Inertial Fusion Energy and the National Ignition Facility

Oct. 11, 2022
SMUD Panel Discussion
with Board of Directors

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LLNL-PRES-XXXXXX
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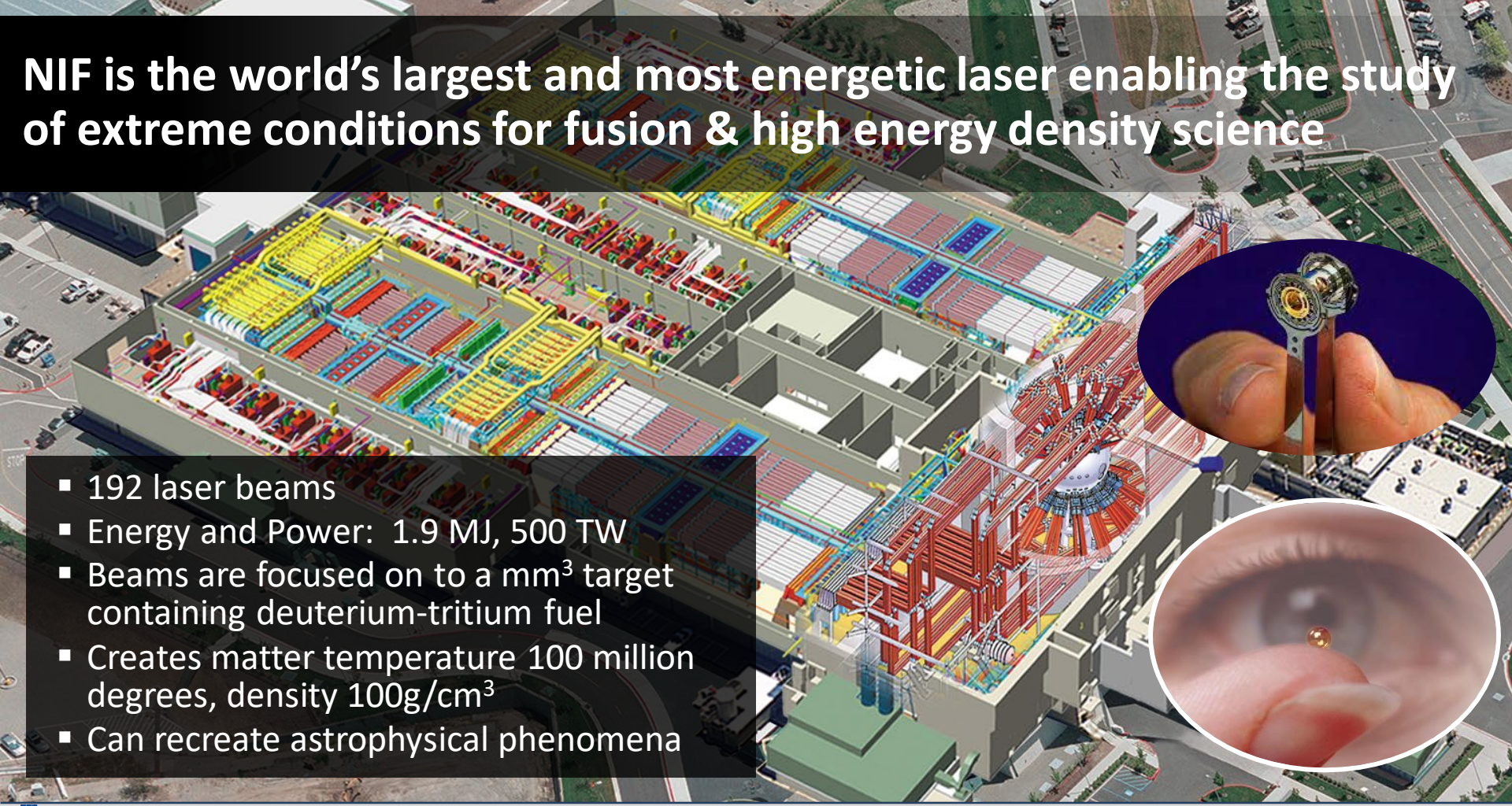
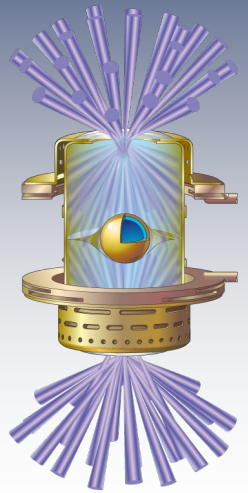
NIF is the world's largest and most energetic laser enabling the study of extreme conditions for fusion & high energy density science



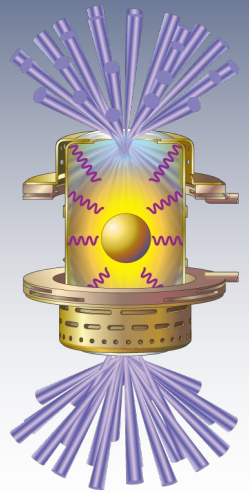
- 192 laser beams
- Energy and Power: 1.9 MJ, 500 TW
- Beams are focused on to a mm^3 target containing deuterium-tritium fuel
- Creates matter temperature 100 million degrees, density $100 g/cm^3$
- Can recreate astrophysical phenomena

The NIF uses a laser driven x-ray oven (hohlraum) to compress a fuel capsule to achieve the conditions for ignition

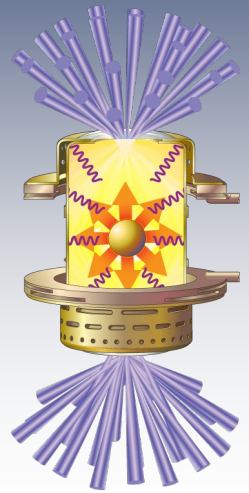
Each of the 192 laser beams are focused onto the inner wall of the hohlraum



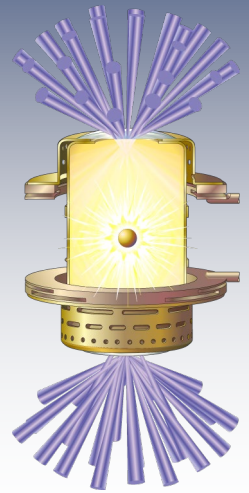
Laser beams rapidly heat the inside surface of the hohlraum creating x-rays



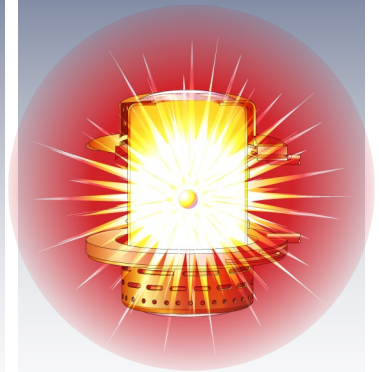
The x-rays blow off the fuel capsule wall, accelerating the fuel inward to 1 million MPH



The fuel core reaches 100 times the density of lead and ignites at 100,000,000°C

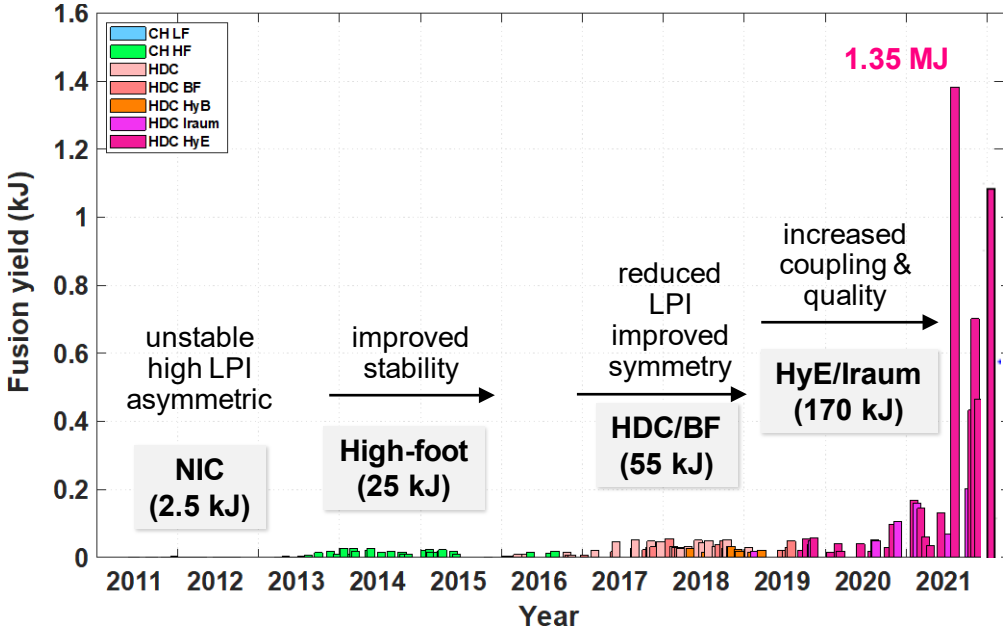


Fusion burn spreads rapidly through the compressed fuel, yielding many times the input energy



Achieving ignition in the laboratory is a scientific grand challenge 60 years in the making

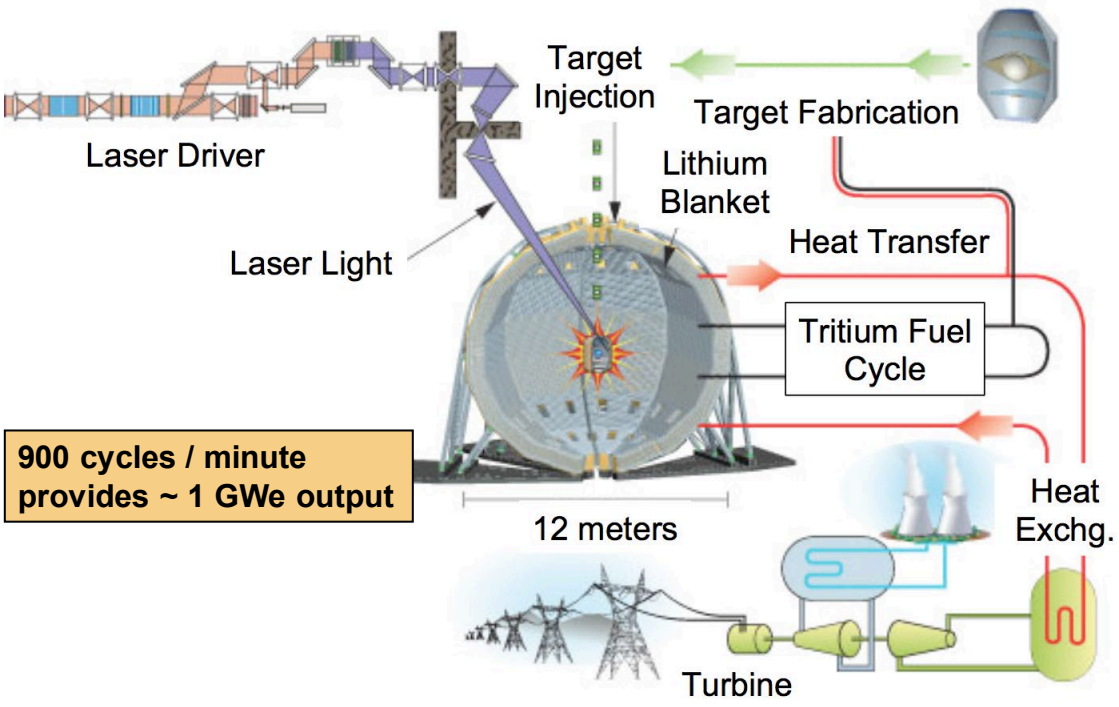
Last August, a shot on the NIF achieved 1.35 MJ of fusion energy; 70% of laser input



- Progress was slow but steady for a decade
- Then in August of 2021, there was a 25x improvement from 2020
- Attempts to repeat have shown that target quality is the limiting factor
- Better targets are expected in December that could push beyond gain = 1; a small increase in laser energy on 9/19 resulted in an experiment with 1.15 MJ of fusion
- Gain of 10 to 100 is needed for energy production

Abu-Shawareb *et al.*, *PRL* **129**, 075001 (2022)

The concept for an inertial fusion power plant includes a driver, target chamber, target factory, and a steam turbine to generate electricity



The challenges are many:

- Ignition and fusion energy gain
- Fuel system delivery and cost
- Lifetime of the fusion chamber and optics
- Safety and licensing
  - Tritium and any activated materials
- High availability plant operations

But the benefits are great:

- Carbon-free
- Ability to meet baseload
- Can be generated near population centers
- Attractive development path (many potential spin-out technologies)

We are holding a virtual Industry Day Oct. 27 to facilitate Public-Private Partnerships in inertial fusion energy R&D

INERTIAL FUSION ENERGY Collaboratory

Lawrence Livermore National Laboratory

UR LLE

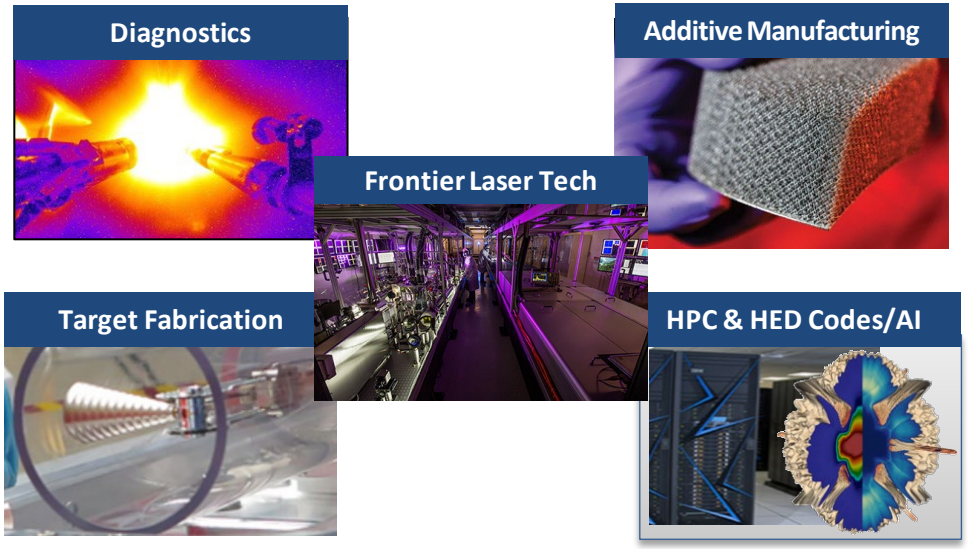
Sandia National Laboratories

GENERAL ATOMICS

Los Alamos NATIONAL LABORATORY

BERKELEY LAB

SLAC NATIONAL ACCELERATOR LABORATORY



The national labs will provide details about their capabilities, and discussions will be held on potential areas of collaboration / tech-transfer

https://events.bizzabo.com/RFI-IFE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