Status of the National Ignition Facility

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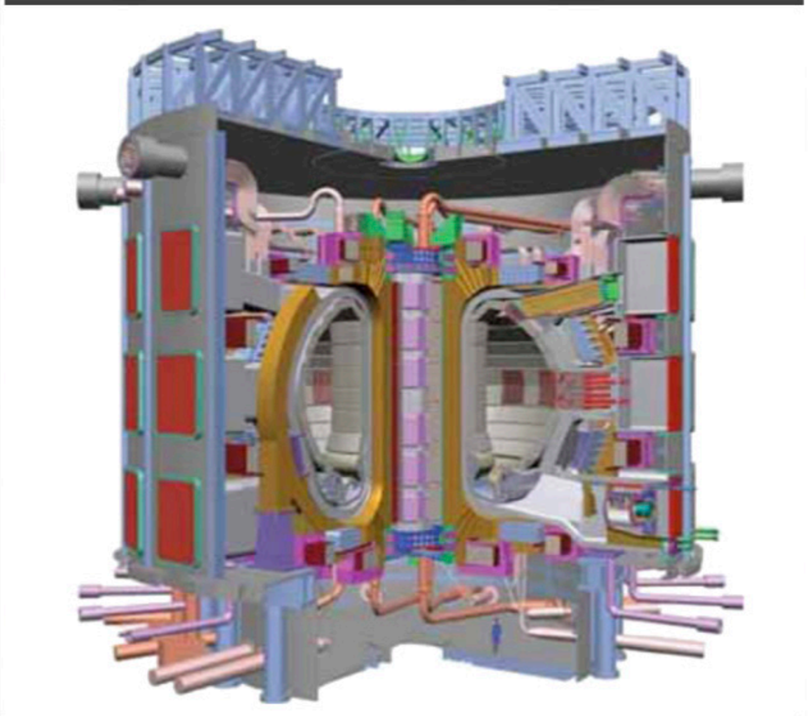
There are two major approaches for fusion energy

Magnetic Fusion Energy (1951)



First plasma 2018

$$Q = \frac{P_{fusion}}{P_{external}} \sim 10$$

Inertial Fusion Energy (1960)

First DT ignition campaign 2010

$$G = \frac{E_{fusion}}{E_{laser}} \sim 10\text{–}20$$

Challenges include making it safe, reliable, and cost effective

The National Ignition Facility is nearing completion and will be conducting full physics ignition experimental campaign in 2010

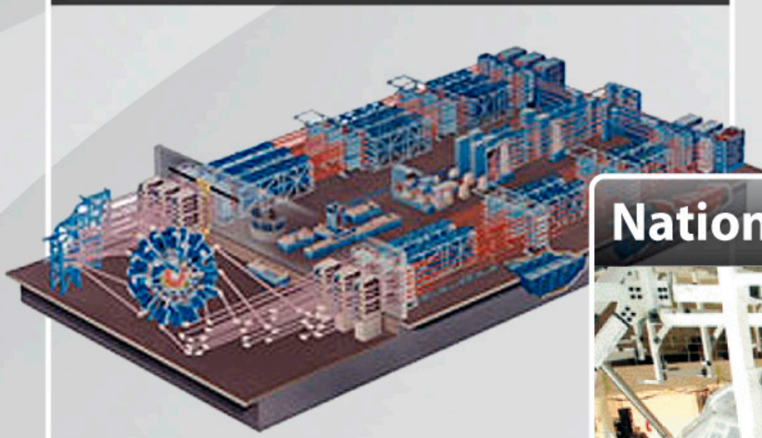

Achieving ignition at the National Ignition Facility can be a defining moment for the world's energy future
We are developing "LIFE," a fusion / fission hybrid approach for power generation

NIF is 99% complete and 4 months from completion

This will be the largest scientific construction project successfully completed by DOE

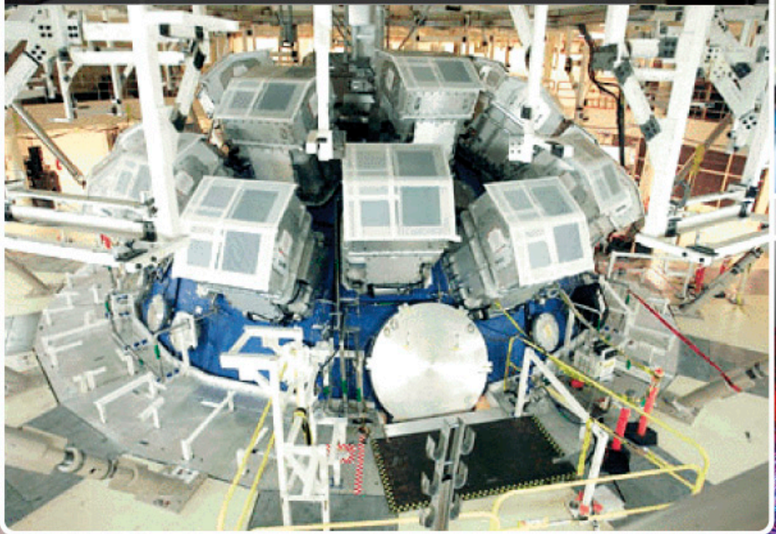
World's leading HED facilities will enable this emerging field to flourish

Omega, OMEGA EP Lasers

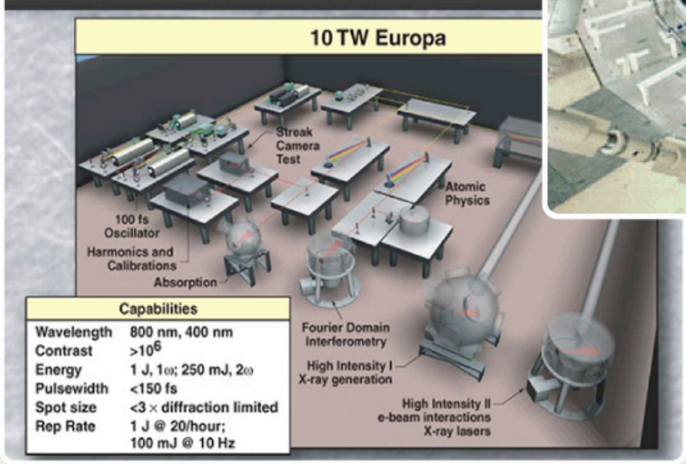


Trident Laser

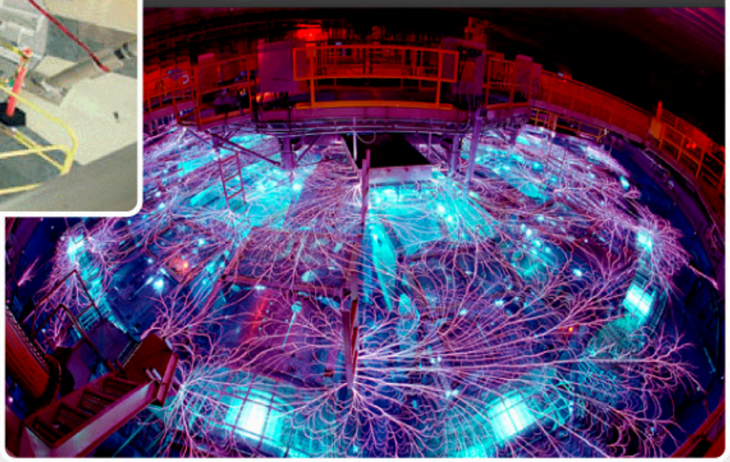
National Ignition Facility Laser



Jupiter Laser Facility



Z, ZR Z-Pinch Facility

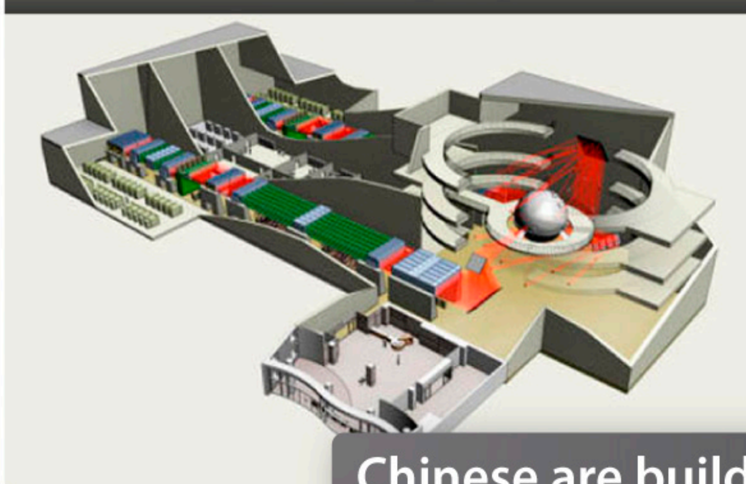


Next generation of large-scale HED facilities are being developed worldwide

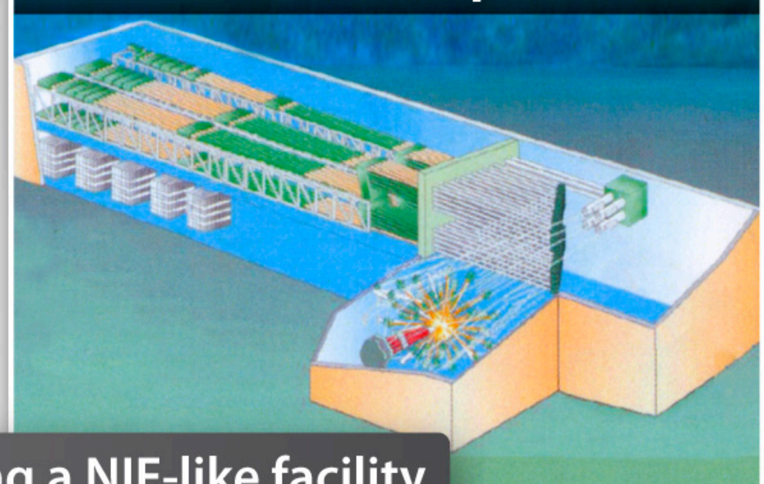
LMJ (France)

ORION (UK)

HiPER (EU)



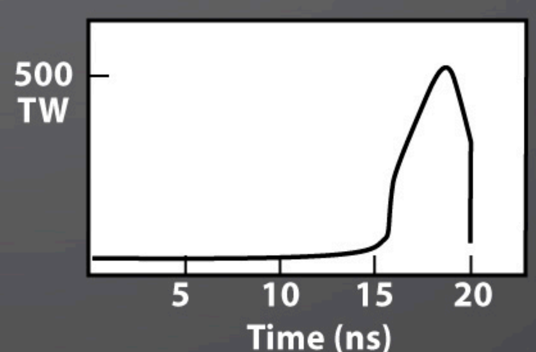
FIREX II (Japan)

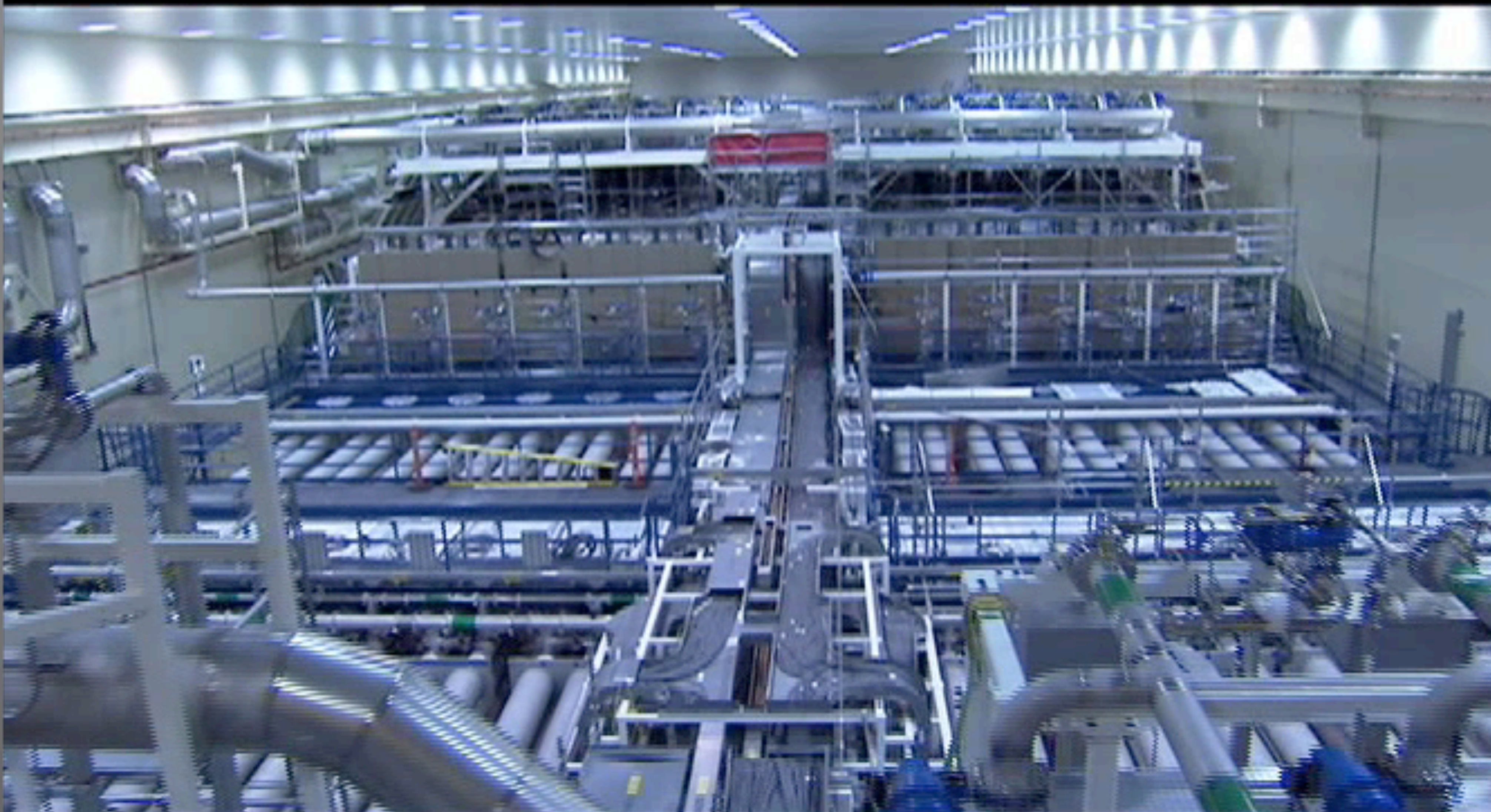


Chinese are building a NIF-like facility

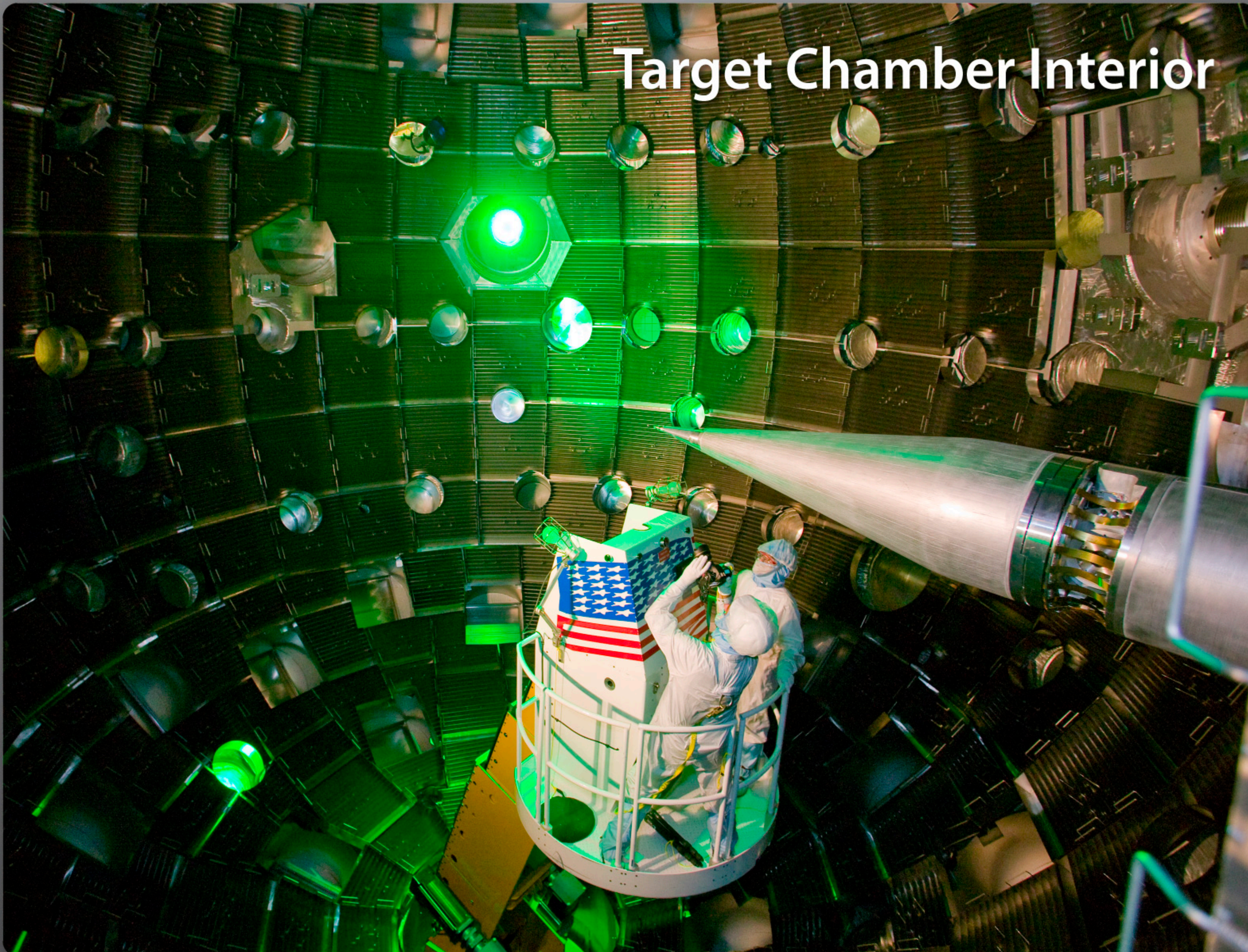
NIF Laser System

- 192 Beams
- Frequency tripled Nd glass
- Energy 1.8 MJ
- Power 500 TW
- Wavelength 351 nm





Target Chamber Interior




LEAD
OPERATOR

192 Main Laser Beams Operationally Qualified September 24, 2008

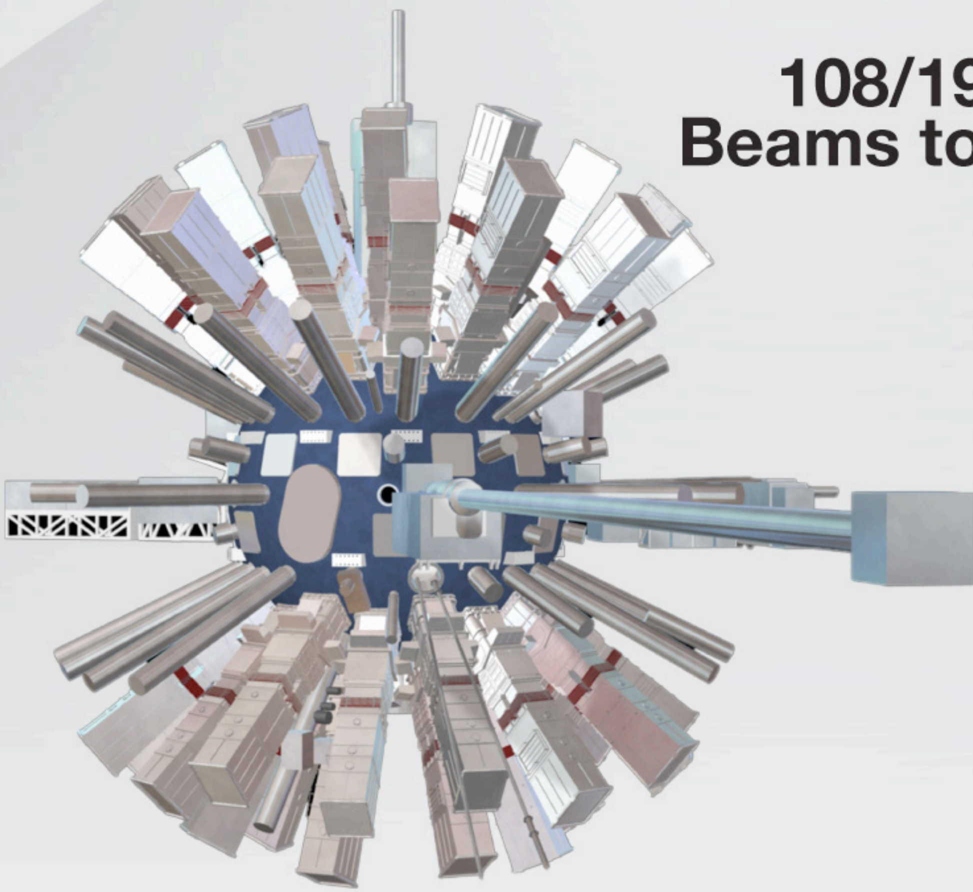
World's Highest Energy Laser – 4.2 MJ 1ω

Target chamber center status

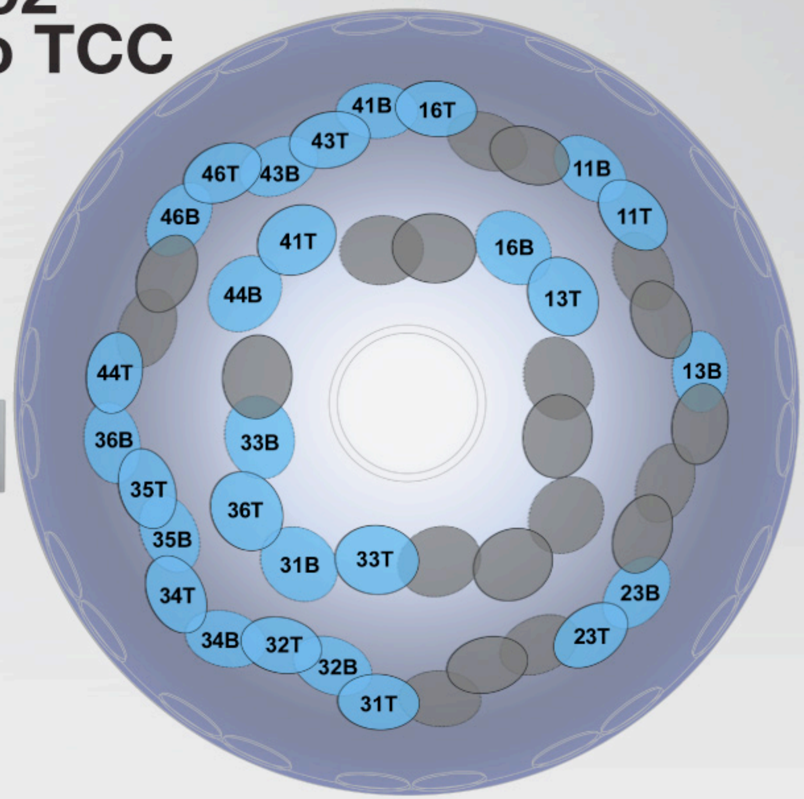
- 166 optical beams installed
- 108 beams aligned to Target Chamber Center (TCC)
- 20 beams OQ'd at 143 kJ
- 8 beams PQ'd at 78 kJ
- 1 beam 1.8 MJ Full NIF equivalent at PDS and TCC

3ω Commissioning in Target bay

108/192 Beams to TCC



52% Overall 3ω Commissioning
(ultraviolet laser light)



189 kJ 3ω Energy

The goal of NIC is thermo-nuclear burn in the laboratory with a credible campaign in 2010

2010
National Ignition Campaign

NNSA
National Nuclear Security Administration

General Atomics

UR LLE

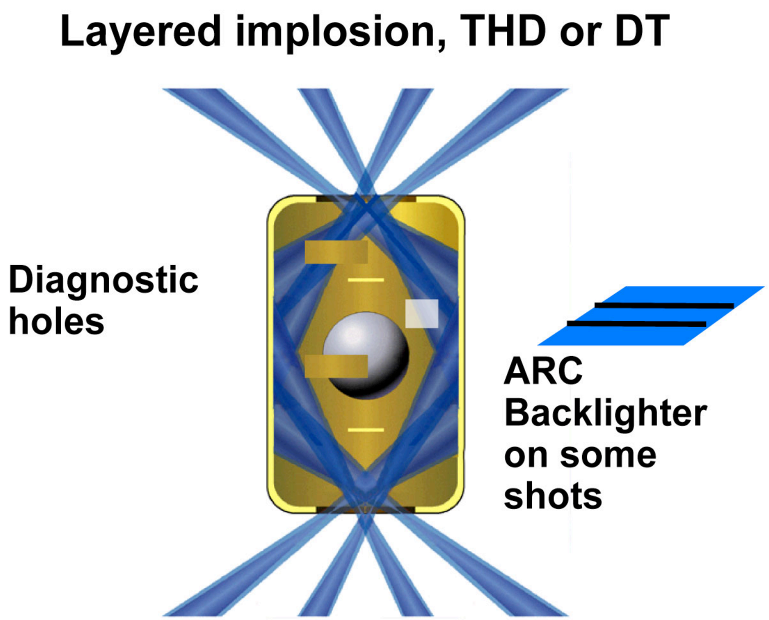
Lawrence Livermore National Laboratory

Los Alamos National Laboratory

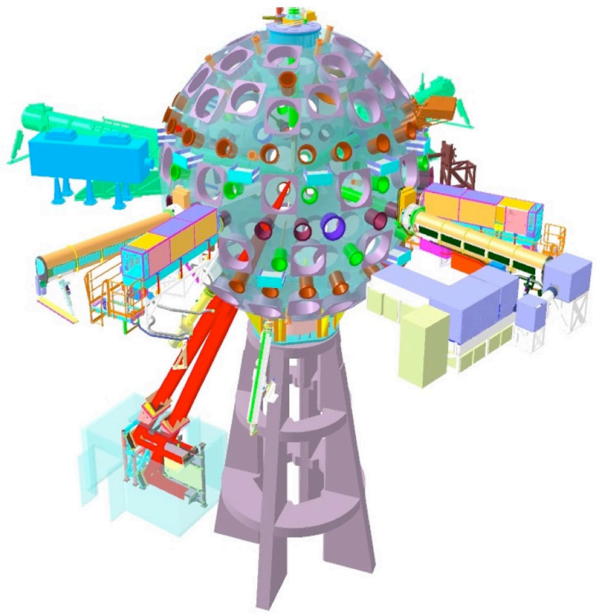
Sandia National Laboratories

National Ignition Campaign goals

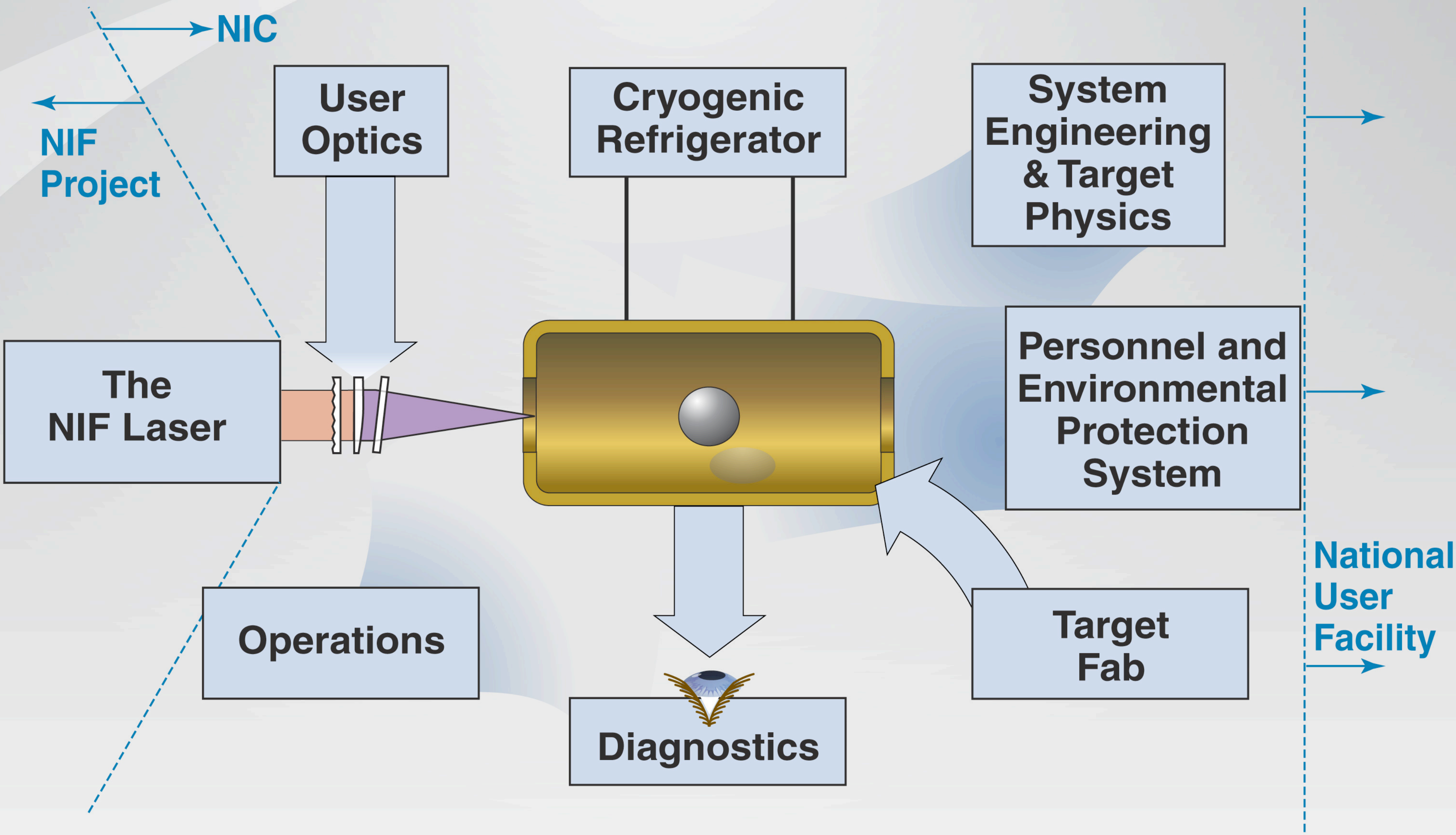
Execute a credible ignition campaign starting in FY2010 with the goal of demonstrating at least 1MJ fusion energy



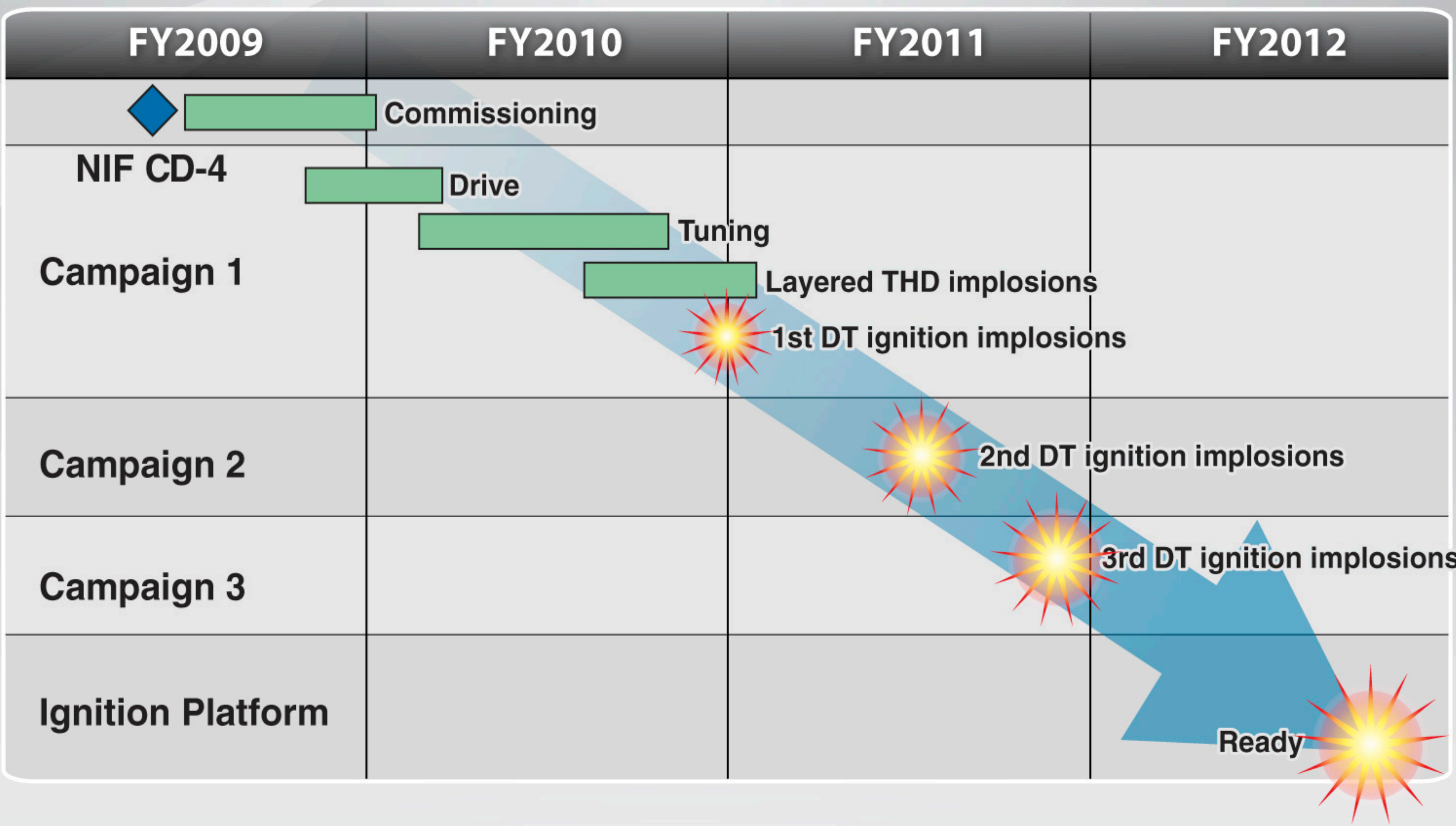
Demonstrate a reliable and repeatable ignition platform for use in stockpile stewardship experiments by 4Q FY2012



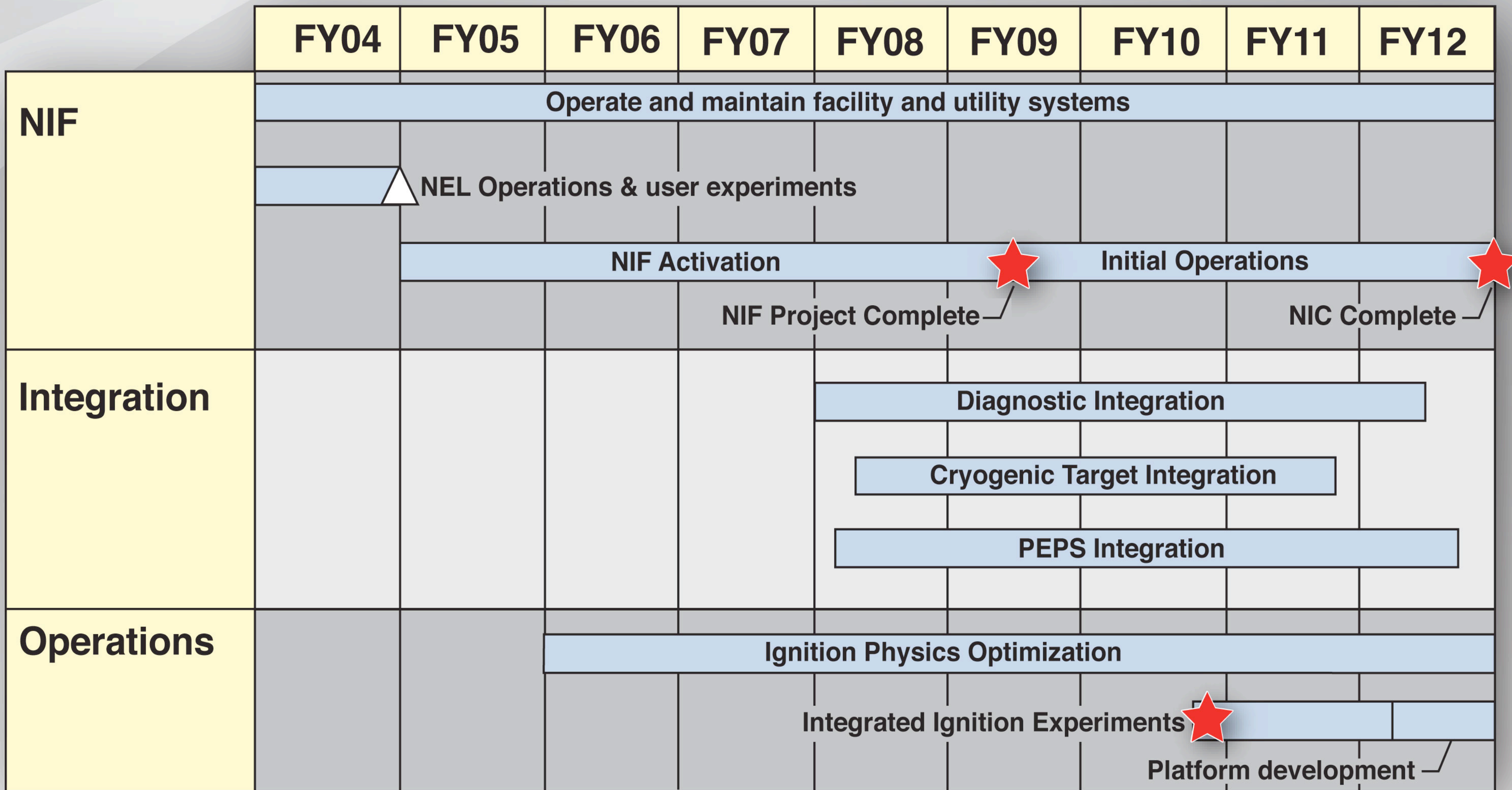
Major elements of the NIF Project and the National Ignition Campaign (FY07 – FY12 Q1)



NIF will execute four major ignition campaigns in the next four years



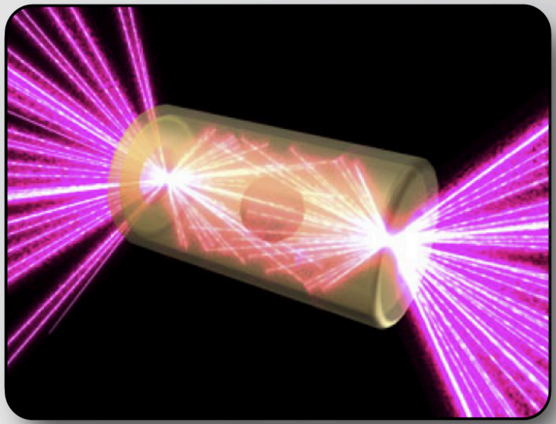
NIF Project and Ignition Campaign Integration Schedule

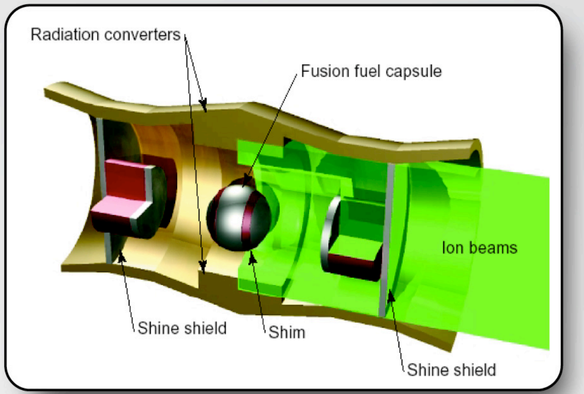


OFES funded target physics efforts have contributed directly to the science that we will derive from NIF ignitiond

The following are examples of discoveries:

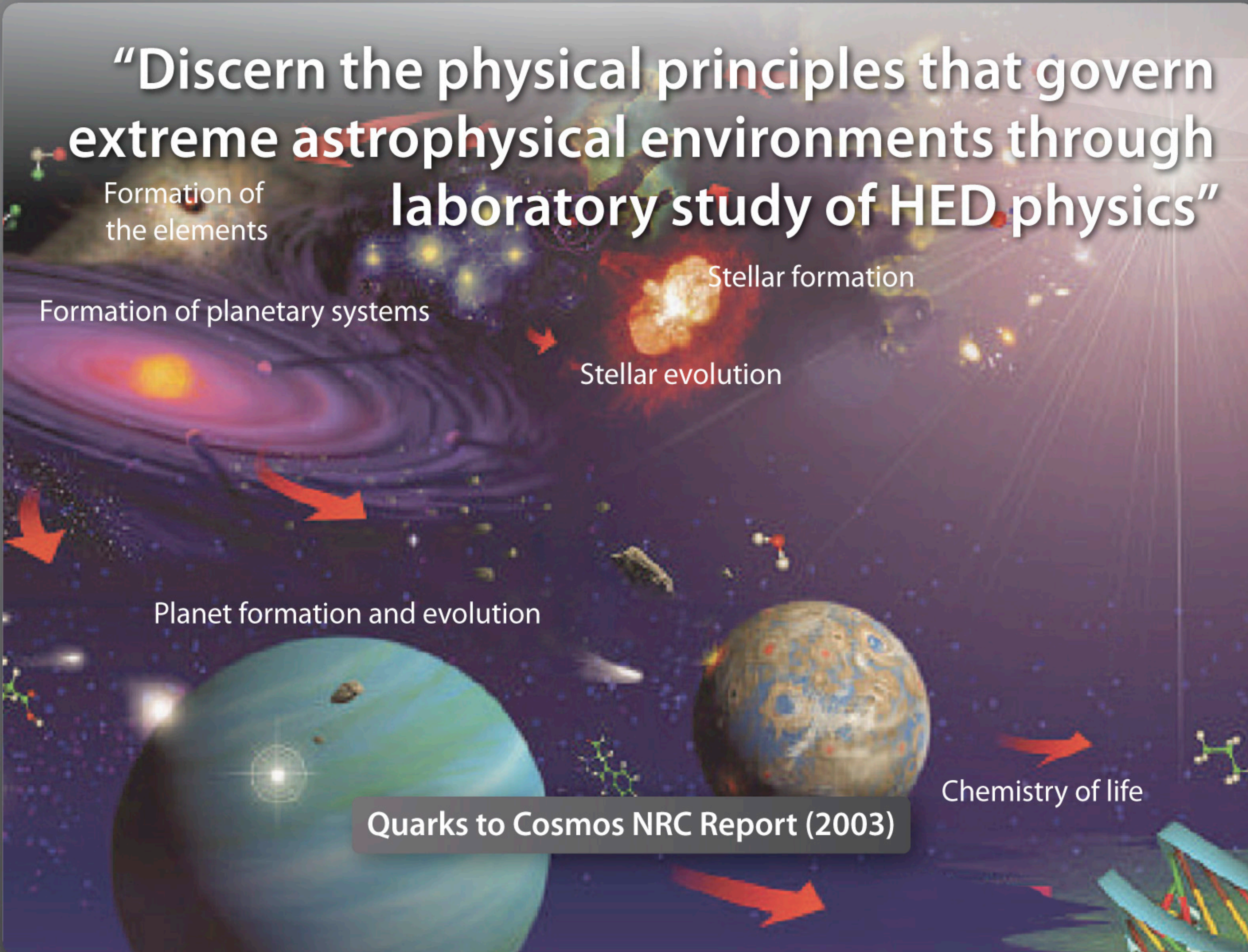
- Identified minimum kinetic energy required for ignition vs. drive pressure, adiabat, and implosion velocity.
- Studied robustness of targets w.r.t. Rayleigh-Taylor & implosion velocity.
- Designed and fielded capsules (with SNLA and GA) that have increased robustness to asymmetries.
- Developed HIF targets for IFE
  - — Proposed radiation shine shields to improve radiation symmetry in hohlraums.
  - — Proposed use of low density materials in hohlraum walls to reduce hydrodynamic losses.





NIC is the bridge from NIF to routine operations of a highly flexible HED science facility

“Discern the physical principles that govern extreme astrophysical environments through laboratory study of HED physics”



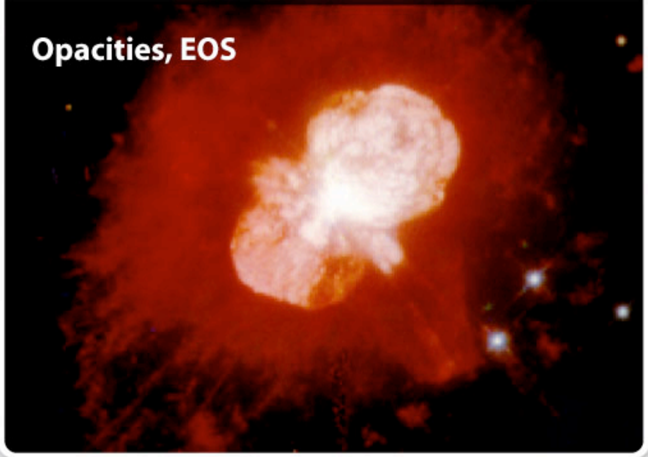
Quarks to Cosmos NRC Report (2003)

NIF provides unprecedented scientific environments for laboratory astrophysics experiments

NIF Scientific Environment	Astrophysical Environment
Extreme temperatures and densities: • T >10^8 K matter temperature • ρ >10^3 g/cc density	• Those are both 7x what the *Sun* does? • Helium burning, stage 2 in stellar evolution, occurs at 2×10^8 K!
Neutron-rich environment: • $\rho n = 10^{22}$ neutrons/cc	• Core-collapse Supernovea, colliding neutron stars, operate at ~10^{20}!
Pressure: • Exceeding 10^{11} bar	• Only need ~Mbar in shocked hydrogen to study the EOS in Jupiter & Saturn
Type Ia Supernovae environment	• Electron degenerate conditions • Rayleigh-Taylor instabilities for (continued) laboratory study

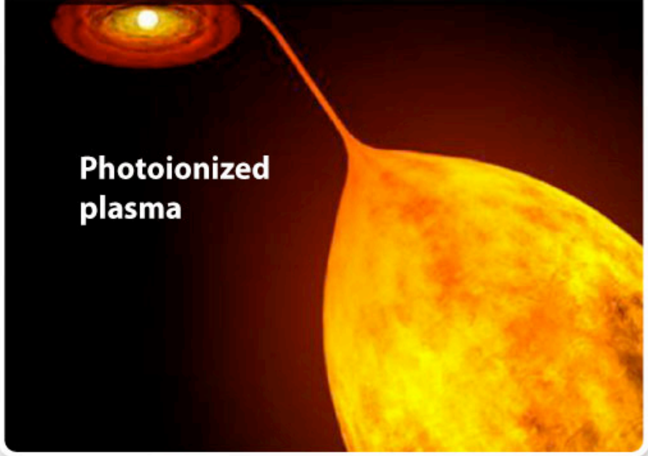
Experiments on NIF can address key physics questions throughout the staellar life cycle

Stellar life

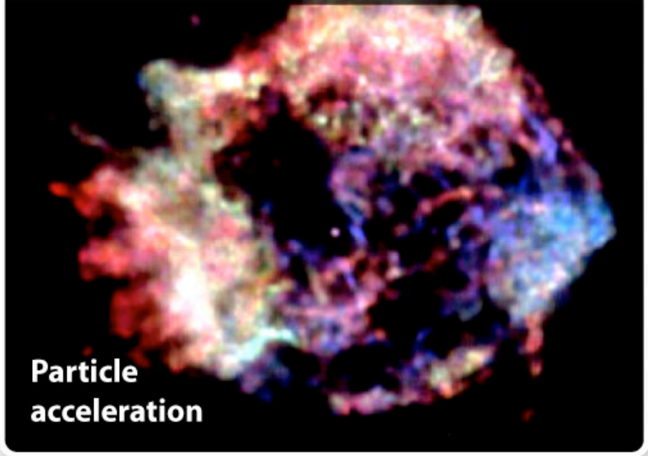


Stellar death

Stellar post-mortem



Supernova shocks



NIF will be a premier international center for experimental science

13EIM/bc • NIF-1108-15624r3

IFSA 2009


IFSA2009 San Francisco, California
The Sixth International Conference on Inertial Fusion Sciences & Applications
September 6 – 11, 2009
Inertial Fusion Sciences • High Energy Density Physics
Pulsed Power • Particle Beam-Matter Interaction
Grand Challenges for the Future
Keynote Speakers
Plenary Sessions
Oral Sessions
Poster Sessions
Industrial Exhibits
Companion Program
On-line registration and abstract submission available on December 15, 2008
Abstract submission deadline is March 1, 2009
Papers will be published on-line
Edward Teller Medal Nominations start on November 4, 2008
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