

Status of the National Ignition Campaign and the NIF Integrated Computer Control System



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The National Ignition Facility is now operational



This is the largest scientific construction project successfully completed by DOE

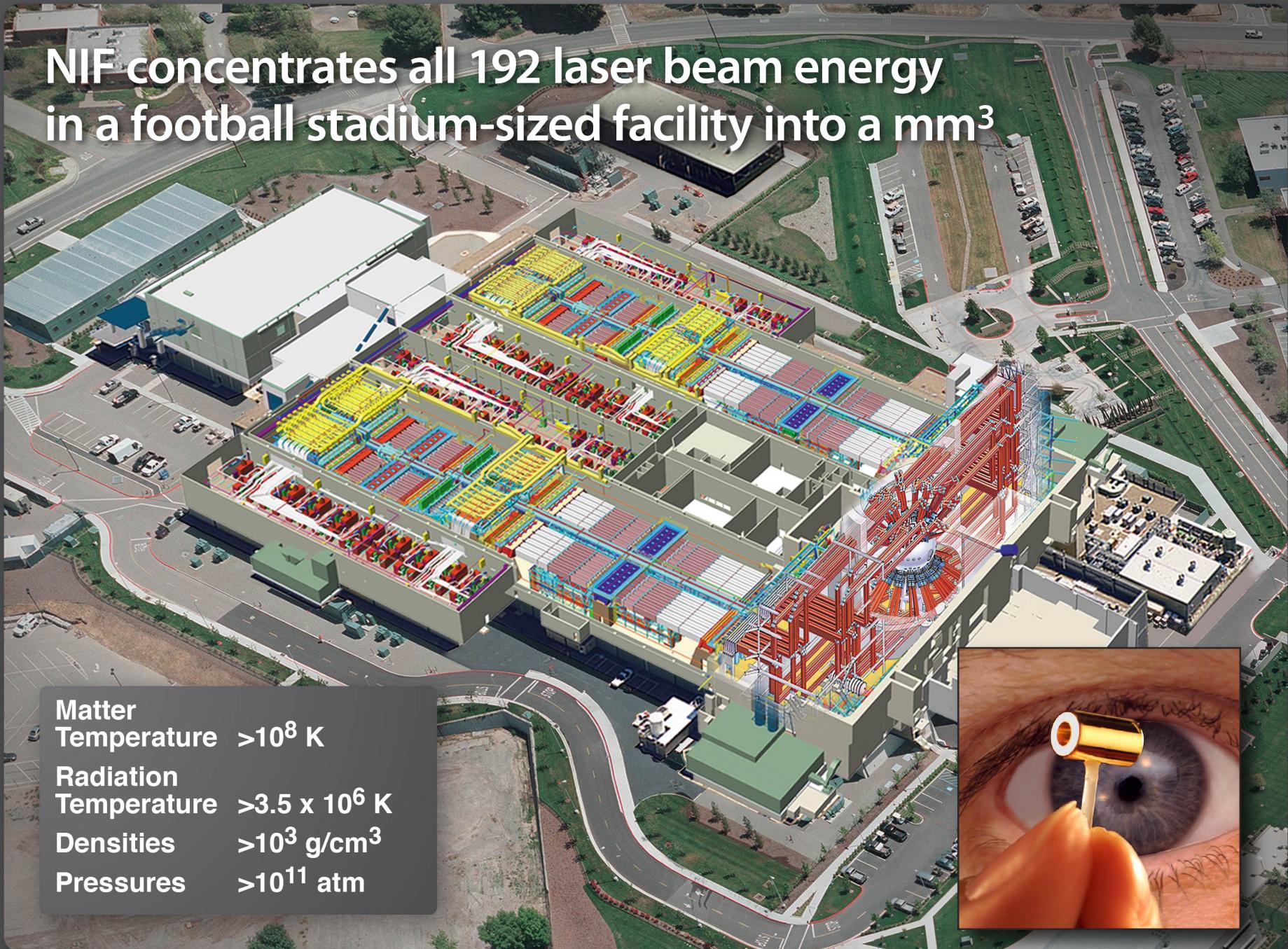


San Francisco
(45 miles)

LLNL

National Ignition Facility

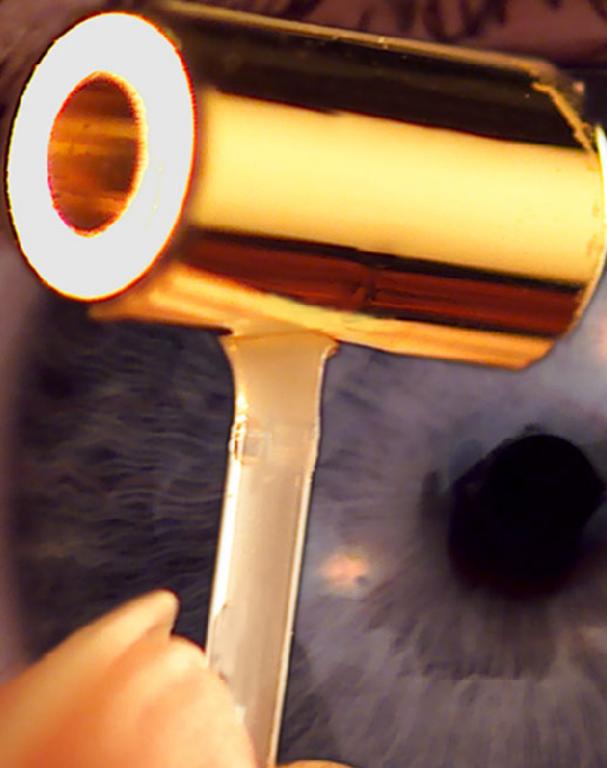
NIF concentrates all 192 laser beam energy in a football stadium-sized facility into a mm³



Matter
Temperature >10⁸ K

Radiation
Temperature >3.5 x 10⁶ K
Densities >10³ g/cm³
Pressures >10¹¹ atm

Ignition target





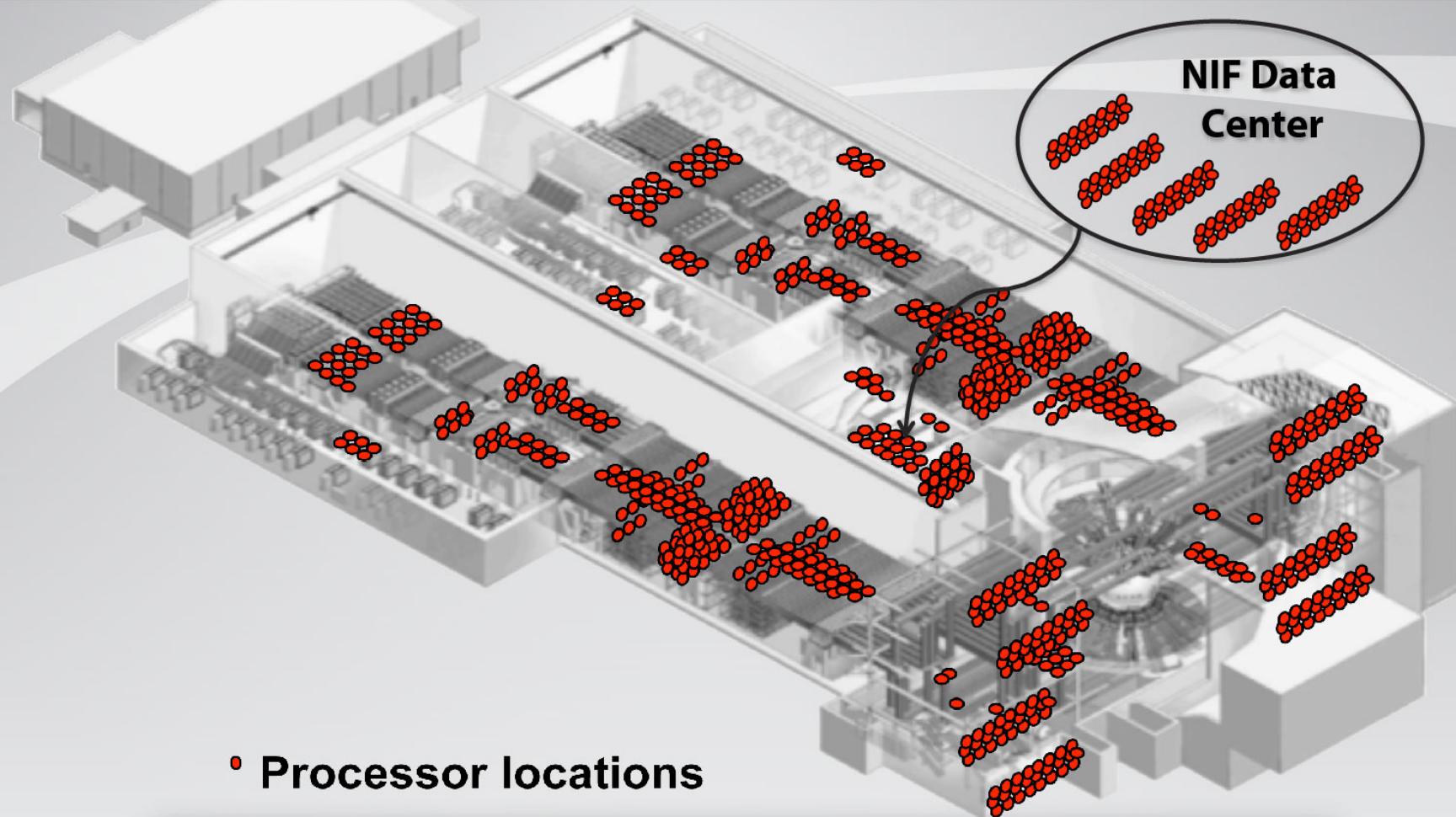
Integrated Computer Control System (ICCS) provides safe, reliable and highly automated 24x7 operation of NIF

- Control 60,000 points using
 - 1,500 processes
 - 1,800 computers
 - 4 M Source Lines of Code
- Align and fire 192 lasers
 - <50 microns on target
 - <30 psec timing
- Automatic shot controls
 - <4-hours shot-to-shot
 - 24x7 Hands-off operation using <12 operators
 - Conducted over 2,500 system shots
- Assure
 - Substantial machine safety

Automatic control of 192-beam shots are overseen by 16 operator stations



ICCS consists of 2.7 million lines of software running on 1,800 distributed computers throughout NIF



- Processor locations

Controls 60,000 actuators, triggers, cameras, digitizers, pulse power and a variety of digital & analog I/O

High level of controls automation enables control room to be staffed by a dozen people



Model-based automated shot control in routine use
for commissioning and laser performance tests

ICCS addressed key challenges to provide an efficient, robust, long-lasting control system

Key Challenges	Solutions
Fire laser shots in 4-hour cycles	Automated shots with model-based shot control software
Trigger all laser systems and diagnostics to 20 ps anywhere in NIF	Developed flexible timing technology over fiber-optics with industrial partners
Develop and deploy new software while supporting 24/7 operational demands	New requirements value and cost metrics Staff appropriately for operational support
Assure machine protection	Incorporated redundant critical device verification

NIF/NIC Strategy: 2009-2012

Completed NIF Project



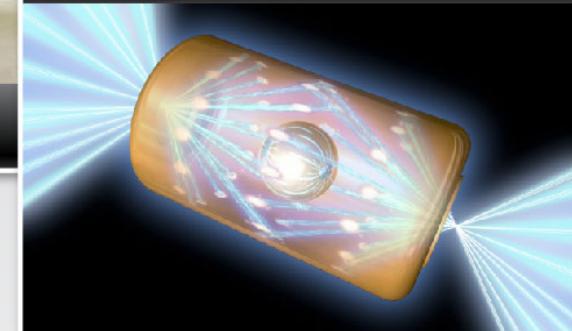
2009

Preparation for Ignition



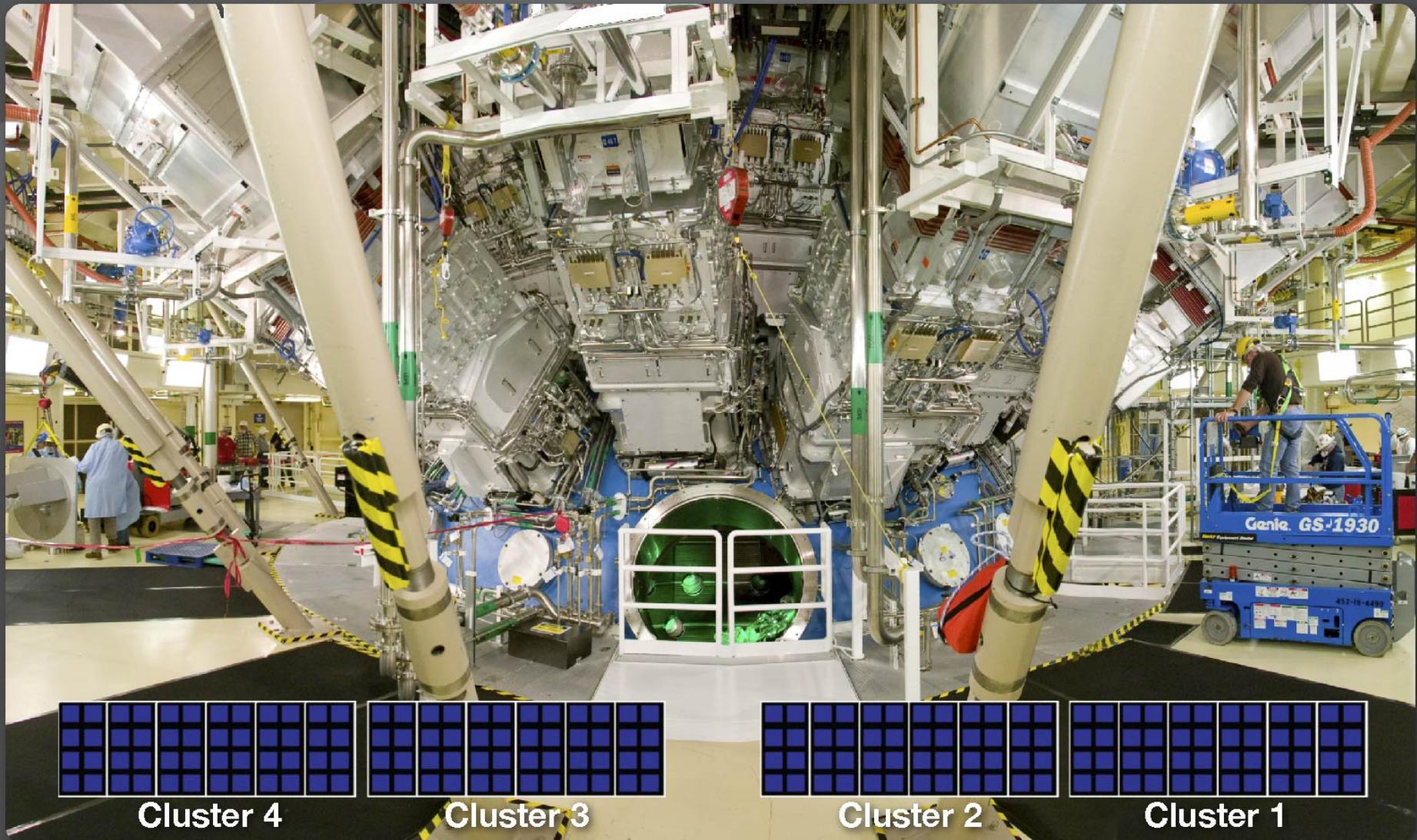
2009–2011

Ignition Experiments



2009–2012

NIF is the World's first Mega-Joule Facility – 1.4 MJ 3ω

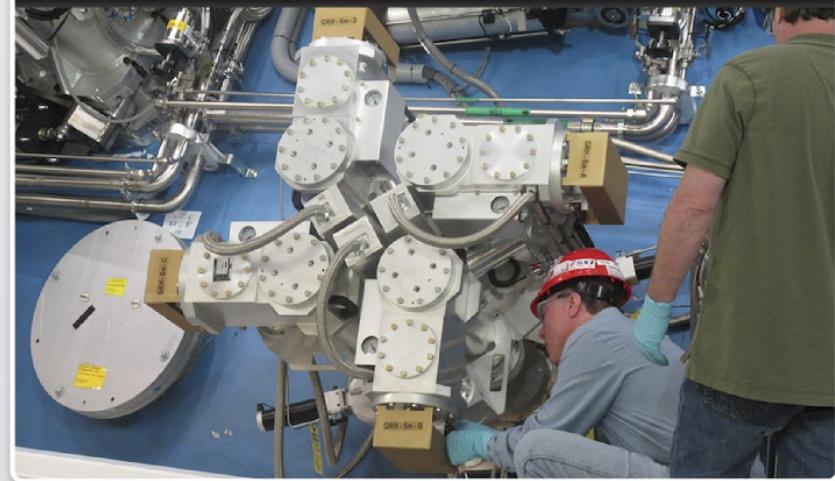


Growing NIF diagnostic capabilities

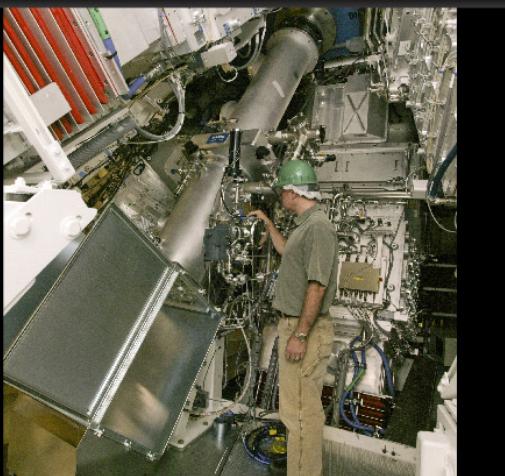
Hot Electron diagnostic



Gamma Reaction History diagnostic



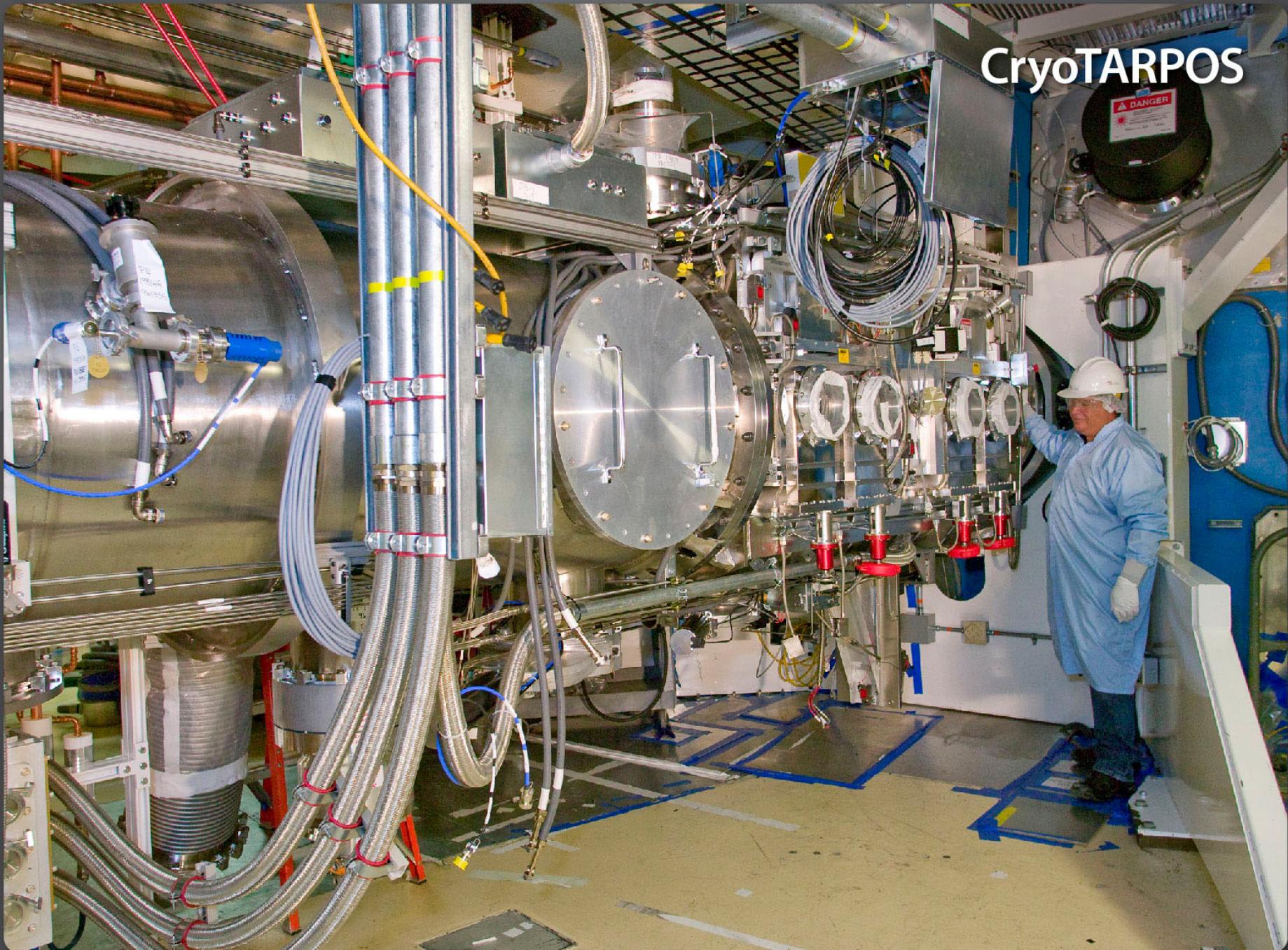
Dante 1



Magnetic Recoil Spectrometer



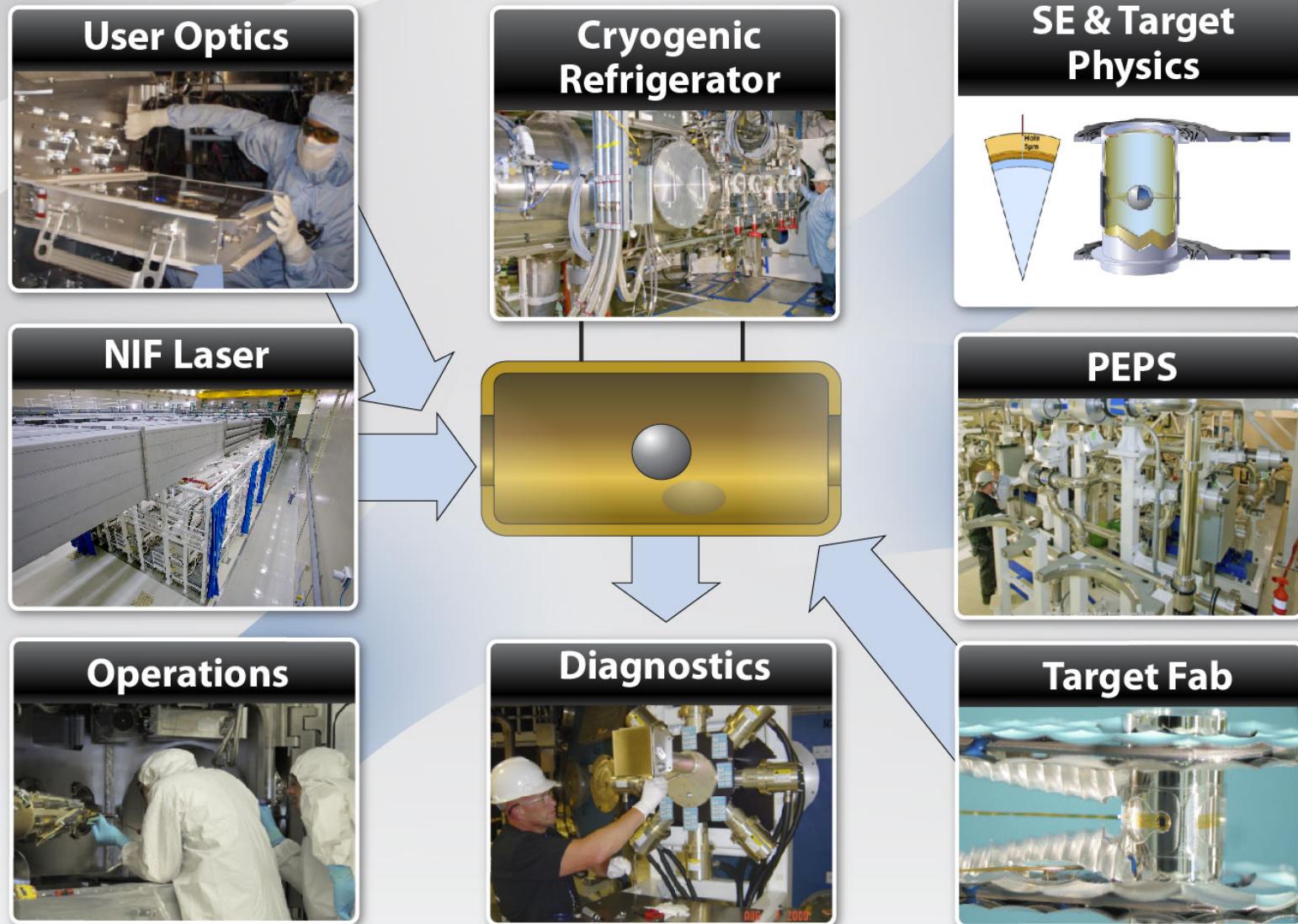
CryoTARPOS



Tritium Processing



All the elements are in place for “integrated ignition experiments”



NIF/NIC Strategy: 2009-2012

Completed NIF Project



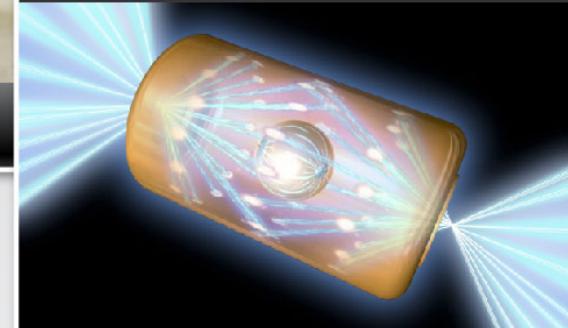
2009

Preparation for Ignition



2009–2011

Ignition Experiments



2009–2012

NIC partners

NATIONAL IGNITION CAMPAIGN



cea

NSTec



Duke
UNIVERSITY

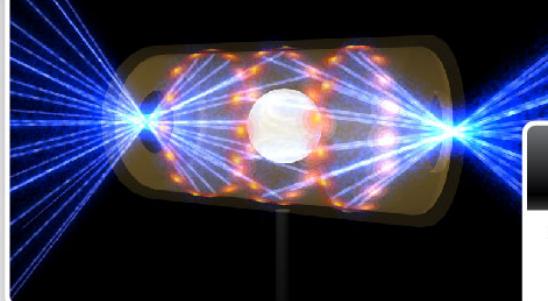


Four steps to ignition

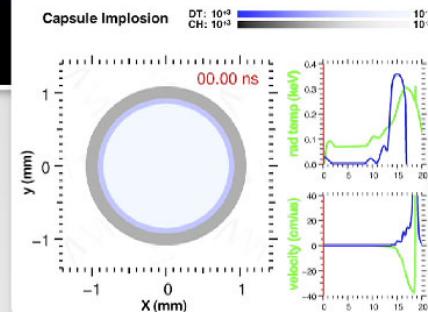
Commission laser



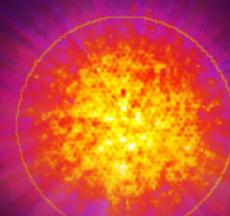
Commission hohlraum



Commission capsule

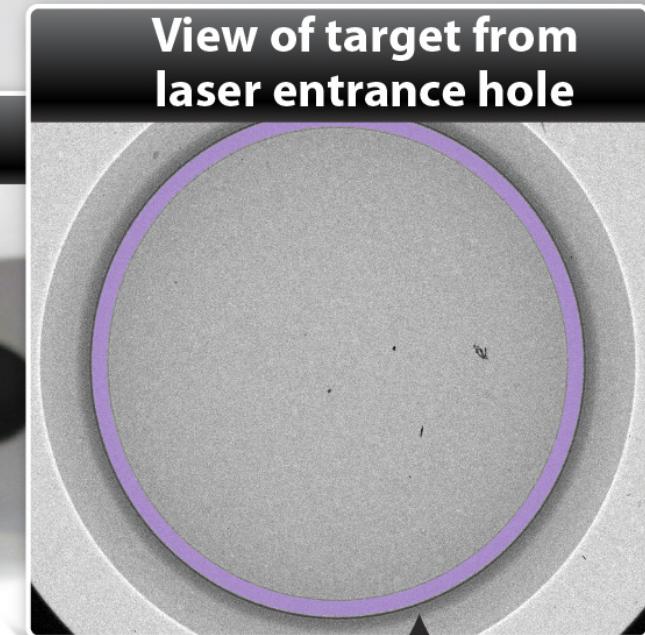


Commission layered target implosions

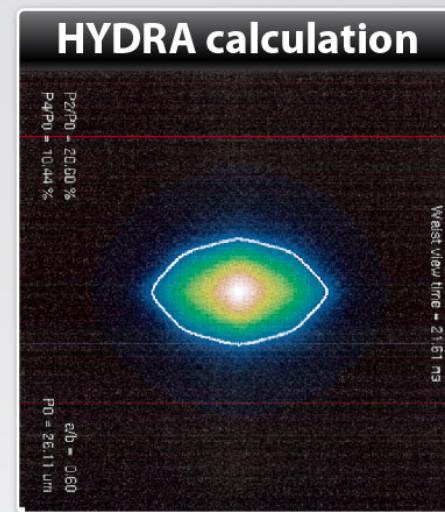
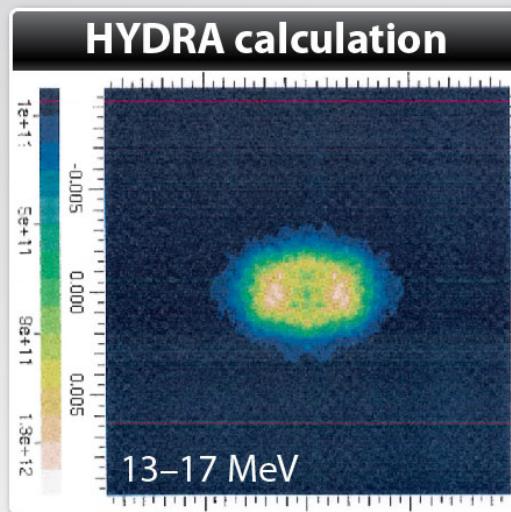
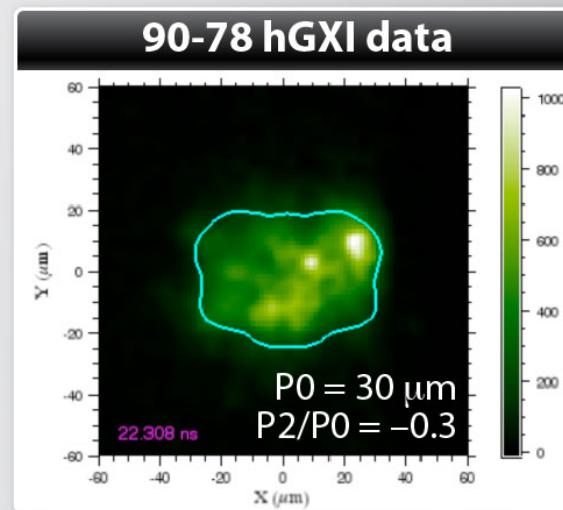
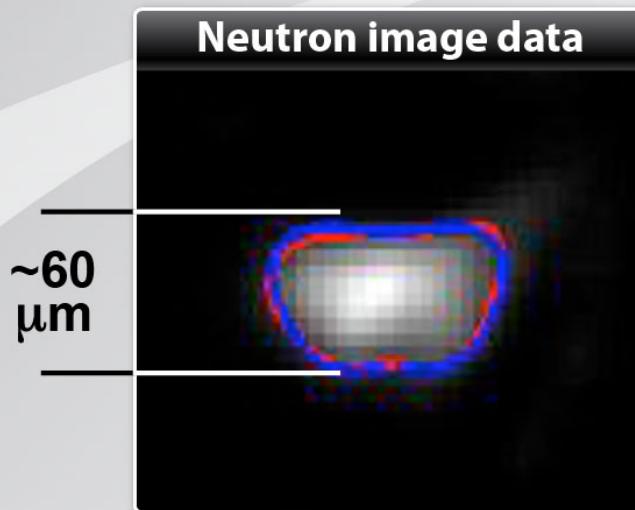


We are taking a systematic approach to learning and improving our engineering design to achieve ignition

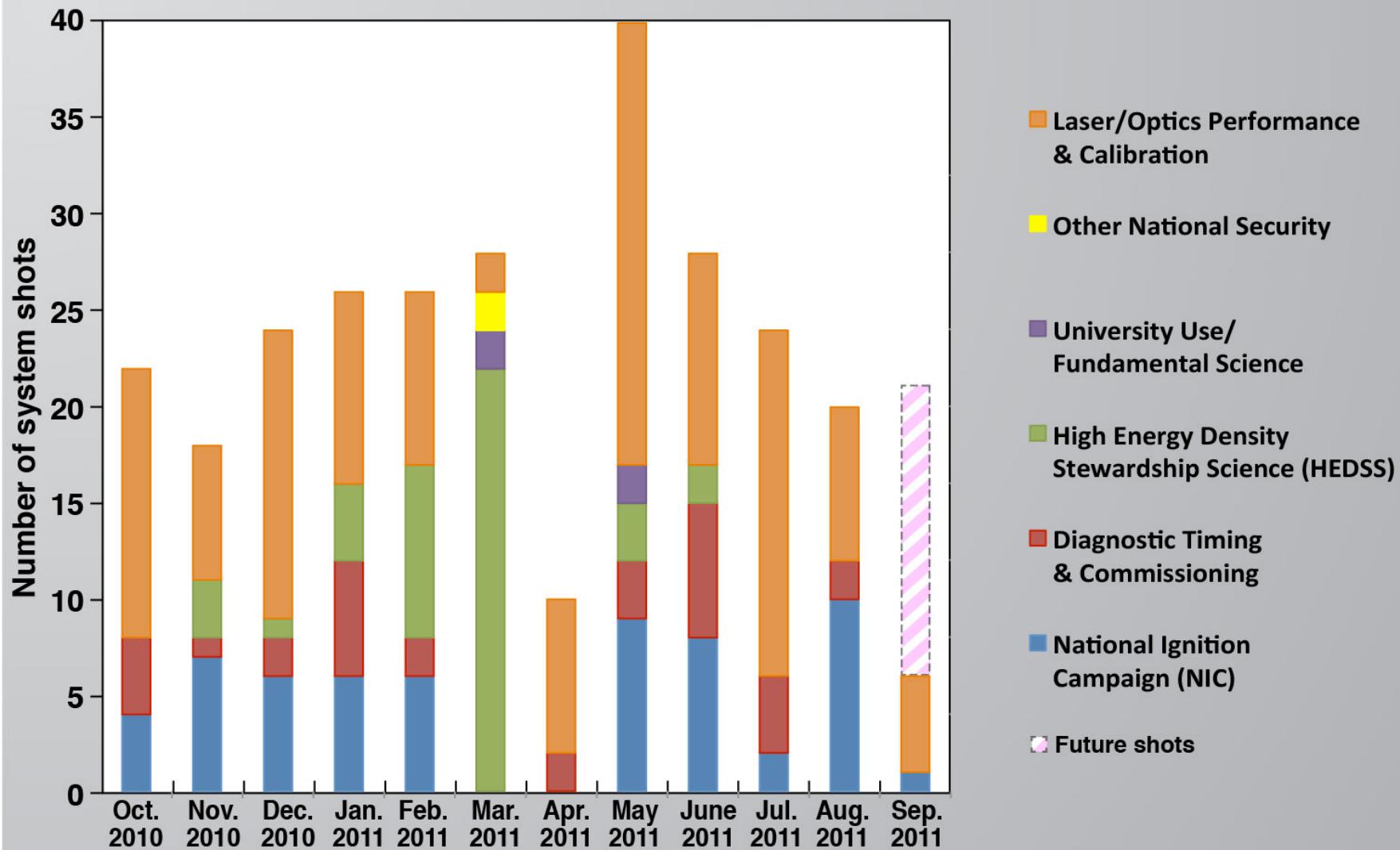
On September 29, 2010 NIC conducted the first cryo-layered target experiment on NIF



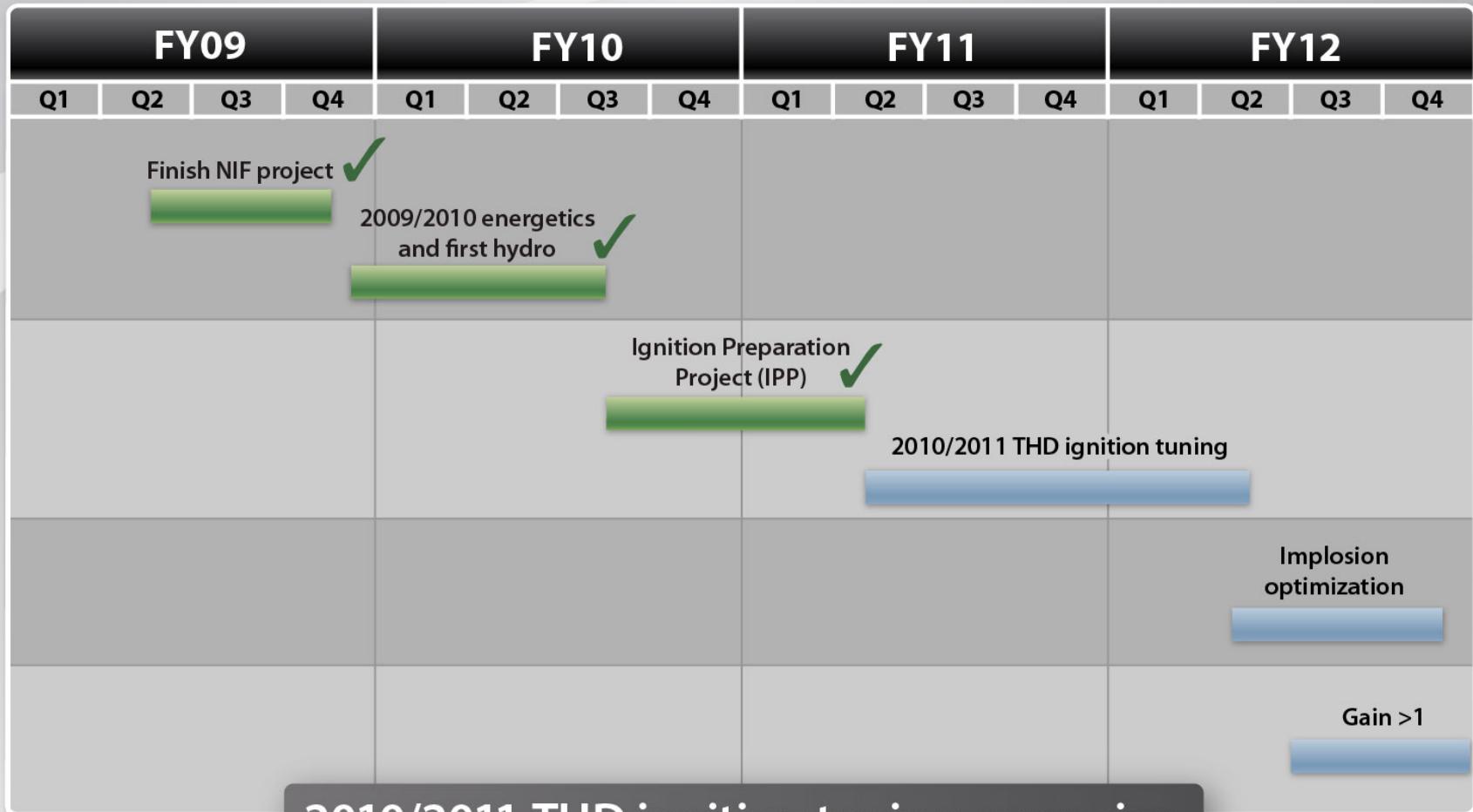
June 8, 2011: First 50/50 DT implosion—Neutron Imager data and x-ray emission show close similarity



NIF fired 272 system shots from October 1, 2010 through September 5, 2011

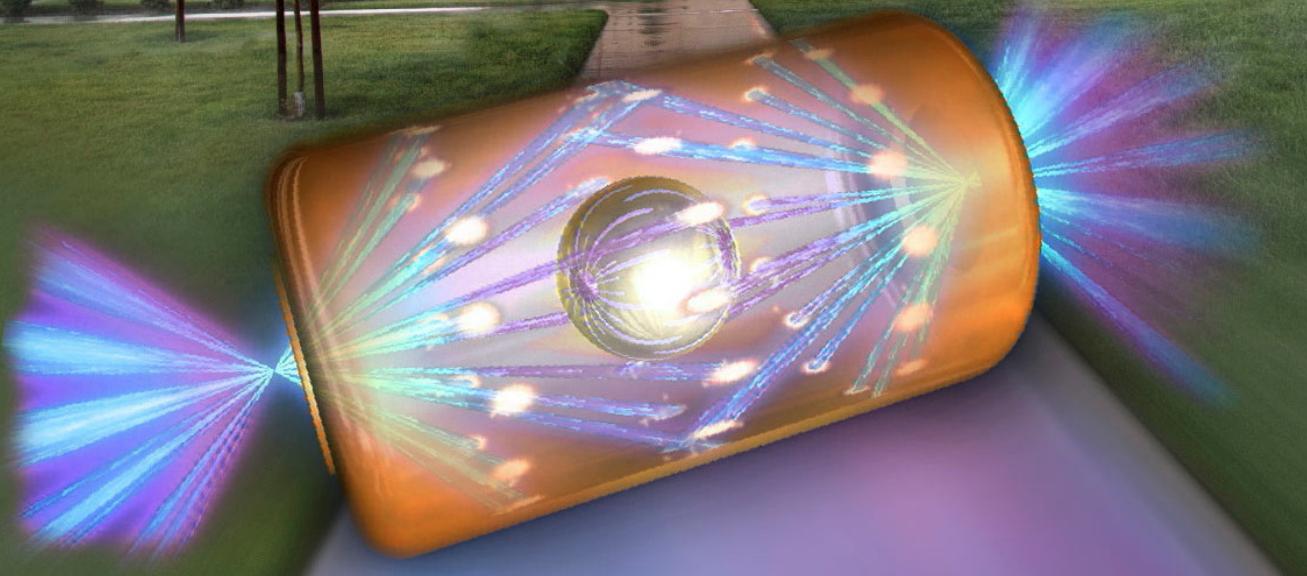


NIF/NIC summary schedule — FY2009–2012

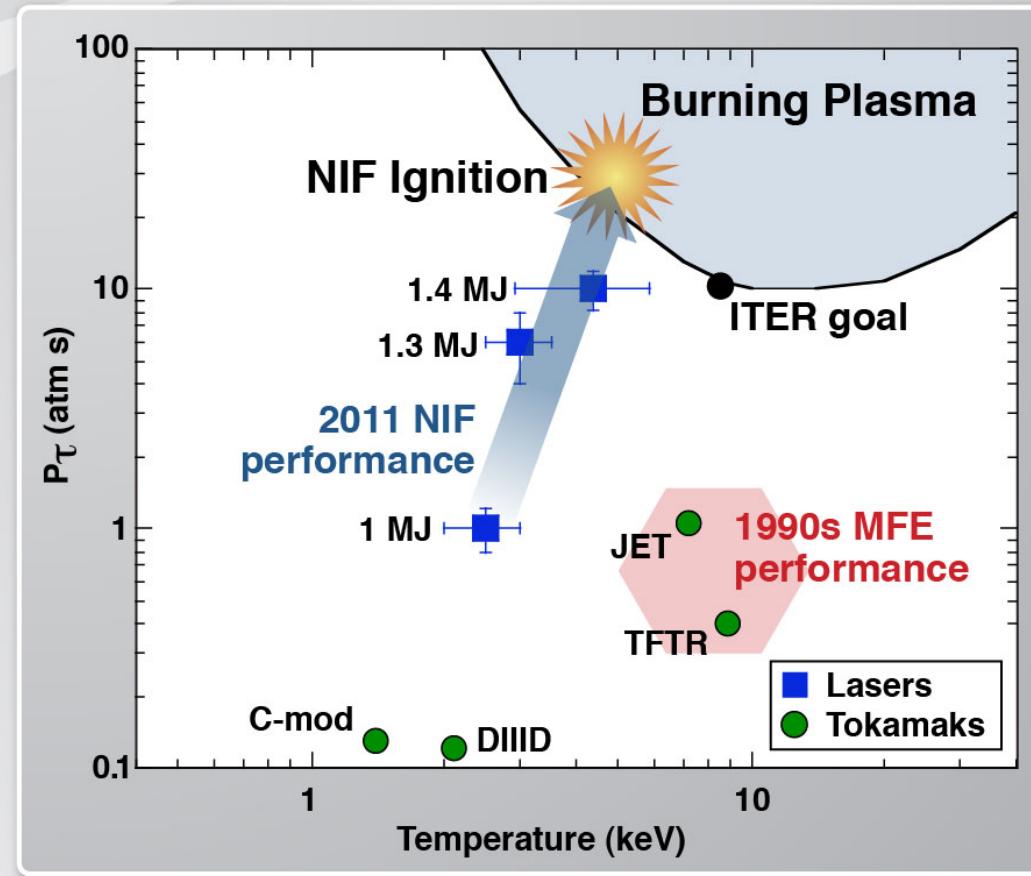


**2010/2011 THD ignition tuning campaign
is focused on preparation for the
transition to neutron yield $>1e15$**

NIF is preparing for fusion gain experiments



NIF is designed to provide full-scale evidence of fusion performance in the near future



Uniquely, NIF provides the full-scale platform to allow direct progression to a power plant

Achieving ignition on NIF can be a defining moment for the world's energy future



