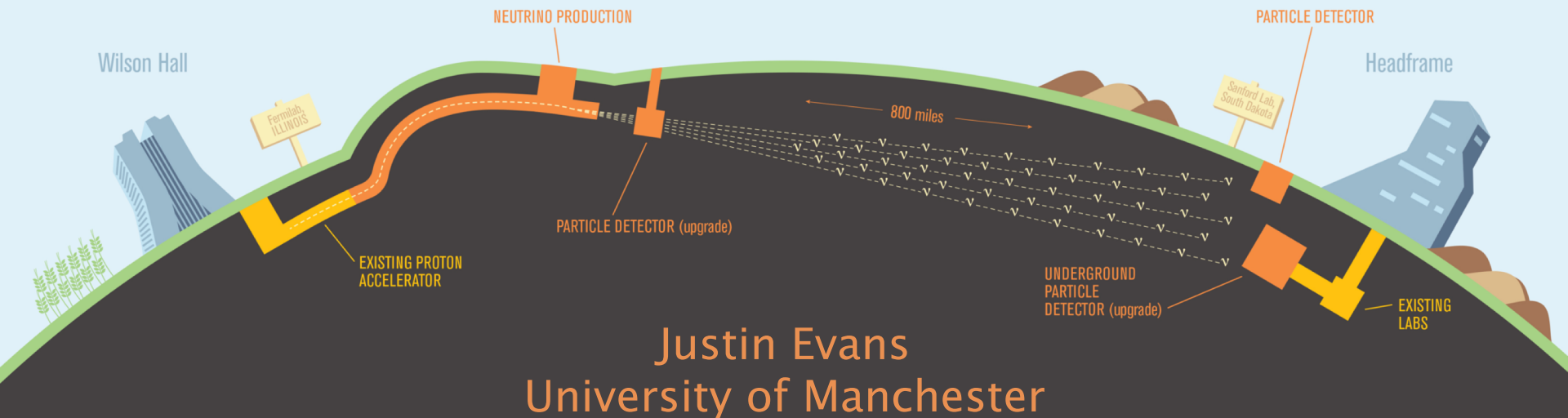


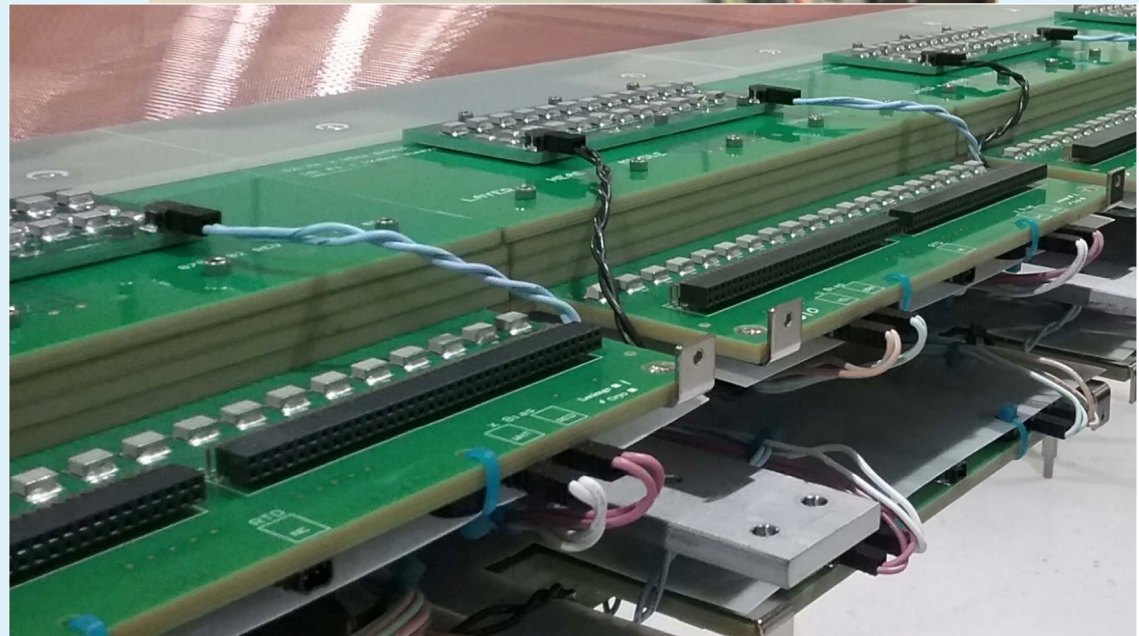
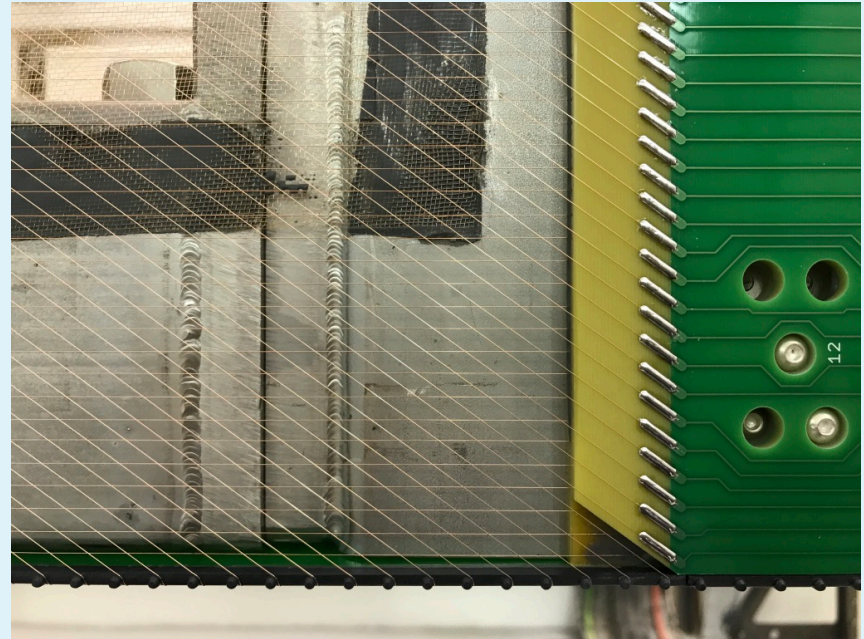
Requirements on APA Boards



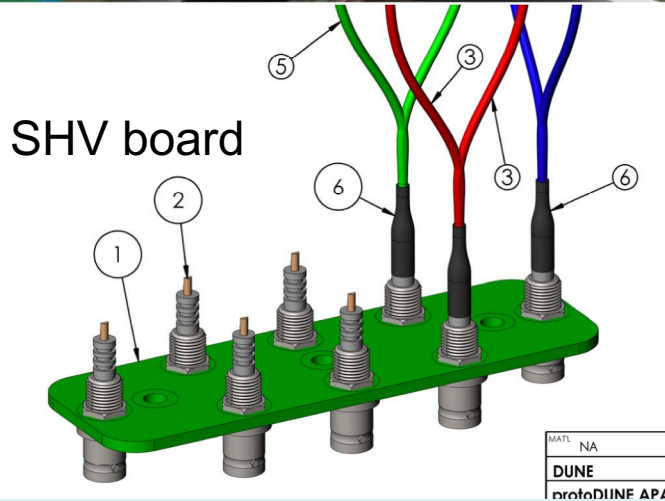
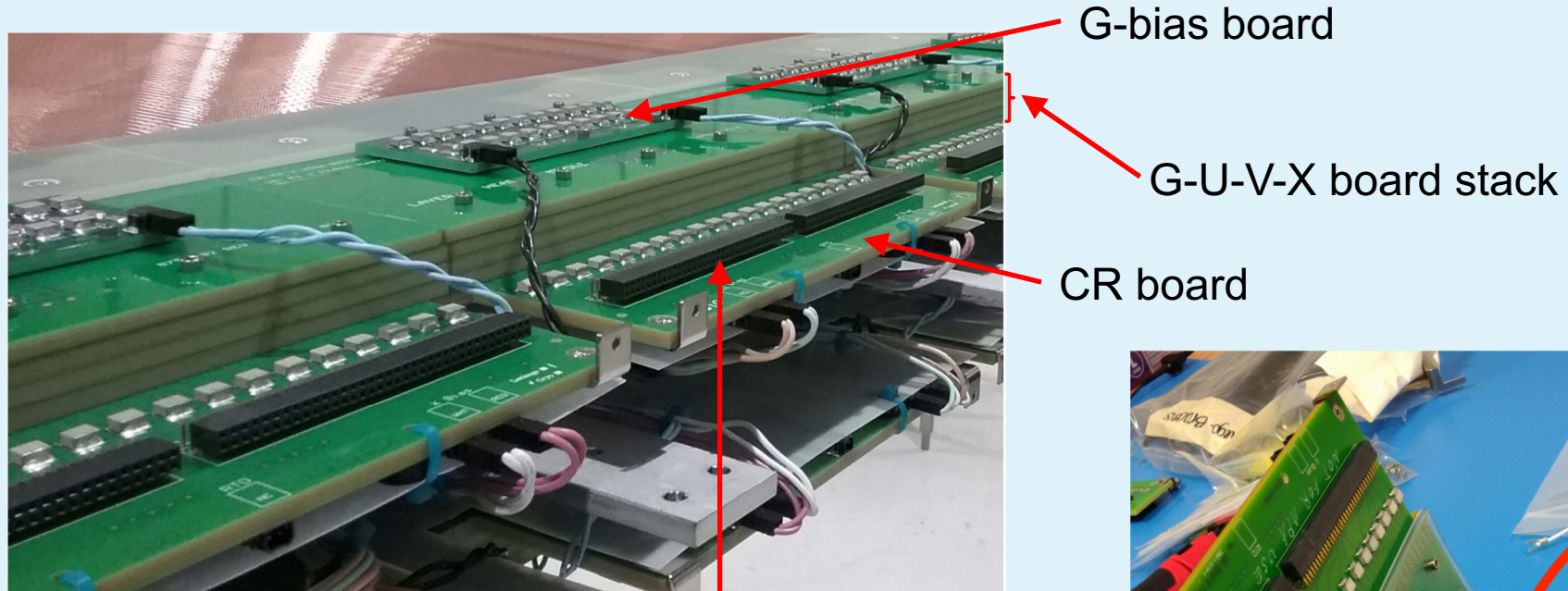
Justin Evans
University of Manchester

APA boards

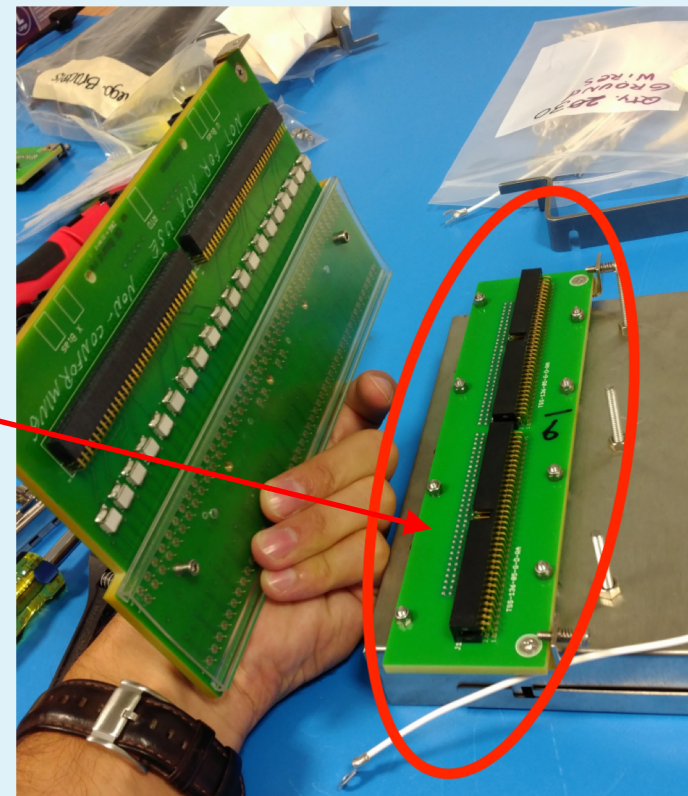
- Geometry boards
- G-bias boards
- CR boards
- Adaptor boards
- SHV boards



Head-end board stack



Adaptor board connects on here

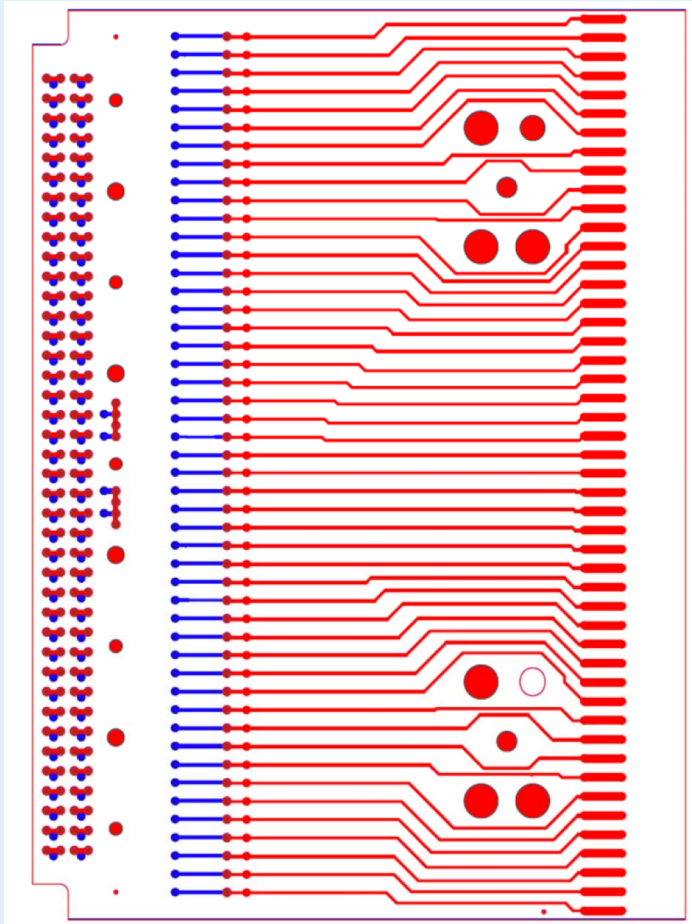


Boards required

- This is the ProtoDUNE board spreadsheet, but I don't think anything has changed

Type	Number for one APA
V side board - end	4
V middle side board w/slot	14
V middle side board w/o slot	24
U side board - end	4
U side board w/ slot - middle	14
U side board w/o slot - middle	24
X board - head	20
V head board middle and right end	18
V board head - left end	2
U head board - left end	2
U head board - middle	16
U head board - right end	2
G head board - middle	16
G head board - left end	2
X layer foot board - end	2
X foot board - middle	8
Foot v board - end	2
V foot board - middle	8
U foot board - middle	8
U foot board - low slot end	1
G foot board low slot end	1
G foot board middle	8
G foot board - high slot end	1
U foot board - high slot end	1
G head board - right end	2
Adapter board	20
CR board	20
G bias board	20
SHV board	1

Electrical requirements



X-layer head board

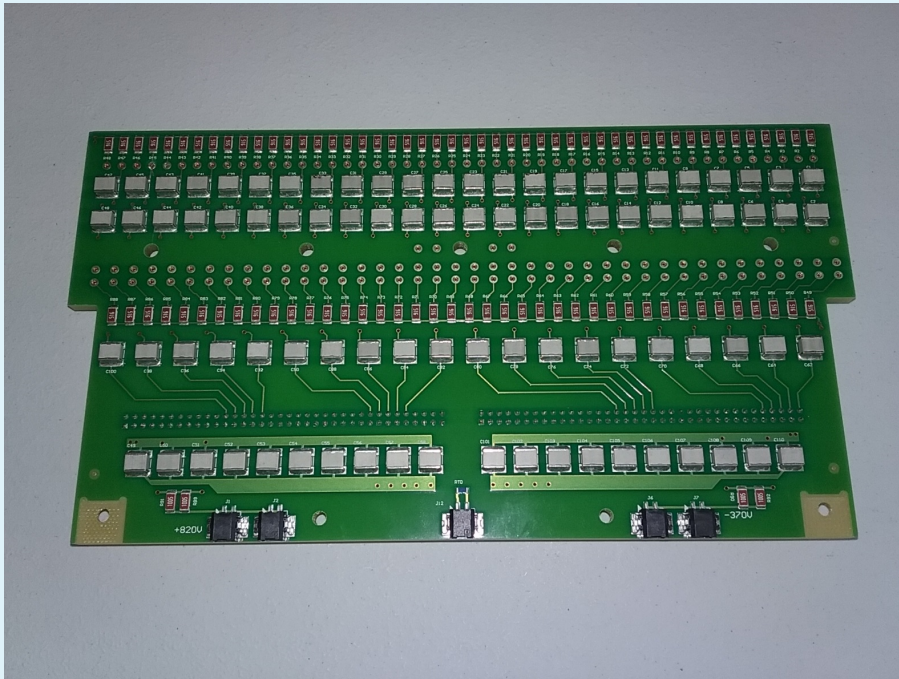
Geometry boards are relatively simple

- Continuity along traces
- Isolation between traces (0.5 nA)
- Separation requirements between adjacent traces to allow 400 V difference for tension testing

Electrical requirements

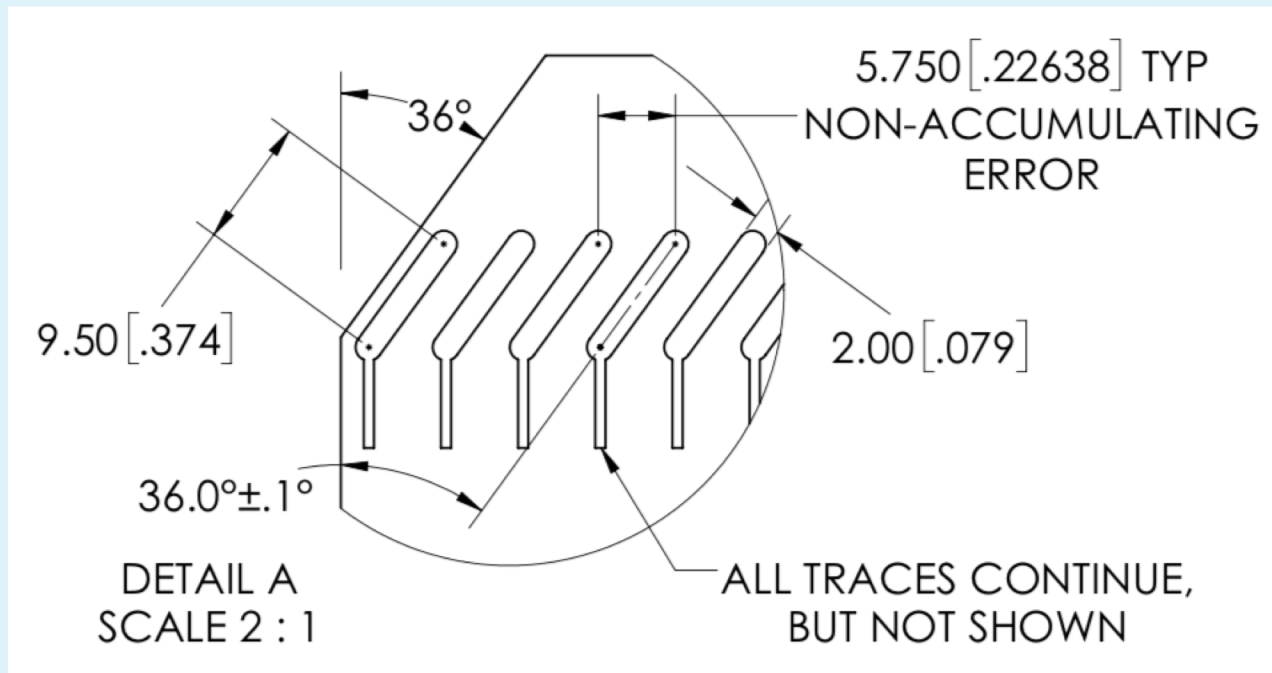
CR boards

- Stringent leakage requirements between channels: 0.5 nA
- Requirement on component attachment to survive cool-down (normal amounts of solder are insufficient)



Geometry requirements

- Spacing between solder pads sets in-layer wire pitch



Geometry requirements

Fab Notes :

- 1) Board Material : FR4
- 2) Number of layers : 2
- 3) Bare board thickness: 0.188(in) +/- 0.007
- 4) External Conductive Layers Copper Weight : 1.0 oz
- 5) Finish: Green LPI solder mask over bare copper on both sides
Electroless nickel immersion gold plating over exposed copper
- 6) Silkscreen using white epoxy ink
- 7) Board must meet or exceeded IPC-6012 Class 2 specifications
- 8) Notes:
 - a) 4 Areas on Mechanical 7 (.GM7 layer) to be milled at a controlled depth of 2.5mm from the top side of board
 - b) 1 Areas on Mechanical 8 (.GM8 layer) to be milled at a controlled depth of 1.0mm from the bottom side of board

Board thicknesses set the inter-plane wire spacing

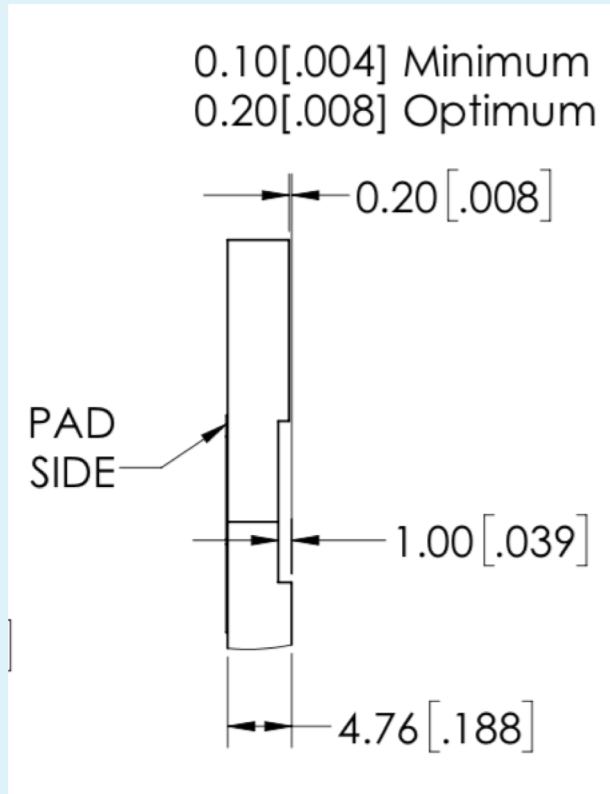
- Overall board thickness and machining of grooves

Layer Stack Legend

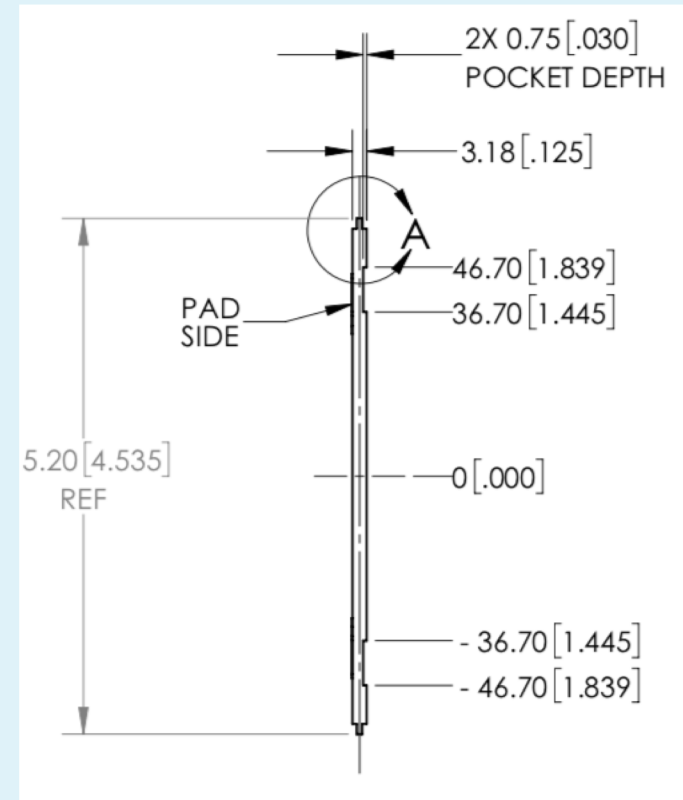
Material	Layer	Thickness	Dielectric Material	Type	Gerber
	Top Paste			Paste Mask	GTP
	Top Overlay			Legend	GTO
Surface Material	Top Solder	0.01mm	Solder Resist	Solder Mask	GTS
Copper	Top Layer	0.04mm		Signal	GTL
		4.68mm	FR-4	Dielectric	
Copper	Bottom Layer	0.04mm		Signal	GBL
Surface Material	Bottom Solder	0.01mm	Solder Resist	Solder Mask	GBS
	Bottom Overlay			Legend	GBO
	Bottom Paste			Paste Mask	GBP

Total thickness: 4.77mm

Geometry requirements



V head

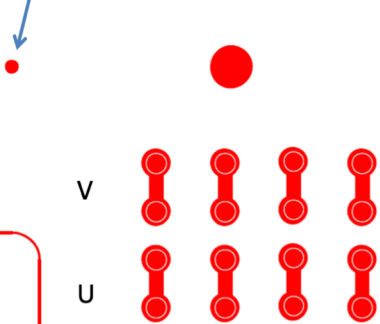


V wrap

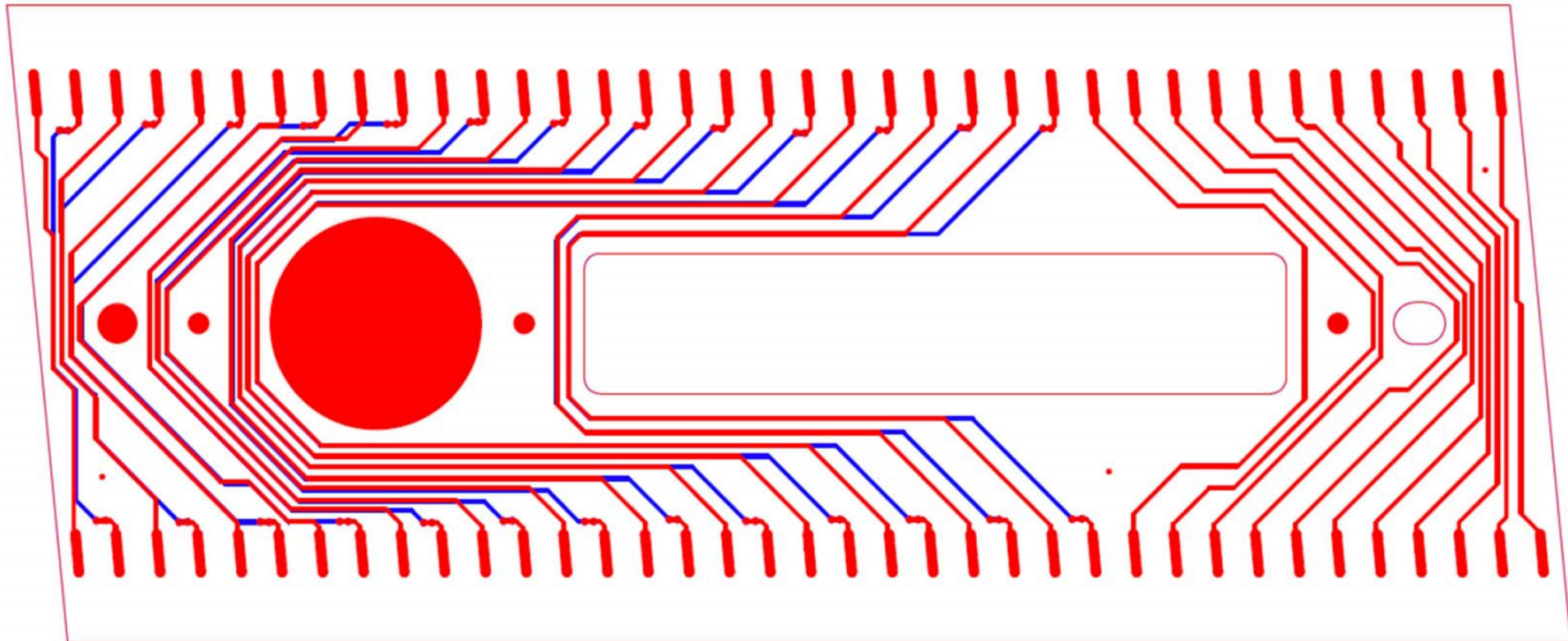
➤ Various grooves in the boards

Geometry requirements

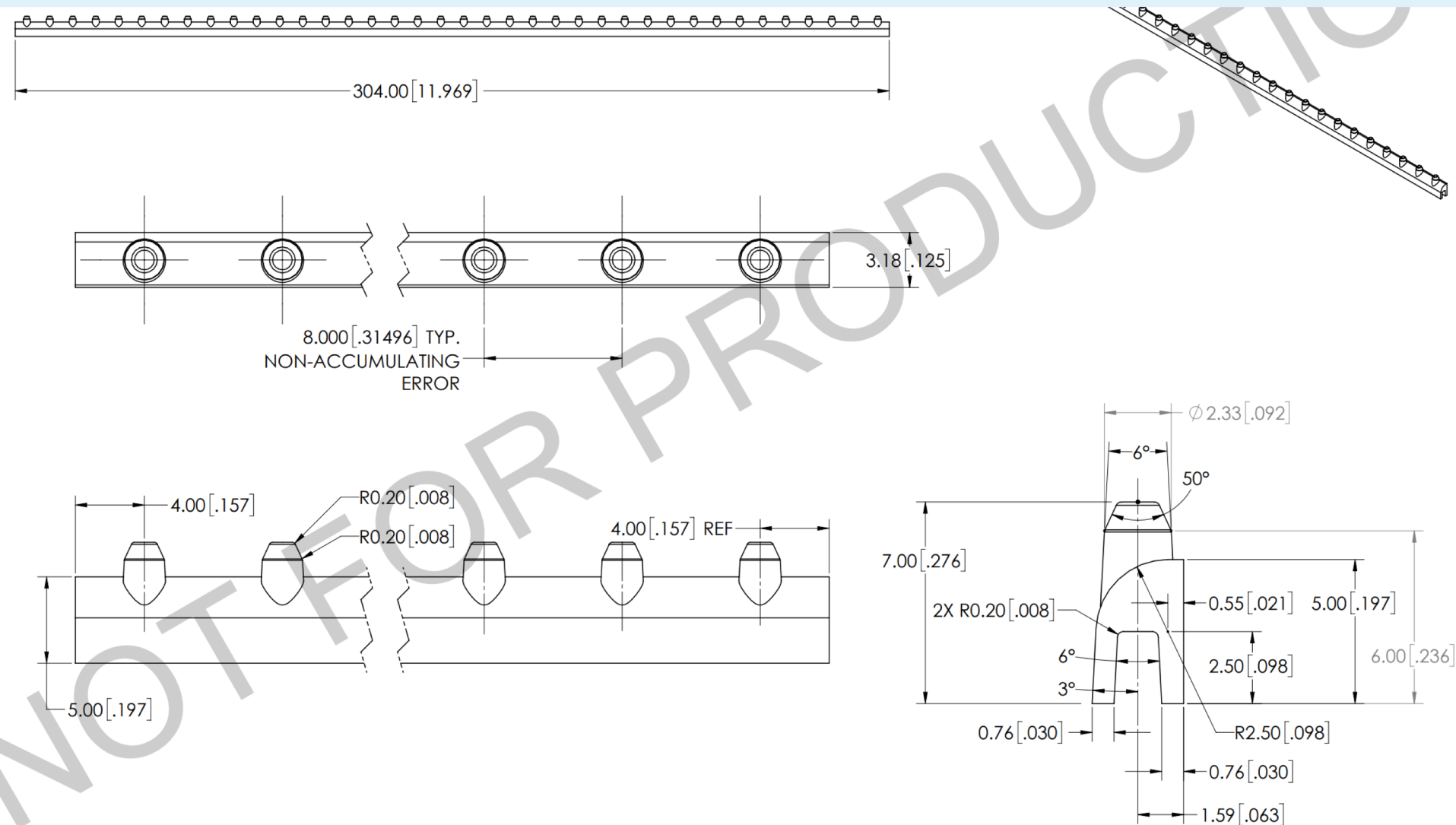
Fiducial reference point



- Positions of pins for connections to adjacent boards
- Positions of various large and small holes to match up with features in the APA frames



Tooth strips



➤ Set the wire spacing on the wrap boards

Requirements document

Andrew Landrie, Jeff Nelson and I have been tasked with writing a requirements document for these boards

- For the APA electrical review at PSL in November