

# NCSX Research Plan

## FY09 – FY11

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**DOE/PSO Briefing**  
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# Overview

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- MIE project will supply core capability to confine plasma with stellarator fields
- As with previous experiments, this core capability will be augmented for fusion research
  - diagnostics
  - heating systems
  - full control system
  - full power supply system
- NCSX Mission and Goals for operating phases 2-4 are unchanged
- Plan accomplishes High Priority Goals through phase 4 **by end of FY11** with alternate year operation, **within budgets**.

# NCSX Research Mission - Unchanged

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**Acquire the physics data needed to assess the attractiveness of compact stellarators; advance understanding of 3D fusion science.**

(FESAC-99 Goal)

## **Understand...**

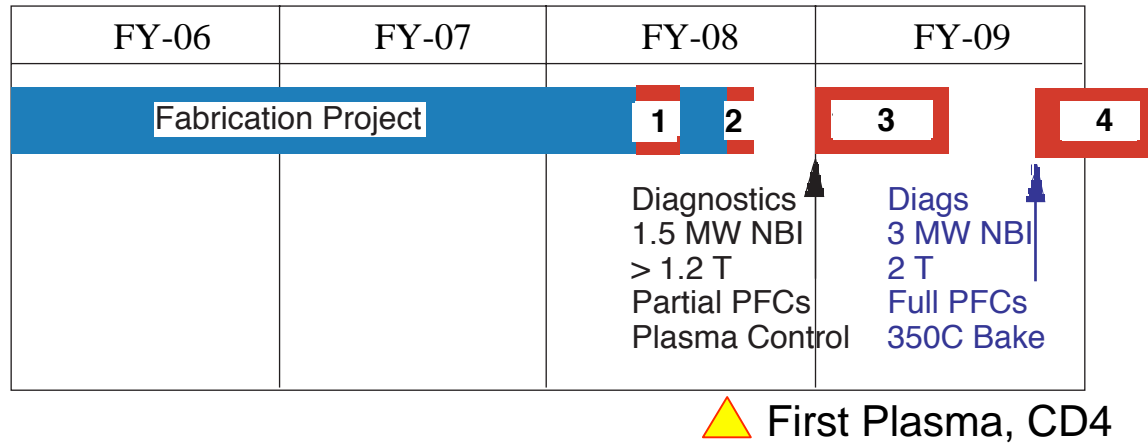
- Pressure limits and limiting mechanisms in a strongly shaped 3D plasma
- Effect of 3D magnetic fields on disruptions
- Reduction of neoclassical transport by quasi-symmetric design.
- Confinement scaling with quasi-symmetry; transport barrier formation and reduction of turbulent transport by flow shear control with 3D field.
- Equilibrium islands and tearing-modes, including effects of magnetic shear, seed perturbations and ion-kinetics
- Effect of stochasticity and 3D shaping on the SOL plasma and power and particle exhaust methods. Compatibility with good core confinement.
- Energetic-ion stability and confinement in 3D magnetic fields

## **Demonstrate...**

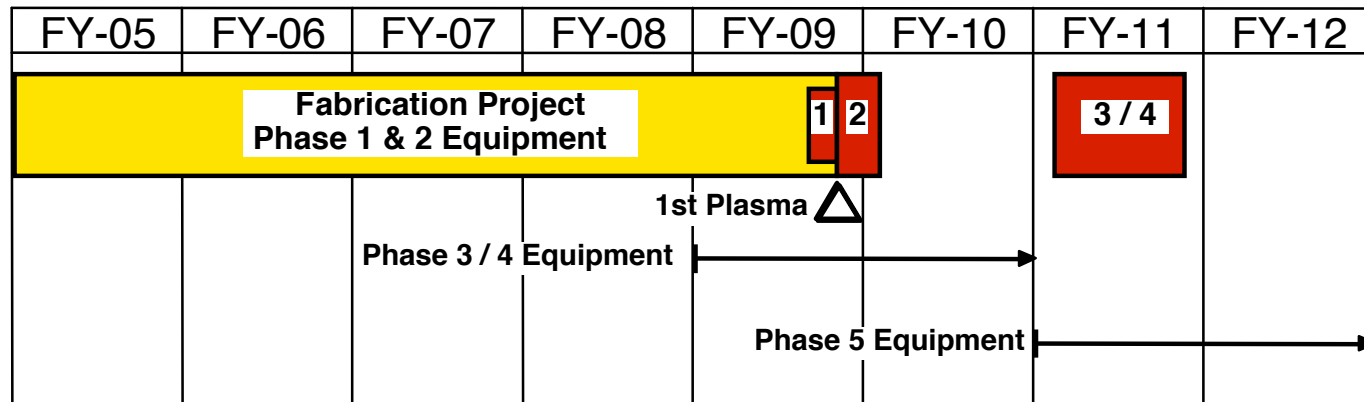
- Conditions for high- $\beta$  disruption-free operation
- High pressure, good confinement, compatible with steady state

# Current Plan Accomplishes Phase 3&4 in FY-11

2004  
CD2  
Plan



2006  
Plan



Research & Operating budget (\$M): 0.7      0.7      17.7      22.5      45.2      21.1

Phases: 1. Initial checkout  
 2. Magnetic configuration studies  
 3/4. Initial Heating Experiments

- Change in 1<sup>st</sup> Plasma date due to OFES rebaselining in 2005
- Change in 2006 operating plan due to alternating-year op schedule

# Research Goals - Unchanged

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## 2. Magnetic Configuration Mapping (FY09)

- Document vacuum flux surface characteristics
- Document control of vacuum field characteristics using coil current

## 3/4. Initial Heating Experiments (FY11)

Merged goals from previous phases 3 & 4 (1.5MW and 3MW phases)

- Explore and establish plasma operating space
- Characterize global confinement, stability, and operating limits, and their dependence on plasma 3D shape
- Investigate local ion, electron, and momentum transport and effects of quasi-symmetry
- Test plasma stability at moderate  $\beta$ , dependence on 3D shape
- Characterize SOL properties for different 3D geometries, prepare for the first divertor design.
- Explore ability to generate transport barriers and enhanced confinement regimes.

## Plan uses FY09 & FY10 Funding to Operate and Prepare for FY11 Run

	FY09	FY10	FY11
Research (incl. diagnostics)	6.0	6.5	19.6
Facility (incl. upgrades)	11.7	16.0	22.6
<b>Total</b>	<b>17.7</b>	<b>22.5</b>	<b>42.2</b>

As spent \$

FY09 and FY10 funding covers

- Operation and Research for Phase 2: Magnetic Configuration studies
- Design and implementation of upgrades (diagnostic and facility) to accomplish phase 3&4 goals in FY11
  
- Research priorities will be reviewed at upcoming meetings
  - PAC, 9-10 November 2006
  - Research Forum, 7-8 December 2006
- Details of research goals and upgrade plans may evolve in consequence
  
- Expect ~25% of the diagnostic upgrades will be funded via independently reviewed proposals for collaboration
  - First call in 2008 for FY09 funding

# Diagnostic Upgrades Planned and Budgeted

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During FY09 and FY10, will add diagnostics for:

- $n_e$ ,  $T_e$ ,  $T_i$ ,  $v_\phi$ ,  $B_p$  profiles
- Magnetic measurements of equilibrium and MHD activity
- Radiated power, impurity content (via spectrometry)
- Scrape off layer density and temperature, power losses to wall.

Diagnostic upgrading will continue throughout the Research Program

# Equipment Upgrades Planned and Budgeted

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Major elements in FY09 & FY10 :

- Data acquisition and control
  - acquisition of diagnostics, data infrastructure
  - diagnostic control; initial plasma feedback control
- Heating systems
  - NBI refurbishment and installation
  - ECH heating may be possible via collaboration, under evaluation
- Plasma facing components and NB armor
  - partial liner inside vacuum vessel
  - wall conditioning & boronization
- Power systems
  - Modular coils and TF powered from D-site, PF coils from C-site
  - Merged C/D-site interlocks and controls
  - Power for diagnostics

Equipment upgrading will continue throughout the Research Program



# FY11 Capability Exceeds CD2 plan for Key Systems

	CD2 Plan	Current Plan for FY11
Neutral beams	One beam refurbished, Not installed	Two beams refurbished and installed
Magnet power supplies	6 D-site circuits	4 D-site circuits, 5 C-site circuits: all coils powered
Central solenoid coils	6 coils (PF1-3)	6 coils (PF1 – 3)
Vacuum systems	2 turbo-pumps	4 turbo-pumps
Cryostat cooling system	Complete: 15 min rep-rate	Complete: 15 min rep-rate
Central Instrumentation and Controls	Ready for phase 3	Ready for phase 3 and 4
VV Bakeout	150 C	150C
Trim coils	18 trim coils installed	MIE capability: 2 trim coils for n=1 modes (sufficient for 3/4 goals)

# Summary

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- NCSX Mission and Research Goals (by operating phase) have not changed
- With alternating-year operation schedule, Initial Heating phases 3&4 will be in FY11
- MIE project will supply core stellarator confinement facility
- Upgrades are planned and budgeted for FY09 & FY10 to accomplish Research Goals
  - Diagnostics
  - Heating systems
  - Control and data acquisition
  - Plasma facing components
  - Power systems

