NSTX, SNL, UCSD Collaboration to Develop and Operate a Liquid Lithium Lower Divertor

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NSTX 5 Year Plan Boundary Physics Brainstorming Meeting

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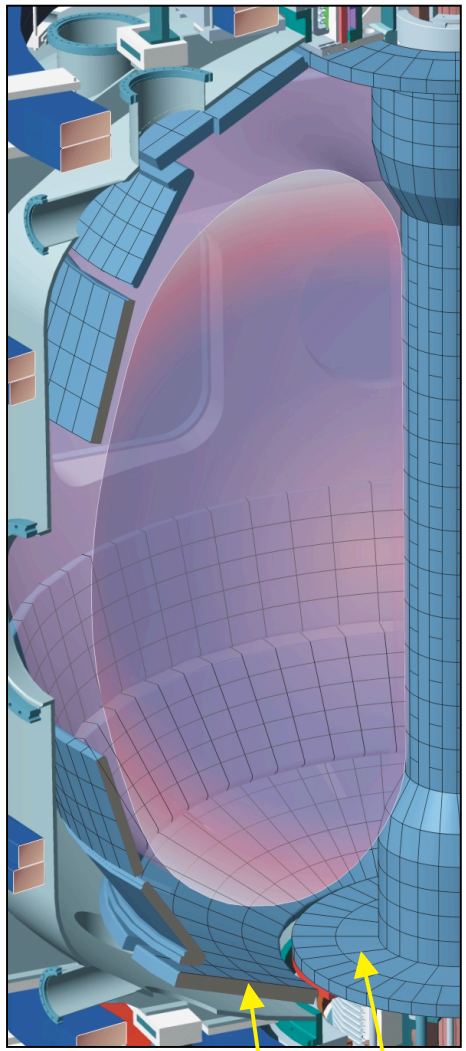
NSTX Is Investigating Lithium for Reduced Recycling Using a 3 Phased Approach: (I) Li Pellet Injection, (II) Li Evaporators, (III) Liquid Li Divertor



- The present 3 Phase NSTX 5-Year Lithium Plan for Particle Control and Power Handling is moving aggressively toward starting the 3rd Phase which will extend into the next 5 Year Plan:

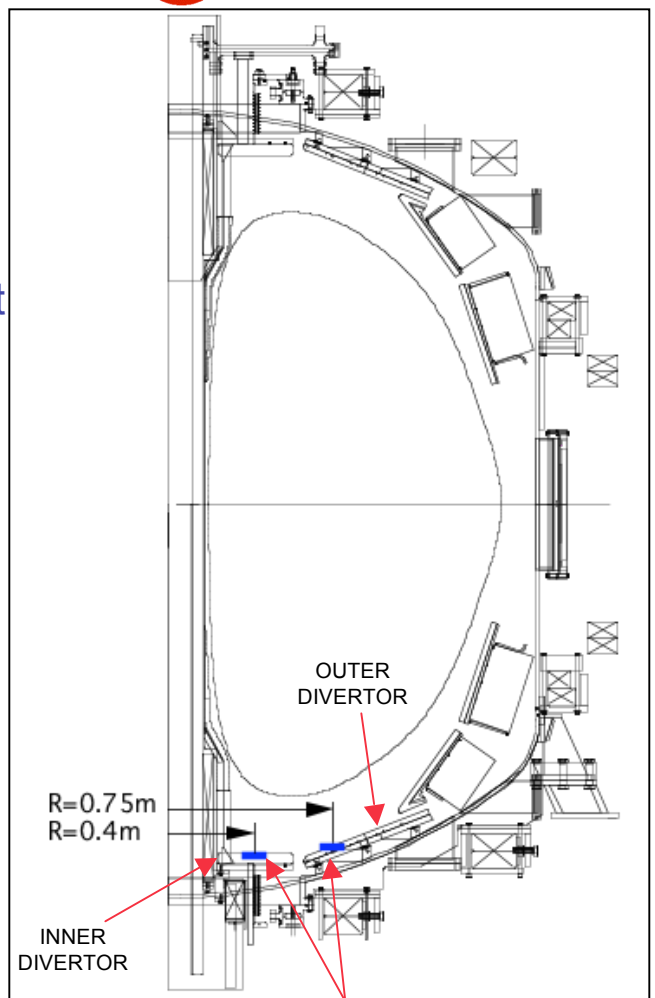
I. Lithium Pellet Injector (2005)

II. Lithium Evaporator (2006)

III. Liquid Lithium Divertor (2008)

- Phase III will enable access to the very low recycling regime for the first time in high power diverted plasmas.

- 2007 Experimental Proposals will investigate open questions using Li Pellet Injector and Li Evaporator.



- Two candidate locations for a toroidal, Liquid Lithium Divertor at lower outer strike-point

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A SNL, UCSD, NSTX Collaboration Will Develop and Operate a Liquid Lithium Divertor for the 3rd Phase Starting in the Present NSTX 5-Year Lithium Plan

- Sandia will supply NSTX with liquid lithium surface divertor hardware for an outer strike point target.

- The collaboration between the SNL and NSTX teams will include the design of the hardware, specification of interfaces and responsibilities, and development of an operational plan, as well as the installation and shakedown of this divertor and participation in experiments in NSTX with this divertor.

- UCSD will participate in the collaboration through a subcontract with SNL and will provide two removable lithium injectors for filling the liquid lithium divertor.

Important NSTX Design Considerations in the Preparation of the SNL, UCSD Hardware for the Liquid Lithium Divertor

- A heating system for the lithium containing modules.

- The initial distribution and wetting of the surfaces by lithium, and mitigation as necessary for the potential subsequent spread of lithium by capillary action.

- Thermal management of the modules and lithium during discharges and plasma disruptions.

- Diagnostics for control, safe operation of the equipment and appropriate data to complement the ongoing experiments, e.g., temperature of the lithium surface.

Lithium PFCs Will Have Significant Positive NSTX Program Impact and May Resolve Outstanding PFC Issues for Future High Power Devices

• CDX-U/LTX achieved very low recycling in lithium limited ohmic plasmas. These noteworthy results (PSI-17, IAEA-06) are promising for the future implementation of lithium plasma-facing components in reactor scale devices.

• NSTX Phase III Liquid Lithium Divertor operation will enable access to the very low recycling regime for the first time in high power diverted plasmas and may yield significant changes in plasma performance.

• After these experiments, the Liquid lithium Divertor design will allow for convenient removal and cleanup for the restoration of high recycling graphite PFC conditions, if desired.

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Present and Next 5 Year Plan Research to Characterize the Performance of the Liquid Lithium Divertor

• In FY09, the NSTX, SNL, UCSD collaboration will initially characterize the performance of the liquid lithium divertor during 2 MW of neutral beam heating at 300 msec pulse lengths.

• Measurements will be performed from low to high volume-averaged plasma densities of the shape of the associated plasma density profiles, recycling, fueling efficiencies, and core electron and ion temperatures, and neutron yields.

• The performance of liquid lithium divertor and plasma conditions during long pulse, high power neutral beam and RF heating will be characterized in the FY10 phase.

Conclusions

- This NSTX lithium research will be the latest step in the decade-long, multi-disciplinary, and multi-institutional US research program to develop lithium as a plasma-facing system that can withstand the high surface heat fluxes and neutron wall loads expected in ITER-like devices and future fusion reactors.

- NSTX is confronting these particle flux and edge heat management issues through its unique program on lithium coatings and its investigation of liquid lithium as a long-term solution for particle and power handling in ITER and future burning plasma fusion reactors.

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