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Boundary Physics TSG Update

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NSTX BP TSG Meeting

20 March 2008

Princeton, NJ

Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
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Boundary Physics TSG priorities are defined by

- **NSTX Milestones**
  - FY 2008 Milestone: Study variation and control of heat flux in scrape-off layer
  - Joint US tokamak FY 2009 milestone on pumping and retention
- **ITPA participation**
- **Coordinated research between Alcator C-Mod, DIII-D and NSTX**
- **ST development path needs, ITER needs**

Milestones reflect high priority of SOL / divertor heat flux and particle control research on NSTX

- **NSTX FY 2008 Milestone (R08-3): Study variation and control of heat flux in SOL**

  The variation of the quasi-steady scrape-off layer (SOL) and divertor heat flux will be determined in NBI-heated H-mode plasmas in lower-single-null and double-null magnetic configurations over a range of plasma conditions. For controlling the divertor peak heat flux, the effectiveness of radiative and/or dissipative divertor regimes and their compatibility with high-performance, long-pulse H-mode plasmas will be assessed. Analytic and numerical SOL and divertor models will be used to distinguish the mechanisms responsible for setting the heat flux width, as well as heat flux reduction in the radiative and dissipative divertor regimes. This will establish a basis for projections of the SOL and divertor characteristics in the CTF and other future ST-based devices, and contribute to improving projections to ITER and future DEMO conditions

- **FY 2009 Joule Milestone on Particle control and retention***

  Conduct experiments on major fusion facilities to develop understanding of particle control and hydrogenic fuel retention in tokamaks. In FY09, FES will identify the fundamental processes governing particle balance by systematically investigating a combination of divertor geometries, particle exhaust capabilities, and wall materials. Alcator C-mod operates with high-Z metal walls, NSTX is pursuing the use of lithium surfaces in the divertor, and DIII-D continues operating with all graphite walls. Edge diagnostics measuring the heat and particle flux to walls and divertor surfaces, coupled with plasma profile data and material surface analysis, will provide input for validating simulation codes. The results achieved will be used to improve extrapolations to planned ITER operation.

  (* text updated, shown as accepted by DoE)

NSTX contributes to a number of high-level ITPA PEP and DSOL experiments

- **Pedestal and Edge Group (PEP)**
  - PEP-6 Pedestal structure and ELM stability in DN
  - PEP-9 NSTX/MAST/DIII-D pedestal similarity
  - PEP-16 C-MOD/NSTX/MAST small ELM regime comparison

- **Divertor and Scrape-Off Layer Group (DSOL)**
  - DSOL-15 Inter-machine comparison of blob characteristics
  - DSOL-17 Cross-machine comparison of pulse-by-pulse deposition

Coordinated Research between Alcator C-Mod, DIII-D and NSTX

- **Topics defined through discussions at National Tokamak Planning Workshop - September 17-19, 2007 at PSFC MIT**
  - **Particle balance and inventory studies**
  - **Edge localized mode (ELM) control, with emphasis on ELM suppression using resonant magnetic perturbations (RMP)**
  - **Scrape-off layer heat flux distribution physics**
  - **Plasma-material interaction (PMI) diagnostic development**

Two Boundary Physics TSG priorities have been defined for FY 2008 run

- **Study variation and control of heat flux in SOL**
  - Characterize divertor heat flux and access to detachment (R08-3)
  - Compare divertor heat flux widths to midplane density and temperature widths and edge turbulence characteristics

- **ELMs and pedestal**
  - Determine relationship of ELM properties to discharge boundary shapes and lithium conditioning
  - Compare stability of pedestal and ELMs with model calculations

Boundary Physics XPs are being executed in accordance with prioritized plan

- **ELM control with RMP** XPs - mostly completed
  - XPs executed early in FY 2008 run to address ITER priorities
  - XP 809 (J. Canik) : ELM destabilization with n=3 RMP and I_p threshold
  - XP 818 (S. Sabbagh, J.-K. Park *et al.*): ELM Control with DC & AC RMP, odd & even field parity

- A number of **ITPA XPs** have been completed
  - XPs were in progress, or initiated in previous years
  - XP 721 (PEP 16) Small ELM regimes has been completed*. A. Hubbard, J. Hughes (PSFC MIT) and H. Meyer (MAST) participated in person
  - XP 609 (PEP 6) Dependence of ELMs on magnetic balance by R. Maingi and H. Meyer has been completed

- XP-806 **Edge electrode biasing** for SOL control by S. Zweben completed
  - Good set of data obtained

* may need ~ 2 hrs to finish XP

Prioritized XP list - status and plans

Completed:

- ☑ **XP 721 - A. Hubbard, R. Maingi, H. Meyer** - Comparison of Small ELM Regimes in Alcator C-MOD, MAST, and NSTX (ITPA PEP-16)
- ☑ **XP 609 - H. Meyer, R. Maingi** - Dependence of ELMs and Power Balance on Magnetic Balance and Fueling (ITPA PEP-6)
- ☑ **XP 809, 818 - J. Canik, S. Sabbagh** - XPs on ELM control with RMP
- ☑ **XP 806 - S. Zweben** - Edge Electrode Biasing for SOL Control

XPs to be run in next 2-3 weeks:

- ☐ **XP 815 - J.-W. Ahn** - SOL width characterization - **1 day**
- ☐ **XP 814 - V. A. Soukhanovskii** - Divertor detachment in highly-shaped plasmas - **1 day**
- ☐ **XP 816 - R. Maqueda, R. Maingi, V. A. Soukhanovskii** - Edge Characterization in high performance discharges - **1 day + 1 day**
- ☐ **XP 824 - C. Skinner, R. Maingi, V. Soukhanovskii -** Gas and particle balance - **0.5 day**
- ☐ **R. Maingi, A. Kirk, T. Osborne** - Dependence of pedestal structure on aspect ratio (PEP 9) - **0.5 day** (may be run in 4-5 weeks, but before lithium)

*** Pending additional run time allocation**

Prioritized XP list (continued)

To be run in Lithium Age and thereafter (April - June 2008)

- **D. K. Mansfield** - Injection of lithium powder - **0.5 day**
- **D. K. Mansfield** - Initial Use of Dual LITER for ELMs Mitigation and Evaporator Characterization - **1 day + 0.5 day**
- **R. Maqueda** - Edge turbulence and blobs - **0.5 day + 0.5 day**
- **L. F. Delgado-Aparicio** - Role of neoclassical impurity transport in the NSTX gradient region - **0.5 day**
- **K. Tritz** - Study of Type V ELMs and edge gradients - **0.5 day**

*** Pending additional run time allocation**