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NSTX

NSTX Facility Plan, Budget, & Issues

To support the enhanced research plan in FY03-04 to meet the FESAC 5-year objectives on ST

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For the National NSTX Team

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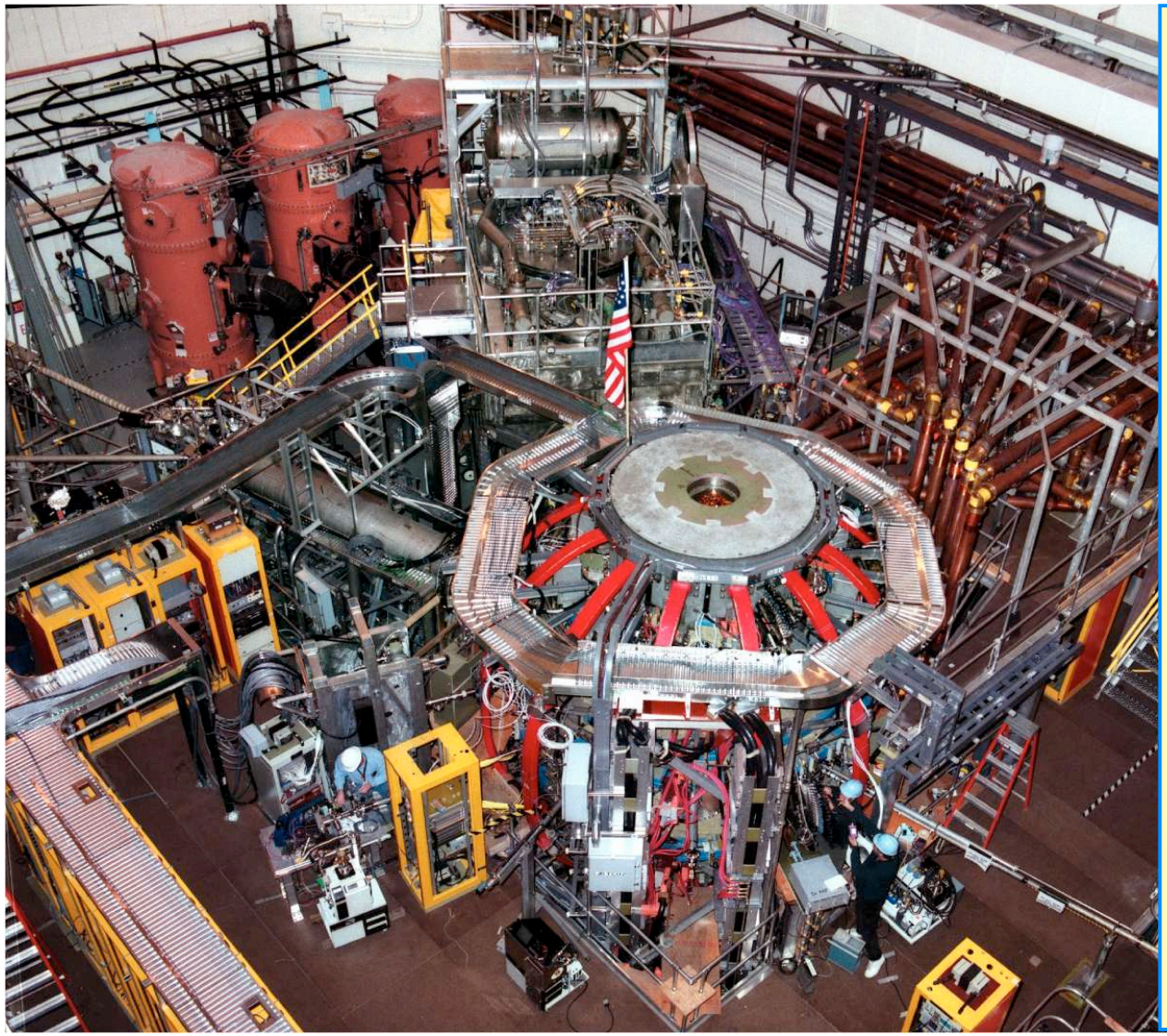
NSTX Facility Has Continued Rapid Progress in Operational and Experimental Capabilities



Baseline Parameters
(Achieved)

Major Radius 0.85 m

Minor Radius 0.68 m

Elongation = 2.2 (2.5)

Triangularity = 0.6 (0.8)

Plasma Current
1 MA (1.5 MA)

Toroidal Field
0.3 to 0.6 T (≤0.45 T)

Heating and CD
5 MW NBI (5 MW)
6 MW HHFW (6MW)
0.5 MA CHI (0.4 MA)

Pulse Length
= 1 □ 5 sec (0.6 sec)

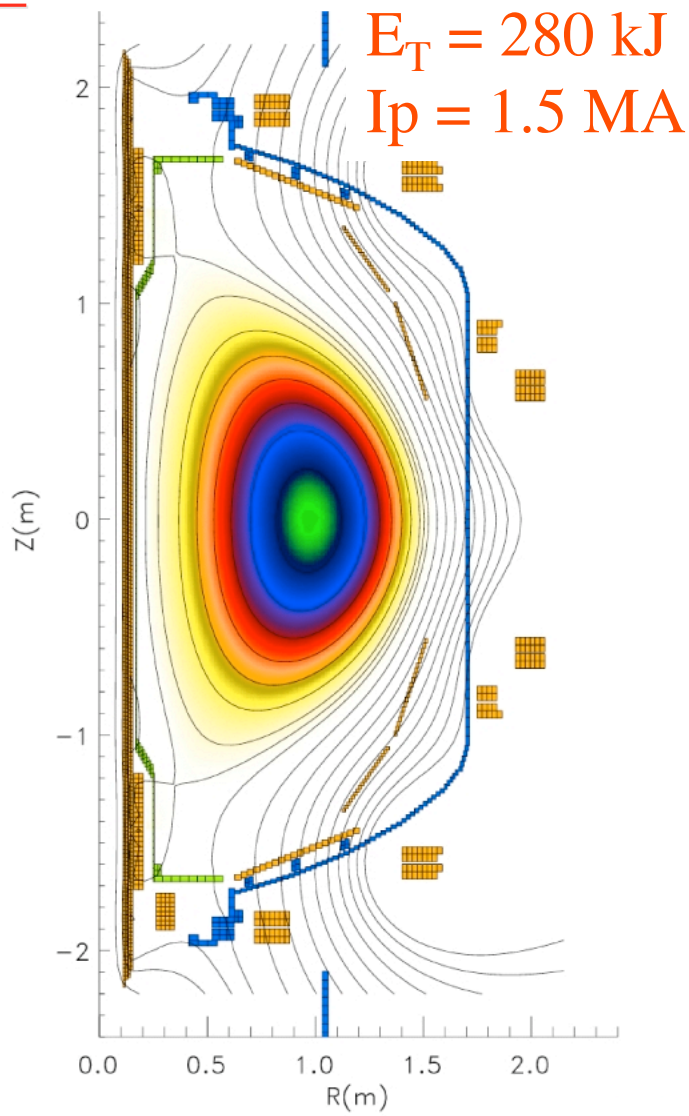
FY 01 Facility Upgrades To Support Research Plan

Plasma Performance Significantly Improved:

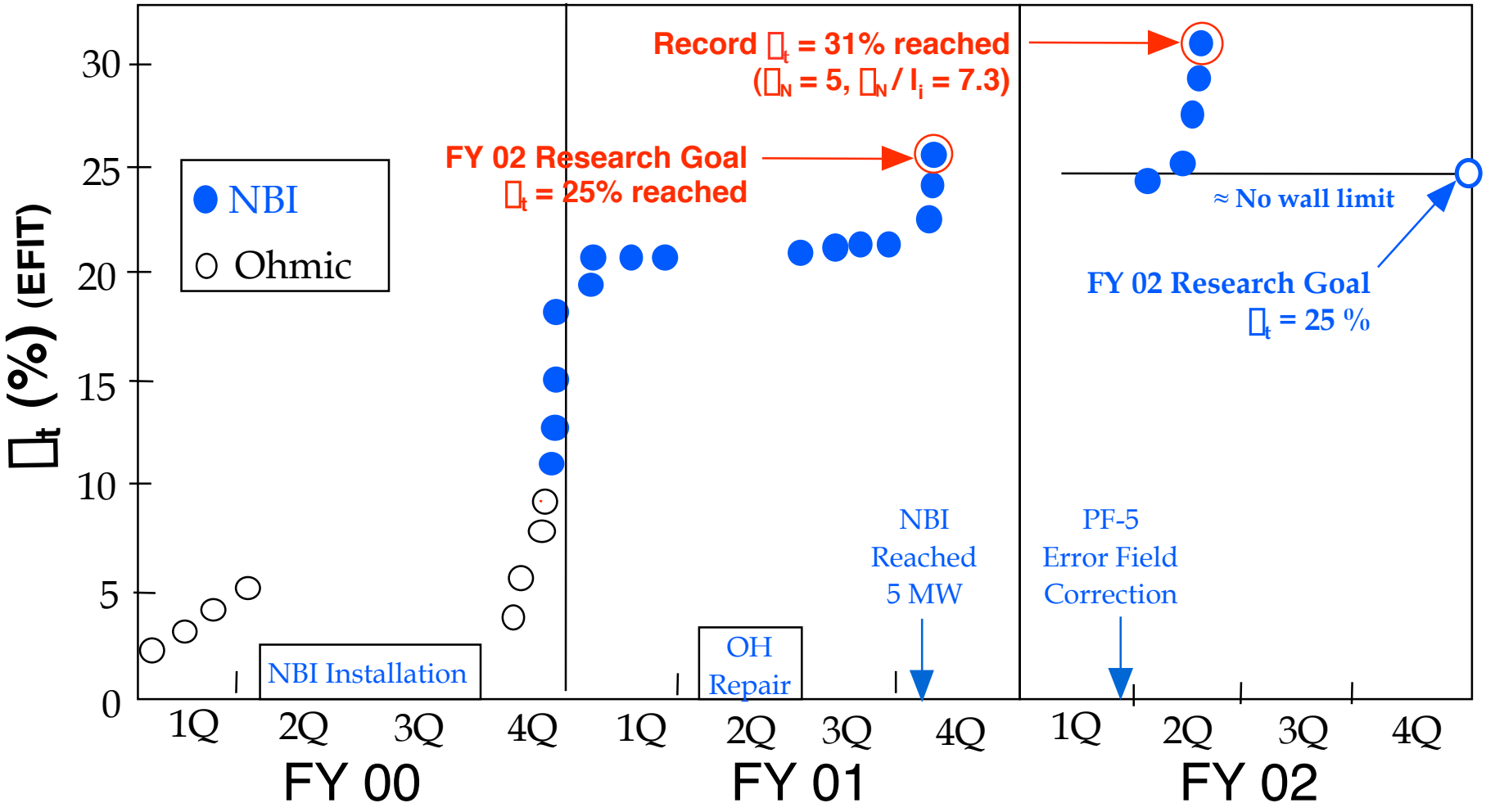
- Error field due to PF 5L coil misalignment corrected - The n=1 error field reduced by x 10.
- New plasma control system commissioned.
  - Routinely making highly shaped (κ=0.8) plasmas.

To Improve H-mode Quality:

- 350 °C high temperature bakeout system implemented.
  - Air leaks developed during the cool down at the 420°C feeds.
  - Leaking metal seal joints being welded.
- Inboard Gas Injector Installed.



High Beta Research Ahead of Schedule



MHD Mode Stabilization

Opportunity Areas are Resonant Field and RWM Controls.

NSTX

Plasma Operations	FY 02	FY 03	FY 04
(Run Weeks)	12	21	4 inc.	20	5 inc.

MHD Diagnostics

- Locked-Mode Coils
- High Freq.Coils
- Poloidal Mirnov Array
- Ultra Soft X-ray Arrays (Johns Hopkins)
- Wall-mode sensors
- Divertor Mirnov Array

- - Base
- - Incremental

Resonant Field Control

- PF 5 Realignment
- Preliminary Resonant Field Control System
- Improved Resonant Field Control System

Plasma Rotation + Wall

+ Modeling

MHD Mode Measurement

+ DIII-D, HBT-EP Expt.

Optimized Resonant Field Control System

Confinement and Transport

Exciting Opportunities For Advanced Fluctuation Diagnostics

Plasma Operations	FY 02	FY 03	FY 04
(Run Weeks)	12	21	4 inc.	20	5 inc.

Profile Diagnostics

- Thomson (20 ch, 60 Hz)
- 4 Channel FIReTIP(UCD) → 7 Channel FIReTIP(UCD)
- 51 Channel Toroidal CHERs
- Thomson (20 ch, 90 Hz)
- Poloidal CHERs

Energetic Patricles

- Scanning Neutral Particle Analyzer
- Fast Ion Loss Probe

Fluctuation Diagnostics

- Low k Reflectometer (UCLA)
- Fast Camera (LANL)
- Install Low k Imaging Reflectometer System
- Install Prototype High k Microwave Scattering System

Complete Fabrication of Full high k Microwave Scattering System

- - Base
- - Incremental

Non-Inductive CD Systems

Enhancement Opportunity areas are CHI and EBW

Plasma Operations	FY 02	FY 03	FY 04
(Run Weeks)	12	21	4 inc.	20	5 inc.

HHFW (6MW)

- Pre-programmed CD Phasing
- Plasma Feed-back phase control
- 2 Channel MSE/CIF (Nova) → 10 Channel MSE/CIF (Nova)
- MSE / LIF (Nova)

CHI (I_T = 0.5 MA)

- New CHI Absorber Insulator Fabrication
- Install
- Absorber field null control
- Dynamo-head For helicity transport
- **CHI in New Center Stack**

EBW -E / -CD

- EBWE / Edge $n_e(r)$
- Optimized EBWE Antenna
- **High Power EBWCD System (1MW)**

- **- Decision Point**
- - Base

Boundary Physics

Exciting Enhancement Opportunity in Core Fueling and Boundary Physics

NSTX

Plasma Operations	FY 02	FY 03		FY 04	
(Run Weeks)	12	21	4 inc.	20	5 inc.

Wall Conditioning

(Gas/plasma Boronization, Between-shot GDC)

- 350°C Bakeout System
- Li/Boron Pellet Injector

- Decision Point
- Base
- Incremental

CDX-U / APEX Lithium Exp.

Power/Particle Control

- •Recip. edge probe (UCSD)
- • Divertor bolometer
- • 2nd IR Cameras
- •Divertor fast camera (Hiroshima Univ)
- Fast IR Camera

Advanced Power and Particle Handling Decision Point (Liquid Lithium or Cryo Panel)

- AEUV Spectrometer
- Divertor Thomson Scattering

Fueling

- In-board gas injector
- Realtime Gas Control
- Pellet injector in "suitcase" (ORNL)

NSTX Facility Utilization

Facility Plasma Operations Availability

	FY 01	FY 02	FY 03	FY 04
# of run weeks	15	12	21(4*)	20(5*)
# of hours	600	480	840 (160*)	800 (200*)

* Incremental

Participating Research Personnel

	PPPL	non-PPPL
Researchers	45	95**
Post Doc.	3	7
Grad. Students	5	5
Undergrad. Students	3	5

** Including ≈ 20 overseas collaborating researchers from countries including Japan, Russia, Korea, UK, Ukraine, and Canada.

NSTX Budget Summary ($M)

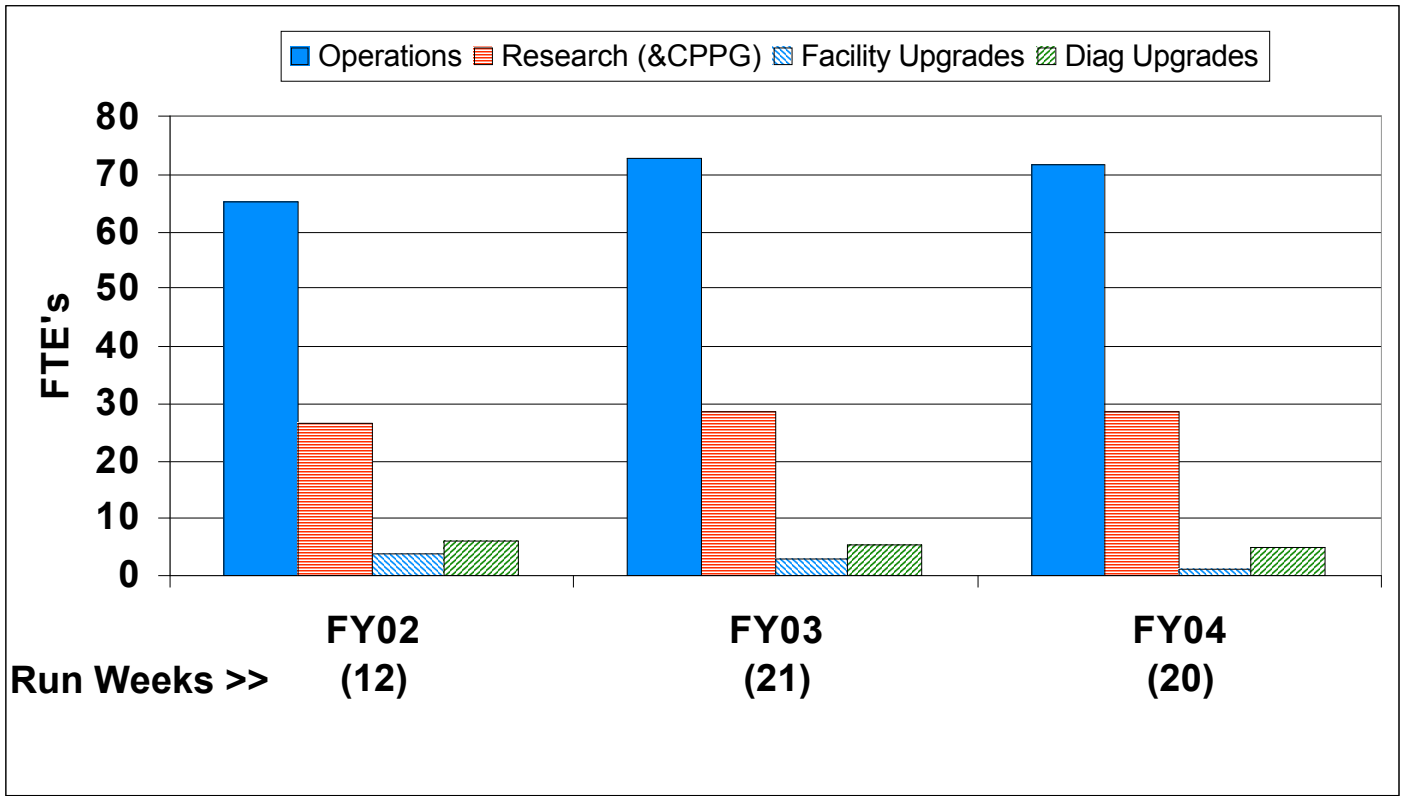
Facilities Run weeks	FY02 12	FY03 21	FY03 4	FY04 20	FY04 5
	Base	Base	Incr.	Base	Incr.
Facility Operation	$13.23	$15.82	$0.82	$16.28	$0.92
CHI Absorber	$0.31	$0.10			
Correction Coil Sys		$0.50		$0.25	$0.25
Pellet Injector			$0.32		$0.34
Facility Upgrades					$1.36
Facilities Total	**$13.54**	**$16.42**	**$1.14**	**$16.53**	**$2.87**

Science					
PPPL Research	$7.04	$7.91	$0.16	$8.21	$0.16
Upgrade Diagnostics	$0.79	$1.37		$0.98	$0.50
Collab. Diag. Interf.	$0.56	$0.76	$0.10	$0.74	$0.10
Collaborations	$4.40	$5.07*	$0.27	$5.07	$0.27
Science Total	**$12.79**	**$15.11**	**$0.53**	**$15.00**	**$1.03**

Grand Total	$26.33	$31.53*	$1.67	$31.53	$3.91

*Note that the PPPL NSTX total budget used in this FWP is $0.67M less than the FY2003 congressional budget, to provide additional support to our collaborators to carry out the baseline research during FY2003. The PPPL NSTX budgets shown exclude the budget for Waste Management ($1.417M in FY2003 and $1.428M in FY2004) that will be directly funded within each B&R line beginning in FY2003.

NSTX PPPL Personnel Staffing



- Overall PPPL staff reduced by ≈ 90 in FY 2003

Incremental Funding For FY 03 - 04 Can Greatly Enhance NSTX Science Output

- Accelerate research program schedule and enhance quality of science through
  - **25 run weeks for on-time achievement of FESAC 5 year goal**
  - Strengthen science team (Collaboration + PPPL)
  - Add key research tools to maintain appropriate level of research output with enhanced run (Collaboration + PPPL)
- Improve facility reliability and increase availability
  - Spare parts and preventive maintenance.
- Prepare for longer term facility capability: Decision point at the end of FY 03
  - Start 1 MA EBW/ECH non-inductive start-up/NTM stabilization system design/construction - and / or -
  - Start Power & Particle handling upgrade design. - and / or -
  - Start Advanced Center Stack design incorporating CHI results.

Consequences of 10% Budget Cut

- **Significant reduction in Runtime (from 21 to 12 weeks)**
- Research progress slowed by 40%.
- NSTX staff reduction of ≈ 13% or ≈ 14 FTE
  - Could result in additional terminations due to severance cost
- Non-labor reduction of ≈ 33%
  - Diagnostic components, spare parts, energy, travel, *etc.*
- Critical diagnostic upgrades deferred.
  - Poloidal CHERS, Fluctuation Diagnostics, Divertor Bolometer
- Defer all facility upgrades.
  - Resonant Field Control Coil and CHI Null Field Coil systems
- **Similar impact on all collaborations**..

The negative impact is similar for FY 03 and 04.

Summary

- FY 01 was a very productive year.
- New Tools were implemented for FY 02 campaign.
- FY02 campaign is already producing exciting results.
  - Record toroidal $\beta_T \approx 31\%$ ($\beta_N = 5$, $\beta_N / l_i = 7.3$)achieved. (surpassing the predicted no wall beta limit of ≈ 25%).
  - Strong shaping ($\kappa = 2.5$ and $\delta = 0.8$) and broad pressure profile led to record stored energy of 280 kJ (50% above 2001 value)
  - Electron confinement shows marked improvement.
- FY 03-04 base budget allows significant (≈ 70%) increase in the run weeks from FY02.
  - Enabling rapid progress for the NSTX Research Program.
- ***Incremental funding (25 run weeks) proposed for on-time achievement of the FESAC 5 year ST objectives.***

NSTX program is oriented to FESAC goals.