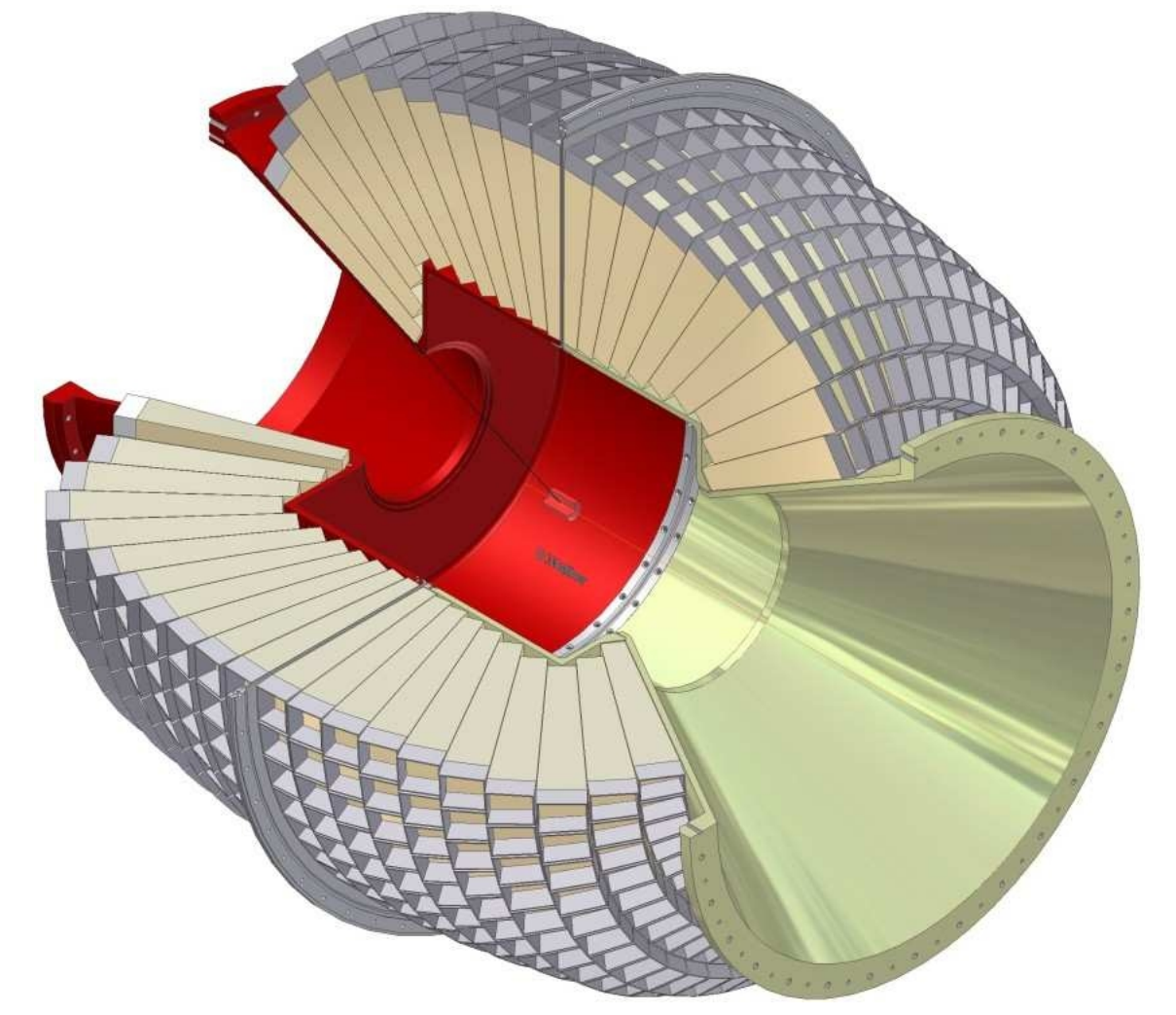


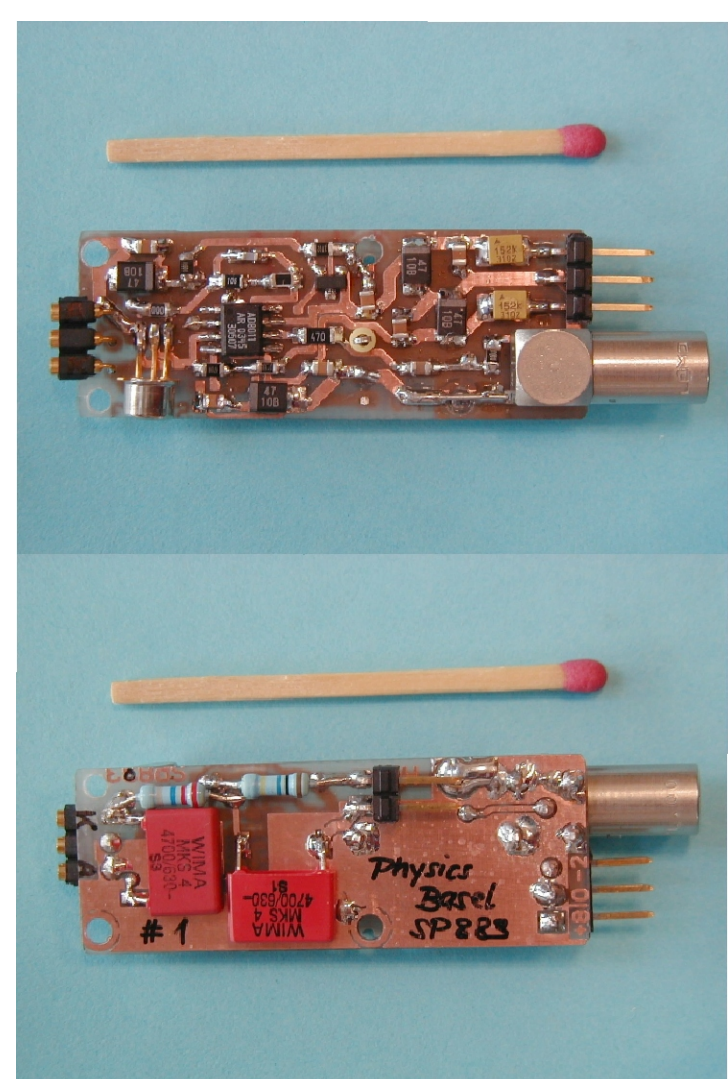
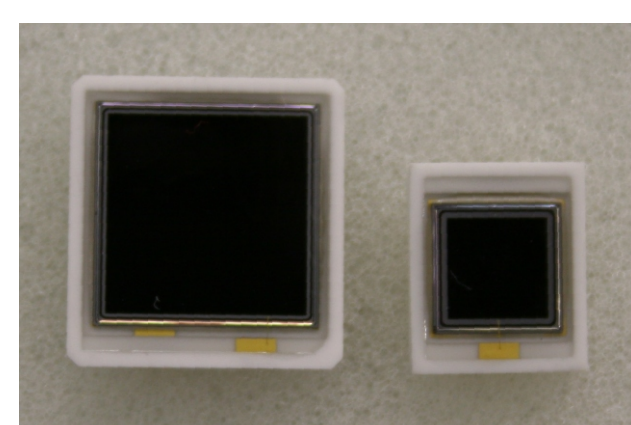
Motivation:

- at present: second-level trigger by determining the number of clusters in the Crystal-Barrel calorimeter,
- decision time of about 6 μ s
--> too long for first level trigger (only 180 ns allowed)
- a faster trigger signal is needed
--> two possibilities were investigated:
 - APD: completely new energy readout and fast timing signal,
 - SiPM: energy readout remains the same, fast timing signal.



Avalanche Photodiode Readout

- Hamamatsu S8664-1010SPL,
- based on CMS design
[Z. Antunovic et al., NIM A537(2005)379],
- active area: 5mm x 5mm,
- reverse biased diode.



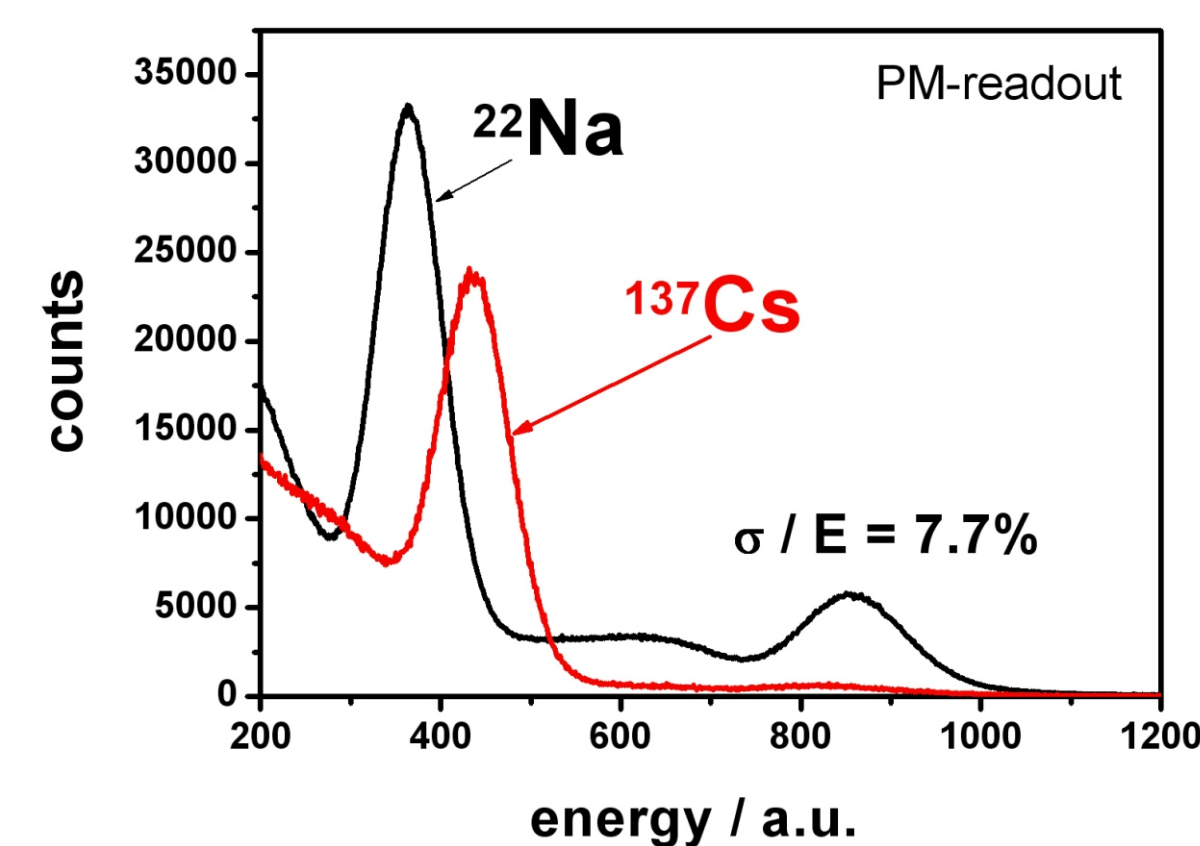
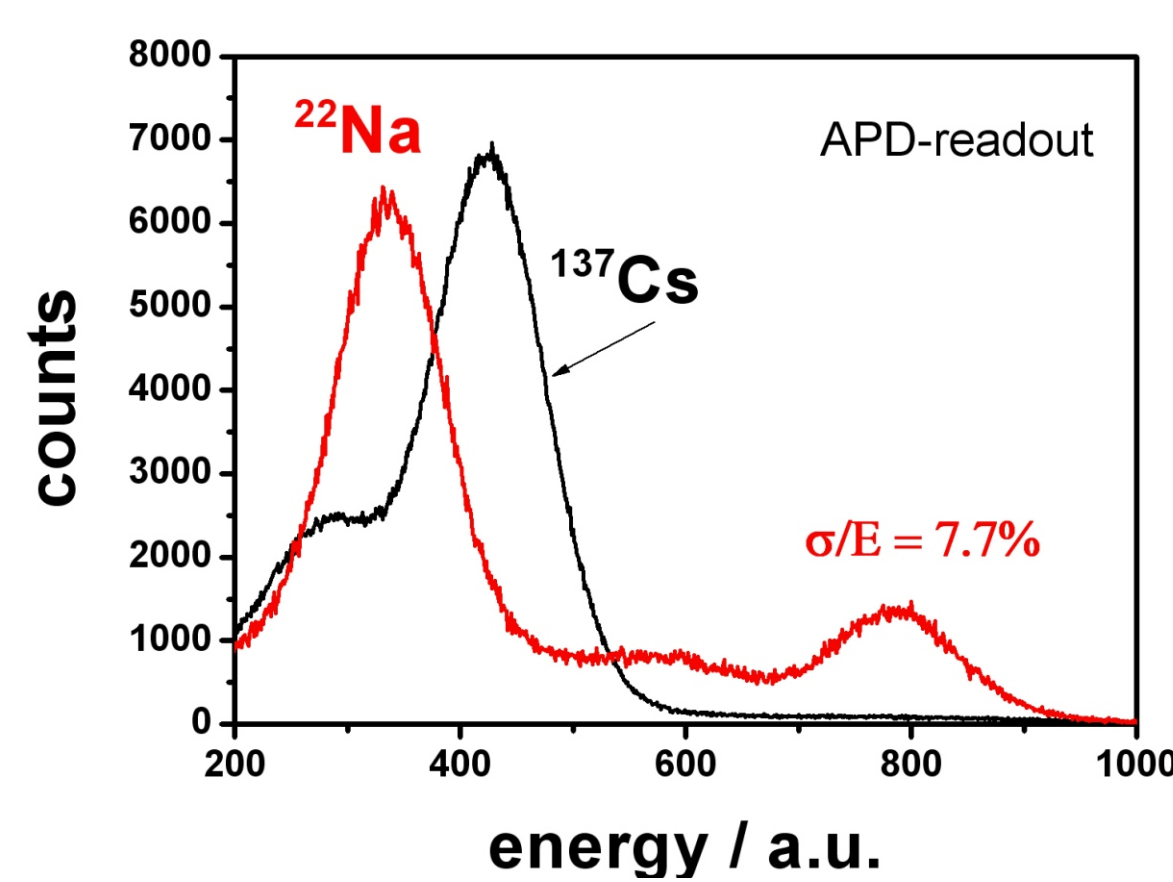
PANDA version:

- active area: 10mm x 10mm,
- C= 270pF at gain 50 and frequency at 100kHz,
- dark current: 10nA at gain 50,
- quantum efficiency 70% at 560nm.

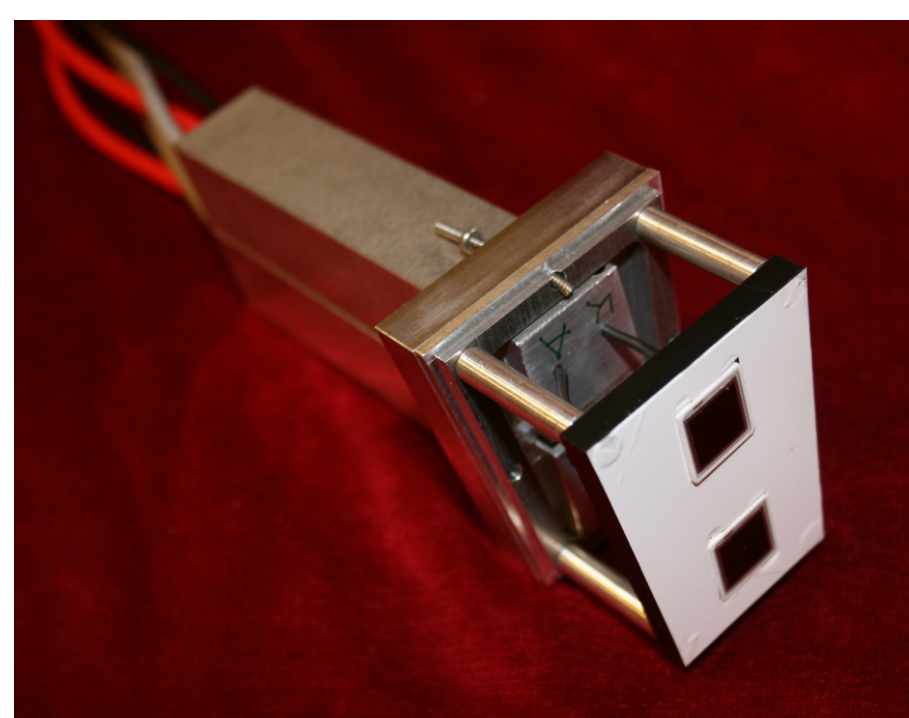
Preamplifier

- charge sensitive preamplifier,
- design: M. Steinmacher et al., Basel,
- Low noise and low power consumption,
- sensitivity: 0,5V/ pC,
- feedback time constant: 25 μ s,
- not yet optimized for CsI(Tl).

Test of single CsI(Tl) crystal at low photon energies



Test of a 3x3 subarray of CsI(Tl) crystals

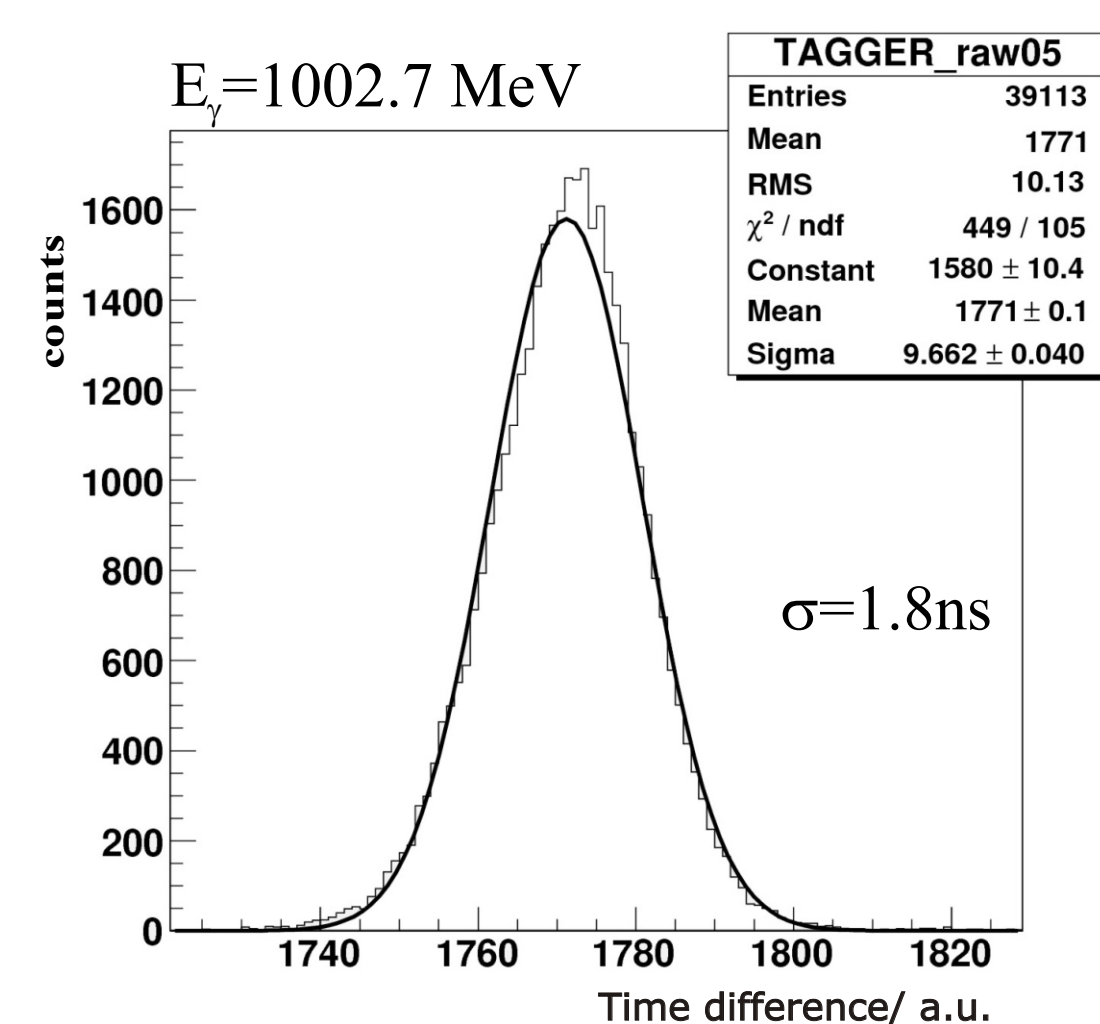
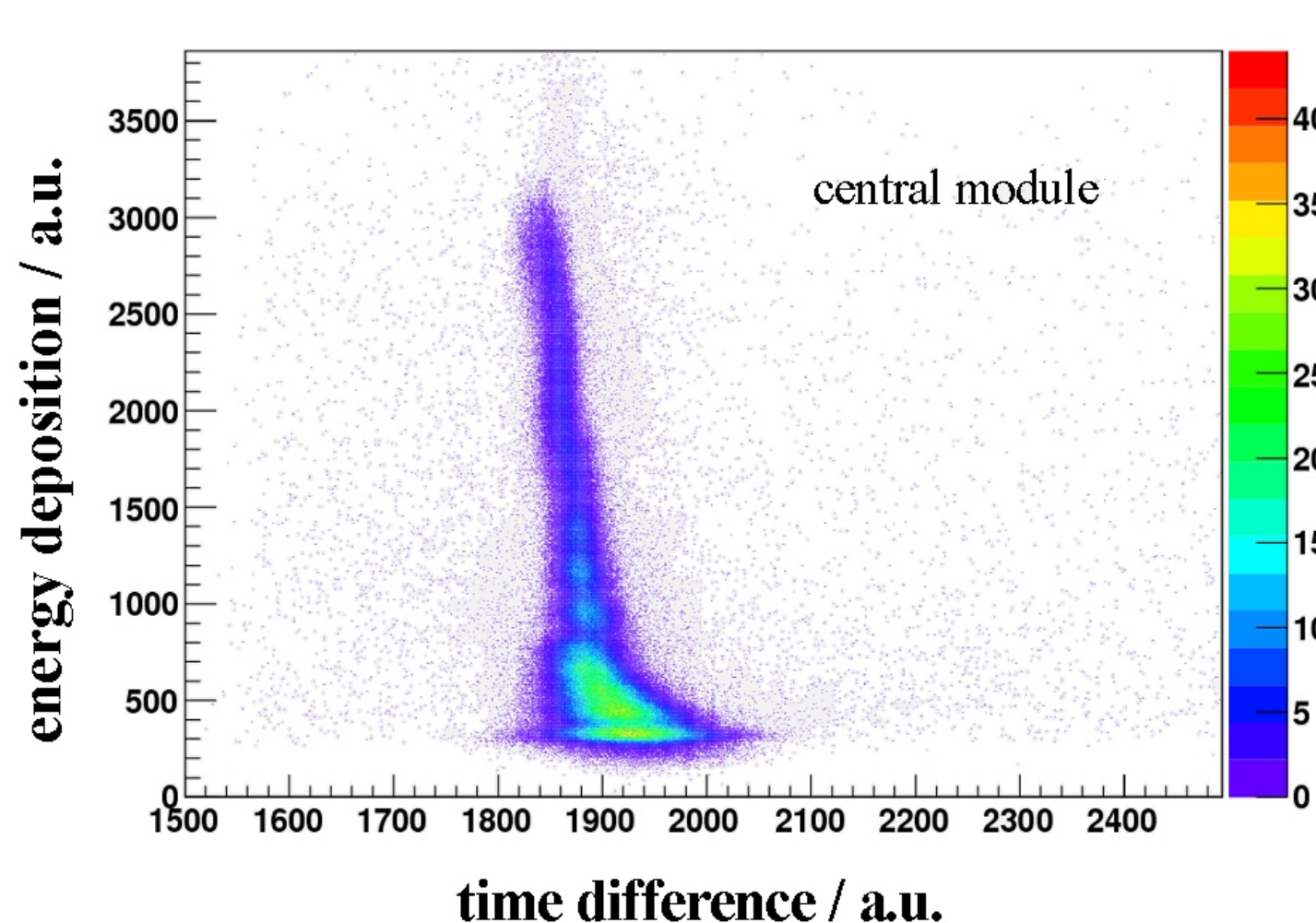


New APD readout for a single CsI(Tl) crystal

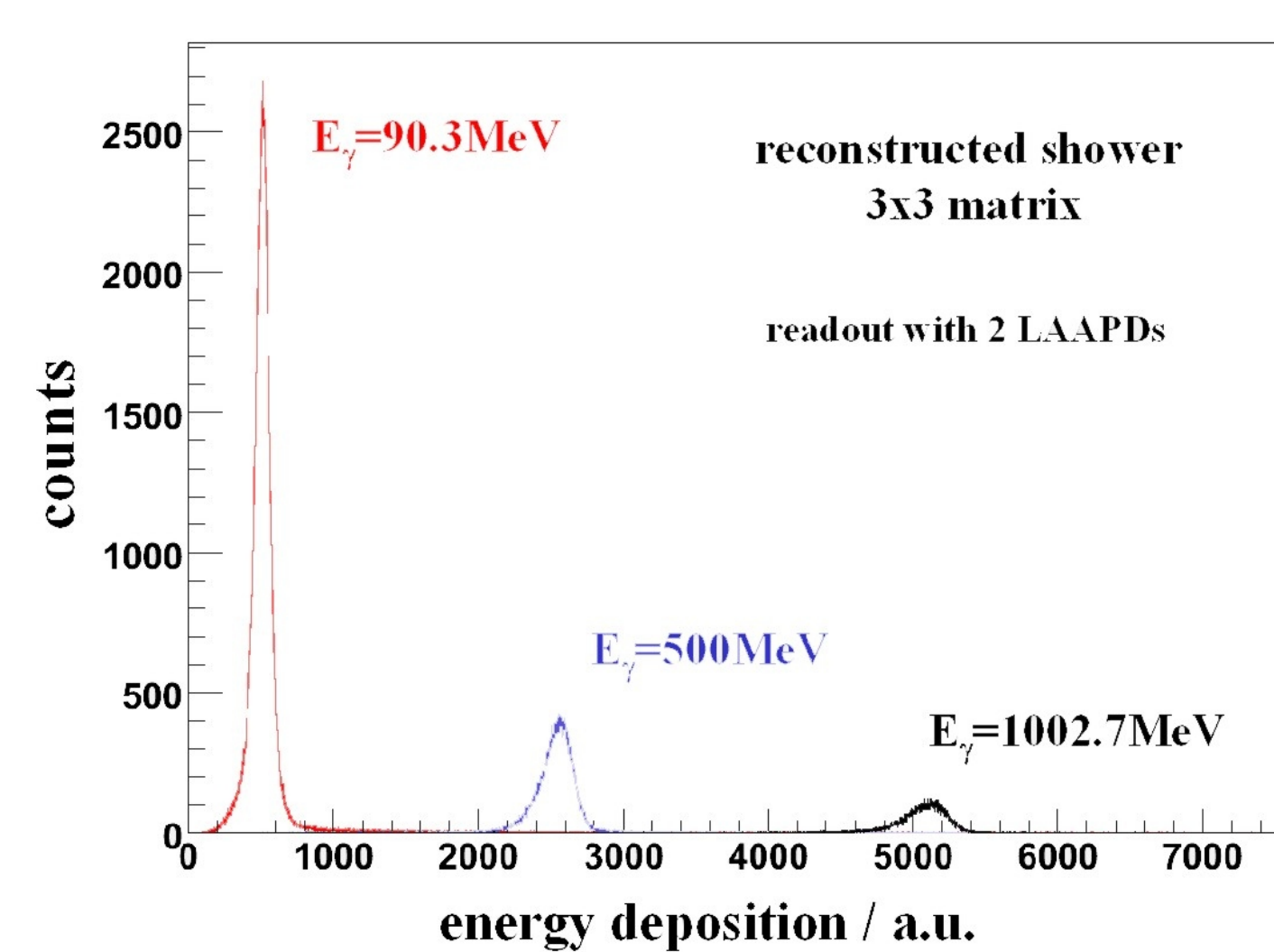


3x3 matrix of CsI(Tl) crystals

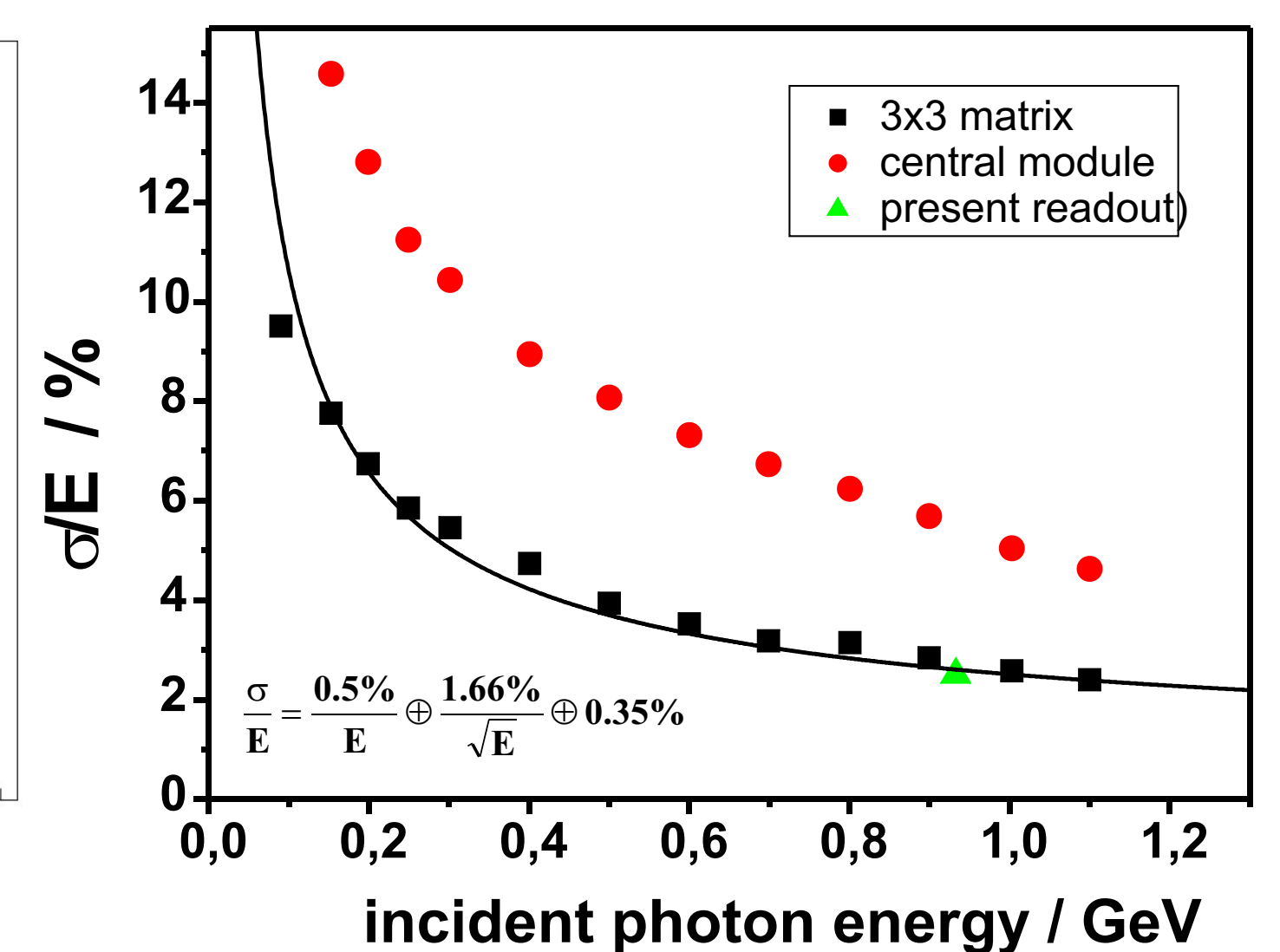
Time resolution of the APD



Energy resolution of the APD

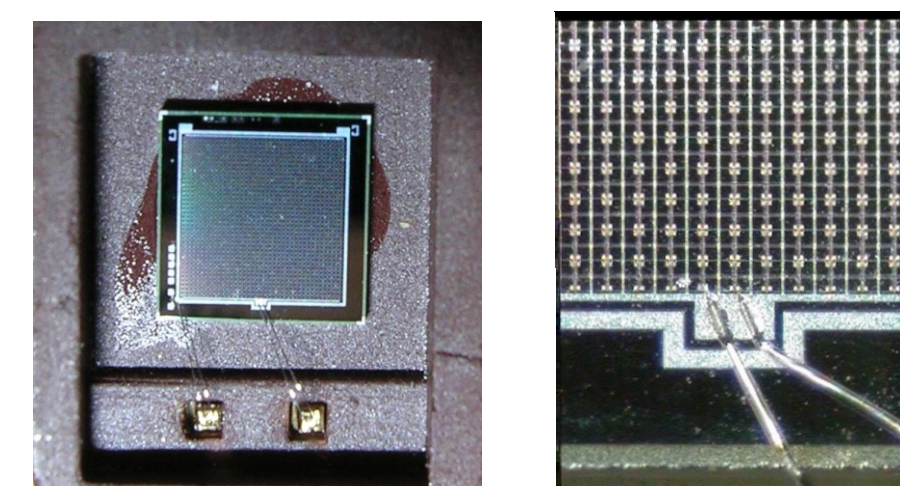


Energy response for three different photon energies



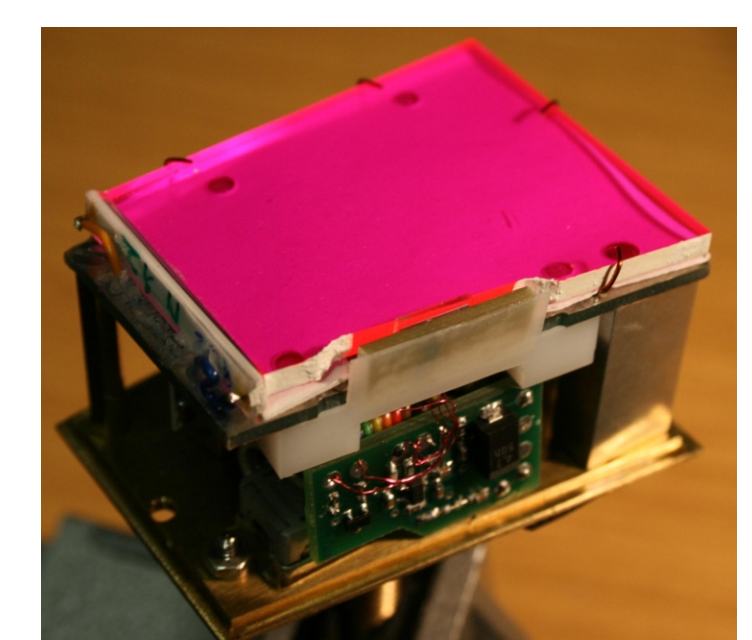
Energy resolution at different photon energies for the central crystal and for the 3x3 matrix

Silicon Photomultiplier Readout



- size: 3mm x 3mm,
- 5625 pixels of 30 μ m x 30 μ m,
- pixels operating in Geiger mode,
- gain factor: 10⁶,
- bias voltage: 30 V,
- no temperature dependency.

- SiPM provide fast timing signals
-> use as trigger signal for the first-level Trigger,
- energy readout of the Crystal-Barrel calorimeter remains the same,
- two SiPMs are mounted on the wavelength shifter in addition to the existing photodiode.



Results of test measurements with electrons and cosmuics:

- 90% trigger efficiency in comparison to the photodiode,
- SiPM usable at an energy threshold of approximately 27 MeV,
- time resolution:
 $\sigma = 12,5$ ns
-> fulfill the timing requirements for the first-level trigger.

