

# Plans and related needs for theory/modeling support – Columbia University group

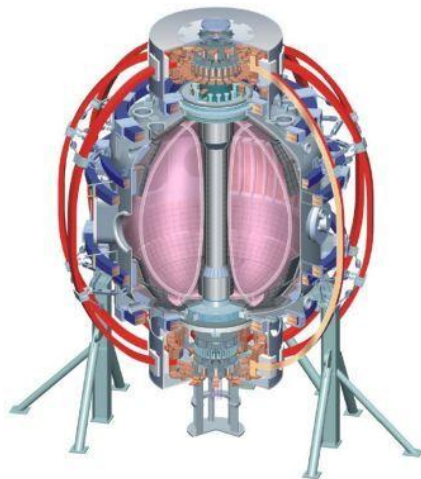
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**NSTX-U Theory/Computation Brainstorming Meeting**  
**March 2<sup>nd</sup>, 2012**



PPPL



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# Needs for theory/simulation plans follow Columbia U. NSTX-U grant proposal research plans

- ❑ Physics research areas on NSTX-U
  - ❑ Global MHD mode stabilization physics
  - ❑ Global MHD mode active control
  - ❑ Plasma rotation alteration / modeling / control
  - ❑ ELM mitigation / stabilization physics
  
- ❑ Related/coordinated research on KSTAR
  - ❑ Aimed at long-pulse, high beta
  - ❑ Higher aspect ratio of KSTAR provides opportunity for comparison to NSTX-U to determine role of A
  
- ❑ Quantitative analysis on ITER cases, future devices
  - ❑ Continue present publication results; device/code benchmarking
  - ❑ Support of ST-FNSF (e.g. PPPL LDRD effort, ORNL target), etc.

# Planned analysis builds from present capabilities and collaborative work

## □ Equilibrium

- Free-boundary: NSTX EFIT
- Fixed boundary: CHEASE (w/Liu), JSOLVER, etc.

## □ Stability

- DCON, PEST: ideal linear stability analysis
- MISK (w/R. Betti): kinetic RWM stability analysis
- M3D-C<sup>1</sup> (w/S. Jardin, N. Ferraro): linear/non-linear stability
- NIMROD (w/S. Kruger): recent collaboration started - NSTX cases being run

## □ 3D Physics

- NTV analysis: New code, starting tests, planned comparison with JK Park
- TRIP3D (w/T. Evans): ELM mitigation – used for KSTAR
- M3D-C<sup>1</sup> (w/S. Jardin, N. Ferraro): effect of 3D field on stability
- V3FIT: (w/J. Hanson): started discussion - 3D field impact on equilibria

## □ Control

- VALEN: RWM / dynamic error field control analysis
- Multi-mode VALEN: Unstable MHD mode spectrum and control
- RWMSC: State-space RWM analysis / feedback control

- Both a control program and an analysis tool

# Analysis expansion driven by proposed research, device needs (and MacroStability TSG suggestions)

## □ Equilibrium

- NSTX EFIT: expand diagnostics/model, increase (R,Z) resolution
  - NSTX-U: begin w/simulations, routine MSE and runs w/rotation during ops
- CHEASE: (w/Liu), etc.: equilibrium refinement / exchange

## □ Stability

- DCON, PEST: ideal linear stability analysis
- MISK: continued development driven by XP data (see J. Berkery talk)
- M3D-C<sup>1</sup>: resistive wall available soon / desire for kinetic effects (~ MISK)
- NIMROD: resistive wall / kinetic effects available – collaborative development

## □ 3D Physics

- NTV analysis: new code written, continued development driven by XP data
- TRIP3D: ELM mitigation – use for NSTX-U as desired
- M3D-C<sup>1</sup> (Jardin, Ferraro): desire wall/kinetic effects/expanded 3D field spectrum input
- V3FIT: start analysis - determine 3D field impact on equilibrium. Plan for NSTX-U ops.
  - Consider STELLOPT and SPEC as alternate codes

## □ Control

- VALEN: continue NSTX-U RWM control analysis (that has already begun)
- Multi-mode VALEN: multi-mode spectrum NSTX-U, active control w/RWMSC
- RWMSC:  $n > 1$  modeling + upgrades, control simulator w/expanded inputs
  - Inputs: Device data, vacuum field, code results (VALEN, M3D-C<sup>1</sup>, etc. )