Summary
Session VI. Innovative Lithium Applications

H. Kugel

2nd International Symposium on Lithium Applications for Fusion Devices,

Princeton, April 27-29, 2011

Study of Processes of Hydrogen Isotope Interaction with Lithium CPS

I. Tazhibayeva

- Experiments were performed to obtain the main parameters of hydrogen isotope interaction with lithium Capillary Porous Systems (CPS).

- Influence of atmosphere gases leak (permissible leak of ~$1.77*10^{-12}$ Pa/(m^3s)) on interaction rate of hydrogen isotopes with Li CPS was measured: decreased the rate of hydrogen absorption by at least 1.5 times.
  - This effect can be explained by interaction of atmosphere gases with liquid lithium and formation of poorly soluble films in lithium.

- The measured parameters of hydrogen isotope interaction with lithium CPS were used to calculate the rate of deuterium (hydrogen) supply into KTM during the pre-start mode.

- Future Work: Li technology application for fusion power reactor
  - Influence of neutron irradiation on parameters of hydrogen isotopes interaction with Li CPS
  - T and He generation and release in/from Li CPS under neutron irradiation

Ruzic et. al. - Lithium/Metal TEMHD Trenches

- Experiments have shown that TEMHD can remove heat fluxes using flowing lithium. Lithium flows fast enough to present a clean surface to the plasma, ready to absorb D.
- The more heat that hits the lithium, the faster the LiMIT system will take the heat away. TEMHD may be able to be used to drive flow in return legs as well to overcome magnetic drag from high fields.
- Both LTX at PPPL and HT-7 in Hefei have expressed interest in testing this LiMIT concept soon. It would also be possible for the NSTX upgrade.
- Using TEMHD to remove high-heat-flux may allow a low-recycling, lithium PFC solution for the future of fusion which could lead to a smaller / cheaper / better reactor.

Design Guidance for the Flowing Lithium Systems in Tokamaks,

L. E. Zakharov

The development and implementation of the LiWall Fusion regime for tokamaks has a reliable reference option, i.e.,

a slow (1 cm/s), thin (0.1 mm) LiLi layer at the top of the heat sink

*The use of flowing LiLi for power extraction **is not vital** for LiWF and represents an unnecessary complication.*

For HT-7 (a pioneer device in flowing LiLi) the recommendation could be:

1. ***Toroidal flow*** *is relatively simple, but has a lot of issues. It can be used as a first step in implementation of LiLi replenishment between plasma shots and as a transition to*
2. ***Poloidal flow of a thin LiLi layer which has multiple advantages:***
   - (a) *The Reynolds number is negligible.*
   - (b) *Flow can be developed without use of magnetic field (on the workbench)*
   - (c) *Flow thickness is in the sub-millimeter range.*

     The side walls are not necessary
   - (d) *Flow velocity is in sub-centimeter/sec range.*
   - (e) *Flow rate for LiLi replenishment is miniscule (2 cm^3/s)*
   - (f) *Flow dynamics is dominated by viscous effects.*
   - (g) *Except unknowns related to the currents from the plasma to the flow, the flow is predictable. Viscosity can protect the flow from unknown effects.*

Poloidal option is consistent with major requirements for the flowing LiLi systems for existing stationary tokamaks and for the next step devices.

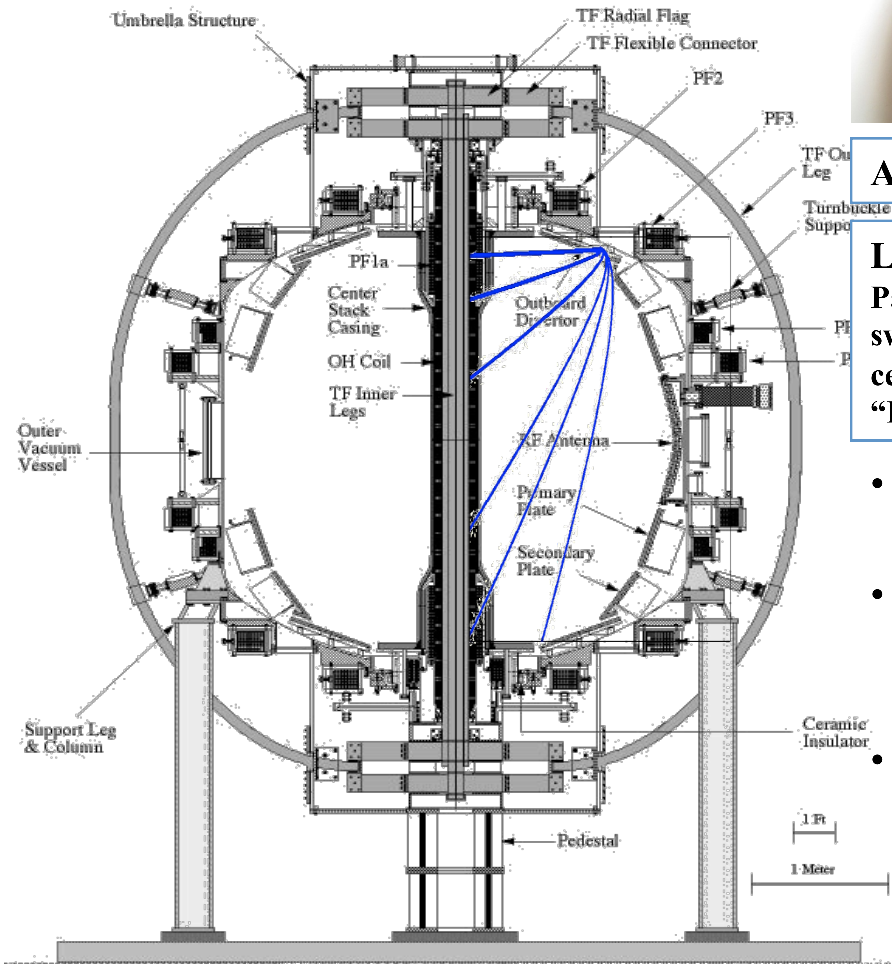
Centrifugal Li Granule Injection
(Can Injected Lithium Granules Trigger ELMs?)

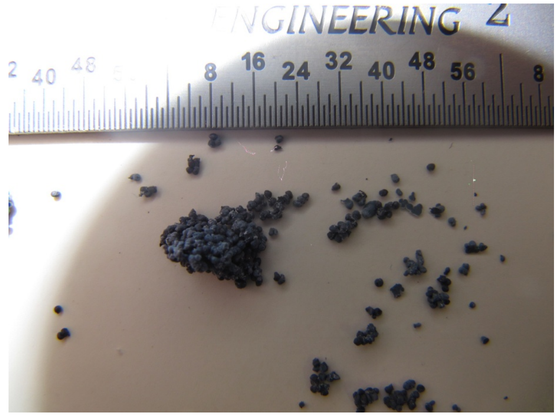
D. K. Mansfield

- Injecting small, slow Li granules should trigger ELMs
- A simple prototype injector allows scans of size, speed and frequency so ELM physics can be explored efficiently
- Long-pulse injection possible for Dia = 0.2 - 1.5 mm,
  Vel = 0 - 100 m/s, Freq = 0 - 500 Hz
- This concept allows other non-cryogenic “pellets” to be injected (Li, LiD, Be, B …)
- “Synchronized engineering masterpiece” will follow…

Electrostatic Lithium Injector – ELiI
D. Andruczyk

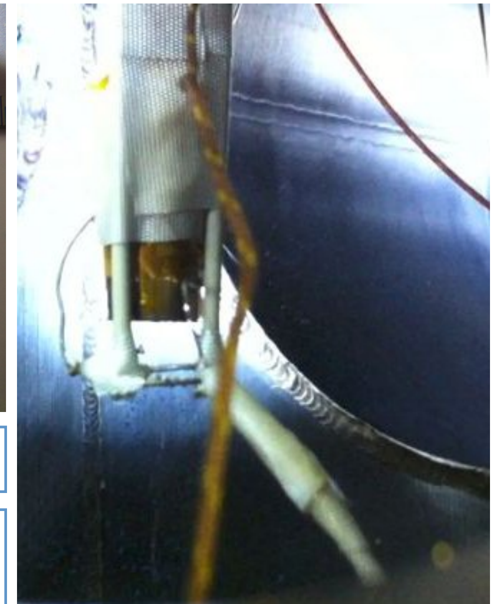
- Based on the electro-spray concept.
- Shows promise of being a novel way of coating the inside of a Fusion reactor.





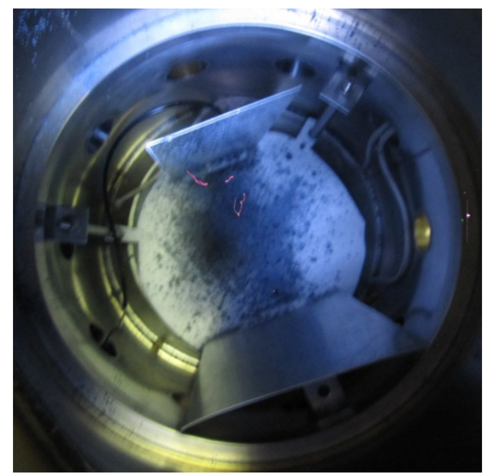
Above: **droplets produced by ELiI**

Left: **Modelling of the charged Li Particle trajectories shows that by sweeping the voltage bias on the center-stack will enable it to be "Painted" by ELiI**



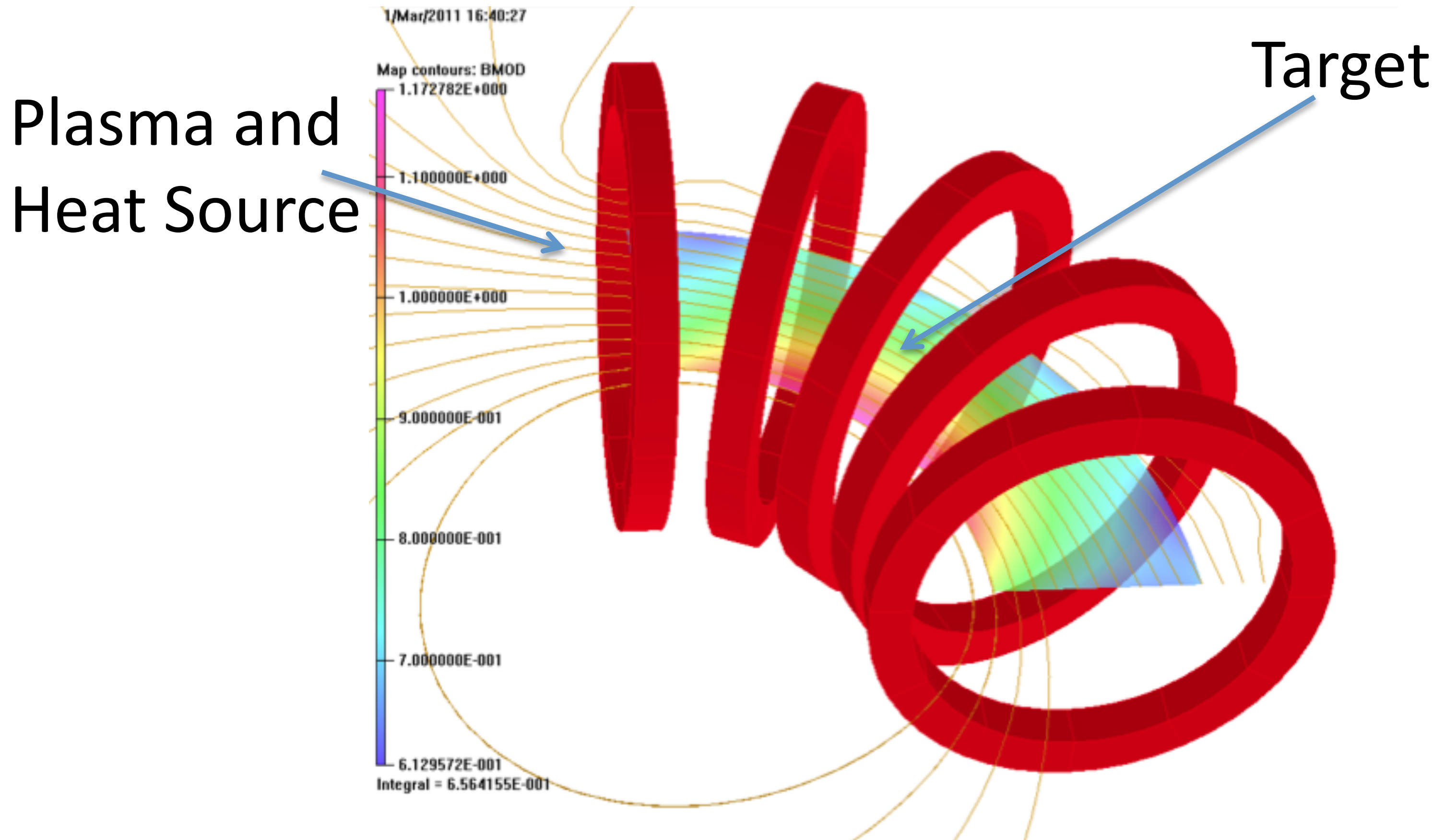
Above: **The ELiI Prototype producing a spray of Li**

- A prototype ELiI has been developed at UIUC **[Andruczyk, Session VI].**
- Initial Modelling shows that sweeping the bias of the centre-stack of NSTX can **"PAINT"** the inside.
- Initial results show a spray produced with daughter droplets between **50μm** < **d** < **1000μm** in diameter.



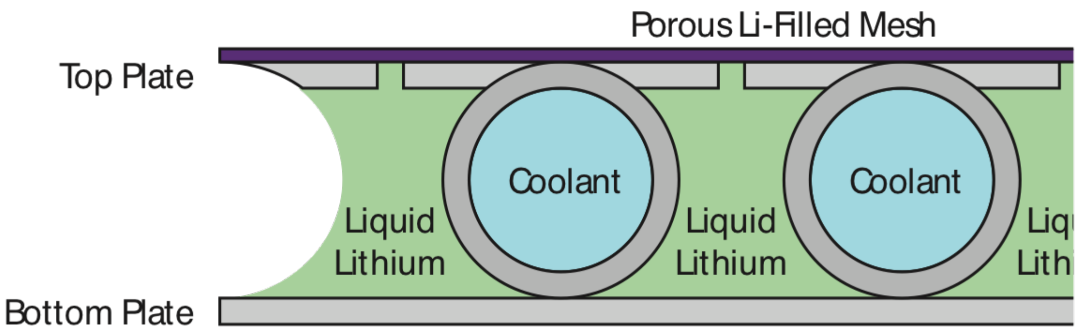
An Integrated PMI-PFC Test Stand

R. Goldston

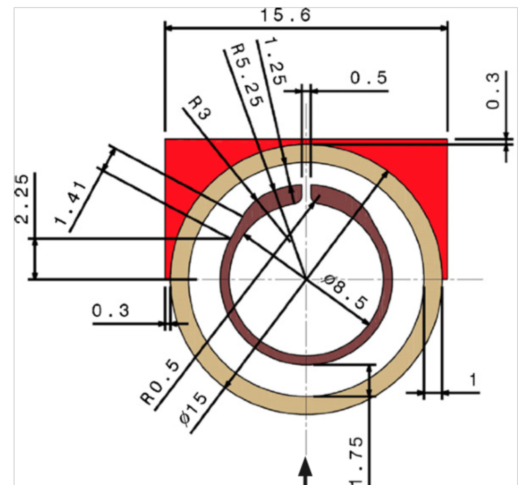


- **This would be a major step along the path to implementing liquid lithium systems in fusion energy systems.**
- **It is not simple to simulate even current experiments.**

Liquid-Li Divertor Concept **Y. M. Goh**



Ihli et. al: **Design and performance study of the helium-cooled T-tube divertor concept**



'Soaker Hose'-Style Liquid Lithium Divertor
'Coolant': Simple Turbulent Pipe Flow or ARIES T-Tube

- Actively-cooled liquid-Li divertor feasible for NSTX-U type heat flux
- 9% heat flux to evaporation with complex solution (T-Tubes)
- 37% heat flux to evaporation with simple solution (turbulent pipe flow)
- Li evaporation effectively clamps system temperatures
- Protects divertor from very high heat fluxes: safety factor/temps O.K.

POSTER: ^{6}Li - An Enabling Material for Fusion, W. T. Rogerson Jr.

- Y-12 National Security Complex, Oak Ridge has Li-6 available, and has supplied Li-6 to more than 35 users all over the world.

- 60 years experience working with moisture sensitive lithium compounds.

- Y-12 can supply lithium metal, lithium hydride lithium deuteride, lithium carbonate and coated Li-6 materials.

- Collaborations involving challenging chemical and dimensional specifications. Current collaborations include ITER, Universities, and many National Laboratories (including PPPL).

POSTER: Making Turn Toward Fusion Development, A. Steinlieb

The LiWF suggests the Best possible plasma regime for fusion devices

1. ***the best possible (diffusion based) confinement***
2. ***the best possible core MHD stability (no saw-teeth)***
3. ***the best possible plasma edge stability (no ELMs)***
4. ***the best possible stationary plasma-wall interaction (no thermo-force)***
5. ***the comprehensive plasma control by NBI and edge conditions (not a hostage of plasma unknowns)***
   (a) ***hours long inductive regime***
   (b) ***the best possible conditions for non-inductive current drive***
   (c) ***the best possible power extraction approach - synchrotron radiation***
   (d) ***no reliance on α-heating***
   (e) ***the best possible use of plasma volume for fusion***
   (f) ***the best possible helium ash exhaust regime***

The real question is "How good is the Best ?"

Crucial and well specified plasma physics and fusion technologies have to be developed in parallel on NSTX, LTX, HT-7 (and design work on FFRF) in order to answer this question.