Main Detector cabling Brainstorming

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Outline

- Detector channel cabling overview
- Cabling req's for each 1/28 segment
- Sample HD connectors for HV, Coax, Twinax, and LV
- Barrel Patch Panel ideas to start discussion
- Dimensional considerations for cable routing within 1/28 segment
- Cable strain management ideas (HyCal example)

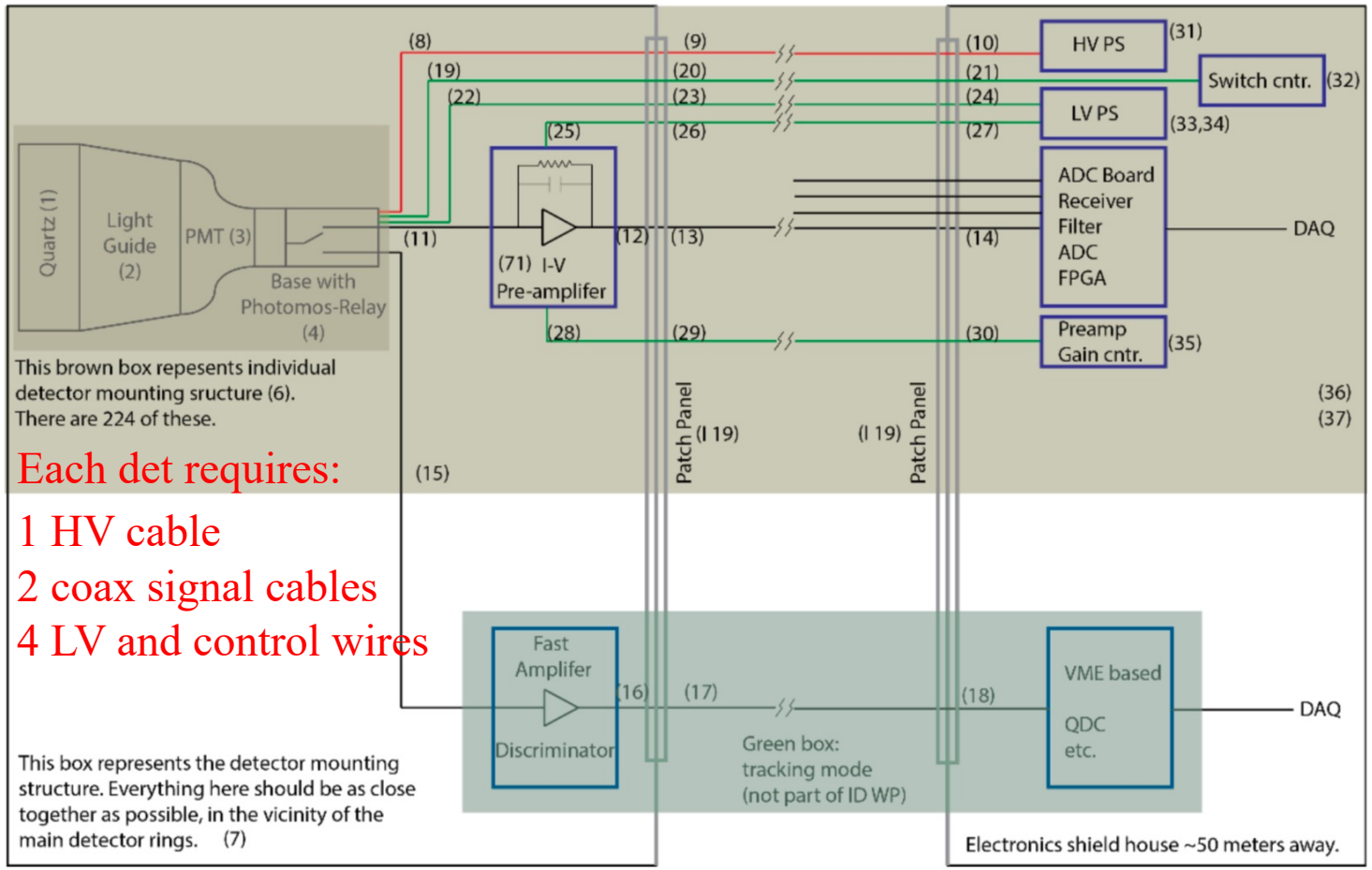
Detector Cabling

- *Twinax RG108AU cables: 302x60", 604x600" & 400x320ft.*
- *Two patch panels for 400 Twinax cables each + cable trays.*
- *RG58 cables: 604x600"*
- *Two patch panels for 302 RG58 cables each + cable trays*
- *384 High Voltage channels (3.5 kV/ 3mA/common floating).*

- *HV cables: 16 - 320ft multi-conductor HV cables. 52-pin Radiall connectors both ends. 384 HV channels total*
- *8 HV breakout boxes (48 ch each) Radiall to SHV*
- *384 RG8A/U, 600"- long, SHV-to-SHV*
- *LV: 1048 ch, grouped into 66 power supplies, V/I TBD, floating. Cabling to electronics in vicinity*

Overview:

- The electronics includes
  - PMT bases (high/low gain)
  - Integrating Preamplifier
  - ADC board
  - LV Power supplies
  - Gain control
  - Base switching control
  - Tracking electronics (green) not part of this project

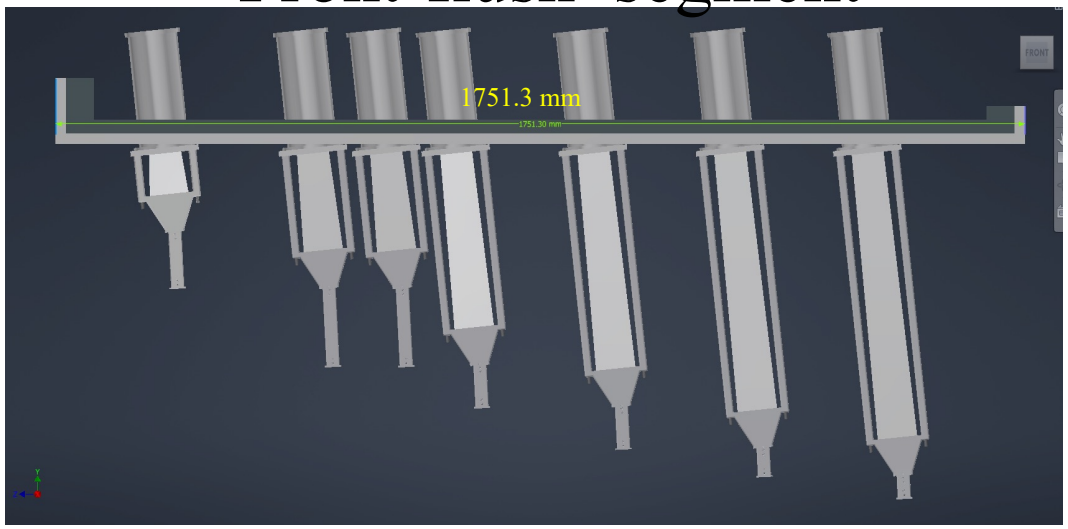


Detector Cabling

Each segment requires:

- 8 HV + 1 spare?
- 8 coax + 1 spare? and 8 twinax + 1 spare?
  --Or 16 coax + spares? (If preamps within segment)
- 32 LV and control + spares?

‘Front-flush’ segment



- Idea is to design patch-panel (PP) breakout box that mounts to outer aluminum of each 1/28 segment
- The 1/28 PP box would have 4 outer connectors -- 1 for each type: HV, coax, twinax, and LV; there would also be a gas inlet for lightguide protection and bkgds and electronics cooling
- Some potential high density connectors have been identified and are discussed here

1/28 Patch Panel Connectors (possible candidates)

- Twinax: 8 or 9 channels

Box Mount Receptacle Pin Insert 25-8 PT* to 8 R/A Twinax Cables to Open Lead

Y	Polarization
1	N
2	A
3	B
4	C
5	D
6	E

Part Number	Cable Type	Cable
02370Y-1XXX	Differential Twinax	540-1099-000

Y = Connector Polarization
XXX = Cable Length in Inches
Please specify cable length when ordering

- Connector Receptacle is supplied fully loaded with Twinax pin contacts terminated to Differential Pair Twinax cable to open lead (all cavities included).

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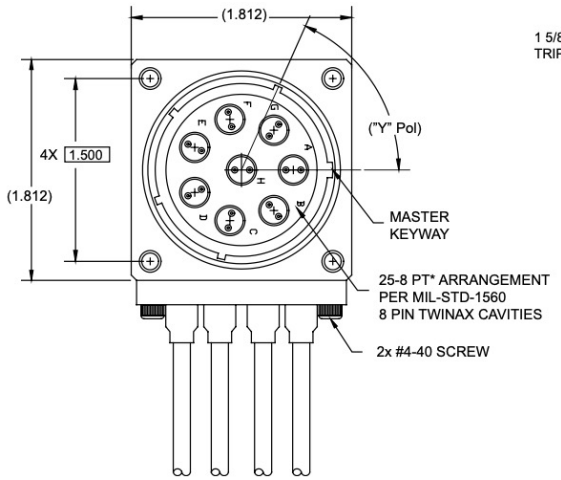
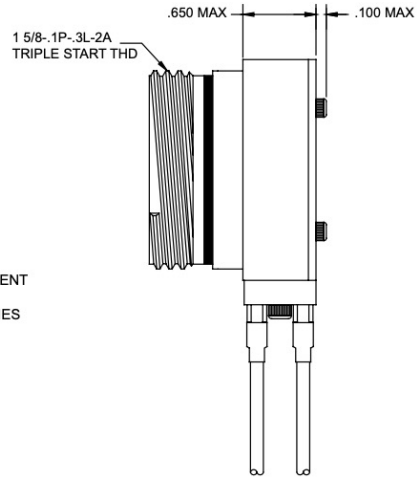


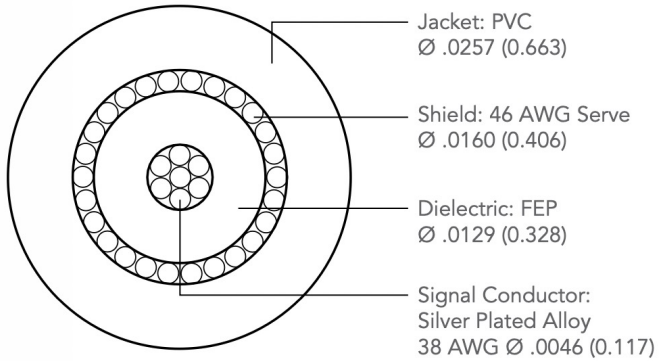


1/28 Patch Panel Connectors (possible candidates)

- Coax: 8 or 9 channels, or more

50 Ω, 38 AWG MICRO COAX CABLE

TCF-3850-XX-XX



PERFORMANCE DATA

Capacitance:	30 pF/ft (nominal)
Propagation Delay:	1.46 ns/foot
Flex Cycles:	80,000 cycles, 20-wide ribbon*
	Single conductor = 1.3 Amps**
Current Rating:	20 conductors = 0.4 Amps**
Shield DCR:	156 Ω/1000 ft
CC DCR:	817 Ω/1000 ft
Min. Bend Radius:	.125"
Availability:	Single, 2-35 ribbon, tape bonded
Temperature Rating:	-25 °C to 105 °C, UL VW-1 Tested ***
DWV Working Voltage:	219 V†

Insertion Loss	0.25 m	1 m
-3 dB	6.6 GHz	0.7 GHz
-7 dB	19.7 GHz	3.5 GHz

* Test Conditions – 8 oz. weight, dia 1/4" mandrel, +/-90 bend X2

** Rating – 30 °C Temperature Rise, 20% de-rated. Testing performed on 20-position ribbon.

*** Test Conditions – Heat Shock/Cold Bend per UL1581, wire wrap 1/4" mandrel, visual inspection

†Test Conditions – IR/DWV/Thermal Shock/Humidity per EIA-364-20, 21, 31 and 32

1/28 Patch Panel Connectors (possible candidates)

- HV: 8 or 9 channels

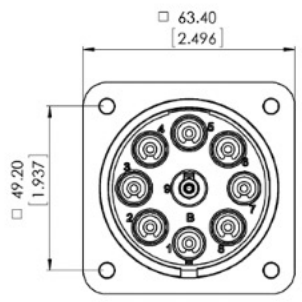
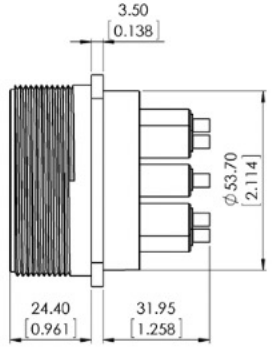
M Series

Type M915/1E 8(+1) Pole 12 kVDC

Electrical values	
Operating voltage (DC)	12 kV
Test voltage (DC)	18 kV
Rated current	30 A

Characteristics	
Number of pins high voltage (HV)	8
Number of pins E-contact 2.5 mm (LV)	1
Number of pins I-contact 1.5 mm (LV)	-
Insulation material	PTFE

Layout

Type / Version / Part number	Picture / Drawing
Type: receptacle, panel mount **Version: GB 915/1E/PTFE** **Part no. 7749011**	  front view 

1/28 Patch Panel Connectors (possible candidates)

- LV/control: standard 34 channel ribbon cable

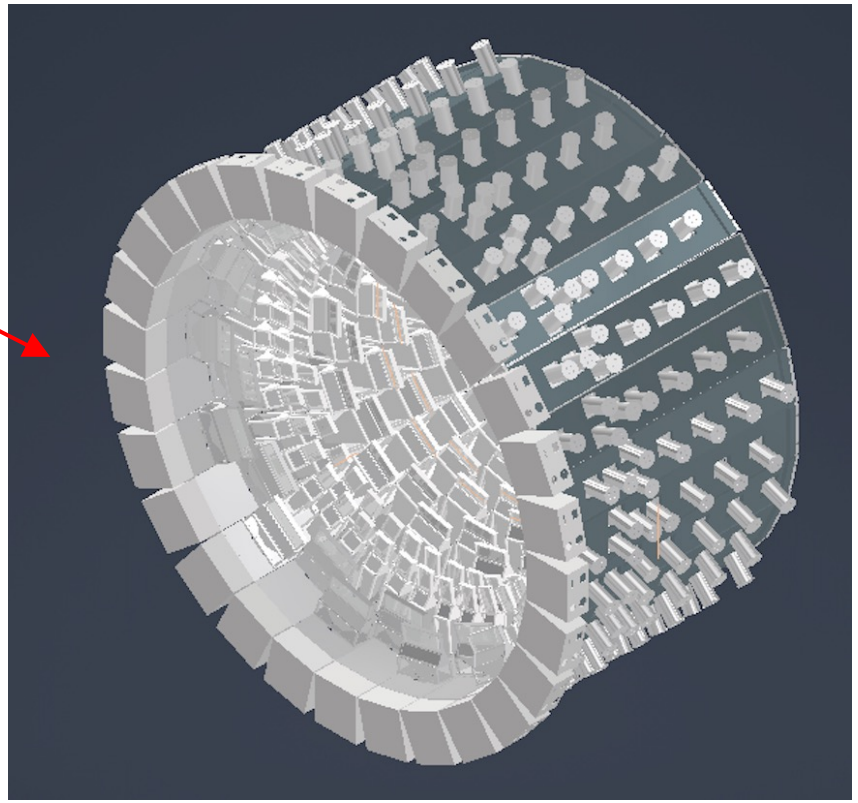
Hi-Flex, Hi-Temp IDC Ribbon Cable

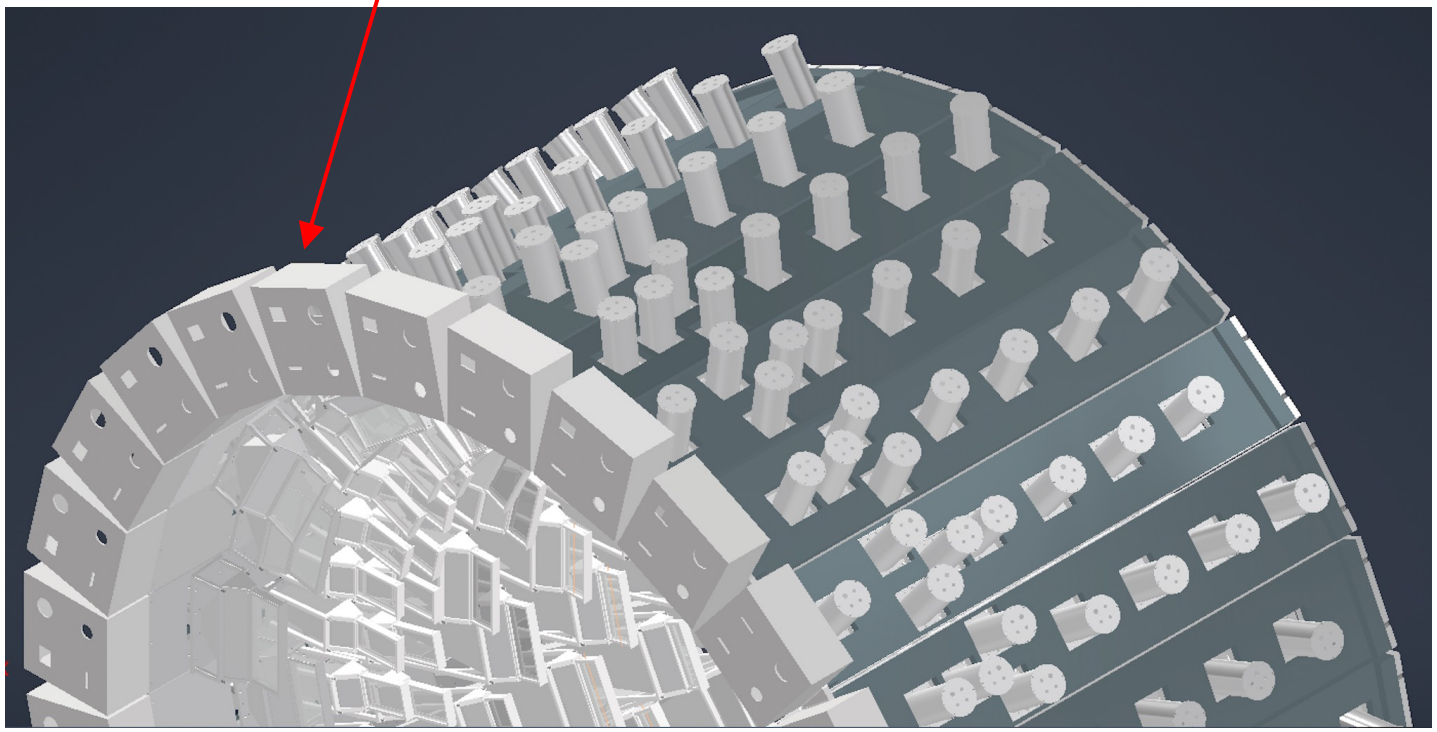
- Ultra Flexible Ribbon Cable for standard IDC Connectors
- Available with up to 64 Conductors in .050″ or 1mm Pitch
- -104°C to +260°C Rating – Ideal for the Harshest Environments
- Low Smoke/Zero Halogen (LSZH)

Cicoil's high performance line of flat ribbon cable is ideal for electronic applications that require better flexibility, broader temperature and harsh environment capabilities than those offered by PVC or other ribbon cables. Cicoil's patented Flexx-Sil™ jacket provides the highest flex, highest performance ribbon cable available.

1/28 Patch Panel Boxes (upstream face mount)

- Box dimensions are 300 by 300 by 150 mm
- One idea has connectors mounted on outer surface
- Another idea has connectors mounted on US face
- Cables would come in/out radially for both cases

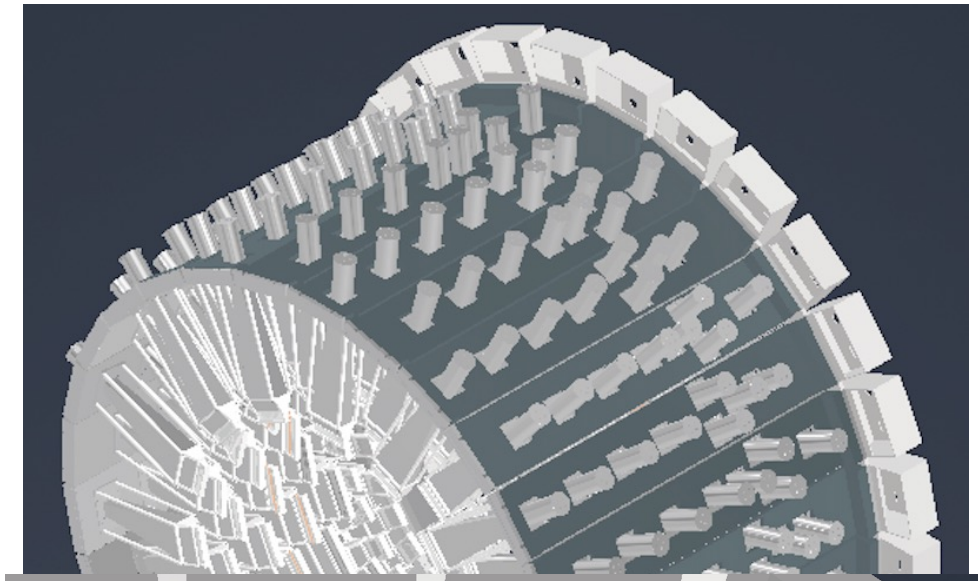


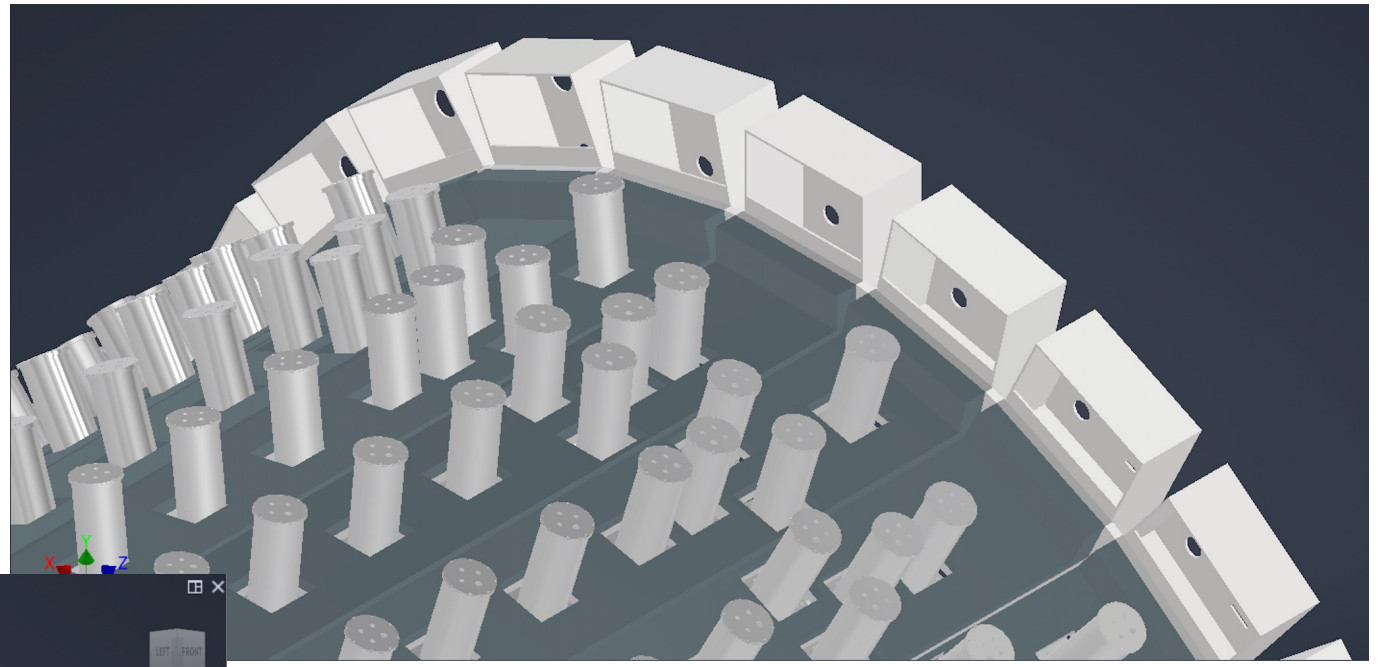


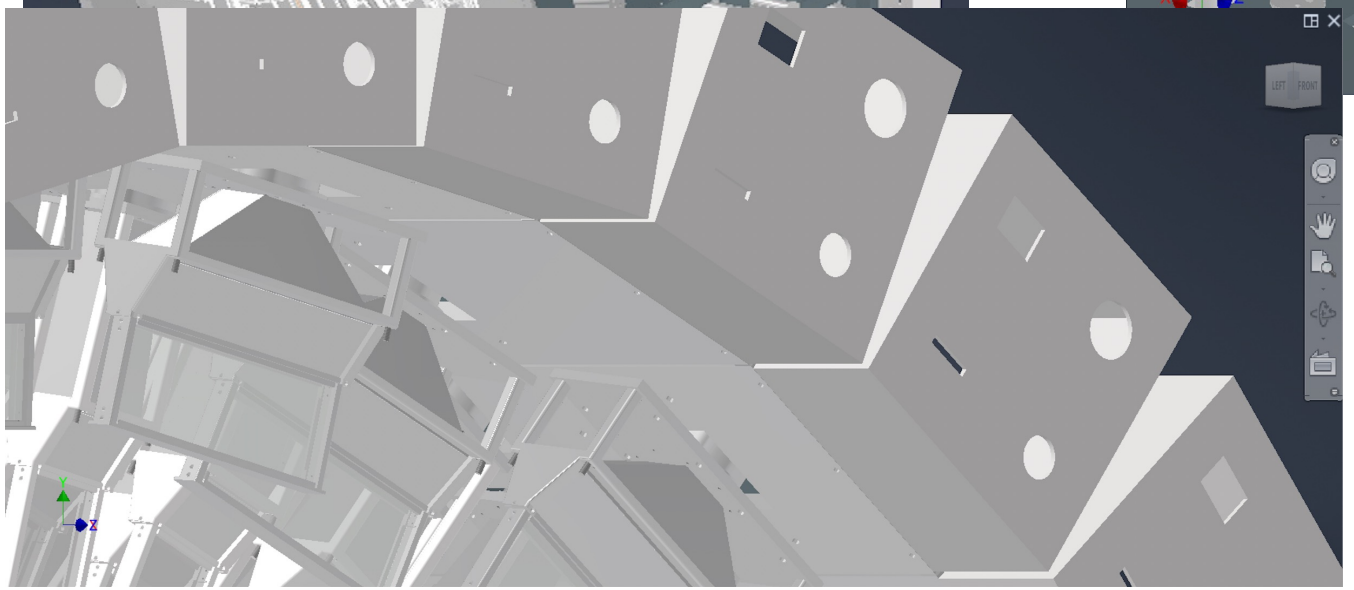
- Of these two simple ideas, I think the outer surface connector config (above) is less desirable due to more possible interference with future ‘hard-back’ outer 1/28 segment support bar that the robot arm attaches to…

1/28 Patch Panel Boxes (all upstream face mount)

- PP box is open on side that faces into the barrel—to allow cables in/out



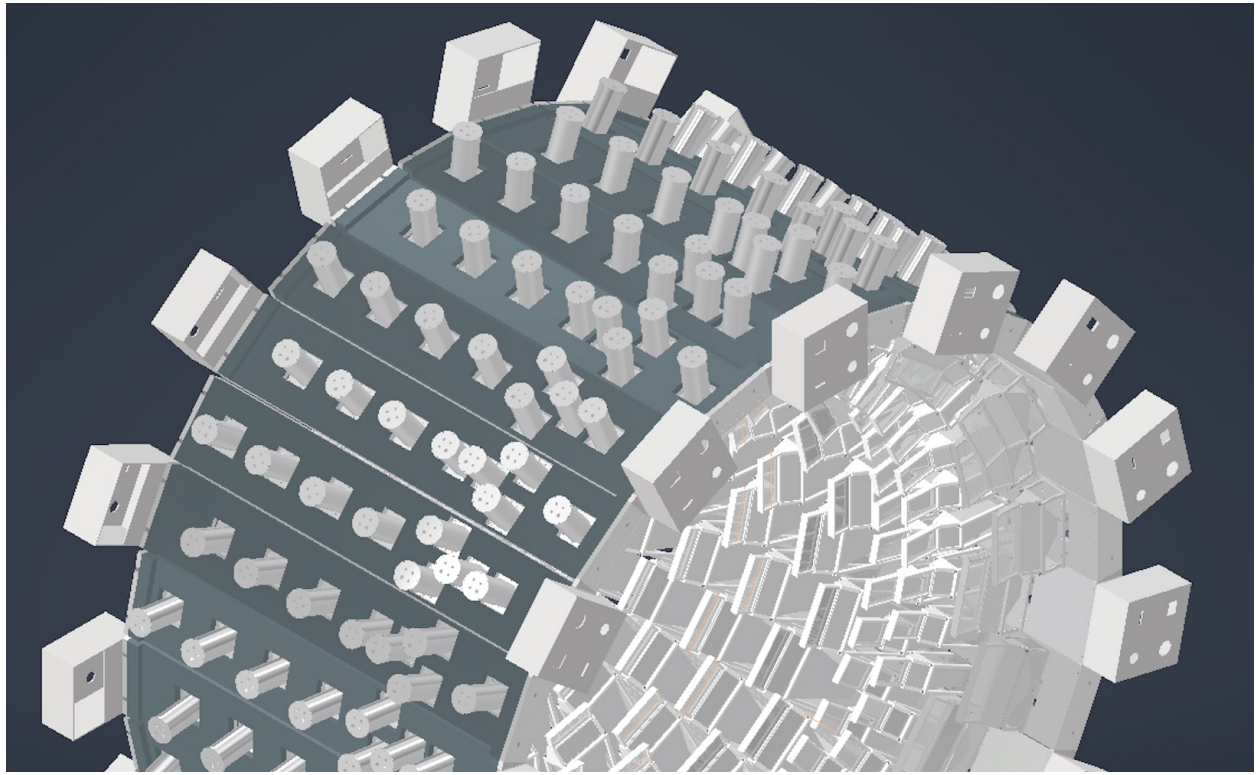




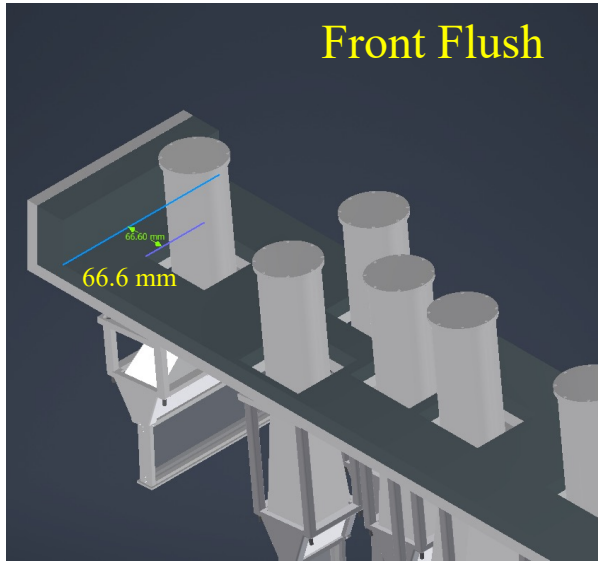
- These renders are for connectors mounted on US face

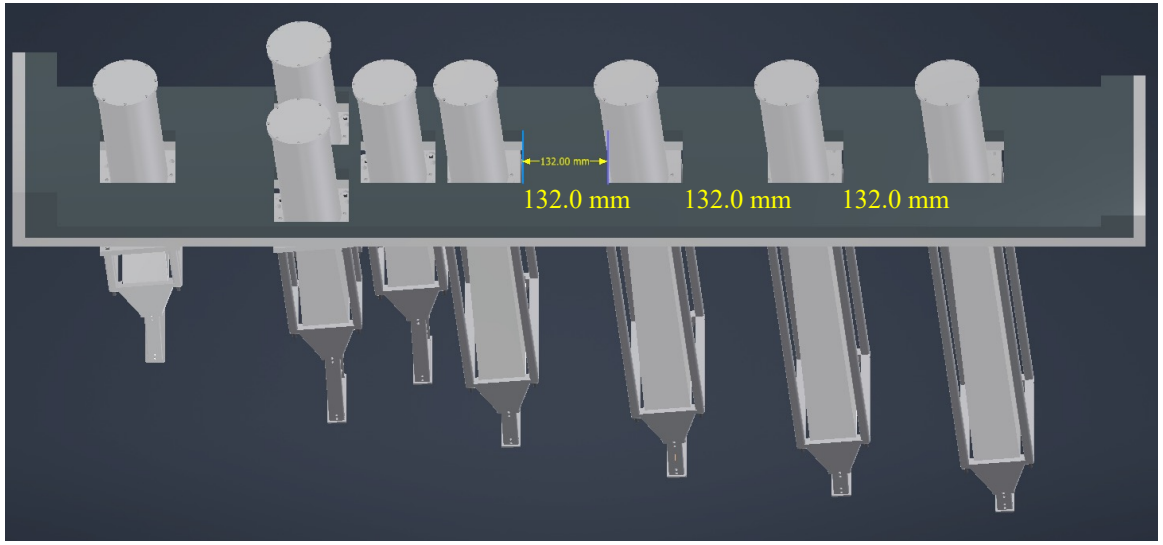
1/28 Patch Panel Boxes (alternating US/DS face mount)

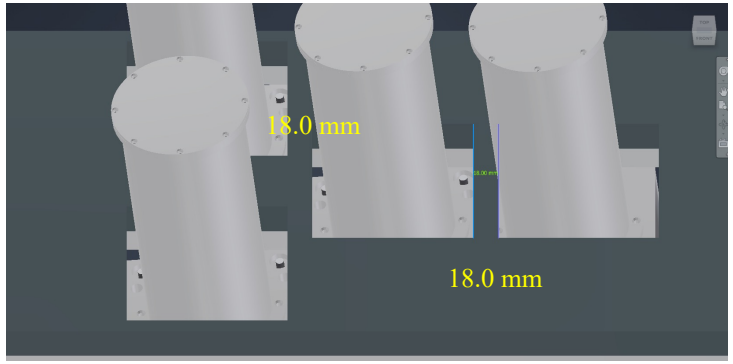
- PP box is mounted on US of back-flush segments and DS of front-flush segments

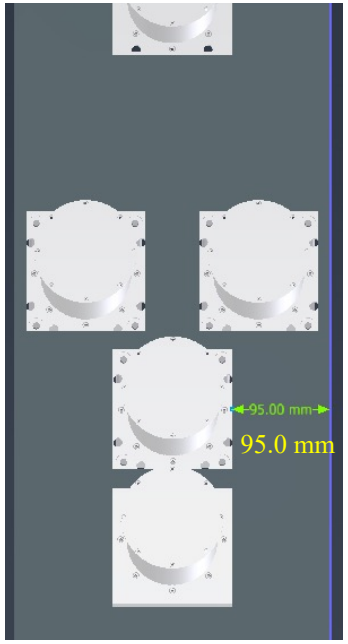


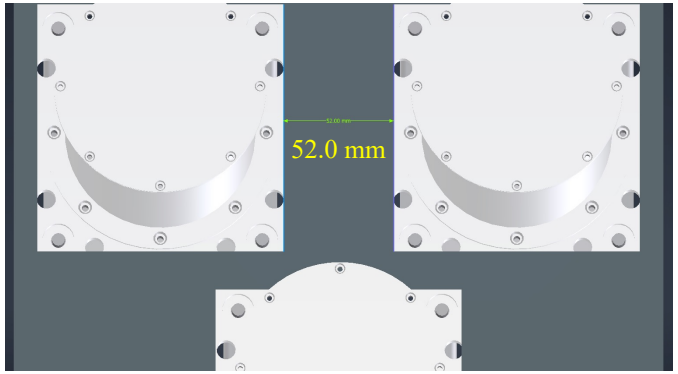
Considerations for cable routing within 1/28 segment (to/from PP and PMT)



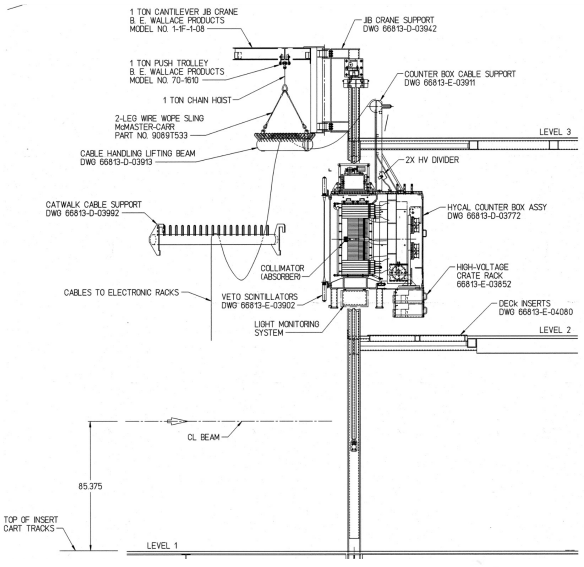








Cable strain management example from HyCal in Hall B



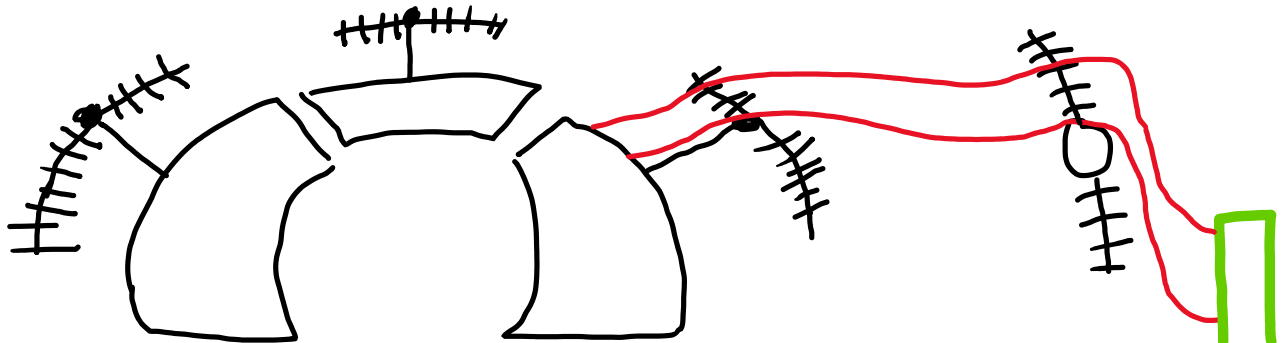
Cable strain management ideas

- Question: Do we want/need to have the cables attached to the barrel PPs when we separate clam-shells and top arch?

If yes, then

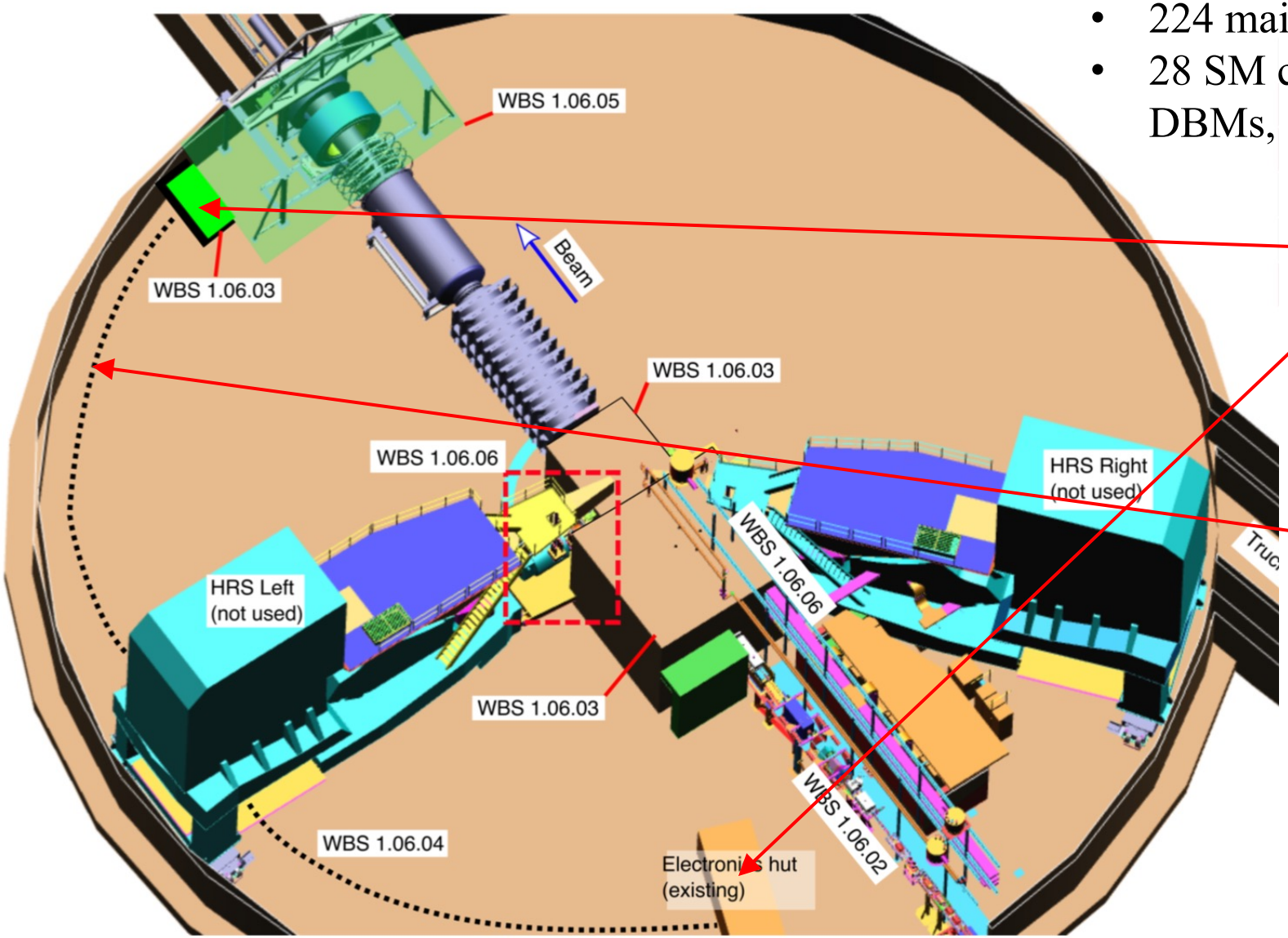
- Design a rigid cable support that is part of each ‘big aluminum frame’ of the two partial clam-shells and top arch piece (similar to HyCal’s Counter box Cable Support idea). The cables that come and go from the PPs of each barrel section are rigidly fixed to this support—relieving all possible strain on the PP box connectors

- There would be 3 additional ‘cable handling lift-beams or arrays’ that would be at larger radius and/or possibly different z that would manage the needed slack in the cables as the barrel sections are separated. There would be a drape of cables between the two cable supports



Backup (old) Slides from March discussion

MOLLER Hall Layout



Detector Cabling

- 224 main detector channels
- 28 SM channels, 14 pion, 8 SAM, LAMs, DBMs, scanners

--Two electronics huts – one downstream and one upstream

--Signal and HV

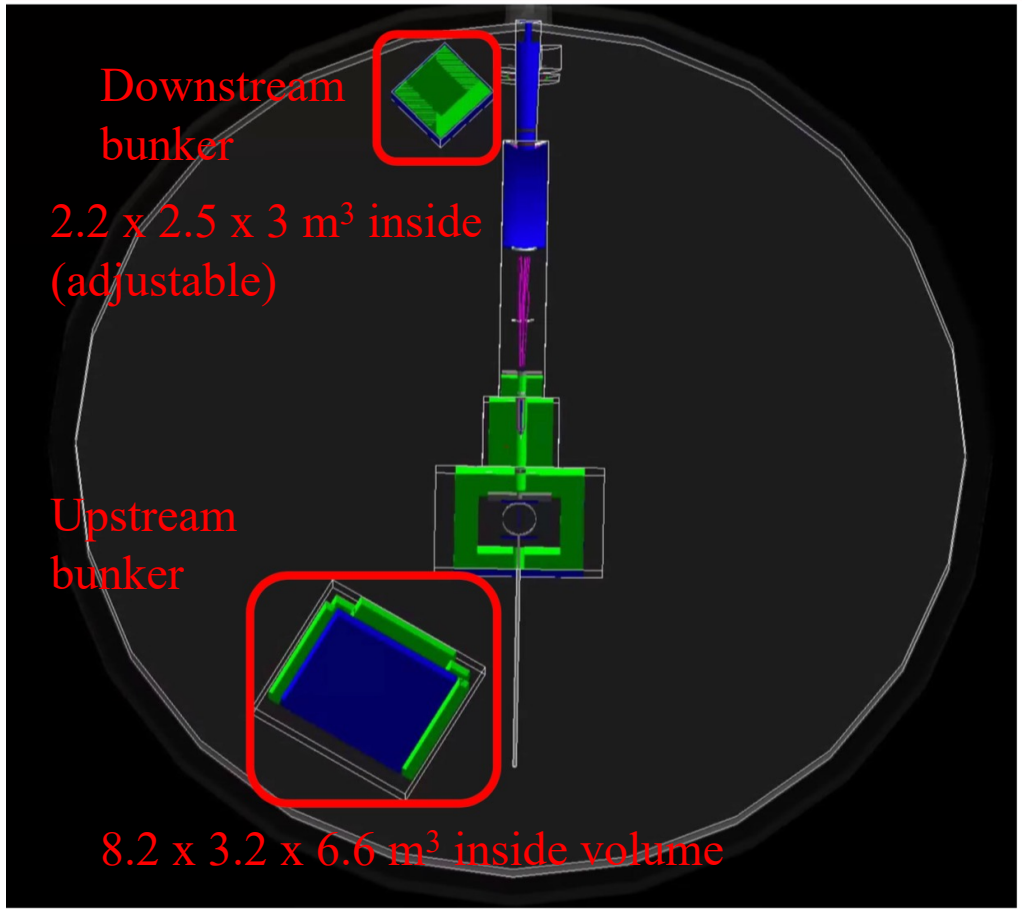
- 50 ft runs from detectors to patch panels
- 320 ft runs from patch panels to upstream hut (ADCs)

--LV and switching

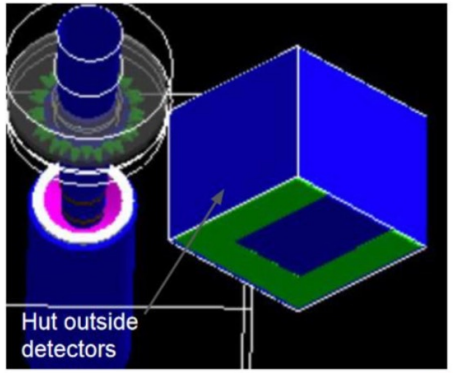
- For powering PMT base relays and preAmps
- And for switching PMT dynode chain and preamp gain

Slides from Ciprian's Dir. Review talk (Aug 2020)

Locations of interest: Shielded bunkers



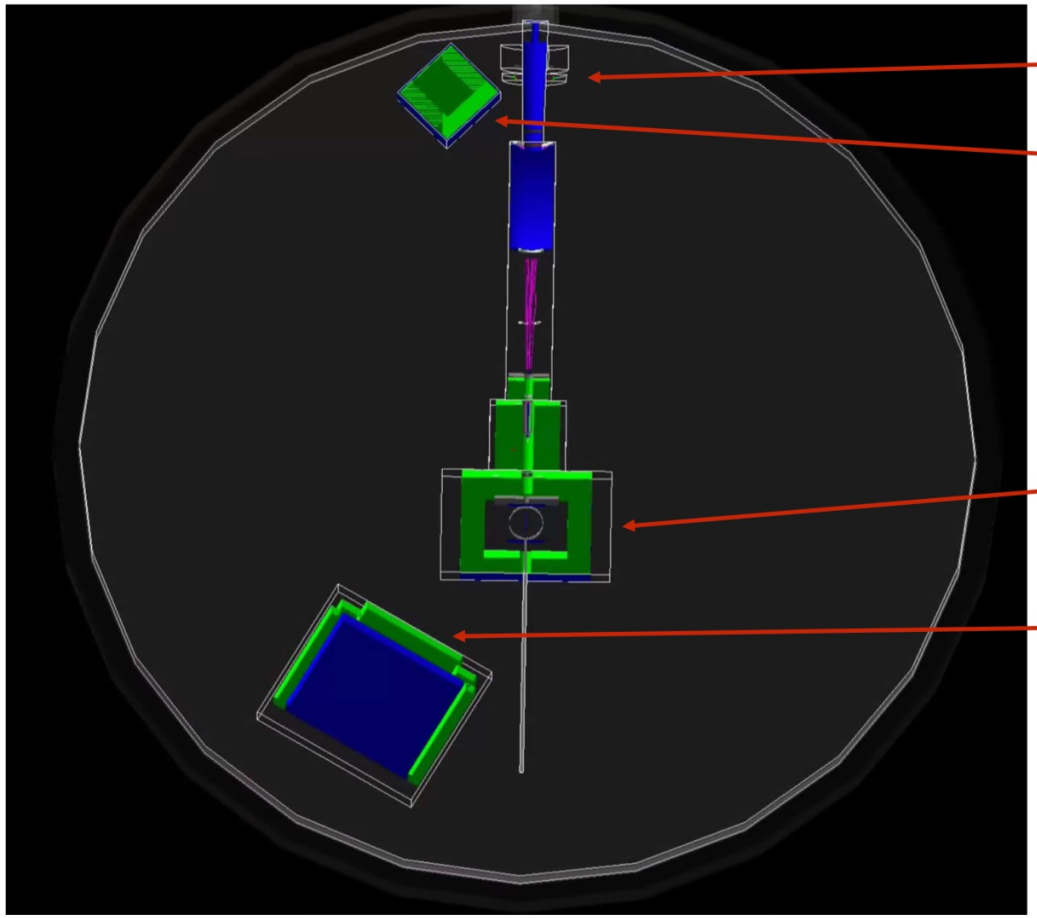
- These bunkers will house sensitive electronics as well as power supplies and controllers for the magnet systems
- We find the levels of neutron and electromagnetic radiation to be several orders of magnitude below damage thresholds
- Optimization of the shielding will follow and ensure that we keep a conservative level of radiation



Shielding 12

Jefferson Lab

Locations of interest



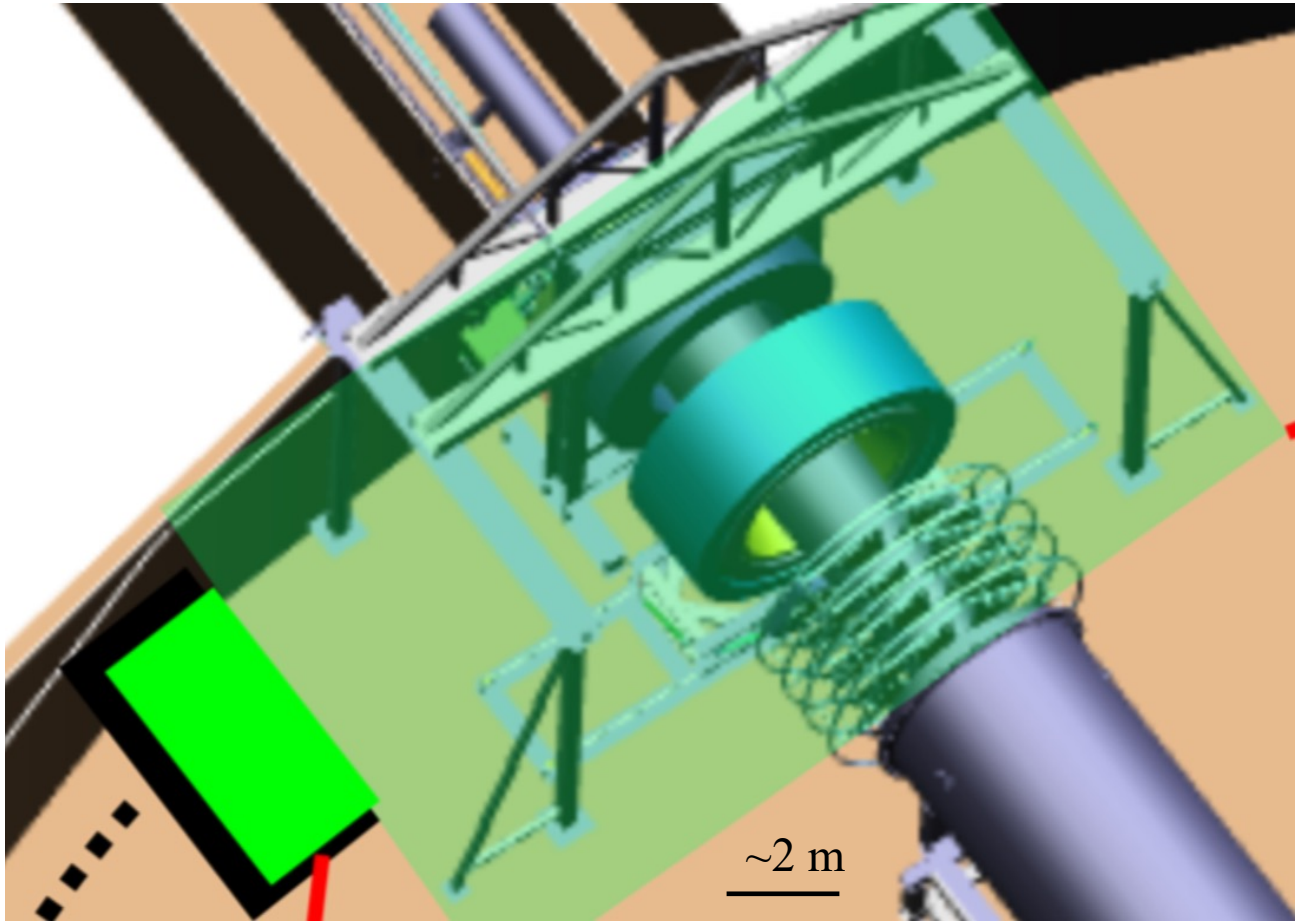
Main detector area

Detector electronics
(Counting and GEMs)
Movement mechanism
hut

Target region

SBS bunker to contain:
a) Magnet power supplies
b) detector electronics

Signal breaks and patch panels



Integration mode signals

--Two patch panels for 400 det channels:
one near detectors and other in US bunker

--1.5 meter cable from PMT to pre-amp (RG-58)
--15 m cable from pre-amp to DS PP (twinax)
--100 m cable between DS-PP and US-PP (twinax)
--15 m cable from US-PP to integrateADC (twinax)

- 1st signal break at pre-amps must be close to detector
- DS-PP needs to be 'close' to detector—for cable relief,…

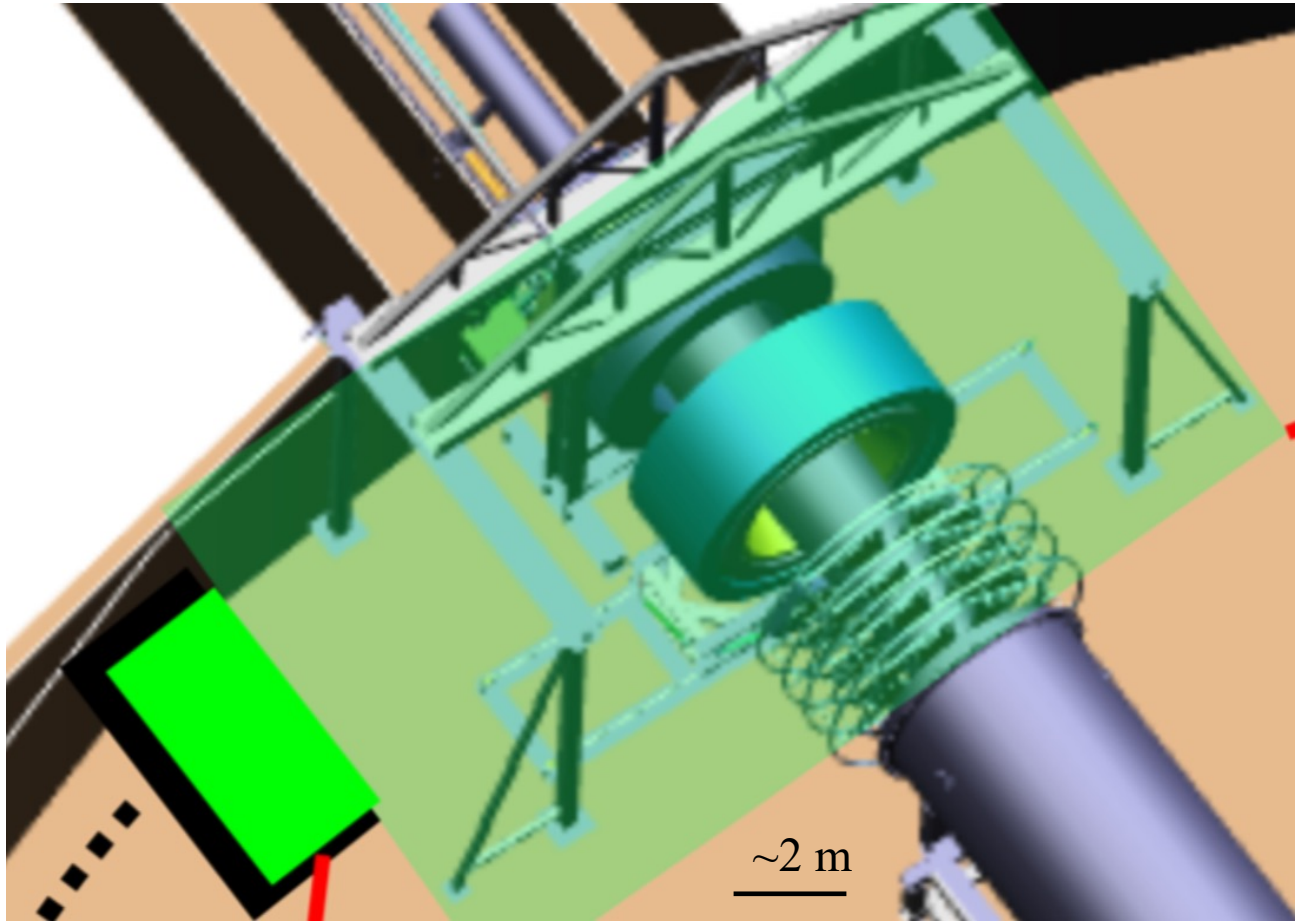
Counting mode signals

--Two patch panels for 302 det channels:
one near detectors? and other in US bunker

--15 m cable from PMT to fast-amp/DS-PP? (RG-58)
--100 m cable between DS-PP and US-PP (RG-58)
--15 m cable from US-PP to flashADC (RG-58)

- 1st signal break at detector 1/28 segment patch panel
- 2nd signal break at fast amplifiers located in DS bunker?

HV cable breakouts and Signal PPs



- 384 HV channels (3.5 kV / 3 mA / common floating)

--8 breakout boxes (48 ch each), one set located near detectors, the other set in US bunker

--Breakout boxes are made in-house and do not need to be in bunkers; they use passive splitters

--15 m cable from det segment PP to nearby BB (SHV-SHV)
--Two 100 m radial 52pin cables run between each HV BB

- 400 integrating signal channels

--10 patch panels; each accommodates 40 channels

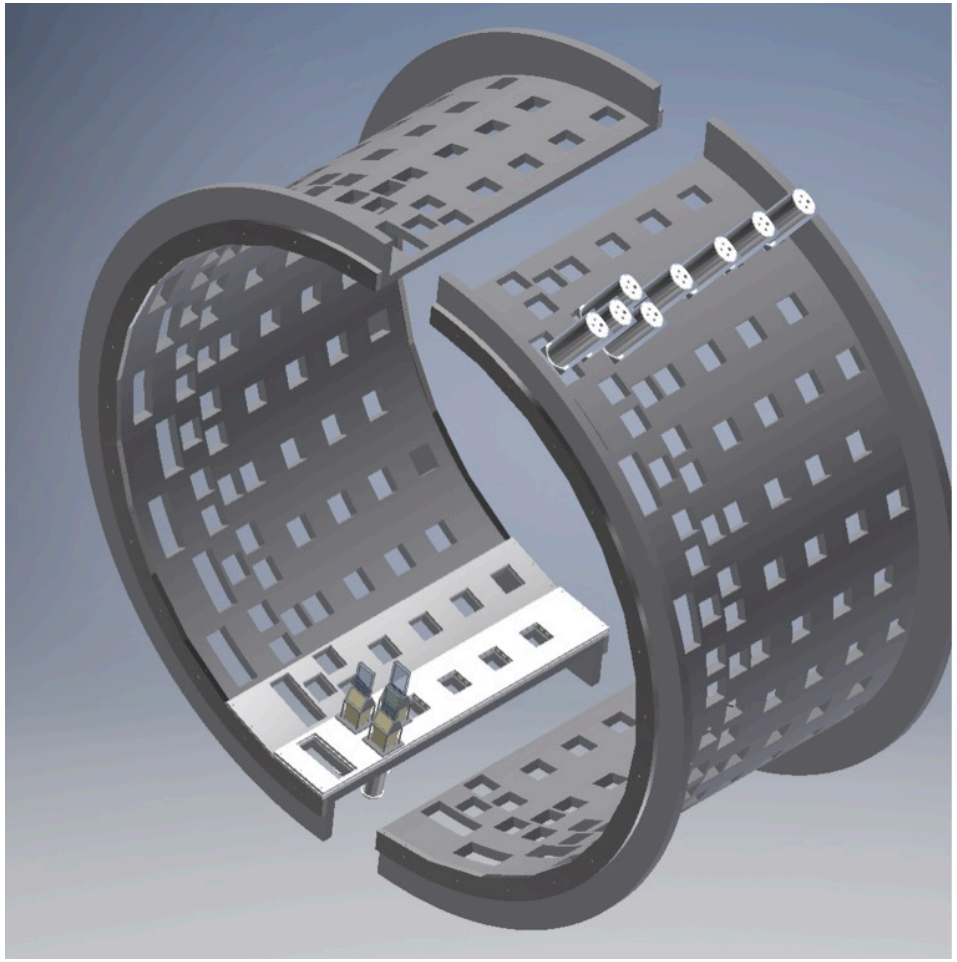
--Can imagine 5 PPs on each side of beamline near detectors and 10 inside US bunker

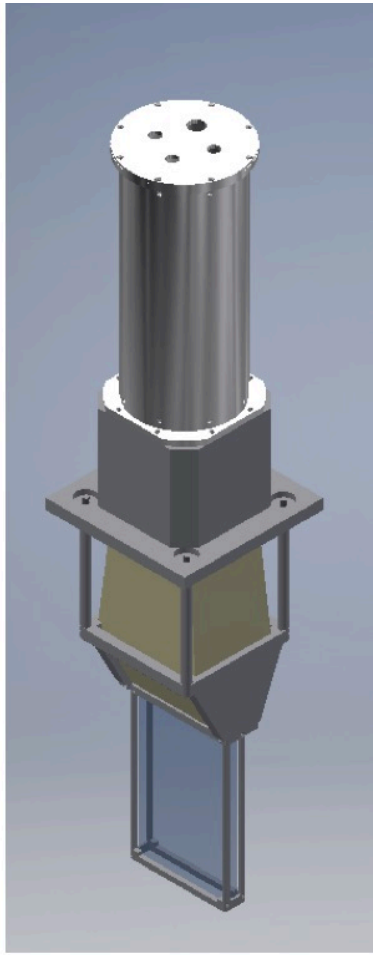
- 302 counting signal channels

--8 patch panels; each accommodates 40 channels

--Perhaps 4 PPs on each side of beamline near detectors and 8 inside US bunker (but need to consider fastamps here)

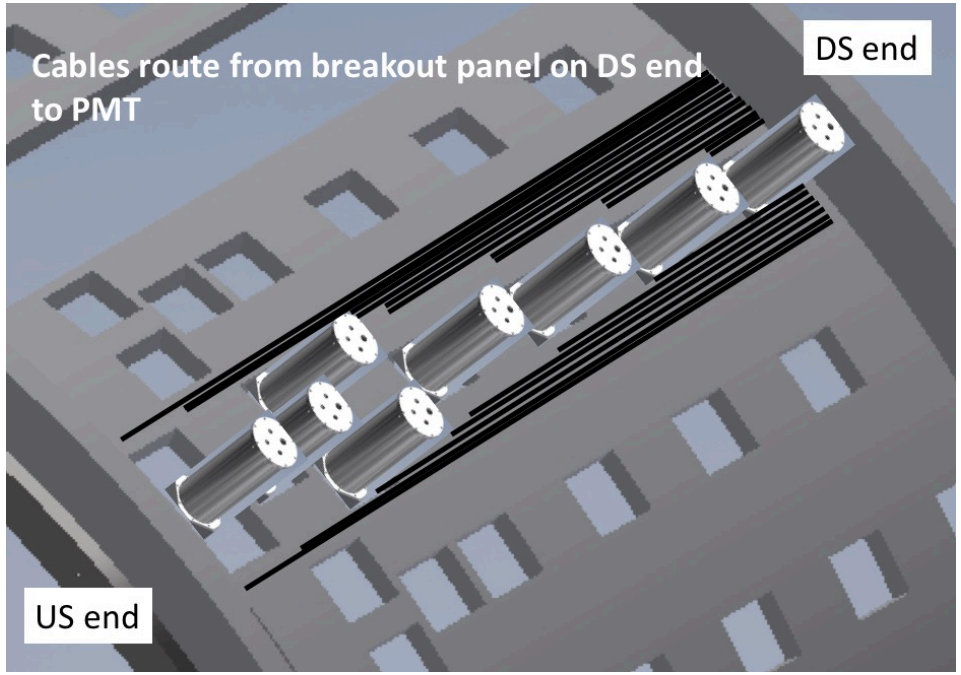
Idea for cable routing at detector assembly





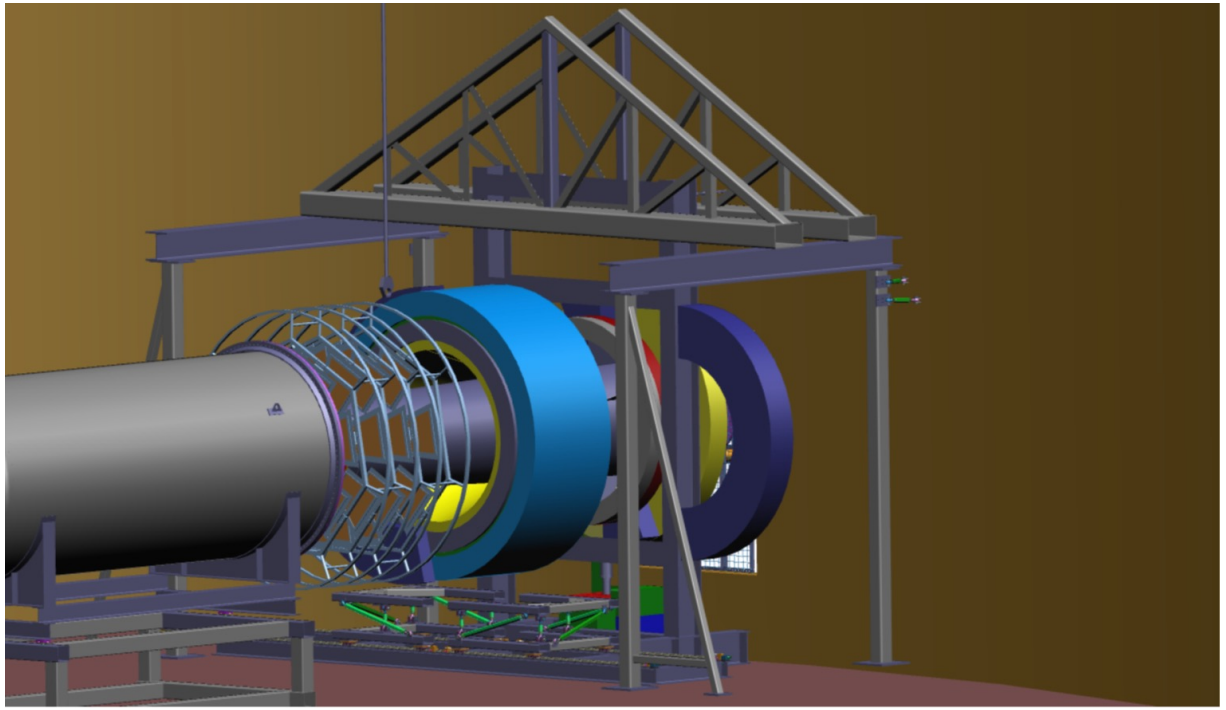
- This is the original idea for the Pb barrel (two solid ‘clam-shells’)
- We now plan to have each 1/28 segment be a separate assembly

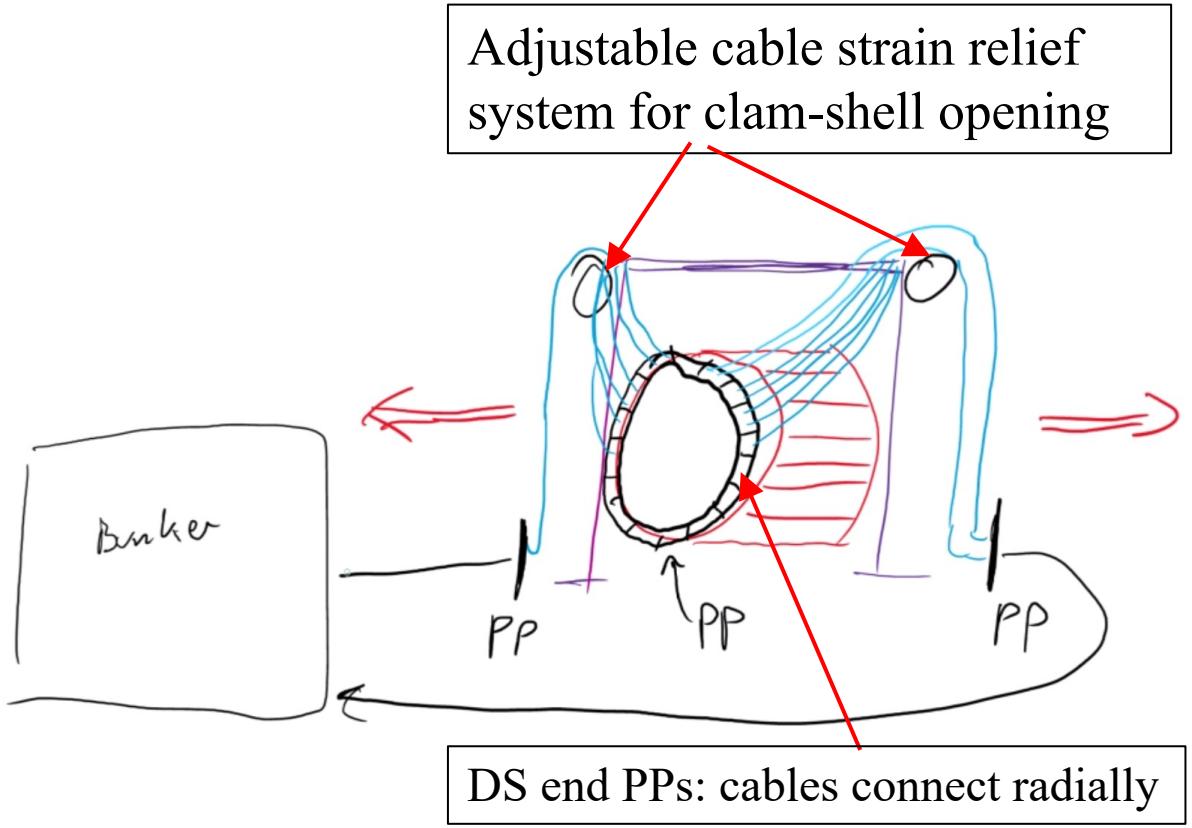
- 8 detectors per 1/28 segment
  => 24 HV & signal cables and 32 ch of LV/control wiring
- Idea is to have custom patch panel mounted on downstream end of each segment
- Panel could house preamps as well as small gas manifold for dry air flow distribution



All cables can be disconnected from custom PP to facilitate segment install/de-install

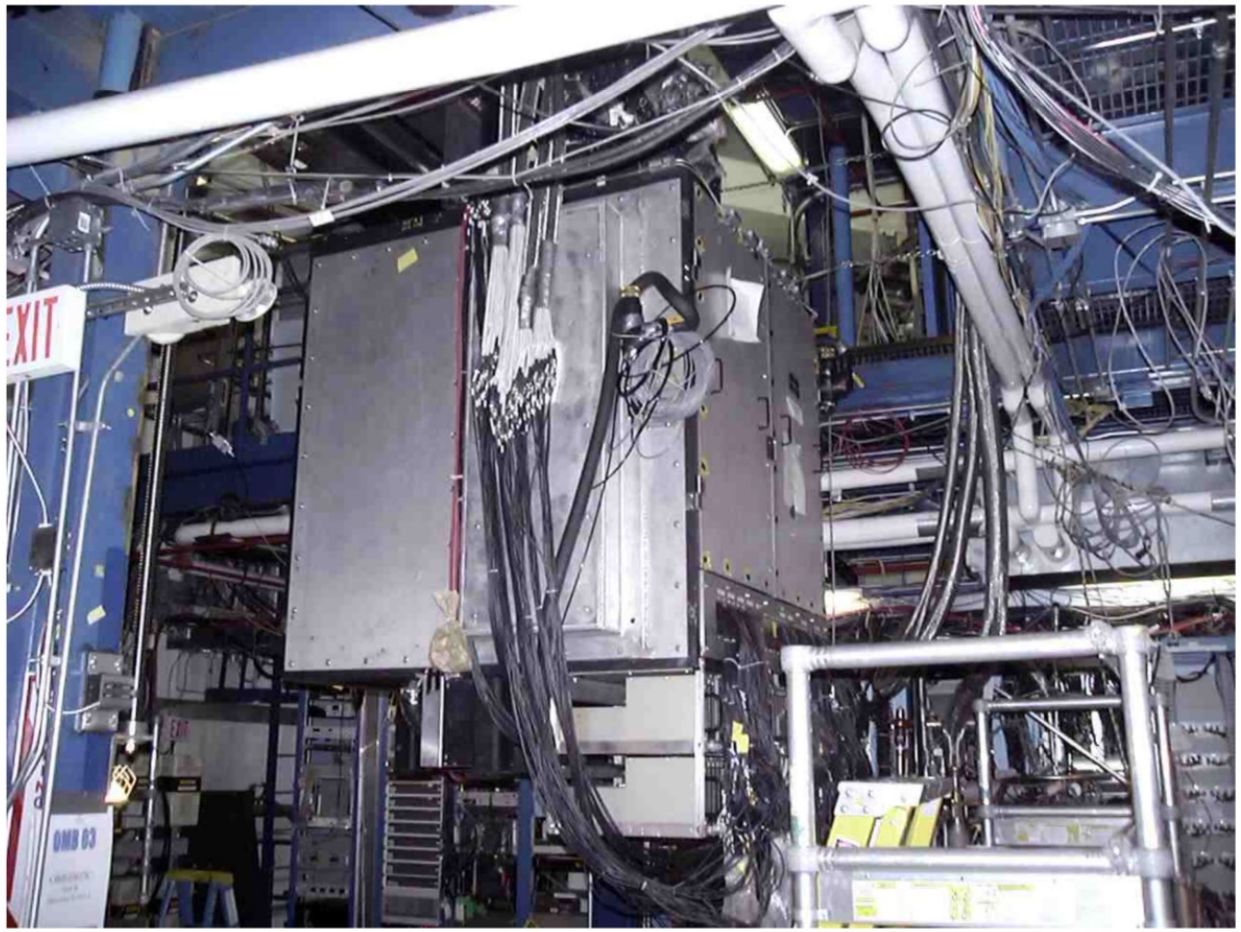
Idea for cable routing from detector barrel to nearby patch panels (not in DS bunker)

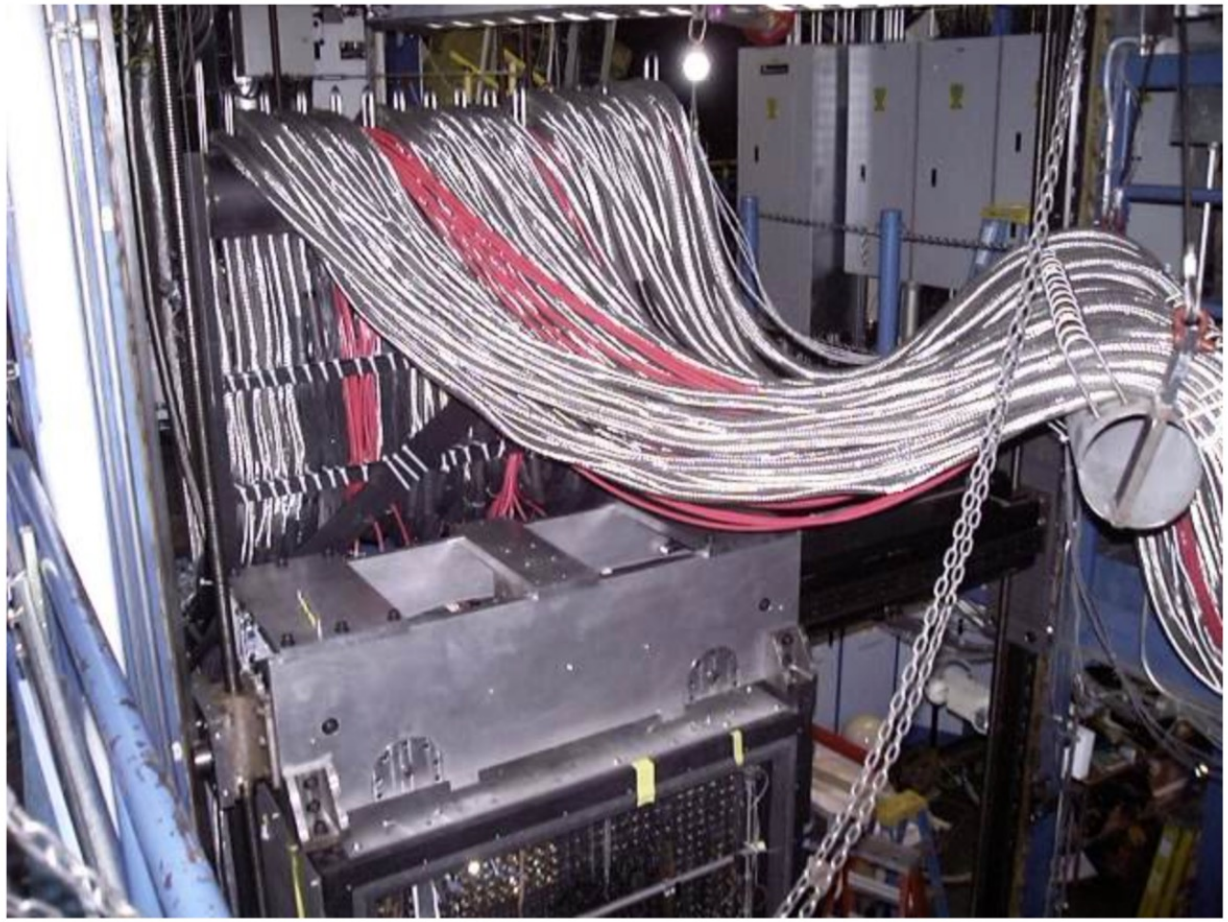




- Integrating signals: Long cable runs go from PPs near detectors to PP's in US bunker
- Counting signals: Long cable runs go from Fast-amps/PPs near detectors to PP's in US bunker
- HV cables: Long cable runs go from PPs in US bunker to PPs near detectors

Hycal hanging from transporter in Hall B





Hycal hanging again