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NSTX Facility Plan, National ST's, Budget, & Issues

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For the National NSTX Team

FY 2003 OFES Budget Planning Meeting
Hilton Hotel, Gaithersburg, MD
March 13 -15, 2001

NBI Came Up Ahead of Schedule

	FY 01	FY 02	FY 03
Run Weeks	8	13	13

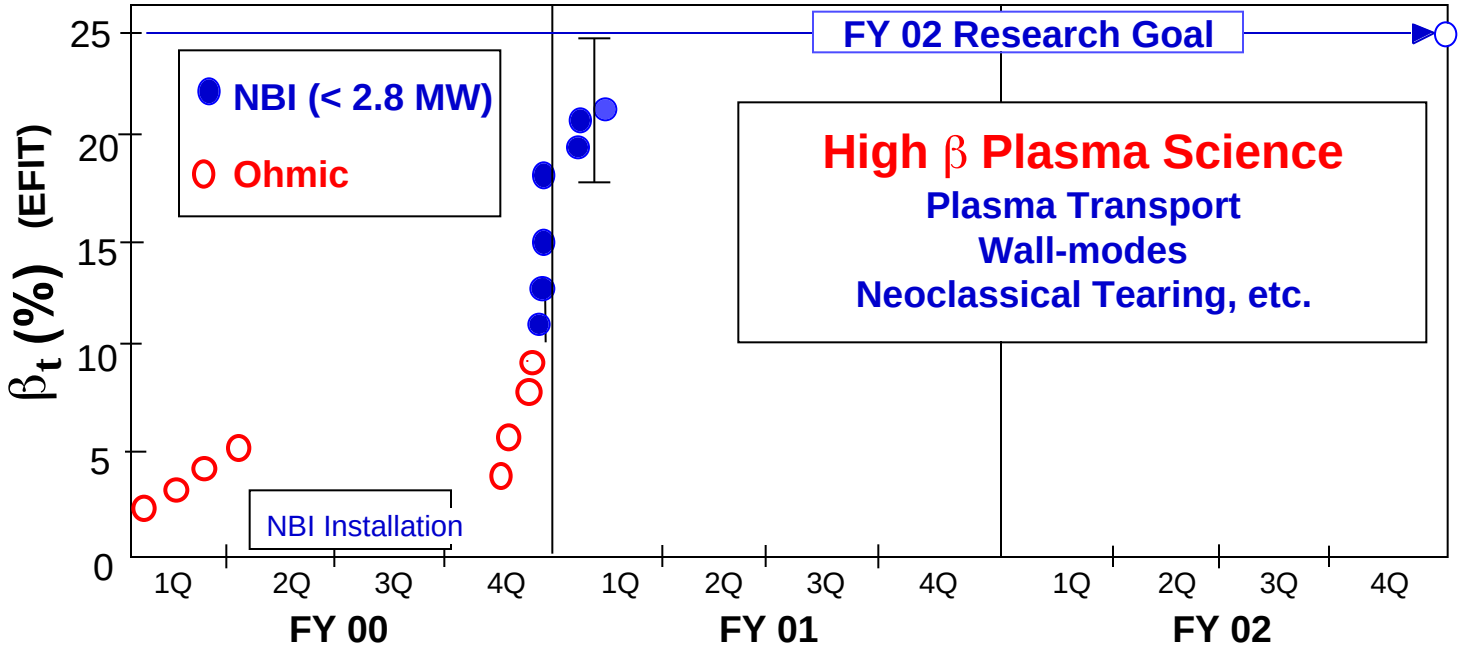
● - When available

NBI

● Three ion sources operational at 80 keV.

● Modulation

• One ion source (≈ 1.5 MW) yielded $\beta_T \approx 20\%$!.



Non-Inductive CD Systems

	FY 01	FY 02	FY 03
Run Weeks	8	13	13

HHFW

(Core Electron Heating Confirmed at ε = 50)

- Heating at 6 MW.
- CD Phasing
- Realtime phase control

Edge Physics, Antenna/system reliability improvements **(ORNL-VLT)**

CHI

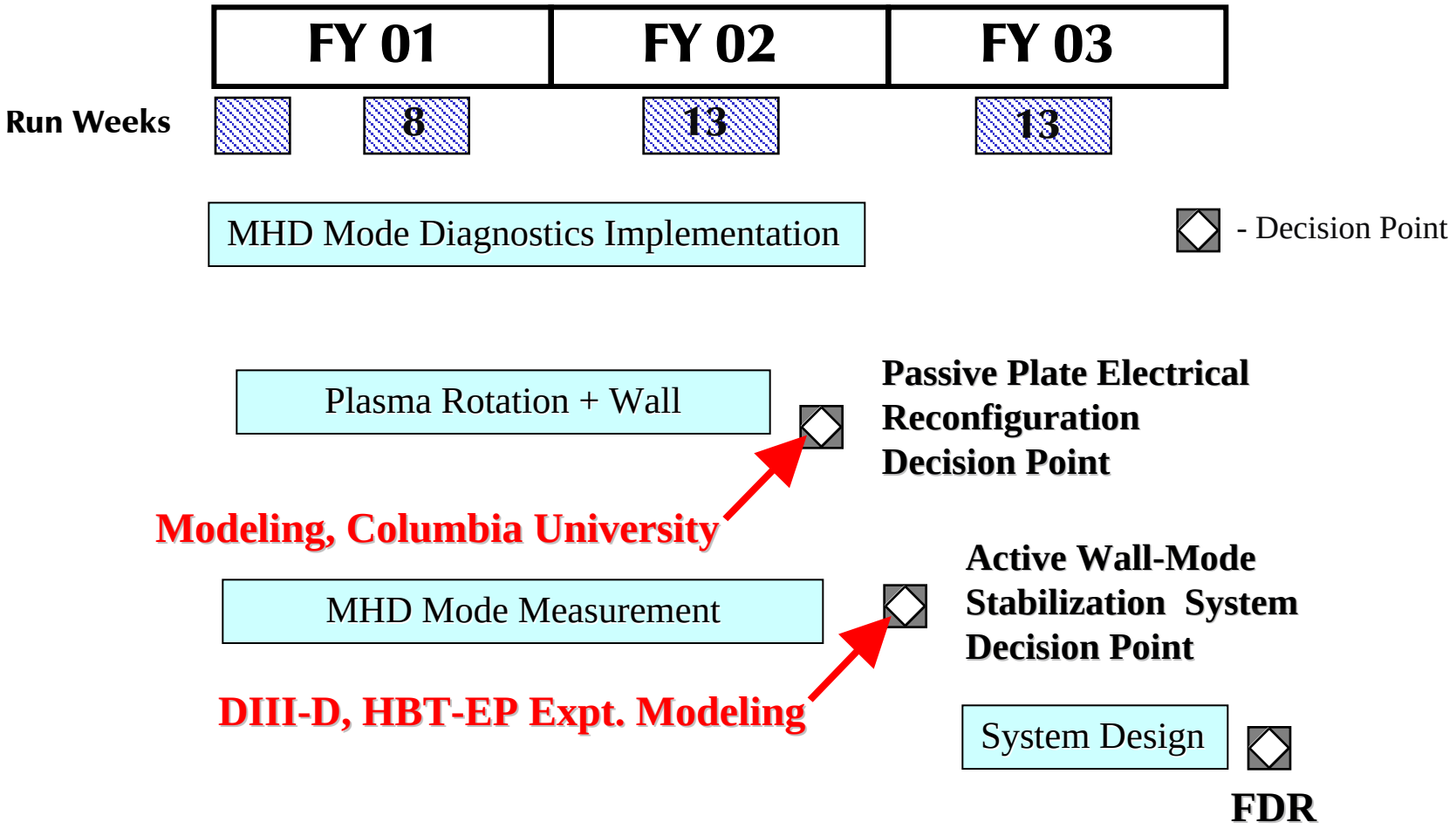
(260 kA Toroidal Current driven with 27 kA Injection)

Absorber Null Field Test/ Absorber Arc Improvements **(Univ. Washington, GA)**

HIT-II Expt.

● - When available

MHD Mode Stabilization



Boundary Physics

FY 01	FY 02	FY 03
Run Weeks: 8	13	13

● - When available

◇ - Decision Point

Wall Conditioning
(Very Successful Start)

- Plasma Boronization
- High Temp. Bakeout System
- Li/Boron Pellet Injector

Heating/Particle Control
(Future Emphasis)

Design Studies:
- Lithium Limiter Module **(VLT)**
- Divertor Cryo-pumping **(ORNL)**

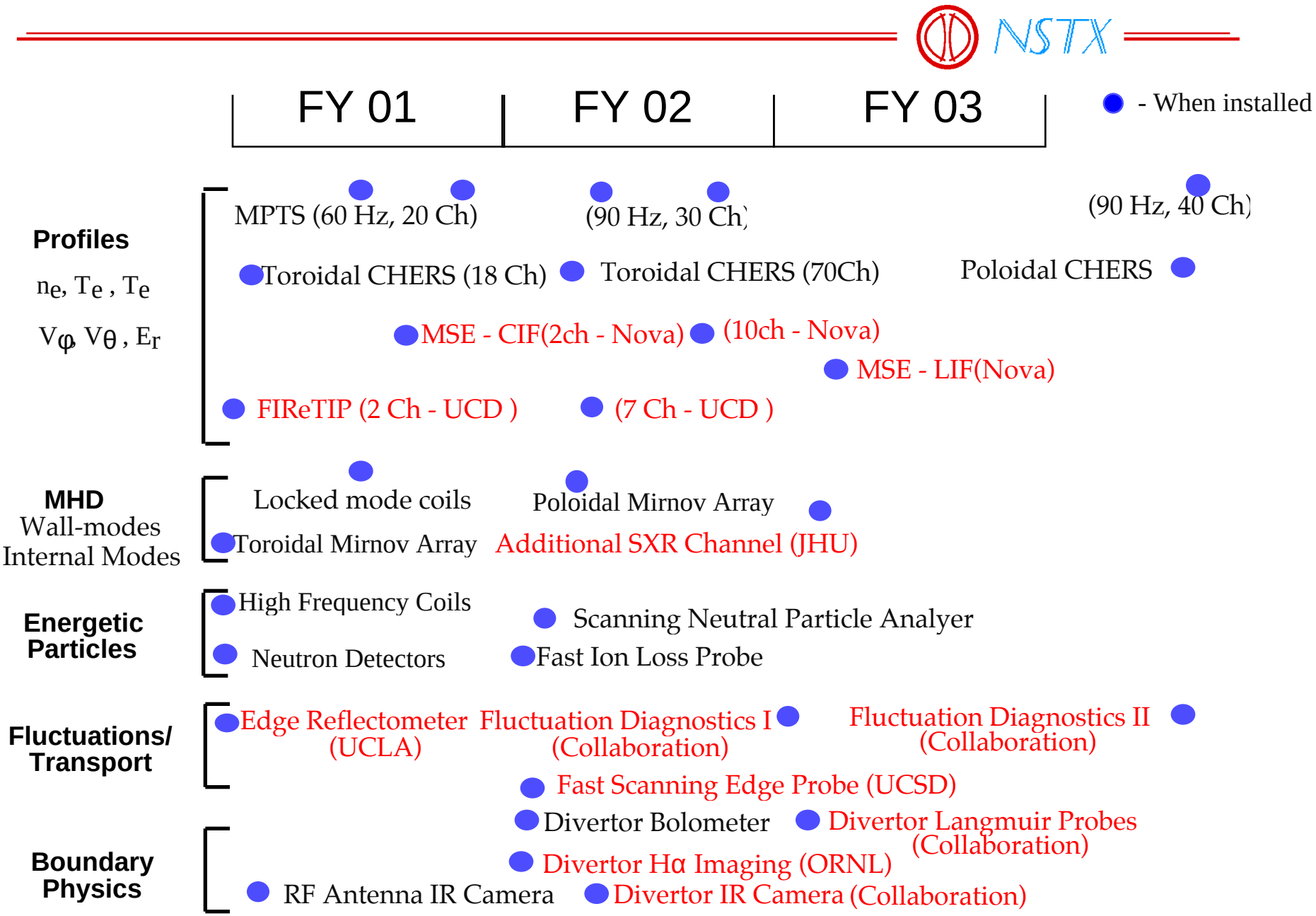
Edge/Divertor diagnostics/modeling
(UCSD, ORNL, LLNL)

◇ **Advanced Particle Pumping / Fueling Decision Point (CDX-U Li Exp.)**

Fueling

- NBI Fueling
- Realtime Gas Control

Collaborative Diagnostics Are Coming Up Rapidly



NSTX Facility Utilization

Facility Plasma Operations Availability

	FY 00	FY 01	FY 02	FY 03
# of run weeks	15*	15(7*)	13	13
# of hours	600*	600 (280*)	520	520

* actual to date

Participating Research Personnel

	PPPL	non-PPPL
Researchers	49	73
Post Doc.	4	7
Grad. Students	4	5
Undergrad. Students	1	5

* The non-PPPL researchers include collaborators from over 17 US institutions and overseas researchers from countries including Japan, Russia, Korea, UK, Ukraine, and Canada.

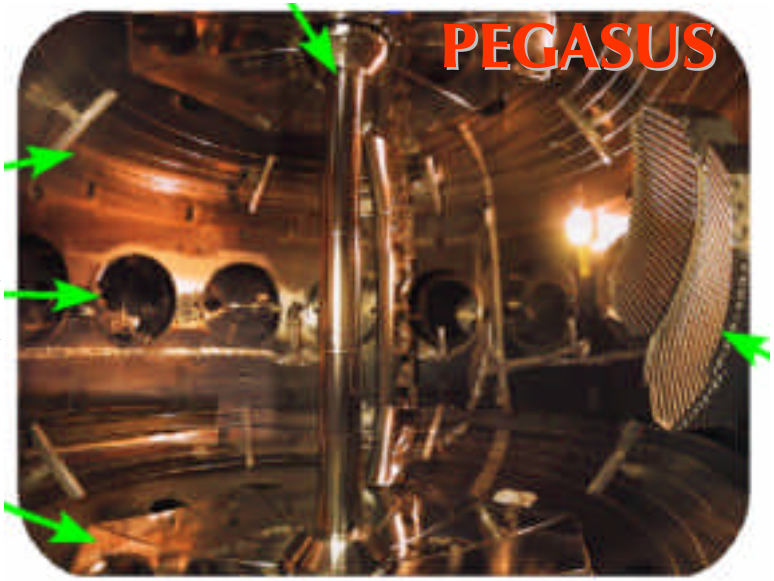
Great Opportunities Are Identified for National NSTX Research Collaboration During FY02-05

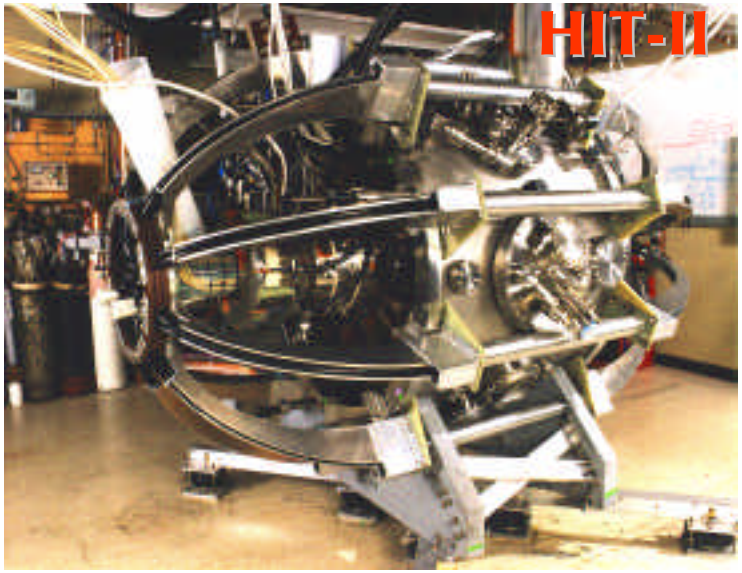
Scientific Emphasis	Scientific Topical Areas	Collaboration Emphasis
M	Noninductive Startup	H
M	Heating, Current Drive, Fueling	M
H	Macroscopic Stability	H
H	Turbulence and Transport	M
M	Energetic Particle Interactions	M
H	Multi-Phase Interface	H
H	Crosscutting Diag. and Enabling Tools	H

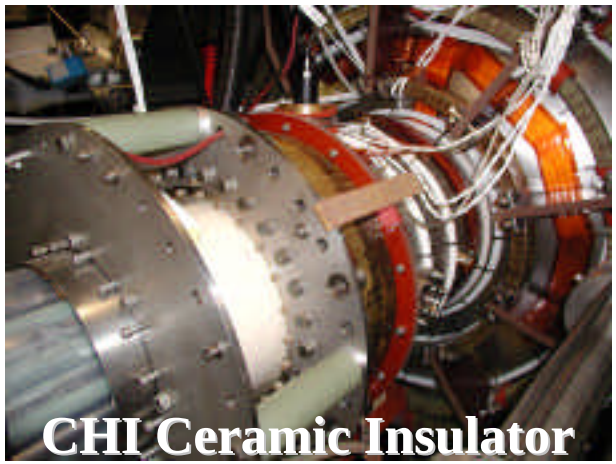
- Incorporated NSTX Research Forum input and PAC-10 advice
- Articulate National Research Plan and describe Emphases in Collaboration in NSTX Program Letter (3/31/01)
- Support preparation of collaboration proposal with Record of Discussion between proposers and PPPL researchers (4/2/01 - 6/22/01)
- Recommended date for submission to DOE - 7/1/01

The National ST Program Addresses Important Near-term and Longer-term ST Issues

NSTP







The National ST Program is Well Integrated

NSTP

FY 01	FY 02	FY 03

◇ - Decision Point

NSTX Major Decision Points

CHI Absorber Improvements

HIT-II

EBW/ECH/HHFW Non-inductive Start-up

PEGASUS
CDX-U

Advanced Particle Pumping

CDX-U

◇

Second Center Stack

HIT-II
PEGASUS
CDX-U

HIT-II — CHI

PEGASUS — Ultra-Low-Aspect-Ratio — High β_T — ECH, HHFW EBW

CDX-U — EBW-Emission — Liquid Lithium Tray (VLT)

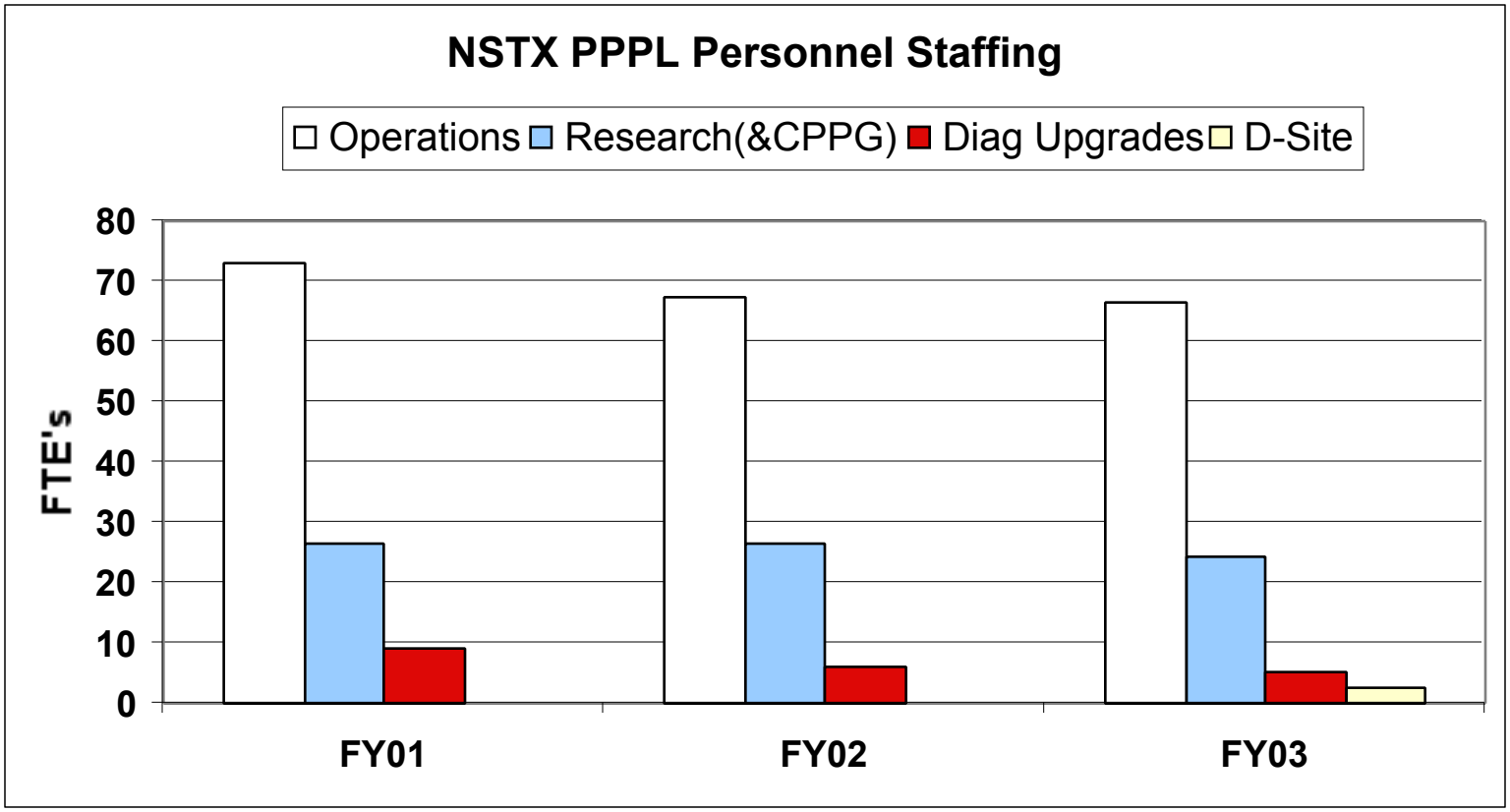
NSTX Budget Summary ($M)

	FY 01	FY 02		FY 03	
Facility (Run weeks)	(15)	**Base** (13)	**Inc.** (7)	**Base** (13)	**Inc.** (7)
Facility Op.	11.47	11.15	0.67	11.71	0.86
Facility Upgrade	0.71				
NBI Op.	2.14	2.25	0.1	2.49	0.1
D-site				0.43	
Wall-mode Stab.			0.2	0.2	0.3
EBW/ECH Upgrade	0.05		0.15		0.5
CS Upgrade		0.2	0.8	0.20	2.13
Facility Total	**14.37***	**13.60**	**1.92**	**15.03**	**3.89**
Science					
PPPL Research	6.39	6.74	0.49	6.64	1.09
PPPL Diag.	1.82	1.35	0.78	1.00	1.05
Diag. Interface	0.59	0.65	0.2	0.63	0.2
PPPL Sci. Total	**8.80***	**8.74**	**1.47**	**8.27**	**2.34**
Collaboration	**4.40**	**4.40**	**0.84**	**4.40**	**1.12**
Grand Total	**27.57***	**26.74**	**4.23**	**27.70**	**7.35**

*Note: FY 01 Budget includes $0.88M of carry-over from FY 00.

For 10% incremental ($2.7 M) case: $1M for 5 additional run weeks, $ 0.8 M for PPPL Science including diagnostic upgrades, $ 0.5 M for Collaboration, and $ 0.4 M for Facility Upgrades.

NSTX PPPL Personnel Staffing



• Number of personnel which can be covered on NSTX base budget declines both in FY 02 and FY 03.

EBW/ECH for Non-inductive Start-up & NTM Stabilization

Motivation:

- **Alternate non-inductive start-up method (as recommended by NSTX PAC)**
  - ECH/EBW (~400 kW) ~100 kA CD for ST formation
    - could also provide efficient tool to stabilize neoclassical tearing modes
      - ECCD effective on tokamaks
  - HHFW (6MW) CD and bootstrap over-drive (ARIES-ST and AT)

Proposed plan:

- **Establish ECH/EBW physics need & feasibility in FY 01-02 through**
  - Studies of EBW emission & low-power coupling in NSTX
  - Joint experiments in PEGASUS
  - Modeling by MIT, ORNL, GA, Wisconsin, PPPL
- **Engineering design / fabrication in FY 02- 04 (Incremental)**
  - Based on existing ECH supplies at ORNL
  - PPPL-ORNL joint project with Enabling Technology

Second Center Stack

Motivation:

- Longer pulse to address FESAC 5-10 year objectives ($\tau_{pulse} >> \tau_{skin}$)
- Somewhat higher current to confine NBI ions better at high q(0)

- Implement after successful completion of research program with present center stack
  - FY 07 for the base and FY 05 for the incremental case

Proposed Plan:

- FY 02 Physics Design: Longer Pulse TF *vs.* OH, better CHI insulator, Shaping, R/a, *etc.*
- FY 03 Pre-conceptual Design: Finite-element analysis, Manufacturability, Cost and Schedule. Finalize design point
- FY 03 **Decision Point**: NSTX 5 Year Program Review
- FY 04 - 06 Engineering Design, Fabrication, Installation
- FY 07 Start of Experiments

Incremental Funding Can Greatly Enhance NSTX Science Output

- Accelerate (≈ 4 months/year) research program schedule and enhance quality of science through
  - **Additional 7 run weeks per year (≈ 50% increase)**
  - **Accelerating key diagnostic tools including Fluctuations, LIF-MSE, Poloidal CHERS, MPTS (Collaboration + PPPL)**
  - **Strengthening science team (Collaboration + PPPL)**
- Improve facility capability (HHFW, CHI, NBI spares) and increase availability
- Prepare for longer term facility capability
  - **Start EBW/ECH non-inductive start-up system construction**
  - **Accelerate Second Center Stack consistent with the research program schedule**

Impact of 10% Budget Reduction

- **Roughly equal reduction in**
  - **Runtime (from 13 to 9 weeks)**
  - **Science/operations**
  - **Diagnostic upgrades**
- **NSTX staff reduction of ≈ 10 % or ≈ 10 FTEs**
  - **Could result in additional terminations due to severance cost**
- **M&S reduction of ≈10%**
  - **Diagnostic components, spare parts, energy, travel, *etc.***
- **Critical diagnostic upgrades delayed**
  - **MPTS, Poloidal CHERS, Divertor Probe.**
- **Longer term upgrades delayed**
  - **EBW, Second Center Stack.**

Summary

- NSTX Team achieved major FY 00 milestones on schedule
- Facility achieved high availability and utilization for FY00 – 01
- Research capability is rapidly increasing:
  - High beta ($\beta_T \approx 20\%$) achieved
  - H-mode with good confinement ($\tau_E \approx 100$ msec) observed
  - Good progress on non-inductive (HHFW and CHI) tools
  - Diagnostic systems are maturing
- Exciting FY01-03 Research Program is planned and started
- FY 02-03 base budget allows 13 run weeks
  - FY 03 is particularly challenging due to the D&D completion

Incremental funding would significantly accelerate research program (by ≈ 33%), enhance science, and allow timely implementation of upgrades to device capability