NSTX

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NSTX CS/NBI Upgrade Status and Progress Toward CD-1

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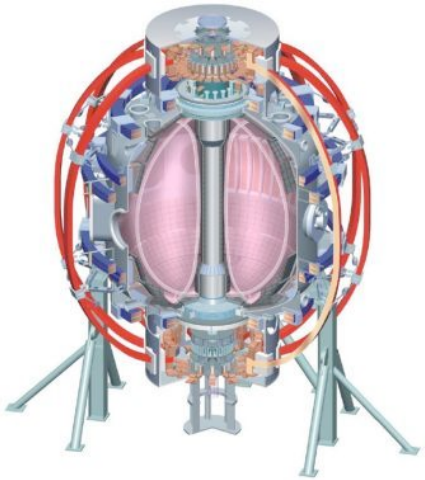
Mike Williams

FY2011 Budget Planning Meeting
March 31, 2009



Culham Sci Ctr
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Outline

- Project Management
  - Deliverables for CD-1
  - Milestones for CD-1
  - Schedule for CD-1
  - Staffing for CD-1
- CS Upgrade/Risks
  - TF Joint Concepts
  - Structural Analyses
  - OH/PF Coils
- NBI Upgrade/Risks
  - NBI Engineering
  - NBI Decontamination

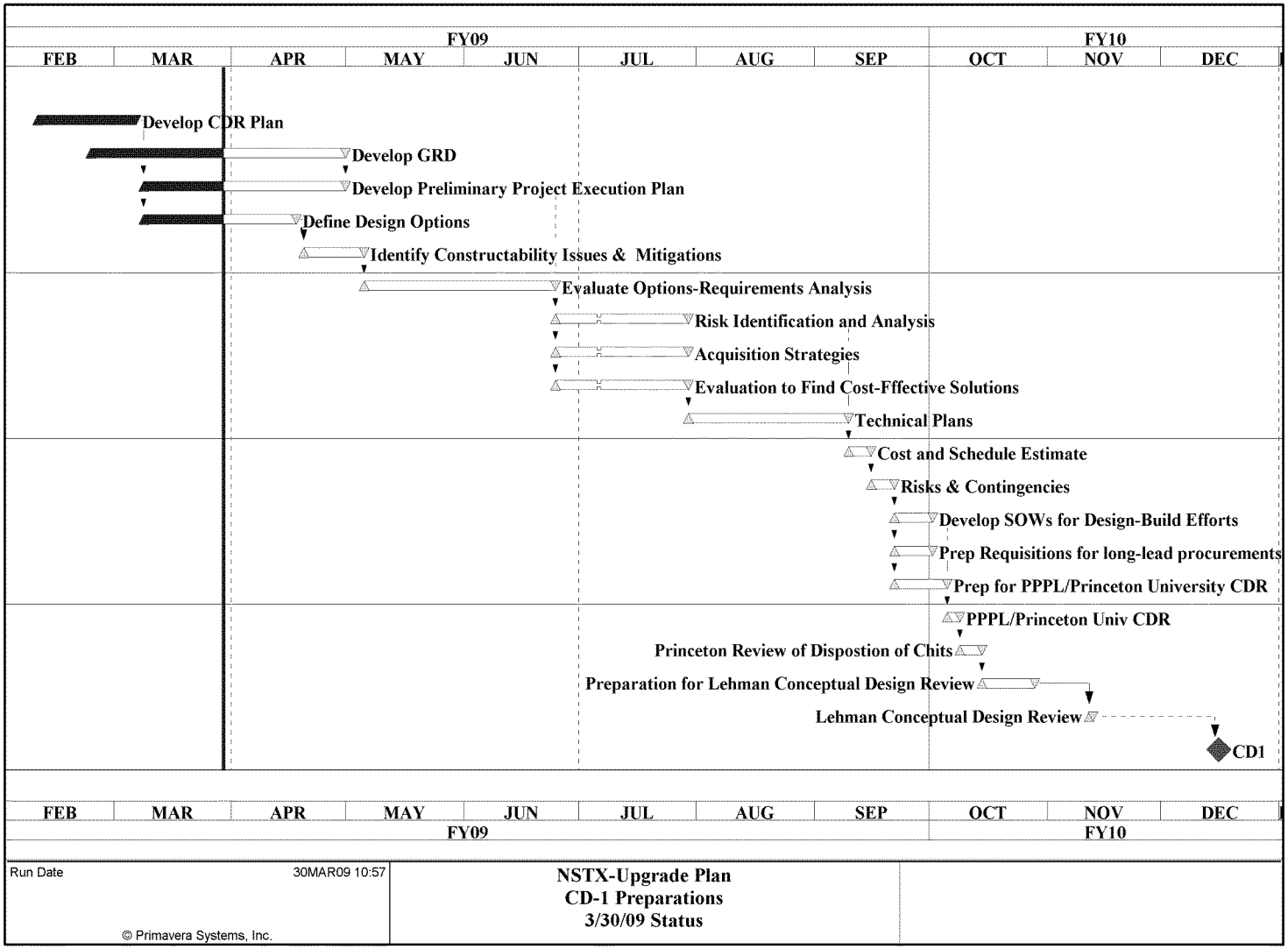
Deliverables for CD-1

- Work Planning Forms - *Complete*
- NEPA - *Request for CX submitted to ES&H*
- General Requirements Documents - *drafts in review*
- Preliminary Project Execution Plan - *draft in preparation*
  - Project organization
  - Integrated Safety Management (ISM) Plan
  - Procurement/Acquisition Plan
  - Risk Management Plan
- Conceptual Design Review
  - Technical Plans
  - Cost and Schedule estimates (range)
  - Risks and Contingencies
- Statements of Work (for subcontracting)
- Requisitions for long-lead procurement items

Milestones to get to CD-1

• Develop CDR Plan	March 6, 2009	complete
• Define Design Options	April 16, 2009	80% complete
• Evaluate TF Options	June 26, 2009	
• Select Primary Option	August 1, 2009	
• Technical Plan	September 14, 2009	
• PPPL/PU CDR	October 16, 2009	
• Lehman (SC) Review	November 20, 2009	
• CD-1	December 11, 2009	

Schedule for CD-1



Staffing for CD-1

- Center Stack
  - Analysis: Neumeyer, Heitzenroeder, Fan, Dahlgren, Avasarala, Zhang, Brooks, Titus, Woolley
  - Engineering: Chrzanowski, Kozub, Ramakrishnan, Hatcher, Blanchard, Meighan
  - Design: Paul, Upcavage, 2 TBD (designers)
- Neutral Beam
  - Decontamination: Gentile, Edwards, plus field crews
  - Critical Lift: Viola, Mitchell
  - Duct/Port: Priniski, Winkelman
  - Armor: Winkleman, 1 TBD (engineer)
  - Services: Denault, Mitchell
  - Power: Ramakrishnan, Edwards, 1 TBD (designer)
  - Controls: Cropper, Rossi, 1 TBD (designer)
  - Removal: Langella, Mitchell
- Management
  - Perry, Egebo, Dudek, von Halle, Stevenson

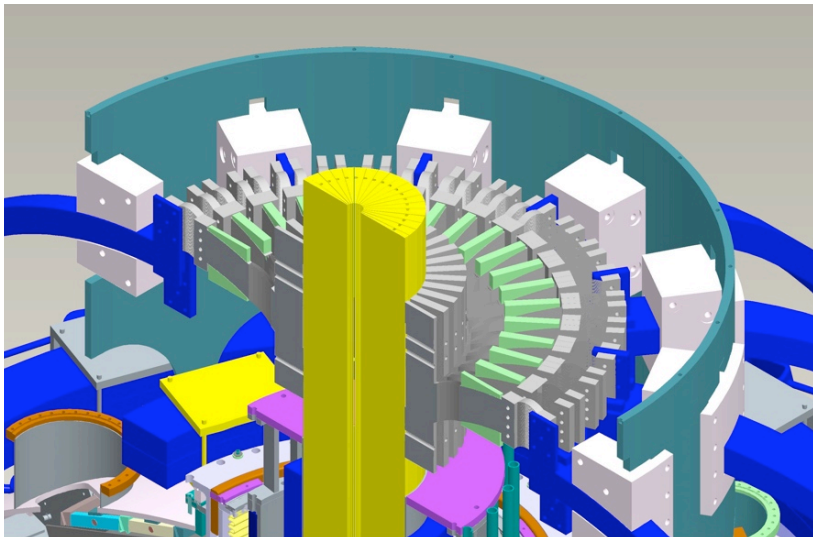
Centerstack Upgrade Technical Risks

- Risk: Outer TF Legs have coolant leaks and are currently dry because of defects in the coolant tubes. The tubes need to be repaired or coolant passage redesigned to provide cooling in support of higher TF currents.
  - Plans to Retire: Estimate includes budget to implement alternate coil cooling approach if needed. (Recent tests have identified only one leaking coolant passage.) We plan to investigate repair options early in the design phase.

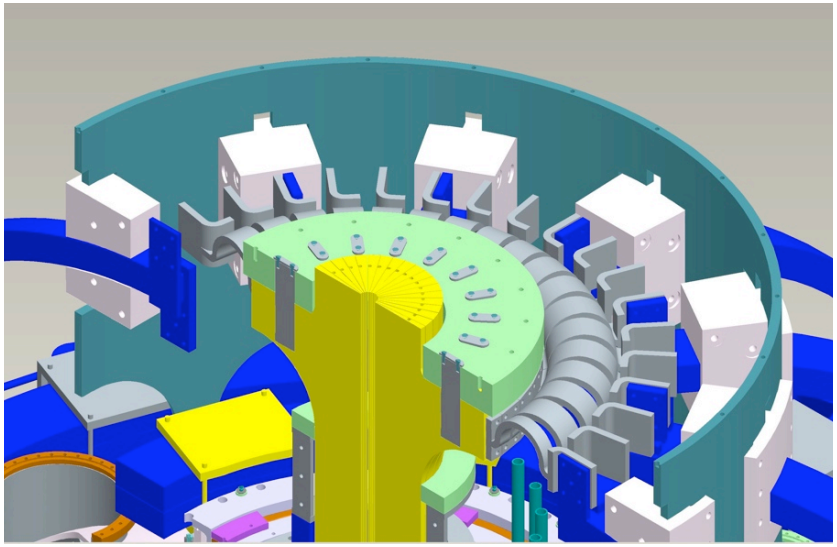
- Risk: The ability to find a cost effective TF Joint that works at higher fields (1T TF/2MA Ip vs. 0.55T TF/1MA+ Ip).
  - Plans to Retire: In consultation with outside engineers (with related design experience), four concepts have been developed and a side-by-side review will select the most promising two concepts for further development. One concept will be selected this summer as the preferred option to be presented at the CDR.

TF Flex Joint Concepts

- Neumeyer Concept Features
  - Bolts threaded into SS inserts within inner leg conductor allowing high clamping force
  - G-10 torque ring transmits torsional loads to umbrella lid
- Issues or Concerns
  - High Parts count
  - SS Inserts inside conductor are trapped making repair or replacement very difficult

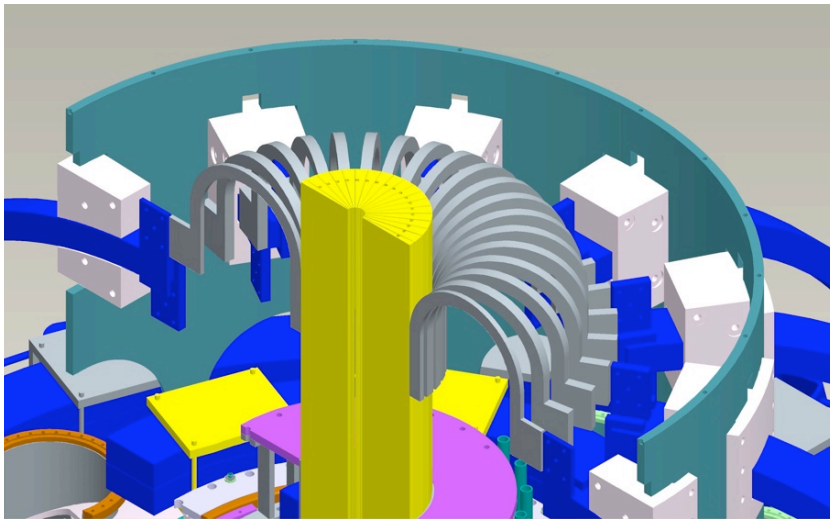


- Heitzenroeder Concept Features
  - Welded extensions to TF conductors provides joint-free regions for current streamlines to transition from vertical to horizontal.
  - Provides bonded integral hubs for positive torque restraint & lower shear stress.
- Issues or Concerns
  - Access to umbrella structure beneath the flex joints
  - eBeam or friction stir welding of the extensions is a new process for PPPL
  - OH Coil is not removable

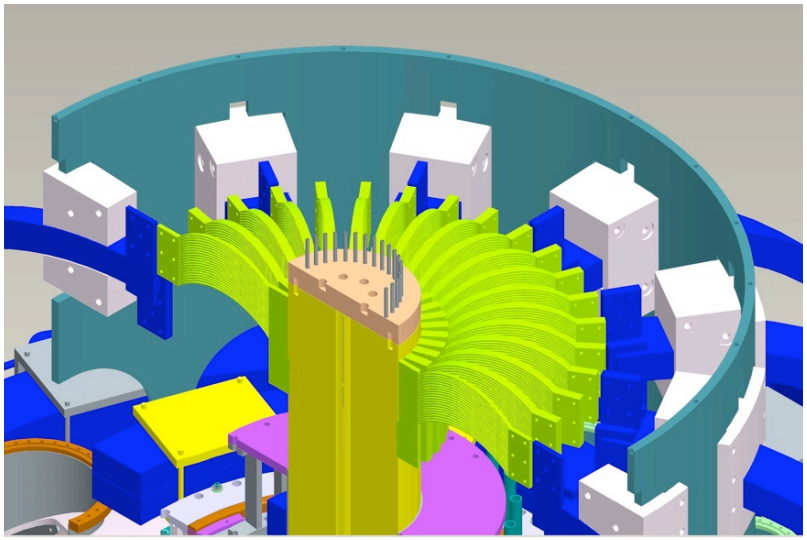


TF Flex Joint Concepts

- Titus Concept Features
  - Simple design
  - Use solid copper loops which are self supported instead of flex joints
  - A “jacking ring” is used to hold the joint between the TF bundle conductor and loop
- Issues or Concerns
  - “Jacking ring” may be difficult to evenly tension to ensure good contact
  - Solid loops may have fatigue life problems
  - Access to assemble the fasteners under the copper loops may be an issue



- Woolley Concept Features
  - Lap-Joint geometry provides uniform current density
  - Parallel current shaping generate EM Forces pressing the joints closed
  - No Bolts cutting through the conducting joint, uses “jacking ring” like concept 3
- Issues or Concerns
  - Ring and jack bolts might be difficult to tension evenly
  - Access to assemble the fasteners under flex connectors may be an issue
  - The flex connectors may need lateral support against out-of-plane forces



TF Flex Joint Concepts

- The four concepts will be analyzed, optimized, combined and down-selected to two by mid-April.

- The remaining concepts will be analyzed, optimized, combined and down-selected to a single design by August 1, 2009 for presentation at the CDR.

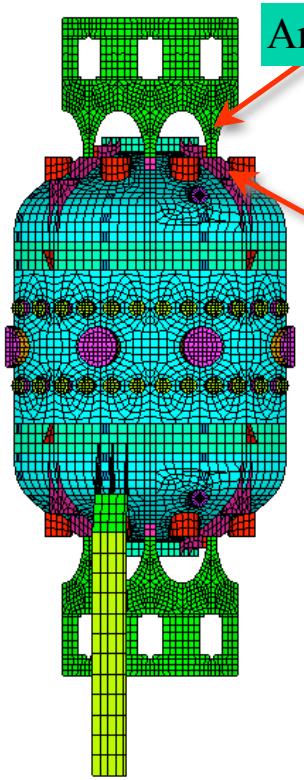
Umbrella Structure and Vacuum Vessel Technical Risks

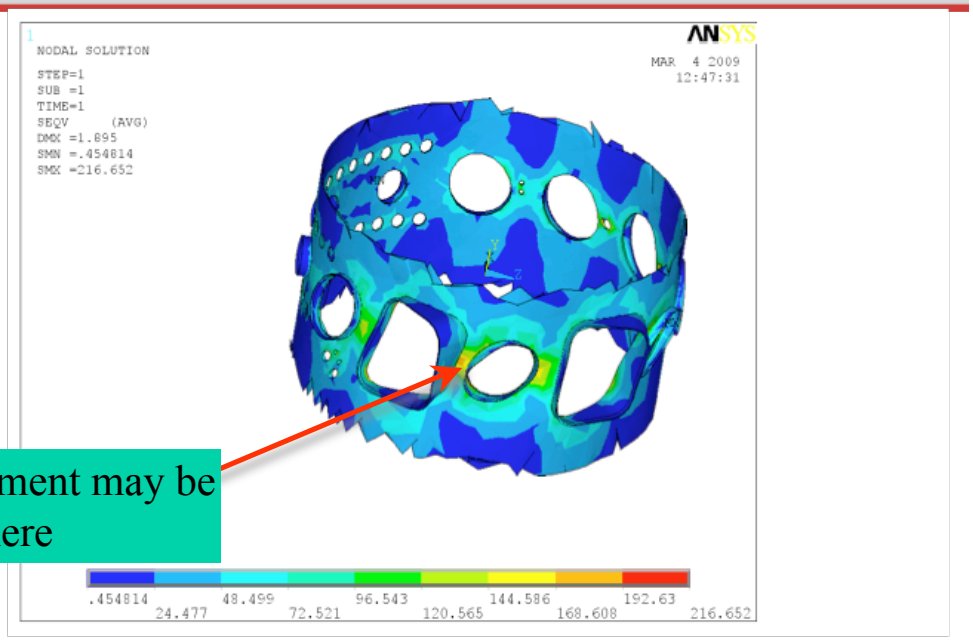
- Risk: Reinforcement of the outer TF Legs and Umbrella Structure to handle the higher loads will be challenging to retrofit on an operational device.
  - Plans to Retire: Analysis to characterize the new loads is about 80% complete. Bounding calculations have established upper bounds for the size of the supports required and mockups have confirmed that space exists for these supports. Analysis to optimize the support sizes and number of locations is in progress.

- Risk: The vacuum vessel may need to be re-enforced to accommodate higher loads.
  - Plans to Retire: Analysis has shown that re-enforcing the vessel is not necessary except in a few locations. Access to these locations seems straightforward at this time.

Vacuum Vessel Structural Analysis

- VV Midsection: Max Stress is 31.4 ksi
- Some minor reinforcement of the VV structure may be required between the large NB ports

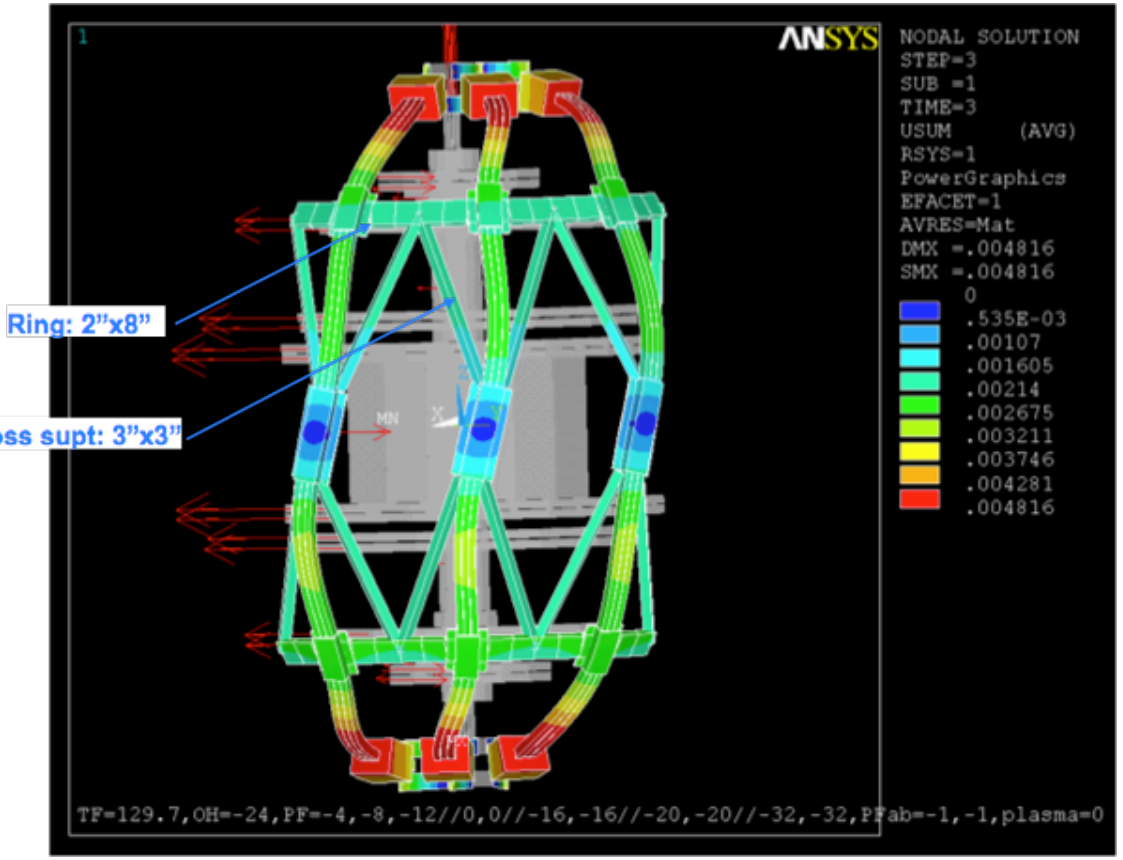




- Adding gusset plate to PF rib would reduce the local stress by distributing it to a greater area on the vessel.
- For the PF4/PF5 support, it is better to connect the upper and lower support brackets by strut for force self-balance, without transfering the load to the VV.

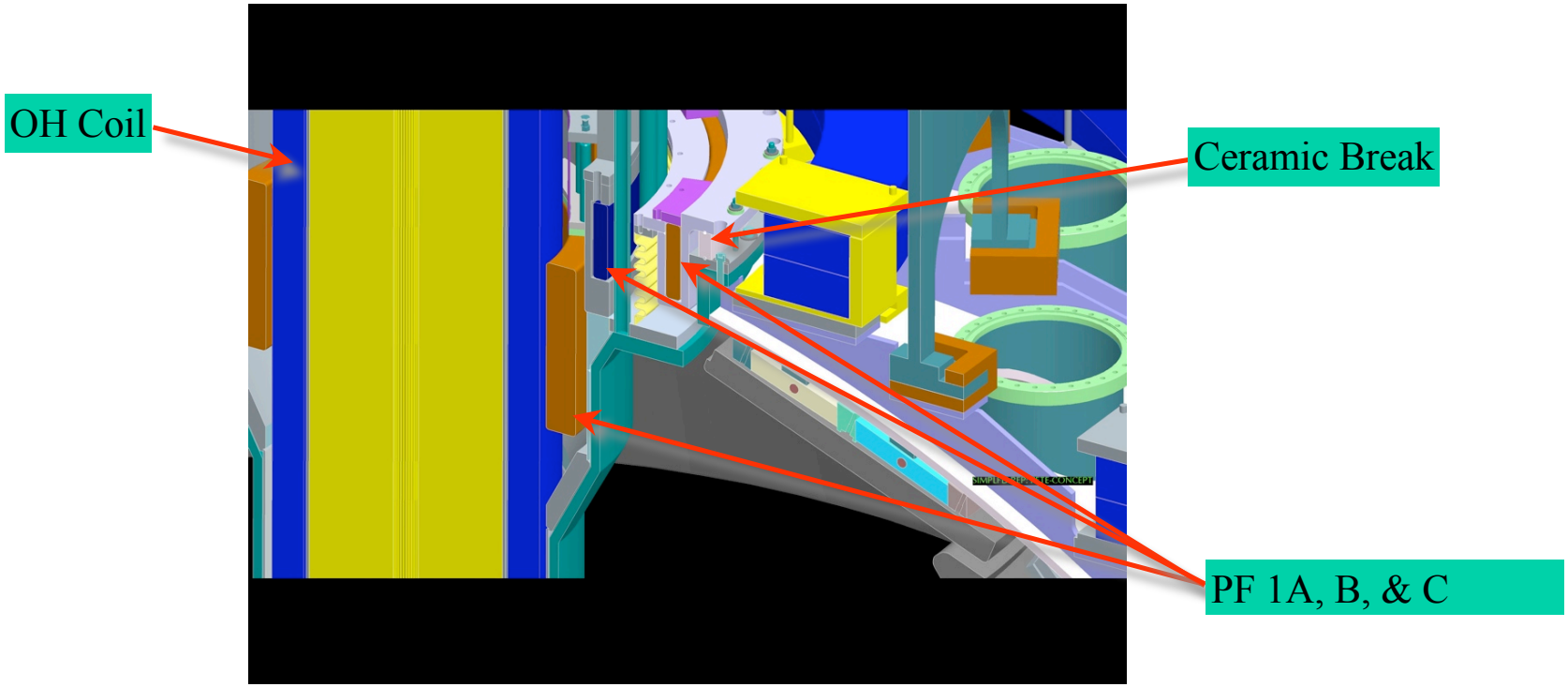
Vacuum Vessel and Outer TF Support

- Initial analysis runs of the existing turnbuckle arrangement indicated the need for additional support on the outer TF Legs
- Analysis has started on a concept of the outer TF Leg structural support.
- Early indications are that the structure works
- Mockups of the structural members have been test fit on the machine and there are no major issues



OH and PF Coils

- Conceptual layout of OH and PF1 Coils and Ceramic break assembly shows that they will be compatible with CHI.



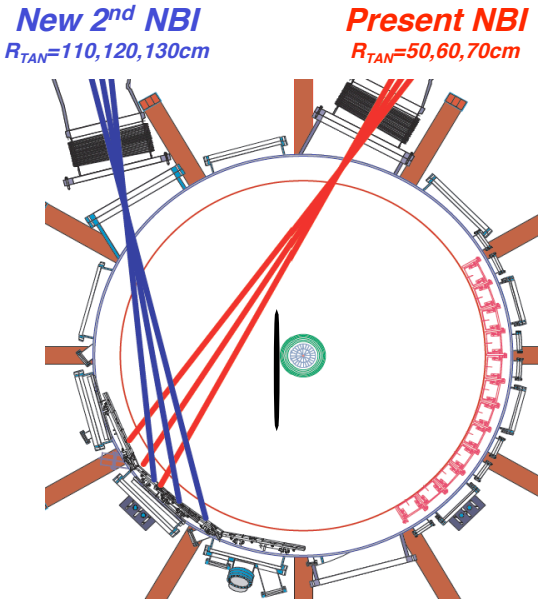
Second Neutral Beam Technical Risks

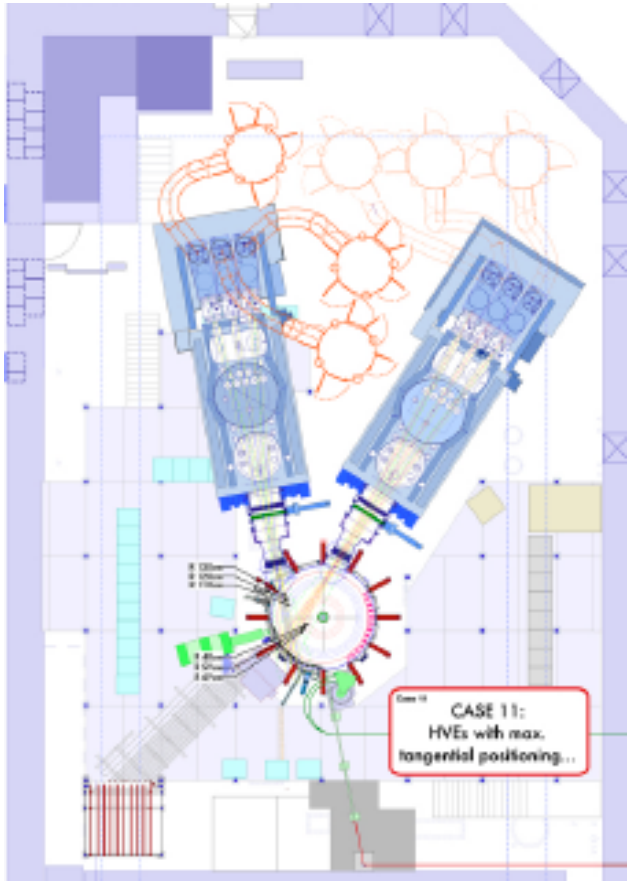
- Risk: The TFTR NBIs were operating very well in tritium when they were taken out of service in 1997. Uncertain of present condition of the NBL internals and the levels of tritium contamination. Also uncertain of the level of effort required to decontaminate.
  - Plans to Retire: The R&D on decontamination can be initiated in the early stages of the project. Decontamination techniques were well tested during the TFTR D&D project and the contamination levels in NB4 are well below that routinely encountered during the maintenance of TFTR NB sources. This risk will soon be retired.

- Risk: Uncertainty in the commercial availability of High Voltage Switch-Tubes, cabling and terminations for the 100kV Accelerator System.
  - Plans to Retire: There are sufficient High Voltage Switch Tubes available on site to support a second NB on NSTX and to still have adequate spares. Contact with vendors has confirmed that the triax cables and connectors are still available. This risk will soon be retired.

NSTX BL2 Upgrade: Duct/ Pumpduct/ Vacuum Vessel

Modeling has begun to lay out BL2, the Beam Duct, the TVPS pumpduct appendage, and Bay K Vacuum Vessel modifications for wider aiming angles.





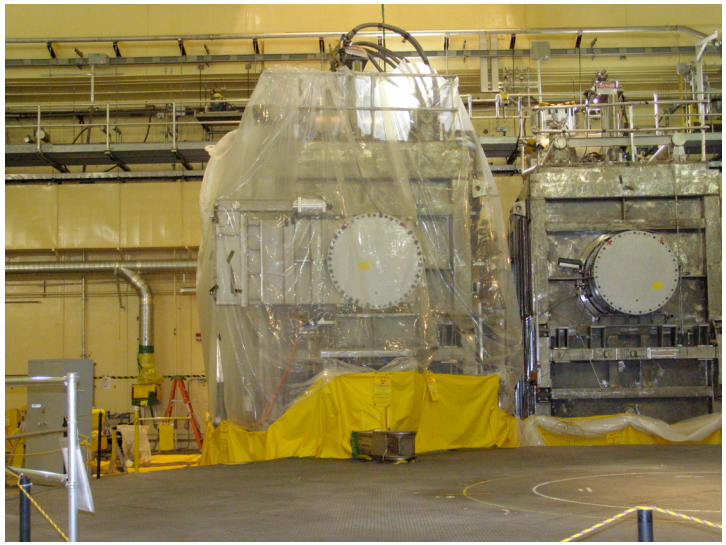
NSTX BL2 Upgrade: Power Systems & Controls

- Power systems from TFTR BL4 A,B, & C have been chosen for NSTX NBI Upgrade BL2 due to their proximity to existing systems and controls already in use.
- Evaluation of the routing of cables and trays has begun with some very promising options already discovered. (Existing routing though the MER looks complicated and expensive so better routes are being sought.)
- Evaluation of the removals of N4 High Voltage Enclosures from the TCB has begun. This work will be slated for an NSTX outage when active water lines can be shut off.
- Preliminary contacts with vendors of the high voltage triax and connectors indicate that these components are readily available.

NSTX BL2 Upgrade: NBI Decon Activities

- Initial Beamline internal tritium surveys have been completed.
  - Airborne and surface contamination are as expected and will allow work to proceed without undue concern of tritium release
- Test Cell access has been reviewed and restricted, as necessary, for NBI decontamination activity.
- Procedures have been developed for pump/purges and component removals.
- All three transmission lines have been removed and lowered to Test Cell basement for storage.
- Engineering sketches have been completed to fabricate a new lid stand required to work on beamline internals; fabrication has begun.

NSTX BL2 Upgrade: NBI Decon, con't.



TFTR BL4 area prepared for work

Lid stand holding BL lid with cryo manifolds and panels (photo circa 1980)

Summary

- We are making good progress toward CD-1
  - CDR in mid-October
  - Lehman (SC) Review in mid-November
  - CD-1 ready by mid-December
- A plan with adequate resources has been developed
- We are already reducing risk
  - So far, our worst-case assumptions have not materialized
    - Vacuum vessel and TF structural supports
    - NBI decontamination