A new Time-of-Flight spectrometer for the 8πLP setup based on the CORSET concept


1 Dipartimento di Scienze Fisiche and INFN, Napoli, 2 Flerov Laboratory of Nuclear Reactions, JINR, 141980 Dubna, Russia, 3 INFN, Laboratori Nazionali di Legnaro, 4 Dipartimento di Fisica and INFN, Padova, 5 Dipartimento di Fisica and INFN, Firenze

INTRODUCTION

In the past few years we have started an experimental program with the 4π apparatus 8πLP aimed at studying the fission dynamics in systems of intermediate mass by using light charged particles (LCP) as probes [1-3]. The experimental method is based on the detection of the LCP in coincidence with the fission fragments and evaporation residues.

LCP are measured in ΔE-E (Si-CsI) telescopes of the whole 4π apparatus (Fig.1). Heavy fragments are fully stopped in the silicon detectors of the rings E, F or G of the BALL and are separated from the LCP which stop in the same detector by means of a pulse shape discriminator analysis. Only a rough value of the energy is obtained for the heavy fragments. At the excitation energies typically involved (>80 MeV), the fission mass distributions are expected to be symmetric and the selection of the fragments from symmetric binary fragmentation is roughly achieved on a kinematical ground.

FIG.1: Schematic layout of the 8πLP apparatus.

THE NEW SPECTROMETER

This method outlined above has however very many limitations and strongly reduces the number of systems in which the fission fragments can be effectively separated from other types of fragments. For instance, the energy-energy correlation alone is not enough in systems with A > 150 in which the folding angle distributions from fission and from deep inelastic events are expected to overlap.

In order to improve the detection capability of the fission fragments in the 8πLP apparatus in the framework of the FIESTA collaboration we have designed the project of a new Time-of-Flight spectrometer based on the CORSET concept from the FLNR in Dubna [4]. The basic system consists of two arms mounted on opposite sides of the beam, each one containing a START and a STOP detector. The STOP detectors are position sensitive. The information of the time of flight and of the position of the fragments in each respective arm along with the two-body kinematics allows the reconstruction of the masses and kinetic energies of the fragments. The START and STOP detectors use a system of microchannel plates to achieve a time resolution of ~150ps. From our simulations, it is possible to achieve a mass resolution of ~1 amu with a flight path of 30 cm.

In order to install the full spectrometer system in the 8πLP support frame we have designed and produced three pyramidal capsules out of carbon fibre. Each one has such a shape to fit inside the frame of the BALL at the locations of the rings E, F and G. Each capsule contains a START and a STOP set of detectors (Fig.2). Standard NIM electronics (CFDs and TACs) is used to guarantee a time resolution of ~150ps. Moreover, to guarantee the vacuum necessary for the correct functioning of the microchannel plates, extensive work has been done to upgrade the vacuum system of the scattering chamber.

FIG.2: The START and STOP detector sand the carbon fibre capsule.

At the moment we have built 2 carbon fibre capsules for each ring and 4 START and 4 STOP detectors, which mean that we have enough detectors to fully equip 4 arms, two in the ring F and two in the ring G. Consequently the
correlations F-F, G-G and F-G can be studied. The 4 arms have been mounted inside the frame as shown in Fig.3. Mechanical work is in progress to guarantee a more precise anchoring of the STOP detectors inside the capsules.

The full system of 4 arms has been tested with a double peak alpha source. Results of preliminary tests are briefly summarized in Fig.4 and Fig.5. In Fig.4 the time-of-flight spectrum of the alpha particles is shown. The FWHM of each single peak is about 300ps. This allows for a mass resolution of less than 1% in the mass range $A=100-150$. In Fig. 5 we show a matrix of the X and Y positions. The horizontal and vertical lines are due to two horizontal and vertical copper wires glued on the entrance foil of the stop detector. These wires have a section of 1 mm and absorb the alpha particle. They are used as a calibration mask to measure the linearity and resolution of the position signals.

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