“Sensors with Intrinsic Gain”

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- **above is name of SSD/RD50 subgroup activity**

All CMS/ATLAS phase II timing->Si w internal gain (Geiger or lin AD)

- **broad (almost*) consensus that Si (or Diamond) w/o internal gain limited to>~80 psec**
- **HFS (HyperFast Silicon) a particular timing sol’n w Deep Depleted AD& mesh readout**

Superficially similarities to PICOSEC- modeling role of Gain/preamp region (differences: Landau/Vavilov, Si rad effects,…)

- **if PICOSEC & HFS had already mature manufacture & proven robustness (&$$) -> would be strongest candidates for “CMS Barrel Timing Layer”-BTL**

[#]reporting for HFS collaboration(CERN, Princeton, Penn,RMD, Sevilla++)

*** see ie. R. Lipton,https://indico.fnal.gov/event/ANLHEP1390/session/7/contribution/63/material/slides/0.pdf**

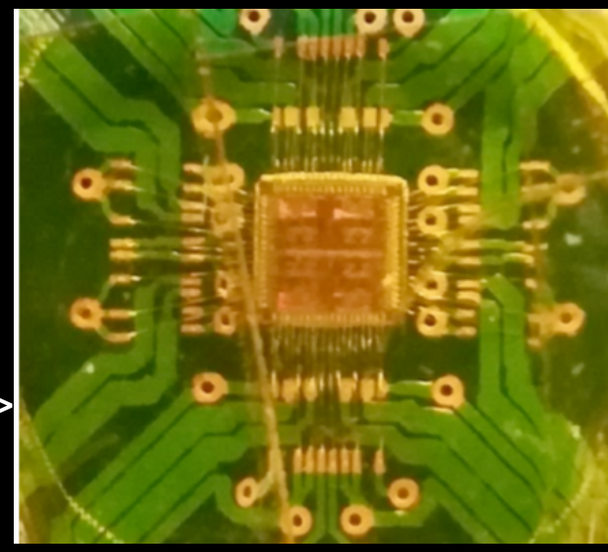
August ’18 at H4- HFS

HFS participated in all PICOSEC runs since start in 2016

originally proposed for T0 ref.

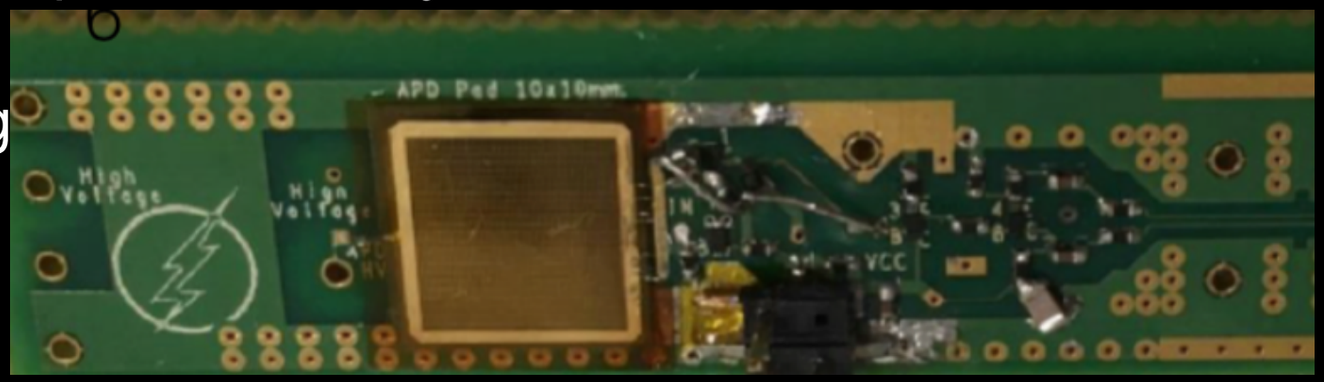
- we never guessed how fast PICOSEC would progress
- Stefano Mazzoni offered his MCP instead

HFS over past 2 years in H4->



• FEE development-> this year w our new ASIC———————>

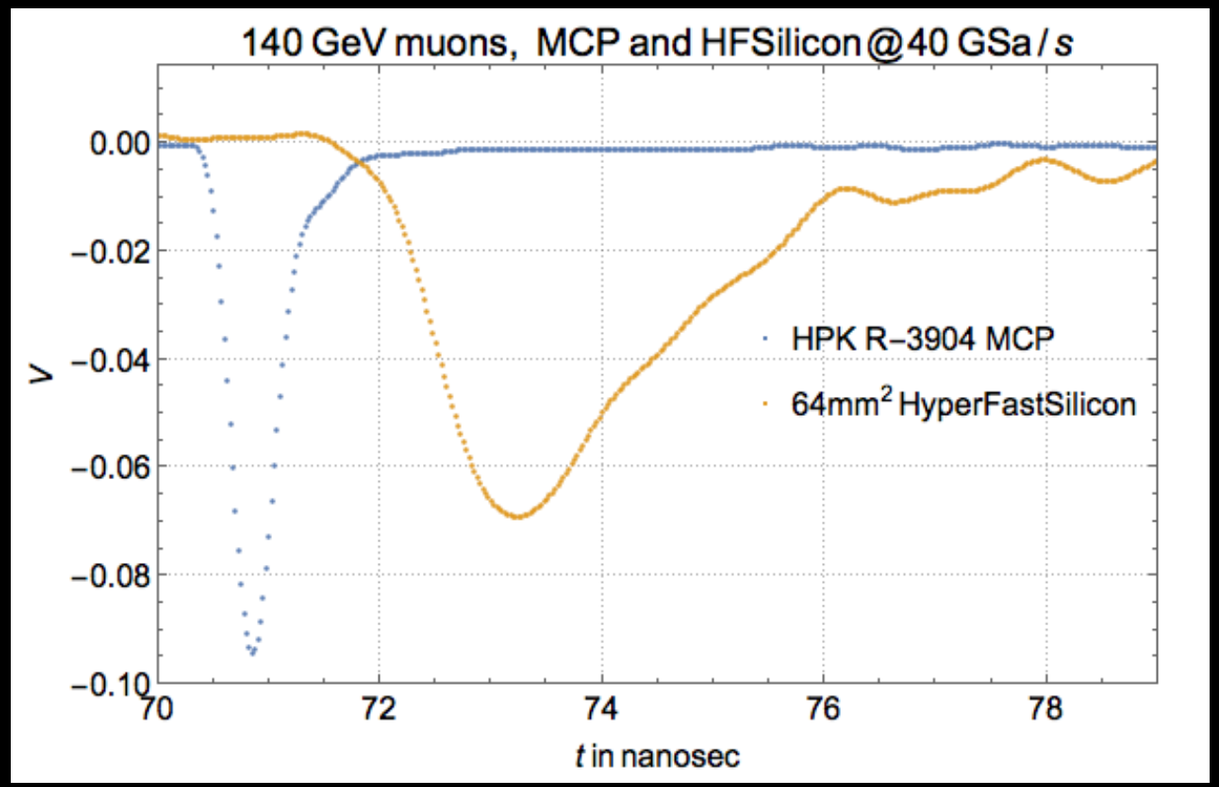
•packaging

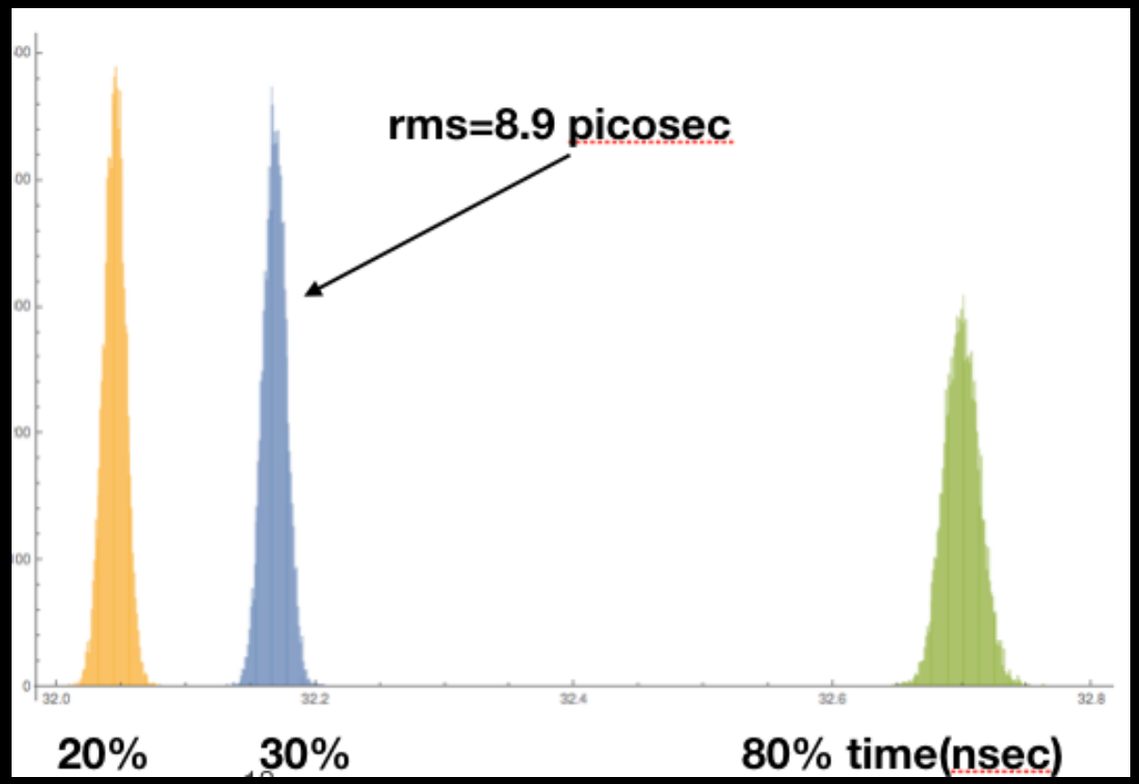


•detailed response mapping vs. impact

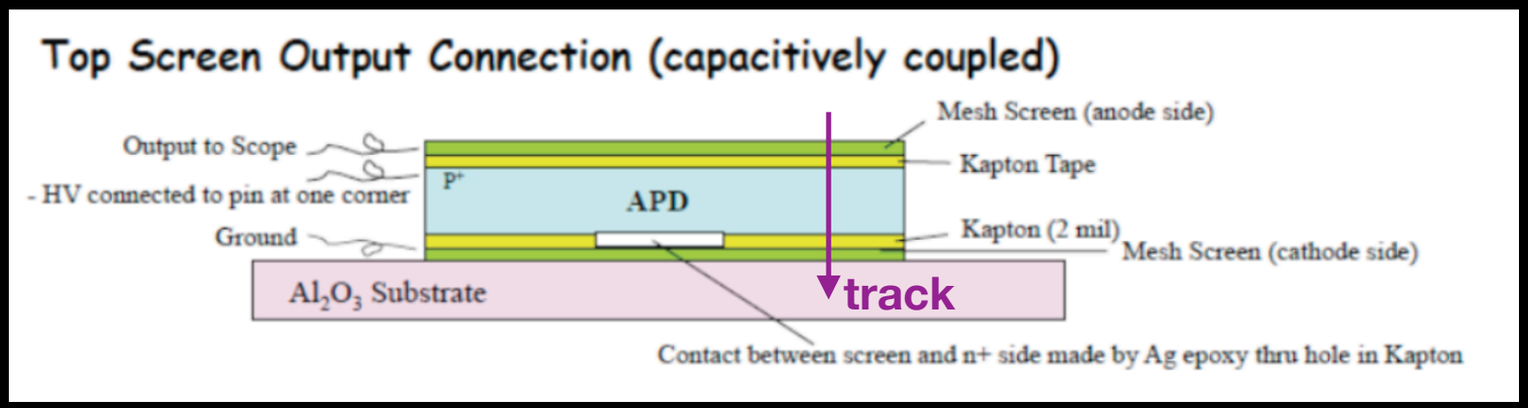
•new this year-> alternate to mesh tested (Isidre & Matteo- see 3 slides at end)

Nice fast signal (w Yi's scope) -> Good time jitter w IR laser model (ie uniform e-h creation in Si)

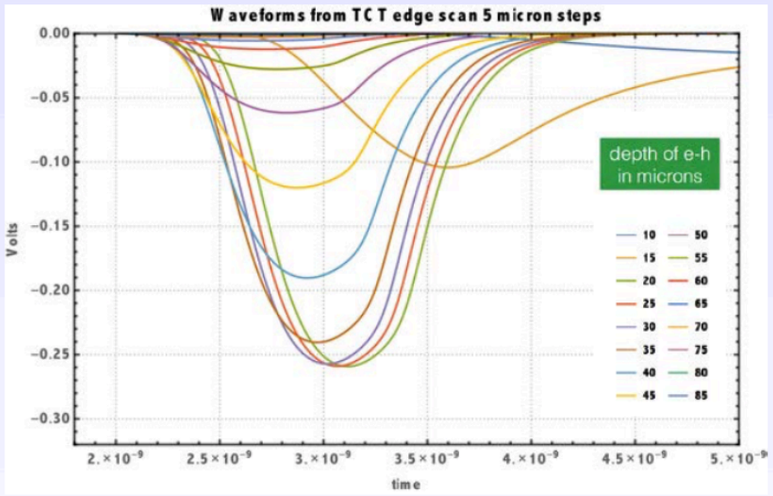




but Landau/Vavilov disrupts waveform (this is advantage of PICOSEC over Si tracking)



arrival time vs. depth

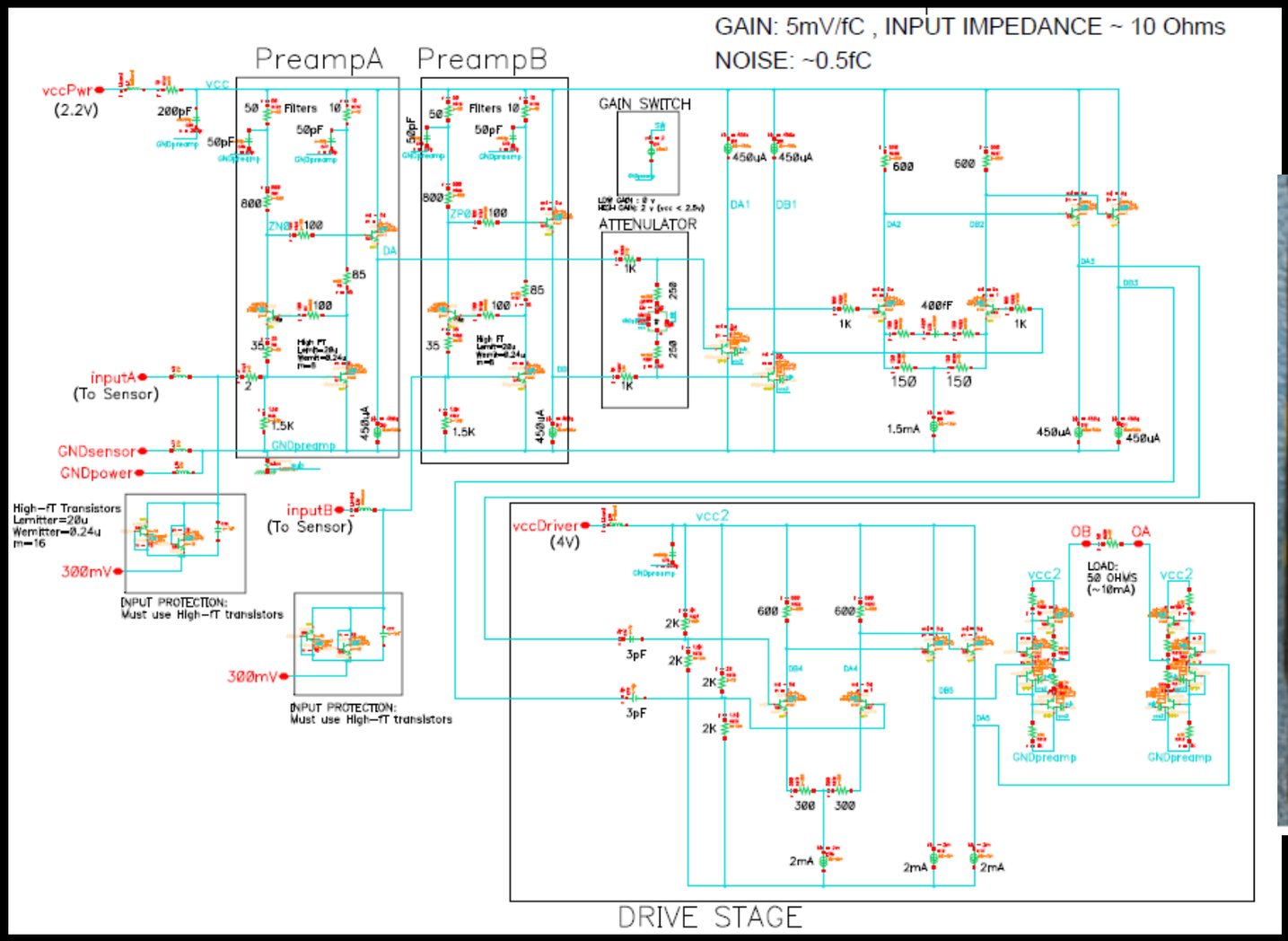


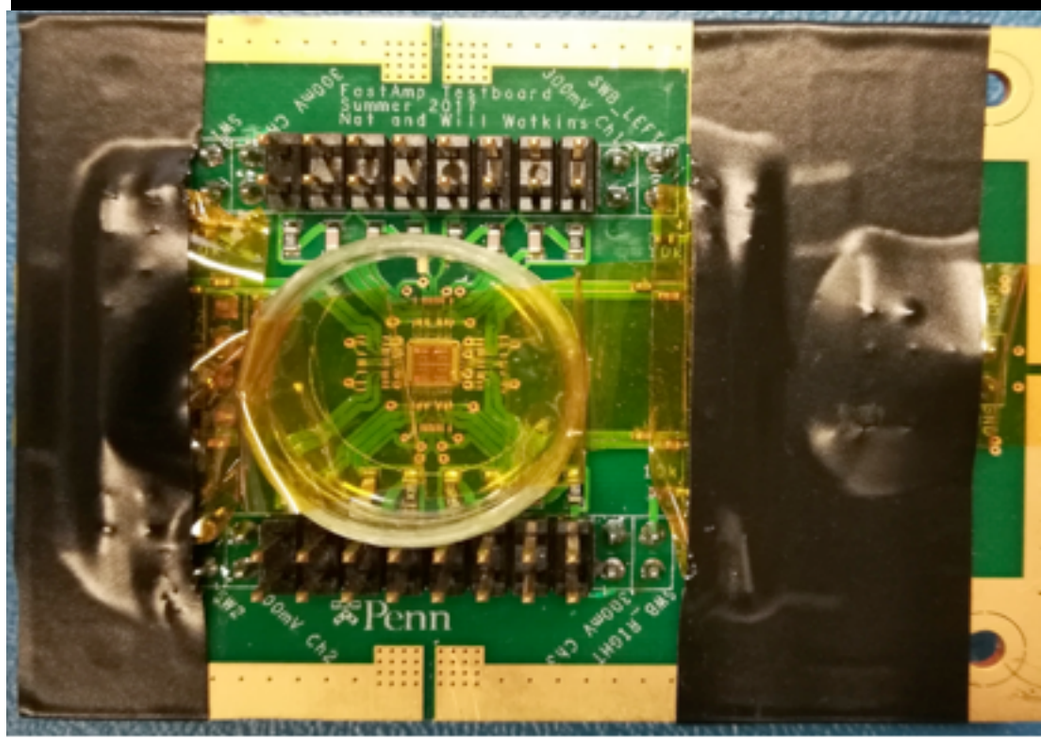
Voltage: 1800 V
16 positions (16 slices)

during previous TB cycles continuous improvement in Front end electronics
(collaboration w Mitch Newcomer- & E. Morales, U.Penn.)

-> enable flexibility in choosing best algorithm to extract time from MIP signal
& also in choosing operating field (Gain up to ~500)

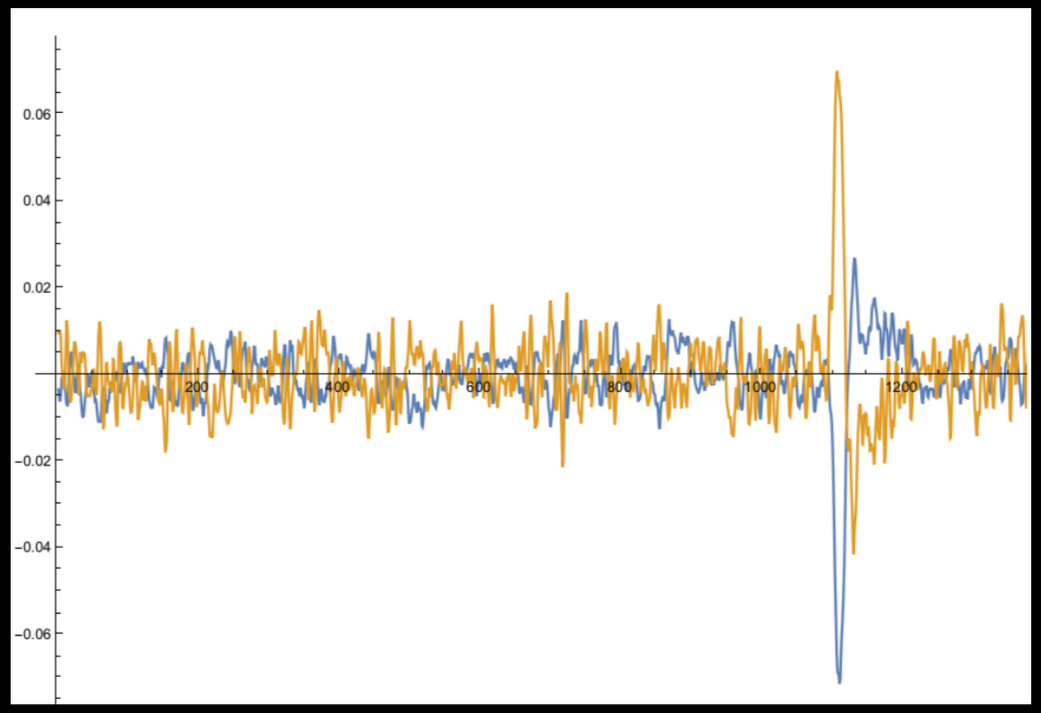
during August run new quad SiGe transimpedance amp ASIC tested for first time

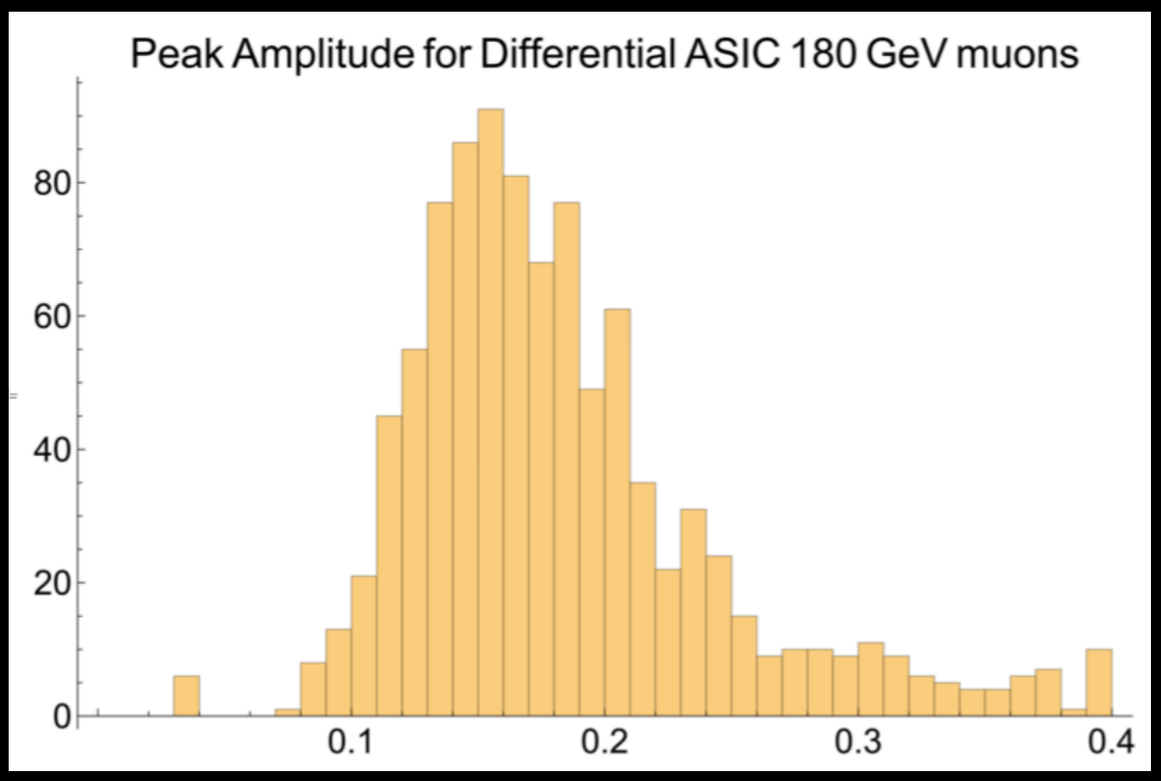




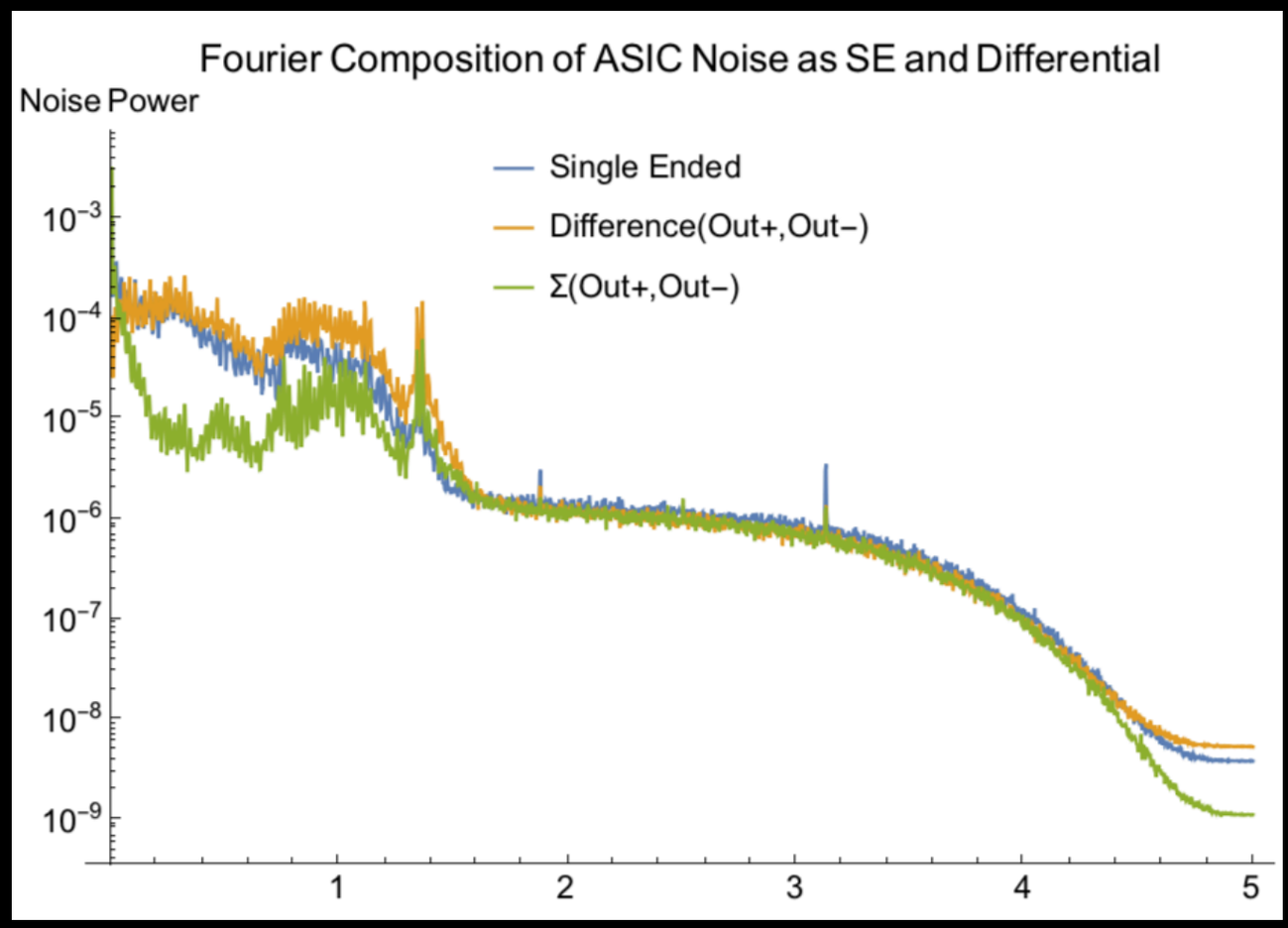
First look at quad ASIC in H4 testbeam

("borrowed" from U. Penn test bench where still being tweaked)
thanks to Fritz Caspers(CERN) for help with rf stability issues!



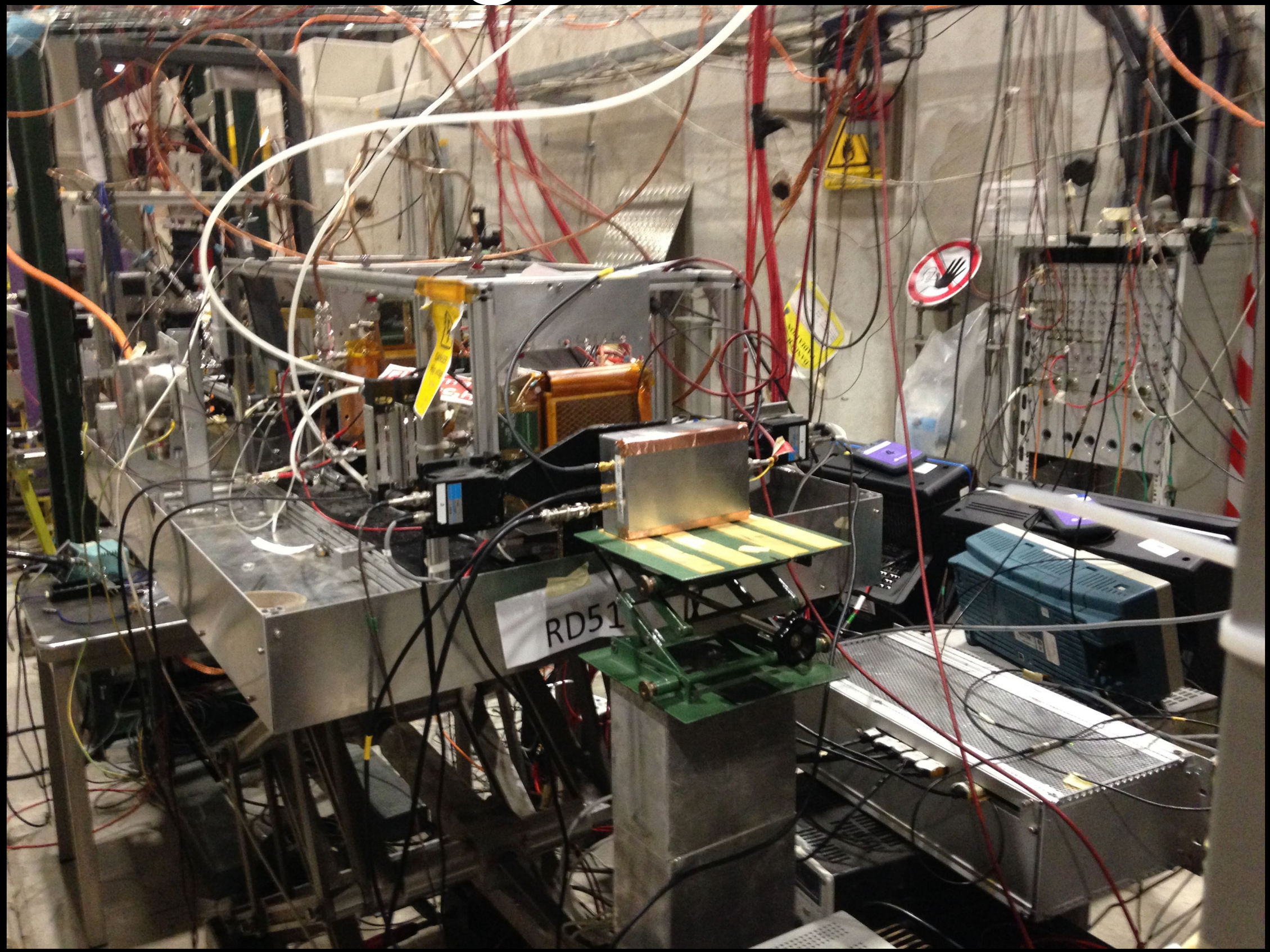


H4 data showed remaining noise not removed by common mode red.

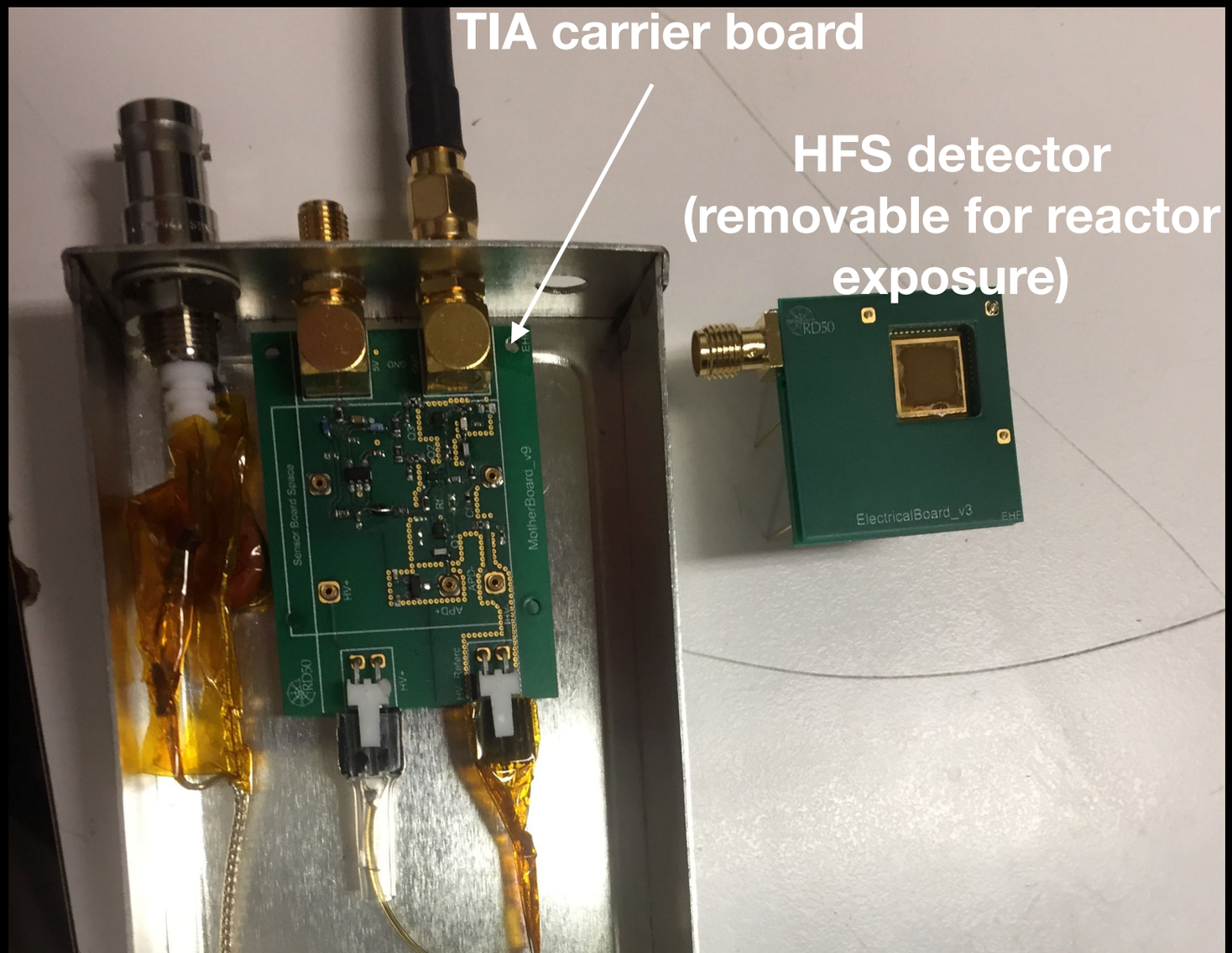


->subsequent work at Penn on noise mitigation

ASIC kluge box in beam



Also prepared for beam:
new amp (w. U. Sevilla- R. Palomo and E. Hidalgo)
-> will enable post-irrad performance studies



multiple detector
packages now being prepared
for future beam tests

APD Beam Tests (non-mesh device tests)

3 slides from Isidre

Beam test periods:

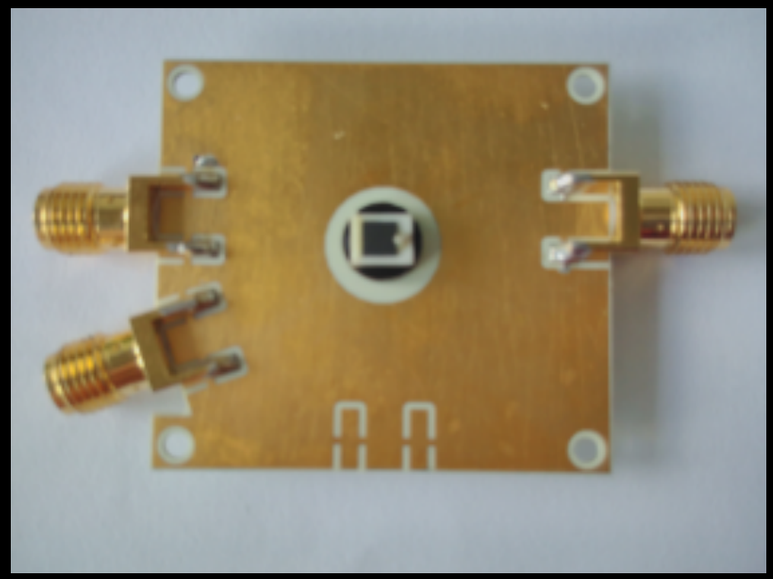
- 25/04 – 09/05 (2 weeks)
- 08/08 – 15/08 (1 week)

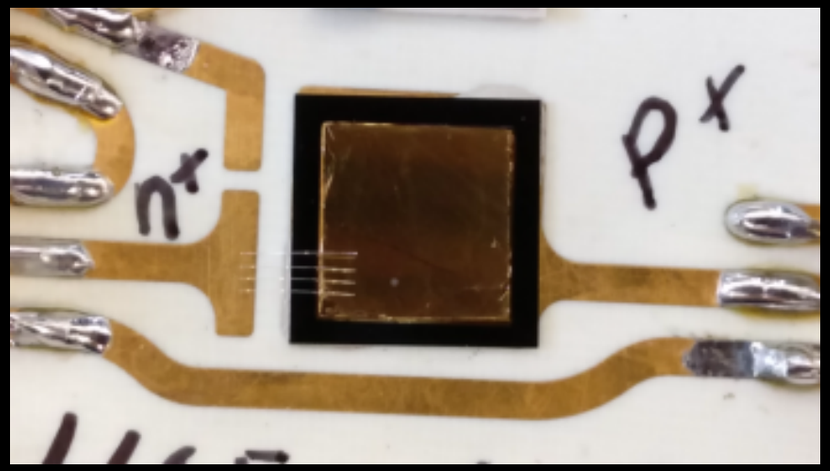
APD types tested:

- Metallized, 8 x 8 mm^2
- Sintered gold on n-side, 8 x 8 mm^2
- Packaged, 2 x 2 mm^2

(Planned) studies:

- Time resolution
- Uniformity of response
- Detection Efficiency



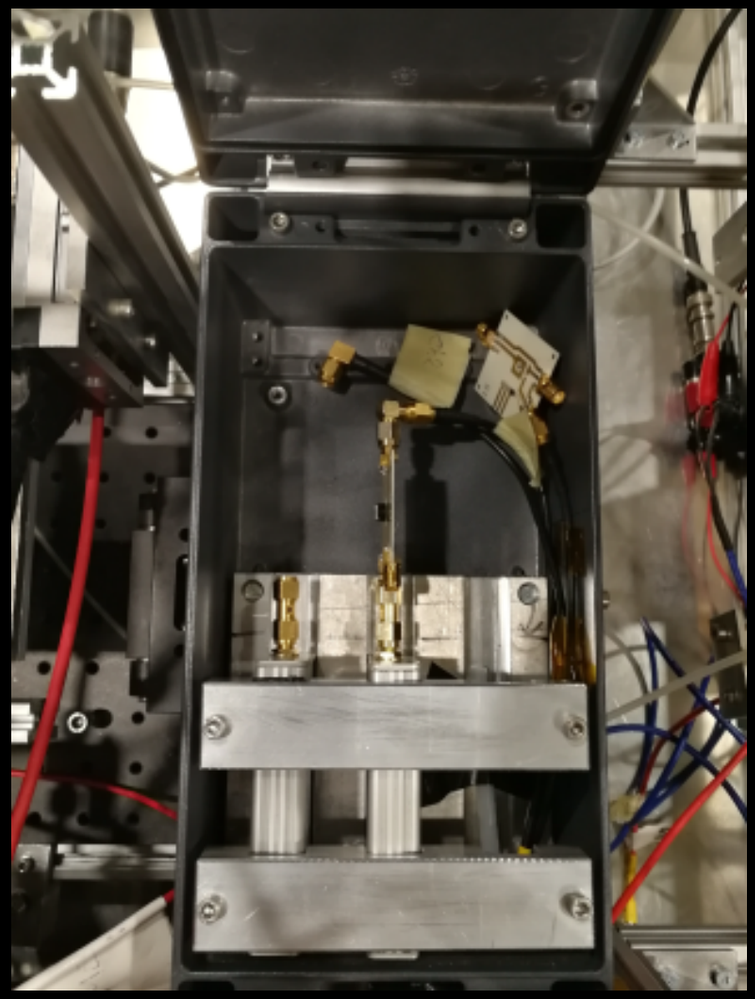


- Dependency of time resolution and efficiency on bias voltage.

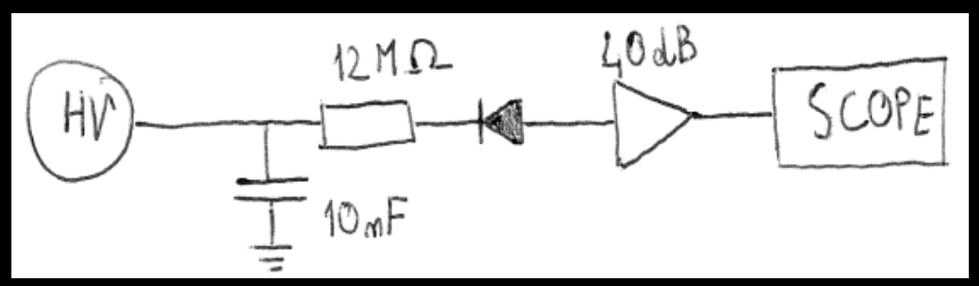
Beam Test Setup

- Sensor box downstream of first tracking GEM
- Amplifiers: CIVIDEC 2GHz, 40 dB
- Data Acquisition: Agilent 2.5 GHz, 10GS/s
  - Ch1: APD
  - Ch2: APD
  - Ch3: Telescope bit pattern (trigger)
  - Ch4: MCP-PMT
- Temperature, bias and current logged.
- Cooling added for second Beam test (detectors measured around 15^{o}C)

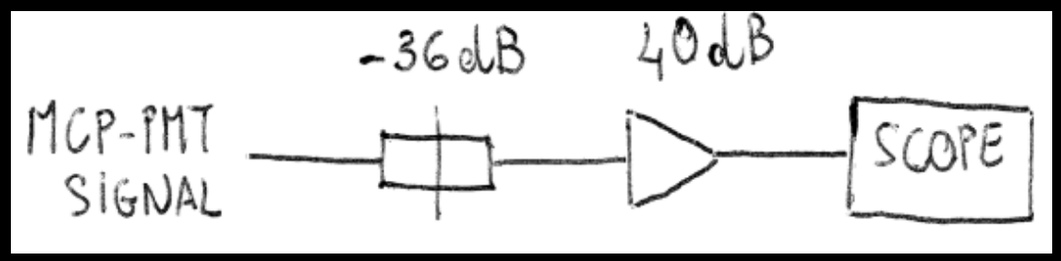
Test Beam box



APD readout



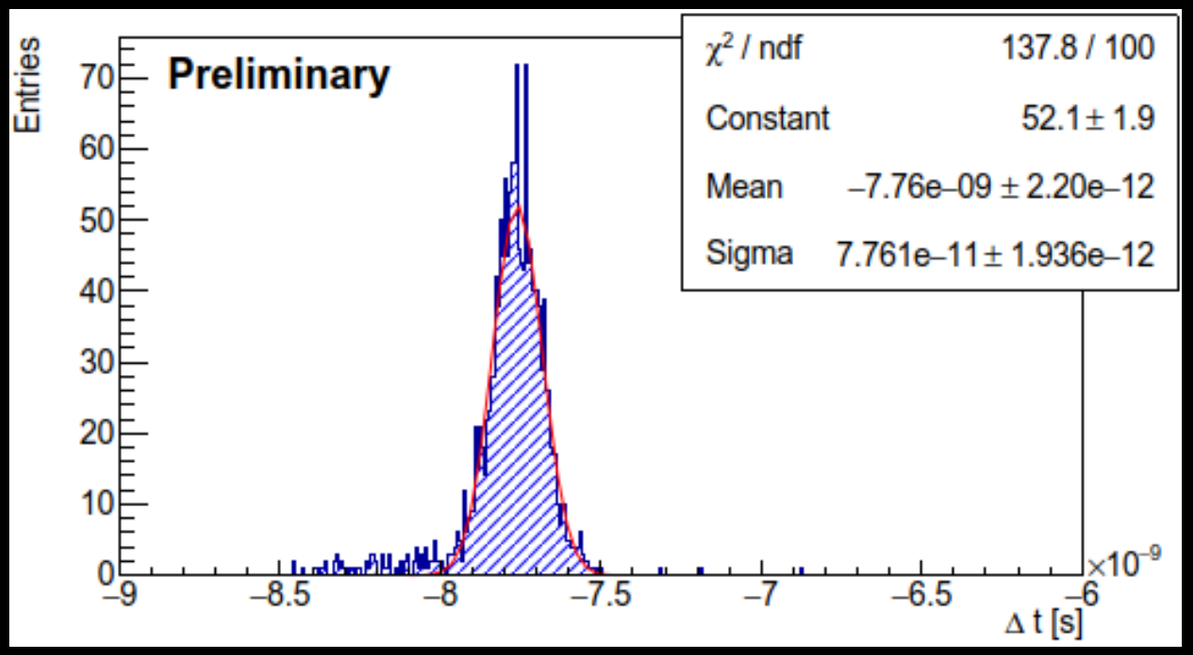
MCP – PMT readout and shaping



Analysis

- Preliminary results from 1st beam test, using only oscilloscope data, no tracking info
- Timing using CFD
- APD threshold 0.2
- MCP-PMT threshold 0.5
- More details in "*Beam test of Deep Diffused APDs". M.Centis, RD51 Collaboration Meeting, 22.06.201*
- Time resolution worse than expected (~20 ps with laser light, 0.8 MIPs, 1750 V)
- Analysis software is now almost ready to use the tracking data. It could explain the worsened performance.

Δt MCP-PMT metallized APD (1775 V), $\sigma_{\Delta t}$ = 77 ps



Δt MCP-PMT gold plated APD (1775 V), $\sigma_{\Delta t}$ = 104 ps