Printed Circuit Board Design Updates

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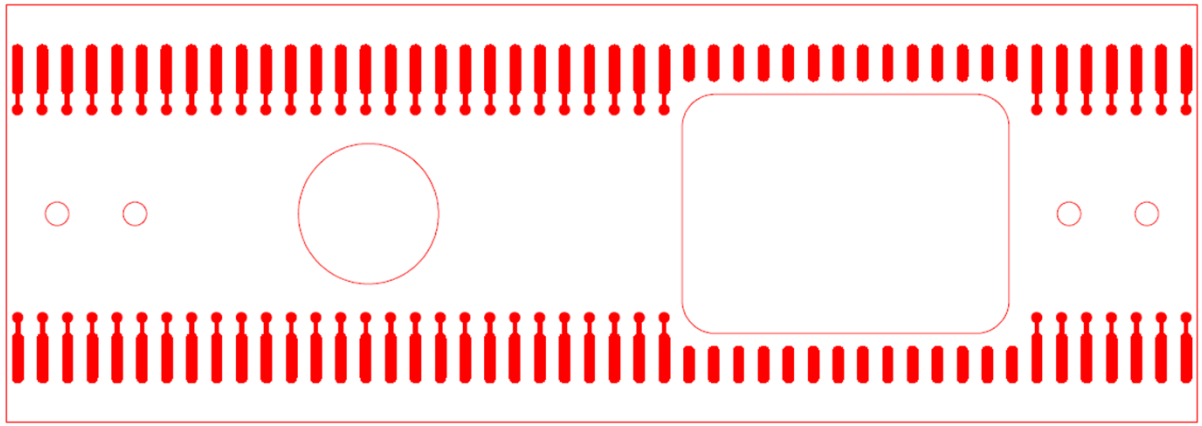
Design Updates – Overview

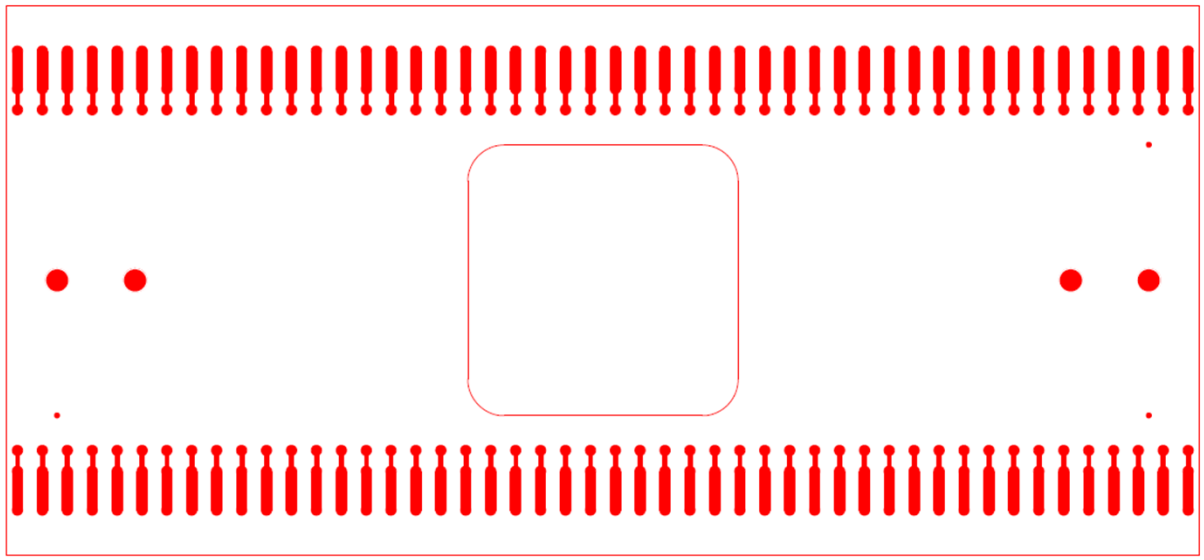
- Foot Boards and Side Boards
  - Dimensions stretched to fit larger frame tubes
  - Multi-layer boards are required in some locations
- Head Boards
  - Increased spacing between wire traces
  - Improved interface for electrical testing
- Hardware Improvements
  - Custom Mill-Max sockets and pins
  - Stronger threaded inserts in boards

X-Layer Foot Boards

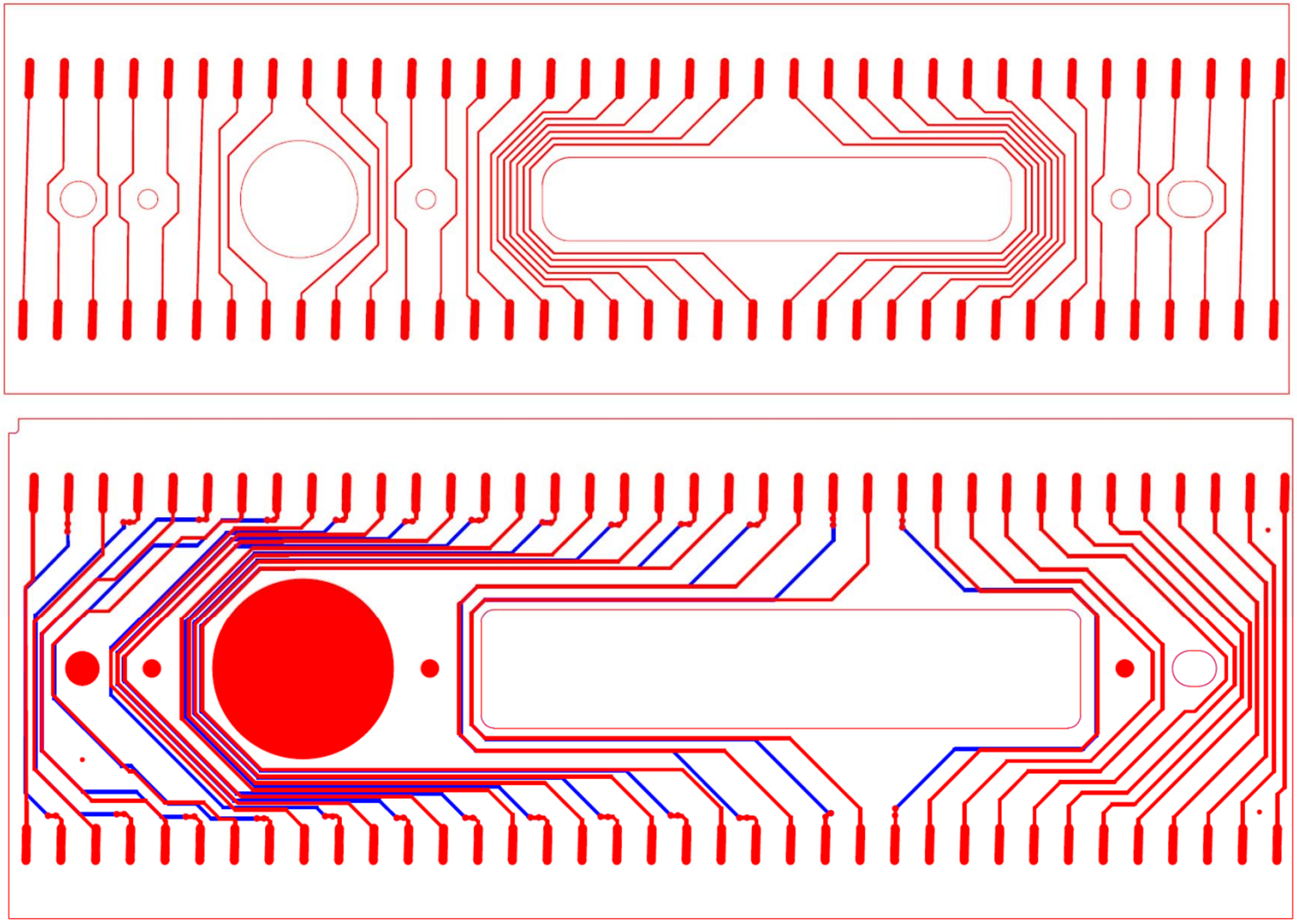
Old



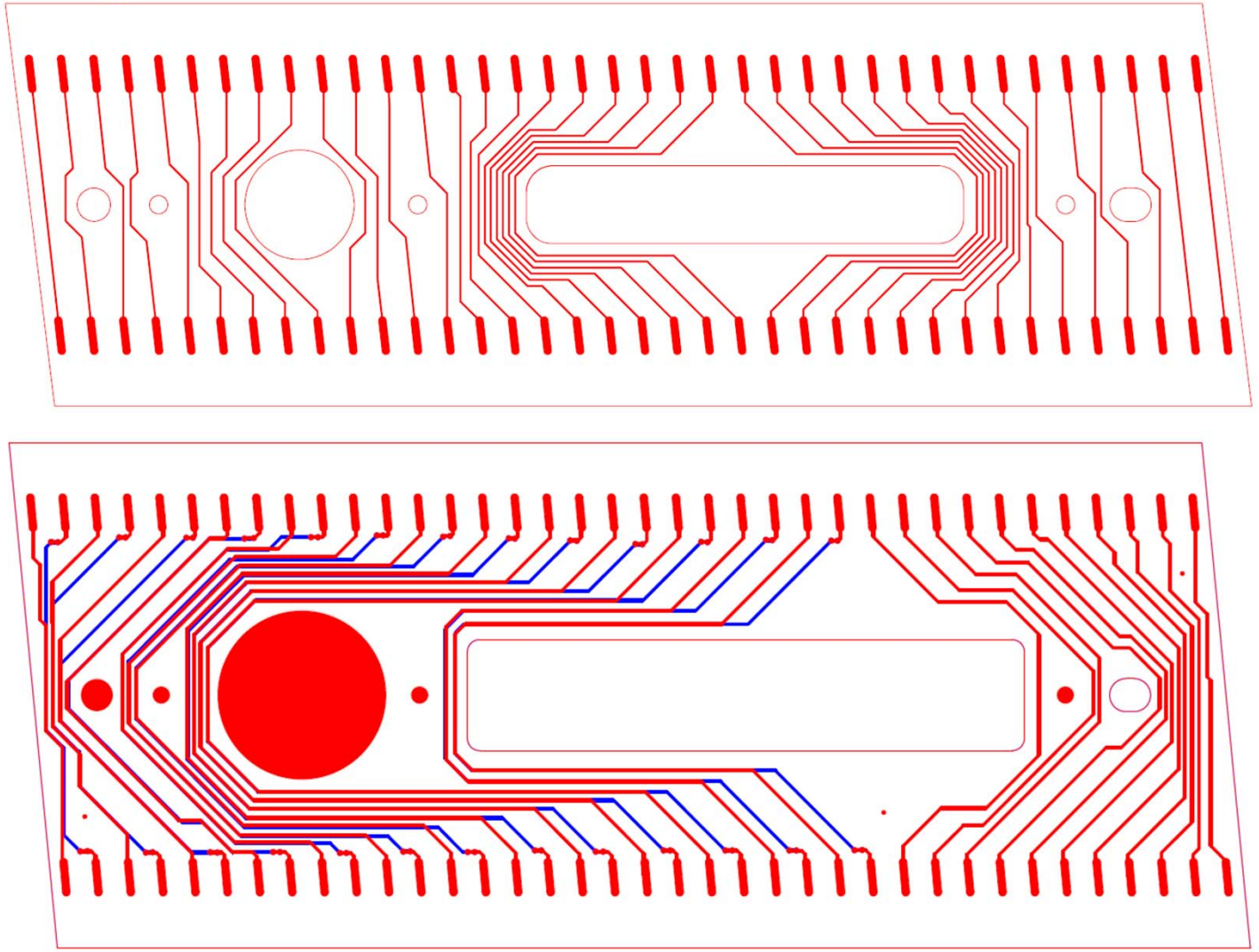
New



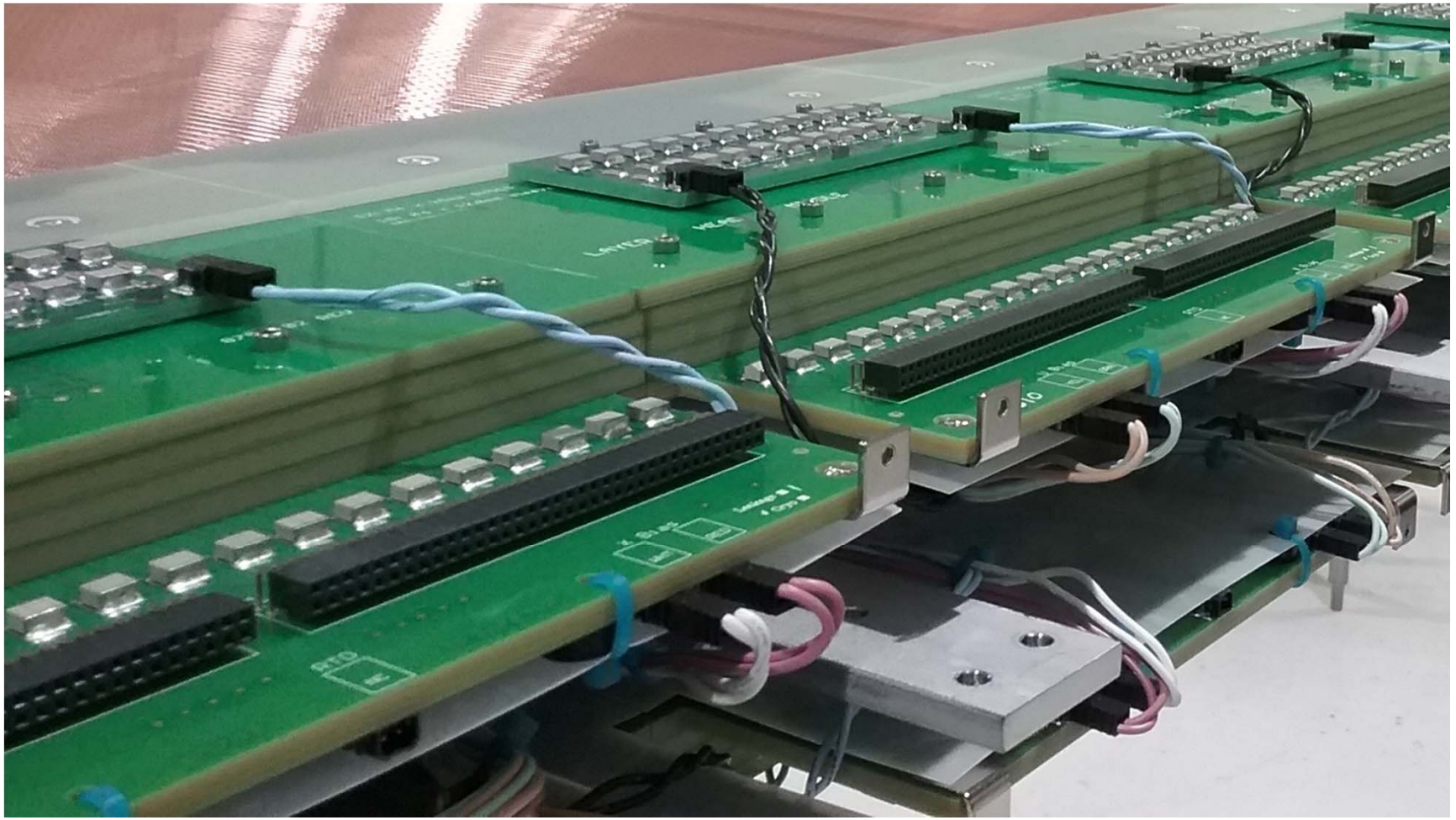
V-Layer Side Boards



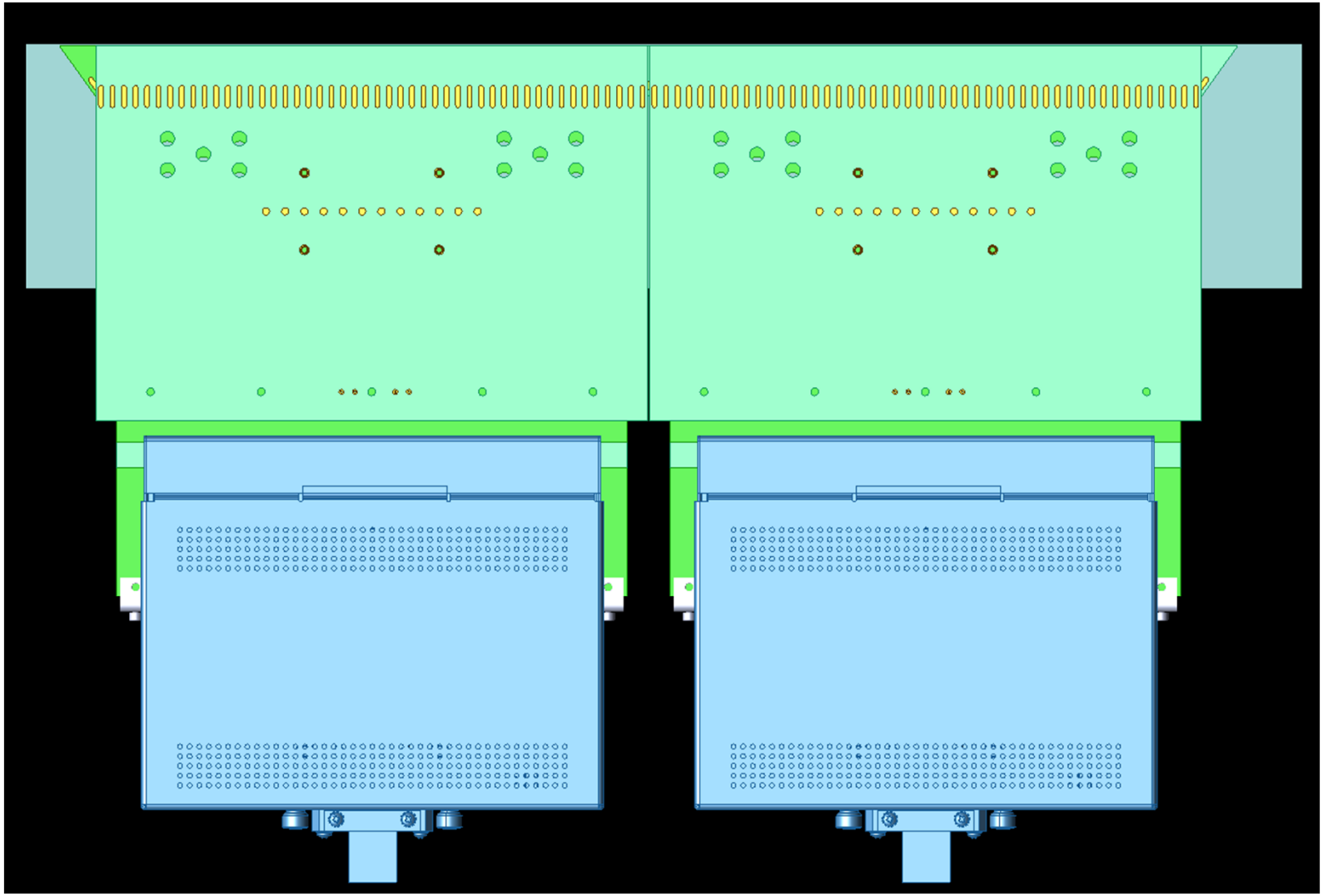
U-Layer Side Boards



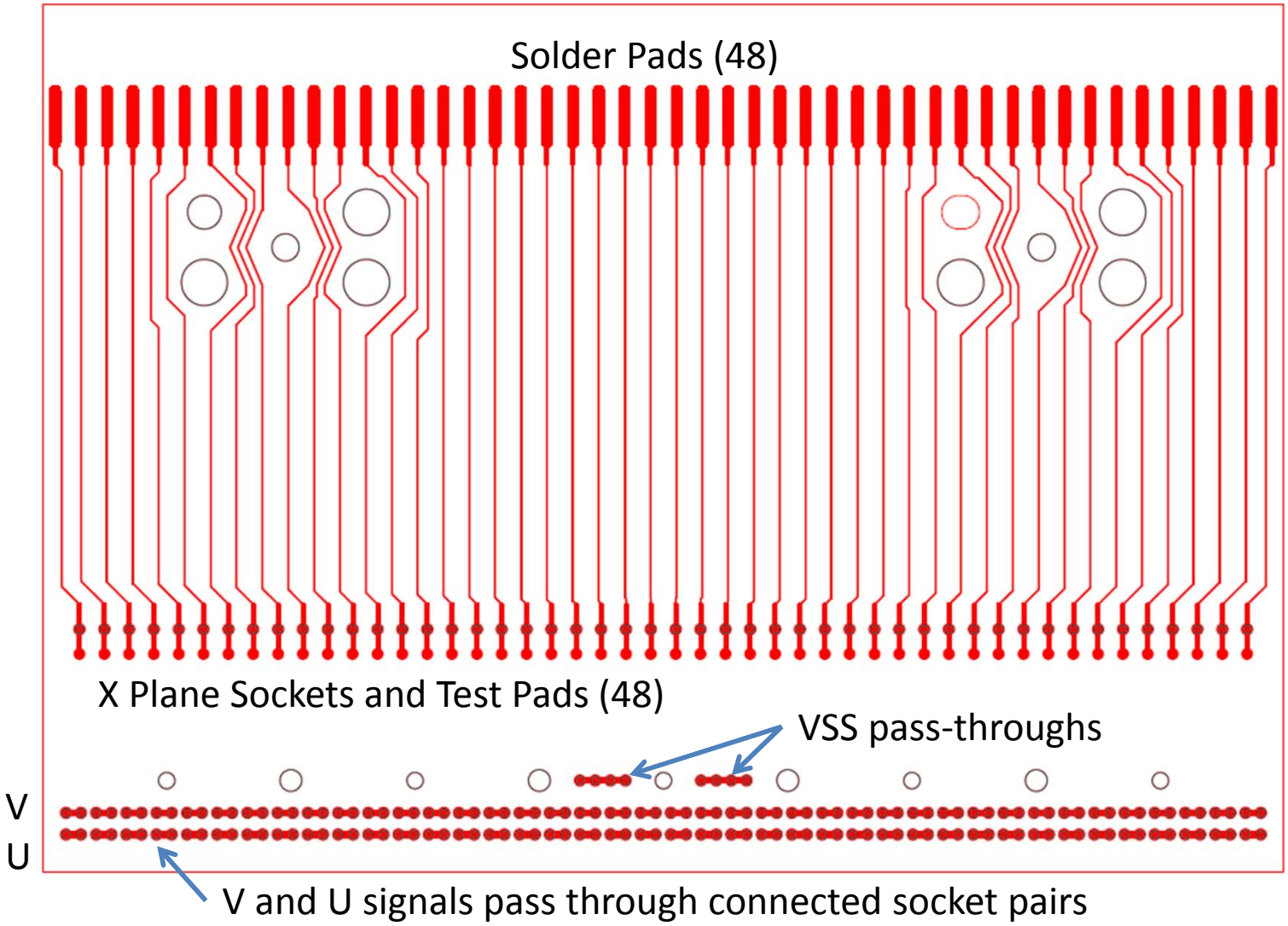
Head Board Structure



Slots Between CR Boards

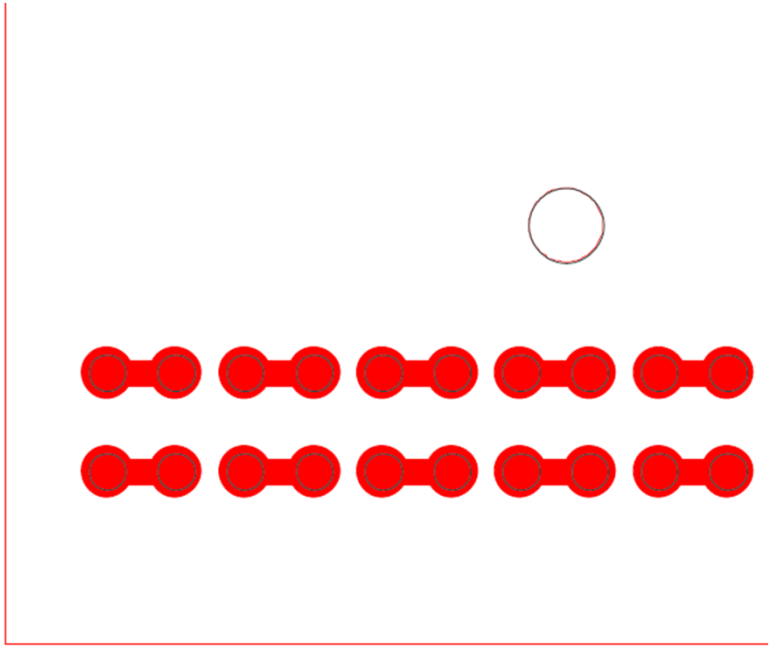


X-layer Head Board: ProtoDUNE

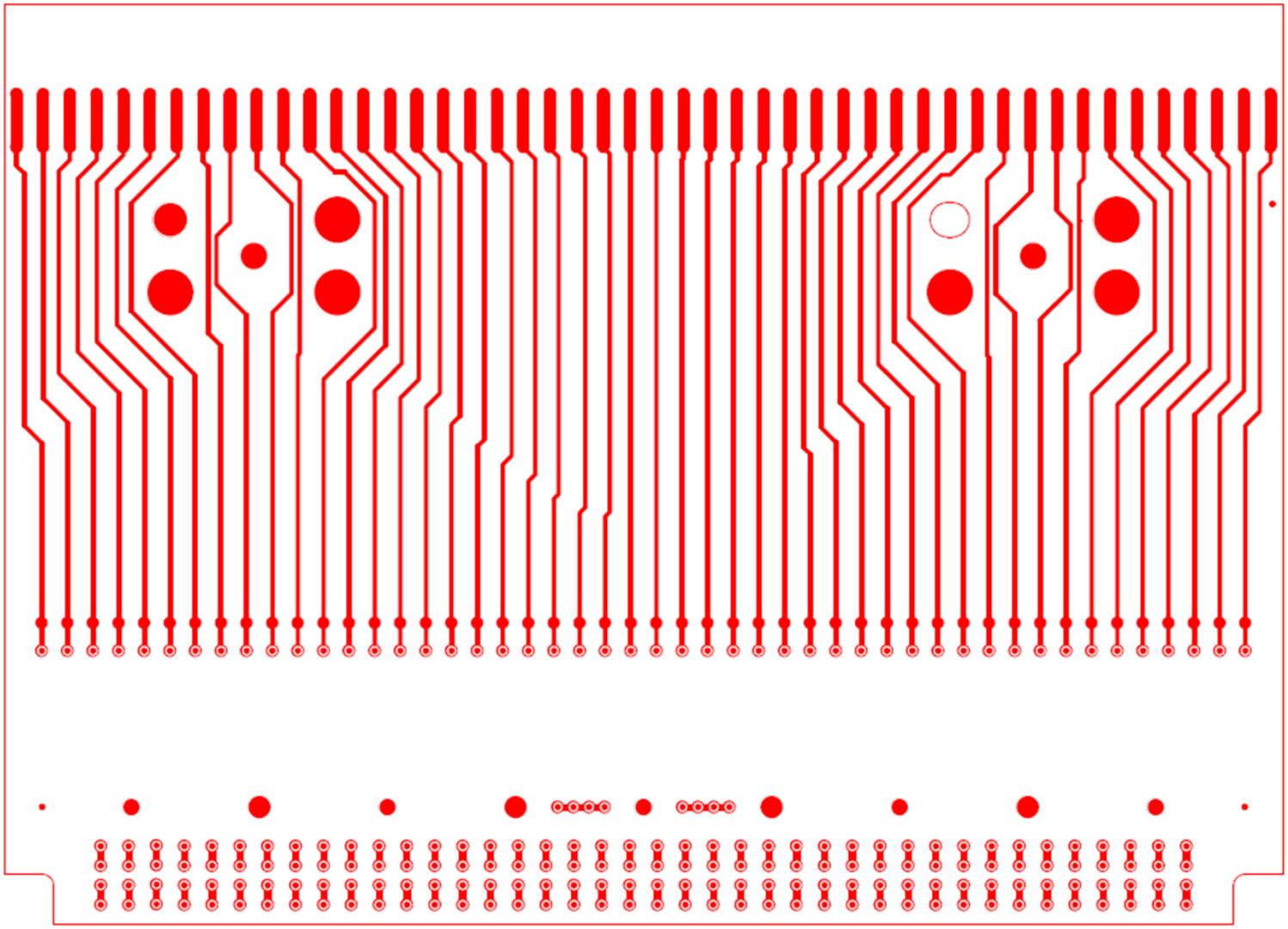


X-layer Head Board: ProtoDUNE

- Spacing of 0.5 mm between channels limits the safe voltage that can be applied between adjacent wires (~100 V)
- Increased spacing is desired to support voltage differences as high as 400 V

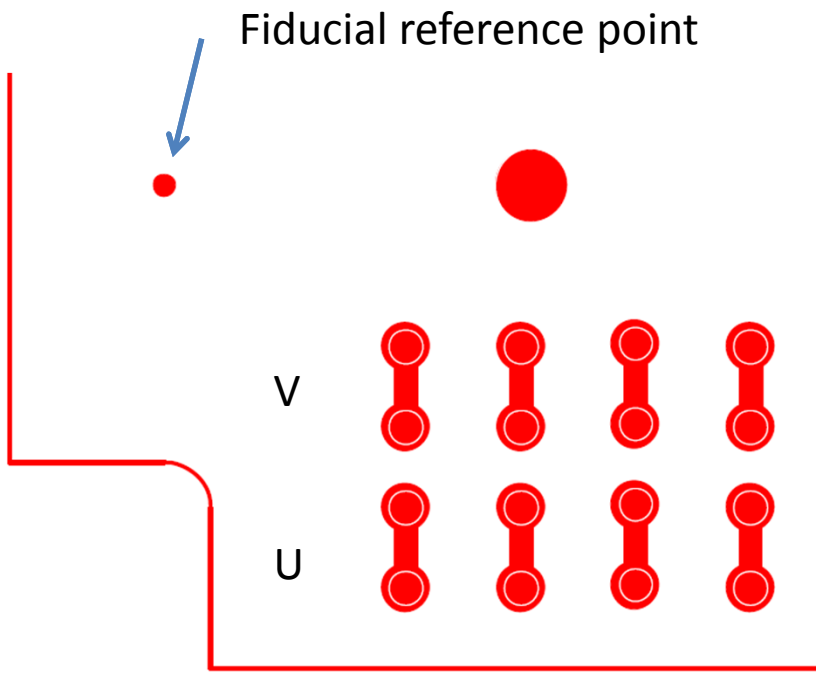


X-layer Head Board: DUNE



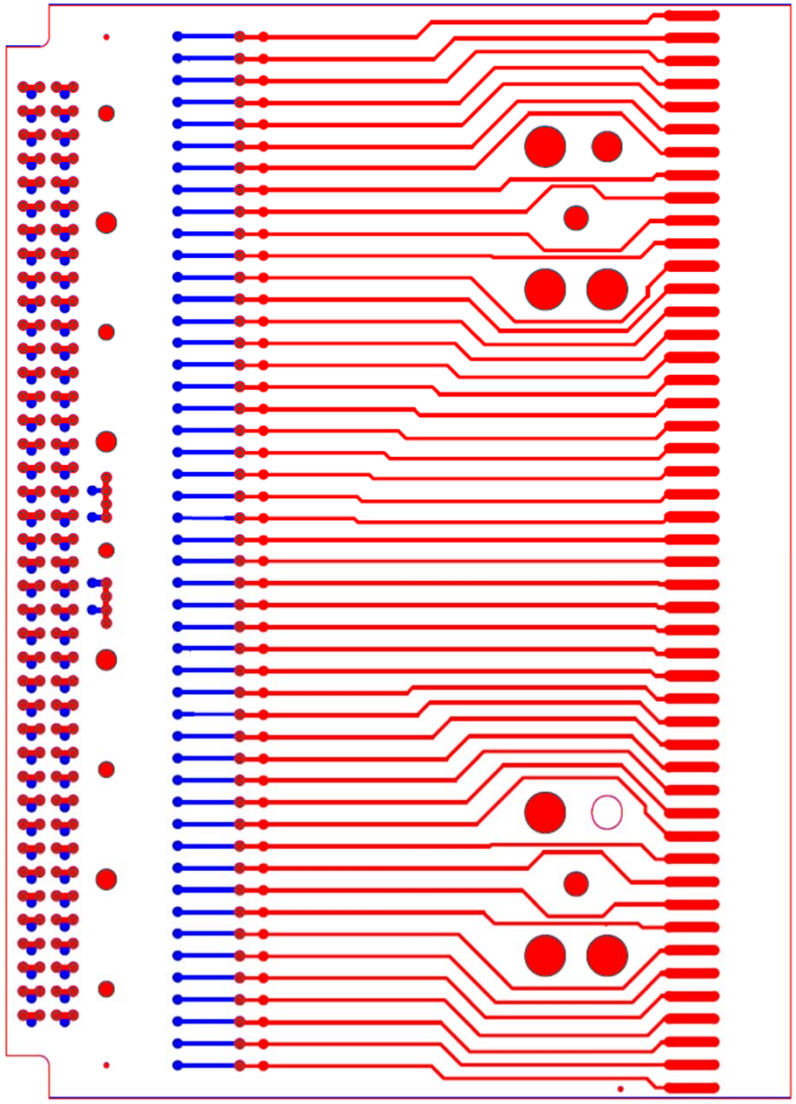
X-layer Head Board: DUNE

- Spacing between U and V wire channels has increased to 2.5 mm
- Board edge was moved 4.0 mm to accommodate increased channel spacing
- Fiducials were added to all boards to support inspection by automatic vision systems

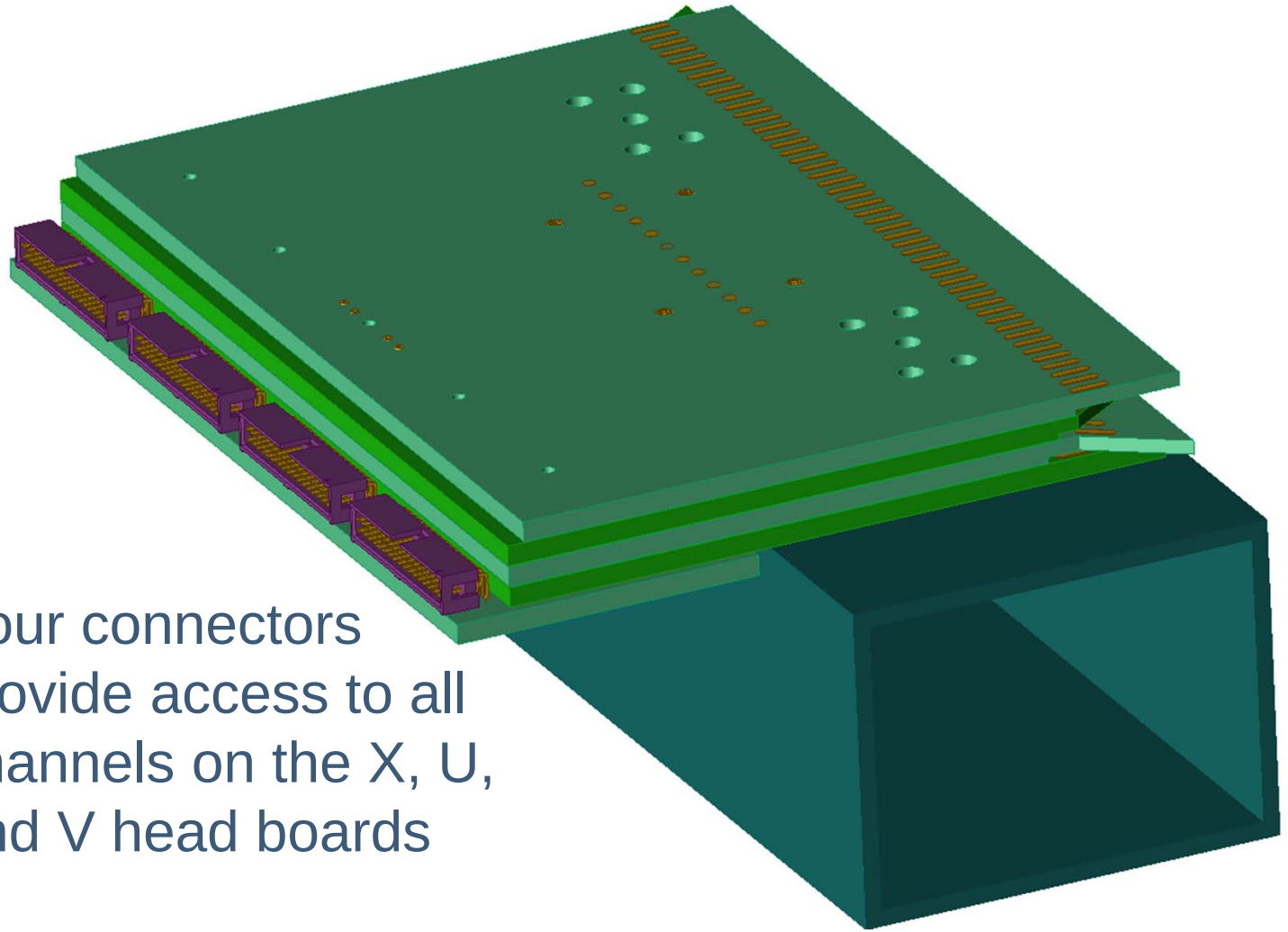


X-layer Head Board: DUNE

- Landing pads were added to the bottom side of X head boards (blue traces)
- Pads allow the attachment of test headers in place of CR boards
- Headers use spring-loaded contact pins

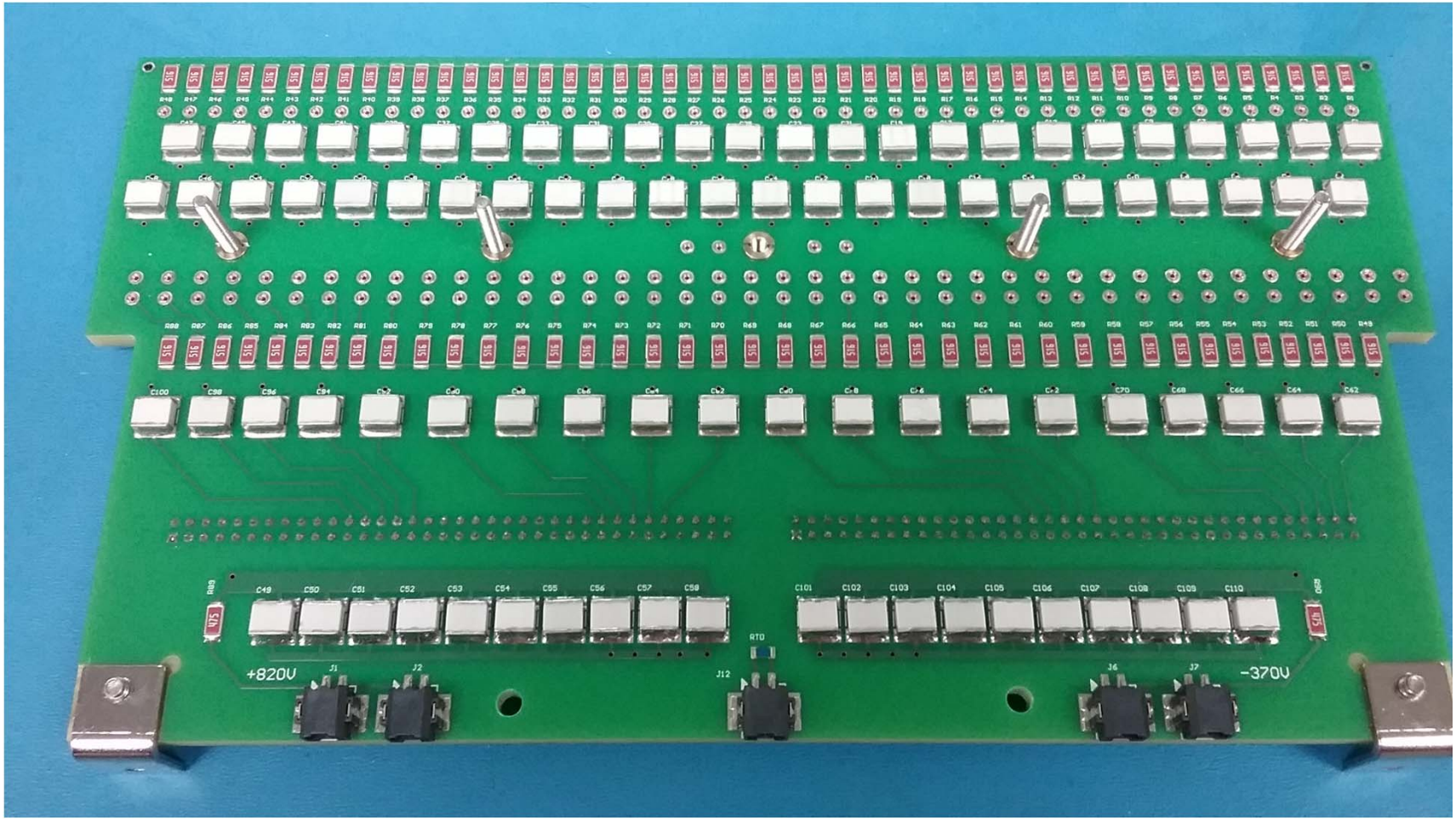


Test Header Concept



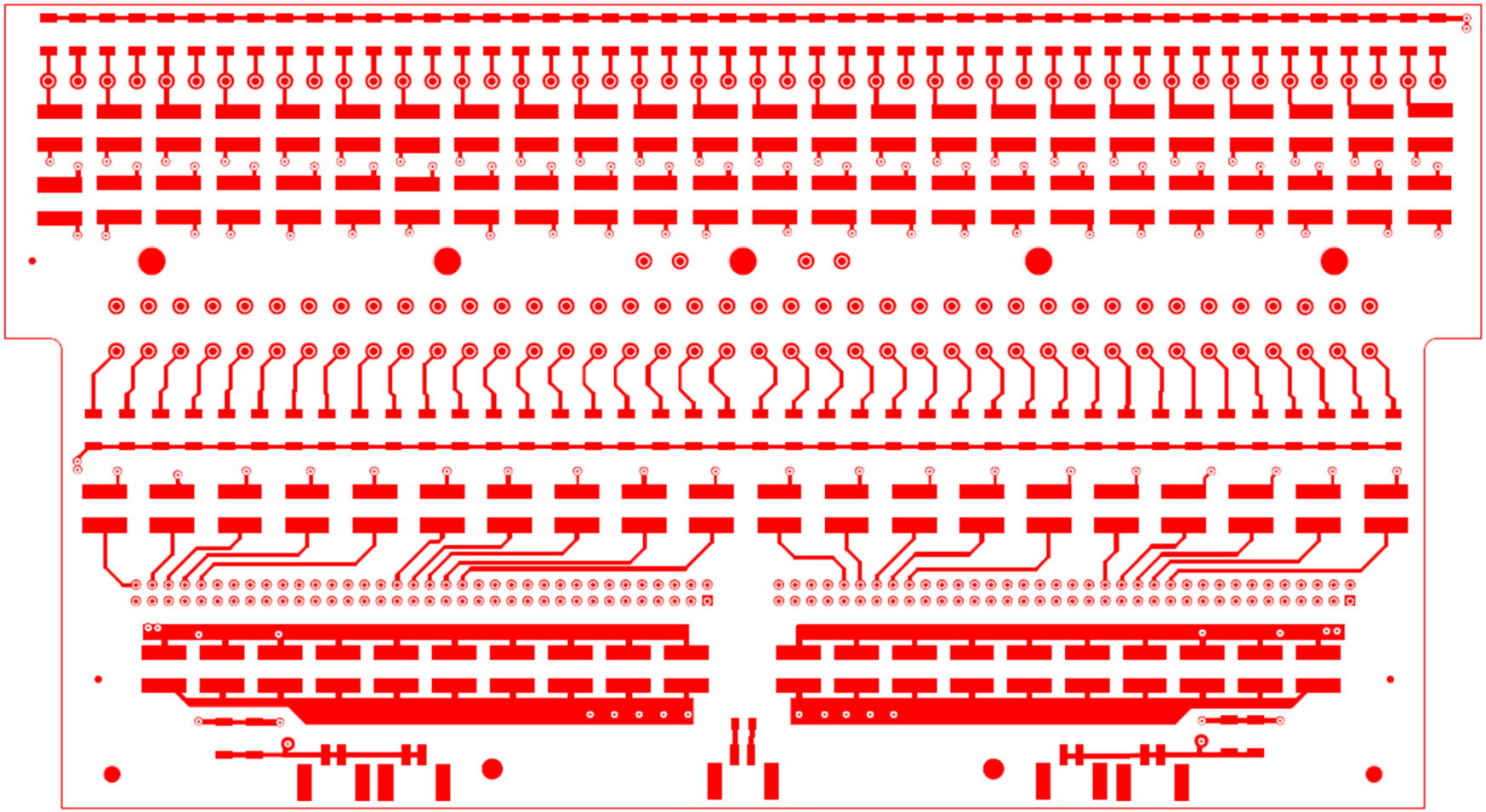
- Four connectors provide access to all channels on the X, U, and V head boards

CR Board (ProtoDUNE)

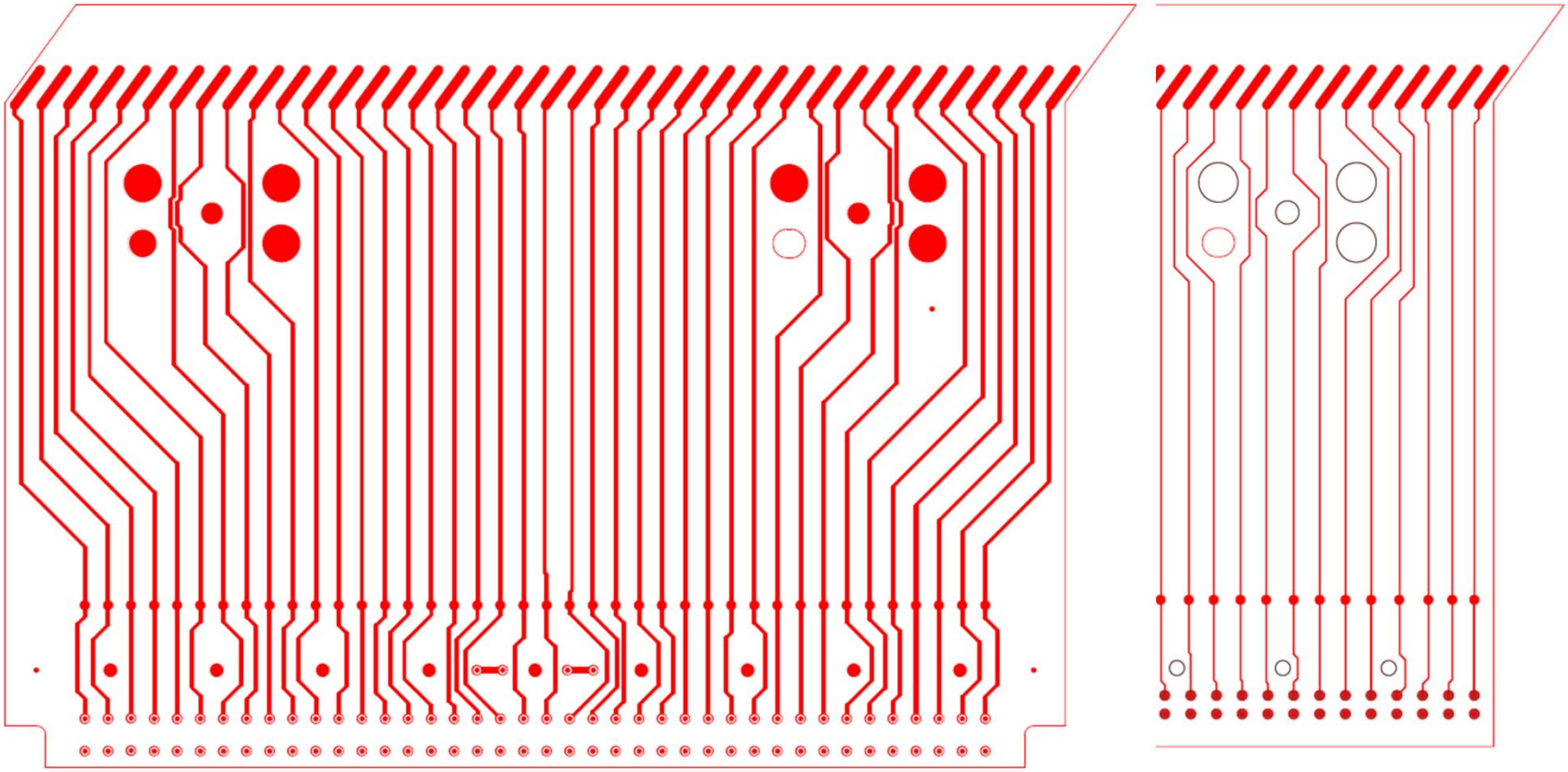


New CR Board

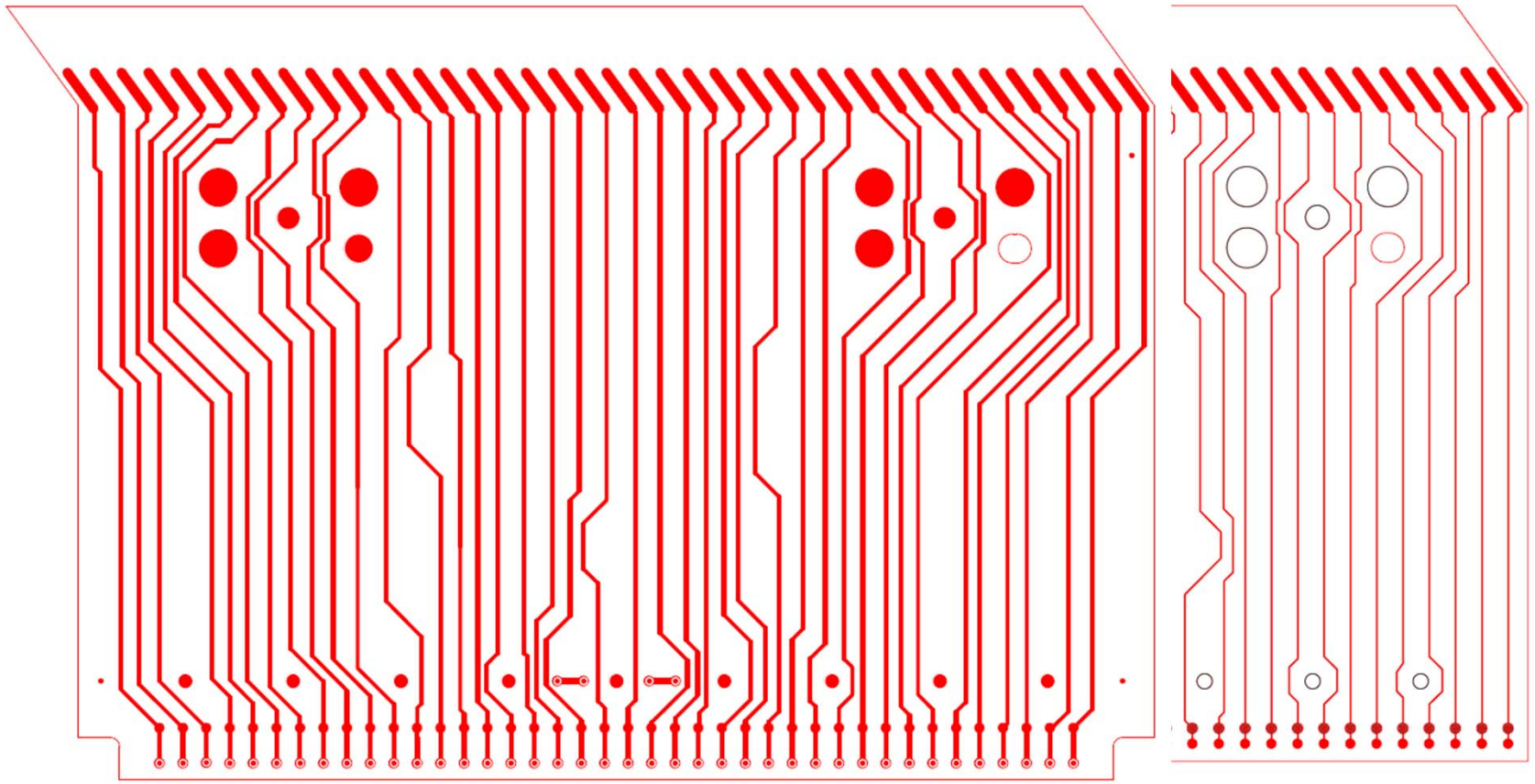
Minor changes only



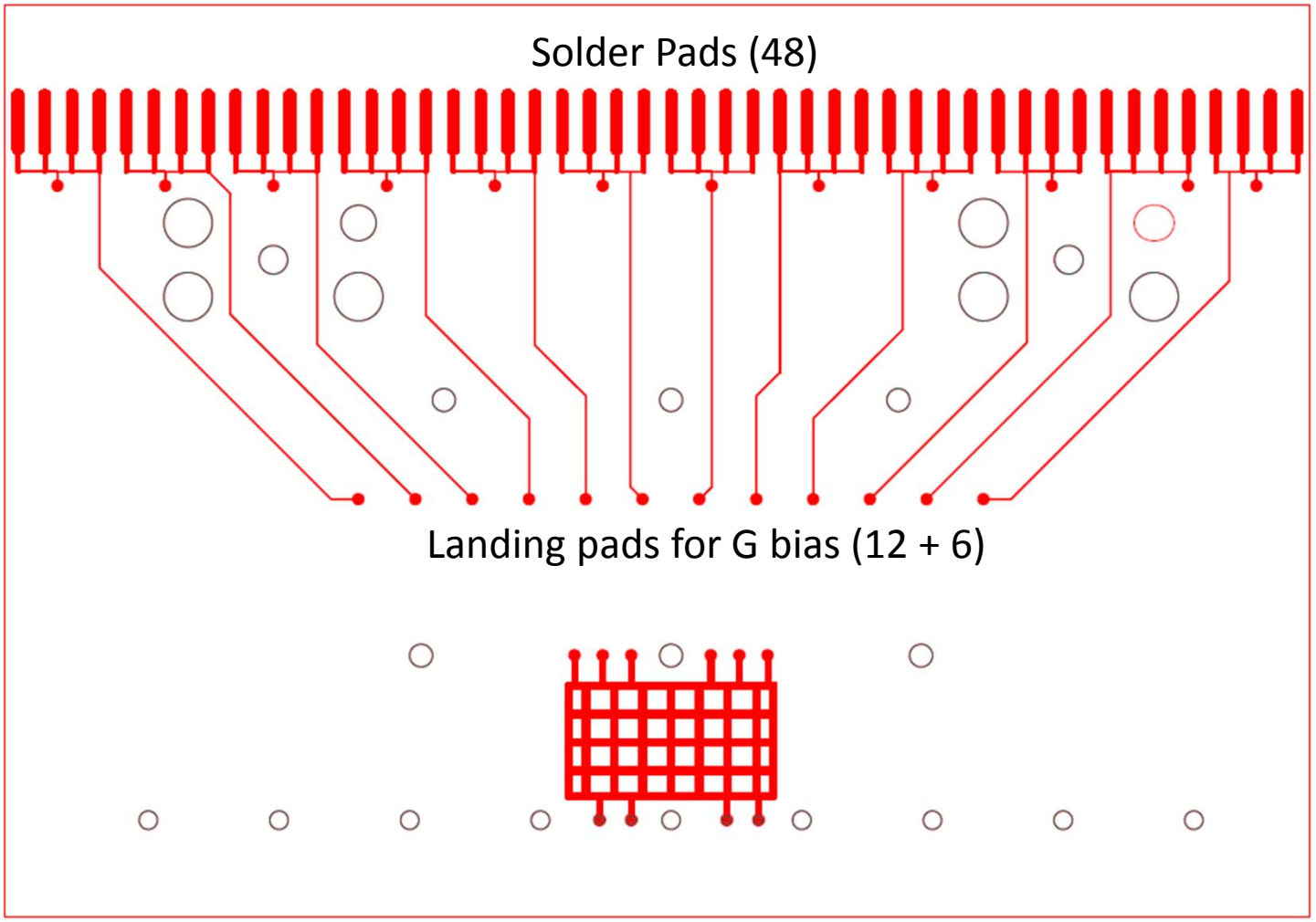
V-layer Head Boards (new / old)



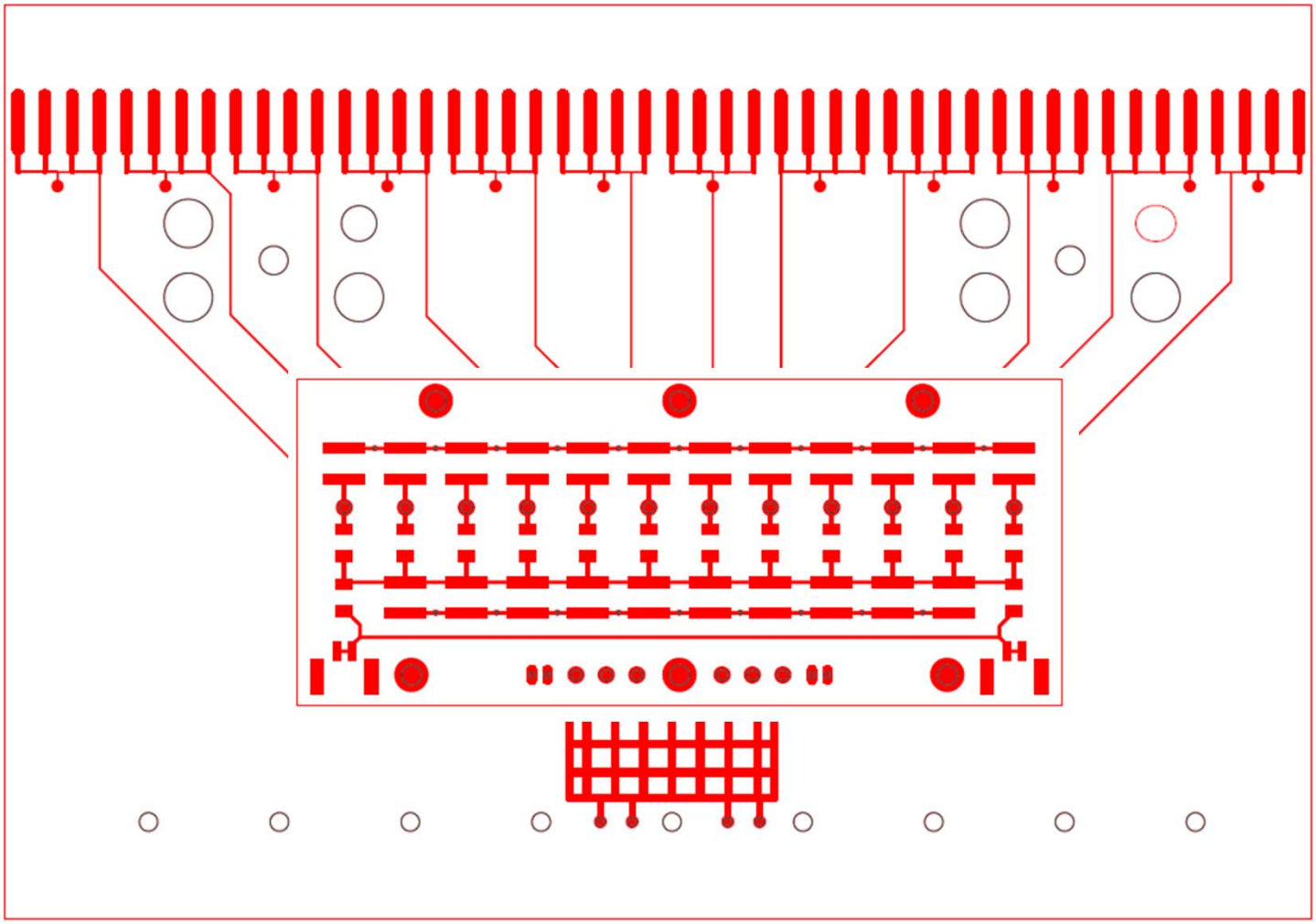
U Layer Head Boards (new / old)



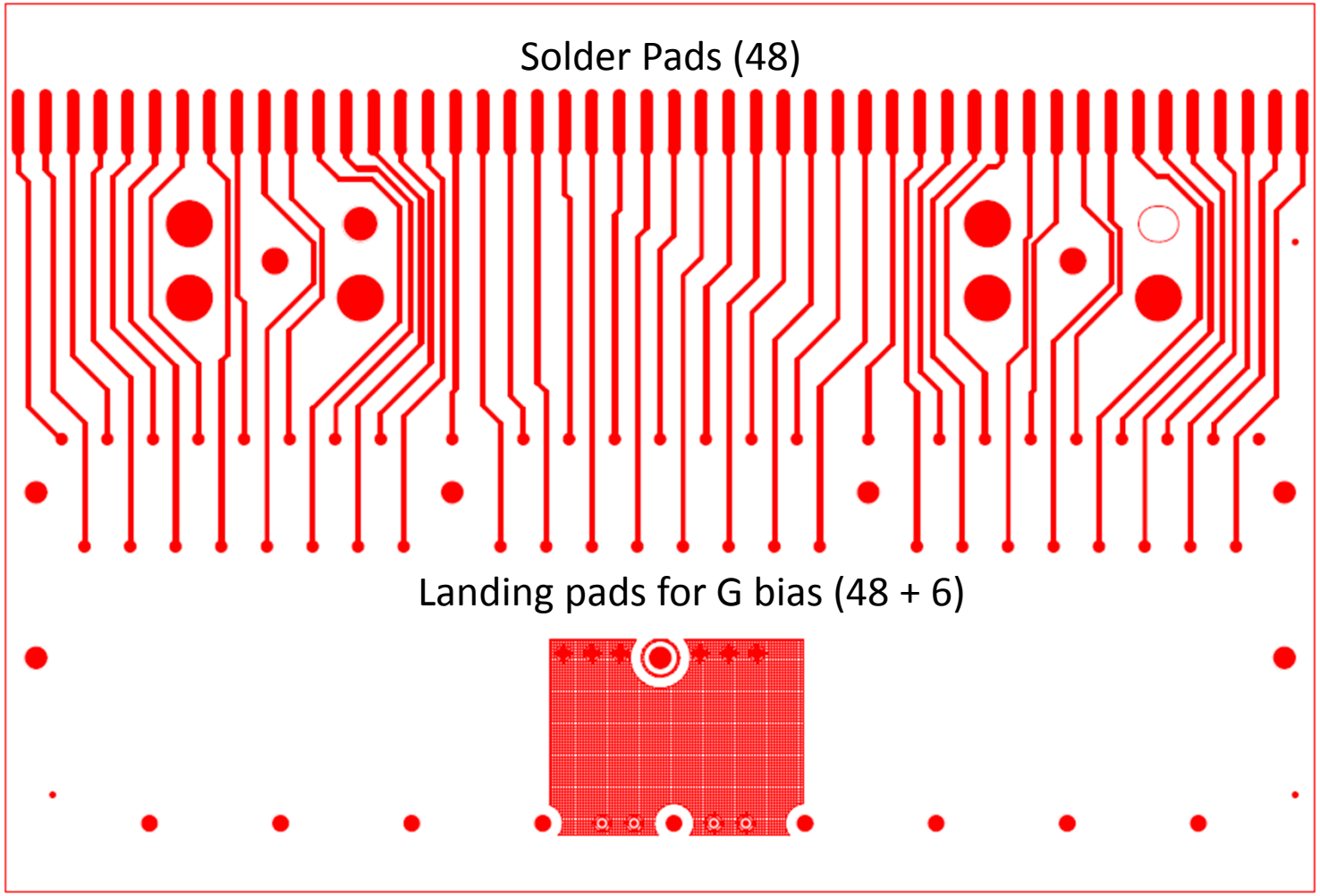
G Layer Head Board: ProtoDUNE



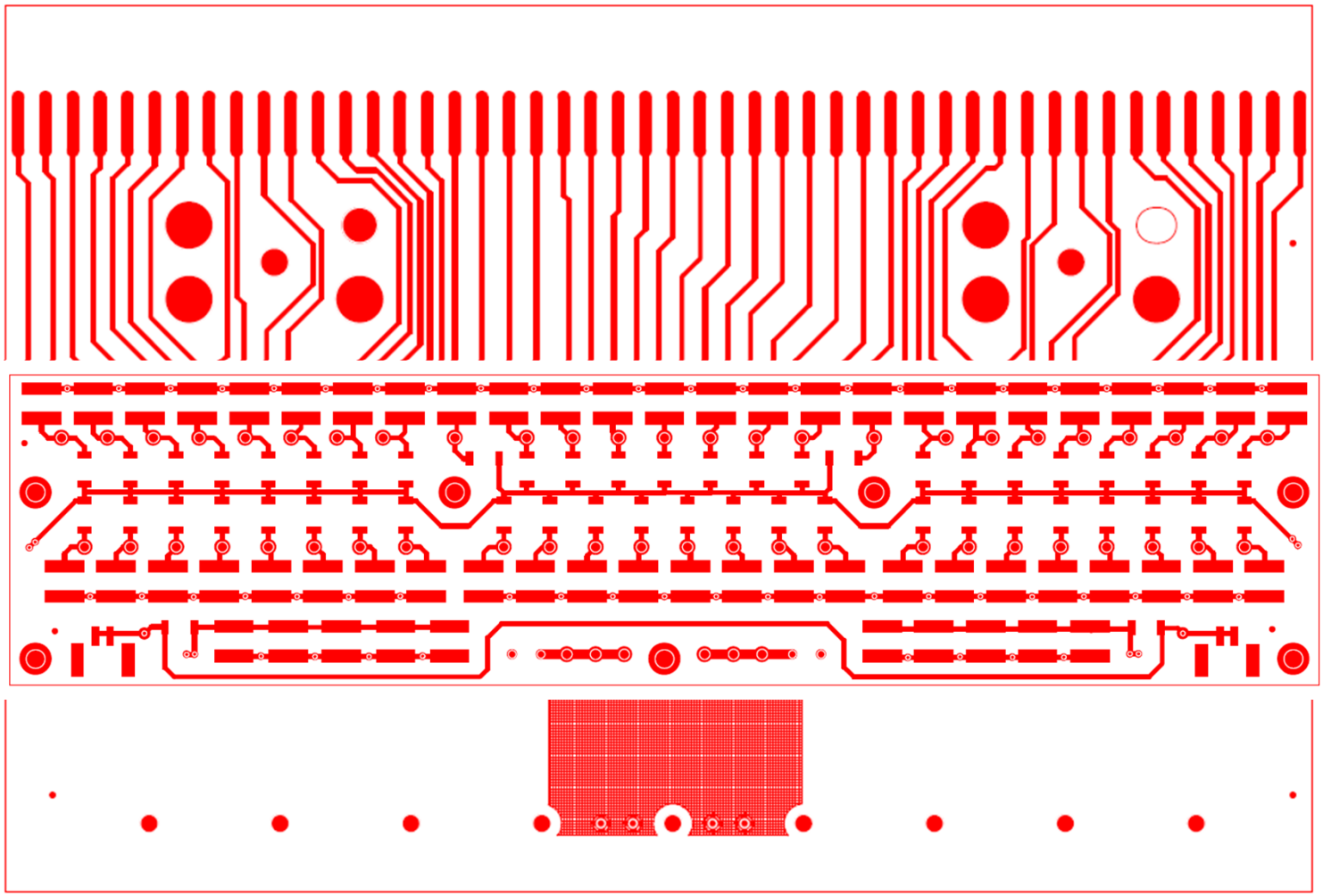
G Bias Board: ProtoDUNE



G Layer Head Board: DUNE

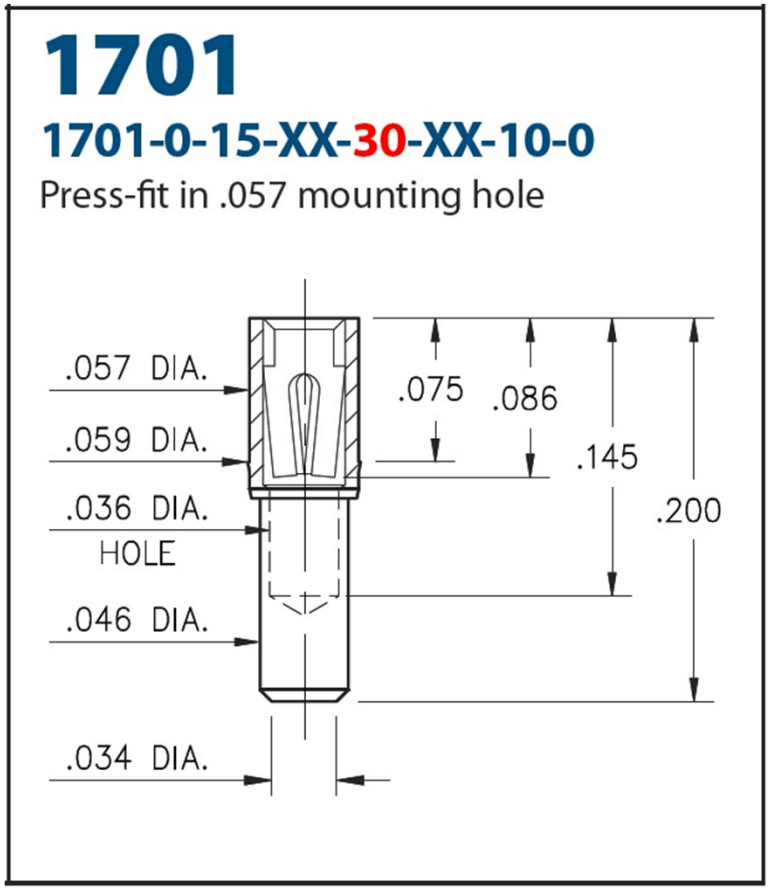


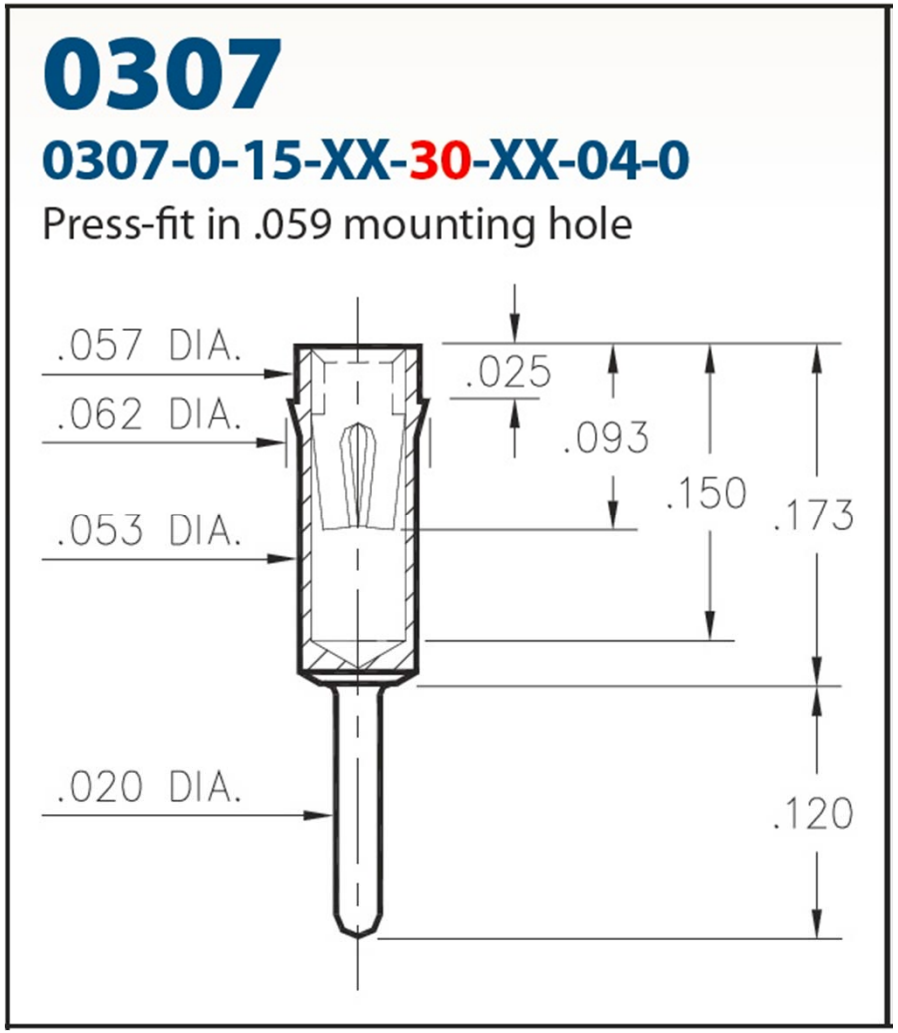
G Bias Board: DUNE



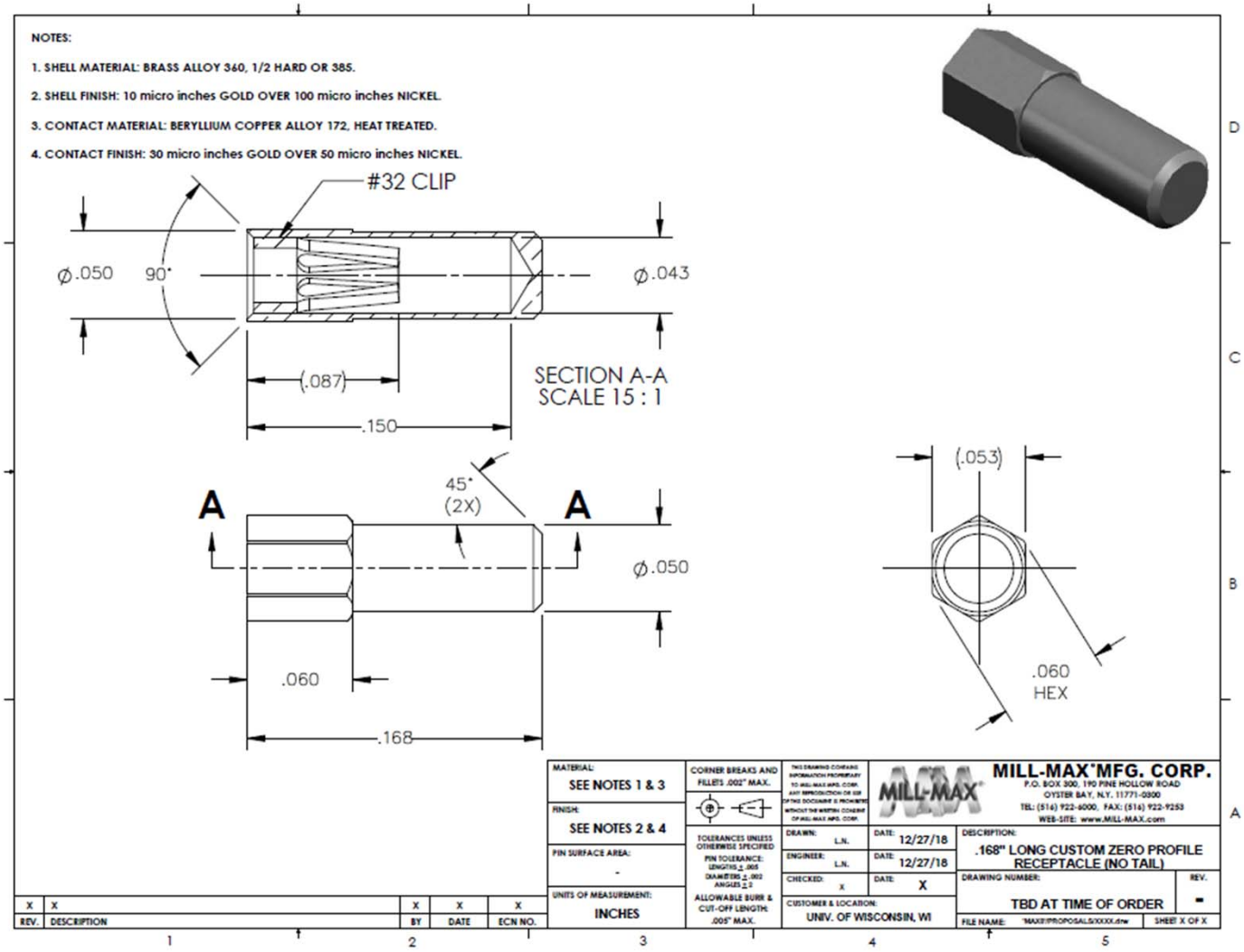
ProtoDUNE Sockets and Pins

Standard catalog items had some performance issues

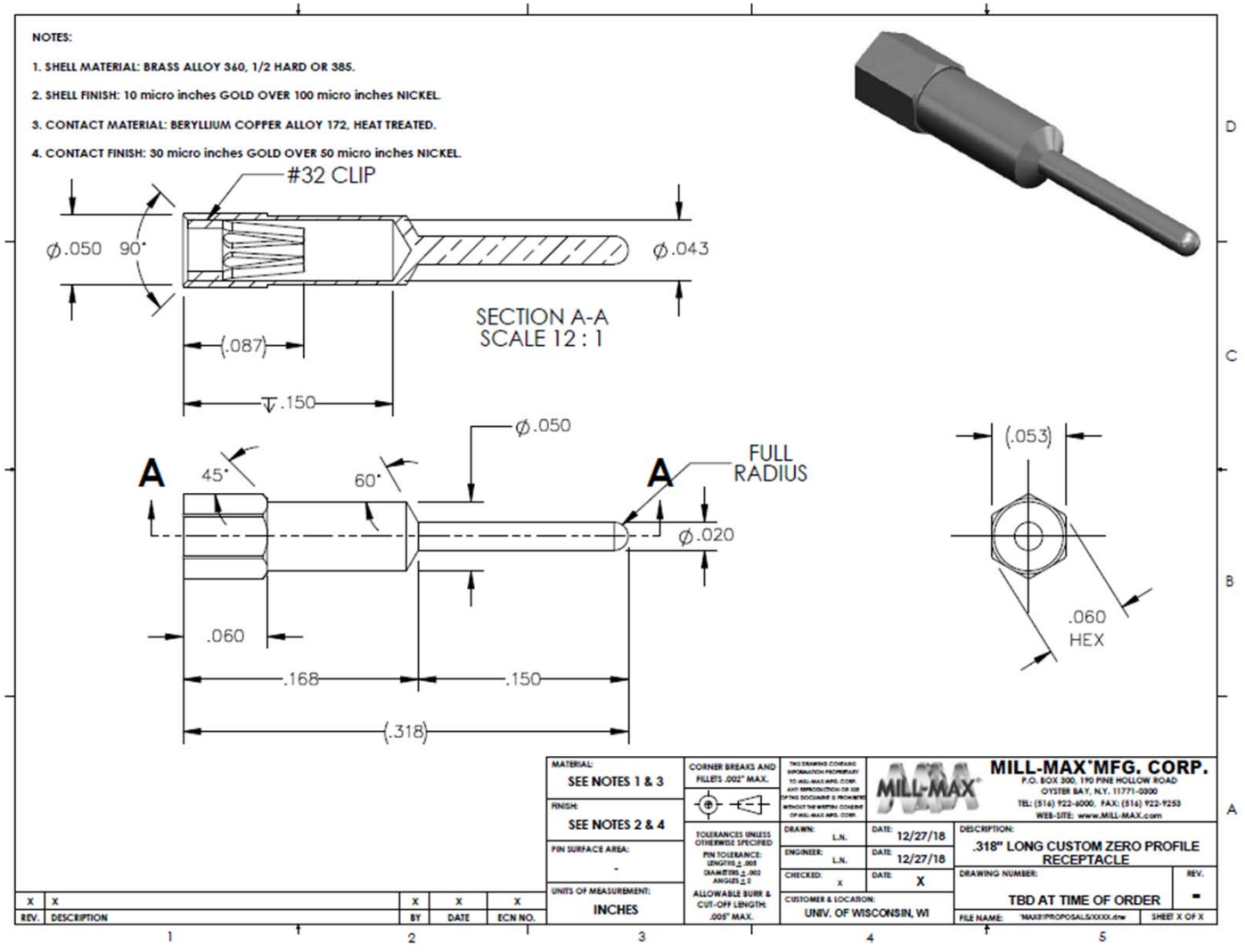




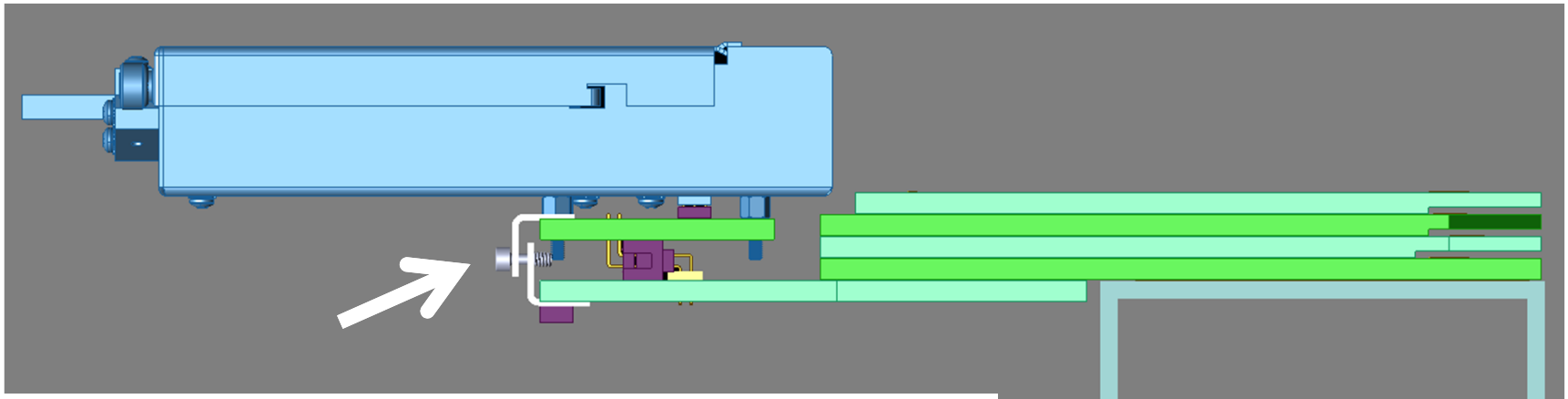
DUNE Sockets



DUNE Pins

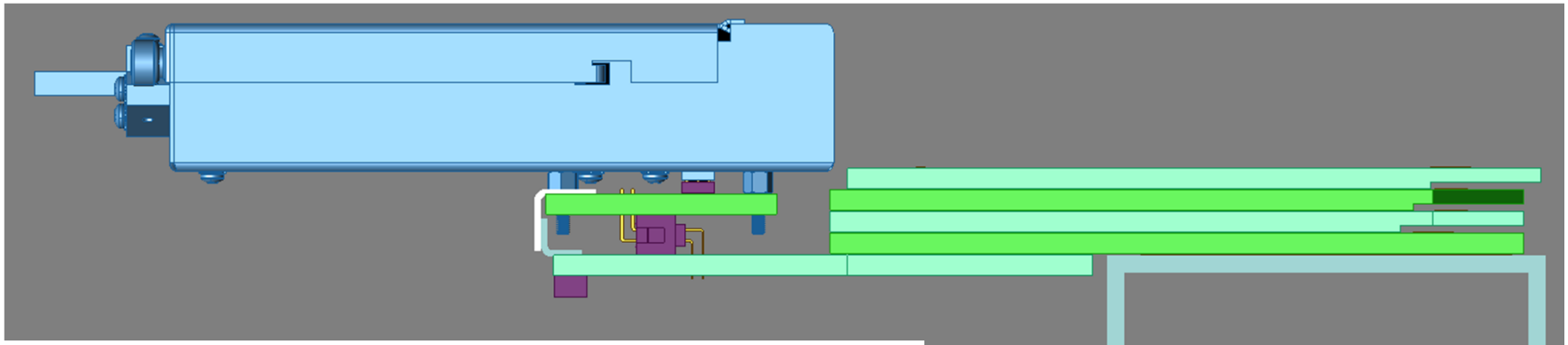

NOTES:
1. SHELL MATERIAL: BRASS ALLOY 360, 1/2 HARD OR 385.
2. SHELL FINISH: 10 micro inches GOLD OVER 100 micro inches NICKEL.
3. CONTACT MATERIAL: BERYLLIUM COPPER ALLOY 172, HEAT TREATED.
4. CONTACT FINISH: 30 micro inches GOLD OVER 50 micro inches NICKEL.
#32 CLIP
Ø.050
90°
Ø.043
(.087)
.150
SECTION A-A
SCALE 12 : 1
Ø.050
A
45°
60°
A
FULL RADIUS
Ø.020
.060
.168
.150
(.318)
(.053)
.060
HEX
MATERIAL: SEE NOTES 1 & 3
FINISH: SEE NOTES 2 & 4
PIN SURFACE AREA: -
UNITS OF MEASUREMENT: INCHES
CORNER BREAKS AND FILLETS .002" MAX.
TOLERANCES UNLESS OTHERWISE SPECIFIED
ALLOWABLE BURR & CUT-OFF LENGTH: .005" MAX.
MILL-MAX
MILL-MAX MFG. CORP.
P.O. BOX 300, 190 PINE HOLLOW ROAD
OYSTER BAY, N.Y. 11771-0300
TEL: (516) 922-6000, FAX: (516) 922-9253
WEB-SITE: www.MILL-MAX.com
DRAWN: L.N. DATE: 12/27/18
ENGINEER: L.N. DATE: 12/27/18
CHECKED: X DATE: X
CUSTOMER & LOCATION: UNIV. OF WISCONSIN, WI
DESCRIPTION: .318" LONG CUSTOM ZERO PROFILE RECEPTACLE
DRAWING NUMBER: TBD AT TIME OF ORDER
REV: -
FILE NAME: MAX#\PROPOSALS\XXXX.drw
SHEET X OF X
REV. DESCRIPTION BY DATE ECN NO.

CE Assembly Installation



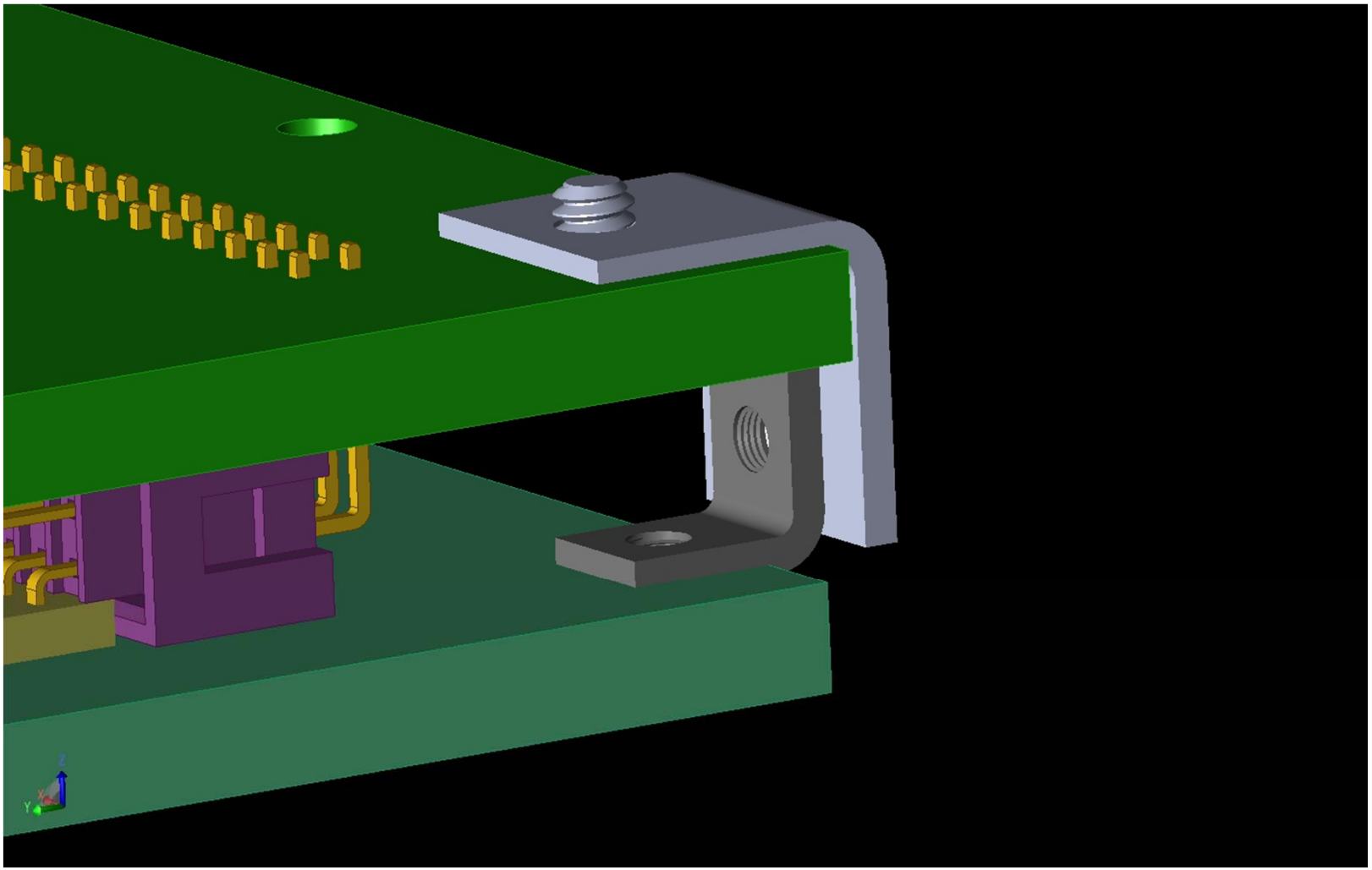
- Captive screws in ProtoDUNE were meant to pull connectors together in a controlled fashion, but they posed a risk of being dropped into the cryostat during CE installation or removal

CE Assembly Installation



- Captive screws were eliminated by changing the angle brackets on CR boards
- Threaded tools are inserted and rotated to pull connectors together, then removed

CE Assembly Installation



Hardware Improvements

- Expanding threaded inserts have been replaced by broaching fasteners to prevent breaking and reduce metal debris

Process Improvements

- Improved tools and methods are being evaluated for PCBs
  - Instrumented tips on soldering irons for process control
  - Vapor-phase reflow soldering for CR and G Bias boards
  - Improved board-washing equipment
  - Automated test systems for CR boards and G-Bias boards

Quality Assurance and Control

- All ProtoDUNE boards were inspected when received
- Complex mechanical features were frequently out of spec
- Continued inspection of most boards is probably needed
- Manual board inspection was time-consuming
- Vision systems are being evaluated for board inspection

Backup Slides

Mill-Max Pins and Sockets

Pins are fragile and not repairable once bent.
Their exposure is minimized during APA assembly.

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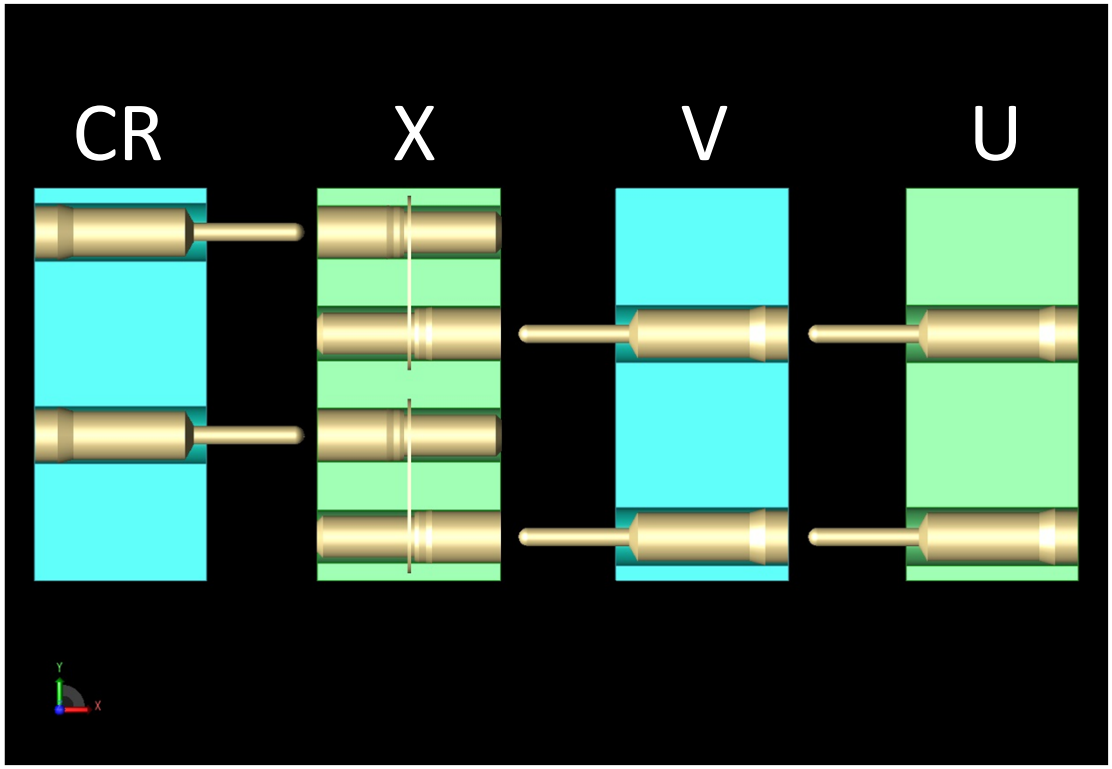

In ProtoDUNE the separation between exposed metal through-hole pads is about 0.5 mm.