Progress on the ^{16}N beta delayed alpha decay studied using the Center for Nuclear Study Multi Sampling Time Projection Chamber

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The importance of measuring the cross section of the nuclear reaction ^{12}C$(\alpha,\gamma)^{16}$O at astrophysical energies is well known. Despite half a century long efforts to perform this measurement, knowledge regarding this cross section remains unsatisfactory. Direct and indirect approaches have been used in order to determine a reliable estimation of its value, which is buried in the realm of the tenth of femtobarn[1)]. Direct measurements were performed down to a center of mass energy of approximately 1 MeV, however, the goal for the application to astrophysics requires to reach 300 keV. With regards to indirect methods, it has been shown that important pieces of information on the E1 component of the ^{12}C$(\alpha,\gamma)^{16}$O cross section can be derived from the study of the ^{16}N beta delayed alpha decay[2)]. Many attempts were conducted to measure the low energy tail of this latter alpha spectrum and the state of the art on these studies is reported in a paper by Tang and collaborators[3)].

In order to improve the available results on the measurements of the spectrum of the alpha particles emitted in the decay of ^{16}N, we proposed a new experimental approach based on the use of the Multi Sampling Time Projection Chamber (MSTPC) of the Center for Nuclear Study (CNS) of the University of Tokyo. In this new approach the limitations arising from the use of implantation foils adopted in all previous experiments were eliminated, because the chamber itself becomes the implantation material, and the detection efficiency of the decay products is also increased.

The experiment required a long technical development phase. During this phase, two ^{16}N beam production test runs were performed at the CNS Radiocative Ion Beam (CRIB) facility with very good results. The intesities of the ^{16}N beam obtained during these tests reached 10^6 ions per second. A key point in the experiment was the necessity of using MSTPC in pulsed mode: an implantation period, during which the beam is sent and stopped in the middle of the active region of the MSTPC, is followed by a time period in which the beam is stopped before entering CRIB and the ^{16}N decay events are detected and registered by the MSTPC. In order to prevent the destruction of the active devices of the MSTPC, namely two gas electron multipliers, a gating grid was introduced to stop electron multiplication during the ^{16}N beam implantation period. Various timings for the implantation (beam on) and counting (beam off) periods were tested. The final decision was to use an equal duration of 50 ms for these two periods.

Despite the fact that during the experiment the intensities of the beam reached a value that was lower than expected on the basis of the previous tests, the experiment was technically successful and data analysis is being initiated.

References
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