

MILO VERMEULEN

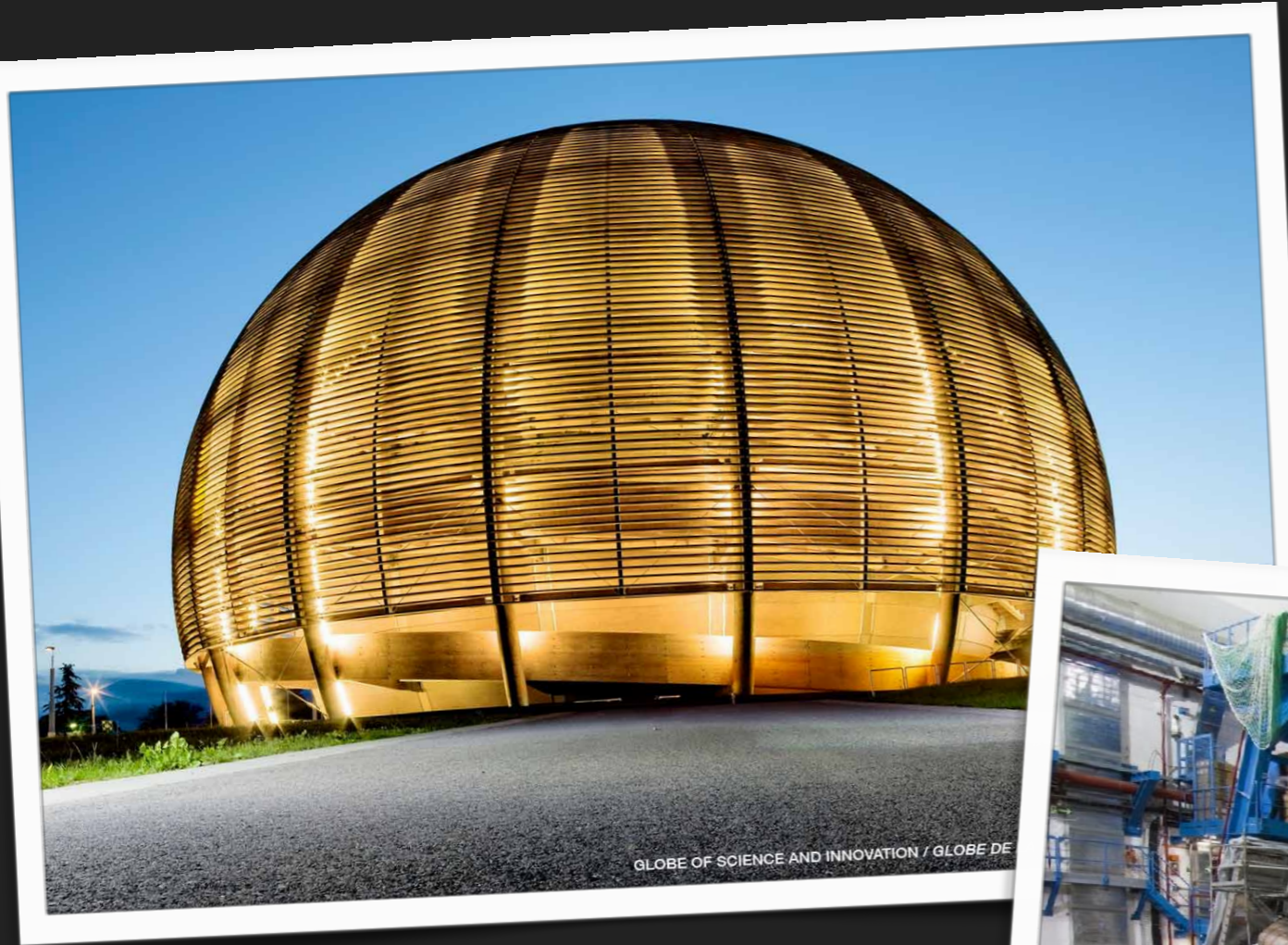
A YEAR AT PROTODUNE

ONE YEAR AGO

- ▶ At Nikhef
- ▶ No colleagues
- ▶ Working alone on ProtoDUNE
- ▶ Tasked with data compression on non-existing data



TO CERN!

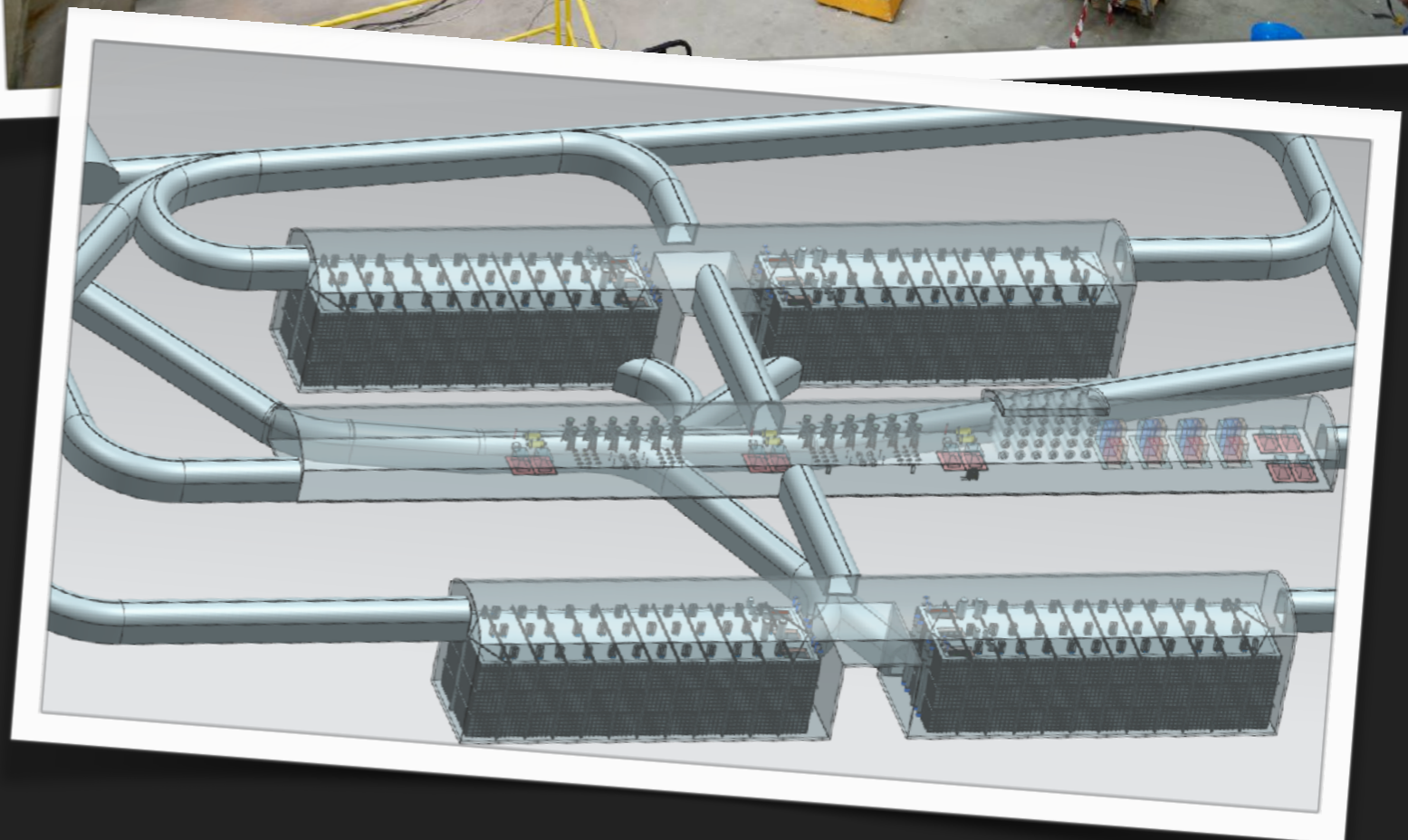


- ▶ Suddenly: colleagues!
- ▶ A great group!
- ▶ Some kind of clarity!

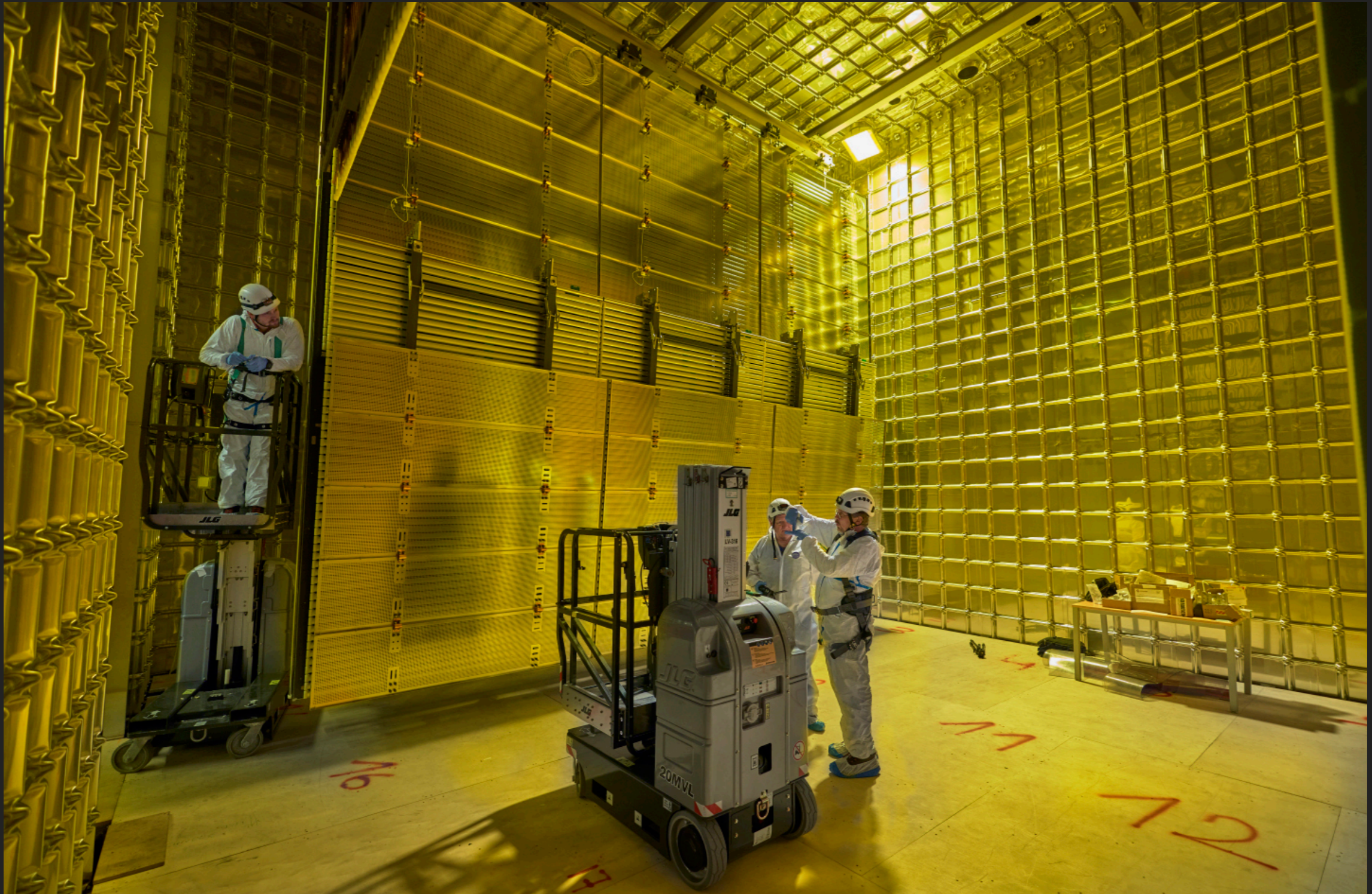


PROTODUNE

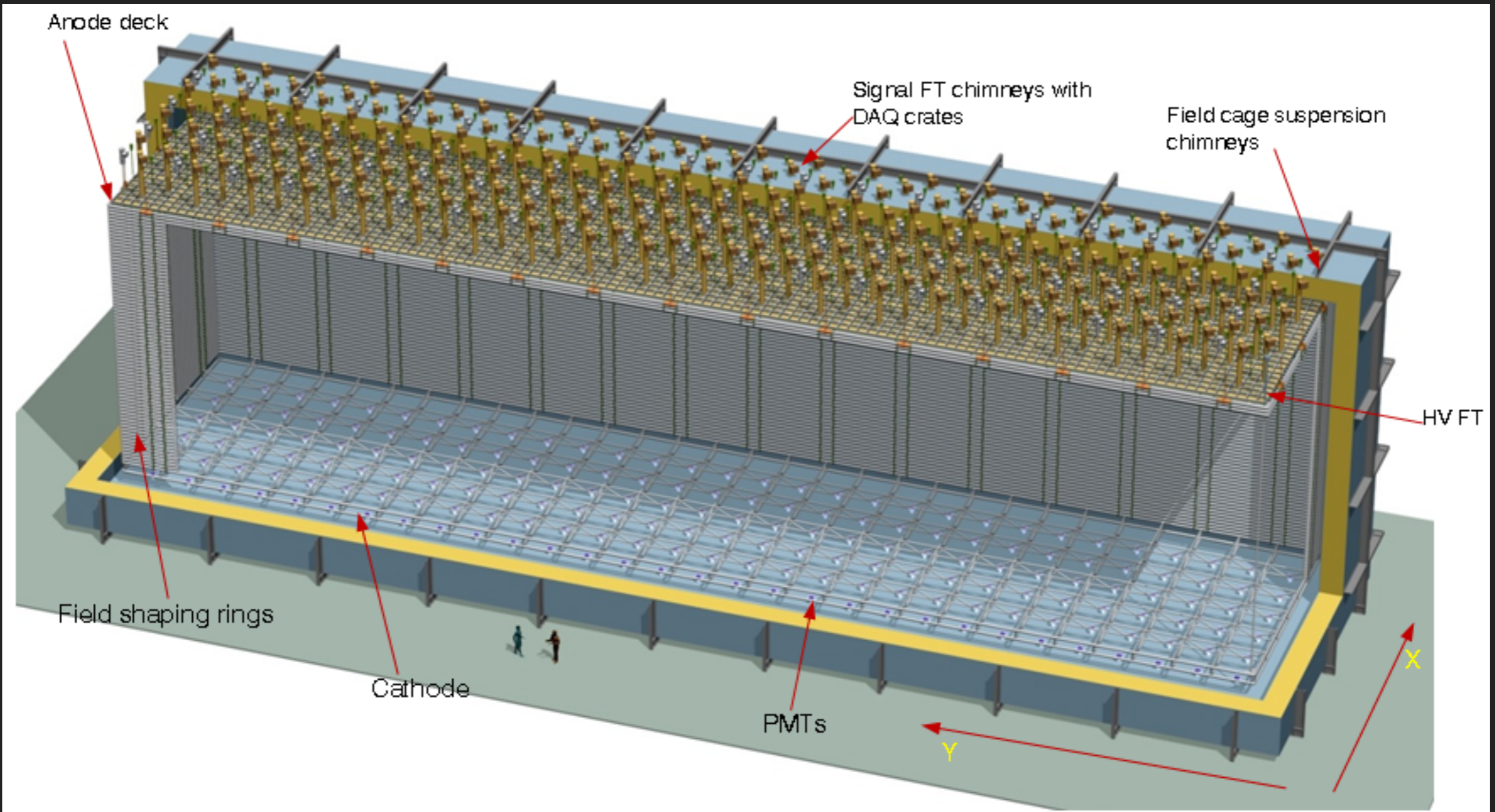
- ▶ Small prototype for DUNE
- ▶ 10x10x10 m cube filled with liquid argon
- ▶ DUNE: 20x20x80 m x 4



PROTODUNE



DUNE



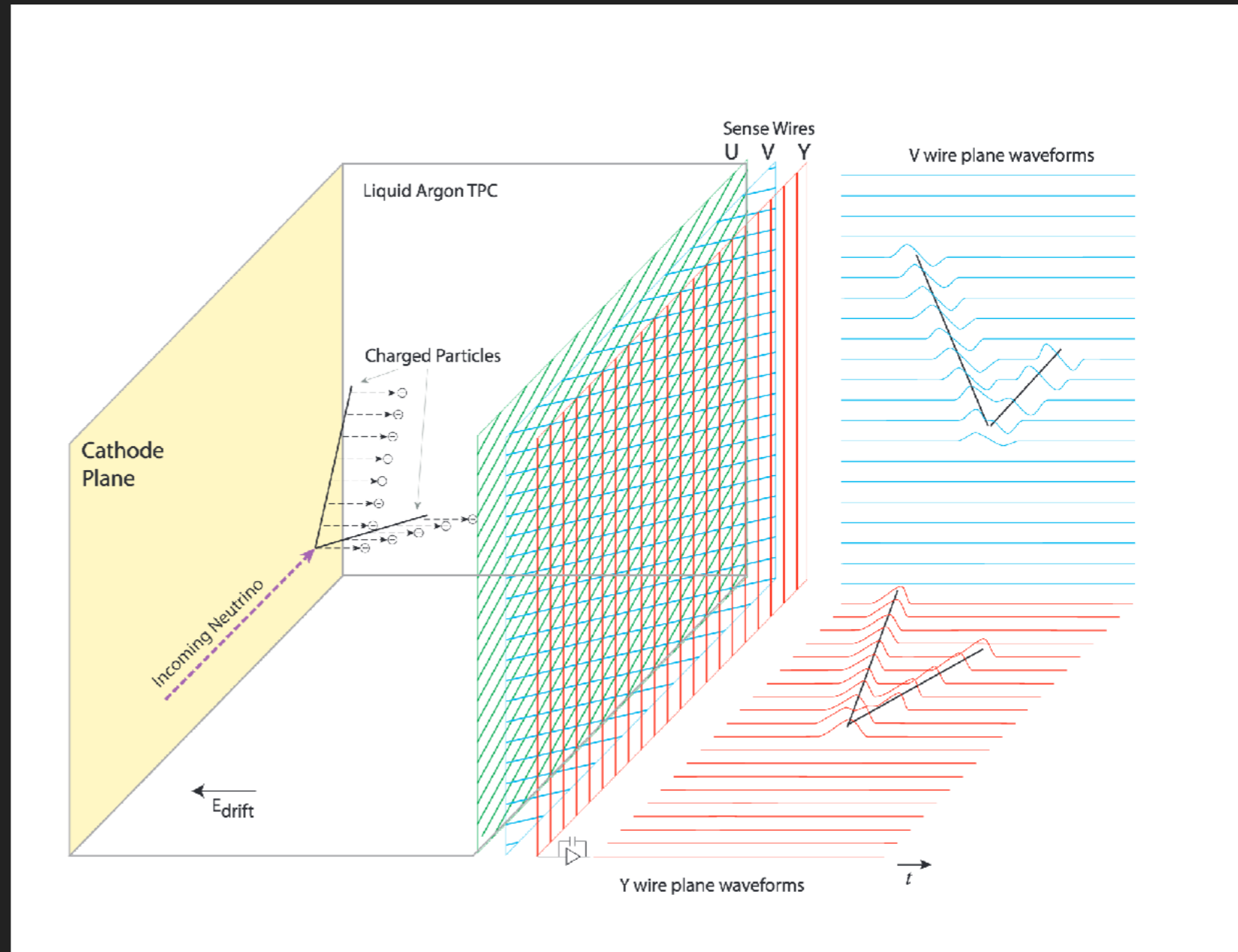
DUNE

- ▶ Deep Underground Neutrino Experiment
- ▶ Neutrino beam from FNAL
- ▶ Far detector 1300 km away
- ▶ Measure neutrino oscillations



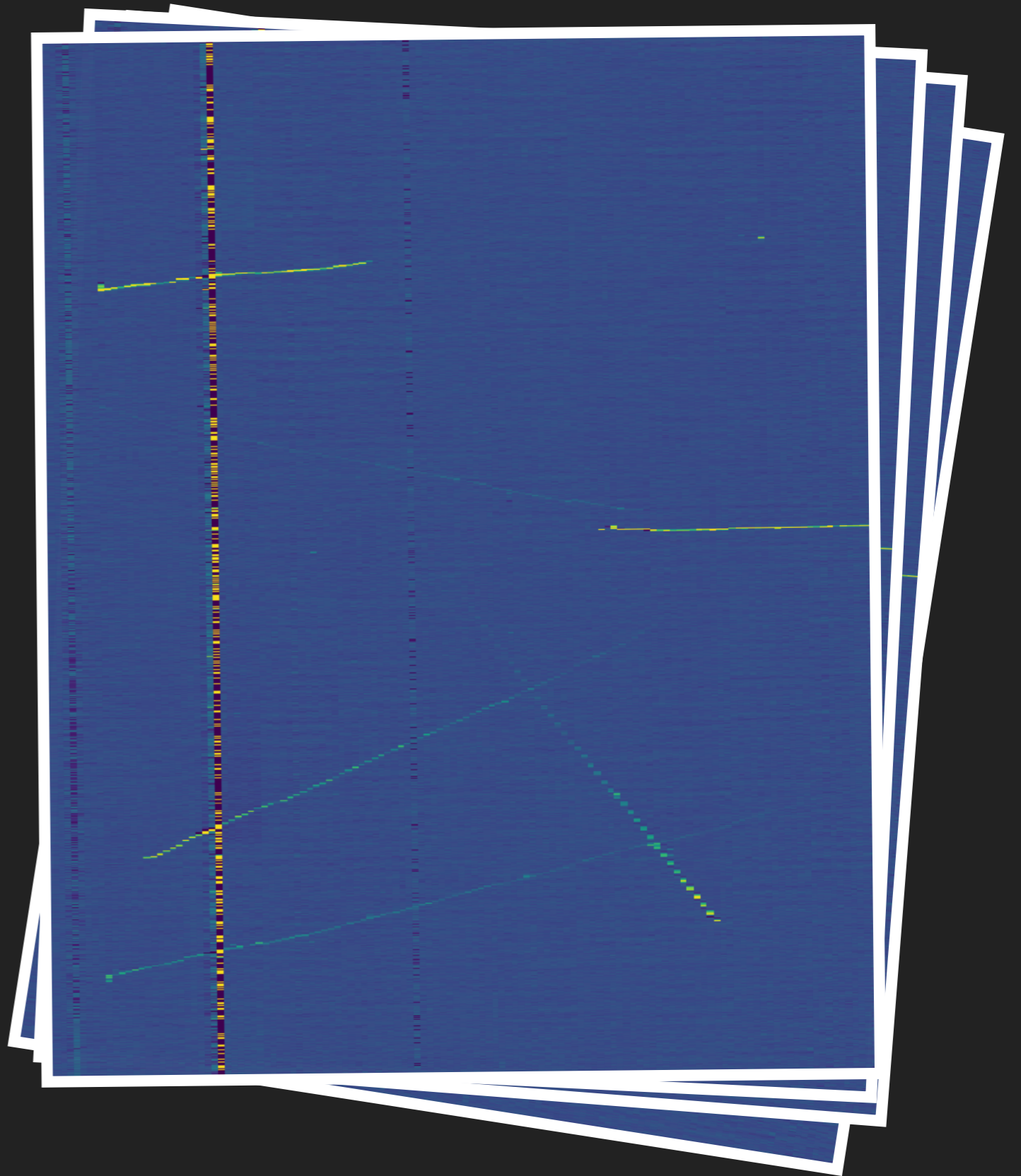
PROTODUNE

- ▶ Working principle: giant time projection chamber
- ▶ Tracks get pulled into wire planes
- ▶ Flashes of light are detected

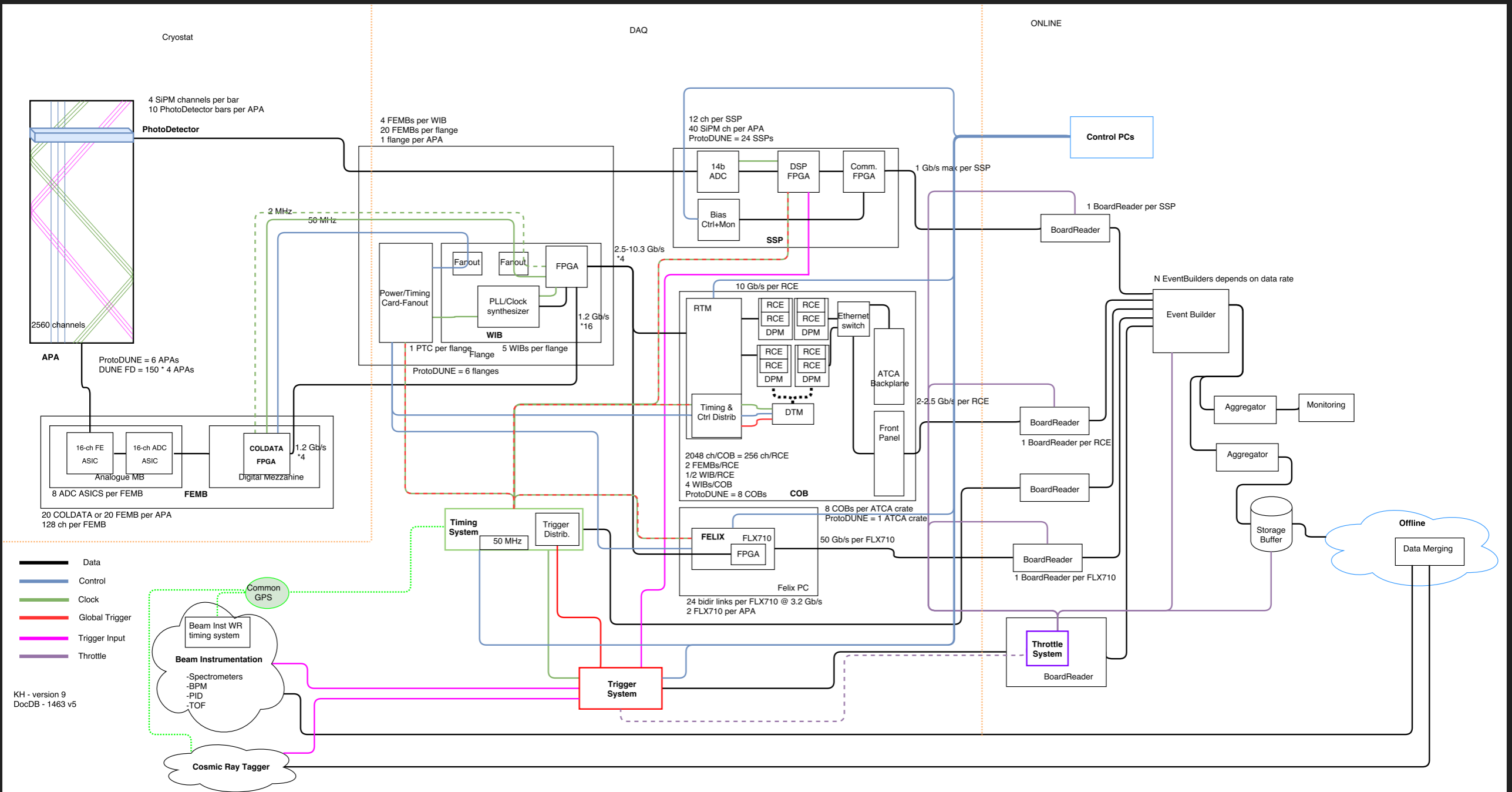


PROTODUNE DAQ

- ▶ Constant pictures of detector interior
- ▶ High data rate: 50 MHz photon, 2 MHz TPC with many wires
- ▶ Lot of DAQ needed



PROTODUNE DAQ



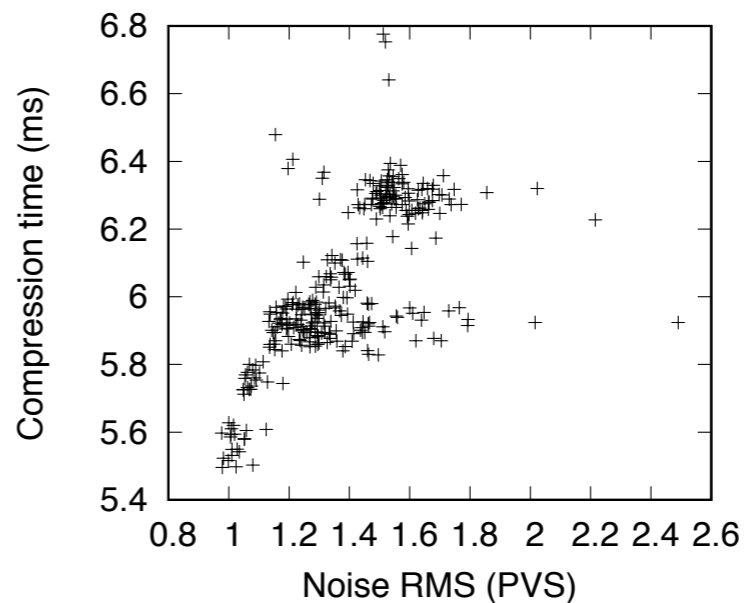
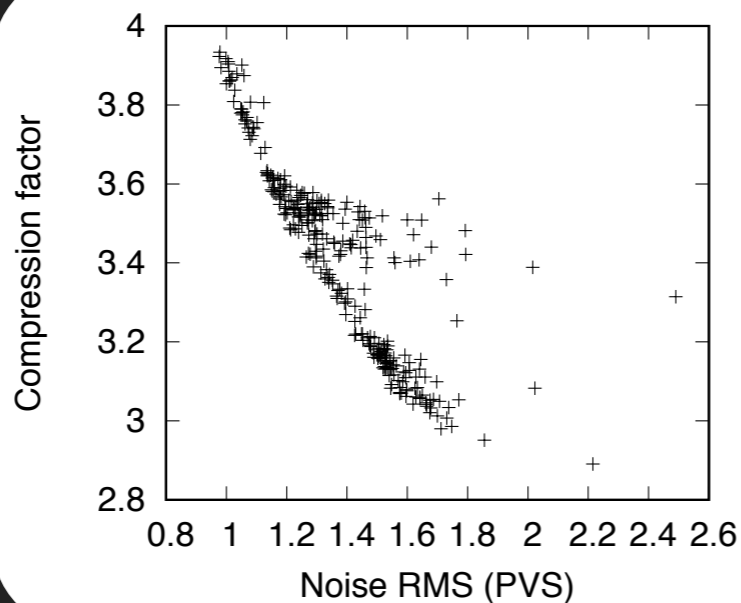
PROTODUNE DAQ

- ▶ FELIX: Front-End Lnk eXchange
- ▶ Find data format
- ▶ Weird data format -> make readable

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	Reserved (8)								SlotNo				CrateNo				FiberNo		Version = 0x1				0x0									
2	WIB Errors																Reserved (14)														OOS	MM
3	Timestamp [31:0]																															
4	Z	Timestamp [62:48] or WIB counter [3]																Timestamp [47:32]														
5	ChkSm B [7:0]							ChkSm A [7:0]							Reserved (8)								Stream 2 ERR				Stream 1 ERR					
6	COLDDATA Convert Count																ChkSm B [15:8]								ChkSm A [15:8]							
7	Reserved (16)																Error Register															
8	HDR8				HDR6				HDR7				HDR5				HDR4				HDR2				HDR3				HDR1			
9	ADC2 CH2[3:0]				ADC2 CH1[11:8]				ADC1 CH2[3:0]				ADC1 CH1[11:8]				ADC2 CH1[7:0]				ADC1 CH1[7:0]											
10	ADC2 CH3[7:0]				ADC1 CH3[7:0]				ADC2 CH2[11:4]				ADC1 CH2[11:4]																			
11	ADC2 CH4[11:4]				ADC1 CH4[11:4]				ADC2 CH4[3:0]				ADC2 CH3[11:8]				ADC1 CH4[3:0]				ADC1 CH3[11:8]											
12	ADC2 CH6[3:0]				ADC2 CH5[11:8]				ADC1 CH6[3:0]				ADC1 CH5[11:8]				ADC2 CH5[7:0]				ADC1 CH5[7:0]											
13	ADC2 CH7[7:0]				ADC1 CH7[7:0]				ADC2 CH6[11:4]				ADC1 CH6[11:4]																			
14	ADC2 CH8[11:4]				ADC1 CH8[11:4]				ADC2 CH8[3:0]				ADC2 CH7[11:8]				ADC1 CH8[3:0]				ADC1 CH7[11:8]											
15	ADC4 CH2[3:0]				ADC4 CH1[11:8]				ADC3 CH2[3:0]				ADC3 CH1[11:8]				ADC4 CH1[7:0]				ADC3 CH1[7:0]											
16	ADC4 CH3[7:0]				ADC3 CH3[7:0]				ADC4 CH2[11:4]				ADC3 CH2[11:4]																			
17	ADC4 CH4[11:4]				ADC3 CH4[11:4]				ADC4 CH4[3:0]				ADC4 CH3[11:8]				ADC3 CH4[3:0]				ADC3 CH3[11:8]											
18	ADC4 CH6[3:0]				ADC4 CH5[11:8]				ADC3 CH6[3:0]				ADC3 CH5[11:8]				ADC4 CH5[7:0]				ADC3 CH5[7:0]											
19	ADC4 CH7[7:0]				ADC3 CH7[7:0]				ADC4 CH6[11:4]				ADC3 CH6[11:4]																			
20	ADC4 CH8[11:4]				ADC3 CH8[11:4]				ADC4 CH8[3:0]				ADC4 CH7[11:8]				ADC3 CH8[3:0]				ADC3 CH7[11:8]											
21	ADC6 CH2[3:0]				ADC6 CH1[11:8]				ADC5 CH2[3:0]				ADC5 CH1[11:8]				ADC6 CH1[7:0]				ADC5 CH1[7:0]											
22	ADC6 CH3[7:0]				ADC5 CH3[7:0]				ADC6 CH2[11:4]				ADC5 CH2[11:4]																			
23	ADC6 CH4[11:4]				ADC5 CH4[11:4]				ADC6 CH4[3:0]				ADC6 CH3[11:8]				ADC5 CH4[3:0]				ADC5 CH3[11:8]											
24	ADC6 CH6[3:0]				ADC6 CH5[11:8]				ADC5 CH6[3:0]				ADC5 CH5[11:8]				ADC6 CH5[7:0]				ADC5 CH5[7:0]											
25	ADC6 CH7[7:0]				ADC5 CH7[7:0]				ADC6 CH6[11:4]				ADC5 CH6[11:4]																			
26	ADC6 CH8[11:4]				ADC5 CH8[11:4]				ADC6 CH8[3:0]				ADC6 CH7[11:8]				ADC5 CH8[3:0]				ADC5 CH7[11:8]											
27	ADC8 CH2[3:0]				ADC8 CH1[11:8]				ADC7 CH2[3:0]				ADC7 CH1[11:8]				ADC8 CH1[7:0]				ADC7 CH1[7:0]											
28	ADC8 CH3[7:0]				ADC7 CH3[7:0]				ADC8 CH2[11:4]				ADC7 CH2[11:4]																			
29	ADC8 CH4[11:4]				ADC7 CH4[11:4]				ADC8 CH4[3:0]				ADC8 CH3[11:8]				ADC7 CH4[3:0]				ADC7 CH3[11:8]											
30	ADC8 CH6[3:0]				ADC8 CH5[11:8]				ADC7 CH6[3:0]				ADC7 CH5[11:8]				ADC8 CH5[7:0]				ADC7 CH5[7:0]											
31	ADC8 CH7[7:0]				ADC7 CH7[7:0]				ADC8 CH6[11:4]				ADC7 CH6[11:4]																			
32	ADC8 CH8[11:4]				ADC7 CH8[11:4]				ADC8 CH8[3:0]				ADC8 CH7[11:8]				ADC7 CH8[3:0]				ADC7 CH7[11:8]											

PROTODUNE DAQ

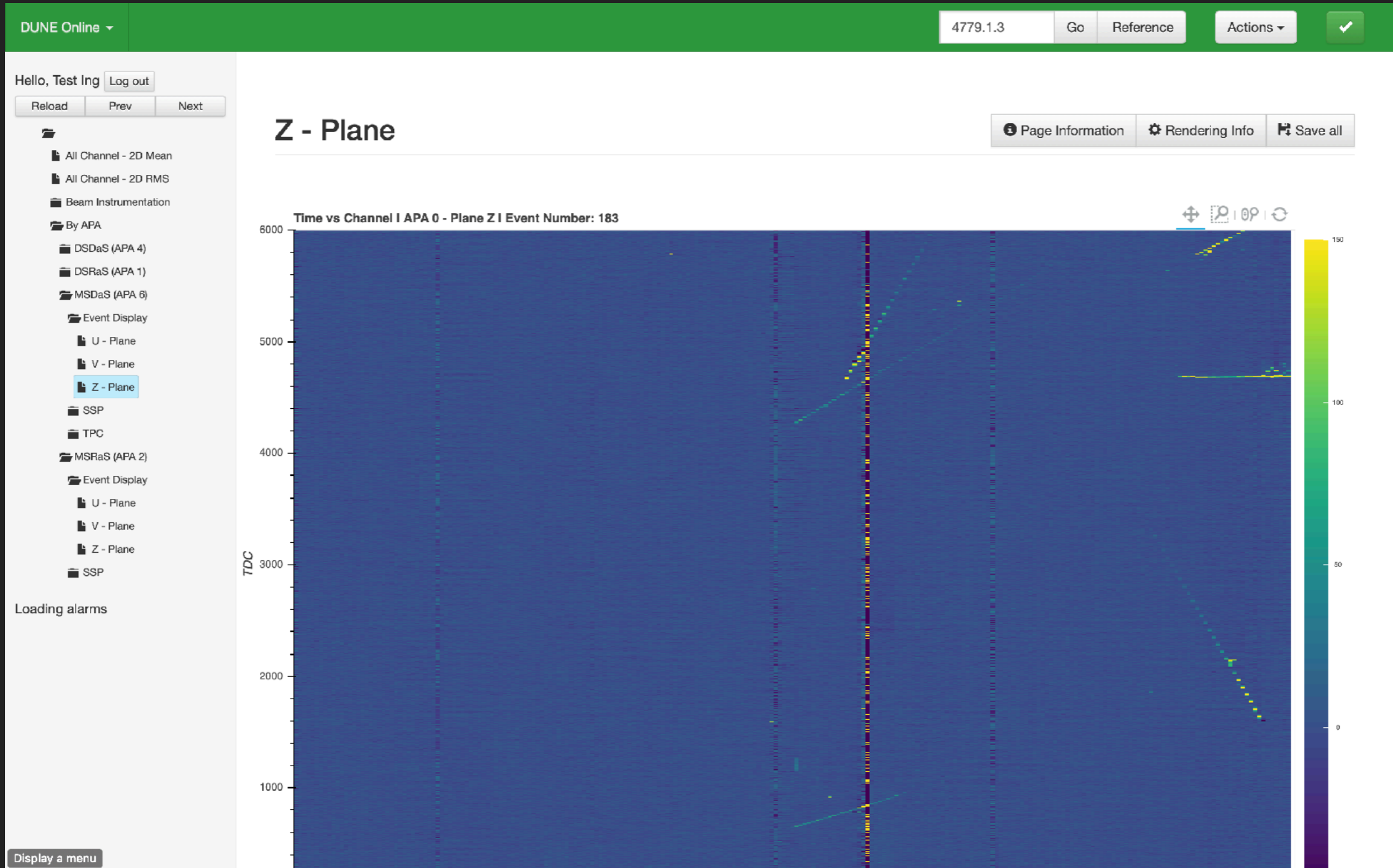
- ▶ Need compression factor 4 in <40 ms
- ▶ Try software compression -> too slow
- ▶ Try hardware compression -> not good enough
- ▶ Combination between software reordering and hardware compression



PROTODUNE DAQ — MUCH MORE

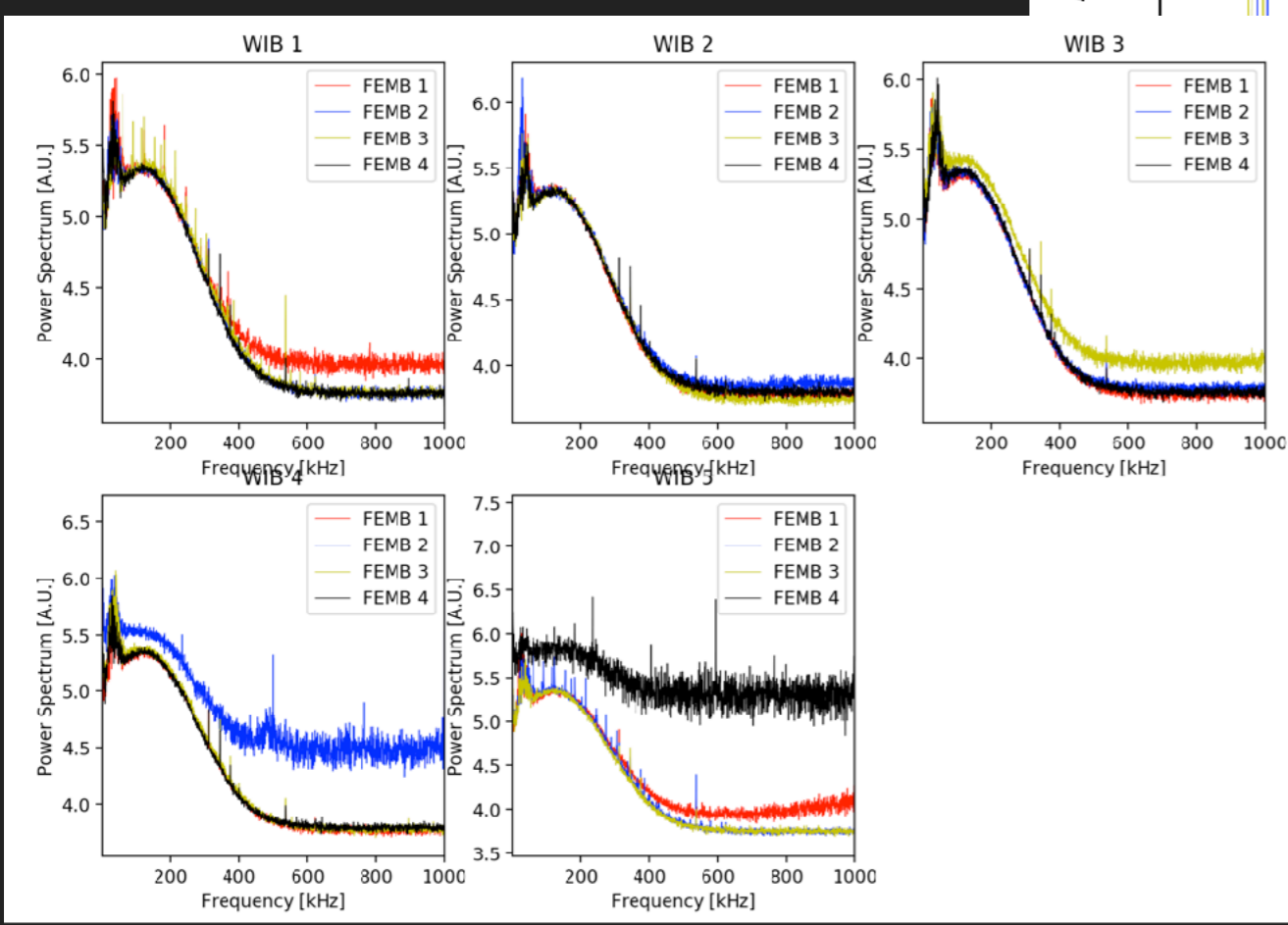
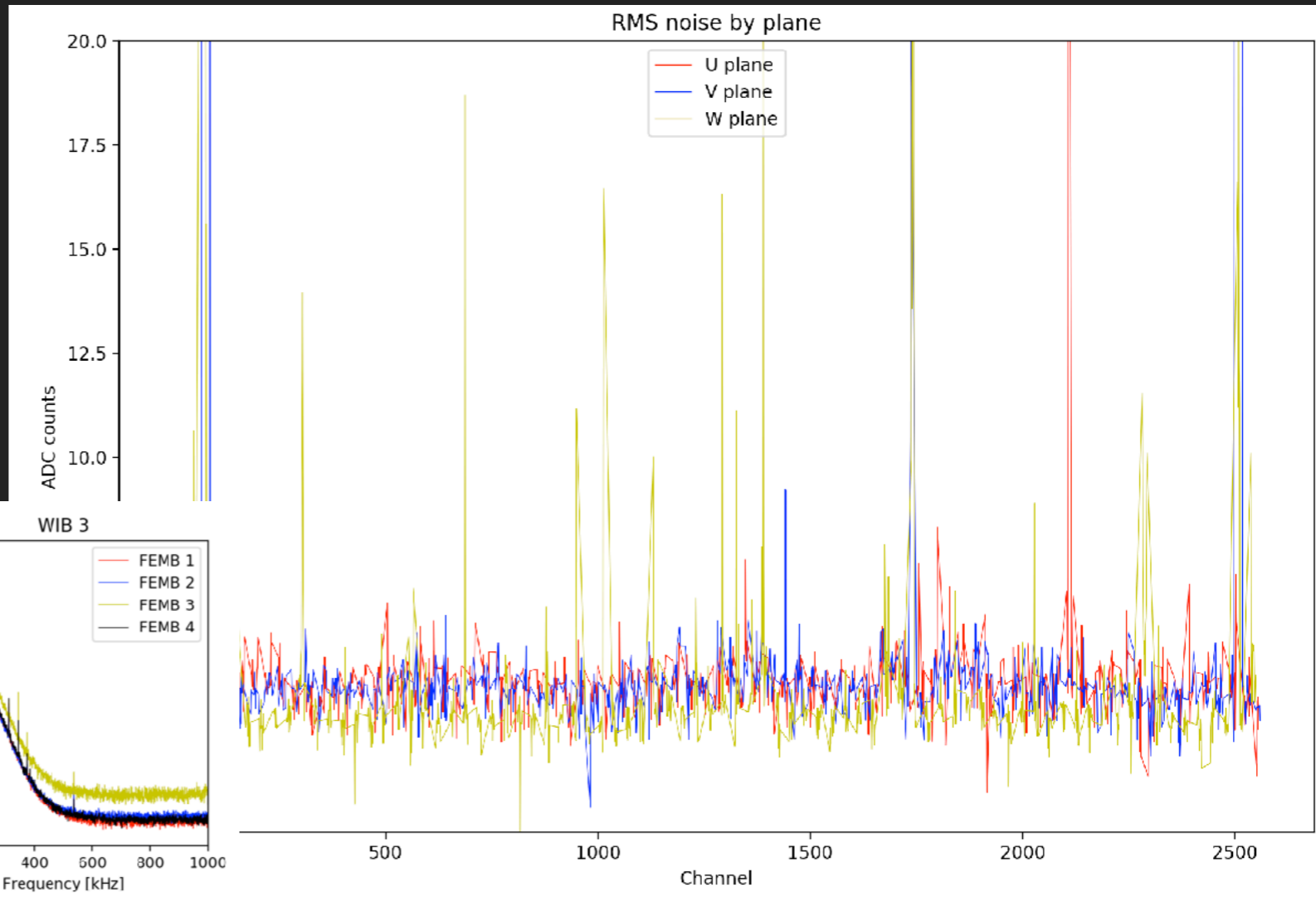
- ▶ Online monitoring
- ▶ Data integrity monitoring
- ▶ Noise analyses
- ▶ Handling various data formats dynamically
- ▶ Many bugs and features
- ▶ Wrestling with custom build frameworks on closed servers

PROTODUNE DAQ — ONLINE MONITORING



PROTODUNE DAQ — DQM AND NOISE STUDIES

```
INPUT METADATA: 6024 0 0 500 6000
FRAGMENT SIZE: 2795136 BYTES OR 6024 RAW FRAMES.
INPUT METADATA: 6024 0 0 500 6000
FRAGMENT SIZE: 2795136 BYTES OR 6024 RAW FRAMES.
INPUT METADATA: 6024 0 40 500 6000
FRAGMENT SIZE: 2795136 BYTES OR 6024 RAW FRAMES.
INPUT METADATA: 6024 0 40 500 6000
FRAGMENT SIZE: 2795136 BYTES OR 6024 RAW FRAMES.
INPUT METADATA: 6024 0 0 500 6000
FRAGMENT SIZE: 2795136 BYTES OR 6024 RAW FRAMES.
INPUT METADATA: 6024 0 0 500 6000
FRAGMENT SIZE: 2795136 BYTES OR 6024 RAW FRAMES.
Calculating noise RMS values per channel.
```



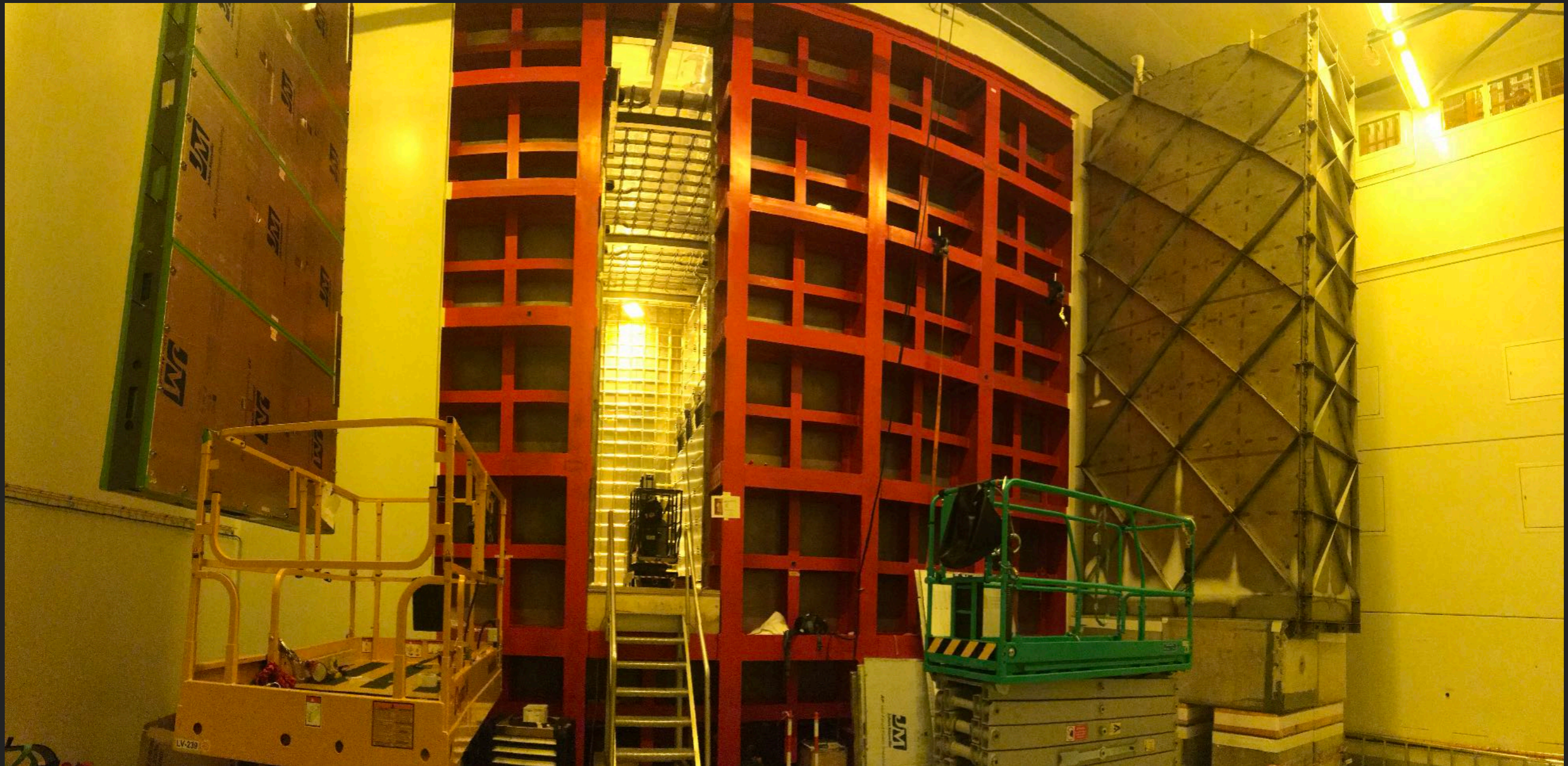
BUILDING PROTODUNE

- ▶ Nothing officially my responsibility, but helped with:
- ▶ Ground plane assembly
- ▶ Photon detector testing
- ▶ Shifts during anode plane testing and beam run
- ▶ Various bits and bobs

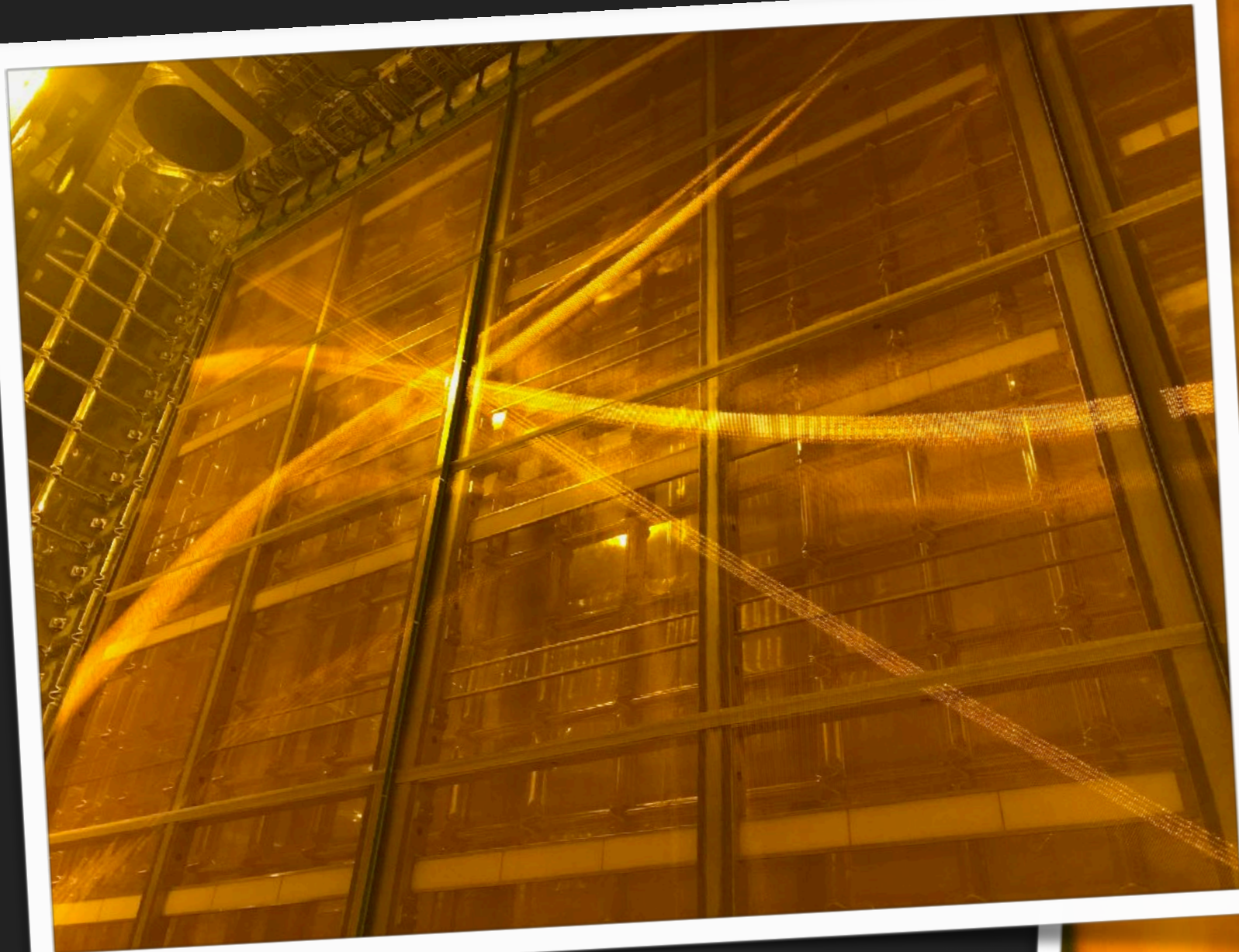
BUILDING PROTODUNE



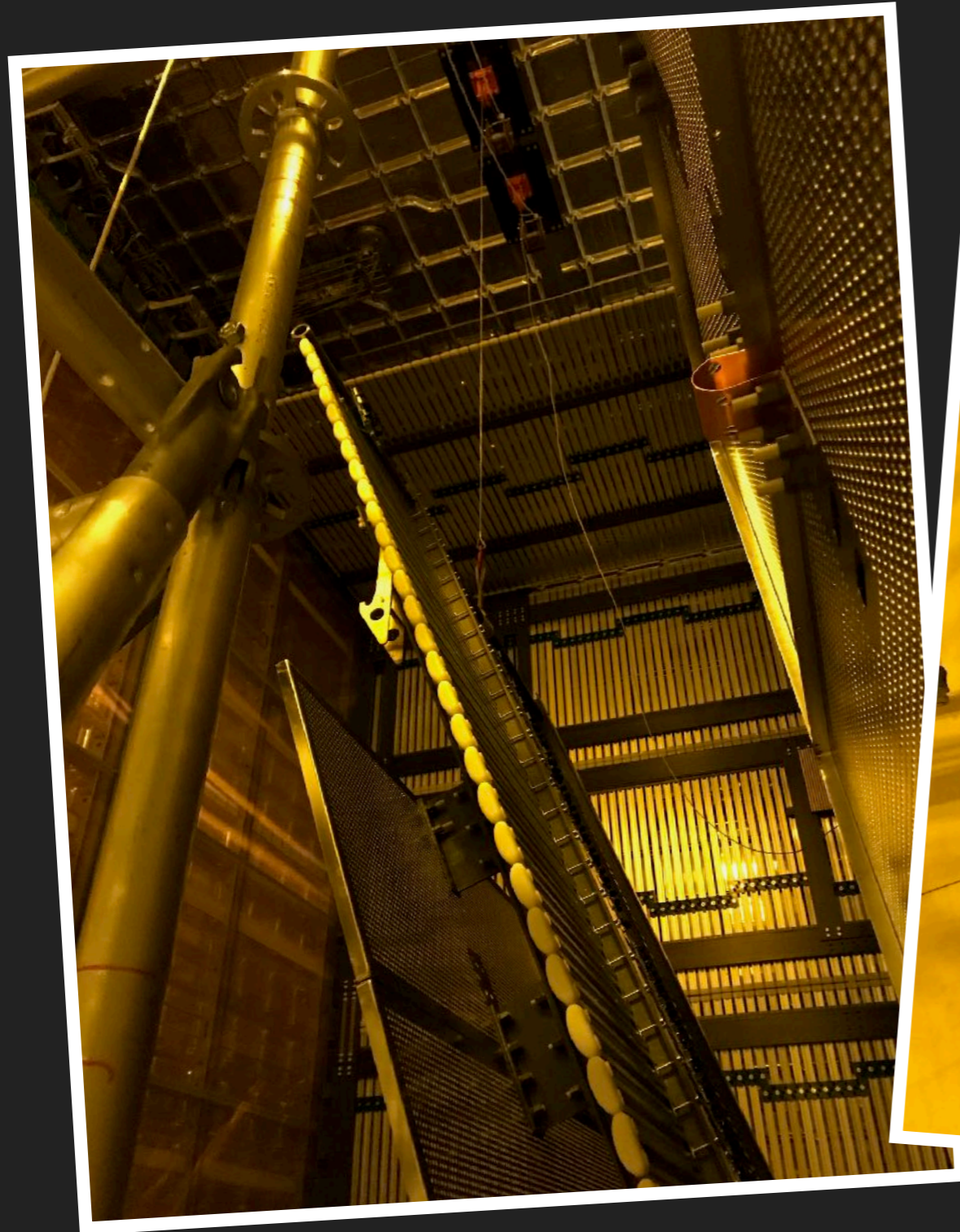
BUILDING PROTODUNE



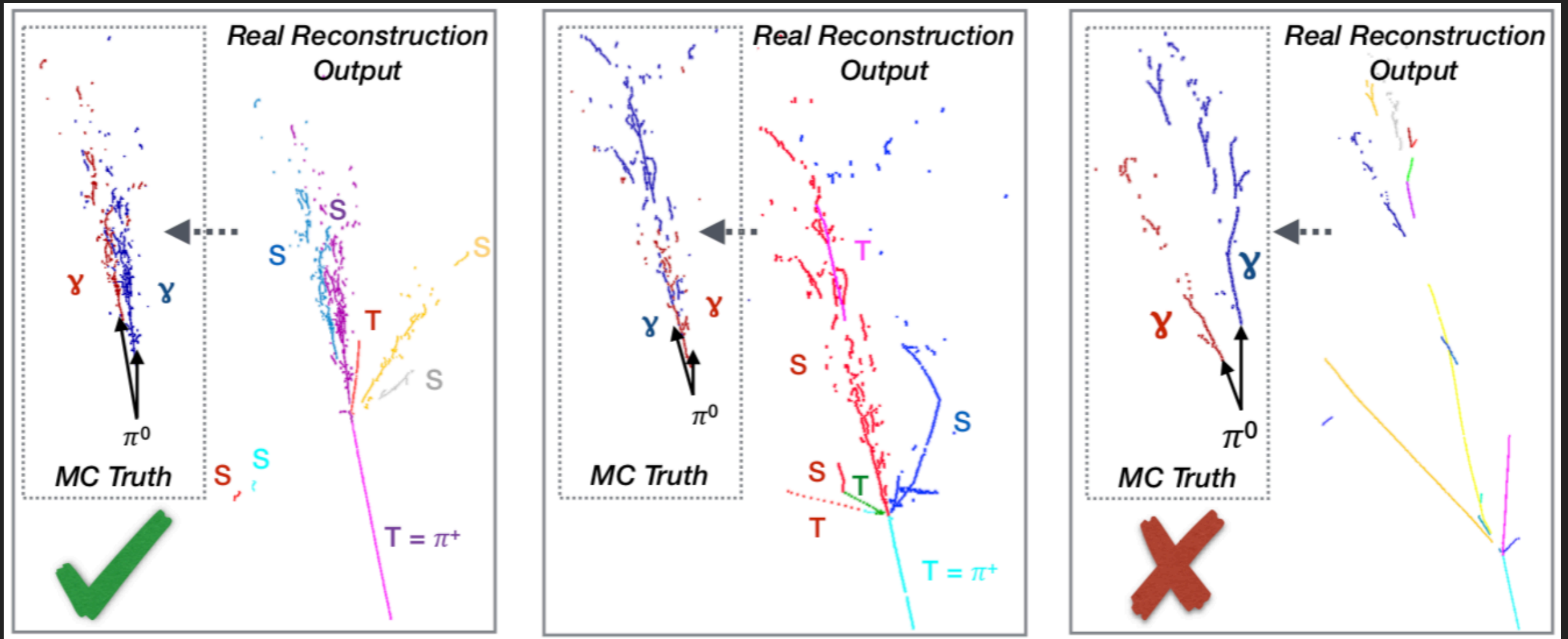
BUILDING PROTODUNE



BUILDING PROTODUNE

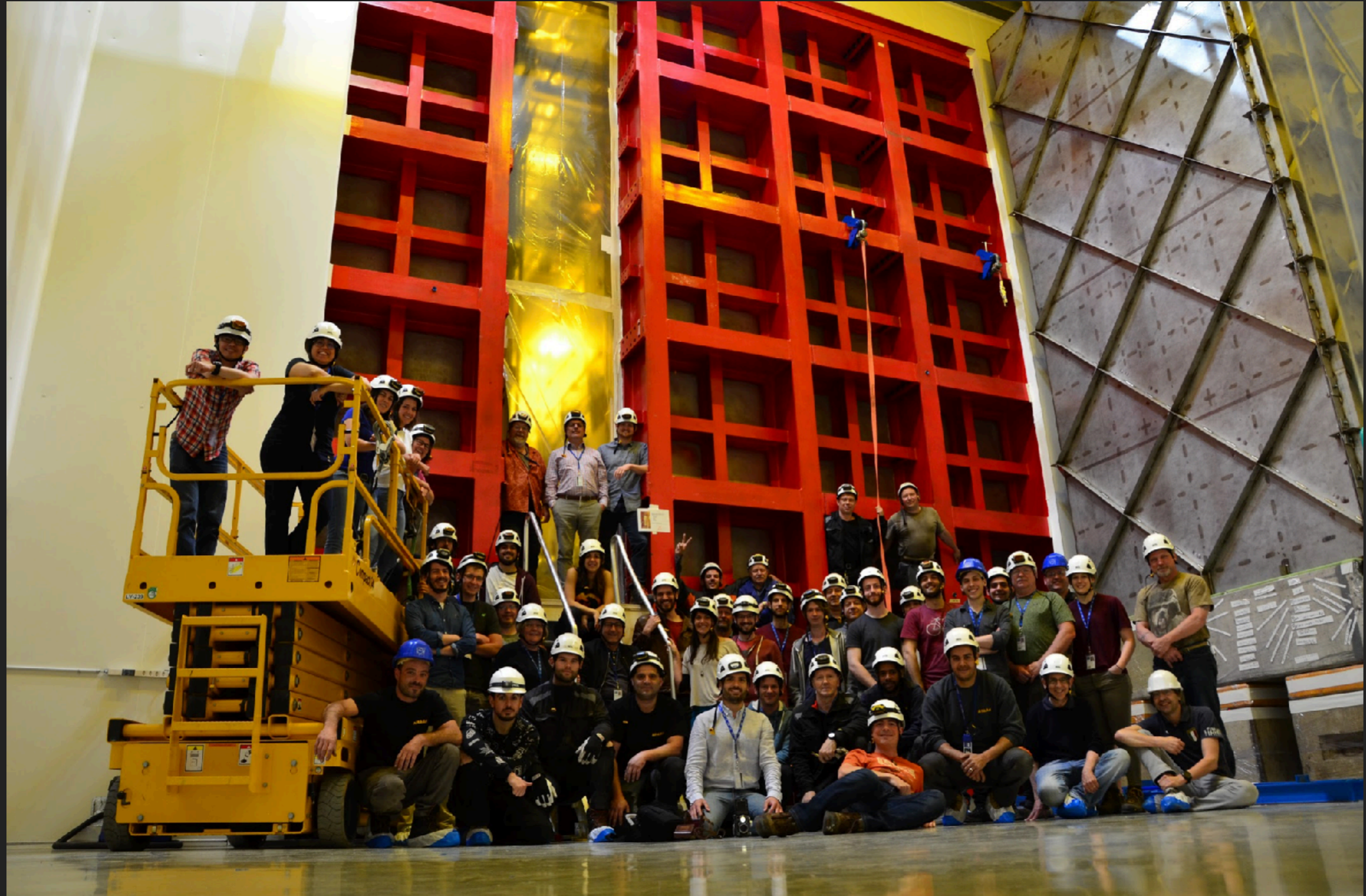


PHYSICS — π^0 -REJECTION



Events analysed by Steven Green

CONTACTS AND COMMUNITY



SUMMARY

- ▶ Colleagues
- ▶ DAQ with FELIX
- ▶ Physics in π^0 -rejection
- ▶ Amazing group