

Fakultät Physik
Institut für Kern- und Teilchenphysik

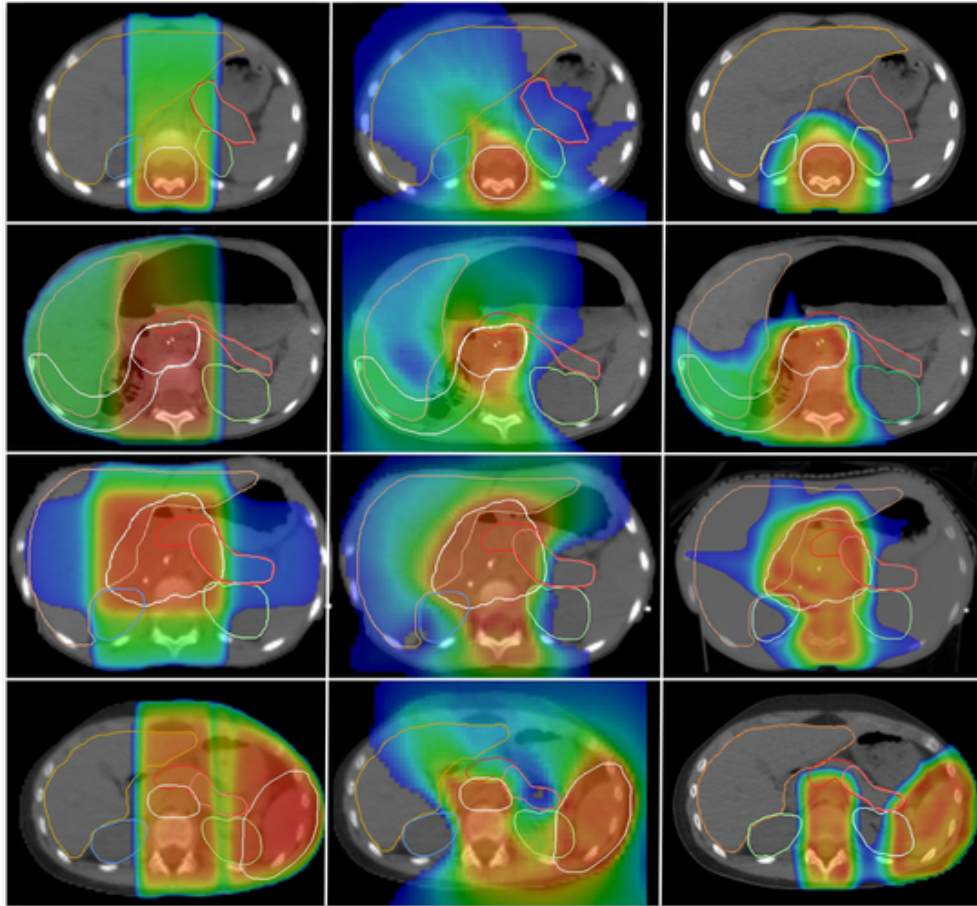
First Results for Prompt Gamma Spectra measured by PETsys Electronics with 100-162 MeV Proton Beam at OncoRay TU Dresden

Olga Novgorodova

23.03.2023

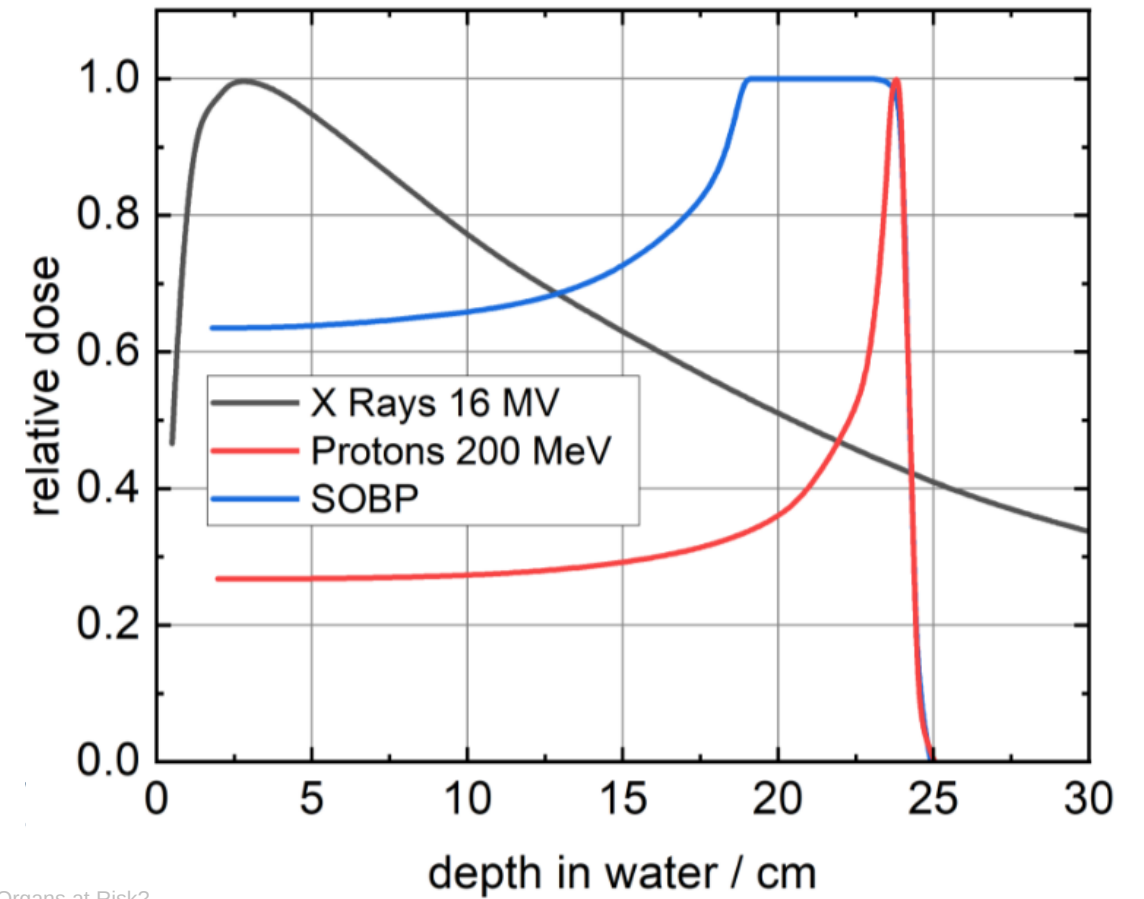
Proton Therapy

R. Mohan and D. Grosshans, "Proton therapy – Present and future" *Advanced Drug Delivery Reviews*, vol. 109, pp. 26–44, 2017, doi: <https://doi.org/10.1016/j.addr.2016.11.006>

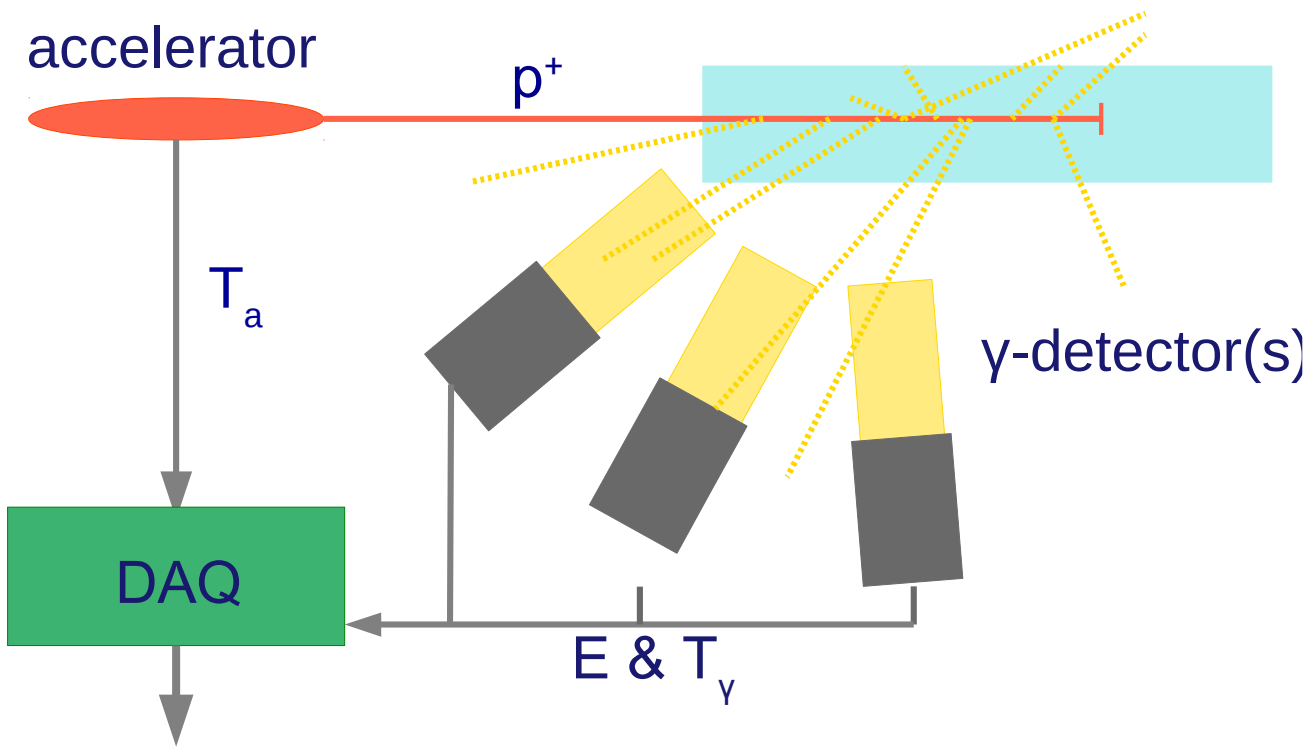


Conformal Radiotherapy Helical Tomotherapy Proton Beam Therapy

Jouglar E, Wagner A, Delpon G, Campion L, Meingan P, Bernier V, et al. (2016) Can We Spare the Pancreas and Other Abdominal Organs at Risk? A Comparison of Conformal Radiotherapy, Helical Tomotherapy and Proton Beam Therapy in Pediatric Irradiation. doi:10.1371/journal.pone.0164643

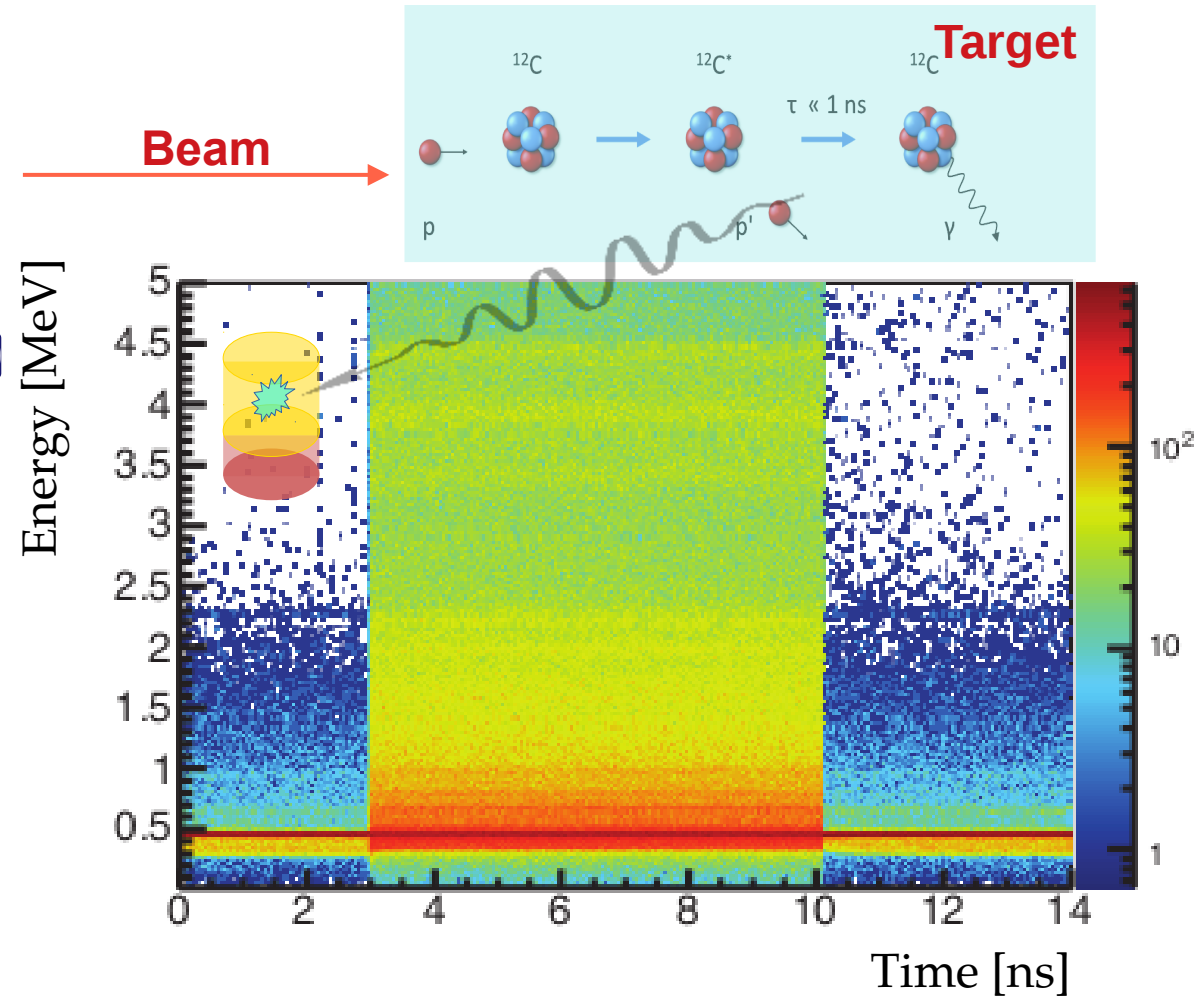


Prompt Gamma-ray Timing (PGT)



Energy & Time

Measurements: Accelerator or Sources in the LAB



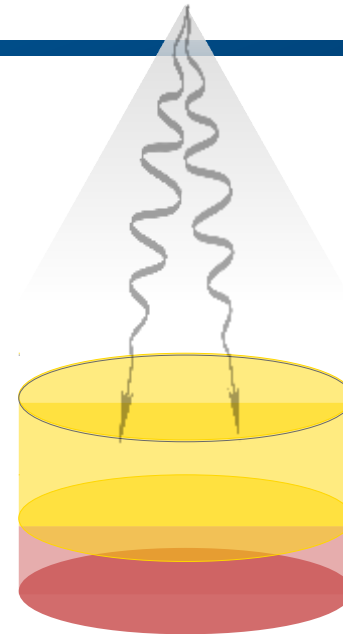
Challenges

High statistics with full acceptance:

- $\sim 10^6 \dots 10^8$ p⁺ / Pencil Beam Spot (PBS)
- Extreme load tolerance ($\sim 2 \times 10^9$ Prompt Gammas / second)

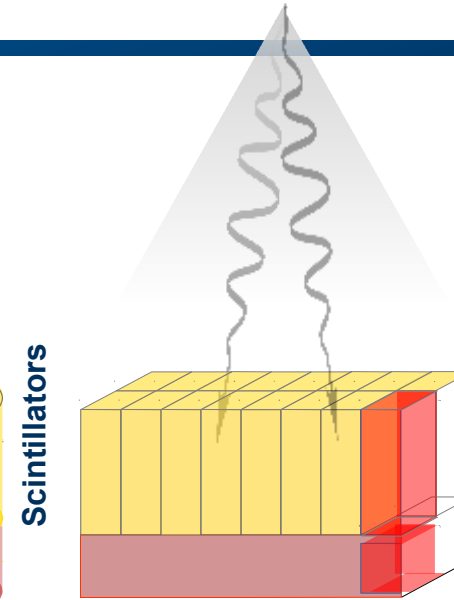
Reduce size of one channel:

- Reduce number of events
- **Optimize the size of crystal**
 - Energy & Time Resolution
 - High rates
- Readout with Silicon Photomultiplier (SiPM)
- Optimize PETsys for Prompt Gammas



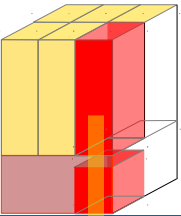
Photomultiplier (PMT)

- High volume scintillator
- High load
- More fully absorbed Prompt Gammas



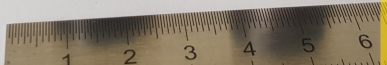
Silicon Photomultiplier (SiPM)

- Segmented scintillator
- Reduced load
- Loss of events – double escape peaks



PETsys Setup

Scintillators:



CeBr₃

5x5x20 mm³
10x10x30 mm³

+

SiPM



Pin 5 Pin 8

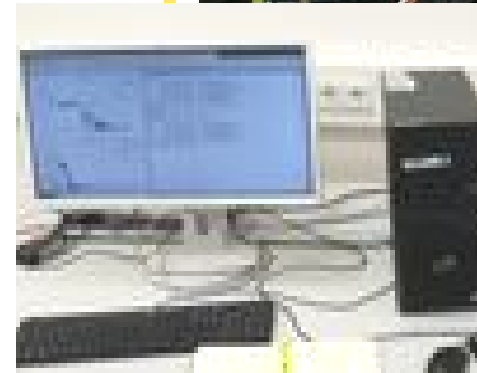
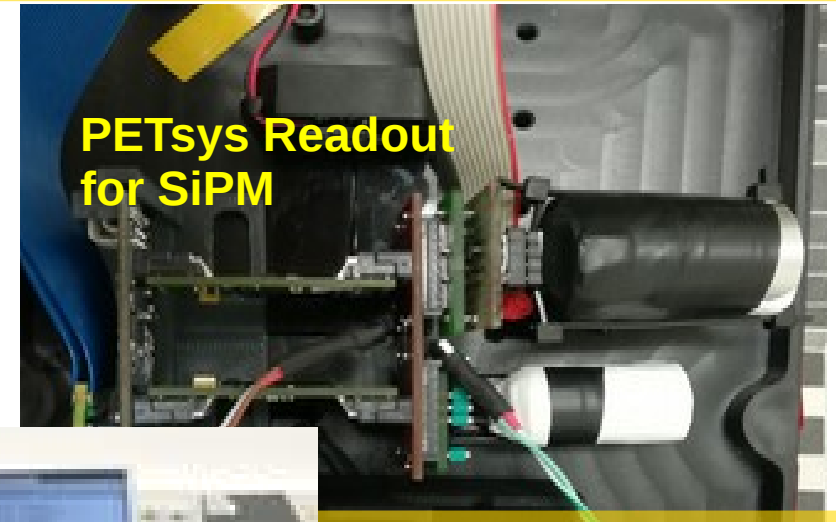


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Assembly



PETsys Readout for SiPM



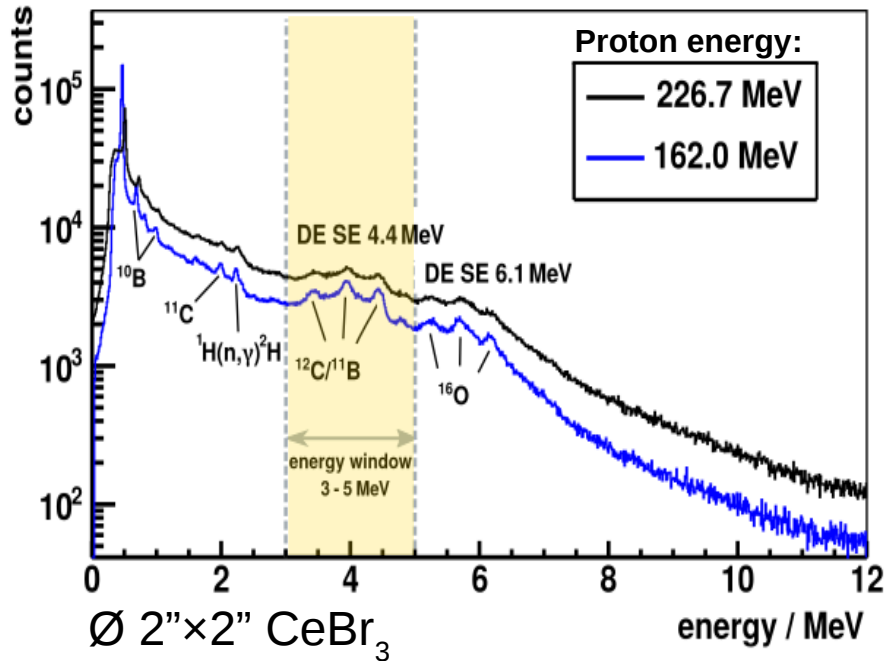
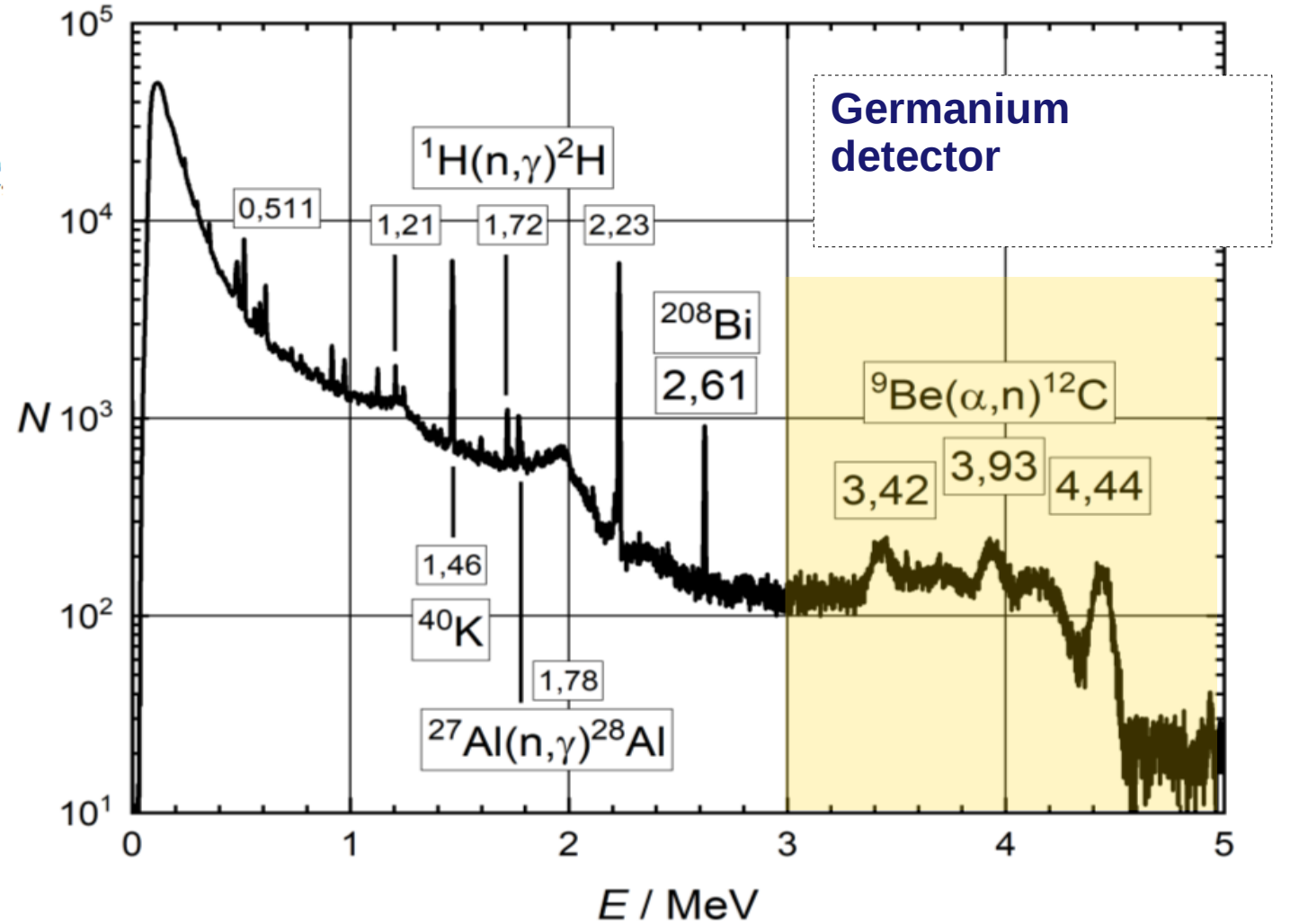
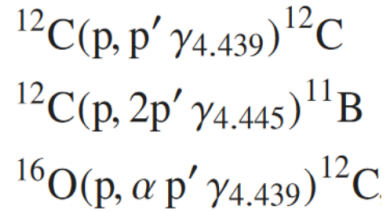
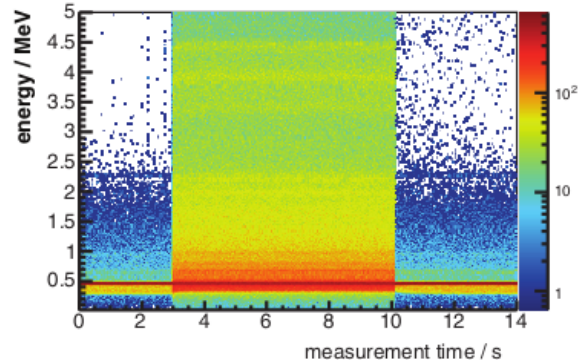
- cost effective
- fast
- scalable



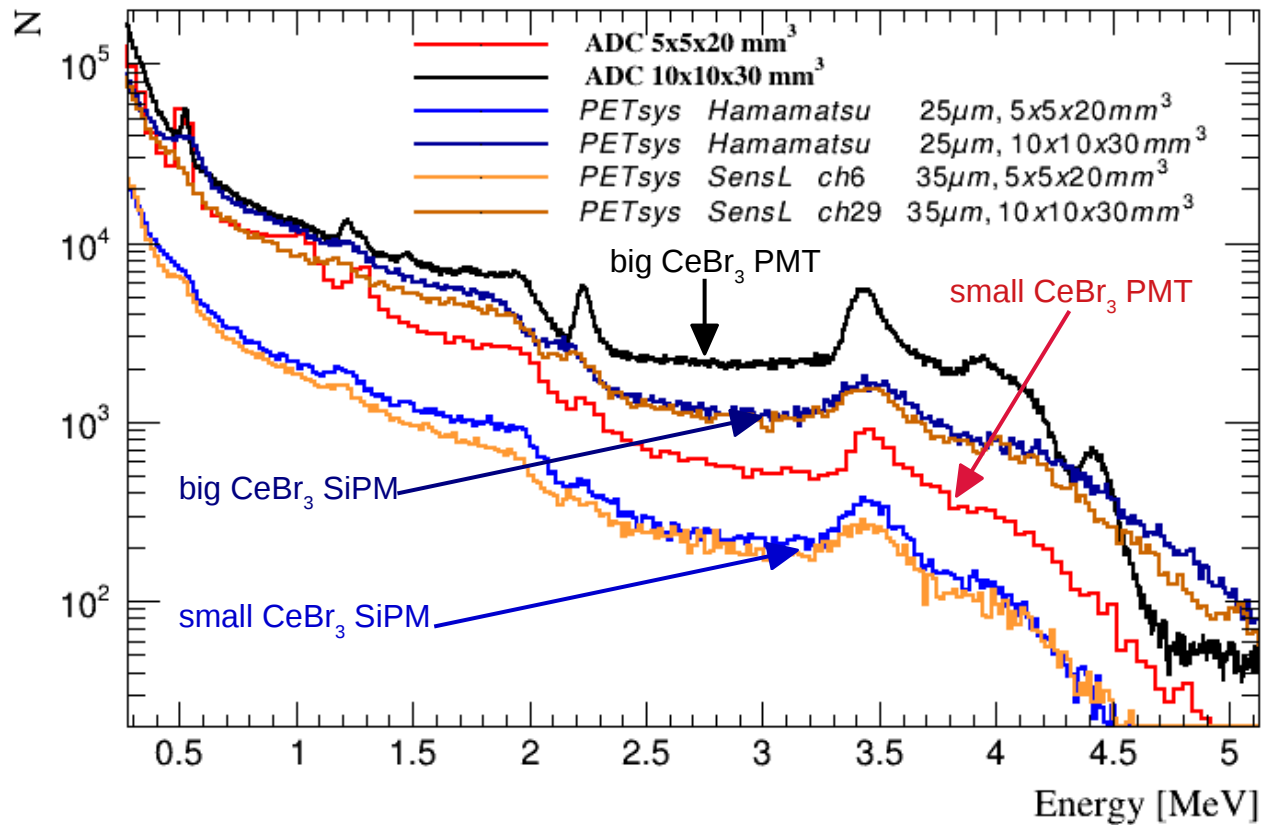
<https://www.petsyselectronics.com>

- PETsys: application from PET to Prompt Gamma 3-8 MeV
- Find fitting SiPM array
- The PET Energy Resolution at 511 keV is 10.5 %
- $E_{\text{resolution}} \sim 1/\sqrt{E}$
- Coincidence Time Resolution of 119 ps FWHM

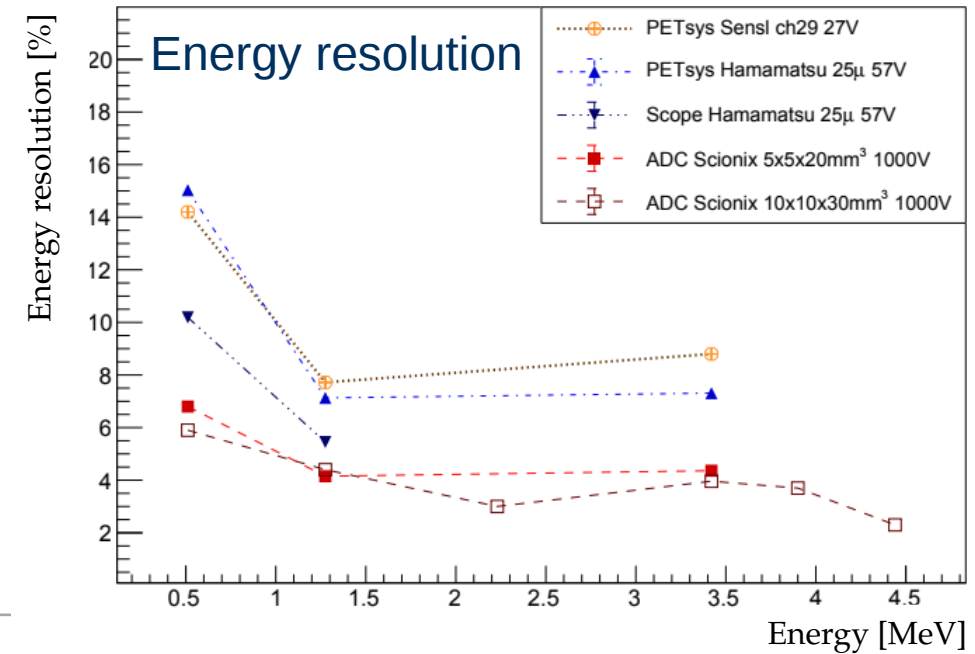
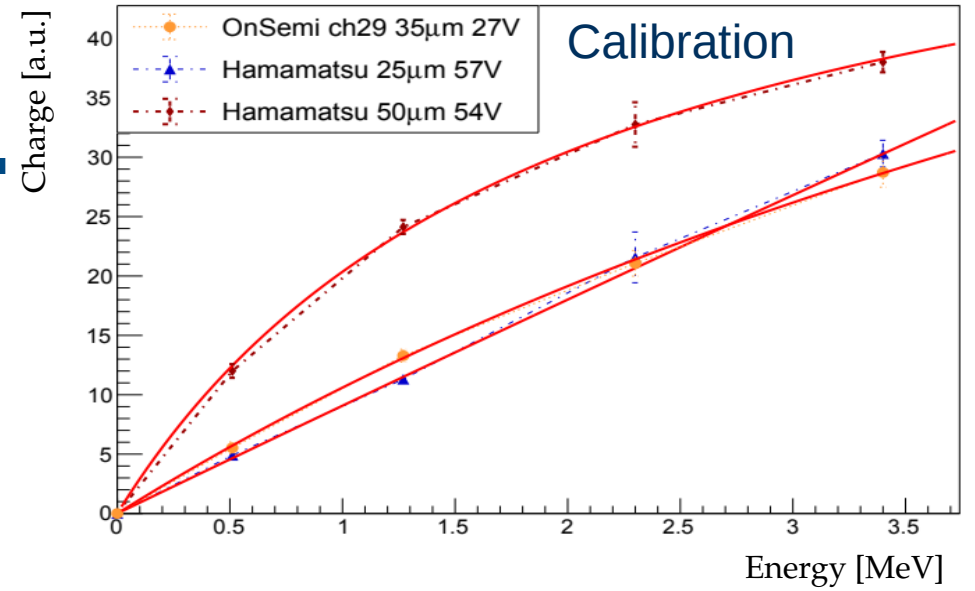
Americium-Beryllium Source



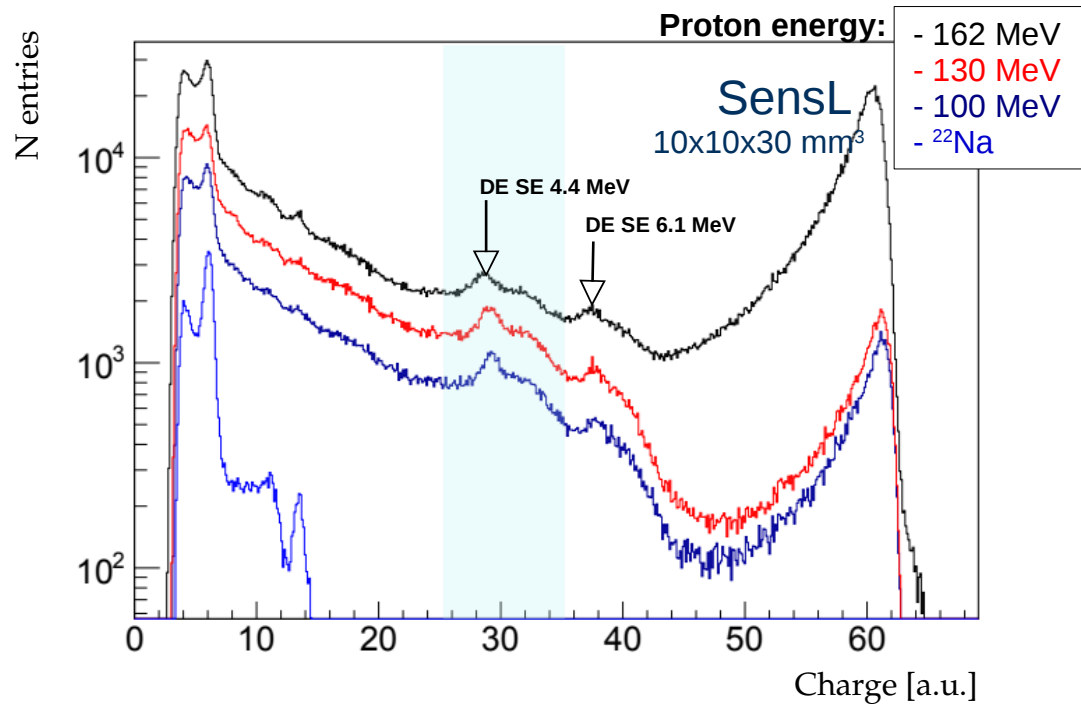
PETsys Measurements



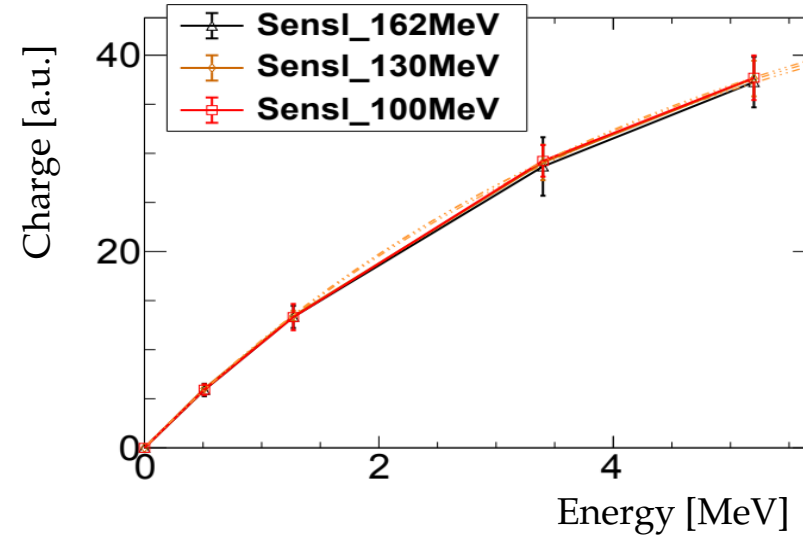
- Am-Be source



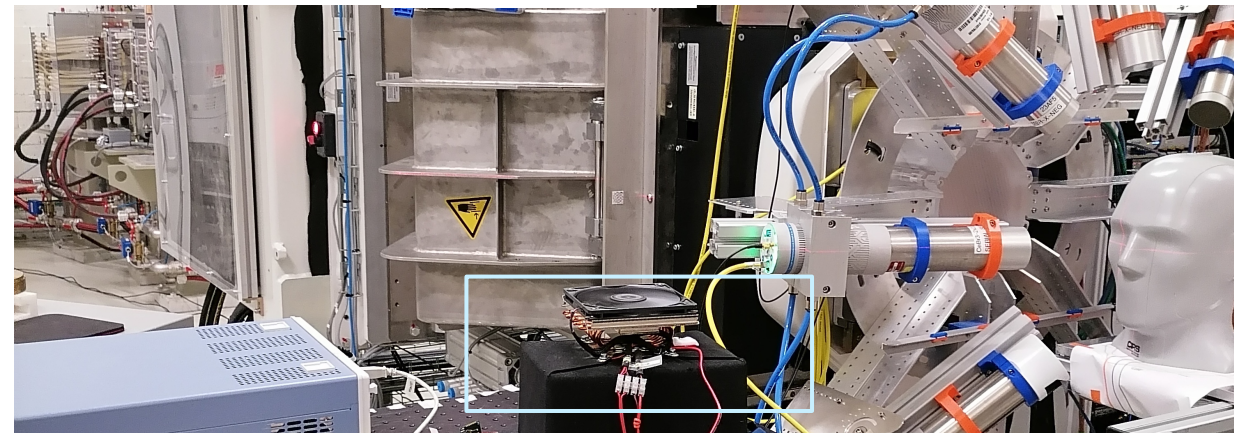
OncoRay Measurements



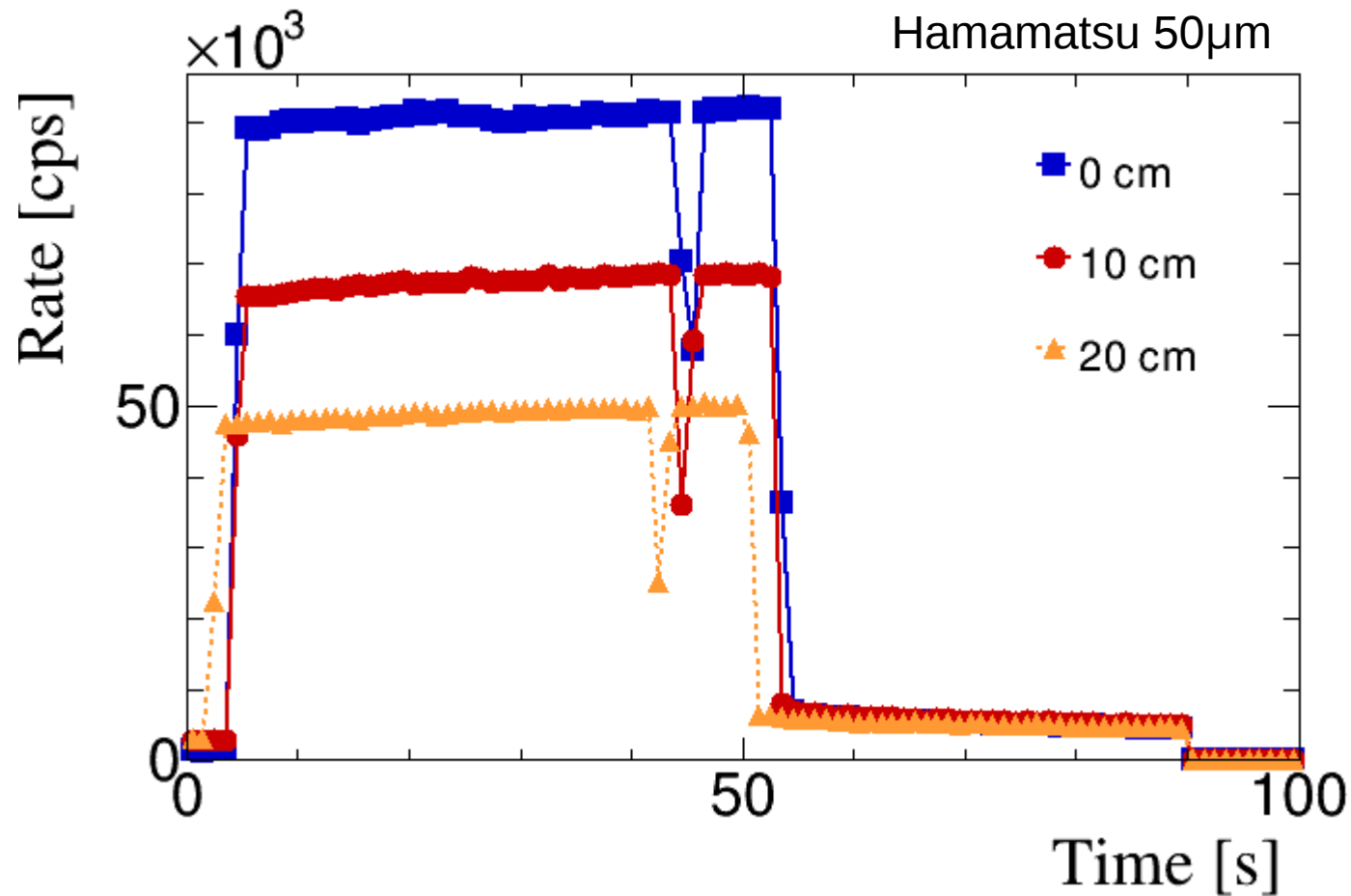
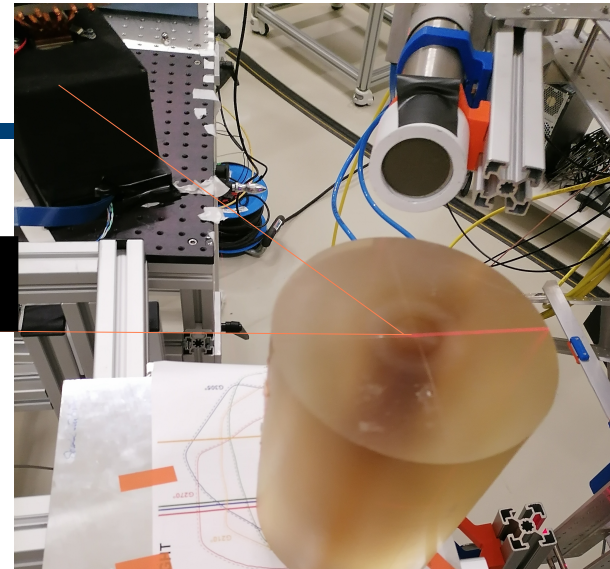
- With increase of p energies - peaks shift
- Double escape peaks from 4.4 MeV and 6.1 MeV



- Calibration almost identical
- < 0.5% reduction in Energy resolution by increasing the energy



Different positions



PETsys

20cm 10cm 0 cm

- Rate measured up to 100 kcps
- Sufficient to cope with Prompt Gamma rate at OncoRay TU Dresden
- Small improvement of Energy resolution with the increase of the distance

Conclusions

- Successful characterization of CeBr_3 + SiPMs + PETsys readout system (energy and time resolution, rates) for PGT
- First measurements in OncoRay TU Dresden of energy spectra with 1-4 channels SiPM + CeBr_3 + PETsys
- Visible double escape peaks from 4.4 and 6.1 MeV
- Rates below 100 kcps

Thank you for your attention...

Aknowledgements:

OncoRay TU Dresden

ELBE HZDR Rsesondorf – gamma source

G. Pausch, T. Kögler, B. Lutz & K. Römer

PETsys electronics for support & Scionix for CeBr_3 production

Continue to backup slides....