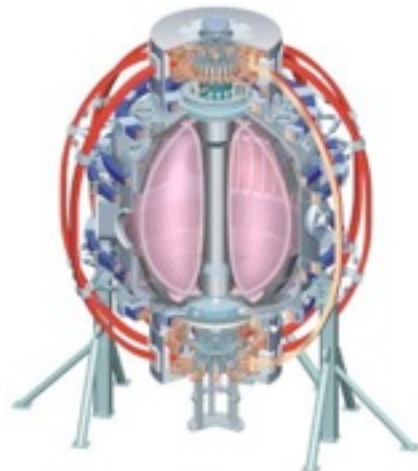


Coil Support Structures

**Design by D. Mangra
Presented by L. Dudek**

**NSTX Upgrade Project
Conceptual Design Review
LSB, B318
October 28-29, 2009**



College W&M
Colorado Sch Mines
Columbia U
CompX
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Washington
U Wisconsin

Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

Outline

- Tasks
- Scope / Requirements / Standards
- Existing Structure
- Design Approach
- Issues
- Summary

Structural- Design

- Scope:
 - Structural Support Components
 - Support Coils: TF, PF2, PF3, PF4 and PF5
 - Support Pedestal: To Support new Center Stack
 - Umbrella structure reinforcement to carry higher magnetic loads
- Requirements:
 - Resist Forcing Inputs
 - Interface with Legacy equipment
 - Real Estate available for installation
 - Coil Alignment - ~5 mm
- Standards:
 - Stress - in house design standard
 - Installation and handling – Module Size and weight such that parts can be easily handled and installed
 - Minimize the impact to existing hardware
 - Minimize the impact to existing assembly as installed

Force Inputs

Cage Links	Power Supply Limit		Operational Limit	
	Max (lbs)	Min (lbs)	Max (lbs)	Min (lbs)
PF 3 Upr to PF 4 Upr Link	272,631	-314,951	103,217	-150,417
PF 5 Upr to PF 5 Lwr Link	665,724	-666,010	258,062	-239,821
PF 4 Lwr to PF 3 Lwr Link	116,805	-471,392	35,711	-150,441
Upper dome load	194,759	-369,644	59,209	-59,365
Lower dome load	191,694	-194,844	44,531	-59,250
Load by vessel to 4 legs to ground	495,107	-495,329	58,722	-65,529

Existing TF & PF Support Details and integration

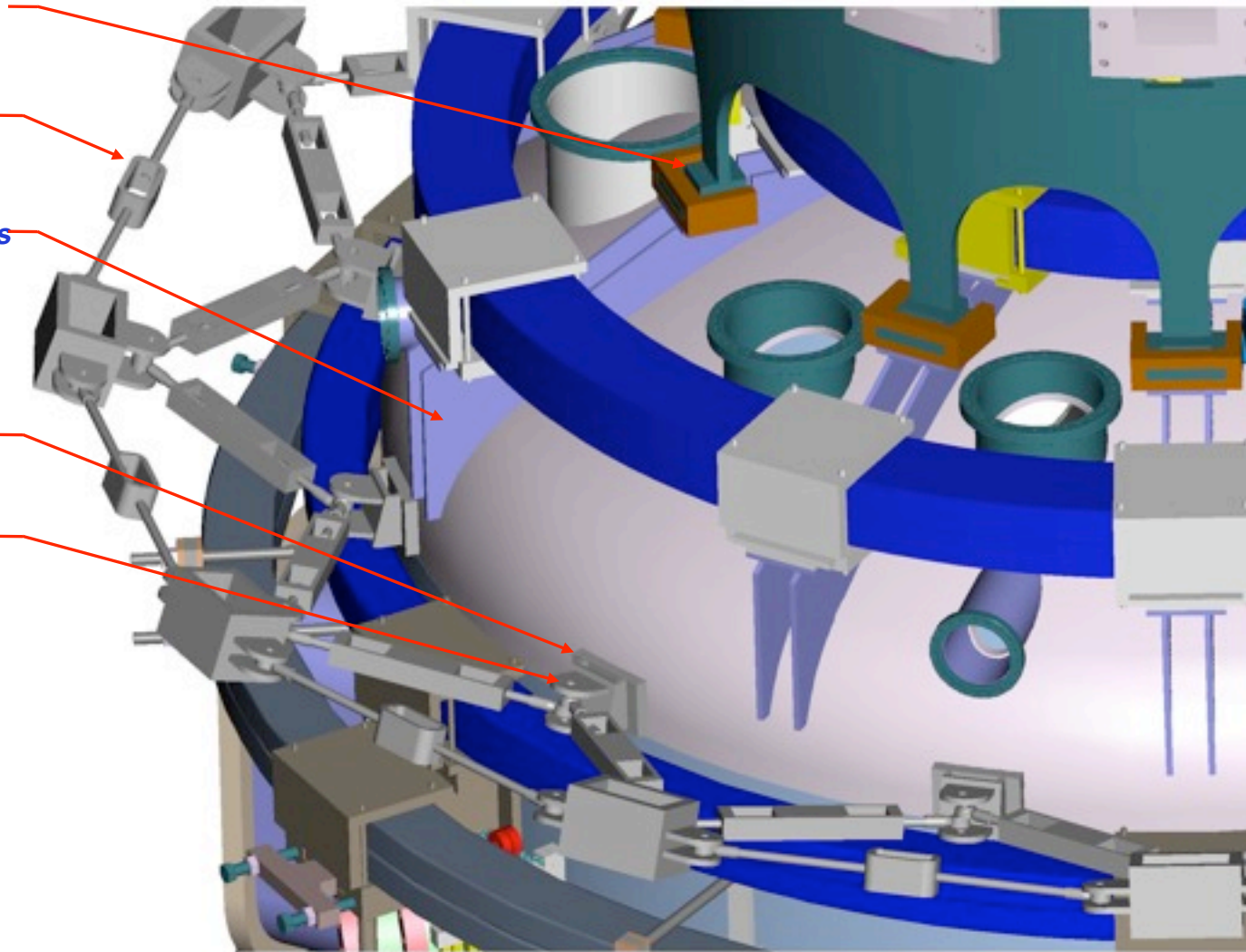
*Existing Umbrella Structure
Legs with sliders*

Existing TF ring

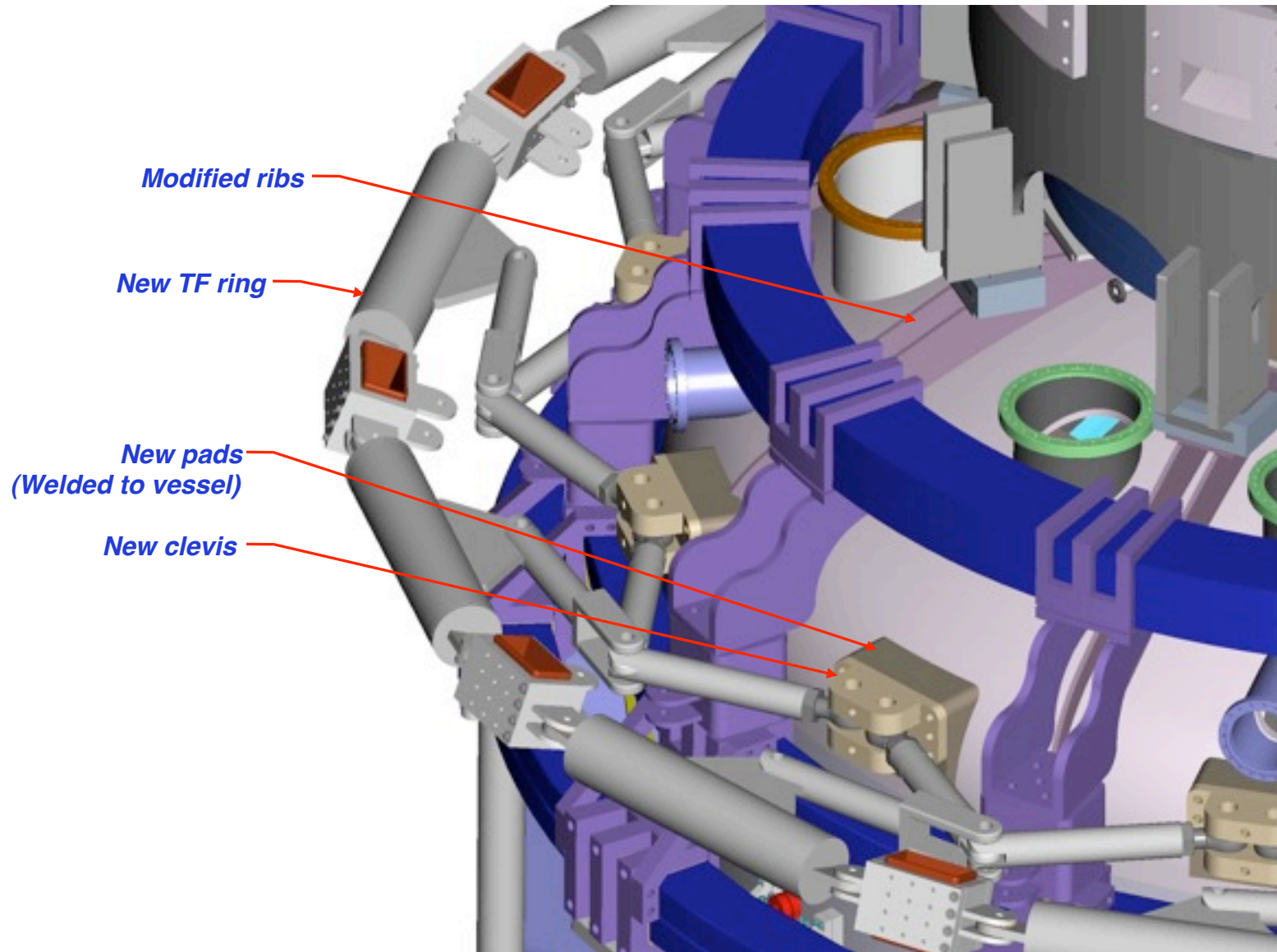
Existing ribs

Existing pads

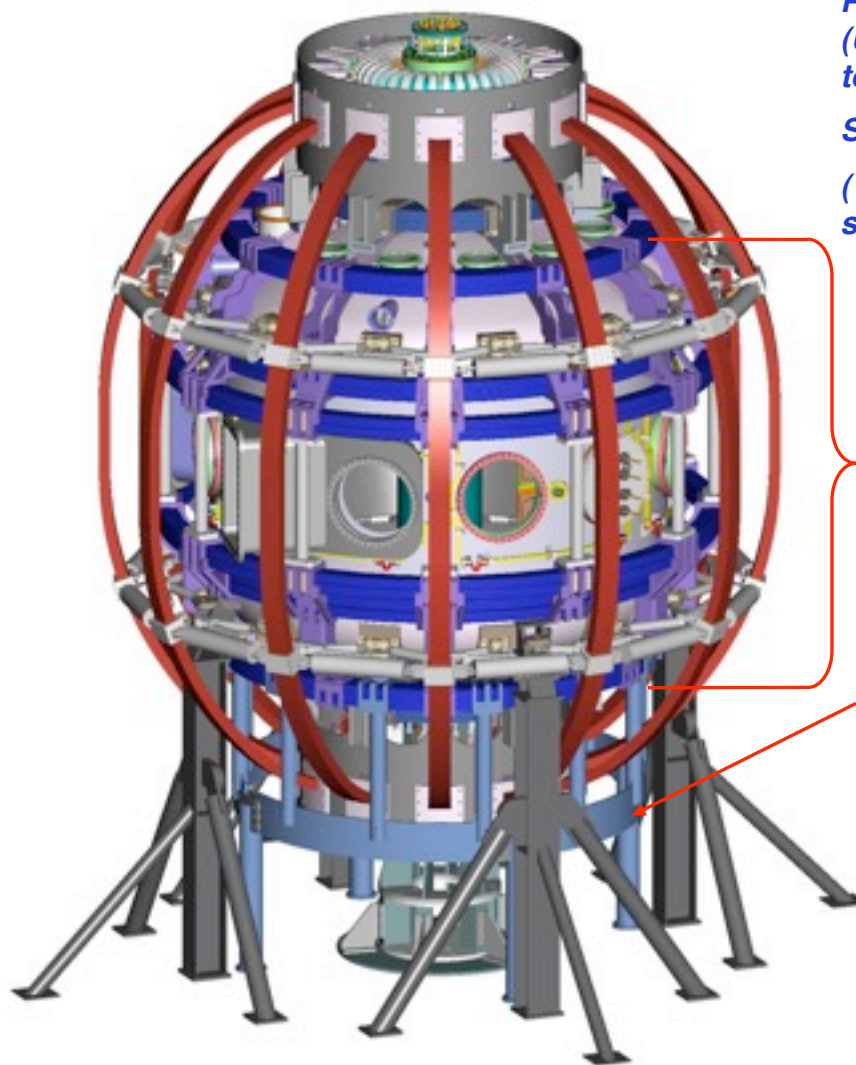
Existing clevis



New Supports Designed to use same Real Estate as Existing



NSTX Main Assembly with PF Cage Support



*PF Cage = PF3, PF4 & PF5 Coils
(Upper and lower) Bundled
together.*

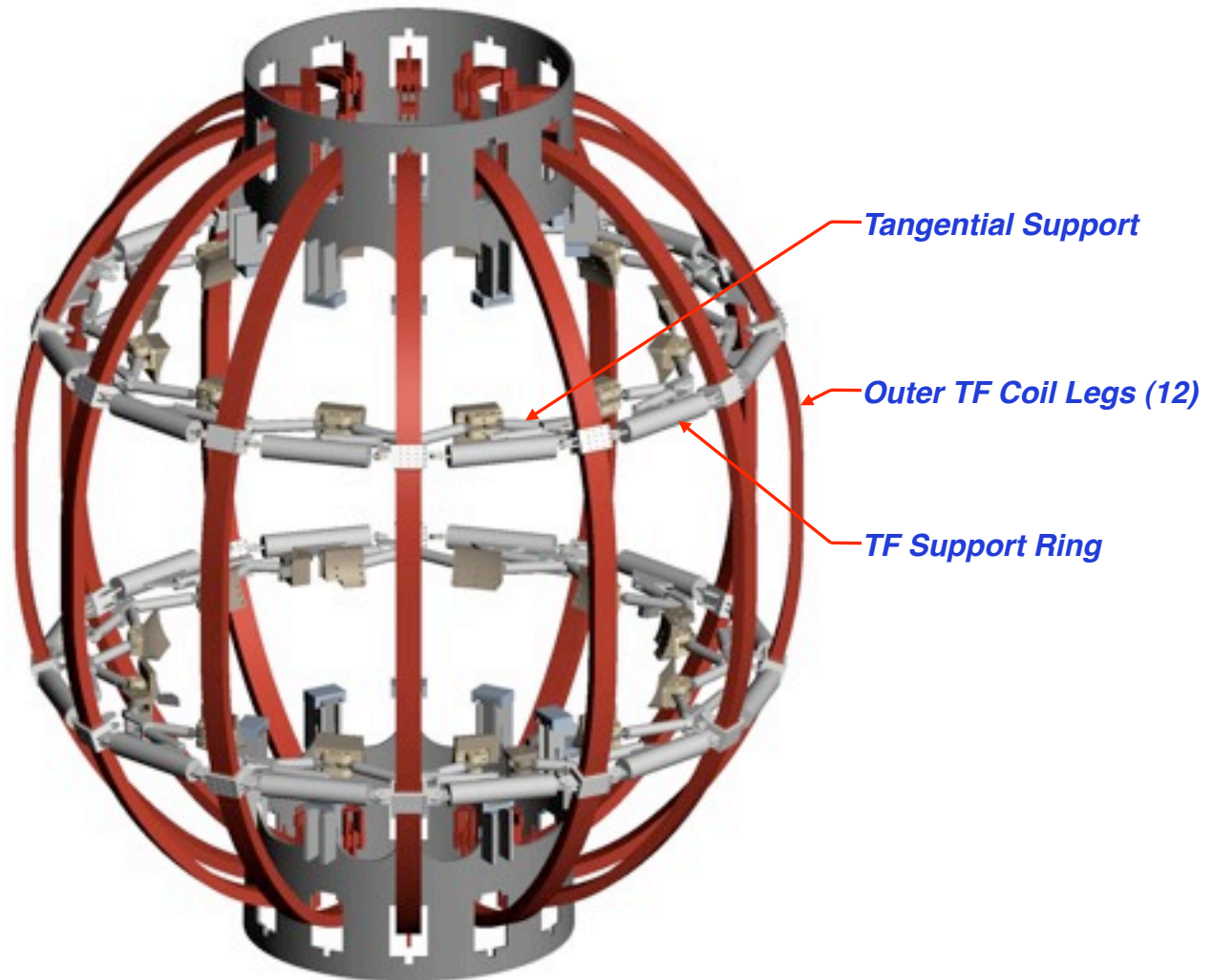
Supported by Cage support.

*(VV Heating/Cooling Manifold not
shown.)*

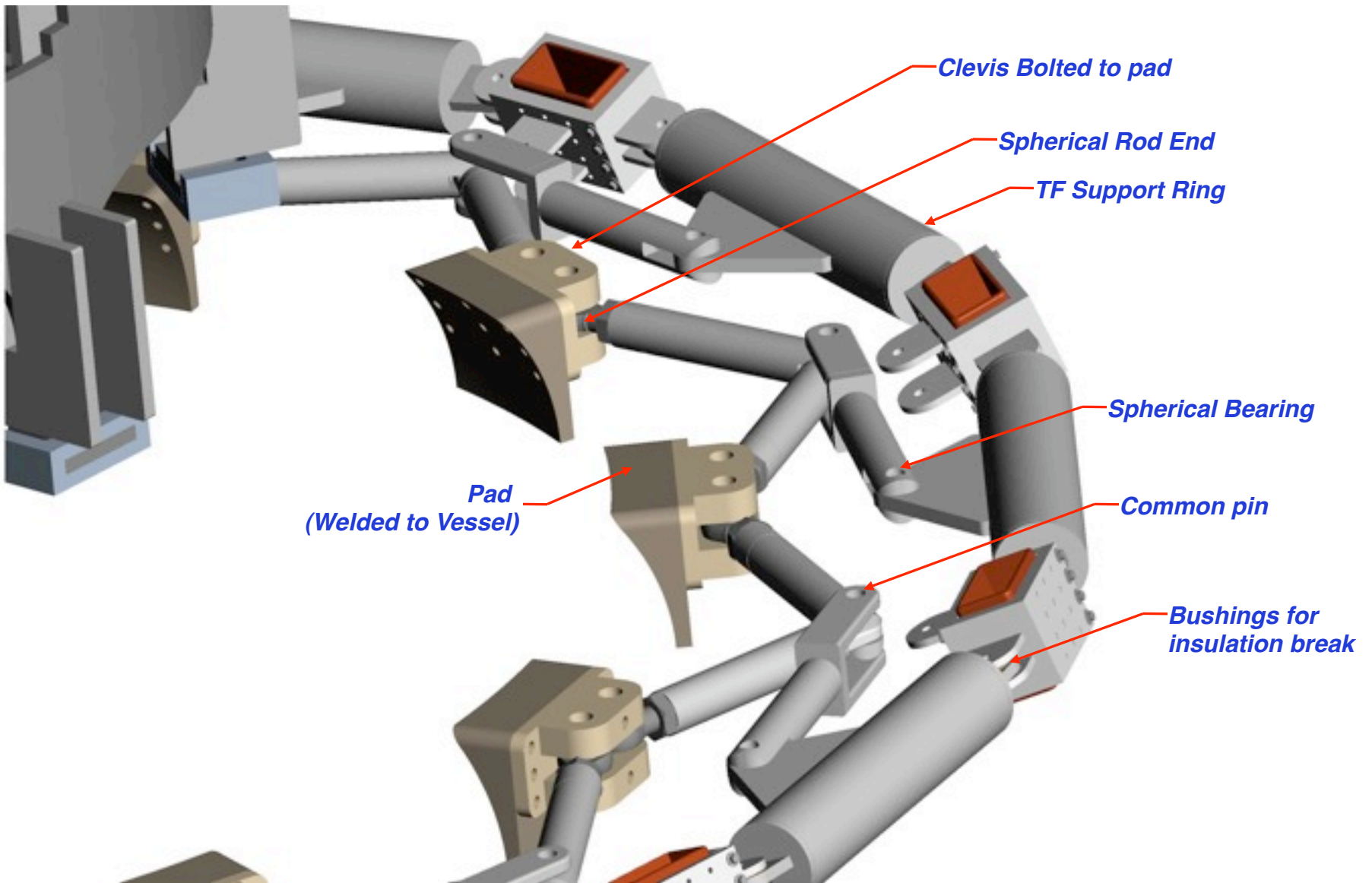
PF Cage

PF Cage Support

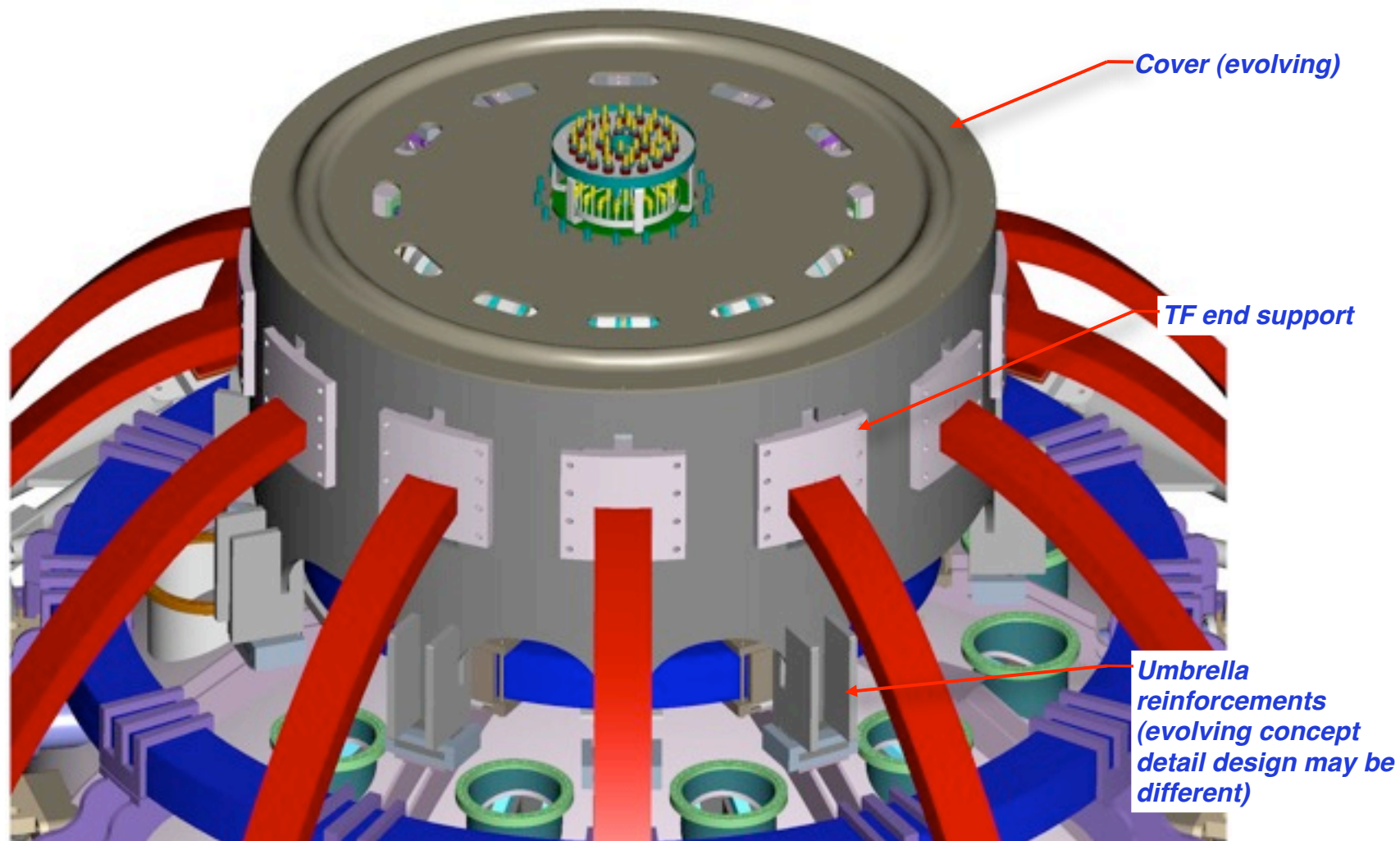
TF Coils and Supports upgrade



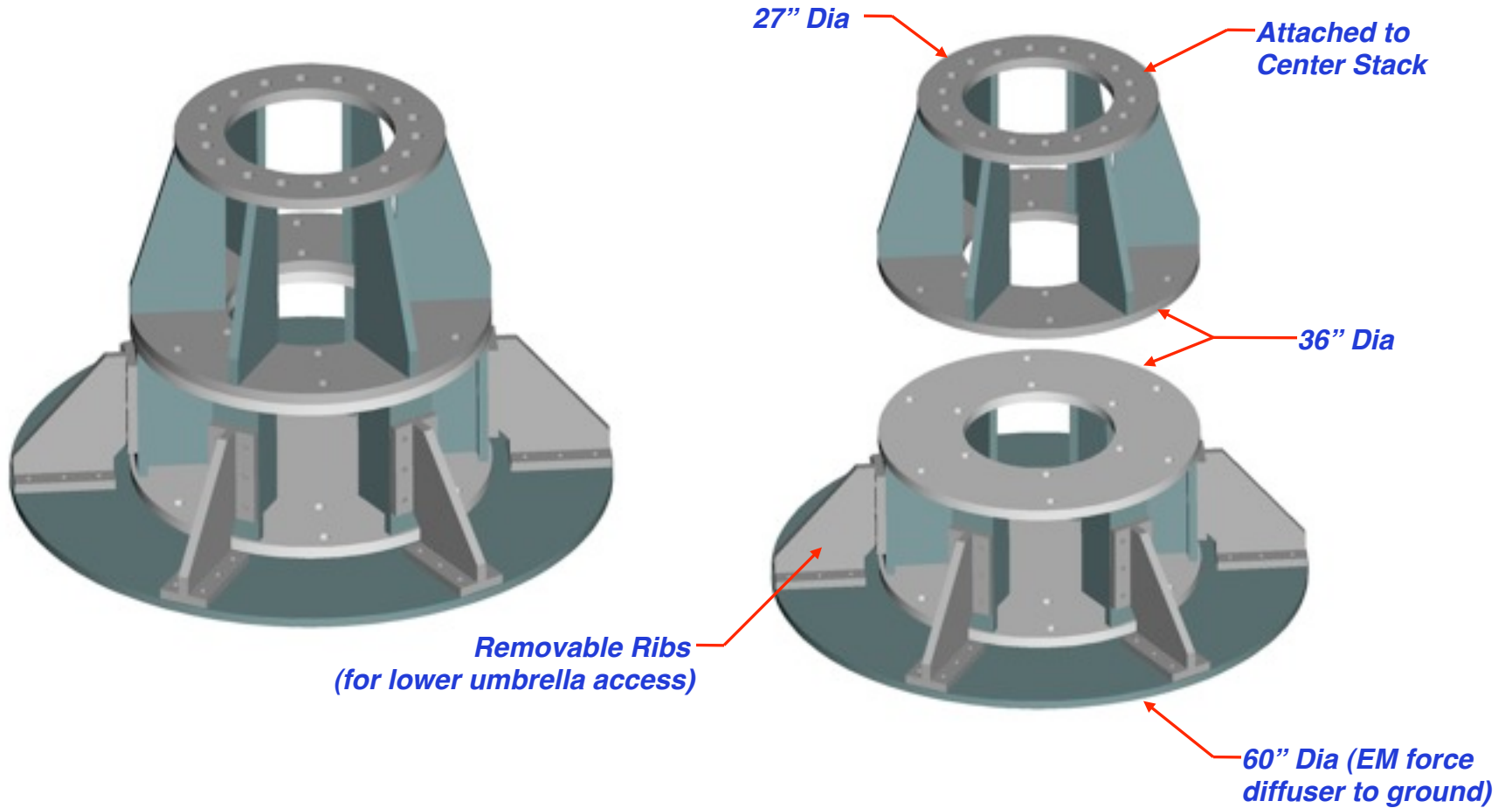
TF Tangential Support Details



Umbrella Reinforcement

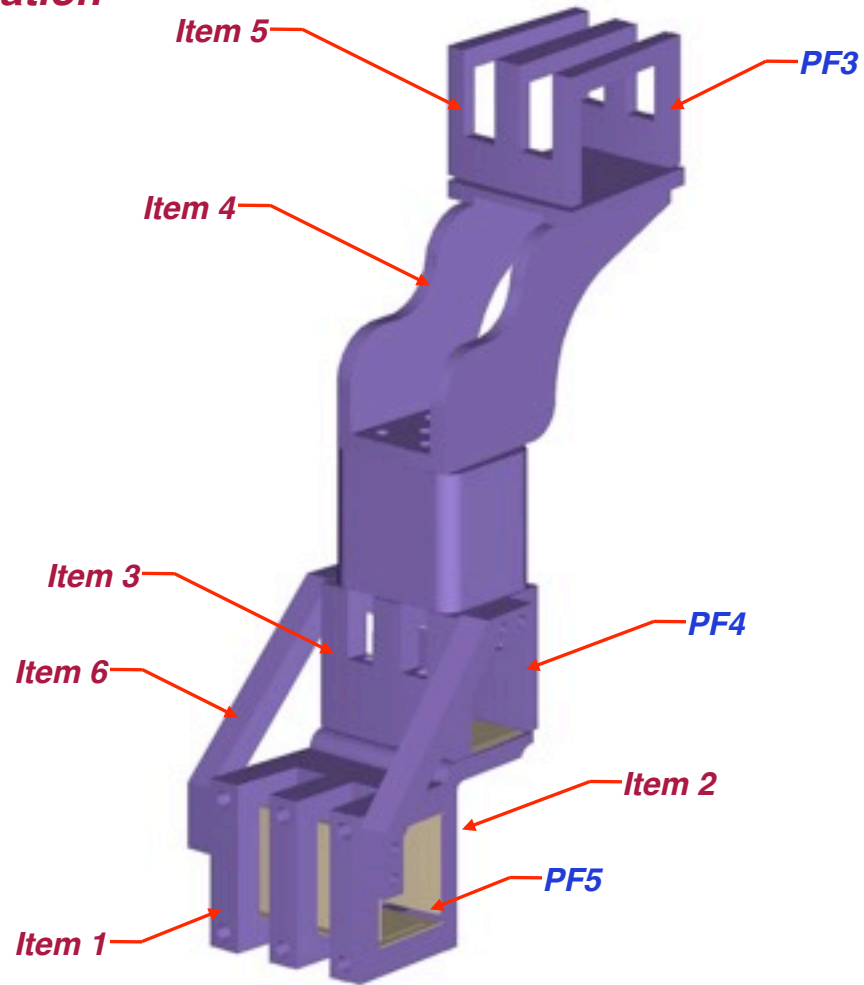


Pedestal Assembly

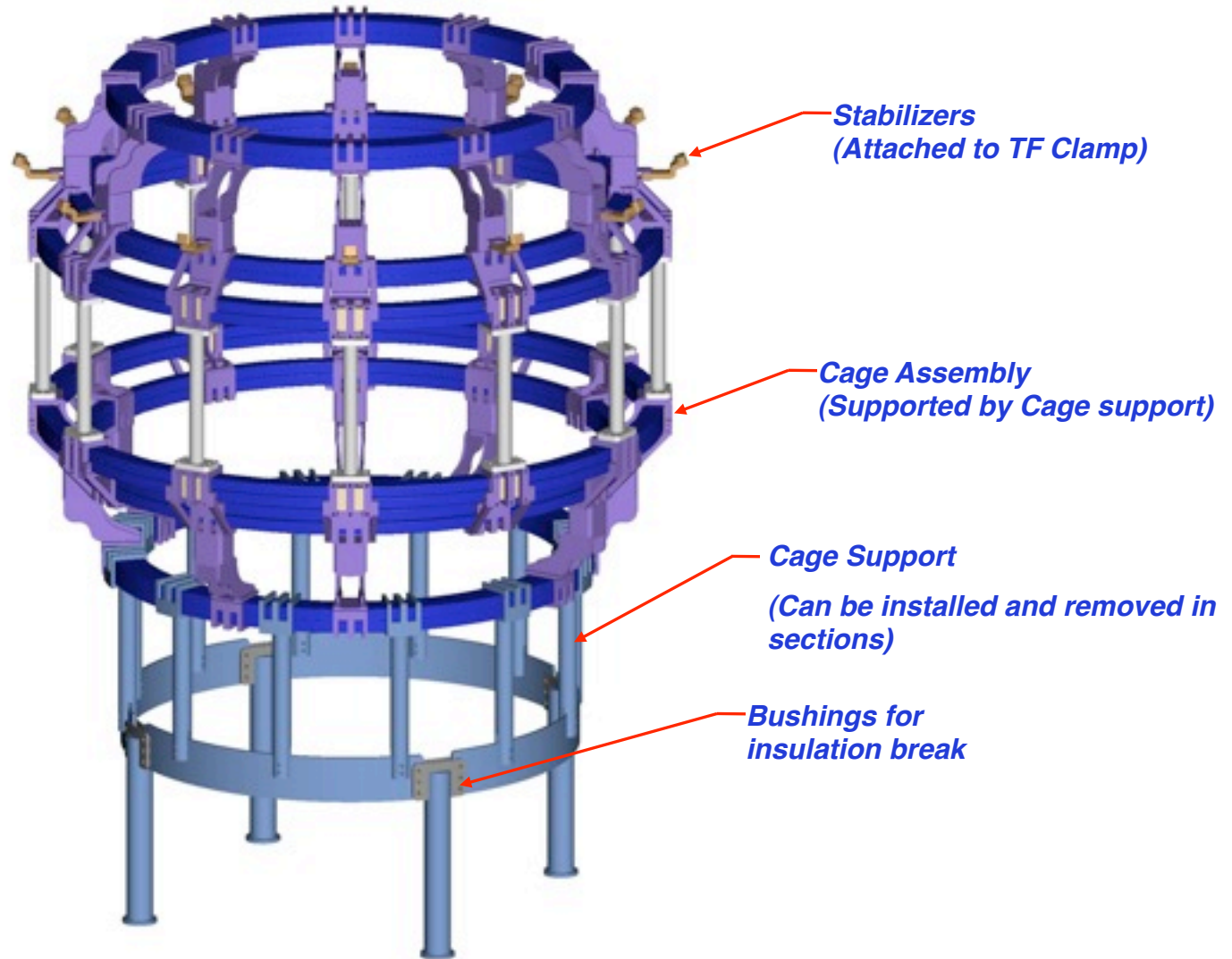


PF Coil Support Assembly

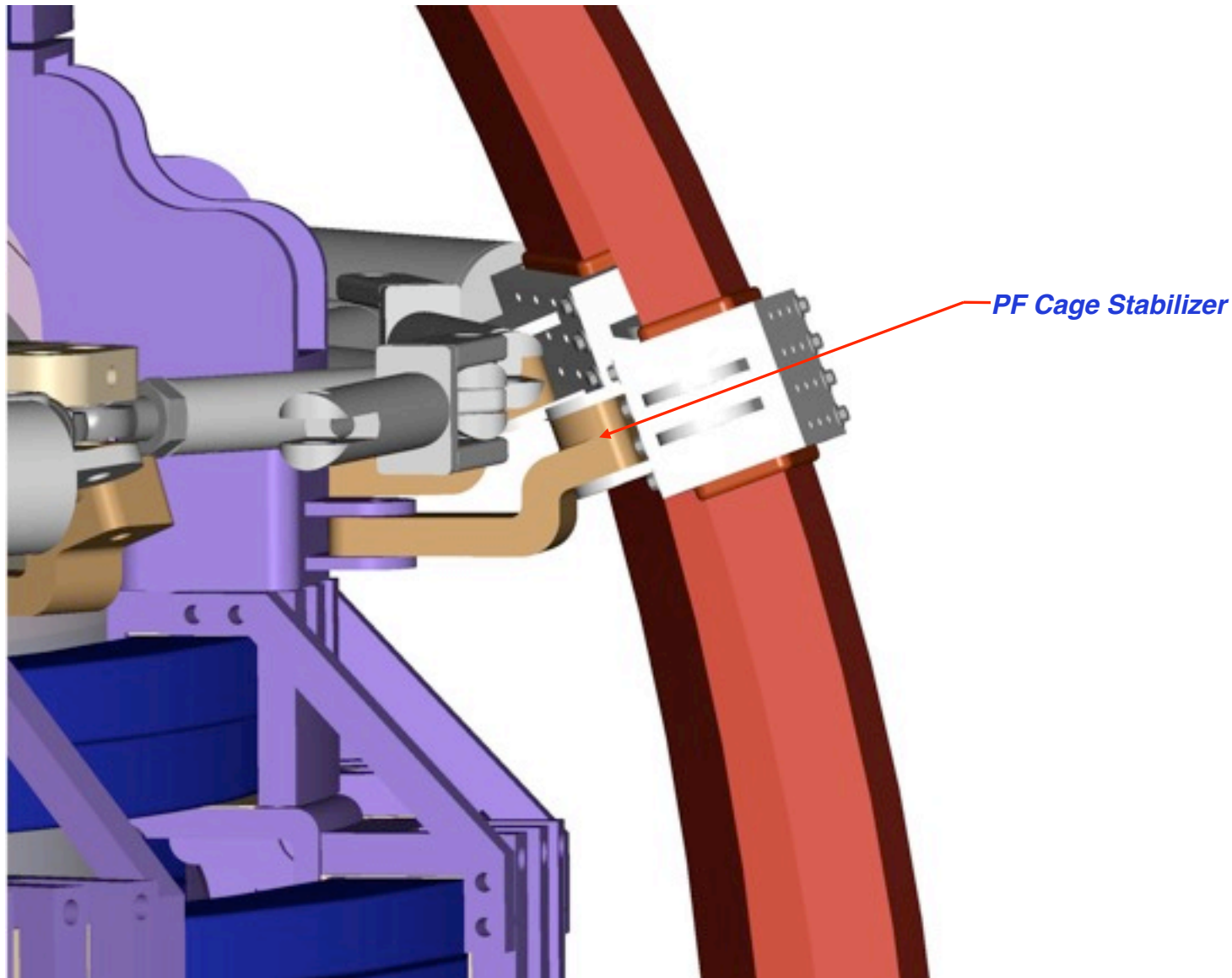
Item # in order of installation



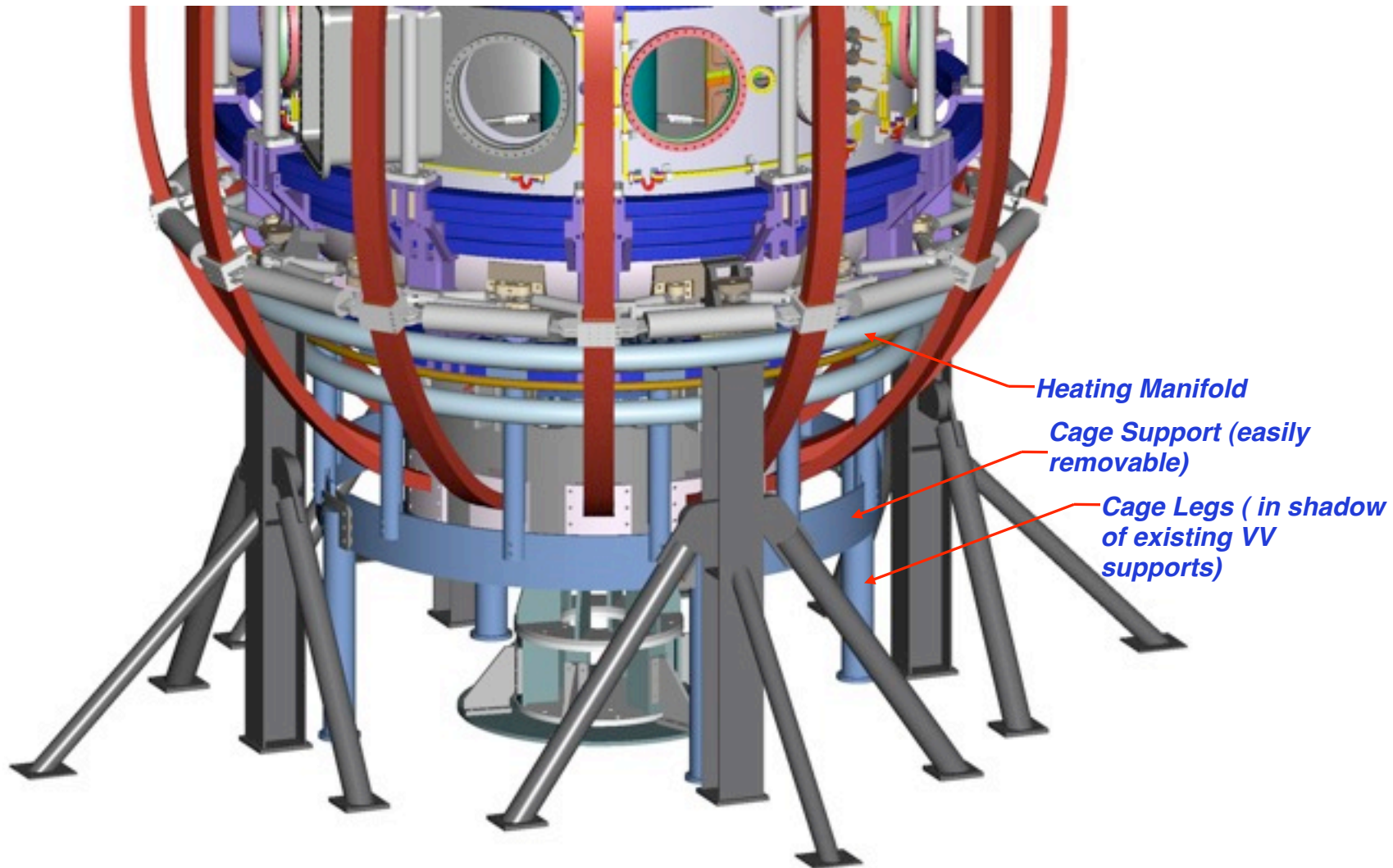
PF Cage – Coils Assembly with bottom support



PF Cage Stabilizer



PF Cage to Floor Connection



Installation Procedure Plan

- Install (TBD) Shaping fixtures to PF5
- Remove existing coil clamps on PF5 and PF4
- Upper PF5/PF4 are raised & Lower PF5/PF4 are lowered
- Inspect coils for repairs (leaks etc) & repair if needed
- Reposition upper PF5 & install PF5 cage clamps
- Link PF4 to PF5 via mechanical supports
- Add columns to PF5 and repositioned lower PF5
- Process continued on the lower coils
- Each coil is mechanical aligned for concentricity
- Leg system for the cage is attached
- Alignment system relative to legs of vessel is installed
- Cage system can be slid on ground (grouting plate to be designed)
- Align cage and bolt to ground/grouted plate
- Remove shaping fixture & alignment fixture
- Address electrical isolation/grounding needs

Cost Estimate

Job	Estimate (\$K)
Job: 1200 - Vacuum Vessel & Structural Support	\$776
Job: 1201 - Outer TF Structures	\$689
Job: 1202 - Outer PF Coil Structures	\$1,111
Job: 1203 - Umbrella Structural Reinforcement	\$397
Job: 1204 - CS Support Pedestal	\$197
Job: 1205 - Misc VV Structural Support	\$252

Estimated using

- \$ / pound rates***
- \$ / models***
- \$ / drawings***

Issues

- PF2 Coil Support Structure - not yet started however the support should be straightforward
- Vessel stands
 - The launching loads on the vessel exceed the capability of the existing vessel connections so some reinforcement will need to be implemented
- Cage Support
 - Still evolving and being evaluated against all of the operational scenarios
- Load Design Point convergence
 - P.S. limit vs Operating Limit
 - Max capacity, 126 KIPS is limited by (18) 3/8" connection bolts to center stack assembly.

Impacts

- Ribs on vessel need significant modification insitu
- Clevises on vessel must be removed and replaced with stronger versions
- Column Supports are installed inside the Outer TFs in 12 locations. Optimization may allow reductions.
- Additional supports for PF cage to the floor

SUMMARY

- **Concept Matured:**
 - PF3, PF4 and PF5 (upper and Lower) support structure
 - TF coils(12) support structure
 - Pedestal for center Stack
 - Both PF and TF coil supports are compatible with the NB2 Bay J/K modifications
- **Concept Pending:**
 - PF2 coils
 - Umbrella structure leg reinforcement
- **Issues- Real estate**
 - Difficulty to install the upgraded structure needs to be evaluated
 - Optimization is expected to identify opportunities for simplifications and cost savings