Search for heavy and superheavy systems in ^{197}Au + ^{232}Th collisions near the Coulomb barrier

M. Barbui, K. Hagel, J. B. Natowitz, M. R. D. Rodrigues, K. Schmidt, R. Wada, Z. Majka, H. Zheng, M. Barbarino, and A. Bonasera[1]

[1]*INFN Laboratorio Nazionale del Sud, Catania, Italy*

The possibility to produce heavy and superheavy elements in the reaction ^{197}Au + ^{232}Th at 7.5 MeV/nucleon has been investigated using the BigSol spectrometer at Texas A&M [1]. This experiment indicated the possibility to produce heavy elements of Z about 100, however a confirmation of this scenario would only come by detecting the high energy alpha particles emitted by the decaying heavy nuclei. In fact, very heavy and superheavy nuclei are expected to decay to stable nuclei trough alpha particle chains with energy around or above 10 MeV.

To search for high energy alpha emission, we designed and performed a new experiment, in which the heavy reaction products emitted in the angular range from 3° to 45° are implanted in a catcher foil. The particles emitted by the implanted nuclei are detected using silicon detectors placed in the backward position. A picture of the experimental setup is shown in Fig.1.

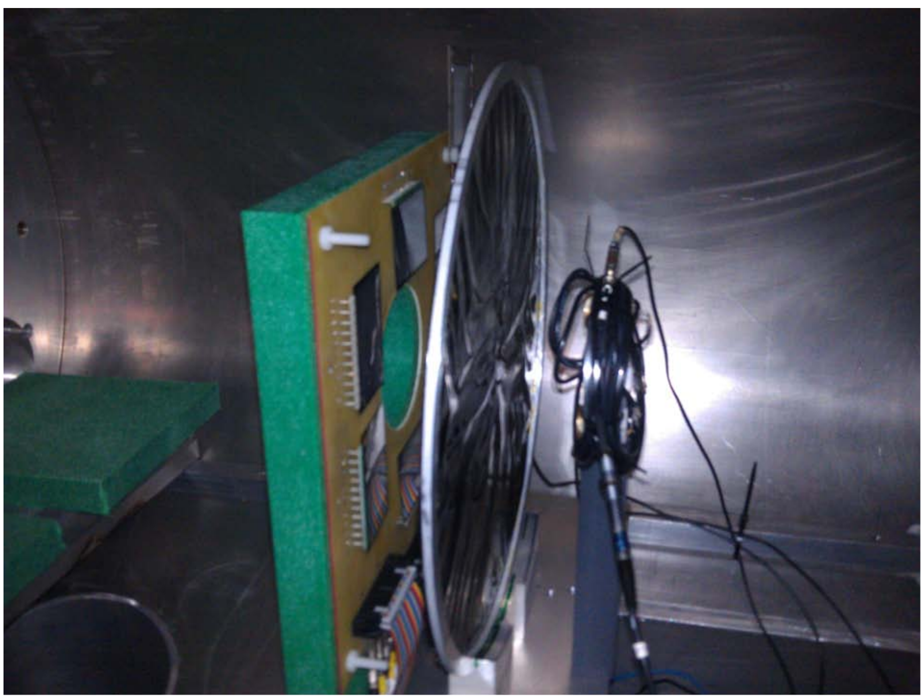

FIG. 1. Picture of the experimental setup as placed in the reaction chamber. 6 seven strips silicon detectors (Micron Semiconductors design I, thickness 300 μm) are placed after the target position, facing the catcher foil. The catcher is a polypropylene layer of thickness 7.5 μm placed at 3 cm from the silicon detectors. The catcher has a central hole to allow the beam to pass trough and three additional holes in correspondence of the position of the monitor detectors. A Faraday cup is placed at the end of the line at about 5 m from the target. Two different ^{232}Th targets were placed in the target ladder: one of thickness 11 mg/cm^2 and another of thickness 6.3 mg/cm^2 followed by a ^{12}C degrader of thickness 3 mg/cm^2.

A first test run was performed after optimizing the experimental setup. The 7.5 MeV/nucleon ^{197}Au beam was delivered by the K500 superconducting cyclotron and pulsed at different intervals in order to be able to identify species of different half-life (i.e. 1 ms beam-on, 1 ms beam-off; 10 ms beam-on, 10 ms beam-off or 100 ms beam-on 100 ms beam-off). The events were recorded both in beam-on and beam-off condition. The calibration of the energy signal from the silicon detectors was performed with a ^{228}Th source before and after the run. Fig. 2 shows a typical spectrum of the ^{228}Th source. The energy resolution of the detectors is in average 170 keV (FWHM) for the 8.78MeV peak.

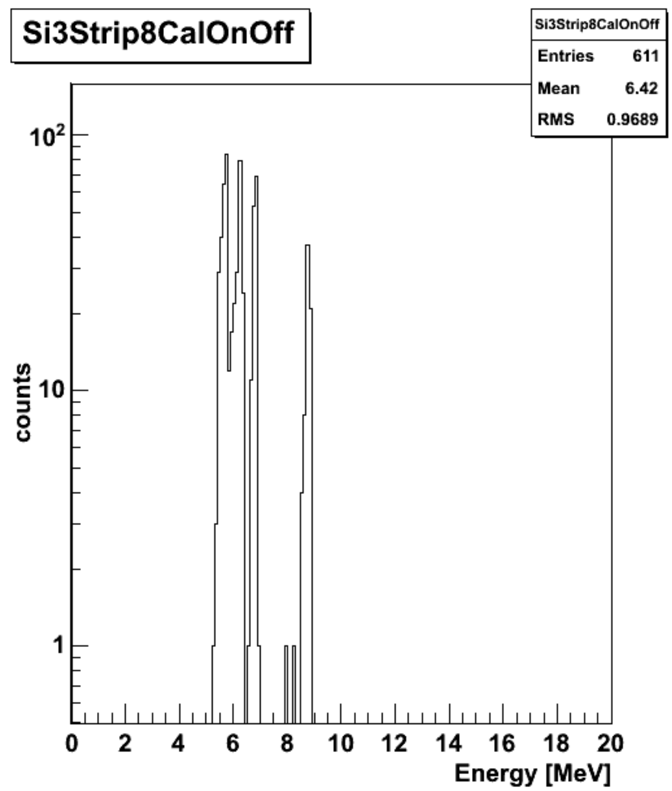

FIG. 2. ^{228}Th source spectrum

The measurements preformed with the beam on target show that there is a huge number of events coming from prompt radiations such as high energy neutrons. Once the beam is turned off these events dramatically decrease as shown in Fig.3.

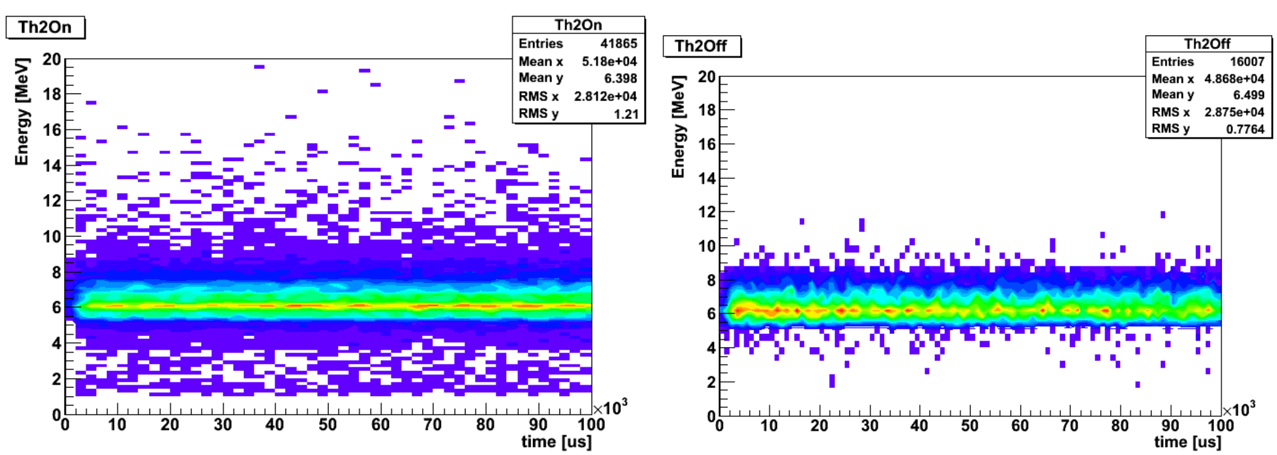

FIG. 3. Energy measured by the Si detectors 3 and 4 as a function of the time in case of beam-on target (left panel) and beam-off (right panel).

A very preliminary analysis of the data measured in the beam-off condition shows several events with energy around and above 10 MeV. The data analysis is still in progress.

A further improvement of the measurement will be possible by adding thin silicon detectors in front of the thick silicon detectors in order to make particle identification and separate alpha particles from other radiation.

[1] M. Barbui *et al.*, INPC 2010 Conference proceedings, J. Phys. Conf. Series (accepted).