

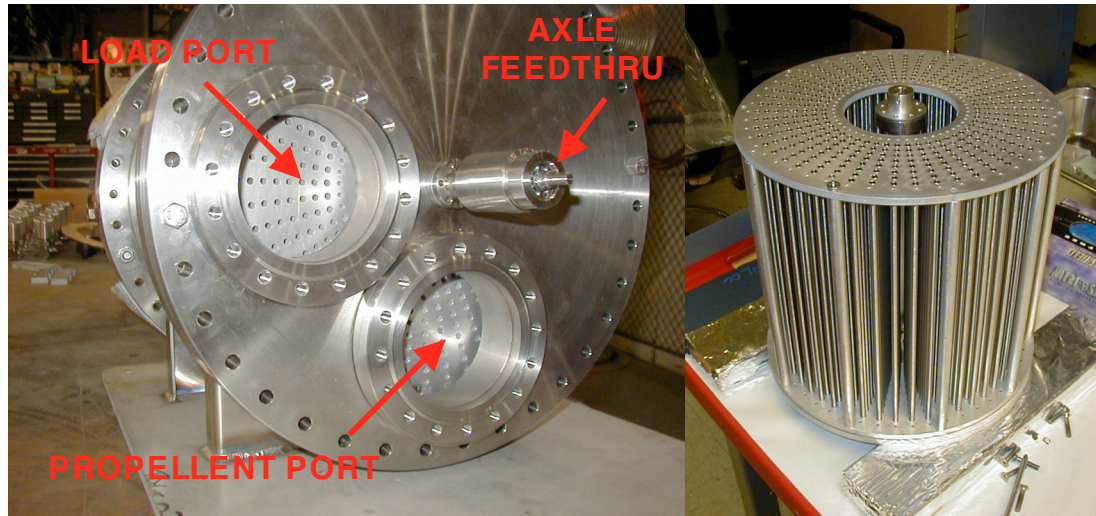
Initial NSTX Lithium Pellet Injection

The First Step in the 3 Step Lithium Plan:
Li Pellet Injection, Li Evaporated Films, Li Liquid Surface Module

H. W. Kugel and the NSTX Team

NSTX Results Review
September 2004

Lithium Pellets Injected into NSTX Discharges



OUTBOARD VIEW

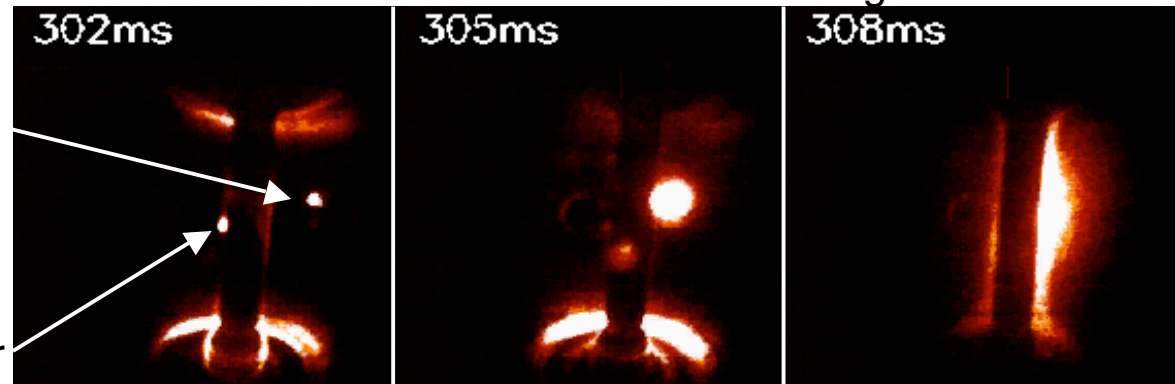
400 BARREL TURRET

- Cartridge style injector for injecting solid pellets (<1 – 5 mg) & powder (micro-pellets)
- 10 – 200 m/s radial injection
- 1 – 8 pellets per discharge
- 400 pellet capacity
- Need to optimize performance

Lithium vapor spreading along the center-stack

Lithium Pellet moving through plasma after entering boundary

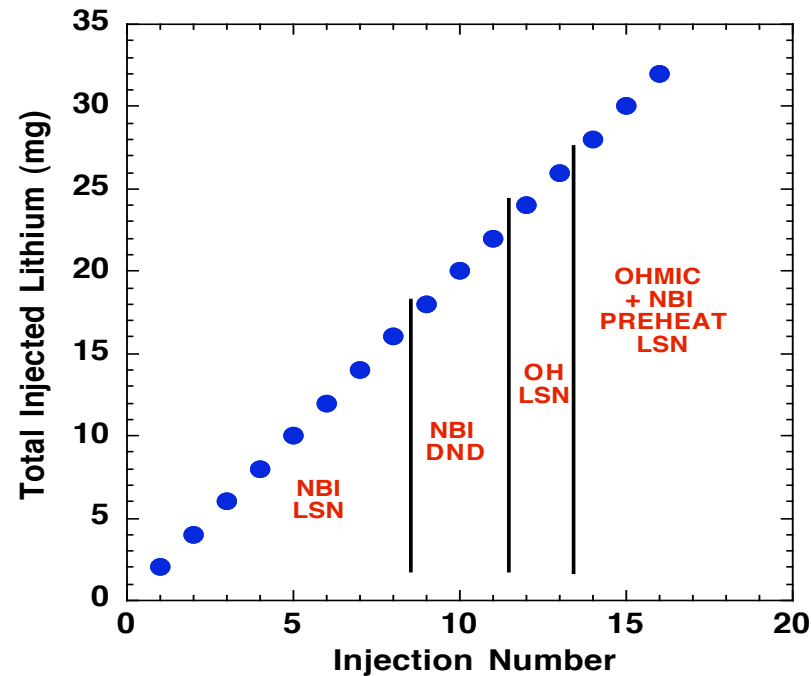
In-board gas injector



Lithium “vapor ball” surrounding pellet as it approaches the center-stack

Li I Plasma-TV
-C. Bush, ORNL
H.W.KUGEL 2

Experimental Sequence for Initial 2 mg Lithium Pellet Injection in NSTX

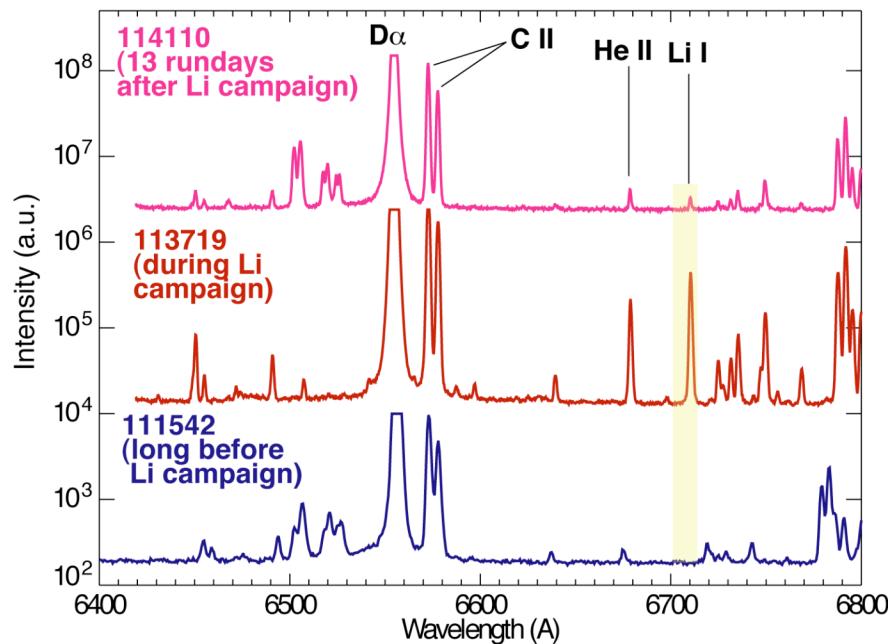


- Deuterium gas was used to propel a Li pellet-bearing cartridge down a barrel to a cartridge stop, and the pellet continued into the NSTX plasma at about 100 m/s.
- 16 lithium pellets, about 2 mg each were injected into LSN and DND, NBI-heated, H-mode plasmas, and into L-mode LSN Ohmic plasmas.

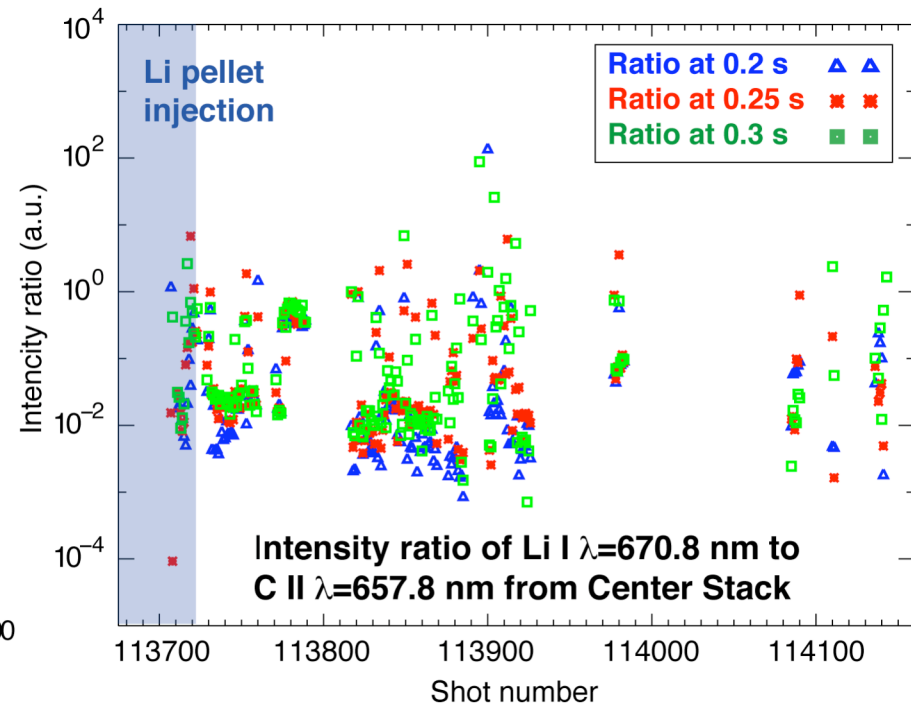
Spectroscopic Li I Measured Long After Li Pellet Injection Campaign



- During LPI sequence, preliminary SPRED results indicate C remained about constant and O was trending downward.
- As LPI sequence progressed, VIPS2 Li I luminosity started to be observed from the very initiation of discharges, due to depositions from preceding discharges.

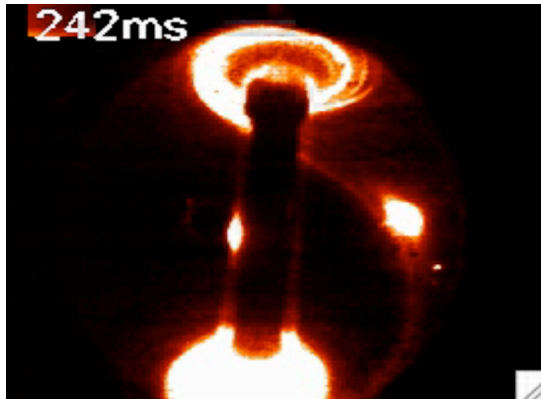


- VIPS2 spectra exhibited traces of Li I on the CS long after Li pellet injection campaign.

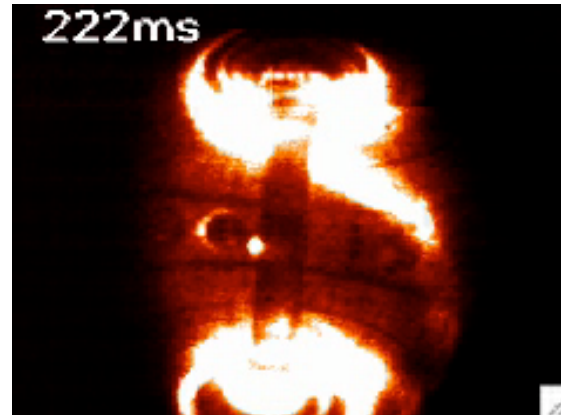


- Background Li I influx (normalized to carbon influx) from CS remained constant long after the Li pellet injection campaign.

In Lower Single Null NBI Discharges, Li Was Transported Along Open Field Lines to the *Upper Divertor*



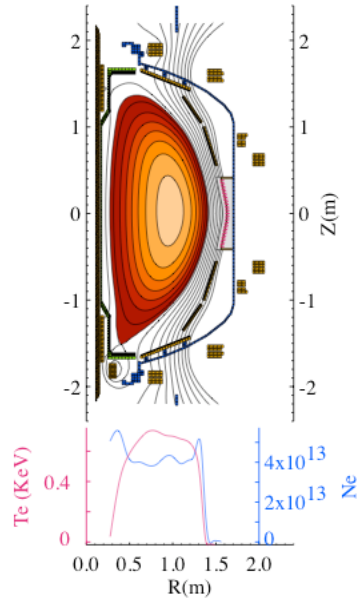
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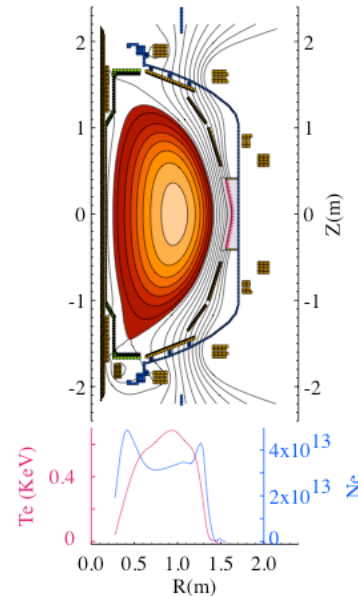
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Li I Plasma-TV
C. Bush, ORNL

from \EFIT02, Shot 113681, time=241ms



from \EFIT02, Shot 113707, time=220ms

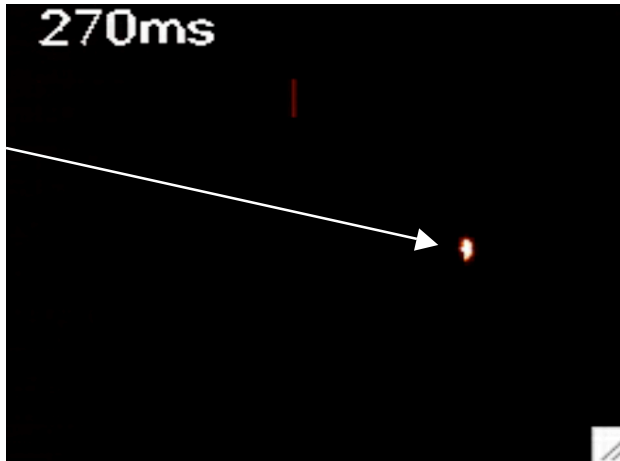


- B. LeBlanc
- S. Sabbagh,
Columbia U

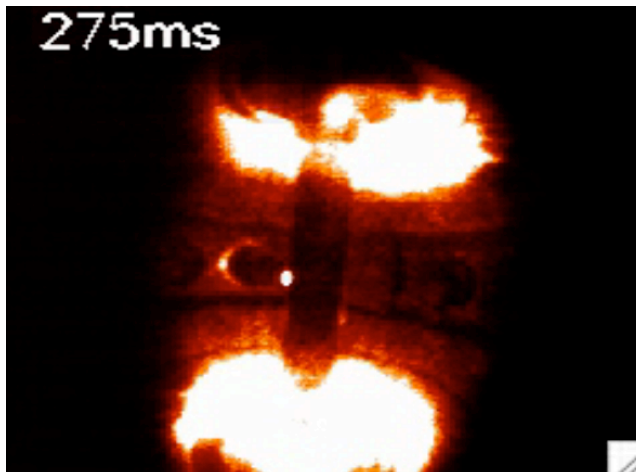
During DND NBI Discharges, Li Appeared to Be Transported More Uniformly to Both Divertors



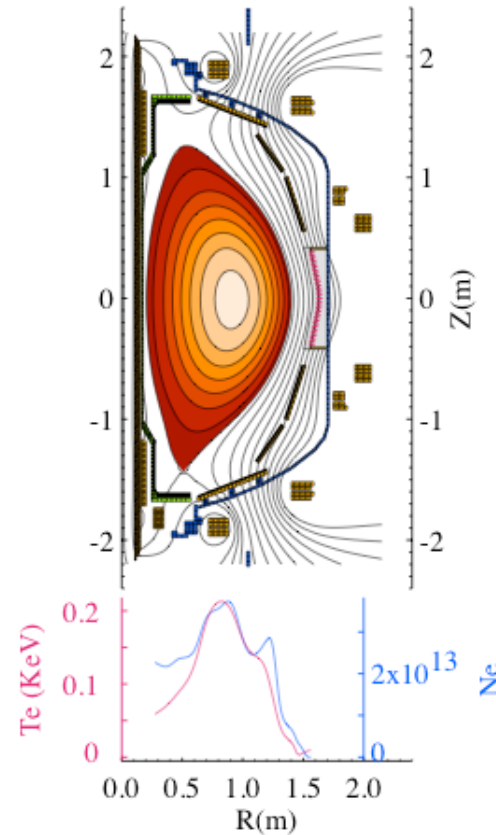
LPI
Ablation
at Edge,
Appears
Vertically
Elongated



Ablation
Reaches
Both
Divertors



from \EFIT02, Shot 113716, time=274ms

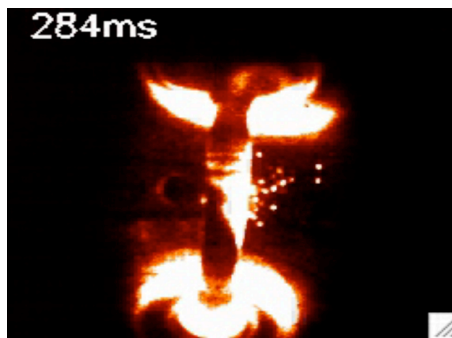


-B. LeBlanc
- S. Sabbagh,
Columbia U

• A Controlled Experiment Was Performed to Vary the LPI Penetration by Pre-heating the Plasma With NBI

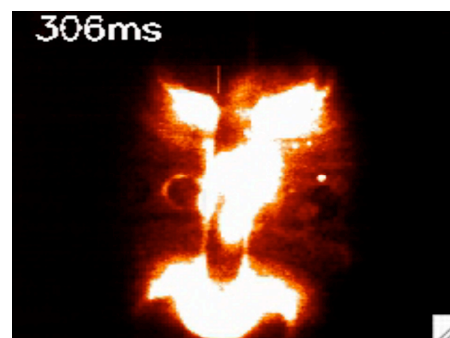


• LPI Penetration Depth into Ohmic Discharges Pre-heated with NBI, Was Found Sensitive to 10 ms change in NBI Off-Time Relative to Pellet Arrival



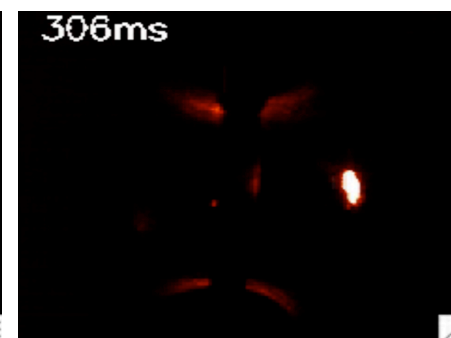
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- Ohmic Only
- LPI Reaches HFS



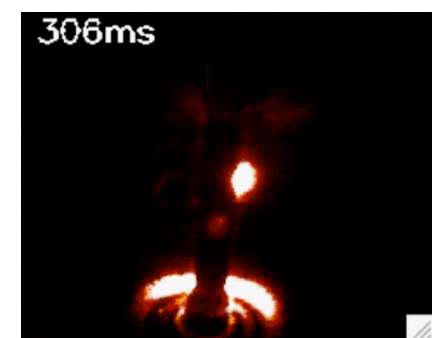
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- NBI Preheat Off @250ms
- LPI Reaches HFS



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- NBI Preheat Off @275ms
- Penetration greatly decreased; LPI Ablates Near Outer Boundary



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Li I Plasma-TV

- NBI preheat Off @260 ms
- LPI Barely Reaches HFS but as Vapor Ball

- R. Raman, U Wa
- C. Bush, ORNL

Preliminary LPI Summary and Plans



- 2 mg Li pellets injected, into 16 discharges (LSN, DND, OH), 32 mg total.
- During the LPI sequence, SPRED C ~constant, O trended downward.
- Long after LPI sequence, VIPS2 observed Li I luminosity from CS region.
- During LSN NBI, LPI ablated near edge and transported to *Upper Divertor*.
- During DND NBI, LPI ablated near edge and transported to both Divertors.
- Density rises were not obviously changed by the limited Li deposition, but the density exhibited interesting outboard edge profile changes.
- LPI Penetration Depth into Ohmic Discharges Pre-heated with NBI, was found sensitive to a 10 ms change in NBI off-time relative to pellet arrival.
- After LPI, some discharges continued, but some discharges terminated slowly; locked modes seemed more prevalent as the Li deposition increased; the mode sequences need to be investigated.
- Future plans include:
 - Measure edge turbulence and perturbation during LPI
 - Determine beam ion contributions by varying I_p and NBI R_{tan}
 - Determine optimum injection times for effecting discharge performance