Basic HED Science is Important to NNSA

Presented to:

OMEGA Laser Facility Users Group

Presented by:

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Director, Office of Inertial Confinement Fusion

May 1, 2009

Outline

- HEDP within NNSA
  - World's largest three HEDP facilities:

    Z (2008), OMEGA with EP (2008), NIF (2009)
  - National Ignition Campaign: progress toward ignition
- The importance of fundamental High Energy Density Physics (HEDP) has been recognized
- NNSA/Office of Science - joint sponsors of HEDLP
- Report of the FESAC Subpanel
- User Facilities
- Safety
- Conclusions

NNSA built and operates the world's three largest HED facilities for its mission: NIF, OMEGA, and Z

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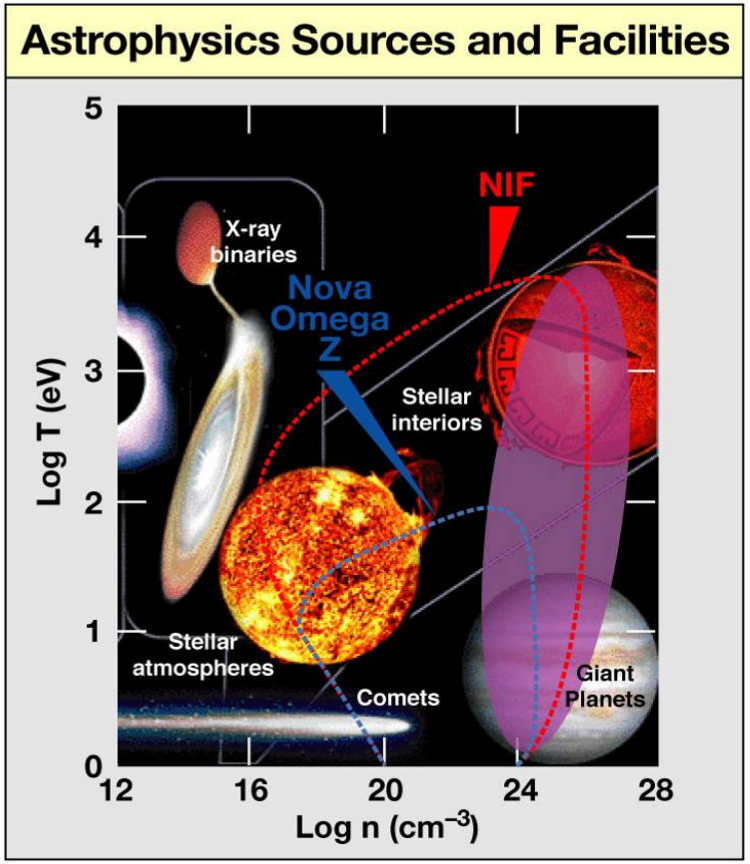

99.999999% of the energy from a weapon is generated in the high energy density state

NIF is Operational !

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NIF
National Ignition Facility

STATUS
100% COMPLETE

	2009
Total LRUs Installed	6206
LRU Installation	COMPLETE
Laser Bay 1	COMPLETE
Laser Bay 2	COMPLETE
CORE	COMPLETE
Switchyard 1	COMPLETE
Switchyard 2	COMPLETE
Target Bay	COMPLETE
Beams Activated	192 COMPLETE
	4.24 MJ 1ω
	0.80 MJ 3ω

Ignition will be the start of a new scientific era for NNSA and the Nation …

Broad scientific input is necessary

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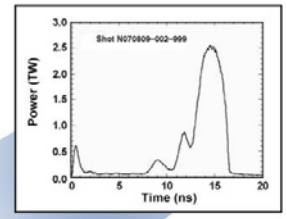
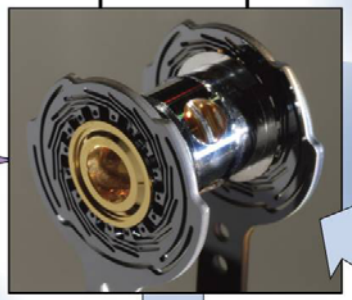
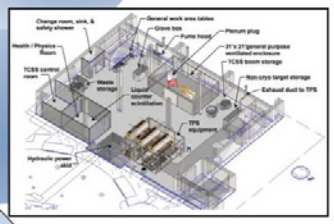
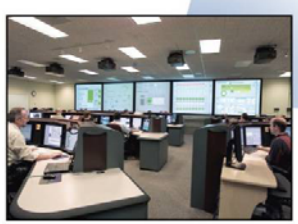
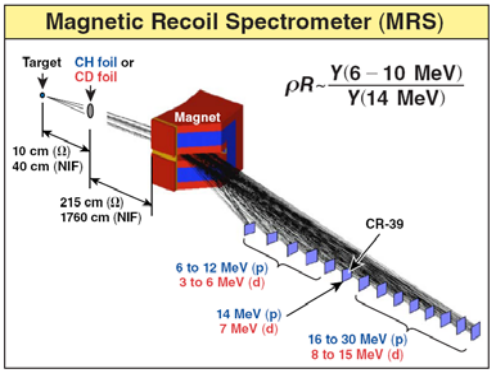






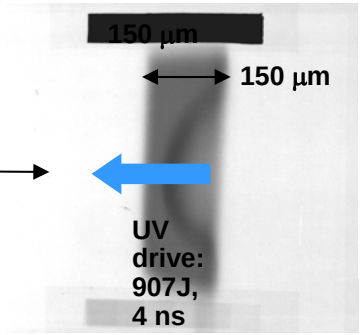


Magnetic Recoil Spectrometer (MIT/LLE)



Radiography on OMEGA EP
Multi-Institutional

Radiograph of shock in Al @17.5 keV
EP shot 4541 (Jan 29, 2009)



Shock front radiography after 4 ns through 800 μm thick Al

Ignition on NIF will be a defining moment for inertial confinement fusion energy

NNSA mission needs have driven the creation of HEDP environments that are ideal to study complex HED plasmas and materials

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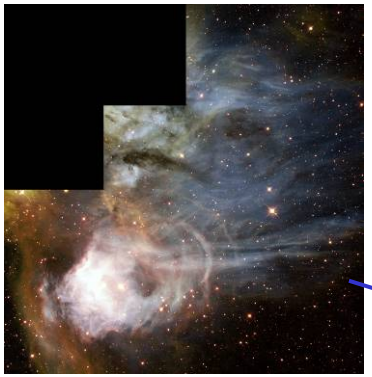
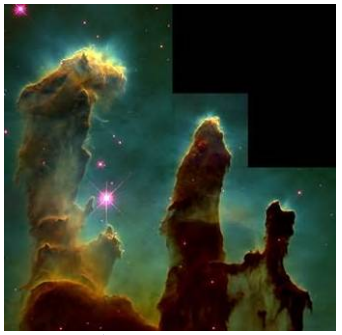
High Mach Number unstable flows

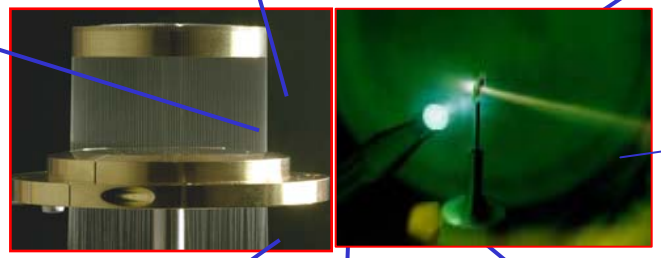


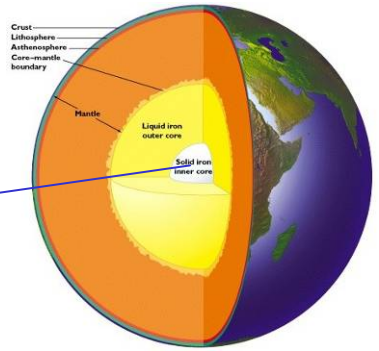
Jets

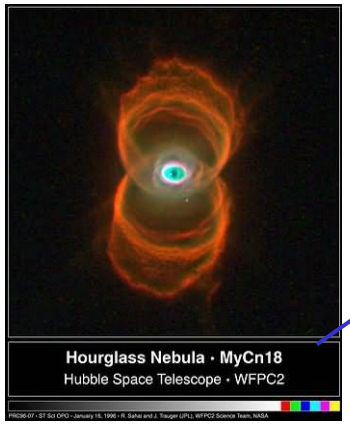


Rayleigh Taylor Instabilities

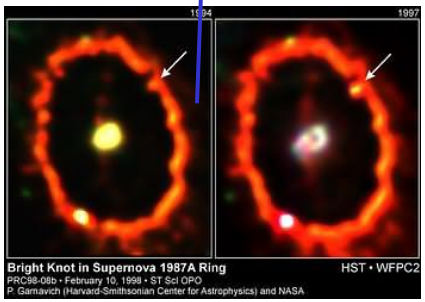
Materials in the Extreme



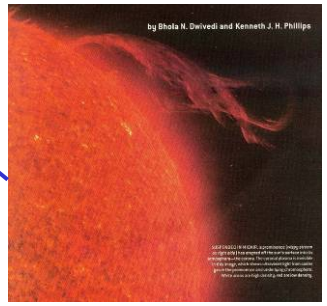




Mass Outflow



Shocks and radiation transport



MHD, thermo-electric, and "anomalous" heating

The broader importance of fundamental HEDP is recognized

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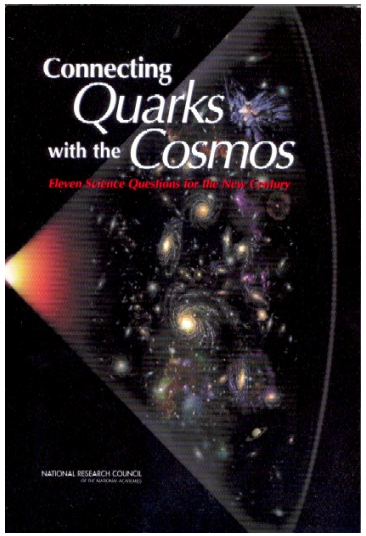
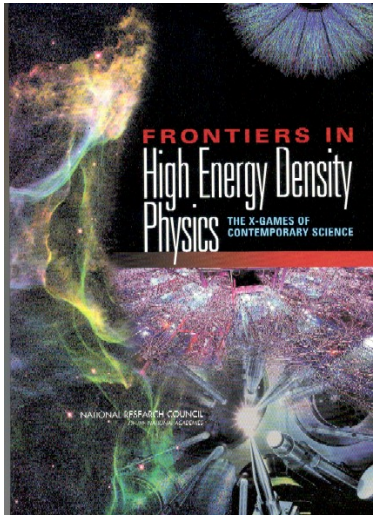
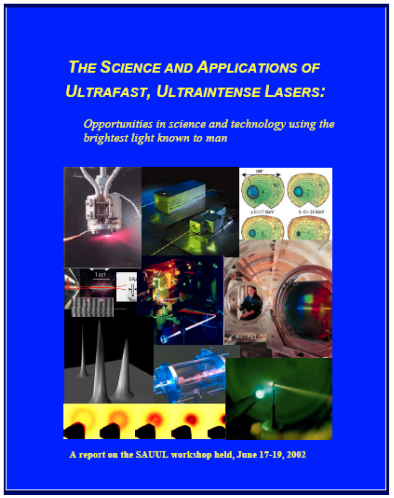
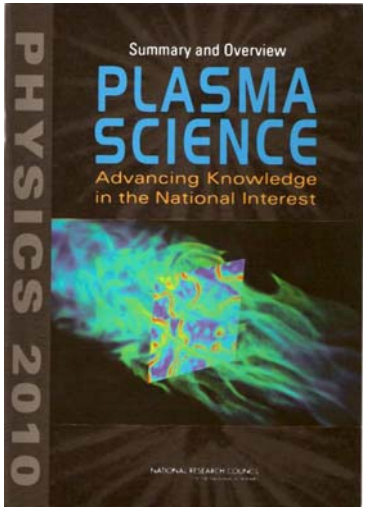
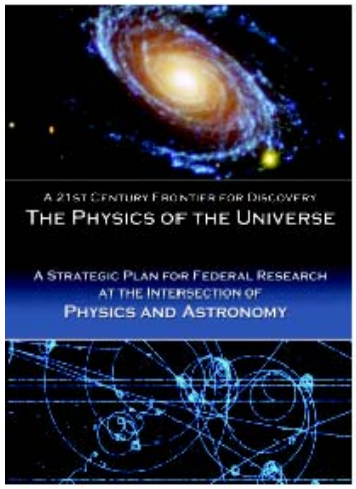
National Academy/workshop reports

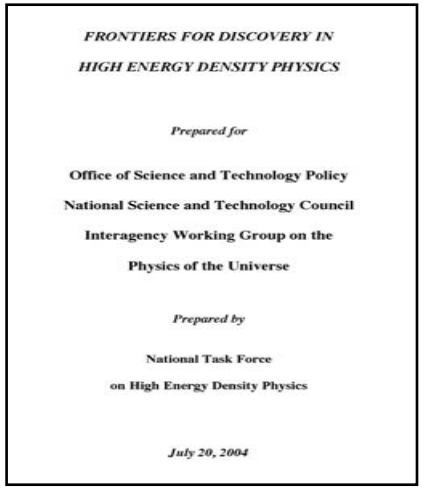


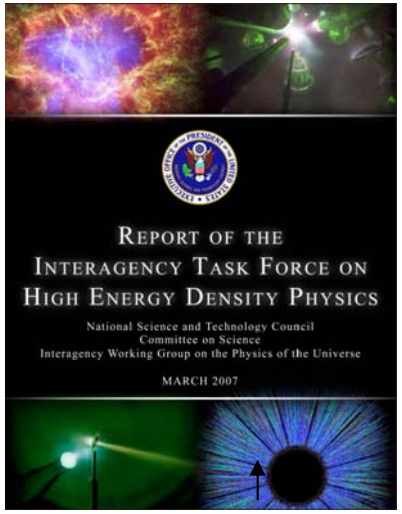


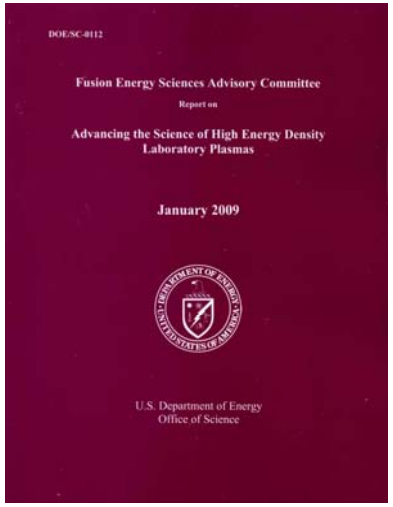






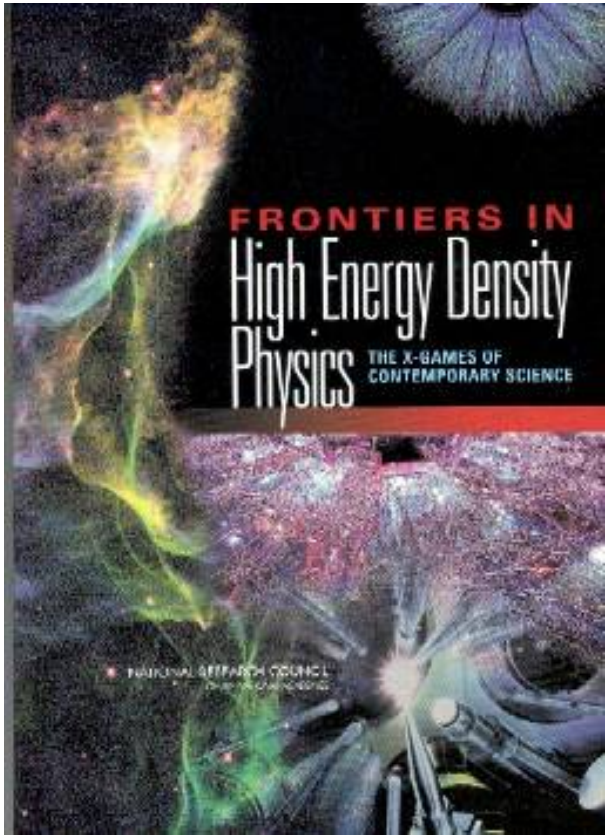






The NNSA/SC Joint Program in Laboratory High Energy Density Plasmas was created to steward HEDLP within DOE

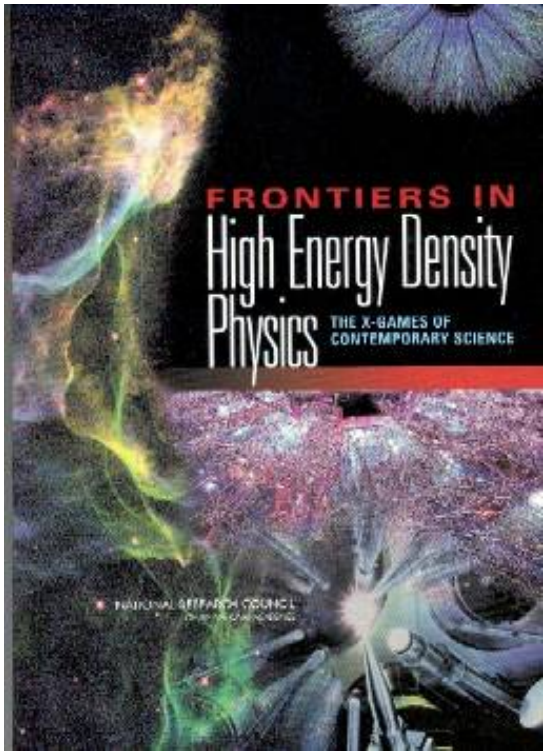
- 2004 Davidson report provided the starting point for the HEDP Interagency Task Force
- Key DOE finding:
  - ***Stewardship of HEDLP needs to be improved***



DOE has taken action to improve stewardship

NNSA and OFES are working on stewarding HED Physics

- We have established a Joint Program in High Energy Density Laboratory Plasmas (JPHEDLP) – announced February 2007
- We ran a joint program solicitation in FY 2009 and received a significant number of proposals (~130)
- We have planned a Research Needs Workshop for later this year

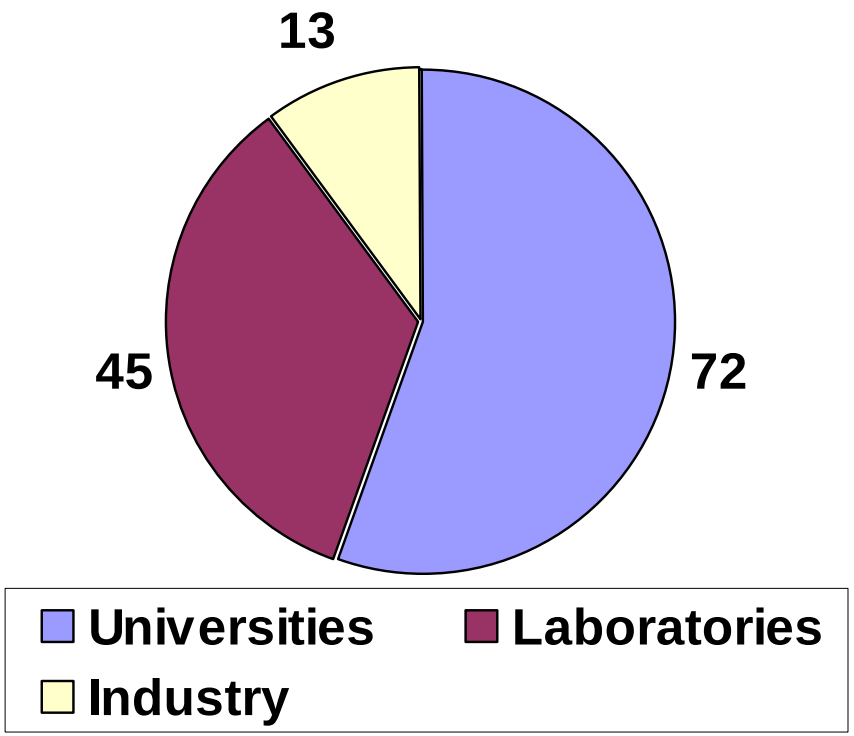


- The DOE charged the Fusion Energy Science Advisory Committee (FESAC) to: *"work with the HEDLP community to provide information to develop a scientific roadmap for the joint HEDLP program in the next decade"*
- A FESAC subpanel was formed, chaired by R. Betti, Univ. of Rochester

Update on Joint HEDLP Program FY09 Solicitation

130 Proposals Received

- 72 university-led, 45 lab-led
- 53 different universities (10 foreign)
- 16 major laboratories (6 foreign)
- Over 300 principle investigators and collaborators



The FESAC Subpanel on High Energy Density Laboratory Plasmas completed its report in Jan 2009

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The FESAC HEDLP report identified numerous research opportunities that should be supported:

- High energy density hydrodynamics.
  - ***How do the distinct properties of high energy density systems alter hydrodynamic behavior?***
- Radiation-dominated dynamics and material properties.
  - ***What are the unique properties of radiation-dominated HED plasmas?***
- Magnetized high energy density plasma physics.
  - ***How do magnetic fields form, evolve, and affect the properties of high energy density plasmas?***
- Nonlinear optics of plasmas.
  - ***How does high-intensity coherent radiation alter the behavior of high energy density plasmas?***
- Relativistic high energy density plasma physics.
  - ***How do plasmas with relativistic temperatures or relativistic flows behave?***
- Warm dense matter physics.
  - ***What are the state, transport, and dynamic properties of warm dense matter?***

FESAC Subpanel Report Recommendations

- Recommendation on fundamental HEDLP science:

  ***By** taking advantage of the new generation of domestic experimental and computational facilities **capable of detailed exploration of high energy density plasmas,** the Joint Program can and should foster the rapid growth and development of this new and exciting field of science.*

- Recommendation on alternative IFE concepts:

  The Joint Program should take advantage of the available NNSA facilities to test the most promising alternative concepts at the proof-of-principle level. ***The current alternative concept effort should be extended by promoting wider university involvement.***

The Joint Program opportunity:
support fundamental and energy-related HEDLP science by leveraging access to NNSA facilities

FESAC Subpanel Report Recommendations

- Recommendation: Access to Facilities for the Broader Scientific Community
  - *Taking **full** advantage of the opportunities **described in this report over the next decade** requires continuing and assured access for the broader scientific community to these facilities**. Formal or informal** user programs should be expanded**, and new ones should be developed to increase access to HEDLP facilities***
- Recommendation: Diagnostics – Funding for novel methods development
  - ***The** Joint Program **in HEDLP** should include**, within its scope,** funding for the development of novel diagnostic methods **that are essential to fully characterize HEDLP systems.***
- Recommendation: Theory & Simulation – Development and Access
  - ***The** Joint Program **in high energy density laboratory plasmas** should include significant components of theory and advanced simulation **both for basic research and for supporting the experimental elements of the program. The program should encourage access to the Office of Science and NNSA computing facilities, and unclassified codes for outside users.** It is also recommended that funds be provided for community code-development projects under the DOE program called Scientific Discovery through Advanced Computing.*

Three essential elements of the Joint Program:

Access to facilities, diagnostics development, and theory & simulation

FESAC Subpanel Report Recommendations

- Recommendation on stewardship:

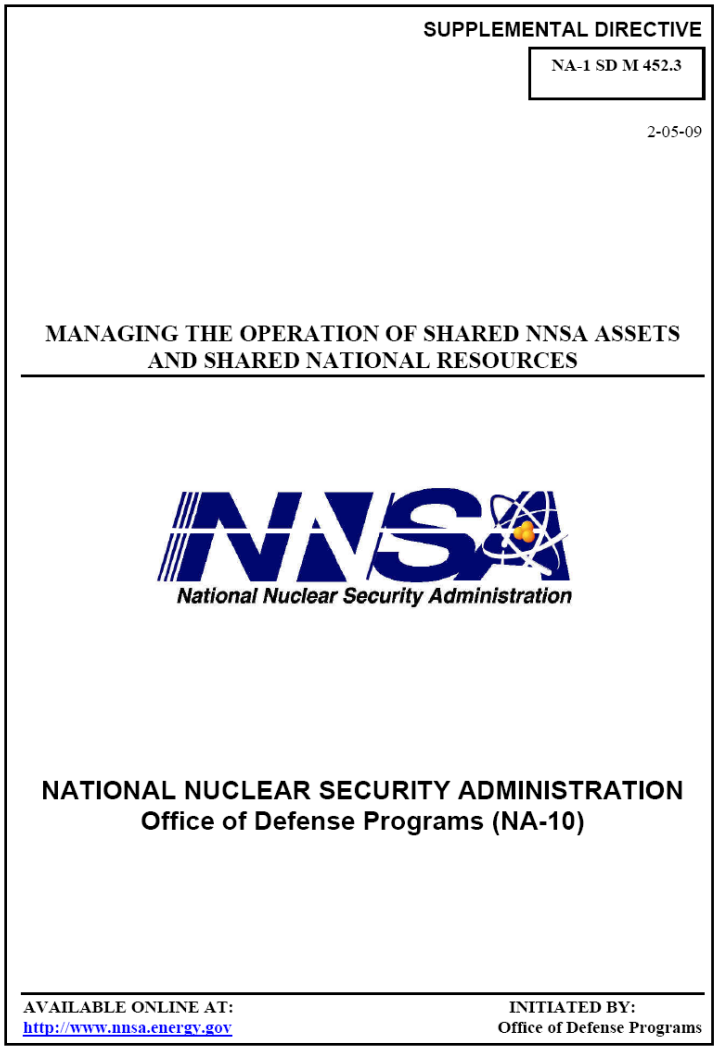
  The** Joint Program should independently steward fundamental and energy-related high energy density laboratory plasma science**, managing solicitations and develop review criteria to respect the important need for both discovery-driven and mission-oriented science.

- Recommendation on planning:

  To facilitate the growth of HEDLP research,** the agencies should hold a research needs workshop at an earliest possible date**. It should be focused on fundamental and energy-related HEDLP science. The workshop should take into account the need for both discovery-driven and mission-oriented science and the differences between them.

Independently managing fundamental and energy-related science is the preferred strategy

NNSA has issued guidance the use of HED facilities for Users



SUPPLEMENTAL DIRECTIVE

NA-1 SD M 452.3

2-05-09

MANAGING THE OPERATION OF SHARED NNSA ASSETS AND SHARED NATIONAL RESOURCES

National Nuclear Security Administration

NATIONAL NUCLEAR SECURITY ADMINISTRATION
Office of Defense Programs (NA-10)

AVAILABLE ONLINE AT:
http://www.nnsa.energy.gov

INITIATED BY:
Office of Defense Programs

- OBJECTIVE: **The objective of this Supplemental Directive is to provide guidance for establishing facility governance for a subset of research facilities that NNSA designates as Shared NNSA Assets or Shared National Resources. NNSA will generally designate research facilities that are recognized as major Research and Development (R&D) facilities that have specialized or unique capabilities within the Nuclear Weapons Complex.**

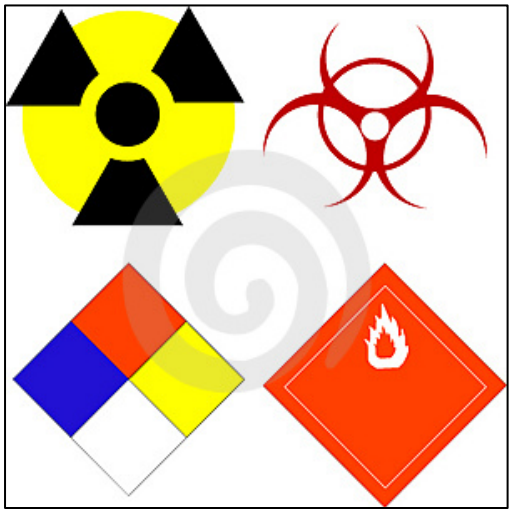
- Shared NNSA Asset: **A facility NNSA selects and designates for which access is provided to scientists and engineers across and within the NNSA complex**

- Shared National Resource: **An NNSA facility that is a state-of-the-art, unique resource, which offers capabilities desired by users external to NNSA that can serve to advance the state of science and engineering for broader national missions.**

OMEGA should be a Shared National Resource

Safety is central to everything we do

- NNSA and the Department are reviewing safety requirements and oversight for university interactions and Cooperative Agreements
- Users must adhere to LLE safety and design protocols and procedures
- Safety is everyone's responsibility !!
  - Follow all safety requirements
  - Ask questions
  - STOP WORK if you have any concerns with safety



NNSA encourages the formation of User Groups at its facilities

- Purpose: To facilitate communication (user to user, user to facility, and user to the broader scientific community)
- Major focus: To define common desires for improvement to the capabilities and operation of the facility
- The formation of the OMEGA Laser Facility Users Group in FY08 was the first step in this process
- This first OMEGA Laser Facility Workshop appears to be a great success

Rich, Paul, and all attendees:

Thank you!

Great scientific progress is being made but we have key planning issues to deal with

- **Overall budgets are stressed –**

  NNSA has not benefited from the increase in support for physical sciences

- **The FY09 budget did not support the Naval Research Lab (NRL) ICF program or the High Average Power Laser (HAPL) Program**

  These two well-regarded programs are closing out and it is not good for the community when any element loses support

- **The FY09 budget did not support full operations of OMEGA**

  Required a reduction in Laboratory Basic Science shots

- **Partnerships, like the joint program with OFES, will provide opportunities for the academic world to get involved in HEDLP**

  We are open to other partnerships

Conclusions and Path Forward

- **Basic HED Science is important to NNSA**
  - **The academic involvement in HEDLP is being stewarded through the Joint Program**
  - **World-leading HED facilities have been built and funded by NNSA**
  - **Our program is making great progress towards ignition and other applications in HEDP space**
  - **Reduced budgets within Defense Programs are putting pressure on basic science and will reduce availability of facilities to external users**
- **Path Forward:**
  - **Grow the Joint Program in HEDLP with the Office of Science**
  - **Respond to the FESAC subpanel recommendations –**

    a Research Needs Workshop is planned for later this year
  - **Work towards stable funding with (hopefully) growth**

Users should take advantage of the opportunity to do great science on OMEGA