LLNL-PRES-619532

NIF

NIF Overview and Facility Plan

Presentation to

NIF/JLF User Group Meeting

February 11, 2013

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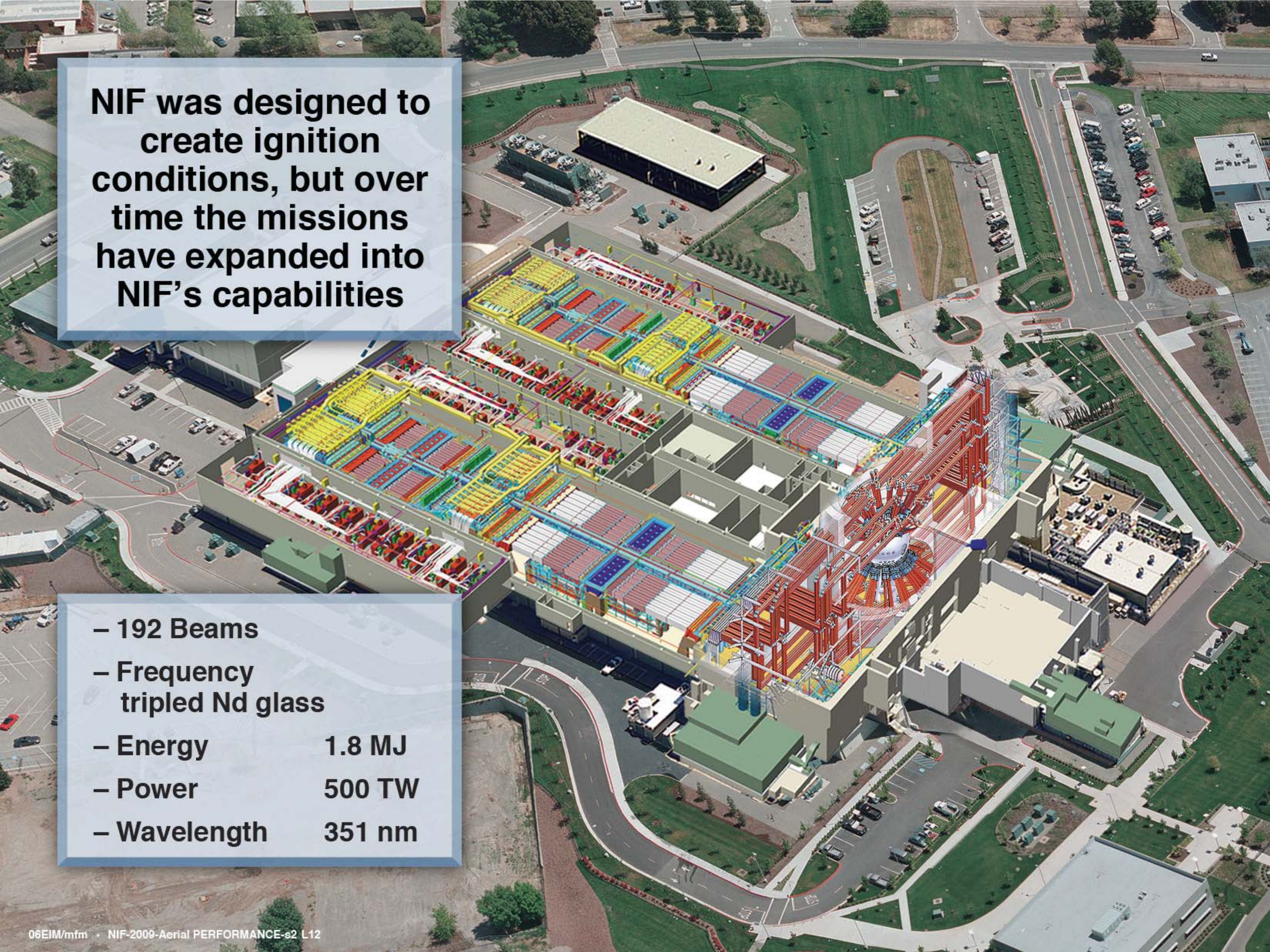
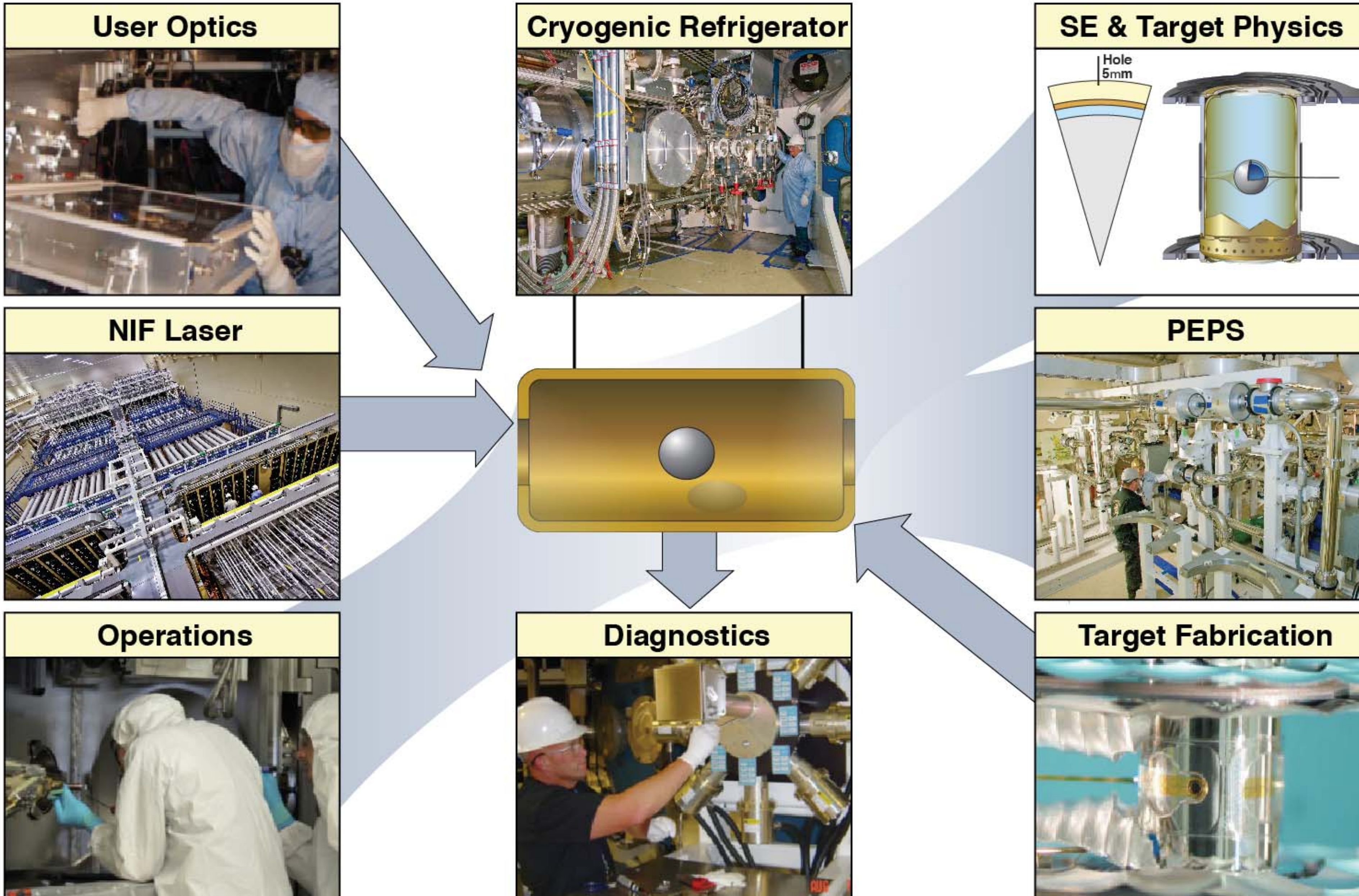
This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

NIF was designed to create ignition conditions, but over time the missions have expanded into NIF's capabilities



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

NIF is much more than the laser



NIC has put in place the capabilities required for a broad range of ignition and other experiments

Laser

Wide variety of pulse shapes, peak intensities, w/ better than 2% reproducibility and precision

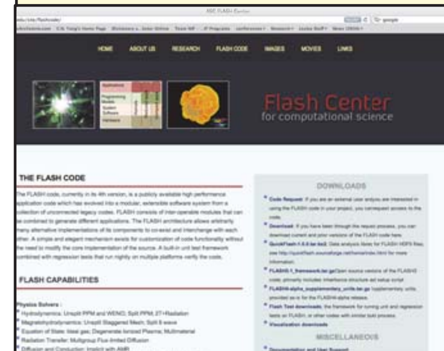
Diagnostics

Over 50 photon and particle diagnostics w/ high spatial, temporal, spectral resolution

Targets

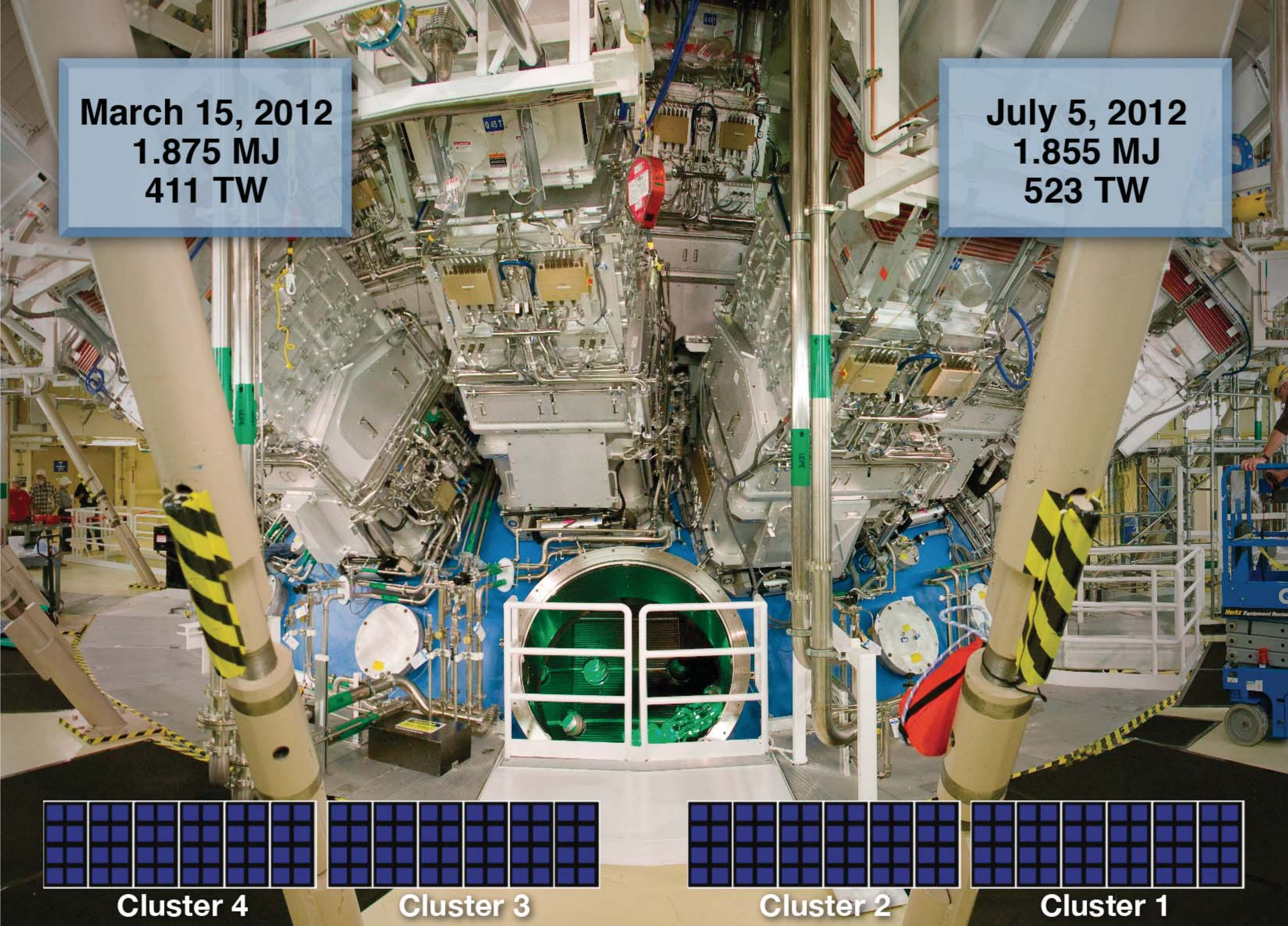
Spherical, planar, machined perturbations, exotic materials,..

Simulation



Experimental design via target and laser simulation tools

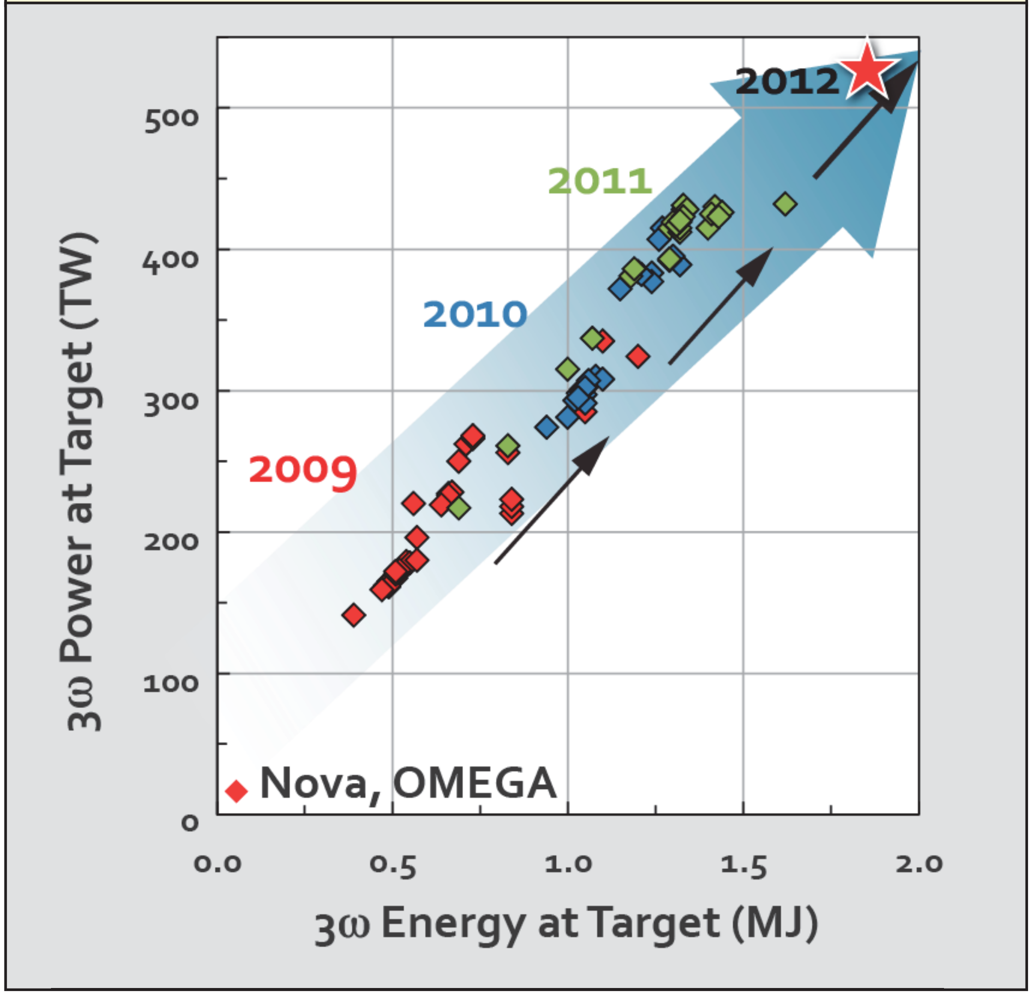
NIF is the world's leading facility for research in high energy density science


March 15, 2012
1.875 MJ
411 TW
July 5, 2012
1.855 MJ
523 TW
Cluster 4
Cluster 3
Cluster 2
Cluster 1

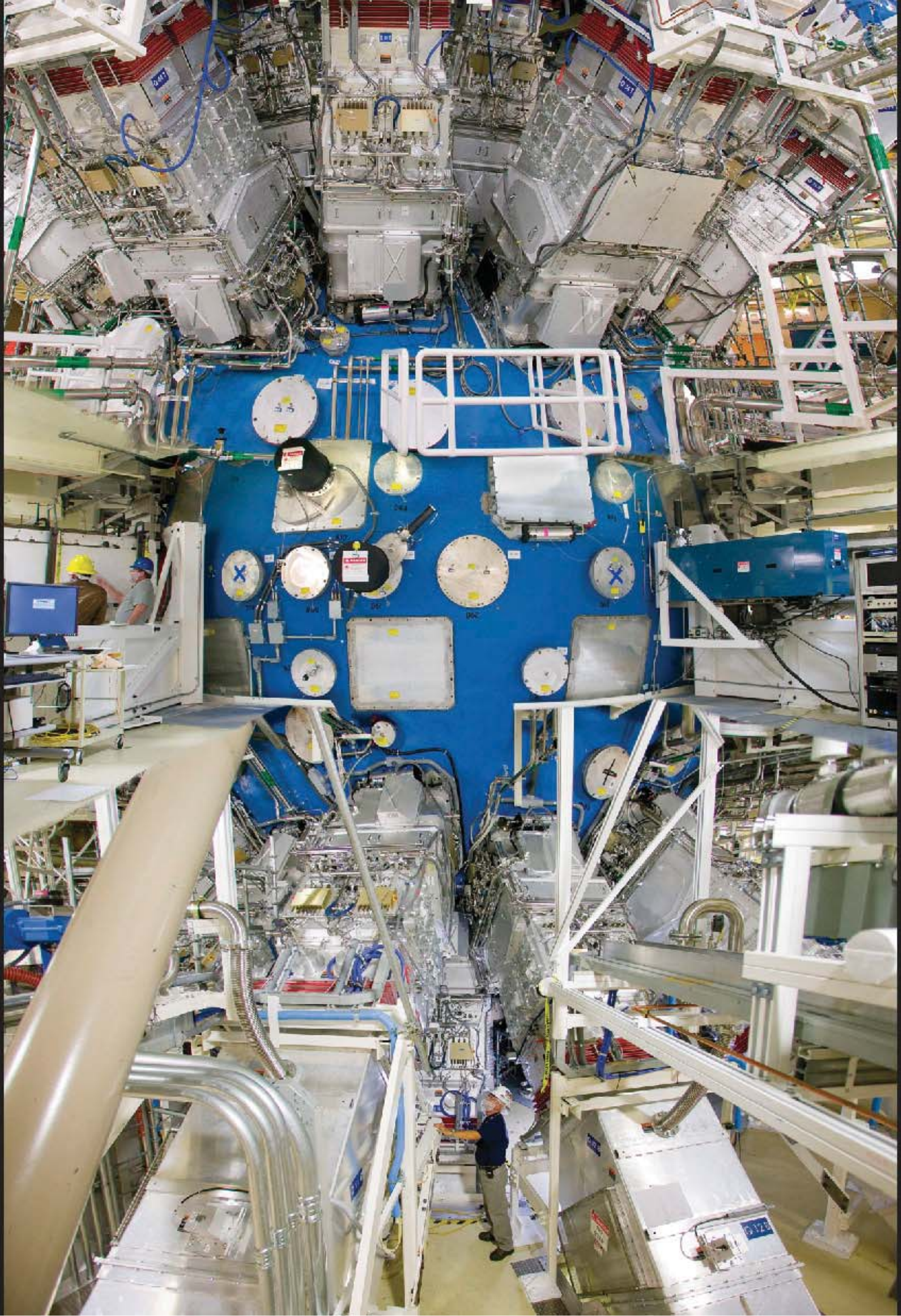
NIF operational capabilities — laser energy/power

- **NIF laser is steadily increasing the laser energy and power**
- **NIF Laser is operating 24/7 with exceptional reproducibility and reliability (99%)**
- **Currently supporting the NIC at 1.4 to 1.8 MJ**
- **We have achieved the 1.8 MJ milestone and a power of 522 TW in a NIC-relevant pulse format**
- **The NIF has intrinsic capability to continue on this growth path for several more years**

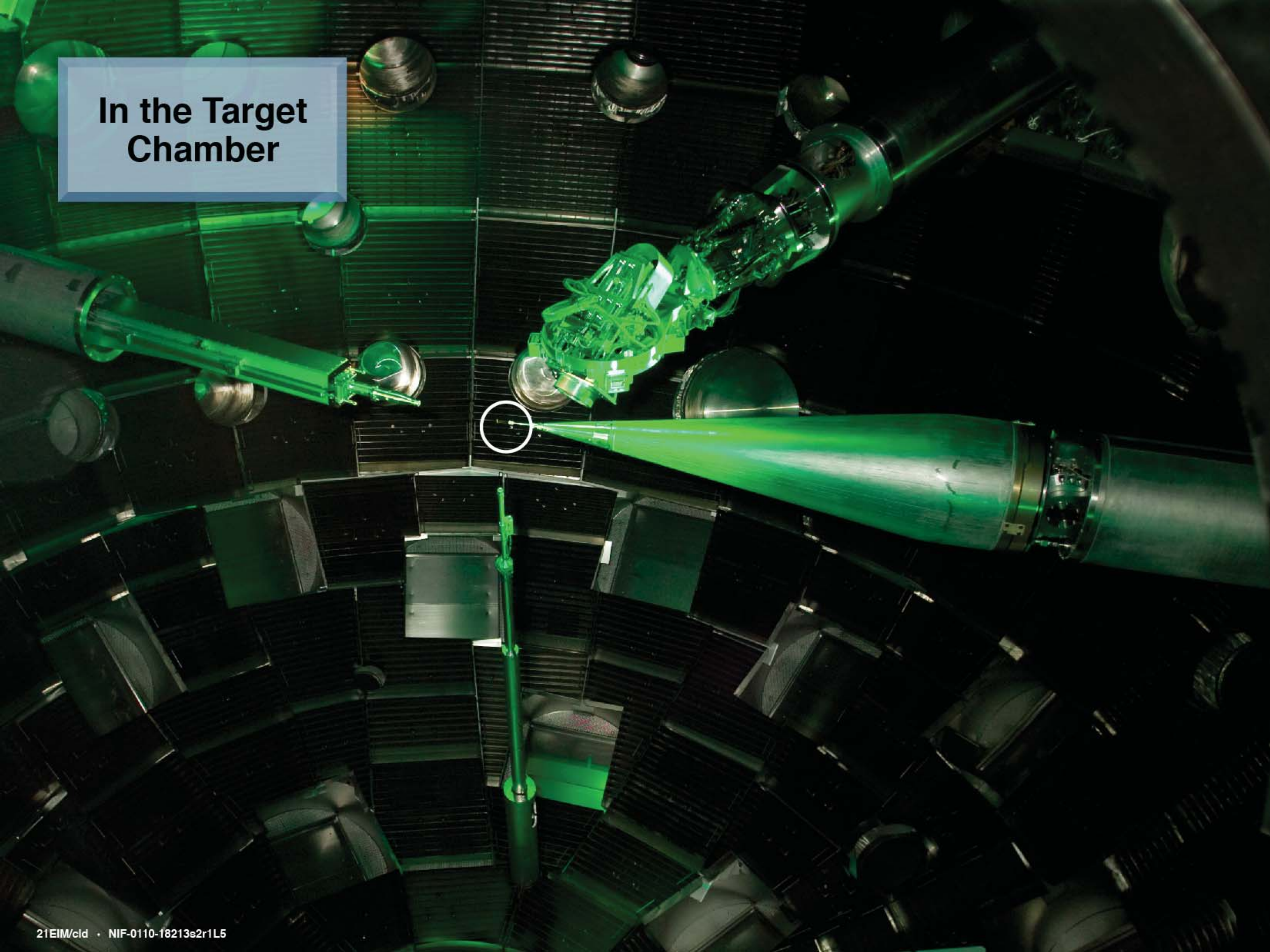
The laser energy and power available for experiments have been steadily increasing



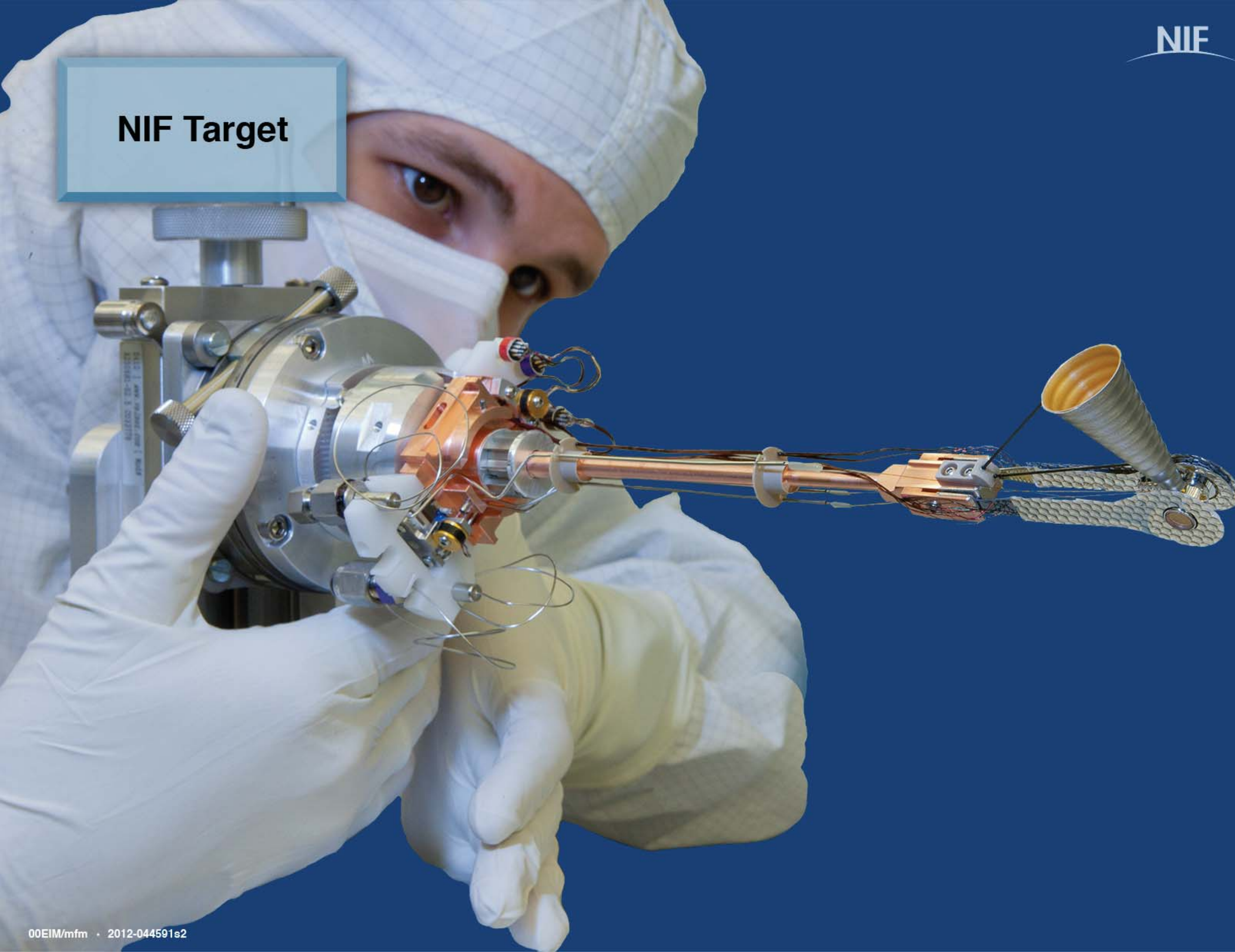
The Final Optics are routinely exposed to fluences exceeding 9 J/cm²



In the Target Chamber

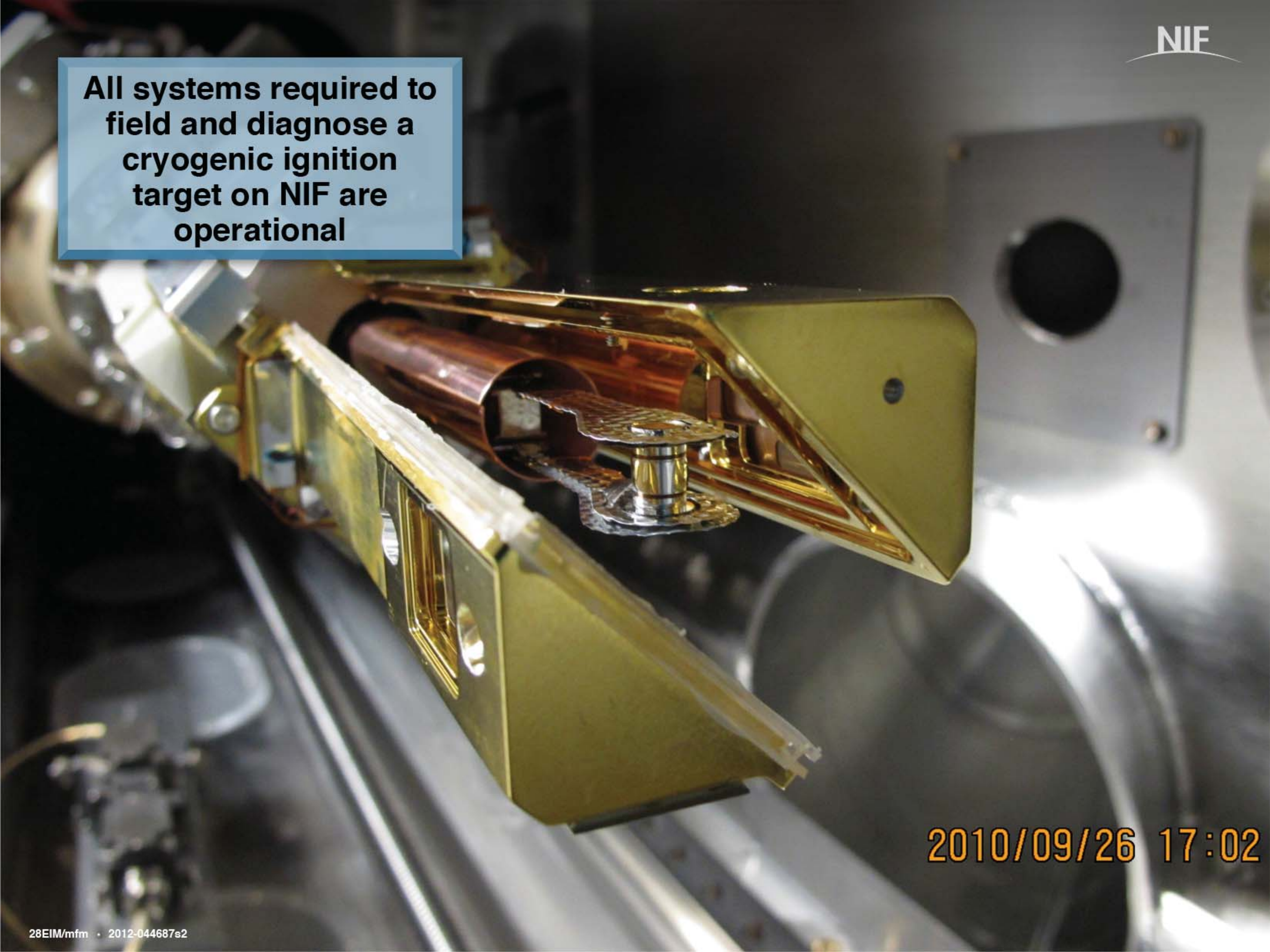


NIF Target

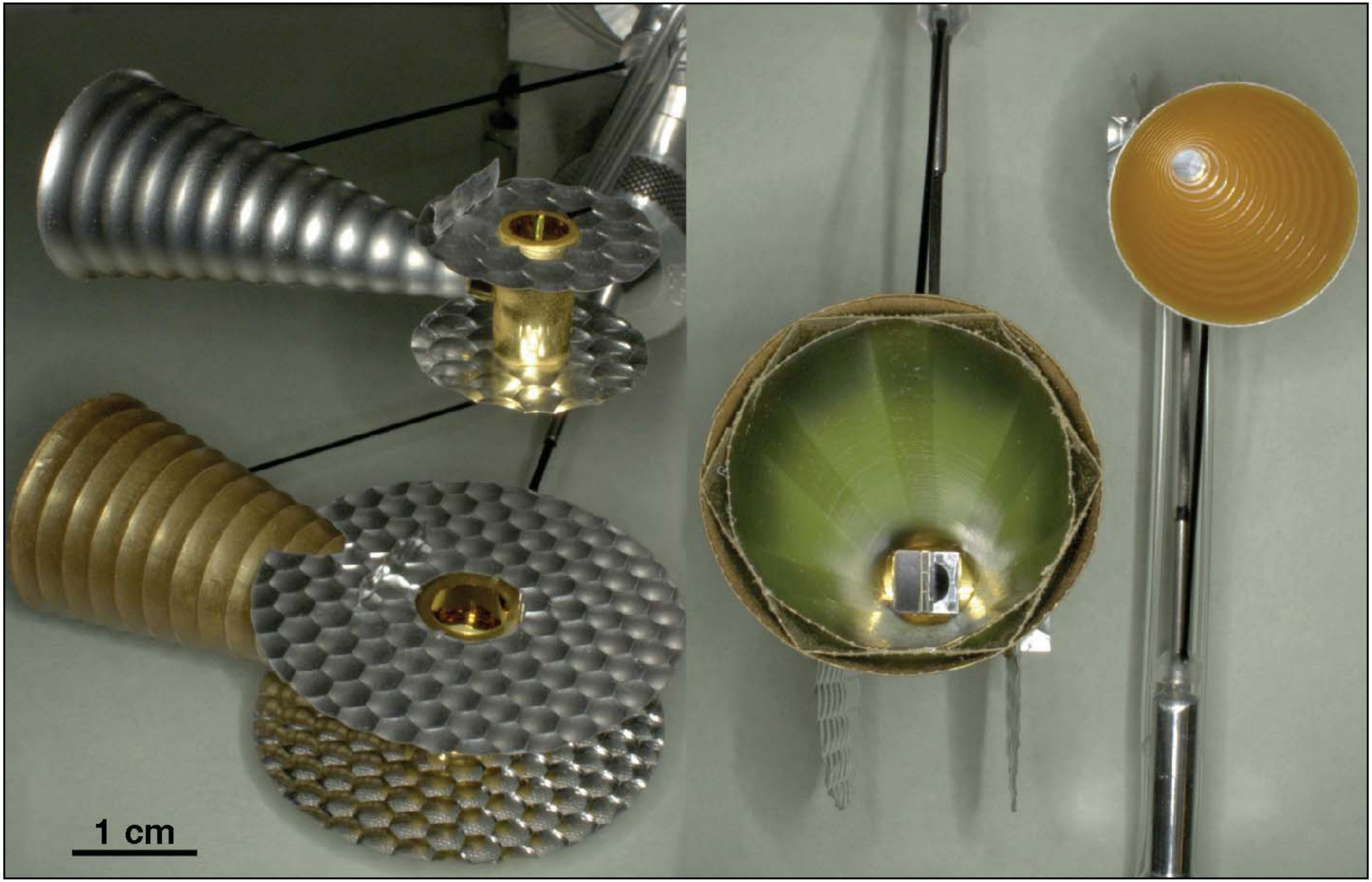


NIF

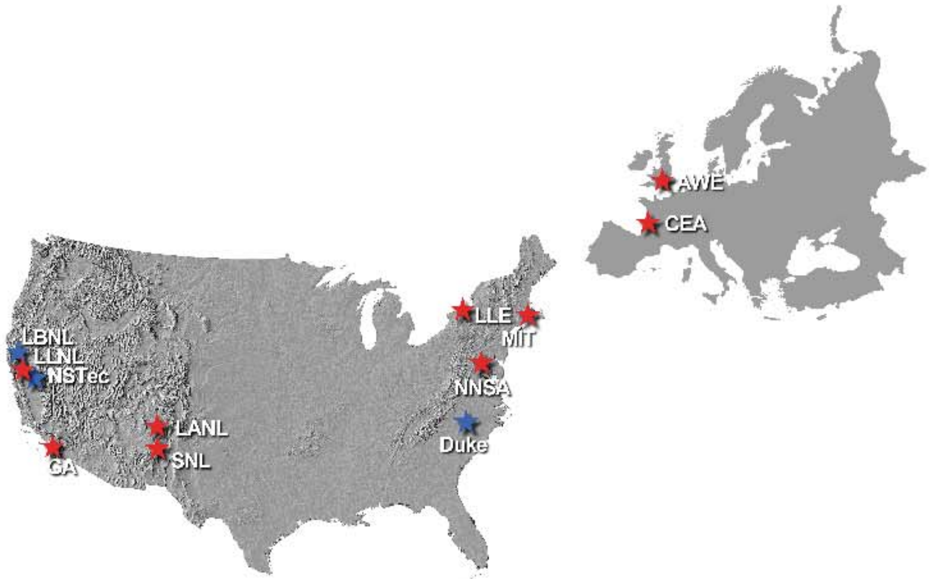
All systems required to field and diagnose a cryogenic ignition target on NIF are operational



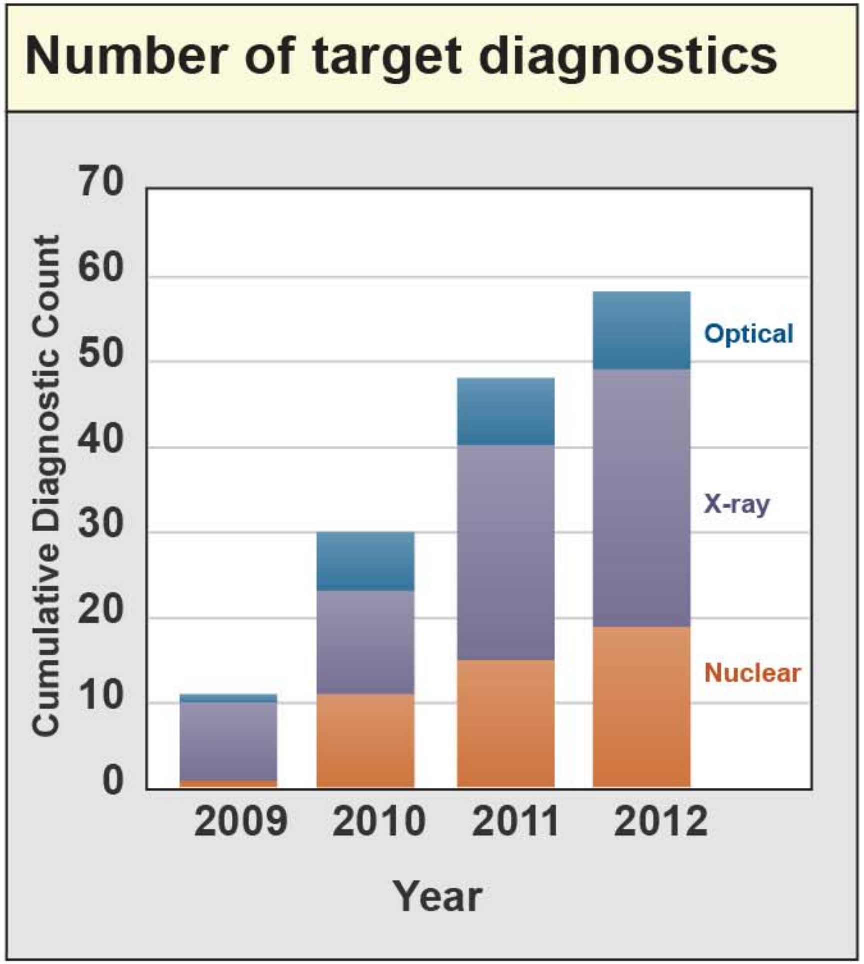
Materials dynamics targets



57 target diagnostics enable cutting edge science on the NIF



- LLNL
- LANL
- LLE
- NSTec
- U of M
- LBNL
- AWE
- MIT
- CEA
- Duke
- SNL
- GSI



The 7th NIF diagnostic workshop in 2012 continued process for diagnostic plan beyond 2012

Advanced Radiographic Capability (ARC)
ARG
UDPE
VAT

NIF actual shots through FY2012 and FY2013 plan

		FY2009	FY2010	FY2011	FY2012	FY2013 plan
Programs	HEDSS	14	2	41	26	92
	HEDICF	25	28	64	105	69
	Fundamental Science	0	3	4	4	14
	Nat'l Sec. Applications	0	5	2	6	7
Subtotal		39	38	111	141	182
Diagnostic/System Qual		37	25	39	38	32
Laser Performance		155	127	141	153	120
Grand Total		231	190	291	332	334

FY2013 shots to date consistent with the overall plan, with all Programs engaged in NIF experiments

We are continually developing new experimental platforms that have a wide range of applications

	FY09	FY10	FY11	FY12	FY13	FY14
Implosions & Applications	Hohlraum implosions	Direct Drive Emplosions		Layerd DT Implosions	Mix Platform Polar Direct Drive	Non-cryogenic implosion
Plasma physics & Hohlraum Drive		GasPipe			Viewfactor	Rugby
Radiation - Hydrodynamics		Planar target: Halfraum			Spherical Target: Hohlraum	
Materials at High Pressure			Hohlraum ICE EOS	Hohlraum ICE Strength	22 keV radiography; 3-axis keyhole, Layered keyhole, Planar ablator; GBar EOS, ICE Strength, Diffraction	Planar Hugoniot EOS
X-ray sources		Low debris 4 KeV source		Low debris 13 KeV source	Low debris 7 KeV source	
Opacity						Long-pulse Hohlraum

In FY12, we commissioned 21 platforms across all programs

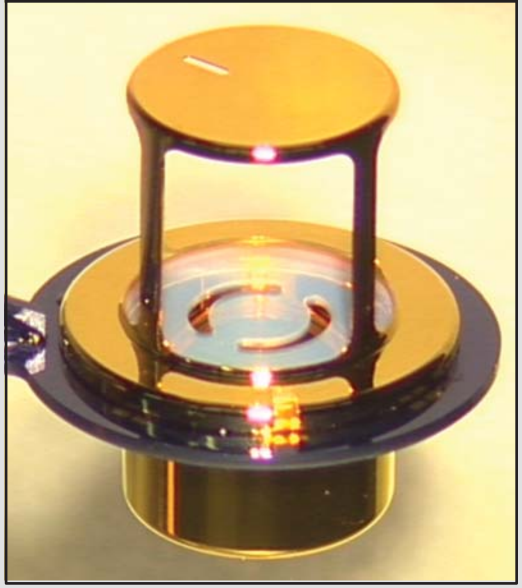
An integrated suite of capabilities to perform an experiment is termed the experimental "platform"

Experimental Platform: "End-station"

Targets

Diagnostics

Radiation Transport Target

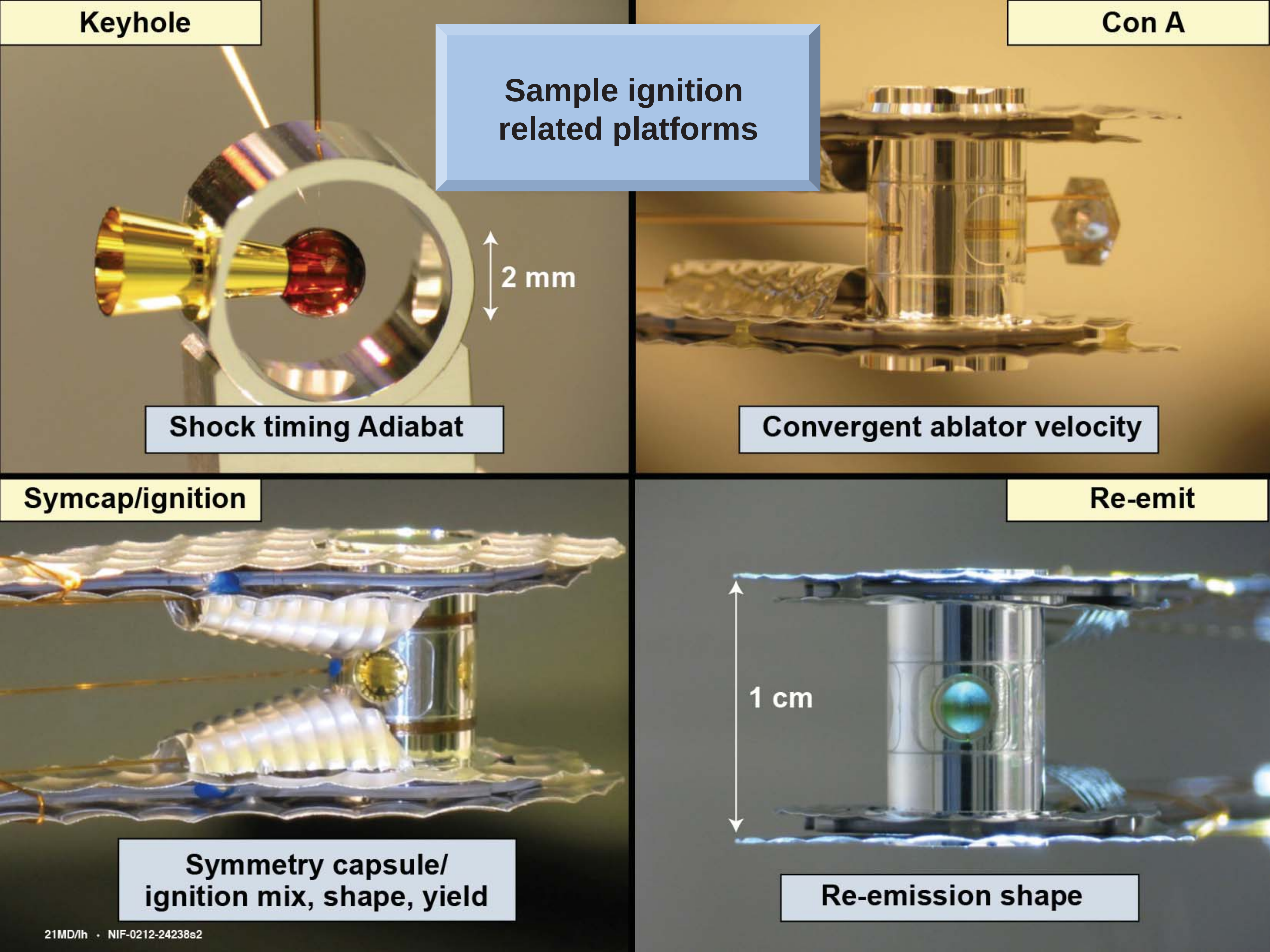


Facility Integration

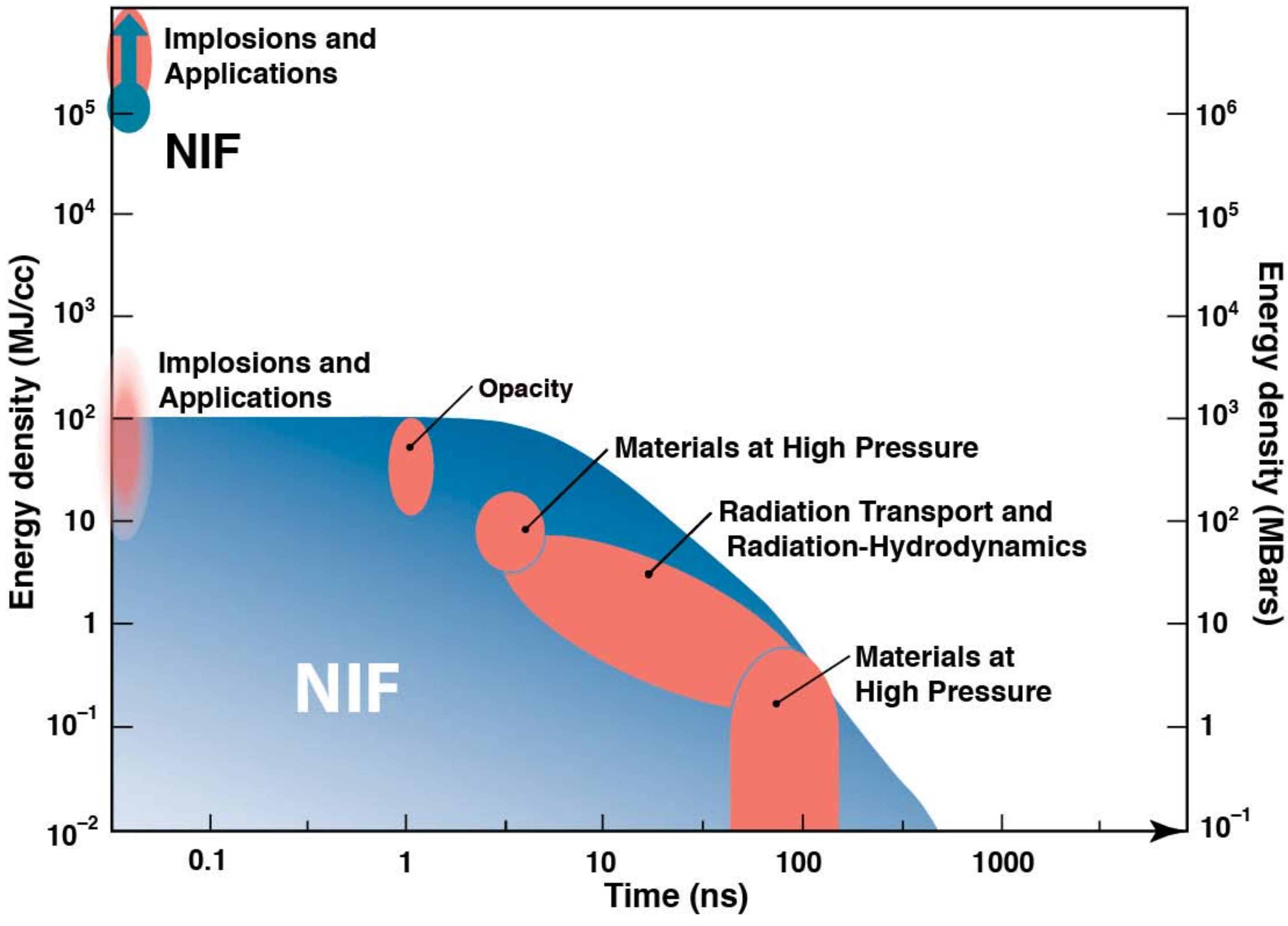
Hohlraum Drive

Data Analysis

Platforms Require Substantial Efforts and Shots to Develop;
Users that Adopt an Existing Platform will Benefit


Sample ignition related platforms
Keyhole
2 mm
Shock timing Adiabat
Con A
Convergent ablator velocity
Symcap/ignition
Symmetry capsule/ ignition mix, shape, yield
Re-emit
1 cm
Re-emission shape
21MD/lh • NIF-0212-24238s2

We are developing new experimental platforms that have a wide range of application



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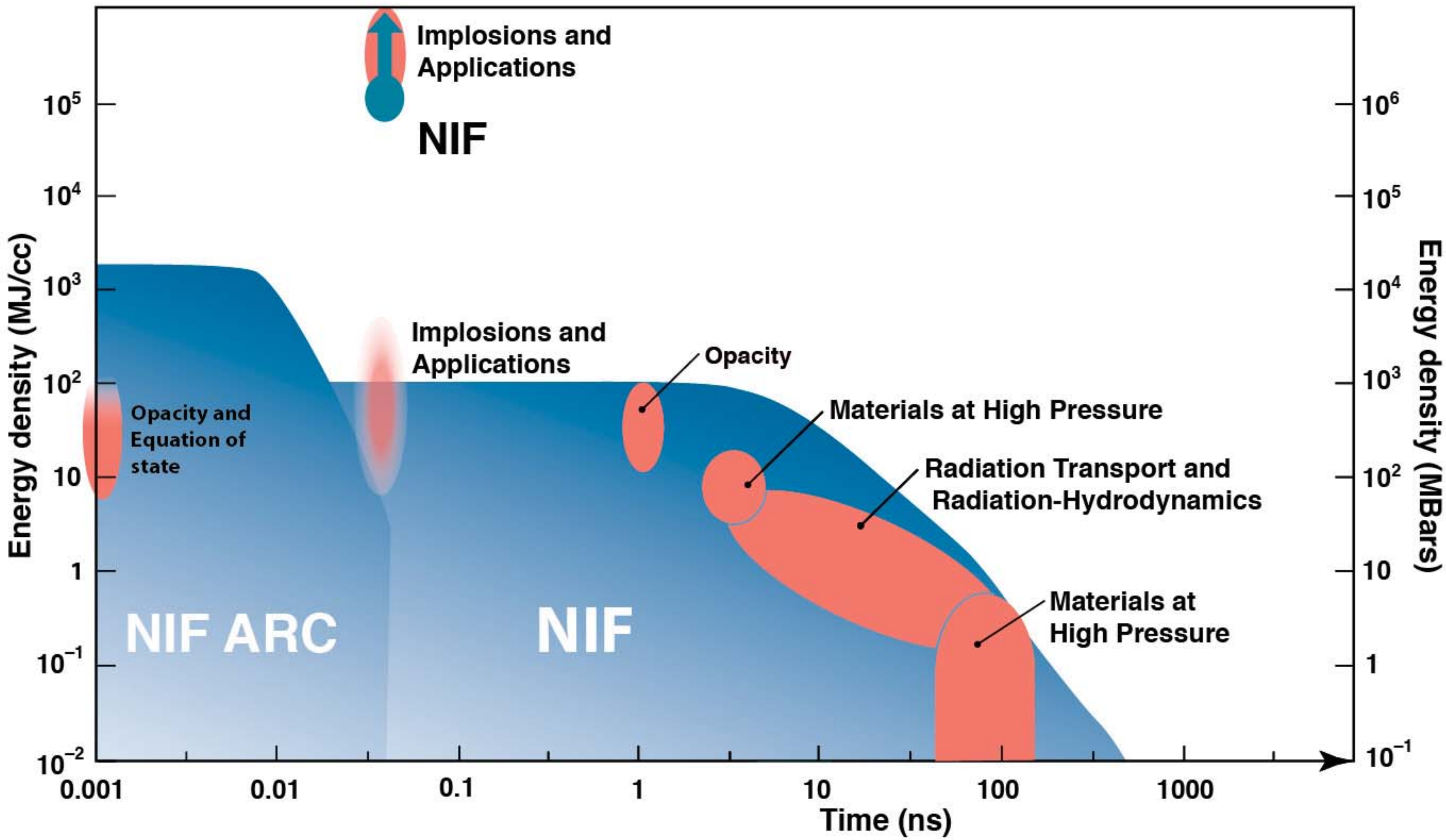
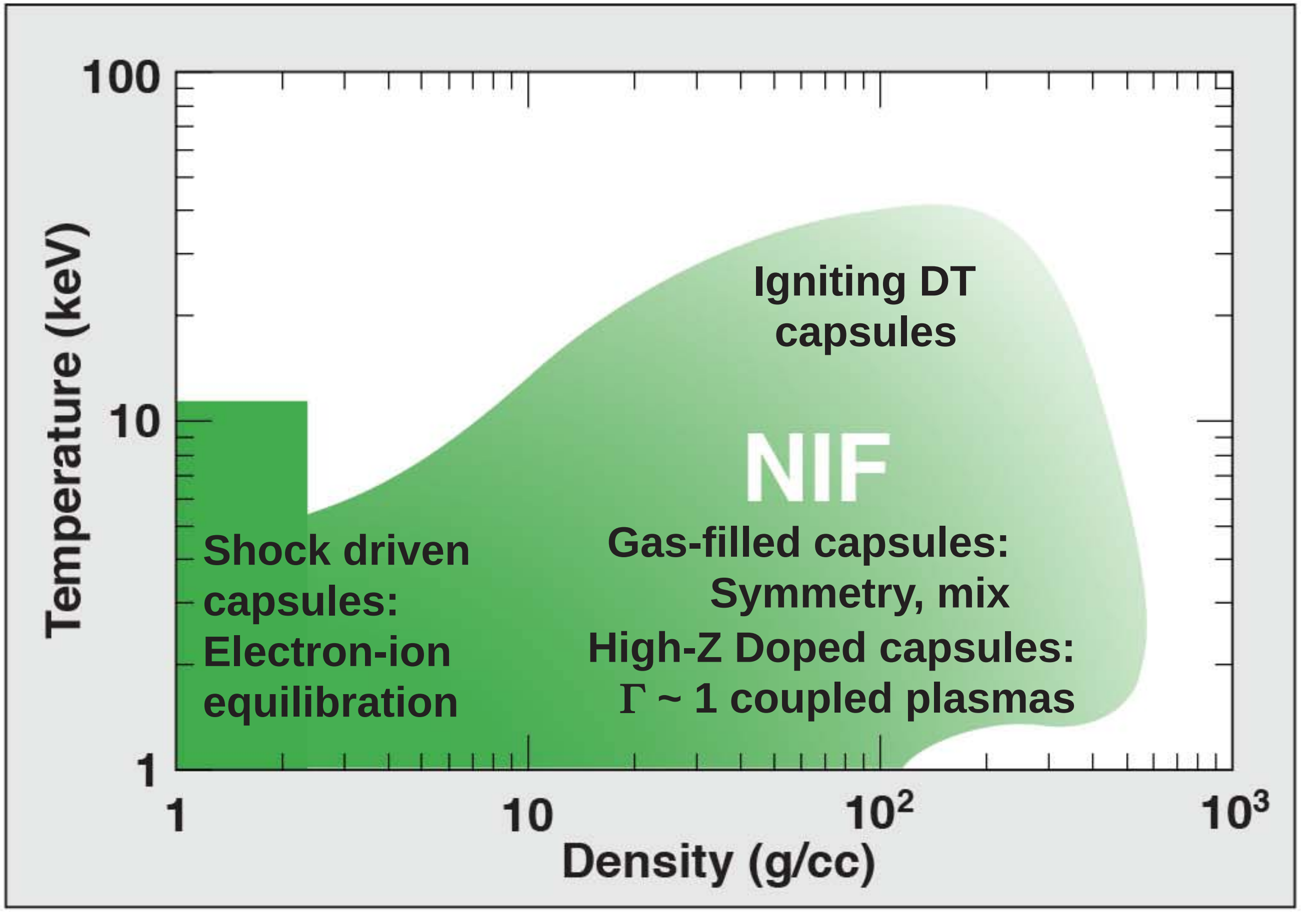


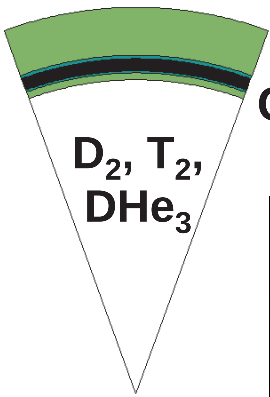
Implosion platforms provide high density or high temperature plasma conditions; igniting capsules provide both



There are many different types of implosion platforms

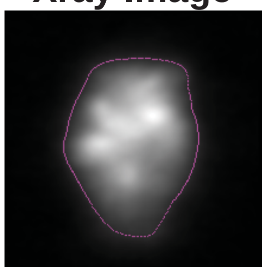
Gas Filled Capsules in Cryo Hohlraums

CH w/ dopants



CD, Ge, Xe

Xray Image

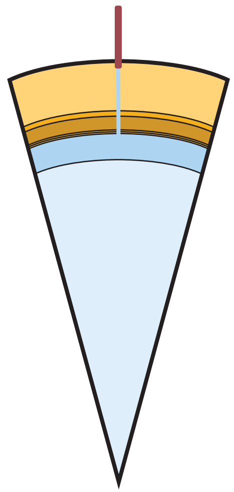


Neutron Image

Yield
Neutron spectrum
Gamma & Xray BT
Rho-r (MRS)
Hard X-rays
Backscatter
…

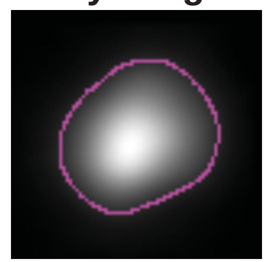
Symmetry
Mix
Nuclear physics

DT Layered Capsules in Cryo Hohraums

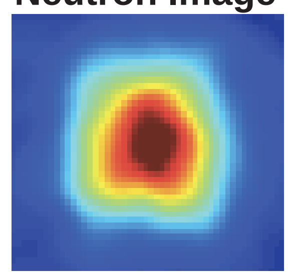


DT/ THD layer

Xray Image



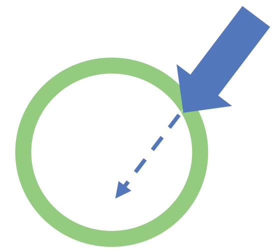
Neutron Image

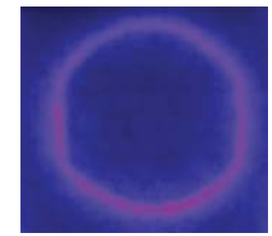


Yield
Neutron spectrum
Gamma & Xray BT
Rho-r (MRS)
Hard X-rays
…

Ignition
Compton Radiography

Direct Drive Capsules





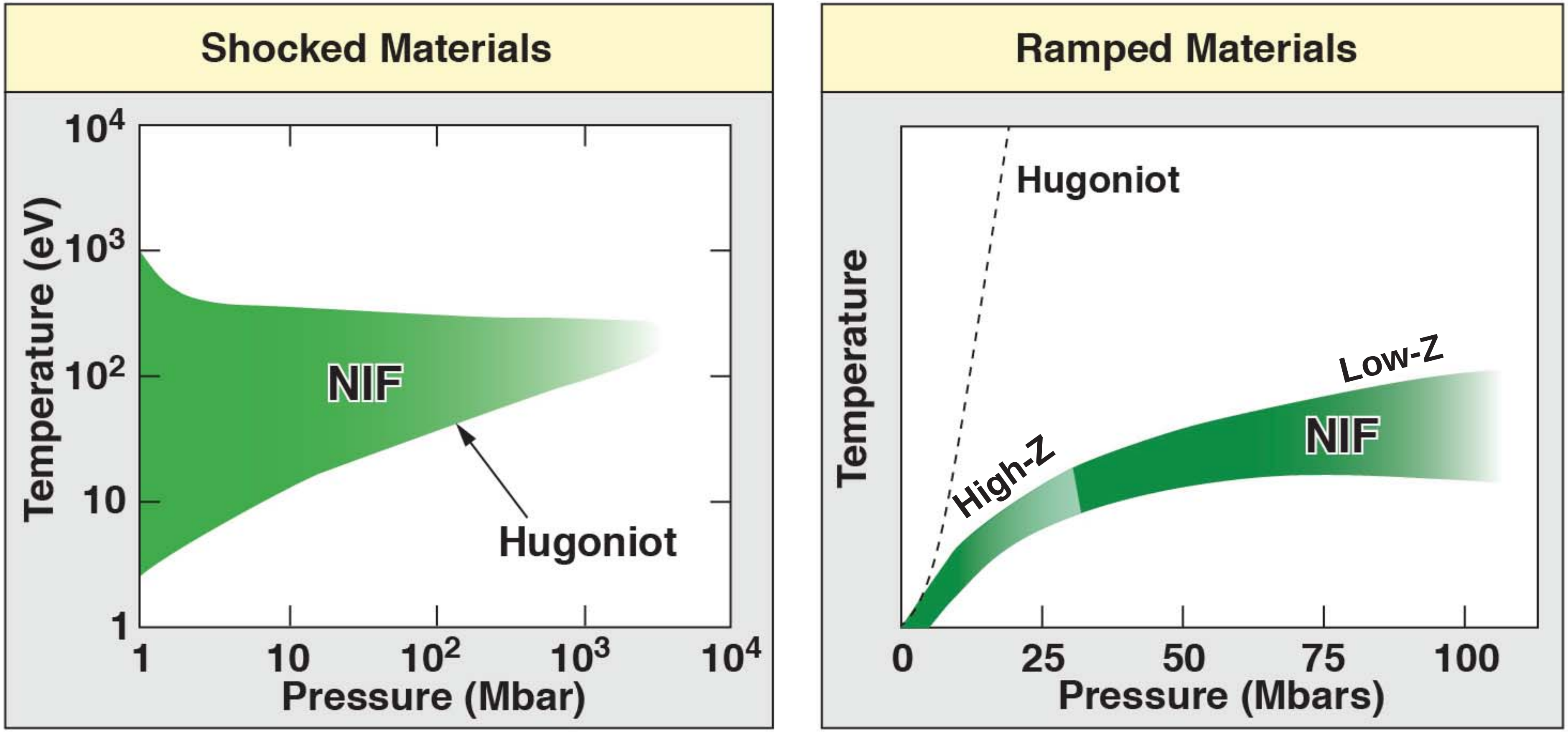
D_2, DT,
DHe_3, Air

Polar Direct Drive
Nuclear Calibration
DIME

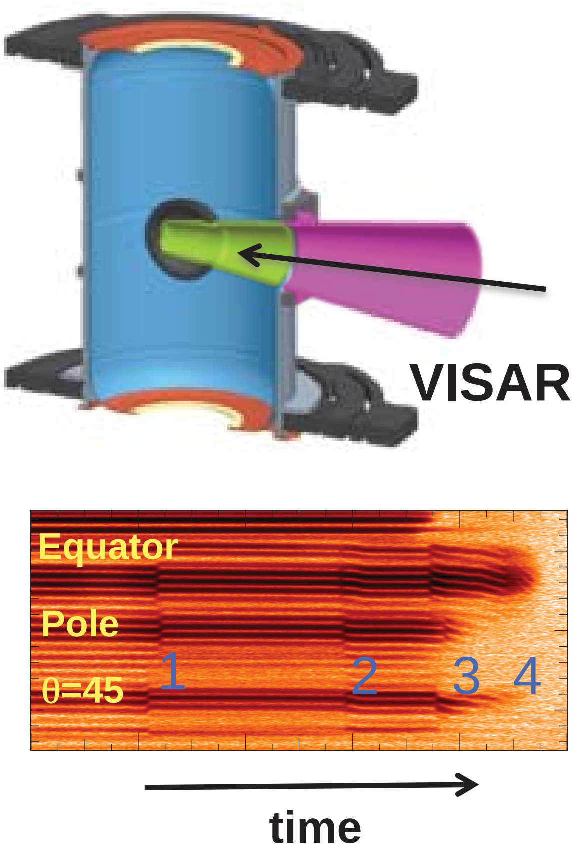
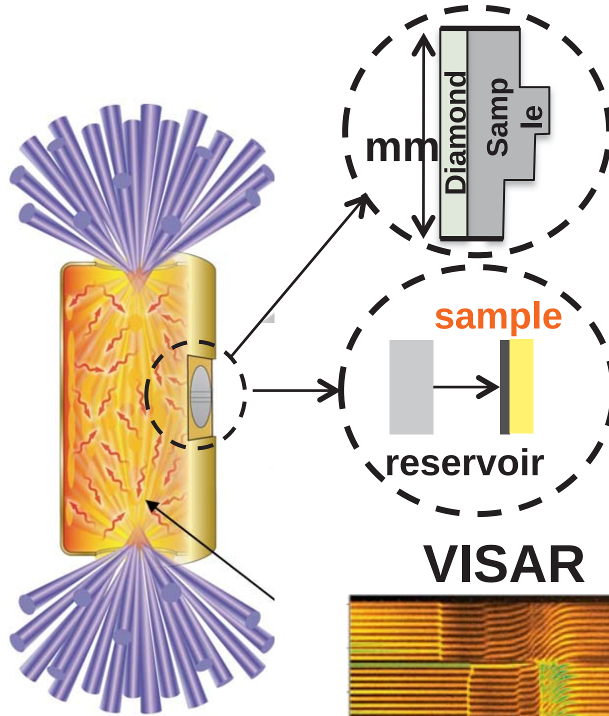
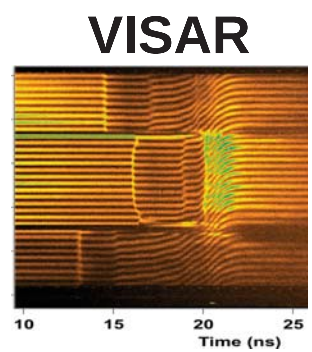
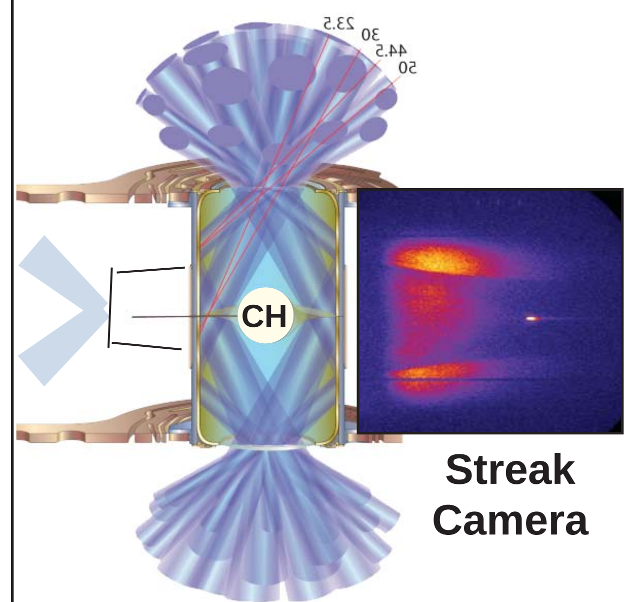
In Development

- Indirect Drive Single Shell
- Gas Filled Capsule in Non-cryogenic Hohlraums
- Exploding Pusher with fill tube

Materials platforms achieve high pressures

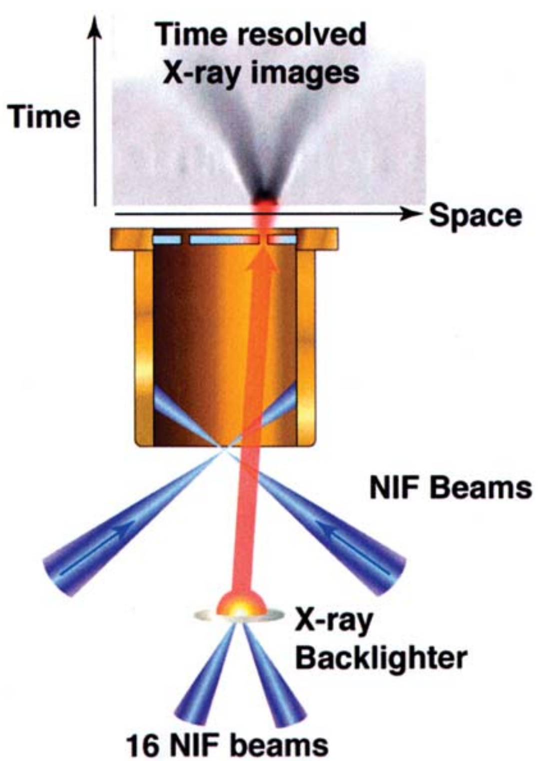


Platforms measure material properties at high pressure

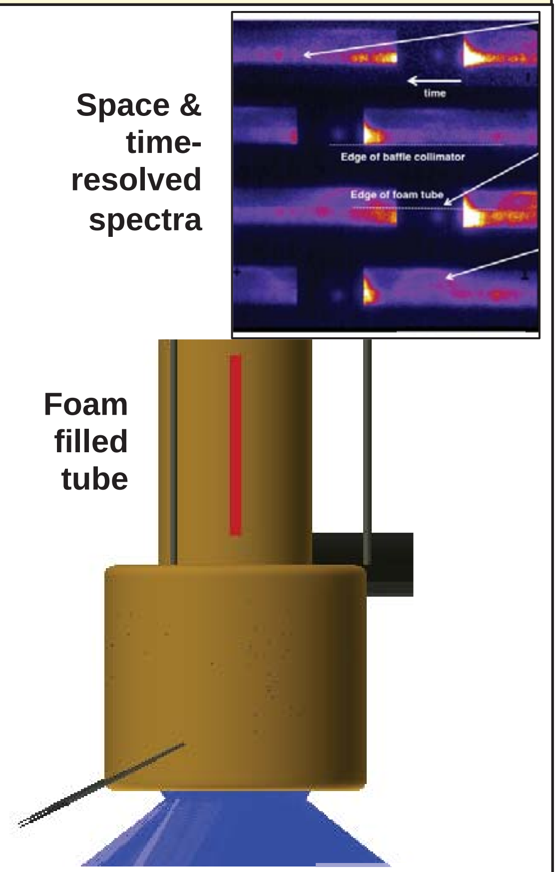
Shock timing	Planar Ramp Drive	Convergent Shock
	  100 Mbars in C >4 Mbars in Ta >7 Mbars in Fe	 ~ 700 Mbars in CH
1, 2, 3 axis keyholes Layered DT keyholes	C, Fe, Ta EOS Strength	Gbar Hugoniot EOS

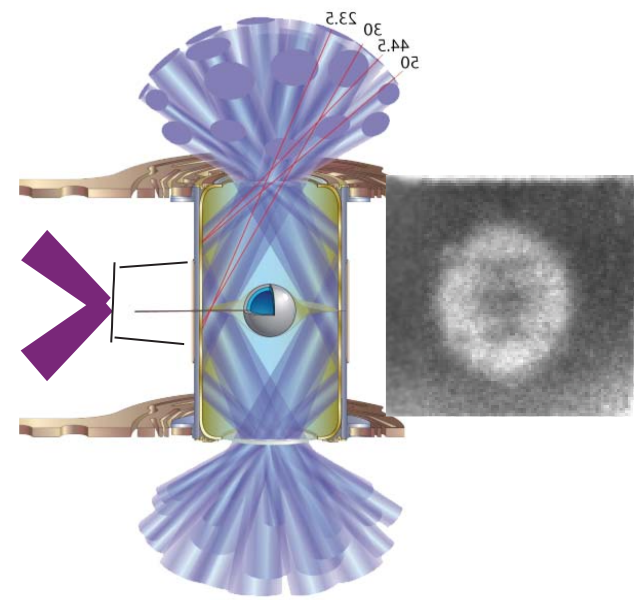
Radiation-Hydrodynamics Platforms investigate a wide range of physics

Hydrodynamic evolution	Supersonic Radiation Transport	Ablator Shape and Thickness



8 keV, 8 nsec point backlighter





Radiation Transport Ablative Rayleigh-Taylor	Pleiades Fanbolt	1D streaked, 2D imaged ablators (ConA, Layered) HDC ablator

Experimental platforms that are developed by one program can be used by all users

Physics	Platforms	ICF	HEDSS	NSA	FS
Implosions & Applications	Cryo Symmetry Capsules	Comm	CDMix	User	Nucl Phy
	Warm Symmetry Capsule	Develop	Potential		Potential
	Direct drive implosion	Comm	Potential		Nucl phys
	DIME	User	Develop		Potential User
	Polar Direct Drive	Develop	Potential		
	Indirect Drive Expl Push	Develop	Potential		
	THD Compton Radiogphy	Develop	Potential		
	Layered DT Implosions	Comm	Hifoot		Nucleo; Nucl phys
	Radchem	Develop	Potential		
Hohlraums & Plasma Physics	Viewfactor	Potential	Comm		Potential User
	Gas Bags	Comm	Potential	User	
	Rugby	Develop	Potential		

Experimental platforms that are developed by one program can be used by all users

Physics	Platforms	ICF	HEDSS	NSA	FS
Radiation-Hydro & Radiation Transport	1D Streaked ablator, D2	Comm	Hifoot		GBar
	1D Streaked ablator, THD	Develop	Potential		Potential User
	2D Imaged ablator, D2	Comm	Hifoot		
	2D Imaged ablator, THD	Develop	Potential		
	1D Imaged ablator	Comm			
	Reemission balls	Comm	Hifoot		
	HDC 1D Streaked ablator	Develop			
	HDC keyhole	Develop			
	Toto		Develop		
	Radiation Transport: Calorimetry		Comm; Pleiades Phase I		
	Pleiades Phase 2		Develop		
	Radiation Transport: Streaked		Comm		Abl RT
	SNRT				Develop

Experimental platforms that are developed by one program can be used by all users

Physics	Platforms	ICF	HEDSS	NSA	FS
Materials at High Pressure	Single axis, 2-axis, 3-axis keyhole	Comm	Hifoot, EOS, Strength Drive, Planar ablator		Potential User
	DT layered keyhole	Comm			
	HDC keyhole	Develop			
	Planar ablator		Develop		
	Crystal Ball	Potential	Develop		
	10 Mbar Ta Ramped Pulse EOS		Develop		C, Fe EOS
	22 keV Backlighter		Develop		Potential User
	10 Mbar Ta Ramped Material Strength		Develop		
	Diffraction		Develop		User

Experimental platforms that are developed by one program can be used by all users

Physics	Platforms	ICF	HEDSS	NSA	FS
Xray sources	EPEC			Develop	
	Low Debris X-Ray Sources: (4, 7, 13 keV)			Comm	Potential User
	High photon energy Xray calibration source	Develop	Potential User		
	Thermal backlighter sources (5 – 10 keV)	Develop	Potential User		

Summary: NIF is developing a wide range of capabilities and transitioning to user facility operation

- Shot rate has been increasing - budget limits total capability
  - Currently running target shots 5 days/week, 50 target shots Q1FY2013
- Selecting and planning experiments involves multiple considerations
  - Number of shot days available
  - Capabilities, e.g. new diagnostics and target types, BL delays, optics use
  - Facility configuration, e.g. DIM uniqueness, cryo vs room temp targets
  - Experimental readiness, e.g. new platforms
- Developing the platform is a primary challenge in fielding new experiments
  - Platform resource requirements are generally underestimated
  - We have modified a number of fundamental science experiments to better match current and future NIF platforms
  - Primary goal has been to get the groups started


NIF