

Update on Planning for ALIST Liquid Surface Module for NSTX

R. Kaita, H. Kugel, R. Maingi, R. Majeski, and the Applications of Liquid-plasma Interactions Science and Technology (ALIST) Working Group*

*Participating institutions: ANL, GA, INEEL, U. of Illinois, LLNL, ORNL, PPPL, SNL, UCLA, and UCSD

ALPS Meeting
11 April 2003

1

Outline

- NSTX Power and Particle Control Issues
- NSTX Five-Year Plan
- Near-term Option for Liquid Surface Module
- Summary of Issues

2

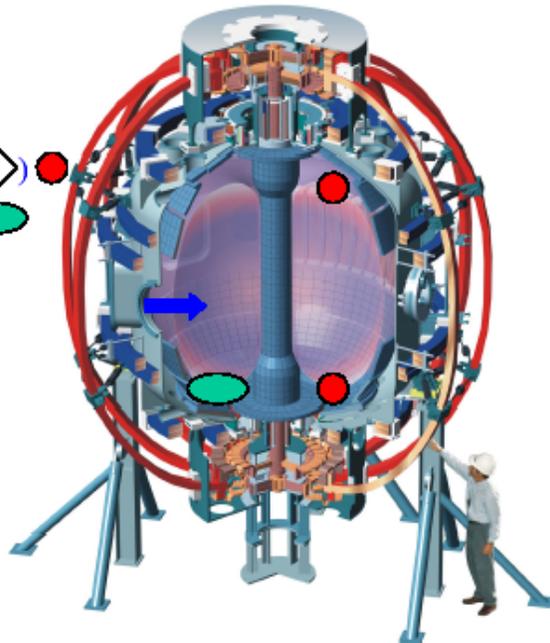
Present understanding of divertor and heat fluxes in NSTX

- NSTX is always (99%) in moderate-high recycling state and suffers from uncontrolled density rise
 - L-mode density increases with only NBI fueling
 - H-mode density increase > NBI fuel rate; $\tau_p^* \sim 0.2-0.4$ sec
- > Density control needed, but where are particles and power?
- D_α peaks near inner and outer strike points, inner $\sim 3x$ outer
 - Ratio reverses during power excursion -> inner probably detached
 - Most particles on outer side -> consistent with module location
- Heat flux always peaks near outer strike point
 - inner strike point peak heat flux and power < 1/3 outer values
 - > consistent with module location
- UEDGE modeling in progress; DEGAS-2/TRANSP to follow to estimate effect of lower recycling

3

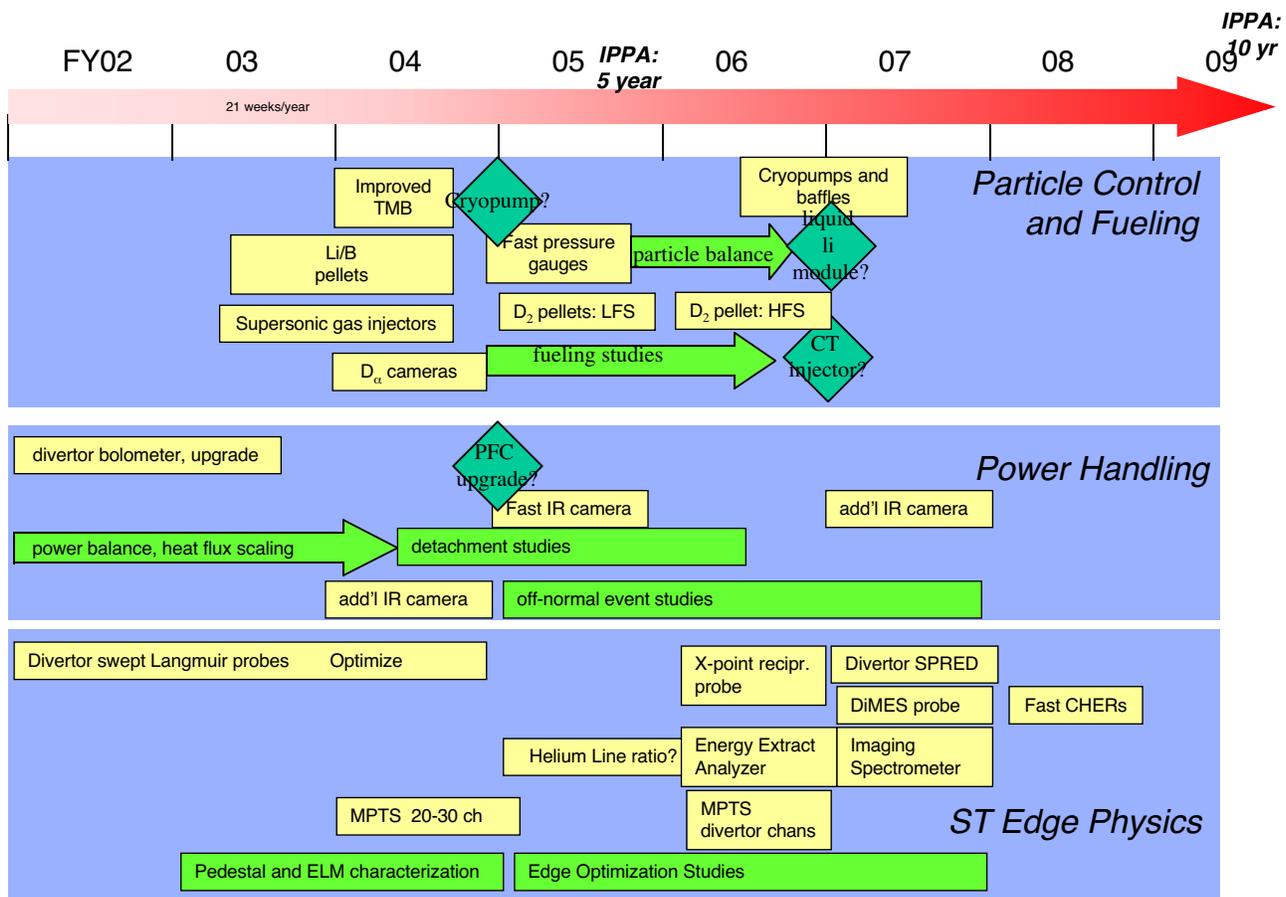
Lithium module appears late in NSTX planning for fuel and impurity sink control

- Improved sink (density) control
 - improved boronization (FY03)
 - lithium pellets (FY03) 
 - in-vessel cryopumps (FY06, FY03) 
 - lithium module (FY08, FY06) 
- New diagnostics
 - $n_c(r)$ f/CHERS, Z_{eff} f/MPTS (FY03)
 - D_α cameras for core fueling
 - divertor SPRED
 - upgraded Langmuir probe array
 - fast pressure gauges



* New capabilities

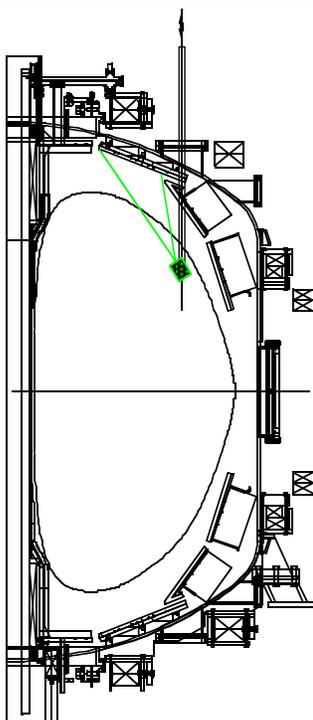
4



Long time scale for original liquid surface module could make simpler near term alternatives attractive

- Present schedule calls for installation of liquid surface module as lithium divertor target for NSTX no earlier than 2008
- Lowered recycling is still desirable for NSTX
 - Cryopump is presently only nearer term possibility
- Simple concept for implementing molten lithium walls is under consideration
 - NOT A FLOWING LITHIUM SYSTEM
 - REQUIRED IN-VESSEL INVENTORY IS SMALL
- Concept developed for LTX concept to reduce wall recycling
 - R. Majeski provided details in earlier APEX meeting presentation
 - Suitability for NSTX and APEX/ALPS programs still an issue

NSTX project interested in “between shots” lithium vapor deposition scheme for upper divertor



- Replace one of the upper divertor plates with a new plate, faced with plasma sprayed tungsten or molybdenum
- Install a retractable e-beam system which can be scanned over the plate
- Deposit 1000Å of lithium and withdraw the e-beam system
 - Similar to cycling retractable getters used between shots in PLT and PDX
 - Time scale for lithium coating
 - Few 10's of seconds for 1000Å coating
 - Cycle time is dominated by insertion/removal of e-beam.
- Coat before *every shot*
 - 1000 shots ⇒ 0.1 mm accumulation

New issues related to long time scale for flowing liquid surface module need to be addressed

- Delay of decision point for flowing liquid surface module (LSM) until 2006 provides opportunities for near-term alternatives
- Cryopump formerly only near-term possibility for particle control
 - Expensive (\$1M for in-vessel modifications alone)
 - Enhances plasma performance only if divertor strike points are sufficiently close to cryopump “throat”
 - Does not lead to solution for future power handling problems
- Non-flowing liquid surface module (LSM) offers near term alternative to cryopumping but still has issues
 - Serious interest exhibited by NSTX project
 - Potentially part of “development path” for flowing LSM
 - New technique means tests required to determine feasibility
- Further analysis of NSTX must be performed to determine exact requirements and need date for particle control and power handling