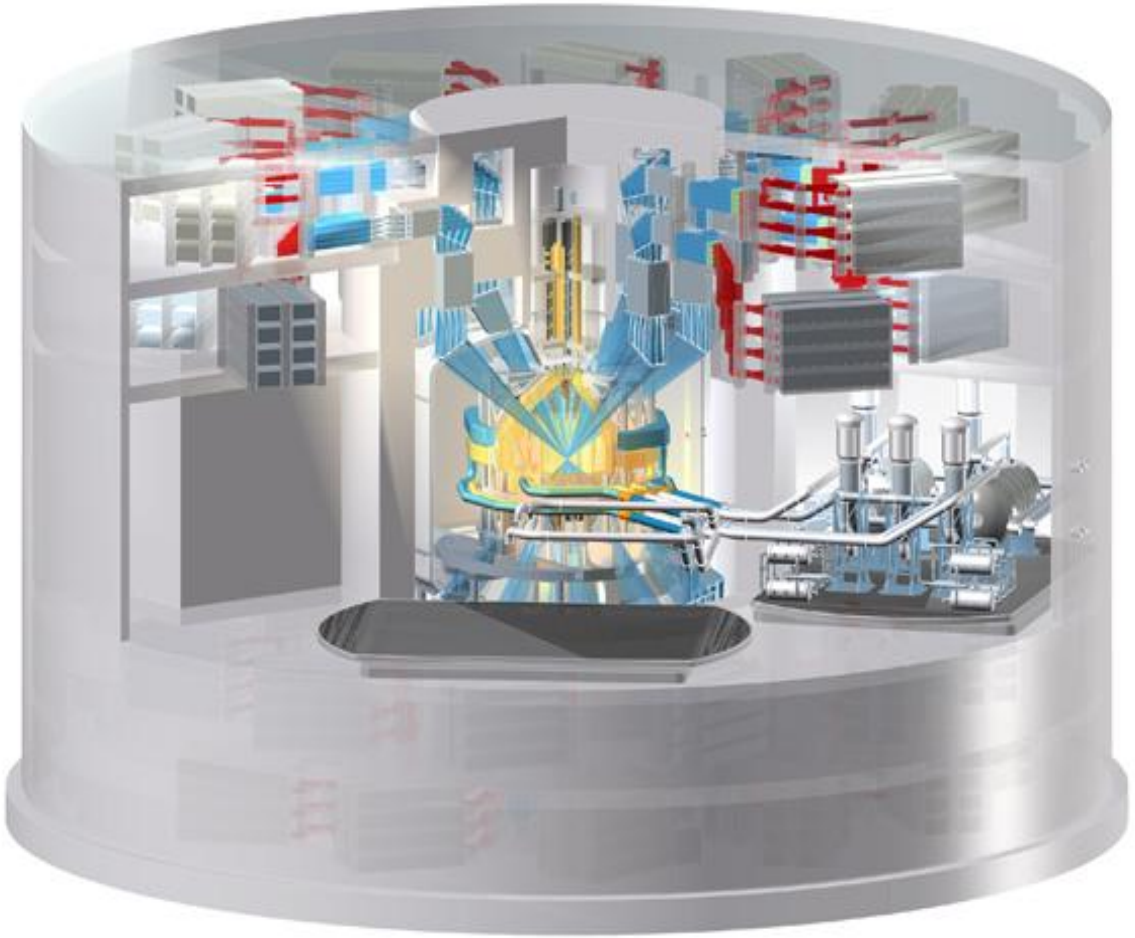
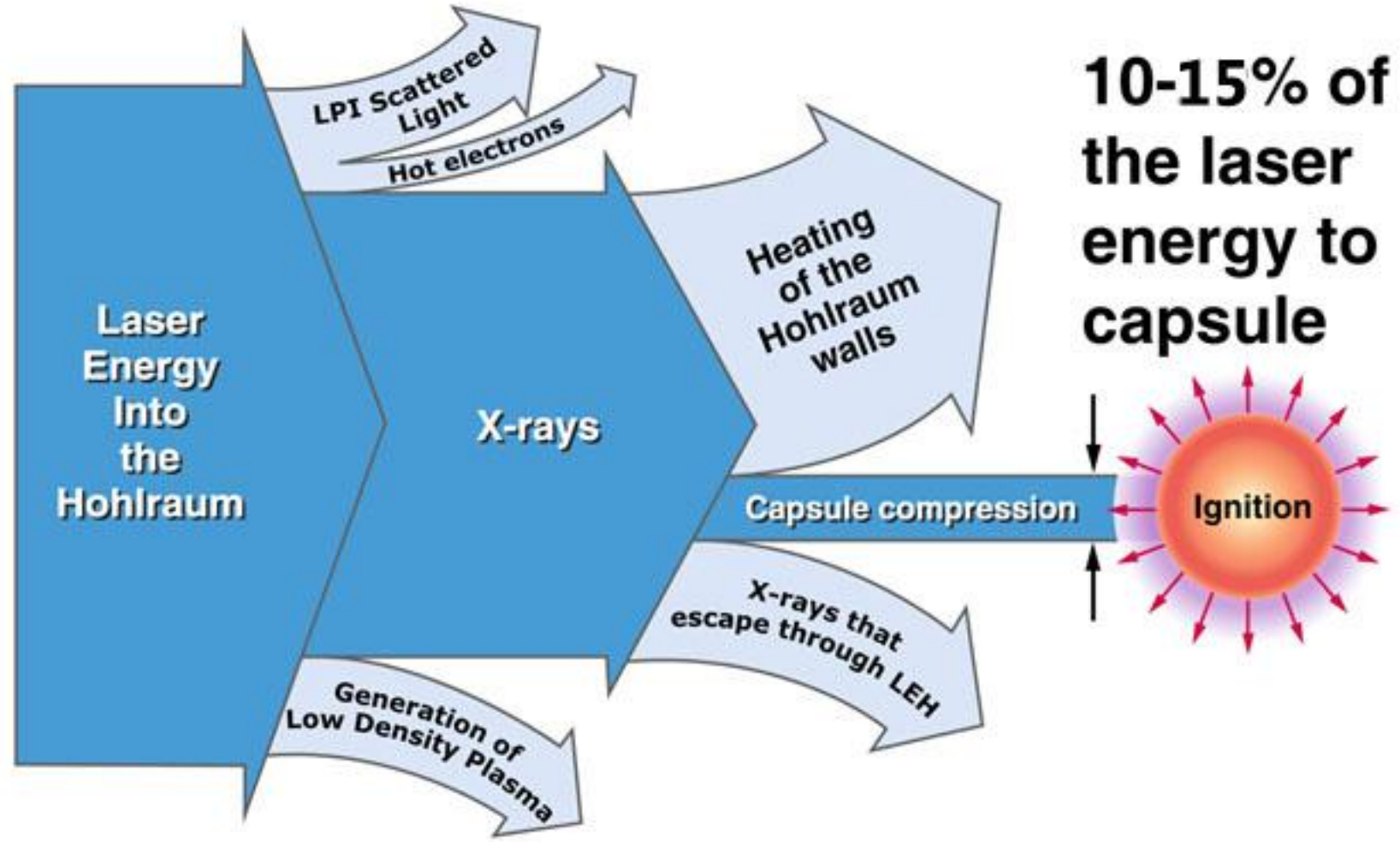


Image: Courtesy and copyright of Elsevier Publishing (ScienceDirect). Fusion. The Energy of the Universe, Book, Second Edition, 2012 [https://doi.org/10.1016/C2009-0-64568-2] Figure 13.5. Proposed design for an inertial-confinement power plant. A target capsule is injected into an evacuated chamber, and a pulse of laser light is fired at it to compress and heat it. The conceptual design is similar to that shown in Figure 13.1, but there are no magnet coils. Heat extracted from the blanket will go to a conventional steam plant.

Image:: Lawrence Livermore National Laboratory, LIFE_fusion_chamber.jpg, Public domain, via Wikimedia Commons [Accessed: August 4, 2025]

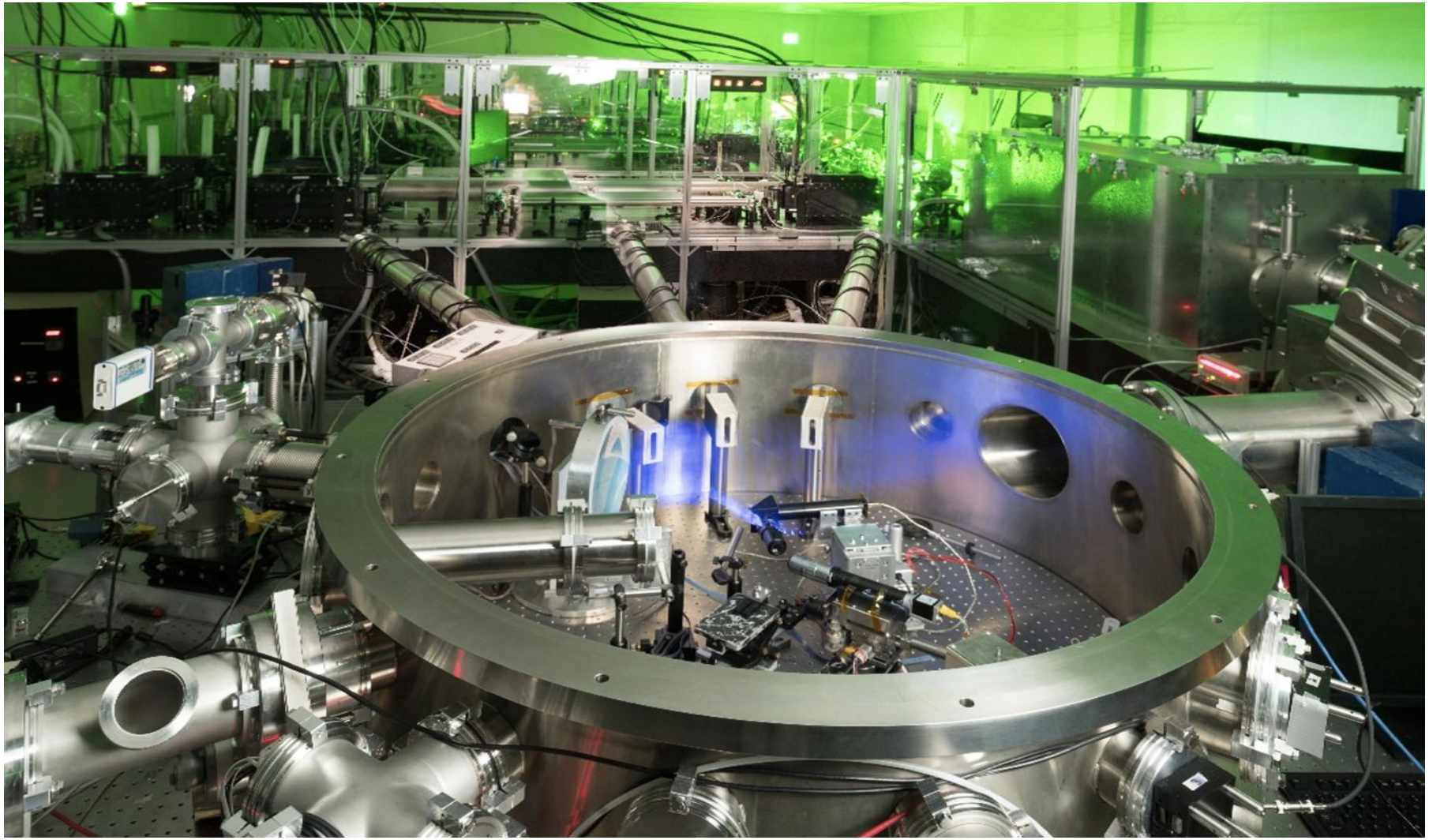
LASER ENERGY TO TARGET



PACIFIC FUSION INERTIAL CONCEPT

https://www.ans.org/file/20149/PF_DS3%20System%20in%20Facility_Raised%20View%20(1).jpg

MARVEL FUSION

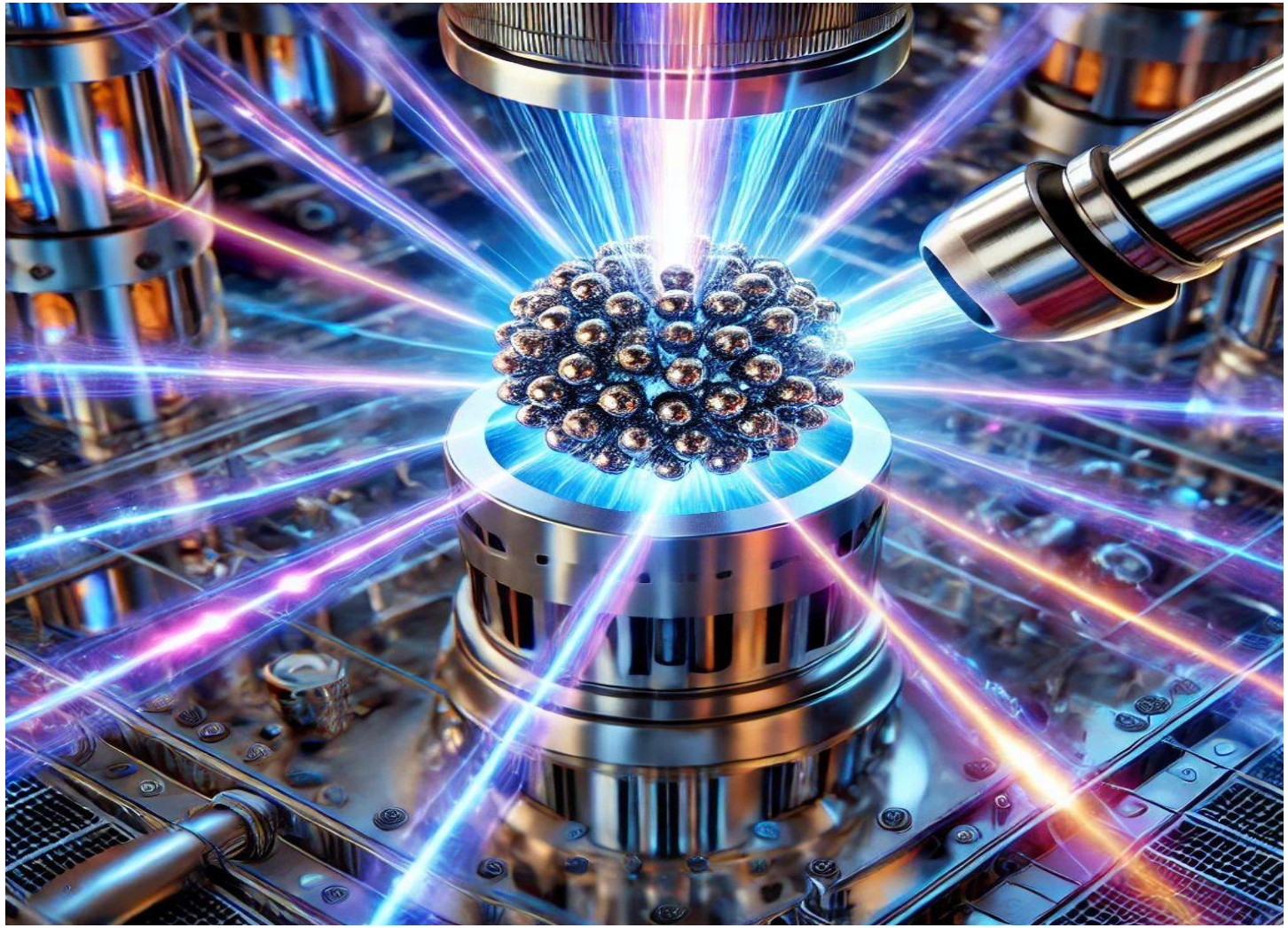


https://source.colostate.edu/wp-content/uploads/2023/08/Screenshot-2023-08-11-at-2.24.53-PM.png

FOCUSED ENERGY DIRECT DRIVE LASER

https://cdn.prod.website-files.com/672b679d563c65aa8b967c48/67408e08dc4f6bbb516025bb_photo-reactor-square-dark.jpg

ANUBAL FUSION



https://cdn.prod.website-files.com/610452b9f5efddef1245ce33/6729c9a4133bcca1858a0ddb_WhatsApp%20Image%202024-10-29%20at%2020.46.16.jpeg

DESKTOP COLD FUSION

- Metatron N.R.G.
- Uses plasmoids at room temperature
- Have recently achieved “ongoing fusion events” in the lab
- Goal is small “personal” fusion machines

INTERPLANETARY PROPULSION

- Pulsar Fusion
- Sunbird – Dual Direct Fusion Drive Propulsion
- Static tests this year
- In-Orbit tests of components in 2027