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Planned Recycling Measurements Following Repeated Lithium Pellet Injection

(NSTX Experimental Proposal 515: for Density Control)

H. W. Kugel, et al.

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The Scheduled NSTX Experimental Plan Follows from Initial NSTX-04 Lithium Pellet Injection Test

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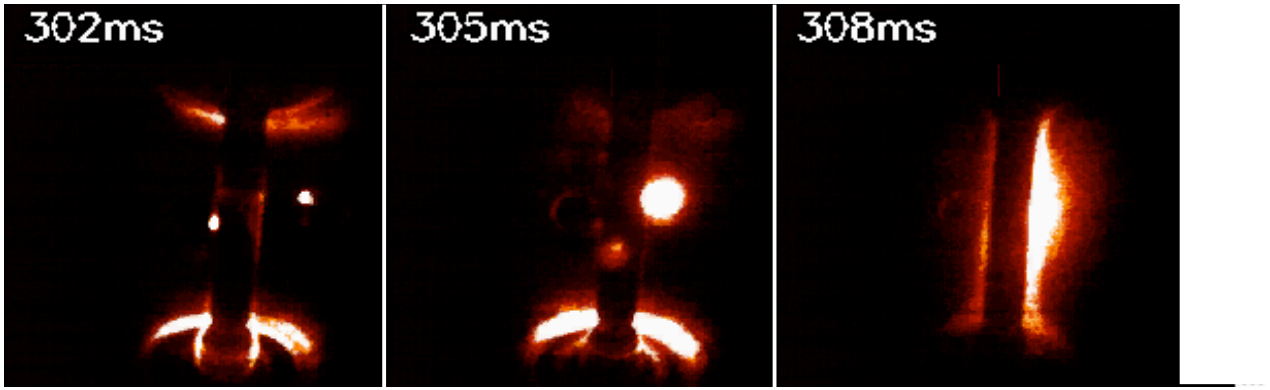
- 2 mg Li pellets were injected into 16 NSTX-04 discharges (LSN, DND, OH), 34 mg total.



Li-I Filtered TV of Lithium Pellet in NSTX Ohmic Discharge

- Plasma performance about the same; O luminosity trended downward with C ~constant.
- Recycling was not obviously changed by the 34 mg Li deposition.
- Long after this LPI (390 discharges), Li I luminosity observed from Center Stack region.
- LPI Penetration Depth in Ohmic Discharges reached Center Stack. If pre-heated with NBI, was sensitive to a 10 ms change in NBI off-time relative to pellet arrival.
- During LSN & DND diverted NBI, LPI ablated near edge and transported to the Divertors.
- *The experimental decision point: how to proceed from these initial NSTX results in light of the previous results on other machines?*

The Effectiveness of Thin Lithium Films on TFTR Has Not Been Reproduced on Large Diverted Machines

- **TFTR found deposition of thin lithium films very effective for reducing recycling and improving edge conditions. This involved:**
  - Large area graphite toroidal limiter
  - 40 helium wall conditioning discharges to remove deposited deuterium prior to Li deposition

- **Since TFTR-97 (and earlier), large diverted machines (TdeV, C-Mod, D-IIID, NSTX-04) have not observed large performance Improvements with thin lithium coatings**
  - some impurity reduction was observed.

Several Effects Have Been Suggested to Explain the Differences in the Previous Lithium Results

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- **Extensive substrate conditioning may be required**

TFTR demonstrated the need for extensive (40) Helium Conditioning Discharges to reduce lithium interactions with absorbed fuel gas in toroidally limited discharges.

- **Diffusion into graphite and erosion in diverted discharges**

The tendency for lithium to diffuse (intercalate) deep into graphite may be enhanced in diverted machines where power deposition is focused on narrow strike regions, and where high erosion rates might also reduce lithium availability to absorb ions and neutrals.

- **Main chamber recycling may be significant in diverted discharges**

Predominant deposition on divertor strike region may not provide sufficient main chamber deposition. Main chamber coatings may be required in diverted machines due to indications of significant recycling from both divertor and main chamber regions.

NSTX Lithium Pellet Injection Plan for Proceeding from the Previous Results

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- ***Experimental Plan: Make contact with the TFTR Lithium Database:***

1. Condition the Center Stack (an Inner Toroidal Limiter) with Helium Ohmic Discharges.

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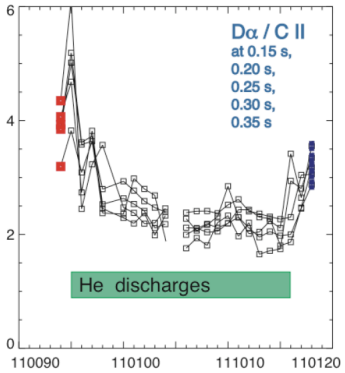
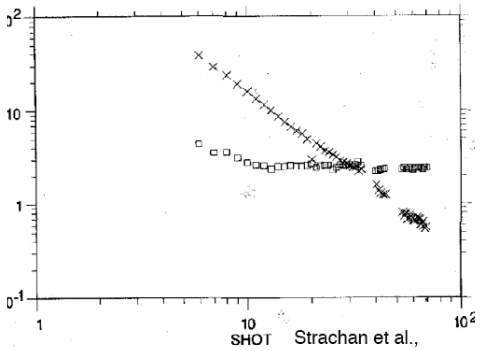


- **Evaluation of D-alpha/CII**

17 conditioning discharges gave modest change in D-alpha intensity, D-a decreased by 40% cf x10 TFTR plot.

C.H.Skinner, NSTX XP304, 2/03.

TFTR



11. Hydrogen (×) and carbon (□) influx in helium
large cleaning pulses following a 1 MA ohmic disruptior
ar the end of a disruptive discharge cleaning campaign.

J.D.Strachan, et al, J.Nucl. Mater., 196-198 (1992) 28.

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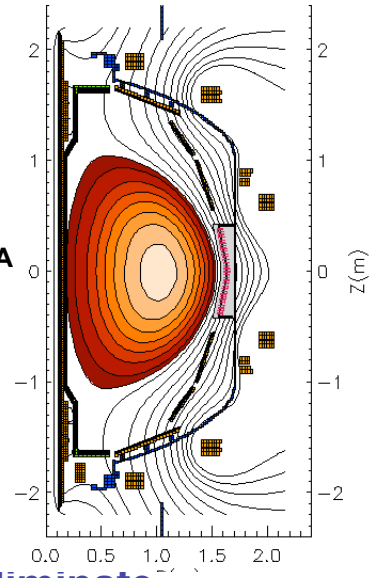
111522
Ip 800 KA



2. Deposit lithium on Center Stack using Helium Ohmic Discharges to eliminate chemical erosion of the deposited lithium.

3. Apply an elongated Center Stack Limited Deuterium NBI Fiducial Discharges and measure reduced recycling.

4. Gradually change these Center Stack Limited Discharges to increasingly diverted discharges while maintaining contact with a recycling effect.

Summary and Conclusions

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- **The effectiveness of thin lithium films on TFTR has not been reproduced on large diverted machines.**
- **The NSTX plan to investigate these results is to make contact with the TFTR lithium database:**
  - Condition: using toroidally limited Helium Ohmic Disharges.
  - Apply Lithium: by injecting into limited Helium Ohmic Disharges.
  - Measure Recycling: using Limited D NBI Fiducial Discharges.
  - Apply More Lithium: by injecting into limited Helium Ohmic Disharges.
  - Measure Recycling: using Limited D NBI Fiducial Discharges.
  - Gradually Divert: move discharge away from Center Stack while maintaining contact with a recycling effect.
- **Characterize lithium edge behavior for lithium evaporator planning.**