TPOT Technical Review Mechanics

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July 20th, 2022

Talk Outline:

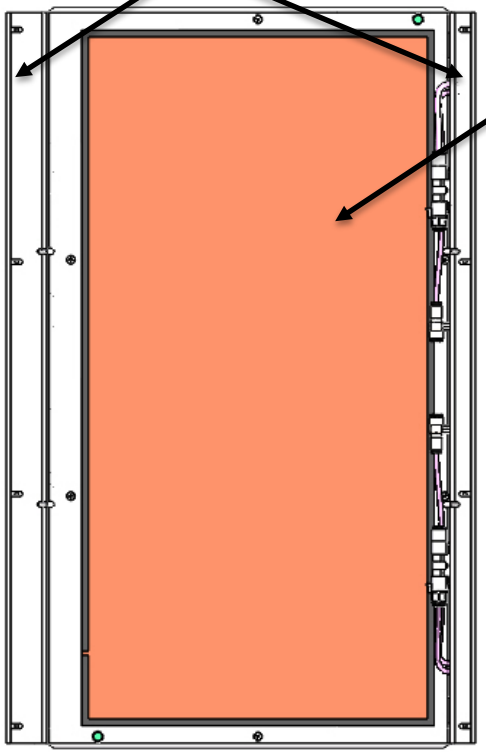
- TPOT module assembly
- TPOT 2 module sector array
- TPOT 4 module sector array
- TPOT 3 sector assembly, plus mechanical analysis
- TPOT 3 sector FEA analysis
- TPOT mid-span support
- TPOT clearances with the TPC and EMCal detectors
- TPOT installation
  - Modification to sPHENIX TPC installation fixture

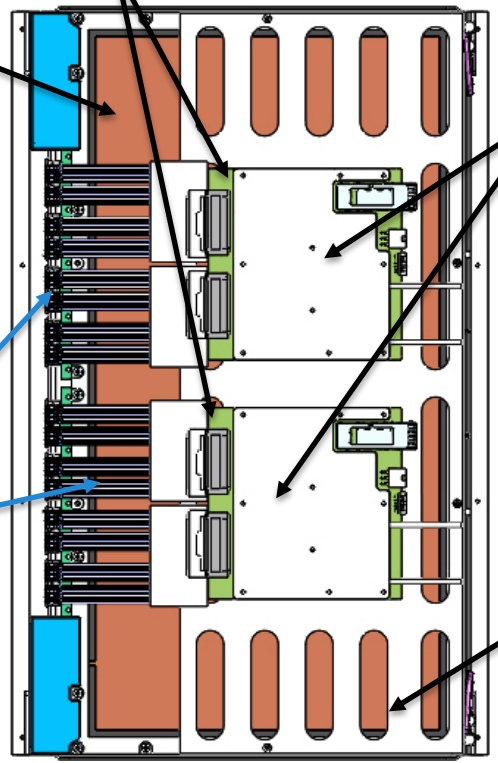
TPOT module assembly:

New detector metal support tray

TPOT Z & phi panels

FEE boards (same as used for TPC)





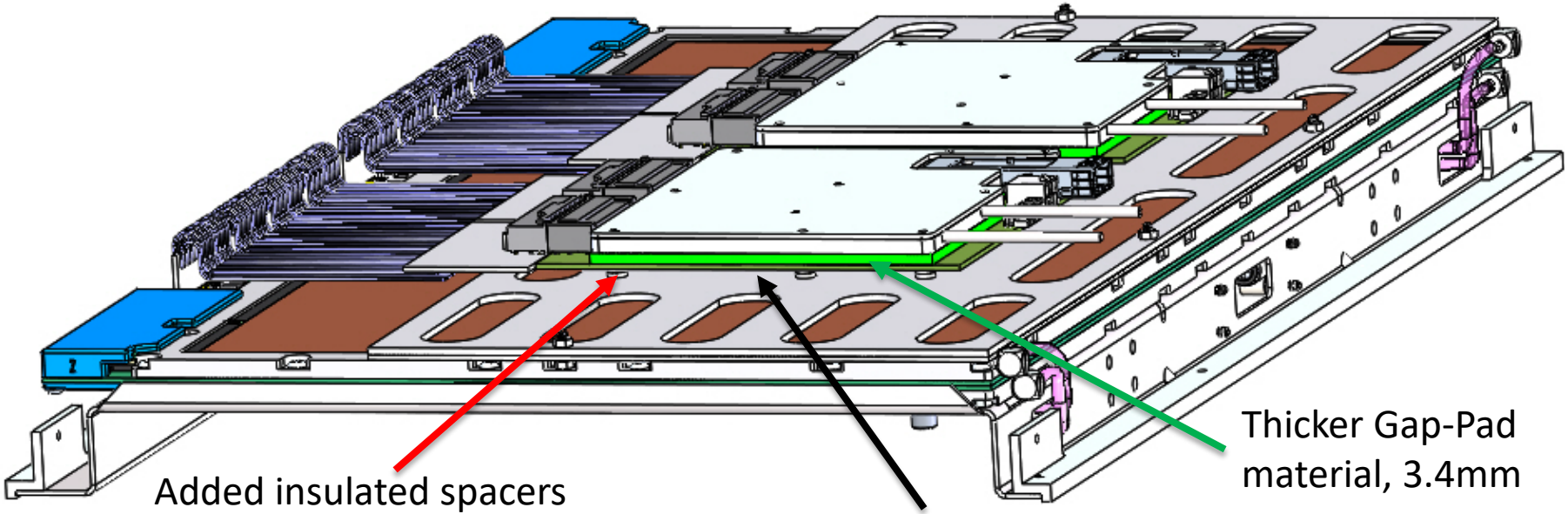
FEE board cooling plate. See thermal study in Back-up slides

Samtec interconnect ribbon cables

Aluminum shielding plate

Estimated power dissipation 20 watts/FEE board, 40 watts per module

Micromegas module – updated:



Added insulated spacers between the FEE board and the aluminum shied plate prevent accidental shorting

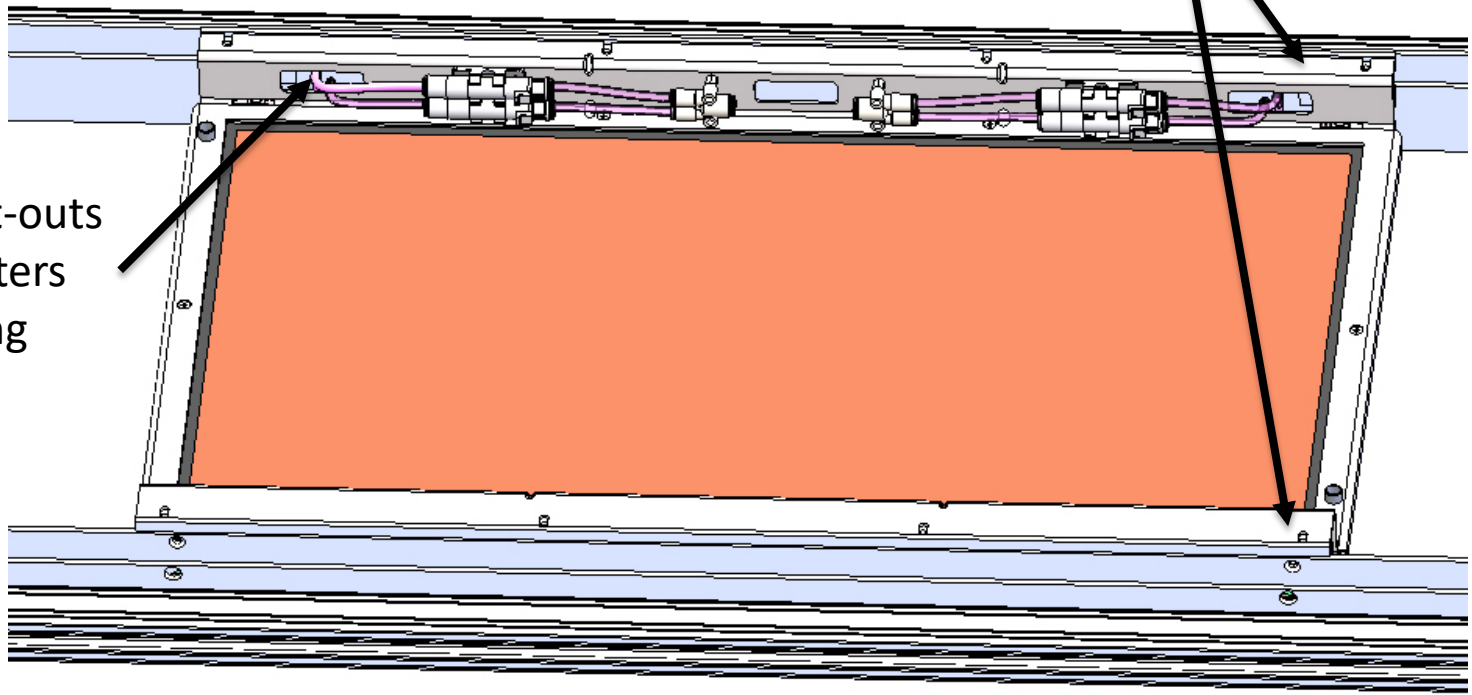
Added a layer of Kapton tape to shield plate, under FEE boards

Thicker Gap-Pad material, 3.4mm

Service channels and tray supports:

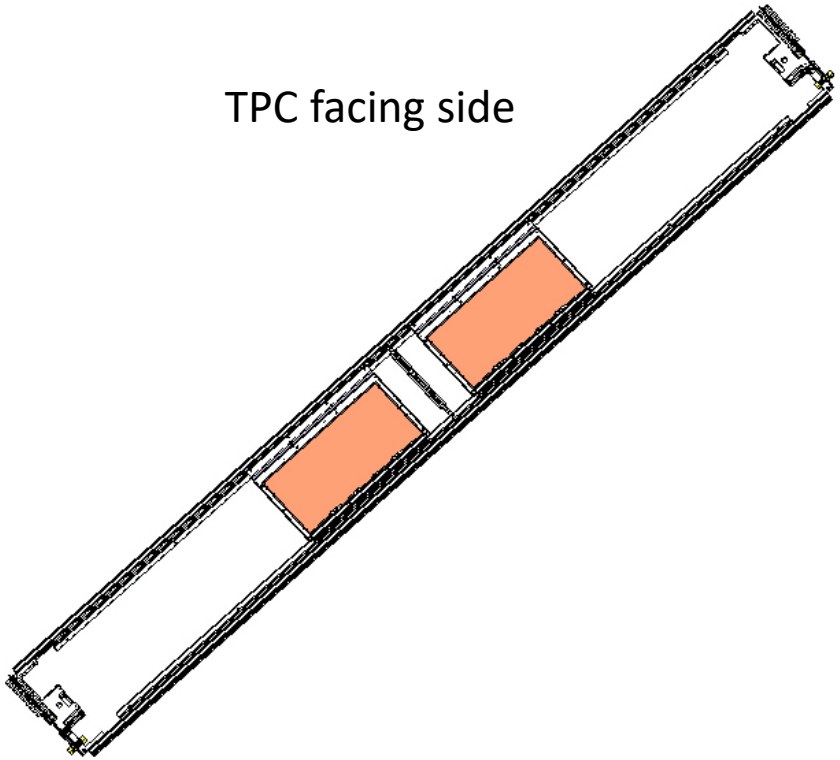
New tray support bracket to cable/service channel

Added cut-outs for gas, filters and cooling lines

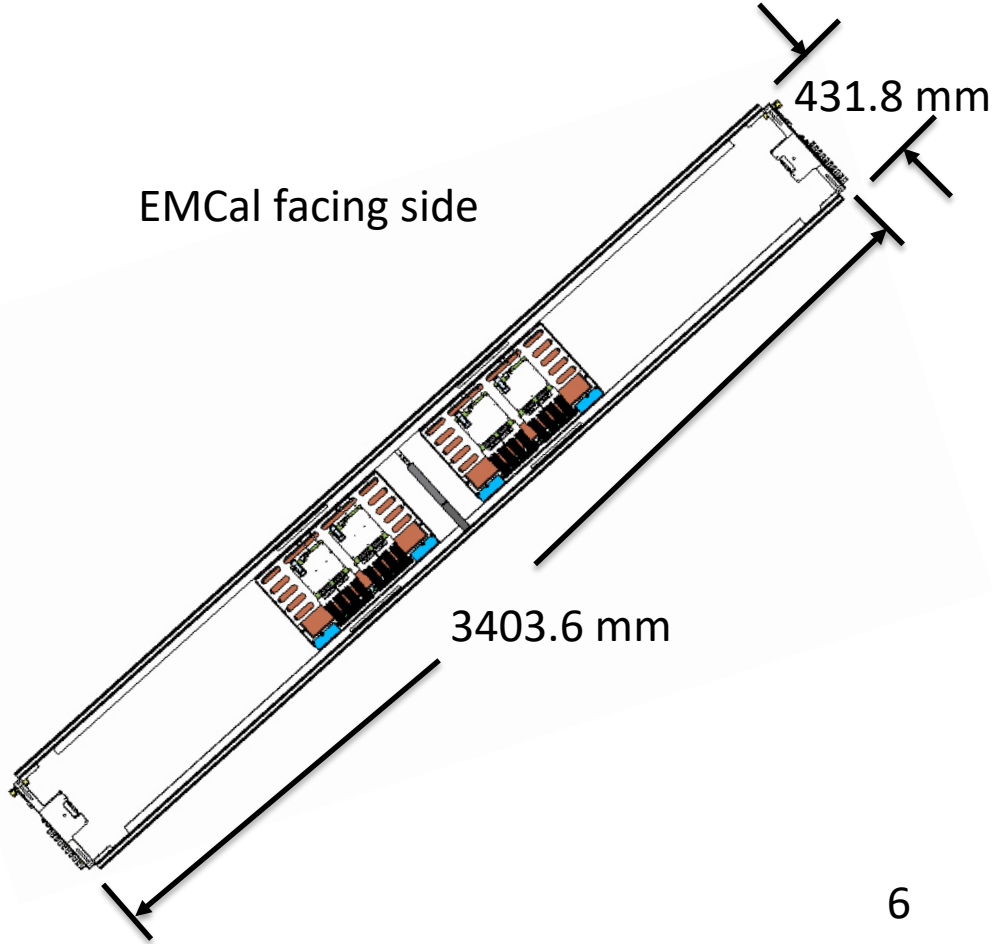


Two detector sector assembly:

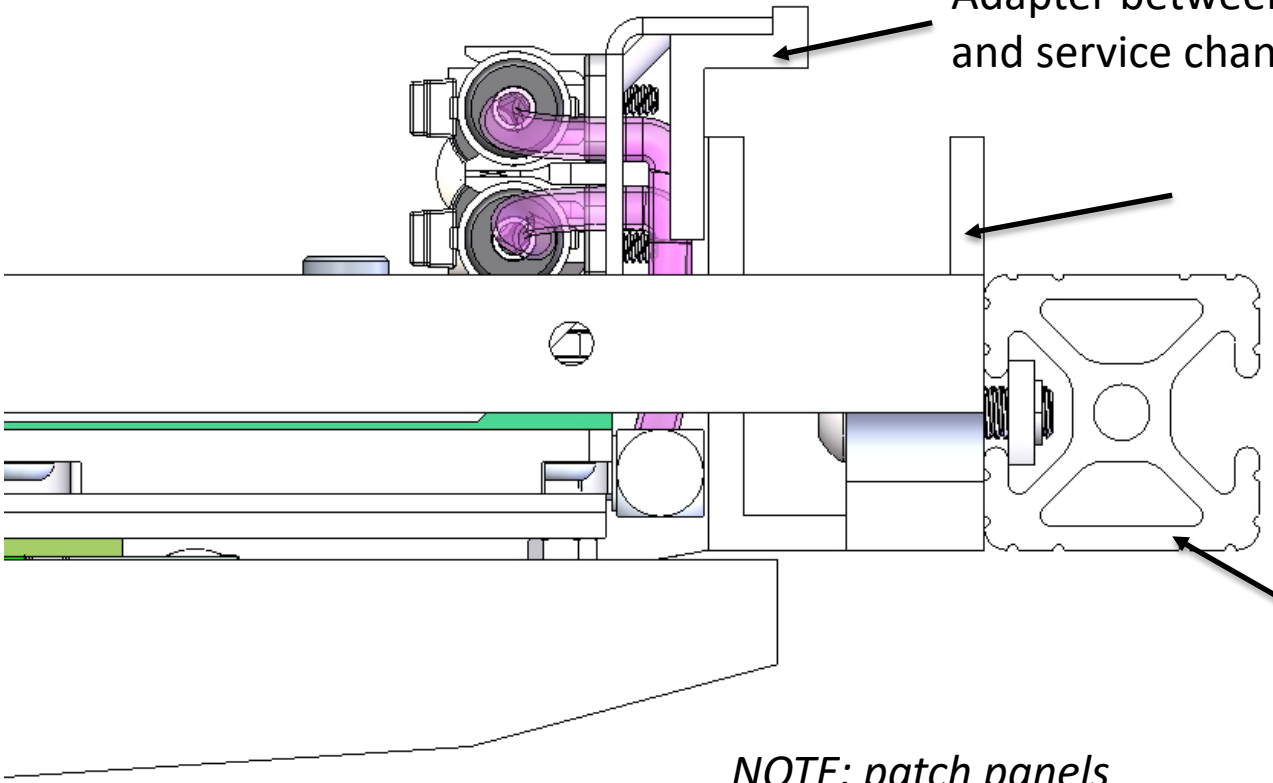
TPC facing side



EMCal facing side

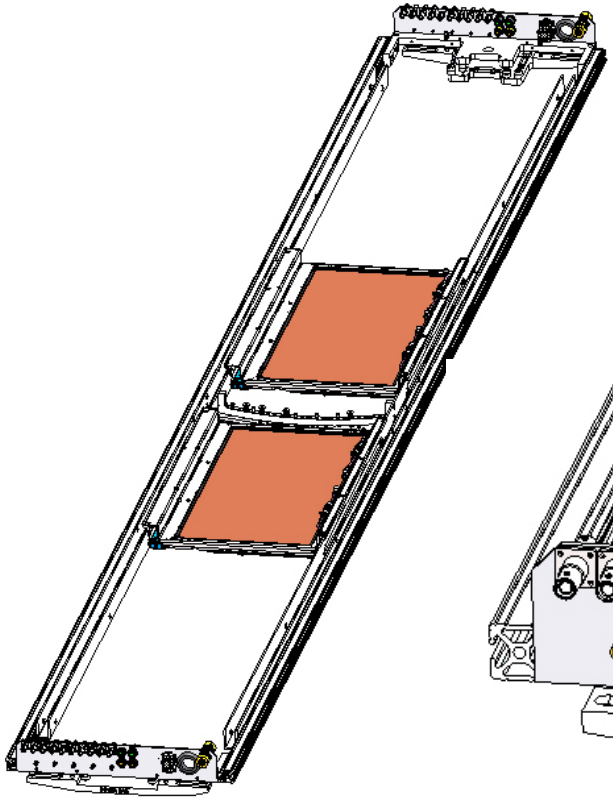


Sector frame detail-80-20,service tray:



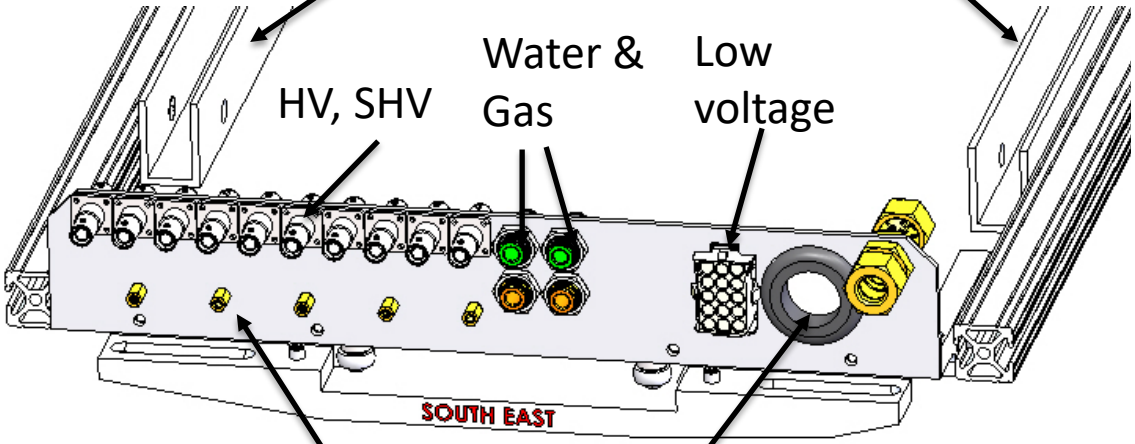
NOTE; patch panels suppressed in this view

TPOT two module sector, detail patch panel:



PATCH PANEL, one for each module;

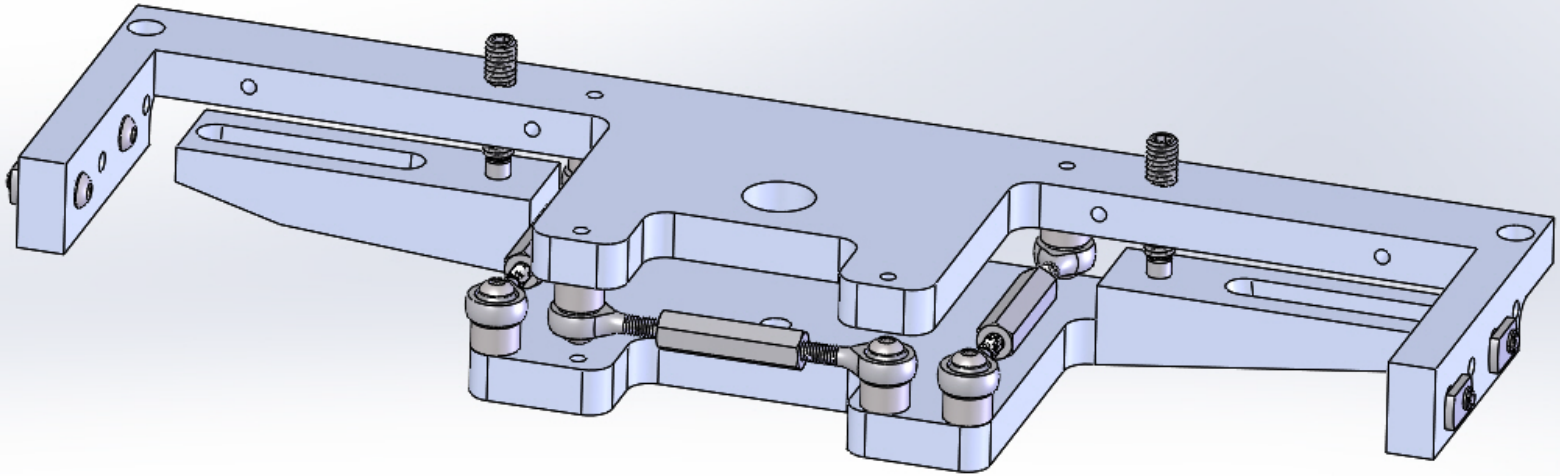
Services support trays



Estimated weight 25. kgms

TPOT sector adjustment capability;

Y adjustment via swivel head set screws

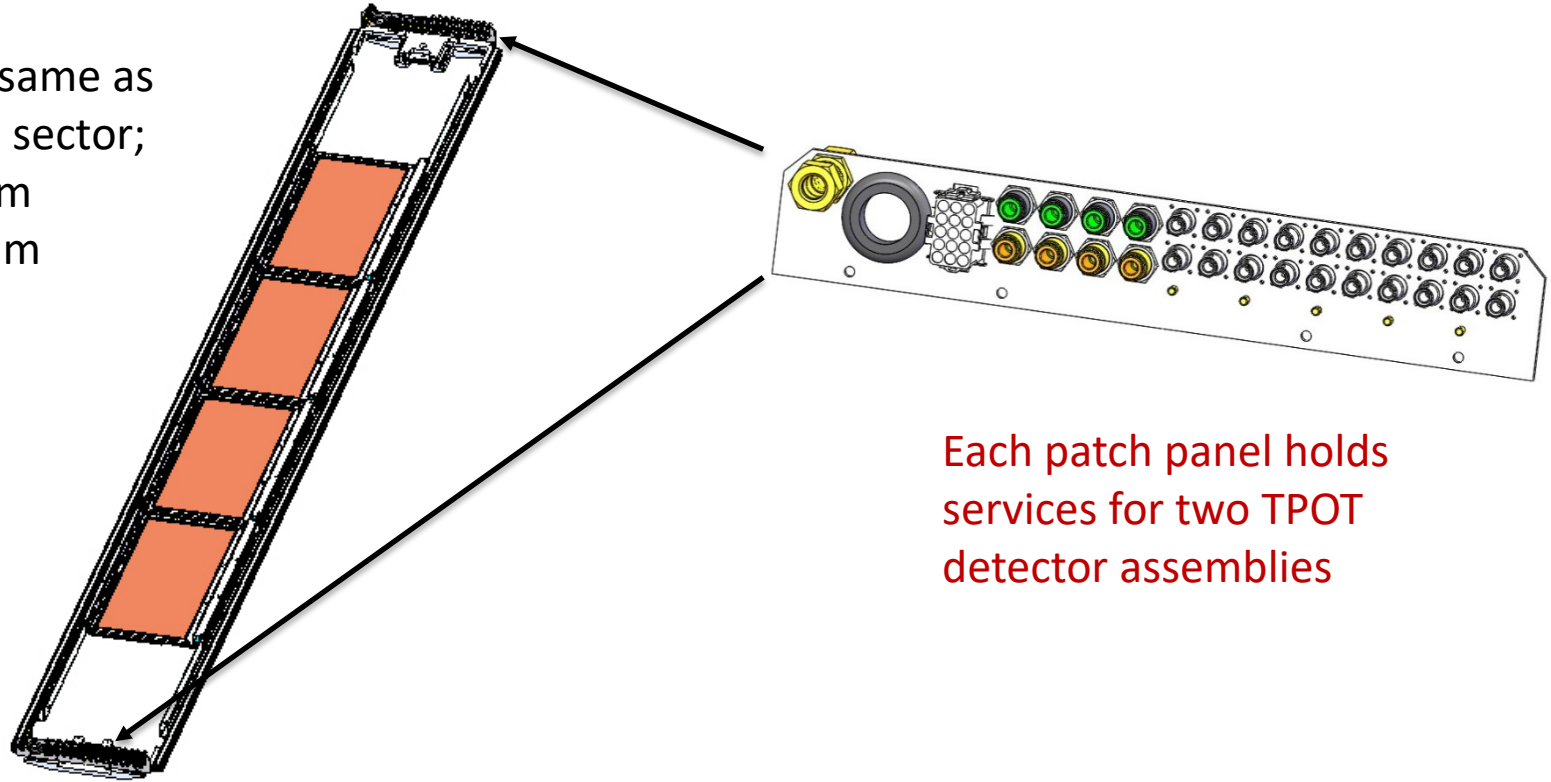


X & Z adjustment via turnbuckles

Same mechanical assembly at the end of each sector assembly

TPOT four module sector, detail patch panel;

Overall size same as two module sector;
L= 3403.6mm
W= 431.8 mm

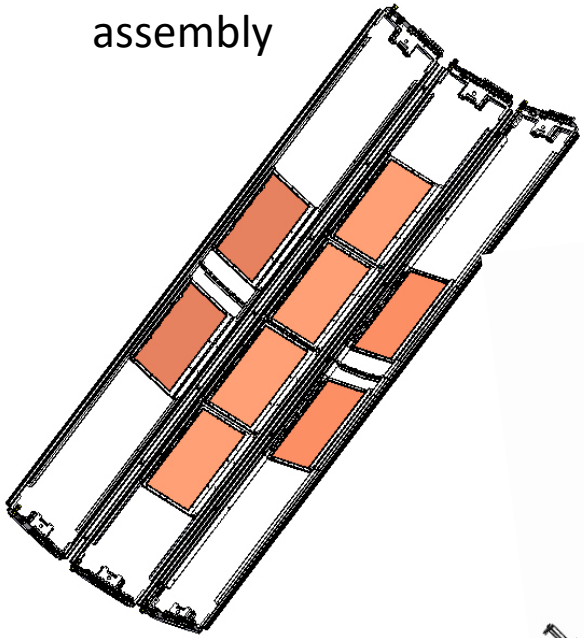


Each patch panel holds services for two TPOT detector assemblies

Estimated weight 35 kgms

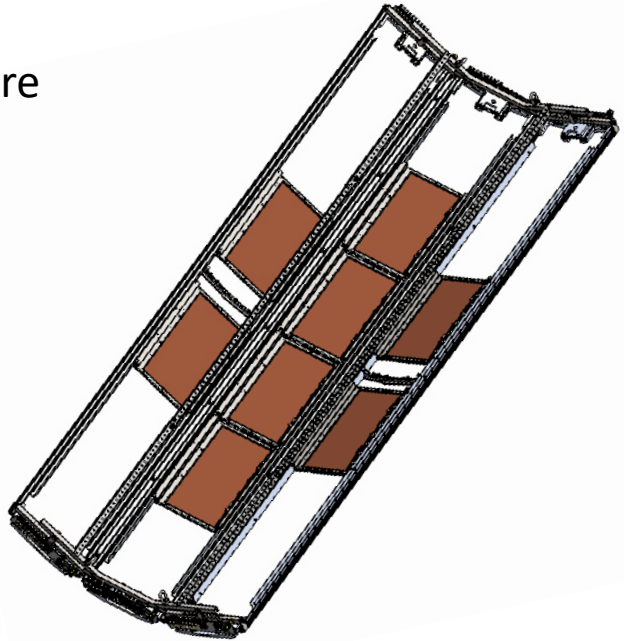
TPOT 3 sector assembly w lifting fixture;

Three sector TPOT assembly



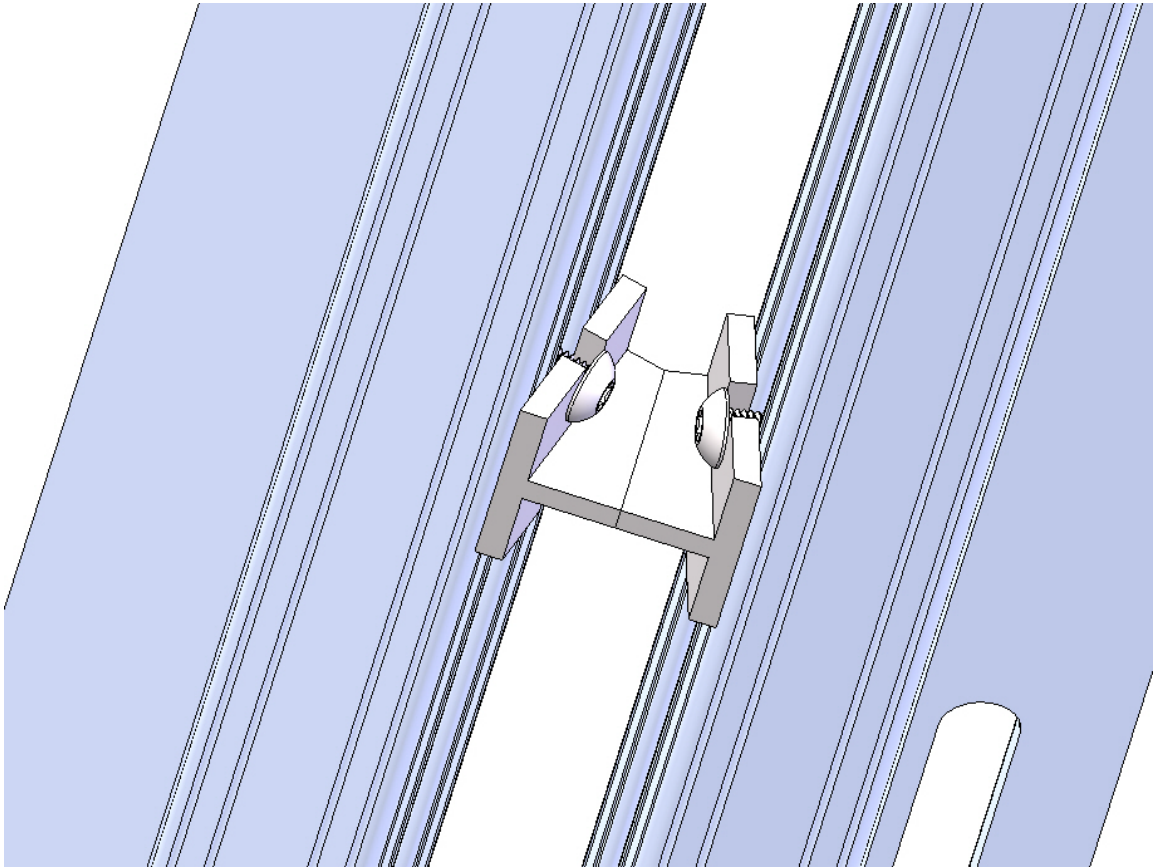
TPOT lifting fixture

TPOT detector with lifting fixture



TPOT three sector assembly, sector to sector joints;

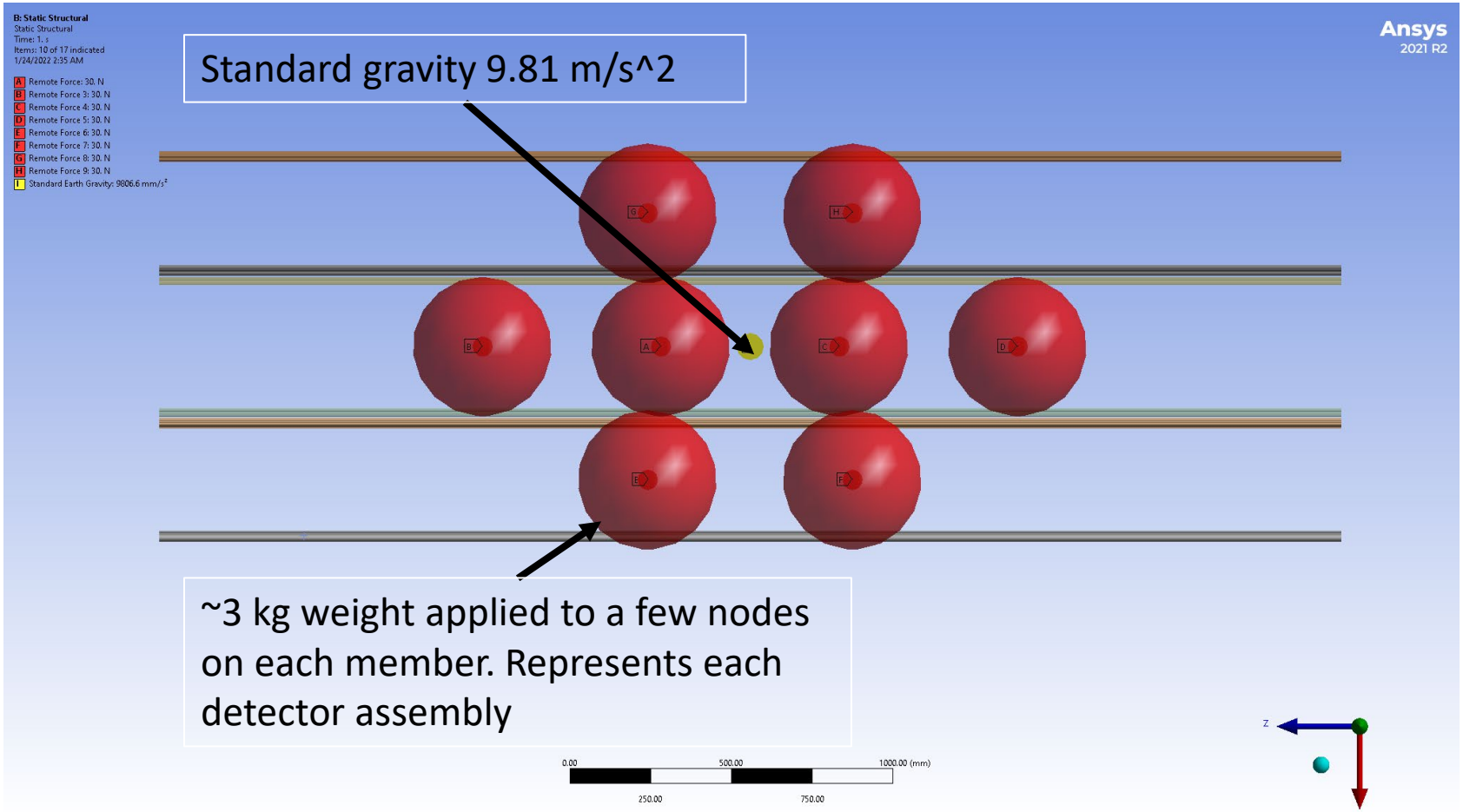
Seven of these between two adjacent sectors, fourteen total in assembly



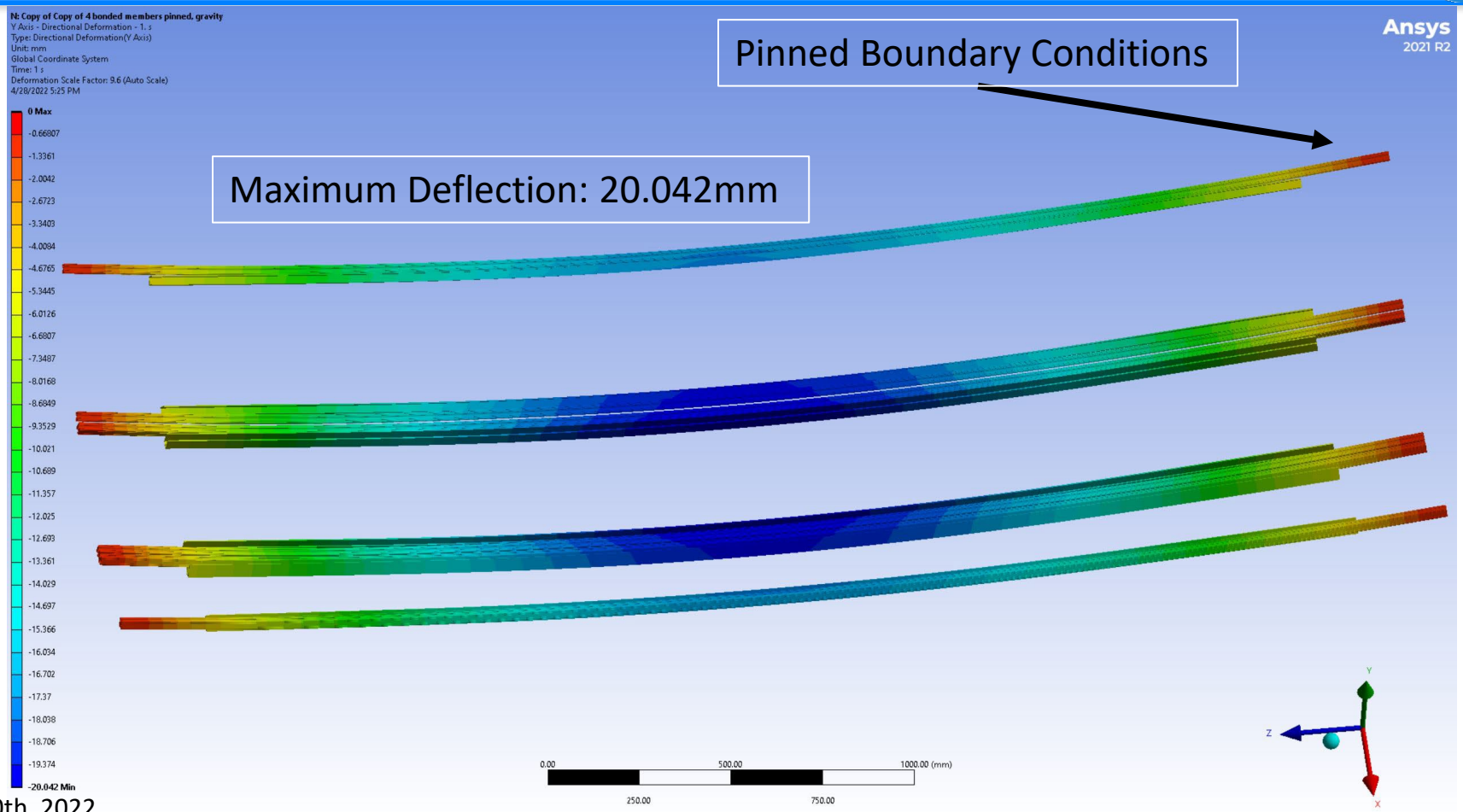
ANSYS mechanical analysis TPOT sector assembly:

- Model run:
  - 1. With architectural members (service channels) pinned patch panel connections
    - In addition joints to represent the architectural members bonded to 80/20
    - Connections between sectors is included

ANSYS analysis of TPOT sector assembly, total mass 200 kgms;

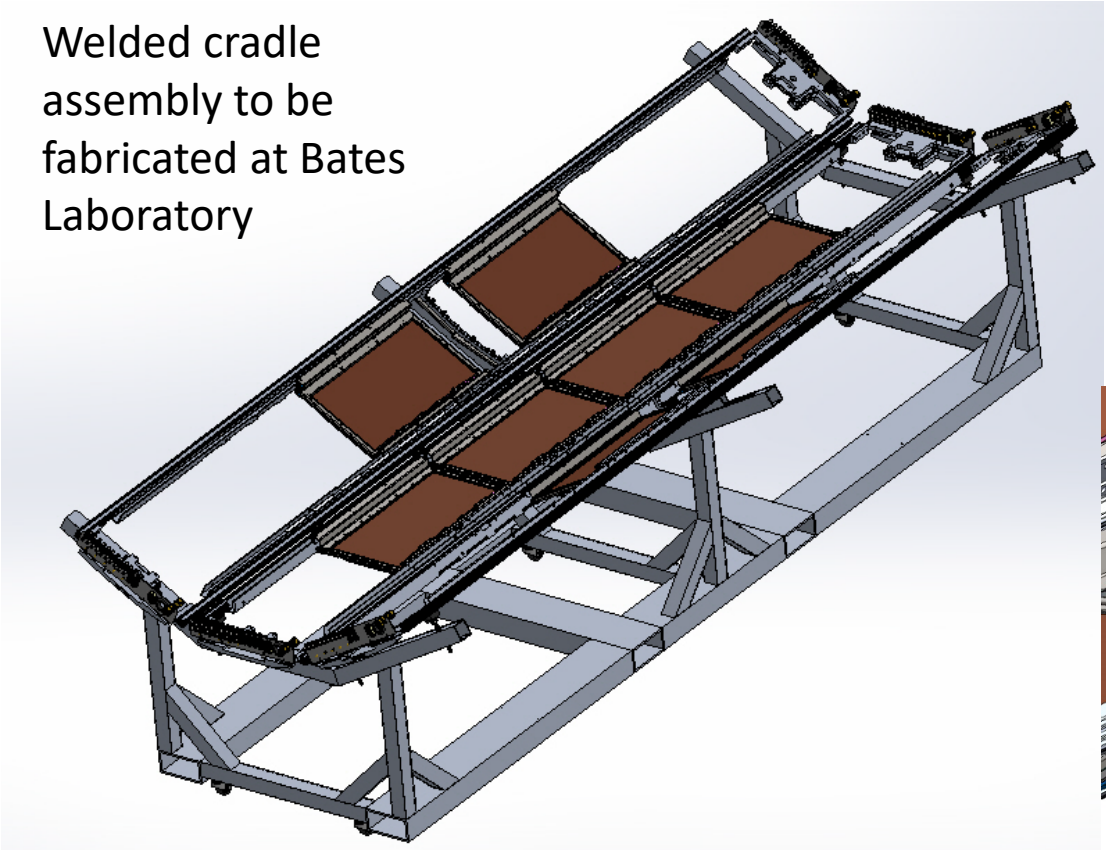


ANSYS analysis of TPOT assembly; max deflection 20.0 mm

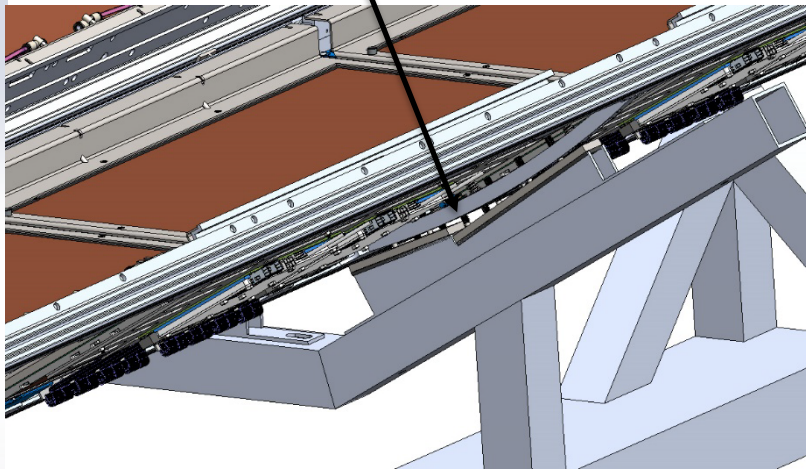


Assembly cradle – mid-span supports:

Welded cradle assembly to be fabricated at Bates Laboratory

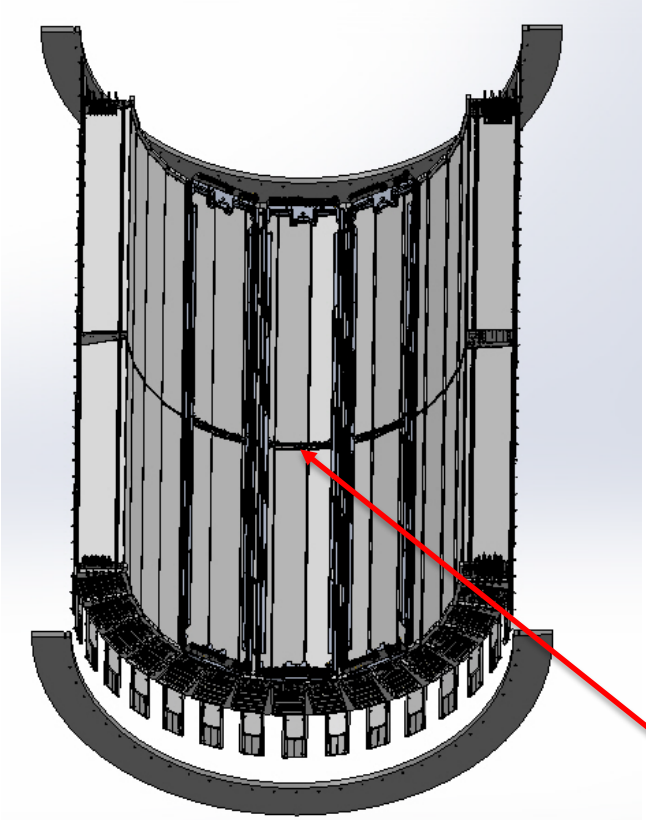


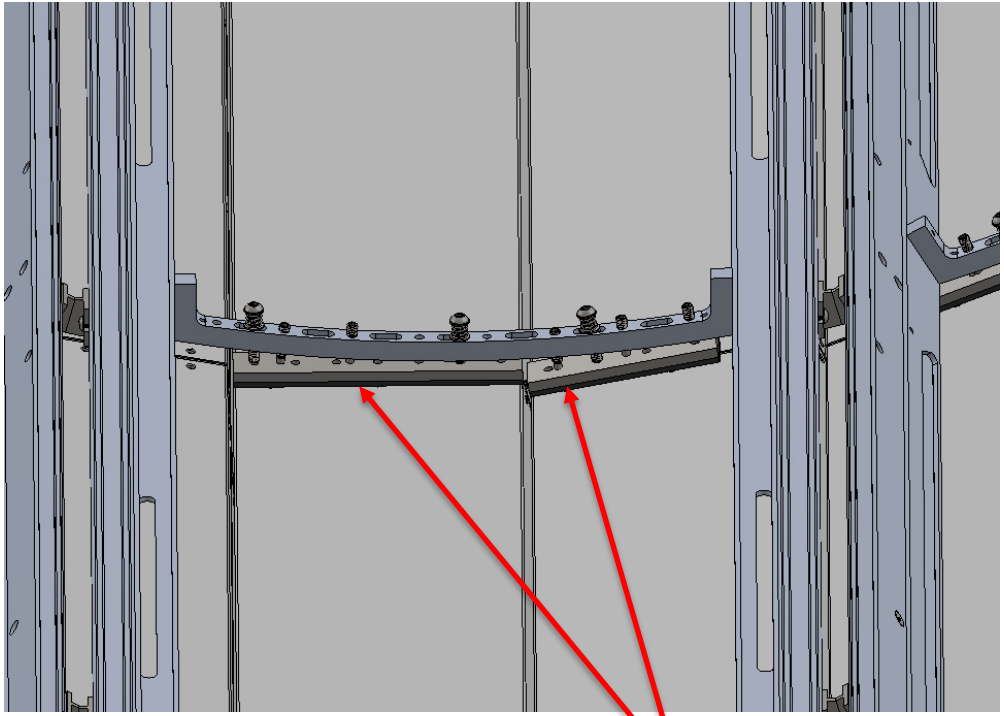
See next couple of slides showing how mid-span support works with EMCal sectors to minimize deflection



TPOT sectors, mid-span support to EMCal

TPOT, minus modules, EMCal model sectioned



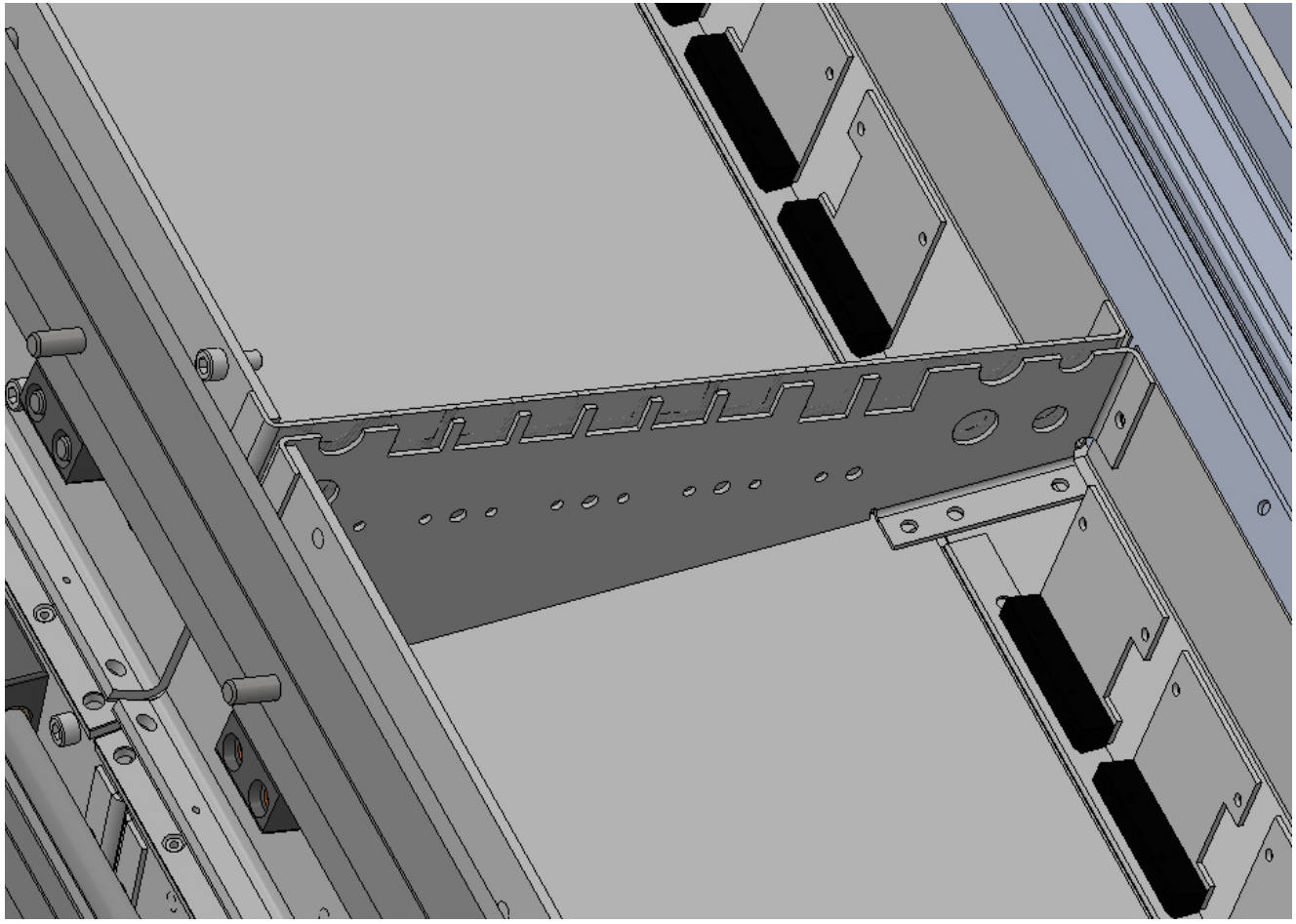


Aluminum plates with padding

TPOT mid-span support, four panel sector

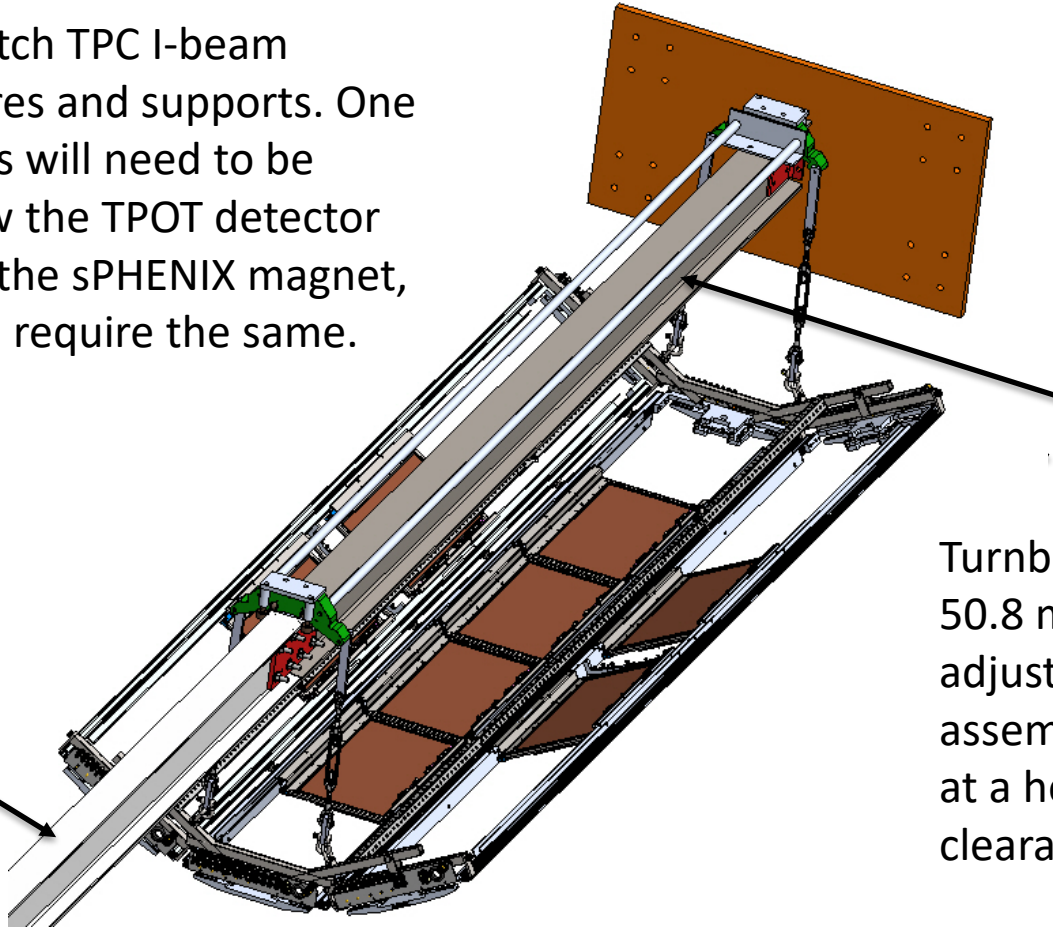
TPOT EMCal model sectioned:

Detail view of the panels that make a full EMCal sector. This is where the TPOT mid-span support rests against. View shows EMCal sector sliced.



TPOT detector connected to I-beam:

TPOT I-beam match TPC I-beam installation fixtures and supports. One of these supports will need to be removed to allow the TPOT detector to translate into the sPHENIX magnet, TPC detector will require the same.



Attachment plate to first Muon-ID North plate

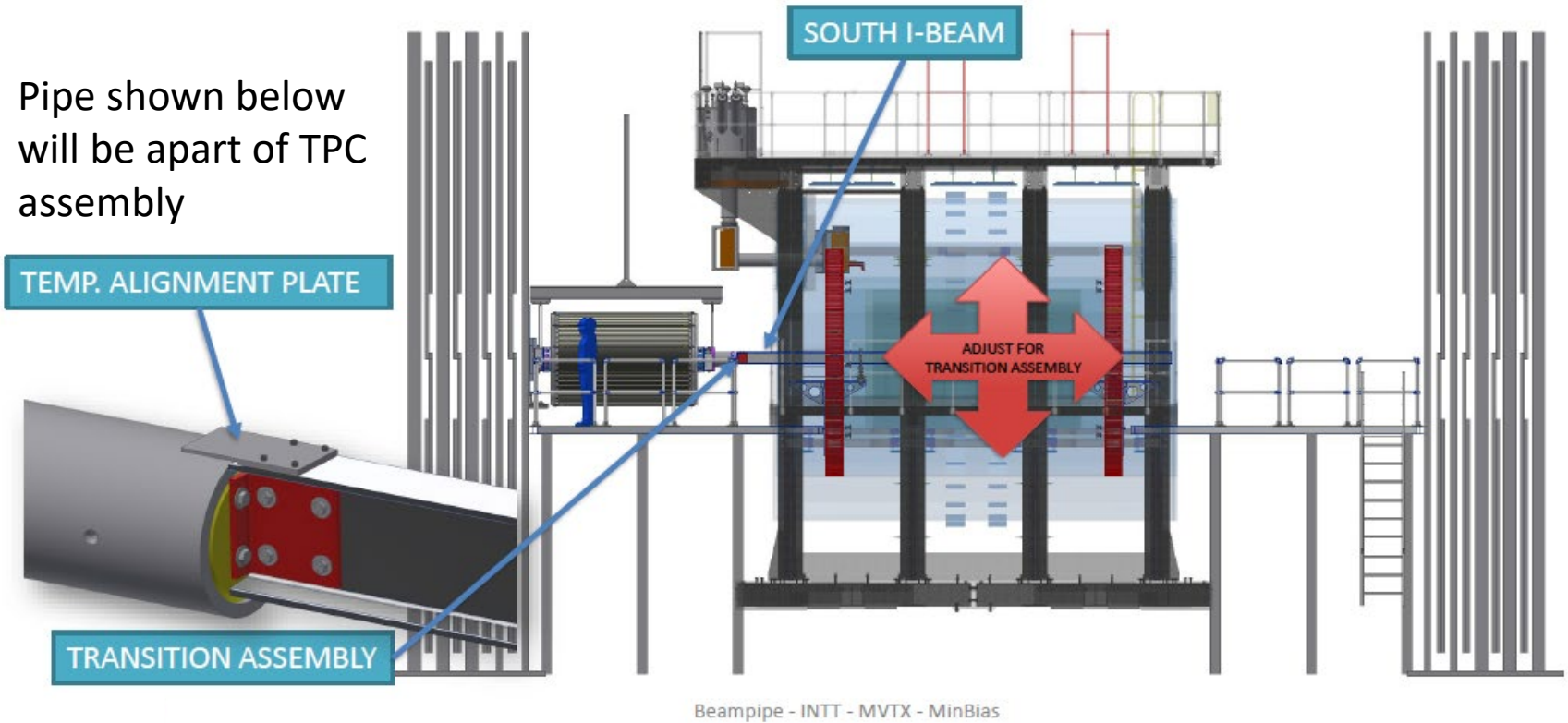
TPOT I-beam

TPC I-beams

Turnbuckles give at least 50.8 mm of vertical adjustment. TPOT assembly will be preset at a height to give clearance from EMCal

TPC INSTALLATION

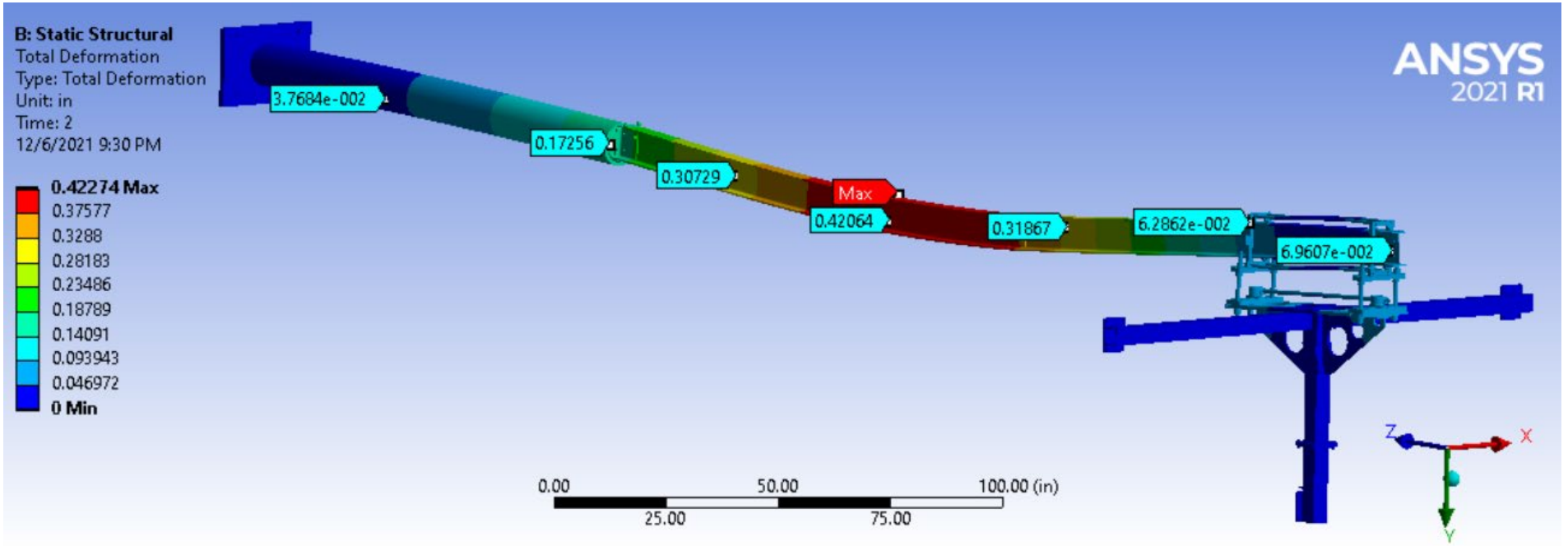
Pipe shown below will be apart of TPC assembly



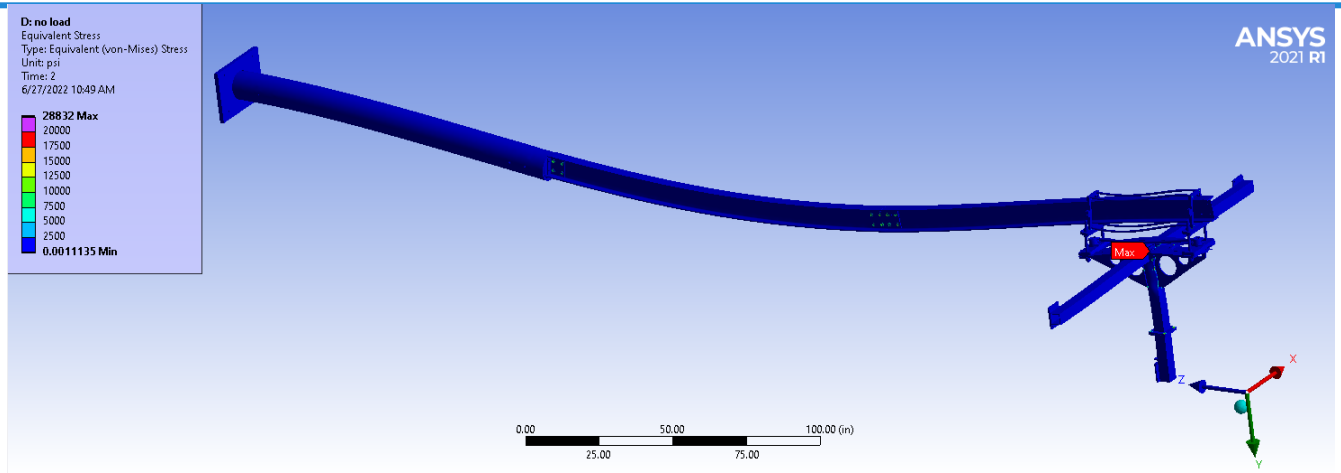
Slide from R. Ruggiero TPC installation sequence

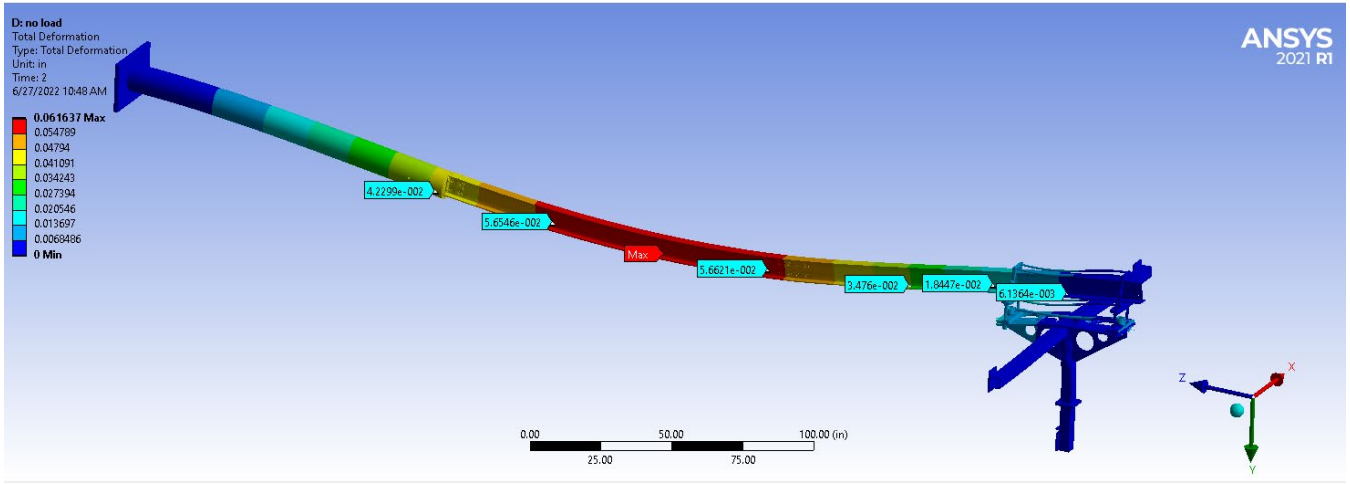
Analysis of sag in I-beam assembly, TPC

Installation beam deflection without middle support, 2,000-pound load from TPC added, max deflection .42 inches, 10.668 mm, TPOT 1/10th the mass



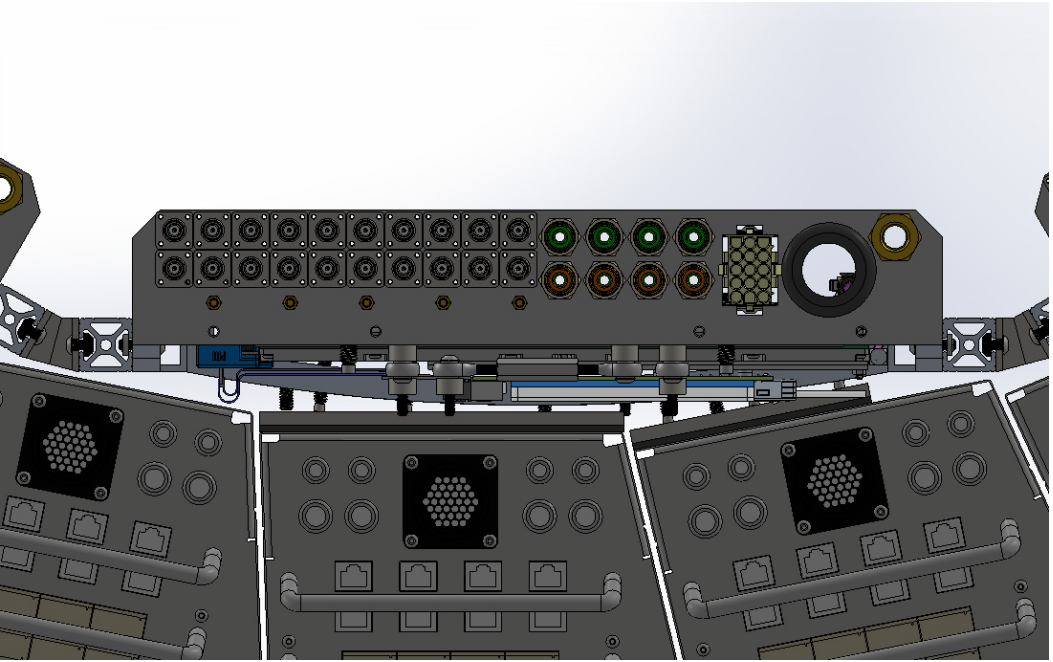
I-beam assembly analysis w/o support:



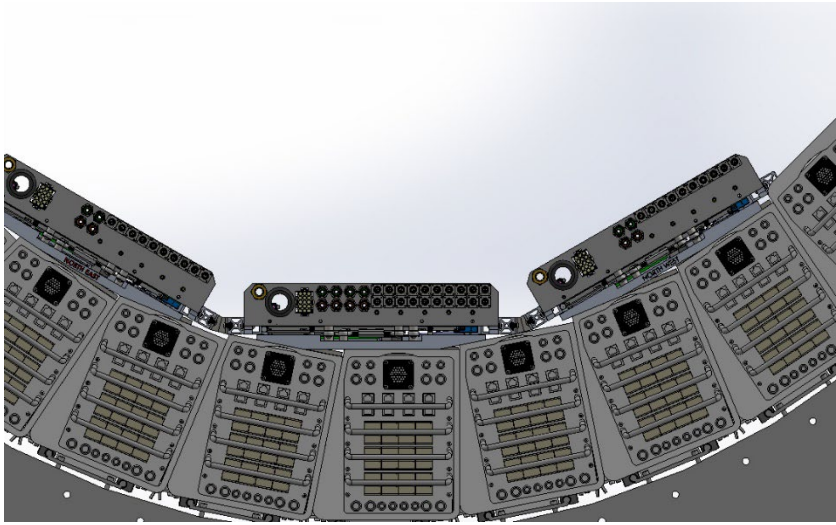


Analysis performed by Christopher Runyan, BNL. Max deflection 1.575 mm

TPC-EMCal-TPOT assembly, details;

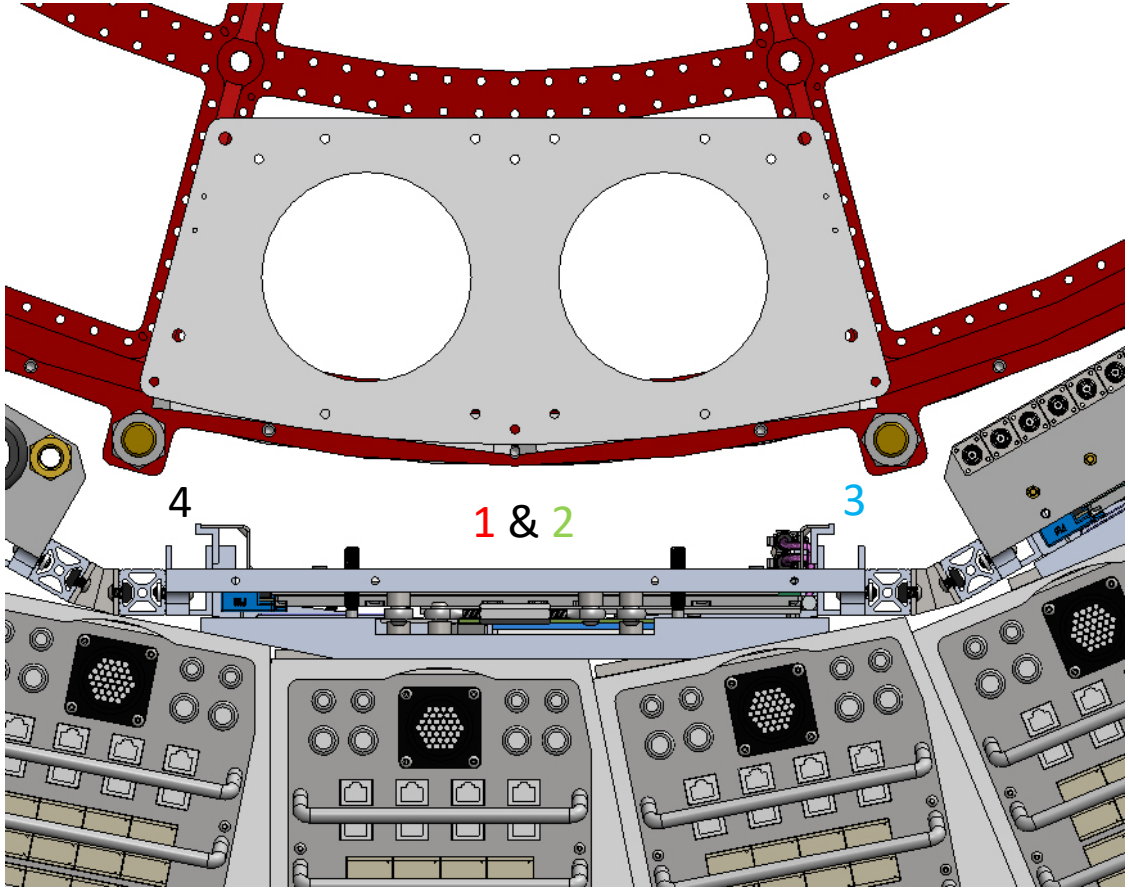


Spacing between TPOT and EMCal sections, picture frames, support pieces suppressed



End view of TPOT detector, no parts suppressed.

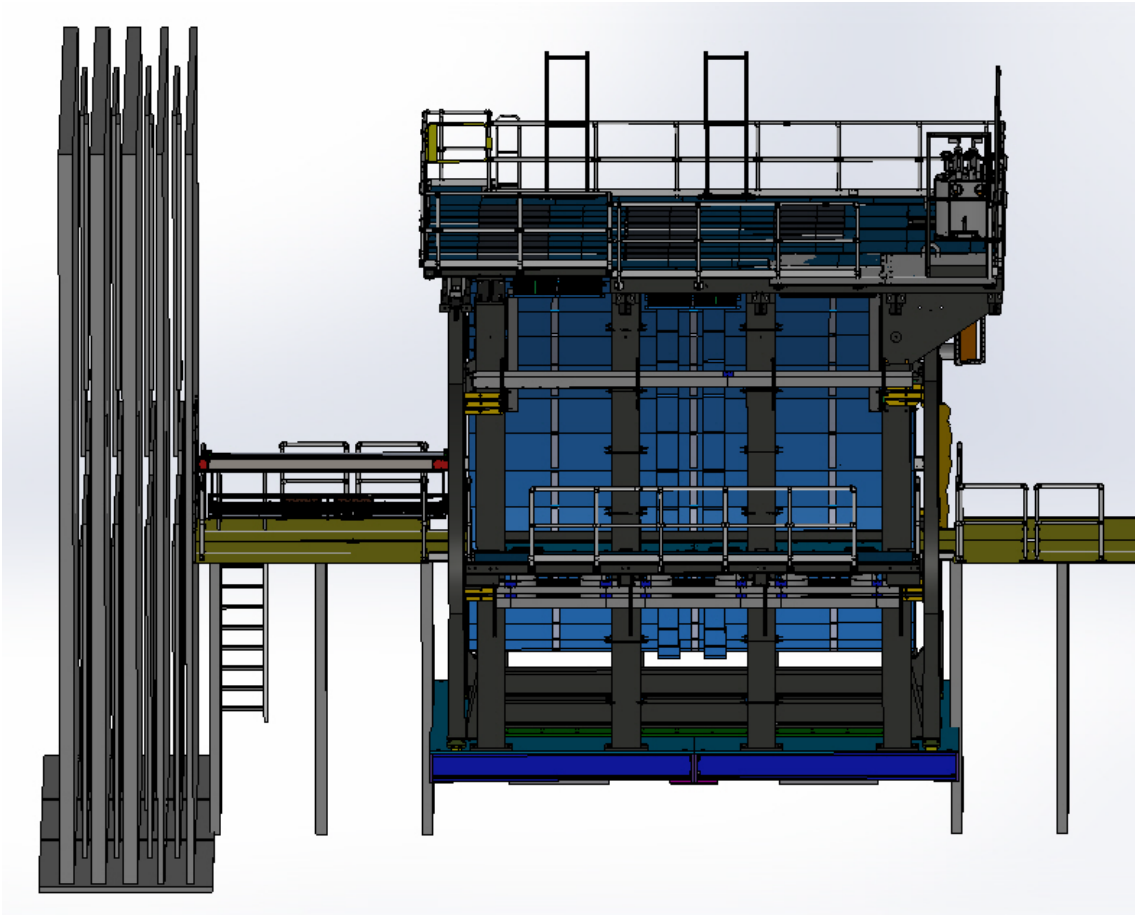
TPC-EMCal-TPOT assembly, details;



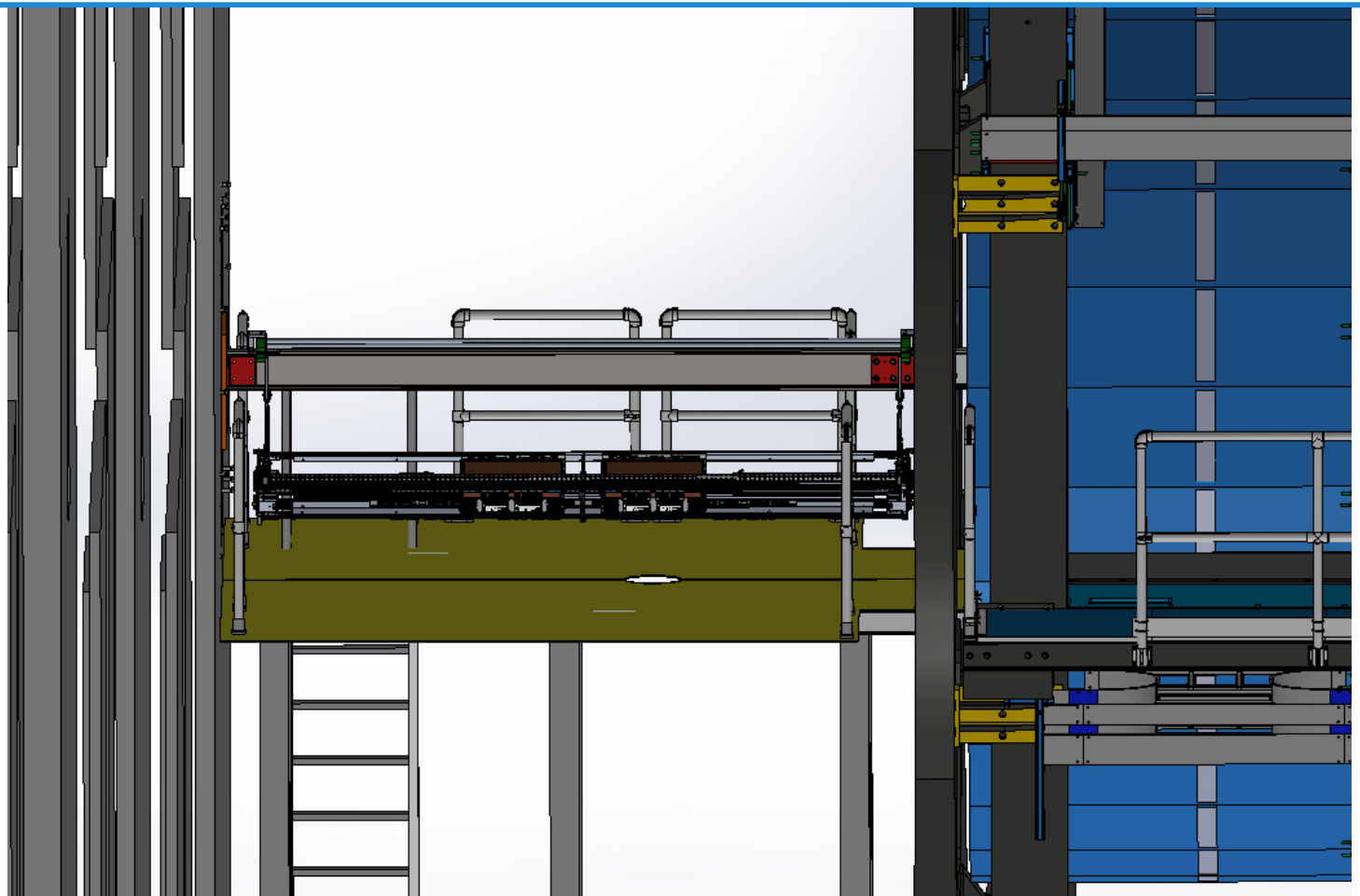
Measured gaps between TPC framework and TPOT assembly:
Gap 1, gray aluminum plate and TPOT trays – 71.53 mm
Gap 2, red TPC framework and TPOT trays – 60.03 mm
Gap 3, TPOT tray edge and Red TPC support frame w rod (left) – 40.0 mm
Gap 4, TPOT tray edge and Red TPC support frame w rod (right) – 39.86 mm

TPOT installation, I-beam located on platform;

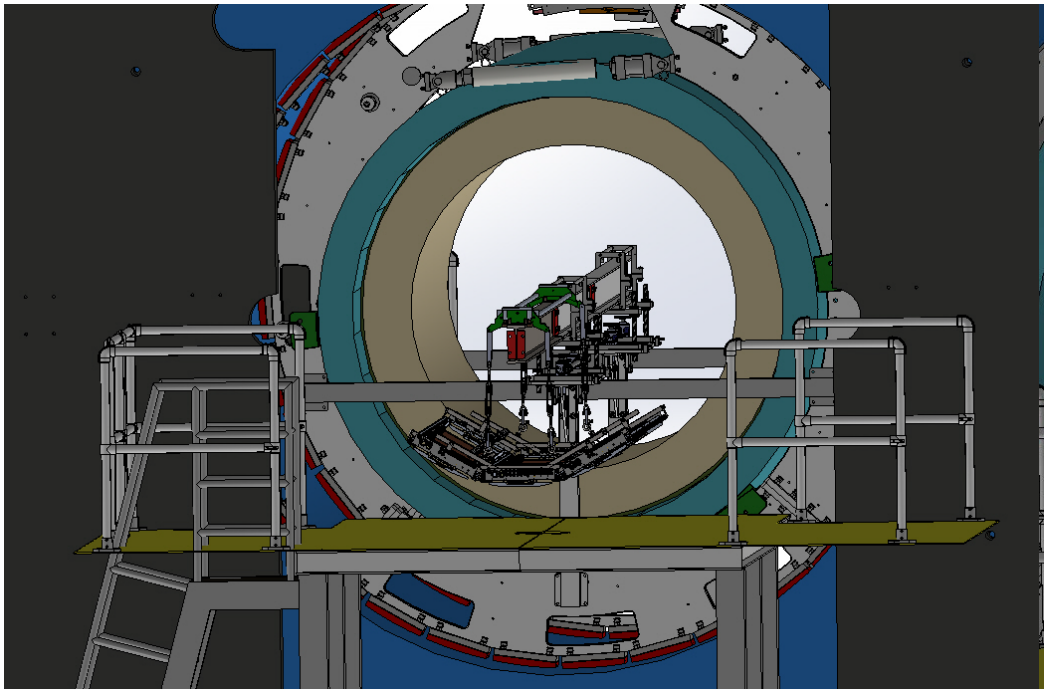
The I-beam support for the TPOT detector array is connected to the TPC I-beams. Height of TPOT assembly and I beams set to give a minimum of 50.8 mm clearance from EMCal sectors.



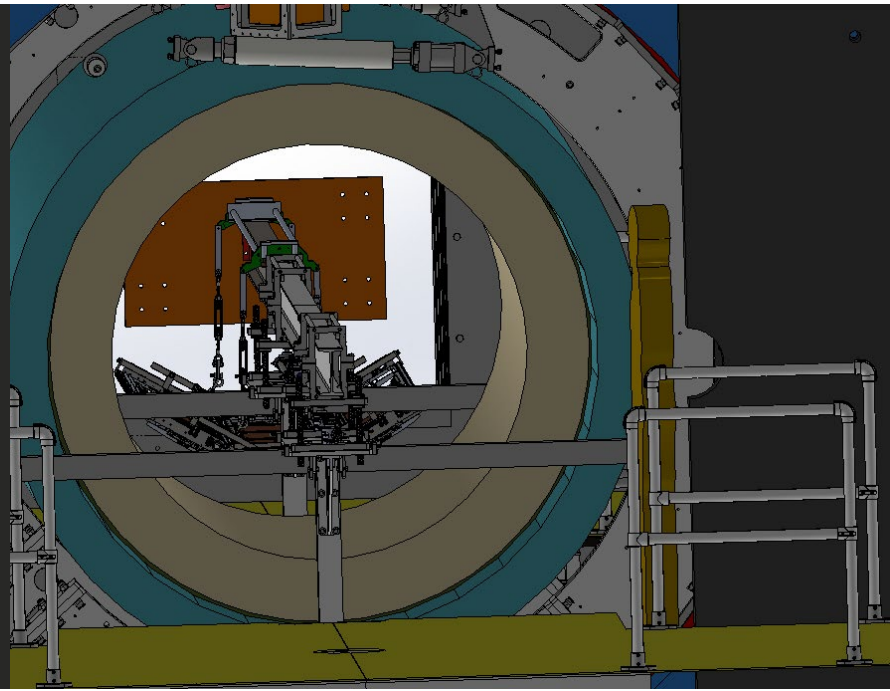
TPOT Assembly on I-beam, North end of sPHENIX



Views of TPOT assembly in EMCal bore:



Looking from North to South



Looking from South to North

Conclusion, a lot of progress since review;

- Updates to TPOT detector assembly
  - New FEE negative pressure cooling plates added
  - SAMTEC interconnection between FEE board and TPOT modules delivered
- TPOT 2 & 4 detector sectors update completed
  - Services patch panels added to all sectors
- Verify adequate clearance to EMCal boxes and TPC envelope
- All the mechanical parts for the TPOT assembly & cart have been ordered
- Design of an installation procedure in progress, working with BNL engineering

Back up slides:

Conclusion; thermal study FEE board with cold plate

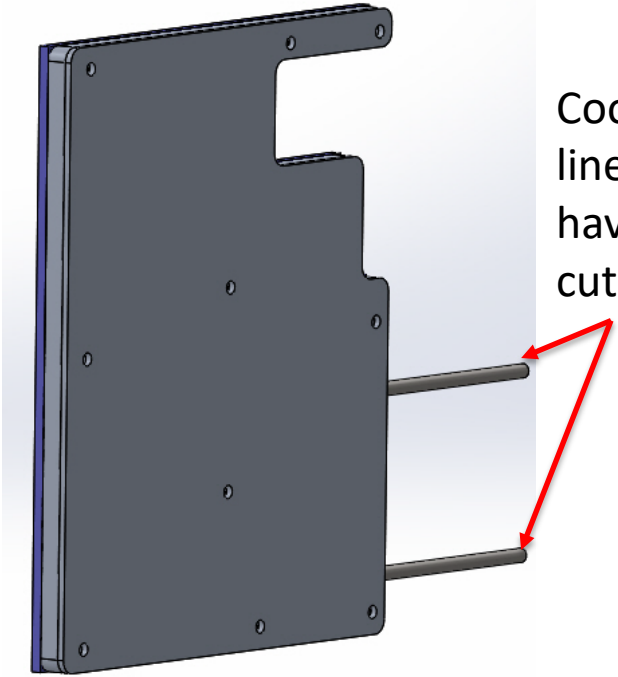
- The hottest point in the model is where the PCB is exposed to both radiation and convection for lower water temperature. Convection and radiation heat the assembly. The PCB components are maintained around 19˚C.

- The hottest point in the model is located on the PCB components for higher water temperature (≥22˚C). Convection and radiation have no heating effect on the assembly.

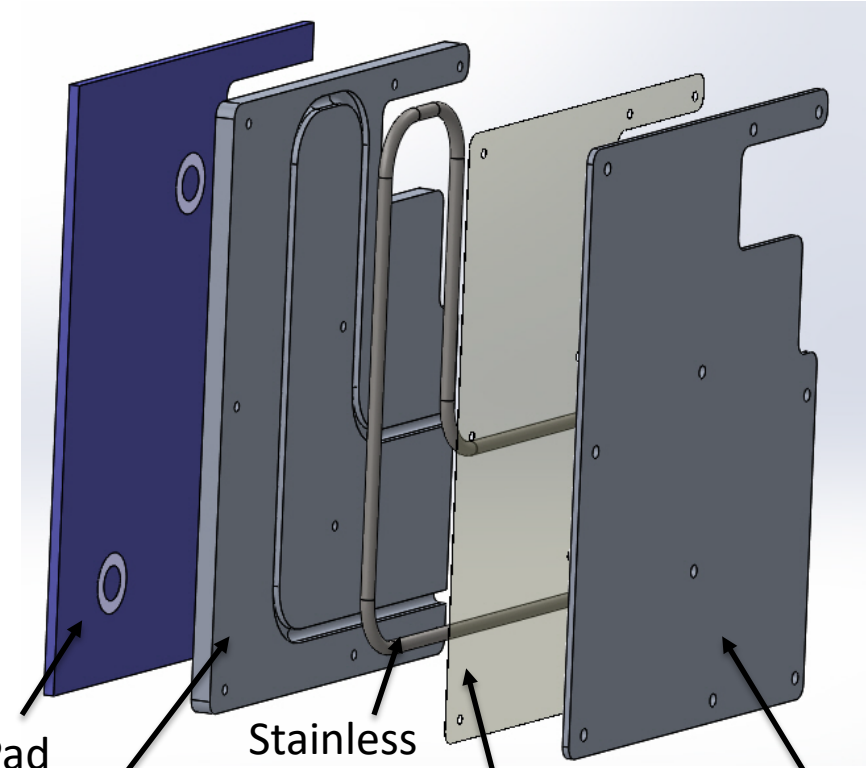
- **If the FEE boards are cooled with room temperature water (22˚C) the PCB components will be maintained around 25˚C and the hottest component could be 26.4˚C.**

- **If the FEE boards are cooled with cold water (16˚C) the PCB components will be maintained around 19˚C.**

FEE cooling plate, negative pressure water;



Cooling line, ends have been cut back -

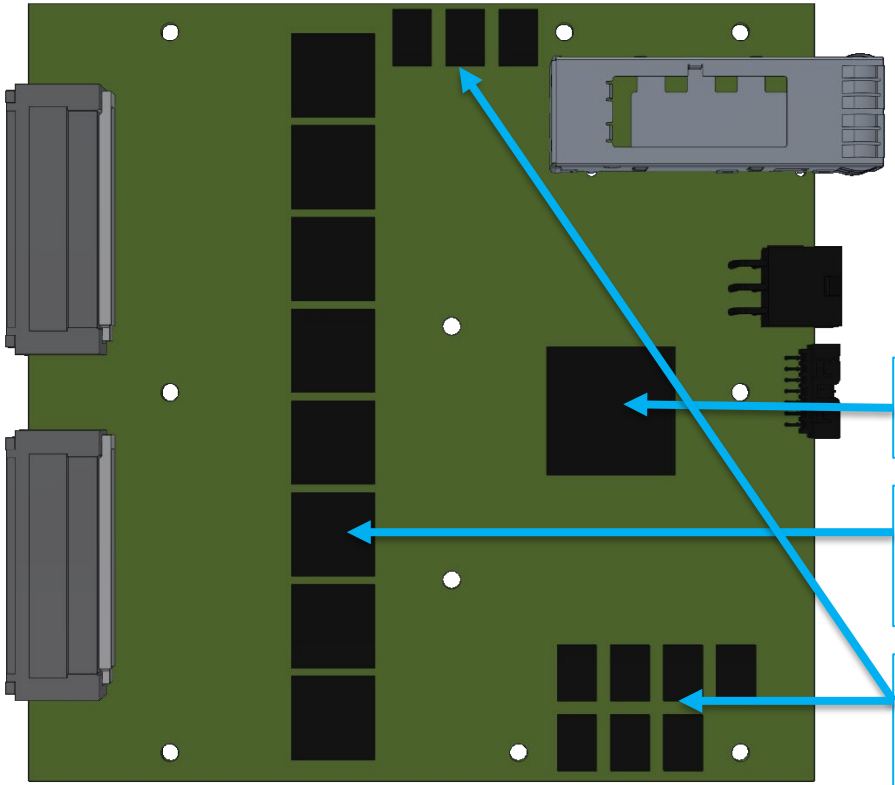


133.65 X 107.95 X 8.95 mm, modification similar design MVTX rack electronics, E Renner, LANL

July 20th, 2022

FEE board heat sources;

From Dan Cacace's, BNL presentation on TPC cooling plates



FEE Total
~15-20W

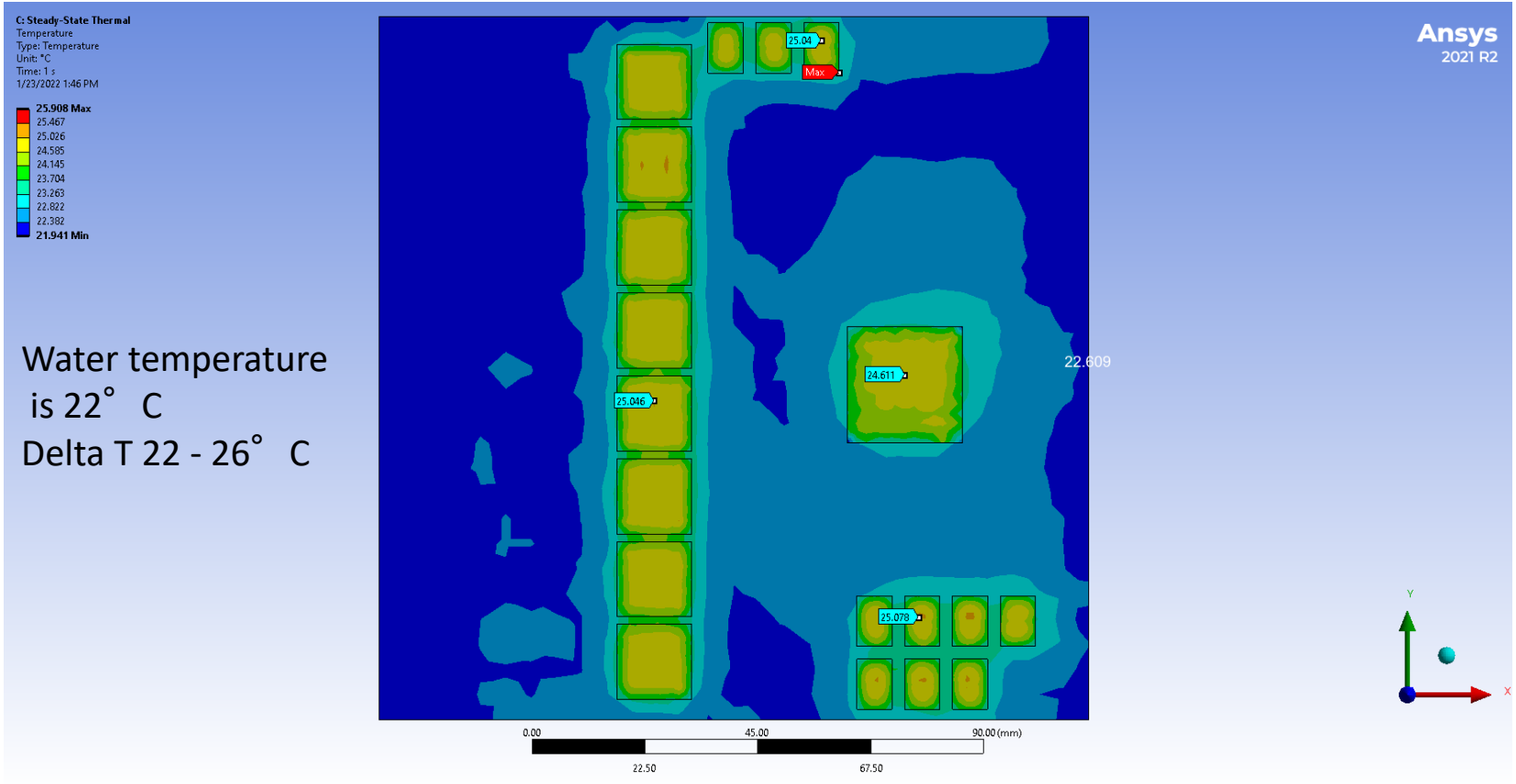
FPGA
~4W

8x
SAMPAs
~7W

10x
Regulators
~4W

Tallest
Component
2 mm

ANSYS thermal model result, FEE board/cooling plate;



Water temperature is 22° C

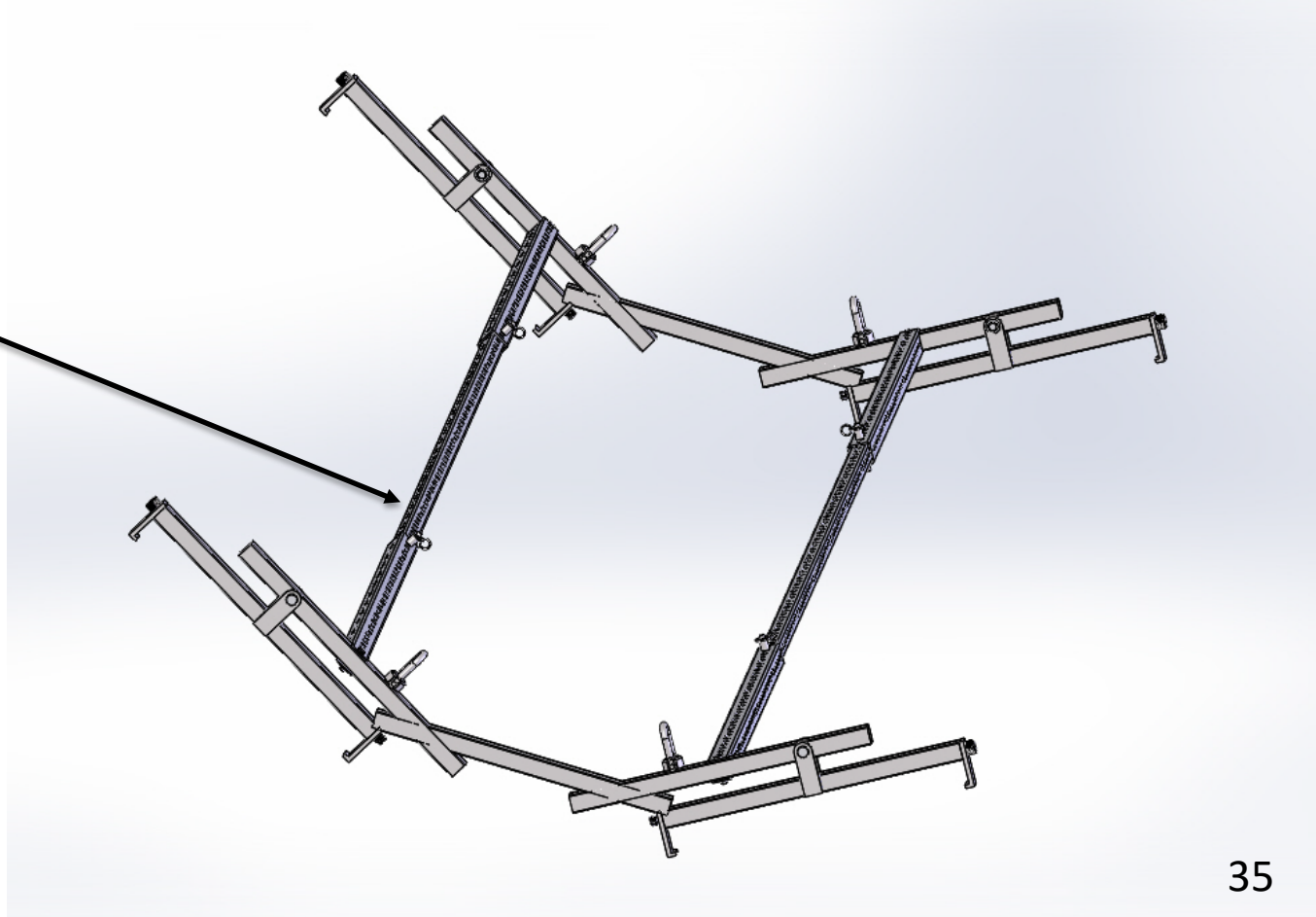
Delta T 22 - 26° C

Proposed TPC FEE inlet temperature 18° C

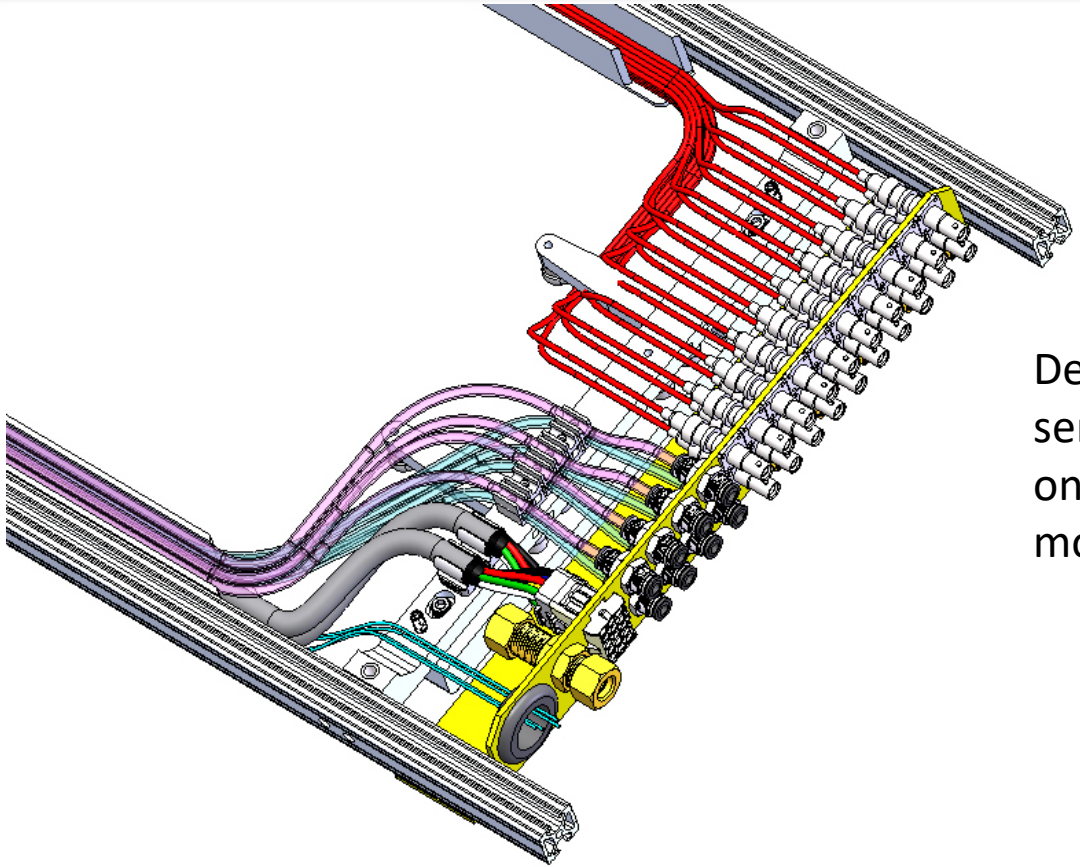
Water Temp. (°C)	Maximum Temp. (°C)	Minimum Temp. (°C)	Heat load to the cooling water (W)
16	21.6372242	15.93427658	17.19731137
17	21.70495987	16.93535995	16.78437634
18	22.05018806	17.93644524	16.37144131
19	23.01454163	18.93753052	15.95850628
20	23.97889519	19.93861389	15.54557124
21	24.94325066	20.93969917	15.13263621
22	25.90760422	21.94078255	14.71970118

New lifting fixture:

Lifting fixture grabs the two outer sectors, 2 panels. The spanner bars are adjustable, swivel eyes interconnect with turnbuckles off installation I-beam. This assembly will be fabricated at the Bates shop.



Earlier TPOT 4 module sector;



Demonstrated running services in service trays on either side of 4 module sector assembly