Report on The HPGe Cluster Array Detector

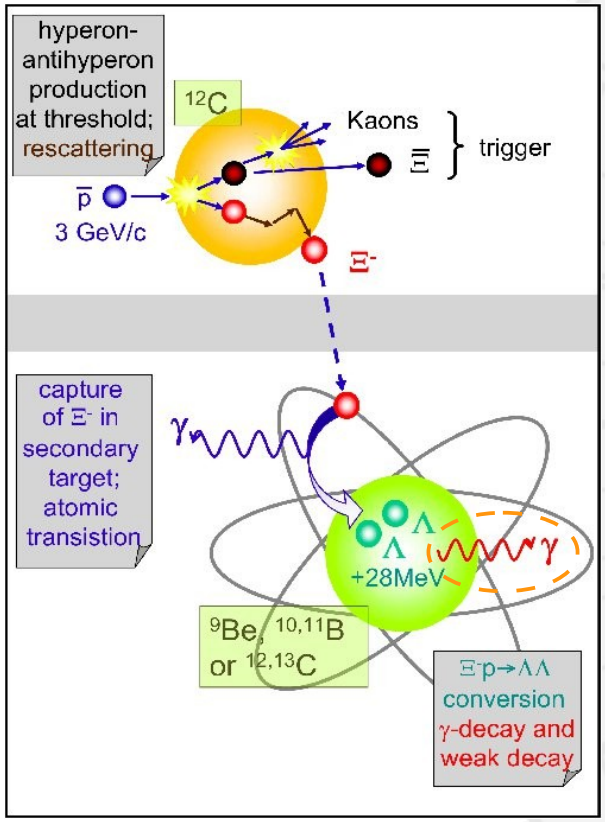
Marcell Steinen

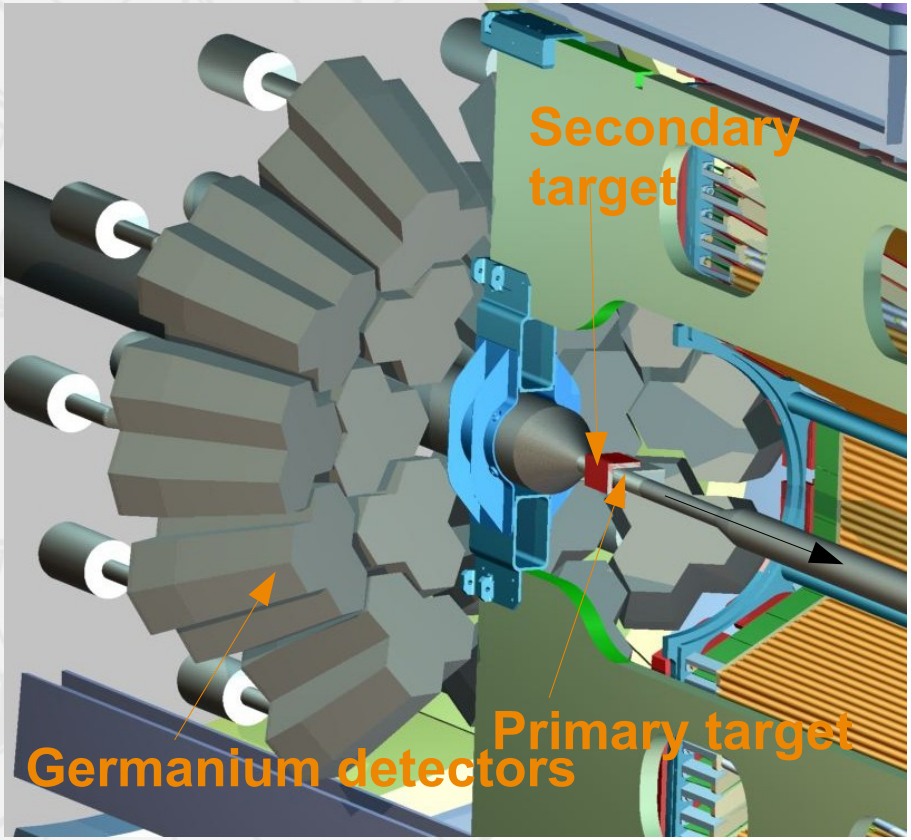
Outline

- Neutron background inside PANDA
- Planned tests at COSY
- Modification of the readout electronics
- Fitting program
- News from Ivan

Motivation

Why do we need this detector?



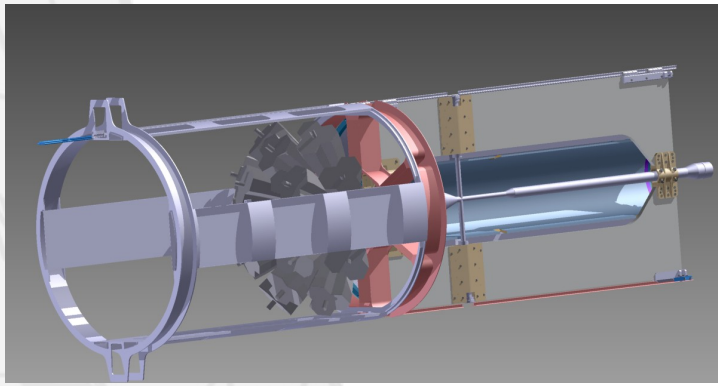


Measure energy levels of double Λ hypernuclei

Motivation

Challenges:

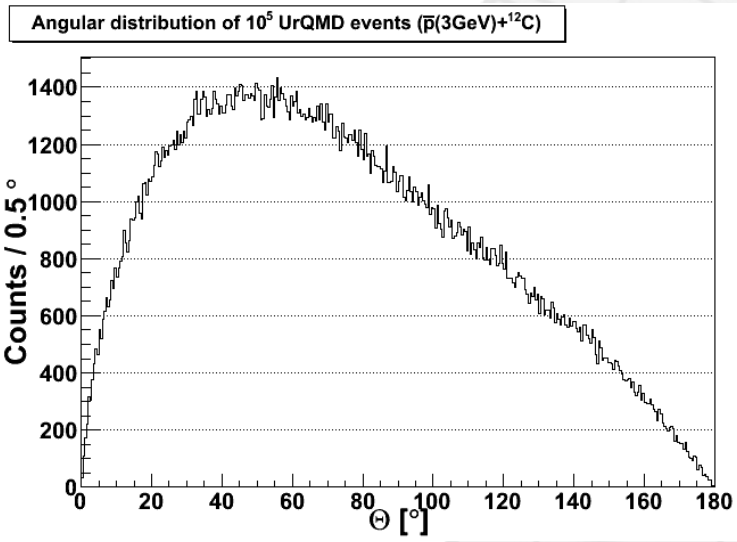
- Space

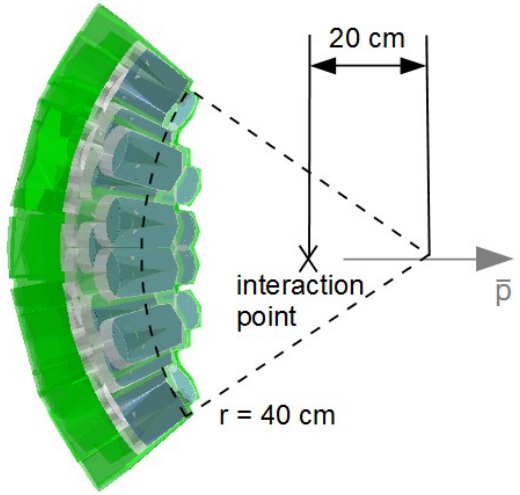


- Magnetic field

- **Neutrons/Background**

Neutron background inside PANDA

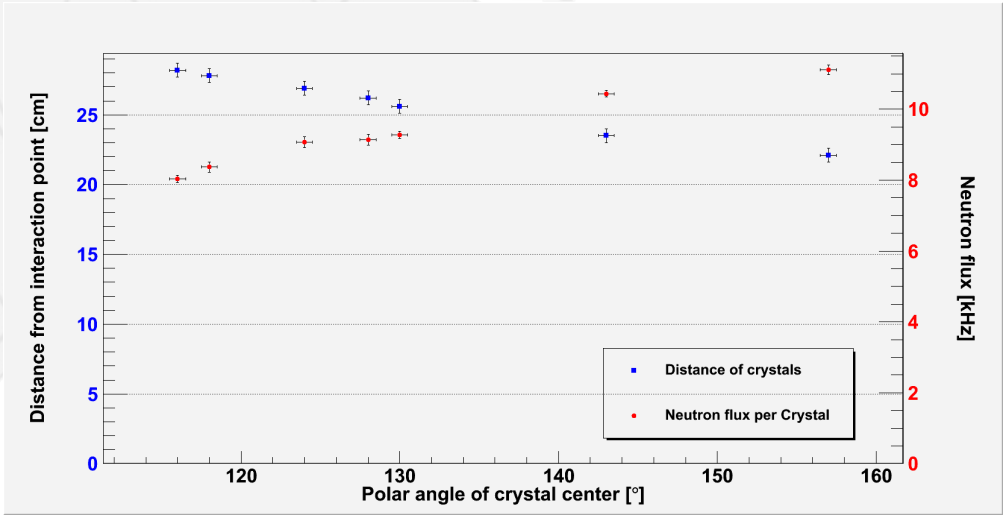




- 10^5 events (100 ms PANDA)
- strong Θ dependance

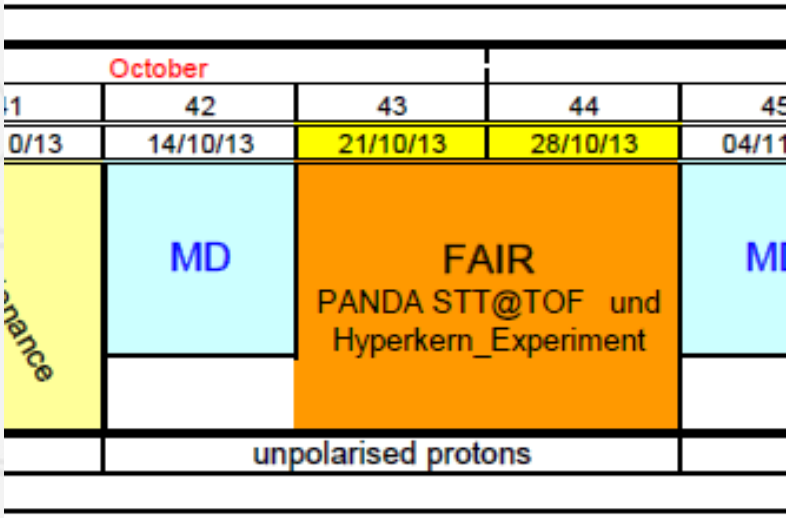
- Geometry with r = 40 cm and shifted center by 20 cm
  → Detector distance to interaction point depends on Θ

- Both dependances nearly cancel out
  ≈11 kHz neutron flux maximal



Planned tests at COSY

Beam time at COSY in october



1. Data taking with background similar to PANDA

2. “Simulate“ irradiation of a PANDA measurement cycle

Planned tests at COSY

1. Data taking with background

- Influence of background on the energy resolution of the germaniums

- PANDA hyp. experiment
  interaction rate ≈10^6 /s
  $\bar{p}$ momentum 3 GeV/c

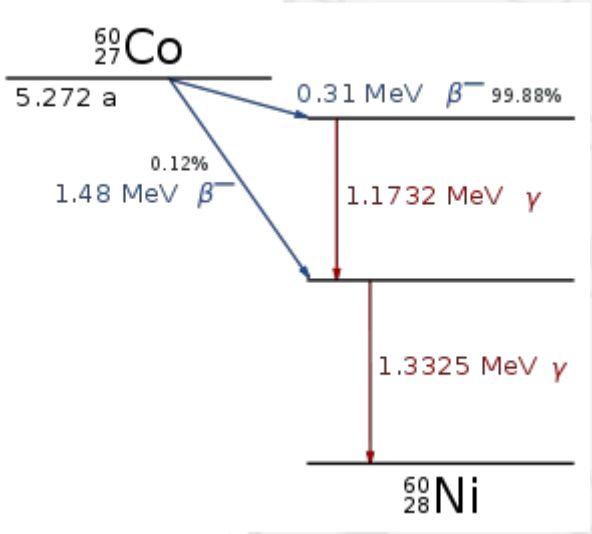
- Background for high Θ angles for p and $\bar{p}$ comparable
  → COSY @ 3 GeV/c

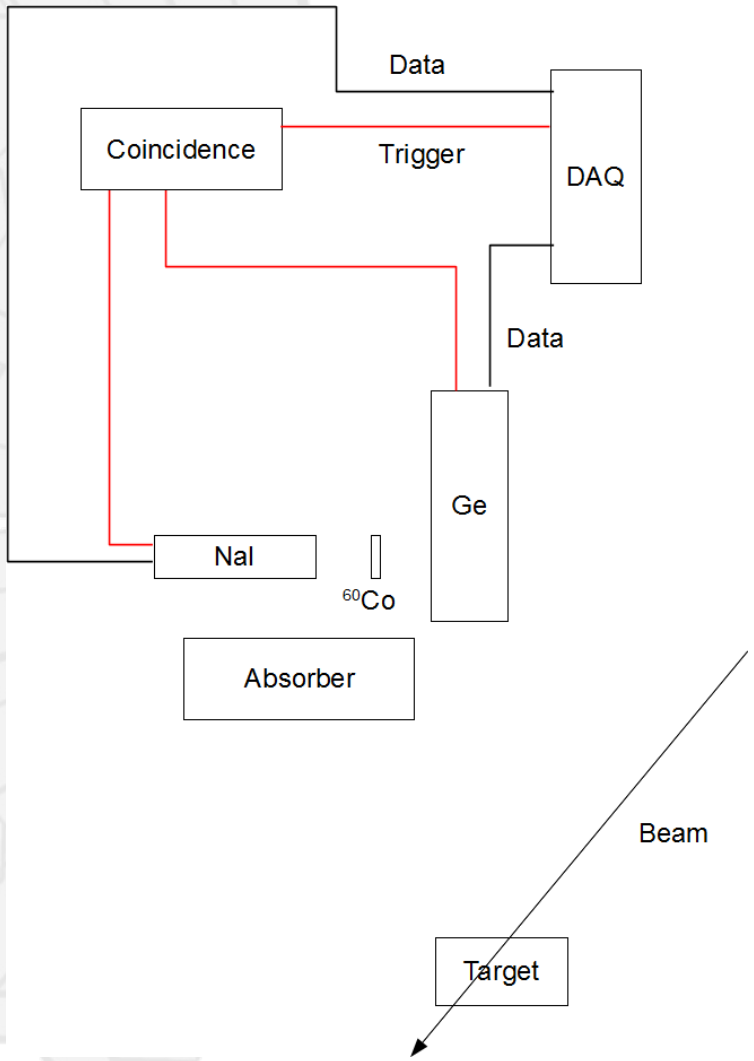
- Thick C target (~5 cm) ~10 % interaction rate
  → 10^7 p /s at COSY needed

Planned tests at COSY

1. Data taking with background

^{60}Co source





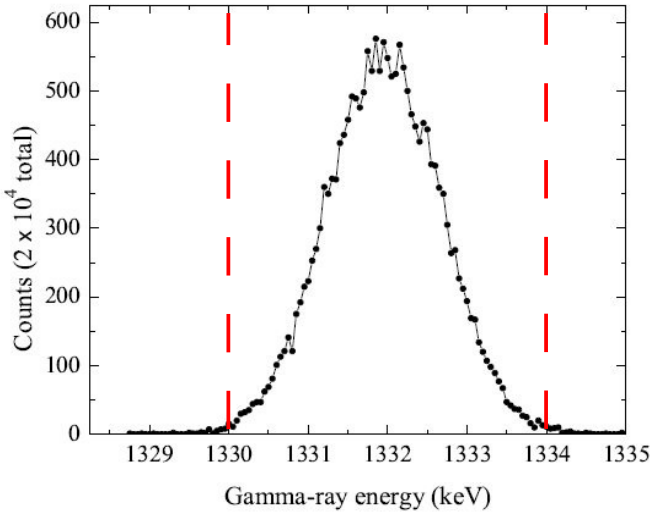
- Coincidence with NaI scintillator

- Rate?
- Absorber?

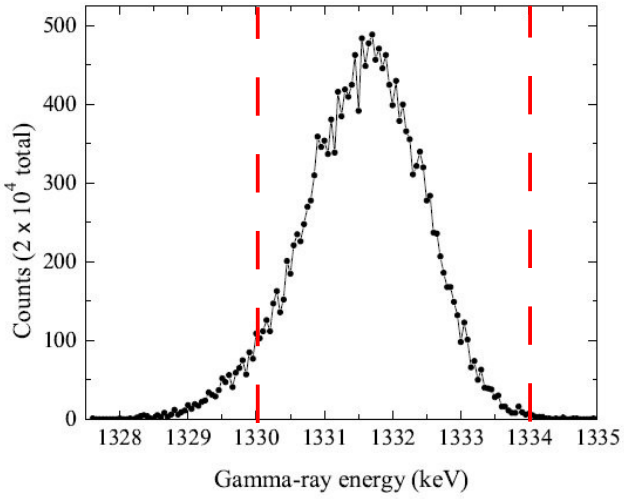
Planned tests at COSY

2. “Simulate“ irradiation of a PANDA measurement cycle

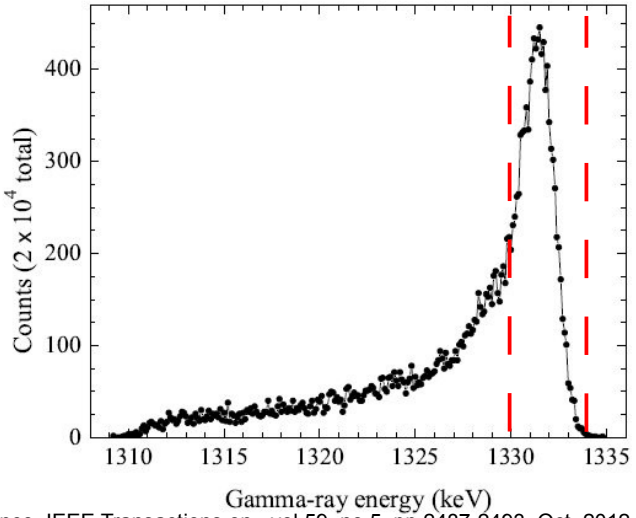
Crystal resolution will degradate due to radiation damage



10^8 n/cm^2



10^9 n/cm^2



10^{10} n/cm^2

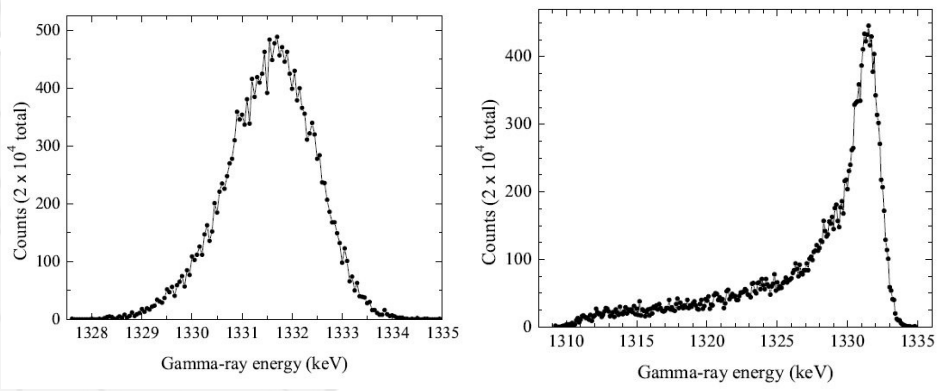
Van Siclen, C.D.; et.al , Nuclear Science, IEEE Transactions on , vol.59, no.5, pp.2487-2493, Oct. 2012

Planned tests at COSY

PANDA beam time	100 days
inter. rate	$2*10^6$ /s
duty cycle	50 %
number of interactions	$8.64*10^{12}$

COSY	
proton rate	10^9 /s
duty cycle	50 %
target efficiency (C target)	10 %
necessary beam time	2 days

PANDA beam time	100 days
n flux (simulation)	11 kHz /crystal
n per beam time	$9.5*10^{10}$
crystal front surface	30.11 cm^2
n per cm^2	$3.16*10^9$



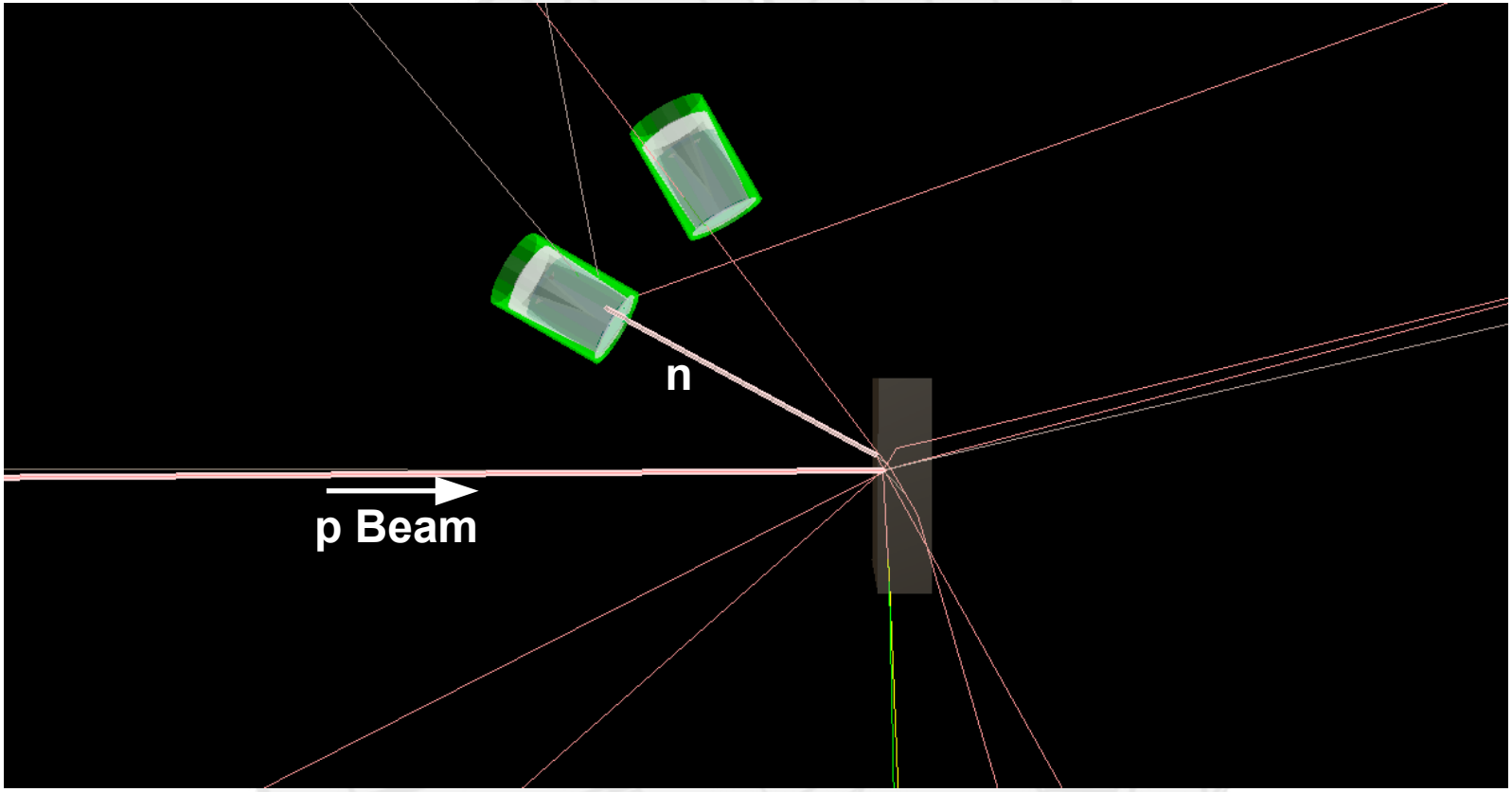
Van Siclen, C.D.; et.al , Nuclear Science, IEEE Transactions on , vol.59, no.5, pp.2487-2493, Oct. 2012

10^9 n/cm^2 10^{10} n/cm^2

- Annealing
- Lend crystals from EUROBALL

Planned tests at COSY

Simulation of radiation test



- C target (5 cm thick)
- single crystal detector (r = 30 cm, Θ = { 120°, 150°})
- no numbers yet

Modification of the readout electronics

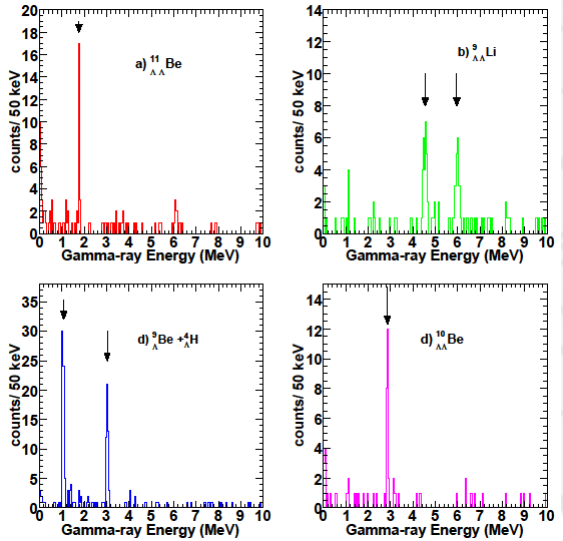
FlashADC (VX1724, 14 bit, Upp = 2.25 V):

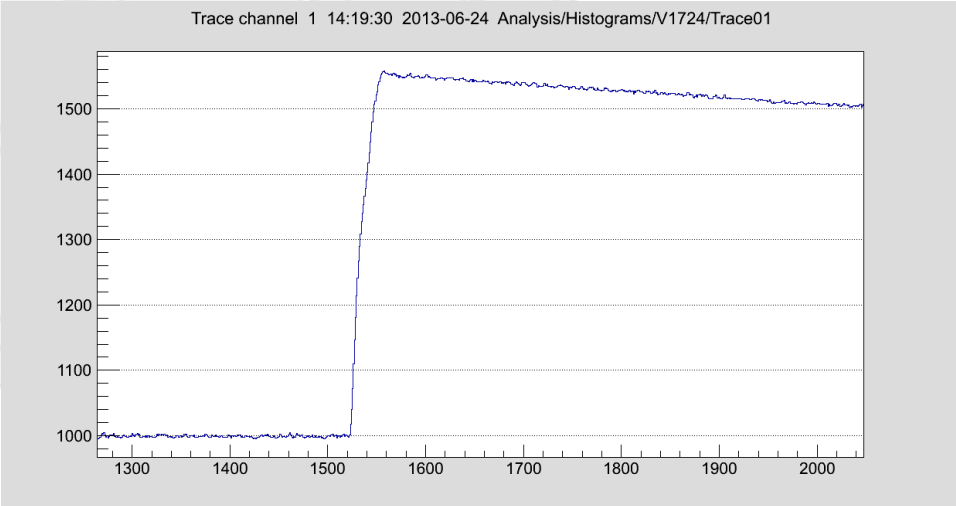
Pulse height of typical 1.332 MeV trace: 80 mV (≈570 bin)
→ max E_γ ≈ 36 MeV resolution: 2.3 keV/bin

Modification of Upp to 0.5 V:

→ max E_γ ≈ 8 MeV resolution: 0.5 keV/bin

Enough for now, more bins needed for final experiment

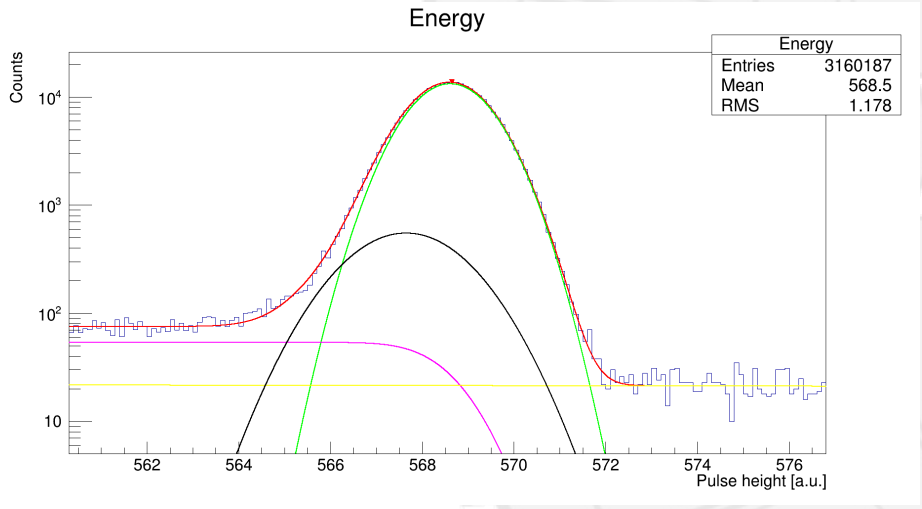




Fitting program

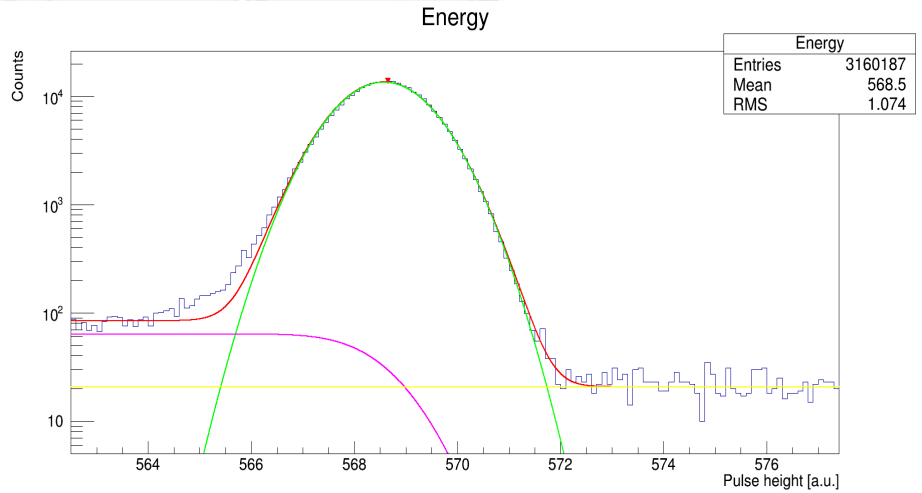
Simple gaussian fitting (+background) not enough

- Components of fit:
  1. Gaussian — main peak
  2. Smoothed step function — compton background
  3. pol1 — background
  4. 2nd gausian — low energy tail



X^2_{red} = 1.25

$x_{0\_1stGaus}$ = 568.613 ± 0.004



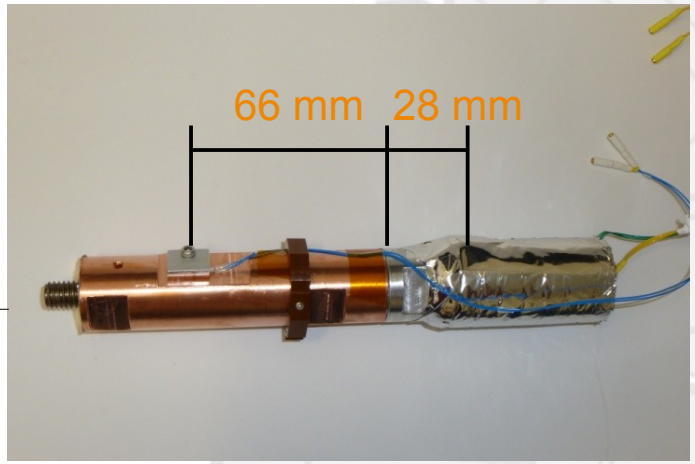
X^2_{red} = 5.14

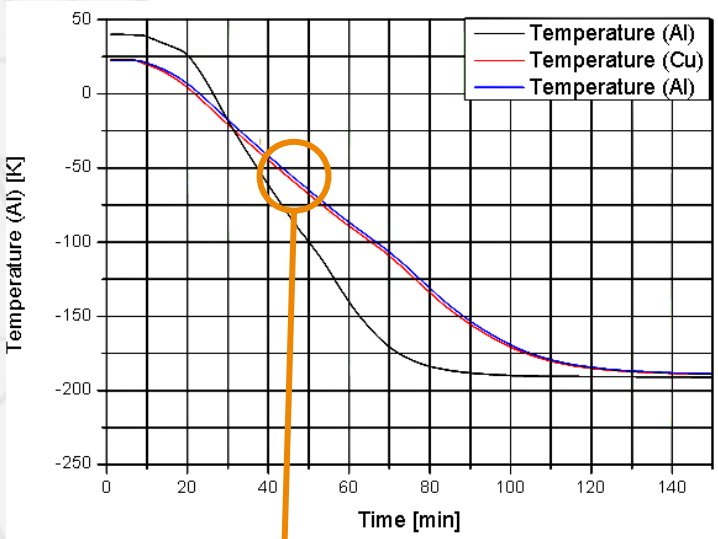
$x_{0\_1stGaus}$ = 568.574 ± 0.002

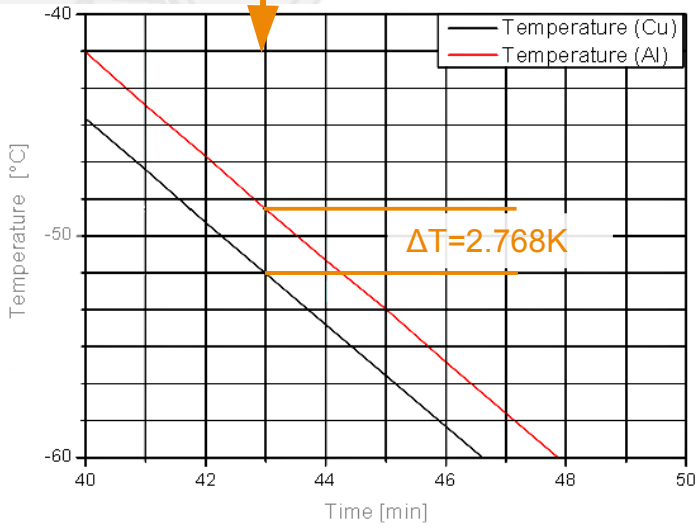
- 9 parameters!, hard to find good starting values
- Fit may be improved by replacing the second gaussian with a skewed gaussian (10 parameters!)

News from Ivan

Measurement of cooling power of a X-Cooler (not specified)





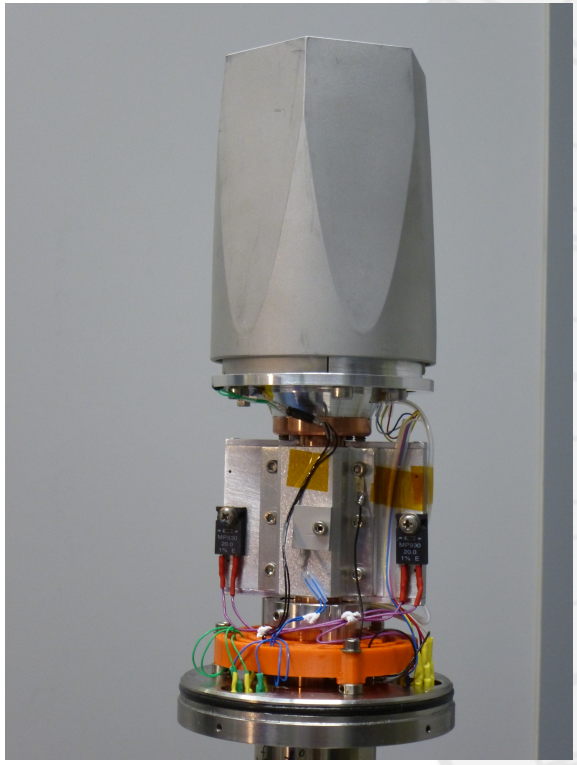


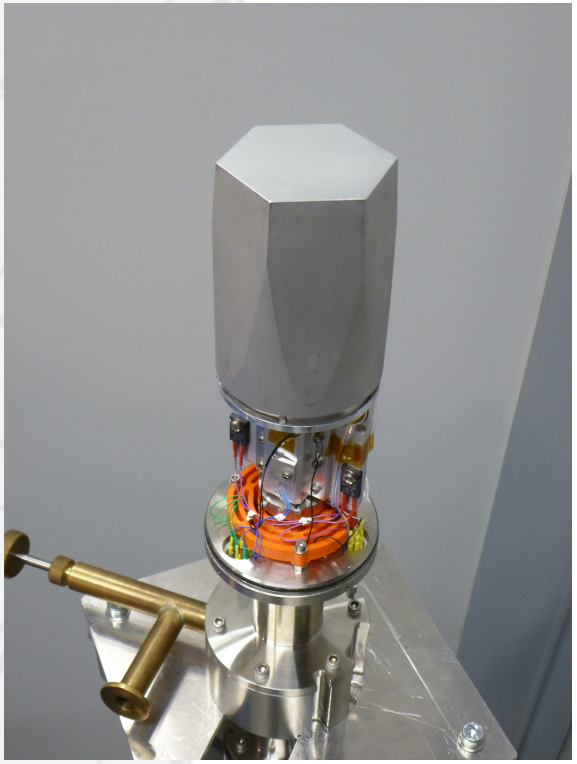
- More than expected!
- 10 W instead of 3 W

- Power is lost in thermal connections
- R&D possible!
- New version of X Cooler available

News from Ivan

Pictures of new detector

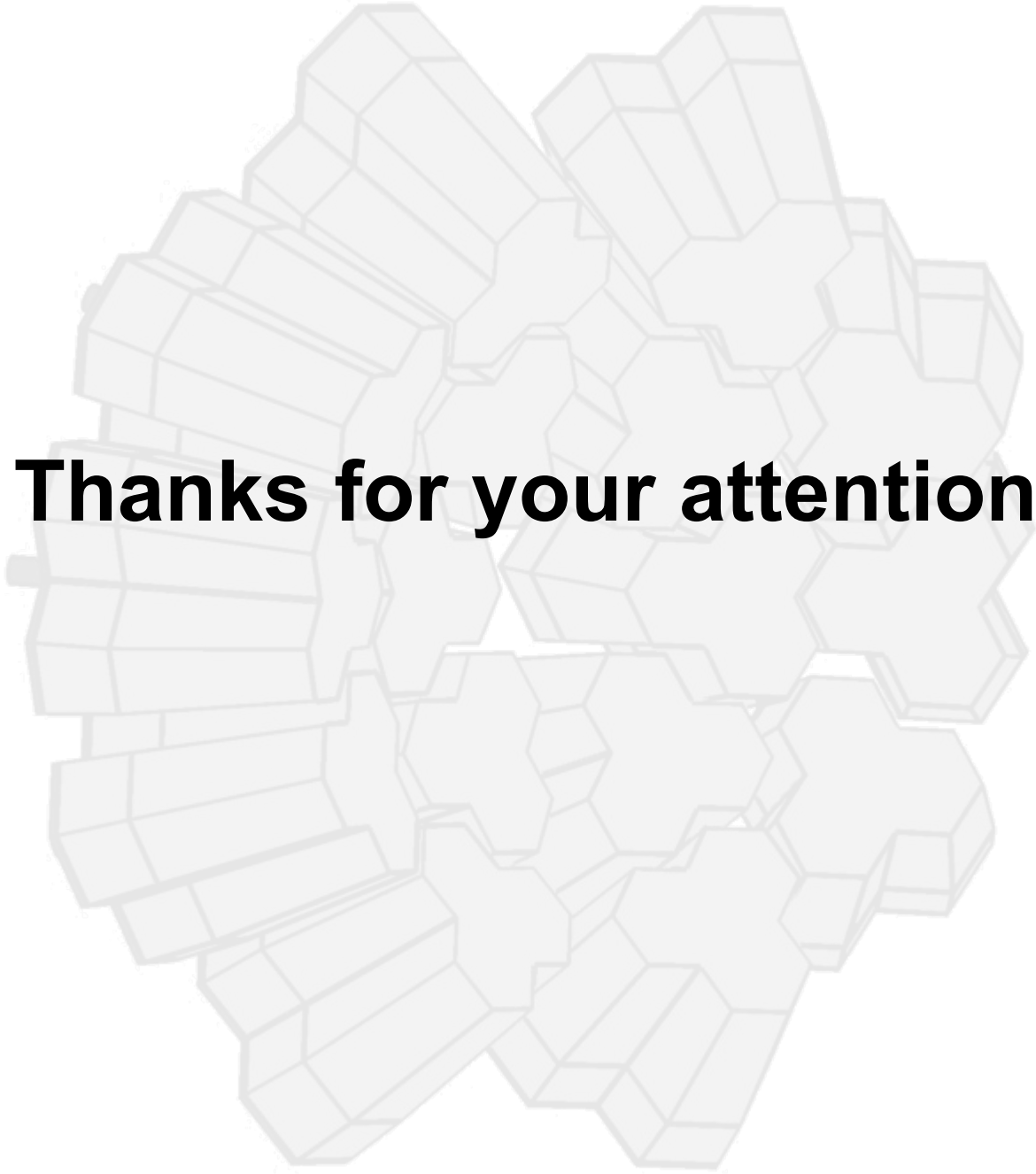




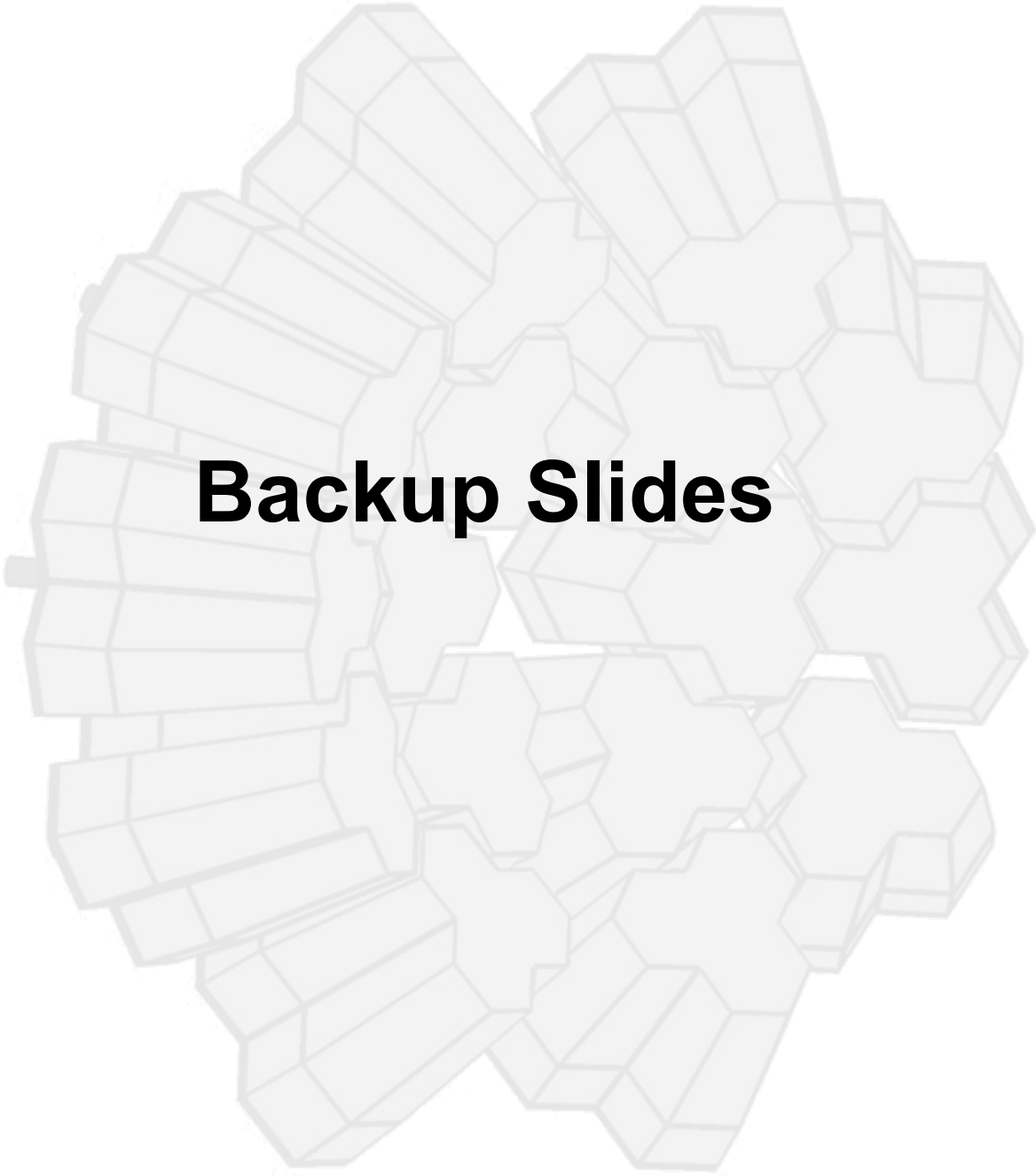
Still waiting on our crystal ...

Summary

- Good compromise geometry found
- 11 kHz neutrons maximal per crystal
- Looking forward to COSY beam time
  - High rate tests
  - Radiation hardness
  - Simulation started
- FlashADC modified for actual needs
- Low energy tail gaussian improves fitting
- X cooler power higher than expected
- R&D for thermal contacts possible and needed!
- Still waiting for the crystal...

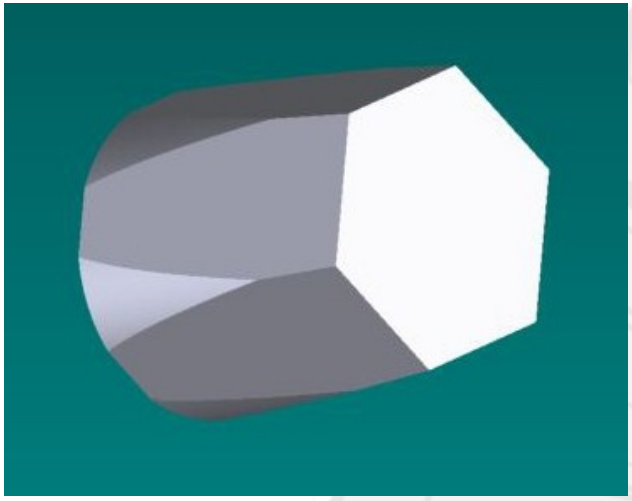


Thanks for your attention

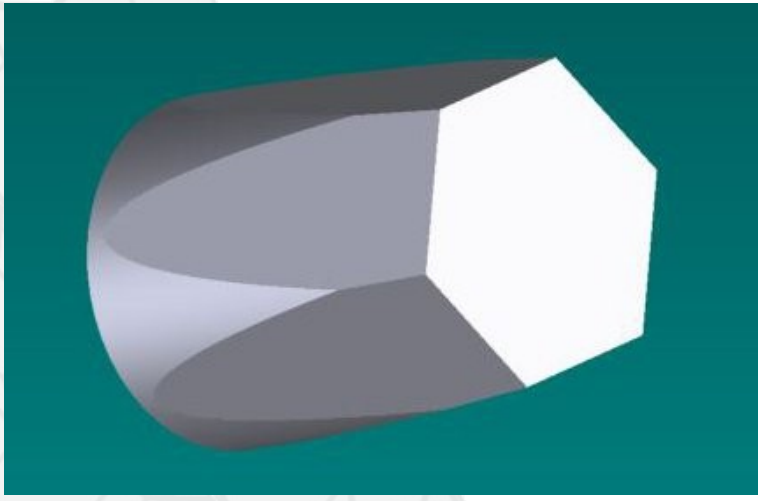


Backup Slides

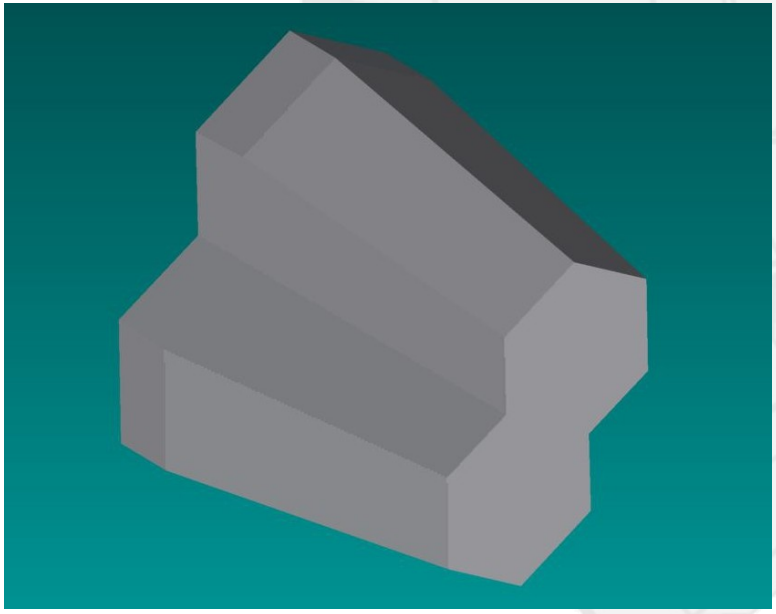
Implementation in PANDAROOT



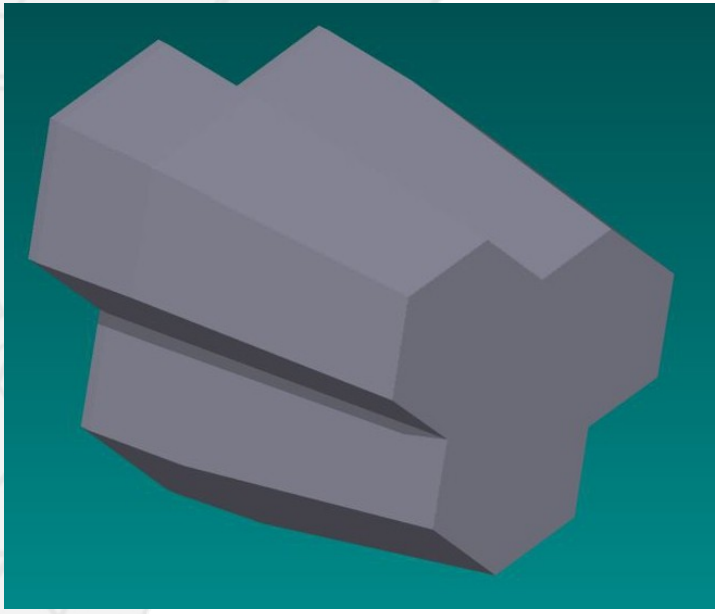
Ge crystal



Al encapsulation



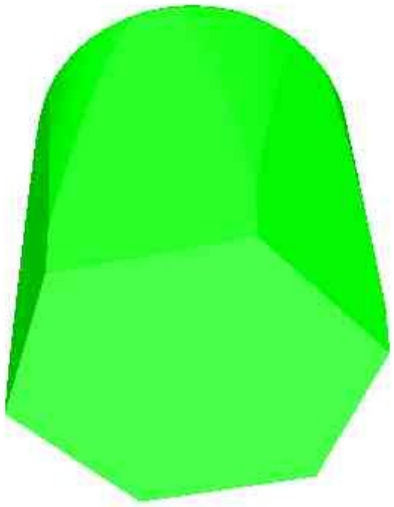
Double detector

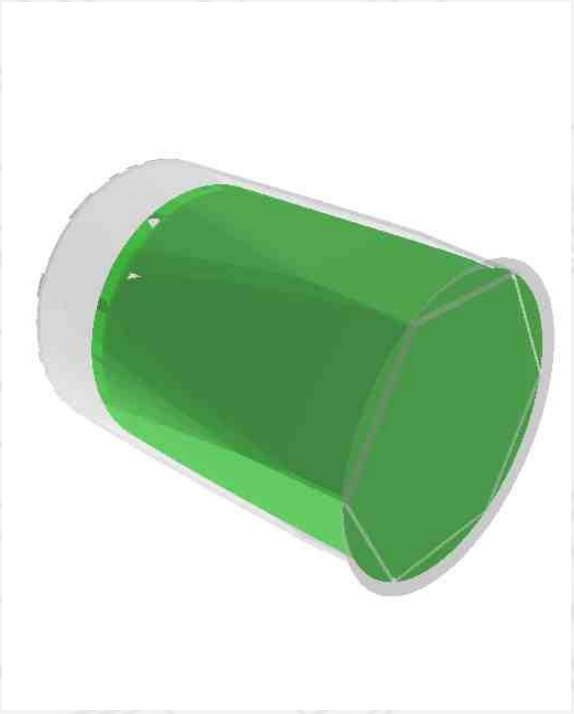


Triple detector

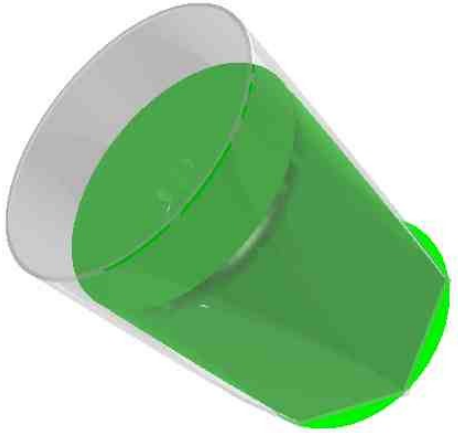
Implementation in PANDAROOT

PndGeoHypGeCrystal





ogl viewer strikes back ...

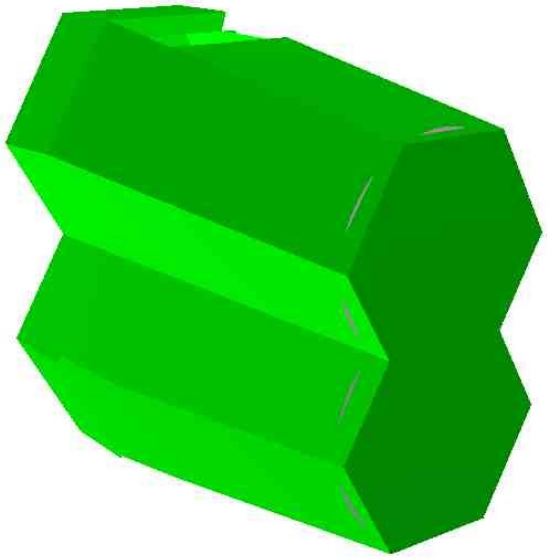


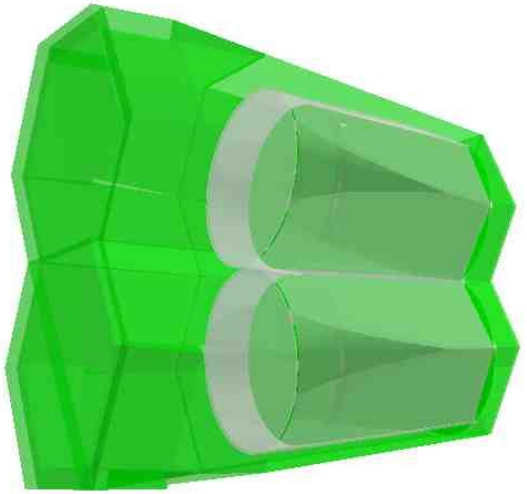
ogl viewer strikes back ...

EUROBALL HPGe crystal in aluminium capsule
TGeoPgon is subtracted of a TgeoTube to create the tapered shape

Implementation in PANDAROOT

PndGeoHypGeDoubleCluster



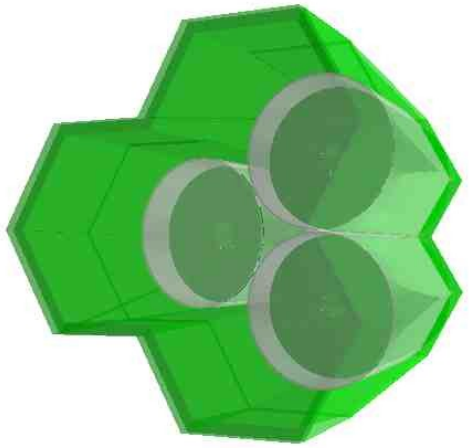


ogl viewer strikes back ...

2 encapsulated crystals
cryostat (38 TGeoArb8 in a TGeoCompositeShape)

Implementation in PANDAROOT

PndGeoHypGeTripleCluster



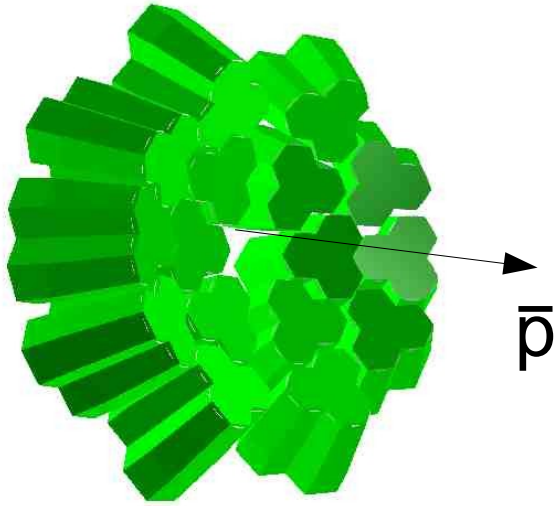
ogl viewer strikes back ...

3 encapsulated crystals
cryostat (46 TGeoArb8 in a TGeoCompositeShape)

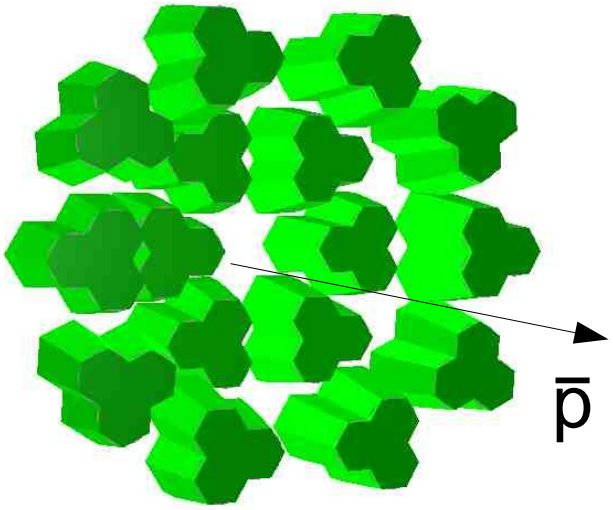
Implementation in PANDAROOT

Example:

Macros in $VMCWORKDIR/macro/hypGe/Marcell/Geometry
root files in $VMCWORKDIR/geometry



hypGeGeoBuilderTripleBall40Offset20Geometry.C
hypGeGeoTripleCluster_Ball40_Offset20.root



hypGeGeoBuilderTripleStraightGeometry.C
hypGeGeoTripleCluster_Straight.root

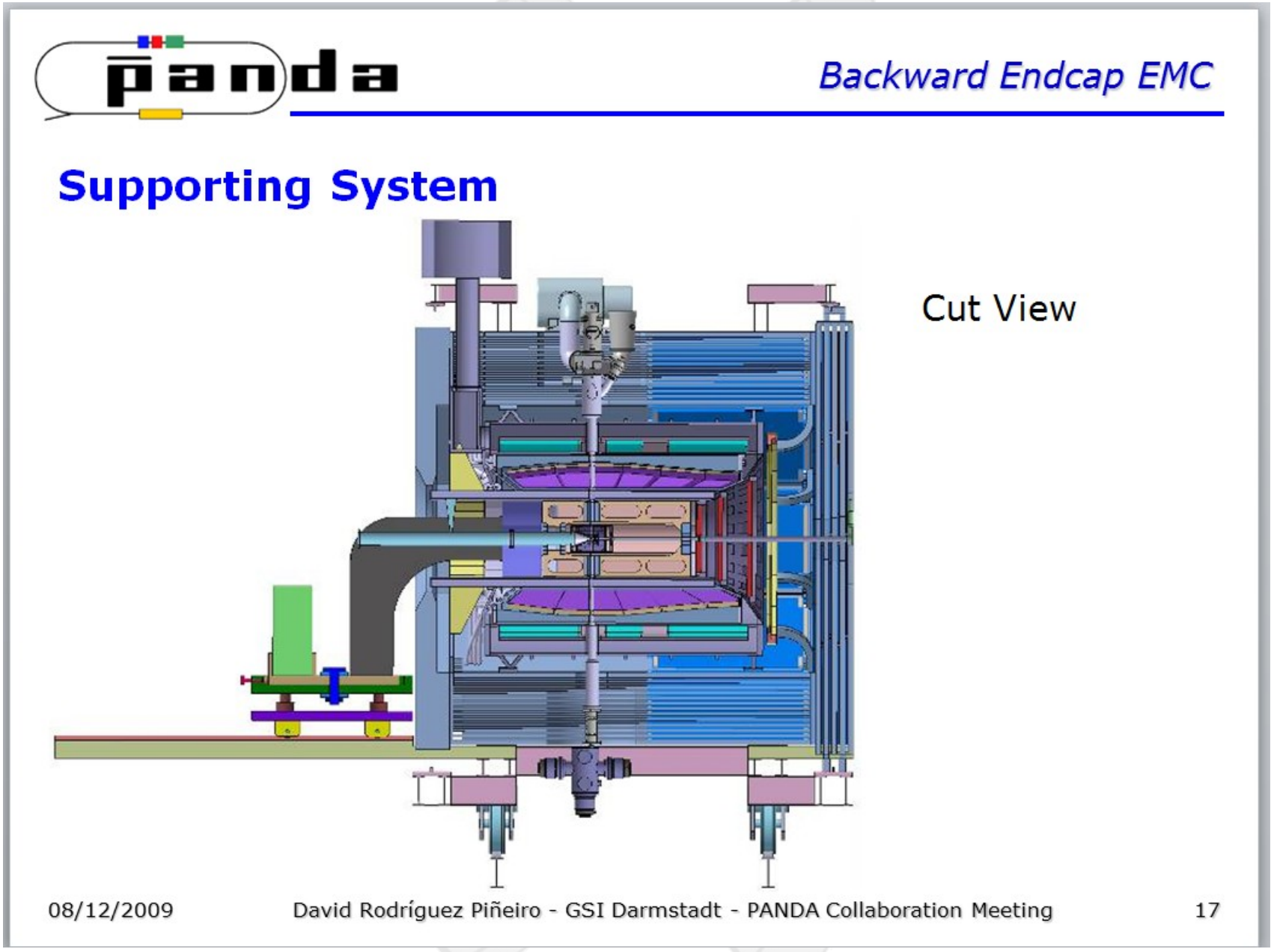
Simulation with different geometries

	1 MeV		2 MeV	
	Peak	P/C	Peak	P/C
Ball30	486841	158	331664	133
Straight	415794	148	277837	123
Ball40_10	537037	153	367159	131
Ball40_20	704206	161	478355	137

Ball30: sphere, 30 cm radius
Straight: Detectors not rotated,
1st layer 30 cm to source, 2nd layer Offset 15 cm
Ball40_10: sphere, 40 cm radius, 10 cm z-Offset
Ball40_10: sphere, 40 cm radius, 20 cm z-Offset

Radiation damage/background not considered!!!

Ideas to hold the germaniums

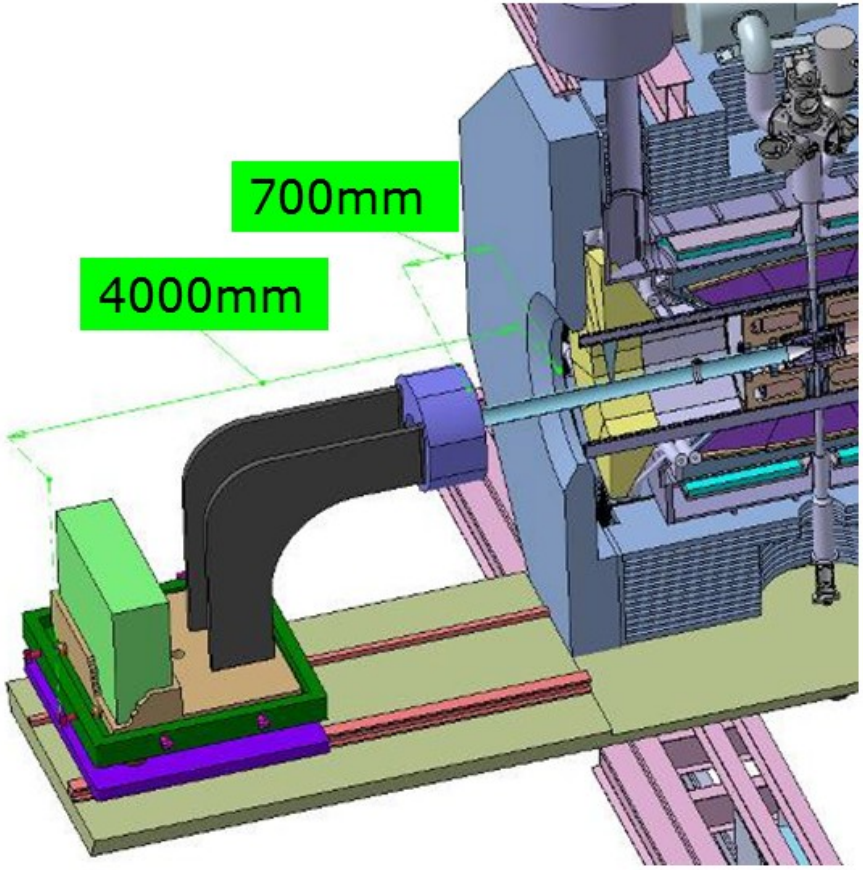


Ideas to hold the germaniums

panda

Backward Endcap EMC

Supporting System



Distances to the **Magnet**

08/12/2009 David Rodríguez Piñeiro - GSI Darmstadt - PANDA Collaboration Meeting 20