

# TPOT detector, mechanics meeting

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Chris Vidal - MIT

January 26<sup>th</sup>, 2022

# Talk Outline:

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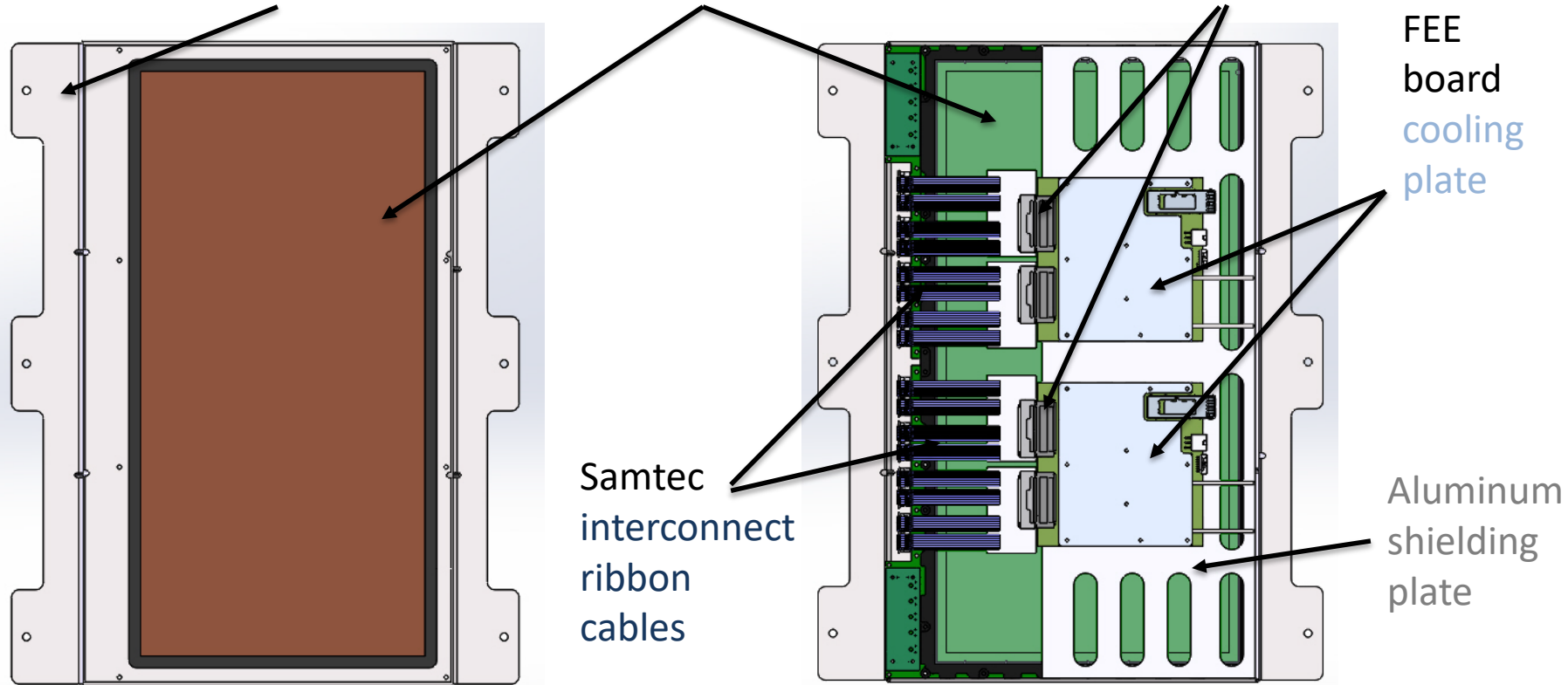
- TPOT detector assembly
  - FEE board cooling plate plus thermal analysis
- TPOT 2 detector sector array
- TPOT 4 detector sector array
- TPOT 3 sector assembly, plus mechanical analysis
- TPOT integration with the sPHENIX TPC and EMCal
- Installation
  - Modification to sPHENIX TPC installation fixture

# TPOt detector module assembly:

Detector metal support tray

TPOt detector panels

FEE boards (same as used for TPC)

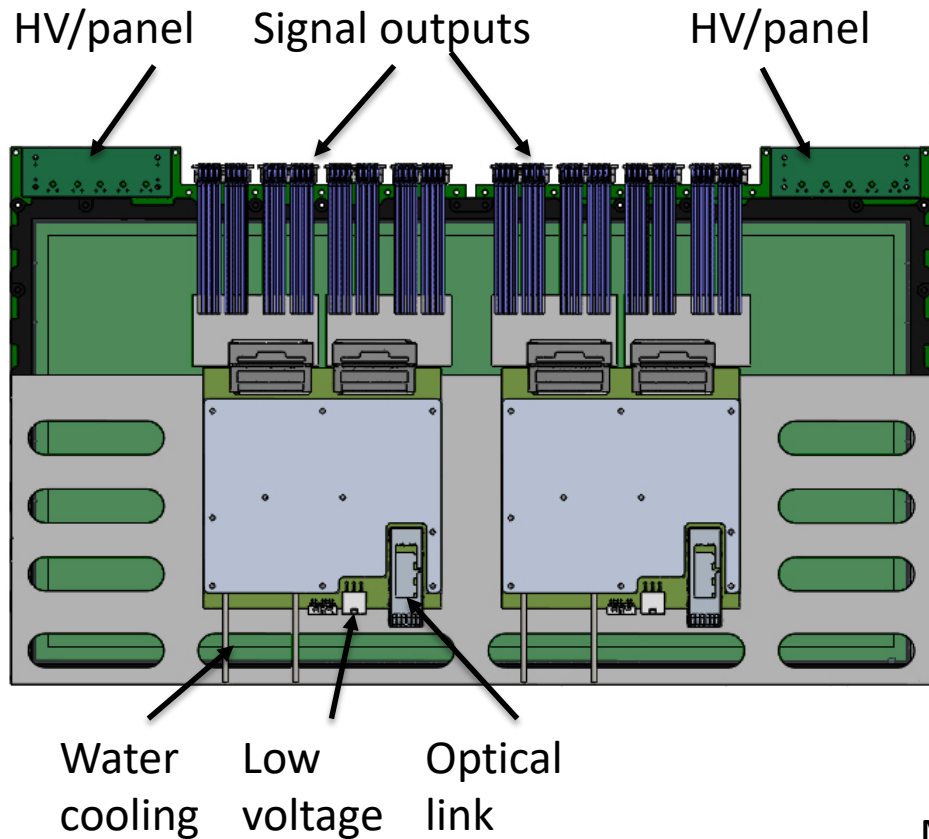


FEE board cooling plate

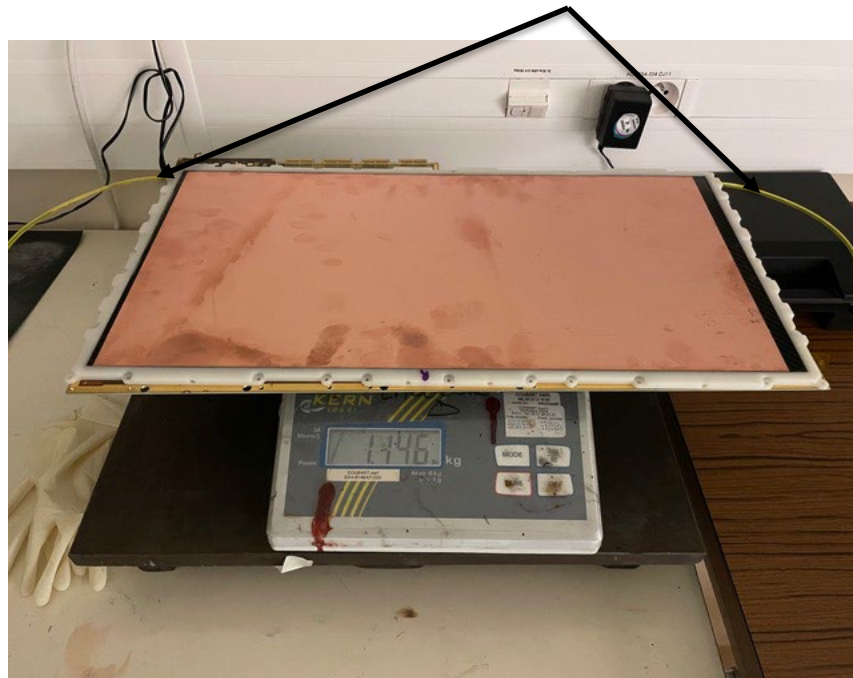
Samtec interconnect ribbon cables

Aluminum shielding plate

# TPOT detector panel, details;

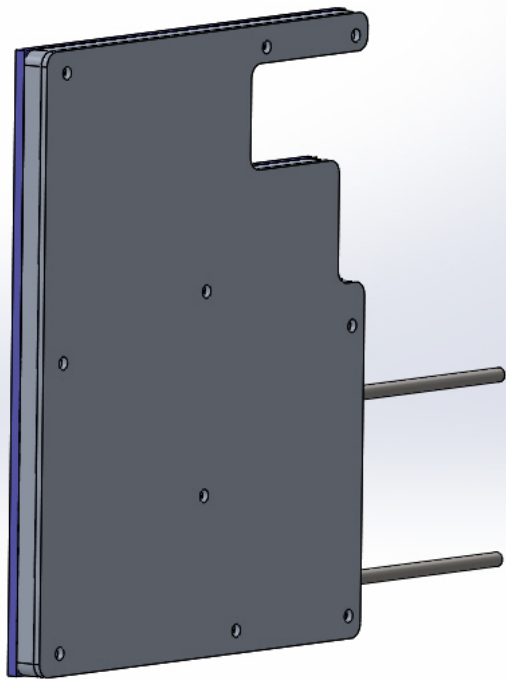


Detector panel frame 3D printed, non-conductive,  
Gas connection on short edges



Mass of one panel 1.146 kgms, 2 panels 2.5 kgms  
Size: 542 X 316 mm.

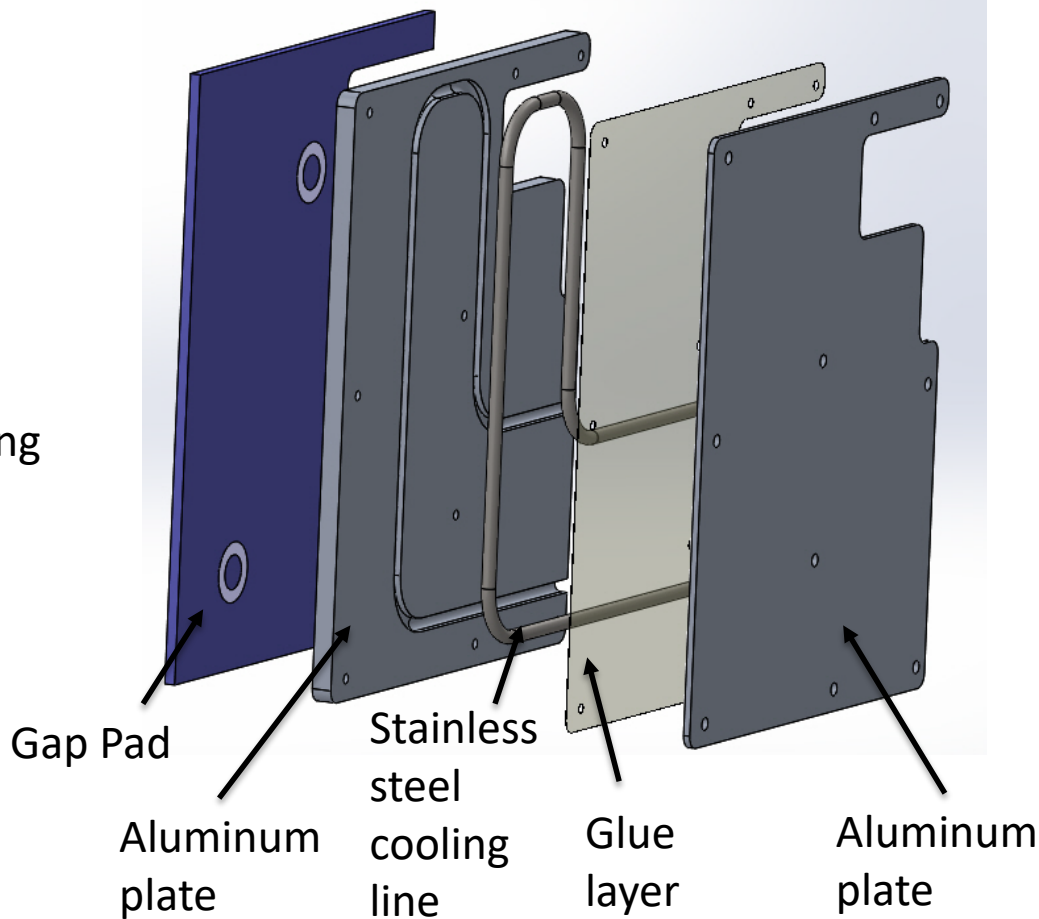
# FEE cooling plate, negative pressure water;



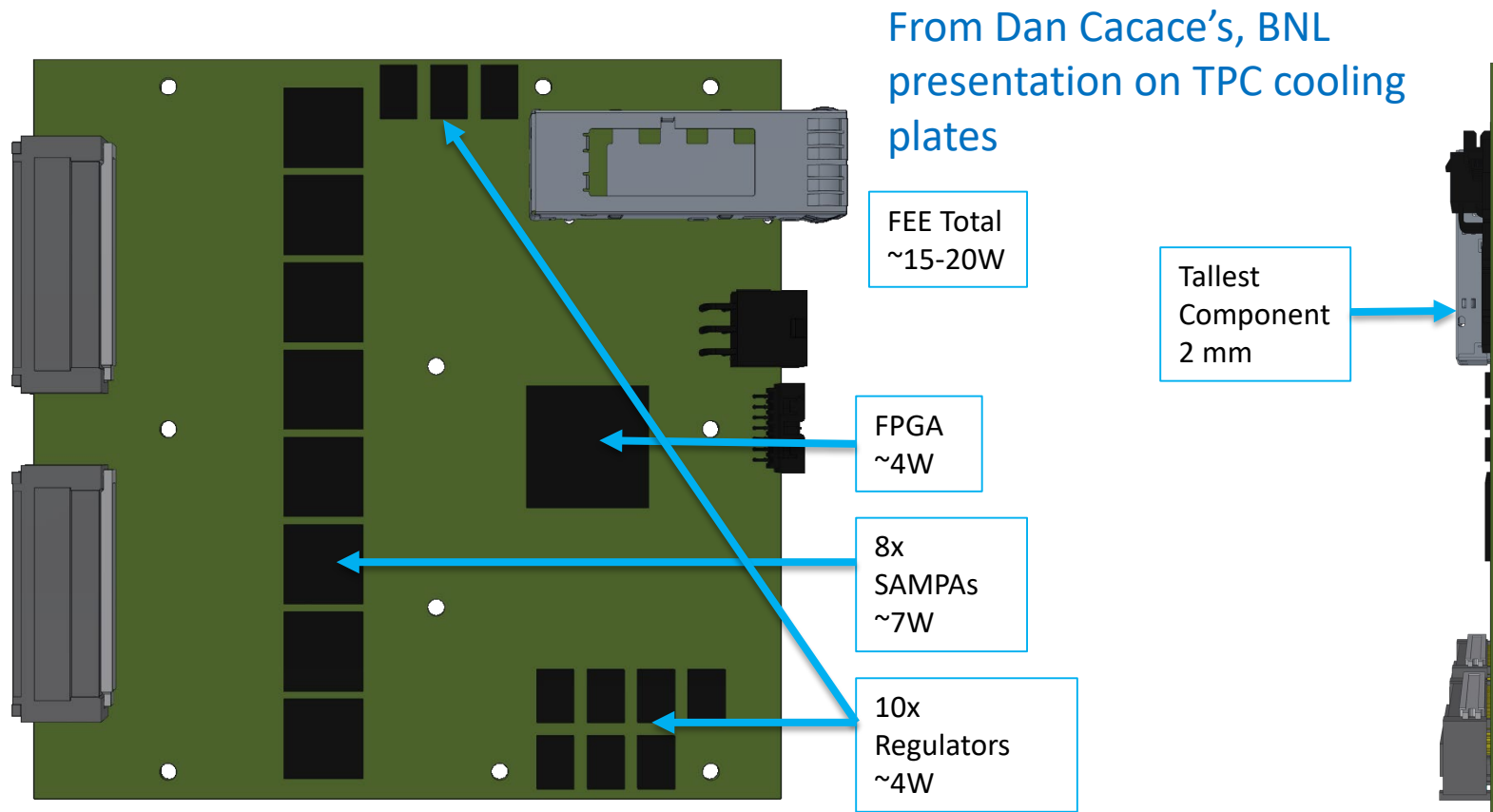
Cooling  
line

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

January 26<sup>th</sup>, 2022

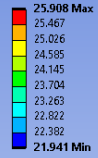


# FEE board heat sources;

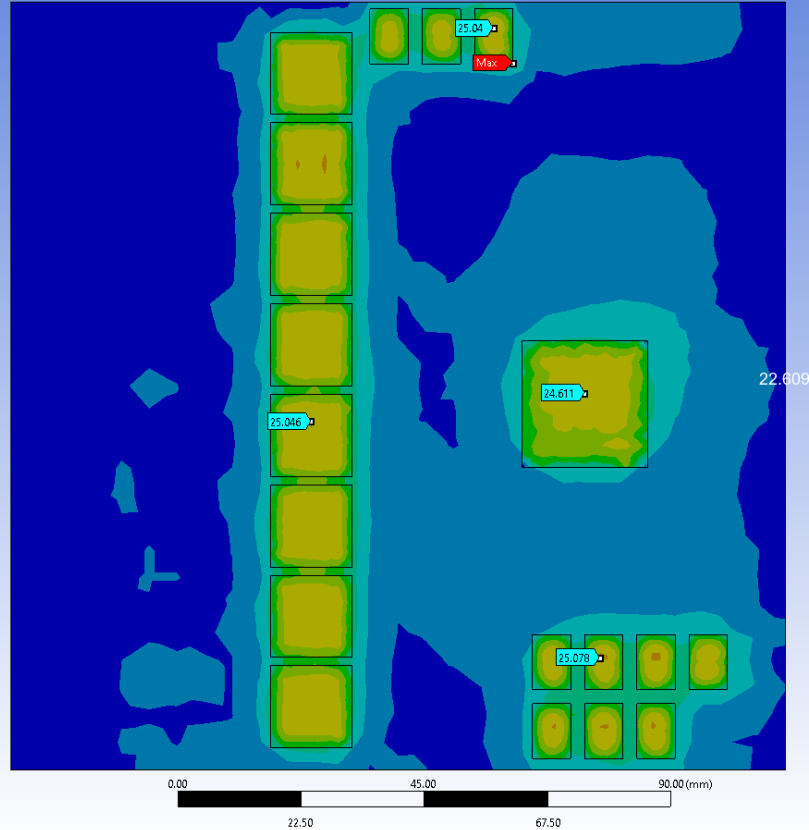


# ANSYS thermal model result, FEE board/cooling plate; SPHENIX

C: Steady-State Thermal  
Temperature  
Type: Temperature  
Unit: °C  
Time: 1 s  
1/23/2022 1:46 PM



Water temperature  
is 22° C  
Delta T 22 - 26° C



Ansys  
2021 R2

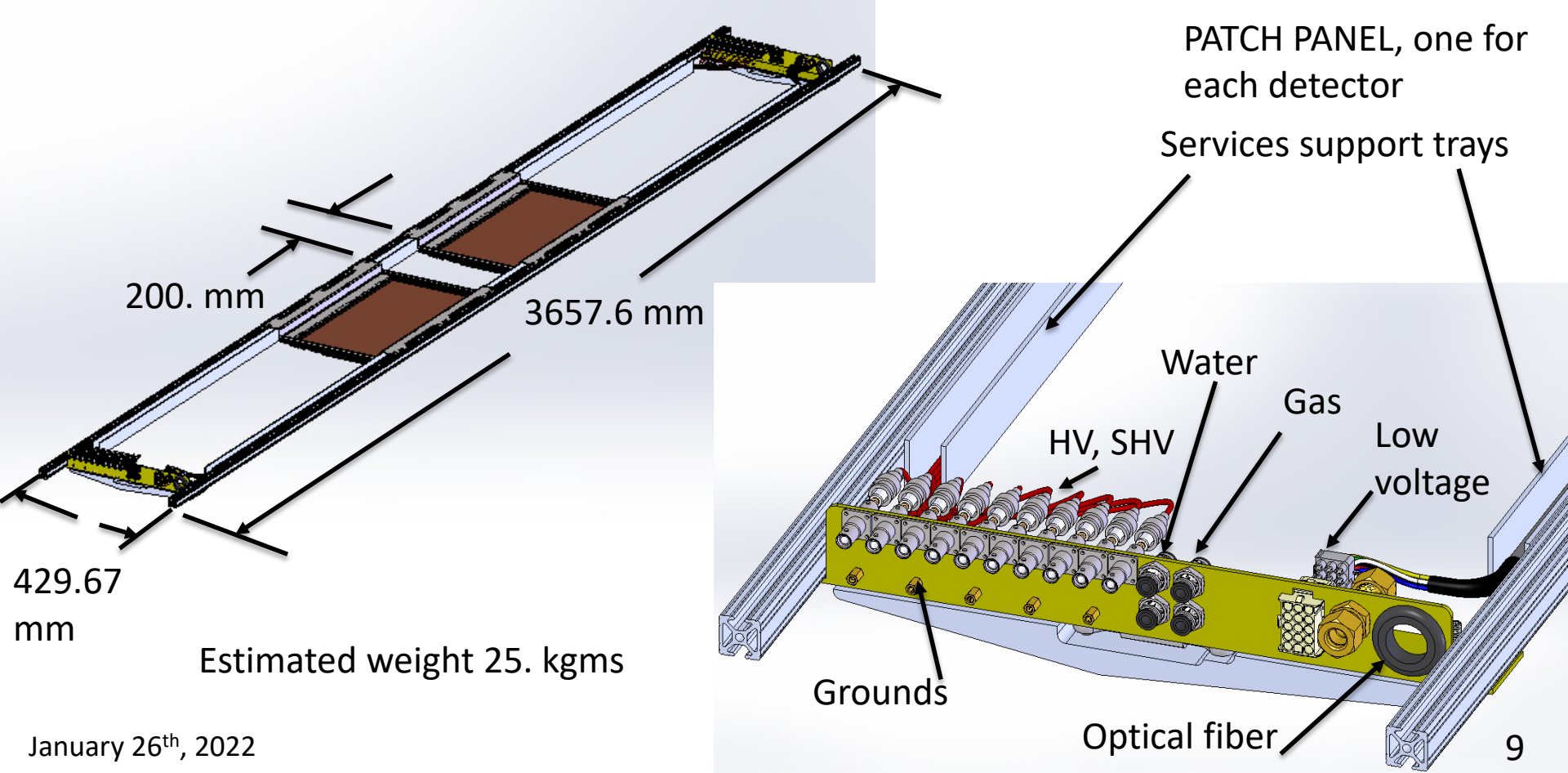
# Proposed TPC FEE inlet temperature 18<sup>o</sup> C



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

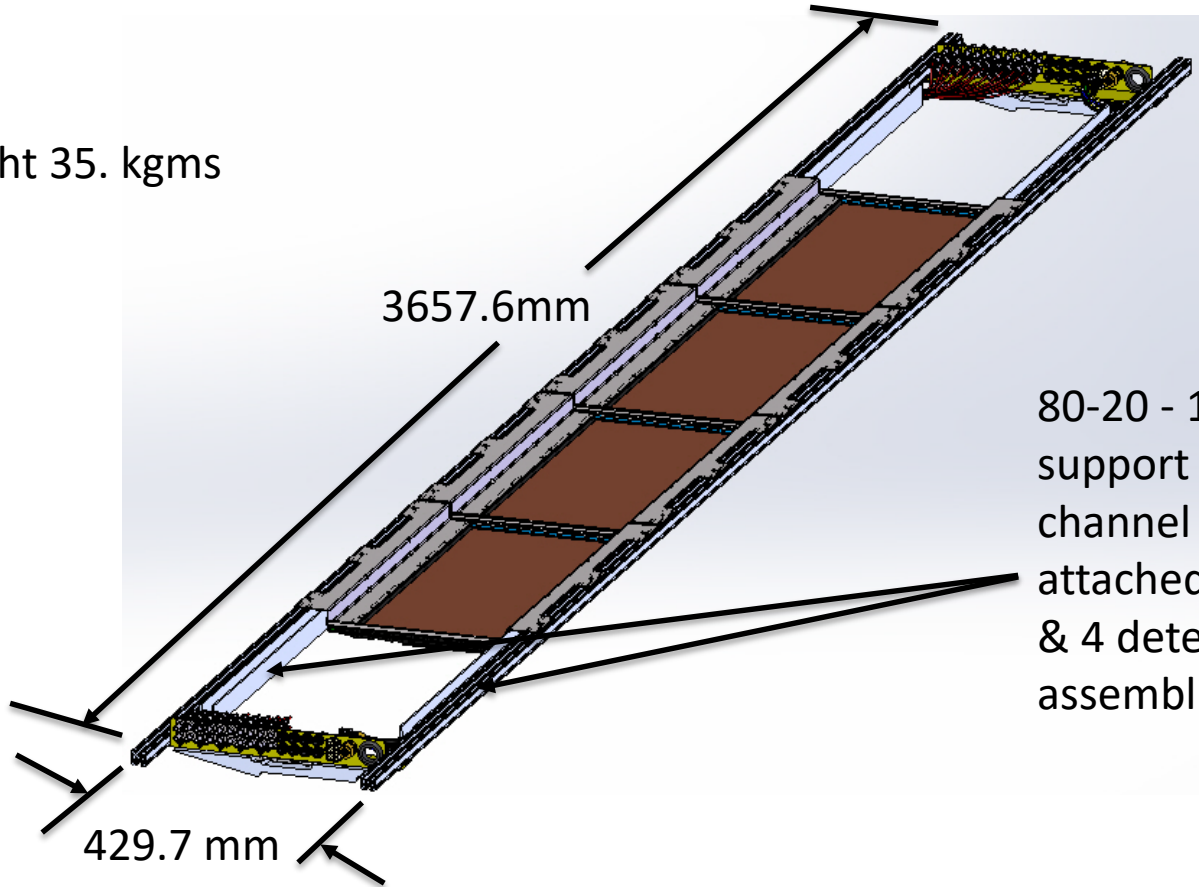


# TPOT two detector sector array:



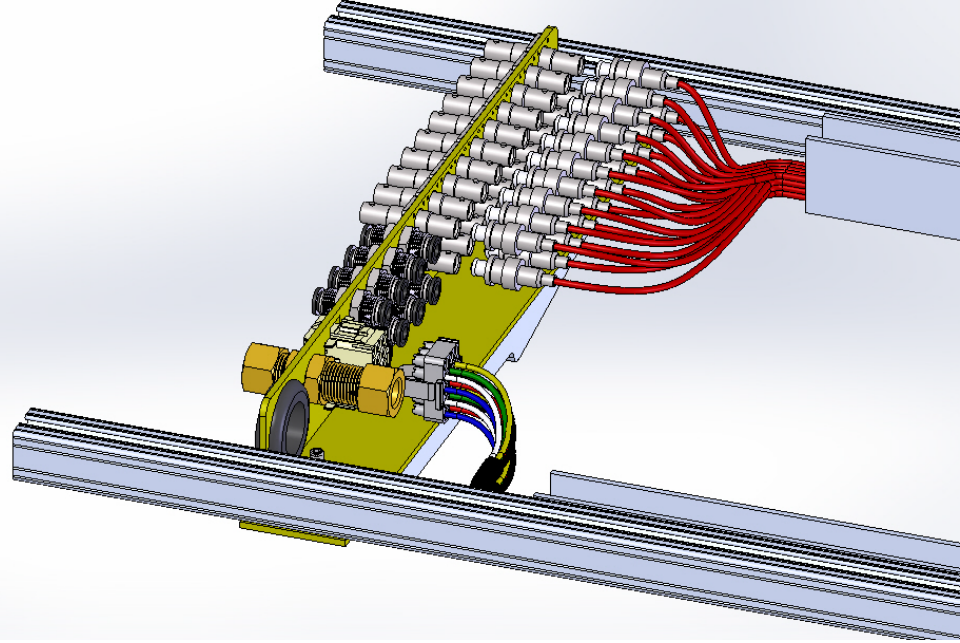
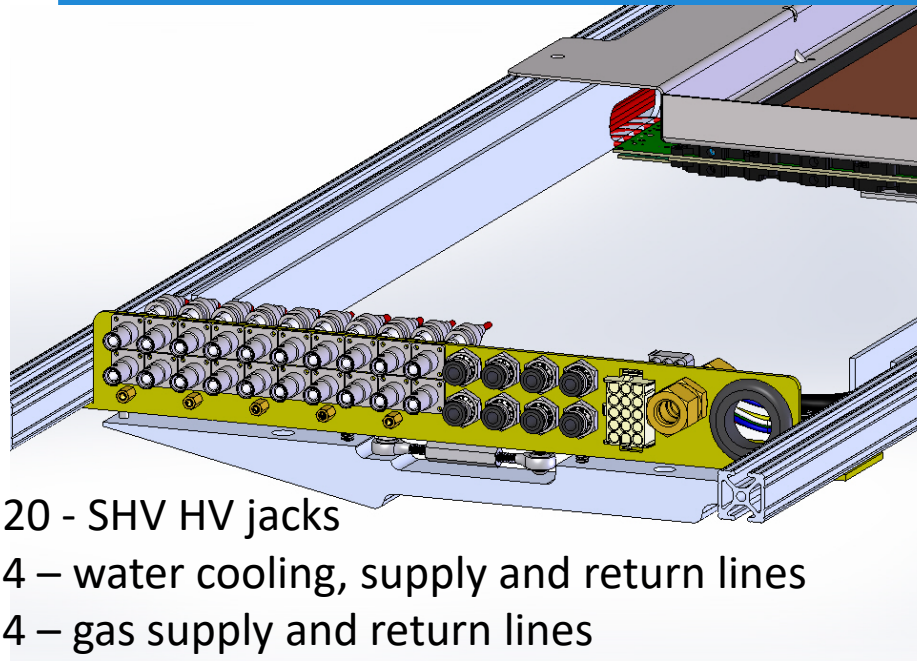
# TPOT-four detector sector array;

Estimated weight 35. kgms



80-20 - 1004 profile support beams, with U channel service trays attached, used in both 2 & 4 detector sector assemblies

# TPOt four detector sector - detail, patch panels;

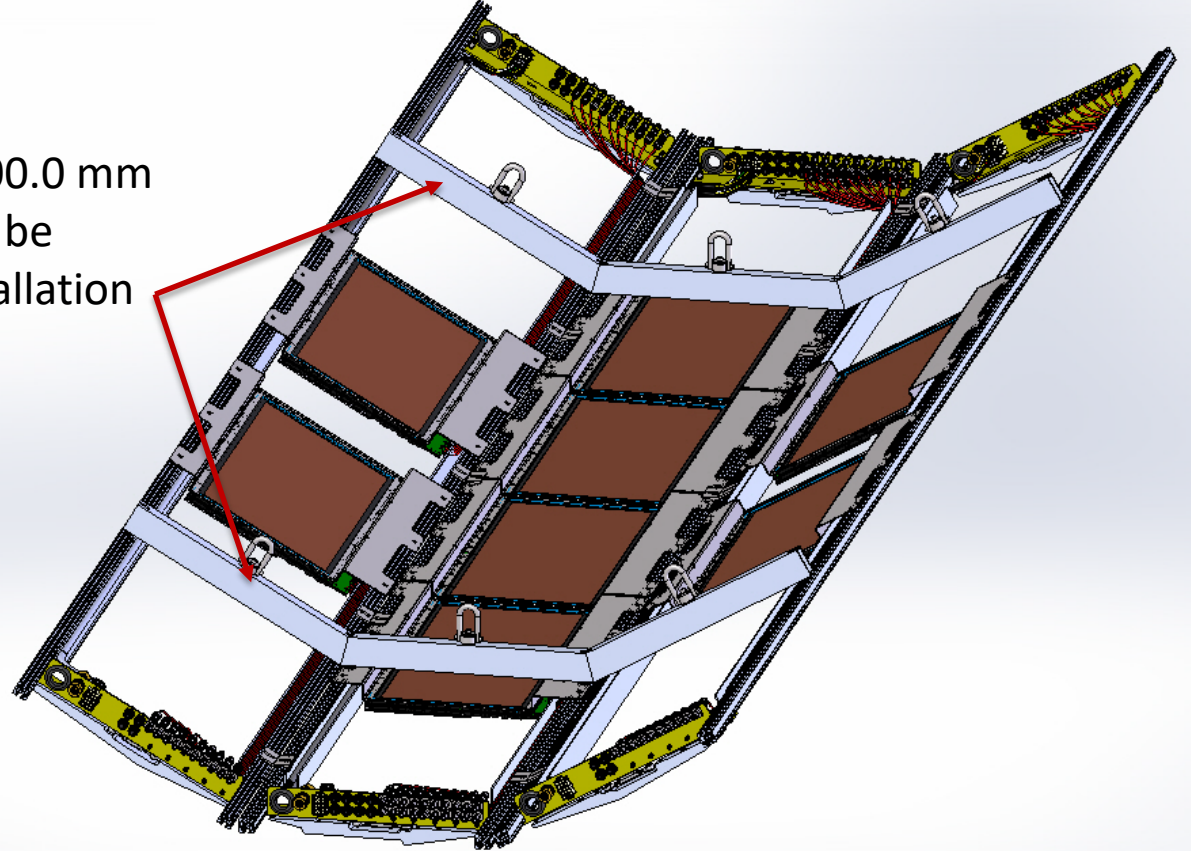


- 20 - SHV HV jacks
- 4 – water cooling, supply and return lines
- 4 – gas supply and return lines
- 1 – Low Voltage cable
- 1 – grommet for two fiber optic cable
- 5 – ground lug connectors
- 1 – feedthrough for gas aspirator (optional)

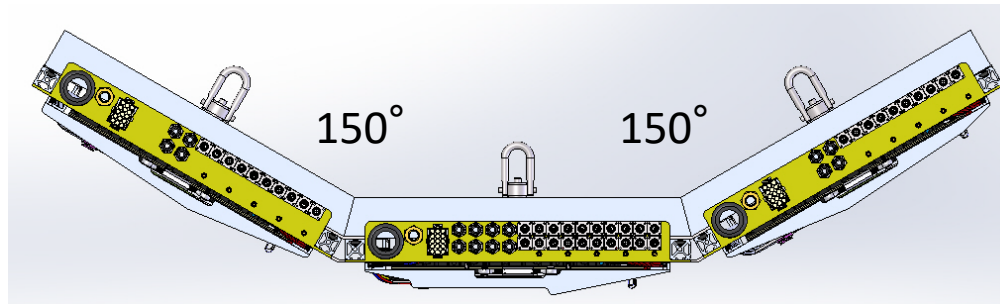
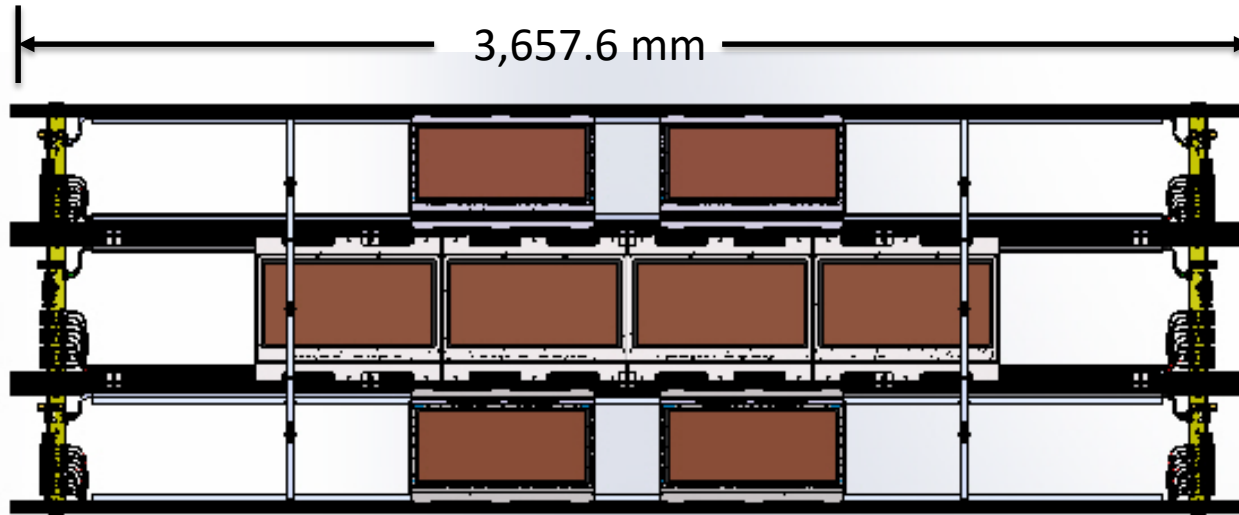
Each patch panel holds services for two TPOt detector assemblies

# TPOT 3 sector assembly;

Lifting fixtures, 2000.0 mm spacing. These will be removed after installation



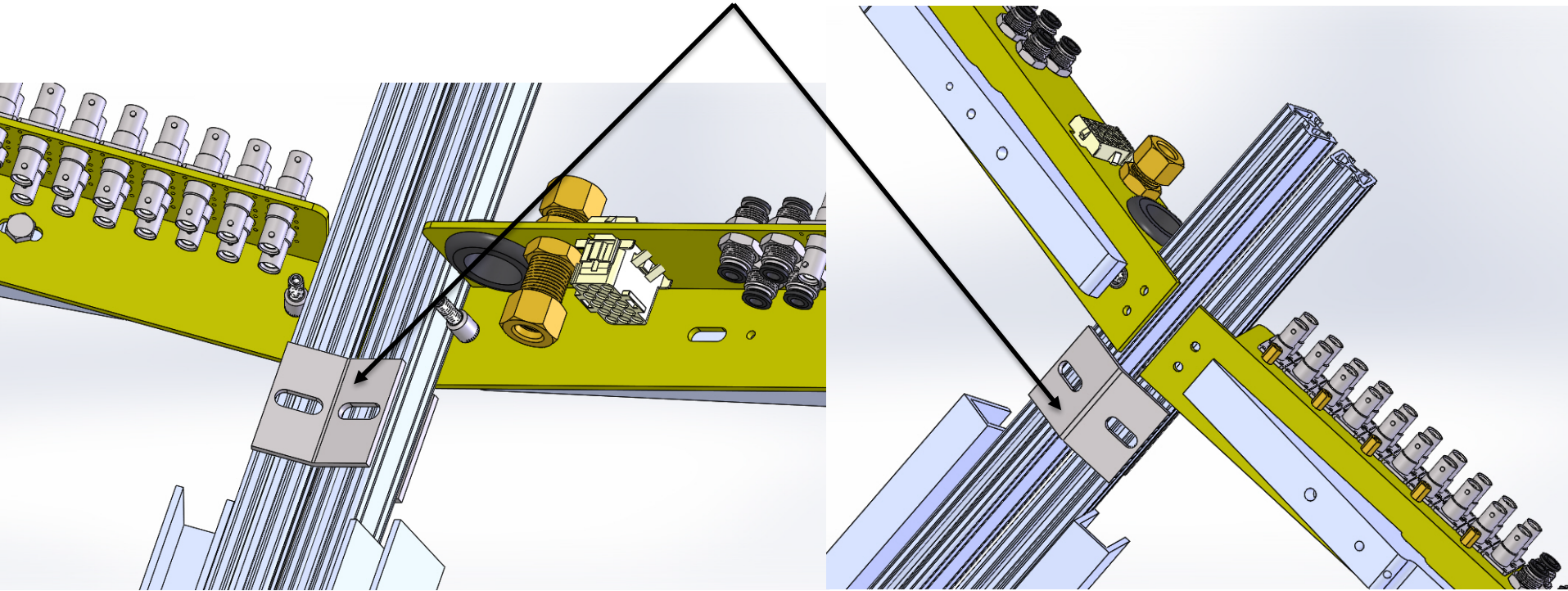
# TPOT 3 sector assembly details;



Patch panels at  
one end

# TPOT 3 sector frame assembly – detail;

150° braces joining 80-20 beams on front and back, 28 per assembly;



- 3 Models run:
  - 1. No Architectural members pinned patch panel connections
    - Loads
    - Joints to represent 150 degree brackets
    - Joints to represent patch panel connection
  - 2. With architectural members pinned patch panel connections
    - Same controls used in #1
    - In addition joints to represent the architectural members bonded to 80/20
  - 3. Fixed patch panel connection
    - Loads and joints set the same as in problem 1 & 2
    - Joints to represent patch panel connection

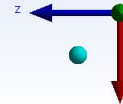
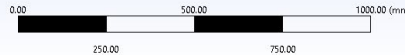
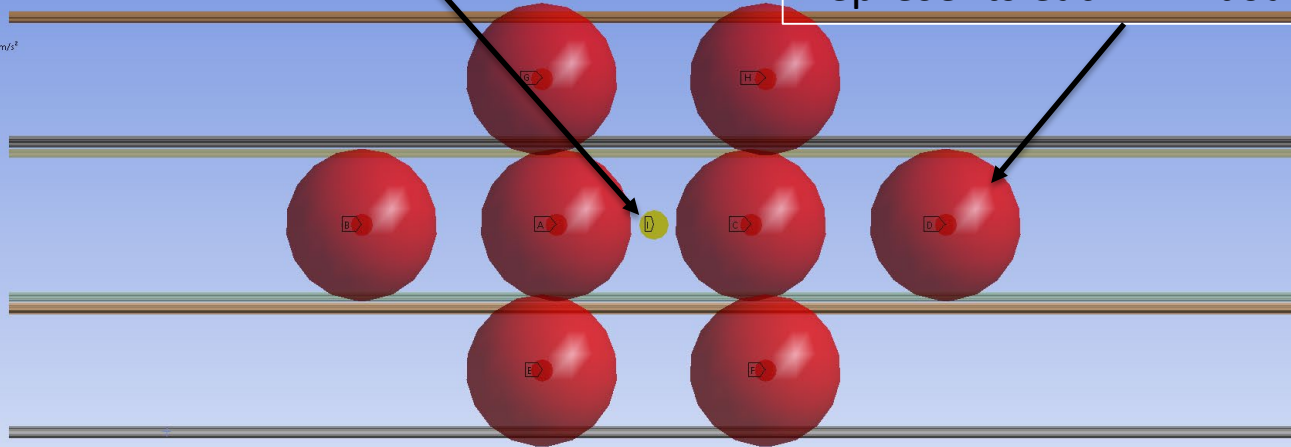
# ANSYS model set up with detectors;

B: Static Structural  
Static Structural  
Time: 1. s  
Items: 10 of 17 indicated  
1/24/2022 2:35 AM

- A Remote Force: 30. N
- B Remote Force: 3: 30. N
- C Remote Force: 4: 30. N
- D Remote Force: 5: 30. N
- E Remote Force: 6: 30. N
- F Remote Force: 7: 30. N
- G Remote Force: 8: 30. N
- H Remote Force: 9: 30. N
- I Standard Earth Gravity: 9806.6 mm/s<sup>2</sup>

Standard gravity 9.81 m/s<sup>2</sup>

~3 kg weight applied to a few nodes on each member.  
Represents each FEE board/tray



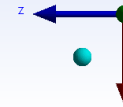
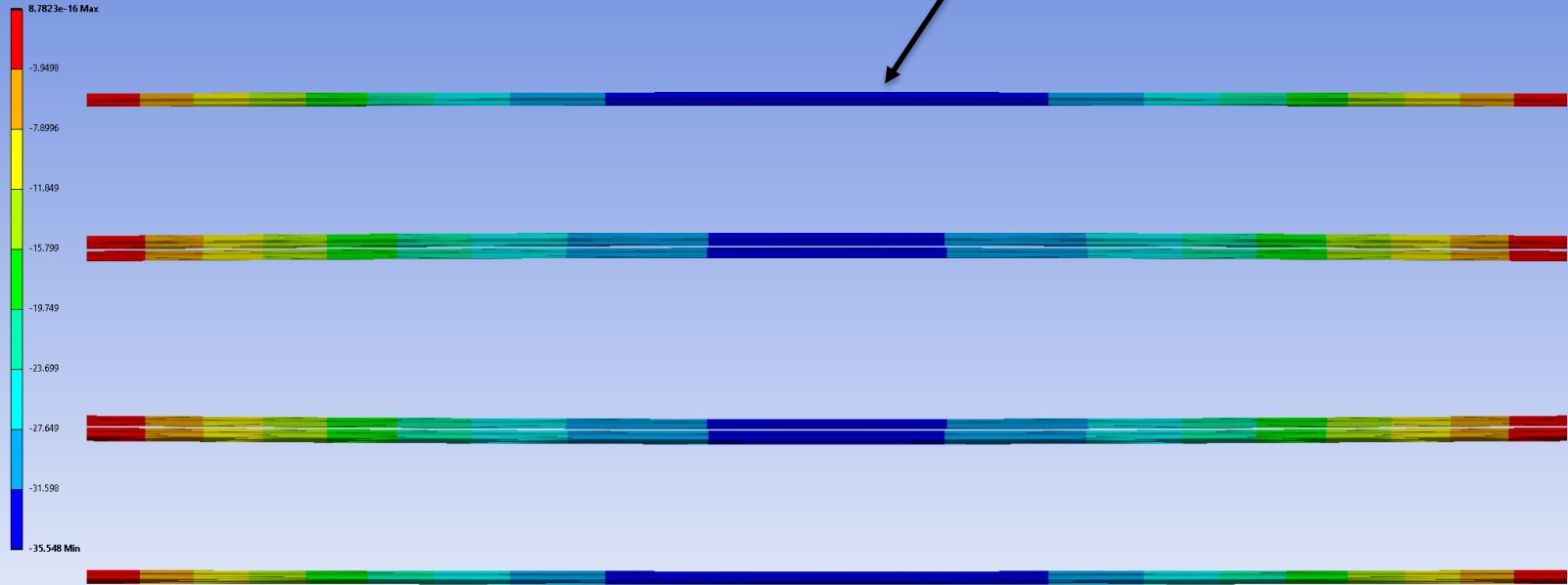


# ANSYS problem #1

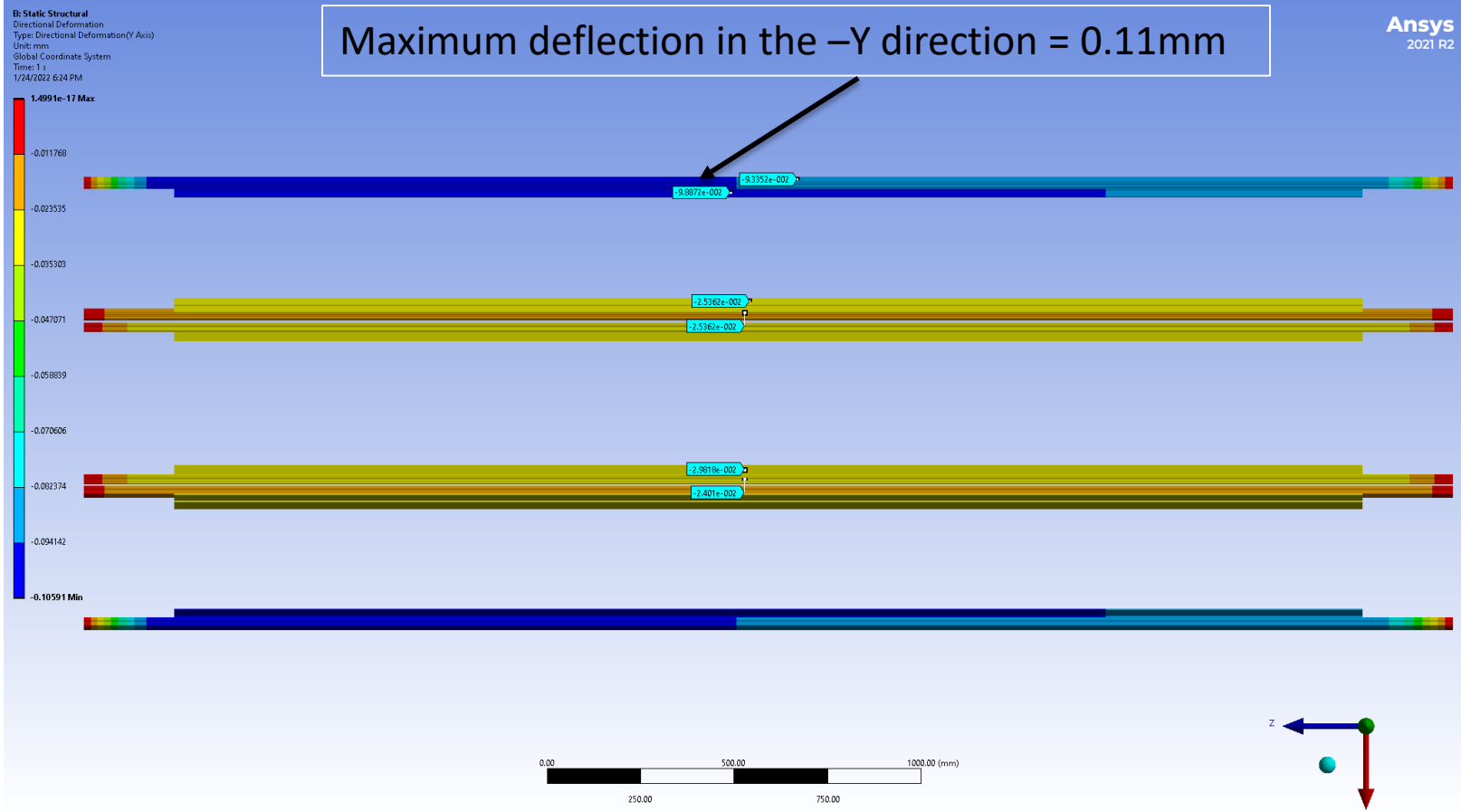
B: Static Structural  
Directional Deformation  
Type: Directional Deformation(Y Axis)  
Unit: mm  
Global Coordinate System  
Time: 1 s  
1/24/2022 6:26 PM

Maximum deflection in the -Y direction = 35.5 mm

Ansys  
2021 R2



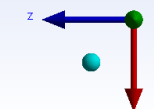
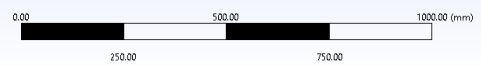
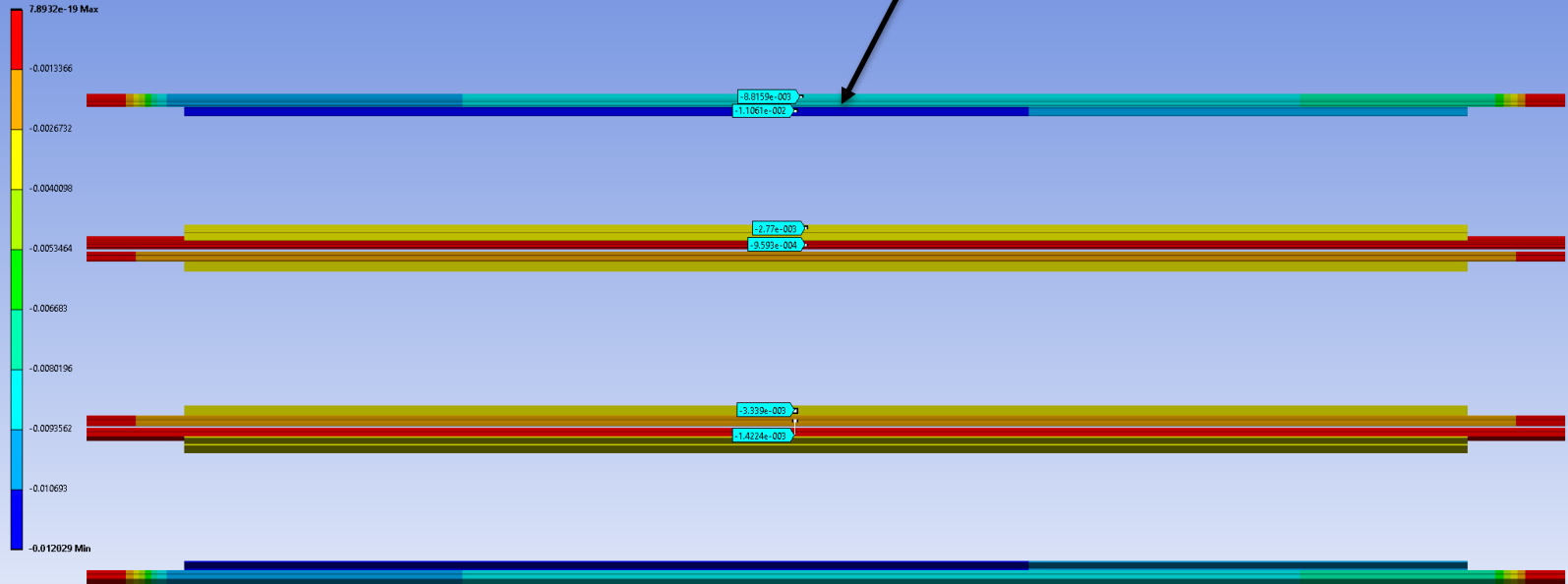
# ANSYS Problem #2, solution closest to assembly

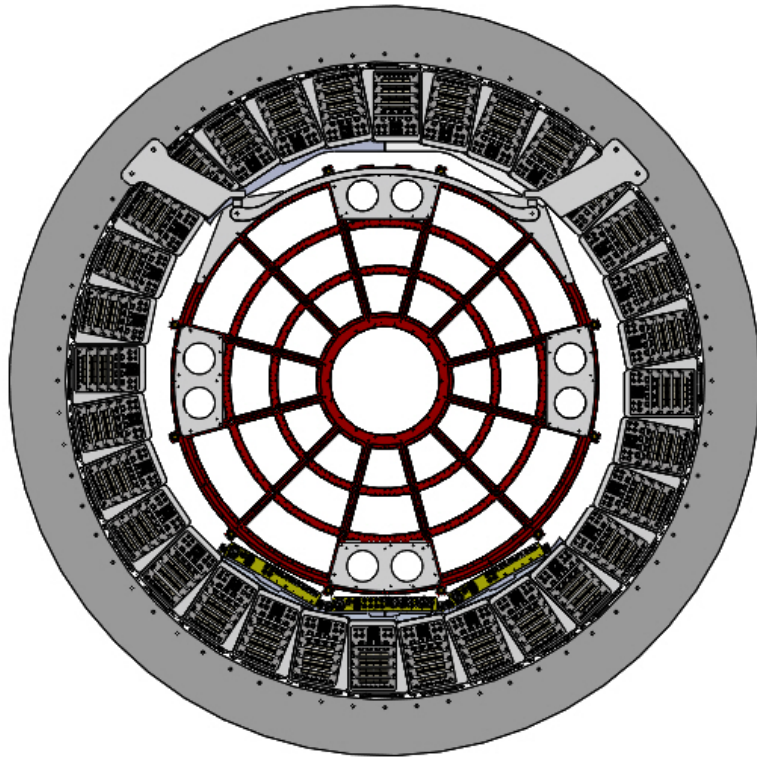


# ANSYS Problem #3

Maximum deflection in the -Y direction = .01mm

B: Static Structural  
Directional Deformation  
Type: Directional Deformation(Y Axis)  
Unit: mm  
Global Coordinate System  
Time: 1 s  
1/24/2022 6:21 PM

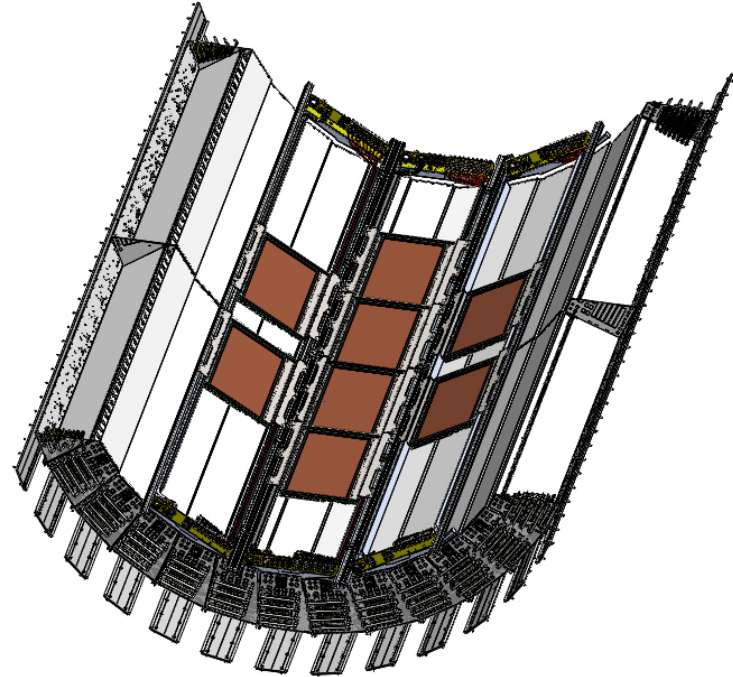




End view

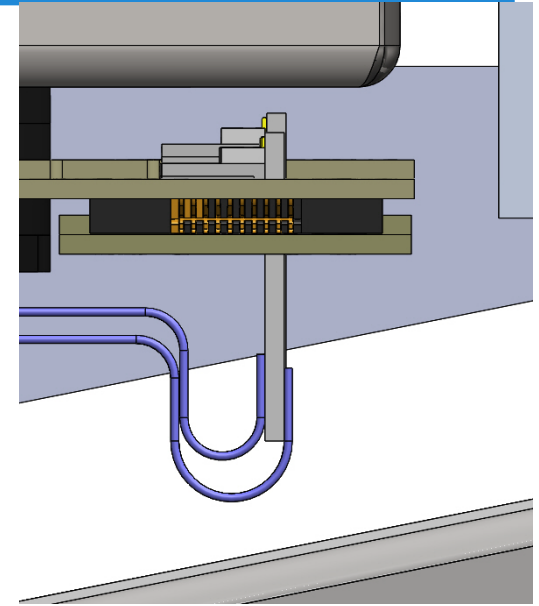
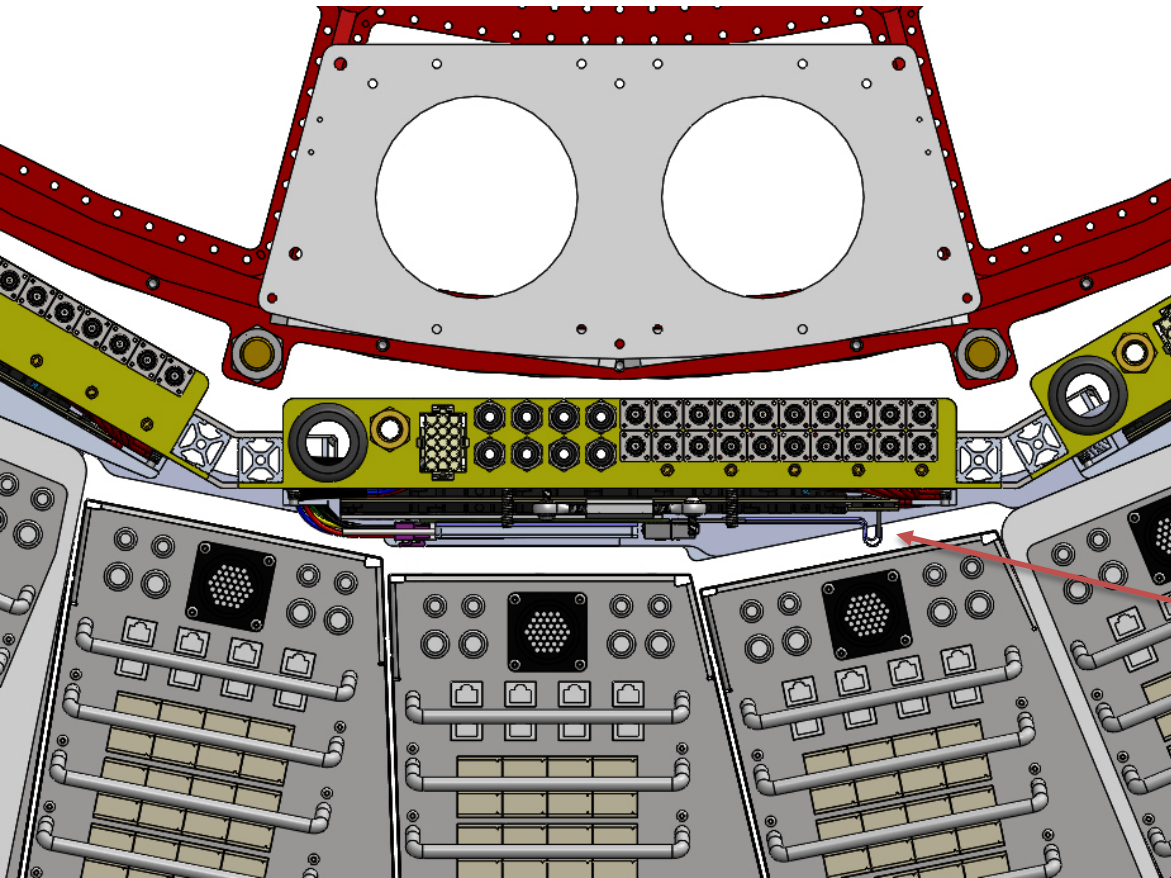
Section view, showing TPOT assembly

Alignment monuments still need to be added



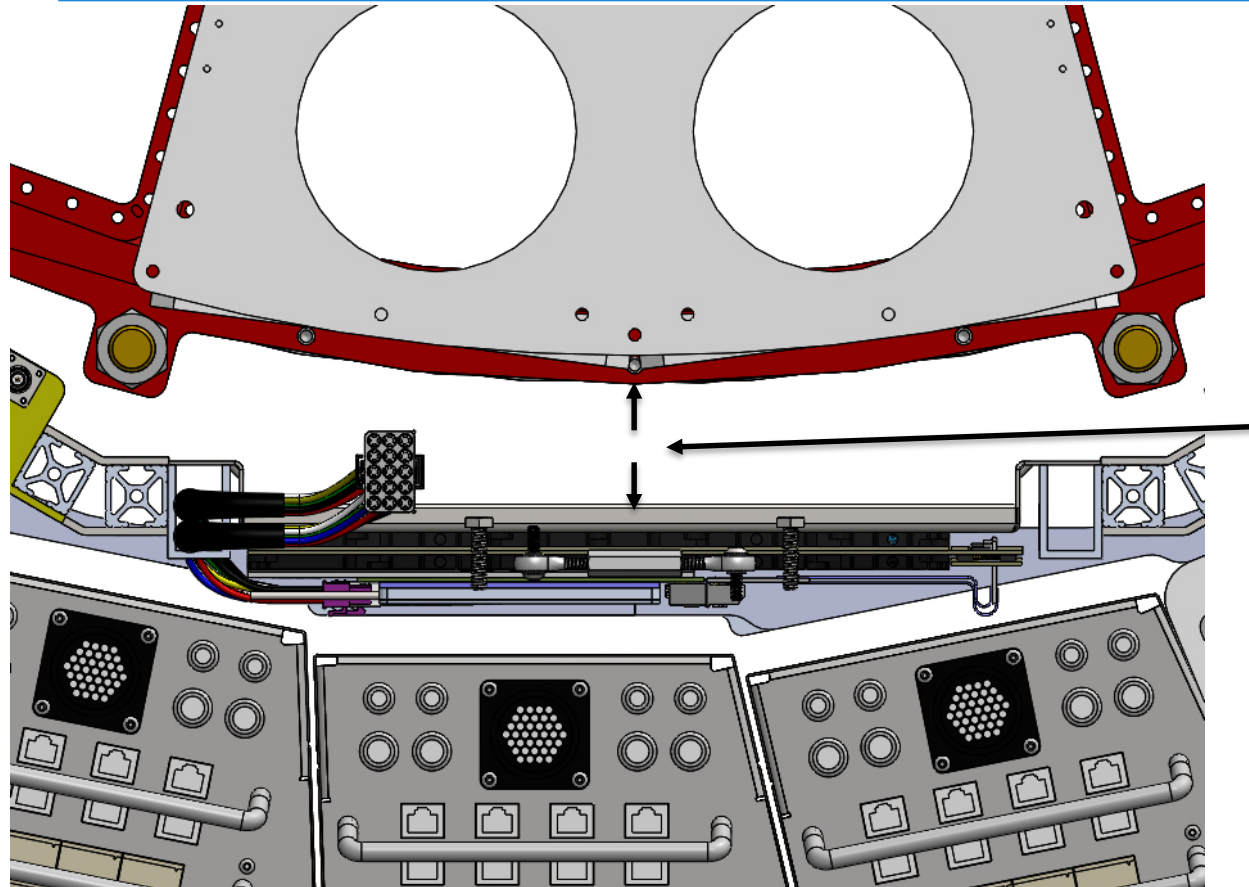
*Having a completed TPOT detector array allows for full testing prior to installation*

# TPC-EMCal-TPOT assembly, details;



Distance SAMTEC cable loop to EMCal sector box skin  $\sim 4.5$  mm, distance from edge of vertical PC board to EMCal box skin 8.5 mm

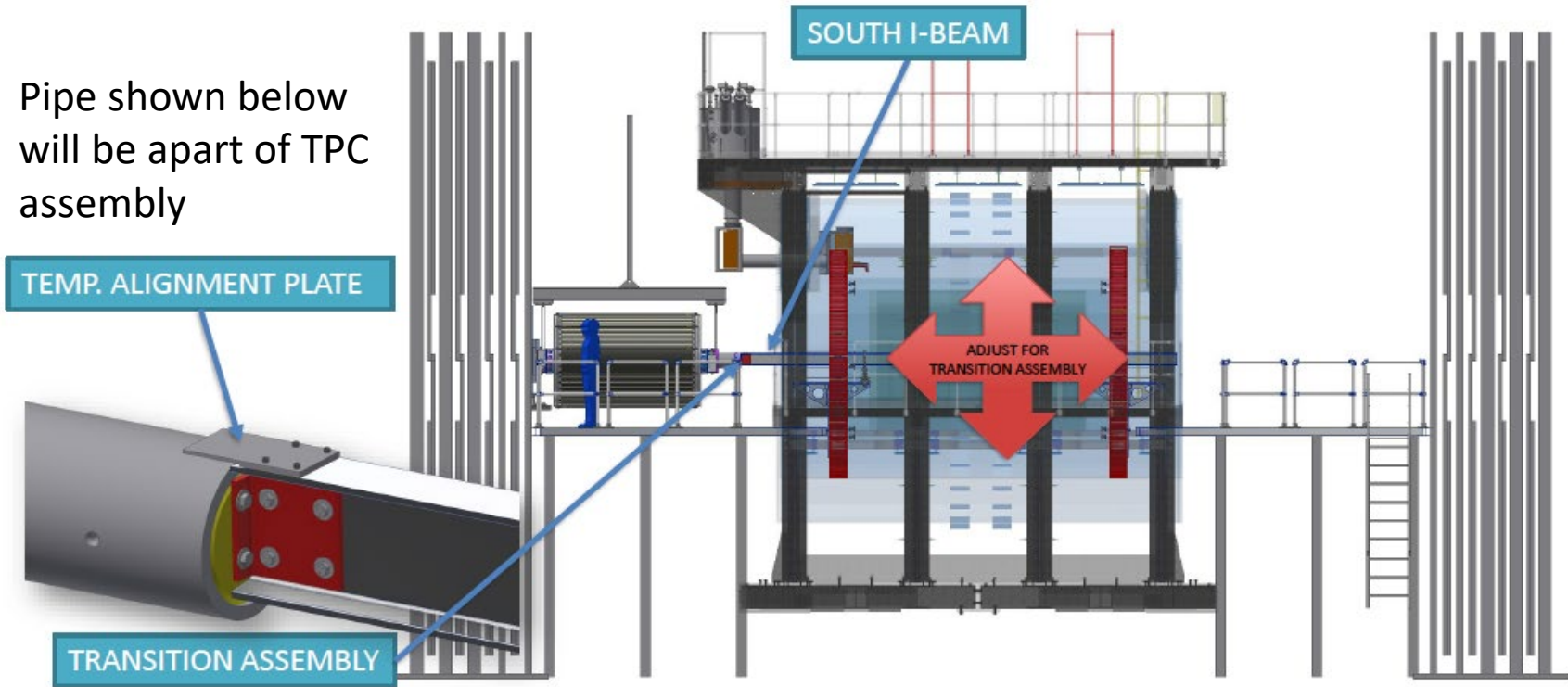
# TPC-EMCal-TPOT assembly, details;



Measured gap between TPOT detector panel edge and TPC cylinder – 50.55 mm. This view has several components at the ends of the TPOT assembly suppressed for clarity, they do not interfere with the TPC assembly

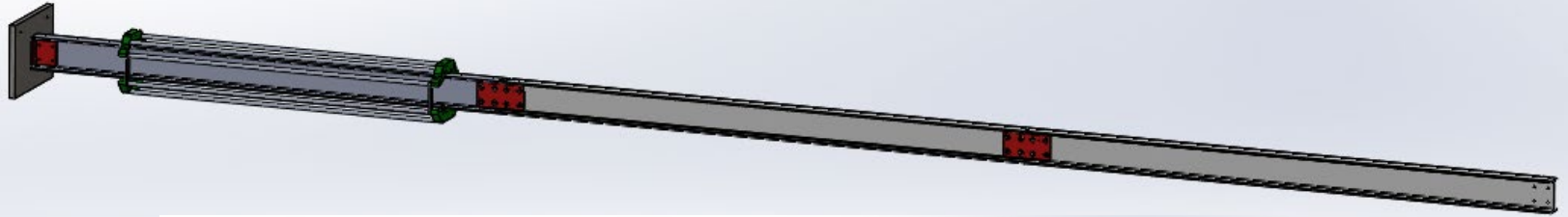
# TPC INSTALLATION

Pipe shown below  
will be part of TPC  
assembly

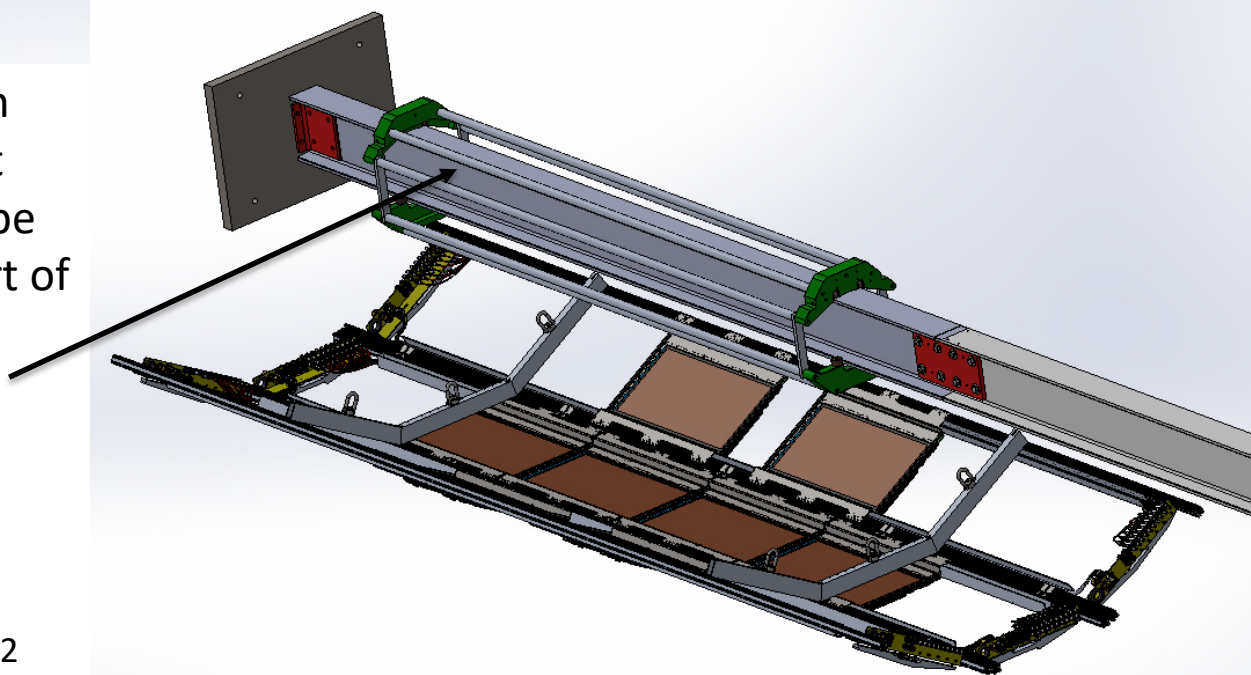


Beampipe - INTT - MVTX - MinBias

# Modification to I-beam assembly used to install TPC;



New I-beam section that replaces tube that is a part of TPC installation

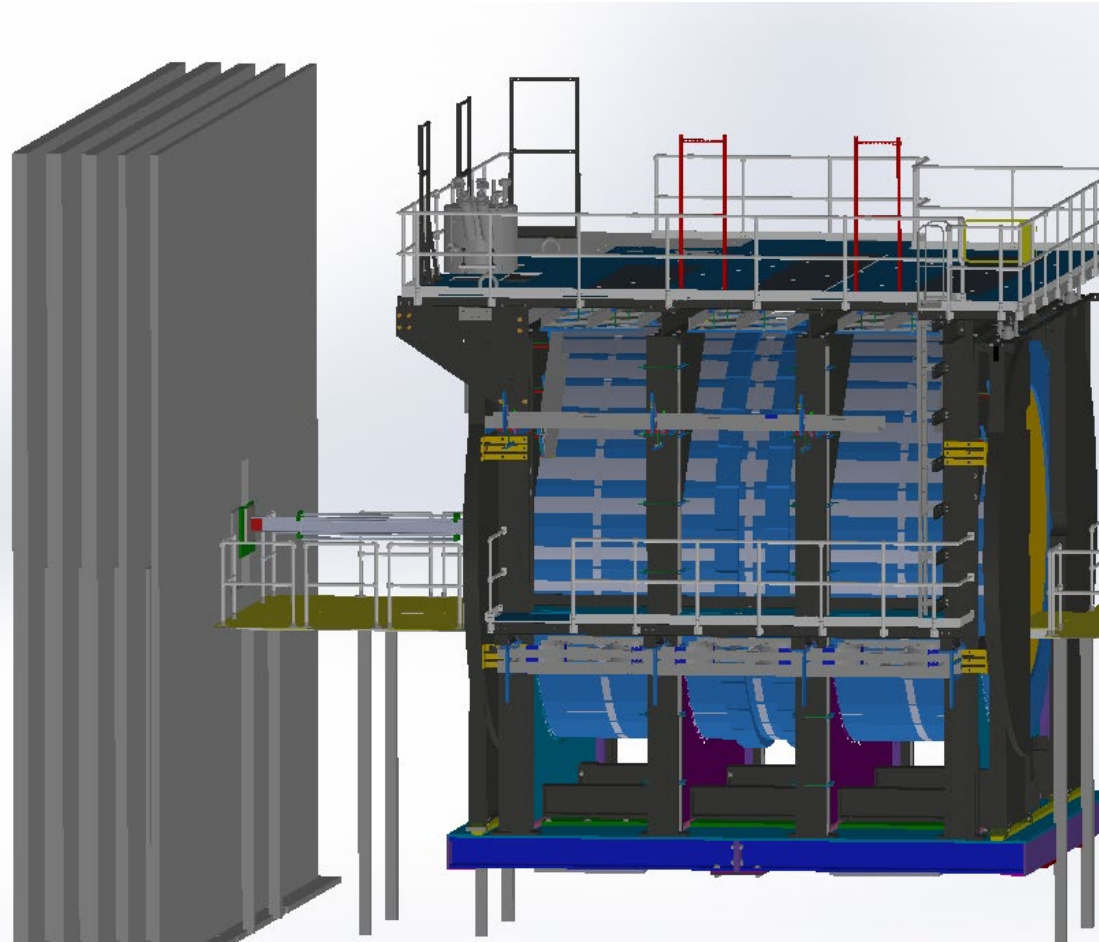


TPOT panels set at correct radial distance to verify clearance from platform height



# TPOT installation I-beam located on platform;

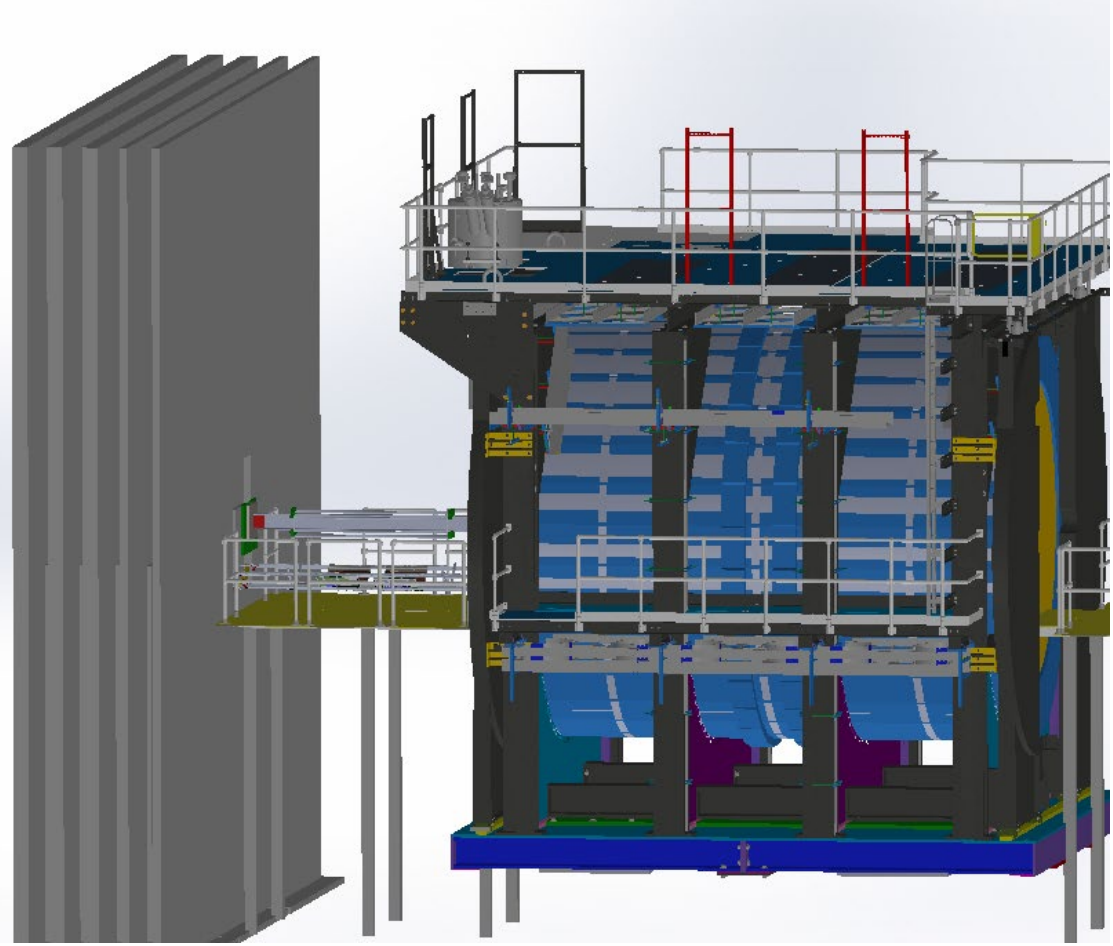
This view has the TPC central pipe removed and the I-beam support for the TPOT detector array installed with roller carriage -



# TPOT detector array positioned to I-beam;

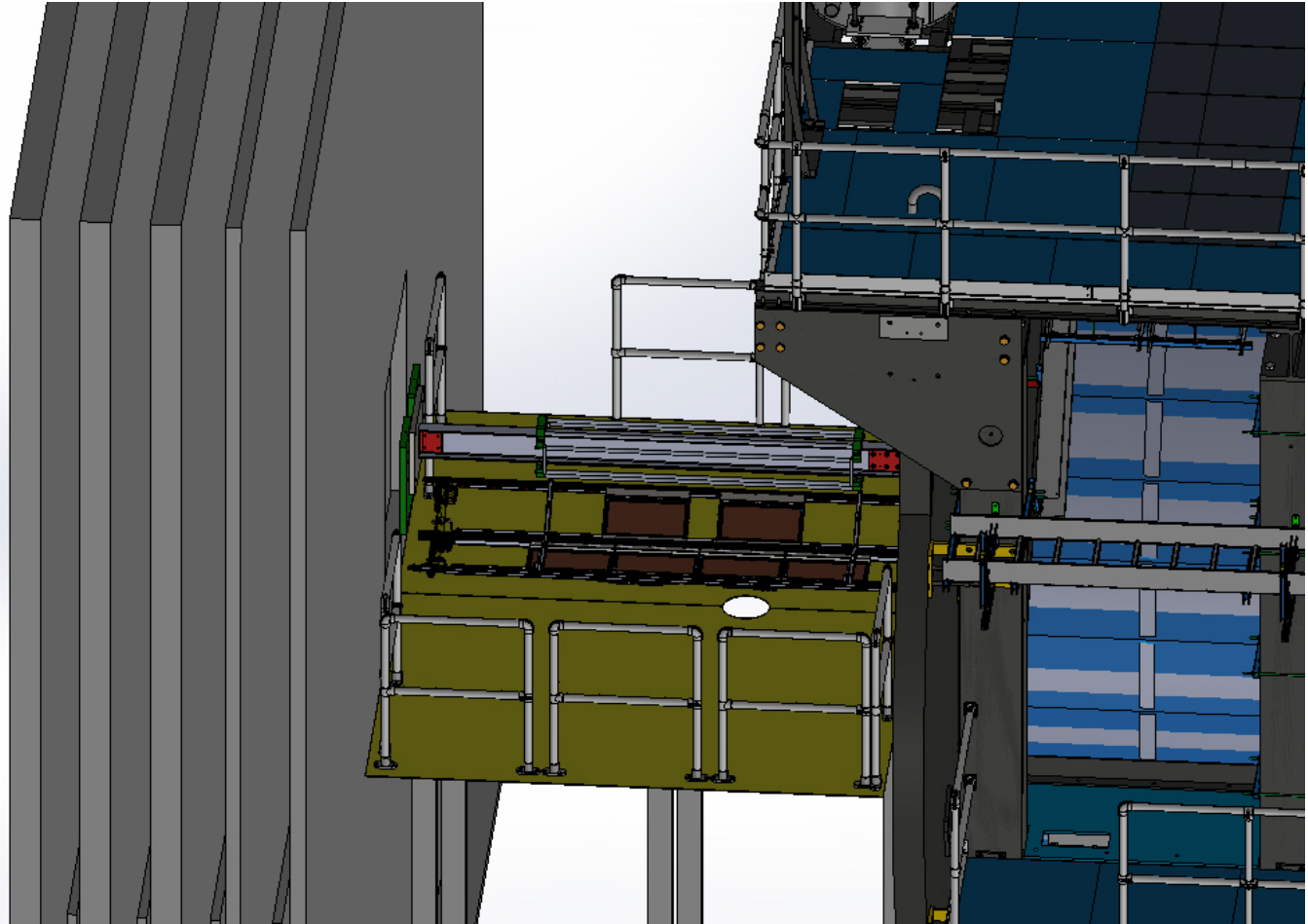
This view has the TPOT detector array located in its final radial position after installation into sPHEIX, to verify vertical clearance.

A cradle will be needed to assemble the three sectors on the floor and used to lift this assembly up to the SOUTH platform.



# Detail view of South platform;

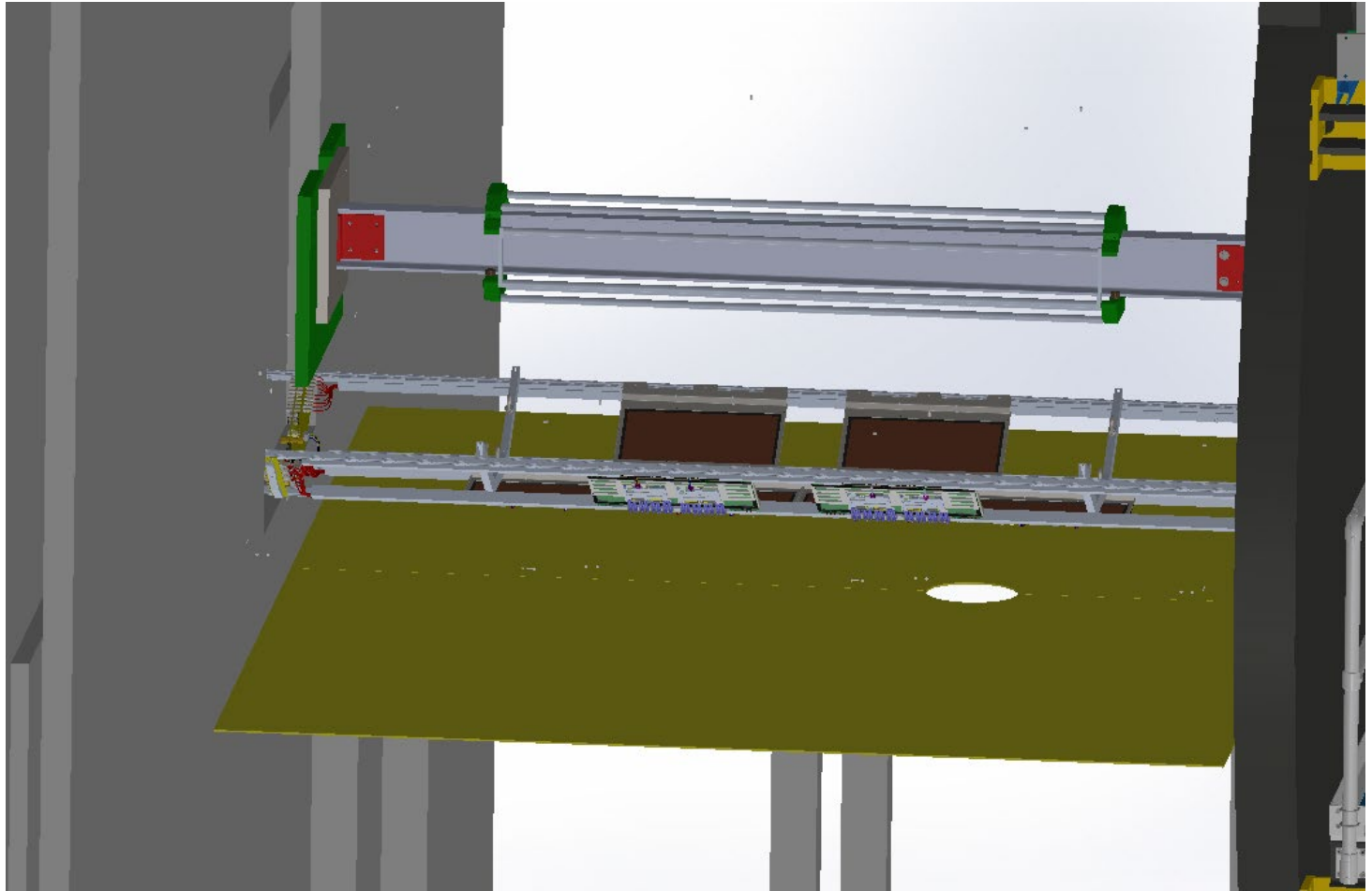
Detail view from  
previous slide



# Detail view of South platform with railing removed; SPHENIX



In this view the platform railing has been suppressed in the model to give a better view of the TPOT detector array



# Conclusion, a lot of progress since last review;

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- Update to TPOT detector assembly
  - New negative pressure cooling plates added
  - Design of SAMTEC interconnection between FEE and TPOT panel
- TPOT 2 & 4 detector sectors completed
  - Services patch panels added to all sectors
- Verify adequate clearance to EMCal boxes and TPC envelope
- Design of an installation procedure in development
  - New I-beam added, make use of TPC rollers
- *Need to define rigging to lower TPOT assembly to EMCal*
  - *Design carriage for assembly of TPOT array, use to lift to platform*

# Share screen – tour CAD model;

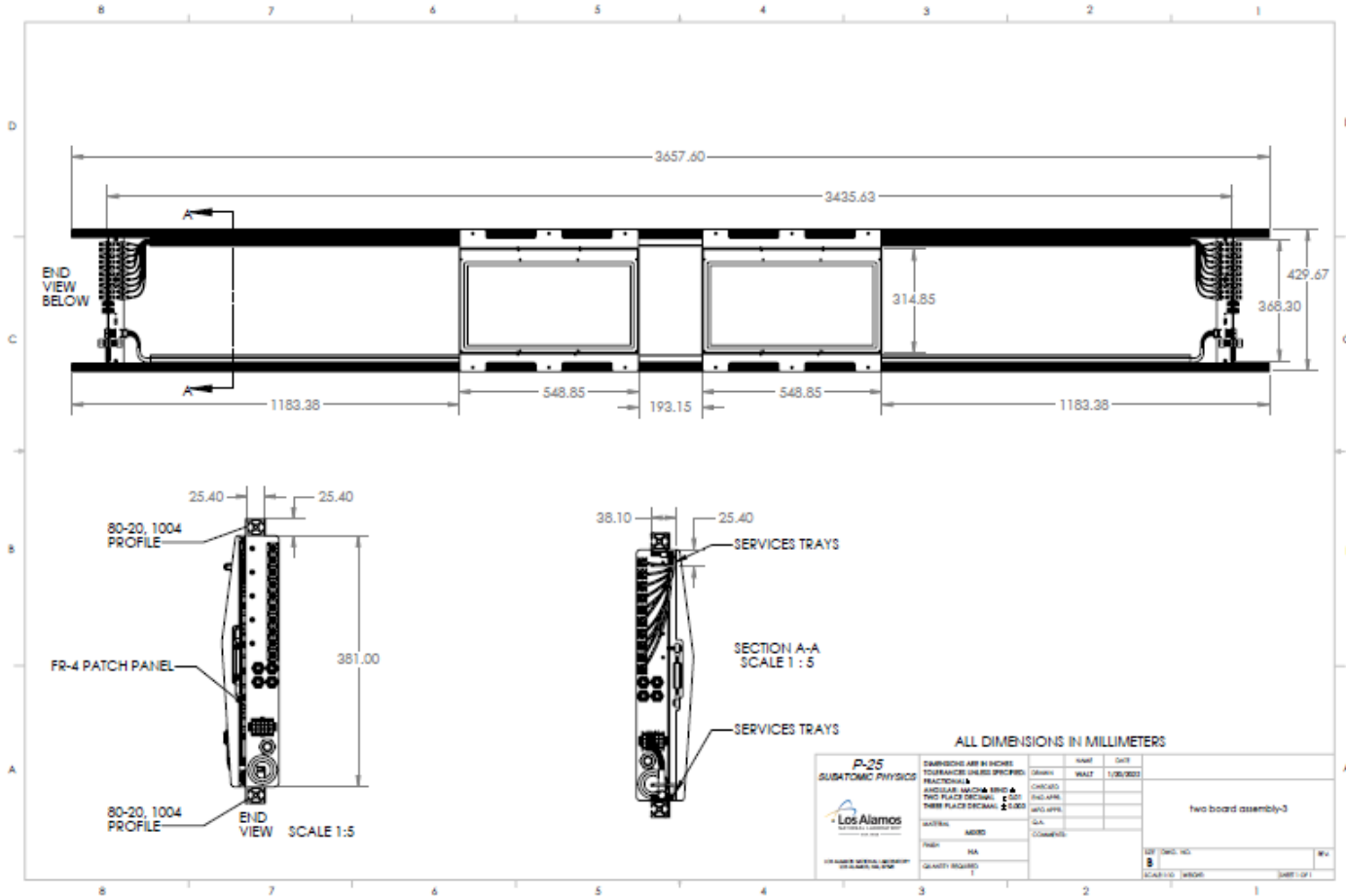
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# Backup slides;

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# TPOT 2 detector sector array drawing;

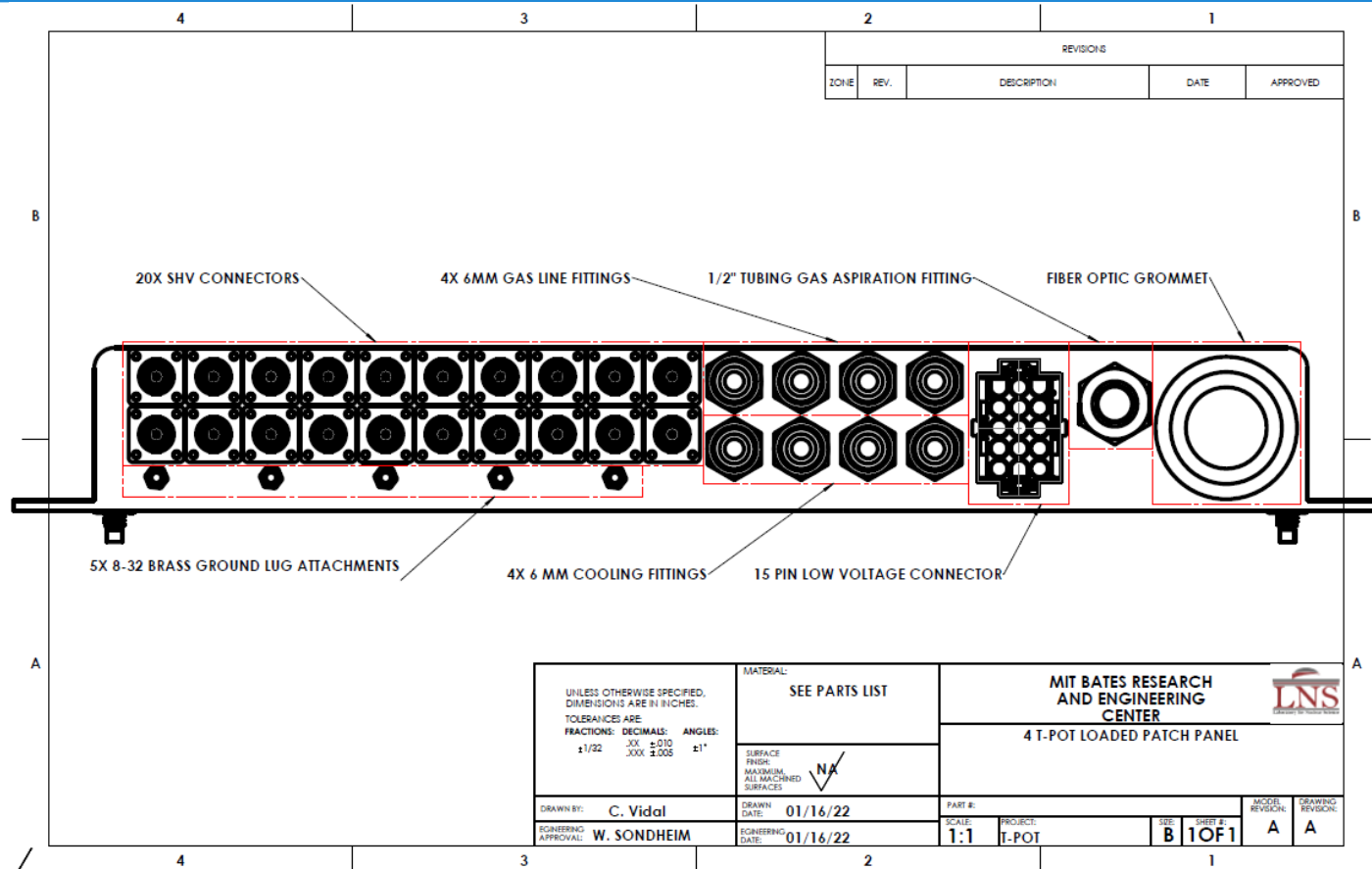




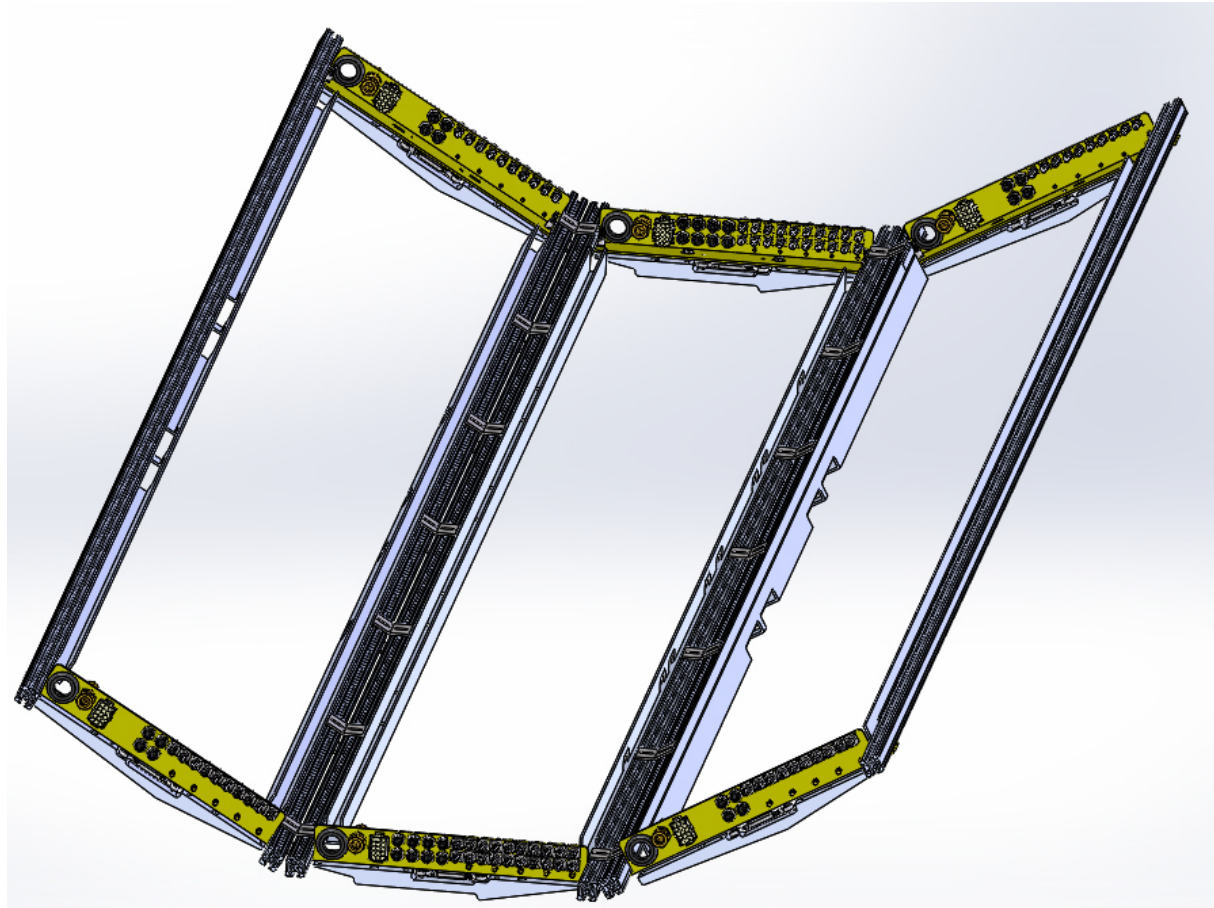
# TPOT 4 detector sector array drawing;



# Drawing of 4 detector sector patch panel;



# TPOT 3 sector support frame assembly;



- 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 ( $\geq 22^{\circ}\text{C}$ ). Convection and radiation have no heating effect on the assembly.
- **If the FEE boards are cooled with room temperature water ( $22^{\circ}\text{C}$ ) the PCB components will be maintained around  $25^{\circ}\text{C}$  and the hottest component could be  $26.4^{\circ}\text{C}$ .**
- **If the FEE boards are cooled with cold water ( $16^{\circ}\text{C}$ ) the PCB components will be maintained around  $19^{\circ}\text{C}$ .**