FY11-12 T&T TSG Research Discussion

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NSTX T&T TSG Meeting

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Proposed NSTX FY2010-12 Research Milestones

(base and *incremental*)

	FY2010	FY2011	FY2012
Expt. Run Weeks:	15 w/ ARRA	14 (20)	14 (20)
		R(11-1)	R(12-1)
1) **Transport & Turbulence**		**Measure fluctuations responsible for turbulent ion and electron energy transport**	**Compare measured turbulence fluctuations to theory & simulation**
2) **Macroscopic Stability**	**Assess sustainable beta and disruptivity near and above the ideal no-wall limit**	*Assess RWM and rotation damping physics at reduced collisionality*	
3) **Boundary/Lithium Physics**	**Assess H-mode characteristics as a function of collisionality and lithium conditioning**	**Assess relationship between lithiated surface conditions and edge and core plasma conditions** *Assess pedestal and SOL response to externally applied 3D fields*	**Assess very high flux expansion divertor operation**
4) **Wave-Particle Interaction**	**Characterize HHFW heating, CD, and ramp-up in deuterium H-mode** (joint with solenoid-free start-up TSG)		*Assess predictive capability of mode-induced fast-ion transport*
5) **Solenoid-free start-up, ramp-up**			**Assess confinement, heating, and ramp-up of CHI start-up plasmas** (joint with WPI-HHFW TSG)
6) **Advanced Scenarios & Control**		**Assess integrated plasma performance versus collisionality**	**Investigate physics and control of toroidal rotation at low collisionality** (joint with MS TSG)
Joint Research Targets (3 US facilities):	**Understanding of divertor heat flux, transport in scrape-off layer**	**Characterize H-mode pedestal structure**	**Understanding of core thermal and particle transport**

Research Milestone R(11-1): Measure fluctuations responsible for turbulent ion and electron transport

Results from NSTX indicate that the scalings of electron and ion energy transport with magnetic field and plasma current differ in the ST, and they also differ from high-aspect-ratio tokamak dependences. Understanding electron transport is particularly important as the electron channel is the dominant energy loss channel in NSTX plasmas, while ion transport commonly approaches neoclassical levels in H-mode plasmas. High-k scattering measurements have identified ETG turbulence as one candidate for the anomalous electron energy transport. However, low-k fluctuations may also contribute to electron and momentum transport. In addition to measuring high-k fluctuations, the low-k portion of the turbulent density fluctuation spectrum will be measured with a Beam Emission Spectroscopy (BES) diagnostic. Additional fluctuation measurements at long wavelength will be made using the upgraded reflectometer, interferometer and gas puff imaging systems. Experiments will be performed to vary plasma parameters such as collisionality, ExB shear, magnetic shear, plasma current, Te/Ti and magnetic field to change the instability drive and damping of the various micro-instabilities (ITG, TEM, micro-tearing, and ETG) thought to possibly be responsible for anomalous energy transport. The k spectrum of the turbulence will be measured as function of plasma parameters and correlated with energy diffusivities inferred from power balance analysis.

Research Milestone R(12-1): Enhance physics understanding of turbulent transport mechanisms by comparing theory and simulation to measured fluctuations

In order to understand the importance of various turbulence-driven transport mechanisms over a broad range of operating space and plasma conditions, the low- and high-k turbulence measurements will be compared with linear and non-linear instability calculations using numerical tools that include the set of benchmarked simulation codes with strong ongoing development efforts and user bases such as GYRO, GTS, GS2, GTC-NEO and other codes as they become available. Synthetic diagnostics that simulate NSTX measurements will be developed and built into these modern, high-performance simulation codes in order to identify the microinstabilities responsible for the observed turbulence through direct experiment-simulation comparisons of the fluctuating quantities and their spectral and spatial characteristics. Improved physics insight of how these instabilities affect electron and ion energy transport in the ST is highly desirable to reduce the uncertainty of extrapolation to next-step STs. This research also contributes broadly to a fundamental understanding of transport.