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Almost pure beta-emitting radionuclides are challenging to detect and differentiate due to their rather short mean free path in scintillator leading to a poor light production. The metrology of activity of gas β particle emitters such as ^{37}Ar, ^{85}Kr, ^{133}Xe, ^{3}H is missing for low activity concentration. This lack can be filled in thanks to the current development of new porous scintillator materials and adapted measurement techniques. However, the properties of these new scintillators must be precisely determined.

As a national metrology institute for ionizing radiation, the LNHB is developing new measurement techniques based on the Compton interaction coincidences method to study the non-linearity of the light yield of scintillators. In this contribution, a new approach is proposed that allows more precise measurements through the separate determination of the parameters of the intrinsic light output and of the non-linearity of the scintillator. The major highlights of the system are the use of three-photomultiplier tubes and of a high-efficiency TDCR device [1] for absolute measurements of the average number of detected photons, together with the application of recently developed corrections for accidental coincidences [2]. The developed detector can be used for simultaneous measurements of the timing properties of the prompt and delayed fluorescence and of the relative intensity of the two components. The performance of the system are demonstrated by measuring the dependence of the light yield on the deposited energy for widely used commercial liquid scintillators (see Figure 1).

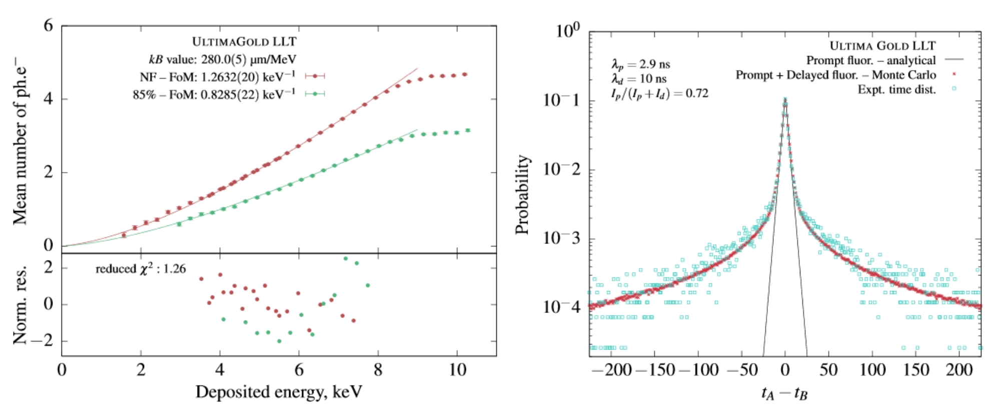

Figure 1: (left) Mean number of detected photoelectrons as a function of deposited energy. (right) Time distribution of prompt and delayed fluorescence.

The Compton-TDCR method is very interesting to characterize the properties of a scintillator. The first results of this method will be presented for standard liquid scintillators and ^{3}H measurement.

In addition, the characterization of novel scintillating materials such as highly porous scintillating materials made of scintillating inorganic YAG:Ce nanoparticles will be presented. This novel material possesses a very high porosity (density about 0.2 g/cm^3), however their detection properties with radioactive gas are unknown. The important properties for the detection of radionuclides are the requirement for a rather fast decay time and a good scintillation yield and a good transparency over a large size (1 sq. inch). In the case of porous scintillators, the Compton-TDCR technique will become the best technique in order to obtain precise response at low energy and thus perform precise metrology of radioactive gas such as ^{3}H.

[1] B. Sabot, C. Dutsov, P. Cassette and K. Mitev, Performance of portable TDCR systems developed at LNE-LNHB, Nuclear Inst. and Methods in Physics Research, A, Volume 1034, 2022.

[2] C. Dutsov, P. Cassette, B. Sabot and K. Mitev, Evaluation of the accidental coincidence counting rates in TDCR counting, Nuclear Inst. and Methods in Physics Research, A, Volume 977, 2020.

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