

# Preliminary LumiCal beam test results

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# Preview

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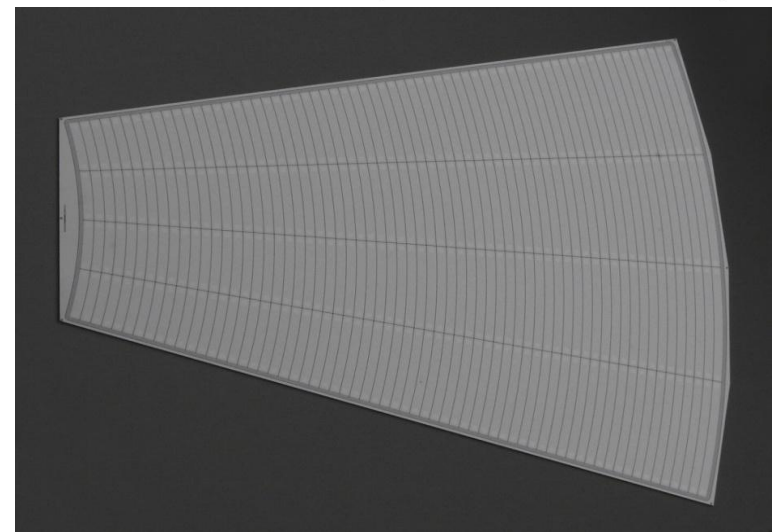
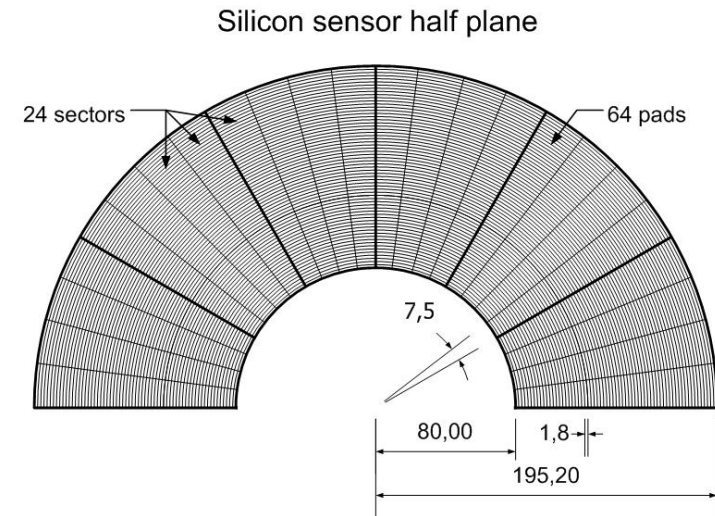
- Electronics setup
- Telescope setup
- Beam test data
- Simulation of beam test data

# Goals

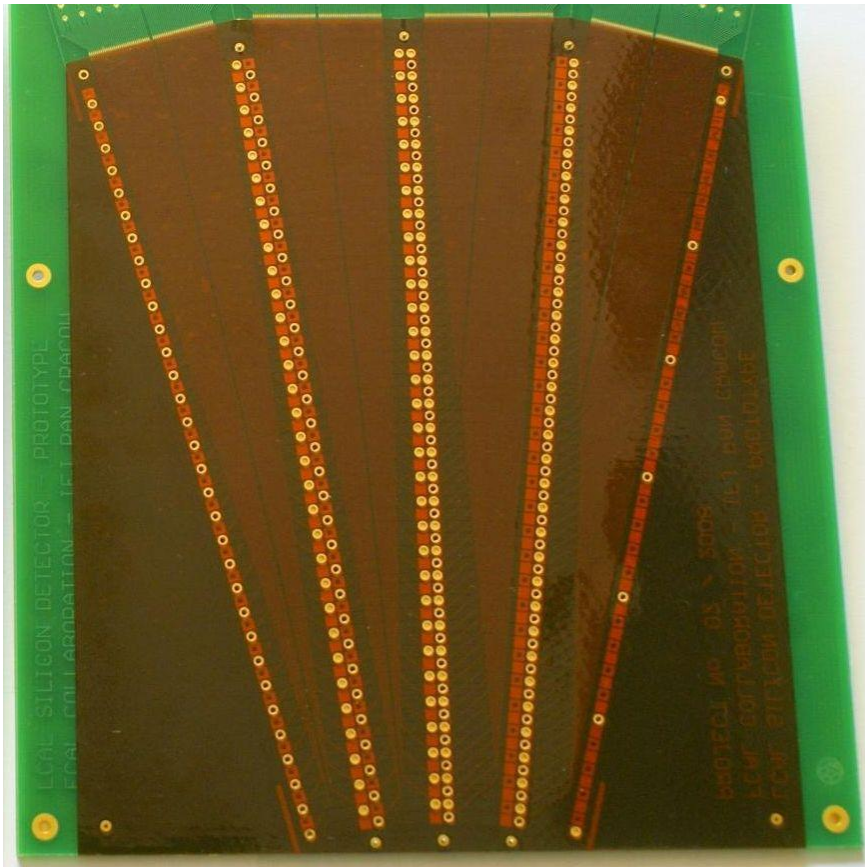
- Check that readout chain output is reasonable
  - Energy deposition fits Landau distro
  - Good signal-to-noise ratio
- Calibration mode and physics mode
  - Shaper and preamp have different gains
  - Only observe saturation in high-gain mode with absorbers

# Sensors

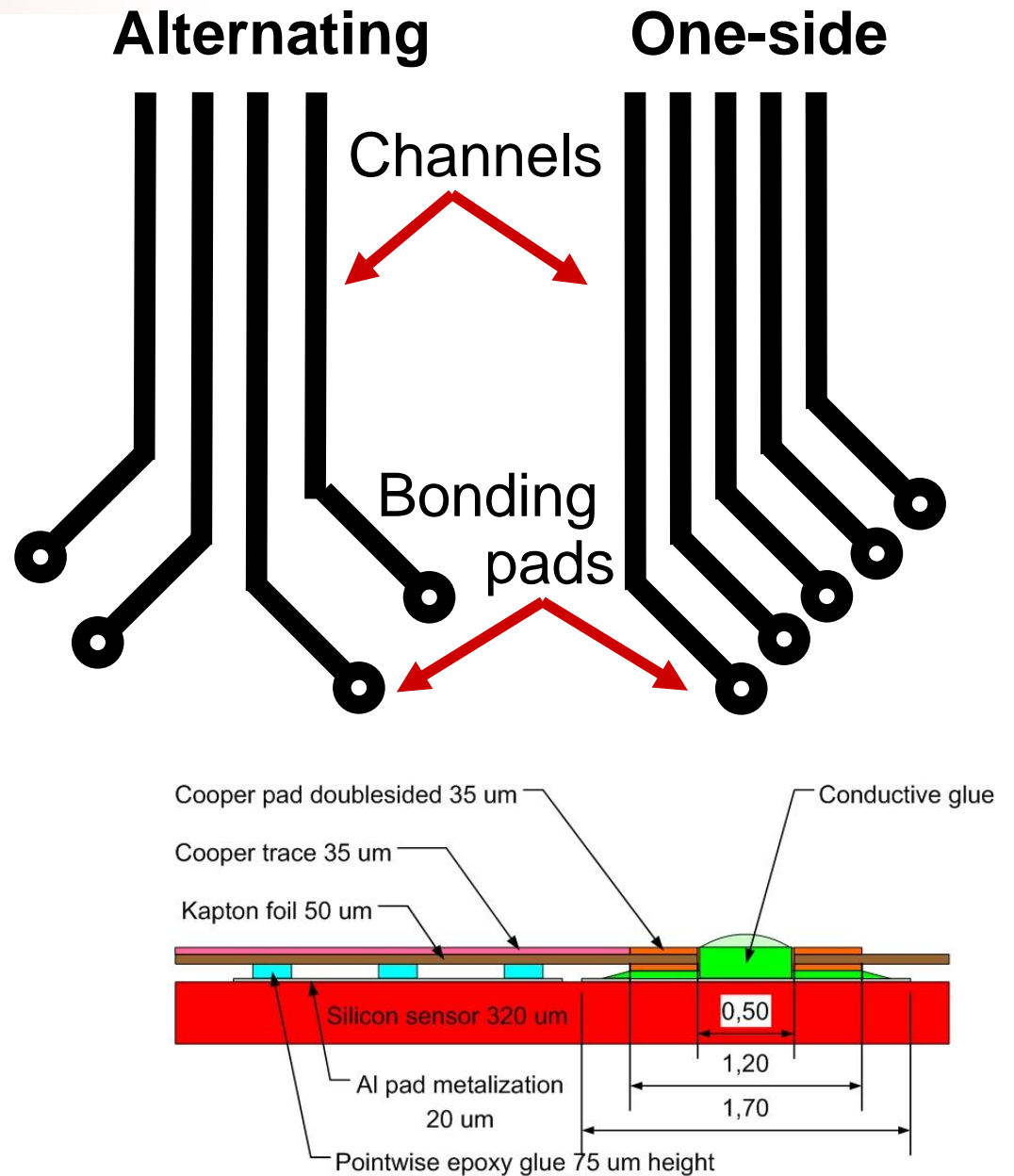
- 1 tile (4 sectors)
- 64 radial pads / sector (1.8 mm)
- High resistivity n-type Si bulk, 320  $\mu\text{m}$  thick
- p+ pads with Al metallization, DC coupled



# Fanout

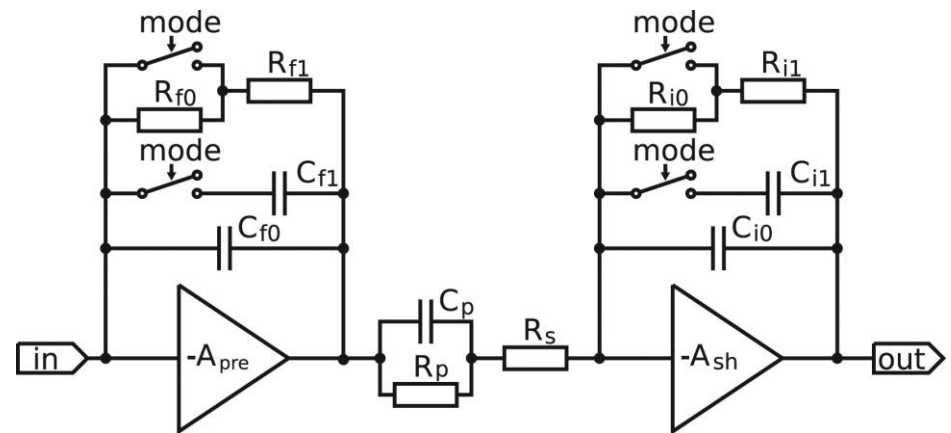


Only "one-sided"  
bonded to sensor



# Electronics: FE ASIC

- Charge-sensitive amplifier
- 1<sup>st</sup> order shaping
- Pole-zero cancellation circuit
- $\sim 1V$  dynamic range
- Gain
  - Low: 0.105 mV/fC
  - High: 25 mV/fC
  - Beam test: high gain and medium gain (preamp high, shaper low)

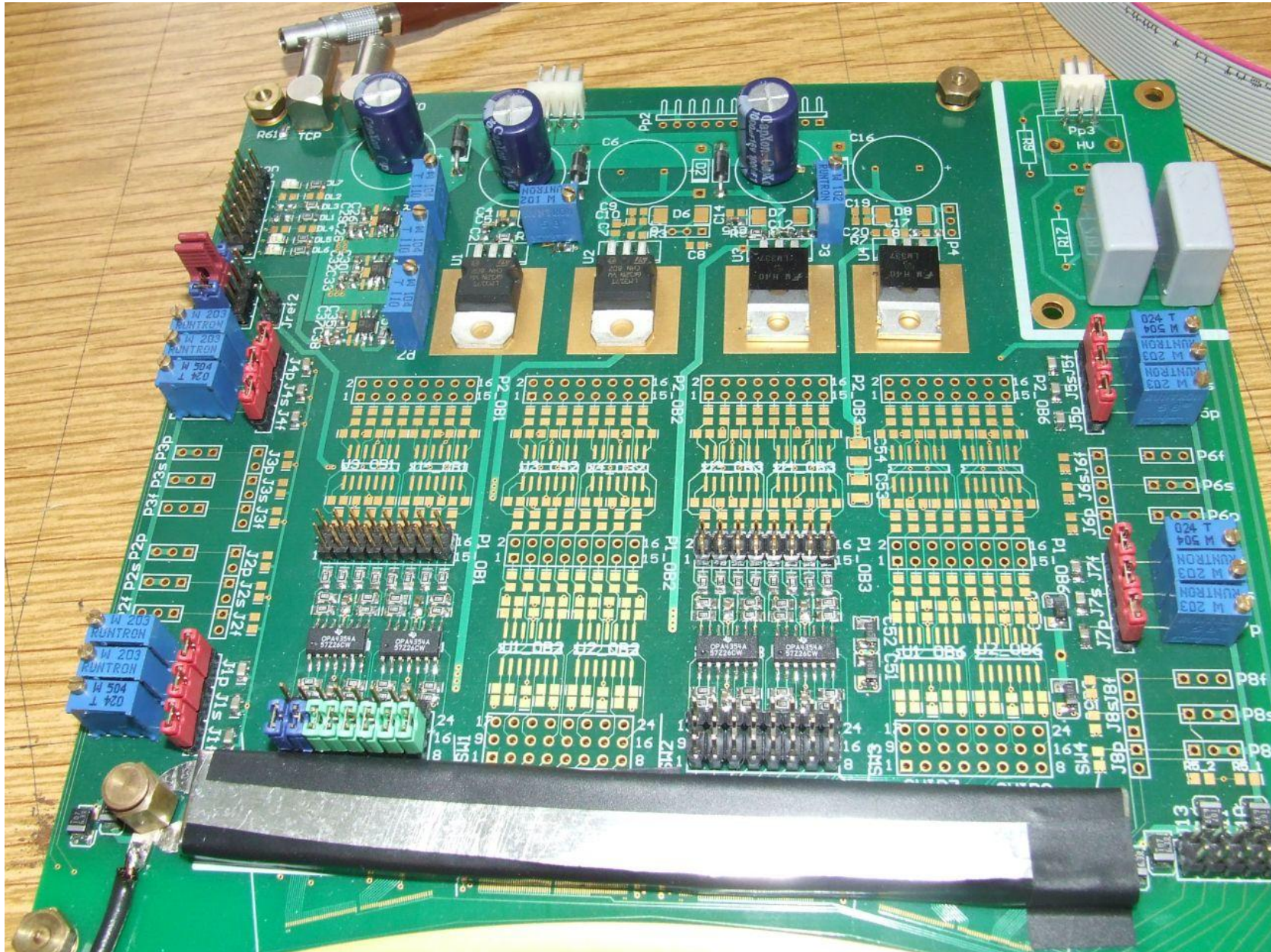


# Electronics: ADC

- ADC: Caen VME – V1724
- 14 bits
- 8 channels
- 100 msp/s
  - Sampling period 10 ns
- Optical link



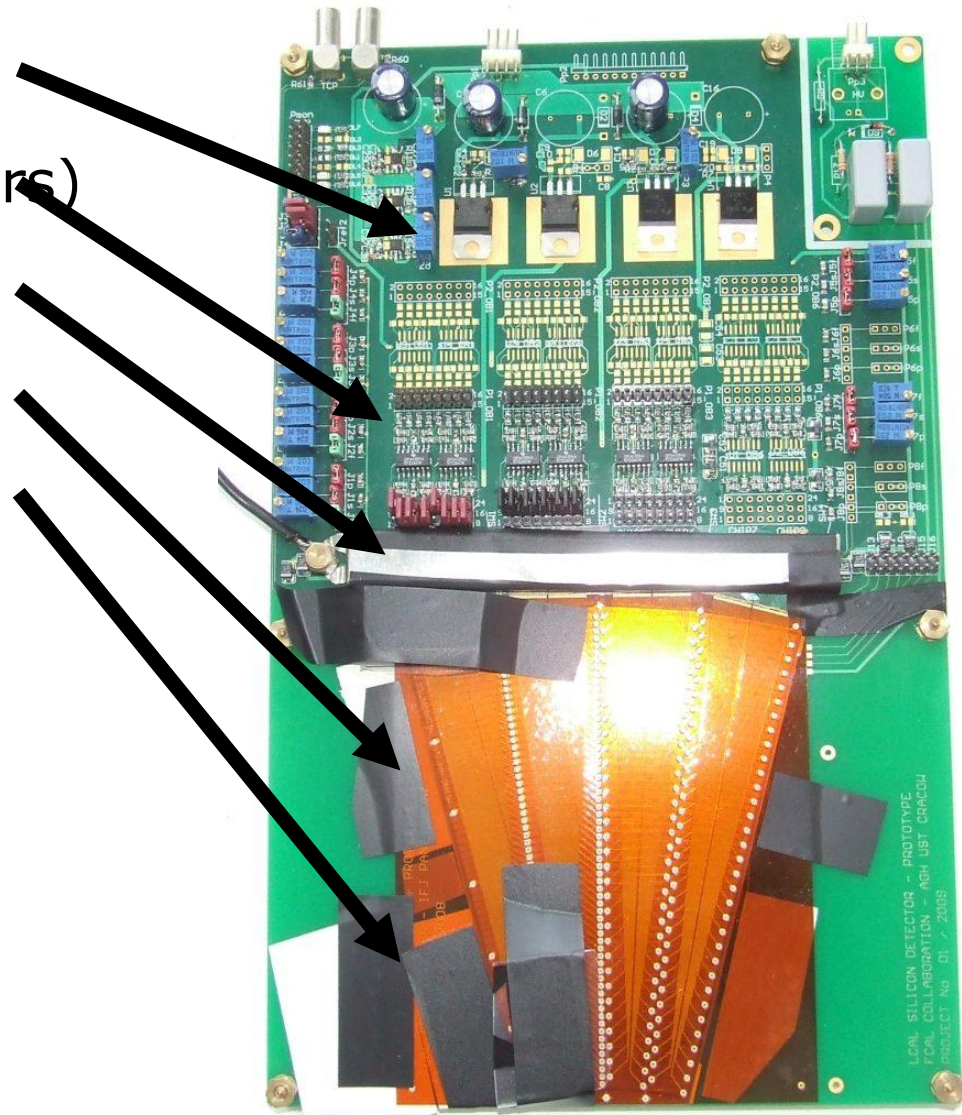
# PCB





# Full readout chain

- Biasing & power blocks
- Output buffers (line drivers)
- 5 chips bonded
- Sensor & fanout glued
- 8 sensors pads bonded



# Telescope

- 3 modules
  - 2 single-sided Si planes per module, 32 x 32 x 0.3 mm
  - Perpendicular
- 640 strips/plane
  - Strip pitch 25  $\mu\text{m}$
  - Readout pitch 50  $\mu\text{m}$

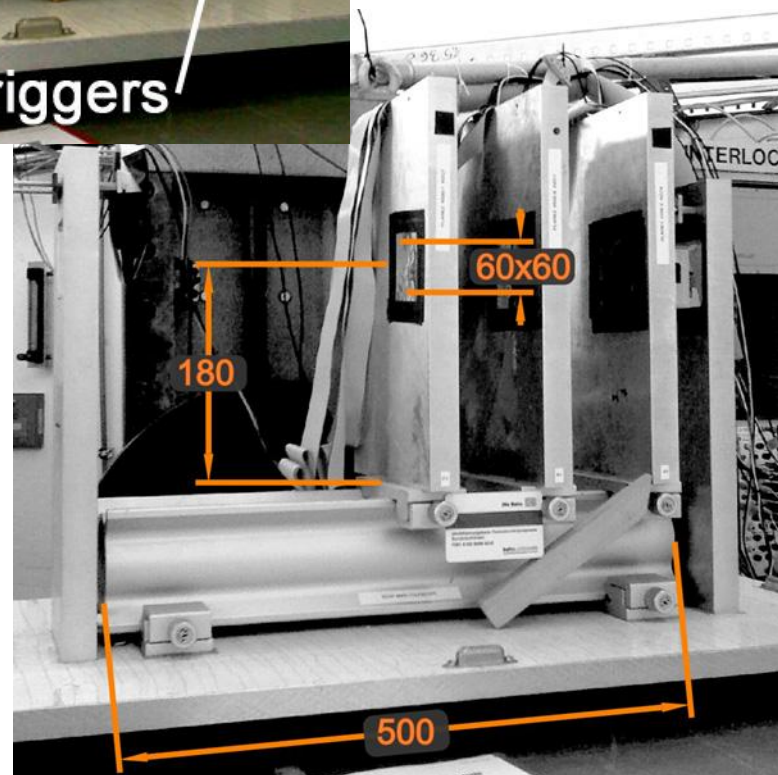
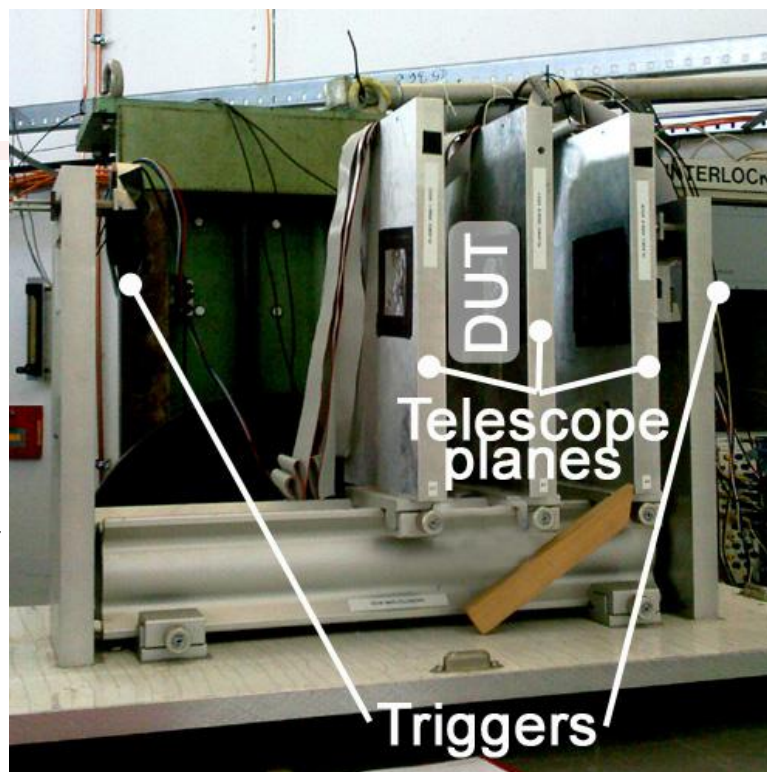
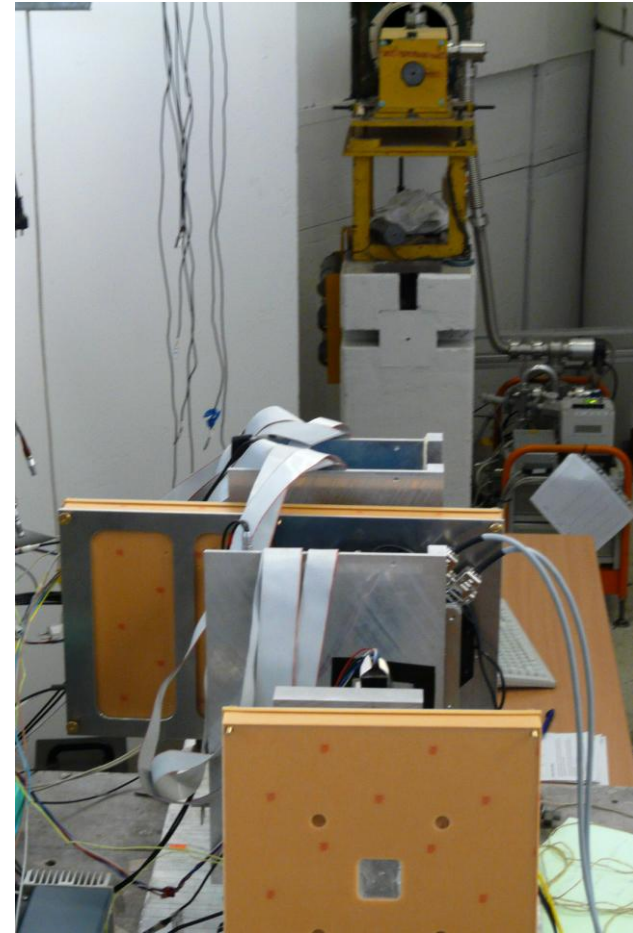


Photo credit: Hans Henschel

# Setup 1 – no tungsten

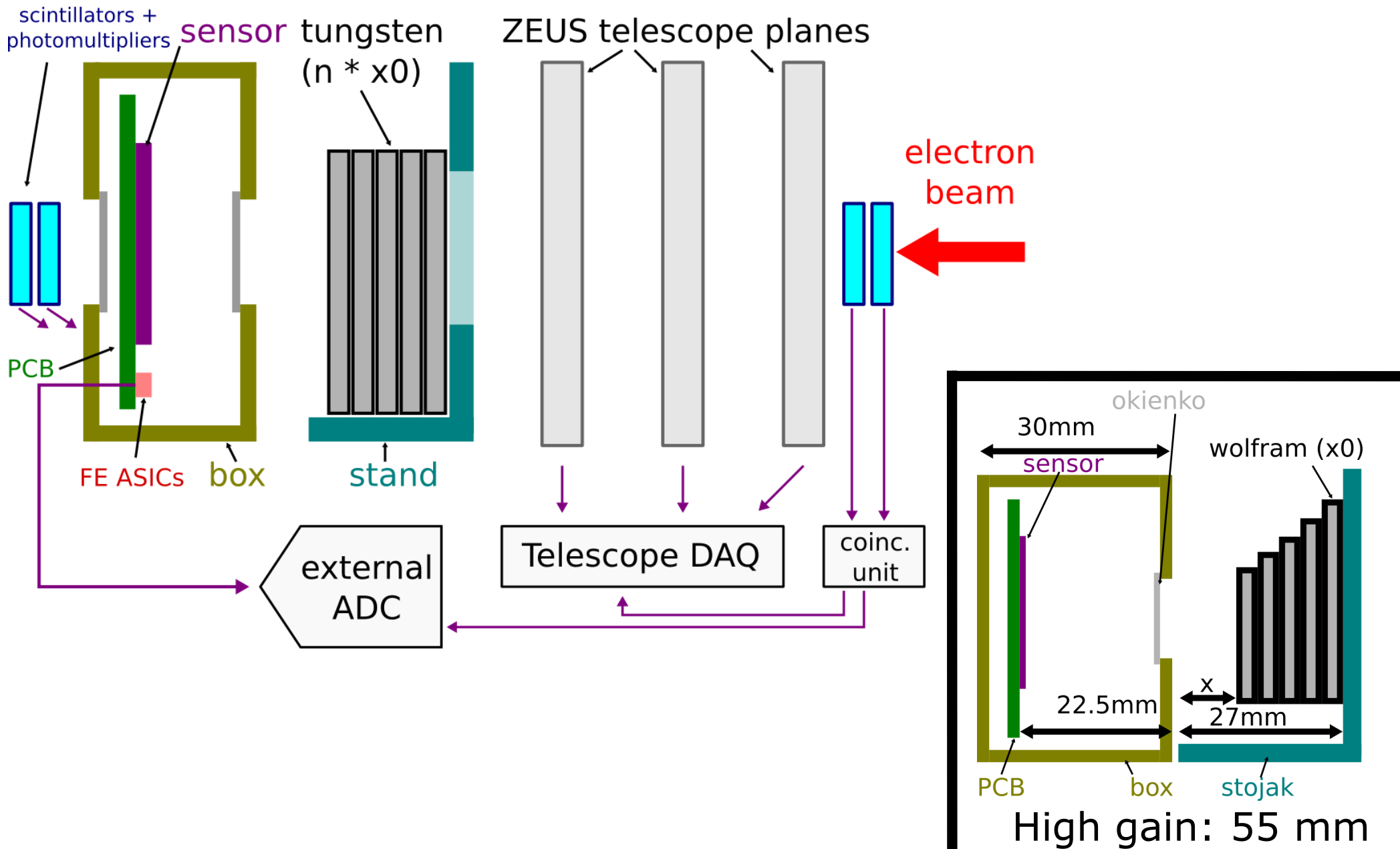


Front



Top

# Setup 2 – tungsten absorbers (not to scale)

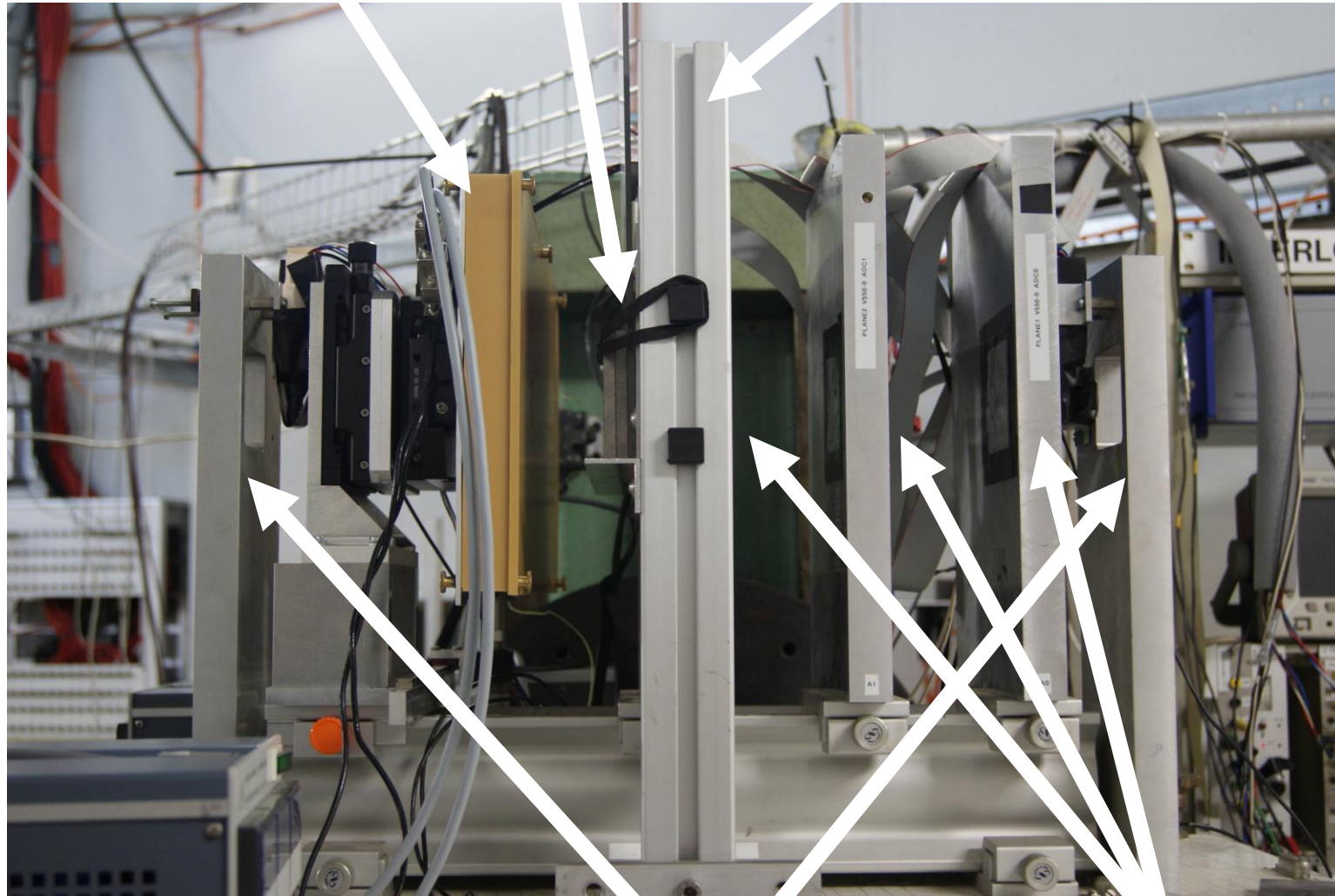


# Setup 2: tungsten absorbers

Sensor box

Tungsten plates

Stand

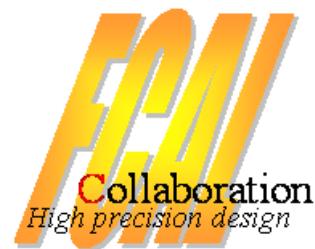


Triggers

Telescope planes  
(3<sup>rd</sup> hidden)

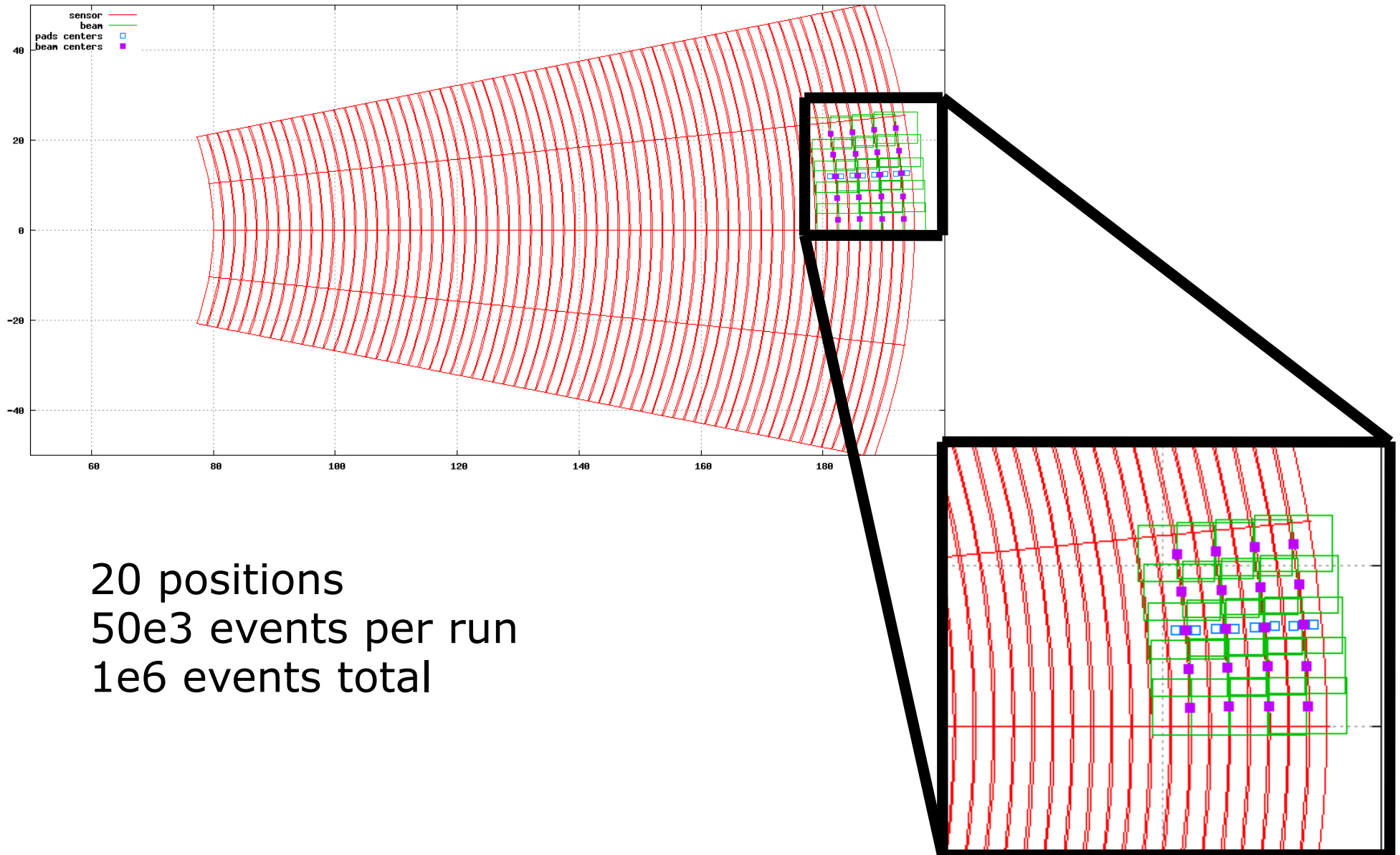
Photo credit: Marcin Chrzyszcz

# Telescope control and DAQ software

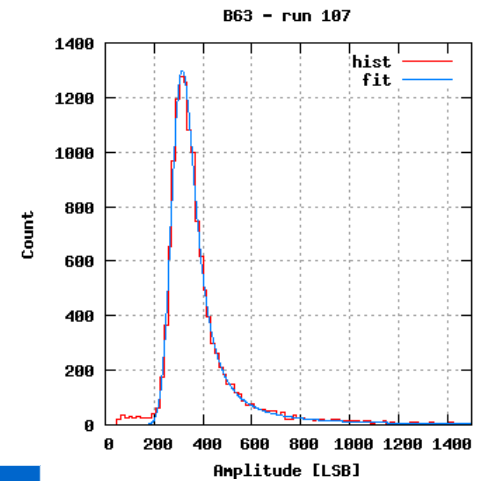
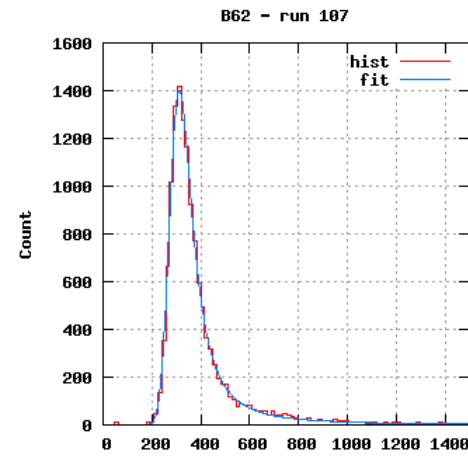
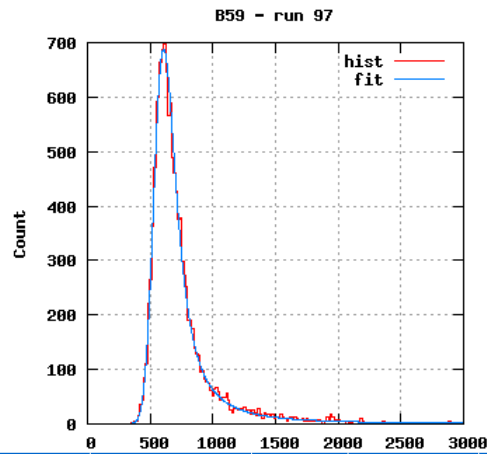
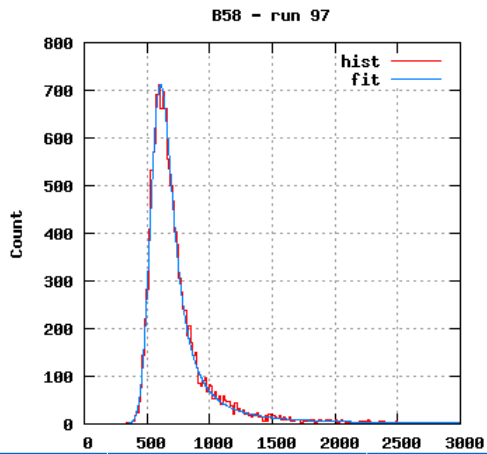
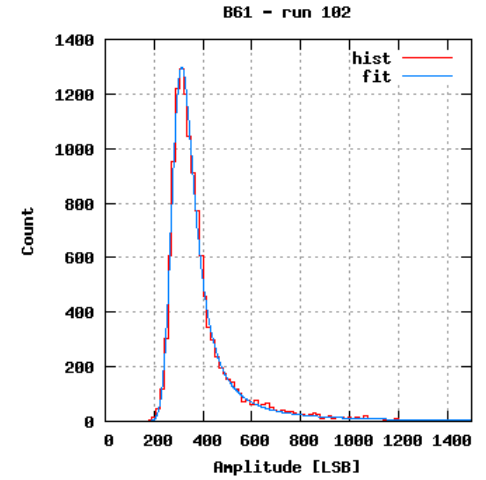
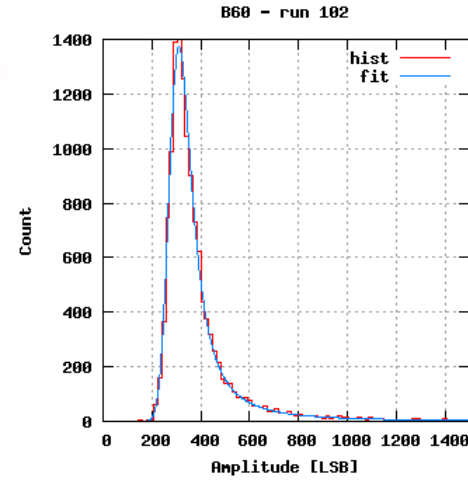
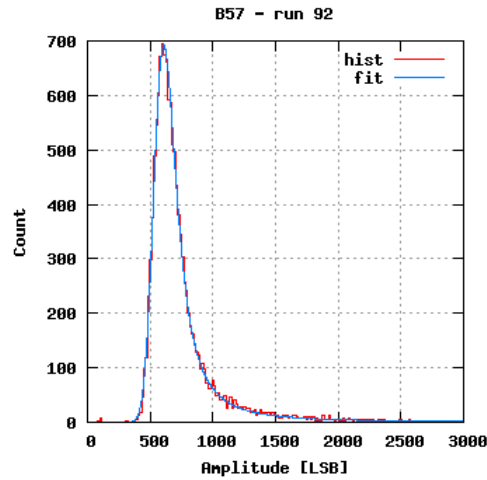
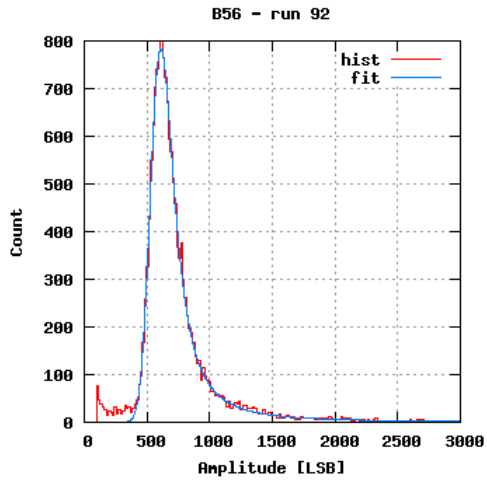


- X-Y table control software (written by Sandro)
- DESY ADC DAQ program modified to support our ADC (ask Szymon for details)
- Temperature monitoring software
- Telescope DAQ
  - [http://www.desy.de/~gregor/MVD\\_Telescope/](http://www.desy.de/~gregor/MVD_Telescope/)  
short\_intro.html (for reference)

# Beam positions



# Calibration signals

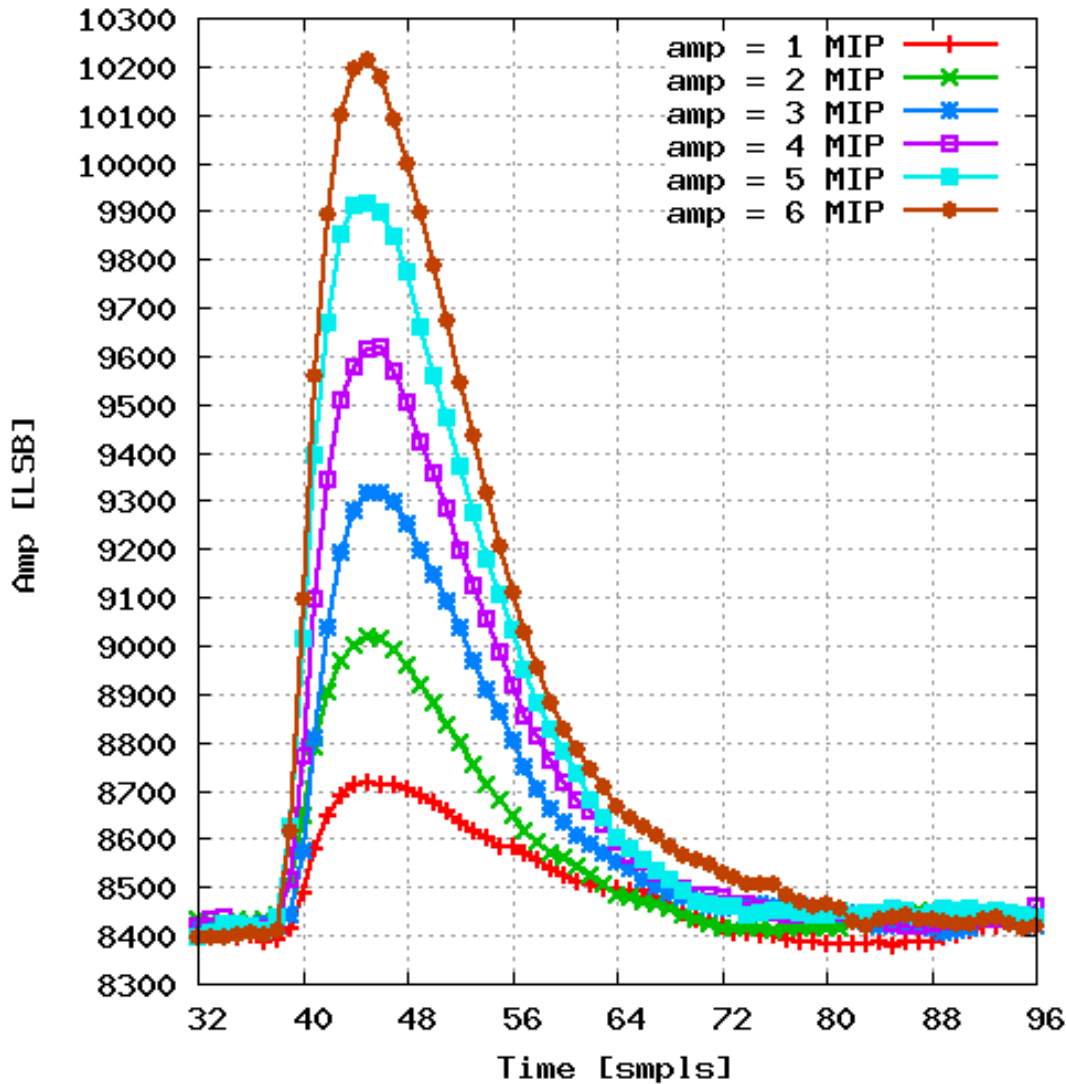


pad	rms baseline	landau mpv	SNR	pad	rms baseline	landau mpv	SNR
0	33.2	588.7	17.7	4	16.7	300.5	18
1	31.2	586.9	18.8	5	17.1	303.8	17.8
2	31.5	588.4	18.7	6	17.2	302.4	17.5
3	31.4	587.5	18.7	7	18.4	303.6	16.5

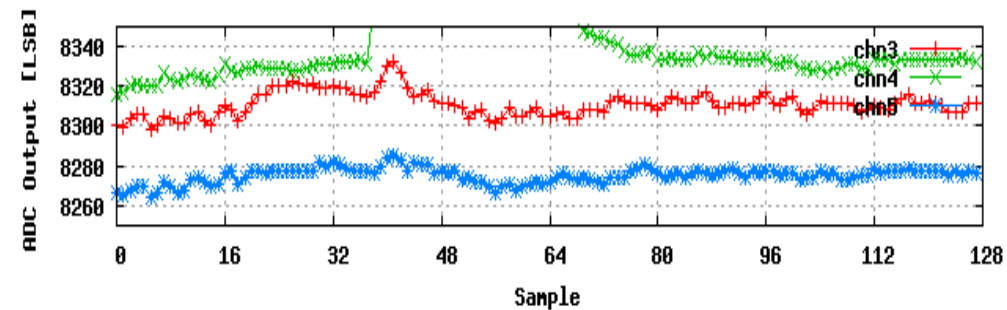
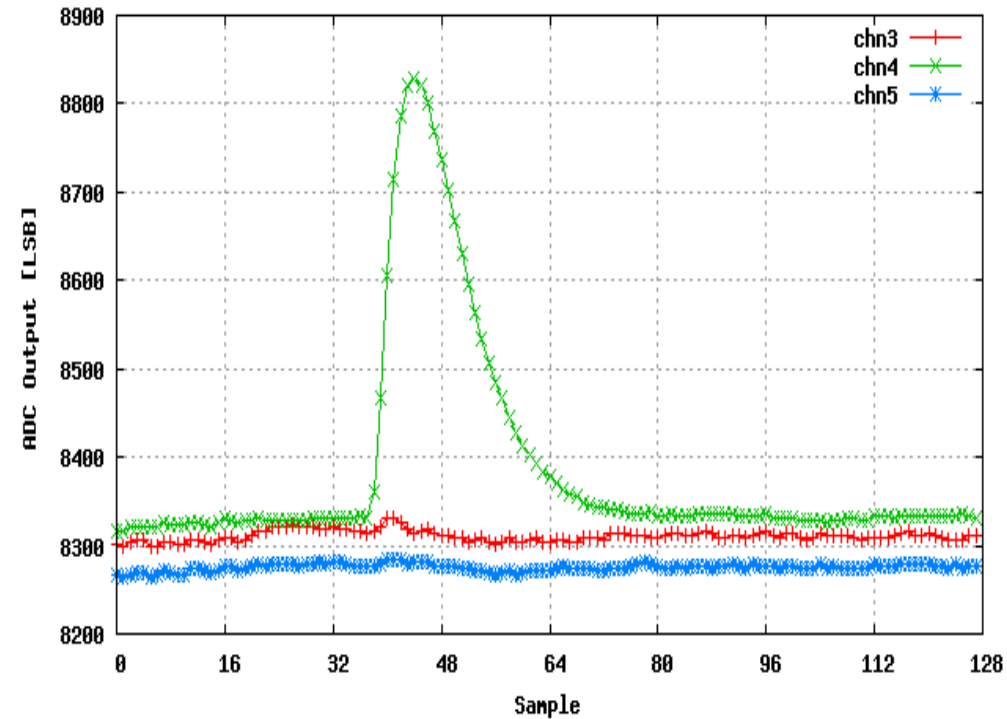
Units:  
ADC LSB



# Timing



Time response of single front-end channel



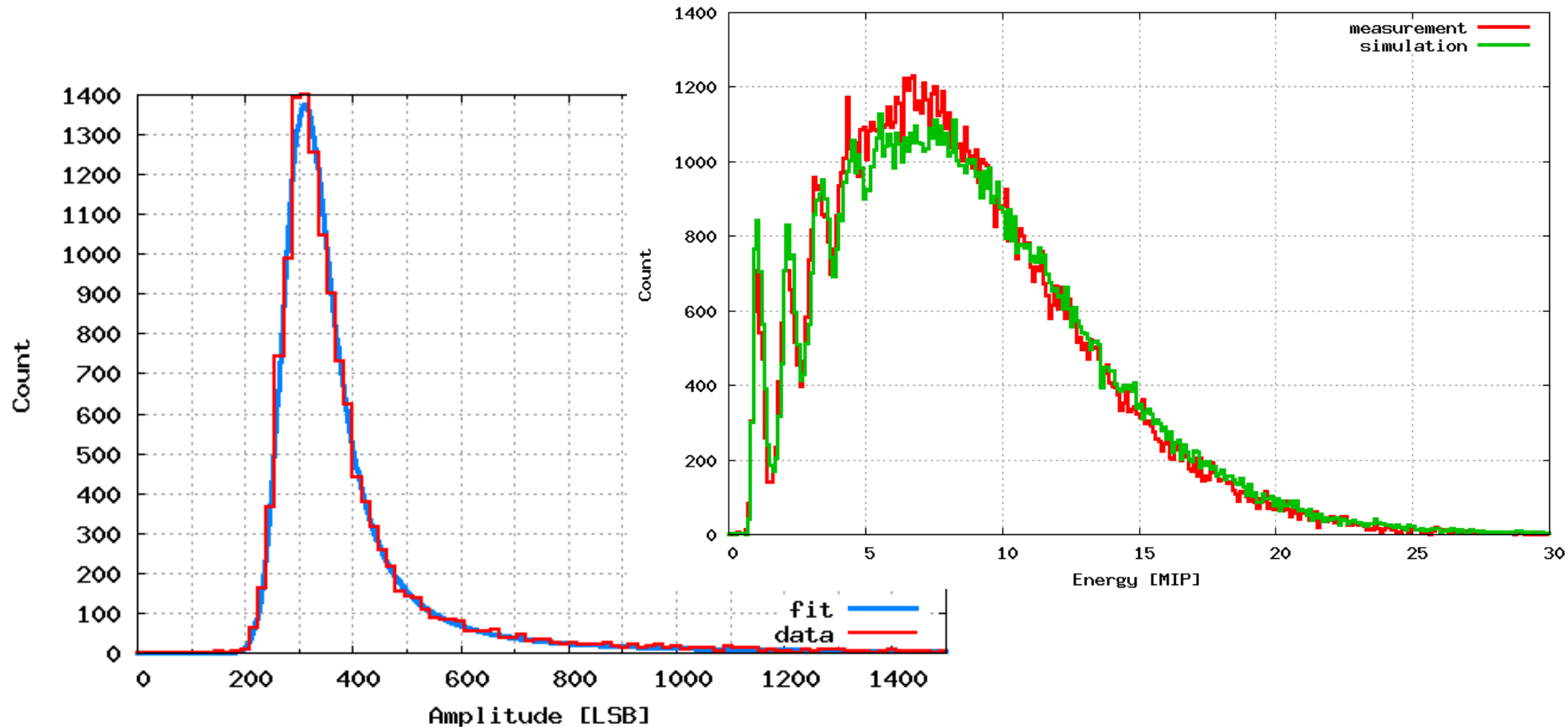
Neighboring signals

# Amplitude



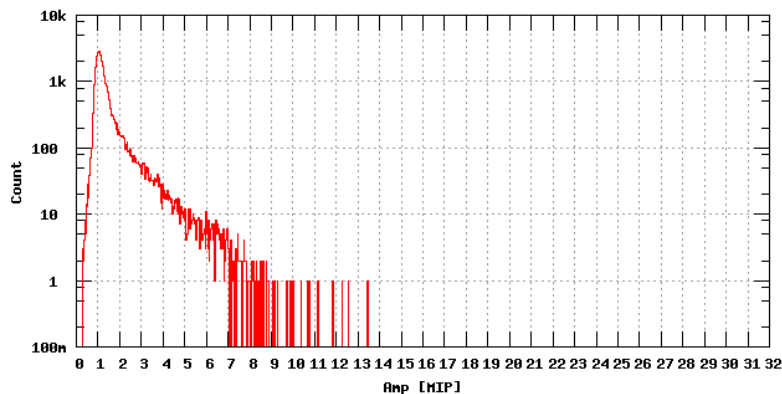
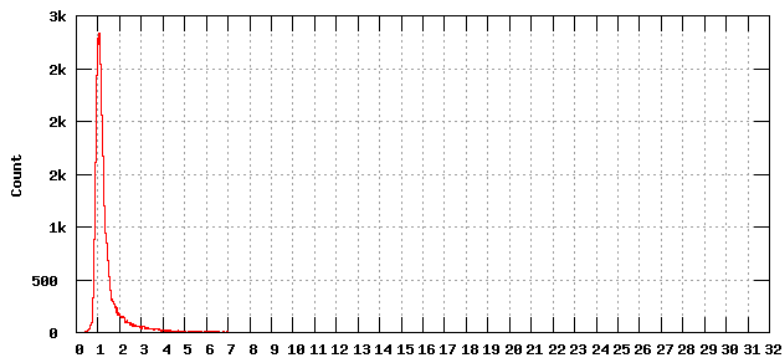
Measurement (red) versus simulation (green) for 2 X0, sum over all channels

Energy deposition in single channel fits  
Landau distribution

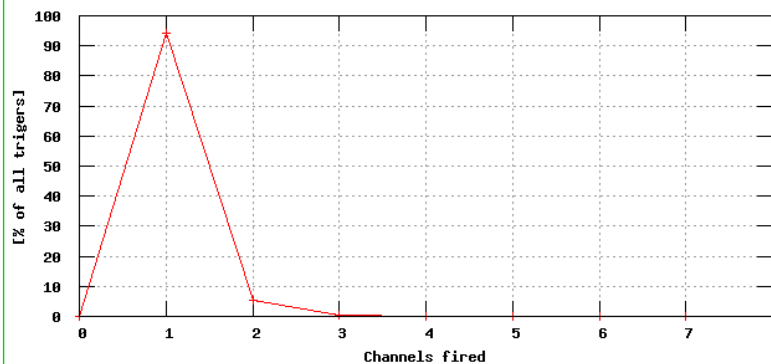


# 0 at

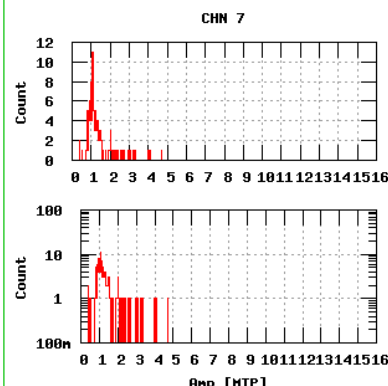
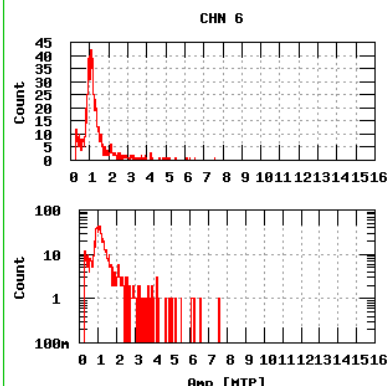
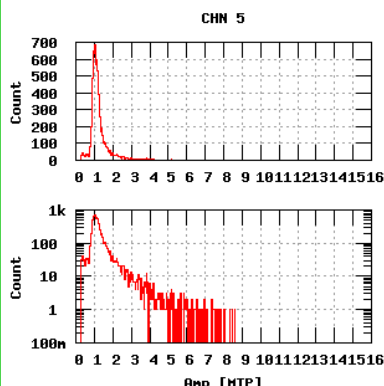
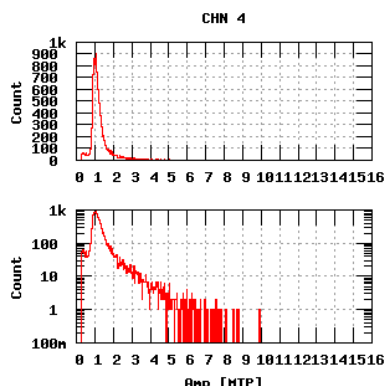
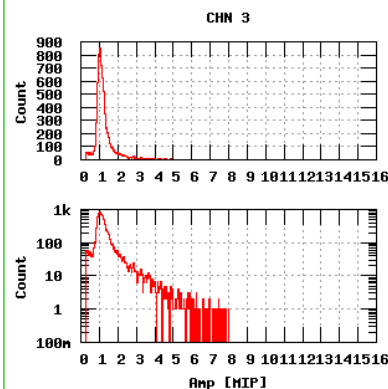
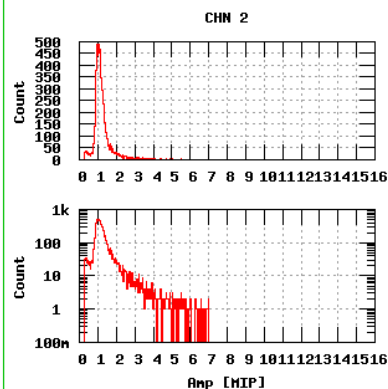
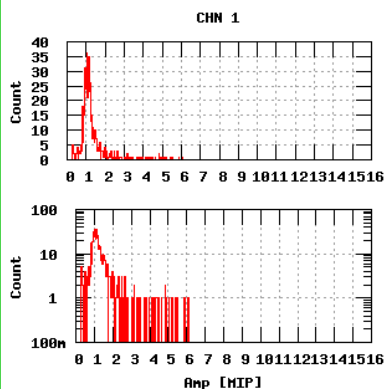
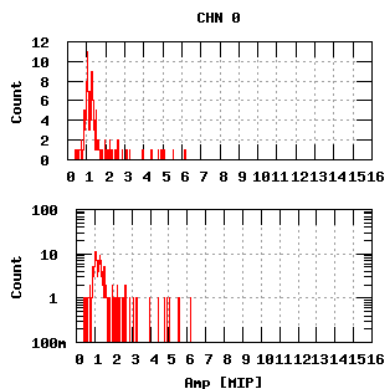
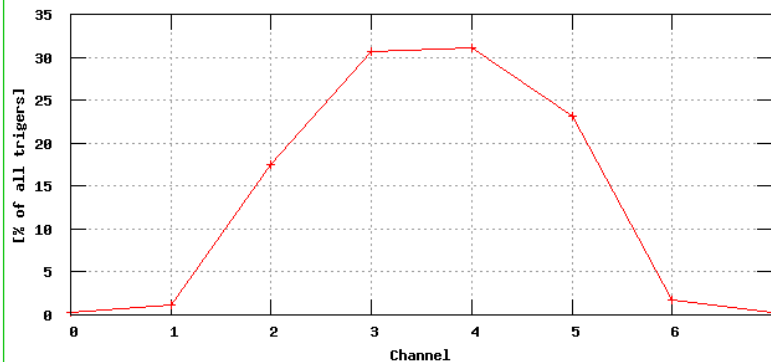
SUM (over 8 channels)



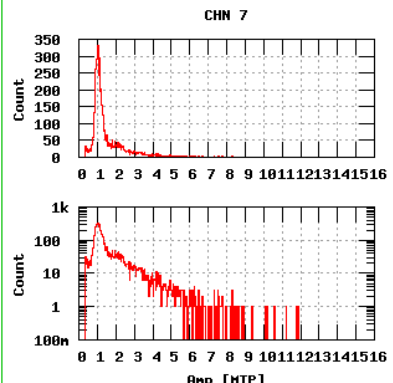
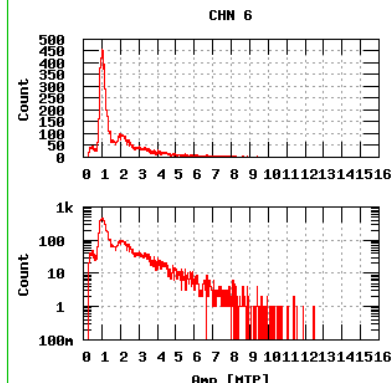
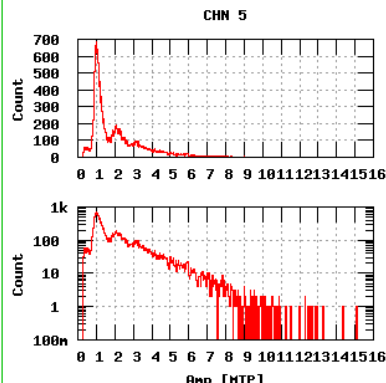
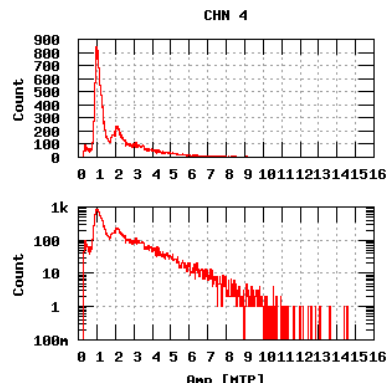
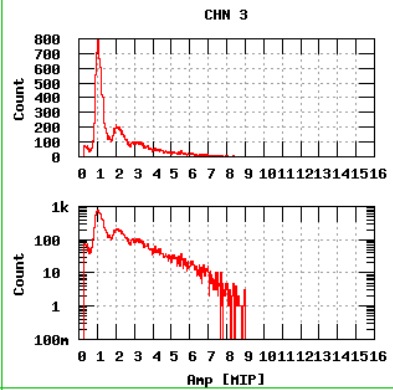
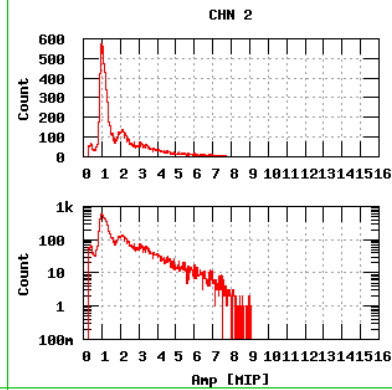
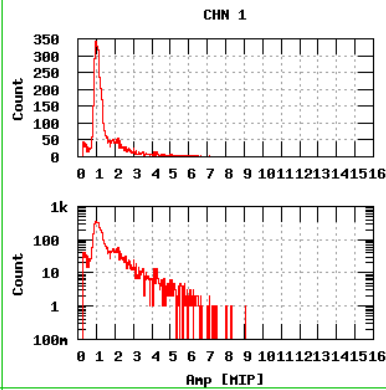
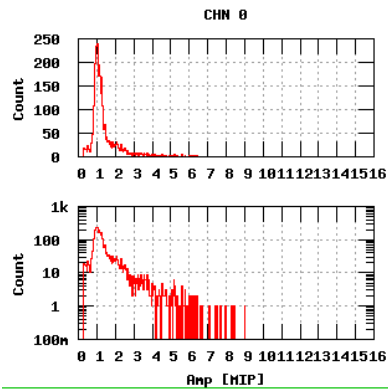
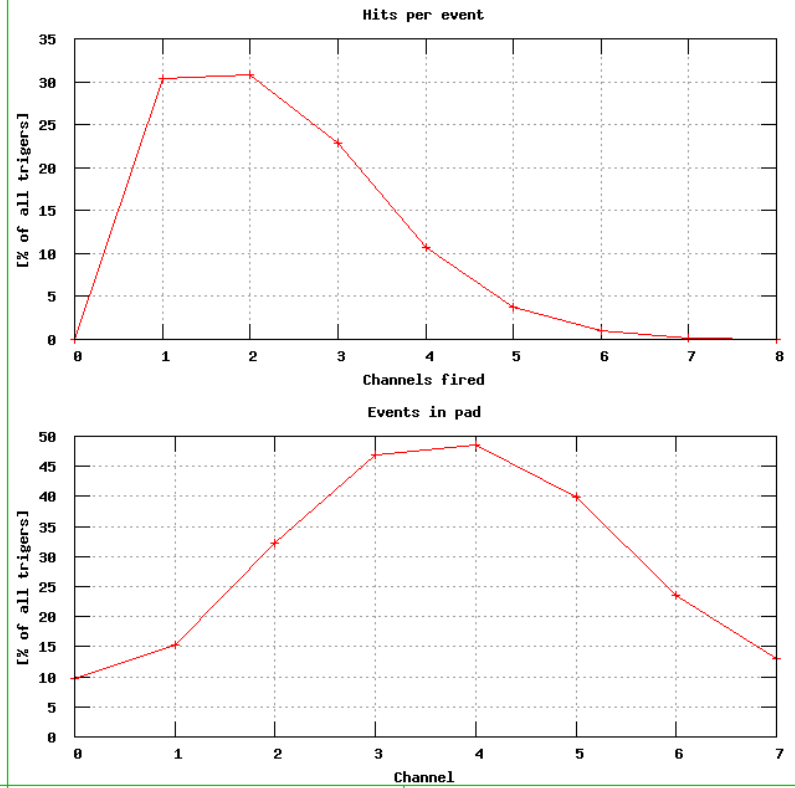
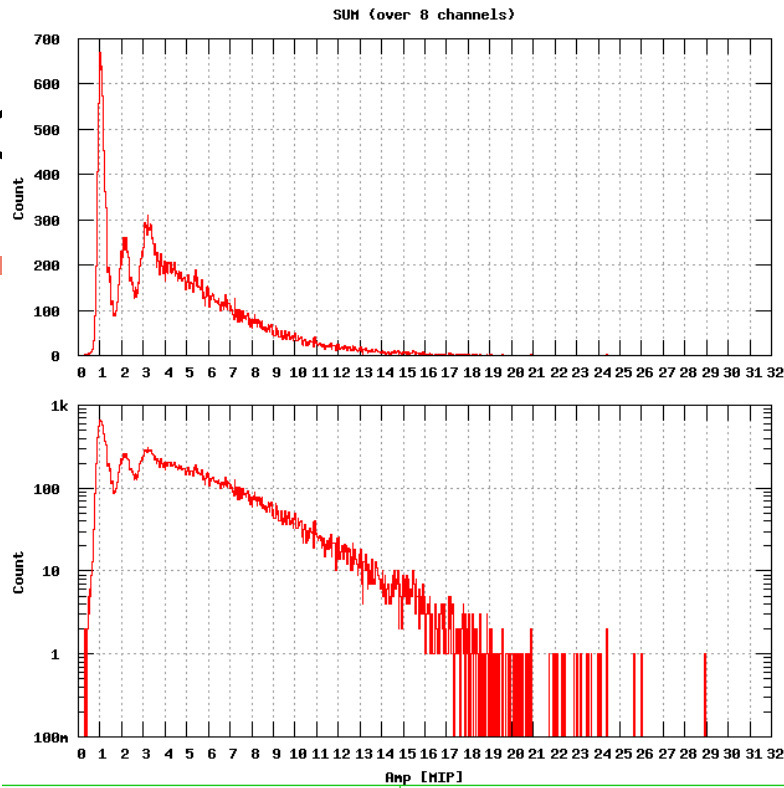
Hits per event



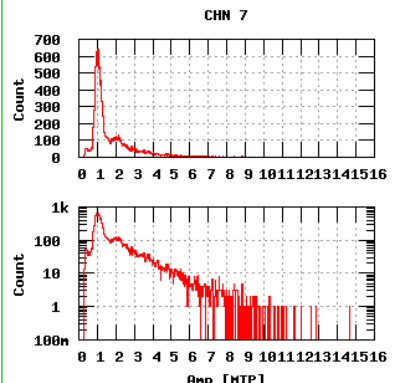
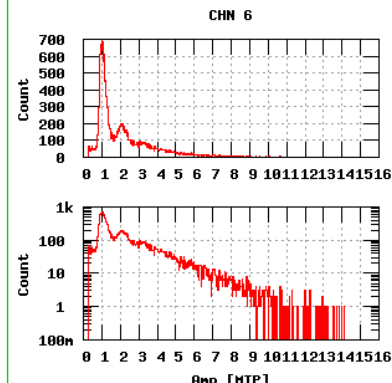
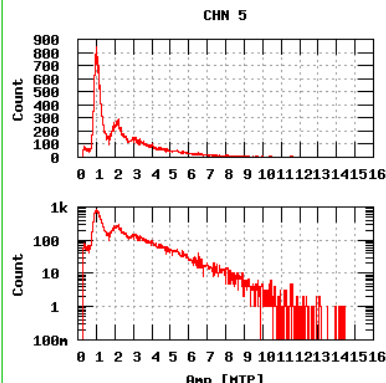
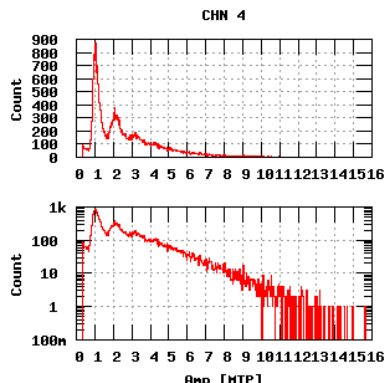
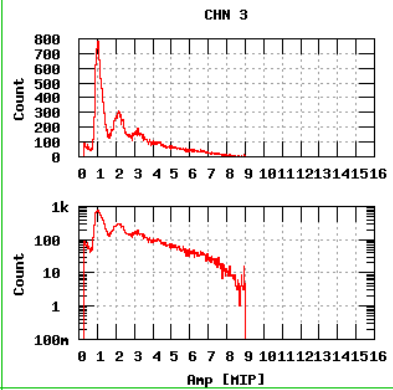
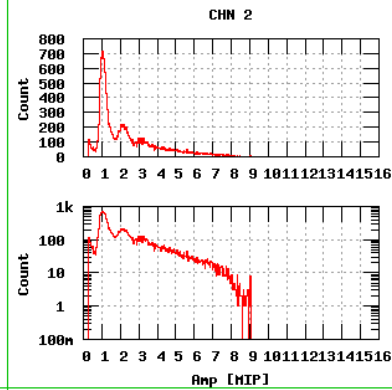
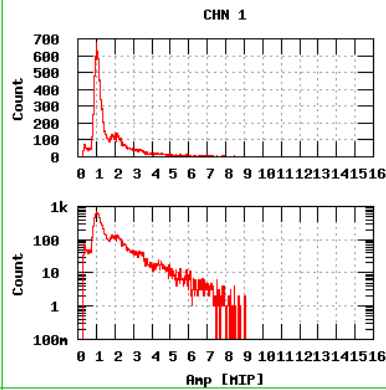
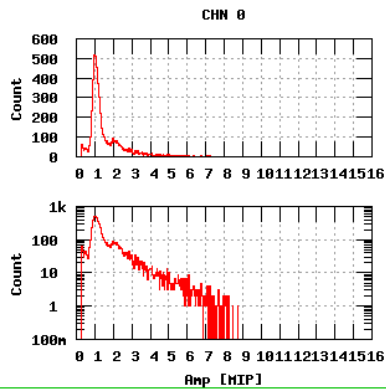
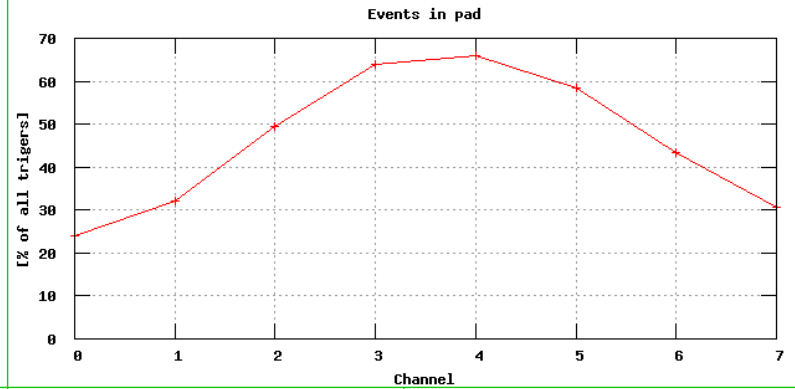
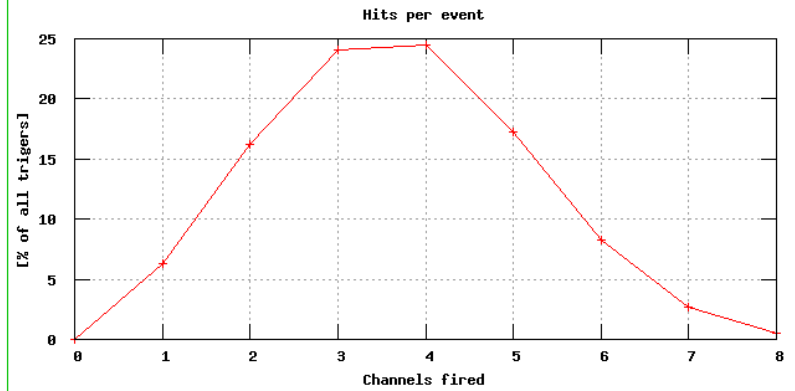
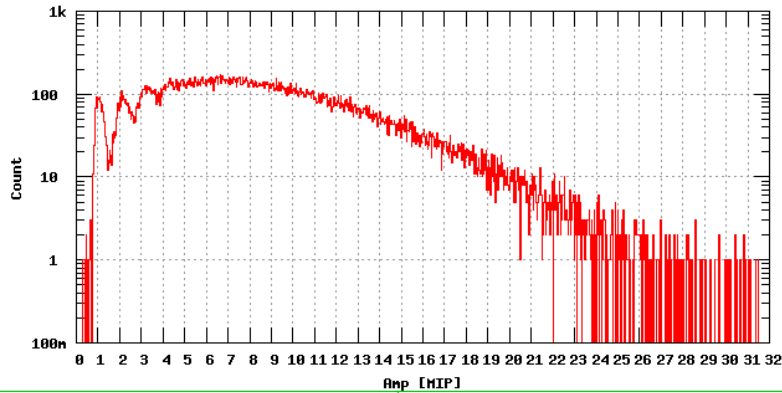
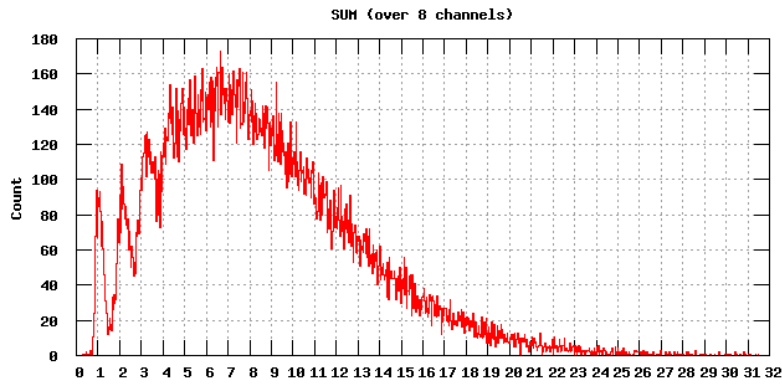
Events in pad



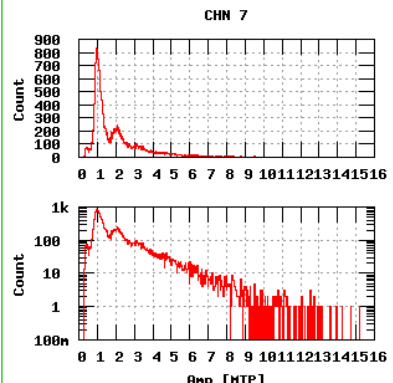
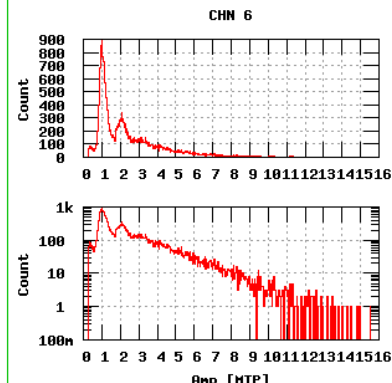
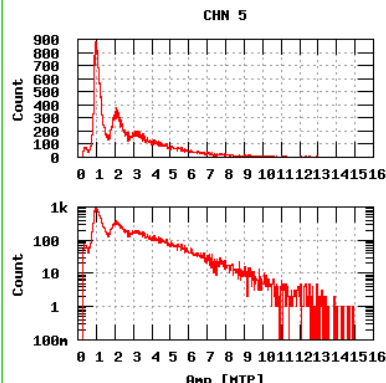
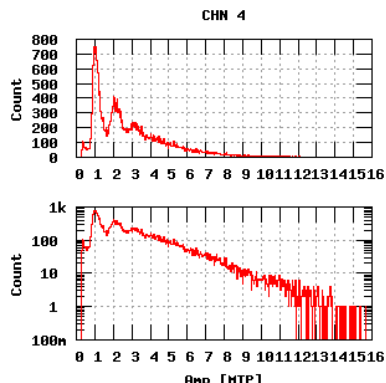
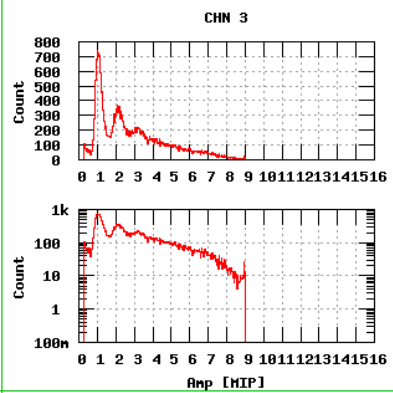
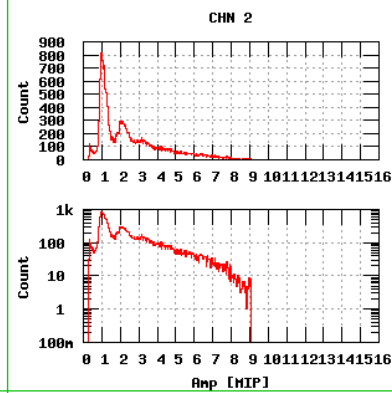
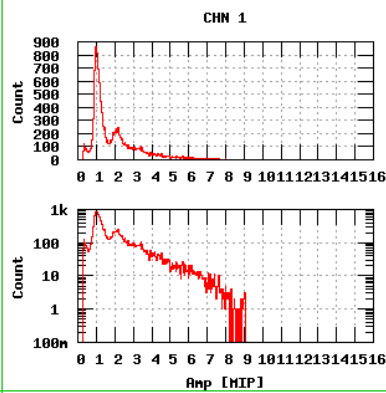
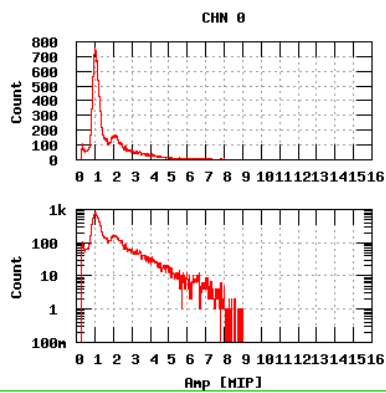
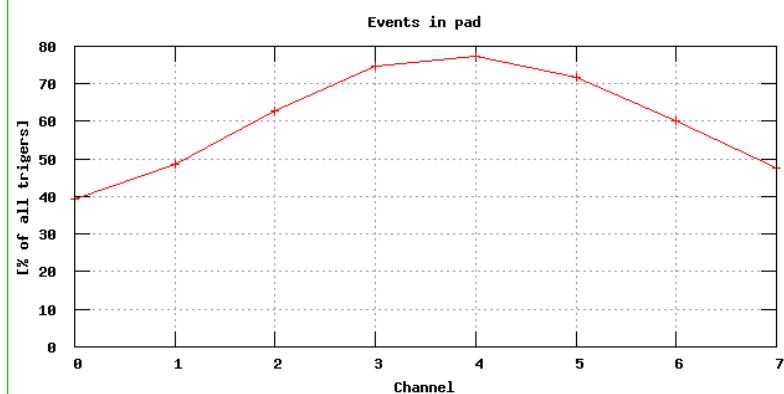
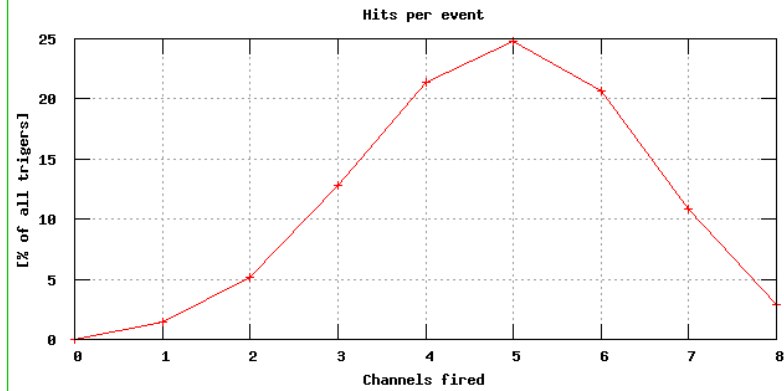
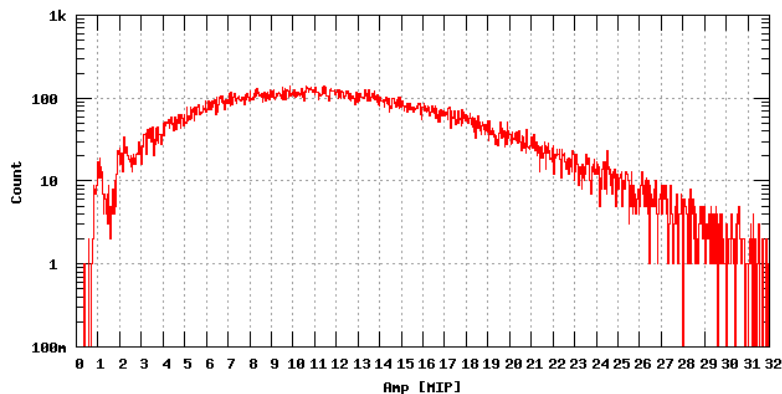
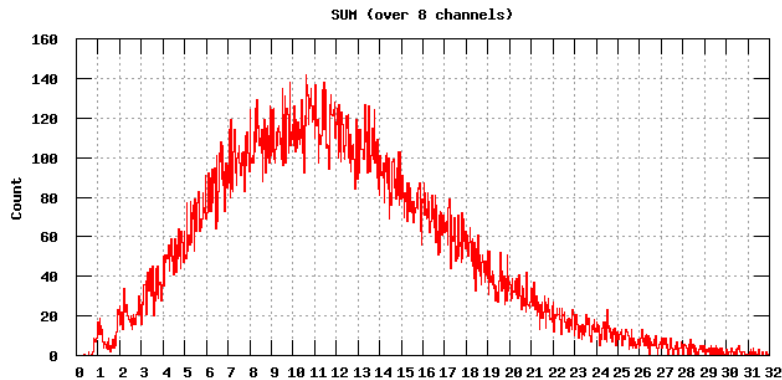
# 1 at



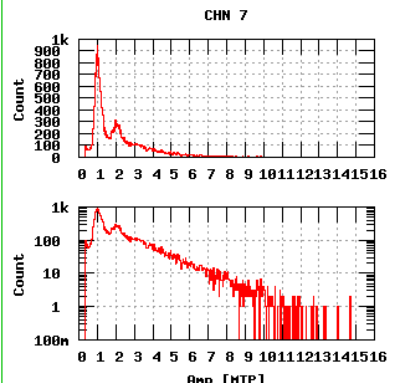
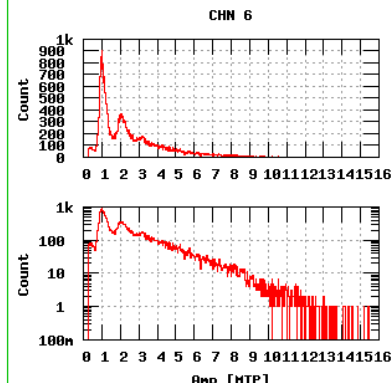
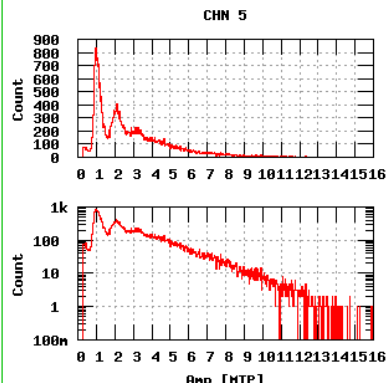
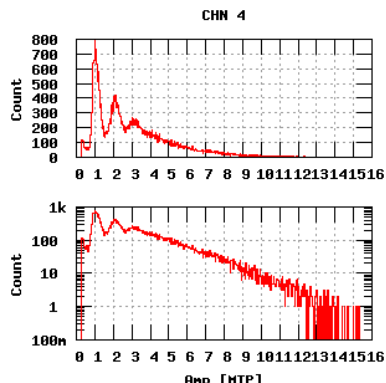
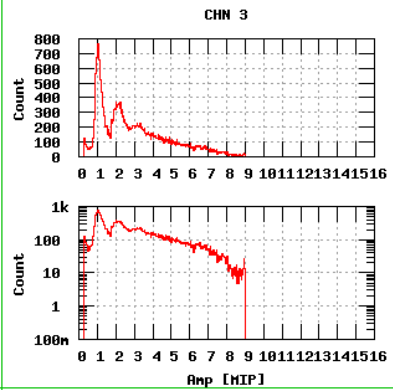
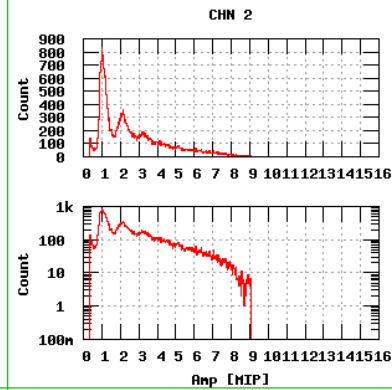
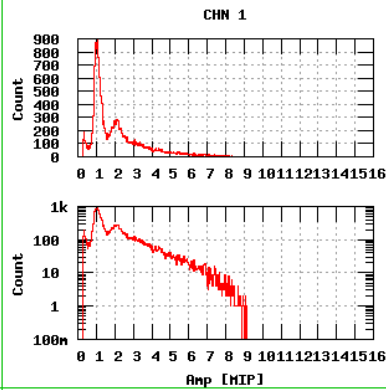
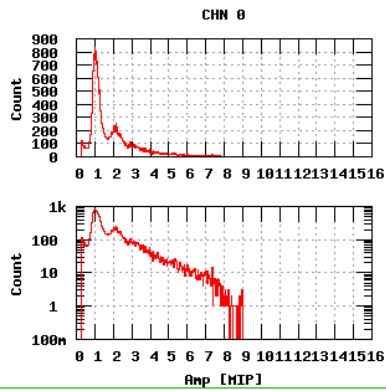
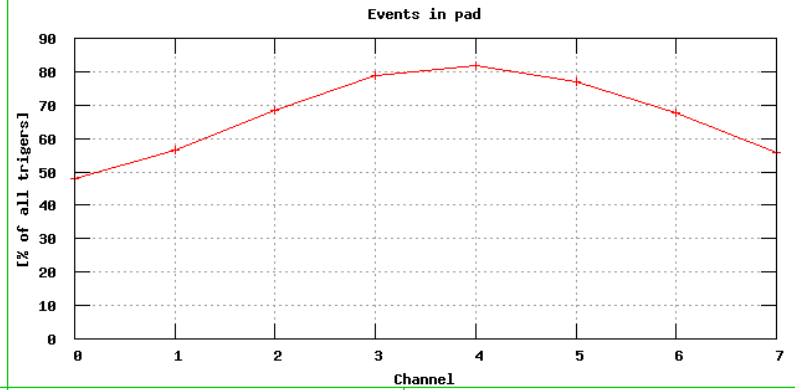
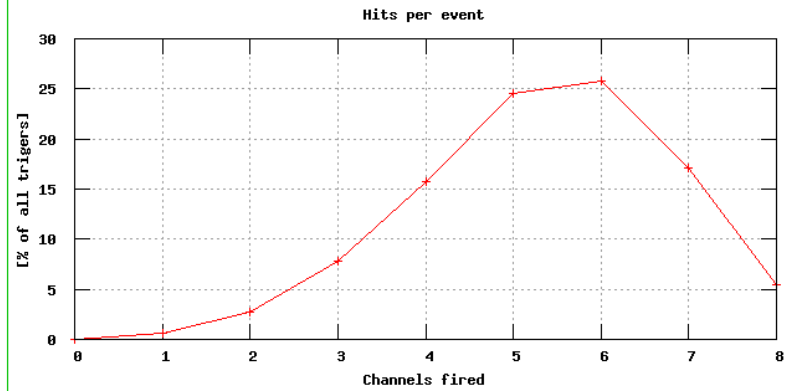
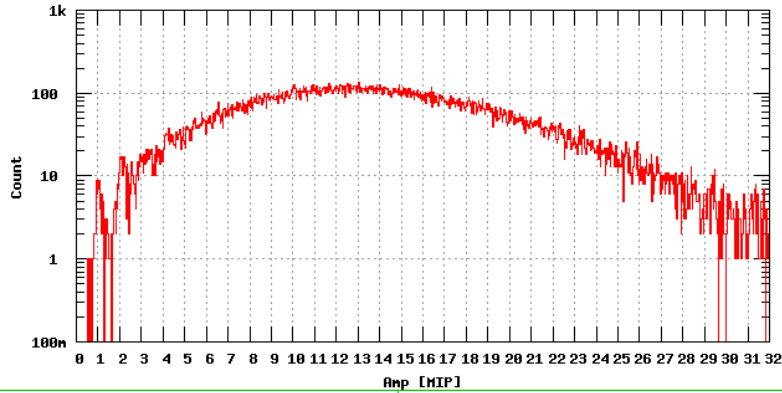
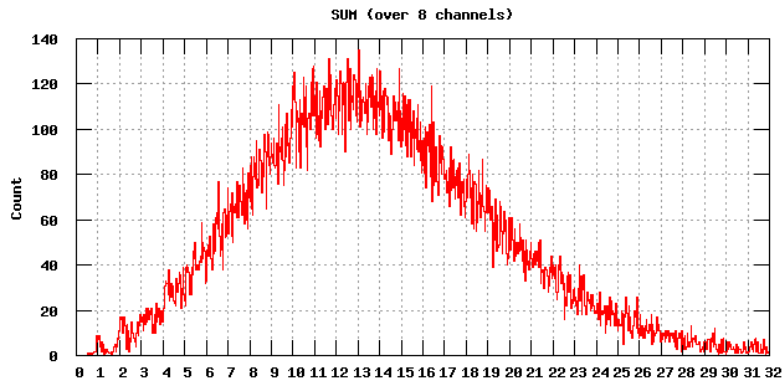
# 2 at



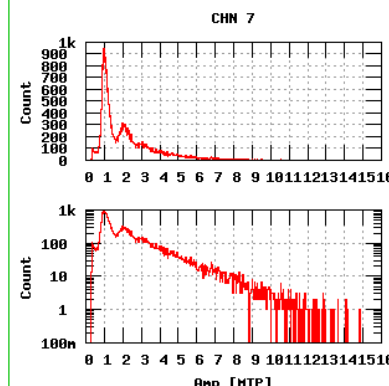
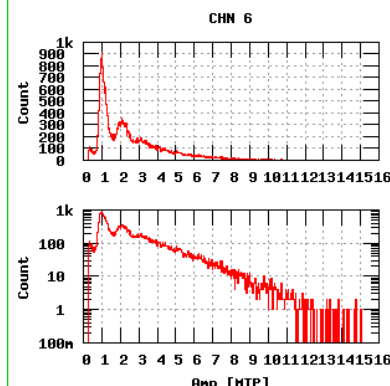
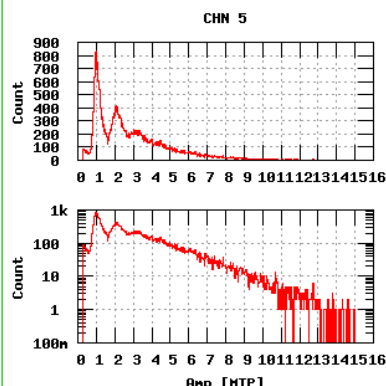
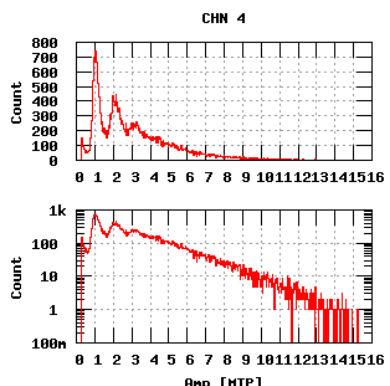
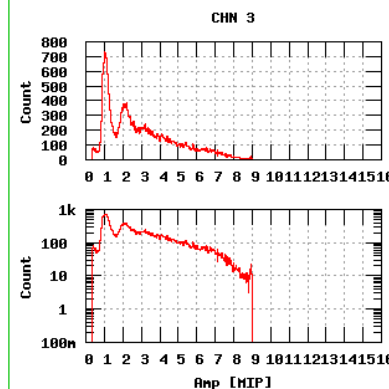
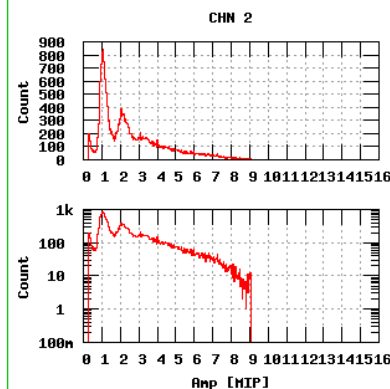
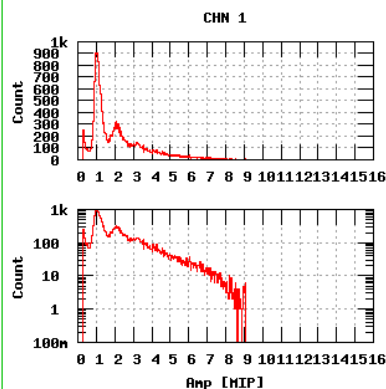
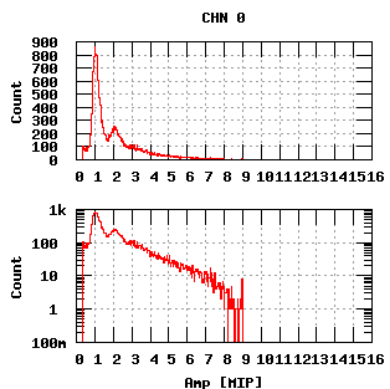
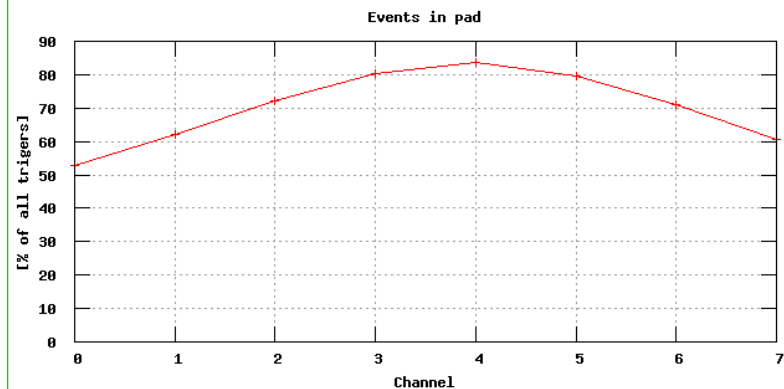
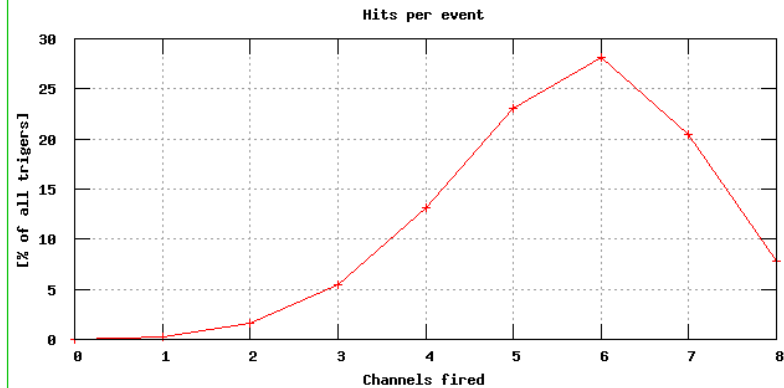
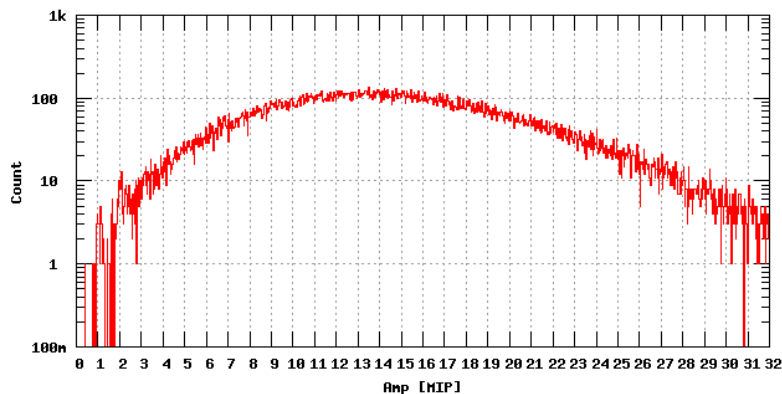
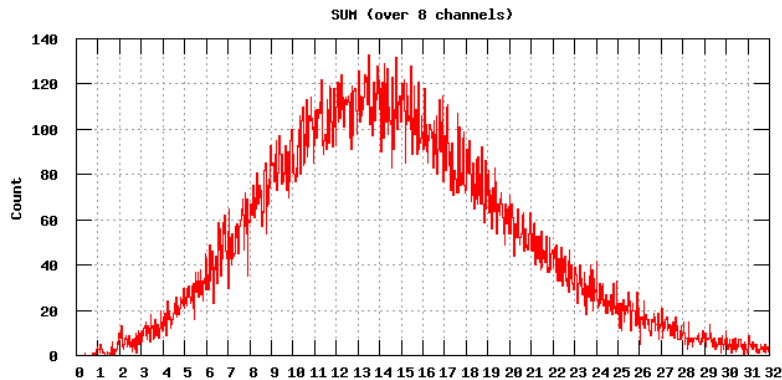
# 3 at



# 4 at

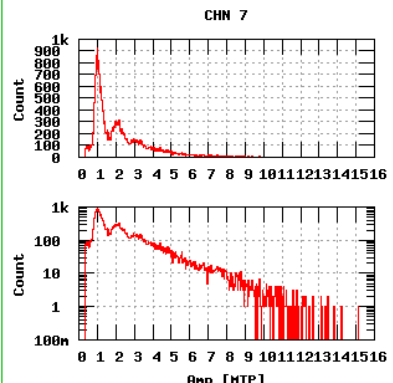
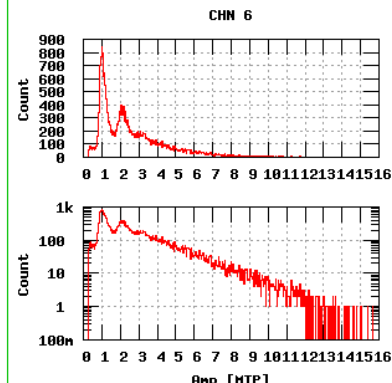
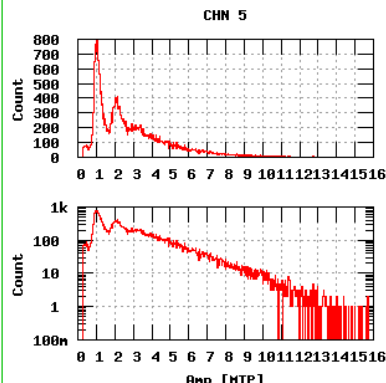
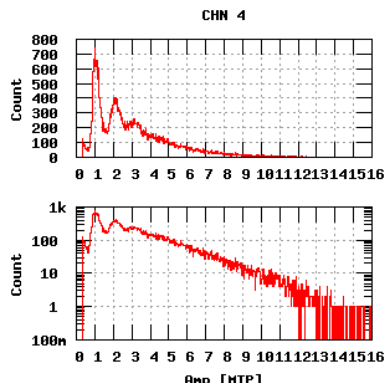
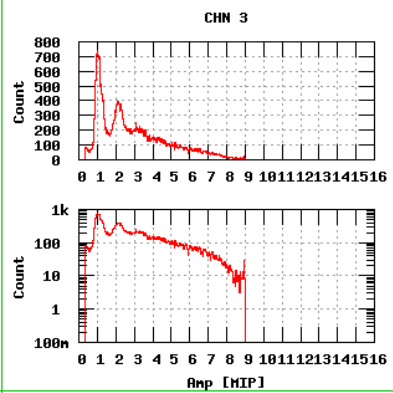
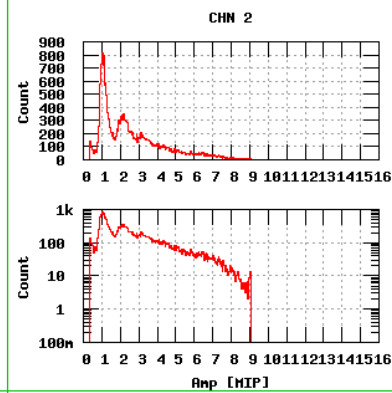
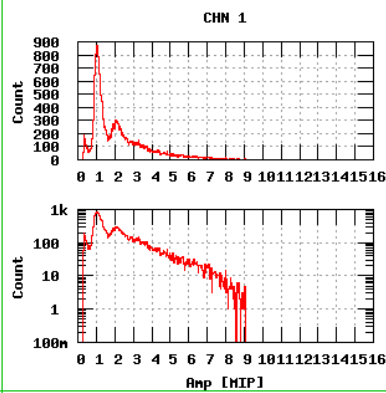
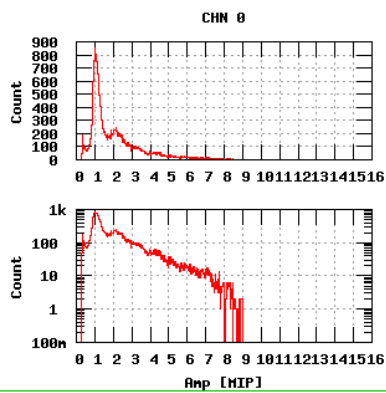
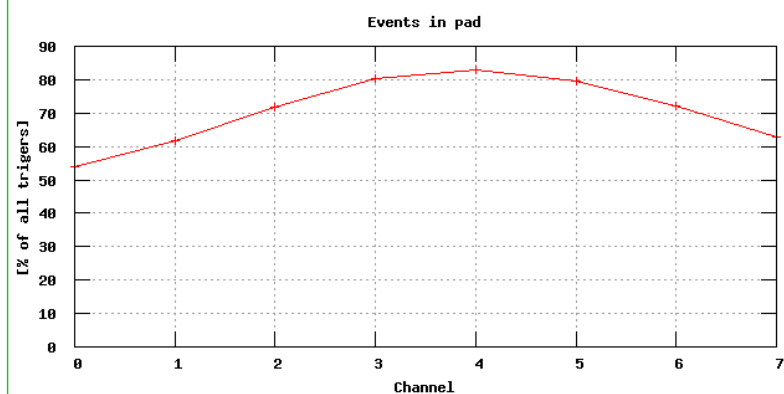
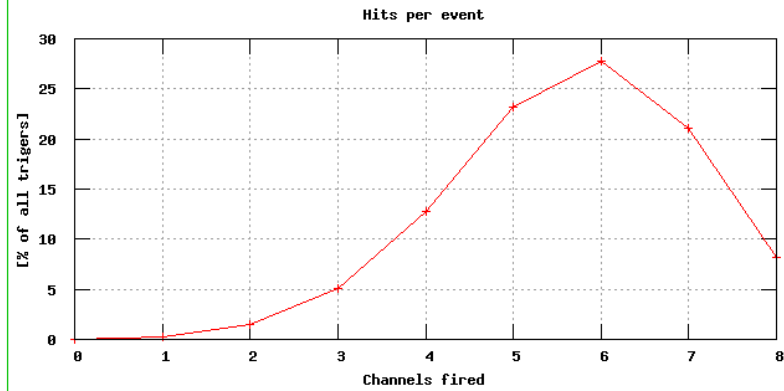
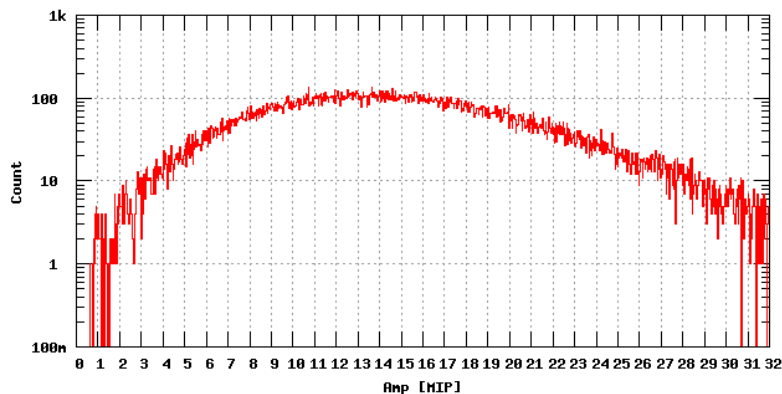
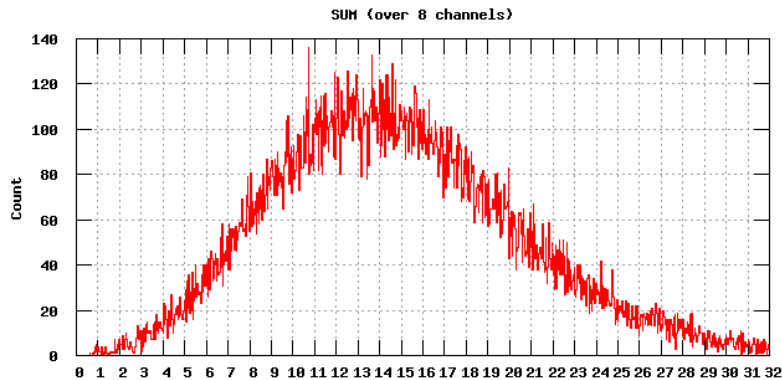


# 5 at

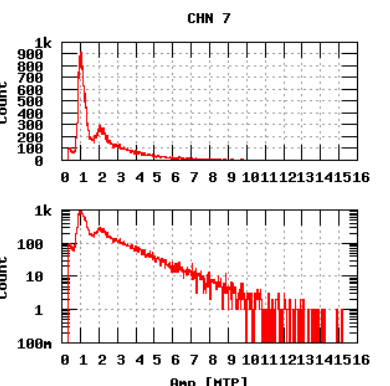
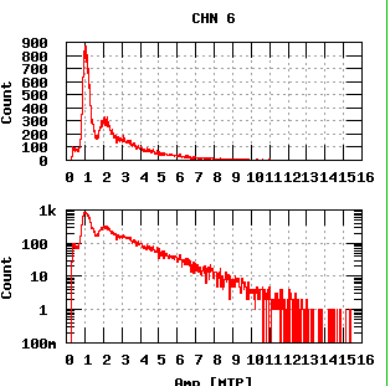
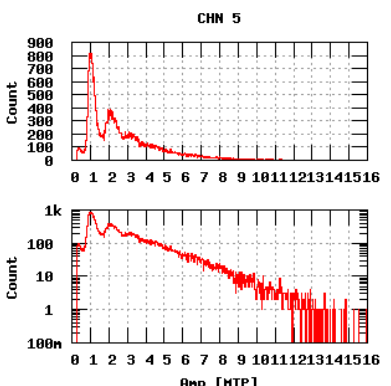
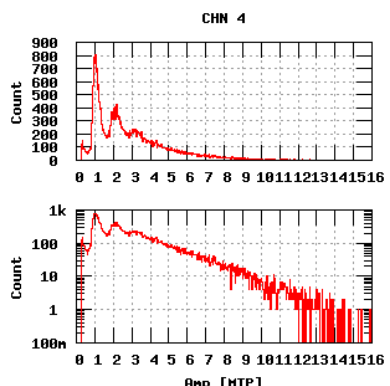
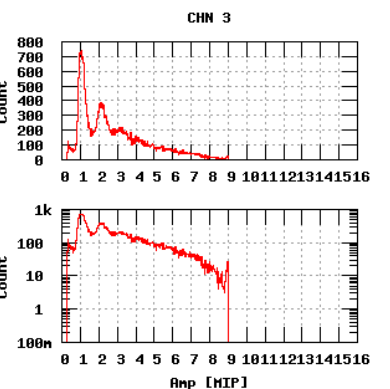
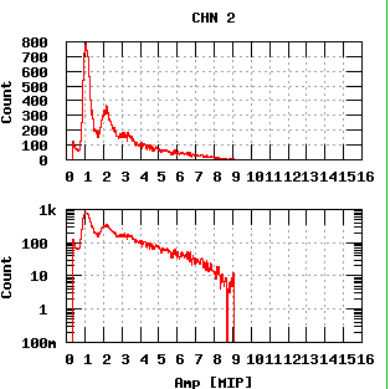
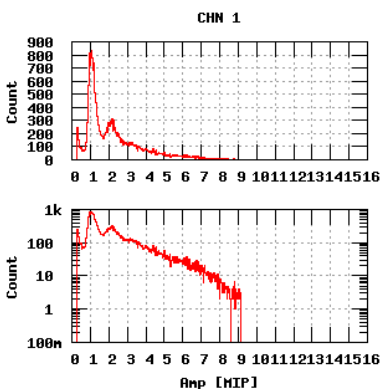
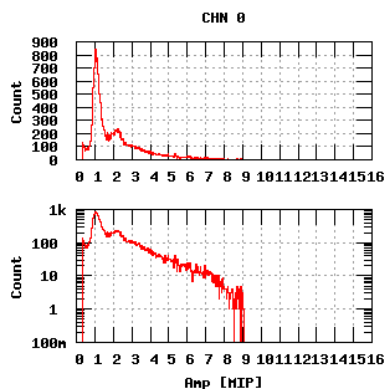
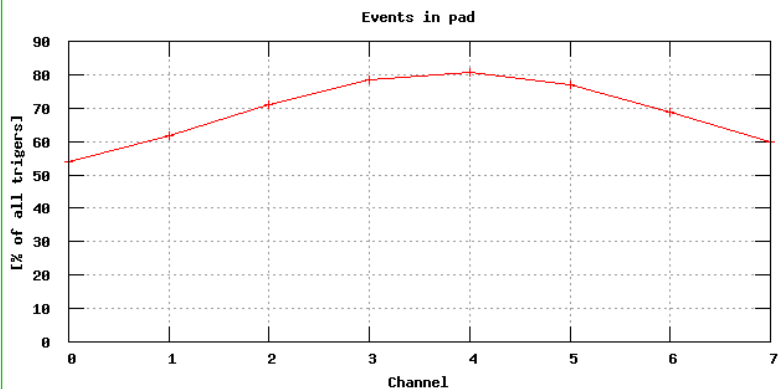
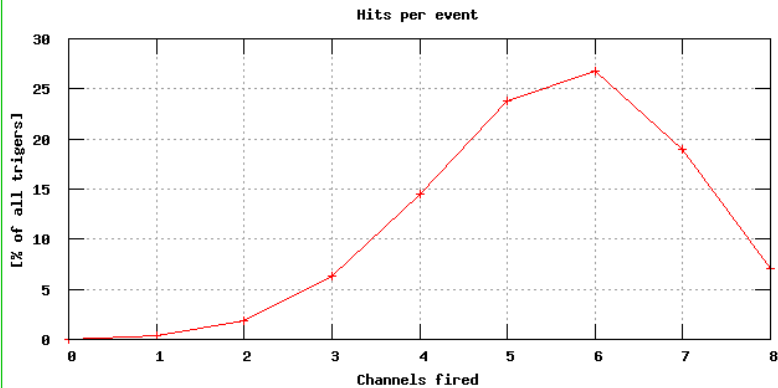
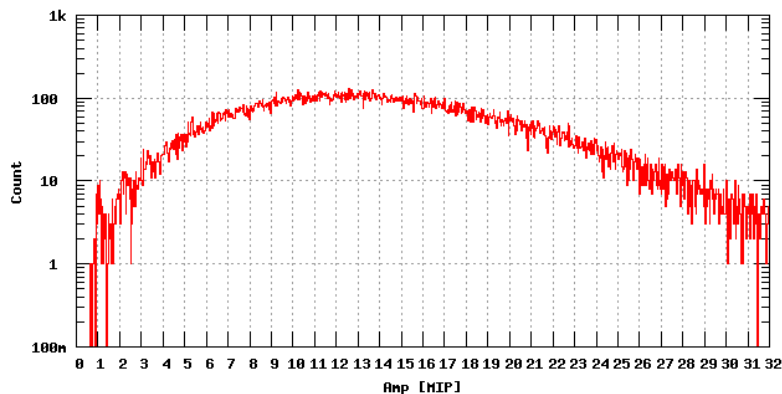
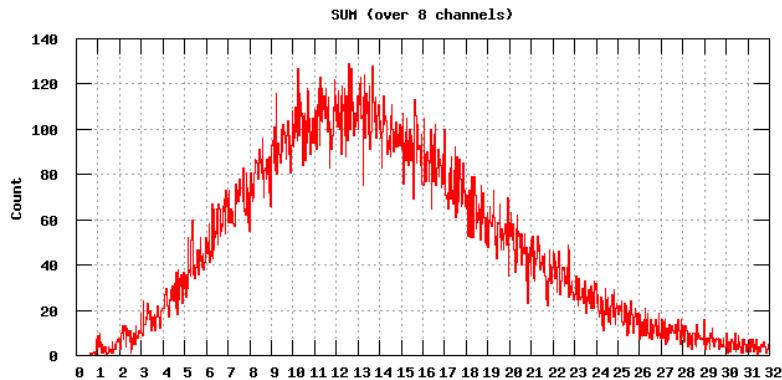




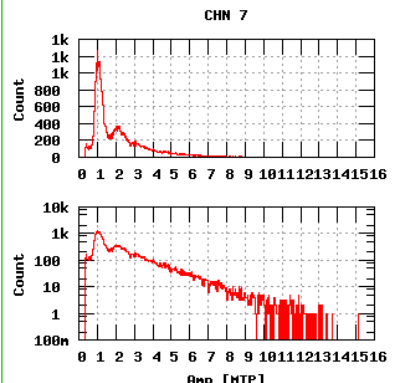
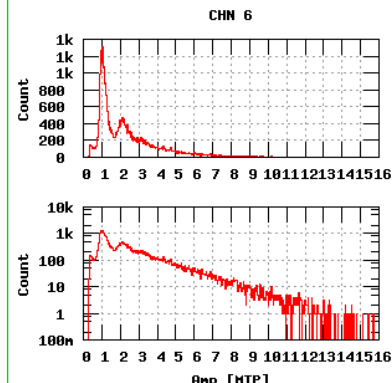
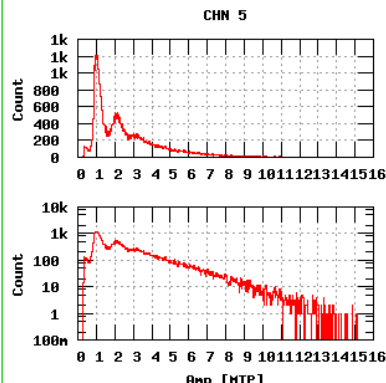
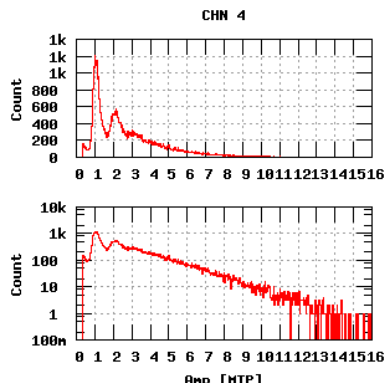
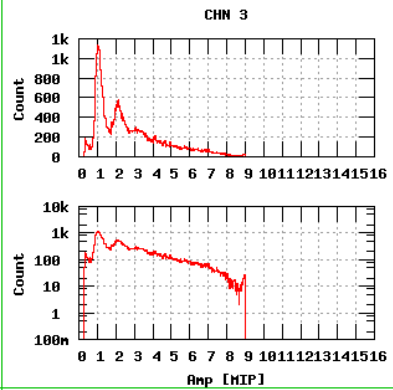
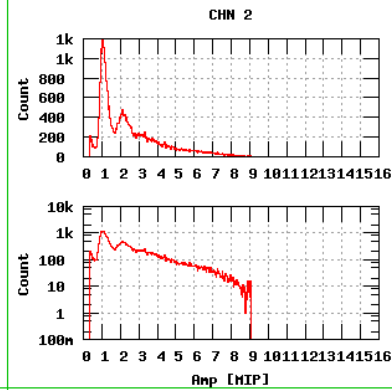
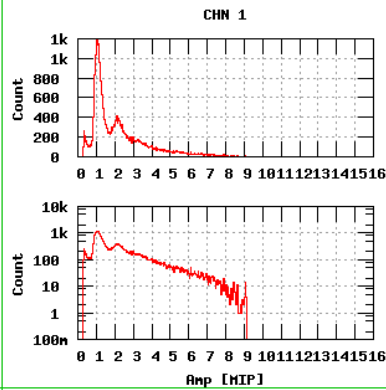
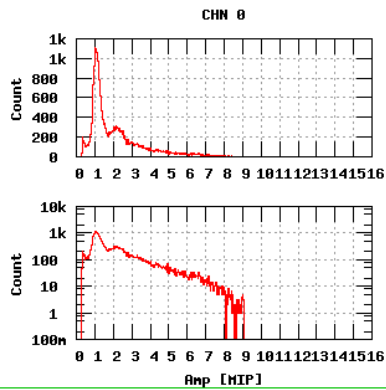
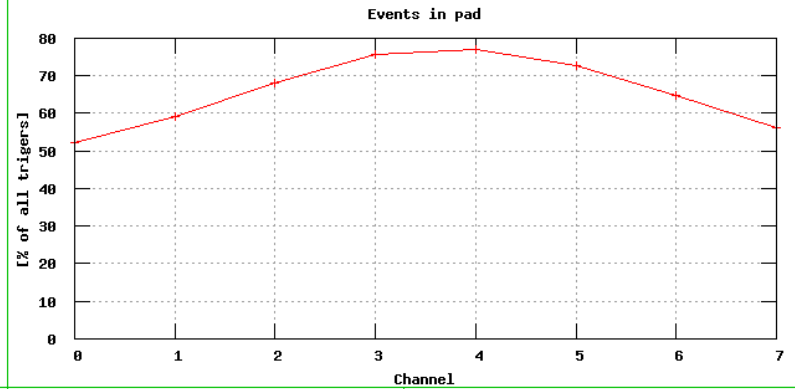
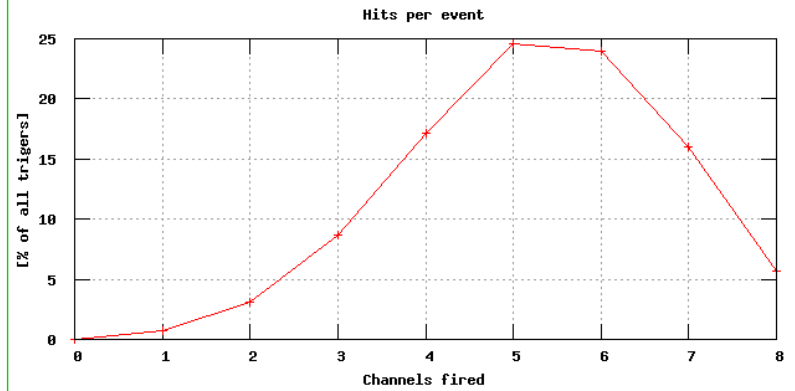
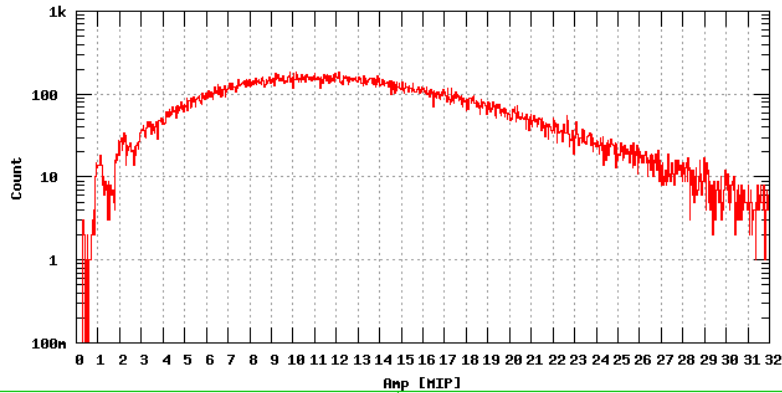
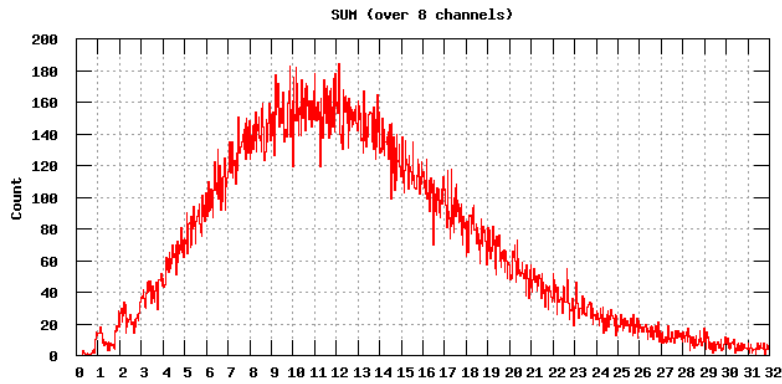
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# 7 at

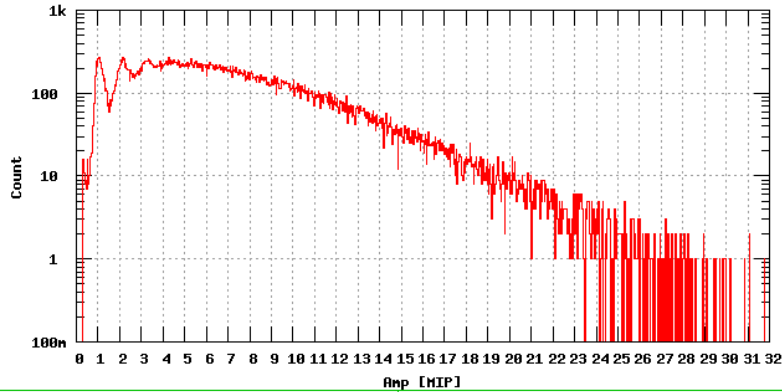
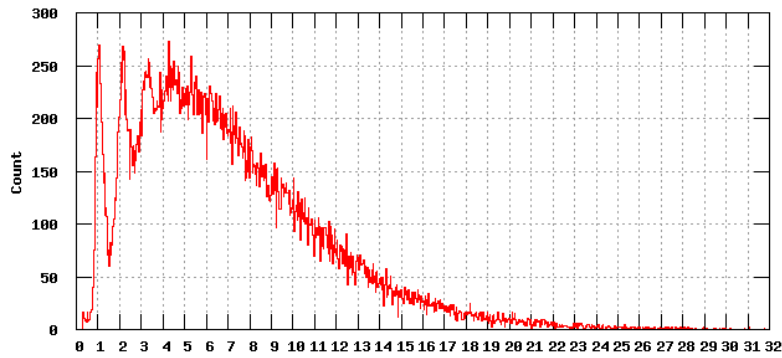


# 8 at

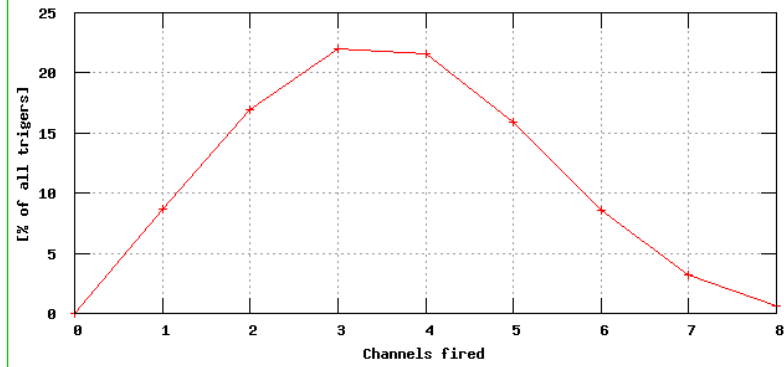


# 10

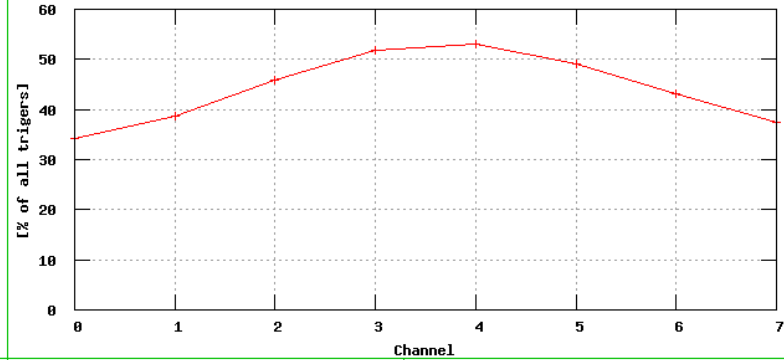
SUM (over 8 channels)



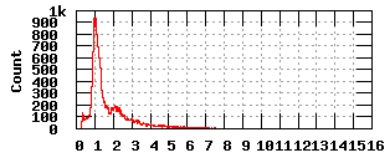
Hits per event



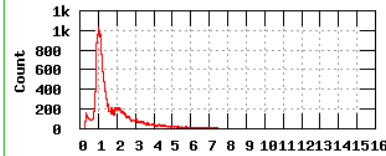
Events in pad



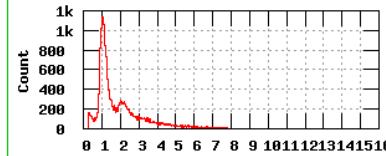
CHN 0



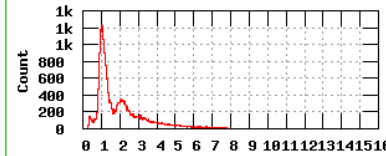
CHN 1



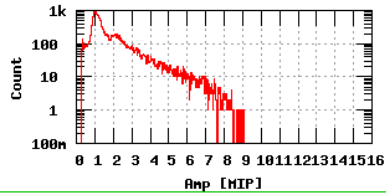
CHN 2



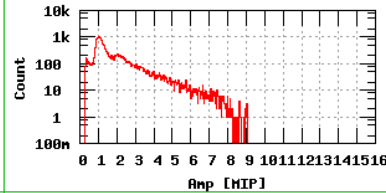
CHN 3



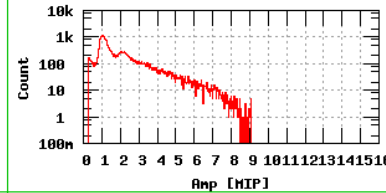
CHN 4



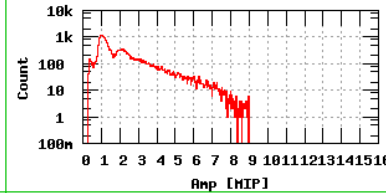
CHN 5



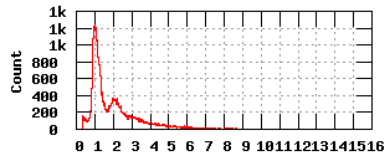
CHN 6



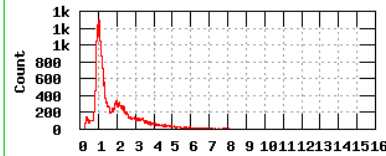
CHN 7



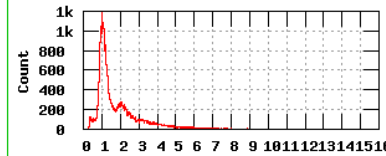
CHN 4



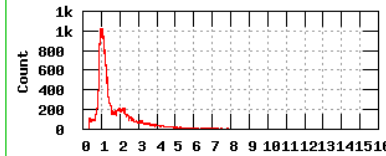
CHN 5



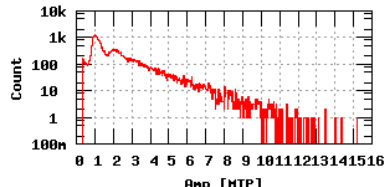
CHN 6



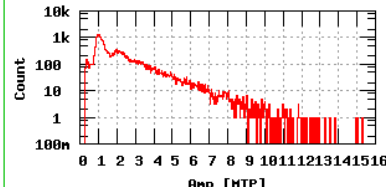
CHN 7



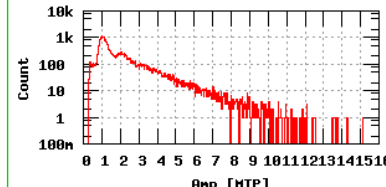
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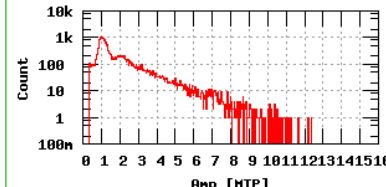
CHN 5



CHN 6

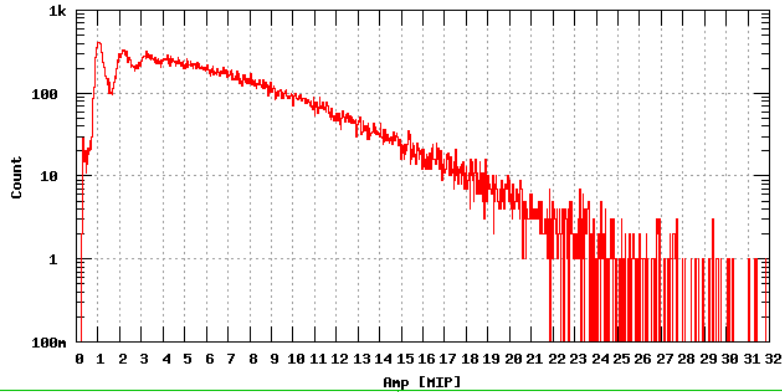
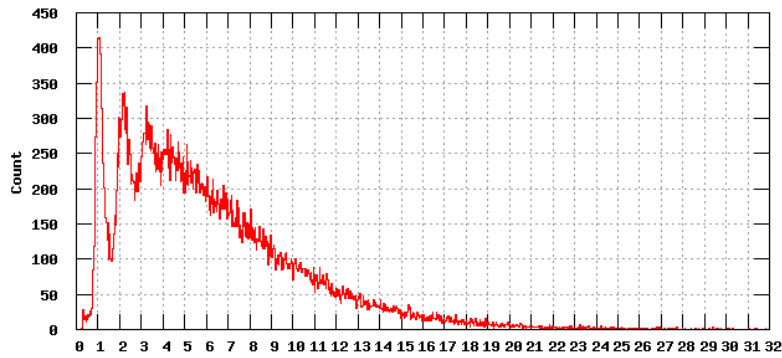


CHN 7

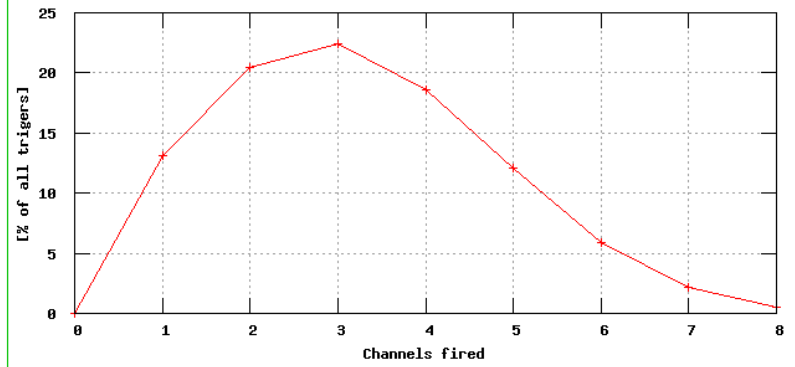


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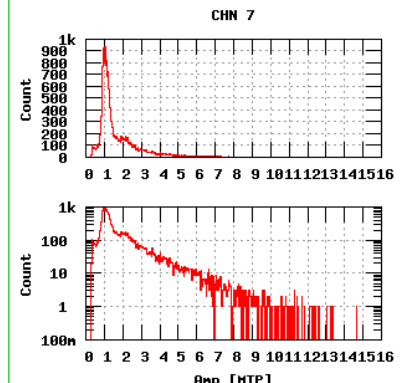
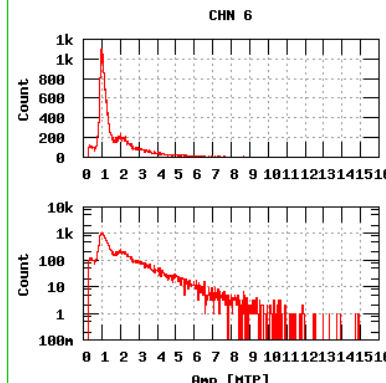
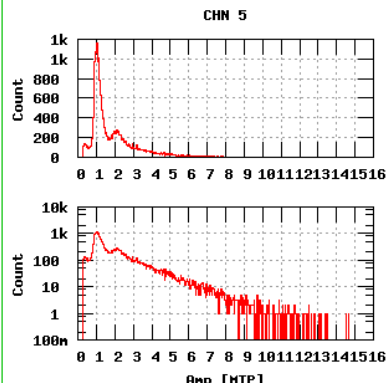
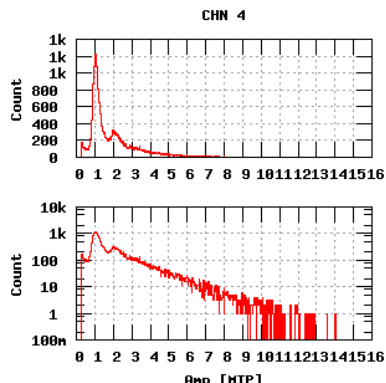
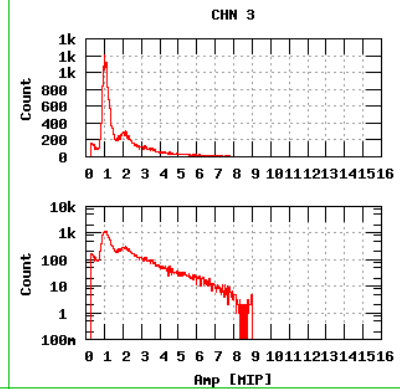
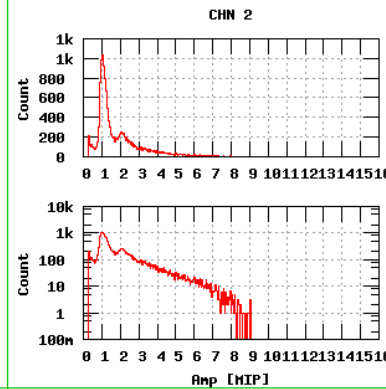
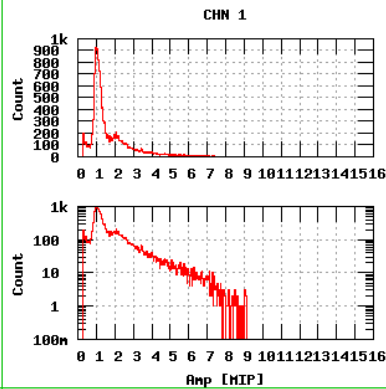
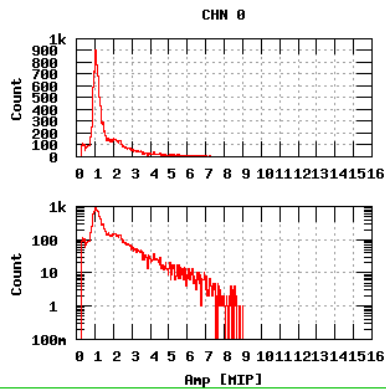
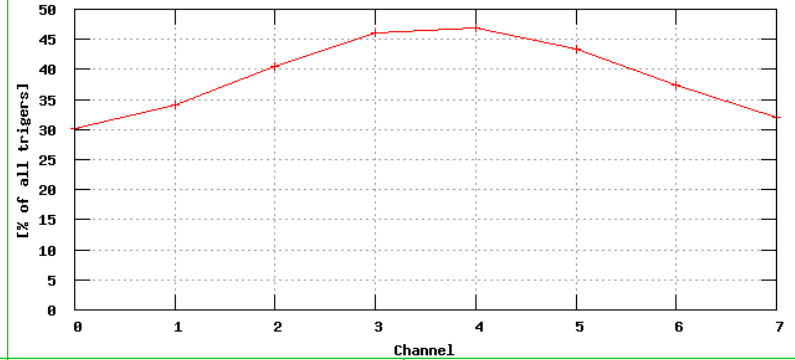
SUM (over 8 channels)



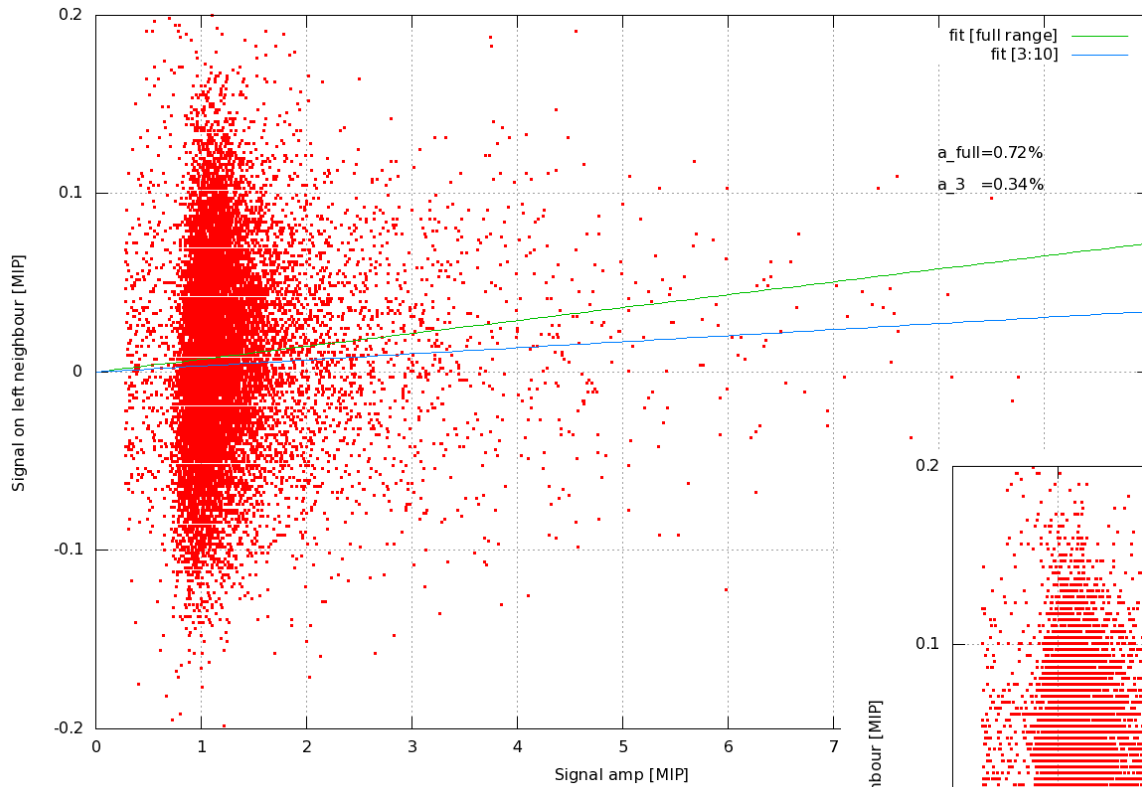
Hits per event



Events in pad

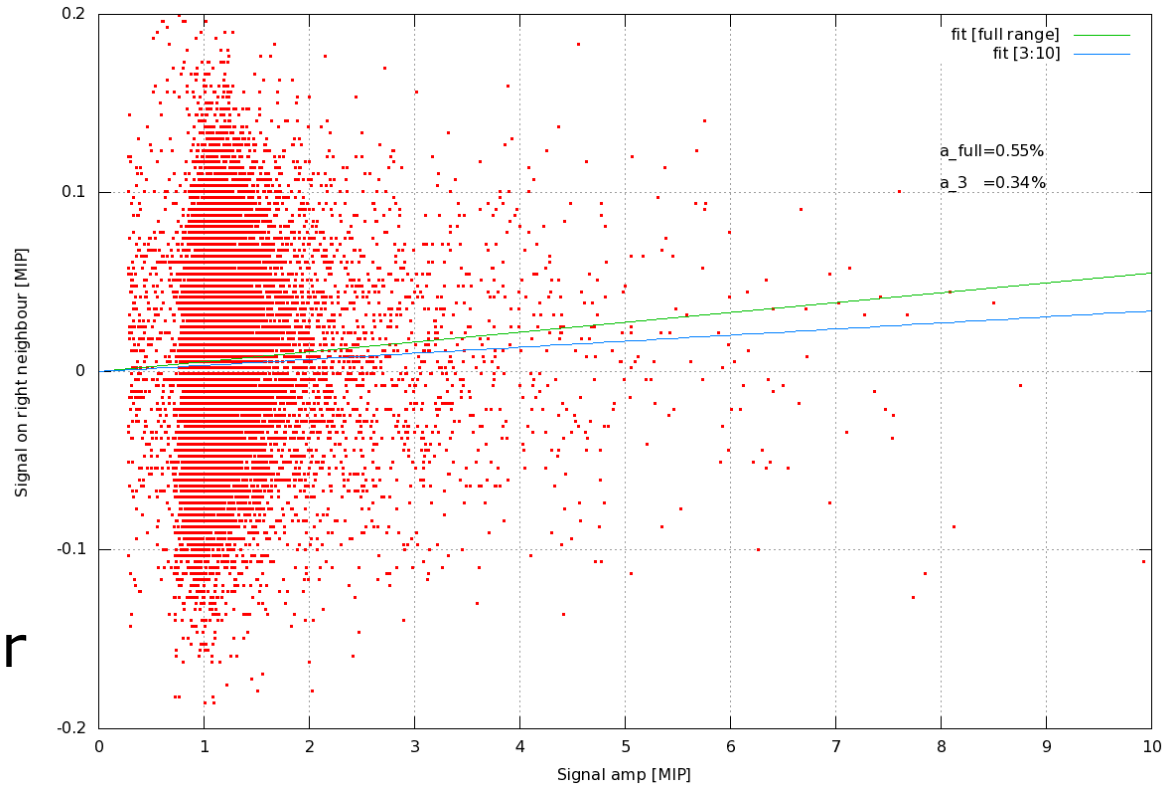


# Crosstalk



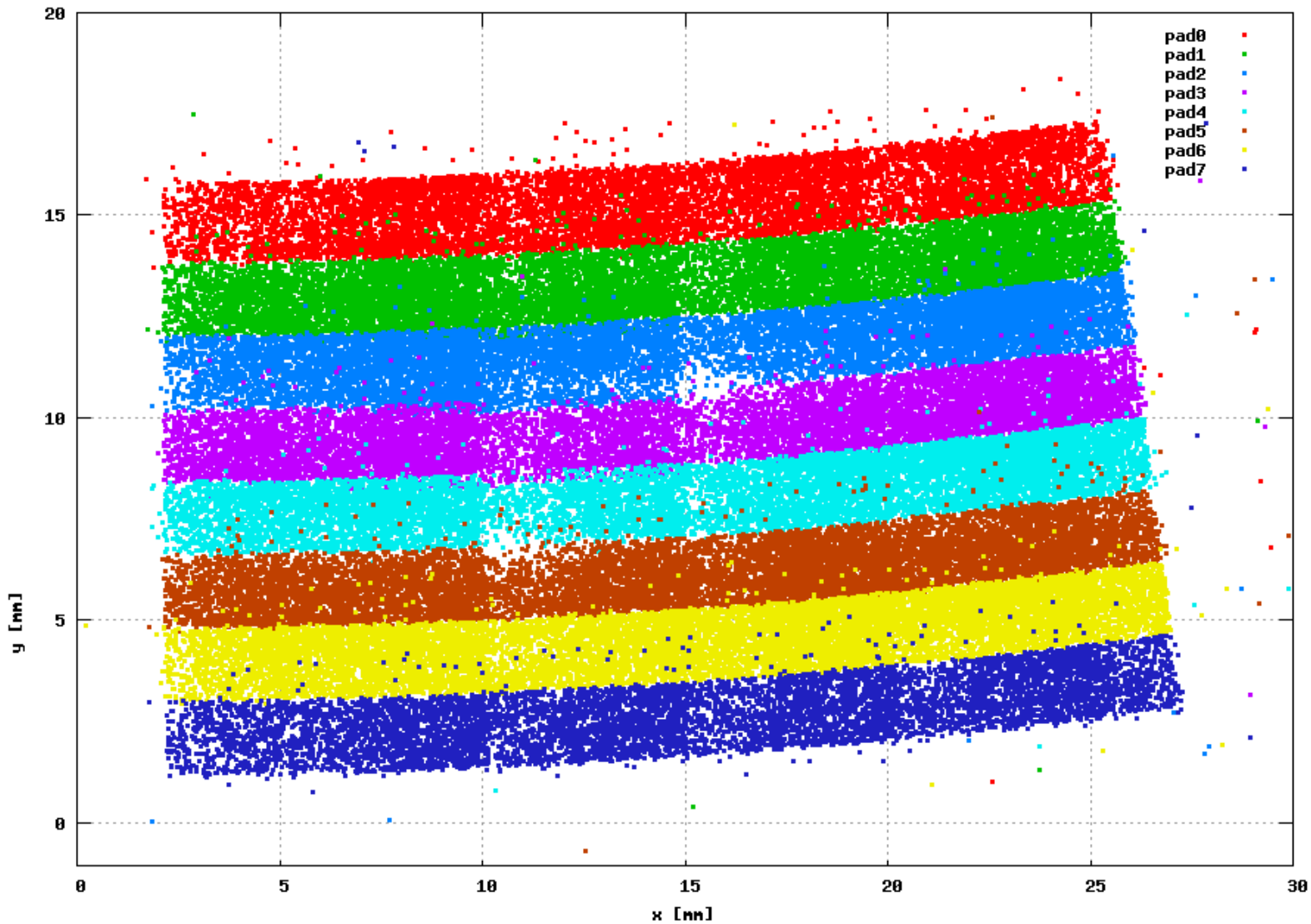
Left neighbor

Right neighbor



Ch. 4  
Correlation coefficients  
Left: 0.1534  
Right: 0.1544

# Position reconstruction

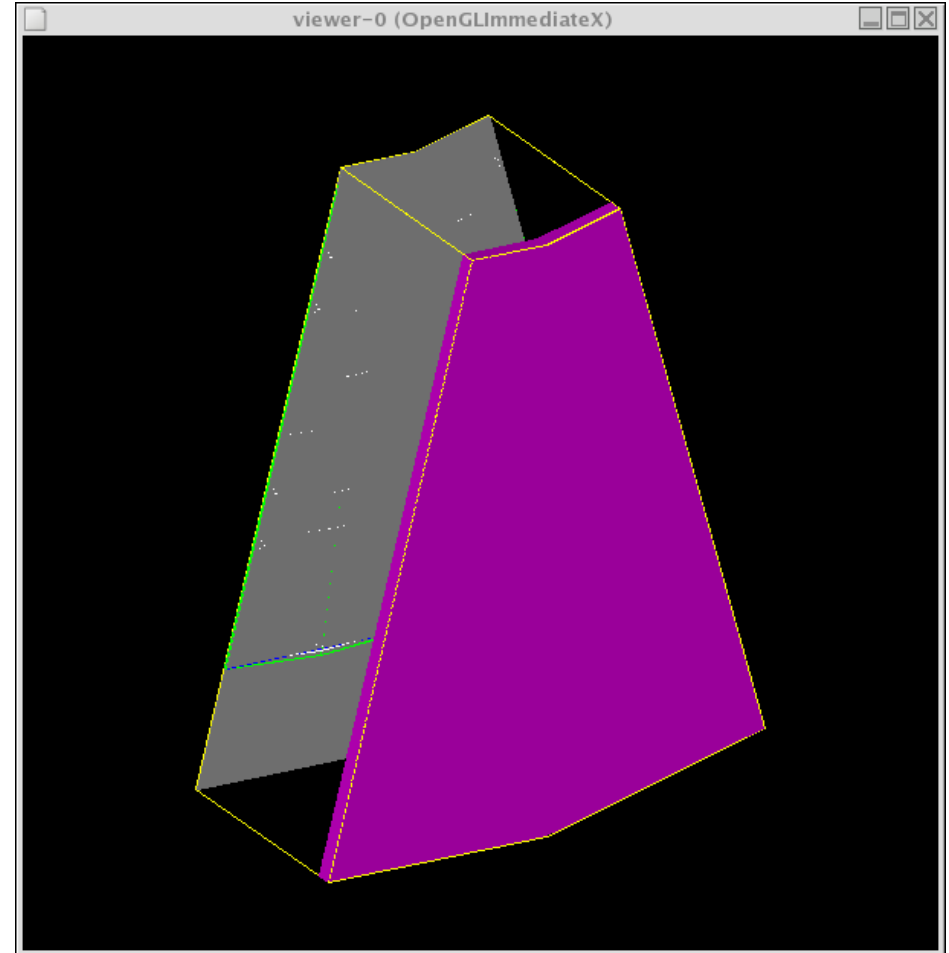


Position  
calculated  
from telescope  
data.

Color set by  
pad signal.

# Simulation

- Reproduce beam test results
- Geant4 Monte Carlo
- Simulations done by both Bogdan and me
- Units scaled to units of MPV, where the MPV is taken from the distribution of energy deposition





# Simulation 1: The Good

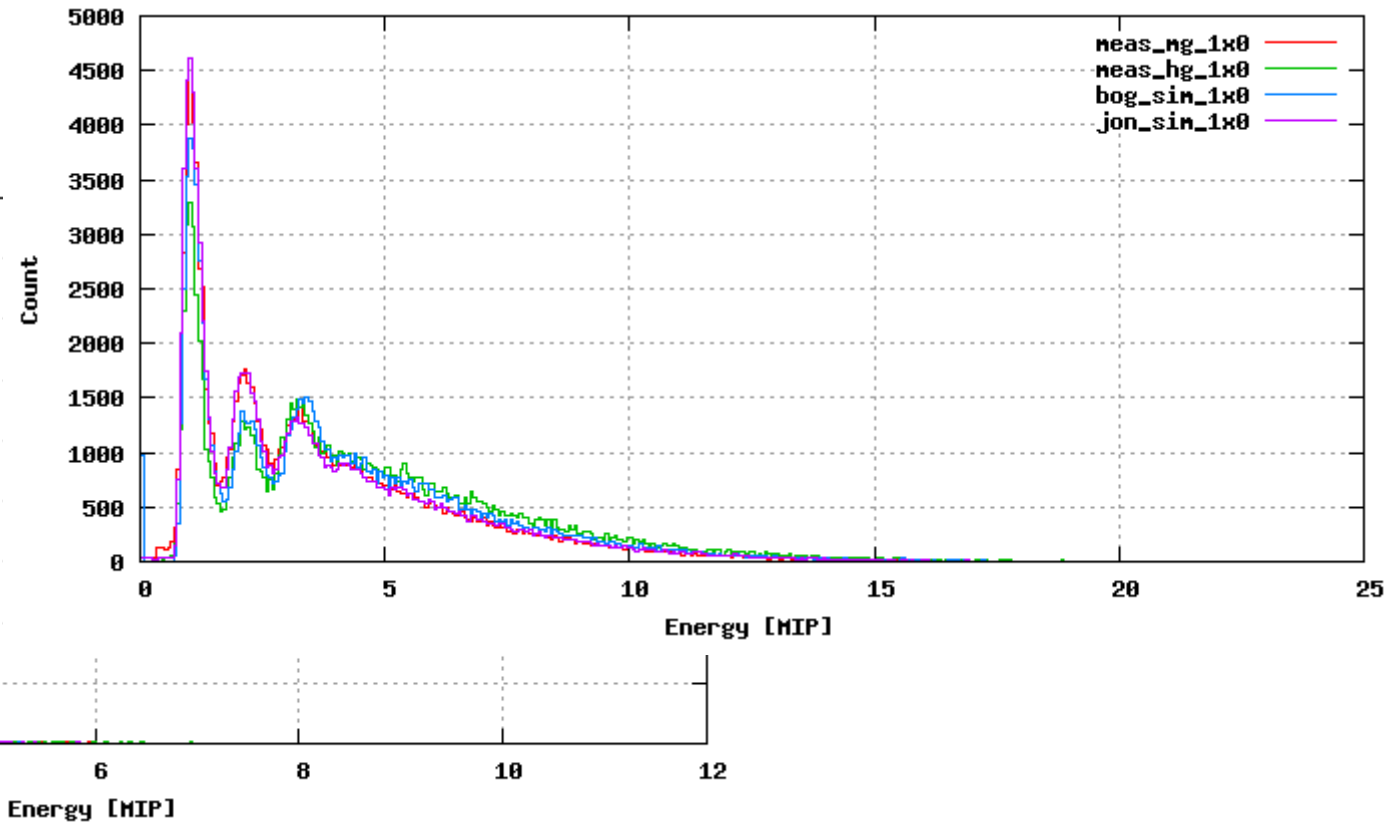
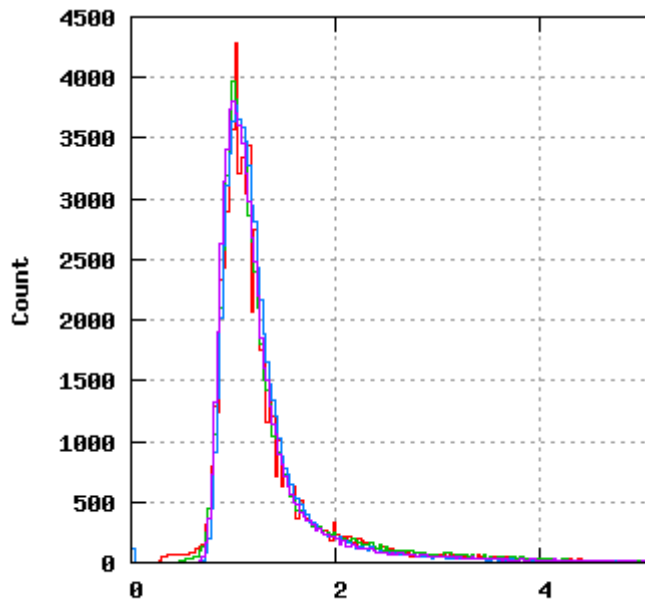
Scales normalized

Beam test: (ADC count)/(single electron MPV)

Simulation: (Energy deposition)/(single electron MPV)

$1 X_0$

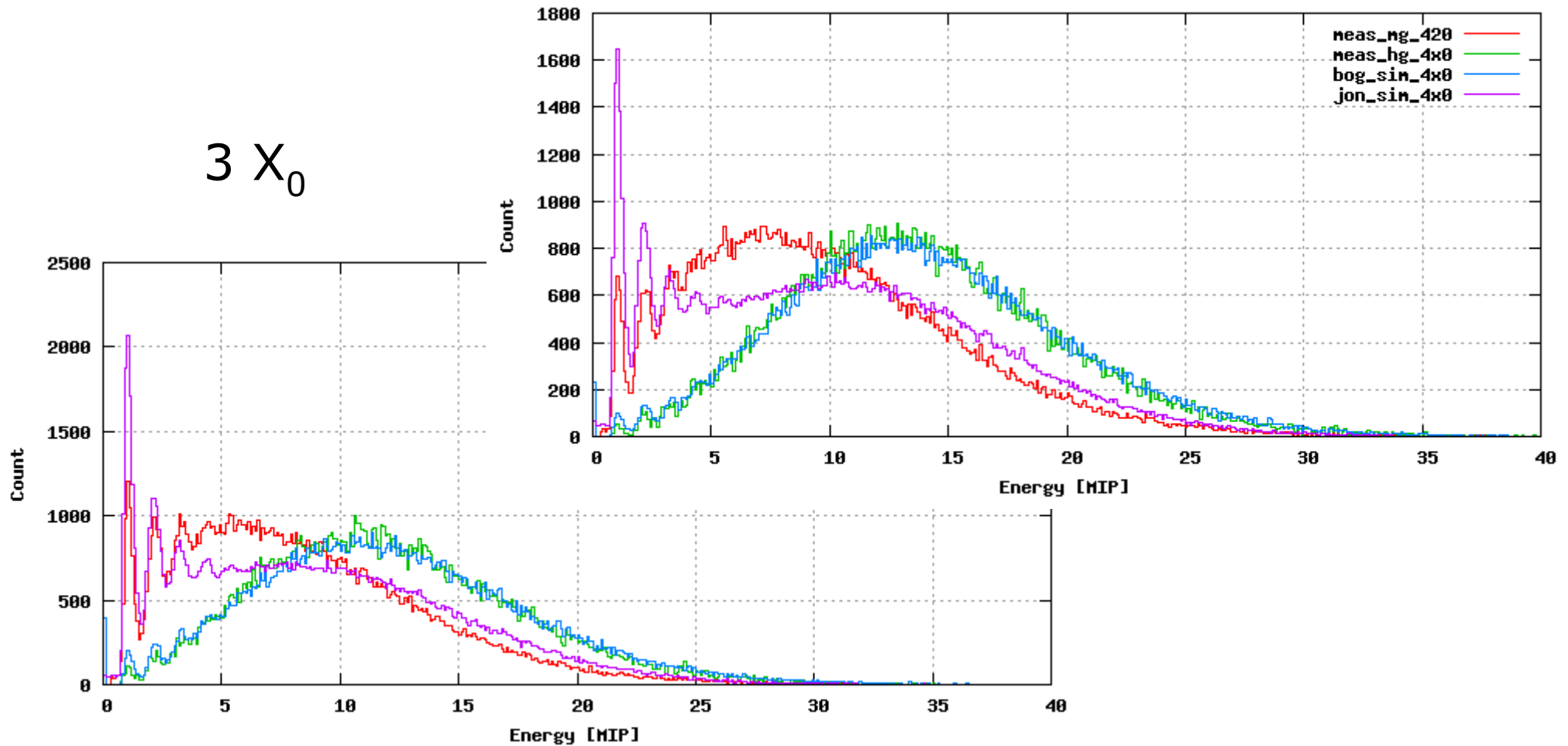
$0 X_0$



# Simulation 2: The Bad

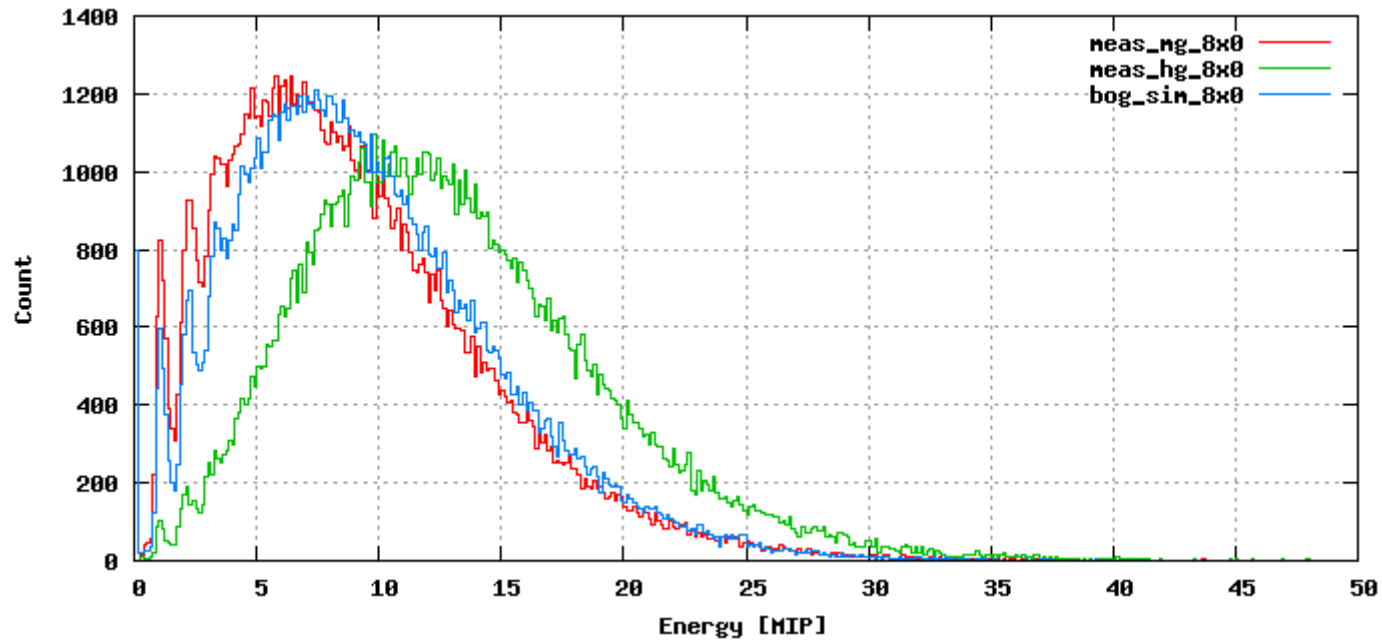
$4 X_0$

$3 X_0$

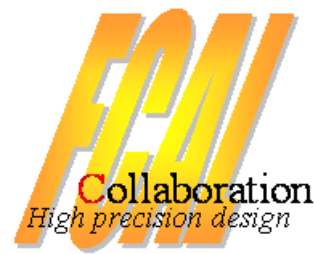


# Simulation 3: The Ugly

$8 X_0$



# Some notes and future directions



- Max charge deposition:  $\sim 200$  fC
  - Measured in medium-gain mode, saturates preamp in calibration mode
- Now that we have position reconstruction working, we can try to reproduce the beam test data more precisely

# Summary

- ADC and ASIC appear to be working
- Simulation matches beam test data well for low radiation lengths, but not for high
- Crosstalk should be explained
- Lessons learned for next beam test
  - Keep distance between absorbers and sensors controlled
  - Measure distances more precisely
  - Cover both x and y range of pads

The Krakow members would like to thank  
DESY-Zeuthen for their invaluable help

# DESY-Hamburg Beam Test Fashion Show



Photo artist:  
Marcin Chrzyszcz