Beta Decay Total Absorption Gamma-Ray Spectroscopy in Basic and Applied Nuclear Research

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Beta decay is the most frequent form of instability of the nuclei in the Universe. The beta-strength distribution is the basic quantity describing the process, determining the half-life and the distribution of beta-, gamma- and neutrino radiation emitted. The beta strength is very sensitive to the underlying nuclear structure of the decaying and daughter nuclei, and can be calculated from the overlap of initial and final wave functions mediated in most of the cases by the simple Fermi or Gamow-Teller operators. In this way the measurement of the beta-strength distribution becomes a tool for nuclear structure investigation. These measurements can provide also information (among other applications) about the beta and gamma-ray energy released by the fission products in a nuclear reactor (decay heat), about the spectrum of neutrinos leaving the reactor used in neutrino oscillation experiments or to improve the calculations of the astrophysical r-process which contributes to the synthesis of heavy elements in the Universe.

The Total Absorption Gamma-Ray Spectroscopy (TAGS) applied to beta decay studies aims at the accurate determination of the beta-intensity distribution over the entire Q_β window. In fact it is the method of choice for complex decays since it is free from the systematic deviations of high resolution spectroscopy which displaces the beta-intensity going to regions of high excitation energy and high level density towards low excitation energies. This is possible because the TAGS method uses large 4π scintillation spectrometers in order to detect the full decay cascade rather than individual transitions.

The principles of the technique will be described and few examples of its application (past and planned) to studies in nuclear structure, nuclear applications and fundamental physics will be presented.