

Report on NSTX Planning Meeting

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Technology (ALIST) Working Group*

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ALPS Meeting
8 November 2002

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Outline

- Background
 - Summaries from recent forums
 - » NSTX 5-Year Plan Forum (6/02), Research Planning Forum (9/02), and Program Advisory Committee Meeting (9-10/02)
- Issues
 - Power and particle control
 - » NSTX input for decision point in FY03 (Maingi)
 - Cryopump and lithium module options
- Liquid Surface Module Planning
 - ALIST input for decision point in FY03
 - » Preparation for NSTX PAC meeting in February 2003

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Summary of Liquid Surface Module Presentation at 5-Yr Plan Forum and Research Planning Forum

- Liquid surface module designed to remove 10^{23} particles/ shot
 - Can also help with power handling capability
- Lithium surface area $\sim 1 \text{ m}^2$, 10 m/s flow velocity
- Proposed liquid surface module has the potential of addressing particle control needs in the 5 year plan.
- Several R& D issues have been resolved over the past 15 months
- Key remaining issue is MHD effects on the flowing liquid metal
- Experiments are beginning to provide the data needed to validate the MHD modeling
- MHD modeling is progressing with key issues about boundary conditions and computational schemes being optimized.
- We anticipate making a decision to implement a flowing liquid surface in a fusion device in Fall 2003.

Program Advisory Committee (PAC) Meeting

- PAC Charge: Consider FY03 program and 5-year plan
 - Cryopumping and liquid surface module (LSM) presented as particle control options
 - » PAC recommendation: get information on future power and particle handling needs in FY03
- PAC Request: Presentation on LSM at next meeting
 - PAC meetings emphasize limited number of topics
 - » Focus on LSM gives ALIST unique opportunity for comprehensive exposure before NSTX and representatives of broader magnetic fusion community

Research Plan will provide input to Power and Particle Control Decision Point at end of FY'03

- Two elements: heat flux and particle control
- Are present PFCs sufficient for pulse ~ 5sec?
- Existing data from FY02
 - Outer strike point tiles increased by 300 °C in first 0.2 sec of quiescent H-mode (2 NBI srcs)
 - Extrapolates to ~ 3 sec. limit for reaching 1200 °C
 - Peak heat flux should be reduced as density increases
 - But combination of RF + NBI power may increase peak flux
 - Existing IR cameras will answer quasi-steady heating question
- New data in FY03
 - More experiments on peak heat flux scaling in FY03
 - Search for detachment and impurity puffing being considered
 - Investigation of double-nulls
 - Fast IR camera needed for transient heating questions

Research Plan will provide input to Power and Particle Control Decision Point at end of FY'03

- Is additional density control needed for pulse ~ 5sec?
- Existing data from FY02 indicates that (nearly) all high performance discharges had uncontrolled density rise during high confinement phase
 - A few DND had density control after MHD (NTM?) appeared
 - Difficult to isolate density dependence from other dependencies
- New data in FY03 for assessment
 - H-mode fueling
 - Role of ELMs in density control
- New data in FY03 for control
 - Helium conditioning
 - Boron + Lithium pellet injector for wall conditioning
 - Improvements to boronization (frequency, temperature)
 - Reactive gas fueling experiments with TMB

<u>NSTX Issue</u>	<u>Cryopump Assessment Status</u>	<u>Cryo Assessment Basis or Schedule for Achievement</u>	<u>Liquid Lithium Module Assessment Status</u>	<u>Liquid Lithium Module Assessment Basis or Schedule for Achievement</u>
Capability for Particle Control	Ability established with operational caveats (see below)	DIII-D (GA) results on edge plasma modification	Ability established	PISCES (USCD) results on hydrogen retention and CDX-U (PPPL) results on recycling reduction
Capability for Power Handling	Not applicable (must be protected from high heat flux)	Not applicable	Required flow rate is 7-12 m/s from analysis	PISCES results on temperature dependence of lithium evaporation confirm temperature limits; power handling tests will be conducted at LIMITS facility (Sandia) in FY03
Safety	Cryogenics handled routinely	DIII-D and NSTX experience	1) Static “pools” of liquid lithium handled safely 2) Circulating Li system assessment required	1) CDX-U has safe handling experience with static fully-toroidal liquid lithium limiter 2) Tests of hardware approved for flowing lithium in progress at LIMITS facility - results by 11/02

<u>NSTX Issue</u>	<u>Cryopump Assessment Status</u>	<u>Cryo Assessment Basis or Schedule for Achievement</u>	<u>Liquid Lithium Module Assessment Status</u>	<u>Liquid Lithium Module Assessment Basis or Schedule for Achievement</u>
Installation	In-vessel modifications substantial but straightforward: Close passive plate gaps and redesign secondary passive plate supports	Preliminary assessment completed – Menon (ORNL), NSTX 5-Yr Plan Ideas Forum (6/02)	In-vessel modifications could be limited but have special requirements: Permit lithium flow into, through, and out of NSTX Accommodate CHI “gap” and diagnostic penetrations	Preliminary assessment completed – Nelson (ORNL), APEX Electronic Meeting (8/02); prototype system tests in progress at MTOR (UCLA) and LIMITS; conceptual design scheduled during FY03; final design after decision to proceed is made in fall of 2003
Operation	Pumping dependence of separatrix distance to plenum limits achievable plasmas	Preliminary assessment completed – Menon (ORNL), NSTX 5-Yr Plan Ideas Forum (6/02)	MHD effects on liquid lithium may limit permissible magnetic field ramp rate; assess ELM, thermoelectric current, and plasma wind effects; control external current loops	Preliminary assessment with CDX-U, MTOR, and LIMITS by 11/02 with additional testing in FY03; complete computational modeling of MHD effects in parallel with final design in FY04/5 (UCLA)

Liquid Surface Module Planning

- ALIST input for NSTX decision point in FY03
 - Address NSTX issues
 - » Capability for particle control: summarize results to date
 - » Capability for power handling: justify design requirements
 - » Safety: explain experience on existing facilities
 - » Installation: show how conceptual design addresses NSTX constraints
 - » Operation: address any constraints imposed on NSTX parameter space - including loss of ability to operate with carbon divertor

Liquid Surface Module Planning

- ALIST input for NSTX decision point in FY03
 - Issues raised at APEX meeting earlier this week
 - » Consider gallium-lithium combination: gallium unattractive as impurity but future use could build on technology developed for liquid lithium
 - » Current diffusion times presently shorter than anticipated due to low electron temperatures: FY03 NSTX results will determine if heat load handling is imminent or long-term concern
 - » Need to get agreement from NSTX project about minimum requirements to permit installation of liquid surface module on machine

Liquid Surface Module Planning

- Near-term schedule for reporting on liquid surface module
 - NSTX 5-Year Plan Meeting: 12-13 December 2002
 - » Summary of liquid surface module plans due on November 22
 - Program Advisory Committee Meeting: 20-21 January 2003 (tentative)
 - » Need to decide if modeling of both liquid surface module and cryopump performance in NSTX should be included