NCSX Program Update

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briefing for

NCSX Program Advisory Committee

November 30, 2005

Topics

- NCSX Construction
- NCSX Research Preparations
- Stellarator Program Highlights
- Relationship to ITER and U.S. Burning Plasma Program
- Building the NCSX Research Team.

Modular Coil Winding Has Started

Twisted Racetrack R&D Coil Tests

- Operated at temperature, current, and pulse length; then sectioned.
- Validated mechanical & electrical integrity, coil cooling, dimensional accuracy.

Modular Coil Winding Forms (MCWF) (Energy Industries of Ohio, Inc.)

- First MCWF was delivered. Second in final inspection, to ship ~Dec. 10.
- 9 have been cast altogether.
- Good quality being maintained, however production is behind schedule.

Winding the First Coil

- Working double shift keeps project on schedule despite MCWF delays.
- Copper cooling strips installed. Currently winding the conductor.

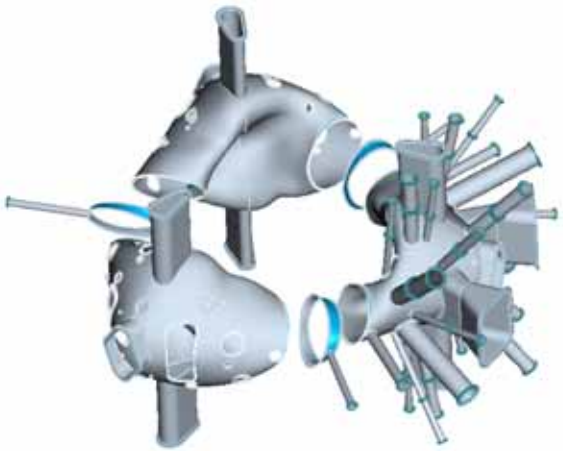
Modular Coil Winding Form

Coil Fabrication

Vacuum Vessel

- First sector nearing completion.
- Project will participate in vendor leak check activities.
- Expect sector deliveries in Jan., Feb., March.

First 120-degree Sector
Major Tool and Machine, Inc.



VV construction

TF and PF Coils

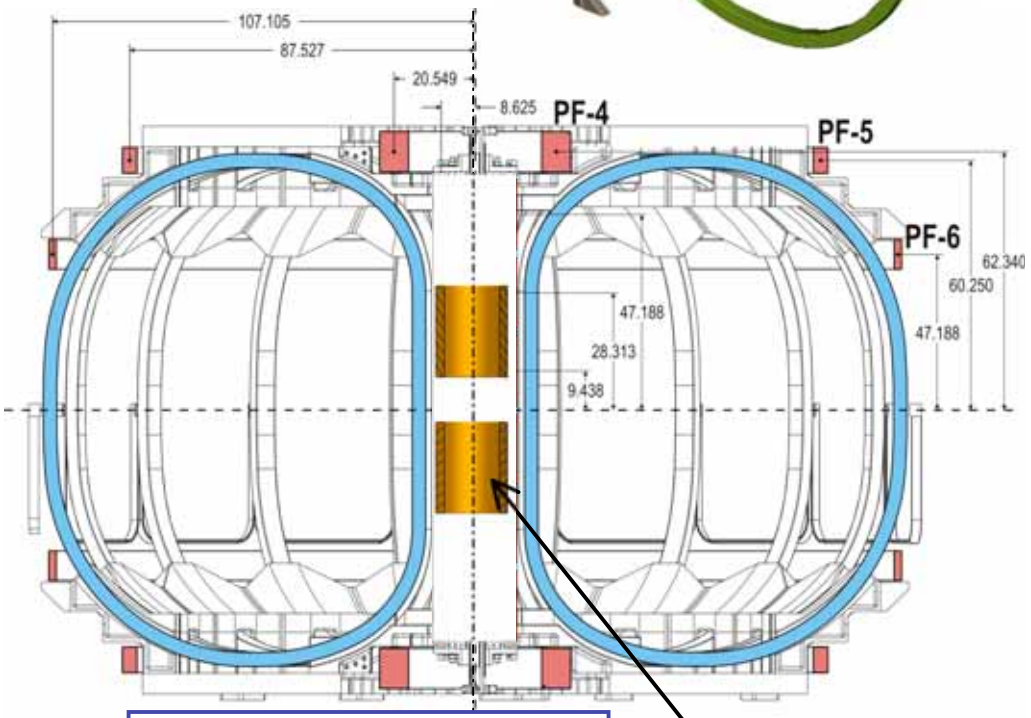
TF Coils

- Conductor, insulation, and leads have been procured.
- Winding facility being installed at PPPL.
- Fabrication by ASIPP (China) under discussion.

PF Coils

- Will use existing NSTX coils for central solenoid.
- Fabrication of PF4, 5, and 6 by ASIPP under discussion.

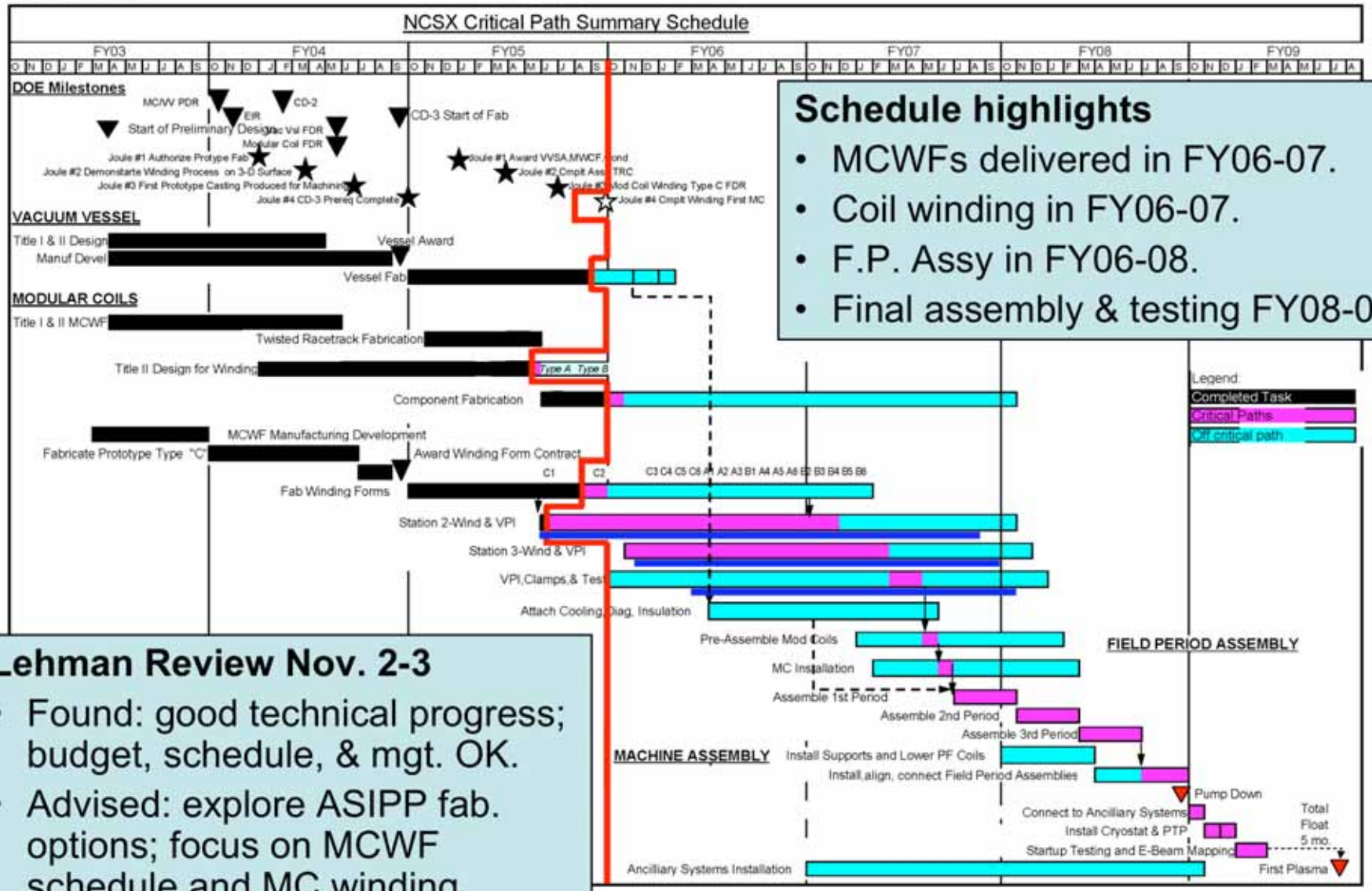
TF Coil with Wedge Supports



TF, PF, and Central Solenoid Coils

Existing NSTX coils

First Plasma Scheduled for July, 2009



Schedule highlights

- MCWFs delivered in FY06-07.
- Coil winding in FY06-07.
- F.P. Assy in FY06-08.
- Final assembly & testing FY08-09.

Lehman Review Nov. 2-3

- Found: good technical progress; budget, schedule, & mgt. OK.
- Advised: explore ASIPP fab. options; focus on MCWF schedule and MC winding.

Near-Term Research Preparation Studies

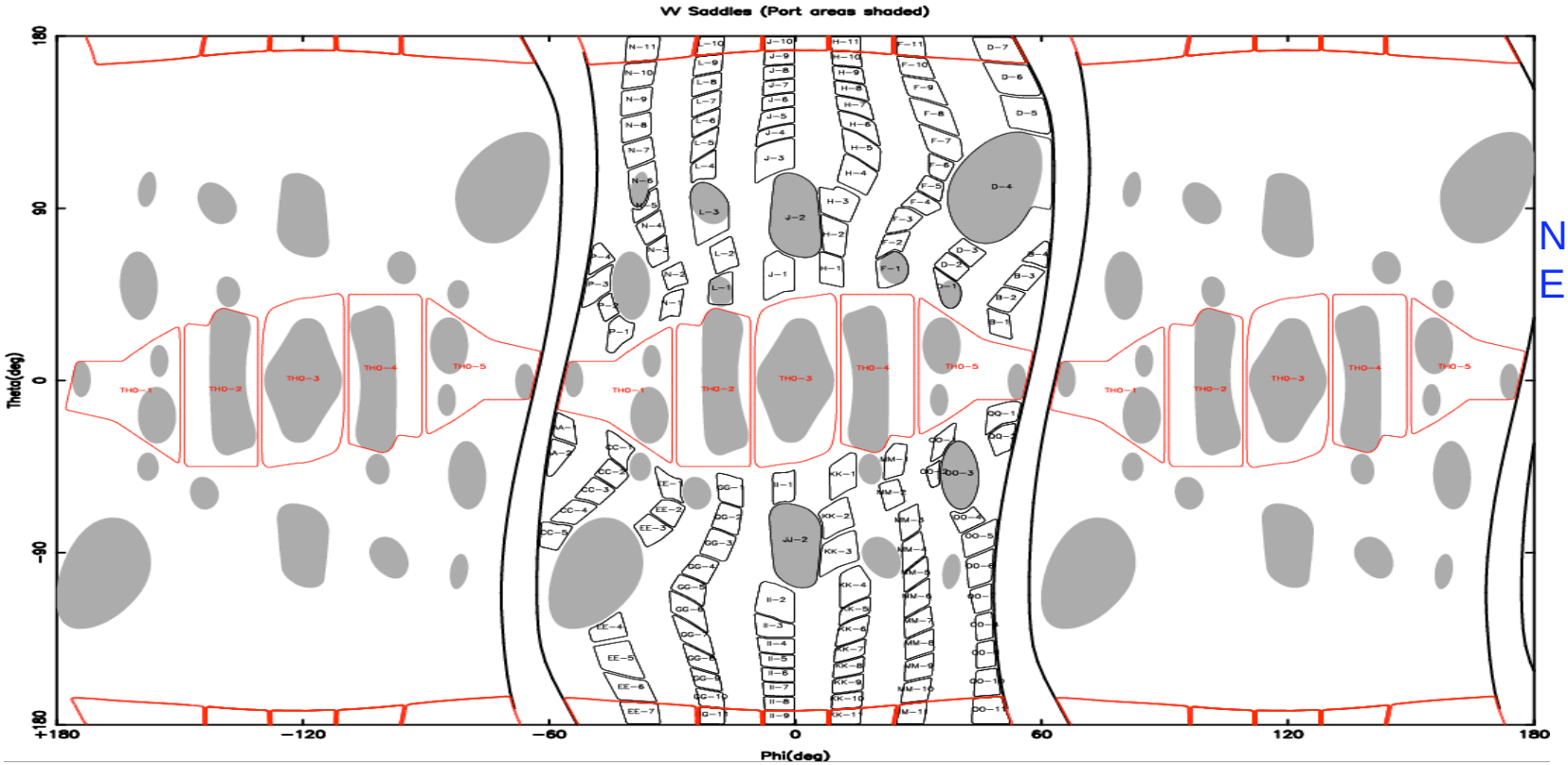
Long-term developments preparing for research

- Diagnostic coordination and planning
- Magnetic diagnostics physics design (ORNL, PPPL)
- Edge Modeling; (UCSD, LLNL,
  Physics design and requirements for PFCs, Divertor ORNL, PPPL)
- Preparation for field mapping (e-beam) (PPPL, Ukraine)

- *Equilibrium reconstruction analysis (funded separately) (V3FIT group)*

- Trim coil design and requirements (starting this year)

Physics Design of Ex-vessel Magnetic Diagnostics



N. Pomphrey
E. Lazarus

- **Database of ~2500 free-boundary equililbria analyzed to identify critical regions to measure**
- **Dense array optimized for sensing periodic stellarator symmetric shape**
- **Distributed array optimized for sensing non-symmetric components**
- **Install starting January 2006.**

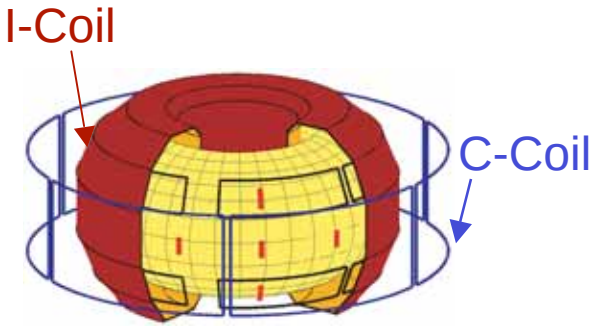
Strong Collaboration Forming with DIII-D, NSTX To Understand 3D Perturbed Equilibria

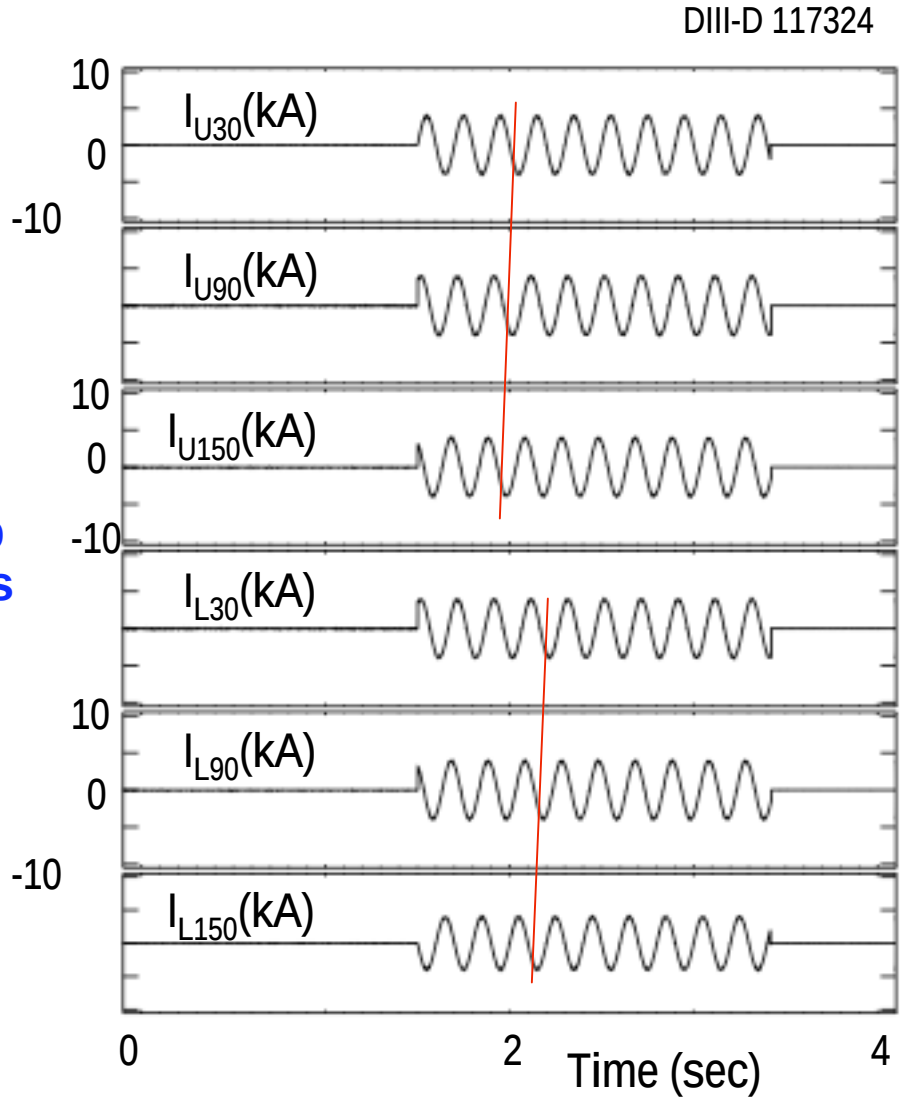
3D Magnetic Perturbations are increasingly used to control tokamaks

- Resistive wall mode feedback
- ELM stabilization
- Typically causes ergodic edge

- **Must understand effect on equilibrium**
  - To understand stability and transport changes, effect of intrinsic error fields
  - To be able to project to ITER
- **Experiment: plasma response significant**
- **Analysis: use stellarator codes & develop new methods also applicable to stellarators**
- **Future collaboration possibility:**

  ergodic divertors





Status and Plans of Other Program Elements

NCSX National Compact Stellarator Experiment

HSX Experimental Program

- Installing 2nd 200-kW 28-GHz ECH system
- Plan extended diagnostics for MHD and core fluctuation studies, understanding edge/divertor structure, and radial electric field at low collisionality.
- Examining particle & thermal transport with and without quasi-symmetry.

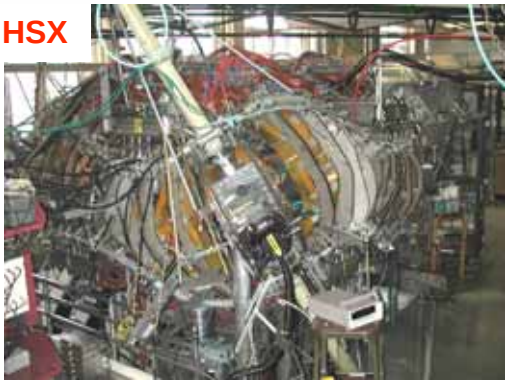
CTH Experimental Program

- Initial operation in Feb. with 2.45-GHz ECH; currently doing extensive vacuum field line mapping.
- 18-GHz 2nd harmonic and OH operation next.
- Plan 3-D reconstruction, magnetic island control and EBW, FW ICH heating studies

QPS R&D and Prototype Development

- Most complex and largest of the modular coil winding forms is in final stages of inspection.
- Pursuing contracts for final machining of MCWF.
- Continue coil winding, vacuum canning and potting tests and R&D at UT Magnet Development Lab.

HSX



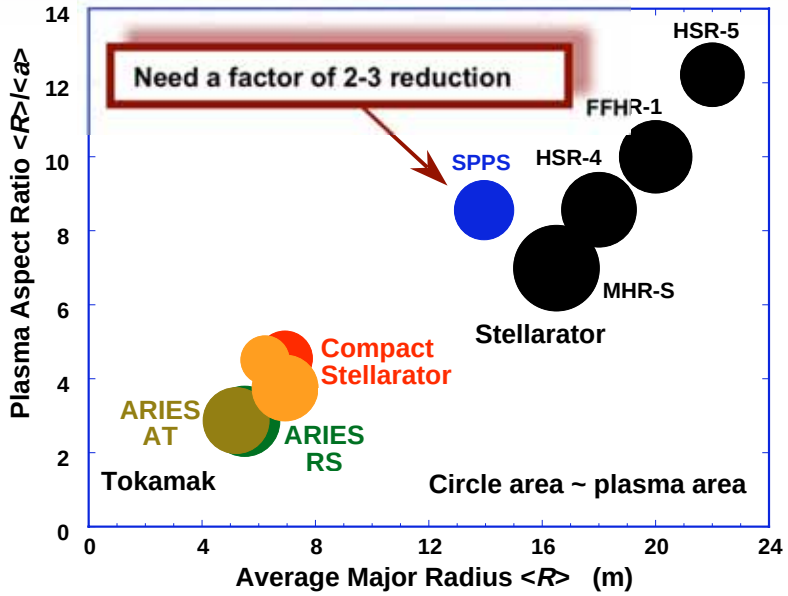
CTH

QPS

ARIES-CS Study in Penultimate Phase

Nearing Selection of Reference Plasma & Coil Configuration for Detailed Design

- Have examined three types of QA configurations.
- Modified NCSX-types and 2-FP MHH2 for better α-particle confinement.
- Both allow <R> ~ 7 m vs >16 m for other designs.

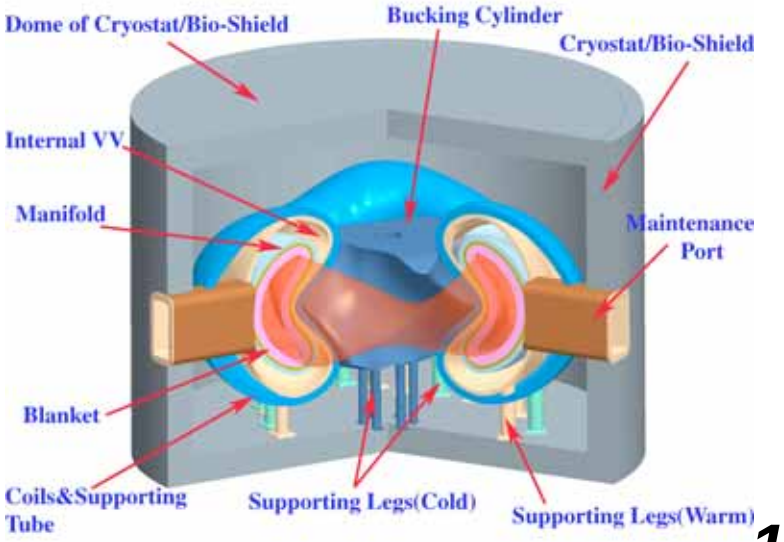


Divertor Design is the Biggest Challenge

- Studying non-conformal plates to spread divertor power load.

Other Aspects Are Being Studied

- Cooling manifolds are being optimized.
- Costing algorithms are being updated.
- Improving blanket and shield design.



NCSX Research Supports, Supplements and Benefits from ITER

Compact Stellarator	Supports	Supplements	Benefits from
Stability	3-D perturbation effects on equilibrium & stability	Unique, variable geometry to test limiting physics, disruption free.	Field error effects at large R/ρ.
Energetic Particles	Interaction of ripple and fast particle modes.	Very high density operation for alpha stability.	Nonlinear alpha physics, burn control, AE stability
Transport	Controllable flows.	Controllable electric fields, symmetry.	Transport at large R/ρ.
Plasma-wall	Radiative edge and divertor at very high density.	Very high density operation, 3-D effects.	Long pulse at high P/R.

Plan to participate in US BPP

- **Provide tools, database, strategies for understanding 3D field effects**
- **Ensure that ITER experiments target needed physics**
- **Provide alternate ways to build upon ITER results**

Building the NCSX Research Team

Compact Stellarator Information Meeting at APS/DPP 2005

- Program overview, presentations on HSX, CTH, NCSX, QPS
- Mainly attended by stellarator program members

NCSX Information Meeting at APS/DPP 2006

First NCSX Research Forums in January/February 2007

- Develop detailed research plans and responsibilities
- Identify groups interested in developing needed diagnostics
- Inform FWPs for FY09.

Expect call for first round of diagnostic proposals in FY08

- For funding at start of FY09
- Call will occur after 2nd NCSX Research Forum
- Additional calls for diagnostic and participation proposals in FY09 and FY10

PAC Meeting on Preparations for Research Forum: Fall 2006

NCSX Coming Events

Dec.	2005	Burning Plasma Workshop
March	2006	PAC telecon
May	2006	Lehman Review
July	2006	PAC telecon
~Nov	2006	PAC-8 Meeting at PPPL: Research Forum Prep.
Nov.	2006	NCSX Information Meeting, APS/DPP Philadelphia
Nov.	2006	Lehman Review
Feb	2007	Research Forum #1: Planning for FY-09.