MuPix8:
Status Update

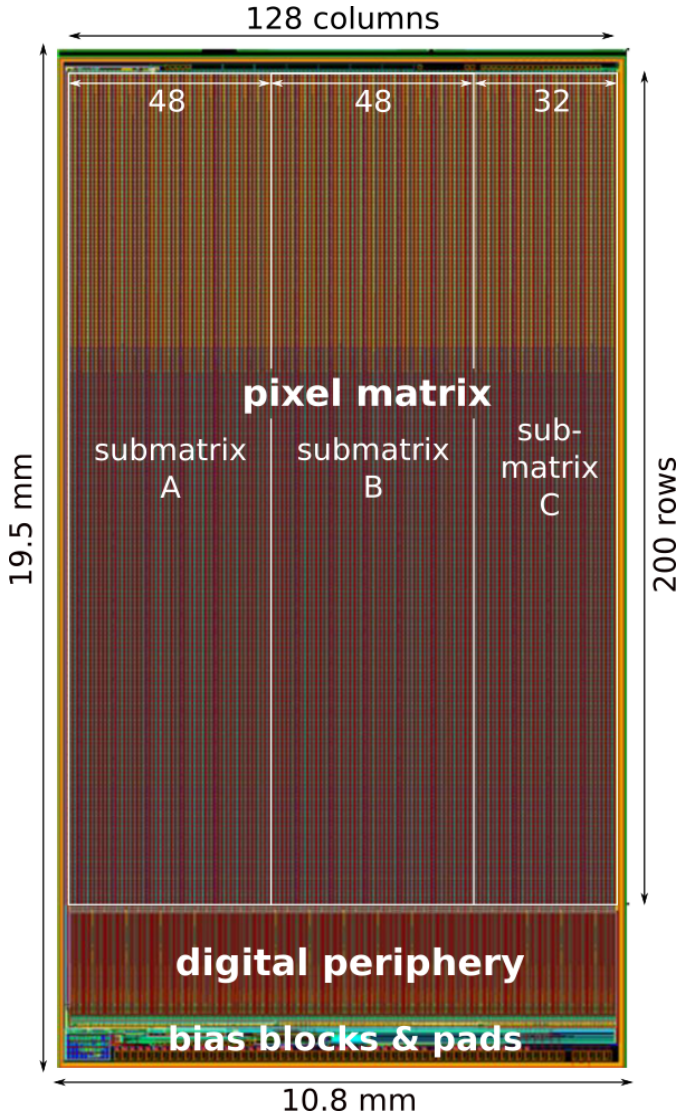
– PANDA Collaboration Meeting 2018/3 –
Luminosity Detector Session

René Hagdorn
Darmstadt, November 6, 2018

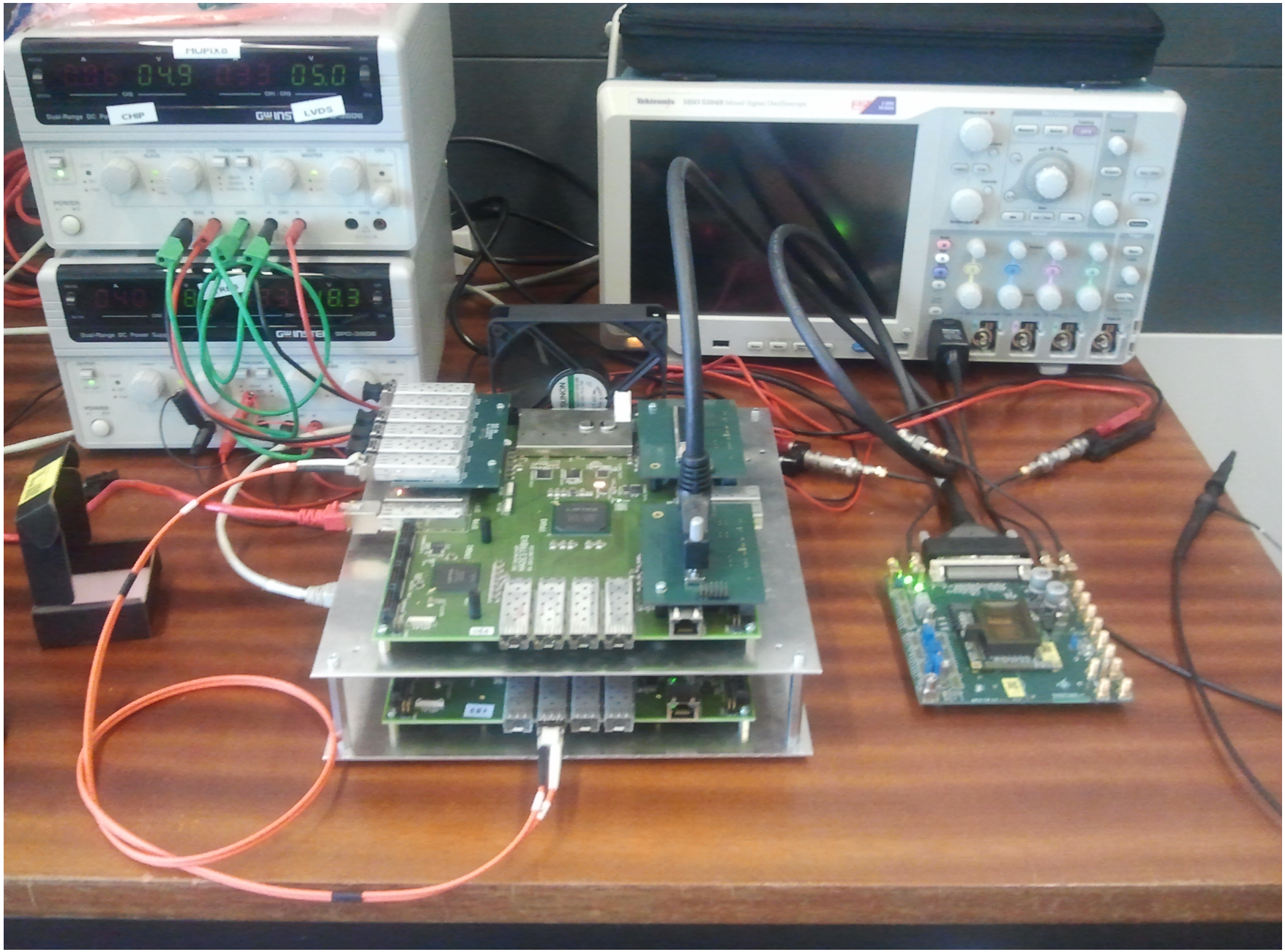
The MuPix8 Chip

- Based on HV-MAPS concept
- Physical size: 10.8 × 19.5 mm²
- Active area: ~ 10.2 × 16.2 mm²
- Matrix: 128 × 200 Pixels
  divided into 3 Submatrices
- Pixel: 80 × 81 µm², single diode

- Charge sensitive amplifier in each pixel
- Two comparators in periferal cells
- 4 LVDS links @ 1.25 Gbit/s
- Analog readout of Hitbus (ToT information)
- Amplifier output (for leftmost column only)

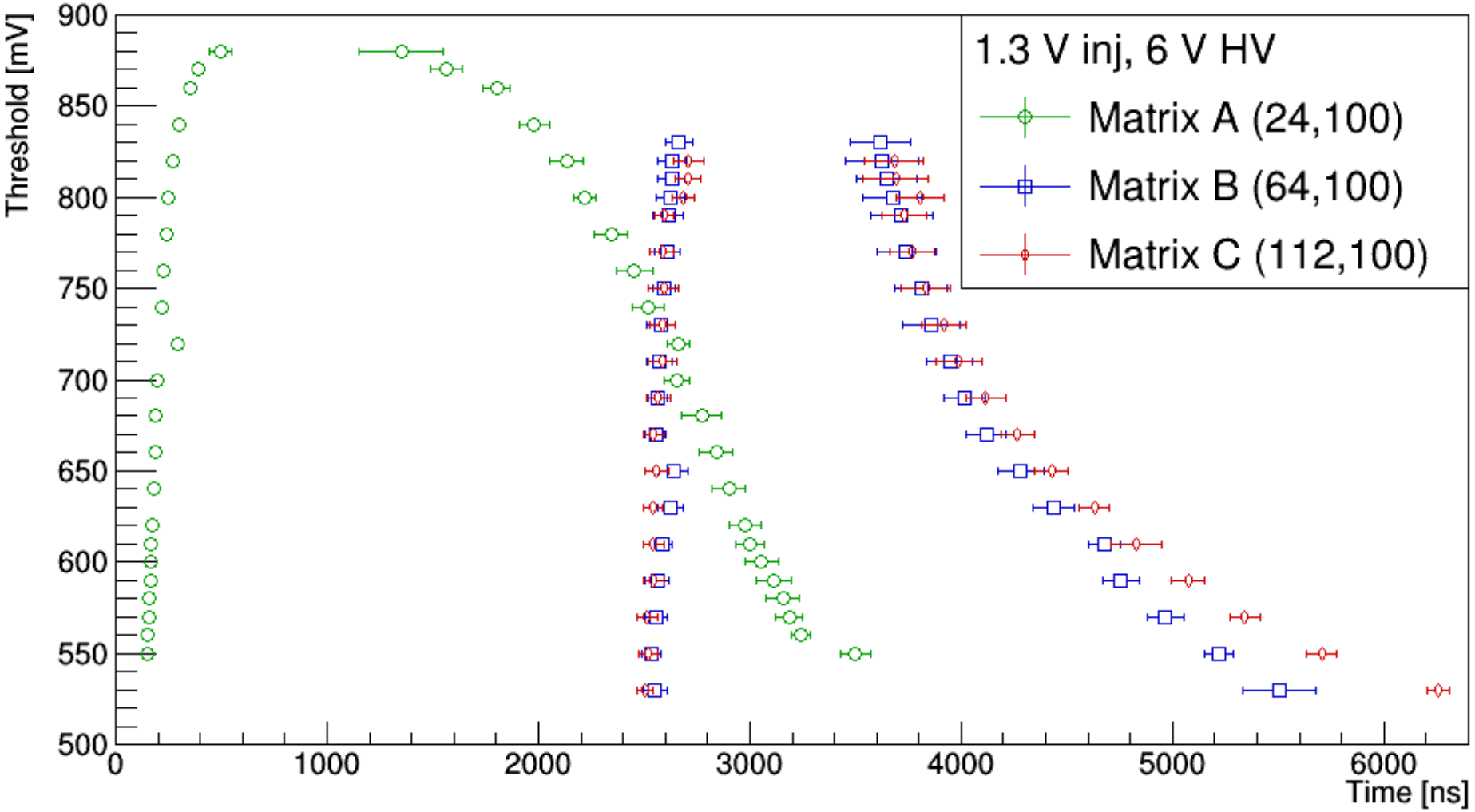


Lab Measurements – Analog Properties



Pulse Shape Reconstruction

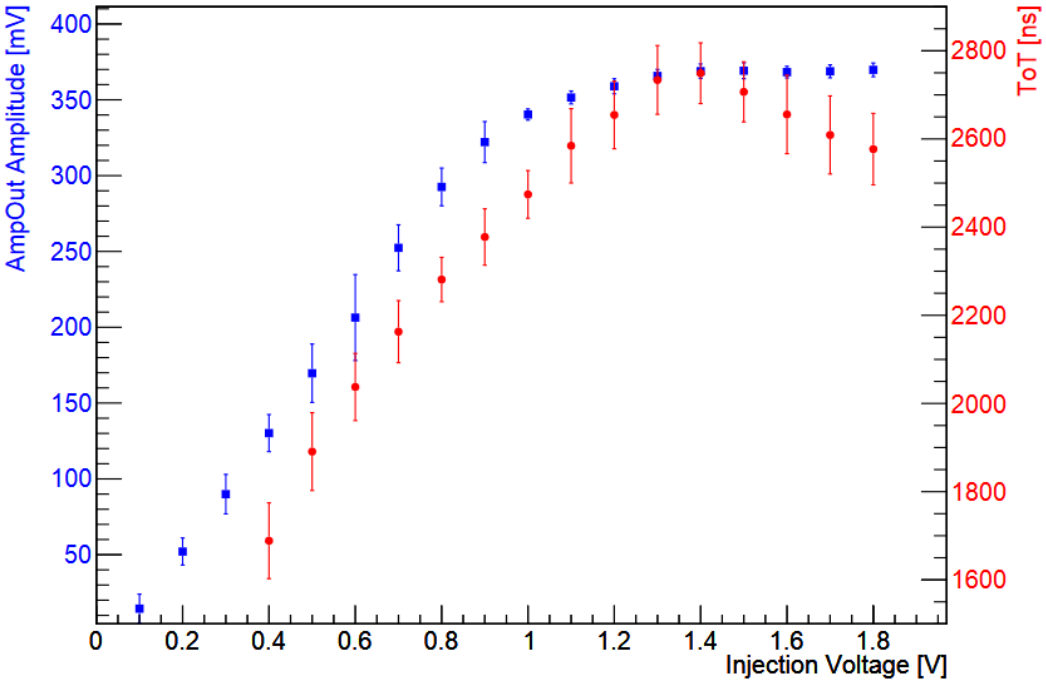
- ToT (measured with oscilloscope)
- Latency between injection pulse and chip response
- Plotted for different comparator threholds



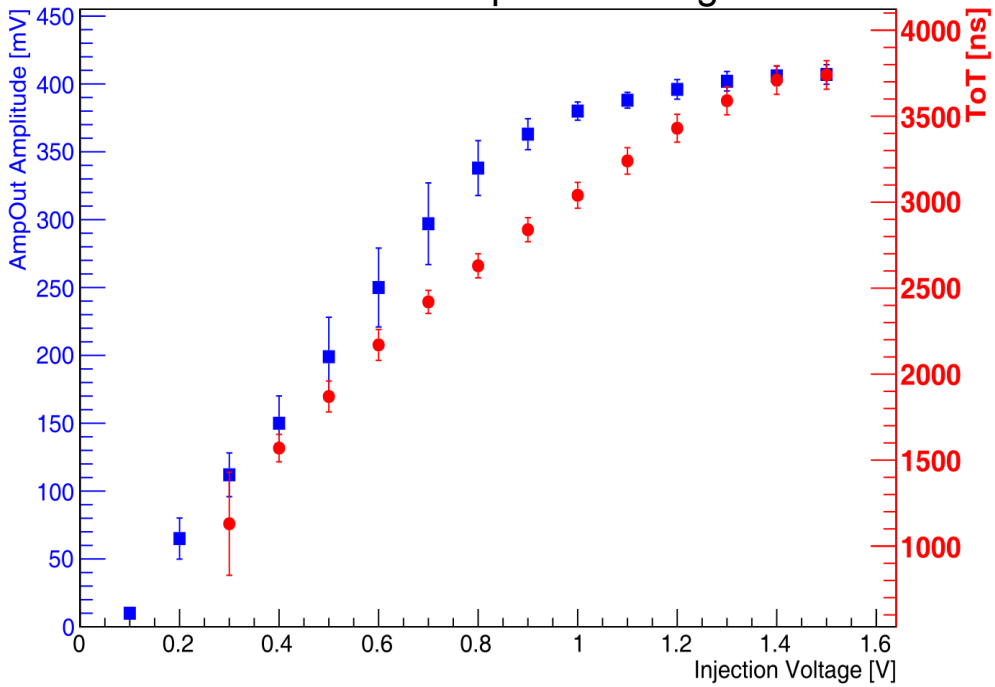
AmpOut Saturation

- Amplifier output saturates at ~ 400 mV
- Slight Saturation of ToT, followed by decrease at high injection voltages
- Might be an injection issue

Bochum

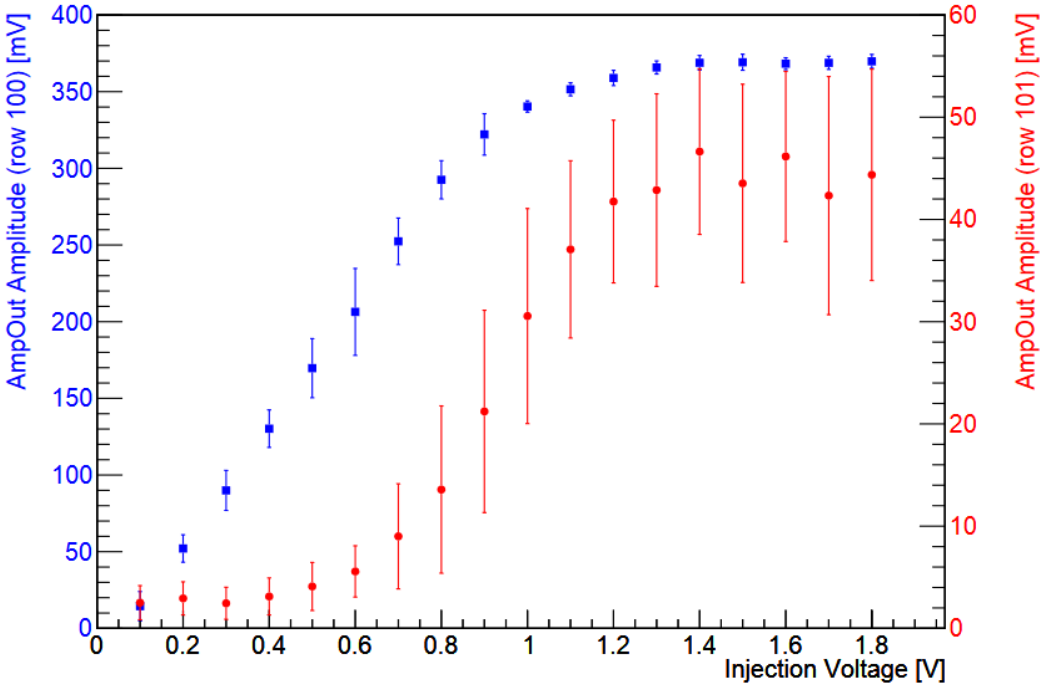


Mu3e-Group Heidelberg

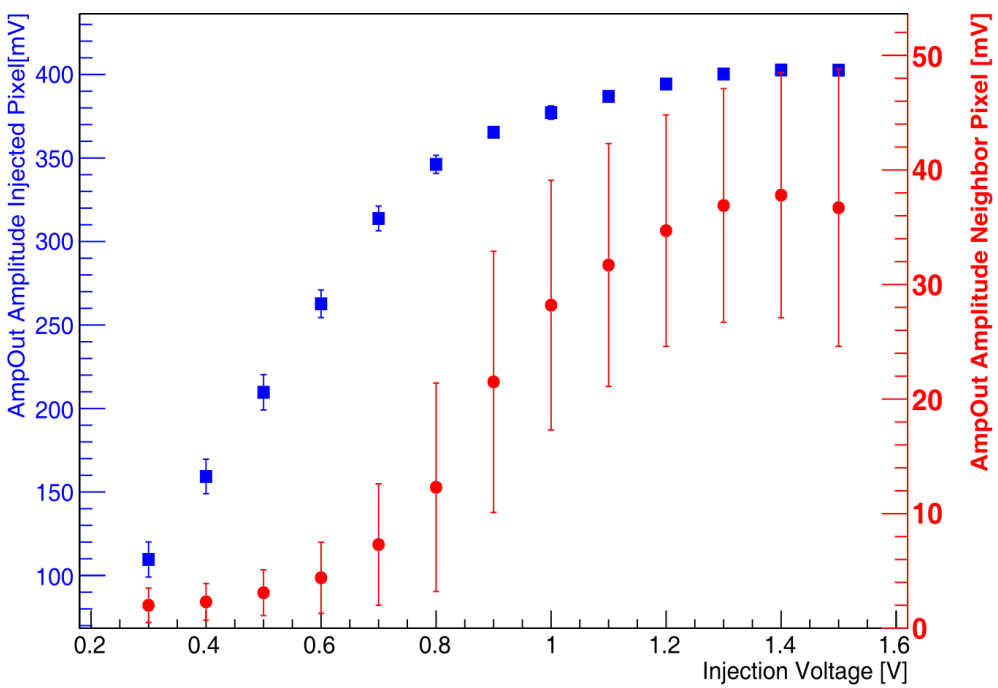


Crosstalk

Bochum



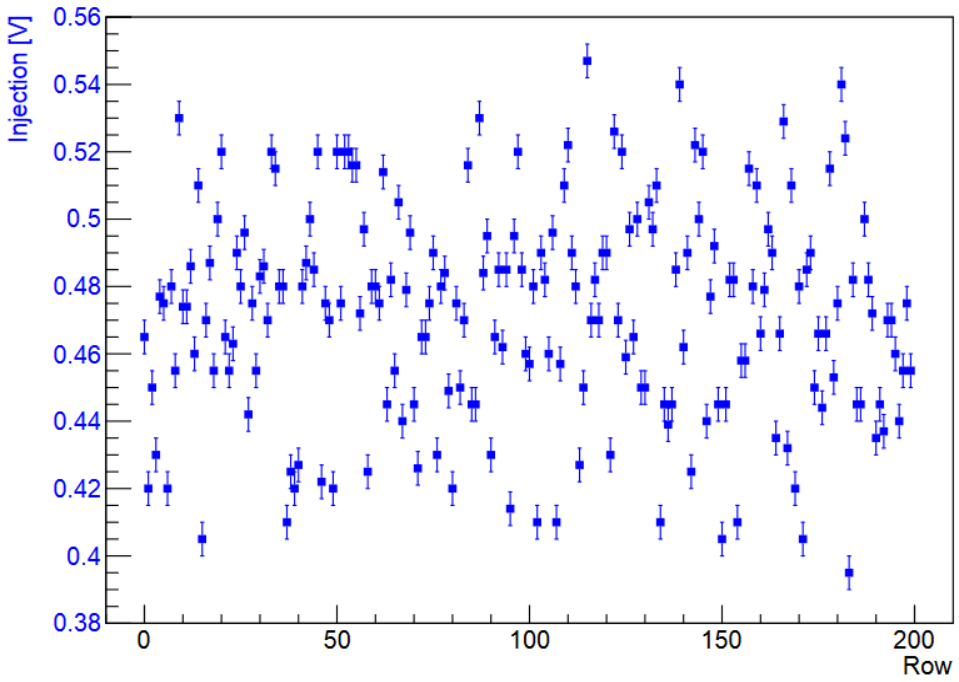
Mu3e-Group Heidelberg



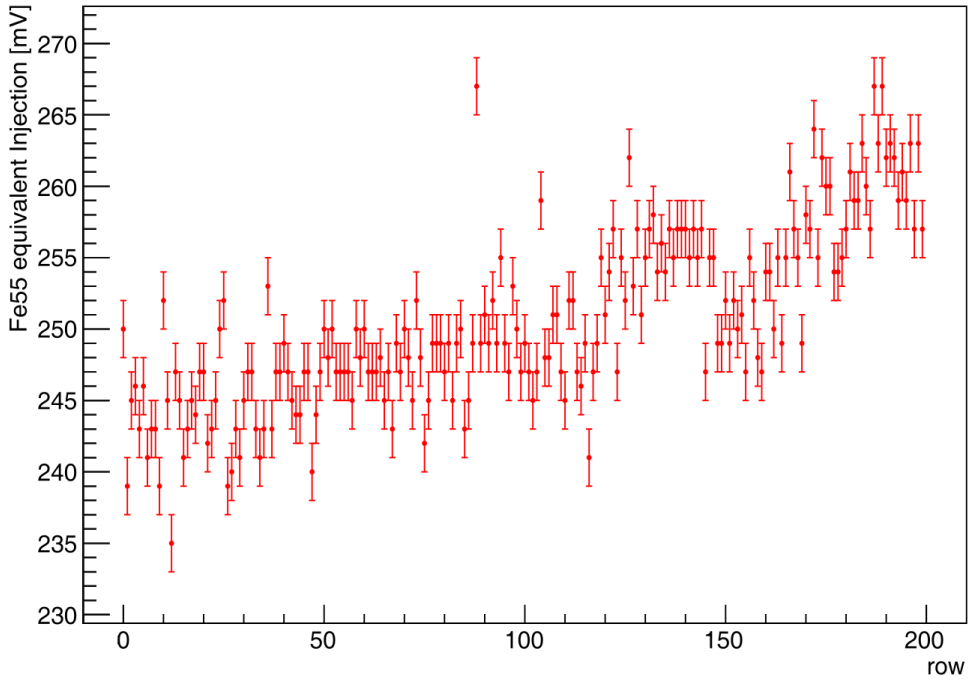
- AmpOut signal of injected pixel compared to signal measured at neigboring AmpOut
- Crosstalk $\lesssim$ 10 %
- Upper limit of Crosstalk due to ampout saturation

Row Dependence of Injection Signal

Bochum



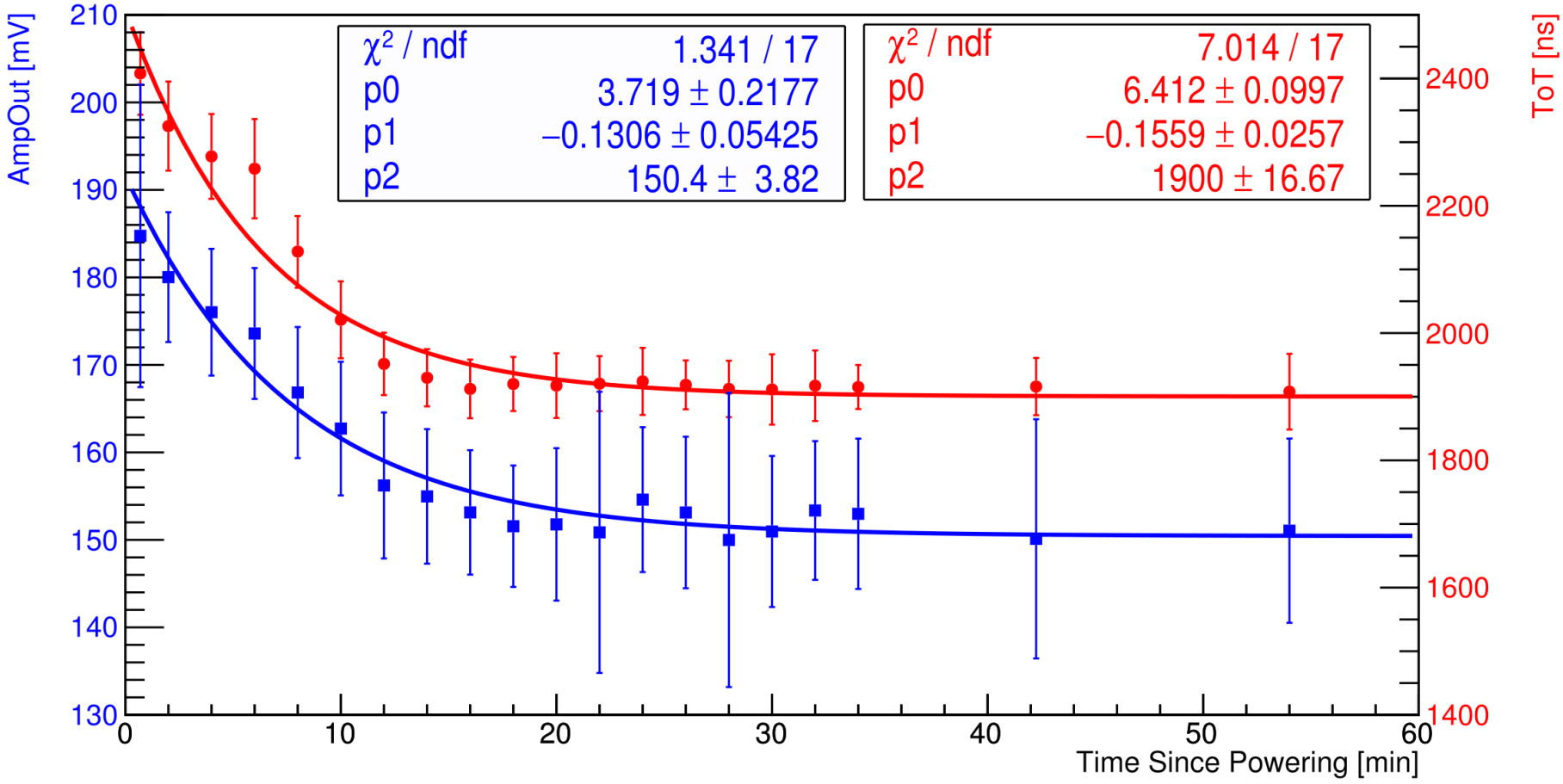
Mu3e-Group Heidelberg



- Row dependent form could not be reproduced in Bochum
- Bochum: Injection adjusted to create AmpOut response of ~ 150 mV
- Heidelberg: Injection ajusted to create AmpOut response equivalent to that of a ^{55}Fe X-ray (5.9 keV)
  → Takes variations of individual pixels into account

Signal Decrease over Time

- AmpOut amplitudes and ToTs show a decrease over time when powered after a longer downtime
- First believed to be a temerature effect (warm-up)
- Actually due to charging of feedback capacities

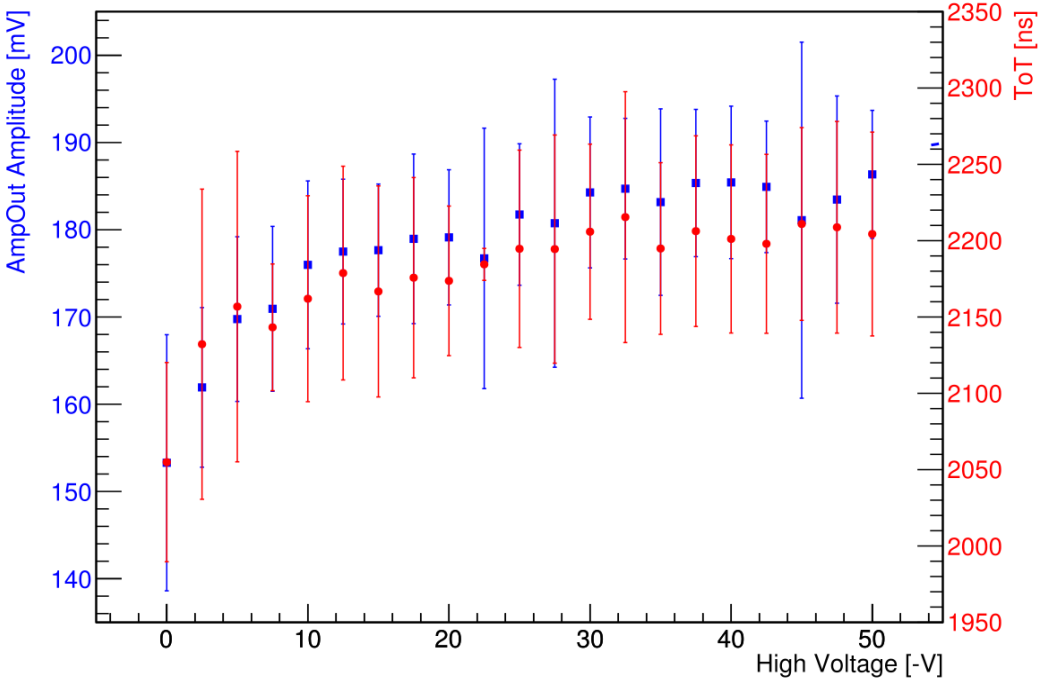


HV Dependence: AmpOut & Hitbus

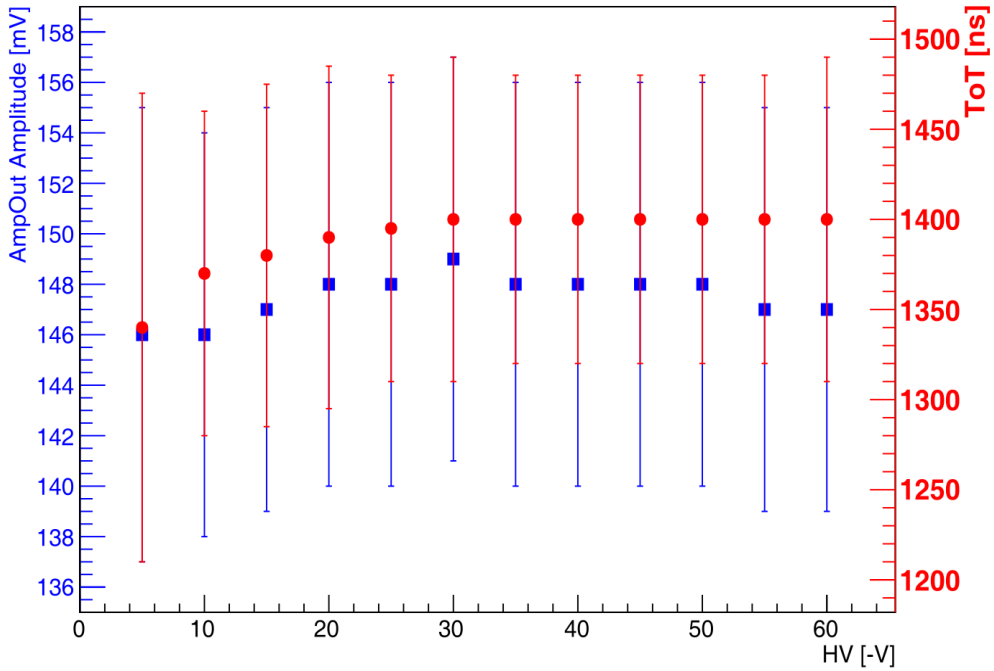
- Heidelberg: AmpOut amplitude and Hitbus ToTs show almost no dependence on HV
- Bochum: clear rise of both signals with HV

→ Still under investigation by Heidelberg group
might be due to different substrate resistivities (80 – 1k Ωcm)

Bochum

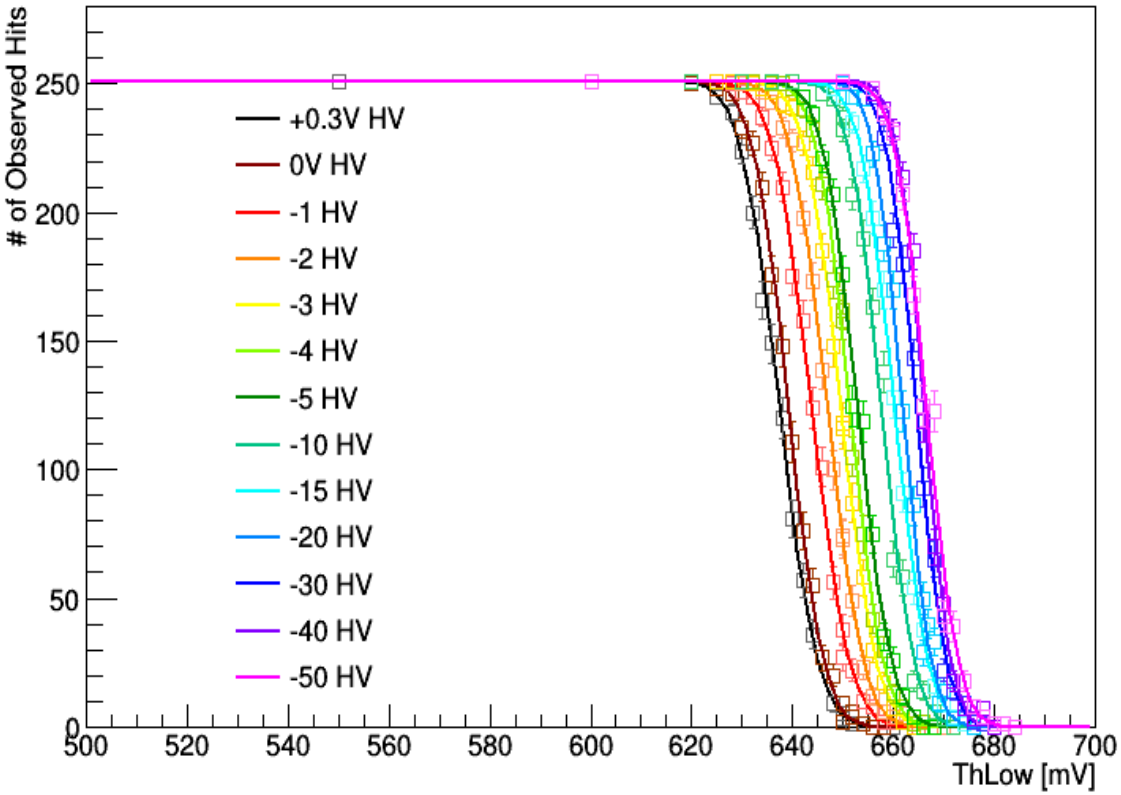


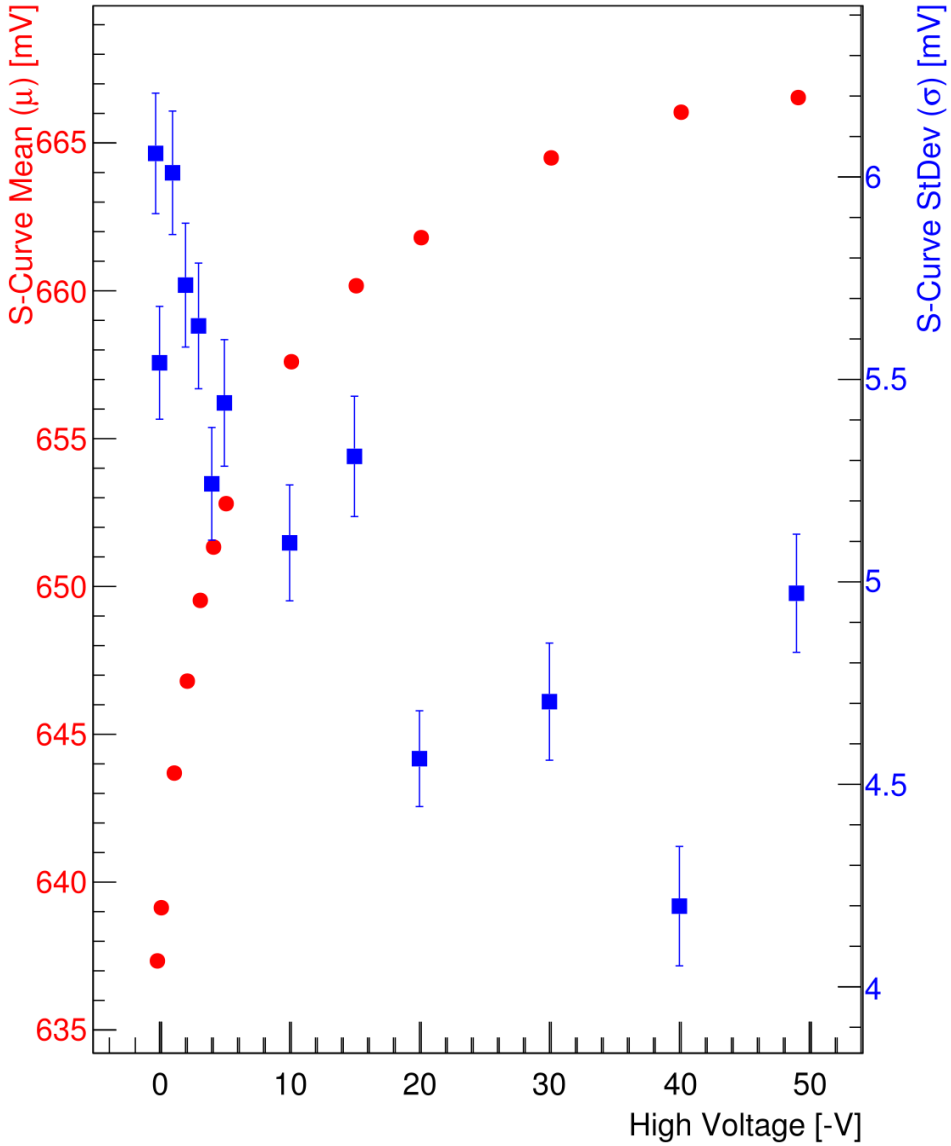
Mu3e-Group Heidelberg



HV Dependence: S-Curves

- Analog S-Curve measurements (oscilloscope counting events)
- Fitted with Gaussian error function
- $\mathrm{SNR} = \frac{\mu - b}{\sigma}$, $b = 500\ \mathrm{mV}$
- SNRs of ~ 25 – 40

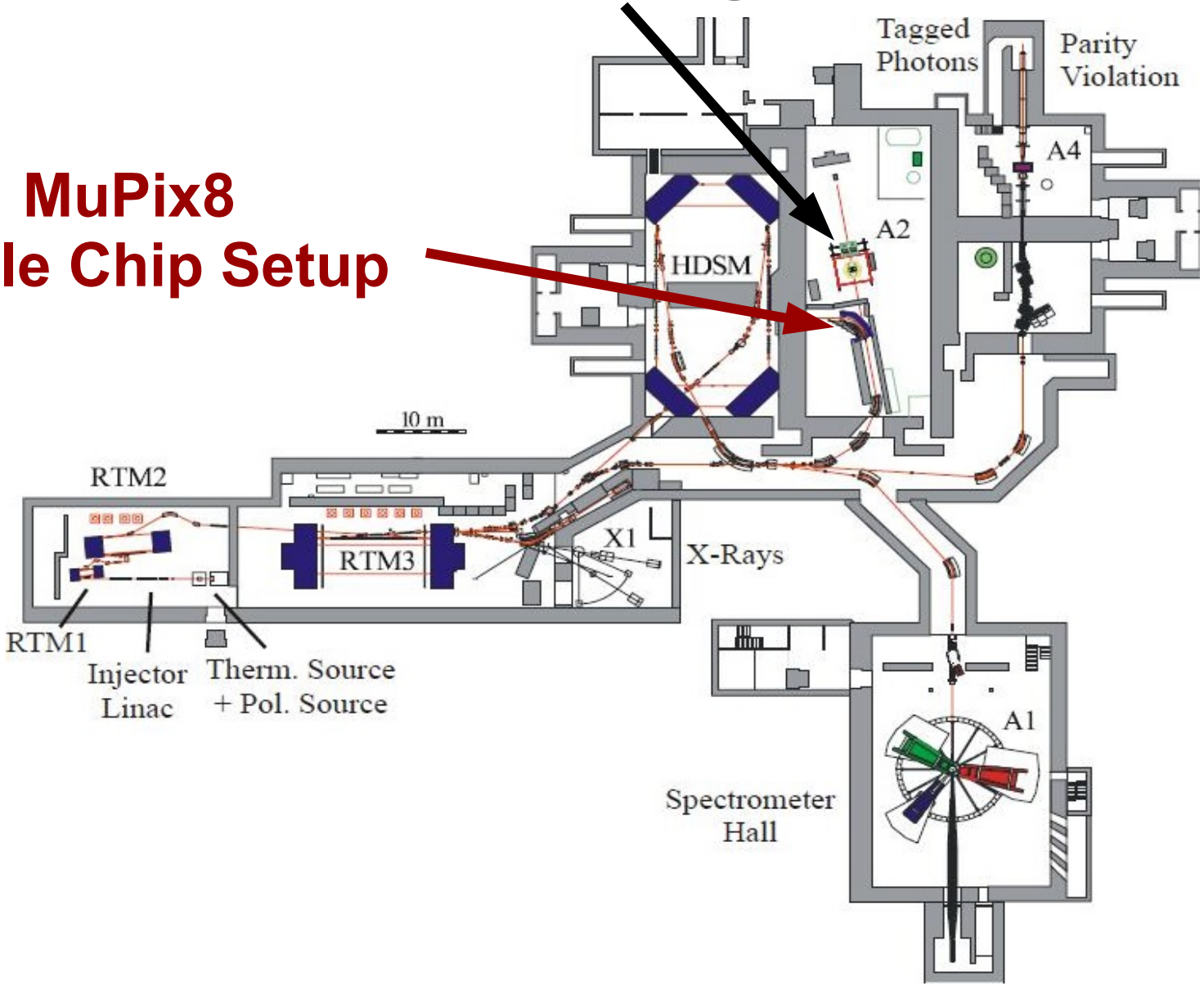




Testbeam Measurements

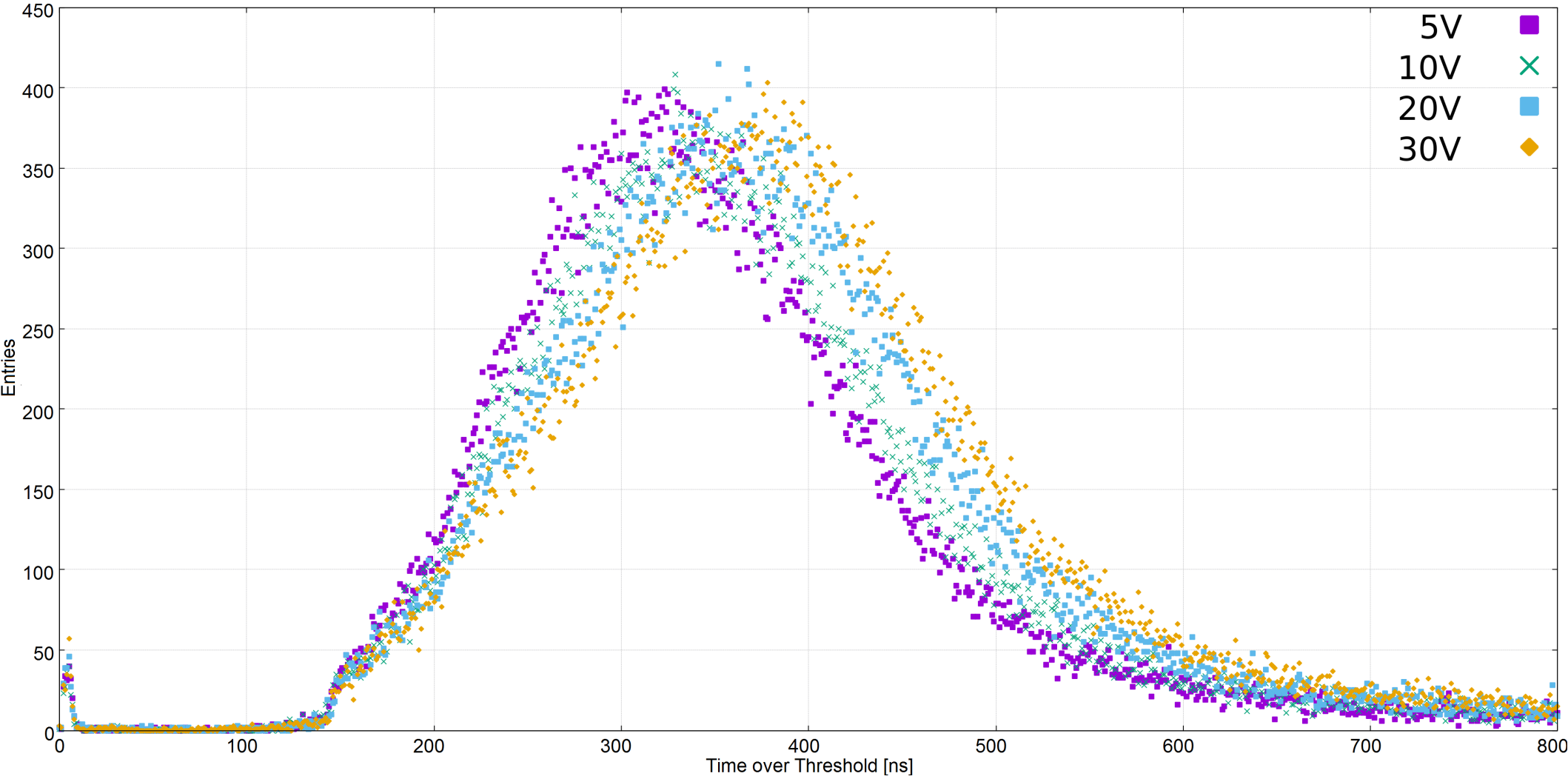
A2 Experiment @ MAMI

MuPix8
Single Chip Setup



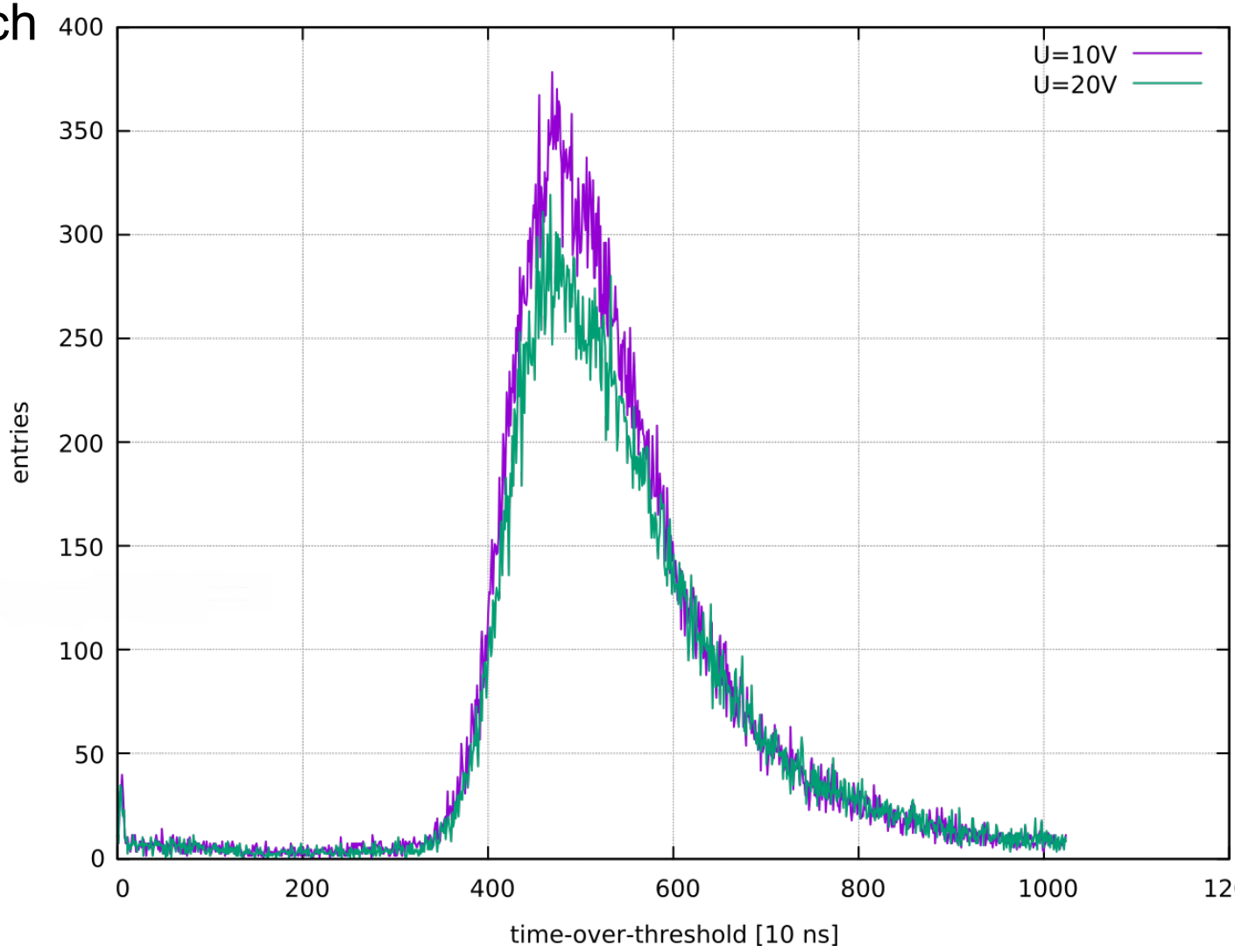
ToT Spectra

- ToTs for pixels in Matrix A and Matrix B at 570 mV threshold
- Clear HV dependence of ToT distribution for Matrix A



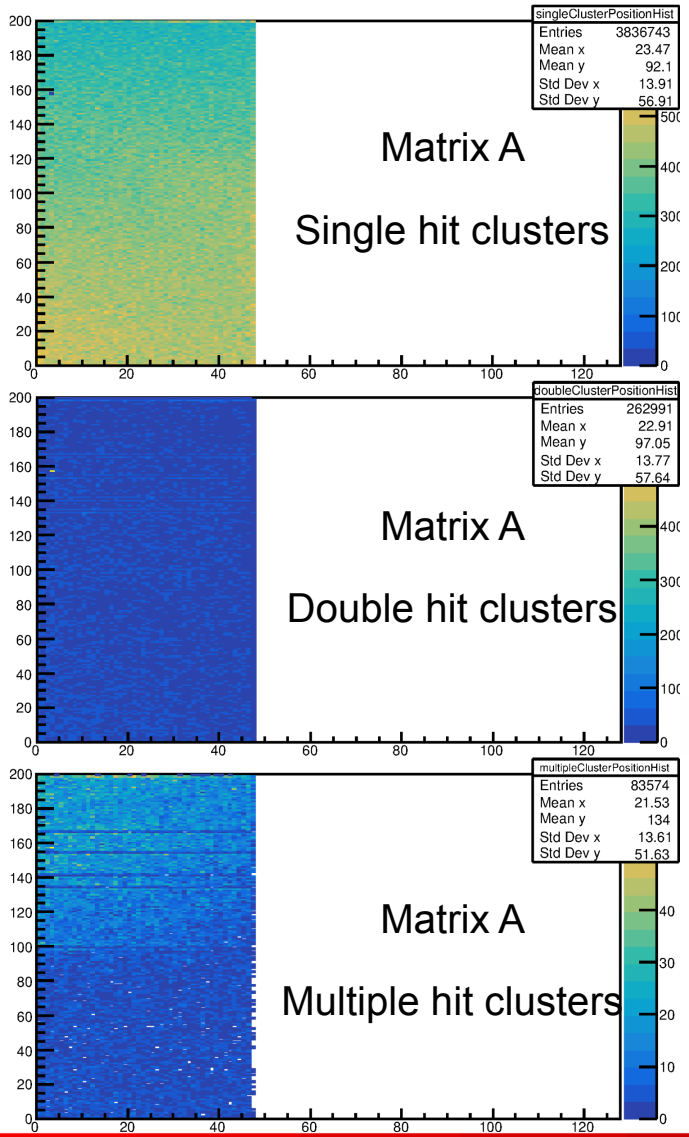
ToT Spectra

- ToTs for pixels in Matrix A and Matrix B at 570 mV threshold
- Clear HV dependence of ToT distribution for Matrix A
- Matrix B – not so much



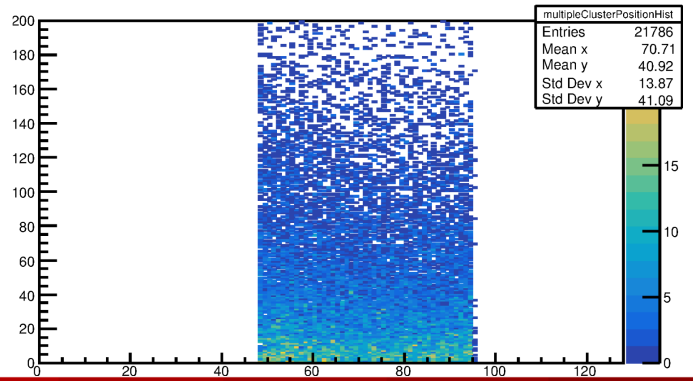
Cluster Positions

- Different cluster sizes show different distributions
- Matrix B behaves differently ...again



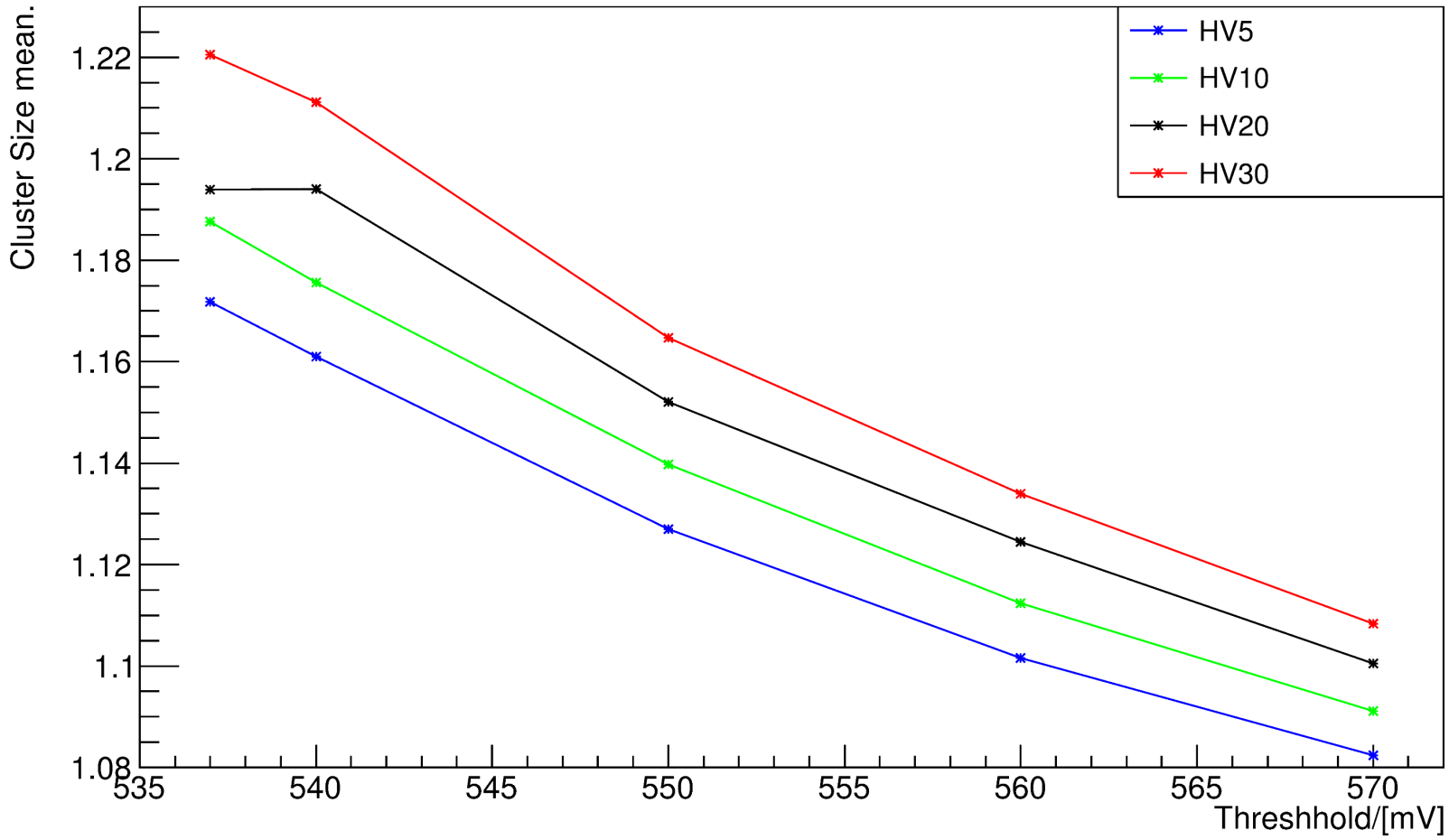
Matrix B

Multiple hit clusters



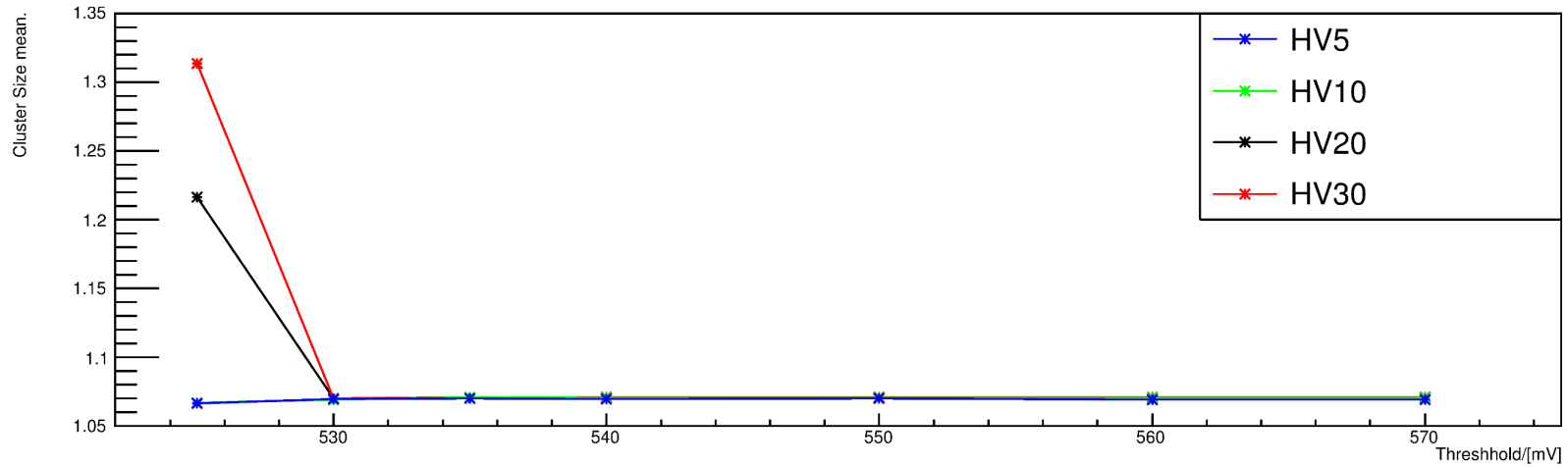
Average Cluster Size

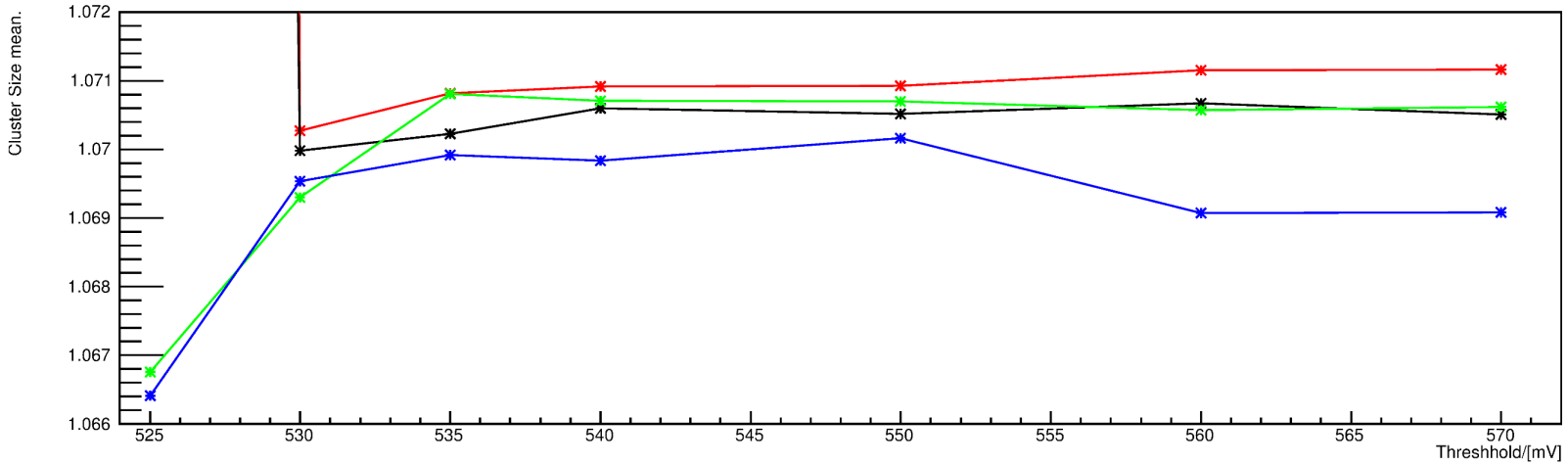
- Average cluster size for Matrix A shows clear HV and threshold dependence



Average Cluster Size

- Average cluster size for Matrix A shows clear HV and threshold dependence
- Clusters in Matrix B are (almost) constant for all HVs and thresholds

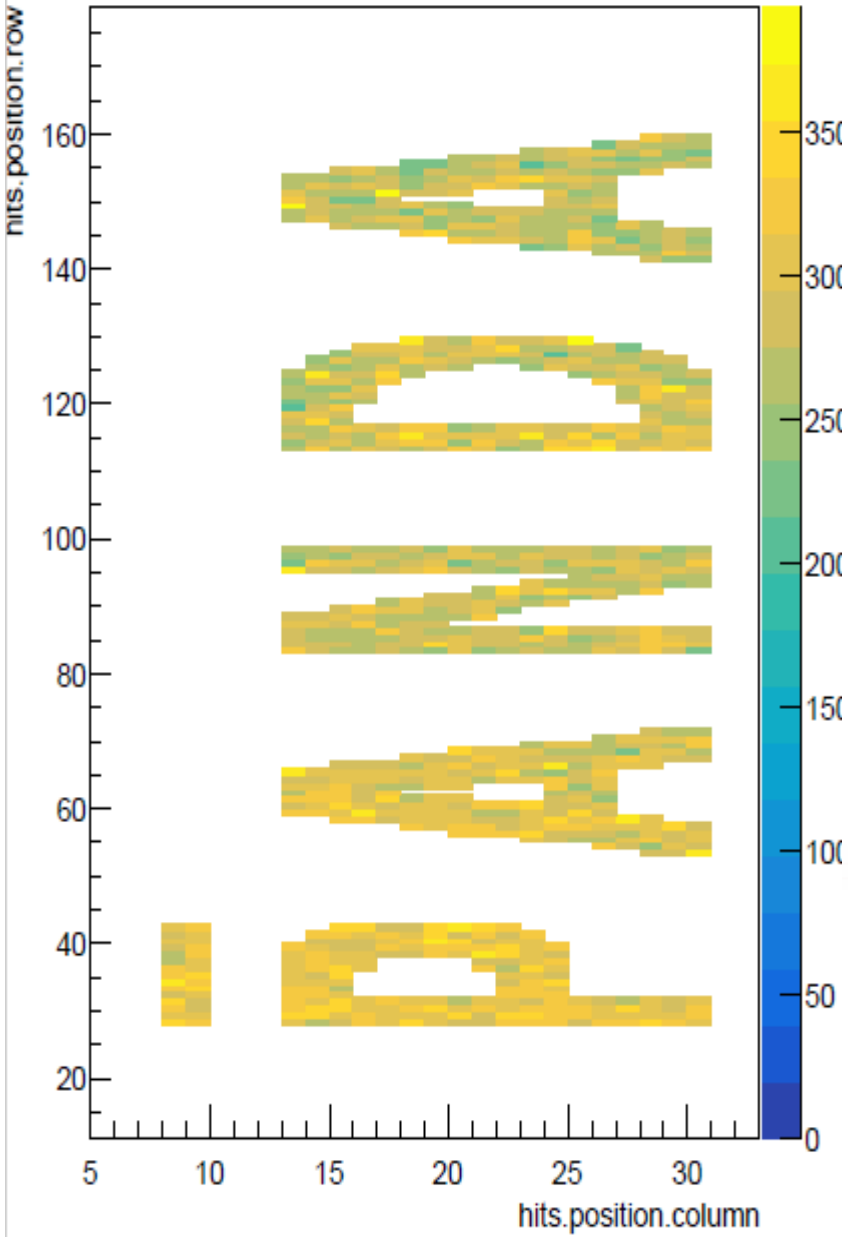




Summary

- Analog properties (AmpOut, Hitbus) tested in lab setup
- Comparison with Heidelberg results:
  - Validation of saturation beahvior and crosstalk strength
  - Row dependence mesurements inconclusive (**^{55}Fe source**)
  - HV dependence still under investigation (**substrate resistivities**)

- First testbeam measurements with Bochum setup
- ToT spectra and cluster analyses:
  - Matrix A (old design, source follower) behaves as expected
  - Matrix B/C (current driver) still has some issues



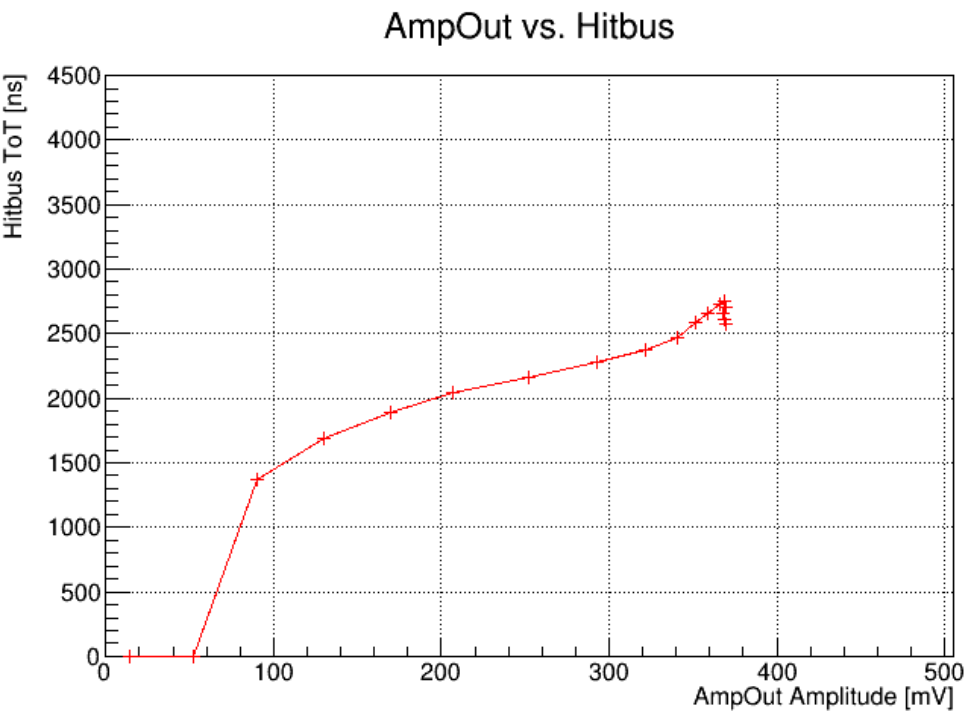
Thank you for your attention !!

– Backup –

AmpOut vs Hitbus

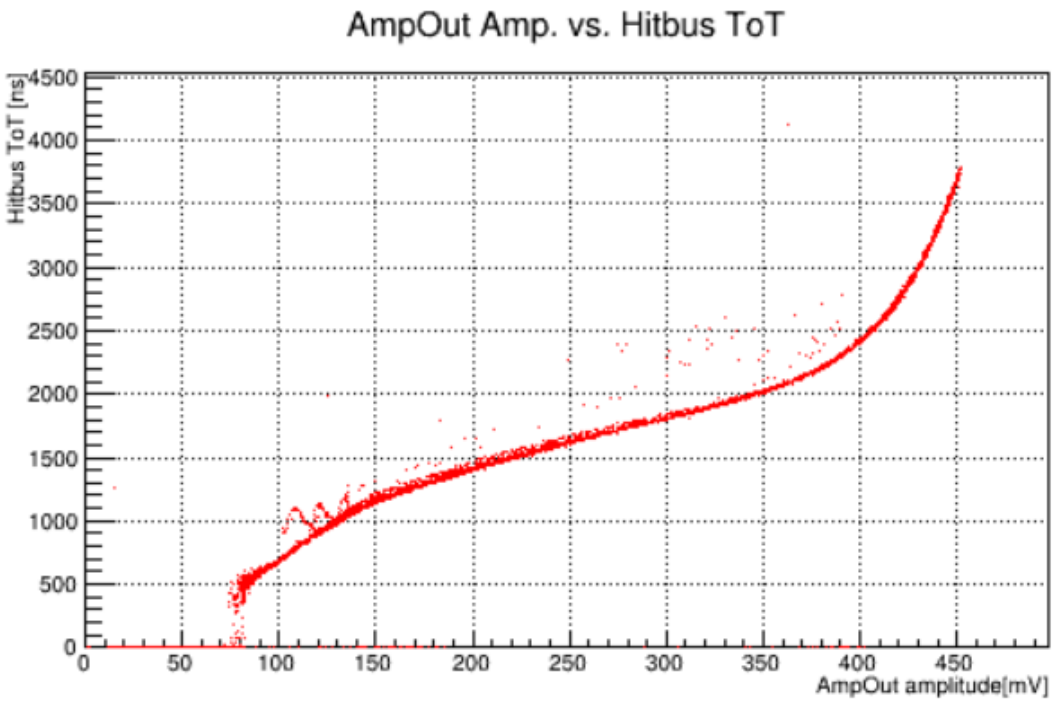
Bochum

Signal source: Injections

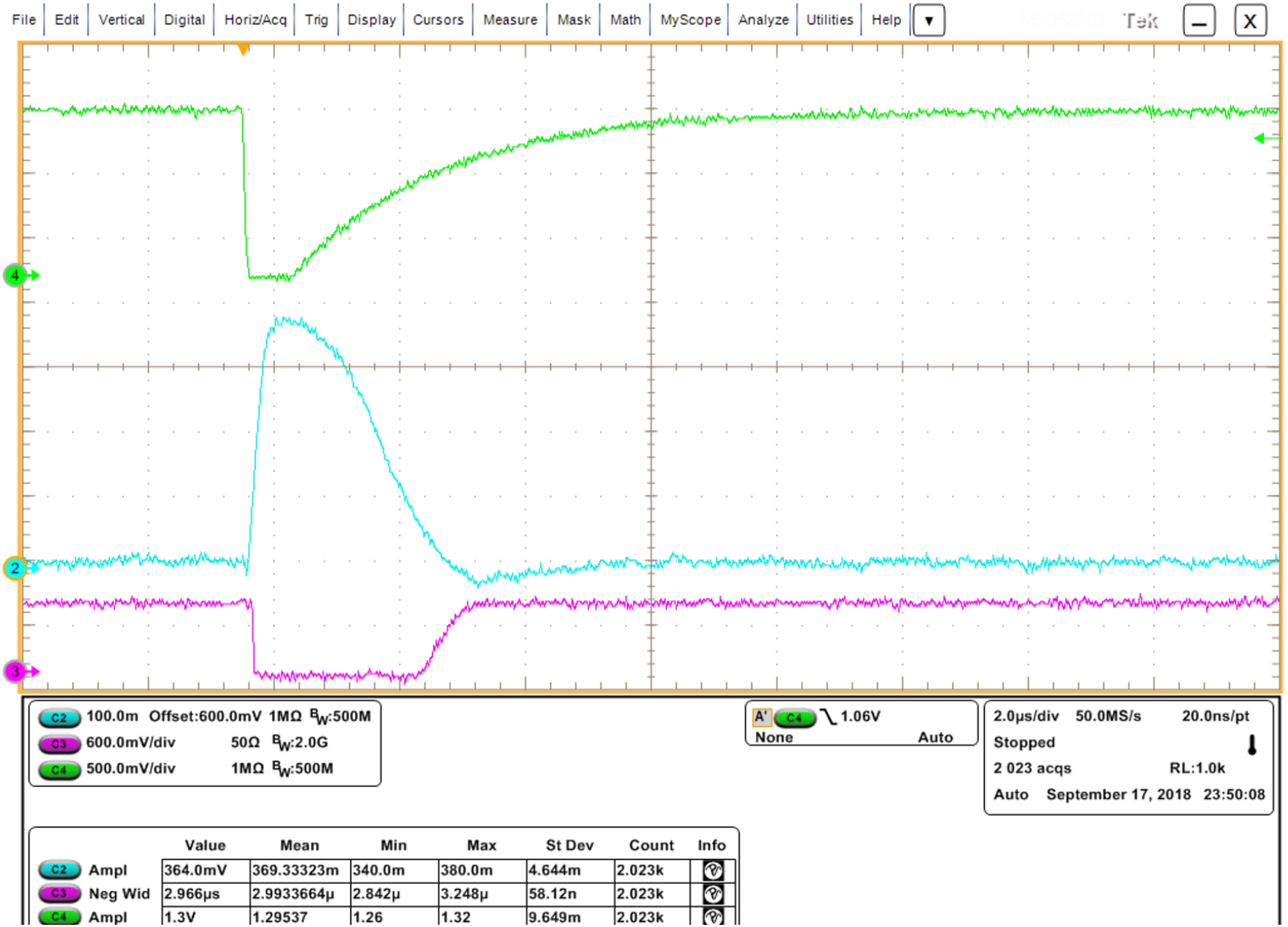


Mu3e-Group Heidelberg

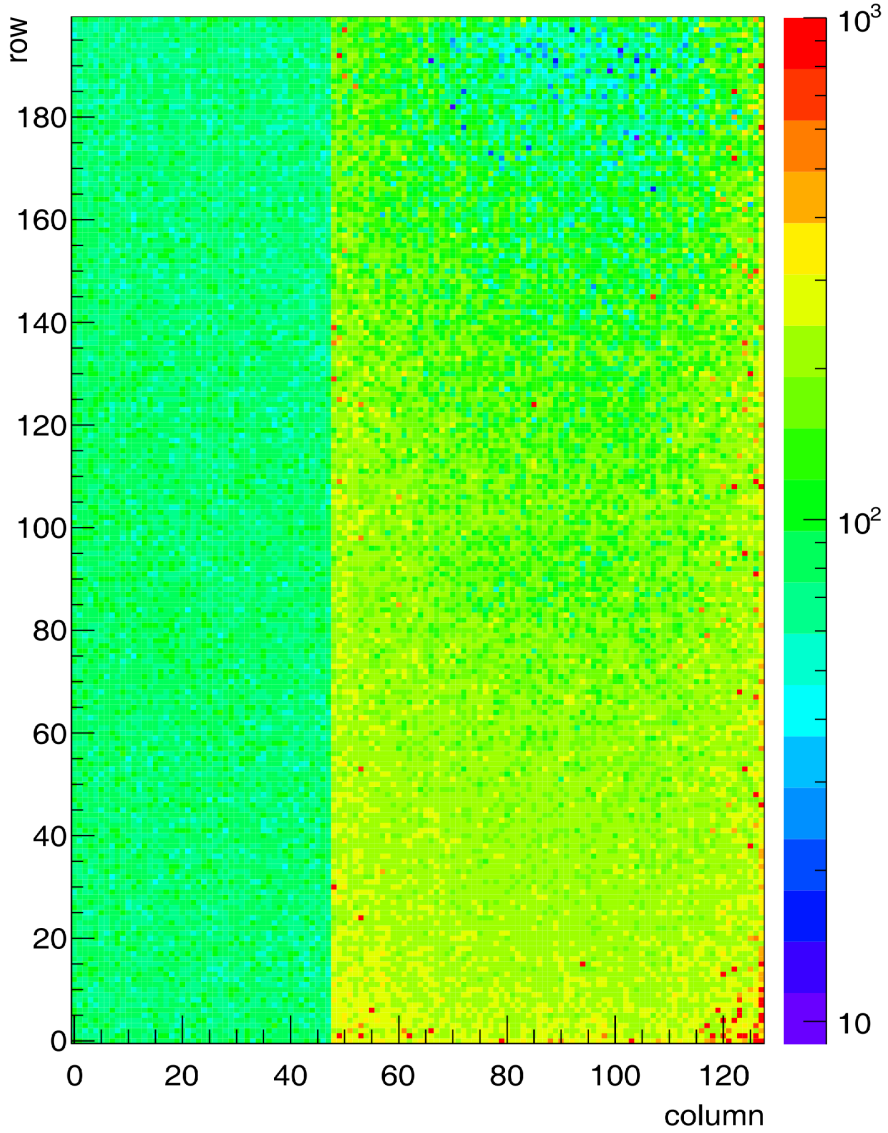
Signal source: IR-Laser

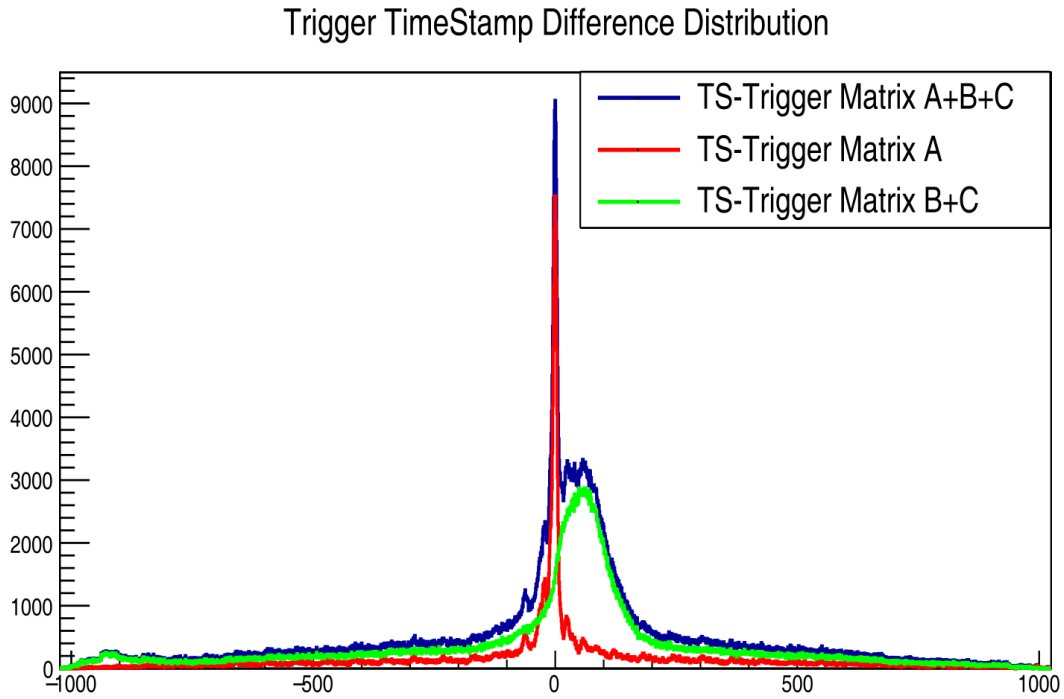


AmpOut on Oscilloscope

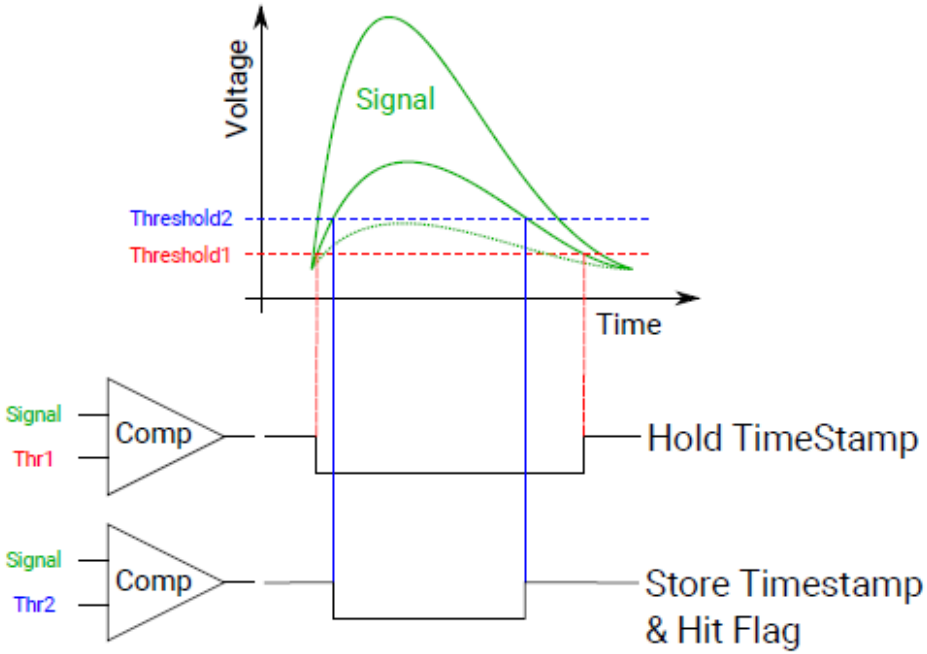


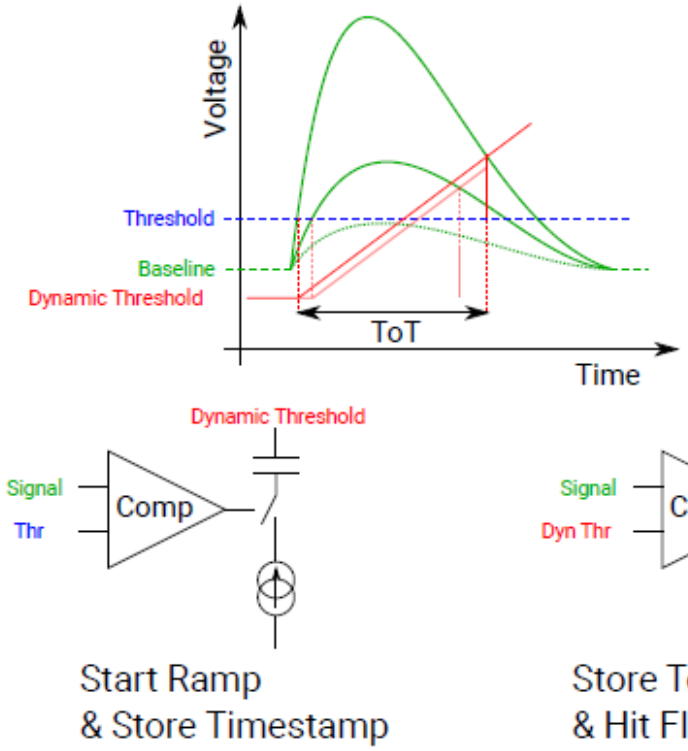
Submatrices



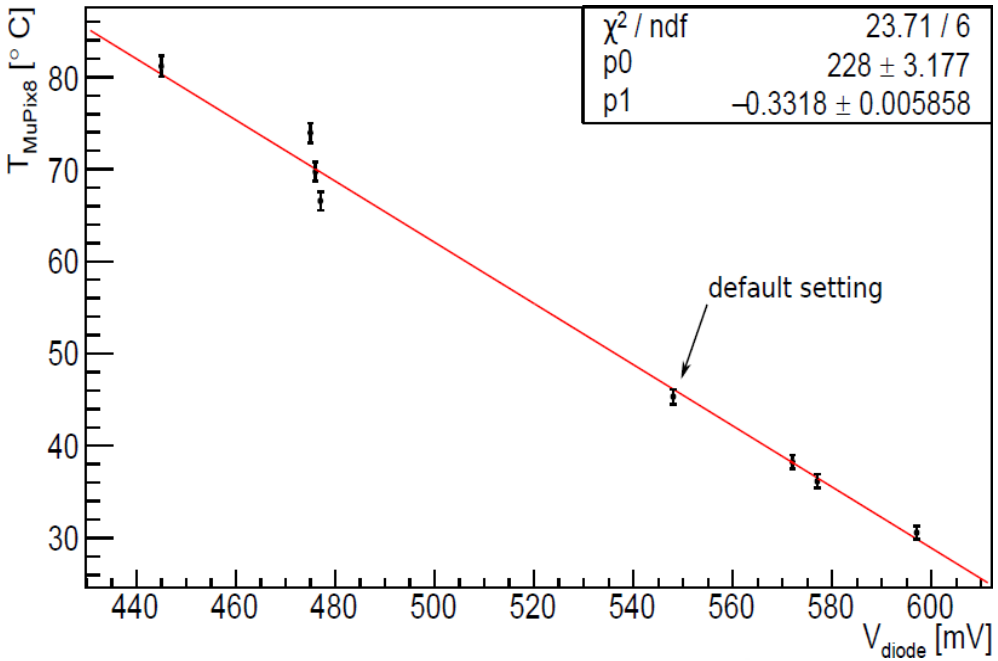


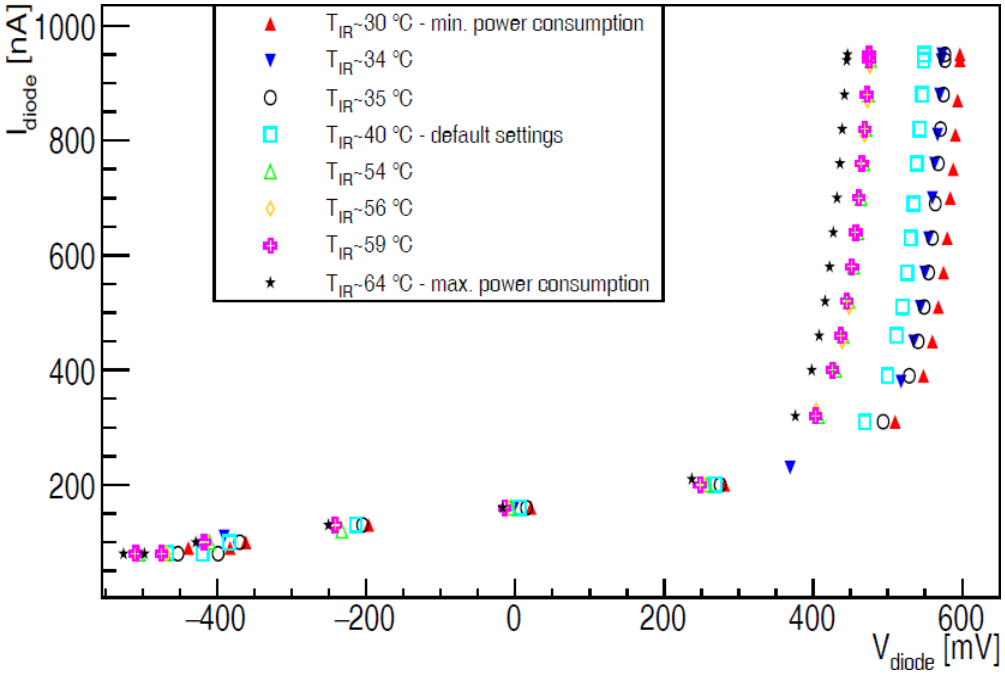
Timewalk Compensation



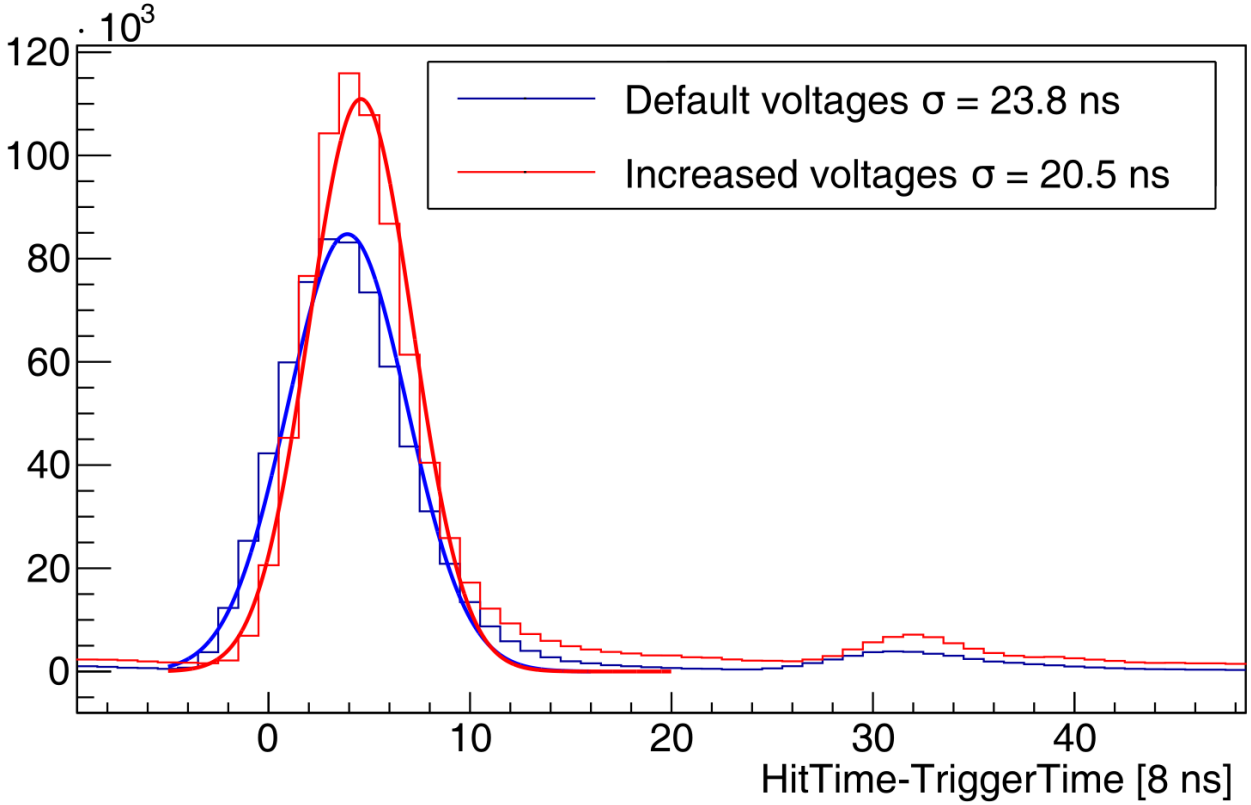
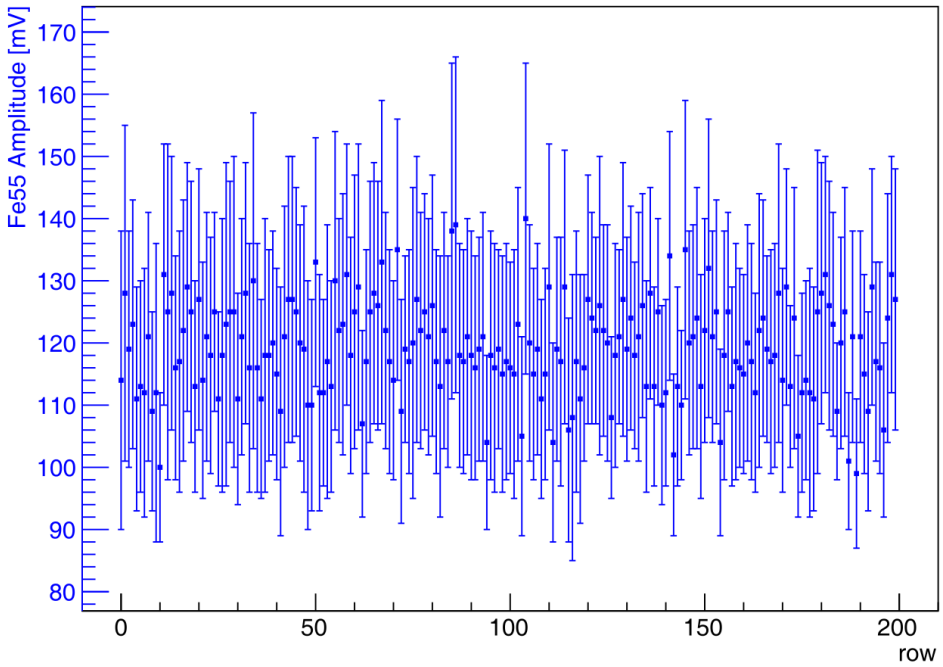
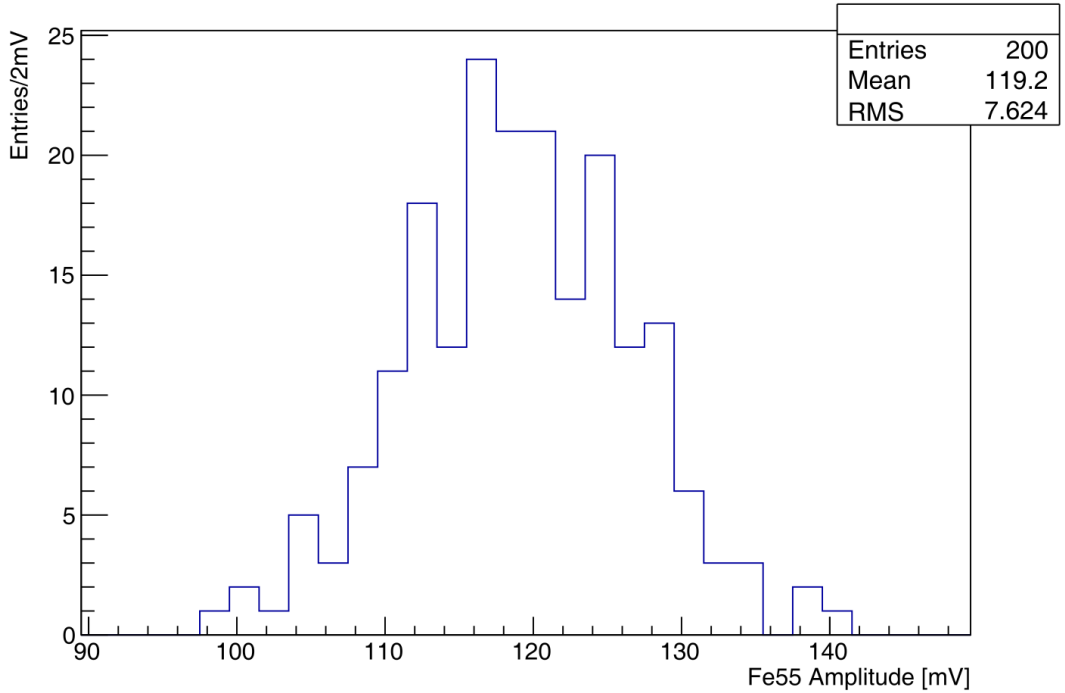


Temperature Diode





Timing with Increased Supply Voltage



Row (In-)Dependence of ^{55}Fe-Signal