

# Proposed FY10 Lithium Plans

(Forum FY10 Li Updated)

LLD XP827(2008) -> LLD XP827(2009) -> XMP064 -> LLD XP1001 (2010)

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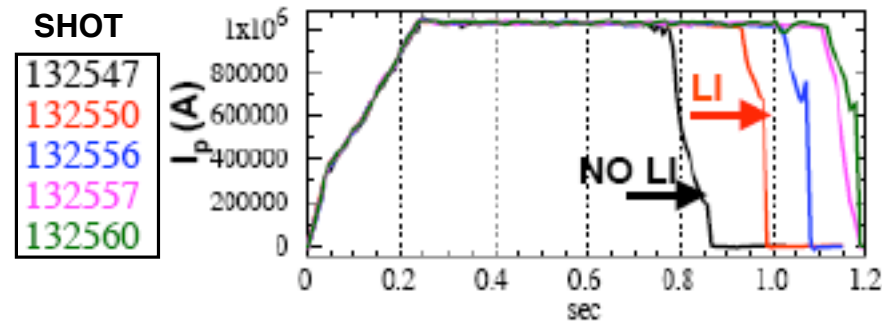
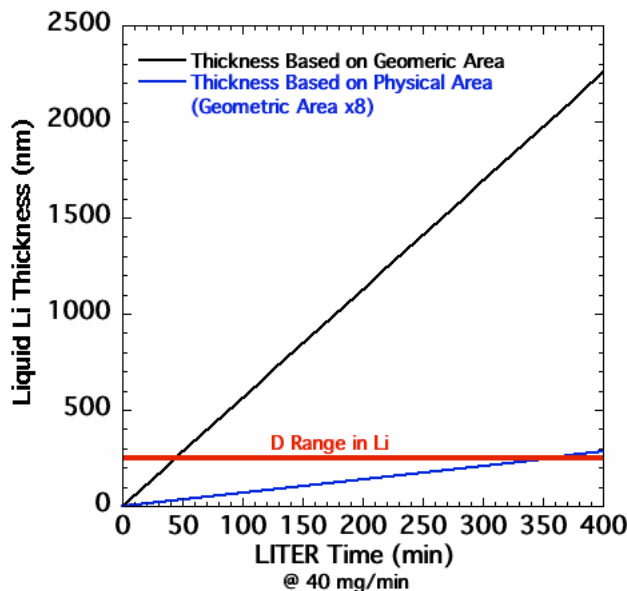
Jan. 29, 2010

# Overview of Proposed FY10 Lithium Plans

1. Vessel Bake and LLD-1 testing during Bakeout to 360°C.
2. After Vessel Bake, do Machine-ISTP, and Field-only shots.
3. XMP-64: Initial coating of LLD to prepare for research grade plasmas [2 days].  
(LITER @40 mg/min for first plasma to first research grade plasma)
4. XP-1001 (Phase-1, R = 0.35m,0.50m): Characterization of Warm LLD (210°C).  
(3 days starting from first research grade plasma)
5. All other inner divertor Milestone XPs.
6. XP-1001 (Phase-2, R = 0.65m,0.75m): Characterization of Warm LLD (210°C).  
[3 days]
7. XP-last: Characterization and Decommissioning of HOT LLD (400-500°C).[1 day]

# XMP-064: Initial Coating of LLD to Prepare for Research Grade Plasmas

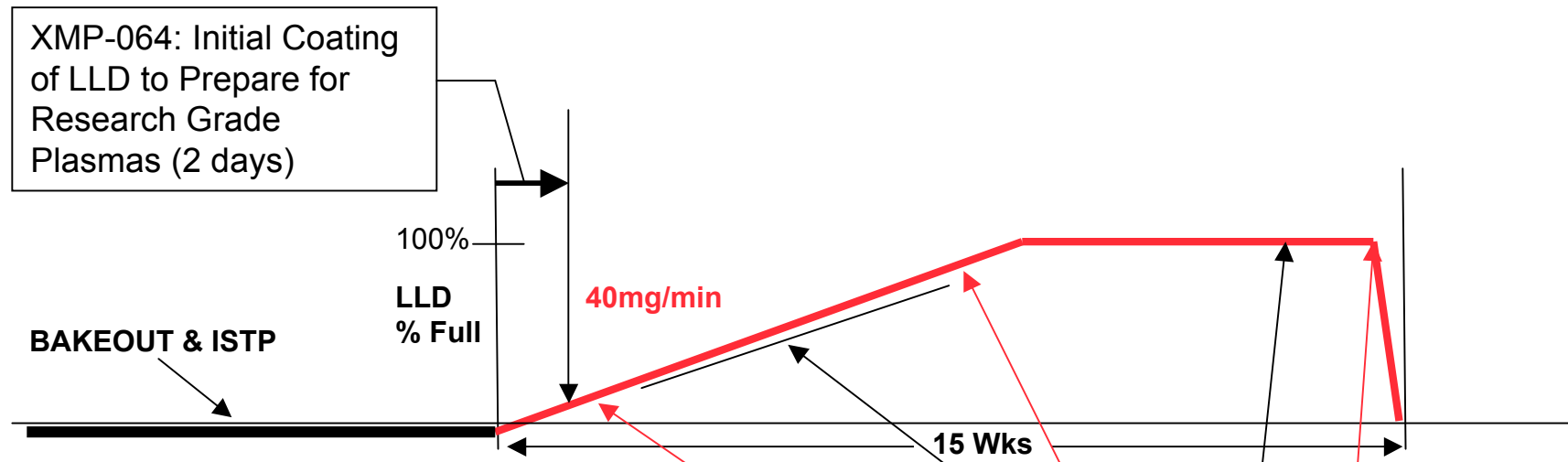
1. After Vessel Bake, do Machine-ISTP, and Field-only shots.
2. Do 2 hrs HeGDC, Set LLD to 210°C, start LITER at 40 mg/min, continue for 2 days (12) hrs to get 667 nm coverage over LLD physical area (~X8 geo area).
3. Then with LLD 210°C and LITER 40 mg/min, try D LSN, Ohmic plasma.



- 4/08/09, discharge performance responded promptly to lithium wall conditions

4. If no LLD Mo luminosity, continue Ohmic plasmas with LLD 210°C and LITER 40 mg/min until NBI target plasma is achieved, or if Mo, continue evaporating.
5. Continue NBI plasma conditioning *ibid.* until research grade plasma achieved.

# Proposed FY10 Lithium Run Plan



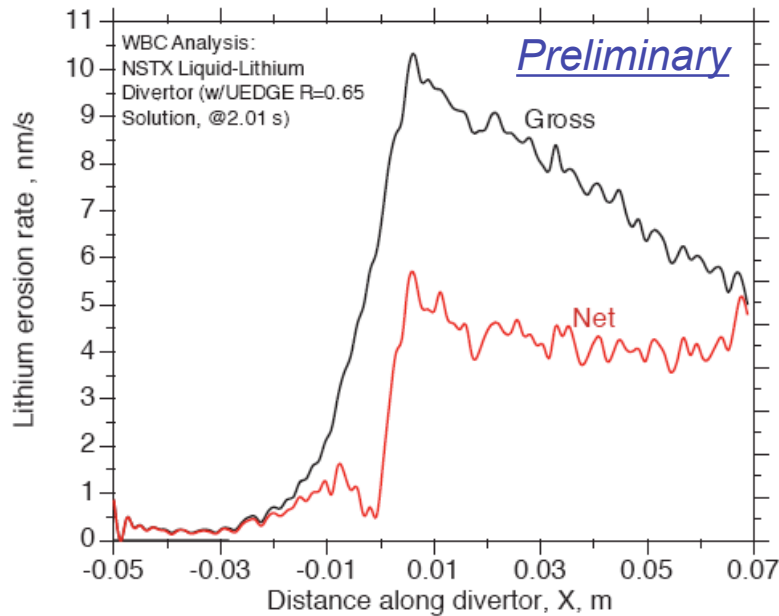
- XP1001 Characterization, R =0.35m,0.5m (3 days)
  - Most other Inner Div Milestone XPs
- XP1001 Characterization, R =0.65m,0.75m (3 days)
  - Snowflake, Powder loading, CHI
- XP LLD Hi Temp Characterization and Decommissioning (400-500°C)

# Backup

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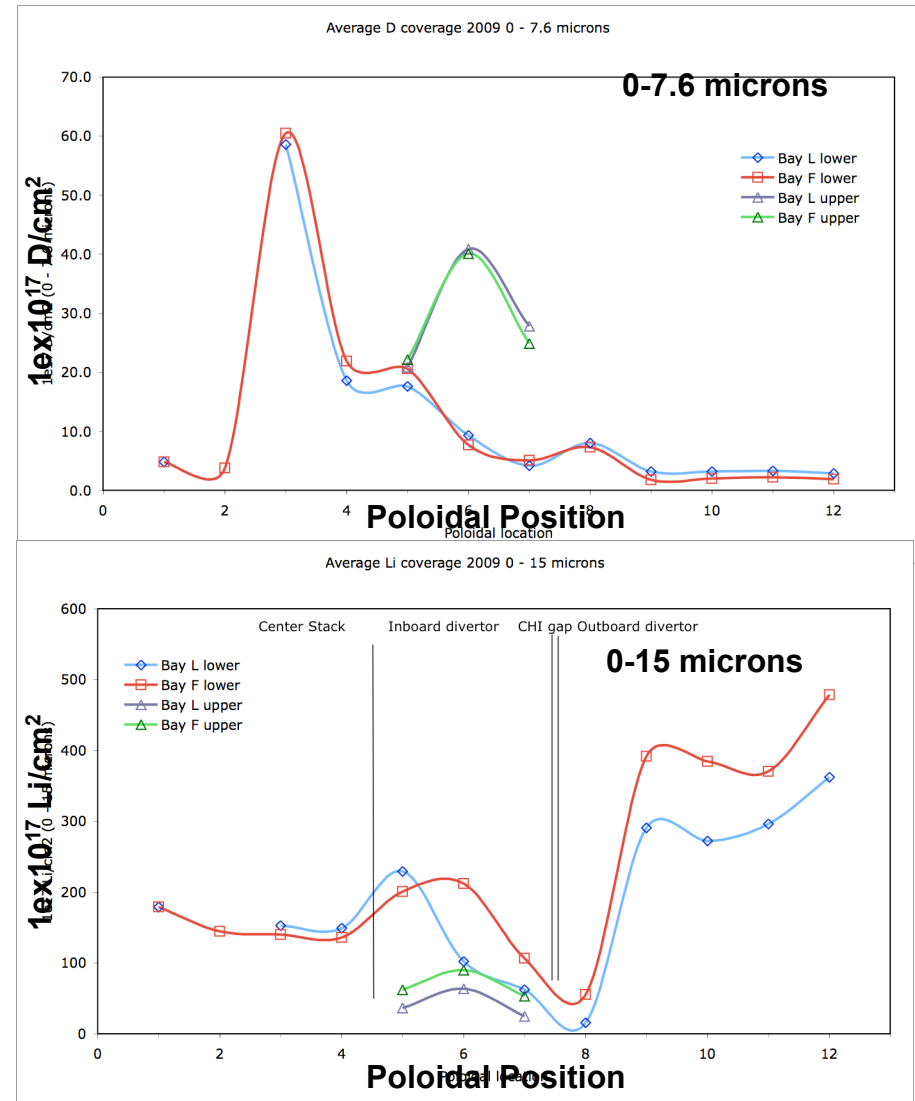
- Simulation Finds 50% of Li Sputtered from LLD Redepleted on Outer Divertor
- Ion Beam Analysis of NSTX 2009 Tiles Finds Li Redeposition on Outer Divertor

- 50.3% of sputtered (neutral) lithium is ionized within the computation zone (LLD and associated near-surface grid). 49.7% of sputtered lithium “escapes”.



### Gross and Net Erosion Rate Along LLD

- J.N. Brooks, J.P. Allain, Purdue Univ, PFC Meeting 7/09



### IBA of NSTX 2009 Tiles

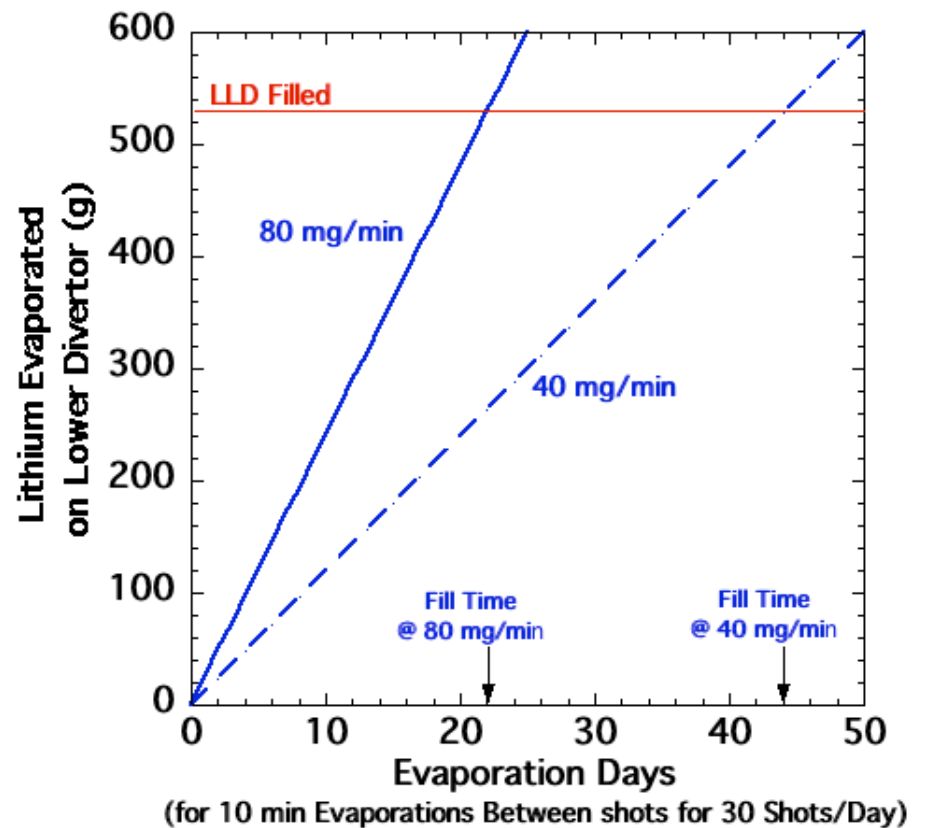
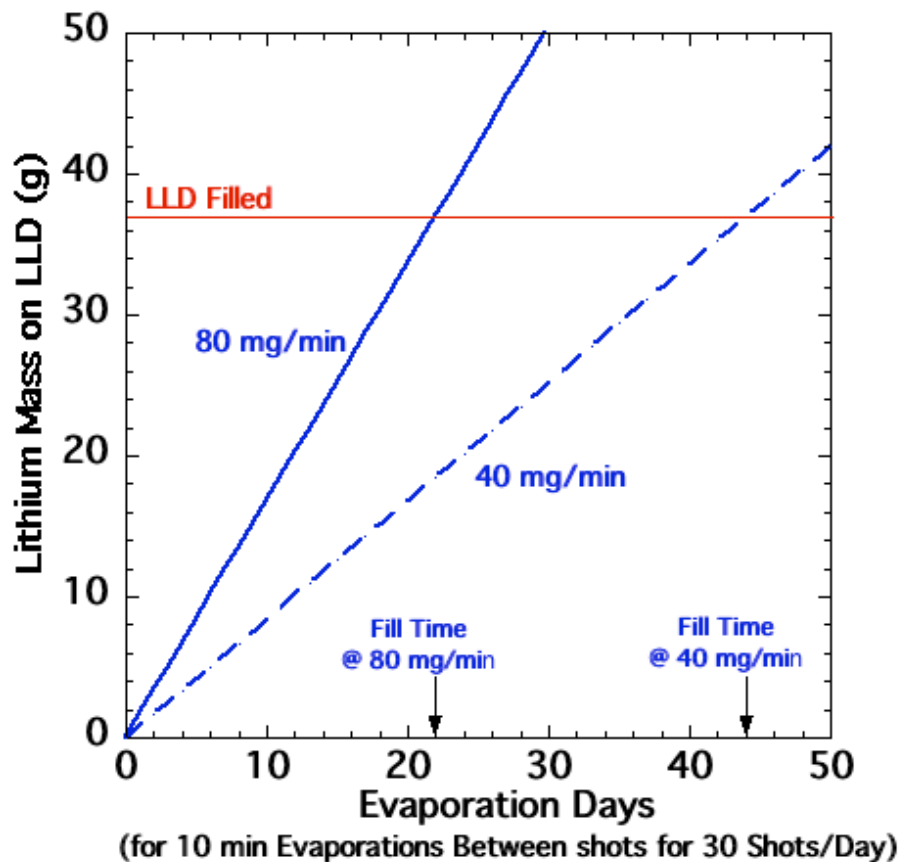
- W. R. Wampler, SNL, 11/09

01/29/2010

# Scenario Using Between Shot Evaporations to Load LLD-1

- Evaporate for 10 mins Between Shots until LLD-1 Full

- Fast Fill Rate for Fully Loaded LLD Li Physics
  - 22 days to load @80mg/min (4.4 run wks, 530g)
- Intermediate Fill Rate
  - 44 days to load @40mg/min (8.8 run wks, 530g)
- Normal Fill Rate (Maintain Contact with 2008-2009 Li Database)
  - 88 days to load @20mg/min (17.6 run wks, 530g)



# Planned LLD-Related External Startup Diagnostics

- Visible Cameras (unfiltered/filtered)
  - Phantom-V710, Bay-E, Top re-entrant window
  - Phantom-V7.3, Bay-J, Top re-entrant window
- IR Cameras
  - Fast IR Camera, Bay-H Top
  - Slow IR Camera, Bay-I Top
  - Slow IR Camera, Bay-G Bottom
- Divertor Spectrometer
- Lyman- $\alpha$  Diode Array
- Divertor Region Sample Probe
- 3 Quartz Deposition Monitors



# Automated IR Camera Calibrated Temperature Waveforms Needed Between Discharges

Li thermal conductivity is low. (~ W/m-°K 400 Cu, 140 Mo, 120 ATJ, 45 Li, 15 SS)

- **Power Handling: SNL thermal analysis for cases with the strike point on the LLD with peak Li temperature set at 400 °C,**
  - can sustain a peak of ~2MW/m<sup>2</sup> for 10s and 4 MW/m<sup>2</sup> for ~3s.
  - Less Li, higher heat transfer.
- **Lithium evaporation from LLD is very high above 400°C and D starts desorbing from LLD. Need to monitor temperature profiles during NBI.**
  - LLD evap = LITER evap @ ~370°C
- **Automated IR Camera calibrated temperature waveforms critical to monitoring LLD operation and benchmarking thermal simulations against initially short low, low power, NBI on LLD.**

## XP1001 Phase 1, Shot List for Day-1 (Reference Shots with Cold LLD-1)

DAY	State of LLD	Outer Strike Pt R (m)	LLD °C	LITER 20-40 mg/min	Li g Deposited	Fueling	Pnbi MW	No. of Shots
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**Coat LLD surface to facilitate wetting.**

0	warm		210	20-40	9.6-19.2			
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**Do Reference Shots.**

1	cold	0.35	Rm temp	NO/YES		HFS	4	2
							6	2
							2	2
						SGI	4	2
							6	2
							2	2
						HFS	4	2
		0.50					6	2
							2	2
						SGI	4	2
							6	2
							2	2

# XP 1001 Phase 1, Shot List for Day-2,3 (Warm LLD-1)

- 1) Repeat Reference shots of Day-1.
- 2) Match  $n_e(t)$  by fueling with both HFS & SGI as required.
- 3) Proceed to lower fueling for lower  $n_e(t)$  using both HFS & SGI.
- 4) Power variation as needed to stay below beta limit.

DAY	State of LLD	Outer Strike Pt R (m)	LLD °C	LITER 20-40 mg/min	Li g Deposited	Fueling	P <sub>bi</sub> MW	No. of Shots
2-3	warm	0.35	210	NO/YES		HFS	4	2
							6	2
							2	2
						SGI	4	2
							6	2
							2	2
		0.50				HFS	4	2
							6	2
							2	2
						SGI	4	2
							6	2
							2	2

# XP1001 Phase II, Shot List for Day-4 (on Warm LLD-1)

1) Select best fueling and LITER from Days #2 & #3

2) Slowly extend 2MW NBI pulse length: 100ms, 150ms, ....

DAY	State of LLD	Outer Strike Pt. R (m)	LLD °C	LITER 20mg/min	Li g Deposited	Fueling	Pnbi MW	Pulse ms	No. of Shots
4	warm	0.63	210	NO/YES			2	100	2
		0.63					2	100	2
		0.75>0.63					2	100	2
		0.75>0.63					2	100	2
		0.75					2	100	2
							2	100	2
							2	150	2
							2	150	2
							2	200	2
							2	200	2
							2	250	2
							2	250	2

# XP1001 Phase II, Shot List for Day-5 and-6 (on LLD-1)

## Repeat Day-4 Reference Shots

DAY	State of LLD	Outer Strike Pt R (m)	LLD °C	LITER 20-40 mg/min	Li g Deposited	Fueling	Pnbi MW	No. of Shots
5	cold	0.63	Rm temp	NO/YES			2	2
							2	2
							2	2
							2	2
							2	2
		0.75					2	2
							2	2
							2	2
							2	2
							2	2
							2	2

1) LLD lithium maintenance.

2) Need nLi (0) measurement.

DAY	State of LLD	Outer Strike Pt R (m)	LLD °C	LITER 20-40 mg/min	Li g Deposited	Fueling	Pnbi MW	No. of Shots
6	warm	0.75	210	NO/YES			2	2
							2	2
							2	2
							2	2
							2	2
							2	2
							2	2
							2	2
							2	2