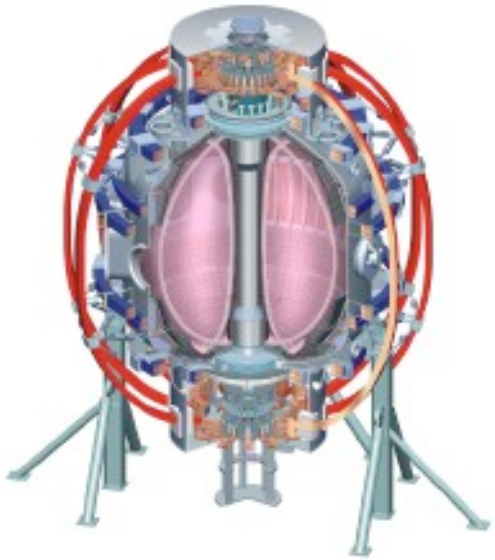
NSTX Impurity Assessment

NSTX BP ET meeting
Friday 11th January 2008, B252.
C. H. Skinner, S. Paul, H Kugel et al.,

- Goals for 2008
- Impurity experience in 2007 (S. Paul)
- Spectroscopic diagnostics status for FY 2008 run (C. Skinner, S. Paul)
- Some spectroscopy needs for 2008 (H. Kugel).
- General Discussion of needs for specific fiducials, spectroscopic data, analysis and result presentation (e.g. for LITER characterization, for everyday (display wall?) impurity assessment, etc)



"NSTX Program Plan for FY08-10 and beyond" (JM)

Excerpts from Menard presentation to Research Council 1/4/08

- Boundary Physics
  - NHTX/ST-CTF have P/R twice that of ITER and operate at low ne/nGW= 0.2-0.5
    - ST-CTF also requires very low T-retention, NHTX goal is to develop this
  - Novel power exhaust and pumping concepts needed
  - Unclear how SOL/divertor heat-flux and pedestal transport/stability scale in ST
  - *Liquid lithium divertor(LLD), develop pedestal/SOL/divertorpredictive capability*
  - High priority for issues w/ large uncertainty in extrapolation to next-steps
  - High priority for unique contributions to ST and toroidal science
  - Need particle pump to control density for high NBICD and low-ν physics, etc...
    - Test liquid lithium divertor(LLD) concept - unique, only near-term n control tool
- 2009 Milestones: JOULE (proposed) -Address particle control & hydrogenic retention in tokamaks.

NSTX FY10 Research Milestone Ideas

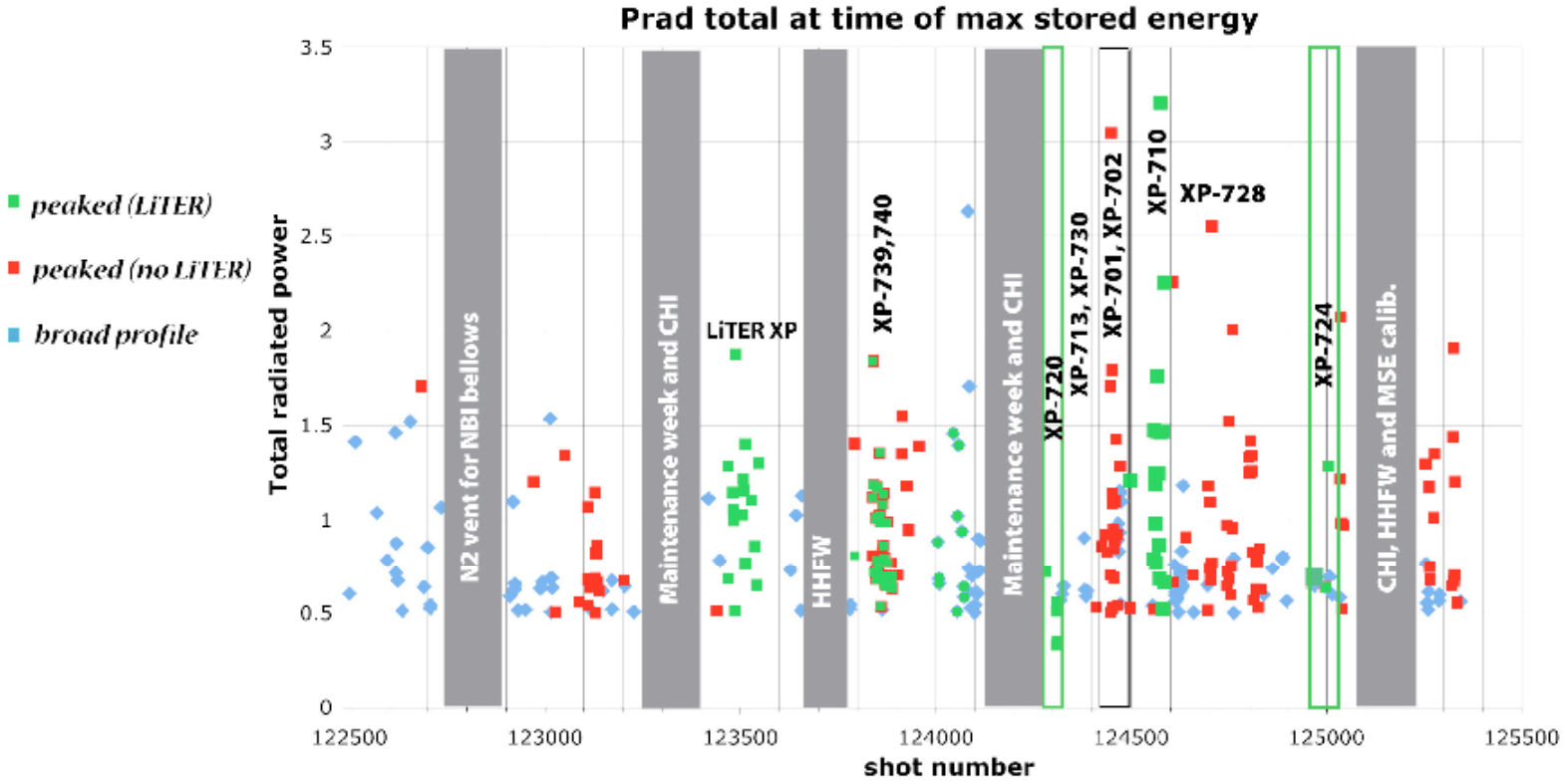
- Characterize LLD-II (mesh or 2nd plate?) performance w.r.t. particle pumping and/or high heat flux handling capability
  - *Haven't demonstrated that LLD-I will work well enough to warrant LLD-II*

5-year plan Sept. 2007 (Maingi): Increased Emphasis on Boundary physics in NSTX in FY09-FY13

- Program organized into prioritized themes
  - 1: Lithium as a divertor plasma-facing component
    - Density and impurity control, heat flux handling
    - Effect on plasma performance
  - 2a: SOL and divertor physics
    - Edge transport and turbulence; SOL width
    - Divertor heat and particle flux optimization
  - 2b: Pedestal and ELM Physics
    - Characterization and theory comparison at low R/a
    - Active control with resonant magnetic perturbations

High (> .5 MW) radiated power shots from 2007 (SP)

Overview of highly emitted radiation shots in the NSTX campaign for 2007

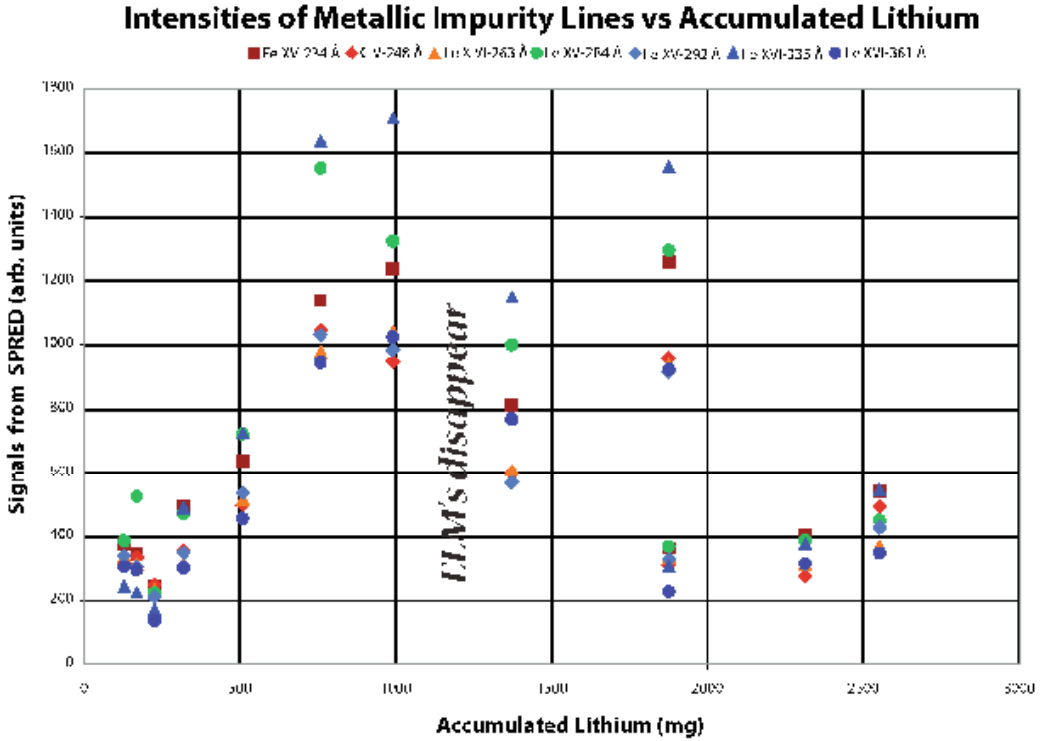


- *Plotted here are only those shots with substantial total radiated power. Short shots, fizzles, etc. are omitted. Maintenance weeks, RF operation and CHI operation are blanked out.*
- *While there are ample shots with impurity accumulation during LiTER operations, there are also a large number of shots that accumulate without LiTER (and prior to LiTER).*
- *The blue points are those high Prad shots that DID NOT have peaked profiles. The green and red points are high radiation shots that were peaked.*

Following the Liter XP, there were as many peaked Prad shots with LiTER as without

Impurity experience in 2007 (SP)

Radiated power seen from Soft UV Spectroscopy showed increase INITIALLY



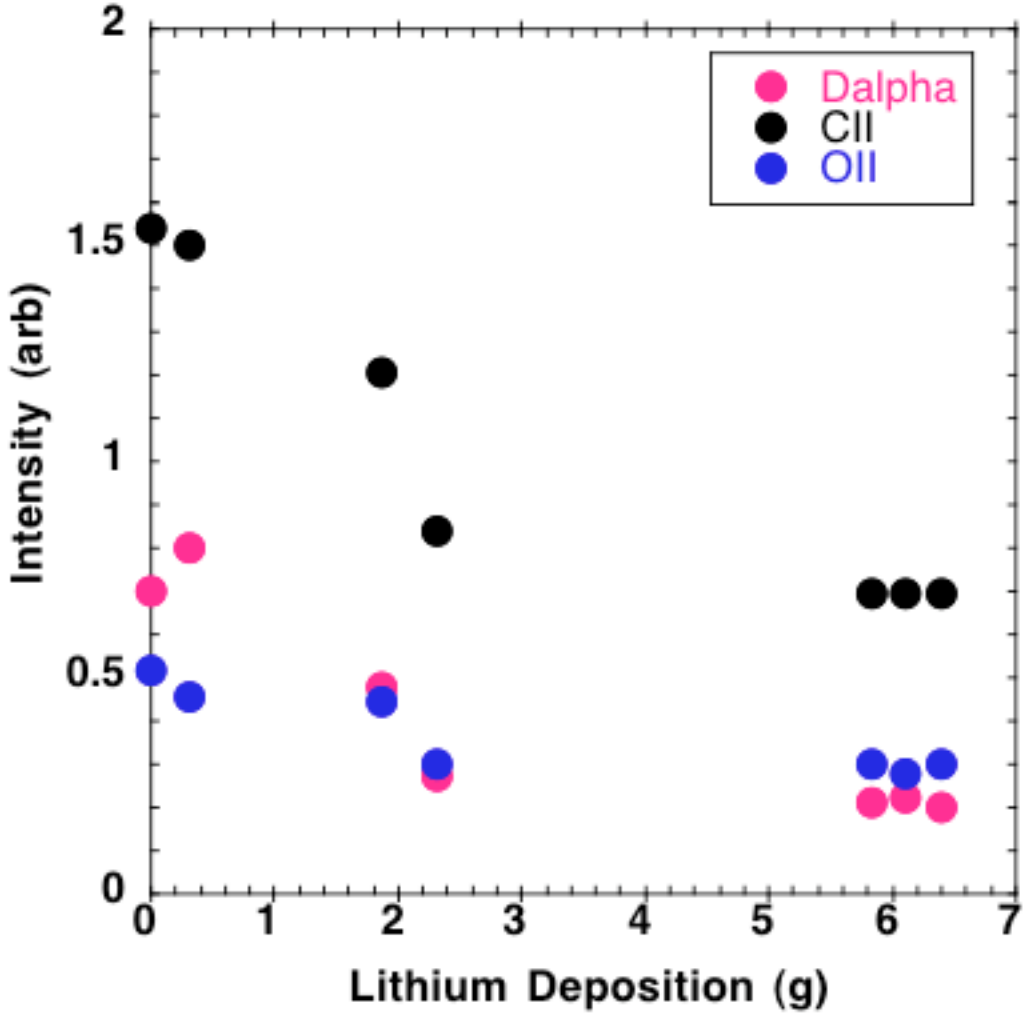
- *With initiation of Li deposition the radiated power from the metals rose and peaked when 1 gram was applied.*
- *But afterwards, the emitted power fell to pre-Li levels, though the ELM's continued to be suppressed.*
- *The principle metallic lines are iron, with some nickel, and occasionally some copper.*

- Was impurity accumulation due to Li supression of ELMs ?
- How 'fresh' does Li have to be for it to 'work' ?
- Is lithiumization better or worse than boronization in suppressing O, metals etc…?
- Can we run without boronization in 2009 when LLD is installed ?

Kugel Nov. 2007 DPP APS talk:

Lower Divertor Dα, C II, and O II Luminosity Decreased with Increasing Li Deposition

NSTX



• Comparison of shots @ 200 ms with n_e within ±14% during Li deposition sequence

Spectroscopic diagnostics update for FY 2008 run

- filterscope web page (Vlad): http://nstx.pppl.gov/DragNDrop/Operations/Diagnostics_&_Support_Sys/EIES
  - One change since last year is that we are now using a small mini-conflat window for Bay E EIES viewing the upper divertor, so the line of sight might have slightly changed (but not much).

Beiersdorfer email 1/11/08 to Manfred.

XEUS - 1: It appears ready. But it may need to be focused once we have the first plasma shots.

- Current setting covers about 55 --110 Å. I am thinking of setting it to 10--50Å during the first maintenance period (Feb 4).
- Gretchen's automatic archiver works for single shots set up by hand (as of test date 1/9/08) . In other words, manual intervention is still required for each shot. She is working on automating the data acquisition to take and archive a spectrum synchronized with the NSTX shot cycle. We are in working with her.

XEUS - 2:The instrument is planned for delivery to PPPL the week of Jan 28, 2008.

- The goal is that XEUS-1 and XEUS-2 run the same software on similar machines to make them interchangeable. This issue could make the delivery date slip further.
- XEUS-2 will be set up for 50--200 Å. Let me know, if you have any questions.
- By the way, I have now booked my flights. I will arrive on Sunday Jan 27 (arrive in Newark at 19:30); I will leave Friday Feb 1 on the 6 pm flight. Peter

Spectroscopy Needs: LITER, General XP, and LLD (HK)

HOW WILL THE IMPURITY INFORMATION BE USED

- Monitor operations: to detect problems ASAP (via O/C ratio, total radiation…)
- Run assessment: how did conditions change during the run
- Data analysis: to assess plasma conditions during an XP
- Presentations: to show plasma conditions during an XP.

SPECTROSCOPIC NEEDS

- Mid-day Fiducial(?): LSN, NBI, high δ, 1MA, 1000ms, with fixed fueling
  - record the standard OV/CIII luminosity ratio (and acquire the below)
- On every shot thereafter, and in particular every plasma parameter scan during a given XP
  - Calibrated SPRED to send long wavelength SPRED C, O, B,..intensities to Dana db
  - Keep SPRED on long wavelength;
  - Apply XEUS for metals and Li; send to Dana db
  - VIPS: (1) on Li during Li XPs and (2) on H/D when not on Li; send to Dana db

WHERE TO SEND DATA

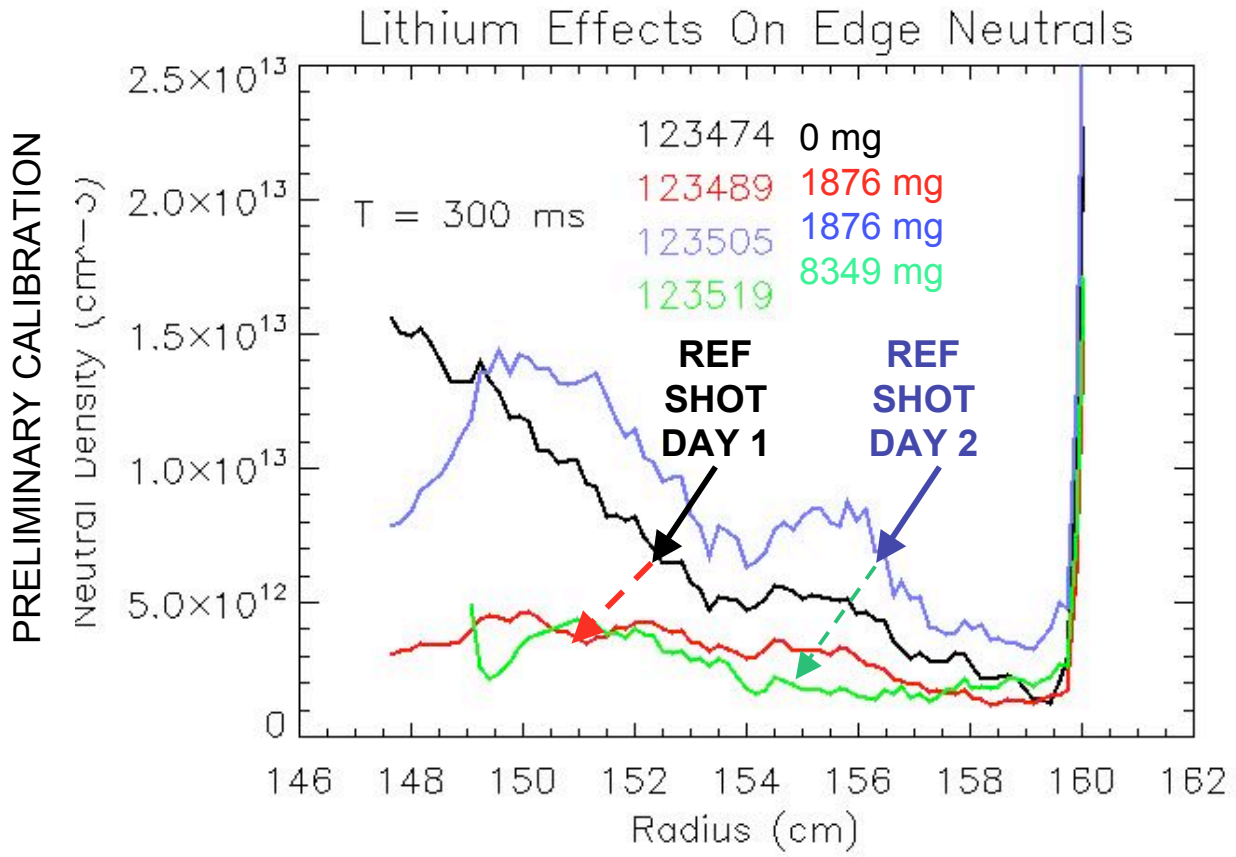
- Record OV/CIII in Spectroscopy logbook and report to operators, SL, and 530 meeting
- Dana's database
- MDS scope waveforms to show C, O, Li I trends
- Spectroscopy comments in Operators Log are helpful

-H. Kugel

Whenever Possible Obtain 3 Fiducials so as to Document the Evolving Conditions Following The First Fiducial

NSTX

- ***Example of a Weekend Change in Edge Conditions***



Day 2 = Day 1+ 64hrs

APS DPP 07
TP8.00073
P.W. Ross

- **Lithium is pumping strongly by the final shot of Day 1 but pumping effect completely disappeared by the reference shot of Day 2. (HK)**

2008 Impurity Issues:

- Will the shutter prevent helium entrapment in Li coatings ?
- Will metallic impurities return ?
- How will we diagnose them and their origin ?
- Should we switch to higher resolution SPRED grating (best for metals, but we loose our traditional O / C ratio).
- Should we run longer pulse fiducials every day to assess impurity accumulation (see later…).
- What is unique effect of Li ?
- Should we run fiducials to compare impurity accumulation pre Li and post Li.
- He density ? Correlation of filterscope Zeff with bolometer and CHERS

2008

What is spectroscopy data do people most care about ?

- H-alpha/D-alpha ratio on first shots of day.
- XUV line ratio: OV 630Å/CIII 977Å
- Visible line ratio: D-alpha / Bay D CII, OIII/CII
- HeII
- BII 3451Å
- Li I 6707Å
- Metals e.g. Fe XVI 335Å Is waveform needed because the toi is not comparable?
- CVI, OVIII, …. (XEUS)
- Zeff

What is highest priority impurity data location ?

- Dana's survey database- is 'Ratios_today' ever used ? Should it be improved ?
- Is filterscope on display wall useful - what waveforms ?
- Anyone used data upload to excel via ODBC drivers ?
- MDS scope waveforms ?
- Operators log comments ?
- 5:30 meeting ?
- How much effort should be diverted to validating data, how to label validated data ?

Potential role of FY 2008 fiducials (S. Paul)

Choices:

A

- No fiducials - qualitive info only e.g. HeII 304Å increased/decreased

B

- Weekly fiducials - 1 week time resolution.

C

- Daily fiducials - 1-day time resolution
  - Should not be first shot of day

D

- Fiducials after something changes ?

Other issues:

- Fiducial shots that are useful for detecting influx of metallic impurities need to last at least 600 msec. Ohmic fiducials are not useful for this.

- It should have at least 2 beam sources with 300 in duration and feature an H-mode.