NSTX

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Run Plan Development For FY2010

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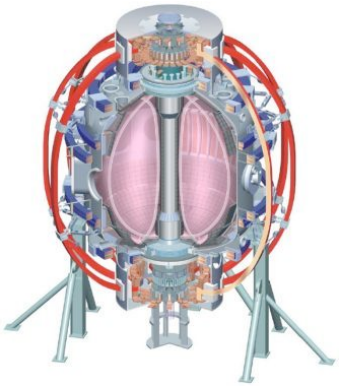

NSTX Research Forum for FY2010 Research
1-3 December 2009

Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
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ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

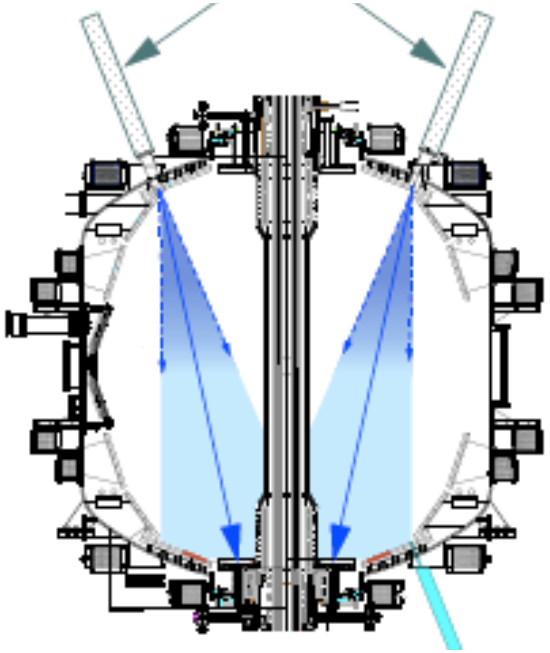
2010 Research Forum has been a Success

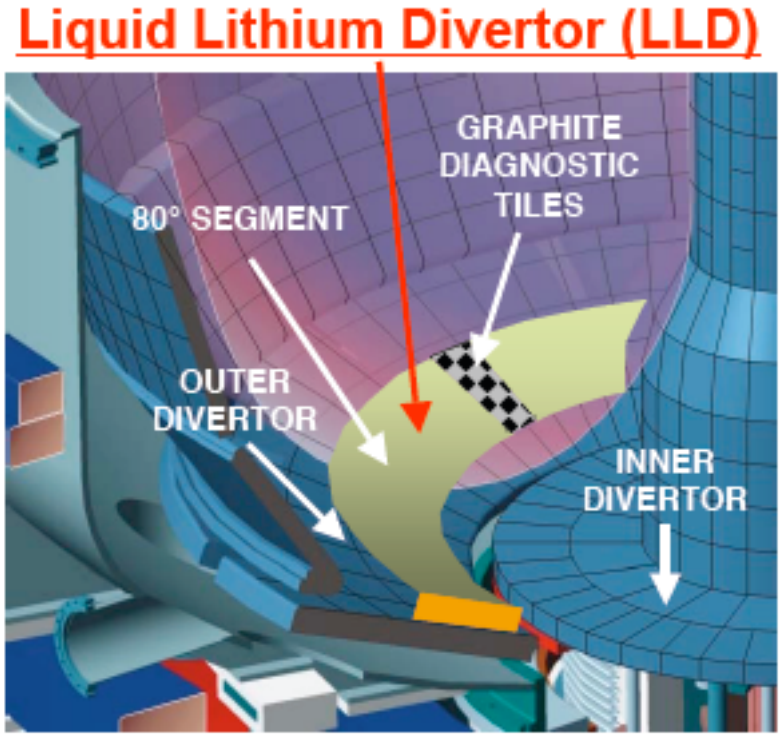
- Thanks to the hard work by many people
  - Michael Bell and Job Menard for organizing the meeting
  - K. Silber and M. Cohen for web support
  - A/V crew – Larry Nixon, Bob Reed, Carl Scimeca
  - Logistics – Joanne Savino
  - Refreshments – Masa Ono and Joanne
  - Presenters of plenary talks from other labs – Brian Lloyd (MAST), Max Fenstermacher (DIII-D), Earl Marmar (C-MOD)
  - TSG leaders who led the breakout session and prepared summaries

- Excellent proposals made by many team members
  - 156 proposals were considered, requesting ~ 168 days
  - TSG leaders have provided a prioritization of which ones can be run this year

This year NSTX will have a major modification, the LLD, which may have a large impact on operations

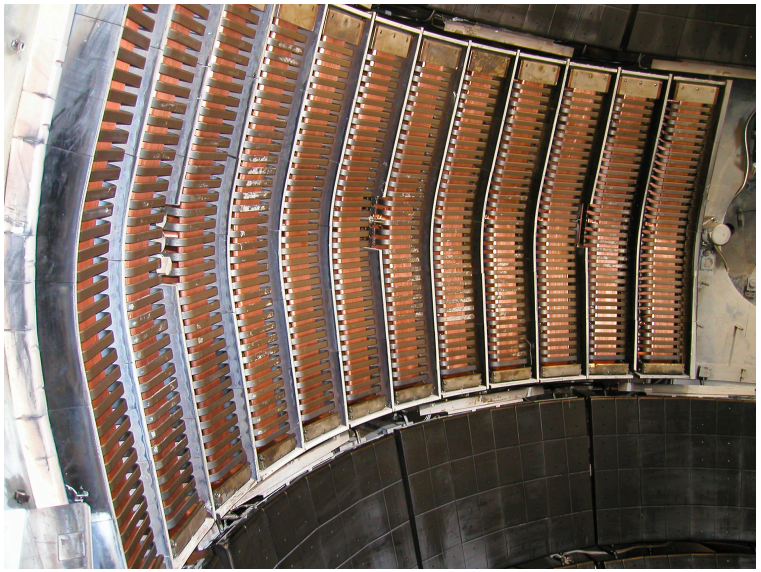
- We need to learn how to operate with LLD,
  - Assess impact on all aspects of NSTX physics research
  - Avoid damaging the LLD, or its Lithium filling
  - How to optimize plasmas using LLD

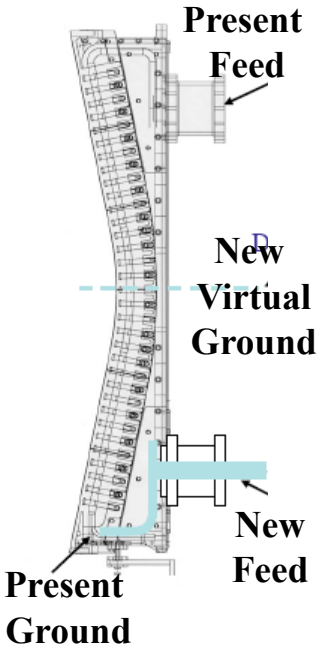




Successful upgrade of HHFW finished at end of 2009,

- Again, need to learn how to use this capability to improve NSTX plasma operations
  - Better heating of NBI H-mode plasmas
  - Aid in non-inductive start-up experiments
  - Use in “phase-space engineering” in Energetic particle group.
  - Current profile tailoring
  - Etc.





New diagnostic capabilities

- Beam Emission Spectroscopy (density fluctuation) diagnostic
  - 8 to 16 channels with 1MHz bandwidth
- Reflectometer upgrades
  - 8 channel system (30GHz to 50GHz)
  - Possibility of additional 8 channels after April (55GHz to 75GHz)
  - Possibility 5 channel, high res system after April (δf=0.35GHz, 53-78GHz)
- Extensions to Langmuir probe arrays
  - Inter-LLD arrays
  - Outboard array
- Fast cameras
  - Divertor and LLD (2-color IR)
- Spectroscopy
  - Lyman-alpha array
  - Divertor UV/visible

NSTX FY2010 research milestones:

- Proposed OFES Joint Research milestone: *"Conduct experiments on major fusion facilities to improve understanding of the heat transport in the tokamak scrape-off layer (SOL) plasma, strengthening the basis for projecting divertor conditions in ITER."*
- R(10-1): Assess sustainable beta and disruptivity near and above the ideal no-wall limit:
  - Utilize new mode control tools/softwareto characterize and quantify the achievable beta sustainment and disruption avoidance in the ST
- R(10-2): Characterize HHFW heating, current drive, and current ramp-up in deuterium H-mode plasmas.
  - Establish HHFW as a reliable, high-power H&CD tool for start-up and sustainment, transport studies, scenario optimization…
- R(10-3): Assess H-mode pedestal characteristics and ELM stability as a function of collisionality and lithium conditioning
  - Utilize particle pumping and density control from LITER, LITER+LLD
    - Determine the relative roles of reduced pedestal density and collisionality versus the possible direct effects of lithium, assess L-to-H threshold, pedestal height and barrier width pedestal stability (affecting ELM type and size), and the down-stream divertor plasma and surface conditions

Run-time guidance for FY2010 run

- FY2010 run-time allocation = 15 run weeks = 75 run days
- 15 days for cross-cutting + calibrations **including 5-10 days for restart w/ LLD+shot/scenario development with LLD → 60 run days** for TSGs
- Complete 1st priority experiments with 75% of total → 45 run days
  - OFES Joint Facility and NSTX Research Milestone XPs are highest priority, and should be completed within this run-time allocation
- TSGs should develop plans for 1st +2ndpriority according to allocation below
  - TSG's are NOT guaranteed to receive the full allocation shown
  - Actual allocation will be decided at mid-run assessment

TSG	1st priority XP run days	1st + 2nd priority XPs	Milestones
Advanced Scenarios and Control	**5.5**	**8**	
Boundary Physics	**8**	**10**	Joint, R(10-3)
Lithium Research	**5.5**	**8**	
Macroscopic Stability	**6**	**8**	R(10-1)
Solenoid-free Start-up and Ramp-up	**4.5**	**6**	
Transport and Turbulence	**5.5**	**7**	
Wave-Particle Interactions	**6**	**8**	R(10-2)
ITER high priority	**4**	**5**	
Total	**45**	**60**	

156 Proposal Ideas Reviewed Requesting 168 Run Days

TSG	# of XPs proposed	Run days requested
Advanced Scenarios and Control	20	21.5
Boundary Physics	33	33
Lithium Research	21	19.1
Macroscopic Stability	23	23.5
Solenoid-free Start-up and Ramp-up	4	10
Transport and Turbulence	27	33.7
Wave-Particle Interactions	28	27.1
ITER high priority	-	-
Total	156	167.9

- Allocate remainder after mid-run assessment considering:
  - –Progress to date
  - –Achievement of Milestones/ITPA tasks
  - –New developments

Pre-run preparation/planning Activities

- Develop start-up program compatible with LLD
  - Start-up without Boronization - no non-Lithium operation period planned
  - Optimize filling profile for LLD (how much Li, how soon?)
    - How much Li is needed to protect LLD plates?
    - What is optimum fill level for plasma operations?
  - Incorporate relevant XPs in LLD commissioning activity
- Work out new 'fiducial' program to monitor machine conditions
- Will Li passivation run periods be possible?
  - Identify XPs that desire this
  - Develop techniques to recover from Li passivation
  - How much running can we do with cold LLD?
- Identify catalog of plasma conditions beyond "standard" shots that may require re-development
- As always, need to get XPs written, approved before start of run!

Draft Start-up run plan

1. Pump-down
2. LLD ISTP before Bake-out up to 400°C
3. Bake-out for 3 weeks with LLD ~50°C above carbon temperature
4. Cool-down vessel with LLD ~50°C above carbon temperature
5. Continue LLD ISTP checkout
6. Start Plasma ISTP and field-only shots ASAP
    1. No DGHDC or HeGDC on moly to avoid possible arcing on the rough moly surface
    2. Evaporate Li from LITERS to coat LLD at 210°C to at least 250 nm (~1day)
7. First plasma attempts:
    1. LLD at room temp, no boronization, probably some continued LITER operation to get burn-through modest to high triangularity plasmas; continue until suitable NBI target plasma obtained
8. Start NBI heated plasmas
    1. do HHFW conditioning
    2. If no burn through, keep trying with more Li; no boronization ever

(all this should take 10-15 days (post bakeout), depending upon success and amount of HHFW conditioning)

Draft Start-up run plan - continued

1. Proceed to XP LLD Commissioning Step-1 (LLD cold, R_{isp}=0.35, R_{osp}=0.50)
2. Proceed to XP LLD Commissioning Step-2 and Day-3 (LLD warm, R_{isp}=0.35, R_{osp}=0.50)
    1. Evaluate IR camera data and benchmark simulations

    {Delay Step 3, R=0.75 m (on LLD) until later in run, ongoing discussions on how soon power should be directly applied to LLD R_{sp}=0.75:
        1. Checkout plasma systems for robustness.
        2. Bring online diagnostic systems critical for Step 3.
        3. Test LLD with lowest possible power density deposition via open field line power deposition.
        4. Acquire LLD halo current and disruption data with open field line low-power deposition. }
3. Proceed to XP LLD Commissioning Step-4 (LLD warm, R_{isp}=0.63, R_{osp}=0.75)
    1. Evaluate IR camera data and benchmark simulations
4. Proceed to XP LLD Commissioning Step-5 (LLD cold, R_{isp}=0.63, R_{osp}=0.75)
5. Proceed to XP LLD Commissioning Step-6 (LLD warm, R_{isp}=0.63, R_{osp}=0.75)
6. Start the other lithium XPs most directly related to LLD characterization and milestones (Vlad, Kallman, Jaworski..)
7. LLD is commissioned, start the other XP

Next Step Activities

- Begin to review 1st priority XPs within the group
  - Some XPs from FY09 that require minimal changes?
  - Identify experiments that should be run during the first two weeks
  - Identify experiments desiring passivated Lithium?
  - Start to identify catalog of shot conditions needing to be developed.
- Expect to begin operations early in March and end at some later time
  - Final XP reviews will commence early in January
  - Shot conditions for Prioritized XPs needed well before reviews
- Start planning for LLD ‘decomissioning”