CDX-U

LTX

Lithium evaporators for CDX-U, NSTX, and LTX

Presented by Dick Majeski

R. Kaita, H. Kugel, D. Mansfield, J. Timberlake *PPPL*
D. Rodgers, *Drexel University*

PFC meeting
3-5 May 2004
University of Illinois - Urbana

Evaporators for the application of thin lithium films to PFCs

CDX-U

LTX

- Electron beam evaporators
  - Rapidly spot-heat a solid evaporant
  - Can easily produce 1000Å lithium films at 1m in <30 sec (demonstrated)
  - Commercial sources cannot be used as-is
    - » All use permanent magnets, magnetic materials
- Resistive evaporators for thin lithium films
  - Sources are commercially available (R. J. Mathis, etc)
  - Tantalum or molybdenum boxes; spot welded construction
  - The evaporation can be accomplished in 3 - 5 minutes
  - 40 - 80 coatings inventory fits in evaporation boat
  - Boat can face up, down or horizontally
  - The operating temperature is reasonable: 542 C = 815 K
  - The power requirements are reasonable: 270 A, 439 W

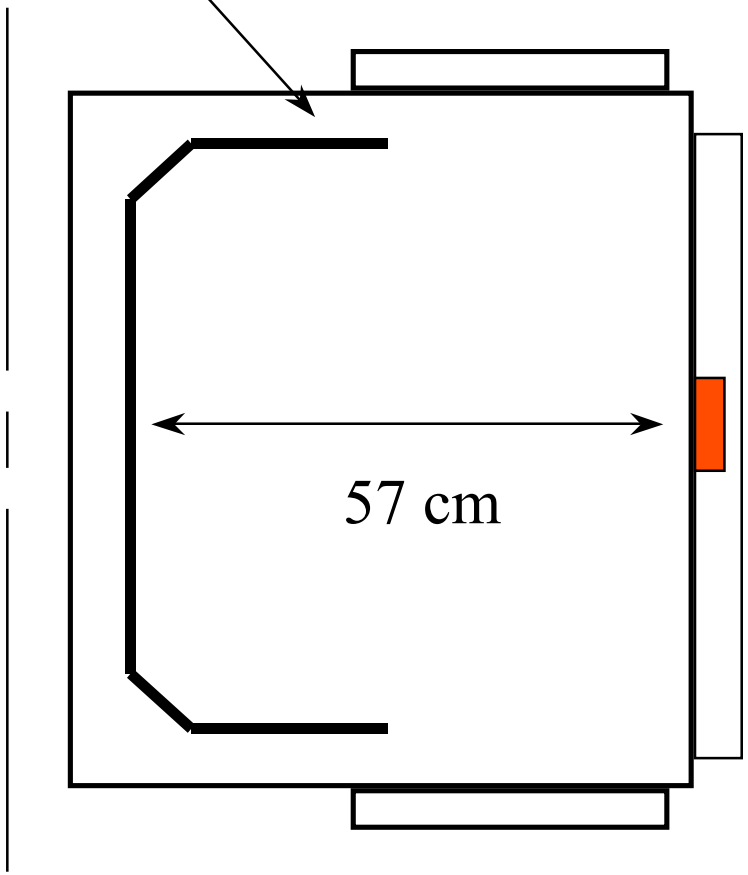
PPPL

A *poloidal* limiter will replace the present *toroidal* lithium limiter in CDX-U this summer

CDX-U

LTX

107 cm x 15 cm = 1,600 cm^2



Assumed Location of Evaporator

Limiter Solid Angle:

$\Omega = 1600\ cm^2 / (57\ cm)^2$

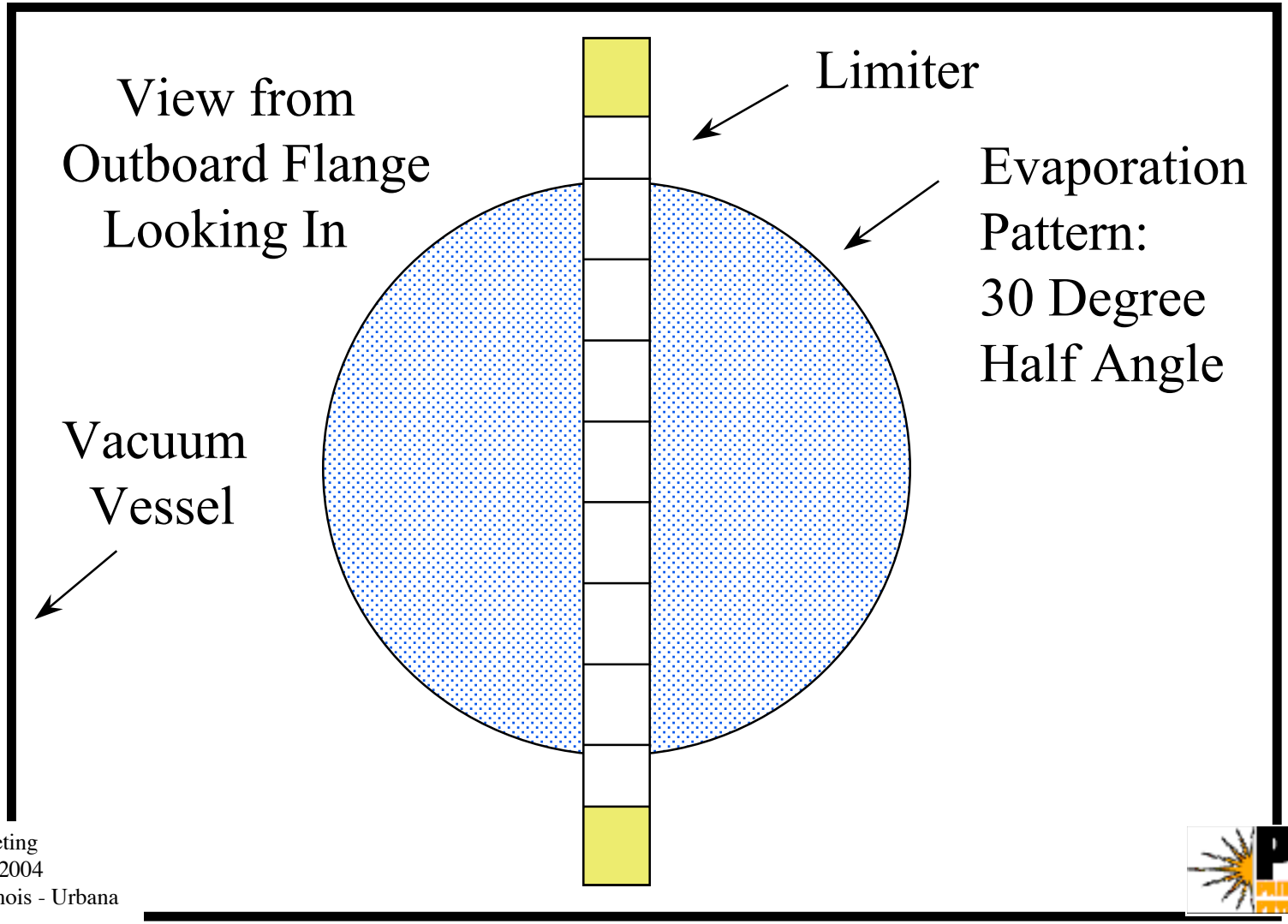
$\Omega/2\pi = 0.08$

PPPL

90 % of Evaporated Lithium Will Miss the Limiter (Baffling Will be Needed)

CDX-U

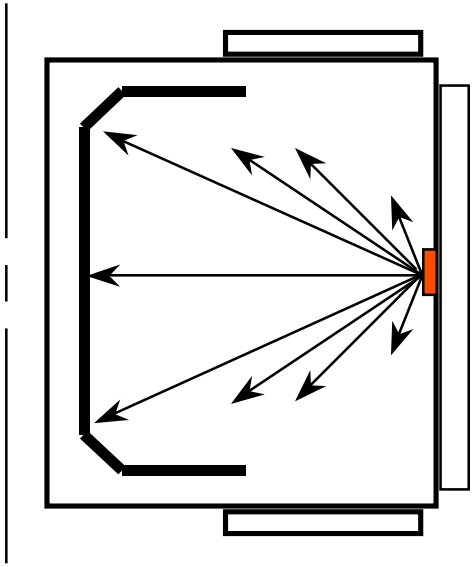
LTX



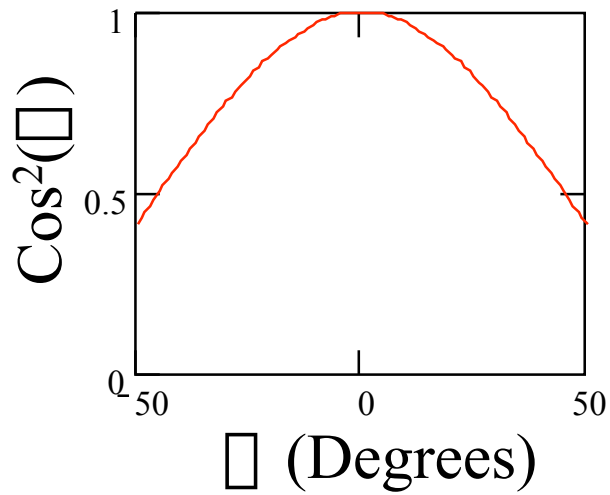
PPPL

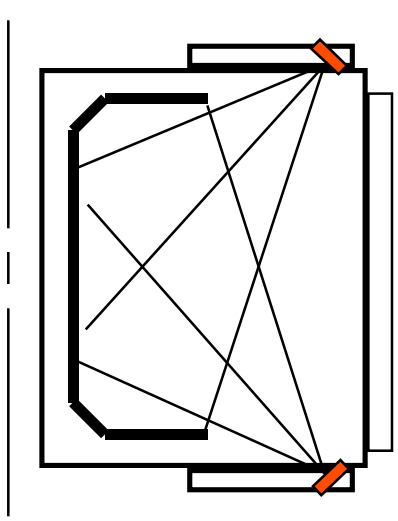
Angular distribution with a single evaporator is sufficiently uniform

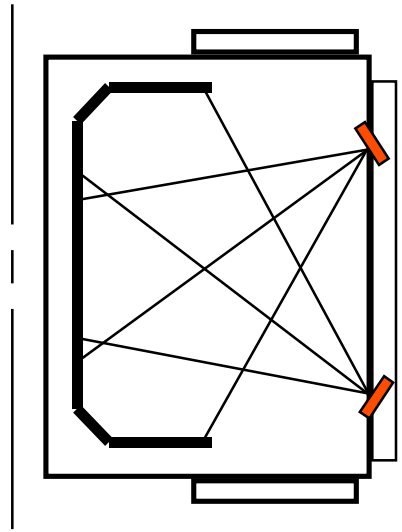
CDX-U



- Deposition rate $\cos^2(\theta)$
- Approximately uniform deposition for θ = +/- 30°
- Multiple evaporators are possible



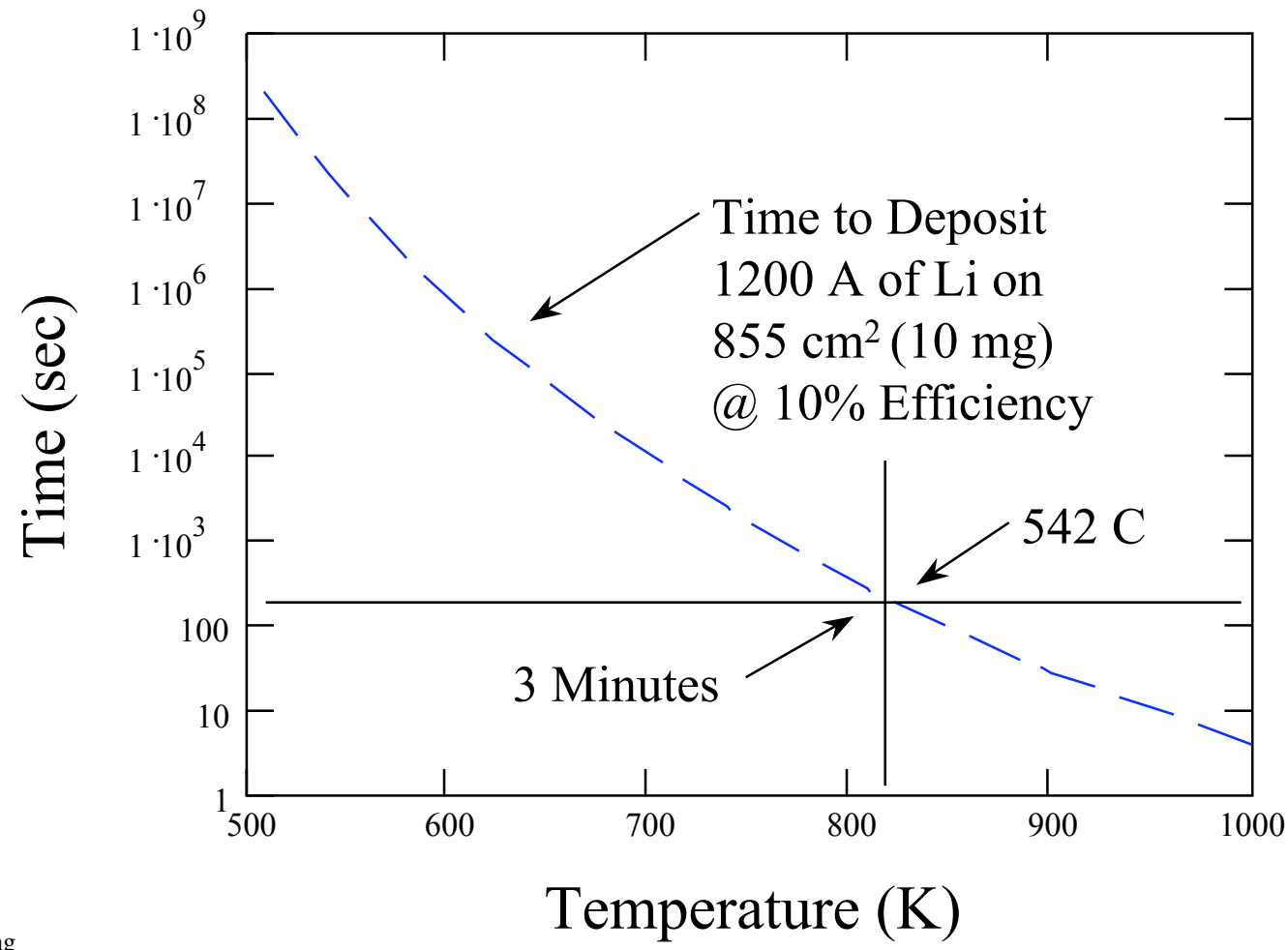




A standard Mathis evaporator operating at modest temperature could uniformly cover half the CDX limiter in a few minutes.

CDX-U

LTX

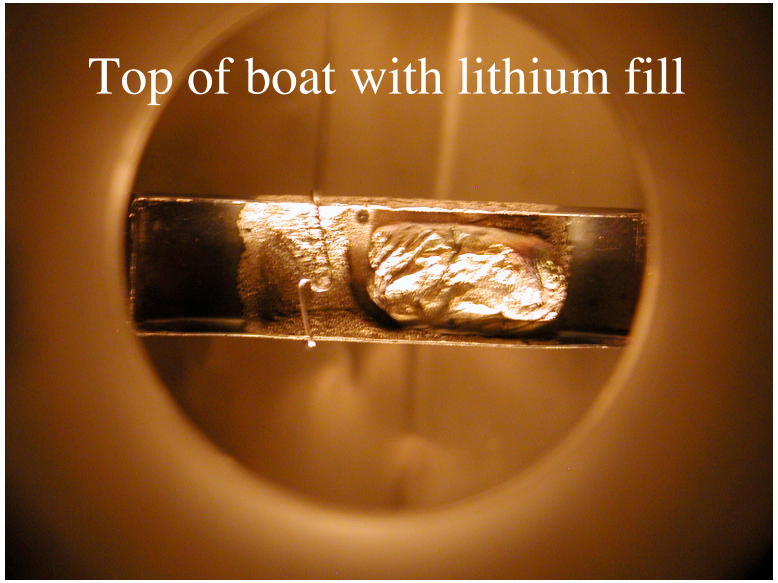


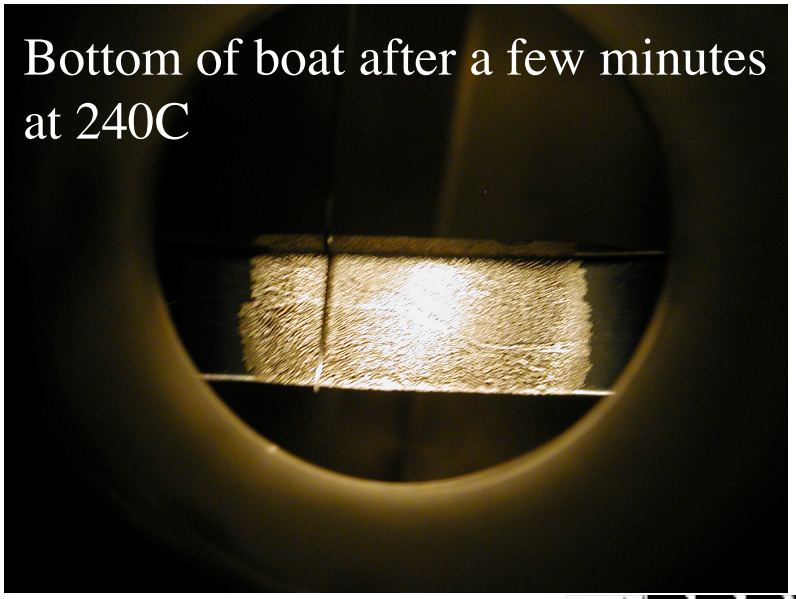
PPPL

Concern:wetting of the boat by the lithium

CDX-U

- Operating temperature for the evaporator is high
  - May promote wetting of the source wall, wicking of the lithium to the outer wall
  - Evaporation from the outside wall will produce a “lithium Ti-ball” instead of a collimated source
- Tests of a simple tantalum boat at 240C are not encouraging
  - Tantalum wetting by lithium at low temperatures would make it a desirable substrate for thin-film coatings

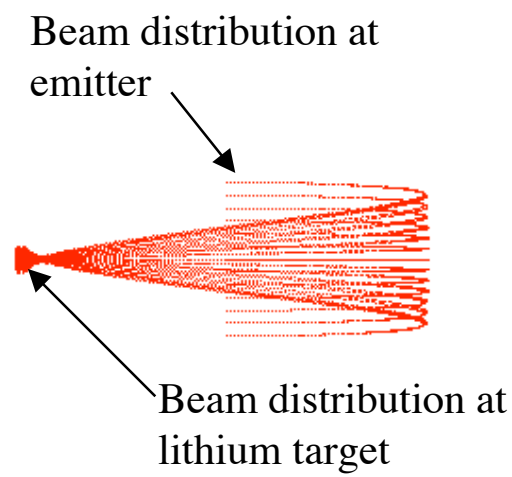


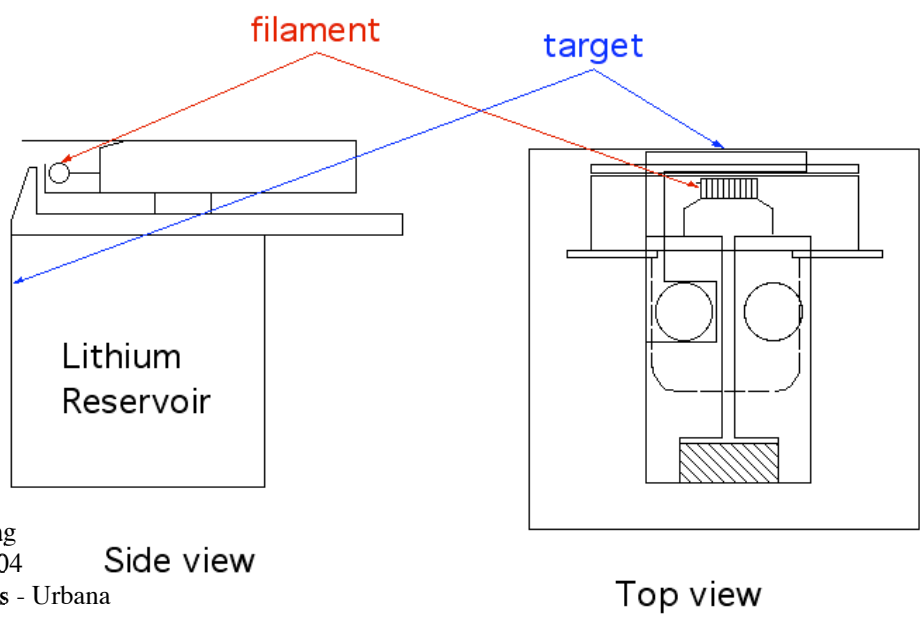


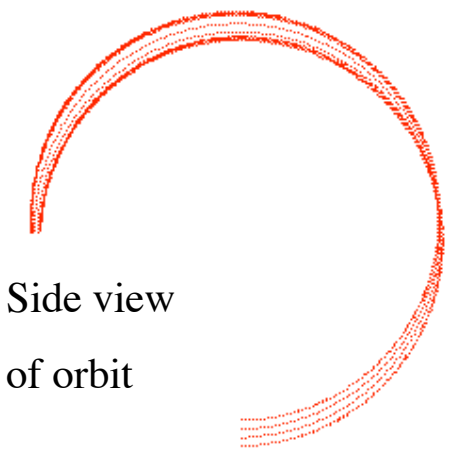
E-beam evaporator work is continuing

CDX-U

- Approach: Duplicate emitter construction of our commercial evaporator
- Utilize either toroidal field (at low levels) or poloidal field coil set to provide magnetic field
- Utilize a sintered porous metal lithium-loaded target
- Constructed a simple model for electron beam orbits
  - Shows focusing of beam after 270° transit
  - Work by D. Rodgers, Drexel University (senior thesis)







Summary

CDX-U

LTX

- We are about to begin tests of the resistive evaporator
  - Start in a very small argon filled chamber
  - Transition to the vacuum test stand shown
- E-beam system is also in development
  - Lithium-loaded porous-metal reservoir will provide evaporant
- CDX-U will need a system later this summer
- NSTX tests have been deferred to next FY

PPPL