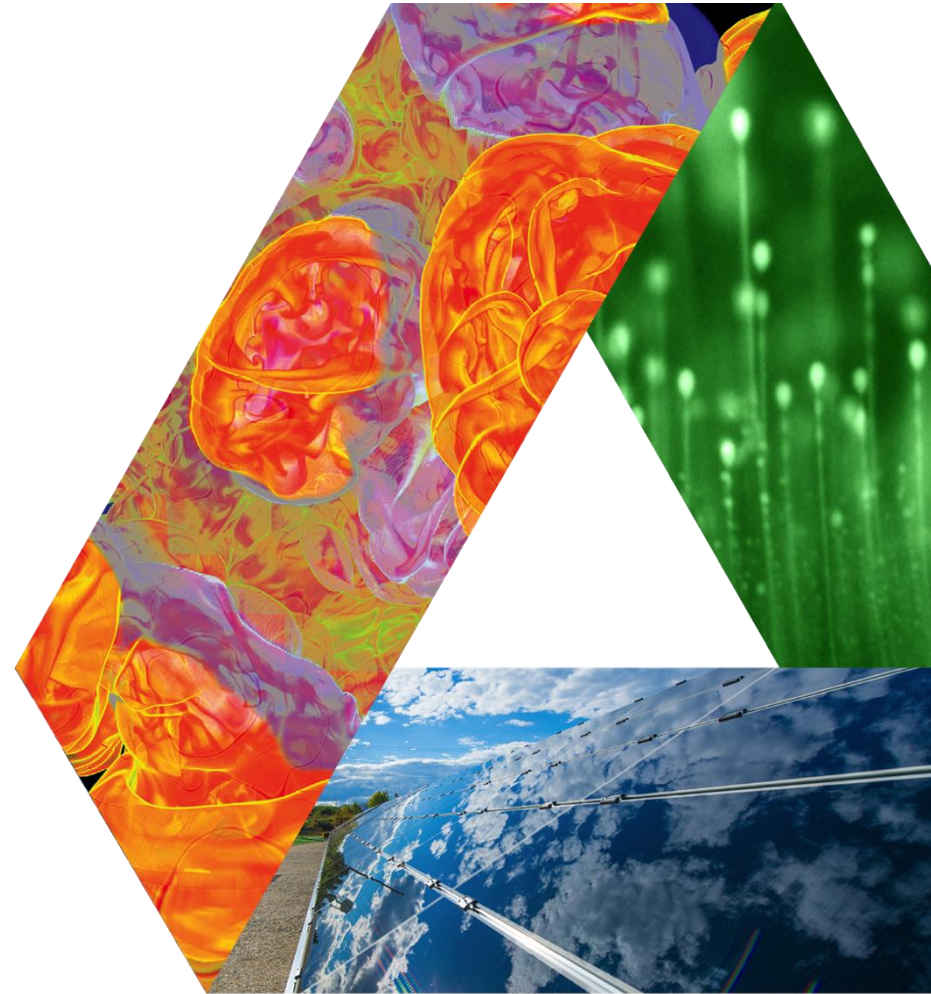


# CPA DESIGN



# VICTOR GUARINO

Argonne National Laboratory  
November 10, 2016

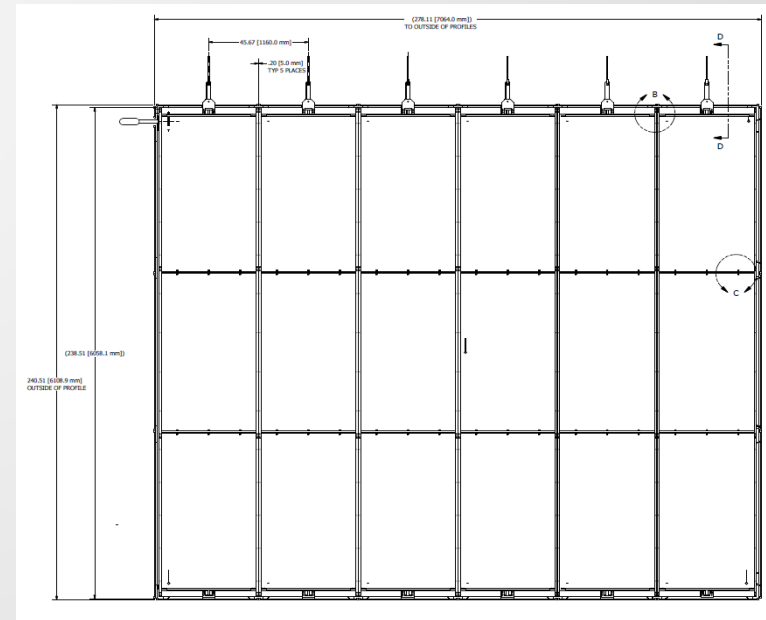
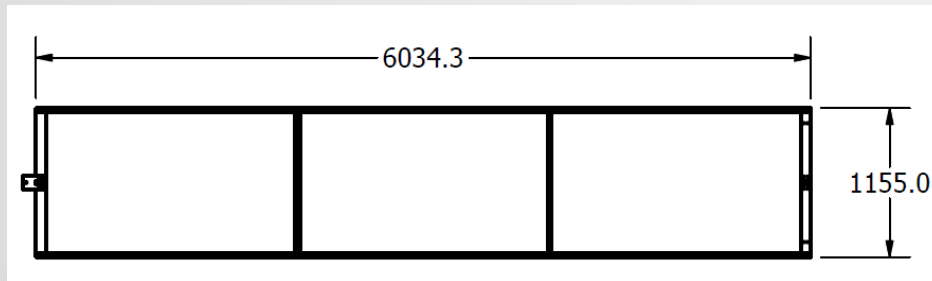
# CPA DESIGN

- Extensive material and physical testing has been done.
- Extensive analysis of CPA structure and joints has been done.
- Mechanical Design Complete -- full set of drawings/parts list are posted
- 4 Ash River prototypes completed and at Ash River
- HV Design integration complete
- Cold Test needs to be performed.



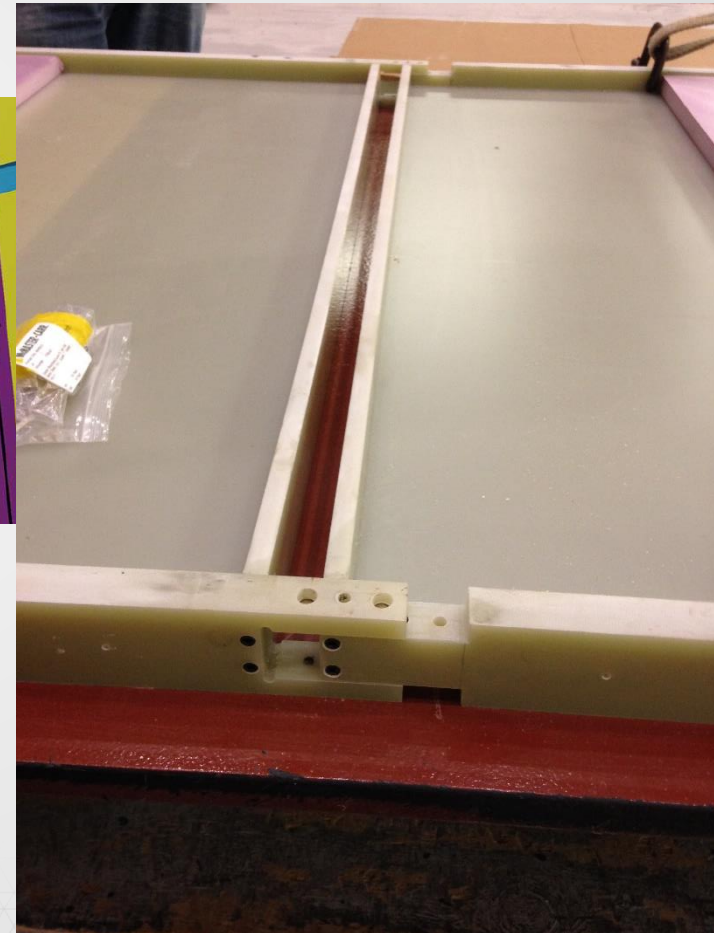
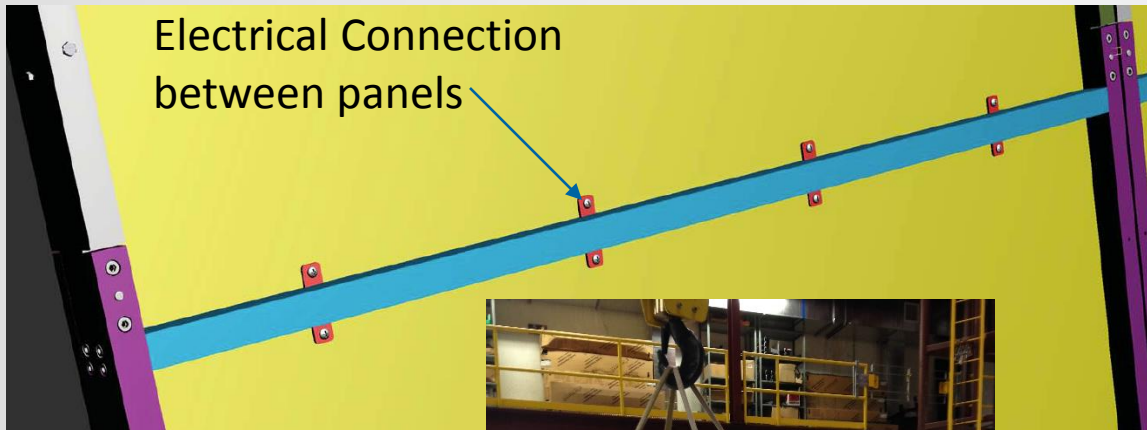
# CPA DESIGN

- CPA Panel is 1.1m x 6m
- Each CPA Panel is made up of 3 modules that are 1.1m x 2m
- Each Module is a simple frame that captures the panel in a groove
- Modules are attached to each other through a tongue/groove connection.
- DUNE CPA 12m long
- Design meets DUNE requirements



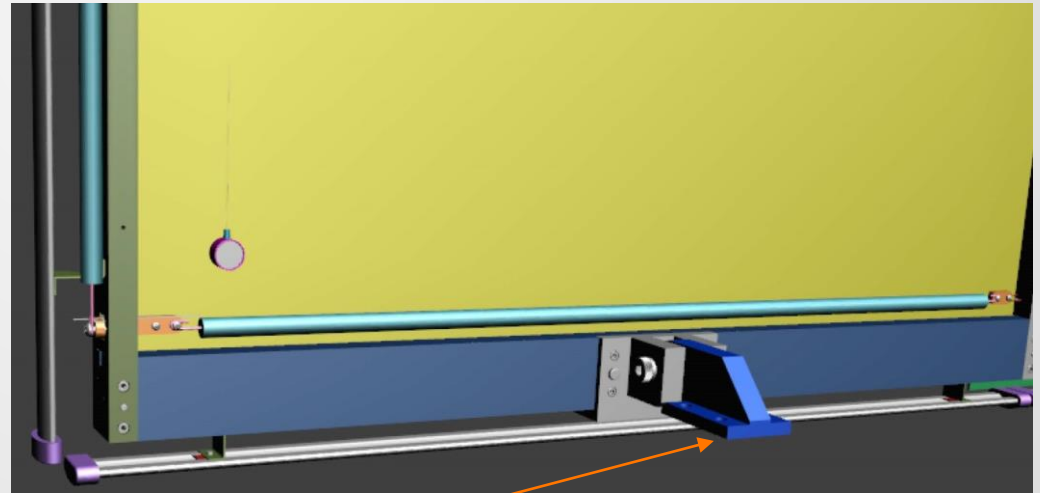
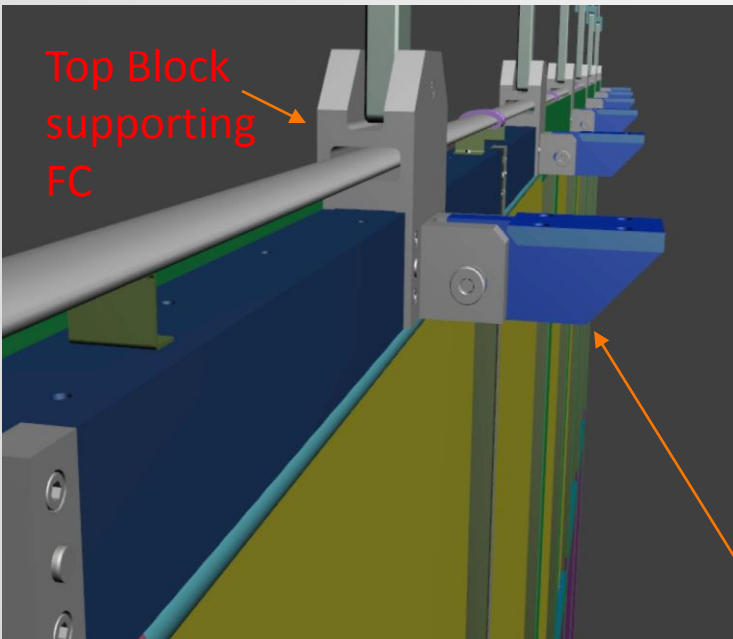
# CPA DESIGN

- Each module is a simple frame connected by a tongue and groove.
- After modules are mechanically connected they are connected electrically with tabs



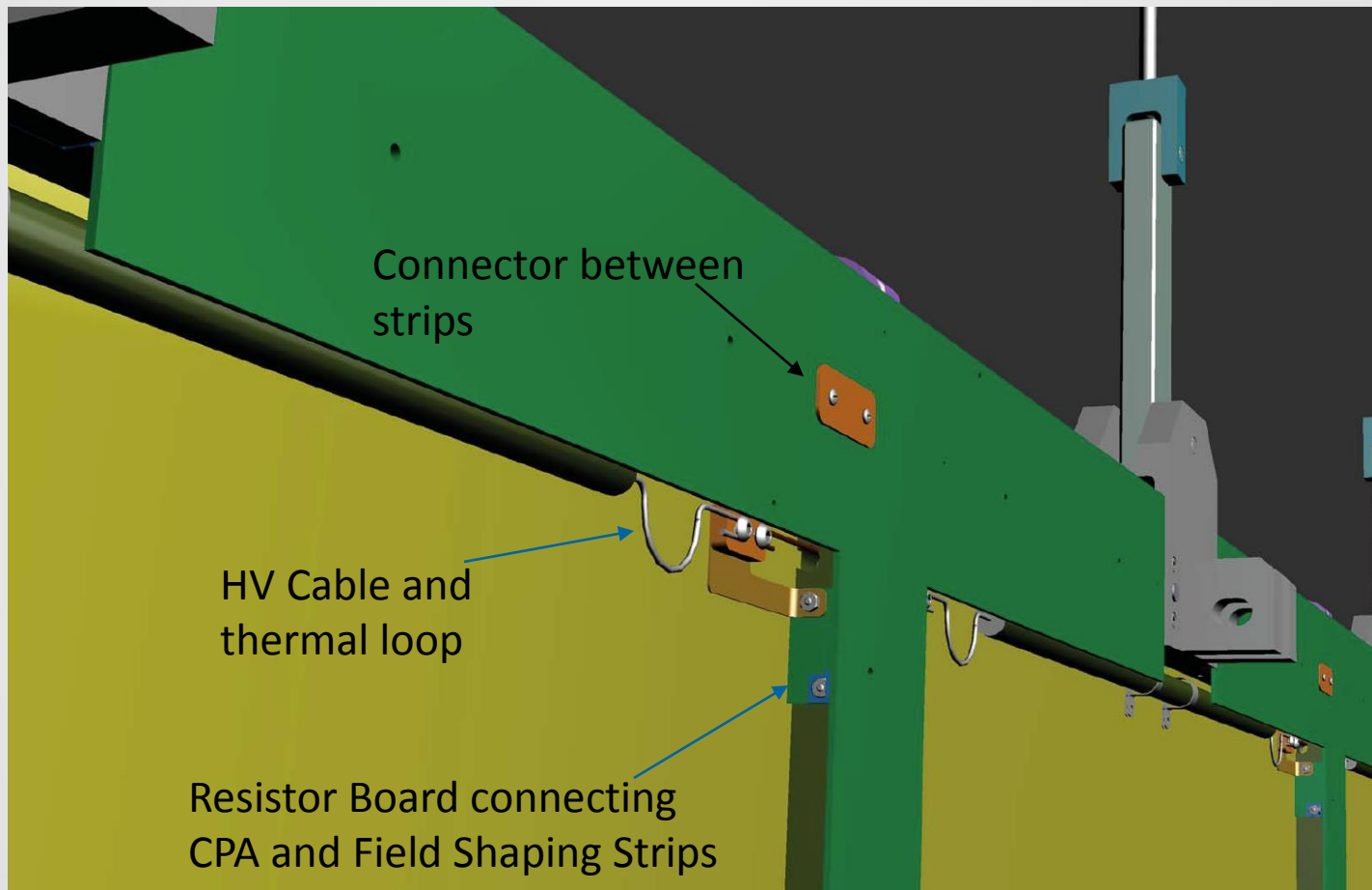
# CPA DESIGN

- Support at top acts at FC hinge and transfers load to DSS
- Support at bottom acts as hinge to carry weight of bottom FC modules



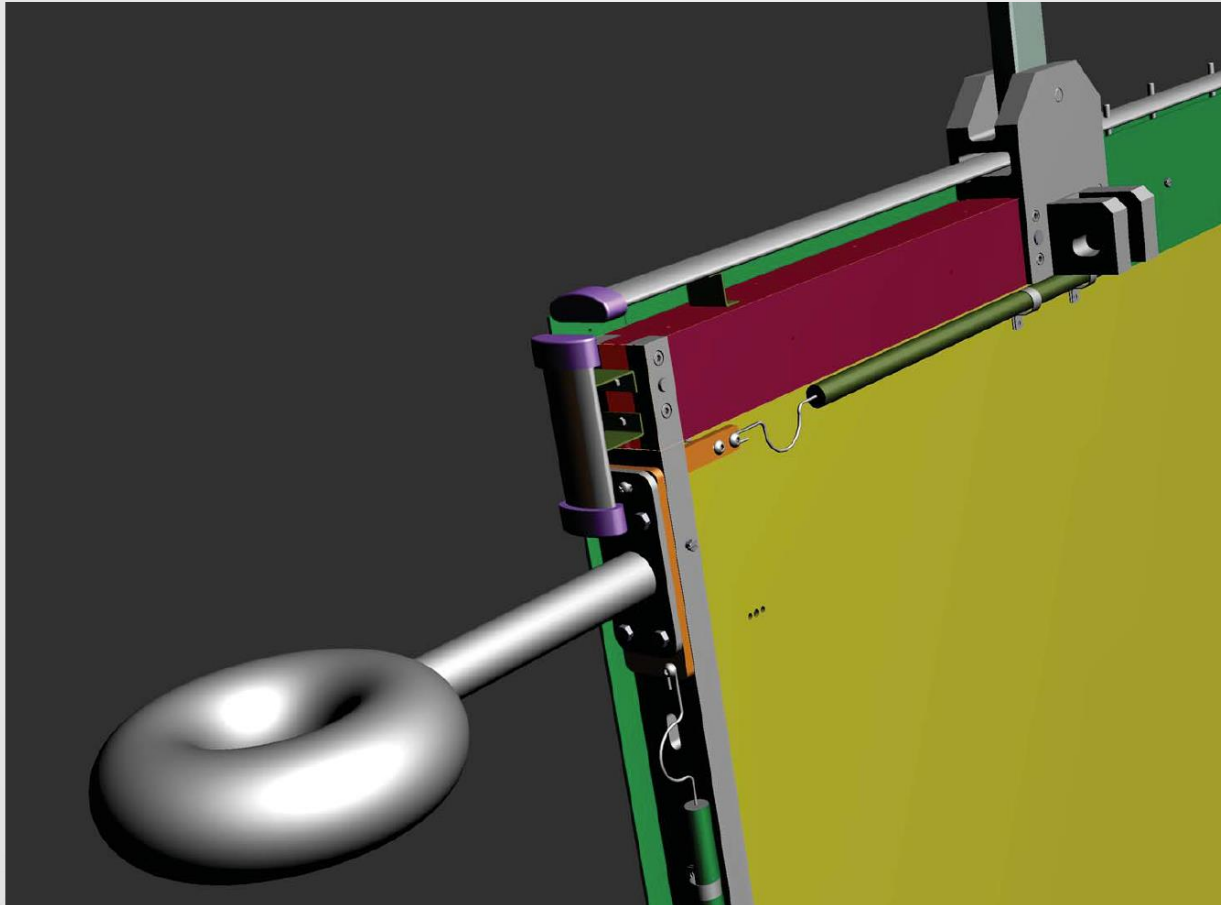
# CPA DESIGN - HV

- HV Connections are Integrated into CPA
- HV cables run along side of CPA and top/bottom



# CPA DESIGN - HV

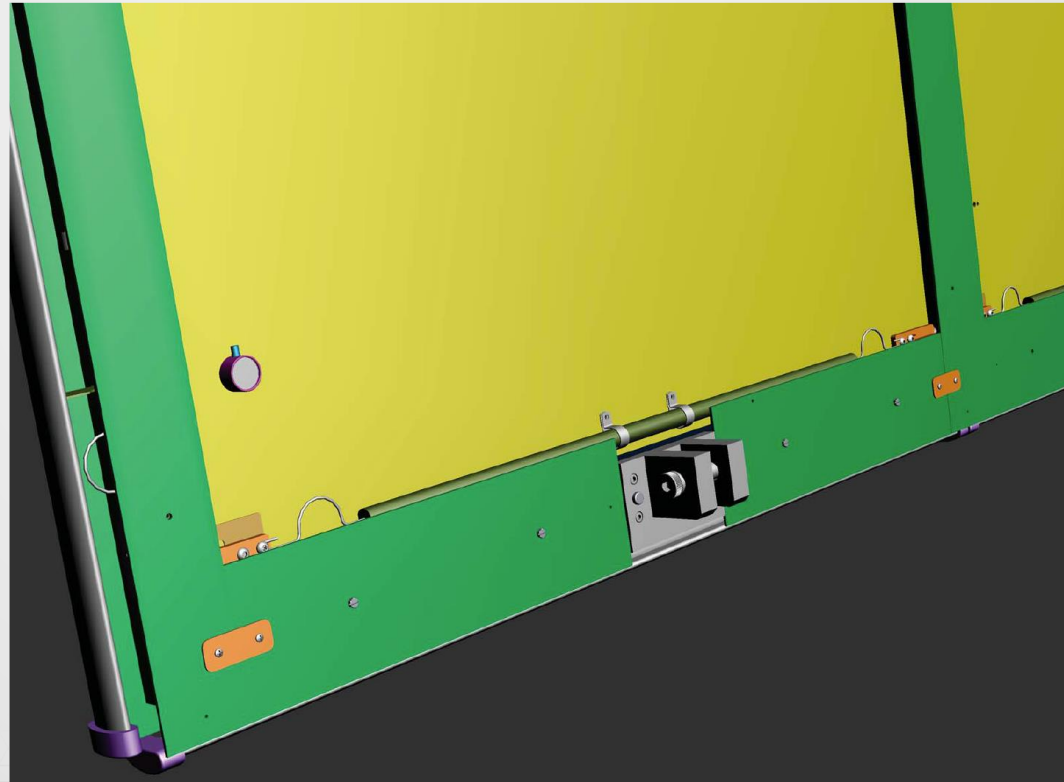
- Feedthrough connects to donut which is secured to CPA frame
- HV cables are connected to donut frame



# FIELD SHAPING STRIPS

- The entire CPA Frame has strips that overlap the frame by 1" to shape the field.
- The strip potential is set by resistors connecting them to the CPA panel.
- Strips are 1/8" thick G10 with same resistive coating as cathode planes

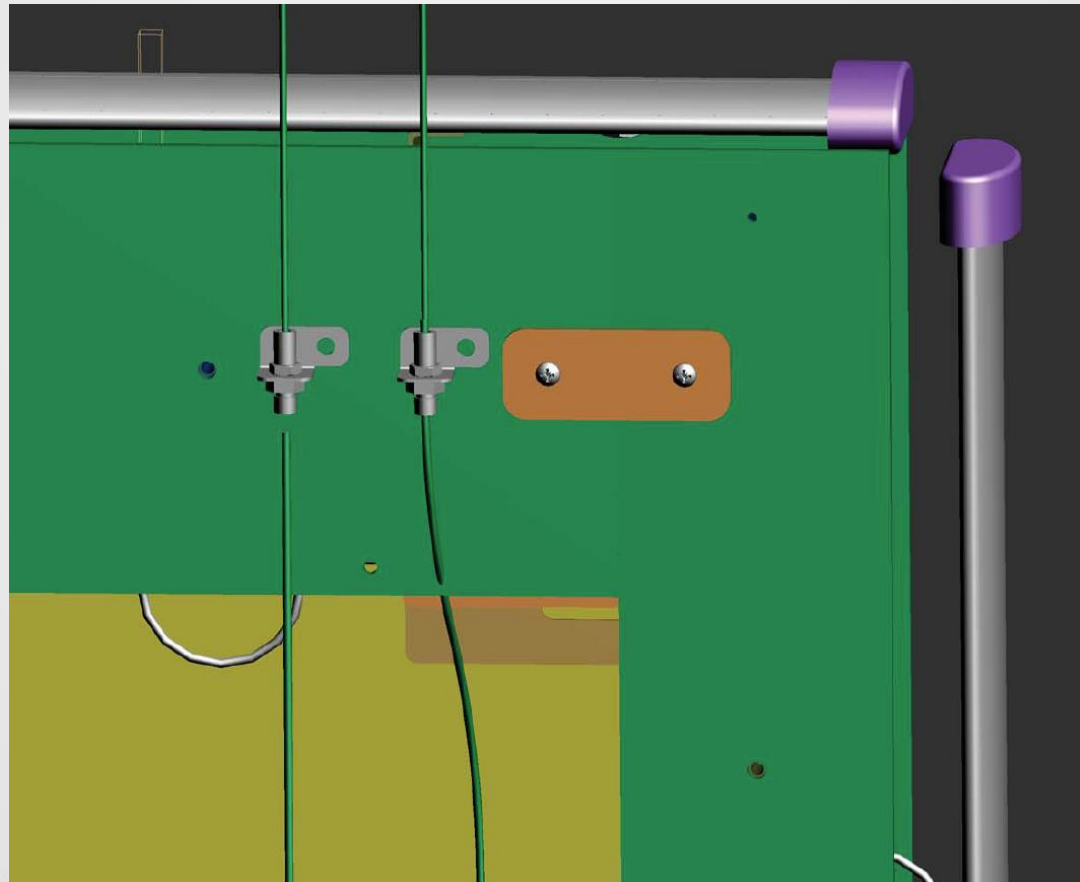
Strips are in  
Green





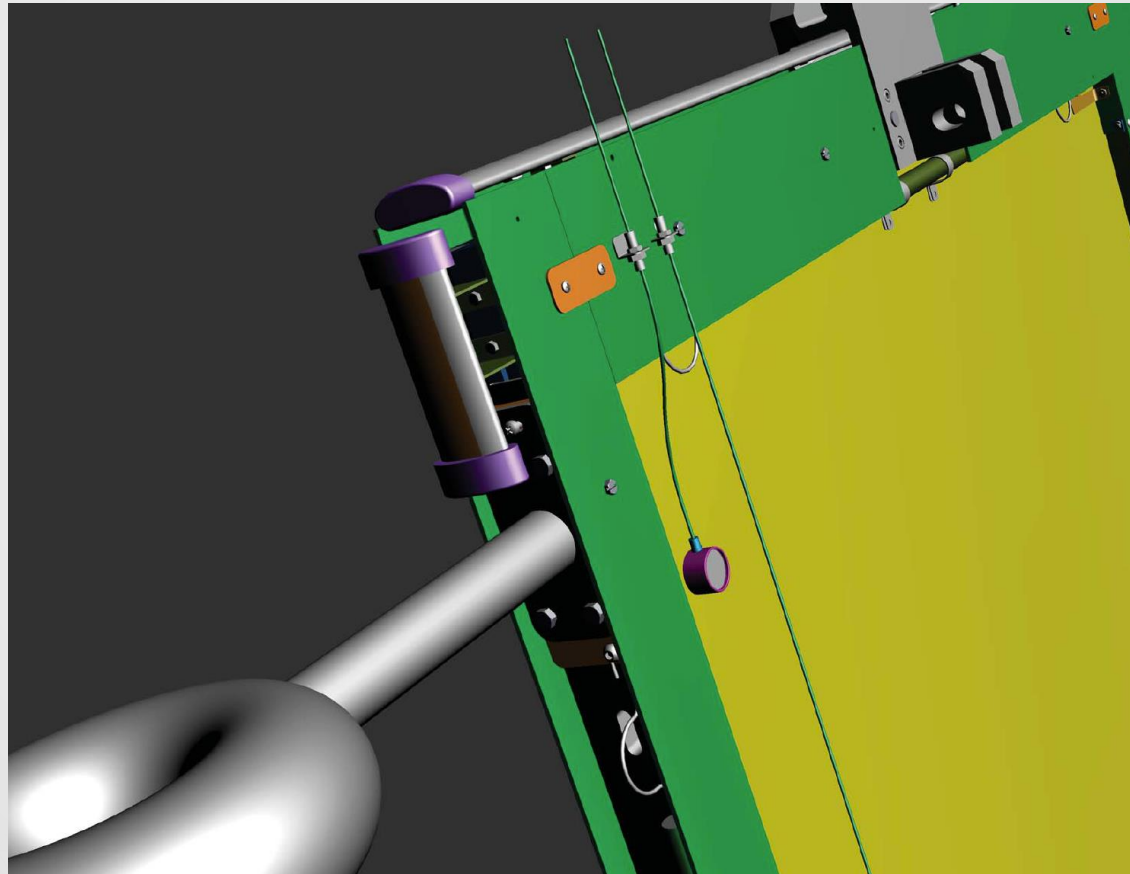
# CPA PROFILES

- The assembled CPA plane has profiles mounted around the perimeter to mimic the FC profiles.



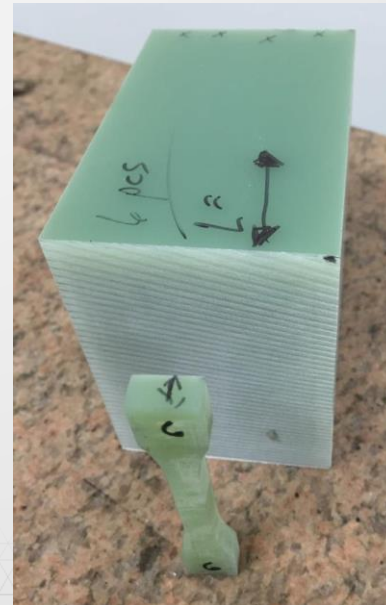
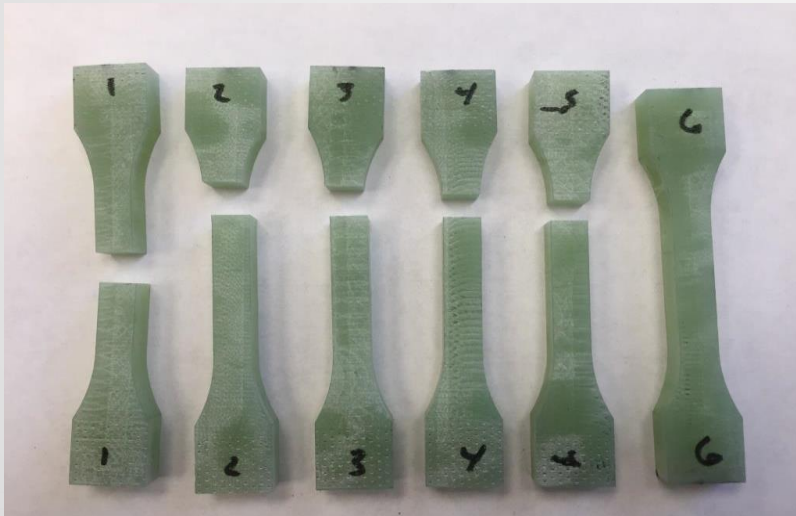
# CPA DESIGN - DIFFUSERS

- Diffuser are integrated into CPA
- 5 Diffusers per side – 1 in each corner and 1 in center.



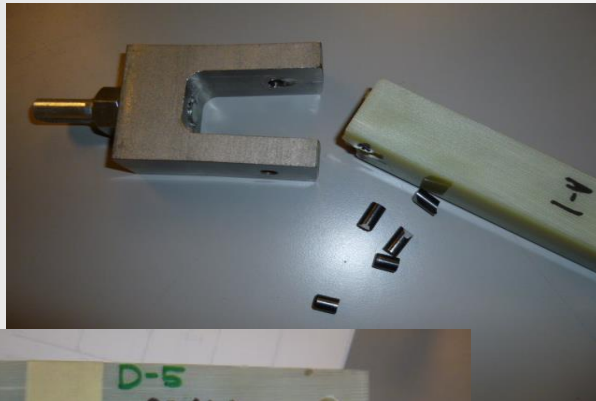
# MATERIAL AND TESTING

- We will be using FR4 and FRP material that meet the International Building Code classification for flame spread and smoke development of a Class A, as characterized by ASTM E84
- Both the FRP structural shapes and FR4 bar material shall be fire resistant and likely will be halogenated.
- Testing was performed to understand the strength of the material in every direction. (see details in design paper)



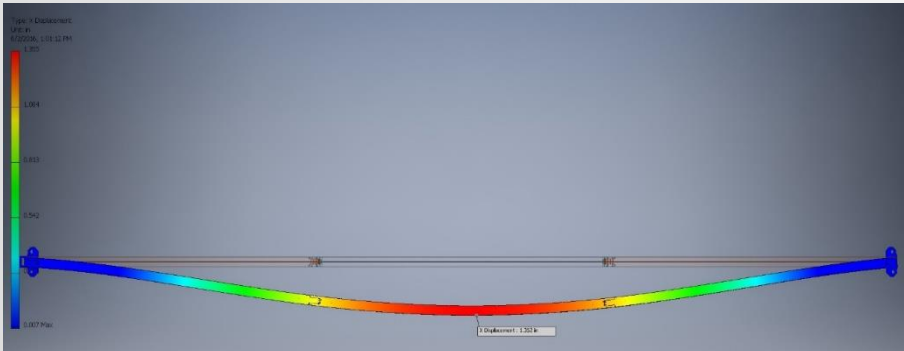
# PHYSICAL TESTING

- Extensive testing was performed on connections (see design paper for details)



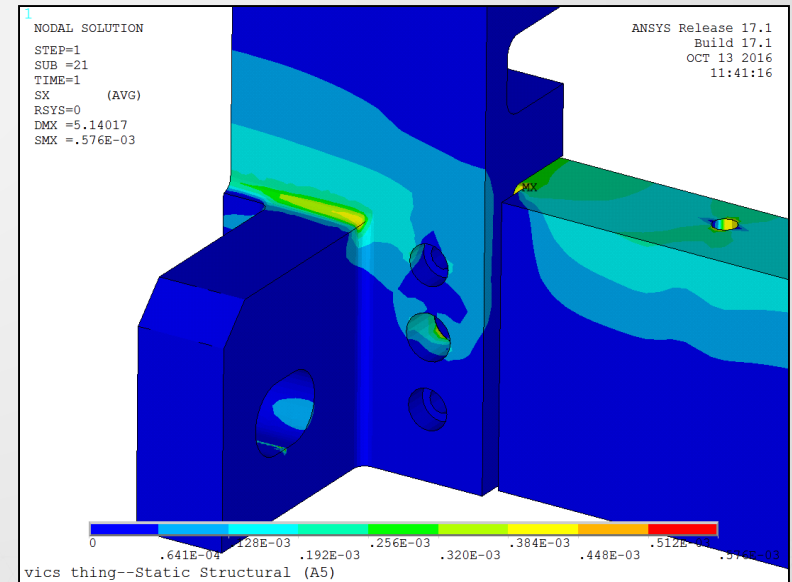
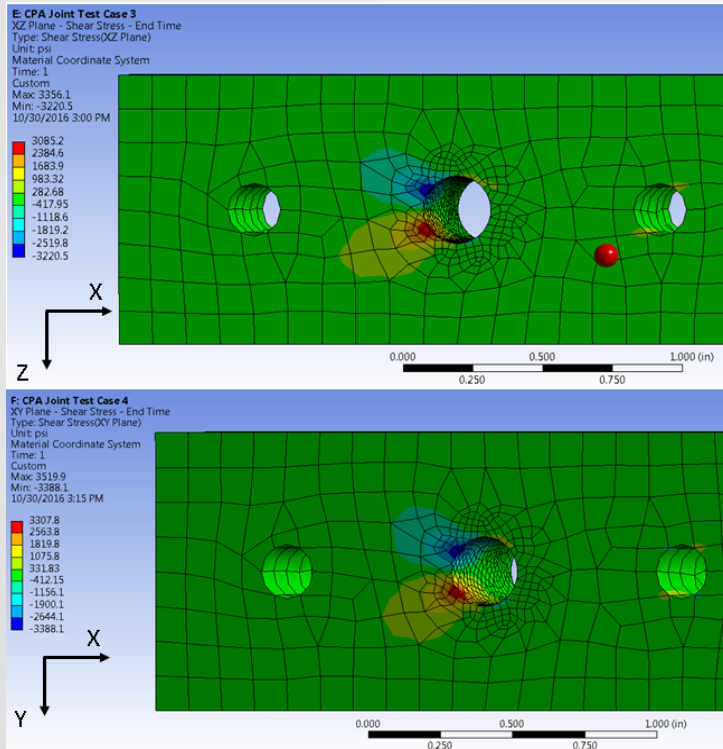
# STRESS ANALYSIS

- Detailed analysis was performed on the structure and joints using beam elements, hand calculations (see design paper Appendix 1), and Solid Elements.
- CERN utilizes the JRC Science for Policy Report “Prospect for New Guidance in Design of FRP” as a guide for designing FRP structures.
  - This is not directly applicable to our unique structure
  - Used as a guide and determination of the safety factor of 3.75
- Calculations checked by physical testing determine the strength of the design.
- The highest loads occur during assembly. We considered:
  - Rotation of the CPA from the assembly table to vertical
  - During installation when the CPA supports the entire weight of the FC modules
  - After deployment and a 200 lbs worker is standing on the bottom FC adjacent to the CPA.



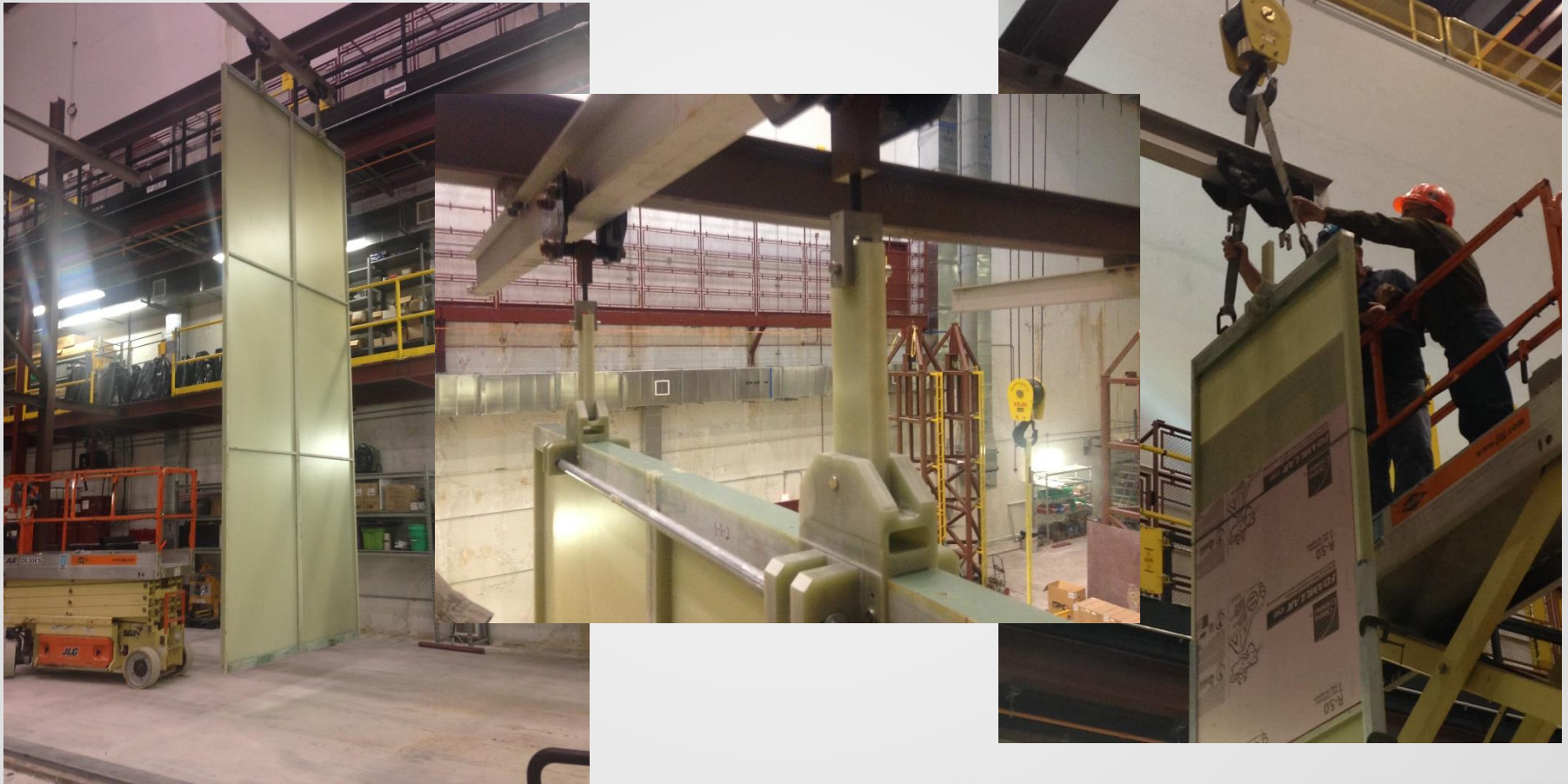
# STRESS ANALYSIS

- Hand calculations/FEA/Testing results all matched well.
- Have a safety factor that exceed 3.75 everywhere.

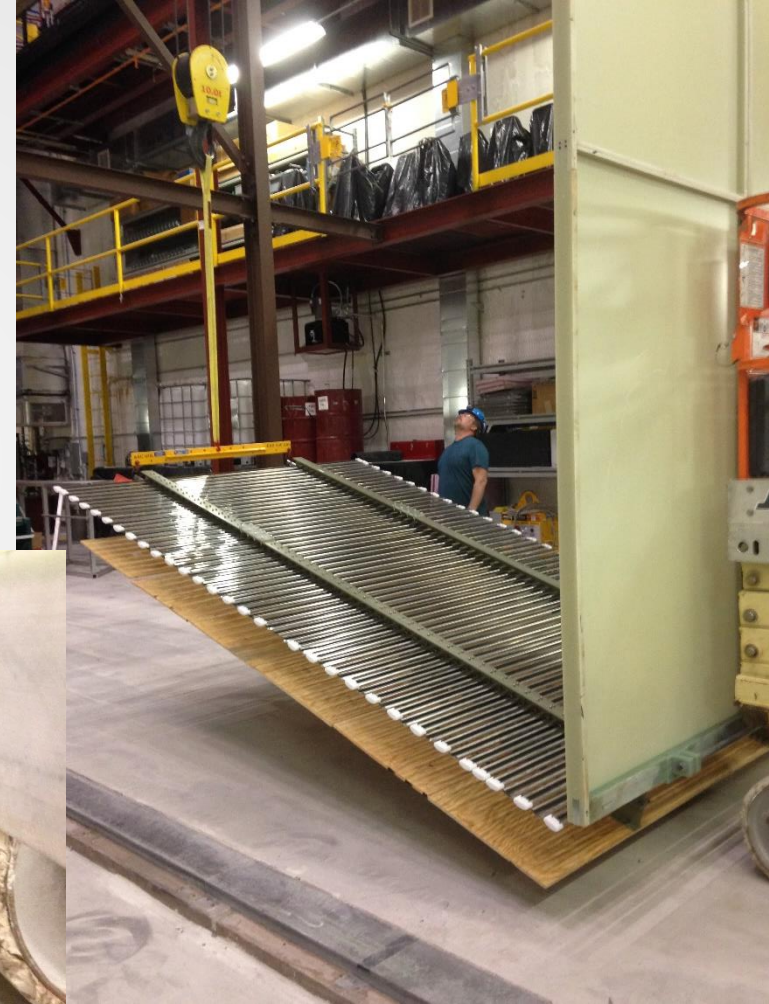
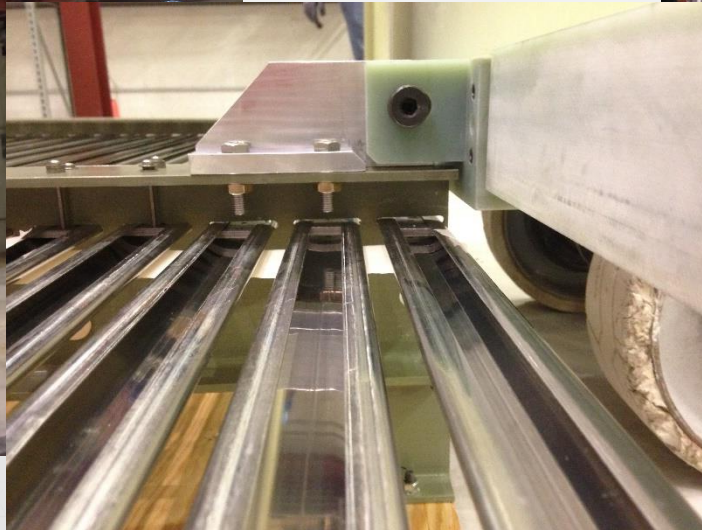


# ASH RIVER

- 4 CPA's delivered to AR. Two have been hung and have had the 1<sup>st</sup> FC module attached.



# ASH RIVER





# CONCLUSION

- A complete design has been developed.
- Four mechanical prototypes have been constructed and shipped to Ash River
- The mounting and deployment of the FC modules will be tested at Ash River before production.
- Extensive physical testing and analysis has been performed and shows we meet Safety Factors
- Developing Hazard Analysis and assembly procedures in conjunction with Ash River assembly



