Developing foundations and advancing fundamental understanding

High Energy Density Laboratory Plasmas

General Plasma Science

U.S. DEPARTMENT OF ENERGY

The High Energy Density Laboratory Plasma Program at FES

Highlights of a world-class program
A science basis for IFE
A plan looking forward
IFE solicitations

U.S. DEPARTMENT OF ENERGY

Riccardo Betti of the University of Rochester wins the E. O. Lawrence Award

"Riccardo Betti will be honored for a series of impactful theoretical discoveries in the physics of inertial confinement fusion including seminal transformative work on thermonuclear ignition, hydrodynamic instabilities and implosion dynamics, and the development of innovative approaches to ignition and high energy gains".

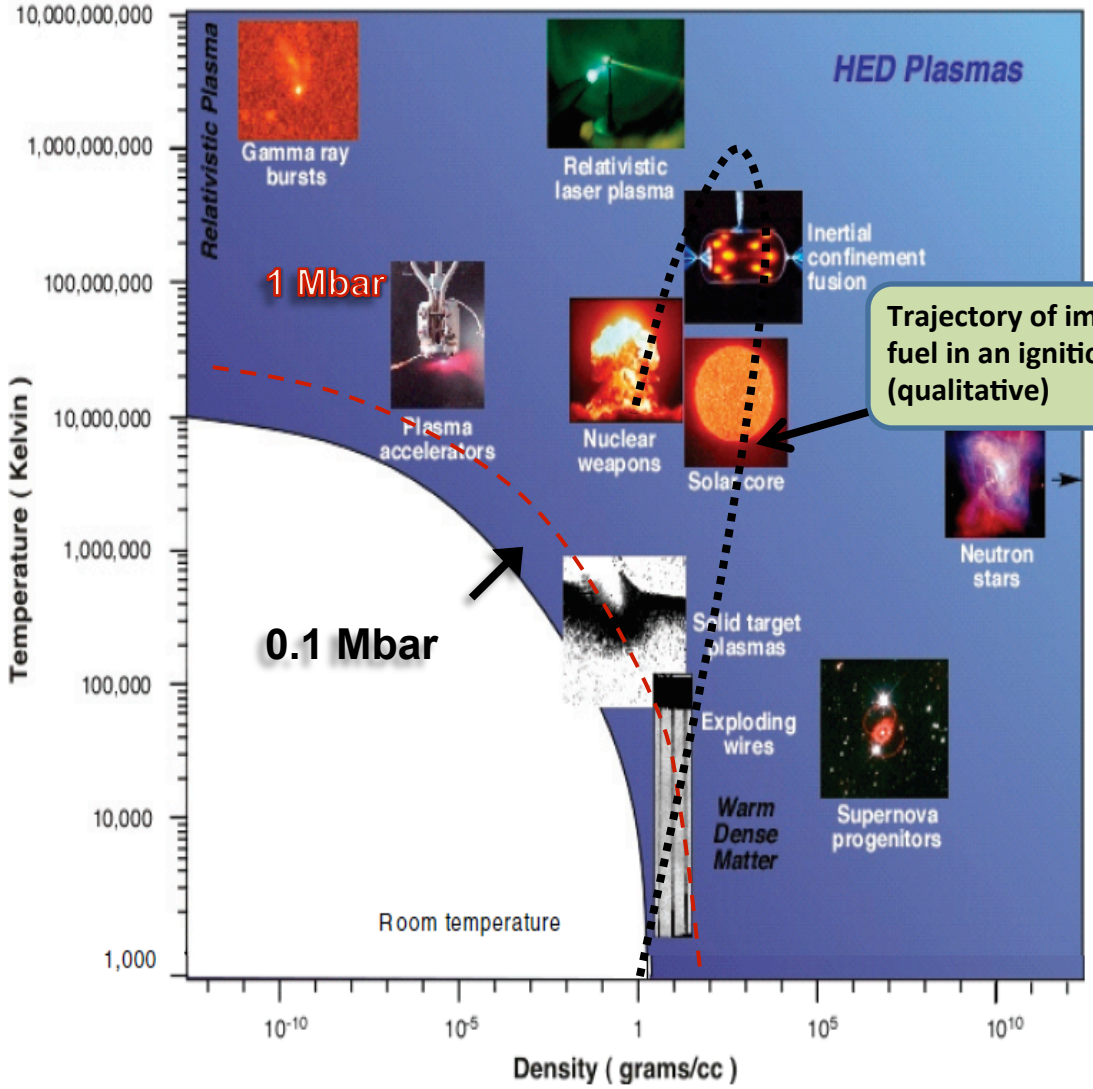
Daniel Sinars of Sandia National Laboratories wins the Presidential Early Career Award for Science and Engineering

"For developing innovative techniques to study the properties of instabilities in magnetized-high-energy-density plasma, enabling quantifiable comparison between experiment and simulation needed for validating cutting-edge radiation-hydrodynamics codes, and for demonstrating substantial leadership qualities in high-energy-density-laboratory-plasma (HEDLP) physics.".

Matter in Extreme Conditions Instrument at LCLS completed

Construction of the Matter in Extreme Conditions Instrument (MECI) at the LCLS will be completed in FY 2013. User assisted commissioning of the MECI began during the spring of FY 2012 yielding exciting scientific results.

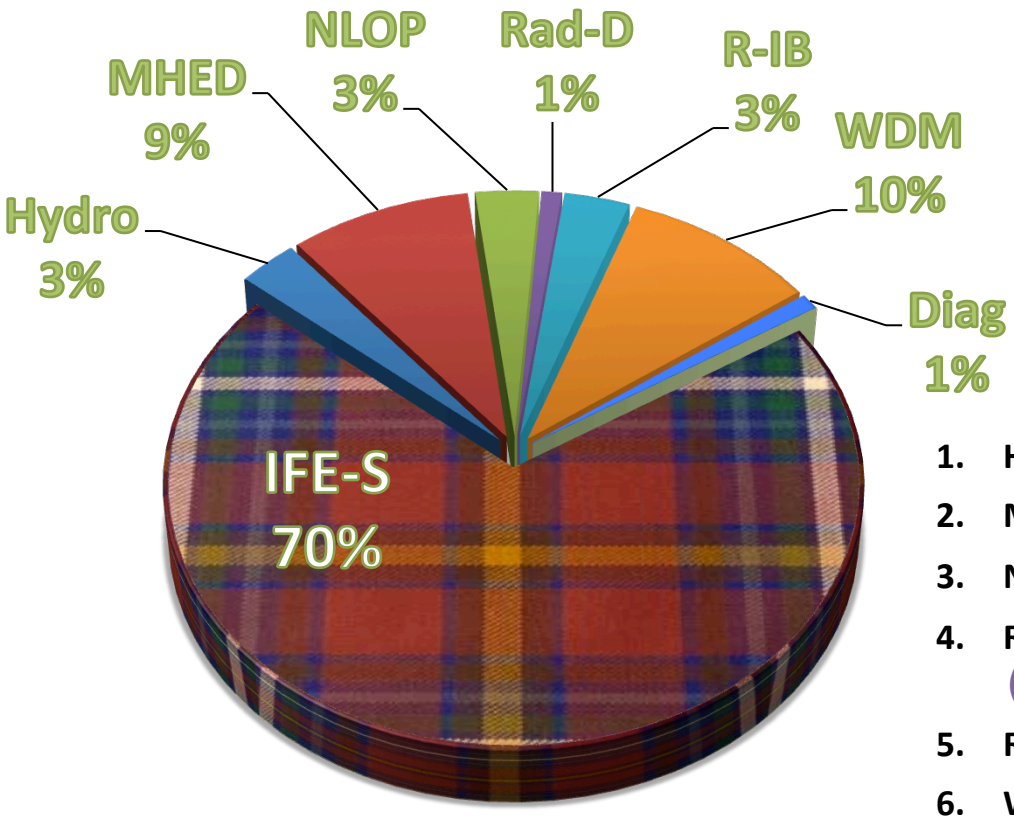
High Energy Density Laboratory Plasmas

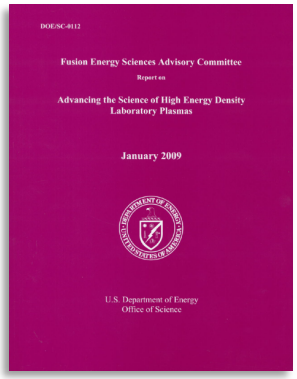


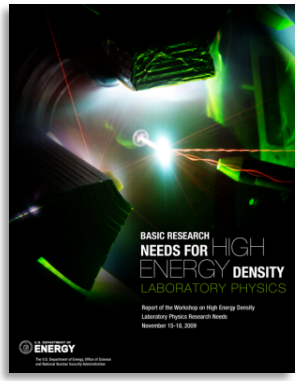
Emphasis on Discovery Science…

- Fundamental basis for Inertial Fusion Energy
- Cross-cutting science, impactful results for national competitiveness
- Cultivate a broad-based HED community to advance research related to IFE

The Portfolio FY 2012







1. High Energy Density (HED) Hydrodynamics (HYDRO)
2. Magnetized High Energy Density Plasmas (MHED)
3. Nonlinear Optics of Plasmas (NLOP)
4. Radiation-Dominated Dynamics and Material Properties (Rad-D)
5. Relativistic HED Plasmas and Intense Beam Physics (R-IB)
6. Warm Dense Matter (WDM)
7. High-Z, Multiply Ionized HED Atomic Physics
8. Research Infrastructure
9. Diagnostics for HEDLP (DIAG)
10. Computer infrastructure and Computing in the HEDLP Environment

Key Objectives

Regular Funding Opportunities

Stability – investments in HEDLP: people, departments

Flexibility – respond to scientific and technological changes

Growth - opportunity for emerging faculty and students

Partnerships and Leveraging

Recognize common interests NNSA/FES

Compliment NNSA investments

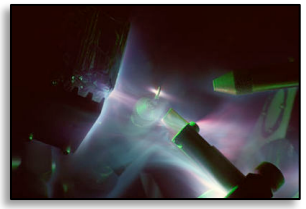
Support of scientists and students doing *fundamental HEDLP science* on world-class DOE HEDLP facilities (NIF, Z, OMEGA, Trident, LCLS)

1st users of MECI in FY13

LCLS

users of intermediate scale facilities

Los Alamos NATIONAL LABORATORY EST.1943

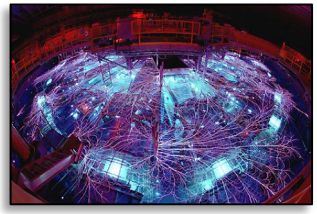


3 *new* user science projects

NIF

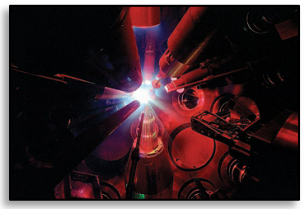
1 PECASE winner

Sandia National Laboratories



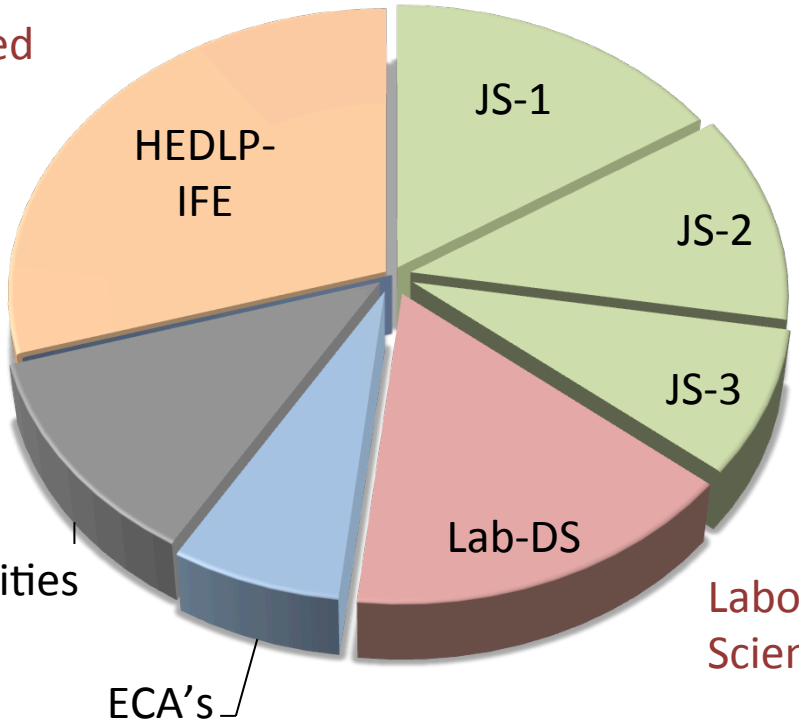
15+ student users

UR LLE



program planning HEDLP

Laboratory-led collaborative teams



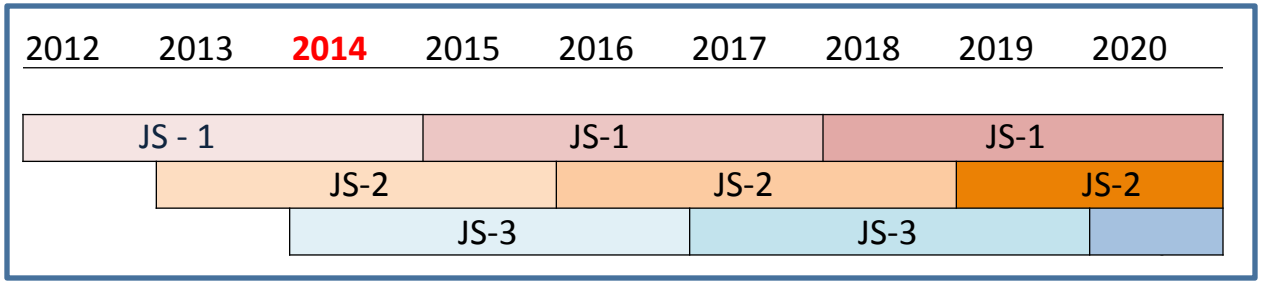
Joint Solicitation University HEDLP Science

Laboratory HEDLP Science

Small-Business

SBIR
IFE
Technology

Growth Activities



* annual solicitation by 2014 will provide a strong and vibrant scientific HEDLP Community

program planning FY 2012

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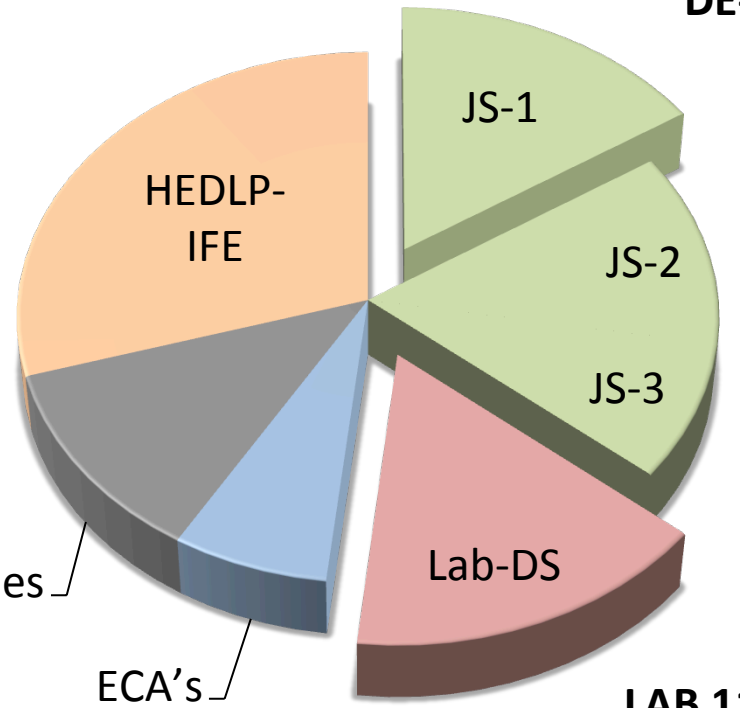

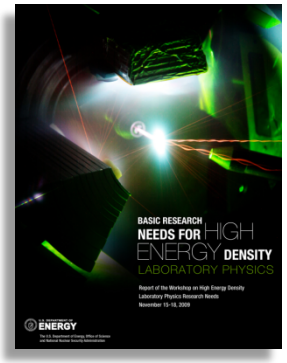

LAB 11-583

Small-business

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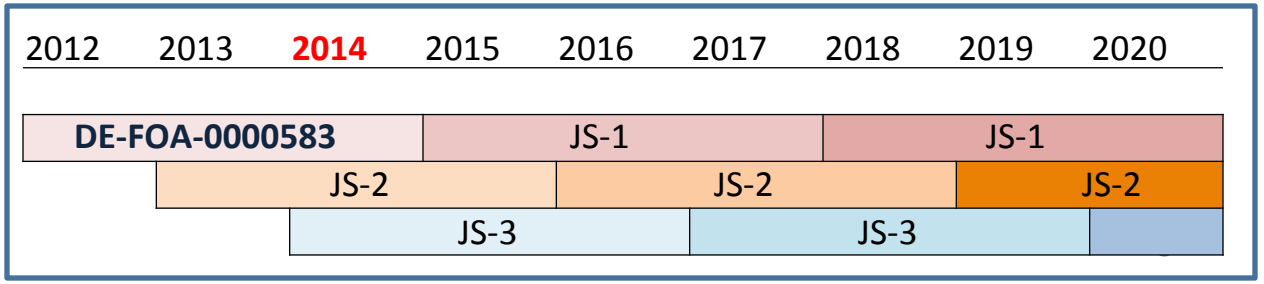
Technology



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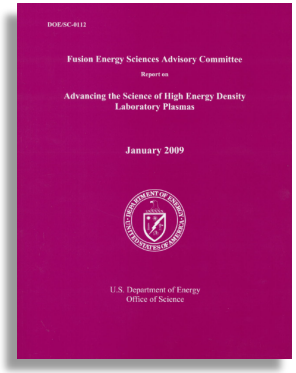
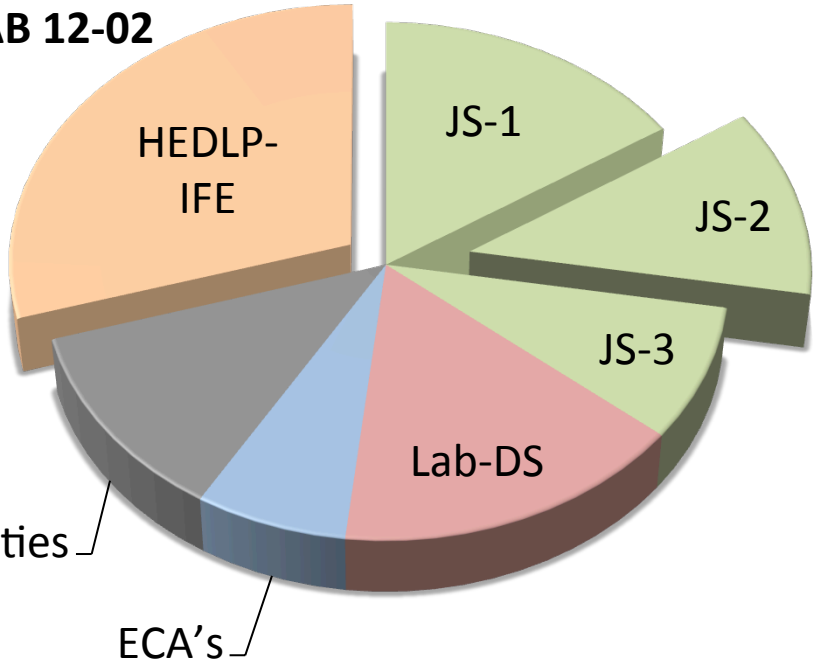


LAB 12-02



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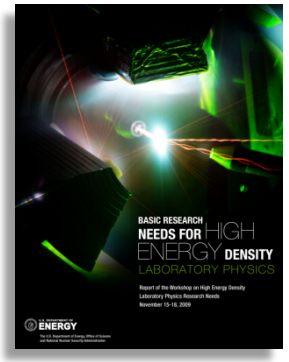

Small-business

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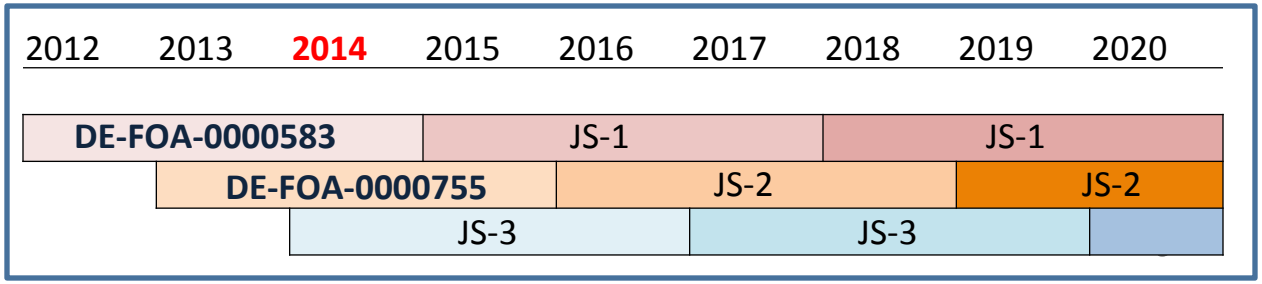
Technology



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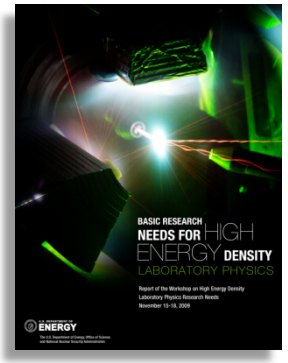

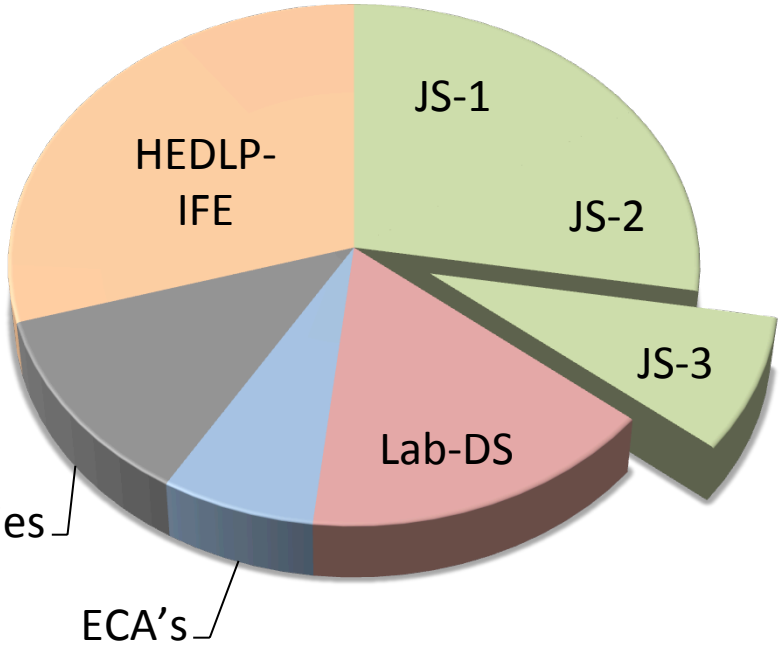

Small-business

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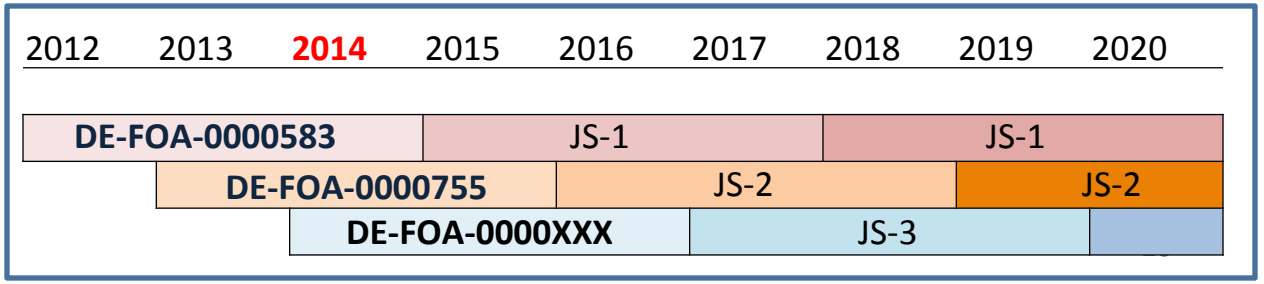
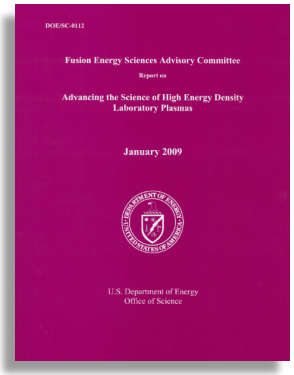


Inertial Fusion Energy Science

High Energy Density for Inertial Fusion Energy, Lab 12-02

- coordinated, multi-institutional, research teams
- integration of experimental, theoretical, and computational science
- experimental results within three years after project initiation



High-priority questions critical to inertial fusion energy:

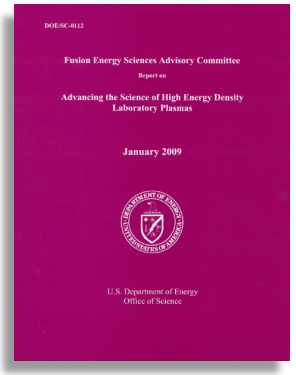
- *Transport and energy coupling of intense particle beams in high energy density plasmas*
- *Intense particle-beam generation by ultra-intense lasers*
- *Influence of magnetic fields on high energy density fusion plasmas*
- *Integrated target physics for inertial fusion energy*

Advancing the Science of High Energy Density Laboratory Plasmas - FESAC, 2009

IFE technology focus of SBIR/STTR

Small Business Innovative Research

- Stimulate technological innovation
- Meet Federal R&D needs
- Encourage participation
- Link between federal R&D investments and innovative commercialization



Today: Greater emphasis on commercialization
Seed capital for early stage R&D with commercial potential

Topic #29 High Energy Density Plasmas and Inertial Fusion Energy

a) Driver Technologies
b) Driver Delivery Systems
c) Ultrafast Diagnostics
d) other

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Budget of SBIR program:
3% of DOE R&D funds over $100M

http://science.energy.gov/sbir

***We support the best science available*!**

We feel that a strong science portfolio provides the best justification and defense of our program in a toughening budgetary environment.

Supporting and Strengthening <u>YOUR</u> community:
Quality reviewing of proposals is essential to: GPS Partnership (NSF/DOE), ASCR, Early Career, SBIR, HEDLP Joint Program

You can: - <u>participate</u> (reviews, panels, volunteer)

We will: - ensure scientific quality through rigorous, unbiased, peer evaluation

Promotion of Success:

You can: - maintain an open dialog, please contact us

- keep us informed of breaking news, high-level publications, significant interactions

We will: - highlight technical successes to SC management

- notify of opportunities (i.e., graduate and postdoctoral fellowships, funding opportunities at other agencies) via HEDSA, DPP, FES web page, etc.

General Plasma Science

Basic Plasma Science

Low Temperature Plasma Science

Highlights
GPS program elements
Identifying needs and opportunities
plasma 2010 recommendations, portfolio

U.S. DEPARTMENT OF ENERGY

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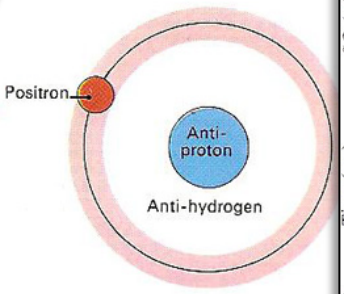
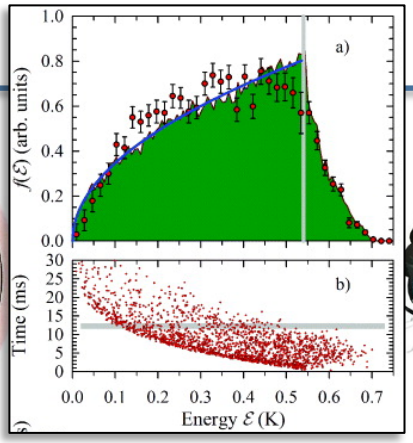
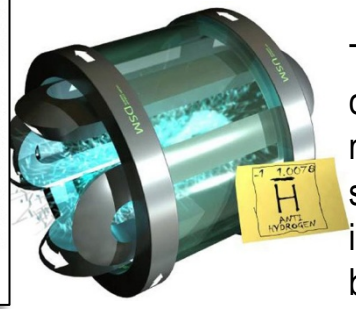
Highlights of General Plasma Science



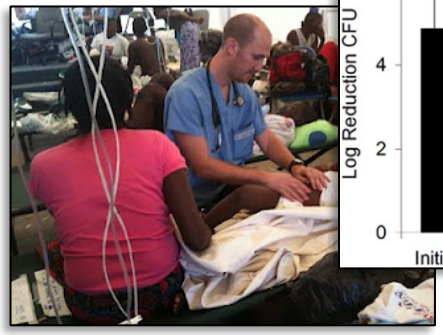


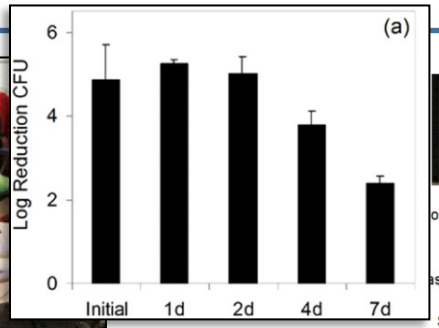


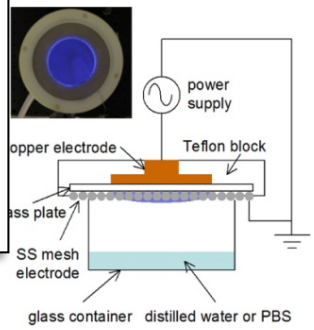
Trapped Anti-Hydrogen

The "spectra" of antihydrogen atoms, synthesized from cold plasmas of positrons and antiprotons and trapped in a magnetic bottle, have been measured, probing the internal structure of the antihydrogen atom for the first time, an initial step toward possible new insights into the difference between matter and antimatter.

Amole et al., Nature 483, 439–443 (2012)







Plasma Activated Water

Plasmas interacting with water can be controlled to create antibacterial compounds, creating a useful disinfectant for up to seven days, and a potential improvement over traditional heat and chemical methods for sterilization of medical equipment and wounds.

Traylor et al., J. Phys. D: Appl. Phys. 44 472001

General Plasma Science Program Elements

NSF/DOE Partnership and Joint Effort

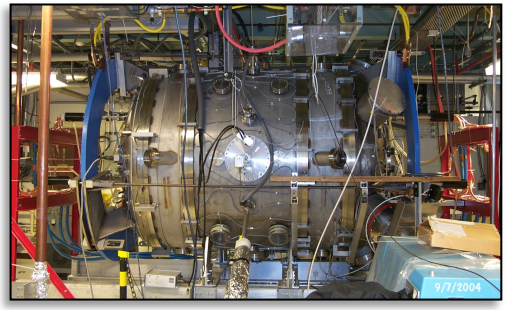
Individual Investigator: annual joint NSF/DOE solicitation – supporting 40 projects at 24 universities

"User" Facility: Basic Plasma Science Facility (BaPSF) at UCLA

Center *for Magnetic Self-Organization (CMSO*) – supporting DOE Laboratory involvement in NSF Physics Frontier Center

Large Collaboration: Anti-hydrogen Trapping (non-neutral plasma) for the international ALPHA collabroation at CERN

International Collaboration: Max Planck-Princeton Center for Plasma Physics



DOE Laboratory General Plasma Science

Individual and collaborative research addressing specific applied plasma, laboratory, space, and astrophysical plasma issues - competitive review in FY 2013

Plasma Science Centers

Multi-institution collaborative teams with a unified theme focused on critical plasma questions

Low Temperature*: Center for Predictive Control of Plasma Kinetics (PSC)*

Basic Plasma: *Center for Momentum Transport an Flow Organization (CMTFO)*,

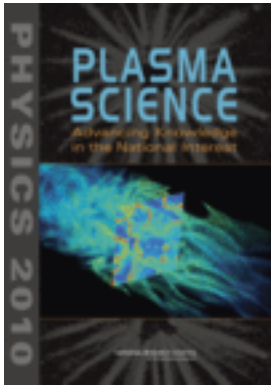
Opportunities at Facilities

Identifying gaps in our current portfolio…

GPS PORTFOLIO	Low Temperature Plasma Science		Basic Plasma Science	
	@ Univ/ Industry	@ DOE Lab	@ Univ/ Industry	@ DOE Lab
Single Investigator	**NSF/DOE Partnership**	**Lab GPS**	**NSF/DOE Partnership**	**Lab GPS**
Centers/ Collaboration	**Plasma Science Centers**	**Lab GPS**	**Plasma Science Centers**	**Lab GPS**
Facilities	**?**	**?**	**BAPSF**	**?**

"Some of the most profound questions of plasma science are ripe for exploitation right now and best addressed at the intermediate scale"

- NRC "Plasma 2010" Report



Plasma 2010 Identified Four Research Challenges:

- ✓ Fundamental low-temperature plasma science
- ✓ Discovery-driven high energy density plasma science
- ✓ Intermediate-scale plasma science
- ✓ Cross-cutting plasma research

Thank you!

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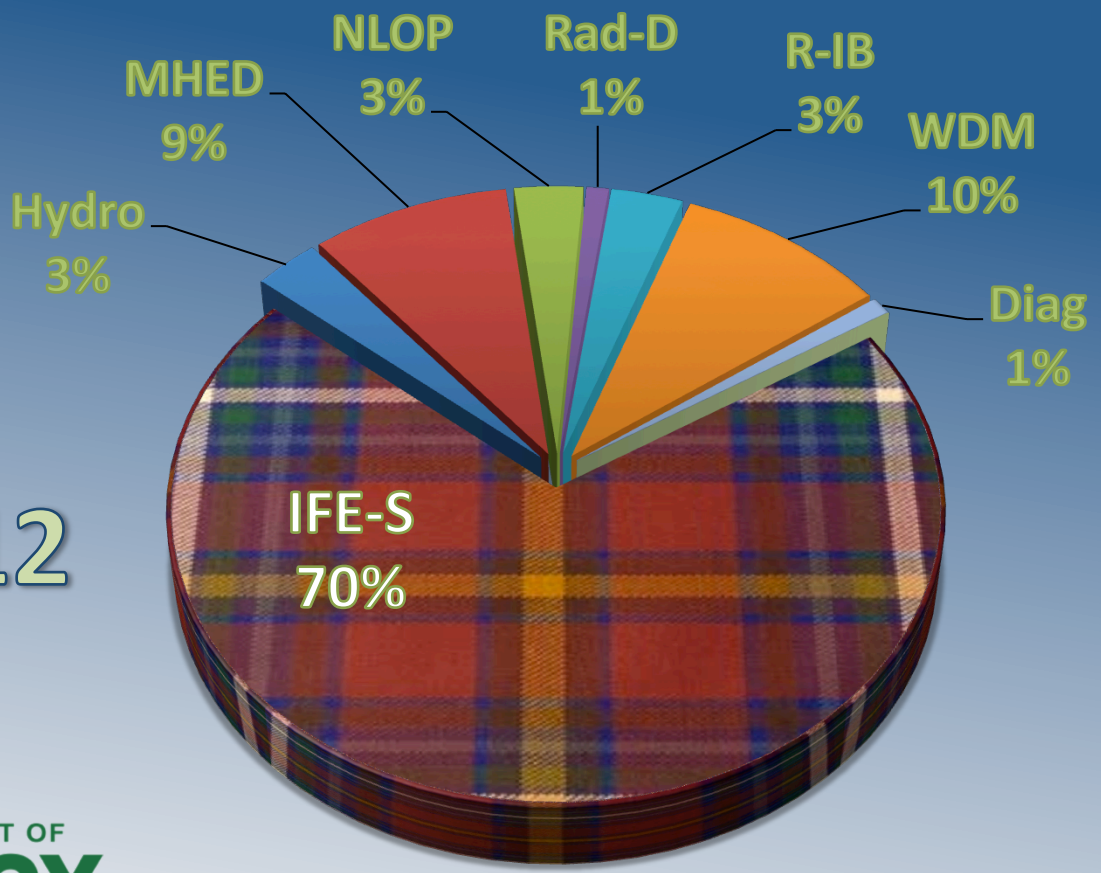
- Backup slides

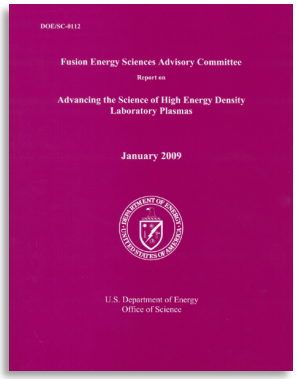
The FES High Energy Density Laboratory Plasma Science Program

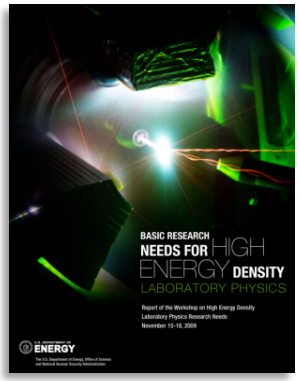


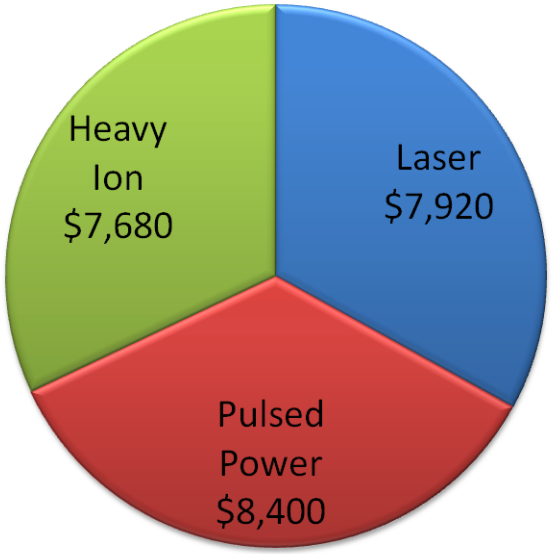
FY 2012

U.S. DEPARTMENT OF ENERGY

the portfolio FY 2009-2011







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8. **Research Infrastructure**
9. **Diagnostics for HEDLP (DIAG)**
10. **Computer infrastructure and Computing in the HEDLP Environment**

responding to congress (FES)

Senate Appropriations Committee Mark-Up of FY12 Budget

"… $12,000,000 shall be spent on heavy-ion fusion, laser-driven fusion, and magneto-inertial fusion to be evenly distributed among these three areas of science".

	Solicitation	Program	Total
MTF	$2,690	$2,501	**$5,191**
LZR	$1,800	$2,314	**$4,114**
HIF	$0	$8,539	**$8,539**
			$17,844