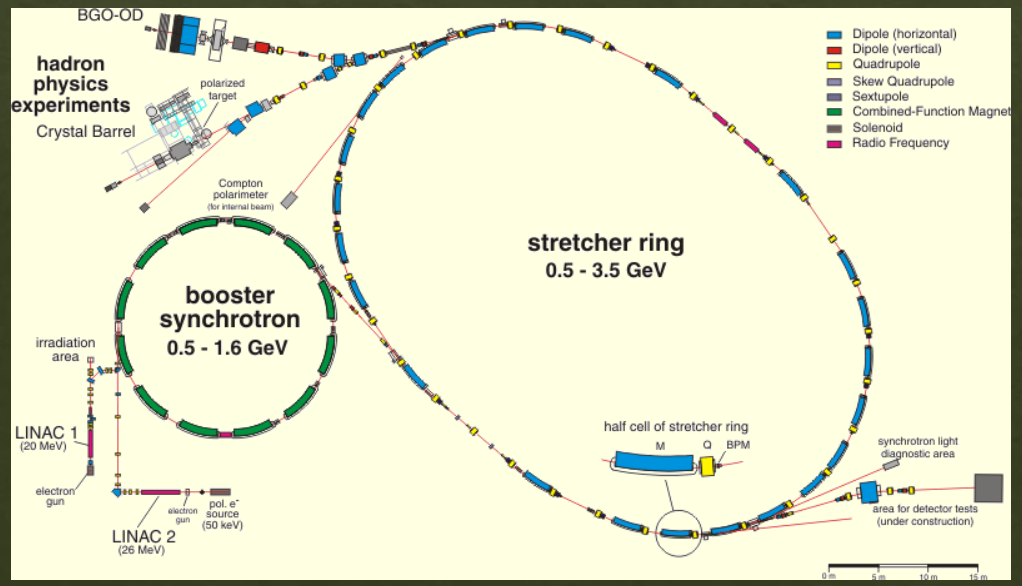
Test beam with ams Chess1 at Bonn

Luigi Vigani

Why test beam at Bonn

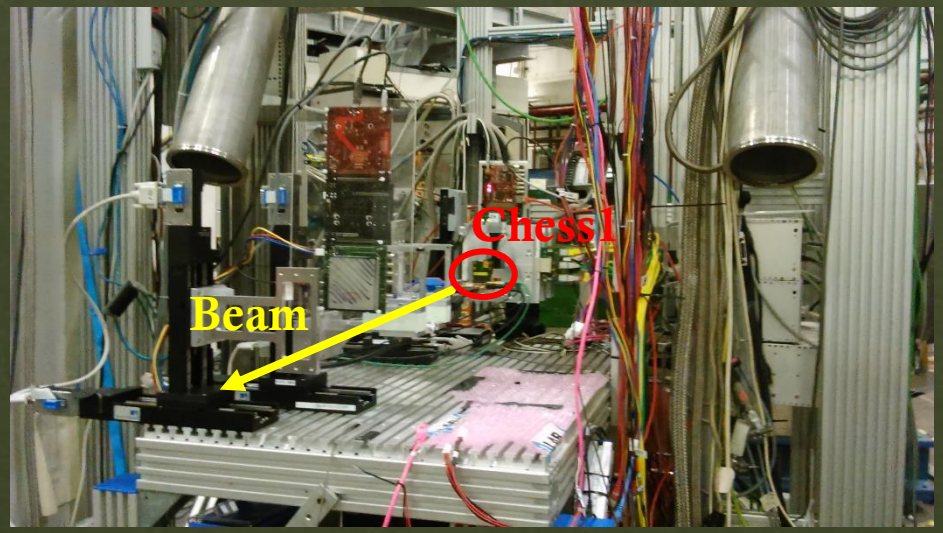
- Had chance to join a test beam in Bonn
- They were going to perform a test beam campaign in March at Elsa (Elektronen-Stretcher-Anlage)
- They kindly let me place an ams Chess1 device on the beamline next to their experiments

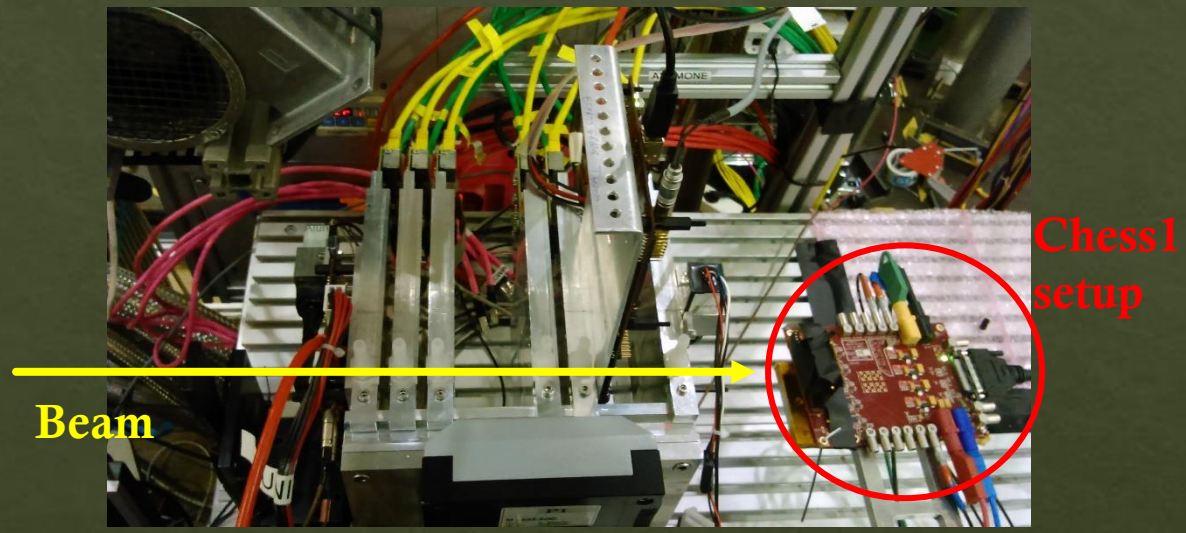


The Elsa beam line

- 3-3.5 GeV electrons
- 200 mA current

Not-irradiated ams Chess1 in beam line





Many experiments on one table (space for Chess1 kindly given).
One experiment with 6 planes before Chess1.
No telescope available.
Chess1 daughterboard, motherboard, atlys board and cable sent from RAL (thanks Jaya and Jens).
No way to verify alignment with beam.

Data taking

- Oscilloscope provided by Bonn, same DAQ as normally used
- Labview drivers for scope (Tektronix)
  - Could save 3 waves at the same time
  - Slow data taking: rate of few Hz
  - When in DC mode scope resolution of 4 mV
  - Trigger on only one channel (not a combination of the 3)
- 2 days of data taking
  - ~36 hours effectively
- Many spectra obtained
- Calibrations still underway…

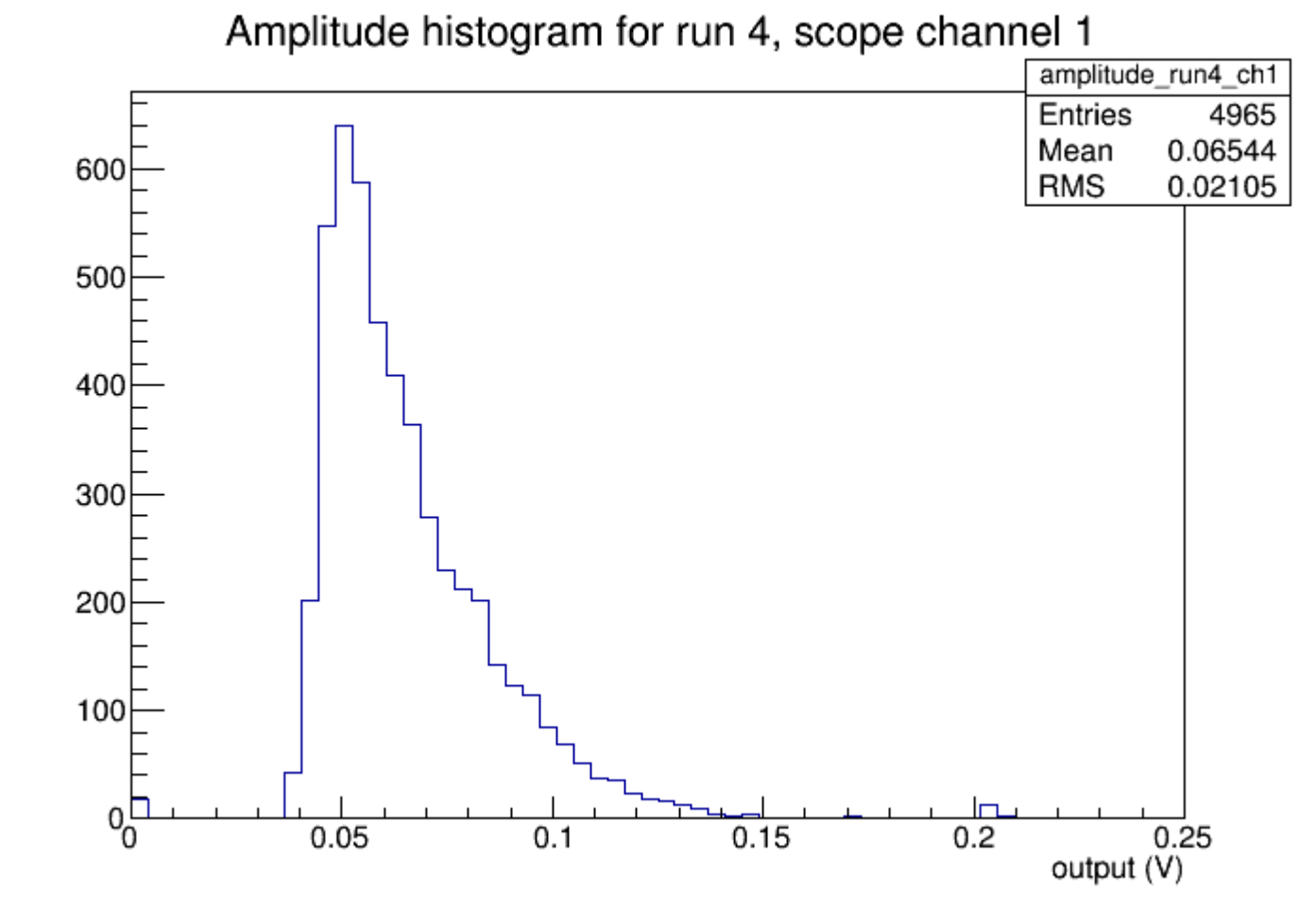
Data taken

Run num	Bias	Config	Board to channel1	Board to channel 2	Board to channel 3	Trigger on scope Ch	Trigger level	Coupling	Events number
1	60	7	31	32	33	1	0.03	AC	1000
2	60	7	31	32	33	1	0.03	AC	1000
3	60	7	31	32	33	1	0.03	AC	157
4	60	7	31	32	33	1	1.5	DC	1000
5	60	7	31	32	33	1	1.5	DC	1718
6	60	7	31	32	33	1	1.5	DC	2244
7	60	7	31	32	33	2	1.5	DC	2444
8	60	7	34	32	33	2	1.5	DC	2287
9	60	7	34	32	33	2	1.5	DC	508
10	60	7	34	32	33	2	1.49	DC	1264
11	40	7	34	32	33	2	1.43	DC	733
12	40	7	34	32	33	2	1.43	DC	1302
13	80	7	34	32	33	2	1.59	DC	1306
14	80	7	34	32	33	2	1.6	DC	359
15	80	7	34	32	33	2	1.6	DC	1917
16	60	8	34	32	33	3	1.37	DC	148
17	60	8	34	32	33	3	1.37	DC	1226
18	80	8	34	32	33	3	1.435	DC	2724
19	80	9	34	32	33	3	1.37	DC	971
20	80	9	34	32	33	3	1.37	DC	1533

Due to the short time, focus only on APA8, outputs 1,2,3 and 4.
Different configurations and biases investigated.
DAC settings as defined by Santa Cruz, plus an extra configuration 9 (see later)

Configuration 7, 60 V bias, output 4

Spectrum



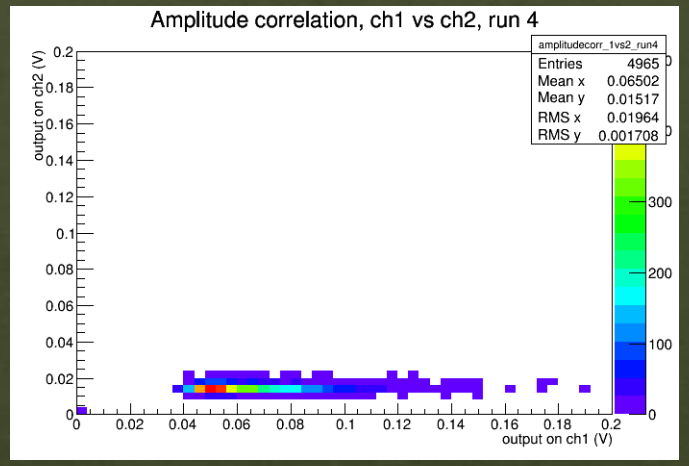
No Landau inferred

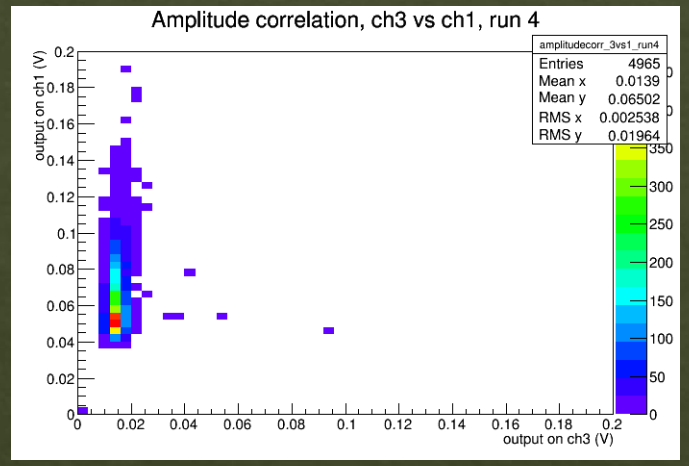
Configuration 7, 60 V bias, output 4

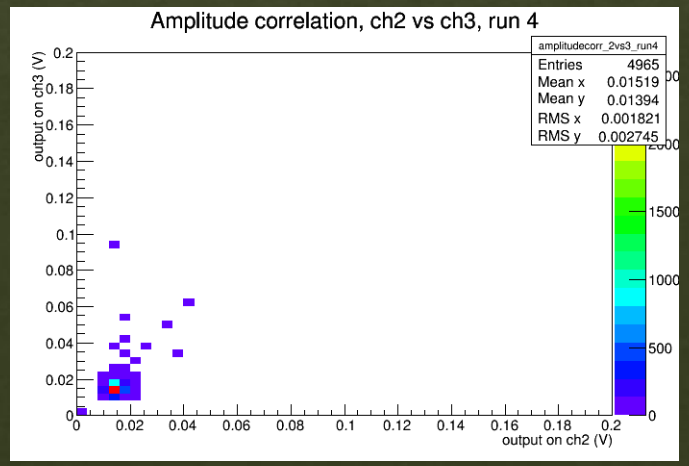
Active Pixel Array

Scope Ch1 (trg)		
	Scope Ch3	Scope Ch2

Correlations





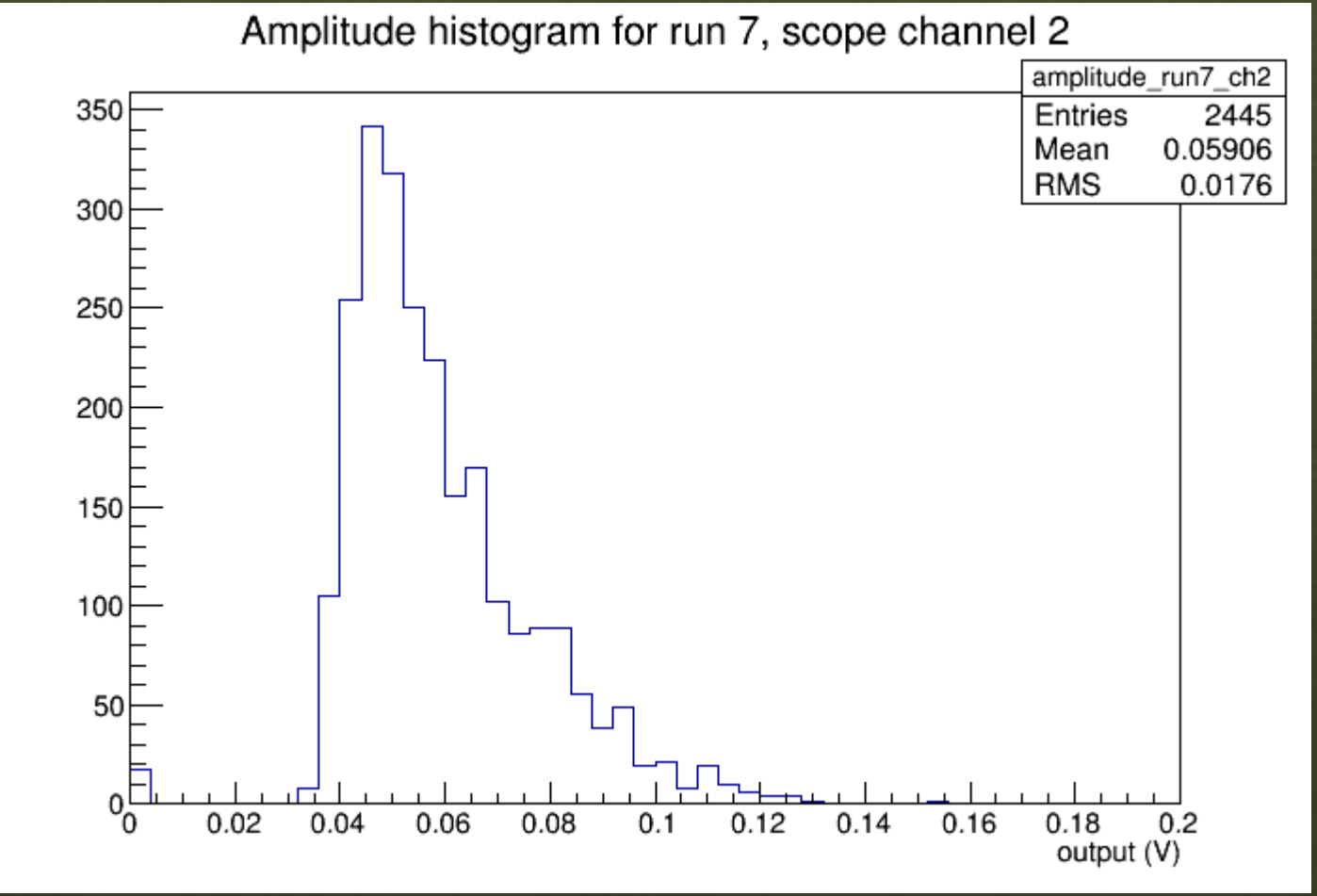


No correlation at all: as expected.

Is the spectrum not well defined because of charge sharing?

Configuration 7, 60 V bias, output 3

Spectrum



Trigger on channel 2 (output 2)

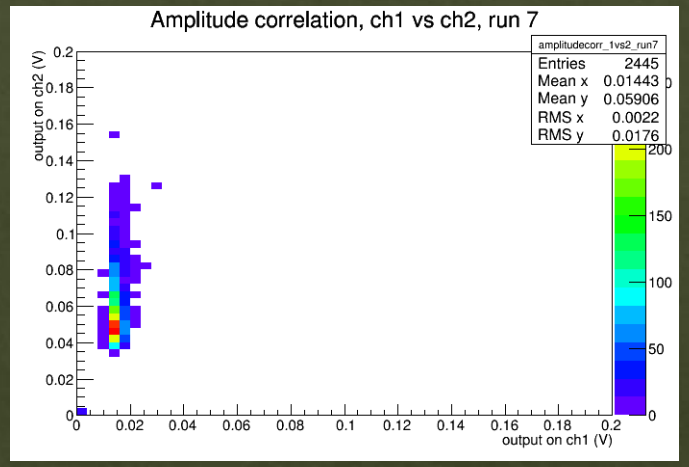
Still undefined.

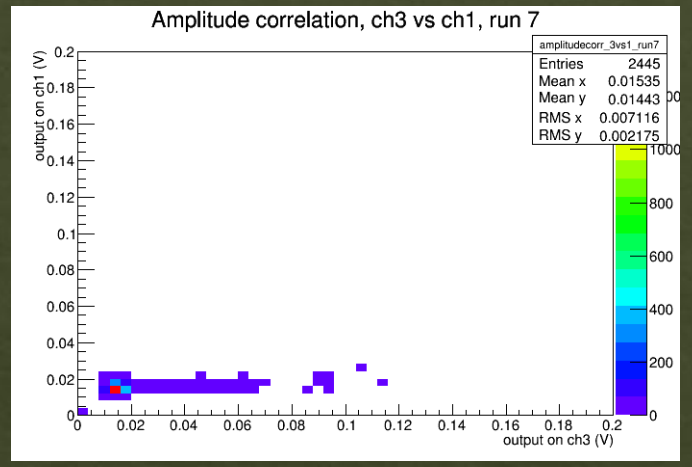
Configuration 7, 60 V bias, output 3

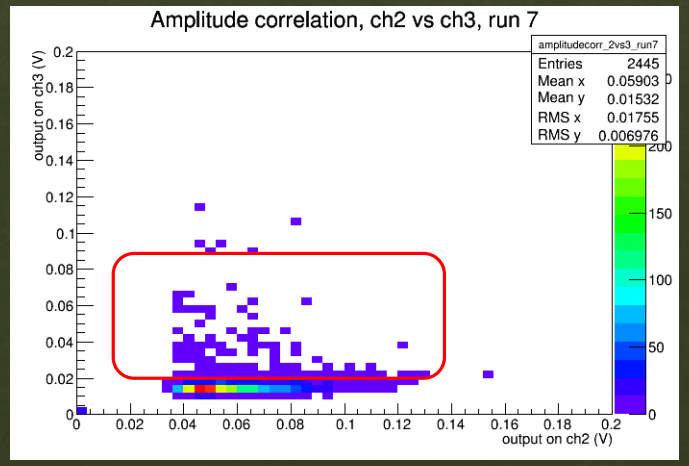
Correlations

Active Pixel Array

Scope Ch1		
	Scope Ch3	Scope Ch2 (trg)







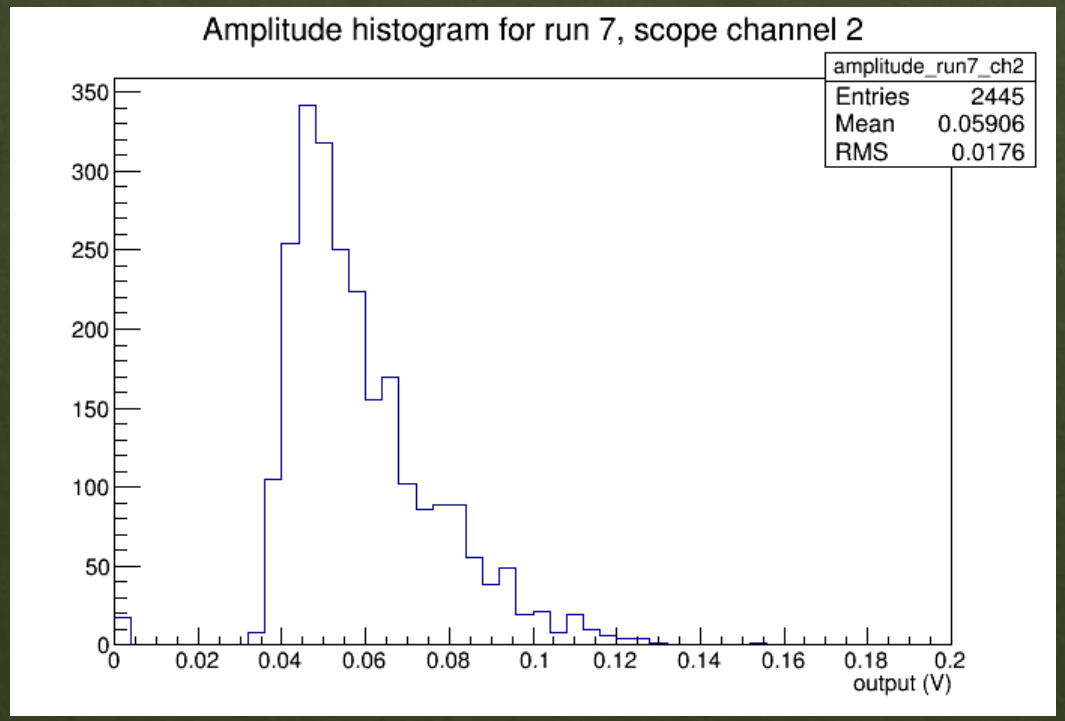
No correlation with channel 1: expected.

Something with channel 3: charge sharing!

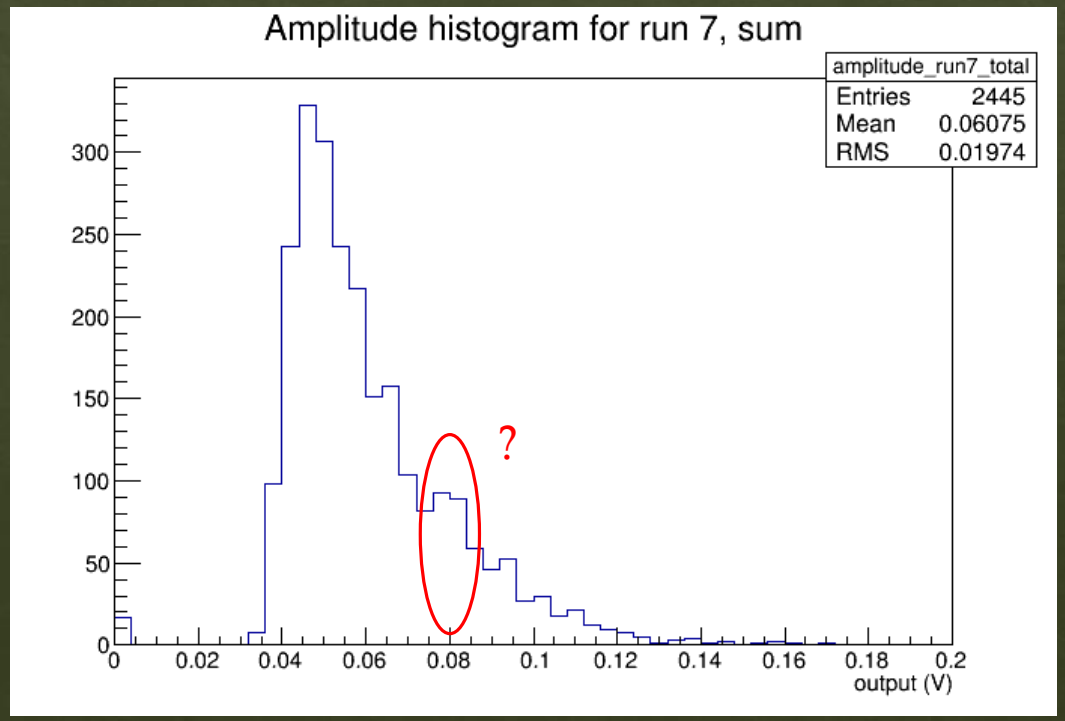
Configuration 7, 60 V bias, output 3

Sum of the 3 signals

(when the signal is below 22 mV is considered 0 to avoid noise contribution)



No sum



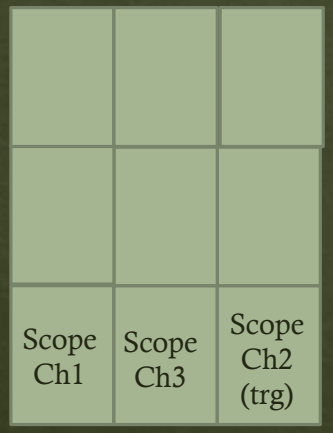
Sum

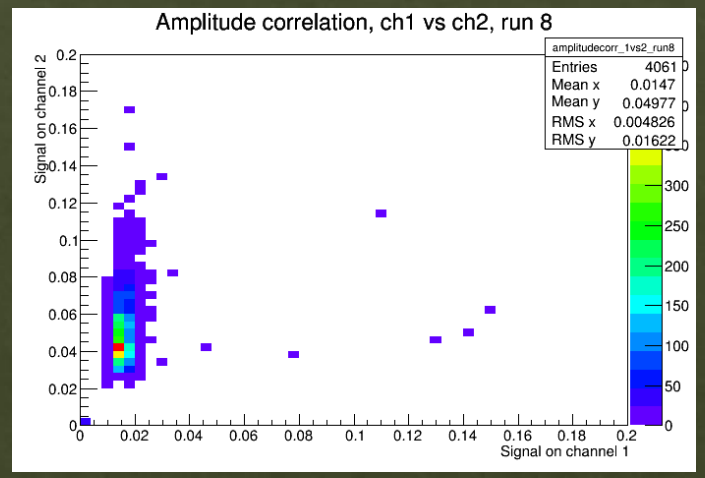
Something more peak-shaped and longer tail

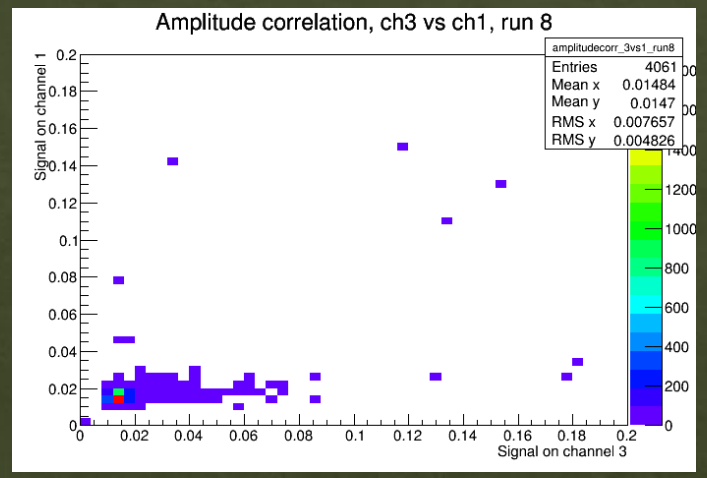
Configuration 7, 60 V bias, output 3

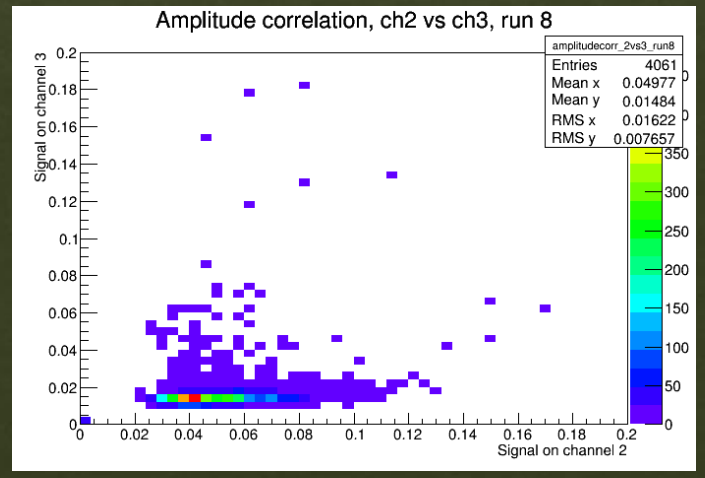
Correlations

Active Pixel Array









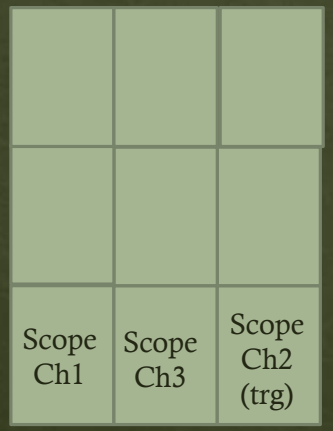
Channel 1 moved on output 1 (beside channel 3). Still triggering on channel 2.

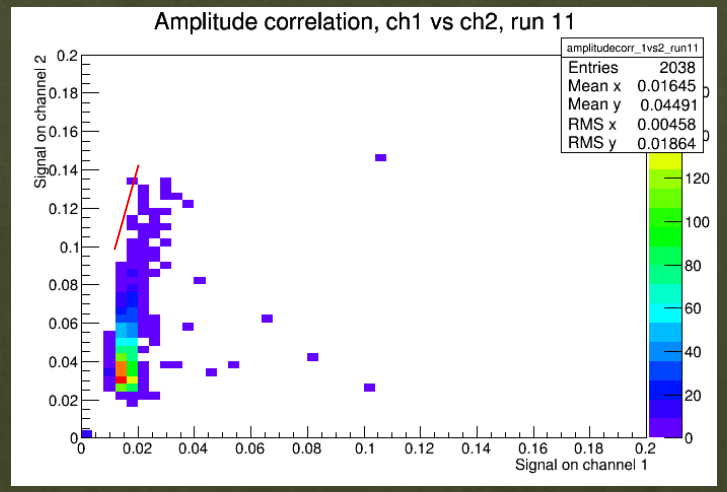
No correlation between 2 and 1: pixel too far for charge sharing.

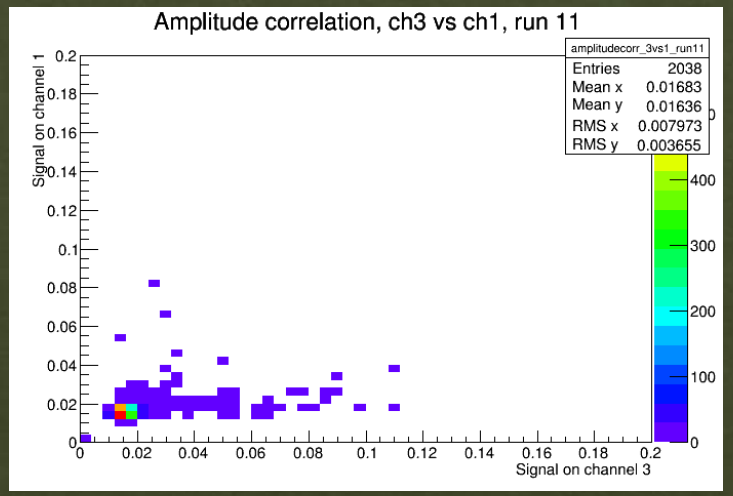
Configuration 7, 40 V bias, output 3

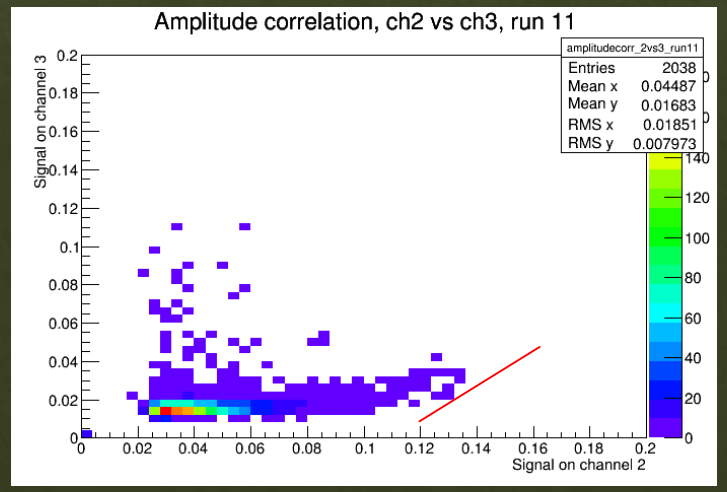
Correlations

Active Pixel Array









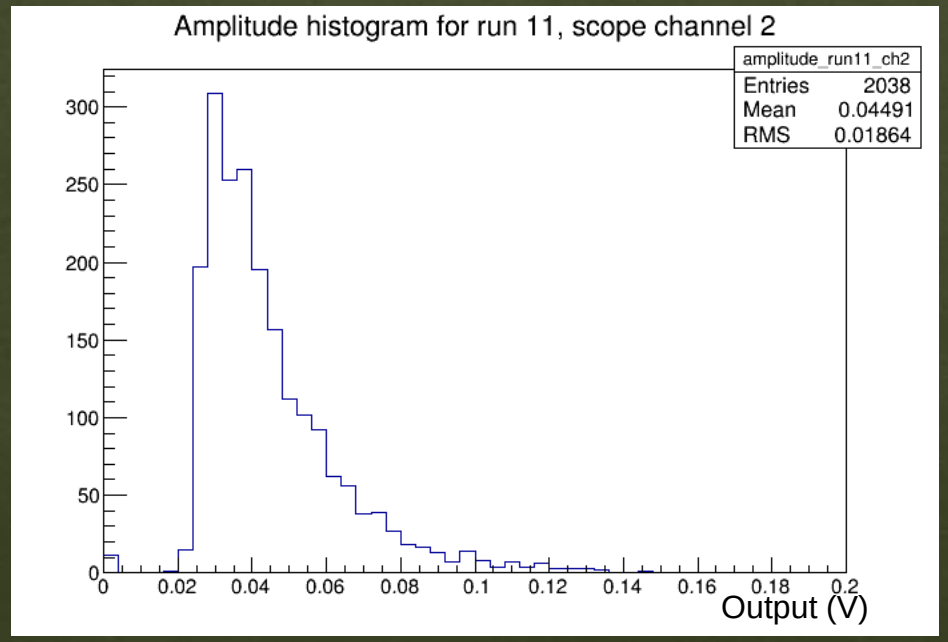
Similar situation as before.

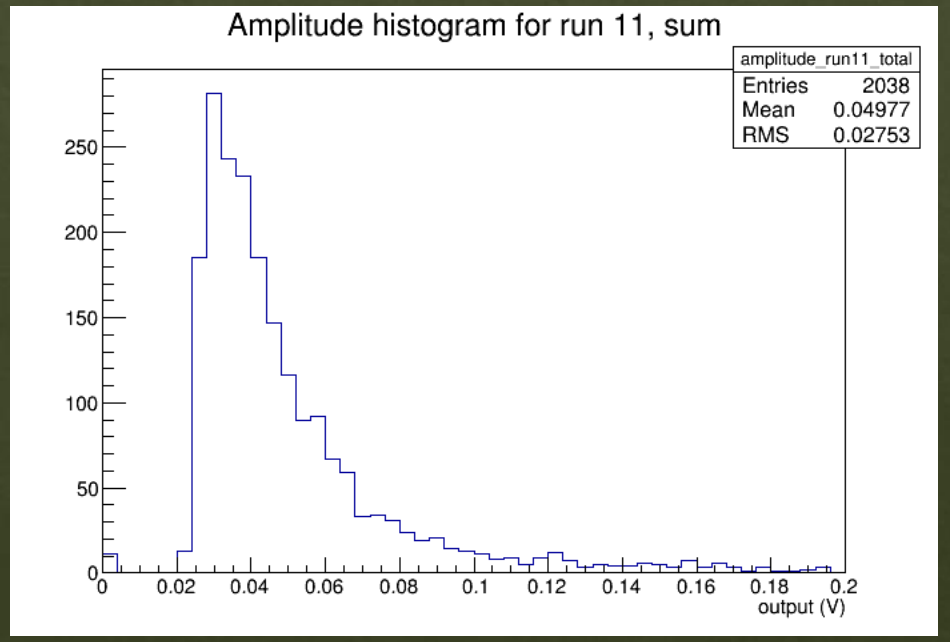
A “bending” in the correlations observed: high release of charge that crosses 2 pixels? Not statistically significant I fear.

Configuration 7, 40 V bias, output 3

Single and sum spectra

(when the signal is below 20 mV is considered 0 to avoid noise contribution)





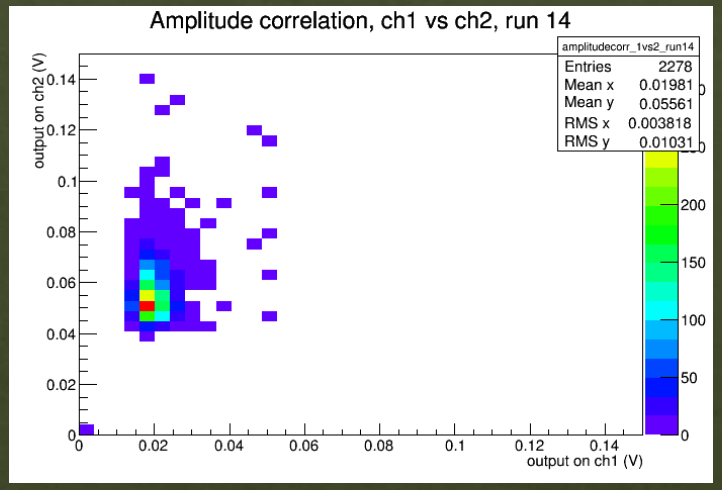
Longer tail…

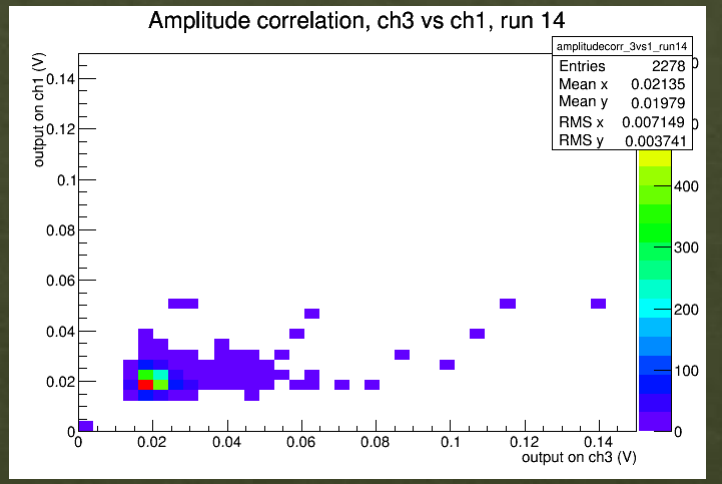
Configuration 7, 80 V bias, output 3

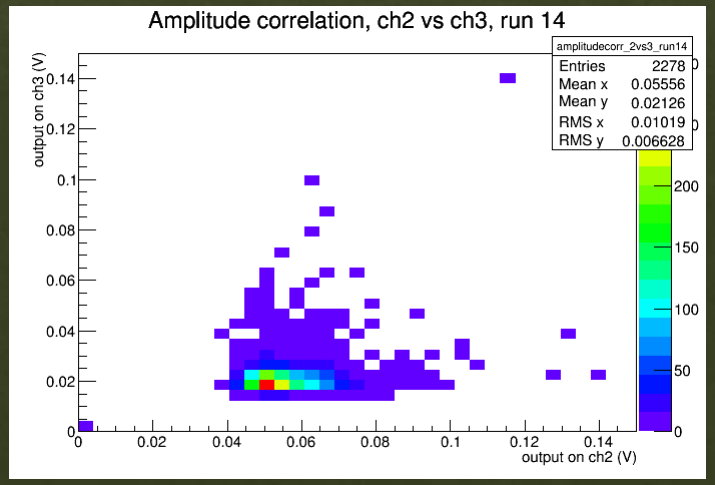
Correlations

Active Pixel Array

Scope Ch1	Scope Ch3	Scope Ch2 (trg)





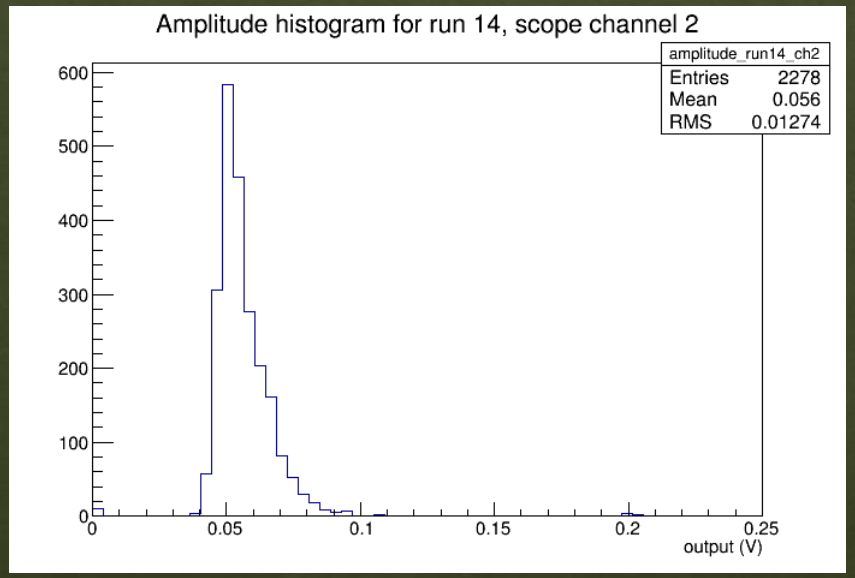


Some little correlation on channel 1 as well…

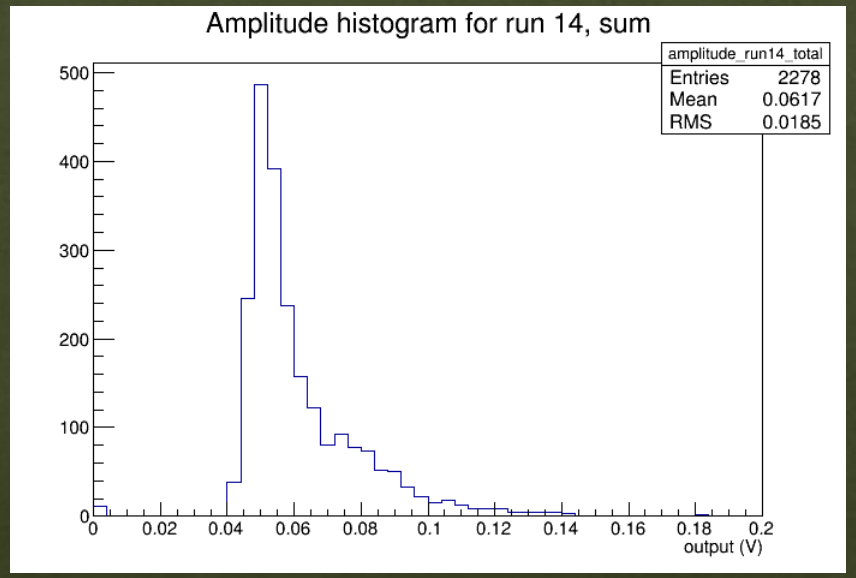
Configuration 7, 80 V bias, output 3

Single and sum spectra

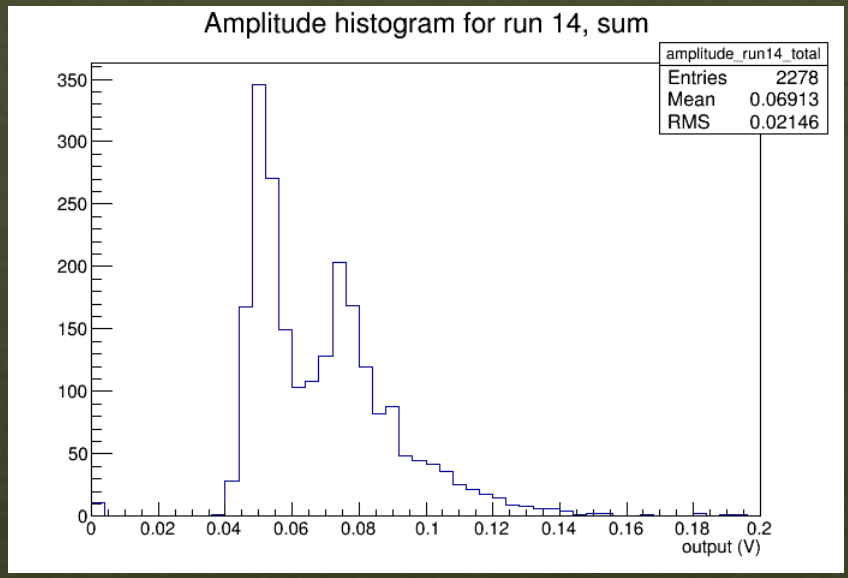
(when the signal is below a certain threshold is considered 0 to avoid noise contribution)



No sum



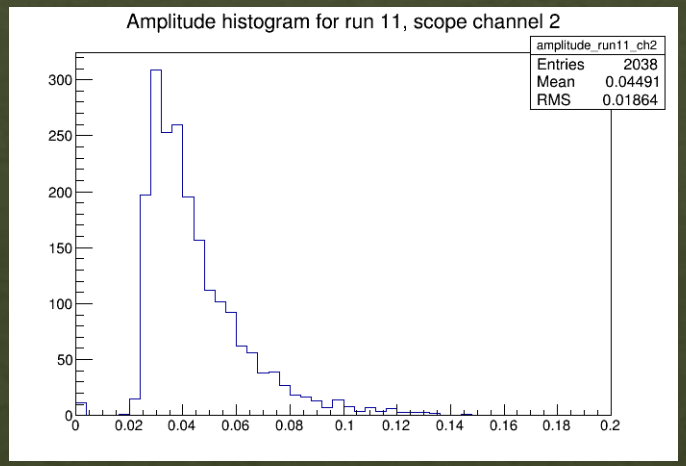
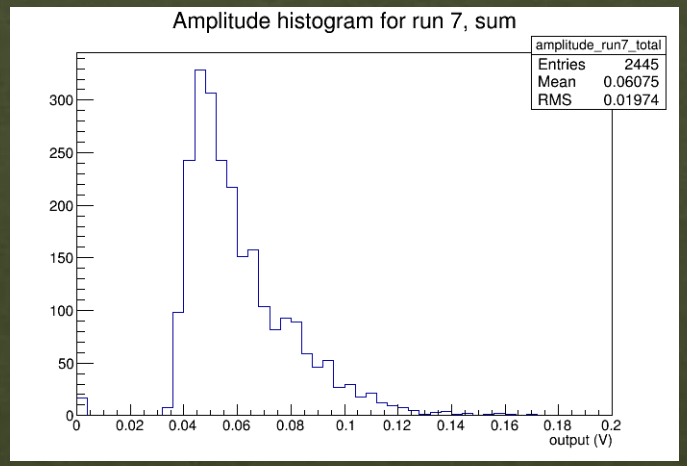
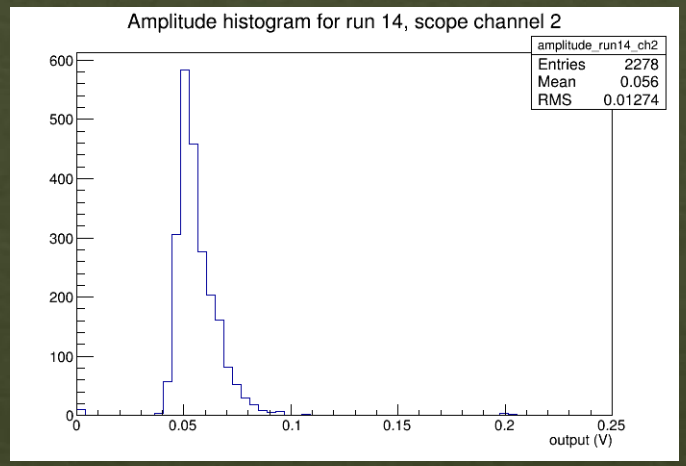
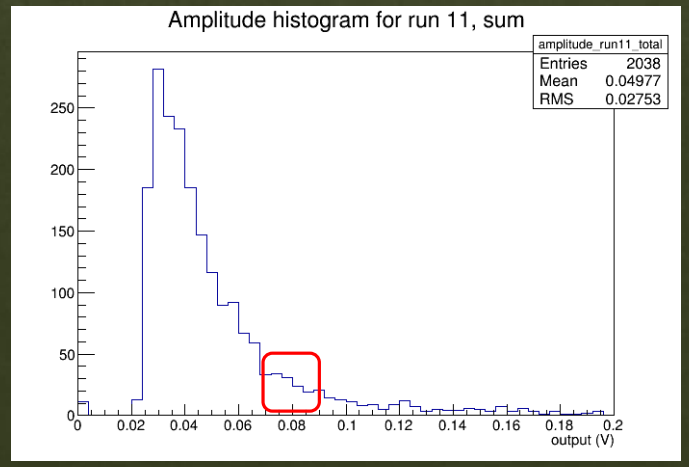
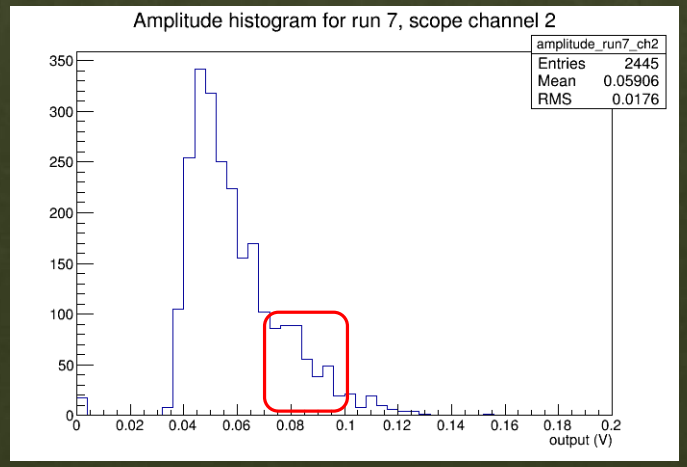
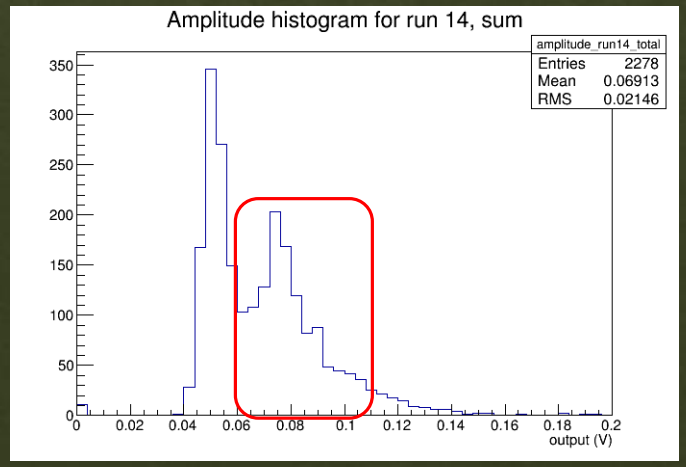
Sum with threshold 25mV



Sum with threshold 22mV

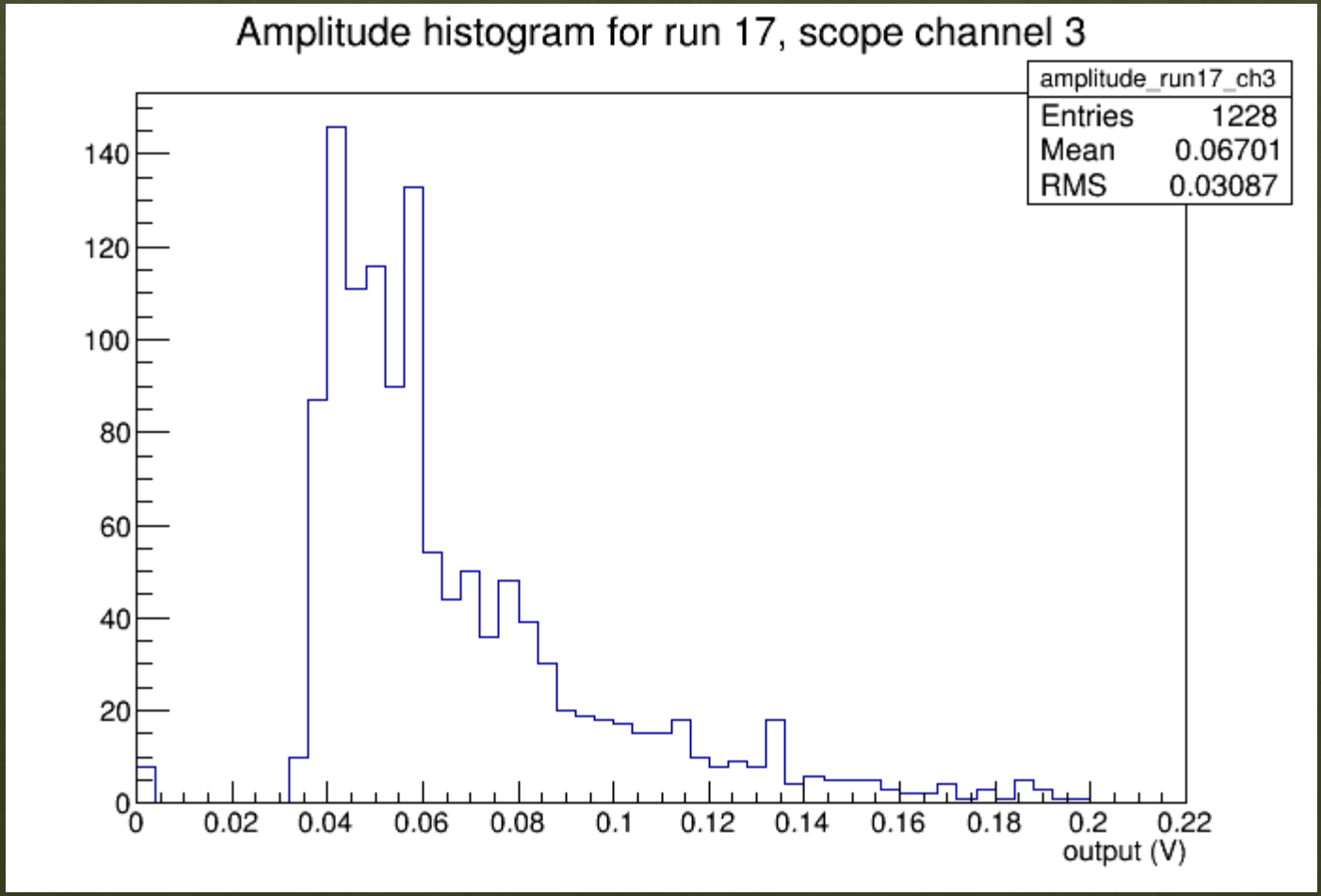
A really nice peak revealed!

Configuration 7, bias comparison

	Bias 40 V	Bias 60 V	Bias 80 V
One channel			
Sum of 3 channels			

Configuration 8, 60 V bias, output 2

Spectrum



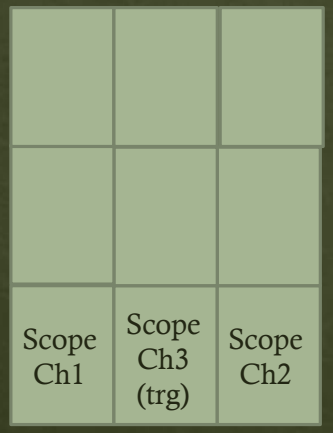
Longer tail: higher gain (proved with laser).

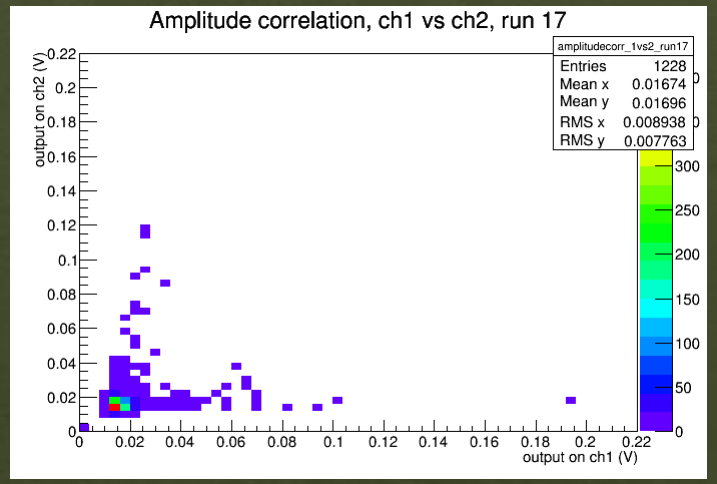
Something observed again at ~80 mV: if the gain is higher that should correspond to a lower value in electrons…

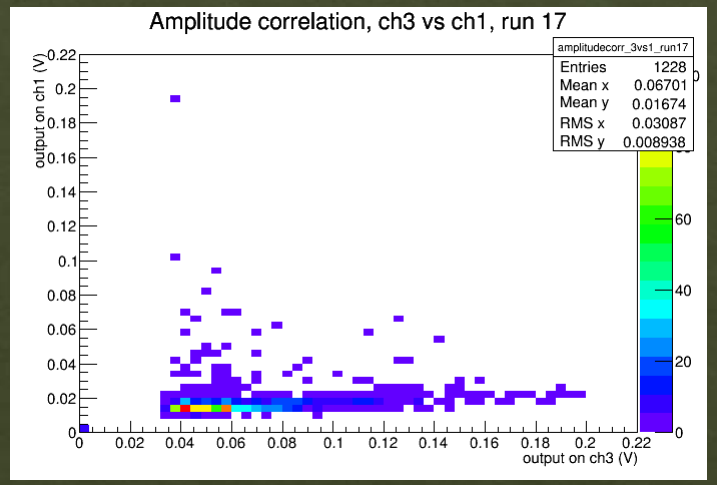
Configuration 8, 60 V bias, output 2

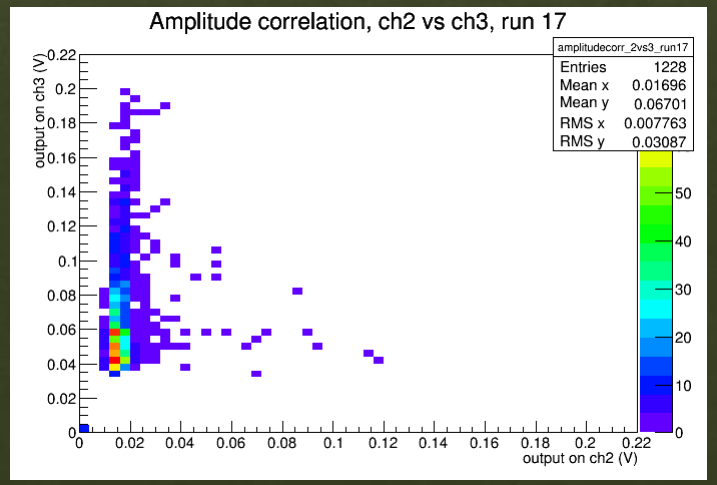
Correlations

Active Pixel Array







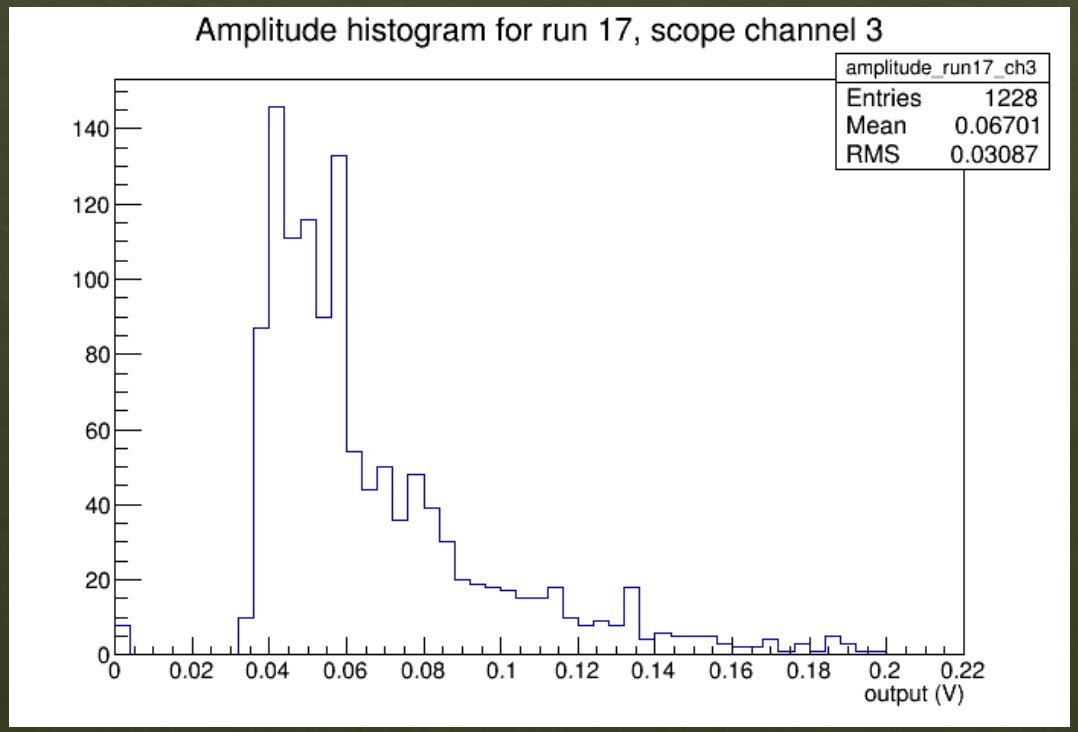


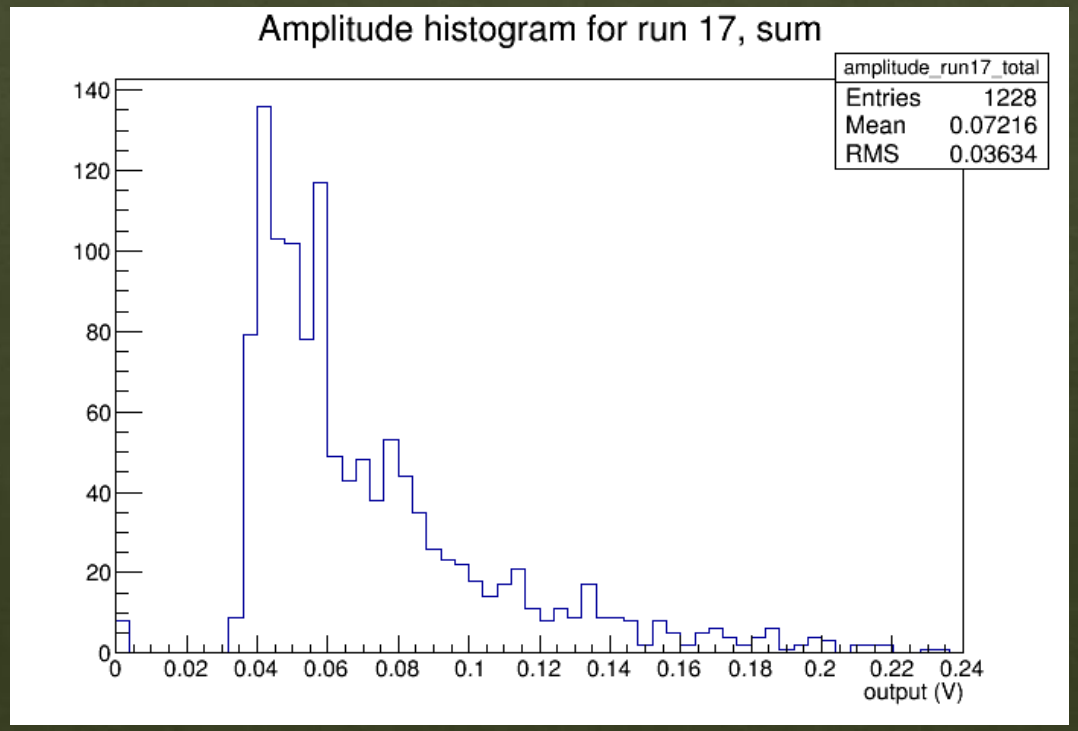
This time triggered on output 2, the central pixel:
charge sharing symmetric!

Configuration 8, 60 V bias, output 2

Sum of the 3 signals

(when the signal is below 22 mV is considered 0 to avoid noise contribution)

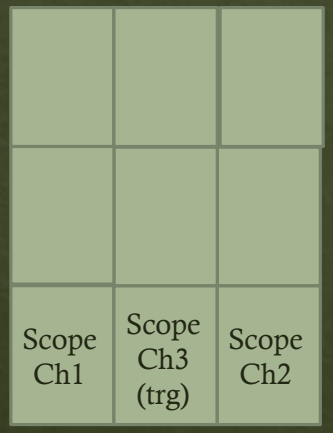




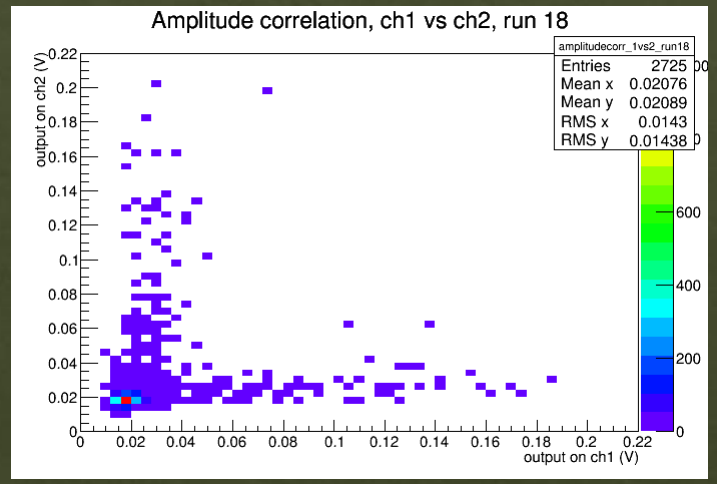
Peak better defined…

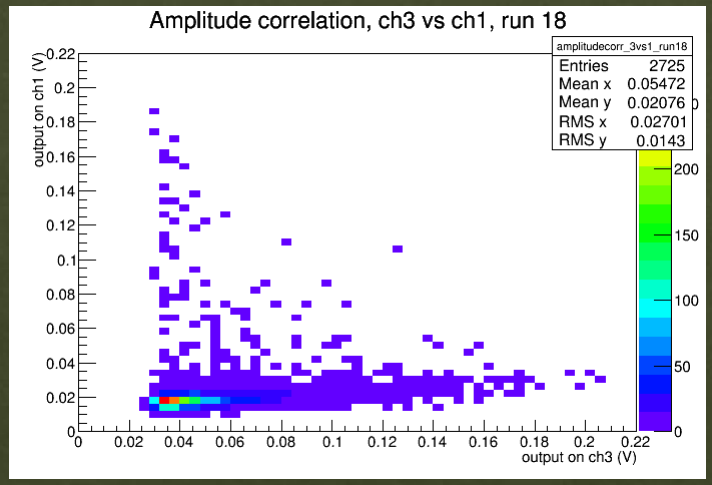
Configuration 8, 80 V bias, output 2

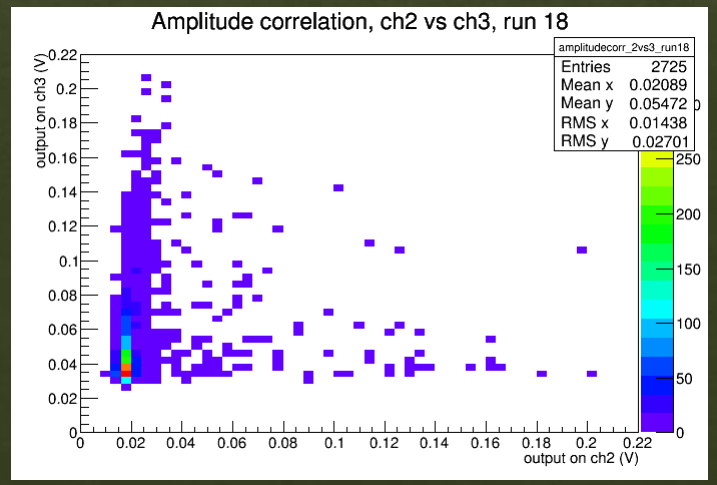
Active Pixel Array



Correlations





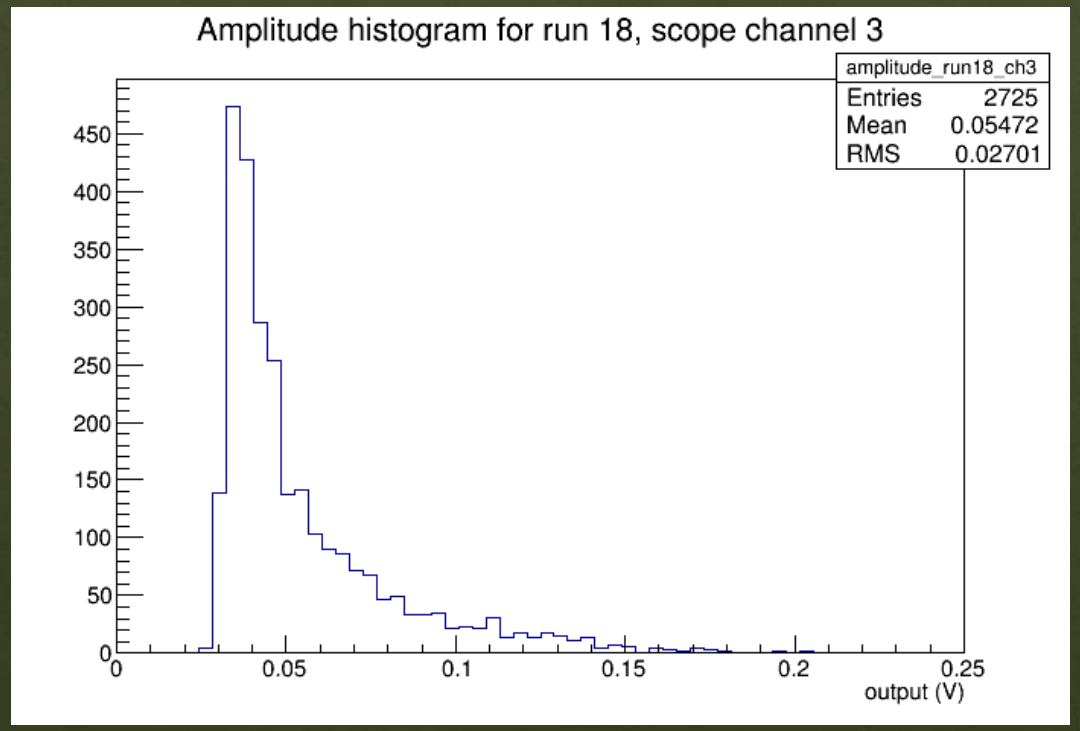


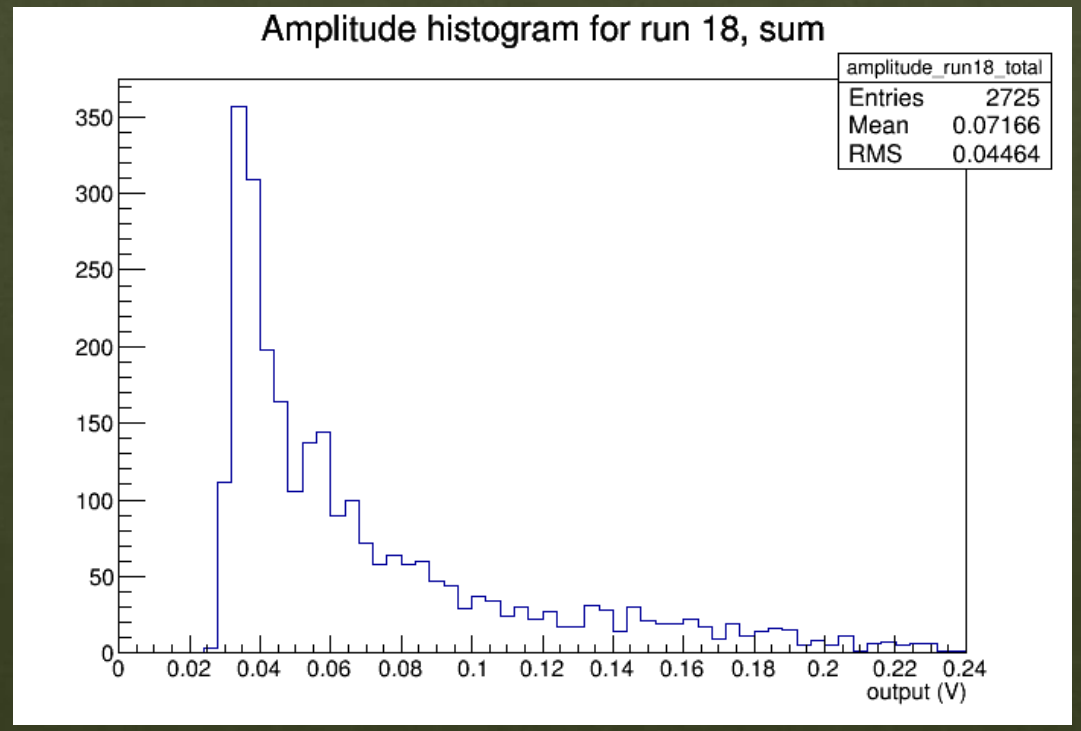
Great increase in charge sharing

Configuration 8, 80 V bias, output 2

Sum of the 3 signals

(when the signal is below 20 mV is considered 0 to avoid noise contribution)

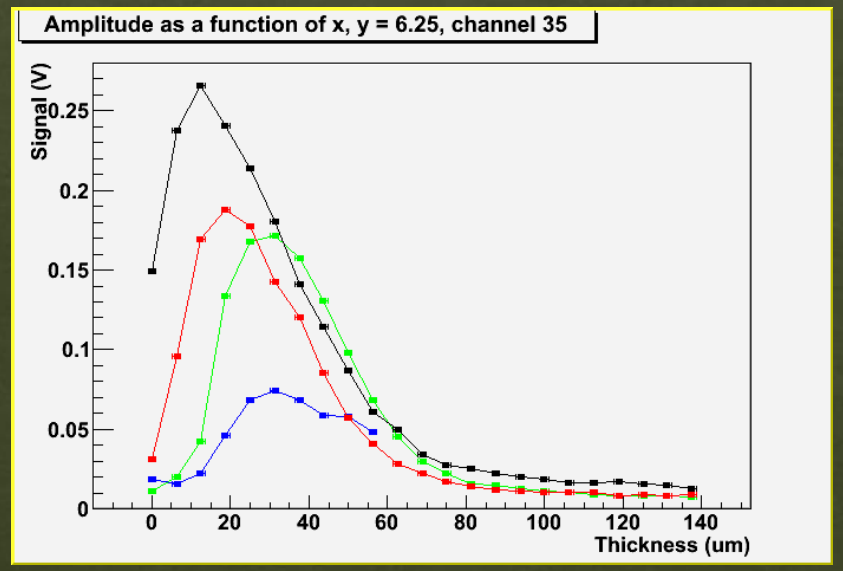




Something peak-ish somewhere else…
Likely not Landau.

Trial for a configuration 9

Some analysis done back with edge-TCT



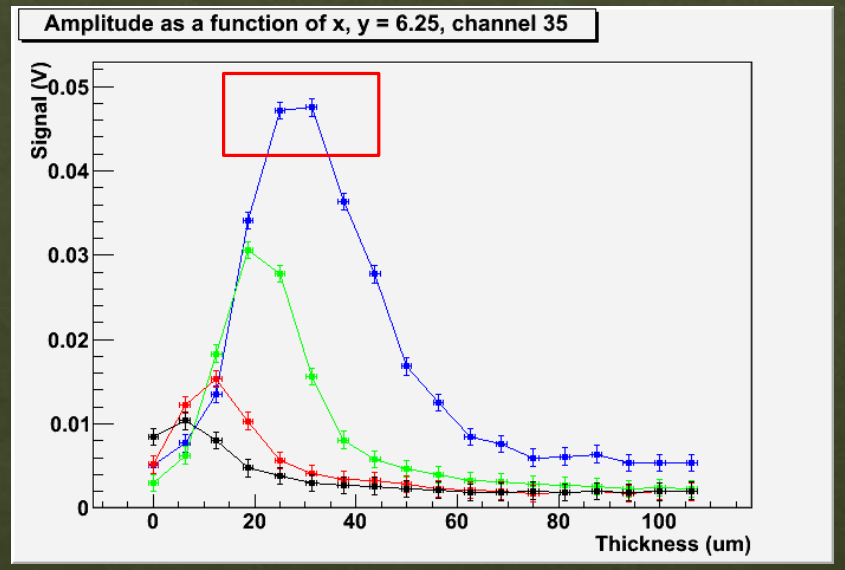
DAC configuration 8:

- **iPFB = 2700**
- **iNSF = 750**
- **Casc = 2600**
- **VPLoad = 2100**
- **iN = 1000**
- **iNBias = 150**

Signal decreases with bias…

Signal as a function of depth, bias dependence:

- **Black: 20V**
- **Red: 40V**
- **Green: 60V**
- **Blue: 80V**



DAC configuration 9:

- **iPFB = 2500**
- **iNSF = 750**
- **Casc = 2600**
- **VPLoad = 2100**
- **iN = 1200**
- **iNBias = 150**

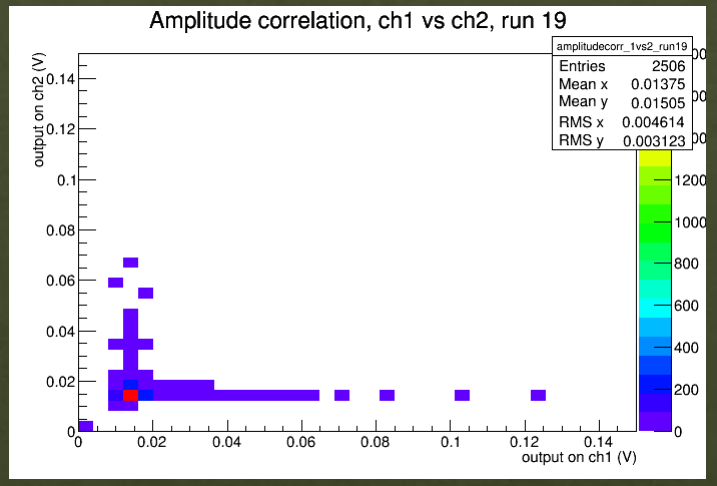
Signal lower but increases with bias

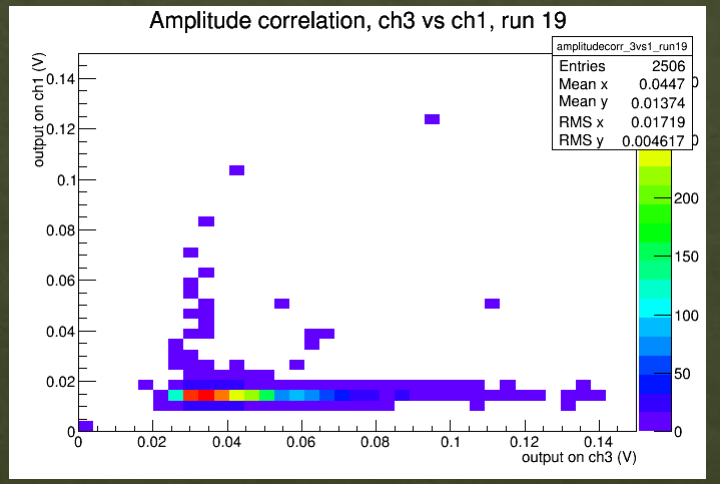
Configuration 9, 80 V bias, output 2

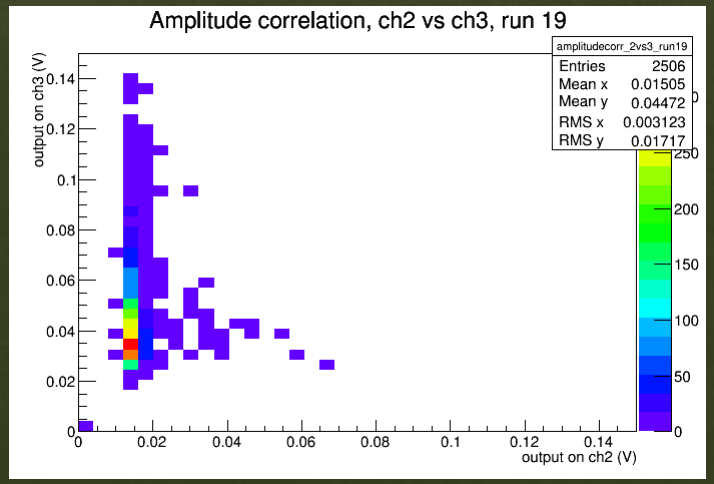
Correlations

Active Pixel Array

Scope Ch1	Scope Ch3 (trg)	Scope Ch2





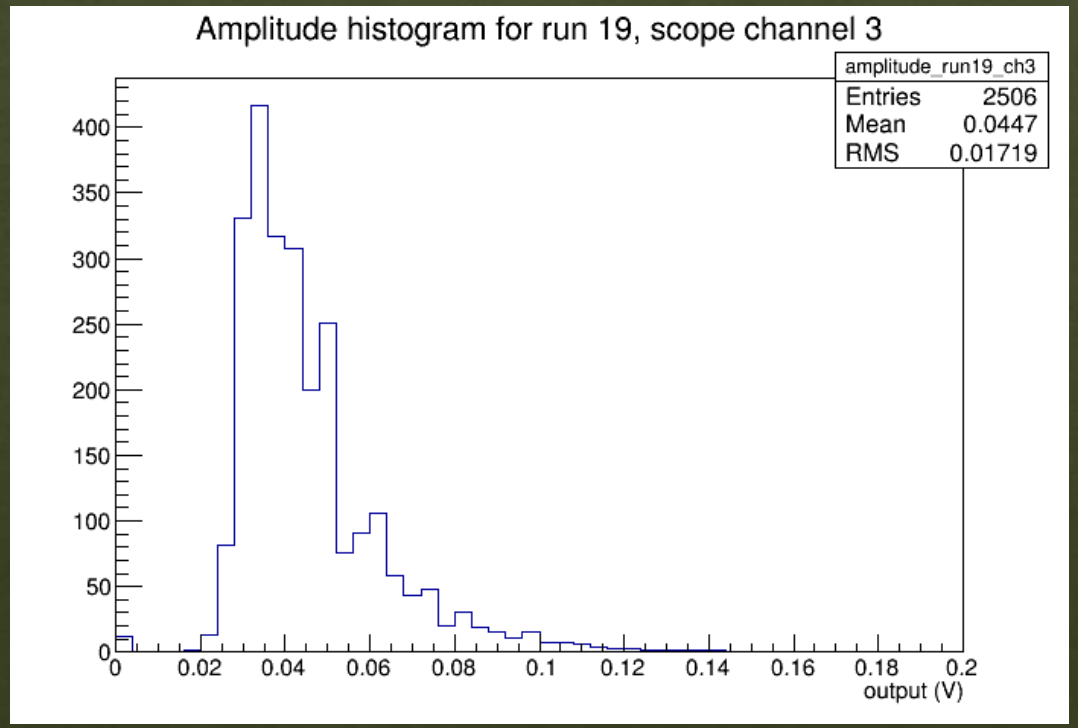


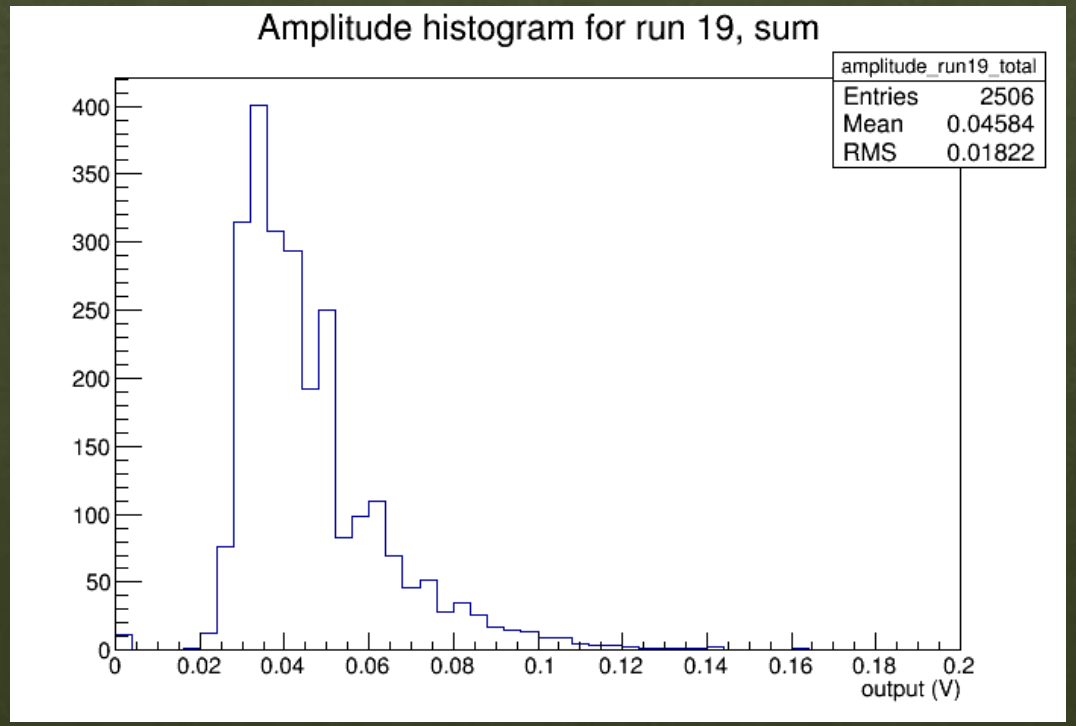
Little charge sharing

Configuration 9, 80 V bias, output 2

Sum of the 3 signals

(when the signal is below 20 mV is considered 0 to avoid noise contribution)





Peak-ish bump in both cases

Conclusions

- Test beam performed in Bonn with a Chess1 not-irradiated device.
- APA8 investigated
- Multiple spectra taken
- Results promising.

Open questions:

- Do we really see Landau distributions?
- What should we expect?
  - Are we depleting enough?
  - Can it be that the read-out is slow and we are getting lot of thermals?
  - DAC dependence?

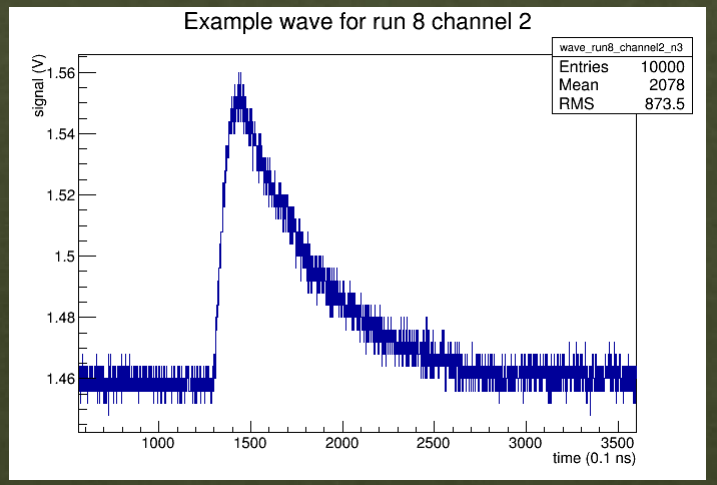
Future plans

- Check the correlation with peaking time of the signal
  - With HVStripV1 it lead to something interesting
- Calibrations!

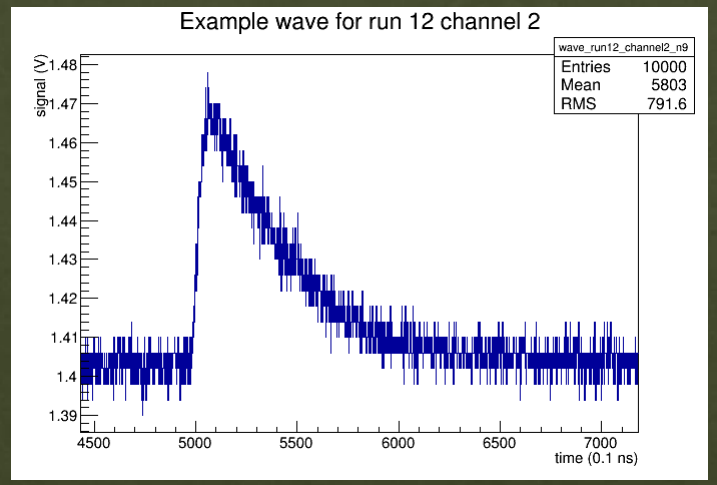
Backup

Some waves

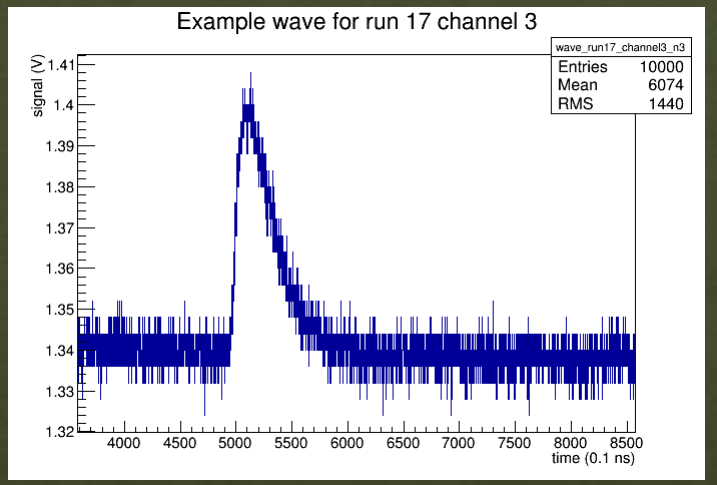
Config 7 Bias 60V



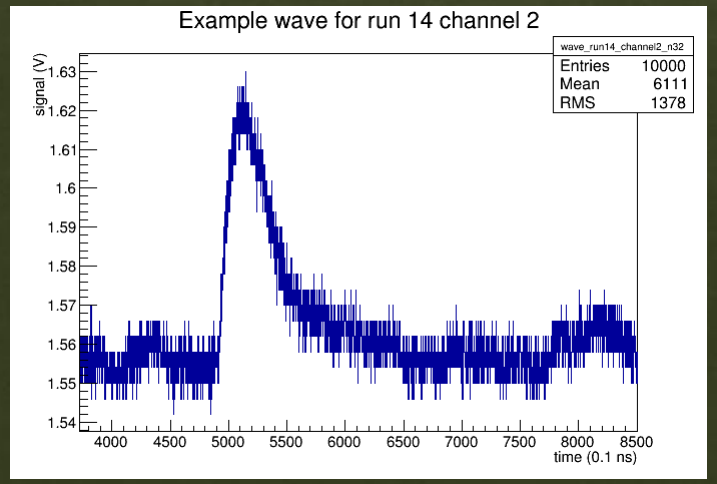
Config 7 Bias 40V



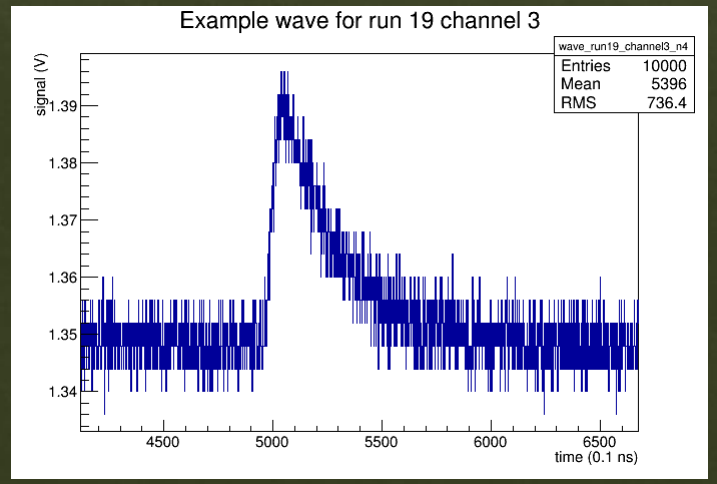
Config 8 Bias 60V



Config 7 Bias 80V



Config 9 Bias 80V



Config 8 Bias 80V