Boundary Physics ET Overview

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Boundary Physics ET Focus: Facilitate Operations and Edge Characterization

- **Present Areas of Focus**
  - **Wall Conditioning for Impurity and Density Control**
  - **Fuelling**
  - **Understanding the ST Edge Boundary**

The advent of high power operations has required upgrading wall conditioning techniques to provide for additional impurity and density control

- **The Impurity and Density Control Techniques Under Study Are:**

  - **HeGDC aided Boronization using deuterated Trimethylboron**

  - **Daily and Inter-discharge HeGDC**

  - **350°C PFC Bake-out aided by D_2GDC and HeGDC**

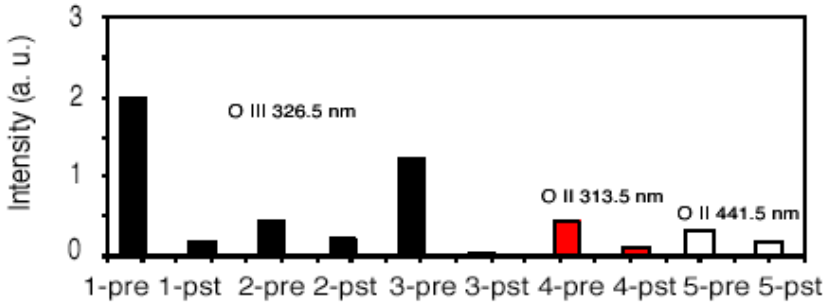
  - **Experiments to test fueling deuterium discharges with He-Trimethylboron mixture and pure Trimethylboron for Conditioning Plasma Wetted Surfaces and Establishing a Low-Z Mantle**

He GDC Boronization of NSTX Using Deuterated Trimethylboron (TMB) Has Significantly Improved Plasma Performance

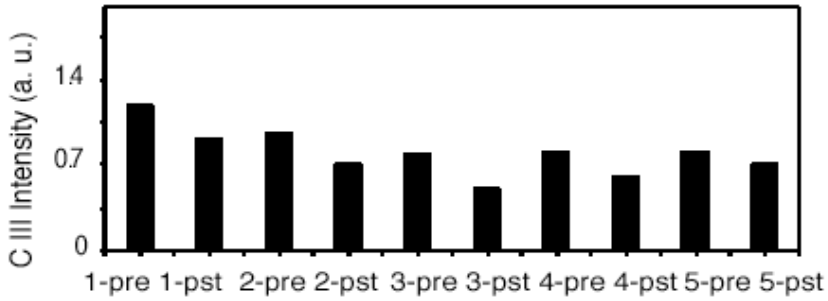
- **TMB has been applied at Rm Temp a total of 16 times using HeGDC (95%He/5% TMB), about every 2-3 operating weeks (~300-400 discharges). Reference D_2 discharges following HeGDC/TMB showed:**
  - **15x reduction in O luminosity**
  - **Factor of 2 decrease in C luminosity**
  - **The D_2 density limit increased from about 60% of the Greenwald limit density to about 75%-80% after boronization**
  - **He density limit increased from 75% to 100% of the Greenwald limit**
  - **Access to H-mode plasmas occurred following the 3rd Boronization, and the 4th Boronization**
  - **The energy confinement time during NBI heating exceeded 120 ms and the toroidally averaged Beta ~32%**

Glow Discharge Boronization Consistently Reduced Oxygen and Carbon

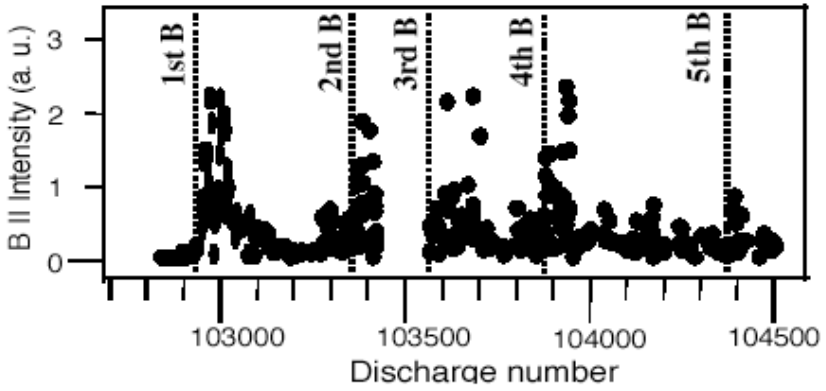
- O III Pre- & Post-Boronization. (Difficult to Compare due to Changing Fiducials)



- C III Pre- & Post-Boronization. (Difficult to Compare due to Changing Fiducials)

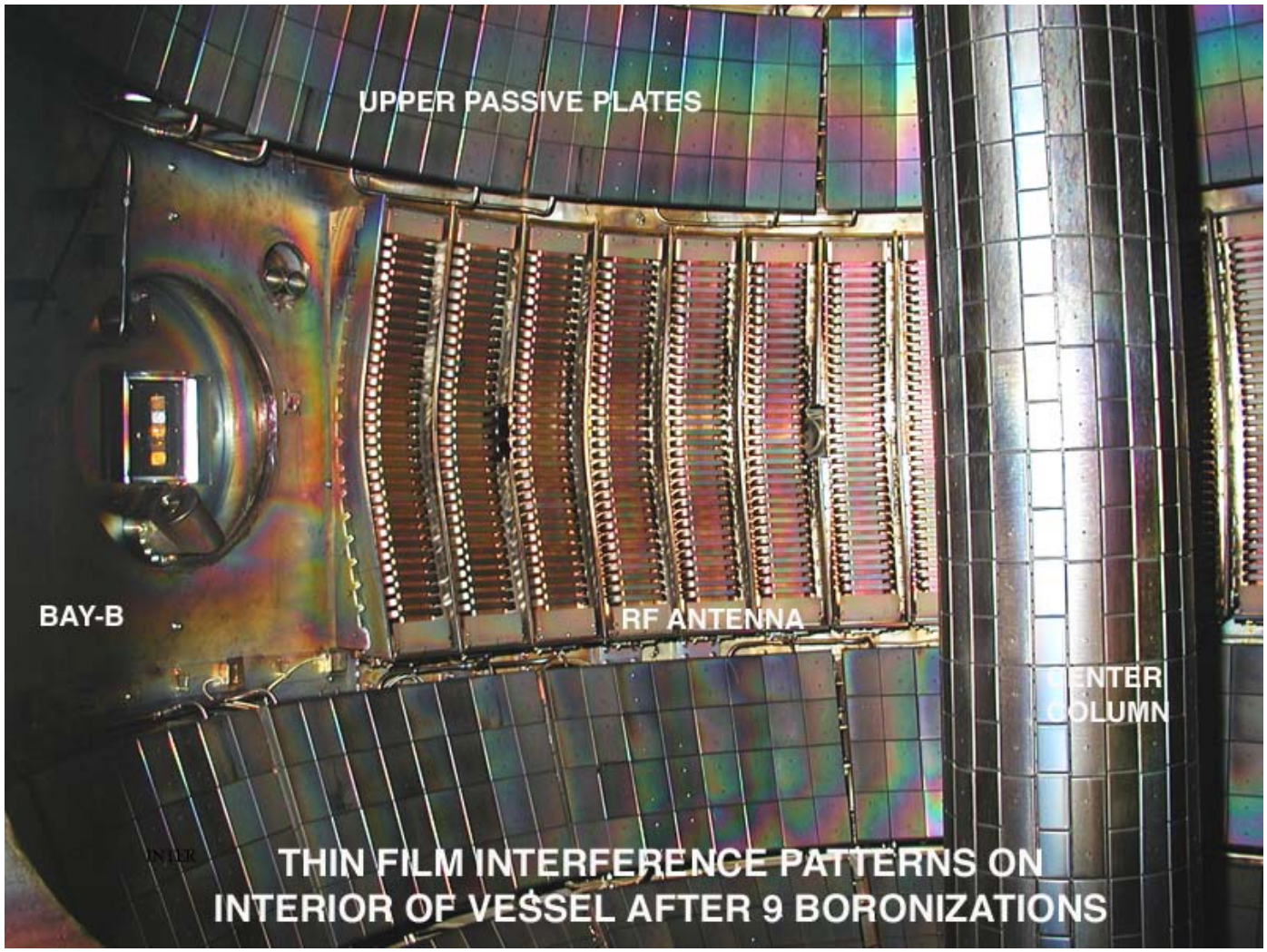


- B II vs Shot Number

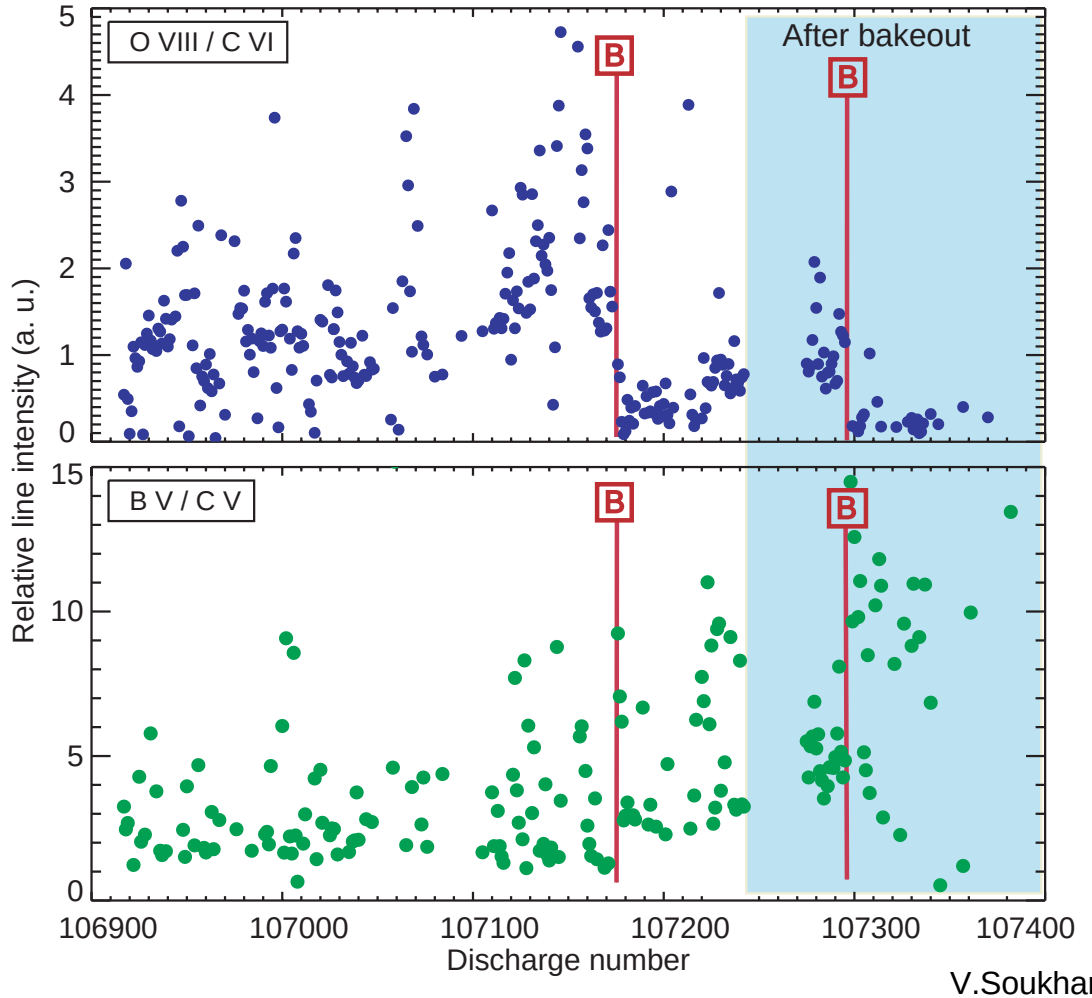


H. Na (KBSI)

Boronization Thin Film Interference Patterns Visible in NSTX



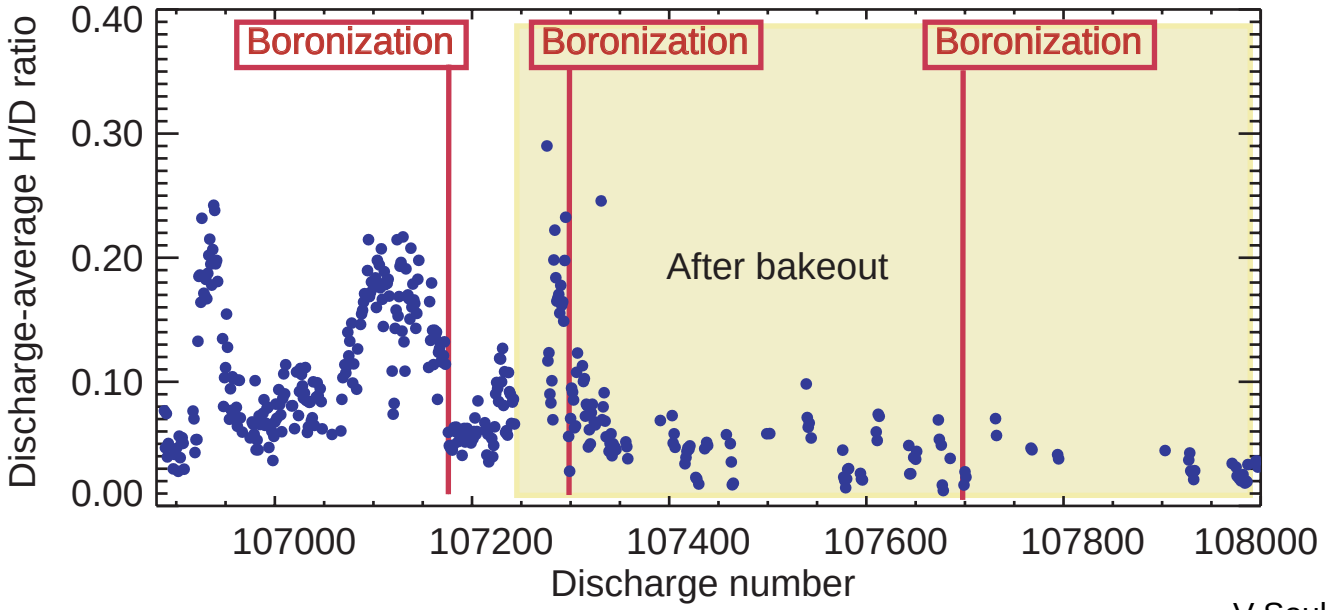
Bake-out Only Is Insufficient to Improve Performance, Boronization Also Required



- **Oxygen and Carbon luminosities after Bake-out and the following Boronization were significantly lower**

V.Soukhanovskii

Discharged-average H/D Ratio After Bake-out Followed by Boronization Decreased Significantly



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Direct Injection of 90%He+10%TMB [$B(CD_3)_3$] Into Ohmic D2 Discharge Yields x2Decrease in Central Radiation & H-mode

- TMB fueling to 15.8 Torr-liters reached operational limits: 800 KA discharge only reached 500 kA due to high radiative power losses and He recycling.

- TMB fueling was then reduced to 6 Torr-liters for next 6 TMB fueled discharges (12 discharges total) : *showed 50% decrease in central radiation after TMB.*

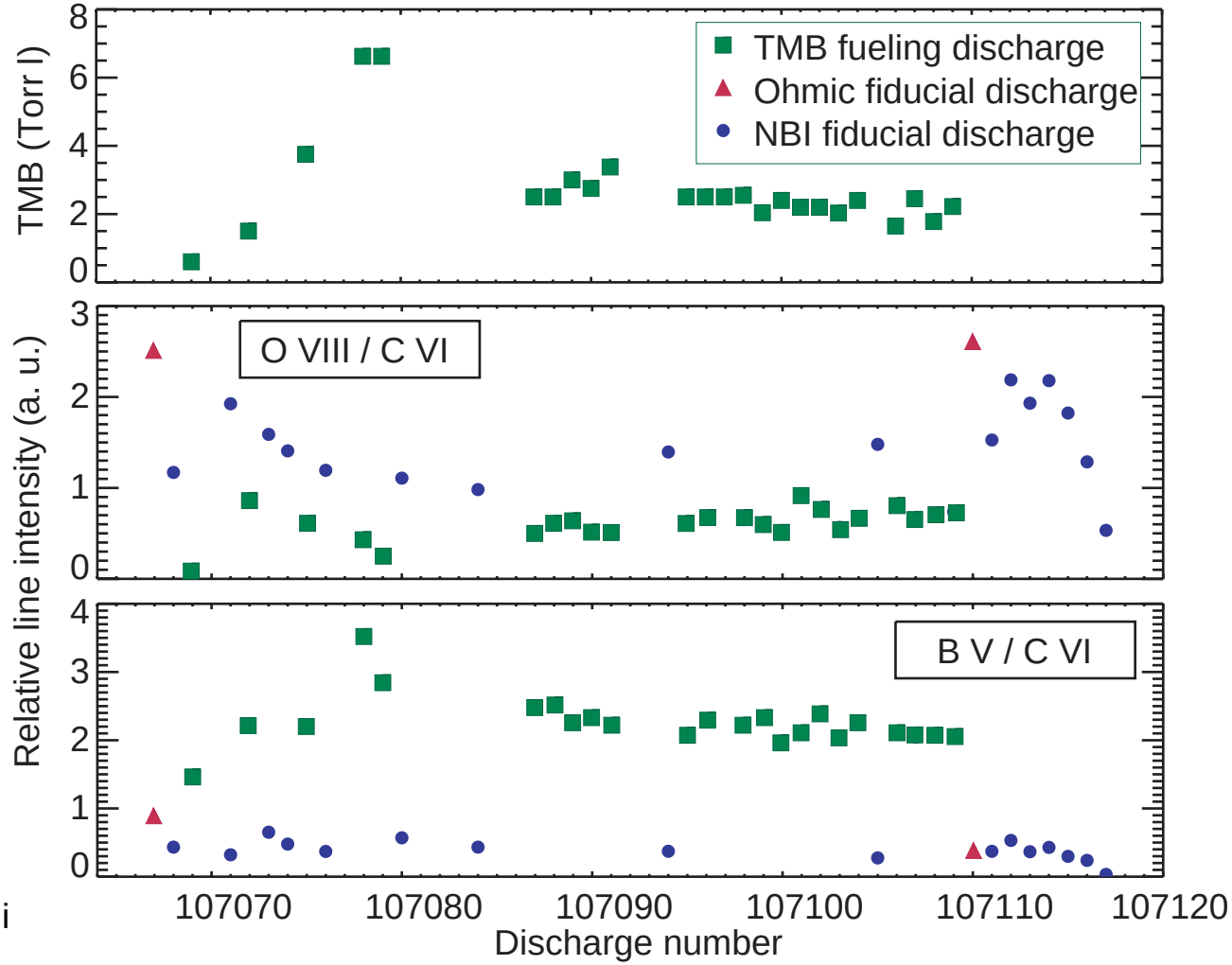
- The subsequent post-TMB, LSN, 900 kA, 1.5 MW, NBI fiducial discharge exhibited a *transition into the H-mode*.

- The edge O and C luminosities were comparable within the limited statistics due to initially clean conditions. Edge fueling with TMB did not increase B V and C VI.

- Density profile for the post-TMB CSL discharge exhibited an outboard shoulder.

•O and C Impurity Levels Decreased Initially, and the Plasma Performance Continued to Improve During 100%TMB Fueling of NBI Deuterium Discharge

- **TMB (100%) Fueling Discharge Sequence included many fiducial discharges.**
- **•O VIII/C VI luminosity ratio decreased relative to the NBI fiducial discharges due to temperature change and possible profile effects.**
- **•Boron increased during TMB fueling but not during fiducials**



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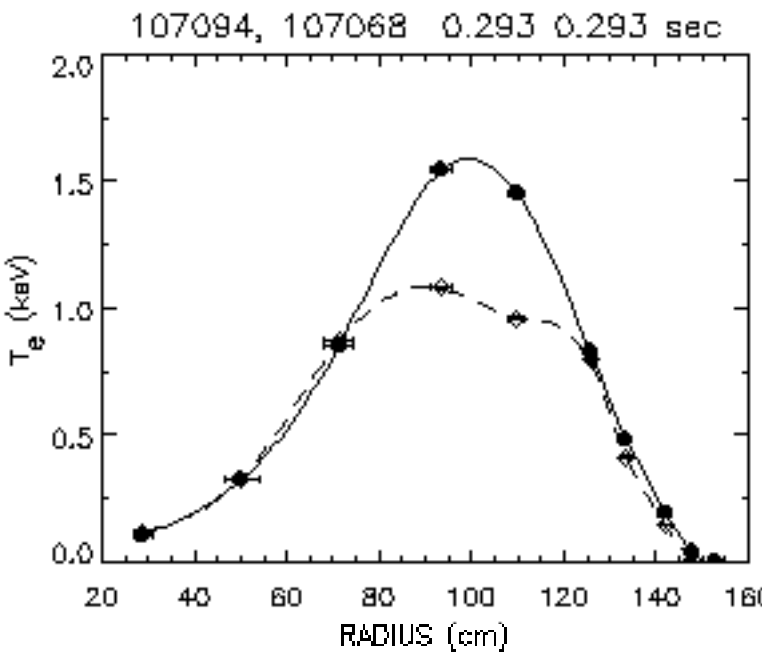
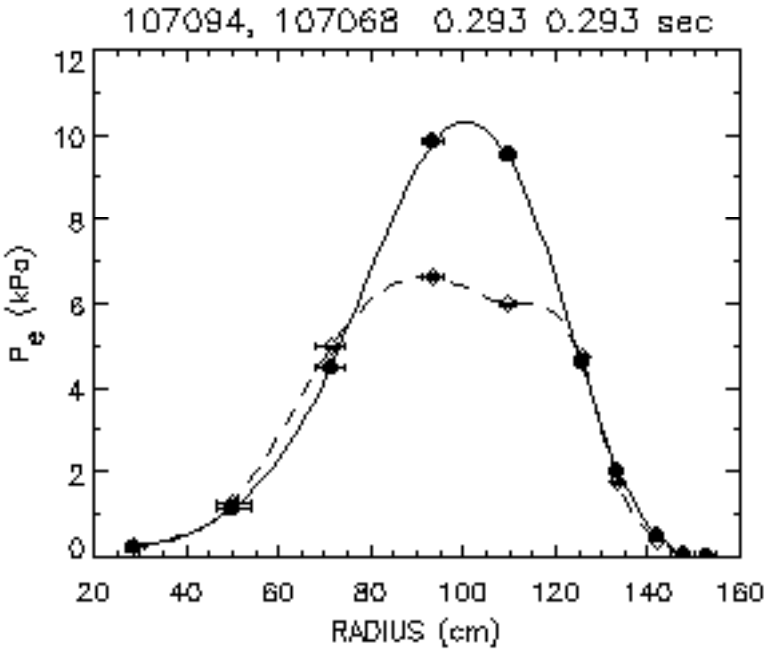
High T_e in NBI Discharge Following TMB Fuelling





LeBlanc

- **Comparison of electron temperature, and pressure profiles for one of the highest T_e (1.6 keV) achieved in NBI heated discharges observed in a fiducial discharge following a TMB fuelling sequence (solid), and a fiducial discharge before TMB fueling started (dashed) . Same density.**

Boundary Physics ET - Operations Conclusions

- ***Facilitate Operations***
  - **The Wall Conditioning procedures have been effective**
  - **Near-ready for Boronization at Bakeout temperature (350°C)**
  - **TMB Fuelling test results promising**
    - **Clean wall conditions found important (need He discharge cleaning)**
    - **Need to investigate coating sweeps of limiter surfaces (painting)**
    - **Measure window deposition**

      -to allow opening shutters for low-Z mantle experiments

• Understanding the ST Edge Boundary

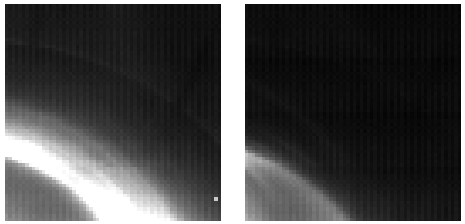
• Results in the Following Areas will be Presented in this Session

- **Results from the Edge Characterization Experiments in NSTX -V.Soukhanovskii**
- **Power Balance and Heat Flow in the NSTX Edge - S. Paul**
- **Edge Reciprocating Probe Results - J. Boedo**
- **Gas Puff Imaging of Edge Fluctuations (R) - R. Maqueda**
- **Simulation of the Boundary Plasma in NSTX - G.Porter /M.Rensink**
- **Non-Local Electron Heat transport in Divertor plasmas and Atomic Physics - F. Allais**
- **Edge pedestal and Er layer Formation by X-transport in NSTX - S. Zweben**
- **Neutral Transport Simulations of Gas Puff Imaging Experiments on NSTX - D. Stotler**
- **SOL Transport Theory and Modeling - D. D'Ippoloto**

• Understanding the ST Edge Boundary

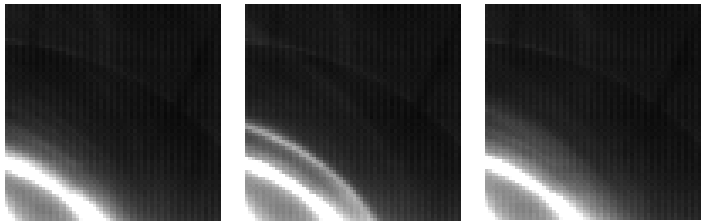
• Additional Work in progress Not Presented in this Session

- **First Results of NSTX Fast Divertor Camera - N. Nishino (Hiroshima Univ.)**



(a) L-mode (b) H-mode

View of L-mode and H-mode during L-H transition (#109069 40500fps with Dα filter)



(a) Before ELM (b) Grassy ELM (c) After ELM

View of grassy ELM (a)→(b)→(c) (#109069 40500fps with Da filter)

(To be presented Proc of JPS, 9/02)

- **Wall Deposition Coupon Sampling - W. Wampler (SNL)**
- **Langmuir Probe Tile Array Measurements - C.E. Bush (ORNL)**
- **Edge Fast Neutral Pressure Studies - R. Raman (Univ. of Washington)**

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- ***Edge Characterization***
  - **About 14 analysis studies in progress**