HEDLP
(draft) Charge Elements to FESAC: OFES Perspective

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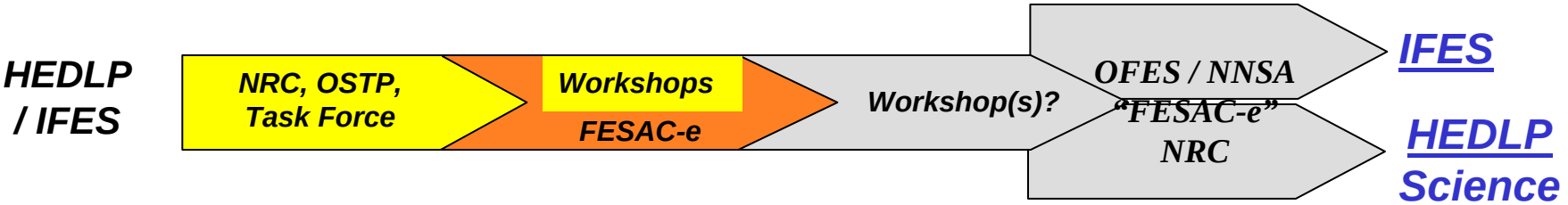
Information for Planning for Joint HEDLP Program

- Following same paradigm as for other OFES planning activities
  - Now in information-gathering stage
  - Inform development of HEDLP program scientific roadmap for the next decade
  - Expect to follow with Workshop and consolidation of issues
- Joint Program Interests
  - Improve stewardship of Federal Government HEDLP program
  - Scientific plan for energy-related HEDLP studies to support case for IFES research in future
- Interested in exploiting scientific opportunities in large NNSA facilities
- First joint solicitation planned in FY2008 for FY2009 funding



- **NOTE**: Nothing definite until charge is issued from under-Secretaries
  - This is a **preliminary discussion** to explore planning ideas only; subject to change

HEDP-Research Topics & Related Federal Research Categories

Federal Research Categories	Research Examples
Astrophysics (NASA, NSF)	Astrophysical jets Neutron star interiors Core-collapse supernovae
High Energy Density Nuclear Physics (DOE/NP)	Quark-gluon plasmas; Nuclear astrophysics
High Energy Density Laboratory Plasmas (DOE/NNSA, DOE/FES)	**Radiative hydrodynamics** **Laser-plasma and beam-plasma interaction** **Fusion burn** **Materials under extreme conditions** **Dense plasmas in ultrahigh fields** **Laboratory astrophysics**
Ultrafast, Ultraintense Laser Science (NSF, DOE/BES)	Ultraintense x-rays for material science studies; applications of ultraintense lasers to chemistry and materials; advanced accelerators

Provide information that will inform a scientific roadmap for the joint HEDLP program

- Two main issues of interest:
  - Identify the compelling scientific opportunities for research in fundamental HEDLP
  - Identify the scientific issues of implosion and target design that need to be resolved to make the case for inertial fusion energy
- Supporting OFES and NNSA programmatic interests and the need to steward the field of HEDLP
- Seminal information
  - Recent NRC reports
  - Interagency Task Force on HEDP
  - Community workshops

Draft Element I: Stewarding HEDLP

- Provide information to inform development of HEDLP program scientific roadmap for the next decade.
- Identify compelling scientific opportunities in fundamental HEDLP
  - Especially focused on using existing and planned facilities
- Description of, and rationale for, scientific interest in issues of this physical regime
  - Desire a prioritized list of scientific issues/opportunities that could be pursued over the next decade or so

Draft Element II:
Addressing Energy-related HEDLP

- Identify scientific issues that need to be addressed to make the case for inertial fusion as a potential energy source
  - Implosion and target design with existing and planned programs
- A gaps and opportunities analysis for a future focus on IFES
  - Define and defend a credible target next step in the next 10-20 years
  - Identify and prioritize underlying science issues that support obtaining the gain-efficiency product and/or suitable target designs
  - Here, assume success of initial NIF ignition campaign
- Anticipate 3 phases of activities
  - Near-term HEDLP in anticipation of future NIF applications
  - Exploit ignition capabilities of NIF to address ignition science challenges with relevance to IFES
  - Resolving issues to establish the scientific basis for focusing on a next step in inertial fusion energy science

Current OFES research in HED plasmas

- Scientific Themes
  - Developing the physics basis of pulsed, high density approach to fusion energy by studying HED plasmas
  - Create, probe, and control new states of HED plasmas
- Research covers fundamental areas of HEDLP physics:
  - Warm dense matter
  - Laser-plasma, radiation-matter interaction
  - Relativistic plasmas
  - Dense plasma in high magnetic fields
  - Compressible, radiative MHD

Current OFES Research in HEDLP

- Warm Dense Matter (Heavy ion fusion)
  - $8.14M, 5 grants, 3 labs, 1 university, 1 industry
- Laser-plasma, radiation-matter interaction and relativistic plasmas (fast Ignition, shock ignition)
  - $5.4M, 9 grants, 4 labs, 5 universities
  - $1.1M, Fusion Science Center at U. Rochester
- Dense plasma in high magnetic fields, compressible, radiative MHD (Magneto-inertial fusion, astrophysical jets, and other)
  - $4.71M, 17 grants, 4 labs, 10 Universities, 4 industries

Summary

- FESAC may be requested to undertake a study to provide information that will inform a scientific roadmap for the joint HEDLP program
  - Identify the compelling scientific opportunities for research in fundamental HEDLP
  - Identify the scientific issues of implosion and target design that need to be resolved to motivate consideration of inertial fusion energy as a potential future energy source
    - A gaps and opportunities analysis, assuming successful ignition campaign on NIF
- Considering three time frames
  - Before NIF ignition
  - Exploiting NIF capabilities
  - Looking beyond NIF ignition
- Current OFES interest emphasizes IFES-motivated HEDLP, but plans to expand program to include HED astrophysics that most overlap with this portion of the HEDLP space.
  - Complements NNSA's interests and stewardship of HEDLP
  - Will need to expand expertise of FESAC subpanel to broader HEDLP community
- Tasks not defined until formal charge issued by Under Secretaries
  - Memo of Understanding in final approval stage to empower FESAC for these tasks

BACKUPS

HED projects in the past ICC program have been consolidated to the Joint Program in HEDLP in FY 2008

- HED ICCs consolidated into the Joint Program in HEDLP
  - Form the core of the program in dense plasmas in high magnetic fields (magnetized HEDLP):
    - Solid-liner MTF
    - Plasma-jet driven MTF
    - Dense-plasma wall interactions
    - Magneto-kinetic compression of FRC
    - Staged Z-pinch
- The SSPX group at LLNL is directing towards a program in fast ignition / HED science to take advantage of major NNSA facilities.

IFES-inspired HED science

- Long-term, IFES requires higher gains, suitable targets and drivers, at reasonable costs
  - Lowering the implosion velocity is one avenue towards higher fusion gain, provided ignition occurs
- Addressing the physics basis for three different approaches to achieve lower implosion velocity
  - Decoupling ignition from fuel assembly so that the dense fuel can be assembled with low implosion velocity
    - Fast ignition, shock ignition
  - Embedding an intense magnetic field in the target to slow down thermal losses from the hot spot
    - Magneto-inertial fusion (magnetized target fusion)
  - Higher efficiency of coupling the driver energy to the target hydro
    - Heavy ion fusion

With international partners, working towards testing the Fast Ignition concept …..

- Develop the scientific knowledge base to enable design of ignition-class FI experiments in the next 5 years
  - Develop low-velocity, low-adiabat fuel assembly
  - Unravel the physics of ignitor energy creation and transmission
  - Develop modeling capability for designing integrated FI
- Suggested program schedule
  - Develop scientific knowledge base to enable design of Q ~ 0.1 integrated FI experiment (2010)
  - Field integrated FI experiments and demonstrate Q ~ 0.1 (2012)
  - Design and field ignition class experiments on NIF (2015)