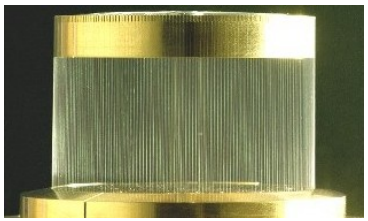
Pulsed power is an enabling technology to create and study matter at high energy densities

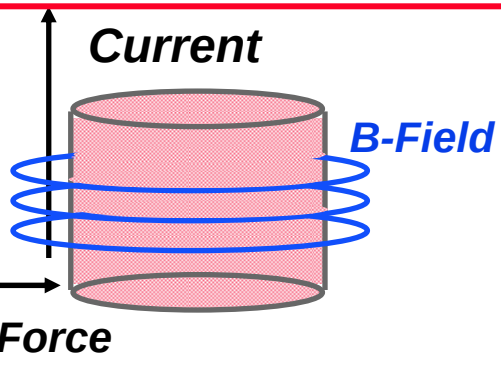
SAND2009-4728P

High Current

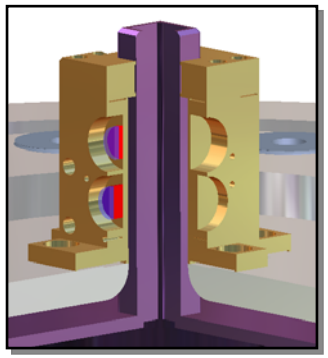
Z-pinch x-ray source

wire array

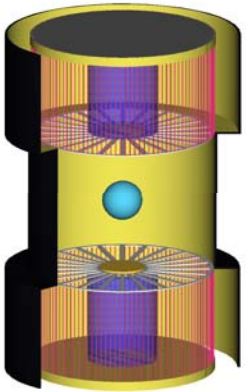




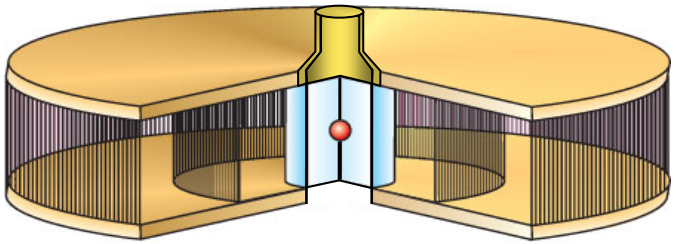
Magnetic pressure



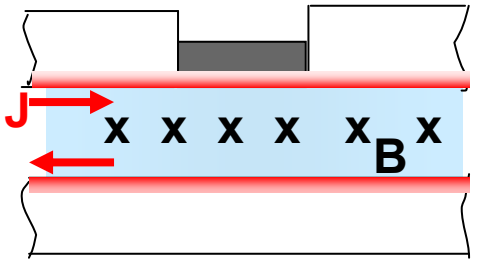
Fusion



Radiation Science



Material Properties



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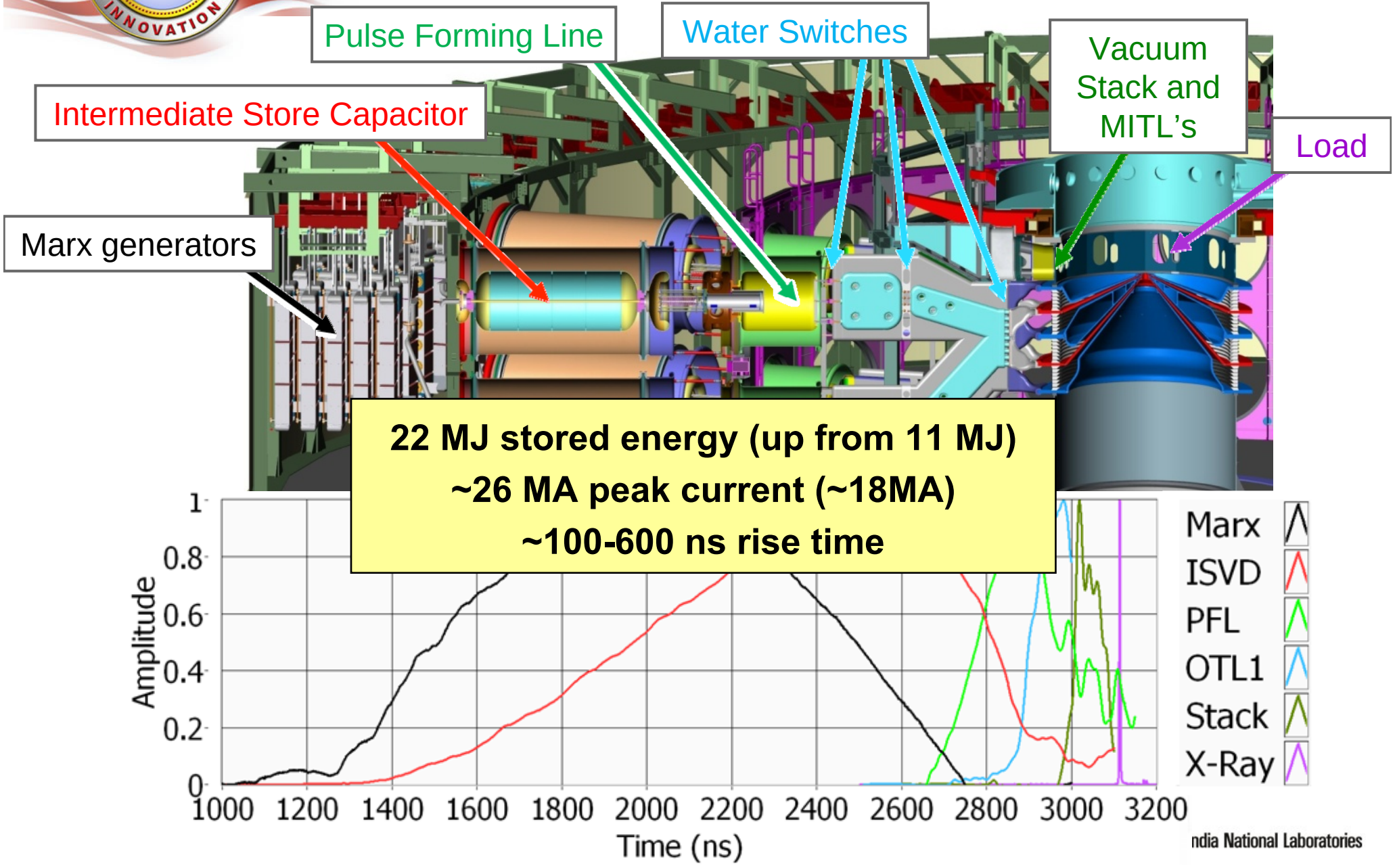
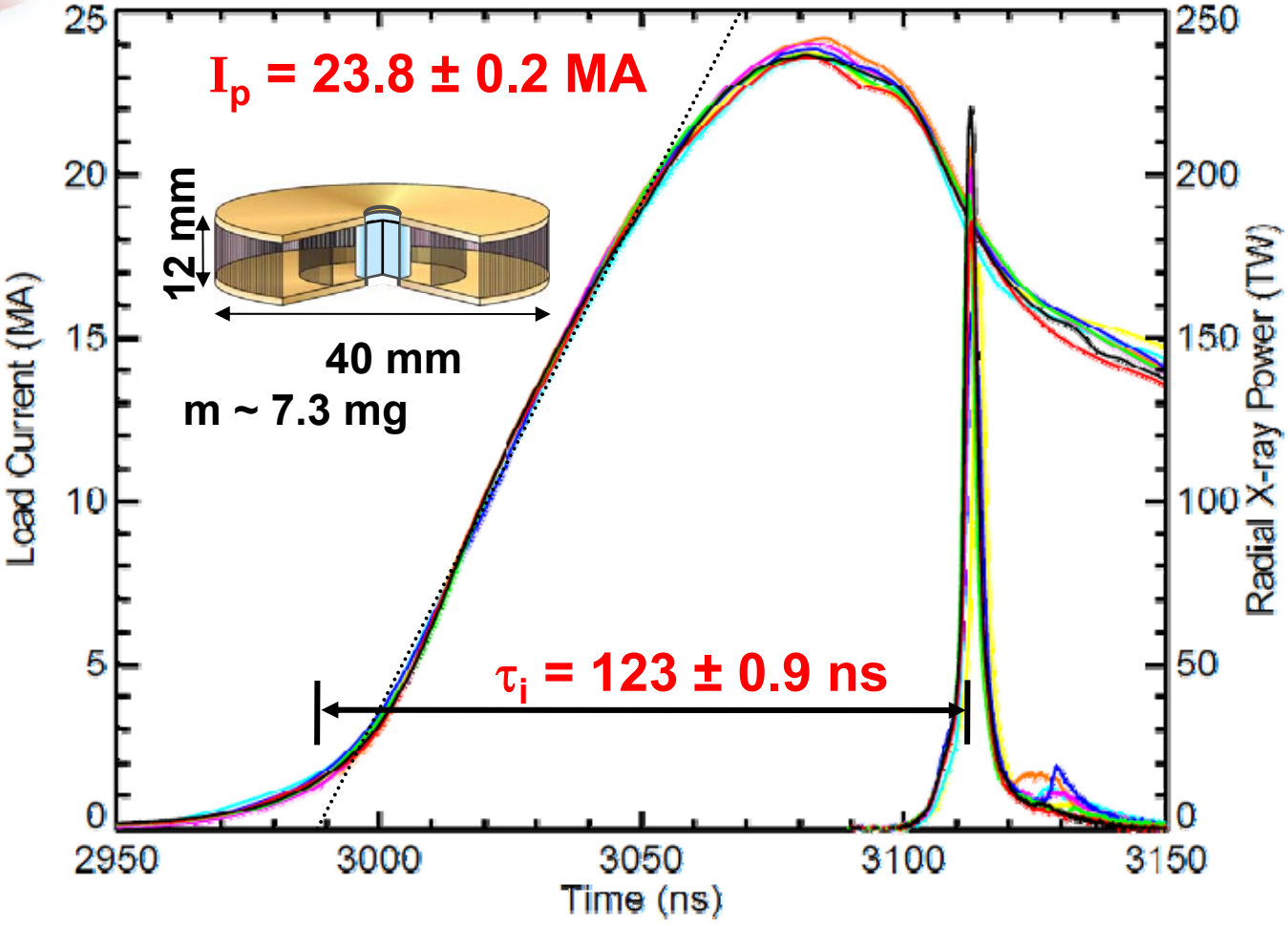
Energy is compressed in time and space with ~15% efficiency from wall plug to x-ray radiation

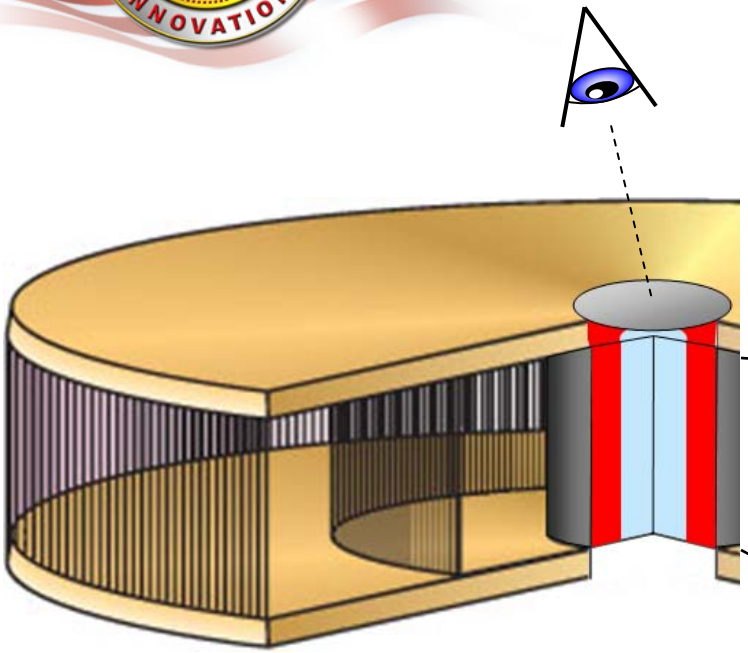


Refurbished Z has delivered world-record currents to Dynamic Hohlraum Z-pinch loads with < 1% shot-to-shot variation



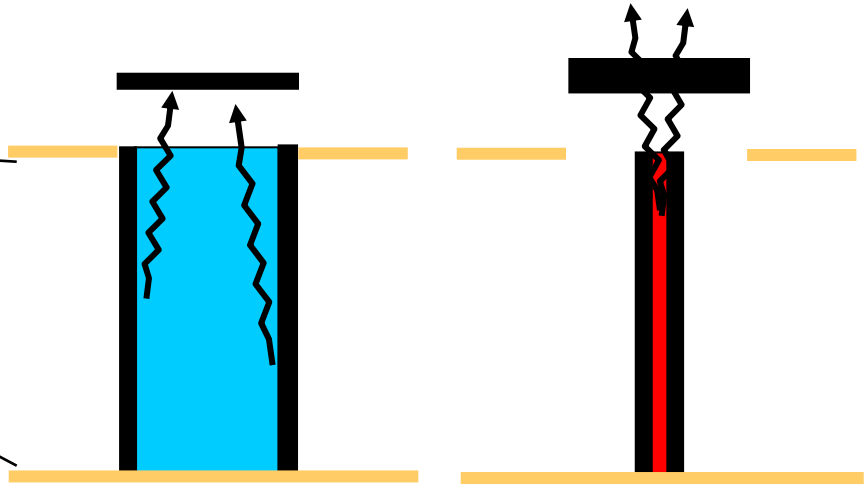
This reproducible, bright (~200 TW) source is ideal for opacity experiments

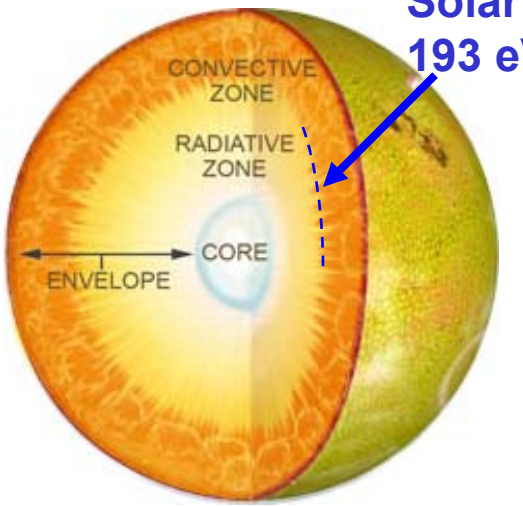
Opacity measurements on the refurbished Z are close to replicating solar interior matter



Foil is heated during the DH implosion

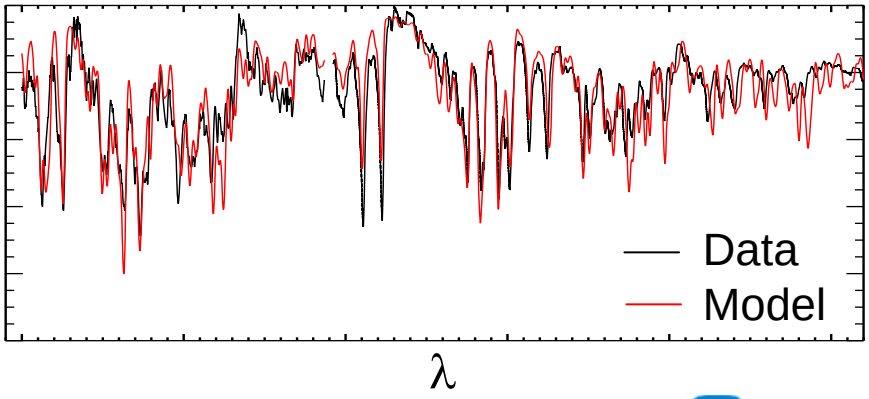
Foil is backlit at stagnation





Solar CZ boundary
193 eV, 10^{23} cm^{-3}

Fe transmission @ Te = 156 eV



2007 Don Dixon / cosmographica.com

Bailey *et al.*, PRL **99**, 265002 (2007).

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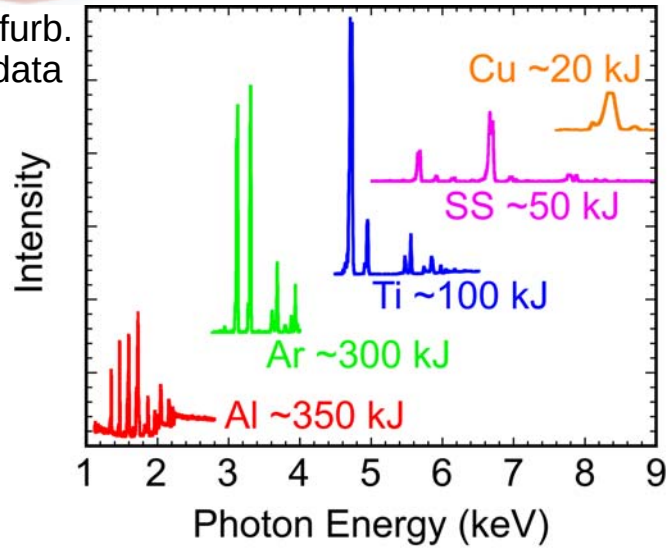
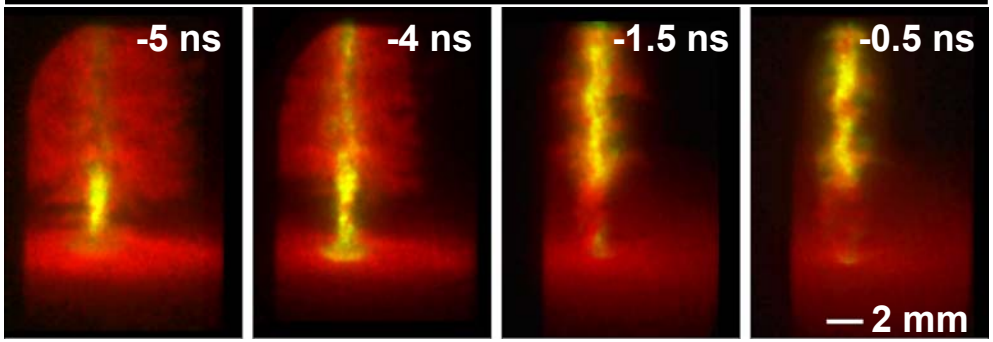
Z-pinch implosions provide intense 1-10 keV x-ray sources for radiation effects studies on Z

Pre-refurb. Z data



Coverdale *et al*., IEEE T. Plasma Sci. **35**, 582 (2007).

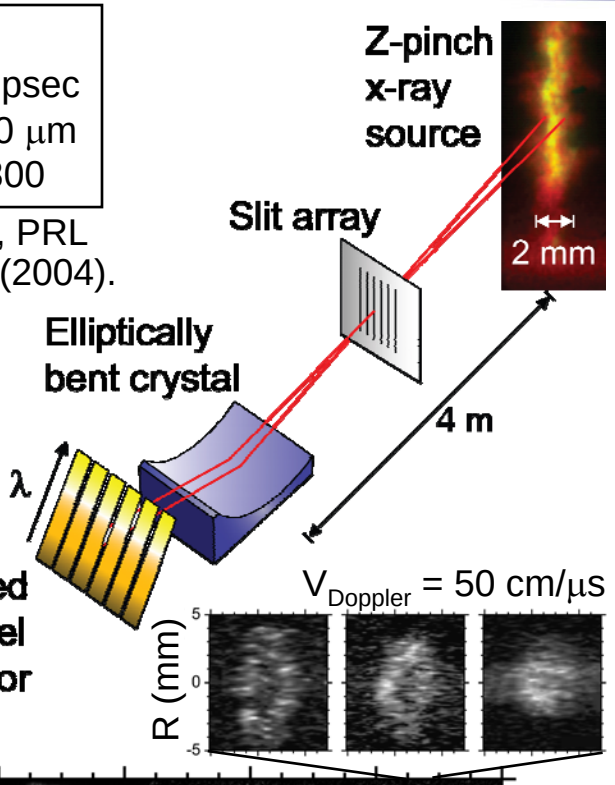
Multi-color x-ray imaging, Ø60 mm nested Cu arrays

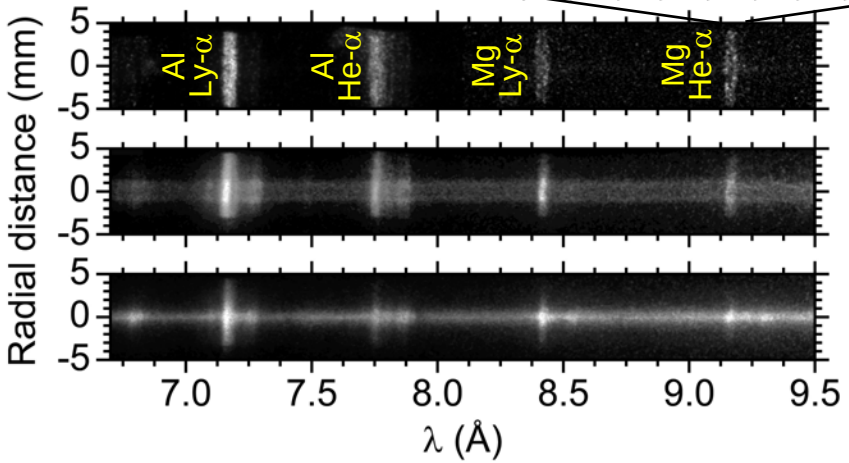


Jones *et al.*, RSI **77**, 10E316 (2006).

Resolution:
Time ~ 350 psec
Space ~ 220 μm
Spectral ~ 800

Bailey *et al*., PRL **92**, 085002 (2004).





Al/Mg wire array

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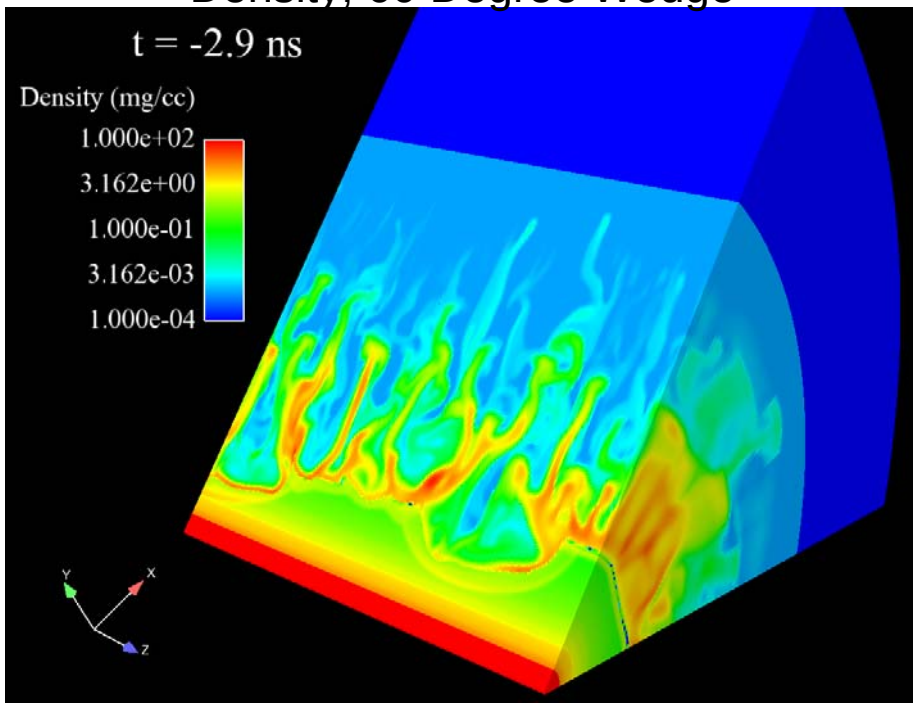
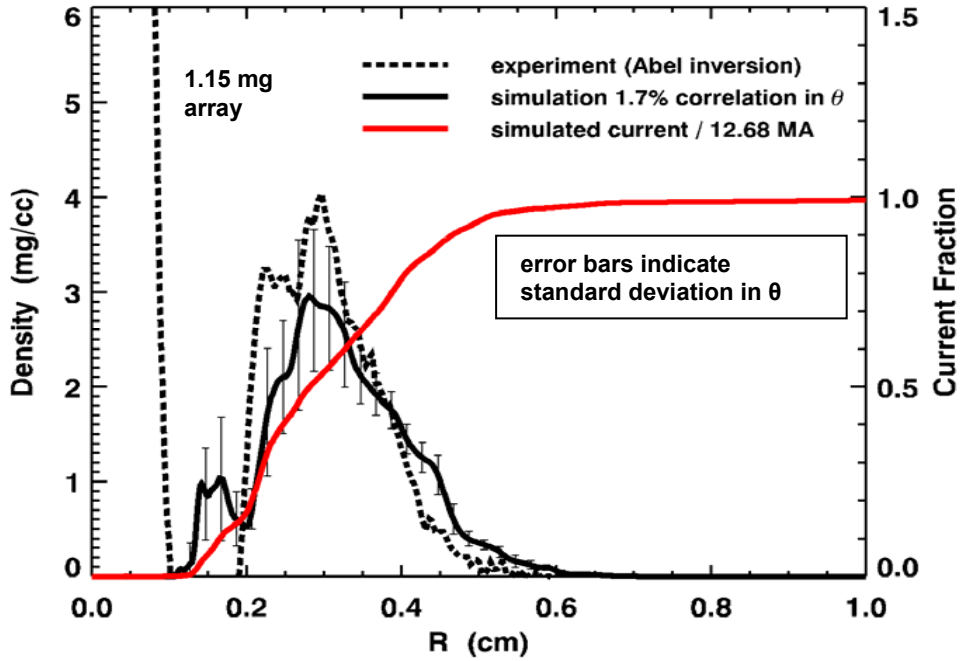
3D Rad/MHD simulations are becoming essential tools in understanding magnetically-driven implosions

Density, 60 Degree Wedge



Yu *et al*., PoP **15**, 056301 (2008).

Z-Pinch Plasma Density vs. R



Sinars *et al*., PRL **100**, 145002 (2008).

3D (and even 2D!) Rad/MHD codes are essential tools. Many issues remain to be worked through and benchmarked with experimental data.

The physics of shorting/current delivery is important to study and understand

Simulations can help optimize arrays for different objectives

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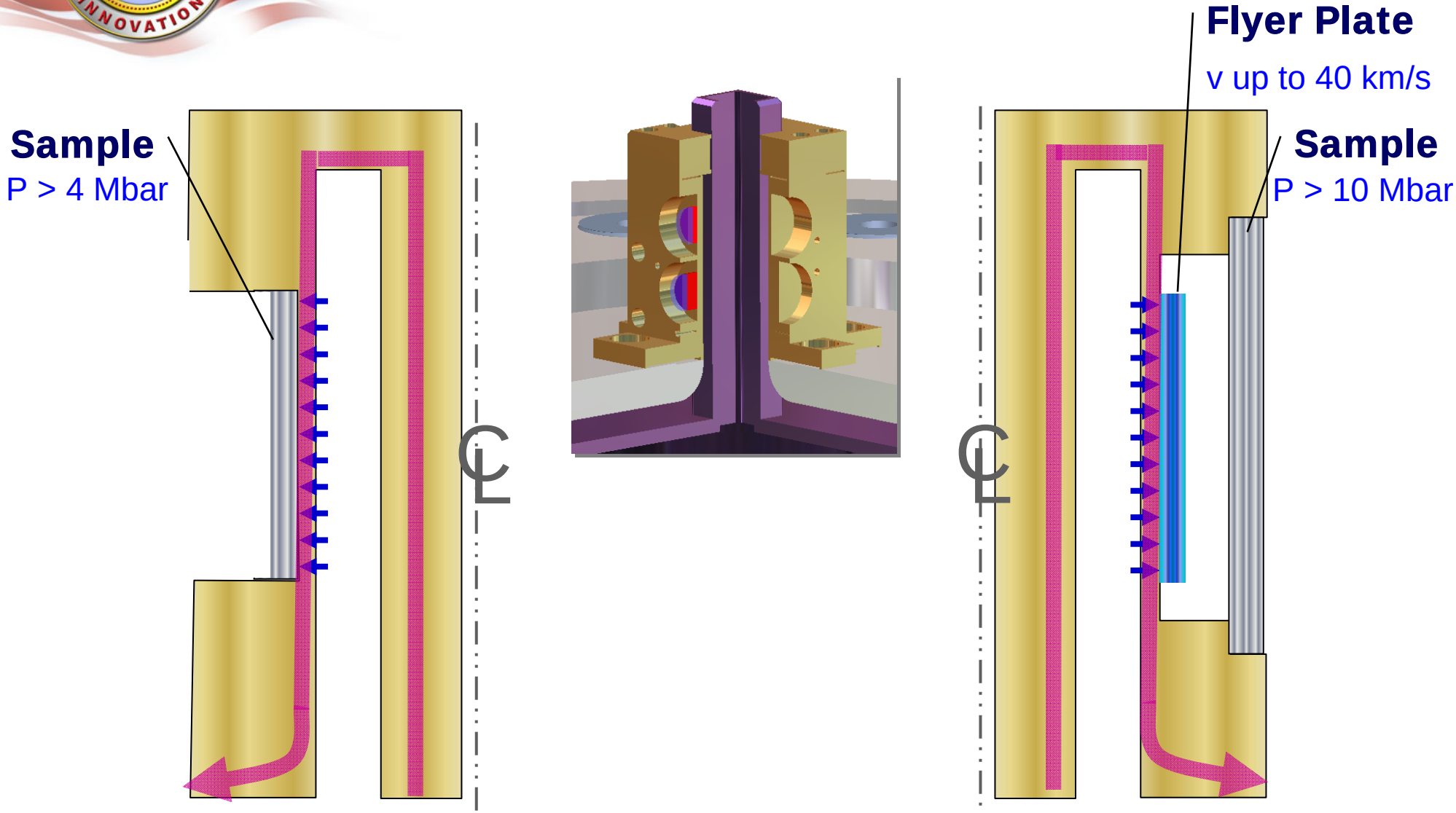
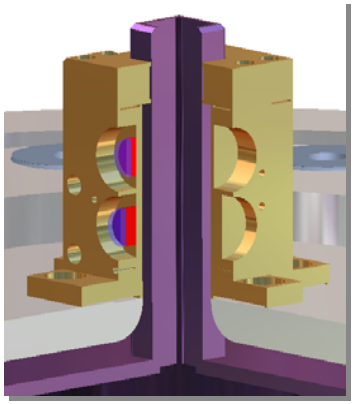
Isentropic compression and shock wave experiments are both possible on Z



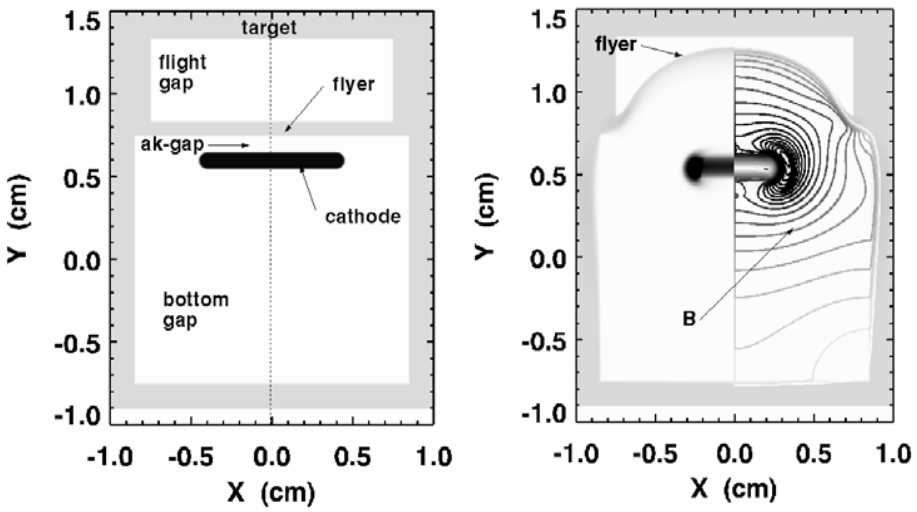
Isentropic Compression Experiments:
gradual pressure rise in sample

Shock Hugoniot Experiments:
shock wave in sample on impact

Our MHD simulation capability is a powerful design tool

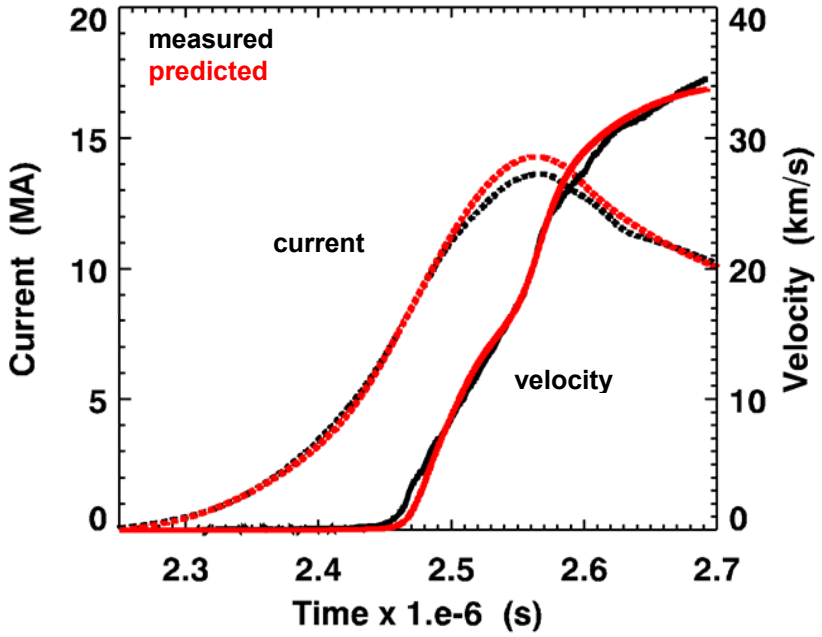


DFT based material models gave us predictive capability
ASC codes enable optimized experiments



R. W. Lemke *et al.*, *J. Appl. Phys.* **98**, 073530 (2005)

Measured / predicted current & flyer velocity (850 μm Al)



In 2-D, 10^6 elements, 160 CPUs, 4 hours (T-Bird)

In 3-D, up to 10^8 elements, 8192 CPUs, 300 hours (ASC Purple)

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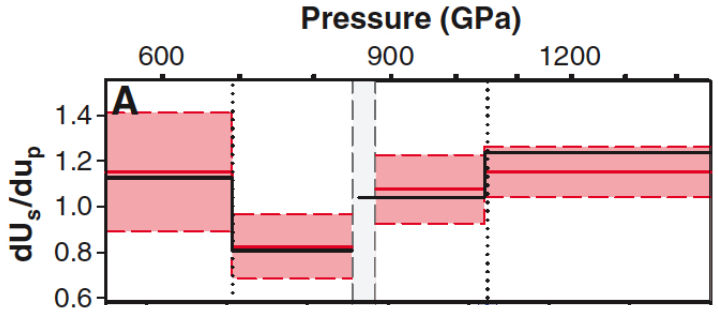
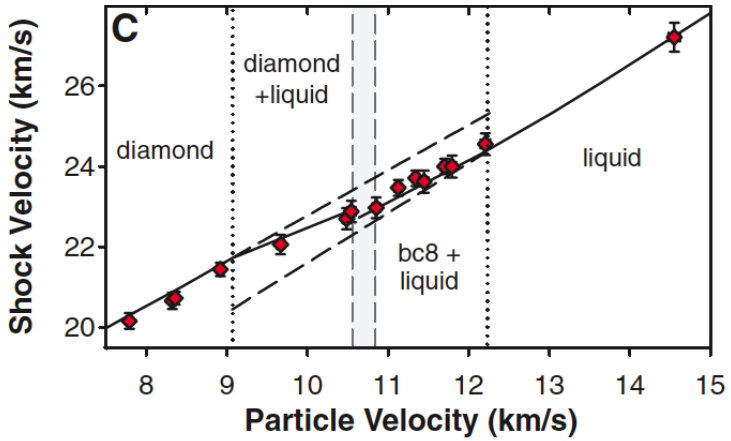
QMD calculations predicted measurable changes in the shock velocity at the phase boundaries



QMD predictions in black

Z data in red



Shock-Wave Exploration of the High-Pressure Phases of Carbon

M. D. Knudson,* M. P. Desjarlais, D. H. Dolan

19 DECEMBER 2008 VOL 322 **SCIENCE**

Melt onset: 6.9 Mbar
Melt completion: 10.4 Mbar
First experimental evidence for BC8 phase in carbon

Impacts ICF and planetary science, validates theory

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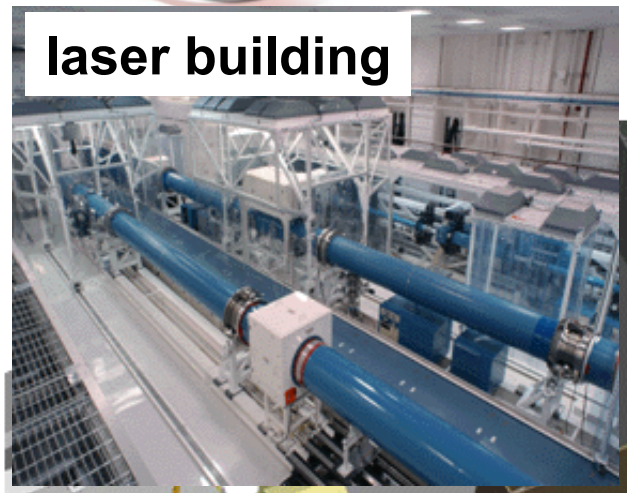
The Z-Beamlet and Z-Petawatt laser backlighters provide a powerful new capability for diagnosing Z experiments

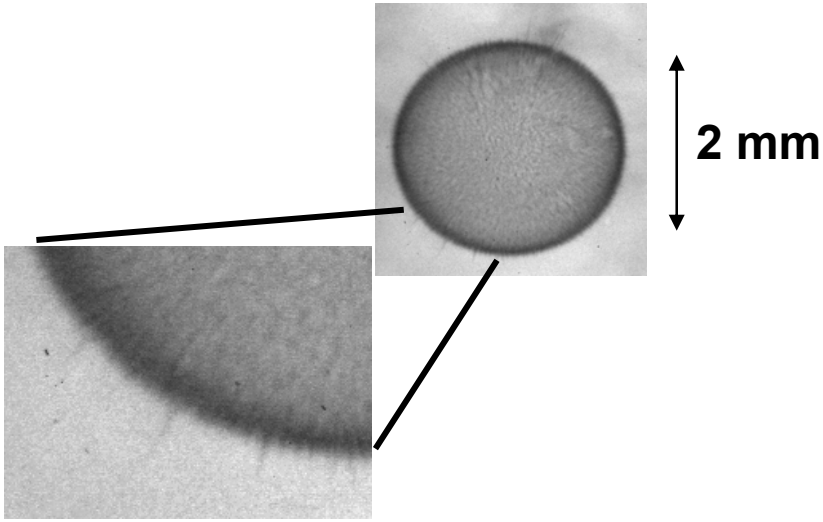
laser building



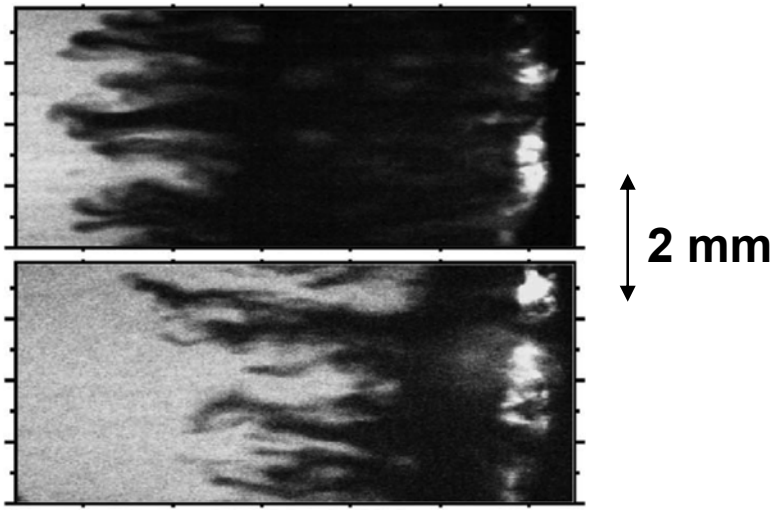
Z facility

Z-Beamlet and Z-Petawatt lasers

imploding capsule



imploding z-pinch



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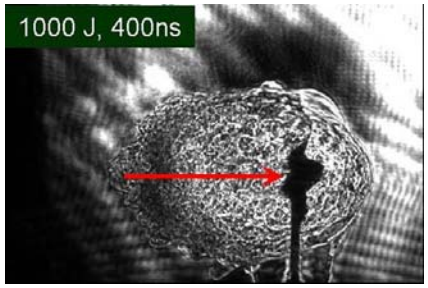
The Z and Z Backlighter Facilities have an active collaboration with University students and faculty

Have explored the physics of high Mach number radiative shocks, such as those found in supernova remnants

Edens et. al., Physical Review Letters, 95, 244503 (2005)



Future experiments are planned to study the equation-of-state of warm dense matter and the confinement of a high energy density plasma by a strong magnetic field

Z Facility Basic Science Call for Proposals due out in September 2009.

To propose experiments contact:

Z Facility	Mike Lopez mrlope@sandia.gov
Z Backlighter	Briggs Atherton bwather@sandia.gov

Questions?	Brent Jones bmjones@sandia.gov

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