

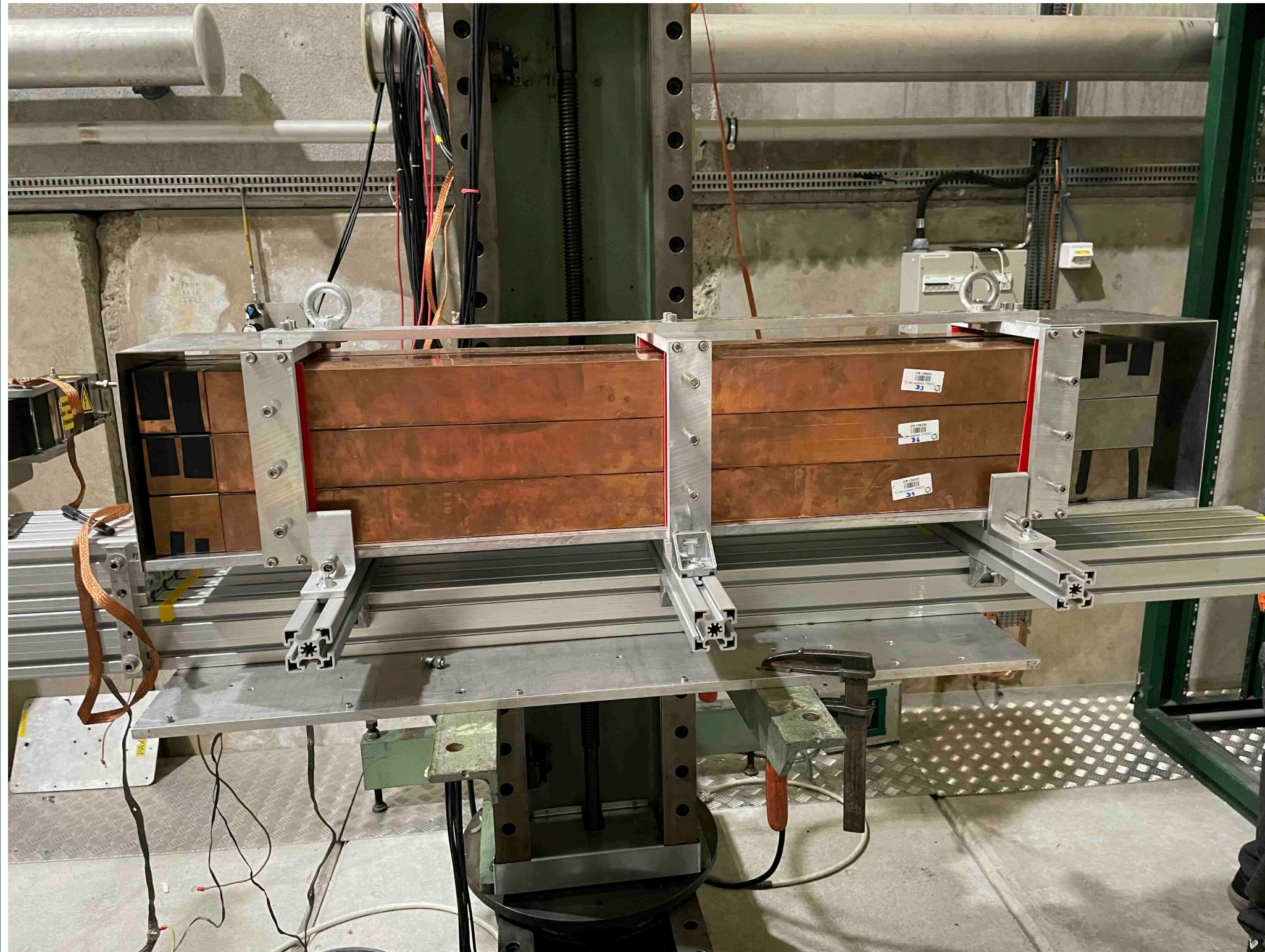
H2GCROC update (Focal-H testbeam)

What we learned for next one...

Norbert Novitzky
(ORNL)

With Miklos Czeller, Gabor Nagy and
Shihai Jia

FoCal-H prototype 3



Capillary tube design:

- Cu tube with scintillating fiber inside
- Tubes are stacked together, reducing air gaps as much as they can
- End scintillators are just attached to 6x6 mm² SiPM's
- Fully tested with CAEN already

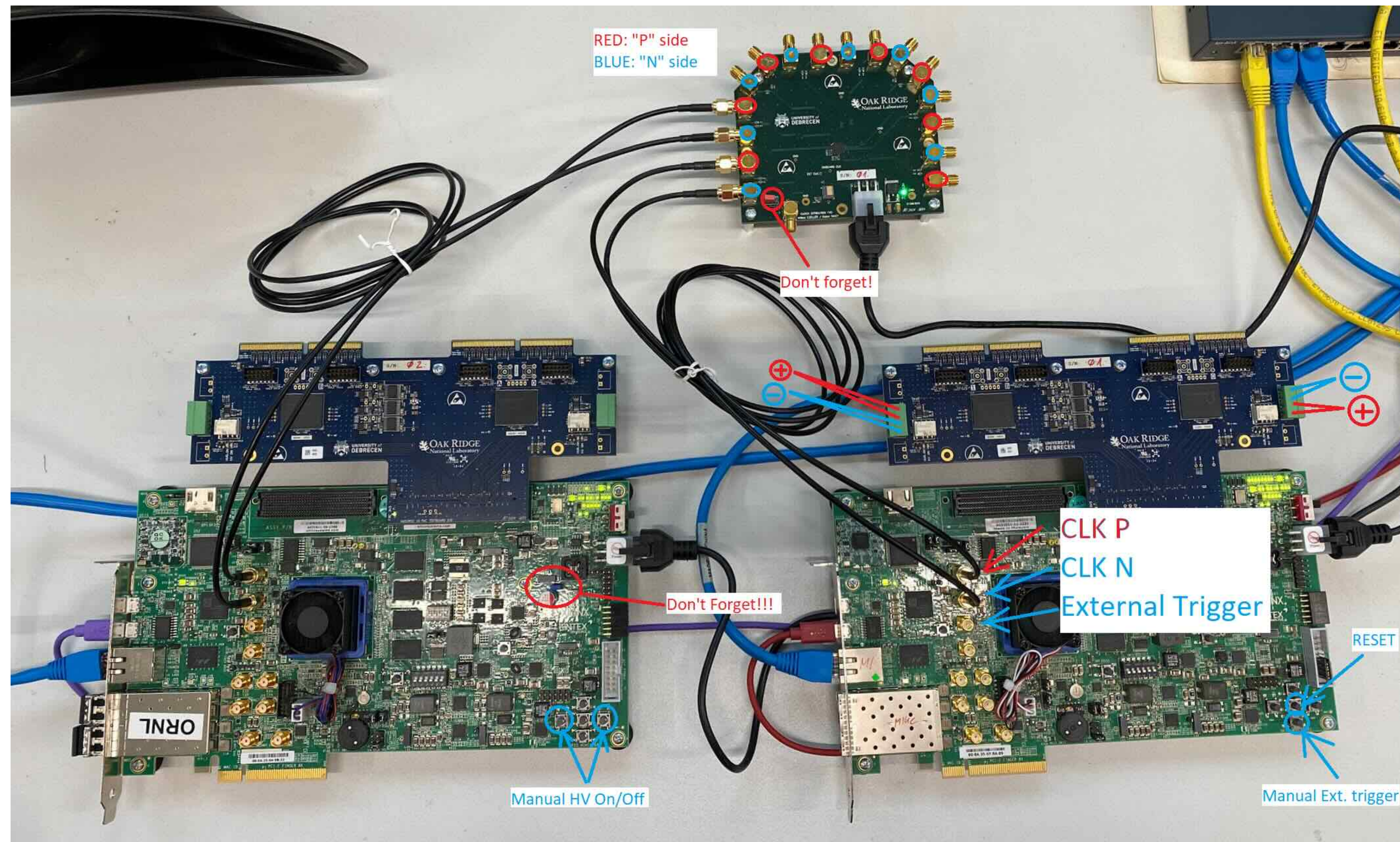
3x3 modules in testbeam:

- Inside module is 7x7 channels
- Outside modules are 5x5 channels
- Altogether is 249 channels (4 H2GCROCs can cover it)

Readout setup

2 KCU's needed, each connected with 2 H2GCROC protoboard2.0:

- Common clock for the KCU's are provided with an LVDS external clock board



Communication with the KCU is via UDP:

- Usually 40-byte commands in set formats
- Data is coming in 40-byte format also, sectioned in the firmware by the FPGA

Slow control:

- I2C setup for each H2GCROC
- HV On/Off
- DAQ setups:
 - Set external trigger on/off
 - Generator, set events
 - Prepulse for calibration
 - Delays adjustment, debug data, etc.

Schedule

FoCal-H Testbeam schedule:

| | Day shift 7am-3pm | Evening shift 3pm-11pm | Night shift 11pm-7am |
|-----------|----------------------|---------------------------|-------------------------|
| 22nd Wed | Installation | 7pm first beam | H2GCROC |
| 23rd Thur | CAEN | | |
| 24th Fri | | | |
| 25 Sat | | | |
| 26 Sun | | | |
| 27 Mon | H2GCROC | | |
| 28 Tue | | | |
| 29 Wed | Removal | | |

Purpose for first night was to try if we can get reasonable data

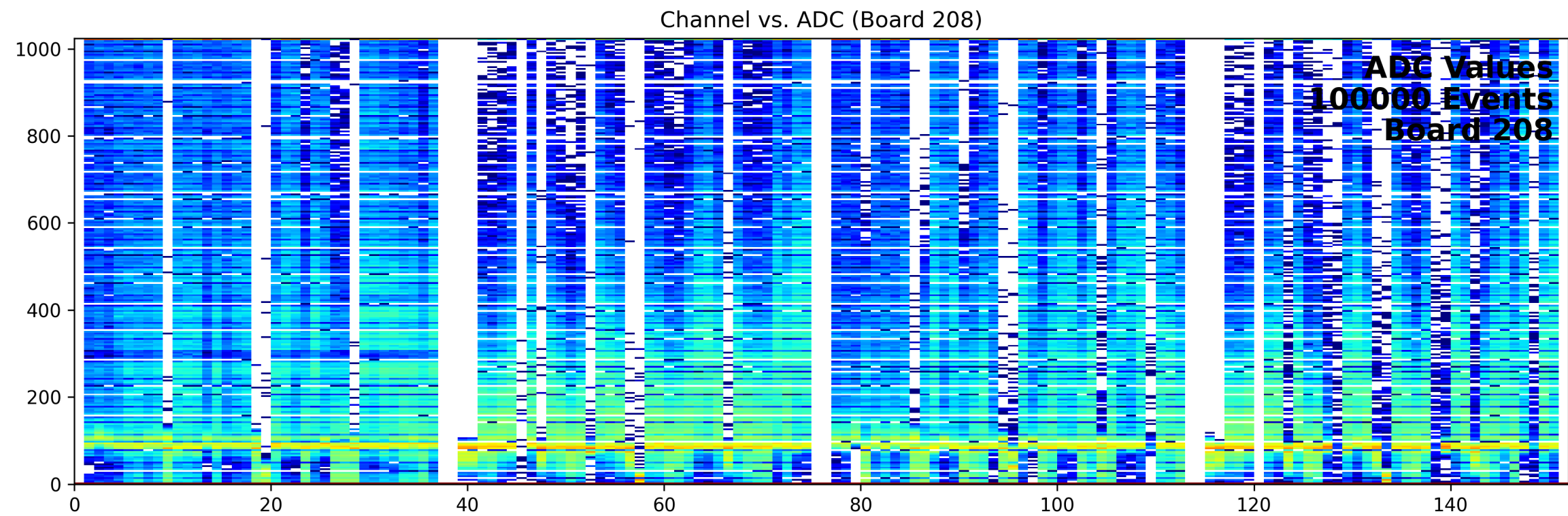
Here we just took data with different energies, check the different responses. Check always for KCU A, KCU B, then KCU A+B runs Very inefficient data taking, but just trying to debug

More smooth data taking, TOA/ TOT were also ‘calibrated’

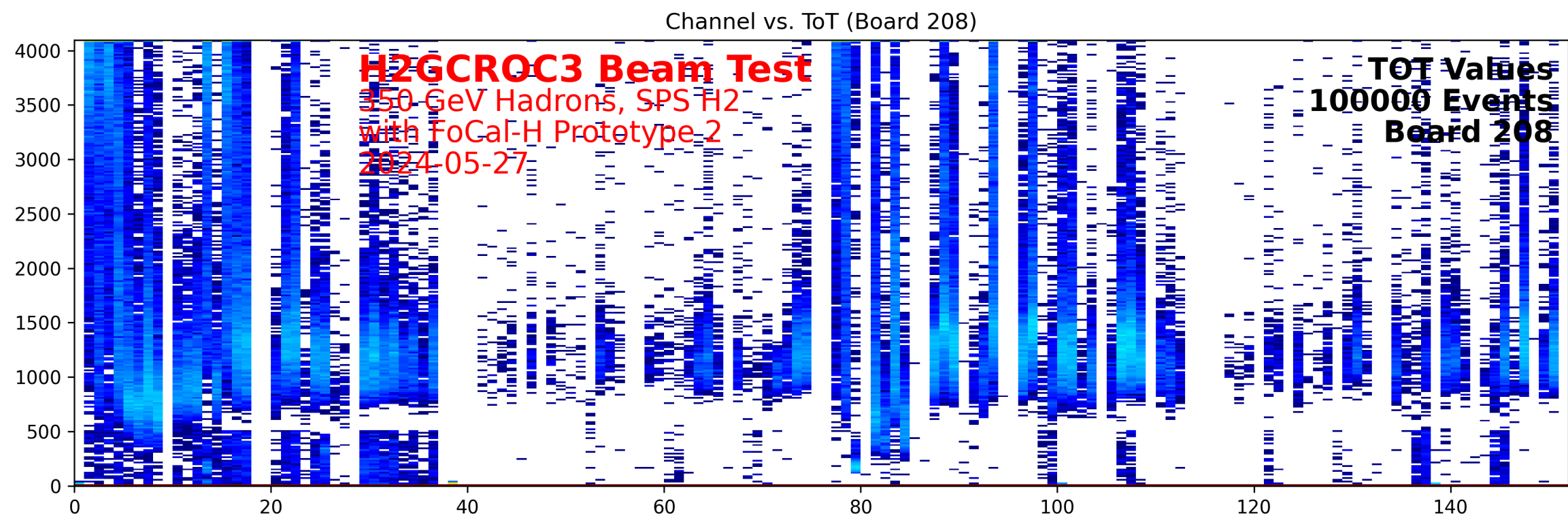
Two day running

| | Run description |
|------------------------|--|
| Run000-006 | Technical runs |
| Run007—015 | Hadron energy scan (each 100k events) 350, 325, 300, 250, 200, 150, 120, 100, 80, 60 GeV |
| Run016—022 + Run052 | Electron energy scan (each 100k) 40, 60, 80, 100, 120, 150, 180, 200 GeV |
| PhaseScan00-15 | Phase scan (internal delay of 25/16 ns) See the full SiPM response |
| Run025—029, Run038—042 | Position scan, hadron beam 250 GeV 10 runs moving the reference by $x/y \pm 6.5\text{cm}$ |
| Run030—033 | Voltage scan, hadron 250 GeV Internal DAC voltage for all channels -1V, -2V, -3V, 0V |
| Run034—037 | Voltage scan, hadron 250 GeV External voltage (on PS) 55V, 54V, 53V, 56V |
| Run043—Run053 | Position scan, electron beam 100 GeV 10 runs moving the reference by $x/y \pm 6.5\text{cm}$ |

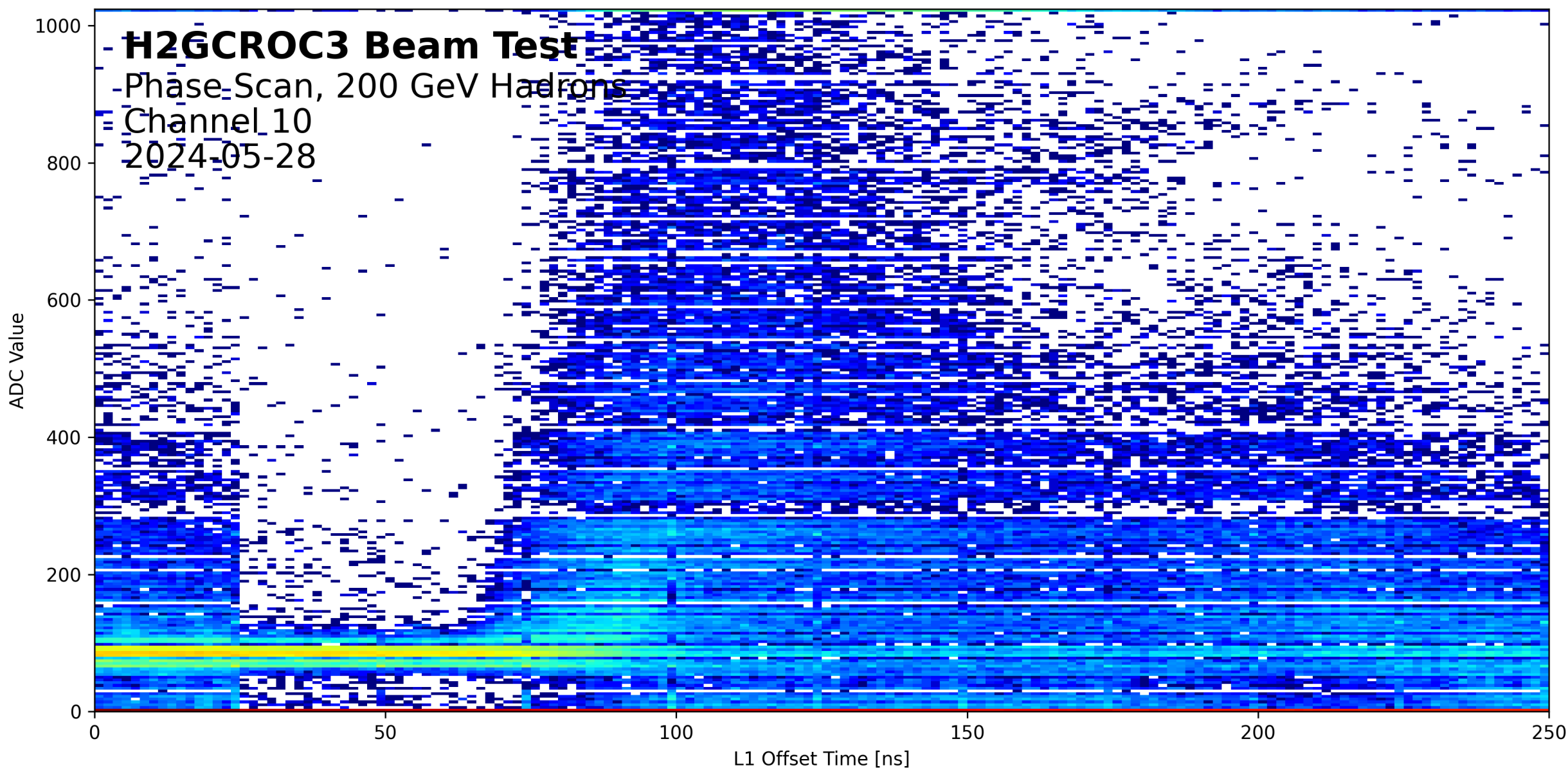
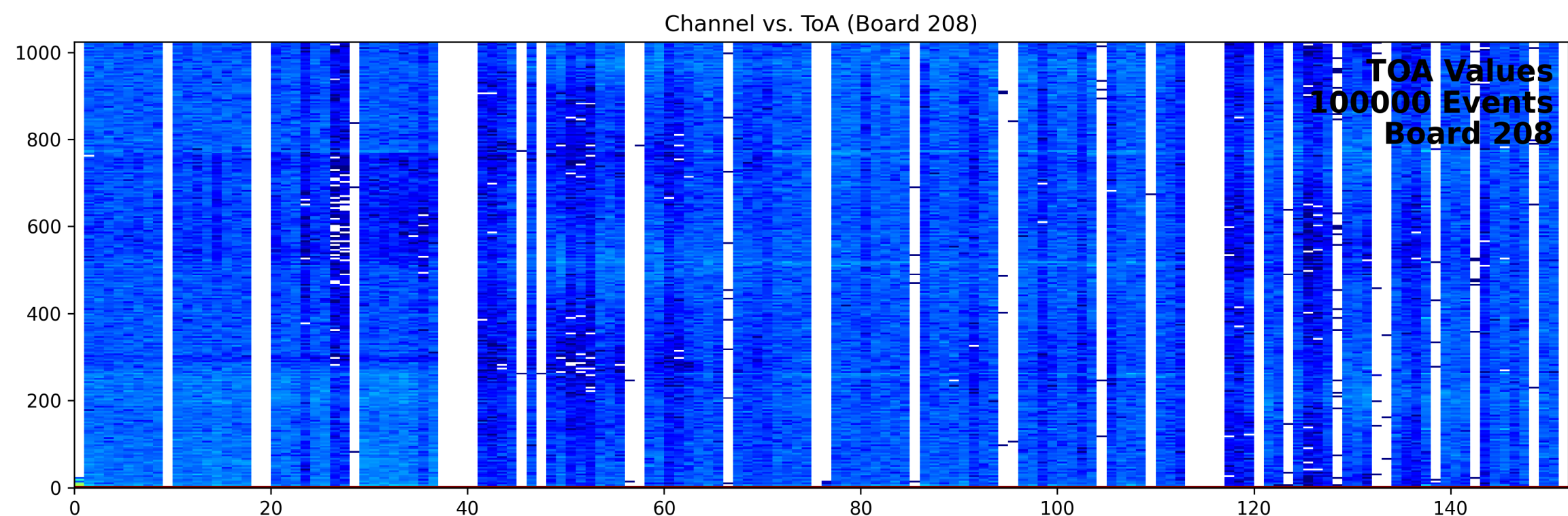
Some very very early results (almost online monitoring)



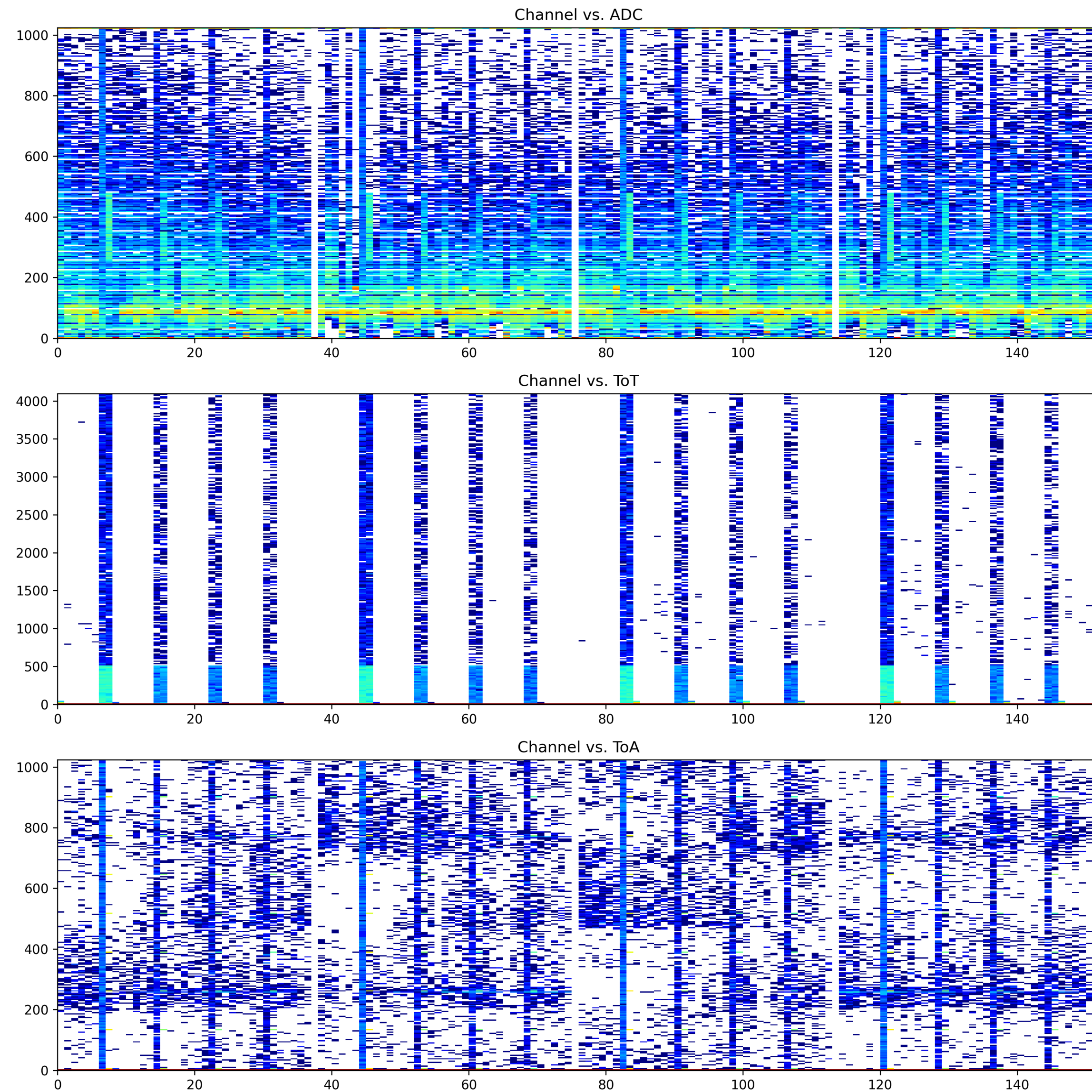
One run of 150 GeV hadrons, TOT and TOA are responding, some channels are cut, but it is mostly in the software (need better reconstruction)



One channel example on the phase scan (sum of 16 runs), ADC only. Overall makes sense, there is a dip in 150-200ns (could be TOT dip, pile up, etc)



Some problems

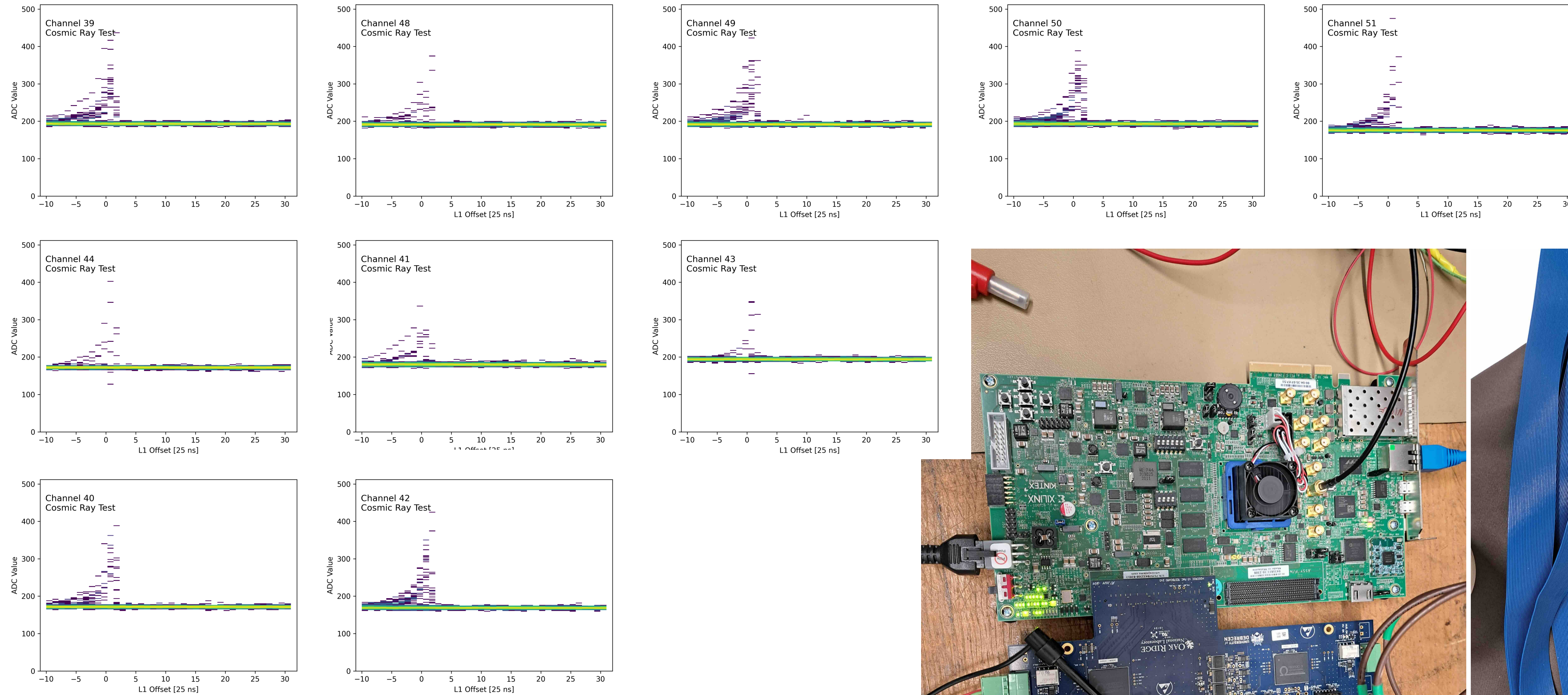


Without the cut, there are strips:

Looks like a counter to me, probably the header is recognized as the 17th channel for example

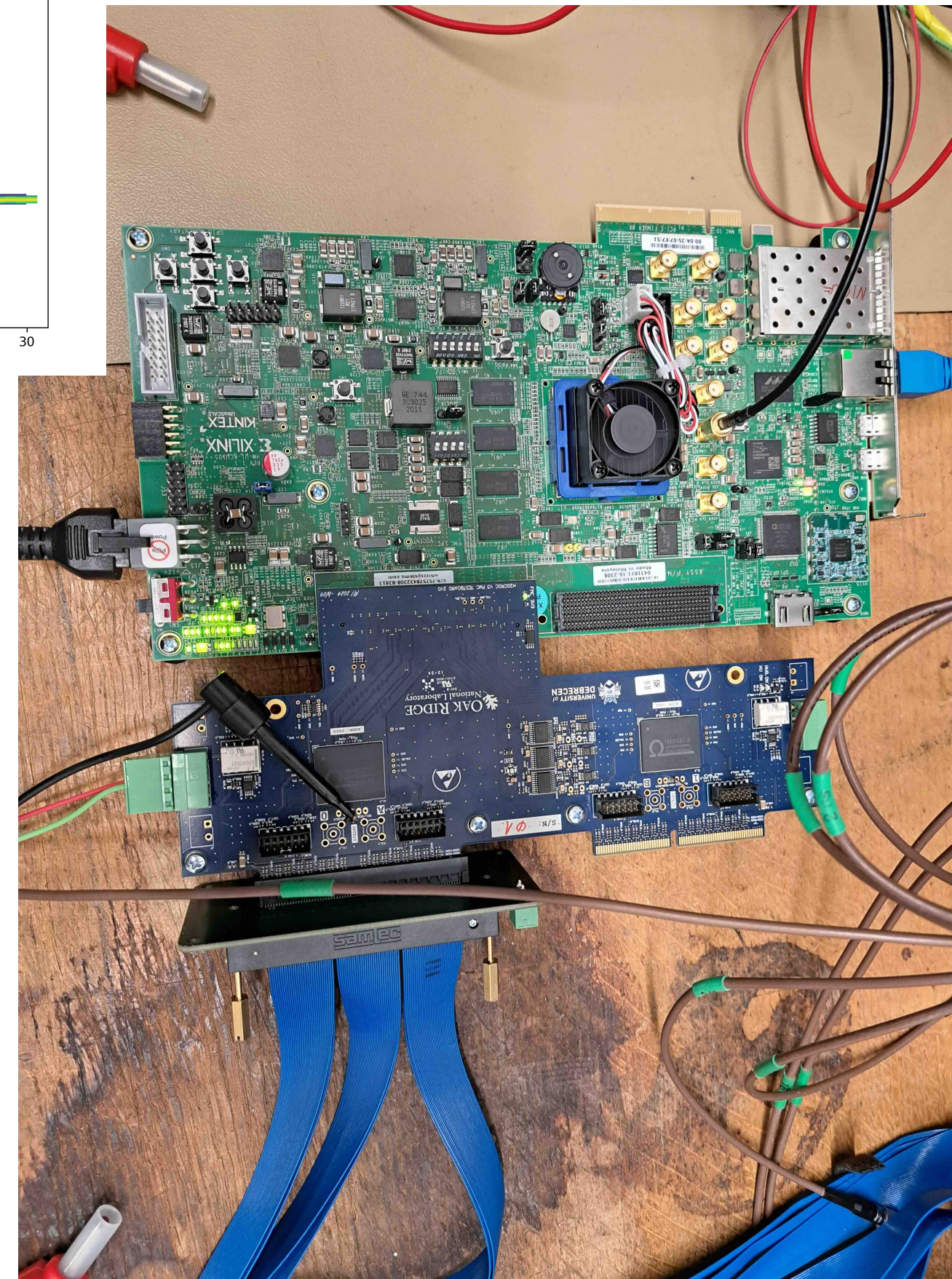
Need to check the reconstruction code...

LFHCal - cosmons seen

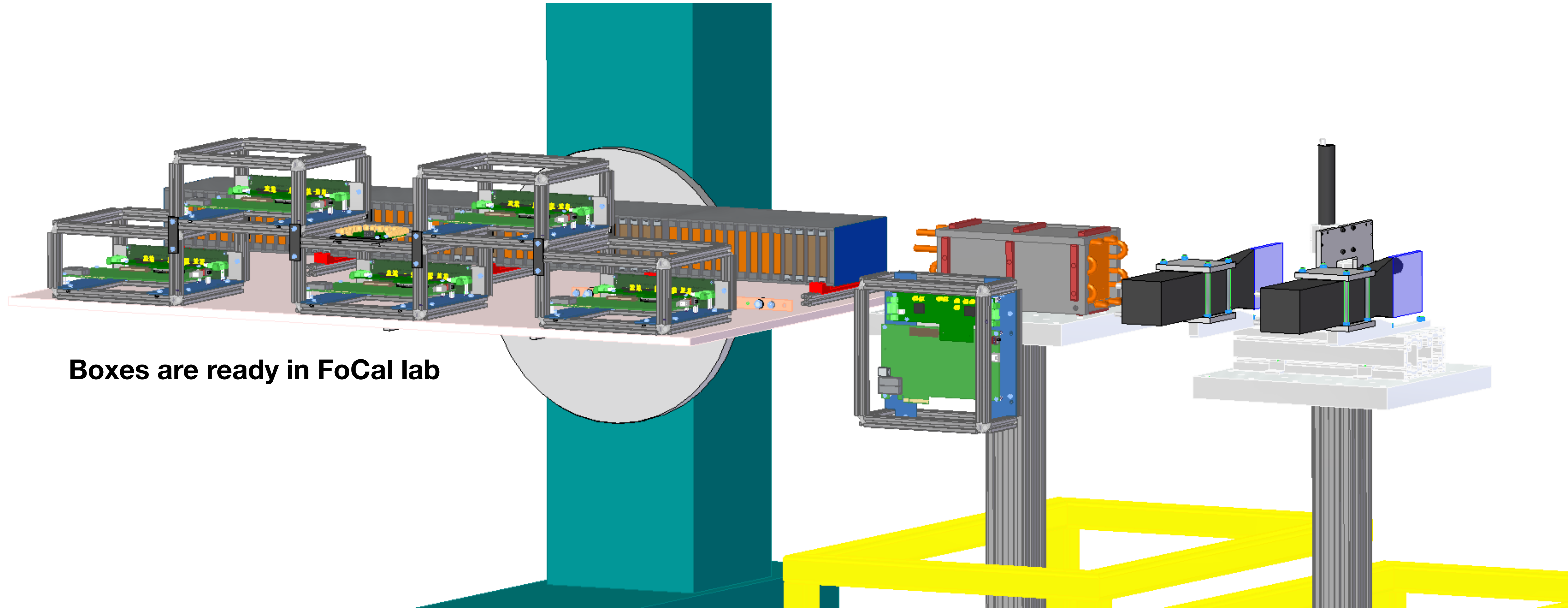


14 channels sees at least 1 hit, 10 channels shown:

- Limited scintillator trigger (10x10cm)
- 2 layers could be attached only
- MIP seems 2x higher? than previous measurement



LFHCal testbeam



Boxes are ready in FoCal lab

Need 5 KCU's: ORNL, FoCal lab, KU, Miki, CTP group CERN. Need at least 1 more for spare.

A0 Asic ID, 00 - FPGA (KCU) ID, 24 half chip ID, 00 - line (0..4)

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|--------|----|----|---|----|----|-----|----|----|----|----|----|--------|-----|----|----|----|----|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|------|-------|----|----|----|
| A0 | 00 | 24 | 00 | 14 | 93 | 4F | 7B | 5B | E9 | 91 | 05 | 00 | 00 | 00 | 00 | 3F | F0 | 00 | 00 | 01 | 60 | 00 | 00 | 3F | F0 | 00 | 00 | 3F | F0 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 04 | 40 | 00 | 00 | | | | | |
| A0 | 00 | 24 | 01 | 14 | 93 | 4F | 7B | 00 | Header | | | | 00 | 00 | CM0 | | | | 00 | 05 | 00 | CH0 | | | | 00 | 11 | 00 | 00 | 00 | 11 | 70 | 00 | 00 | 17 | 40 | 00 | 00 | 1D | 60 | 00 | 00 | 0A | 00 | 00 | BC |
| A0 | 00 | 24 | 02 | 14 | 93 | 4F | 7B | 15 | 00 | 00 | 00 | 00 | 0A | 00 | 00 | F0 | 15 | 00 | 00 | 00 | 04 | B0 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 09 | 00 | 00 | 00 | 07 | F0 | 00 | 00 | 0E | 00 | 00 | 00 | CH5 | 00 | | | |
| A0 | 00 | 24 | 03 | 14 | 93 | 4F | 7B | 06 | E0 | 00 | 00 | 07 | 70 | 00 | 00 | 0F | D0 | 03 | 66 | 05 | F0 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 05 | 00 | 00 | 00 | 0D | 70 | 00 | 00 | 0E | F0 | 00 | CF | | | | | | |
| A0 | 00 | 24 | 04 | 14 | 93 | 4F | 7B | 0B | 90 | 00 | 00 | 0B | A0 | 00 | 8D | 04 | 20 | 00 | 00 | 05 | Calib0 | | | | 00 | 05 | CH17 | | | | 00 | 04 | A0 | 00 | 00 | 00 | 07 | 50 | 00 | 00 | F8 | 01 | C9 | 4A | | |
| A1 | 00 | 24 | 00 | 14 | 93 | 4F | 7B | 52 | 10 | 92 | 05 | 00 | 00 | 00 | 00 | 3F | F0 | 00 | 00 | 3F | F0 | 00 | 00 | 3F | F0 | 00 | 00 | 0B | D0 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | CH35 | CRC32 | 00 | | |
| A1 | 00 | 24 | 01 | 14 | 93 | 4F | 7B | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 04 | A0 | 00 | 00 | 0A | 00 | 00 | 00 | 12 | 50 | 00 | 00 | 18 | 20 | 00 | 00 | 08 | 00 | 0A | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | |
| A1 | 00 | 24 | 02 | 14 | 93 | 4F | 7B | 05 | 40 | 00 | 00 | 04 | 10 | 00 | 00 | 0B | F0 | 03 | D0 | 04 | 40 | 00 | 00 | 02 | 00 | 00 | 00 | 07 | 90 | 00 | 00 | 0D | 00 | 03 | A5 | 05 | 10 | 00 | 00 | | | | | | | |
| A1 | 00 | 24 | 03 | 14 | 93 | 4F | 7B | 08 | 50 | 00 | 00 | 0A | F0 | 00 | 00 | 07 | F0 | 00 | 00 | 05 | D0 | 00 | 00 | 09 | 00 | 00 | 00 | 04 | 50 | 00 | 00 | 06 | B0 | 00 | 00 | 09 | 60 | 00 | 00 | | | | | | | |
| A1 | 00 | 24 | 04 | 14 | 93 | 4F | 7B | 0C | 50 | 03 | BD | 0B | A0 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 05 | A0 | 00 | 00 | 05 | F0 | 00 | 00 | 05 | 40 | 00 | 00 | 09 | 50 | 00 | 00 | A1 | 74 | 8B | 29 | | | | | | |
| A0 | 00 | 25 | 00 | 14 | 93 | 4F | 7B | 5B | E9 | 91 | 05 | 00 | 00 | 04 | 00 | 05 | 20 | 00 | 00 | 05 | 20 | 00 | 00 | 05 | 00 | 00 | 00 | 05 | D0 | 00 | 00 | 05 | D0 | 00 | 00 | 06 | F0 | 00 | 00 | | | | | | | |
| A0 | 00 | 25 | 01 | 14 | 93 | 4F | 7B | 00 | 00 | 00 | 00 | CH0 on other side (half ID 25) = channel 36 | | | | | | | | | | | | | | | | 06 | 50 | 00 | 00 | 05 | 40 | 00 | 00 | 05 | 90 | 00 | 00 | 05 | 00 | 00 | 00 | | | |
| A0 | 00 | 25 | 02 | 14 | 93 | 4F | 7B | 05 | F0 | 00 | 00 | 05 | F0 | 00 | 00 | 05 | A0 | 00 | 00 | 0A | 00 | 00 | 00 | 06 | F0 | 00 | 00 | 06 | F0 | 00 | 00 | 05 | 00 | 00 | 00 | 06 | F0 | 00 | 00 | 05 | 70 | 00 | 00 | | | |
| A0 | 00 | 25 | 03 | 14 | 93 | 4F | 7B | 05 | F0 | 00 | 00 | 05 | A0 | 00 | 00 | 0A | 00 | 00 | 00 | 06 | F0 | 00 | 00 | 06 | F0 | 00 | 00 | 05 | 00 | 00 | 00 | 06 | F0 | 00 | 00 | 05 | 70 | 00 | 00 | | | | | | | |
| A0 | 00 | 25 | 04 | 14 | 93 | 4F | 7B | 08 | 10 | 00 | 00 | 05 | 50 | 00 | 00 | 0A | 50 | 00 | 00 | 05 | F0 | 00 | 00 | 06 | B0 | 00 | 00 | 05 | F0 | 00 | 00 | 08 | 20 | 00 | 00 | D1 | D6 | 1D | 75 | | | | | | | |
| A1 | 00 | 25 | 00 | 14 | 93 | 4F | 7B | 52 | 10 | 92 | 05 | 00 | 00 | 00 | 00 | 05 | 00 | 00 | 00 | 05 | 00 | 00 | 00 | 05 | D0 | 00 | 00 | 05 | 00 | 00 | 00 | 05 | B0 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | |
| A1 | 00 | 25 | 01 | 14 | 93 | 4F | 7B | 05 | F0 | 00 | 00 | 05 | 90 | 00 | 00 | 05 | 00 | 00 | 00 | 06 | B0 | 00 | 00 | 04 | A0 | 00 | 00 | 04 | A0 | 00 | 00 | 05 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | |
| A1 | 00 | 25 | 02 | 14 | 93 | 4F | 7B | 05 | 00 | 00 | 00 | 0D | A0 | 00 | 00 | 06 | A0 | 00 | 00 | 04 | B0 | 00 | 00 | 00 | 50 | 00 | 00 | 08 | 50 | 00 | 00 | 07 | 70 | 00 | 00 | 04 | 80 | 00 | 00 | | | | | | | |
| A1 | 00 | 25 | 03 | 14 | 93 | 4F | 7B | 08 | 40 | 00 | 00 | 00 | 00 | 00 | 00 | 05 | 20 | 00 | 00 | 06 | 90 | 00 | 00 | 07 | 40 | 00 | 00 | 04 | B0 | 00 | 00 | 06 | 80 | 00 | 00 | 05 | F0 | 00 | 00 | | | | | | | |
| A1 | 00 | 25 | 04 | 14 | 93 | 4F | 7B | 0B | 90 | 00 | 00 | 05 | 70 | 00 | 00 | 0A | B0 | 00 | C6 | 00 | 00 | 00 | 00 | 05 | B0 | 00 | 00 | 07 | F0 | 00 | 00 | 08 | 50 | 00 | 00 | 57 | 42 | 74 | 42 | | | | | | | |
| A0 | 00 | 24 | 00 | 14 | 93 | 4F | A4 | 5B | EA | 95 | 05 | 00 | 00 | 00 | 00 | 3F | F0 | 00 | 00 | 00 | 00 | 00 | 00 | 3F | F0 | 00 | 00 | 0D | 20 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | |
| A0 | 00 | 24 | 01 | 14 | 93 | 4F | A4 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 05 | 70 | 00 | 00 | 0B | A0 | 00 | 00 | 0B | B0 | 00 | 00 | 0F | 90 | 00 | 00 | 14 | 00 | 00 | 00 | 06 | D0 | 00 | 00 | | | | | | | |
| A0 | 00 | 24 | 02 | 14 | 93 | 4F | A4 | 0D | F0 | 00 | 00 | 07 | 50 | 00 | 00 | 0D | 70 | 00 | 00 | 05 | 50 | 00 | 00 | 00 | A0 | 00 | 00 | 07 | B0 | 00 | 00 | 06 | A0 | 00 | 00 | 0B | 20 | 00 | 00 | | | | | | | |
| A0 | 00 | 24 | 03 | 14 | 93 | 4F | A4 | 05 | F0 | 00 | 00 | 05 | F0 | 00 | 00 | 0B | F0 | 00 | 00 | 05 | F0 | 00 | 00 | 05 | 00 | 00 | 00 | 05 | 70 | 00 | 00 | 0A | 90 | 03 | 0D | 0B | E0 | 00 | 00 | | | | | | | |
| A0 | 00 | 24 | 04 | 14 | 93 | 4F | A4 | 09 | 00 | 03 | 71 | 09 | 00 | 00 | 00 | 03 | F0 | 00 | 00 | 04 | 00 | 00 | 00 | 05 | 00 | 00 | 00 | 04 | 00 | 00 | 00 | 07 | 50 | 00 | 00 | 96 | 00 | 21 | 01 | | | | | | | |
| A1 | 00 | 24 | 00 | 14 | 93 | 4F | A4 | 52 | 11 | 96 | 05 | 00 | 00 | 00 | 00 | 3F | F0 | 00 | 00 | 00 | 00 | 00 | 00 | 3F | F0 | 00 | 00 | 07 | D0 | 02 | 7D | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | |
| A1 | 00 | 24 | 01 | 14 | 93 | 4F | A4 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 05 | 60 | 00 | 00 | 06 | D0 | 03 | 4A | 0B | 40 | 00 | 00 | 0F | 70 | 00 | 00 | 05 | 00 | 00 | 00 | 07 | 20 | 02 | 3D | | | | | | | |
| A1 | 00 | 24 | 02 | 14 | 93 | 4F | A4 | 05 | 00 | 00 | 00 | 03 | E0 | 00 | 00 | 08 | 90 | 00 | 00 | 05 | 00 | 00 | 00 | 02 | D0 | 00 | 00 | 05 | 00 | 00 | 00 | 09 | 00 | 00 | 00 | 05 | 20 | 00 | 00 | | | | | | | |
| A1 | 00 | 24 | 03 | 14 | 93 | 4F | A4 | 07 | 50 | 00 | 00 | 07 | 70 | 00 | 15 | 05 | F0 | 00 | 00 | 05 | A0 | 00 | 00 | 05 | F0 | 00 | 00 | 05 | 00 | 00 | 00 | 06 | 80 | 00 | 00 | 06 | F0 | 00 | 00 | | | | | | | |
| A1 | 00 | 24 | 04 | 14 | 93 | 4F | A4 | 09 | 00 | 00 | 00 | 08 | 20 | 00 | 0D | 00 | 00 | 00 | 00 | 04 | 20 | 00 | 00 | 05 | E0 | 00 | 00 | 05 | 00 | 00 | 00 | 0A | 10 | 00 | 00 | 34 | 18 | 04 | 17 | | | | | | | |

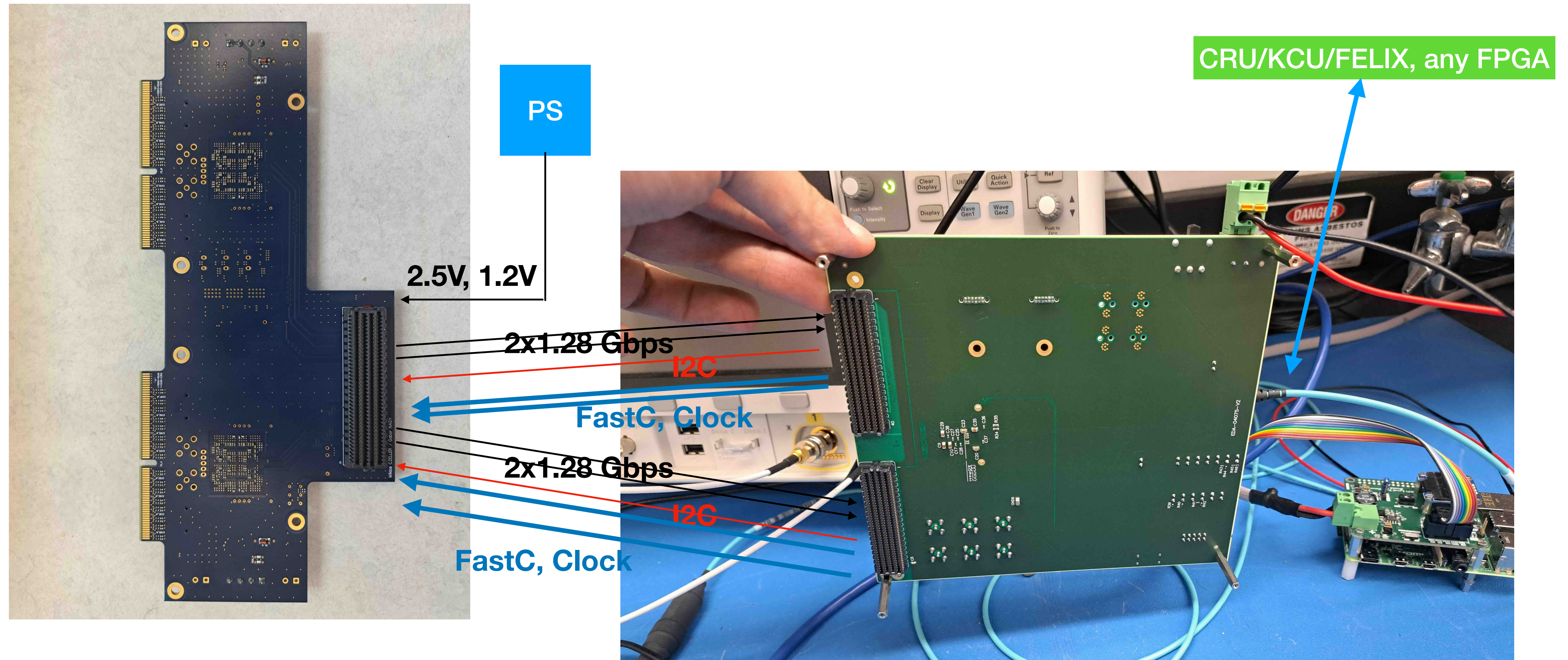
FPGA timestamp

Backup

ORNL is managed by UT-Battelle LLC for the US Department of Energy

Next steps toward the final FoCal-H design

The H2GCROC is designed to interface with the input of the LpGBT ASIC



All of this in the middle is a quite passive board

FoCal-H final

