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Boundary Physics TSG Update

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V. A. Soukhanovskii, TSG Leader

Lawrence Livermore National Laboratory, Livermore, CA

R. Maingi, TSG Deputy

Oak Ridge National Laboratory, Oak Ridge, TN

D. P. Stotler, Theory & Modeling

Princeton Plasma Physics Laboratory, Princeton, NJ

NSTX BP TSG Meeting

8 January 2008

Princeton, NJ

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U St. Andrews
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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
  - Incremental FY 2009 Milestone: Characterize performance of liquid lithium divertor
  - Proposed Joint US tokamak (three facility) 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

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

  Experiments on Alcator C-MOD, DIII-D and NSTX in FY09 will address the issue of understanding particle control and hydrogenic fuel retention in tokamaks. Used together, these facilities offer a unique opportunity to 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 state-of-the-art simulation codes. The results achieved at the major facilities will be used to improve extrapolations to planned ITER operation.

- **Incremental NSTX FY 2009 Milestone: Characterize performance of liquid lithium divertor**

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 Alcator C-Mod, DIII-D, and NSTX National Tokamak Planning Workshop - September 17-19, 2007 at MIT/PSFC**
  - **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

Several new factors have affected run time allocation in FY 2008 since NSTX FY 2008 Forum

- Priority of ELM control with RMP XPs was raised to very high because of urgent ITER needs
  - Topic has become a self-contained cross-cutting effort on NSTX
  - BP TSG run time allocation will likely be 1-2 days
  - Need to run the XPs early

- New run time allocation guidance received from NSTX Program Director J. Menard
  - NSTX operation and facility/diagnostic upgrade budgets will be increased in FY 2008
  - NSTX FY 2008 run-time is expected to increase to **18 weeks total** = 90 run days
  - Boundary Physics TSG is now allocated **11 run days (+ 4-5 days after midrun?)**

- NSTX FY 2008 Run Coordinator M. Bell released a tentative XP schedule
  - First 4 run weeks without LITERing
  - In the first three weeks, Boundary Physics TSG will run one 1/2 day XP since most pre-LITER Boundary Physics XPs require good plasma conditions, 3 NBI sources, and many diagnostics

Revised top priority XP tier (9 days / 11 days)

- **V. A. Soukhanovskii** - Divertor detachment in highly-shaped high-performance H-mode plasmas - **1 day**
- **J.-W. Ahn** - Characterization of the divertor heat flux width and the mid-plane SOL widths - **1 day**
- **A. Hubbard, R. Maingi, H. Meyer** - Comparison of Small ELM Regimes in Alcator C-MOD, MAST, and NSTX (ITPA PEP-16) - **0.5 day**
- **R. Maingi, A. Kirk, T. Osborne** - Dependence of pedestal structure on aspect ratio (PEP 9) - **0.5 day**
- **D. K. Mansfield** - Initial Use of Dual LITER for ELMs Mitigation and Evaporator Characterization - **1 day + 0.5 day**
- **C. Skinner, R. Maingi, V. Soukhanovskii -** Combined XP on gas and particle balance - **0.5 day**
- **R. Maqueda, R. Maingi, V. A. Soukhanovskii** - Edge Characterization in high performance discharges - **1 day + 1 day**
- **S. Zweben** - Biased Electrodes for SOL Control - **0.5 day**
- **H. Meyer, R. Maingi** - Dependence of ELMs and Power Balance on Magnetic Balance and Fueling (ITPA PEP-6) - **1 day**

FY 08 Milestone **ITPA** **FY09 Milestone**

Second priority XP tier (9 days / 11 days)

- **J. Canik, J.-k. Park** - Combined XP on ELM control with RMP - **1 day**
- **R. Maqueda** - Edge turbulence and blobs - **0.5 day + 0.5 day**
- **D. K. Mansfield** - Injection of lithium powder - **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**

Inter-TSG high-priority effort