Pulse shape analysis for the KRATTA modules*

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The KRATTA, Kraków Triple Telescope Array [1], has been built to measure flow of midrapidity light charged particles in the ASY-EOS experiment [2] conducted at GSI in 2011. Modular design, portability, low thresholds (below 3 MeV/nucleon) and high maximum energy ($\sim$260 MeV/nucleon for p and α) are its main characteristics.

The off-line pulse shape analysis applied to the data from KRATTA allowed to decompose the complex signals from the Single Chip Telescope, SCT [3], segment into their individual ionization and scintillation components and to obtain a satisfactory isotopic resolution with a single readout channel. The obtained, ballistic-deficit free, amplitudes were constrained to follow the trends of the range-energy tables, which allowed for easy identification and energy calibration.

The final agreement between the decomposed ionization and scintillation components and the calculated ATIMA [4] lines presented in Fig. 1, is a result of an iterative procedure of improving the calibration and searching for optimal values of the fixed parameters. This procedure finally converged into providing quite reasonable trends of the isotopic lines.

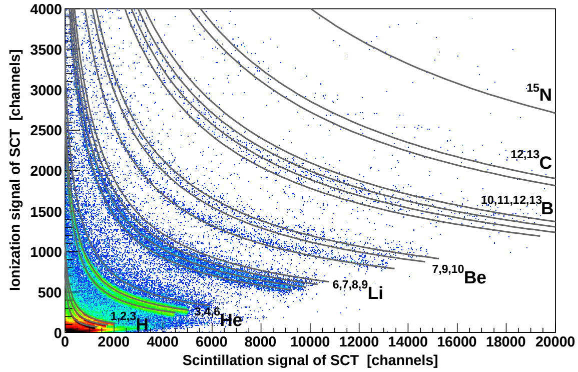

Figure 1: Decomposed SCT ΔE-E identification map (obtained with a single readout channel) with the superimposed ID lines calculated using the ATIMA tables.

The pulse shape analysis allows also to identify particles stopped in the first photodiode [1] and helps to isolate the secondary reactions and scatterings in the crystal as well as the punch-through hits, which leads to a substantial reduction of the background in the thick crystal of the KRATTA module. An example of a quite useful identification map, which profits from both, the ΔE-E and the Fast-Slow representations, is presented in Fig. 2.

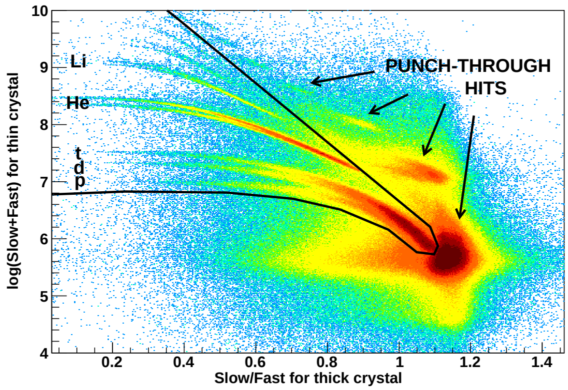

Figure 2: Logarithm of the total light in the thin crystal vs Slow over Fast component of light in the thick crystal. The line defines the border of the region of well identified particles (inside the cut).

In this representation the punch through segments as well as a substantial amount of secondary reactions and γ-ray hits can be isolated from the well defined hits of particles stopped in the thick crystal (located inside the cut). Since the ratio of the Slow over Fast amplitudes increases monotonically, and is well correlated, with the fall time of the CsI(Tl) fluorescence, the observed separation between the well identified and punching-through or scattered particles can be possibly interpreted by taking into account the relation between the effective fall time of the pulse and the ionization density [5] in the crystal. For particles escaping from the crystal, one can expect that the high ionization density part of the track (near the Bragg peak) contributes less to the fluorescence signal than in the case of stopped particles. Thus, the light signal is mainly due to the low ionization density part of the track which is characterized by a longer effective fall time and, consequently, by a larger Slow over Fast ratio.

* Work supported by Polish Ministry of Science and Higher Education under grant No. DPN/N108/GSI/2009 and by the Foundation for Polish Science - MPD program, co-financed by the European Union within the European Regional Development Fund.

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