NSTX

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LLD Observations and Operational Considerations

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M.A. Jaworski, *et al.*

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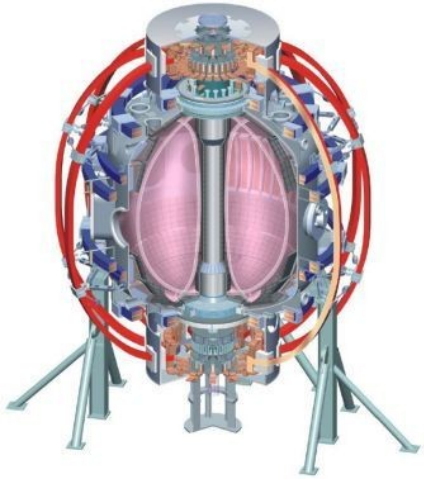
LRTSG Strategy Session, Dec. 7, 2010 – B318 PPPL



A General Goes to War with the Army he's Got

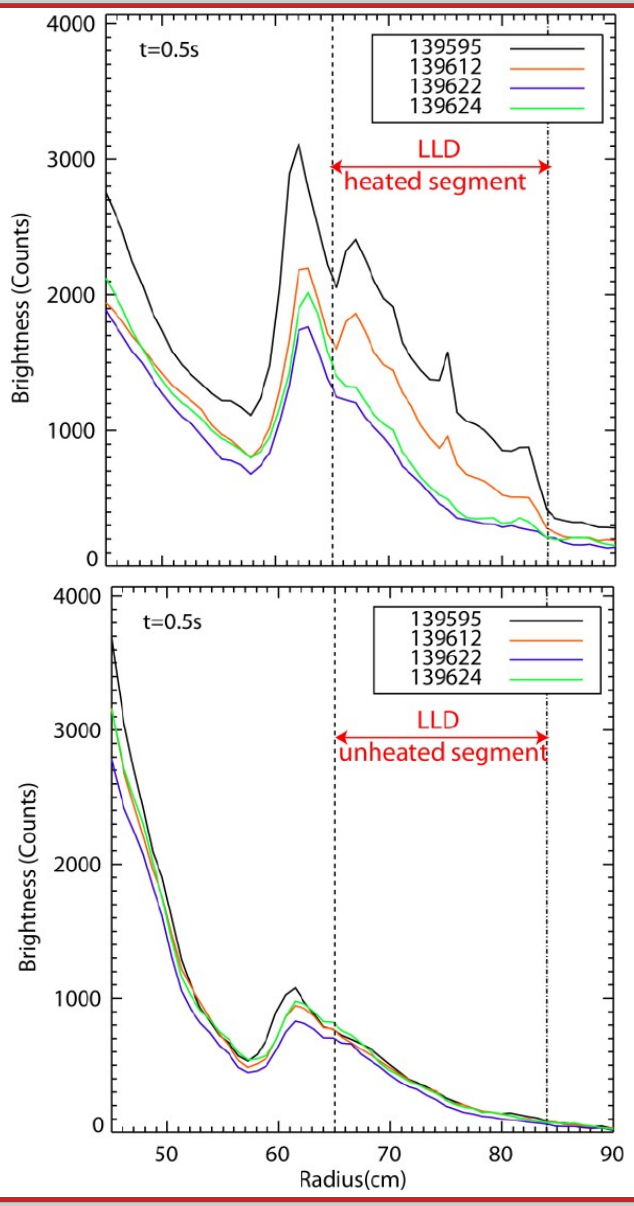
- No magic bullets obtained in FY10 run
  - LLD effects on machine have been subtle*
  - Current opening already over-subscribed
  - Must make ends meet with what one has...
- LLD Status (Addressed in H. Kugel talk earlier)
  - Active cooling/heating?
  - Filling system?
- Mo-tile upgrade
  - Proceeding forward?
  - Provide opportunity to examine Mo-Li PFC on both ends of flux tube without much (any?) discharge development
- Still have LITERs for Li wall conditioning
- Have learned some things this past year and have some suspicions

*In the way we currently operate the machine...

Indications of a “right” way to operate with LLD

- Initial analysis indicates that the cold-fills/plates exhibited the least recycling
- F. Scotti fast camera D-alpha data from XP1000 and XP1059
  - Increased emission over heated plates
  - Smooth transition between Li-ATJ and unheated segment
- XP1041/1041A and XP1000r1 results obtained after cold depositions
  - Month-long (June) deposition during normal ops for XP1041
  - Overnight deposition of 7-9gm lithium for XP1000r1

XP1059 – Plate temps 220, 220, 100, 110C

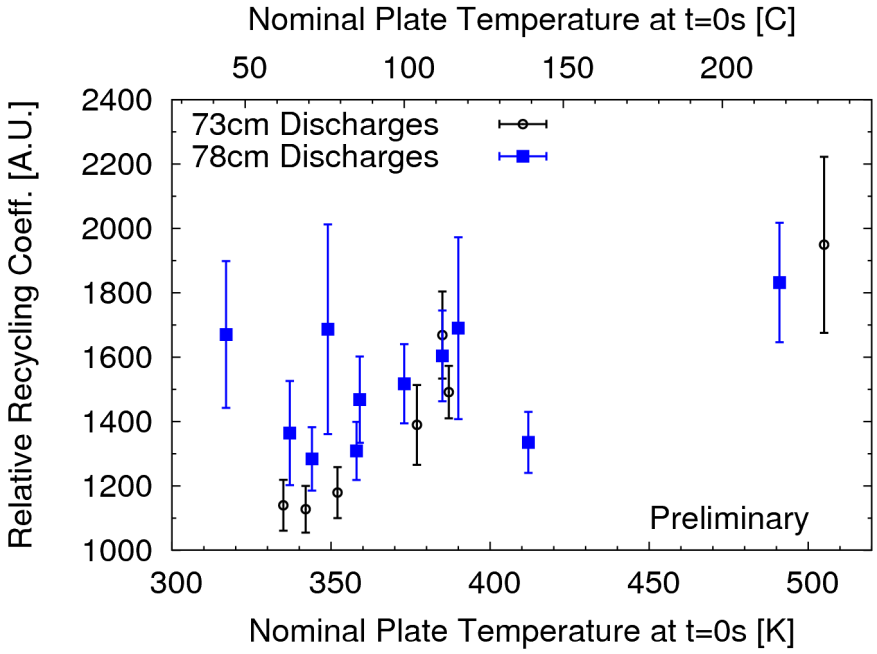


F. Scotti – LLD Fest Presentation

Relative Recycling Seems to Bear Out Fast Camera Data

- Temperature scan performed in XP1000r1
  - Track relative recycling assuming toroidal symmetry
  - Ratio of D-alpha signal to ion saturation over the LLD
- Trend observed upward in the data as temperature increases
  - Preliminary for now, using nominal (log-book) plate temperature at discharge start
  - Both 73cm and 78cm RSP shapes compared (No D-alpha fast cam)
- Need IR data to distinguish between two effects
  - Long-term passivation between discharges
  - In-shot temperature based effects

Lower starting temperatures seem to exhibit less recycling, additional variable with fluence



Example diffusion time constants:

1 micron, liquid → <1ms

1 micron, solid → ~10s

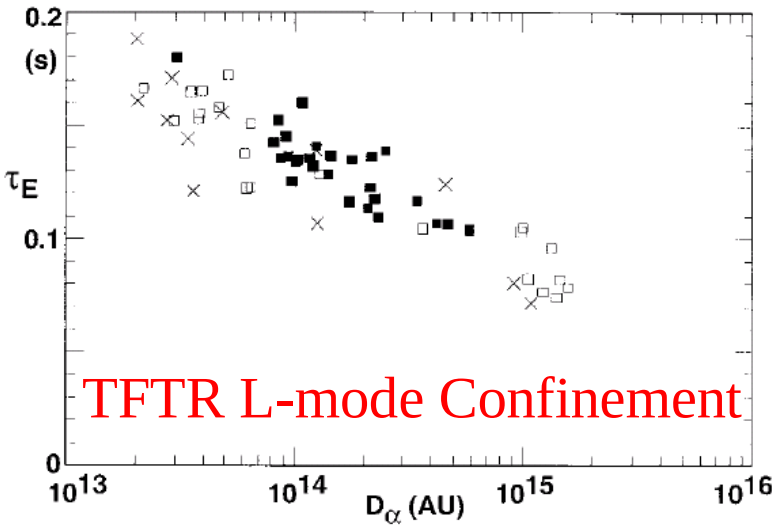
Other Observations and Implications for FY2011 Operations

- Other observations from the run year
  - Inboard divertor consistently *detached*
  - Core deuterium content not affected by operation and changes in LLD local recycling
- Implications:
  - Starting the plate cooler seems to work best and
  - Cold depositions may be better than hot (still analyzing)
  - Still not clear that Li-ATJ and LLD can(not) be distinguished in terms of global machine parameters

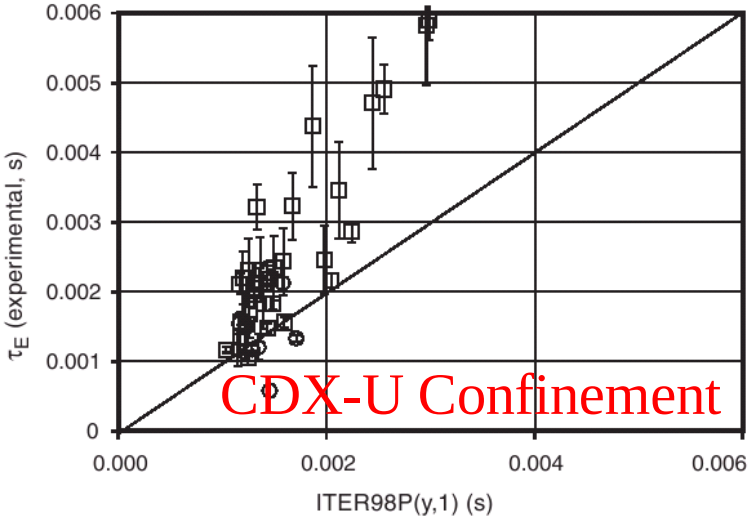
- **Is this the most that can be achieved from lithium?**

Confinement Time is the Key Metric for Lithium

- Confinement up to ~3x L-mode scaling in TFTR
- Confinement up ~2x L-mode in CDX-U
- Relationship with H-alpha signal explicitly linked in TFTR
  - Possible explanation for confinement degradation in L-mode with input power due to heating and degas of PFCs
  - Decrease in H-alpha in CDX-U alongside lithium area increase
- Both machines pre-filled only and limited
- **Contrast with NSTX:**
  - S. Gerhardt confinement scaling now *stronger degradation* w/ power



J. Strachan, Nucl. Fusion, v39, (1999) 1093.

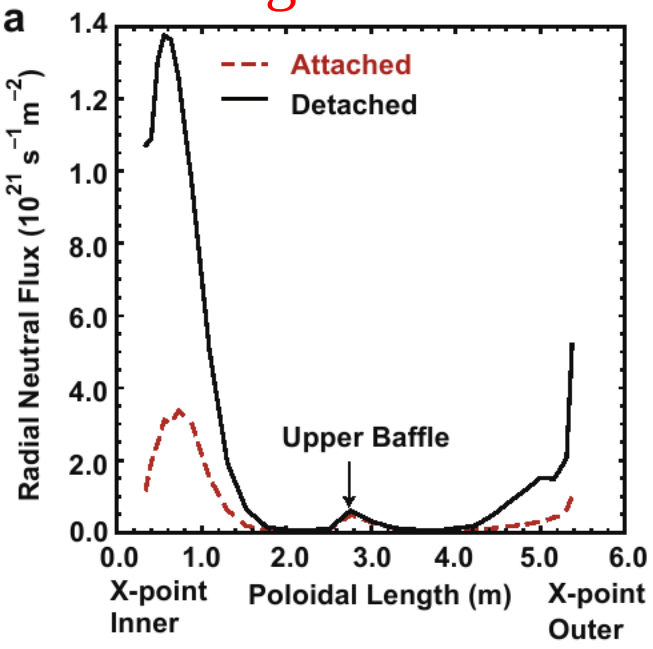


R. Majeski, Phys. Rev. Lett., v97, (2006) 075002.

Suggestion: Exploratory Machine Time to Develop Supershot

- Benefits of lithium obtained by reducing *fueling*
  - DIII-D has determined that H-modes are fueled through X-point region
  - Cold, detached plasma allows far neutral penetration
  - Work in progress toward analyzing NSTX, but this could explain why fueling was unchanged (inboard divertor always *detached*)
- Need to change the fueling to improve lithium discharges (radical suggestions)
  - Prefill discharges?
  - "Turn off the gas"?
  - Late-beam turn-on?
  - Discharge development

DIII-D Poloidal Fueling Distribution



A.W. Leonard, J. Nucl. Matl., v390-391 (2009) 470.

This goal is not necessarily milestone relevant (hence exploratory), but significant in addressing the relevance of lithium PFCs.

Last Chance to Verify Lithium Performance in a Diverted Machine for a While

- Changing the fueling of the core is not as simple as was initially thought
- Most recent confinement scaling indicates we have progressed in the wrong direction
- We should consider a serious effort at how NSTX is operated in order to best utilize lithium wall coatings (LLD-agnostic)
- We should have this conversation soon (here?) to plan for the coming run