Studies for the radioactive waste management of copular air filters

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One of the main tasks of the radiation protection department at GSI is the radioactive waste management. Among the duties around the radioactive waste management (see other annual reports of 2012) are the inspection and utilization of used air filter systems, fig. 1 a). As the filters could contain radioactive isotopes, it is mandatory to analyze the possible radioactive nuclides and their activities within the filter. The isotopes emitting distinctive γ ray decay lines allow identification using a High Purity Germanium (HPGe) detector. The remaining difficulty is the determination of the efficiency calibration and thus the determination of the minimum detectable activity (MDA) [1]. In the following we introduce results from simulation and experimental studies of the MDA determination.

The main difficulty for the determination of the MDA is the complicated internal structure of the copular air filter. Each filter consists of an inlet and an outlet section, see fig. 1 b) and c).

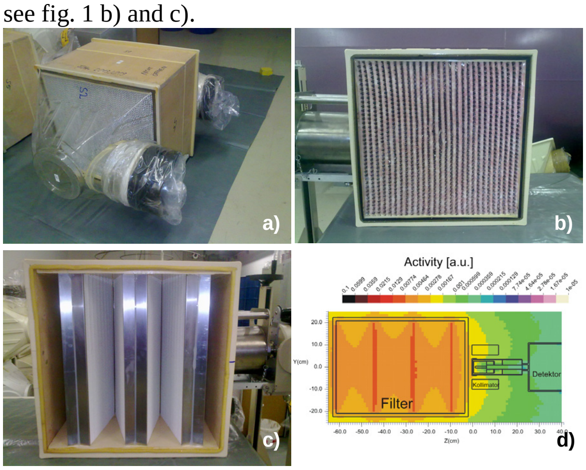

Figure 1: a) Copular air filter. b) charcoal filter of the incoming air section. c) Micro structure filter fins of exhaust section. d) Simulated activity distribution of the air filter.

The HPGe detector is used with a tungsten collimator reducing the background counts. To determine the MDA we used several calibration point sources (^{241}Am, ^{152}Eu, ^{210}Pb) in combination with an unused copular air filter (fig.1). These sources were placed behind and in the middle of the filter, while the detector was placed right in front. The experimental results are compared to the simulation using the Monte Carlo radiation transport code FLUKA [2]. The comparison of the results from FLUKA and the experiment for the point sources shows relative agreement with 20% discrepancy means the differences in the ideal to real terms of the detector-filter system. Additional simulations were done for expanded sources to be compared with point sources. Figure 1 d) shows example of the simulated activity distribution for expanded sources related to the activated filter fins. Figure 2 shows the detector efficiency as a function of the γ ray energy.

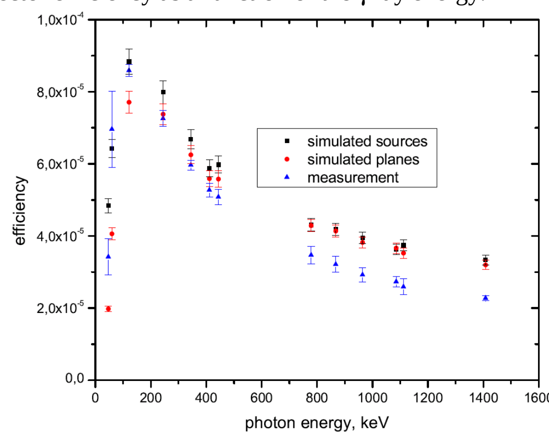

Figure 2: Detector efficiency as a function of γ ray energy.

The difference between the efficiency of a point source and an expanded source is not significant with a discrepancy of less than 5%. So, for future measurements of copular air filters we can use point sources for the efficiency calibration instead of complicated expanded sources.

Nuclide	Energy keV	Iγ %	MDA (Bq)	
			Middle	Behind
Pb-210	46,54	4,25	1,13E+02	2,58E+03
Cs-137	661,66	85,10	4,04E+00	5,65E+01
K-40	1461,00	10,67	6,04E+01	4,43E+02
Tl-208	2614,53	99,16	1,04E+00	7,53E+01

Table 1: MDA of different background lines of detector-filter system. The detector efficiency was used in terms of the calibration using point sources in the middle and the back of the filter element.

Table 1 shows the MDA of the detector-filter system for the γ ray lines of naturally occurring isotopes. It demonstrates the high accuracy for the determination of a low MDA for different γ decay lines using the mentioned results.

The consolidated results of the detector efficiency study lead to the determination of isotopes with very low activities satisfying the DIN norms [1]. Furthermore, future measurements of used copular air filters can be done with high accuracy which lead to a proper and routine radioactive waste management.

References:

[1] Nachweisgrenze DIN 25 4825
[2] http://www.fluka.org