CE Feedthrough and Warm Electronics Crate Design

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BROOKHAVEN NATIONAL LABORATORY

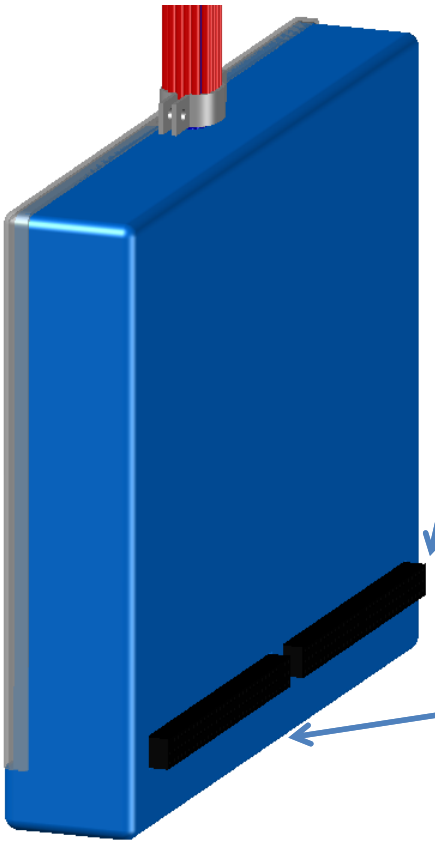
DUNE

SBND Cold Electronics Boards

Width of the FEM board: 180mm. Current DUNE APA has a 230mm board pitch.

The SBND cold electronics development is progressing well ahead of that of ProtoDUNE. We are planning to adopt a slightly modified version of the SBND FEMB and FPGA board for ProtoDUNE. The signal feedthroughs from SBND and ProtoDUNE are also evolved into a very similar design as well.

Modular Electronics Enclosure Concept



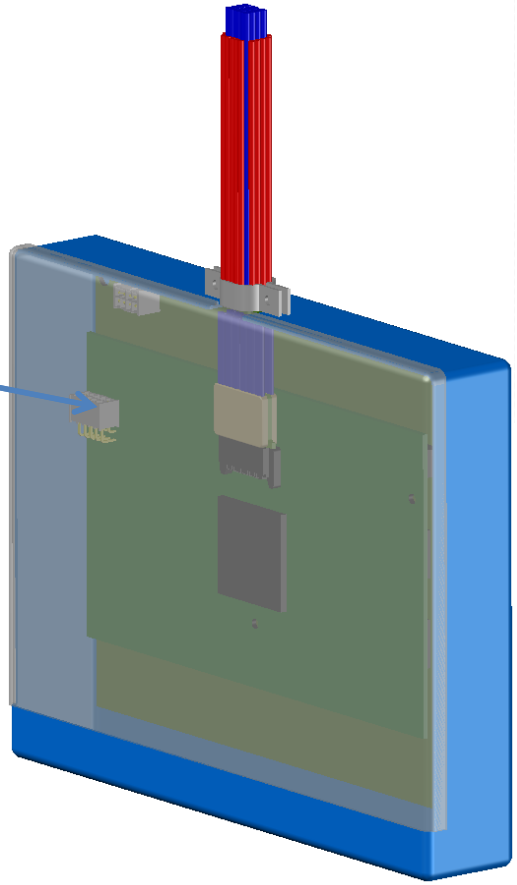
Input connectors on the back of the box (straight connector from the FEM).

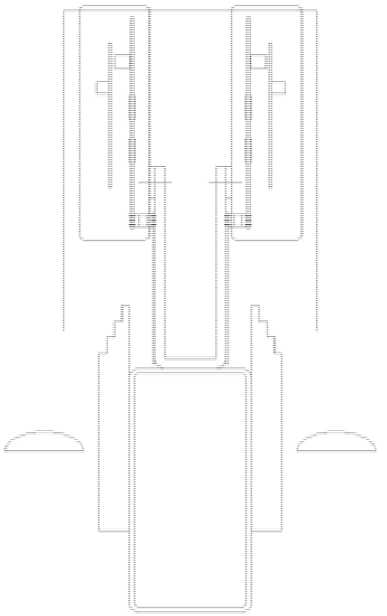
Bottom edge of the box leak tight to trap and divert boil off gas

Plugged in →

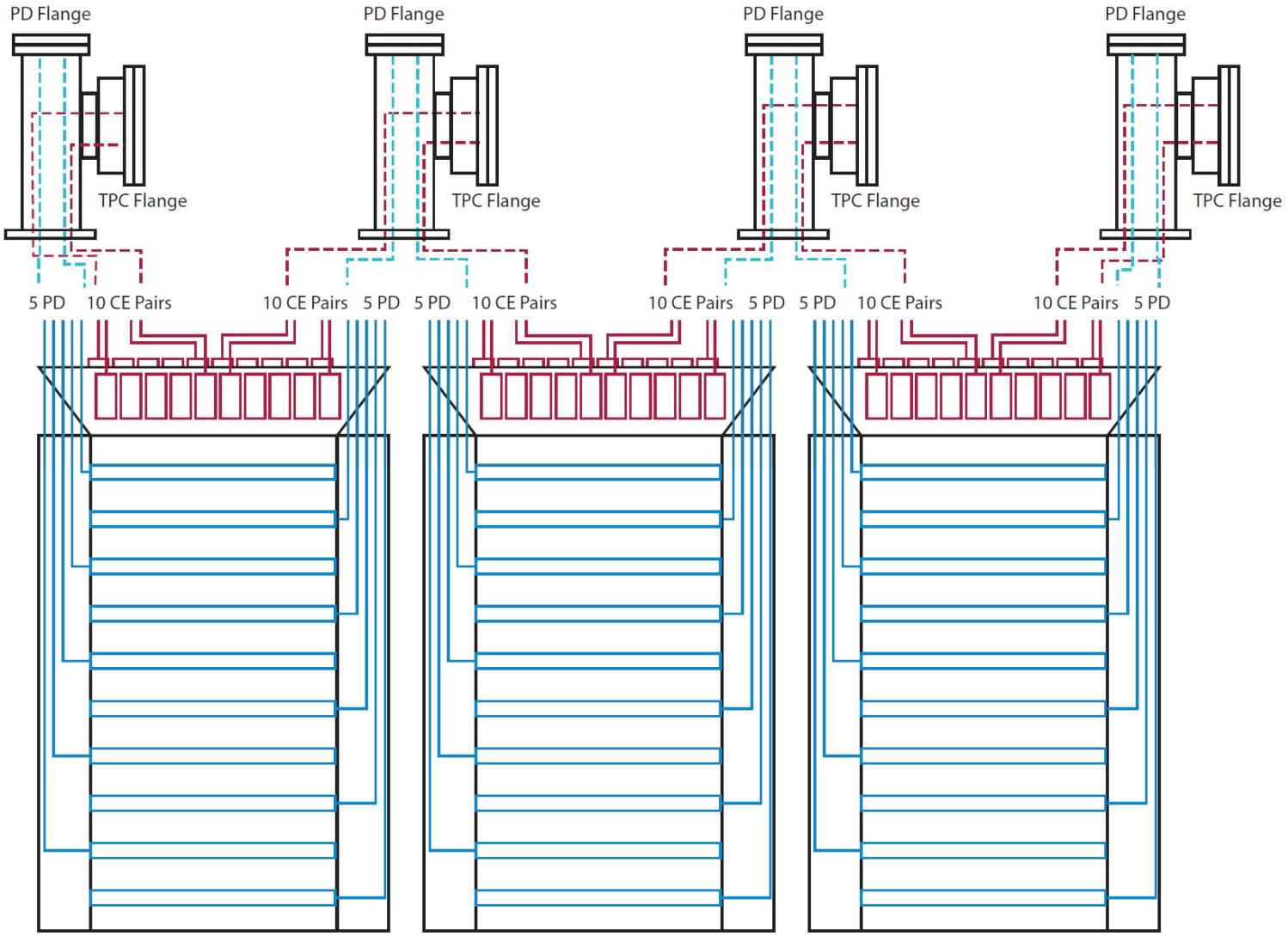
Box opening in line with the data cable to minimize cable bending

Right angle power connector to reduce box thickness





ProtoDUNE APA Cable Routing Concept



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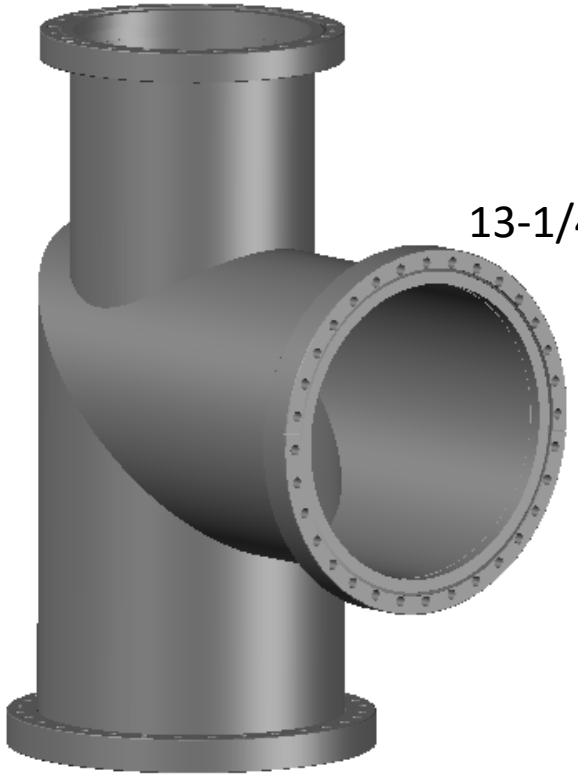
Cryostat Interface (what should we call it?)

ProtoDUNE version

DN200
(PD)

13-1/4” CF

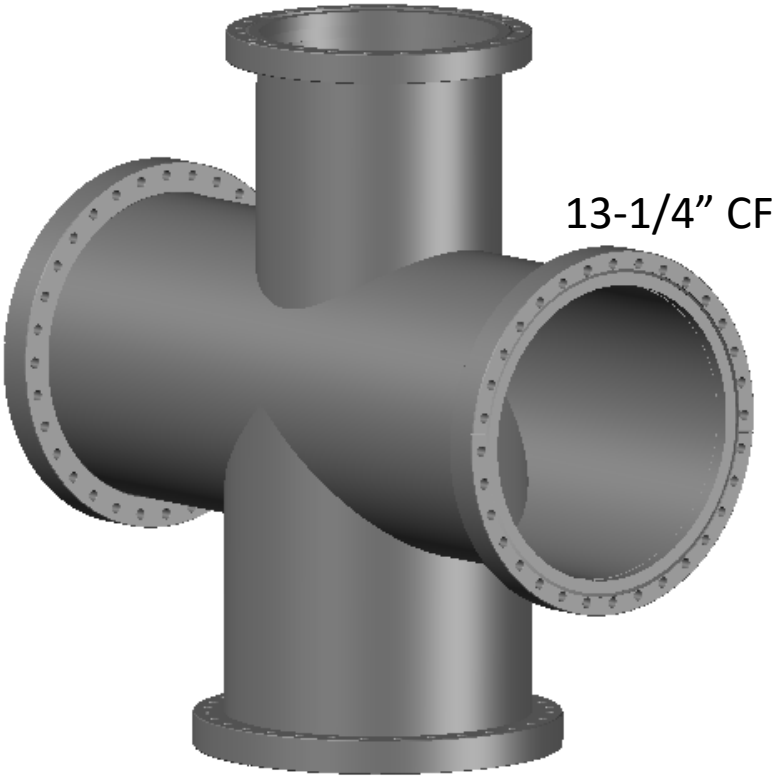


DN250

DUNE version

DN200 (PD)

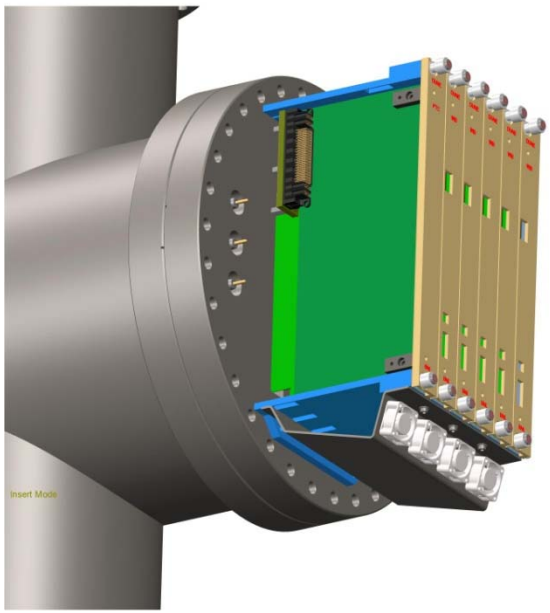
13-1/4” CF

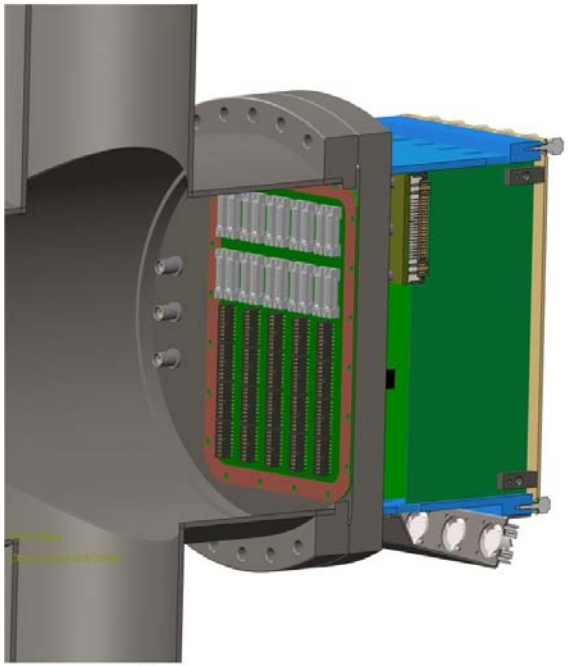


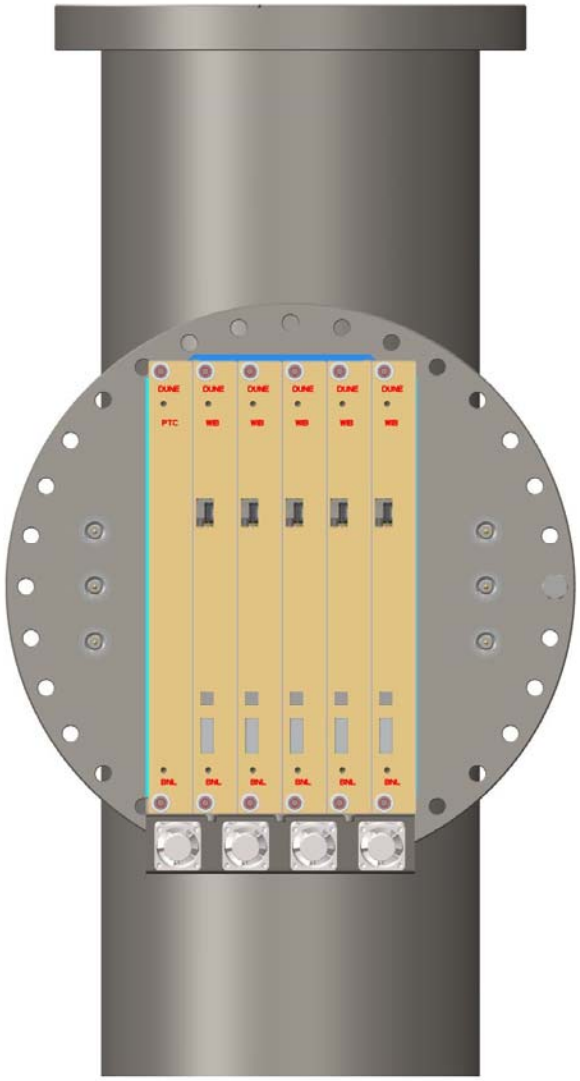
DN250

ProtoDUNE Warm Interface Electronics

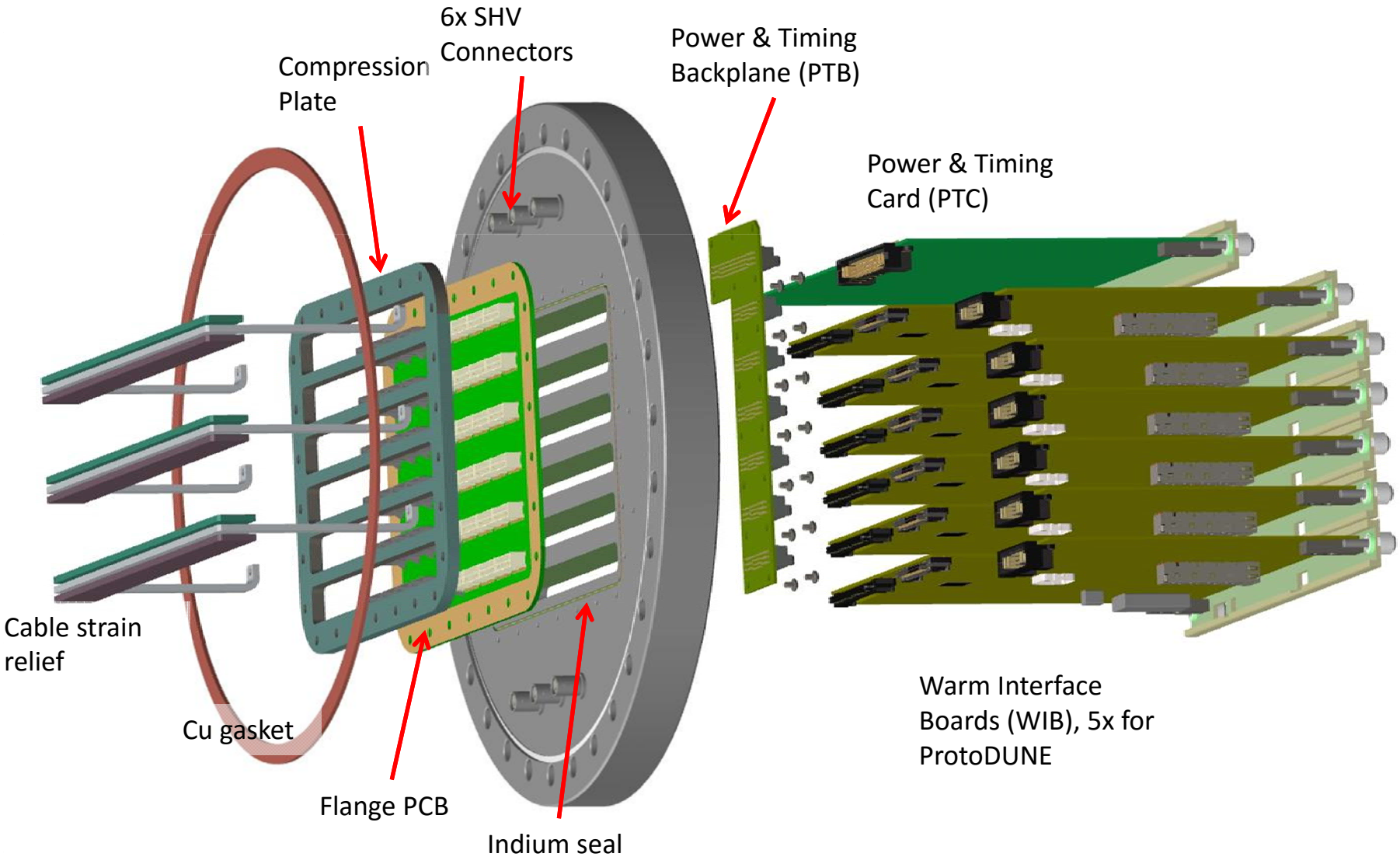
- The 13-1/4” flange holds five Warm Interface Boards (WIBs)
  - SBND uses the same size flange with 6 WIBs





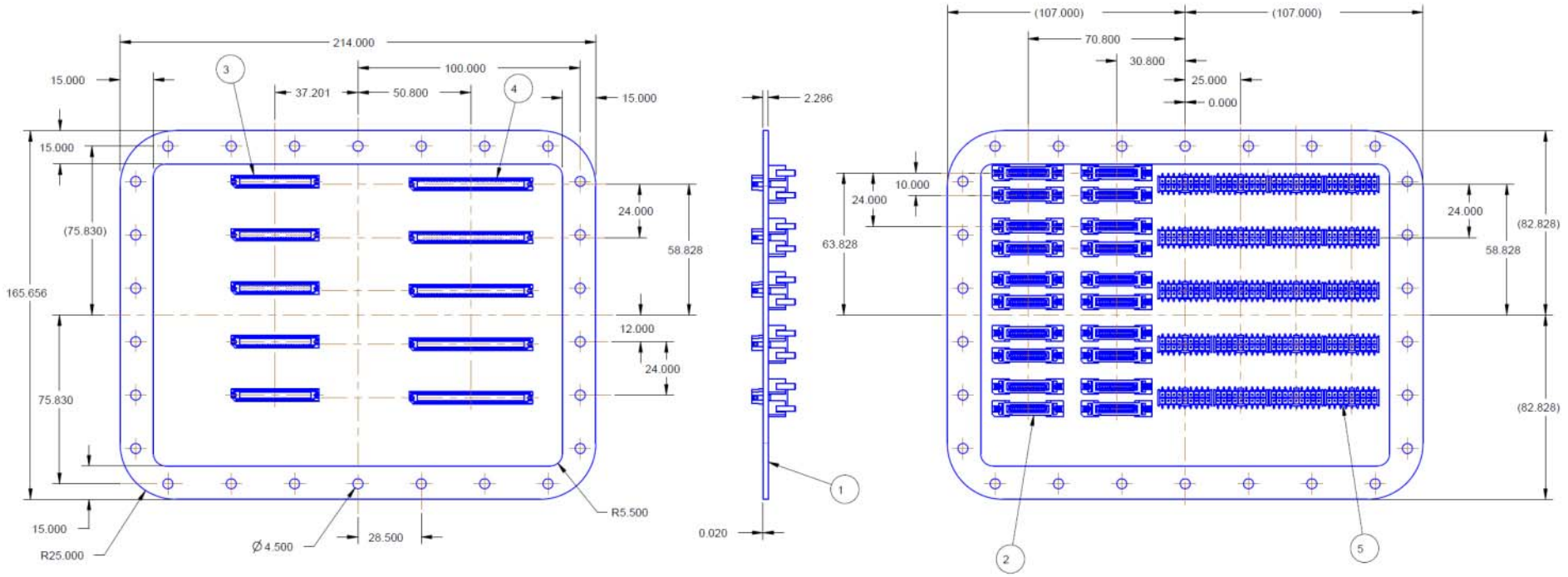


Exploded View of the Flange and Crate (SBND)



BROOKHAVEN NATIONAL LABORATORY DUNE

Layout of the Flange PCB



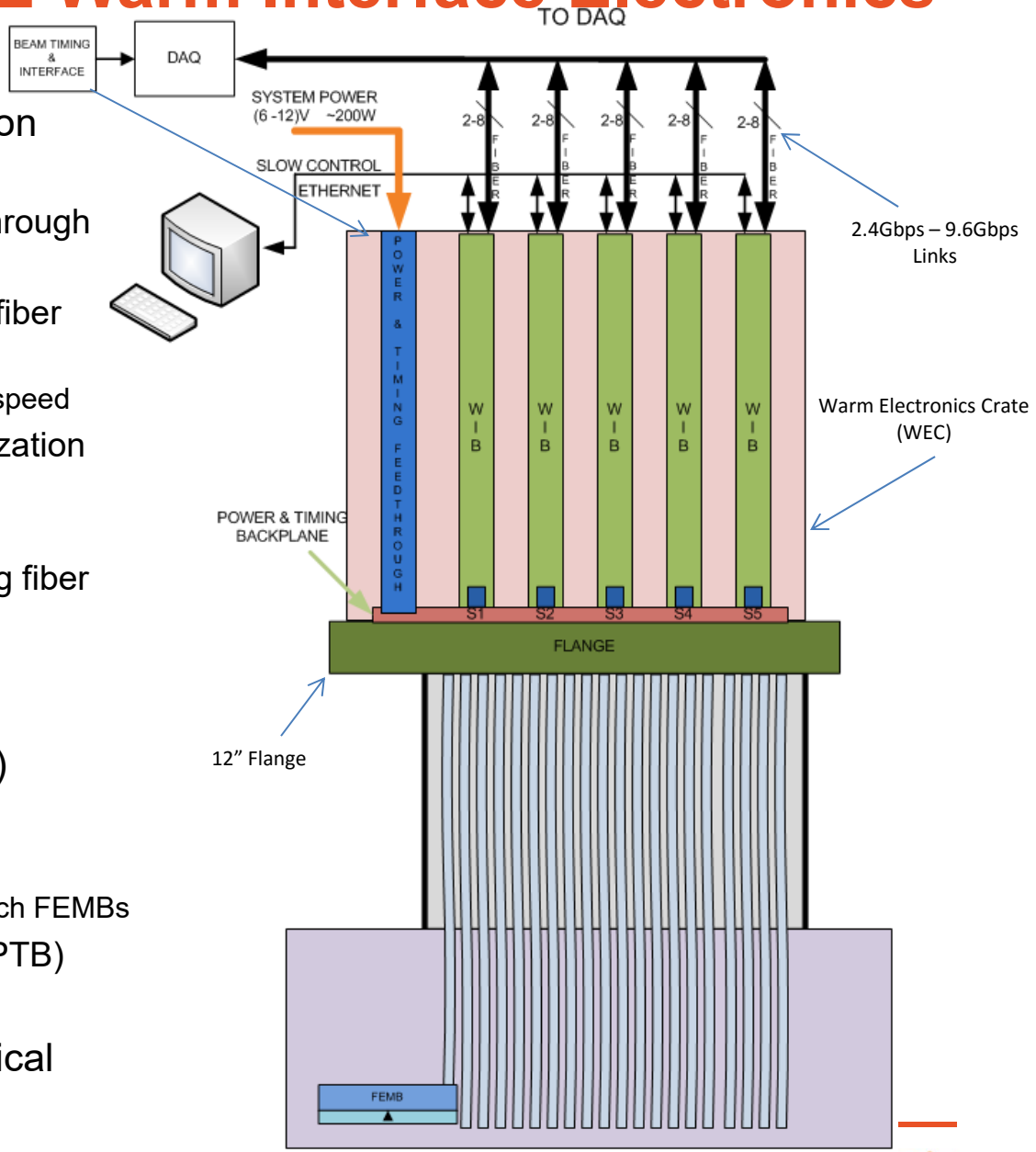
Air Side

Argon Side

ITEM	QTY	PART NAME / DESCRIPTION
5	20	SAMTEC_IPL1-110-02-X-D-K
4	5	SAMTEC PN ERF8-060-05_0-X-DV-L
3	5	SAMTEC PN ERF8-040-05_0-X-DV-L-K
2	20	HSEC8-120-01-L-DV-A-BL
1	1	DUNE_CF13-25_FLANGE_PCB

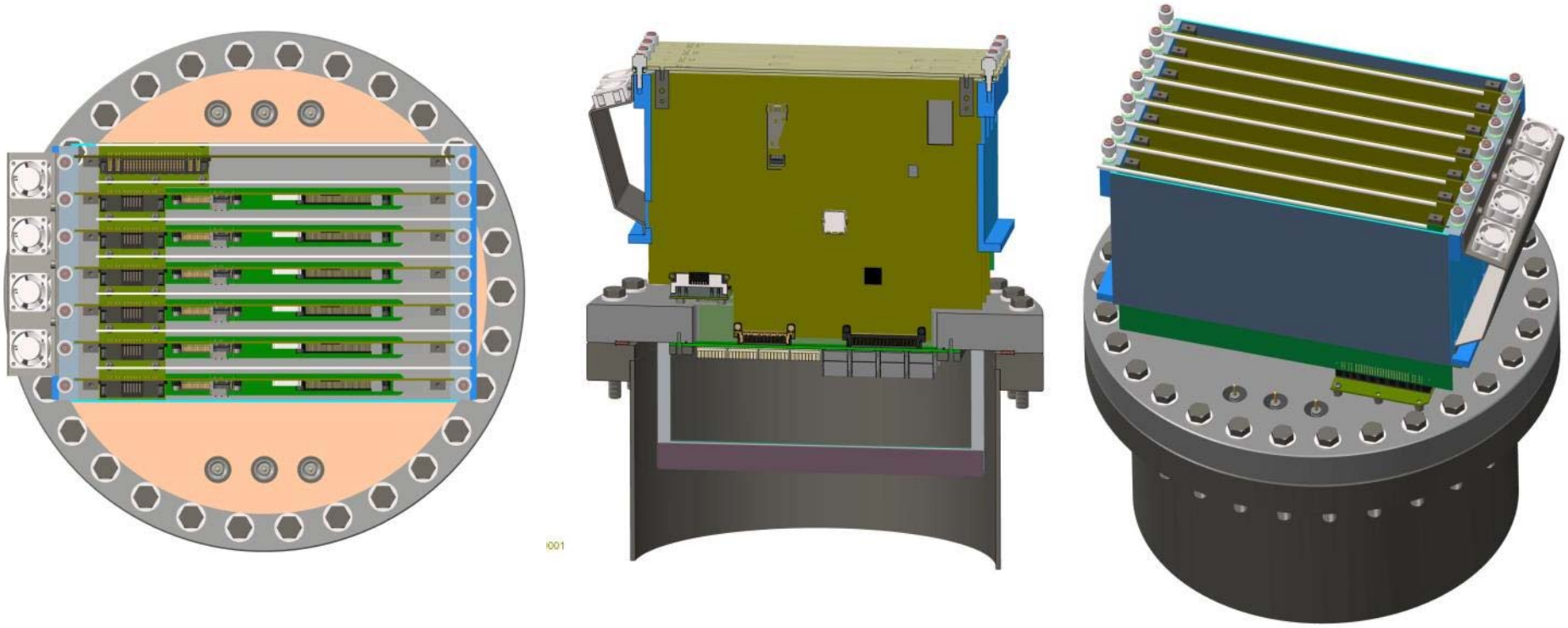
Proposed ProtoDUNE Warm Interface Electronics

- Warm interface electronics installed on flange board
  - Receive data from cold electronics through cold cables
  - Send data to ProtoDUNE DAQ over fiber optical links
    - Two to eight links depending on link speed
  - Receive system clock and synchronization signals form DAQ over fiber links
    - (PTC or WIB)
  - Interface to slow control system using fiber GIG-E
  - Manage power and control for cold electronics
- Each Warm Electronics Crate (WEC) contains the following
  - Five Warm Interface Boards (WIB)
    - Each WIB will control up to four 128-ch FEMBs
  - One Power and Timing back plane (PTB)
  - One Power and Timing Card (PTC)
- WEC is a faraday cage with only optical signals going in and out



See talk by J. Fried for more details.

Few More Views of the Flange and Crate (SBND)

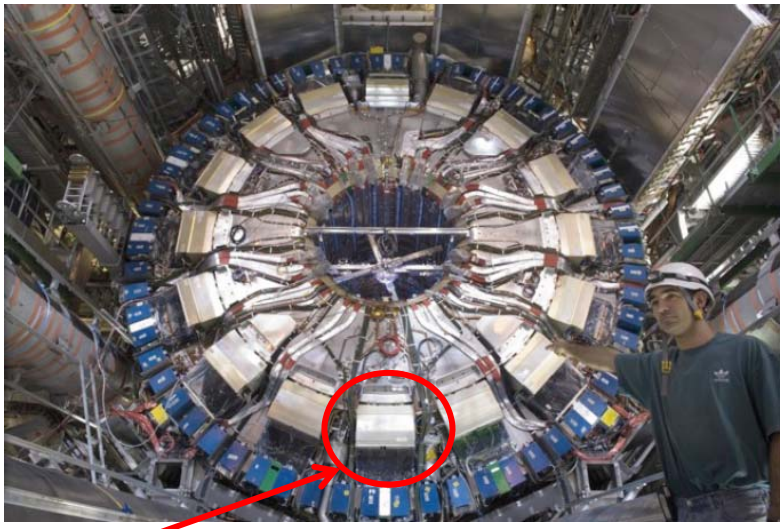


Summary

- The warm interface electronics is the bridge between cold electronics and DAQ systems
- *Signal feed-through*, *warm electronics crate* and *warm interface boards* are ***integrated*** part of warm interface electronics system
  - Development shall be closely coordinated to ensure the integrity of the system design
  - Grounding scheme should be developed with warm interface electronics, cryostat and active detector
- ProtoDUNE signal feed-through and warm electronics crate design are very similar to SBND design
  - SBND changed to single warm feed-through design recently
  - Synergy of both ProtoDUNE and SBND
- SBND warm interface board can be easily adapted to ProtoDUNE
  - Minor revision to include higher (4.8Gbps or 9.6Gbps) speed optical links
  - Important tool to provide diagnostic capability of detector through GbE without relying on DAQ system
  - Important tool to act as data emulator for early integration with DAQ system
  - Versatile interface to different DAQ systems

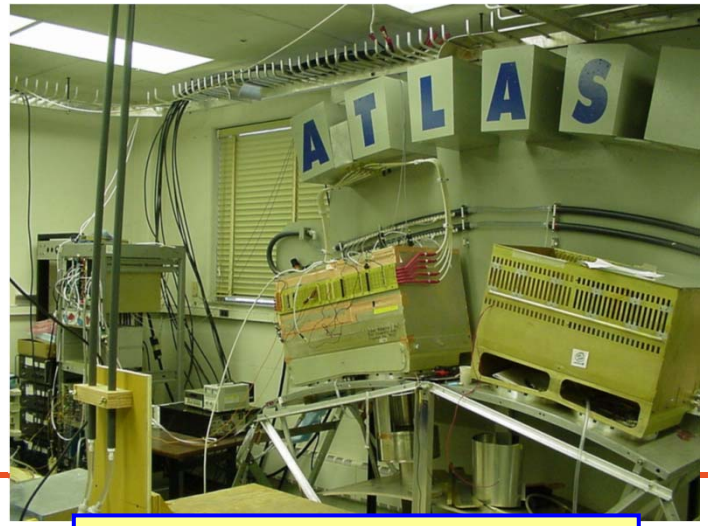
Backup Slides

ATLAS LAr FEC System



Front End Crate

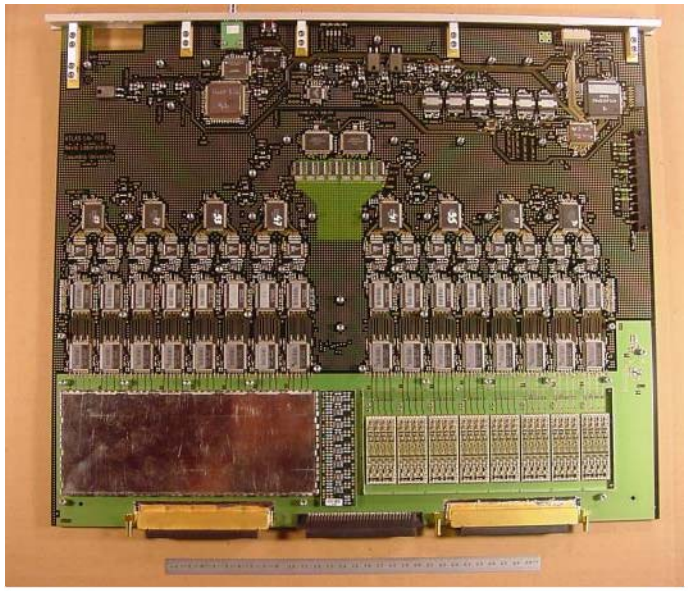
Barrel calorimeters in detector hall, surrounded by barrel toroids



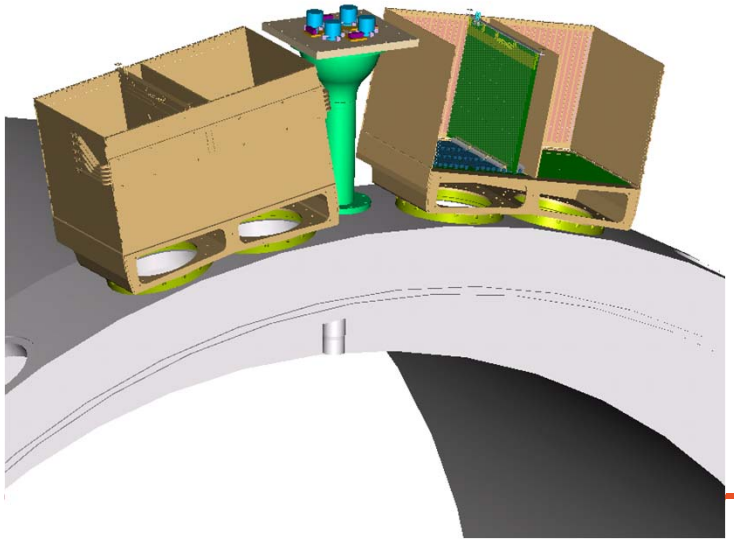
Front End Crate Test Stand at BNL

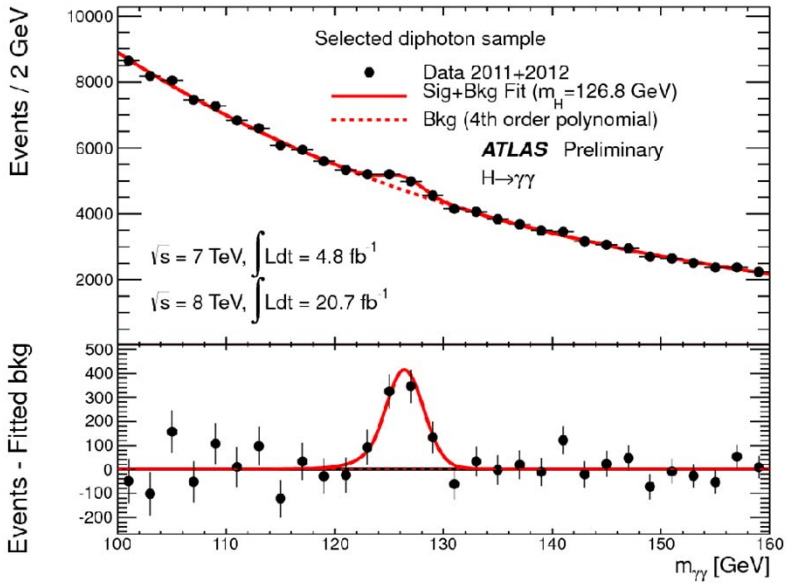
- ATLAS LAr FEC (front end crate) system was developed at BNL
  - Total 58 FECs for ATLAS LAr Calorimeters
  - 3.5kW power supply per FEC to power 38 front end electronics boards, with water cooling
  - Total ~1900 front end electronics boards running ***on detector***
  - Grounding scheme designed by Veljko and implemented by CERN
- DUNE 10kt far detector will have
  - Total 150 WEC
  - 0.2kW power supply per WEC to power 5 warm interface boards, with fan cooling
  - Total ~750 warm interface boards

ATLAS LAr FEC System

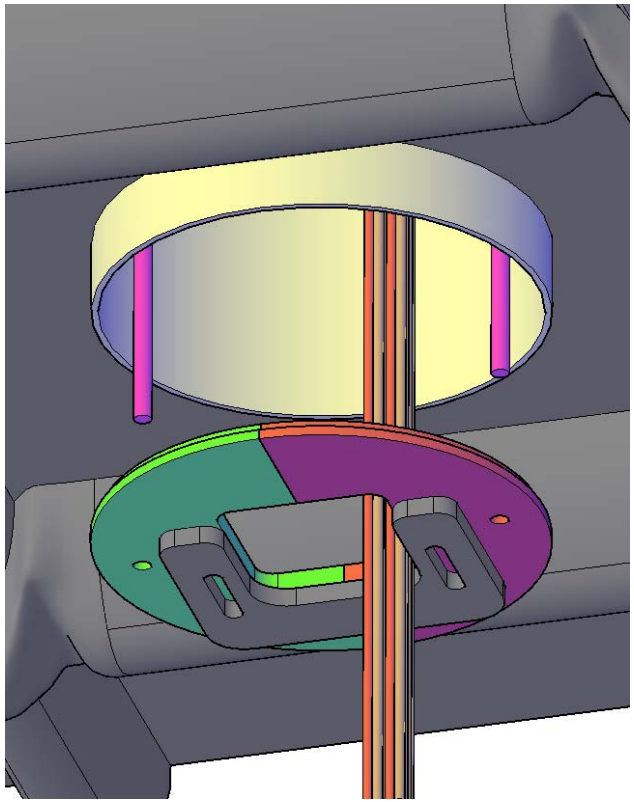


- ATLAS LAr front end board
  - 408mm x 489mm
  - More than 10 different types of ASICs on board
  - 40MHz ADCs, multiplexer, serializer and high speed optical link running on board
  - Non-amplified current signal coming from detector to FEB through cold cable
  - 16-bit dynamic range (up to 10mA or 3TeV)
  - Extremely low noise system (<100nA or 35MeV)
- ATLAS LAr Calorimeter contributed >5 sigma to Higgs discovery by itself

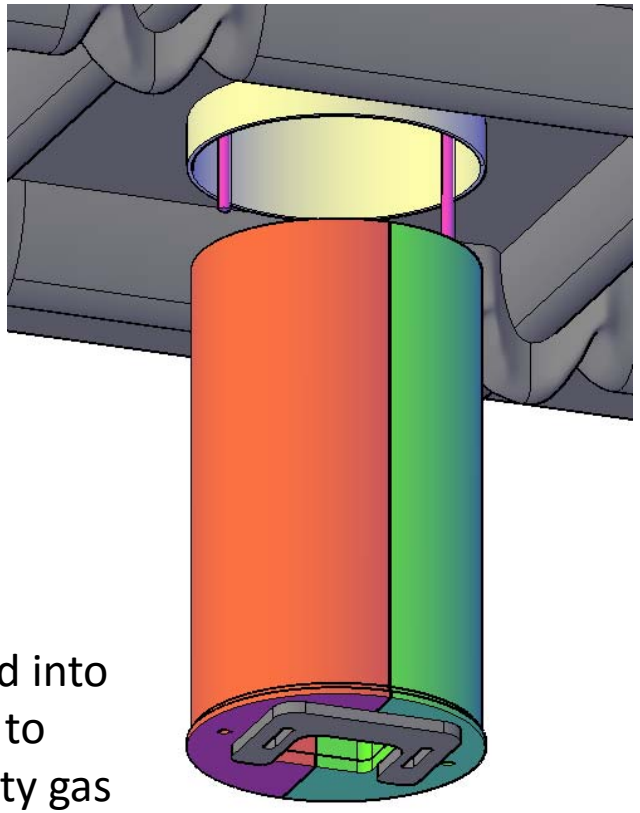




Integrated Cable Strain Relief and Baffle



Simple baffle plate to create local high velocity purging flow



Baffle plug pushed into the crossing tube to create high velocity gas flow over extended distance

Gore Cable

Sample cable from Gore, with Samtec ECDP connector

It would be nice to have a better connector shell