Boundary Physics Experimental Proposals

NSTX

- Evaluate Boronization During High Temperature Bakeout

- Evaluate Short Morning Boronization for Stable Conditions

- Characterize Low-Z Pellet Injection in NSTX

- Particle Control Using Lithium Wall Coatings via Pellet Injection

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Experimental Proposal to Evaluate Boronization During High Temperature Bakeout (HTB)

NSTX

- **International Fusion Experiments Use Boronization to Control Impurities**
  - **ASDEX, ASDEX-UG, TCA, TFTR, NSTX, MAST and other machines deposit boron on PFCs at room temperature**
  - **D-III D, JT-60, JET, TEXTOR perform boronization at PFC temperatures up 350°C**

- **Deposition on Hot Substrates**
  - **Films grown at high temperatures are less porous and more uniform (J.Winter)** ***This could reduce impurity traps and recycling***

- **NSTX Room Temperature Deposition is Very Effective**
  - **Will deposition on hot surfaces** ***further enhance plasma performance?***

- ***Experiment***
  - **Wait for clean machine conditions mid-run (after ~3rd std boronization)**
  - **6 Fiducials before HTB (0.2 day), 6 Fiducials after HTB (0.2 day)**

Experimental Proposal to Evaluate Short Morning Boronization for Stable Conditions

NSTX

- 19 Routine NSTX Boronizations have facilitated operations
  - Application Frequency: ~2-3 weeks, (~300-400 discharges)
  - Application Amount: 10 g
  - Application Process: ~ 150 min

- ***Experiment***
  - Evaluate short (e.g.~10-15 min, ~ 1g), TMB Boronization in the morning, or perhaps midday to repair recent erosion as required to maintain stable operating conditions
  - Wait for clean machine conditions mid-run (after ~3rd std boronization)
  - 6 Fiducials before (0.2 day), 6 Fiducials after (0.2 day)

Experimental Proposal to Characterize Low-Z Pellet Injection in NSTX

NSTX

- **Low-Z Pellet injection into the NSTX high edge density, temperature, and rotation gradients may be exhibit unique ablation and transport behavior in different plasma and velocity regimes (e.g., at low velocity, in SOL, surface ablation with no NGS, at higher velocity, beyond LCFS, NGS and grad effects)**
- ***Experiment***
  - **C, 1mg, 20- 400 m/s: 5 velocities, 2 shots/velocity = 10 shots**
  - **B, 1mg, 20-400 m/s: 5 velocities, 2 shots/velocity = 10 shots**
  - **Li, 1mg, 20-400 m/s: 5 velocities, 2 shots/velocity = 10 shots**
    - ***initial scoping study: 1 day for LSN, 1 day for DND***
- ***Measurements***
  - **Pellet Ablation along radial trajectory [filtered cameras]**
  - **Midplane Impurity transport, core to edge [filtered cameras, UXR, ..]**
  - **Transport to and from Divertor [filtered cameras, UXR, bolometers,..]**

Experimental Proposal for Particle Control Using Lithium Wall Coatings via Pellet Injection

NSTX

- ***Particle Control Using Lithium Wall Coatings***
  - ***TFTR demonstrated the benefit of a partial lithium coating on carbon PFCs***
    - ***Strong edge pumping (reduction of recycling)***
    - ***Improvement in energy confinement (x2)***

- **Effectiveness of Lithium PFCs Depends on Substrate and Thickness**
  - **Partial Li film coverage on unconditioned substrate - ineffective (TFTR,C-MOD, DIIID…)**
  - **Partial Li film coverage on clean substrate - very effective (TFTR, HL-1M)**
  - **Thick Li PFC - very effective (CDX-U)**

- **NSTX Wall Conditioning via Lithium Pellet Injection**
  - **Capacity 400 Pellets, 1 to 8 pellets per discharge**
  - **Variable mass per pellet (< 1 mg to >10 mg)**
    - **1 mg pellet deposition averaged over outer divertor - film 0.5 nm thick**

Experimental Proposal for Particle Control Using Lithium Wall Coatings via Pellet Injection

NSTX

- *Survey Experiment*

  1) Use Results from the Pellet Characterization XP to select the optimum discharge conditions and pellet deposition region

  2) Injection During Preceding LSN, DND Discharge (1 day)
     - Inject 1-4 pellets 1 mg ea, near end of previous discharge (8 shots)
     - Inject 1-4 pellets, 2 mg ea, near end of previous discharge (8 shots)
     - Inject 1-4 pellets, 5 mg ea, near end of previous discharge (8 shots)
     - Inject 1-4 pellets, 10 mg ea, near end of previous discharge (8 shots)

  3) Injection Early in LSN, DND Discharge of Interest (1 day)

     Inject 1-4 pellets, 1 mg ea, near end of previous discharge (8 shots)
     - Inject 1-4 pellets, 2 mg ea, near end of previous discharge (8 shots)
     - Inject 1-4 pellets, 5 mg ea, near end of previous discharge (8 shots)
     - Inject 1-4 pellets, 10 mg ea, near end of previous discharge (8 shots)

- Measure: density control, fueling efficiency, confinement, profiles, neutron and power yields