National Compact Stellarator Experiment (NCSX)

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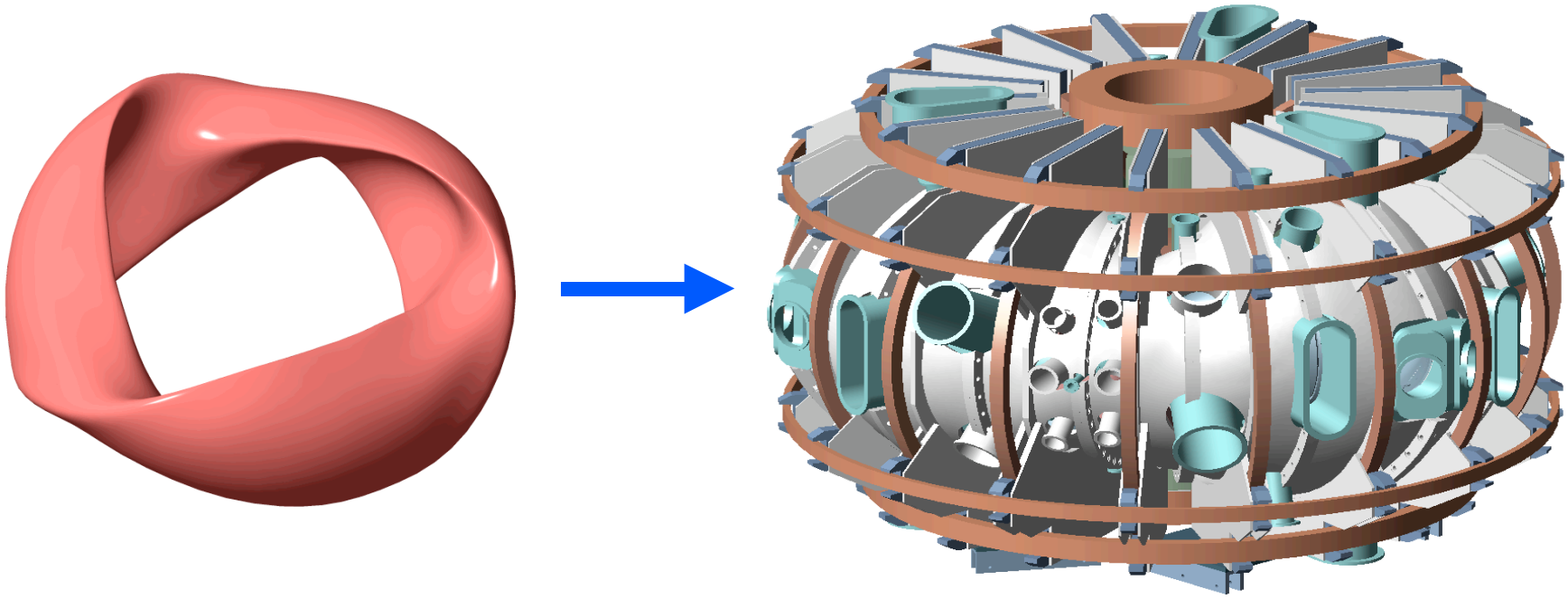
NCSX Plans for FY03-04: Becoming A Reality

- Complete design, R&D, and prototyping of critical components.
- **Start fabricating production components in FY-04.**
- Continue research planning and long-lead preparations.



Stellarators: Unique Science, Solutions for MFE

Advance 3D Plasma Physics (FESAC / IPPA Goal 1)

- Rotational transform sources (int., ext.): effect on stability, disruptions?
- 3D plasma shaping: stabilize without conducting walls or feedback?
- Magnetic quasi-axisymmetry: tokamak-like transport control possible?
- 3D divertors: effects on boundary plasma, plasma-material interactions?

Complements research on tokamaks, ST, and other ICC's.

Solutions for Attractive Fusion Systems (Goal 2)

- Passively stable without active feedback; no disruptions.
- Steady state with minimal recirculating power.
- Low aspect ratio and high beta high power density.

FESAC-approved 10-Year Program Goal: Determine the attractiveness of the compact stellarator as a confinement concept for MFE.

Program Goals Will be Achieved via the Integrated National Stellarator PoP Program

NCSX Proof-of-Principle Experiment

- High-beta stability, confinement, heating, power & particle handling.
- Conditions for high-beta disruption-free operation.

CE Experiments: HSX, CTH, QPS (J. Lyon)

Theory and Computation

- Tools for data analysis and design predictive capability.
- January planning workshop identified critical needs and opportunities.

International Collaboration (N. Sauthoff)

- Unique facilities to advance physics and gain stellarator experience.

Reactor studies (in collaboration with ARIES team)

- Finding the optimum compact stellarator power plant configuration.

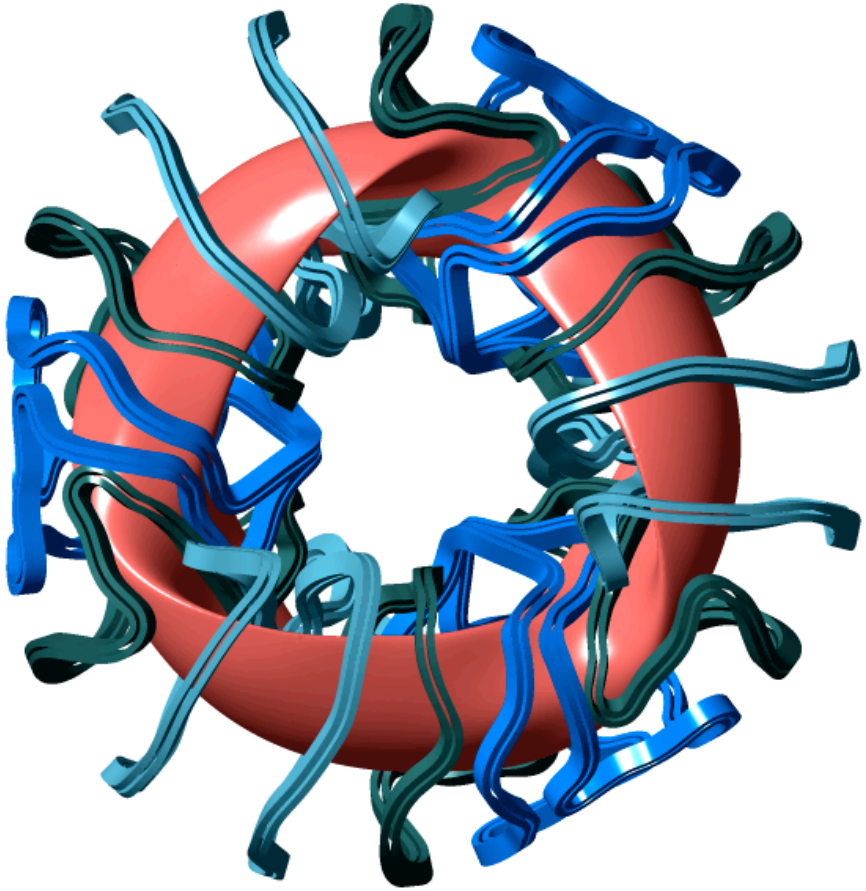
NCSX Is Making Good Progress Toward FY-03 Start

Milestones Achieved

- Physics Validation Review (Mar., 01)
- Endorsed as PoP by FESAC.
- Mission Need (CD-0) Approved.

Conceptual Design Advances

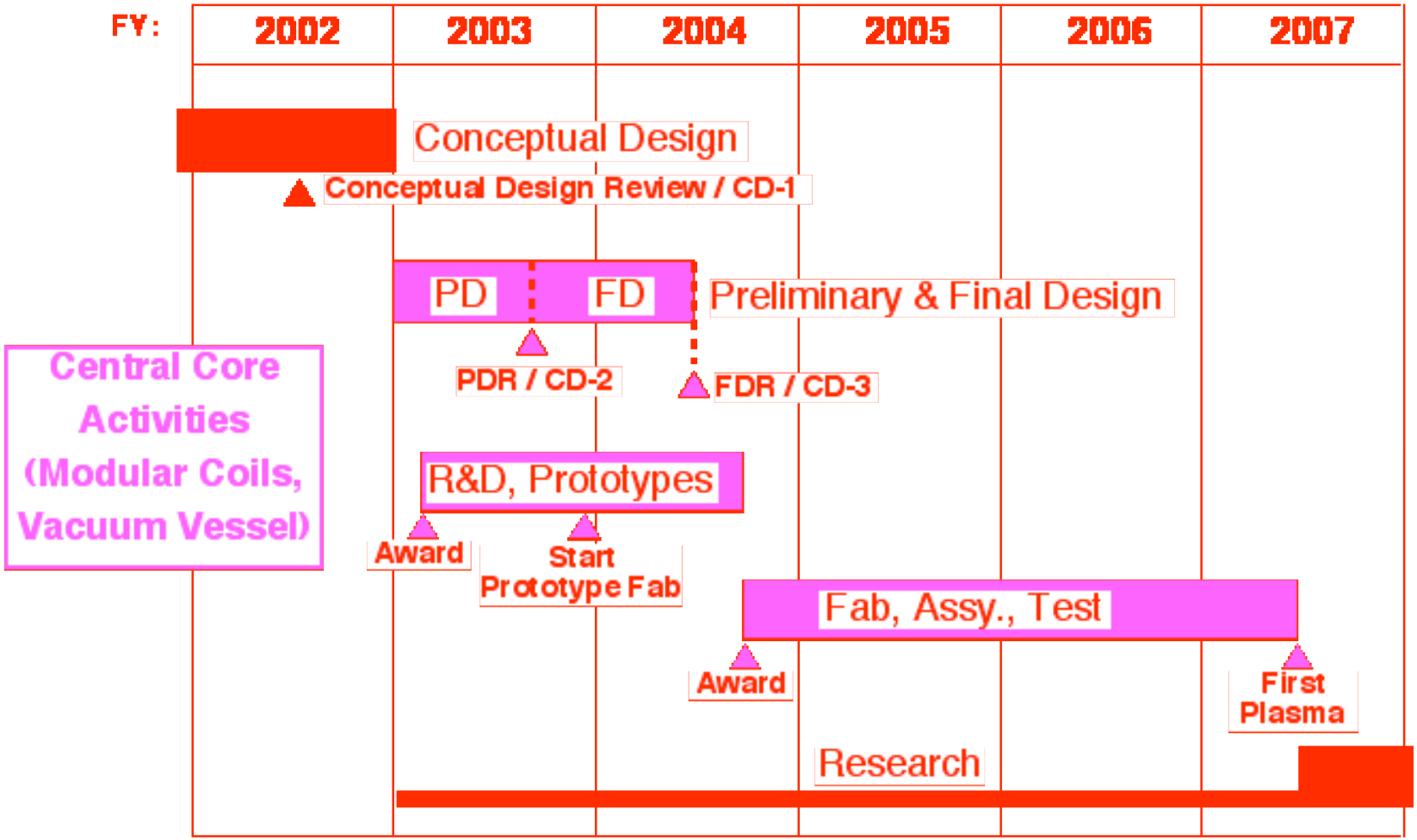
- Improved configuration
  - Fewer modular coils
  - Better diagnostic access
  - More space for divertors, launchers.
- Convergence of physics and engineering in the coil design.
- Manufacturer input being used to optimize designs and plans.



Conceptual Design Review, May 21-23

May-Sept.: Design refinements.

NCSX Goal: Start Major Component Fab. in FY-04



FY03-04 Preparations: Design, R&D, Prototypes, Research Input

NCSX Team Works Closely With Manufacturers in The Design Process

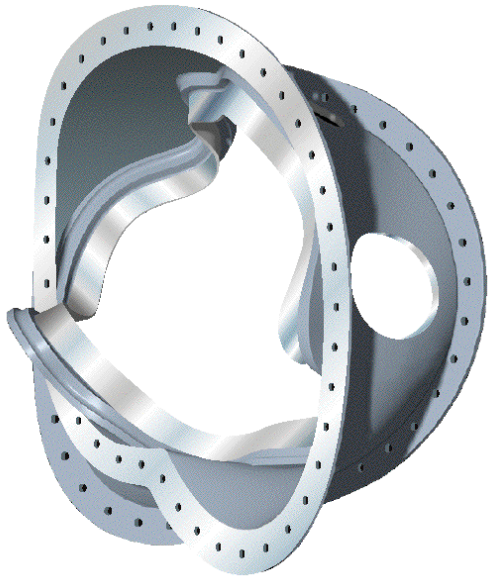
FY-03 Plans

Manufacturers: Develop tooling and processes

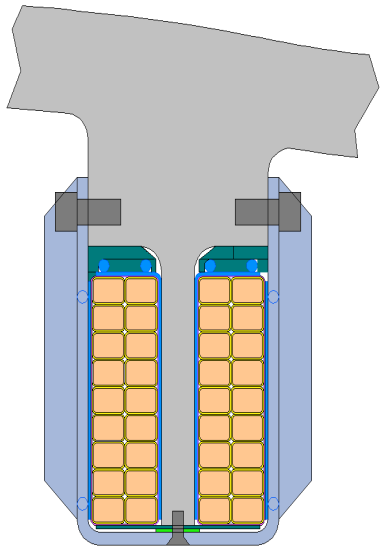
- Small-scale tests, process development (Award Nov., 2002).
- Full-scale coil form and vacuum vessel prototypes.

PPPL-ORNL Team: Design

- Preliminary design of central core. (PDR May, 2003)
- Start final design
- Design of TF/PF coils, structure, power supplies, beams, utilities, etc.



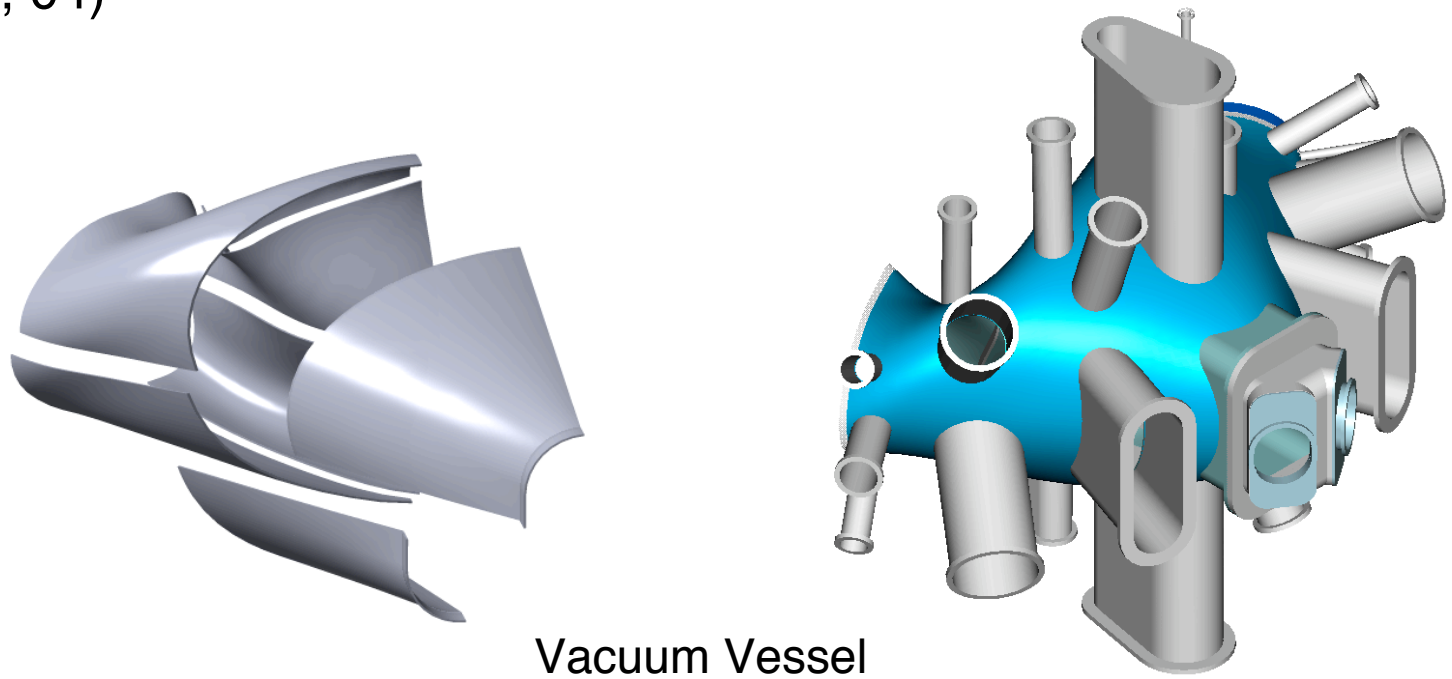
Modular Coil Form and Winding Pack



Machine Component Fabrication Will Start in FY-04

FY-04 Plans

- Complete prototype manufacture and test.
- Complete final design of central core. (FDR, March, 2004)
- Award modular coil & vacuum vessel fabrication contracts. (June, 04)
- Continue design of other components and systems (TF Coils FDR: Sept., 04)



Vacuum Vessel

NCSX Research FY03-04: Long-Lead Preparation of Tools for the Physics Program

- **Set requirements on machine design to ensure compatibility with envisioned research hardware.**
- **Apply Theory-developed tools to design and analysis needs.**
- **Maintain scientific connnections with other confinement programs.**

Plasma Control

- Diagnostics, trim coils.
- Data analysis codes, control algorithms.
  - 3D equilibrium codes (PPPL, ORNL).
  - 3D reconstruction codes (ORNL-GA collaboration).

Boundary Control

- Plasma-facing components, edge diagnostics (design, interfaces).
- Design and analysis codes.
  - Field-line tracing, 3d edge simulation code (Germany-LLNL collaboration)

RF heating (incremental)

- Launchers, circuits, sources for various upgrade paths.

Increased Funding: Start Component Fab. Sooner

Restore Project budget to $15M in FY-03, per original request. Benefits:

- Accelerate modular coil design and R&D Earlier start on manufacture of production coils (March instead of June, 2004).

Augment Research Prep. by $0.4M in FY03 and 04. Benefits:

- Accelerate rf heating preparations Earlier rf tests to optimize NBI – RF balance for high-power heating.

$M FY:	2002	2003 (G)	2003 (I)	2004 (G)	2004 (I)
Project		11.0	4.0	16.0	
Research	4.0	0.8	0.4	0.8	0.4
Total NCSX	4.0	11.8	4.4	16.8	0.4
$M by Institution (per revised guidance*)					
PPPL	2.7	9.5	3.8	13.8	0.3
ORNL	1.3	2.2	0.6	2.9	0.1
LLNL		0.1		0.1	

G = Guidance
I = Increment

* FY-03 distribution was revised (PPPL ; ORNL & LLNL ↑) to match project needs. Total kept fixed.

10% Reduced-Budget Case

Project Budget Cuts of $1.1M in FY-03, $1.6M in FY-04 Would Adversely Impact Schedule:

- Start of major component fabrication slips into FY-05.
- All design and R&D tasks would slow down.
- Overall delay of ~4 months by end of FY-04.

Research Cuts of $80k in FY-03 and FY-04 Would:

- Reduce physics influence on machine design activity.
- Weaken U.S. position in stellarator research

Resource Implications:

- Significant staff cuts at PPPL and ORNL.
- Reduced funding to suppliers delays and potential loss of interest.

Summary

NCSX is making excellent progress.

- Design is coming together.
- On track for a successful CDR and Project Start.

Fabrication of production components will start in FY-04.

- Complete the design, R&D, and prototyping for most critical components in FY03-04.
- Design machine to be compatible with envisioned research tools.
- **Optimize Designs and Plans with Manufacturer Input.**

The U.S. is the World Leader in Compact Stellarators

- Start component manufacture ASAP raise FY-03 budget to $15M.
- Strengthen physics preparations raise research budgets.
- **Maintain strong leadership position!**

NCSX Plans for FY03-04: Becoming A Reality

- Complete design of the most critical components.
- Complete R&D and prototypes; begin manufacture.
- Continue research planning and long-lead preparations.

Outline

- Mission and FESAC goals.
- Accomplishments.
- Budgets and plans.

Working with industry to clarify manufacturing processes, reduce risks, improve the design.