

# Energy resolution of forward endcap EMC (with VPTTs) below 100 MeV

- measurements with a 4x4 - EMC prototype -

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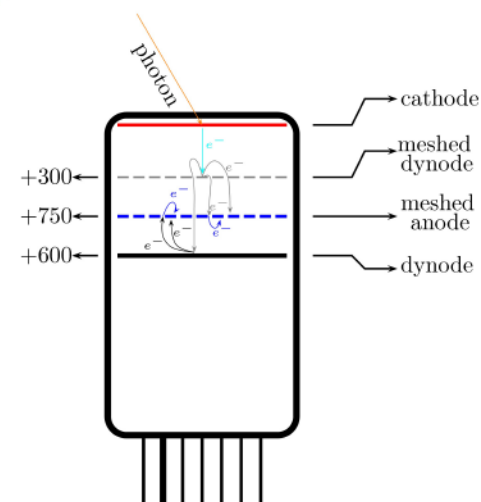
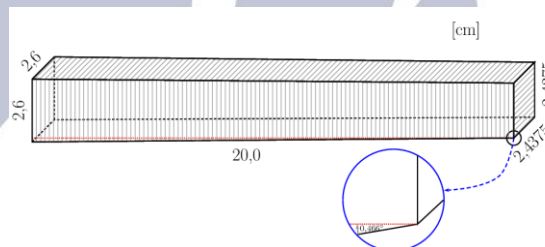
T. Johansson, K. Fransson, P. Marciniowski [2]

B.Schröder, K. Hansen, M. Lundin, L. Isaksson, [3]

[1] Stockholm University

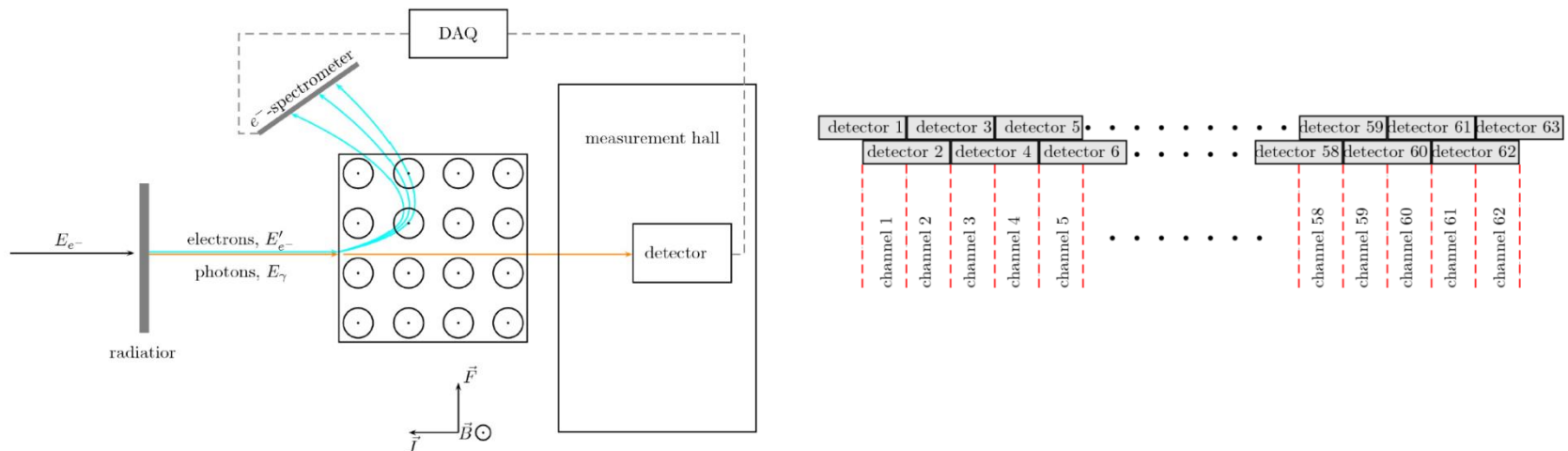
[2] Uppsala University

[3] Lund University



# Experiment

- Experiment was done in 2015
- A 4x4 forward endcap EMC prototype was designed after guideline of the PANDA EMC TDR
- This prototype was placed in the tagged photon facility of the old MAX IV laboratory in Lund
- Photon energies below 100 MeV were used
- 32 tagged photon energies in two tagger ranges were selected



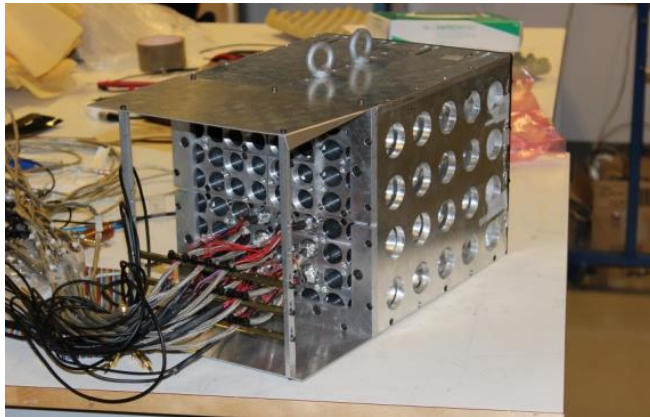
# The prototype

- PWO II scintillators attached to Hamamatsu VPTT of type R11375-01 (Visilox V-788 glue)
- Basel preamplifiers and PCBs (SP883d) are soldered directly on the VPTT unit
- Signal cables extra shielding with metal hose

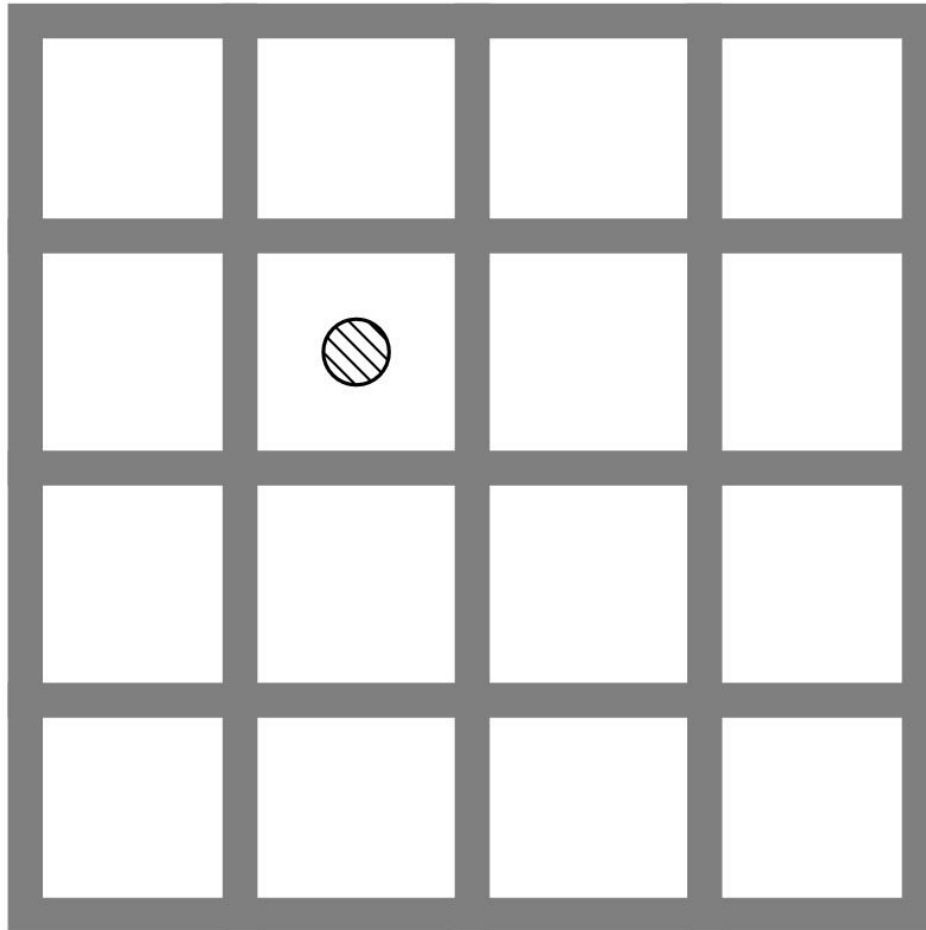


# The prototype

- Low voltage was battery powered
- Matrix mounted on x-y moveable table and placed in a climate chamber Vötsch VT 4021 (-25 °C)
- Detectors were connected to 14 bit 80 MHz SADC board of brand Virtex 6 (shaping time 0.046  $\mu$ s)
- Trigger was set to the tagger only

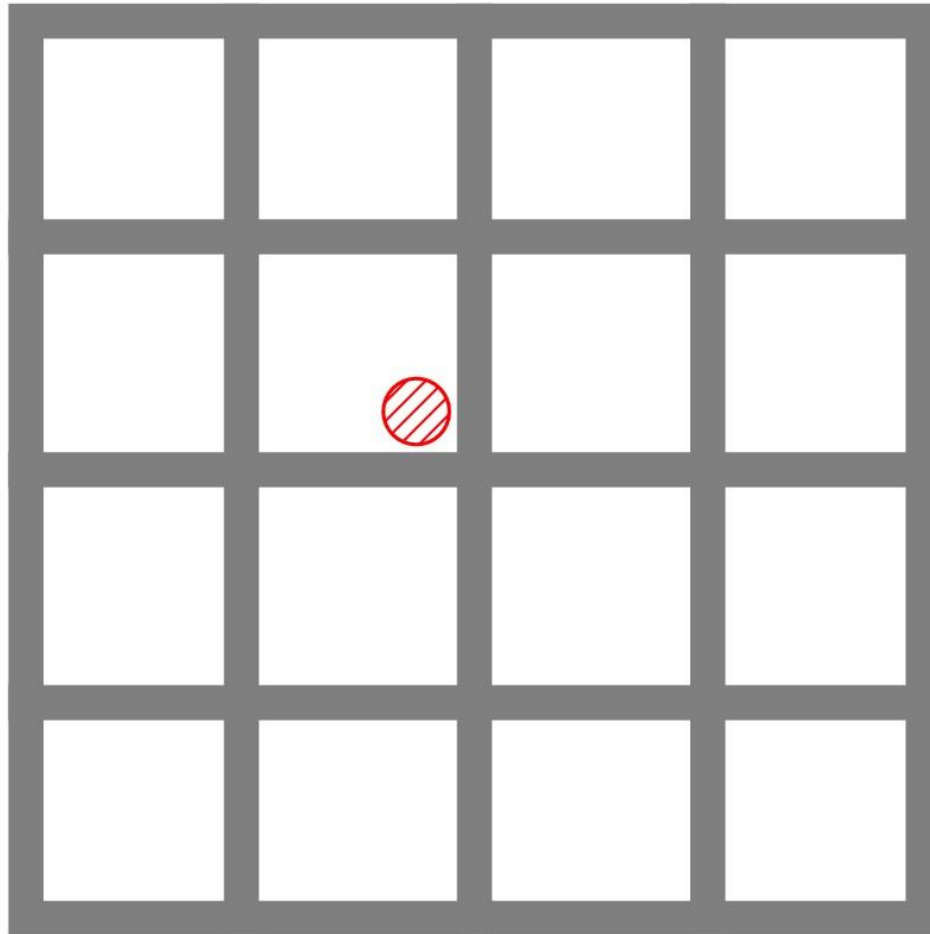


# Three beam positions



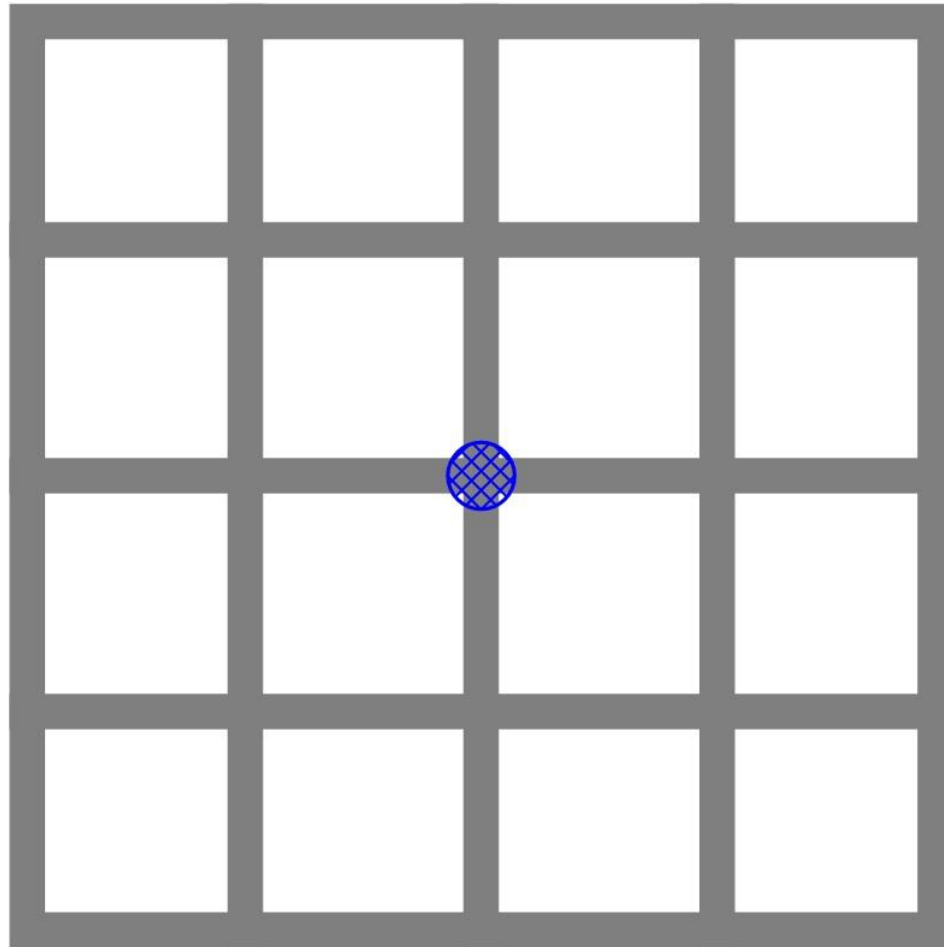
Center

# Three beam positions



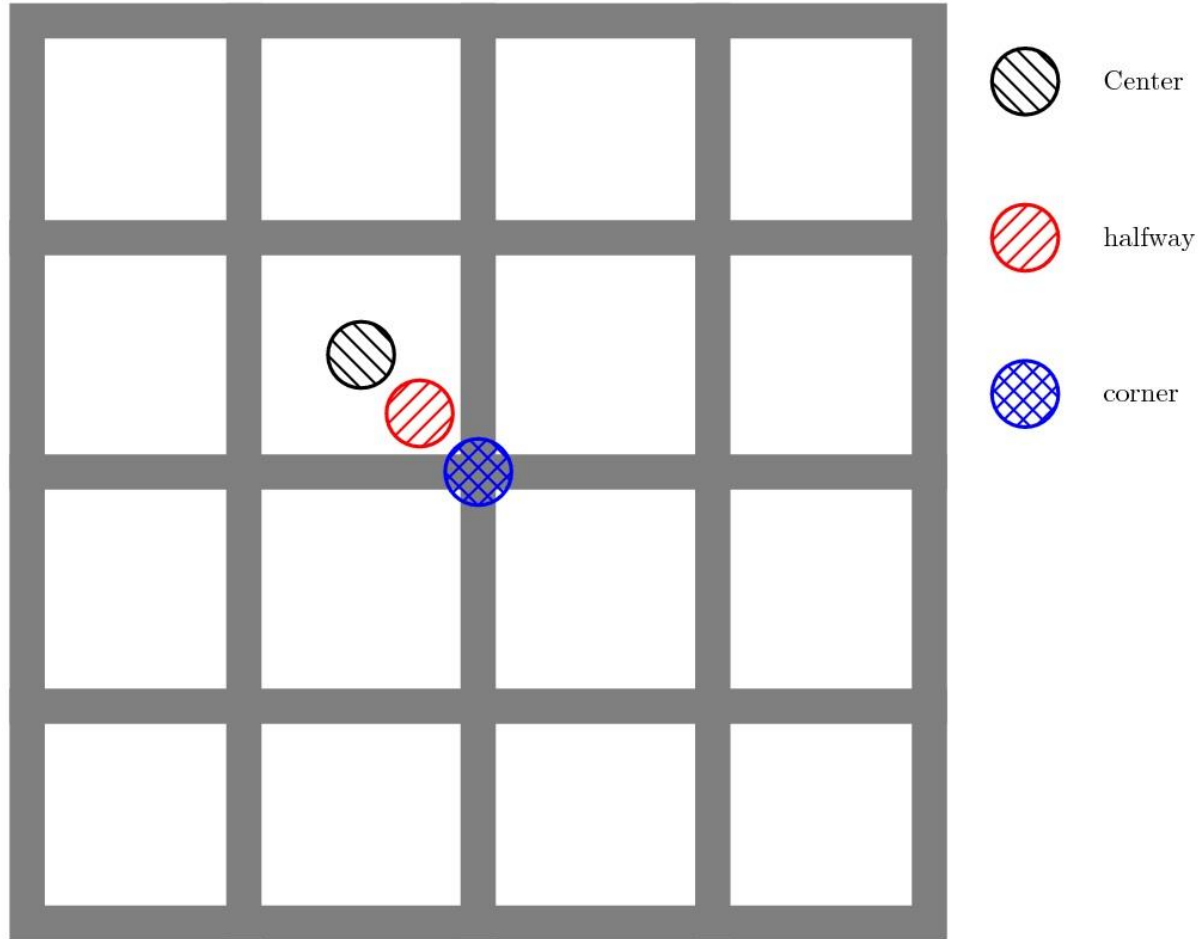
halfway

# Three beam positions



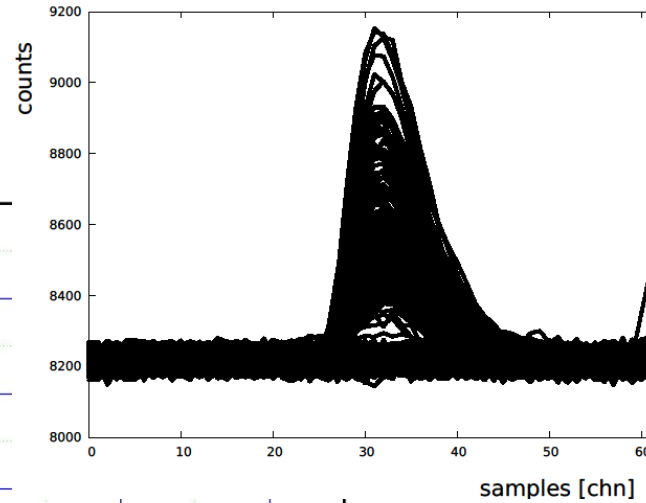
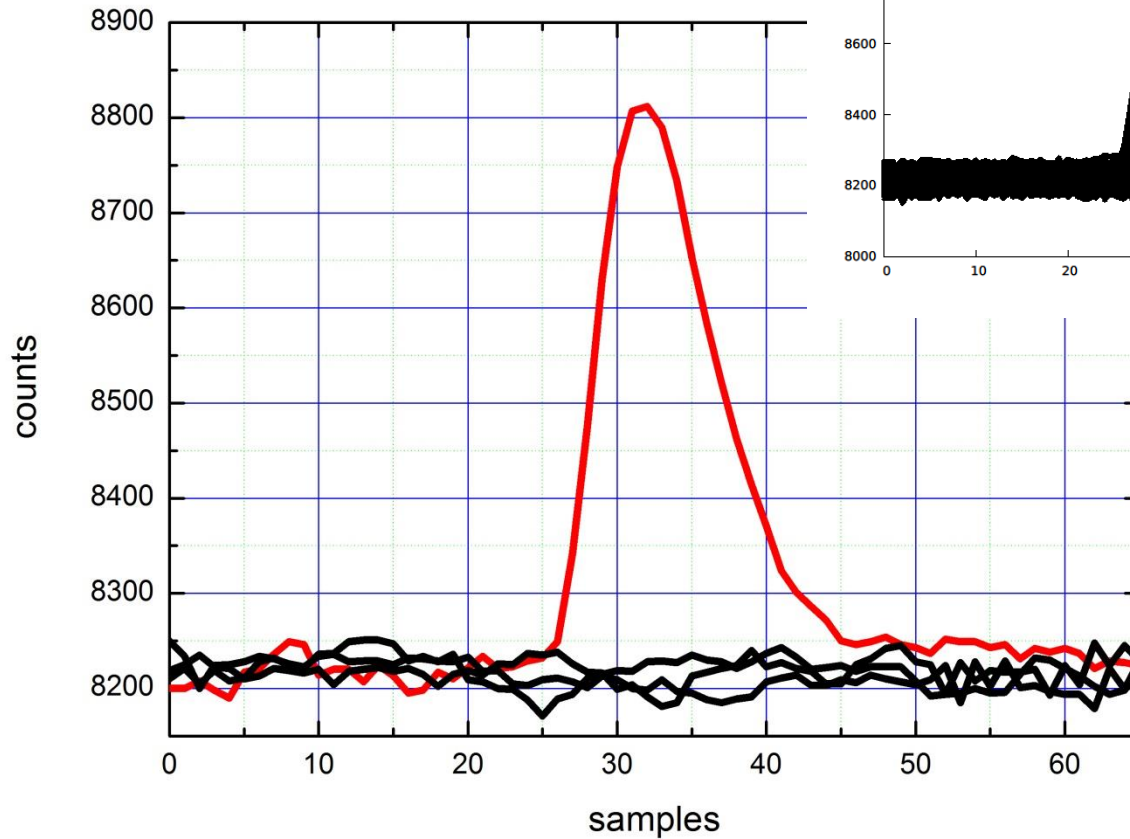
corner

# Three beam positions

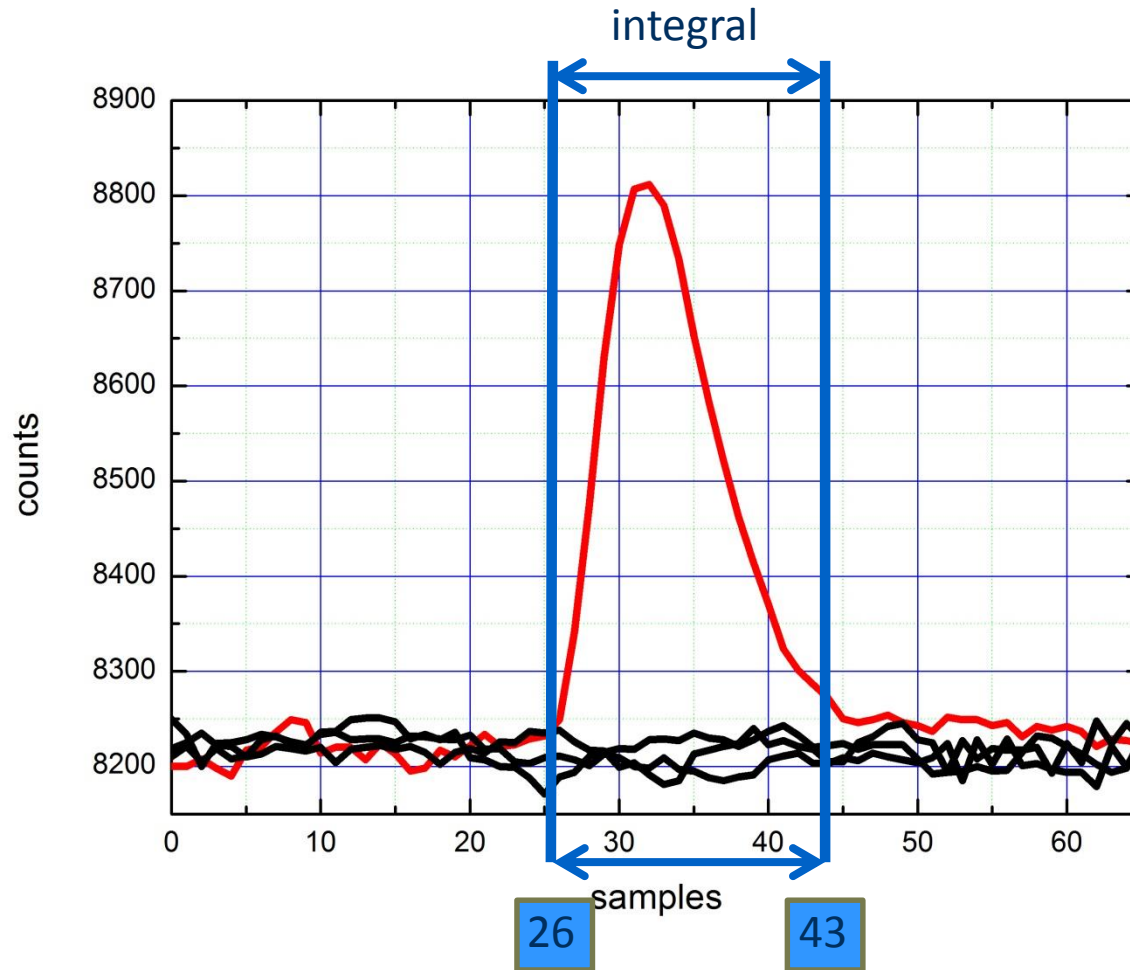




# Data extraction



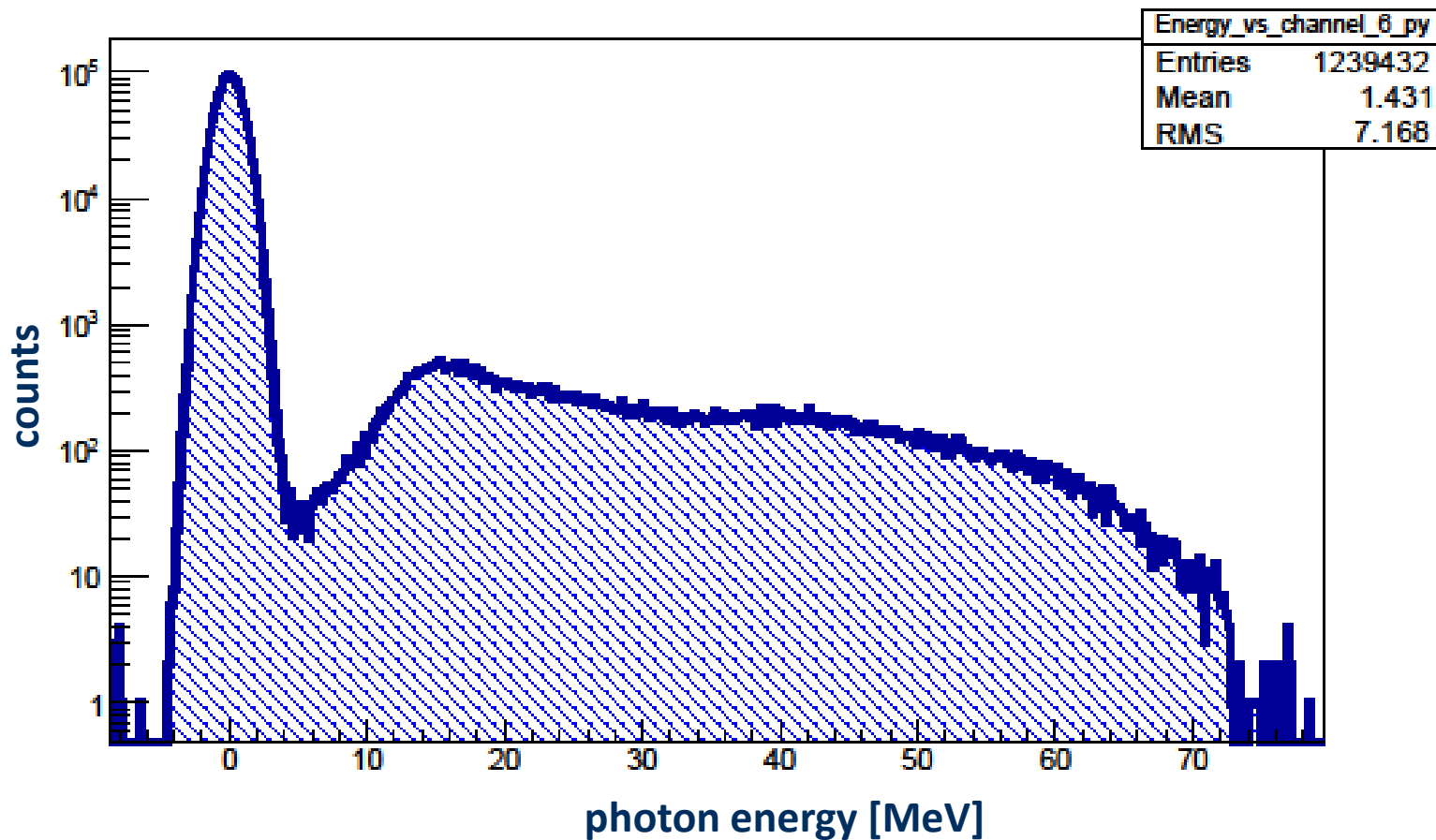
# Data extraction



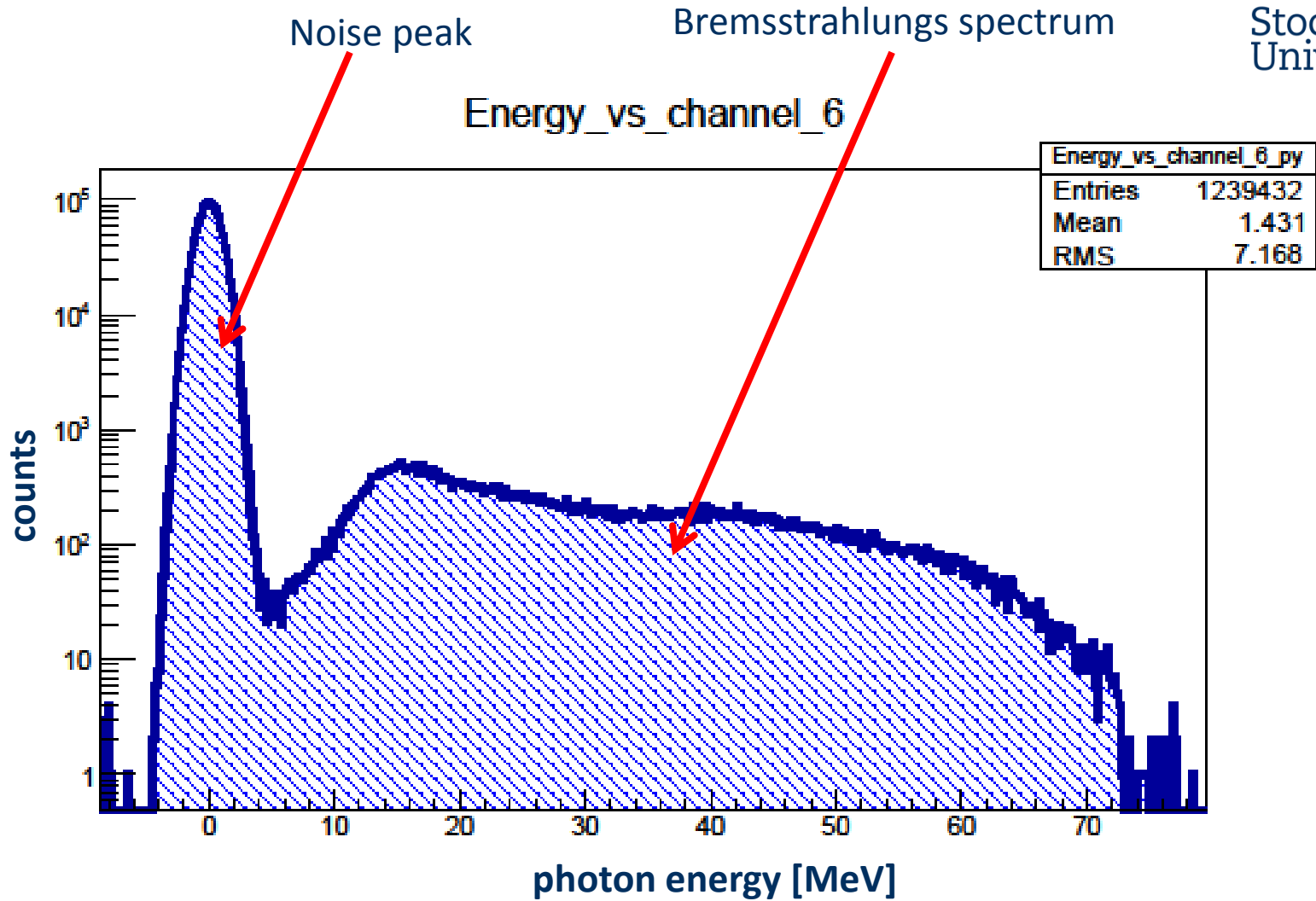
- selection of one pulse transformed into time
- we know the position and the time of the signal
- use the fix interval and integrate that

# Pulse height spectrum after data extraction

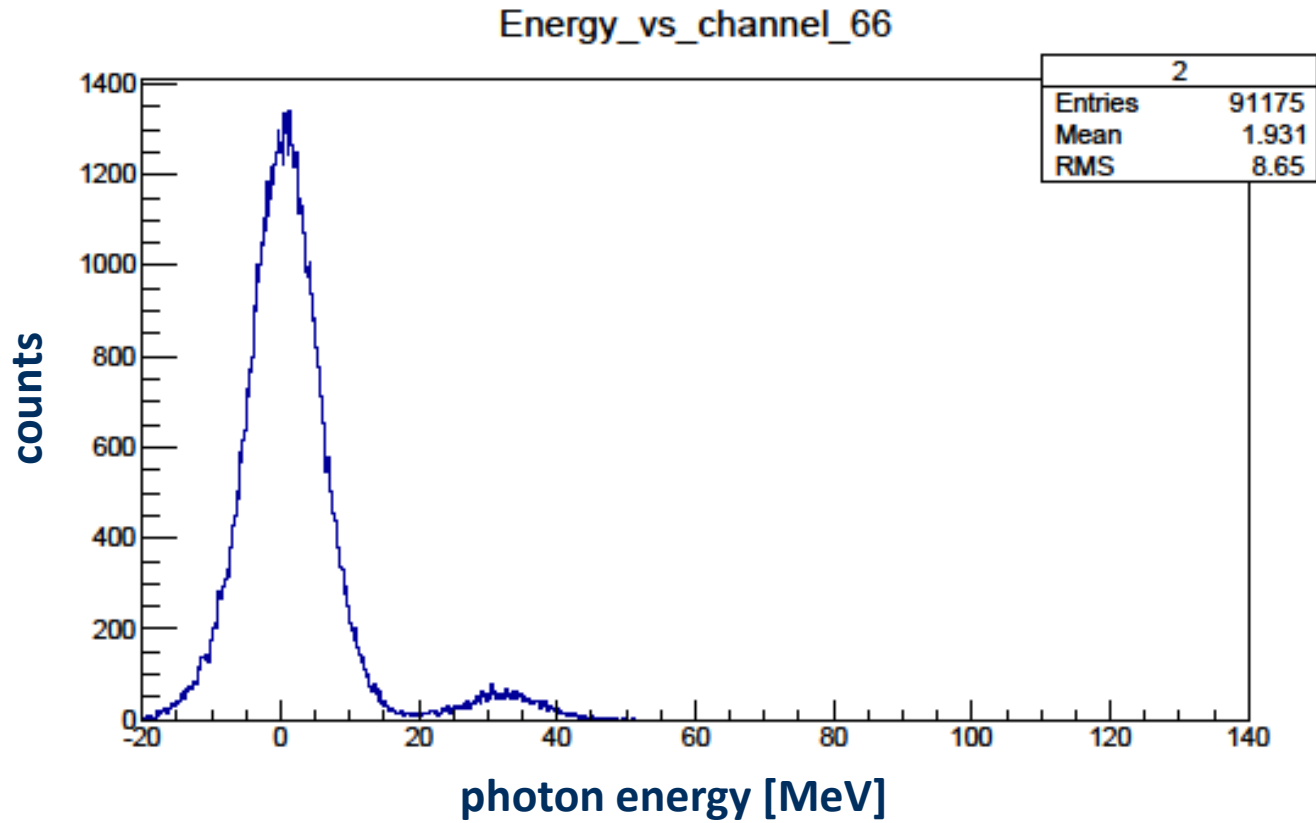
Energy\_vs\_channel\_6



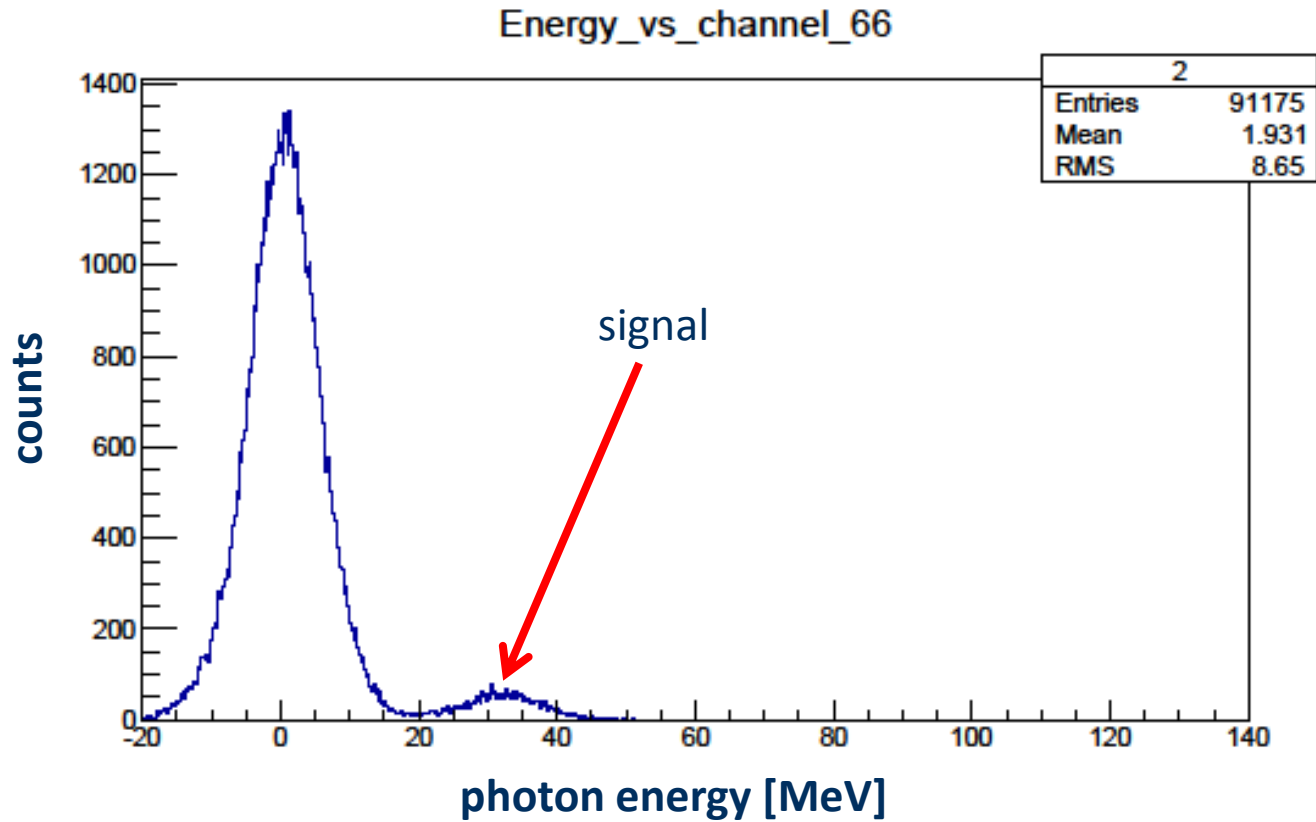
# Pulse height spectrum after data extraction



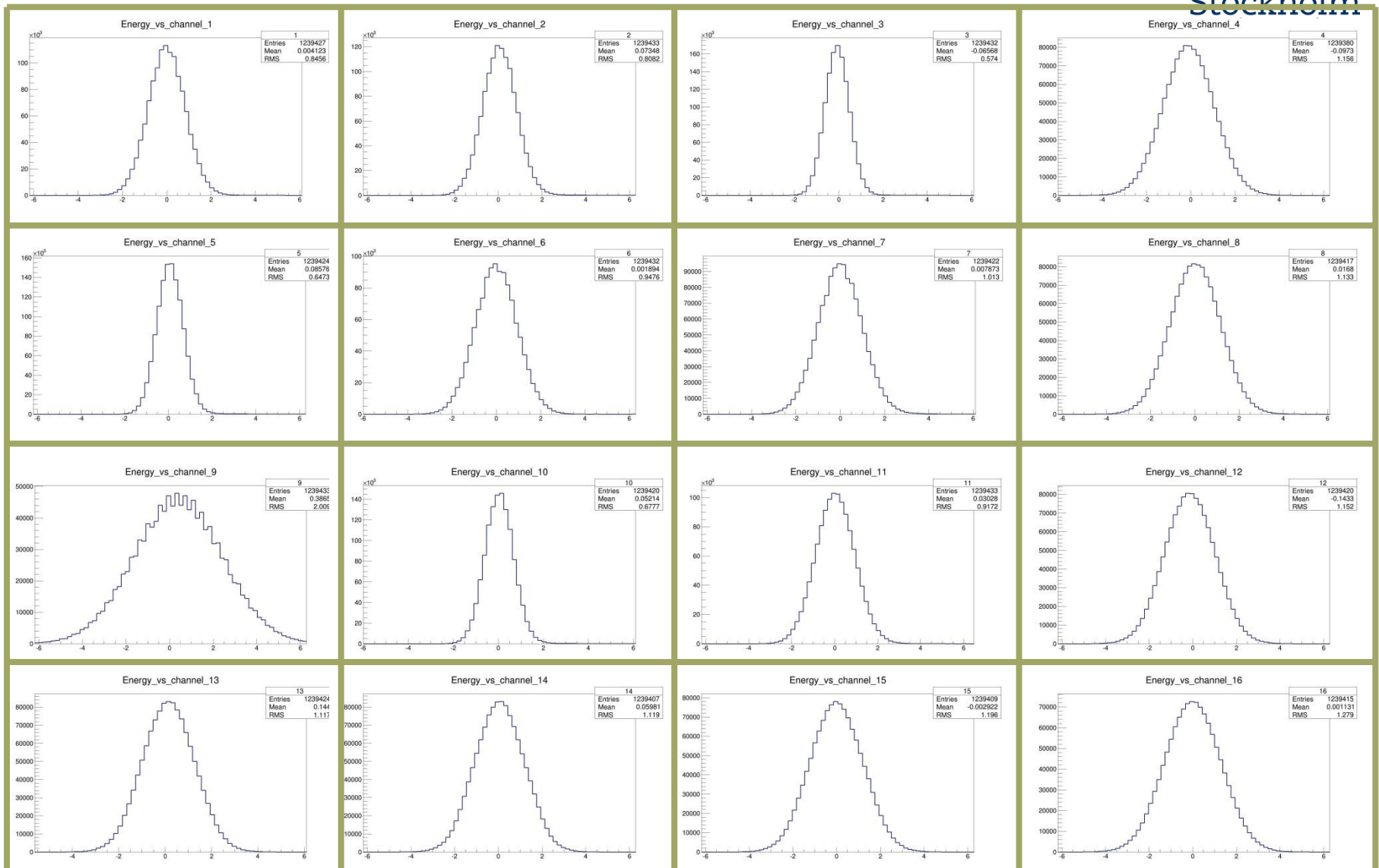
# Pulse height spectrum after data extraction



# Pulse height spectrum after data extraction

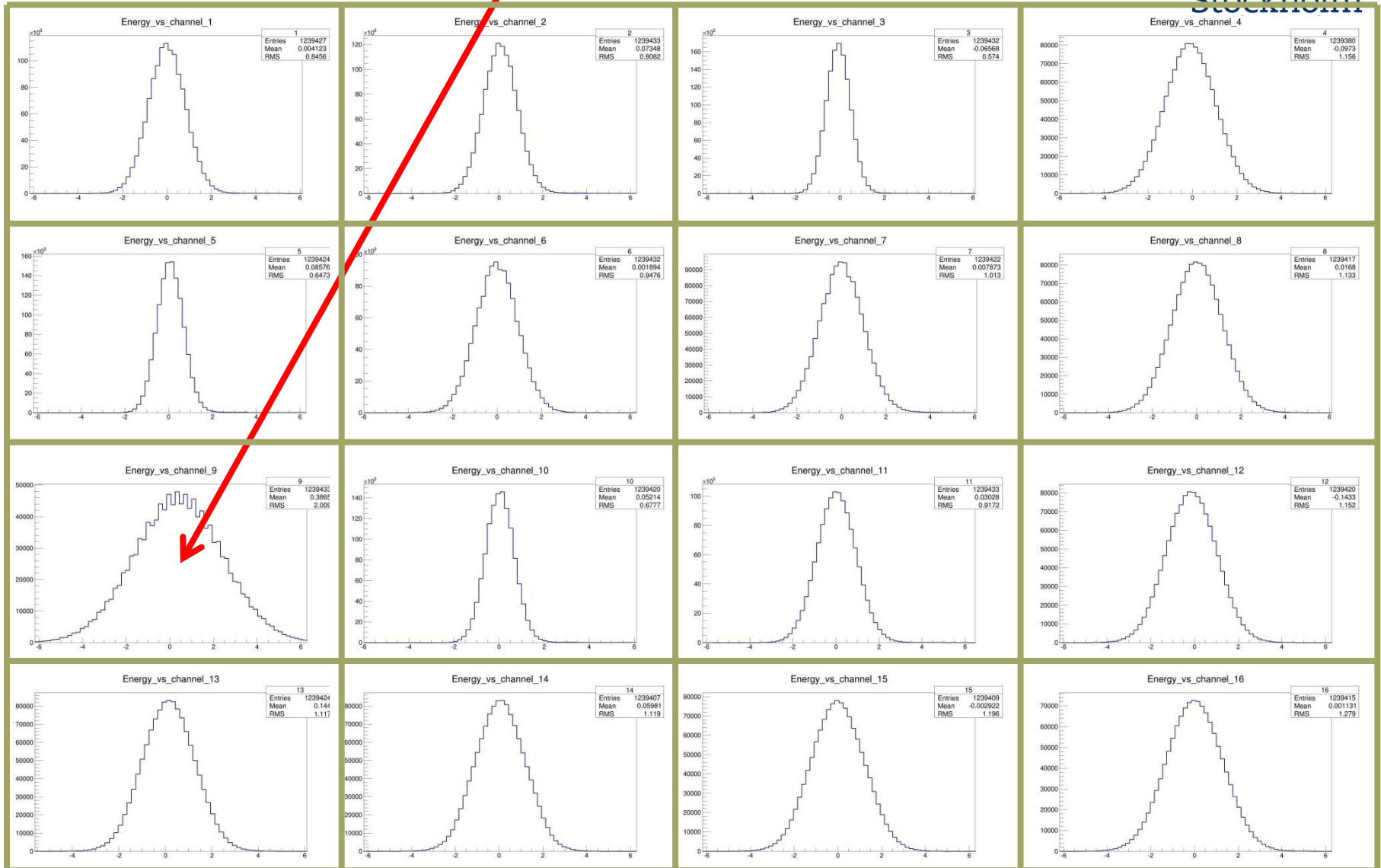


# Noise



# Noise

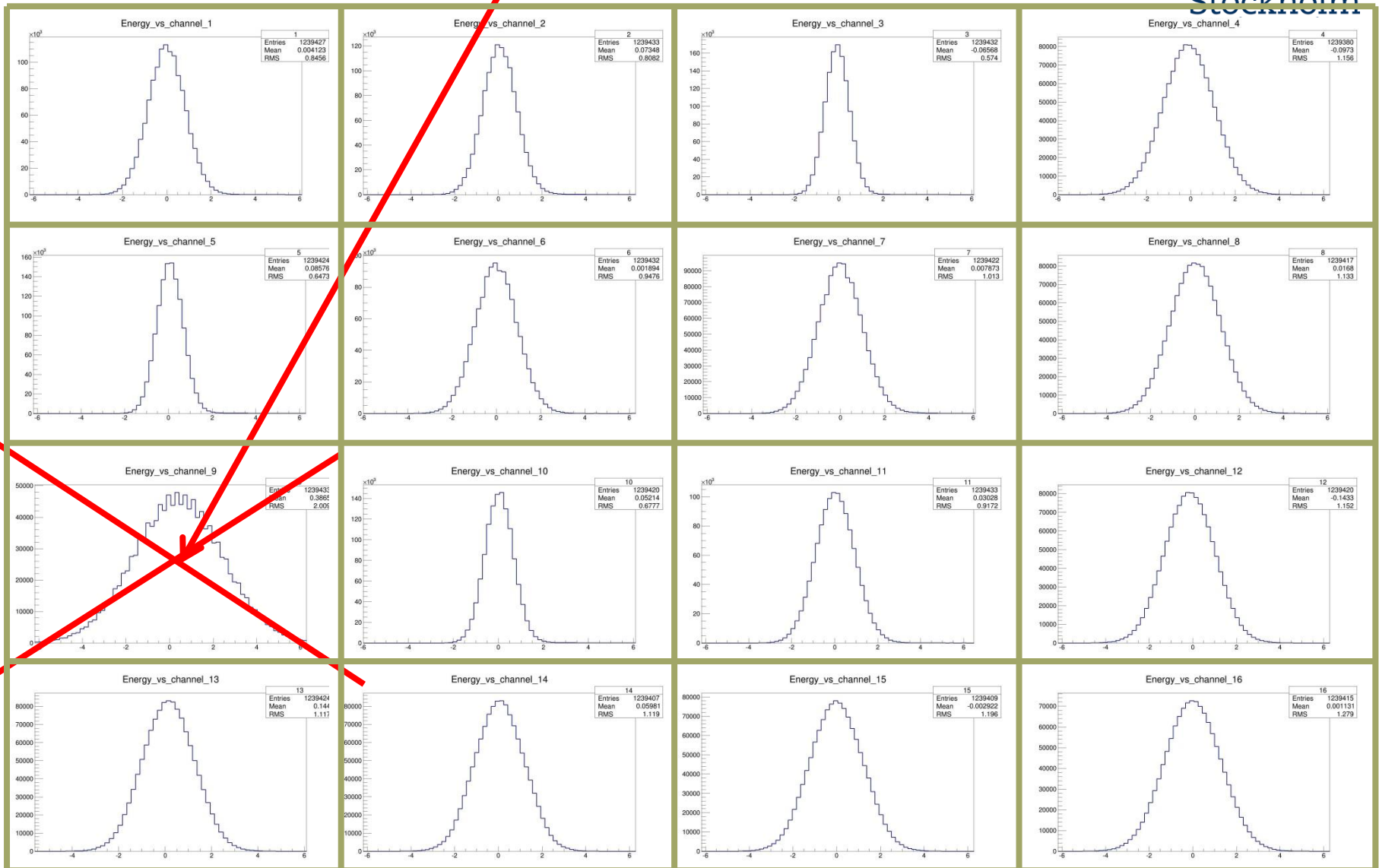
Noise of 3.60 MeV



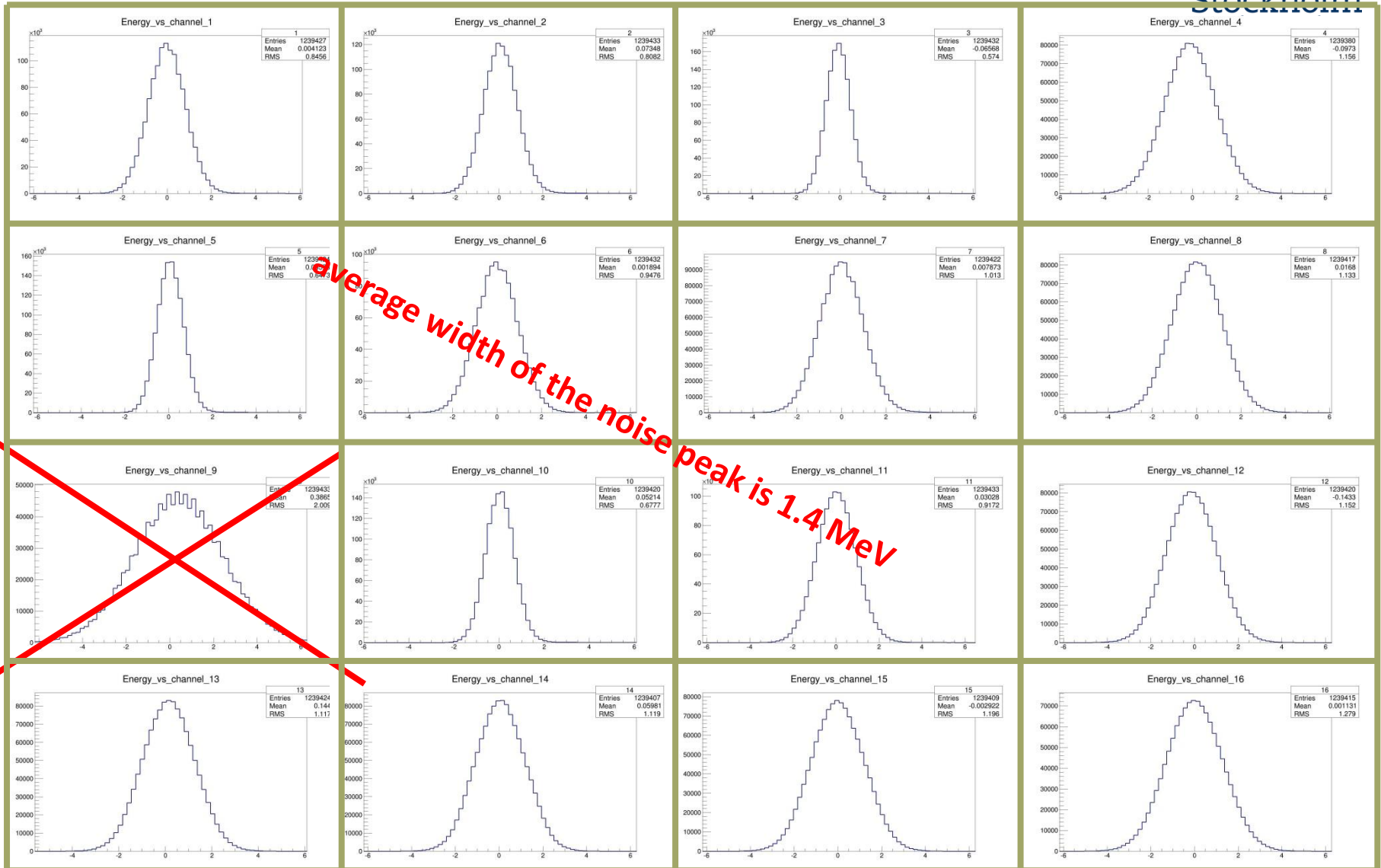


# Noise

exclusion of channel in analysis



# Noise



# Optimal threshold setting

Method:

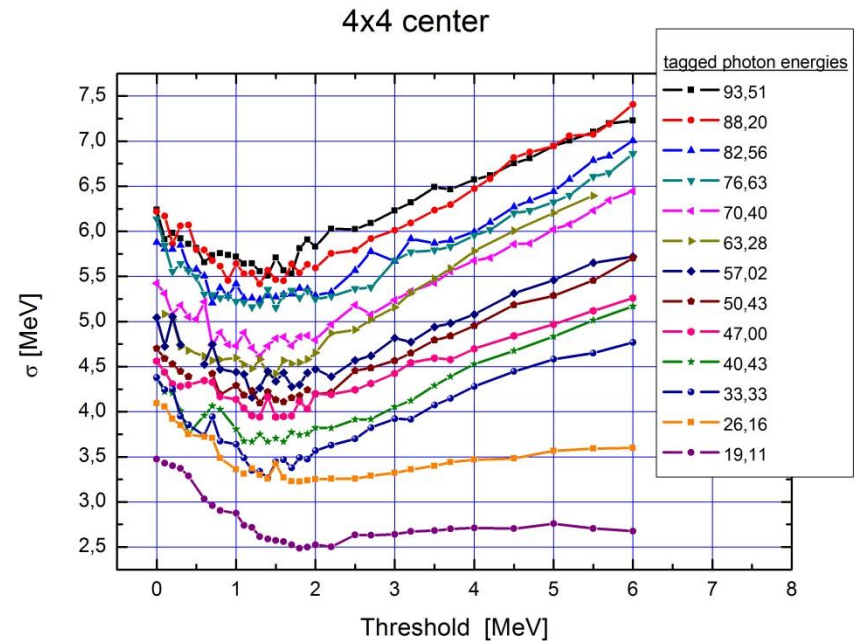
- Determine the resolution as a function of threshold for all tagged photon energies



# Optimal threshold setting

Method:

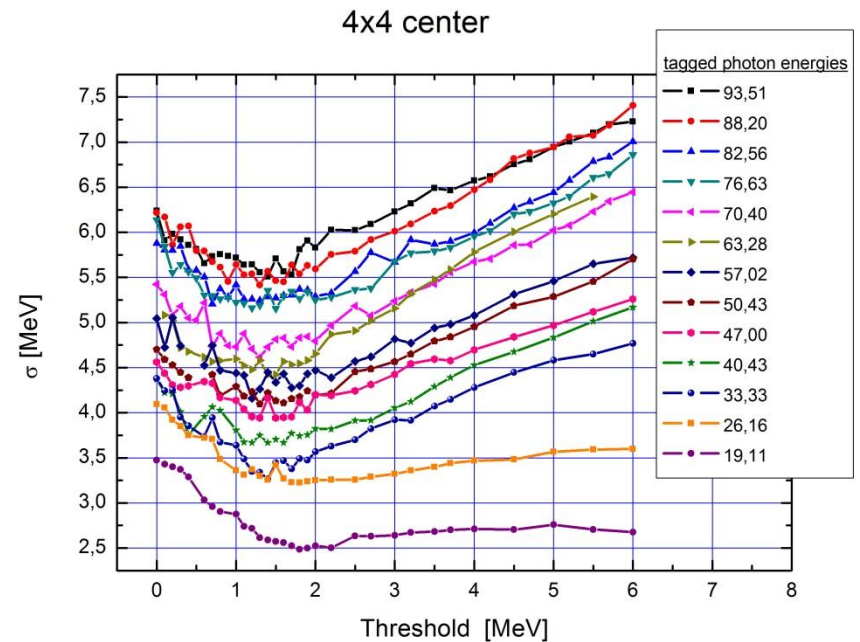
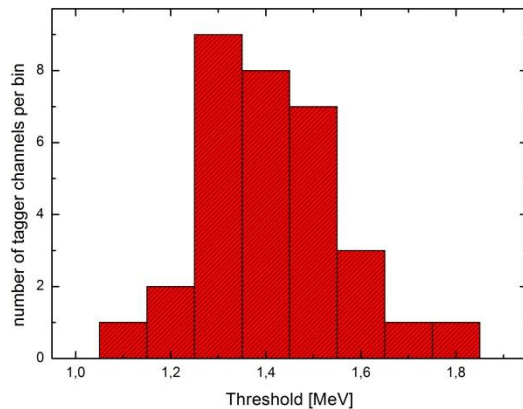
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# Optimal threshold setting

Method:

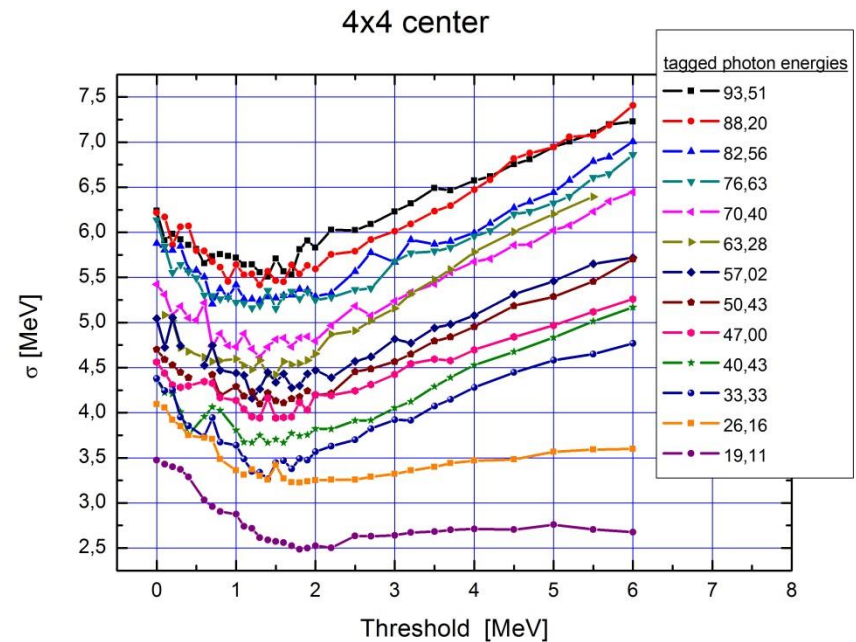
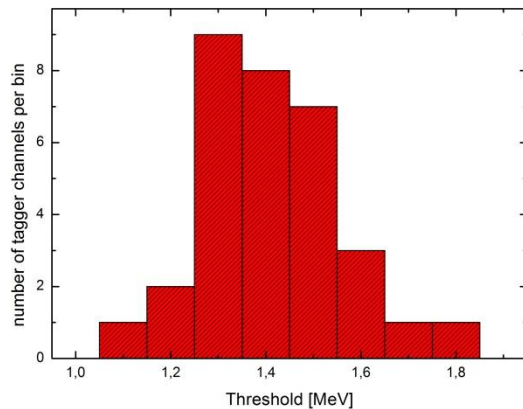
- Determine the resolution as a function of threshold for all tagged photon energies
- Each minimum value of every tagged photon energy is filled into a histogram



# Optimal threshold setting

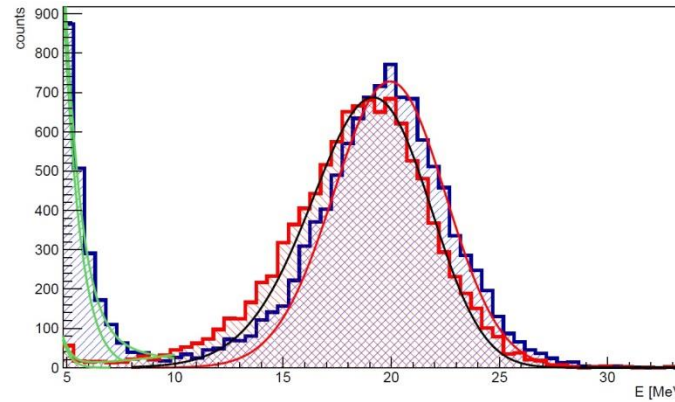
Method:

- Determine the resolution as a function of threshold for all tagged photon energies
- Each minimum value of every tagged photon energy is filled into a histogram
- Determine the average of that histogram  $\rightarrow$  **1.4 MeV** threshold



# Comparison of different threshold settings

- Red histogram: Threshold 4.2 MeV
- Blue histogram: Threshold 1.4 MeV



Stockholm  
University

Photon energy  
20 MeV

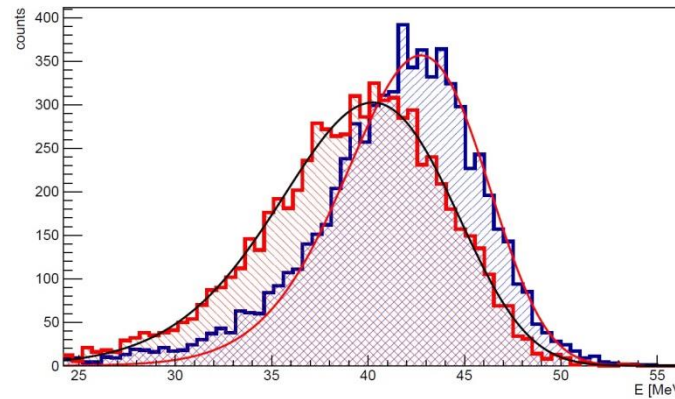
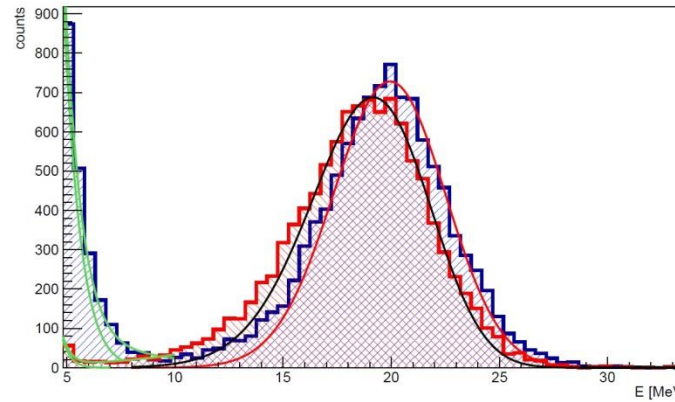
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- Red histogram: Threshold 4.2 MeV
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Stockholm University

Photon energy  
20 MeV



43 MeV



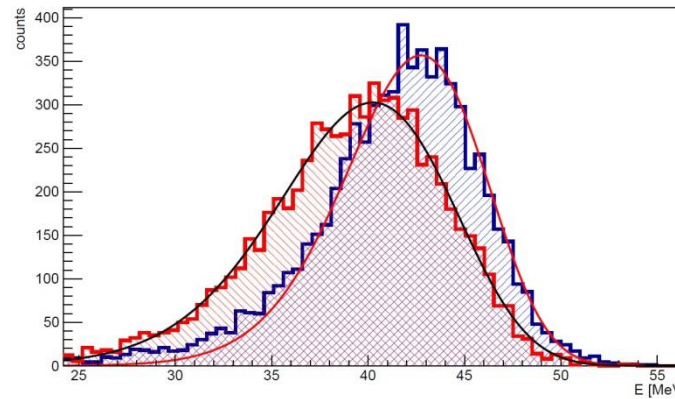
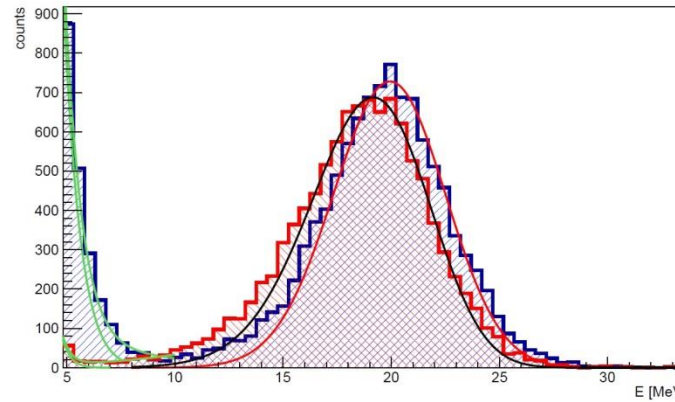
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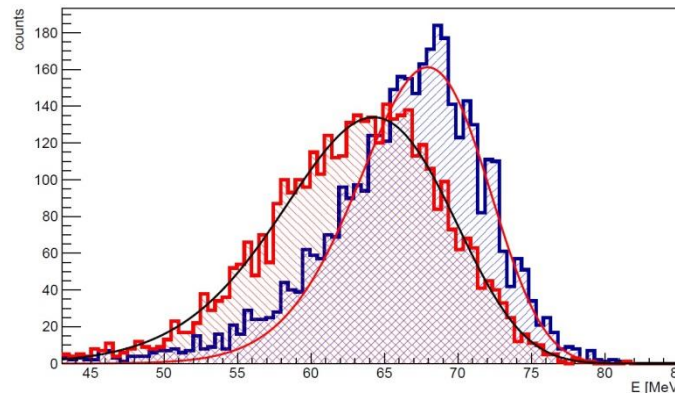


Stockholm University

Photon energy  
20 MeV



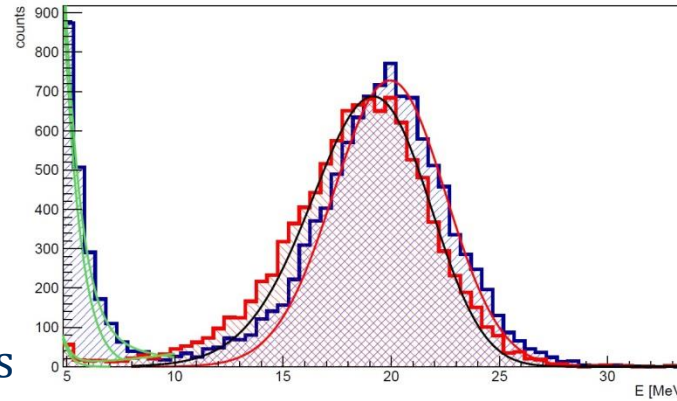
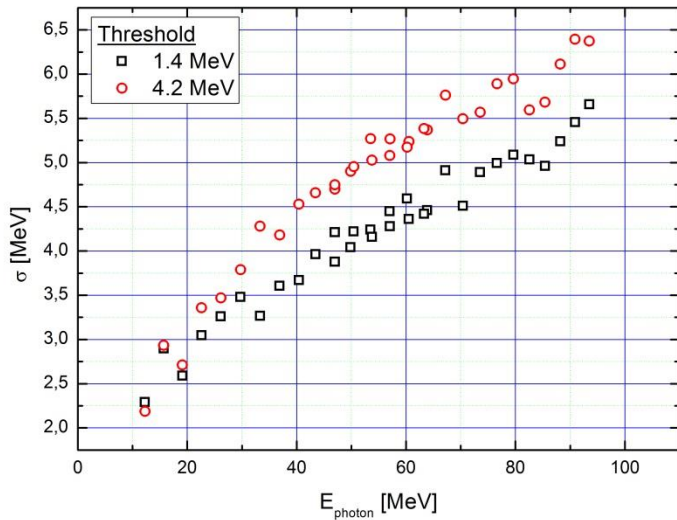
43 MeV



63 MeV

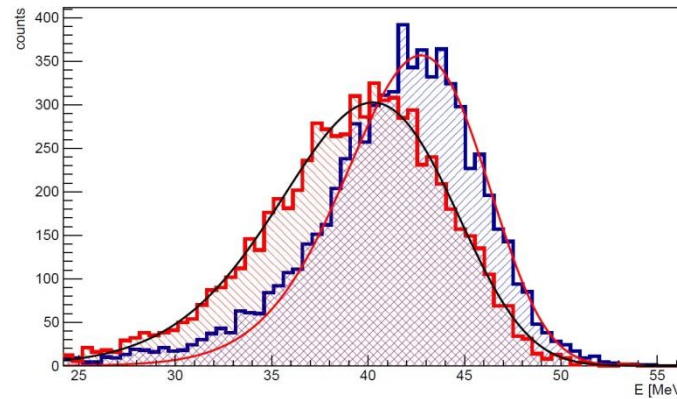
# Comparison of different threshold settings

- Red histogram: Threshold 4.2 MeV
- Blue histogram: Threshold 1.4 MeV
- **1.4 MeV** threshold was used for further analysis since the resolution is better

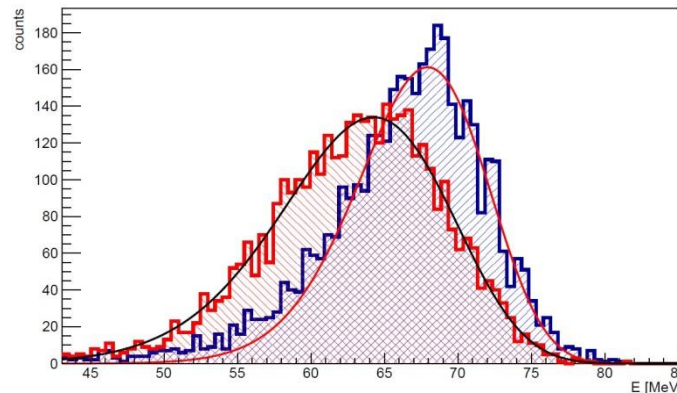


Stockholm University

Photon energy  
20 MeV

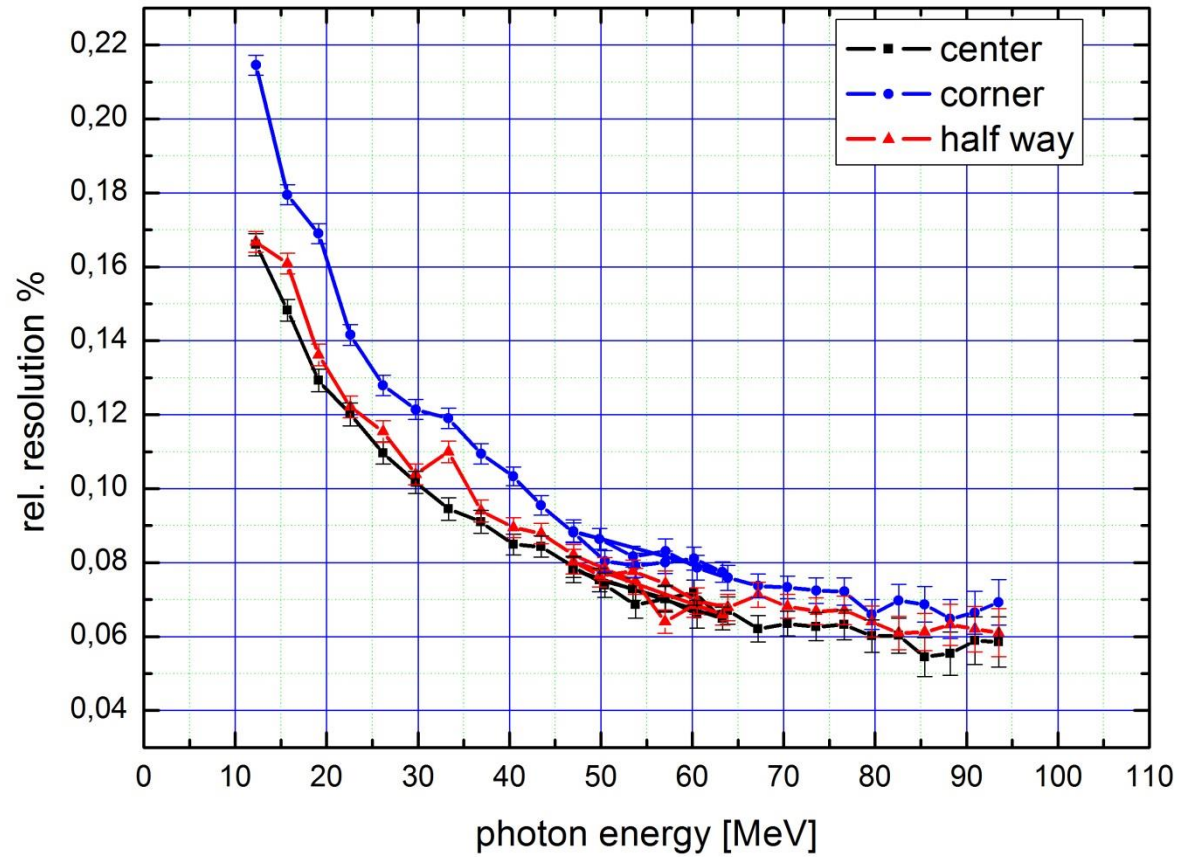
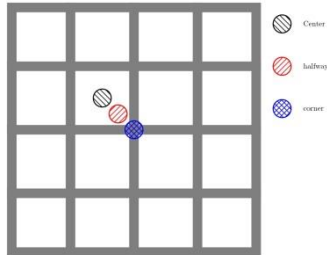


43 MeV

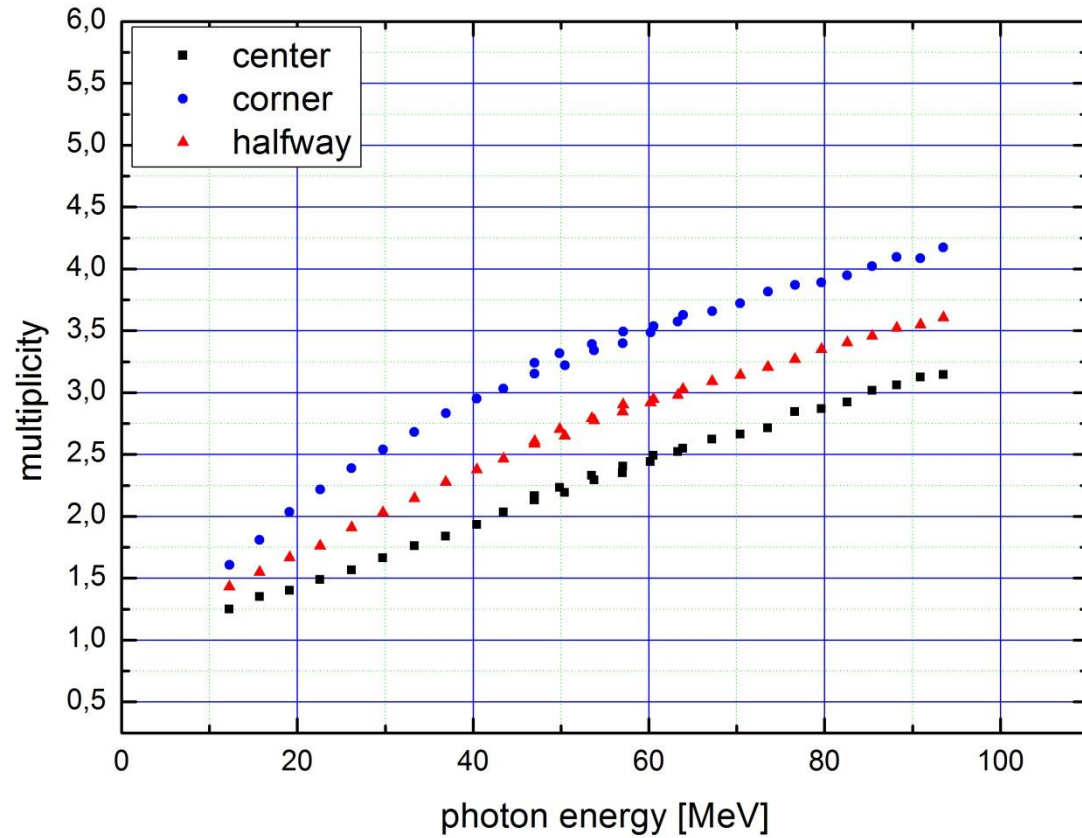
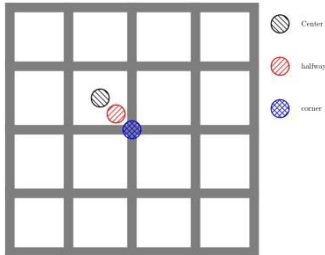


63 MeV

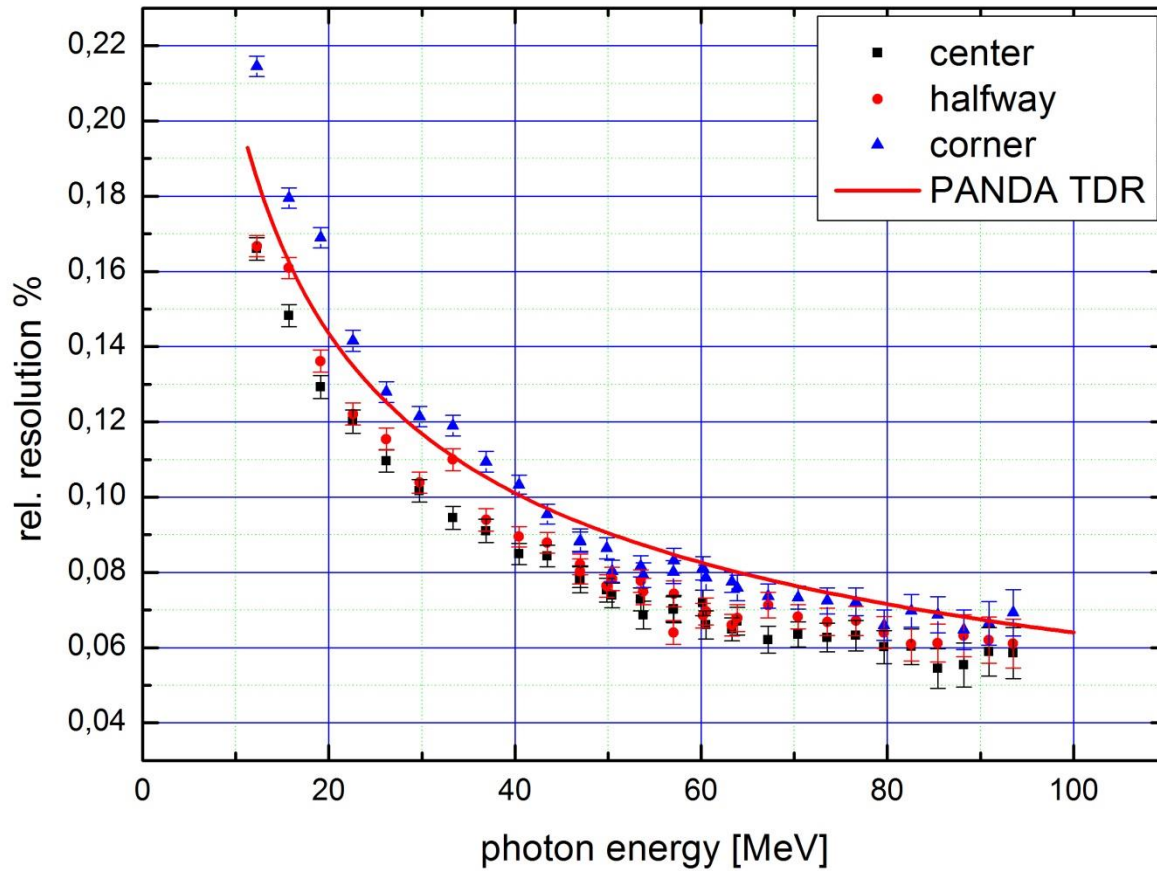
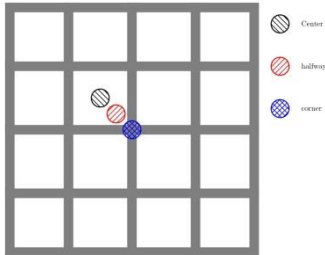
# Relative energy resolution



# Relative energy resolution (multiplicity)



# Relative energy resolution in comparison to TDR



# Conclusion

- Offline data analysis where the threshold was set to 1.4 MeV
- below 100 MeV VPTTs with 0.046  $\mu\text{s}$  shaping time are close to the requirements of the TDR
  - + one detector was excluded
  - + the shaping time
  - B-Field acting on EMC
  - detector material in front of EMC



**Thank you for your attention**