NATIONAL SPHERICAL TORUS EXPERIMENT

FY2010 RESEARCH FORUM

Boundary Physics Topical Science Group Breakout Session

Wednesday, 2 December 2009

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The NSTX boundary physics research goal is to develop a comprehensive understanding and predictive capability for edge turbulence, H-mode pedestal physics, ELMs, divertor heat flux and power handling, and fueling.

Priorities for FY2010

- Determine the relationship of ELM properties to discharge boundary shape, lithium conditioning, and 3D resonant magnetic perturbations (RMPs), and compare stability of pedestal/ELMs with model calculations (Milestone R10-3)
- Compare divertor heat flux widths to midplane density and temperature widths and edge turbulence characteristics, and determine the scaling of SOL and divertor heat transport (FY10 Joint Research Milestone)
- Understand and develop a predictive capability for the physics mechanisms responsible for the structure of the H-mode pedestal (FY11 Joint Research Milestone)

Milestones

FY2010 Research Milestone R(10-3): Assess H-mode pedestal characteristics and ELM stability as a function of collisionality and lithium conditioning.

The high performance scenarios of next-step STs such as NHTX and ST-CTF are based on lower Greenwald density fraction and significantly lower pedestal collisionality than NSTX, which could significantly alter their H-mode pedestal characteristics. Possible differences include deviations from the L-to-H transition threshold power scaling inferred from present ST experiments, different projections for the pedestal height and barrier width, pedestal stability (affecting ELM type and size), and the down-stream divertor plasma and surface conditions, which can also influence the pedestal. Many different ELM regimes have been identified on NSTX, and the dependence of these regimes on collisionality and lithium will be investigated utilizing high-resolution kinetic equilibrium reconstructions coupled to leading linear and non-linear ELM-stability codes to compare to experiments. Pedestal profiles will be compared to kinetic neoclassical predictions to determine if the observed transport is consistent with theory. Particle pumping and density control in these experiments will utilize the liquid lithium divertor (LLD), and a major research focus in this research will be to determine the relative roles of reduced pedestal density and collisionality versus the possible direct effects of lithium. This research will aid development of a predictive capability for pedestal transport and stability limits for the ST, and through comparisons to results from higher aspect ratio tokamaks, will help aid understanding of the role of toroidicity in H-mode confinement.

Proposed text for FY2010 OFES Joint Research 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.

In FY2010, 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. The unique characteristics of C-Mod, DIII-D, and NSTX will enable collection of data over a broad range of SOL and divertor parameters (e.g., collisionality, beta, parallel heat flux, and divertor geometry). Coordinated experiments using common analysis methods will generate a data set that will be compared with theory and simulation.

Proposed text for FY2011 OFES Joint Theory-Experiment Research Milestone: Conduct experiments on major fusion facilities to improve the understanding of the physics mechanisms responsible for the structure of the pedestal and compare with the predictive models described in the companion theory milestone.

Proposed description: The goal of the joint theory-experiment milestones (or replace with research campaigns depending on what OFES prefers) is to understand the physics mechanisms responsible for the structure of the pedestal and develop a predictive capability. The edge of high performance tokamaks is characterized by very steep pressure gradients forming a pedestal in the pressure profile. Core confinement is strongly correlated with the value of the pressure at the top of the pedestal, which is predicted to significantly impact the fusion power in ITER.

Experimental milestone: Conduct experiments on major fusion facilities to improve the understanding of the physics mechanisms responsible for the structure of the pedestal and compare with the predictive models described in the companion theory milestone. Perform experiments to test theoretical physics models in the pedestal region on multiple devices over a broad range of plasma parameters (e.g., collisionality, beta, and aspect ratio). Detailed measurements of the height and width of the pedestal will be performed augmented by measurements of the radial electric field. The evolution of these parameters during the discharge will be studied. Initial measurements of the turbulence in the pedestal region will also be performed to improve understanding of the relationship between edge turbulent transport and pedestal structure.

Theory milestone: The performance of future burning plasmas is strongly correlated with the pressure at the top of the edge transport barrier (or "pedestal height"). Predicting the pedestal height has proved challenging due to a wide and overlapping range of relevant spatiotemporal scales, geometrical complexity, and a variety of potentially important physics mechanisms. A focused analytic theory and computational effort, including large-scale simulations, will be used to identify and quantify relevant physics mechanisms controlling the structure of the pedestal. Predictive models will be developed and key features of each model will be tested against observations, to clarify the relative importance of various physics mechanisms, and to make progress in developing a validated physics model for the pedestal height.

Boundary Physics Topical Science Group Breakout Session Agenda

Table format: Time, Lead author, Title, Requested run time
Note: indicated times are approximate

Remote Presentations (1:30 – 2:45 PM)

1:30 PM	X. Q. Xu	Controlling the onset of Type-I Elms by rigid-body toroidal rotation via ExB flow shear	0 day
1:40 PM	A. Yu. Pigarov	Study of secondary electron emission and thermoelectric current effects with Li	0.5 day
1:50 PM	R. D. Smirnov	Modeling of dust trajectories and radiation mantle	0 days
2:00 PM	G. McKee	H-mode Pedestal Fluctuation Dynamics in ELM'ing and ELM-free scenarios	1 day
2:10 PM	J.-W. Ahn	Effect of externally applied 3-D fields on divertor profiles	1 day
2:15 PM	J. Canik	Probing the role of homoclinic tangles in the ELM process	1 day
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2:30 PM	A. Loarte	Effects of ELM control with resonant magnetic perturbation on edge power fluxes between and at ELMs	2 days
	A. Loarte	Physics processes leading to ELM triggering by vertical jogs and extrapolation to ITER	1.5 day

Pedestal and ELMs, including ELM control with RMPs (2:45 - 3:50 PM)

2:45 PM	A. Sontag	ELM stability dependence on triangularity	1-2 days
2:50 PM	J.-W. Ahn	Characterization of ELM heat flux profiles	1 day
2:55 PM	D. Battaglia	ELM suppression using 3D fields from a single row off-midplane coils on NSTX	1 day
	D. Battaglia	Imaging the edge island structure in NSTX during the application of 3D fields	0.5 day or piggyback
3:10 PM	A. Diallo	Increasing the Range of Achievable Pedestal Height	1.5 days
	A. Diallo	Correlation of Fluctuations measurements inside the separatrix and GPI	0.25 day
3:25 PM	J.-K. Park	RMP threshold of ELM modification at different q95	0.5-1 day
3:30 PM	R. Goldston	Use of ICRF to Trigger ELMs	1 day
	R. Goldston	Use SPAs to Drive EHOs	1 day
	R. Goldston	When Does Core Radiation Affect Confinement	1 day
	R. Goldston	Drive Edge Harmonic Oscillations with Modulated Radio Frequency Heating	0.5 day
3:45 PM	R. Maingi	Dependence of edge profile modification by lithium to proximity to LLD	1 day

FY2010 JRT on SOL thermal transport (3:50 – 4:05 PM)

3:50 PM	R. Maingi	Measurements of heat flux profiles for the FY2010 Joint Research Milestone	5 days
4:00 PM	R. Maqueda	GPI based research in support of the 2010 edge JRT milestone	0.5 day

Divertor and SOL transport, turbulence, sources, flows, and heat flux mitigation (4:05 – 4:50 PM)

4:05 PM	V. A. Soukhanovskii	Divertor heat flux reduction and detachment studies with impurity seeding and LLD pumping for NSTX-U	1 day
	V. A. Soukhanovskii	Snowflake divertor characterization in NSTX	1 day
4:20 PM	A. McLean	Simple As Possible Plasmas (SAPP) on NSTX	1 day
	A. McLean	Regular Spectroscopic Characterization of the LLD	0.5 day
	A. McLean	Spectroscopic characterization of molecular sources in NSTX	1 day
4:35 PM	S. Zweben	Test of LLD Electrodes for SOL Control	0.5 day
4:40 PM	N. Nishino	Two dimensional ion flow measurement	0 days
4:45 PM	M. A. Jaworski	Turbulence and divertor target plasma characterization during transition to sheath-limited regime	0 days

Dust studies (4:50-4:55 PM)

4:50 PM	C. H. Skinner	Dust Mobilization studies with PMI probe	0.25 day +piggyback

Discussion: proposal prioritization and initial run time allocation (5:00-5:30 PM)