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Recycling, pumping and impurity studies with lithium-coated molybdenum PFCs

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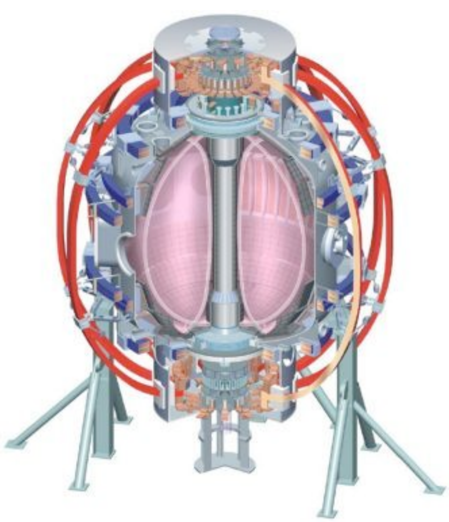
V. A. Soukhanovskii for the postdoctoral research staff member being hired (LLNL)

Acknowledgements: NSTX Team



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Plasma-surface interaction with lithium-coated molybdenum PFCs will be studied in this XP

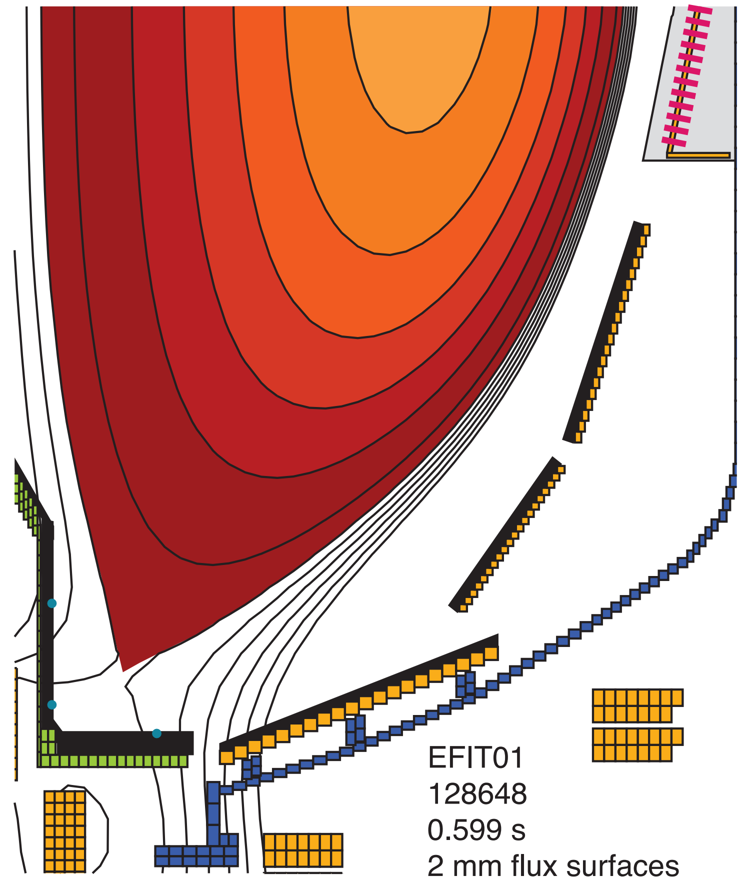
- Three main deliverables anticipated
  - Recycling in inner and outer divertor strike point regions
  - Lithium coating longevity and interaction with ion fluxes in outer strike point region
  - Molybdenum erosion from lithium-coated divertor molybdenum targets and molybdenum core screening
  - (Carbon sources in Scotti's XP)

… as functions of lithium coating thickness, SOL power, divertor ion flux density

- Connect with LITER 2008 and LLD 2010 analysis
- Provide information for NSTX-U PFC options and lithium strategies
- Connect with other divertor tokamak experience
  - Alcator C-Mod – all molybdenum PFCs with boron coatings and lithium pellet PFC conditioning
  - ASDEX-Upgrade – mixed tungsten and graphite PFCs and boron coatings

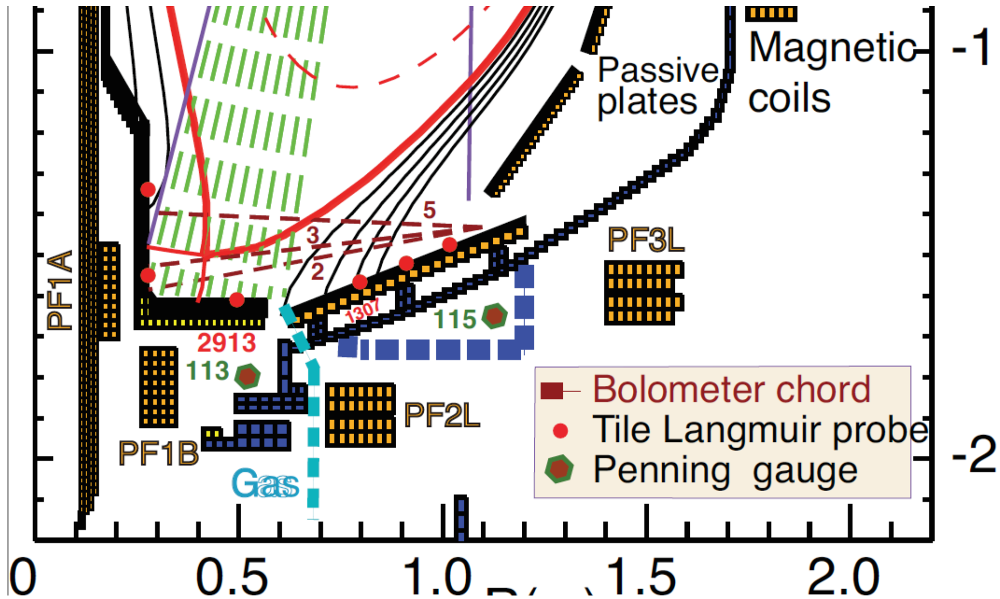
Vary power, ion flux density and lithium rate to study lithium-coated moly PFC

- High-triangularity configuration with PF1B and carbon (inner) and moly (outer) targets, I_p=0.8-0.9 MA, ELM-free ?
- Study neutral, ion, impurity (Li, C, Mo) fluxes and particle balance as functions of
  - LITER rate (10-300 mg / shot)
  - NBI power (1-6 MW)
  - Steady-state ion density values (n_d ~ 1-6 x 10^{19} m^{-3} by HFS+SGI)
  - Response of SOL and/or divertor density to source perturbation
    - Use SGI gas pulses to measure "pump-out" times
- Develop shot sequence vs lithium deposition strategy to document lithium coating life-time



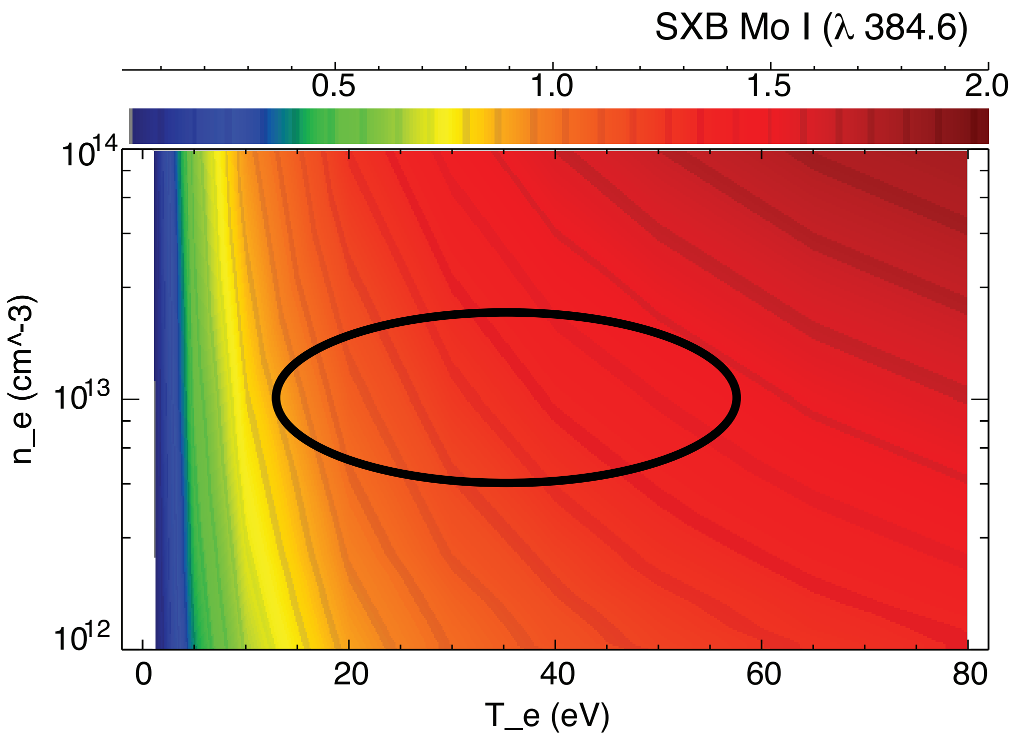
- Repeat if possible in low-triangularity configuration with moly (inner) and LLD (outer) targets

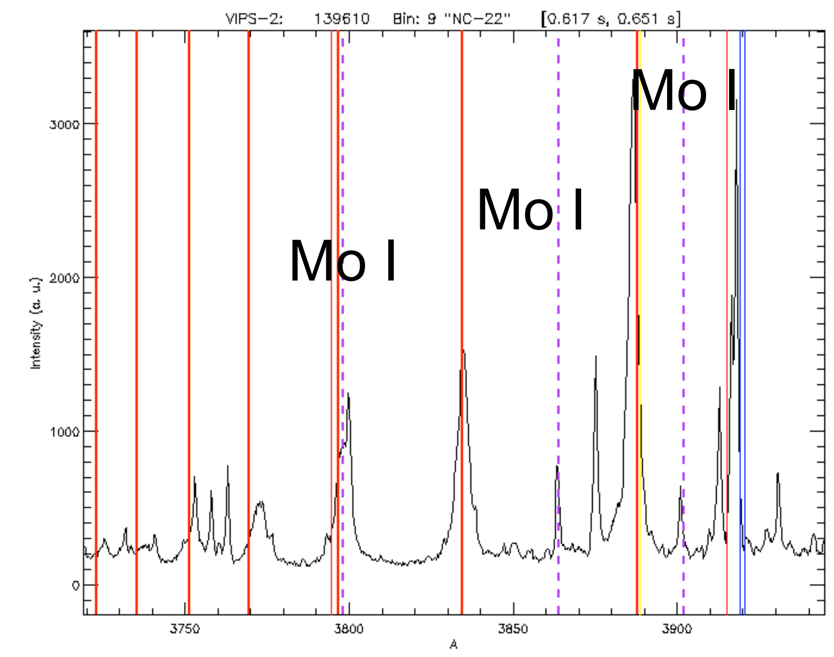
Diagnostic set well suited for divertor recycling and Li, C, Mo erosion measurements



- Key diagnostics
  - D_α , lithium and carbon EIES and cameras for full poloidal coverage
  - Neutral pressure gauges
  - Langmuir probes
  - Divertor spectrometers for moly flux profiles
  - Core soft X-ray and VUV spectroscopy (SPRED, Lowes, Xeus)

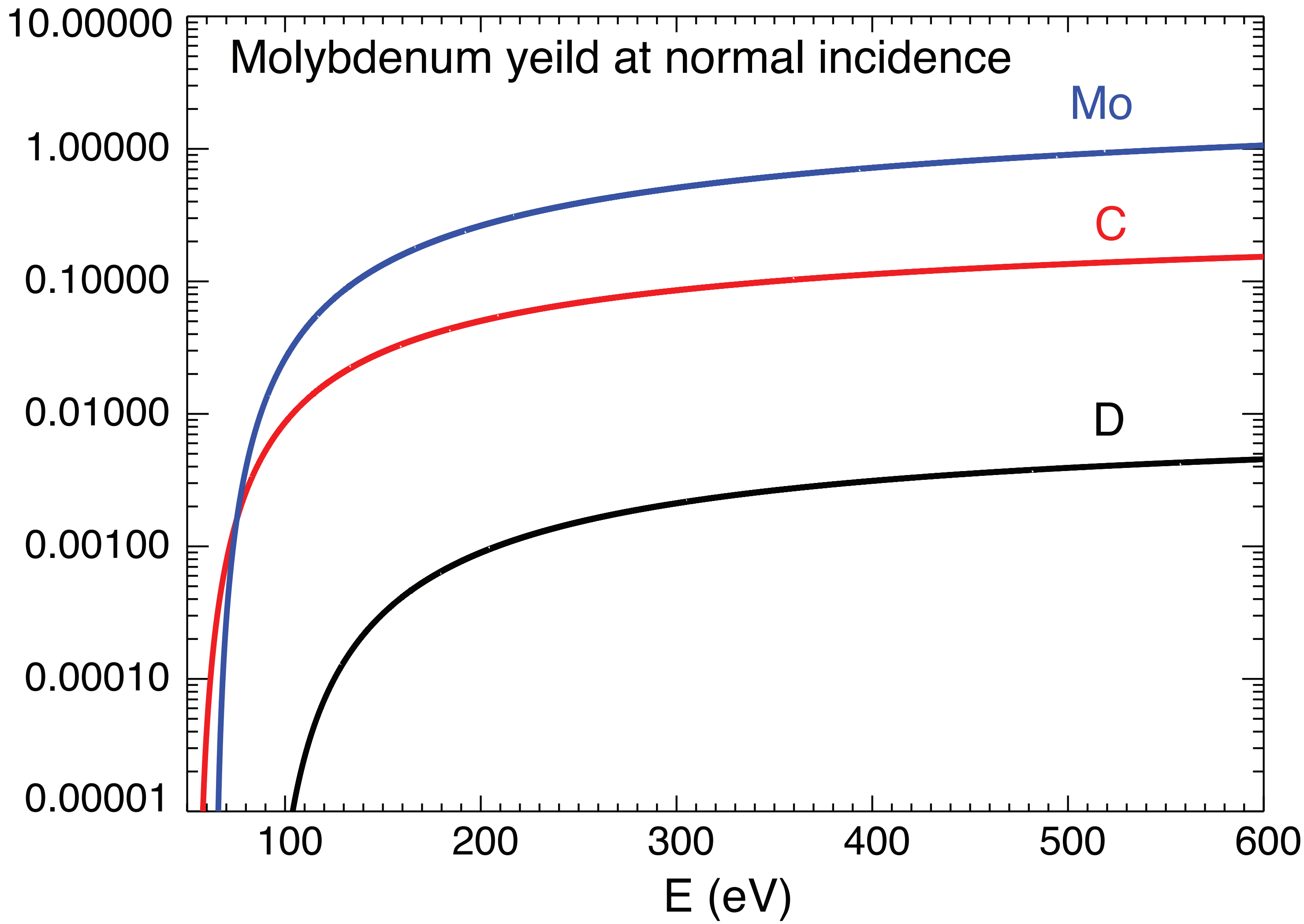
Spectroscopic method to measure particle fluxes is well developed (e.g., Mo here, but applicable to recycling, Li and C fluxes)





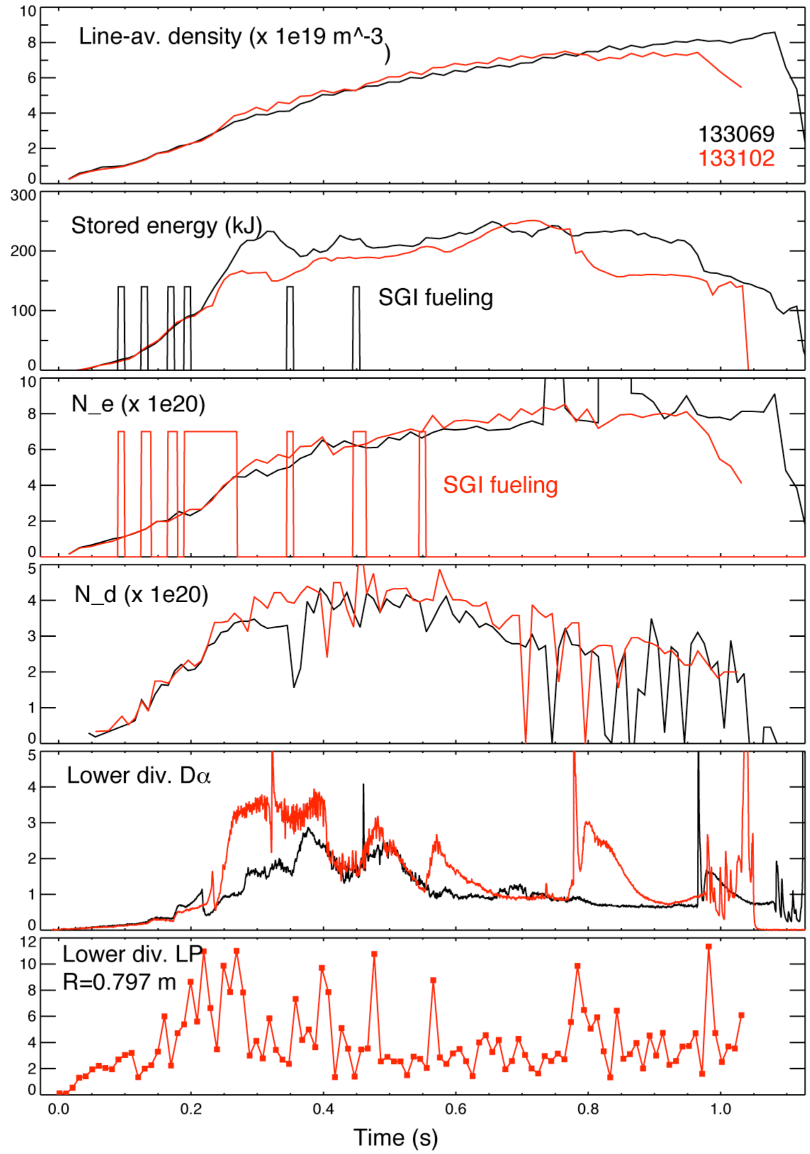
- Prominent Mo I spectral line triplet will be measured with DIMS and VIPS 2 spectrometers
- ADAS S/XB atomic factors will be used to convert spectroscopic measurements to Γ_{moly}
  - S/XB is a weak function of T_e and n_e

Molybdenum erosion can be significant due to self- and impurity sputtering



SGI singular gas pulses will be used to measure "pump-out" (edge " τ_p* ")

- Measure dynamic SOL density response to singular flat-top SGI pulses ("pumpout") at various Li temperatures, plasma densities
  - Use FIReTIP channel 7 (R_{tang} ~ 150 cm) at midplane (n_e)
  - Use divertor Langmuir probes (Γ_i, n_e)
  - Use neutral pressure gauges (Γ_n, n_0)
- Example - Two shots compared
  - 14 mg/min Li evaporation, 10 min clock cycle
  - HFS at 700 Torr + SGI
  - Higher SGI and **lower SGI** fueling rate
- Accordingly, higher N_e, N_d and **lower** $\boldsymbol{N_e}$**,** $\boldsymbol{N_d}$ obtained
  - Carbon inventory the same (not shown)
- Divertor D_α and Langmuir Probe I_{sat} correlated with SGI pulses, showed density pump-out



Discharges without lithium conditioning never showed pump-out with SGI singular gas pulses