A high resolution germanium detector array for hypernuclear studies at $\bar{P}$ANDA

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Helmholtz-Institut Mainz

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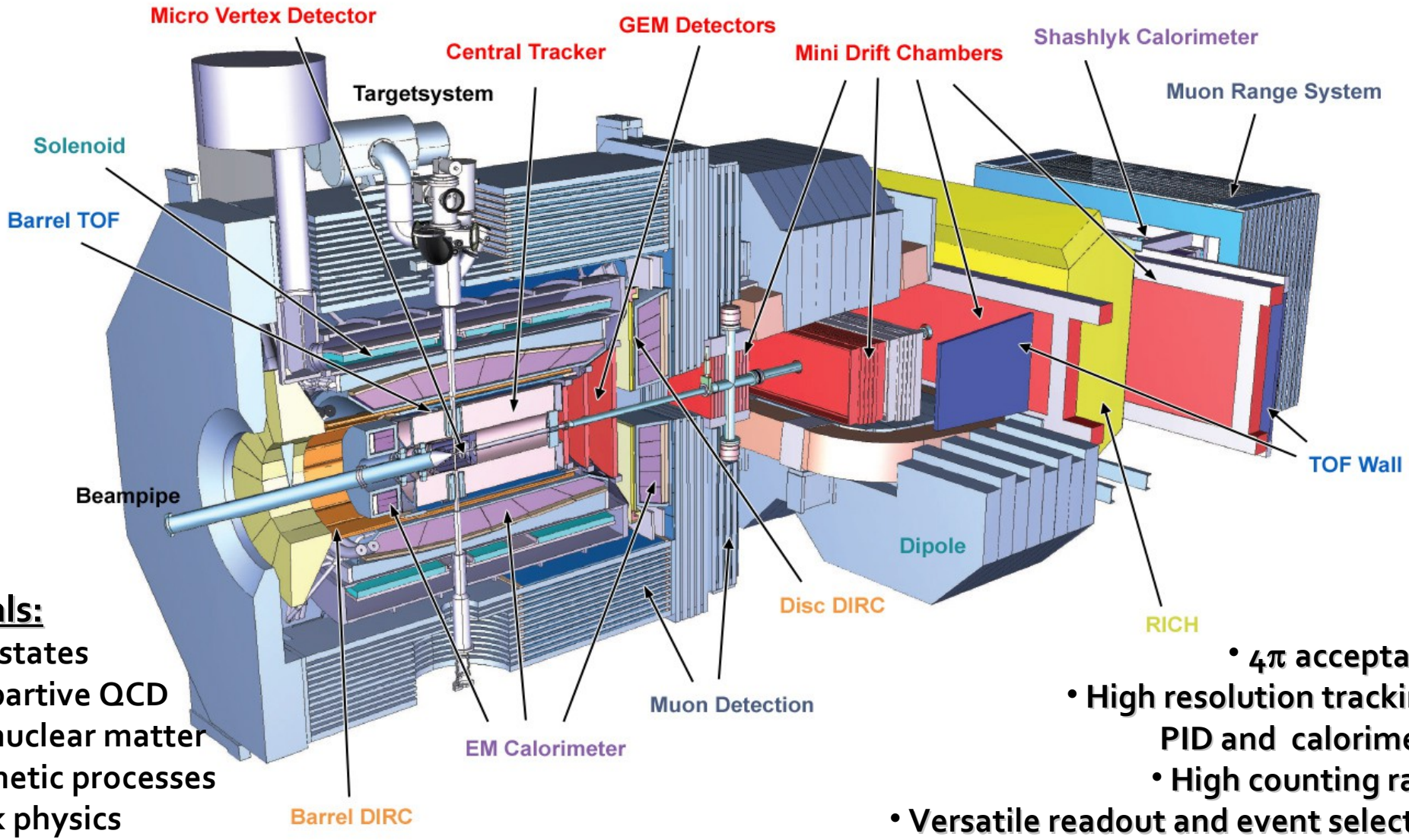
GSI

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Outline

- $\bar{\text{P}}$ANDA
- Hypernuclear experiment of $\bar{\text{P}}$ANDA
- Germanium detector array
- Beam test at COSY

PANDA

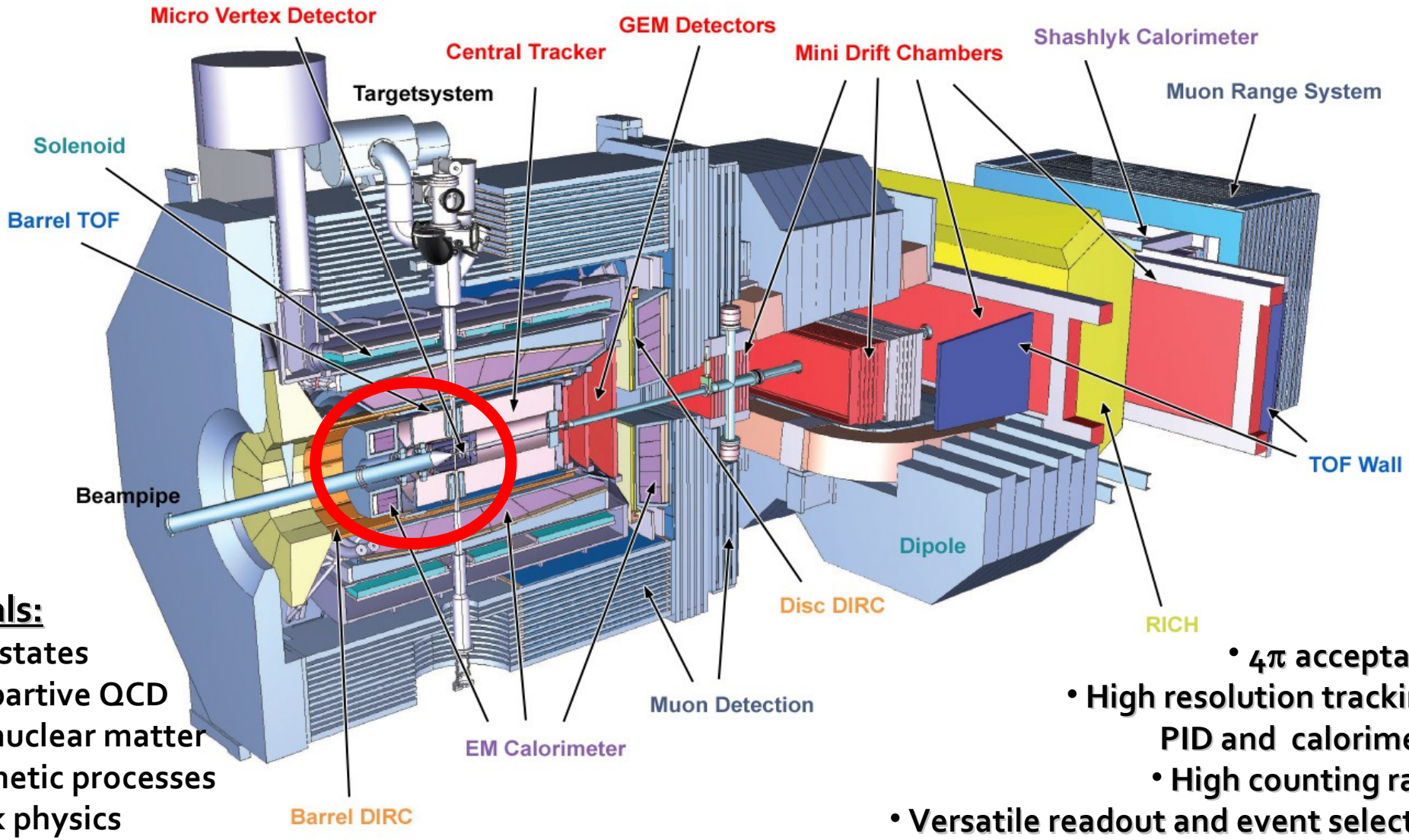


Physics goals:

- 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**

PANDA



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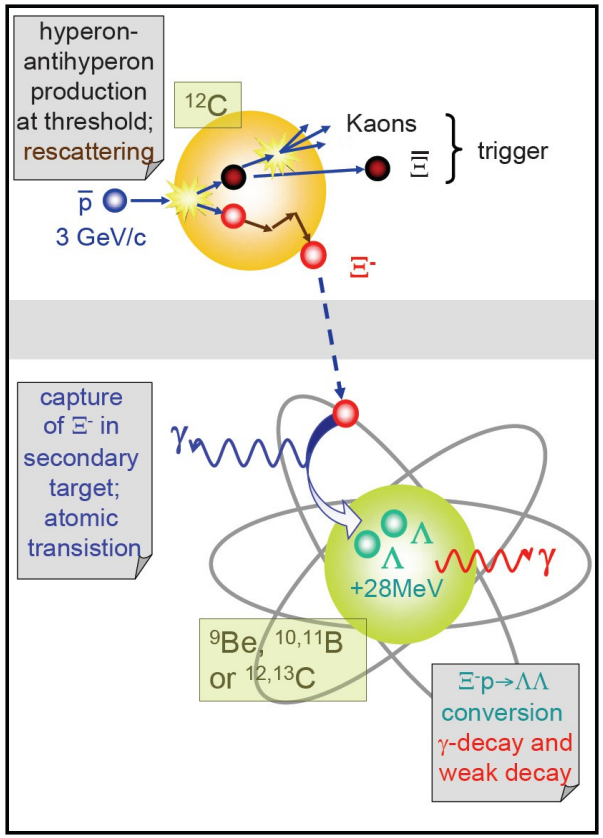
Hypernuclear experiment of $\bar{P}$ANDA



<u>prim. target</u>

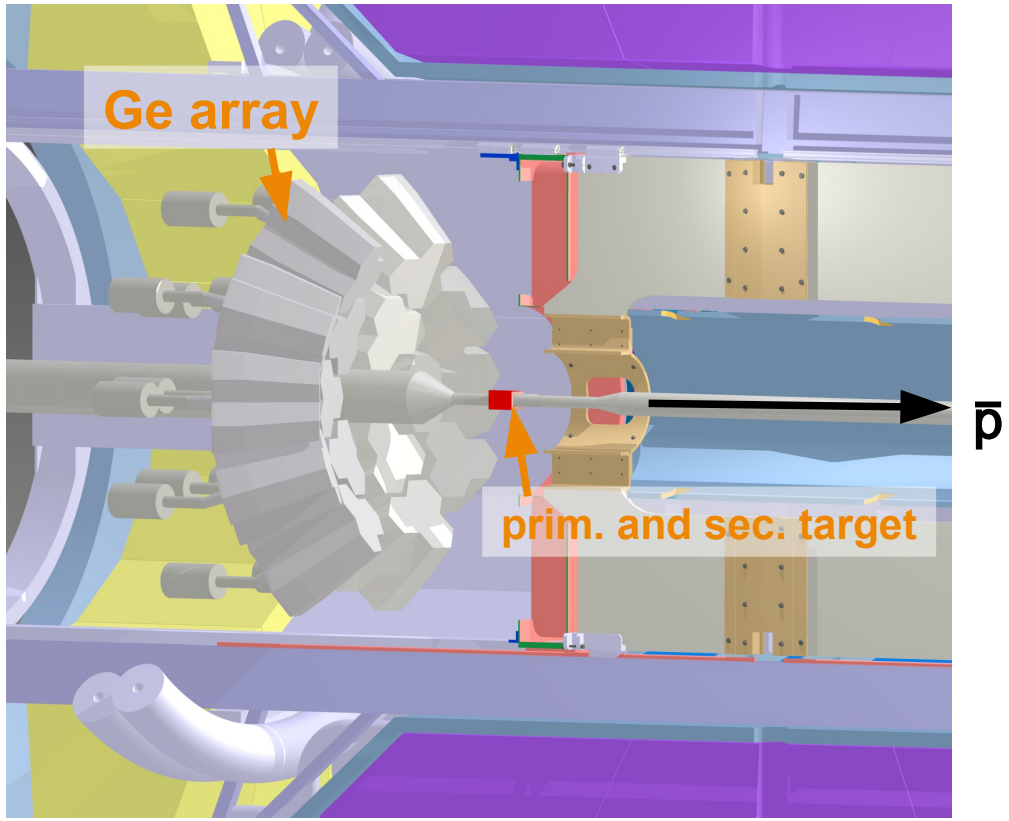
$\bar{p}\ N \rightarrow \Xi^-\ \Xi^{0/+}$

<u>sec. target</u>

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

γ isotropic

Physical process of the hypernuclear experiment

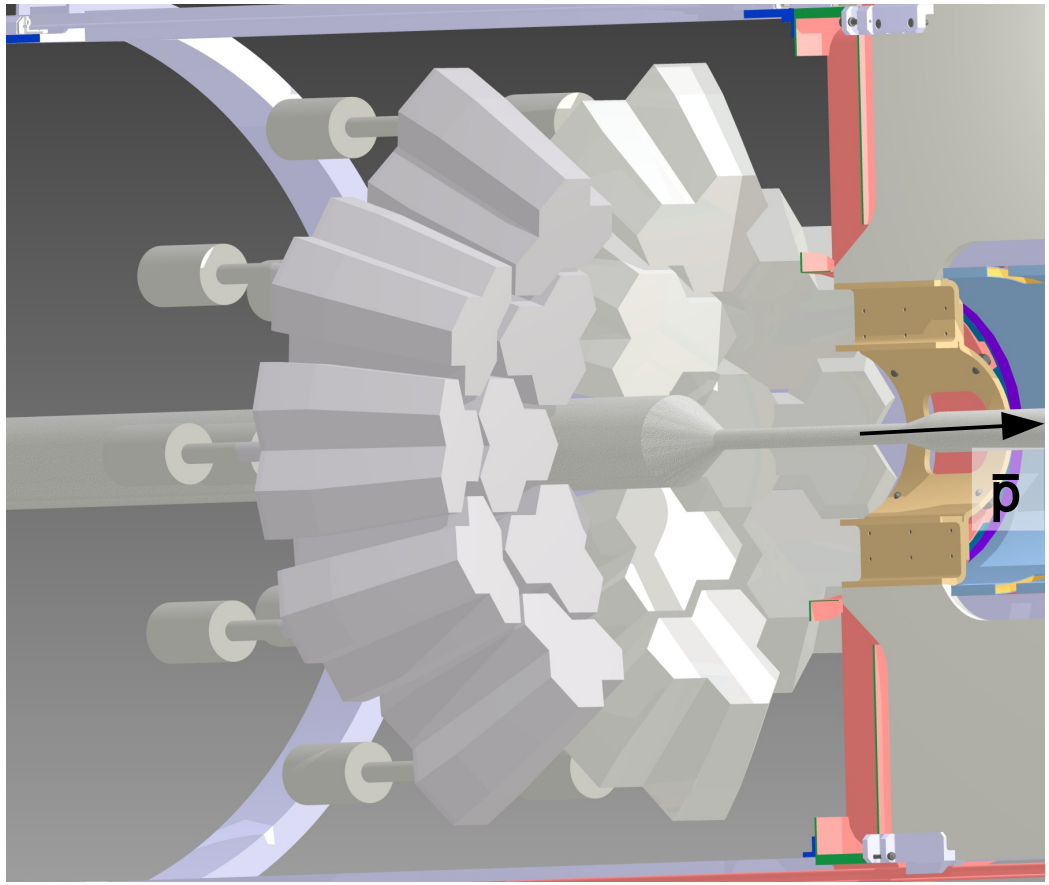


Modified $\bar{P}$ANDA components for the hypernuclear experiment

For the target system see HK45.4

Germanium detector array

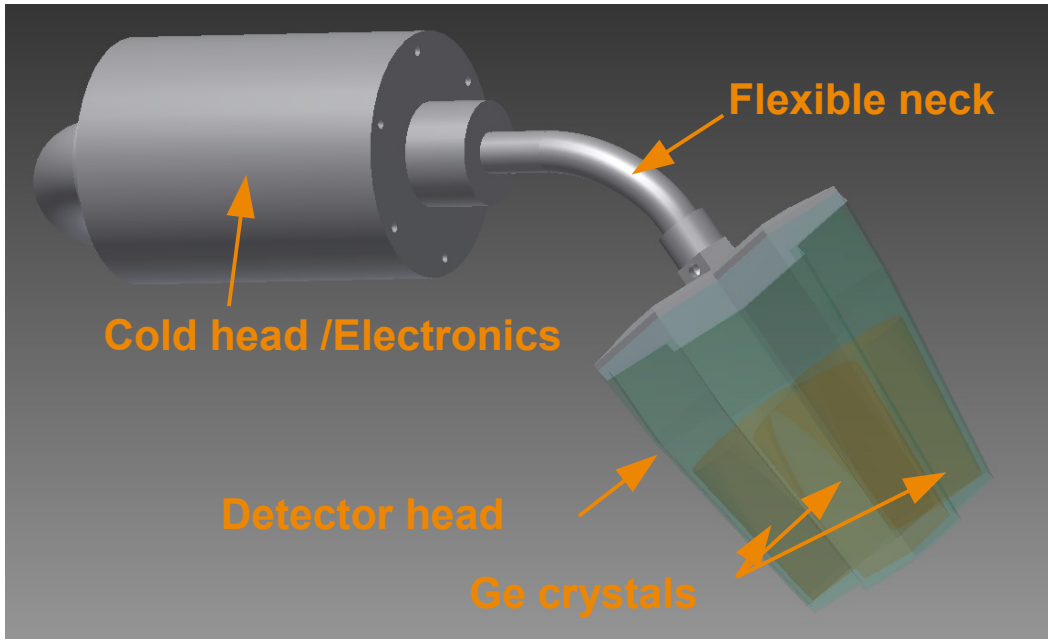
- Space highly limited inside the $\bar{P}$ANDA barrel
  - Complete rearrangement of existing detectors needed
  - No LN2 cooling possible
- High Magnetic Field
  - Effects on energy resolution [1]
- Particle background
  - Backward angles for reduction
  - Effects on energy resolution
  - Some radiation damage on the crystals expected



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

New detector design

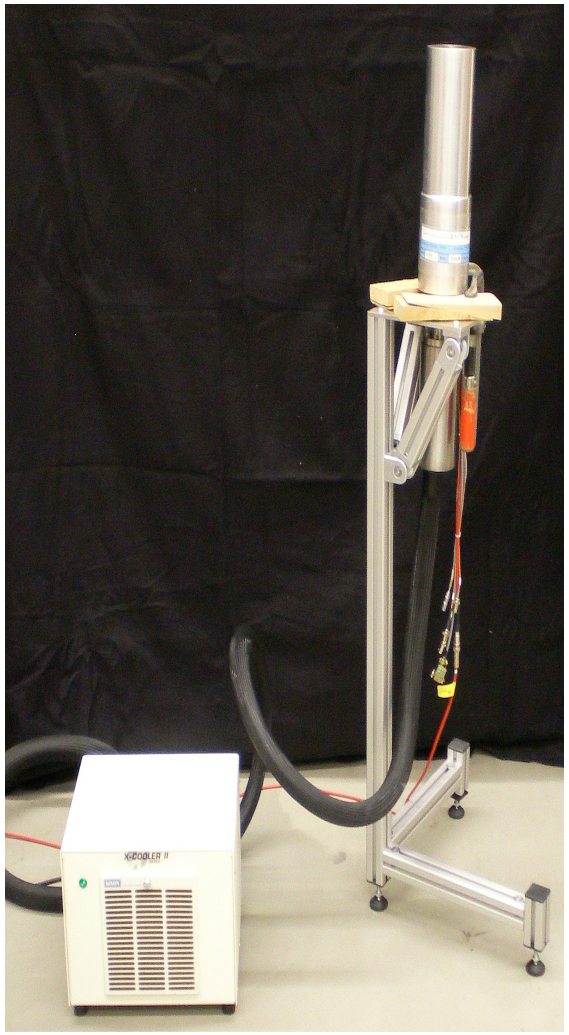
- Triple crystal detector
- Electro.-mech. cooler
- HV and readout “onboard”
- Flexible neck



- Prototype is planned to be finished until end of 2014 / begin of 2015

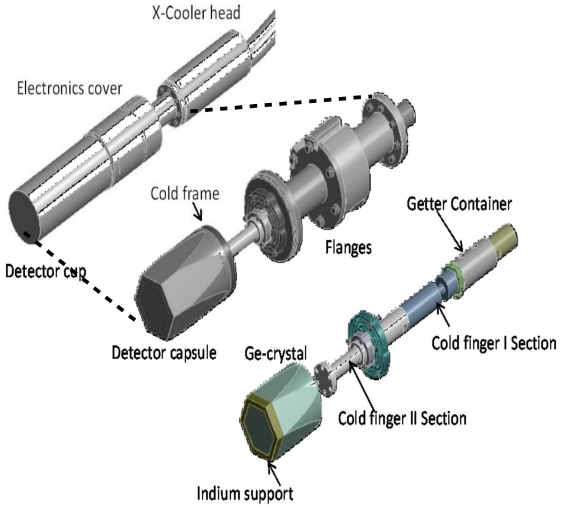
Electro mechanical cooler

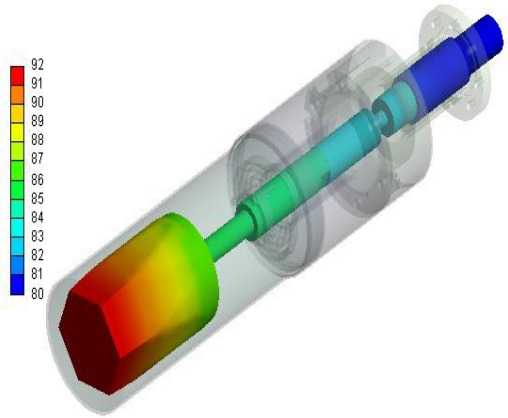
- Ortec X Cooler II
- Placed outside of the $\bar{P}$ANDA barrel (space, magnetic field)
- Limited but sufficient cooling power for three crystals
- Resolution of prototype detector deteriorates slighty due to higher temperature of 95 K (2.25 keV @ 1.332 MeV)

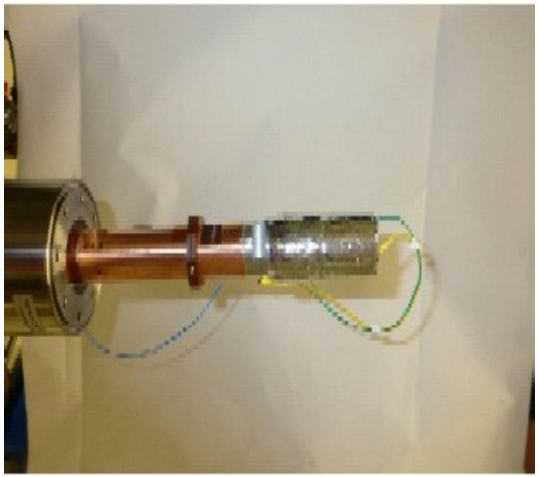


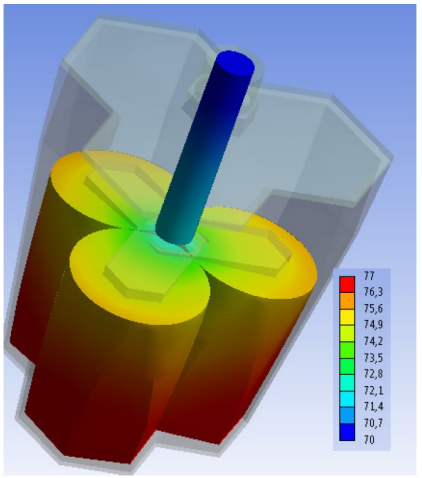
Thermal Simulation

- 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
- Final drawing for triple prototype are in progress

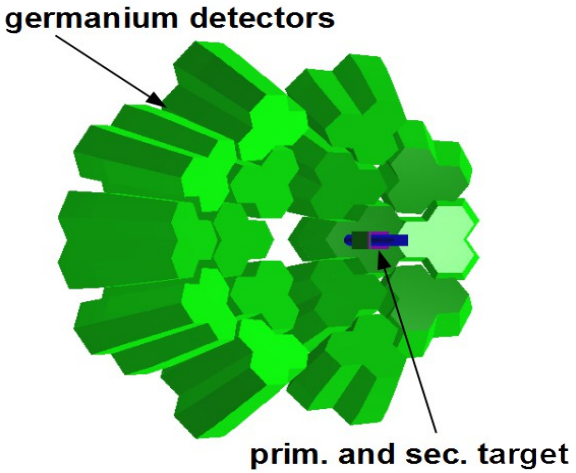


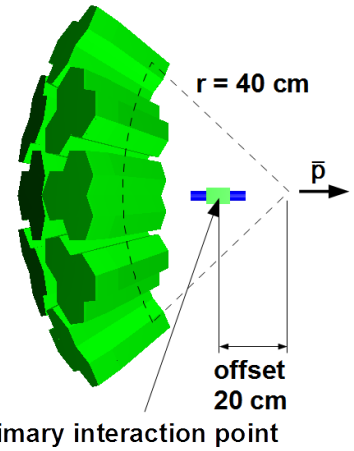


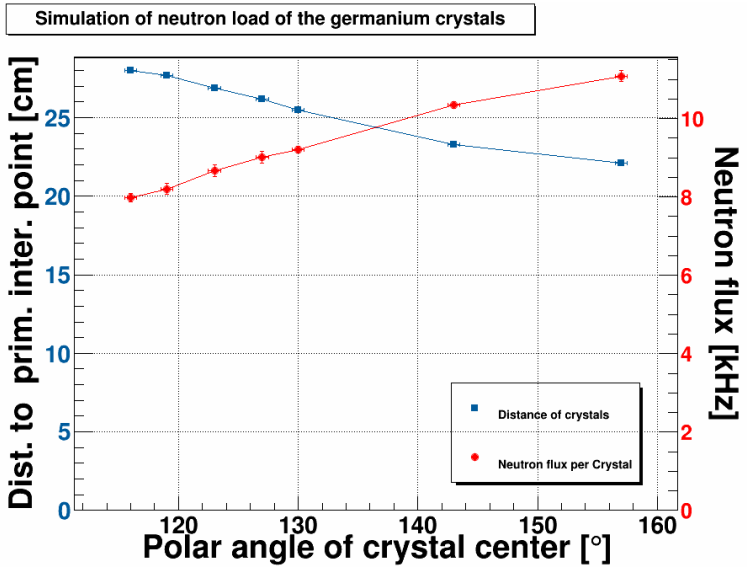




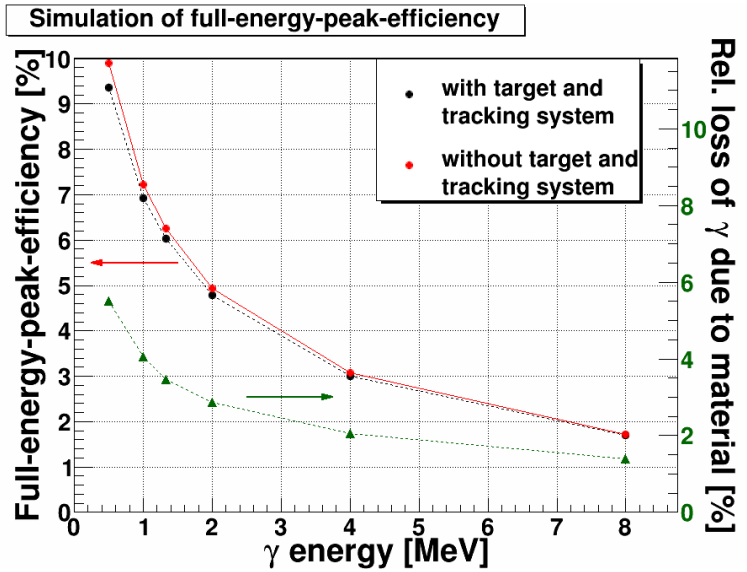
Simulation of the detector





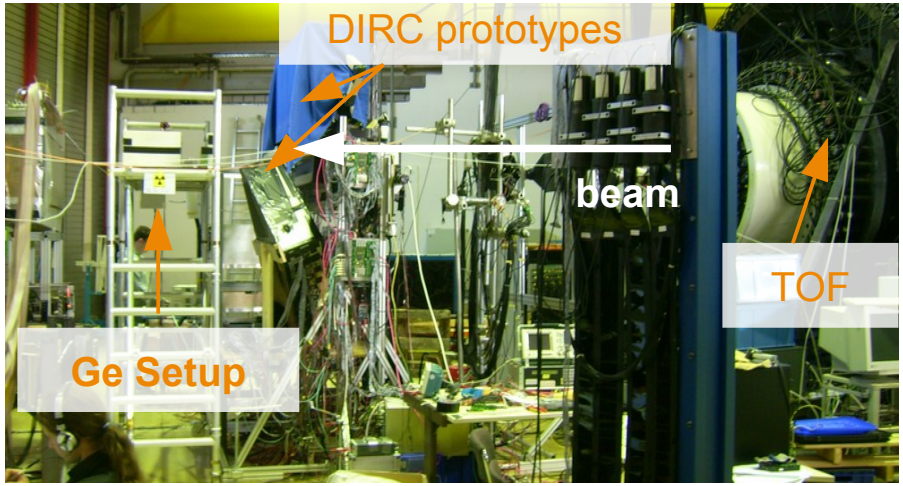


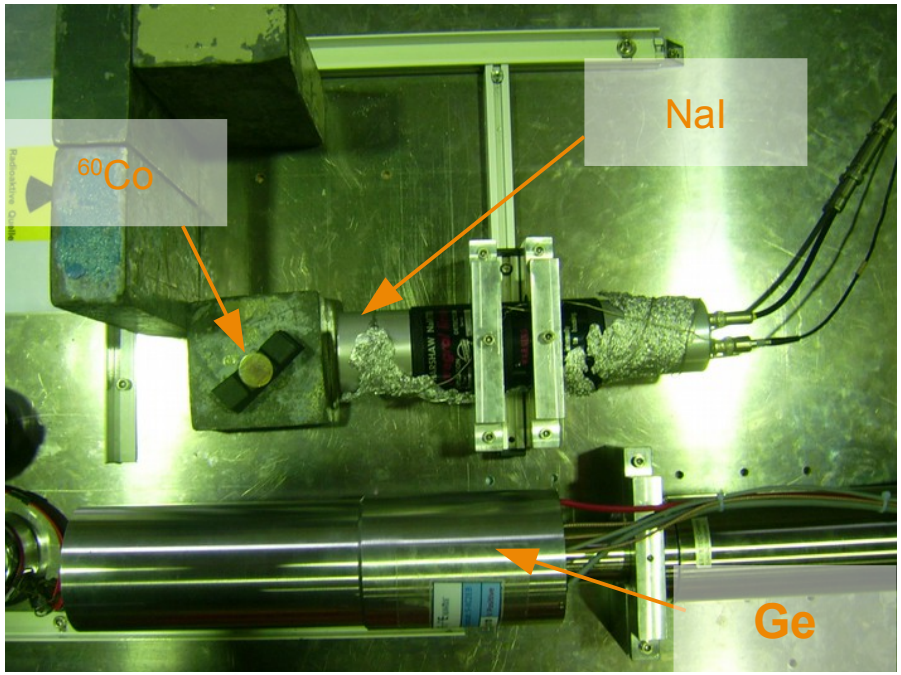
- Efficiency and background simulations
- PandaRoot framework (ROOT, Geant4)
- $3*10^9$ n/cm^2 accumulated over 3 months of $\bar{P}$ANDA conditions



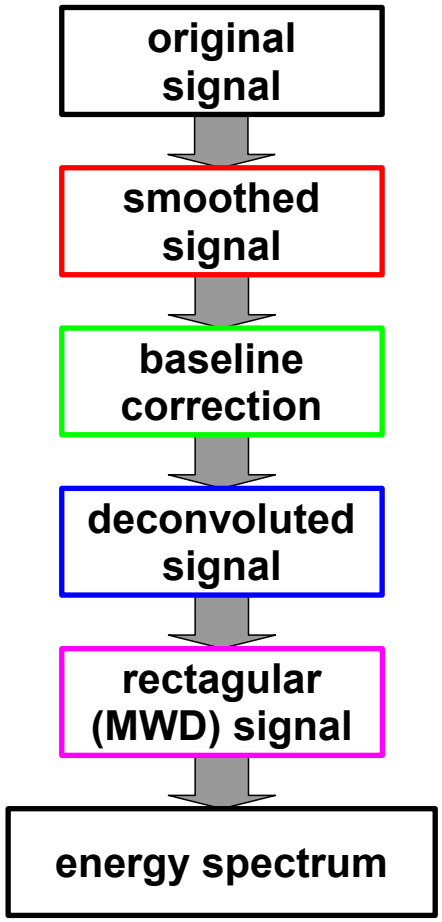
Radiation tests @ COSY in Jülich

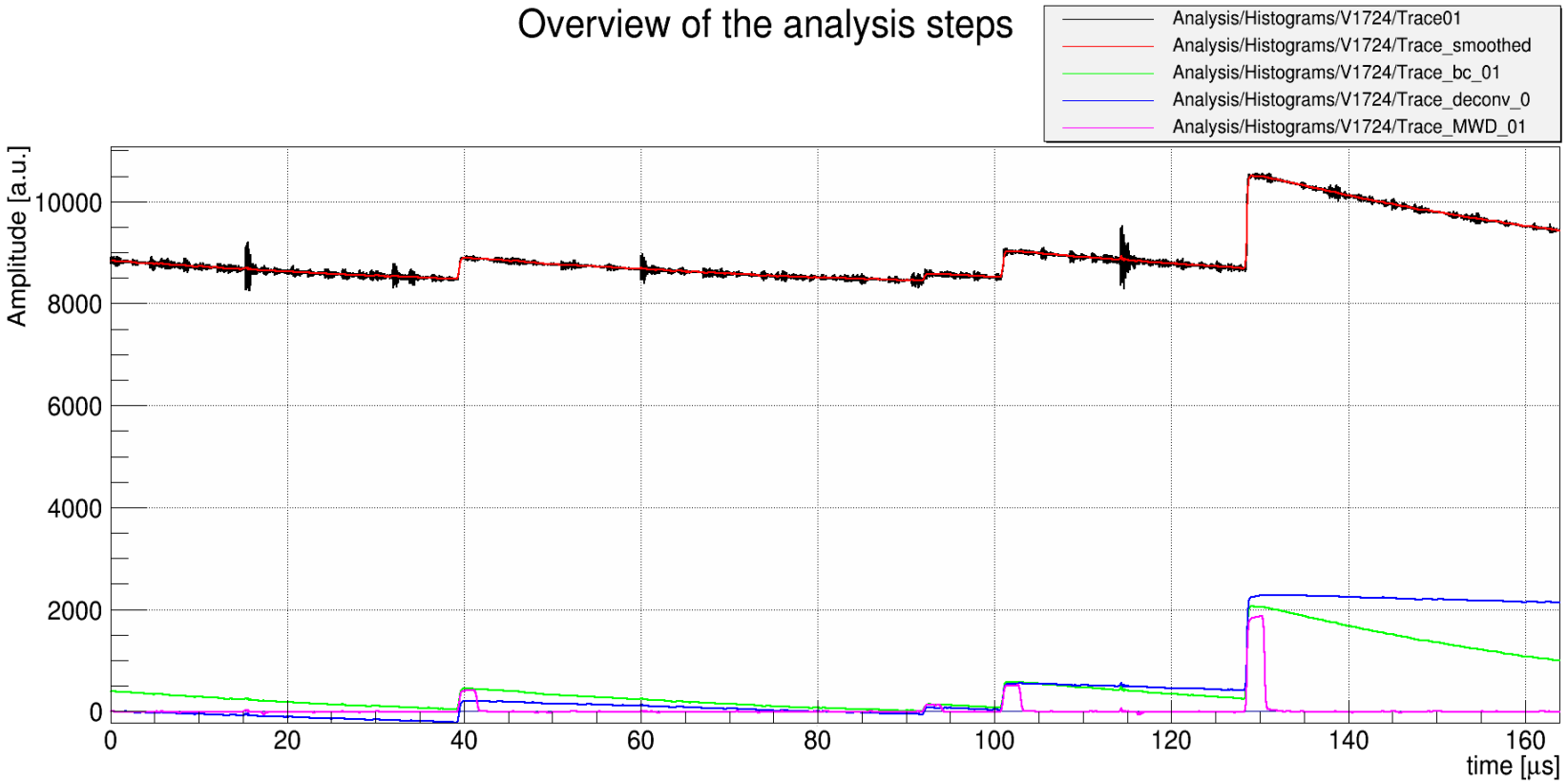
- Beam test in the end of 2013 in FAIR test week
- Parasitic with STT and DIRC group in TOF area
- Thick carbon target in beam (3 GeV p) to produce particle background similar to $\bar{P}$ANDA
- Coincidence (Ge + NaI)for triggering on ^{60}Co source





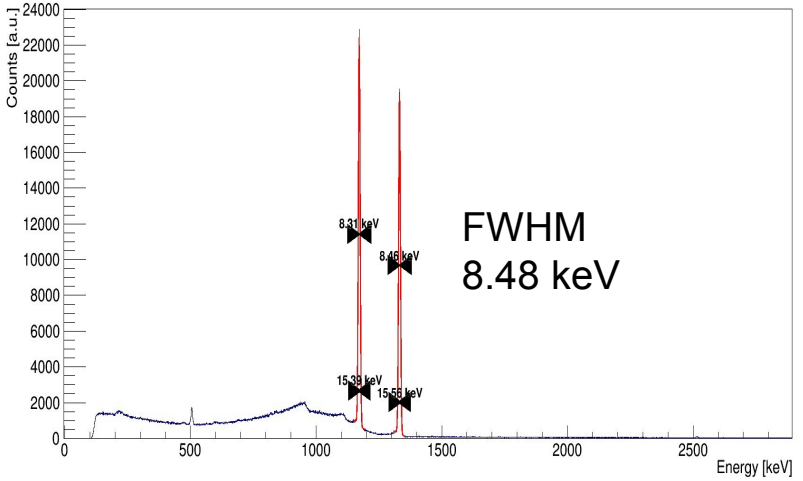
Analysis procedure

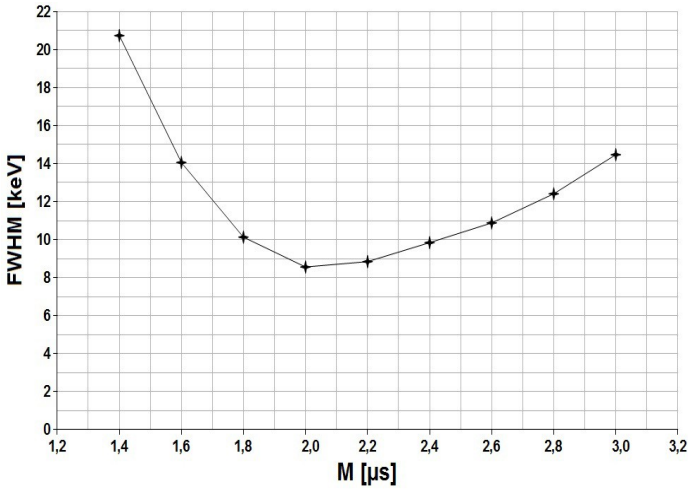




Results

- Resolution limited by pick up noise in this test!
- Proton rate too low to cause detectable radiation damage ($6*10^6$ n/cm^2)
- Next test foreseen in summer 2014 with higher rate and improved setup





Summary / Outlook

- Some challenges for the germanium array, but a working solution for all of them!
- Good performing single crystal prototype
- Full size triple crystal prototype at the end of 2014 / beginning of 2015
- Gained a lot of experience during our first beam test
- Second beam test with higher proton rate and improved setup this summer

Thanks for your attention