

Field Period Assembly

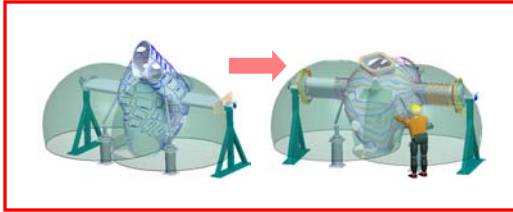
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**Office of Science Project Review
Princeton Plasma Physics Laboratory
Princeton, NJ
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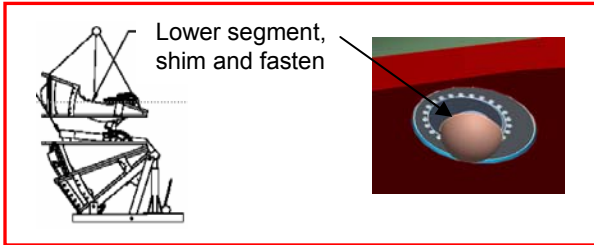
FPA is accomplished in five Stages

Stage 1



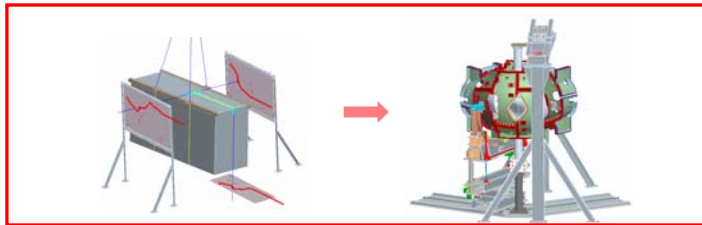
VV Prep
(FY06)

Stage 2



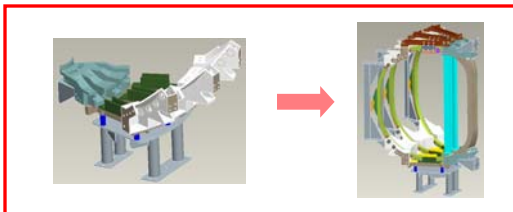
MC Half Period
Assembly
(FY07)

Stage 3



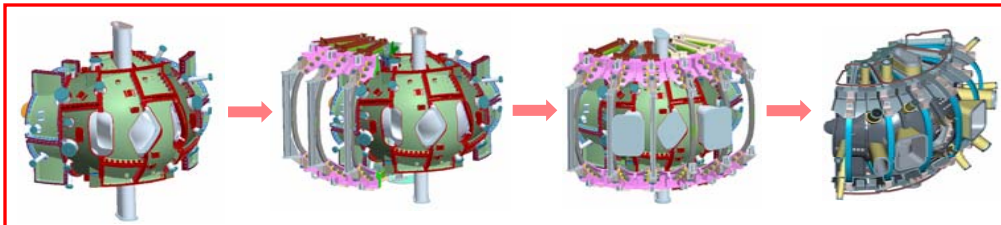
MC installation over
VV Field Period
(FY07)

Stage 4



TF Half Period Assembly
(FY07)

Stage 5



Final FP Assembly
(FY07, FY08)

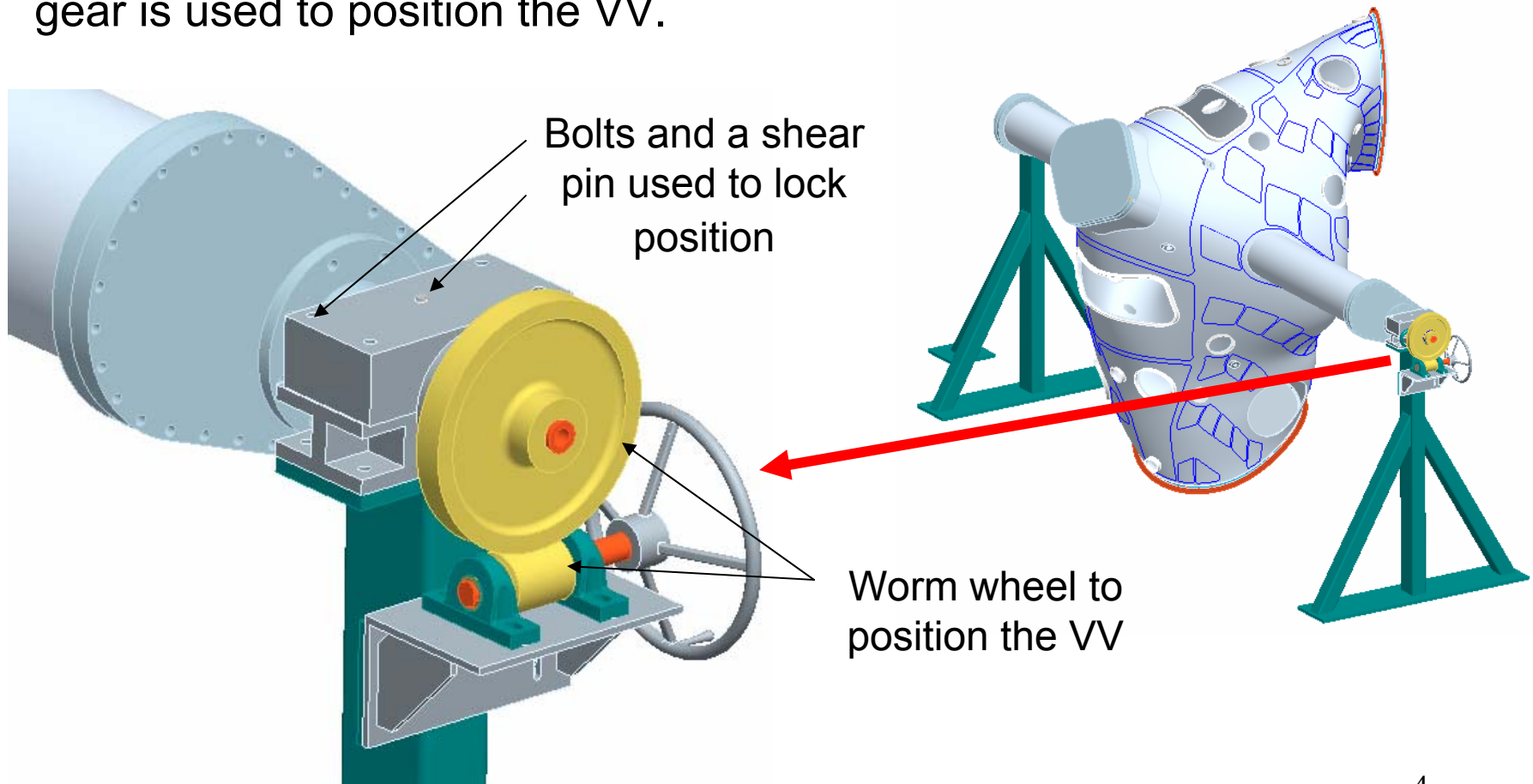
Field Period Assembly (FPA)



- What is involved with FPA
- What are the FPA plans and schedule for FY 06 and FY 07
- What technical issues and risks are associated with this activity
- What R&D activities are used to reduce assembly risk and improve cost and schedule success

VV Prep Station – Stage 1

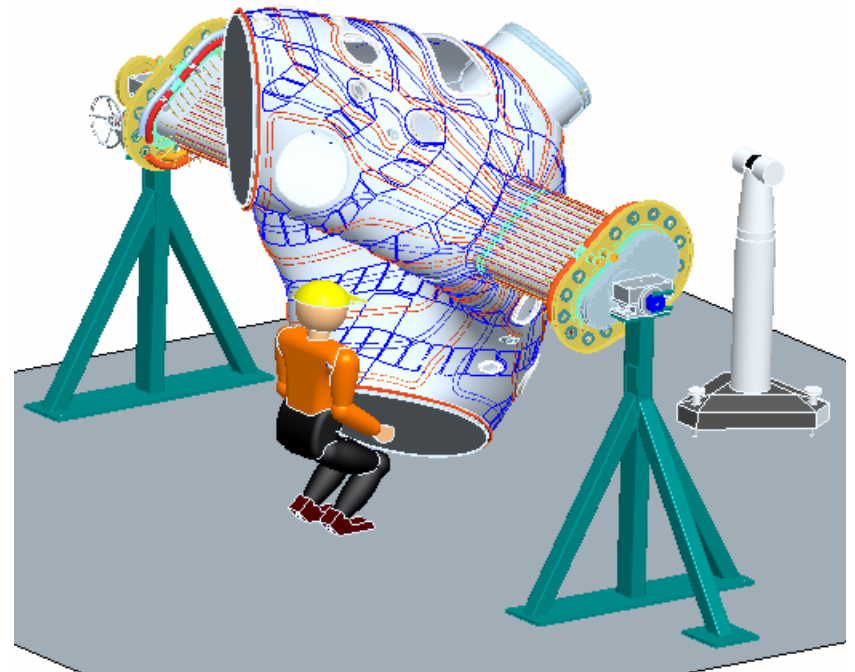
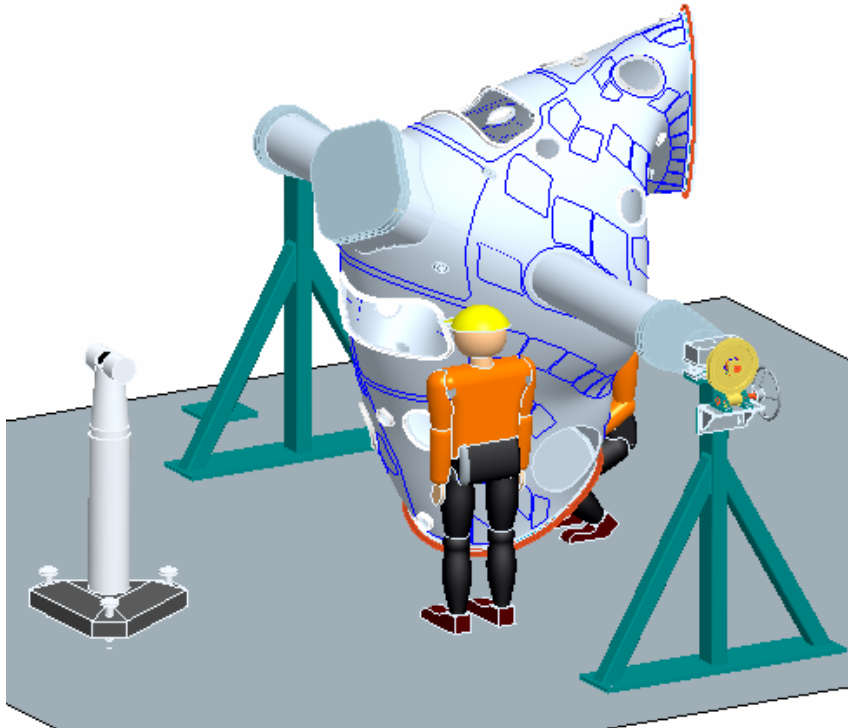
Simple support stands are bolted to the floor and a mechanical worm gear is used to position the VV.



VV Prep Station – Stage 1 (cond.)

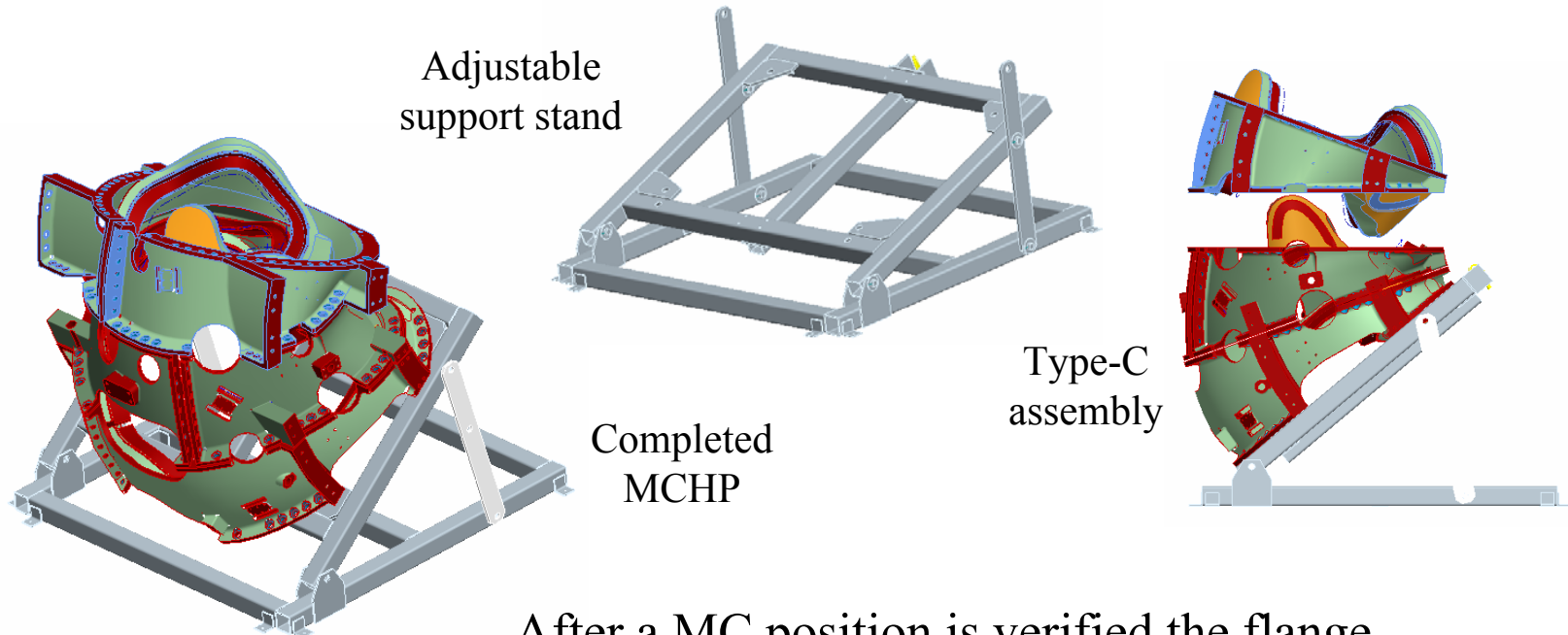


Stage 1 is used to install (with metrology alignment) 15 magnetic loops on VV Field Periods 1 & 3 and 138 loops on FP 2. In addition 64 coolant tubes with ~ 1000 studs will be installed on each Field Period.



MC Half Period Assembly – Stage 2

An adjustable support stand is used to support the Modular Coil Half Periods (Type A, B and C) as the individual coil windings are set on three precision adjusted spherical seats.

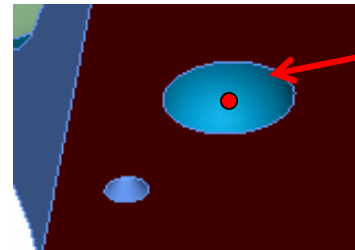
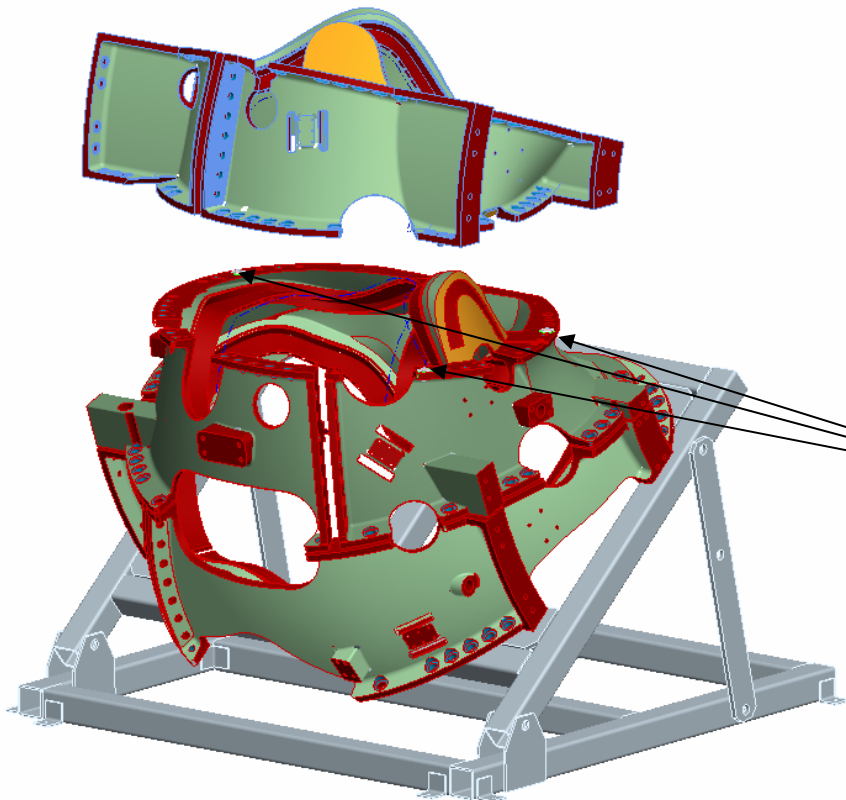


After a MC position is verified the flange surfaces are shimmed and bolted tighter.

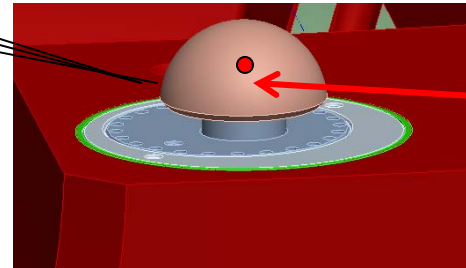
MC HP Assembly – Stage 2 (cond.)



Three spherical seat positions are pre-adjusted for every Modular Coil winding based on metrology measurements of the winding and manipulation of a NCSX Field Period Assembly CAD model prior to Modular Coil Half Period assembly.



Female side spherical seat.
+.002 Machine Tol
-.000

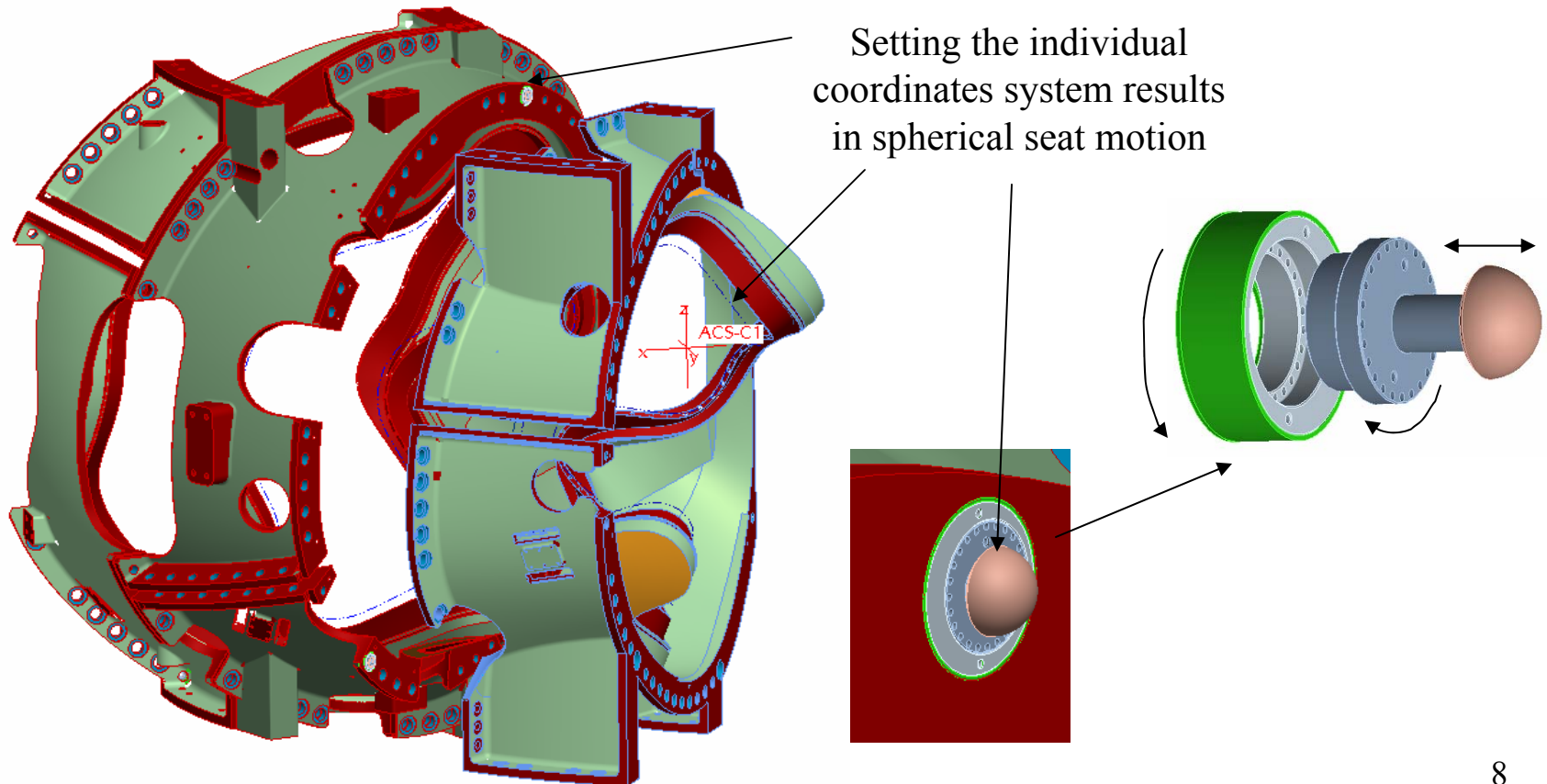


Adjustable male spherical seat

FPA CAD model used in the assembly process



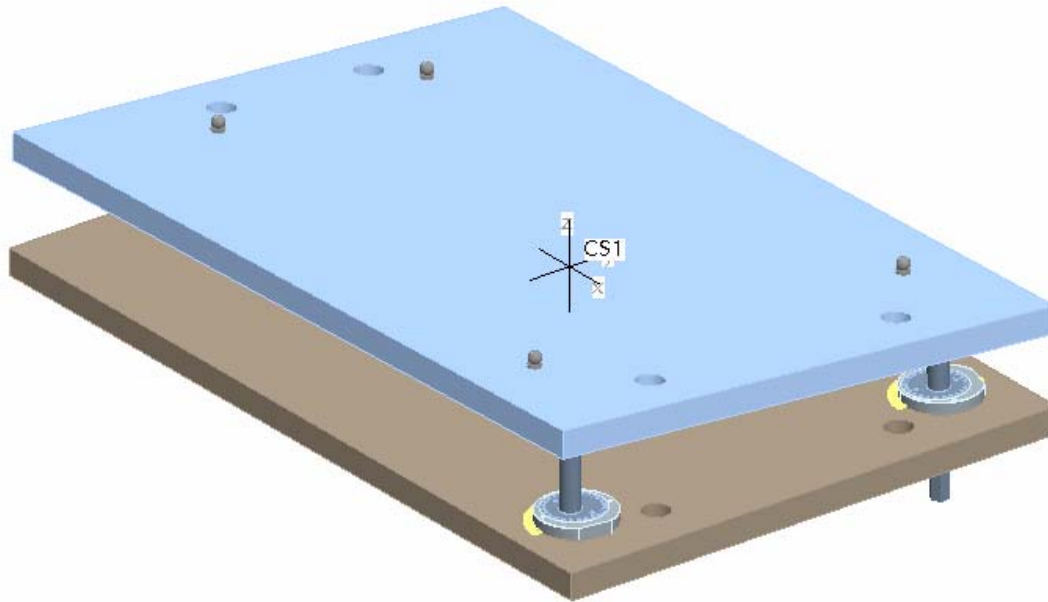
All 18 MC's will be set to match the measured metrology data and spherical seats will automatically adjust to the correct position to align male and female interfaces.



MC HP Assembly – R&D Activity



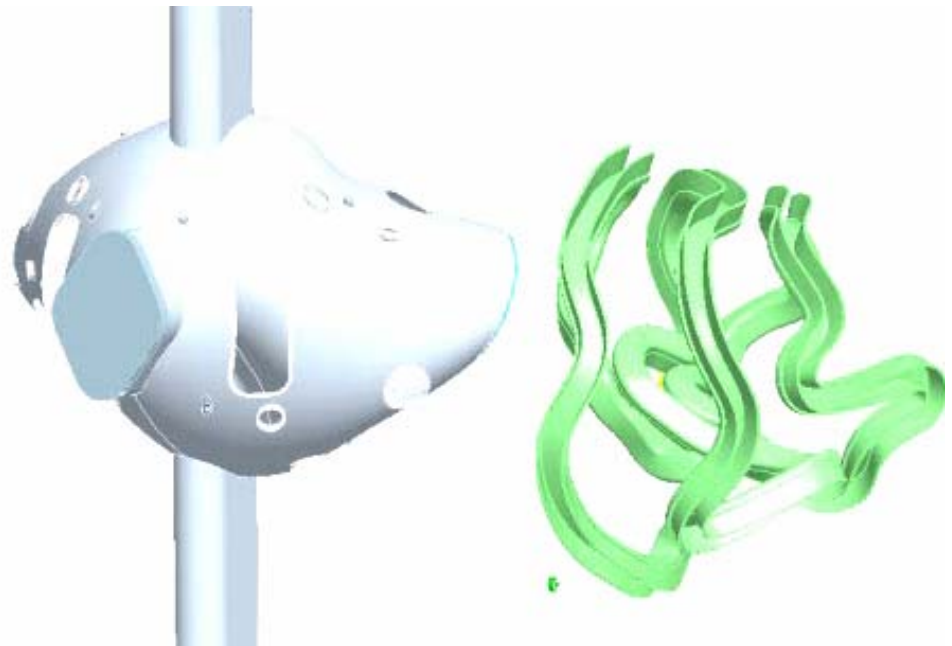
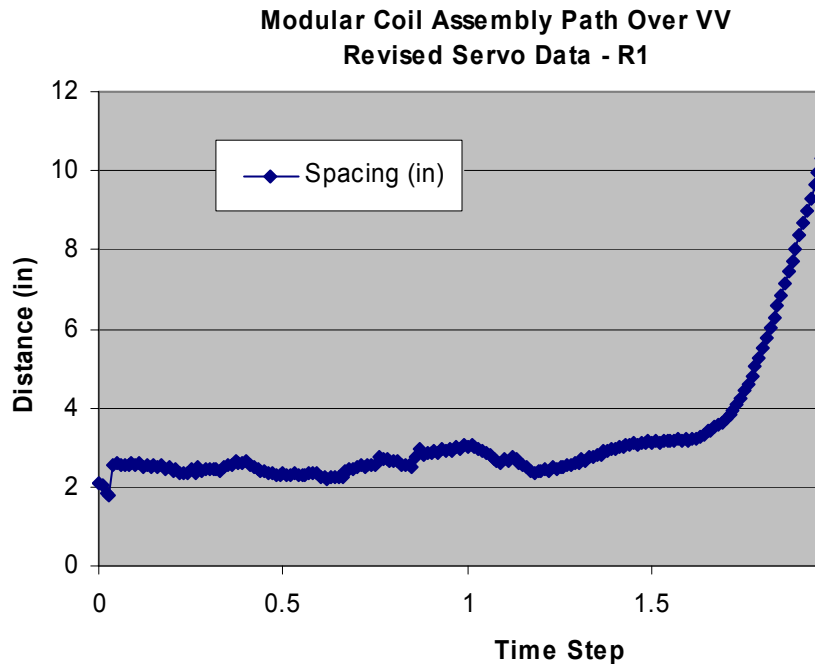
A pair of 20” x 30” plates with three spherical seat assemblies have been fabricated to use in an R&D set-up to test our ability to set the alignment of the plates and accurately measure their position using our Leica laser metrology system.



MC installation over a VV FP – Stage 3

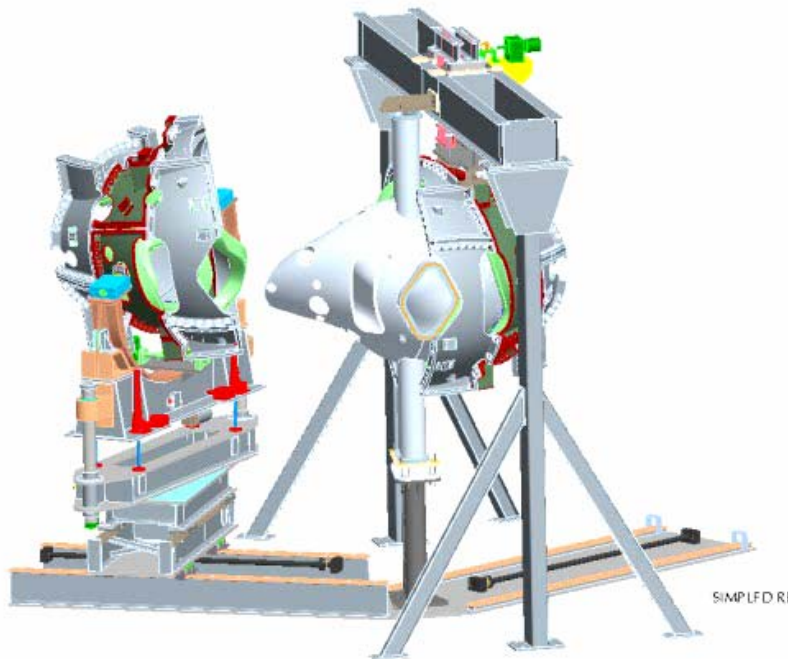


Stage 3 involves manipulating two 24,000 lb MCHP over a VV field period within the prescribed assembly path.

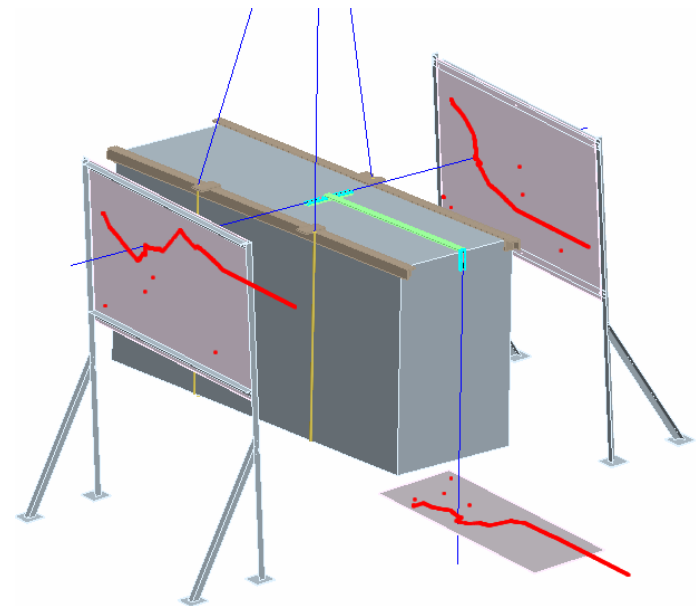


MC installation over a VV FP – Stage 3

An R&D activity was used to select a lower cost assembly approach for installing the modular coil half period over the VV period.



Mechanical Assembly

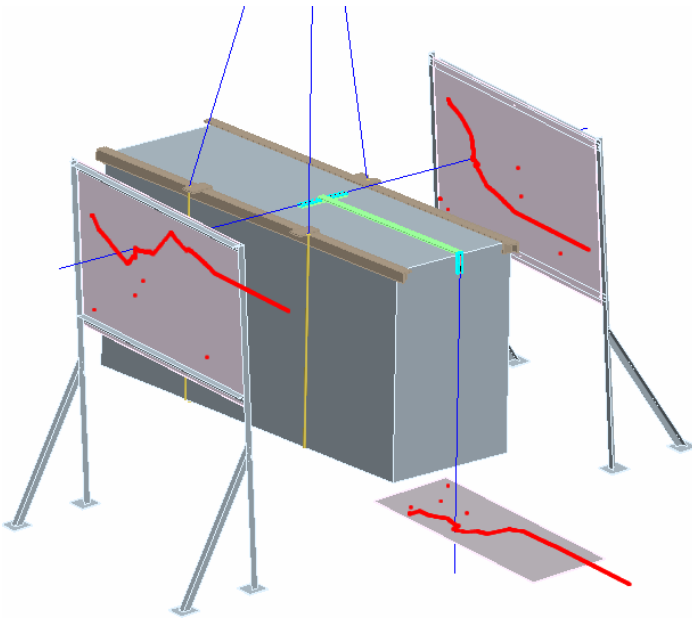


Crane Supported – hand assisted assembly

MC installation R&D Activity



MC crane assisted assembly simulation was set up using a concrete block with three lasers mounted to it.



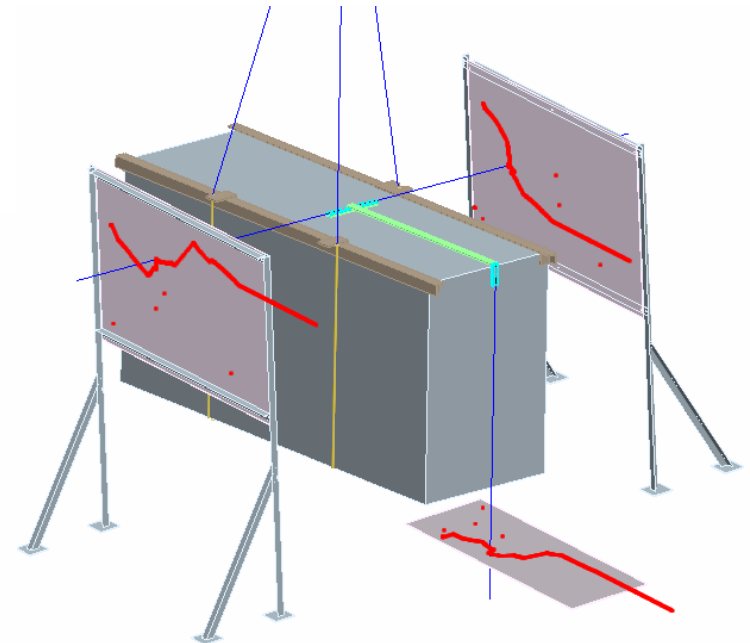
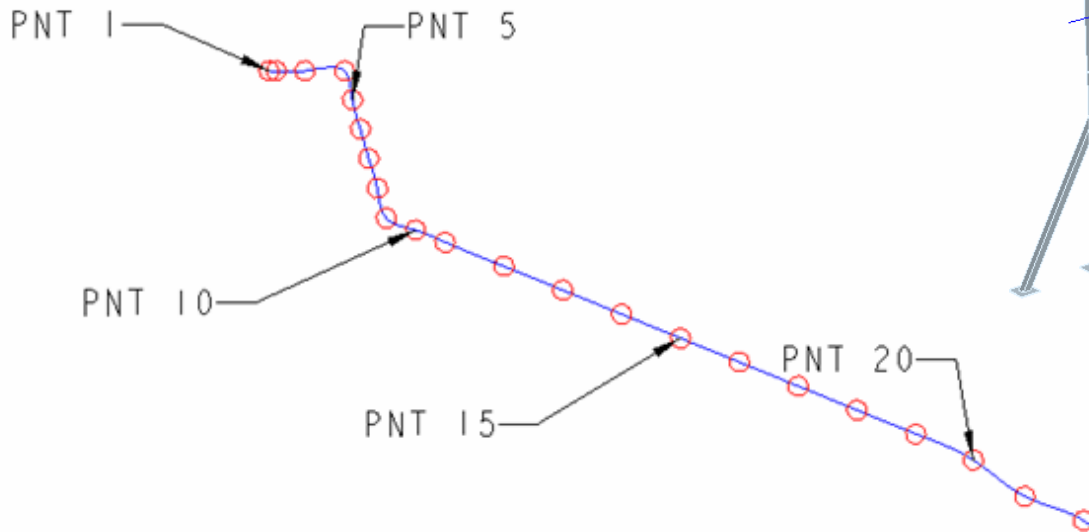
The concrete block motion was controlled by using a combination of the D-site crane, three chain-fall supports mounted to the crane hook and hand manipulation of the block for rotation.

25,000 lb concrete block

120" long, 40" wide and 60" high

The path traveled by each laser was plotted on sheets of velum and mounted to the screens, aligning pre-marked crosshairs located on the screen with marks on the printed paper

One-quarter inch circles were used to define the required laser positions along the curve path.

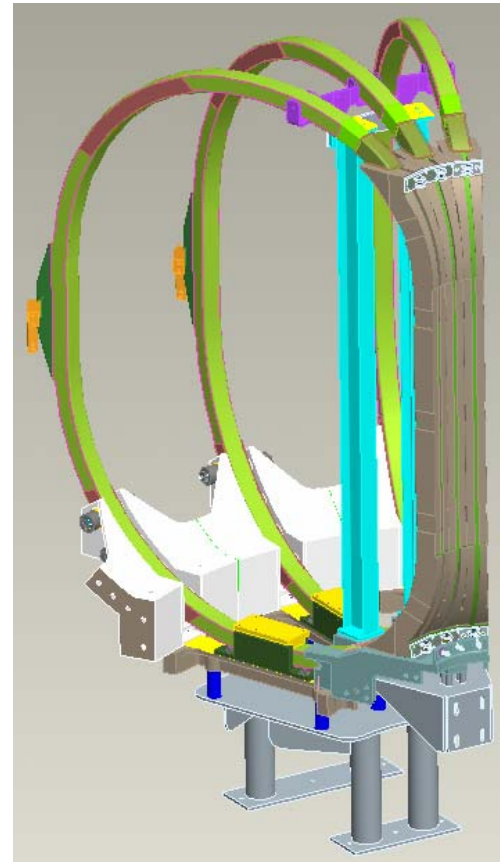
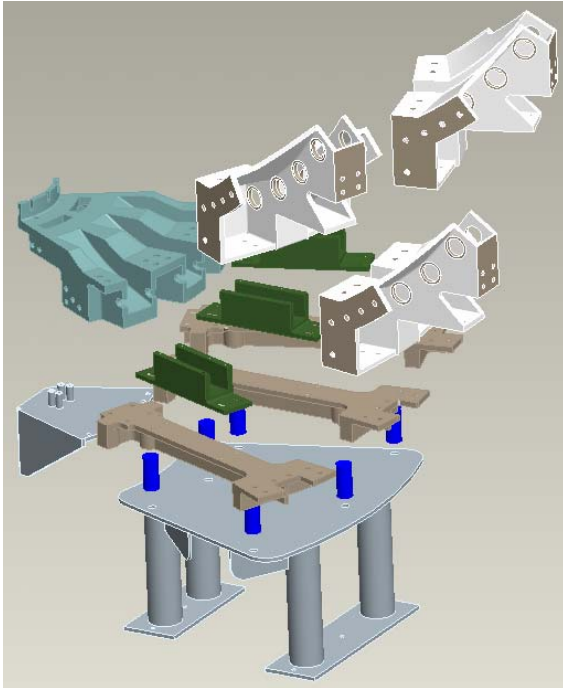


Improvements will be made using motor driven mechanical screws with in-line encoder.

The block was manipulated to follow the sequential points with an occasional maximum deviation of about $\frac{3}{4}$ " to 1", all within our allowed assembly tolerances.

TF Half Period Assembly– Stage 4

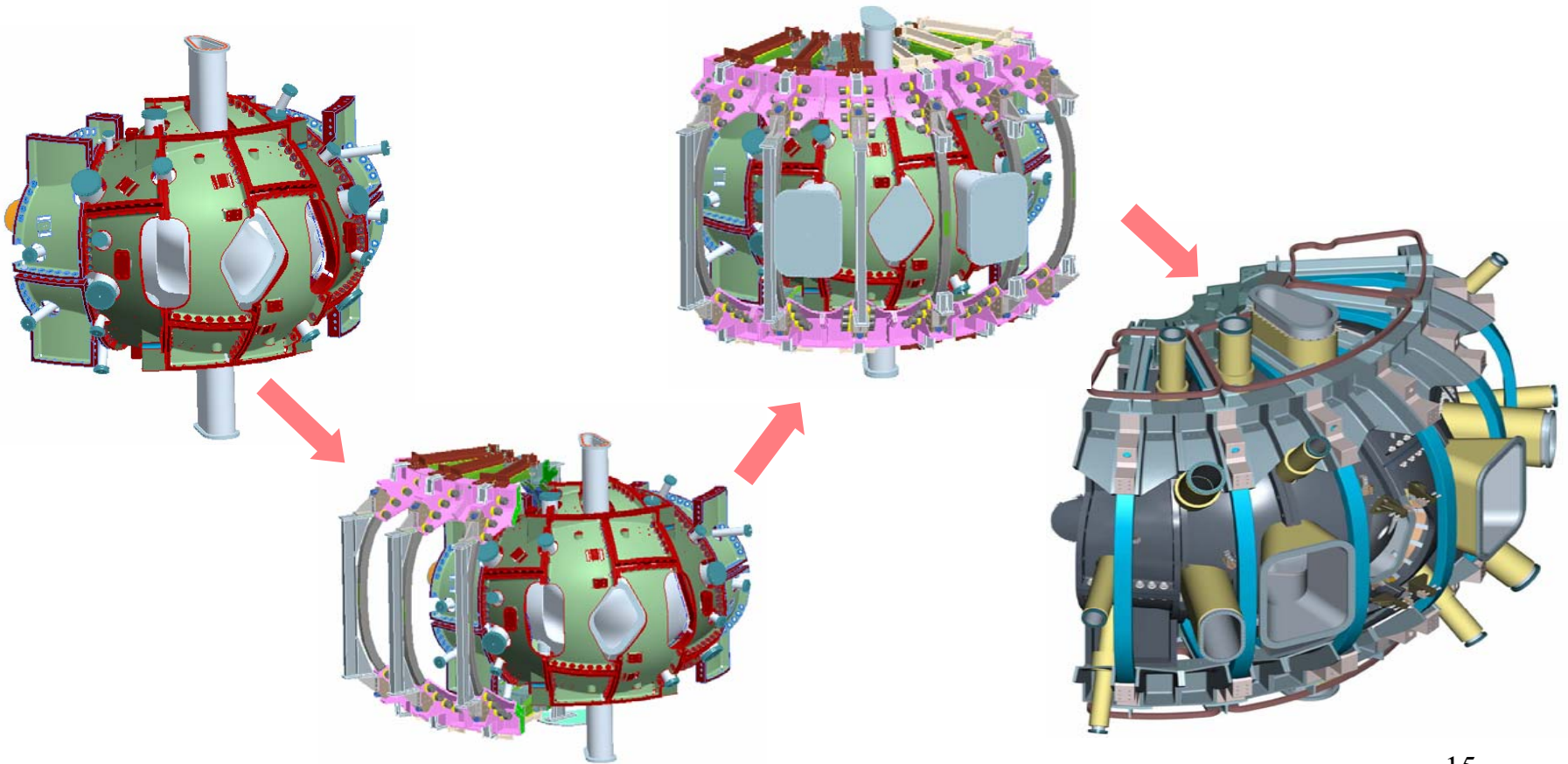
Stage 4 involves assembling three TF coils and structure into a three coil half period.



Final FP Assembly– Stage 5

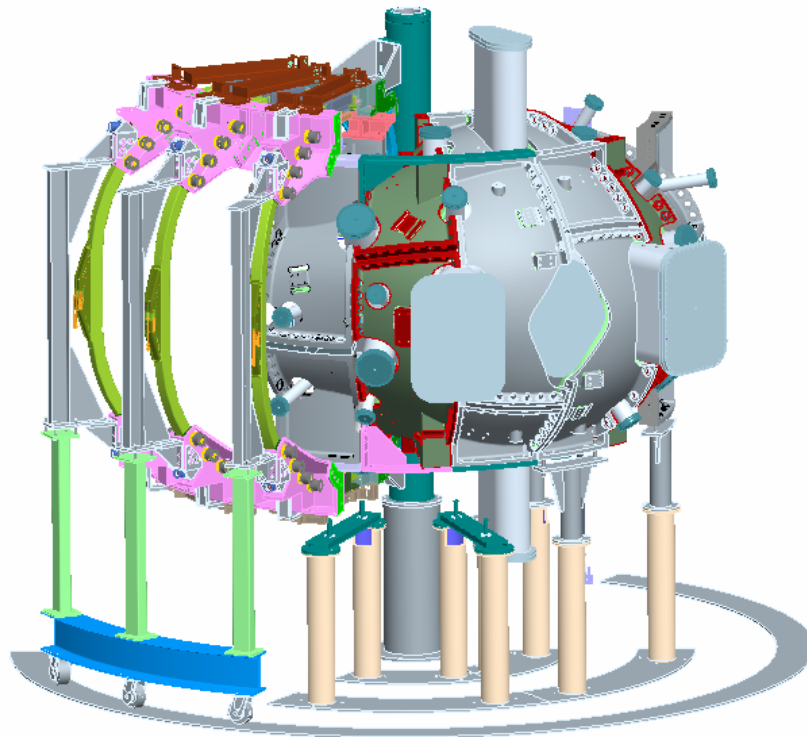


Stage 4 completes the FPA assembly process bringing together the VV/MCHP assembly, TFHP and attaching VV ports, correction coils and services.



Stage 5 assembly design details

Stage 5 Final FP Assembly details have been developed in sufficient detail to develop cost and schedule estimates.



FPA Plans & Schedule Development

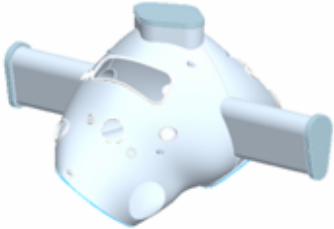
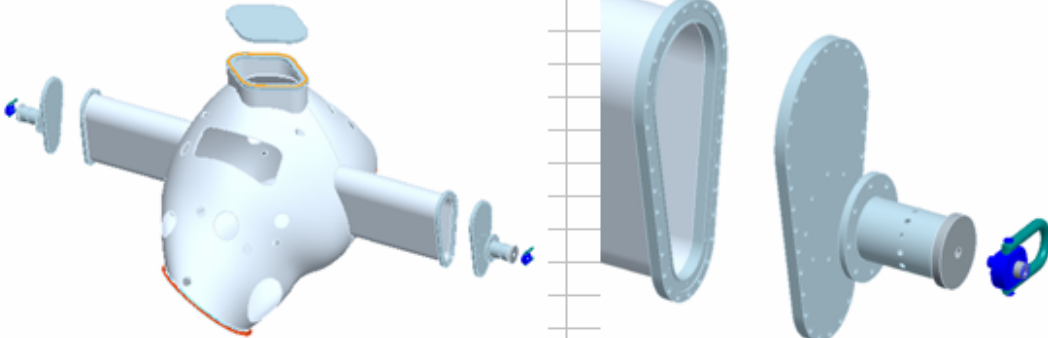


Assembly tasks are design driven and solidified through peer reviews. Assembly steps have been established for all five FPA Stages based on current design understanding.

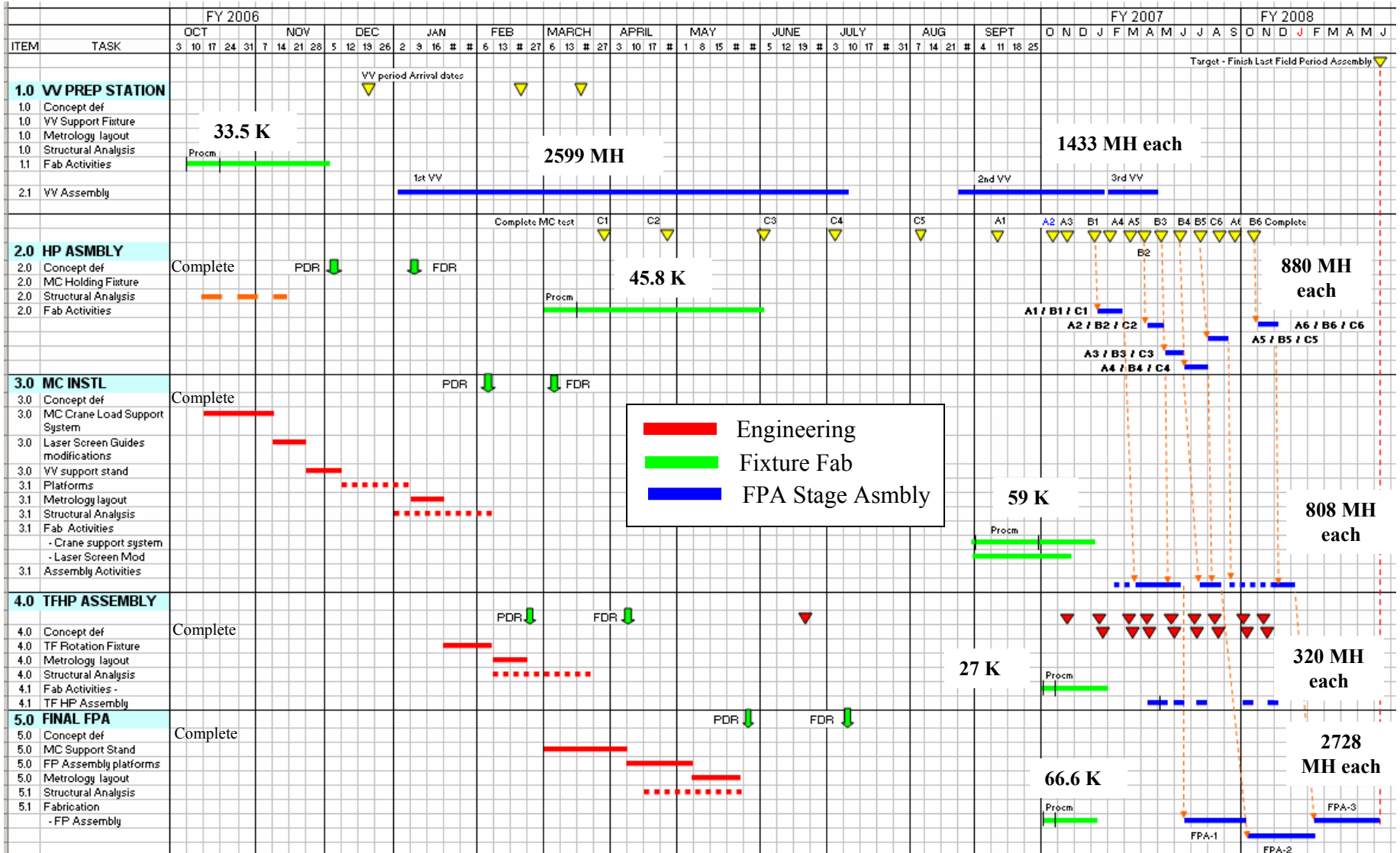
Step	Field Period Assembly Steps	Expected Days	nb men	man hrs	1 FTE Crane	Measurement	Comments
Stage 1 (VV Prep - max loops)		153		1023			FPA that includes 135 diagnostic sensors
1	Receive VV and Inspect	4					
2	Mount VV on VV Prep fixture (+60° position), see comment	1	3	24	X		
3	Establish metrology setting and monuments with respect to assembly	4	3	96	X	2	
4	Mark surface for 135 loop placement and verification check	24	1			1	4 marks for each of 135 loops (540 marks): Note 2
5	Mark surface for coolant line stud placement (on half period)	4					600 studs per period at ~ 8" spacing. Metrology will be used to locate marks based on CAD defined locations. Fine accuracy is NOT important.
6	Attach studs (hardware) on for mounting coolant lines.	5	3	120	X		300 studs at ~ 8" spacing. [300 studs / 10 studs per hr / 6 hrs per day] Per Mike Viola, assume 10 studs per hr
7	Install diagnostic loops	23	3	540	X	2	[135 diagnostic loops / 1 per hr / 6 hrs per day]
8	Run diagnostic loop leads	6					Assumes 4 loops / hr, per George Labik
9	Loop termination and verification check	45					Assumes 1 hr/wire and 2 wires per loop, per George Labik
10	Install cooling lines to vacuum vessel	11	2	171			Assumes 3 tubes per day, per Goranson. There are 64 tubes per period.
11	Rotate VV to - 60° position and establish metrology settings	2					
12	Mark surface for 7 loop placement and verification check	2					
13	Mark surface for coolant line stud placement (on half period)	4					

Input to MIT/QA pan

Finalized process steps developed for Stage 1 will be used as input to MIT/QA pan

Stage 1 (VV Prep - max loops)		
Item	Assembly Step	Comments
1.0	Receive VV and Inspect	Receive and perform visual inspection. Take metrology measurements.
		
1.1.0	Replace port flanges with Stage 1 assembly flanges	
1.1.1	Remove two horizontal port flanges	Horizontal ports have 32 bolt assemblies; bag hardware for future use
1.1.2	Remove horizontal port vacuum seal	"White glove" removal needed to protect the vacuum surface. Bag for future use.
1.1.3	Remove NB port flange and hardware	NB port has 34 bolt assemblies; bag hardware for future use
1.1.3	Remove NB port vacuum seal	"White glove" removal needed to protect the vacuum surface. Bag for future use.
1.1.4	Attach Stage 1 port flanges	Insert bolt assemblies into every other hole.
		

FPA activities are in-line with project schedules



Summary

- The FPA plans are in place to meet the NCSX FPA assembly requirements,
- A sound basis has been established for FPA cost assessments, and
- R&D activities have been used to reduce FPA risks.