Status Report
- Germanium Activities

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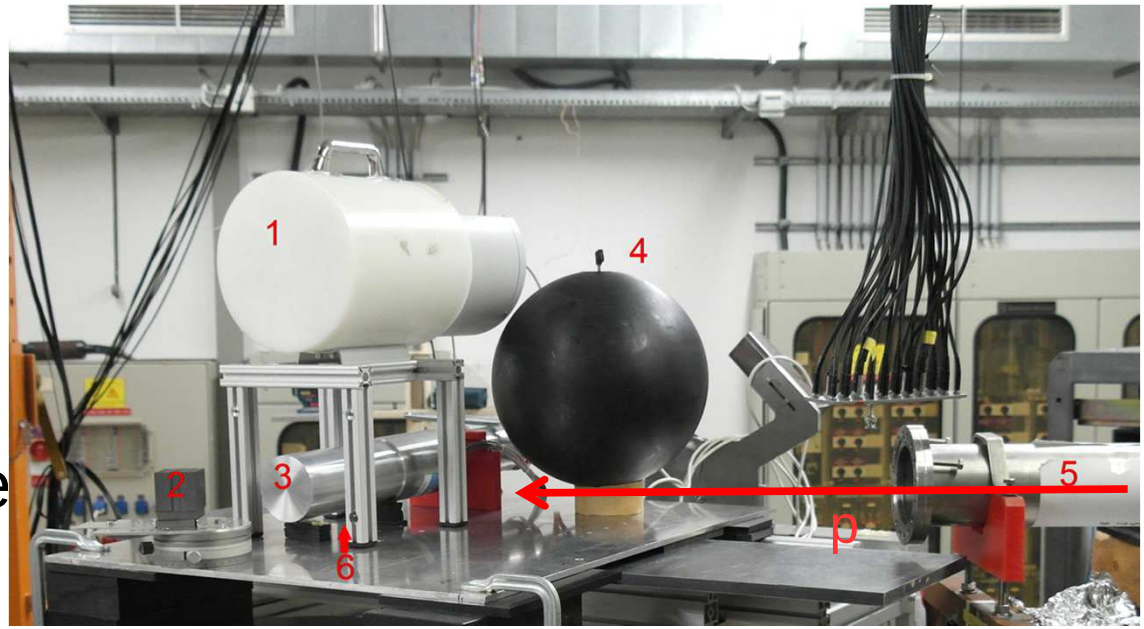
Panda LI. Coll. Meeting, Juelich, 12/10/14

Outline

- Beam test at COSY
- Simulations
- Hardware progress

Irradiation test @ COSY in Jülich

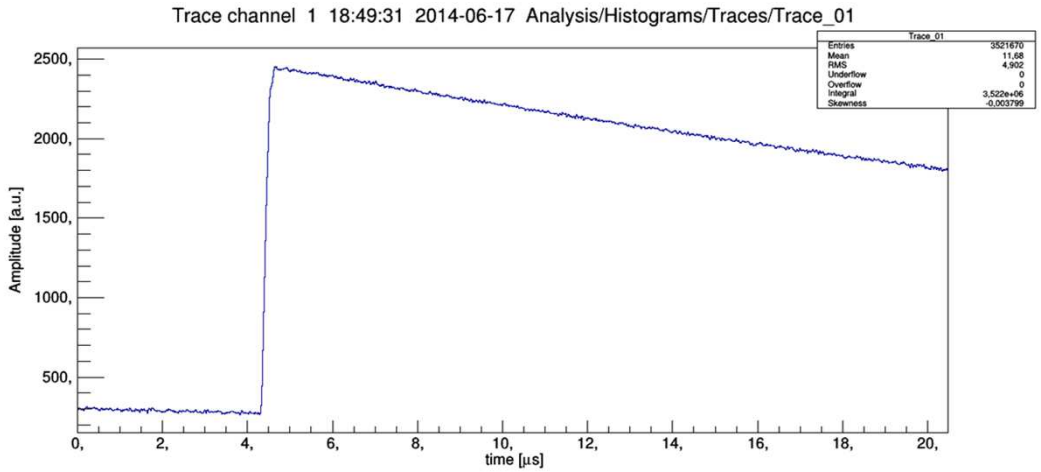
- Beam time in june and july 2014
- Jessica area
- Beam: $8*10^{8}$ p, 6 s beam,
- 17 s cycle, 2.78 GeV/c
- 5 cm carbon target
- Measurements in 11s spill pause
- Detector @ 120°, 15 cm distance
- Additional neutron detectors



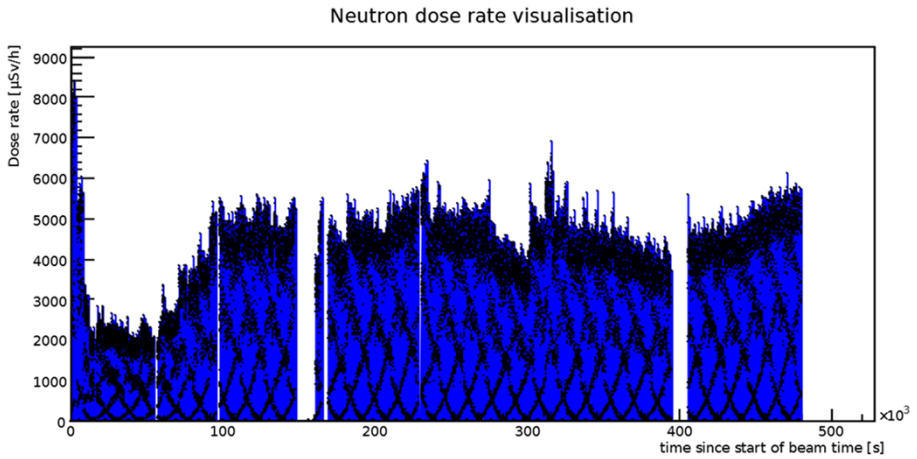
1 act. n detector
2 target
3 Germanium
4 pas. n detector
5 beam pipe
6 ^{60}Co source

Irradiation test @ COSY in Jülich

- Better noise conditions due to improved grounding of the setup



- $4 * 10^{13}$ protons accumulated
  ~50 days $\bar{P}$ANDA
- Limitation by radiation protection and beam time

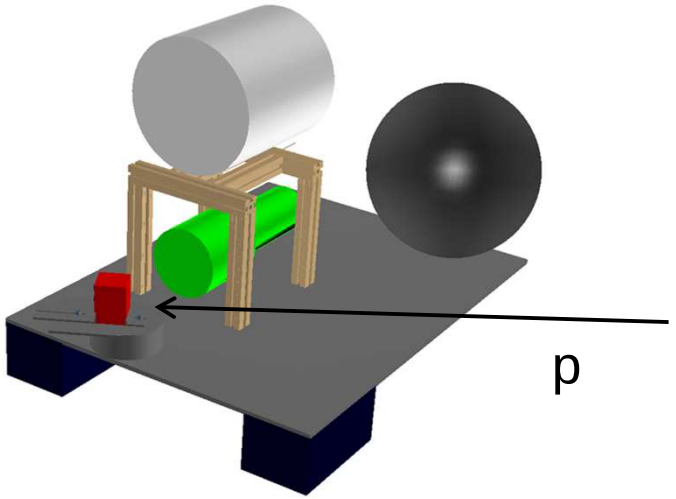


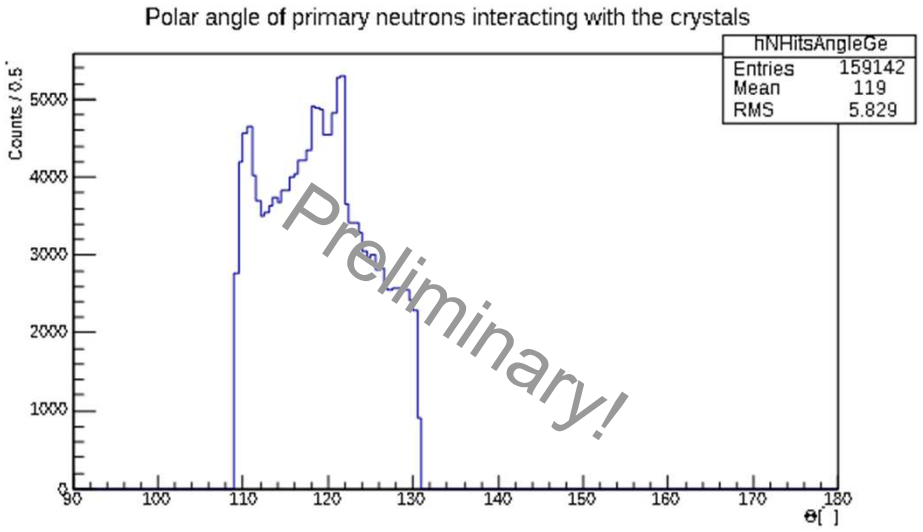
Irradiation test: Simulation

- Geometry of test setup build in PandaROOT
- 10^8 events, 1.6 *10^5 n

  → 2.1*10^9 n/cm^2 total

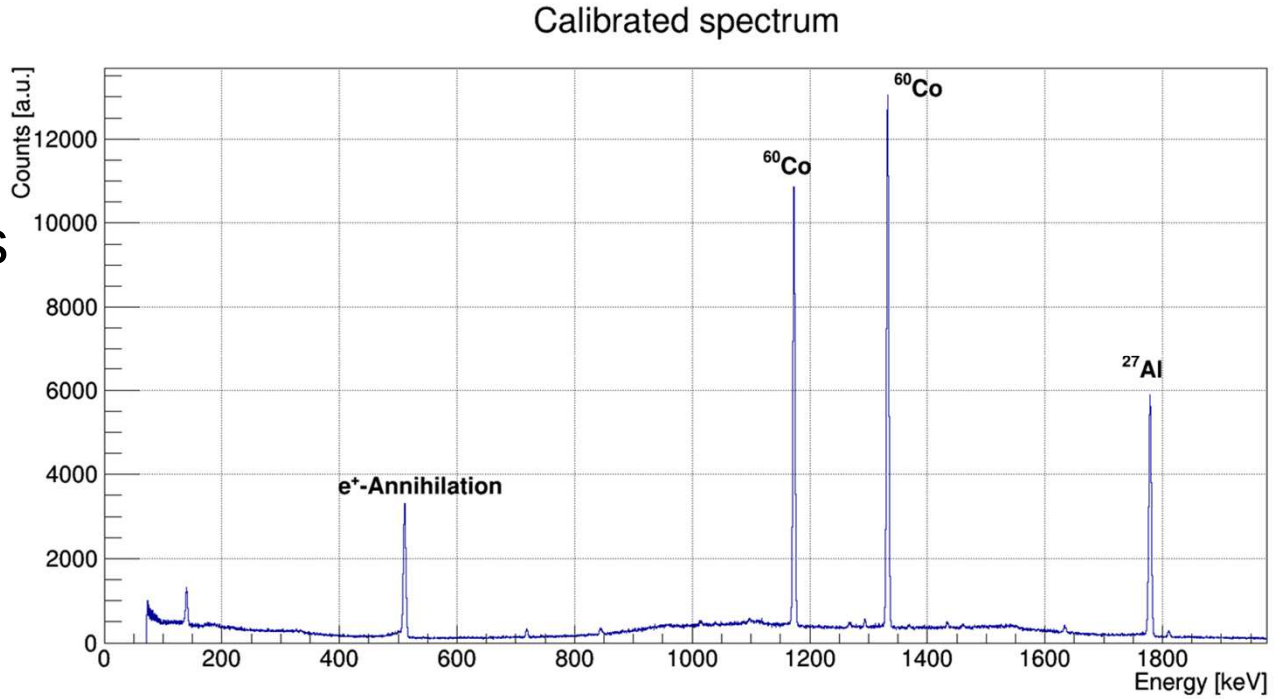
  (~75 days of $\bar{P}$ANDA)
- 2.9*10^9 n/cm^2 accumulated over 100 days of $\bar{P}$ANDA conditions @ 10^6 interactions/s
- More detail in geometry and analysis in progress
- Confirmation via neutron detector measurements foreseen





Irradiation test: results

- Spectrum in spill pause, active resetting preamp needed for measurements with beam
- Activation of surrounding material gives additional lines
- Useful for calibration, but additional background

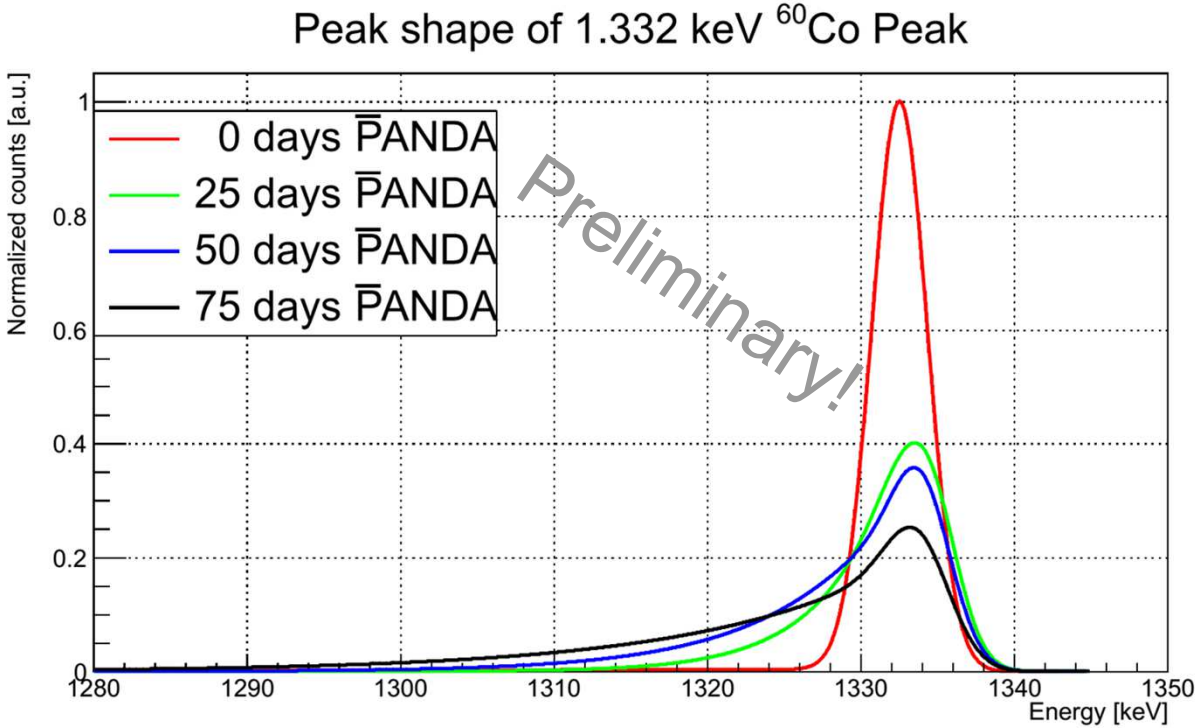


Analysis done in Bachelor thesis of Torben Rathmann

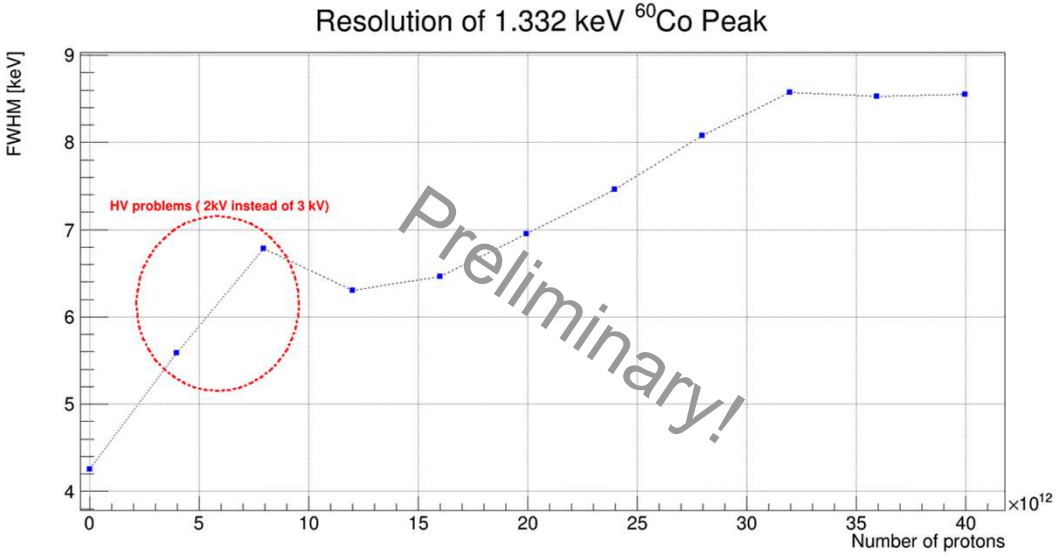
Irradiation test: results

Evolution of line shape:

- Broadening
- Low energy tail



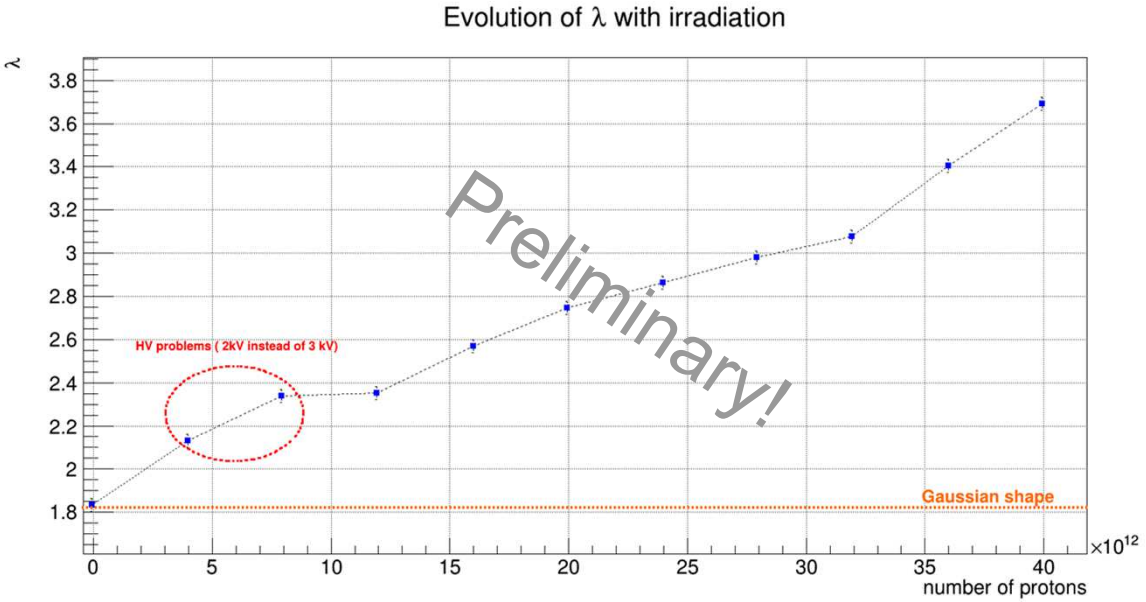
Irradiation test: results



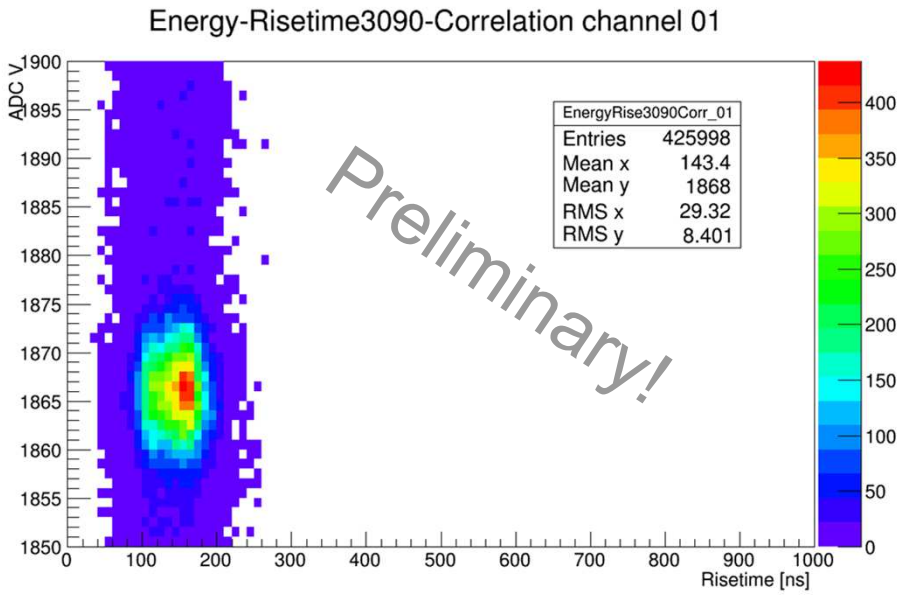
$$\lambda = \frac{FWTM}{FWHM}$$

- Gaussian: λ = 1.82
- Ratio is steadily growing

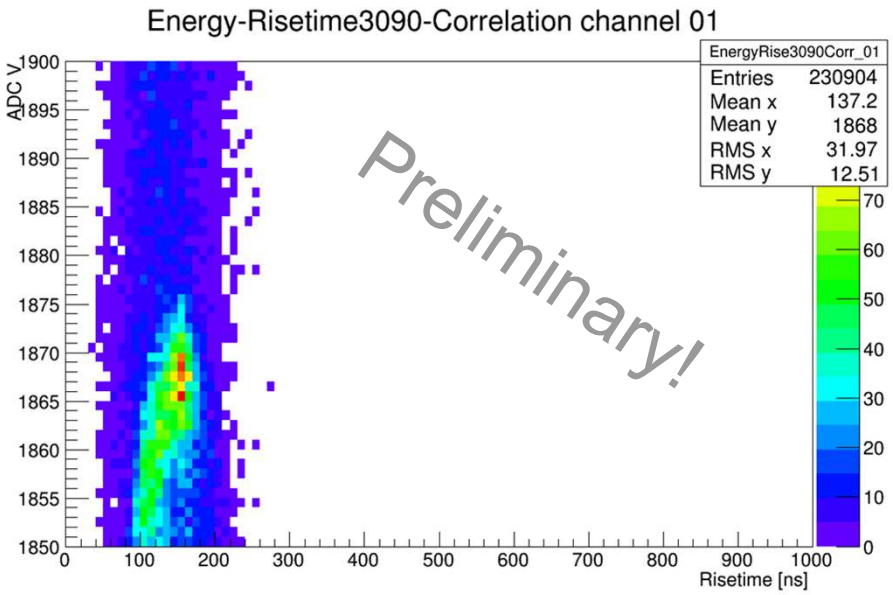
- Degradation of resolution
- FWHM seems to flatten
- at 8.5 keV
- No corrections (risetime, variation of window size) applied yet!



Irradiation test: results



Start of beam time

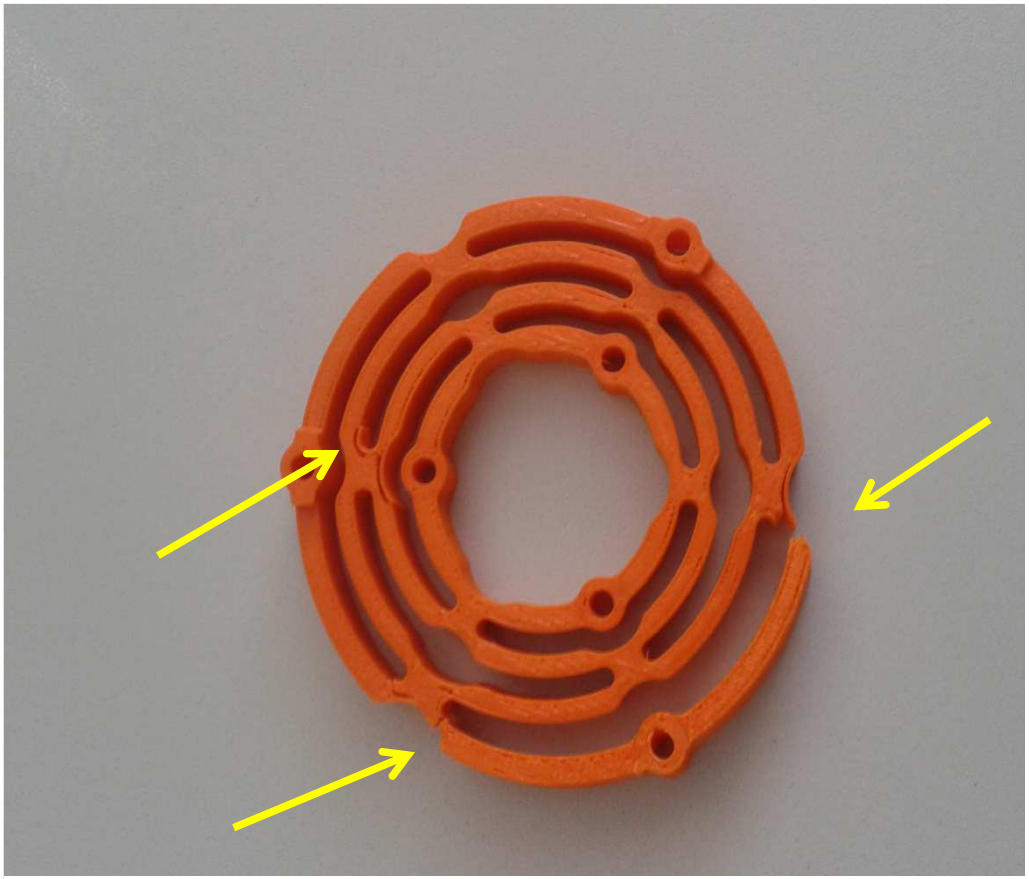


End of beam time

- Energy risetime correlation offers room for improvements!

Irradiation test: second test

- Hardware and radiation damage on detector
- Used older prototype for second beam time
- Seems to have less radiation damage
- Not analyzed yet
- Both crystals annealed now, but no information of their performance

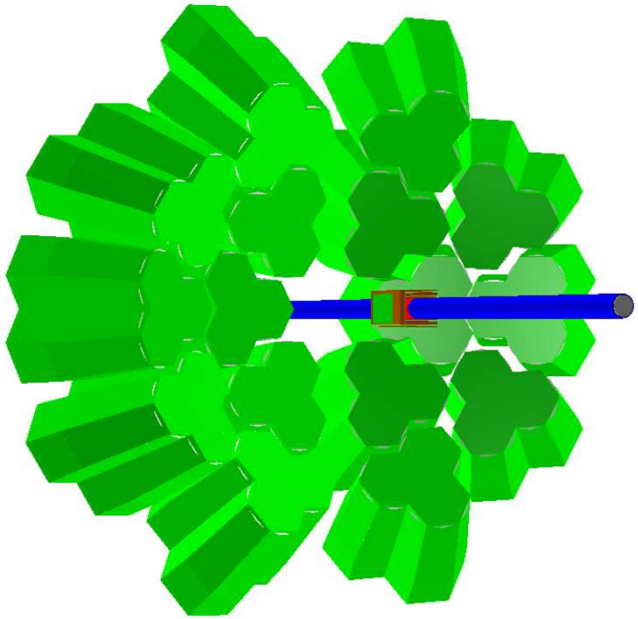


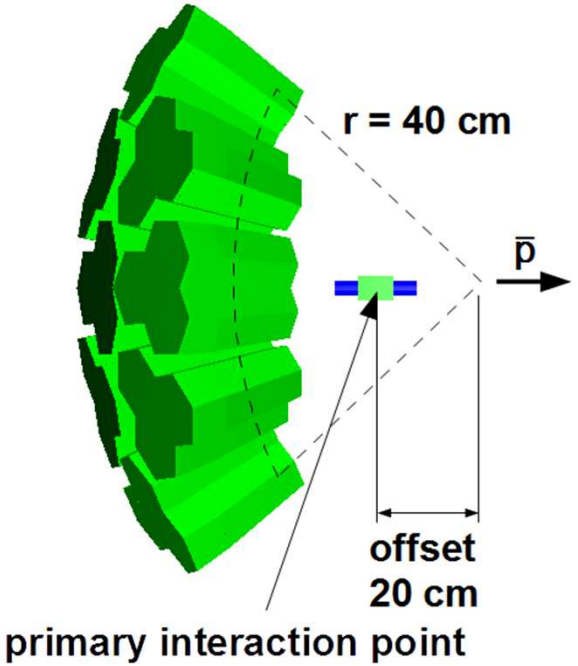
Nylon, new part will be vespel

Simulation of the detector

- Simulations getting more realistic :)
- All implemented into a PandaROOT task to make it more convenient
- Smearing of measured energy improved (~sqrt(a+b*$E_{measured}$)), a and b from measurements
- γ starting at stopping points of Ξ inside the absorbers (GIBUU events)
- Especially important to optimize geometry of target system (γ absorption)

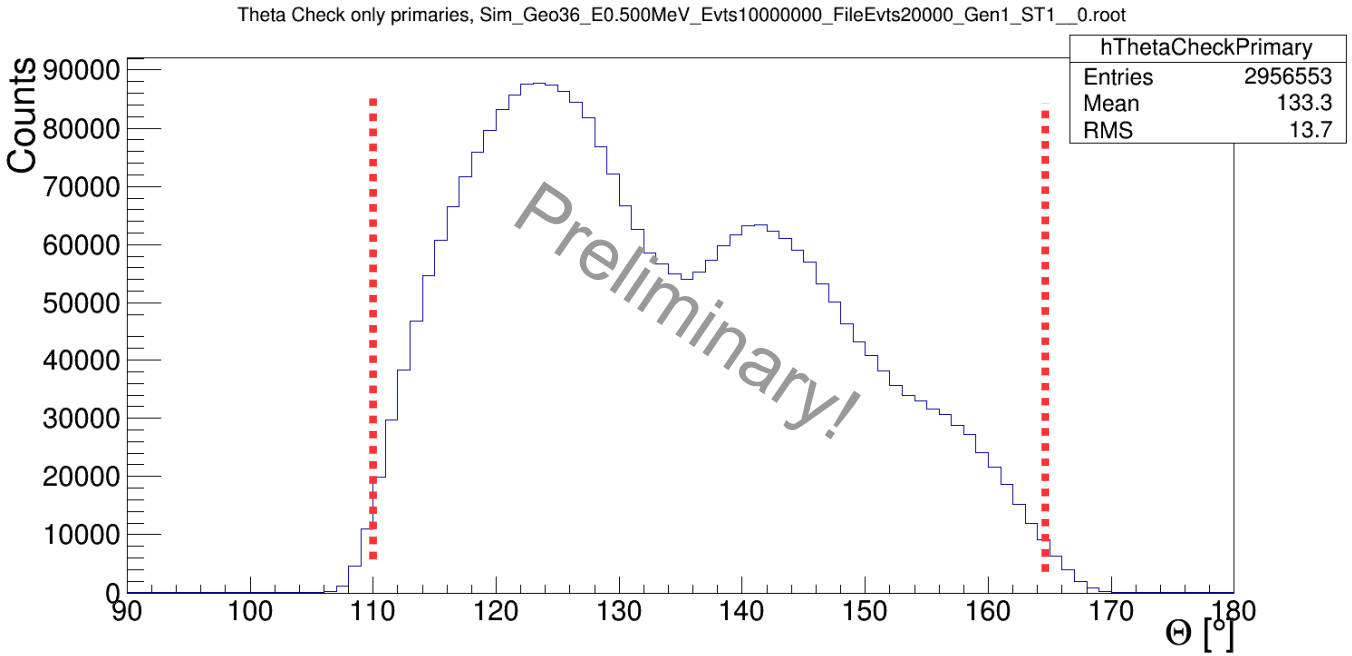
Simulation of the detector





- Germaniums on 40 cm ball, 20 cm Offset
- ST with edge absorbers, 4 absorber layers, 7 sensor layers
- No primary target included (only beam pipe, target chamber, Ti foil)
- Easily adaptable to new geometries (sim. and ana. chain is done)

Simulation of the detector

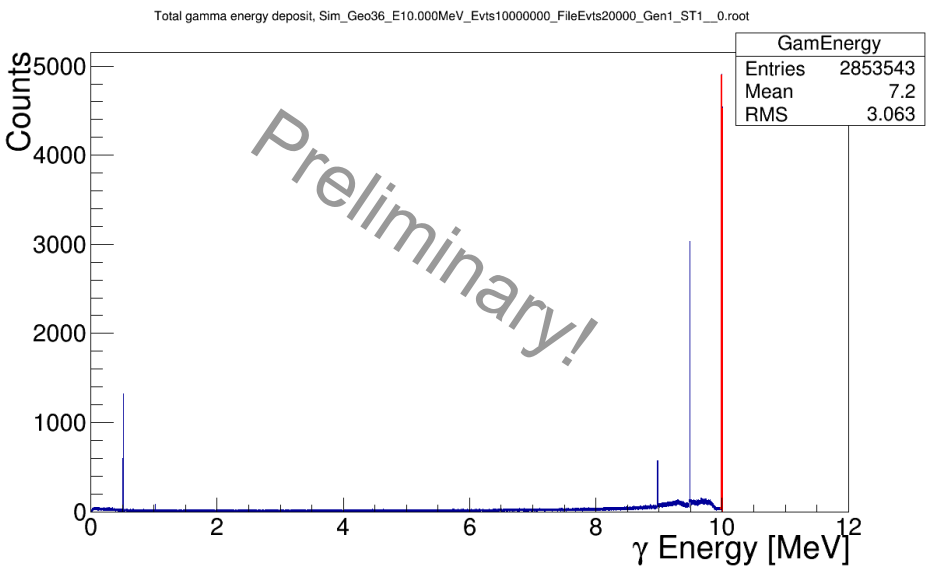


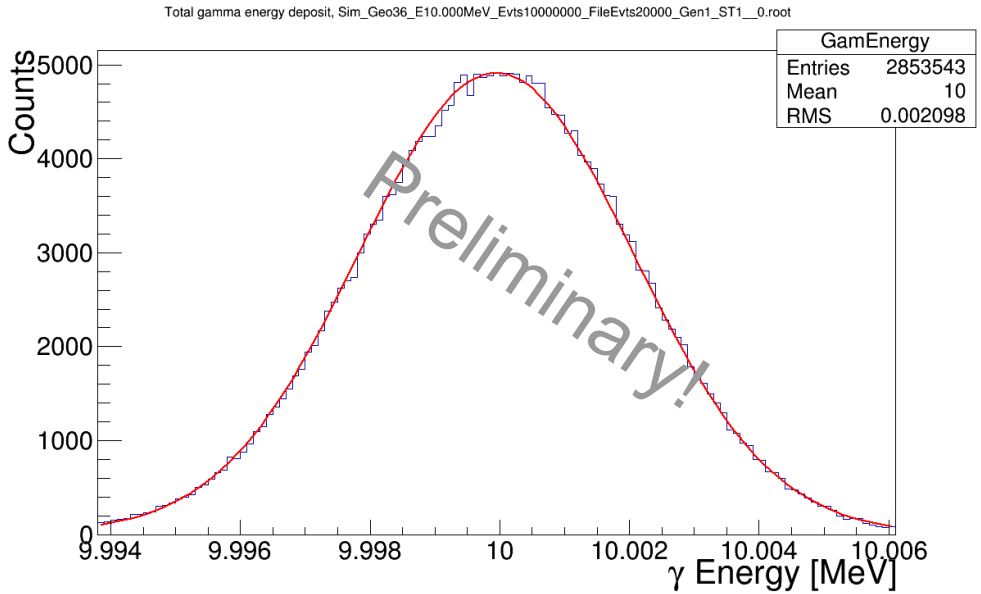
- Solid angle of germaniums Θ ~ 110° - 165°
  - Used as first simple cut if “absorption event” is interesting
- Distribution of γ in Cos(Θ) now
  - Numbers remain roughly the same :)

Simulation of the detector

- 0.5 Mev to 10 MeV
- 10^7 γ in Θ = [90°, 180°], effectively 2 * 10^7 γ in 4π
- Simulation with and without target
  (starting points remain the same)
  - Compare full energy peak efficiency
  - Check critical components of target
  - Compare energy resolution

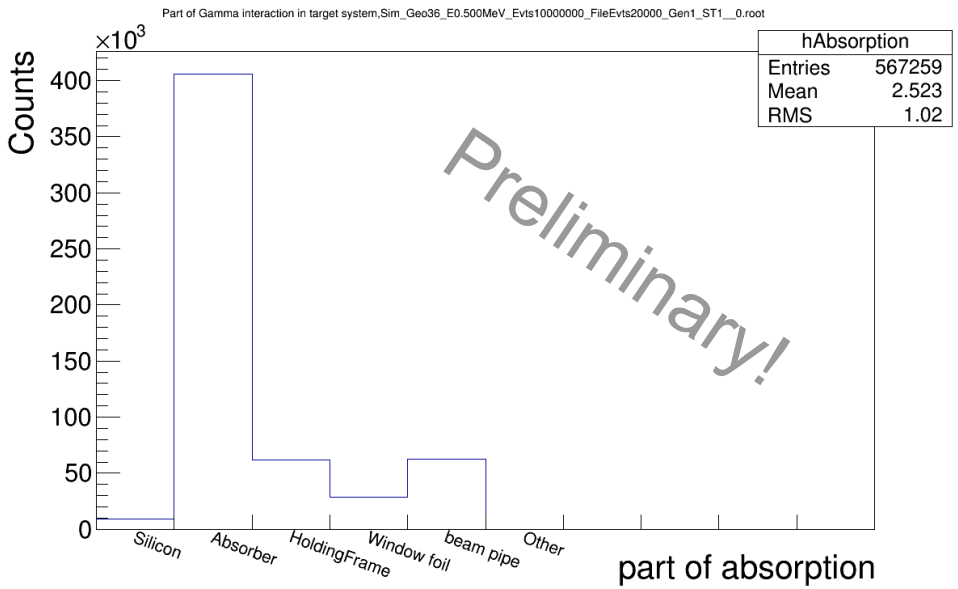
Simulation of the detector

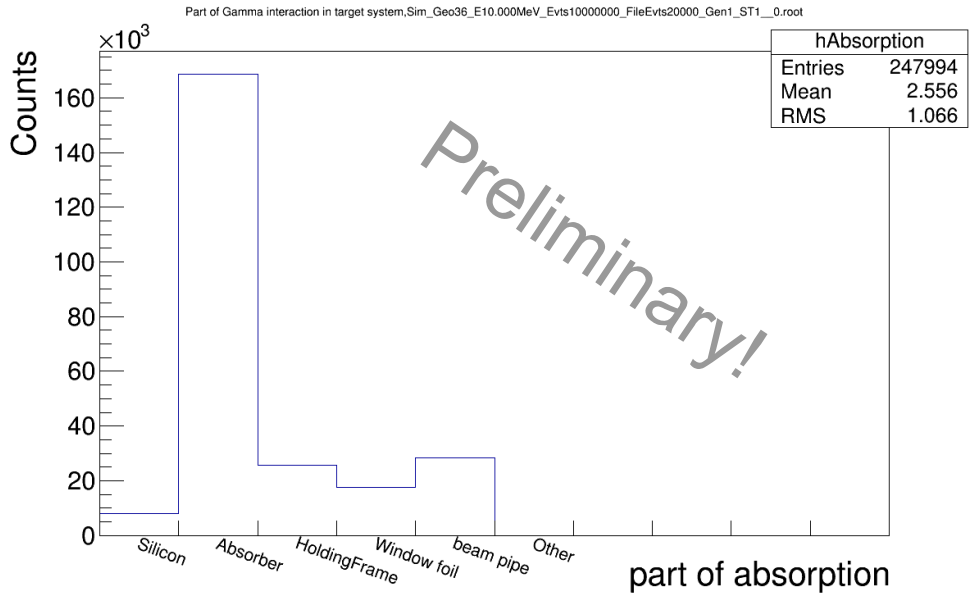




- Spectrum of simulation for 10 MeV γ
- Nice gaussian shape (no radiation damage implemented yet)
- Fit with gaussian + pol1

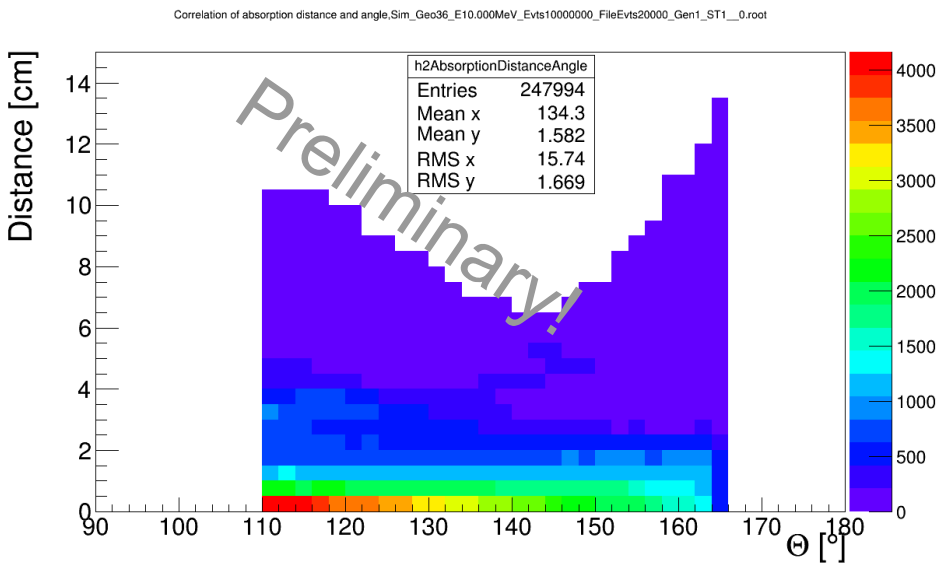
Simulation of the detector

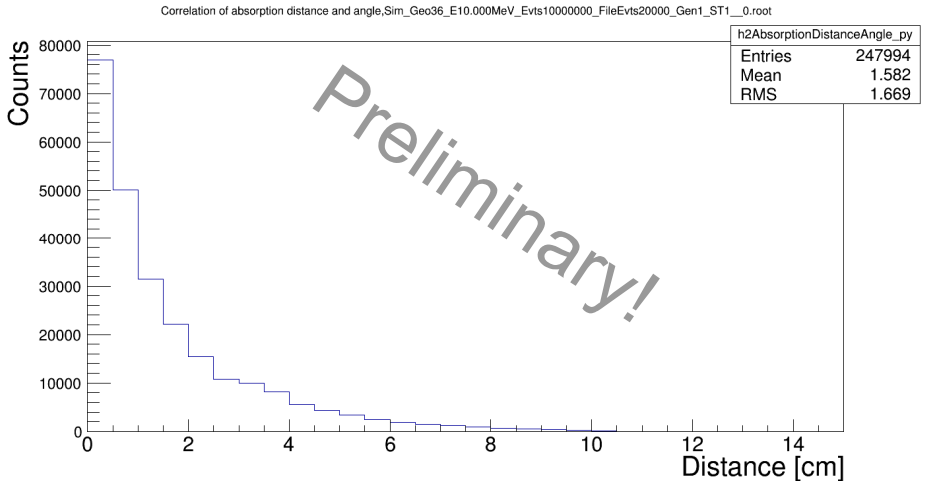


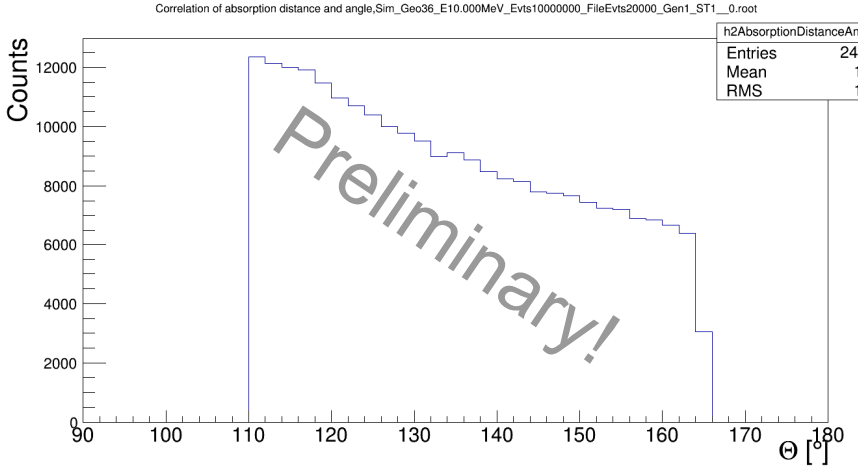


- First interaction of γ target system in Θ = [110°, 165°]
- Dominated by absorber
- Similar for all energies, only total numbers differ

Simulation of the detector

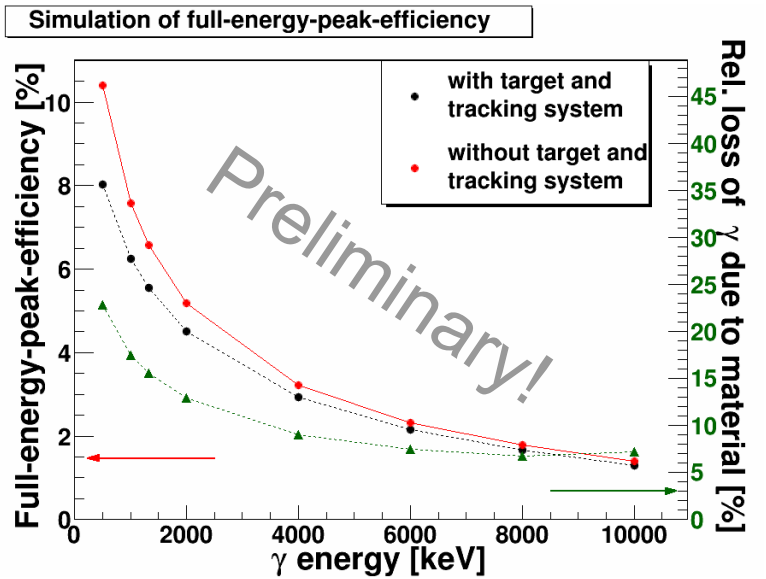


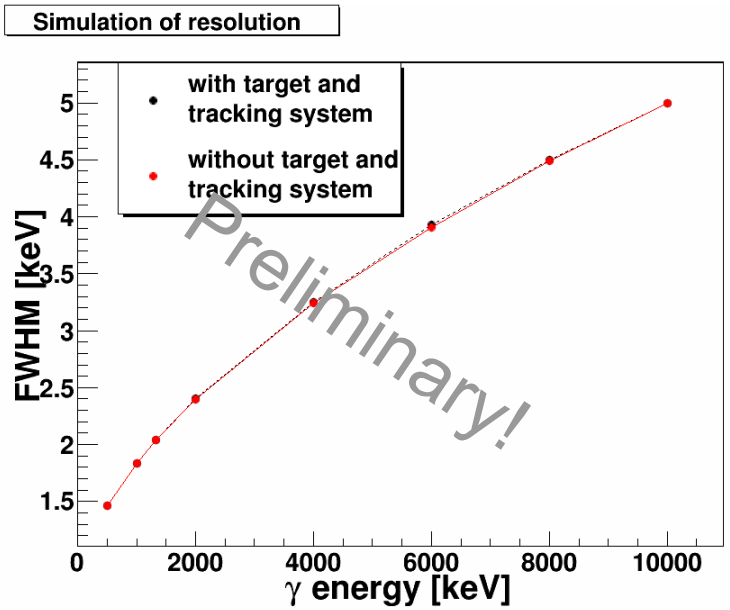




- 2D Plot of γ interactions in target system
- Most interactions at low distance
- Only Θ range of germaniums, not the solid angle → not the bumpy structure

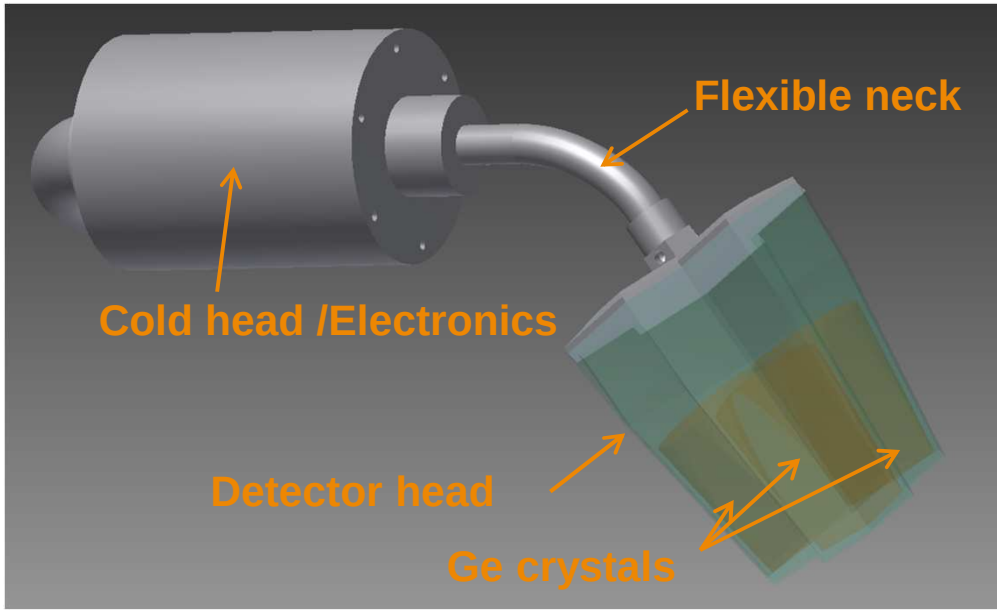
Simulation of the detector

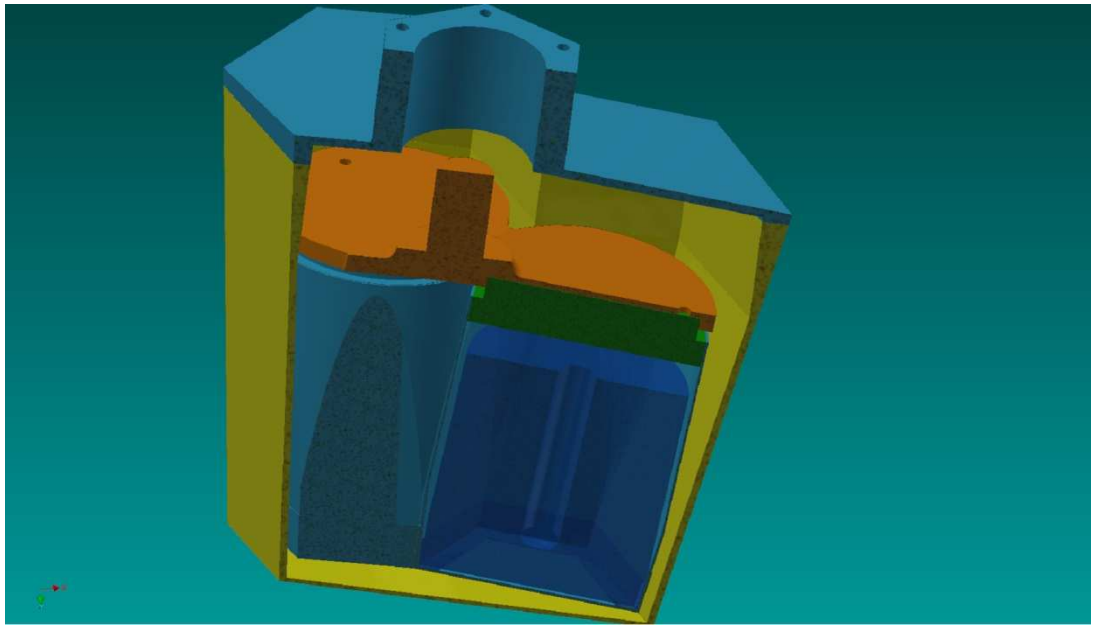




- Similar values for FEP than before
- Relative loss of FEP efficiency depending on energy ~5 - 20 %
- No change in resolution due to target, as expected

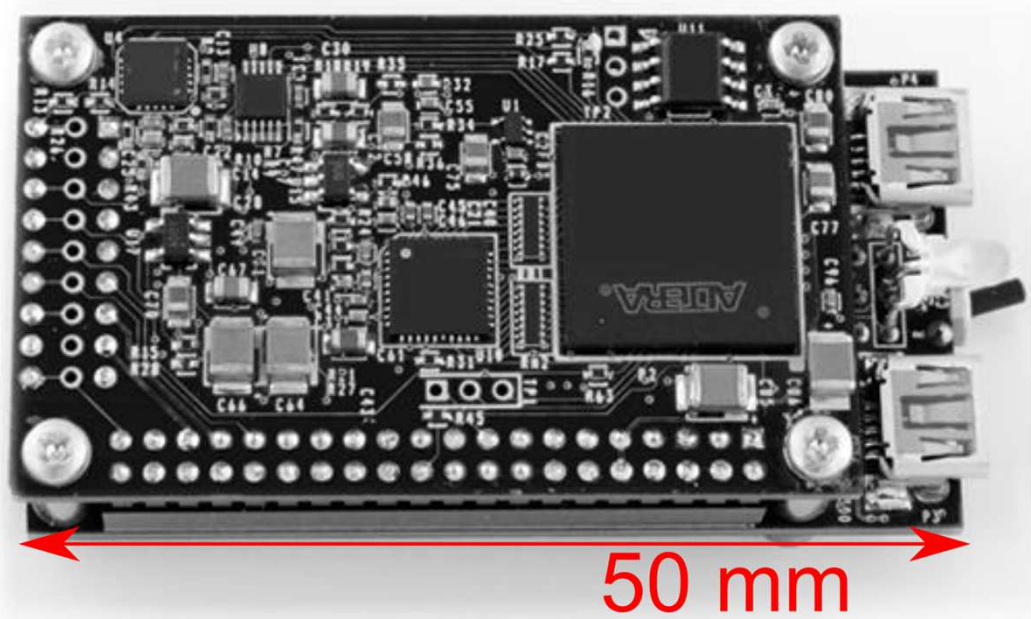
Hardware: Triple Prototype





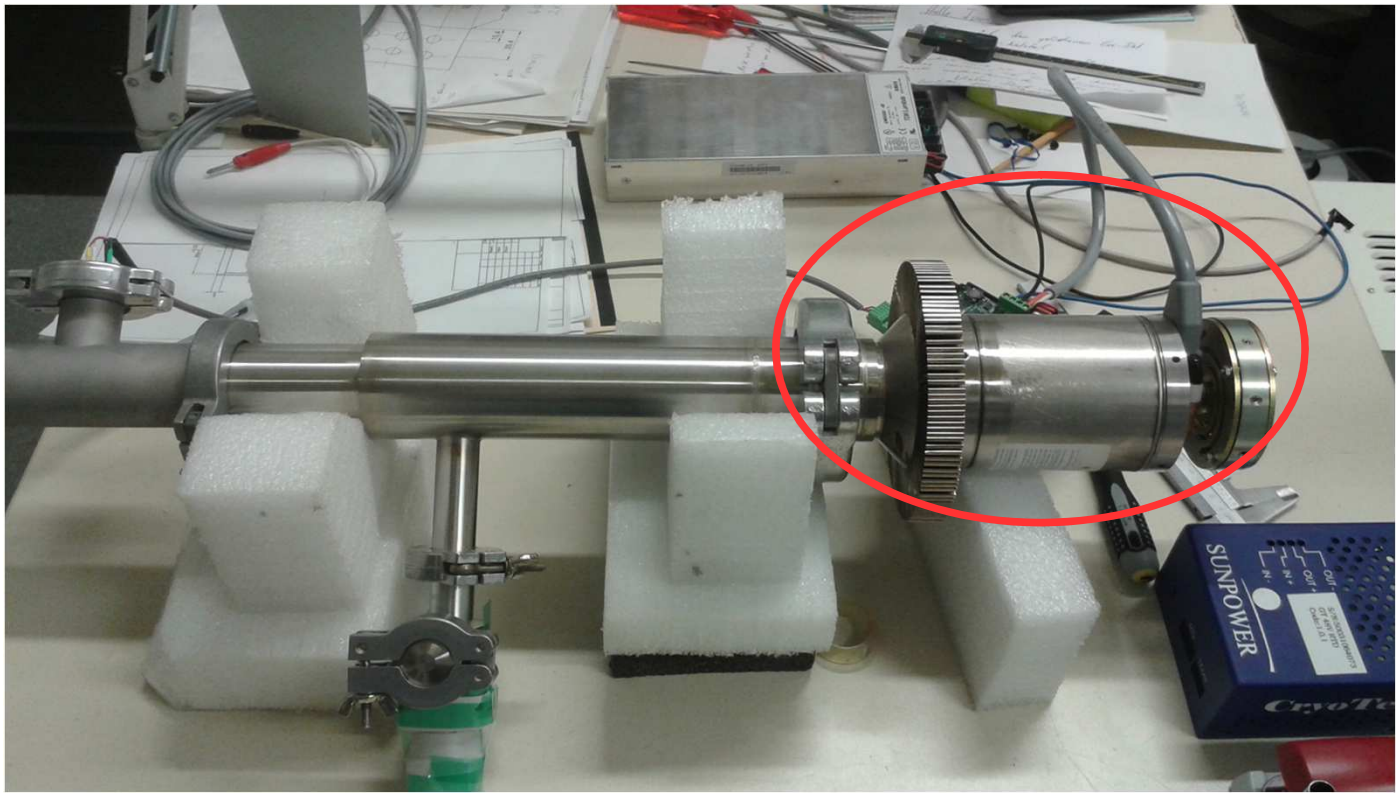
- Information mostly by Ivan
- First parts of Triple prototype ordered
- Drawings of detector head ready for workshop

Hardware: Readout



- Readout chip by LabZY: NanoDPP (in module NanoMCA)
- FPGA based FlashADC (16 bit, 80 MSa/s) and pulse processing
- Close contact to developer to include our wishes
- Good performance in tests at GSI
- More NanoMCA foreseen for testing, one for Mainz

Electro mechanical cooler

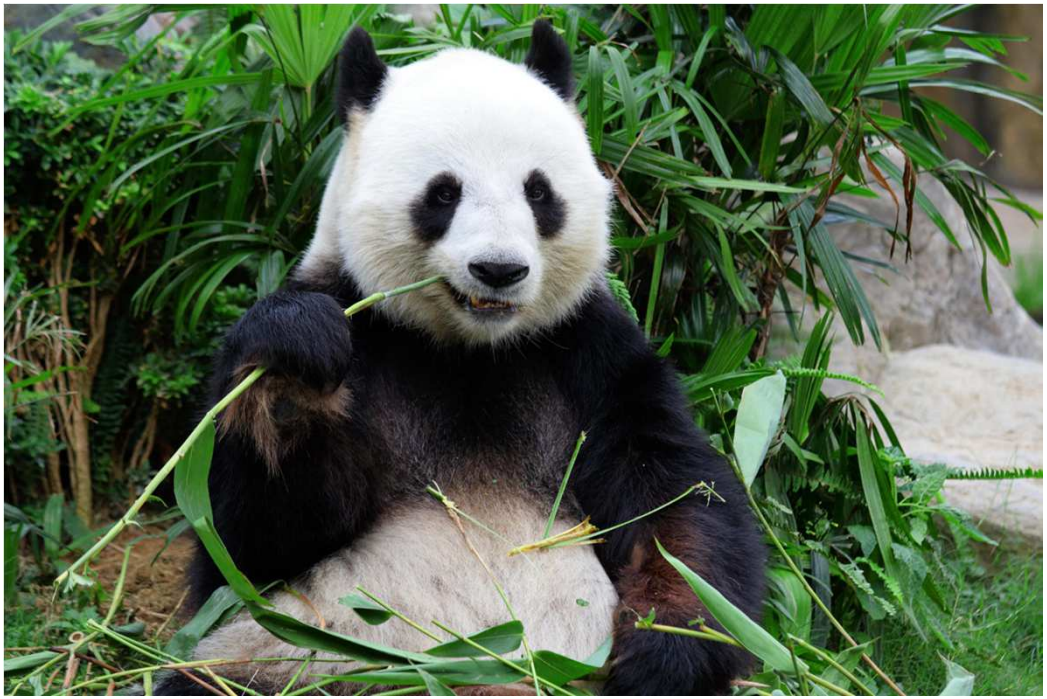


- Test of alternative cooler Sunpower CryoTel CT / GT
- Much smaller (no tube), size roughly the X-Cooler cold head
- More powerful, less consumption, water coolable
- Tested in magnetic field
- Price similar to X-Cooler

Summary / Outlook

- Irradiation test done, first results looks promising and offer room for improvements
- Simulation in good shape and progressing, more synergies with target simulations
- Actively resetting preamplifier will be implemented for next test (applied for new test in Jülich)
- Progress in all Hardware topics
- Full size triple crystal prototype foreseen for 2015

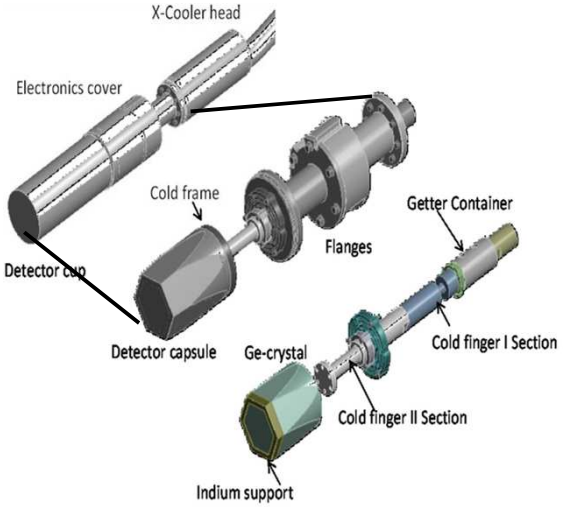
Thanks for your attention

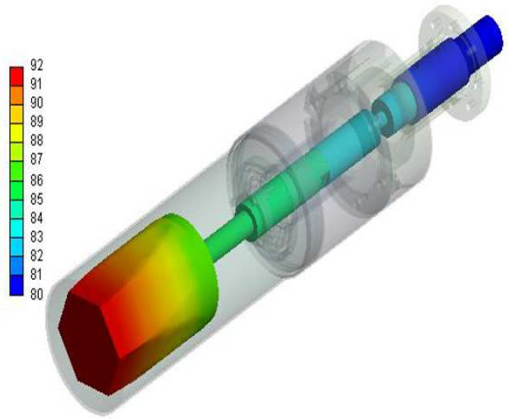


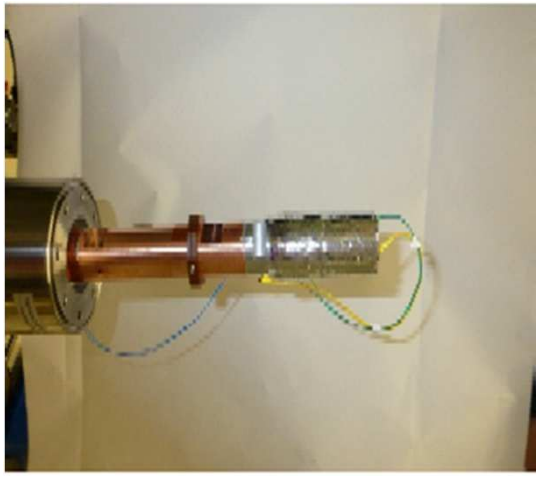
Backup slides

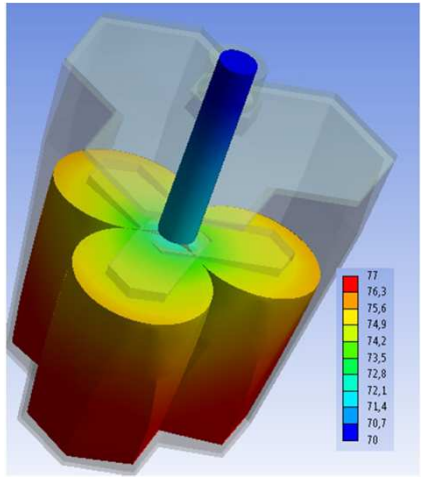
Thermal Simulation

- Optimization of cryostat needed
- Thermal resistance of cold finger very important
- Cryostat emissivity of 0.1 needed
- Exp. validation of thermal simulations has been done

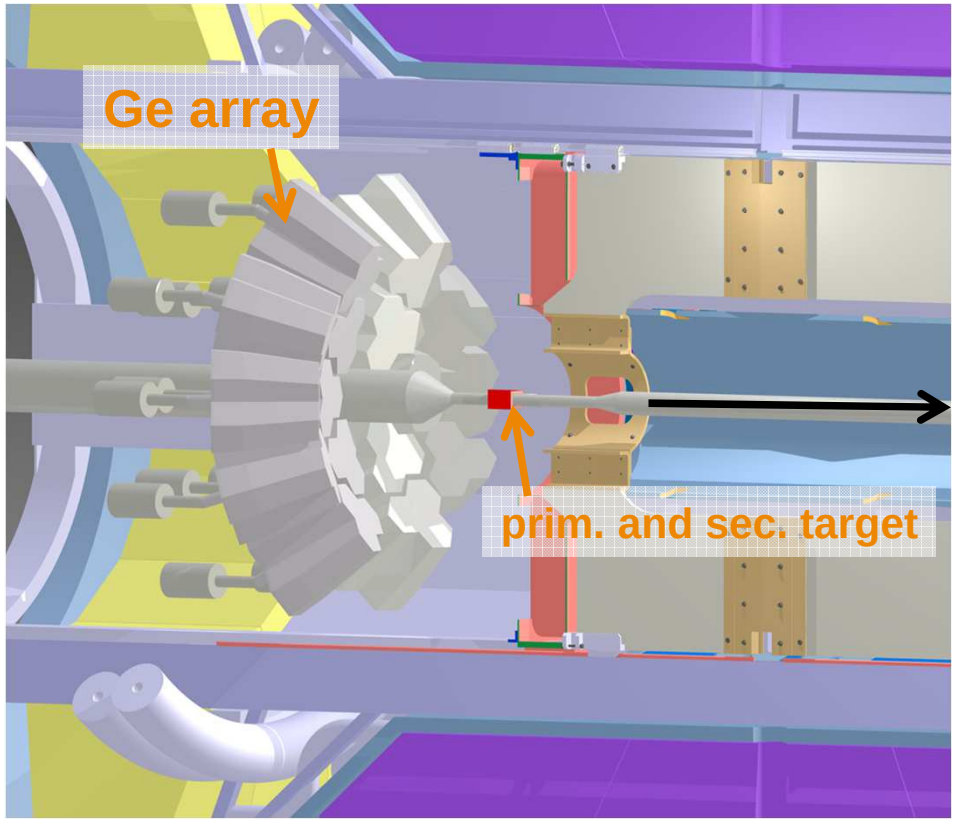








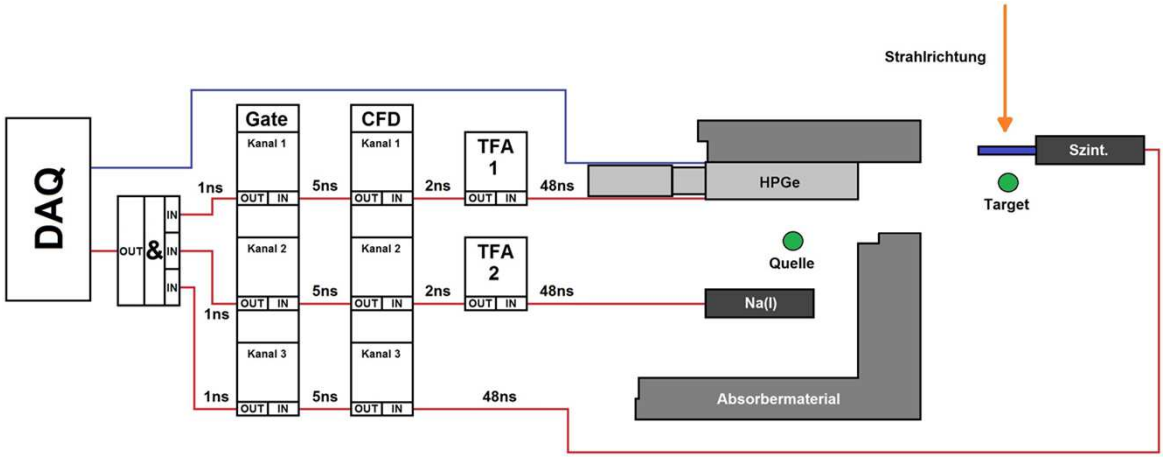
Hypernuclear experiment of $\bar{P}$ANDA



Modified components of $\bar{P}$ANDA
for the hypernuclear experiment

Data

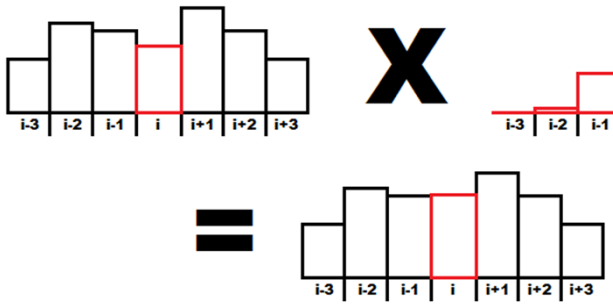
- triple coincidence
- ^{60}Co source
- 106 GB (~3 M traces)
- long traces (~160 µs)
- dist target – detector: 90 cm
- max p flux: ~10^7/s



Smoothing filters

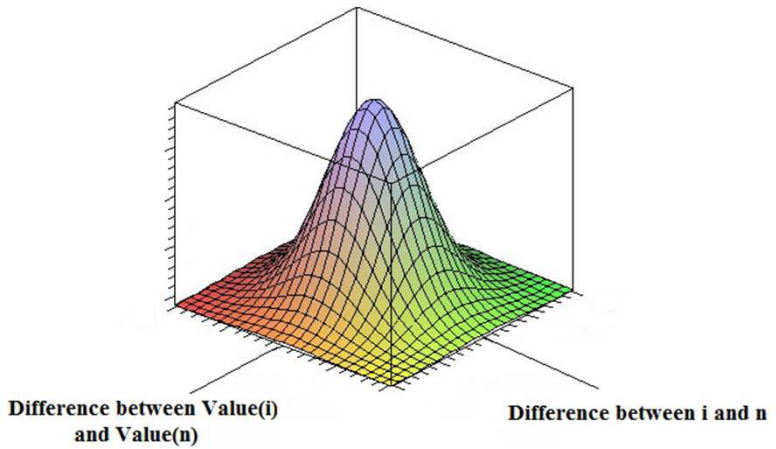
Gaussian filter

+ linear low pass filter
+ fast
+- only 1 parameter
- real signals heavily influenced



Bilateral filter

+ particle signals less affected
+- 2 parameters
- slow
- non-linear



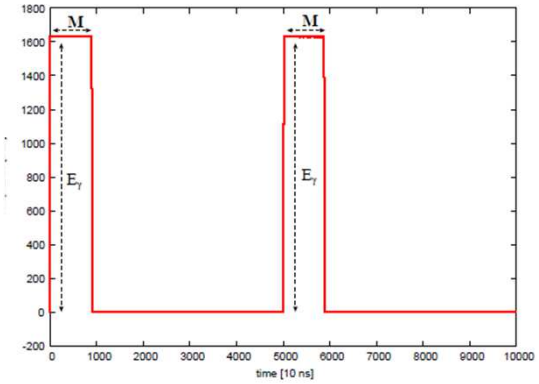
Analysis Parameters

- Variation of 2 (3) parameters for gaussian (bilateral) filter
- 1 (2) smoothing parameter:

- σ_{gaus}: 10 ns – 110 ns (2 ns steps)
- σ_{bil} : 100 - 2100 (200 steps)

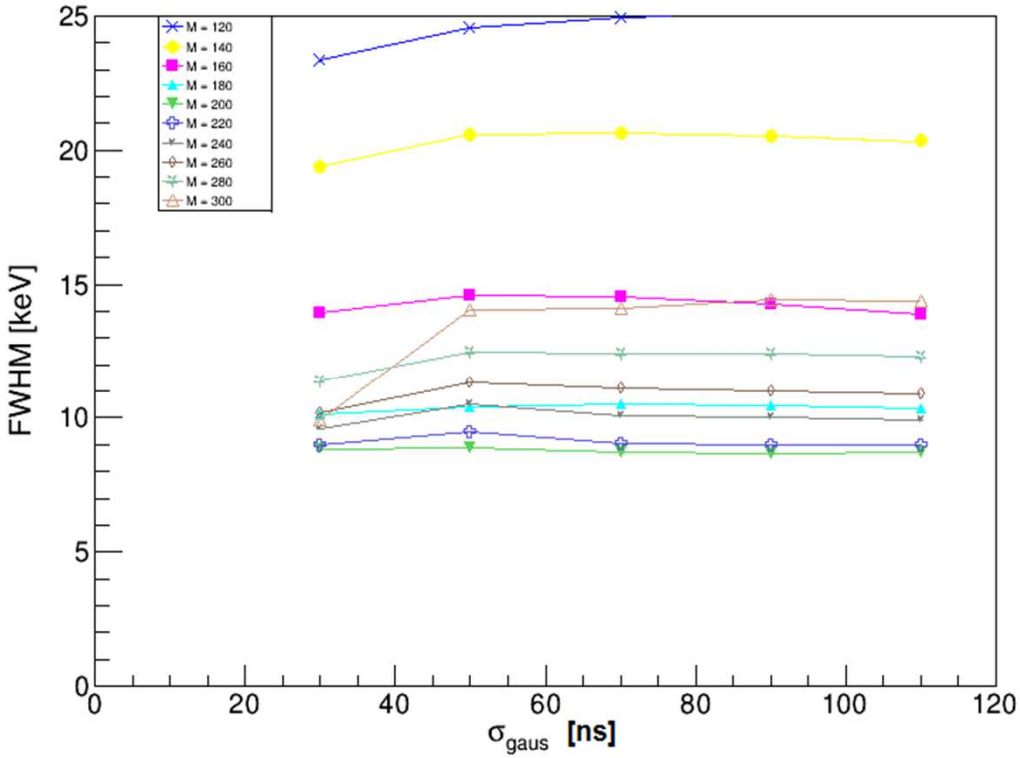
- width of rectangular filter:

- M : 1.2 µs – 3 µs (0.2 µs steps)

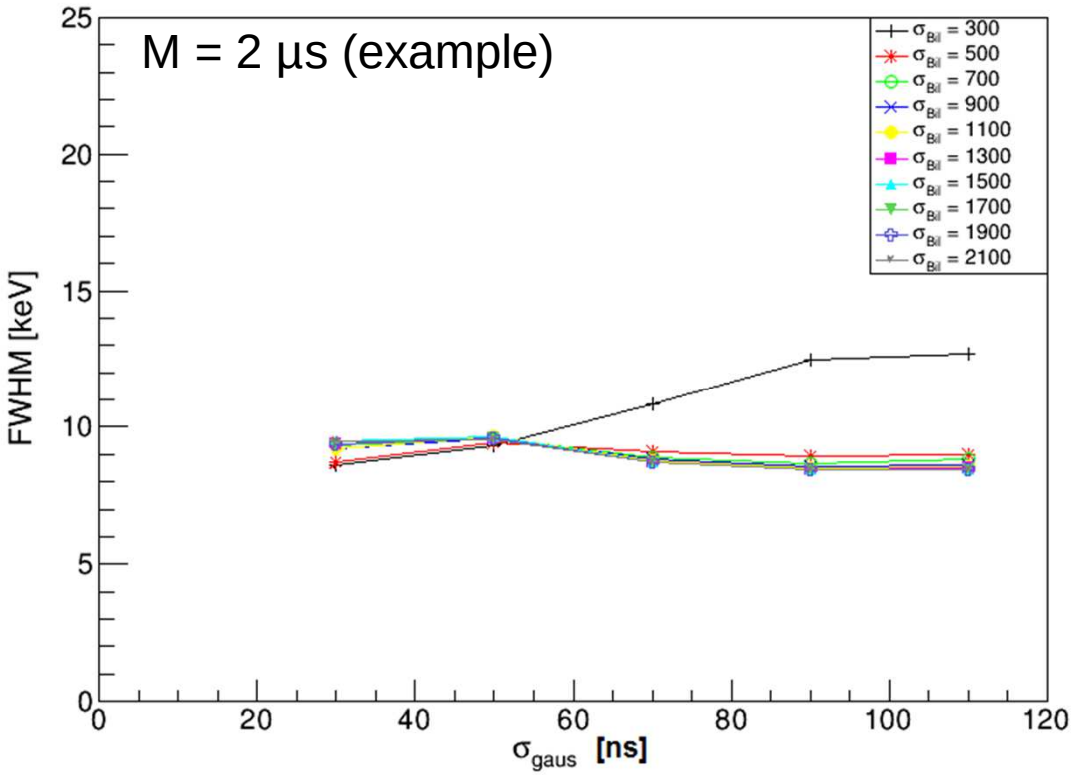


Results

Gaussian filter

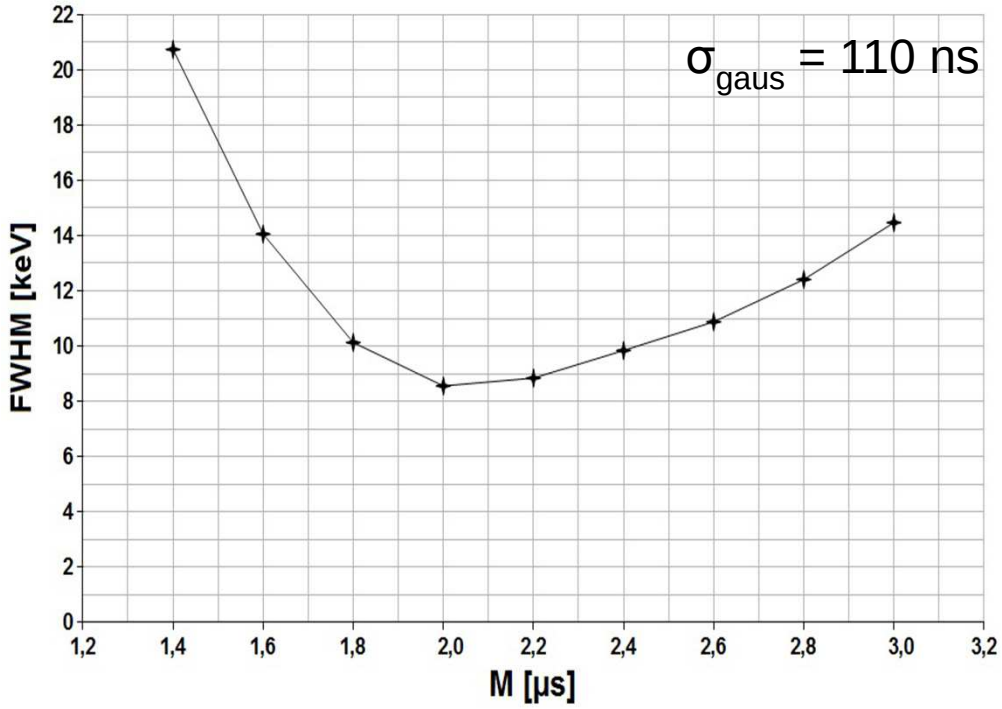


Bilateral filter

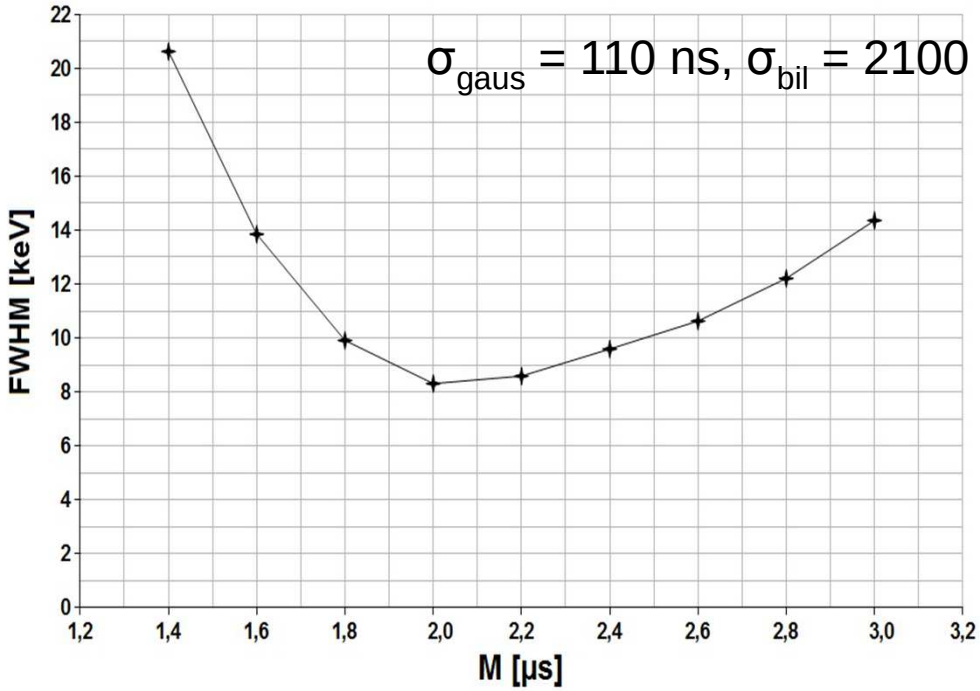


Results

Gaussian filter



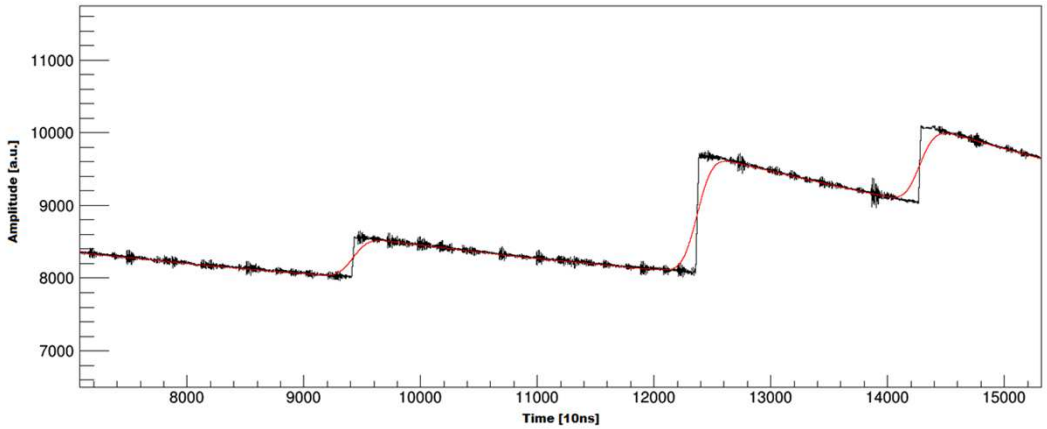
Bilateral filter



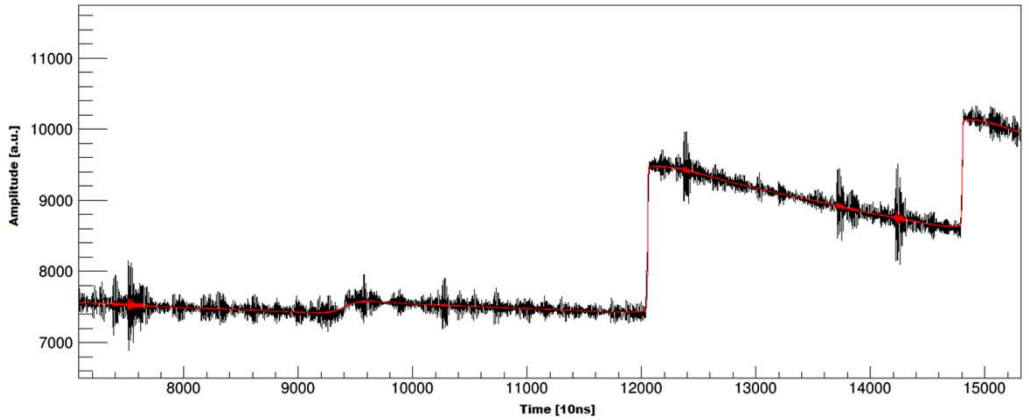
noise too strong to achieve good resolution (2.25 keV)!

Smoothing filters

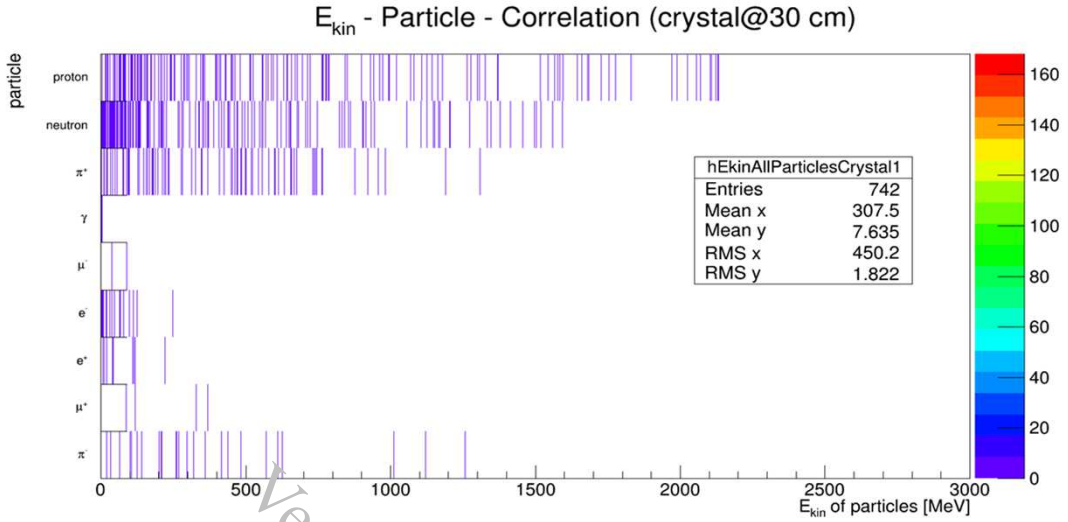
Gaussian filter

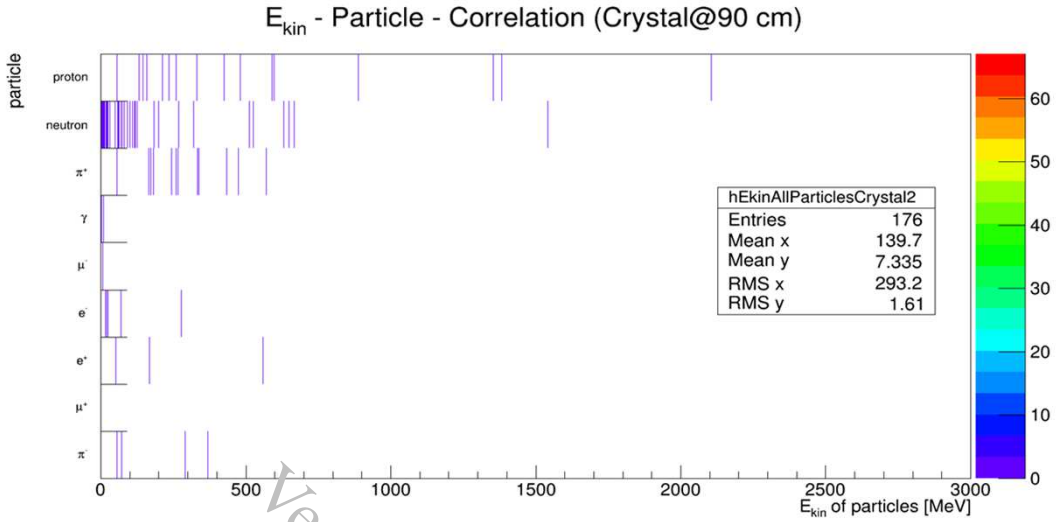


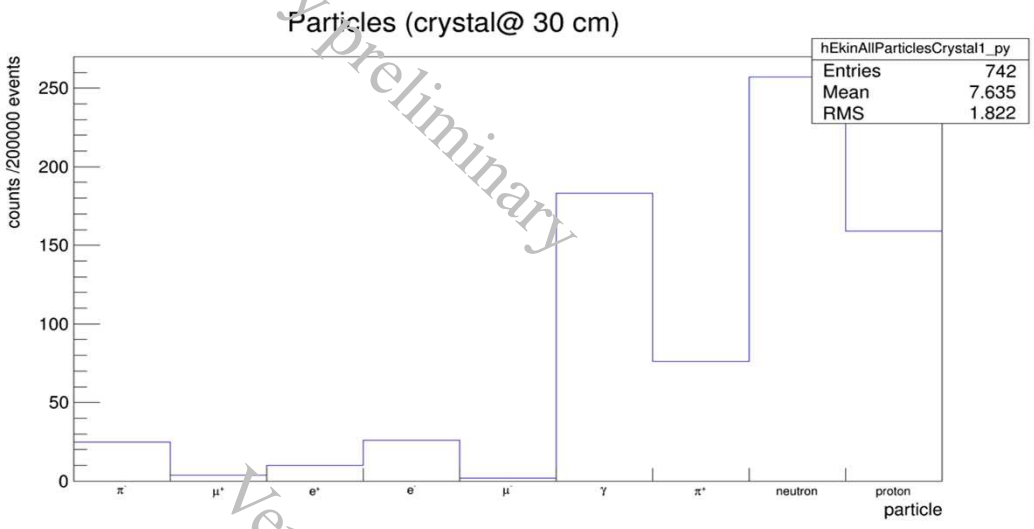
Bilateral filter

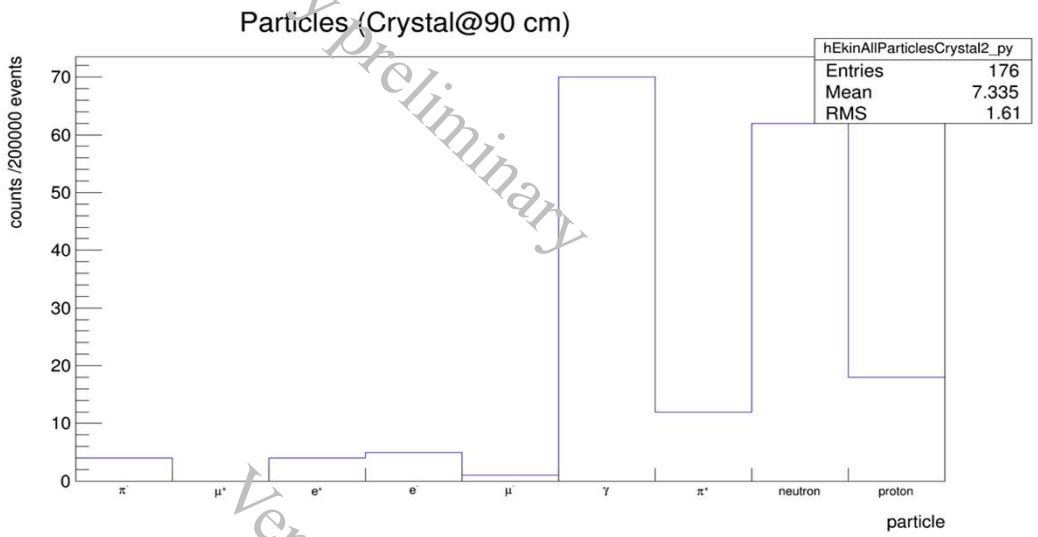


Simulation of beam time







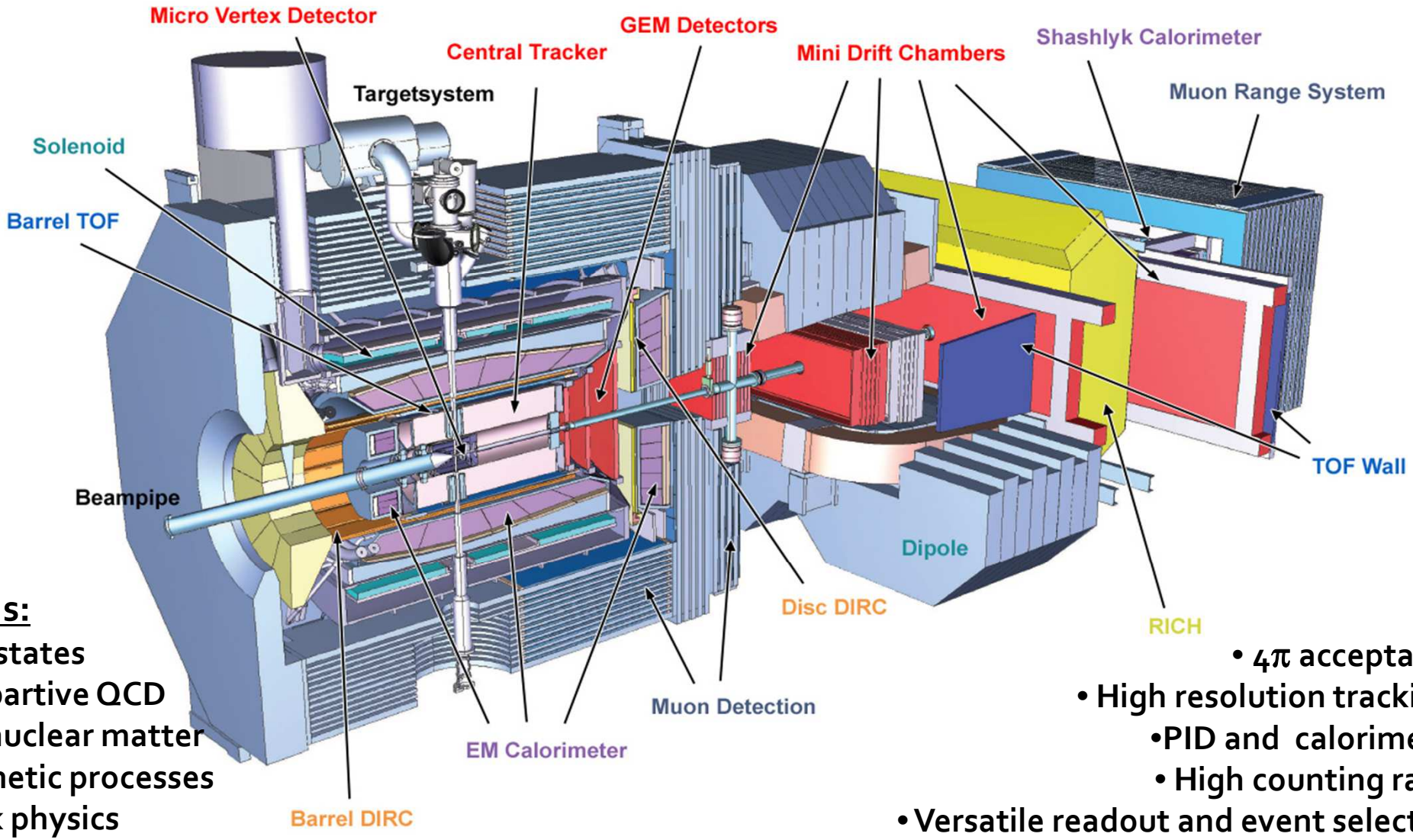


12.85 kHz neutron rate in position 1

3.1 kHz neutron rate in position 2

accumulated: ~2 **10^8 neutrons on the crystal (~6.6***10^6 n/cm^2)** ==> no effect on resolution expected

PANDA

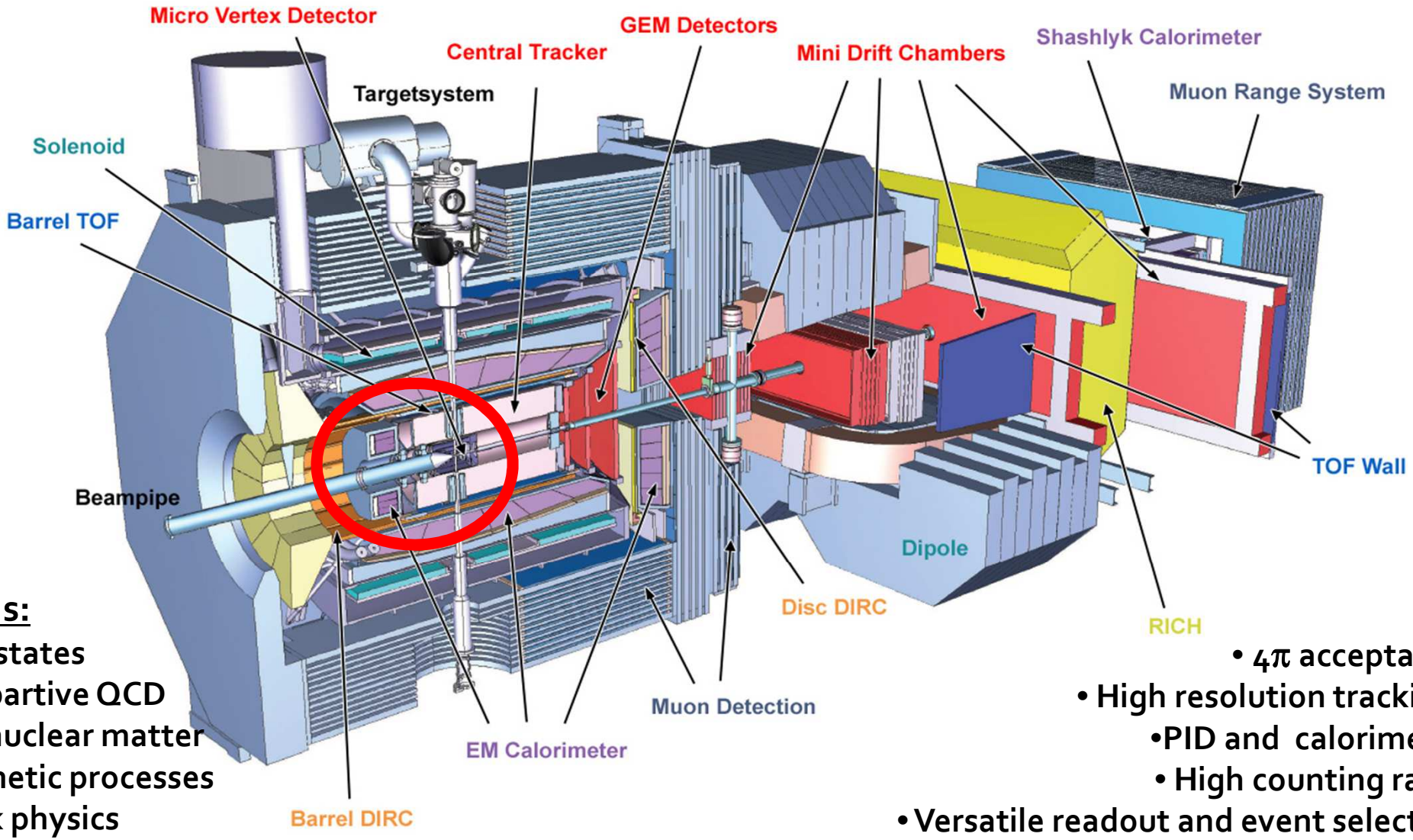


Physics goals:

- QCD bound states
- Non-perturbartive QCD
- Hadrons in nuclear matter
- Electromagnetic processes
- Elektroweak physics
- **Hypernuclear physics**

- 4π acceptance
- High resolution tracking,
- PID and calorimetry
- High counting rates
- Versatile readout and event selection
- **Modular design**

$\bar{P}$ANDA



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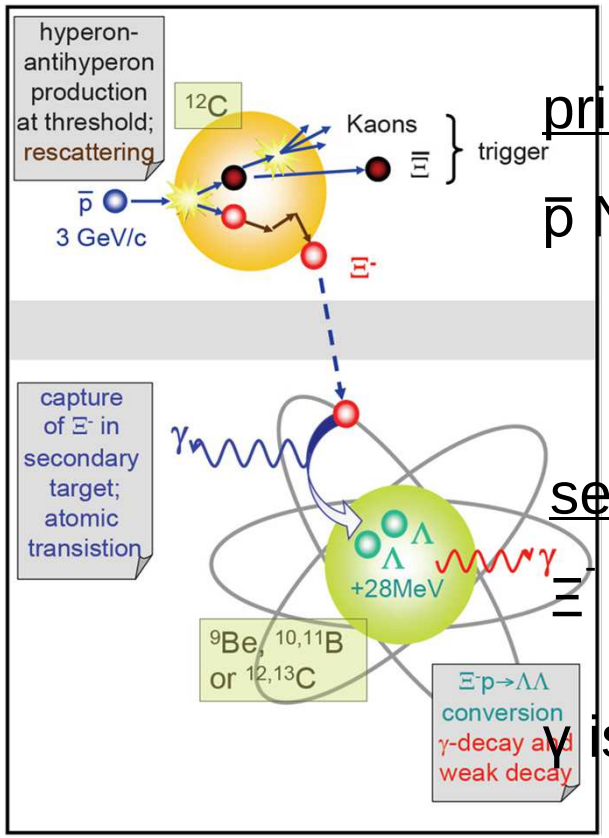
Hypernuclear experiment of $\bar{P}$ANDA



prim. target

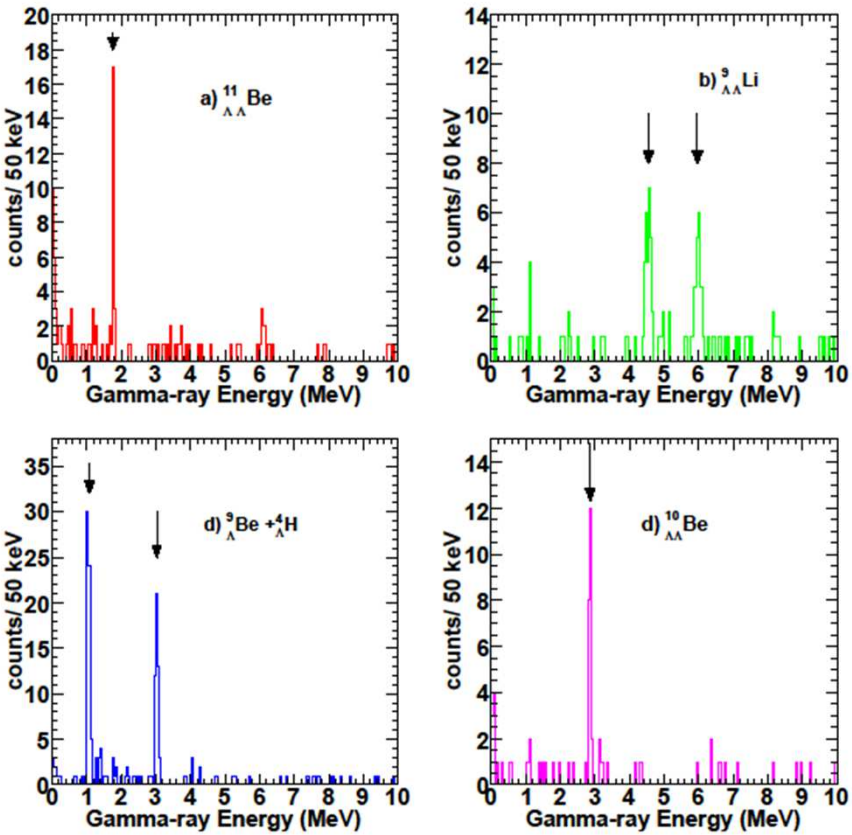
$\bar{p}\,N \rightarrow \Xi^- \bar{\Xi}^{0/+}$

sec. target

$\Xi^- p \rightarrow \Lambda\Lambda$

γ isotropic

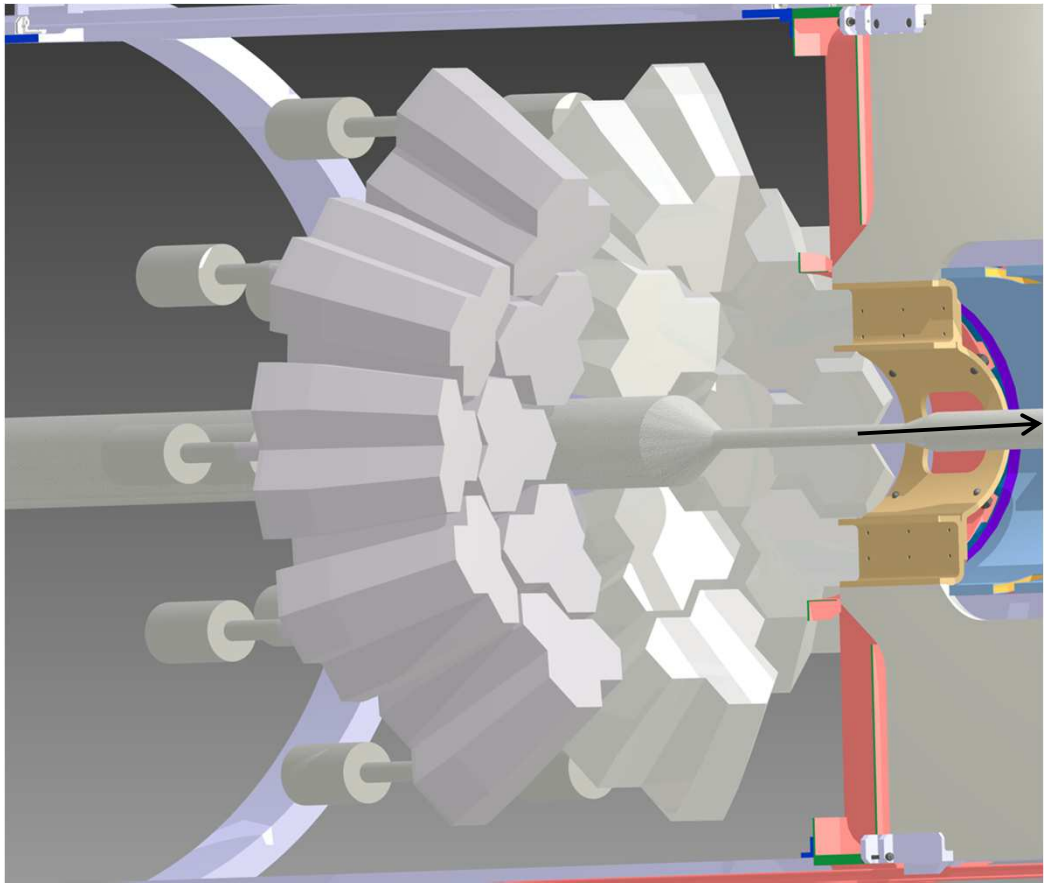
Physical process of the hypernuclear experiment



Expected spectra of most frequently produced double Hypernuclei

Germanium detector array

- Space highly limited inside the $\bar{P}$ANDA barrel
  - Complete rearrangement of existing detectors needed
  - No LN2 cooling possible

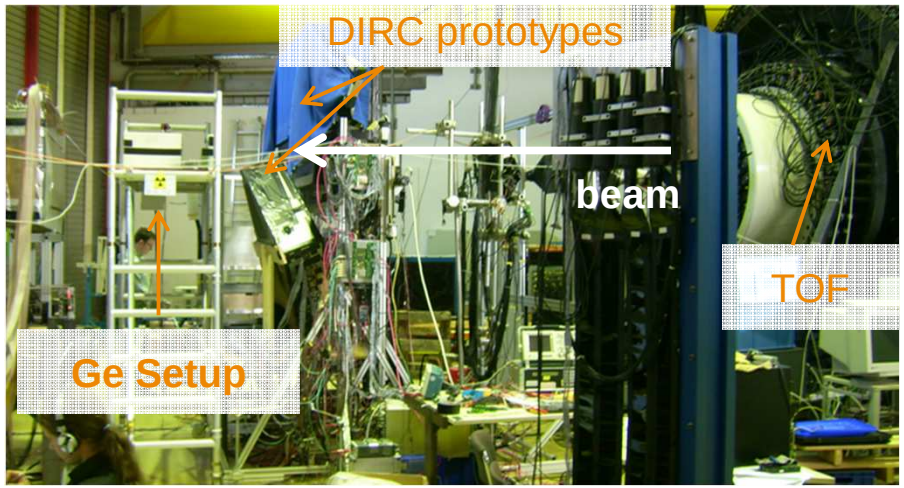


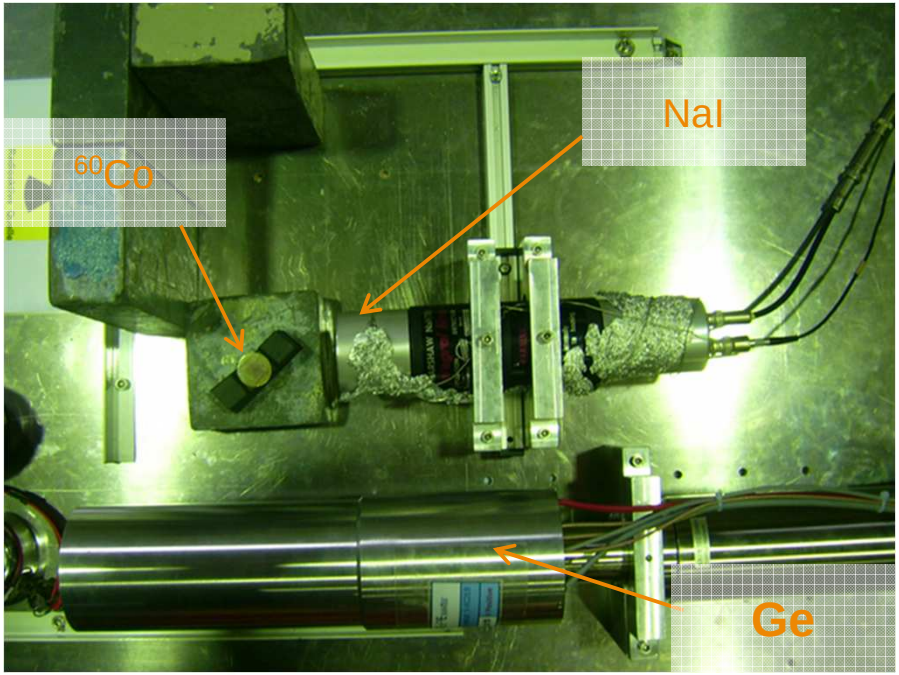
- High Magnetic Field
  - Effects on energy resolution [1]
- Particle background

[1] *A. Sanchez Lorente et al.*, Nucl. Instr. and Meth. A 573 (2007) 410–417

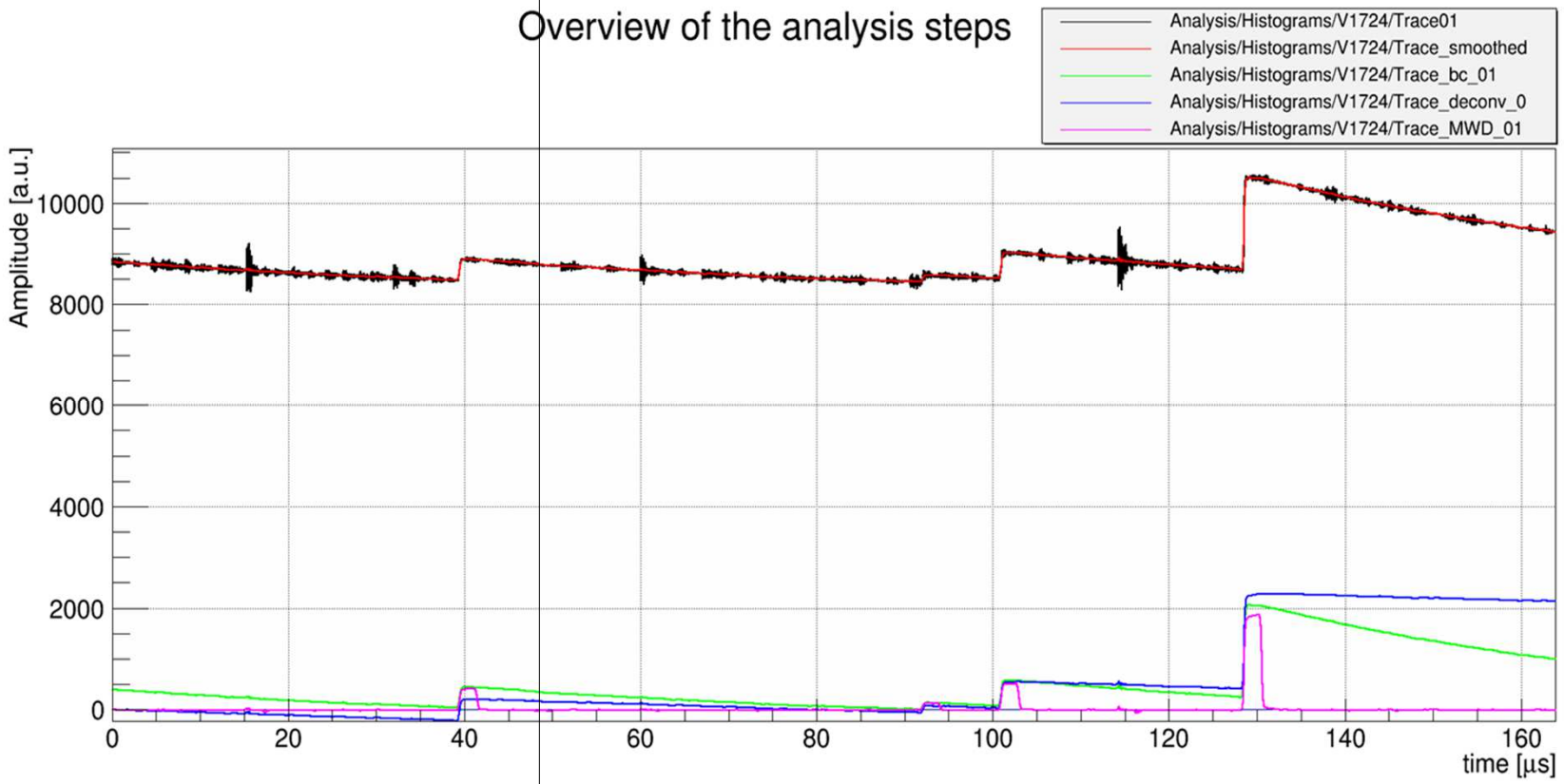
First beam test @ COSY in Jülich

- Beam test in oct./nov. 2013
- Parasitic, TOF area
- 5 cm carbon target in beam (2.95 GeV/c p, 10^7/s) to produce particle background similar to $\bar{P}$ANDA
- Detector @ 90°, r = 90 cm





Analysis procedure



Results of first beam test

- Resolution limited by pick up noise in this test!
- Beam intensity too low to cause detectable radiation damage ($6*10^6$ n/cm^2)
- Further measurements with beam require actively resetting preamplifier
-