

NCSX Program Update

Hutch Neilson, Jim Lyon, and Mike Zarnstorff
for the NCSX Team

*Princeton Plasma Physics Laboratory
Oak Ridge National Laboratory*

briefing for
NCSX Program Advisory Committee
July 13, 2005

Highlights Since PAC Telecon of March 3



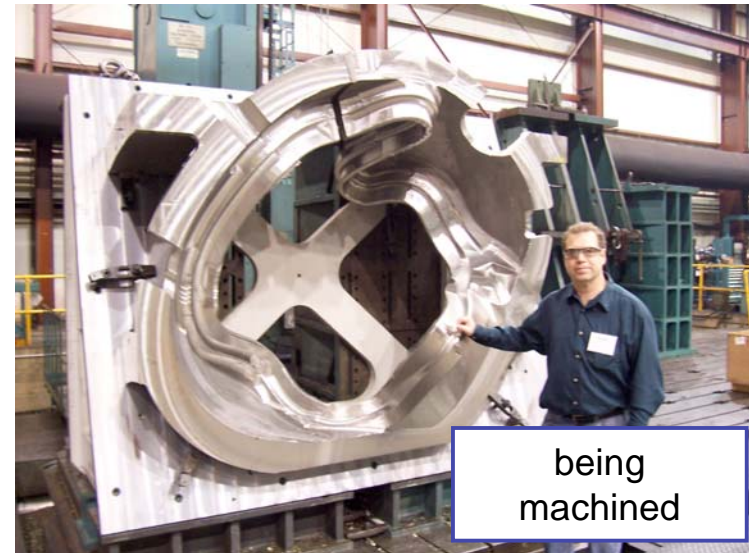
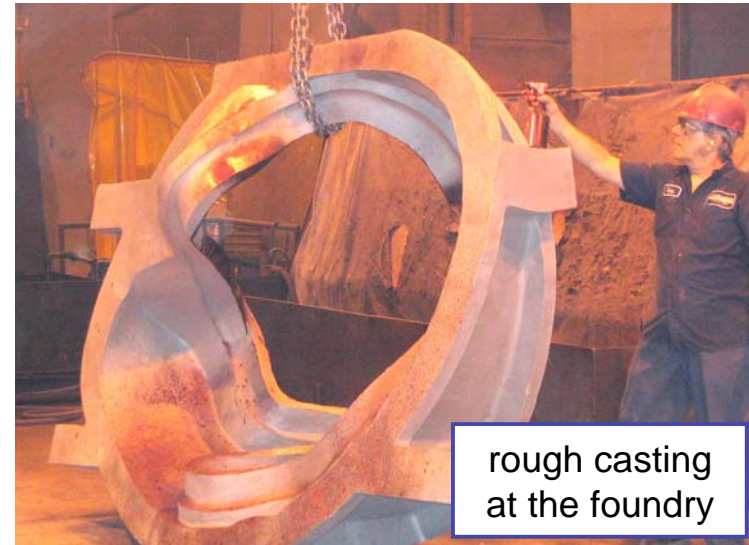
- NCSX construction progressing well.
 - Finished the twisted racetrack R&D coil.
- Plans for ECH collaborations are moving forward.
- Plans for community interactions have developed in response to PAC advice.
- ARIES-CS reactor study has made good progress.

We seek your continued advice and support.

Modular Coil Winding Forms



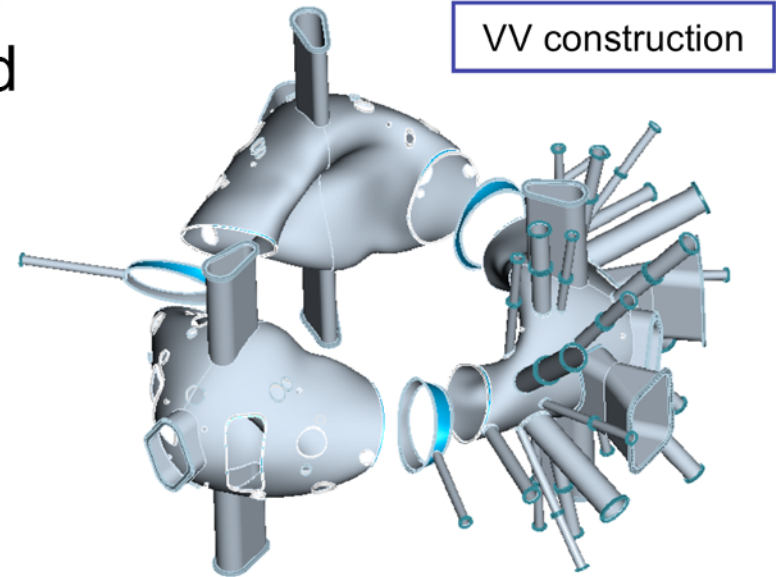
- 18 MCWFs are being supplied by Energy Industries of Ohio consortium.
- 4 have been cast, 2 are in machining.
- Casting tests show good structural properties, low μ , good casting quality.
- Additional time was needed on MCWF#1 to address manufacturing issues:
 - Casting pattern design. (resolved)
 - Numerical machine tool programs. (development in progress)
- MCWF#1 now expected in August.
- Project can absorb the delay without impacting completion date or schedule contingency.



Vacuum Vessel



- Vacuum vessel is being fabricated by Major Tool and Machine.
- All material (3/8-in. inconel) has been received, fixtures prepared.
- Panel forming and sector fabrication are proceeding well.



Panel being formed



Formed panels being assembled on weld fixture

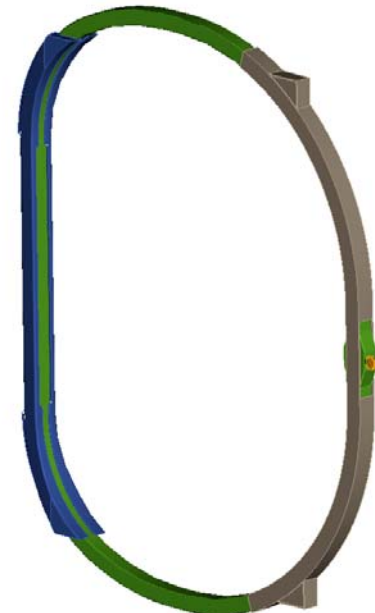
Coil Winding Preparations



- “Twisted racetrack” R&D coil has been successfully fabricated.
 - Results have greatly improved modular coil design and fabrication plans.
 - Electrical testing has started.
- “Shimless” winding strategy achieves required tolerances efficiently.
 - Physics team is involved in dimensional control issues.
 - Benefiting from HSX experience via collaboration w/ S. Anderson (U. Wisc.)
- Will start winding modular coils as soon as MCWF#1 arrives.
- TF coils will also be wound at PPPL.
 - Minimizes quality risks.
 - Conductor ordered, winding table installed.

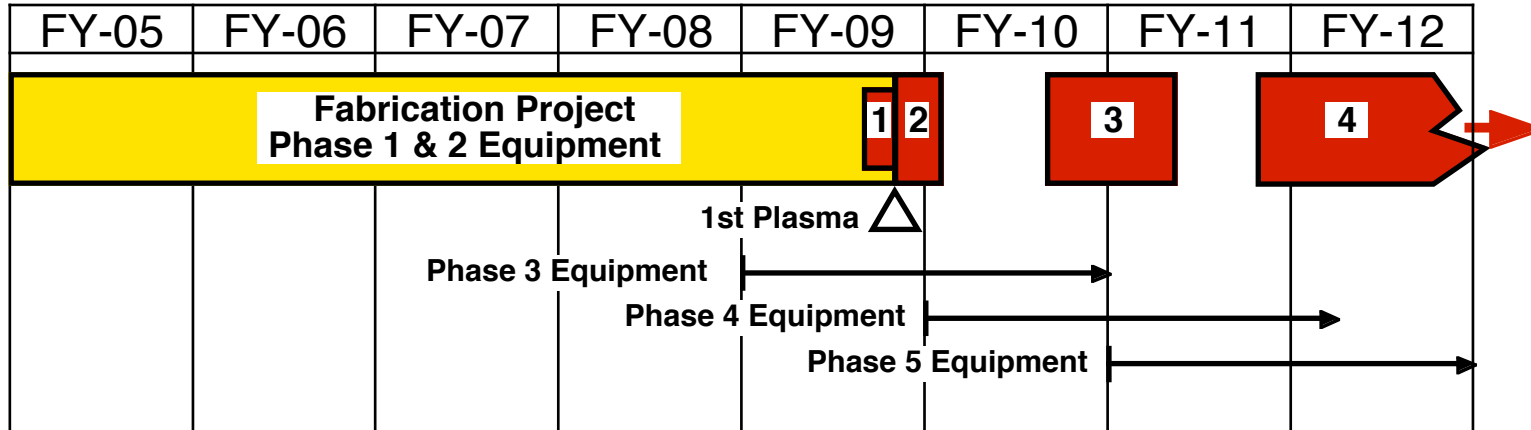


Twisted Racetrack Coil



The TF coils are relatively simple.

Technical Capabilities Will Be Phased In to Support Research Goals



Phase / Research Goals	Key Equipment
1. Stellarator Acceptance Testing <ul style="list-style-type: none"> • Verify construction accuracy • First Plasma 	<ul style="list-style-type: none"> • Stellarator @B = 0.5 T • Ohmic heating, 150 C bake. • E-beam & ex-vessel magnetics
2. Magnetic Configuration Studies <ul style="list-style-type: none"> • Vacuum flux surface documentation. • Magnetic configuration control w/ coils. 	
3. 1.5MW Initial Experiments <ul style="list-style-type: none"> • Explore plasma operating space • Confinement, stability, operating limits 	<ul style="list-style-type: none"> • Stellarator @B = 1.2 T • 1.5 MW NBI, NB Armor, 350 C bake • Thomson scattering, in-vessel magnetics, interferometer/polarimeter, SX arrays
4. 3MW Heating Experiments <ul style="list-style-type: none"> • Confinement vs. 3D shape • Stability at moderate β vs. 3D shape • Local transport, effects of quasi-symmetry • SOL characterization. • Transport barriers & enhanced confinement. 	

ECH Collaborations are Developing



“Electron Dynamics in Advanced Confinement Concepts”

- proposed for Japanese funding

- Would bring 1MW of 70GHz ECH to NCSX and EBW to NSTX (separately)
- Proponent team led by S. Okamura (NIFS) and Y. Takase (U. Tokyo)
- Japanese group would join NCSX for research on electron transport.

Re-use of W7-AS 70-GHz ECH (600kW) requested.

Re-use of DIII-D 110-GHz ECH (Gycom systems) requested.

ECH collaborations would augment the NCSX program.

- Experiments without Ohmic or NB current
- Easy access to low-collisionality plasmas.
- Likely less sensitive to wall conditioning

ECH would reuse existing HV-PS, gyrotron vault & infrastructure from PBX

NCSX Research Preparation Priorities, FY2005-07



Experimental planning for research on NCSX

- Maintain up-to-date experimental plan.
- Provide physics oversight of NCSX construction.

Long-lead analyses to prepare for the experimental program

- Diagnostics:
 - in-vessel magnetic sensor requirements.
 - requirements for initial heating phases
- Boundary: requirements for PFC, divertors, and edge diagnostics.
- Trim coil requirements.
- Magnetic configurations: e-beam mapping scenarios.

FY-07 & beyond

- Formation of national NCSX research team.
- Implementation of long-lead equipment upgrades.

Community Involvement in NCSX Planning



PAC advised more action to maintain community interest and support for NCSX during construction.

Community participates in NCSX Lehman reviews, design reviews.

Updated stellarator white paper was issued at BPM in March.

Seminars on NCSX and stellarator physics since last Fall:

- Wisconsin, GA, Columbia, MIT, DOE, PPPL, IPP-Greifswald, FPA Symposium, EPS.

Future Events

- | | |
|------------|---|
| Oct., 2005 | NCSX information meeting at APS/DPP, Denver. |
| Nov., 2005 | PAC telecon. |
| Feb., 2006 | PAC-8 Meeting at PPPL: <i>Priorities for FY07-08.</i> |
| June, 2006 | PAC telecon. |
| Oct., 2006 | PAC telecon. |
| Nov., 2006 | NCSX information meeting at APS/DPP, Philadelphia. |
| Jan., 2007 | NCSX Research Forum #1: <i>Project plans, priorities. Collaborator interests.</i> |
| Feb., 2007 | PAC-9 Meeting at PPPL: <i>Priorities for FY08-09, collaborator contributions.</i> |

Other forums, e.g. Burning Plasma program activities?

PAC feedback requested.

ARIES Compact Stellarator Reactor Studies



Configuration Studies Have Made Progress

- Promising MHH2-like (N=2) and NCSX-like (N=3) reactor configurations are being developed.
- Alpha losses are coming down: $\leq 10\%$ in NCSX-like, $\sim 5\%$ in MHH2-like cases.
 - Sensitivity to collisionality is being examined.
- Reactor size (7-8 m) is close to tokamaks and much smaller than previous stellarator reactor studies.
- Divertor configuration still being optimized.

September workshop is planned to provide stellarator community feedback to ARIES.

- Summarize ARIES-CS work to date and high-leverage issues.
- Feedback on ARIES-CS models, assumptions, and directions for FY-06.

Current ARIES Plans Are to Complete CS Study in FY06

- Continue with multiple configurations through mid-FY06.
- Develop point design around one configuration, examine variants.

Program Planning Short Topics



- QPS -- status of R&D and prototype modular coil winding form.
- Sept. 26-29 Knoxville SOFE meeting.
- Oct. 3-7 International Stellarator Workshop, and
Oct. 10-11 IAEA TM on Innovative Concepts and Theory of Stellarators.