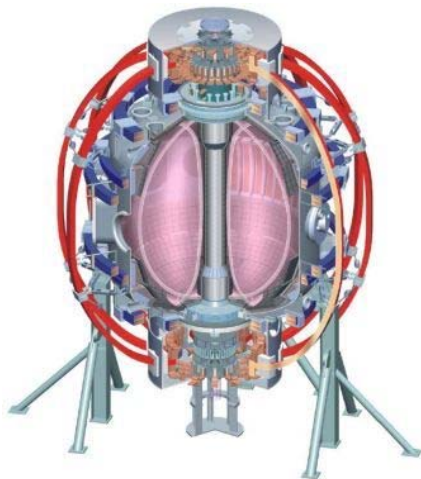


Vacuum Vessel & Support Structure WBS 1.1.2

Mark Smith

and the NSTX Upgrade Team

**NSTX Center Stack Upgrade Peer Review
LSB B318
May 18, 2011**



Columbia U
 CompX
 General Atomics
 FIU
 INL
 Johns Hopkins U
 LANL
 LLNL
 Lodestar
 MIT
 Nova Photonics
 New York U
 ORNL
 PPPL
 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
 TRINITY
 NFRI
 KAIST
 POSTECH
 ASIPP
 ENEA, Frascati
 CEA, Cadarache
 IPP, Jülich
 IPP, Garching
 ASCR, Czech Rep

Outline

- Charge Questions
- CHITs
- Design Overview
- Vessel Leg Reinforcement
- Pedestal Upgrade
- Umbrella Upgrades
- PF2/3 Support Upgrades
- PF4/5 Support Upgrades
- TF Outer Leg Support Upgrades
- Interconnections
- Cost & Schedule
- Open Items

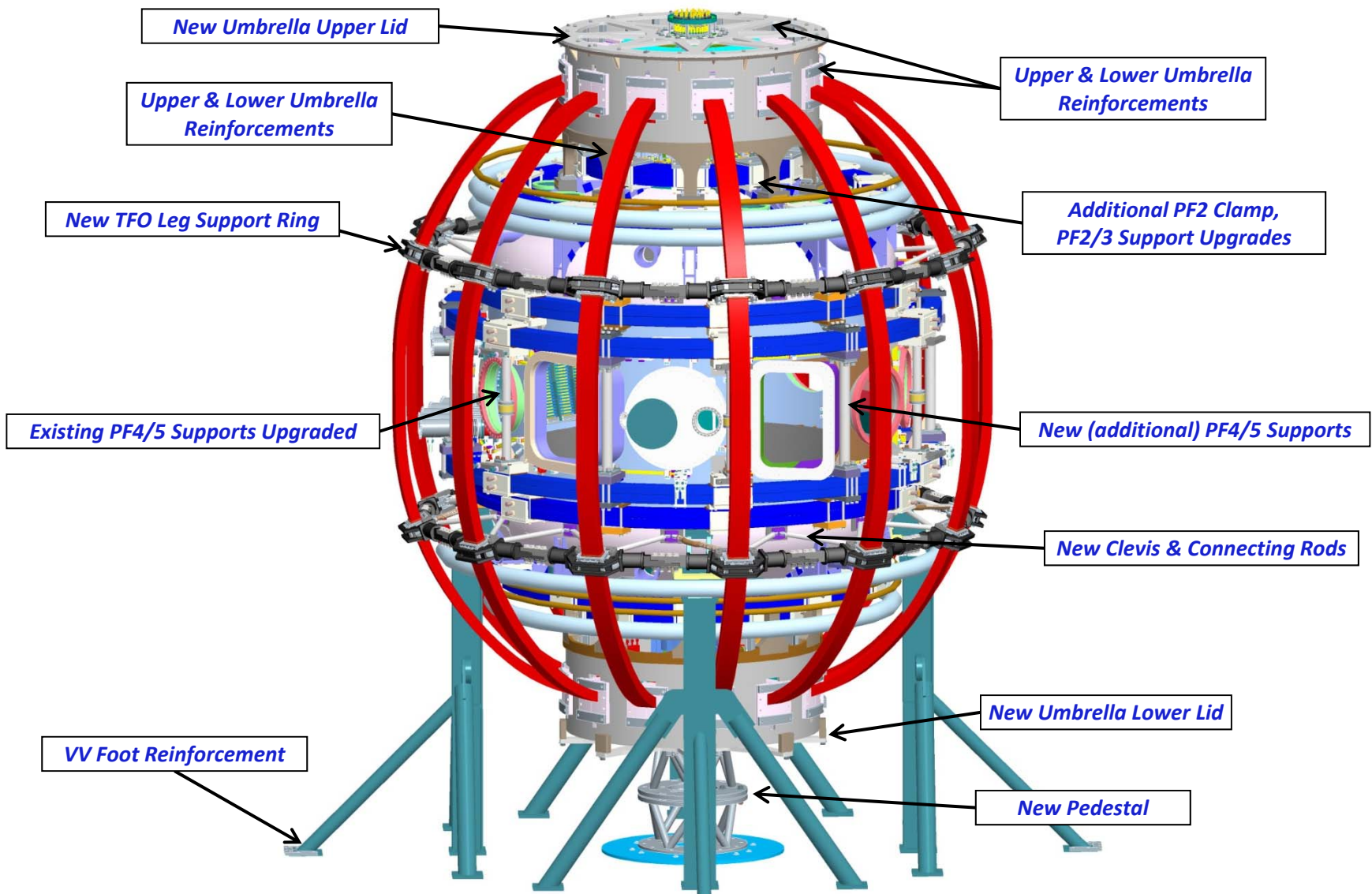
Charge Questions

- Has ES&H been properly addressed?
- Does the final design meet the GRD?
- Does the FDR satisfy PPPL Procedure ENG-033 Design Verification?
 - Attachment 4: Design Review Objectives and Input Documentation
 - Attachment 6: Human Performance Improvement/Factors Considerations.
- Have the CHITS & previous recommendations been addressed?
- Have risks been appropriately identified and mitigated?
- Are the cost and schedule estimates updated and reasonable?

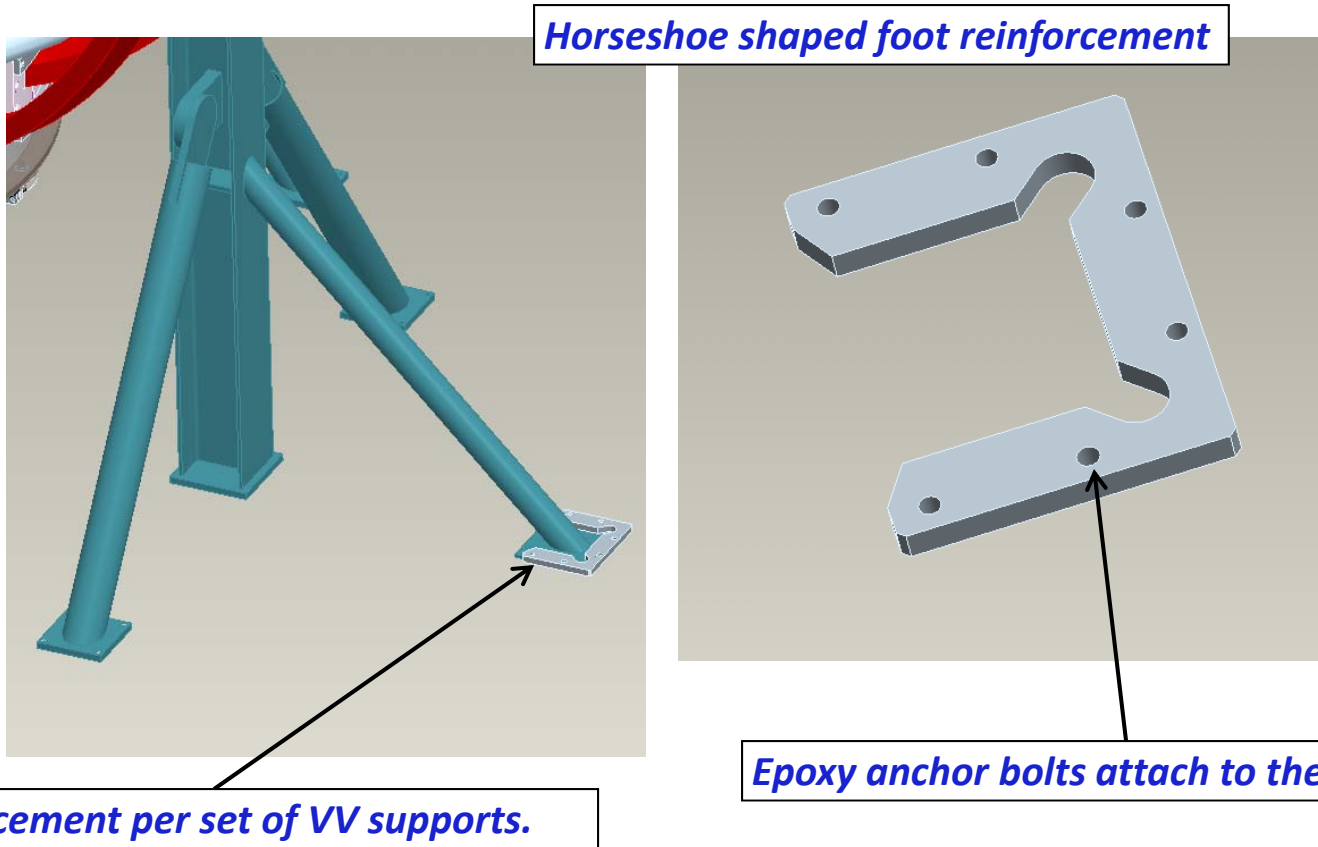
CHITs

- CHIT log line item 215: CHIT-07 PDR June 2010
 - TF Outer Leg Support Bolted Joint:
 - Are dielectric breaks (insulated joints) required?
 - No.
 - How is a shear load carried?
 - *Design has been modified to accommodate shear load.*
- CHIT is closed.

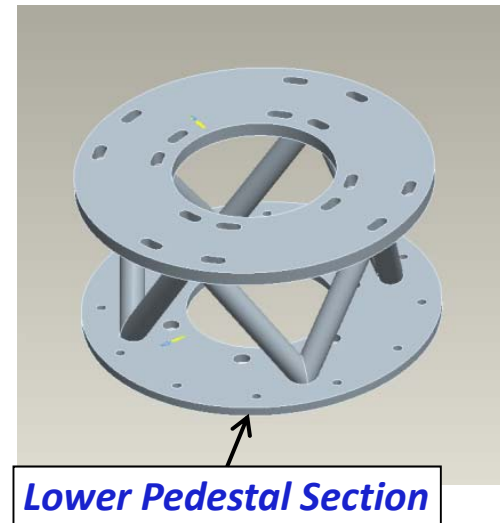
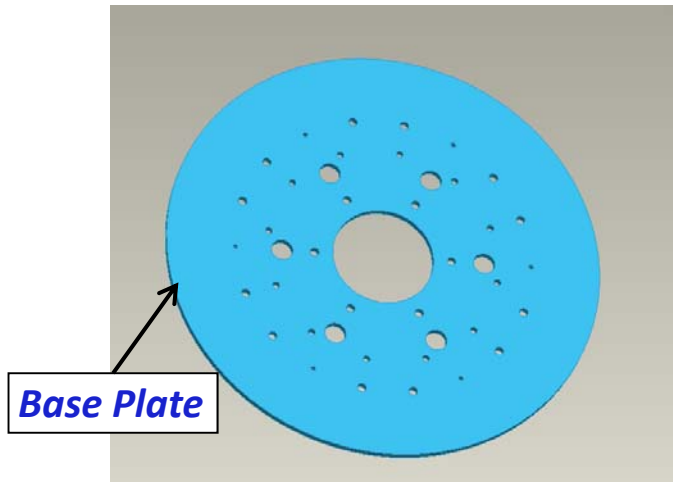
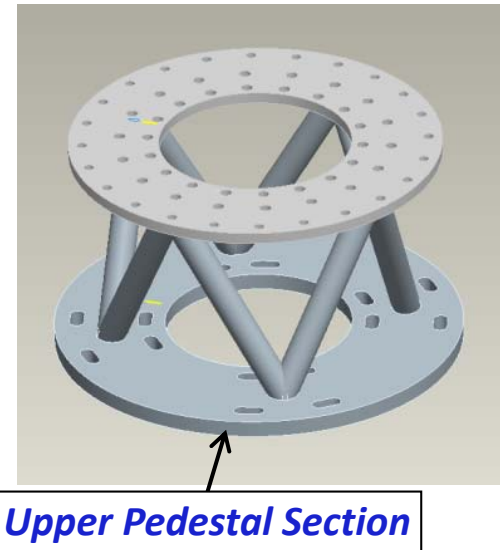
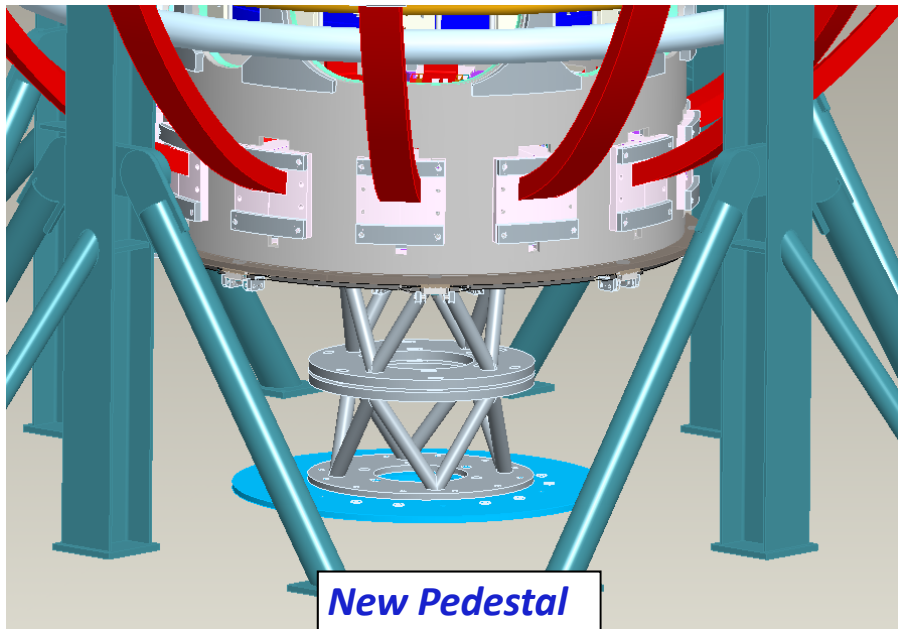
Design Overview



Vessel Leg Reinforcement



Pedestal Upgrade



Pedestal Upgrade

Design provides access / clearance for equipment.

Attachments for lower crown bolt plate and umbrella lower lid.

Bolt slots provide for alignment.

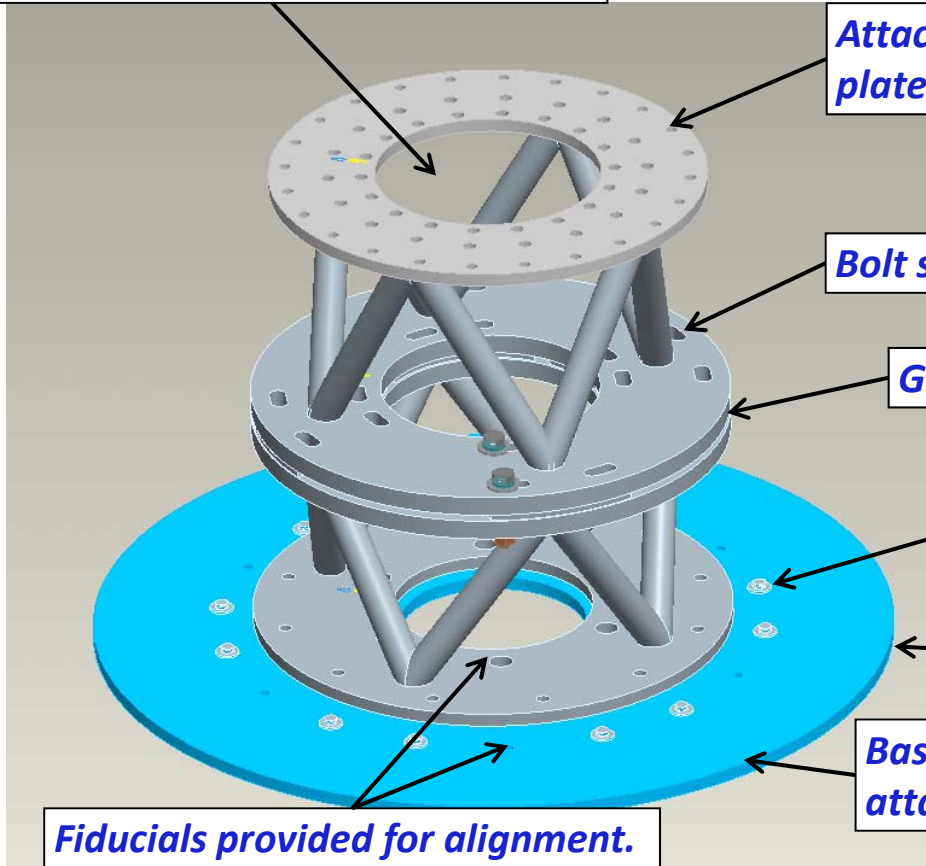
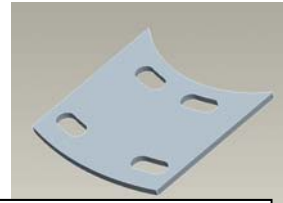
Gap allows for height adjustment via shims.

Epoxy anchor bolts attach to the concrete.

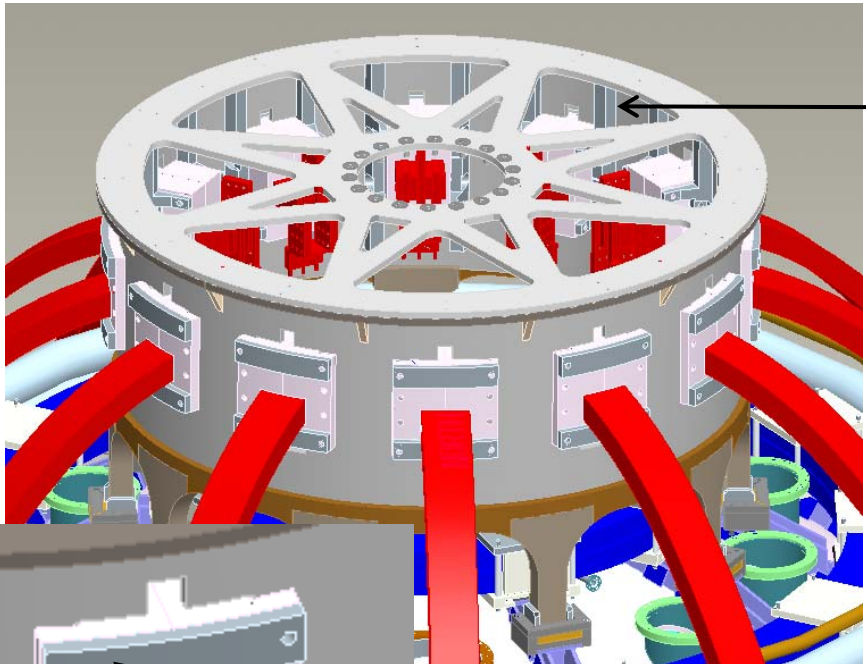
Grouted base allows for leveling.

Base Plate distributes load and provides attachment point for equipment.

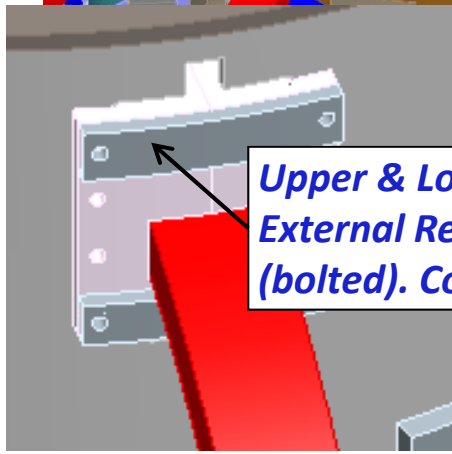
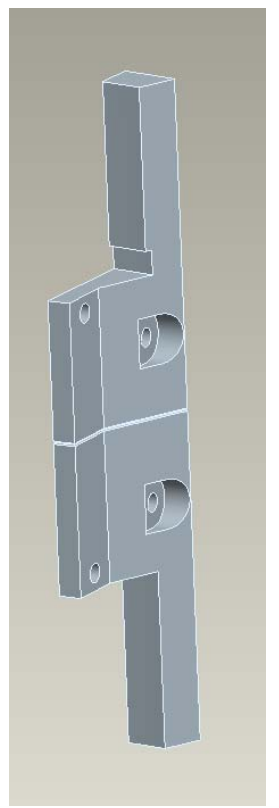
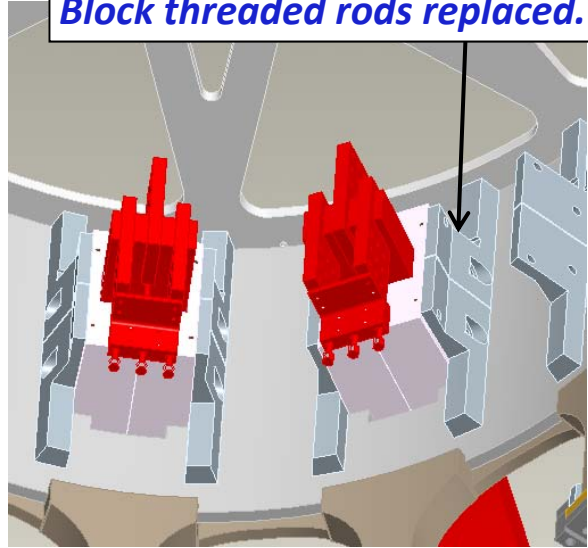
Fiducials provided for alignment.



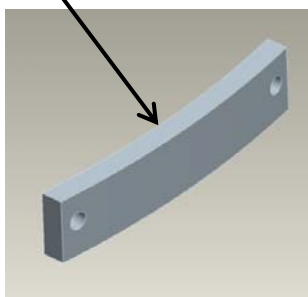
Umbrella Upgrades



*Upper & Lower Umbrellas
Internal Reinforcement adjacent to AI Blocks
(2 part & welded).
Block threaded rods replaced.*

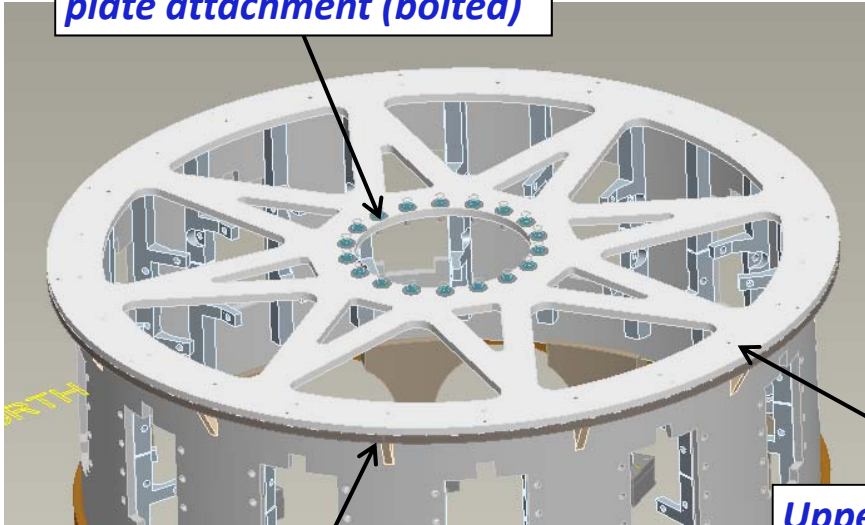


*Upper & Lower Umbrellas
External Reinforcement on AI Blocks
(bolted). Corner bolts replaced.*

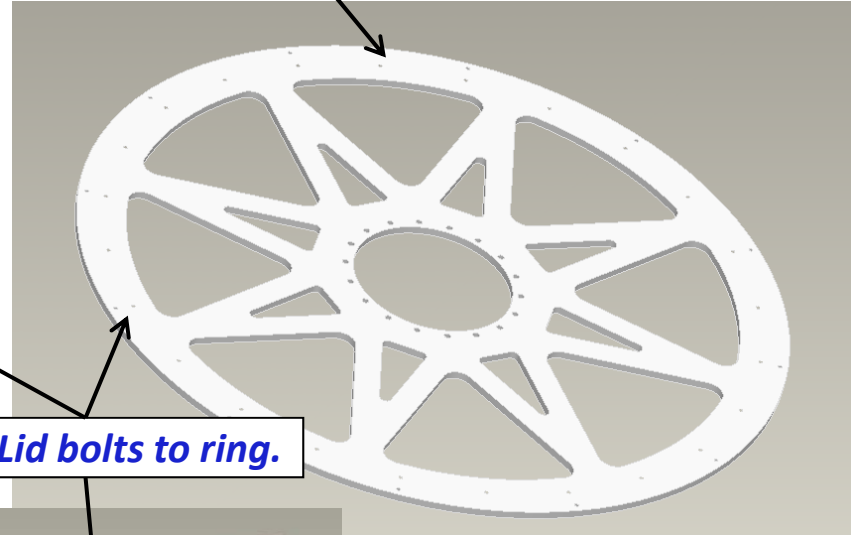


Umbrella Upgrades

Upper lid and crown bolt plate attachment (bolted)

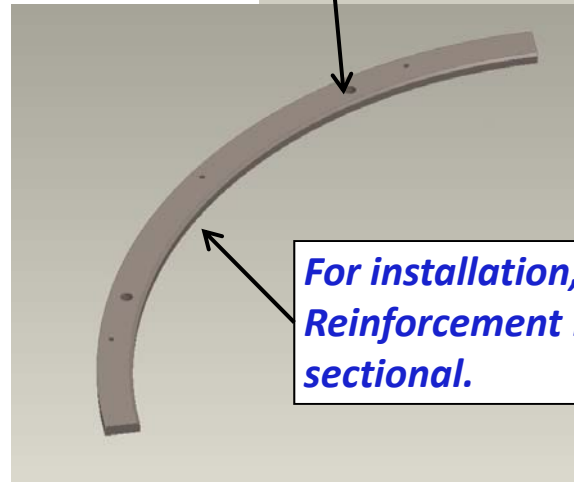


New Upper Lid (1 water jet part)



Upper Lid bolts to ring.

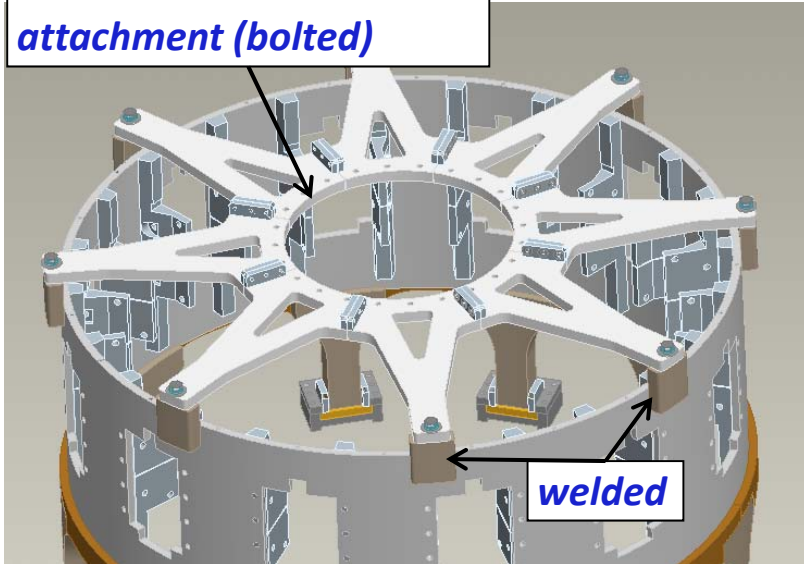
Upper Lid Reinforcement Ring and Gussets (welded)



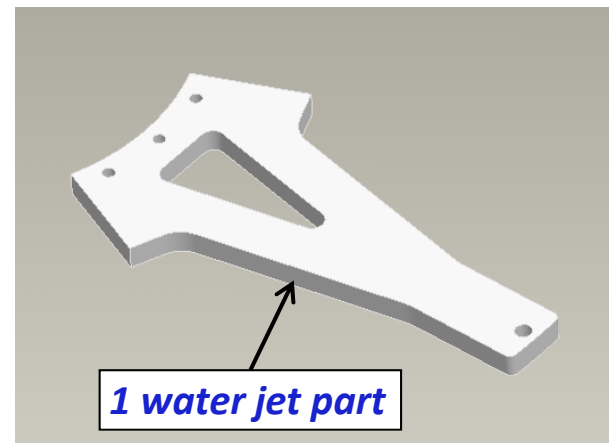
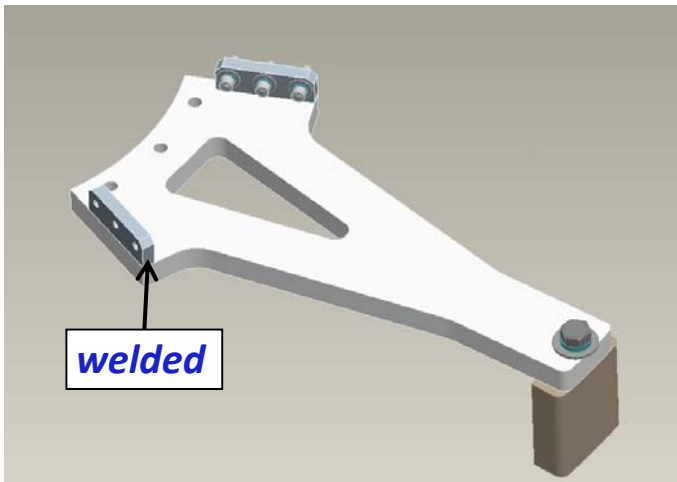
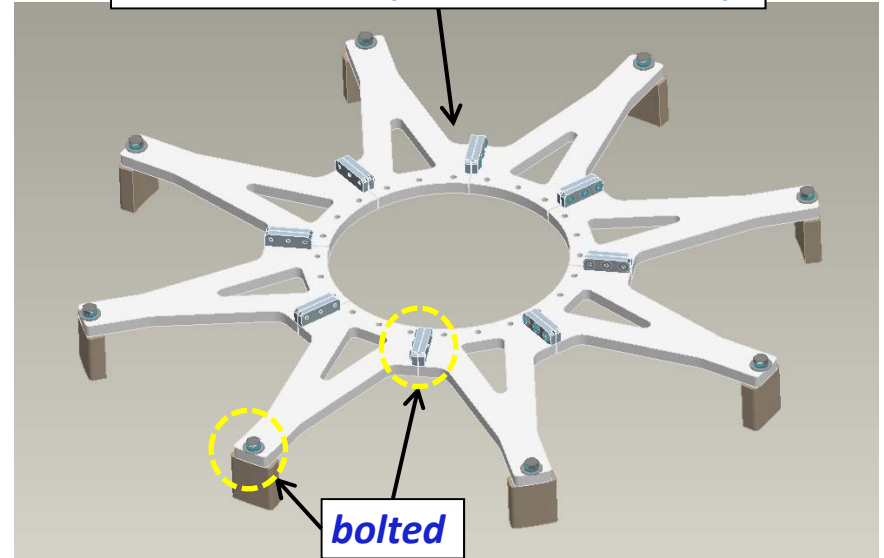
For installation, Upper Lid Reinforcement Ring is sectional.

Umbrella Upgrades

Lower lid and Pedestal attachment (bolted)

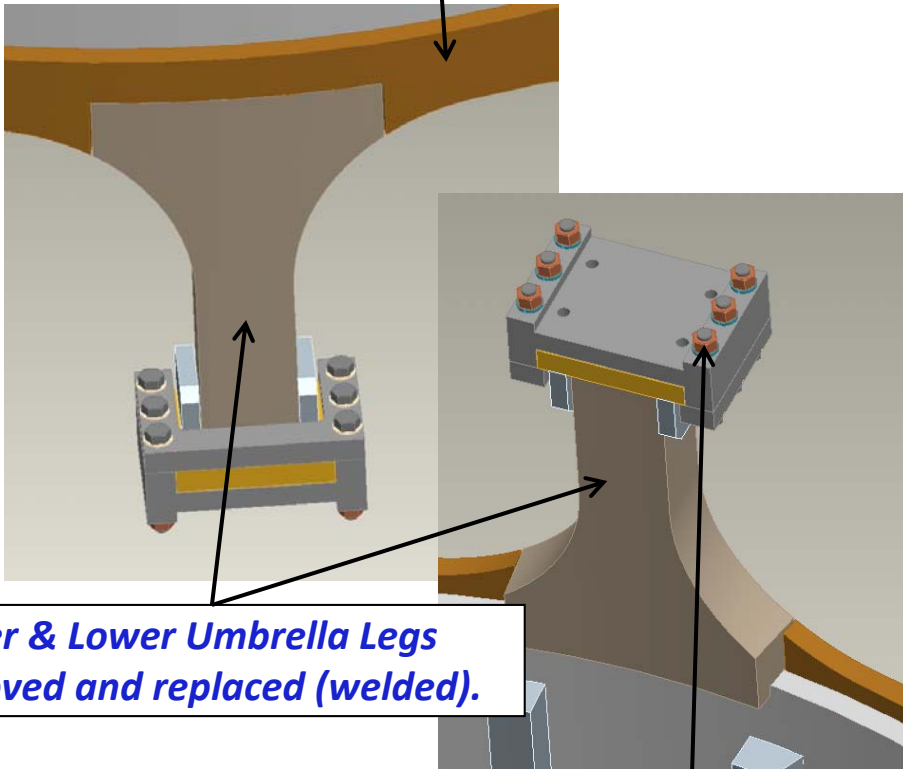


New Lower Lid (sectional & bolted)



Umbrella Upgrades

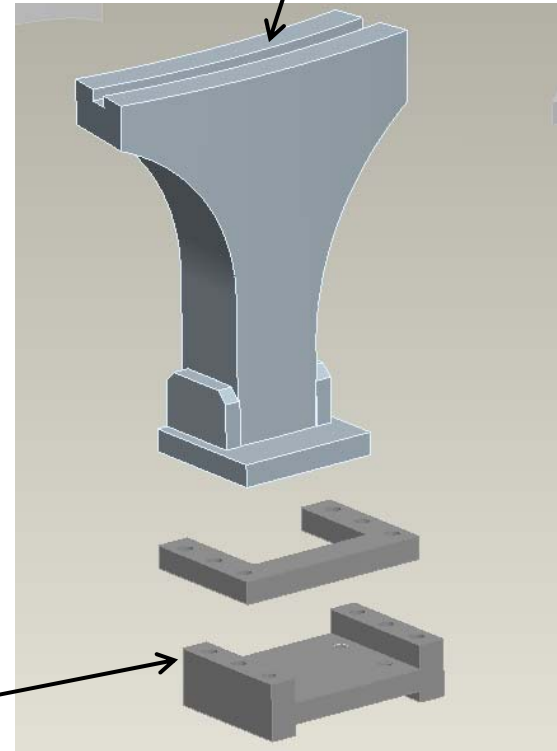
Arch Reinforcement Ring (sectional & welded)



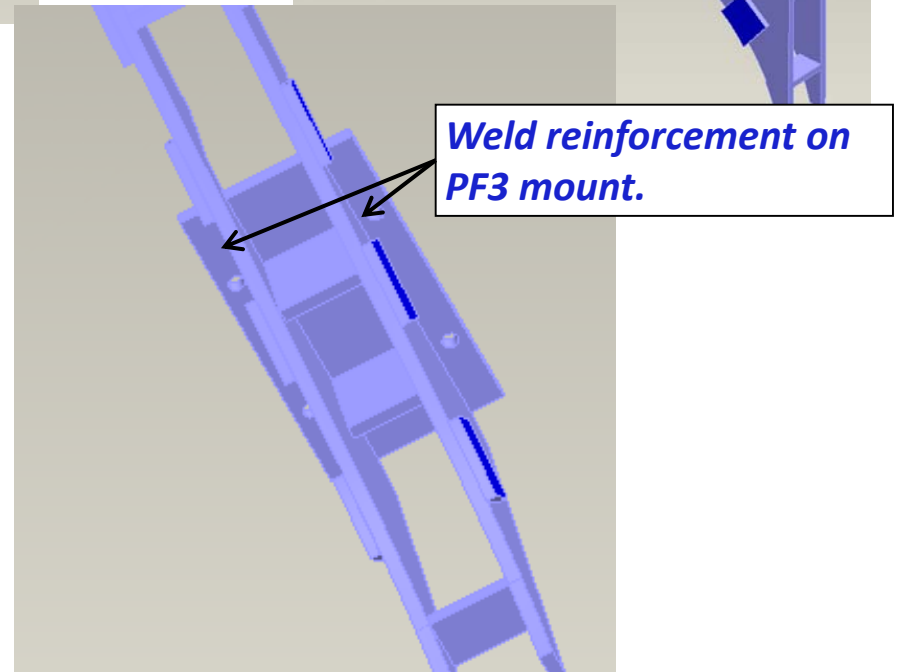
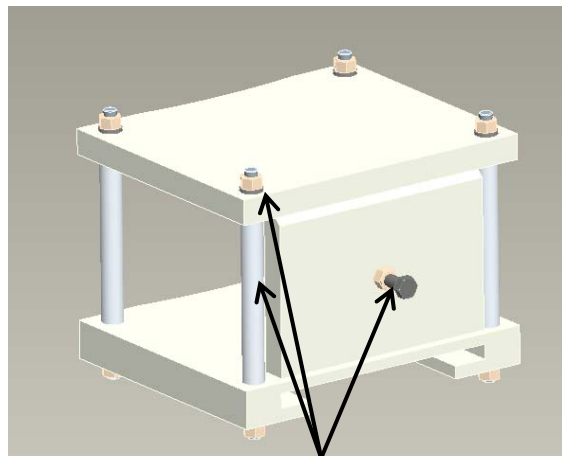
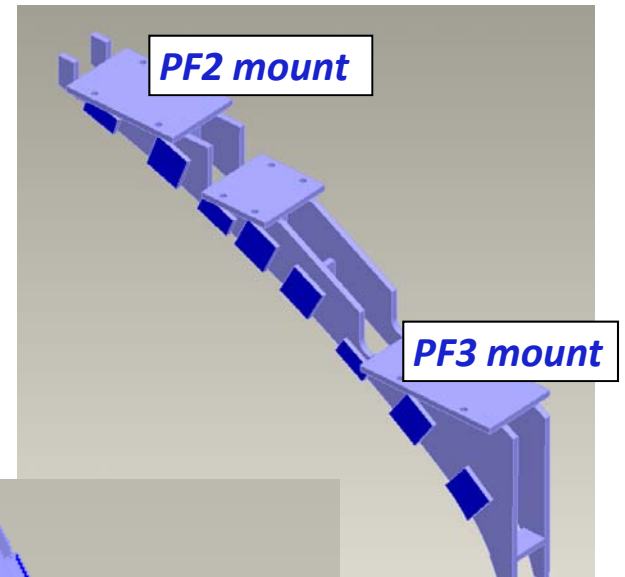
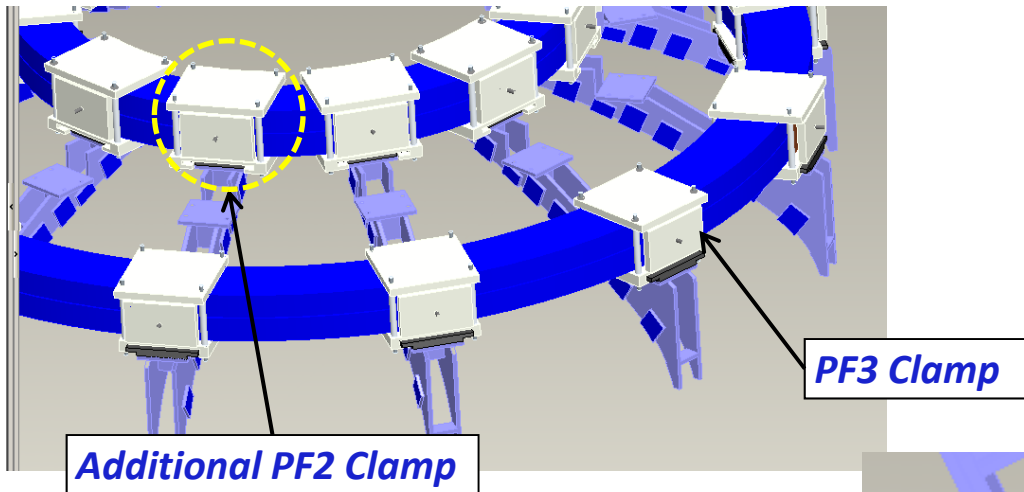
Upper & Lower Umbrella Legs removed and replaced (welded).

Replace foot hardware, capture and slide with Inconel parts.

Replacement Leg (1 machined part)



PF2/3 Support Upgrades



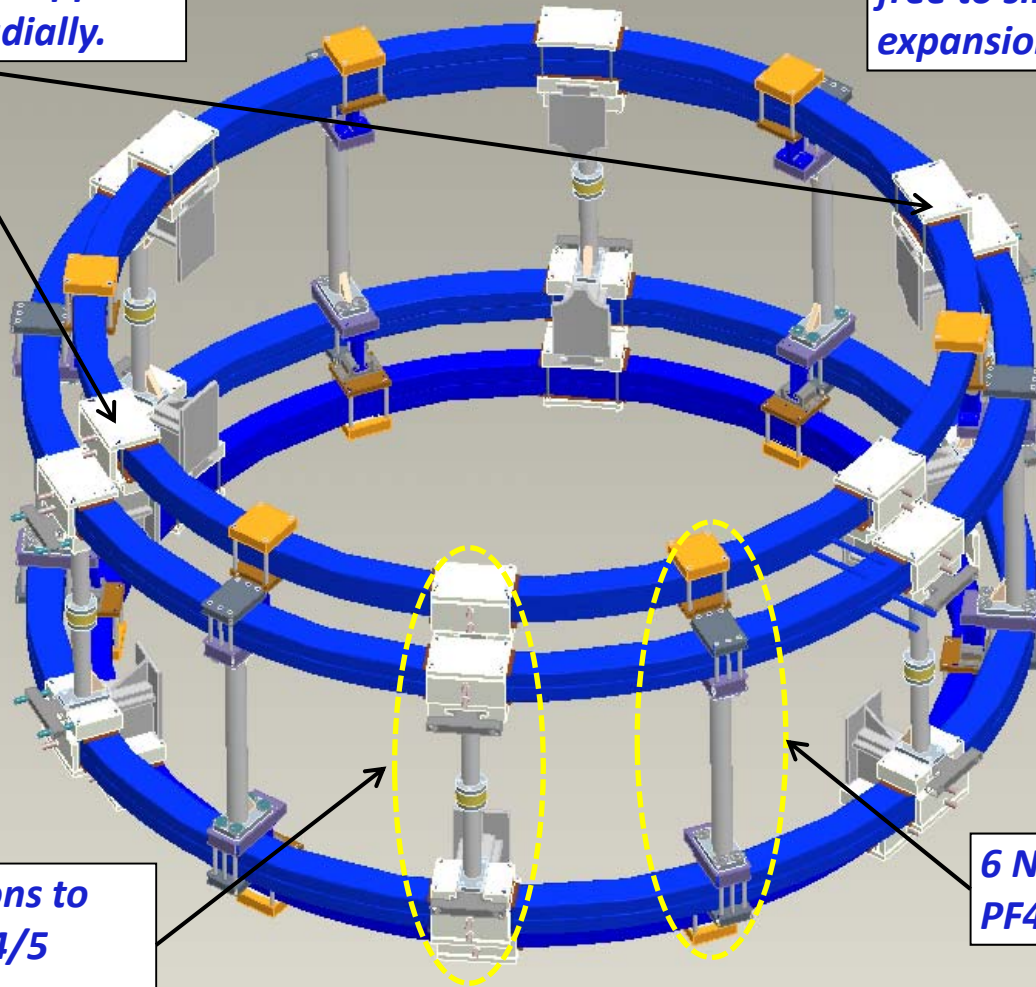
PF4/5 Support Upgrades

2 of 6 existing PF4/5 supports (180° apart) fixed radially.

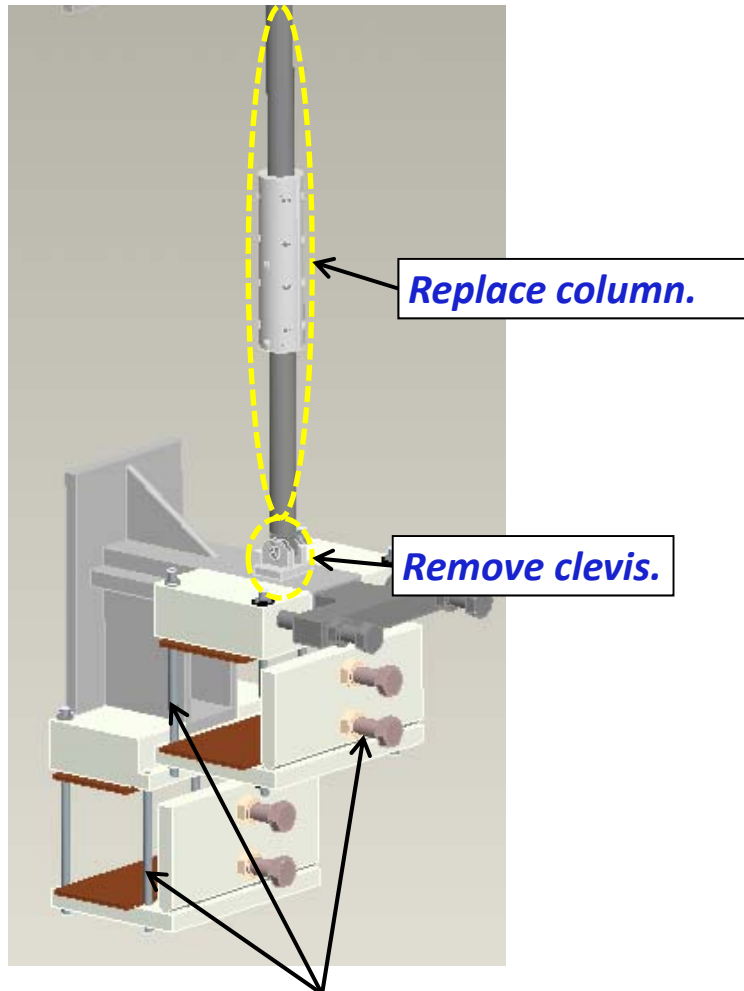
4 of 6 existing PF4/5 supports free to slide radially for thermal expansion.

Modifications to existing PF4/5 supports.

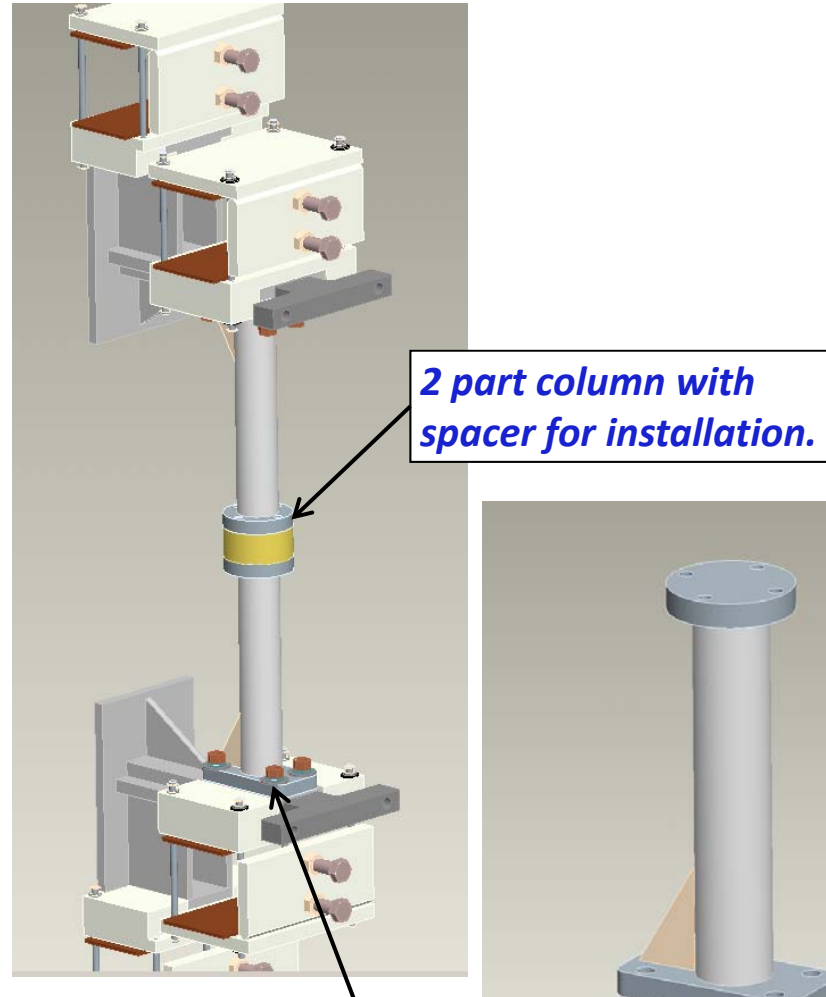
6 New (additional) PF4/5 Supports



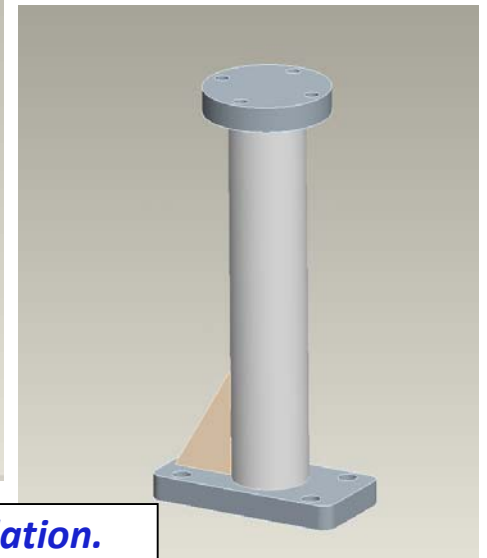
PF4/5 Support Upgrades



Replace hardware with ASTM A193 B8M Class2 Material.

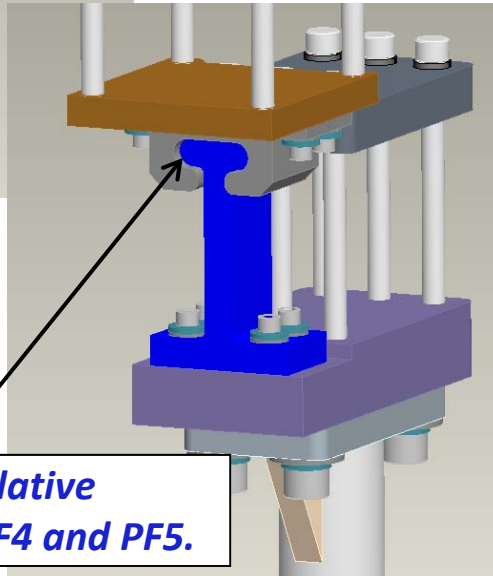
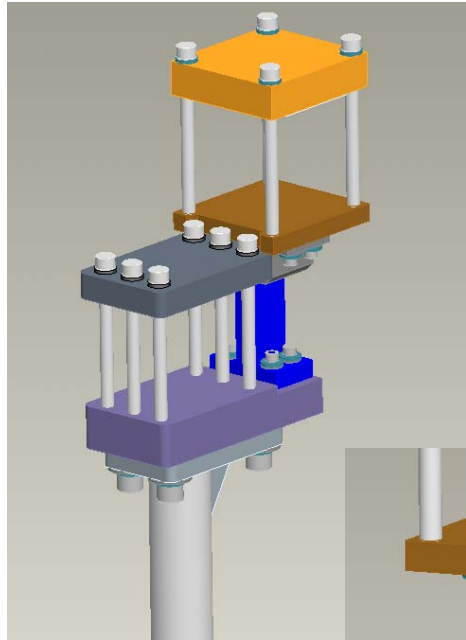
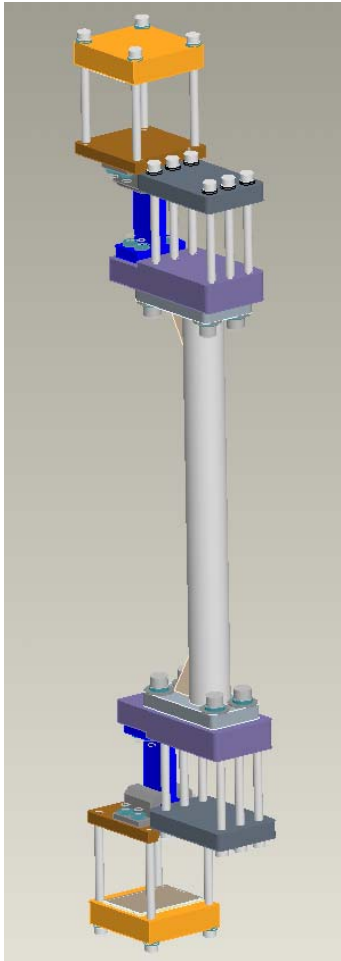


Studs used for installation.

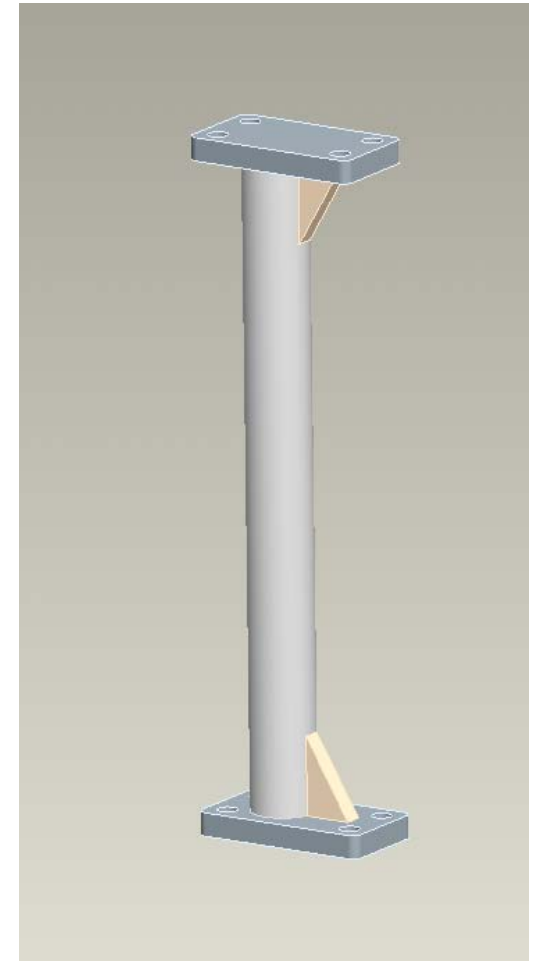


PF4/5 Support Upgrades

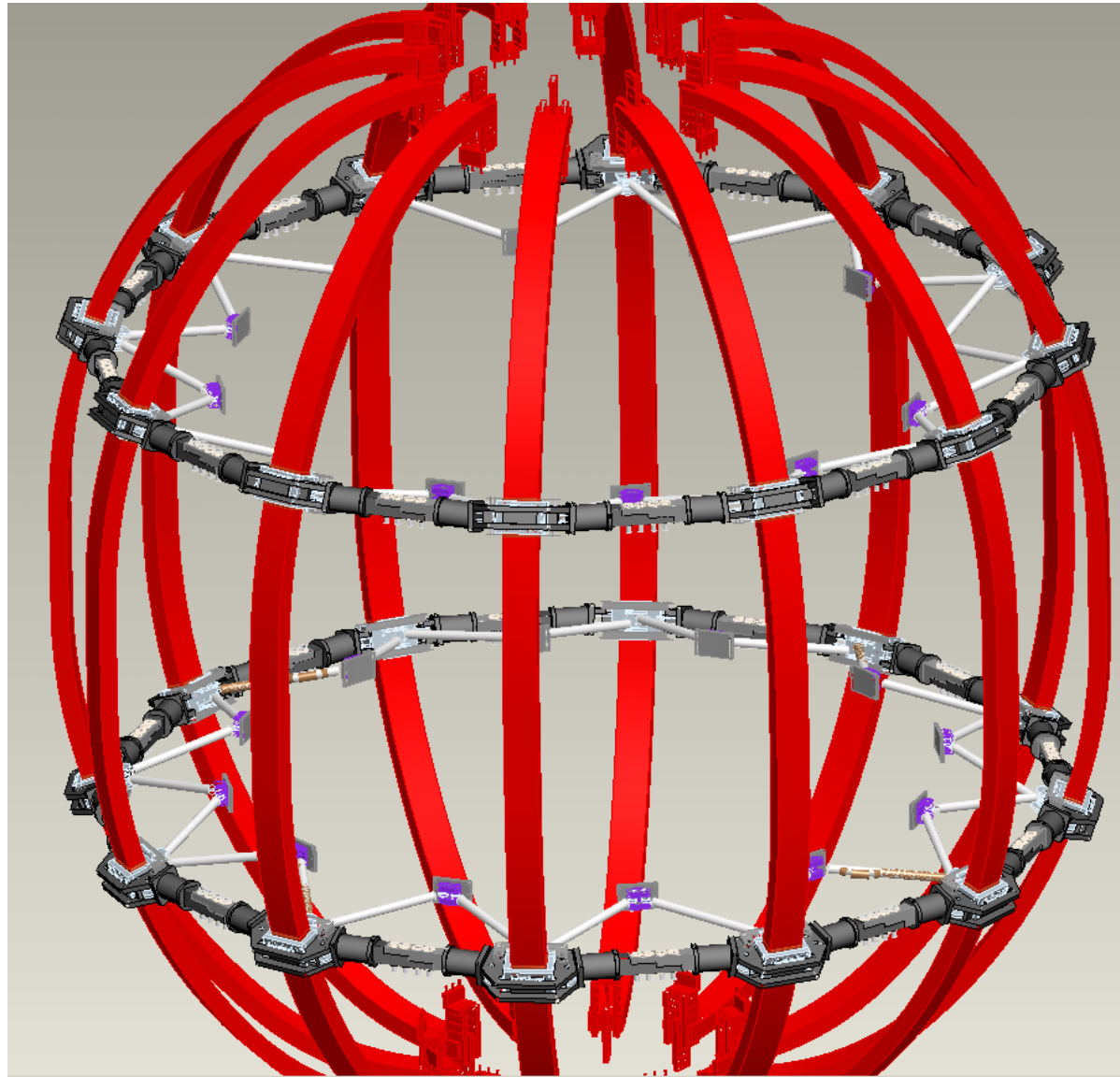
New (additional) PF4/5 Support



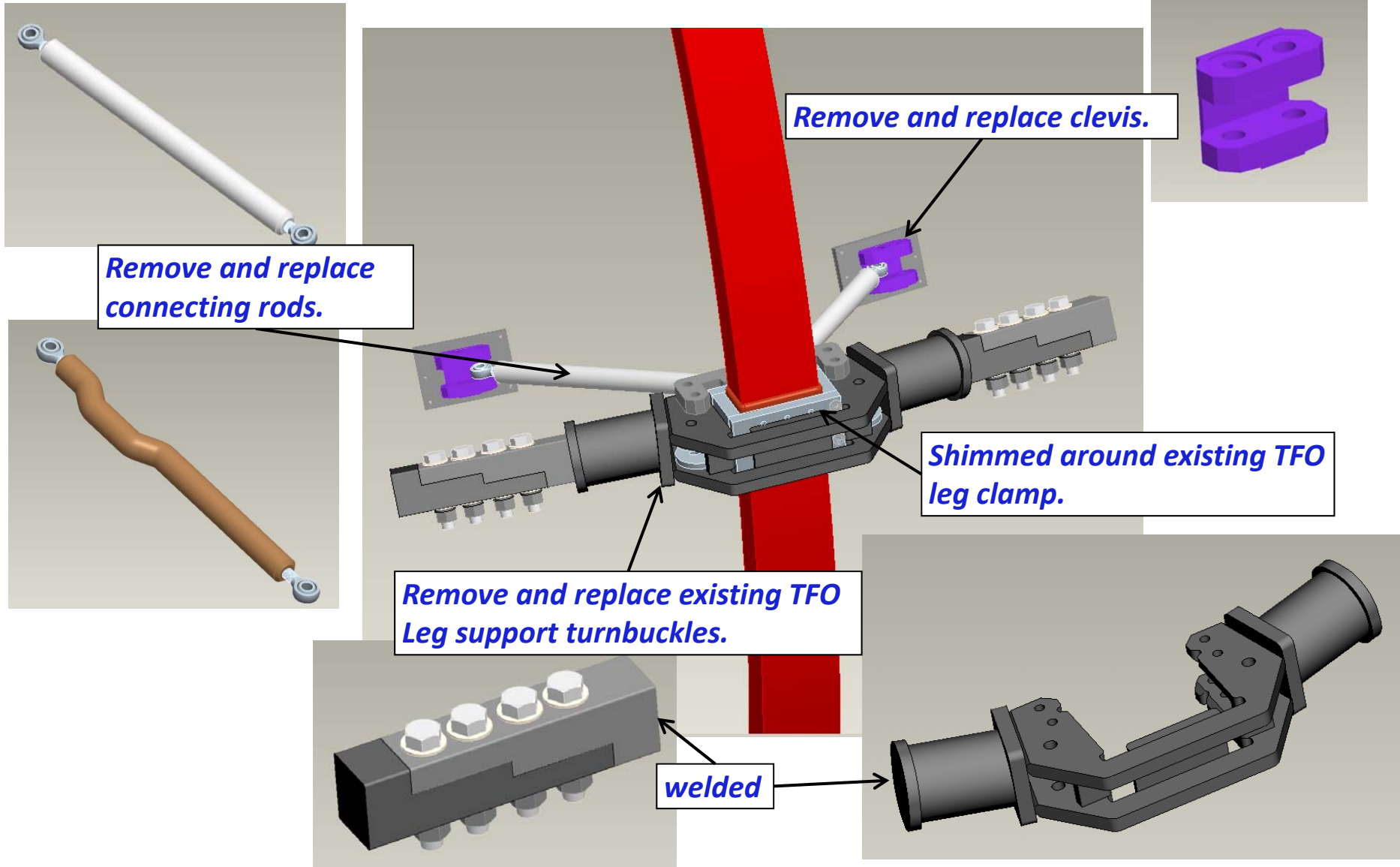
T-slot allows for relative motion between PF4 and PF5.



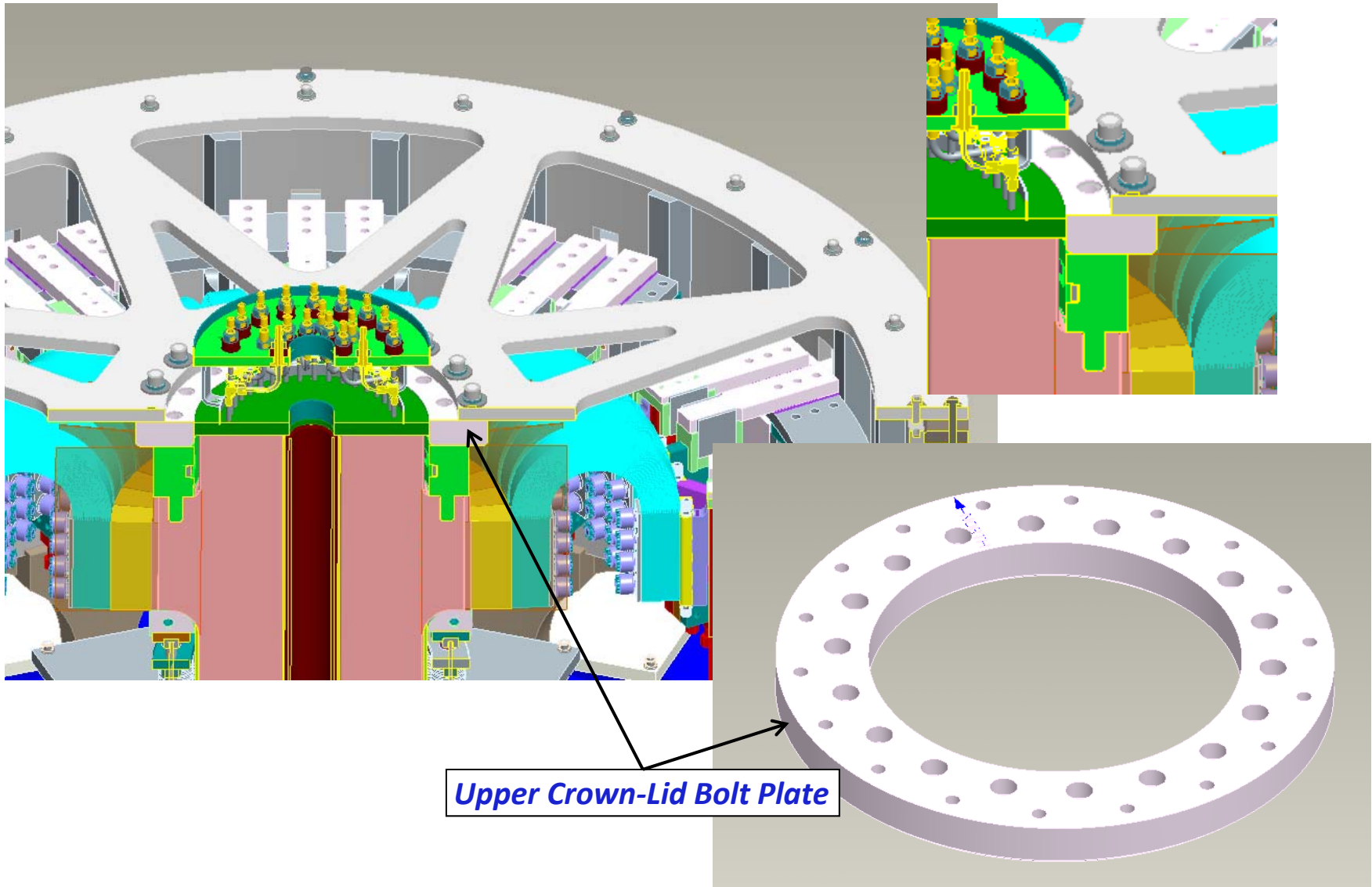
TF Outer Leg Support Upgrades



TF Outer Leg Support Upgrades

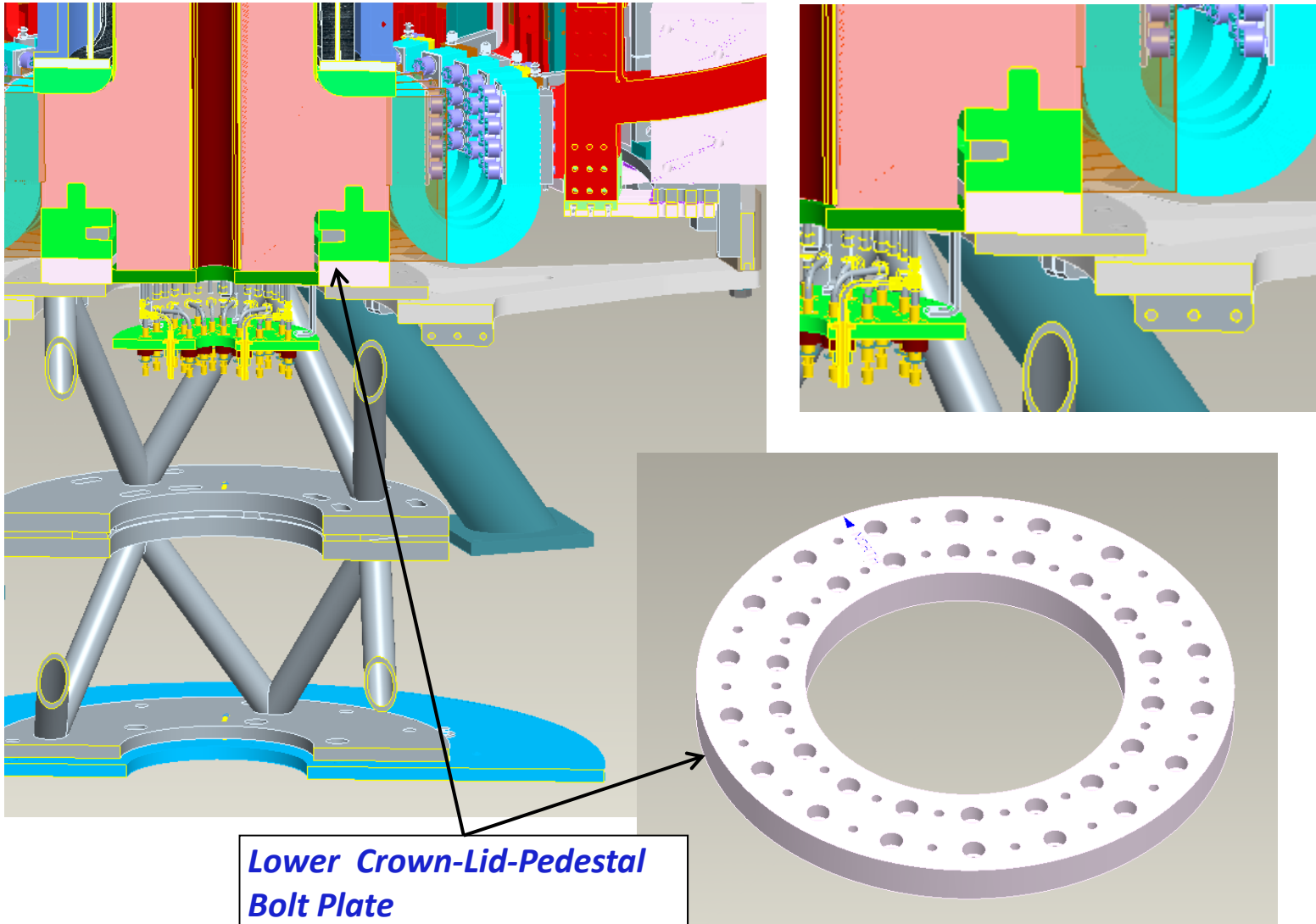


Interconnections



Upper Crown-Lid Bolt Plate

Interconnections



Cost & Schedule

- ETC updated for FDR effort and M&S.
 - Additional EAEM man-hours required: \approx 830 man-hours.
 - Assembly and detailed drawings mostly completed.
 - Design finalization pending calculation completion.
 - M&S reduced \approx \$200k.
 - This requires validation.
- Will need to update ETC upon completion of the calculations.

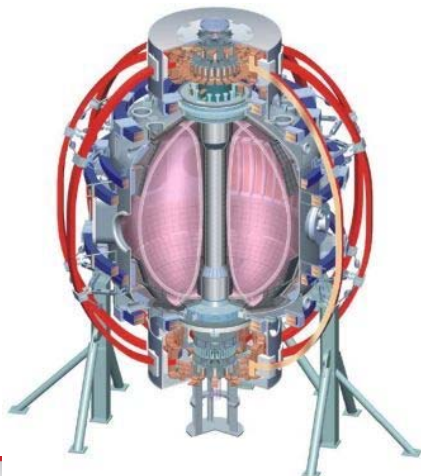
Open Items

- Anchor spacing & Concrete Loading
- Pedestal bolted details.
- Lower Lid Assembly bolted details.
- Upper/Lower Lid to Crown Bolt Plate details.
- PF4/5 New Support FEA details.
- TFO Leg Weldment bolted details.
- ETC Cost & Schedule.

Bus Bars & Supports WBS 1.5.5

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Outline

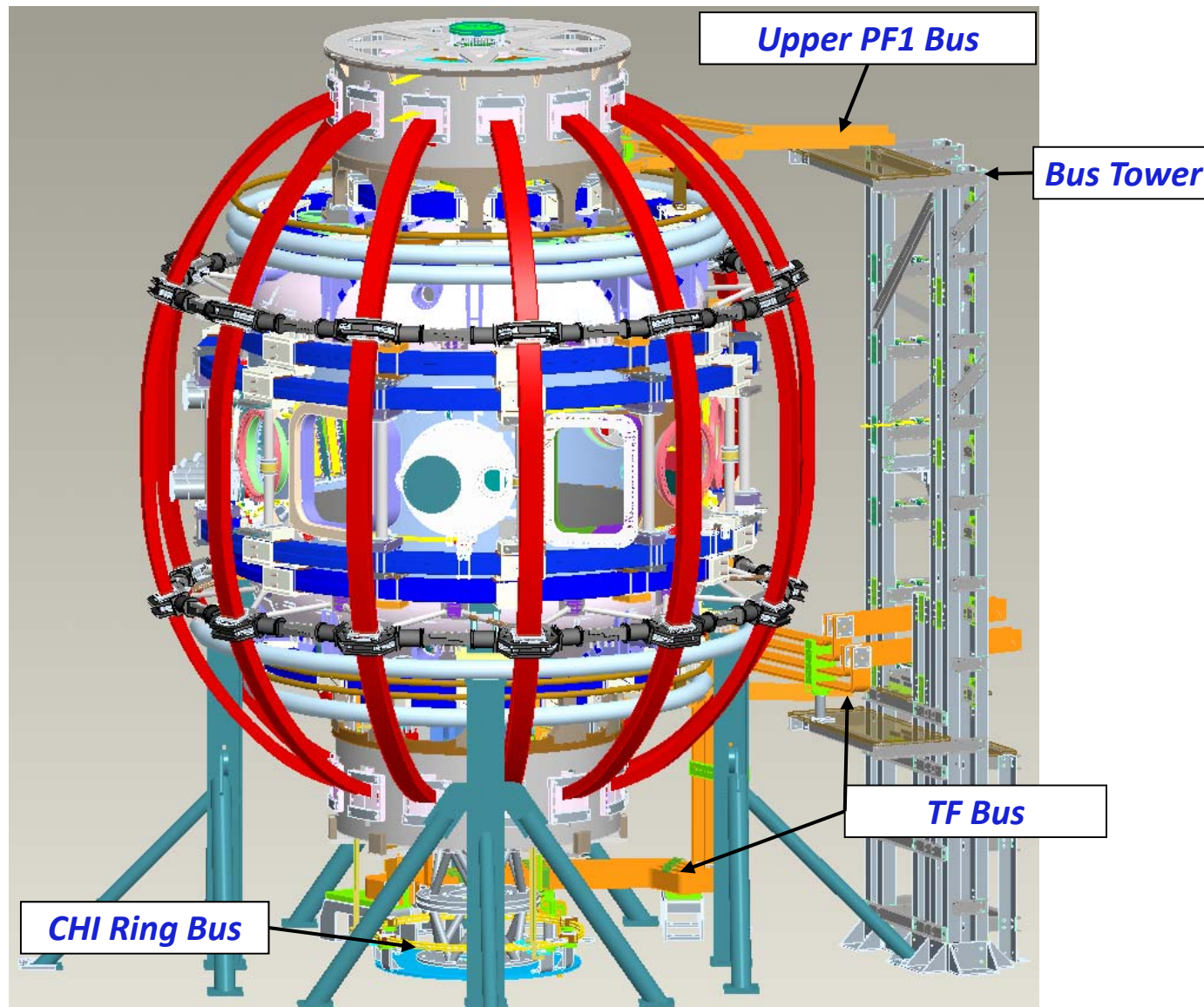
- Charge Questions & CHITs
- Installation Layout
- CHI Ring Bus
- PF 1a, b, c Bus
- OH Coaxial Bus
- TF Bus
- Cost & Schedule

Charge Questions & CHITs

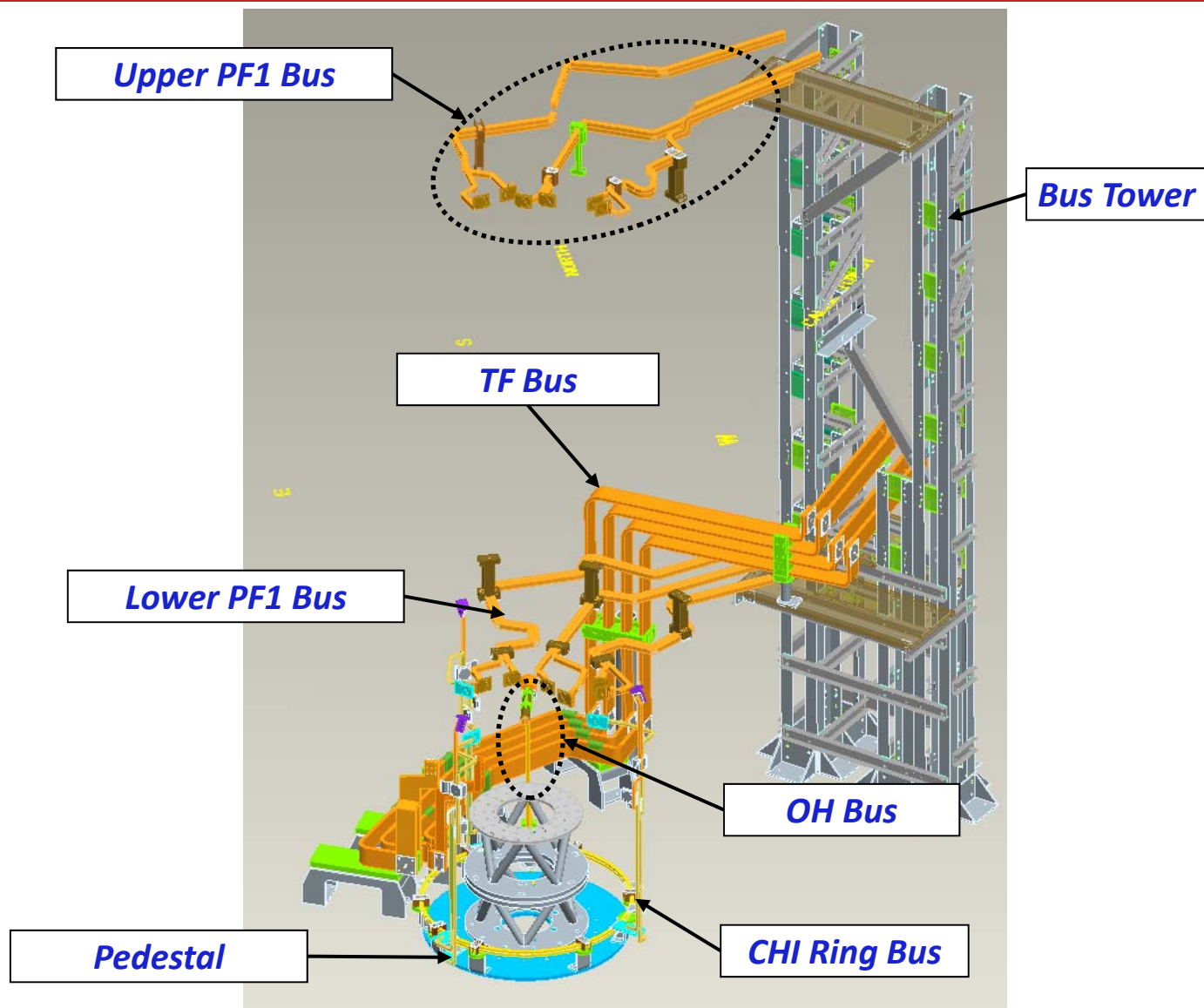
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- Does the final design meet the GRD?
- Does the FDR satisfy PPPL Procedure ENG-033 Design Verification?
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 - Attachment 6: Human Performance Improvement/Factors Considerations.
- Have the CHITS & previous recommendations been addressed?
- Have risks been appropriately identified and mitigated?
- Are the cost and schedule estimates updated and reasonable?

- There are no open CHITs.

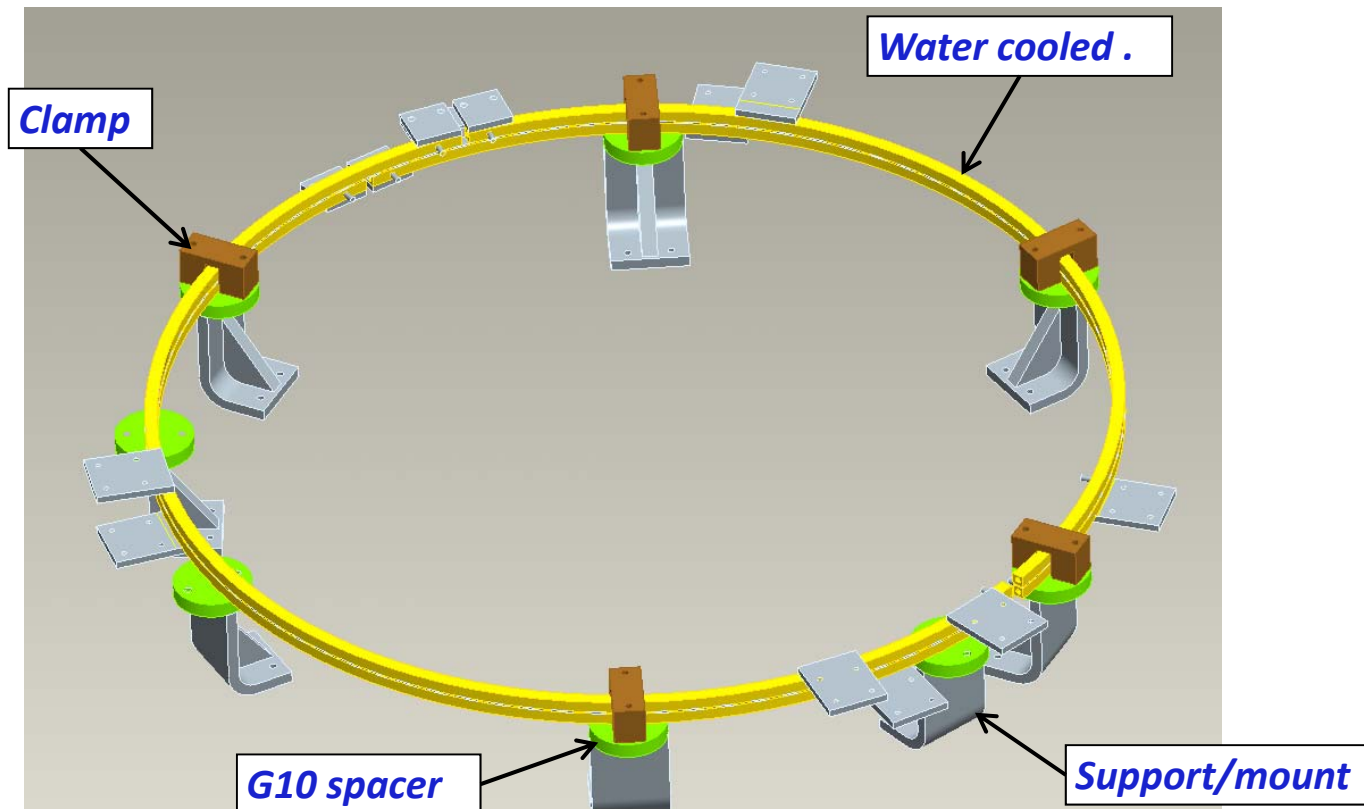
Installation Layout



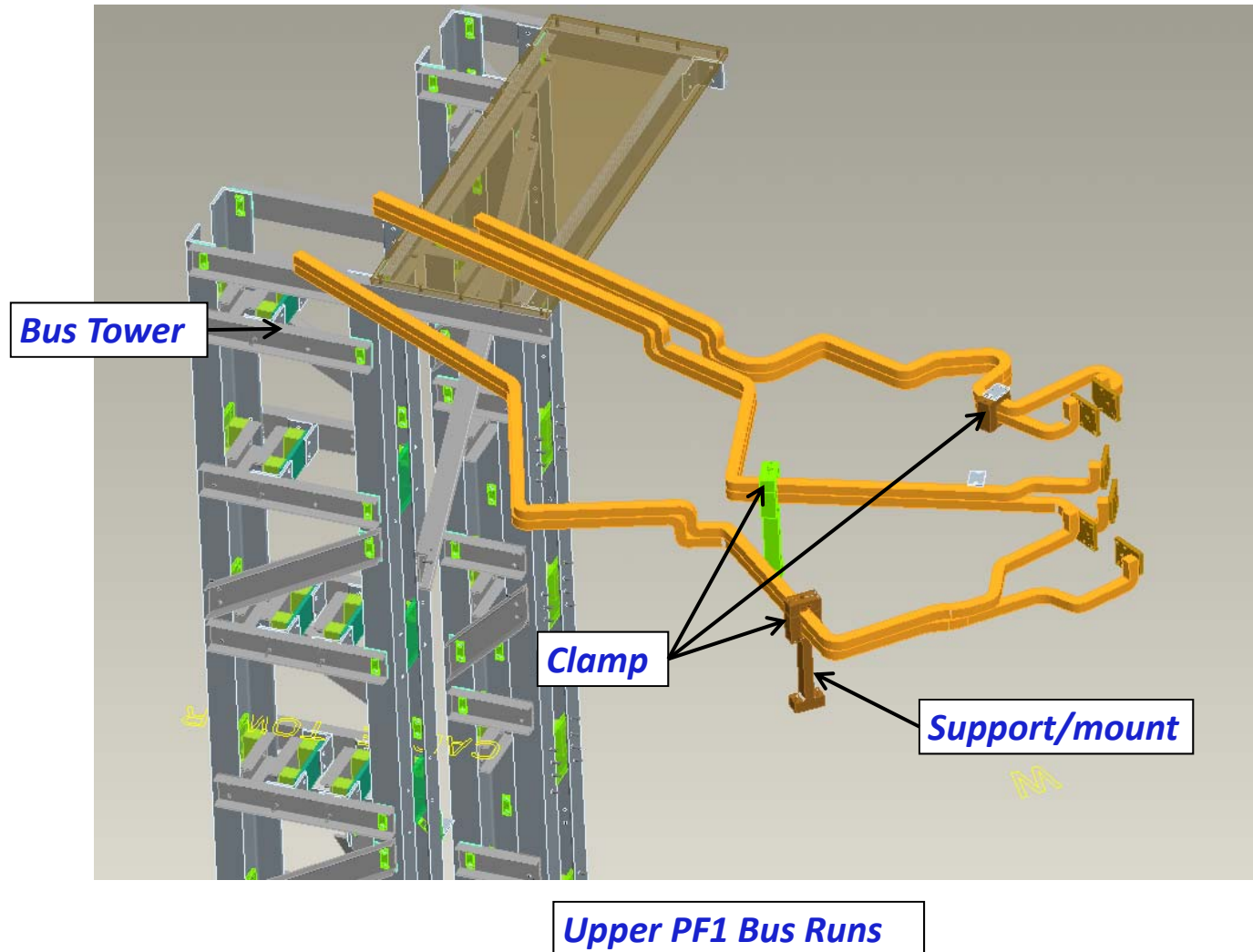
Installation Layout



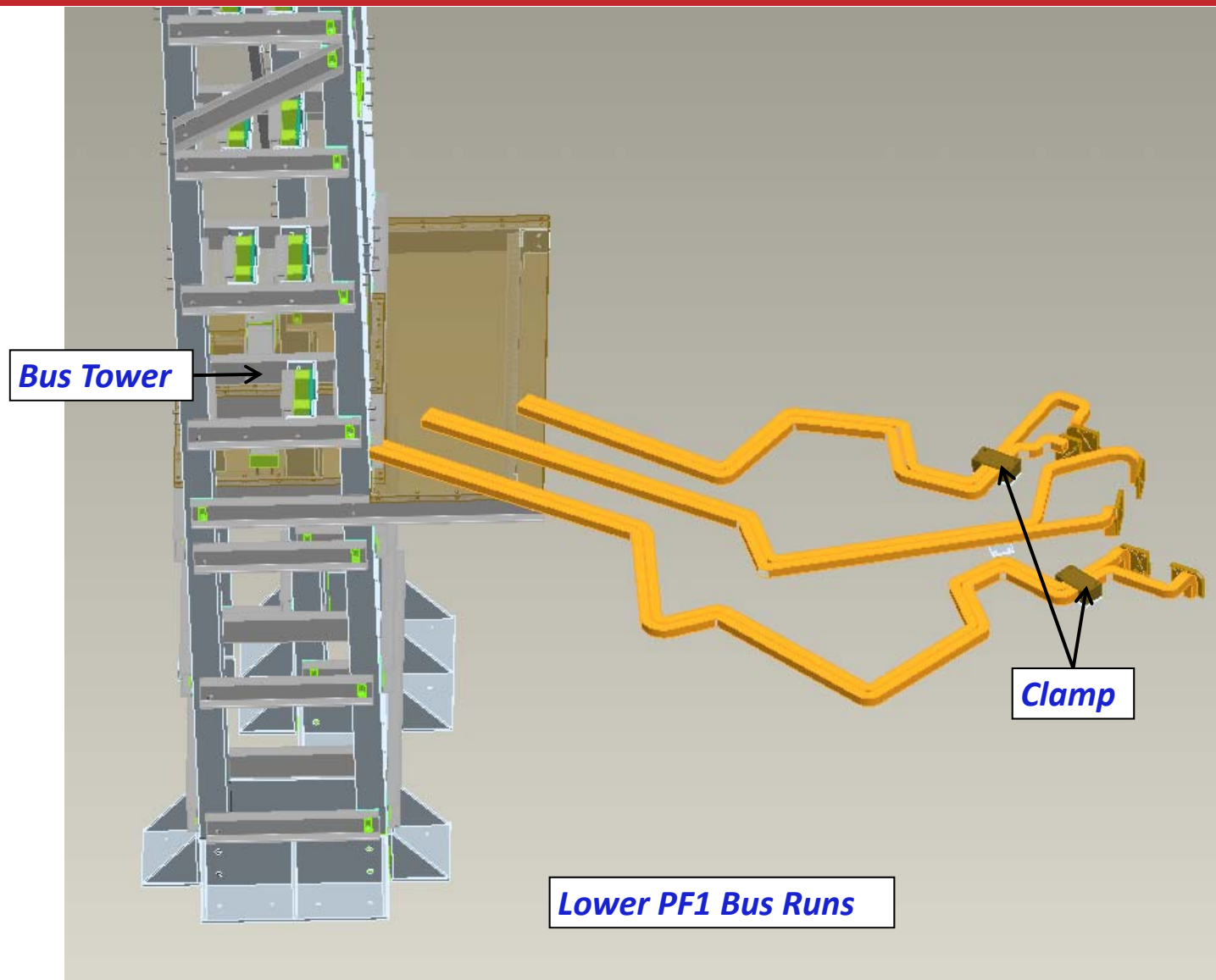
CHI Ring Bus



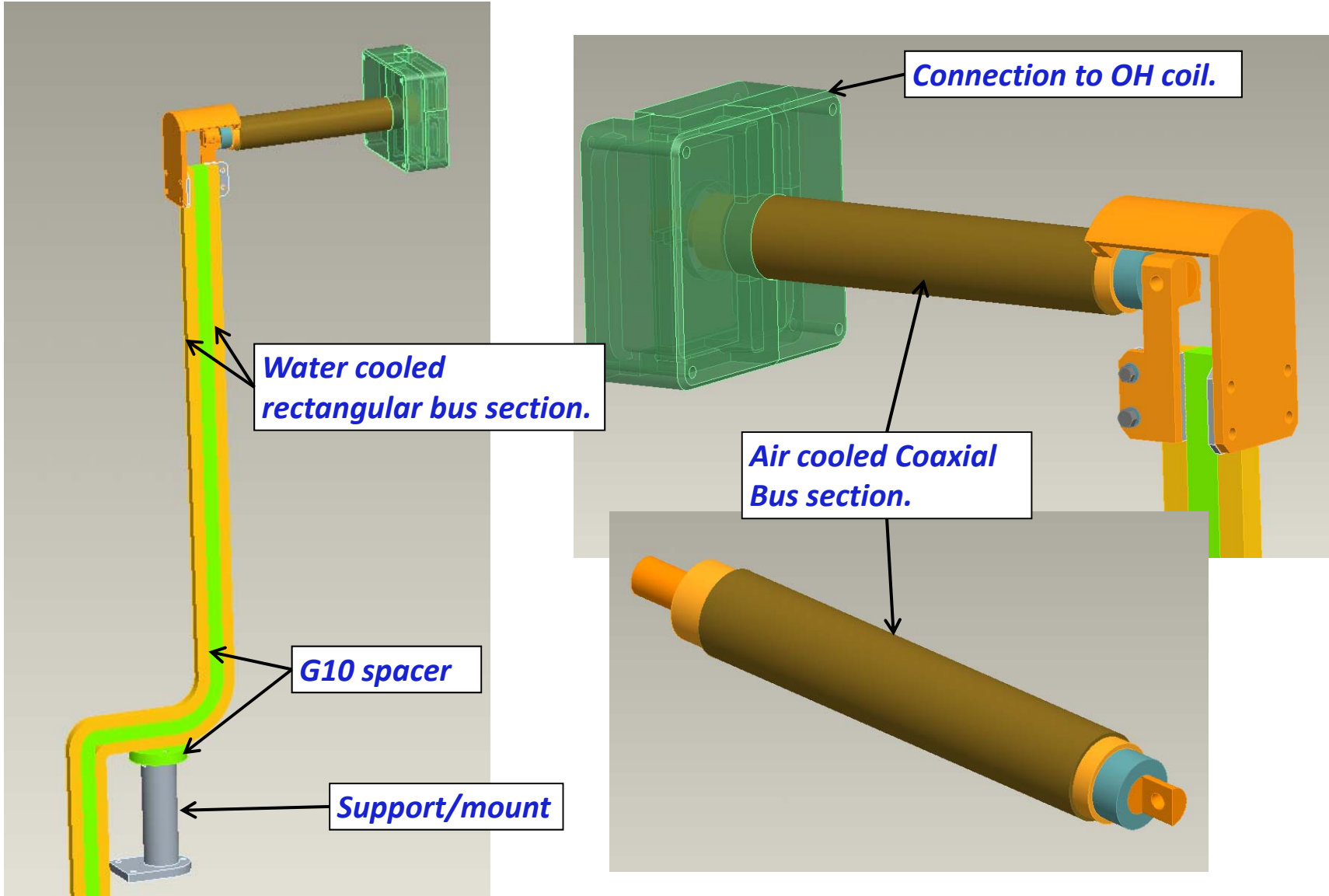
PF 1a, b, c Bus



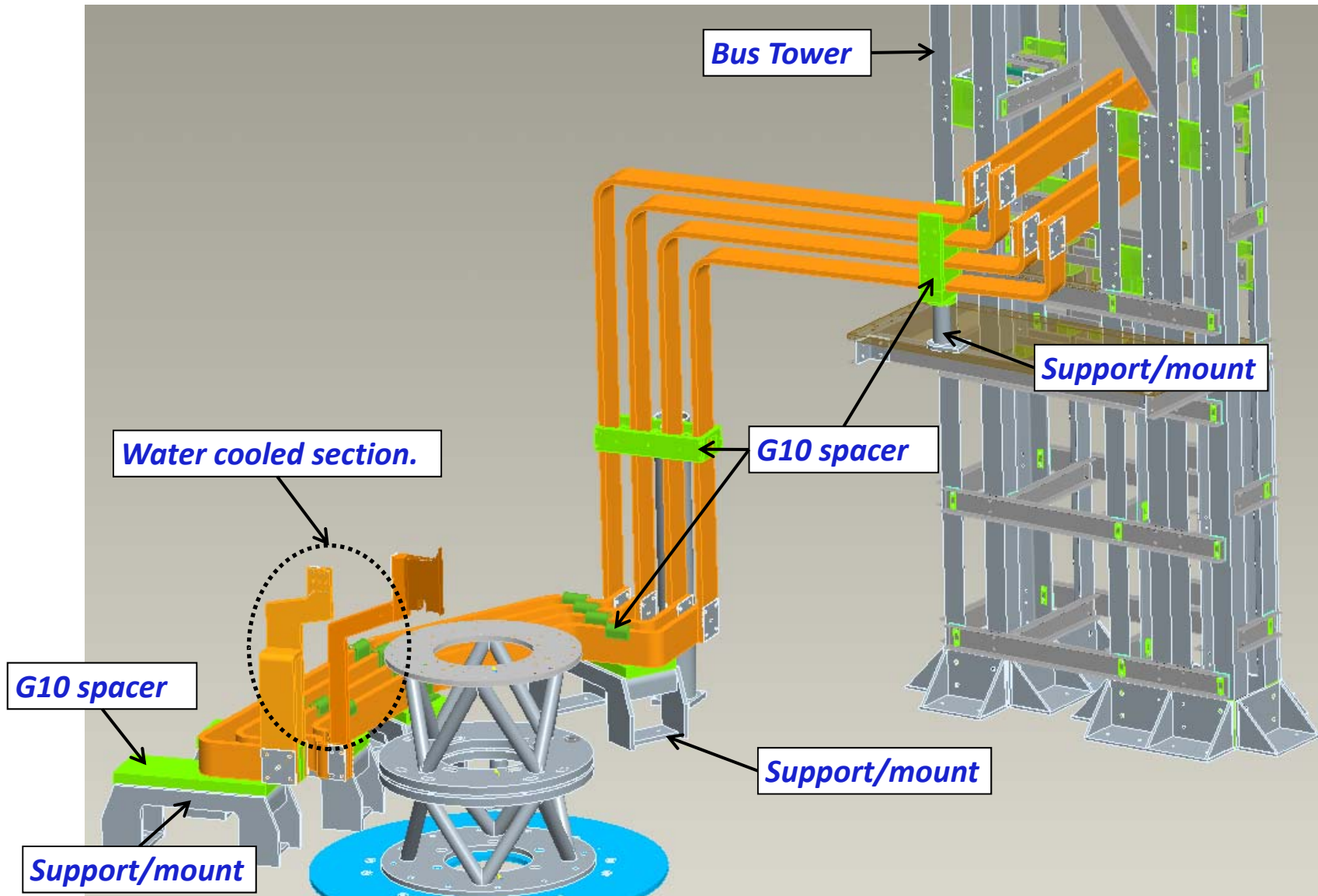
PF 1a, b, c Bus



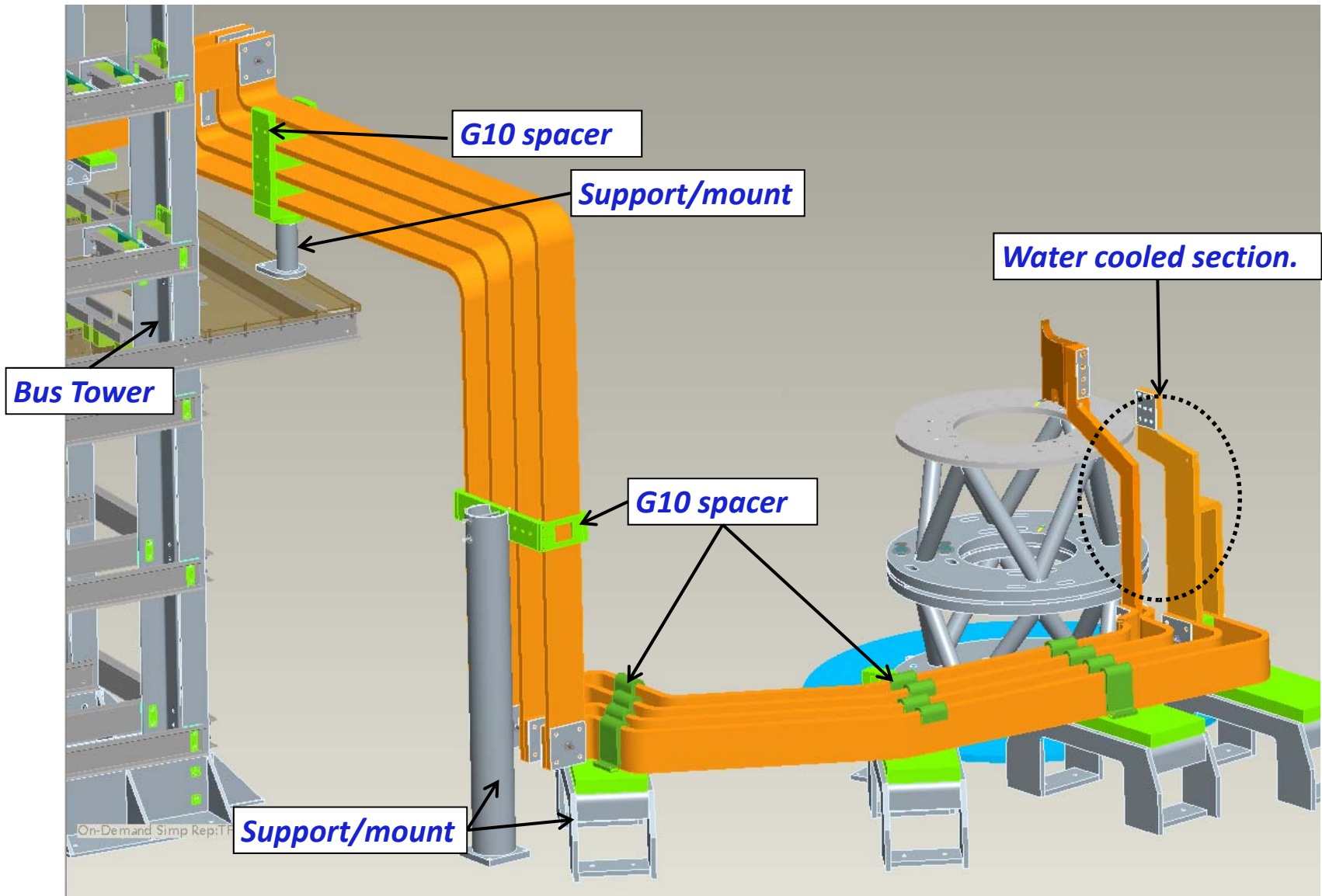
OH Coaxial Bus



TF Bus



TF Bus



Cost & Schedule

- ETC required for FDR.
 - Note: Since bus runs are field fit, design is frozen until installation.
 - 1st pass analysis is completed.
 - Assembly and detailed drawings mostly completed.
 - Design modifications (per analysis) implemented prior to installation.
 - ETC to include designer man-hours.
 - ETC to include EMEM man-hours.
 - ETC to include additional EAEM (analysis) man-hours.