

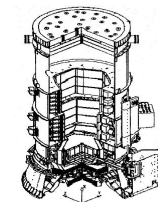
MAIN OBJECTIVE

Detection plan characterisation :

- Detection array uniformity
- Detection array efficiency for the single and multiples events

To perform these items we have **3 campaigns** of measurement :

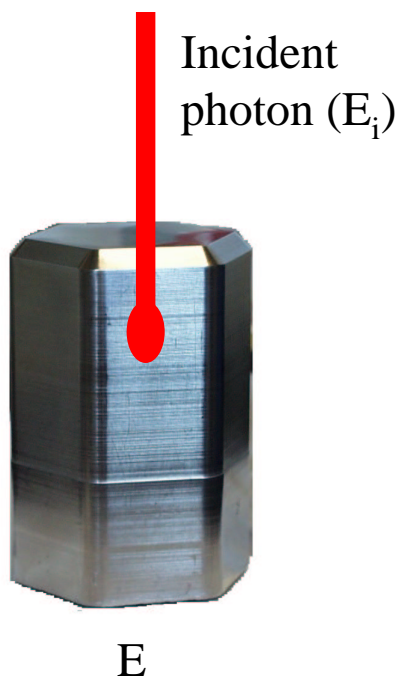
- Camera FM calibration campaign
- SPI FM calibration during the scientific and performances tests
- SPI FM calibration at BRUYERES LE CHATEL



SINGLE AND MULTIPLE EVENTS

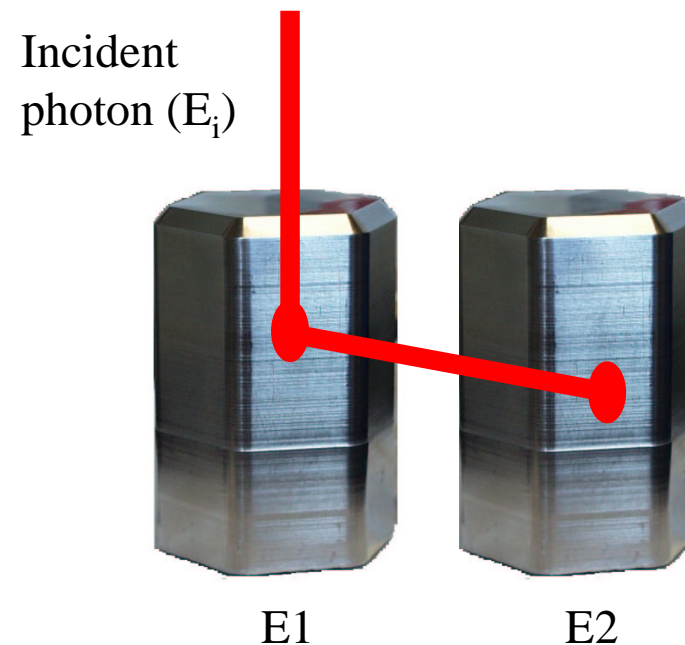
SINGLE EVENTS

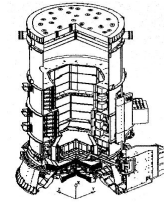
$$(E=E_i)$$



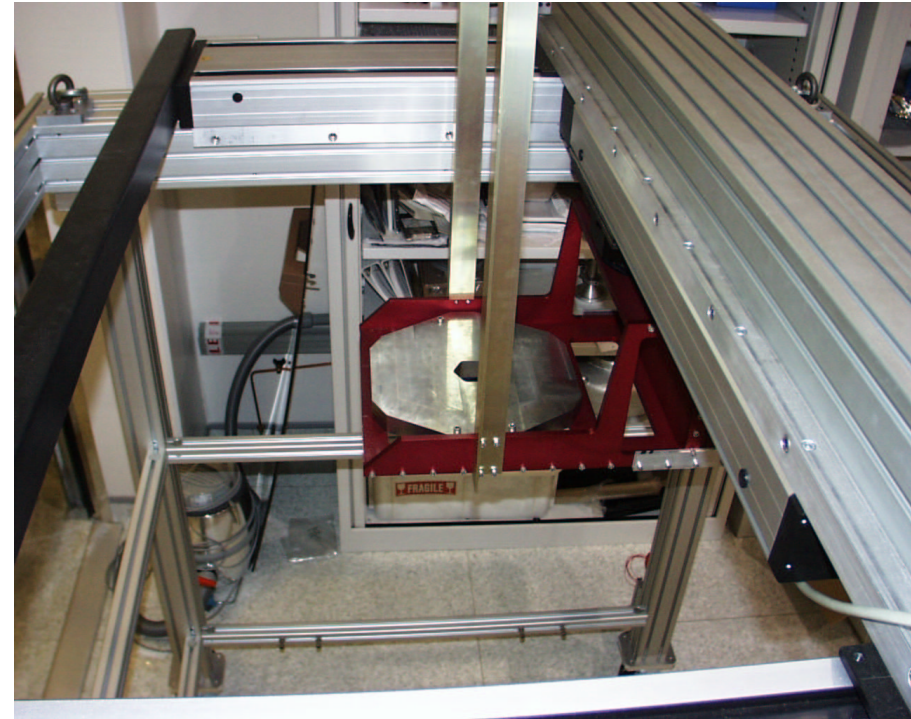
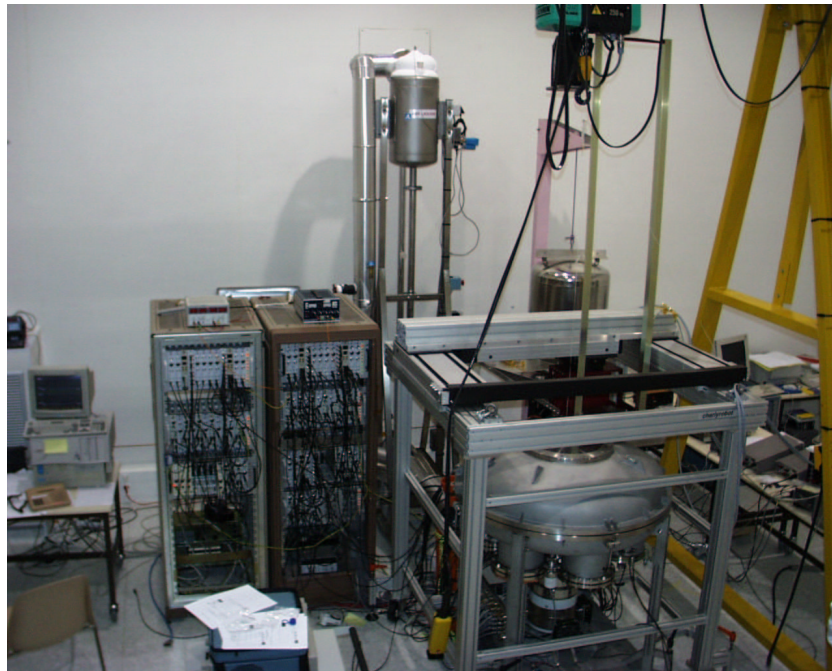
MULTIPLE EVENTS

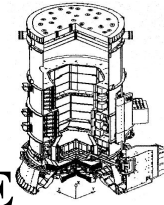
$$\text{Double events } (E_i=E1+E2)$$





CAMERA FM CALIBRATION SYSTEM





DETECTION PLAN CALIBRATION WITH THE XY TABLE

XY TABLE status:

We can move a tungsten mask above the detection plan with a precision of 0.2 mm. The mask projection onto the detector plan reproduces a in-flight projection mask element.

The distance between the source and the detection plan is 1945 mm

We did two types of measurement:

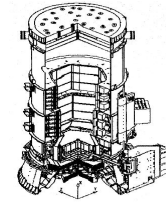
We project an open mask element onto each germanium detector centers.

The angle between the SPI X-axis and the source location is 0 deg ($\theta = 0$ deg).

The angle between the SPI X-axis and the source location is 3 deg ($\theta = 3$ deg). In fact, we project an open mask element between two germanium detectors

Each measurement duration had been minimized to have enough statistics into the single events.

The total XY Table calibration duration is 9,7 days (11 sources + backgrounds measurement)



DETECTION PLAN CALIBRATION WITH THE “PORTIQUE”

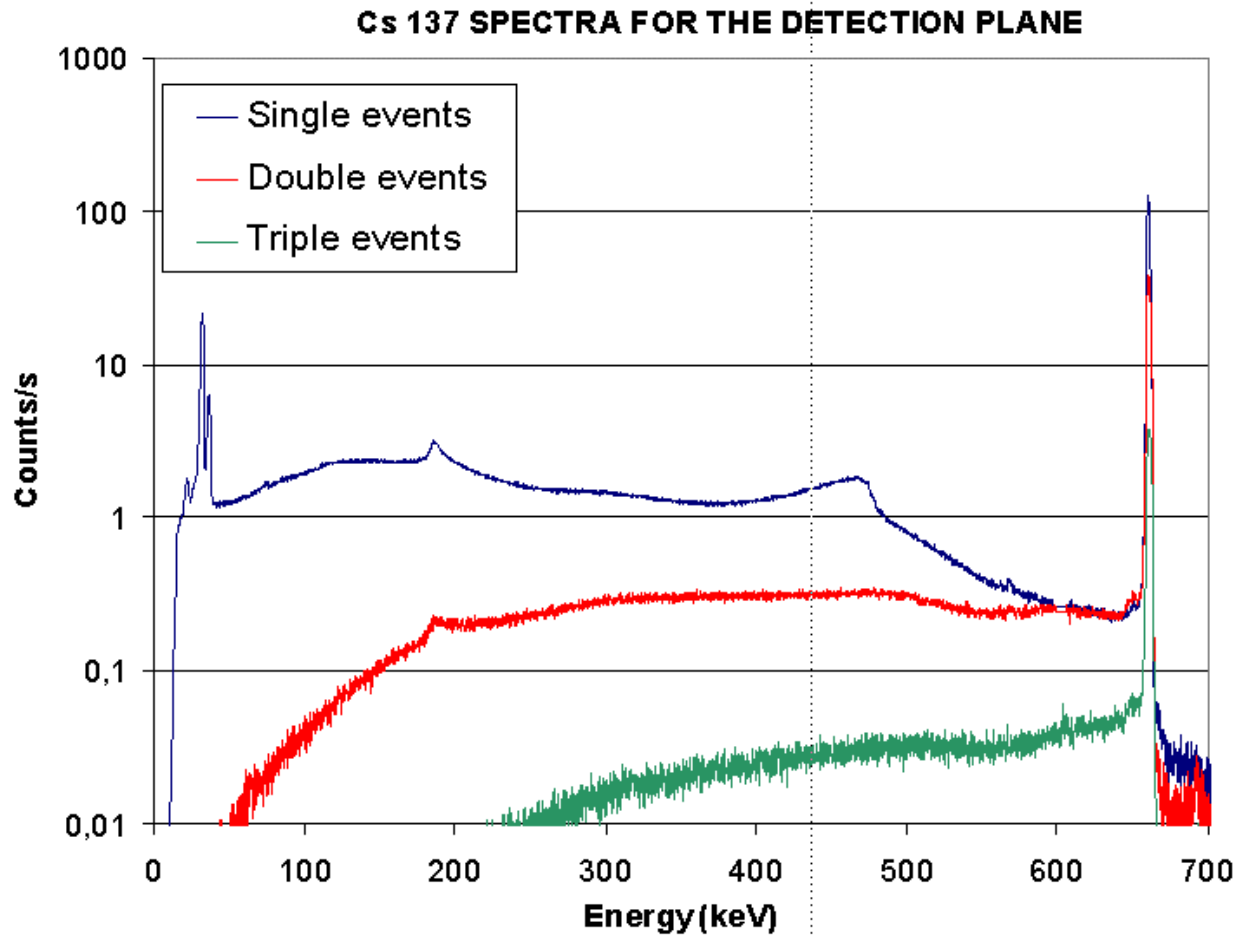
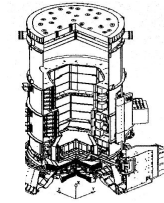
We use a tripod to put a radioactive source above the center of the detector 0.

The source lights the entire detection plan.

The distance between the source and the detection plan is 1318 mm

Each measurement duration had been minimized to have enough statistics into the double detector events.

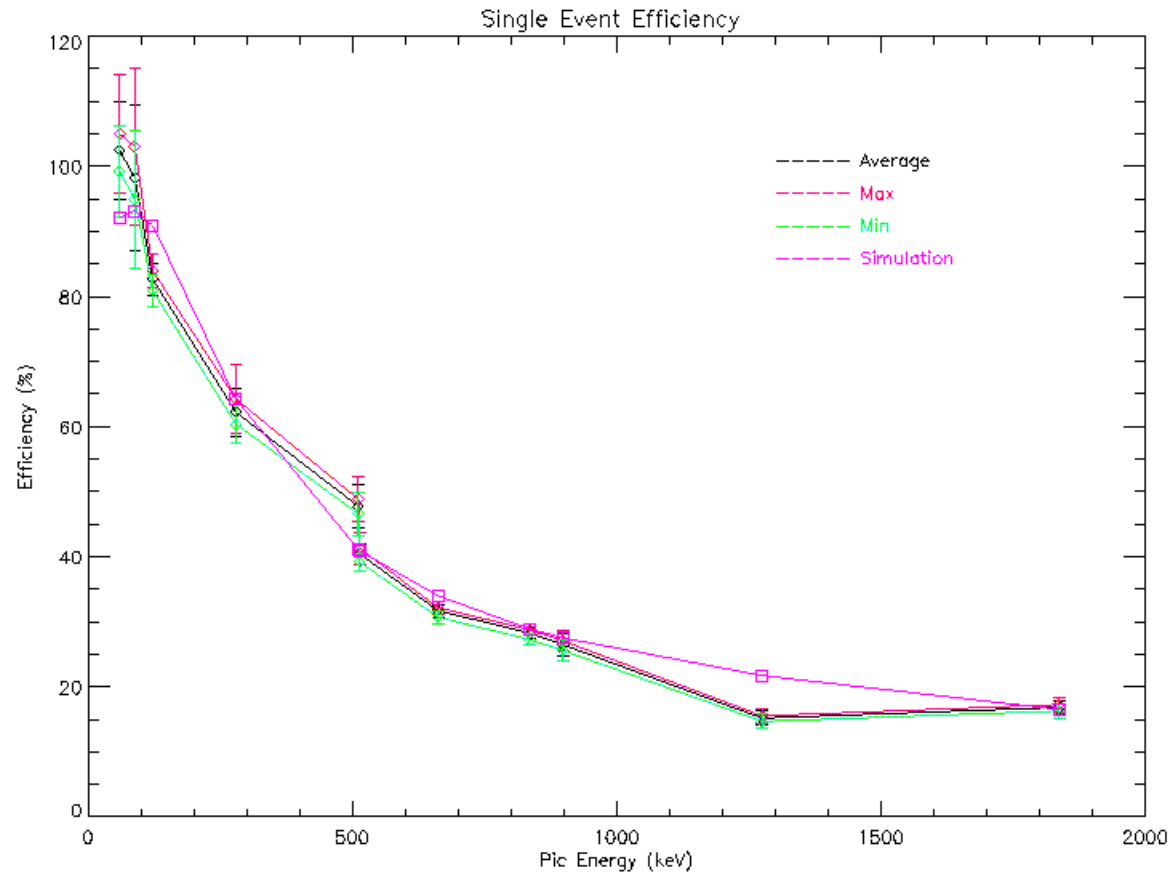
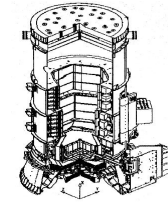
“Portique” calibration duration is 3 days
(10 sources + background + PSD measurement)



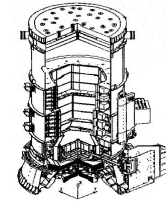
Radioactive Source : ^{137}Cs

Calibration system : Portique

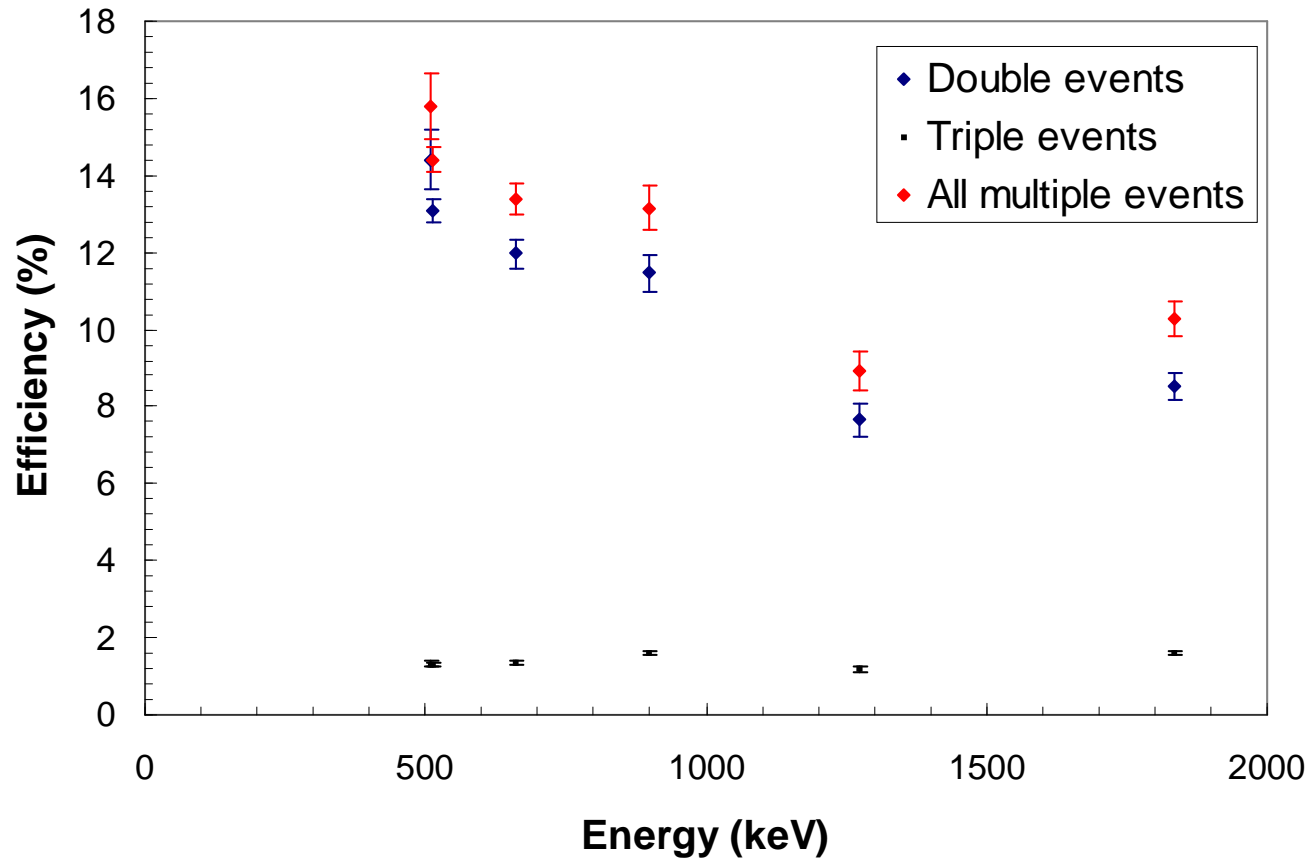
Single and Multiple events for the flight model camera.

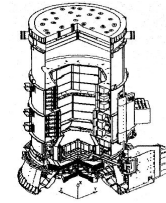


“Single event” detection efficiency for the average of 19 Ge detectors (black), minimum and maximum value (min, max). We have superimposed simulation processed with Monte-Carlo method (Geant code)

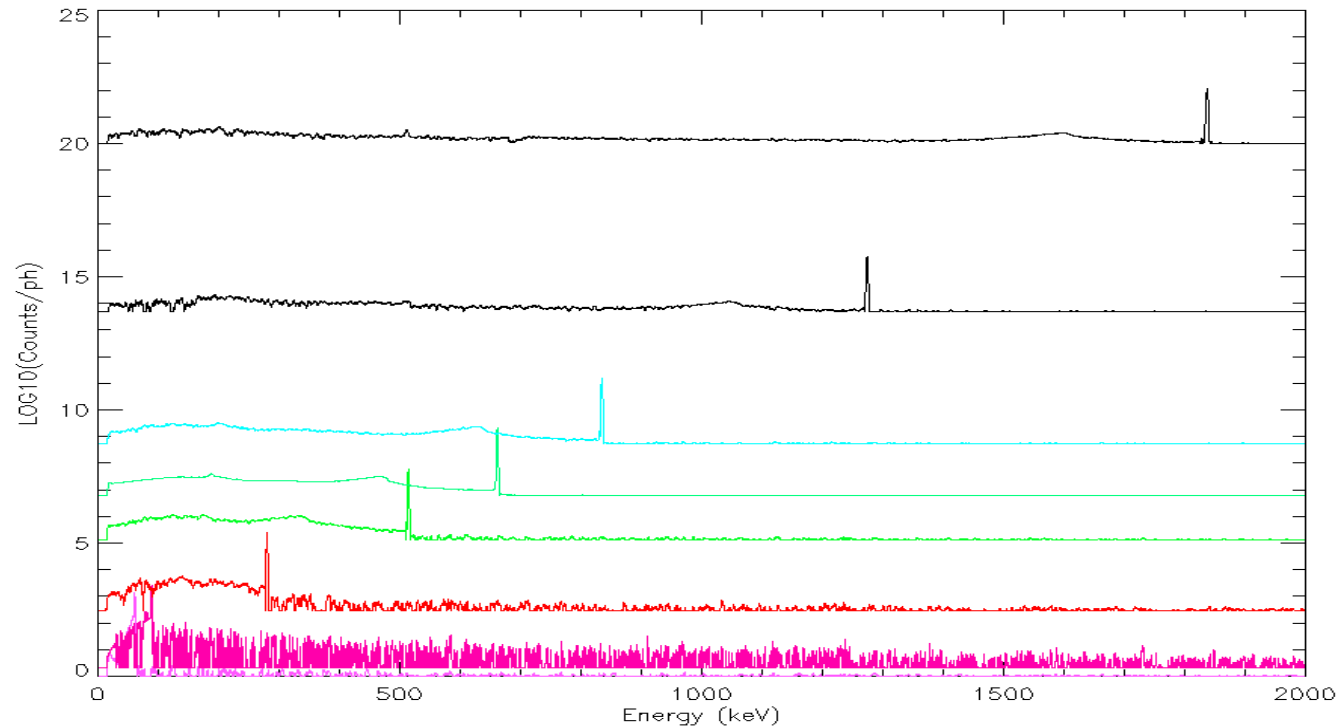


MULTIPLE DETECTORS INTERACTION EFFICIENCY FOR THE DETECTION PLANE

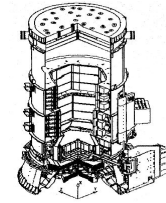




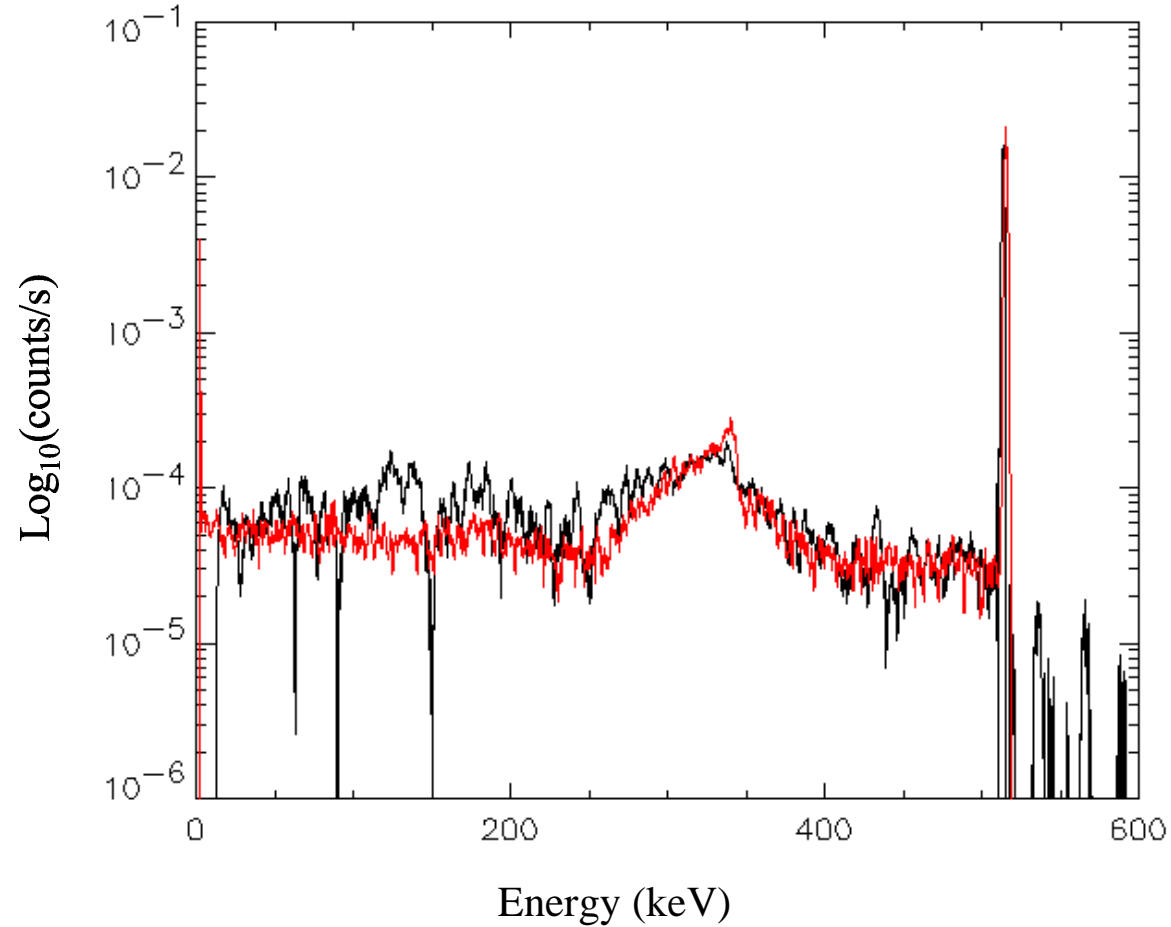
Energy response for detector 0



“Single event” spectra for the following line energy in keV from bottom to top:
 59.59 keV, 88.05 keV; 279.19 keV, 513.99 keV, 661.65 keV, 834.81 keV,
 1274.54 keV and 1836.08 keV.

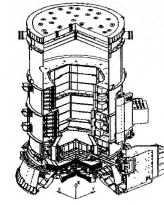


Single event spectra

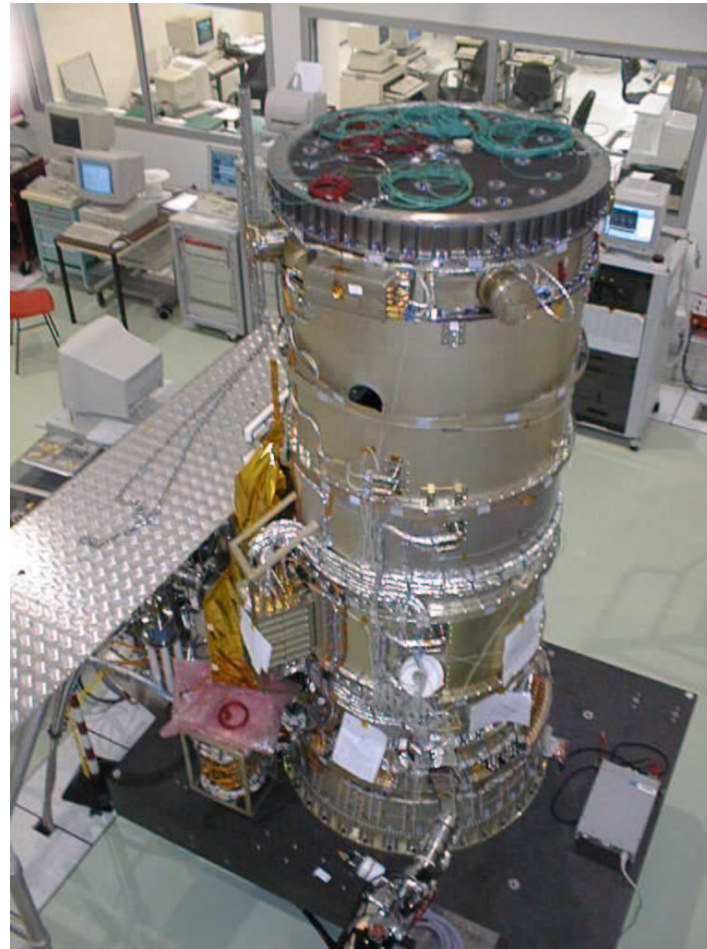


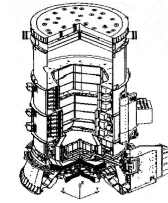
Single event spectra simulation and measurement for the central detector.

Radioactive source : ^{85}Sr



SPI FM calibration during the scientific and performances tests

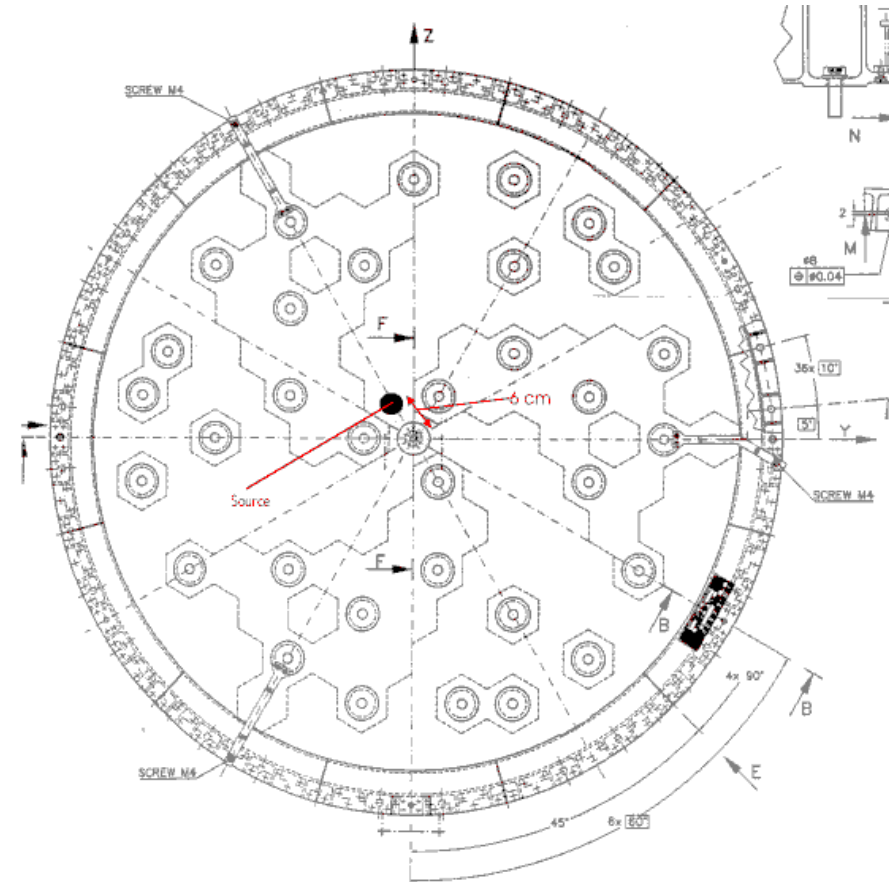


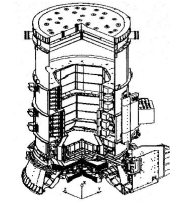


EXPERIMENTAL SETUP

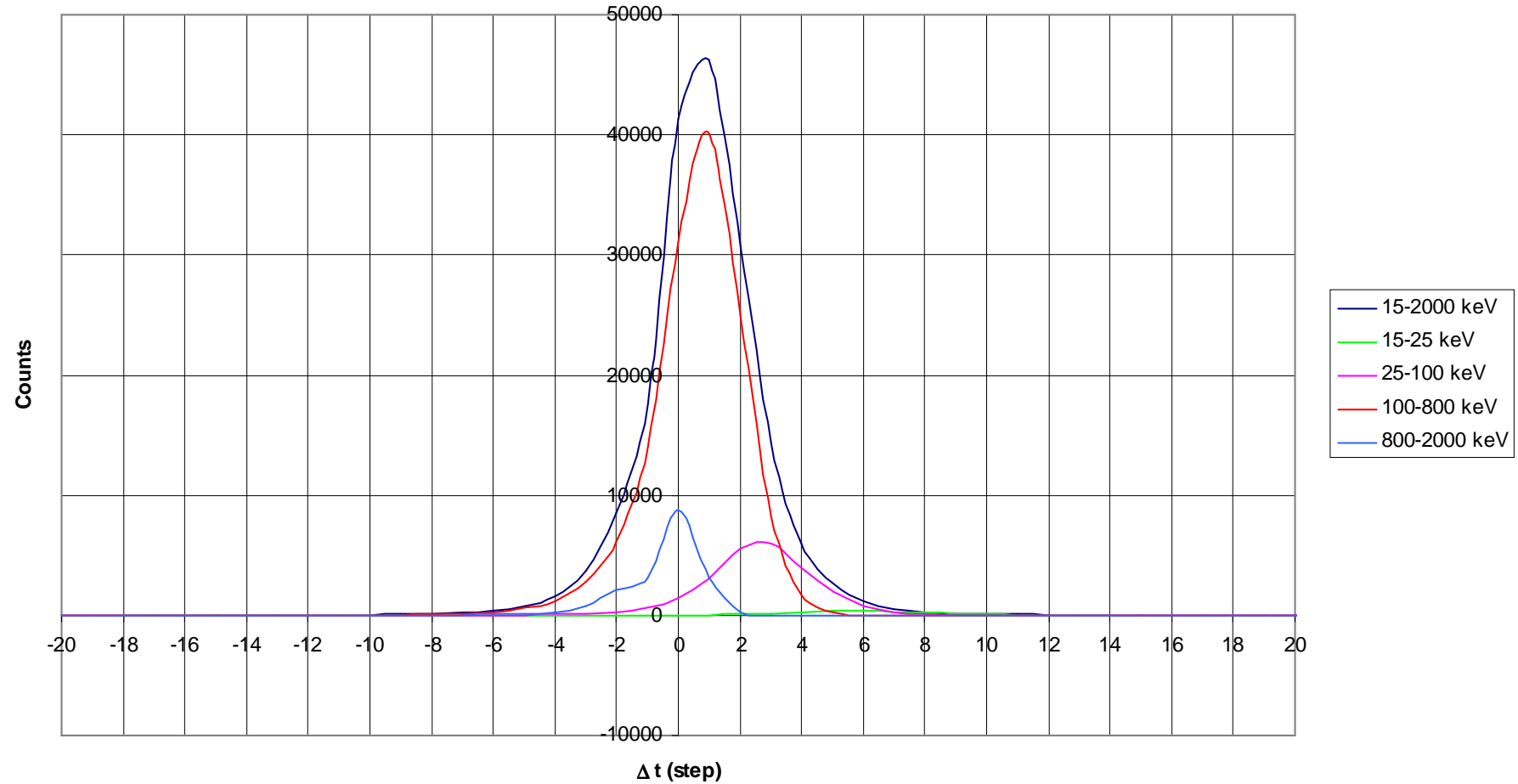
We used 9 radioactive sources :

^{22}Na , ^{137}Cs , ^{57}Co , ^{85}Sr , ^{241}Am , ^{203}Hg ,
 ^{109}Cd , ^{54}Mn , ^{228}Th



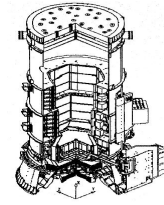


Multiple Window size
Double Events : $\Delta t = T_{det2(E1 < E < E2)} - T_{det0}$



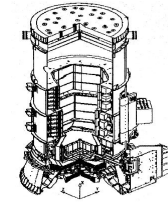
1 step = 50 ns

W=7 steps = 350 ns



SPI FM calibration at BRUYERES LE CHATEL





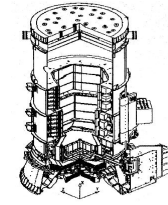
CALIBRATION WITHOUT CODED MASK



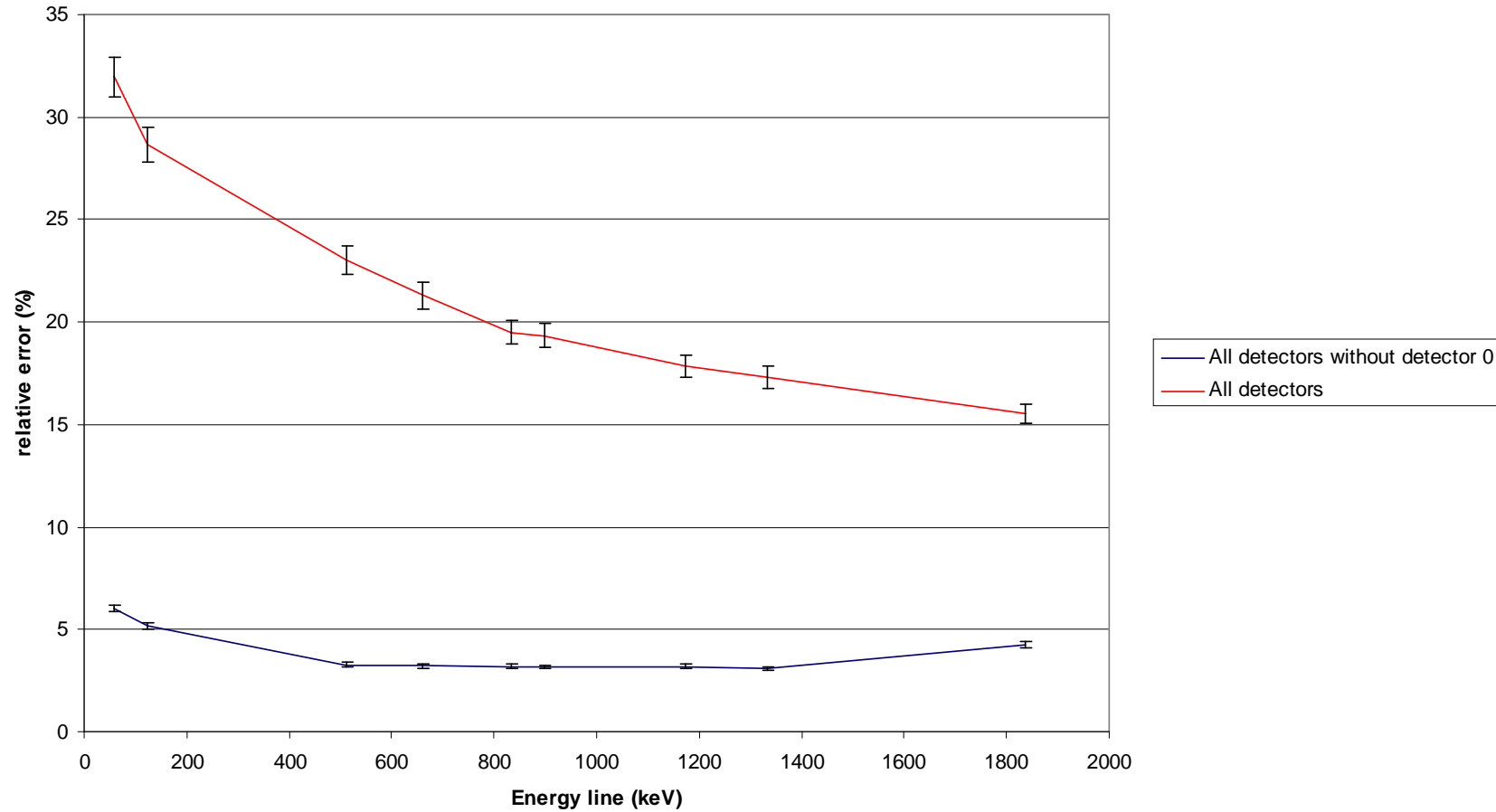
8 m sources

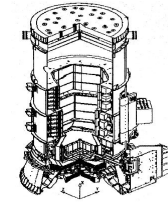
The next sources had been used :

^{242}Am / ^{133}Ba / ^{137}Cs / ^{22}Na / ^{60}Co / ^{57}Co / ^{203}Pb / ^{85}Sr / ^{54}Mn
 ^{65}Zn / ^{88}Y / ^{139}Ce



DETECTION ARRAY UNIFORMITY FOR SEVERAL ENERGY LINES

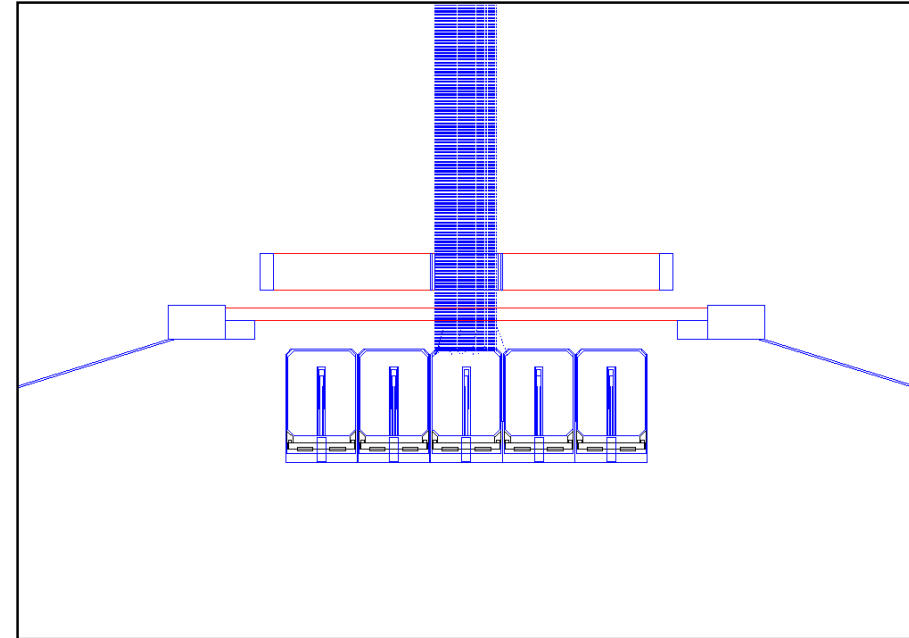


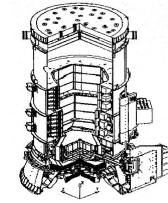


SIMULATIONS

All measurements and particularly “single events” spectra have been simulated using the standard GEANT code. The geometry used in this simulation included the main elements of the experimental setup, like the slab of tungsten, the cooling box and the detection array with its 19 germanium crystals.

The main goal of this simulation is to validate the geometry used in the simulation for the γ camera.





UNIFORMITY OF DETECTION ARRAY FOR THE 513 keV LINE (Sr85)

