Integration of the hypernuclear detector Setup in the PANDA spectrometer

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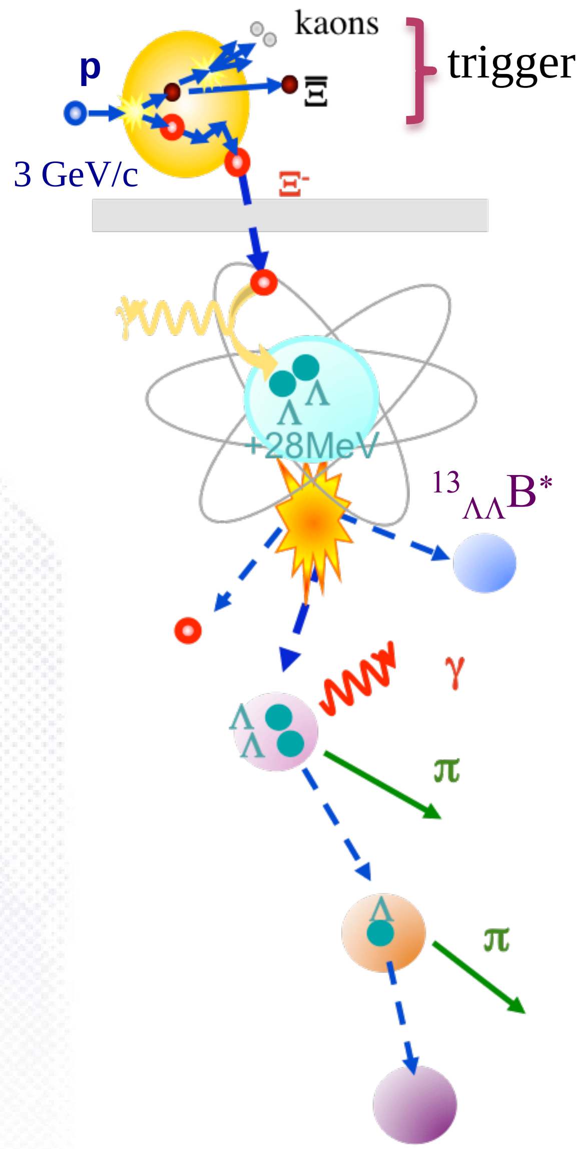
- Short motivation
- Integration in the PANDA spectrometer
- Beam Pipe
- Primary target
- The Secondary Active Target
- The HPGe Array

ΛΛ- Hypernuclei at Panda



$p + {}^{12}C \Rightarrow \Xi^- + \Xi$ bar in a primary target

$\Rightarrow$ Slowing down, capture and conversion of Ξ in a secondary active target.

$\Rightarrow$ Statistical decay of slightly excited hypernuclei

$\Rightarrow$ Electromagnetic transition to g.s

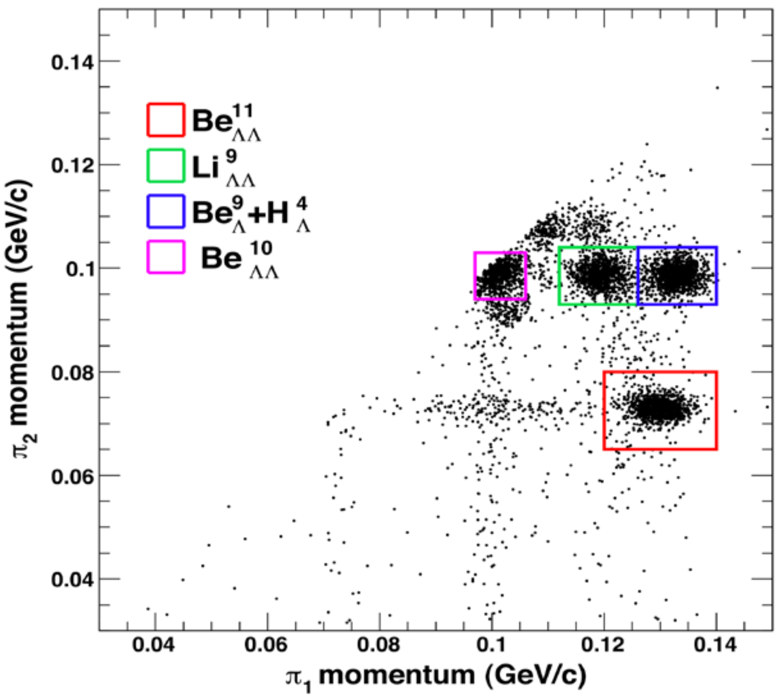
$\Rightarrow$Sequential mesonic decay

Need for a devoted detector setup

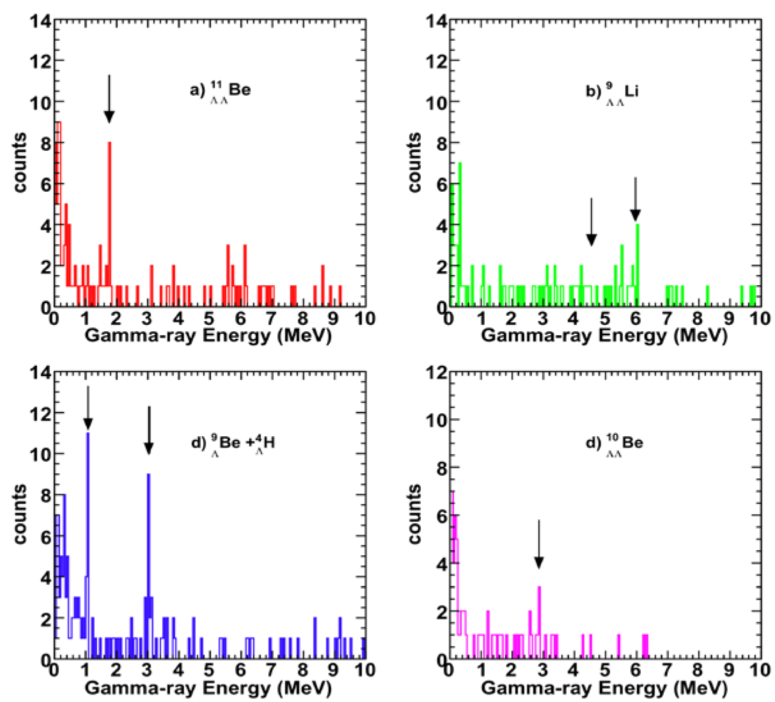
Identification of ΛΛ-Hypernuclei at PANDA

- Mesonic weak decay of the order of 10% of the total width
- Sequential mesonic decay of DHP releasing 2 pions
- 50 % data taking available
- Example: secondary ^{12}C target. Present Statistics runnig period ~ 2 weeks. Prob. Ξ Capture and Conversion ~ 5%. *(arXiv:0903.3905)*

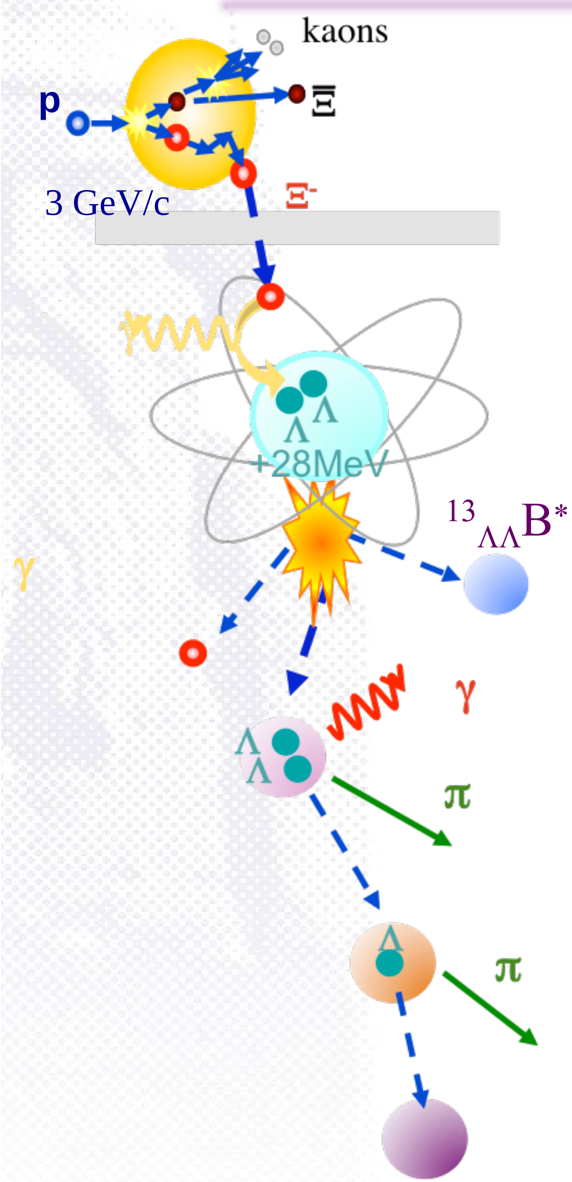
$\pi + \pi$ correlation



γ ray energy

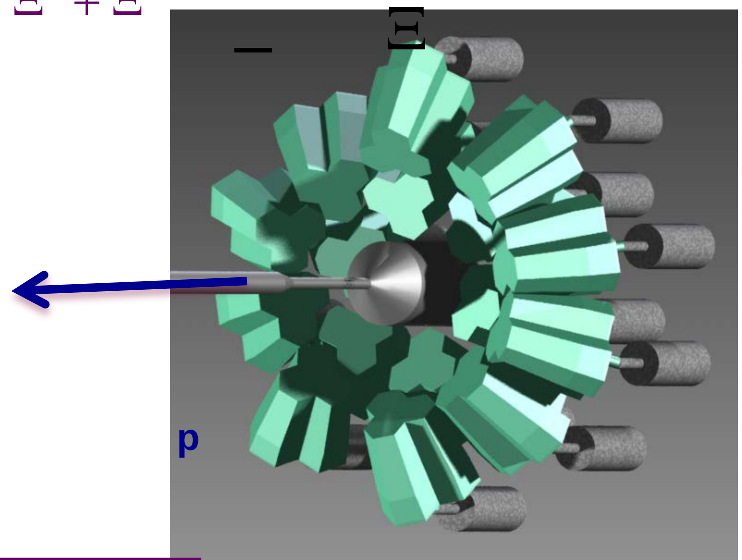


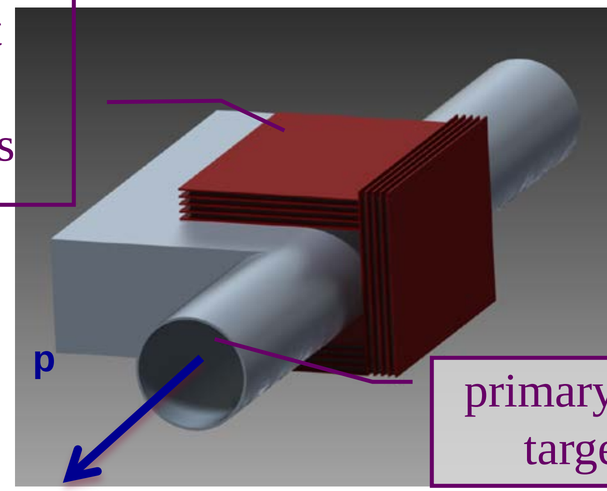
ΛΛ- Hypernuclei at Panda



$p + {}^{12}C \Rightarrow \Xi^- + \bar{\Xi}$

Array of HPGe



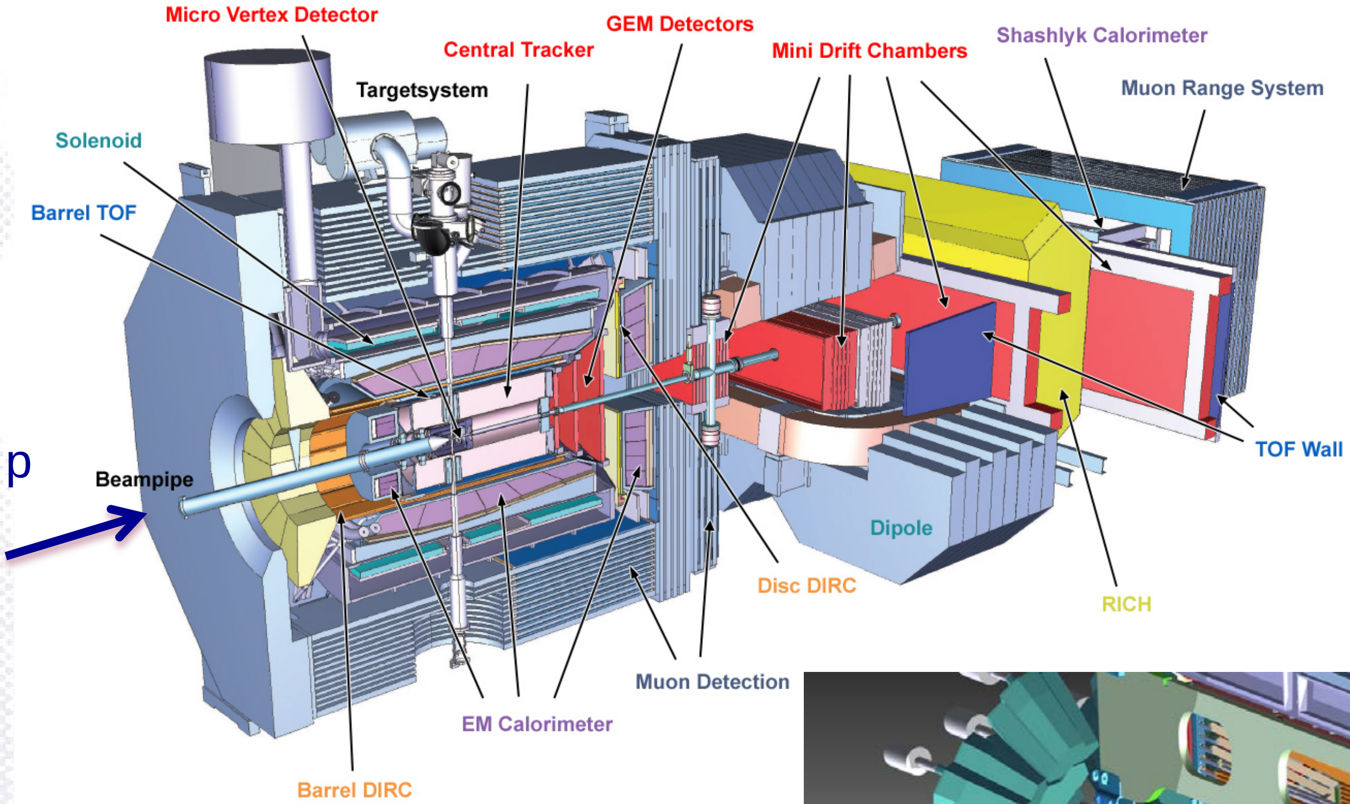


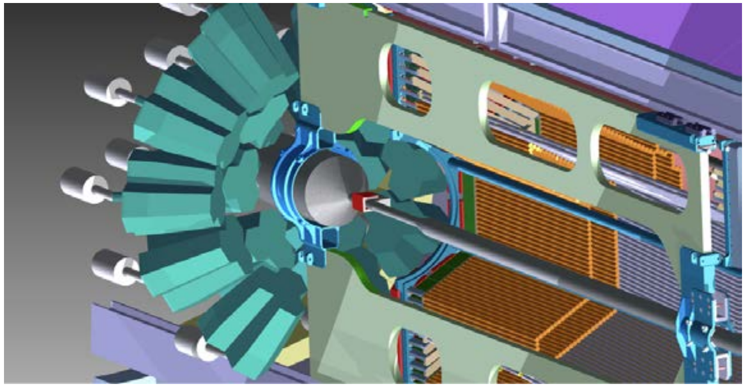
Active secondary target

Detector developments

- Integration in the PANDA spectrometer
- The Secondary Active Target
- The HPGe Array

Integration in the PANDA Spectrometer

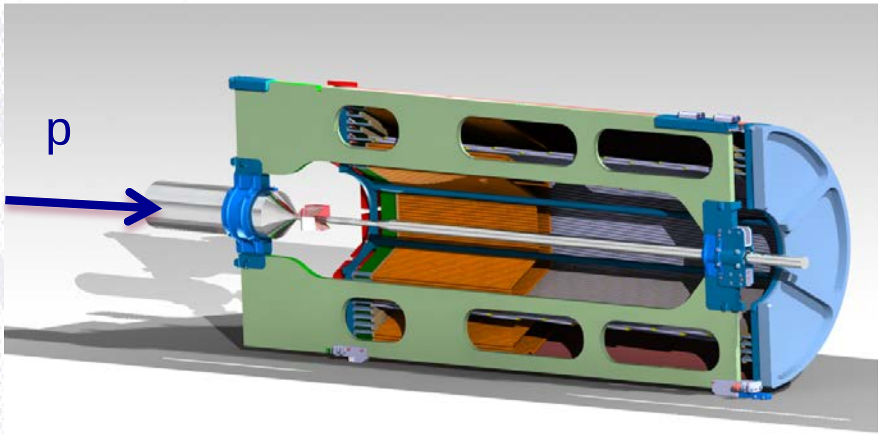


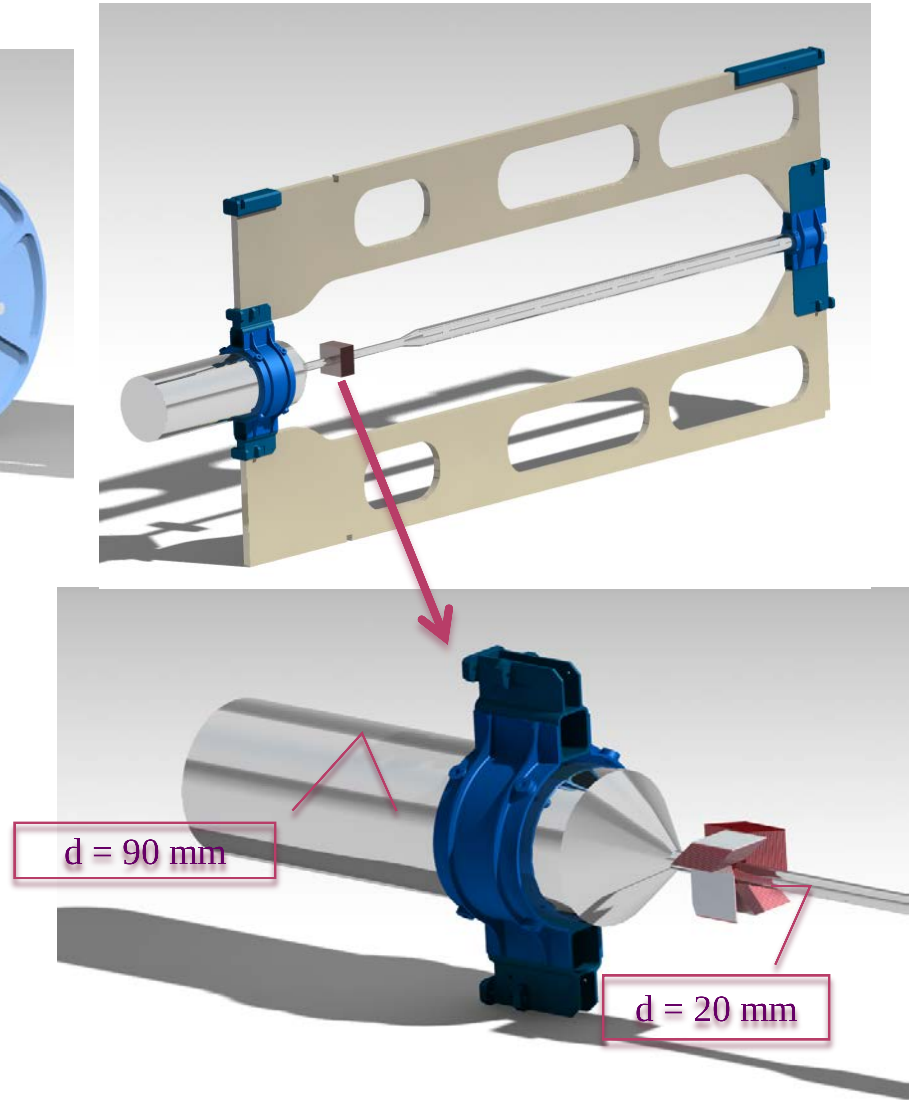


- Limited space inside the target spectrometer but

- Modular structure of PANDA
- Dedicated beam pipe system
- Backward End Cap EMC and MVD will not be used

Dedicated Beam Pipe system



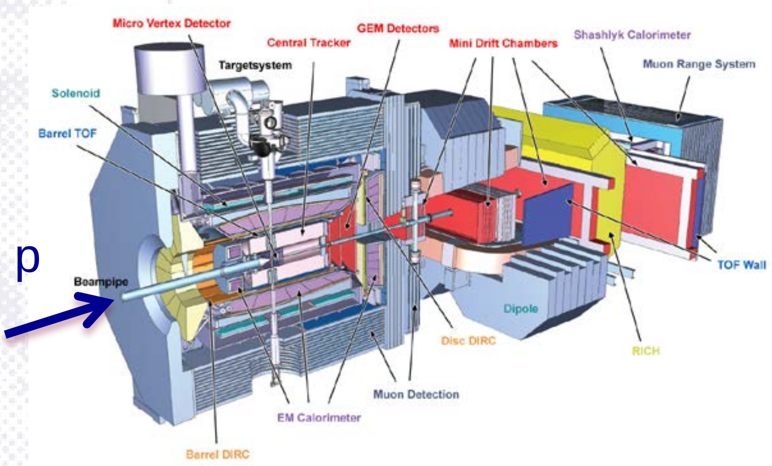


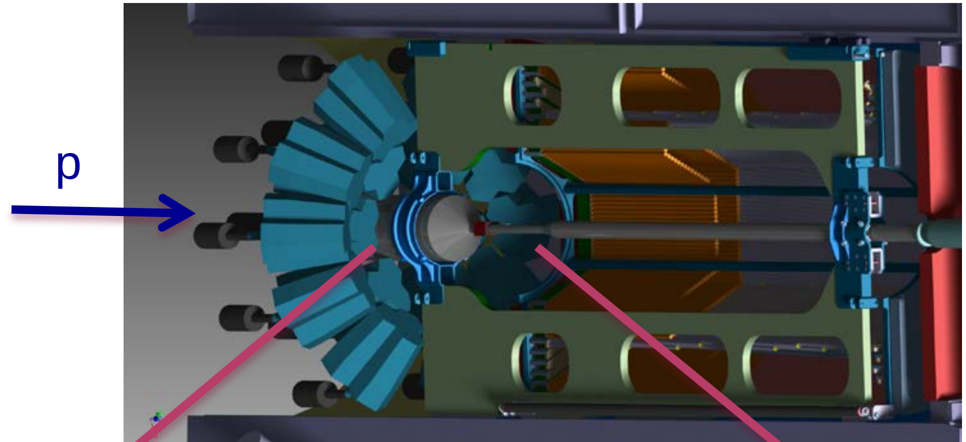
- Interaction Point
  - Primary target (wire /foil)
  - pipe thickness

- Central Tracker Frame
  - Elongated version (upstream)

by cortesy of D. Rodriguez

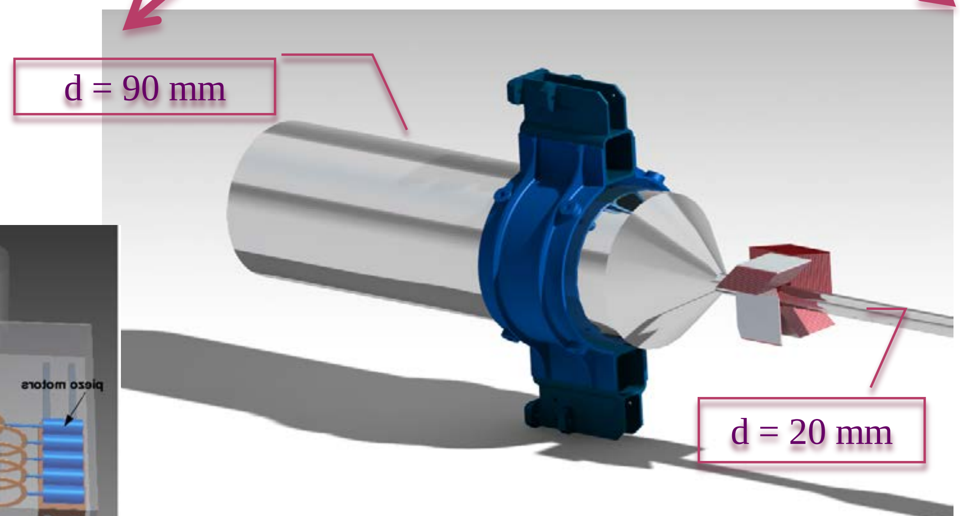
Dedicated beam pipe / target system

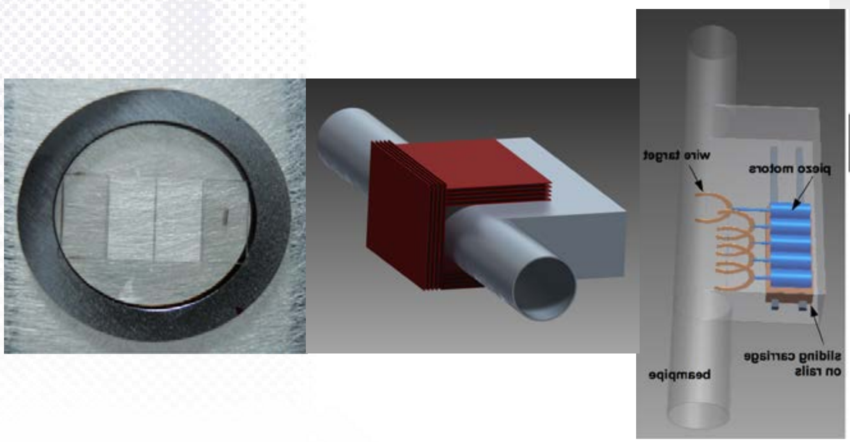




Backward End Cap Calorimeter
and MVD will be not used

- Modular structure
- Dedicated beam pipe/target system





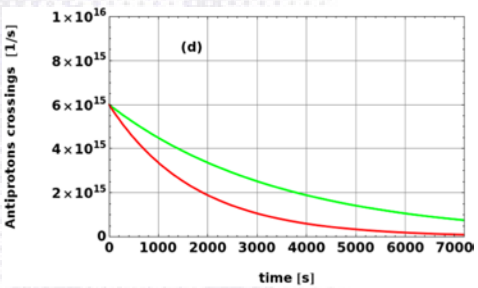
by cortesy of D. Rodriguez,
M. Steinen,
F. Iazzi and S. Bleser

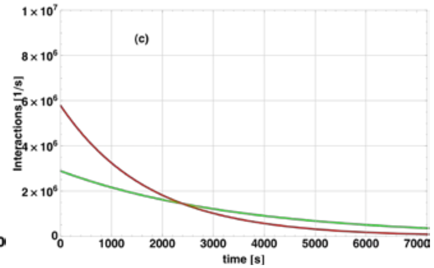
Primary target system

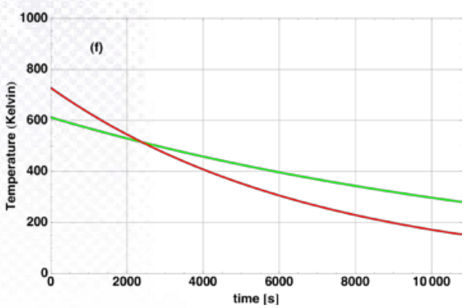
Large Production rate

- Average pbar rate 10^7
- beam losses -> Coulomb scattering
  ->thin target d = few μm

3 X 10^6 pbar/s -> stable behaviour of luminosity + target stability

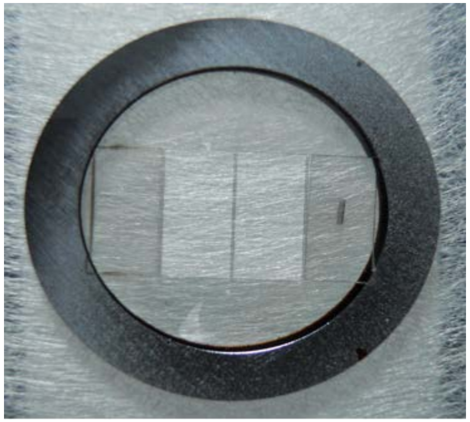




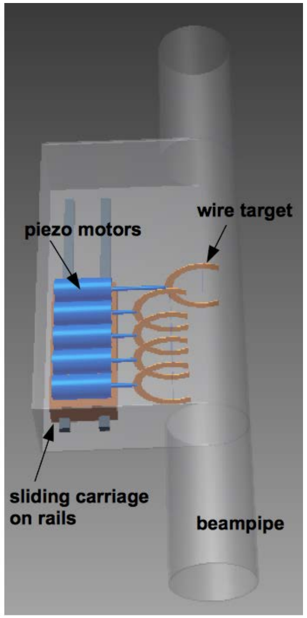


Insertion of the wire target (3 μm)into the beam pipe

- Piezo-motors
- steering of beam and target



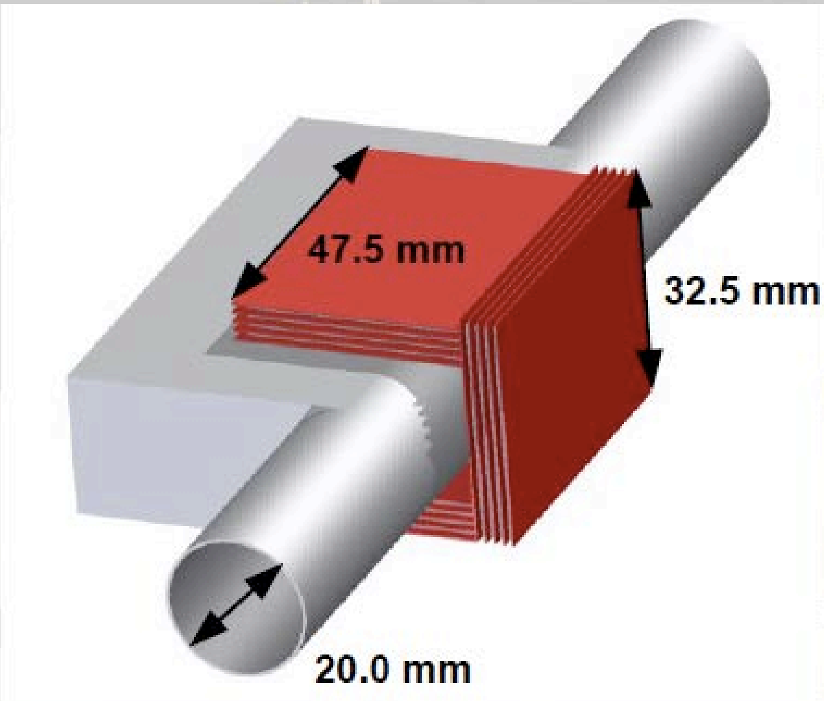
14 mm



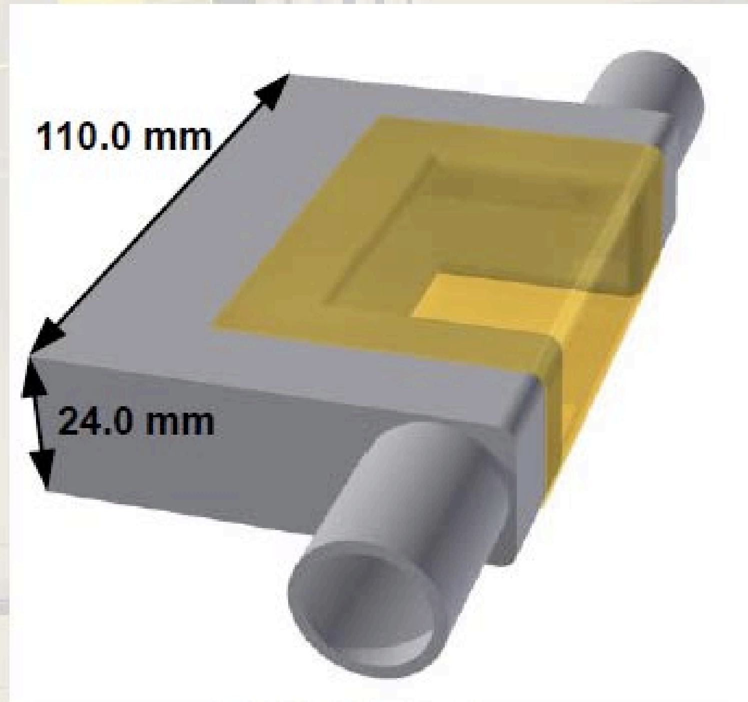
by cortesy of F. Iazzi and S. Bleser

Primary target system

Arrangement of DSSD-absorber-assemblies directly around the target chamber and beampipe → minimization of beampipe diameter



Minimization of material budget → reduction of thickness



by cortesy
S. Bleser

Primary target system

Target chamber development

Target chamber:

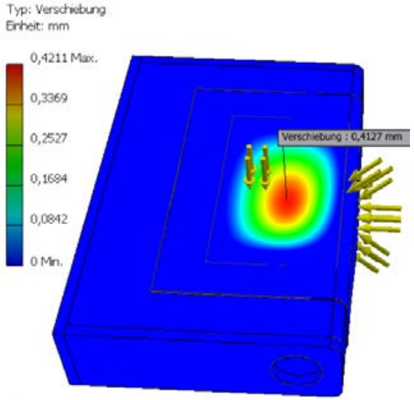
Aluminium, thickness 3 mm
110 mm x 72 mm x 24 mm
cut-out: 54 mm x 37 mm

Foil, 1st try:

Kapton, thickness 75 µm,
glued around the cut-out
for stability test

Vacuum flange

Stainless steel, 16 mm outer diameter,
glued to target chamber by „UHU Endfest 300"

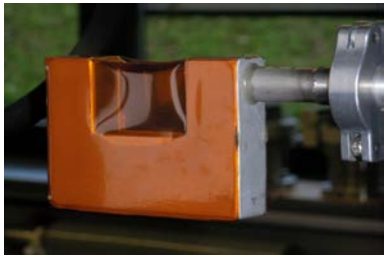


Finite element analysis
of a 0.5 mm thick titan disk
on an aluminium frame

First evacuated target chamber model with a thin wall thickness in the sensor area for less Ξ^- stopping:

75 µm Kapton foil glued on an aluminium frame

→ further stabilization necessary



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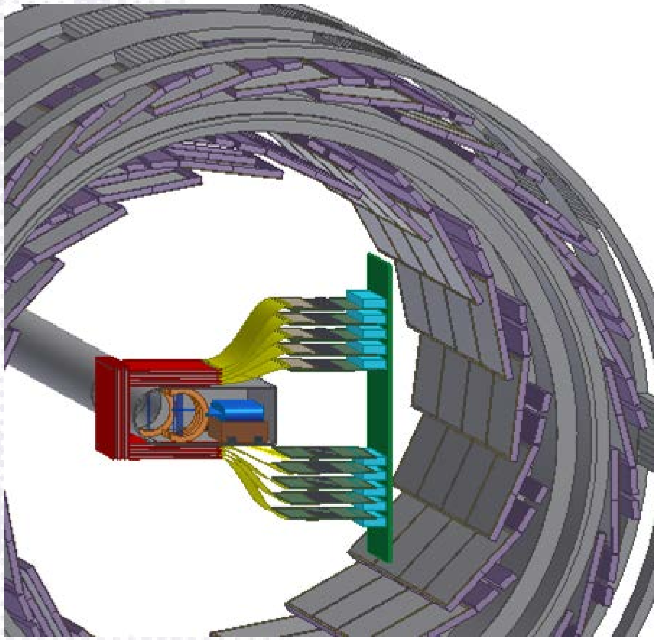
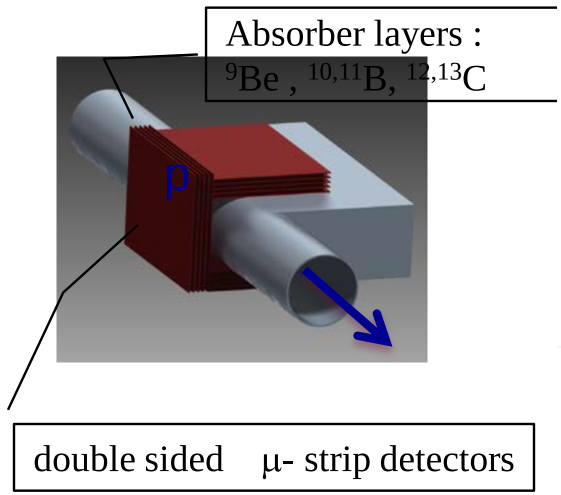
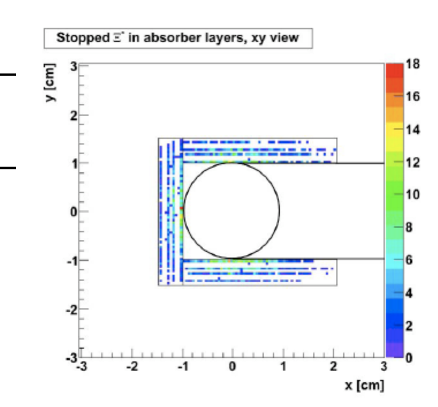
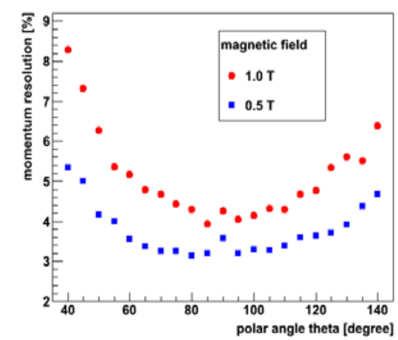
The Secondary Active Target

- Compact Structure of detector and absorber:
  - Performance of Silicon Strips Detector in direct contact with absorbers









by cortesy
S. Bleser

- Ongoing projects:

  Space required for frontend electronics:
  - Minimization of additional material budget on detecting volume:
  - Ultra-thin Al-Polyimide readout cables

  J.M. Heuser et al. HadronPhysics2/JRA-ULISI

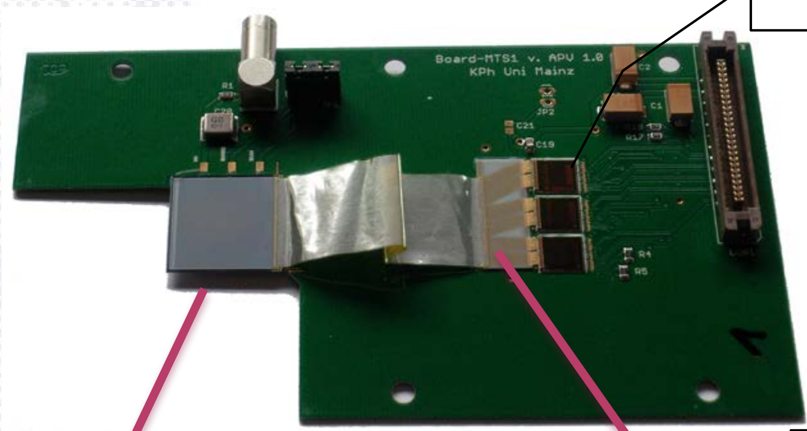
Effect of microcables on detector analog signals

by cortesy of S. Bleser and SERSTII

- Secondary Active Target :
  - Fan out of the readout electronics.
    - Sensors and readout boards connected by Ultra-thin microcables via TAB bonding.

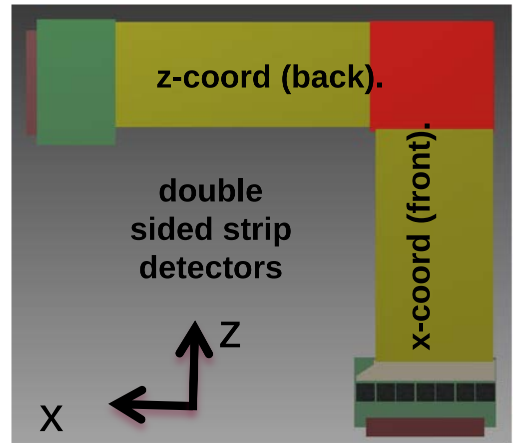
- Readout boards hosting pitch adapter, frontend chips and connector.

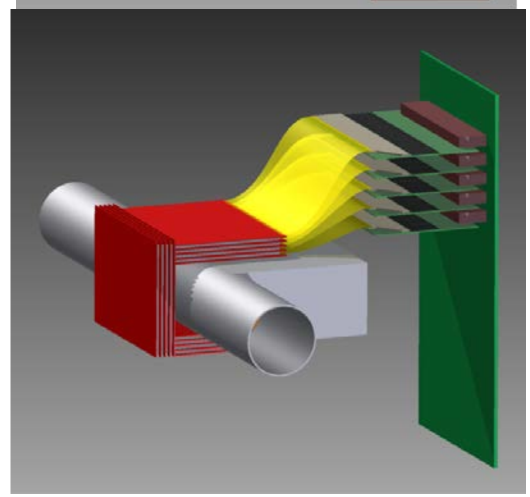
APV-25 chips



Si μ–strip sensor
20 x 20 mm
Pitch 50 um

Pitch Adapter

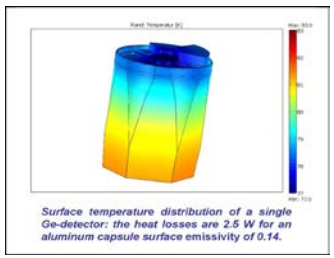


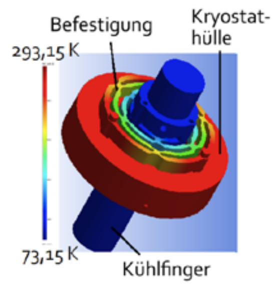


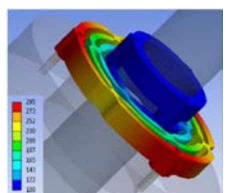
Toward a prototype of HPGe Cluster Array

- Limited space :

  Recent activities : X- Cooler system
  - Influence on Ener. Resolution
  - cooling efficiency for a double and triple cluster detector.







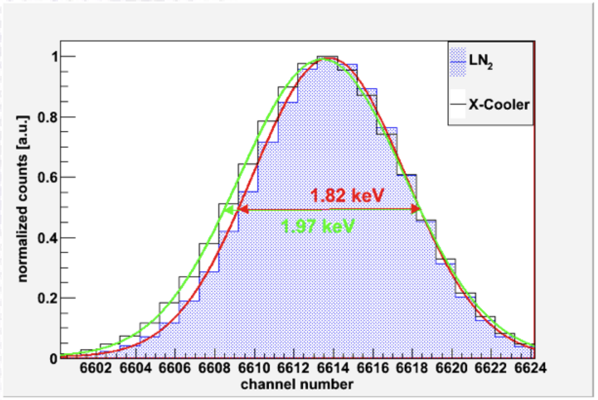
- Ongoing activities: High Rate environment:
  - Radiation Damage studies with a prototype
  - Pile-Up effects
  - Pulse shape analysis

HPGe encapsulated crystal attached to the X-Cooler

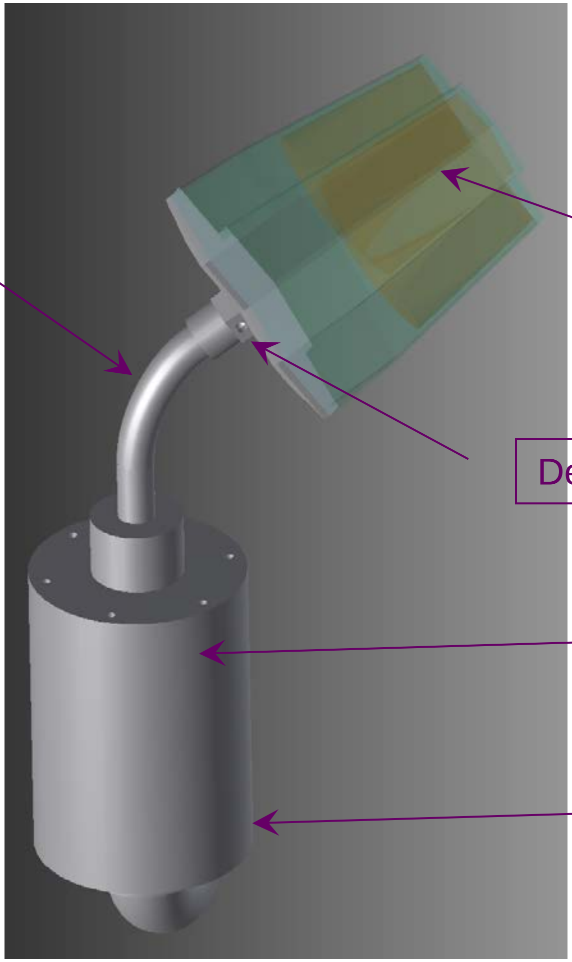
by cortesy of M. Steinen and I. Kojoujarov

Further considerations concerning the X-Cooler

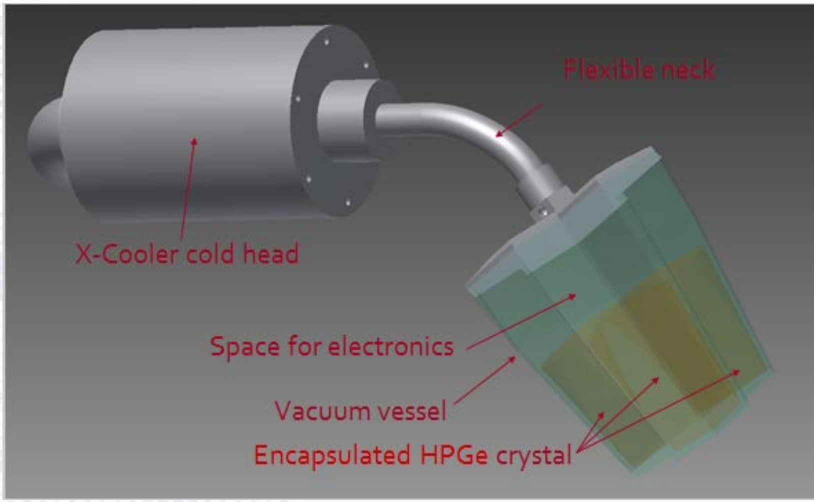
Influence of X-Cooler device on the energy resolution



by cortesy of M. Steinen and I. Kojoujarov



Further considerations concerning the X-Cooler



by cortesy of M. Steinen and I. Kojoujarov

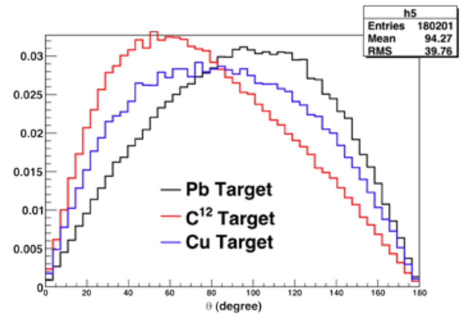
X-Cooler Head, partiallly hidden inside the electronics chamber

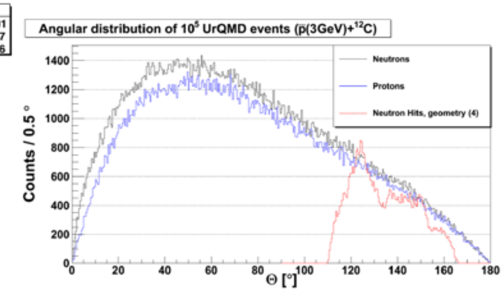
Prototype for a single Euroball Crystal cooled electromechanically

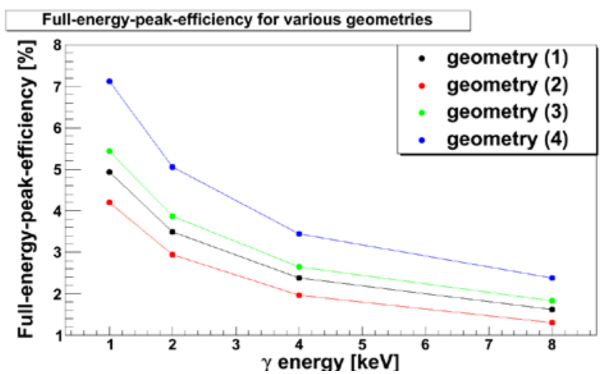
Optimization of the geometrical acceptance

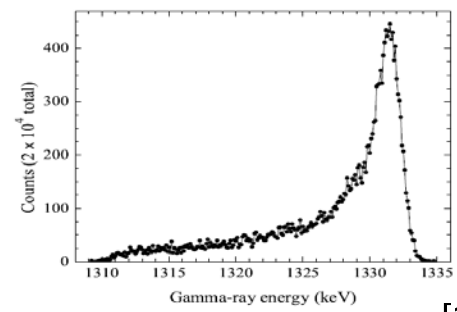
Effect of hadronic background from
primary interaction
at backward angles

by cortesy of M. Steinen









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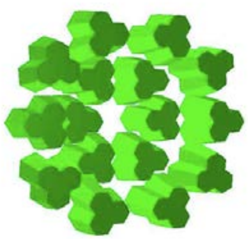
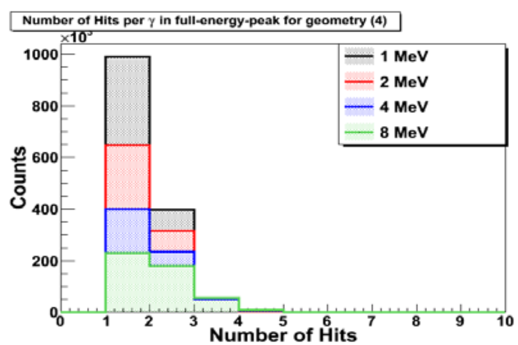
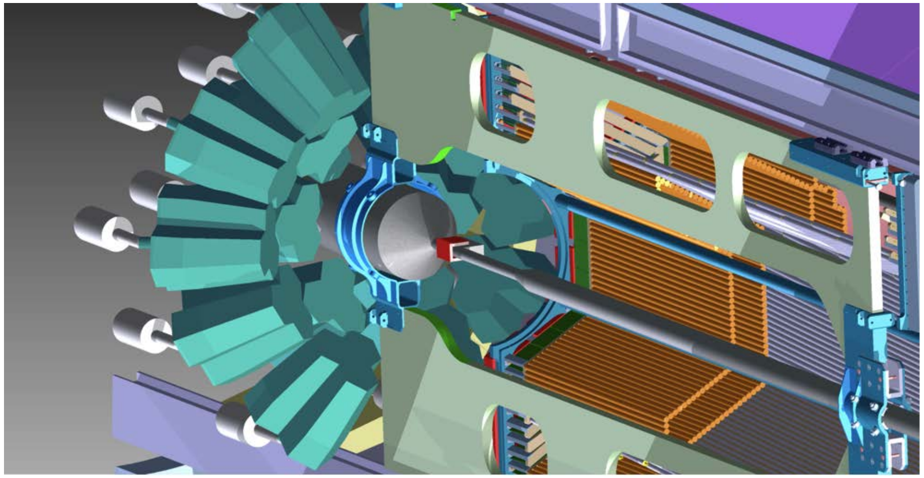
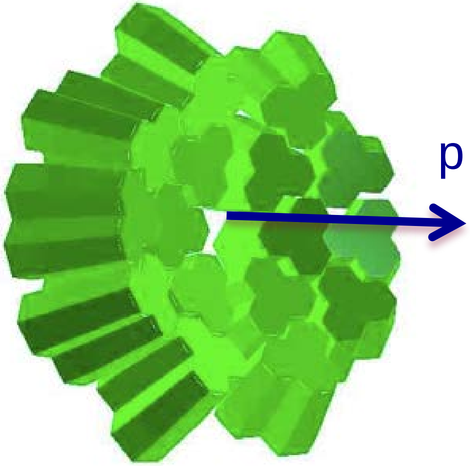


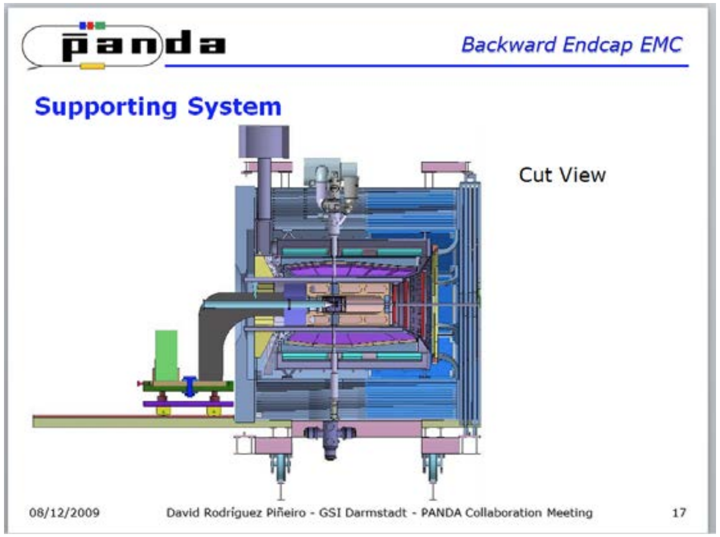


The germanium crystals will suffer a high background of thermal neutrons inside the PANDA spectrometer. This background is simulated using UrQMD generated events. The maximum neutron load per crystal for geometry (4) is 12 kHz. At the expected reaction rate of $2 \cdot 10^6$ Hz this results in $3.4 \cdot 10^9$ n/cm^2 after 100 days of irradiation with a duty cycle of 0.5.

HPGe Array integration inside PANDA







OUTLOOK

- Ongoing activities:
  - Tracking of low momentum particles : GEANE
  - Background influence at backward angles : URQMD and GiBUU
  - detector response treated accordingly
  - Optimization of the whole geometry by means of simulation studies.