

APA Activities Update

Christos Touramanis

DUNE-UK Meeting

Lancaster, 12/01/2023



Key points

- UK-US scope adjustments, MOU
- Production schedule
- Daresbury Factory
- Documentation, procedures, EDMS, Hardware database, Redmine, Elog
- APA 1-4 tested at CERN, ProtoDUNE II TPC is assembled (4 APAs, 3 from the UK)
- Transportation of APAs: First DUNE elements to be lowered in the Ross shaft!
- Challenges

UK-US scope assignment

- The UK will construct **134** APAs at Daresbury.
 - Four winders plus fifth one on its way from PSL.
- The US will construct **14** APAs at Chicago, with the possibility to assemble a few more.
- The UK will supply frames, geometry boards, grounding mesh panels, combs.
- The US will manufacture 160 sets of: CR boards, G bias boards, CE adapter boards, cable harnesses, SHV boards, and procure the capacitors required.
- **10%** of APAs will be cold-tested at CERN.
- All APAs will be inspected and stored at Fermilab, then shipped to SURF.
- The APA MOU Annex draft is almost final, already signed by the consortium.
- Integration and Installation at SURF resources is an open issue.

Production schedule

	2022	2023	2024	2025	2026
Daresbury	4	25	30	35	40
Chicago		2	4	4	4

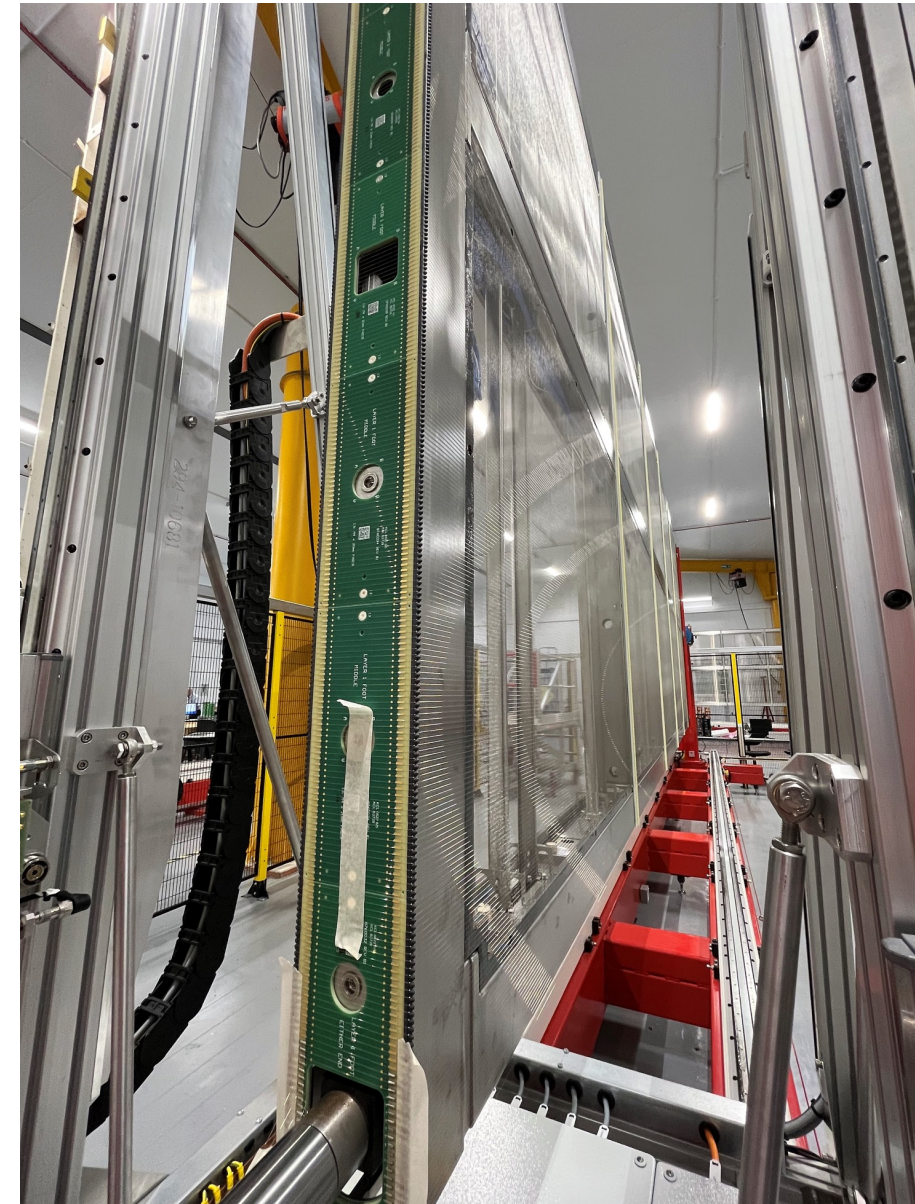
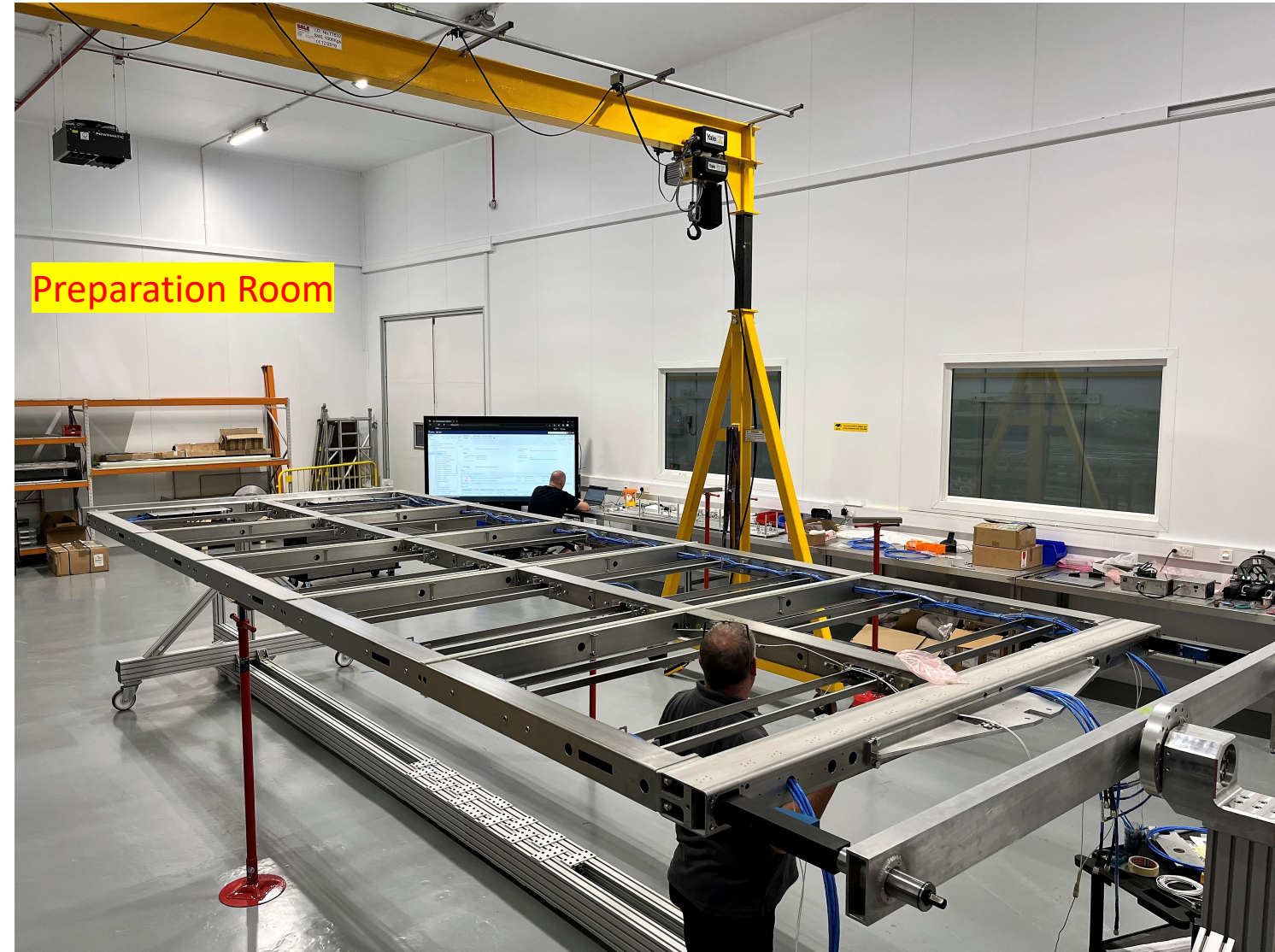
- 148 APAs will be made in addition to the 4 already at CERN for ProtoDUNE II.
- This gives us 150 + 2 spares for FD1.
- The last APAs will ship from Daresbury in January 2027.
- The Chicago schedule is conservative. We could implement gains in assembly time developed at Daresbury to make 2 or more extra APAs from UK-sourced parts if the FD1 schedule requires that.

Daresbury factory: 4 operating winders, 5th on its way.



Winding Room

Daresbury factory



Daresbury factory



Documentation, database, collaboration tools

- All the APA project documents are on CERN **EDMS**
 - Models, drawings, production documents, procedures, QA/QC, non-conformances, tenders and contracts, Project management and Risk Management, ProtoDUNEs, Reviews, Shipping ...
- Our own **hardware db** is live and used in production; data will be ported to DUNE db.
- We use FNAL **Redmine** to track open issues.
- We have our **production Elog** at Wisconsin.
- APA tests at CERN are on the **ProtoDUNE Elog**.
- Each APA has all details in the database; a summary “traveler” extracted from that and stored on EDMS; a non-conformance report on EDMS; a set of notes on the Elog.

- Navigator**
- No active tags.
- SP APA consortium
 - 3D Models
 - Part Drawings
 - Production Documents
 - Procedures & Quality Assurance and Quality C
 - Parts
 - Pre-production Procedures
 - Production Procedures
 - 2616181 (v.2) Board installation
 - 2616182 (v.3) Wiring
 - 2616201 (v.1) Epoxy dispensing
 - 2616203 (v.2) Comb installation
 - 2694261 (v.1) Procedure for Broken Wi
 - 2694262 (v.1) Procedure for an Unantic**
 - 2703968 (v.3) Lifting
 - 2703976 (v.1) APA survey
 - Post-production Procedures
 - Travelers
 - Shipping
 - Procedural Change Records
 - 2615584 (v.4) APA identifiers
 - 2615586 (v.3) Fastener Torque Specificatio
 - 2711796 (v.1) APA QA-QC Plan
 - Non-conformance and Root Cause Documenta
 - Tenders and contracts
 - Risk assessments and certifications
 - Project management
 - ProtoDUNE I Documents - Historical Record O
 - Grounding Diagram
 - Wiring Diagrams
 - Printed Circuit Boards
 - Interface Documents
 - Engineering notes
 - Instrumentation
 - Requirements
 - APA Reviews
 - Installation Procedures

2694262 v.1 Released Public access
Procedure for an Unanticipated Event During APA Assembly by BRIAN JAMES REBEL

Engineering/Technical Report

Created on 2022-02-09
 Last Modified on 2022-03-16

Edit Status Share Visibility More

Info

Description: The procedure to follow when an unanticipated event occurs during the process of assembling an APA
 External reference:
 Keywords:

Details

Local administrators: [List of Administrators](#)
 Context: CENF-LBNF-DUNE
 Associated Links:
 Equipment code:
 Release procedure: DOC-AL
 Approval by Approval Leader with Engineering Check
 CDN Links:

This page <https://edms.cern.ch/document/2694262/1>

Files

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Name	Size	Last modified date	Last modified by
APA_Assembly_Unanticipated_Event_Procedure.pdf	29.5 KB	2022-02-09 19:58:36	BRIAN JAMES REBEL

Page 1 of 1 Total: 1 (displaying 1 - 1)

More info

Sub-Documents Used In Approval & Comments Access rights Versions History

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#	Id	Title	Files	Status	Created on	Author	Document type	Tags
No documents								

Page 1 of 1 No data to display

APA Hardware database

Component Types			
Available Component Types			
Type ID	Type Name	Component Count	
APAFrame	APA Frame	13	✂ Create New Component of this Type
AssembledAPA	Assembled APA	4	✂ Create New Component of this Type
BoardShipment	Board Shipment	105	✂ Create New Component of this Type
GeometryBoard	Geometry Board	5525	✂ Create New Component of this Type
GeometryBoardBatch	Geometry Board Batch	135	✂ Create New Component of this Type
GroundingMeshPanel	Grounding Mesh Panel	80	✂ Create New Component of this Type
ToothStripBatch	Tooth Strip Batch	0	✂ Create New Component of this Type

APA Hardware database: Frame record

Component UUID

18d39320-3f3c-11ed-b81f-b9435835fed2

Copy

Component Name

D00300200001-00001-US200-010000

Short UUID

44NWu5kNUTDLwEHw2fQhoo

Component Data:

This is version 3 of the component, and it was last edited on September 28th 2022, 3:05:25 PM by [Brian Rebel](#)



Frame Production Location *

Wisconsin

Which institution or company made the frame?

Frame Number *

1

Of the frames to be made at this location, which number is this one?

DUNE PID

D00300200001-00001-US200-0100

High Slot Beam Serial Number

1101

Format of the serial number:

UK: 44-6-0001-1-HS

US: 1234

High Slot Beam Drawing Number

8760013 Rev C

Center Beam Serial Number

1102

Center Beam Drawing Number

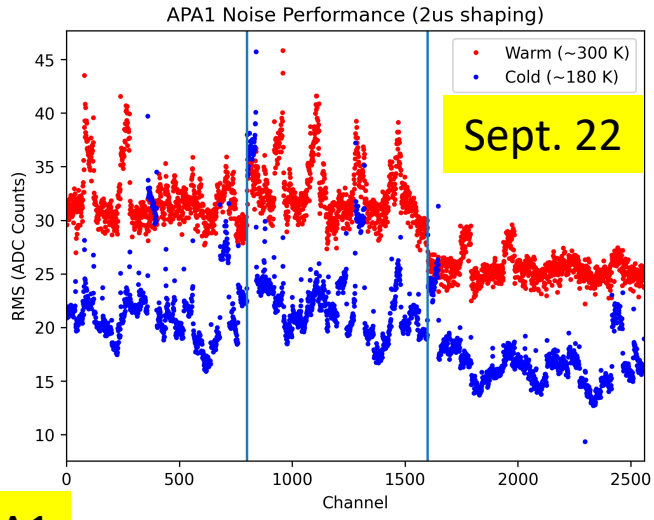
8760016 Rev -

ProtoDUNE II APAs

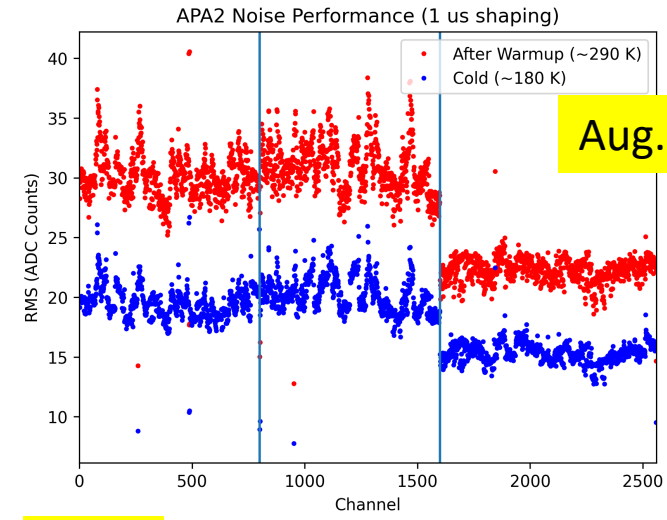
	Frame	Assembly	Geom. boards	Orientation	Cold Box
APA 1	USA	UK	USA	Top	June, September
APA 2	UK	UK	UK	Top	June, August (x4)
APA 3	UK	UK	UK	Bottom	Ongoing
APA 4	USA	USA	USA	Bottom	September

Cold Box test results (noise at warm and cold)

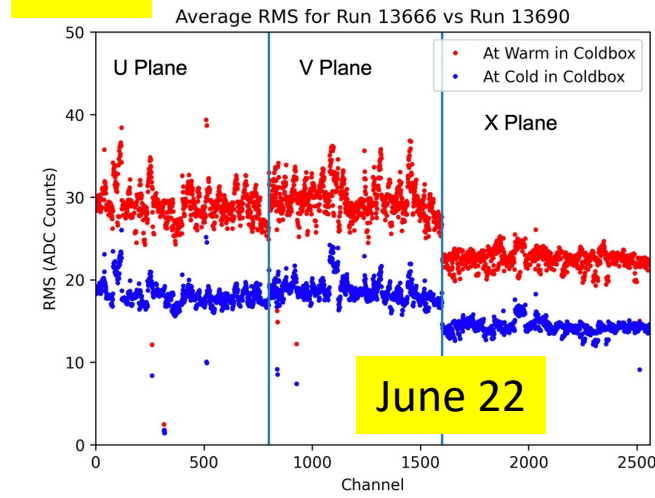
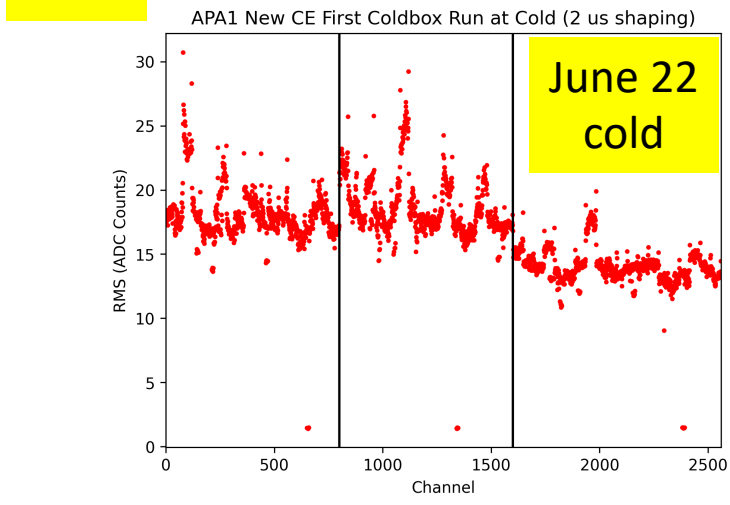
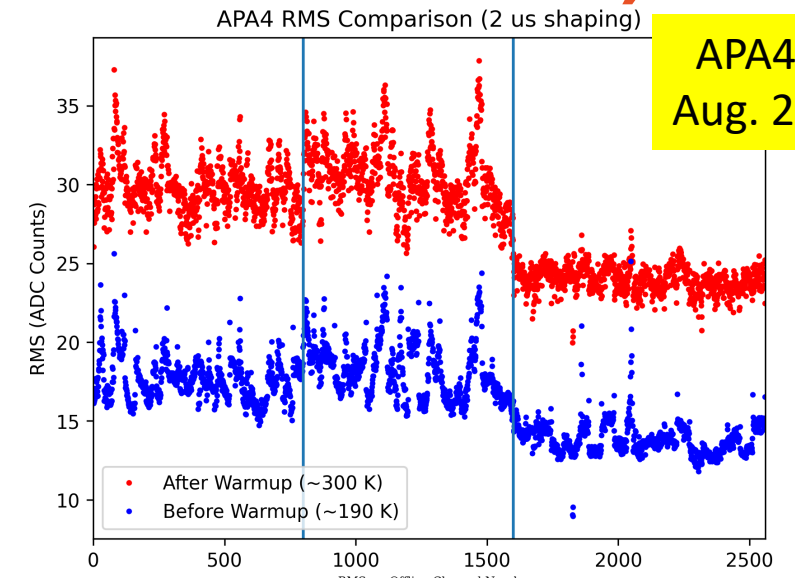
APA1



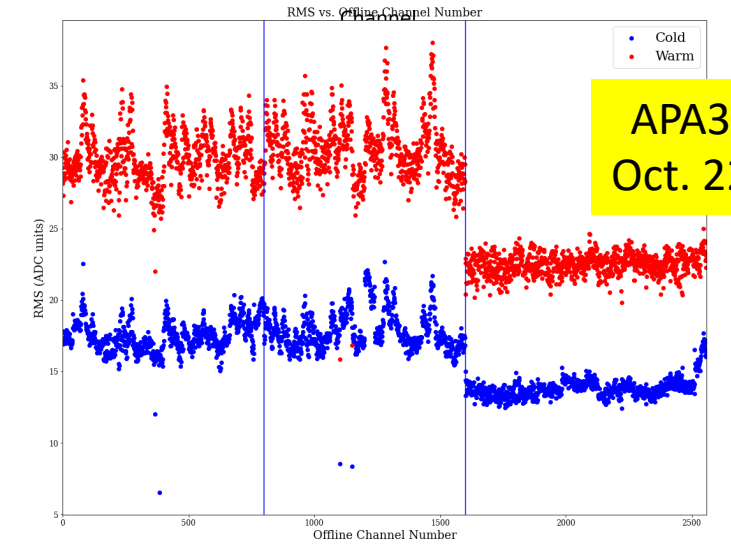
APA2



APA4
Aug. 22



APA3
Oct. 22



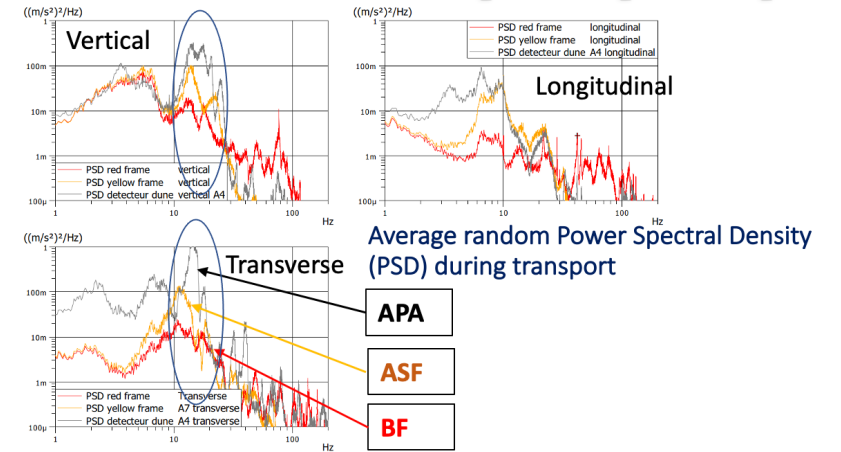
APA transportation

- Yellow : ASF
 - Holds two APAs
 - Packed at the factory, going all the way down the shaft to the FD1 integration room.
 - Loaded and transported horizontal, rotated vertical for lowering in the shaft and for unloading.
- Red: base frame
 - Used during transportation (boat, truck).
 - Isolated from the ASF with 8 wire shock absorbers.
- Three prototypes built (1 at CERN, two in the UK), two more are on order from an EU company.



Analysis and validation

- Static and dynamic analysis of APA, ASF, combined.
- Analysis mainly done by our CERN team.
- Two old (ProtoDUNE) APAs were loaded in the prototype and then on a truck, equipped with accelerometers.
- Truck driven inside Prevesin campus and to CMS.
- Measurements used to validate analysis parameters and results: the absorbers are stiffer for low force excitations than specified, but fine for high loads.
- One absorber was destructively tested as part of the validations.



ProtoDUNE APAs underground at SURF

- The test shipment went from CERN to Liverpool via truck and ferry.
- Data were analysed and the APAs and the ASF were inspected.
- Then the shipment went from Liverpool port via RoRo to Baltimore, from there on a truck to Fermilab.
- ASF and APAs checked, data found OK, DWA wire measured.
- In November the shipment went from Fermilab to SURF.
- The ASF with the two APAs was lowered in the Ross shaft to the 4850 level, and brought back up to the surface: Success!
- **The first DUNE scientific equipment to go underground at SURF**
- Operation was very smooth, different speeds of descent tried, emergency stops also.



Challenges

Ramping up from prototype to series production always takes time.

1. Production rate still very slow

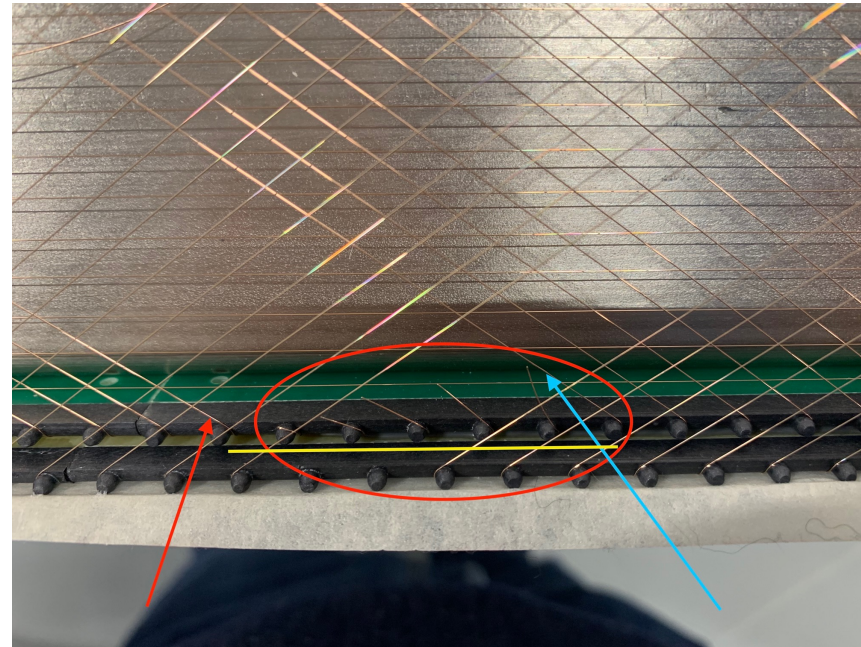
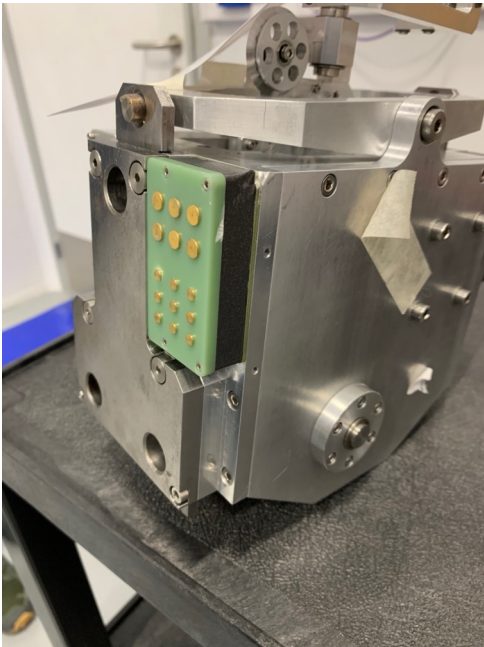
1. Teething problems with winder controls (ongoing work to improve safety and accuracy)
2. Training of staff
3. Management of the team (Manchester hiring a detector physicist; one more to be hired from Liverpool)
4. Hiring and retention of technicians (need 16; 2 resigned before Christmas; have 9; hiring again)
5. Frame assembly to tolerances (very near to solution in problems with second steel batch)

2. Quality concerns

1. ProtoDUNE APA 2 has the most bad channels (17 of 2560) of any APA so far.
2. UK ProtoDUNE APAs have higher sensitivity in the head stacks to ambient humidity: current leaks at warm. Tests ongoing at Cambridge and Manchester.
3. Five broken wires on APA 4 following winder incident in November: procedures updated.
4. One wire broke loose from head board on APA 3 in ProtoDUNE (TBC). Under investigation.

APA 4 winder incident

- Winder head driven into winder frame.
- While dismantling head movement system wires were broken on the APA.
- Winder now fixed.
- APA4 has 6 missing V wires.

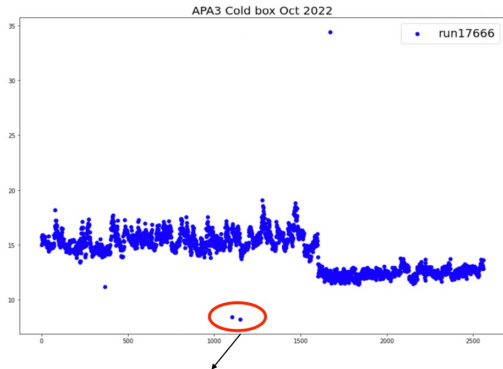


APA 3 broken V wire (I)

- **Mid-October** cold box runs show noise as expected for connected wires.
- **17 and 18 November** photos show the wire in place.
- **23 November** the wire appears disconnected (low noise) in first cryostat CE run, but no wires have very high noise (happens when wires are shorted).
- **28 November** the wire appears in place in a photo taken for independent purpose.
- **7 December** the wire is noticed to have broken free from at the headboard and curled between the other APA wires.
- **9, 11, 12 December** CE runs show a few very high (shorted) wires which are not always the same: broken wire moving and touching different wires (?)

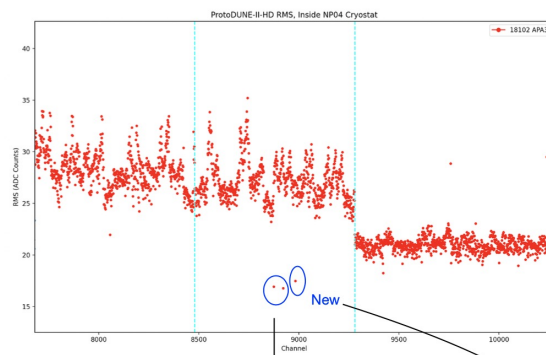
APA 3 broken V wire (II)

One of the last APA3 cold box on Oct 2022



Offline Channels	FEMBs
1102	FEMB 8, ch 72
1149	FEMB 9, ch 106

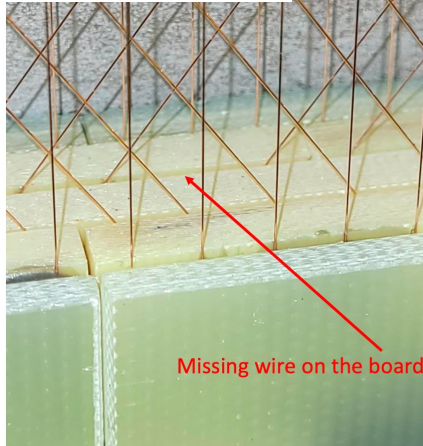
First cryostat run, Nov. 23 2022



Offline Channels	FEMBs
8922	FEMB 8, ch 72
8875	FEMB 9, ch 106
8983	FEMB 7, ch 54

Newly Broken wire location:
V2 wire on adapter board 7

*FEMB channels are raw data channels not U, V, X channels



Conclusions

- DUNE APAs are under construction.
- The whole chain of construction – transportation – tests has been demonstrated.
- A lot of work ongoing, a lot of pressure to ramp up to expected production speeds.

- Many thanks to all involved at Daresbury, Manchester, Liverpool, Lancaster, Sheffield, Cambridge, Sussex for sustained efforts to get us to where we are currently.

- Many opportunities to experience (and help) in APA assembly at Daresbury and APA testing at CERN in the coming years: watch this space!