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Oral Presentation

The reduction of the detection limits in *in vivo* measurements by using energy adapted detector arrays

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ABSTRACT

The development of new radionuclides in nuclear medicine and the increasing use of recycled plutonium in the reactor fuels have led to develop new techniques able to detect and quantify the radioactive burden in case of accidental inhalation. These isotopes are indeed characterised by the emission of low energy photons, difficult to detect with classical techniques. The new detectors and the new techniques have to reduce the lack of accuracy in this type of measurements. The position of the detectors, the distribution of the burden in the measured organs and the physiological parameters of the person are among the major factors influencing the accuracy of a measurement. These problems have already been emphasised during the workshop "In Vivo 99" held in Belgium in 1999. The purpose of this paper is to compare two approaches to improve the accuracy in the measurement, to reduce the detection limits and to follow the metabolism of radionuclides after accidental inhalation, ingestion or uptake. The talk describes these problems and presents the role of anthropomorphic phantoms able to simulate the different dispersions inside the organs. The first results show that the use of a diode array correctly placed on the body enables to follow the metabolism, to determine the specific biokinetic model and to increase the accuracy of the result by locating the burdens. They also show that the size of the detectors must be matched to the investigated energy. The thickness of the detector can be precisely optimised to reduce the detection limit to a

minimum whereas the shielding has a limited effect in case of in vivo counting. In many circumstances, the quality of a measurement device is defined by the detection limits it can reach. For a defined area, the thickness of a detector has a linear effect on the continuum and an exponential effect on the counting efficiency of the examined photo-peak (Fig. 1).

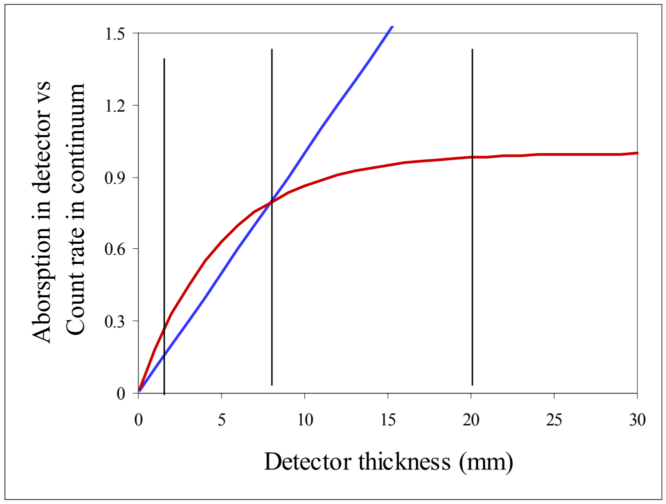

Fig. 1: Effects of thickness on absorption and continuum

An optimized thickness can be defined for each detector type (Si, Ge, CdZnTe,...) and for each photon energy (Fig. 2).

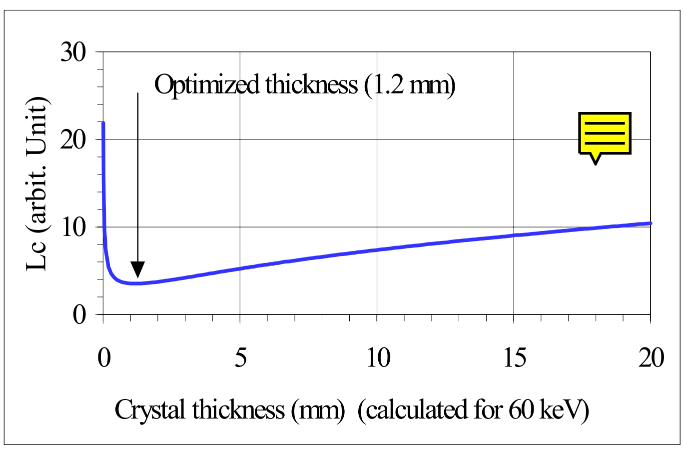

Fig. 2: Optimized thickness for a HPGe detector for the measurement of the 60 keV photons.

The same calculation can be made for different detector materials as shown in Fig. 3.

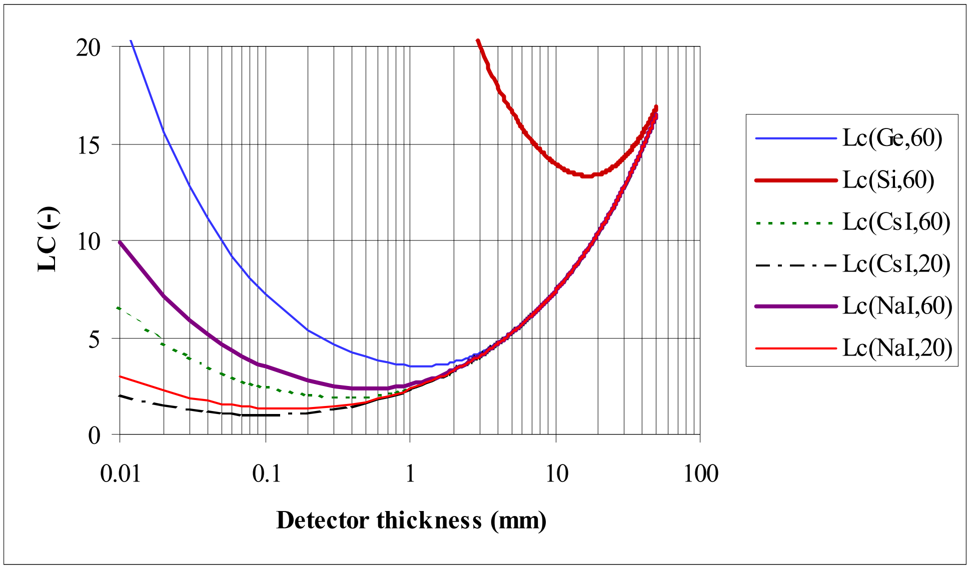

Fig. 3: Effect of detector thickness on detection limits for different materials

This figure shows that the optimized thickness' for different materials and different energies (Table 1).

	HPGe	Si	CsI(Tl)	NaI(Tl)
60 keV	1.2	13.3	0.4	0.5
20 keV			0.1	0.2

Table 1: Thicknesses of different detection materials for two photon energies

The presentation will show that the only way to reduce the detection limits, in the measurement of low energy photons, is not by improving the shielding but by optimizing the detector's thickness and that a detector can be optimized for only a small photon energy range.