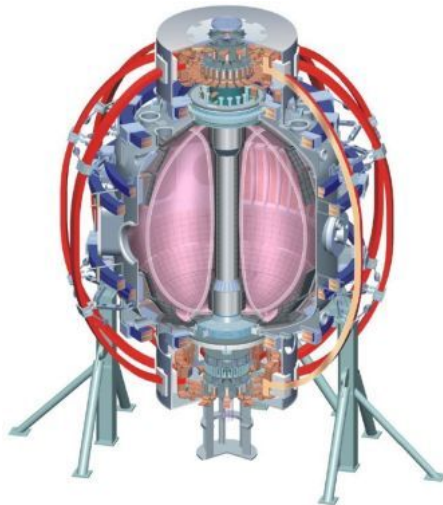


NSTX Program Update

J. Menard

For the NSTX Research Team

**NSTX Team Meeting
PPPL, B318
December 4, 2008**



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
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

NSTX successfully completed all FY2008 research milestones and produced many important results

- Joule milestone: “evaluate the generation of plasma rotation and momentum transport, and assess the impact of plasma rotation on stability and confinement...”
 - Momentum transport strongly influenced by turbulence-driven inward pinch
 - Momentum sink from 3D fields consistent w/ (new) generalized NTV theory
 - Effect of rotation on confinement is through ion channel and localized to large r/a
 - Kinetic effects important in understanding rotational stabilization of RWM, rotation shear effects important for NTM stability
- R(08-1) Measure poloidal rotation at low A and compare with theory
 - Measured poloidal rotation is consistent with neoclassical prediction
- R(08-2) Couple inductive ramp-up to CHI plasmas
 - Successfully coupled CHI to induction, but impurity production must be reduced
- R(08-3) Study variation and control of heat flux in SOL
 - Interpretation of near-SOL widths improved, far-SOL “widths” a mystery
 - Shorter connection length impacts partially-detached-divertor (PDD) at higher I_p
- e^- -gyro-scale turbulence consistent with ETG, GAE may cause e^- -transport
- Li can suppress ELMs, and 3D fields can trigger ELMs → ELM control
- Li + error-field/RWM control help sustain high β_N → record pulse-lengths

Upcoming Events

- NSTX Research Forum – Dec 8-10 (PPPL)
- ITPA/IEA joint experiment planning – Dec 11-12 (MIT)
- DIII-D Research Opportunities Forum – Dec 16-18 (GA)
- DIII-D PAC meeting – Feb 10-12, 2009 (GA)
- Start of NSTX FY2009 run – Mid-February
- NSTX PAC meeting – Feb 18-20, 2009 (PPPL)
- ReNeW Theme Workshops – complete by April 17, 2009
 - ExeCom consolidates initiatives - by May 2, 2009
 - Consolidated initiatives reviewed by Themes - by May 9, 2009
- Completion of NSTX FY2009 run – end of May 2009
- ReNeW Workshop – June 7-13, 2009 (Bethesda, MD)

NSTX FY2009 research milestones:

- DOE Joule milestone: *“Conduct experiments on major fusion facilities to develop understanding of particle control and hydrogenic fuel retention in tokamaks”*
 - *...identify the fundamental processes governing particle balance by systematically investigating a combination of divertor geometries, particle exhaust capabilities, and wall materials.*
 - *...NSTX is pursuing the use of lithium surfaces in the divertor...*
- R(09-1) Understand the physics of RWM stabilization and control as a function of rotation
 - RWM stabilization mechanisms will be characterized over a wide range of plasma rotation and collisionality conditions
- R(09-2) Study how $j(r)$ is modified by super-Alfvénic ion driven modes
 - Emphasis on the effects of *AE modes on the beam CD profile
- R(09-3) Perform high-elongation wall-stabilized plasma operation
 - Assess BS current at high k and q , and NBICD at low density - operating near the ideal-wall limit

NSTX FY2010 research milestones:

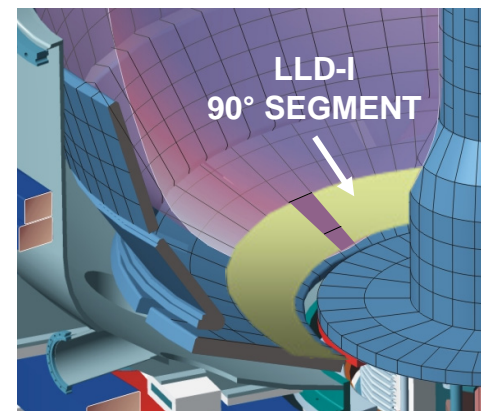
- DOE Joule milestone: *“Conduct experiments on major fusion facilities to improve understanding of the heat transport in the tokamak scrape-off layer (SOL) plasma, strengthening the basis for projecting divertor conditions in ITER.*
 - *FES will measure the divertor heat flux profiles and plasma characteristics in the tokamak scrape-off layer in multiple devices to investigate the underlying thermal transport processes.*
- R(10-1) Study turbulence responsible for ion and electron energy transport
 - The low-k portion of the turbulent density fluctuation spectrum will be measured with BES... and low-k magnetic-field fluctuations will be measured...
- R(10-2) Characterize High-Harmonic Fast Wave (HHFW) heating, current drive, and current ramp-up in deuterium H-mode plasmas
 - Antenna upgrades to attempt BS current overdrive ramp-up of an ST, ...
- R(10-3) Assess H-mode pedestal characteristics and ELM stability as a function of collisionality and lithium conditioning
 - Particle pumping and density control in these experiments will utilize the LLD...

2009-10 facility/diagnostic upgrade goals and status

1. Reduce electron density using **liquid** lithium, improve understanding of how Li improves confinement and reduces/eliminates ELMs

→ Implement liquid lithium divertor (LLD)

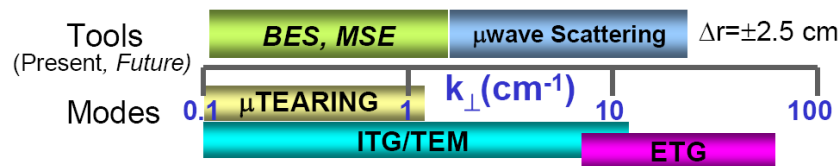
Status: Install plates summer of 2009, commission complete system Sept 2009



2. Measure full wave-number spectrum of turbulence to determine modes responsible for anomalous transport

→ Implement BES to complement existing high-k scattering diagnostic

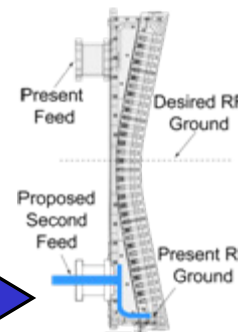
Status: Install lenses summer of 2009, commission Sept 2009



3. Assess if higher power HHFW can ramp-up I_p in H-mode (BS+RF overdrive) and heat high- β_N NBI H-mode scenarios

→ Upgrade HHFW system for higher P_{RF} + ELM resilience

Status: In-vessel mods nearly complete, higher power ready ~mid-run FY2009



Run-time guidance for FY2009 run

- FY2009 run-time allocation = 14 run weeks = 70 run days
- 10 days for cross-cutting + calibrations → 60 run days available for TSGs
- Complete 1st priority experiments with 75% of total → 45 run days
 - Joule and research milestone XPs are highest priority, and should be completed within this run-time allocation
- TSGs should develop plans for 1st + 2nd priority according to allocation below
 - TSG's are NOT guaranteed to receive the full allocation shown
 - Actual allocation will be decided at mid-run assessment

TSG	1st priority XP run days	1st + 2nd priority XPs	Milestones
Boundary	8	11	Joule
T & T	6	8	
Macro	7	9	R(09-1)
WPI	7	9	R(09-2)
SFSU	6	8	
ASC	7	9	R(09-3)
ITER high priority	4	6	
Total	45	60	

Assignment of FY2009 XPs to TSGs

- Some XPs should be “redirected” from BP TSG to ASC TSG
 - Optimizing ELM pacing for long-pulse impurity control → ASC TSG
 - Early Li dust injection for flux savings → ASC TSG
- Assessment of HHFW heating in ramp-up should be done initially within WPI TSG
 - If heating successful, high-power HHFW non-inductive ramp-up will be carried out in SFSU TSG (2 run days) with input from ASC TSG
- “ITER high priority” XP possibilities/examples:
 - Impact of He/H operation on L→H threshold, H-mode confinement, ELMs
 - Control/suppression of ELMs – Try RMP at lower q_{95} ? Vertical jogs?
 - Experimental simulation of ITER TBMs – use EF/RWM coils, or Fe?
 - Others?

Team should prepare for operation early in FY2010

- FY2009 Milestones: LLD/BES to be commissioned Sept 2009
- **Plan to operate NSTX for 6-8 run weeks Sept-Dec 2009**
 - Emphasis on LLD characterization and XPs, FY2010 milestones
- FY2009 XPs should be written to be continued/extended into FY2010 to explicitly investigate the impact of modified density, collisionality, transport, etc resulting from LLD operation
 - XPs should be written such that the extended run plans for early FY2010 are contingent upon operational LLD
- Boundary, Transport, and WPI TSGs should have FY2010 Joule and research milestone XPs ready in Sept 2009
- Next research forum planned to be held in Dec/Jan 2009/10 to plan remainder of the FY2010 run **and FY2011 run**
- There may be NO additional machine openings until the summer of FY2010 if LLD/BES operate well in early FY2010