NSTX

U.S. DEPARTMENT OF ENERGY | Office of Science

Dependence of edge profile modification on proximity of strike point to LLD

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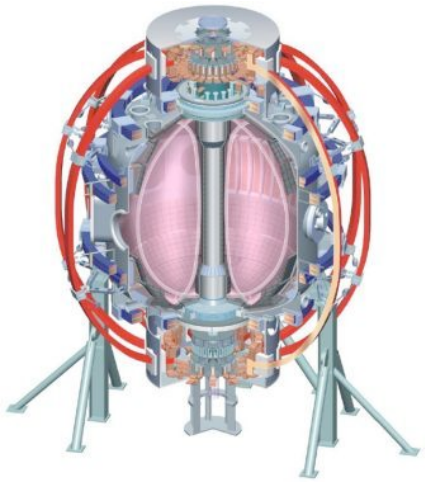
NSTX Boundary Physics TSG Discussion
Princeton, NJ
March 5, 2010



Pedestal density profile and edge stability may be strongly influenced by proximity of outer strike point to LLD

- 0-D calculations indicated that the pumping and density reduction should increase as the outer strike point approaches the warm LLD (as compared with no-lithium baseline)
- Semi-analytic model predicts that n_e pedestal width should increase dramatically with decreasing edge density (at constant transport): partly tested on DIII-D
  - Some evidence for this in NSTX: ELMs disappeared gradually in $\delta \sim 0.5$ discharges with increasing Li, with main change in n_e profile
  - In general n_e profile changes affect edge stability (QH,RMP,VH)
- Proposal: vary LLD pumping by changing OSP location and assess effect on edge profiles

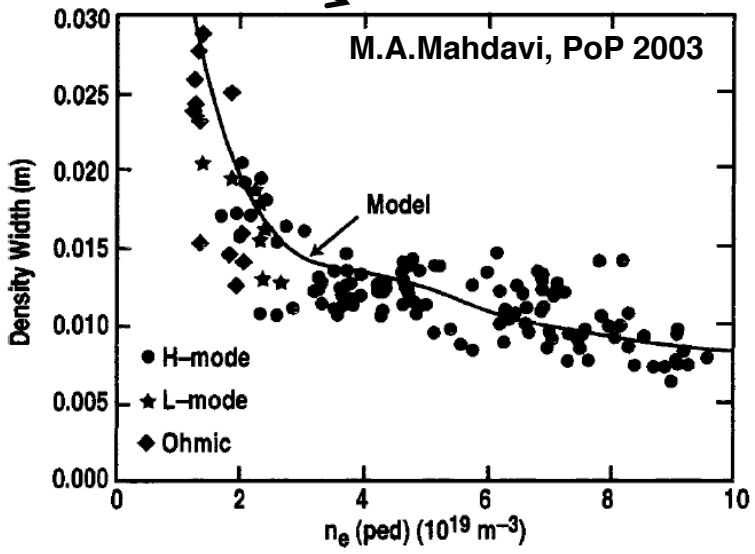
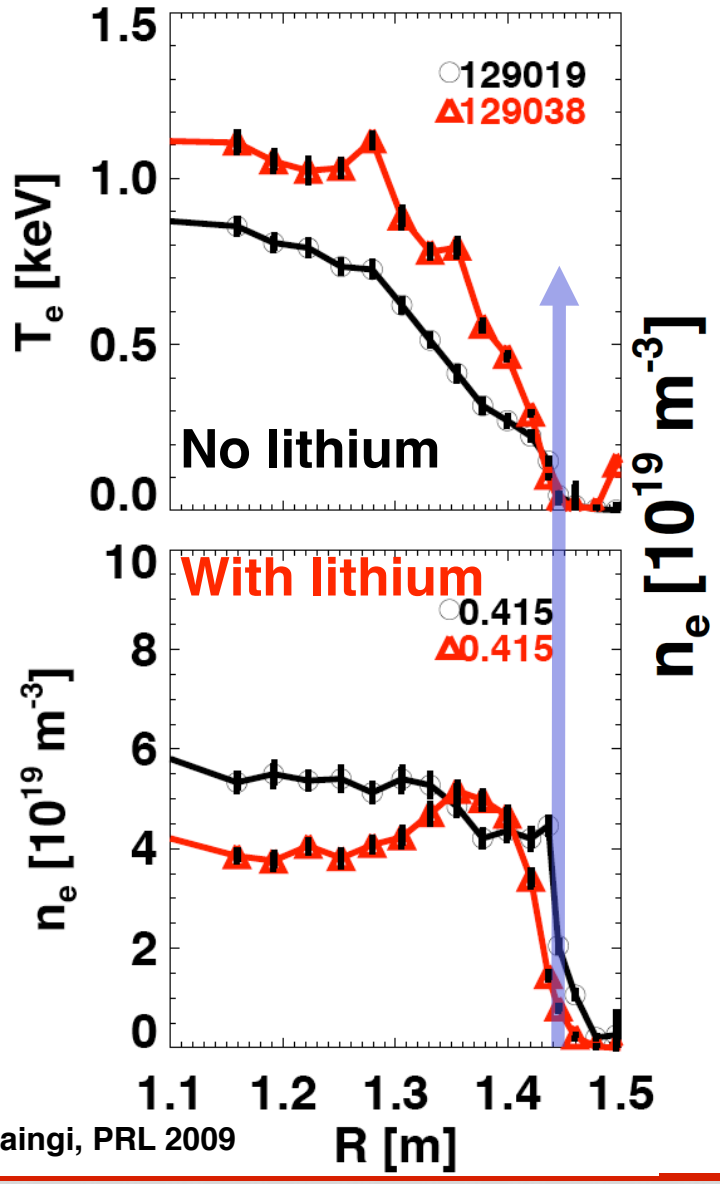


FIG. 4. A fit of the experimental data to the predictions of the analytic model density width projected to the outboard midplane.

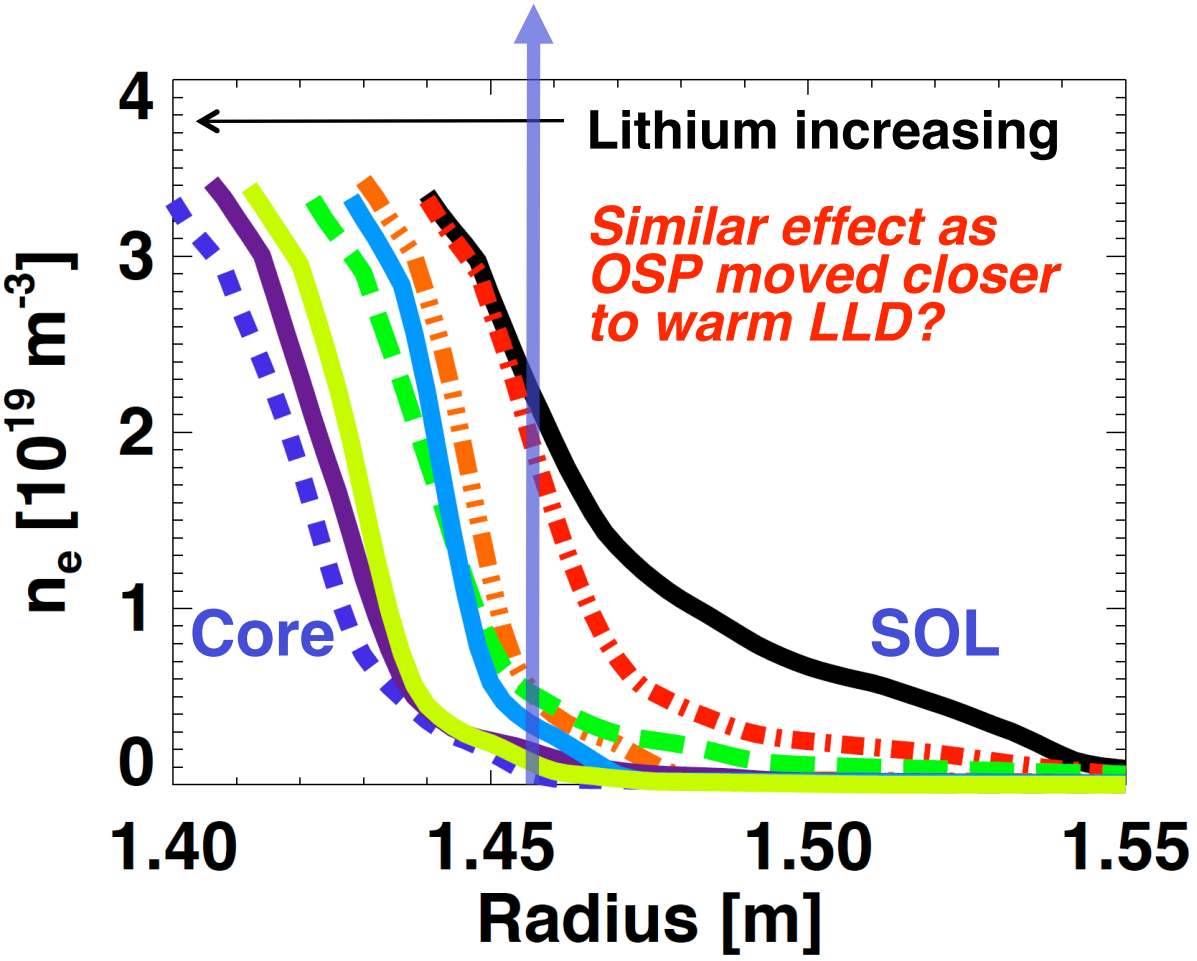
This XP targets FY2010 Research Milestone R(10-3): Assess H-mode pedestal characteristics and ELM stability as a function of collisionality and lithium conditioning

The high performance scenarios of next-step STs such as NHTX and ST-CTF are based on lower Greenwald density fraction and significantly lower pedestal collisionality than NSTX, which could significantly alter their H-mode pedestal characteristics. Possible differences include deviations from the L-to-H transition threshold power scaling inferred from present ST experiments, different projections for the pedestal height and barrier width, pedestal stability (affecting ELM type and size), and the down-stream divertor plasma and surface conditions, which can also influence the pedestal. Many different ELM regimes have been identified on NSTX, and the dependence of these regimes on collisionality and lithium will be investigated utilizing high-resolution kinetic equilibrium reconstructions coupled to leading linear and non-linear ELM-stability codes to compare to experiments. Pedestal profiles will be compared to kinetic neoclassical predictions to determine if the observed transport is consistent with theory. Particle pumping and density control in these experiments will utilize the liquid lithium divertor (LLD), and a major research focus in this research will be to determine the relative roles of reduced pedestal density and collisionality versus the possible direct effects of lithium. This research will aid development of a predictive capability for pedestal transport and stability limits for the ST, and through comparisons to results from higher aspect ratio tokamaks, will help aid understanding of the role of toroidicity in H-mode confinement.

Edge/SOL n_e decrease with lithium coatings thought to be responsible for ELM stabilization



Maingi, PRL 2009



Maingi, APS 2009, courtesy of S. Kubota

Proposed run plan outline

- Variation of LLD pumping will be accomplished by varying OSP location relative to LLD
  - Overlaps nearly 1:1 with Kugel's LLD commissioning XP that will develop OSP locations of 0.5, 0.63m, 0.35, and 0.75m, with LLD cold and "warm" at ~ 210 ^{0}C
  - P_{NBI} will be reduced with OSP on LLD to prevent excessive heating
  - Need to keep outer gap ~ 10cm for optimal Thomson resolution
  - Need UCLA and ORNL reflectometry
- Edge profiles will be analyzed with standard profile analysis tools (developed by Osborne)
  - Edge stability analyzed with ELITE and PEST
- Proposed run time: 1/2 day dedicated for systematic scan after substantial piggybacking on Kugel's XP
  - Conditions to be filled in after Kugel's XP: probably at least 0.5, 0.63, and 0.35m OSP locations base case with cold and warm LLD
  - May request "warmer" LLD for larger OSP locations