

MuPix8: Current Status

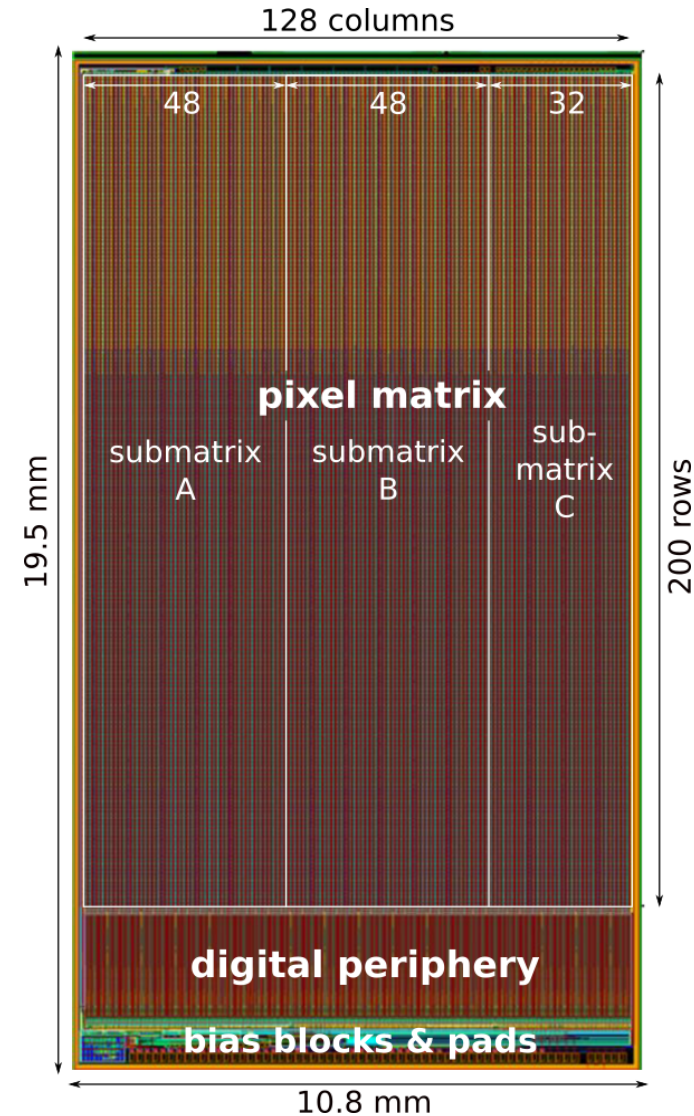
**– PANDA Collaboration Meeting 2018/1 –
Luminosity Detector Session**

René Hagdorn
Darmstadt, March 7, 2018

The MuPix8 Chip

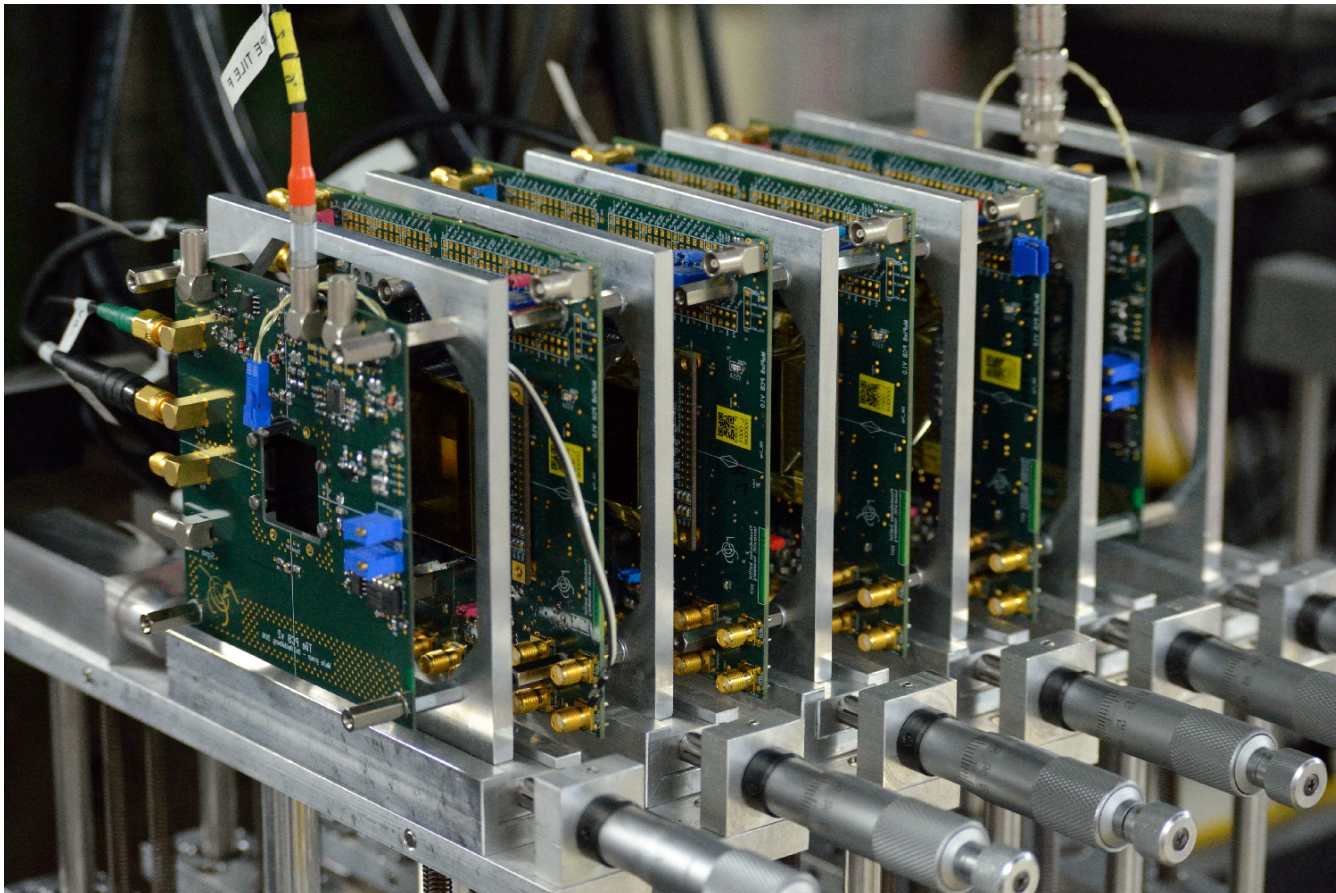
2

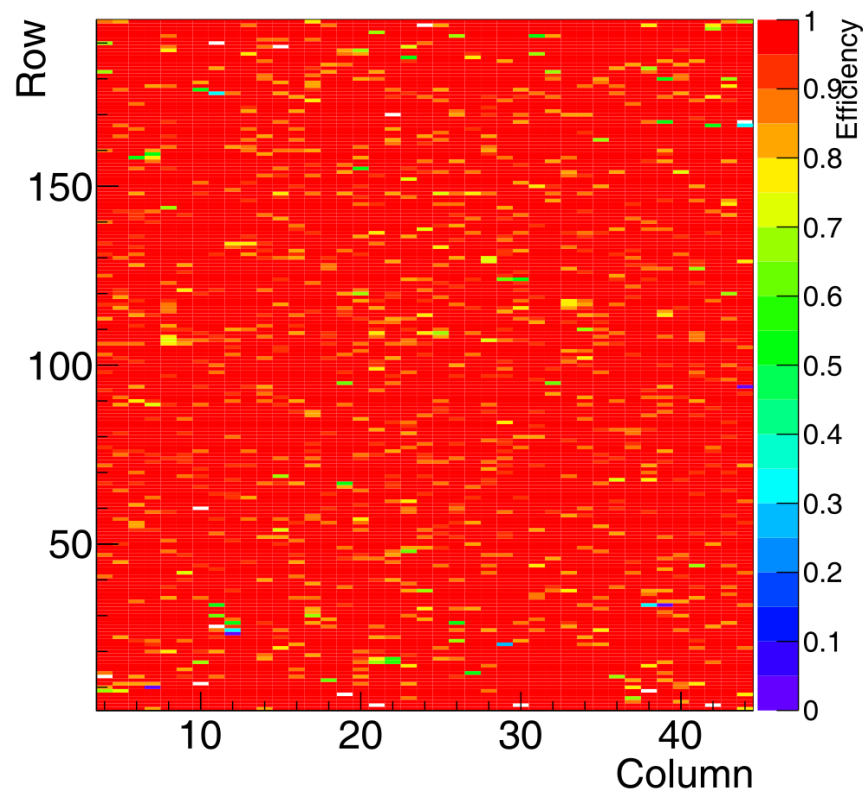
- Physical size: $19.5 \times 10.8 \text{ mm}^2$
- Active area: $\sim 16.2 \times 10.2 \text{ mm}^2$
- Matrix: 200×128 Pixels
divided into 3 Submatrices
A: Source follower,
B & C: current driver
- Pixel: $80 \times 81 \text{ } \mu\text{m}^2$, single diode
- 4 LVDS links @ 1.25 Gbit/s
- Timewalk compensation by
two-stage comparator scheme
- Temperature diode
- *On chip state machine
(works only if slowed down)*



– Testbeam Measurements –

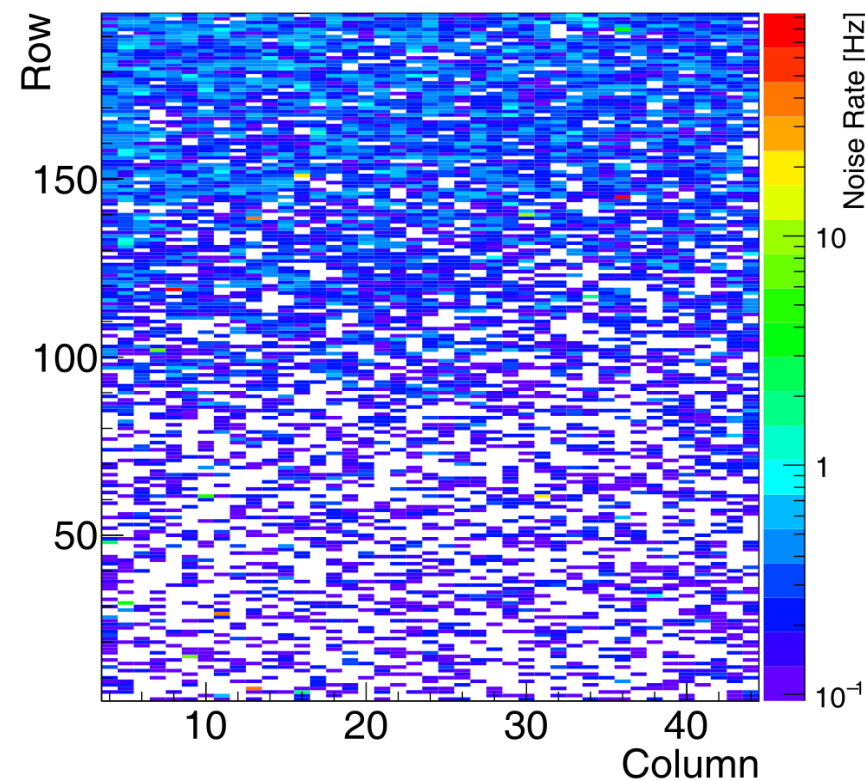
- Several test beams @ DESY (October – December 2017)
- 4-layer telescope of MuPix8 + 2 scintillating tiles





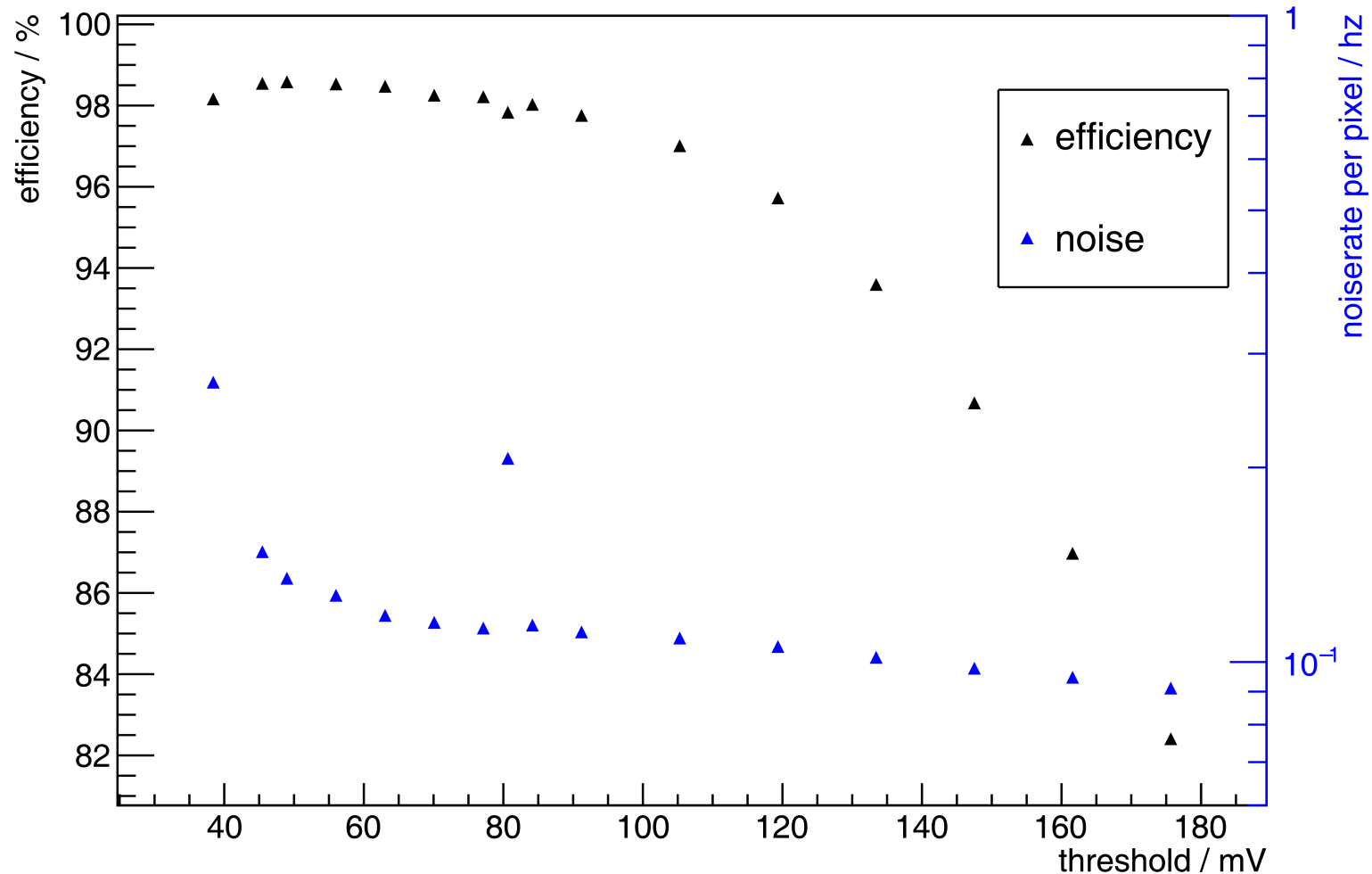
- Efficiency > 95 %

Plots by Mu3e-Group Heidelberg



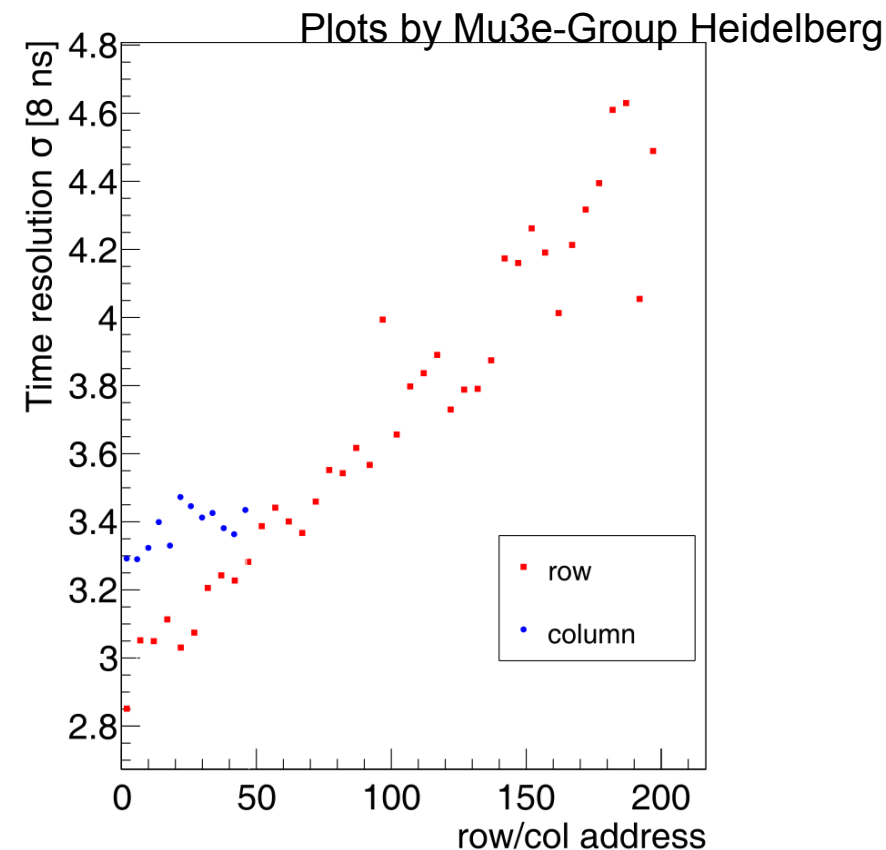
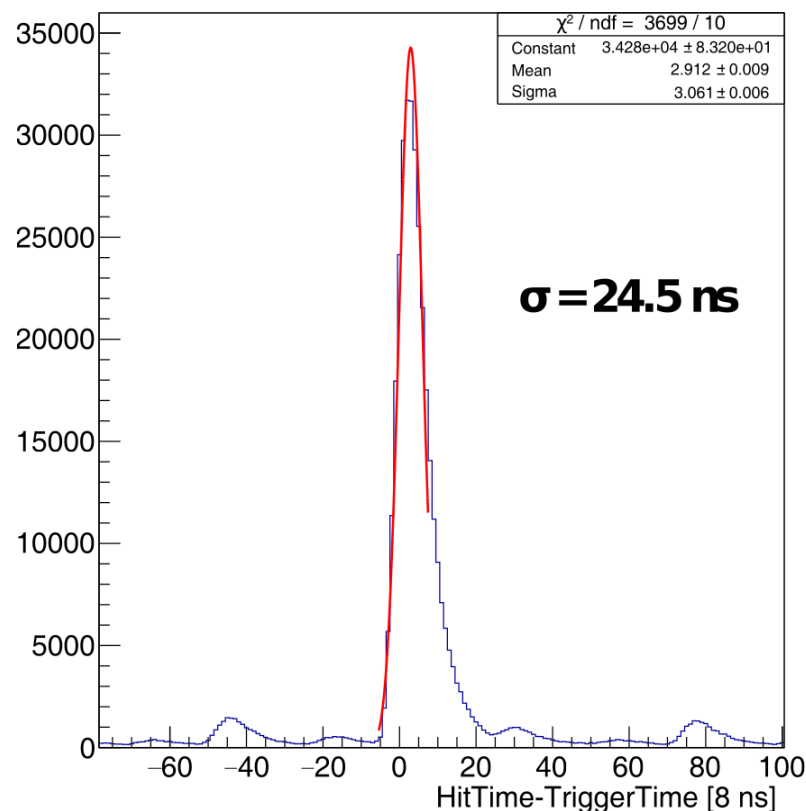
- Noise rate < 1 Hz

Plots by Mu3e-Group Heidelberg



- Wide plateau region
- Noise corrected

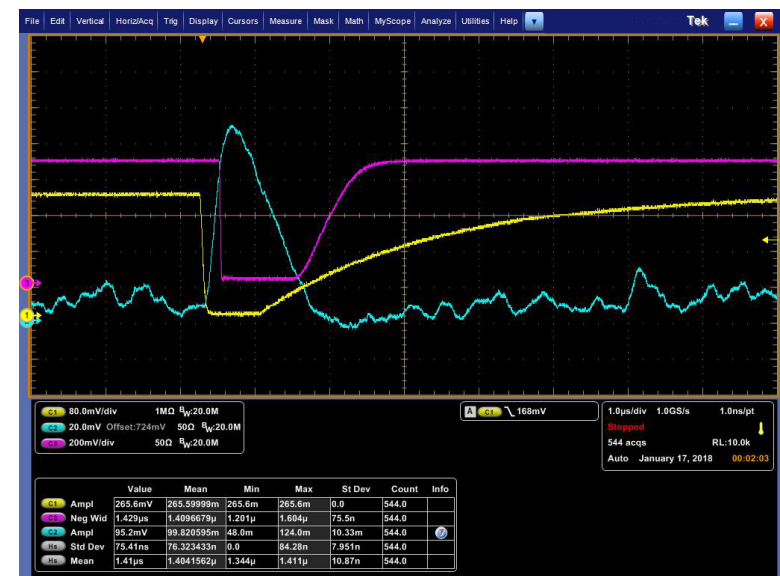
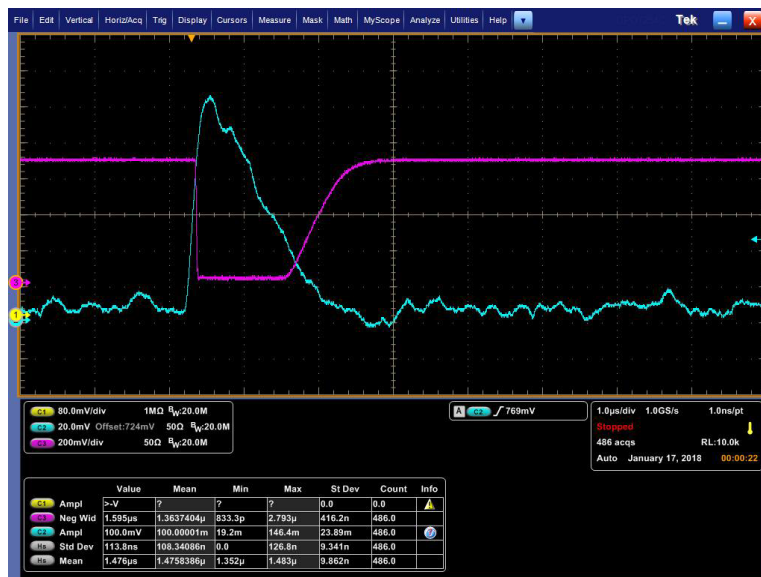
- Using scintillating tiles as reference
- Time resolution dependent of row position (probably because of line capacities)
- Row and column dependend delay (presumably due to voltage drop and/or clock distribution)



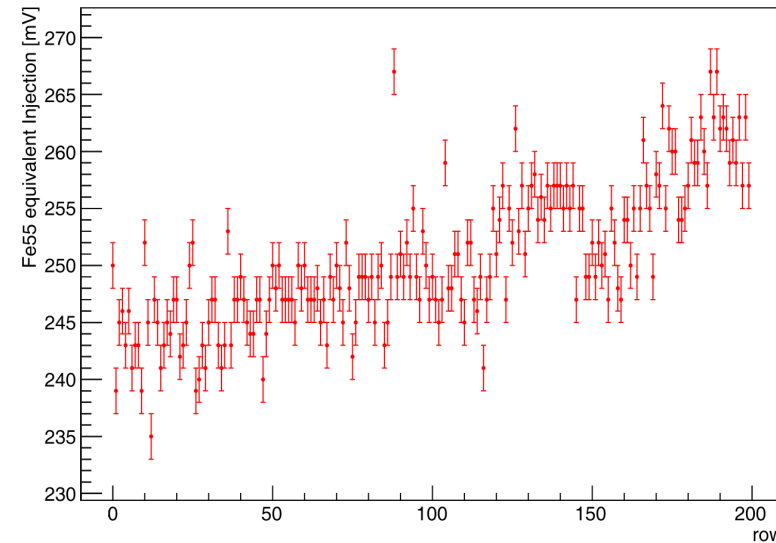
– Lab Measurements –

- New feature: Read out analog signal from amplifier
- ^{55}Fe (5.9 keV photon) @ 0V HV:
AmpOut ~ 100 mV (and ToT ~ 1.3 μs)
- Equivalent injection voltage: ~ 250 mV
- Measured peak-to-peak noise: ~ 20 mV
→ estimated SNR ~ 17 (assuming uniform noise distribution)

Plots by Mu3e-Group Heidelberg

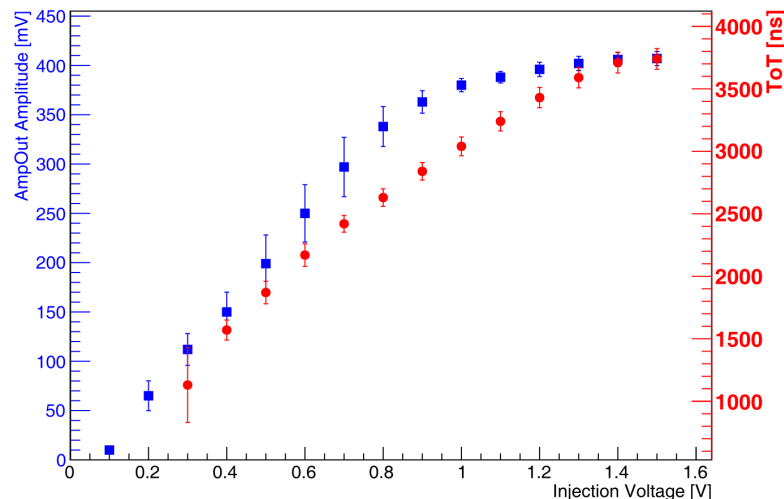


- Injection voltage for Fe-equivalent output depends on pixel row (probably due to line capacity)

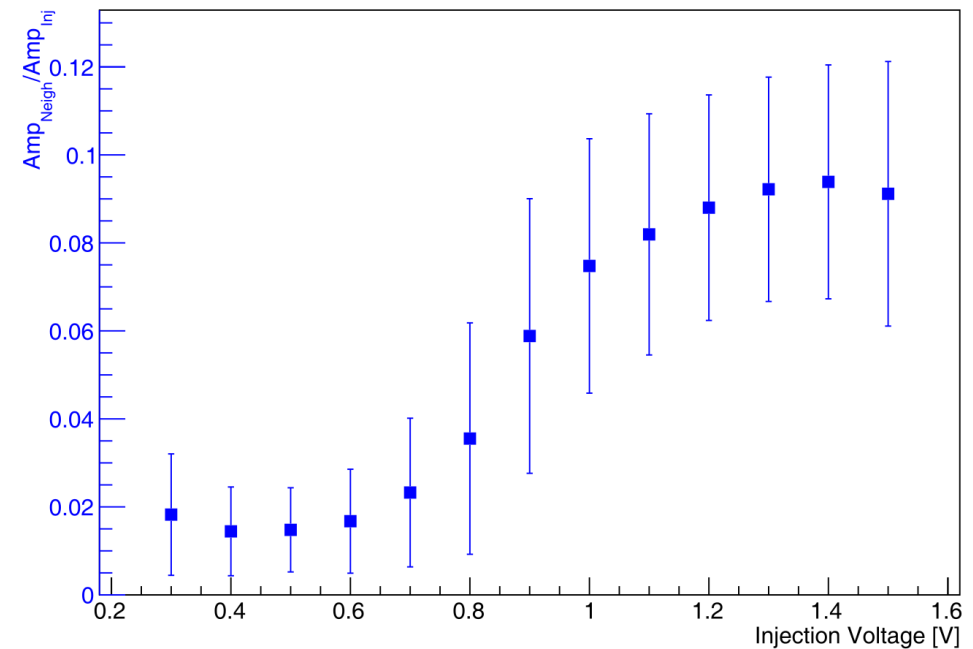
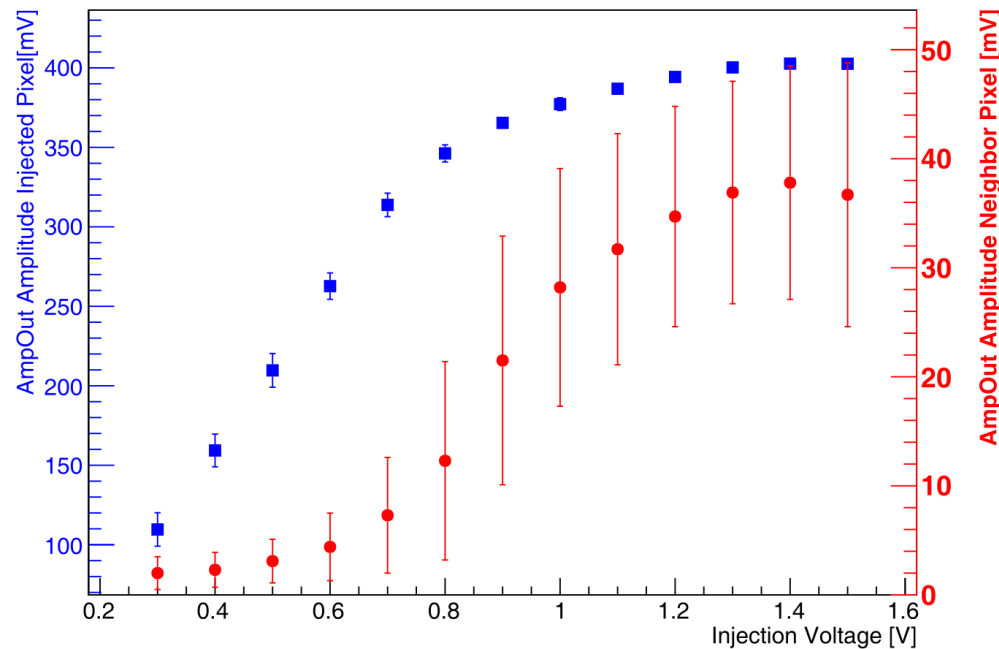


Plots by Mu3e-Group Heidelberg

- AmpOut goes into saturation, shape no longer triangular, ToTs less affected

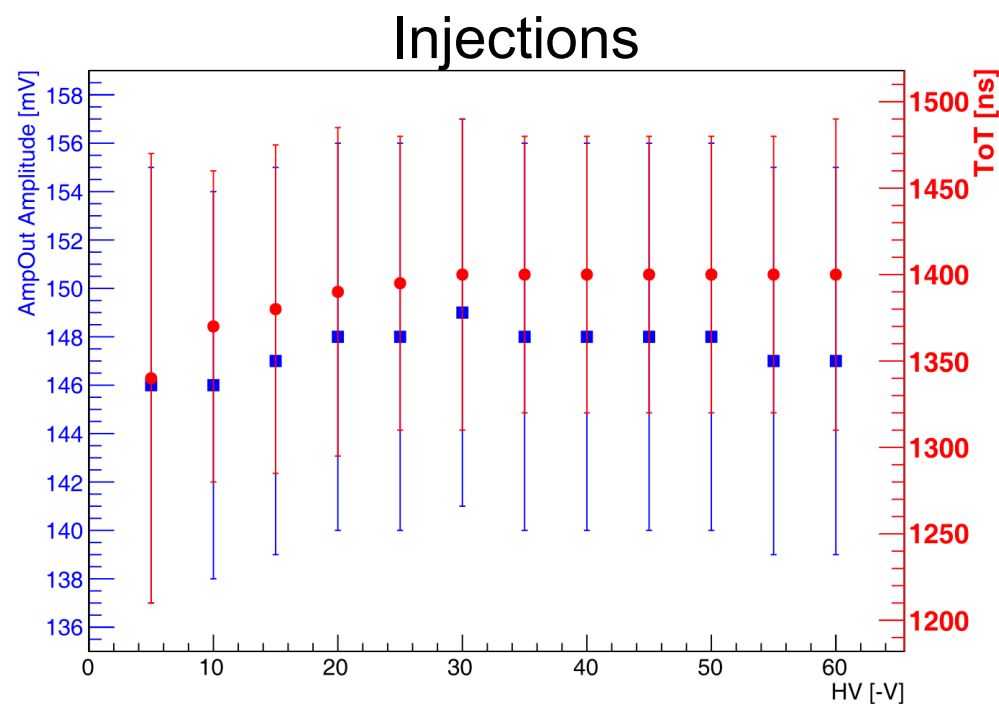
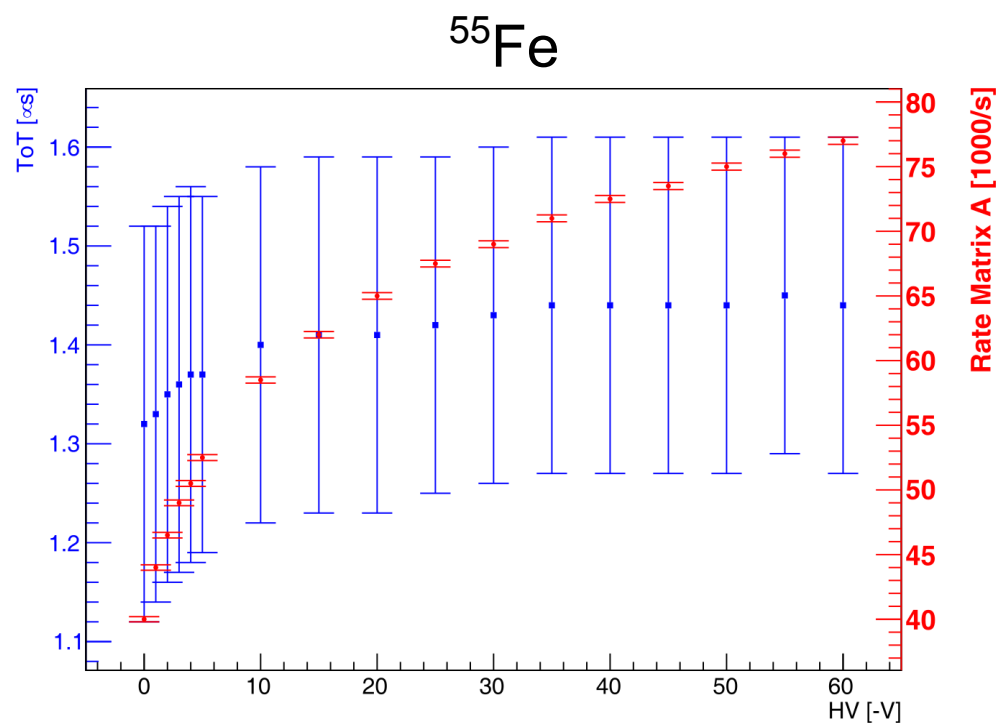


Plots by Mu3e-Group Heidelberg



- AmpOut signal of injected pixel compared to signal measured at neighboring AmpOut
- Crosstalk $\leq 10 \%$

- HV dependence: depletion layer thickness / sensor capacity $\propto \sqrt{HV}$ but signals show only little dependence on HV



Plots by Mu3e-Group Heidelberg

– Software –

- Written in C++, Qt for GUI designs
- Sensorboard interface:
 - Thresholds
 - Injections
 - Addresses
- Currently working on ChipDAC interface

The screenshot shows a Qt-based GUI window titled "BoardDACs". At the top, there are two input fields: "TRB address" and "MuPix address". To the right of these fields are two buttons: "Set MuPix address" and "Read back MuPix address". Below these fields, the window is divided into two main sections: "Threshold Settings" on the left and "Injection Settings" on the right. The "Threshold Settings" section contains three input fields: "Thes low [mV]", "Thres high [mV]", and "Thres Pix [mV]". Below these fields are two buttons: "Set Threshold DACs" and "Set Injection DAC". The "Injection Settings" section contains three input fields: "Amplitude [V]", "Duration [ns]", and "Frequency [Hz]". Below these fields, there is a section for "Injection Mode" with two radio buttons: "Fixed Number" and "Continuous" (which is selected). Below the radio buttons is an input field for "# of Injections". At the bottom of the window, there are three buttons: "Set Board DACs" (centered), "Start Injections" (right-aligned), and "Set Injection DAC" (left-aligned, below the threshold settings).

- First tests of MuPix8 performed at testbeams and in lab
- Efficiency $> 95\%$, noise below 1 Hz
- Time resolution ~ 24.5 ns

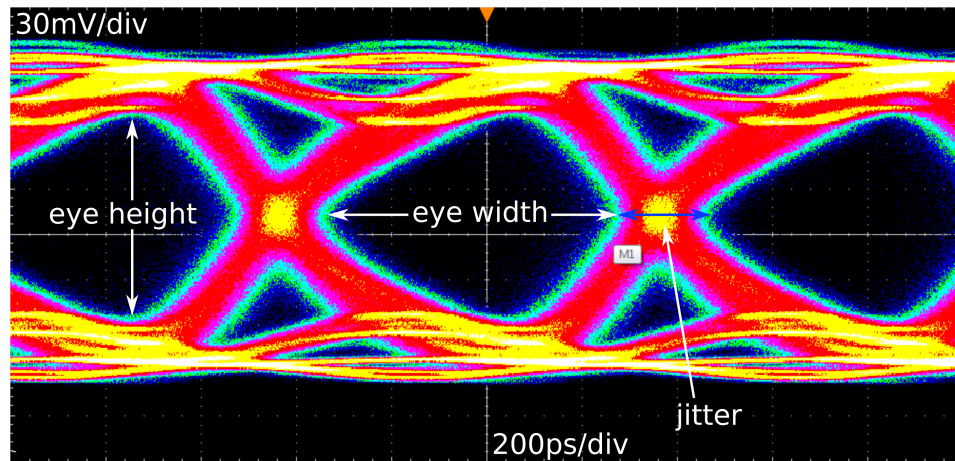
but: There is still a lot of testbeam data to analyse

- New features like AmpOut
- Some don't work as intended
- Causes of (some) problems identified
- Development of Software progressing

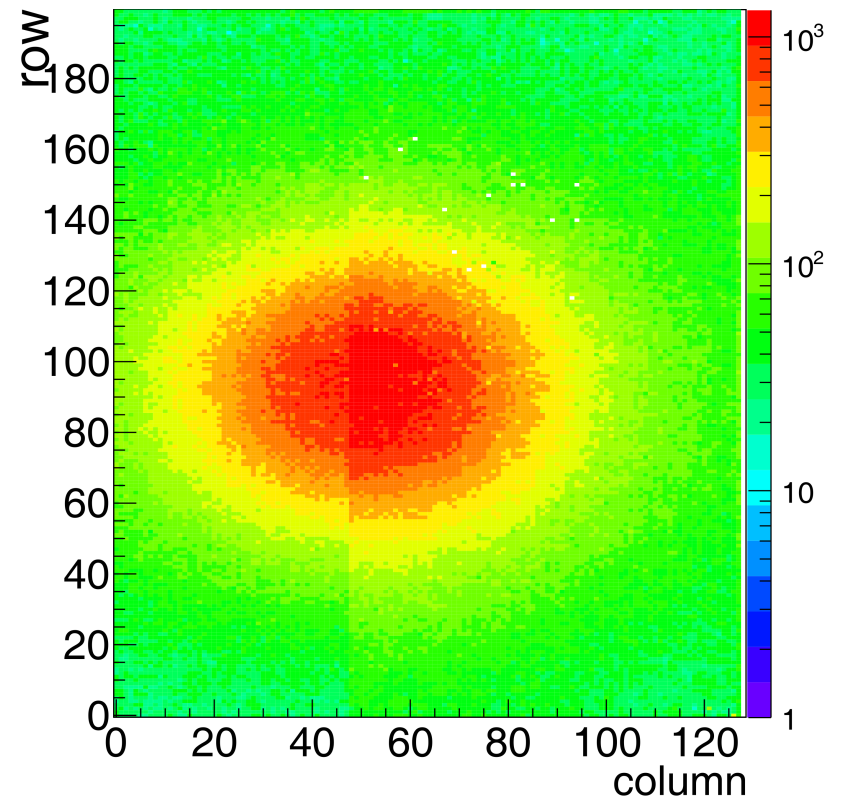
– Backup –

^{90}Sr -Hitmap & Eye Diagram

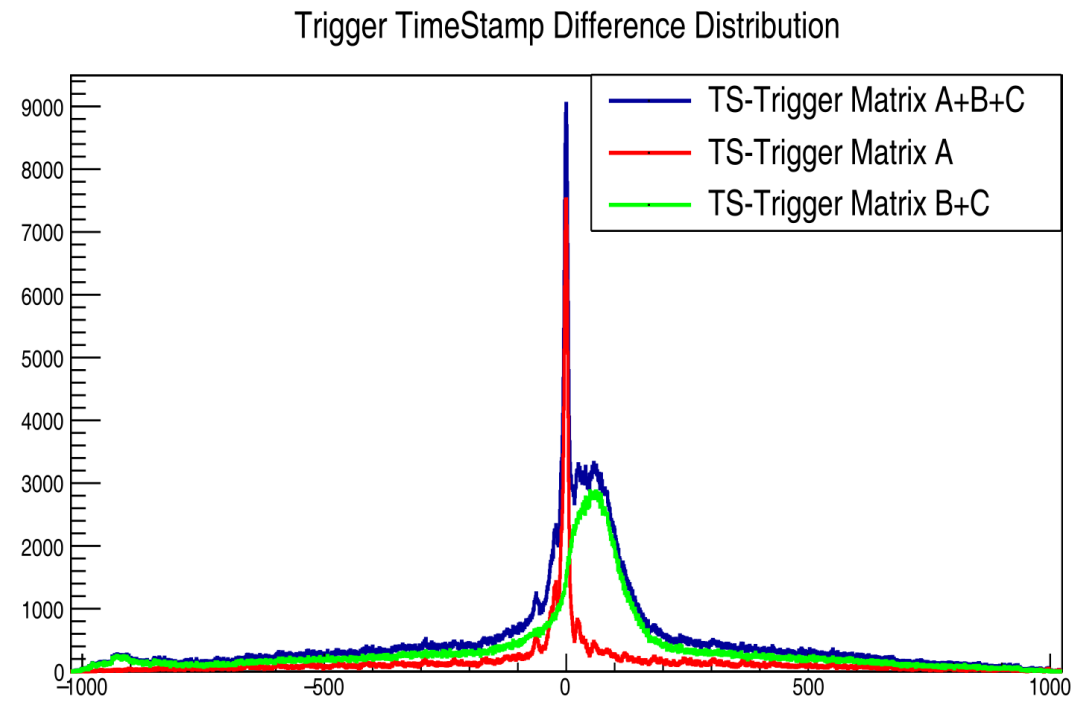
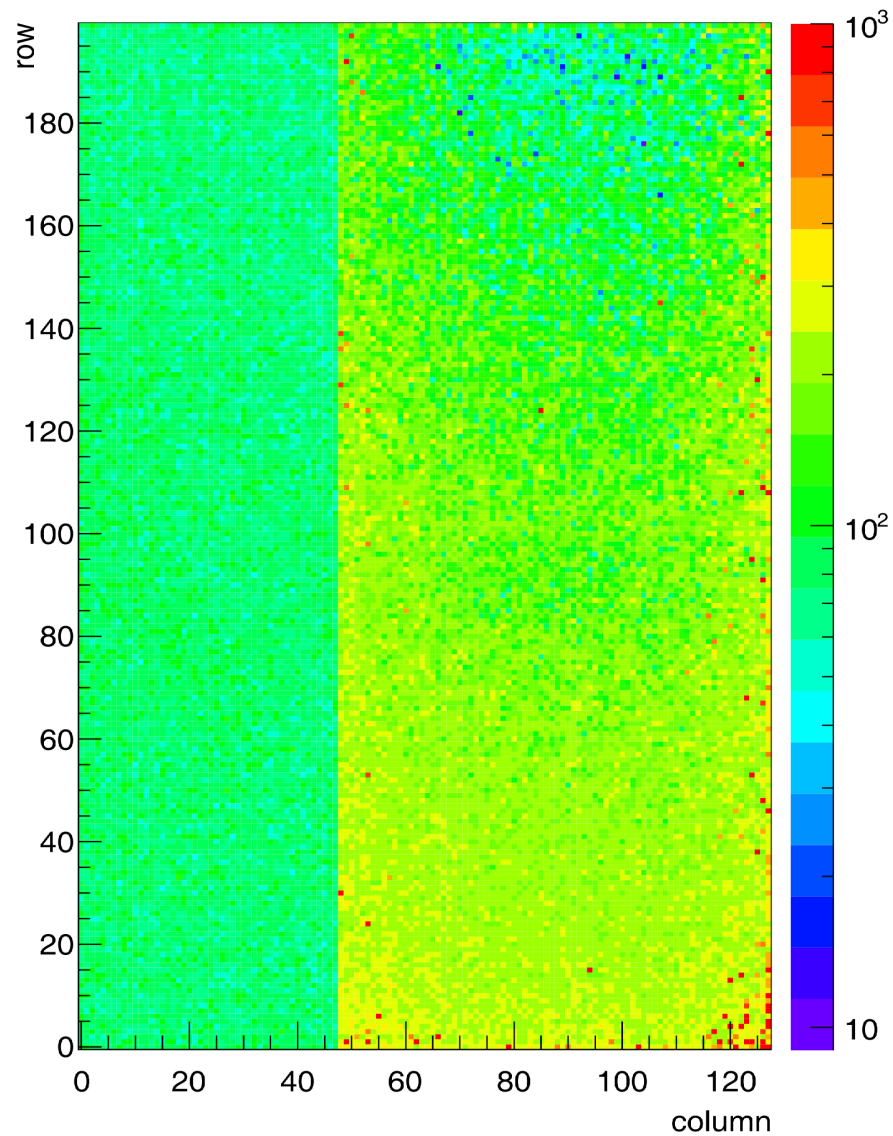
Eye Diagram of LVDS Link @ 1.25 Gbit/s



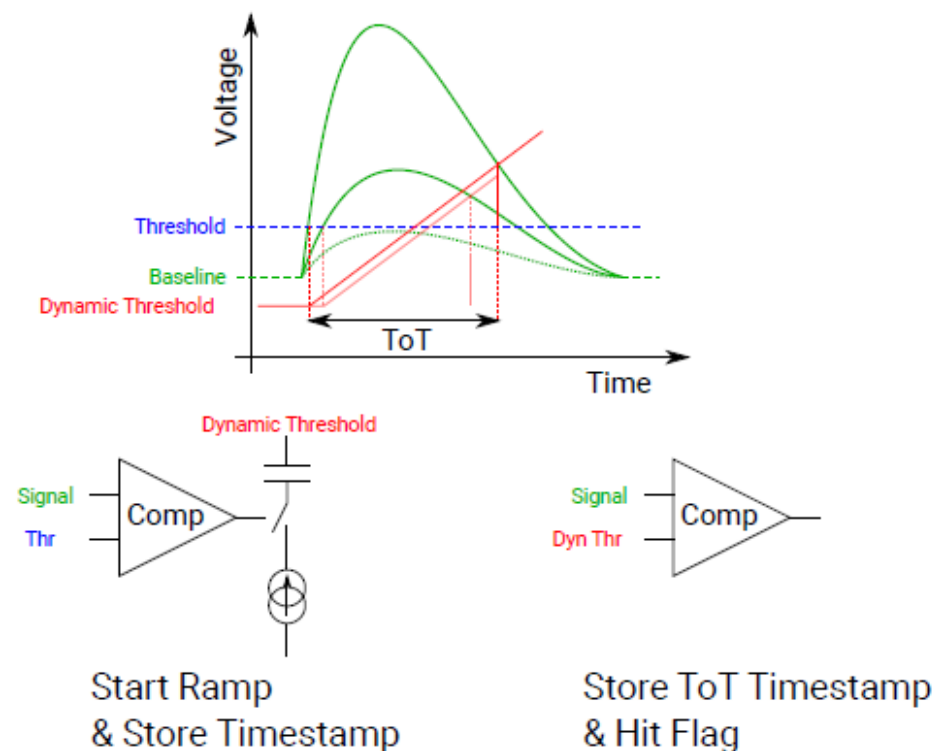
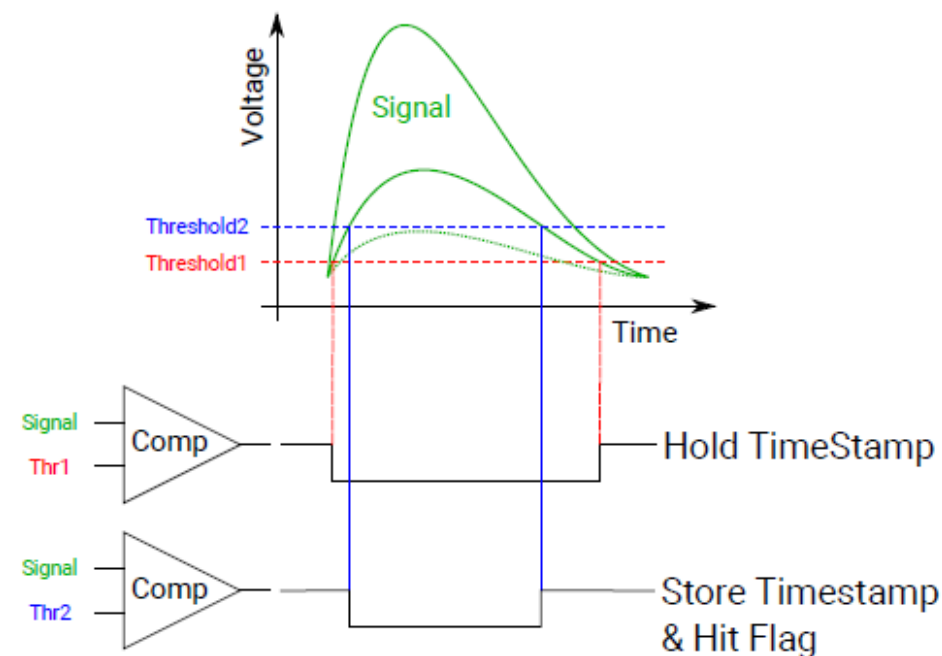
^{90}Sr Hitmap



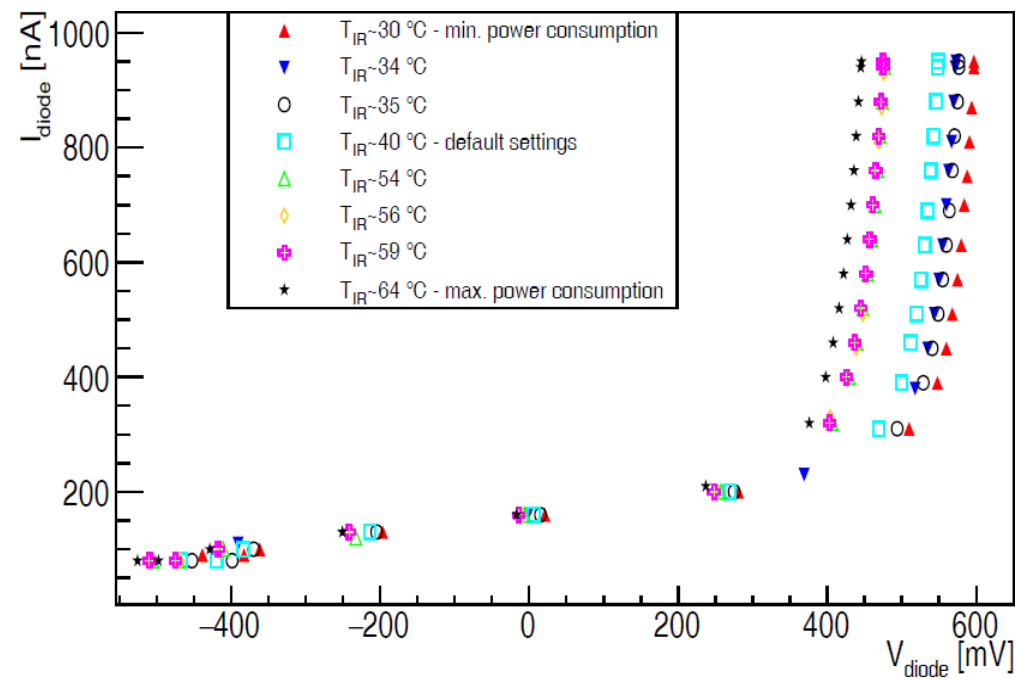
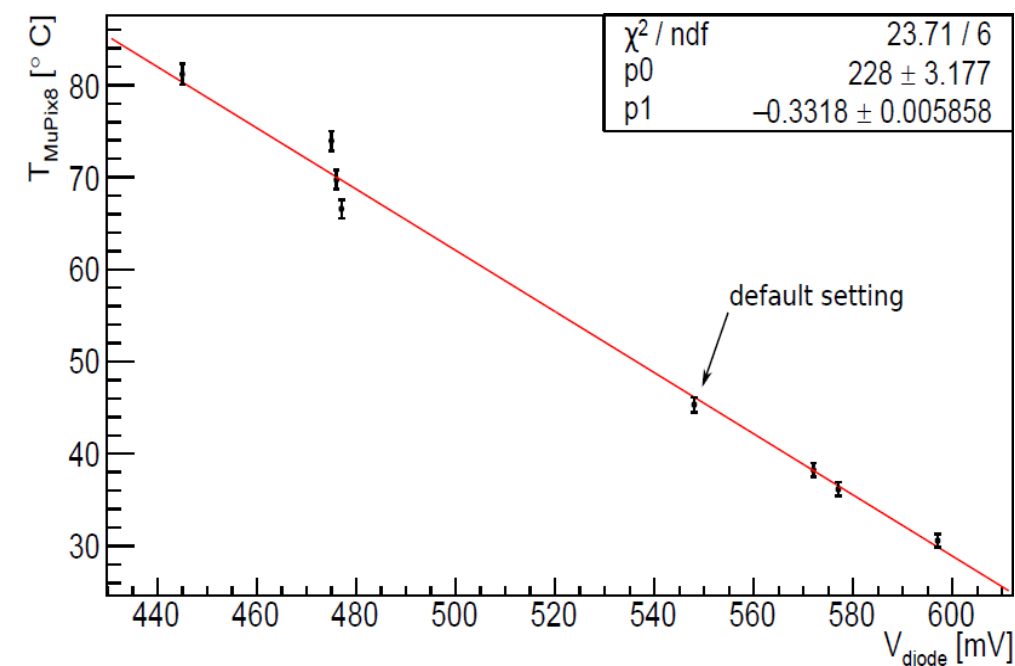
Submatrices



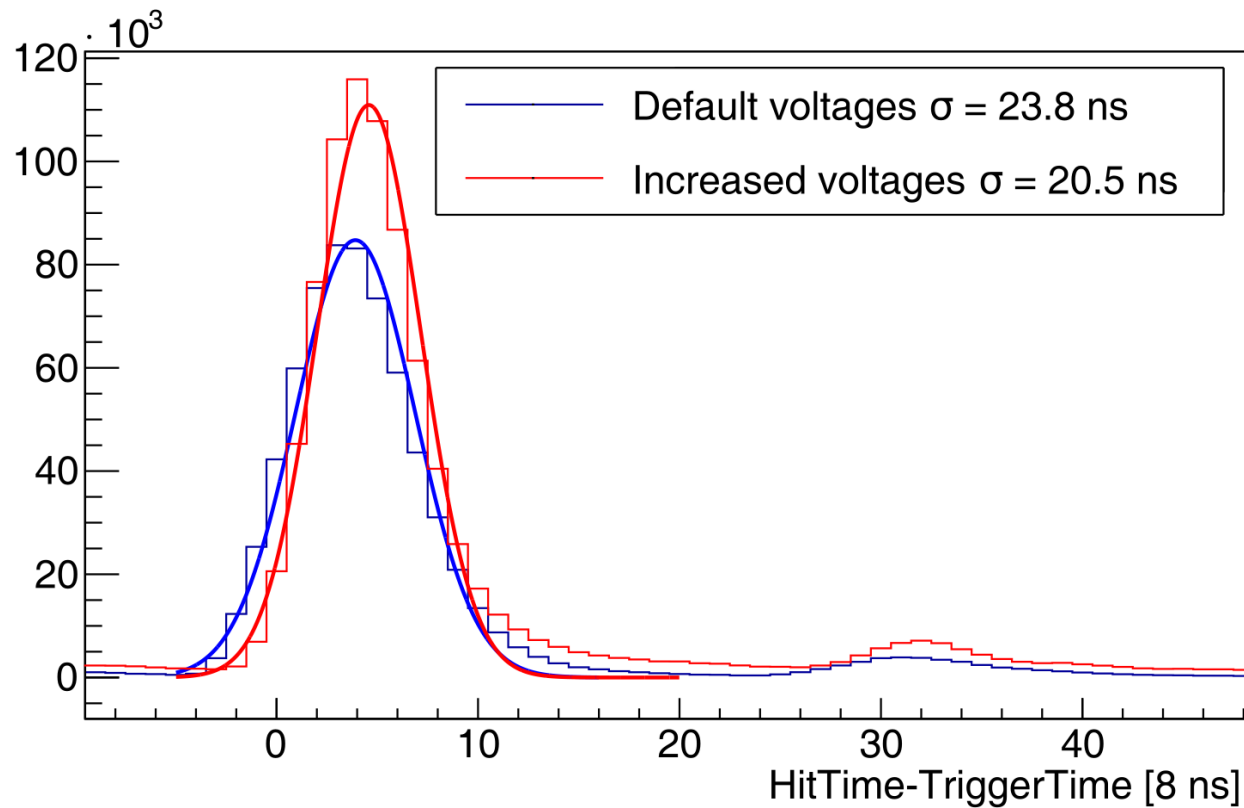
Timewalk Compensation



Temperature Diode



Timing with Increased Supply Voltage



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

