NSTX-U

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DivSOL TSG experimental proposals

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and the NSTX Research Team

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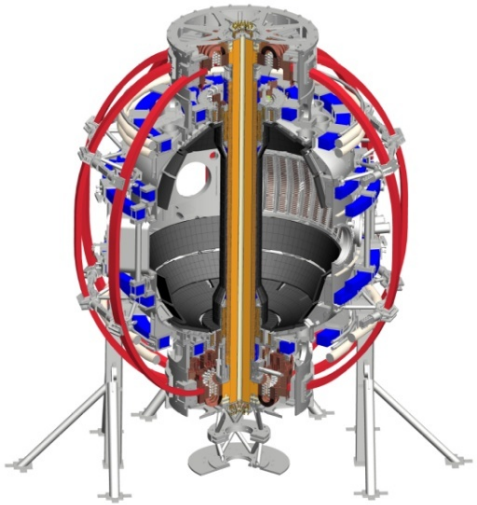


1. Initial NSTX-U edge characterization

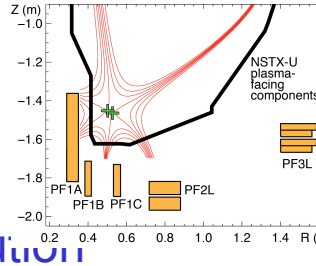
- Goals:
  - provide input to R15-1 and R15-3 and initial development for R16-1 and R16-2
  - Enable divertor and SOL characterization under boronized and lithiated conditions
  - enable dedicated XP development after 2 months
- Boundary conditions
  - P_{NBI} = 1-6 MW and 6-12 MW ; I_p = 0.7-1 MA and 1-1.4 MA; n_e = (0.5 – 0.8) x n_G
  - Boronized, Lithium coatings 10-100 mg
  - Shaping (high triangularity vs low triangularity) and magnetic balance (LSN vs DN)
- Deliverables
  - Divertor peak heat flux scaling and initial assessment of power balance, in-out assym.
  - Initial assessment of SOL power width scaling (I_p, S, $L_{||}$, …)
  - Initial assessment of SOL and divertor turbulence
  - ELM type identification and ELM regimes, ELM heat fluxes and profiles

2. Radiative divertor experiments

- Assess radiative divertor operating space and heat flux mitigation in high delta shape with D_2, CD_4, N (?), Ne, Ar seeding
- Assess impurity radiation, recombination, and heat flux toroidal asymmetries with wide angle cameras
- Assess pedestal temperature degradation due to seeding
- At best seeded impurity gas and rate, assess partial detachment threshold and radial extend vs SOL power width (e.g. change I_p).
- The experiment should prepare the basis for
  - Detachment modeling with UEDGE
  - Radiative divertor optimization with highest NBI input power, high non-inductive current fraction scenarios in FY16-17
  - Milestone R(16-1)
  - Radiative divertor feedback control with several new divertor diagnostics (Divertor Control Camera, Divertor Control Spectrometer, Divertor SPRED, LADA, etc)

3. Clarifying Snowflake divertor configuration physics

1. Transport in the snowflake divertor
   - Obtain heat flux profiles for SOL power width analysis at different I_p to enable direct comparison of snowflake vs standard divertor
   - Use GPI, BES and fast divertor cameras to document turbulence and modes in the null-region
   - Measure heat and particle flux sharing fractions between strike points, inter-ELM and ELM
2. Radiative snowflake divertor limits
   - Increase divertor radiation via D_2 or impurity seeding
   - Document heat flux, radiated power and impurity radiation distribution and dynamics, as well as turbulence
3. Optimize pedestal placement w.r.t. MPTS and document pedestal profiles for pedestal structure analysis and linear MHD stability calculations.
4. Finer snowflake experiments, e.g. understand impact of lithium pumping, snowflake with cryopump, enhanced divertor ion loss, churning mode characterization, snowflake + 3D fields, etc



4. Boundary diagnostic-optimized configuration (BDOC) for model validation

- Run discharge periodically to accumulate database
  - Neutrals for cryopump
  - Recycling coefficients with boron and lithium
  - Multi-impurity erosion, redeposition and migration (Li, B, C, O, High-Z)
- Enable comparisons to and complementarity of various transport and PSI models
  - UEDGE, SOLPS, OEDGE, BOUT++, XGC
  - DEGAS 2, ERO, DIVIMP, TRIM, WallDyn, MD
- Two shapes: high triangularity and low triangularity (high-Z tile)
- Highly reproducible parameters: e.g., 4 MW, 0.8-1.0 MA, medium density, calibrated LFS fueling, probably H-mode, etc
- All core profiles, all divertor and SOL diagnostics
- Examples of what this approach may yield for DivSOL TSG
  - Baseline case for SOL cross-field transport and turbulence models
  - Radial and parallel SOL impurity transport and ionization source
  - Divertor radiation models

5. Transport and radiation in the high flux expansion divertor configuration with cusp-like fields (H. Takase JPSJ 70, 609 (2001))

- Motivation
  - Many interesting advanced divertor ideas since 1970-s

    http://fire.pppl.gov/APS-DPP14_Divertor_Soukhanovskii.pdf
  - Partial detachment onset in NSTX high-flux expansion divertors (snowflake-minus and standard (EPS 2009, APS 2010))
- Cusp-like field divertor enables studies
  - impact of flux expansion in the standard divertor on neutral and impurity radiation distribution, detachment onset, radiation limits
  - heat transport models and turbulence
- Cusp-like field divertor is possible in NSTX-U with 3 divertor coils
- Experimental scans: I_p , P_{NBI}, gas seeding rate