MST Program Plans

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Budget Planning Meeting

March, 2003

Outline

- Overall goals
- Relation to IPPA goals
- Major tasks
- Current status
- FY 05 decrement case
- FY 05 program planning case

MST Goals

- Advance specific fusion physics issues

- Advance the RFP reactor configuration

Major MST Physics Goals

- Discover lower limit to magnetic transport
- Discover role of electrostatic transport
- Determine beta limit
- Uncover physics of magnetic self-organization, and links to astrophysics

  (dynamo, angular momentum transport, magnetic chaos and transport, ion heating, magnetic helicity conservation)

Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas

- Funding pending, likely authorized in few weeks
- An NSF Physics Frontier Center
- A partnership with OFES
- Goal: advance physics of MSO common to lab and astro, establish links between 2 communities
- Teams lab physicists and astrophysicists
- Involves 4 experiments (MST, MRX, SSPX, SSX)
- Involves theorists, computation scientists, and astrophysicists at Chicago, Princeton, SAIC, UW

Center for Magnetic Self-Organization in Laboratory and Astrophysical Plasmas

- Complementary to MST fusion goals

- Will establish new links and outreach for fusion program

- Exploits and requires a proof-of-principle facility

- About a 15% increase in MST resources (mostly staff),

RFP configuration goals for MST

Establish sustained, good confinement

or

Establish an attractive pulsed reactor scenario

MST Strongly linked to two IPPA Goals

1. General understanding

   turbulent transport, macrostability, wave-particle interactions, general science

2. Innovative magnetic confinement configurations

   RFP confinement and sustainment

MST contributes modestly to other two IPPA goals

3. Burning plasmas

   fast particle effects in RFP

4. Technology

   RF antennas, pellets, neutral beam sources, in-situ boronization…

Major MST Tasks
(from budget viewpoint)

- Current drive and heating
  - Develop and apply to RFP
  - For confinement improvement, sustainment, beta limits

- Diagnostics
  - For equilibrium measurements (transport, flow....)
  - For fluctuations (magnetic and electrostatic)

Current drive and heating

- Lower hybrid wave injection
- Electron Bernstein Wave injection
- Oscillating field current drive
  (ac helicity injection)
- Neutral beam injection
- (pellet injection)

Status in FY 03

- Current drive and heating
  - Staged development, beginning at low power
  - Good progress in all systems
  - Will select for high power pending results and funds

- Diagnostics
  - Good equilibrium/transport diagnostics
  - Novel diagnostics developed and developing
  - Diagnostic set not fully utilized

Current drive and heating - status

Lower hybrid waves

Status: Antenna successful at 50 kW,

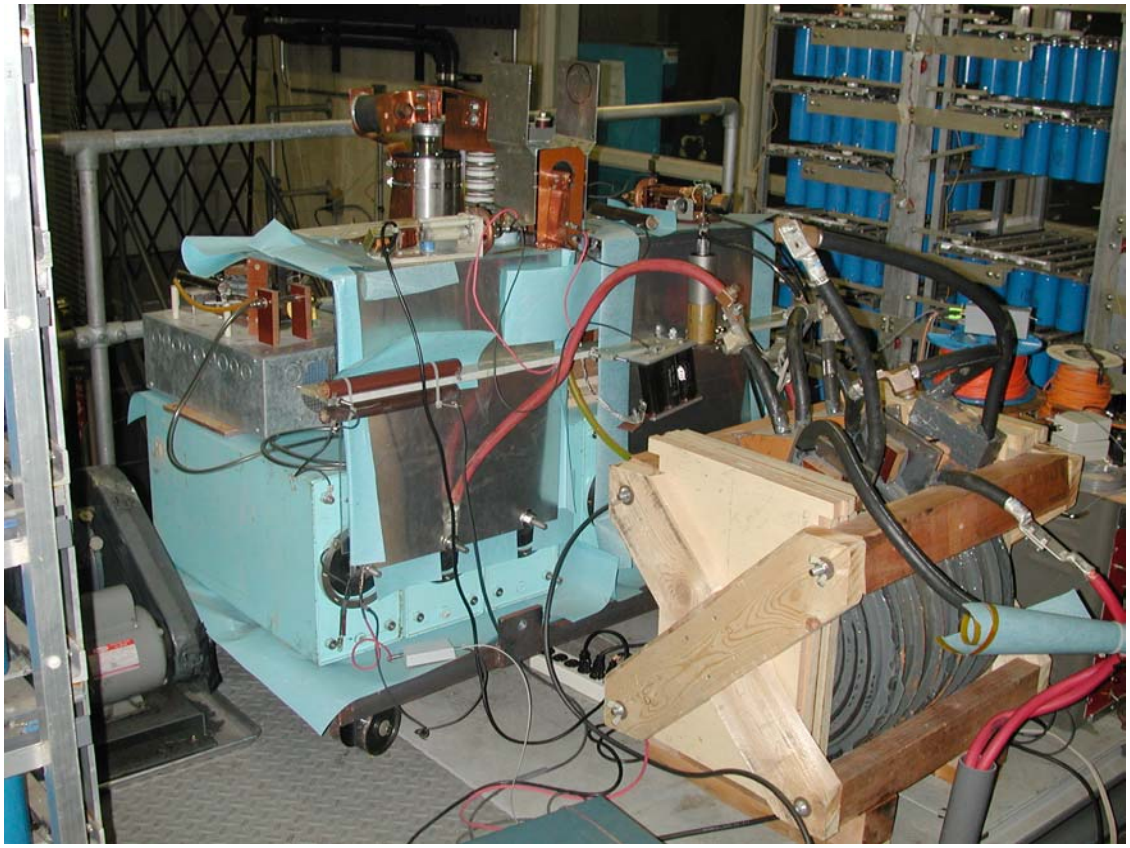
200 kW system construction in CY 03

Electron Bernstein Wave injection

Status: emission and low power coupling successful,

~ 70 kW tests CY 03

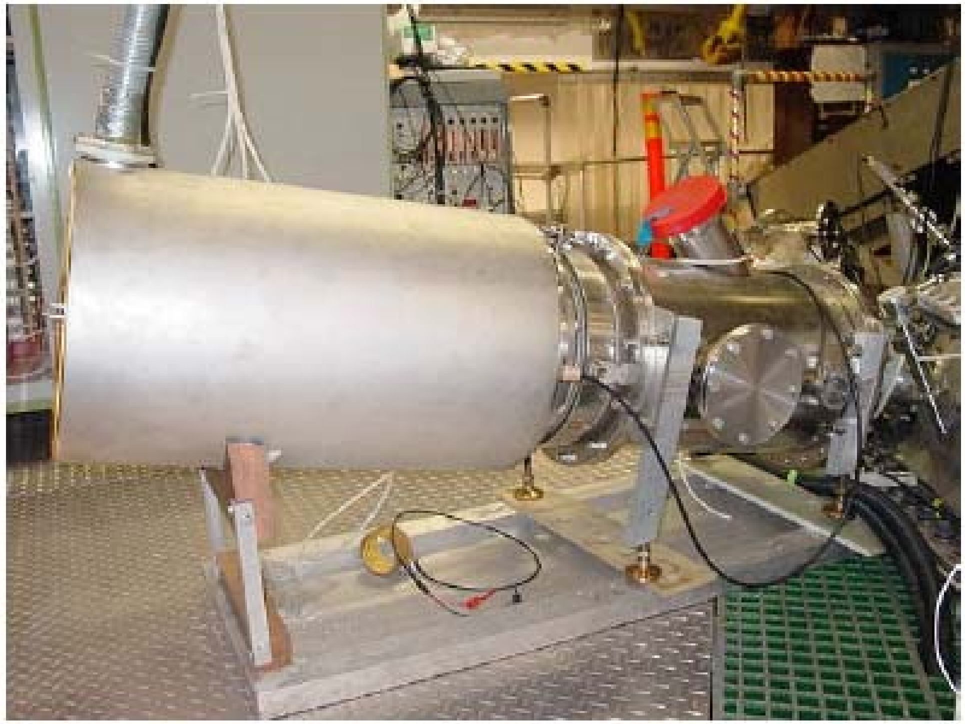
Oscillating Field Current Drive



Status: low current tests underway; physics studies

1 MW operation begins FY 04

Neutral beam injection

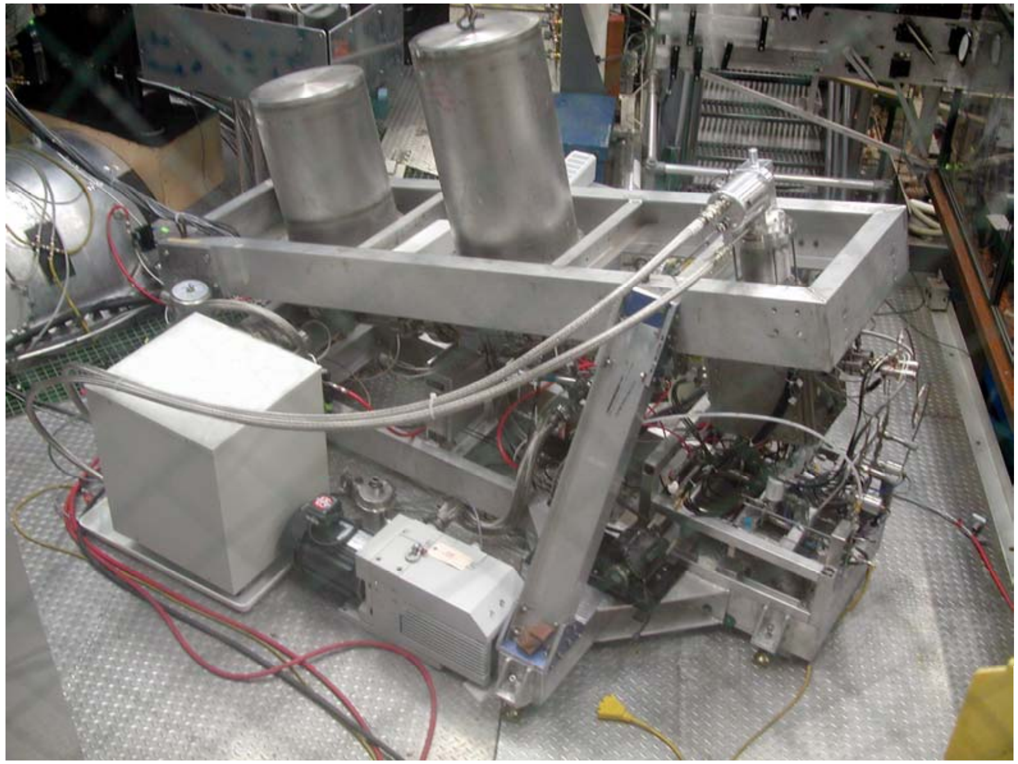


Novosibirsk

Status: two 150 kW diagnostic beams operate routinely

1.5 MW, 1.5 ms heating beam beginning FY 03

Pellet Injection



ORNL

Status: experiments underway with 2 barrels,

2 more barrels in FY 03

Status of Major Diagnostics

Ions

CHERS, Rutherford scattering, charge exchange analysis, passive Doppler spectroscopy

Electrons

Thomson scattering (multi-point installation FY 03), SXR, HXR

Magnetic field:

Laser Faraday rotation, motional Stark effect

Electric field

Heavy ion beam probe

Upgrading many systems for profiles and fluctuations

FY 05 decrement case

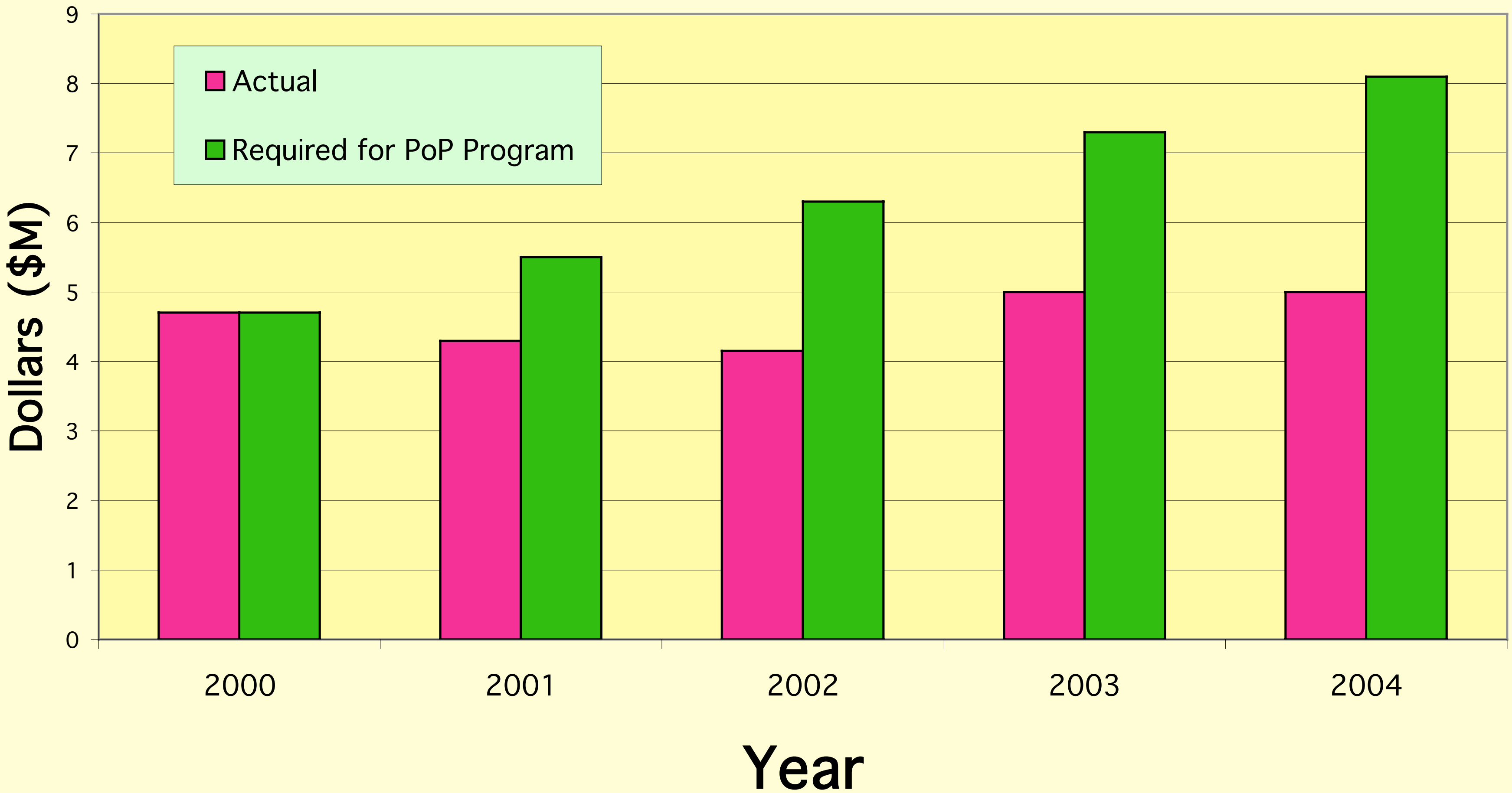
- Eliminate planned programmable power supply (for loop voltage programming)

- Eliminate mechanical technician

- Eliminate either lower hybrid, electron Bernstein wave, or neutral beam injection

  (premature downselection)

MST Funding



Actual
Required for PoP Program
Dollars ($M)
0
1
2
3
4
5
6
7
8
9
2000
2001
2002
2003
2004
Year

FY 05 program planning case

- Advance to PoP program
- Increase facility utilization
- Develop critical auxiliary systems

MST Utilization

Type of run	Run Weeks		
	Appropriate Utilization	Current Utilization (FY 03, 04)	Earlier Utilization (prior to FY 01)
Full diagnostic set	16	3	0
Reduced diagnostic set	14	27	30
Instrument development	15	15	15

Program Planning Case - New Tasks

- Begin upgrade of either LH or EBW to 1 MW ($1M)
- Upgrade neutral beam to higher power or longer pulse ($0.5M)
- Add staff for diagnostic/machine operation for fuller utilization ($0.75M)
- Add data acquisition engineer for fuller facility utilization ($0.09M)
- Upgrade CHERS for fluctuation profiles ($0.07M)
- Upgrade MSE for fluctuations ($0.14M)
- Begin construction of programmable power supply for loop voltage control ($0.4M)
- Install rotating magnetic perturbation for mode rotation control($0.15M)
- Design, begin construction of fast Thomson for electron dynamics ($0.5M)

MST Collaborations

About 20% of MST research is collaborative (by cost)

MST Collaborations

- UCLA - FIR interferometry/polarimetry
- RPI - Heavy ion beam probe
- Novosibirsk - neutral beam diagnostics and heating
- ORNL - pellet injection

- ORNL/GA - lower hybrid/ EBW injection (help in planning expts)
- LANL - RFP system studies
- University of Texas - mode braking theory

- RFX, Italy - Laser impurity injection, SXR, data analysis
- TPE-RX, Japan - PPCD expts
- T2, Stockholm - PPCD expts
- University of Strathclyde - Atomic data modeling

- Pegasus, HSX - Thom scat, HXR detection, dnb
- Astronomy Dept - pending

MST Collaborations

If NSF center is funded, collaborations will be expanded, particularly qualitatively

MST Budget Summary

(funding in $M)

	FY 03 Approp	FY 04 Request	FY 05 -10%	FY 05 Level	FY 05 Plan
Research Operations	3.1	3.1	2.8	3.1	5.0
Facility Operations	1.5	1.4	1.2	1.4	2.7
Research Collab.	0.61	0.61	0.61	0.61	1.12
Educational Outreach	0.05	0.05	0.05	0.05	0.05
Total	5.2	5.2	4.7	5.2	8.8

MST Staff Levels (FTEs)

	FY 03 Approp	FY 04 Request	FY 05 -10%	FY 05 Level	FY 05 Plan
Scientists	9	9	9	9	12
Engineers	8	8	8	8	10
Technicians	3	4	3	4	7
Admin	1	1	1	1	1.5
Professors	1.5	1.5	1.5	1.5	1.5
Postdocs	3*	3*	2	2	5
Grad Students	7	8	8	8	11

*including fellowship support

Theoretical RFP Research at Wisconsin

- Control techniques
  - 3D Single fluid modeling of inductive control (OFCD, PPCD)
  - RF studies (EBW, ICRH, ponderomotive stabilization)
  - Effects of fast particles
- Finite pressure effects on fluctuations and transport
  - 3D single fluid, nonlinear studies
  - coupling between large-scale and small-scale fluctuations
- Two-fluid effects on fluctuations and transport
  - Quasilinear calculations of dynamo
  - NIMROD development
- RFP turbulence
  - Effects of shear flow
  - self-consistency constraints

Severe underutilization of codes due to staff shortage

Summary

MST is well-poised to

- Advance the RFP fusion configuration to full proof-of-principle investigation
- Advance fusion plasma physics associated with self-organization
- Initiate links to astrophysics