Fusion Power – Now it's an Engineering Problem

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Fluor Nuclear Power

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Fusion Energy Week (May 6-10)

- 100 Years of Fusion
- Cecilia Payne-Gaposchkin
  - Born May 10, 1900
  - PhD Thesis (1925) postulated sun was predominantly hydrogen and helium
  - Not widely accepted due to going against current scientific thinking
  - Otto Struve confirmed her results 4 years later

Agenda

- Why fusion?
- Laser Fusion – How it Works
- The National Ignition Facility (NIF)
- Engineering Hurdles to Power Plant
- Video of Conceptual Laser Fusion Power Plant (courtesy of Longview Fusion Energy Systems)

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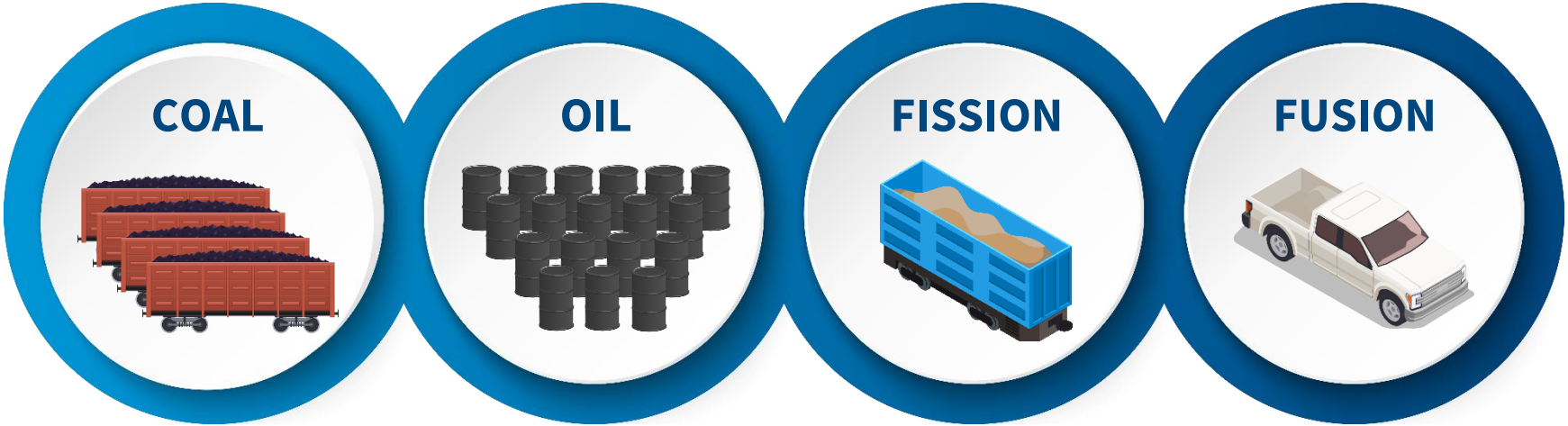
Fusion Energy Compared to Fossil Fuels



COAL	OIL	FISSION	FUSION
Approximately **2 million tonnes** (21,010 railcar loads)	Approximately **1.3 million tonnes** (10 million barrels)	Approximately **30 tonnes UO_2** (1 railcar load)	Approximately **0.5 tonnes D** (1 pickup truck)

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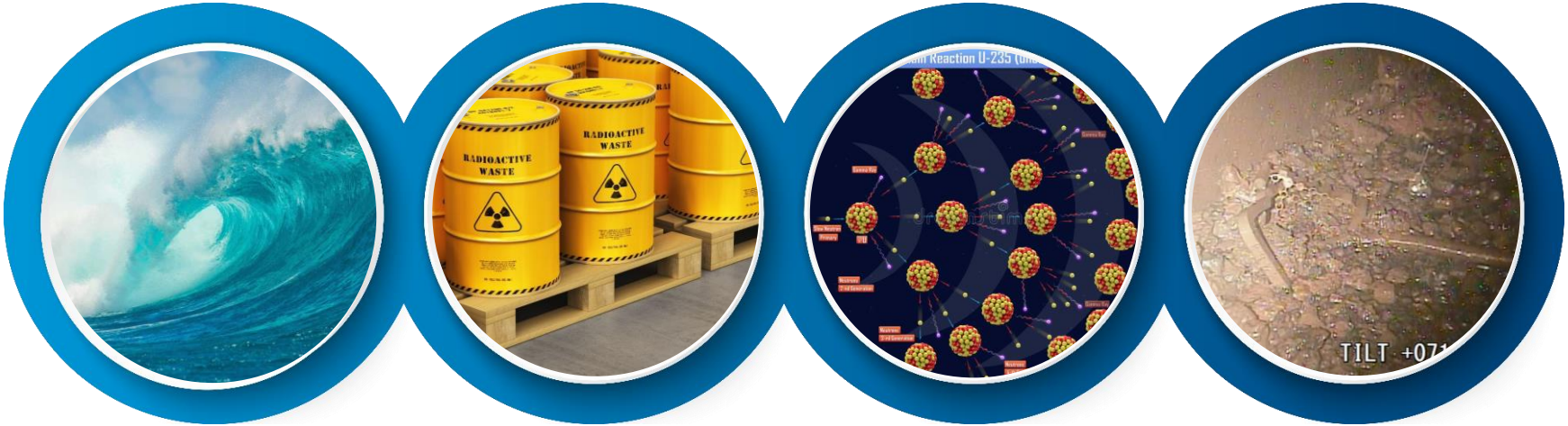
Advantages of Fusion Energy



Abundant fuel source

No High-level Waste

No Runaway Reactions

No Long-term Cooling

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Fluor and Longview Partnership

world nuclear news

Fluor to design laser fusion power plant

Nuclear Engineering International

Longview Fusion selects Fluor to design laser fusion plant

PEi POWER ENGINEERING INTERNATIONAL

Fluor and Longview start design work on laser fusion plant

OPTICS & PHOTONICS NEWS

Longview Partners with Fluor on Laser Fusion

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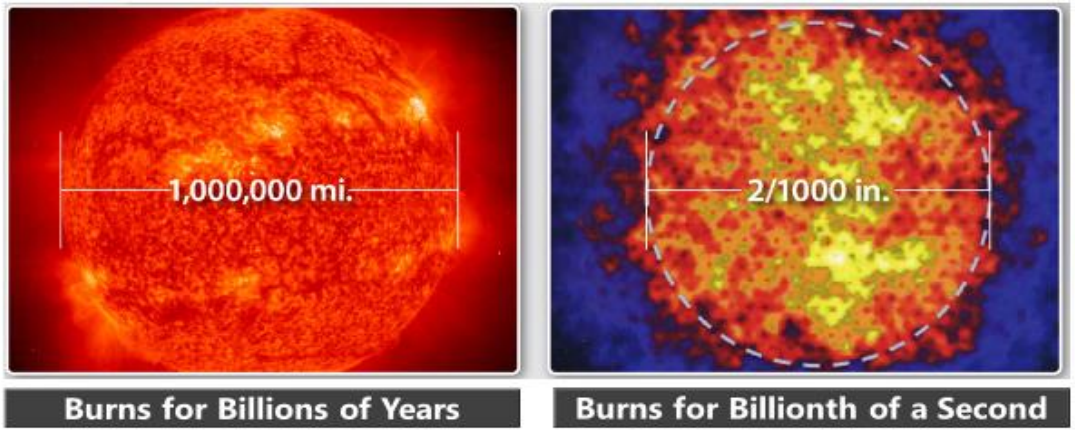
Creating a Miniature Sun

Building a miniature Sun on Earth



Use high-power lasers to create fusion –
releasing city-scale energy, safely and sustainably

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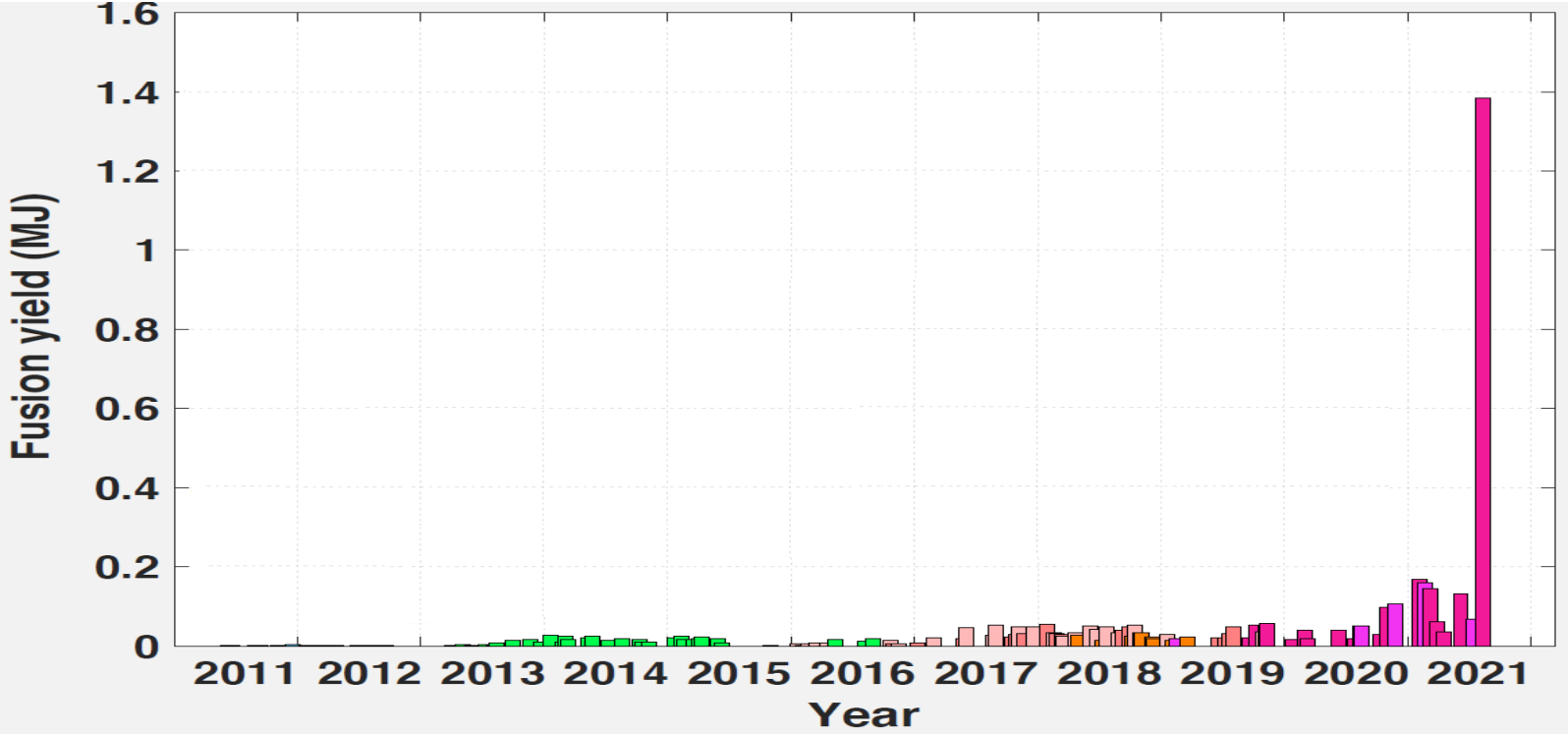
Persistence



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

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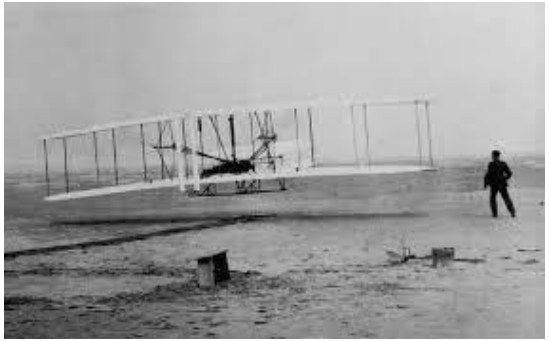
Wright Brothers and Alex Bell

- December 5, 2022
  - 2.05 MJ of laser energy delivered
  - 3.15 MJ of fusion energy generated
  - Scientific gain (Q) of 1.5
  - 300 MJ used by lasers for test
- Feb. 11, 2024
  - 2.2 MJ delivered
  - 5.2 MJ produced
  - Q of 2.4



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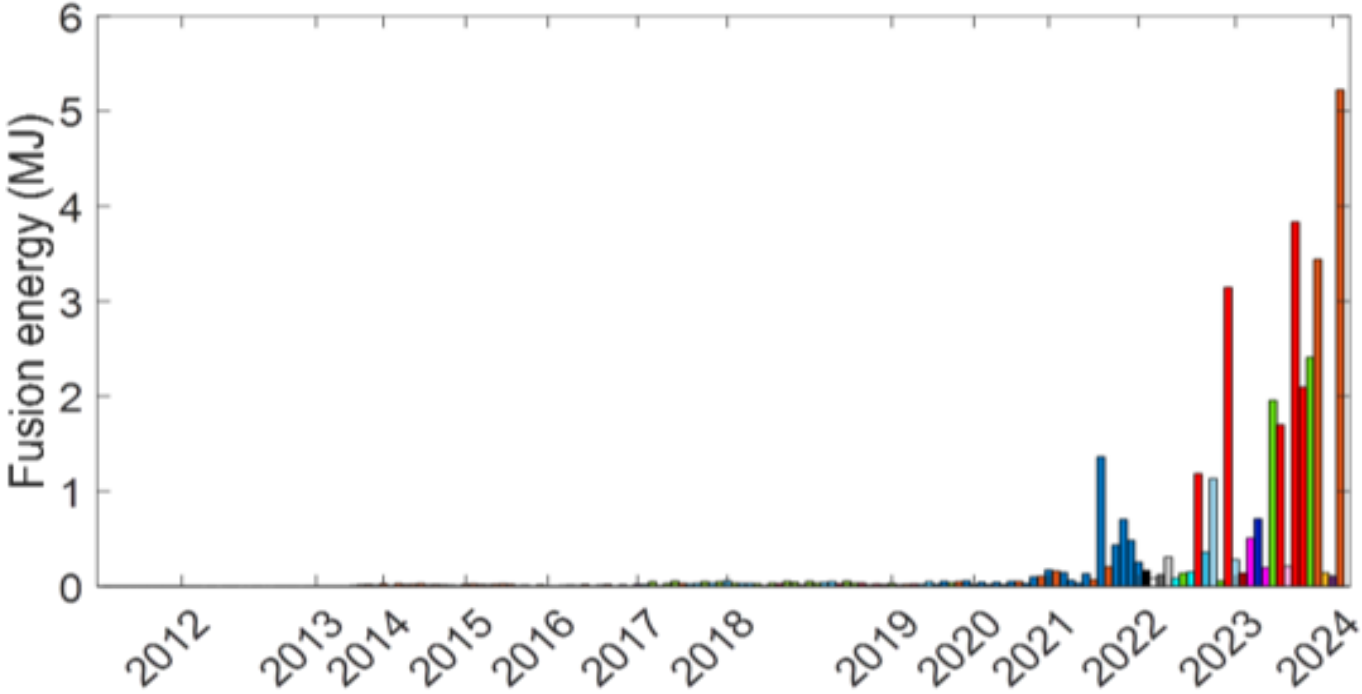
Persistence



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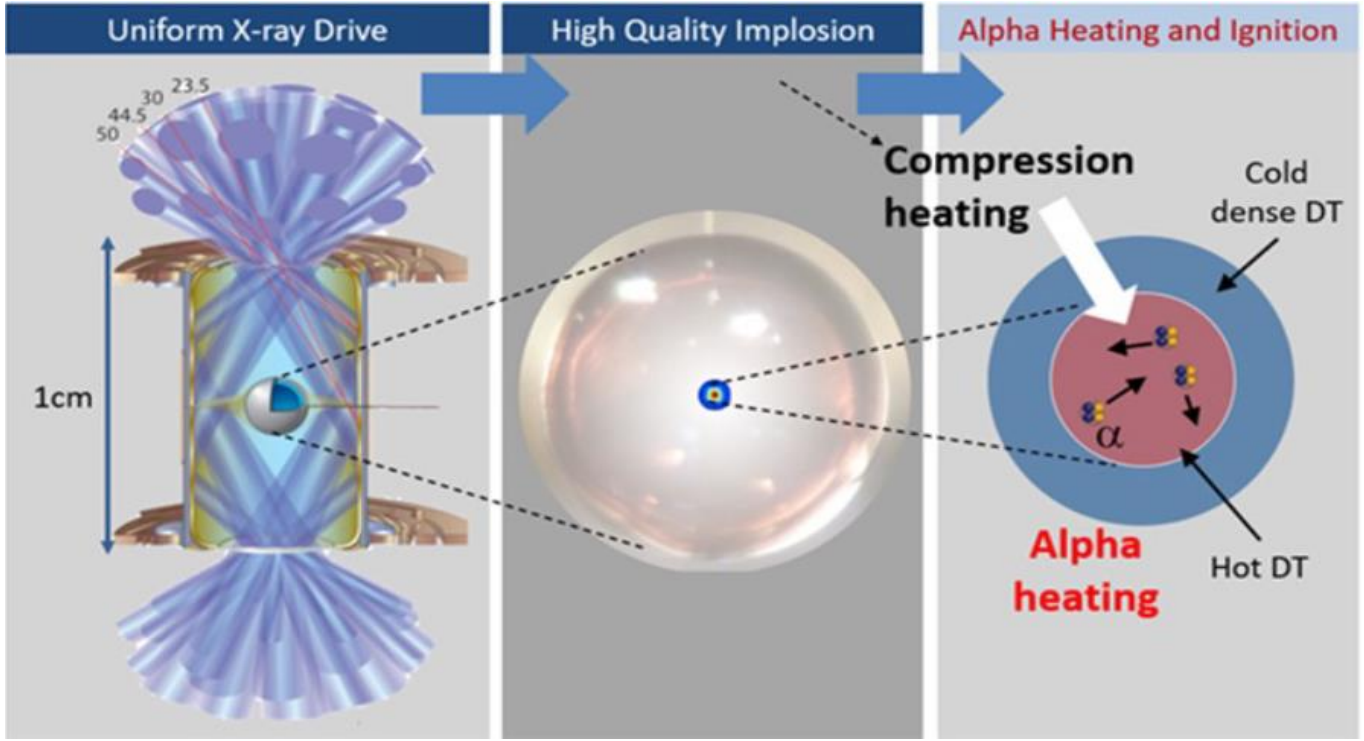
Pellet Implosion



The Age of Ignition, LLNL-BR-857901

Only Demonstrated Fusion Net Energy Technology

Laser fusion is the only fusion science and technology that has been demonstrated

Longview is the **only** fusion company based upon this proven energy gain

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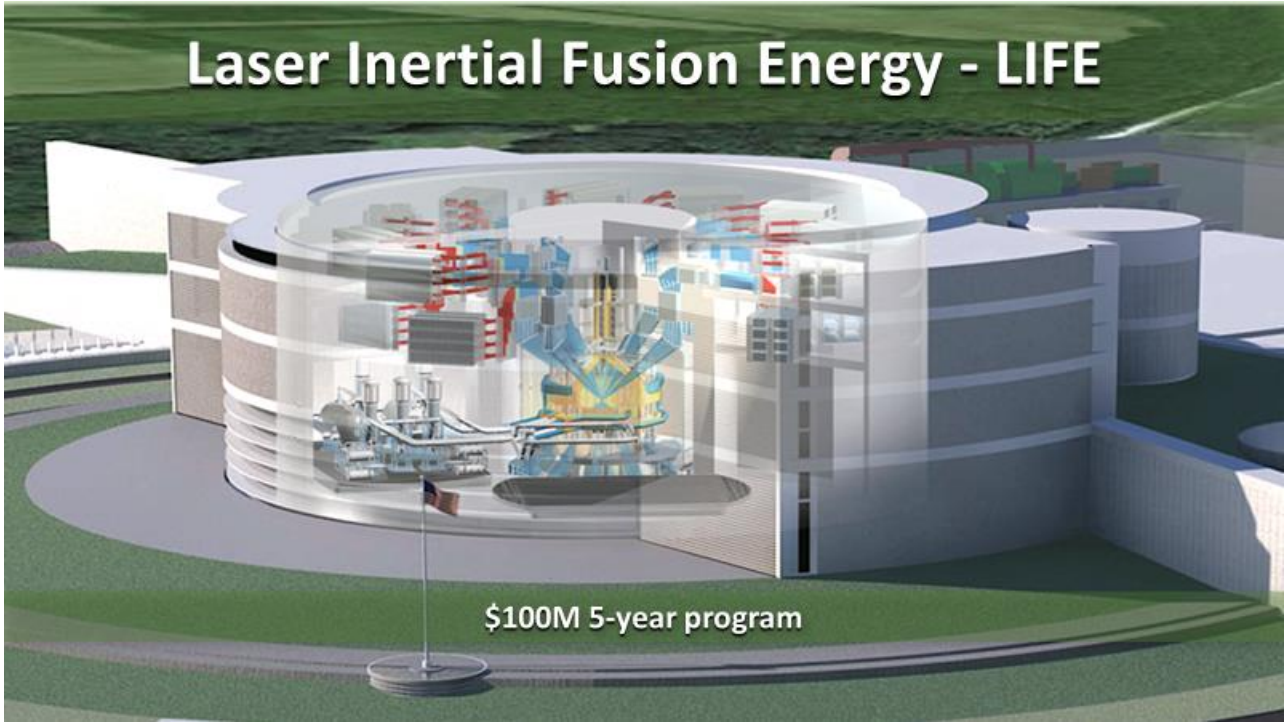
NIF to Power Plant



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Flashlamp Technology

By Science and Technology Review, LLNL - https://www.llnl.gov/str/September03/Moses.html, Public Domain, https://commons.wikimedia.org/w/index.php?curid=5976165

NIF Laser Bay

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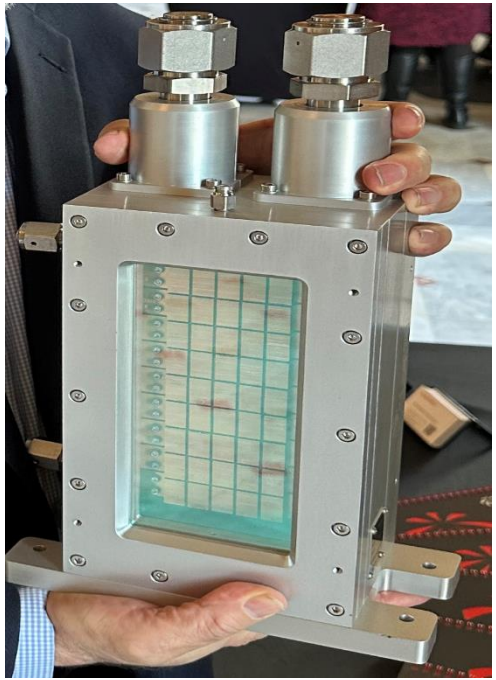
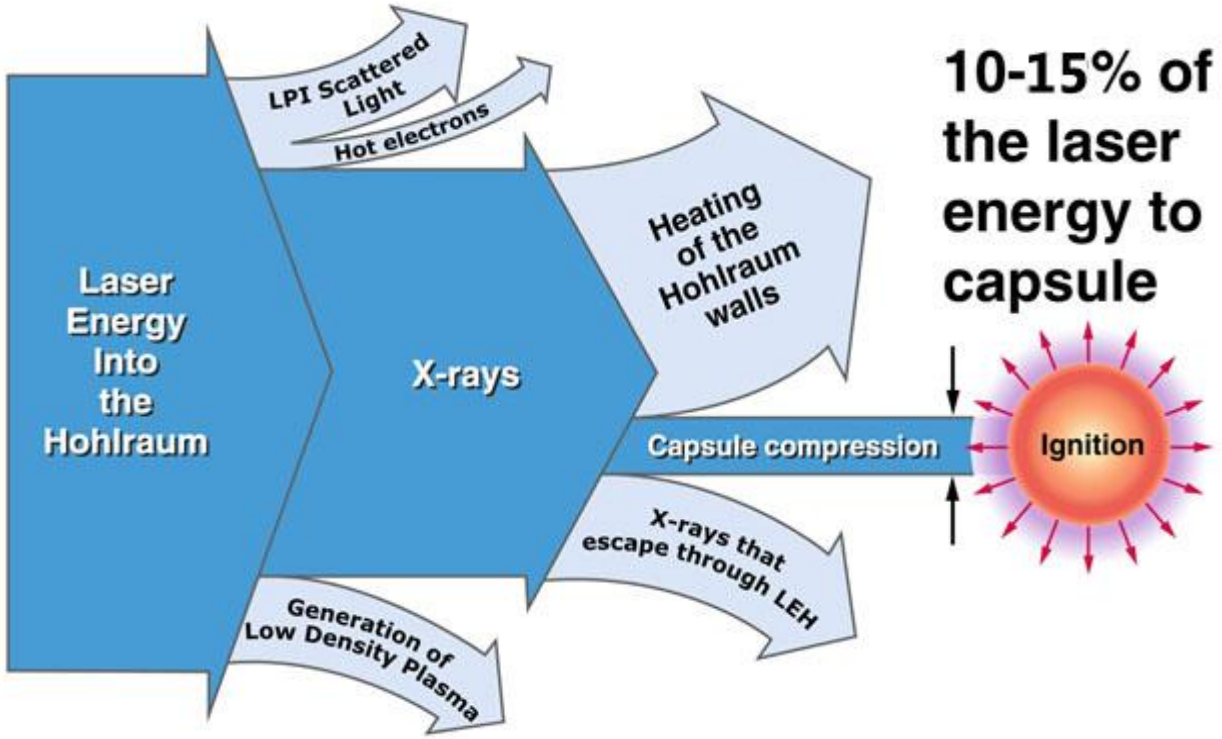
Diode Lasers

- Laser Diodes
  - 0.7% efficient → 10-20%
  - Once every 4 hrs → 10-15 Hz
  - These lasers exist now – need to drive cost down



Laser Energy to Target



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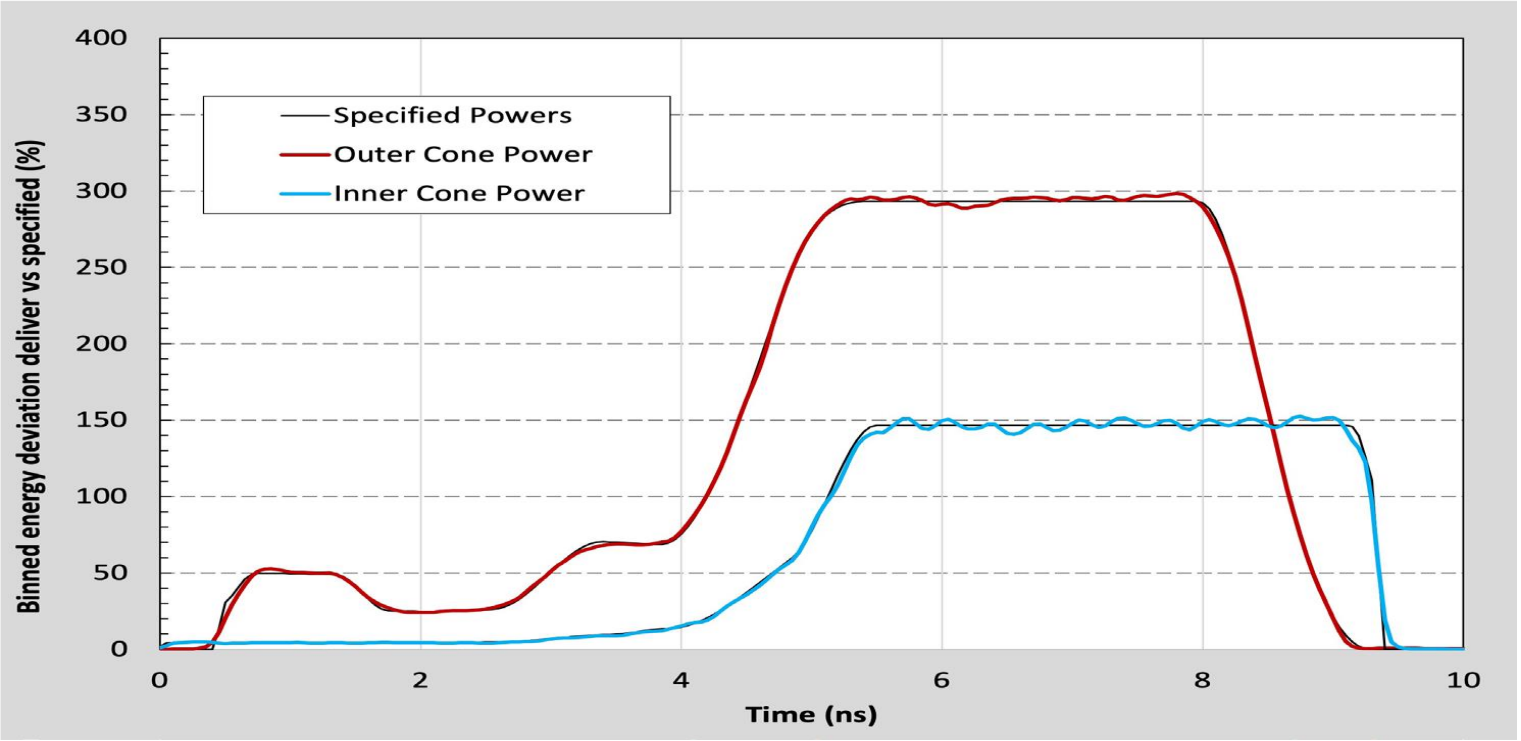
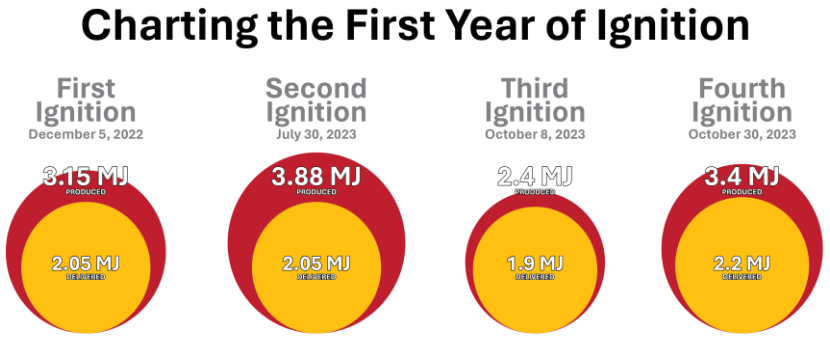
Laser Pulse



The Age of Ignition, LLNL-BR-857901

Continue to Increase Target Gain

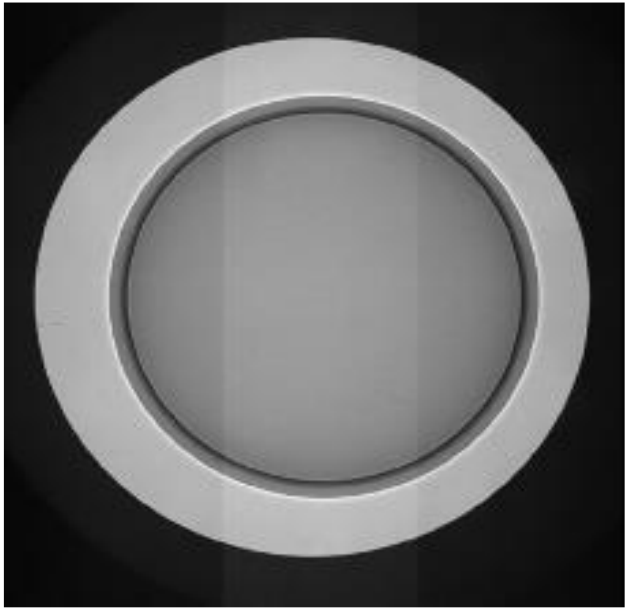
- Hohlraum design
- Capsule refinement
- Laser energy
- Capsule quality/uniformity



https://contenthub.llnl.gov/sites/contenthub/files/2023-11/P15603627_WO20181_NIF%26PS_ignition_updates_v6_nif-update.png

DT Fuel Cycle

- Targets
  - One per month → 10/sec
  - Additive manufacturing



The Age of Ignition, LLNL-BR-857901

DT Fuel Cycle

- Tritium handling
  - Breed T in Li blanket
  - Extract T from Li
  - Recycle tritium from fusion chamber
  - Capsule manufacture
- Target injection/tracking
  - 2-300 m/sec; >500 g acceleration
  - Tracking by light reflection
  - Protoypes have been developed

The Age of Ignition, LLNL-BR-857901

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Longview's First-to-Market strategy enables a Fleet of fusion power plants

Complete detailed plant design, licensing, IP, and supply chain development	2023 – 2029
Enable design, construction and delivery of a 440 MWe Fusion Pilot Power Plant	2028 - 2034
Worldwide fleet deployment of 1000 MWe+ Power Plants	2030 - 2050

- **Simplified regulatory pathway:** No risk of a nuclear accident, no criticality possible, no long-lived radioactive waste, non-proliferent technology
- **Cost-competitive** in terms of capital costs, O&M, and LCOE with existing sources of energy production
- **Maximizes use of readily available materials and technologies**, savings years of expensive R&D
- **Compact, highly modular, and grid-friendly** design enables rapid plant deployment, simple maintenance, and high availability operations

LFE Fusion Power Plant

- Power Plant Animation

End of the Beginning

"Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning."

Winston Churchill, Nov. 10, 1942