

Controlling Impurity Sources by Diffusive Lithium Injection

*D. P. Stotler, C. H. Skinner, S. A. Sabbagh**
& the NSTX Team

Princeton Plasma Physics Laboratory

*Columbia University

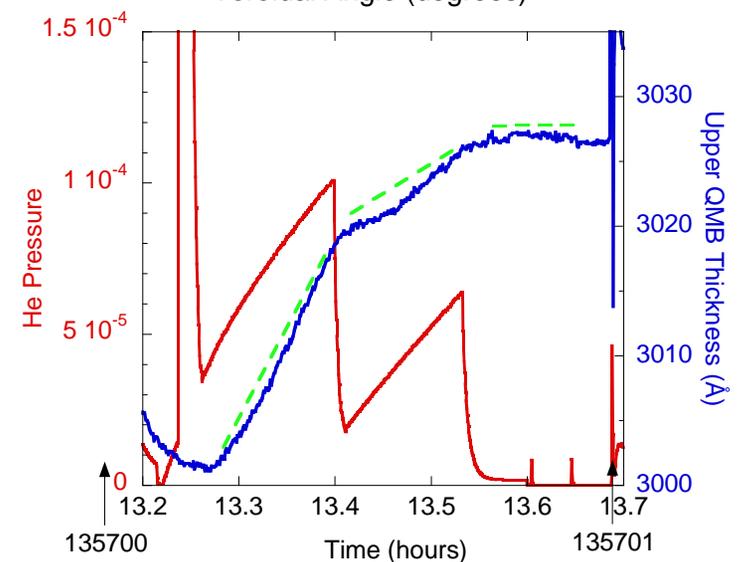
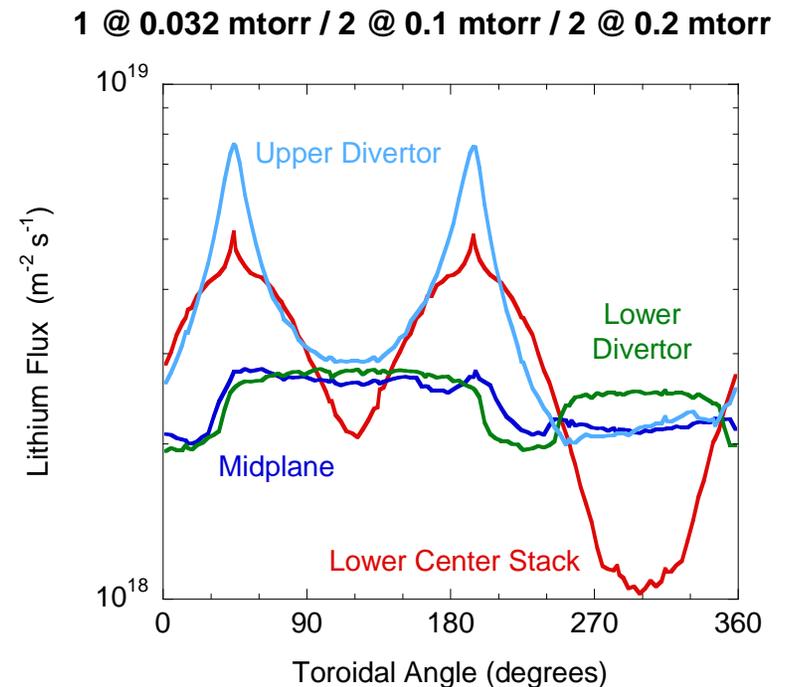
NSTX FY2011–2012 Research Forum
Lithium Research Topical Science Group
March 16, 2010

Understand & Minimize Impurities by Coating Midplane & Upper PFCs

- **Contribute to milestone R(12-1):** investigate relationship between Li conditioned surface composition & plasma behavior.
- **Is carbon source due to sputtering from PFCs?**
 - If so, applying Li to all PFCs should reduce or eliminate carbon content.
 - Should XP not demonstrate reduced carbon, conclude source not due to sputtering.
- **Secondary objectives:**
 - **Validate Monte Carlo model of diffusive evaporation,**
 - Use MAPP to monitor actual conditions of graphite after diffusive evaporation, including effects of H₂O.
 - Response of plasma to broader Li coverage,
 - Density, recycling, fueling...
 - ELMs, MHD...

LITER Li Atoms Redirected Towards Midplane & Upper PFCs by Collisions with He

- Use 3-D DEGAS 2 simulations to construct sequence of He pressures providing minimum coating everywhere,
 - With Li mfp's: 0.5, 1.0, & 3.1 m,
 - \Rightarrow \sim few collisions per atom.
- Previous XP 951 (2009) complicated by outgassing during evaporation.



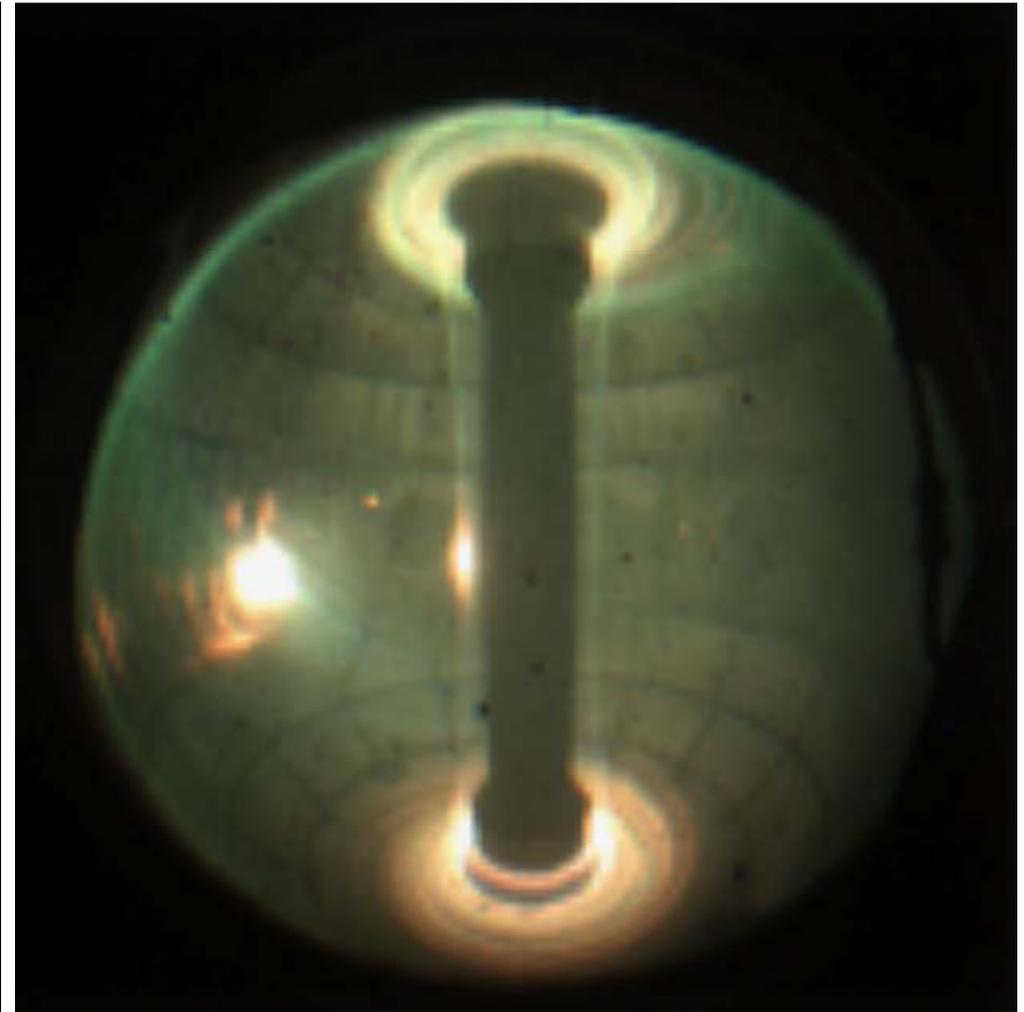
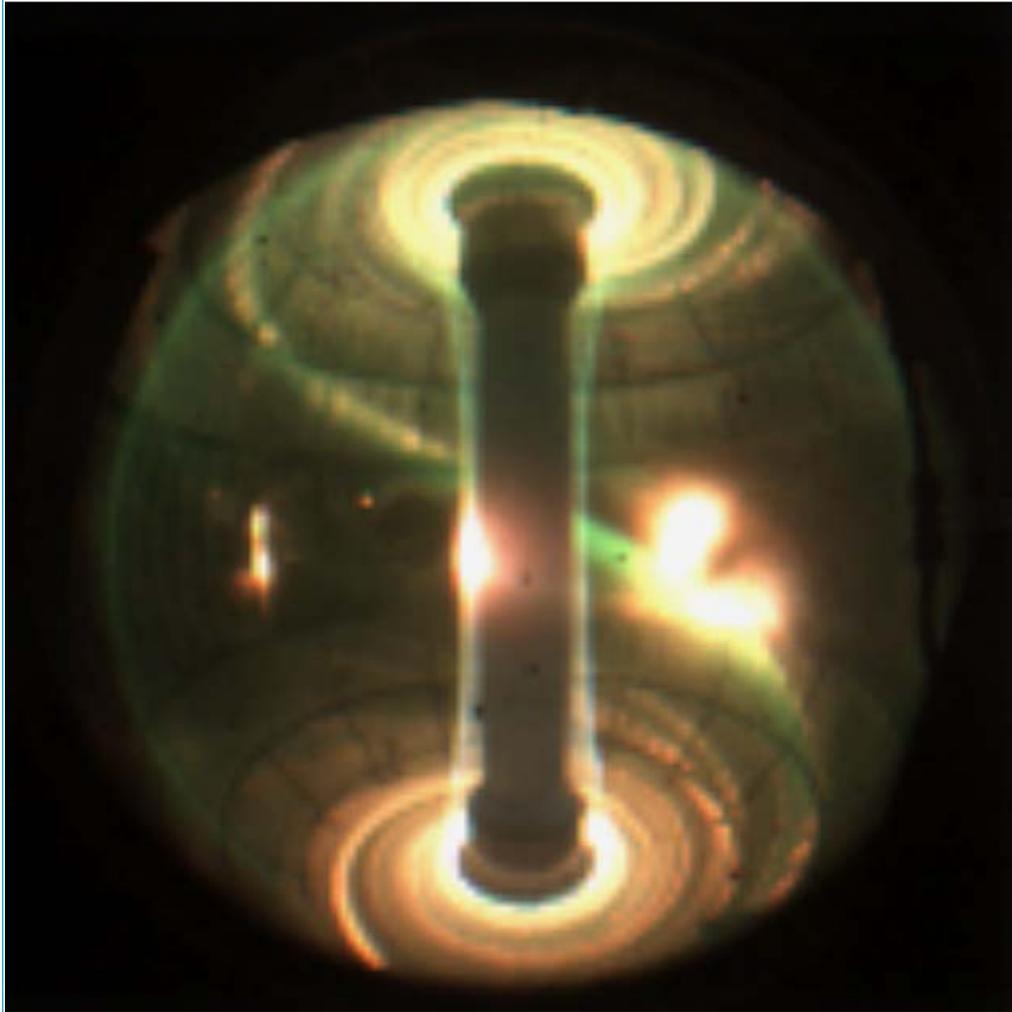
New Procedure Mitigates Effects of Outgassing

- Outgassing made controlling vessel pressure difficult,
 - And complicated interpretation & modeling of QMB data.
- And resulted in significant ($> 10^{-6}$ Torr) partial pressures of H_2O ,
 - $\Rightarrow H_2O$ flux to surfaces \gg Li flux,
 - Likely resulting in Li_2O , $LiOH$ before discharge.
- Instead: leave torus pumps open during evaporation,
 - Maintain steady He pressure via flow from leak valve,
 - Goal: keep H_2O pressure $< 4 \times 10^{-9}$ Torr during & after evaporation.

2009 XP951 Hampered by Off-Normal Events

/p/nstxcam/miro/2009/Miro_135701.cin at 144.987 ms

/p/nstxcam/miro/2009/Miro_135701.cin at 755.487 ms



Strong interaction at Bay I @ 144 ms
Arcs ?

Strong interaction with RF limiter @ 755 ms.

Use RWM Control to Minimize Off-Normal PWI

- Plasma-wall interactions can erode Li,
 - And result in impurity influxes,
 - Perhaps offsetting beneficial effects of Li coating.
- Model shot 140124: quiescent 1.0 MA, 4 MW discharge achieved with RWM control via $B_p + B_R$ feedback.
 - Remove 3rd NB source during ramp up to avoid lost beam ions ?
 - If do have PWI, increase I_p to 1.1 MA & outer gap clearance?

Run Plan

- Characterize impurity levels with normal vacuum Li evaporation into 140124 model shot,
 - Monitor VB & CHERS Z_{eff} , bolometry, fast cameras, spectroscopy,
 - Need also QMBs, 0.1 Torr baratron,
 - MAPP determination of surface composition useful.
- Evaporate Li at specified He pressures,
 - 2 x 0.2 mTorr, 2 x 0.1 mTorr, 1 x 0.03 mTorr.
- Repeat model shot at same n_e & compare impurity levels.
- If unchanged, increase Li amounts,
- If density too low or PWI excessive, reduce Li amounts.