NSTX-U

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Materials and Plasma-Facing Components (M&P) TSG Prioritization for FY2015 and campaign startup

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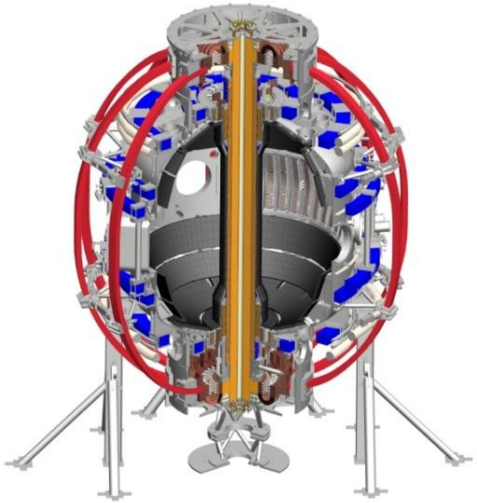


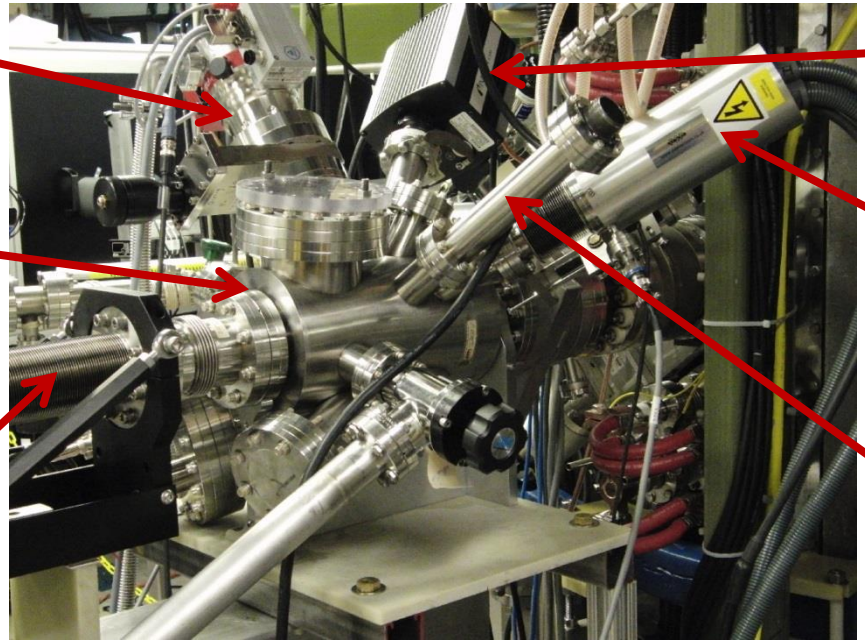
Boron->Lithium transition input

- Initial discussions indicate a lot of desire for boron campaign and establishment of boronized baseline performance
  - Have unique opportunity to get surface science information on B vs. Li conditions – what is really happening?
  - Could complement end-of-campaign Li->B experiment and address this question for future run campaigns

- MAPP provides key capabilities not yet utilized on NSTX-U

- We recommend gauging demand for B-conditions before deciding a transition date
  - XP authors will be asked to specify B, or Li, or both conditions in the experiment
  - XP authors will also be asked to develop a contingency plan (if possible) if Li-transition occurs early and no B data can be obtained

Materials Analysis and Particle Probe – enabling more than "waving dead chickens"



Analysis Technique	Fundamental Information	Status
X-ray photoelectron spec. (XPS)	Elemental/chemical state analysis	Operational
Thermal desorption spec. (TDS)*	Binding E of surface volatiles	Operational
Low-E ion scattering spec. (LEISS) Direct Recoil Spectroscopy (DRS)	Impurities with LEISS and H with DRS in forward scattering geometry	In development

***Possible XP – use sample heating capability to investigate effect of boronization with dTMB on PFC material at elevated temperature**

Initial cut at XP/XMPs for run and B demand

Red Text = first 2 run months, Blue Text = experiments before Li transition

No.	Title	XP/XMP	Candidate Lead	First 2 months?	Candidate Theorist	Surf. Sci.	B and/or Li	Purpose
MP1	MAPP operational readiness	**XMP**	Allain	Yes			**B**	Demonstration/model MAPP inter-discharge anaylsis
MP2	Effect of B conditioning	XP	Skinner/Allain/ Bedoya	Yes	Wirth	yes	**B**	Correlate B-zation PFCs with discharge performance
MP3	Effect of B->Li	XP	Skinner/Allain/ Bedoya	Maybe	Wirth	yes	**and**	Characterize surface conditions during transition to Li
MP4	B vs. Li material migration	XP	Nichols	Maybe	Wirth	yes	**and**	Compositional variation at MAPP and QCM mass flux with WallDYN sim.
MP5a	High-Z reference discharge development	**XMP**	Jaworski	Maybe			**B prefer.**	Develop high-Z reference shape for future experiments. MP5a-can likely develop contingency for Li-only data
MP5b	Impact of B vs. Li on divertor conditions	XP	Jaworski	Maybe	SOLPS/UEDGE modeler?	yes?	**and**	Compare B vs. Li lifetimes and divertor impact for high-Z reference shape
MP6	Far-SOL particle fluxes DSOL-34	XP	Zweben/ Jaworski	No	Myra/??	??	Or*	Examine far-sol filling and turbulence changes due to SP condition
MP7	Leading edge heat fluxes DSOL-31	XP	Gray	Maybe	Jaworski PFC/kinetic ??	??	**B prefer.**	Determine leading edge heating with existing graphite gaps. Compare with JET-ILW.
MP8	Li -> B transition	XP	??	No	??	yes?	Li	Determine if B-conditions can be re-established mid-run
MP9	...							

Old slides

FY2016 milestone R16-2 needs baseline data before high-Z upgrade

- Tile design process has commenced
  - Still evaluating pros/cons between W vs. Mo
  - Targeting row-2 of NSTX-U with minimal divertor height changes

- Development of reference, high-Z discharge proposed at previous meeting alongside reference parameter scans (e.g. power, connection length, current)
  - Already expect useful information comparing B vs. Li conditions on graphite substrates (e.g. erosion vs. erosion + diffusion)
  - Expect to repeat discharges with high-Z to simultaneously get 4-point experimental matrix in substrates and coatings

- Reference shape will also provide closer strike-point to MAPP location for material transport and evolution studies

ITPA-DSOL activities have a lot of leverage with high-Z programme at this time

- DSOL-31: Leading edge power loading and monoblock shaping
  - High-spatial resolution IR measurements of existing carbon tile gaps to determine whether heat flux is “missing” in NSTX-U as in JET-ILW
  - Start determining “threat level” to NSTX-U PFCs
- DSOL-34: Far-SOL fluxes and link to detachment
  - Diagnose whether conditions at strike-point enhance cross-field transport into far-SOL to better predict first-wall power loading (e.g. LPs + GPI)
  - Also impinges Particle Control TF and cryo-pump calculations
- DSOL-35: In/out divertor ELM-energy density asymmetries
  - Determine power splitting during ELMs and impact on design margins for PFCs during ELMy discharges

Guidance for writing strong-XPs in the M&P TSG

- Goal: move away from “kitchen physics” branding
- Having the following items indicated in the XP idea submission will get you extra consideration from M&P TSG leadership group
  - Clear, hypothesis-driven experimental proposals
  - Strong partnering with theorists/modelers informing experimental scans/conditions
  - Partnering with surface-science and other materials groups who can supplement tokamak studies with lab measurements
  - Well-defined initial publication strategy including XP partners and diagnosticians
- M&P TSG leadership is here to help!
  - Discussions to date have already started finding potential sticky parts in this, but we are here to help clarify and help make connections

MAPP and LGI presentations…

Ye Olde Slides from pre-forum meeting #1 beyond here

FY 2016 research milestone will drive XP/XMP development (ITPA-DSOL experiments relevant to high-Z upgrade)

- R(16-2): Assess high-Z divertor PFC performance and impact on operating scenarios (joint with divertor-SOL TSG)
  - **Carbon-only baseline needed in FY2015 for comparison**
  - Validate high-Z PFC design in actual operation
  - Establish additional heat-flux mitigation schemes needed for whole-machine high-Z conversion
  - Determine high-Z impurity production/influx and impact on operations and mitigate if necessary
- DSOL-31: Leading edge power loading and monoblock shaping
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- DSOL-34: Far-SOL fluxes and link to detachment
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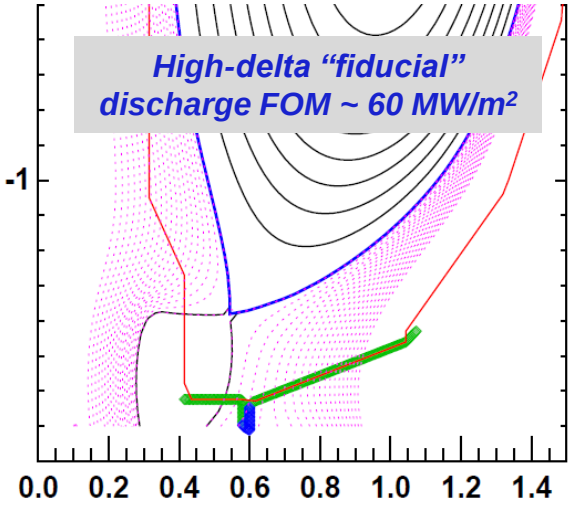
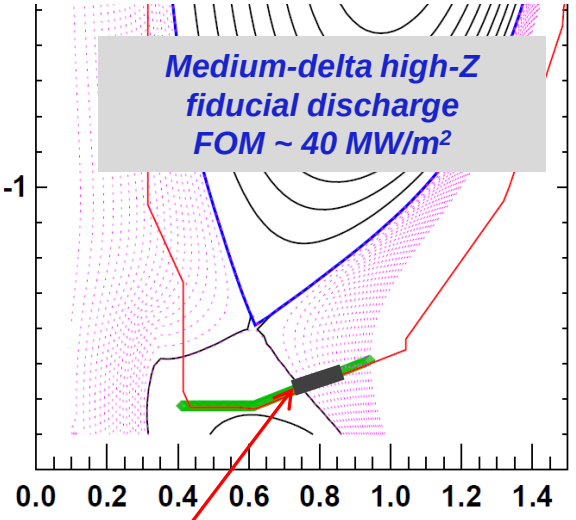
Develop high-Z relevant baseline discharge in FY2015

- Incremental upgrade to high-Z proposed for outboard row 2 tiles
- Proposed figure-of-merit (FOM) for divertor PFC is unmitigated heat-flux to divertor surfaces
  - High-delta NSTX-U reference discharge: P_{inj}~12MW FOM up to 60MW/m^2
  - Medium-delta, high-Z discharge: P_{inj}~9MW FOM up to 40MW/m^2
- FY2015 development of medium-delta shape and create "standardized" parameter scans
  - P_{inj}, q95, divertor gas puffing, B-field and angle-of-incidence, other mitigation
  - Duplicate scans in FY2016 (single variable experiment!)





Critical diagnostics for milestone and DSOL activities

- ASC-support with wall conditioning experiments
  - MAPP characterization of boronization and lithiumization
- Critical diagnostics/capabilities for milestone R16-2:
  - IR thermography for heat flux, including high-spatial resolution view (DSOL-31)
  - Langmuir probe for particle fluxes to divertor under different operating conditions (low-high density, detached, etc.) (also DSOL-34)
  - Visible and X-ray emission spectroscopy to characterize impurity production, SOL and core conditions
  - Managing plasma-surface interactions of boronized and lithiumized high-Z PFCs with MAPP and standard plasma diagnostics
- Additional diagnostics/capabilities would be beneficial:
  - IR view on vertical target for DSOL-35 (or new plasma shape)
  - GPI to support far-SOL effects (DSOL-34)
  - Divertor bolometry for power-balance evaluation
  - MAPP measurements and post-run coupon analysis for material transport studies (support new model capabilities with WallDYN)
  - Surface science studies, e.g. mixed-material sputtering and detailed plasma-exposed sample characterization