Study of the Heavy Fragment survival in Multi Nucleon Transfer reactions

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I. INTRODUCTION

Information on the heaviest elements have been obtained up to now mainly via fusion evaporation reactions. It is however well known that the only nuclei reachable using fusion-evaporation reactions are neutron deficient and moreover limited by the number of beam-target combinations and cross-sections. An interesting alternative to fusion-evaporation could be Multi Nucleon Transfer (MNT) reaction. Theoretical calculations predict large cross-sections for neutron-rich heavy isotops production close to zero degrees and at grazing angles [1]. The goal of this LOI is to start a program at GANIL studying MNT mechanism in the heavy elements region for optimizing the production of neutron rich nuclei. This will be done using the AGATA array coupled with VAMOS++ separator, including VAMOS second arm. The work will focus in understanding the survival of the Heavier Fragment (HF) depending on the emission angle, incident beam energy and the beam+target combinations. The reaction to start this program envisaged today is ^{64}Ni+^{238}U followed by more symmetric combination in inverse kinematics, such as ^{238}U+^{124}Sn and ^{238}U+^{197}Pt. In addition to challenges in the choice of the beam-target system, the choice of beam energy is critical. Near the Coulomb barrier, the reaction is known to be governed by Quasi-elastic, with the products emitted around the grazing angle. At higher incident energy, the production of more neutron rich nuclei would decrease due to a larger evaporation of neutrons arising from increased excitation energy in the products. However higher energy will allow more damped collisions, leading to the exchange of more nucleons, thus enlarging the range of exit channels [2] [3].

II. EXPERIMENT

The first proposed study is ^{64}Ni beam at 7.2 MeV/A impinging a ^{238}U target. This energy correspond to 40% above the Coulomb barrier. The reaction has been simulated using Monte Carlo simulation codes DIT [4] and GEMINI++ [5]. DIT has been used for simulating MNT reactions and GEMINI++ for the evaporation and fission of the Quasi-Projectile (QP) and the Quasi-Target (QT) obtained from DIT (see Fig 1).

VAMOS++ placed at 45° will be used to identify the Ni-like fragments while the Time of Flight (ToF) of the U-like nuclei will be measured with VAMOS second arm, placed a 55 degrees. ToF will allow a partial separation between fission fragments and U-like fragments. The coincidences between the Ni-like fragments identified by VAMOS and Heavy-fragments detected using the second arm will allow to obtain a good separation between the U-like fragment

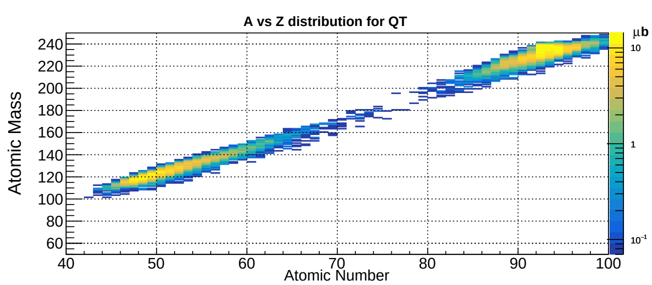

FIG. 1. A vs Z distribution for the Quasi-Target obtained using DIT and GEMINI++ simulation codes. The lower A and Z corresponds to fission fragment while the higher A and Z are U-like fragments surviving fission

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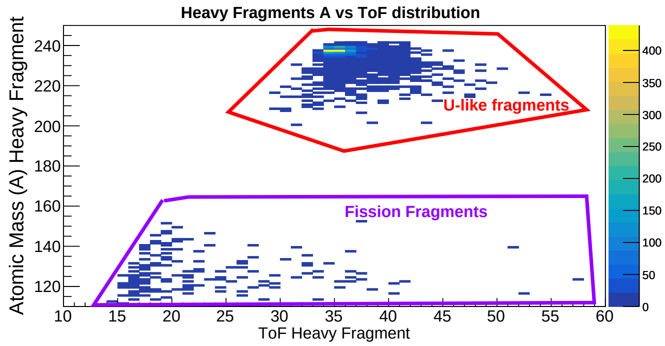

FIG. 2. Atomic number vs ToF of the Quasi Target (U-like fragment and fission fragments). This figure is obtain by selection a Quasi Projectile with VAMOS placed at 45° and the Quasi Target detected with the second arm of VAMOS placed at 55°. The figure shows a good separation in ToF can be seen between the fission fragments and the U-like fragments.

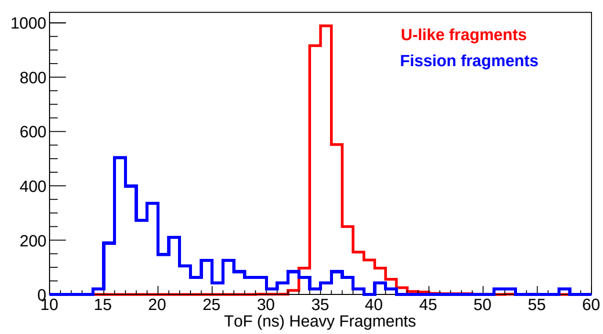

FIG. 3. ToF separation between fission fragments and the U-like products surviving fission (obtained with DIT & and GEMINI++). Quasi Projectile is identified in VAMOS placed at 45° and the Quasi Target detected by the second arm placed at 55°.

surviving fission and fission fragments (see Fig. 2). The U-like fragments will be identified using prompt γ rays measured with AGATA array (see 4). Delayed gammas will be measured by EXOGAM detectors placed around the second arm. In a recent experiment , MNT reactions in the ^{136}Xe+^{198}Pt system, the production of heavy quasi target like fragments have been successfully studied using a similar technique (Ref. Y. Cho et al , GANIL E805).

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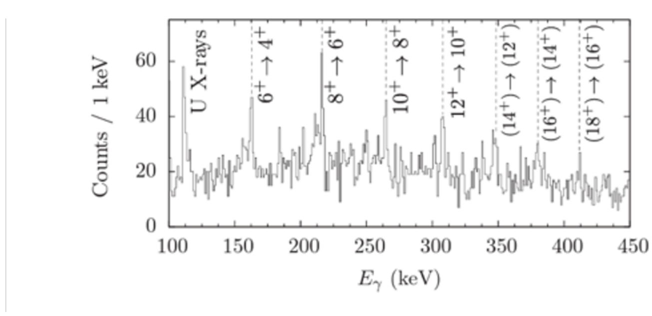

FIG. 4. Preliminary results from ^{136}Xe on ^{238}U experiment performed at ANL using AGFA placed at 0 degree and GAMMASPHERE array. The rotation band in ^{240}U can be seen

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