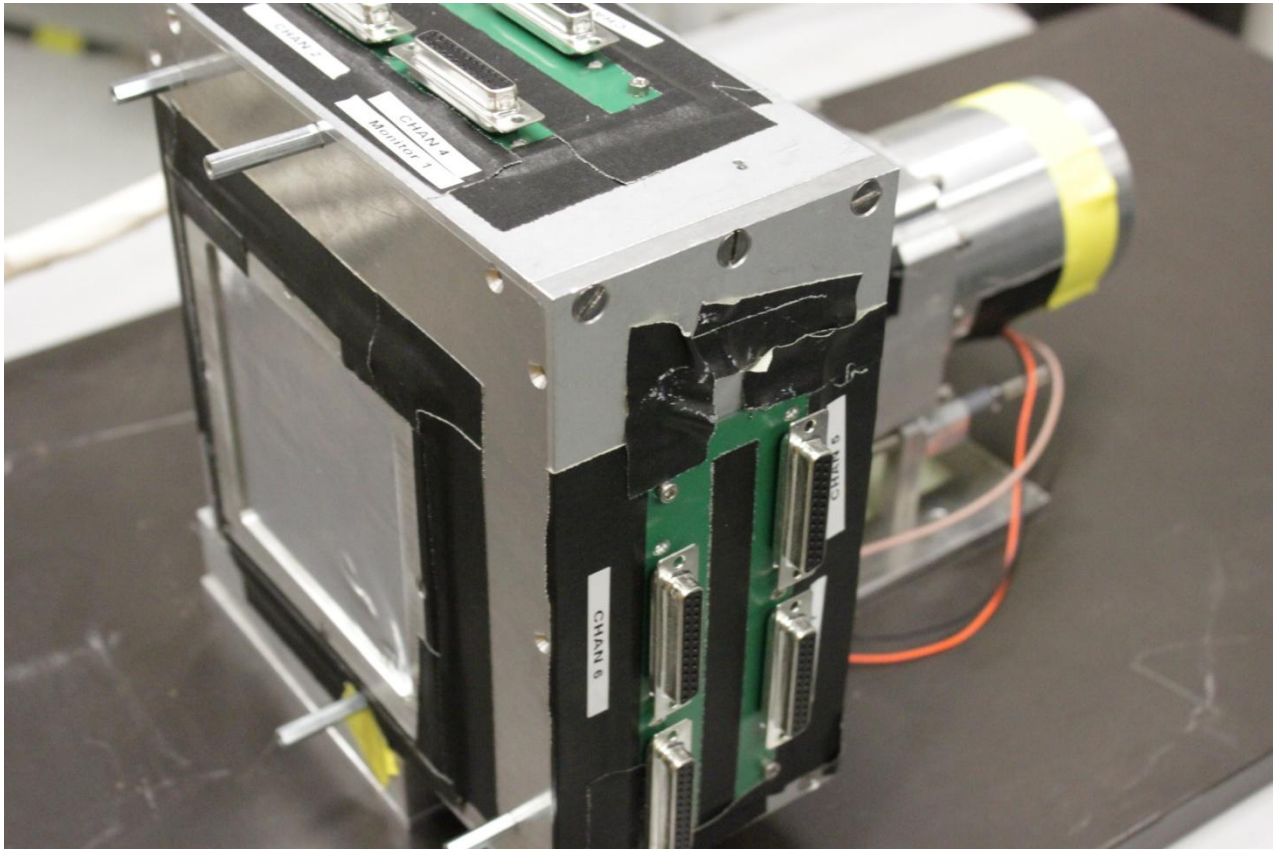
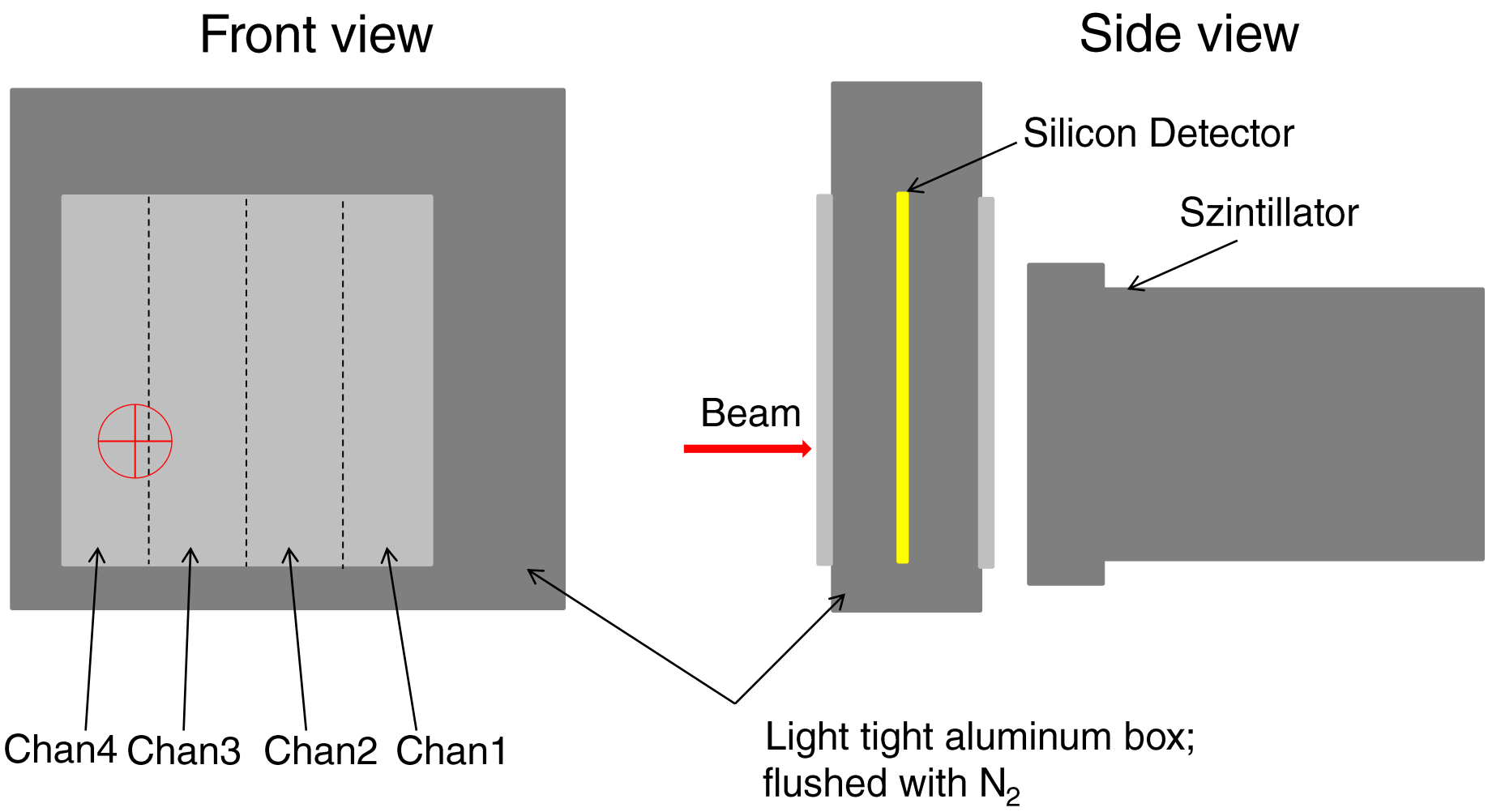
Data Analysis of MLL Beamtime
Detector 2814_25



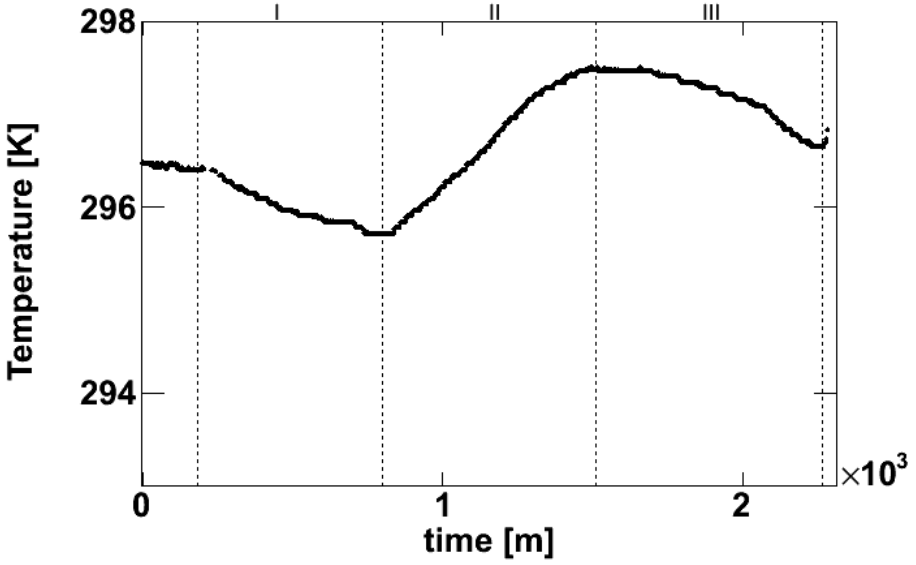
Setup

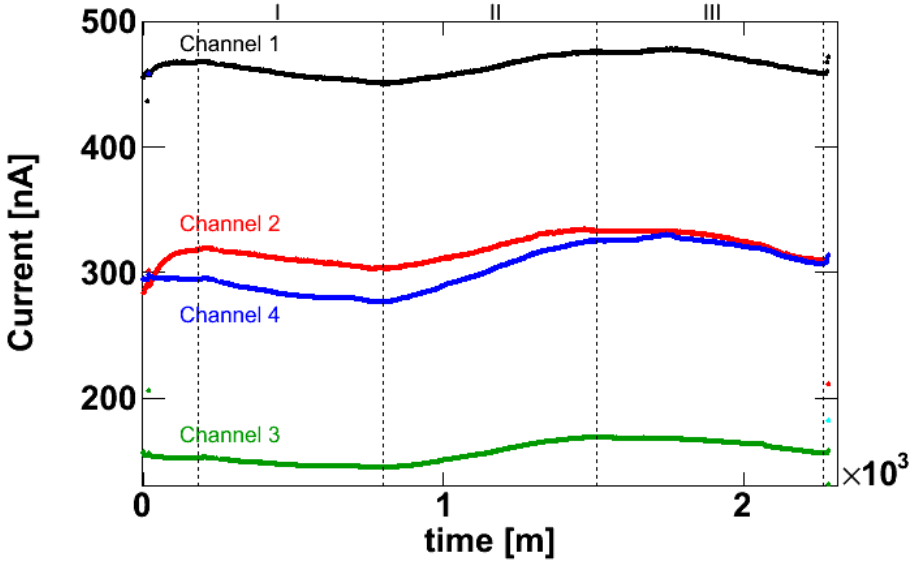


Beam:

- 20 MeV proton beam from Tandem
- 15 MeV protons reach silicon detector (Energy loss in air, aluminum foil etc. in front of the detector; calculated with LISE).

Leakage Current before beam (evening 6.6.2012-morning 8.6.2012)





Current follows Temperature! For ideal bulk detector:

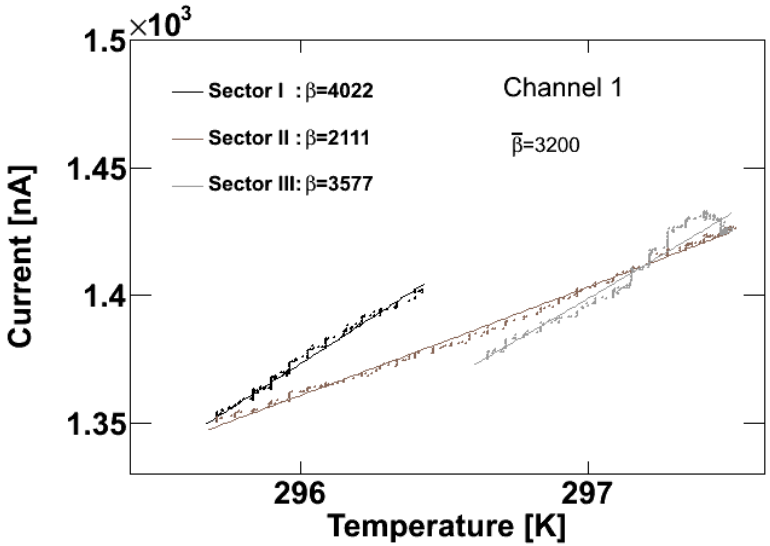
$$I(T) \propto T^2 \exp\left(-\frac{E_g}{k_B T}\right) = T^2 \exp\left(-\frac{7021}{T}\right)$$

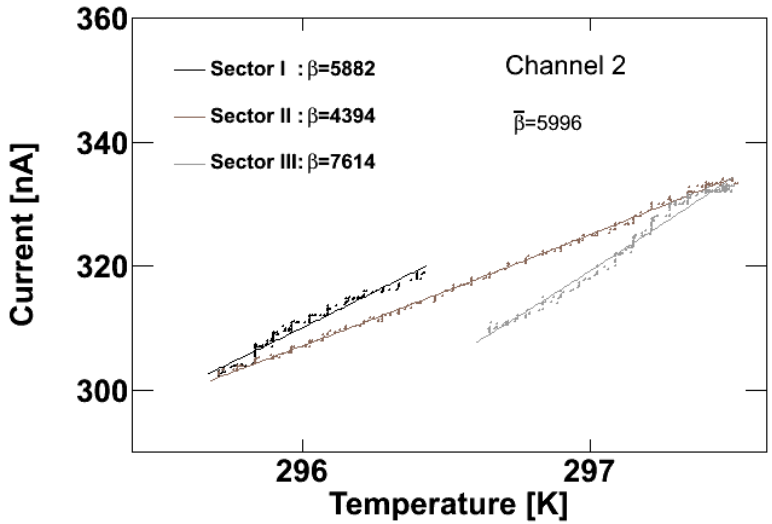
As we have no ideal detector we try to describe the data with:

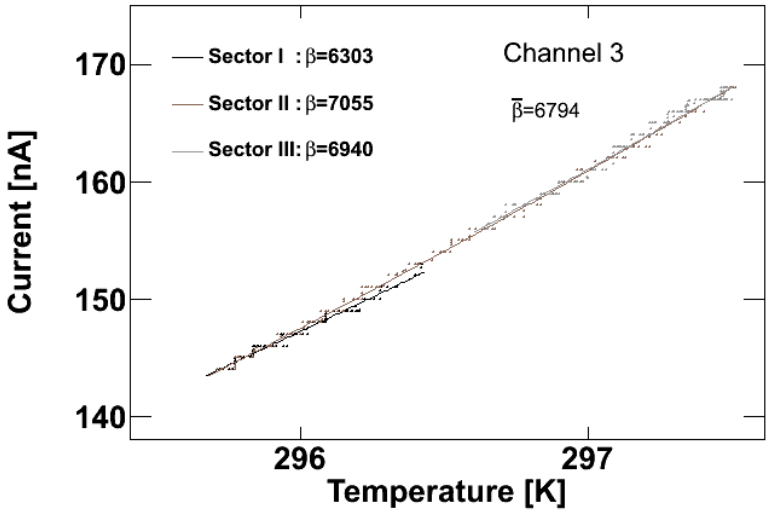
$$I(T) \propto T^2 \exp\left(-\frac{\beta}{T}\right)$$

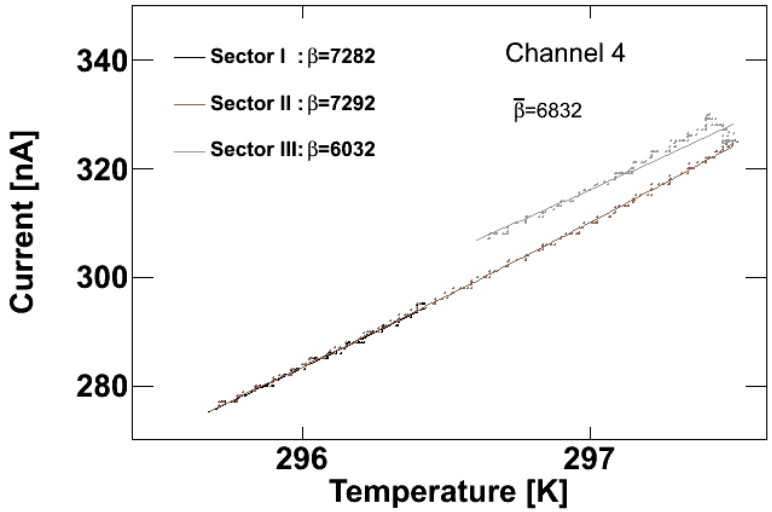
Where β is a fitting parameter

Current vs. Temperature for each channel in the three areas I,II and III





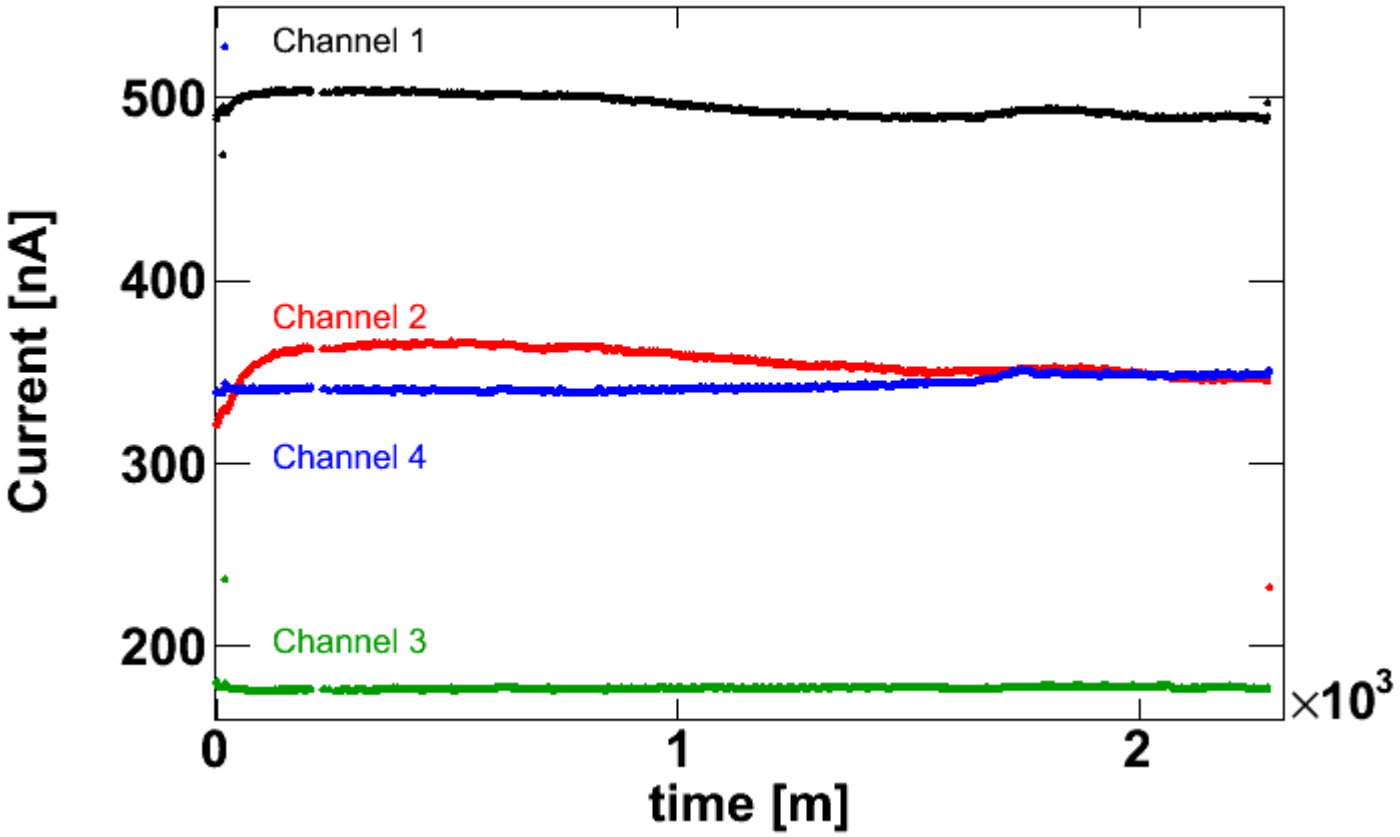




Current normalized to 298.15 K

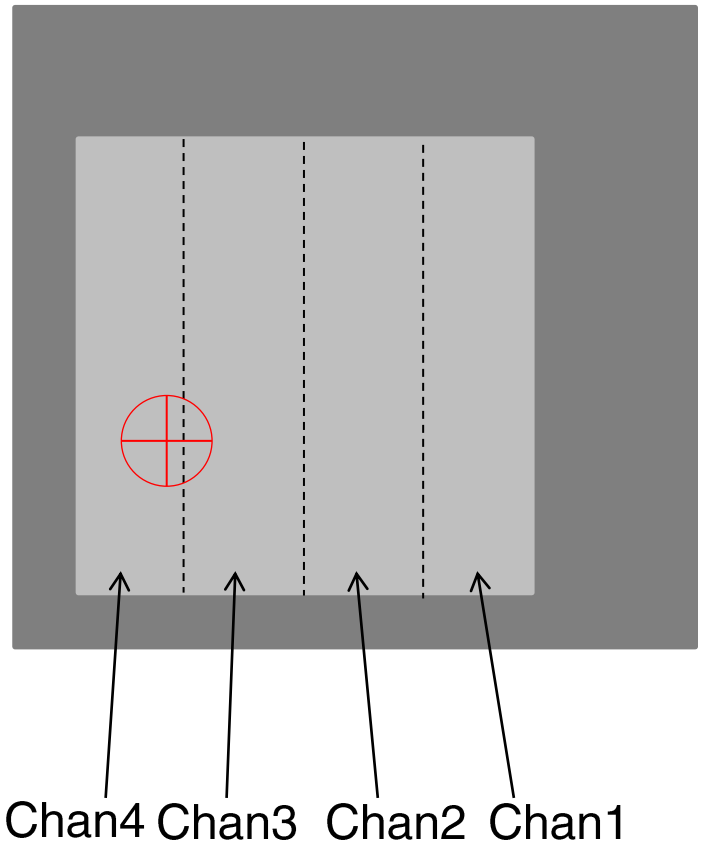
Normalize Current of each channel with following function:

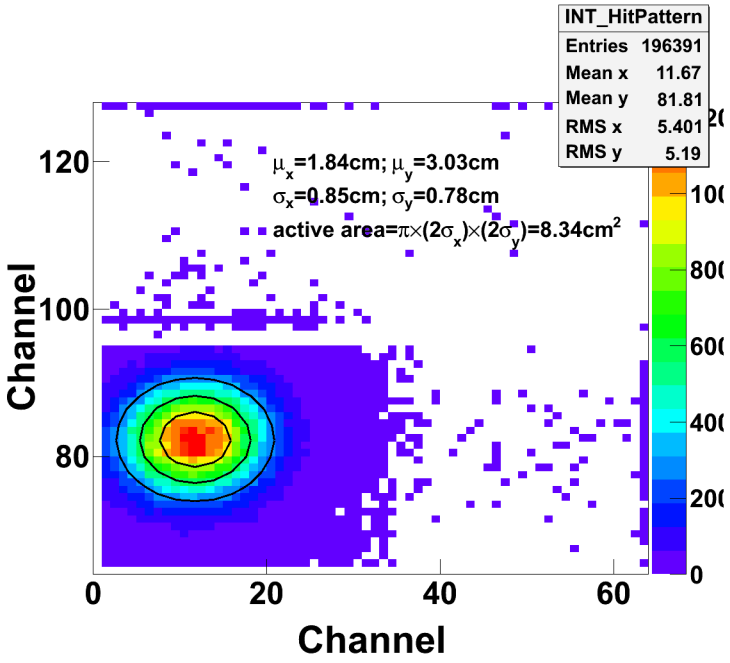
$$I(T = 298.15K) = I_m\left(\frac{298.15}{T_m}\right)\cdot\exp\left(-\overline{\beta}\left(\frac{1}{298.15}-\frac{1}{T_m}\right)\right)$$



Beam on detector

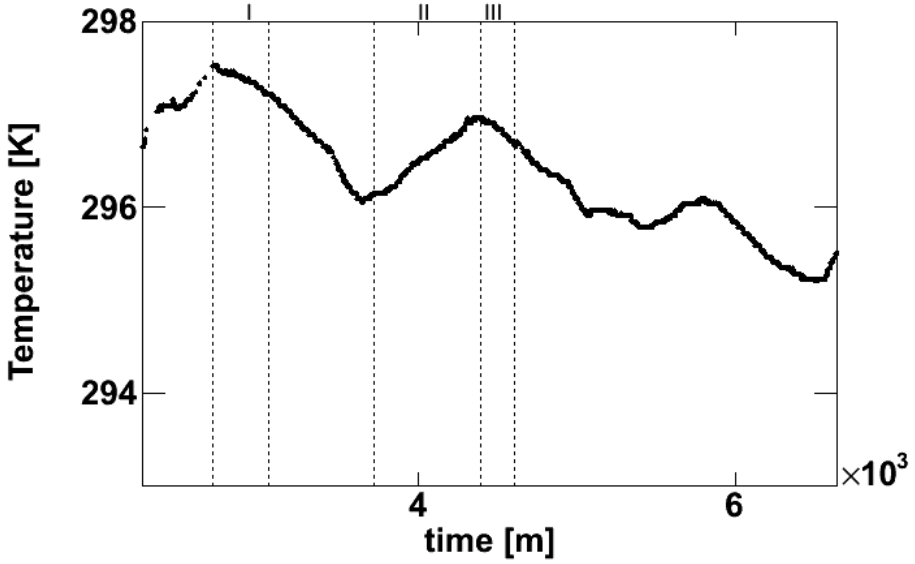
Front view

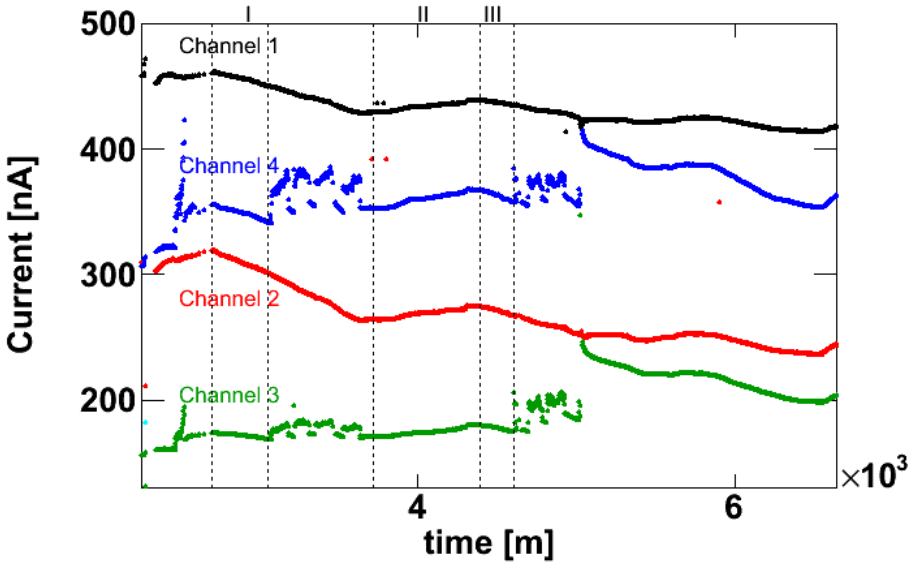




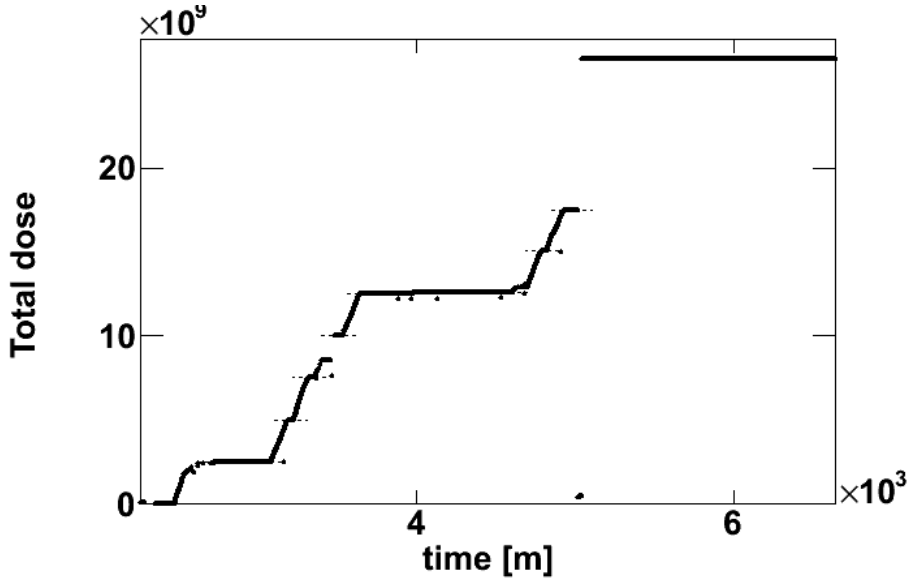
Only channel 3 and channel 4 are hit by the beam

Leakage Current with beam (evening 8.6.2012-morning 10.6.2012)

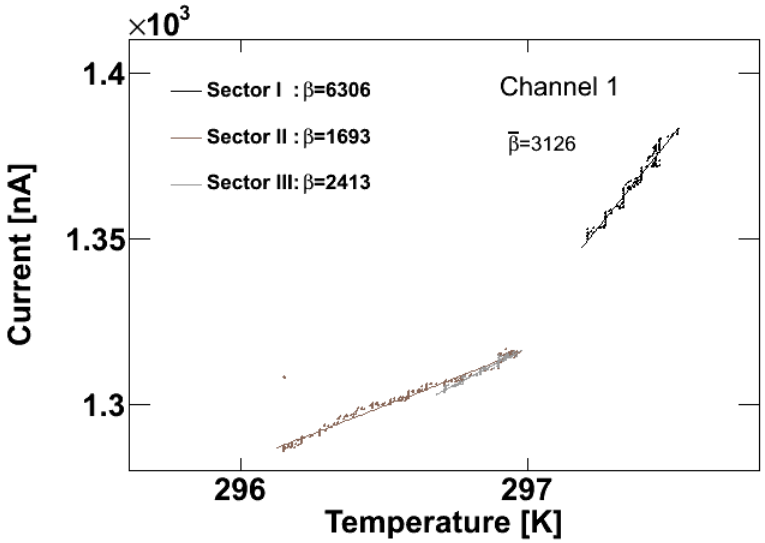


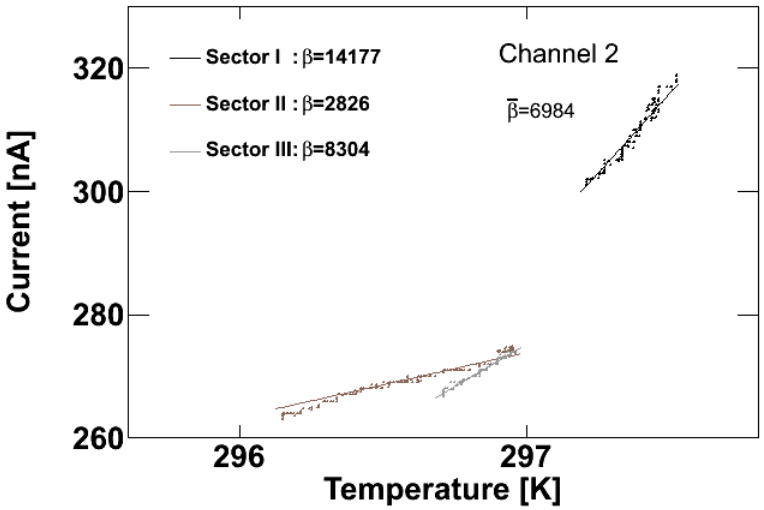


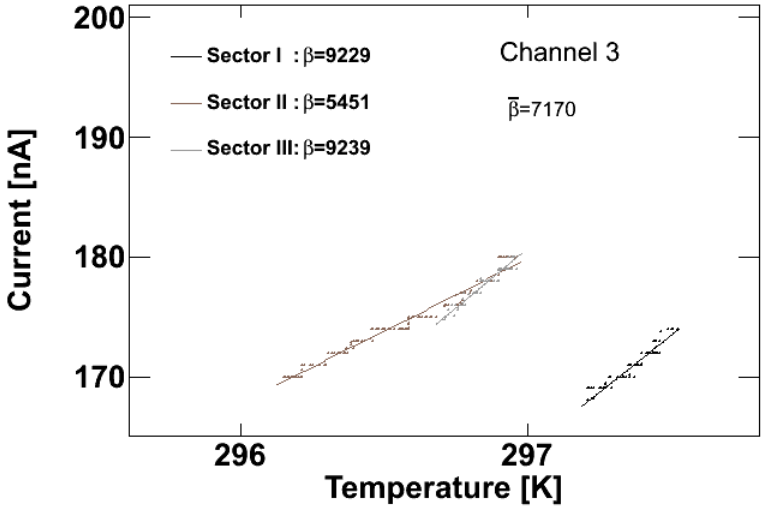
Current follows again temperature behavior. Steps in channel 3 and 4 are attributed to high intensity beam periods.

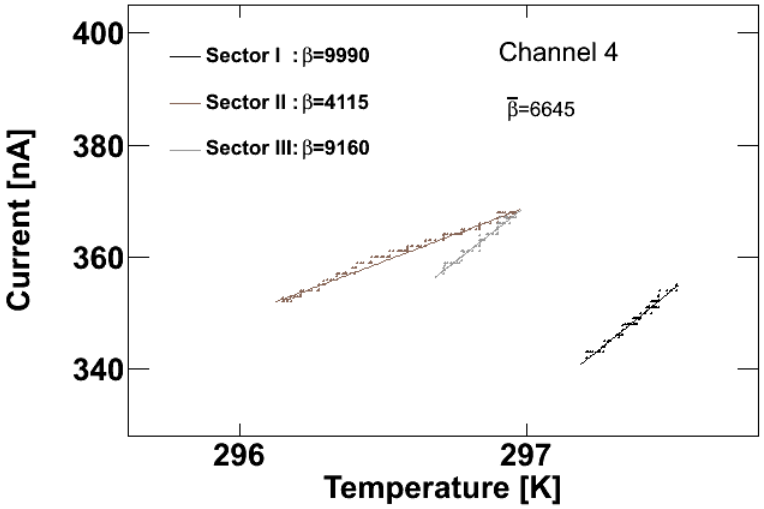


Current vs. Temperature for each channel in the three areas I,II and III









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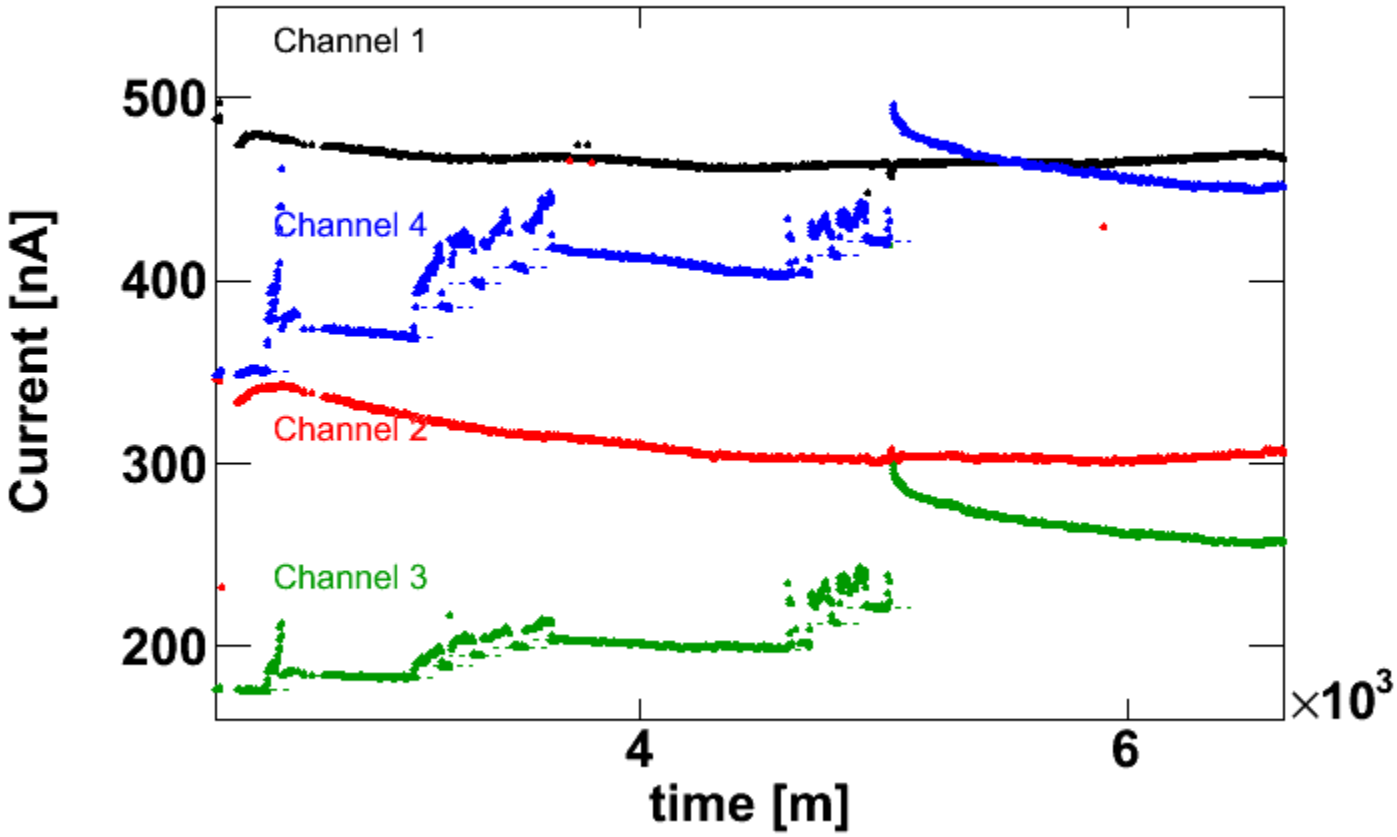
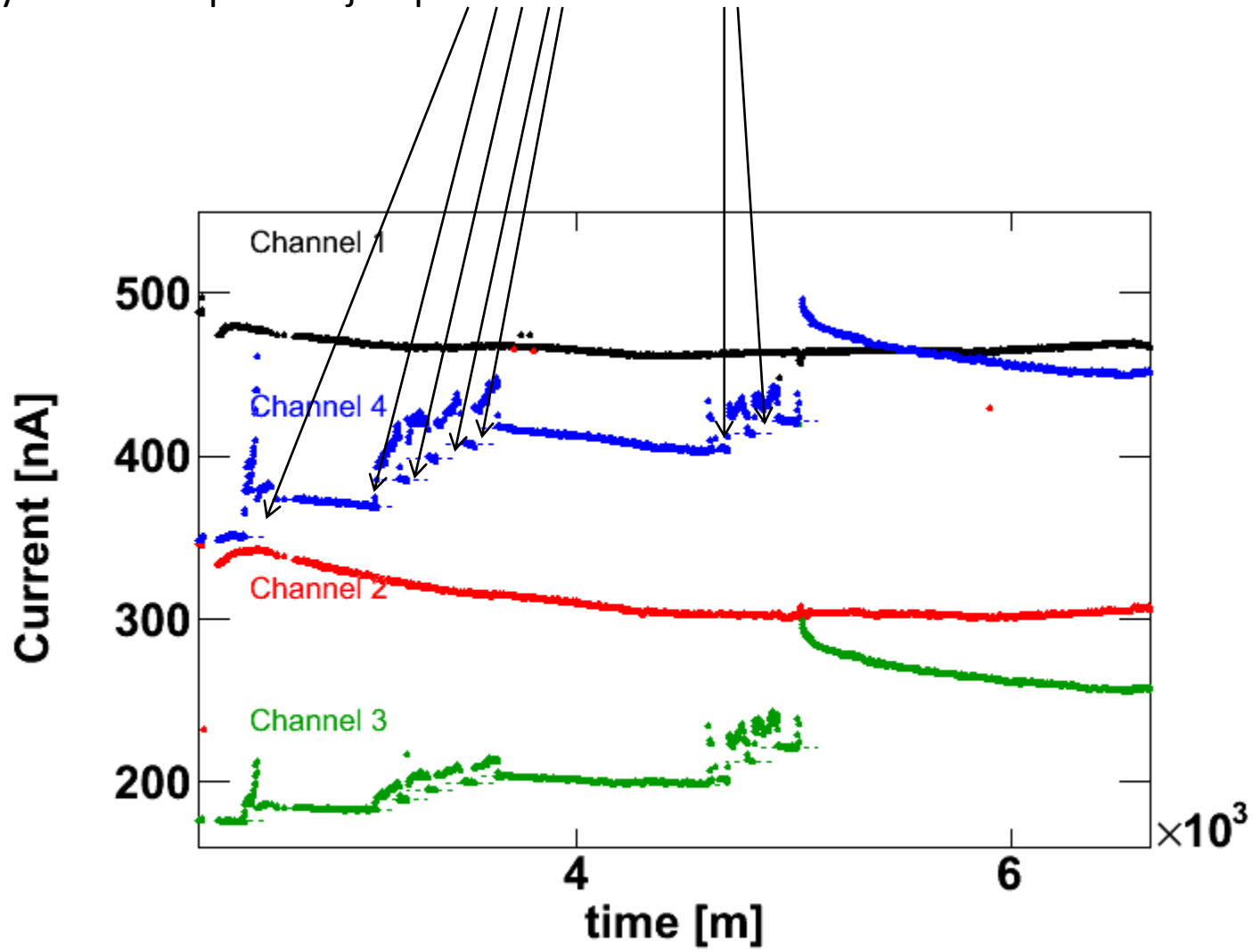


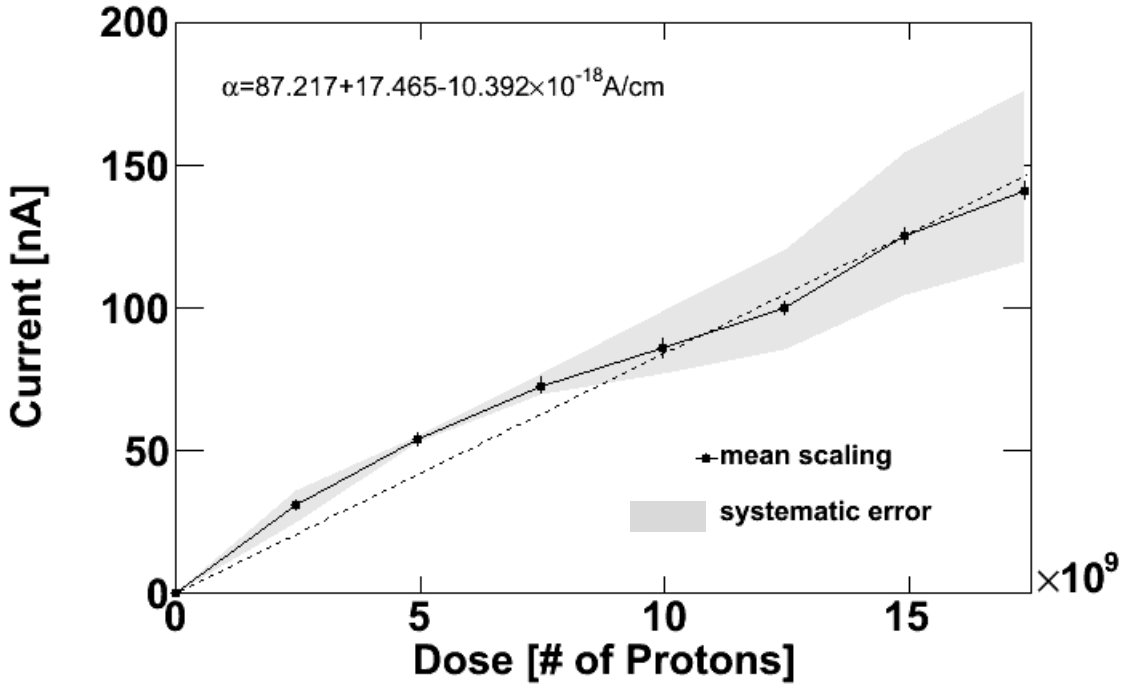
Current normalized to 298.15 K

Extract height of jumps in the current of channel 3 and channel 4 after high beam intensity and sum up these jumps



Current vs events

Draw the total increase in leakage current as a function of the particle flux

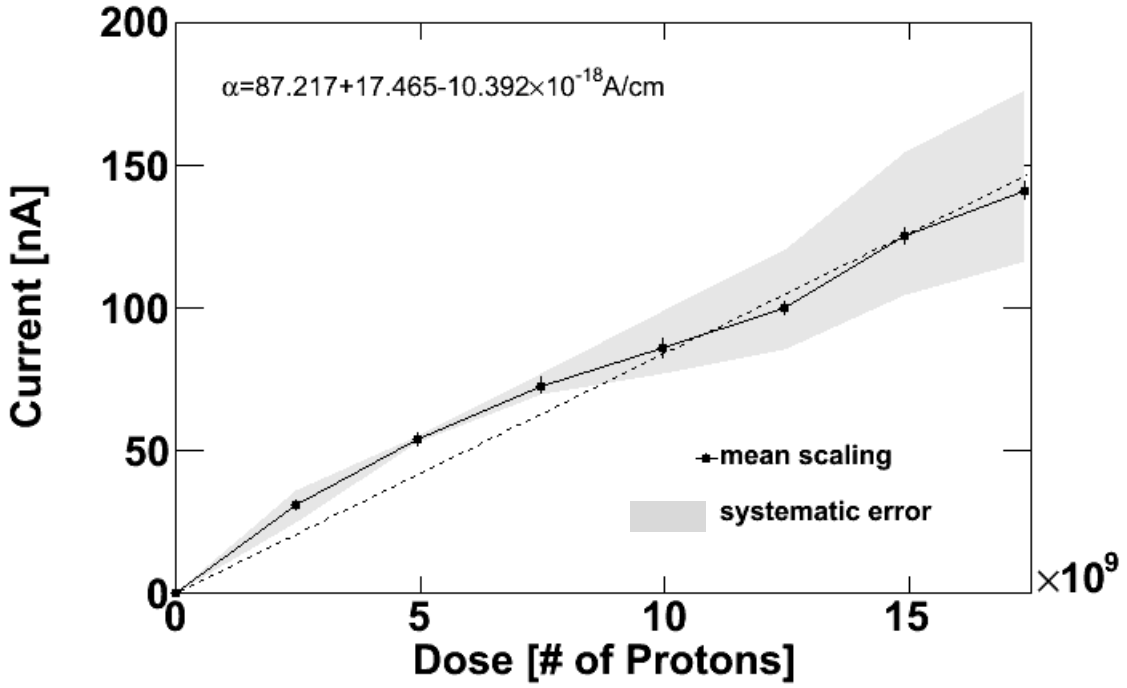


Follows more or less a linear function.

Systematic errors were evaluated by taking not only the average β value but also the highest and lowest β value of the fits in the three regions I,II and III.

Current vs events

Draw the total increase in leakage current as a function of the particle flux



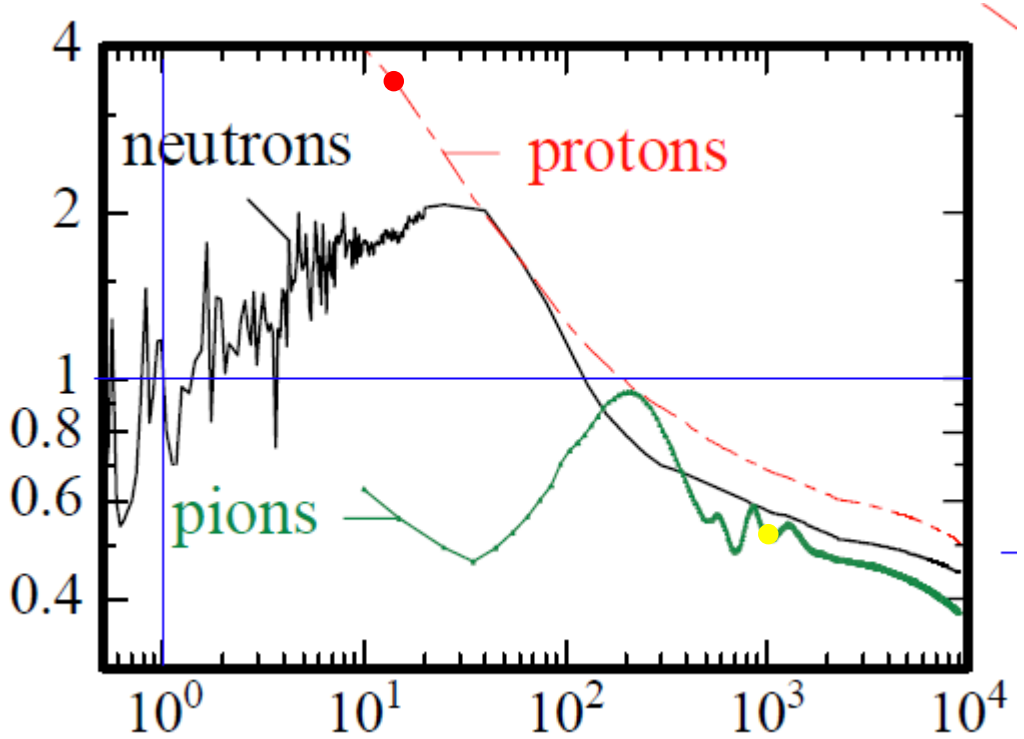
Fit distribution with the following function:

$$\Delta I = \alpha V \Phi_{eq} = \alpha A d \frac{\kappa N_p}{A} = \alpha d \kappa N_p$$ with

ΔI: increase in Current
a: Damage Factor
V: active volume of Detector
A: active area of detector
d: thickness of detector (305µm)
Φ_{eq}: equivalent flux on detector
N_p: Number of protons on detector
κ: damage factor normalized to 1MeV Neutrons

MLL Proton Beam vs. HADES pion beam

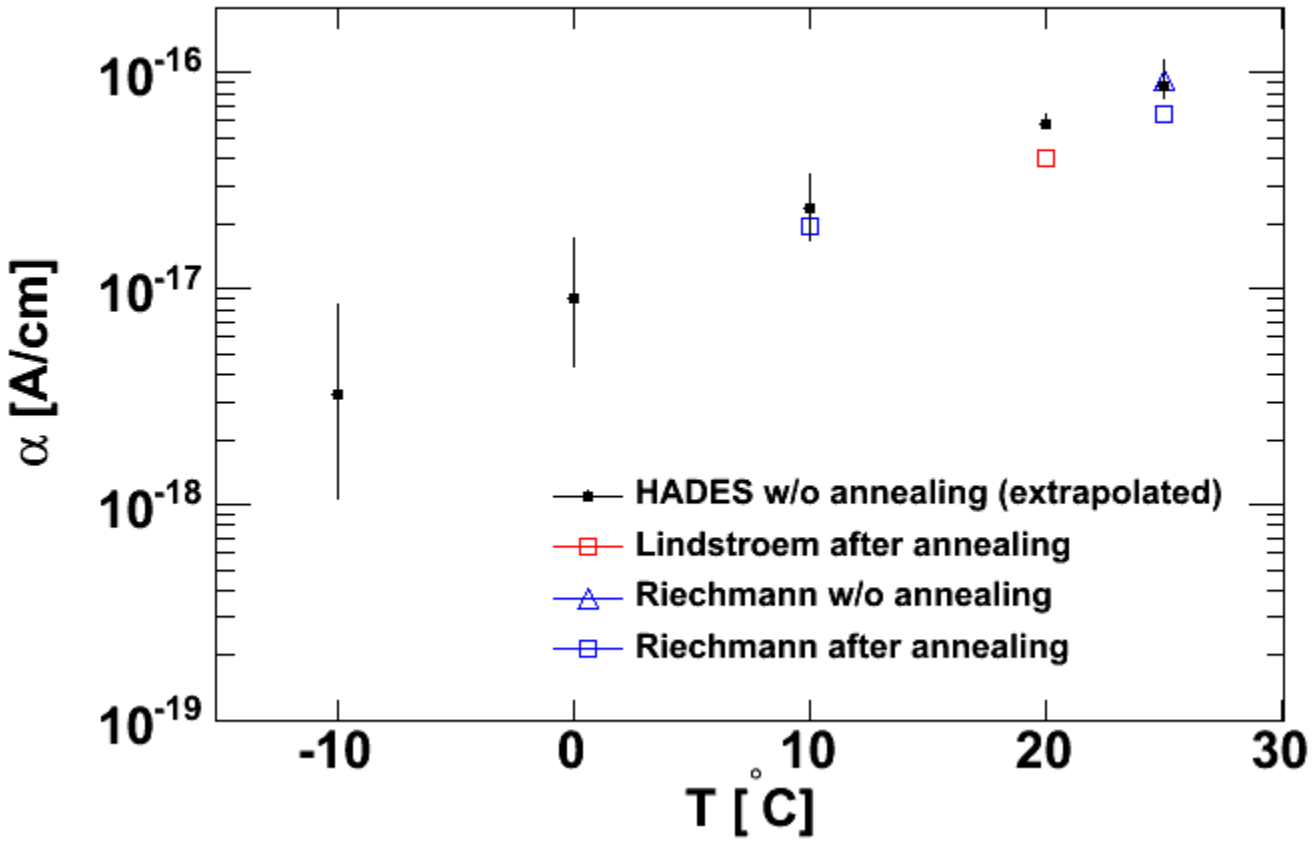
Observable	Proton	Pion
Energy	≈15MeV ●	≈1.0 GeV ●
κ Factor	≈2.85-3.16	≈0.5
Total # hits	17.5*10^9	2.7*10^13
Active area	2.60cm^2	36cm^2
Total flux (norm. to protons)	6.13*10^9/cm^2	1.10*10^11/cm^2



Meaning for the HADES beamtime

- During the proton run the current has increased by ≈**150nA** after the total dose of **17.5*10^9** protons on the detector with 15MeV.
- HADES expects **2.7*10^13** pions on the detector with 1GeV.
- This HADES dose can be normalized to **2.7*10^13/3.4*0.5=4.0*10^12** 15MeV protons on the detector.
- This would result in an increased leakage current by **4.0*10^12/17.5*10^9*150nA=34µA**.
- But this is valid for a detector temperature of **25°C**.
- What changes if temperature is changed?

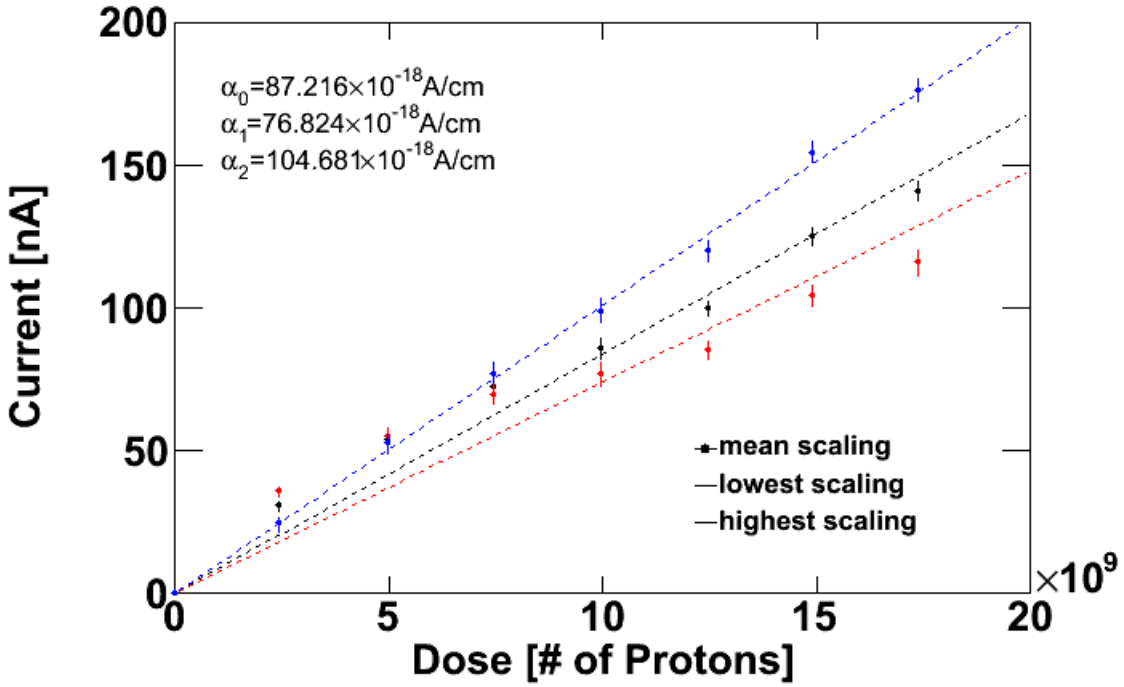
α value vs. temperature



α value would reduce by factor 10 – 20 if detector is cooled to -10°C.
Cooling is essential!

Current vs events

Draw the total increase in leakage current as a function of the particle flux



Follows more or less a linear function.

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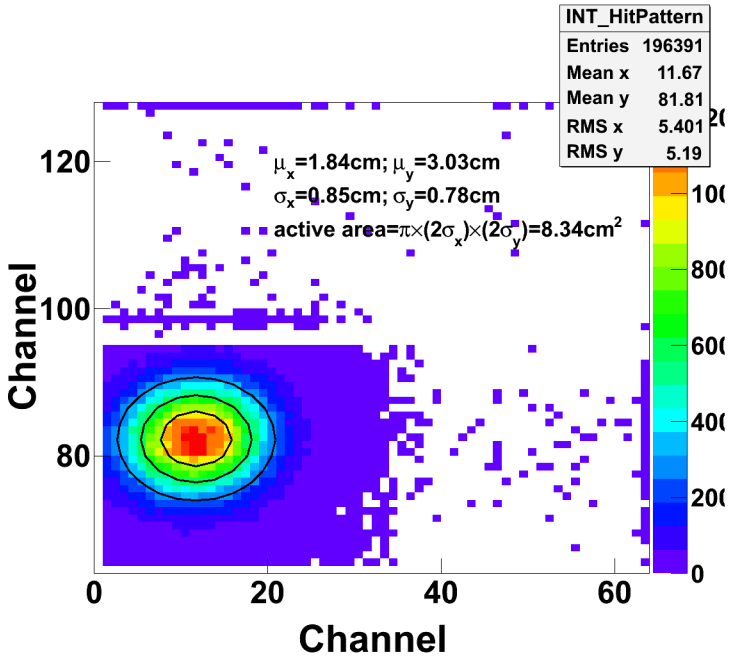
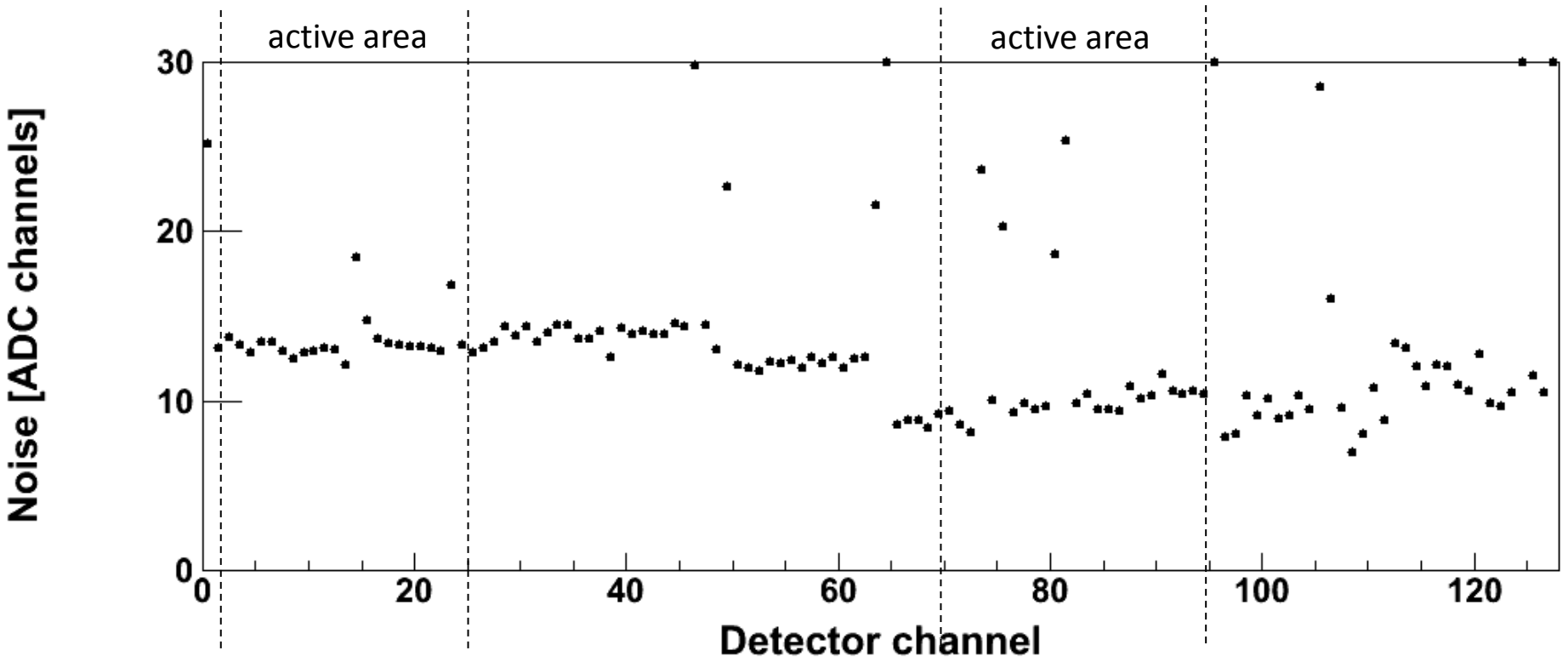
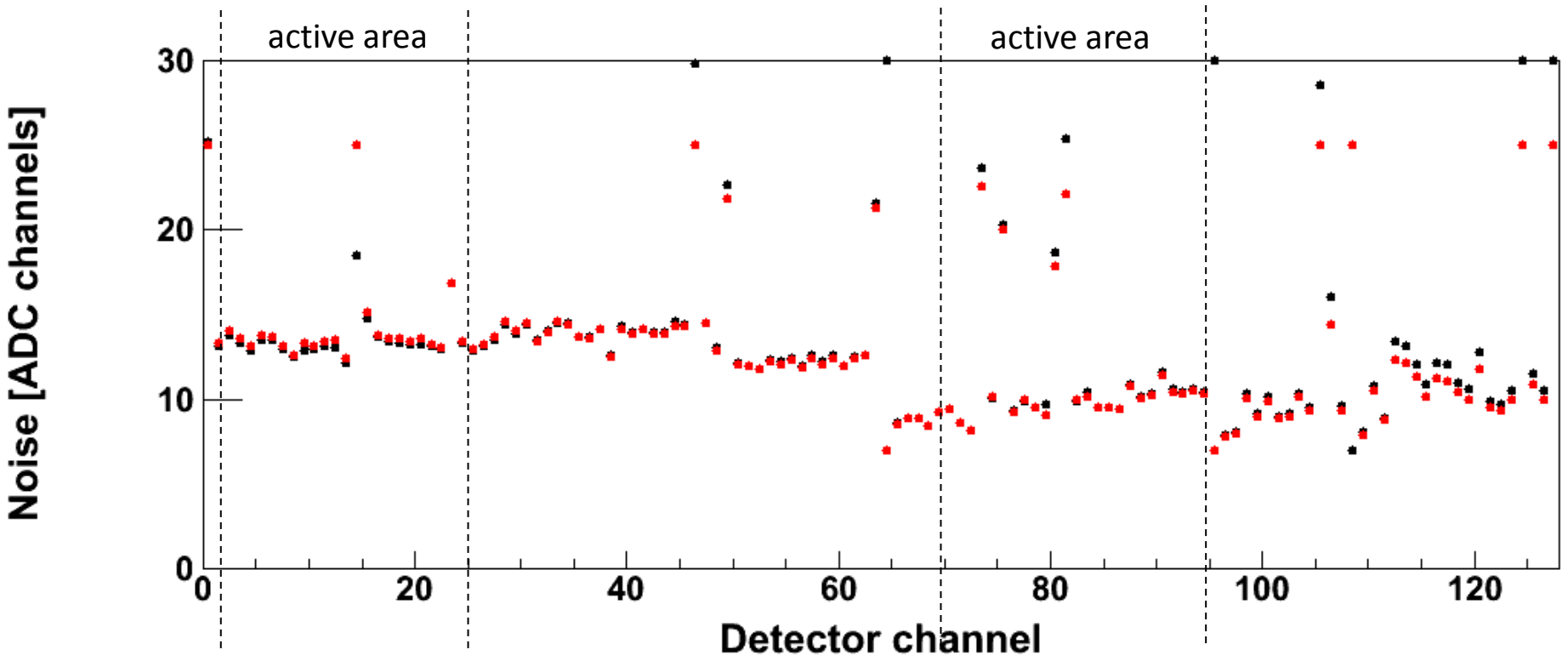


Behavior of noise



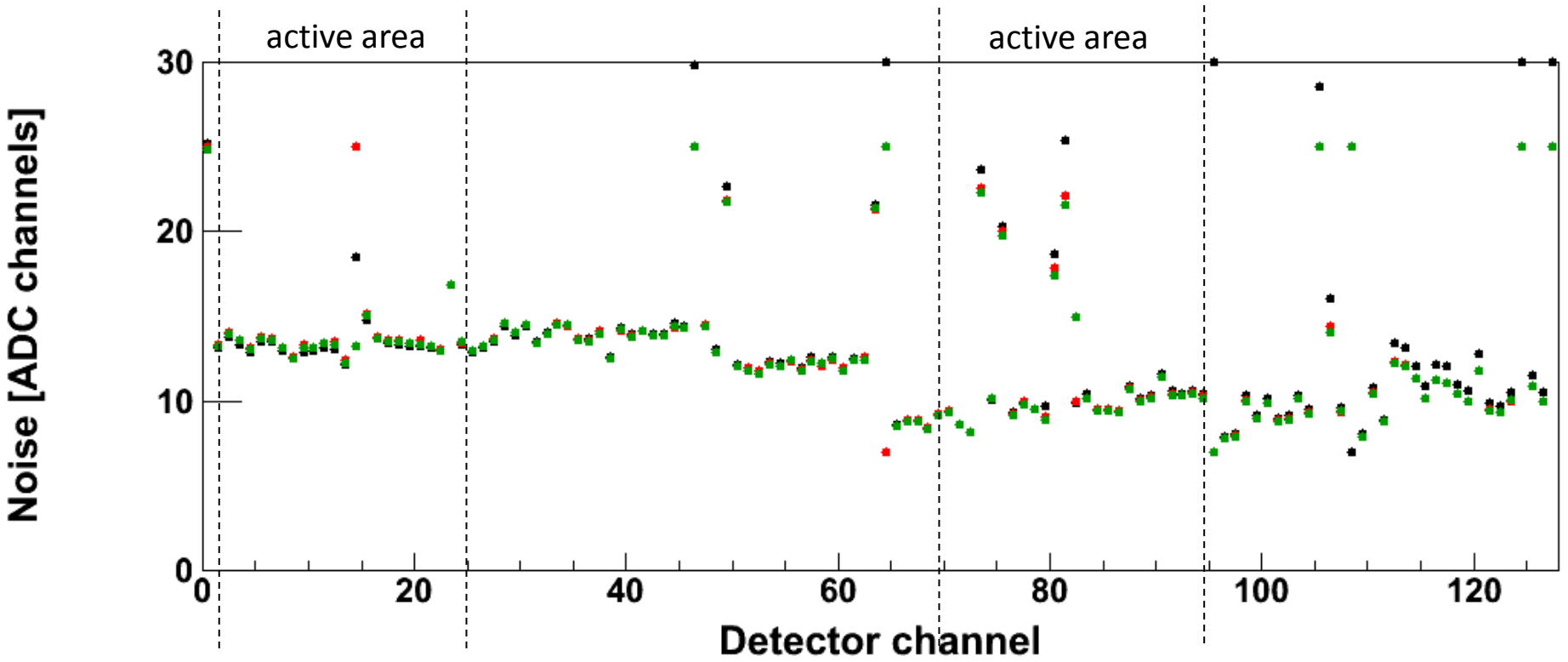
- after 2.5*10^9 events/8.2cm^2=0.30*10^9/cm^2 (=0.28% of HADES flux)

Behavior of noise



- after 2.5*10^9 events/8.2cm^2=0.30*10^9/cm^2 (=0.28% of HADES flux)
- after 5.0*10^9 events/8.2cm^2=0.61*10^9/cm^2 (=0.55% of HADES flux)

Behavior of noise



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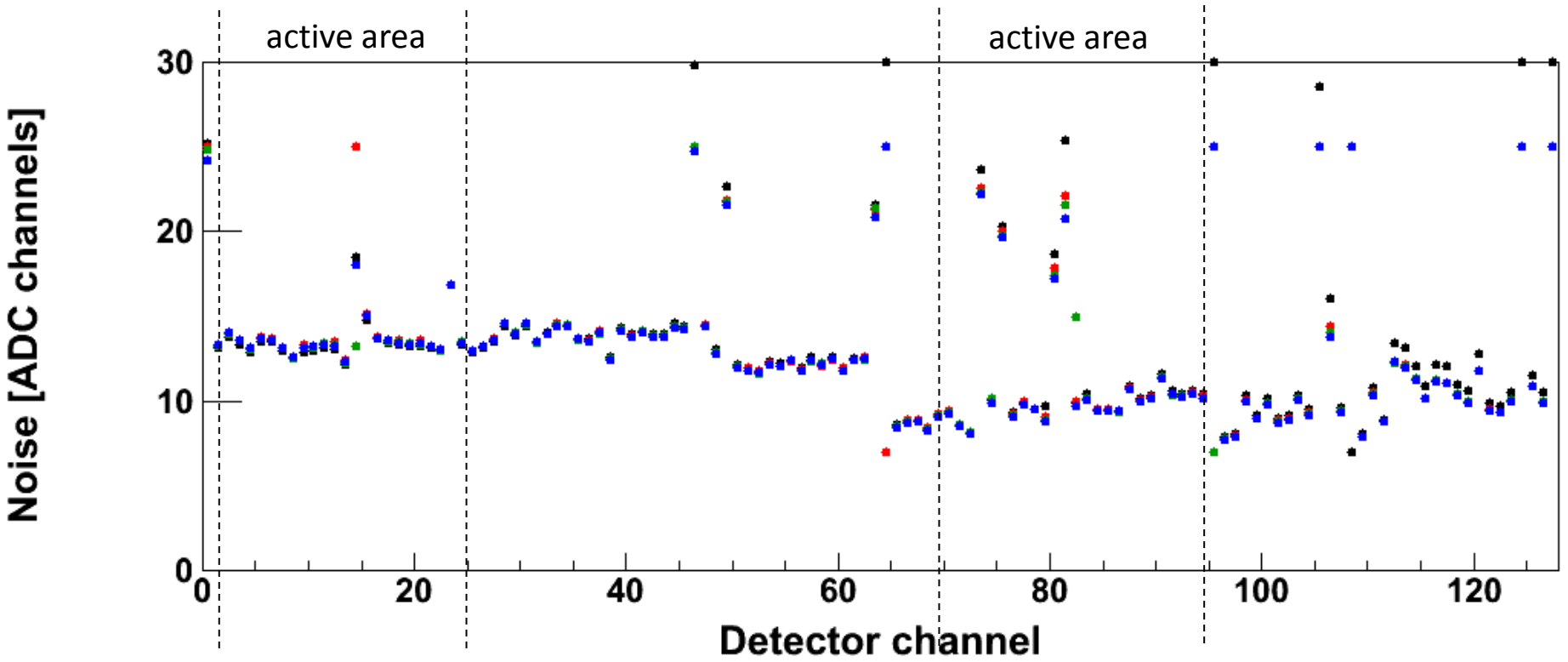
- after 7.5*10^9 events/8.2cm^2=0.91*10^9/cm^2 (=0.83% of HADES flux)

Behavior of noise



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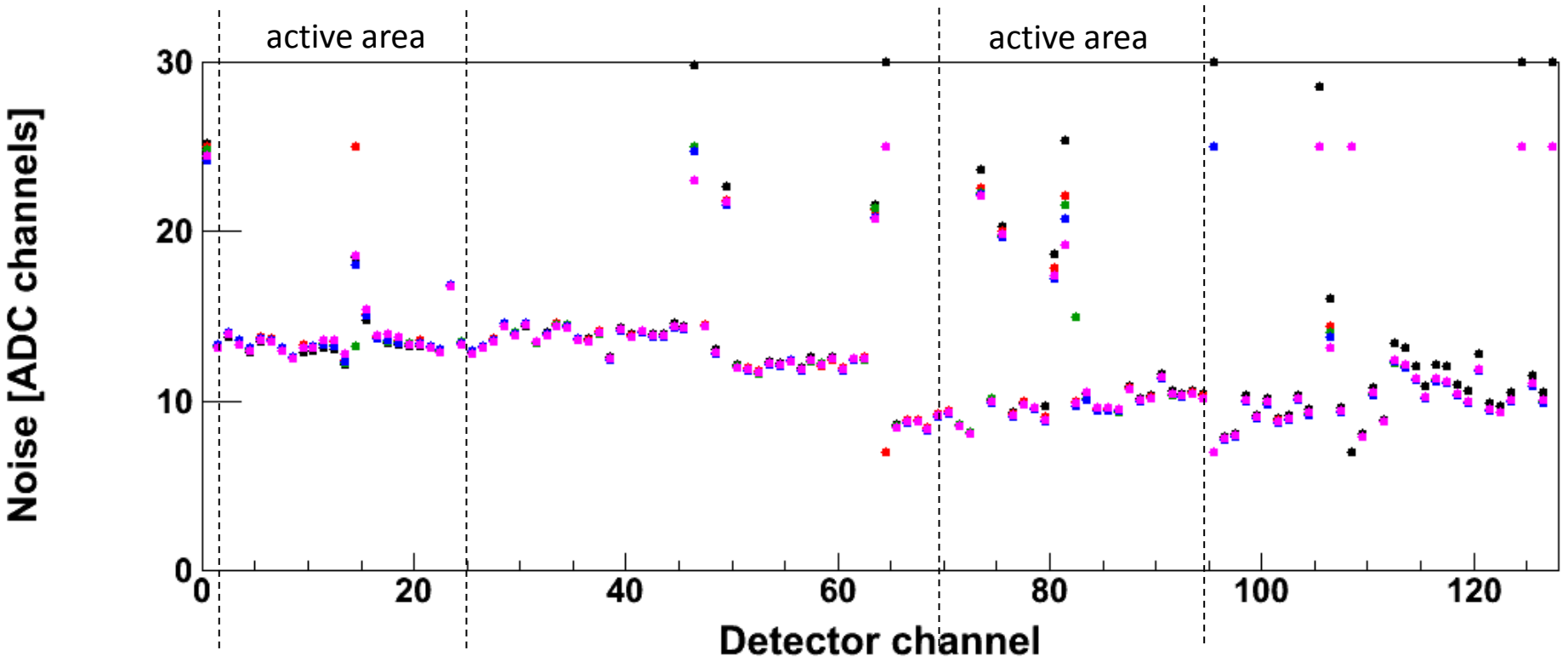
- after 7.5*10^9 events/8.2cm^2=0.91*10^9/cm^2 (=0.83% of HADES flux)
- after 10.0*10^9 events/8.2cm^2=1.22*10^9/cm^2 (=1.10% of HADES flux)

Behavior of noise



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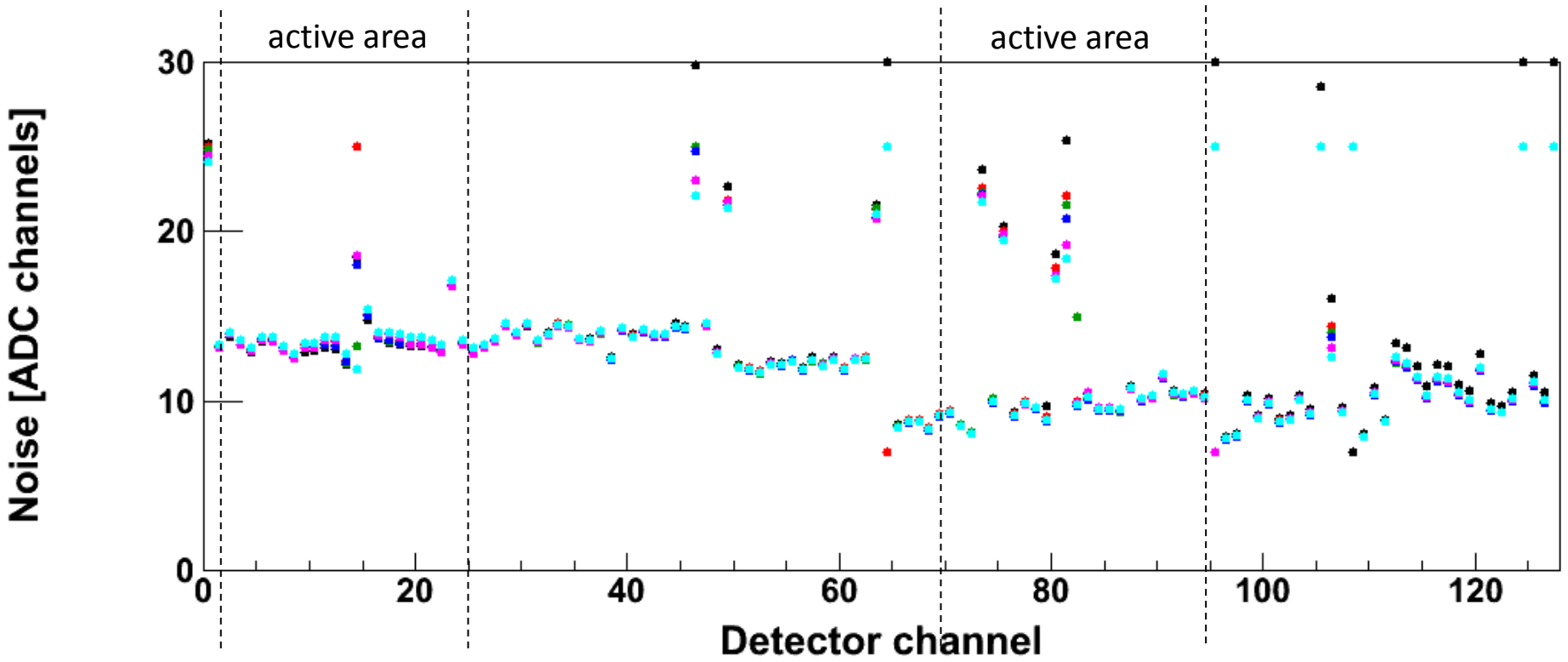
- after 12.5*10^9 events/8.2cm^2=1.52*10^9/cm^2 (=1.38% of HADES flux)

Behavior of noise



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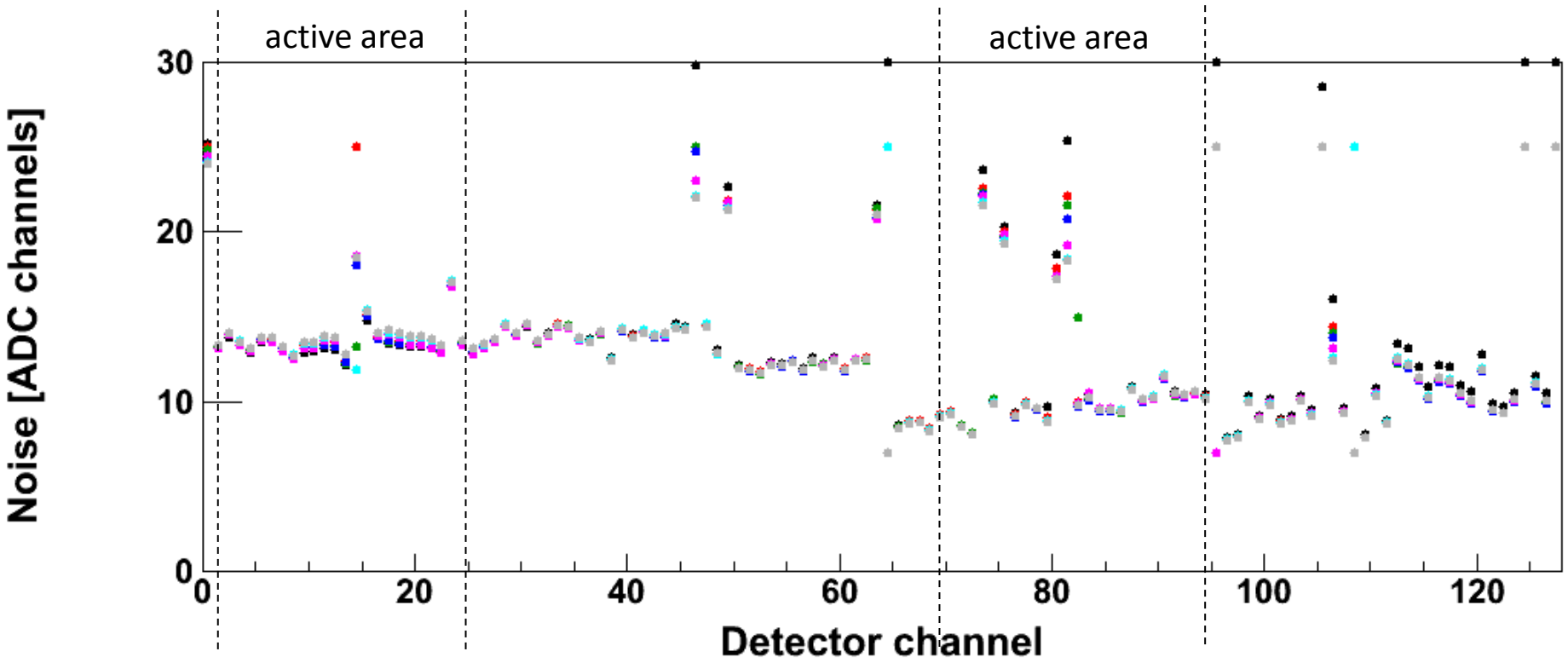
- after 15.0*10^9 events/8.2cm^2=1.83*10^9/cm^2 (=1.66% of HADES flux)

Behavior of noise



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- after 7.5*10^9 events/8.2cm^2=0.91*10^9/cm^2 (=0.83% of HADES flux)
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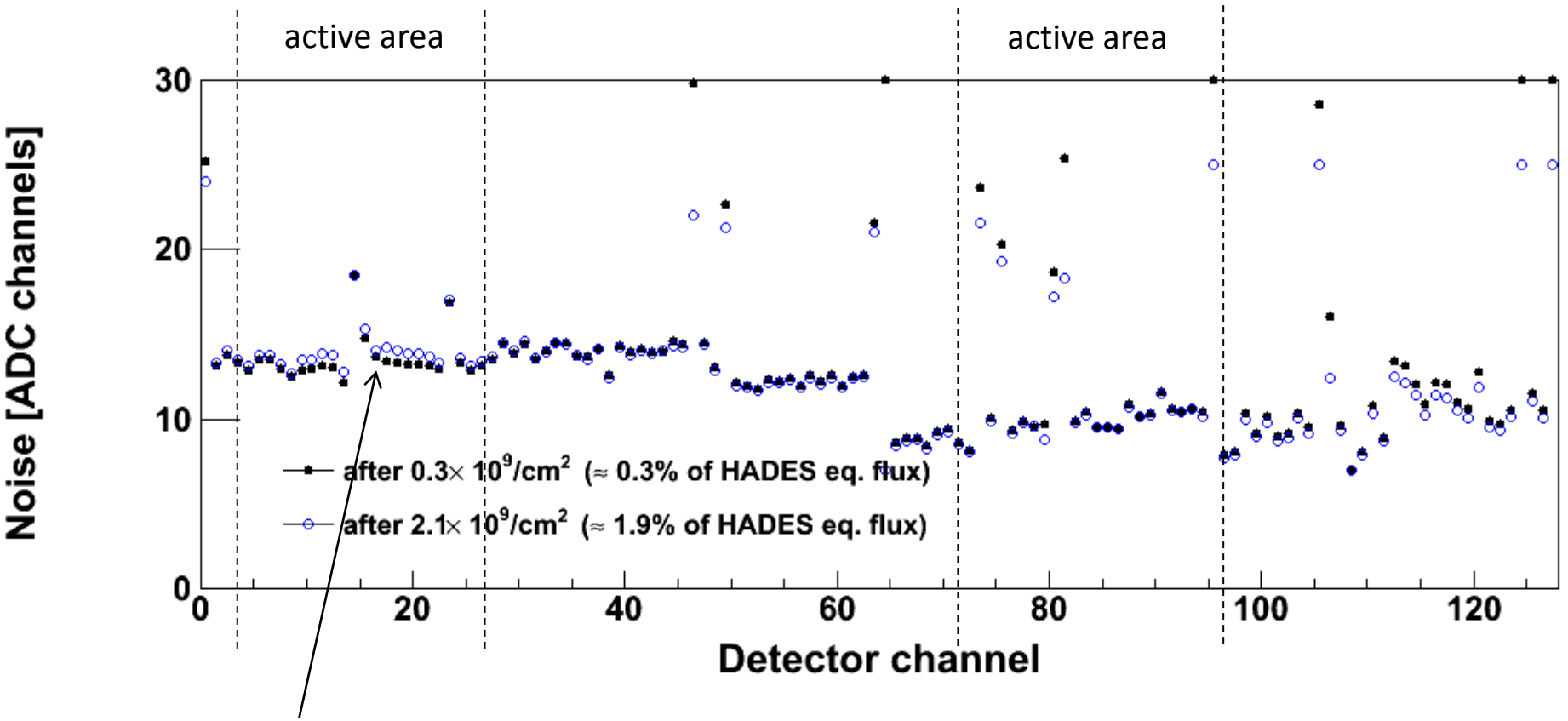
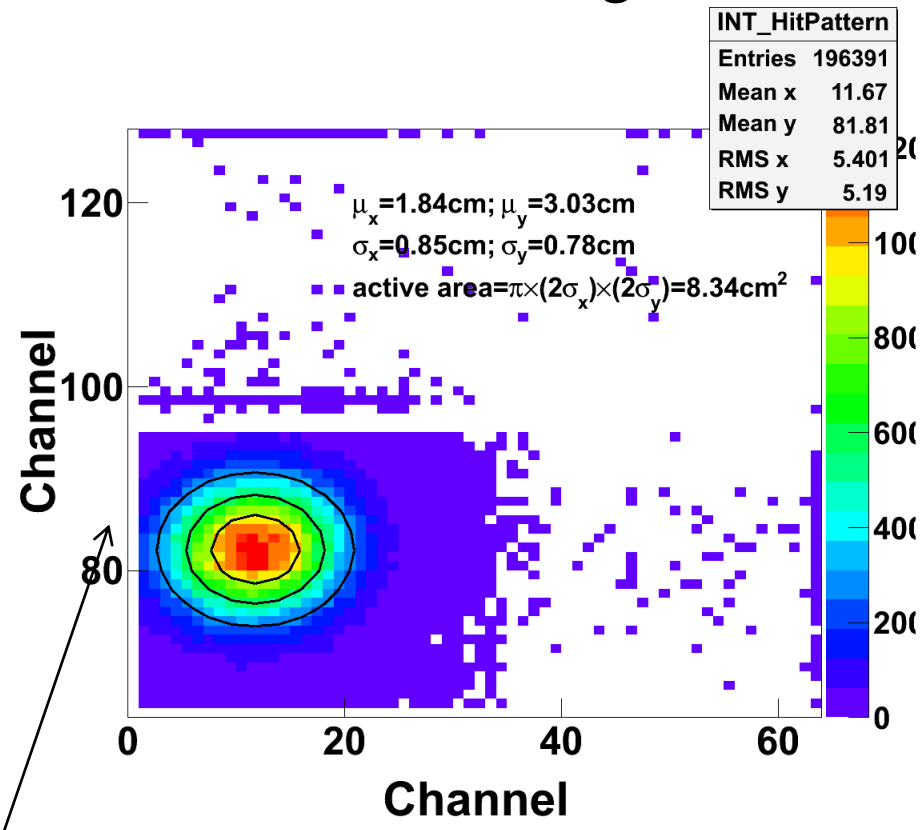
- after 12.5*10^9 events/8.2cm^2=1.52*10^9/cm^2 (=1.38% of HADES flux)
- after 15.0*10^9 events/8.2cm^2=1.83*10^9/cm^2 (=1.66% of HADES flux)
- after 17.5*10^9 events/8.2cm^2=2.13*10^9/cm^2 (=1.94% of HADES flux)

Behavior of noise



Perhaps small increase in the noise (1 ADC value). But the effect does not appear on the other active area around channel 80?

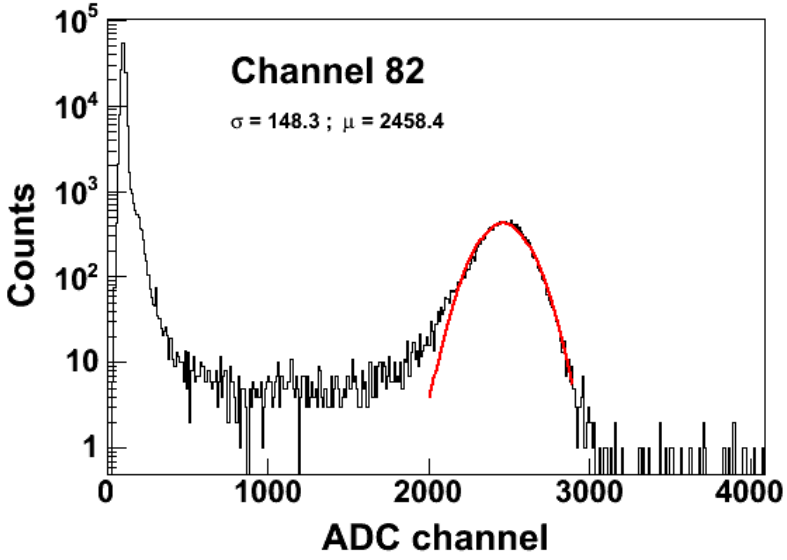
Behavior of signal



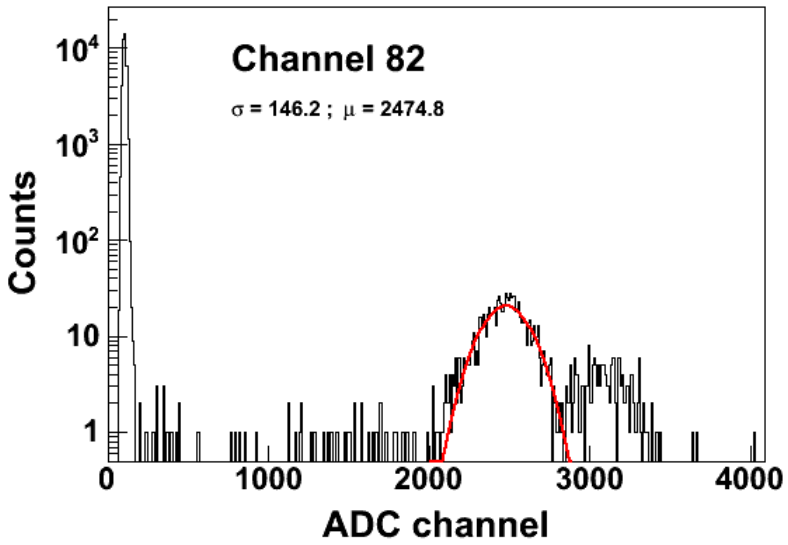
Concentrate on channel 82 which is in the centre of beam spot

Behavior of signal

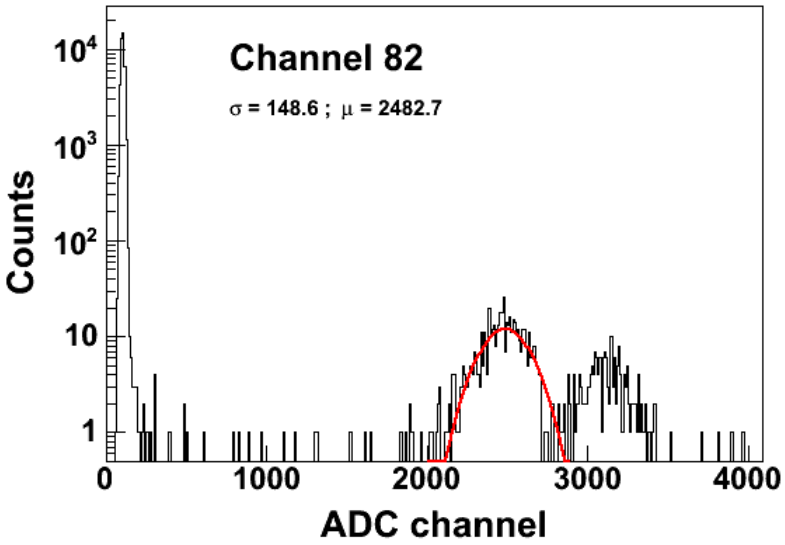
after 0.0*10^9 events



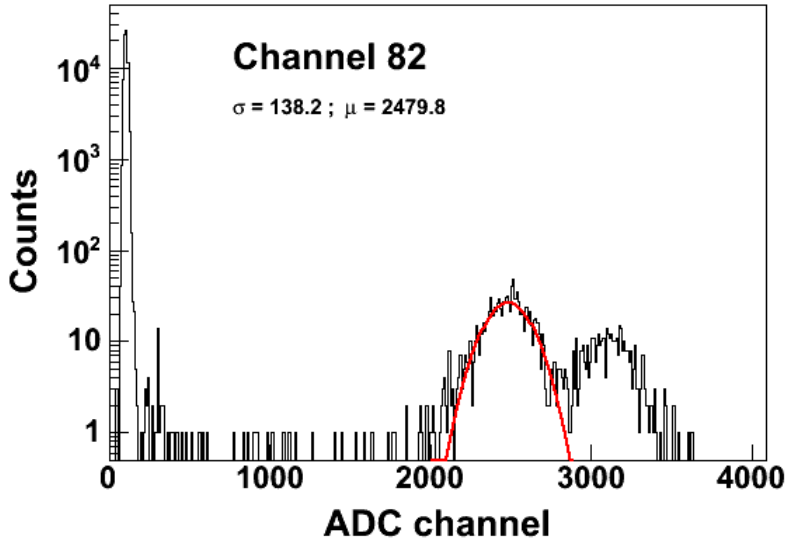
after 5.0*10^9 events



after 7.5*10^9 events

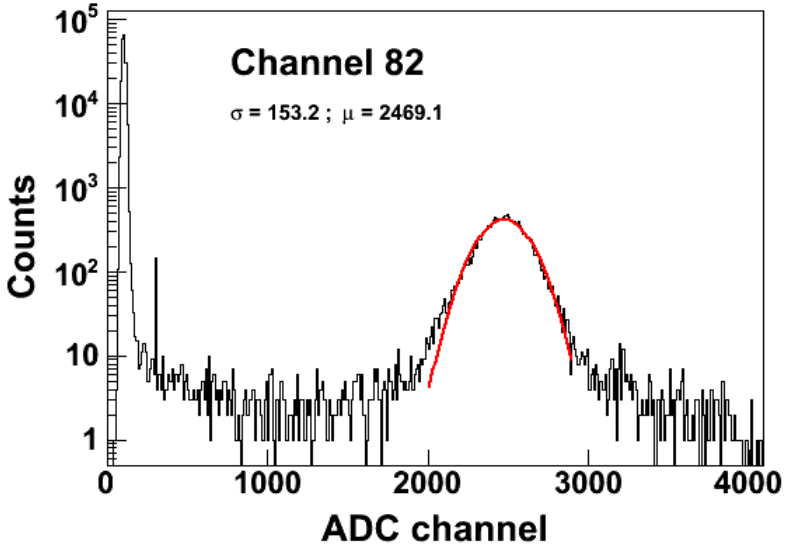


after 10*10^9 events

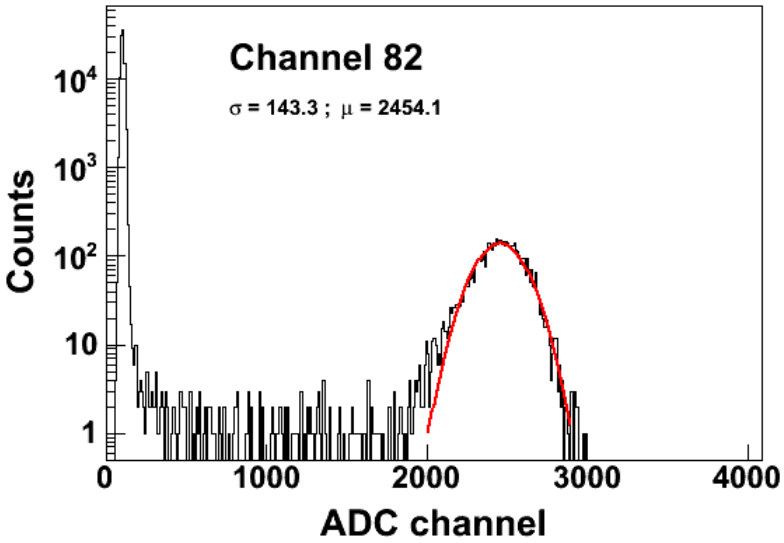


Behavior of signal

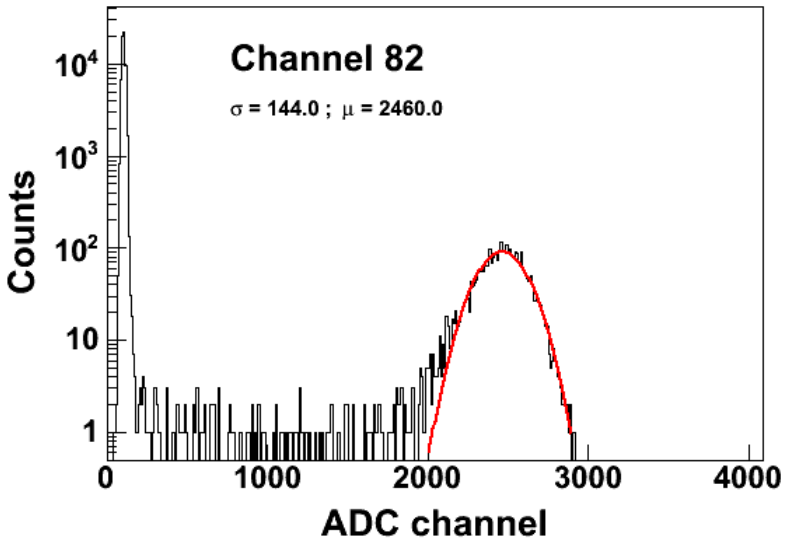
after 12.5*10^9 events



after 15.0*10^9 events



after 17.5*10^9 events

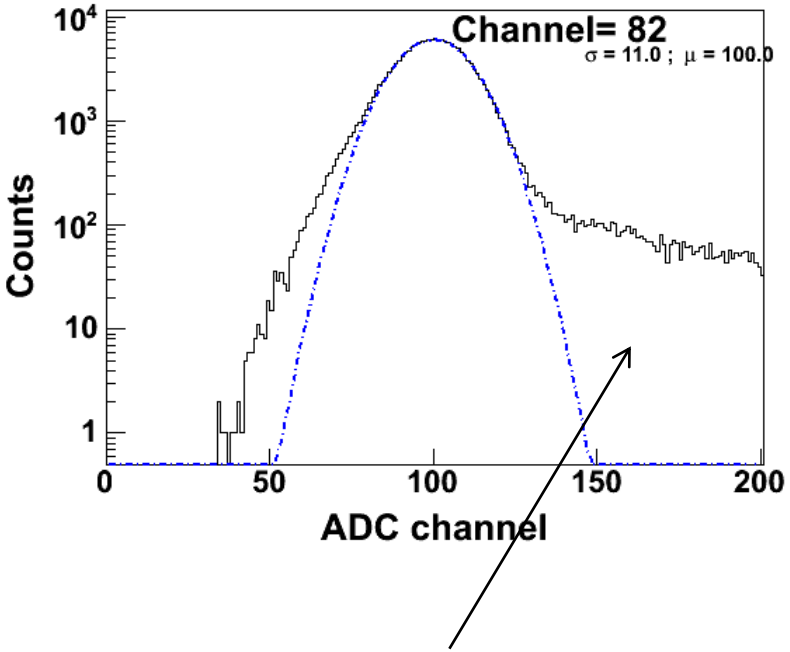


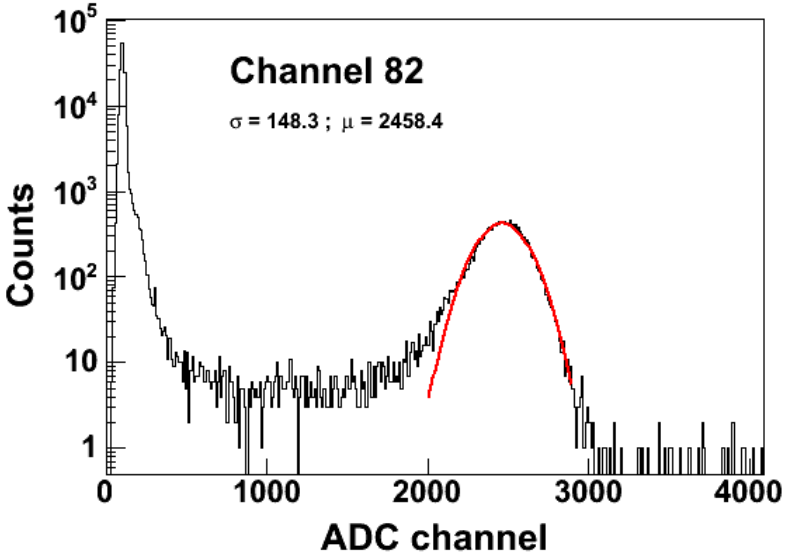
Events [10^9]	mean
0.0	2458.4
5.0	2474.8
7.5	2482.7
10	2479.8
12.5	2469.1
15.0	2454.1
17.5	2460.0

Backup slides

Signal and Noise behavior

_proton_05: 8.6.2012, 11:35; beam positioned, Intensity between High- and LowIntensity,
Total Flux: 0.0

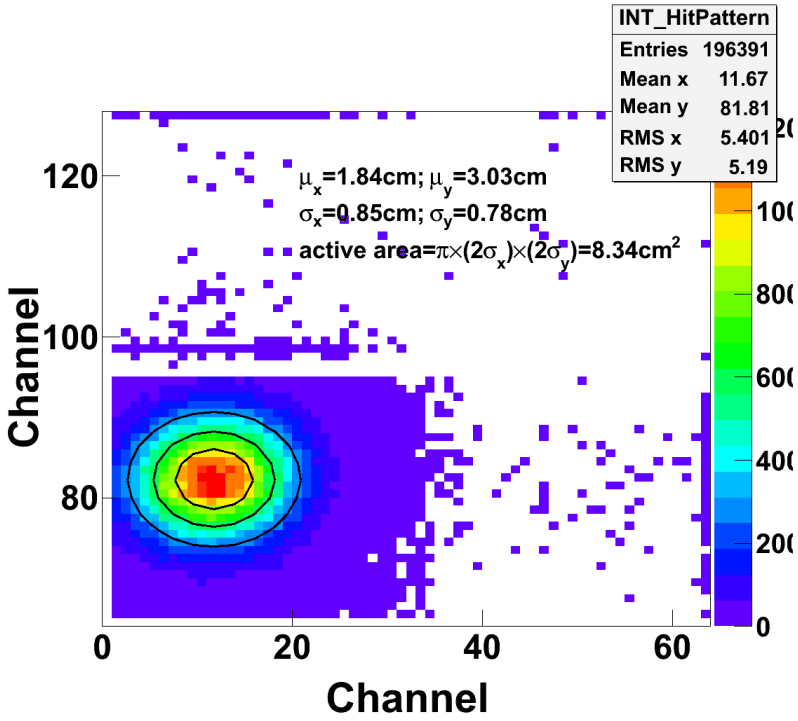


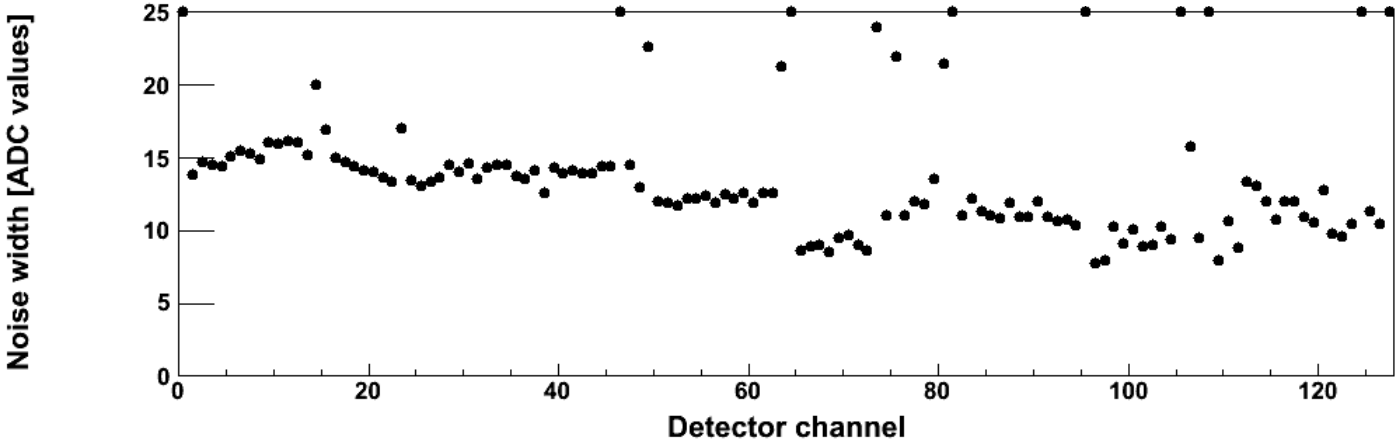


Comes probably from long integration time combined with high intensity (-> no reliable noise pattern)

Signal and Noise behavior

_proton_05: 8.6.2012, 11:35; beam positioned, Intensity between High- and LowIntensity,
Total Flux: 0.0

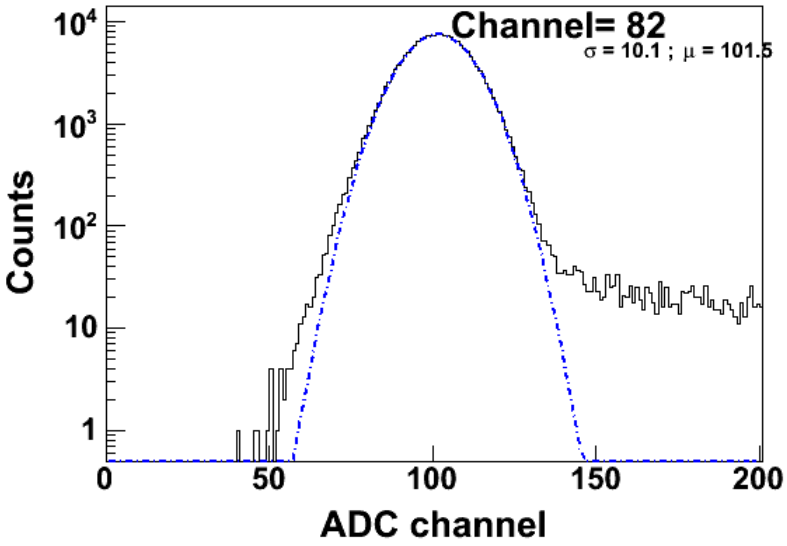


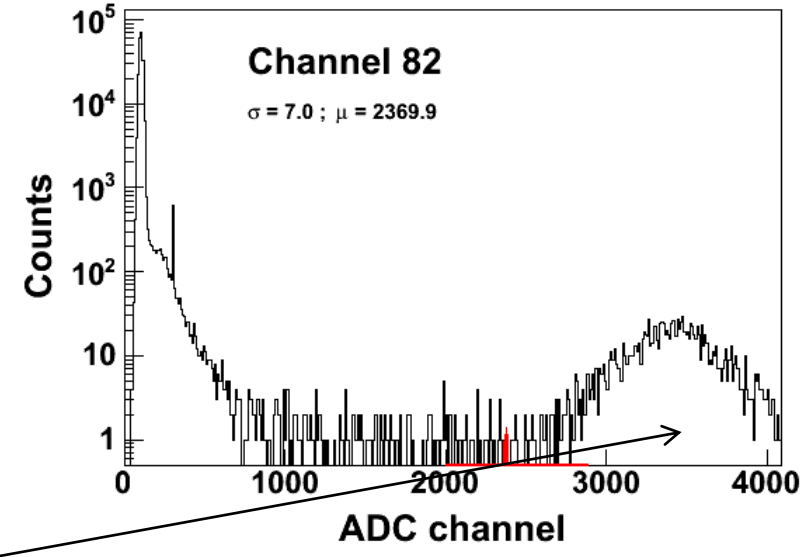


Signal and Noise behavior

_proton_09: 8.6.2012, 15:55, with Cup in front of detector, no HitPattern, LowIntnesity

Total Flux: 2.5*10^9 events



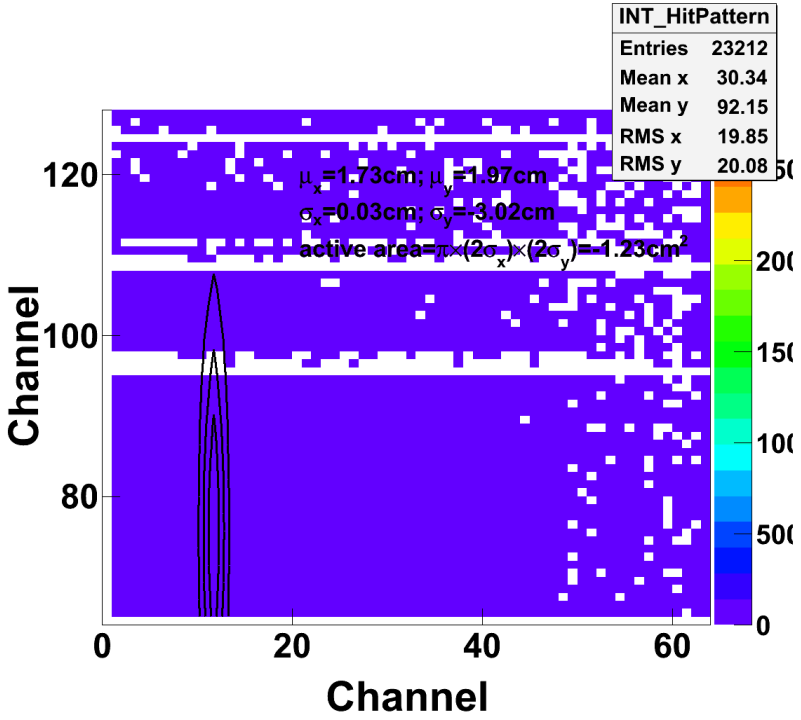


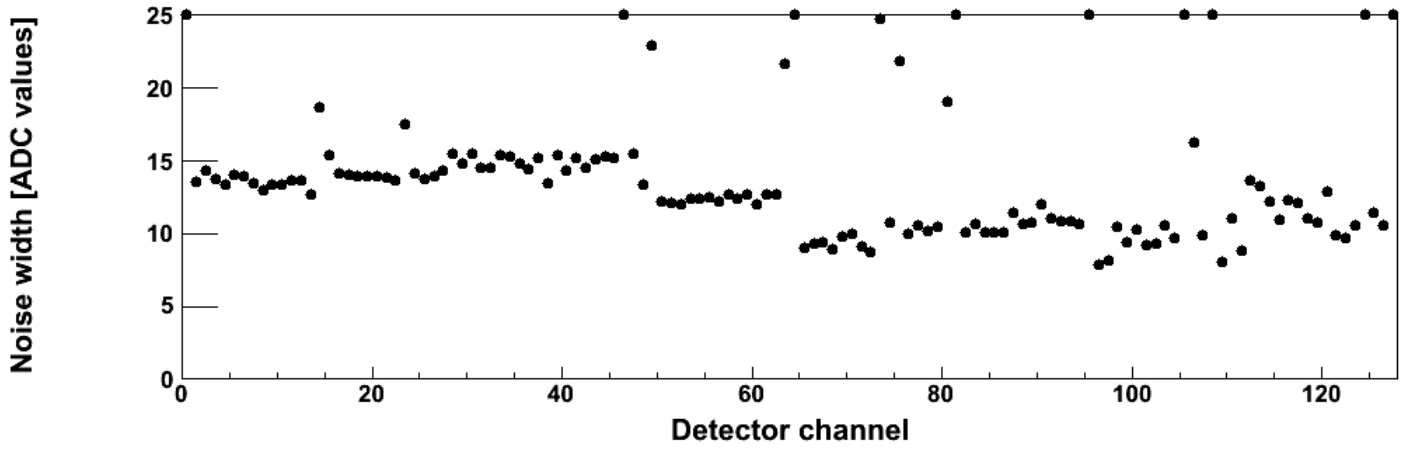
Bump shifted (probably protons loose energy due to cup)-> Higher energy loss in detector

Signal and Noise behavior

_proton_09: 8.6.2012, 15:55, with Cup in front of detector, no HitPattern, LowIntnesity

Total Flux: 2.5*10^9 events

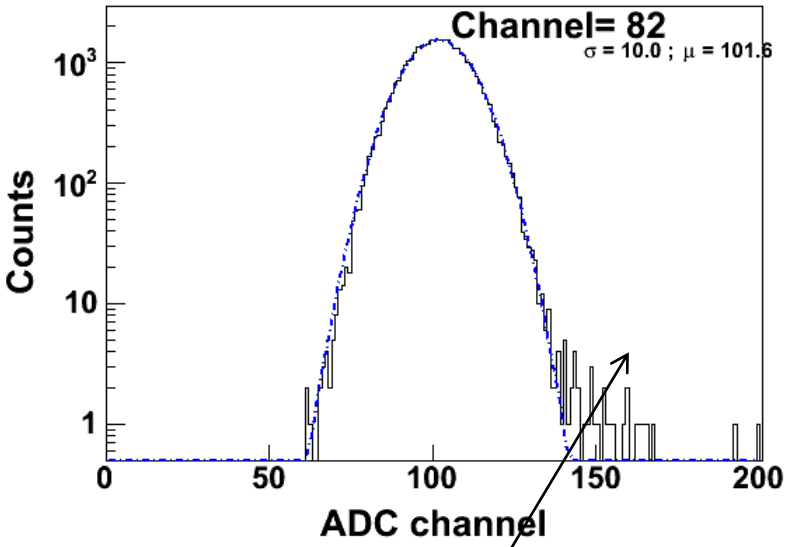


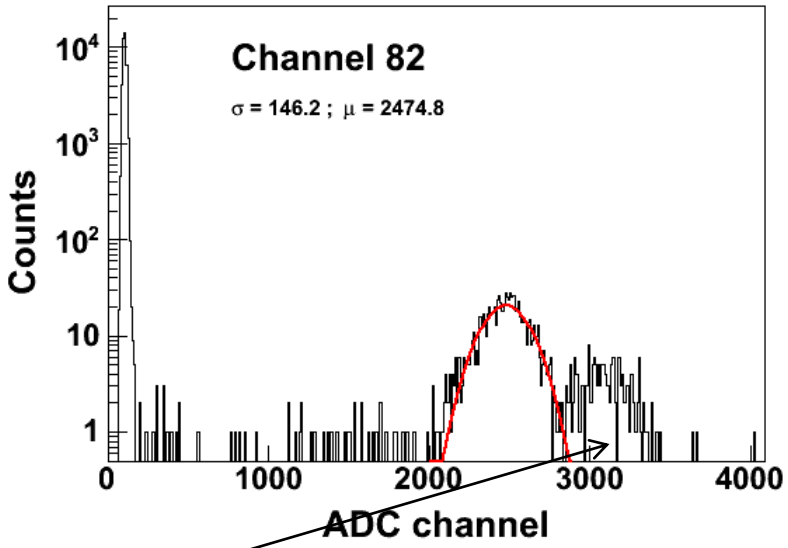


Signal and Noise behavior

_proton_13: 8.6.2012, 23:50, after 4% (5*10^9 events), LowIntensity

Total Flux: 5*10^9 events





Low Intensity->no structure as before

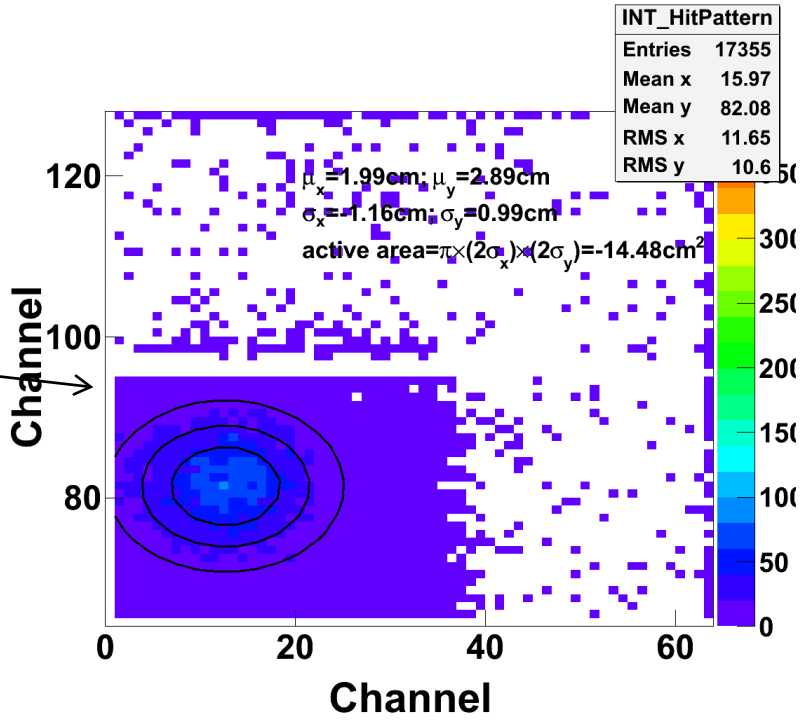
Strange 2nd bump (origin unclear)

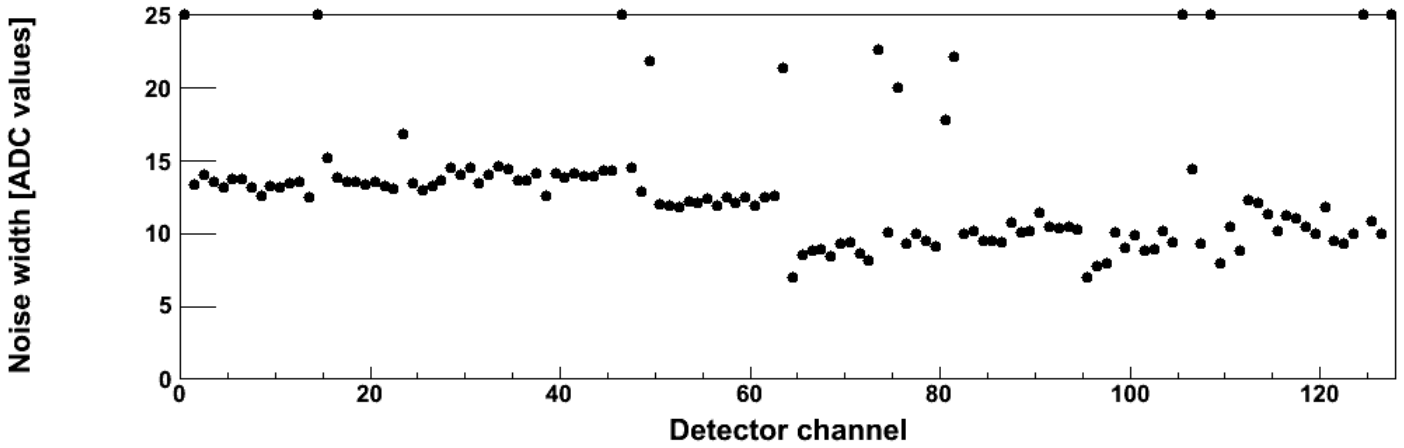
Signal and Noise behavior

_proton_13: 8.6.2012, 23:50, after 4% (5*10^9 events), LowIntensity

Total Flux: 5*10^9 events

Strange HitPattern, no clear circle,
very low efficiency

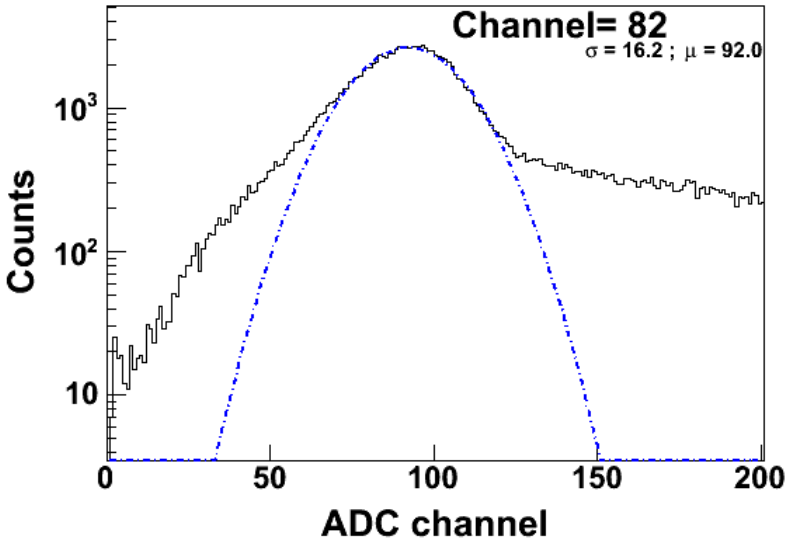


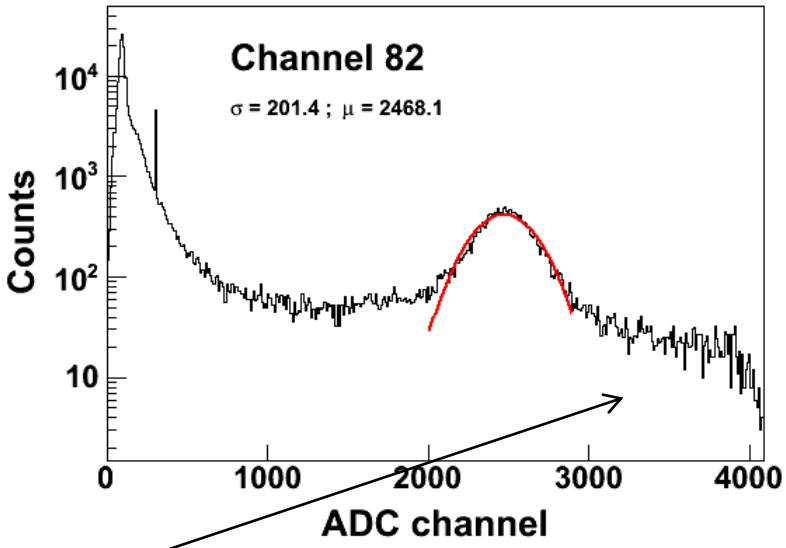


Signal and Noise behavior

_proton_14: 9.6.2012, 00:20, HighIntensity

Total Flux: 5*10^9 events





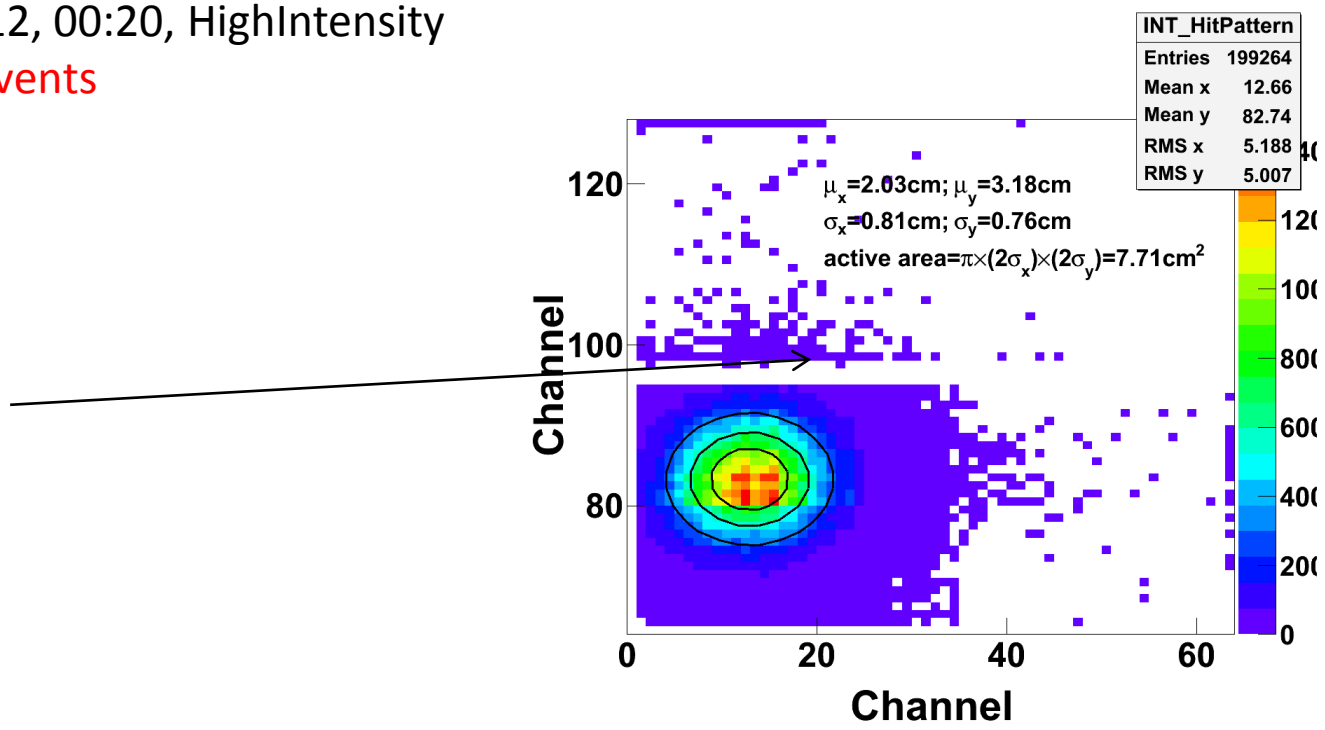
Perhaps small 2nd bump or only rest of integration time problem

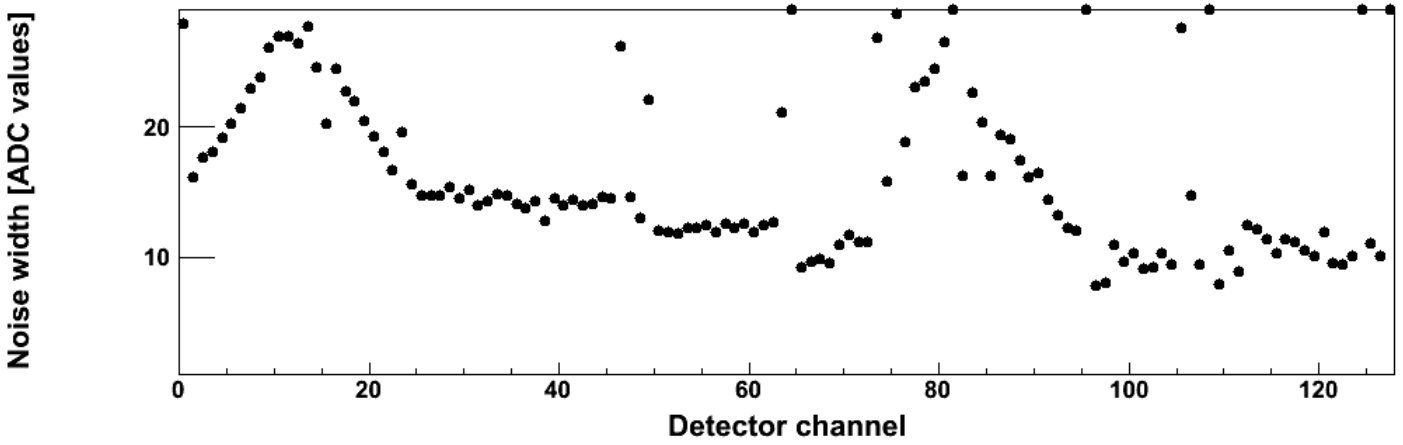
Signal and Noise behavior

_proton_14: 9.6.2012, 00:20, HighIntensity

Total Flux: 5*10^9 events

Normal Hitpattern

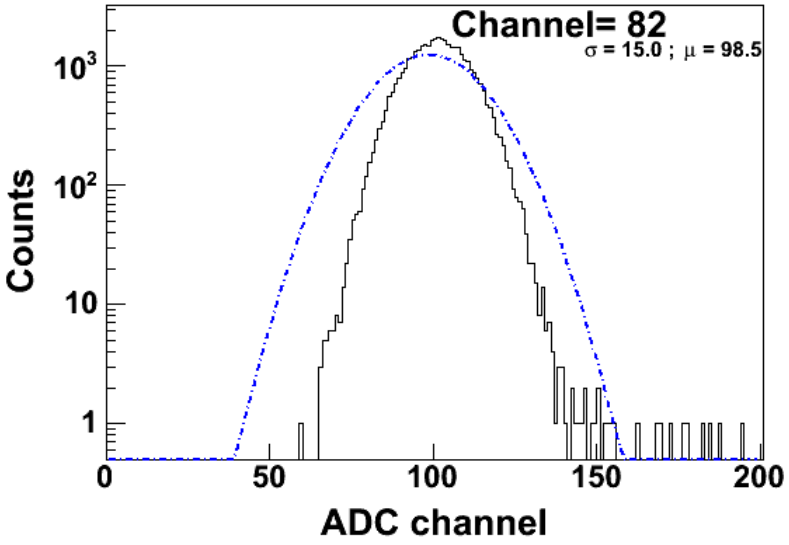


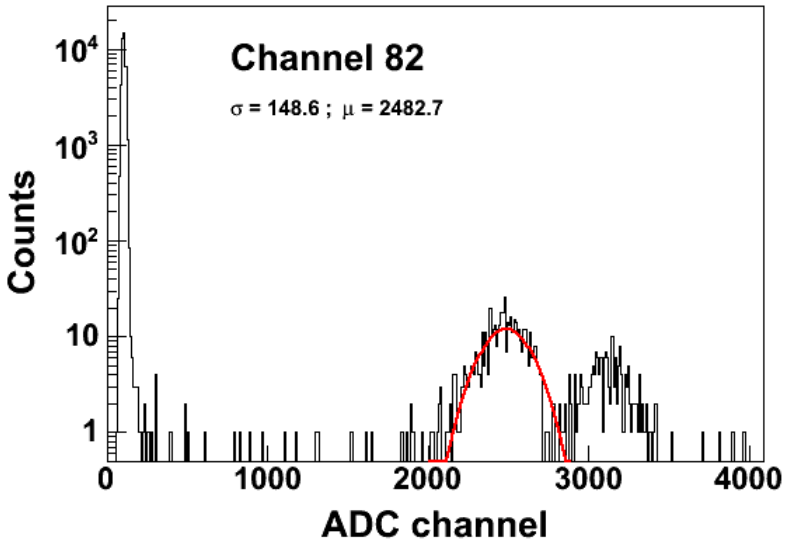


Signal and Noise behavior

_proton_15: 9.6.2012, 1:52, after 6% (7.5*10^9 events), LowIntensity

Total Flux: 7.5*10^9 events

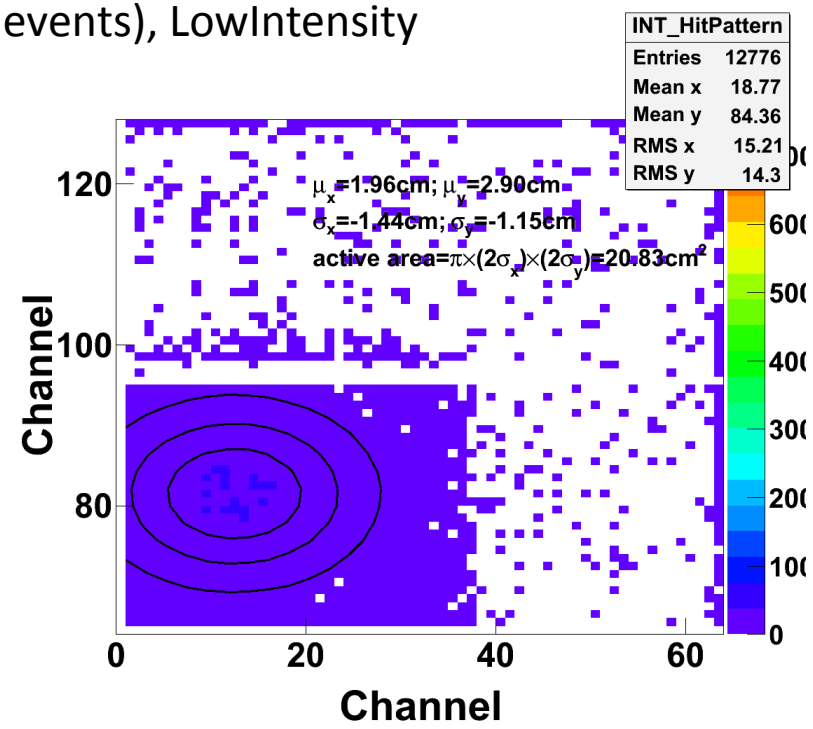


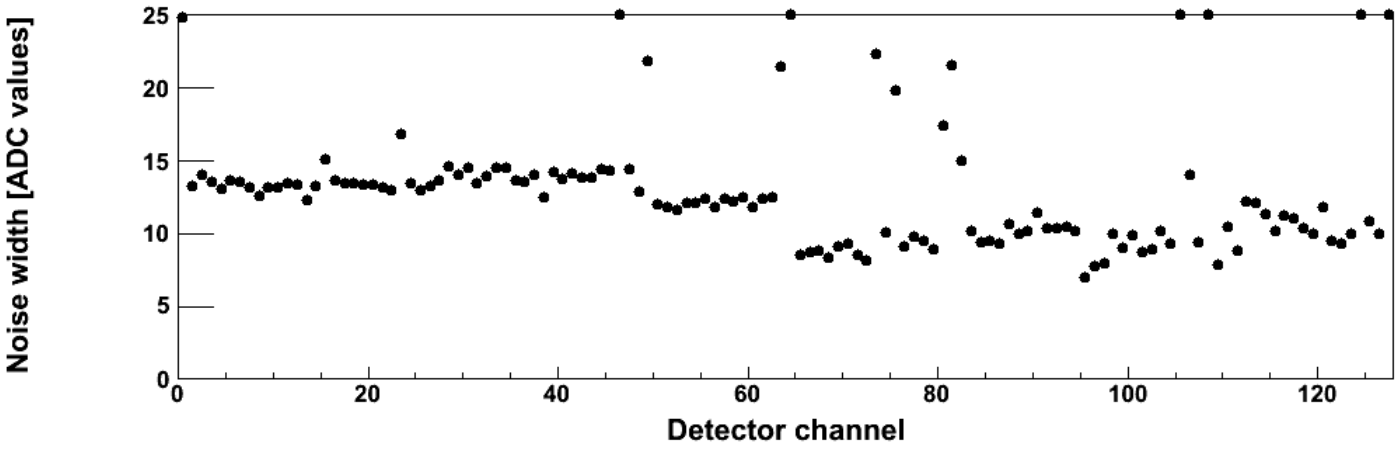


Signal and Noise behavior

_proton_15: 9.6.2012, 1:52, after 6% (7.5*10^9 events), LowIntensity

Total Flux: 7.5*10^9 events

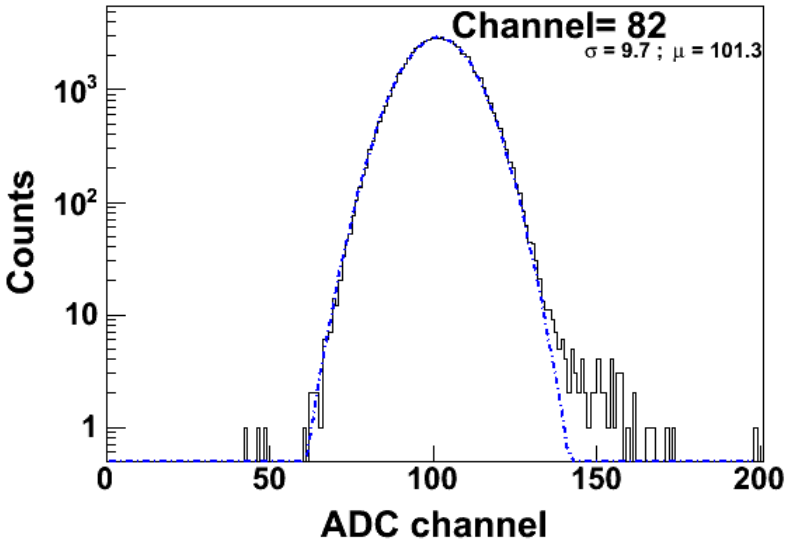


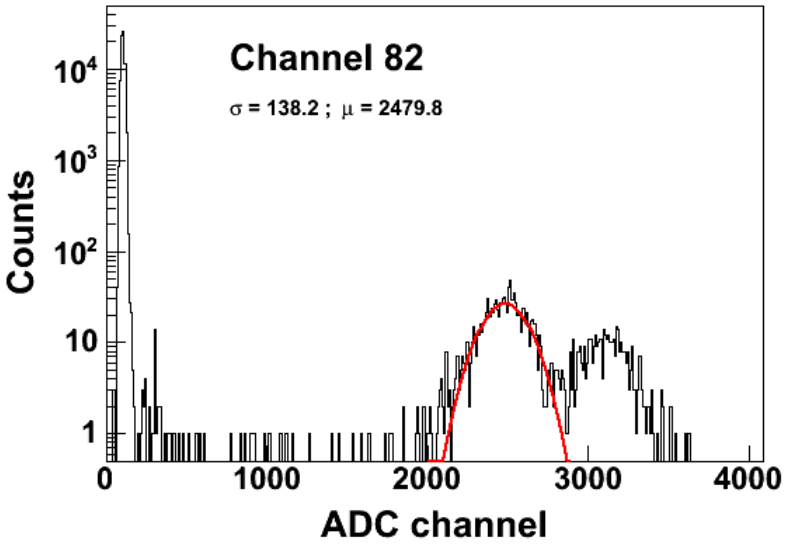


Signal and Noise behavior

_proton_17: 9.6.2012, 4:22, after 8% (10*10^9),LowIntensity

Total Flux: 10*10^9 events

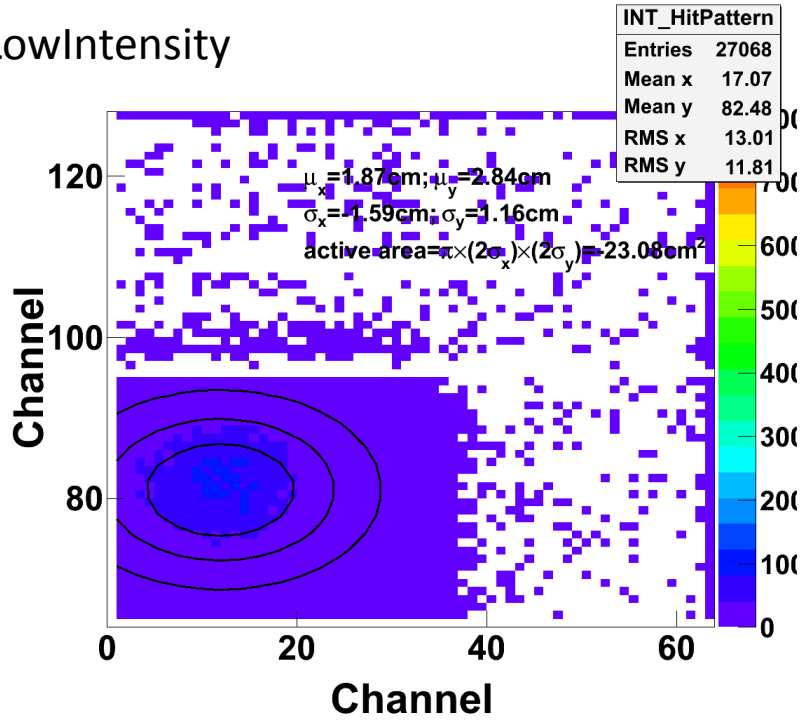


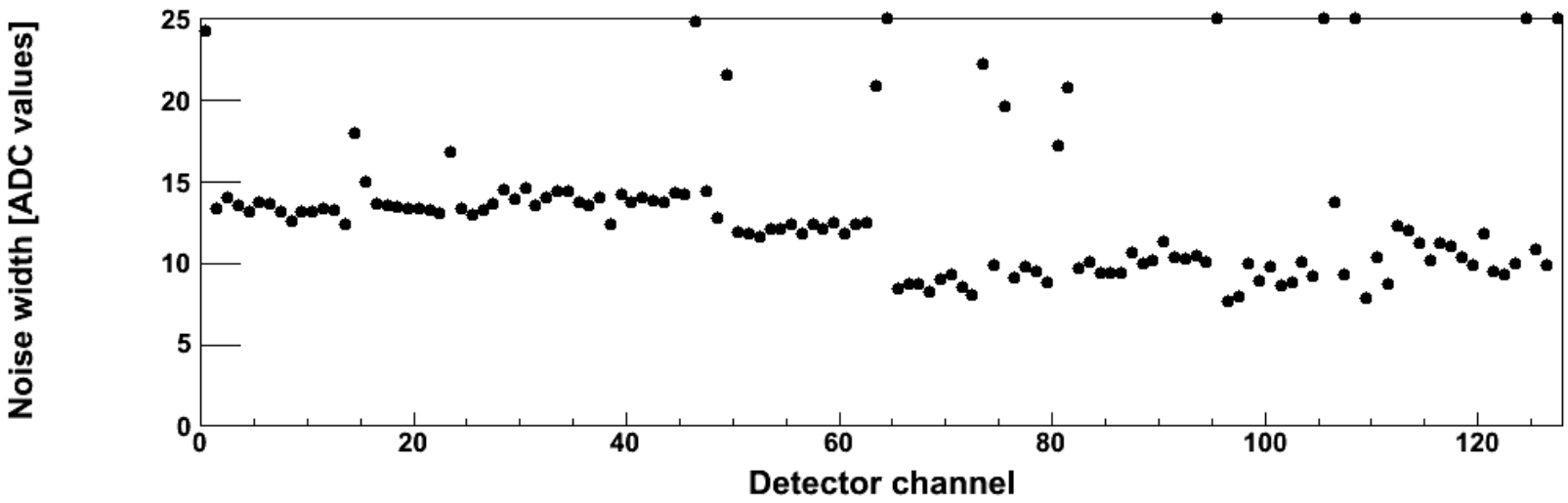


Signal and Noise behavior

_proton_17: 9.6.2012, 4:22, after 8% (10*10^9),LowIntensity

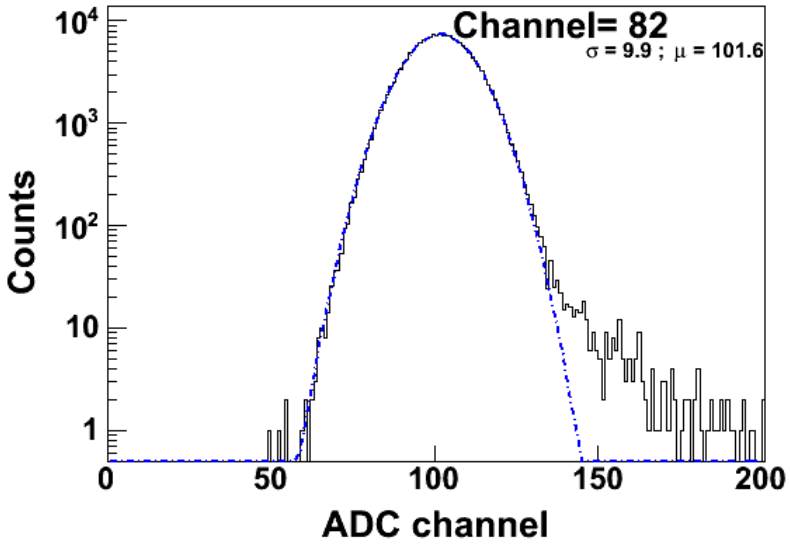
Total Flux: 10*10^9 events

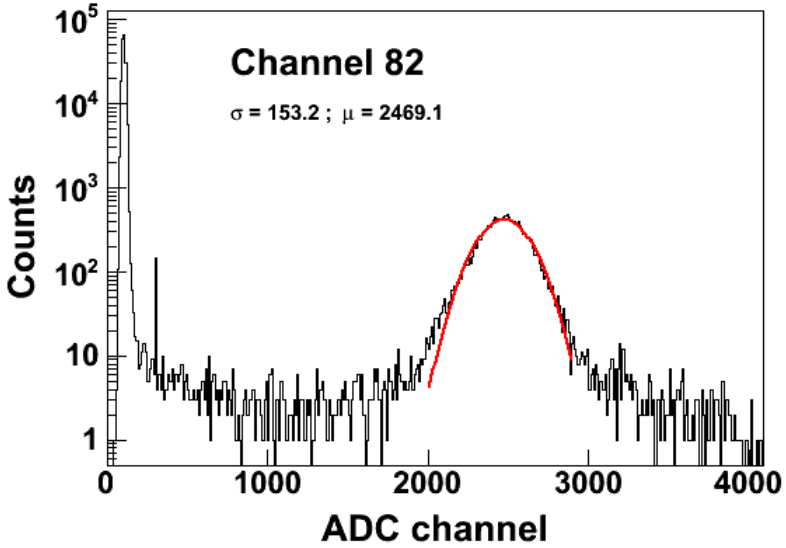




Signal and Noise behavior

_proton_20:9.6.2012, 18:35, after 10%(12.5*10^9), LowIntensity, with Lochblende of Roman double bump structure gone Total Flux: 12.5*10^9 events

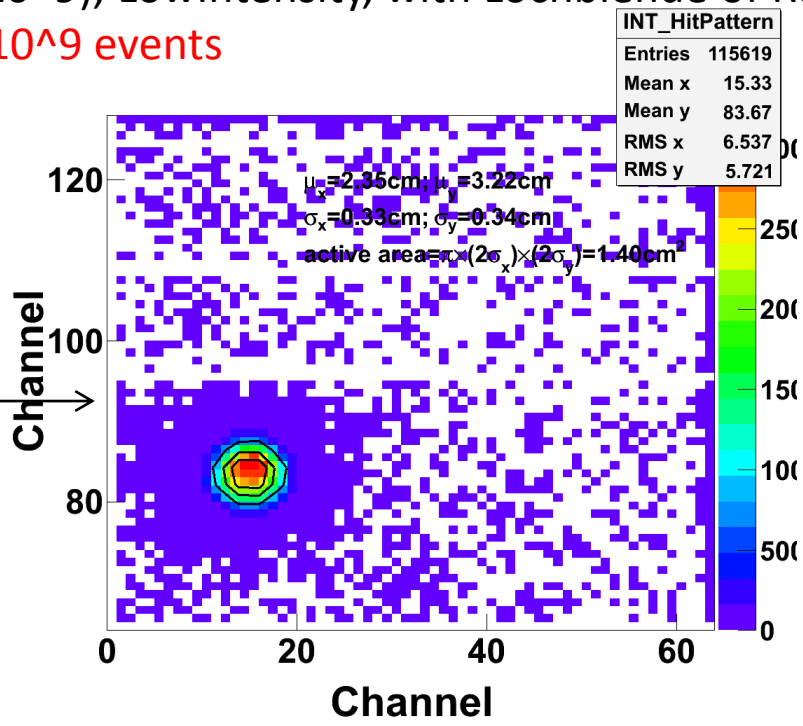


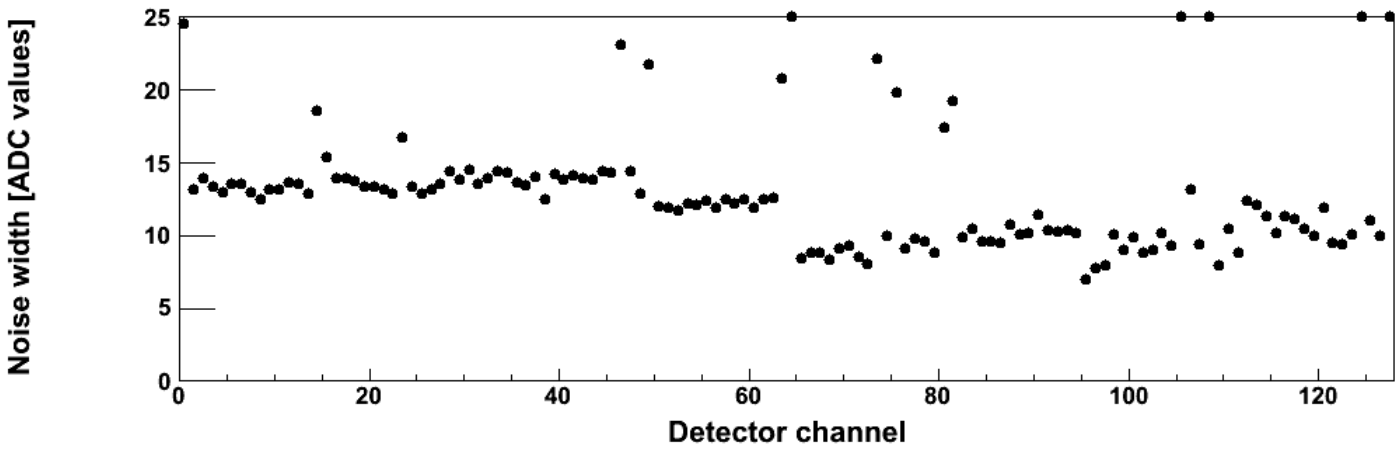


Signal and Noise behavior

_proton_20:9.6.2012, 18:35, after 10%(12.5*10^9), LowIntensity, with Lochblende of Roman double bump structure gone Total Flux: 12.5*10^9 events

Result of the Blende

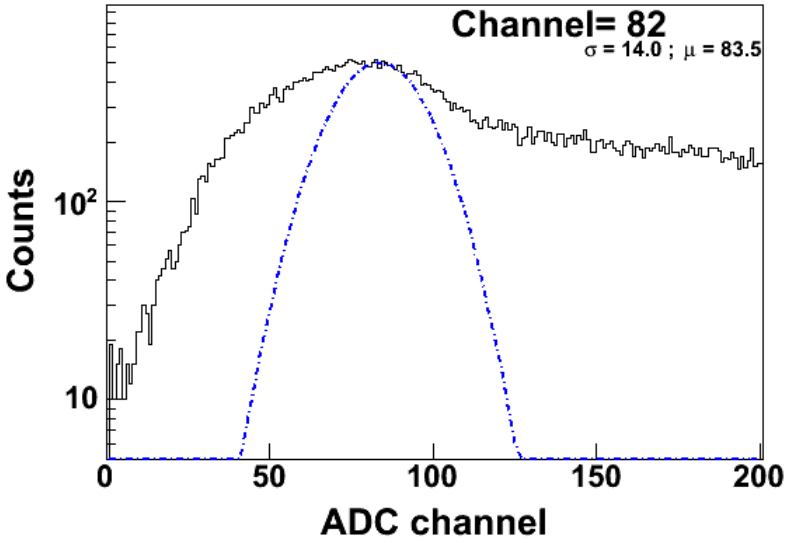


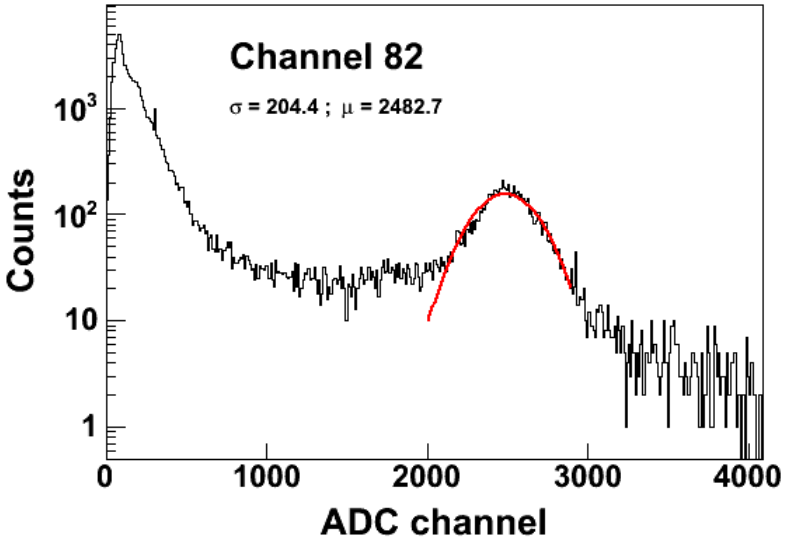


Signal and Noise behavior

_proton_26: 10.6.2012, 00:59, HighIntensity

Total Flux: 12.5*10^9 events

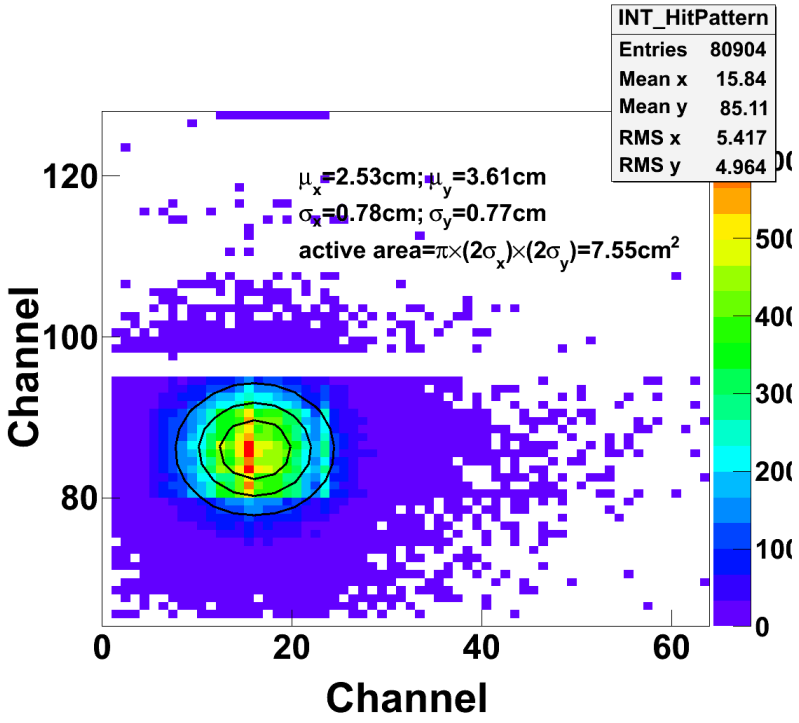


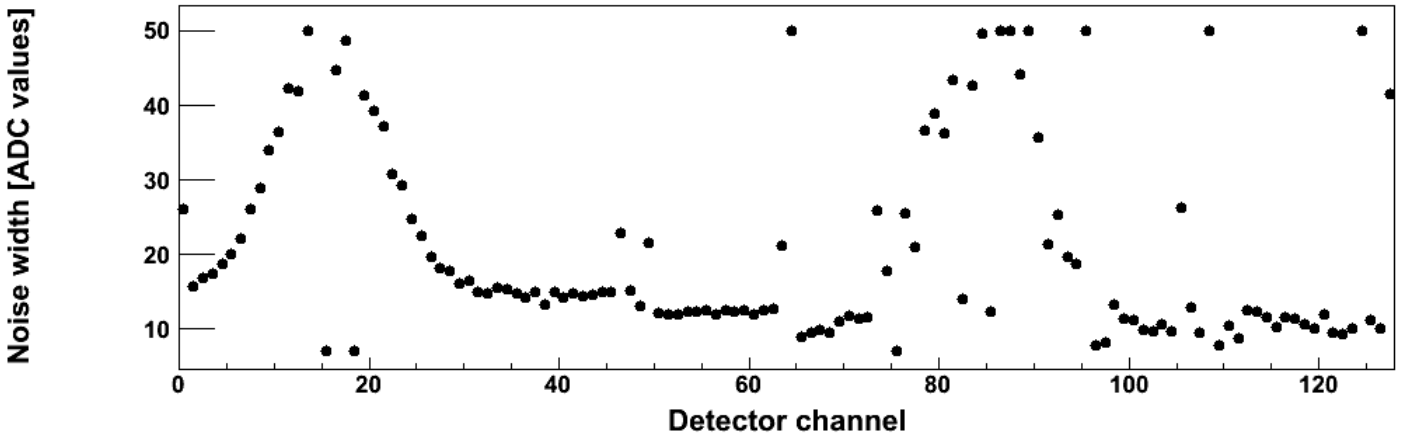


Signal and Noise behavior

_proton_26: 10.6.2012, 00:59, HighIntensity

Total Flux: 12.5*10^9 events

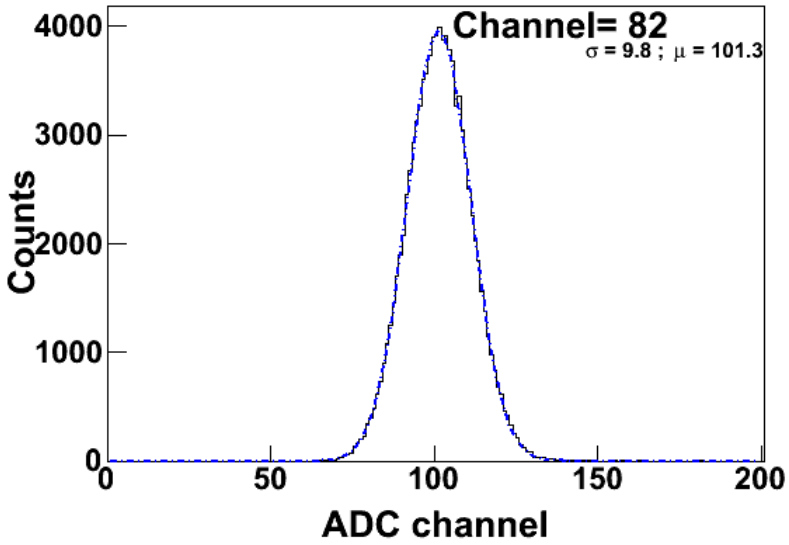


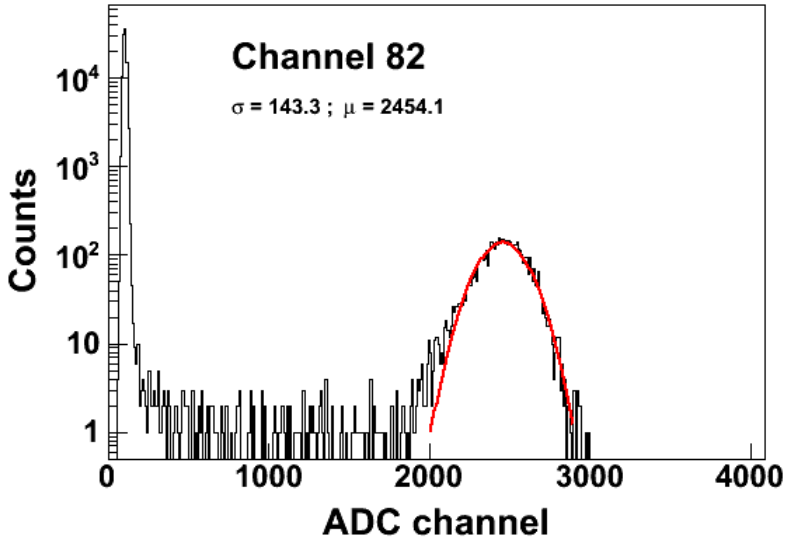


Signal and Noise behavior

_proton_27: 10.6.2012,--:--, after 12% (15*10^10), LowIntensity

Total Flux: 15*10^9 events

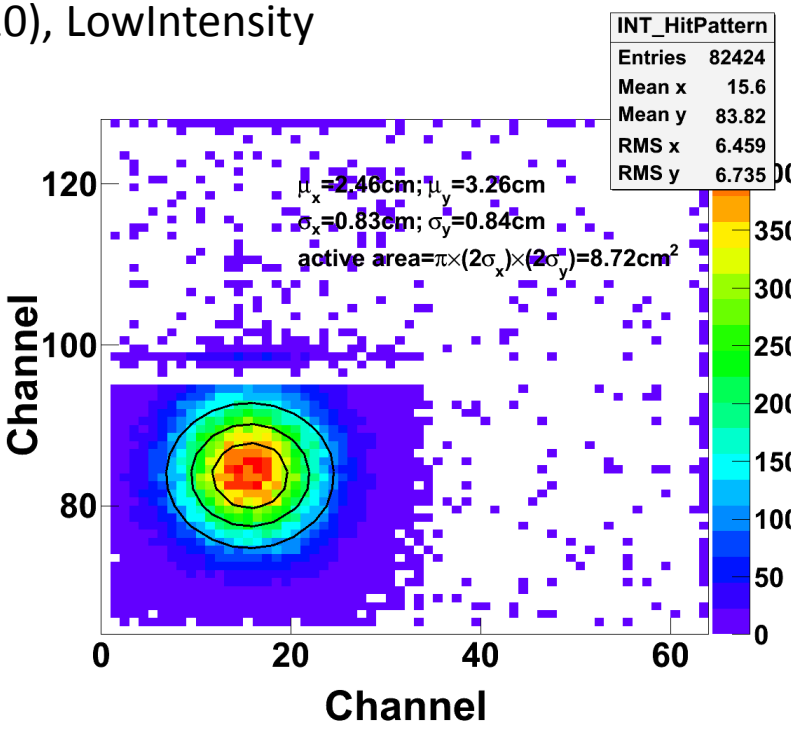


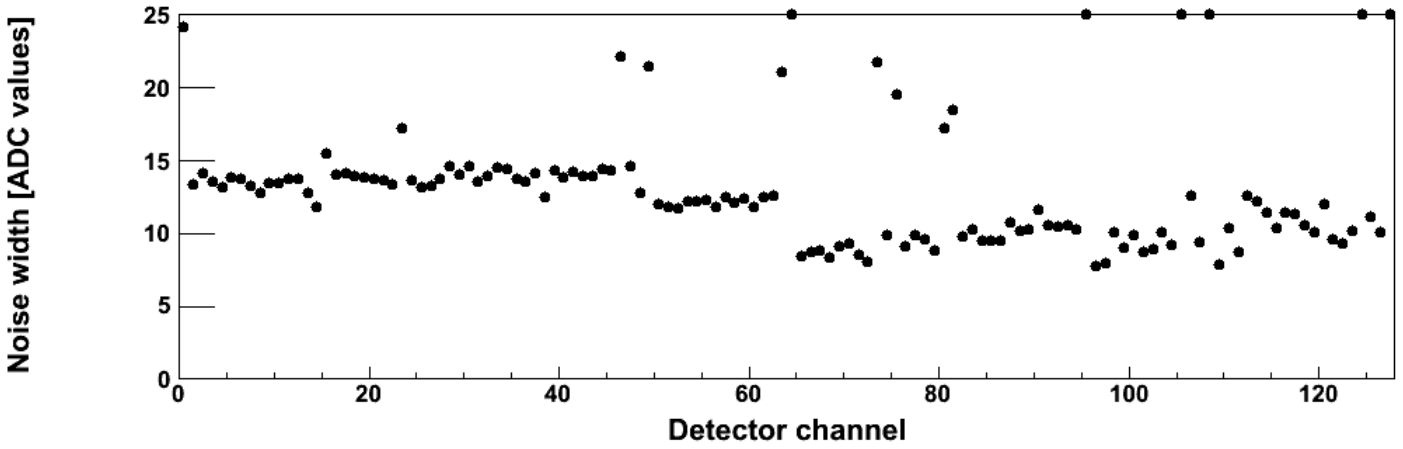


Signal and Noise behavior

_proton_27: 10.6.2012,--:--, after 12% (15*10^10), LowIntensity

Total Flux: 15*10^9 events

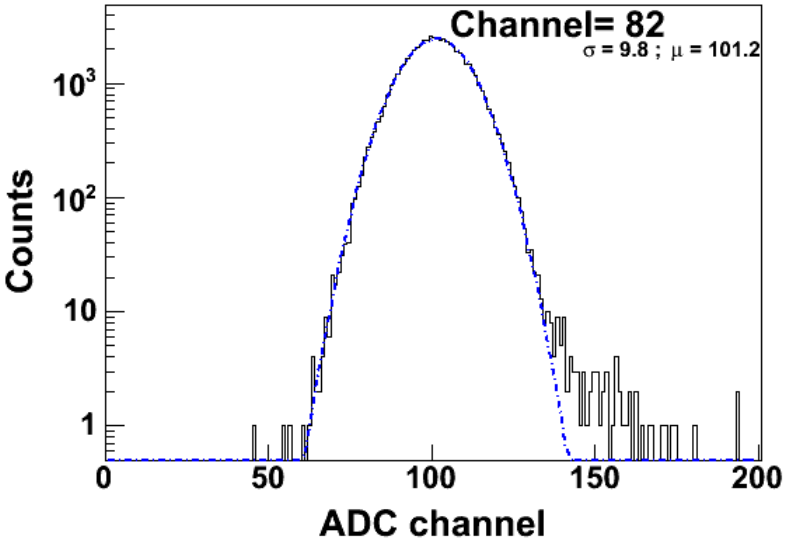


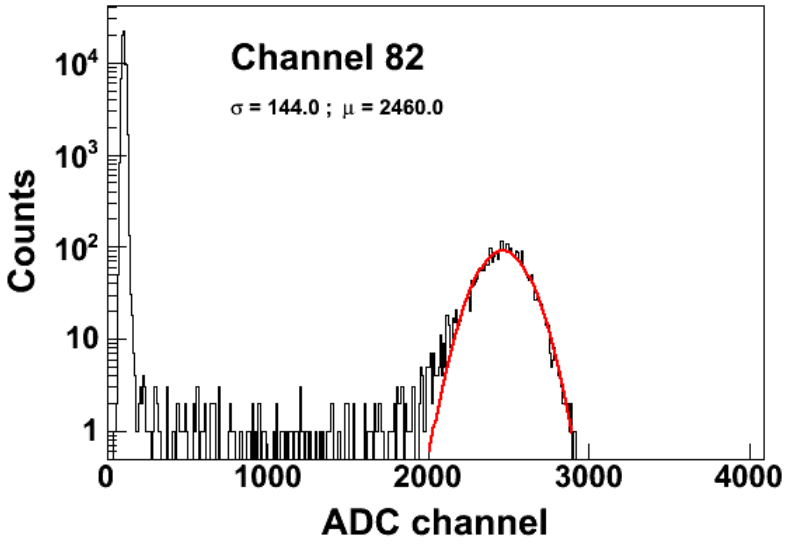


Signal and Noise behavior

_proton_28: 10.6.2012,--:--, after 14% (17.5*10^10), LowIntensity

Total Flux: 17.5*10^9 events

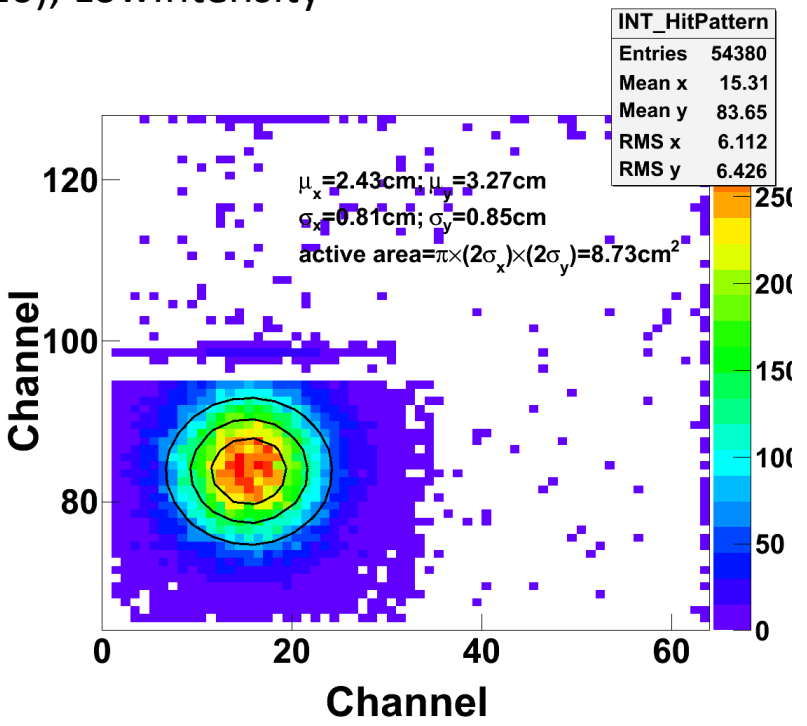


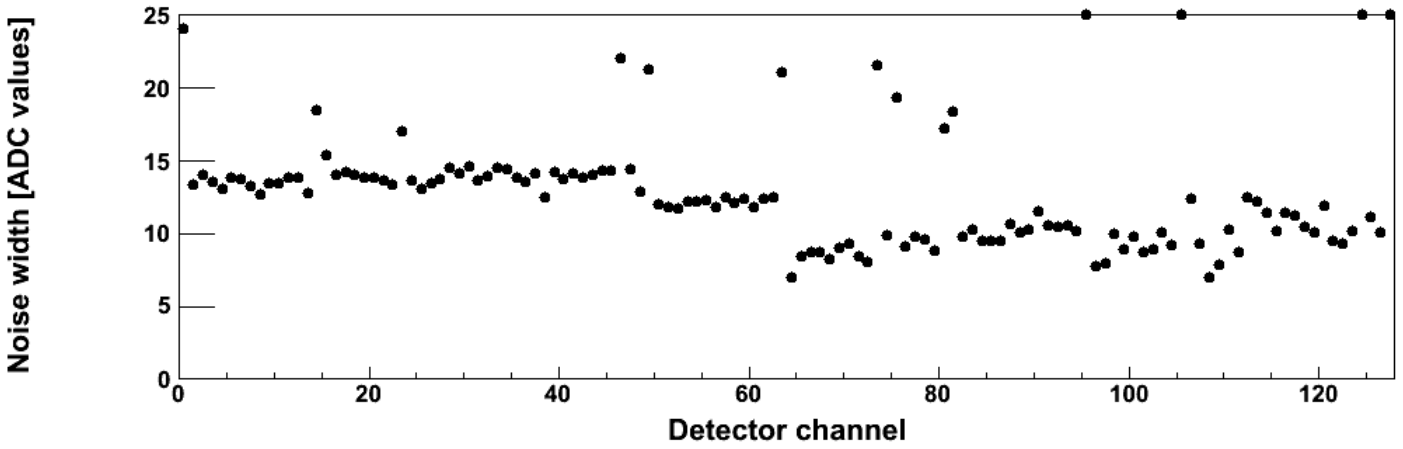


Signal and Noise behavior

_proton_28: 10.6.2012,--:--, after 14% (17.5*10^10), LowIntensity

Total Flux: 17.5*10^9 events

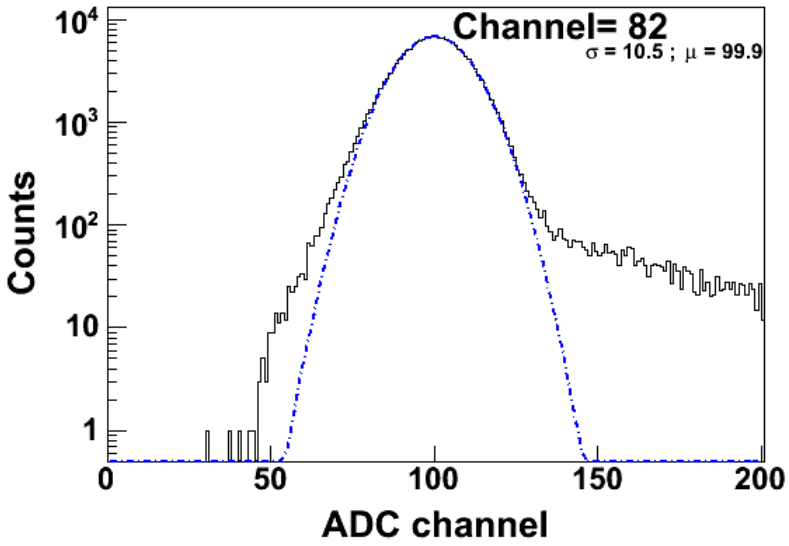


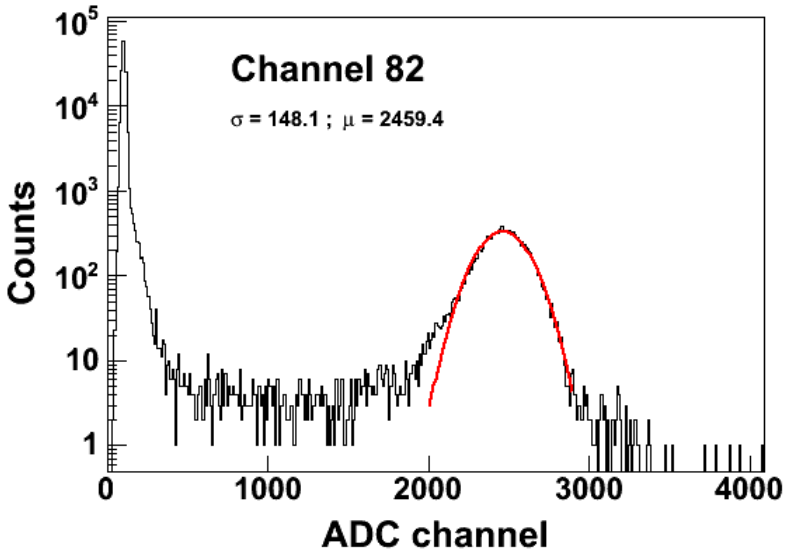


Signal and Noise behavior

_proton_29: 10.6.2012,--:--, after very HighIntensity run, LowIntensity

Total Flux: after very HighIntensity

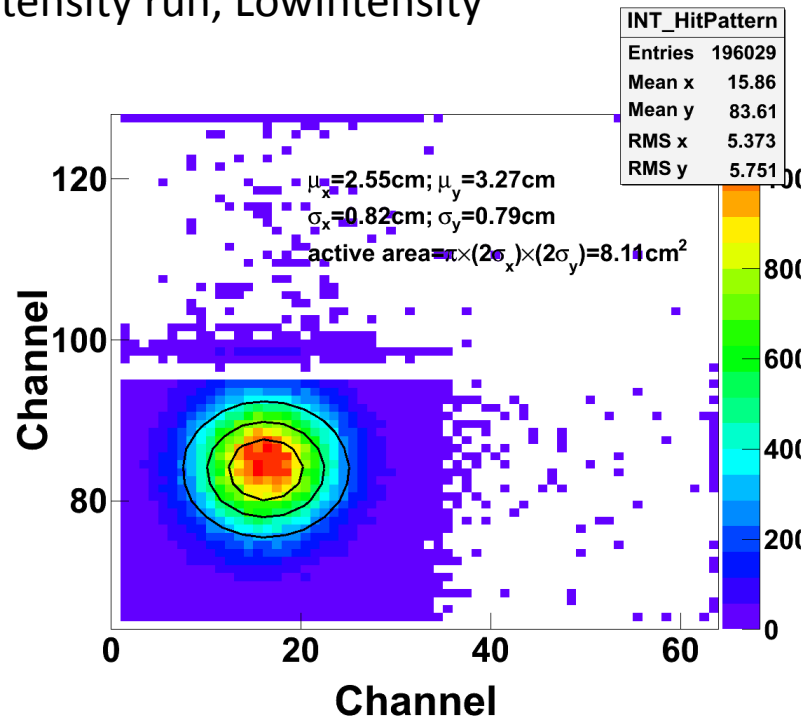


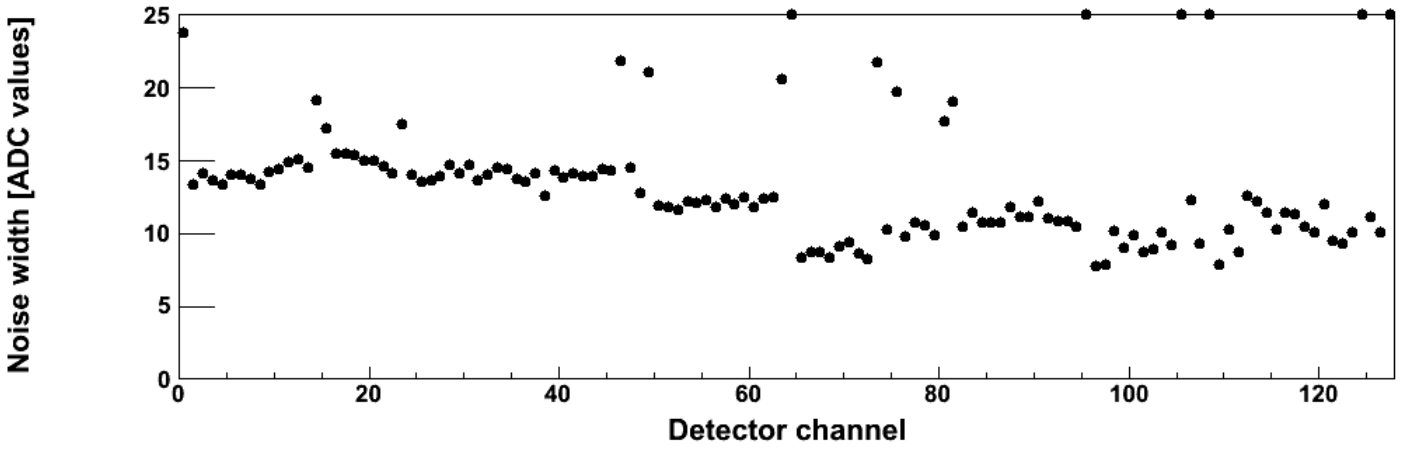


Signal and Noise behavior

_proton_29: 10.6.2012,--:--, after very HighIntensity run, LowIntensity

Total Flux: after very HighIntensity



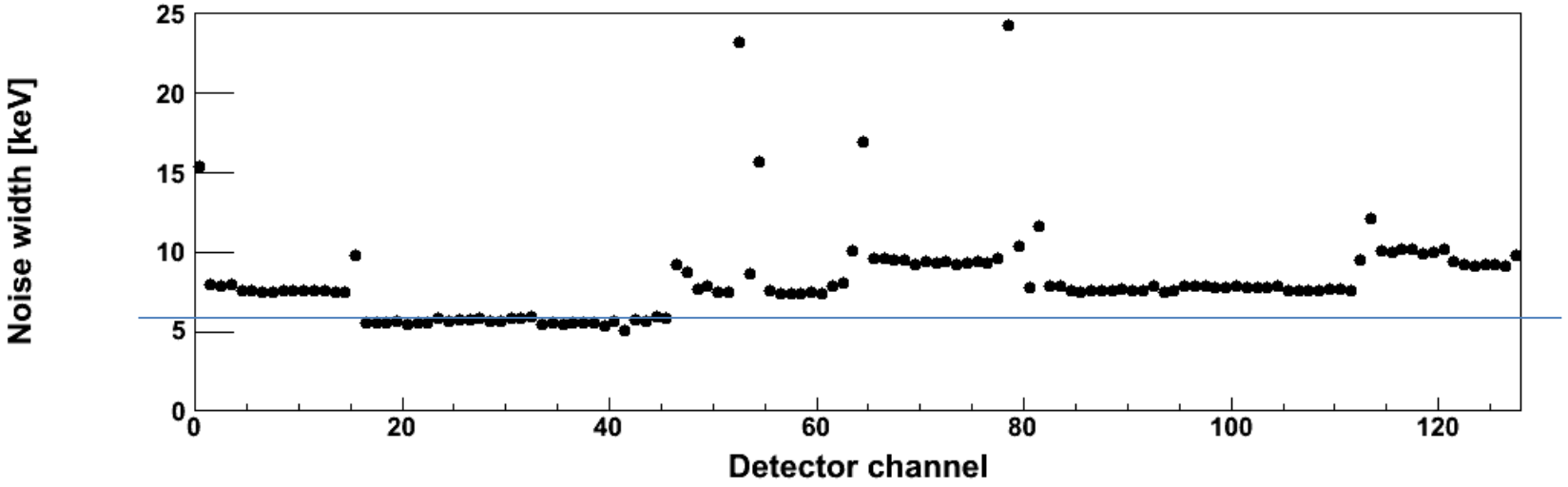


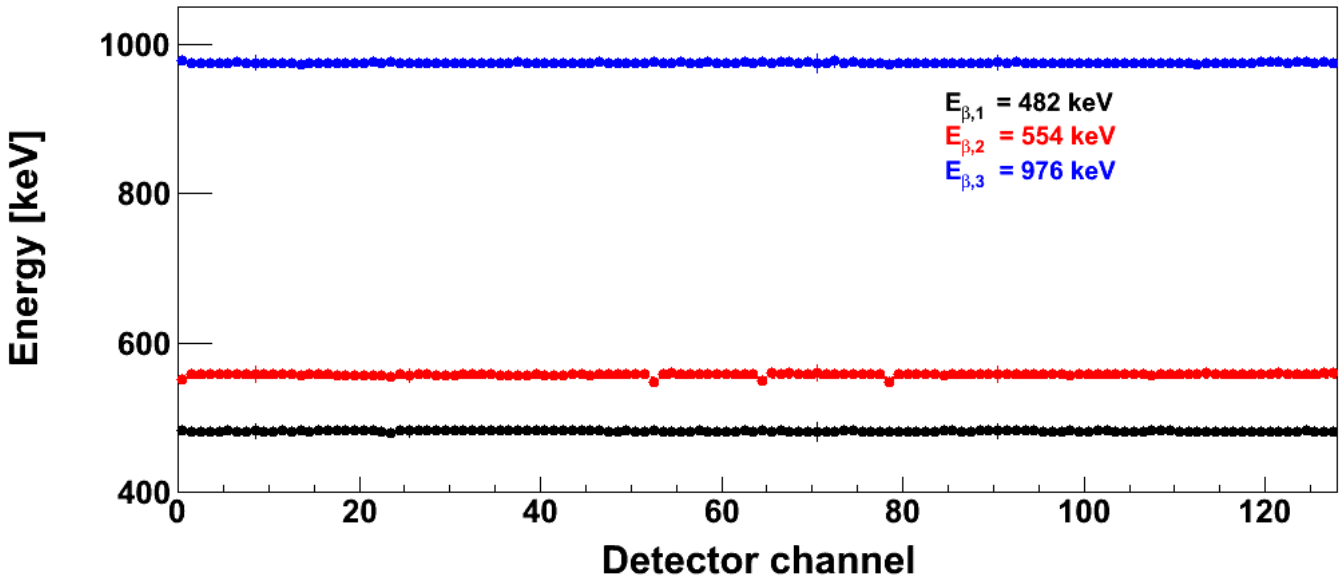
Average size of active area

File	Active area [cm^2]
_proton_05	8.34
_proton_14	7.71
_proton_26	7.55
_proton_27	8.72
_proton_28	8.73
_proton_29	8.11
Average	8.19

Signal and Noise after calibration

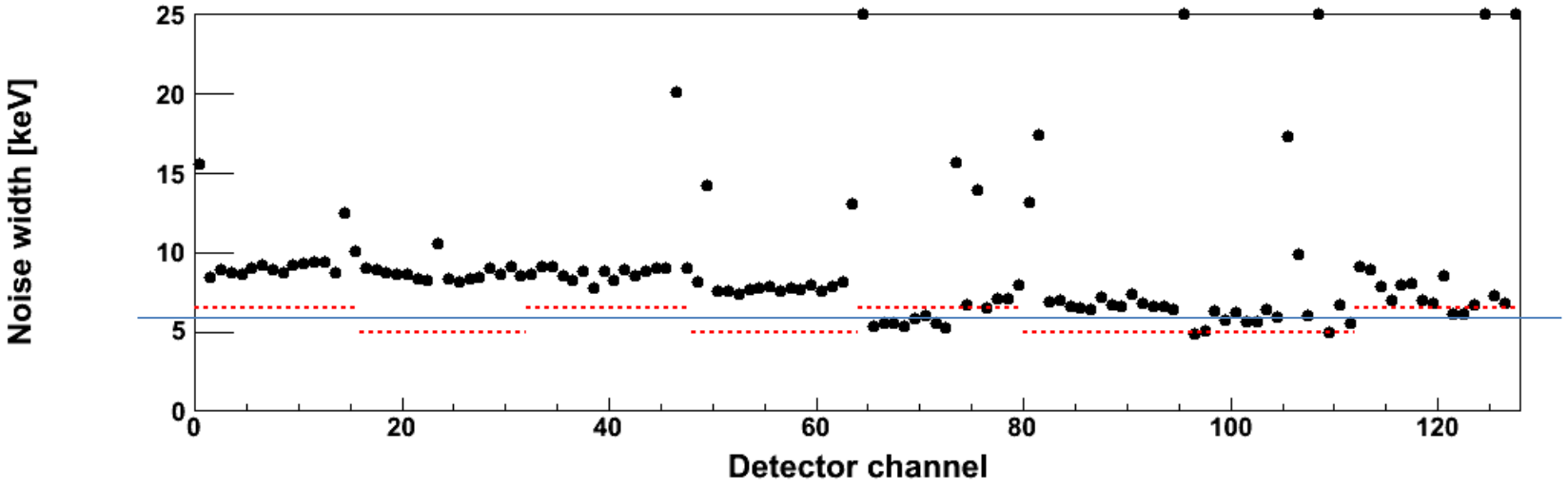
Noise spectrum from old bismut measurement 2814_25_all.root. The setup was different, for example shorter kapton tapes and different kind of preamplifiers and shapers!

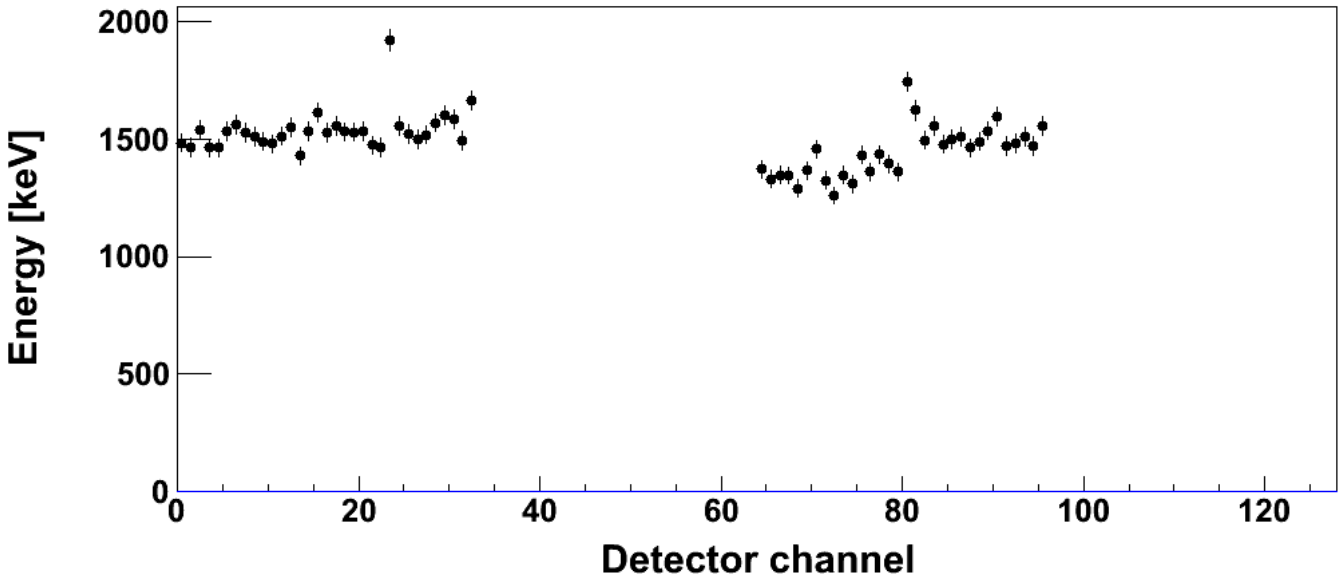




Signal and Noise after calibration

_proton_05: 8.6.2012, 11:35; beam positioned, Intensity between High- and LowIntensity,
Total Flux: 0.0; Calibration done with old bismut measurement





Signal and Noise after calibration

_proton_05: 8.6.2012, 11:35; beam positioned, Intensity between High- and LowIntensity,
Total Flux: 0.0; artificial decrease Slope parameter by 0.85