



MIT PLASMA SCIENCE AND FUSION CENTER

OVERVIEW

Miklos Porkolab

Director

**OFES Budget Planning Meeting, March 18,19, 2003
Gaithersburg, MD**



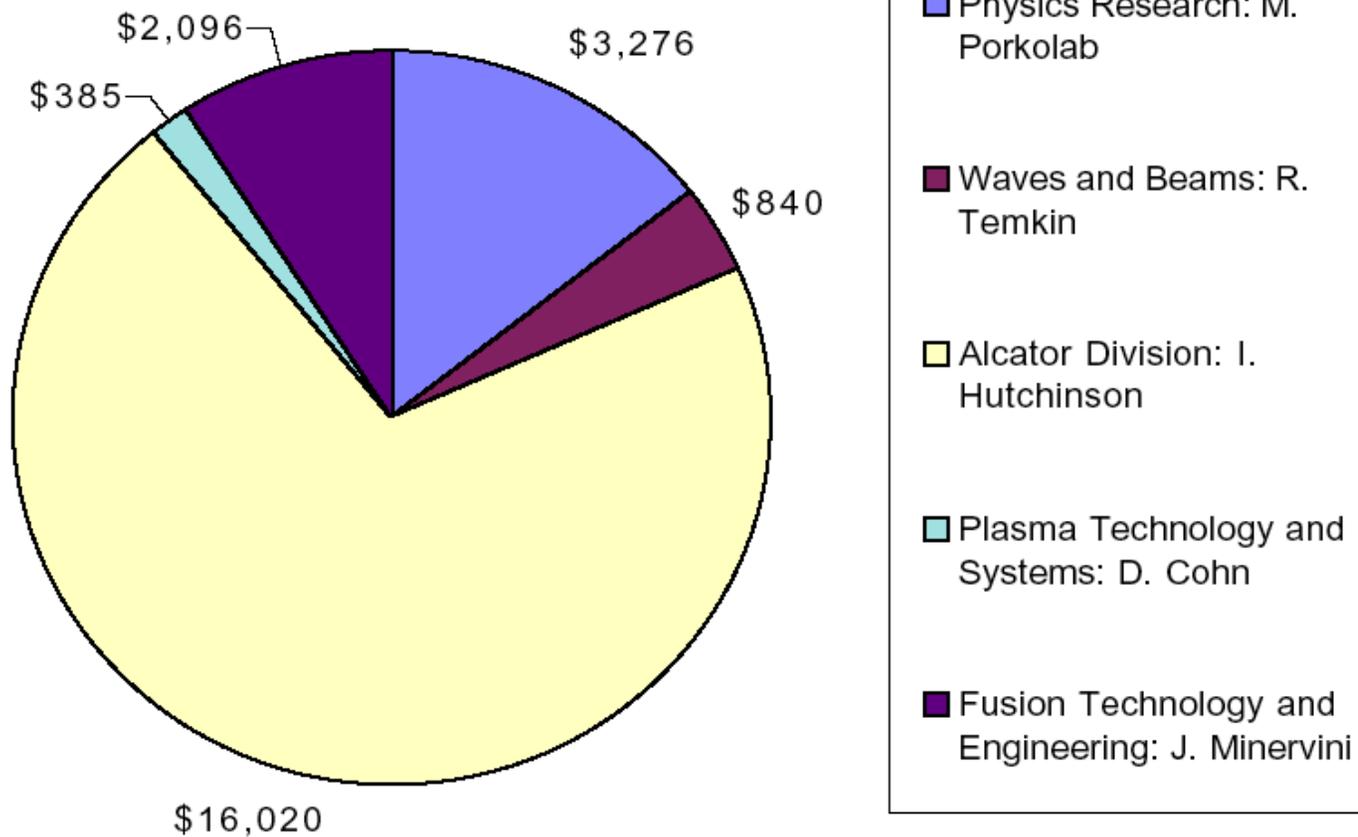
PERSONNEL

	<u>FY98</u>	<u>FY99</u>	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>
Undergraduate Students	6	7	6	5	9	17
Graduate Students	49	48	44	54	49	56
Faculty/Sr. Academic	18	18	18	16	18	18
Visiting Scientists & Staff Engineers	57	59	58	54	61	58
Engineering/Scientific Research Staff	76	68	65	68	72	68
Administrative Staff	13	13	10	12	13	12
Support Staff	14	13	11	9	10	13
Technicians/Drafters	36	29	28	30	30	31
TOTAL	269	255	240	248	262	273



FY 03 OFES Funding by Division

Total funding: \$22,617,000





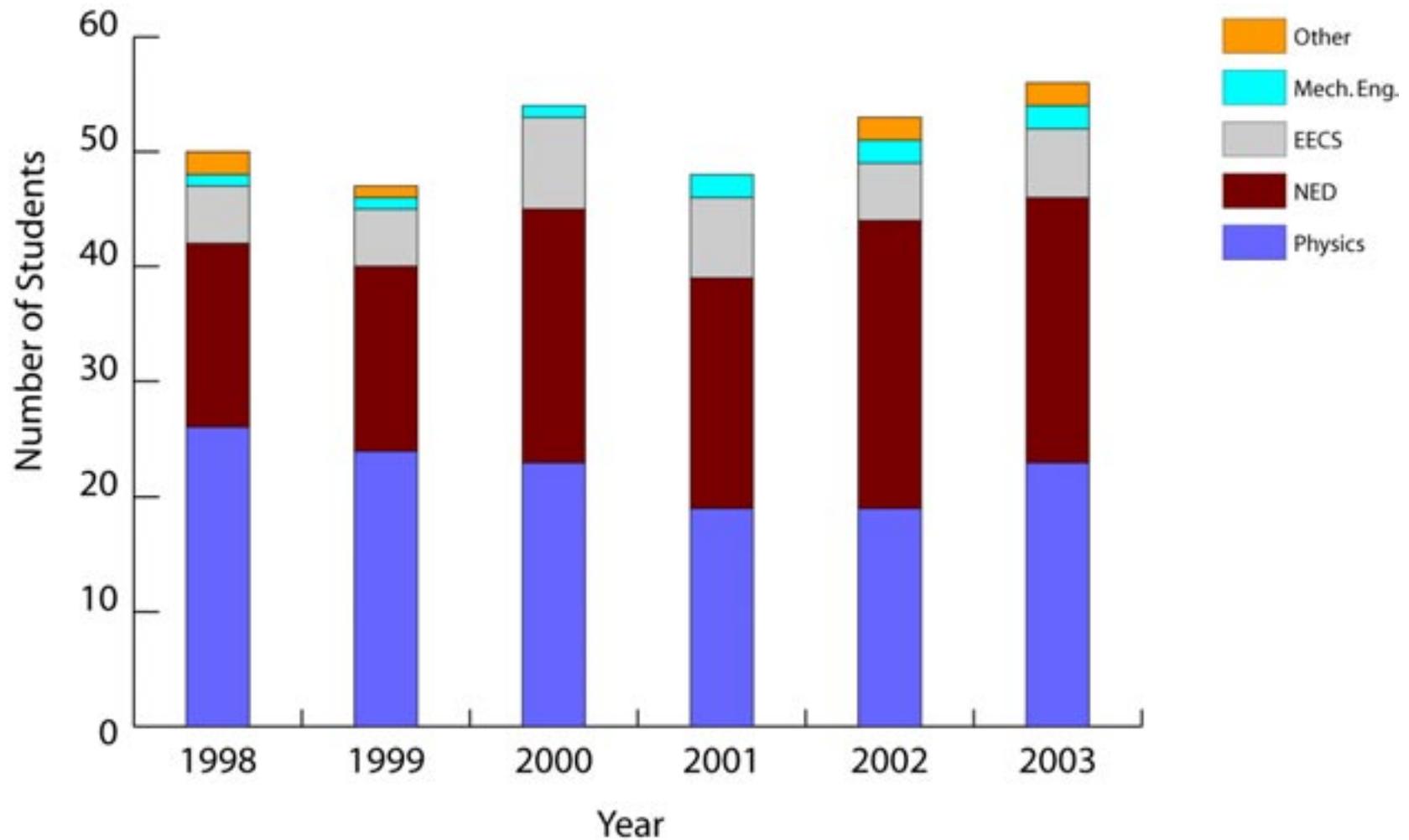
PSFC BUDGET PROJECTION

PLASMA SCIENCE AND FUSION CENTER
Summary of FY02-03 and Projection of FY04-05 Funding
(\$ In thousands, government fiscal years 10/1/01-9/30/05)

PSFC DIVISION	FY02 BUDGET	FY03 BUDGET	Projected FY04 BUDGET	Need FY04B BUDGET	Projected FY05 BUDGET	Need FY05B BUDGET
Physics Research: M. Porkolab	3,233	\$3,276	3,365	4,263	3,365	4,339
Waves and Beams: R. Temkin	806	\$840	840	887	840	887
Alcator Division: I. Hutchinson	14,304	\$16,020	20,159	22,100	20,159	24,330
Plasma Technology and Systems: D. Cohn	424	\$385	365	365	365	365
Fusion Technology and Engineering: J. Minervini	2,171	\$2,096	2,096	2,301	2,096	2,301
TOTAL DOE OFES AT MIT:	20,938	\$22,617	26,825	29,916	26,825	32,222



Total Enrollment of Graduate of Students at the PSFC, by Year





Graduate Student Applicants Double for the Fall of 2003

Physics:

**40 new applicants with first choice in plasma physics,
and another 40 with second or 3rd choice in plasmas;
more than 80 % US citizens**

Nuclear Engineering:

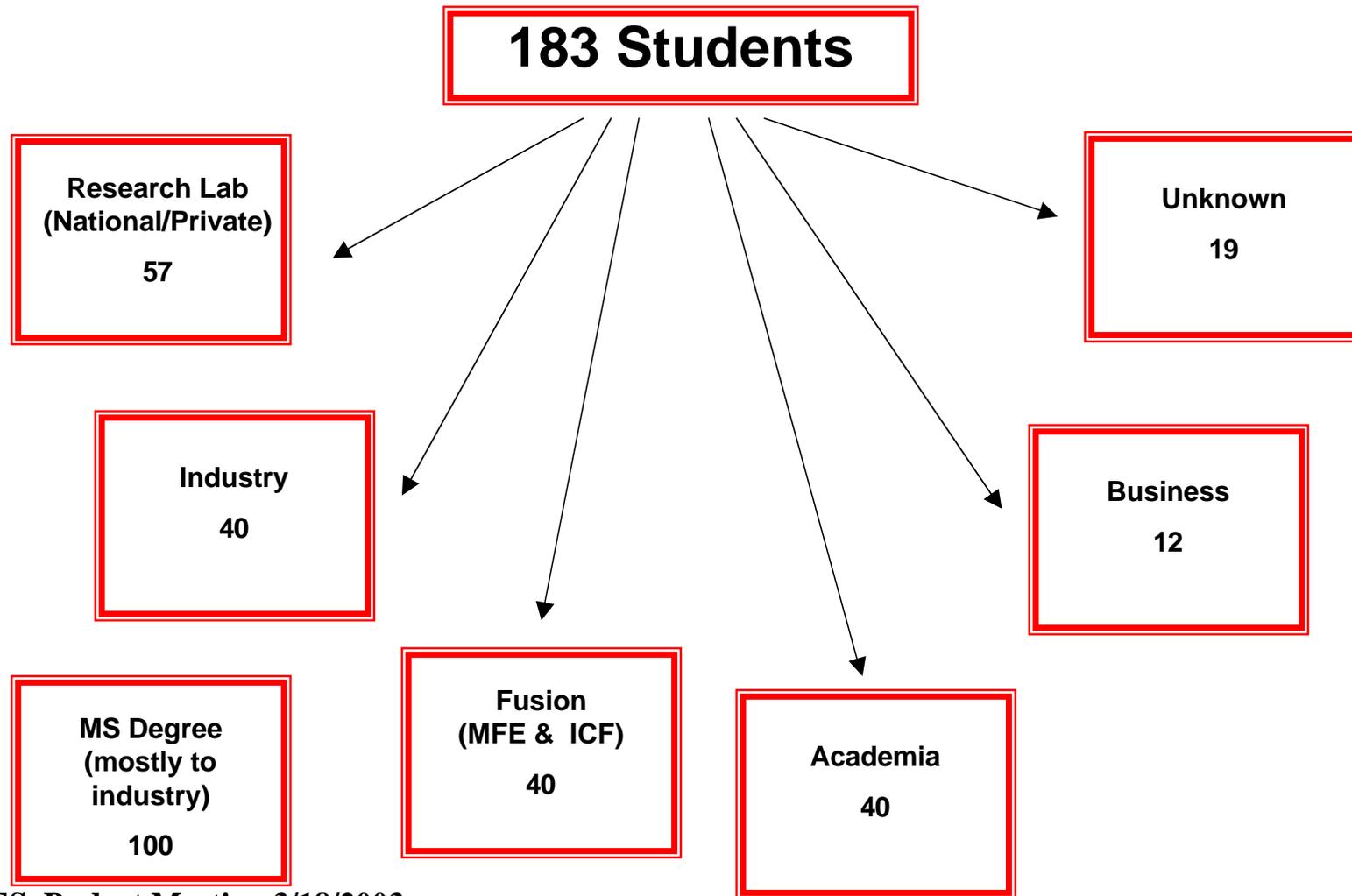
34 applicants, about 40% US citizens

Research Assistant positions available:

9 in experiment, none in theory, only 6 OFES funded



Employment Status of MIT PSFC Students upon Graduation 1980–2002





Vigorous K-12 Outreach Program in Plasma Science (Internally Funded)



- The Mr. Magnet Program (Paul Thomas) reaches over 30,000 students per year.
- The Center provides over 35 tours of the Center per year, reaching over 800 K-12 students, teachers and general public.
- MIT PSFC supports growing APS-DPP education activities, and prepares to lead these outreach efforts in 2004 in Savannah, GA.
- PSFC helps maintain and expand Coalition for Plasma Science educational activities, including website and publications.



ALCATOR C-Mod ADVANCED TOKAMAK

A National Facility

- **Advanced Tokamak (AT) Program:**

Quasi-steady state configuration at $B \sim 5T$ with high bootstrap current fraction and RF current and profile control
[FESAC MFE Goal #3 -AT]

→ Add 3(4) MW of lower hybrid (4.6 GHz) power

- **Burning Plasma Relevant**, RF heated plasma regimes at reactor relevant magnetic fields (5-8T) and densities ($n_e \sim 2 - 4 \times 10^{20} m^{-3}$), with metallic plasma facing components
[FESAC MFE Goal #3 - Burning Plasma Physics]

→ 8 MW ICRF installed for heating and flow drive

- Typically **20 + graduate students** doing Ph.D. theses

- **Increased funding needed for FY 2004, 2005 for 21 (24) weeks of operation; complements DIII-D, and prepares the US to optimize, and to take full advantage of future ITER operations**

PHYSICS RESEARCH DIVISION



OFES FUNDED EXPERIMENTS

A. Levitated Dipole Experiment (LDX)

(J. Kesner - MIT; D. Garnier, M. Mael - Columbia University)

New proposal to be submitted this Spring

B. Advanced Diagnostics -Each Experiment funded through FY 05

- Phase Contrast Imaging (PCI)
(DIII-D, C-Mod collaboration) (M. Porkolab, C. Rost, Grad students)
- CTS from energetic ICRF tails
(TEXTOR, ASDEX-U collab.) (P. Woskov, Post-Doc)
- TAE modes in the presence of alphas and ICRF tails (JET collab.)
(A. Fasoli, J. Snipes, Post Doc)

C. Driven Magnetic Reconnection Experiments on VTF

(Dr. J. Egedal + 2 grad students + 2 undergrads; Prof. A. Fasoli on leave)

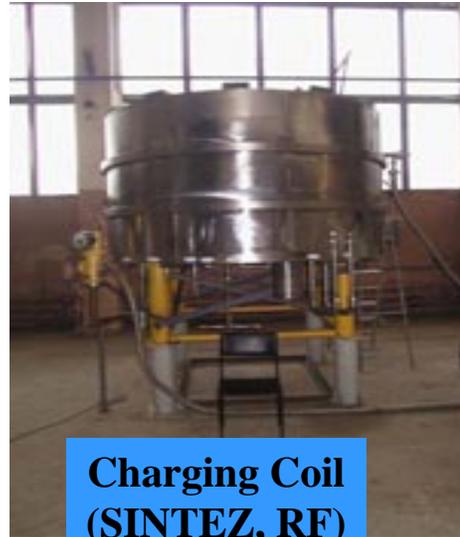
-Experiment funded internally; proposal submitted to NSF/DOE initiative in January; substantial student and Phys. Dept. interest, only “Laboratory Basic Plasma Physics Experiment” at the PSFC; (Previously funded by Prof. Fasoli’s DOE Junior Faculty Award;



LDX COMPONENTS NEAR COMPLETION



LDX Cell



**Charging Coil
(SINTEZ, RF)**

- Base diagnostics, power supplies, and ECRH being installed at MIT
- Nb₃Sn **Floating Coil** with final super-insulation being installed at Ability Technology
- NbTi **Charging Coil** tested at SINTEZ (Russia) in March
- Fusion's first High T_c coil completed for the LDX **Levitation Coil**
- **First plasma this summer**



**Floating Coil
(Ability)**

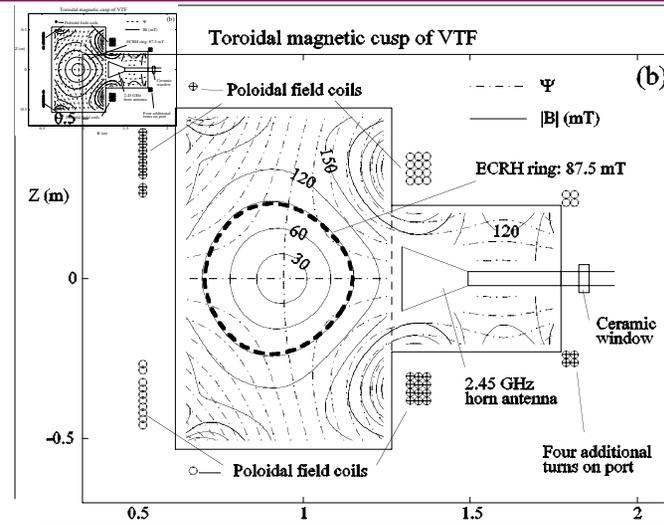


**Levitation Coil
(Everson Elec.)**

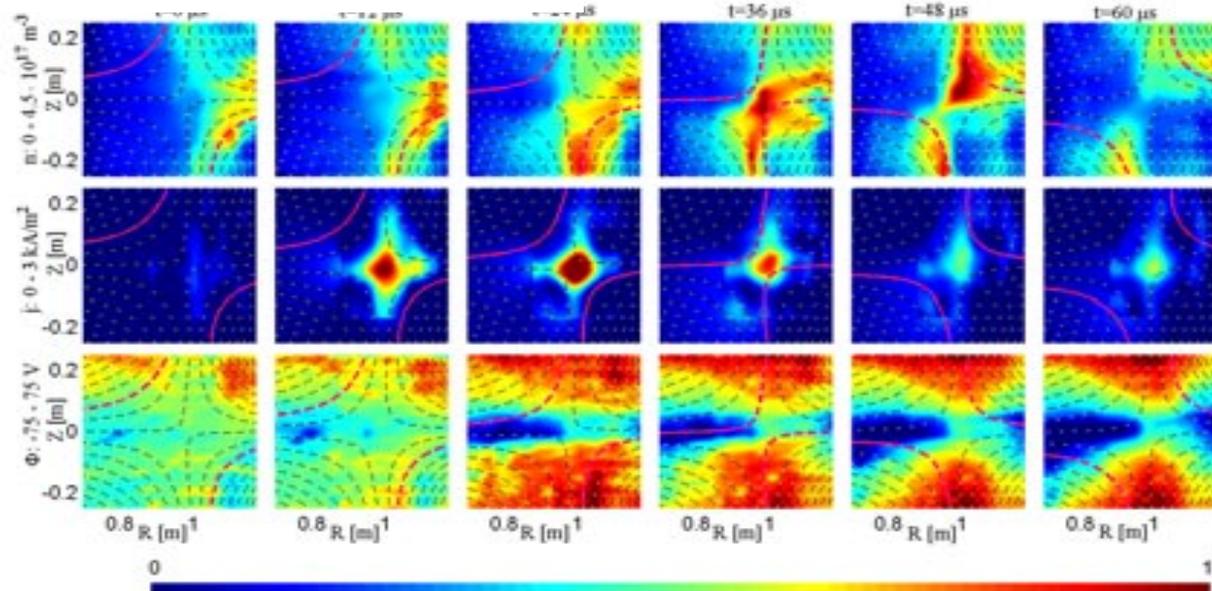


Collisionless Reconnection Processes in VTF

The Versatile Toroidal Facility (VTF)



Example of experimental measurements providing detailed information on the time evolution of the plasma density, current and electrostatic potential during reconnection.





PHYSICS RESEARCH DIVISION THEORY (P. Catto, Head)

- A. Edge Physics, Turbulent Transport, Divertor Theory, ITER
(P. Catto, D. Ernst, **Prof. K. Molvig**, A. Simakov (post-doc))
- B. Advanced Tokamak, LDX, MHD Stability, ITER,
Computational Physics
(P.T. Bonoli, **Prof. J. Freidberg**, J. Kesner, J. Ramos, J. Wright)
- C. Current Drive, Nonlinear Dynamics, EBW on NSTX,
RF Heating on Alcator
(P.T. Bonoli, A. Ram, Profs. A. Bers, M. Porkolab)

ISSUE:

**Post-Doc Simakov being let go due to budget shortfall;
Profs. Kim Molvig (recently returned to fusion research) and
Jeff Freidberg (stepping down as Nucl. Eng. Dept. Head) need
summer salary and travel funds (\$ 200k) starting in FY 03,
as well as support for 2 students in FY 04 (\$100k) and 2 more
students in FY 05 (+\$100k)**

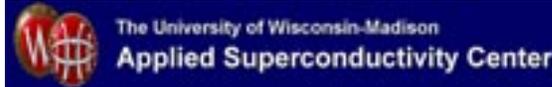


Technology & Engineering Division

Issues at the PSFC

- **6 years of flat funding eroded by inflation leads to significantly reduced effort and capability.**
 - Inadequate funding for small-scale experiments, operating test facilities, or maintaining equipment
 - No funding available for development of advanced SC materials
- **Division core capability has been maintained since 1999 by >40% non-OFES Work-for-Others**
- **Recent effort applied to ITER cost study is virtually unfunded compared with level of effort required.**
 - Reengagement in ITER magnet activities requires substantial ramp-up in funding :
 - **\$2M in FY 2004**
 - **\$4M in FY 2005**

FY02-03 Accomplishments of the Magnet Technology Program



Model Coil Testing



**Nb₃Al
Coil
Tested at
JAERI**



**TFMC
Tested
at FzK**

Superconducting Magnets for LDX



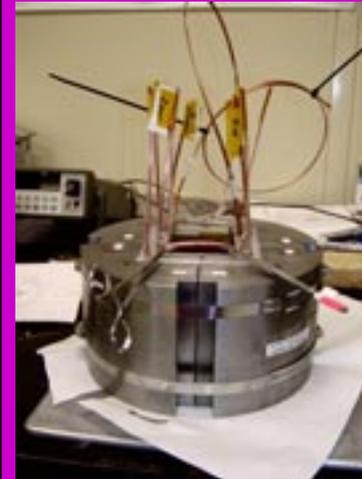
**NbTi
Charging
Coil**

**Nb₃Sn
Floating
Coil**



**HTS
Levitation
Coil**

Quadrupole Magnets and Cryostat for HCX



**Optimized
Quadrupole**



**HCX
Cryostat**



ECH Technology Issues

- **Program needs to be strengthened to meet commitments to the base program and ITER**
- **Base program research tasks:**
 - **Prototype 1.5 MW, 110 GHz highly reliable gyrotron**
 - **1 MW, 15 GHz gyrotron design for EBWH on NSTX**
 - **Future gyrotron development: frequency tunability; higher efficiency, power and frequency availability**
 - **High efficiency transmission lines and mode converters**
- **ITER research:**
 - **1 to 1.5 MW, 170 GHz gyrotron development for ITER**
- **Additional funding requested:**
\$250k in FY04, \$500k in FY05