NSTX

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XP1134: Comparison of Diverted Plasmas Incident on Lithiated LLD, Molybdenum, and Graphite Surfaces

For Research Milestone R(12-1) and NSTX-U Planning

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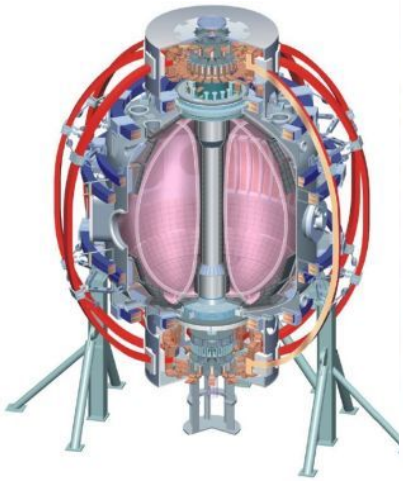
NSTX Team Review
June 15, 2011



Goals

- Comparison of diverted plasmas with strike-points incident on lithiated:
  - LLD
  - molybdenum tiles
  - graphite tile surfaces

- Resolution of LLD 2010 open issues for completion of analysis
  - described in IAEA2010, ISFA2011 papers,
  - referred to in following slides

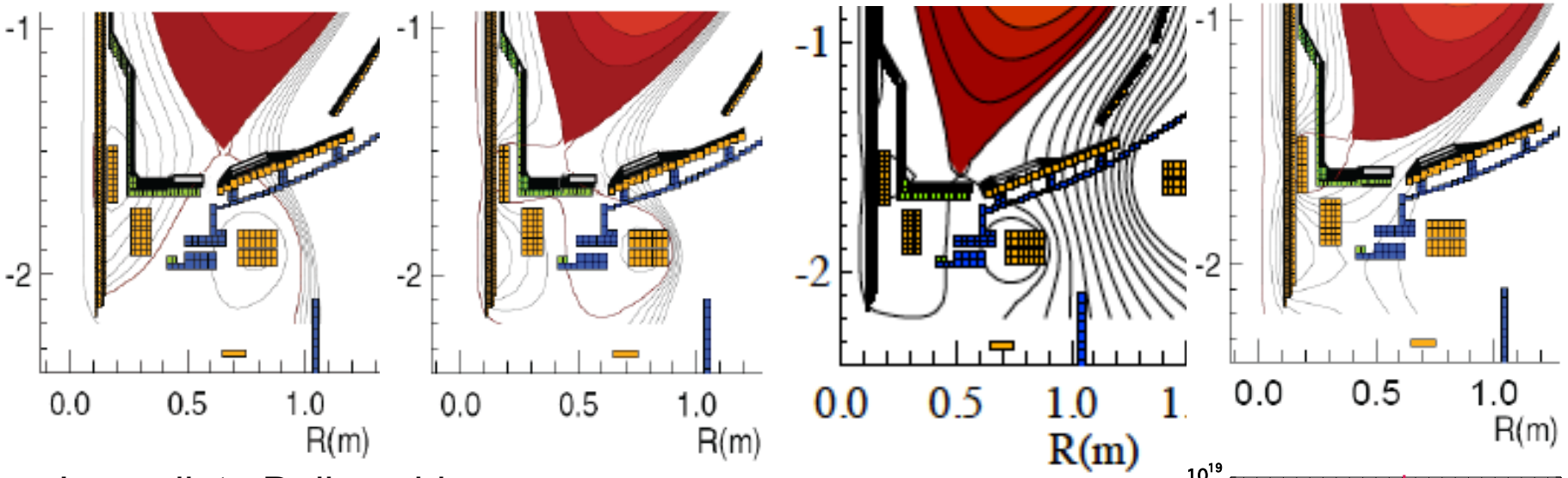
Early in the Run, with Impurity-free LLD, with Constant Fueling, and Minimal but Sufficient LITER for ELM-free H-modes: *XP to Compare 4 LSN Plasmas Incident on Lithiated –LLD, -Molybdenum and -Graphite Divertor*

1. LSN SP on Mo-LLD and Mo (IBD-tile)
REF: 142505 [16]

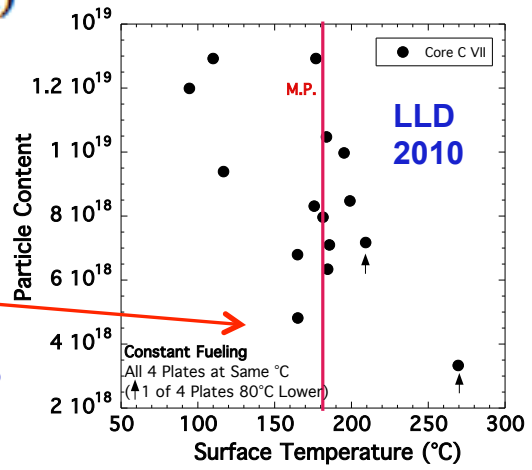
2.OBSP Mo-tile, IBSP on ATJ
REF: 139571 [10]

3.Snowflake-minus OBSP on Mo tile
REF: 139497 [3]

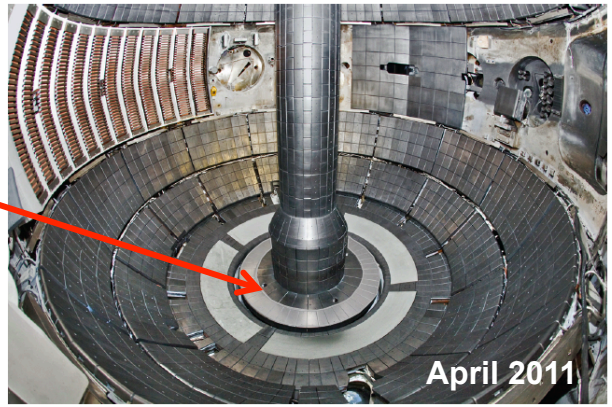
4.Standard IBD SPs on ATJ
REF: 139630 [3]



- Immediate Deliverables:
  - How does core D^+ change?
  - How does electron density rate of rise change?
  - How does core C^{6+} change?
  - How do the edge C source terms change, Prad?
  - How do edge conditions (ELMs, quiescence) change?
  - How does SGI tau p* change?

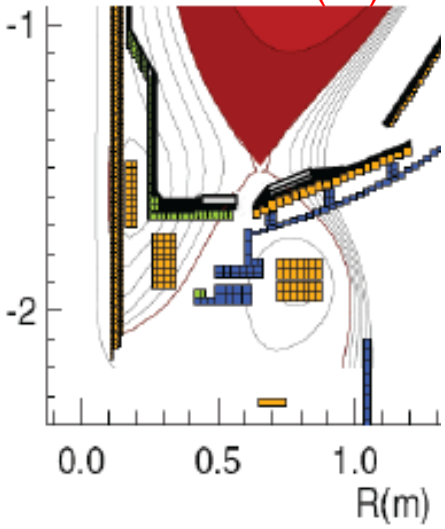


Day-1 (16 shots) : Begin with Both LSN Strike Points on Lithiated -LLD and -Mo (IBD tile)

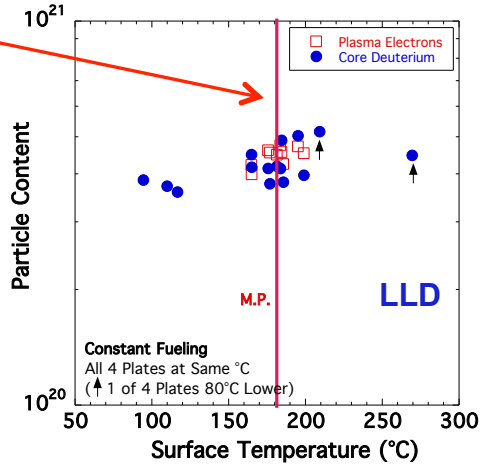


1. Both LSN SPs on Mo-LLD and Mo (IBD-tile)

REF: 142505 (16)

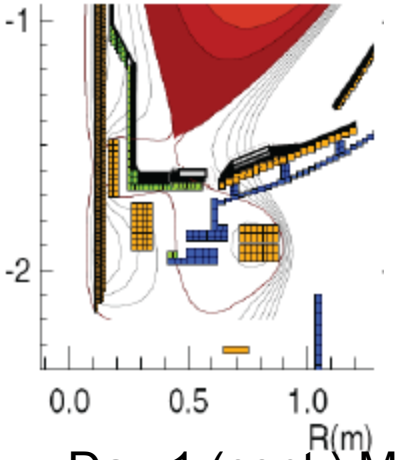


- Day-1 Measurement Plan (16 shots)
  - Early in Run, LITER 20 mg/min, constant fueling
  - Let LLD plasma auto-heat 10°C per shot
  - SGI for selected tau p* measurements
  - As FF transitions through Li melting (180°C) measure:
    - Waveform of Core D and C^{6+} particle content
    - Electron density rate of rise
    - Li, CII, OII, Mo, Prad waveforms
    - Fast IR front face temperature waveforms
    - LP array and edge turbulence measurements
    - ELM characteristics
    - Global wall pumping characteristics

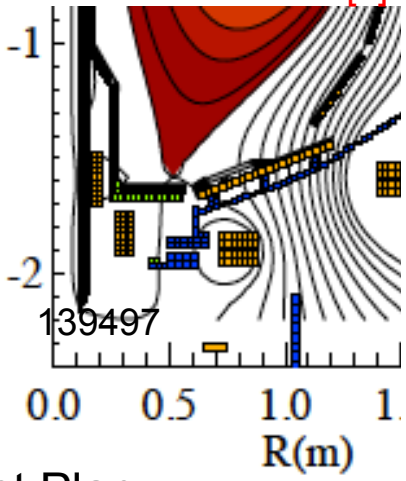


Day-1 (cont.): Move Strike Points Inward and Repeat
(while LLD cools down and LLD Li solidifies)

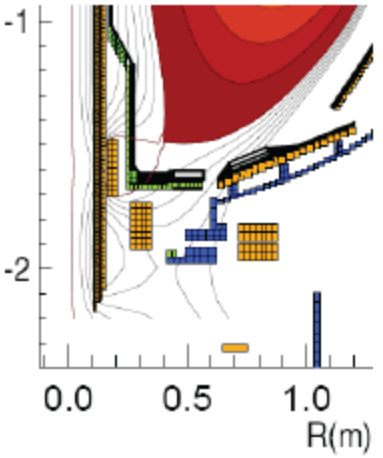
2.OBSP Mo-tile, IBSP on ATJ
REF: 139571 [10]



3.Snowflake-minus OBSP on Mo tile
REF: 139497 [3]



4.Standard IBD SPs on ATJ
REF: 139630 [3]



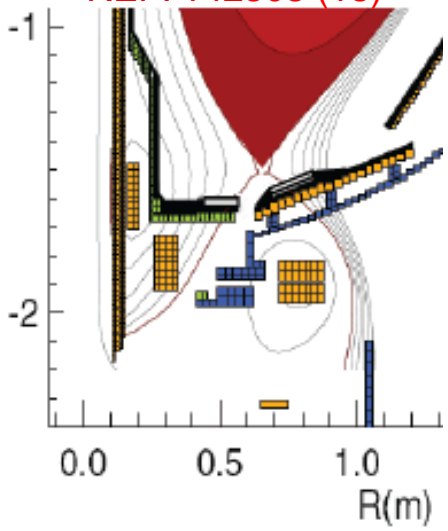
- Day-1 (cont.) Measurement Plan
  - Early in Run, LITER 20 mg/min, constant fueling
    - Waveform of Core D and C^{6+} particle content
    - Electron density rate of rise
    - Li, CII, CIII, OII, Prad waveforms
    - Fast IR front face temperature waveforms
    - LP array and edge turbulence measurements
    - ELM characteristics
    - Global wall pumping characteristics

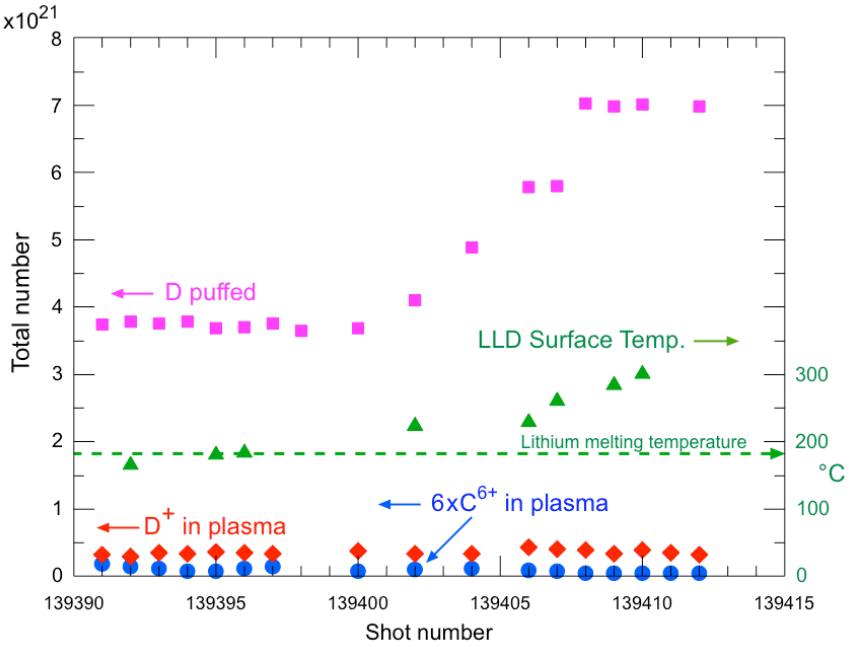
Day-1.5 (16 shots): Strike Points on Lithiated -LLD and –Mo

Goal: Resolve the Fueling Pathways

1. Both LSN SPs on Mo-LLD and Mo (IBD-tile)

REF: 142505 (18)





- The difference between the deuterium gas input and the plasma deuteron content reached very high values in this experiment without disrupting the plasma, but there was little change the plasma deuterium content.
- This may indicate that the added deuterium, after becoming ionized in the scrape-off layer flowed to the divertor and was absorbed by the liquid lithium rather than recycling and increasing the plasma density.
- But this is not definitive because the cooling the LLD to the lithium solidification temperature to allow the solid lithium to saturate and restore deuterium recycling was not performed.

Prerequisites

1. LITER-F and K able to evaporate at 5-20mg/min.
2. The 2-color IR camera monitoring LLD Tsurf using previous calibrations if necessary to provide between discharge measurements.
3. The slow IR camera using the previous 2-color and other calibrations to provide between discharge measurements.
4. The LLD viewing 1D-CCD/Dα and 1D-CCD/Li cameras operating for radial and time dependent documentation.
5. The LLD viewing fast cameras operating with carbon and oxygen filters operating for radial and time dependent documentation.
6. VIPS 2 spectrometer monitoring Mo luminosities
7. The DIMS spectrometer centered on the oxygen and carbon luminosities for impurity time dependent documentation.
8. ZEUS, LOEUS, SPRED, JHU, and Fiberscope systems operating and monitoring metals.
9. Apply 10 ms SGI pulses for Tau p* measurements as requested.

XP1134 Shot Sequence

Day-1

Run Day	Shot No.	Estimated Bulk T°C	Estimated FF T°C	ISP	OSP	Fueling
1	1	35		Mo (50cm)	LLD (77cm)	constant
1	2	45		Mo (50cm)	LLD (77cm)	constant
1	3	55	166	Mo (50cm)	LLD (77cm)	constant
1	4	65		Mo (50cm)	LLD (77cm)	constant
1	5	75	181	Mo (50cm)	LLD (77cm)	constant
1	6	85	224	Mo (50cm)	LLD (77cm)	constant
1	7	95	261	Mo (50cm)	LLD (77cm)	constant
1	8	105	301	Mo (50cm)	LLD (77cm)	constant
1	9	115		Mo (50cm)	LLD (77cm)	constant
1	10	125		Mo (50cm)	LLD (77cm)	constant
1	11	135		Mo (50cm)	LLD (77cm)	constant
1	12	145		Mo (50cm)	LLD (77cm)	constant
1	13	155		Mo (50cm)	LLD (77cm)	constant
1	14	165		Mo (50cm)	LLD (77cm)	constant
1	15	175		Mo (50cm)	LLD (77cm)	constant
1	16	185		Mo (50cm)	LLD (77cm)	constant
1	17			ATJ	Mo(50cm)	constant
1	18			ATJ	Mo(50cm)	constant
1	19			ATJ	Mo(50cm)	constant
1	20			ATJ	Mo(50cm)	constant
1	21			ATJ	Mo(50cm)	constant
1	22			ATJ	Mo(50cm)	constant
1	23			ATJ	Mo(50cm)	constant
1	24			ATJ	Mo(50cm)	constant
1	25			ATJ	Mo(50cm)	constant
1	26			ATJ	Mo(50cm)	constant
1	27			Snowflake-	Mo(50cm)	constant
1	28			Snowflake-	Mo(50cm)	constant
1	29			Snowflake-	Mo(50cm)	constant
1	30			AJT	ATJ	constant
1	31			AJT	ATJ	constant
1	32			ATJ	ATJ	constant

Day-1.5

Run Day	Shot No.	Estimated Bulk T°C	Estimated FF T°C	ISP	OSP	Fueling
1.5	1	35		LLD (77cm)	LLD (77cm)	increase
1.5	2	45		LLD (77cm)	LLD (77cm)	increase
1.5	3	55	166	LLD (77cm)	LLD (77cm)	increase
1.5	4	65		LLD (77cm)	LLD (77cm)	increase
1.5	5	75	181	LLD (77cm)	LLD (77cm)	increase
1.5	6	85	224	LLD (77cm)	LLD (77cm)	increase
1.5	7	95	261	LLD (77cm)	LLD (77cm)	increase
1.5	8	105	301	LLD (77cm)	LLD (77cm)	increase
1.5	9	115		LLD (77cm)	LLD (77cm)	increase
1.5	10	125		LLD (77cm)	LLD (77cm)	increase
1.5	11	135		LLD (77cm)	LLD (77cm)	increase
1.5	12	145		LLD (77cm)	LLD (77cm)	increase
1.5	13	155		LLD (77cm)	LLD (77cm)	increase
1.5	14	165		LLD (77cm)	LLD (77cm)	increase
1.5	15	175		LLD (77cm)	LLD (77cm)	increase
1.5	16	185		LLD (77cm)	LLD (77cm)	increase

- *Options for this afternoon time slot:*
  - include 3 shots of X-point fueling (change versus fueling location)
  - or, 3 shots Snowflake on ATJ
  - or, start other inboard XP, e.g., XP1135

After LLD Cooldown and Lithium Solidifies

After cool	17	55	166	LLD (77cm)	LLD (77cm)	Ibid #16
	18	65		LLD (77cm)	LLD (77cm)	Ibid #16
	19	75	181	LLD (77cm)	LLD (77cm)	Ibid #16

- If time, do: 1) divertor C source reduction with a small gas puff, 2) divertor OSP detachment with a higher gas puff (probably can get enough information in ~5-7 shots)