# Calibration method for the activity measurements in the 200-l barrels

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## Motivation

At GSI in the near future some reconstructions of controlled areas and renovations of laboratory facilities as a preparation for the FAIR facility have to be performed. According to the German Radiation Protection Ordinance all objects and equipment from such areas must be inspected before a removal. To reduce time and keep the costs of the necessary measurements to a minimum the items can be analyzed directly in 200-l barrels, after sorting in disposal groups (e.g. „flammable“or „non flammable“).

For the activity estimation of the items situated in the barrels an ORTEC High Purity Germanium (HPGe) detector is used. Such measurement method requires efficiency calibrations, which is discussed in this paper.

## Measurements and simulations

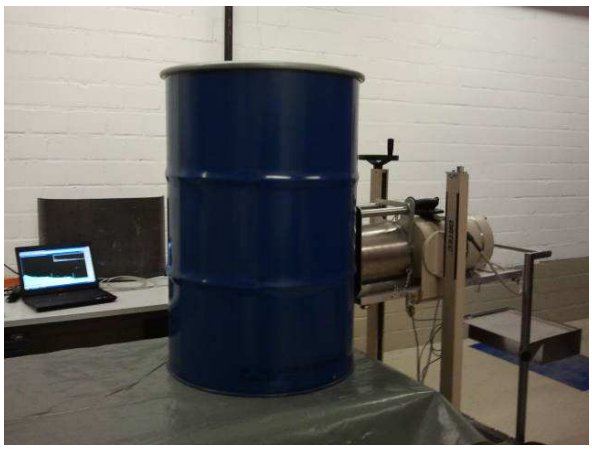

Fig. 1: 200-l barrel with the diameter 64.2 cm and height 92.3 cm. The weight of the empty barrel is 55 kg.

First measurements were done with an empty barrel. In Fig. 1 the barrel and detector are shown. For the calibration $^{241}$Am, $^{22}$Na, $^{137}$Cs, $^{60}$Co, $^{133}$Ba and $^{152}$Eu point sources were used. The sources were situated behind the empty barrel and the detector was in front. The results of the measurements are presented in Fig. 2. The energy range for the measured efficiency curve is between 59 keV and 1408 keV. The measured results were compared with simulations, which were done with the Monte Carlo code FLUKA [1]. The comparison is shown in Fig. 2. The results have 85 % agreement. The energy range of the simulated efficiency was extended up to 2500 keV, because in the activated waste can be a lot of nuclides with gamma lines above 1408 keV.

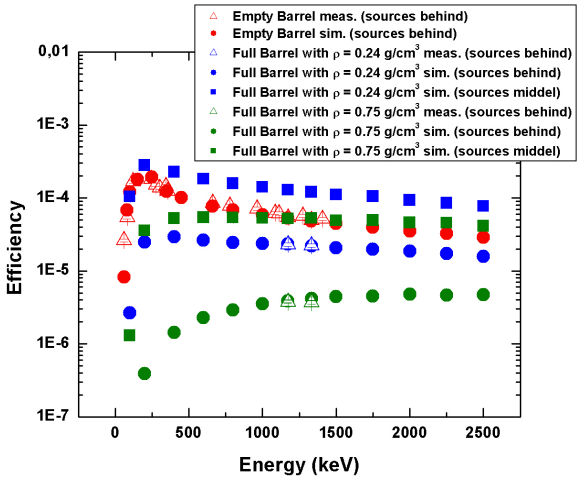


Fig.2: Detectors measured and simulated efficiency curves.

The next step was the calculation of the efficiency calibration for the full barrels. For these measurements a strong point source $^{60}$Co was taken. It was situated behind the full barrel and the detector was in front. With the results of this measurement the density of the full barrel was defined. The defined density was taken for the simulations of the efficiency curve. The typical content of the barrel is a mixture of metal, glass, plastic and minor contributions of other materials. A mixture of steel and glass was taken for the simulations. The results for the barrels with a density of 0.24 g/cm$^3$ and 0.75 g/cm$^3$ are presented in Fig. 2. In most cases the waste in the barrels is distributed all over the barrel. Therefore calculating the activity by using the efficiency calibrations for the sources behind the barrels is too conservative and can lead to large overestimations of the waste activity (e. g. for the nuclides with gamma lines below 100 keV is a factor of 400, ρ = 0.24 g/cm$^3$). The most realistic estimation of the activity is achieved by applying the efficiency calibrations for the sources situated in the middle of the barrel. The efficiency curves for the sources in the middle of the full barrels were computed using FLUKA code. The results for the barrels with a density of 0.24 g/cm$^3$ and 0.75 g/cm$^3$ are shown in Fig. 2.

## Conclusion

The developed calibration method for the activity measurements in the 200-l barrels can be applied for the safe routine radioactive waste management.

## References

[1] www. fluka.org