NSTX-U

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Boundary Chapter Outline Discussion

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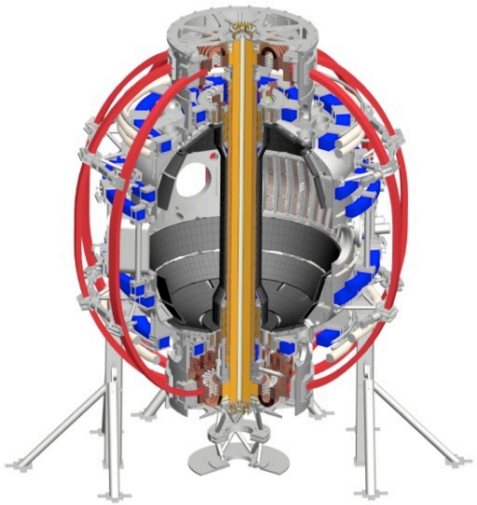

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To develop an understanding of outstanding boundary issues and project to advanced ST, FNSF, and ITER

- Develop and validate divertor heat and particle control in standard and snowflake regimes
- Establish an understanding of the heat flux scalings in connections with SOL models
- Assess and optimize the pedestal structure, and establish its understanding with respect to transport and stability
- Develop and exploit methods to study various ELM regimes and mitigations strategies to understand the complex mechanism responsible for triggering ELMs
- Investigate the midplane and divertor SOL turbulence, relate the turbulence to SOL parameters, and compare with edge codes
- Investigate different divertor PFCs and establish their impact on H-mode confinement

Boundary Research in years 1-2 of NSTX-U operation aims at comparing results to NSTX trends, extending to longer pulse

- Re-establish reliable H-mode operation [Maingi]
- Complete assessment of trends w.r.t. NSTX
  - Pedestal structure[Diallo,Maingi]
    - Dependence on B_t, I_p, shaping
  - Response to 3D magnetic field perturbations [Canik, Ahn, ?]
    - ELM studies, ELM control development, pedestal transport
  - H-mode research [Maingi, ?]
    - EPH-mode, I-mode development
  - Edge and SOL physics [Zweben]
    - Midplane and divertor turbulence, zonal flows, L-H transition
  - Divertor research [Soukhanovskii, Ahn, Gray]
    - Heat flux width scaling, connection to SOL models
    - Snowflake divertor studies and control development
    - Radiative divertor with D_2, Ne, Ar seeding
    - Impurity erosion and SOL transport studies
    - Experiments to support validation of cryo-pump designs

Advanced diagnostic and facility capabilities of NSTX-U aim to establish Boundary Physics basis for ST-FNSF in Years 3-5

- Assess Mo divertor PFCs and their impact on H-mode confinement (?)
  - Core moly density and transport in baseline scenarios
  - Effect of lithium coatings on molybdenum PFCs (synergistic study with EAST)
  - Divertor Mo influx in baseline and impurity-seeded radiative divertor scenarios
- Develop and validate divertor heat and particle control
  - Support projections of heat flux width and divertor scenarios to ST-FNSF
  - Utilize magnetic control for long-pulse snowflakes with reduced heat flux
  - Implement radiative divertor control
- Assess and optimize pedestal structure and SOL parameters for advanced ST operation
  - Utilize 3D fields to optimize pedestal transport and stability
  - Perform experiments and develop models enabling projections to FNSF

Theory and Simulations Capabilities (need input)

- Edge simulation codes:
  - DEGAS2 [Stodler]
  - XGC0 & XGC1 [Chang, Ku]
  - UEDGE [Meier (?)]
  - ELITE, EPED [Snyder (?)]
  -

Boundary Relevant Diagnostics

- Pedestal and SOL fluctuations
  - 3D GPI, 2D BES
- Divertor diagnostics
  - Langmuir probes
  - Ion energy and temperature
  - Bolometry
  - Inner and Upper IR cameras
  - Visible cameras
  - VUV and visible spectroscopy
  - Divertor Thomson scattering
- MAPP probe
- SOL diagnostics
  - Flows, temperature, current sensors
- Edge profile reflectometry
- Edge neutral density
- Full plasma radiation tomography

2014-18 Boundary Physics Research Timeline

FY13 | 14 | 15 | 16 | 17 | 18

5 year plan period → **5 year goal**

Physics

- Characterization of the pedestal structure
- Investigate the 3D fields impact on pedestal transport, and ELMs
- Develop EPH- and I- modes
- Midplane and divertor turbulence, zonal flows, L-H transition
- Snowflake divertor studies and control development
- Heat flux width scaling and investigate connection to SOL models
- Radiative divertor with D2, Ne, Ar seeding
- Investigate impurity erosion and SOL transport

→ Optimize pedestal structure and SOL parameters for advanced ST operation

→ Develop and validate divertor heat and particle control

→ Assess Mo divertor PFCs and their impact on H-mode confinement

→ Develop predictive capabilities for the pedestal structure

Heat flux mitigation

Tools

Diagnostics

- Upgraded MPTS, 2D BES, 3D GPI, MAPP, Upper & Inner Divertor IR cameras, Visible cameras, spectroscopy
- 3D fields, Lithium granule injection

→ Molybdenum core, edge, divertor spectroscopy; Edge profile reflectometry;

→ Full plasma radiation tomography; Edge neutral density measurements; Divertor Thomson Scattering system

→ Full plasma radiation tomography; Edge neutral density measurements; SOL flows, SOL and divertor ion energy or temperature; SOL current sensors

Theory

→ Edge pedestal simulations using XGC1, XGC0, DEGAS2,UEDGE, SOLPS,ELITE, EPED

Facility

→ Divertor Thomson Scattering system;

Plasma Control

→ Bt, Ip,shaping, 2nd NBI