

NSTX FY 2009 Q3 Update Facility/Diagnostics/Operations

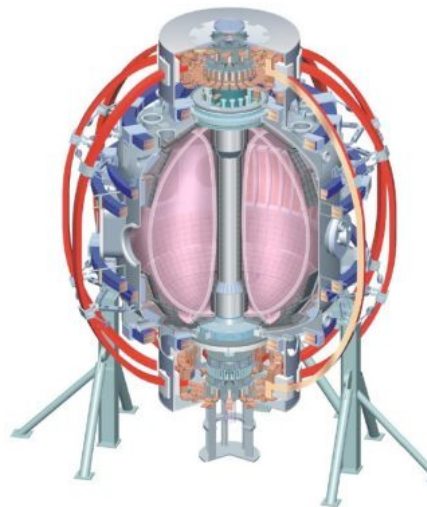
Masa Ono / Jon Menard

For the NSTX Team

PPPL-OFES/DOE

July 15, 2009

College W&M
Colorado Sch Mines
Columbia U
Comp-X
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Maryland
U Rochester
U Washington
U Wisconsin



Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITY
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

NSTX FY 2009 Facility Operations

ARRA Funding Significantly Enhances Research Capability

- **Planning to run 16 weeks (11 base and 5 ARRA) this year.**
 - **11 run weeks with 1,705 plasma shots achieved for Base**
 - **1 run week achieved for ARRA**
 - **Schedule to complete the run by Aug 14th**
- **Leaky NBI Calorimeter Bellows replaced during the maintenance week. LITER also reloaded**
- **HHFW installations completed and began operation last week**
- **Dual Lithium Shaker installed and began operation last week**
- **CHI Absorber Coils were commissioned with the SPA sources.**
- **Making good progress on LLD and BES preparations for the upcoming outage**
- **Making good progress on the NSTX Upgrade Project for the new center stack and 2nd NBI (Erik Perry to update)**
- **Making good progress on the ARRA funded upgrade project planning**

ARRA Funding Greatly Enhanced Research Capability

Significantly Increases NSTX Science Output

Enhanced operation of Major Fusion Facilities in FY09 and FY10

- **5 extra run weeks in FY 09 - FY 10** will enable the NSTX researchers to conduct high priority fusion plasma experiments.

Diagnostics and Facility Upgrades in FY 09 - 11:

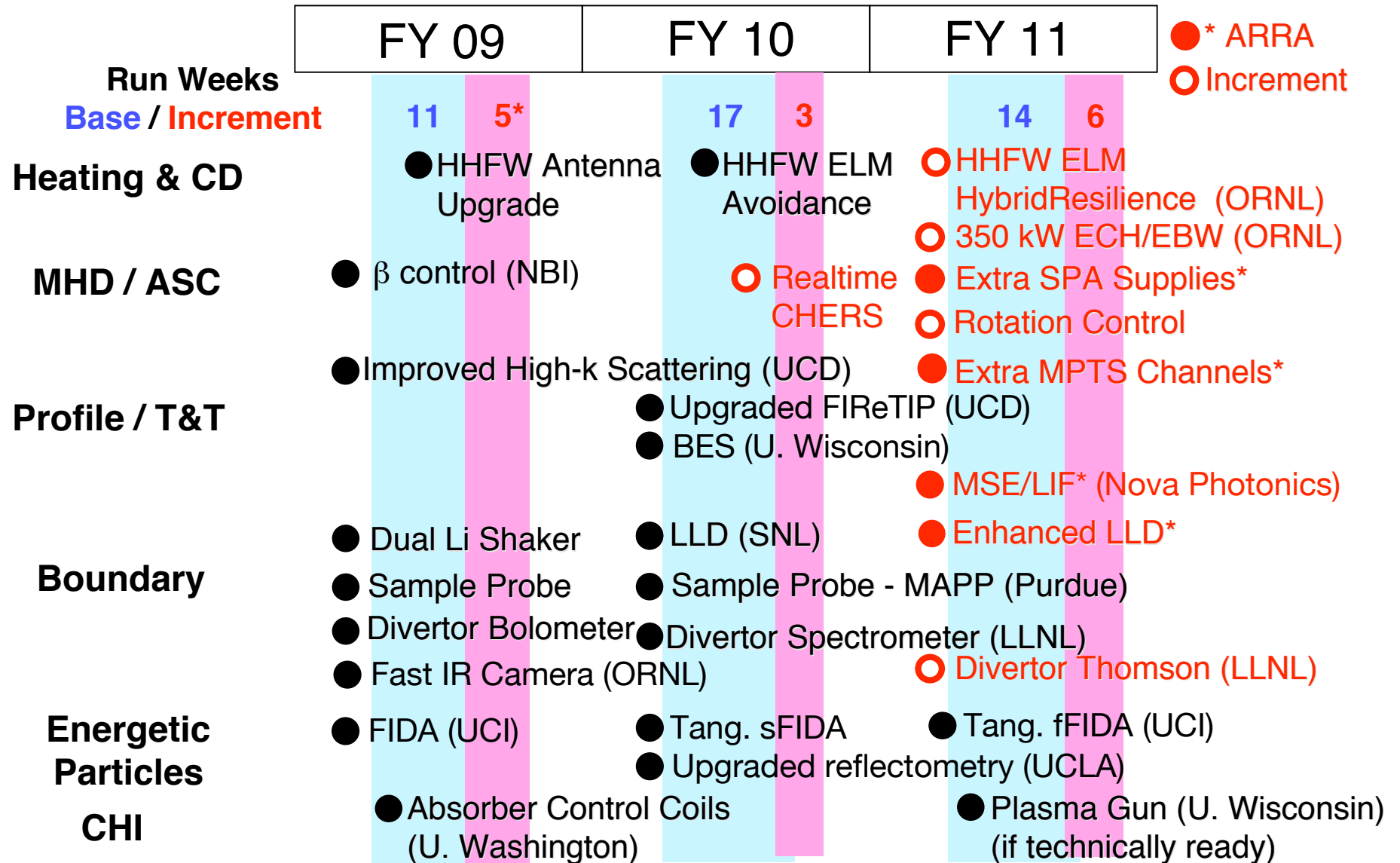
- **Extra 10 channels for the multi-pulse Thomson scattering system** for improved H-mode pedestal and plasma edge spatial resolution to support the FY 11 joint research milestone.
- **Motional Stark Effect Laser Fluorescence advanced diagnostic system** for internal magnetic and electric field measurements will be also installed which can also provide important data for the FY 11 joint research milestone.
- **Enhancement to the lithium liquid divertor target capability** for improved divertor pumping to control edge collisionality for the FY 11 joint research milestone (Improved diagnostics and fill system).
- **Post Doctoral Fellows** to support the enhanced research capabilities
- **2nd switching power amplifier system** for improved error field/resistive wall mode/resonant magnetic perturbation spectra to control the edge error field for the FY 11 joint research milestone.
- **Note:** Hybrid ELM resilience system for HHFW will not be included due to the funding reduction of \$888k.

FY09 Outage/ FY10 Ops Planning:

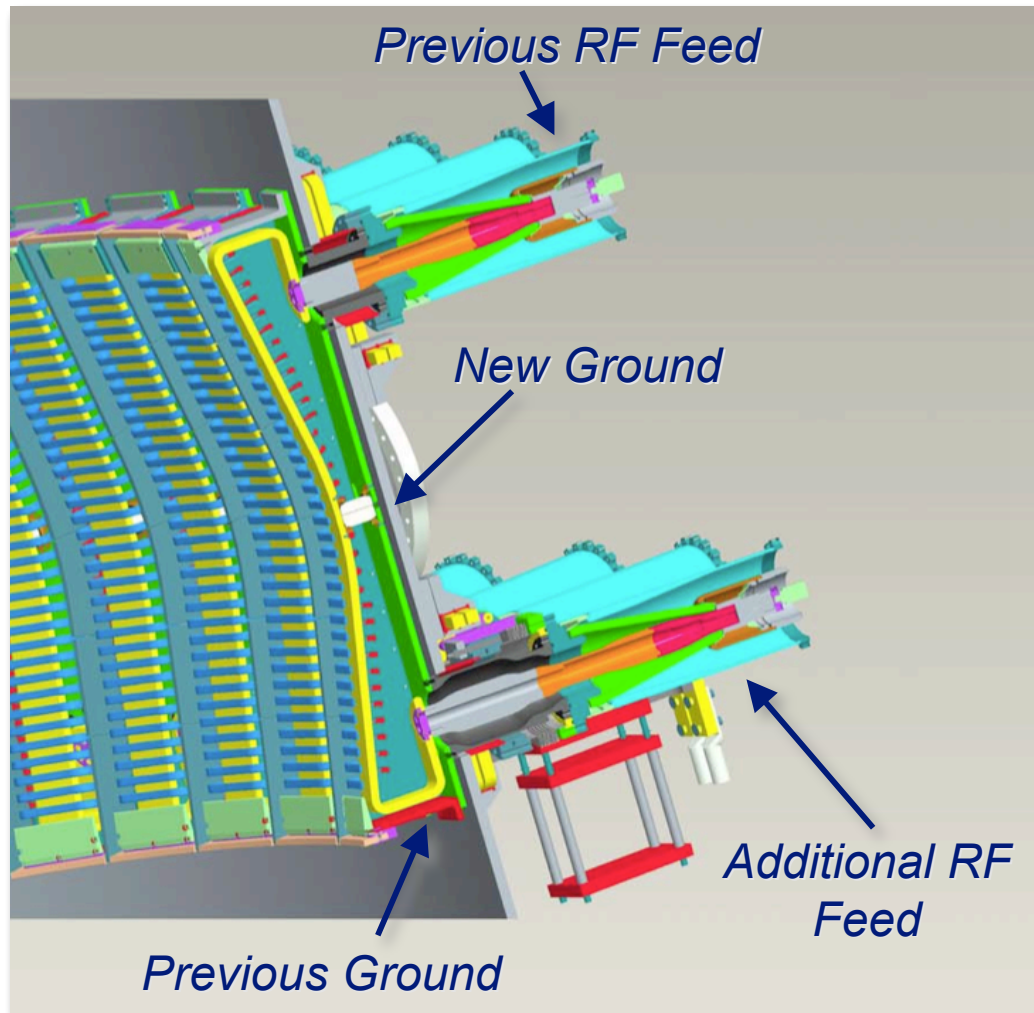
- **2009 Outage to focus on installing the Liquid Lithium Divertor system and the BES diagnostic system.**
- **Ten weeks of in-vessel work are planned (Sept 21st - Nov 30th).**
 - **2 weeks of post run & ~ 4 weeks of post outage calibrations planned.**
 - **Pump-down scheduled for Jan 22nd**
 - **ISTP scheduled to start on March 12th**
 - **Considering 17 run weeks in FY10**
- **Significant Elevated Water Tower riser repairs, and a PSE&G replacement of 138kV lines are needed before the start of the FY10 run.**

NSTX Near Term Upgrade Plan

ARRA Funding Significantly Enhances Research Capability



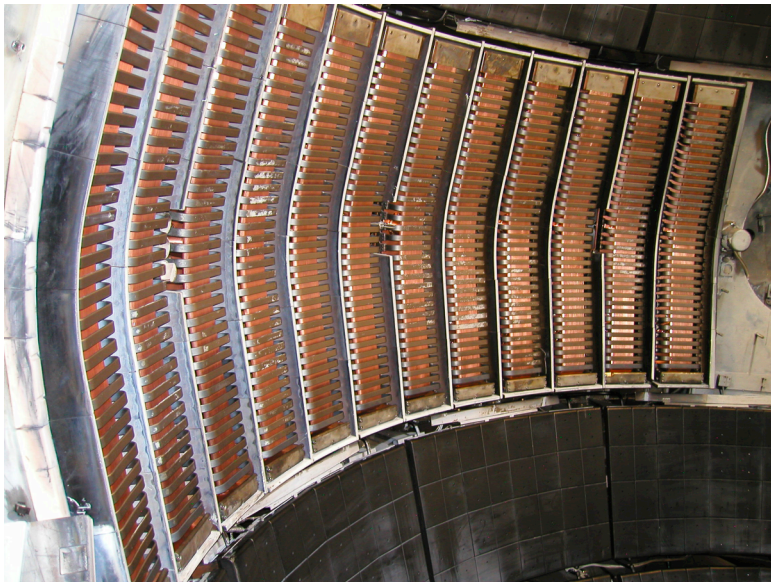
HHFW System Upgrades Completed



- **2009 Double-feed upgrade shifts ground from end to strap center.**
- **Lower strap voltage for a given strap current:**
 - **Double power per strap for the same plasma load.**
 - **Permits larger plasma-antenna gap (lower load)**
- **ELM avoidance system will be tested in 2010 for H-mode operation.**

Installation views of HHFW antenna and resonance loops

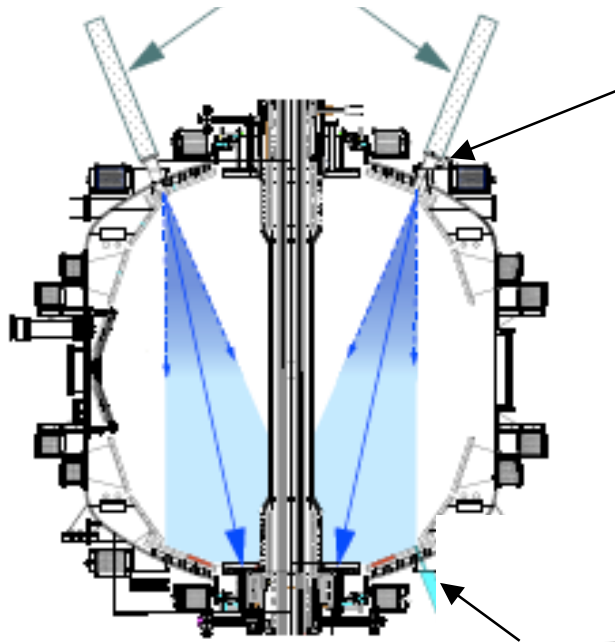
Successful Loop Installation During NSTX Operations



New Capability for Joint Research Milestone (Q-3 Report)

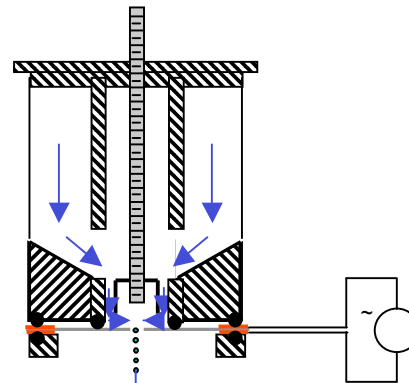
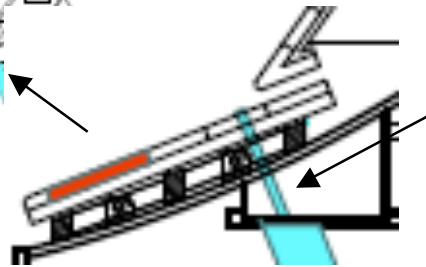
Dual LITER, Dual Lithium Dropper, Sample Probe, Fast IR Camera

Dual Liquid Lithium Evaporator
For Li wall coatings
Now routinely used



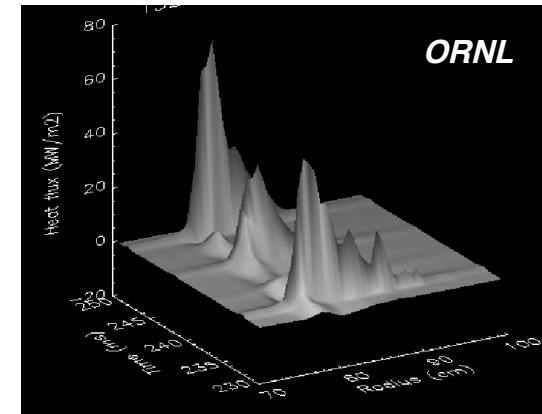
SAMPLE PROBE for
retention
measurements and
surface analysis

To be upgraded -
Material Analysis
Particle Probe (MAPP) *Purdue U*

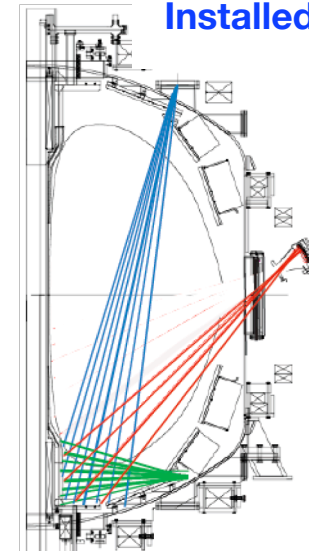


Dual Lithium
Powder Dropper for
Li injection into
plasma

Fast IR Camera Operational
ELM-resolved heat flux



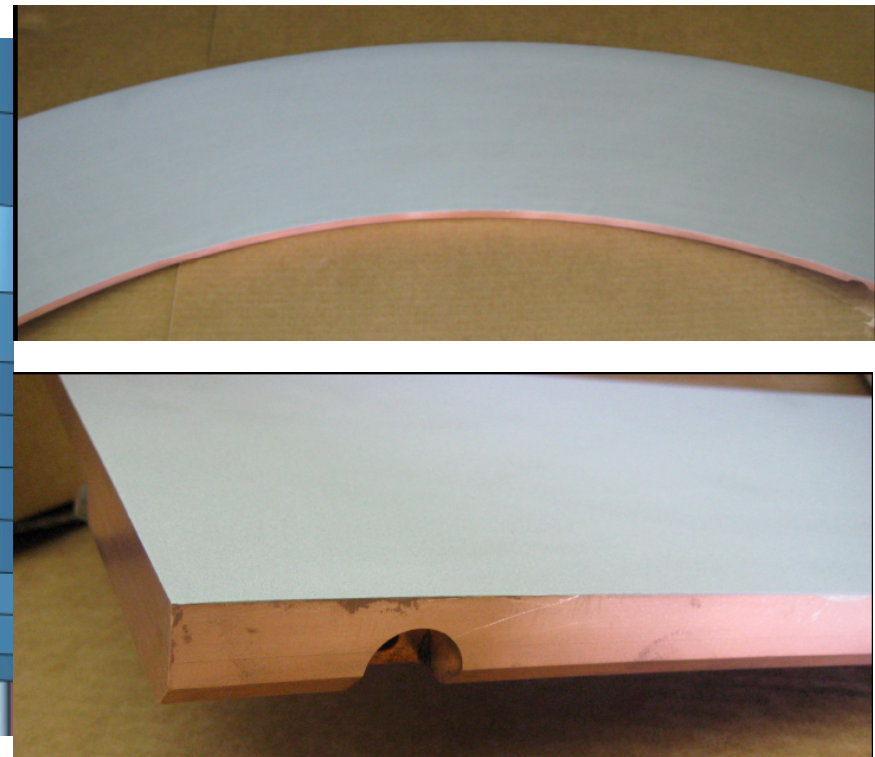
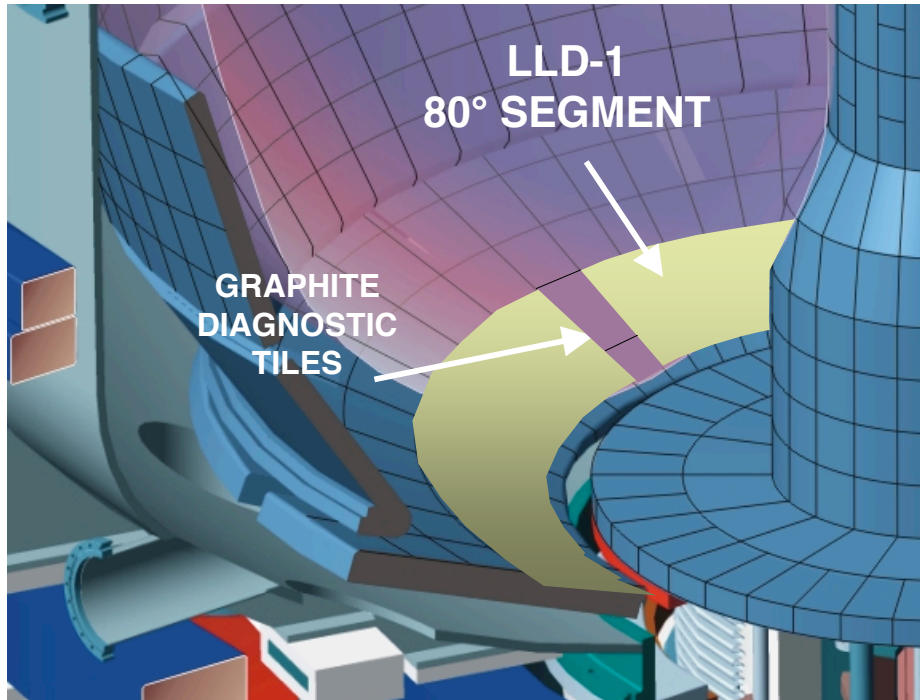
Three-view Divertor Bolometer
Installed for divertor radiation



Repaired
electronics
received at PPPL
and checked out
on the bench; will
be installed this
week and ready
to operate next
week

Liquid Lithium Divertor is Critical for 2009 Outage

LLD Plate Fabrication More Challenging Than Anticipated



Moly-Coated SNL LLD Plate

- LLD Scheduled to be installed for FY 2010 run
- Enhanced LLD to achieve density control - improved diagnostics (per PAC) and improved fill system - to be installed for FY 2010 run via ARRA

Making Good Progress on LLD Preparation

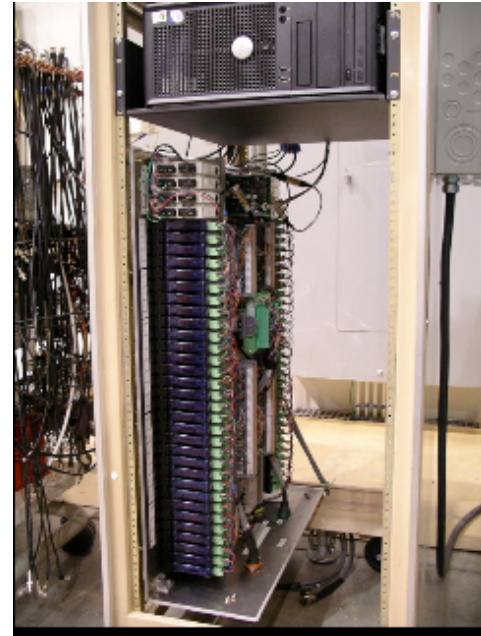
SNL Moly-Coated Plates (six) will be completed this week

SNL LLD Plate #3 with a small hole to be plugged. All others look fine



5mm

SNL LLD Control Rack



Fabrication of LLD system in progress

- Laminated SS/Cu plates at vendor: moly coating is on-going to be completed this week.
- Control rack delivered from SNL preliminary checkout in cal lab completed
- Control software development in progress using heater mockup in vacuum

Diagnostic operations

– Maintenance Activities

- JHU multi-energy tangential optical soft X-ray (ME-tOSXR) array
- Installation of camera for LLNL Long Wavelength Extreme Ultraviolet Spectrometer (LoWEUS)

– Lyman-alpha Array

- Digitizer and detector amplifiers for new Lyman-alpha array received
- Diagnostic is under development as collaboration with LLNL for edge measurements in the vicinity of the NSTX liquid lithium divertor

– X-ray Spectrometer

- Single-channel X-ray spectrometer installed on NSTX
- Instrument to be used to study plasma instabilities and monitor impurities during NSTX operations

Diagnostic upgrade status

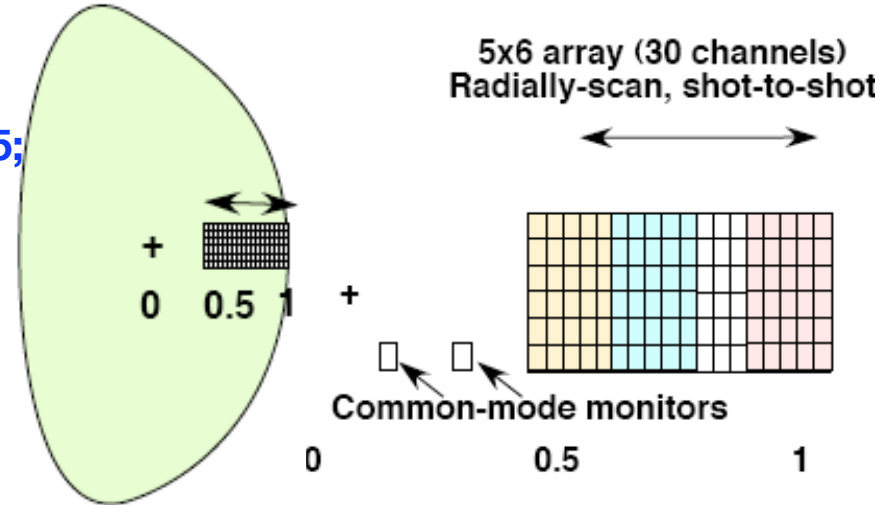
BES

- Fabrication and initial fit up of in-vessel components complete
- FDR of ex-vessel components held May 5; fabrication in progress
- Fiber SOW is out for bids
- UW making good progress on assembly of detector boxes
- On track for completion of installation during CY09 shutdown

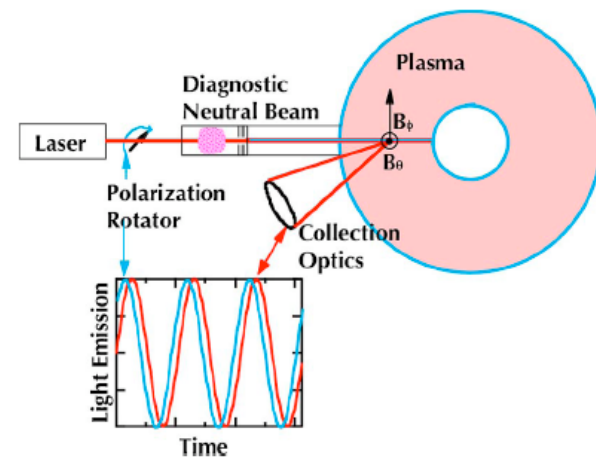
MSE-LIF

- FDR for bay G port cover modifications held May 22; plan to modify port cover during CY09 shutdown
- Peer reviews held for design of DNB stand and DNB vacuum chamber
- Redesign of tangential bolometer nearly complete
- Bulk of installation will occur in CY10 shutdown

BES together with high-k to provide most comprehensive turbulence diagnostic set



MSE-LIF to Measure $E_r(r)$, $B(r)$



NSTX aims for A to A+ in Research / Facility Areas in PEMP

PEMP Requirement	NSTX PEMP Status/Comment
<p>1.0 Provide for Efficient and Effective Mission Accomplishment</p> <p>1.1 Science and Technology Results Provide Meaningful Impact on the Field.</p> <p>1.2 Provide Quality Leadership in Science and Technology.</p> <p>1.3 Provide and Sustain Outputs that Advance Program Objectives and Goals.</p> <p>1.4 Provide for Effective Delivery of Products.</p>	<ul style="list-style-type: none"> • Very productive FY 08 run - all milestones achieved on schedule • World leading research on electron transport and ETG physics, Lithium utilization and 3-D field physics for tokamak performance improvements • 5 PRLs during the last twelve month and two more are in the pipeline. • 20 IAEA papers (the most for NSTX) and six APS invited papers, strong presence in ITPAs and ITER design • Exciting upgrades (LLD, BES, MSE-LIF, MPTS, SPA) planned
<p>2.0 Provide for Efficient and Effective Design, Fabrication, Construction and Operations of Research Facilities</p> <p>2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community</p>	<ul style="list-style-type: none"> • Successful implementation of the ground breaking high-k scattering system and lithium evaporation system for FY 2008. (d.g., APS, EPS invited talks) • 40% improvement in plasma shots/week achieved in FY 2008 in a 5 year period.
<p>3.0 Provide Effective and Efficient Science and Technology Program Management</p> <p>3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision..</p> <p>3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management</p> <p>3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs</p>	<ul style="list-style-type: none"> • NSTX PAC commended the NSTX research achievements and the researc plan • The major facility review for the NSTX 5 Year Plan strongly endorsed its research plan. • The major facility operations review gave a high mark on the NSTX facility operations and achievements • NSTX management has been responsive to both OFES and DOE/PSO through effective and rapid as well as periodic (weekly, quarterly, and annual) communications

NSTX is on track to meet FY09 milestones

Milestone	Description	Baseline	Comment
JRM(09)	Particle control and hydrogenic fuel retention in tokamaks , NSTX to explore lithium surface	09/30/09	Exp. Completed
R(09-1)	Understand the physics of RWM stabilization and control as a function of rotation.	09/30/09	Exp. Completed
R(09-2)	Study how $j(r)$ is modified by super- Alfvénic ion driven modes.	09/30/09	Exp. Completed
R(09-3)	Perform high-elongation wall-stabilized plasma operation.	09/30/09	Exp. Completed
F(09-1)	Operate NSTX Facility for 11 Experimental Run Weeks.	09/30/09	Completed
F(09-2)	Complete fabrication of the liquid lithium divertor target for particle pumping.	09/30/09	On schedule pending final inspection of coating
AF(09-1)*	Operate NSTX Facility for 5 additional Experimental Run Weeks	05/30/10	Complete the 5 run weeks by August 14
D(09-1)	Upgrade the divertor bolometer to three views with 20 channels.	09/30/09	Complete during this month
D(09-2)	Complete fabrication of the Beam Emission Spectroscopy system for transport studies.	09/30/09	On schedule
AD(09-1)*	Complete engineering design of MPTS Extra Channels.	11/30/09	Pending ARRA funding

* ARRA related milestones

ASIPP-PPPL Collaboration Activities

- **NSTX OH Spare manufactured by ASIPP:**
 - NSTX is being tested at PPPL. Has passed high-pot and dimensional tests
 - NSTX will complete adapting fixtures for future installation
- **EAST diagnostic status: All of the planned diagnostic systems have been tested at PPPL by the NSTX personnel and shipped to ASIPP**
 - ECE grating polychromator arrived at ASIPP and installed on EAST
 - Germanium PHA detector arrived at ASIPP
 - Neutron (^3He) detectors arrived at ASIPP
 - Neutral Particle Analyzer (NPA) arrived at ASIPP
 - NPA calibration source arrived at ASIPP
- **ASIPP researchers' visits to NSTX/PPPL for tokamak code training**
 - Two researchers have completed one year visit to NSTX (Apr.2008 - May 2009). They were trained on tokamak simulation and analysis codes for NSTX and EAST (TSC, TRANSP, etc.)
- **Assisting EAST operations**
 - The head of NSTX plasma operation, Dennis Mueller has been visiting EAST to help the plasmas operations since its successful first plasma in 2006.

Summary: Facility Operations

ARRA Funding Significantly Enhances Research Capability

- NSTX is running very well (~12 run weeks) and aiming to complete 16 run weeks (5 ARRA funded) by Aug 14th
- New Capabilities are now available:
 - Upgraded HHFW system
 - Dual Lithium Shaker
 - Edge Sample Probe
 - Fast IR Camera
 - CHI Absorber Coils with SPA
- All milestones are progressing on or ahead of schedule.
- Good progress on LLD and BES preparations for the upcoming outage.
- Making good progress on the NSTX Upgrade Project for the new center-stack and 2nd NBI (Erik Perry to update)
- Making good progress on the ARRA funded upgrade project planning to be fully ready to proceed when the fund arrives