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Boundary Physics Research Planning For FY11-12 NSTX Run Campaign

Ahmed Diallo
Vlad Soukhanovskii
Daren Stodler

BP TSG Meeting
B252
March 8, 2011

NSTX experiments supporting FY11-12
Research Milestones, JRT, ITPA, beginning-of-run issues, and NSTX-U

- Anticipating 10 weeks of plasma operation in FY11 to support JRT and ITPA.
- FY12 is forecasting ~ 10 weeks of operation to support research milestone and NSTX-U.
- "Piggy back" should be considered.
- BP TSG at Forum is on March 17, 9am- 1pm B318
  - ~ 3 hours allotted to presentations (please limit presentations < 7 min).
  - ~ 1 hour for prioritizing XPs and discussions.
- **Research activities**
  - Advance the understanding in predictive capability for the physics mechanisms responsible for the structure of the H-mode pedestal
  - Study SOL/pedestal heat and particle transport and pedestal MHD stability with the snowflake divertor configuration and compare with 2D fluid and ideal MHD stability models
  - H-mode pedestal transport, turbulence, and stability response to 3D fields.
  - Initial assessment of Mo tile performance – impurity response, Mo influx, plasma performance (with ASC and ITER/CC)

NSTX experiments supporting FY11-12 Research Milestones, JRT, and ITPA

- **FY2011 OFES Joint Theory-Experiment Research Milestone**
  - Pedestal structure, jointly with T&T
    - Experimental proposals should count on additional MPTS channels
- **Assess very high flux expansion divertor operation (R11-3)**
  - Snowflake configuration, jointly with ASC
- **ITPA activities [contact persons]**
  - PEP-19 Basic mechanisms of edge transport with RMP[Canik/Maingi]
  - PEP-23 Quantification of the requirements for ELM suppression by magnetic perturbations from off-midplane coils[Battaglia]
  - PEP-25 Inter-machine comparison of ELM control by magnetic field perturbations from midplane RMP coils[Maingi/Canik]
  - PEP-26 Critical parameters for achieving L-H transitions[Battaglia/kaye]
  - PEP-27 Pedestal profile evolution following L-H/H-L transition[Kaye/Battaglia]
  - PEP-28 Physics of H-mode access with different X-point height[Battaglia]
  - PEP-29 Vertical jolts/kicks for ELM triggering and control[Canik/Gerhardt]
  - PEP-31 Pedestal structure and edge relaxation mechanisms in I-mode [Kaye/Maingi]
  - PEP-33 Effects of current ramps on the L-H transition and on the stability and confinement of H-modes at low power above the threshold [Kaye]
  - PEP-34 Non-resonant magnetic field driven QH-mode [Sontag]
  - DSOL-21 Introduction of pre-characterized dust for dust transport studies in divertor and SOL [Pigarov/Roquemore]

FY11JRT- Target Topics

- Continue documentation of the dependence of the pedestal structure with I_p, B_t, and shape parameters
  - Pedestal structure on X-point height.
  - Testing several pedestal models (e.g.,EPED2).
  - Stability analysis (ELITE).
- Quantify edge transport rates and correlate with turbulence
  - Investigate different transport channels through EPH and I- mode.
  - Effect of recycling and fueling and role of lithium.
  - Assess the role of ETG in limiting edge T_e gradient.
  - 3D effects in pedestal thermal transport.
- ELM physics
  - Continue studies on role of n_e and T_e gradients on ELM stability.
  - Assess EHO excitation with HHFW.
  - ELM dependence on shape.

Research plan is being developed to assess high flux expansion divertor operation in milestone R(11-3)

- Snowflake divertor research
  - Shape control
    - Development of PCS control (w/ ASC group)
    - Development of lower divertor snowflake + upper single null or upper snowflake
    - Development of NSTX-U shape with lower and upper snowflake configurations
    - Steady-state snowflake-plus
  - Divertor physics
    - Divertor power balance, radiation distribution
    - Turbulence characteristics upstream and downstream (flux tube squeezing barrier)
    - Pumping with lithium coatings of various thickness
    - Impurity sources vs core accumulation
    - Divertor impurity seeding (nitrogen, neon, argon)
    - Snowflake-plus characterization (long connection length but low flux expansion)
  - Pedestal stability and ELM control
    - Documentation of pedestal profiles with snowflake-minus and snowflake-plus (w/ MSE and turbulence measurements)
    - ELM control (with and without lithium, snowflake-minus and -plus)
    - Modeling (Peeling-ballooning theory, ideal MHD stability (ELITE or SPIDER) + Osborne pedestal analysis tools)
- Radiative divertor research
  - Long-pulse H-mode with divertor impurity seeding (neon, argon).
  - Radiative divertor in NSTX-U shape.
  - Assessment of radiative divertor feed-back control.

Control the 2nd X-point (In collaboration with Ferron, Markowski)

- Locally expand of the Grad-Shafranov equation in toroidal coordinates:

$$(R+x)(\partial_x(R+x)^{-1}\partial_x)\psi+\partial_z^2\psi$$

- Find the second magnetic null of the simplified system.
  - There is a closed form solution based on NSTX configuration.
- Add this fast algorithm with reasonable accuracy in PCS.
- Control both the location of the X-points with PF coils.
  - Need 4 independent actuators for full control
  - Optimal use of the capability we have 2 or 3 PF coils (PF1AL-2L and sometimes PF1B)
  - Control the best combination of properties of interest (Relative distance/angle between the X-points…)
- Use this algorithm to control the upper snowflake configuration as well.
- This is a parallel task to the snowflake physics study.

Koleman