Sandia National Laboratories

28 July 2009

An Overview of SNL facilities and user access

John Porter

Workshop on Science with High-Power Lasers and Pulsed Power

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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The Z, Z-Beamlet, and Z-Petawatt facilities are all available for HED science experiments

Z pulsed power facility

Z accelerator

Z-Beamlet and Z-Petawatt lasers

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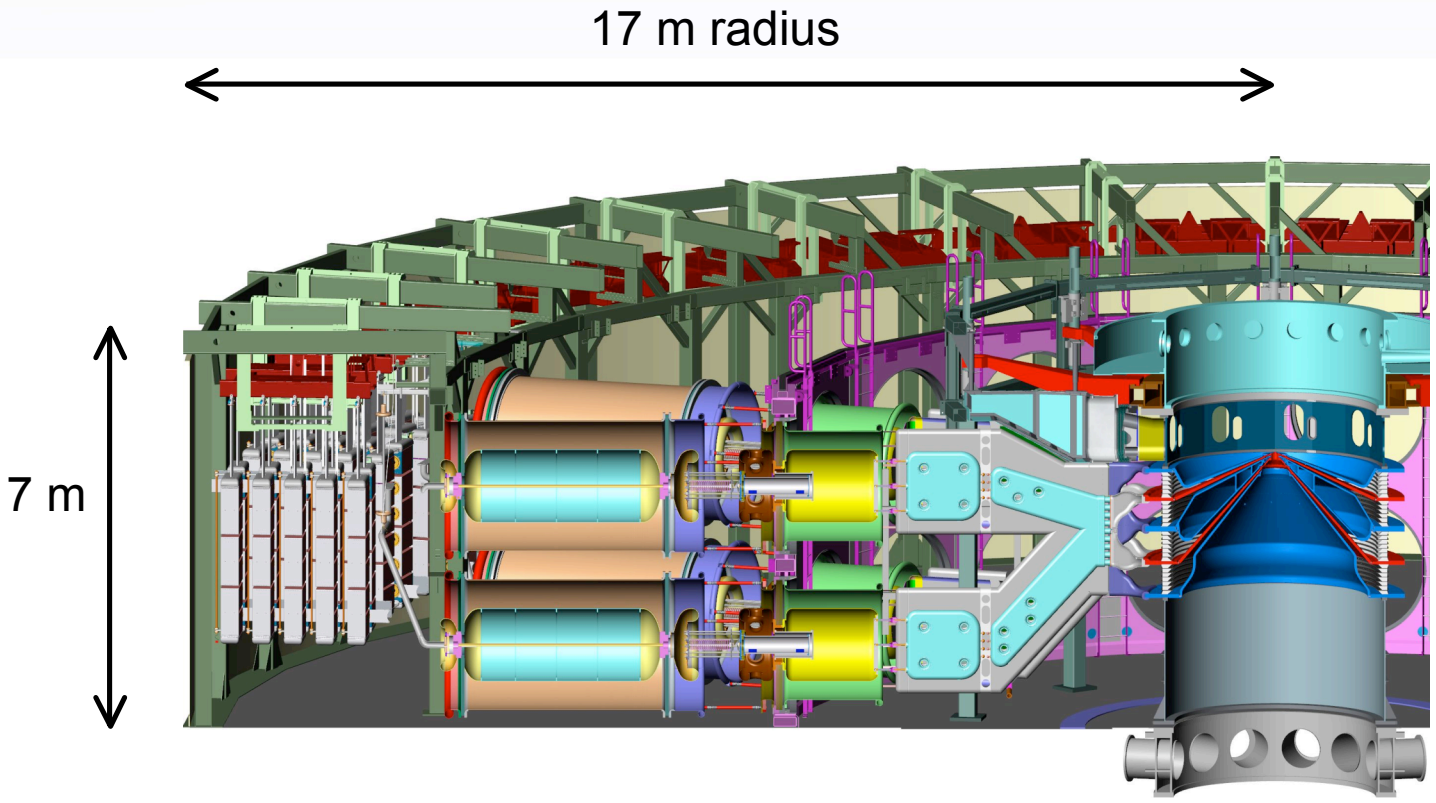
The Refurbished Z Machine has more energy and more pulse shaping flexibility



22 MJ stored energy (up from 11 MJ)

26 MA peak current (up from 18 MA)

100 TW peak electrical power (up from 50 TW)

100-600 ns rise time

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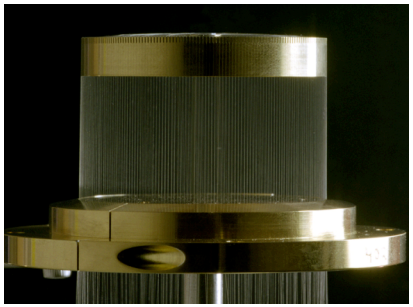
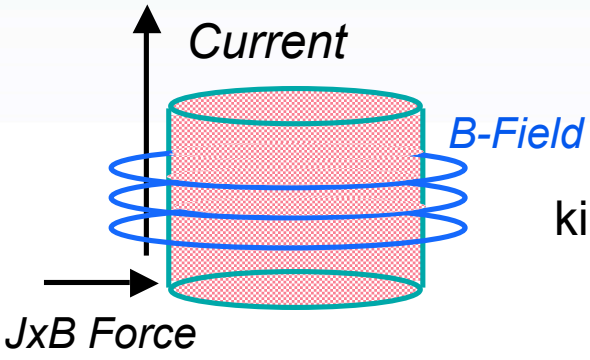
Z-pinches are intense and efficient x-ray sources

wire array



2 cm



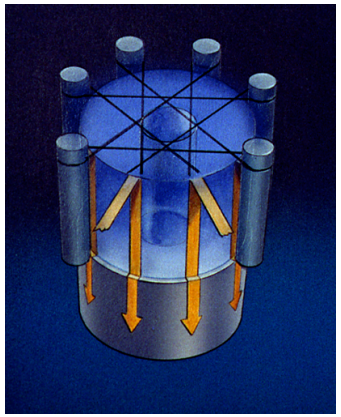
kinetic and electrical energy

internal (shock heating)

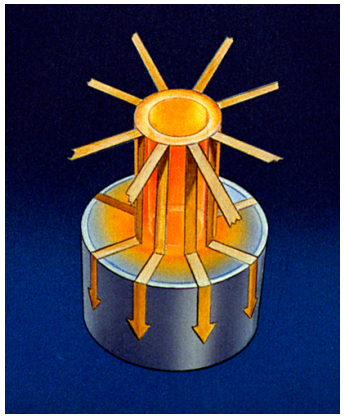
x rays

electrical energy

kinetic energy



Initiation



Implosion

Stagnation

2 MJ total radiation
200 TW peak power

electrical to x-ray
~10% efficient

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The Z facility has an extensive suite of x-ray diagnostics

X-ray Power and Energy

Filtered X-ray Diodes (XRDs)…… < 4 keV Power
Photo-Conducting Diamonds (PCDs)…….. > 1 keV Power
Silicon Diodes (TEP)…… Broad-band Power
Bolometers…….. Broad-band Energy

X-ray Spectroscopy

Elliptically Curved Crystals……0.7-10 keV Time-gated
Convex Curved Crystals…….. 0.7-10 keV Time-integrated
Spherically Curved Crystals…… 0.7-10 keV Time-integrated
Transmission Crystals……> 10 keV Time-integrated

X-ray Imaging

Filtered Pinhole Cameras……..> 0.7 keV Time-gated
Multi-layer Mirror Pinhole Cameras……0.277±0.003 keV Time-gated

X-ray Backlighting

Point-projection……two-frame @ ~1kJ ea.
1 or 2-color Monochromatic Imaging.....two-frame @ ~1kJ ea.

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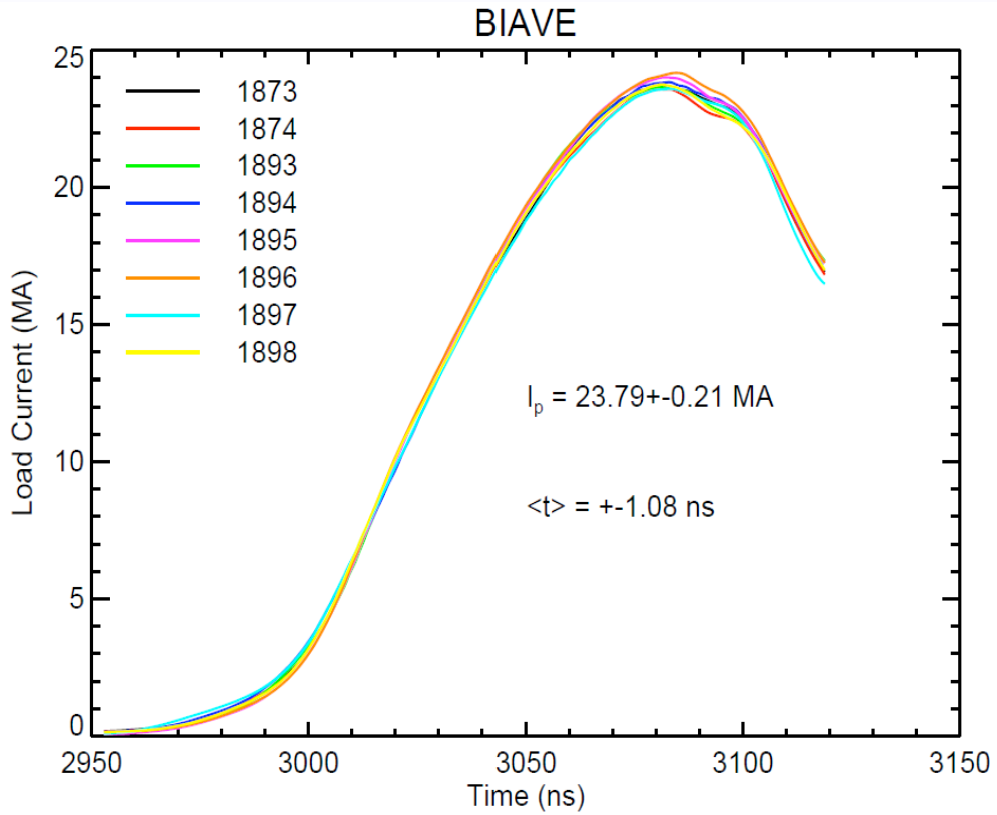
Short pulse (100 nsec current rise time) experimental currents are highly reproducible



Greg Rochau will describe how to perform x-ray spectroscopy experiments on Z in his presentation at 11:45 this morning

Mike Cuneo will give a tutorial on how to develop ideas for successful experiments on Z in his presentation at 9:00 tomorrow morning

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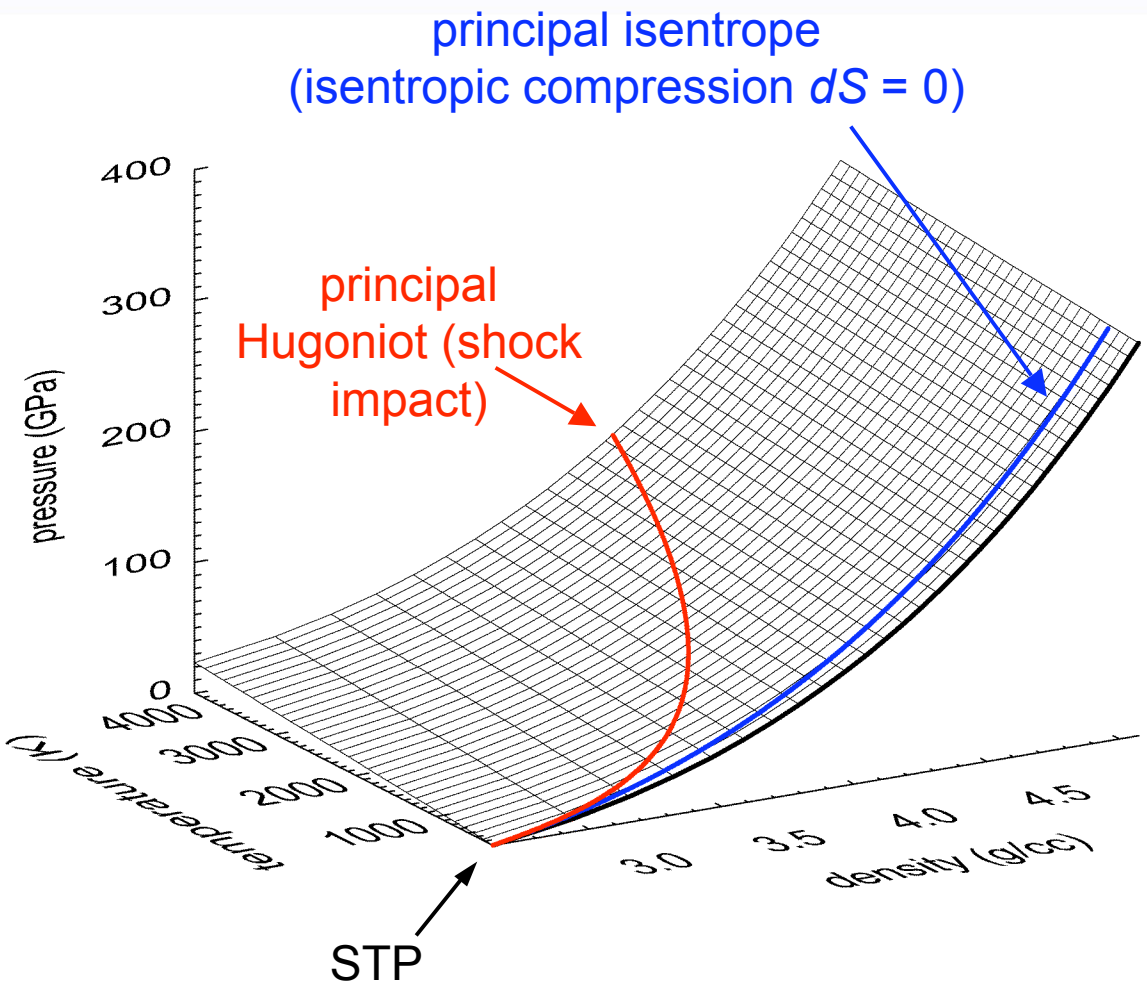
Isentropic compression and shock impact allow us to measure material properties at HED conditions



- Isentropic Compression produces a gradual pressure rise in the sample up to 5 Mbar
- Shock Impact from flyer plates traveling at velocities up to 40 km/sec produce pressures up to16 Mbar in Al and 32 Mbar in Ta
- A velocity interferometer (VISAR) is the primary diagnostic used in dynamic material experiments

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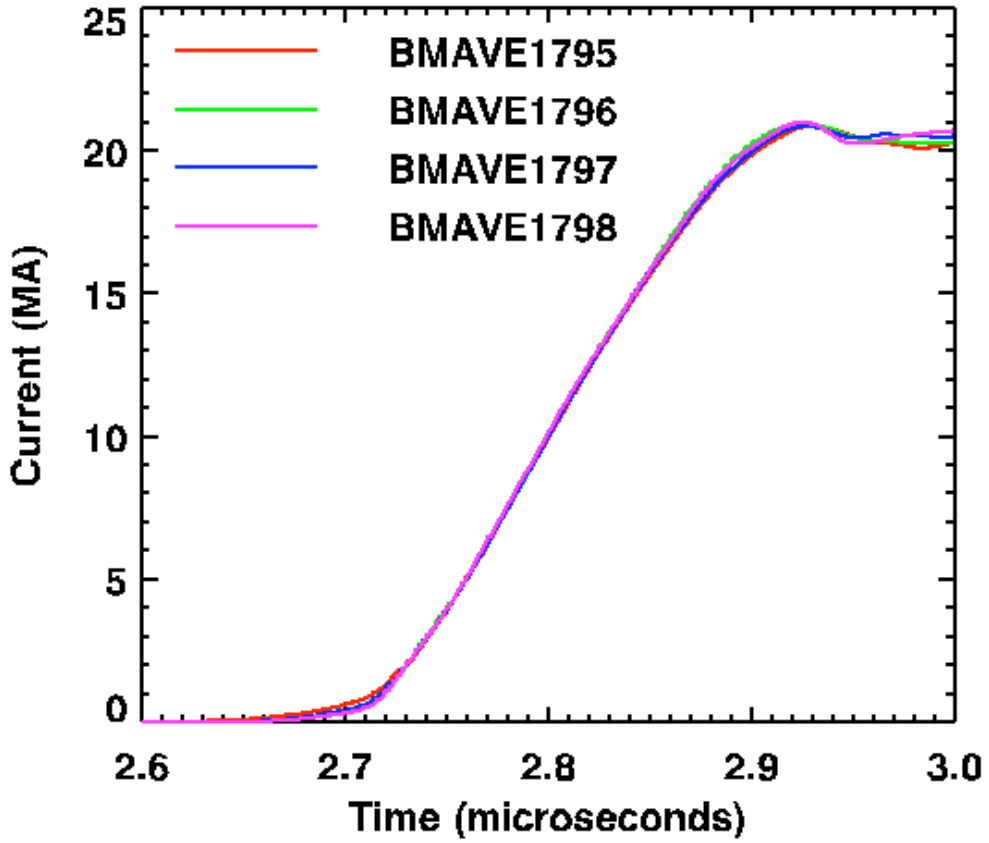
Long pulse (up to 300 nsec current rise time) experimental currents are highly reproducible



Ray Lemke will describe how to perform dynamic material experiments on Z in his presentation at 8:30 tomorrow morning

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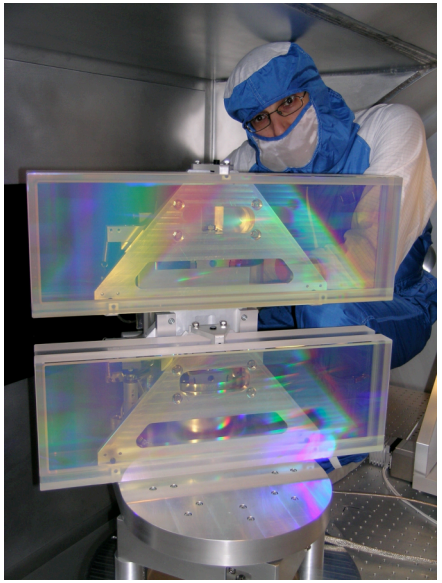
The Z-Beamlet and Z-Petawatt laser systems

Z-Beamlet

- λ = 527 nm
- τ = 0.3 - 8 nsec
- $\phi \geq$ 75 μm spot size
- E ≤ 1.5 kJ (5 kJ planned)
- I ≤ 10^{17} W/cm^2
- 3 hr/shot

Z-Petawatt



- λ = 1054 nm
- τ = 0.5 - 15 psec
- $\phi \geq$ 30 μm spot size
- E ≤ 100 J (500J planned)
- I ≤ 5 x 10^{19} W/cm^2
- 3 hr/shot

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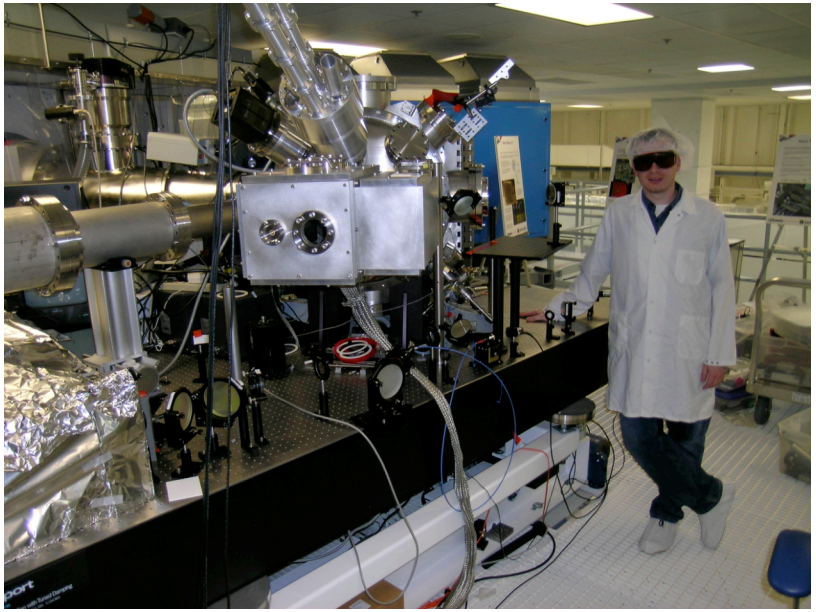
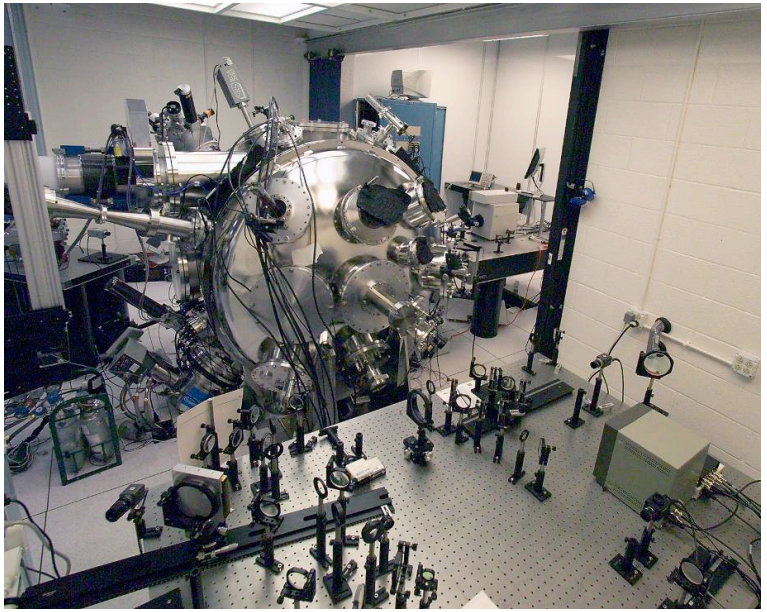
We have 2 target areas with an extensive suite of diagnostics for stand alone experiments with either of the lasers

Z-Beamlet



- 2 ft diameter target chamber

Z-Petawatt



- 5 ft diameter target chamber

Matthias Geissel will will describe how to perform experiments using the laser systems in his presentation tomorrow during the Particles and Beams breakout session

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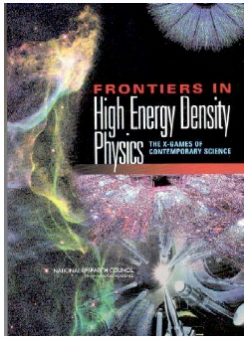
We are working to increase the fundamental science effort on Sandia's HED facilities

- High Energy Density (HED) science is an emerging field that offers many compelling scientific opportunities.
  - HED hydrodynamics
  - Relativistic HED plasma and intense beam physics
  - Magnetized HED plasma physics
  - Radiation-dominated dynamics and material properties
  - Warm dense matter



Frontiers in High Energy Density Physics, R. Davidson et al. 2004

- A new OFES-NNSA joint program in high energy density laboratory plasmas has been established to help build and maintain a robust research community.
  - The first proposal cycle is just being completed with funding awards to be distributed later this summer
  - A national workshop is planned for November 15-18, 2009 to establish the science basis for a substantially expanded fundamental HEDLP research program

- We want to collaborate with scientists from academia and industry to develop strong research proposals that utilize the Z, Z-Beamlet, or Z-Petawatt facilities
  - Experiments will have the best chance to succeed if they utilize existing sources and diagnostics and have a team member experienced in performing experiments on the Sandia facilities

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Users are allocated time on Sandia's HED facilities through an annual proposal process run by the Z facility

- Proposals are evaluated on the basis of technical merit and feasibility of execution
  - Special consideration will be given to proposals funded by the joint OFES-NNSA HEDLP program
  - We encourage proposals in 1 week blocks
- Our baseline facility budget covers the costs to operate the facility, field standard diagnostics, and fabricate standard load hardware and targets
  - Users are responsible for covering labor and travel costs for the external team members and any costs for new diagnostics and specialized targets
- We are planning to announce the first call for fundamental science proposals this fall for experiments to be performed in the June 2010 through May 2011 time period
  - Our goal is to grow the fundamental science effort over the next several years to a level of 15% of available experimental time which would be approximately 30 shots/year on Z and 90 shots/year on Z-Beamlet and Z-Petawatt
  - Contact Mike Lopez (mrlope@sandia.gov) for Z proposals and Briggs Atherton (bwather@sandia.gov) for Z-Beamlet and Z-Petawatt proposals

It's an exciting time to be working on high energy density physics

- High energy density physics is an emerging field that offers many compelling scientific opportunities.
- New facilities such as the refurbished Z, Z-Beamlet, Z-Petawatt, and the Texas Petawatt make it possible to create conditions in the laboratory that were previously unattainable.
- Advances in both diagnostic instruments and high-performance computing are making it possible to measure and simulate the properties of high energy density plasmas with exquisite detail.
- A new Department of Energy joint program in high energy density laboratory plasmas has been established and and is poised to create a substantially expanded research program in fundamental HED science.