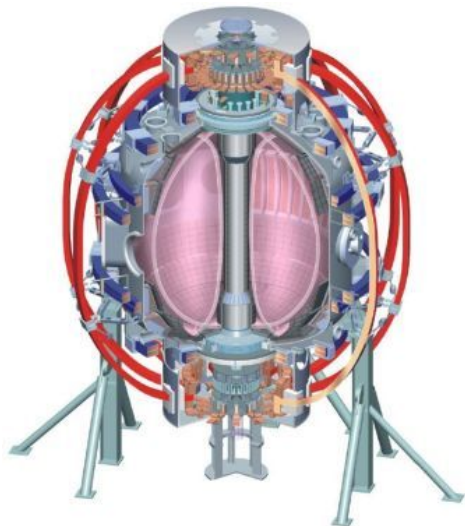


Overview of Li research options and goals for NSTX for FY11-12 runs

J. Menard

**NSTX Lithium Research TSG Meeting
PPPL B318
December 7, 2010**



*Culham Sci Ctr
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Hyogo U

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TRINITY

KBSI

KAIST

POSTECH

ASIPP

ENEA, Frascati

CEA, Cadarache

IPP, Jülich

IPP, Garching

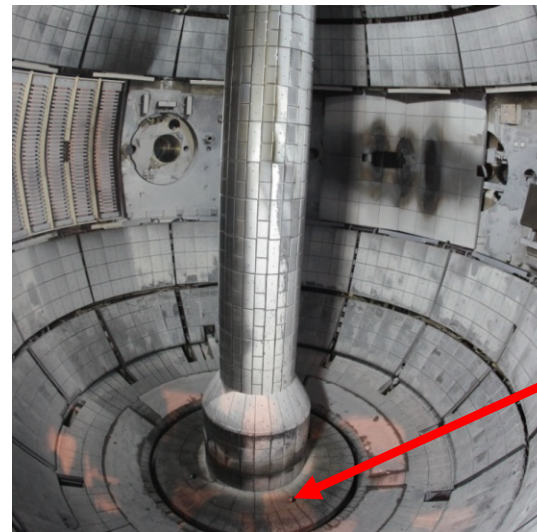
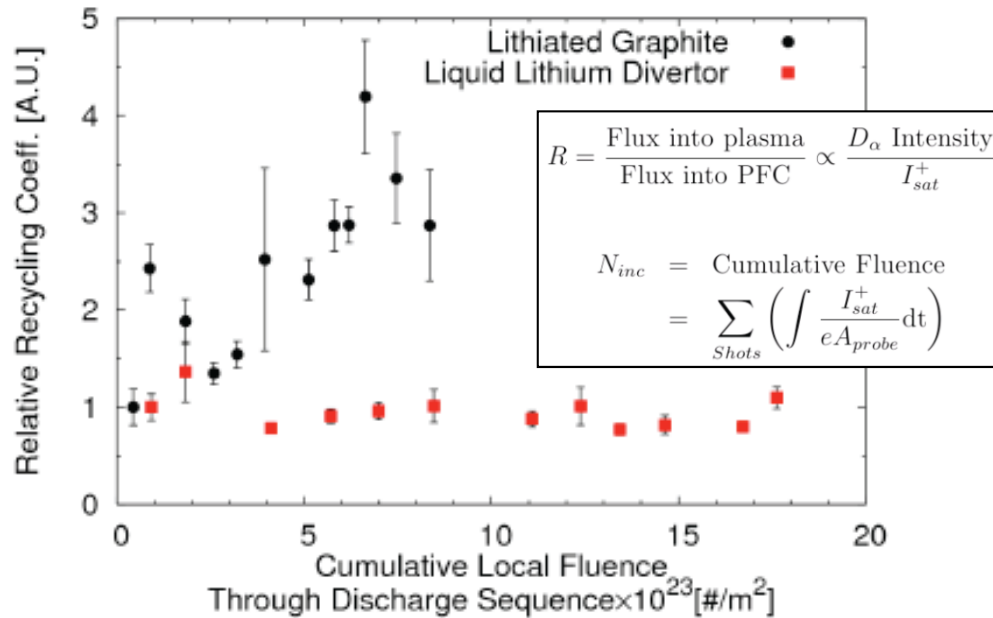
ASCR, Czech Rep

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Overview

- 2010: Most Li evaporated into NSTX thus far (~2 lb)
 - First-ever LLD experiments – sustained reduced recycling at strike-pt on LLD?
 - LLD pumping similar to lithiated C? Is this sufficient or useful for NSTX/NSTX-U?
 - Rapid start of plasma operations w/ no boronization or He glow
 - Adversely impacted HHFW operations, LiTER shutters, end-of-run LiTER ops
 - Several vents in Ar – air from shutter replacements compromised surface conditions
 - LiTER snout/apertures accumulated Li, dropped onto lower div = multi-day cleanup



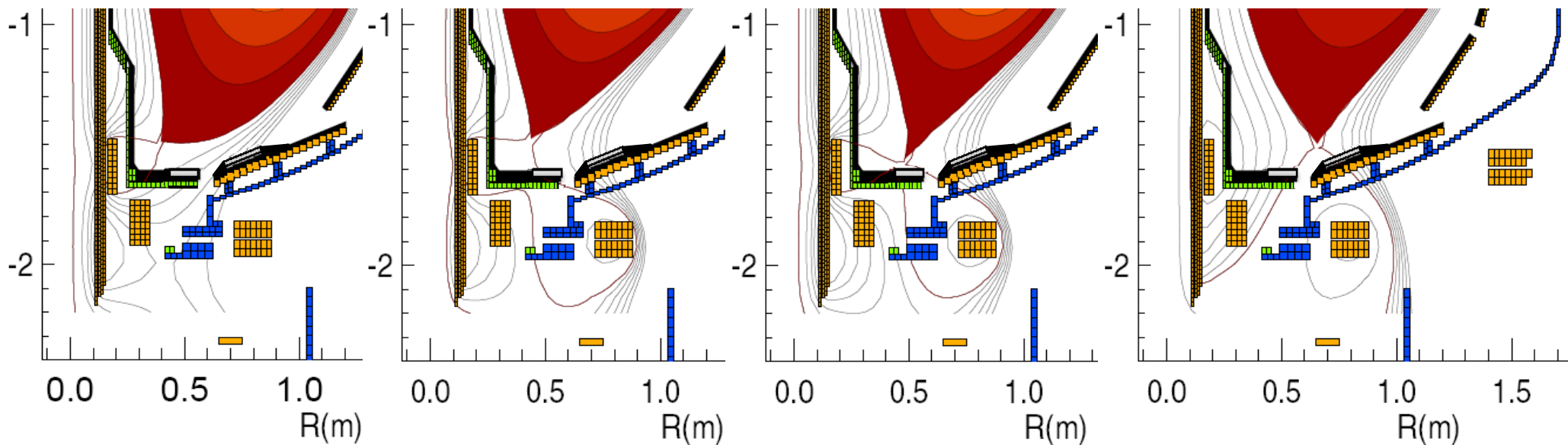
- 2011-12 (22 run weeks): LiTER limited to ~2009 levels

FY11-12 Li plans and options (subject to resource limitations)

- Reduce impurities in LiTER ELM-free H-mode
 - Snowflake divertor, divertor gas puffing, USN/I-mode, EHOs, ...
- LLD uncleanable? → if so, remove from NSTX?
 - What are metrics for cleanliness?
- LLD cleanable?
 - Retain/re-install for FY2011-12 – worst case = heat plates w/ plasma
 - Implement air heaters on all plates – will heaters survive (disruptions)?
 - Repair/replace electrical heaters on at least 1 plate - liquid Li fill test(s)
- Mo tiles on outer row of inboard divertor?
 - Assess core C, Mo impurities vs. outboard strike-pt position: Mo vs. C
 - LiTER onto IBD to test Li on Mo – impurity influx, D pumping by Li
 - If LLD present, operate with both LSN strike points on Mo, Mo + Li
- Liquid lithium fill of LLD?
 - Test LLD pumping with thicker Li film – end of FY12 run - if at all?

Addition of IBD Mo tiles would enable important divertor studies

- Help quantify fraction of core C coming from lower divertor
- Potentially reduce C content of Li ELM-free scenarios
- Characterize Mo performance to inform choice of div/CS PFC in Upgrade
- Enable LSN shape with both strike-points on Mo (how different than C?)
- Apply Li (LiTER/Li-fill) to IBD/OBD Mo for full LLD



Standard divertor on C

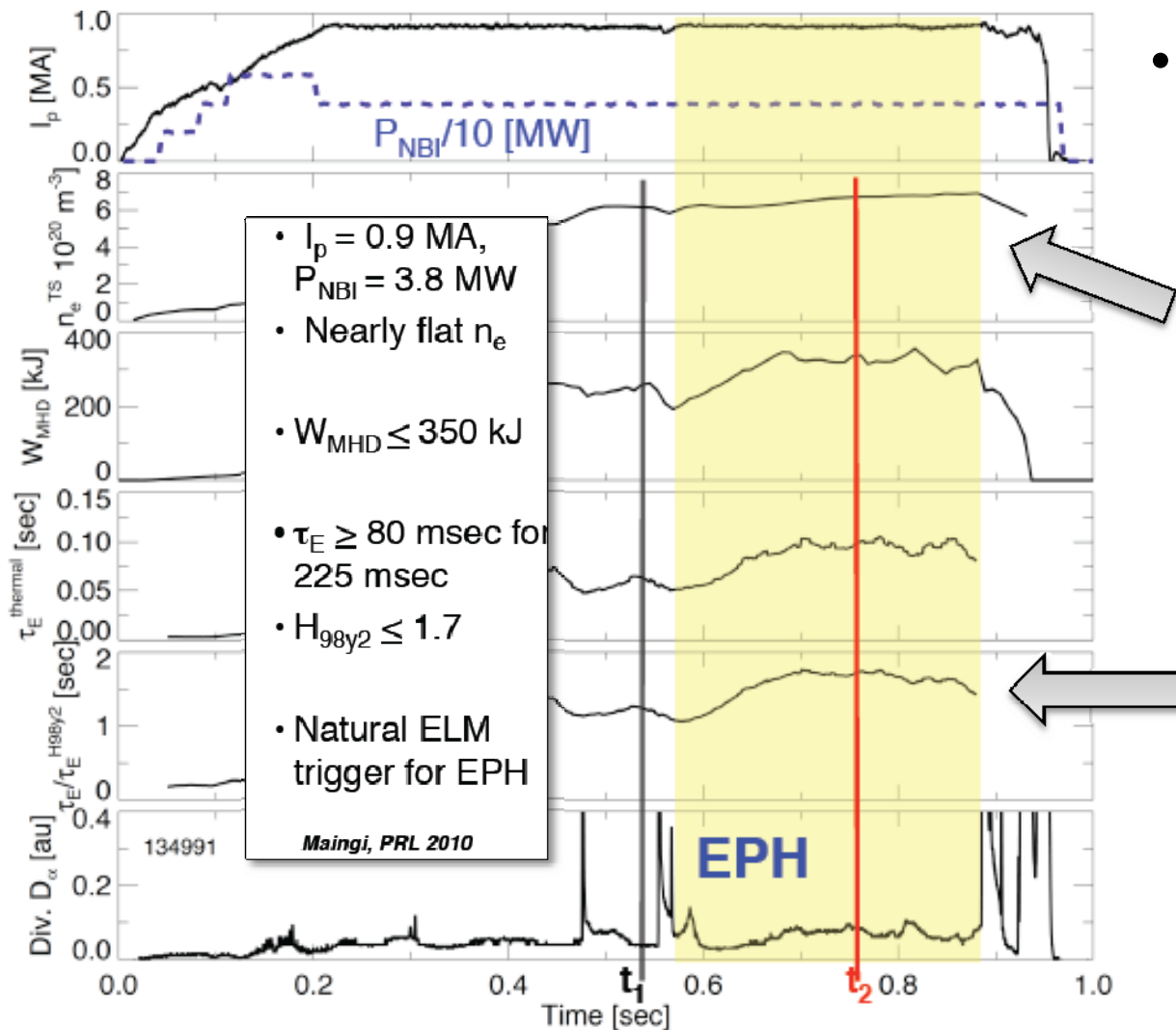
Standard divertor on Mo

*Snowflake on Mo
(also possible on C,
not shown)*

*LSN strike-pts on Mo,
Mo + Li, or
C (IBD) + Mo (OBD)
(not shown)*

Goal: integrated core+divertor solution for Upgrade & beyond

Example: consider 100% non-inductive scenario requirements in Upgrade



- Need higher B_T and more tangential 2nd NBI to keep $q_{min} > 1$, avoid β_N limit

$n_e / n_{Greenwald} \sim 0.7-0.9$

- Achieved - D inventory saturates in Li ELM-free
- C, Fe influx is usually problem (EPH different?)

$H_{98} \sim 1.2-1.4$ (increases f_{BS})

- Achieved - enabled w/ Li (LiTER) and EP H-mode
- How to trigger, sustain?

- **Sustained ELM-free (small ELM) operation with $H_{98} \gg 1$ + acceptable n_e / n_{GW} and Z_{eff} would be major advance**

Pumping questions for NSTX / NSTX Upgrade

- Can LiTER pump D of 3-5s Upgrade plasma?
 - D inventory saturates at $n/n_{\text{gw}} < 1$ for NSTX pulses $\sim 1\text{s}$
 - Still need to develop reduced fueling scenarios in NSTX
- If not, can LLD provide more sustained pumping?
 - Inboard?, outboard?, both? How to replenish Li?
- Are there more advanced LLD concepts?
- Implement cryo-pumping in Upgrade? – perhaps for upper divertor, to compare to/supplement LLD?
- Fundamentally, Li reacts with impurities more strongly than with D – how to overcome this?