NSTX

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Materials and PFCs Topical Science Group Update
December 5, 2012

R. Kaita for M. Jaworski with contributions from C. Skinner and D. Stotler

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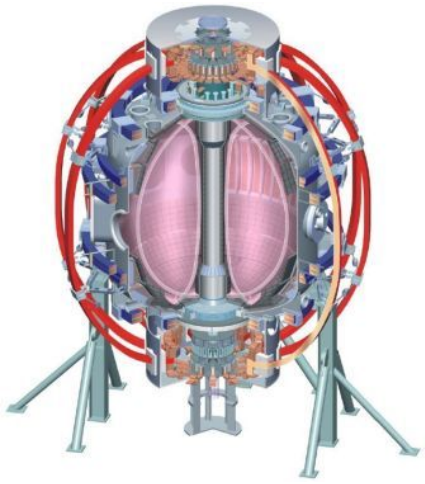

Culham Sci Ctr
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U Quebec

Mike Jaworski on travel this week

- **Mike's at 20th European Fusion Physics Workshop in Ericeira, Portugal where he gave talk entitled "Possible Technical Solution for a Liquid Divertor in DEMO"**

- **Mike's report:**

"The talk went well and the entire liquid-metal session stimulated vigorous debate. In particular, the possibility of lithium vapor shielding is both exciting and terrifying to many people. There is a decided focus/inertia behind the low-recycling regime which I had to de-emphasize. Several people were quite impressed with our s-CO2 [supercritical carbon dioxide cooling] results. I pushed the significance of testing in divertor-like plasmas and in the discussion, Greg [De Temmerman] (i. e., Magnum-PSI) became a very popular person (i.e. experiment)."

Draft nearly complete but considerably simplified

- **Research Goals and Plans for Materials and Plasma-Facing Components**
  - Introduction: Motivation for long-term liquid lithium research and near-term focus on solids
  - Research thrusts: Emphasis on FNSF and DEMO issues that can be uniquely addressed with NSTX-U capabilities and PPPL expertise
    - Material migration – investigate at high power densities
    - Continuous vapor shielding – *PFC-based* approach to power handling
    - Surface science – unique combination of MAPP for *in-situ* and new surface science labs for *in-depth* studies

Research Thrusts followed by Research Areas

- **Solid Plasma-Facing Component Research and Development**
  - Includes “offline” - and “offsite”- work on Magnum
  - Assumes starting with all-carbon PFCs and “phased” implementation of TZM
  - Allows for “simple” upward Li evaporation
- **Liquid Plasma-Facing Component Research and Development**
  - Based on “offline” development of liquid lithium loop
  - Fully-flowing, liquid metal divertor module in NSTX-U by 5th year of operation is goal with full funding

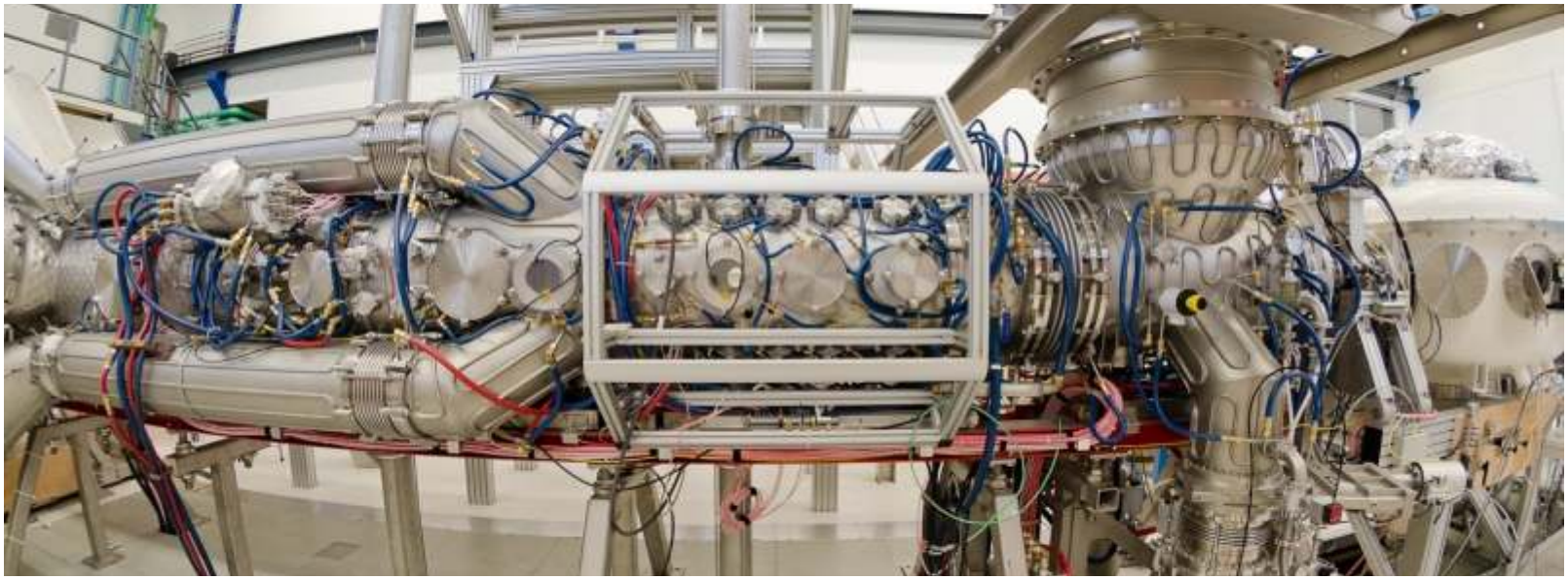
Remaining issues related more to budgeting assumptions than technical details

- **Should we develop $5M/year materials and PFC proposal linked to FNSF deliverables?**
  - Leads to “aggressive” liquid lithium development program to address technical issues that include corrosion, hydrogen recovery, substrate optimization, and even choice of liquid metal
- **Should significant surface science lab funding out of NSTX-U budget - and associated deliverables - be assumed?**
  - NSTX-U PFC issues strongly motivate surface science lab research but NSTX-U project presently not expected to provide bulk of operating funds

BACKUP SLIDES

Offline experiments in progress on Magnum-PSI

- Magnum-PSI
  - $\Gamma < 10^{24}$ $m^{-2}s^{-1}$ D^+, $T_e < 2$ eV, $n_e < 5*10^{20}$ m^{-3}
  - 5 s pulses, B~1 T **(> 60 s, 5T superconducting- coming 2013)**
  - Normal incidence: no magnetic pre-sheath
  - Evaporative Li coatings applied in-situ, calibrated with quartz crystal microblanace (QCM)



MHD facilities to revive?

- **MTOR at UCLA**
- **Toroidal Magnetic Field (0.2 to 0.6 Tesla)**
- **Vertical field from permanent magnets**
- **Can increase B with iron inserts**
- **Liquid Ga or GaInSn only**
- **T< 100C**
- **Flow ~2l/s up to 400kPa**
- **Flow speed <10 m/s**

- **LIMITS at Sandia**
- **Iron yoke permanent magnet system (0.1 to 0.8 Tesla)**
- **Vertical field by pole face shaping**
- **Liquid Lithium flow system**
- **T< 450 C**
- **Flow ~2.5 l/s up to 600 kPa**
- **Flow speed up to ~15 m/s**
- **Heat removal studies without B field.**

LIMITS facility available from Sandia

- Jet of Liquid Lithium flowing through a gradient magnetic field in a vacuum