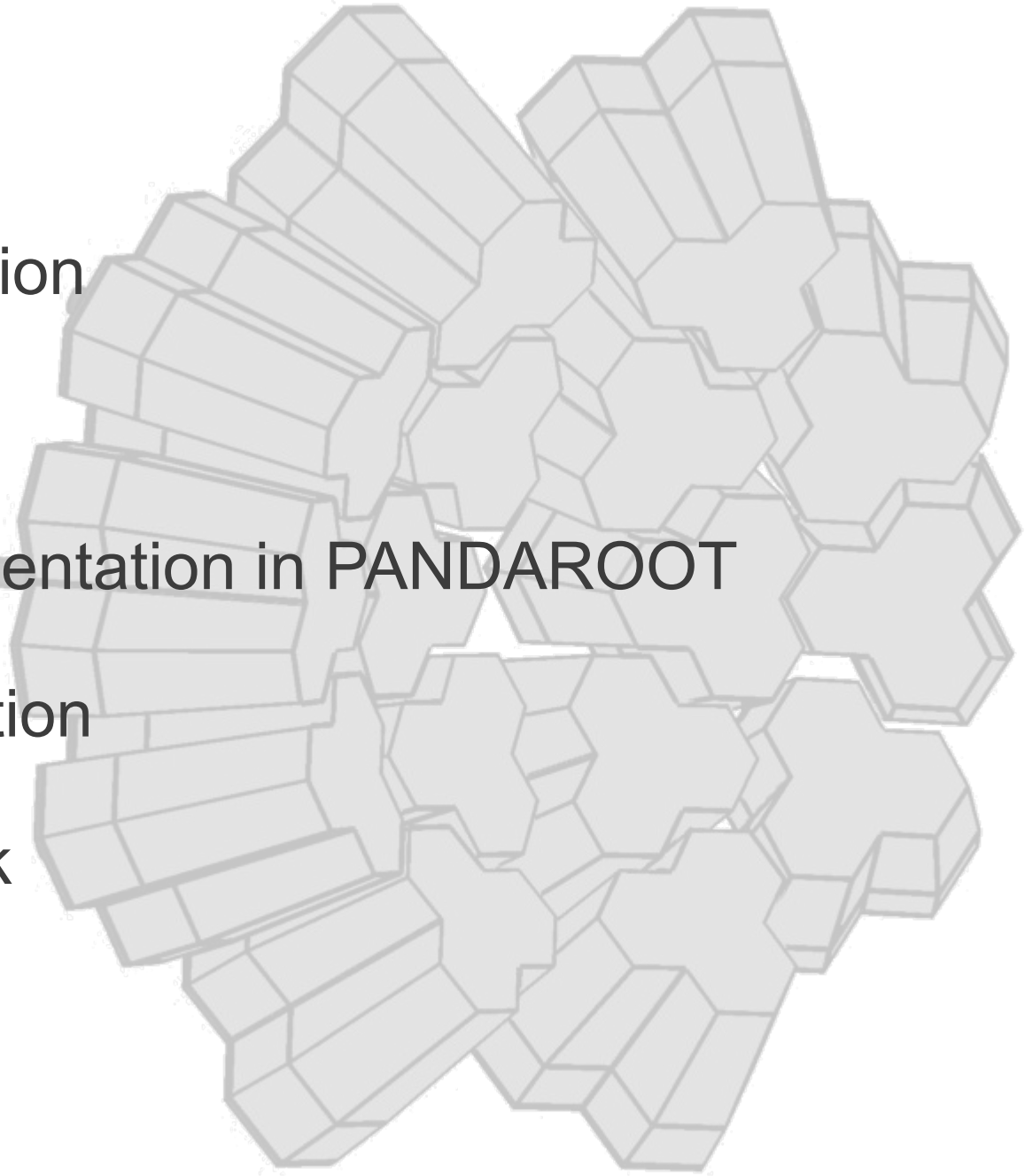
# HPGe Array Detector

Marcell Steinen



# Outline



Motivation

Design

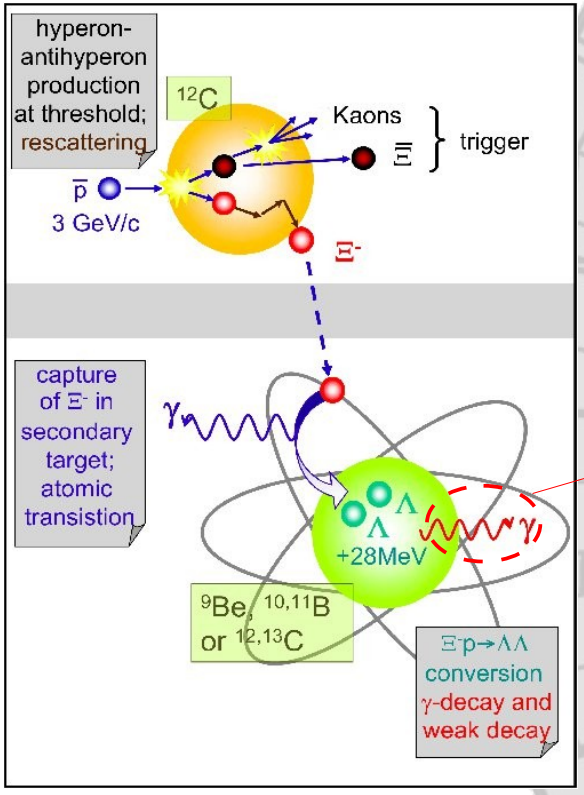
Implementation in PANDAROOT

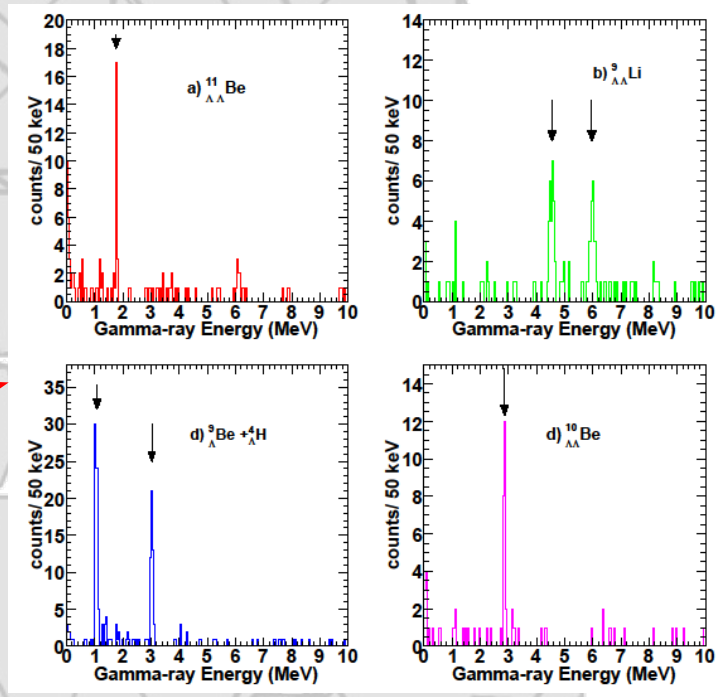
Simulation

Outlook

# Motivation

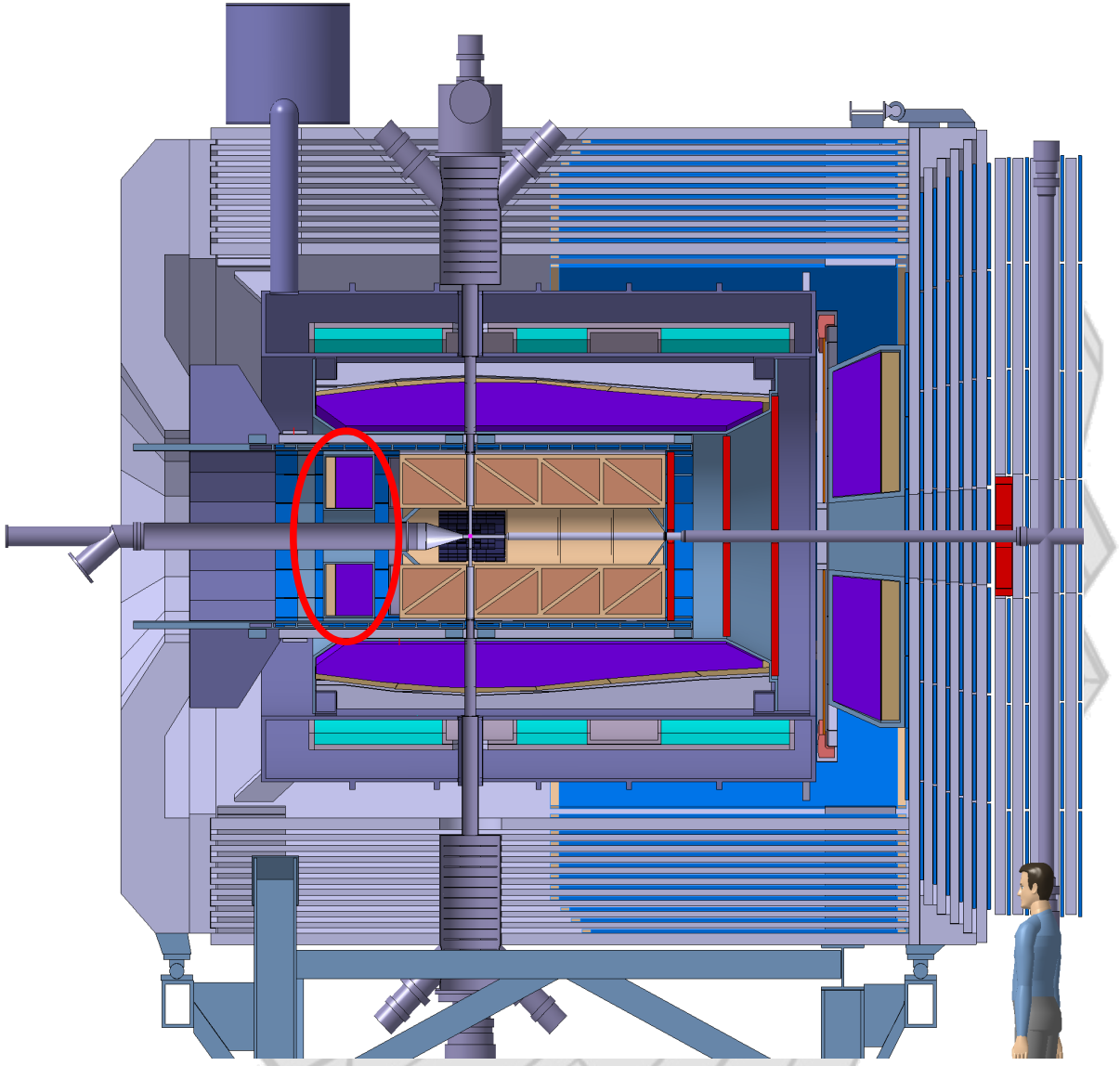
## Why do we need such a detector?



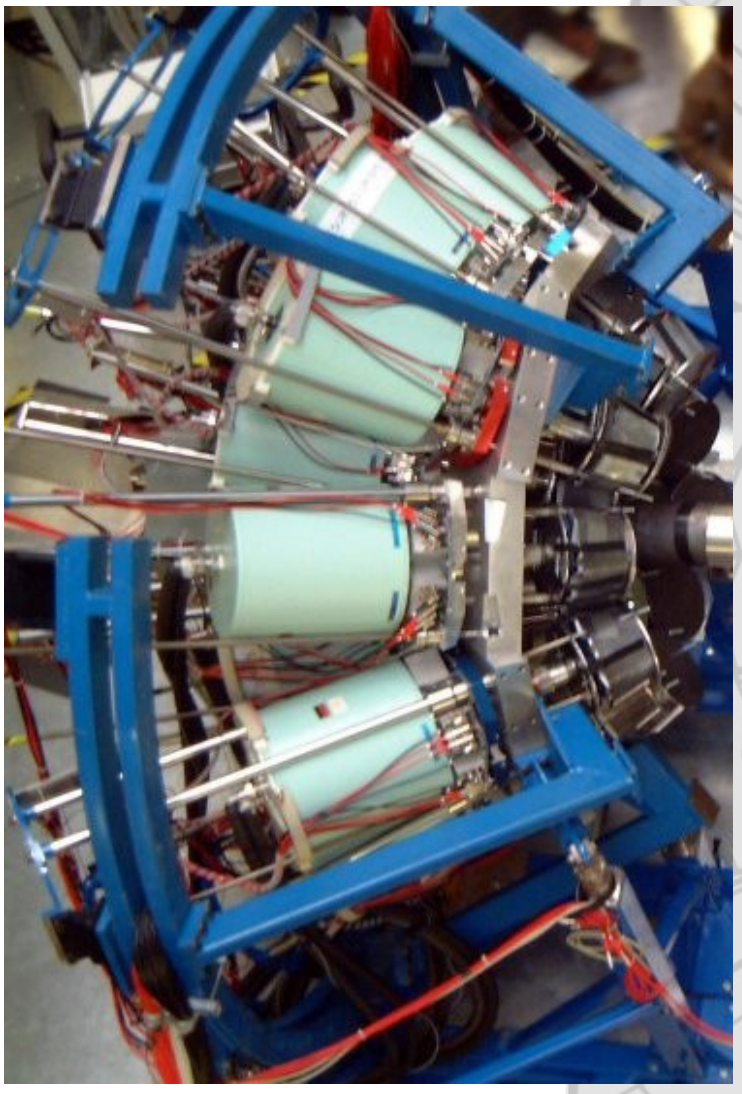

Energy levels in the range of 1 to 8 MeV
→ High precision needed!
low statistics compared to background
→ Background must be minimized

# Integration of the germaniums in PANDA



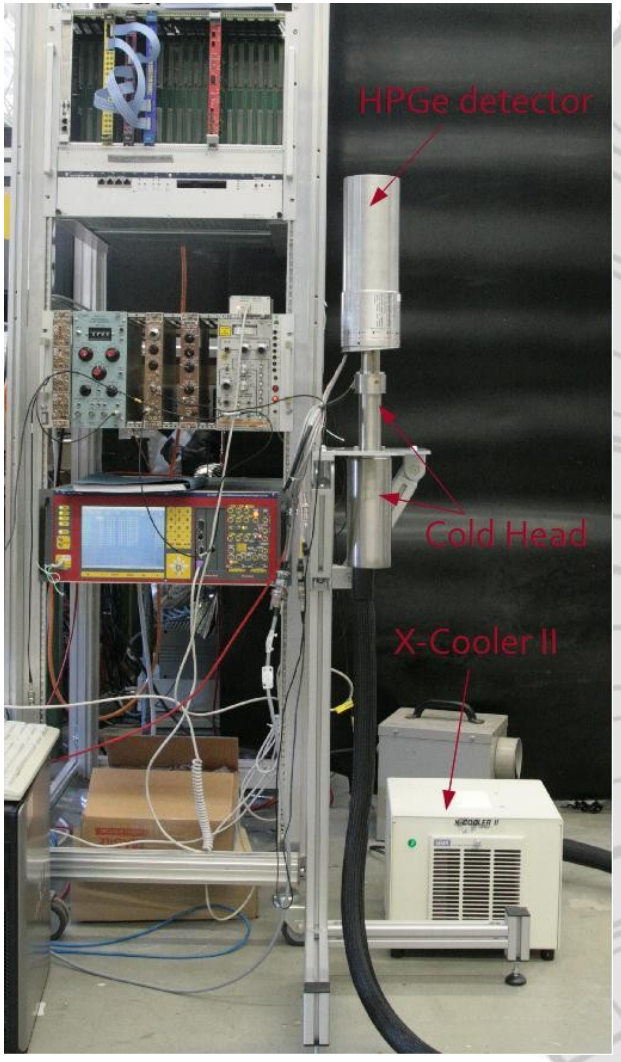
Germaniums must be inside the DIRC
Germaniums in backward direction

# Present Detectors



EUROBALL (RISING@GSI)
Too bulky due to LN2 cooling,
doesn't fit inside of the DIRC

# Solution

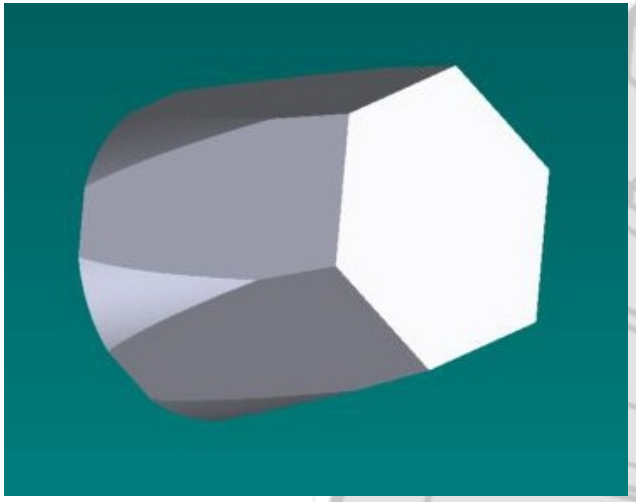



Electro-mechanical cooler:
Ortec X-Cooler II

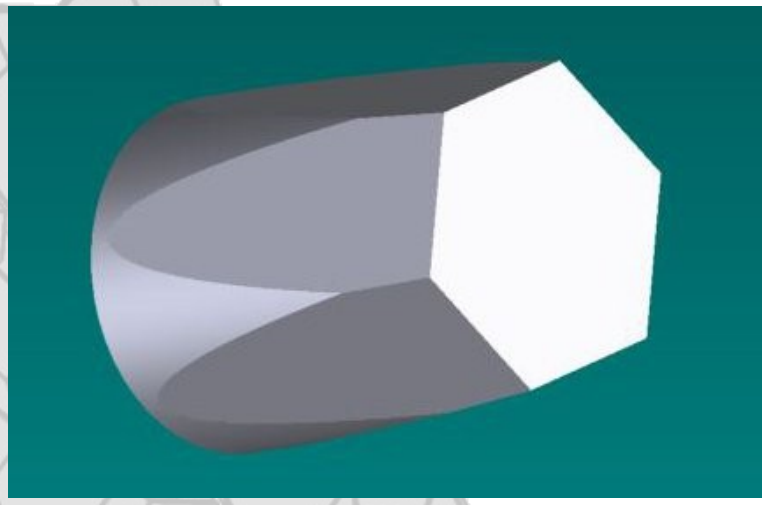
Detectors in backwards angles
→ Coolers can be placed outside of the spectrometer

Limited cooling power
→ Number of crystals per cryostat must be reduced

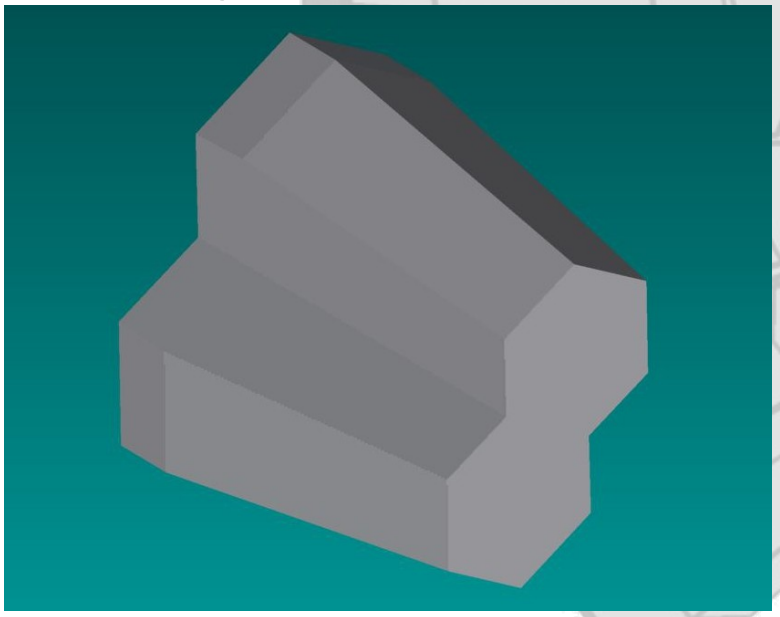
# New Design needed!



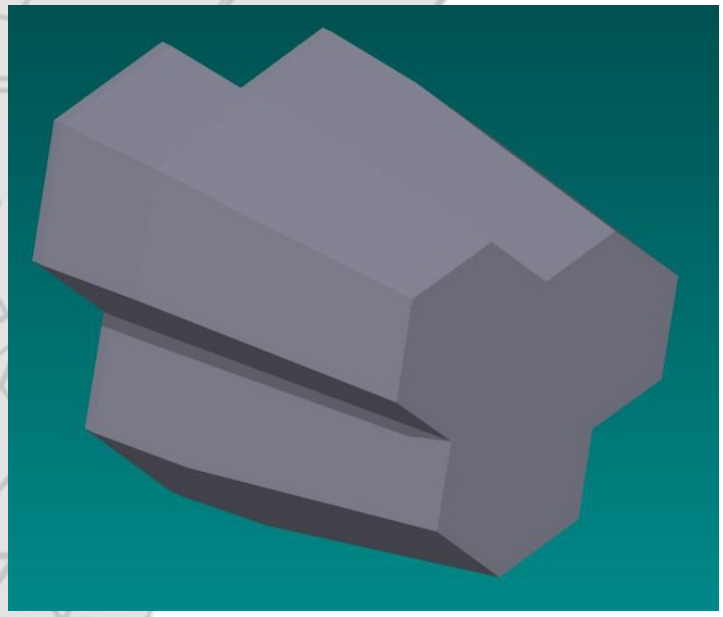
Ge crystal



Al encapsulation

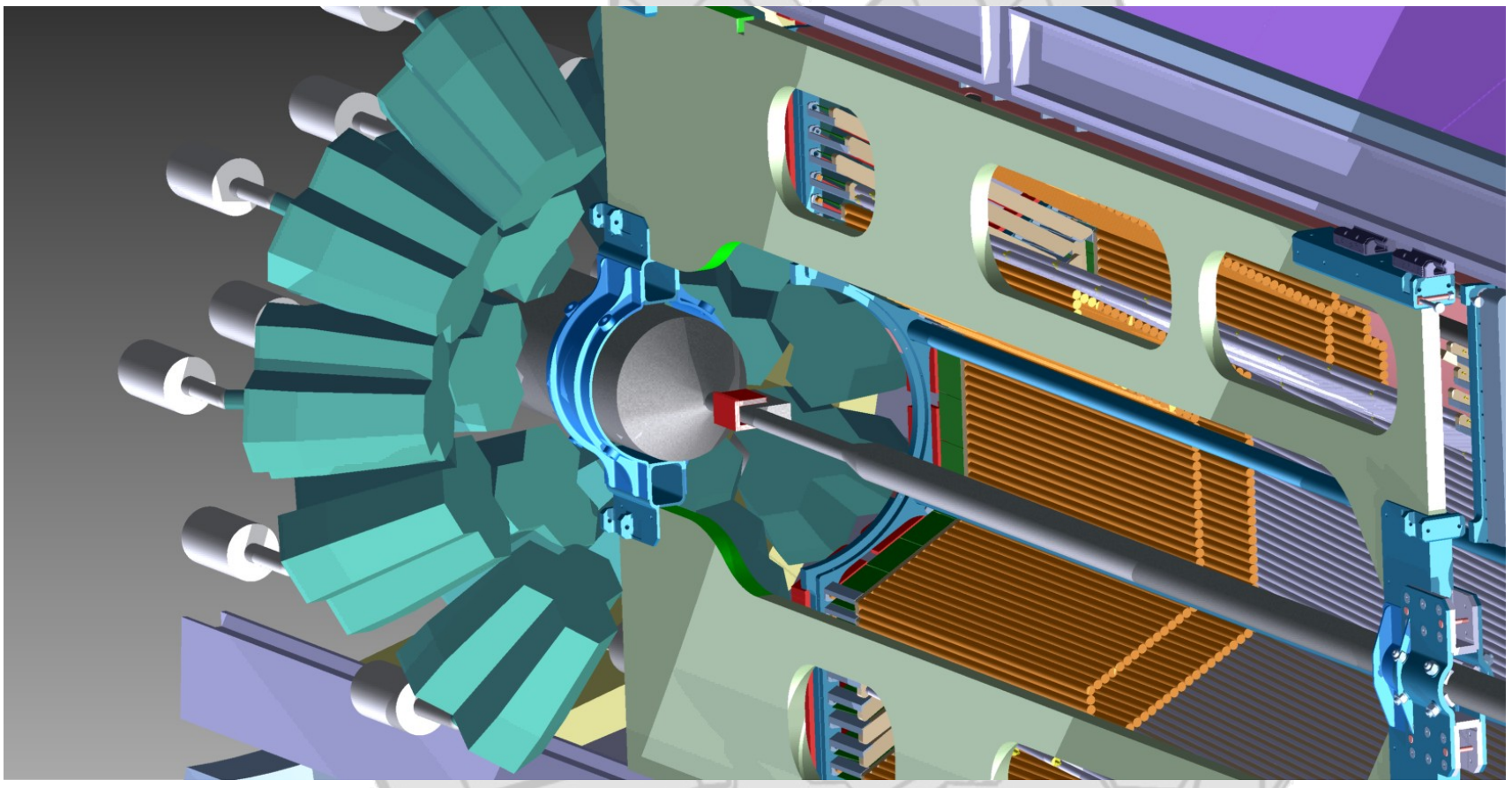


Double detector



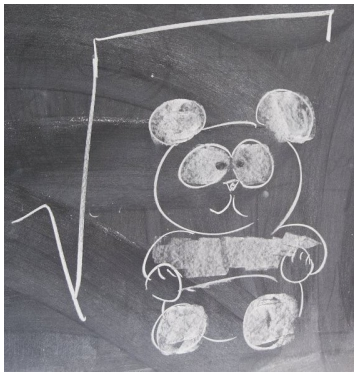
Triple detector

# Integration of the germaniums in PANDA



Outer Radius of ~40 cm (STT cabling?)
Backward Endcap EMC and MVD removed
CT frame and beampipe modified

# Implementation in PANDAROOT



Mamen in Torino

Geometry is too complex for CADconverter (I tried!)

Must be build by hand using ROOT classes

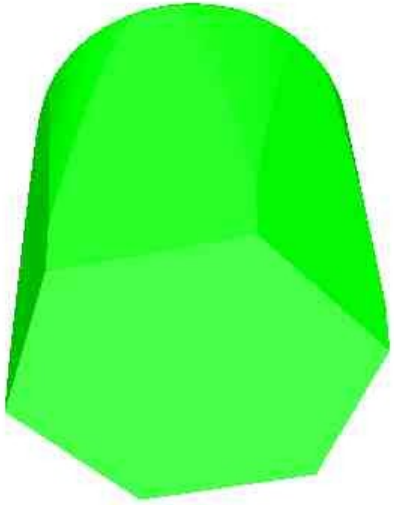
New classes in LibHypGe:

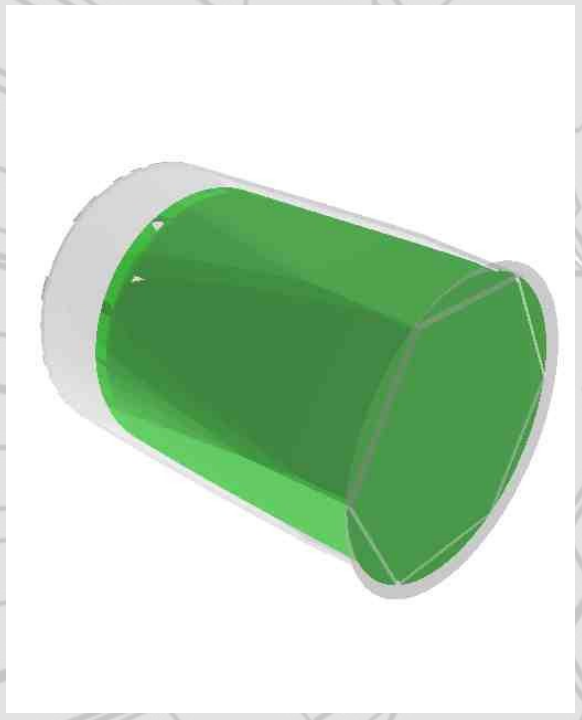
PndGeoHypGeBase
**PndGeoHypGeCrystal** (encapsulation included)
PndGeoHypGeCluster
**PndGeoHypGeDoubleCluster**
**PndGeoHypGeTripleCluster**

(not yet in the trunk, development/steinen, sorry)

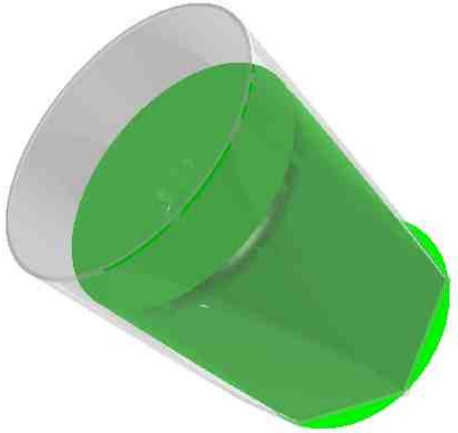
# Implementation in PANDAROOT

PndGeoHypGeCrystal





ogl viewer strikes back ...



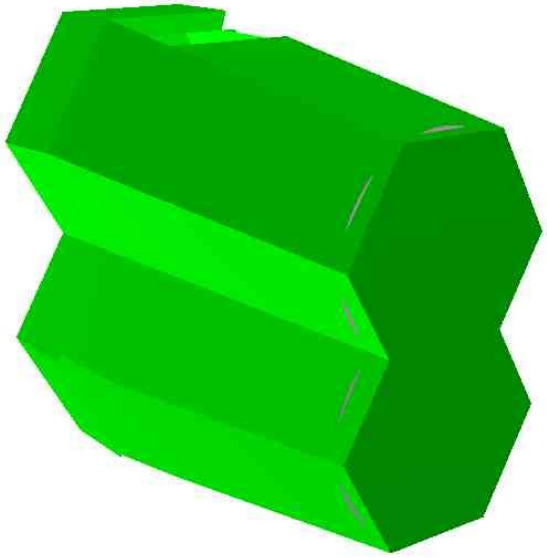
ogl viewer strikes back ...

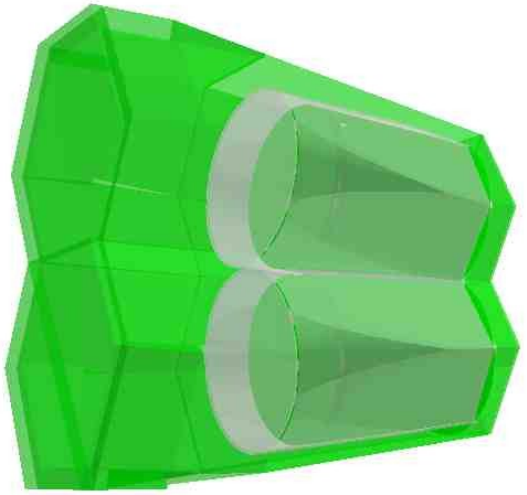
EUROBALL HPGe crystal in aluminium capsule

Tapered shape is created by substracting a TGeoPgon of a TGeoTube

# Implementation in PANDAROOT

PndGeoHypGeDoubleCluster



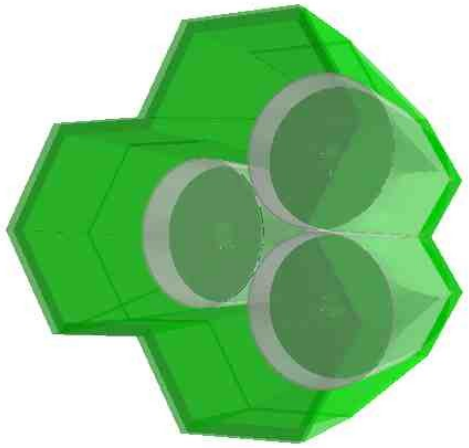


ogl viewer strikes back ...

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)

# Placing the detectors

In both classes, placement of detectors is achieved via PlaceCluster method

By an external TGeoMatrix

```
void PlaceCluster(TGeoVolume *top,
    TGeoMatrix*ClusterPlaceAndDirectionTranslation,Int_t *CrystalNumber);
```

By coordinates and euler angles

```
void PlaceCluster(TGeoVolume *top, Double_t x, Double_t y, Double_t z,
    Double_t GlobalZOffset , Double_t phi, Double_t theta, Double_t psi,Int_t
    *CrystalNumber);
```

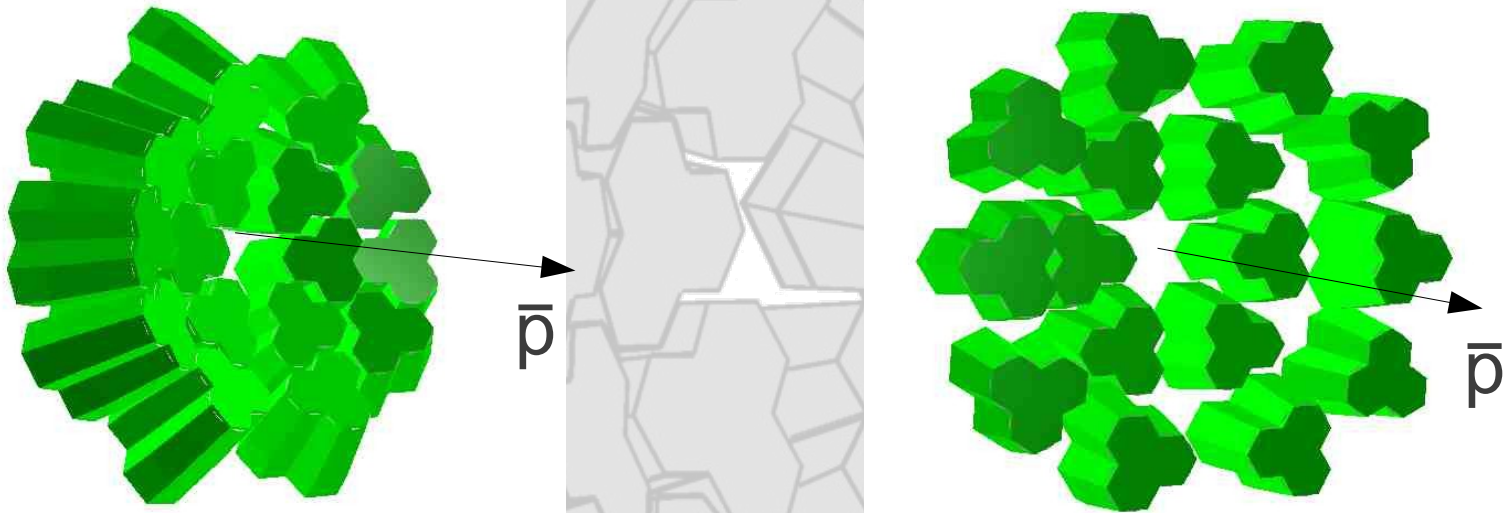
On a sphere by euler angles and radius

```
void PlaceCluster(TGeoVolume *top, Double_t GlobalZOffset, Double_t Radius ,
    Double_t phi, Double_t theta, Double_t psi,Int_t *CrystalNumber);
```

# Placing the detectors

## Example:

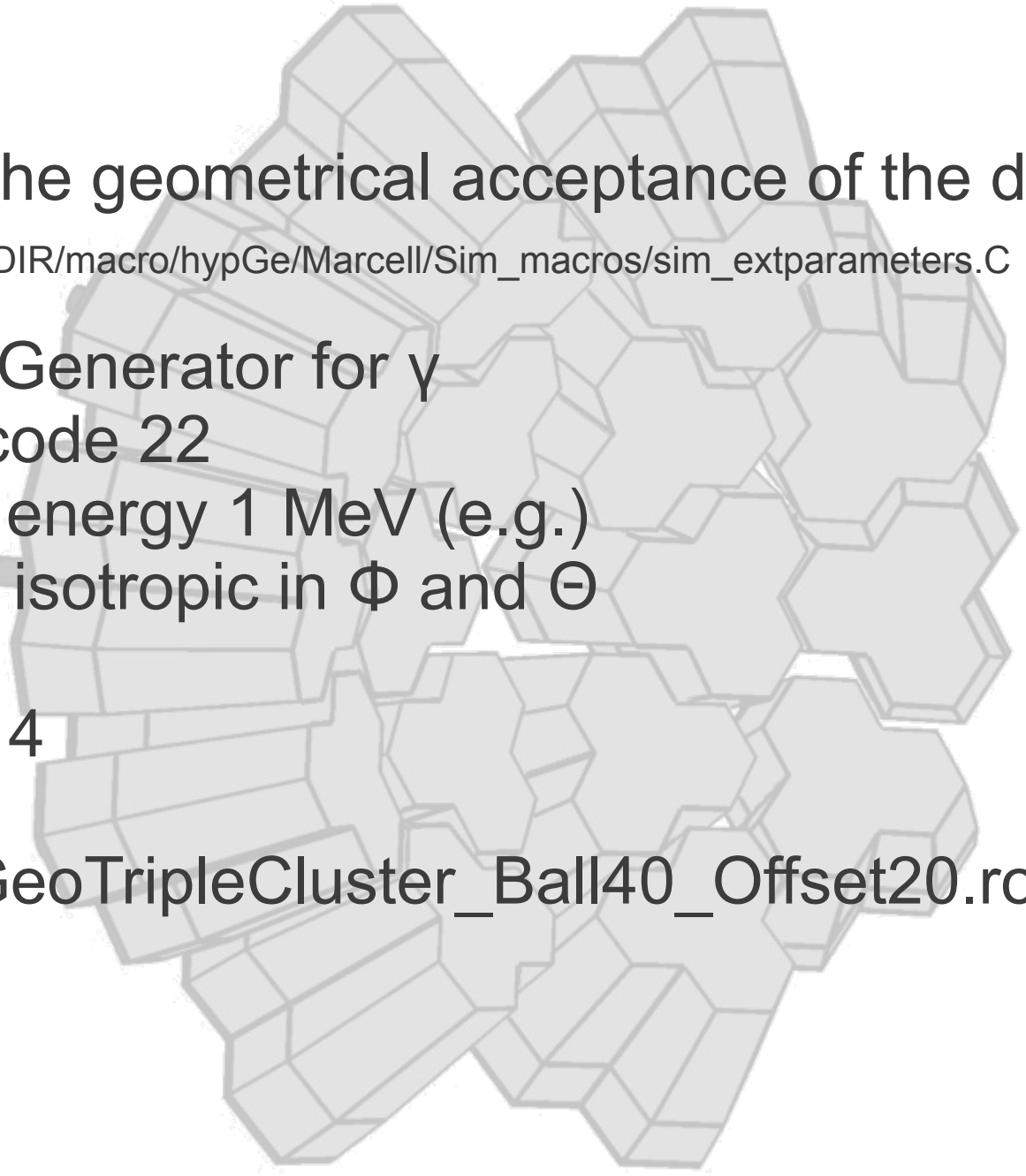
Macros in $VMCWORKDIR/macro/hypGe/Marcell/Geometry
root files in $VMCWORKDIR/geometry




hypGeGeoBuilderTripleBall40Offset20Geometry.C
hypGeGeoTripleCluster_Ball40_Offset20.root

hypGeGeoBuilderTripleStraightGeometry.C
hypGeGeoTripleCluster_Straight.root

# Event simulation



## Example:

testing the geometrical acceptance of the detectors

$VMCWORKDIR/macro/hypGe/Marcell/Sim_macros/sim_extparameters.C

PndBoxGenerator for γ

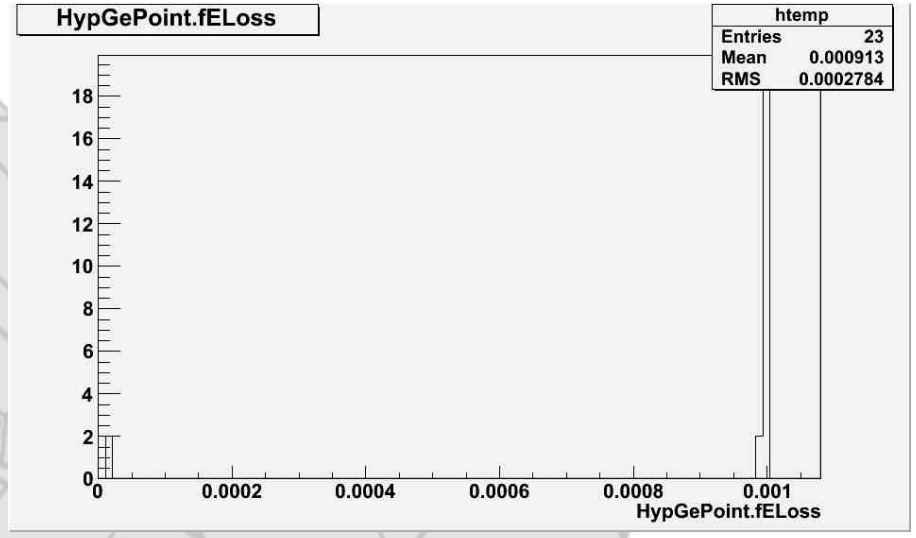
- pdg code 22
- fixed energy 1 MeV (e.g.)
- $10^7$ γ isotropic in Φ and Θ

GEANT 4

hypGeGeoTripleCluster_Ball40_Offset20.root

# Event simulation

## Empty spectrum! Why?




GEANT Settings

$VMCWORKDIR/gconfig/SetCuts.C

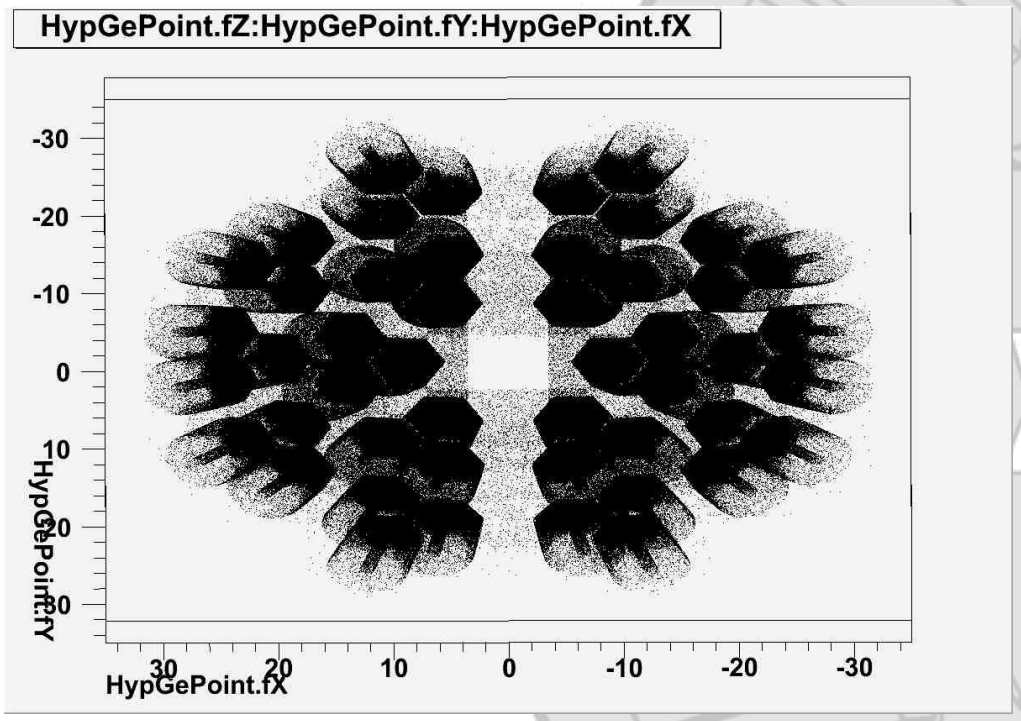
```
34  gMC->SetProcess("MULS",1); /**multiple scattering*/
35
36  Double_t cut1 = 1.0E-3;          // GeV --> 1 MeV
37  Double_t cutb = 1.0E4;           // GeV --> 10 TeV
38  Double_t tofmax = 1.E10;         // seconds
39  cout << "SetCuts Macro: Setting cuts.." <<endl;
40
41  gMC->SetCut("CUTGAM",cut1);    /** gammas (GeV)*/
42  gMC->SetCut("CUTELE",cut1);    /** electrons (GeV)*/
```

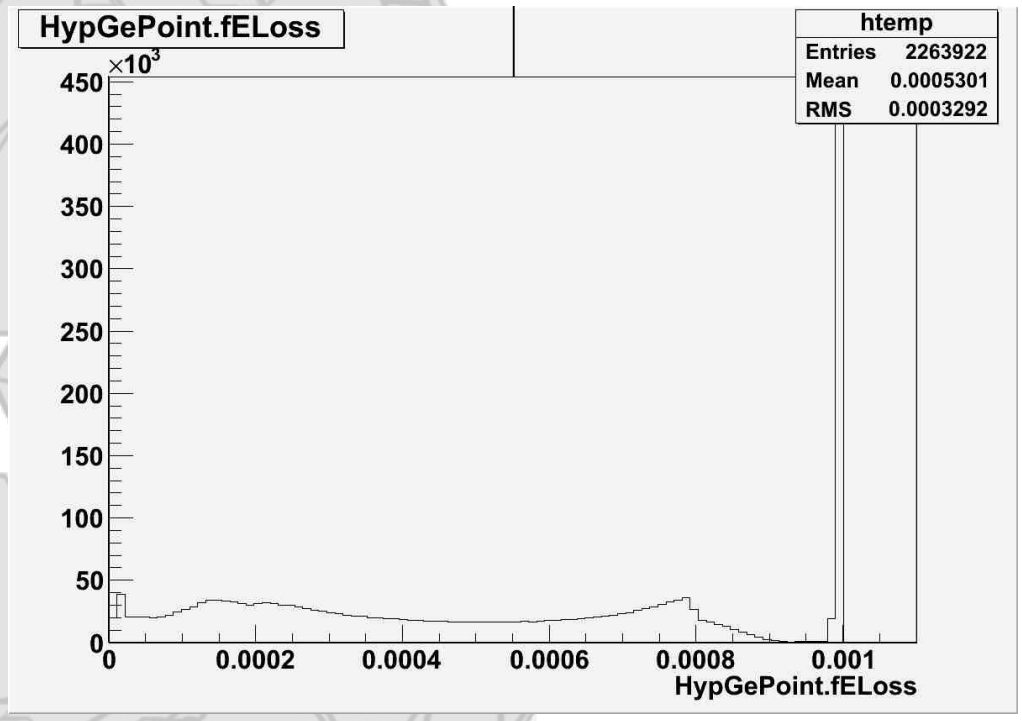
Low energy photons

Present energy threshold must be modified!

```
33  gMC->SetProcess("LOSS",1); /**energy loss*/
34  gMC->SetProcess("MULS",1); /**multiple scattering*/
35
36  Double_t cut1 = 1.0E-3;          // GeV --> 1 MeV
37  Double_t cut2 = 1.0E-5;          // GeV --> 0.01 MeV
38  Double_t cutb = 1.0E4;           // GeV --> 10 TeV
39  Double_t tofmax = 1.E10;         // seconds
40  cout << "SetCuts Macro: Setting cuts.." <<endl;
41
42  gMC->SetCut("CUTGAM",cut2);    /** gammas (GeV)*/
43  gMC->SetCut("CUTELE",cut1);    /** electrons (GeV)*/
```

# Event simulation




Interaction point with the crystals

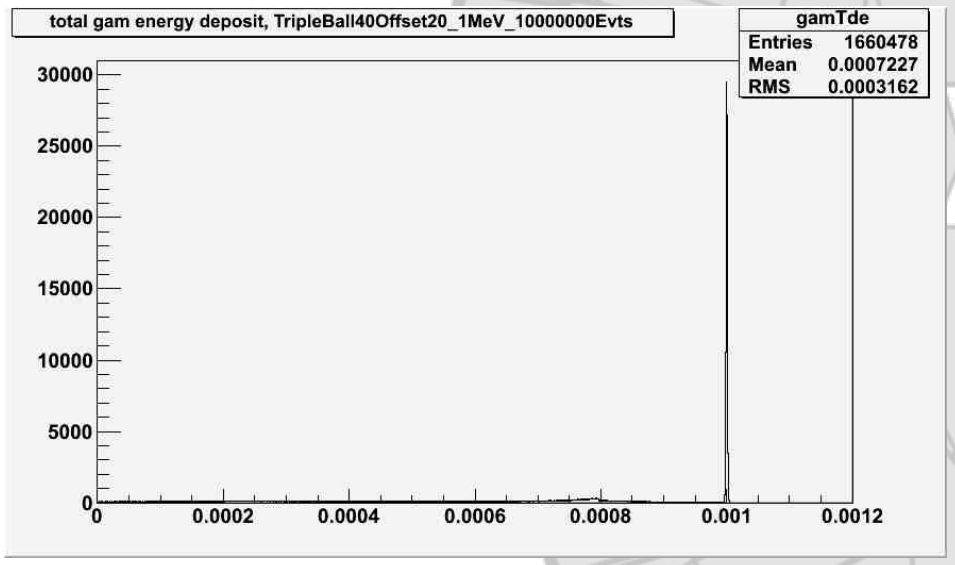
Energy loss per interaction with the crystals

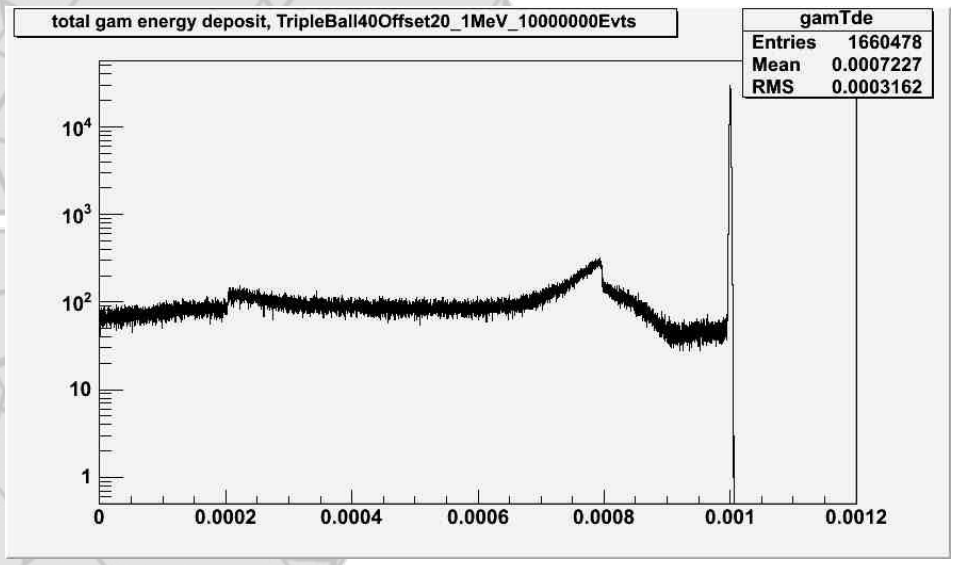
# Analysing the pseudo data

Make a spectrum of the full energy loss per event

$VMCWORKDIR/macro/hypge/Marcell/Analysis_macros/
GammaSpectraAnalysis_extparameter.C

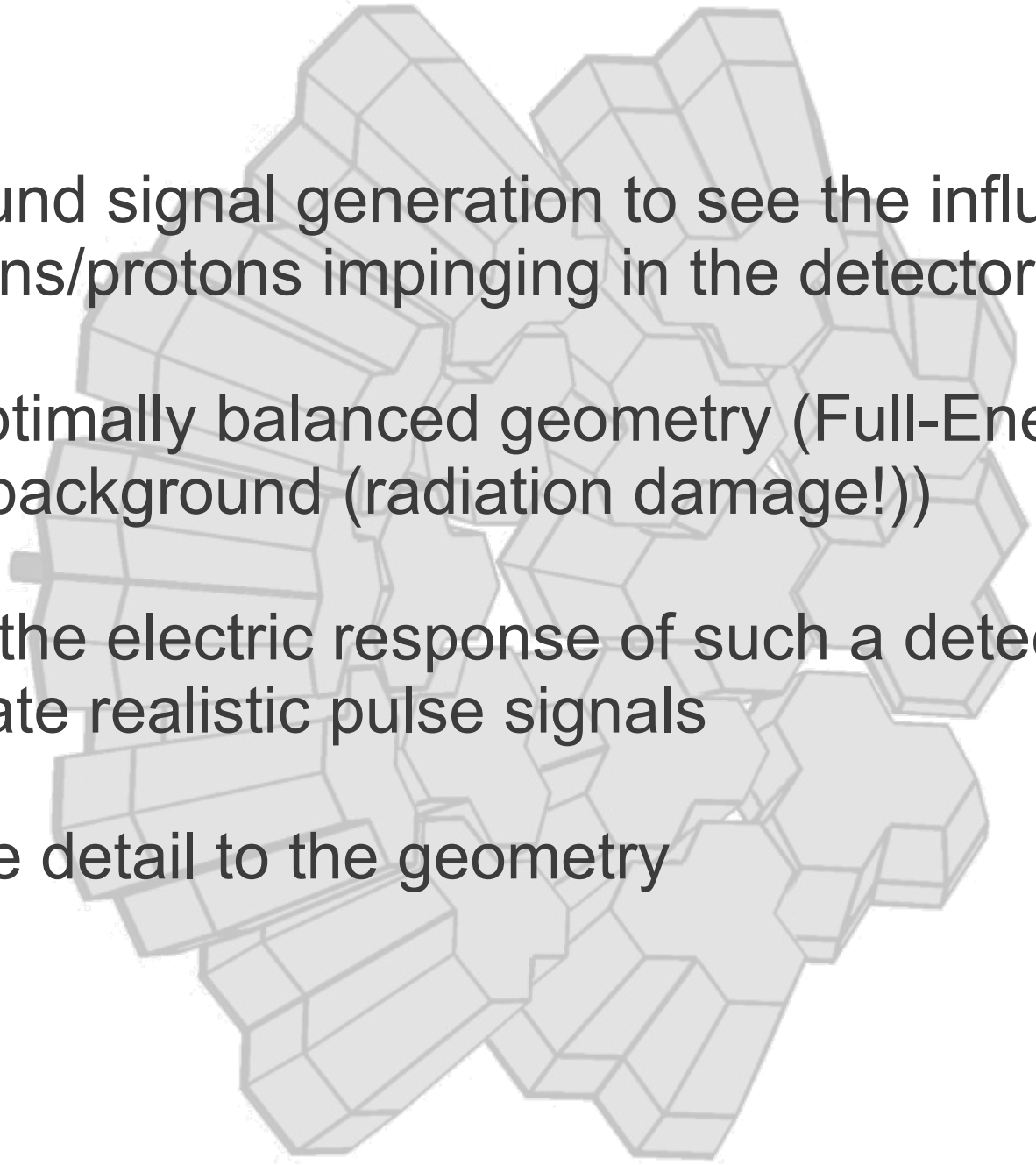
Each hit is smeared with 2 keV (preliminary)




Information can be gathered from this spectra:
Full-Energy-Eff., Peak/Comp., Resolution

# Outlook

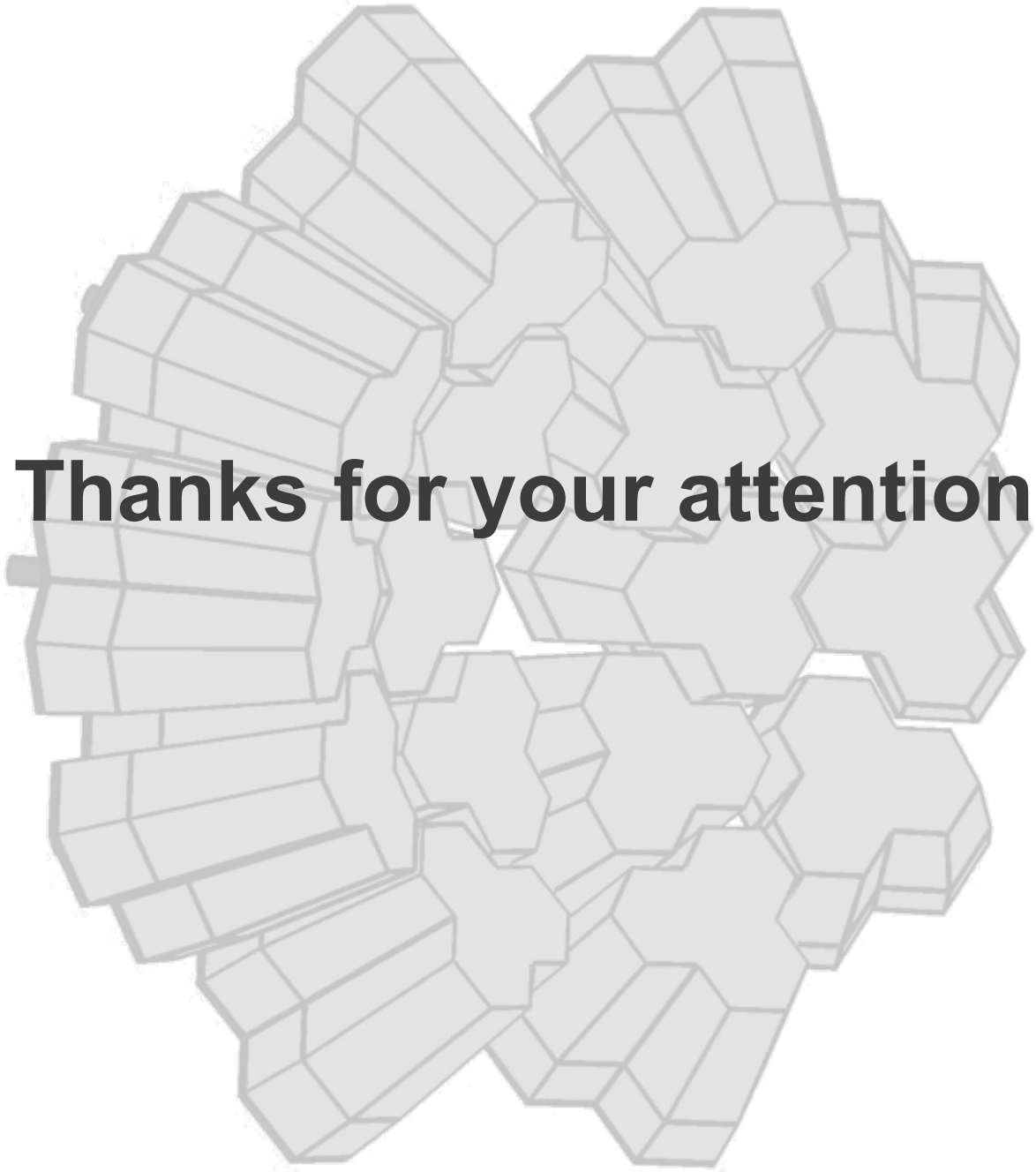


Background signal generation to see the influence of neutrons/protons impinging in the detector

Find a optimally balanced geometry (Full-Energy-Eff. and background (radiation damage!))

Emulate the electric response of such a detector to generate realistic pulse signals

Add more detail to the geometry



# Thanks for your attention