

FPA Station 5 PDR

March 11, 2008

Charge

- 1. Are the requirements well defined?**
- 2. Does the design meet the requirements?**
- 3. Do the drawings define the design adequately to be used as the sole basis for fabrication and acceptance of the support fixture?**
- 4. Does the analysis adequately underpin the design and have they been checked?**
- 5. Has safety been adequately addressed in the design of the support fixture?**
- 6. Can the support fixture be fabricated and installed within the budget and schedule identified in the project baseline?**
- 7. Have all relevant chits from previous design reviews been adequately addressed?**

Scope

This review covers the general arrangement of the Station 5 assembly, the Station 5 support fixture, the lift fixture for moving the finished Period, the port 4 installation fixture and a brief overview of the Station 5 assembly sequence.

Preliminary analysis of the supporting structure will also be covered.

Requirements

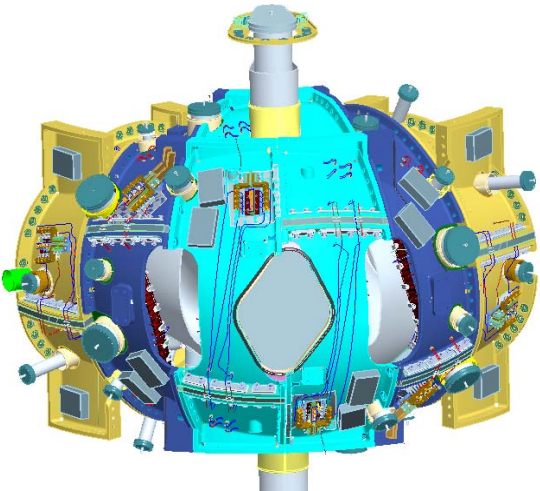
Support Fixtures

- Provide a stable support stand to perform the Period assembly steps call for in Station 5
- Provide the needed spatial access to allow the assembly of all Station 5 Period components.
- The support stand shall provide different support points to allow for the assembly of four TF coils.
- The support stand shall provide the ability to transfer the support from the MC surface to the final support points off the lower TF coil mounting structure.
- A separate fixture is required for Port 4 installation
- VV platform required for in-vessel installation activities

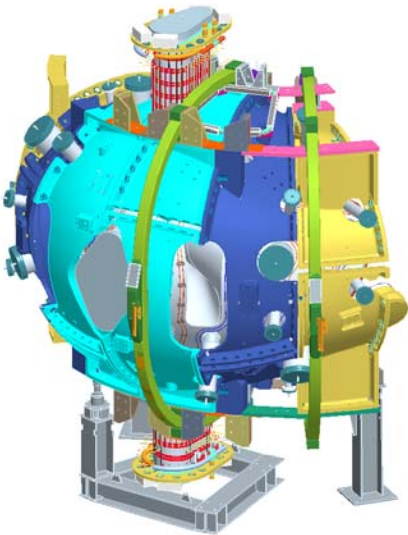
Lift Fixture

- A lift fixture shall be sized to support a completed Station 6 Period assembly weight (40 ton current estimate).
- The lift fixture shall accommodate a non precise location of the Period CG.

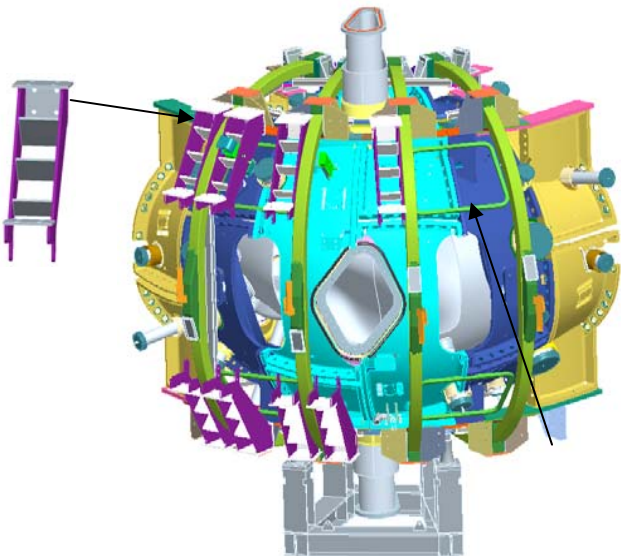
Station 5 assembly sequence overview



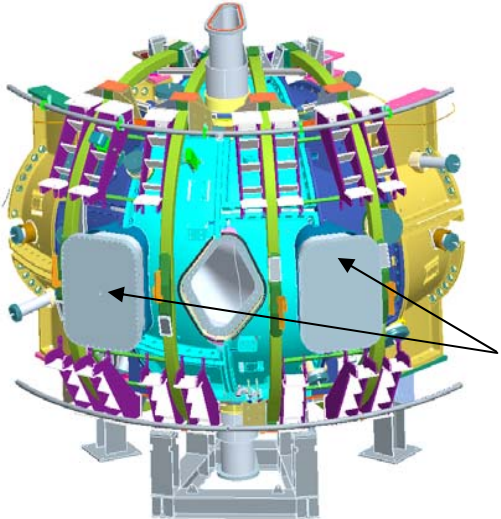
Port / boot seal assembly



TF assembly



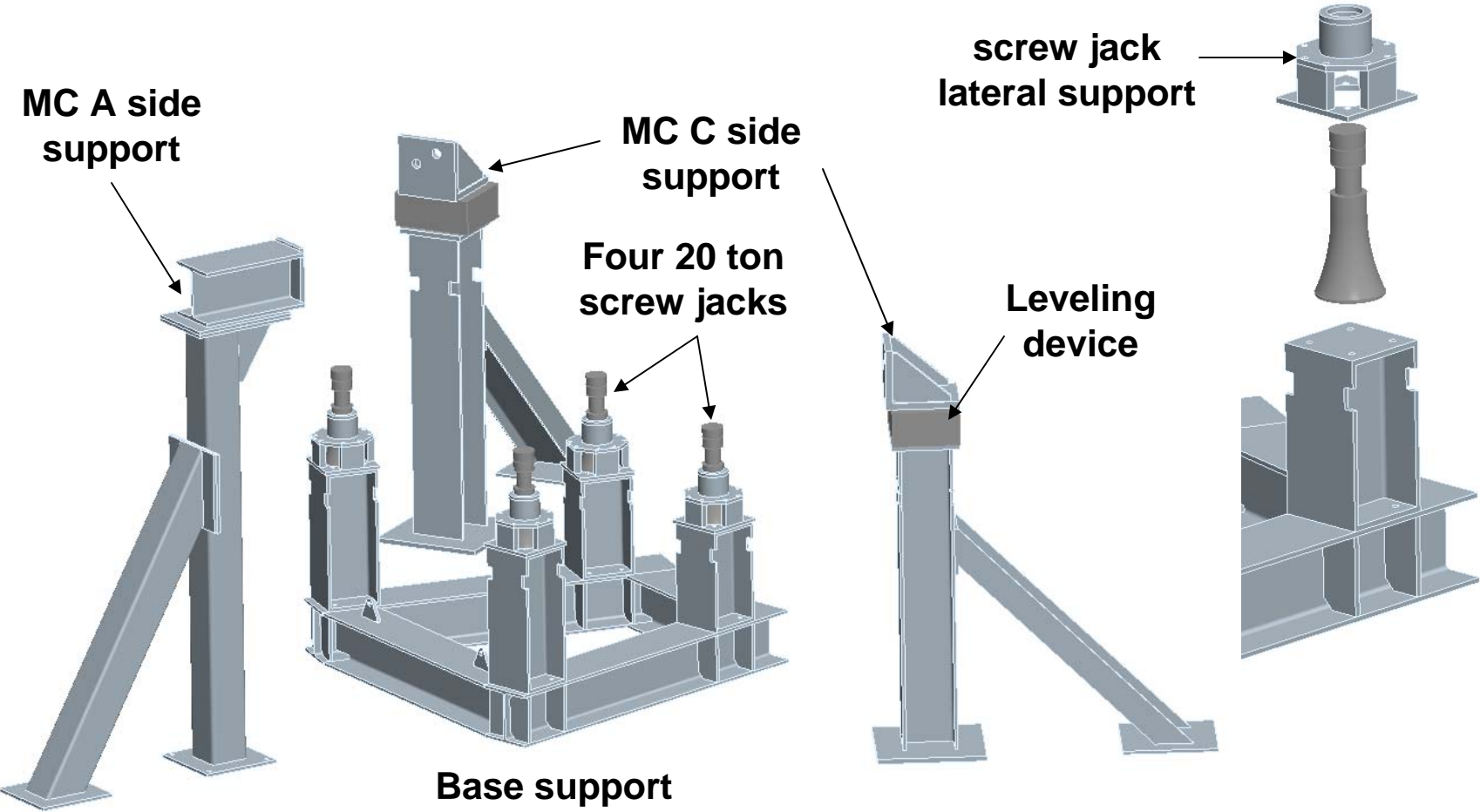
Trim coil, lead stubs and support structure assembly



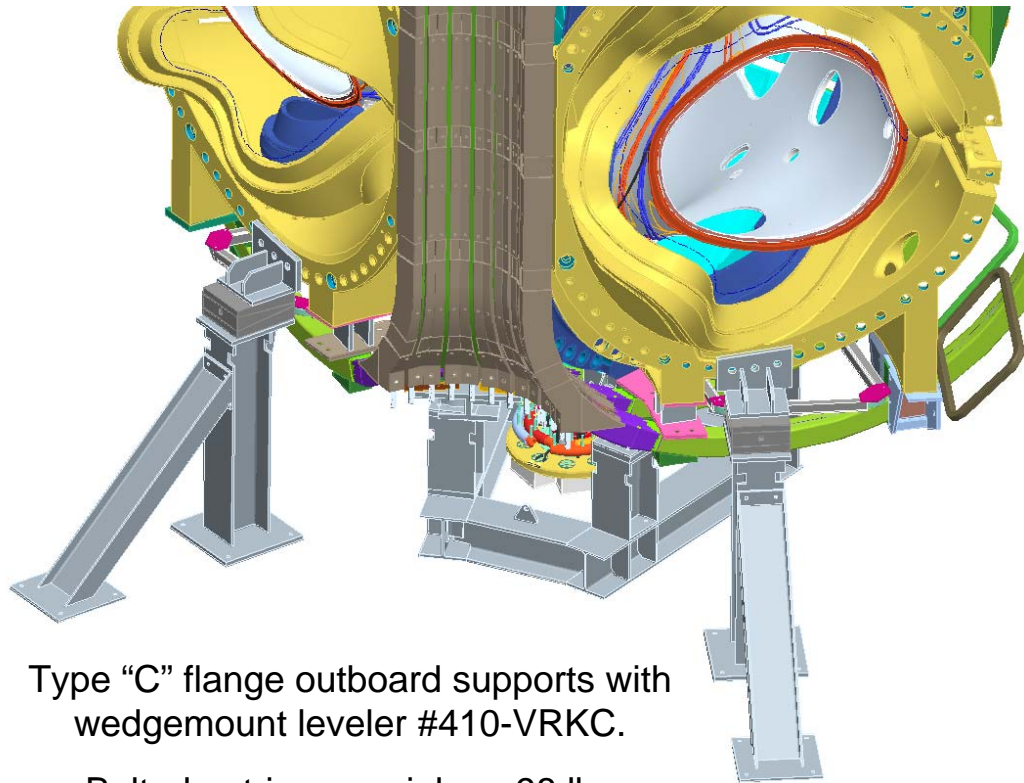
Service connections and Port 4 installation

Port 4

General Arrangement (Station 5 supports)



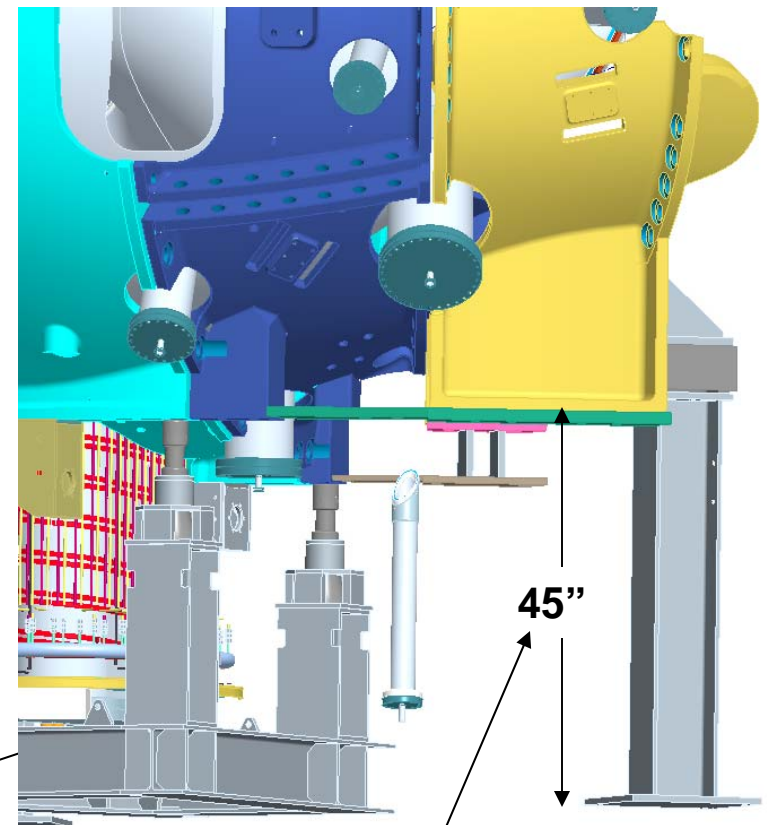
Station 5 support details



Type "C" flange outboard supports with wedgemount leveler #410-VRKC.

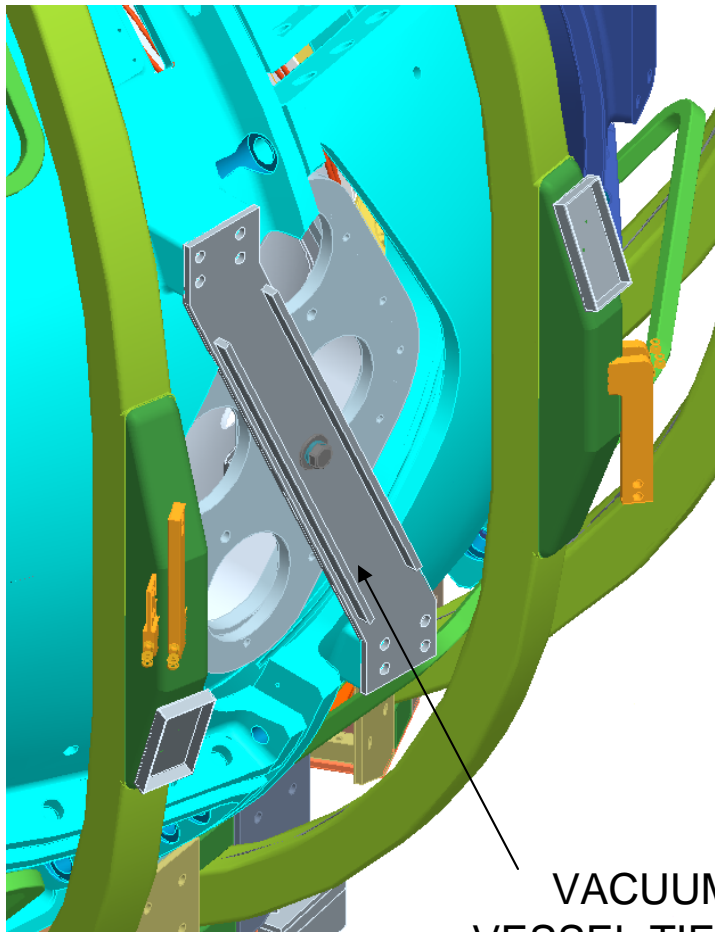
Bolted outrigger weighs ~ 98 lbs

Floor height allows access for lower component assembly

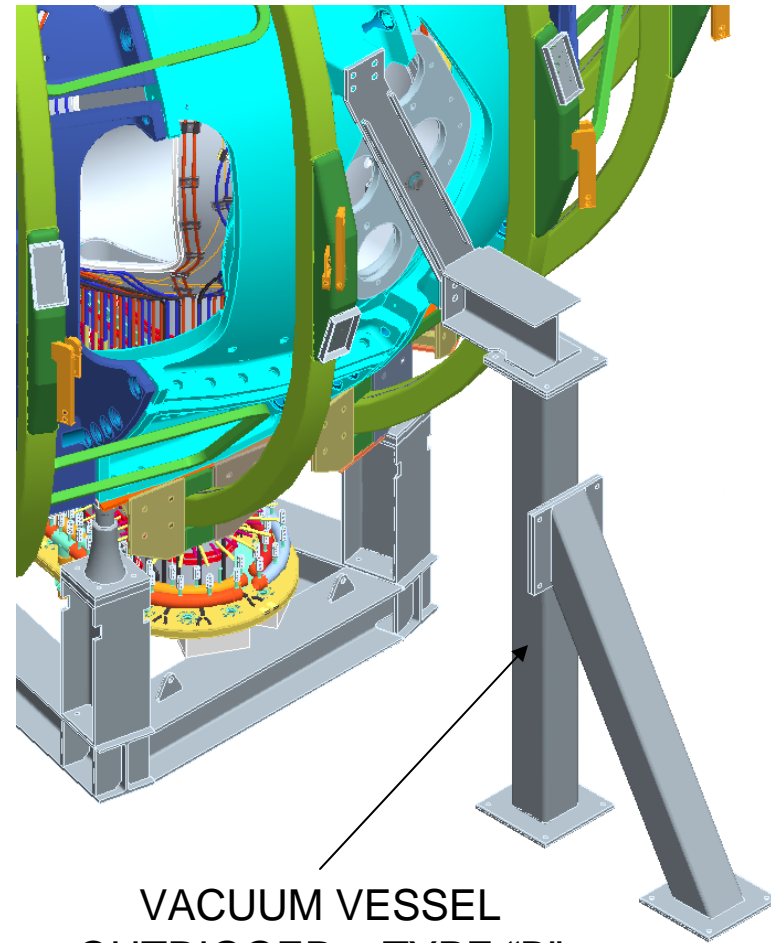


Is this enough?

Station 5 support details (cont)

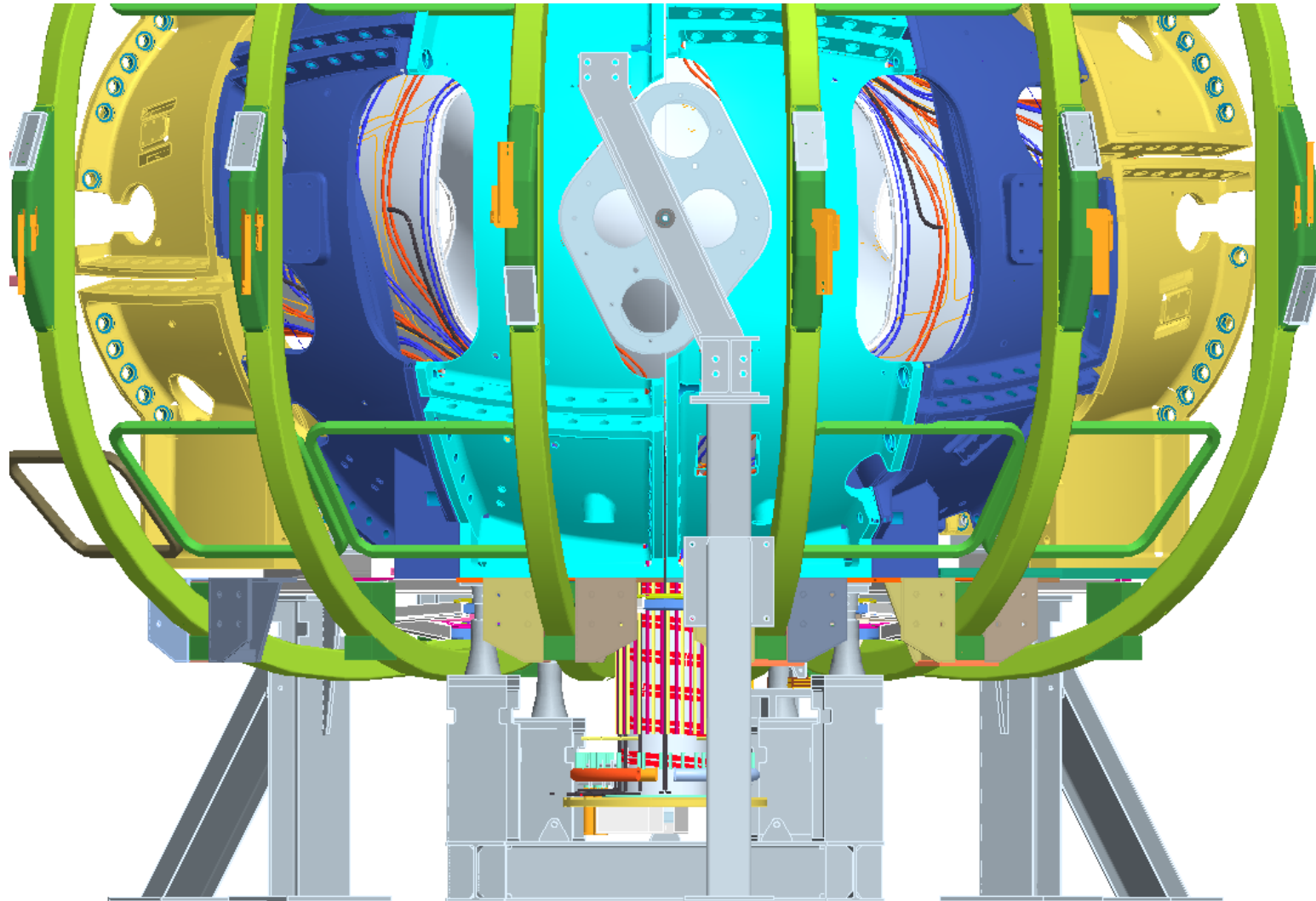


VACUUM
VESSEL TIE BAR

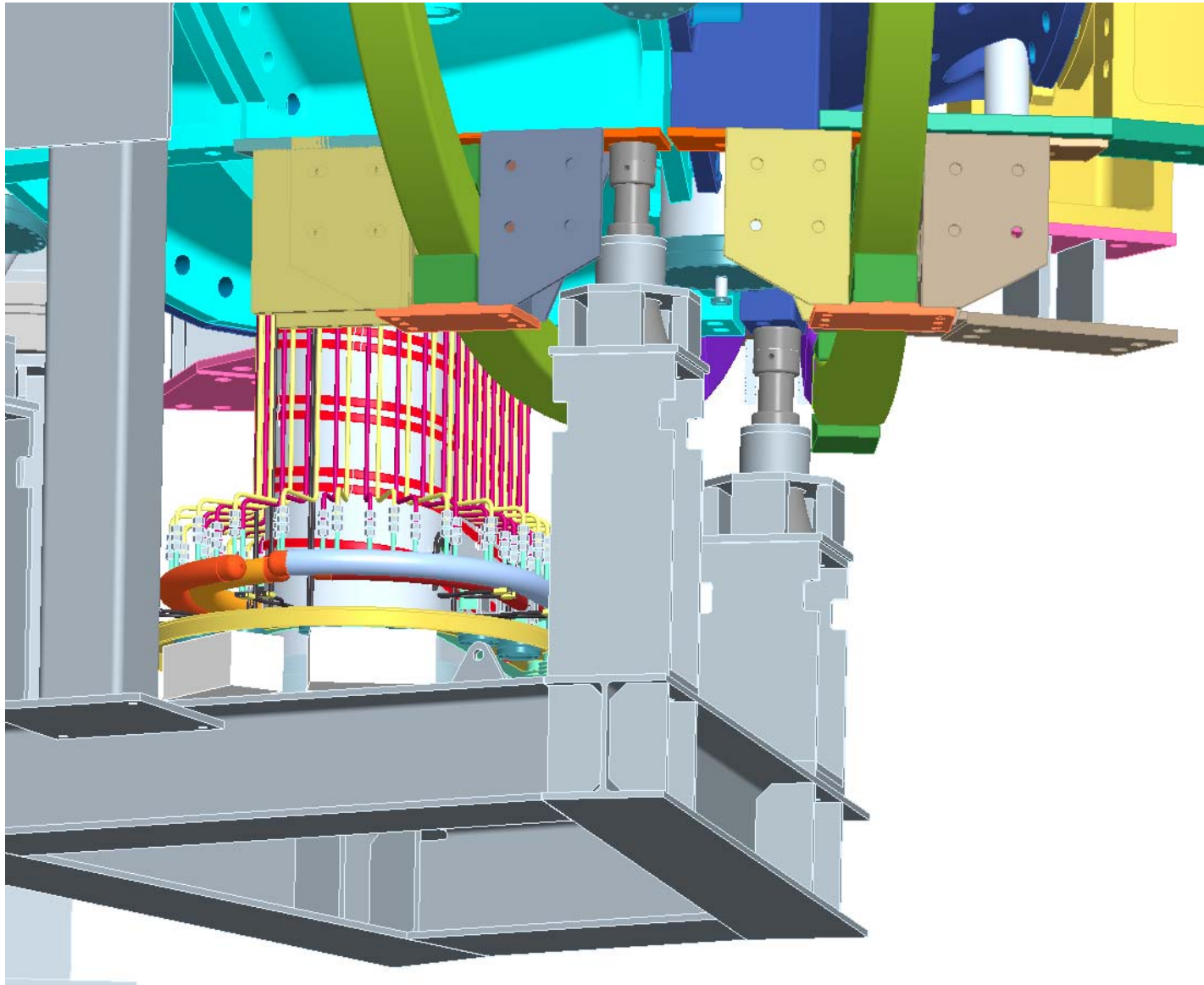


VACUUM VESSEL
OUTRIGGER – TYPE "B"

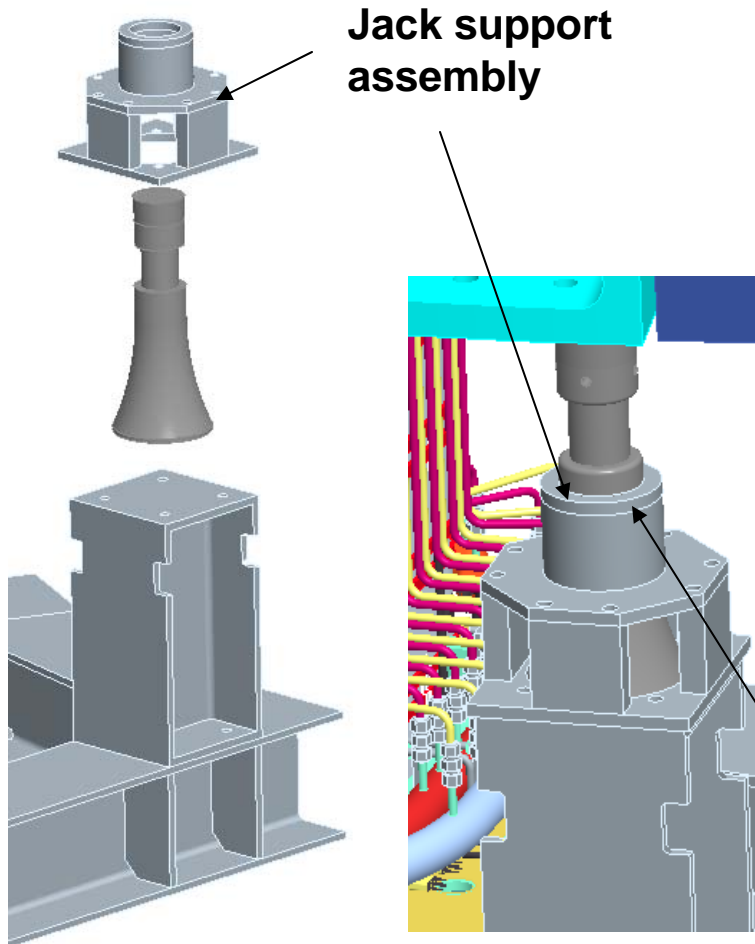
Station 5 support details (cont)



Station 5 support details (cont)



20 ton screw jacks used on base support



Screw Jacks



Lift and support machinery and equipment with these multipurpose jacks. The jack head has four openings so you can choose the best angle for inserting the optional turning bar (sold separately). A welded stop prevents overextension of the screw.

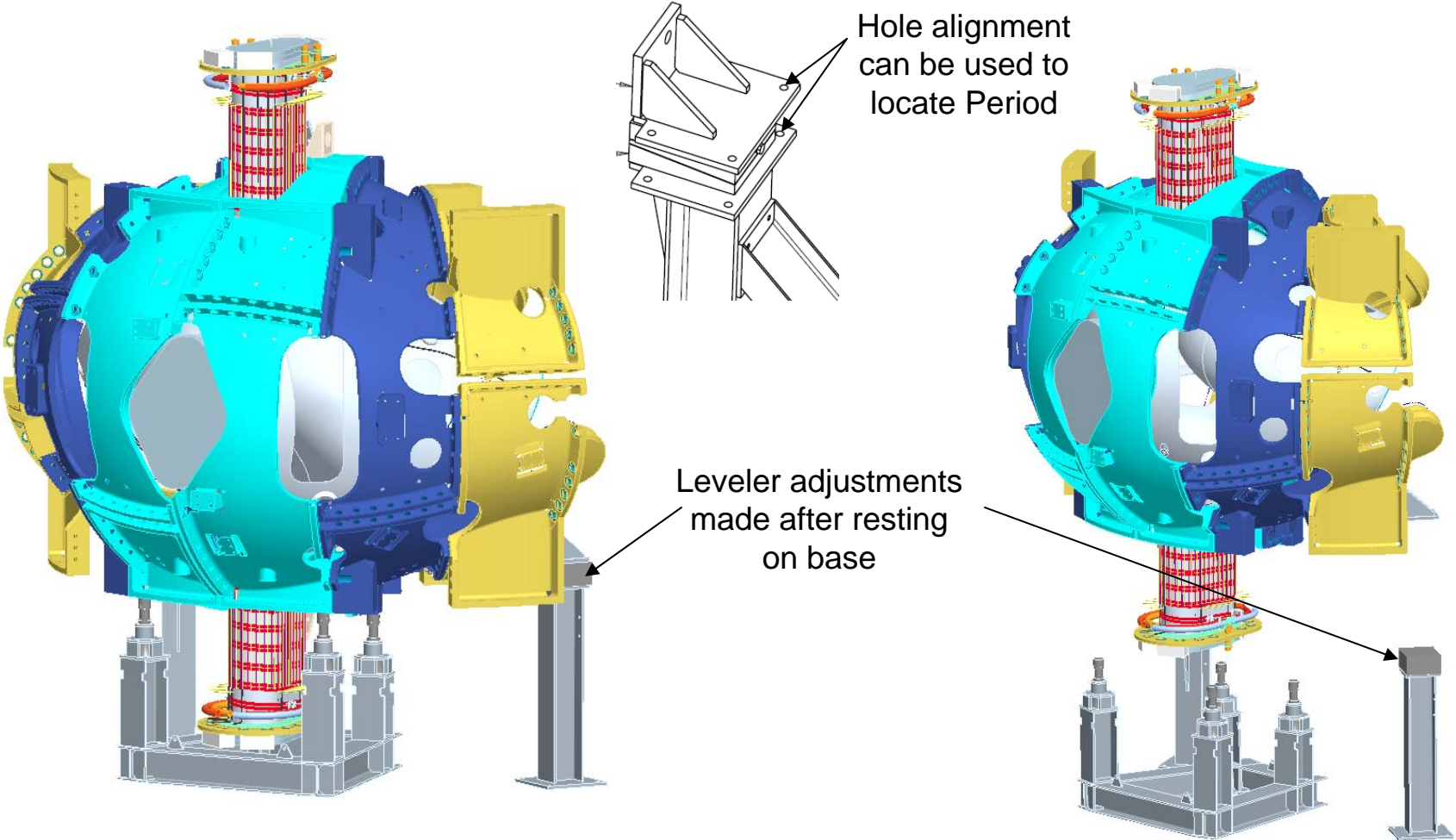
These flared-base jacks are housed in ductile iron and have a drop-forged steel serrated saddle that pivots and rotates to keep loads from slipping.

Optional turning bars are made of steel.

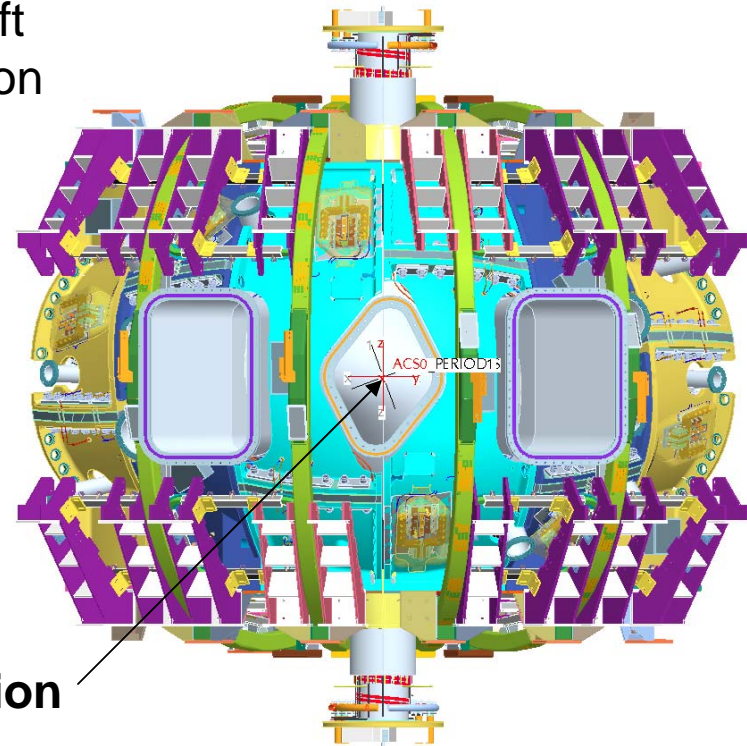
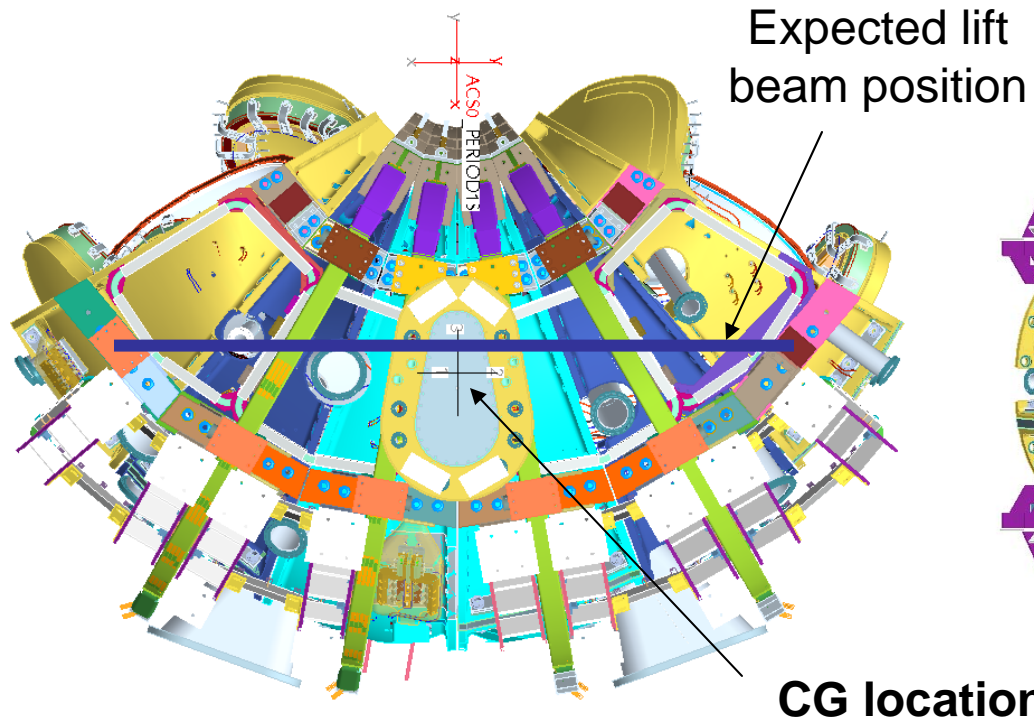
Cap., tons	Min. Ht.	Max. Lift	Max. Ht.	Saddle Dia.	Base Dia.	Each
12	9 ³ / ₄ "	3 ³ / ₄ "	13 ¹ / ₂ "	2 ⁷ / ₈ "	4 ³ / ₄ "	2926T13 .. \$109.74
12	11 ⁵ / ₈ "	5 ³ / ₄ "	17 ³ / ₈ "	2 ⁷ / ₈ "	5 ¹ / ₂ "	2926T14 .. 116.41
12	15 ⁵ / ₈ "	9 ³ / ₄ "	25 ³ / ₈ "	2 ⁷ / ₈ "	6 ¹ / ₄ "	2926T16 .. 148.34
20	11 ³ / ₄ "	5"	16 ³ / ₄ "	3 ¹ / ₈ "	6"	2926T18 .. 163.67
20	13 ³ / ₄ "	7"	20 ³ / ₄ "	3 ¹ / ₈ "	6 ¹ / ₂ "	2926T19 .. 177.78
20	15 ³ / ₄ "	9"	24 ³ / ₄ "	3 ¹ / ₈ "	6 ³ / ₄ "	2926T21 .. 193.61
24	17"	8 ¹ / ₄ "	25 ¹ / ₄ "	3 ¹ / ₄ "	7 ¹ / ₄ "	2926T24 .. 258.31
24	23"	14 ¹ / ₄ "	37 ¹ / ₄ "	3 ¹ / ₄ "	8 ¹ / ₂ "	2926T27 .. 337.36
Optional Turning Bar for 12-ton Jacks (24" long)						2926T42 .. 27.77
Optional Turning Bar for 20-ton Jacks (36" long)						2926T43 .. 26.76
Optional Turning Bar for 24-ton Jacks (42" long)						2926T44 .. 75.26

Local bolts at top of jack support assembly are not shown.

Installation of Period onto support stand



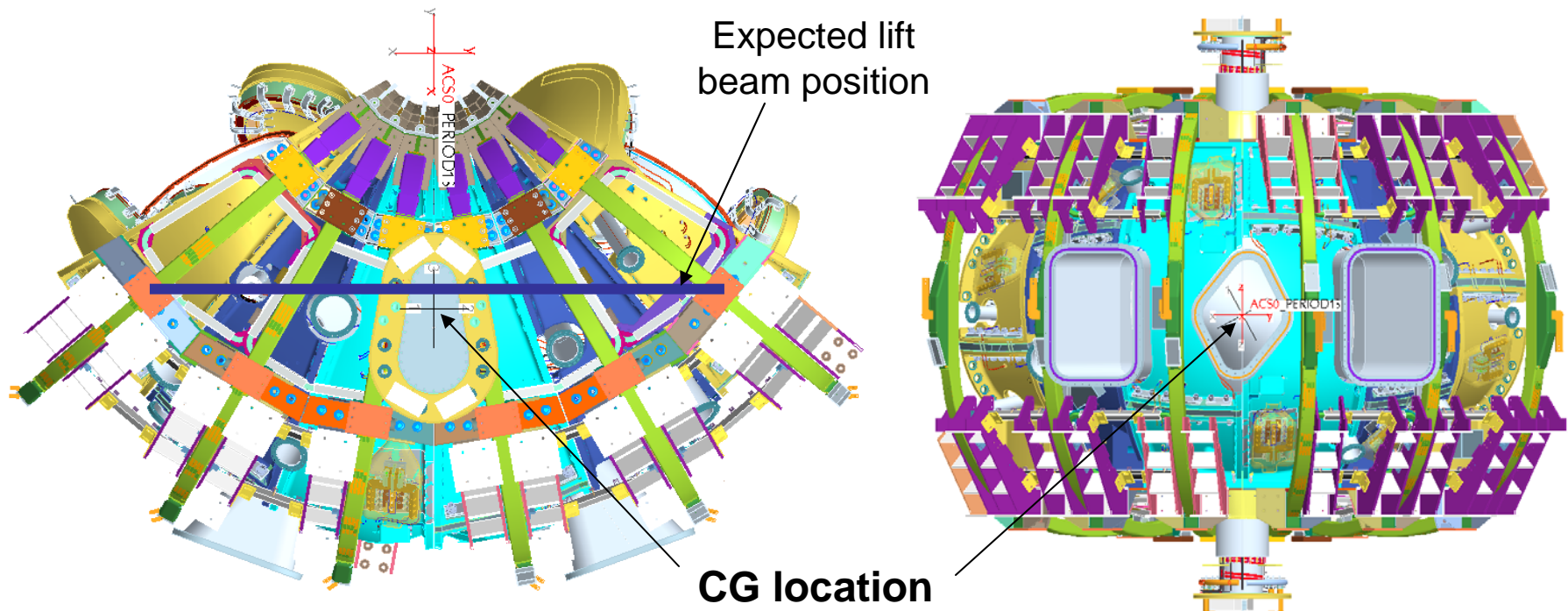
Period Weight – Station 5



Station 5 weight with four TF coils is 65,723 lbs per the CAD model

ACS0:F9(CSYS)	
Results	
VOLUME =	2.0788267e+05 INCH ³
SURFACE AREA =	7.8399877e+05 INCH ²
AVERAGE DENSITY =	3.1646255e-01 POUND / INCH ³
MASS =	6.5723788e+04 POUND
CENTER OF GRAVITY with respect to ACS0 coordinate frame:	
X Y Z	5.5335136e+01 7.8989836e-02 -1.1833047e-01 INCH

Period Weight – Station 6

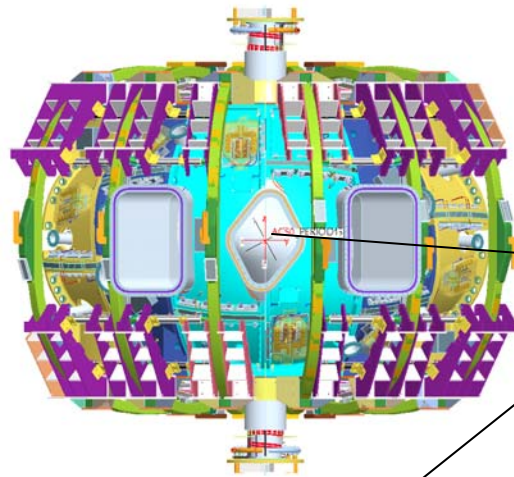


Station 6 weight with four TF coils is 70,282 lbs per CAD model

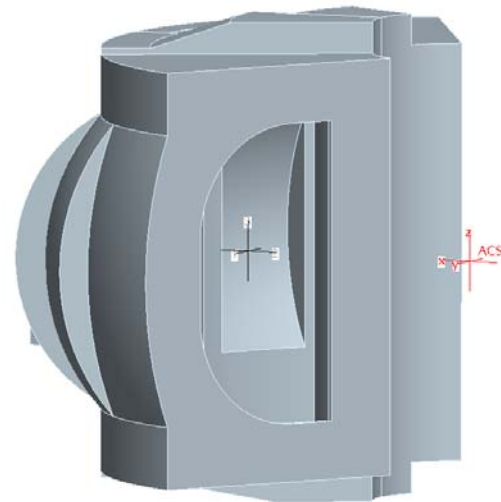
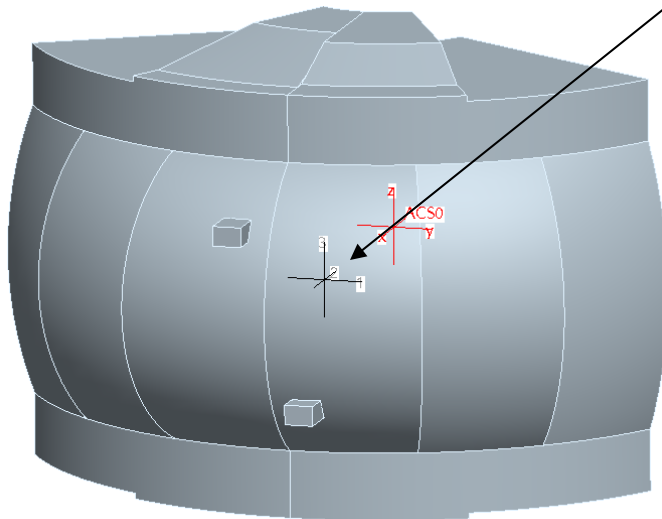
Considering some missing components plus added contingency the Station 6 weight is assumed to be 80,000 lbs.

ACS0:F9(CSYS)
Results
VOLUME = 2.2445360e+05 INCH ³
SURFACE AREA = 9.2603035e+05 INCH ²
AVERAGE DENSITY = 3.1312439e-01 POUND / INCH ³
MASS = 7.0281897e+04 POUND
CENTER OF GRAVITY with respect to ACS0 coordinate frame:
X Y Z 5.4116712e+01 8.7560112e-02 -6.0072264e-02 INCH

Simulated Core model used in calculations



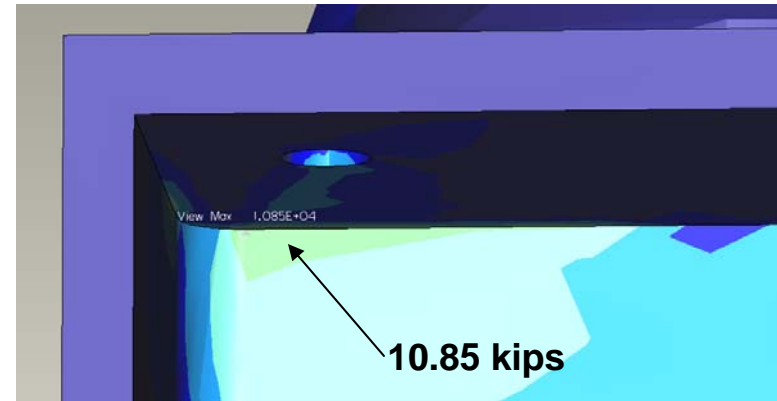
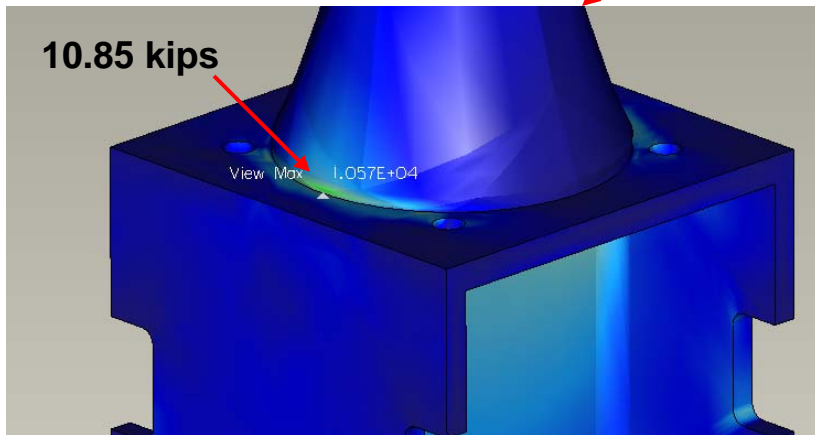
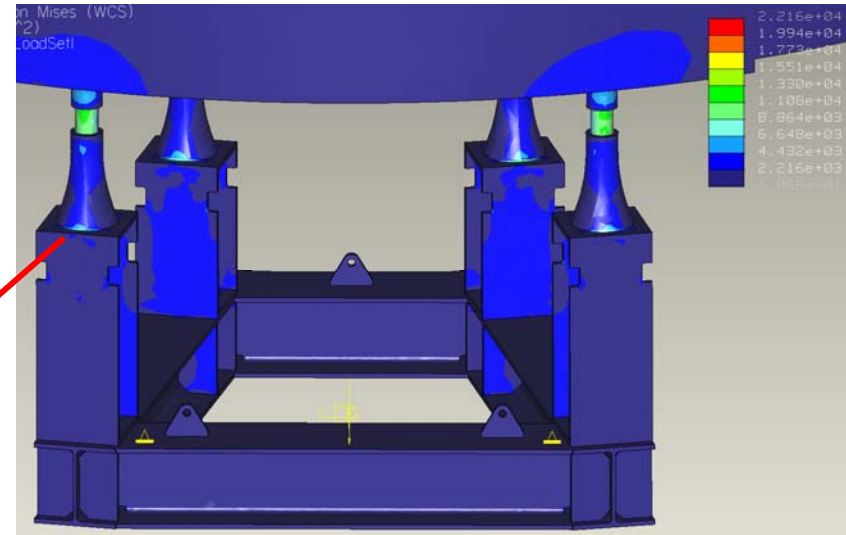
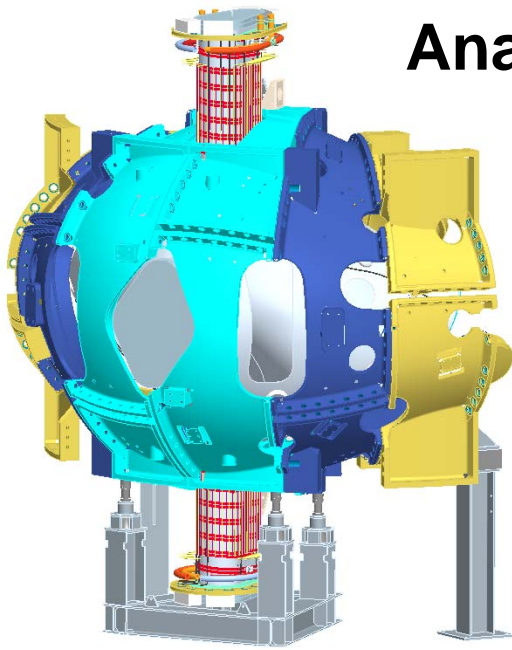
A simulated model of Station 6 matches its weight and CG location



Station 5 – Analysis Assumptions

- **Material properties**
 - ASTM A36, $F_y = 36$ ksi, $F_{tu} = 58$ ksi**
 - Allowable stress: at 2/3 yield is 22 ksi**
 - at 1/3 ultimate is 19.3 ksi**
- **Factor of safety of 5 against buckling**
- **For lifting devices:**
 - Allowable stress design factor $N_d = 3.0$ for Category B lifters**
- **Assumed maximum weight of the period is 80,000 lbs**
- **Linear FEA analysis with the lift support frame fully constrained at the bottom**

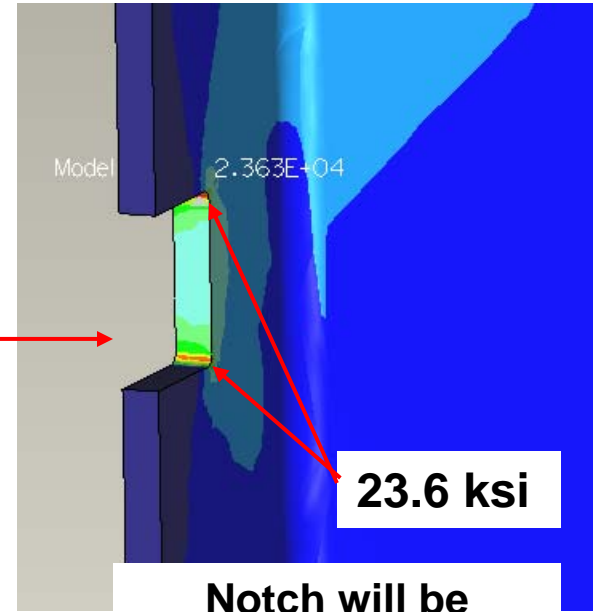
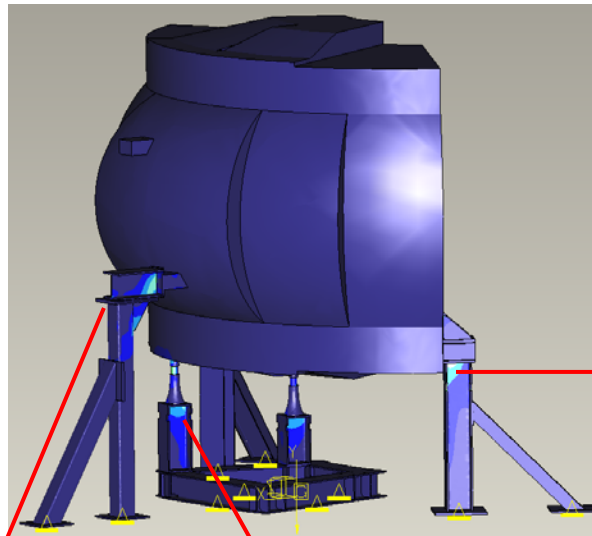
Analysis of base support – no C supports



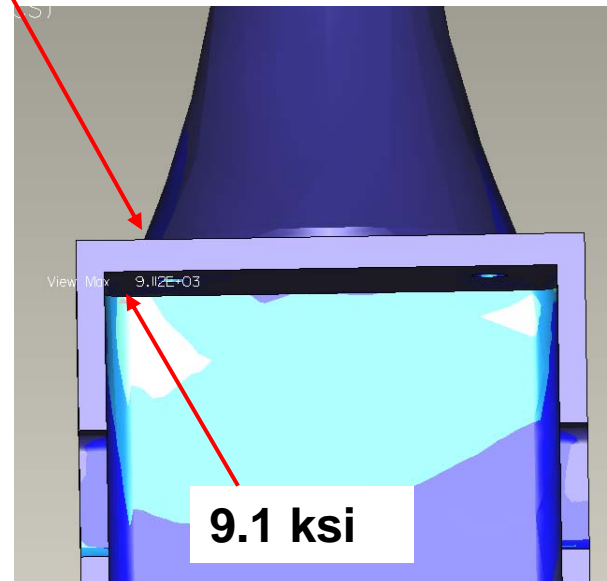
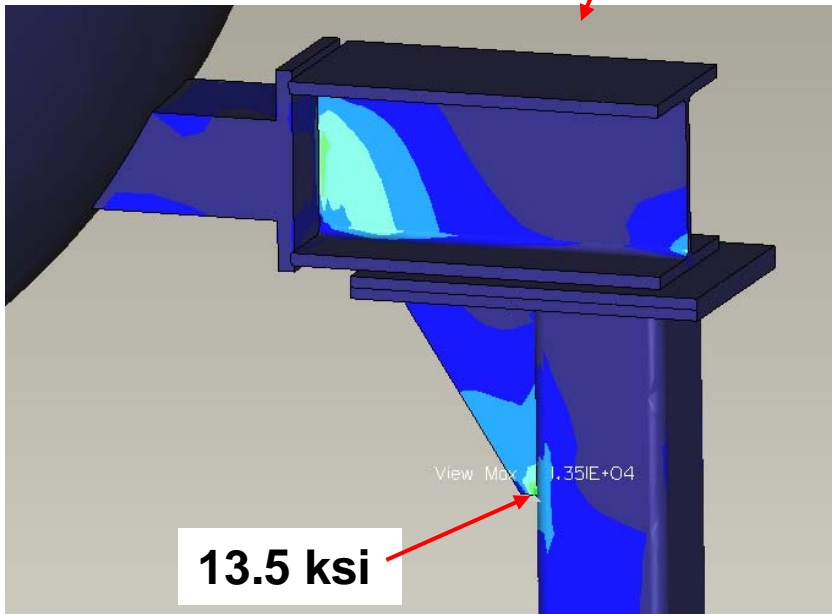
The max. von mises stress in the support frame (10.9 ksi) locates in the base column.

TF assembly arrangement

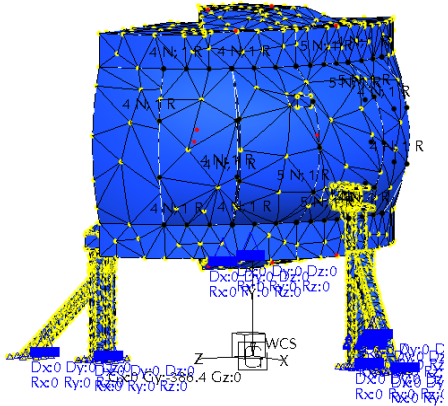
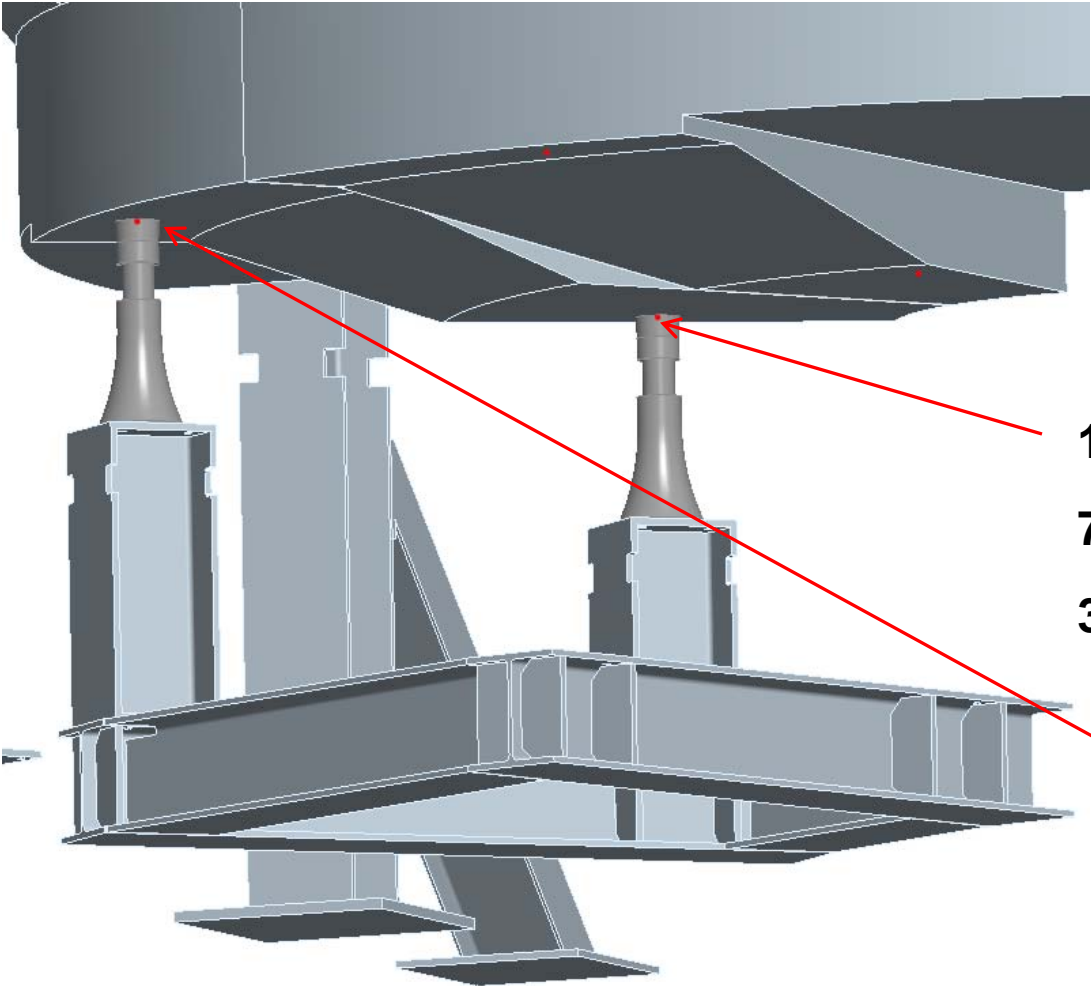
The maximum stress was 23.6 ksi found in a local notch which can be altered or removed.



Notch will be altered or removed

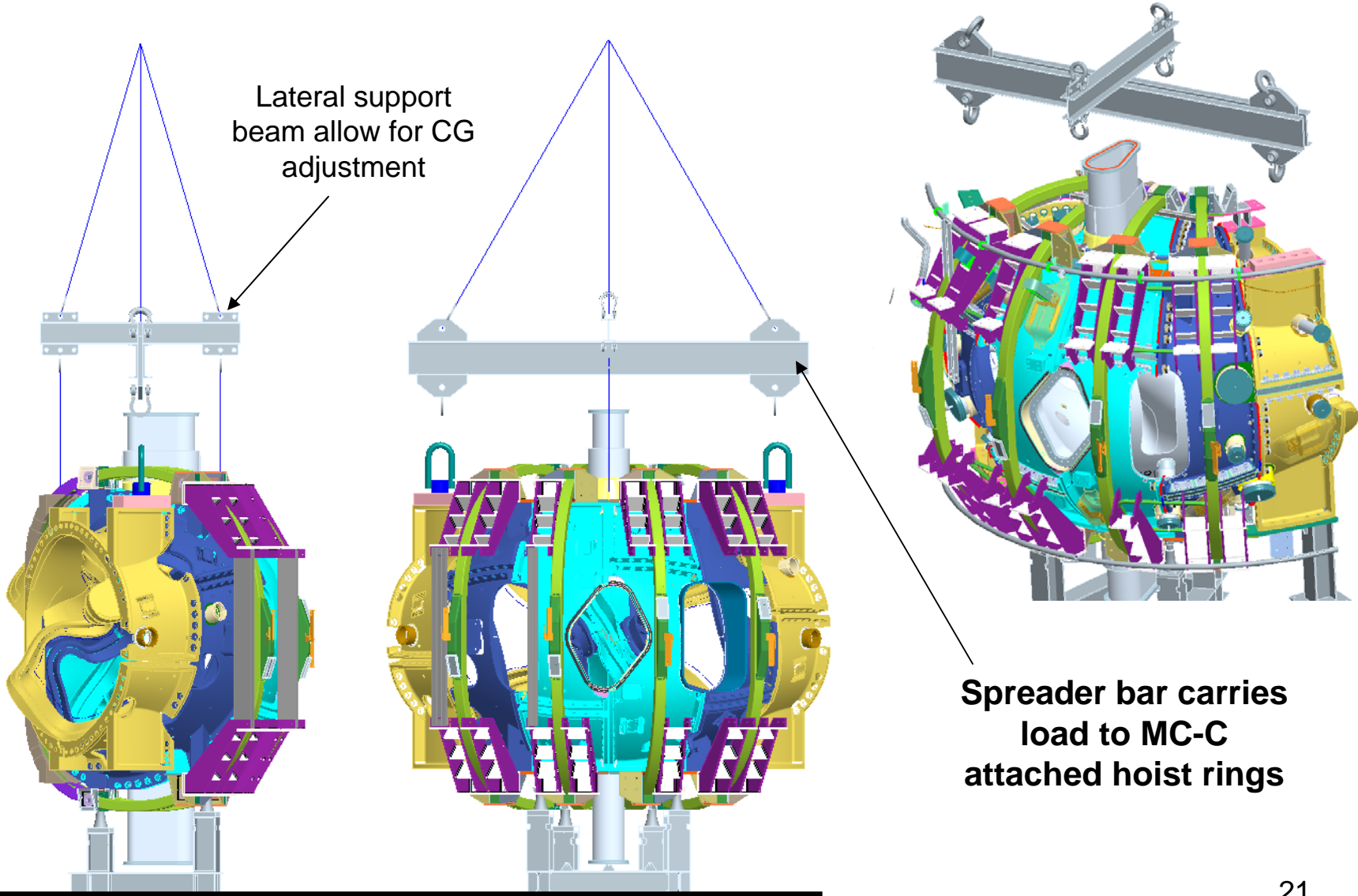


Station 5 – Jack stand peak bearing load

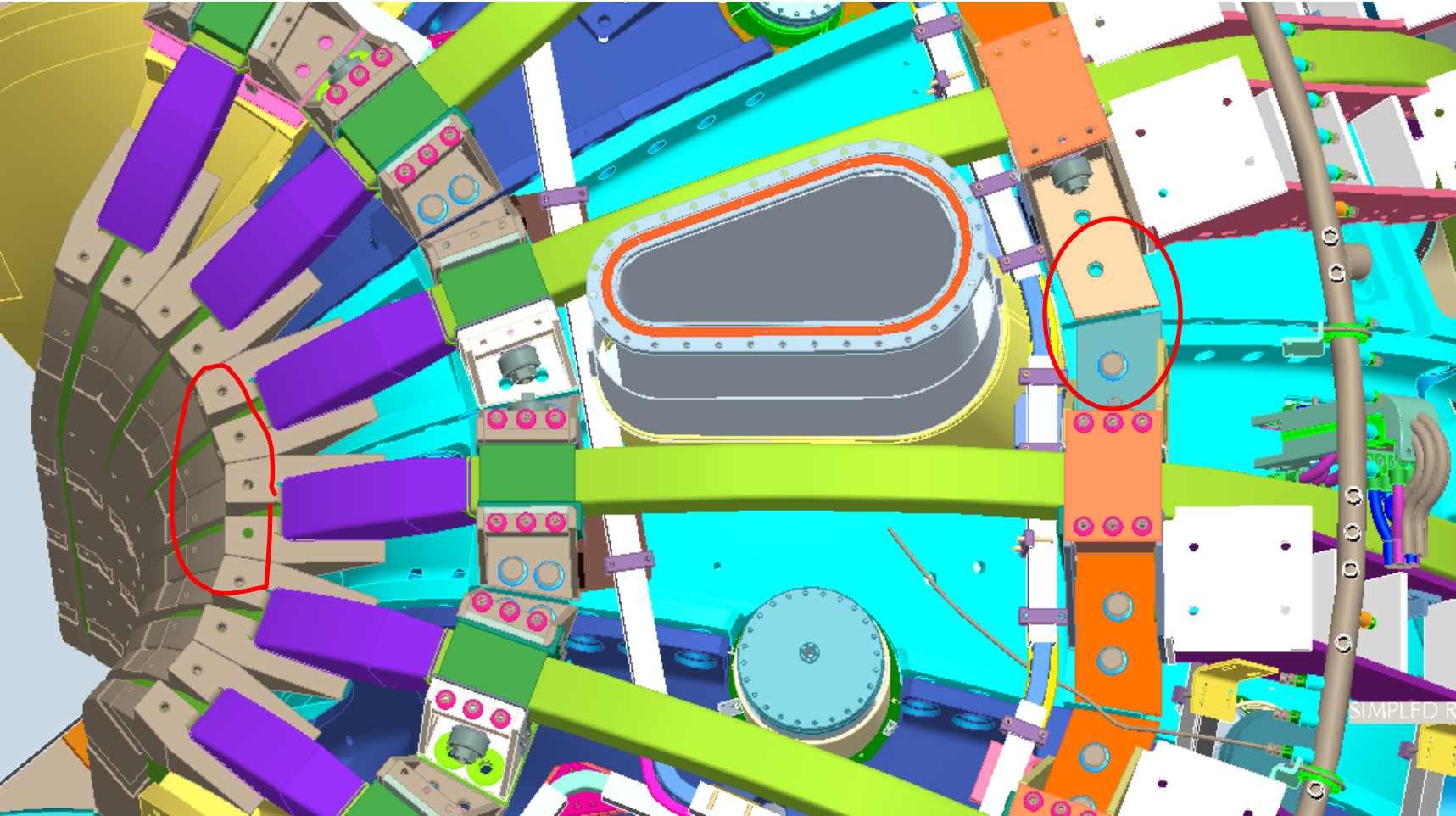


- 12.7 ton reaction force**
- 7.67 in² jack bearing area**
- 3.3 ksi bearing stress**
- 11.7 ton reaction force**

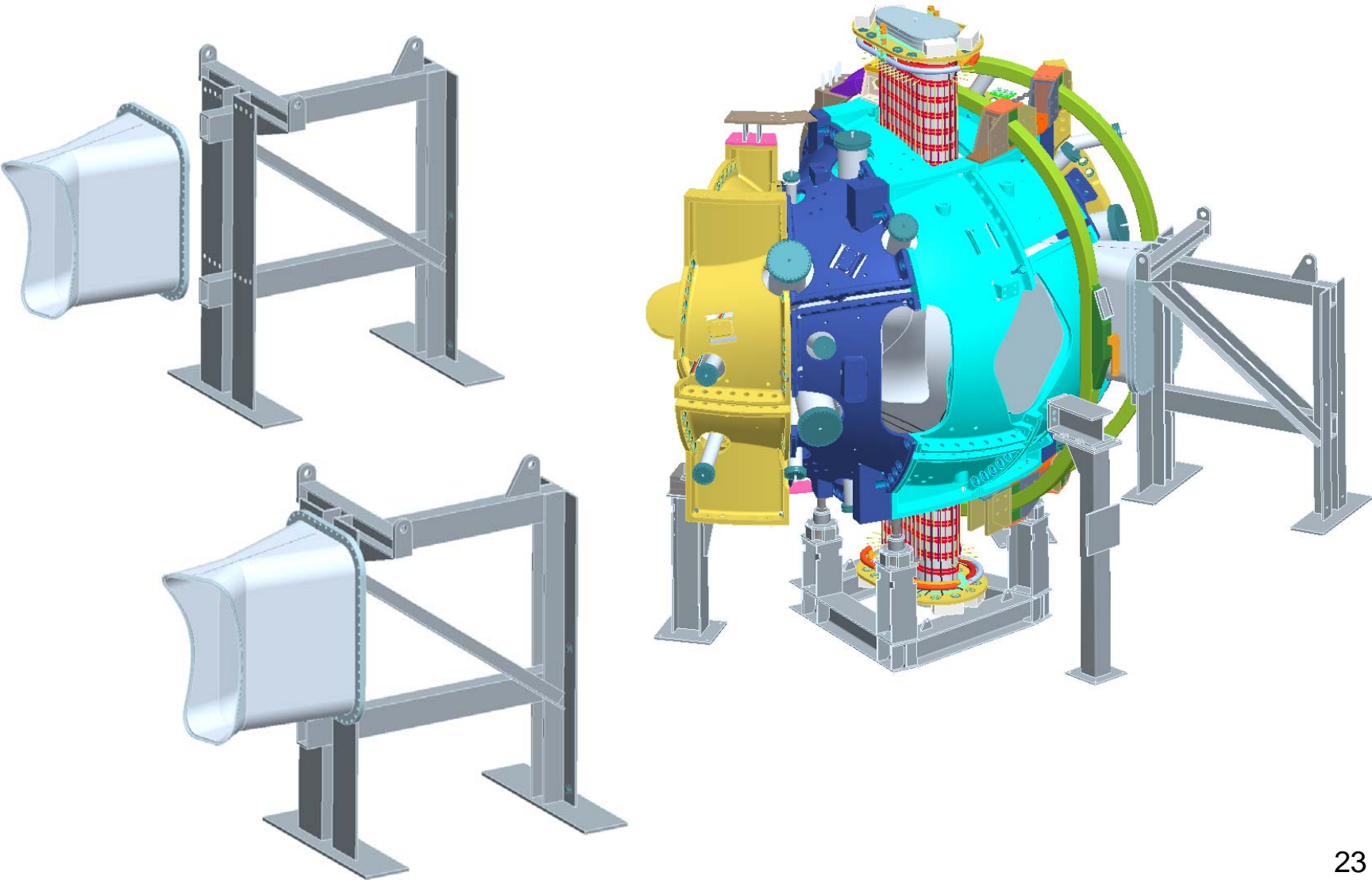
Station 5 – Lift beam



Pick up points for lateral beam



Port 4 installation fixture



Baseline procurement
cost estimate

Uncertainty range - 10% / +15%

1	2	3	4	5	6	7	8	9	10	11	12
Item	Description	Weight (lbs)	\$ per Lb	Unit Cost (\$)	Qty	Total Cost (\$)		Comments	Equip hrs		
	Stage 5 - Final FP Assembly Fixture Cost							Estimate is for one Stage 5 units			
1	FPA base support system	930	5.5	5,115	1	5,115		Weight based on CAD model	63		
2	Type-C side support structure	340	4.25	1,445	2	2,890		Weight based on CAD model	36		
3	NB side stabilizing support structure	440	4.25	1,870	1	1,870		Weight based on CAD model	23		
4	TF local temporary supports	50	5.5	275	2	550		Weight estimate	7		
5	20 ton screw jacks			164	4	656		McMaster-Carr price			
6	AirLoc Wedgmount Precision Levelers			500	2	1,000		Estimate based on earlier purchas of lighter unit			
7	Port 4 handling structure	800	5.5	4,400	1	4,400		Weight based on CAD model	54		
8	Small port handling structure	50	5.5	275	4	1,100		Weight estimate	14		
9	Station 5 (and 3) lift fixture structures	1,366	5.5	7,513	1	7,513		Weight based on CAD model	93		
10	VV work platforms							Cost covered in Viola's WBS			
11	Stage 5 assembly platform							Cost covered in Viola's WBS			
12	Hardware & Masc. items					1,000					
13	Misc. assembly Cost					8,100		Assumes additional 2.5 wk shop hours	100.0		
						34,194			389	9.7	wks

New cost inputs:

Weight of structure: 4970 lbs

Cost range: \$18,350 or \$3.69/lb (includes \$2k shipping) (Station 3)

\$20,478 or \$4.12/lb

\$25,880 or \$5.21/lb

\$26,496 or \$5.33/lb

\$32,144 or \$6.47/lb

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