1.3 Upgrading of the ALADIN Spectrometer Detecting System for Experiments in the Collaboration Long-Term Research Program*

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An upgrade of the ionisation chamber MUSIC-III aimed at improving Z resolution and fragment trajectory reconstruction is underway. For the latter purpose it appeared mandatory to improve on precision of the y-coordinate determination, the function fulfilled by the proportional counters installed in the device. Till now a prototype of the new proportional counter has been built and tested, demonstrating improved position resolution. Moreover, an effort to improve and simplify the associated electronic chains is pursued. The latter two goals will be achieved by replacing the previously used charge-sensitive preamplifiers with the current-sensitive ones. They will provide signals of the proper shape and magnitude to be fed directly into flash-ADCs, thus avoiding the need for shaping amplifiers as an intermediate amplification stage. Also the foreseen application of twisted-pair cables, instead of the coaxial ones, is expected to cut substantially on the cabling costs.

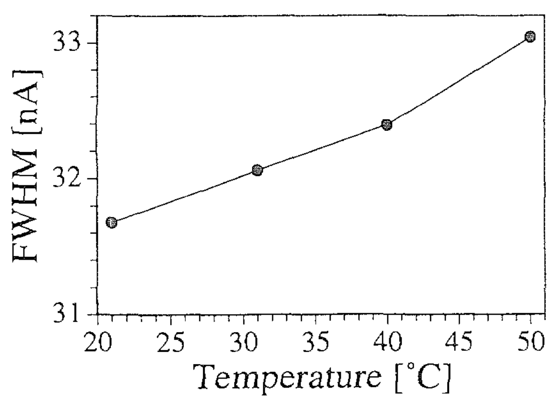

Fig.1 Full-width at half-maximum (FWHM) of the output noise spectrum as a function of ambient temperature for the preamp prototype.

A prototype of low-noise, current-sensitive preamplifier, based on best current-feedback operational amplifiers available on the market, has been built and successfully tested. It employs three amplification stages. The second and third stage provide preamp output signals differing in amplitude by a factor of 8. This permits to cover with two flash-ADCs, the entire fragment Z range from 2 to 82, occurring in multifragmentation. A single integrating RC filter is inserted between the input and the second amplification stage for pulse shaping. Because of a direct galvanic coupling used between the input and the outputs, the preamp demonstrates remarkably short double-pulse resolution time. This feature is vital to resolve two fragments widely differing in Z, emitted in the same event. Some of its characteristics have already been tested. As an example, Fig. 1 presents full width at half maximum of the output noise as a function of ambient temperature.

The question of limiting excitation energy above which thermalization ceases to be seen, posed in the previous research note, will benefit from the study of neutrons emitted by the target residue. An obvious advantage of neutrons is in that their low energy part, which carries the thermalization signature, is not distorted by energy losses in a target material. Moreover, neutrons are more abundantly produced, because of the target N/Z, making them apparently a more sensitive probe than protons. In the planned experiment peripheral to semicentral ^{197}Au+^{197}Au collisions will be studied at 600 and 1000 MeV/u. Excitation energy of the residue will be tagged with the aid of Z_{bound} of the coincident projectile fragments, detected with the ALADIN spectrometer, whose detection performance will be upgraded taking advantage of the measures described above. Two conceivable systems are treated as alternatives for the coincident neutron detection: a large-volume Gd-loaded liquid scintillation detector ("Neutron Ball") and the multidetector DEMON, consisting of 96 separate organic liquid scintillators.

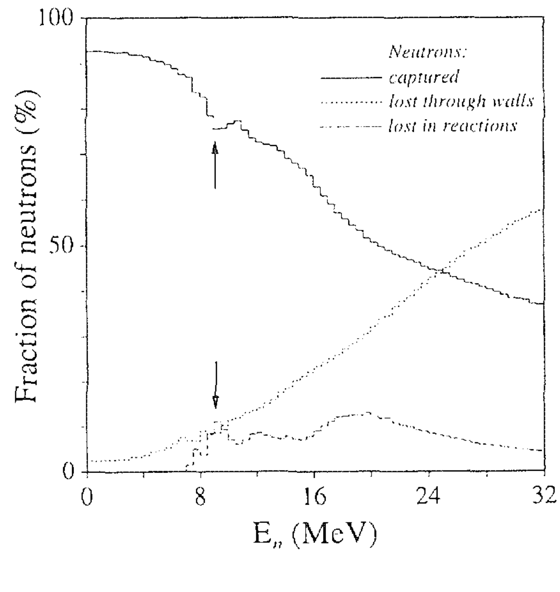

Fig.2 Number of neutrons balance for the „Neutron Ball". The meaning of different curves is explained in the insert. Arrows mark the position of the group of resonances in the $^{12}C(n,\alpha)^9Be$ reaction, centred at $E_n \sim 9$ MeV.

A Monte-Carlo code, dubbed MSX, has been written to perform a comparative study of these two systems, aimed to select the more suitable from the point of view of the above application. The novel feature, employed for the first time in MSX, is a recursive calling of the tracking subroutine. This resulted in a substantially improved tracking efficiency, permitting to include into simulations many effects not covered by the concurrent code DENIS [1] and its later modifications, introduced in several intermediate energy heavy ion laboratories. In particular, a simultaneous tracking of two and more neutrons produced in the n+^{12}C interaction, an exact sampling of the radiative capture cross sections in the relevant energy range and gamma-ray cascades in ^{156,158}Gd have been implemented. Last but not least, a simulation of the scintillation light transport, the stage entirely missing from DENIS, has been incorporated into MSX. The latter permits to evaluate the detector performance in regimes utilising the full amplitude information carried by the prompt and the delayed signals. A detailed account of the physics input, the principle of recursive calling and many results of simulations for the "Neutron Ball" which fulfils constraints imposed by the existing ALADIN instrumentation are contained in [2]. Fig. 2 presents neutron capture efficiency as a function of neutron energy for this detector.

[1] J.Poitou, H.Nifenecker, C.Signarbieux, Report CEA-N-1282(1970);
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1.4 Coherent π^+ Production in the ^{12}C(^{3}He,t) Reaction at an Incident Energy of 2.0 GeV*)

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Charge exchange reactions have proved to be the a particularly useful tool in the investigation of the nuclear response in the Δ resonance energy region. In contrast to pion and electron probes, inclusive (p,n) and (^{3}He,t) reactions display a universal downward shift of the Δ peak on all targets. It is now generally accepted that only a fraction of that shift can be attributed to a collective softening of the response due to the residual Δ – hole attraction in the spin longitudinal channel. An exclusive ^{12}C(^{3}He,t) experiment performed at Laboratory National Saturne in Saclay at an incident ^{3}He energy of 2.0 GeV has shed new light on this issue. In the experiment the Δ decay products were measured in coincidence with momentum analysed tritons. Particular attention was paid to the decay channel in which a single pion is emitted and the nucleus remains in its ground state. This channel, producing the so called „coherent pions", has been found theoretically to be most sensitive to the collective softening of the response.

The pion momentum and emission angle were measured in a magnetic spectrometer consisting of two multiwire proportional chambers and a scintillation hodoscope placed in a magnetic field. The energy and momentum transferred to the target, $(\omega, \vec{q})$ were obtained from the triton emission angle and momentum. The excitation energy of the residual ^{12}C nucleus was measured with an resolution (FWHM) of 4.7 MeV. The ^{12}C excitation energy spectrum is dominated by the ^{12}C ground state, contributing by more than 90% to the spectrum. The angular distribution of pions leaving the residual nucleus in its ground state shows a correlation with the transferred momentum $\vec{q}$. For the spin longitudinal channel the Δ excitation is proportional to $\vec{S}\cdot\vec{q}$, where $\vec{S}$ is the Δ – N spin transition operator, while the Δ decay has a structure $\vec{S}^+\cdot\vec{p}_\pi$ In consequence, the longitudinal cross section for the coherent pion production will be characterised by a $(\vec{p}_\pi\cdot\vec{q})$ dependence on the momentum vectors. The width of the angular distribution gives a measure of the longitudinal to transverse ratio [1] of the cross sections. The measured angular distribution exhibits a strong peaking of coherent pions along the momentum transfer.

The width of the distribution depends on the energy transfer and amounts to (32 ± 2) FWHM for $\omega = (215 \pm 15)$ MeV and (20 ± 1) FWHM for $\omega = (295 \pm 15)$ MeV.