



# **Path Forward for Fundamental Science at NIF**

**Presentation to  
NIF/JLF User Group Meeting  
February 11, 2013**

**C. Keane  
Director, NIF User Office**

# Elements of NIF as a user facility

## Facility management and governance



## Proposal submission, evaluation, award



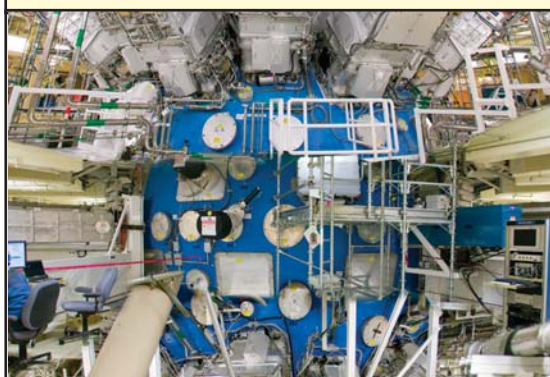
## Site access, office space, computer access



## User infrastructure (data access,...)



## Experimental planning and execution



## Data analysis and post-experiment support



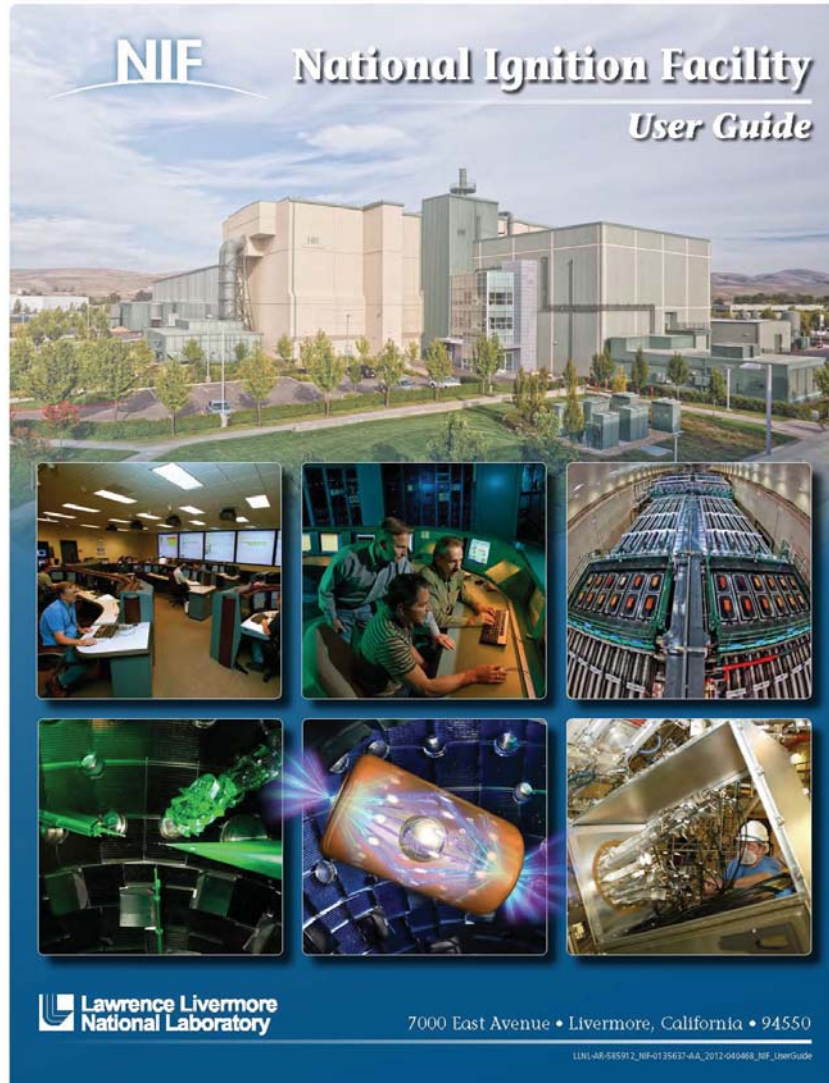
# The NIF Governance Plan was signed on October 1, 2012



- Defines the process for allocation of NIF facility time for all missions (Stockpile Stewardship Program (ICF and other HED science), National Security Applications, Fundamental Science)
- Modeled on DOE user facility best practices- includes peer review panels and a senior level external committee for input on facility strategic direction and related topics
- NIF Science Technical Review Committee (TRC) fulfills the peer review role for fundamental science



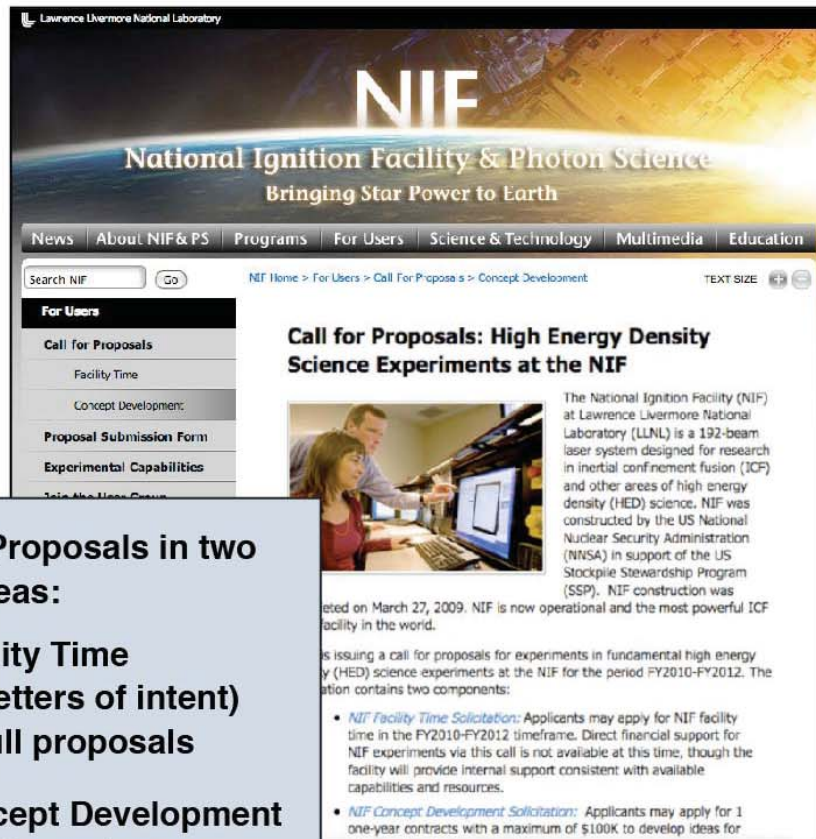
# The NIF User Guide (v1.0), available on the NIF website, includes a wide variety of information



## Key individuals for experimental preparation and execution

- **Authorizing Individuals (AIs)- Program:** Principal Investigator and NIF Fund. Science manager- responsible for authorization of campaign and experiments
- **Authorizing Individuals-Facility:** NIF Operations Manager and NIF Experiments Leader- responsible for final authorization of expts.
- **Responsible Individual (RI)-** lead NIF experimentalist/liaison
- **Project Engineer-** responsible for integration and process workflow
- **Diagnostic Responsible Scientist (RS)-** responsible for ensuring quality data delivered to RI

# Call for proposals for fundamental science at NIF received a strong response





## Call for Proposals in two major areas:

- **Facility Time**  
(44 letters of intent)  
40 full proposals
- **Concept Development**  
(\$100k maximum  
1 year awards)  
(42 proposals)


DRAFT- PREDECISIONAL

## National Ignition Facility Governance Plan

August 31, 2009

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**Proposed NIF experiments will be reviewed  
by an advisory committee chaired  
by Dr. Robert Rosner**

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# NIF concept development competition — work is complete on all 14 contracts

Principal Investigator	Topic	Research area
Bradley, J. (LLNL)	Interstellar dust grains	Astrophysics
Liang, E. (Rice)	Collisionless Shock Experiments at the NIF	Astrophysics
Niemann, C. (UCLA)	Collisionless Shocks and the Origin of Cosmic Rays	Astrophysics
Wei, M. (GA)	Nonlinear evolution of the Weibel instability of relativistic electron beams	Astrophysics
Pound, M. (Maryland)	Dynamics of the Eagle Nebula	Hydrodynamics
Drake, P. (Michigan)	Astrophysically Relevant Turbulence on NIF	Hydrodynamics
Kuranz, C. (Michigan)	Imaging scattered x-ray radiation	Hydrodynamics
Plewa, T. (FSU)	Core-Collapse Supernova Explosion Mechanism Studies	Hydrodynamics
Duffy, T. (Princeton)	Development of a New Materials Platform	Materials
Jeanloz, R. (UC Berkeley)	Next-Generation Tunable Targets for Laser-Compression	Materials
Stewart, S. (Harvard)	Recovering Large Volumes of Shocked Water	Materials
Yoo, C-S. (WSU)	Structure and Bonding in Carbon	Materials
Antonsen, T. (Maryland)	Relativistic Plasma Physics at the NIF	Plasma physics
Seely, J.(ARTEP Inc.)	High Resolution K Shell X-Ray Spectroscopy Experiments	Plasma physics

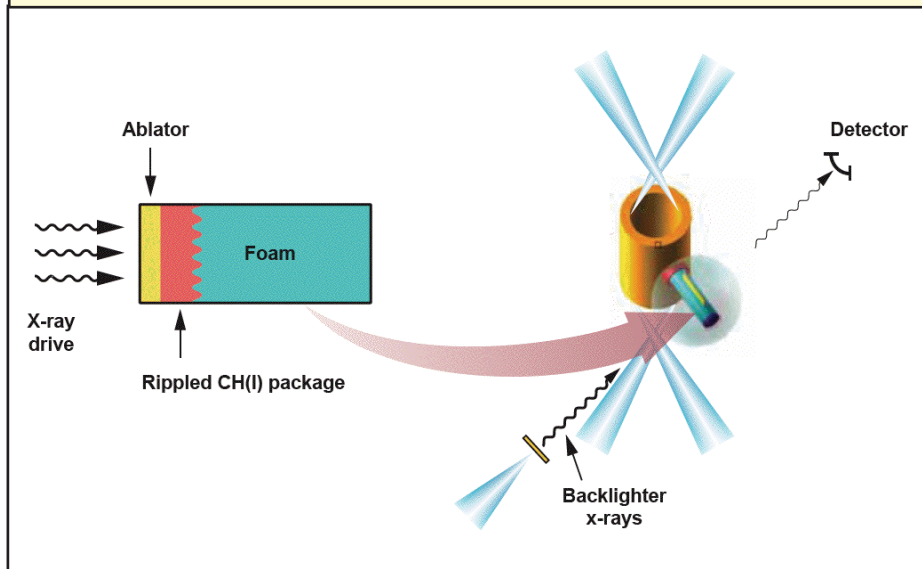
# NIF Fundamental Science Program consists of 10 experiments covering a wide range of topics

Topic	PI Last	PI Institution	NIF experimentalist
Carbon and Iron Equation of State	T. Duffy/ R. Jeanloz	Princeton/UCB	R. Smith
Supernova hydrodynamics-Radiative Effects (Rad SNRT)	C. Kuranz	Univ. of Michigan	H. Park
Novel phases of compressed diamond	J. Wark/ J. Eggert	Oxford/LLNL	J. Eggert
Nucleosynthesis and the s-process	L. Bernstein	LLNL	L. Bernstein
Rayleigh-Taylor instability and astrophysical implications (merged proposal)	A. Casner/ V. Smalyuk	CEA	V. Smalyuk
	J. Kane	LLNL	
Matter at ultra-high densities (merged proposal)	P. Neumayer	GSI	T. Doeppner
	R.Falcone	UC Berkeley	
Hydrogen and methane at ultra-high pressures (merged proposal)	R. Jeanloz	UC Berkeley	P. Celliers
	R. Hemley	Carnegie Institution of Washington	
Diverging Supernova hydrodynamics	T. Plewa	FSU	H. Park
Astrophysical collisionless shocks (merged proposal)	Y. Sakawa	Osaka University	H. Park
	G. Gregori	Univ. of Oxford	
Relativistic pair plasmas	H. Chen	LLNL	H. Chen

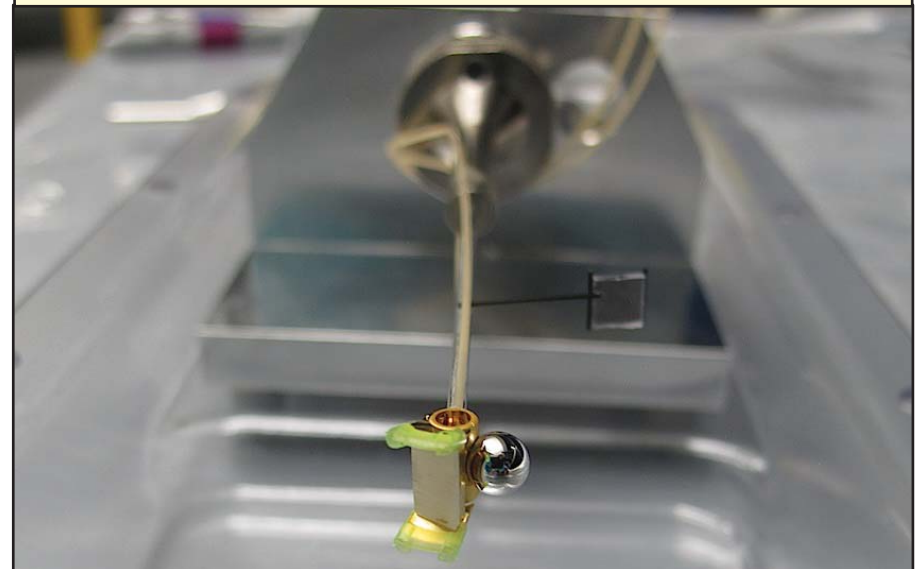


# The Rad SNRT team executed a background test shot on Sept. 25, 2012 (shot N120925-003)

## Experimental configuration



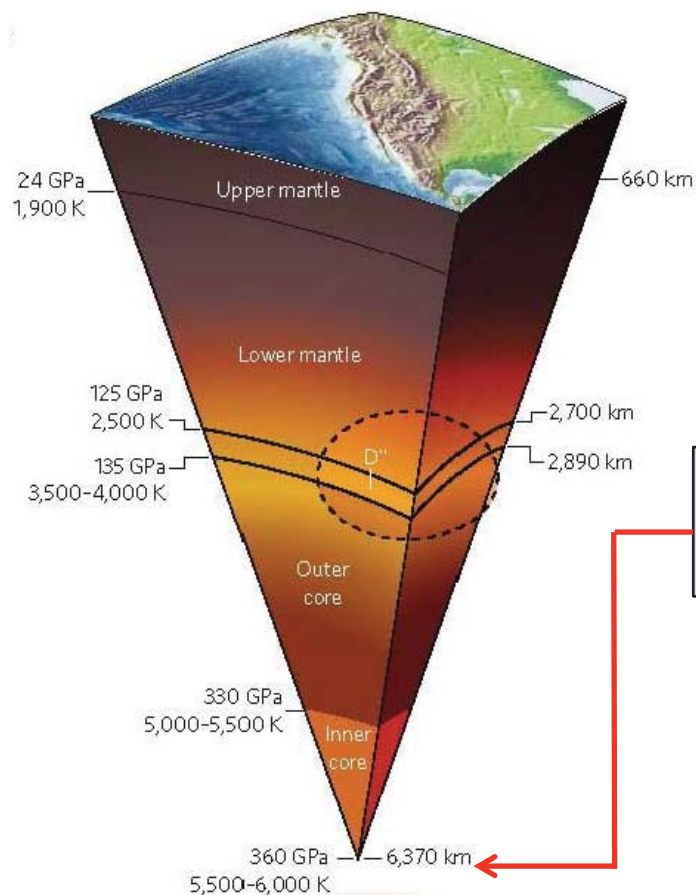
## Actual target



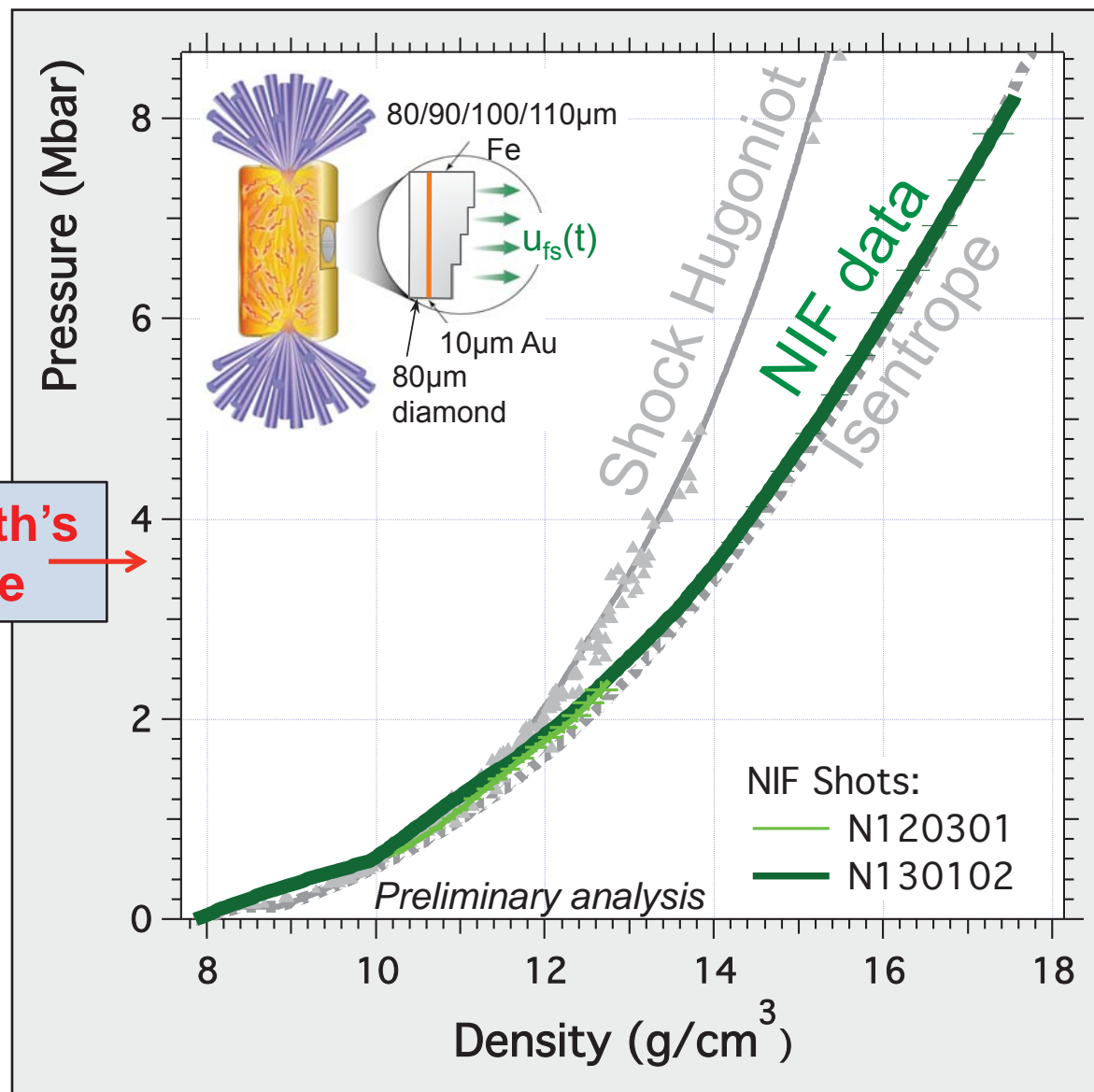
**Reduced hohlraum background by  $\sim 100\times$ , but still  $\sim 10\times$  too high; redesigned expt. using area backlighter reviewed by NIF Science TRC Jan. 7-8, 2013**



# Shot N130102 provided Fe EOS data up to 2x pressure of Earth's core



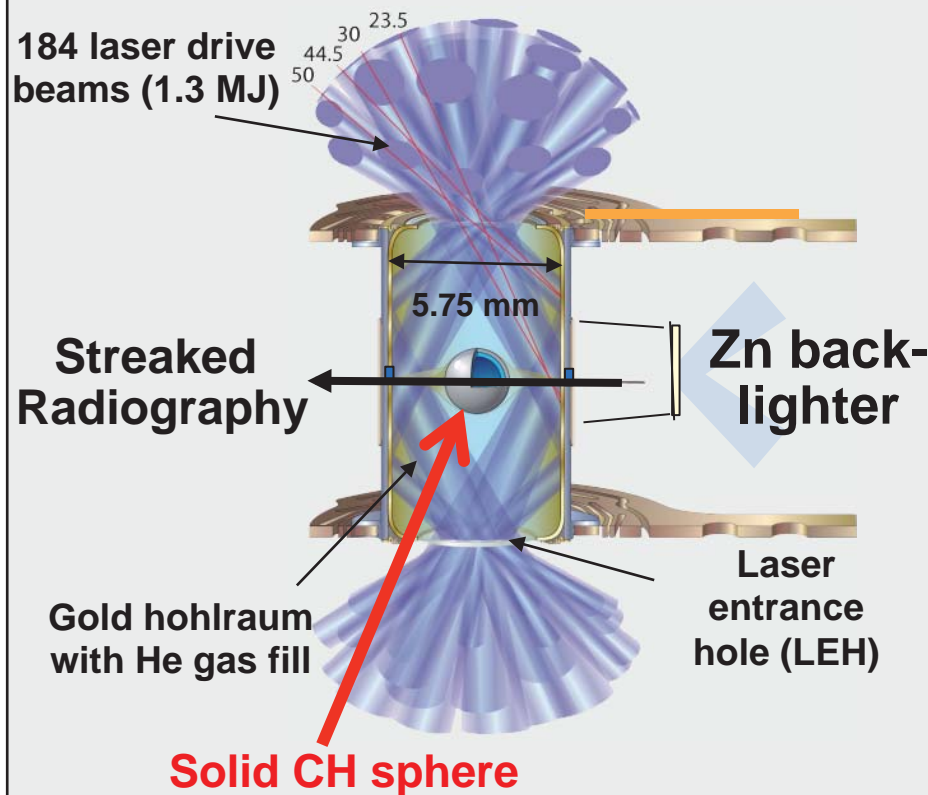
**Earth's Core**



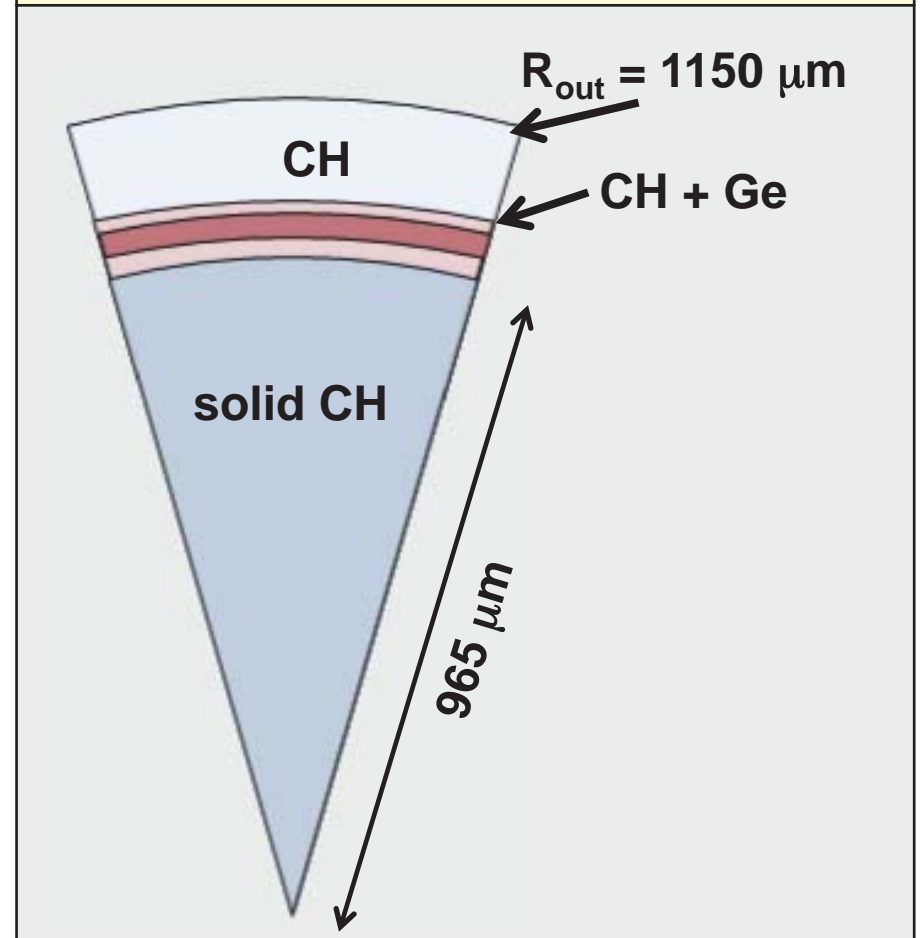
R. Smith, J. Eggert, D. Braun, R. Patterson,  
G. Collins et al. (LLNL), R. Jeanloz (UCB),  
T. Duffy (Princeton)

# We use a modification of the ICF “convergent ablator” platform to study matter at Gbar pressures

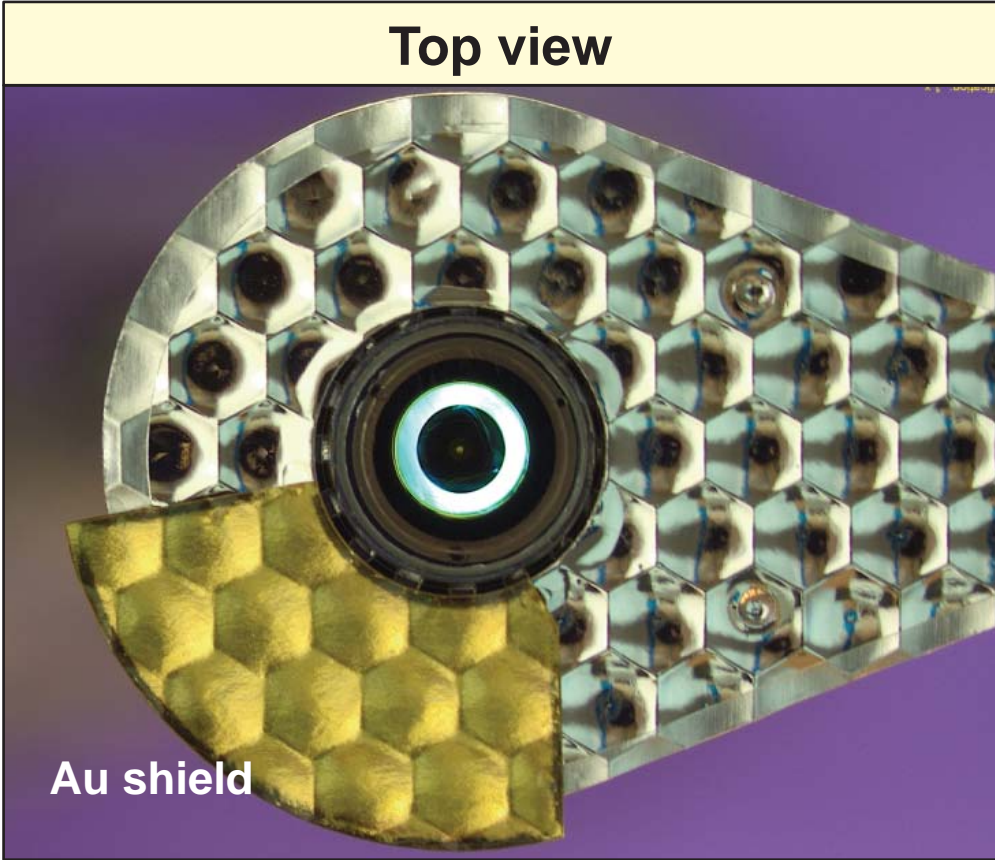
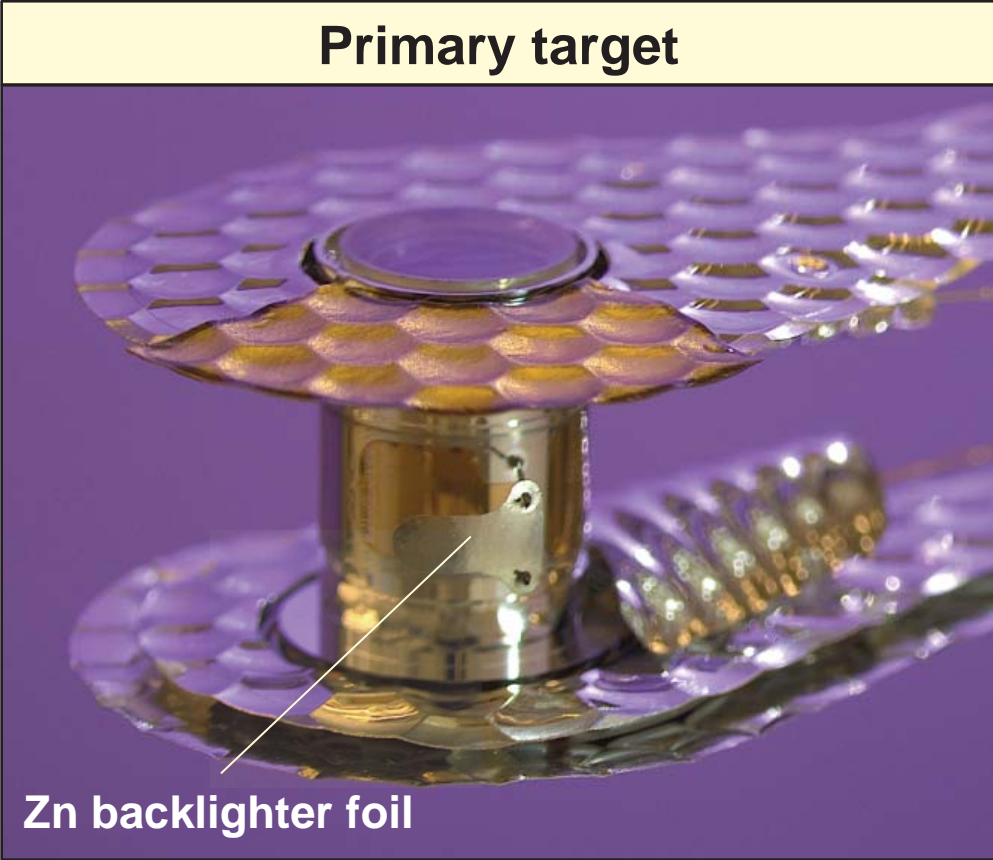
## Gbar Equation of State Experimental configuration



## Capsule design



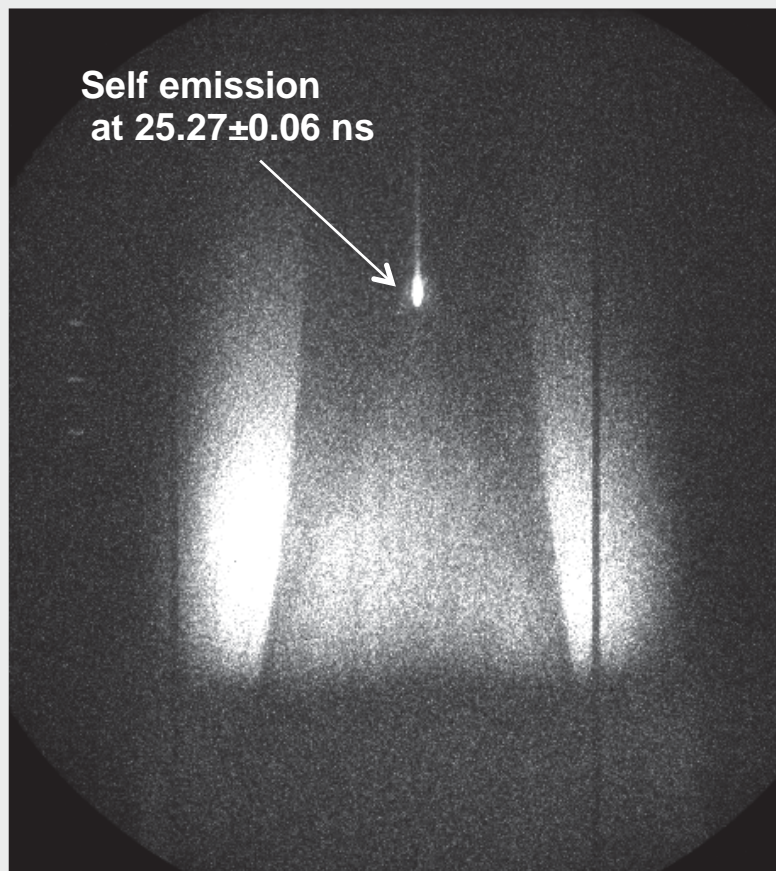
# The first Gbar EOS target was fielded on January 3<sup>rd</sup> 2013



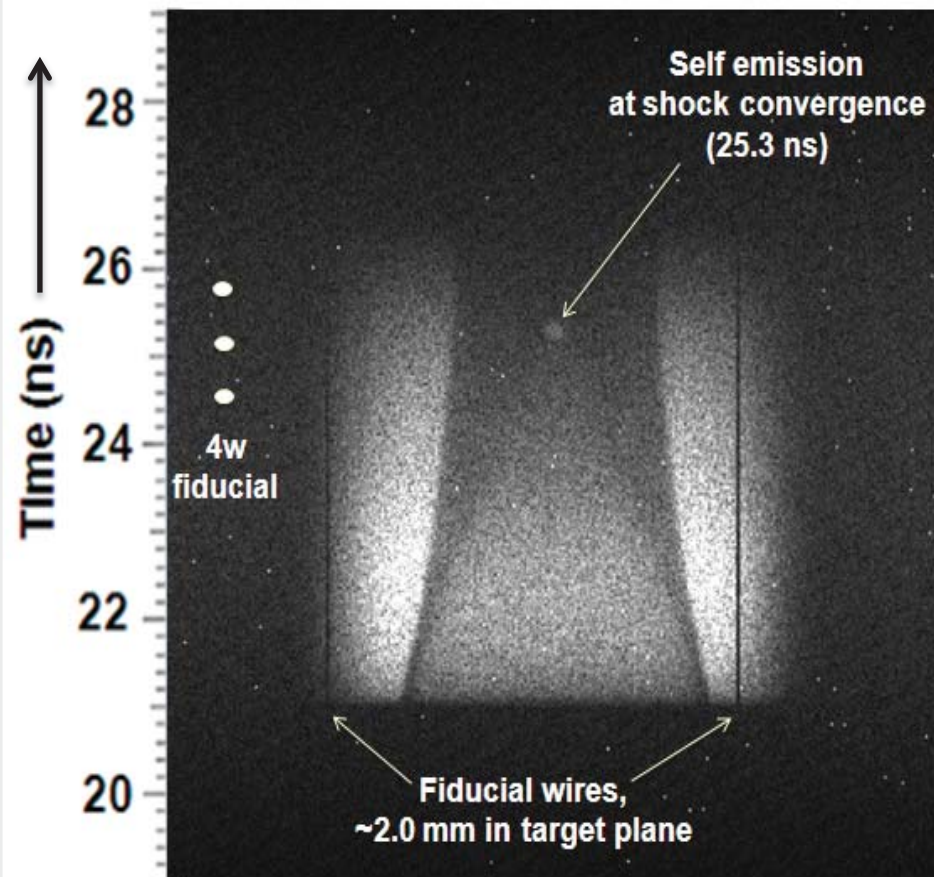


# Experimental data show excellent agreement with pre-shot simulations

Radiography data  
taken on N130103



Pre-shot simulated radiograph

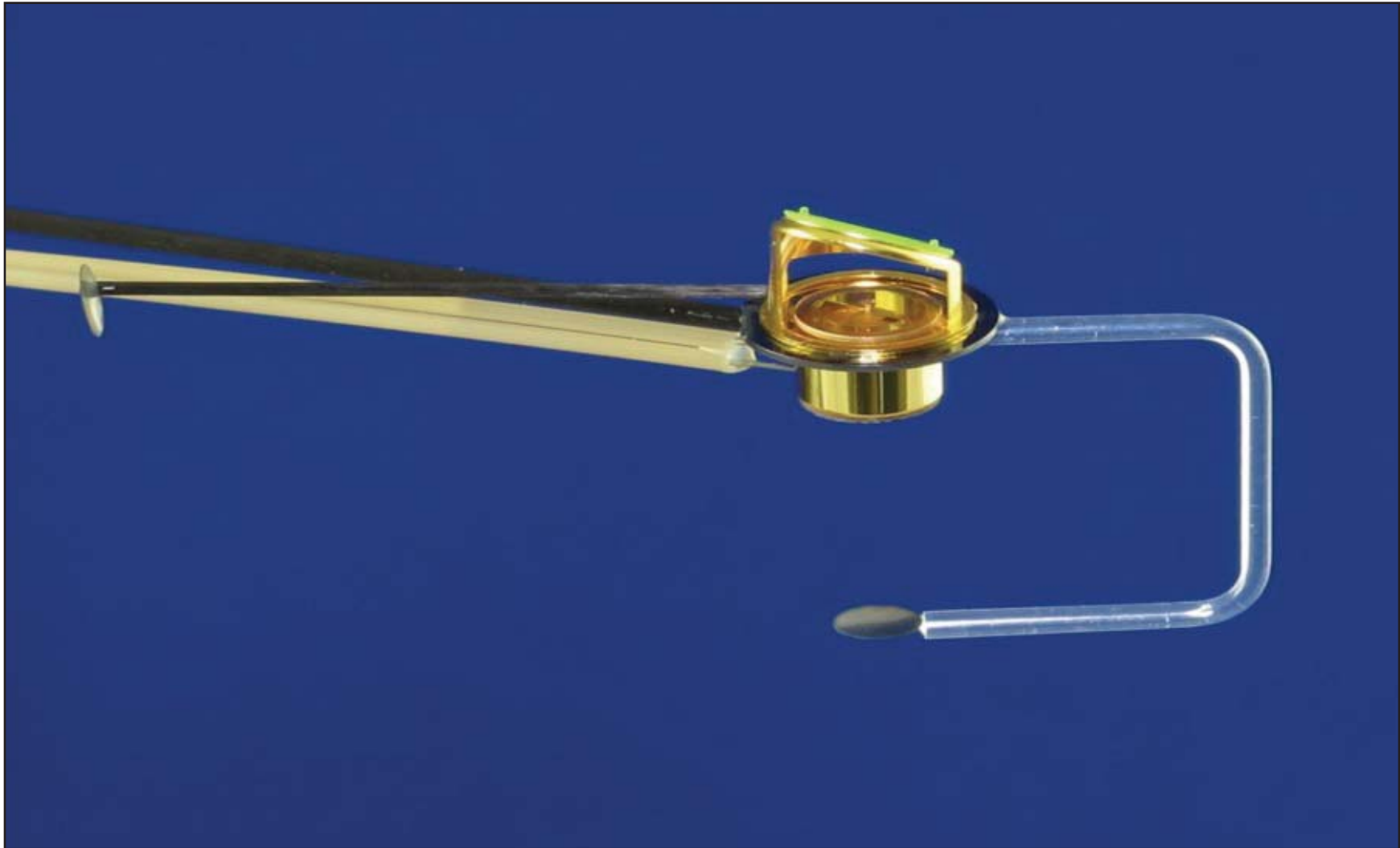


A. Kritcher, J. Hawreliak

Inferred peak pressure is 700MBar;  
analysis of radiograph underway



# First ablative Rayleigh-Taylor experiment to test “side-on” and “face-on” backlighting set for March 2013



# NIF fundamental science experiments – status

Topic	PI Last	PI Institution	Status
Carbon and Iron Equation of State	T. Duffy/ R. Jeanloz	Princeton/ UCB	C EOS experiments complete, publication being prepared; Fe EOS underway, ablator redesign needed (Total 6 C shots, 3 Fe shots)
Supernova hydrodynamics- Radiative Effects (Rad SNRT)	C. Kuranz	Univ. of Michigan	Experiment redesigned to account for x-ray background issues; 2 test shots reviewed by NIF Science TRC and recommended for execution
Novel phases of compressed diamond	J. Wark/ J. Eggert	Oxford/ LLNL	Diagnostic under development; first shots anticipated Q4FY2013
Nucleosynthesis and the s-process	L. Bernstein	LLNL	Original proposed work complete with ~ 50 “ride-along” shots; low energy neutron spectrometer required for further progress.
Rayleigh-Taylor instability and astrophysical implications (merged proposal)	A. Casner/ V. Smalyuk	CEA	Extensive preparation for 1 <sup>st</sup> shot complete; backlighter test shot scheduled for March 2013.
	J. Kane	LLNL	

## NIF fundamental science experiments – status (cont.)

Topic	PI Last	PI Institution	Status
Matter at ultra-high densities (merged proposal)	P. Neumayer	GSI	First experiment in convergent geometry (R. Falcone portion of proposal) executed Jan. 3, 2013; x-ray Thomson scattering diagnostic under development.
	R. Falcone	UC Berkeley	
Hydrogen and methane at ultra-high pressures (merged proposal)	R. Jeanloz	UC Berkeley	Plans underway to execute using a version of NIC “keyhole” target.
	R. Hemley	Carnegie Institution	
Diverging Supernova hydrodynamics	T. Plewa	FSU	Initial experiments now focused on diagnostic development.
Astrophysical collisionless shocks (merged proposal)	Y. Sakawa	Osaka University	Initial experiments now focused on diagnostic development.
	G. Gregori	Univ. of Oxford	
Relativistic pair plasmas	H. Chen	LLNL	Deferred until ARC available; implementation of improved gamma-ray spectrometer at Omega under consideration for mitigation.

# NIF fundamental science experiments – current proposed plan for remainder of FY2013

	Q2FY2013	Q3FY2013	Q4FY2013	Total	Comment
Fe EOS	2			2	Examining ablator design
AbIRT	1	1	1	3	
Gbar	1	1	1	3	
Diffraction			2	2	
Rad SNRT		1	1	2	Proceeding per NIF Science TRC (detailed schedule TBD)
Collisionless Shock					Investigate 1 Q4 opp. shot-diagnostic test
Div. SNRT					Investigate 1 Q4 opp. shot-diagnostic test
TOTAL	4	3	5	12	

A final version of this proposed plan will be submitted to the Fundamental Science Change Control Board (CCB) shortly



# **The NIF Director requested the NIF Science Technical Review Committee (TRC) to review the path forward for the NIF Fundamental Science Program**

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- **Committee general charter:**
  - **Provide a critical and independent peer review of all fundamental science experiments proposed at the NIF**
  - **Serve as an advisory group for the NIF director on the strategic direction for NIF to ensure that NIF is acknowledged as a premier user facility for high quality leading edge science**
  - **Review and provide advice, as needed, on the operation of NIF as a user facility in support of the broad fundamental science community**
  - **Play a critical role in helping establish a first rate fundamental science program at NIF and transitioning the facility to a major national user capability**
  
- **Specific charge for Jan. 7-8, 2013 meeting:**
  - **Recommend a path forward for the NIF fundamental science program, factoring in the relative scientific merit and complexity/difficulty of planned experiments**
  - **Provide input regarding scientific merit and priority for particular aspects of experiments (specific questions to be provided)**

# Based on the committee report, we are developing a modified proposal process for science on NIF for your comment

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- **Guiding principle: Follow best practices for user facility operation**
  - Perform the best science
  - Peer-review based proposal process, with timely experimental execution
- **Key elements of new proposed process**
  - Two scores (scientific merit, “campaign readiness”) to be used
  - Phased approach to experiment proposal and execution
    - a) Experimental concept development (discuss w/ NIF staff to identify platform- no shots assumed)
    - b) Platform development if needed
    - c) Data acquisition
  - Proposals to be reviewed prior to proceeding to each phase
  - Proposals to be solicited every 12-18 months, with corresponding timeframe for shots
  - Committee recommendation on accepted proposals includes designation as either phase a, b, or c
  - Approved shots in phase b or c to go on facility schedule immediately following NIF Director approval of committee recommendation

**Experiments requesting new or existing platforms will be considered**

NIF

