Simulations for DEGAS detectors at FAIR*

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DEGAS detector

For the future Low Energy Branch of FAIR facility, experiments using stop beam in the focal plan of the Super FRS aim at studying the decay properties of exotic nuclei. The AIDA [1] active stopper, consisting of a stacks of DSSD (8x8 cm^2), will cover the large focal plan of 24x8 cm^2. The γ rays emitted by the implanted nuclei will be detected by HPGe detectors arranged in a compact geometry around the DSSD. For the γ detection, three steps are forseen [2]. The first is to use standart Ge detectors, like the existing RISING detectors [3]. In a second step, the new generation of Ge detectors, who have the ability to reconstruct the path of the γ rays inside the Ge volume, will be used. Finally, the goal is to use imaging detectors (with planar Ge for instance [4]).

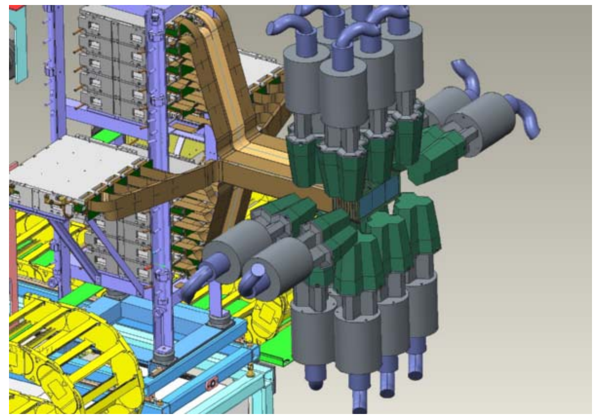

Figure 1: Integration of the Box configuration with the AIDA detectors, including their support and electronics [7].

Simulations

In this report we present the results of the efficiency simulated using RISING detectors arranged in seven-detectors per cluster (as used for the previous stop beam campain in GSI [5]) or three-detectors per cluster. The idea is to optimize the space occupation around the large focal plan while having the maximum γ detection efficiency. The simulations have been performed using the Monte Carlo code GEANT4 [6]. Several configurations have been tried for both 3- and 7-fold clusters. First, placing the detectors in a sphere like configuration. Then a very compact configuration with the detectors arrranged as a box around the decay chamber. And finally, a *shell* configuration, intermediate between box and sphere, characterized by a less compact arrangement than the box, but detectors closer to the chamber than for the sphere. The source of γ rays was extended over the surface of the focal plan.
The effect of γ multiplicity, energy, and the presence of a γ *flash* associated with the ion implantation at the focal plan (simulated by a burst of $\simeq$ 30 gamma rays of energy $\leqslant$ 100 keV in addition to the γ of interest) were investigated. A computer rendering of 3-fold clusters in box configuration is presented figure 1.

Results

The simulated efficiency for the shell and box configurations are reported in table 1. The simulations show an advantage for the triple clusters in respect to the 7-fold clusters in both shell and box configurations, but not in the sphere configuration where both 7-fold and 3-fold clusters have similar and low efficiency. The effect of gamma multiplicity has been investigated and we conclude that higher multiplicities of gamma rays ($M_\gamma \geq 4$) decreases the efficiency in the addback mode (sum of the energy over a cluster), without any significant impact on single crystal efficiency. The presence of the γ flash is larger at low energy, and most proeminent in the most compact configuration (box) as the crystals are more exposed to the γ rays from the flash. Overall, the simulations show that, for low γ multiplicity and even with the γ flash, a better detection efficiency is acheived by using a more compact configuration than by increasing the number of detectors. In that respect, 3-fold clusters present less geometric constrains as they are smaller and allow a better compact coverage of the decay chamber.

E (keV)	$\epsilon 3_{Box}$	$\epsilon 7_{Box}$	$\epsilon 3_{Shell}$	$\epsilon 7_{Shell}$
122	29.7%	22.4%	24.4%	18.0%
244	26.0%	20.0%	21.4%	16.1%
511	19.1%	15.6%	15.9%	12.6%
1333	12.8%	11.0%	10.7%	8.7%

Table 1: Efficiency of the Box and Shell configurations for 3- and 7-fold clusters at four energies. An expended source with γ multiplicity of 5 has been considered, without taking into account the γ flash.

To conclude, a compact configuration has high detection

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efficiency, in particular with a γ-multiplicity $\leqslant 3$. This preliminary study favors the use of triple clusters arranged in box configuration. It seems that it is more favourable to keep the detectors close to the source than to increase the number of detectors. The integration of this geometry with AIDA is under study and is presented in Fig.1. For using triple cluster in box configuration, electronic cooling should be used. The technic is now investigating in GSI.

References

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