Preparation of silicon pad detectors for measurements of the $pn \to pn\eta$ and $pn \to pn\eta'$ reactions at COSY–11

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For measurements of the meson production in quasi-free proton-neutron reactions at COSY-11 a silicon detector system will be installed close to the target region. The detector setup consisting of four modules with a total active area of 72 cm^2 [1] will be positioned at a distance of 5 cm from the interaction region between beam and target [2], and hence will cover about 22 % of the full solid angle. The detectors, manufactured by ELMA [3] Research Association have been used previously in experiments at the CELSIUS storage ring of The Svedberg Laboratory by the PROMISE/WASA collaboration. Its adoption to the COSY-11 setup needs, however, few significant changes. First of all, the geometry of the COSY-11 facility requires 80 cm long cables to transfer the signals from vacuum to the outside of the scattering chamber, which is by 50 cm longer then those used at the PROMICE/WASA setup. The prolongation of the vacuum compatible printed circuit board is desinged and will be manufactured by the STRASCHU company [4]. The additional transmission circuit will increase the capacitance of the detection setup by about 40% which will increase the noise and hence reduces the capability of identification of the low energetic spectator protons. At the PROMISE/WASA experiments the minimum energy of the spectators which still could have been identified was about 0.5 MeV [1], a value at which the distribution of the nucleons' kinetic energy inside a deuteron reaches its maximum as shown in Figure 1.

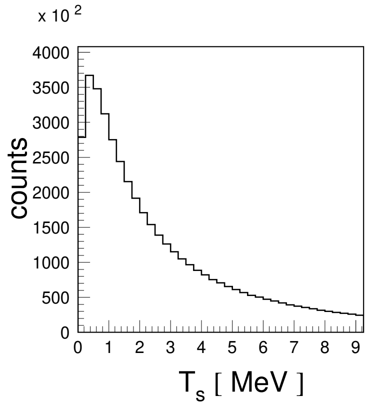

Fig. 1: Kinetic energy distribution of the nucleons in the deuteron, generated according to the analytical parametrization of the deuteron wave function [5].

The growth of that limit could diminish significantly the fraction of the spectators which can be identified. Therefore, to compensate the increase of the noise due to the inevitable extension of the signal transmitters the preamplifiers used previously have been modified and the signal to noise ratio was improved by a factor of 2. This has improved the energy resolution by about the same factor.

Tests of the energy resolution of each of the 96 silicon pad (with still short transmission cables) have been performed using Plutonium, Americium and Curium elements. The detectors and sources of alpha particles have been positioned inside the recovered scattering chamber which was used at the former experiments at the Jülich-Cyclotron [6]. Figure 2 is an example of the obtained energy distribution for one of the tested pads. It can be seen that the energy resolution (FWHM) is about 50 keV. Assuming conservatively that the extension of cables and the operation at the COSY ring will deteriorate this value to 100 KeV Monte-Carlo calculations of the $pd \to pnp_s\eta'$ reaction have been performed which resulted in a missing mass distribution of about 8 MeV for excess energies Q lower than 20 MeV, as depicted in Figure 3.

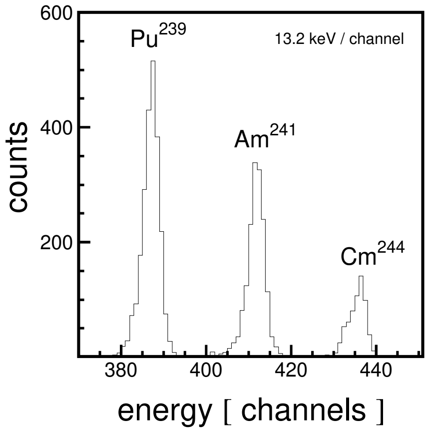

Fig. 2: Energy spectrum of alpha particles emitted from ^{239}Pu, ^{241}Am and ^{244}Cm with mean kinetic energies of 5.15 MeV, 5.48 MeV and 5.80 MeV, respectively.

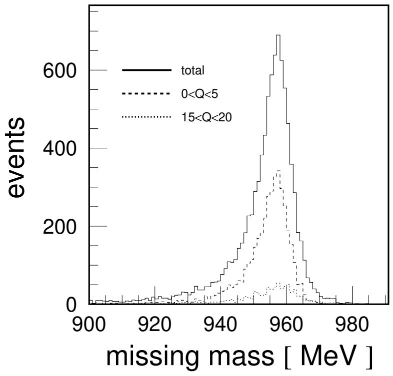

Fig. 3: Missing mass distribution with respect to the pn subsystem of the quasi-free $pn \to pn\eta'$ reaction as reconstructed from $5 \cdot 10^6$ simulated events. The neutron detector was placed at a distance of 430 cm from the target. The spectator detector was positioned at $Z_{SD} = -3.3$ cm [2]. The distance between the silicon pads and the reaction vertex was 5 cm.

References:

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