

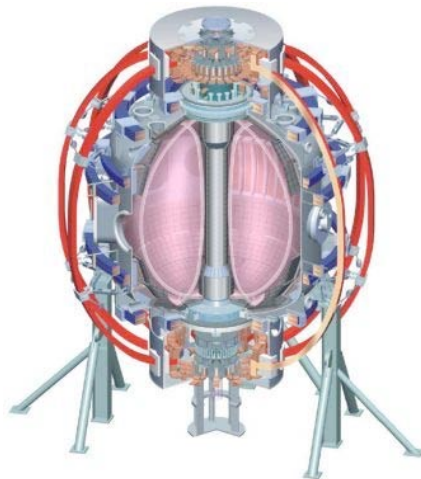
NSTX Facility Overview

Masa Ono

For the NSTX Team

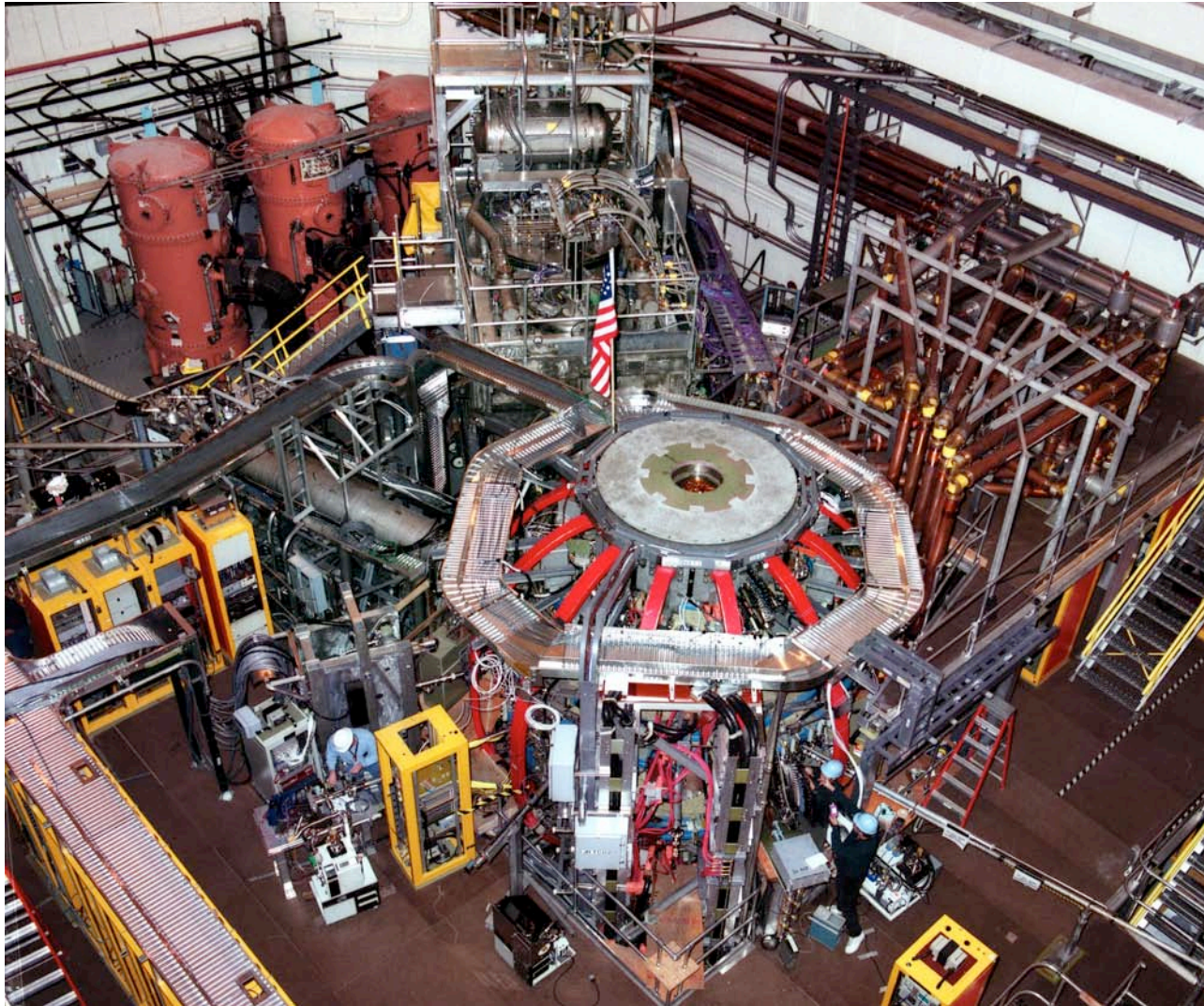
**NSTX Research Forum
December 1 - 3, 2009**

College W&M
Colorado Sch Mines
Columbia U
CompX
General Atomics
INL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
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Princeton U
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ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

NSTX Facility Overview



Device Capabilities

Major Radius 0.85 m

Minor Radius 0.68 m

Elongation 1.8 - 3.0

Triangularity 0.2 - 0.8

Plasma Current

1 MA (1.5 MA peak)

Toroidal Field

0.35 - 0.55 T

Heating and CD

7 MW NBI (2 sec)

5 MW NBI (5 sec)

6 MW HHFW (5 sec)

0.2 MA CHI

Pulse Length

~ 1 sec at 0.55 T

~ 2 sec at 0.38 T

Successful FY09 operations completed

- **17 run weeks: 2750 good plasmas out of 2900 attempts (~95%), More plasma shots than any other year for NSTX**
 - FY08: 16.5 rw: 2570/2760 (93%)
 - FY07: 12.6 rw: 1890/2080 (90%)
 - FY06: 12.7 rw: 1615/1930 (84%)
- **Over 50 XP/XMPs performed: more than any other year**
- **New capabilities in FY09**
 - HHFW upgrade allowed for lower strap voltage, higher power (up to 4 MW)
 - Dual LITER and Dual Li dropper system for boundary tools
 - Sample probe for retention measurements and surface analysis
 - Fast IR camera for ELM-resolved heat flux measurements
 - NBI Feedback
 - CHI absorber coil energization
 - Reversed B_T

Diagnostic Systems Operational with Strong Collaboration Contributions

Collaboration contributions

MHD/Magnetics/Reconstruction

Magnetics for *equilibrium reconstruction*
Diamagnetic flux measurement
Halo current detectors
High-n and high-frequency Mirnov arrays
Locked-mode detectors
RWM sensors (n = 1, 2, and 3)

Profile Diagnostics

Multi-pulse Thomson scattering (30 ch, 60 Hz)
T-CHERS: $T_i(R)$ and $V_f(r)$ (51 ch)
P-CHERS: $V_q(r)$ (71 ch)
MSE-CIF (15 ch)
FIReTIP interferometer (119mm, 6 ch)
Midplane tangential bolometer array (16 ch)

Turbulence/Modes Diagnostics

Tangential microwave high-k scattering
Microwave reflectometers
Ultra-soft x-ray arrays – tomography (4 arrays)
Fast X-ray tangential camera (2ms)

Energetic Particle Diagnostics

Neutral particle analyzer (2D scanning)
SSNPA
Fast lost-ion probe (energy/pitch angle resolving)
Neutron measurements
Fast Ion D_a profile measurement

Edge Divertor Physics

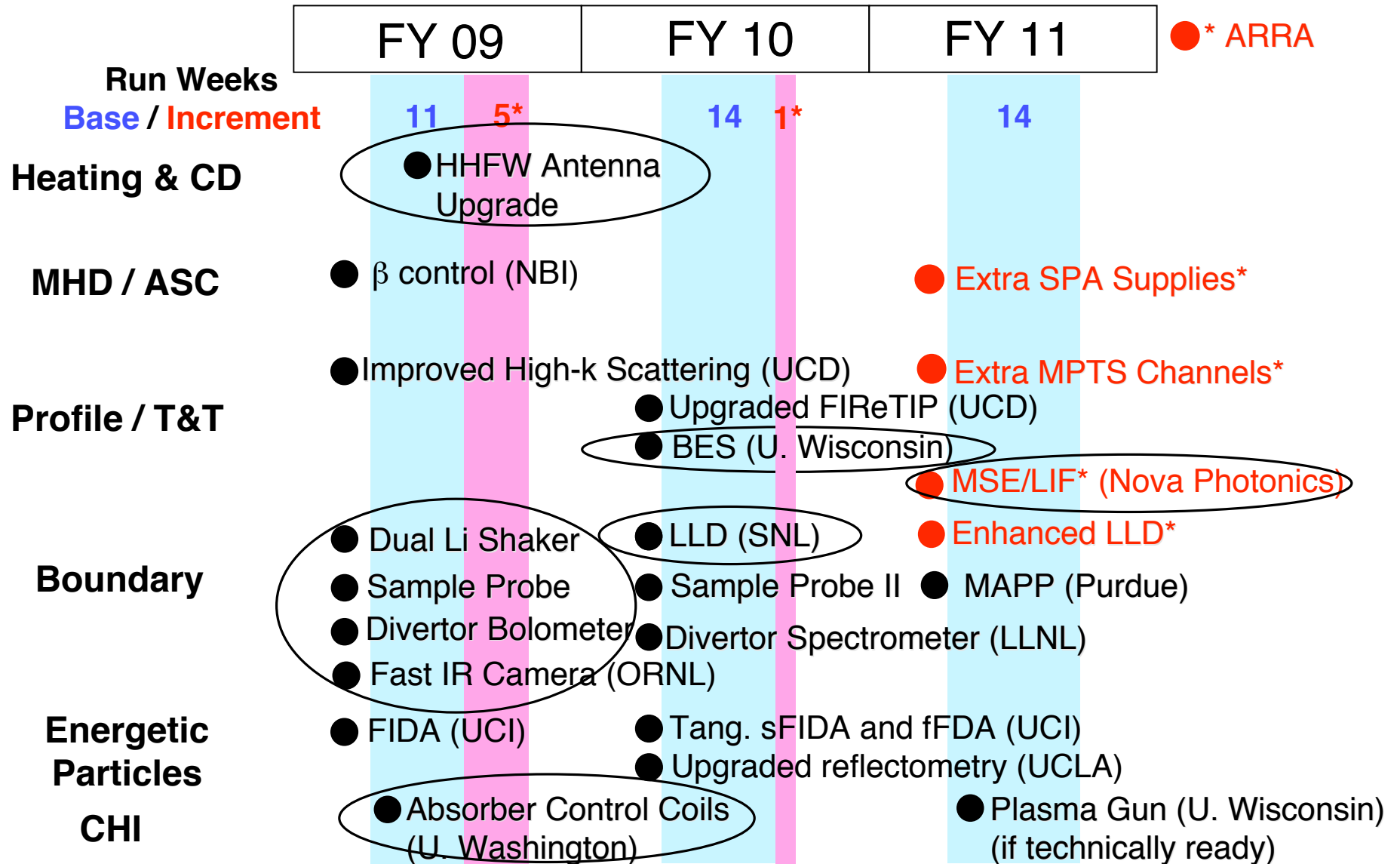
Reciprocating Edge Probe
Gas-puff Imaging (2ms)
Fixed Langmuir probes
Edge Rotation Diagnostics (T_i , V_f , V_{pol})
1-D CCD H_a cameras (divertor, midplane)
2-D divertor fast visible camera
Divertor bolometer (20ch)
IR cameras (30Hz) (3)
Fast IR camera
Tile temperature thermocouple array
Dust detector
Edge Deposition Monitors
Scrape-off layer reflectometer
Edge neutral pressure gauges
Edge Sample Probe

Plasma Monitoring

Fast visible cameras
Visible bremsstrahlung radiometer
Visible survey spectrometer
UV survey spectrometer
VUV transmission grating spectrometer
Visible filterscopes
Wall coupon analysis
X-ray crystal spectrometer (astrophysics)

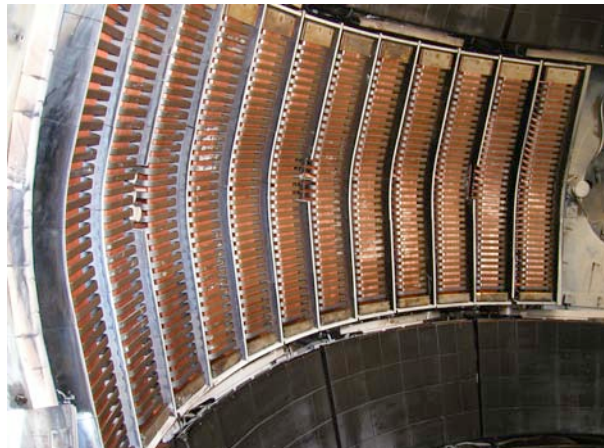
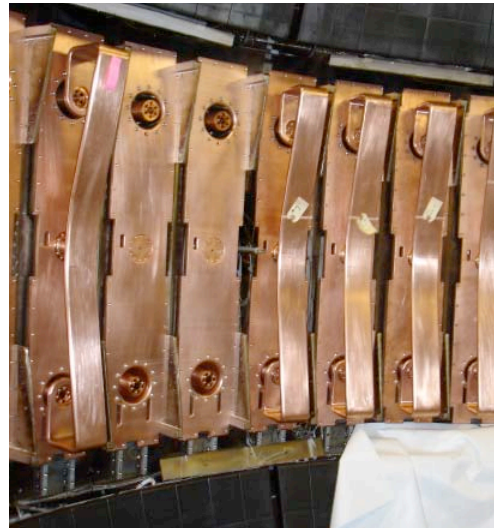
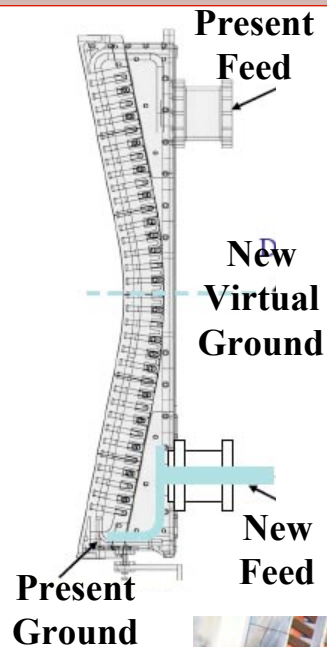
NSTX Near Term Upgrade Plan

ARRA Funding Significantly Enhances Research Capability



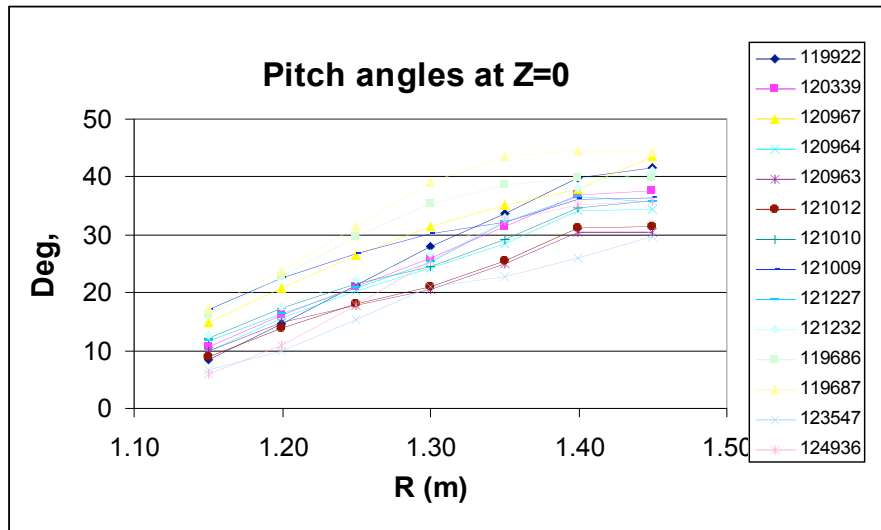
HHFW System Upgrades Completed

Successful Loop Installation During FY 09 NSTX Operations



- 2009 Double-feed upgrade shifts ground from end to strap center.
- Double power per strap for the same plasma load. *J. Hosea, R. Ellis (PPPL) et al.,*

Beam Emission Spectroscopy Diagnostic With High-k to Provide Comprehensive Turbulence Diagnostic Set



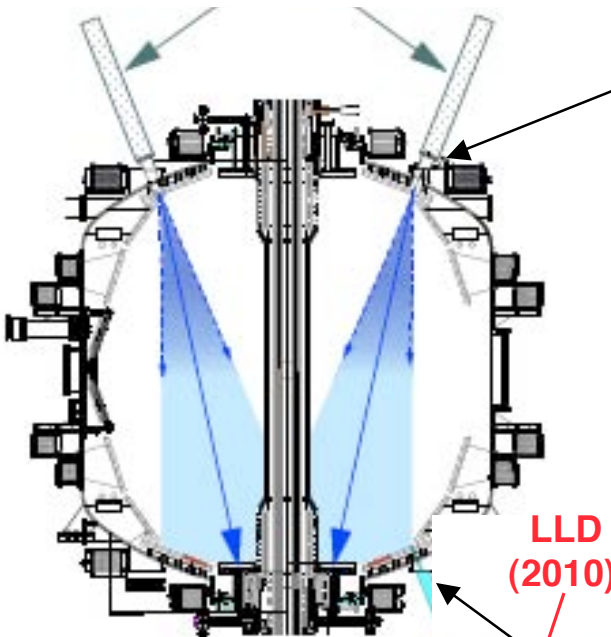
- Two re-entrant sets of optics required to match field line pitch over most of outer plasma radius ($r/a=0.3-1.0$)
- In-vessel BES component installation completed.
- Optics, fibers, and detectors are being installed during current outage
- Low-noise, cooled PIN photodiode detectors being fabricated by University of Wisconsin (32 channels)
- Plan to take initial data in spring 2010

G. McKee, R. Fonck, D. Smith (U. Wisconsin), B. Stratton, G. Labik (PPPL) et al.,

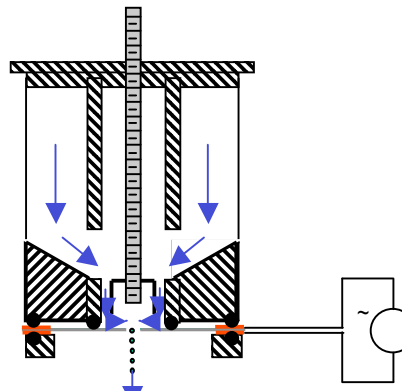
New Capability for Boundary Physics

Dual LITER, Dual Lithium Dropper, Sample Probe, Fast IR Camera

Dual Liquid Lithium Evaporator
For Li wall coatings
Now routinely used

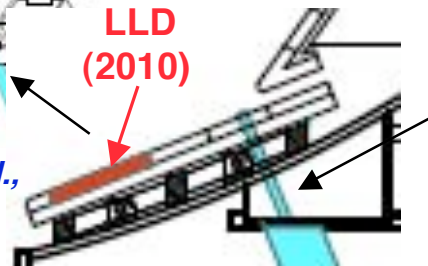


H. Kugel, R. Kaita (PPPL) et al.,



Dual Lithium
Powder Dropper

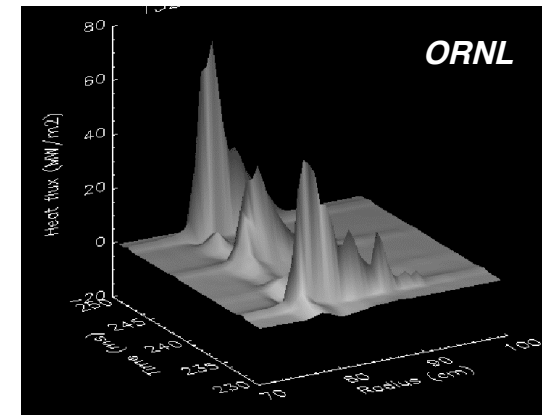
D. Mansfield (PPPL) et al.,



SAMPLE PROBE for
retention measurements
C. Skinner (PPPL) et al.,

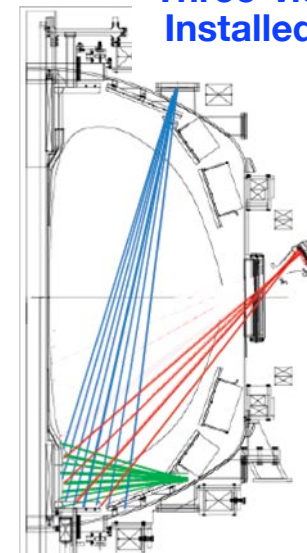
and surface analysis
Purdue U

Fast IR Camera Operational
ELM-resolved heat flux



J-W Ahn et al.,

Three-view Divertor Bolometer
Installed for divertor radiation



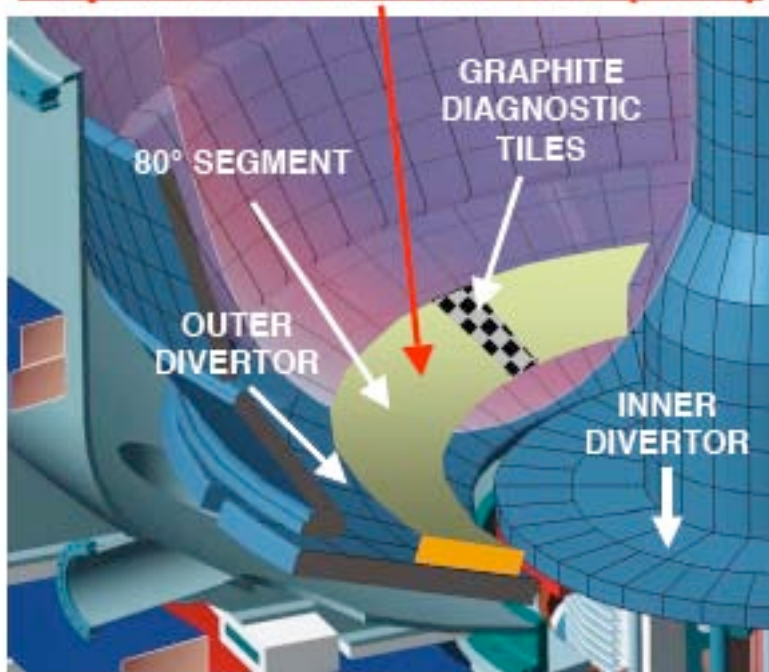
Repaired detector
received at PPPL
and being
checked out on
the bench; will be
installed this
coming week

S. Paul (PPPL) et al.,

Liquid Lithium Divertor to Test Pumping Effectiveness

LLD Plates To Operate at Lithium Melting Temperature (200 - 400 °C)

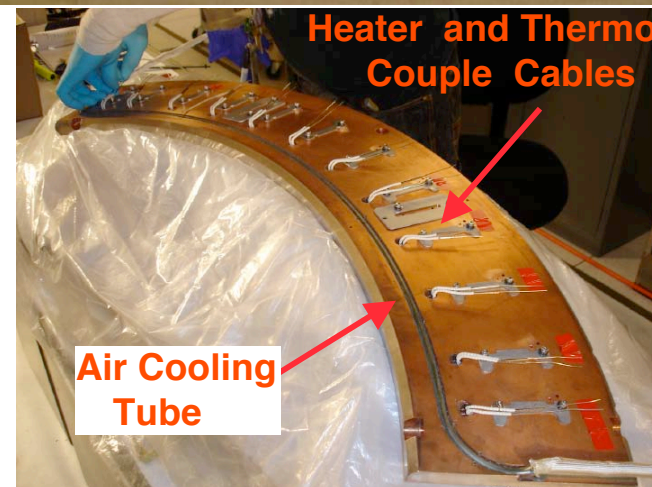
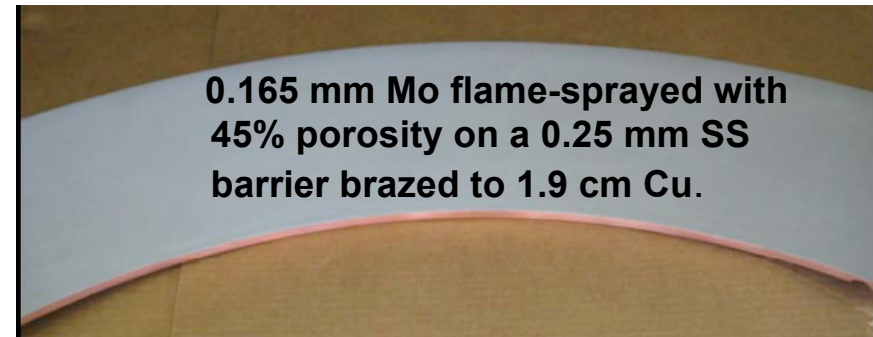
Liquid Lithium Divertor (LLD)



*H. Kugel, R. Kaita (PPPL) et al.,
R. Nygren (Sandia NL) et al.,*

PPPL Eng: R. Ellis, M. Viola, H. Schneider et al.,

Moly-Coated SNL LLD Plate

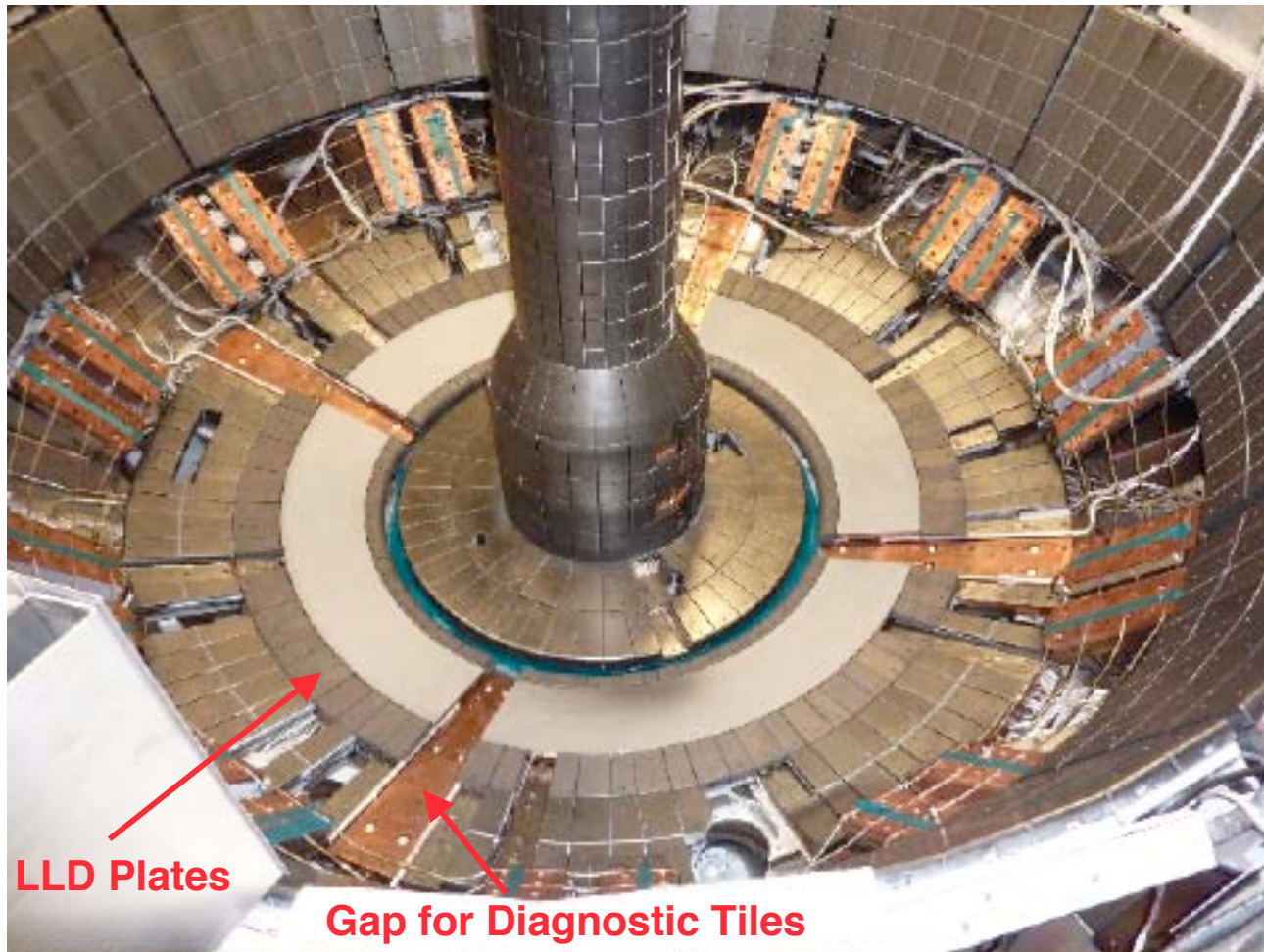


LLD plate with 12 heater elements, 32 thermocouples and air cooling tube for temperature control

LLD gap-diagnostic tile set: a Mirnov Coil array, a 99 probe Langmuir Probe Array, and 2 tiles for toroidal or radial bias to the diverted strike points.

LLD Installation Progressing On-Schedule

Full LLD Plate Set and Two Gap Tiles Installed



LLD-related external diagnostics: 2 fast wide angle visible cameras, IR / fast IR cameras, a Lyman-alpha Detector Array, a multicord divertor viewing visible spectrometer, and a divertor region Edge Sample probe. (LLNL, Purdue, U. Illinois, ORNL)

SNL-PPPL LLD Control Rack in NSTX Test Cell



3x33 Langmuir Probe Array



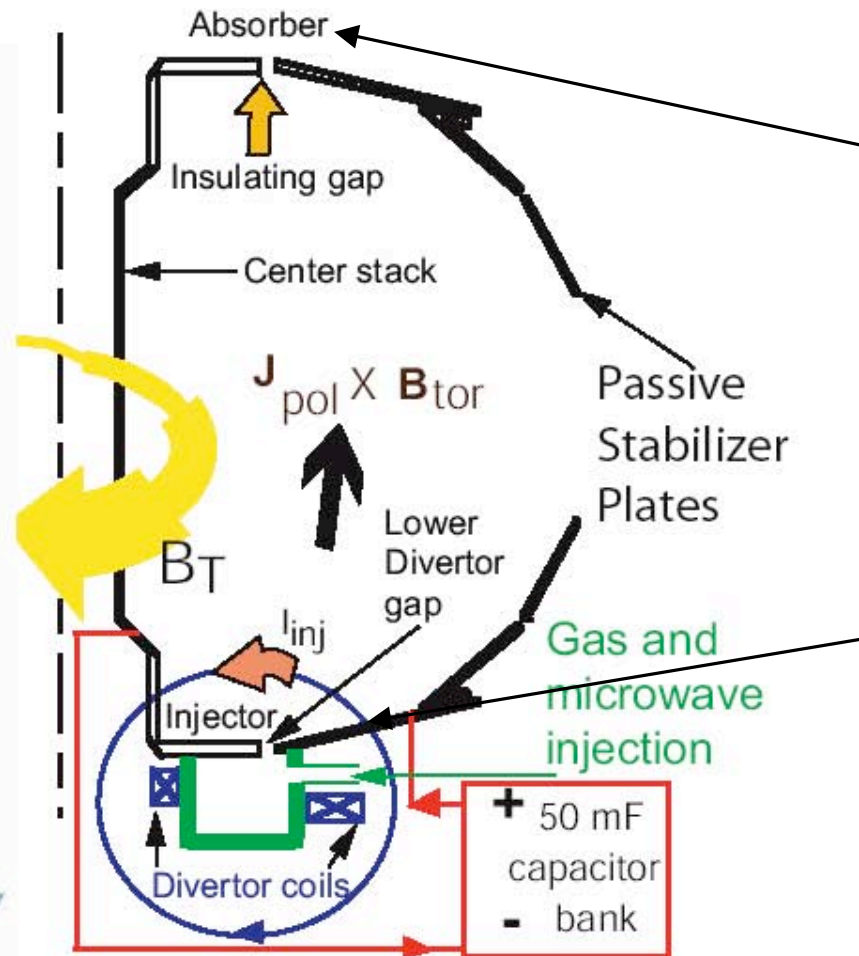
J. Kallman (Ph.D. Thesis)

Co-axial Helicity Injection

Achieved significant flux savings through impurity control

Role of impurities identified - Need to minimize impurity radiation

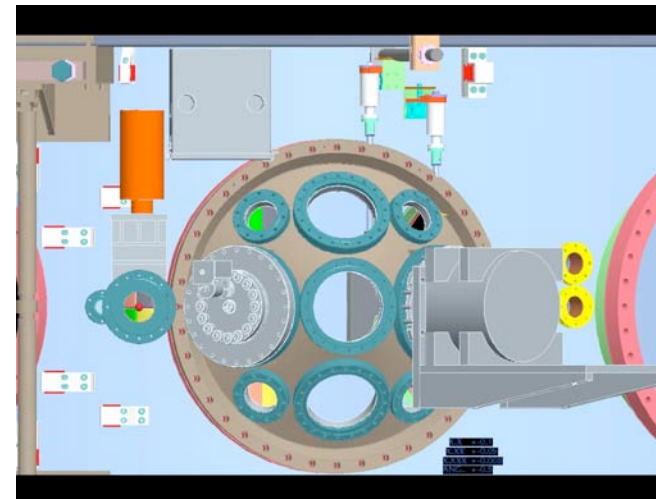
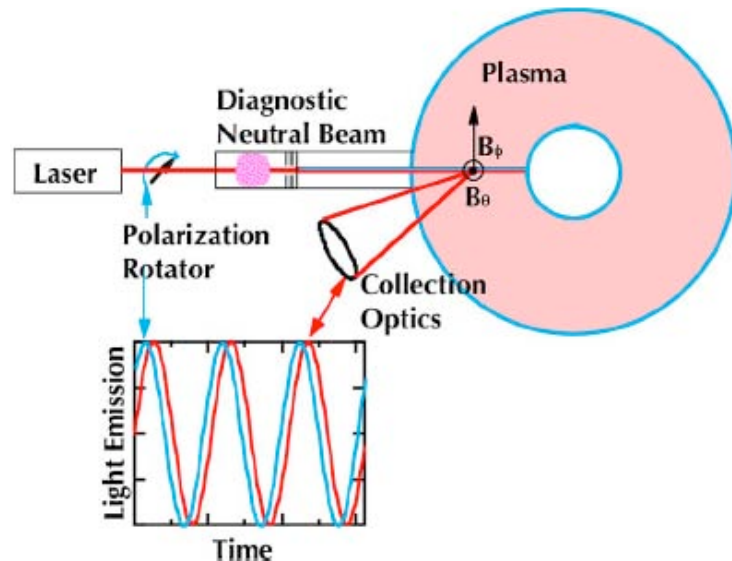
- Minimize absorber arc using the absorber coils with SPA
- Use of conditioning and lithium/metal to reduce low-Z impurity radiation



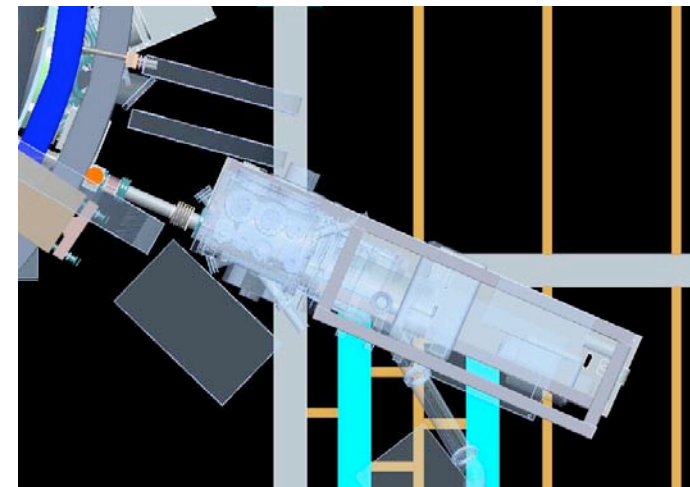
Absorber coils tested utilizing the SPA power supplies in 2009

LLD to be used to test metal divertor wall in 2010

Motional Stark Emission-Laser-Induced Fluorescence Measures $j(r)$ and $B(r)$ without MSE-CIF and $E_r(r)$ with MSE-CIF

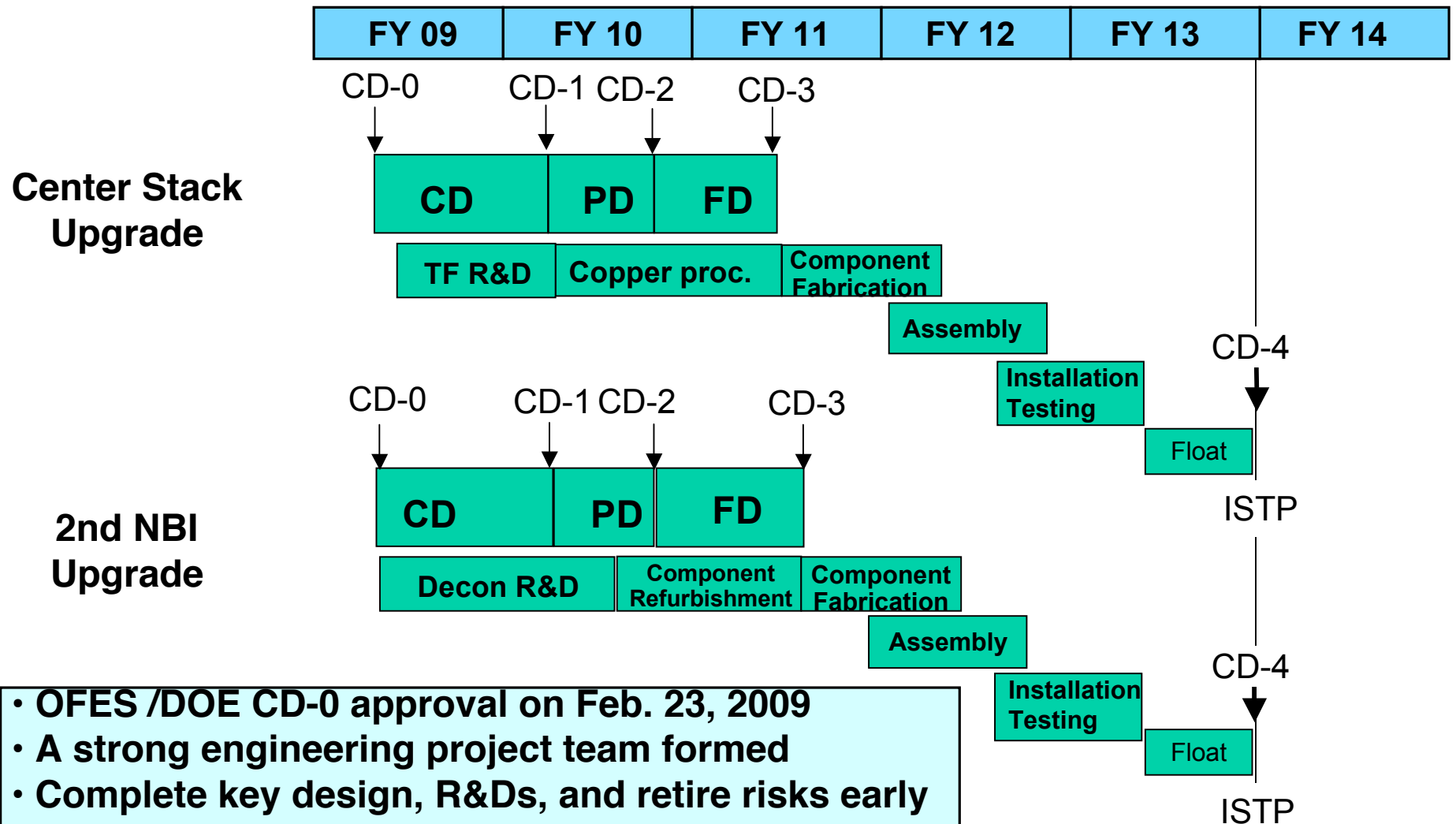


- A collaboration with Nova Photonics under DOE Innovative Diag. Initiative
 - Provides DNB/laser, optics, and detectors
 - DNB packaged for installation on NSTX
 - Diode laser being tested
- PPPL provides diagnostic interface and infrastructure needed for DNB/laser
- Design nearly complete
- Readied for operation in FY 2011 run



E. Foley, F. Levinton (N. Photonics), B. Stratton (PPPL) et al.,

Schedule for CS & NBI Upgrades Proposed in "Mission Need Statement" for CD-0

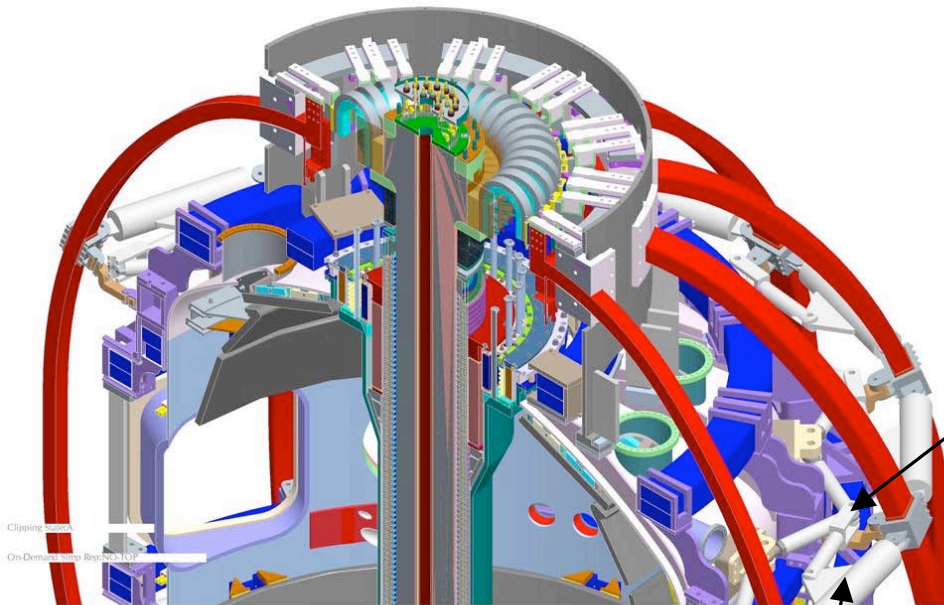


- OFES /DOE CD-0 approval on Feb. 23, 2009
- A strong engineering project team formed
- Complete key design, R&Ds, and retire risks early
- Rigorous external reviews
- OFES / DOE CD-1 Review on Dec.15 - 16, 2009.

Extensive Analyses Performed Using Global and Local Analysis Codes

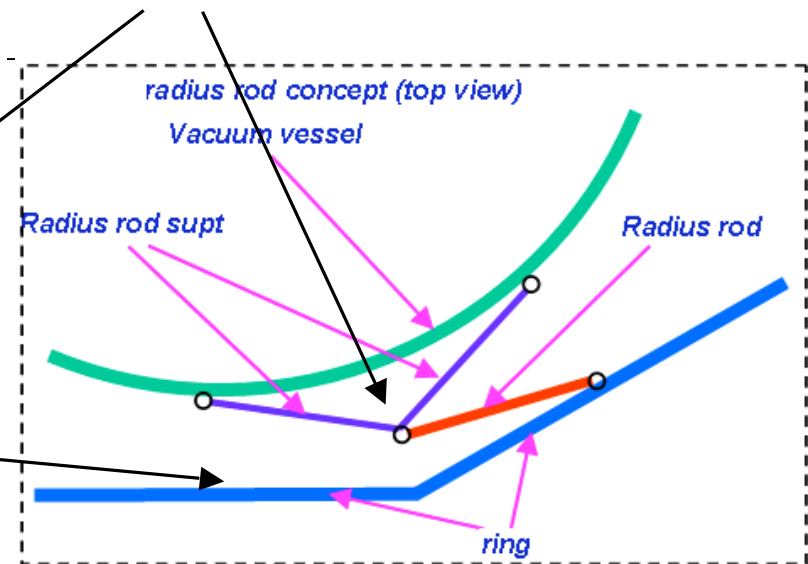
Static, Dynamic, Fatigue Analyses for Electro-Magnetic, Thermal, Mechanical Loads

Outer TF, Vessel, Umbrella Structure, Reinforcements



- Toroidal-Ring Supports In-Plane Loads

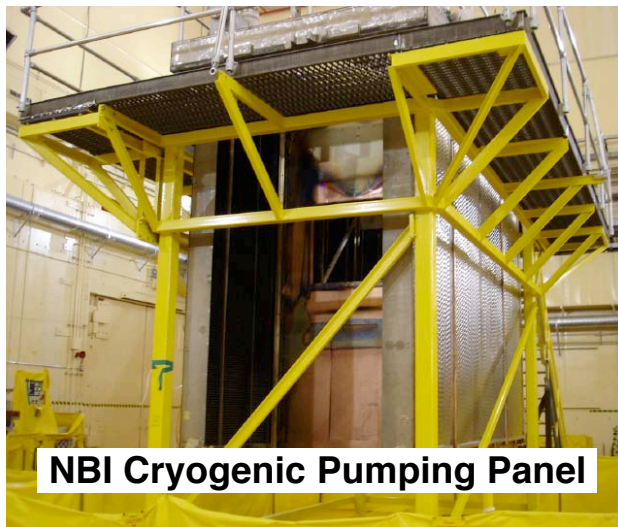
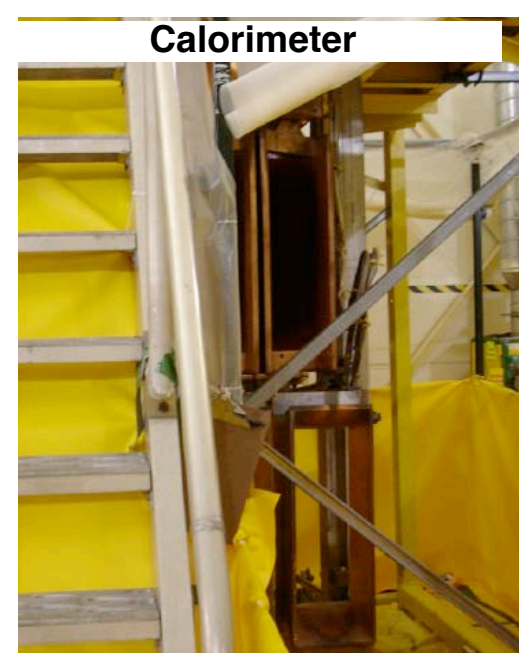
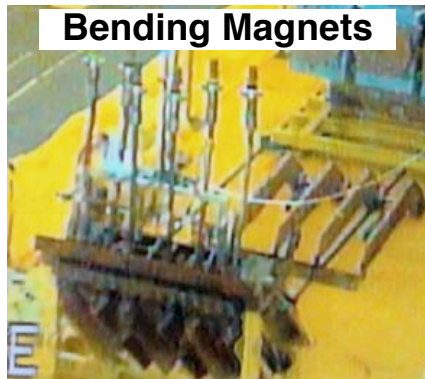
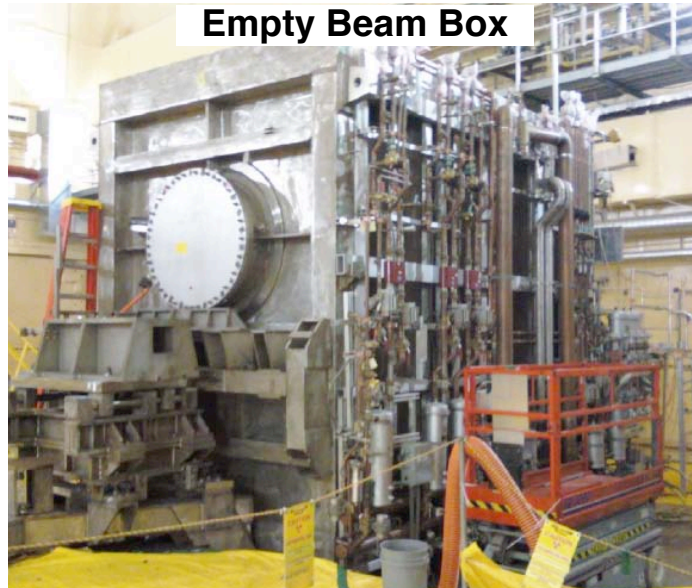
- Tangential Radius Rod Concept Supports Out-of-Plane Loads; Allows Radial Growth During Bake-Out
- Utilizes Space Used by the Present TF Support Truss



NSTX Center-Stack Upgrade Engineering Team

TFTR Neutral Beam Line #4 Disassembled

Tritium Contamination Level Assessed - Looks Excellent Thus Far!



**Radiologically
Controlled Clean Area**
NBI Upgrade Engineering Team

NSTX Facility Capability Ramping Up for Nearer Term and Longer Term

- NSTX has completed 17 weeks of very productive experimental operations meeting all of the FY 09 milestone.
- FY 2010 15 run weeks from March through July 2010
- New/Upgraded Facility Capabilities for FY 10 Run
 - Liquid Lithium Divertor
- New/Upgraded Diagnostic Capabilities for FY 10 Run
 - Beam Emission Spectroscopy Diagnostic
 - LLD Related Diagnostics
 - Two color fast IR camera
 - High-k mirror remote steering
- FY 2010 Summer Outage to install MSE-LIF and other upgrades will require careful planning and team effort to minimize the down time.
- Longer term upgrade of new center-stack and 2nd NBI is making steady progress in design and R&D.

Let us make the best out of the FY 2010 Run!