EIC HRPPD evaluation @ BNL

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eRD110 meeting, June 5, 2024

EIC HRPPD assembly

Fused silica window

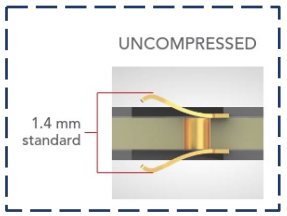
MCPs, spacers, etc

Side wall

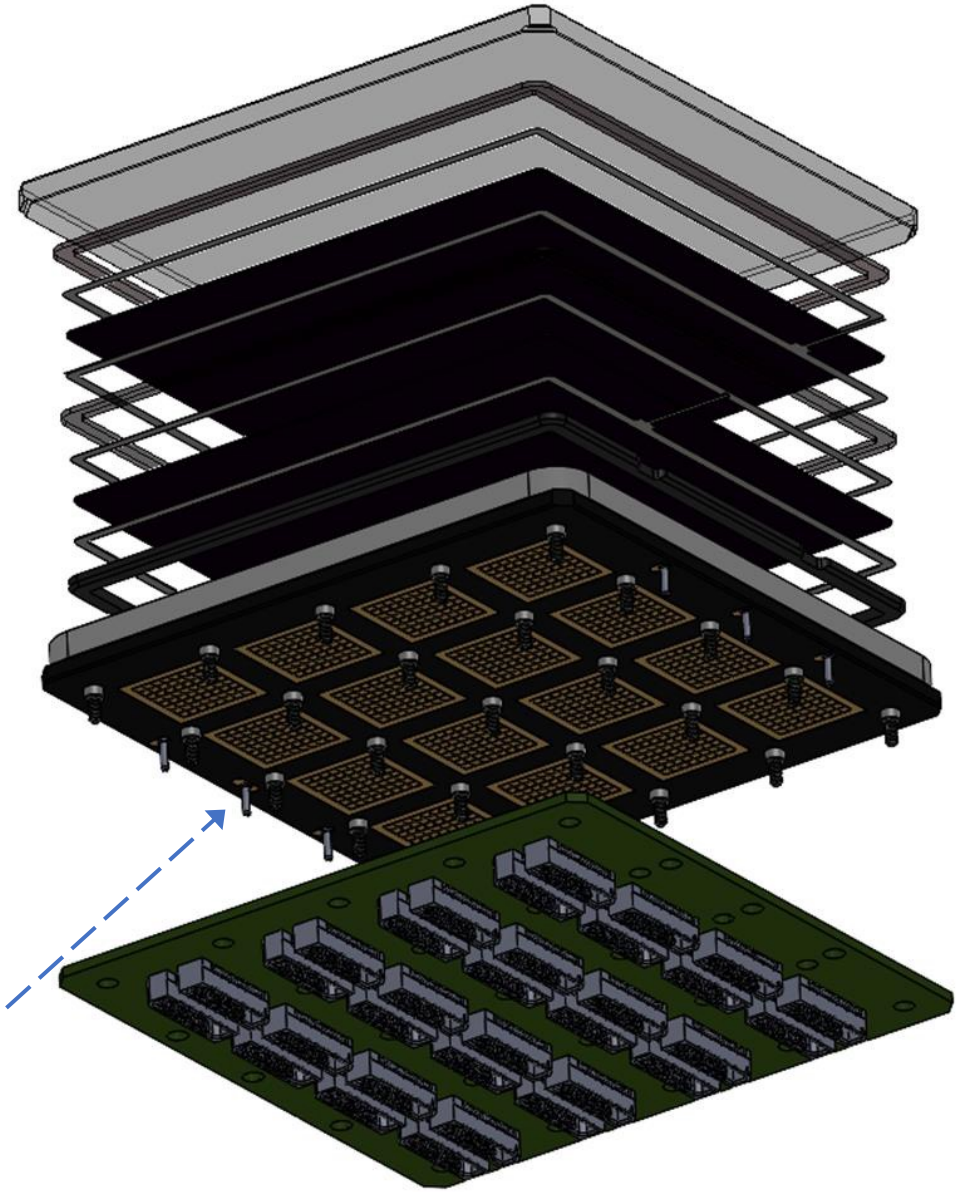
Anode plate (Y03h),
a pre-routing ceramic circuit board

Compression interposers
(not shown)

Interface PCB (Y05f)



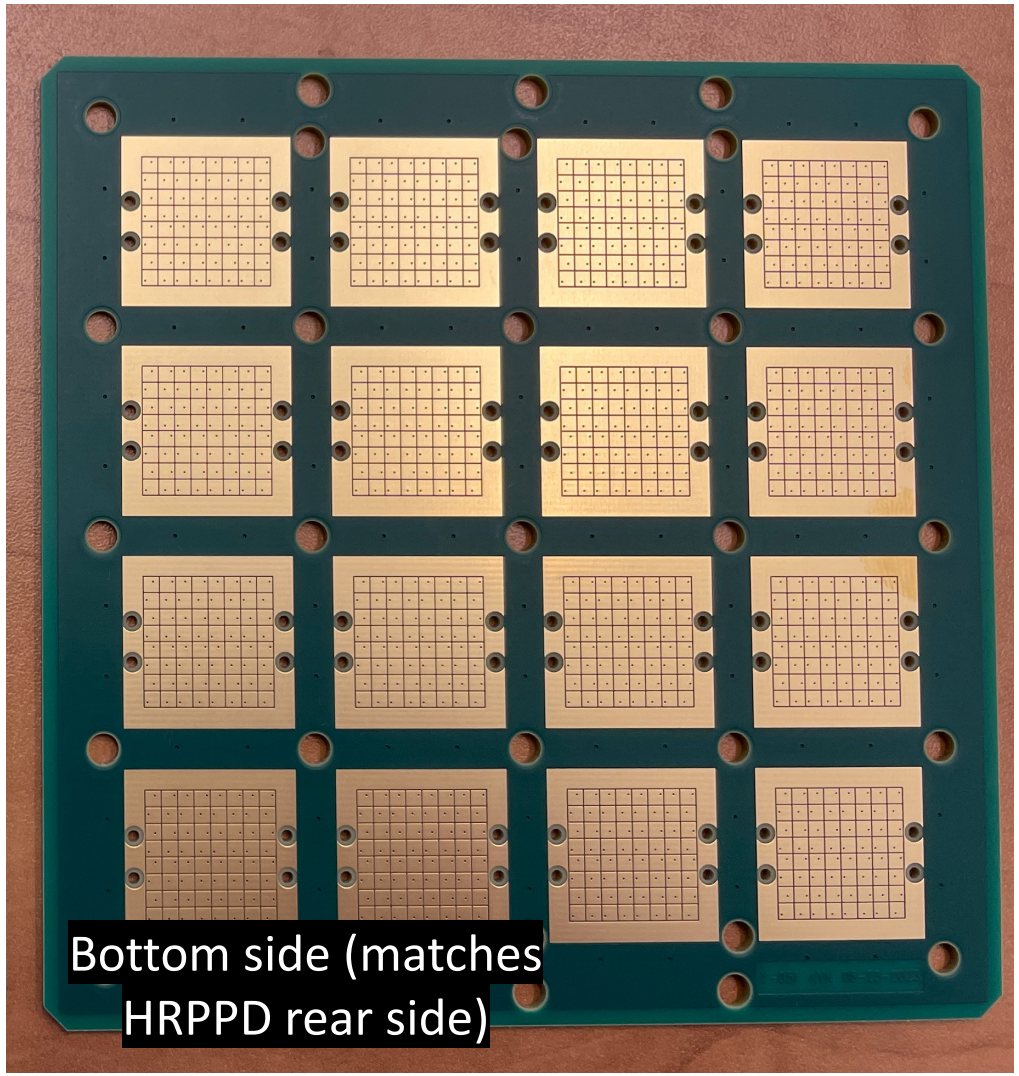
4x4 spots, each with 8x8 square pads; 3.25mm pitch



Charge path: (1) vacuum side anode pads -> anode plane stackup -> air side pads -> compression interposers -> (2) interface PCB -> MMCX adapter PCB -> pigtail RG-316 (?) cables -> 6” RG-174 cables -> V1742 digitizer

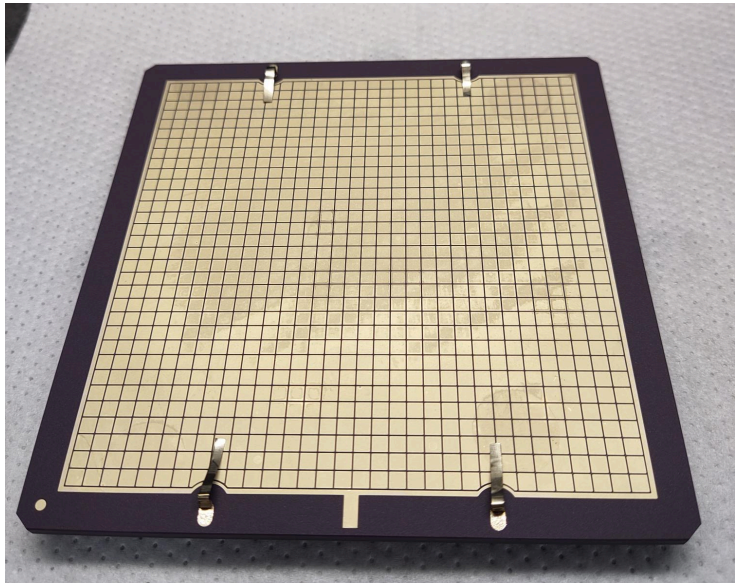
Cross-talk evidence

HRPPD passive interface PCB (Y05f)

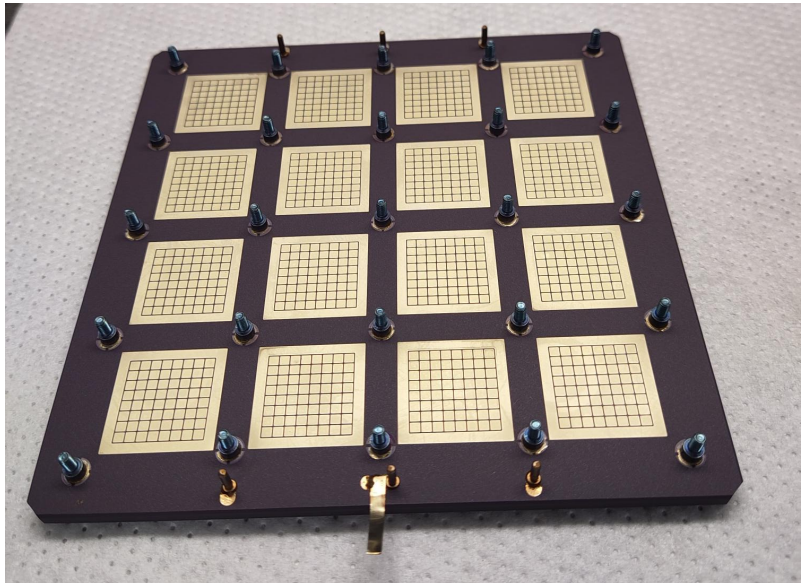


- A simple 119mm x 119mm two-layer board with Samtec ERF8 connectors

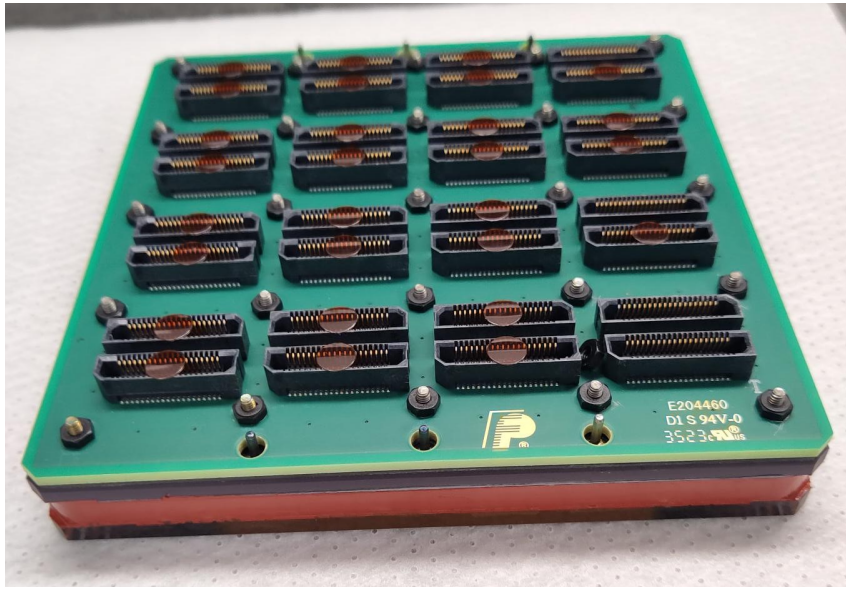
Picture gallery



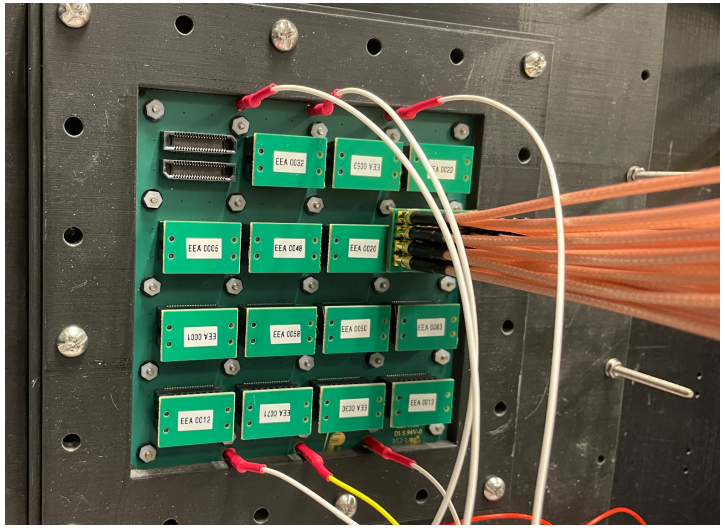
Anode plate vacuum side



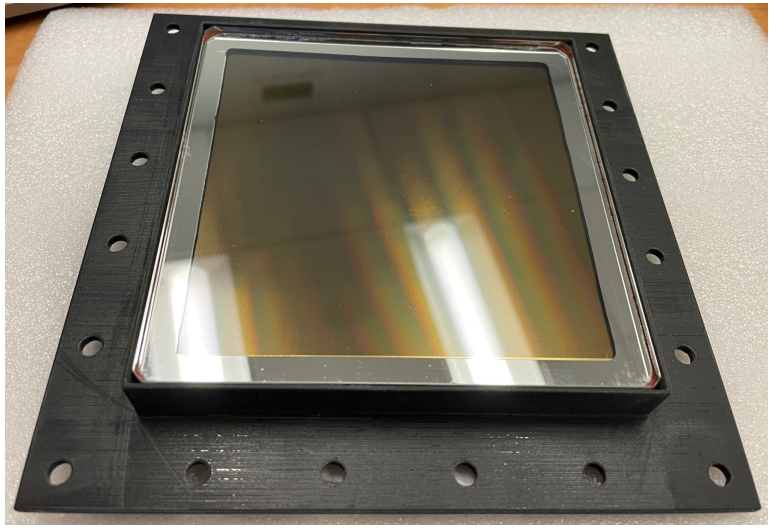
Anode plate air side



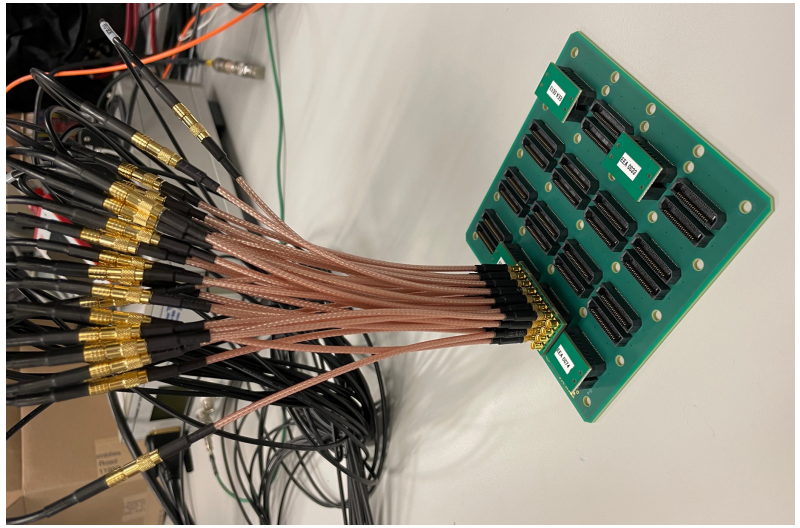
With Y05f board mounted



With MMCX interface

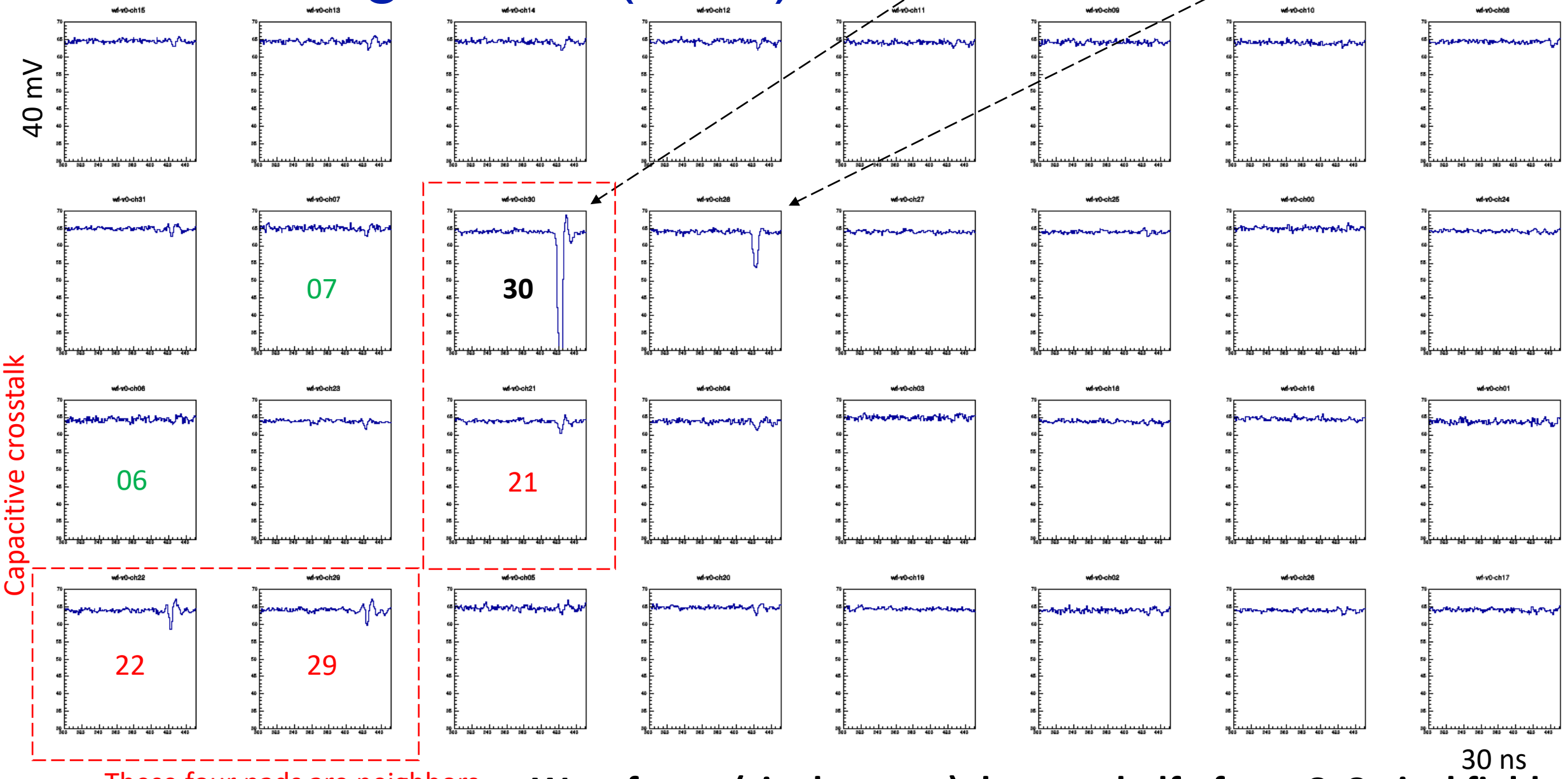


Fused silica window



MMCX -> MCX pigtail cables

Crosstalk signature (SPE)



These four pads are neighbors on a Samtec ERF8 connector

Waveforms (single event): bottom half of one 8x8 pixel field

Electronics channel routing of a single 4x8 pad area

Channel numbering 00 .. 31 as connected to a single V1742 digitizer

15	07	G	14	06	13	05	G	12	04	11	03	G	10	02	09	01	G	08	00
31	23	G	**30**	22	29	21	G	28	20	27	19	G	26	18	25	17	G	24	16

Samtec ERF8 / ERM8 connector pinout

Neighbor on the air side anode surface

15	14	13	12	11	10	09	08
07	06	05	04	03	02	01	00
31	**30**	29	28	27	26	25	24
23	22	21	20	19	18	17	16

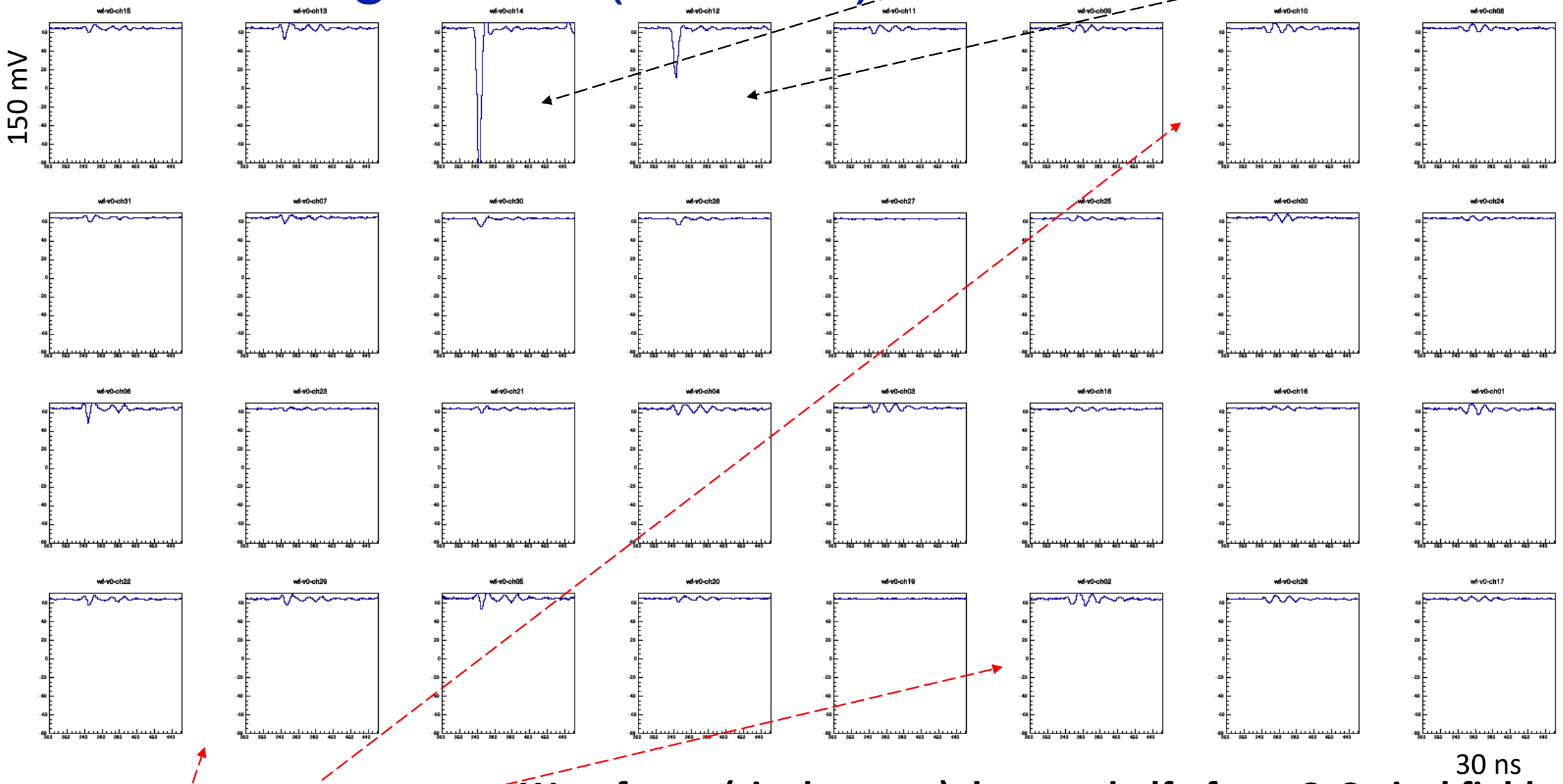
Y05f -> HRPPD interface

Neighbor on the vacuum side anode surface

15	13	14	12	11	09	10	08
31	07	**30**	28	27	25	00	24
06	23	21	04	03	18	16	01
22	29	05	20	19	02	26	17

Physical HRPPD pad map
(bottom half of one of the sixteen 8x8 pad spots, as seen on the previous slide)

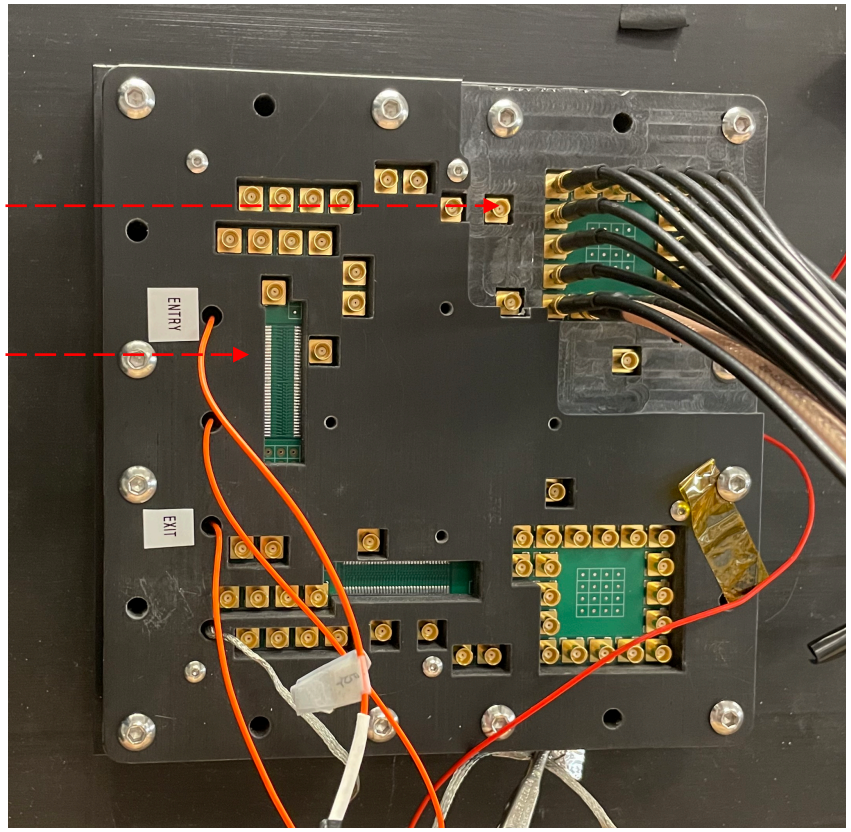
Crosstalk signature (3x SPE)



Mitigation strategy

Our options [for a passive interface]

- Verify that origin of this cross-talk is the backplane PCB
  - (1) Make sure there is no such cross talk in the old HRPPD #6 with MCX connectivity in its P00i backplane
  - (2) Optionally, make sure there is one when connecting via Samtec MEC8 DV interface, which should suffer from the same problem
  - (3) Alternatively, use HRPPD #6 as a reference pulse generator, and pass the signal through a Y05f board without connecting it to HRPPD #15 (or even through a MMCX-Y05f-interposer-Y05f-MMCX sandwich assembly)



- Choose a different type of connector, re-design the interface board & the cable bundle; order ten sets new
  - See what's up with the HGCROC backplane design

- If cross-talk is due to a routing in the EIC HRPPD anode plate itself, then we have a much bigger problem

Connector choice criteria

- Reliable manufacturer

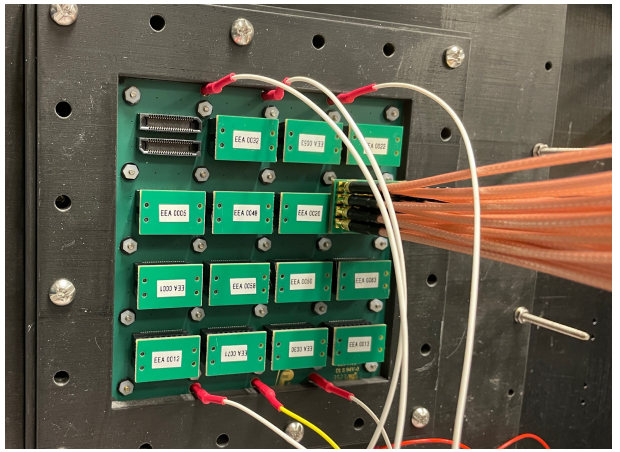
- Either enough pins to make at least half of them grounded, or a grounding plane, or both
- Minimal insertion (and extraction!) force

- Simple routing of both the interface board itself and the MCX (MMCX) adapters

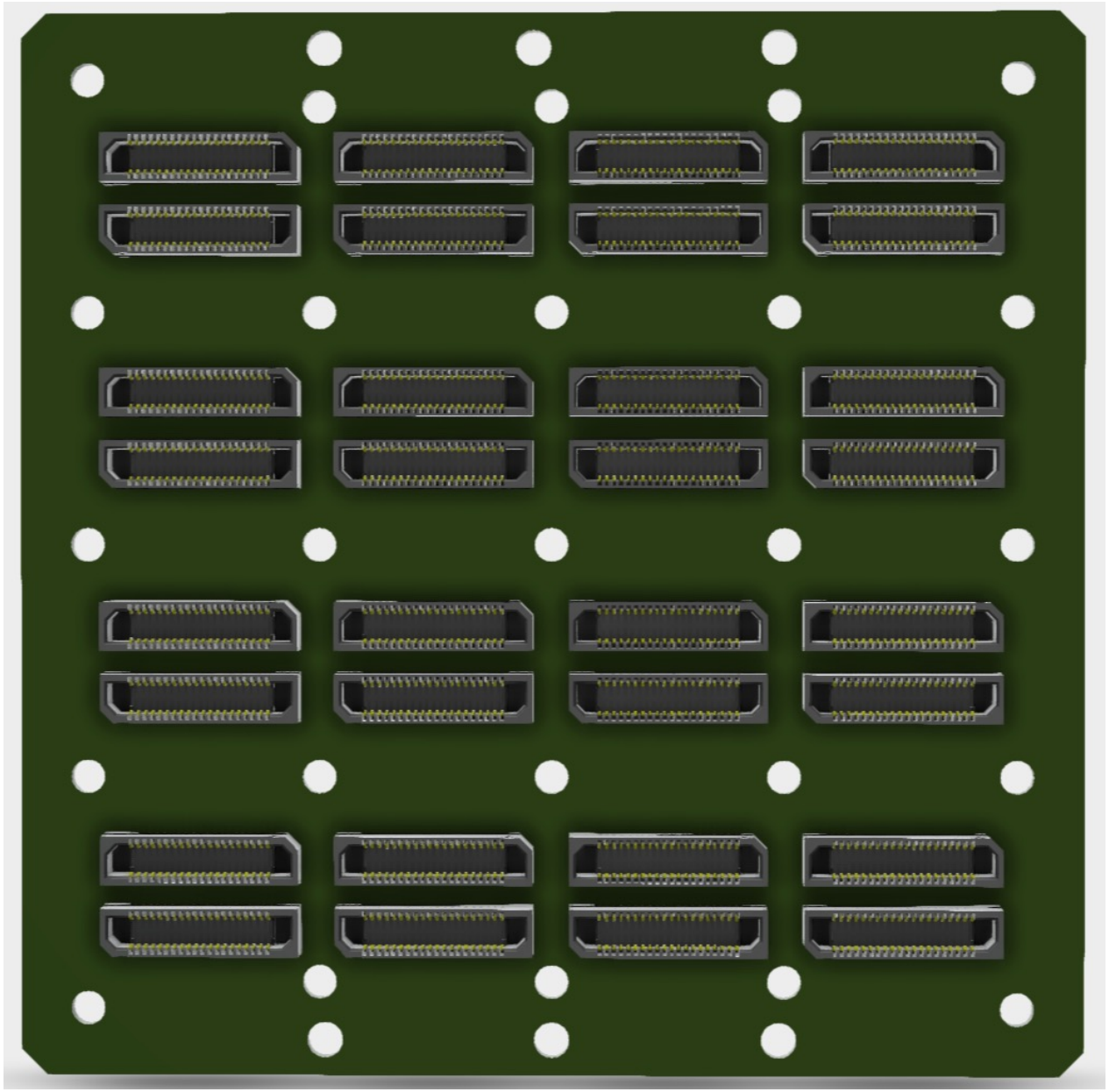
- Cost (and associated variety & cost of the MCX / MMCX adapter boards)

- Minimal warping on the PCB after the assembly

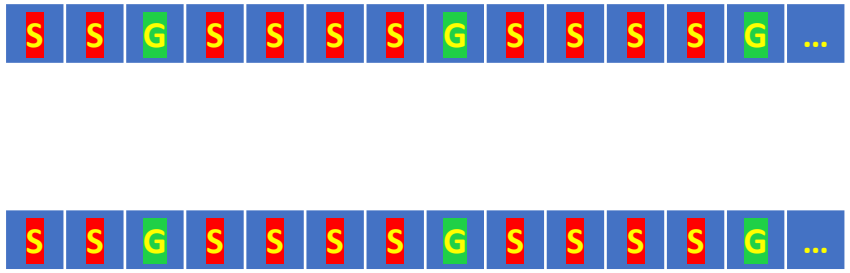
In the following it is assumed that a cable bundle is attached to a subset of these connectors, to provide a *partial* connectivity to V1742 module(s)



Samtec ERF8-020-05.0-L-DV (present Y05f board)



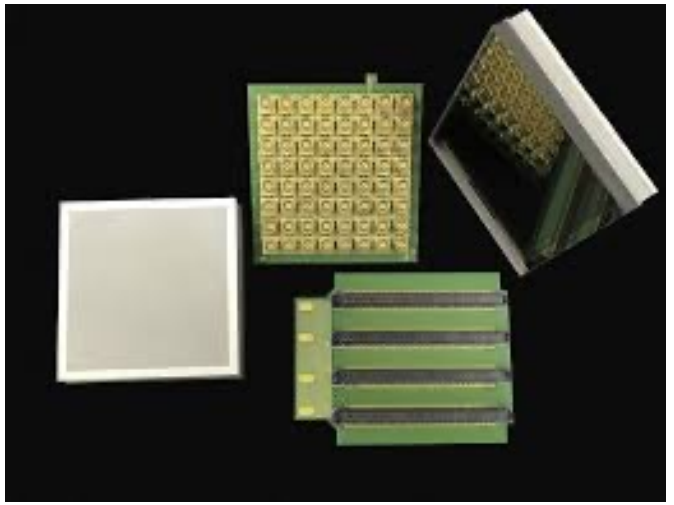
single connector pinout

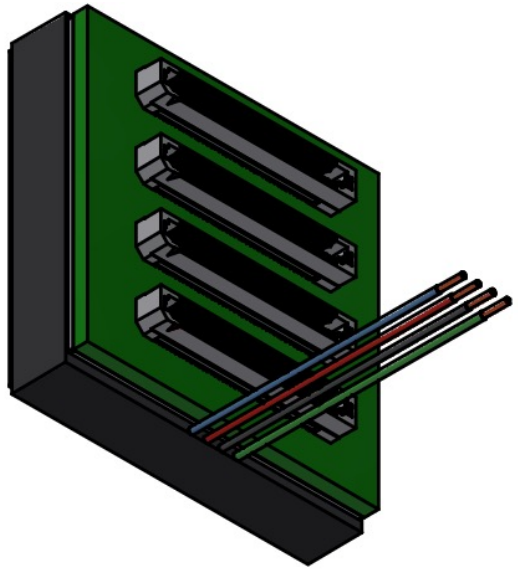


- 800 μm pitch
- Insertion “force”: 80 pins per 8x8 pad spot
- 32x ~$5.0 -> ~$150 / board
- Pros
  - It exists (together with a 32ch MMCX interface) and must be sufficient for single photon studies
  - 180^0 symmetry in every 8x8 pad spot
    - Simplifies a passive interface design [?]
- Cons
  - [Hopefully], lack of ground pins is the X-talk origin

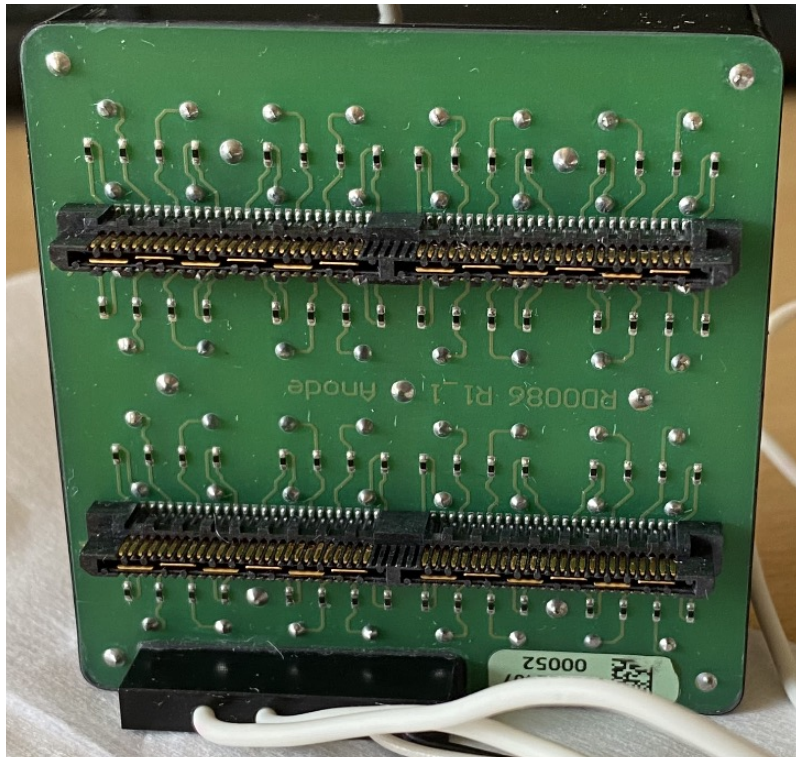
A note on Photek Auratek MAPMT253 backplane

- It uses pretty much the same ERF8-040-05.0-L-DV Samtec connectors
- Pad traces are grouped by four, without interleaved ground ones
  - May exhibit the same cross talk as we observe with the present HRPPD backplane

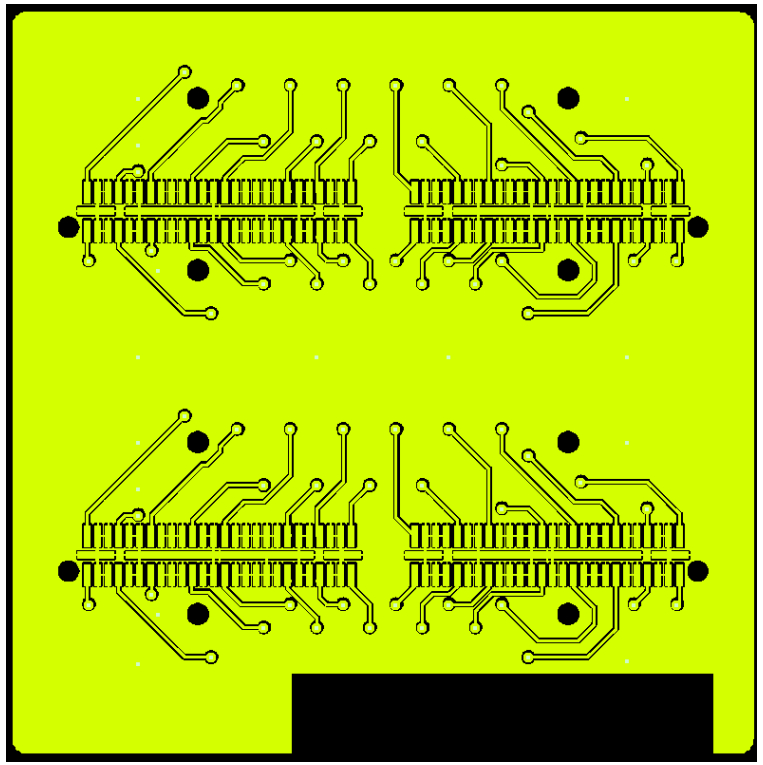




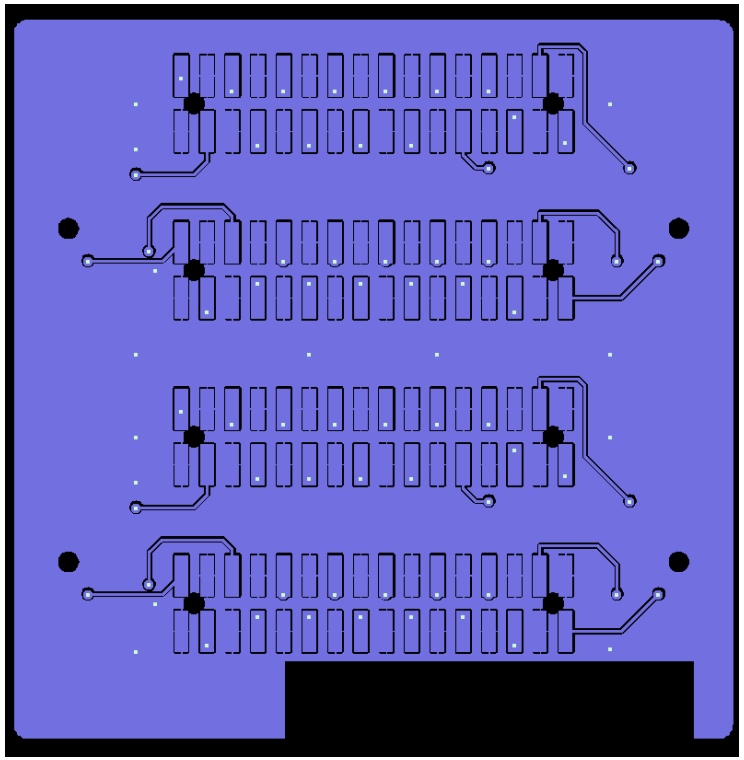
A note on Photonis Planacon interface



2” MCP-PMT; 8x8 pads



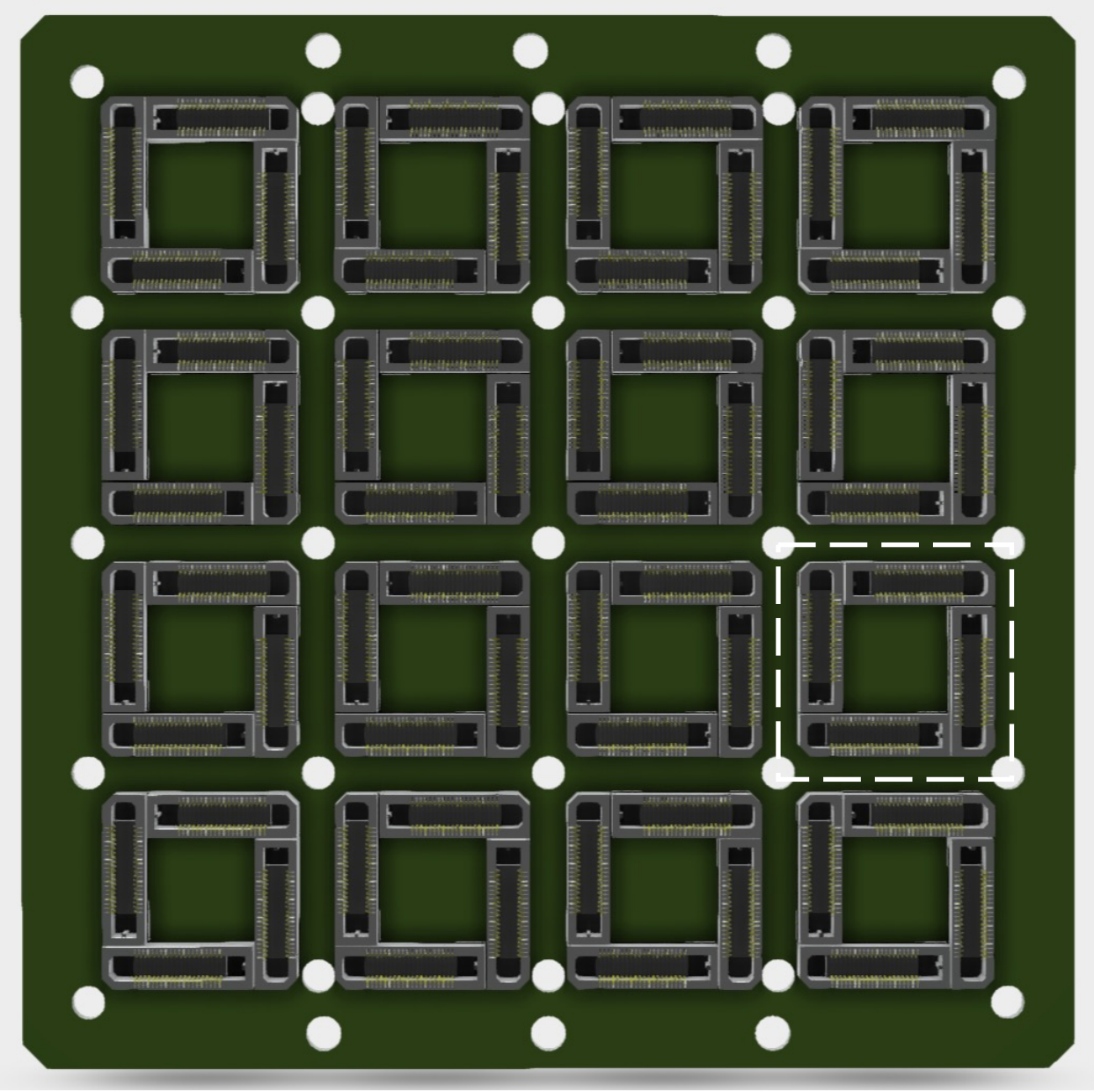
Interface board: sensor side



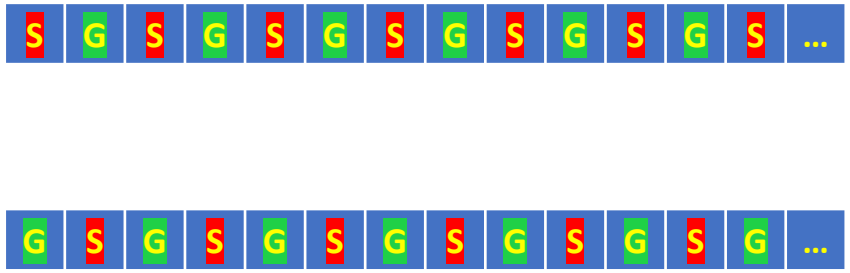
Interface board: outer side

- Photonis backplane has a pair of Samtec QRM8-052-* connectors
  - And a bunch of active components
- A separate interface board is of a straightforward two-layer design (has Samtec QRF8-052-05.0-L-D-A connectors on one side and TMMH-116-01-L-DV-LC ones on the other side)
  - TMMH: 2mm pitch; 2x16 pins per connector; Signal & Ground pins in a chessboard fashion

Samtec ERF5-020-05.0-L-DV

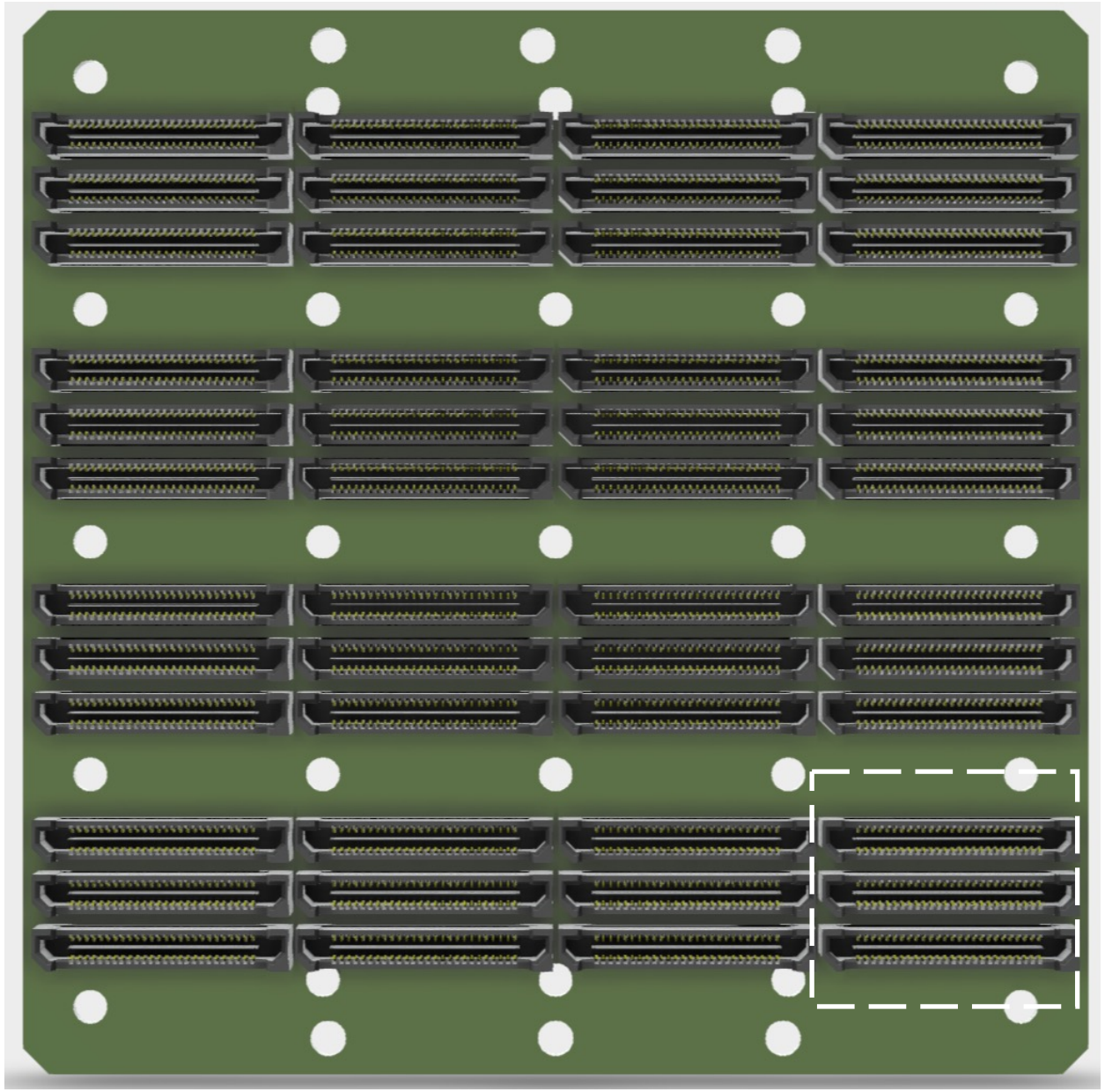


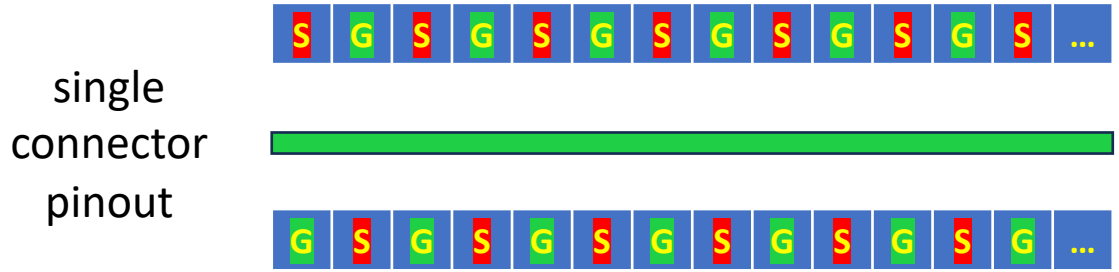
single connector pinout



- 500 μm pitch
- Insertion “force”: 160 pins per 8x8 pad spot
- 64x @ ~$3.0 -> ~$200 / board
- Pros
  - A bit more compact than 800 μm options
  - 90^0 symmetry in every 8x8 pad spot
    - Simplest possible interface design (4x4 16ch MCX connectors on a 25mm x 25mm mini-PCB in every 8x8 pad spot); fully tilable
- Cons
  - No ground plane

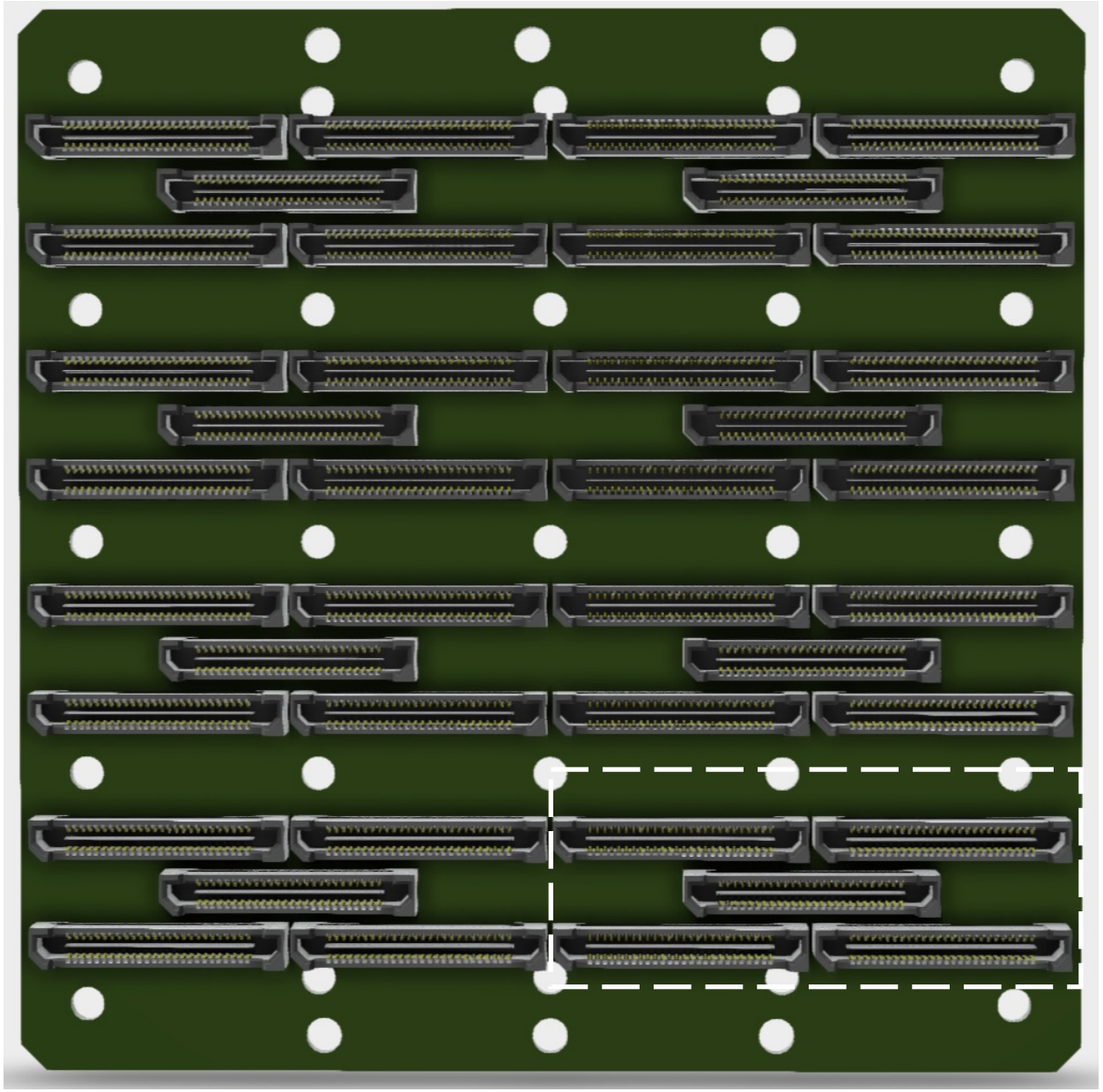
Samtec QRF8-026-05.0-L-D-A #1

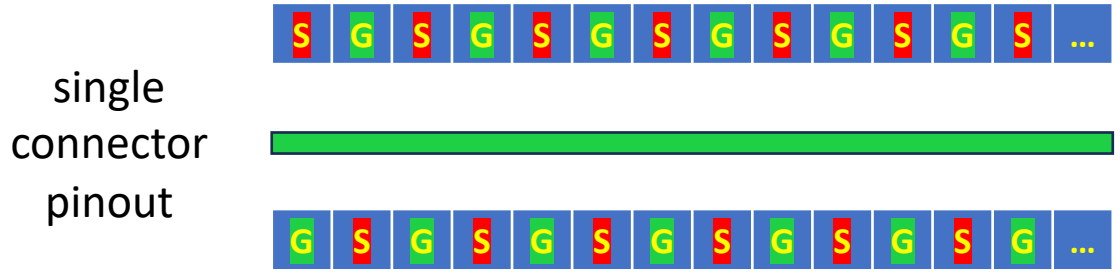




- 800 μm pitch
- Insertion “force”: 156 pins per 8x8 pad spot
  - And ground plane contacts
- 48x @ ~$9.0 -> ~$450 / board
- Pros
  - Ground plane
- Cons
  - No rotation symmetry in an 8x8 pad spot
    - Either MMCX (or especially MCX) interface will be of a nasty design; for sure not tilable
    - Two types of 32ch MMCX adapters will likely be needed (and even more for MCX version)

Samtec QRF8-026-05.0-L-D-A #2 (less connectors)

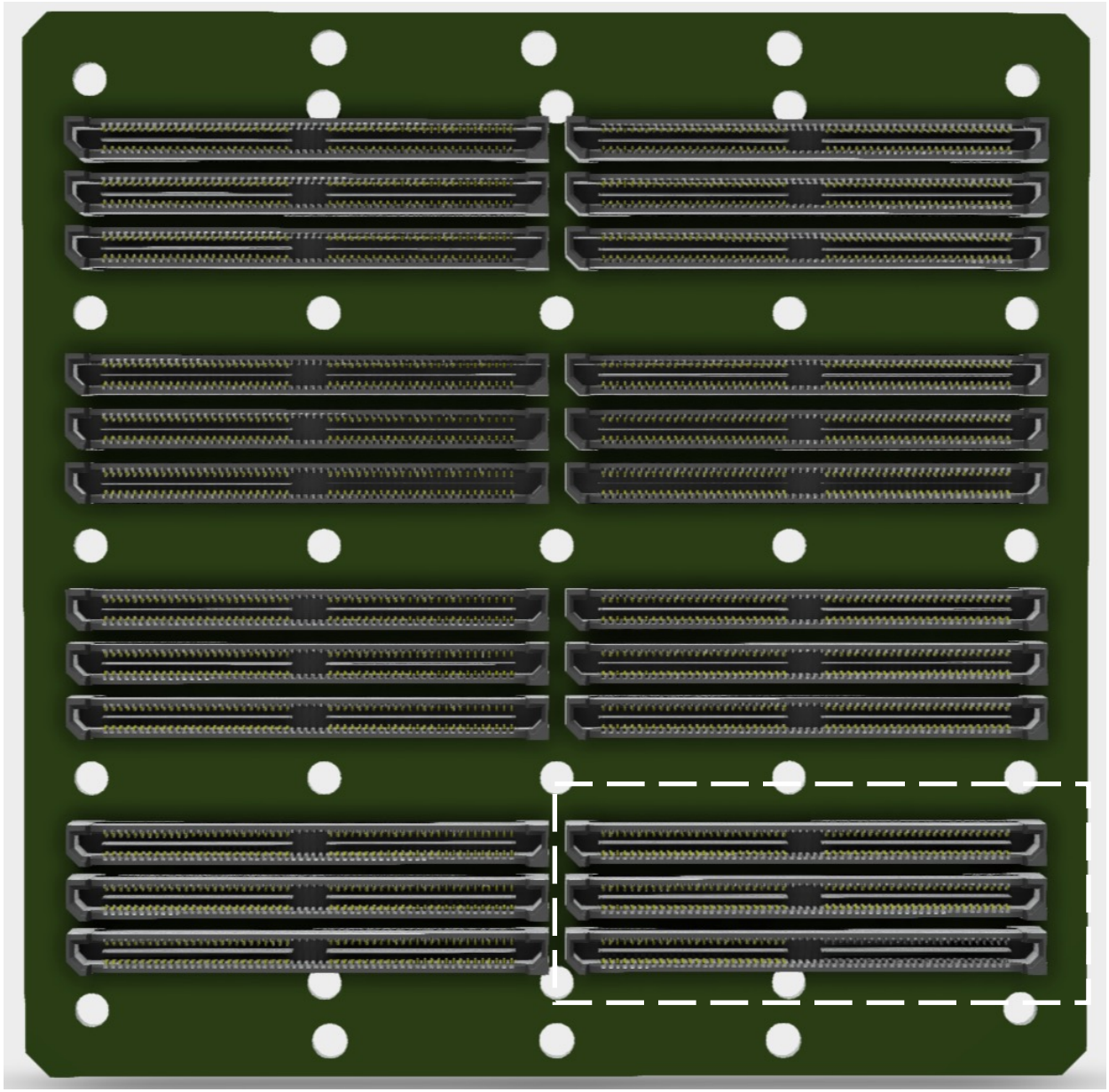


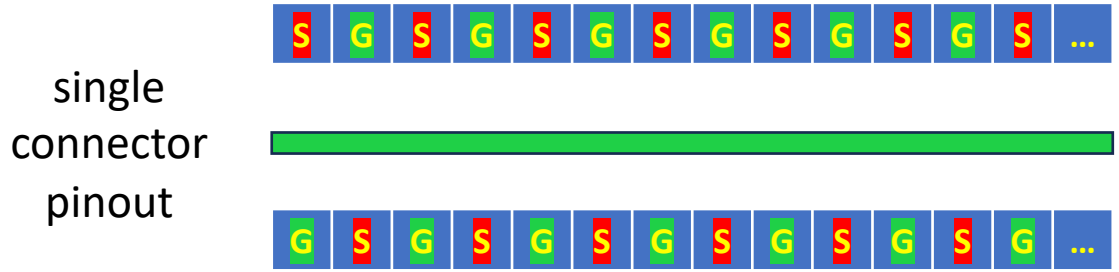


- 800 μm pitch
- Insertion “force”: 130 pins per 8x8 pad spot
  - And ground plane contacts
- 40x @ ~$9.0 -> ~$350 / board
- Pros
  - Ground plane
- Cons
  - Will have to use 8x16 pad interface PCBs
    - Worst possible option for routing
    - Four different types of tilable 32ch MMCX adapters

Samtec QRF8-052-05.0-L-D-A

These ones are used on Albert's Planacon interface

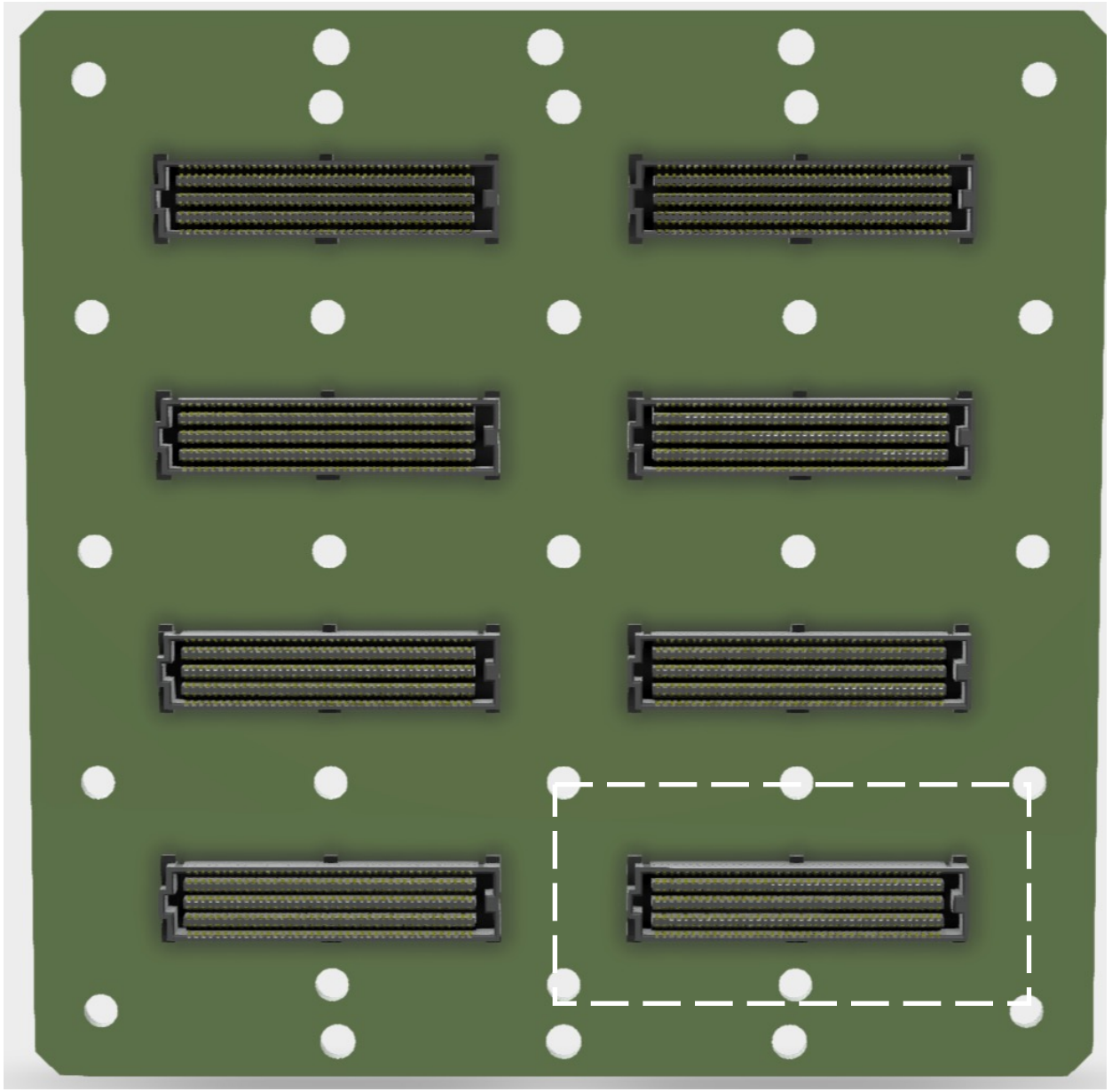




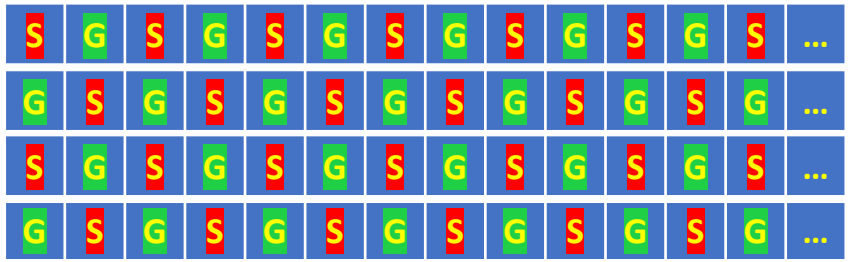
- 800 μm pitch
- Insertion "force": 156 pins per 8x8 pad spot
  - And ground plane contacts
- 24x @ ~$11.0 -> ~$250 / board
- Pros
  - Ground plane
- Cons
  - Will have to use 8x16 pad interface PCBs
    - Routing is probably OK
    - Four different types of tilable 32ch MMCX adapters
  - A bit too long (PCB warping?)

Samtec SEAF8-40-05.0-S-08-3

These ones are used on Xilinx KCU105 FPGA kit (?)

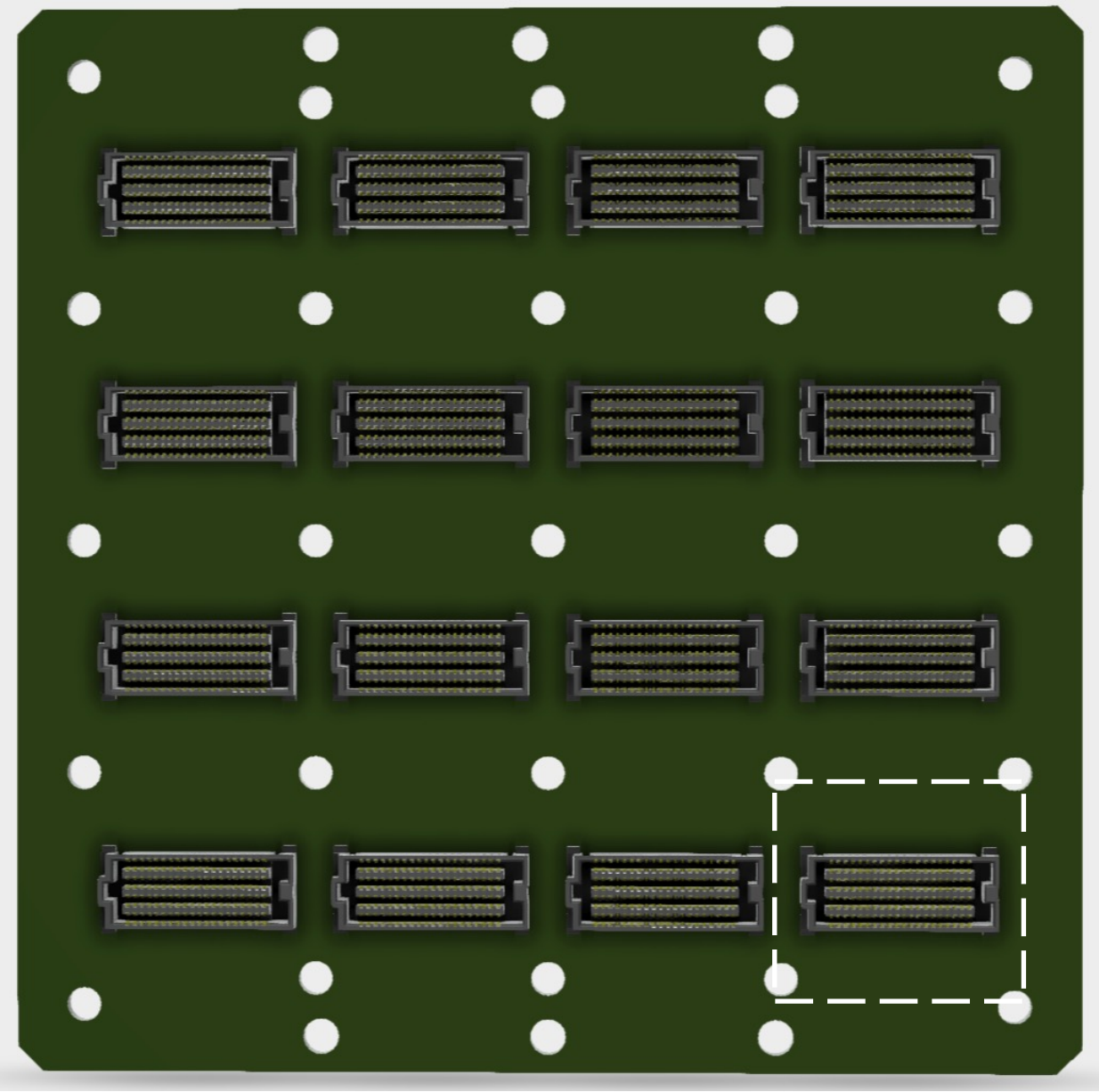


single connector pinout

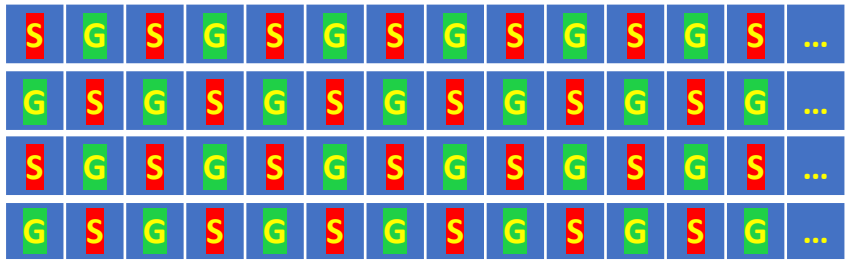


- 800 μm pitch
- Insertion “force”: 160 pins per 8x8 pad spot
- 8x @ ~$45.0 -> ~$350 / board
- Pros
  - Compact
- Cons
  - Will have to use 8x16 pad interface PCBs
    - Routing is probably OK
    - Four different types of 32ch MMCX tilable adapters
  - Looks like worst possible family for X-talk (?)
  - Not available on stock (?)

Samtec SEAF8-20-05.0-S-08-3

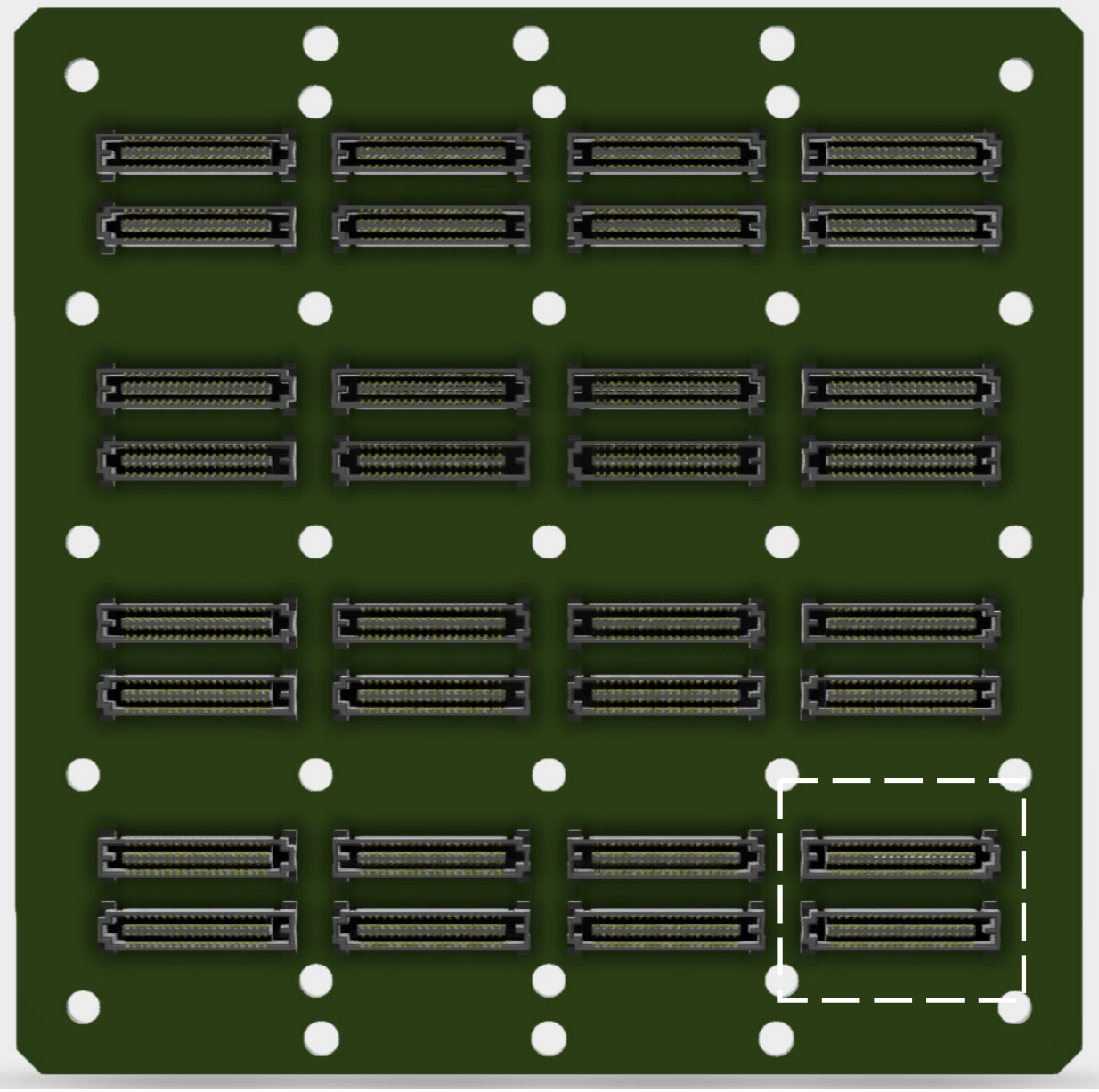


single connector pinout

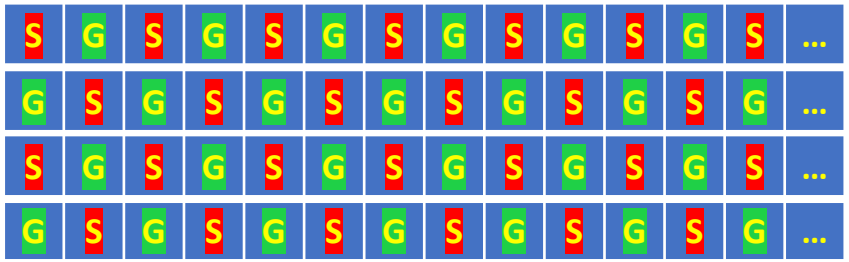


- 800 μm pitch
- Insertion “force”: 160 pins per 8x8 pad spot
- 16x @ ~$15.0 -> ~$250 / board
- Pros
  - Compact
- Cons
  - May consider 8x8 pad interface PCBs?
    - Routing is probably OK
    - Two different types of 32ch MMCX tilable adapters
  - Looks like worst possible family for X-talk (?)

Samtec SEAF8-20-05.0-S-04-3

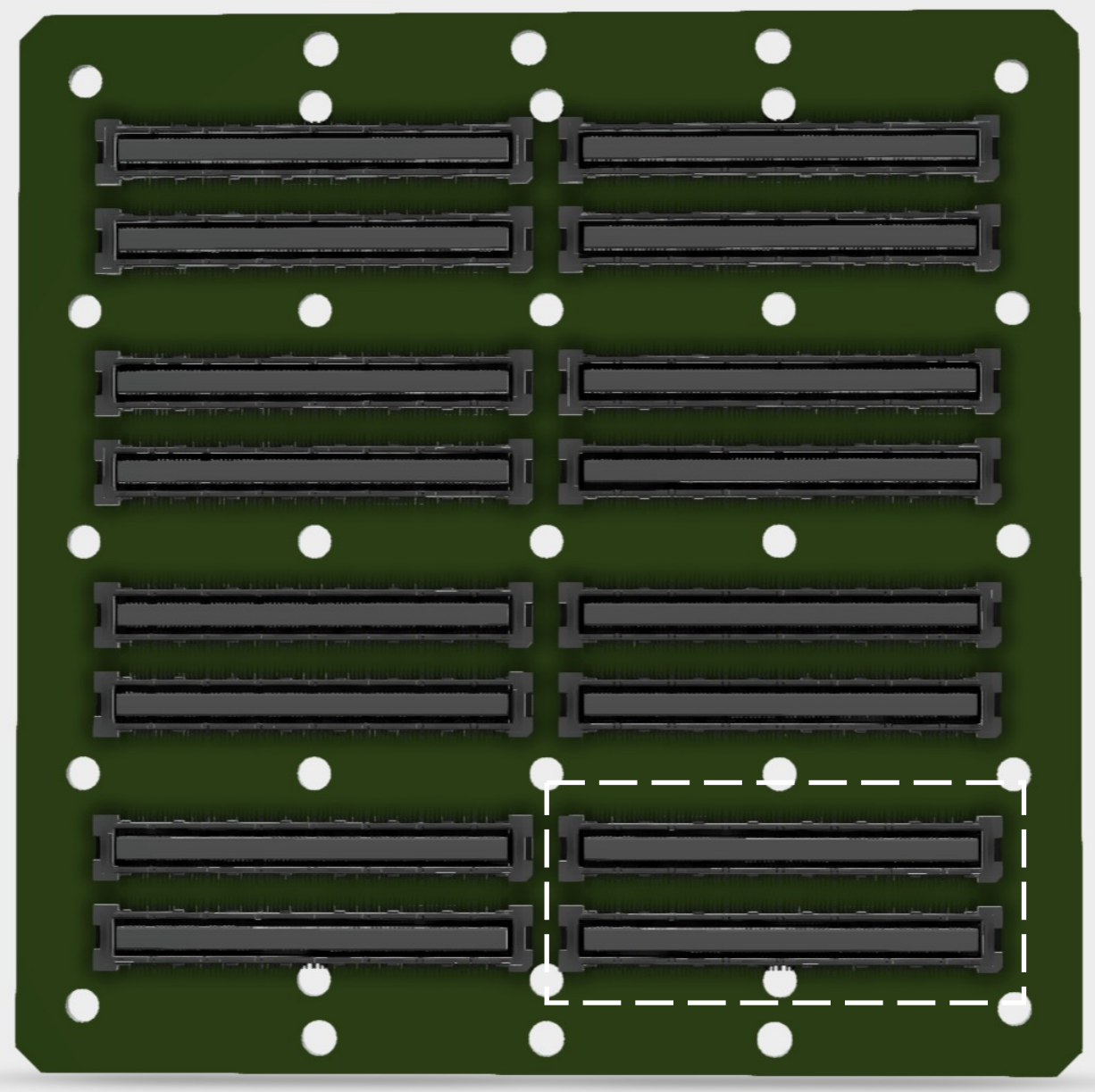


single connector pinout

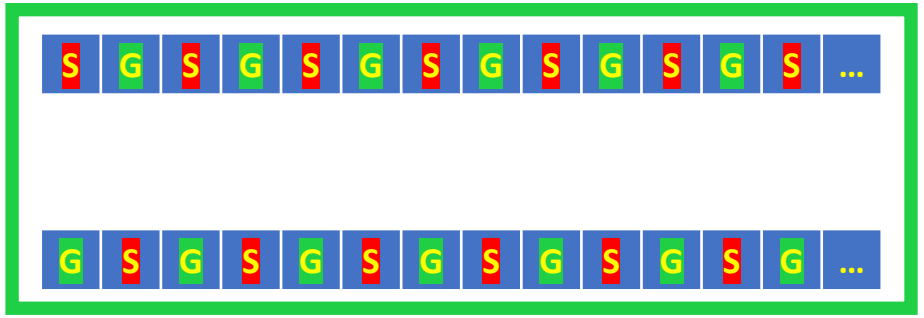


- 800 μm pitch
- Insertion “force”: 160 pins per 8x8 pad spot
- 32x @ ~$10.0 -> ~$300 / board
- Pros
  - Compact
- Cons
  - May consider 8x8 pad interface PCBs?
    - Routing is probably OK
    - 180^0 rotation symmetry -> two different types of 16ch MCX tilable adapters possible
  - Looks like worst possible family for X-talk (?)

Hirose FX10A-140S/14-SV

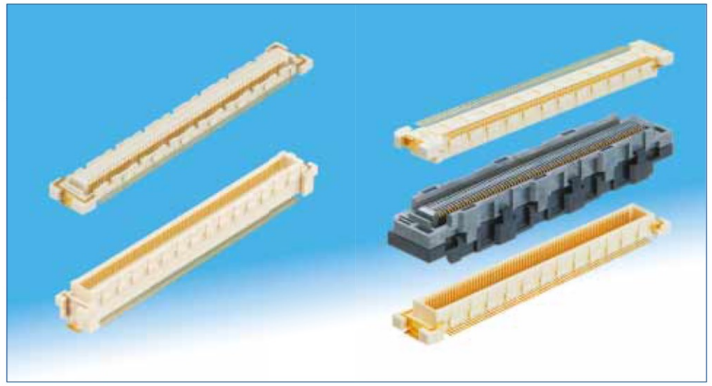


single connector pinout

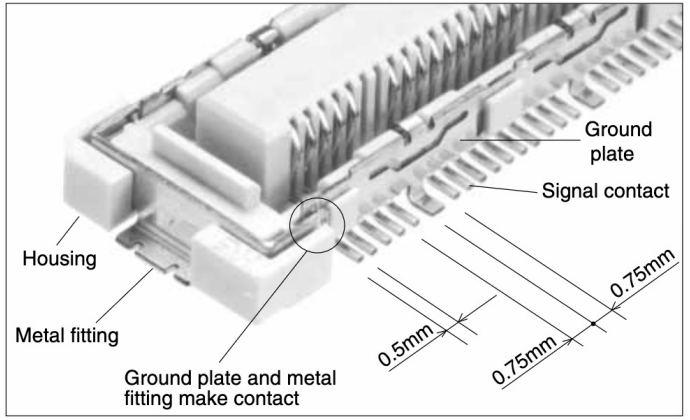


- 500 μm pitch
- Insertion “force”: 140 pins per 8x8 pad spot
- 16x @ ~$6.0 -> ~$100 / board (interposers?)
- Pros
  - Floating ground interposer design (next slide)
- Cons
  - 16x8 pad interface PCBs
    - Routing is probably OK
    - 180^0 rotation symmetry -> two different types of 32ch MMCX tilable adapters

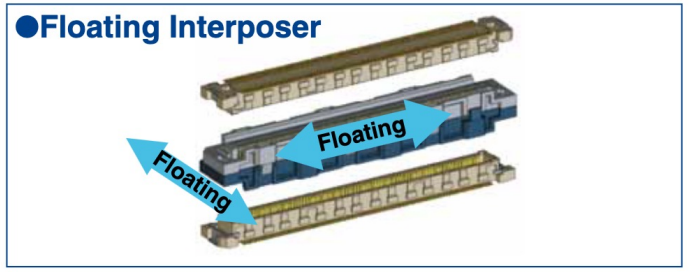
Hirose FX10A-140S/14-SV



■With GND Plate Type



●Floating Interposer



■Mechanical Features

- **0.5mm Pitch**
- **Stacking height : 4 to 8mm (2-piece type)**
  8 to 13mm (3-piece type)
- **Number of Contacts**
  With ground plate : 80 / 100 / 120 / 140
  Without ground plate : 96 / 120 / 144 / 168
  3-piece interposer : 120 / 144 /168
- **OIF MSA-100GLH Electrical Interface**
  FX10A-168P/S-SV(83) assembly is specified for the OIF 100G Long-Haul DWDM Transmission Module host line card - MSA-100GLH electrical connector.

OIF OPTICAL INTERNETWORKING FORUM

- **Suited to High-Density Applications**
  The 0.5 mm signal contact pitch provides a smaller overall connector, using less mounting area on the board.
- **Optional Ground Plate**
  An alternate style without the ground plate is available. The space provided by the ground plate removal has been filled with additional signal contacts.
  <3-piece type>
  ●Smooth floating with high speed transmission capability supported by unique 3-piece floating system
  ●Multiple connectors are allowed on the same PCB (Allowable Mis-alignment Range : ± 0.3mm in XY direction)

Any experience in the community?