LIGHT CHARGED PARTICLES DISTRIBUTION AND FISSION FRAGMENTS SELECTION IN ^{48}Ti+^{40}Ca AT 600 MeV*

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The reactions ^{48}Ti+^{40}Ca at 600, 450 and 300 MeV were employed at the Laboratori Nazionali di Legnaro (LNL) to investigate the charged particles and the Giant Dipole Resonance (GDR) decay of hot rotating ^{88}Mo nuclei. Some preliminary results about Light Charged Particles (LCP) distribution in coincidence with Evaporation Residues (ER) and fusion–fission events selection are shown.

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1. Introduction

Since 2002, the GARFIELD and HECTOR Collaborations have performed several joint experimental campaigns to study the Compound Nucleus (CN) decay by measuring both the γ-rays and LCP spectra. From LCP energy distributions information on CN temperature and on pre-equilibrium emission are obtained, allowing for a more precise estimate of the initial CN characteristics [1, 2, 3]. In particular, ^{48}Ti+^{40}Ca at 600, 450 and 300 MeV were measured with the aim to observe signals of a Jacobi shape transition in the ^{88}Mo nucleus. Experimental data on LCP and Fission Fragments (FFs)

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were compared with the results of the recently upgraded GEMINI code [4,5]. This comparison is particularly interesting as experimental data are missing in the ^{88}Mo zone.

The experimental apparatus is divided into three main parts: a detector array (HECTOR [6]) formed by 8 large BaF_2 crystals used to detect high energy γ-rays at the backward angles, a two-stage ΔE–E detector for charged particles (GARFIELD [7]) covering polar angles $30^\circ < \theta < 85^\circ$ (2π in azimuthal angle) and 32 triple stage phoswich detectors each having a 6.4×6.4 cm^2 section (formerly employed in the FIASCO experiment [8]) forming a forward wall at angles between $5^\circ < \theta < 12^\circ$. Other 17 phoswich detectors were grouped in two symmetric boxes at $13^\circ < \theta < 20^\circ$, for the in-plane FFs detection. The GARFIELD apparatus, formed by ΔE–E modules made by a gas drift chamber stage read by microstrips deposed on glass followed by CsI(Tl) crystals, allows charge resolution from $Z = 1$ up to $Z = 28$, with an identification threshold of around 0.9 MeV/u. Isotopic resolution for LCP detected by CsI(Tl) is achieved through digital Pulse Shape Analysis using custom built digitizer [9]. Signals from phoswiches are processed using the same digital electronics [10], obtaining a charge resolution from $Z = 1$ up to $Z = 12$.

2. Preliminary results

The first step in data analysis is the graphical selection of ER in the Energy *vs.* Time of Flight (ToF) correlations obtained from the phoswich wall detectors. ER velocity distributions and angular distributions are nicely reproduced by home-made Monte Carlo (MC) simulations describing the main features of fusion-evaporation process. Protons and α-particles energy spectra in coincidence with a detected ER at different θ angles are shown in Fig. 1. The identification procedure for LCP is described in [11]. The experimental data are compared with a GEMINI simulation, filtered in order to take into account the geometry of our apparatus. In the simulation we considered only complete fusion events, assuming a triangular spin distribution for the CN ending at the vanishing fission barrier value ($I = 62\hbar$ according to Sierke calculations). More details about the model parameters can be found in [4].

Though the comparison with the GEMINI model is very preliminary, the agreement between data and simulation suggests that the pre-equilibrium emission in this system should be practically negligible. A precise estimation of pre-equilibrium emission will be performed using also the LCP spectra at smaller θ angles from the phoswich detectors. In the zone of the Coulomb barrier, the agreement between data and simulation is not perfect. This is probably due to the experimental thresholds which have not been included in the simulation filter, yet.

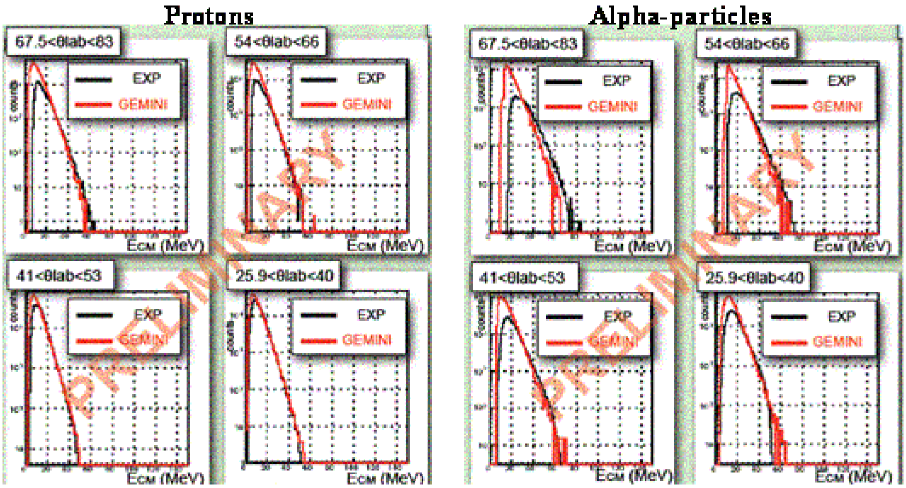

Fig. 1. Energy distribution in the centre of mass system for proton (left part) and α-particles (right part) emitted in coincidence with a detected ER.

The fusion–fission channel is also studied in our analysis. Preliminary results shown in Fig. 2 are obtained by the analysis of phoswich wall detectors only.

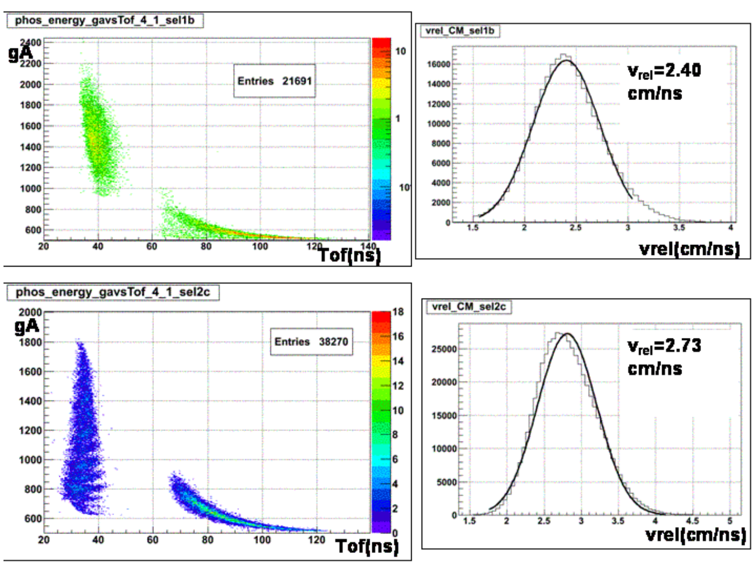

Fig. 2. Left part: Energy *vs.* ToF of the two FFs for the symmetric fission (upper part) and asymmetric fission (bottom part). Right part: Relative velocity between the two FFs.

The fission events are separated into symmetric (upper part of Fig. 2) and asymmetric (lower part), depending on Z of the two FFs. If both of them are with $Z_{\rm FF} > 12$, the fission is labelled as symmetric. By looking to the $\theta_{\rm cm}$ and $\phi_{\rm lab}$ relative angles for events with two heavy ions, it is possible to recognize when the two fragments are emitted from the same source. Comparison with Ref. [12] shows a fair agreement as fission fragment yield is concerned, with the asymmetric fission prevailing on the symmetric one. The experimental plot energy *vs.* ToF in the left part of Fig. 2 is well reproduced by our MC simulation which describes the kinematics of the fission events. The relative velocity of the two FFs is presented in the right part of Fig. 2. The mean velocity of this distribution is 2.40 cm/ns for the symmetric fission and 2.73 cm/ns for the asymmetric. They should be compared with the values of 2.15 cm/ns and 2.27 cm/ns obtained in the MC simulation, based on the Viola systematics [13]. We are refining the analysis to reduce possible non-fission contributions and we are evaluating the role of nuclear spin in increasing the relative velocity between FFs.

3. Summary and conclusions

The ^{48}Ti+^{40}Ca at 600 MeV reaction was studied at LNL by GARFIELD and HECTOR collaborations. ER selection is performed using a phoswich detector wall at forward angles. LCP spectra in coincidence with ER are studied and compared with the GEMINI model, suggesting a negligible contribution from pre-equilibrium emission. Fusion–fission events are also studied. Both α-particles chain and fission events will be tested as CN angular momentum selectors, in order to study the GDR emission from the CN with different angular momentum looking for a Jacobi shape transition.

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