

Status Proto120

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LII. $\bar{\text{P}}\text{ANDA}$ Collaboration meeting

June 9th, 2015



Pickup

RF Pickup

- Result from previous beam time: shielding of APD and preamp input critical
- Single crystal assembly with full Al shield
- No measurable difference in pick-up and noise level between shielded assembly and crystal-array mounted ASIC



Two LV Supplies – one detector – two results

HAMEG HMP4040



AGILENT U8002A



Baseline „noise“, i.e. correlated ringing:

~600 ADCpp

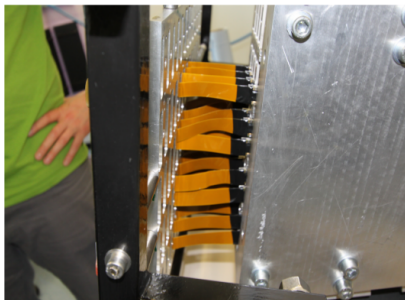
~100..200 ADCpp

Residual ripple::	3 Hz...100 kHz	3 Hz...20 MHz	Ripple and Noise (25 °C ±5 °C)	CV: 12 mVp-p, <1 mVrms; CC: 3 mA _{rms}
Voltage	<150 μ V _{rms} typ.	1,5 mV _{rms} typ.		
Current	<1 mA _{rms}			

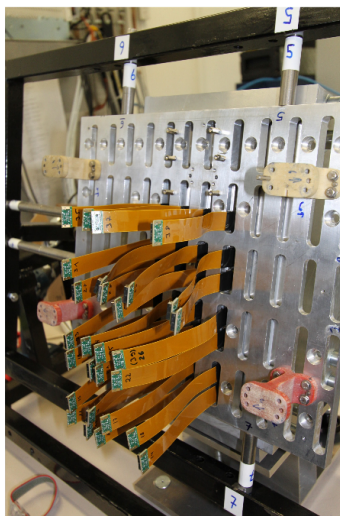
RF Pickup



PROTO120 assembly

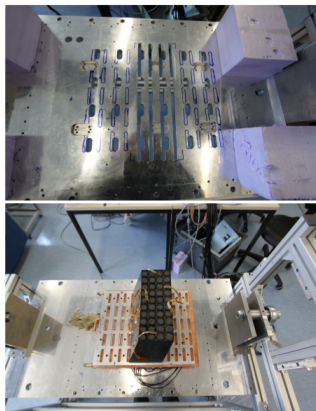
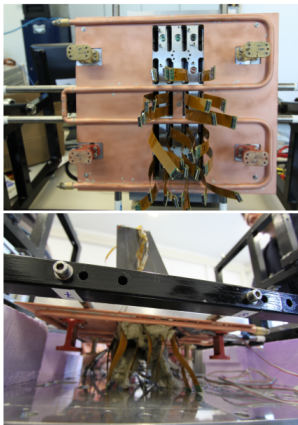


- Mounting of crystal block (inside mounting tool) to mounting plate - ok



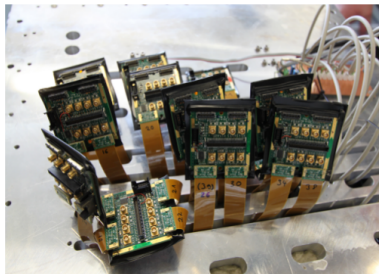
PROTO120 assembly

- Temporary new design of cooling plate necessary
- Direct feed-through of flex-cables to warm volume
- Intermediate plate needs redesign

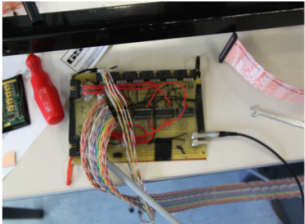


Backplane Forest

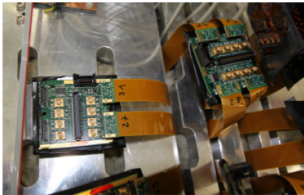
- 10 BP-PCBs with 2 connected ASICs
- 2 BP-PCBs with 4 connected ASICs



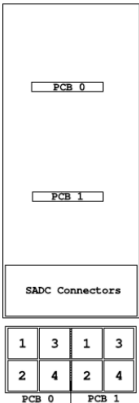
Electronics



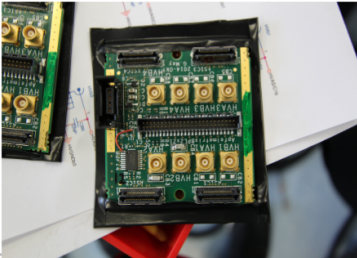
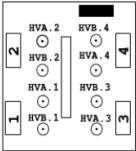
- Old Slow Control Hub: max 7 SC Ports
- 12 Backplane PCBs a 4 ASICs
- 6 Driver-PCBs, each controlling 2 BP PCBs
→ needed to connect SC-Ports on Driver-PCBs
- Connect 24 ASICs with 2 on one BP
or
48 ASICs with 4 on one BP



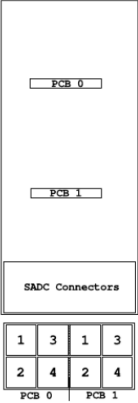
Buffer Board



Backplane PCB



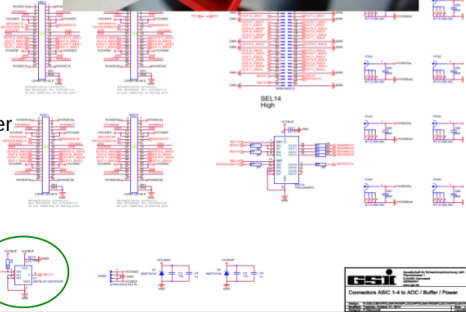
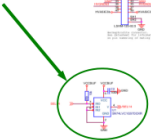
Buffer Board



Need to select ASICs 1..4 or 5..8, but not both simultaneously

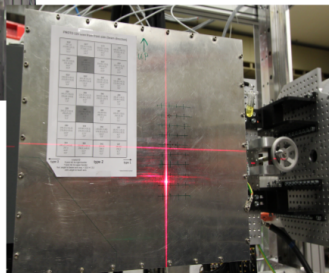
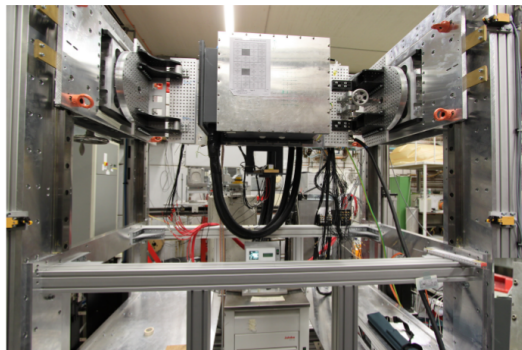


Bypass of inverter for SEL signal



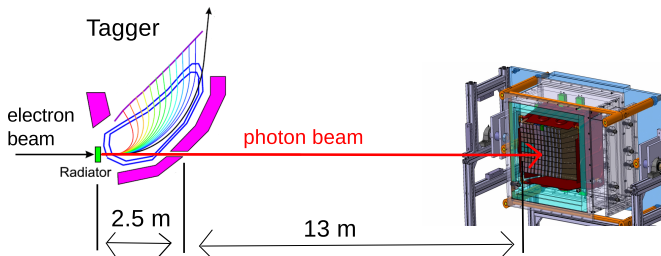
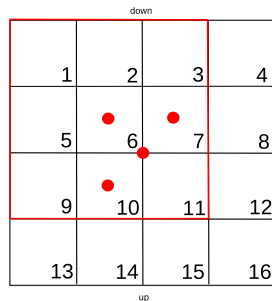
Beamtime

Beamtime in April 2015



Setup polished matrix

- read out 16 crystals (64 channels) of type II with SADCs (SIS3302)
- 830 MeV tagged photon beam
 - calibration run in each crystal
 - long run in the center of 3x3 (crystal 6), center of 4x4 and crystal 7 and 10
- only relative gain 32 analysed



Observations at beamtime

- Time for cooling down to $-25\text{ }^{\circ}\text{C}$ $\sim 12\text{h}$ (as in previous setups)
- 29 ASICs tested and delivered by GSI
 - one ASIC with defunct slow control
 - two ASIC with one dead APD channel (HG/LG)in total 3/29 ASICs not regularly operational (10.3% failure)
- Power consumption:

APFEL

3.12W/29 ASICs
=107 mW/ASIC
=53.7 mW/APD

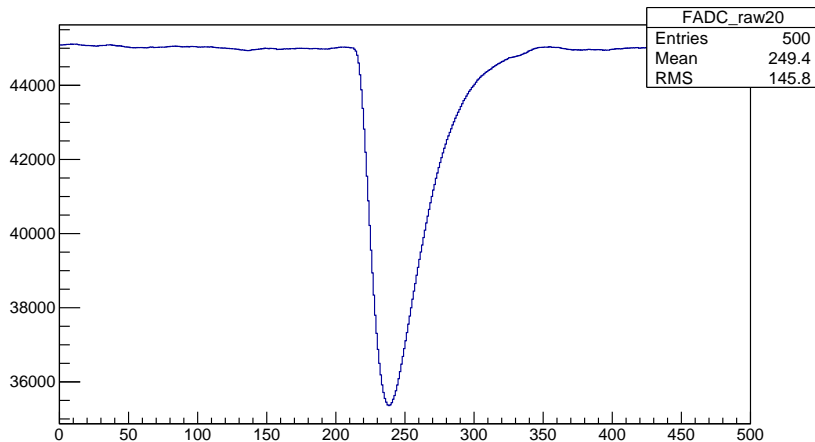
Basel LNP

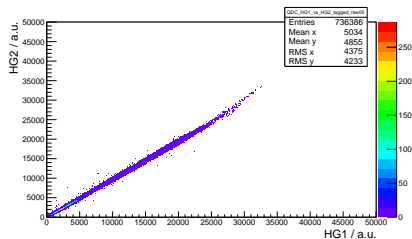
0.65 W/12 LNPs
=54 mW/APD

- Note:
 - values obtained at low event rate
 - power consumption of signal transmission not included to APFEL

Analysis

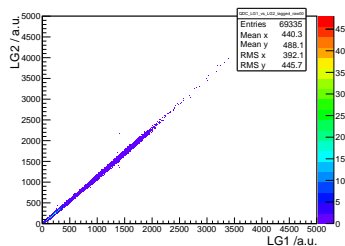
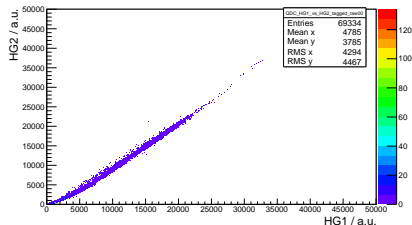
- pulse height (pulse maximum - baseline) is extracted as energy information



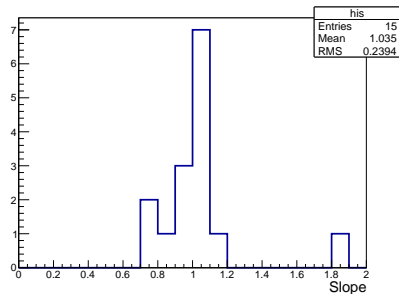
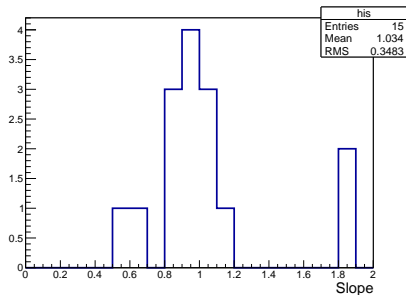


APD linearity

- HG of the central crystal (upper left), HG of crystal 1 (lower left) and LG of crystal 1 (lower right)
- Kink due to wrong ASIC programming
- linear part fitted and used as APD calibration

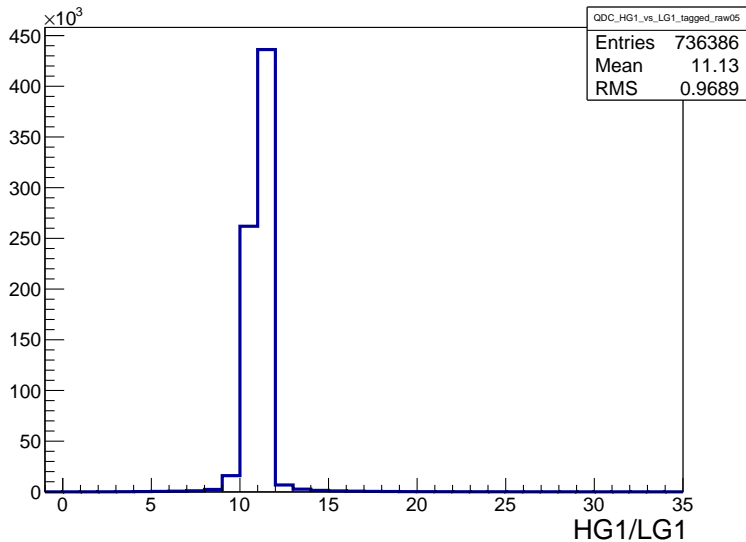


Slopes

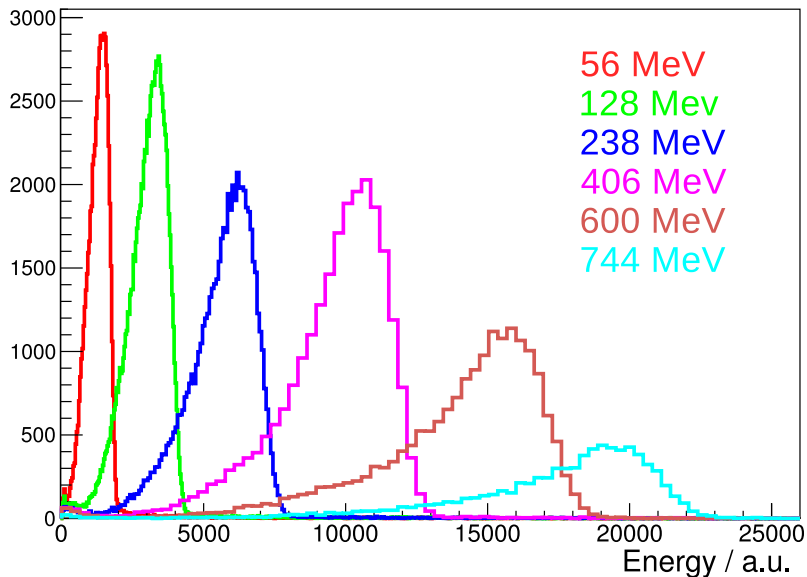


Slopes

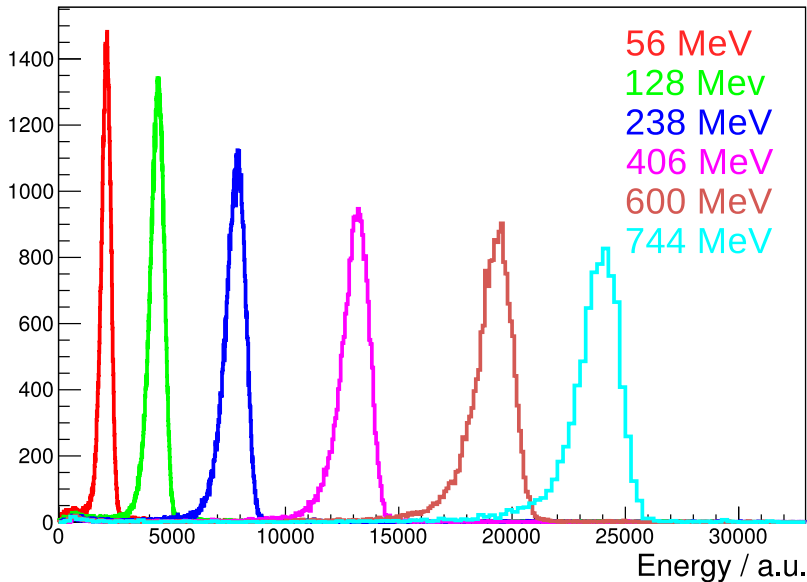
- Distribution of APD linearity slopes for HG (left) and LG (right)
- Variation possibly due to wrong APD gain



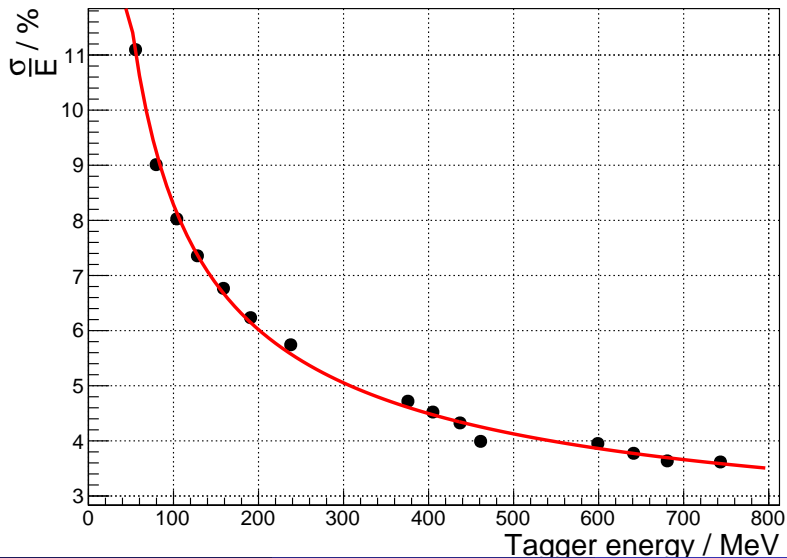
Calibrated and tagged lineshapes



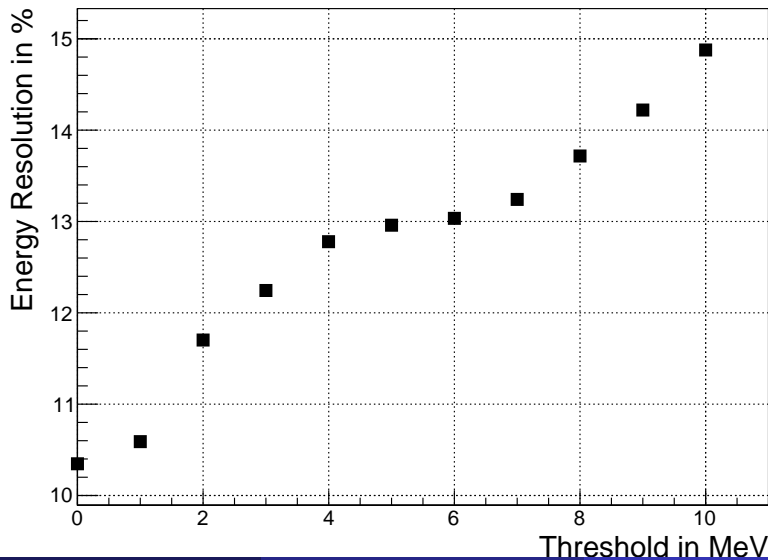
Calibrated, tagged and summed lineshapes



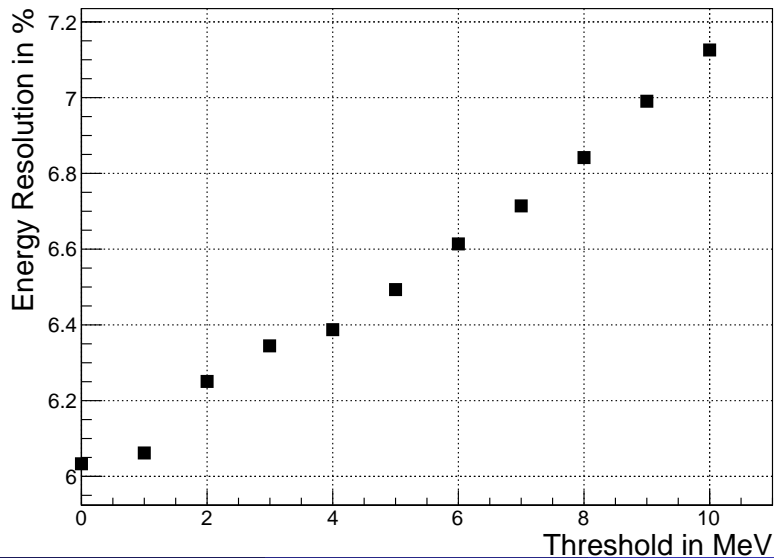
Energy resolution 3x3 with timecut and threshold 3 MeV



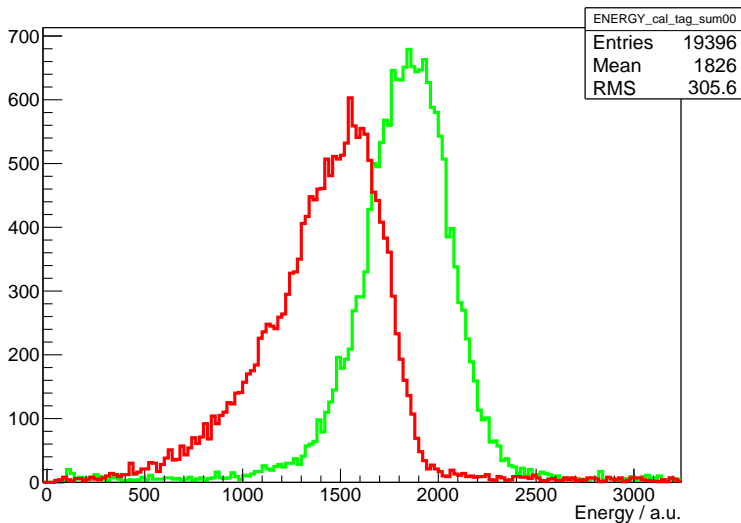
Threshold scan 56 MeV



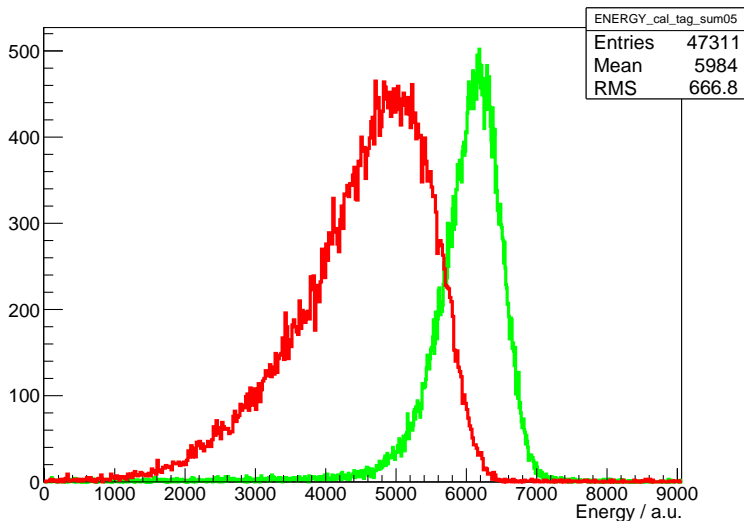
Threshold scan 192 MeV



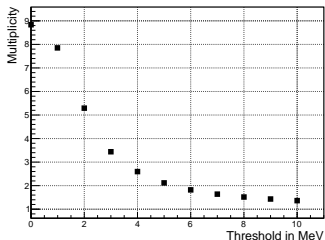
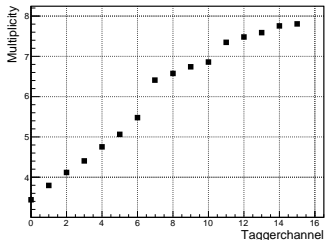
Central crystal vs summed matrix for 56 MeV with threshold 3 MeV



Central crystal vs summed matrix for 192 MeV with threshold 3 MeV

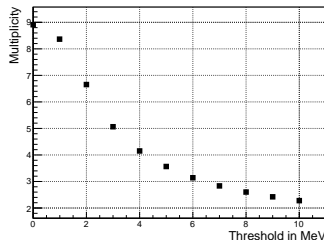


Multiplicity



Multiplicity

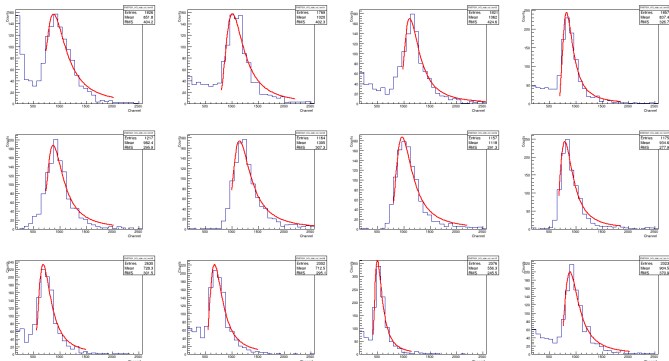
- Multiplicity as a function of the energy with 3 MeV threshold (upper left), multiplicity as a function of threshold for 56 MeV (lower left) and multiplicity as a function of threshold for 192 MeV (lower right)



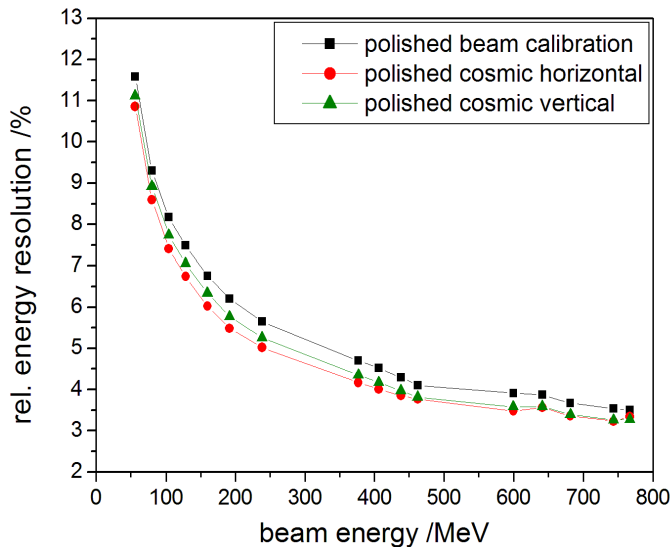
Cosmic calibration

Method

- Absolute calibration based on energy deposition of cosmic muons
- Horizontal 26.5 MeV and vertical 220 MeV energy deposition
- Calibration factor (horizontal 44.1 ch/MeV and vertical 44.5 ch/MeV) different to GEANT4 based calibration (39.2 ch/MeV)



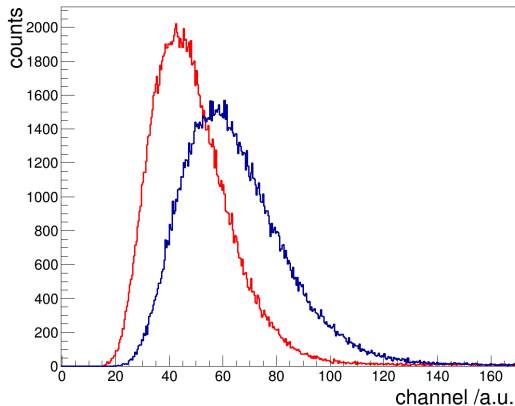
Comparison of obtained energy resolutions with different calibrations



Noise

Noise level

- Definition of noise: Maximum value of baseline - baseline



HG1

- mean = 58.4 ch
 - sigma = 22.3 ch
 - Mean + 3σ = 125.3 ch
- 3.2 MeV (GEANT4)
→ 2.8 MeV (cosmic)

Added traces

- mean = 41.2 ch
 - sigma = 15.6 ch
 - Mean + 3σ = 88.04 ch
- 2.2 MeV (GEANT4)
→ 2.0 MeV (cosmic)

⇒ Improvement of $\sqrt{2}$ by adding traces

Depolished matrix

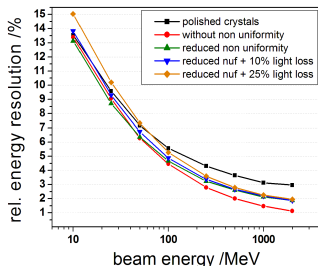
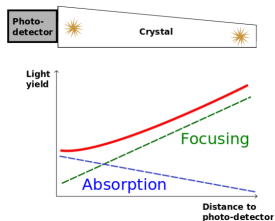
Influence of light collection non uniformity on the energy resolution

What is NUF?

- Interplay between focussing and absorption of the produced scintillation light

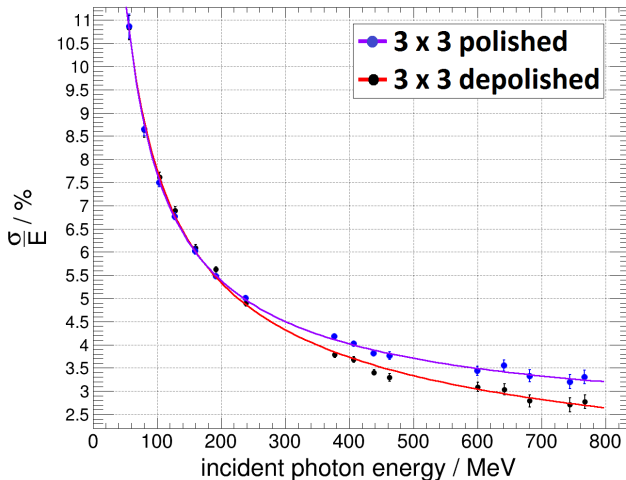
Simulation with GEANT4

- Simulation includes NUF, photon statistics and APD characteristics (no single photon tracking)
- Interaction in center of type 1 section
- threshold = 1.6 MeV

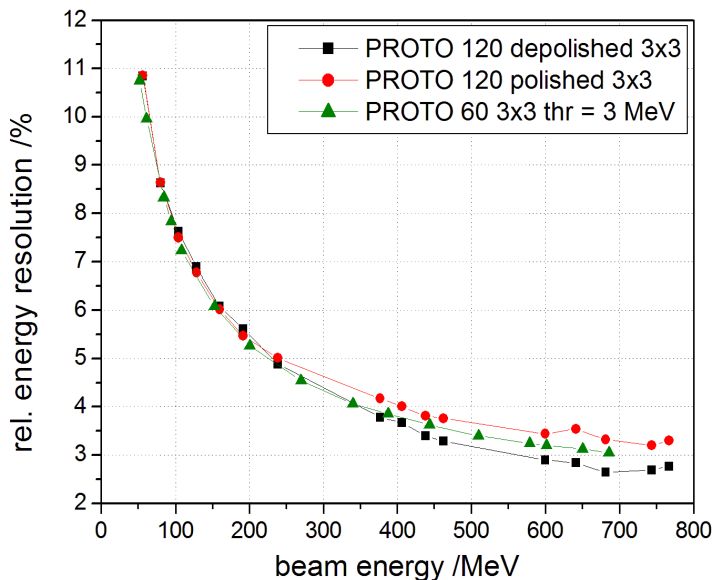


Experimental results of depolished matrix

- Comparison of the energy resolution of a 3x3 polished and a 3x3 depolished (one crystal side roughed) matrix



Comparison with PROTO60



- Improved shielding → less pickup noise
- Design of PROTO120 has to be modified
- Successful measurement of a polished, depolished and Basel matrixes
- $\sim 10\%$ failure of ASICs
- Better results with cosmic calibration than with beam calibration
- Still high noise level of 3 MeV but improvement by adding traces
- Better energy resolution at higher energies for depolished matrix

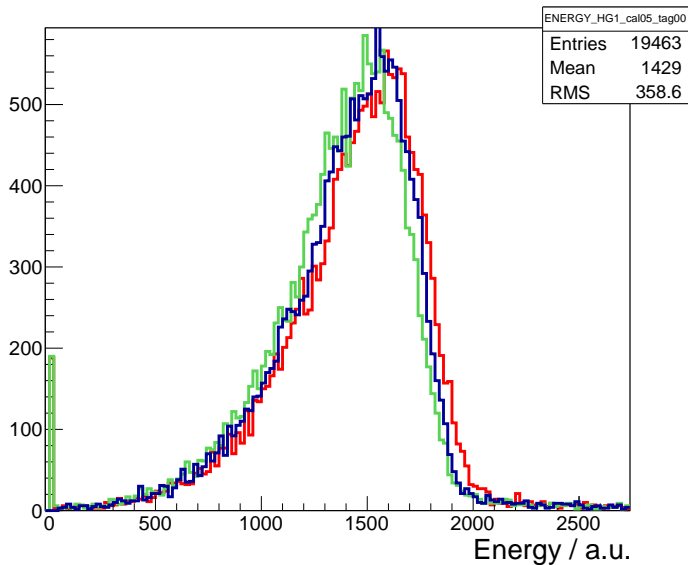


Thank you for your attention!



Backup

One APD vs two APDs for 56 MeV



Energy resolution 1x1 with timecut

