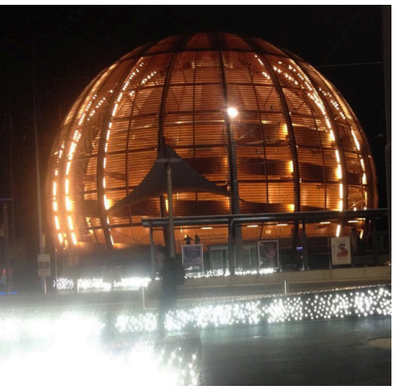


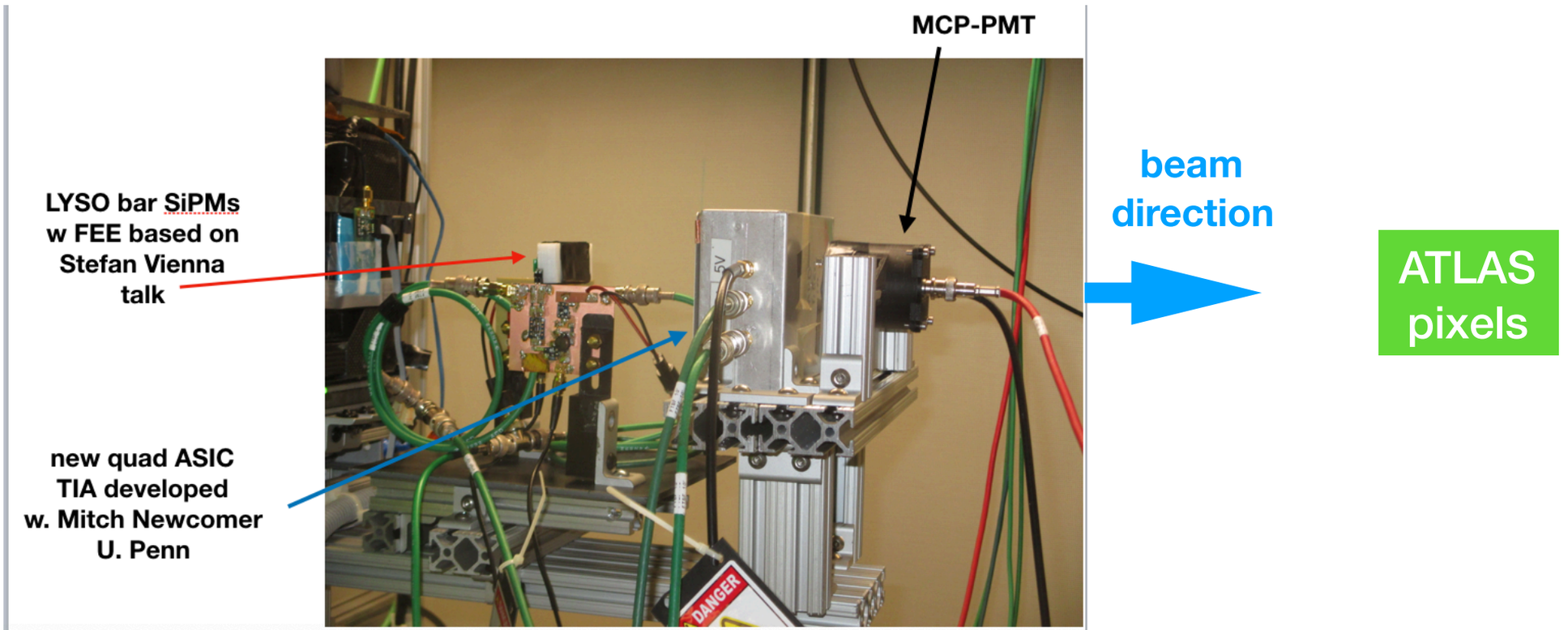
FNAL Parasitic test on March 8 ’19 +DCR Update

Sebastian White, CERN/UVa.

MTD sensors, April 3, 2019

- **this was a 1-day parasitic beam test opportunity courtesy of Syracuse LHCb group**
- **beam was ~120 GeV protons**
- **probably not well focussed on our setup**
- **setup (from downstream):**

-HPK R3809 11mm diam MCP-PMT,
-64mm² HFS sensor w. Penn ASIC readout,
-50mm*3mm*3mm LYSO w SiPM/each end&new FEE from UVa.
-emphasis on FEE evaluation

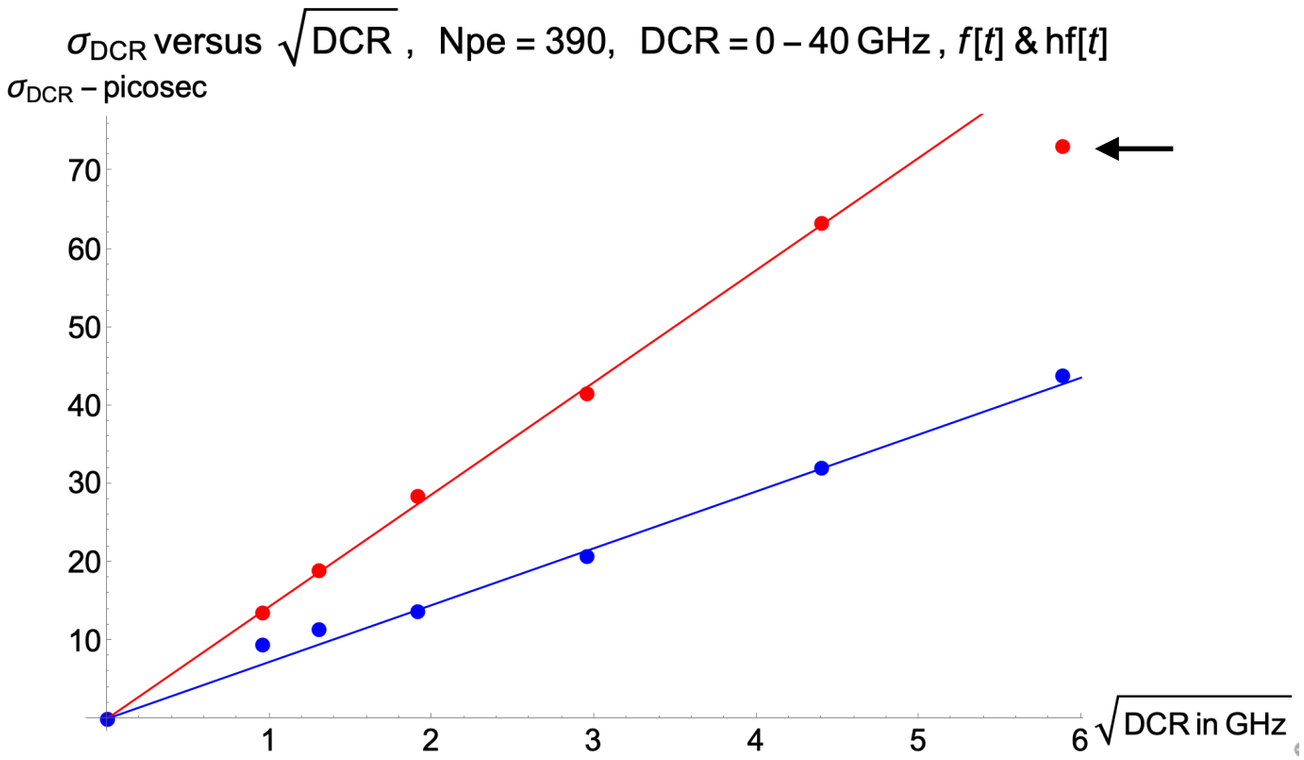


aside on DCR update

- note submitted as MTD detector note here:

http://cms.cern.ch/iCMS/jsp/openfile.jsp?tp=draft&files=DN2019_022_v1.pdf

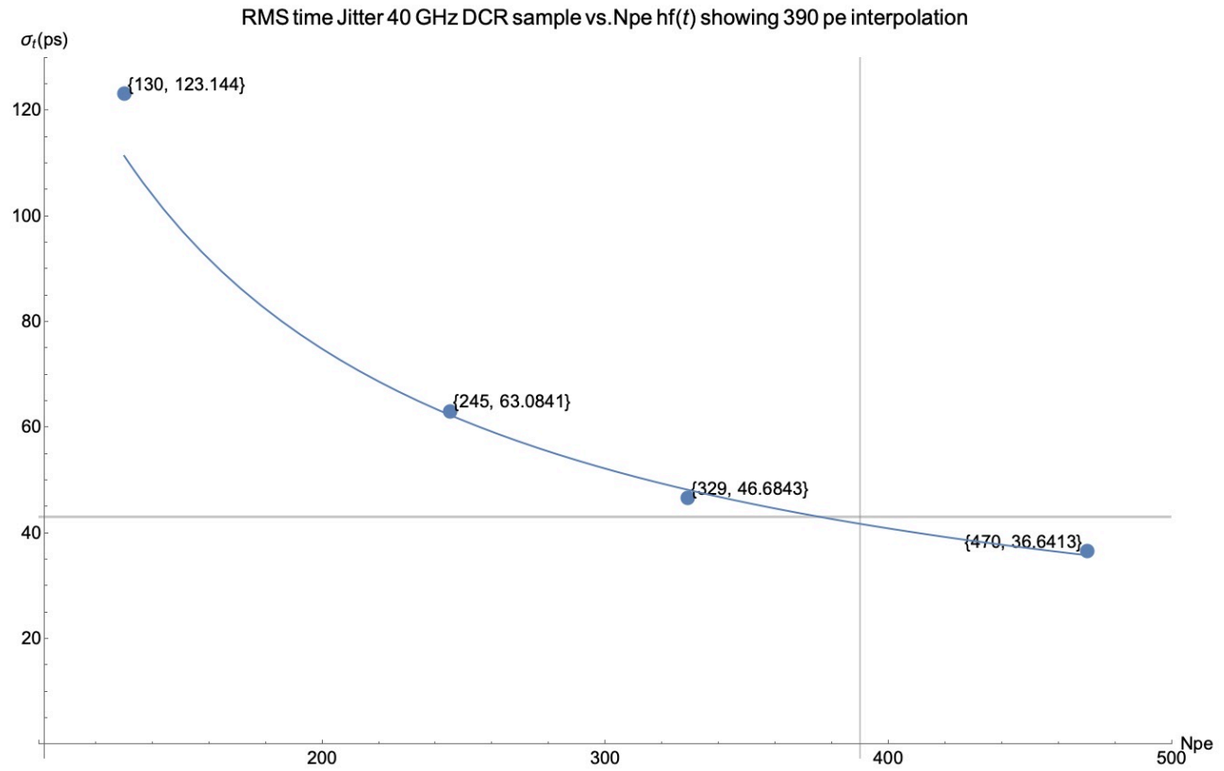
- plot for TDR had puzzling point @34.7 GHz, f[t]

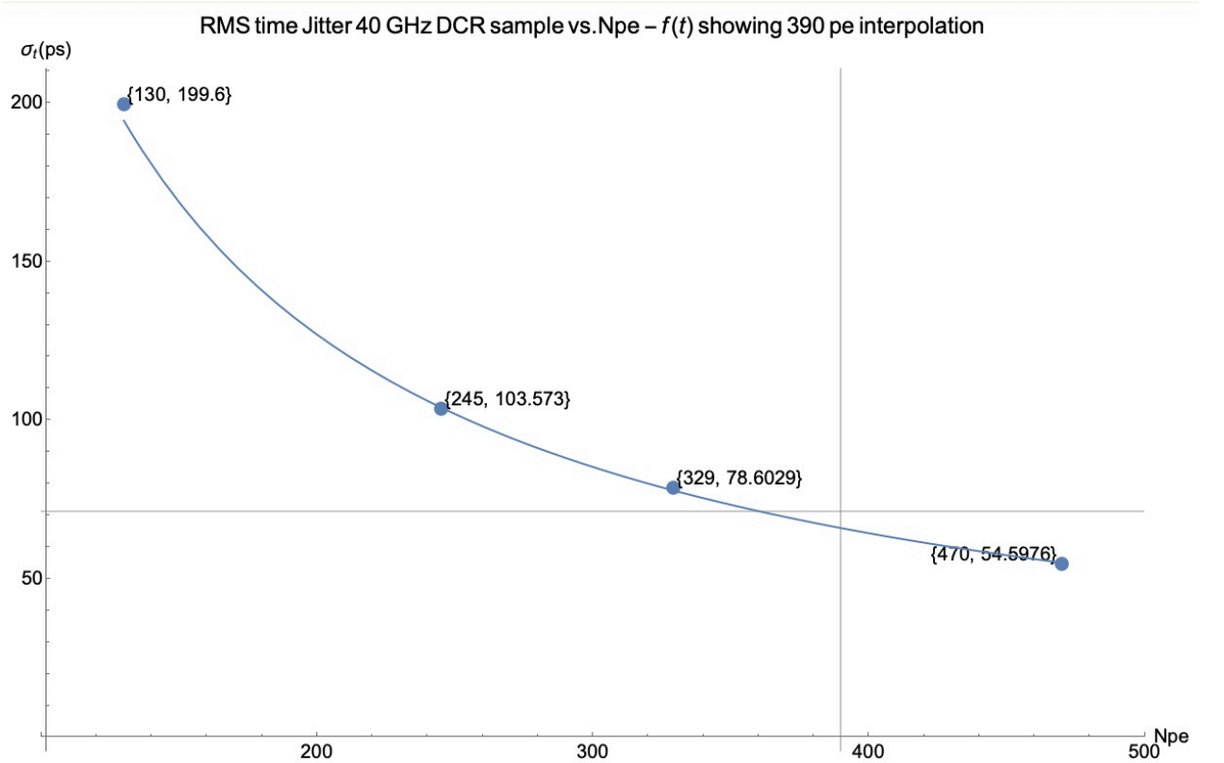


tried several consistency checks including 34.7GHz, Npe scan cross-hairs show plotted points

most likely the outlier due to fact that conditions were changed for 34.7 GHz data

->moved led closer->smaller amplitude->narrower pulse





Motivation for parasitic test:

- ▶ we feel waveform data will continue to play a role, especially once TOFHIR is being evaluated

- DCR note demonstrates usefulness of this approach

- discrepancy between SPICE of FEE for TOFHIR and our discrete TIA performance (also between our SPICE and t_{rise})

- continued to work w Mitch Newcomer on this in Feb @ Penn

- new approach presented by Stefan @ Vienna-> faster t_{rise}

- -> prepared breadboard for test @ UVa, Thomas A. also submitted dual range pc board for production completing next week

Front End: Common approach to offsetting large C_D w low R_{in} ->TIA

1) in TOFHIR, 2) collaboration w Mitch Newcomer(HFS), 3) discrete UVA TIA's

-> ~2 ns t_{rise} for ~300 pF C_{Det}

->~0.6 nsec t_{rise} for C_{Det} ~25 pF

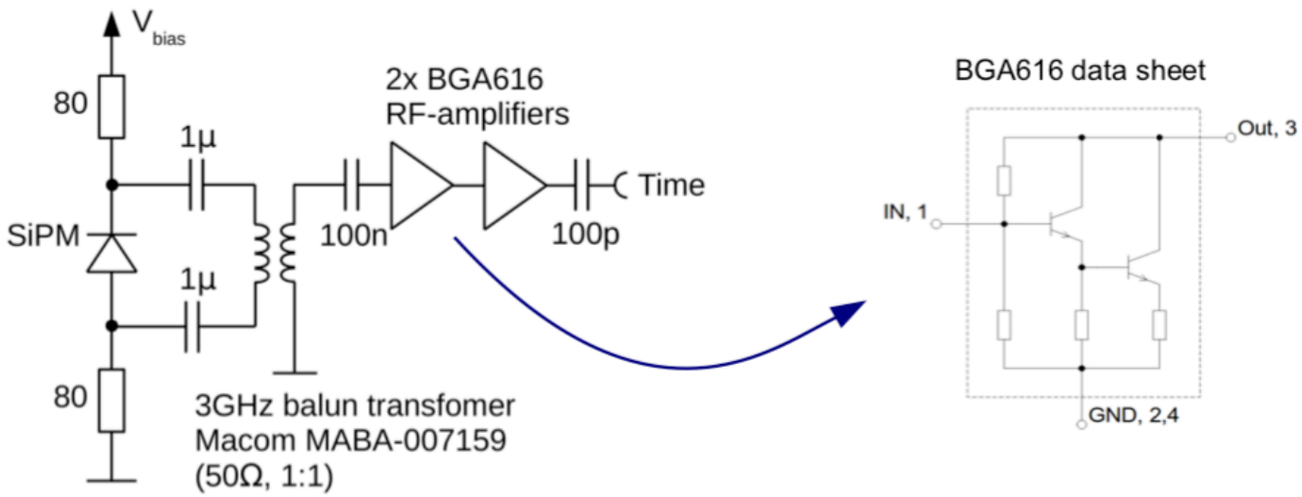
-> >2 nsec not consistent w SPICE

At FNAL tested our new Quad ASIC version of 2)

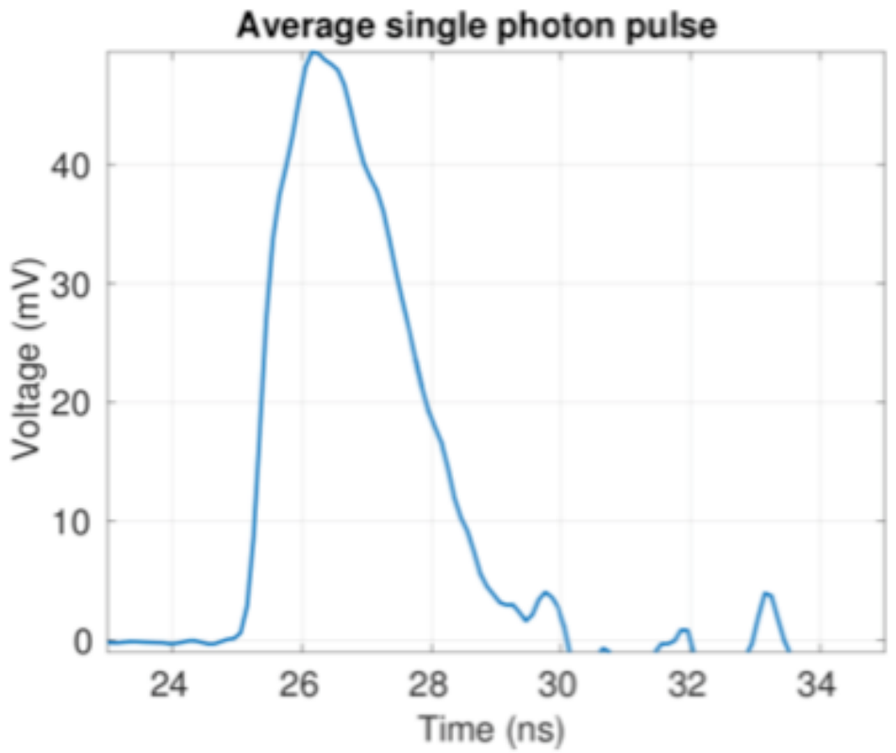
and different approach to SiPM front end for 3) (below)

High-frequency (HF) bipolar transistor readout

from Stefan G. @ 2019 Vienna Conf.



→ BGA616 RF-amplifier reads SiPM differentially via RF balun
→ High frequency path via SPAD quenching capacitance C_d
→ High frequency for time ~1.5GHz bandwidth



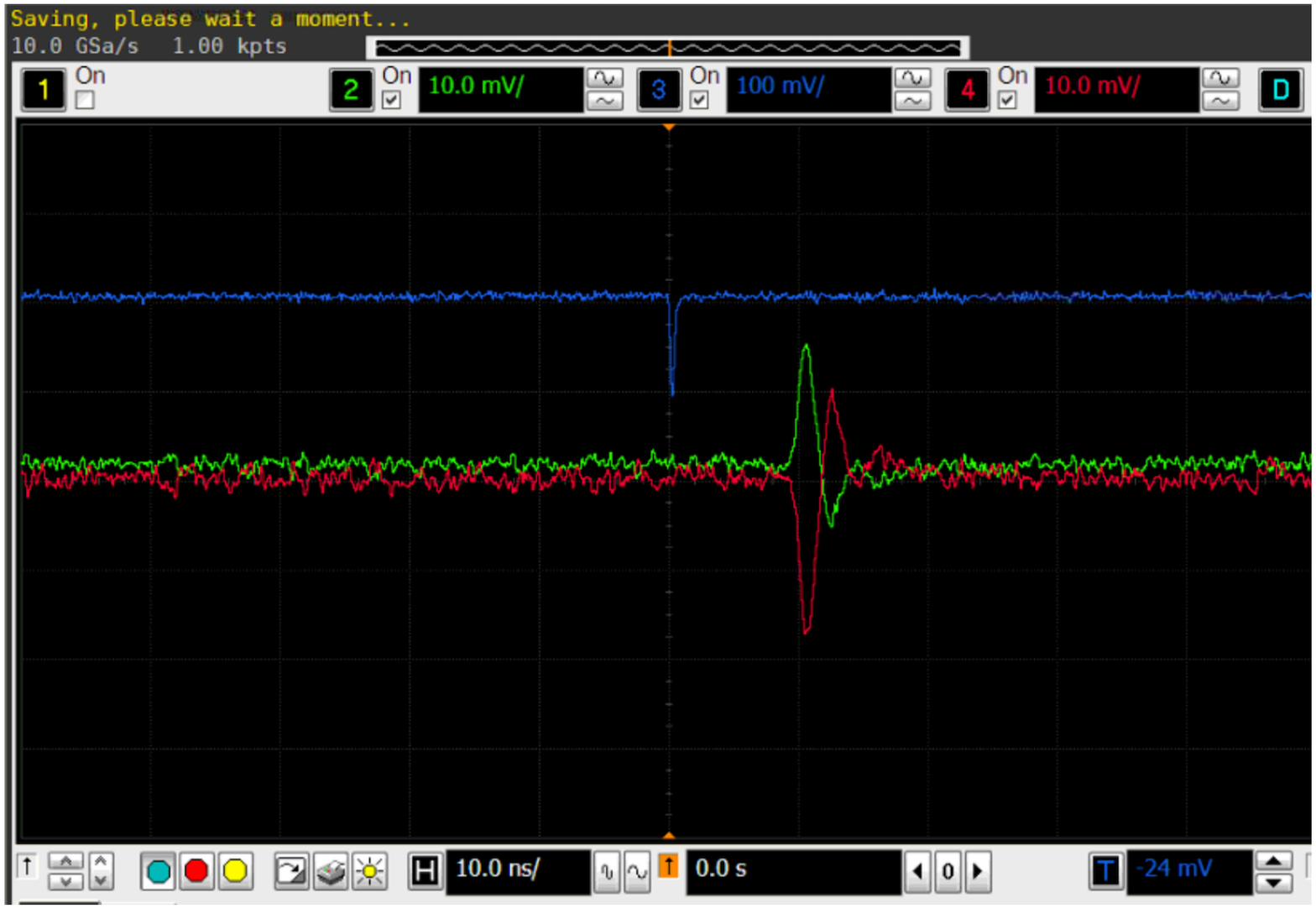
J.W. Cates, S. Gundacker, E. Auffray, P. Lecoq and C.S. Levin, "Improved single photon time resolution for analog SiPMs with front end readout that reduces influence of electronic noise", Phys. Med. Biol. 63 (2018) 185022 (11pp)

MCP(blue trace) used as a trigger

independent of LHCb trigger&tracking

acceptable singles rate ->recorded ~400 good coincidences

next slides:
test of quad ASIC (HFS)



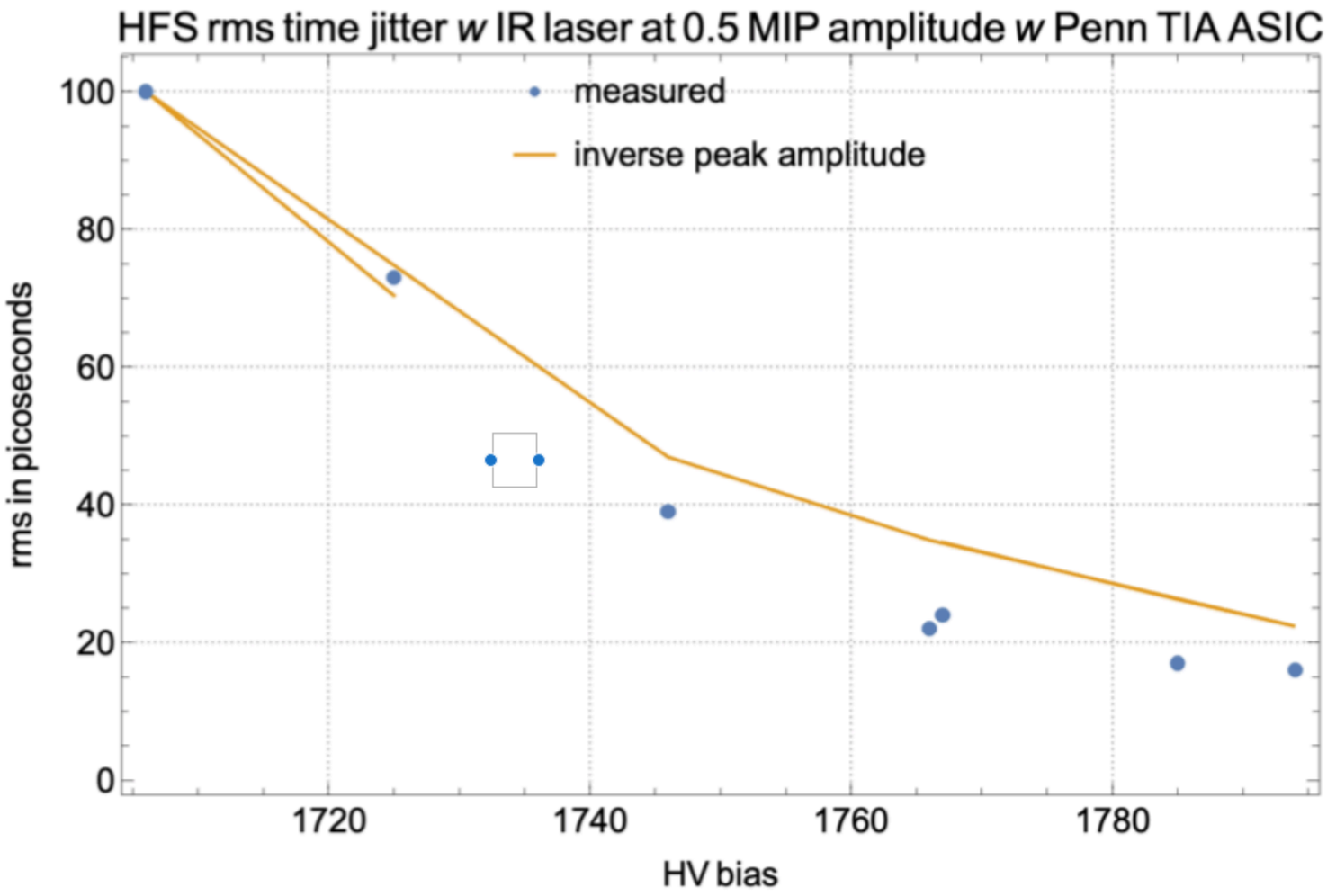
HFS bias 1800V
I_{HFS}~400nA

+'ve,-'ve out@10mV/div

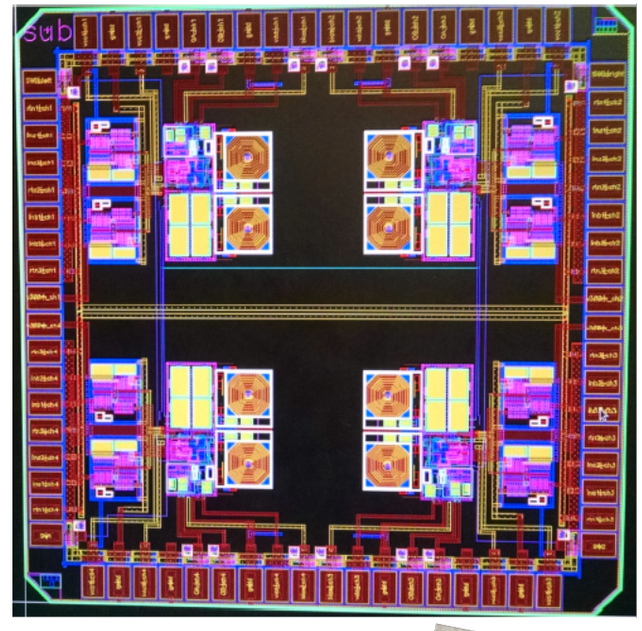
signal (&noise) low compared to lab tests @ Penn
->amp had been switched from Hi->Lo gain @Penn?

this was first beam test of ASIC quad TIA
we would like another run in Hi gain mode
nevertheless good results (see below)

We had promising laser results @Penn the week before FNAL test

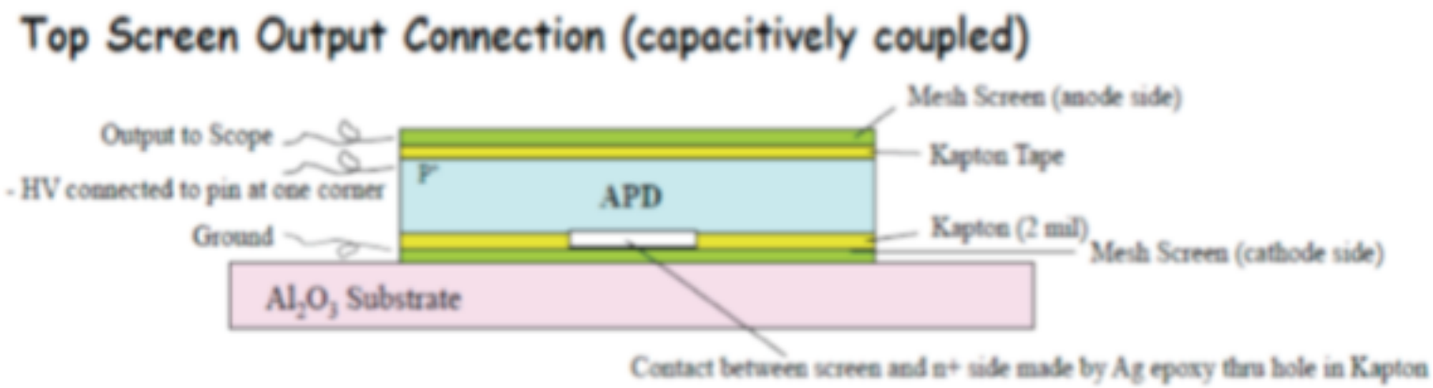


ASIC



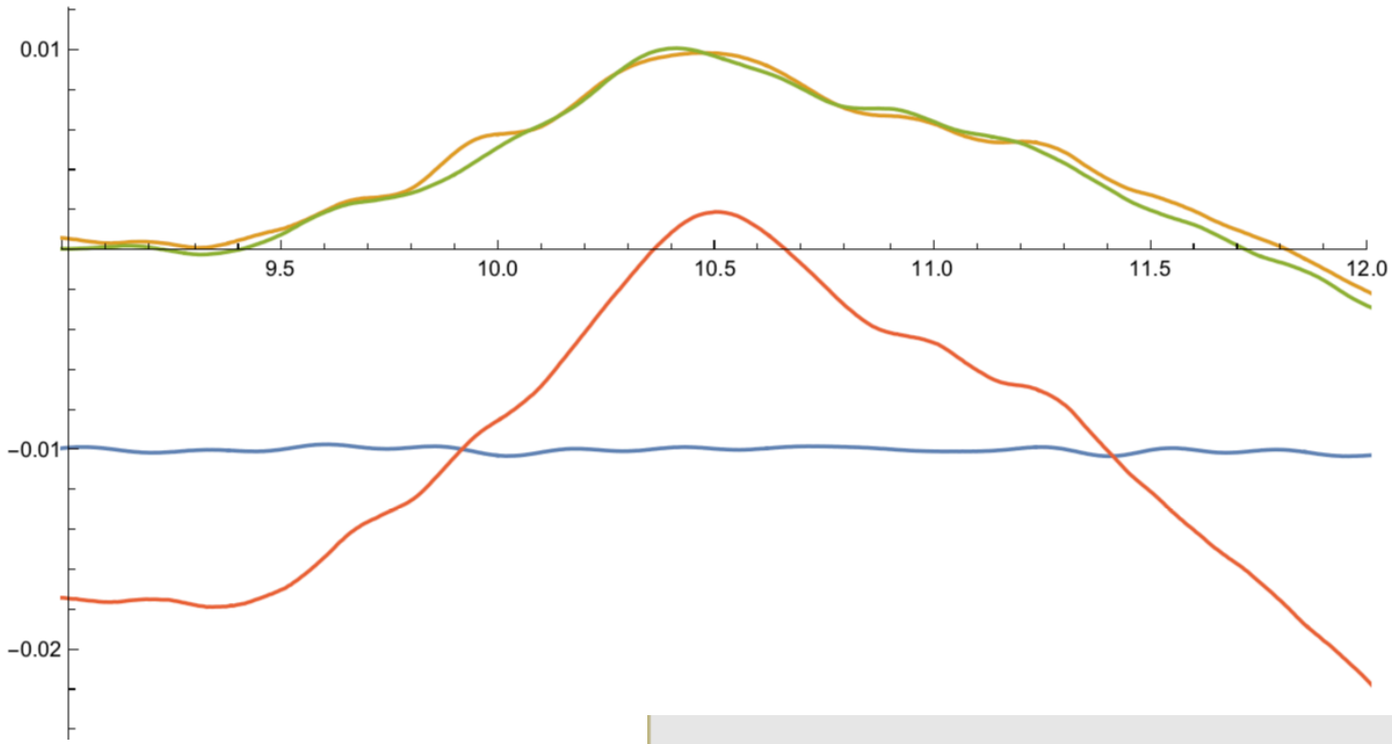
discrete

for details on HyperFast Silicon (HFS) see eg. 2015 CERN det. Seminar: https://indico.cern.ch/event/439571/



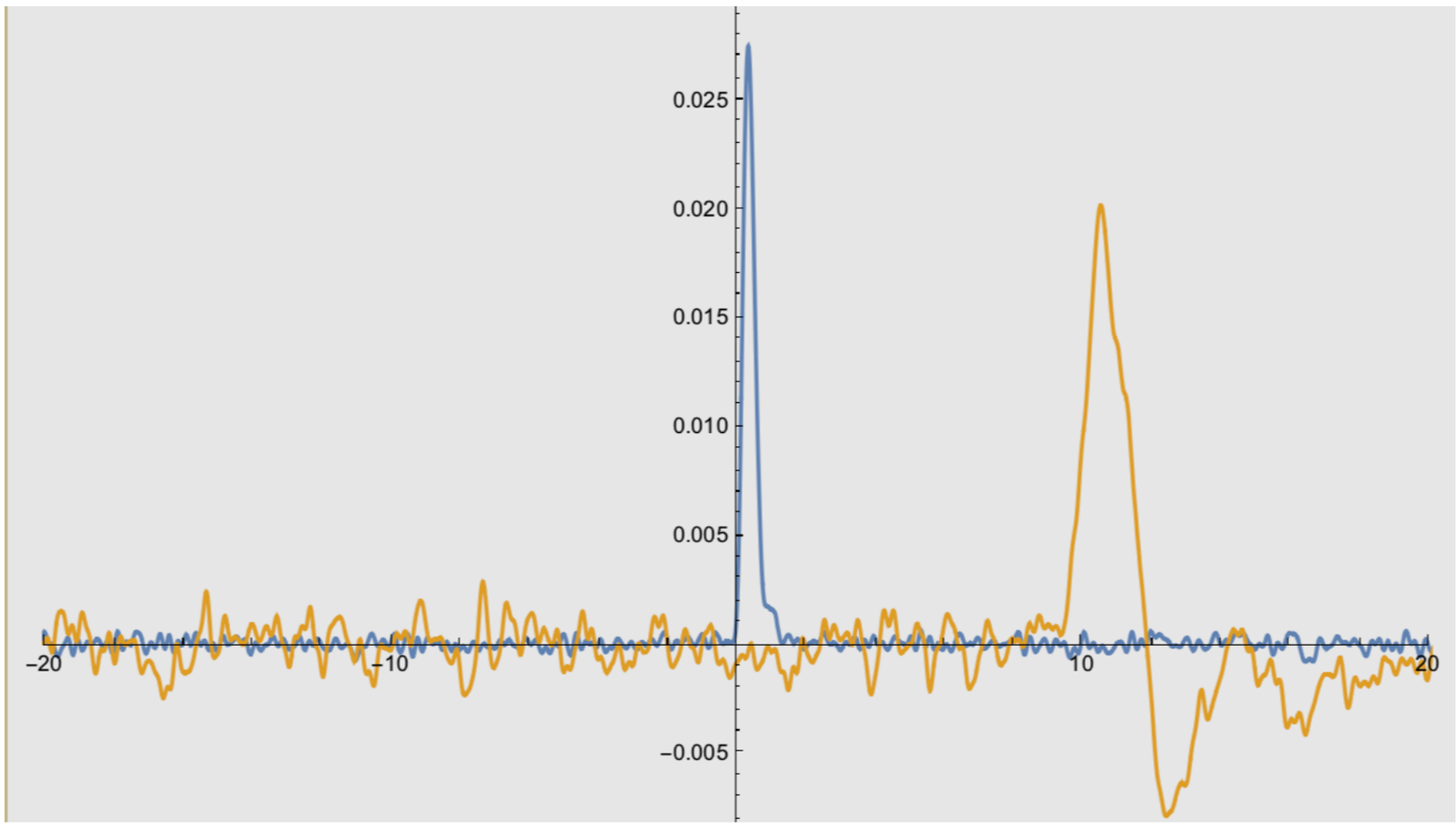
in what follows +'ve & -'ve difference, including 100 picosec offset and 20% Gain diff

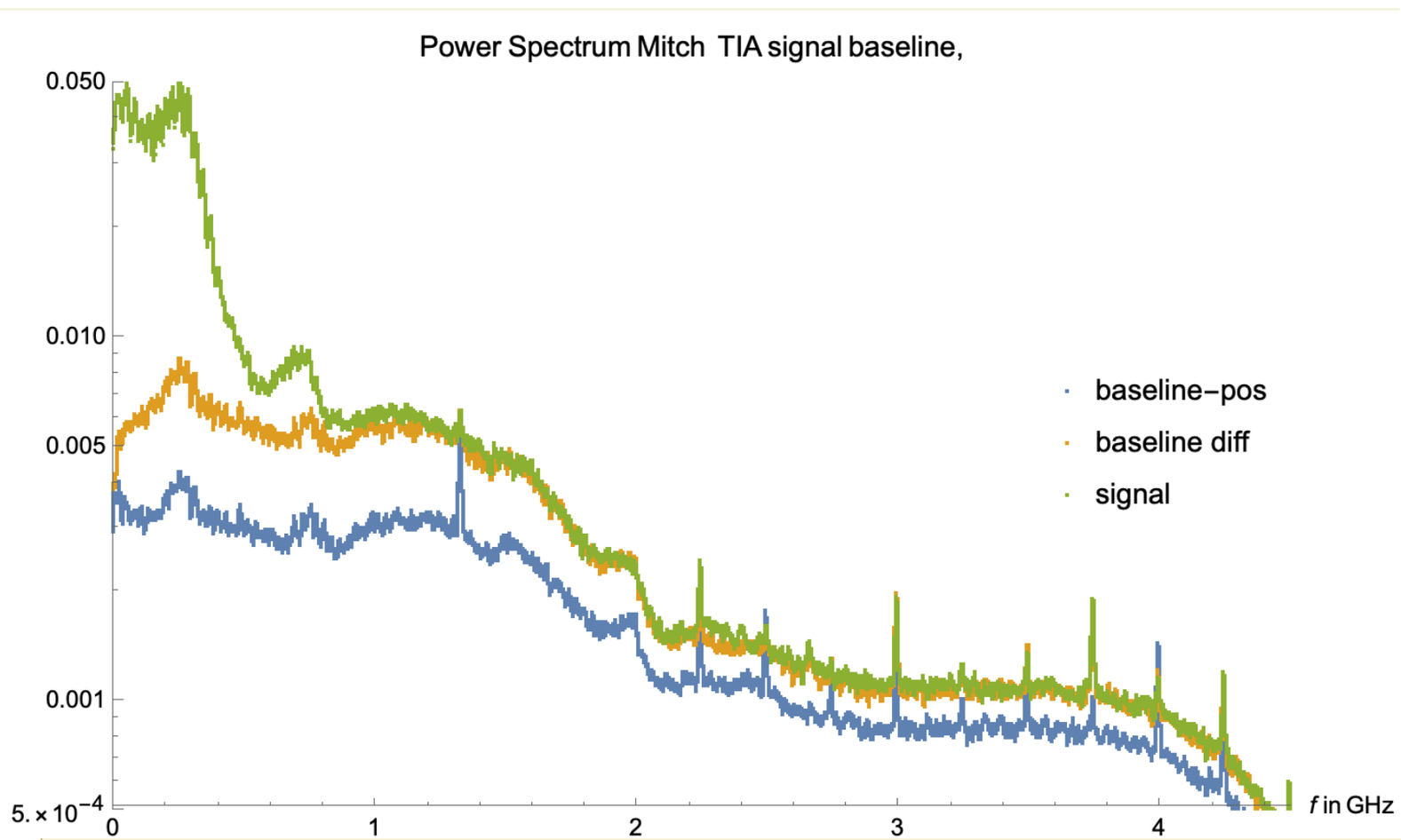
```
ListLinePlot[{Transpose[{time, 0.05 * mcp - 0.01}], Transpose[{time, ch1 + .018}], Transpose[{time - .1, -.8 * ch3}],
  Transpose[{Drop[time, 1], Drop[ch1, 1] - 0.8 * Drop[ch3, -1]}]}, PlotRange → {{9, 12}, Full}, ImageSize → Large]
```



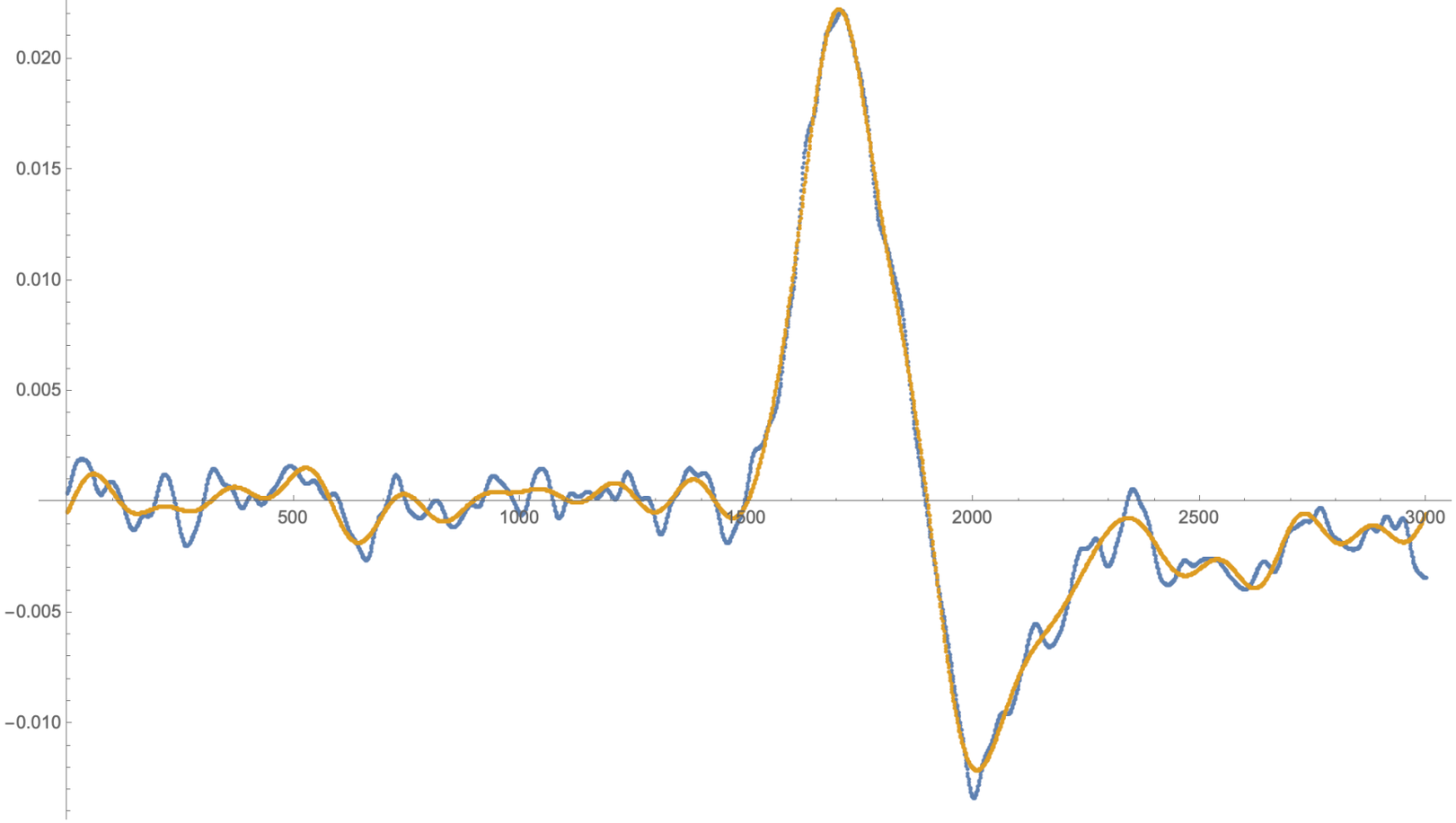
SNR of comb~ 19:1
t_{Rise}(20-80%)~ 0.65 ns

improve jitter
w . digitally applied
bandpass filter?
(scope BW=1GHz)

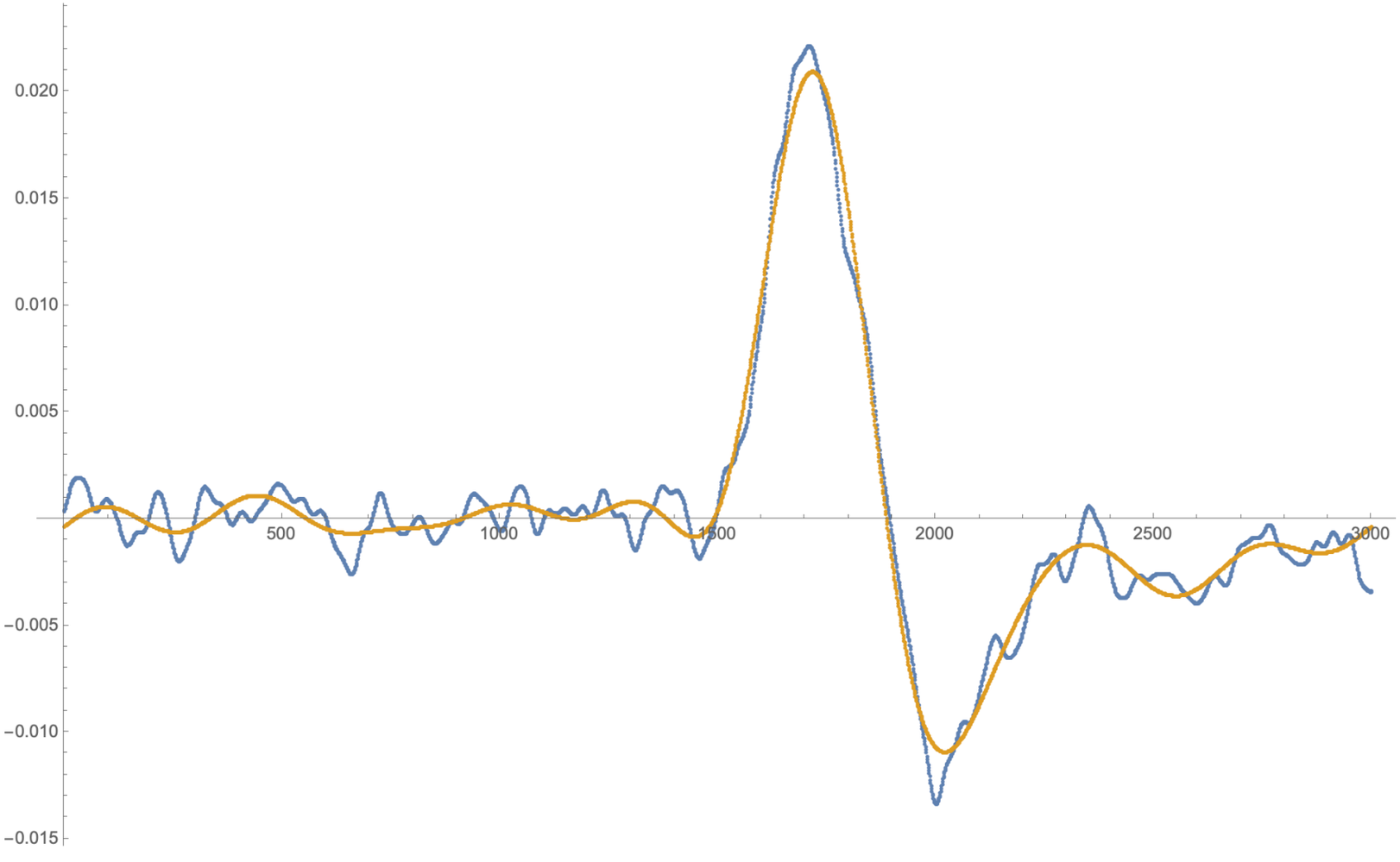



Power Spectrum Mitch TIA signal baseline,
0.050
0.010
0.005
0.001
5. × 10^−4
0
1
2
3
4
f in GHz
baseline−pos
baseline diff
signal

Power Spectrum Mitch TIA signal baseline,
0.05
0.04
0.03
0.02
0.01
1
2
3
4
f in GHz
baseline−pos
baseline diff
signal

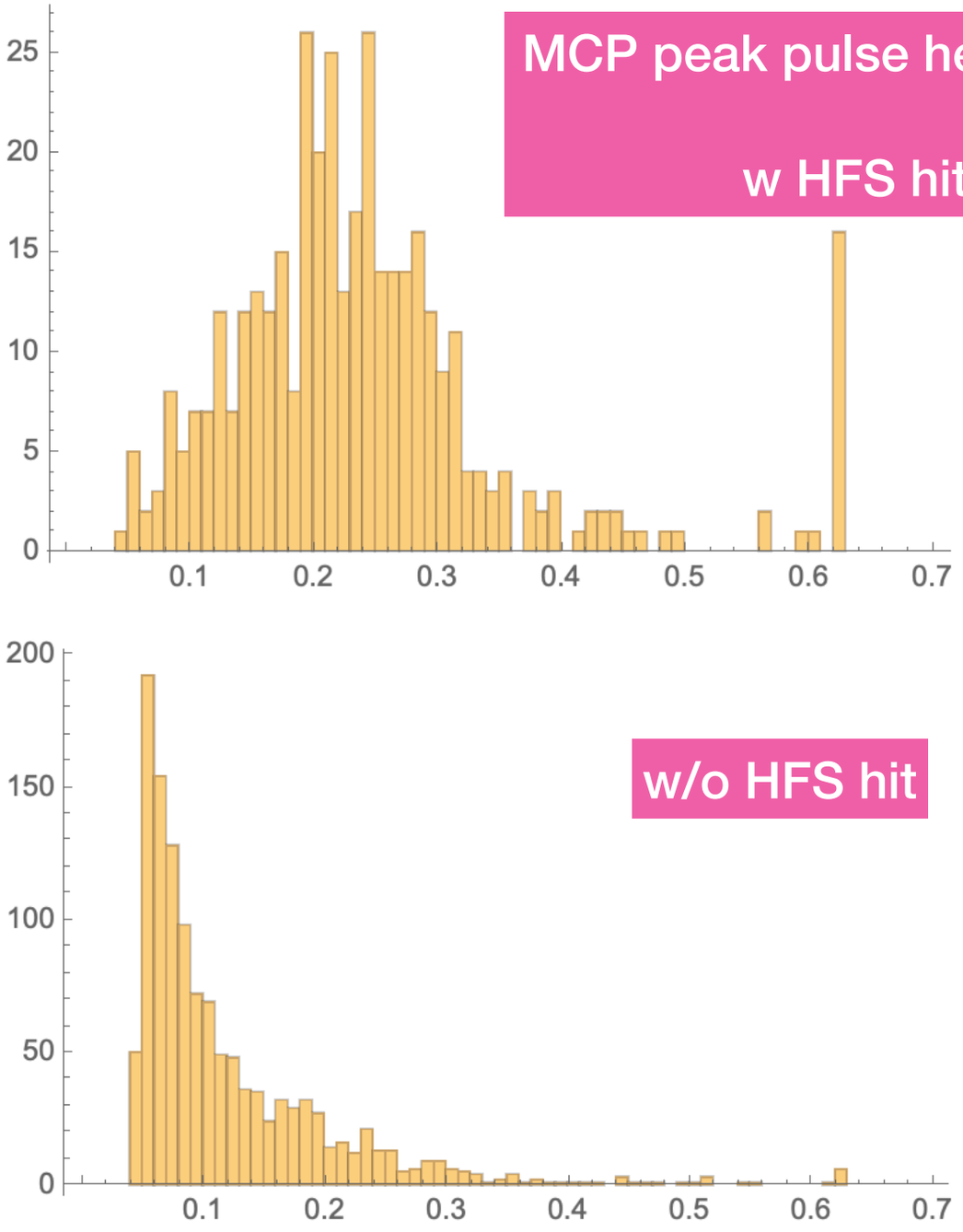


1GHz bandpass

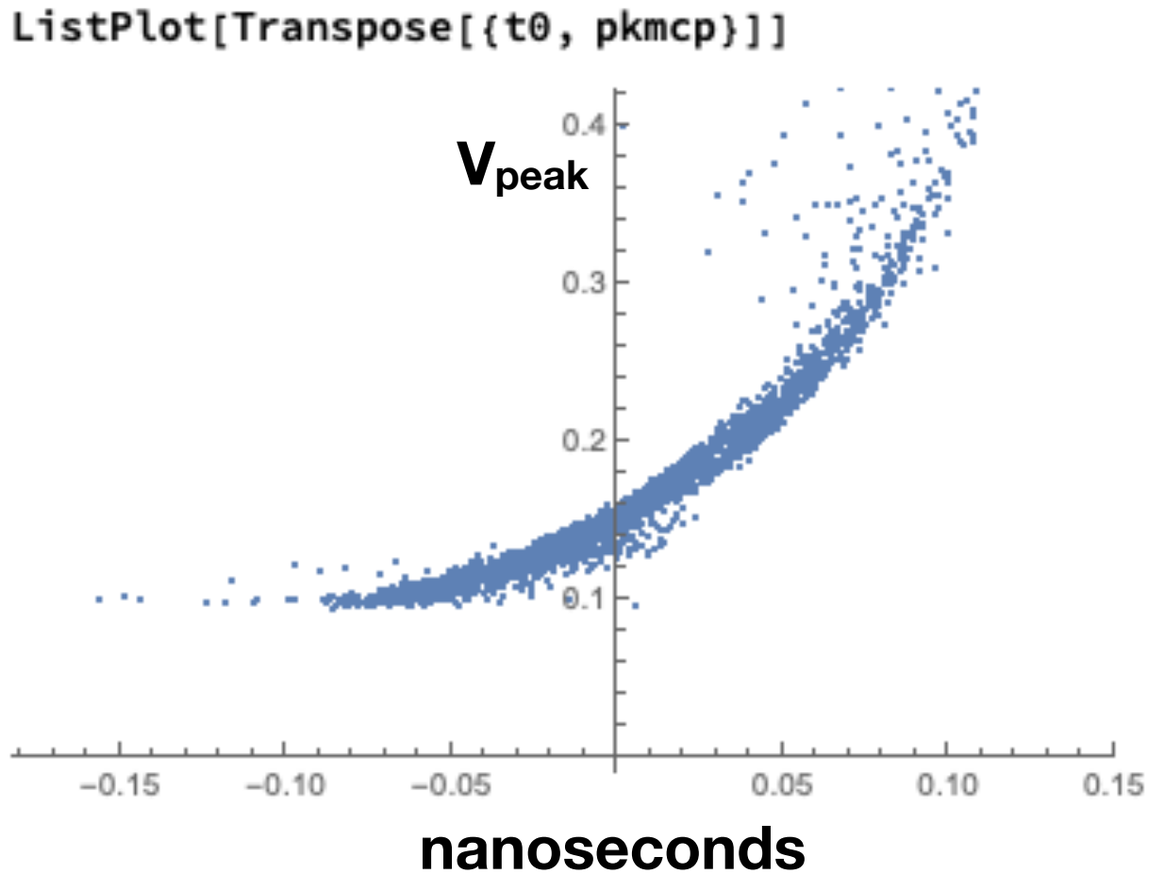


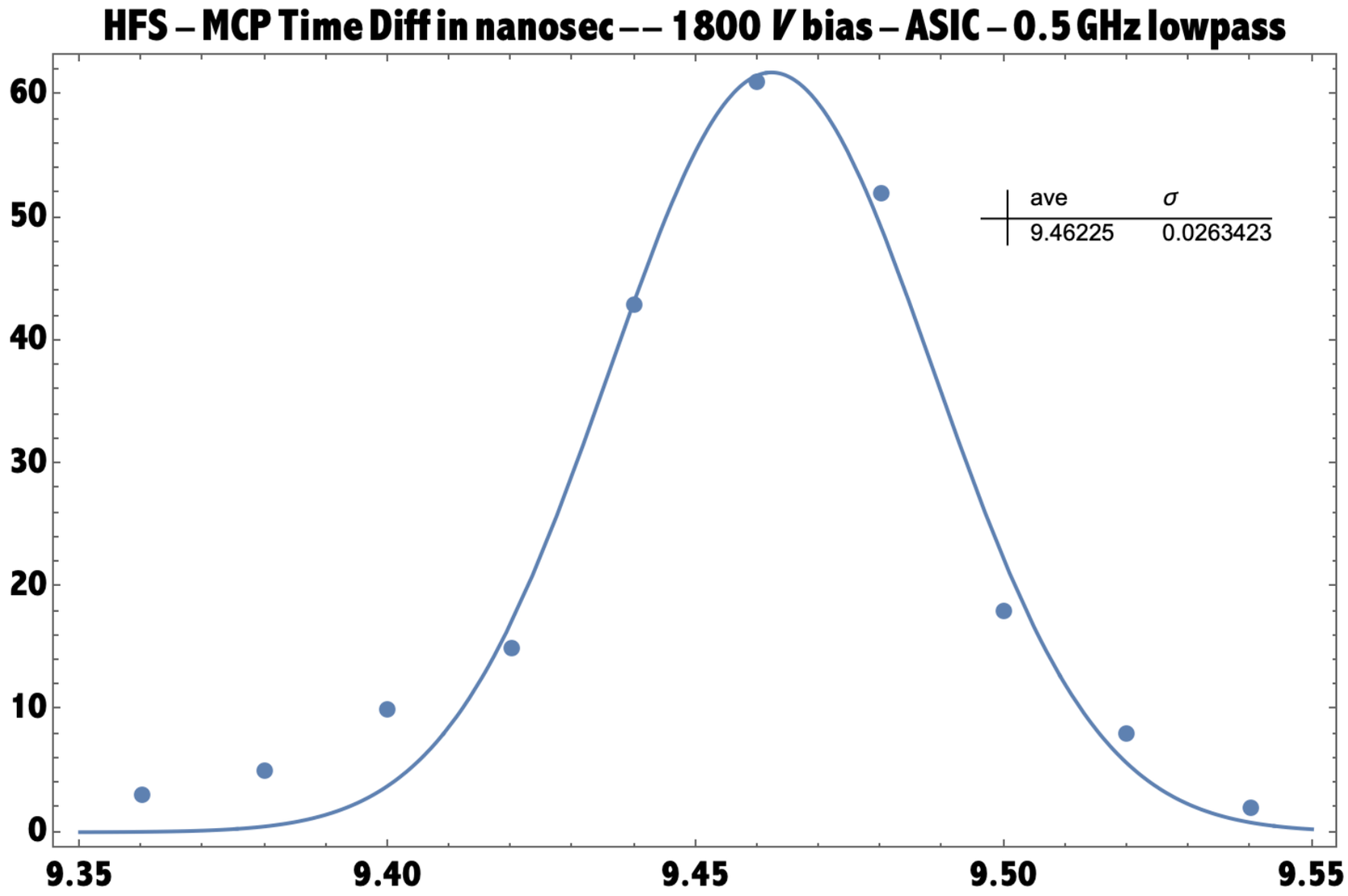
0.5 Ghz bandpass

MCP start time:
would have benefited from tracking to select hits in center of photocathode



MCP-PMT walk correction



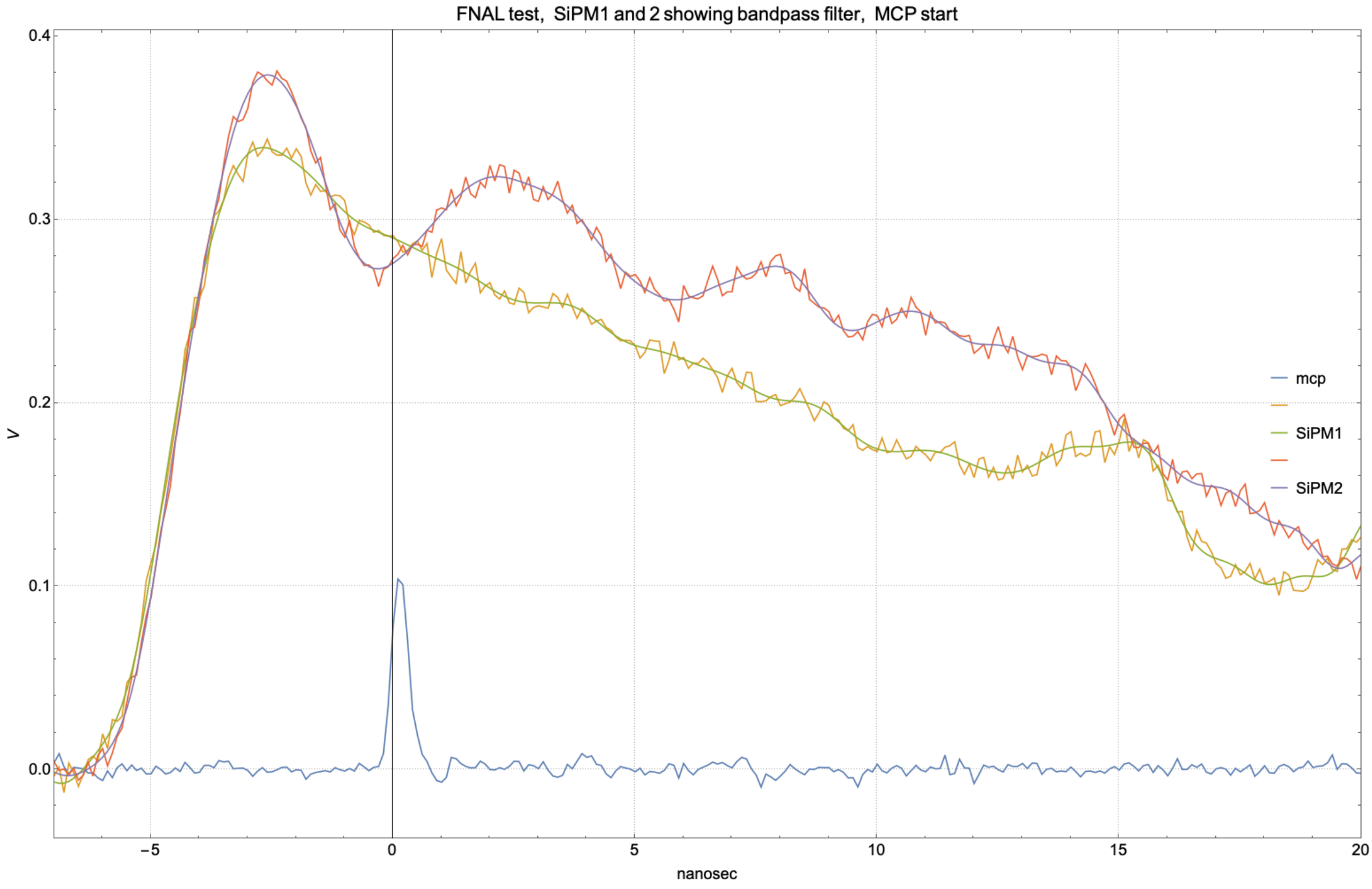


Summary:

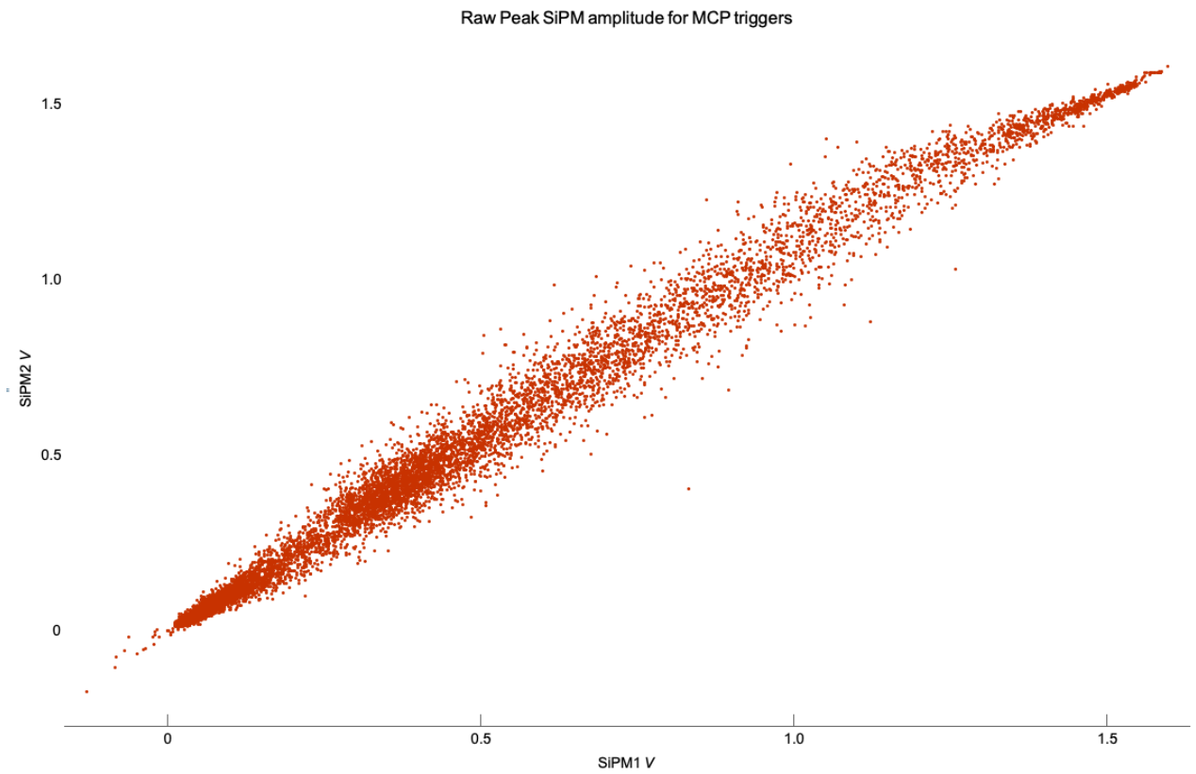
- not a bad result for a 1 day testbeam campaign !
- in fact, it was a 3 hr. test I snuck in at the end of my CMS day job (Barrel Timing layer LYSO/SiPM)
- no evidence of significant CMRR in lo gain (Slide 4)-> follow up at Hi gain

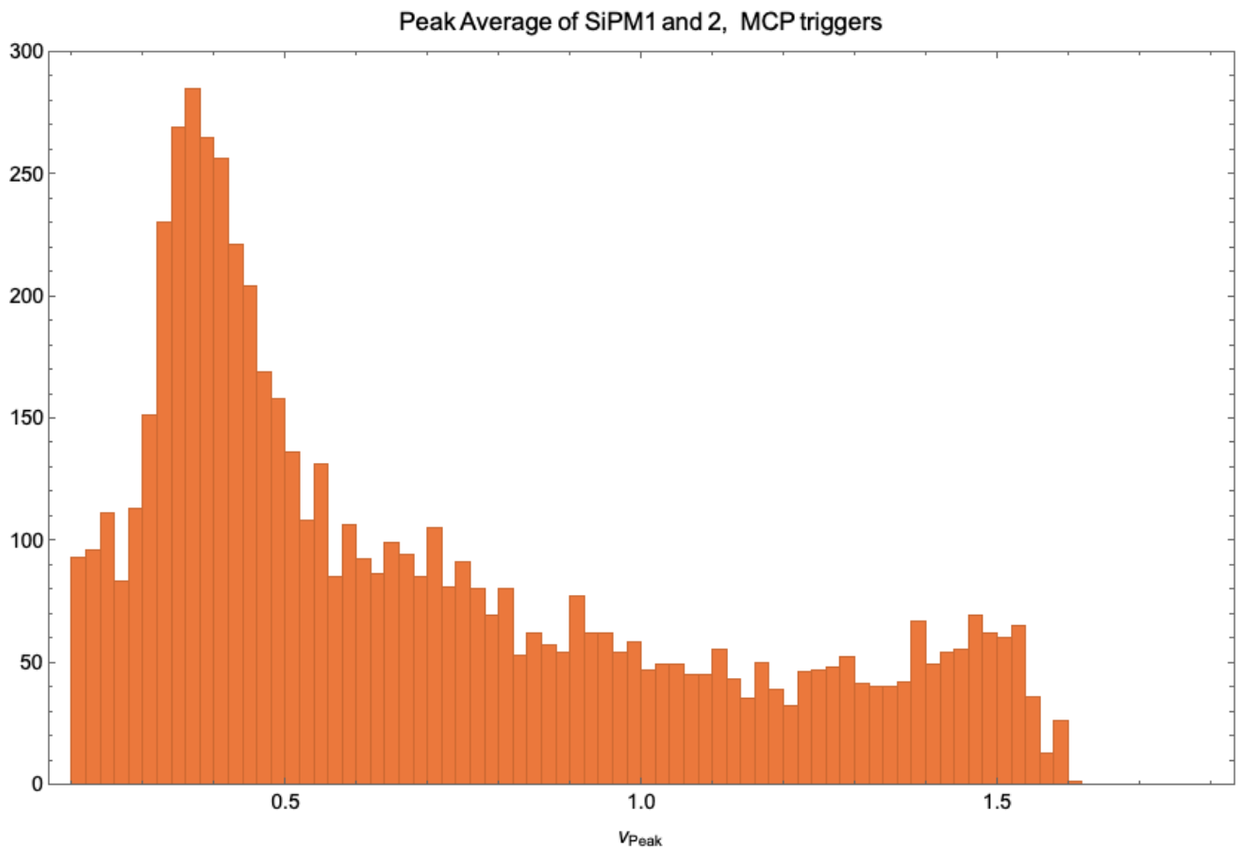
LYSO/SiPM data w new FEE

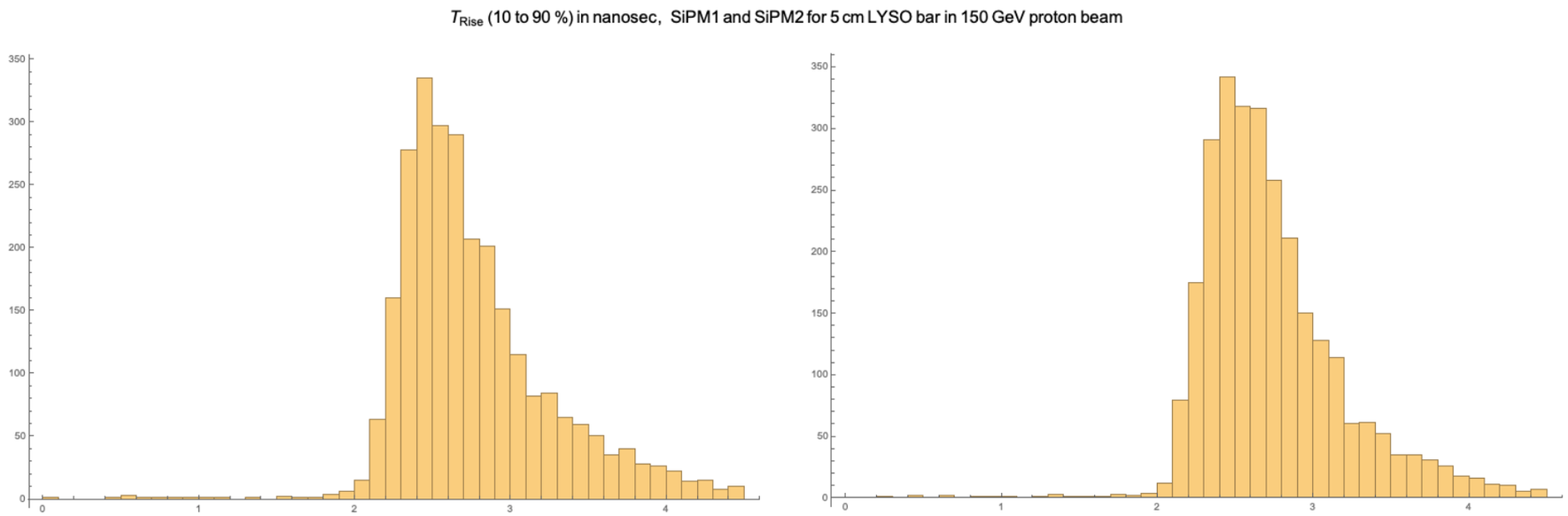
accumulated 3k coincidence events in 16k MCP-PMT triggers
signals clean and strongly correlated SiPM1&2



working with MIP candidates, <Vpeak> from 0.25 to 0.6 V







Conclusions

- opportunities for parasitic focused measurements @FTBF and helpful support group (JJ, Mandy,Lorenzo,Todd)

- also downstream, thanks to Henry F.

- FEE design from Stefan seems promising-> dual output boards being prepared at U Va.

- worth keeping in mind that we can complement the large MTB test campaigns with simpler ones