XP601:“Effect of Evaporated Lithium PFC Coatings on Density Control”

Summary of Recent Results

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XP601 Summary

Evaporation	mg	Duration	Restart	He Discharge Conditioning	Confine ment	Shot	Effect
E-1, 4/07/06	1.6	11 min		none	L	none	
E-2, 4/11/06	14.3	245 min	151 min	7 He, 4/10/0	L	119872	no change
E-3, 4/11/06	77.0	128 min	11 min	none	L	119875	no change
E-4, 4/12/06	215	128 min	167 min	none	L	119879	no change
E-5, 4/12/06	0					none	
E-6, 4/13/06	643	369 min	85 min	none	L	119894	no change
E-7, 5/04/06	378	63 min	23 min	6 He, 5/04/06	L	120474	first improvement
E-8, 5/05/06	0					none	
E-9, 6/09/06	440 [c)]	76 min	75 min	none	H	121323	similar improvement
E-10, 6/09/06	203 [a)]	50 min	17 min	none	H	121334	no change
E-11, 6/09/06	295 [b)]	36 min	25 min	none	H	121336	marginal increase
E-12, 6/22/06	4780	12.3 hrs	160 min	none	H	121507	similar improvements
E-13, 6/22/06	1046	66 min	24 min	none	H	121512	similar improvements
E-14, 6/22/06	1008	28 min	8 min	none	H	121521	similar improvements

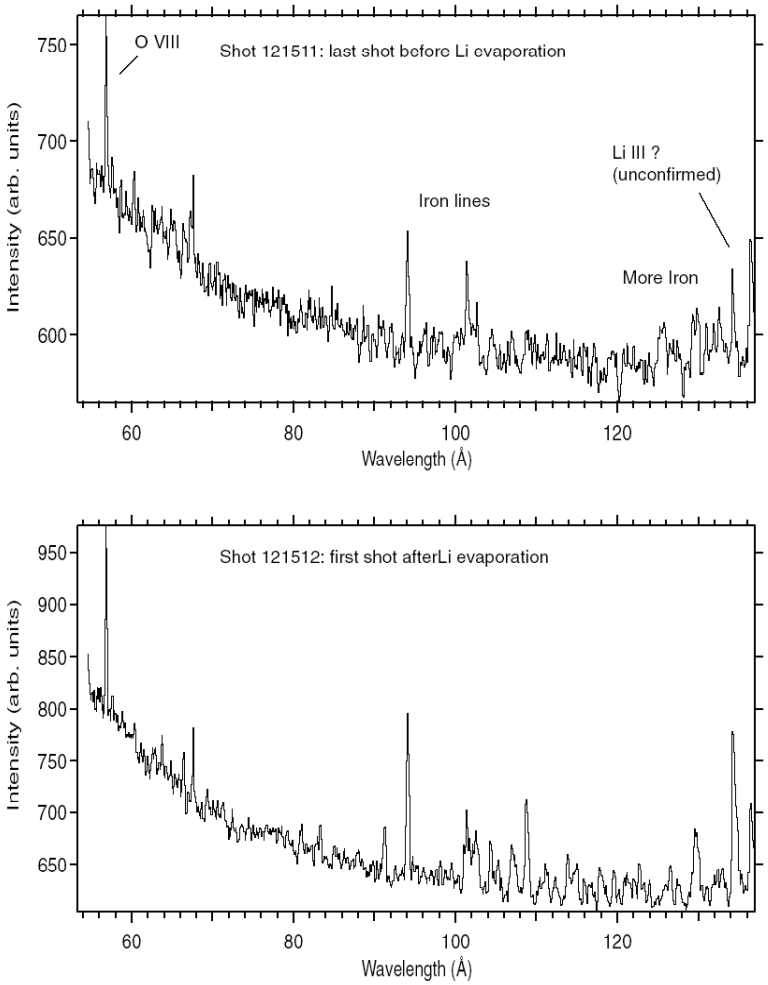
Summary XP601: JUN 21, 22-2006

Sequence of events:

1) 2-NB fiducial discharge developed prior to lithium evaporation
2) Lithium evaporation-12 (E-12)
    a. Operating temperature of 600°C
    b. Rate of ~6.5 mg/min for 12.3 hrs
    c. Total deposition of 4.8 grams
3) First post-evaporation discharge results
    a. About a 7-11% decrease in secular trend (time evolution) of line-averaged density
        i. Similar to results from earlier lithium deposition
    b. Very decreased divertor D-alpha luminosity
    c. Apparent increase in confinement time of about 13-22%
    d. Increase in stored energy and β_t
    e. Reduced flux consumption
4) Results in following 4 reference discharges
    a. Density decrease reverted back to the comparison discharge after one shot
    b. Confinement time and stored energy continued to be higher
    c. Flux consumption continued to be lower
    d. D-alpha was very low and never returned to the level of the comparison discharge

22 June 2006

e. Te profile continued to broaden and was very broad relative to that of the comparison discharge
    i.Radiation from increased impurity influx not responsible since central Te was higher than in comparison discharge
        1. Metallic impurities in core similar before and after lithium evaporation



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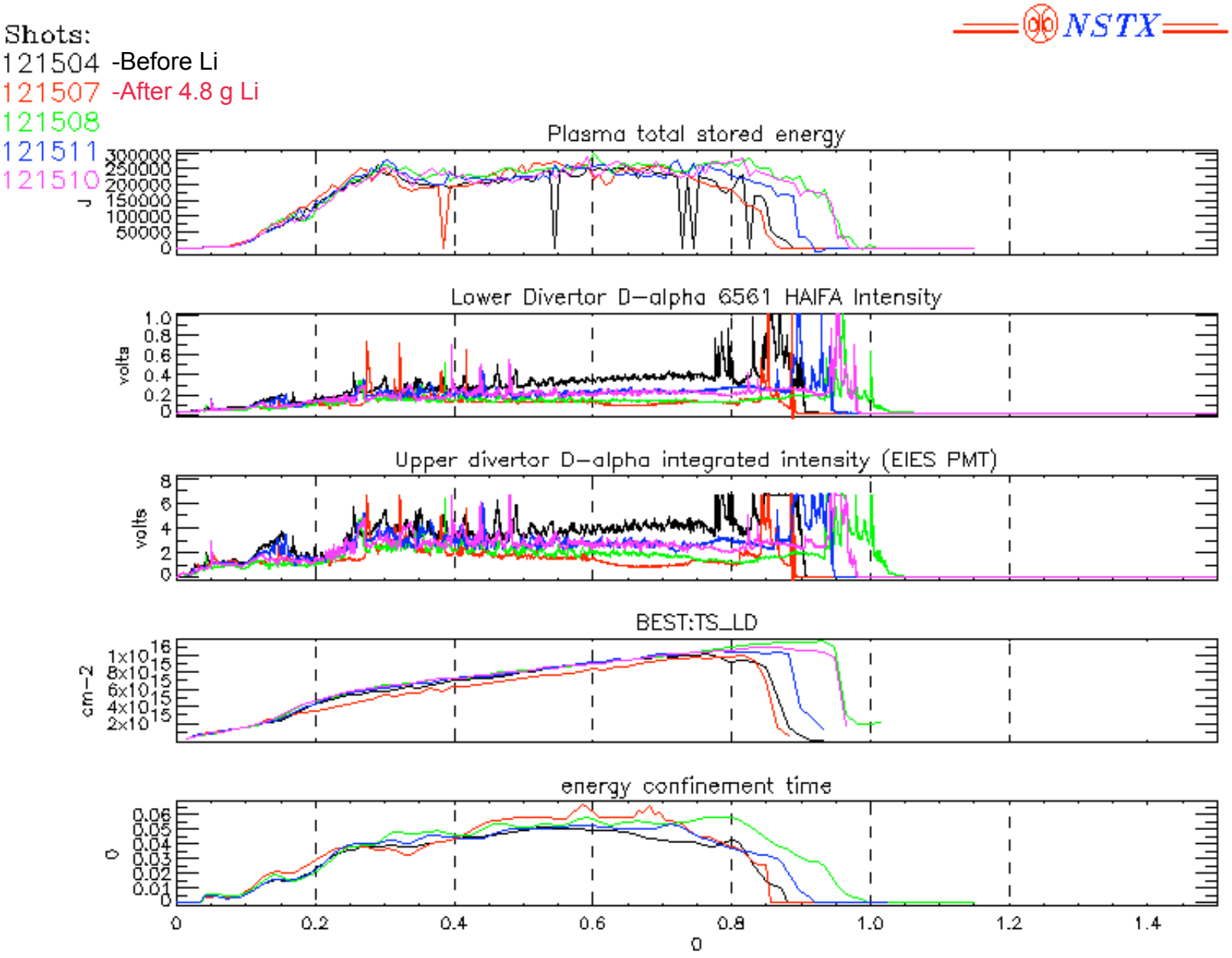
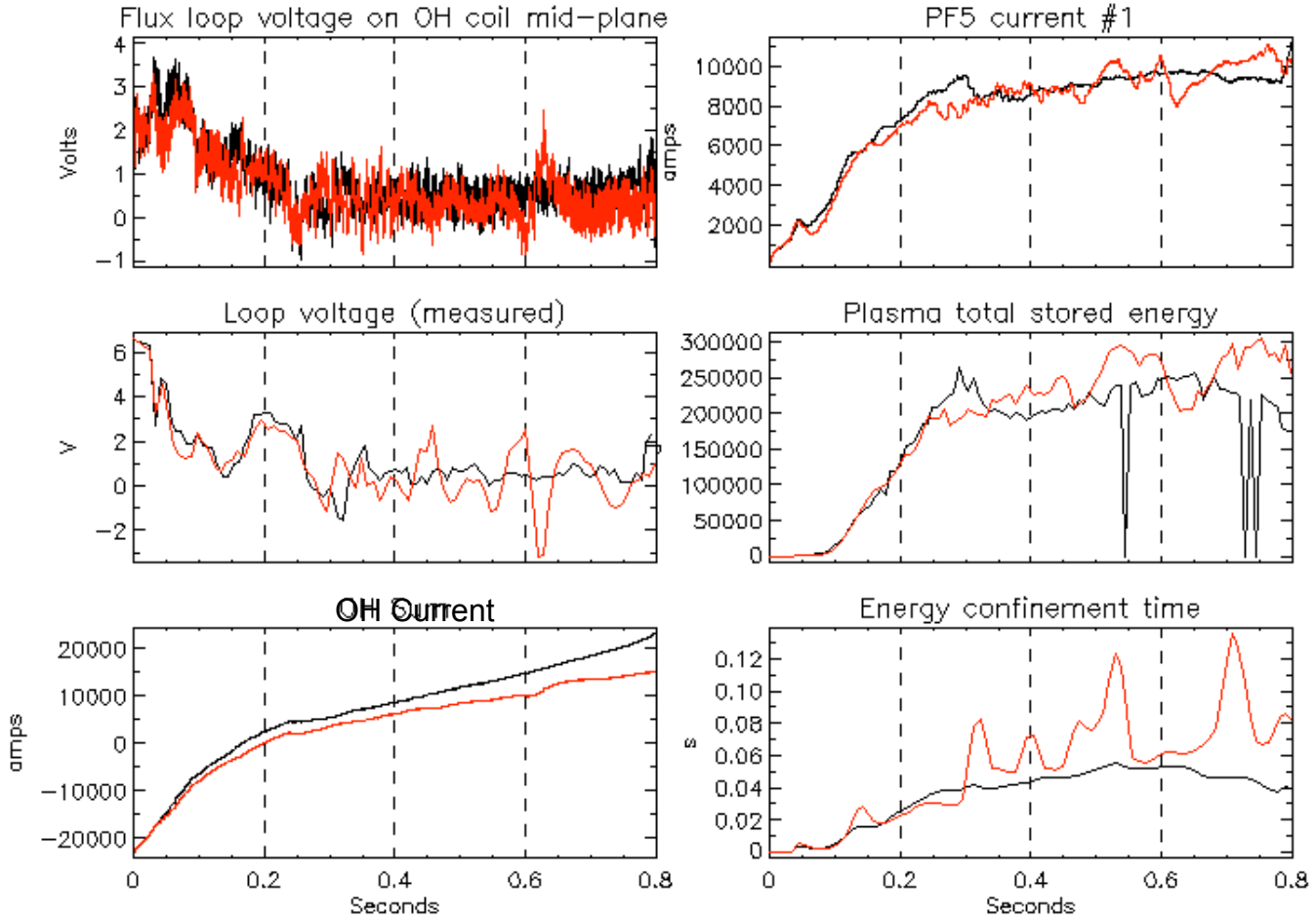
5) Next lithium evaporation (E-13)
    a. Operating temperature of 650°C
    b. Rate of ~19 mg/min for
    c. Deposition of 1.0 grams
6) Results from following scan of 5 discharges
    a. Reduction in line-averaged density in first shot similar to that observed after E-12 (4.8 gram) deposition
        i. Broader Te profile was very reproducible
        ii. 2 subsequent Reversed Shear discharges from the XP610 also showed improvement
7) Final lithium evaporation (E-14)
    a. Operating temperature of 680°C
    b. Rate of ~37 mg/min
    c. Deposition of 1.0 grams
8) Results from 2 NB reference fiducials
    a. Reduction in line-averaged density in first shot similar to that observed after E-12 (4.8 gram) deposition
    b. Large apparent radiated energy may indicate higher carbon influx
        – need to check CHERS results
9) Results from subsequent Reversed Shear comparison discharge
    a. Longest Reversed Shear 900 KA with highest Te discharge to date
10) Results from 1 MA Reversed Shear discharge
    a. Longest 1 MA Reversed Shear discharge this year
        i. Te of slightly under 2 keV
    b. Next discharge showed same behavior
    c. Monotonic reference discharge immediately reproduced exactly the earlier comparison discharge

Gradual Revert to Pre Li Conditions After Reference Discharge



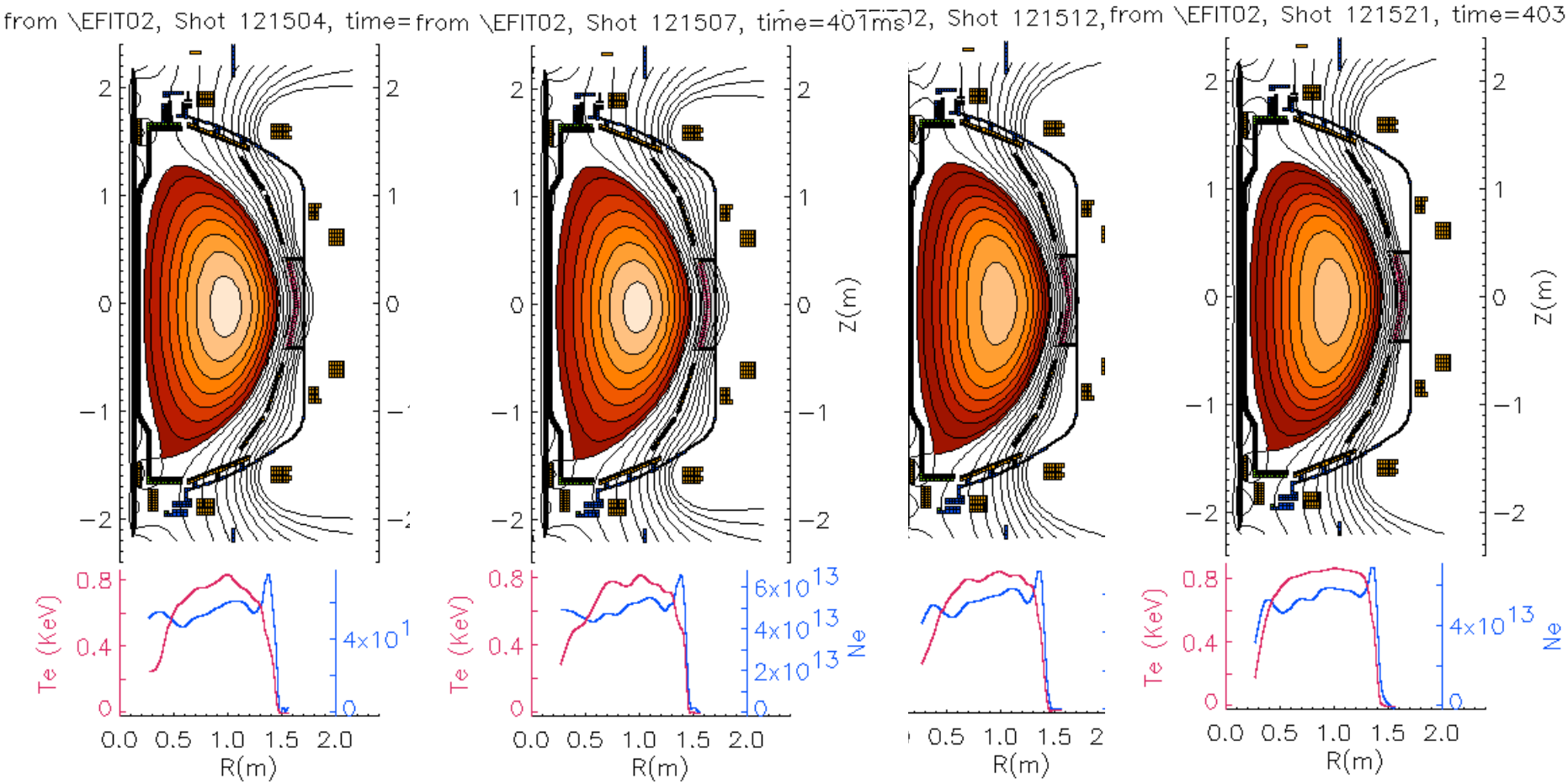
Shots:
121504
121521

Reduced Loop Voltage and Flux Consumption



- 121504 before Li
- 121521 after an additional 1.1g Li between discharges (2nd evaporation after 4.8g)

Li on PFCs Broadens Profiles



Before Li

After 4.8g Li

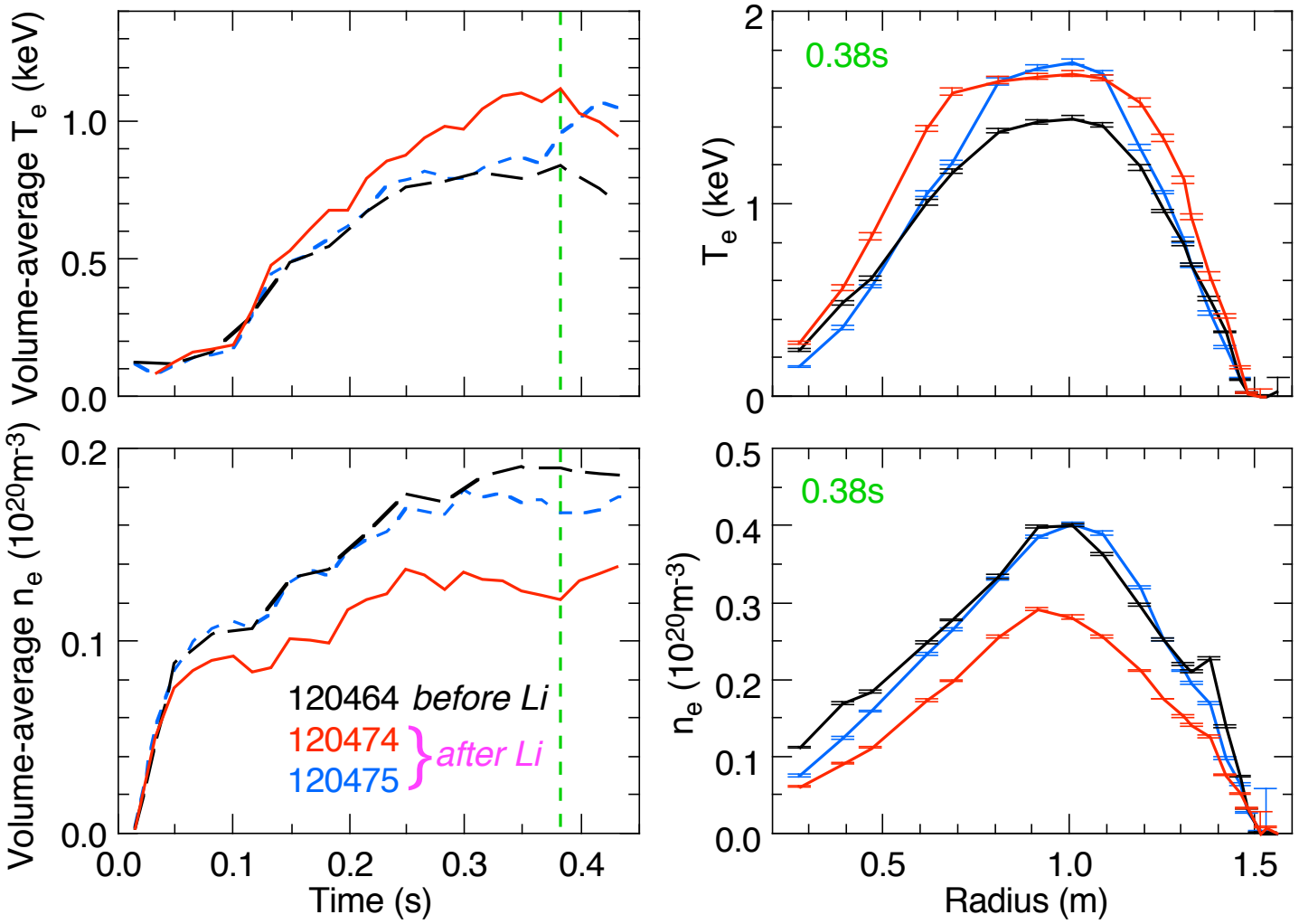
After +1.1g Li

After +1.1g Li

S. Sabbagh, Columbia U.

B. LeBlanc

Lithium coating (E-7, 0.38g) - L-mode



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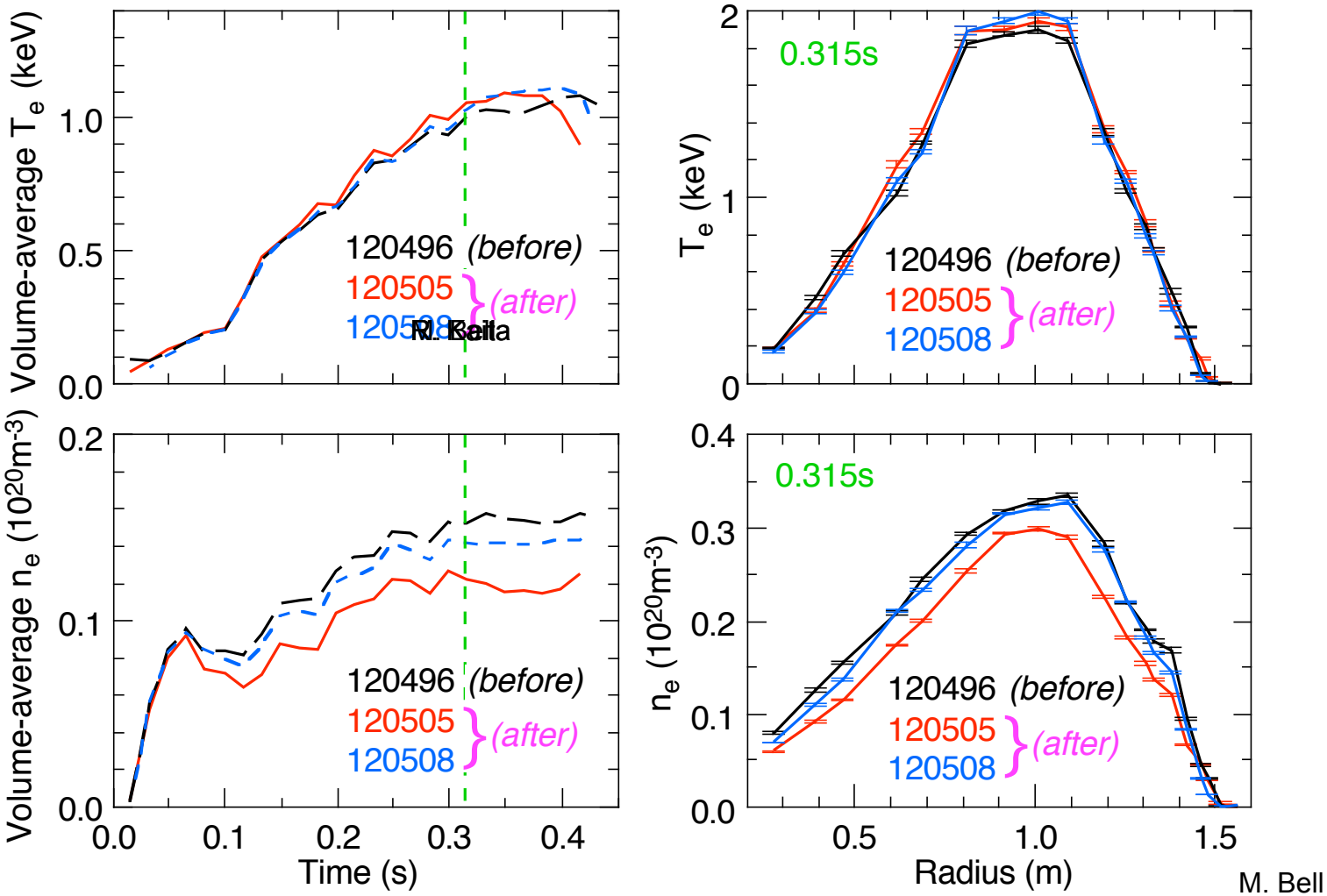
Helium conditioning (6 shots) - L-mode: Graphite Pumping Alone Less Than With Lithium



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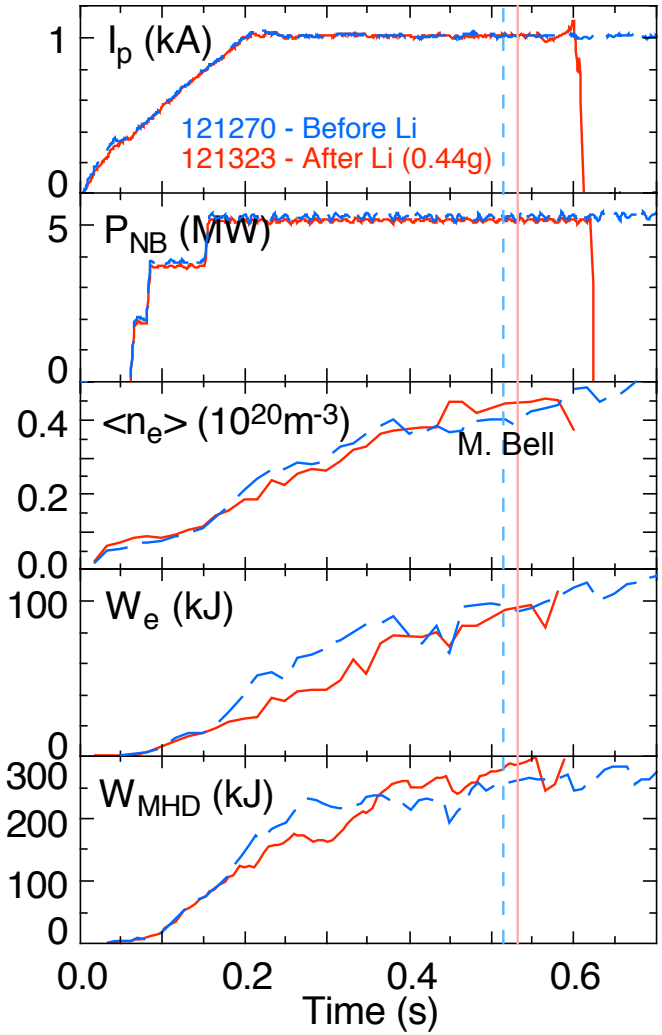
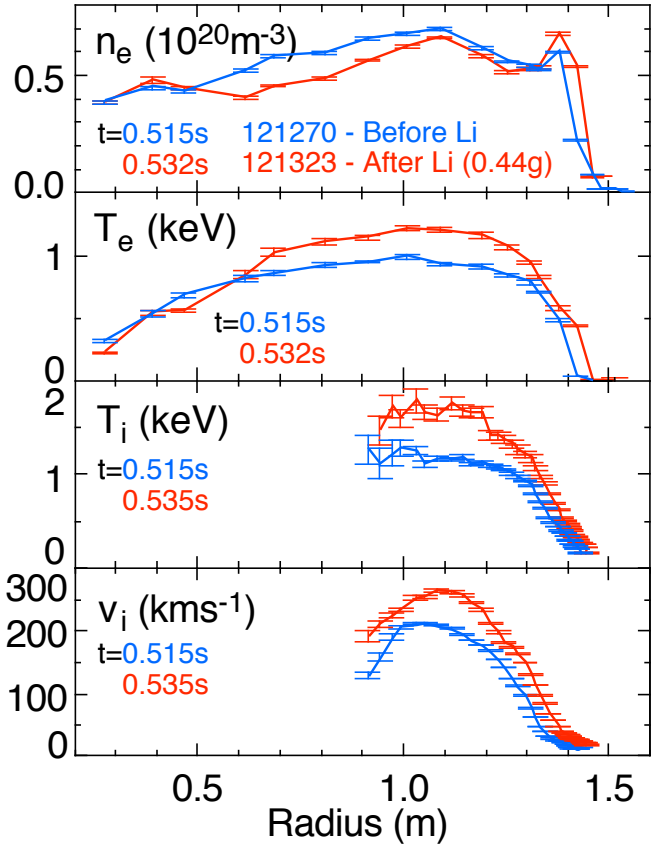
Lithium coating (E-9, 0.44g) - 1st H-mode





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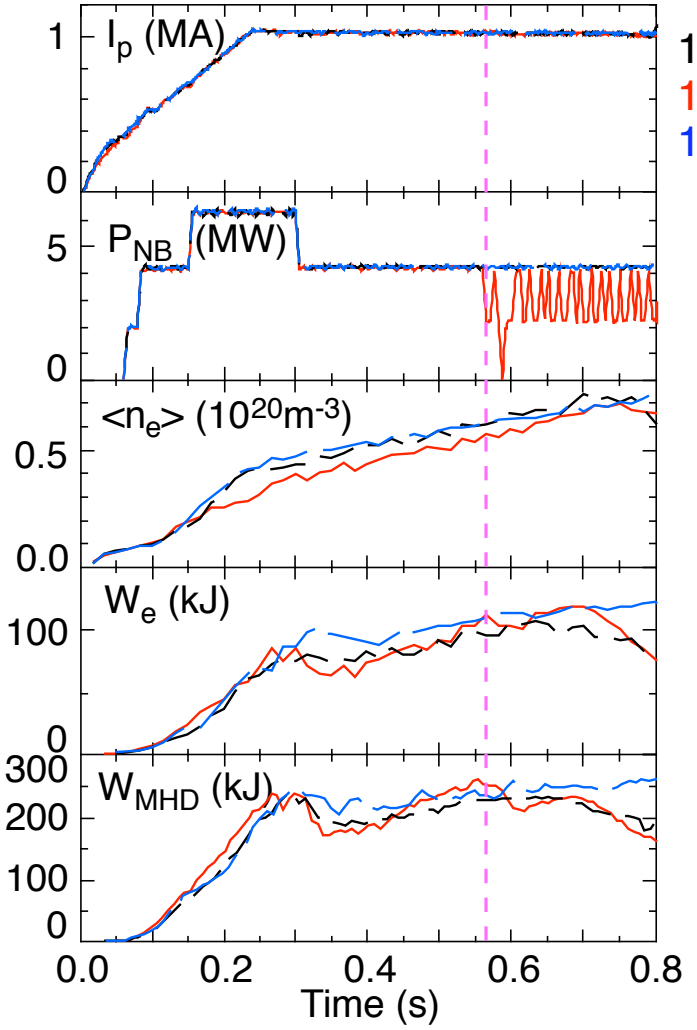
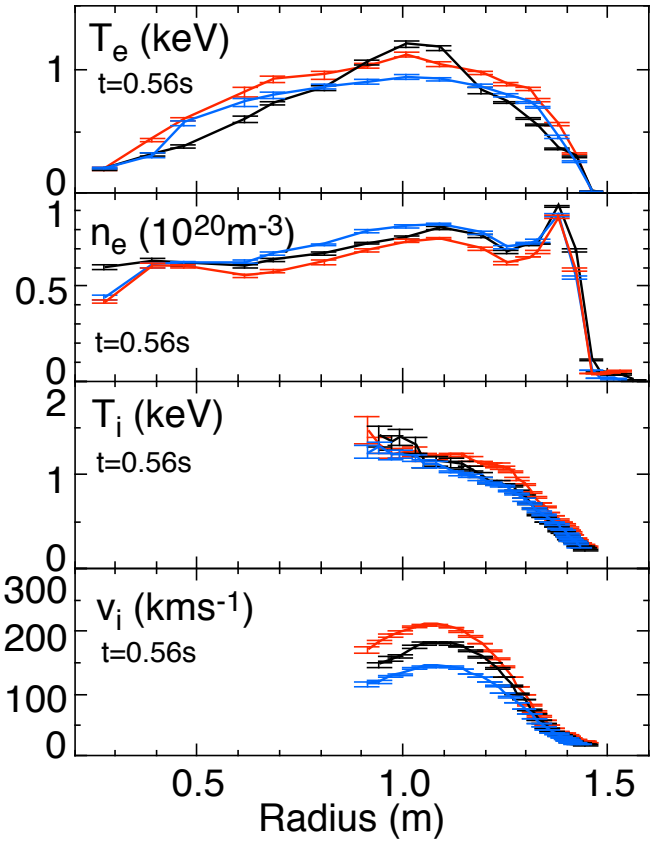
Heavy Lithium coating - H-mode

121504 – Last shot before Li
121507 – First shot after Li (4.8g)
121508 – Second shot





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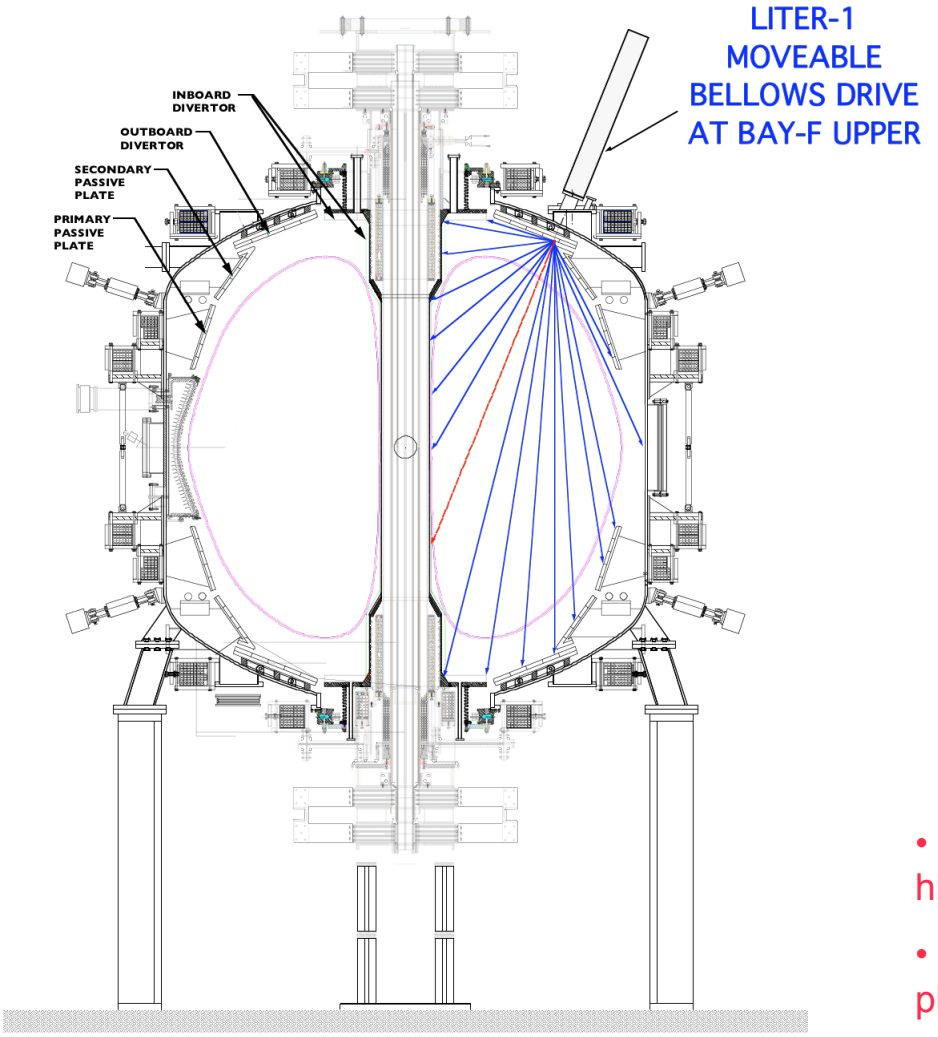
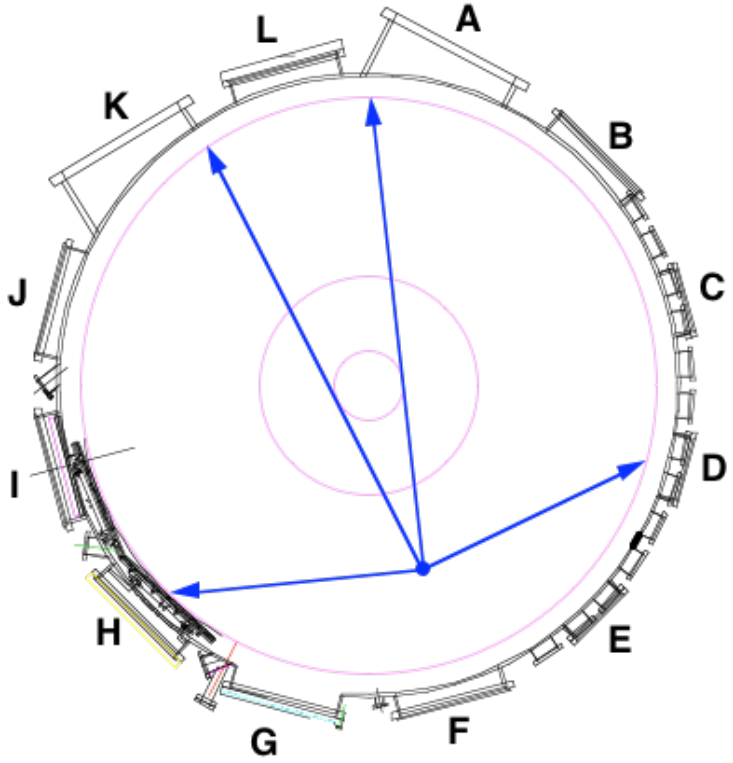
- The effect not as clear as in the previous H-mode comparison series.
- The density slightly lower in core on the first shot after the 4.8g of Li, but similar at the peak of the "ears".
- The central density was above the pre-Li levels in the second shot but was still lower at the inner edge.
- The T_e was broader after Li, but the peak was lower than before Li and fell further on the 2nd shot.
- The T_i didn't change much, but the profile was broader immediately after the Li and the velocity shear in the outer region was higher.

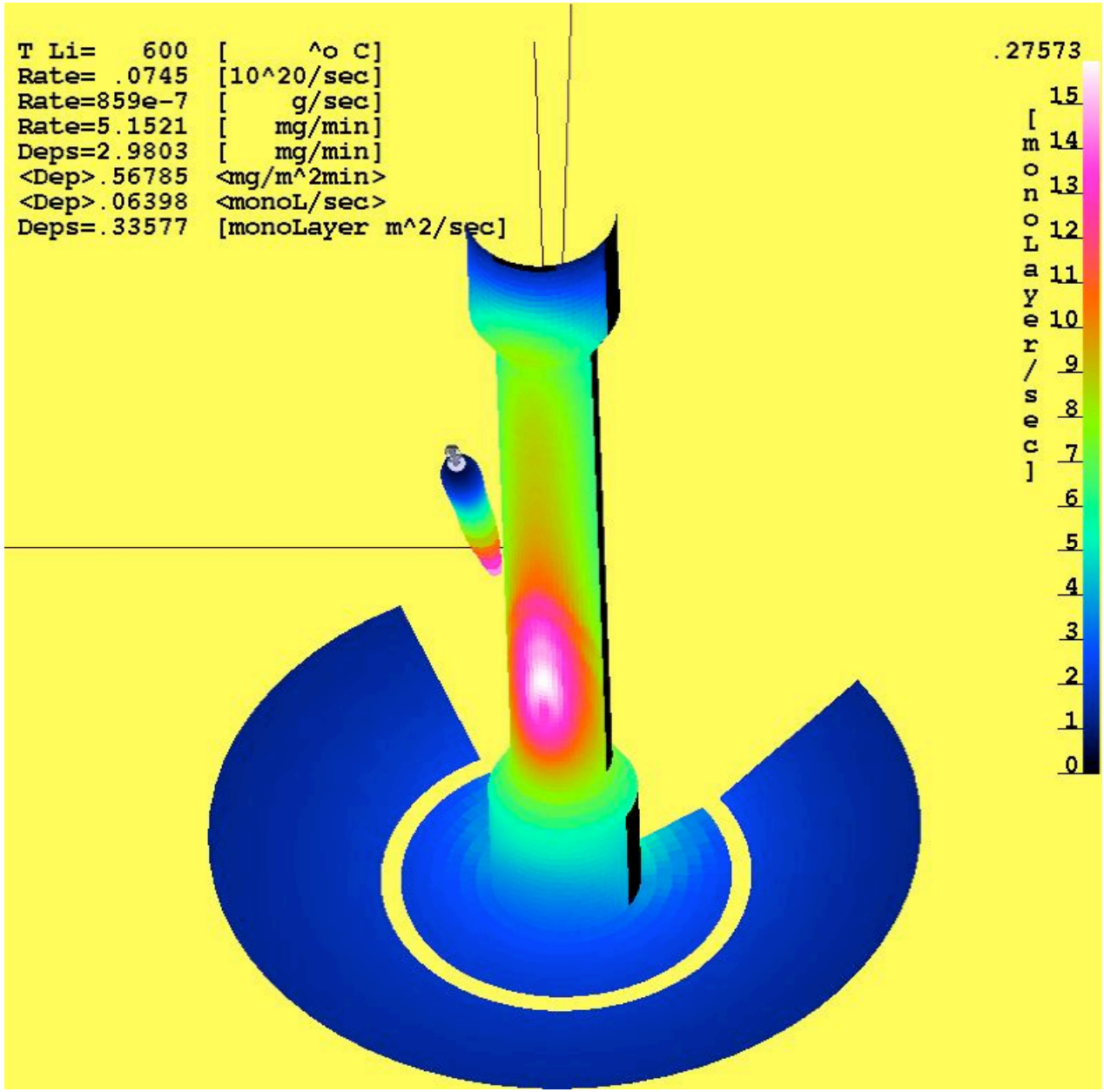
Lithium Evaporation From LITER-1 on BAY-F Upper Port Reaches Significant Fraction of NSTX PFC's





- Wide coverage over CS and Inner divertors for high performance DND plasmas.
- Thick deposition on Lower Divertor for LSN plasmas.

Model of LITER-1 Angular Distribution



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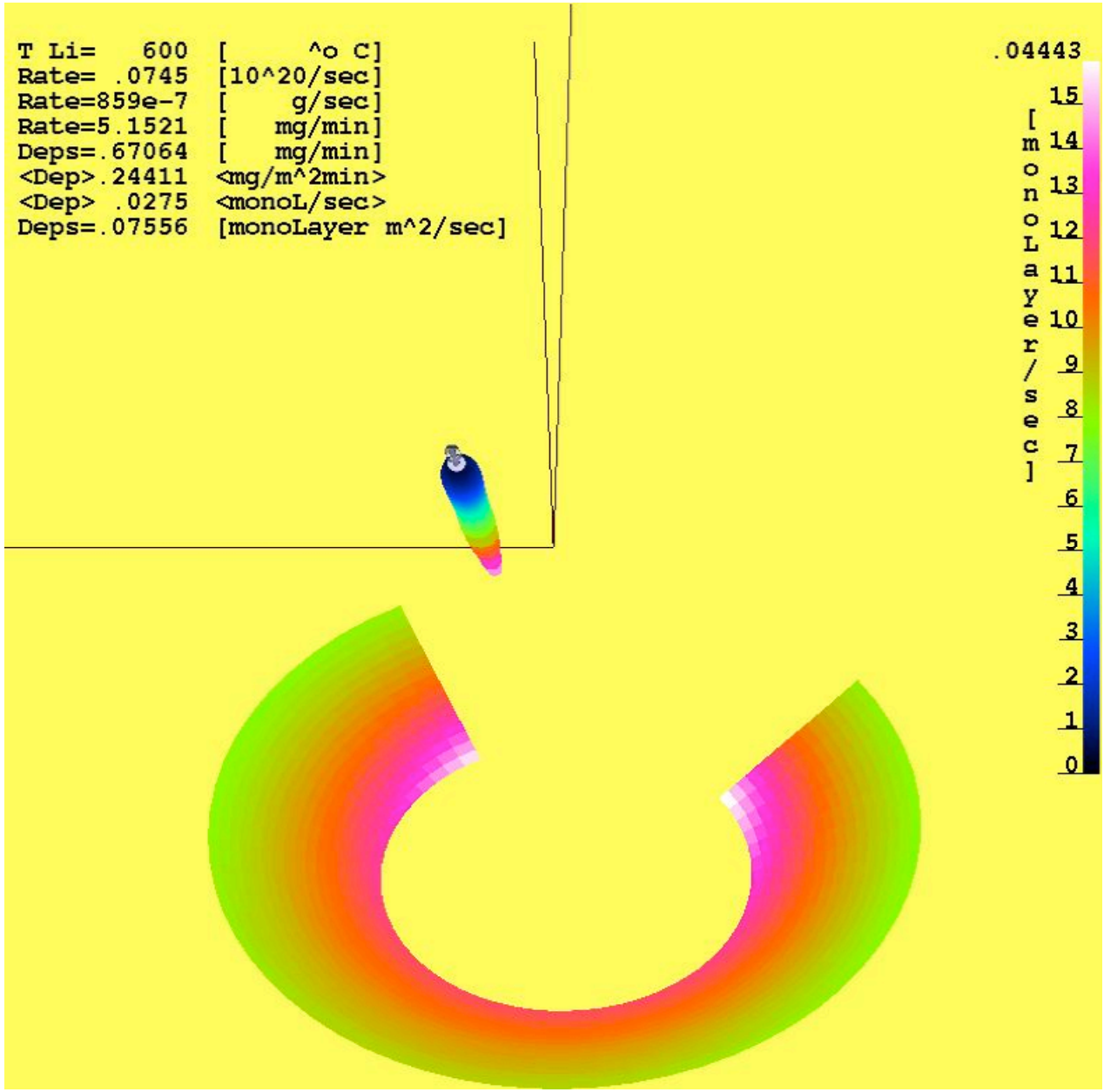
Model of LITER-1 Lower Divertor Angular Distribution



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Summary and Conclusions

- Effect on density persists for one shot after application of lithium

- Other plasma effects persist longer

- Performance improvements appear not dependent on quantity of lithium deposited beyond certain threshold but small increments thereafter seem to yield improving conditions

- Suggests upgrade of present capability for
    - Between-shots evaporation
    - Broader coverage