# Recent Activities in Task B: Plasma-Liquid Wall Interactions

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# Participants

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|---|---|
| **PPPL:** | **S. Jardin** |
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| | **C. Kessel** |
| | **R. Woolley** |
| | **L. Zakharov** |
| **UI:** | **D. Ruzic** |
| | **J. P. Allain** |
| **ORNL:** | **R. Maingi** |
| **IFS:** | **M. Kotschenreuther** |
| | **H. Rappaport** |

# Task I. Explore options and issues for implementing a flowing liquid wall in the National Spherical Torus Experiment

* I.1 Characterization of NSTX plasmas:
  - Provided input for compilation of poloidal field distribution in and near NSTX and CDX-U plasmas (see presentation by M. Ulrickson at this meeting).

* I.5 Identification of key issues and development of an R&D plan for implementing liquid walls in NSTX (ALIST concerns):
  - Work is progressing on large area toroidal liquid lithium limiter in CDX-U (see presentation by R. Majeski at this meeting).
  - Intentional exposure of lithium to air demonstrated safety of “worst case” scenario in University of Illinois Flowing Lithium Retention Experiment (see presentation by J. P. Allain at this meeting).

# Task I. Explore options and issues for implementing a flowing liquid wall in the NSTX (continued)

* I.4 LM experimental facility set up and initial exploratory experiments with and without a magnetic field gradients and applied currents:
  - Prepared recommendation for MTOR grounding and ground fault detection scheme (documented in memo by

    R. Ramakrishnan and R. Woolley

    on March 1, 2001).

# Task II. Exploration of High-Payoff Liquid Wall Concepts

* Recent modeling work has focused on areas formerly under Task II but now part of Task V (see presentation by M. Kotschenreuther at this meeting).

* Initial tests of flowing liquid lithium performed on University of Illinois Flowing Lithium Retention Experiment (see presentation by J. P. Allain at this meeting).
  - Lithium successfully melted and circulated using argon pressurization system.

# Task V. Plasma Stabilization

* Goal:
  - Assessment of rapidly flowing liquid metal walls relative to simple conformal shells for stabilizing MHD modes:
    1) Conformal shell option
       a. Liquid metal wall (installed for other purposes) may be used
       b. Active feedback system required
    2) Rapidly flowing liquid metal wall option
       a. Rapid flow required for mode stabilization
       b. No active feedback

# Task V. Plasma Stabilization (continued)

* Status -
  - 1) WALLCODE (IFS/UT) for resistive MHD has been used to determine:
    a. Conformal shell requirements
    b. Plasma elongation limits
    c. Field coil requirements for feedback stabilization
  - 2) Coupling of resistive wall mode to liquid wall surface modes studied analytically (see H. Rappaport, Phys. Plasmas **8**, 3620 (2001)).
    » Kelvin-Helmholtz instabilities predicted for flowing liquid metal walls due to currents induced by tokamak magnetic fields (also noted by Smolentsev).
    » Forces due to poloidal currents in fast liquid metal flows (A. Aydemir, Phys. Plasmas **7**, 3411 (2001)) can be balanced by forces from externally-driven currents.

# Summary

* Support of Task I and Task II has broadened to include input from liquid lithium experiments in CDX-U and FLiRE.
  - Encouraging preliminary results on liquid lithium flow and safety from FLiRE.

* Task V effort progressing with analytic and computational modeling
  - WALLCODE developed and tested.
  - Liquid metal wall equilibria, fluid surface waves, and consequences of induced currents investigated.