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XP1000 (1059): LLD Characterization Part-2

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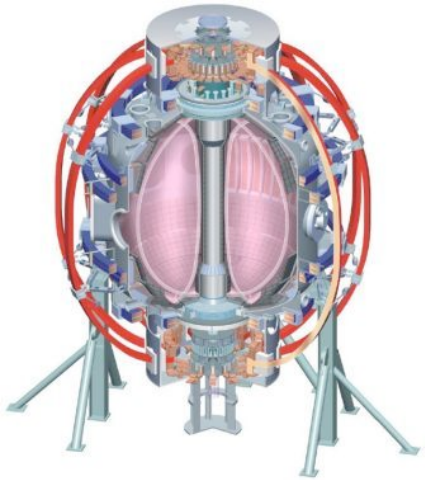
NSTX Team Review
Friday, 2:00pm, June 11, 2010



XP1059 with Cold Lithium Coating + Liquid Lithium LLD Exhibited Lithium Related Pumping

- Although the LLD was above Li melting temperature, initial XP1000 results are consistent with pumping by solid coatings.
  - Saturation of the solid coating on the nearby graphite has not been tested
- Core Pumping was indicated by
  - Required increase in integrated gas puffing ~x2
  - Required front-end startup adjustments in fueling and heating power
  - Reduction in flux consumption early in the discharge
  - HeGDC not required to remove fuel gas from previous discharge
- Edge pumping was indicated by
  - Edge plasma density and Te profiles very similar to extensive operation with solid lithium coatings
  - Characteristic improvements in confinement relative to no Li
  - *Absence of ELMS*

XP1000 Tested LLD Under Thin Film Conditions
- LLD Was Not a Liquid Li Reservoir with LiD the Dominant Reaction

- During XP1000, LLD fill was only <5%. For this low initial fill, analysis is complicated by several interleaved issues.

- Filling LLD to >40-50% Li capacity decreases the physical to geometric area ratio and bypasses or minimizes 6 issues:
  - desorption of deuterium exacerbated by the high surface area of the porous Mo
  - mass-limited diffusion into the Li
  - mass-limited retention
  - effective range uncertainty
  - Impurity strata due to repeated hot-cold-hot cycles
  - Li to impurity ratio higher

Part 2, Day-1: Filling LLD to 50-100% of Lithium Capacity Gives Highest Probability of Observing Maximum Pumping Duration of Liquid Lithium

Day-1:

- Fill 50% @220°C
- Keep LLD at 220°C with LITER 20-40mg/min
- Take R=35cm fiducial [2]
- Take R=50cm, R=63cm, R=70cm reference discharges [2]
- When ELM-free, and characteristic Li-edge conditions are confirmed at R=70cm, turn off LITER and allow cold Li coating to saturate [3]
- If R=70cm Li-edge conditions persist due to LLD pumping, measure the number of shots until Li-edge conditions cease (e.g, ELMy, non-Li profiles) [6]
- If R=70cm Li-edge conditions persist, vary HFS and SGI fueling to minimize central density [6]
- Let LLD cool from liquid (220°C) to below solidification (<180°C) and characterize rate at which LLD Li saturates and Li-edge conditions cease

Part 2, Day-2: Starting with LLD at Room Temperature Raise LLD Temp to 220°C and Attempt to Recover Active Li-edge Conditions of Day-1

Day-2:

- Start with LLD at room temperature and LITER 20-40mg/min.
- With LLD cold, take R=35cm fiducial. [2]
- With LLD cold, take R=50cm, R=63cm, R=70cm reference discharges. [2]
- Start heating LLD from cold to 220°C. [6]
- If at 220°C, ELM-free, characteristic Li-edge conditions are confirmed at R=70cm, turn off LITER and allow cold Li coating to saturate. [3]
- Restart LITER and restore Li-edge conditions. [3]
- If Li-edge conditions restored, start XP1001.
- If Li-edge conditions not restored, apply LITER at 50-60mg/min until Li-edge conditions are restored.[5]

Reference Discharges

- XP 1000 Initial Reference Discharges
  - R = 0.35m, 0.5m: Candidate Reference shots: 129061, 132582.
  - R=0.65m, 0.75m: Same Candidate Reference shots: 129061, 132582 but with OSP extended to higher R for pumping demonstration. Candidate Reference shots from 2008-09 database,129015-19, 129038.
  - R=0.63m Kallman Shots 134986 - HFS, 134991 - SGI PF2L current ~ 3.5 kA (the value that strike point control approaches)

- XP 1000 Tested Reference Discharges
  - 137487 (R=35cm), 137564(R=50cm), 137536 (R=63cm)
  - 137610-137623 (EFIT01 = 69.8-71 cm)
  - The adopted discharge for OSP R=71cm may benefit from XP1003 (X-pt Cntrl)