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Enhanced NSTX Scientific and Programmatic Goals for FY03-04

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NSTX Program Advisory Committee Meeting (PAC-12)

January 10-11, 2002

PPPL

Princeton, NJ

Potential Opportunity Exists to Enhance Momentum of the ST Program

- Possible enhancement of run time (fuller facility utilization)
  - Not final
- Need a robust plan – for baseline and enhanced run time
- How should we take advantage of this opportunity?
- Want would the impact be of the enhancement?

Enhanced NSTX Scientific and Programmatic Goals for FY03-04 Are to Meet FESAC 5-Yr Objective

- FESAC 5-year objective (Goal #2) & IPPA implementation approaches
- Baseline plan for FY02-03
- Enhanced FY03-04 research milestones
- Completion of implementation approaches

Also

- ⇒ World leadership
- Very high % more physics / % more $ ⇒ FESAC Goal #1

ST 5-Yr Objective: Make preliminary determination of the attractiveness of the spherical torus (ST), by assessing high-beta stability, confinement, self-consistent high-bootstrap operation, and acceptable divertor heat flux, for pulse lengths much greater than energy confinement times (IPPA, 1999)

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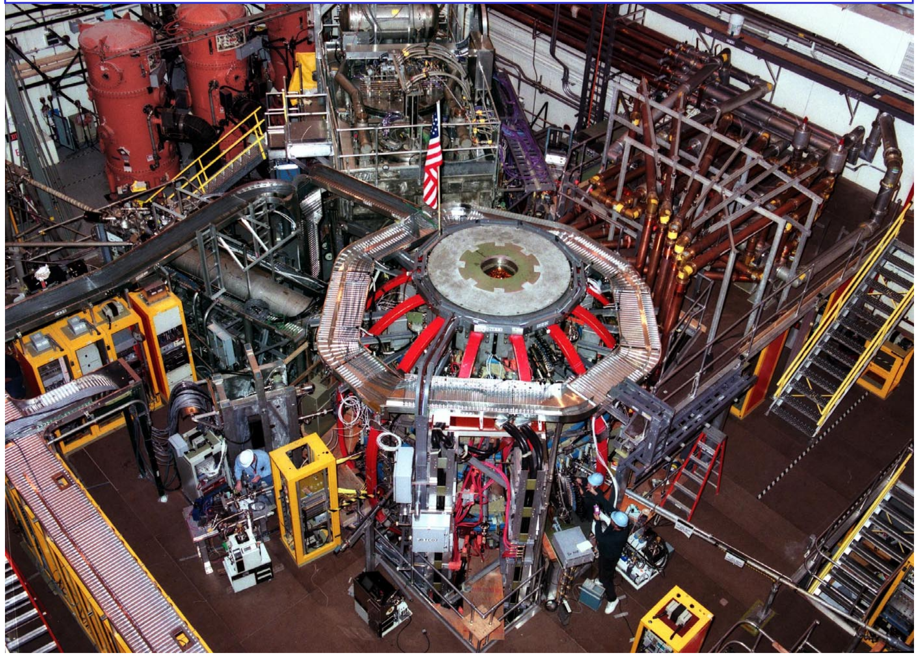
Implementation Approaches

- Achieve efficient heat and particle confinement
- Verify stability of large scale MHD perturbations
- Heat high-beta over-dense plasmas
- Test plasma startup with noninductive techniques
- Disperse edge heat flux at acceptable levels
- Integrate high confinement and high beta
- Explore spherical torus issues in directed laboratory experiments

National Spherical Torus Experiment



Collaborations:

- **Japan:** TST-2, HIST, TS-3, TS-4
- **R.F.:** Globus-M
- **U.K.:** MAST
- **U.S.:** Pegasus, HIT-II, CDX-U

Baseline Plan From PAC-11 Meeting Assumed 13 Run Weeks in FY02-03 and Underutilize NSTX

FY	2001	2002	2003	2004 - 2006
Expwks	15	12	13	40

ST MHD & Transport Physics for $\tau_{skin} \gg \tau_{pulse} \gg \tau_E$, $\beta_T \leq 25\%$

ST Current Drive & Edge Physics for $\tau_{skin} \gg \tau_{pulse} \gg \tau_E$, $\beta_T \leq 25\%$

ST Physics for $\tau_{pulse} > \tau_{skin}$, $\beta_T \leq 40\%$

FY01-03 Research Milestones (IPPA Implementation Approaches)

- Study τ_E
- Heat with HHFW
- Study MHD modes (no feedback)
- Assess effects of high β_T & flow on χ
- Demonstrate CHI startup
- Assess HHFW current drive efficiency
- Study SOL fluxes
- Integrate high β_T & high τ_E for ~$5\tau_E$
- Extend startup & sustainment to ~1s

2004 – 2006 Program Areas

- Solenoid-free startup
- Noninductive sustainment
- Heating, CD, BS current prof. control
- MHD mode control
- Turbulence suppression
- Supra-Alfvénic fast ion effects
- Multi-state interface control

Enhanced Research Milestones Will Enable the Determination of ST Attractiveness by End of FY04

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FY	2001	2002	2003	2004	2005
Expwks	15	12	13+12	13+12	25

ST Physics for τ_{skin} » τ_{pulse} » τ_E, $\beta_T \leq 25\%$

ST Physics for longer pulse, higher $\beta_T \leq 40\%$

FY02-04 Research Milestones address IPPA Implementation Approaches

2001
- Study τ_E
- Heat with HHFW

2002
- Study MHD modes (no feedback)
- Assess effects of high β_T & flow on χ
- Test CHI startup
- Test HHFW current drive efficiency

2003
- Study SOL fluxes
- Integrate high β_T & high τ_E for ~5τ_E
- Extend startup & sustainment to ~1s
- Characterize EBW emission, estimate H&CD
- Assess error field response & rotation
- Assess pellet injection benefits

2004
- Measure ΔJ by RF, NBI, & BS
- Assess small-k turbulence
- Avoid or suppress β-limiting modes
- Optimize edge & SOL
- Characterize plasma-fast ions-wave interactions
- Assess high-k turbulence
- Integrate very high β_T & τ_E with active error field correction for ~5τ_E

2005

(Begin τ_{pulse} >> τ_{skin} research)

10-year checkpoint (FY2009)

5-year checkpoint

'05-'06

Blue + Red: 25 wks/yr
Blue: 13 wks/yr

Enhanced FY03-04 Research Milestones Provide Opportunities to Complete the IPPA Implementation Approaches

3.2.1.1. Achieve efficient heat and particle confinement

- FY01 – Study τ_E
- FY02 – Assess effects of high beta and flow on χ
- FY03 – Assess pellet injection benefits
- FY04 – Assess long wavelength turbulence in a range of scenarios
- FY04 – Assess short wavelength turbulence in a range of scenarios

3.2.1.2. Verify stability of large-scale MHD perturbations

- FY02 – Study modes without active feedback
- FY03 – Assess error field response & plasma rotation interactions
- FY04 – Avoid or suppress beta-limiting modes

3.2.1.3. Heat high-beta over-dense plasmas

- FY01 – Heat with HHFW
- FY04 – Characterize plasma-fast ion-magnetosonic wave interactions

Black: FY01-02; Blue: 13 wks/yr in FY03-04; Blue + Red: 25 wks/yr in FY03-04

Enhanced FY03-04 Research Milestones Provide Opportunities to Complete the IPPA Implementation Approaches (cont.)

3.2.1.4. Test plasma startup with noninductive techniques

- FY02 – Test CHI startup
- FY02 – Test HHFW current drive efficiency
- FY03 – Extend startup & sustainment to 1 s
- FY03 – Measure fast ΔTe via EBW emissions, estimate H&CD requirements
- FY04 – Measure J profile modifications from RF, NBI, & BS

3.2.1.5. Disperse edge heat flux at acceptable levels

- FY03 – Study SOL fluxes
- FY04 – Optimize plasma edge & SOL

3.2.1.6. Integrate high confinement and high beta

- FY03 – Integrate high β_T and high τ_E for ~ 5 τ_E
- FY04 – Integrate very high β_T & τ_E with active error field correction for ~ 5 τ_E

3.2.1.7. Explore spherical torus issues in directed laboratory experiments

- Pegasus, HIT-II, CDX-U – explore new ST parameter space

Black: FY01-02; Blue: 13 wks/yr in FY03-04; Blue + Red: 25 wks/yr in FY03-04

Enhanced NSTX Scientific and Programmatic Goals for FY03-04 Are to Meet FESAC 5-Yr Objective

- Enhanced NSTX research milestones are identified for FY03-04 to meet FESAC 5-year objective
- Provide opportunities to complete the IPPA Implementation Approaches
- The baseline plan (~13 run-wks/yr) delays completion of the ST “5-year” objective to end of FY06

- ⇒ World leadership; FESAC Goal #1

Presentations on NSTX FY03-04 Plans

Ed Synakowski	FY03-04 Research Program Plan (Incl. Phys Analysis)
Masa Ono	FY03-04 Facility Plan and Budget

We look forward to hearing your advice on our plans.

The Updated Baseline Plan Will Delay Completion of IPPA Implementation Approaches Beyond FY04

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		Noninductive Assisted		Noninductive Sustained	
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FY02-04 Research Milestones address IPPA Implementation Approaches

- Study τ_E
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- Measure ΔJ by RF, NBI, & BS
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5-year checkpoint