NP04 CPA/FC/HV Interfaces

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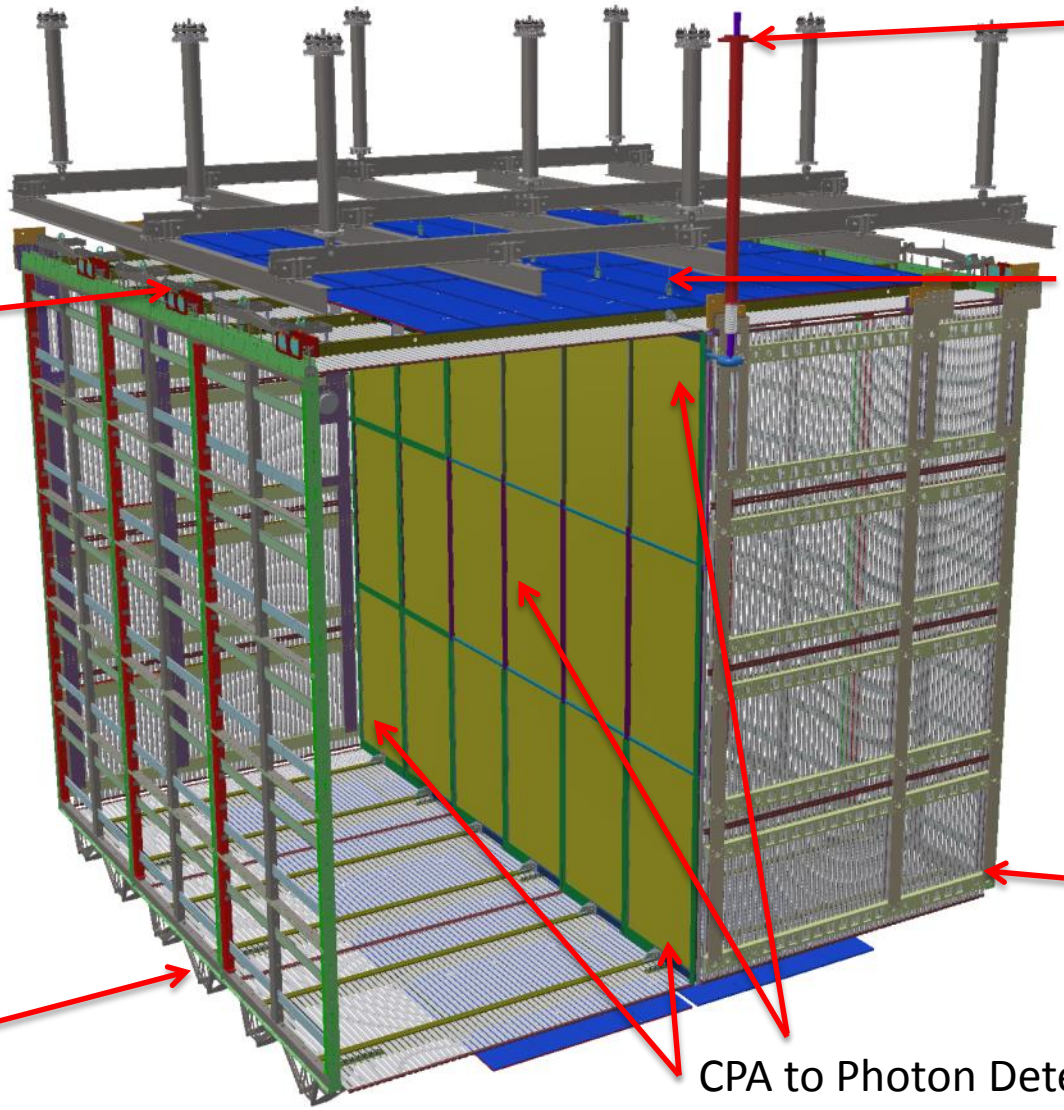
October 10, 2016

The Current TPC Model



NP04 Interface Matrix

ProtoDUNE Interface Control Document Matrix	Cryostat	TPC Mech Detector support	APA	HV/CPA/FC	Cold Elec incl Feedthru	Photon Detection System	DAQ/Comp/Slow Cntrls	Rack Space & Power Reqs
Cryostat								
TPC Mechanical and Detector support	1676							
APA		1465						
HV/CPA/FC	1677	1681	1345					
Cold Electronics incl Feedthru	959		1357					
Photon Detection System	1678		1372	1682	xxx			
DAQ/Computing/Slow Controls	1679			1683	1481	xxx		
Rack Space and Power Requirements				1684	1685	1686	1687	

- In addition, each subsystem must provide a Cable Database listing and fully describing all cables (connectors, pinouts and materials) .
- In the case of a cable running between subsystems, the subsystem responsible for the purchase of the cables should be the responsible party to provide all documentation.
- Grounding and shielding documentation/plans must be included in all interface descriptions where relevant.

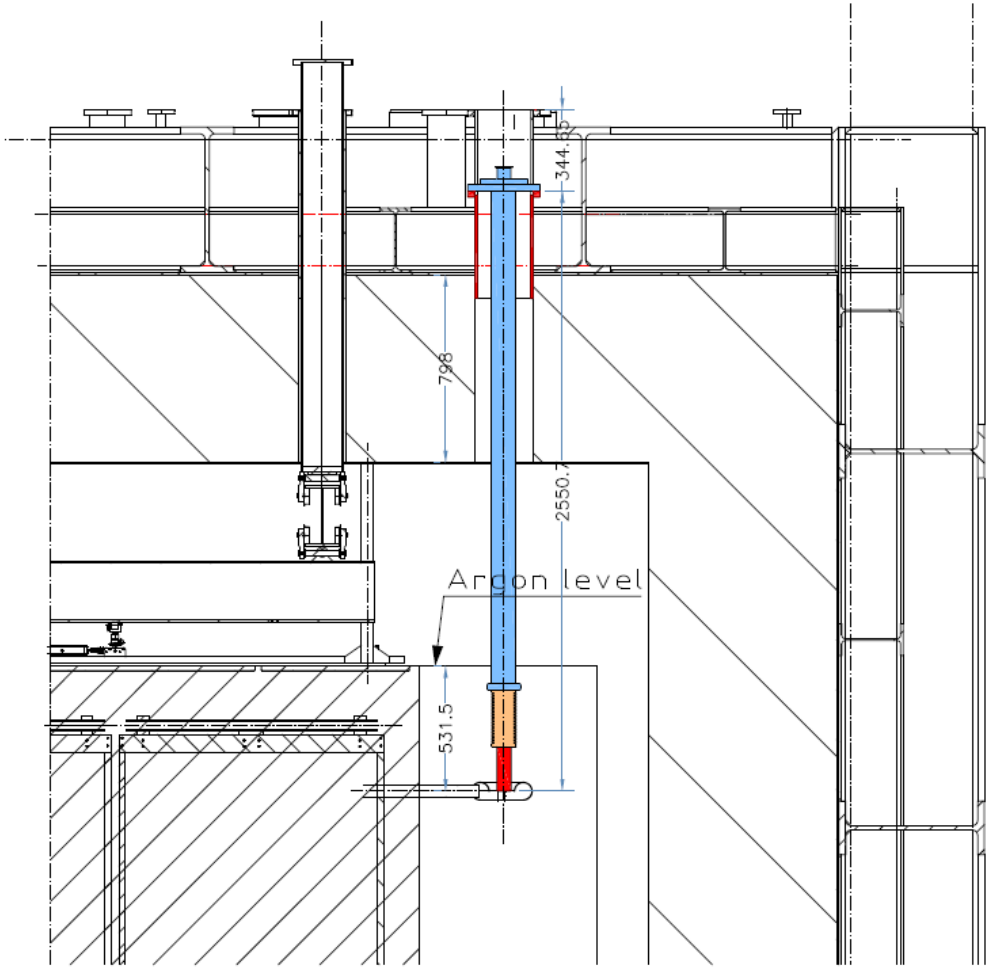
CPA/FC/HV System to Cryostat

ICD: Docdb #1677

Item	protoDUNE-SP Cryostat Provides	protoDUNE Detector Support Provides	Interface
Cryostat <--> Penetration location for HV	The cryostat will have penetrations through the roof for the HV Feedthrough	The HV/CPA/FC provides the locations of the penetrations.	The cryostat penetrations are agreed upon in (link to drawing in EVMS)
Cryostat <--> TCO	The cryostat will provide a TCO for detector installation.	The HV/CPA/FC will agree upon the design requirements of the TCO.	The cryostat TCO dimensions are agreed upon in (link to drawing in EVMS)
Electrical-Ground connection to the FC	Cryostat conforming to the grounding rules of the Grounding Shielding committee.	The HV/FC/CPA provides the HV distribution to the detector. The FC ground plane could be grounded to the cryostat. Any electrical connections to the cryostat must be agreed upon.	Electrical connections to the cryostat.

HV System to Cryostat

- The default HV feedthrough for NP04 is a copy of the NP02 feedthrough with a spring loaded tip to connect to the HV cup mounted on the CPA.
- This drawing shows the fitting of the (long version) NP02 FT positioned in the NP04 cryostat with the TPC.
- The spring loaded tip length and travel need to be finalized with Franco.
- The HV cables running between the power supply and the filters & feedthrough have rather large bending radius.



CPA/FC to DSS

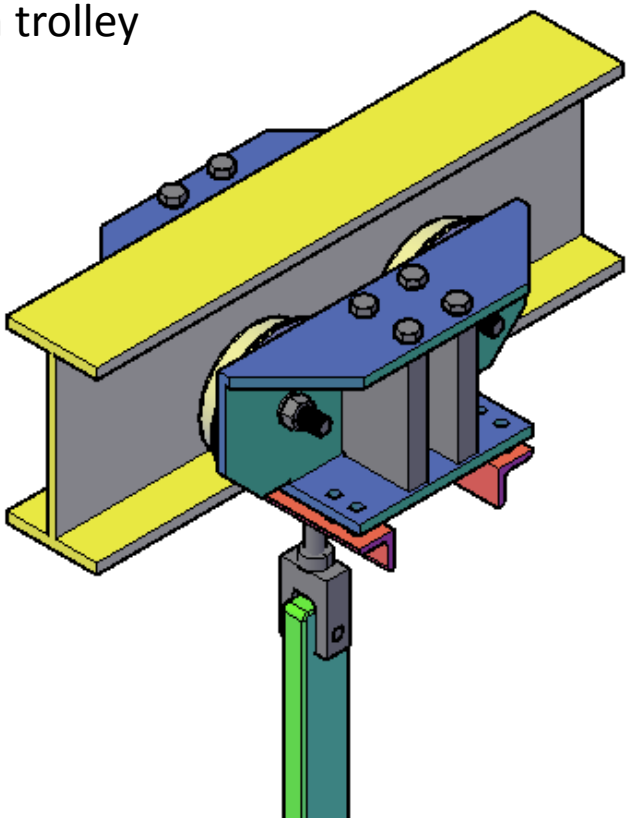
ICD: docdb #1681

Item	protoDUNE-SP CPA Provides	protoDUNE Detector Support Provides	Interface
HV/FC/CPA <--> Detector support mechanics	The CPA provides a connection point to Clevis on the DSS trolley.	The DSS will provide the trolley and Clevis to which the CPA connects.	An interface drawing showing the CPA and DSS interface. This includes adjustment range and pivot axes.
HV/FC/CPA loads <-> DSS	The loads The CPA will exert on the DSS	The DSS will be designed to support the HV/FC/CPA loads	Will be on drawings. In Design paper 1504.
HV/FC/CPA mounting <-> DSS	The tooling to mount the CPA on the DSS.	The DSS verifies the tooling has no interference to the DSS	The tooling is in the drawing package.
Adjustment/Alignment	CPA will ensure that sufficient adjustability is provided.	DSS provides the deformations expected from cooldown and defines the nominal alignment.	The DSS design document will define the CPA alignment.
Electrical-Ground connection	The CPA will be isolated from the DSS.	The CPA will be isolated from the DSS.	A scheme to verify the isolation.

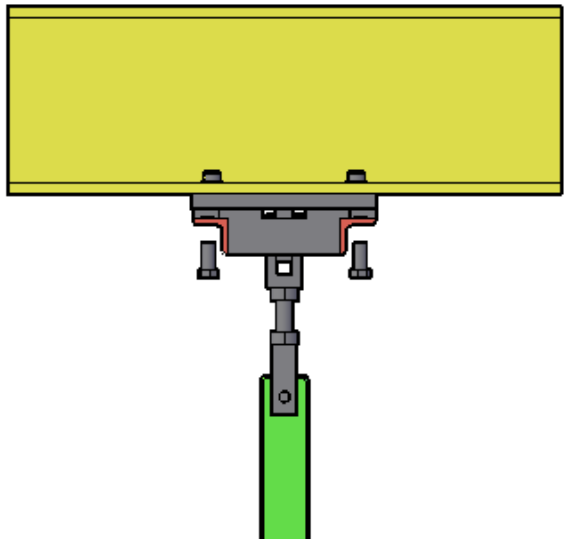
CPA to DSS

- The CPAs are initially loaded onto trolleys and rolled into the cryostat. Once reach their final position, the load is transferred off the trolleys and directly locked onto the CPA beam.

CPA on trolley



Transfer load to the beam
(trolley not shown)



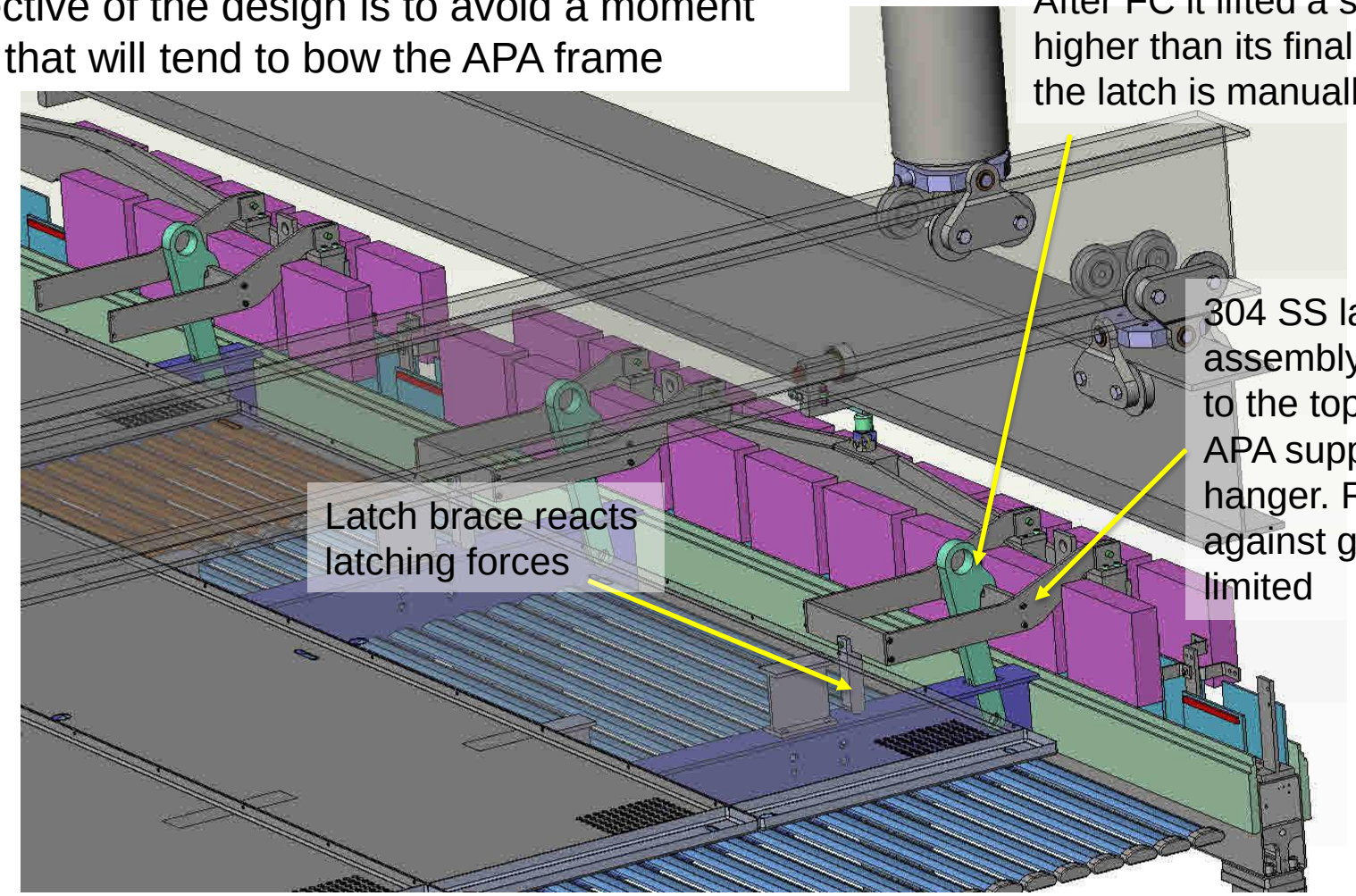
Field Cage to APA

ICD: docdb 1345

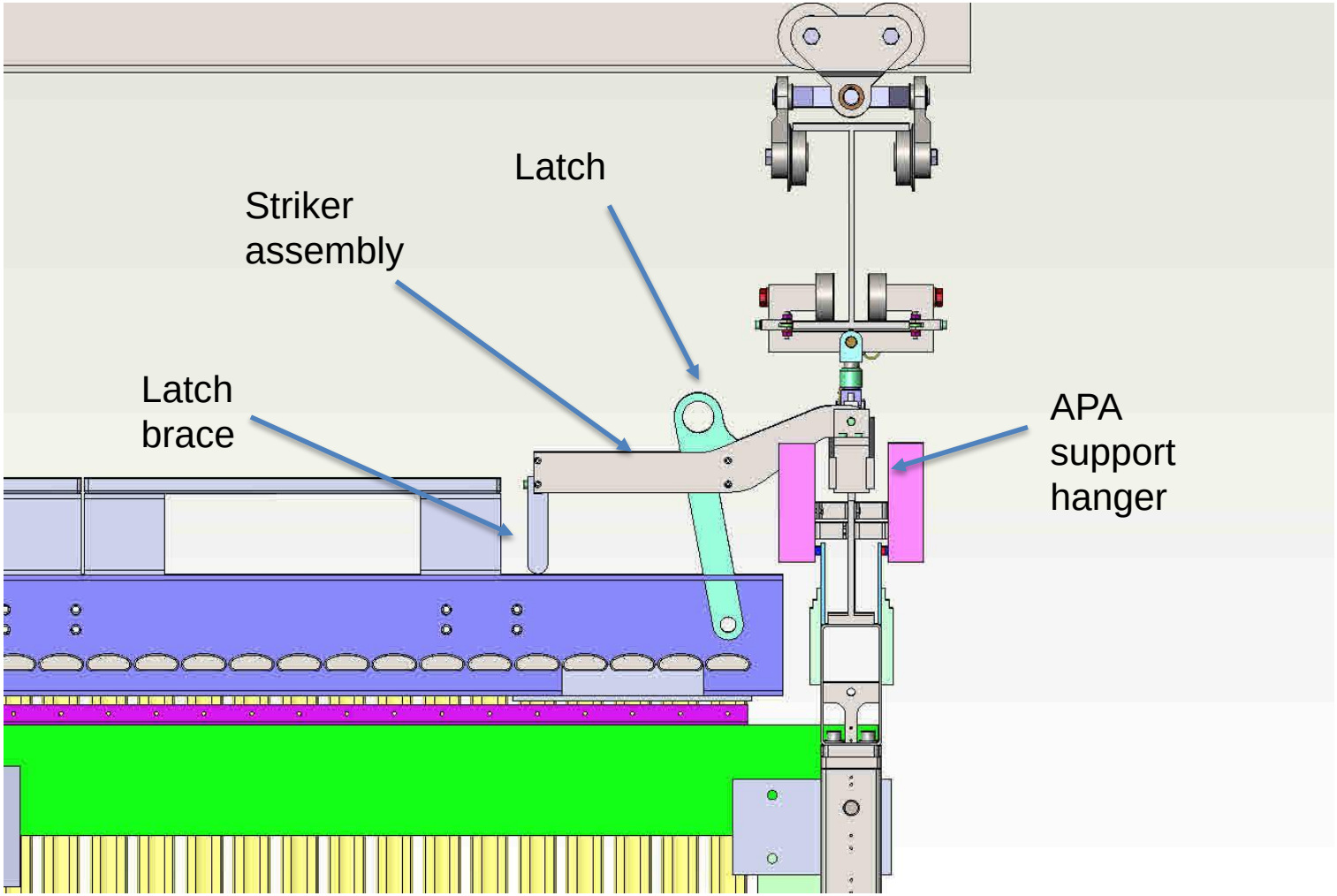
Item	protoDUNE APA Provides	protoDUNE HV/CPA/FC Provides	Interface
APA <--> Field Cage Support	APA provides support brackets for the Field Cage.	HV/CPA/FC engineering loads to the APA and design tolerances warm/cold.	FC end of TPC brackets on APA, fasteners by FC
Electrical-Ground connection to the FC	APA electrical/electronic connection to the FC	HV/CPA/FC electrical ground connection to the APA	FC end of TPC brackets on APA, APA provides ground components crossing the interface

Top Field Cage to APA, Mechanical

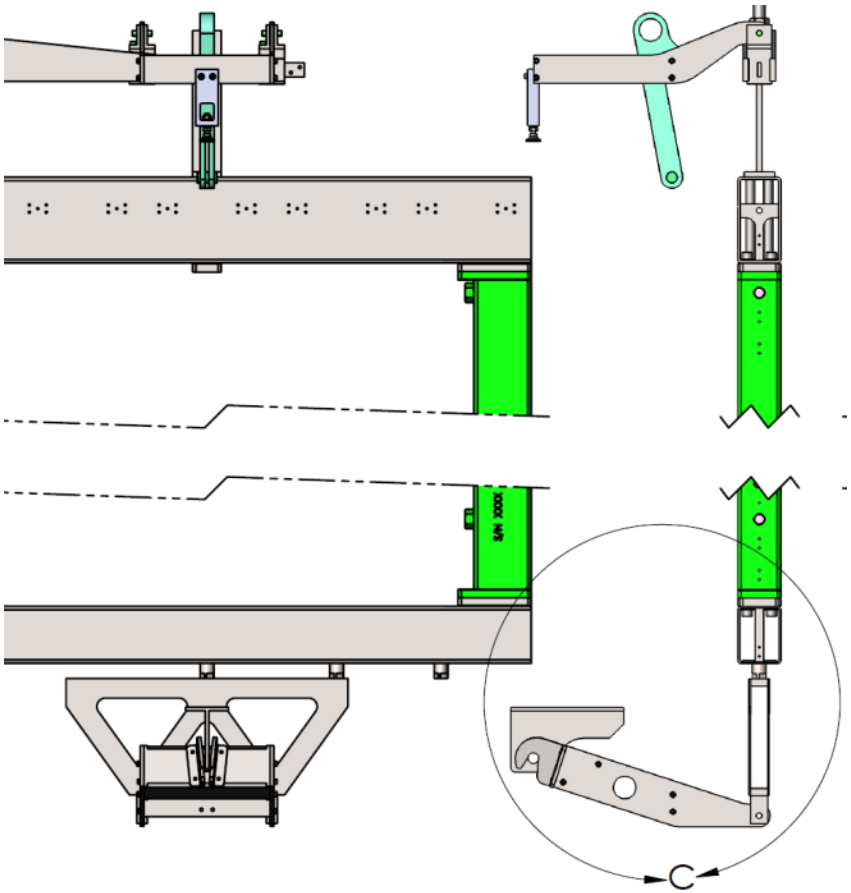
Objective of the design is to avoid a moment load that will tend to bow the APA frame

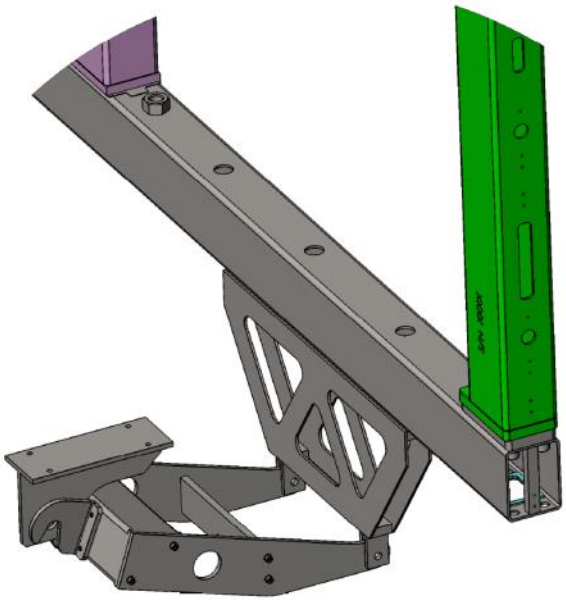


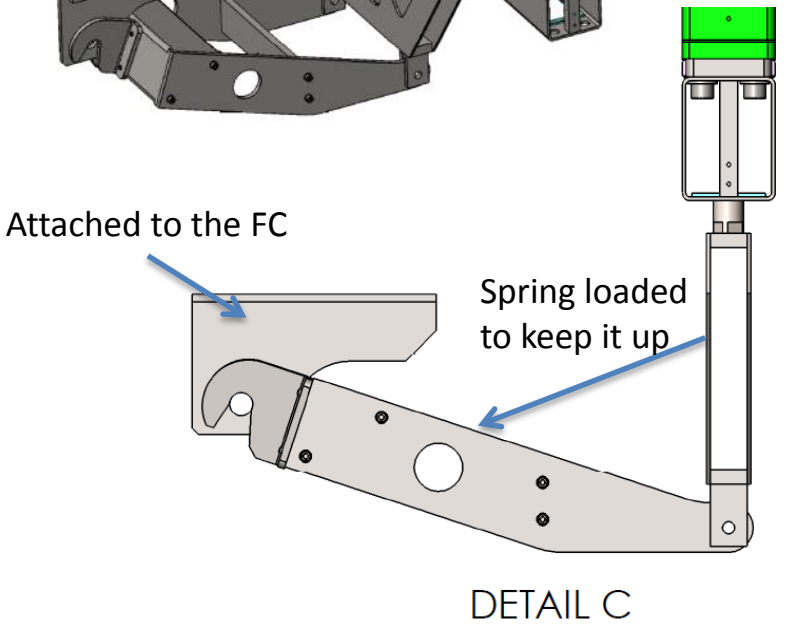
Top Field Cage to APA, Mechanical



Bottom Field Cage to APA, Mechanical

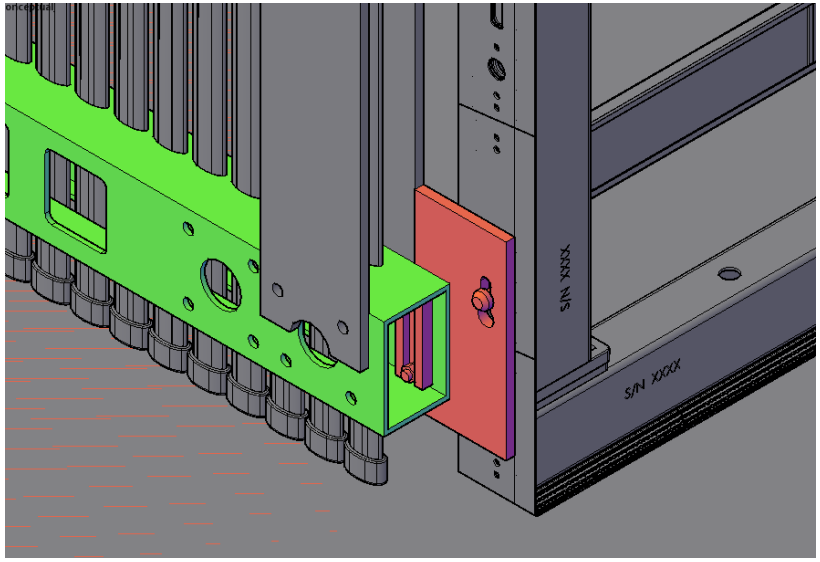


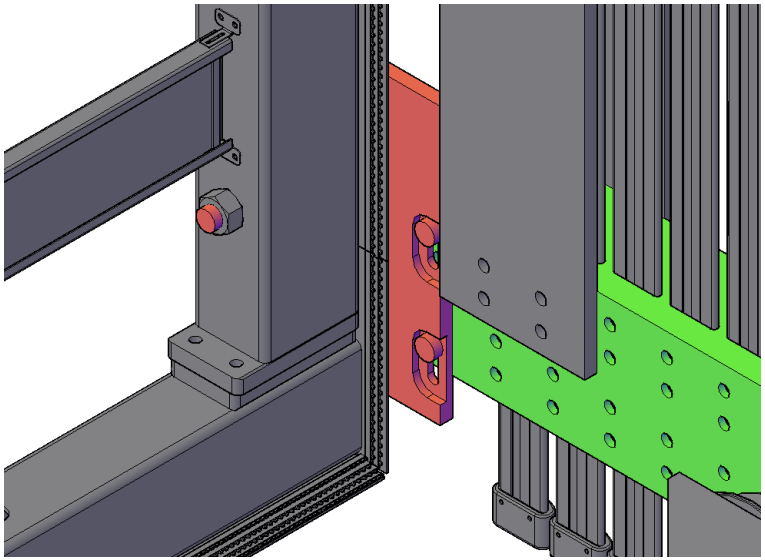




End Wall Field Cage to APA, Mechanical

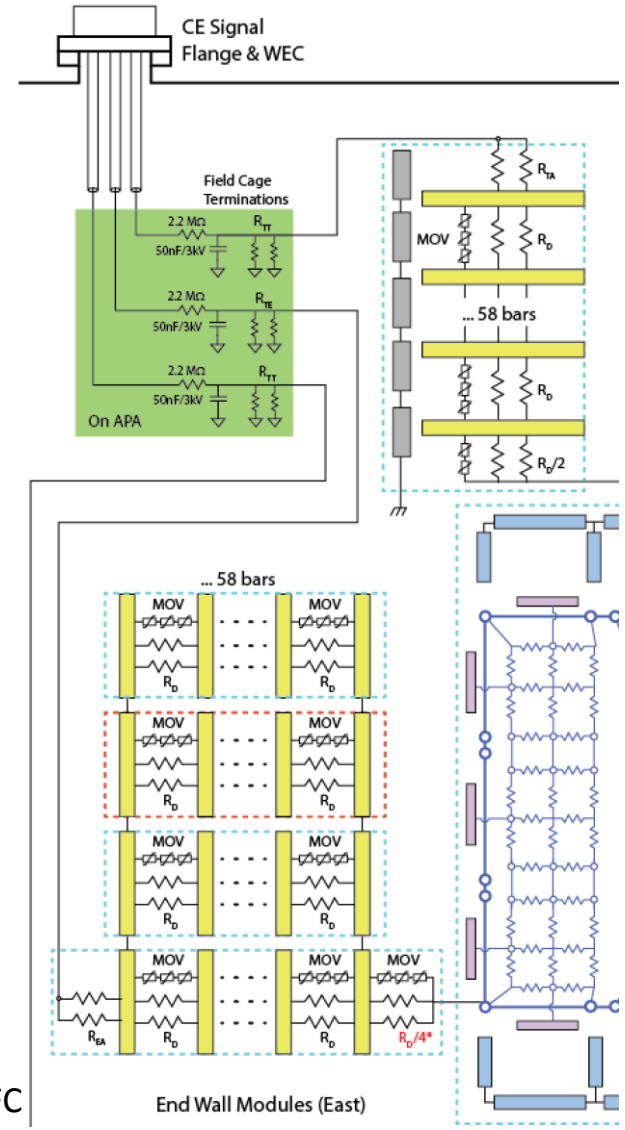
The end wall field cage modules are guided onto the APA frames through these mounting plates.
No rigid connections since the CTEs are different between the field cage (fiberglass) and the APAs.





Field Cage to APA (Cold Electronics), Electrical

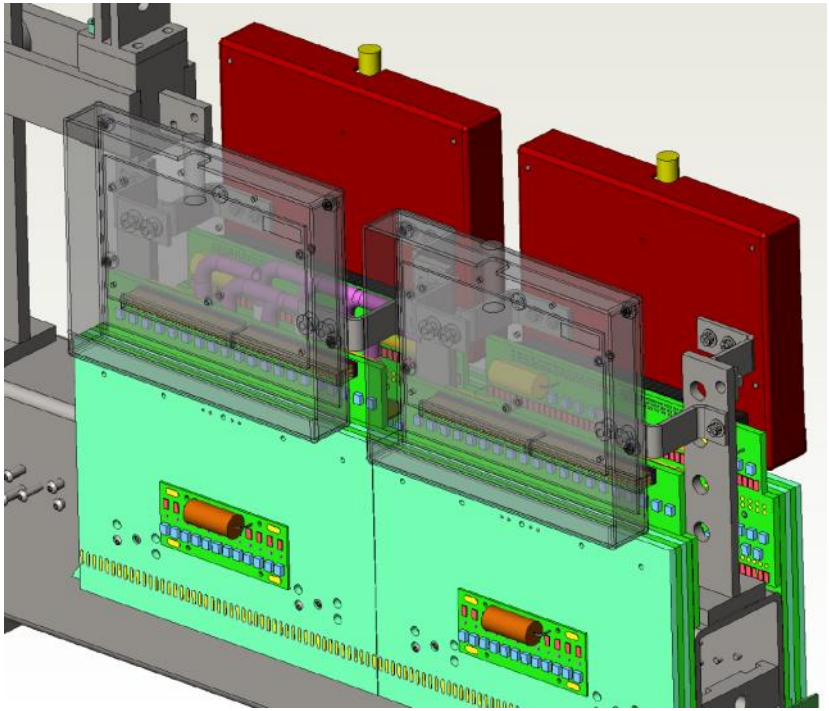
- The low voltage end of the FC divider chains are terminated at the APAs through the wire bias and FC termination boards.
- One or more such boards are mounted on a corner of an APA, with bias inputs from the CE signal flange, and the filtered outputs in either single ended or coax HV wires routed to pre-determined locations on the APA.
- The default connection locations are:
  - APA top, east corner (top FC divider)
  - APA bottom, east corner (bottom and end wall FC dividers)
- Once the field cage module is locked onto the APA, the termination wire is connected to the terminal on the end of the divider board.

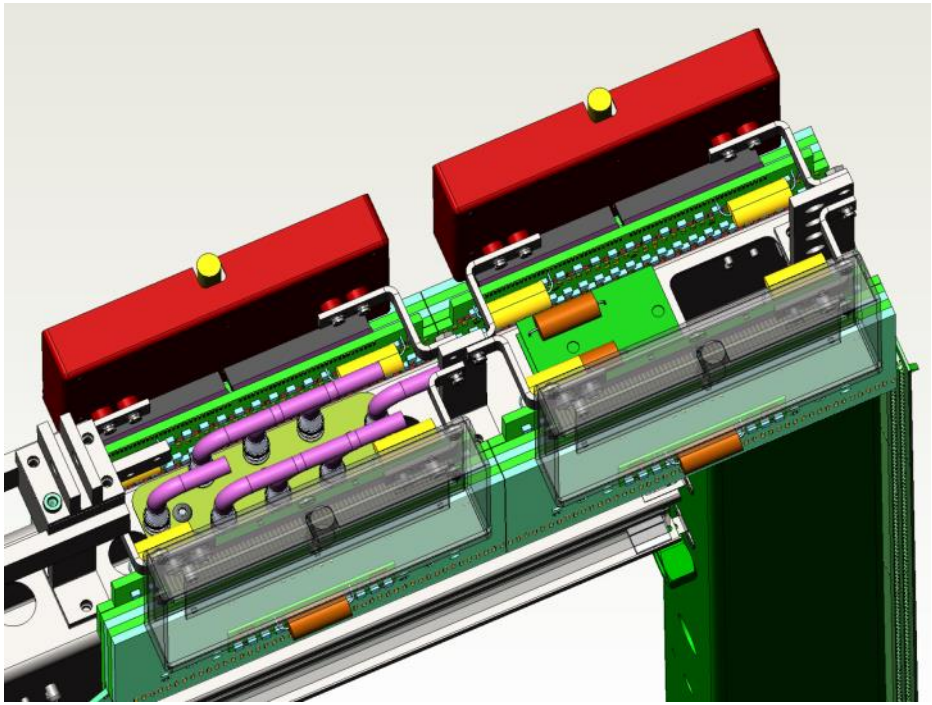


Field Cage to APA (Cold Electronics), Electrical

These two views shows the preliminary design of the termination filtering connector block and filtering board locations. They are at a corner of an APA, between the two rows of FEE boxes.

Output cables will be routed through the APA side tube down to the bottom, with proper strain relieves along the way.



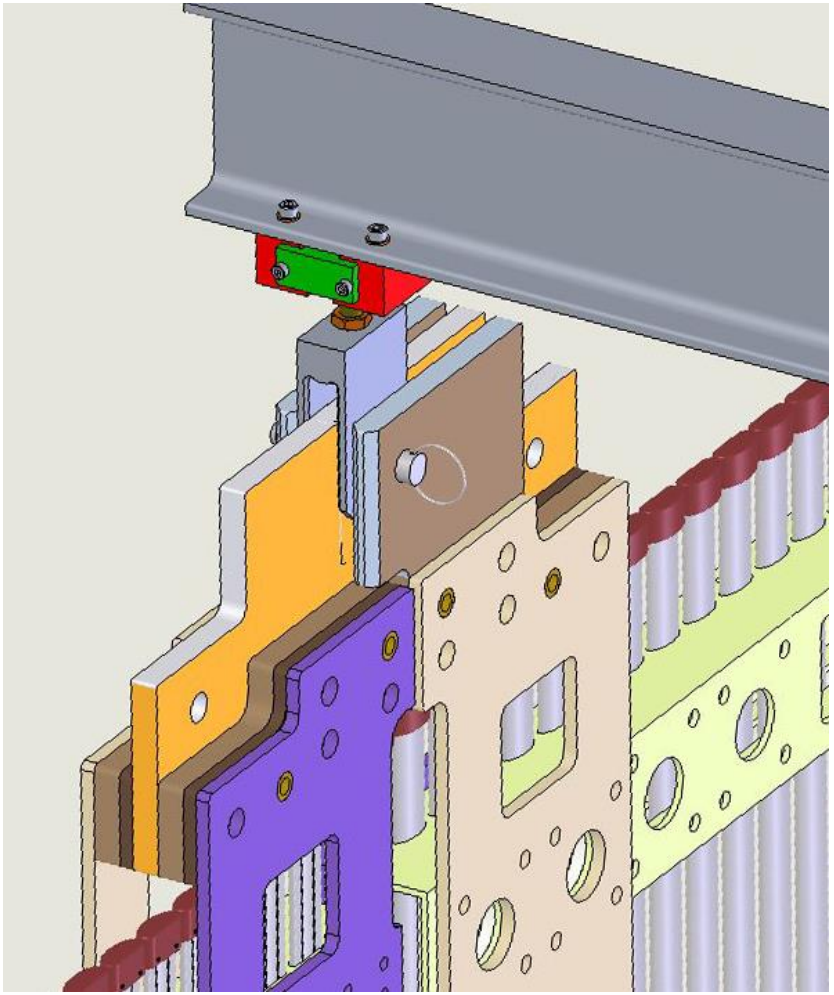


Field Cage to DSS, Mechanical

The end wall FC modules are moved into the cryostat on the “B” & “D” rails. They are transferred and locked onto the APA and CPA rails at the end.

Both the south and north end walls are attached to the same lifting fixture, but the two assemblies are tied to the beam at two different stages of the installation. So the first wall (lower left) is connected with a sleeve, and later on, the second wall (lower right) is locked in with a pin, through the sleeve.

The connection allow minor pivot and vertical height adjustment.



Field Cage to DSS/Cryostat Electrical

- The ground planes on the 6 top and 6 bottom field cage modules need to be connected to the detector ground (cryostat). These ground planes serve as a static shield and have no current flow through them during normal operation.
- The bottom connection will be simply made to the cryostat floor through wire braids and some weights.
- The (electrically) preferred connection points for the top FC modules are the inner load bearing tubes of the DSS feedthrough ports.
- However, connecting to the CPA mounting rail (through the CPA trolley) is far more straightforward to implement during the installation.
- Will consult with the grounding and shielding committee for guidance.

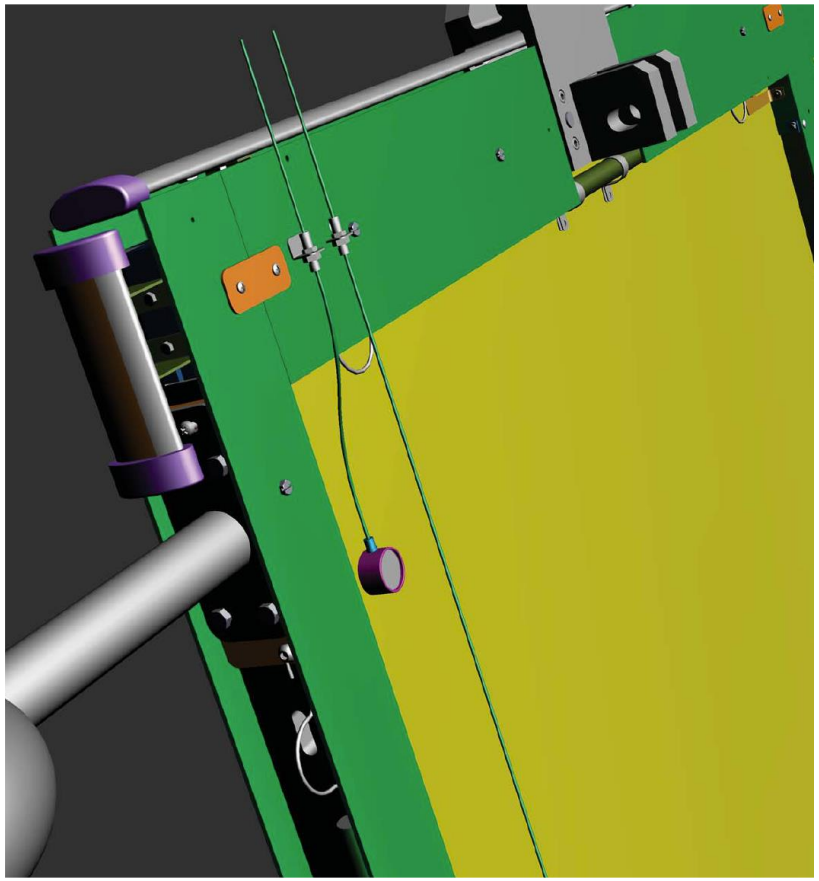
CPA to Photon Detectors

ICD: docdb 1682

Item	protoDUNE-SP HV/FC/CPA Provides	protoDUNE Photon Detector Provides	Interface
CPA <--> Photon gain monitoring Diffusers	The CPA will have fixtures for mounting the gain monitoring diffusers.	The photon detector provides the gain monitoring diffusers.	Interface drawing with diffusers mounted on the CPA. TO-DO Interface drawing is CPA main assembly drawing DUNE-3. DocDB 1488 May need a sheet for the mechanical connection.
CPA <--> Photon gain Fibers mounting	Will provide the appropriate holes and mounting points.	Photon detector will provide the fiber and any connectors and mounting hardware.	Consider cable tying the fibers to the field shaping strips. Need Drawing.
CPA <--> Photon gain Fibers installation	The expectation is that there are no fixtures needed on the CPA for fiber installation.	The photon detector will use an SMA connector mounted to the CPA to interface to the fiber run to the cryostat.	Need Drawing.
Electrical-Ground connection between the photon detector and CPA	The Photon detector will not connect the CPA to ground. The Photon detector diffuser is metallic but the connection through the cryostat is an optical fiber. The diffuser housing is electrically connected to the CPA.	The Photon detector will not connect the CPA to ground. The Photon detector diffuser is metallic but the connection through the cryostat is an optical fiber. The diffuser housing is electrically connected to the CPA.	No specific drawing is needed.

CPA to Photon Detectors

- 5 diffusers are mounted on each side of the cathode plane (center + 4 corners) to spread calibration light pulses to the photon detectors.
- Each diffuser has a metal outer housing, which is connected to the 180kV cathode surface.
- Bare optical fibers send the light pulses into the diffuser.



HV System to Integration (Rack and Power)

- ICD: Docdb#1684

Item	protoDUNE-SP HV/FC/CPA Provides	protoDUNE Racks and Power Provides	Interface
HV <--> Slow Control readout	The HV will provide the HV power supply and support in programming the readout.	The slow control provides cable to the HV power supply and the interface for readout.	HV slow control interface document.
HV <--> Slow Control interlock	HV will provide any interlock needed.	Slow control will read out the status of the interlock.	Schematic of the HV power supply connections.
Electrical-Ground connection between the HV and slow control	The HV and slow control electrical connections will be approved by grounding and shielding.	The HV and slow control electrical connections will be approved by grounding and shielding..	Schematic of the HV power supply connections.

CPA/FC/HV System to Slow Control

- ICD: Docdb#1683

1	Detector element	Contact person	# channels	Nominal V	Current	Monitoring	Hardware	Location	Connector type	Cable type /length
2				(V)	(uA, mA)	(V, A, both, other)	(brand/model)			
3										
4	3 CPA HV	Bo Yu	1	-180 kV	0.2 mA	both	Heinzinger 300kV			
5	Corona mon	Glenn Horton-Smith, **Adrew Renshaw**	2	n/a	<1mA	both	custom built	Inline of HV system, one at each filter box	SMA	Rg-58 is acceptable
6	Field cage top	Bo Yu	6	-2 kV	6 uA	both	Wiener MPOD		SHV	
7	Field cage end wall	Bo Yu	4	-2 kV	20 uA	both				
8	Field cage bottom	Bo Yu	6	-2 kV	6 uA	both				
9	APA Grid	Bo Yu / M. Soderberg	6	-665 V		both				
10	APA Induction U	Bo Yu / M. Soderberg	6	-370 V		both				
		Bo Yu / M.			0 if		Wiener			

Summary

- Charge question #5: Are all CPA/FC/HV interfaces to other detector components (APA, detector support system and beam plug) and cryostat documented, clearly identified and complete? Does the TPC integrated 3D model adequately represent the mechanical interfaces to the CPA/FC/HV and between adjacent CPA/FC?
- All known interfaces between the CPA/FC/HV subsystem to the rest of the system have been defined.
- Interface control documents have been created and discussed among the involved subsystem managers.
- Beam plug interface to cryostat has not yet been included in the CPA/FC/HV to Cryogenic ICD.
- Most of the mechanical implementation details are in the integrated model while others are still being worked on.

Backup slides

CPA/FC System Schematic Diagram

Placement of Divider Boards

These divider boards can be mounted anywhere along the metal profiles. They are staggered to provide a continuous chain. Avoid putting them very close to the I-beam allow room for installing locking floor planks.