Lithium results from LTX

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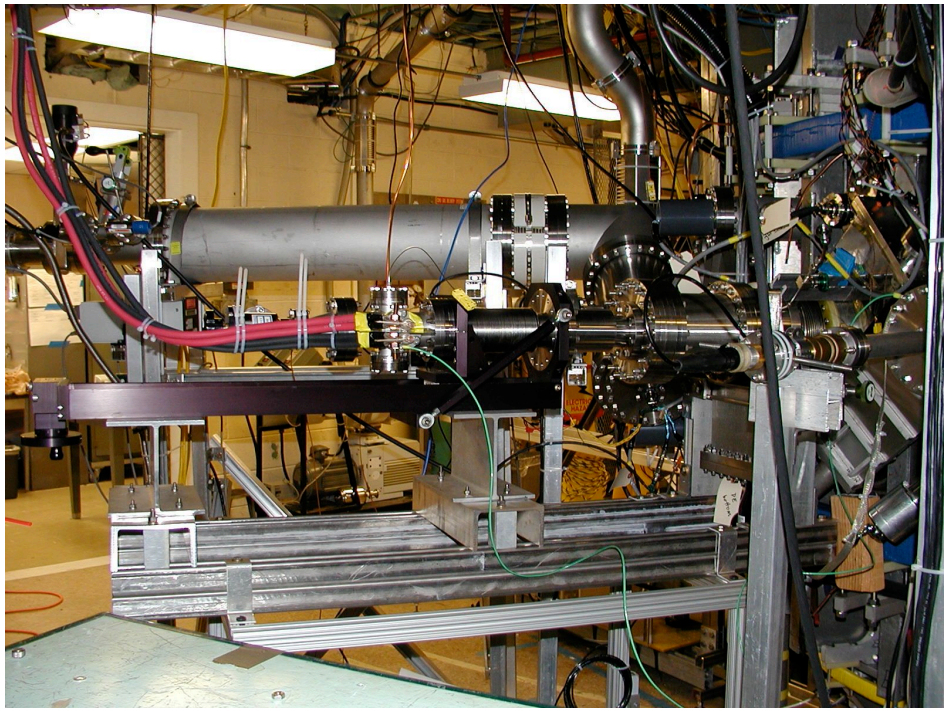
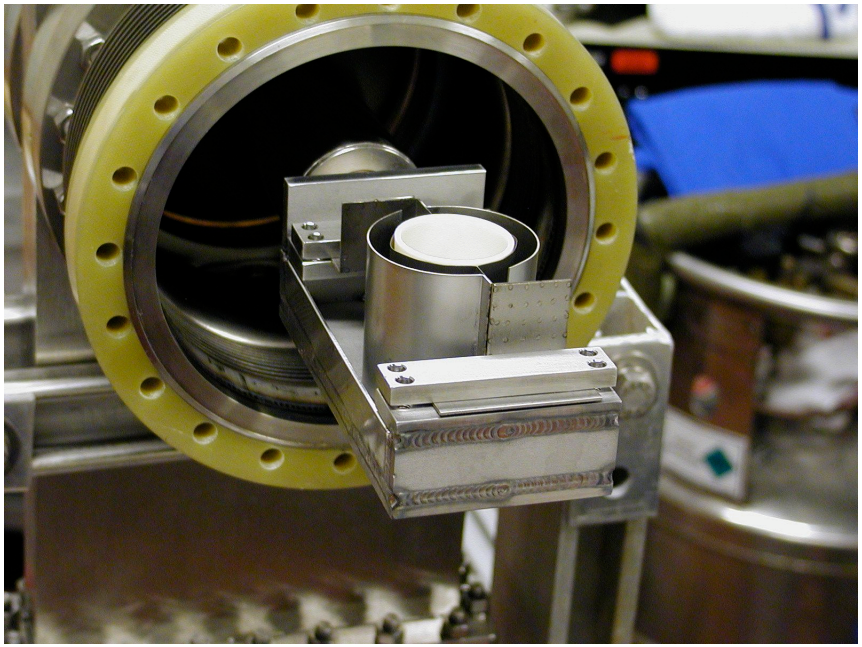
LTX lithium coating systems (2)



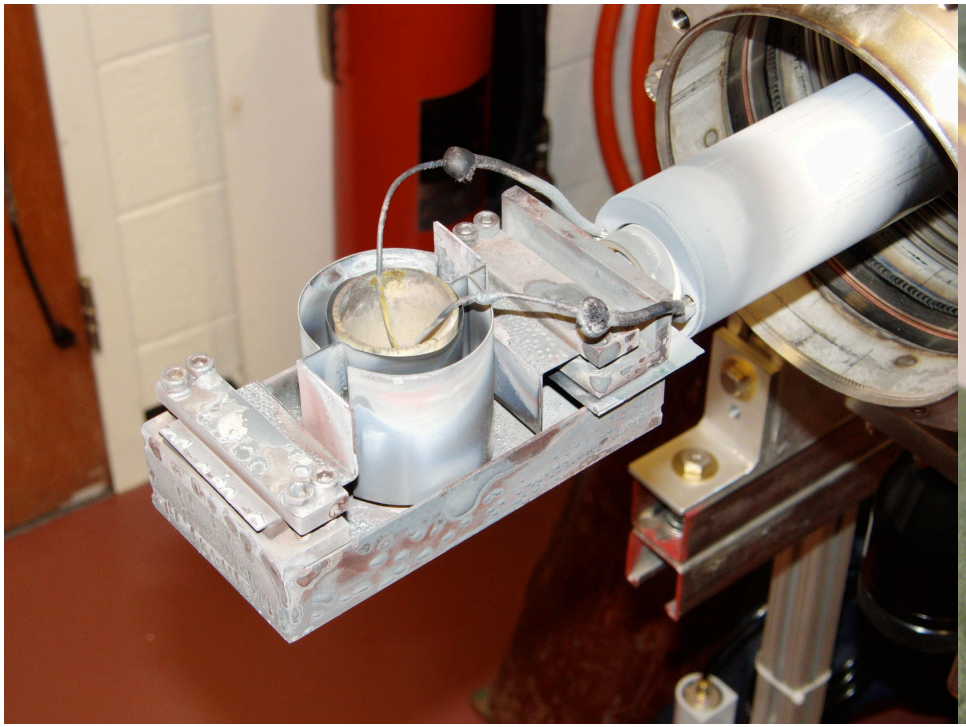
Evaporator (1 of 2) with linear motion stage mounted on LTX

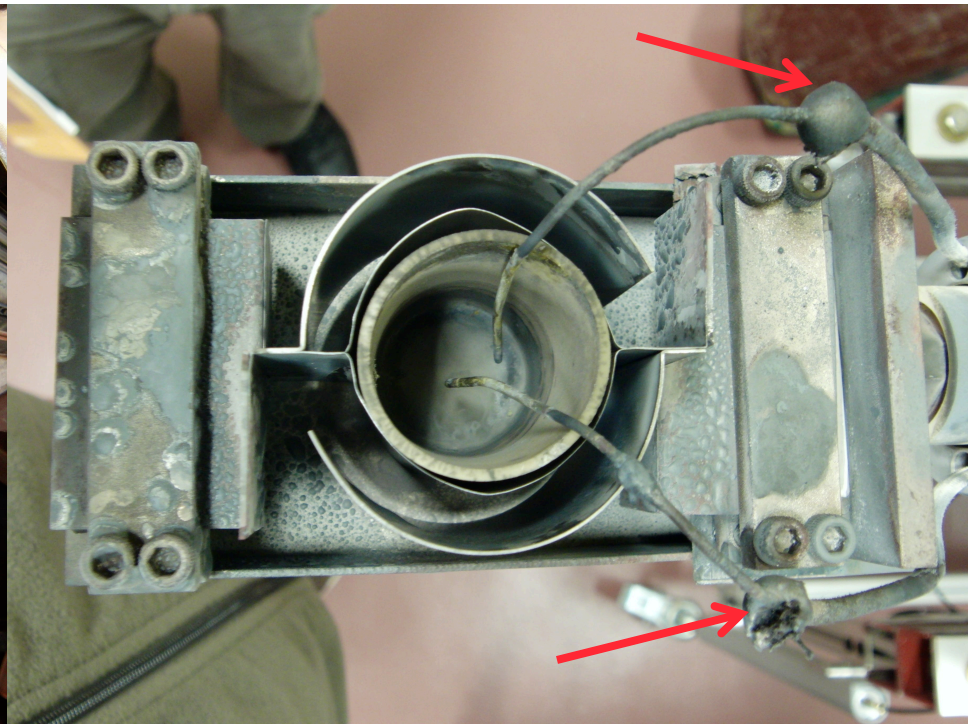


Y_2O_3 crucible, Ta heater
➢Tested to 700 °C

- Two evaporators installed
- Lithium evaporates *upward* if not dispersed
- Total of 10 g evaporated onto walls in first round
  - 30g of lithium employed to date

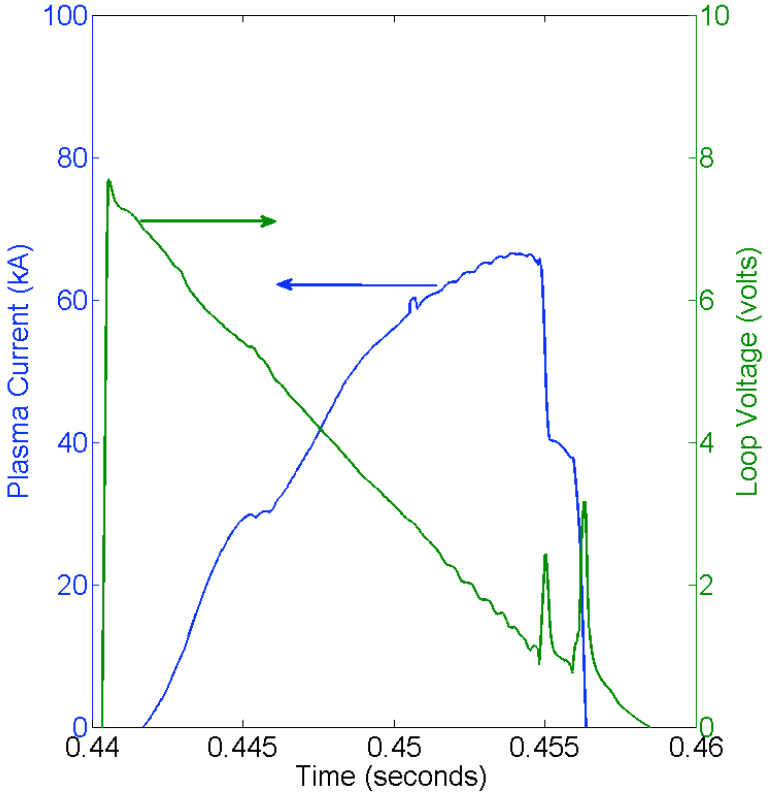
Crucibles and heaters recycled successfully



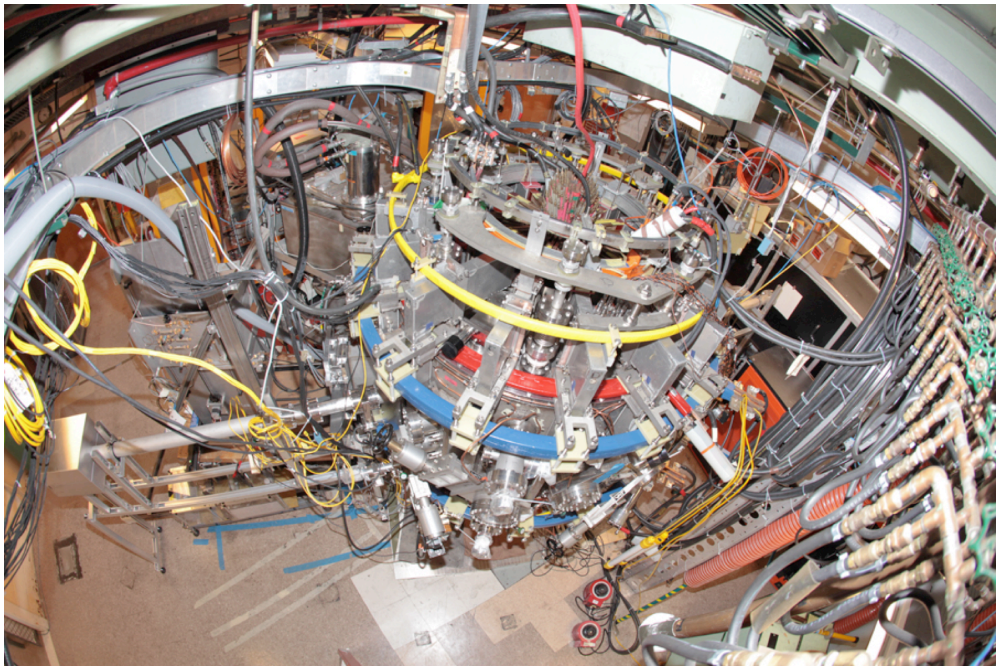


- Cleanup relatively straightforward
- No significant issues with yttria crucibles after 600C operations
  - Lithium did not wet the crucible
  - Thermocouple wetting provided an escape route

Current LTX status

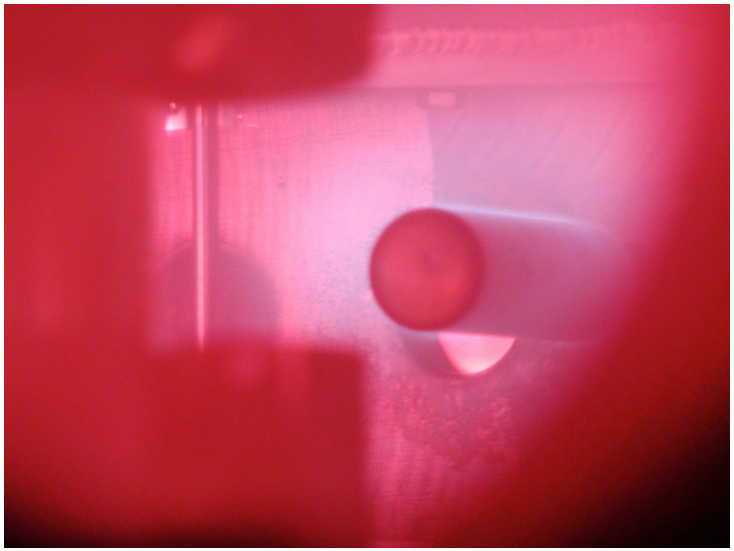


- (Almost) overhead fisheye view of LTX

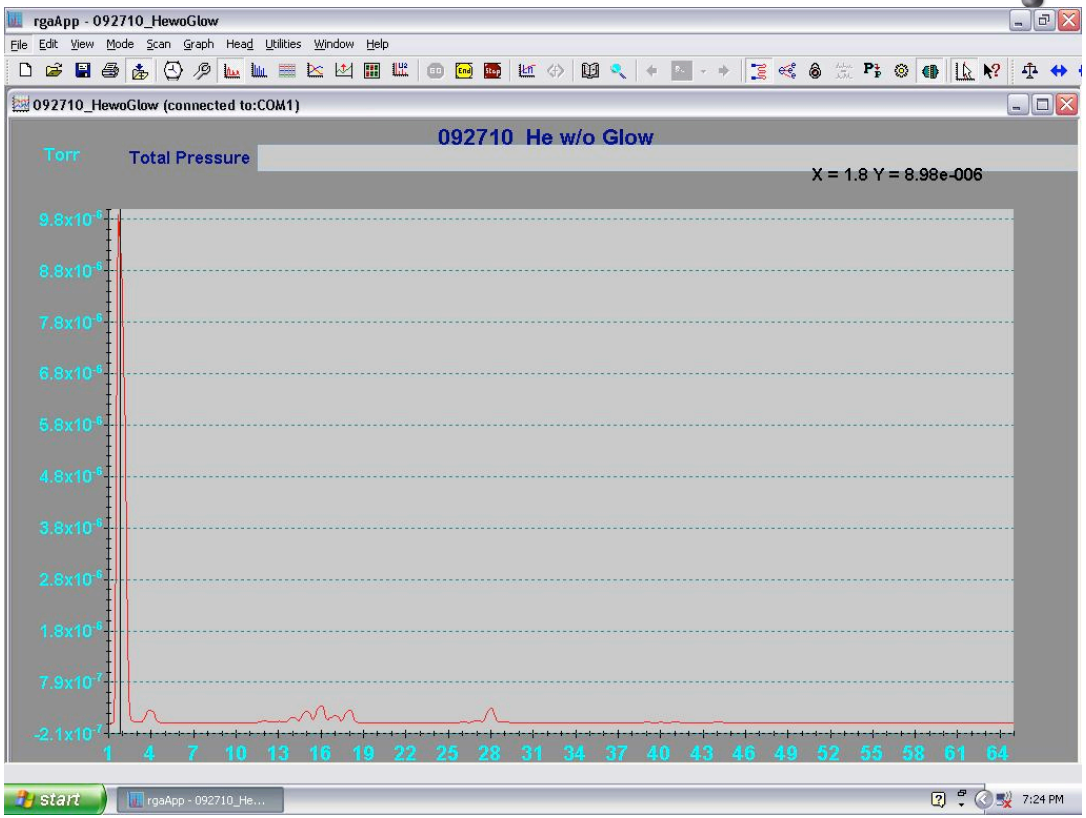


- Plasma current ~70 kA, shot duration ~20 msec
- Multiphase IGBT-based H-bridge supply in operation
- Shells routinely heated to 300 C for bakeout
- Operating with lithium coatings since early October

Lithium initially evaporated into helium glow



Glow probe head
>Lithium-dominated discharge
>Working gas was helium

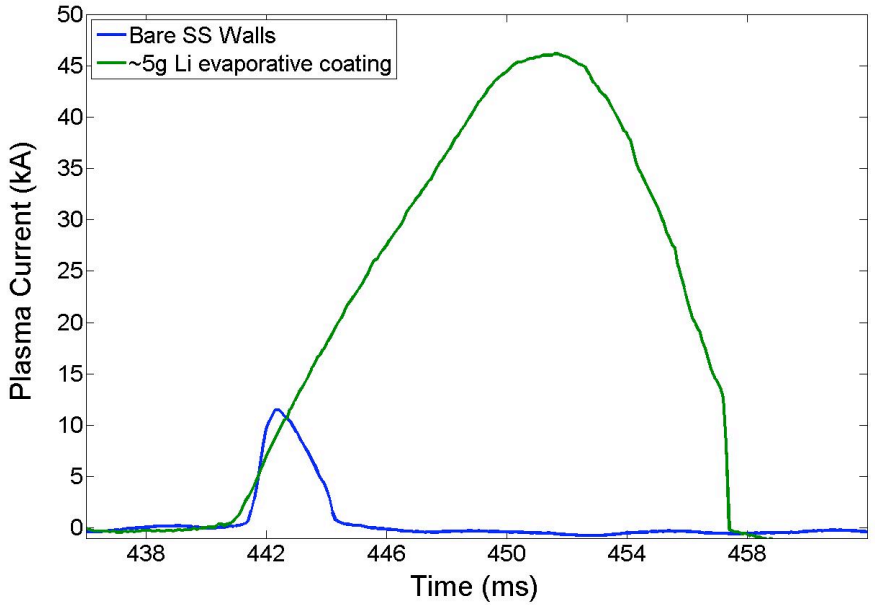


Most recent evaporations used
5 mTorr He gas fill; no glow

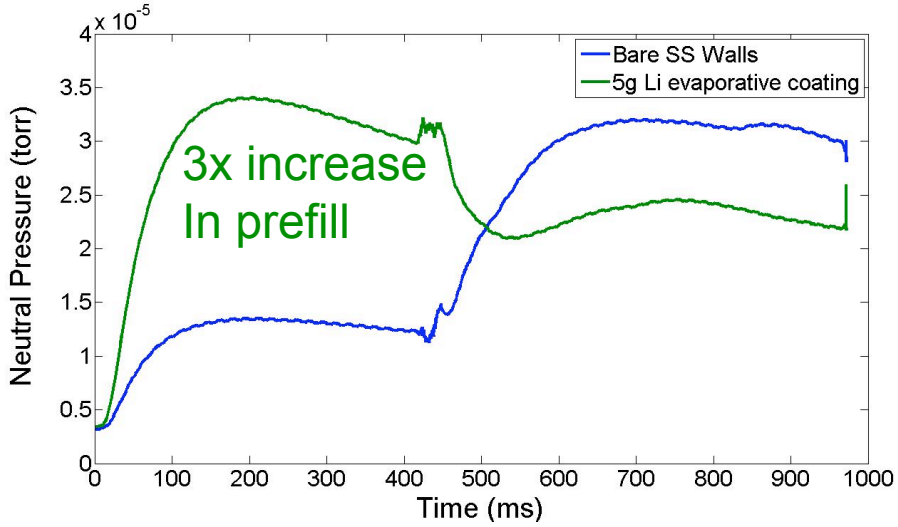
RGA trace indicating lithium gettering of water
>Trace is dominated by liberated hydrogen

- Lithium introduced by evaporation from yttria crucibles at 550 C
- 5 gram load per crucible, 2 crucibles, 1.2 g evaporated in first run

Lithium wall conditioning produced immediate effect on the discharge



Plasma current comparison

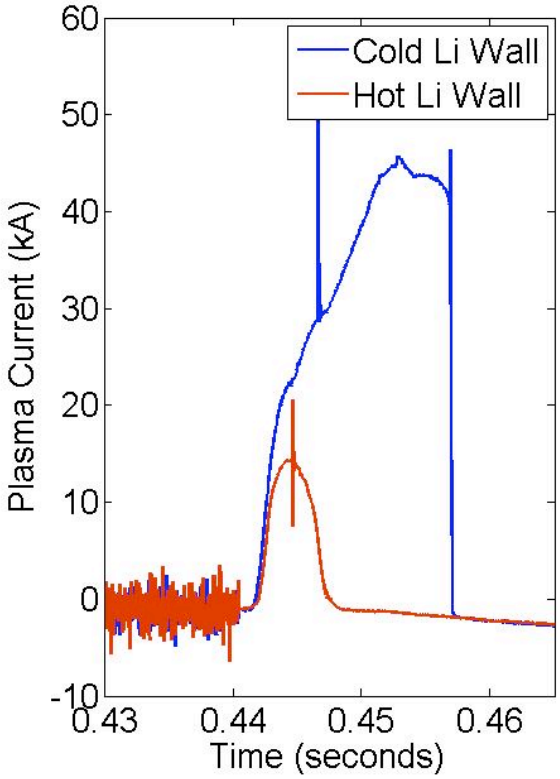


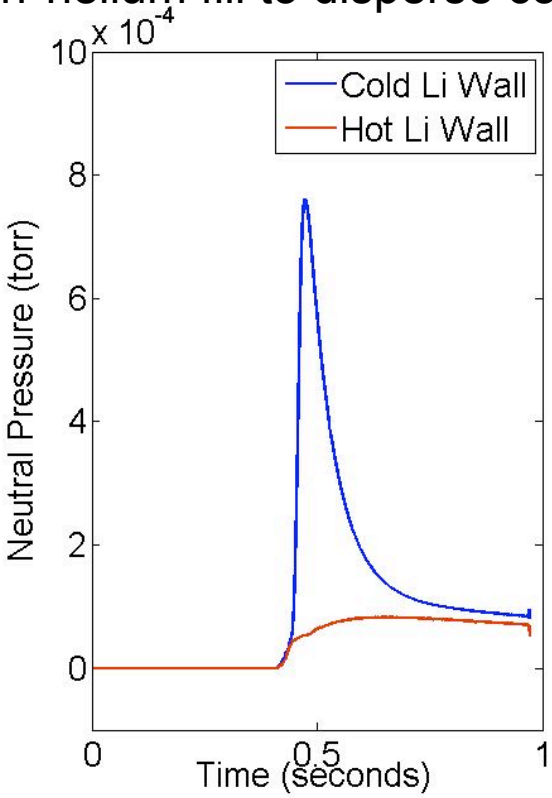
Pressure evolution

- First lithium operation
- Lithium glow preceded by helium glow with hot (250C) walls for preconditioning, to remove water
- Discharge current, duration significantly increased after only a few hours of operation following Li glow
- Pressure history shows recycling is reduced

LTX was operated with a lithium-coated 300 °C shell

- First full high temperature, high Z wall operation of a tokamak
  - Lithium evaporate into 5 mTorr helium fill to disperse coating

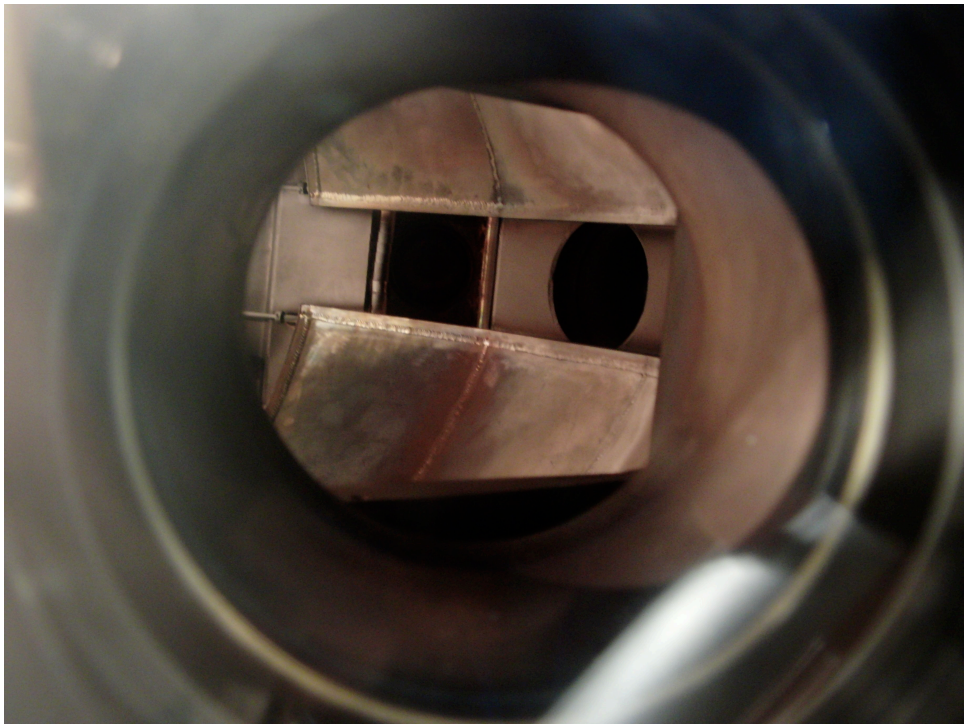


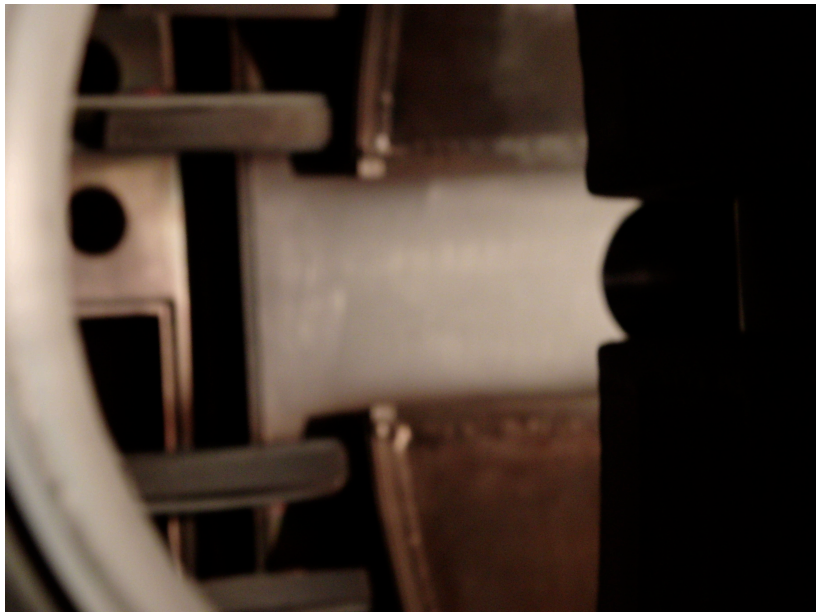


Cluster injector employed for fueling with cold lithium walls

- Hot (300 °C) shell with thin lithium coatings does *not* exhibit reduced recycling
  - Suspect rapid passivation of hot lithium coating
  - Strong lithium emission observed
  - Relevant to NSTX LLD operation ?

Shell interior at 300 °C after 4 g lithium deposition





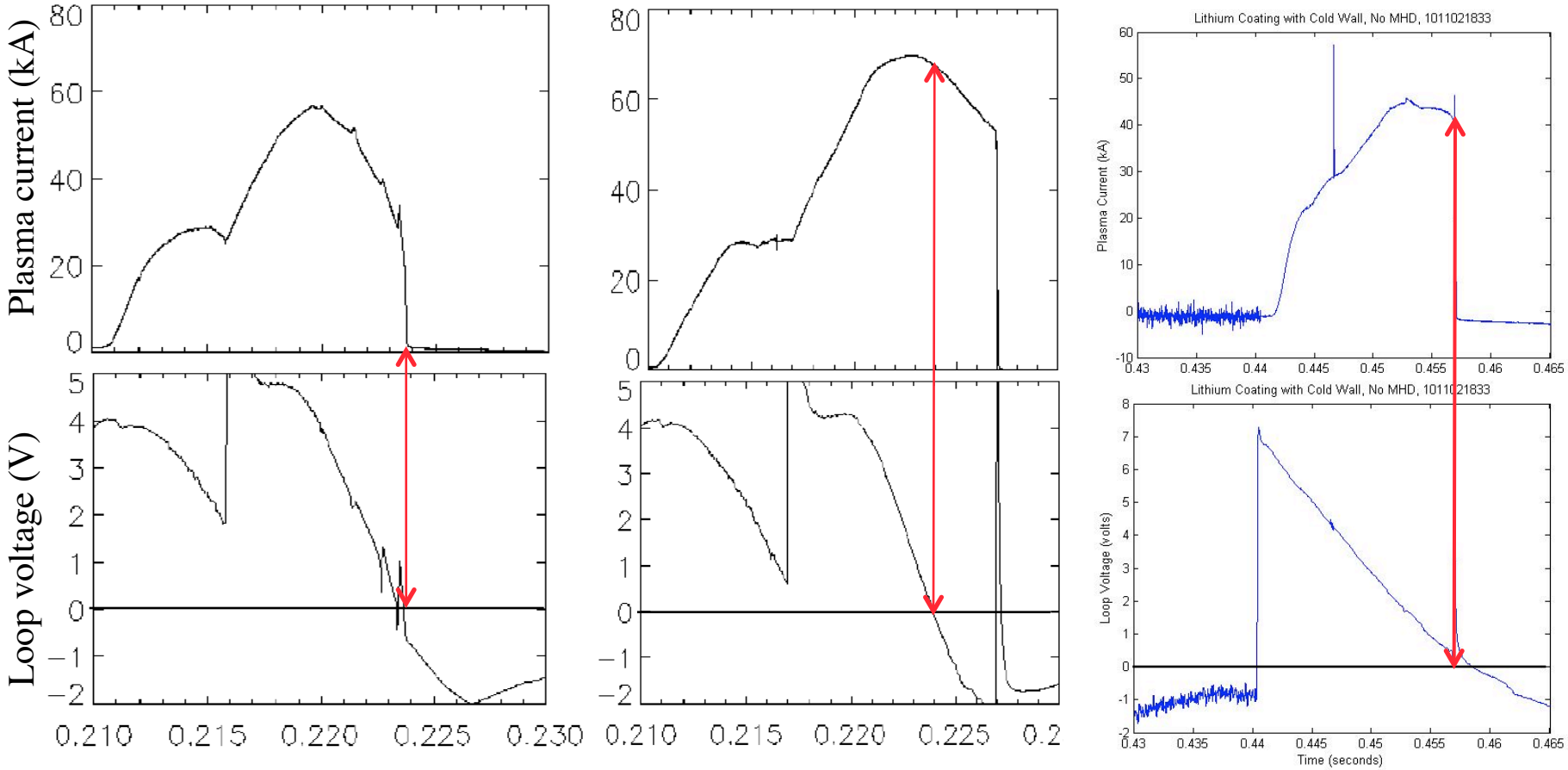
- Deposition rate ~0.75 g/hour/evaporator; 3 hour evaporation
  - Evaporate into 5 mTorr helium to distribute lithium
  - Est. 1.6 micron average deposition layer
- Lithium coating darkens rapidly
  - Indicative of reactions with background gases
- No visual evidence of metallic surface
  - CDX evaporation rate was up to 1 micron/5 minute evaporation cycle

Comparison of plasma current, loop voltage on CDX-U and LTX

CDX-U
Pre-lithium

CDX-U
Lithium tray operation
(300C liquid)

LTX
Lithium wall operation
(cold, solid)



LTX and CDX-U fueling

- Fueling requirements for LTX are approaching CDX-U requirements for low recycling operation
  - LTX: similar shot duration
  - Lower plasma current, density

Total fueling ⇒including prefill