# National Ignition Facility
# Project Completion and Control System Status*

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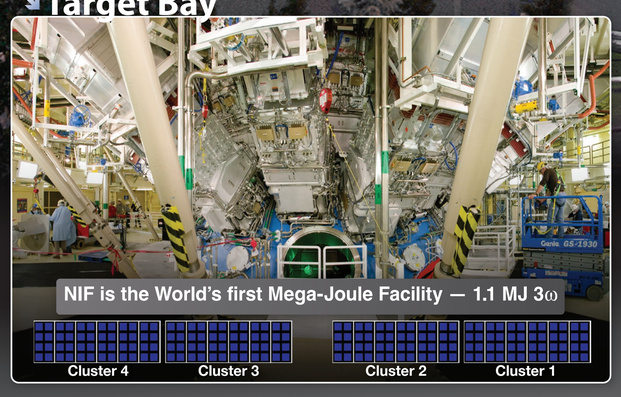
## Abstract

**The world's largest and most energetic laser**

The National Ignition Facility (NIF) is the world's largest and most energetic laser experimental system providing a scientific center to study inertial confinement fusion (ICF) and matter at extreme energy densities and pressures. Completed in 2009, NIF is a stadium-sized facility containing a 1.8-MJ, 500-TW 192-beam ultraviolet laser and target chamber. A cryogenic tritium target system and suite of optical, X-ray and nuclear diagnostics will support experiments in a strategy to achieve fusion ignition starting in 2010. Automatic control of NIF is performed by the large-scale Integrated Computer Control System (ICCS), which is implemented by 2 MSLOC of Java and Ada running on 1300 front-end processors and servers. The ICCS framework uses CORBA distribution for interoperation between heterogeneous languages and computers. Laser setup is guided by a physics model and shots are coordinated by data-driven distributed workflow engines. The NIF information system includes operational tools and a peta-scale repository for provisioning experiment results. This talk discusses results achieved and the effort now underway to conduct full-scale operations and prepare for ignition.

## Target Chamber

## Target Bay




## Project Statistics

### NIF Timeline

- May 1997, NIF groundbreaking
- June 1999, Target Chamber dedicated
- May 2003, World record 10.4 Kj 3ω single beam
- July 2007, First laserbay comissioned
- March 2009, Project completion, 1.1 MJ of 3ω
- 2010, Ignition experiments begin

### NIF by the numbers

- 192 Pulsed Laser Beams
- Energy 1.8 MJ 3ω
- Power 500 TW
- Target temperature >100 million degrees C
- Target pressure >100 billion atmospheres
- 8,000 large optics
- 30,000 small optics
- Building height 10 stories
- Building width 3 football fields
- Project cost $3.54 billion

### NIF is now operational

- This is the largest scientific construction project successfully completed by DOE

## Laser Bay

## Control System Status

**Control 60,000 device points**

- 1,340 computers
- 1,500 processes
- 140,000 distributed software objects
- 2,000,000 SLOC Java & Ada

**Align and fire 192 lasers**

- On target < 50μm
- Closed loop < 15 minutes
- Timing < 30 pS

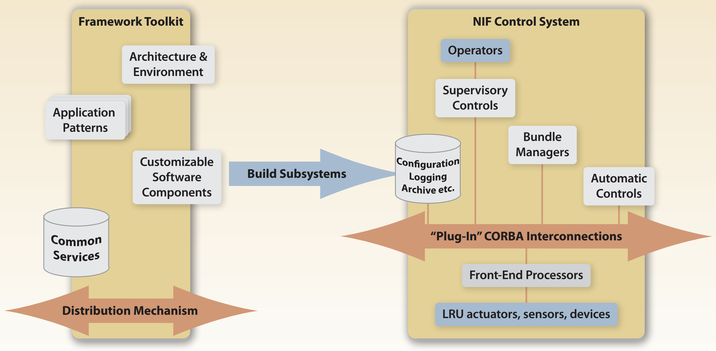
**Automatic shot controls**

- Hands-off operation
- < 4-hours shot-to-shot

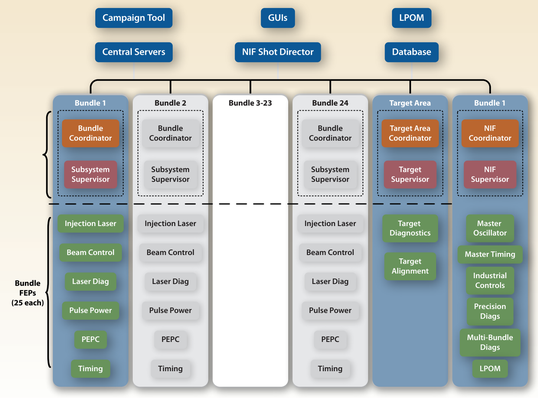
**Assure**

- Personnel safety
- Situational awareness
- Machine protection
- Reliable operation

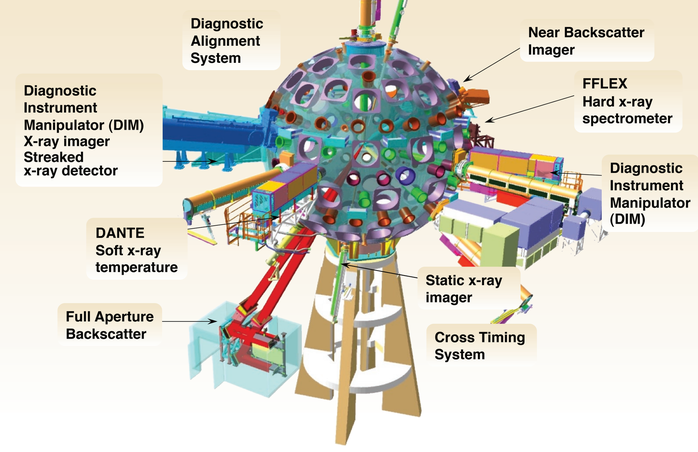
### CORBA-Based Framework



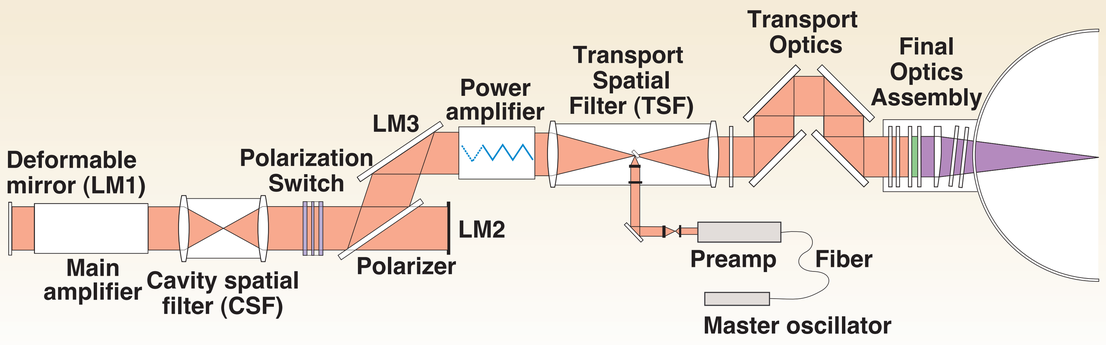

### Bundle-Based Control System




### Diagnostics

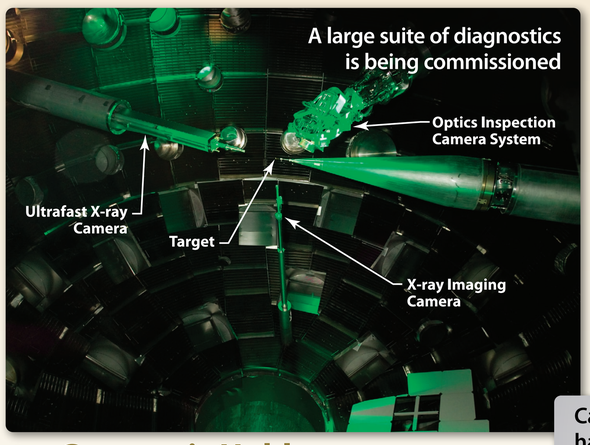


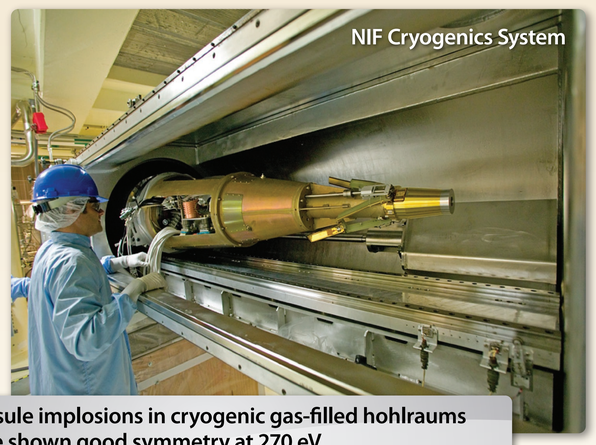

## Laser Beam Schematic



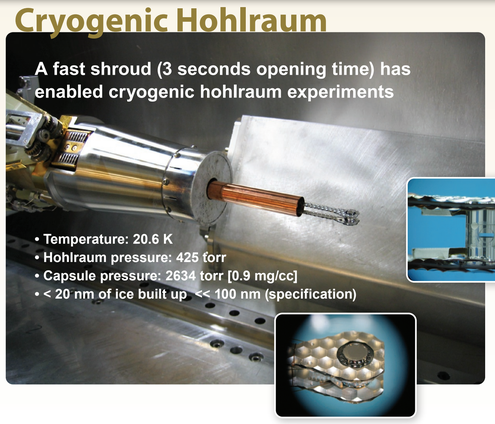

## Control Room

## Early Results from the National Ignition Campaign

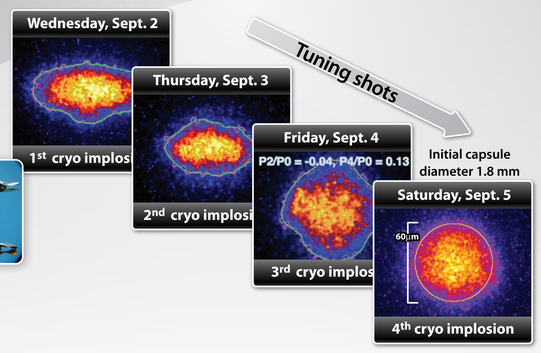



### Cryogenic Hohlraum

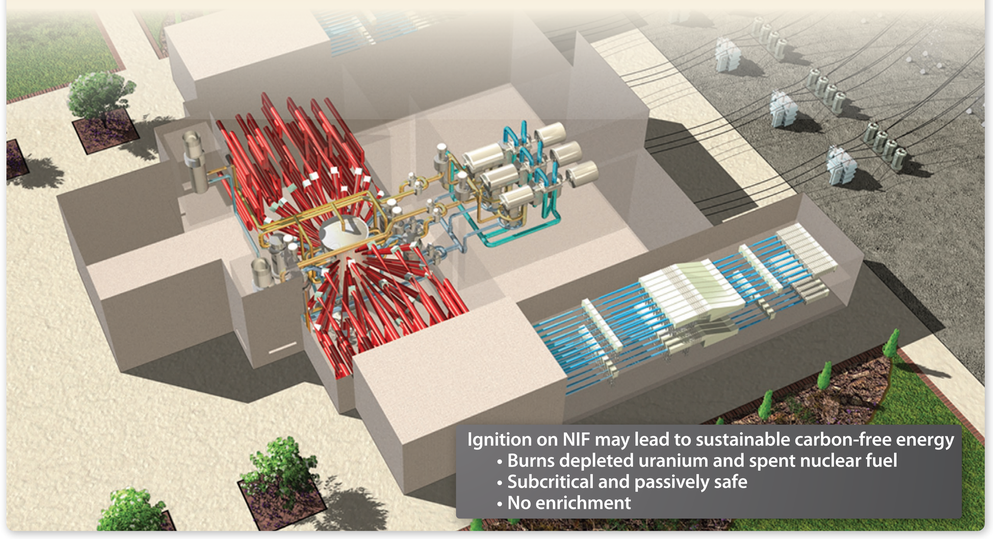



**Capsule implosions in cryogenic gas-filled hohlraums have shown good symmetry at 270 eV**




## LIFE — A future energy source

Laser Inertial Fusion Energy based systems for
electric power production and disposal of nuclear waste




## Summary

- The NIF project is complete and operational as the world's first megaJoule laser facility
- Initial 192-beam experiments are already producing key data for the National Ignition Campaign
- Cryogenic hohlraum tuning shots have achieved good implosion symmetry and generated the first deuterium fusion neutrons on NIF
- Control system extensions are underway to add tritium fuel, new target diagnostics and a large-scale experimental data repository

NIF-0909-17315

Lawrence Livermore National Laboratory

National Ignition Facility • Lawrence Livermore National Laboratory • Operated by the US Department of Energy
This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

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