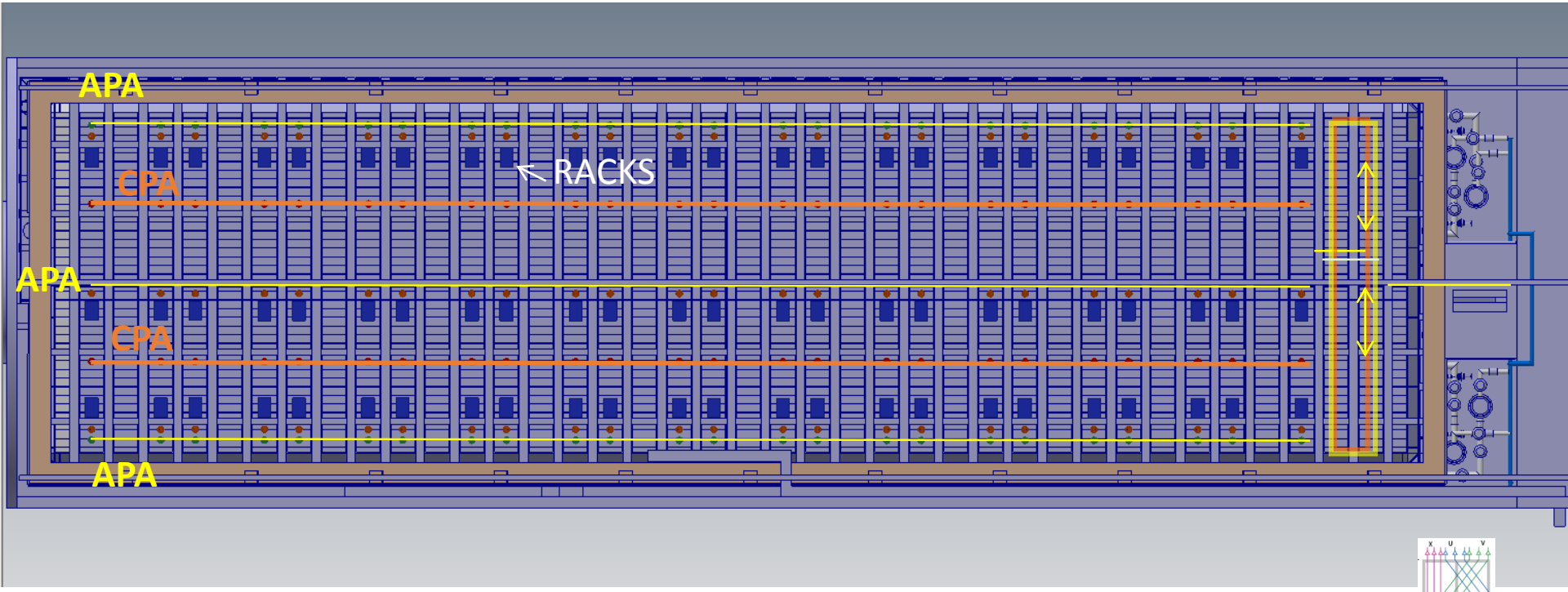
DUNE-SP Cable Feedthrus

Jim Stewart

Far Detector Technical Board

Sept 29 2017

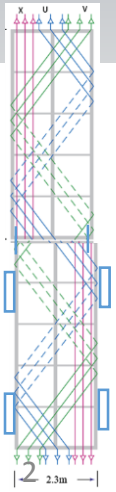
Present Rack Feedthru Layout



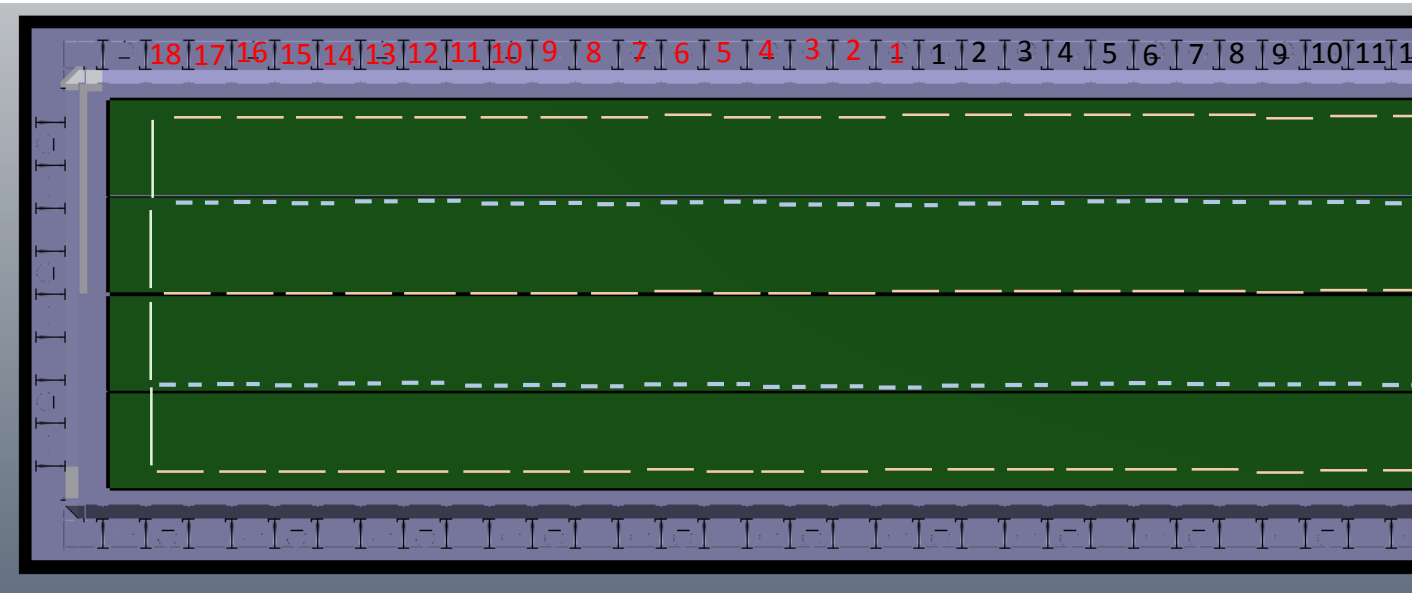
The present layout has feedthrus for 24 APA pairs per row.
We need 25 APA pairs per row so a change is needed.

We need 1 penetration per APA pair (Top APA-Bottom APA).

We show one rack per cable penetration. There are no slow control racks in this model.



Cartoon of the APA Placement



Jack is adopting a bay numbering scheme for the gaps between I-Beams. The bay numbers are shown at the top. Red is negative.

The Proposed Bay slots for the cabling is shown in the table.

There are 11 empty slots.

The feedthrus are centered in the bays and ~1m inbound from the DSS supports. This gives space to work and ensures that access to the ports is un-impeded.

Bay #	Current Cable	Proposed cable CL of APA
19		
18	24	25
17		
16	23	24
15	22	23
14		22
13	21	
12	20	21
11		20
10	19	
9	18	19
8		18
7	17	
6	16	17
5		16
4	15	
3	14	15
2		14
1	13	
-1	12	13
-2		12
-3	11	11
-4	10	
-5		10
-6	9	9
-7	8	
-8		8
-9	7	7
-10	6	
-11		6
-12	5	5
-13	4	
-14		4
-15	3	3
-16	2	2
-17		
-18	1	3 1
-19		

Penetration Diameter

- The remaining consideration is the diameter of the penetrations.
- As neither the design of the Cold Electronics (CE) not the Photon Detector (PD) are complete the space requirements must be based on assumptions and then we need to look at how much margin we have.
- As a starting point we have taken cables from ProtoDUNE-SP and created a strawman design of the feedthru assuming that we have cables for two APAs and 20 PD detectors (with Spares).
- I also assume that the cables cannot run up the wall of the cryostat. Feedback from the cryostat team indicate that attaching support points to the walls is impossible. The only support points available are using small bolts at the edges. The cable mass of the detector is large – (the CE power cables alone are ~100 lb).

CE cables

ProtoDUNE-SP Data Cable

7m long custom edge card cable assembly. The DUNE-SP cables will be 25m long.

ProtoDUNE-SP Power Cable

The ProtoDUNE-SP cables are 7m long. The DUNE cables are 25m long.

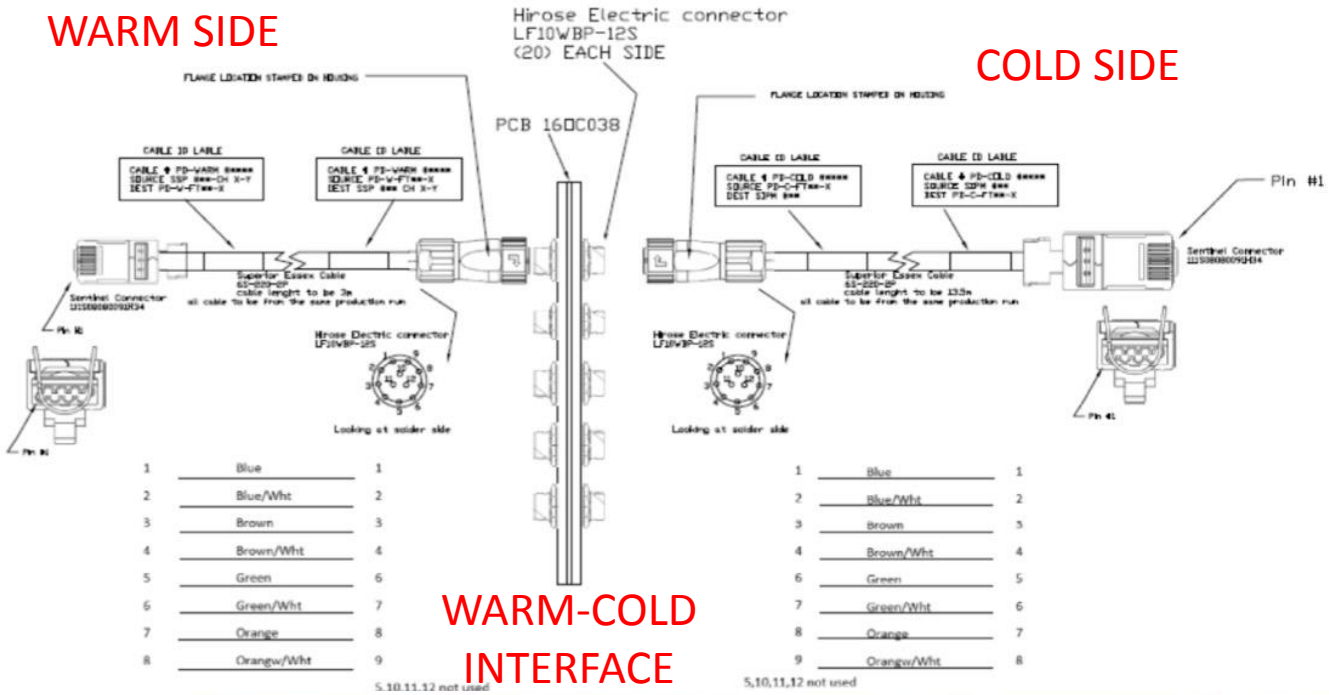
Each APA will have 22 CE data cables and 22 CE power cables.

This assumes 2 spare cables per APA pair.

Extensive tests have been done and the Samtec 26 gauge cables are the only cables to have adequate data transmission capability over the 25m with acceptable cost. We assume here we will use these cables.

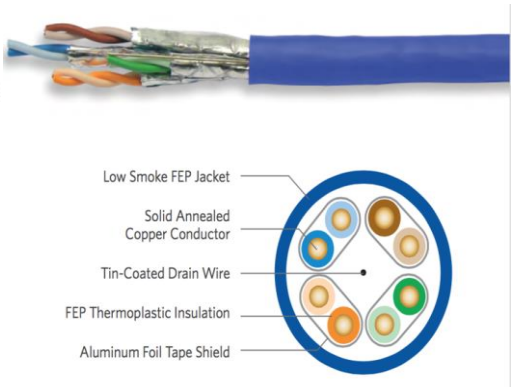
ProtoDUNE-SP Cable Assembly

WARM SIDE



WARM-COLD INTERFACE

COLD SIDE



Teflon® Jacket Cat-6

RJ-45 Connector (SiPM Board and SSP)

Hirose Twist-Lock Bayonet (Flange)

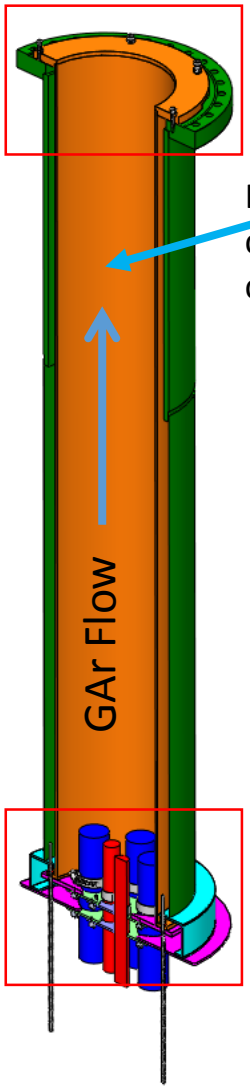
DUNE PD cables

- It is unlikely that the ProtoDUNE-SP PD cables will be used for DUNE. They are very expensive and take significant space.
- For the purpose of estimating the space needed in the feedthru I assume that the final PD cable volume will be roughly equal to the existing cable bundle.
- The changes to the PD system will either then need to fit in this space allotment or need to negotiate using the spare space.

Strawman Signal Feedthrough Design

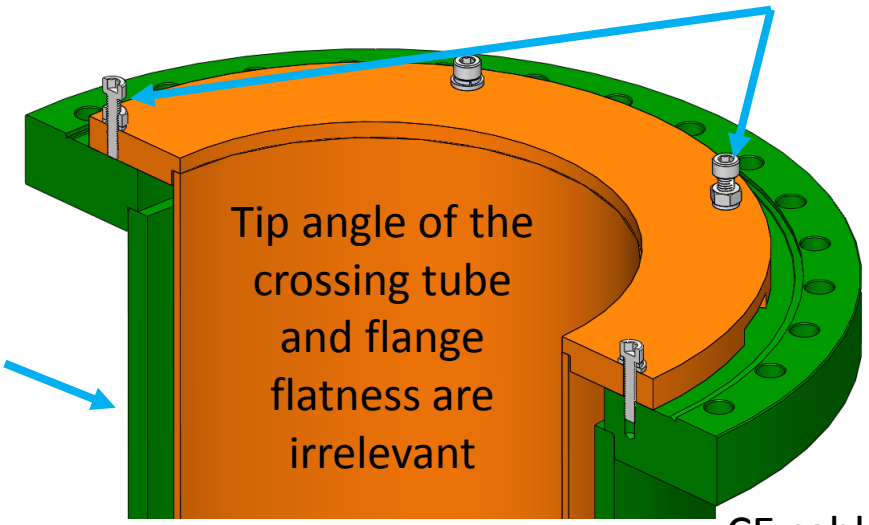
Cable Strain Relief Installed on CERN Crossing Tube

Current CERN crossing tube:
250 mm (OD), 230 mm (ID).



Inner tube confines contaminates

CERN crossing tube



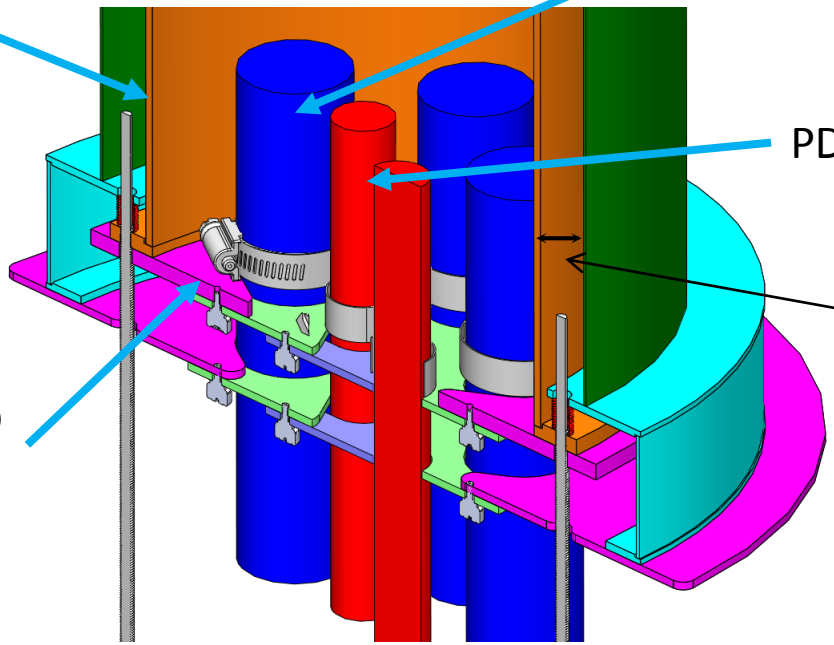
Inner tube 203mm (8in OD)

CE cables

PD cables

13.5 mm GAP (SPARE)

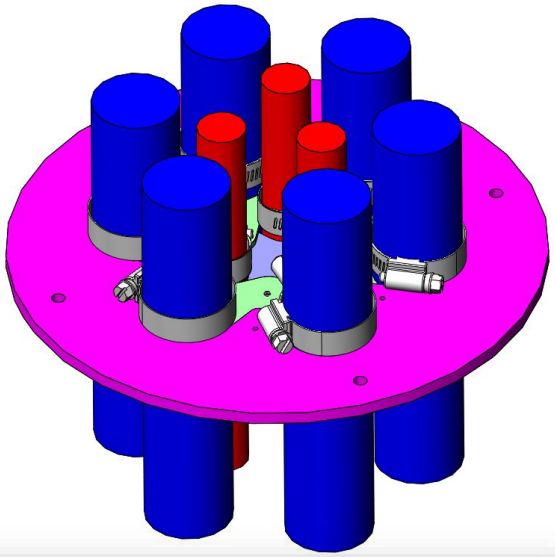
Clamp plate

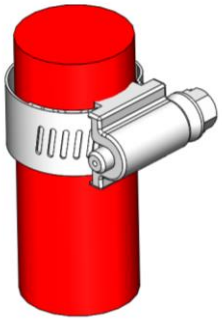


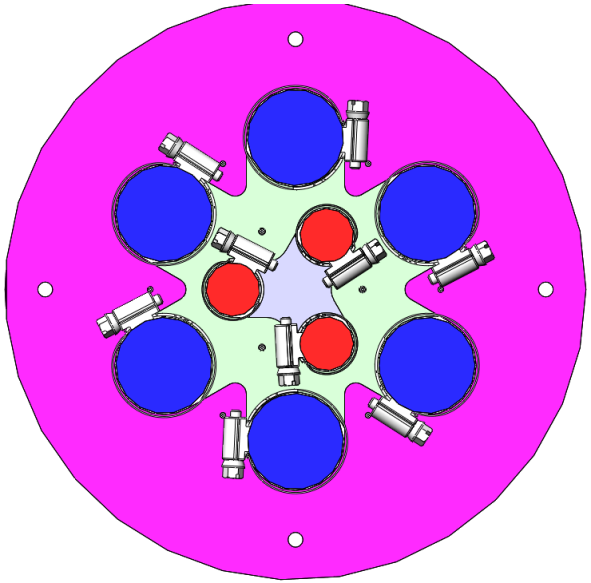
Penetration Cabling Plan

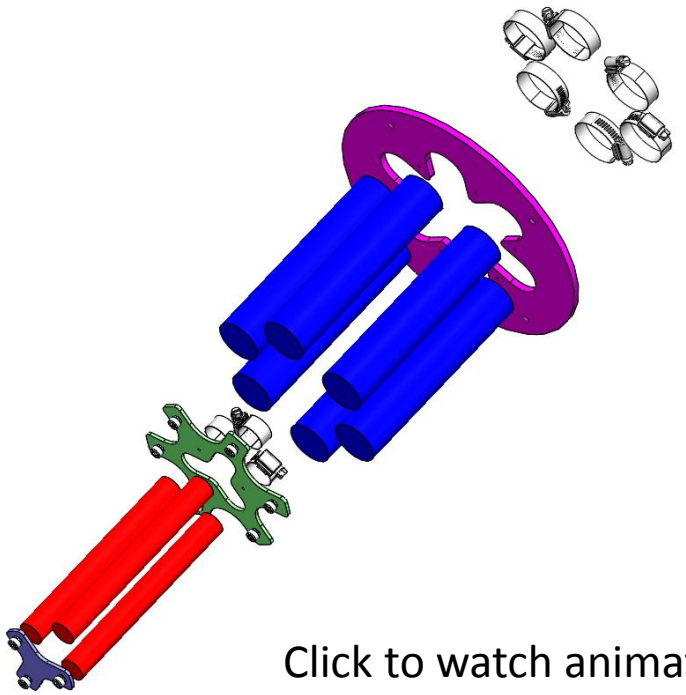
PD cable bundle
8 PD cables
ϕ25mm
Assume 3 bundles
(4 spare cables)

CE cable bundle
8 CE data/power cables
ϕ44mm
Assume 6 cable bundles
(8 Spare Power and data cables)









Validation and contingency

Diameter of the bundle of 8 CE cables is 44 mm. Pull tests indicate the strain relief is adequate.

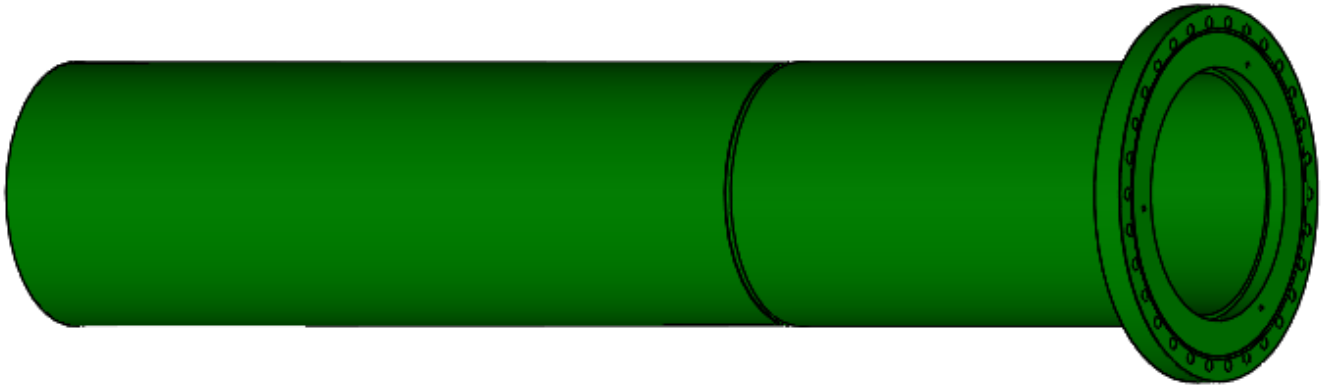
- The ultimate contingency is defined by the diameter of the crossing tube.
- Given the diameter of the cable and the connectors Manhong has estimated there is roughly 20% contingency on the cable bundle cross section through the crossing tube.

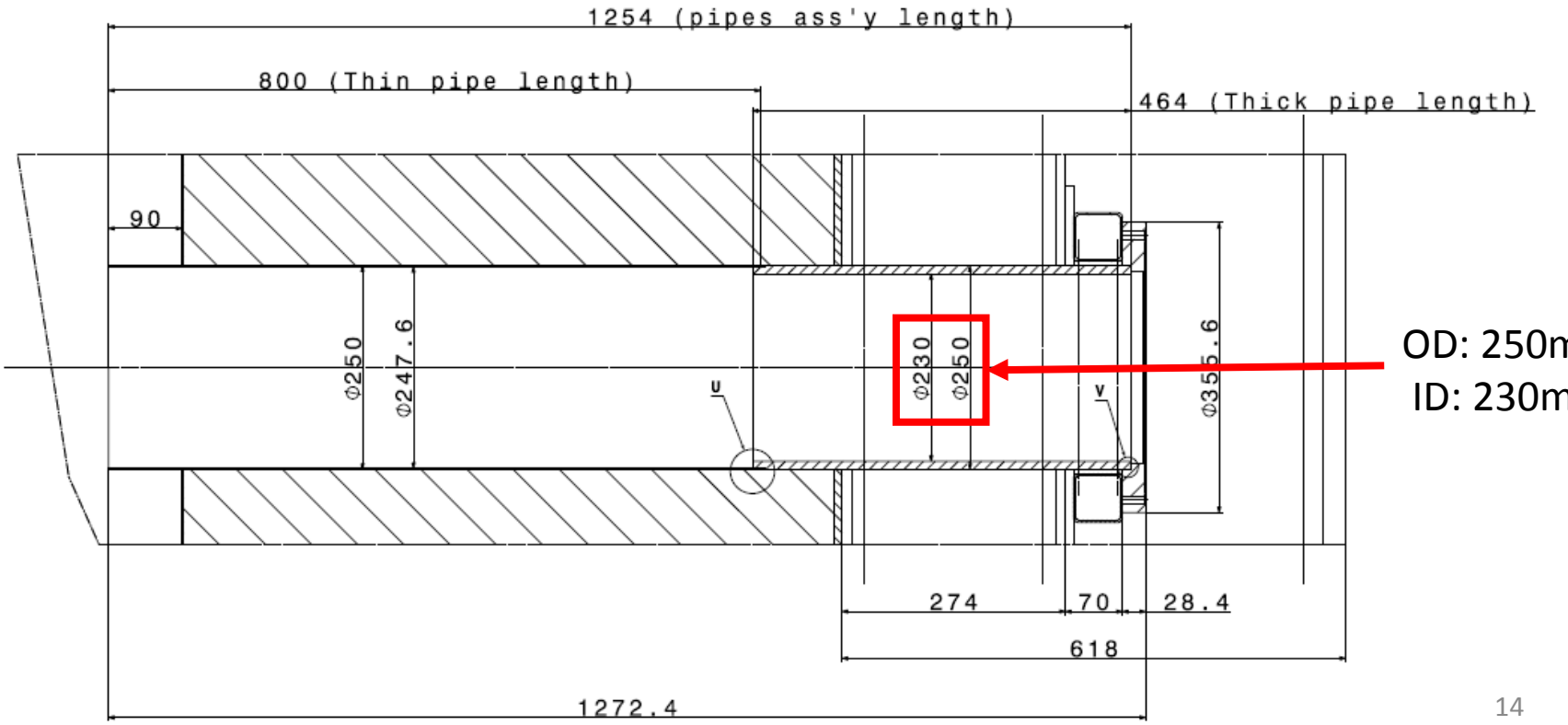
Summary

- A change order is needed to increase the number of penetrations from 24 to 25 for each APA row.
  - Add 4 penetrations
- The existing 250mm diameter (230mm ID) are sufficient for the APA cable plant.
- A feedthru concept based on ProtoDUNE-SP cables with 10% spares was presented.
- A space contingency of roughly 20% was estimated but this is very rough.
  - Prototyping is necessary to be sure this works. This is planned in 2018.

Backup Slides

CERN Crossing Tube for ProtoDUNE





OD: 250mm
ID: 230mm