

UPDATED EXPERIMENTAL PLAN FOR FY 2002

R. Maingi

Oak Ridge National Laboratory

For the National NSTX Research Team

NSTX Program Advisory Committee Meeting #12

Princeton, NJ

Jan. 10-11, 2001



Los Alamos
NATIONAL LABORATORY



ORNL

PPPL
PRINCETON PLASMA
LABORATORY



UCDavis

Outline

- Planning process update
 - milestones and decision points
 - new facility and diagnostic capabilities
- Topical area research program
 - Transport and Turbulence
 - RF heating and current drive
 - MHD studies
 - Boundary Physics
 - Non-inductive startup
 - Integrated Scenario Development
 - Cross-cutting experiments
- Updated run time allocations

*** changes since last
PAC in this color**

NSTX research plan is ready for execution

Fundamental ST physics issues addressed by milestones

- Milestones and decision points drive program priorities

Formulation of plan has multiple steps

- NSTX Results Review (9/19 - 9/20)
- Top-down planning and PAC input (10/4 - 10/5)
- Refined analysis presented at APS meeting (11/'01)
- NSTX Research Forum (end 11/'01)

→ • 75 presentations, > 100 days run time requested

- Refinement of plan and PAC input (12/'01 - 1 /'02)

12 run weeks in FY '02

Run plan has been updated due to major machine and diagnostics upgrades

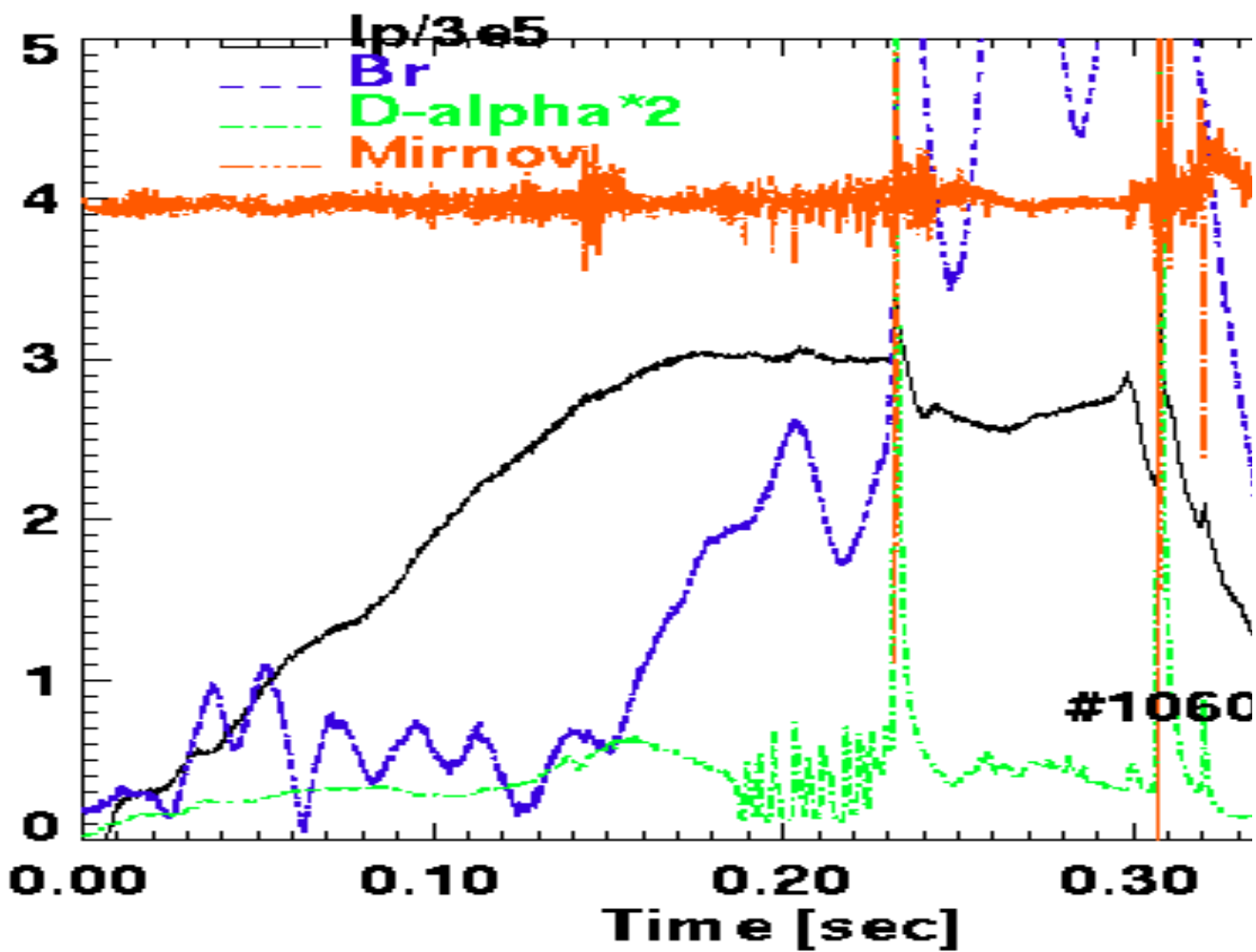
Facility upgrades will widen operating space

- Error field reduction
 - Locked modes previously limited pulse length many discharges, esp. single-null
- 330⁰ C bake-out
- New control computer
- Upgraded fueling capability, including inner-wall
- ➔ More routine H-mode operation, ala MAST?
 - Broader pressure profile, higher limit

Major diagnostics delayed since last PAC meeting

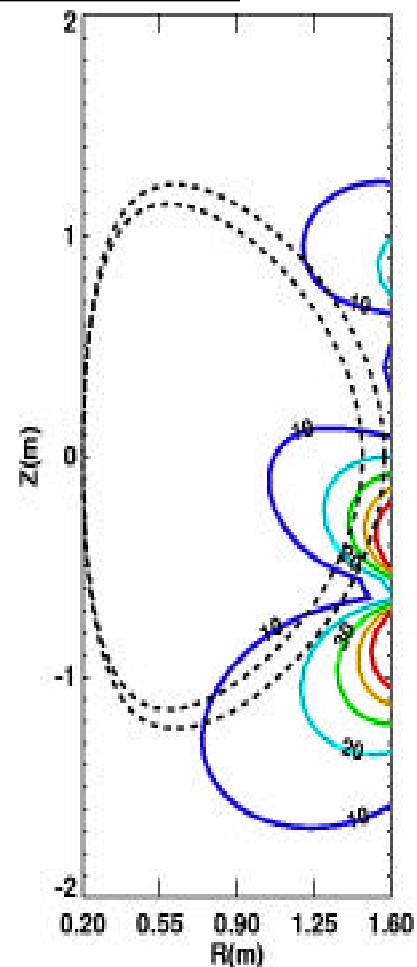
- Full toroidal CHERS after this run
- CIF MSE after this run

NBI ELMy H-mode duration in NSTX was limited by locked modes during last run



Error field reduced by PF5 coil centroid shift

- Re-align PF5 coil centroid
 - Reduce 30-50G edge error
 - Minimize $n=1$ component
- All edge error fields predicted to be below 5 G
 - $n=1$ down by 90-92%
 - $n=3$ decreased slightly
 - $n=2$ increased moderately
- Combined with inner wall gas puff -> routine H-mode?



before
coil

NSTX milestones updated since last PAC meeting

- Transport with high β and rotation ('02)
- MHD stability without active control ('02)
- Effectiveness of HHFW current drive (FY '02)
- 400 kA CHI discharge, feedback control, add induction and HHFW to CHI (FY '02)

- Wall heat flux measurement (FY '03)
- Sustainment of ~ 1 -s pulses (FY '03)
- Simultaneous high β and β_{max} (FY '03)

Deputy run coordinator and experimental task group leaders selected since last PAC meeting

- Deputy run coordinator for FY 2002 is Stan Kaye
- Topical area research program leaders selected
 - Transport and Turbulence (Darrow, Stutman)
 - RF heating and current drive (Wilson, Swain)
 - MHD studies (Menard, Fredrickson)
 - Boundary Physics (Kugel, Bush)
 - Non-inductive startup (Raman, Mueller)
 - Integrated Scenario Development (Gates, Sabbagh)
 - Cross-cutting experiments

Transport and turbulence research plan (8 day allocation)

- Transport at high β and high rotation - FY '02
- Research topics and tentative plan from group
 - Resolution of 2-fluid power balance - 2 days
 - power balance with and without CAE modes
 - NBI coupling to electrons vs. ions
(comparison of T_e from different diagnostics - cross-cut)
 - Transport as a function of beta and flow - 3 days
 - Aspect ratio scaling of transport - 1 1/2 days
 - NBI H-mode physics study - 1 day
 - RF H-mode physics study - 1/2 day
 - Additional density limit studies - 1/2 day

plan

RF research plan (8 day allocation)

- Effectiveness of HHFW current drive (FY '02)
- *NTM scientific assessment - input to EBW plan (mid FY '03)*
- *EBW System Technical Needs Assessment (end FY '03)*
- Research topics and tentative plan from group
 - RF heating studies - 2 days
 - Current drive studies - 3 days
 - Ion interactions - 3 days
 - EBW research - piggyback

← plan →

MHD Research Plan (8 day allocation)

- MHD mode identification at high - FY '02
 - *Error Field/RWM Active stabilization (end FY '02)*
 - *NTM scientific assessment - input to EBW plan (mid FY '03)*
 - *Error Field/ RWM Active stabilization system phase I FDR (end FY '03)*
 - Research topics and tentative plan from group
 - RWM/kink mode studies - 3 days
 - Tearing modes (error field reduction impact) - 2 days
 - CAE/TAE mode studies - 2 days
 - push - 1 day
 - dedicated ELM studies
- plan →

Coaxial Helicity Injection Plan (5 day allocation)

- 400 kA, feedback control, add heating to CHI - FY '02
- Research topics
 - Flux closure studies - 2 days
 - Need $I_{\text{tor}} \sim 300\text{-}400$ kA for $n=1$ activity
 - believed necessary for flux closure
 - Desire flat-top $\sim 100\text{ms}$
 - Feedback control: phase I - 2 days
 - Vertical position control in arc-free discharges
 - Phase II after new absorber installation - absorber null
 - Adding CHI to Ohmic for edge current drive - 1 day
 - Adding HHFW to CHI - piggyback
 - Optimizing addition of ohmic to CHI - 1 day

Boundary Physics research plan (5 day allocation)

- Heat flux scaling - FY '03
- *Advanced PFC and density control - end FY'03*
- Research topics and tentative plan from group
 - Edge characterization - 3 days
 - Heat flux scaling
 - SOL widths at mid-plane
 - Core fueling
 - X-point radiation
 - Wall conditioning studies - 2 days
 - Edge biasing - 1 day
 - Core fueling study - 1 day

← plan →

Integrated Scenario Development group focuses on heating and control development

- Goal: long-pulse, high discharges
- Simultaneous high and - FY '03
- Startup and sustainment ~ 1s pulse - FY '03
- Research topics
 - H-mode duration extension with NBI and/or RF
 - Low ℓ_i scenarios
 - Pulse length extension with HHFW
 - Control system development(Handoff between CHI and ohmic - within CHI group)

Integrated Scenario Development group plan (8 day allocation)

- Research topics and tentative plan from group
 - H-mode development studies - 2 days
 - effect of inner wall gas puffing
 - combining with internal transport barrier
 - HHFW heating during I_p ramp - 1 day
 - HHFW long pulse - 1 day
 - Long pulse, high β with NBI and RF - 1 day
 - RWM stability vs. equilibrium parameters - 1 day
 - rtEFIT isoflux control development - piggyback, maybe some dedicated time later during run
 - contingency - 2 days

plan

Cross-cutting category elements (6 day allocation)

- Analyzing effect of error field on locked modes
- Cross-comparing T_e from multiple diagnostics
- Diagnostic calibrations
- Density limit studies
- Wall conditioning evaluations
- Control system development not in other groups

Planned run time allocations for FY '02

	<u>FY 2001(actual)</u>		<u>FY 2002 (plan)</u>	
HHFW heating & CD	16 days	(24%)	8 days	(13%)
Transport	11 days	(17%)	8 days	(13%)
MHD	14 days	(21%)	8 days	(13%)
CHI	5 days	(8%)	5 days	(8%)
Boundary (heat flux)	1 day	(2%)	5 days	(8%)
Enabling/cross-cutting	18.5 days	(28%)	6 days	(10%)
Scenario Development			8 days	(13%)
Scientific Contingency	{13 days (20%)}		12 days	(20%)

NSTX has an exciting set of experiments to execute this year!

- Plan driven by milestones and decision points
- Significant new facility and diagnostic capability
 - Error field reduction
 - 330⁰ C bake-out
 - New control computer
 - Upgraded fueling capability, including inner-wall
- Seventy-five (75) presentations at the Research Forum
 - Represents over 100 days of needed run time
 - Only ~ 1/2 of these can be accommodated this year
- Execution of the program plan is beginning

backup VGs

mode access greatly improved

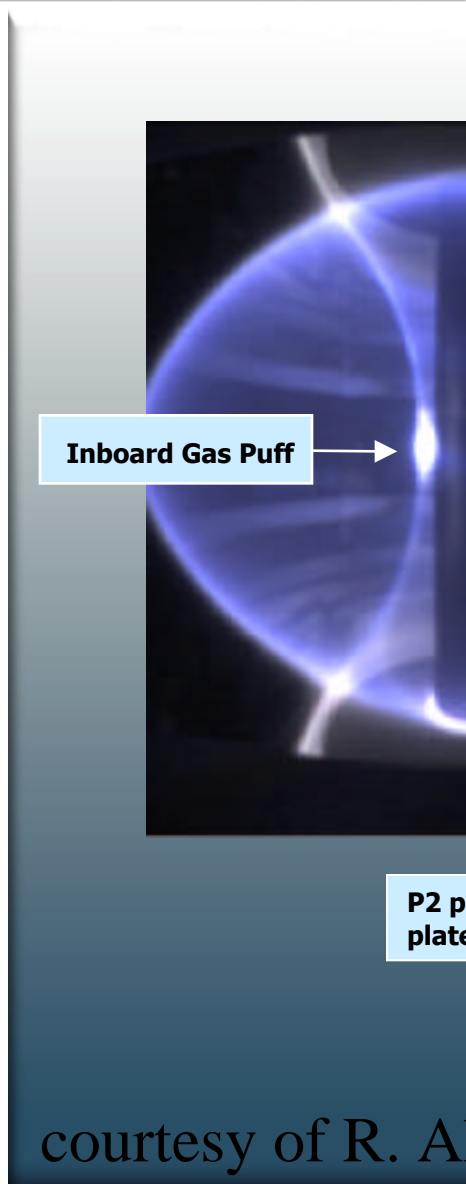
0 - refuelling from low field side gas puff + a previous high density shot was needed to load the walls

1 - refuelling from high field side through a 3mm tube fed from 0-10 bar D2 supply, running under the centre column graphite.

together with improved understanding of the importance of strike point positioning (access improves when divertor legs miss P2 coil plates)



mode access now routine



courtesy of R. Akers, APS 20