Lithium Research Topical Science Group
NSTX-U Theory - Computation Brainstorming Preparation

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NSTX-U Theory & Computation Brainstorming Meeting on March 2

Stan says:
We would like to identify key theory and modeling needs in support of the NSTX-U research program. The meeting will attempt to address key issues from the perspectives of both experiment and theory (including modeling/CPPG), and seeks:

(1) Ideas and presentations from members of the NSTX-U experimental research team describing needed capabilities from existing or new theory and simulation to support NSTX-U research goals.

(2) Ideas and presentations from the NSTX-U and PPPL theory and simulation communities describing what new experiments and/or measurements are needed to better support the development or interpretation of theory and simulation.

I have asked the TSG leaders to develop a list of three to five main areas that would benefit from enhanced theory-experiment collaboration and work.

LiRTSG Areas: What Theory & Modeling Work Can Help Us Answer These Questions?

1. How do we use lithium (as a plasma facing material) to:
   - Control core plasma deuterium inventory?
   - Reduce impurity sources and / or core impurity content?
   - Increase heat load / pulse length handling capability of passively cooled surfaces?
   - Some related questions:
     - What substrate material(s) be used in NSTX-U? C? Mo? W?
     - At what rate will deposited Li pump & what total fluence can be absorbed?
     - Are there more efficient means of depositing Li on PFCs?

LiRTSG Areas: Continued

2. By what physical mechanism does Li alter core plasma transport?
   - Energy confinement improves. Why?
   - Profiles altered $\rightarrow$ ELMs stop. Why?

3. More generally, can we develop a predictive capability for plasma-material interactions and / or near-surface plasma behavior?
   - Encompassing the usual phenomena:
     - Sputtering, retention, mixed material behavior,
     - Material migration,
     - Sheath structure & kinetic effects.
   - This area overlaps with the BP-TSG.

LiRTSG Areas: Continued

4. Can we develop viable PFC concepts for FNSF, DEMO, & other future devices?
   - Some things being discussed at PPPL:
     - Technical implementation of flowing liquid metal PFCs,
     - Evaluation of non-Li liquid metals.

5. Something else?

Start Listing "Ideas"

1. "Center for Plasma Edge Simulation" may make multiple contributions to understanding of edge Li transport & behavior.
   - CPES completed, but base program work continues.
   - Follow-on proposal submitted: Partnership for Edge Physics Simulation (EPSI) (C. S. Chang, PI).

2. "Integrated Petascale Simulation of Plasma Facing Materials Response to Normal and Transient Fusion Plasmas",
   - Purdue-led SciDAC proposal submitted 10/2011.
   - Promises improved PMI modeling capability.

3. Your Idea Here . . .

Relevant CPES / EPSi Capabilities Being Developed

- Incorporation of transport of all impurity charge states & associated radiation into XGC0 neoclassical transport code,
  - Impurity sputtering will be added to DEGAS2 (coupled to XGC0).
  - $\Rightarrow$ simulate Li (& other impurities) neoclassical & anomalous transport.
  - Consistent calculation of impurity radiation power.
  - Consistent Li source rates due to sputtering, evaporation (assuming we know surface composition).
- Development of XGC0 into SOL transport code,
  - Key step is computation of 2-D electrostatic potential.
  - Represents next step towards full kinetic edge / SOL simulation capability.
- Add Li & neutral transport to XGC1,
  - $\Rightarrow$ study effects of neutrals (e.g., due to recycling) on turbulence.