NNSA Perspective

Presented to

NAS/NRC Plasma Science Committee

by

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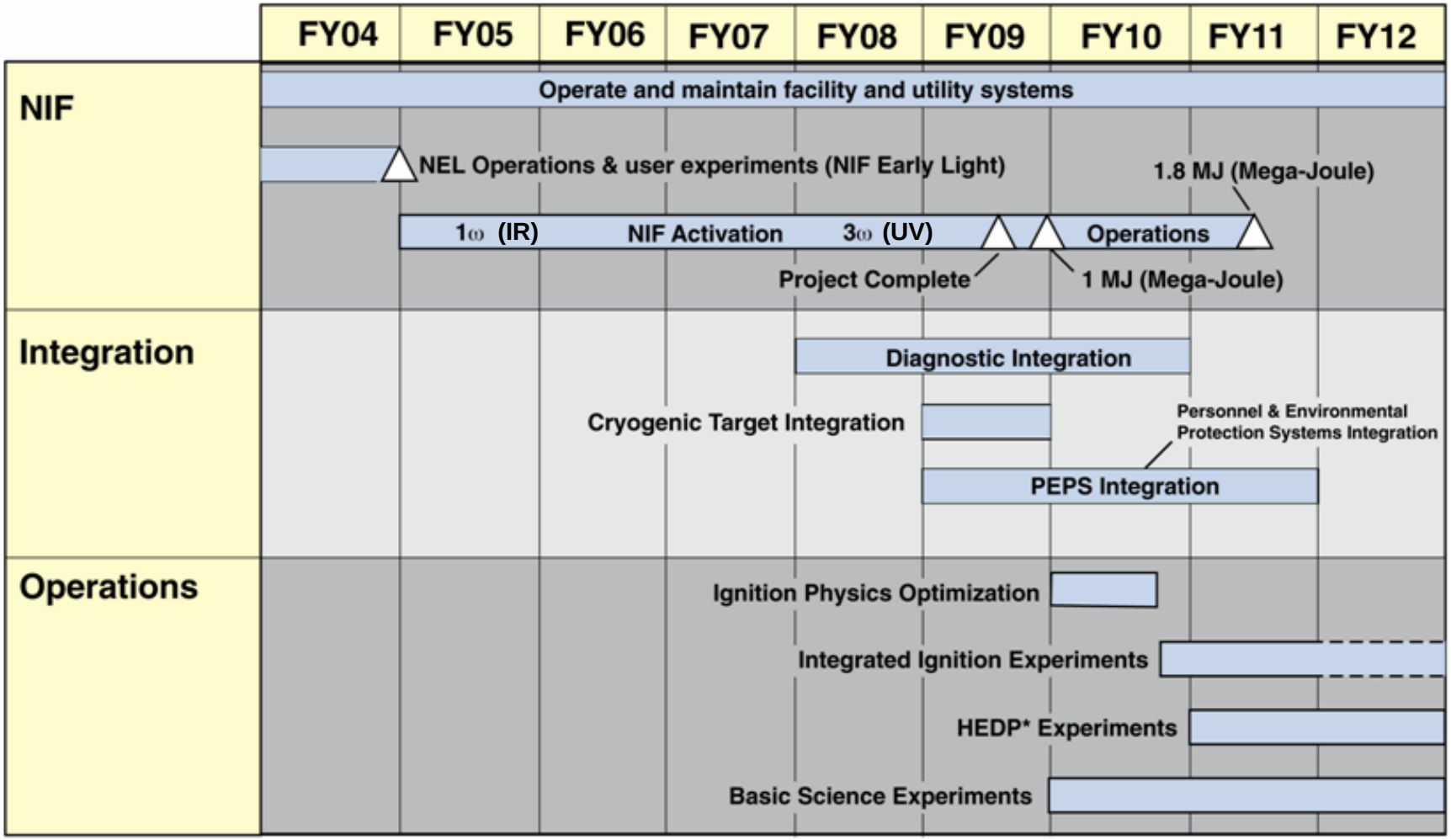
Summary points

- **Inertial fusion and high energy density physics is a key element of stockpile stewardship- HEDLP experiments provide integrated test of advanced simulation codes**
- **Highest priority for ICF is NIF completion and execution of ignition experiments starting in FY2010**
- **Program is entering a scientific “golden age” with completion of ZR (2007), OMEGA EP (2008), and NIF (2009)**
- **NNSA/SC Joint Program in Laboratory High Energy Density Plasmas created to steward HEDLP within DOE**

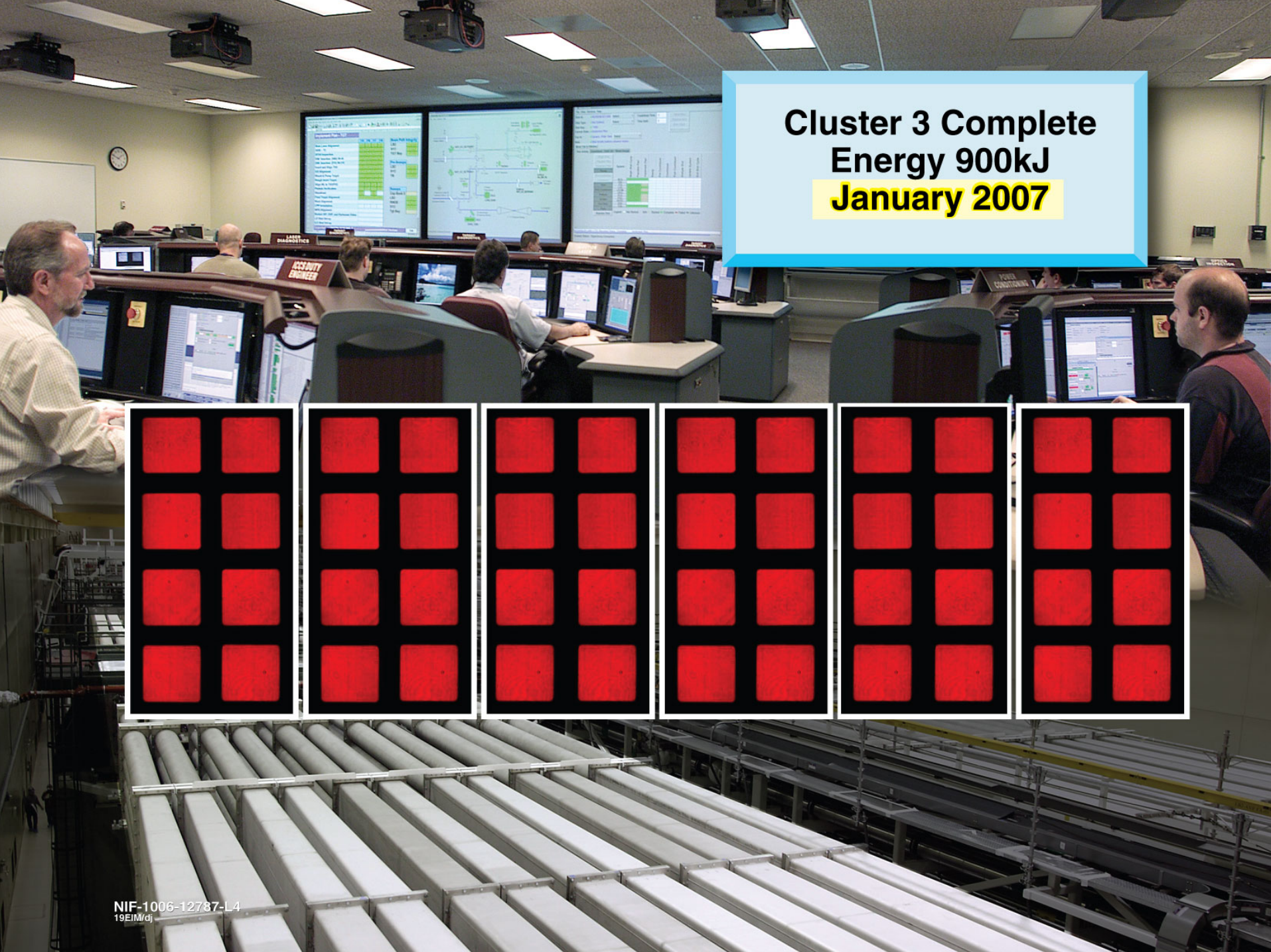
ICF and High Yield Campaign Strategic Objectives

1. Achieve ignition in the laboratory and develop it as a scientific tool for stockpile stewardship
2. Execute high energy density weapons physics experiments in support of stockpile stewardship in collaboration with other NNSA campaigns
3. Develop advanced concepts that support the long-term needs of stockpile stewardship
4. Steward the field of high energy density laboratory plasma physics (via joint program with DOE Office of Science)

The plan for use of NIF calls for first ignition experiments in FY 2010



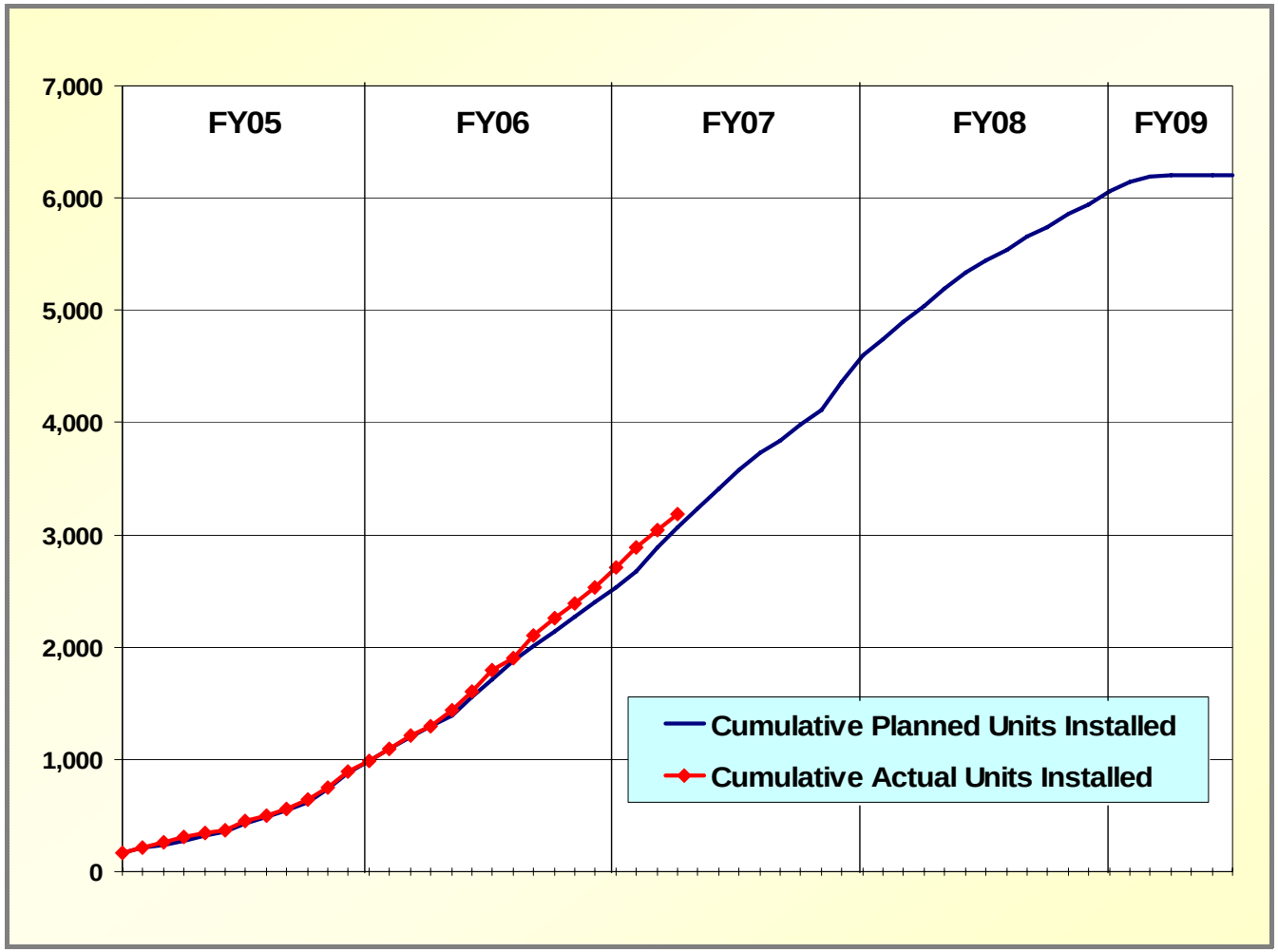
* Weapons physics experiments in support of Stockpile Stewardship



NIF-1006-12787-L4
19EIM/dj

NIF is meeting its Line Replaceable Unit (LRU) Production and Installation Schedule

National Nuclear Security Administration

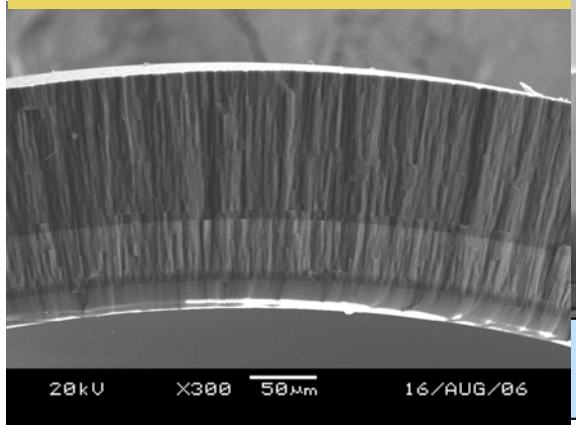


3,182 Line Replaceable Units (51%) were installed by December 31, 2006

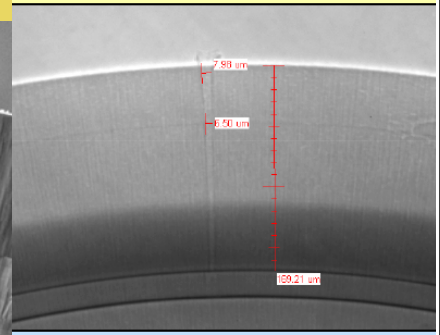
National Ignition Campaign: Progress towards an integrated ignition target

- **Complete Be shell capsule characterization capability**
- **Demonstrate scientific prototype ignition capsules (Be and plastic)**

Uniform micro-structure NIC Be shell

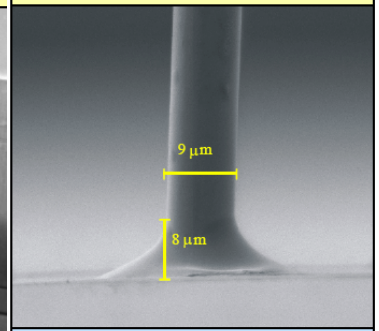


Fill tube hole



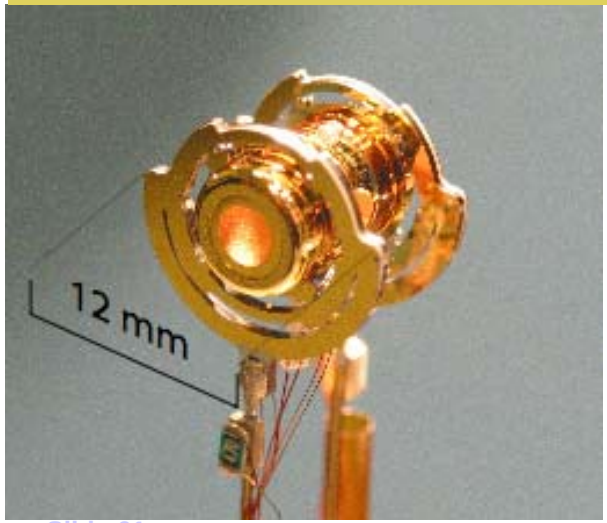
Hole meets requirements

NIF fill-tube bond

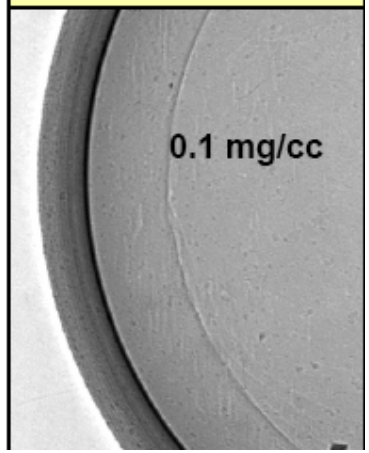


Bond joint meets NIF mass defect spec of 2.5 ng of adhesive

Hohlraum thermomechanical assembly



DT Layers in a Be Shell



Ice meets roughness spec.

Ice roughness 0.5 µm

DT layer, plastic shell ,OMEGA

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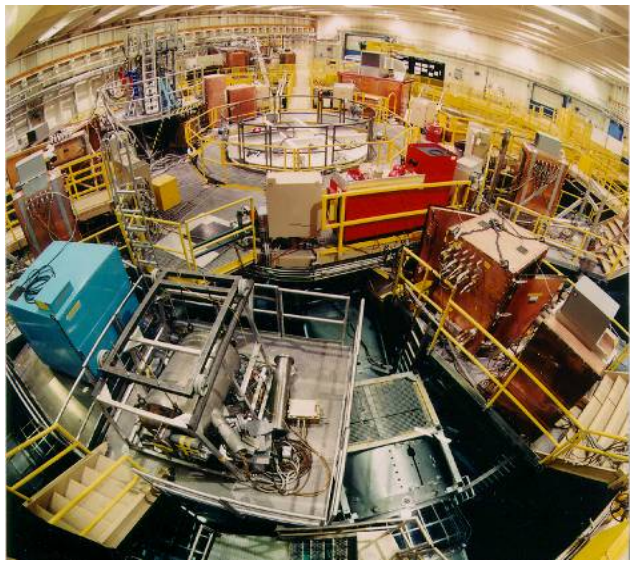
Recent Progress on the Z Refurbishment Project

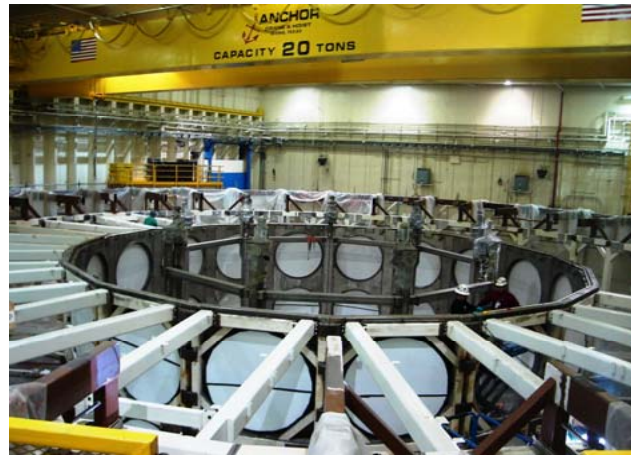
National Nuclear Security Administration

July 2006
(last shot)



September 2006
(dismantlement completed)

December 2006
(tank modifications completed)



- **Z has been dismantled**
- **Major tank modifications are complete**
- **Component installation began in January 2007**

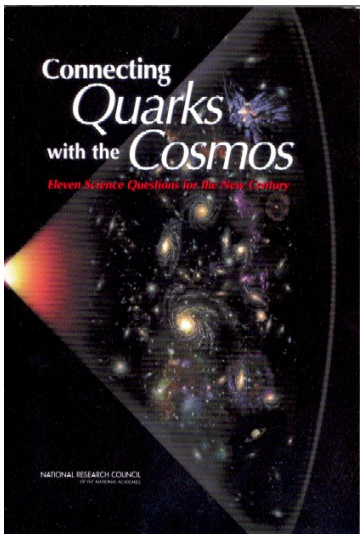
January 15, 2007
(tank painting completed)

Sandia National Laboratories

OMEGA EP Laser Bay photo shows recent beamline progress

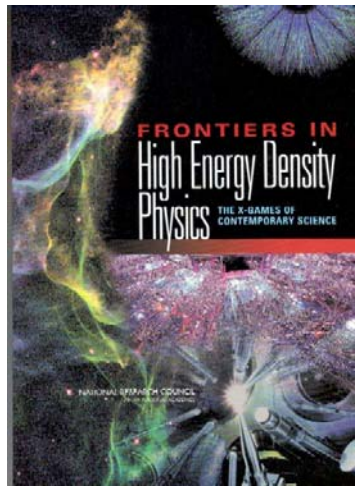
OMEGA EP

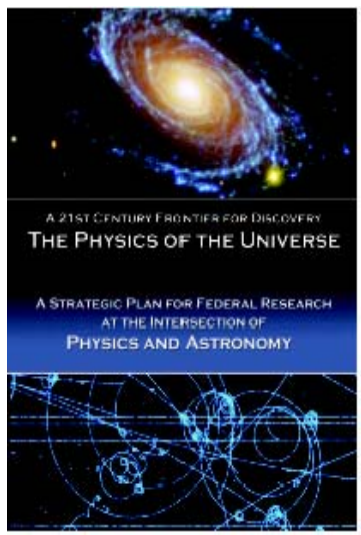
Previous Reports on HEDP



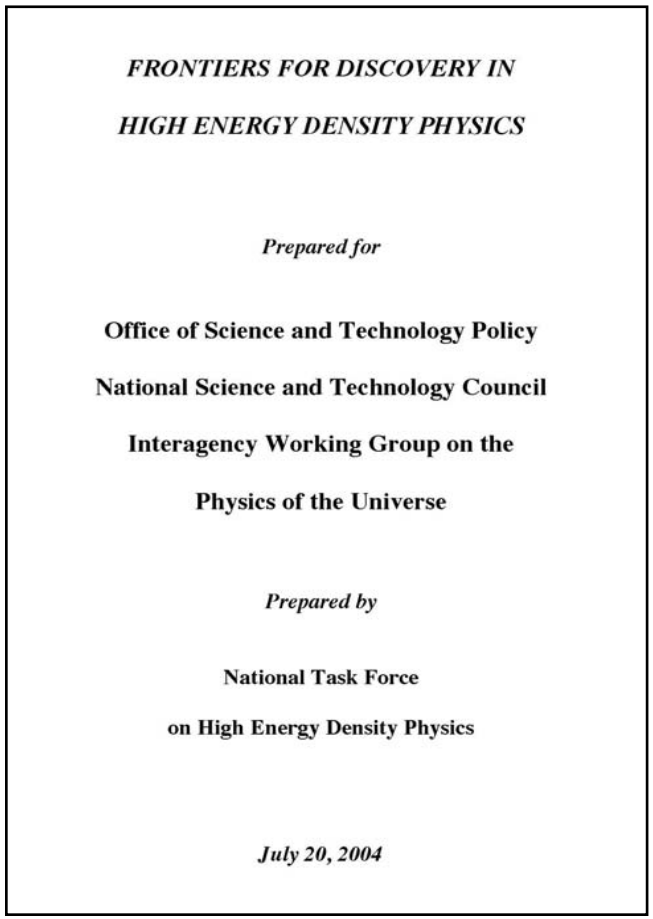
A number of reports sponsored by the Federal government in recent years have presented

- **Technical advances relevant to HEDP,**
- **Emerging scientific opportunities, and**
- **Recommendations for enabling further progress.**





2004 Davidson report provided the starting point for the HEDP Interagency Task Force



FRONTIERS FOR DISCOVERY IN

HIGH ENERGY DENSITY PHYSICS

Prepared for

Office of Science and Technology Policy

National Science and Technology Council

Interagency Working Group on the

Physics of the Universe

Prepared by

National Task Force

on High Energy Density Physics

July 20, 2004

The interagency Task Force on HEDP (TF-HEDP) was chartered by the Interagency Working Group on the Physics of the Universe (IWG-POU) under the Committee on Science in the National Science and Technology Council to

- **respond to a community-based report (*Frontiers for Discovery in HEDP*) previously commissioned by the IWG-POU, and**
- **recommend specific steps needed to move forward on the scientific opportunities identified in HEDP.**

Interagency Task Force on HEDP: Chair/Members

Co-Chairs: C. Keane (DOE/NNSA- ICF/NIF)
D. Kovar (DOE/SC/Nuclear Physics)

Exec. Secretary: F. Thio (DOE/SC/Office of Fusion Energy Sciences)

Members: OSTP (R. Dimeo, J. Morse, K. Beers)
DOD (S. Ossakow)
DOE/NNSA (R. Schneider, C. Deeney, A. Hauer)
DOE/SC/Basic Energy Sciences (E. Rolfing, M. Casassa)
DOE/SC/Nuclear Physics (J. Simon-Gillo)
DOE/SC/High Energy Physics (R. Staffin, L.K. Len)
NASA (M. Salamon)
NIST (J. Gillaspy, T. Lucatorto)
NSF (J. Dehmer)

Davidson 2004 report defined 15 "scientific thrust areas"

1. Astrophysical phenomena:
2. Fundamental physics of HED astrophysical phenomena:
3. Laboratory astrophysics:
4. Heavy ion driven HEDP and fusion:
5. HED physics with ultrarelativistic electron beams:
6. Characterization of quark-gluon plasmas:
7. Materials properties:
8. Compressible dynamics:
9. Radiative hydrodynamics:
10. Inertial confinement fusion:
11. Laser excitation of matter at the relativistic extreme:
12. Attosecond physics:
13. Ultrafast, high peak-power x-rays:
14. Compact high energy particle acceleration:
15. Inertial fusion fast ignition:

- **Thrust areas touch upon many well-established fields of science, such as atomic physics, nuclear physics, plasma physics, high energy physics, astrophysics, materials science, and laser science.**

Davidson research thrusts may be placed into 4 categories

Federal Research Category	Research thrust area(s) from the *Frontiers for Discovery in HEDP* report
Astrophysics	**1. Astrophysical phenomena** **2. Fundamental physics of HED astrophysical phenomena**
High Energy Density Nuclear Physics	**6. Characterization of quark-gluon plasmas**
High Energy Density Laboratory Plasmas	**3. Laboratory astrophysics** **4. Heavy ion driven HEDP and fusion** **5. HED physics with ultrarelativistic electron beams** **7. Materials properties** **8. Compressible dynamics** **9. Radiative hydrodynamics** **10. Inertial confinement fusion** **15. Inertial fusion fast ignition**
Ultrafast, Ultraintense Laser Science	**11. Laser excitation of matter at the relativistic extreme** **12. Attosecond physics** **13. Ultrafast, high peak-power x-rays** **14. Compact high energy particle acceleration**

Key DOE finding: stewardship of HEDLP needs to be improved

What characterizes a "well-stewarded" area of science?

- **Compelling scientific questions are clearly identified and prioritized (workshop process)**
- **Solicitations exist with adequate funding from clearly defined agency leads**
- **User facilities are established with program advisory committee process used to allocate time**
- **Facility user groups are active**
- **Federal advisory committees or other groups set strategic direction and build technical consensus on opportunities and priorities**
- **Scientific excitement is publicly visible**

DOE has taken action to improve stewardship of HEDLP

- **Joint Program in Laboratory HEDP announced 2/5/07 (FY08 Congressional budget submission)**
- **Oversight of HEDLP now a joint NNSA/SC responsibility**
- **Key actions**
  - **Workshops**
  - **Joint solicitations**
  - **Establishment of federal advisory committee**
  - **Implementation of facility user programs**
  - **Strategic plan for HEDP**

Joint Program in High Energy Density Laboratory Plasmas

- NNSA and Office of Science (OFES) have established a joint program in high energy density laboratory plasmas
- Purpose is to steward effectively this emerging field within DOE while maintaining the interdisciplinary nature of this area of science
- Program includes individual investigators, research centers activities, and user programs (National Laser User Facility program)
- Other agencies may join in the future (NSF, NASA)

Dollars in Thousands

NNSA	**12,356**
User Facility Programs (fund via ICF Campaign)	1,613
Individual Investigators, Center Research, Grants & Fellowships (fund via Science & ICF Campaigns)	10,743
Office of Science (OFES)	**12,281**
Fast Ignition	2,840
High Mach Number Plasma Jets / Dense Plasmas in Ultrahigh Magnetic Fields	1,255
Heavy Ion Science	8,186
Total	**24,637**