Direct mass measurements of neutron-rich Ca isotopes beyond $N = 34$

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The shell evolution in nuclei far from stability is one of the main subjects of nuclear physics. Nuclear mass is one of the most fundamental quantity providing information on the shell structure. The neutron numbers of 32 and 34 have been suggested to be candidates of new magic numbers in the Ca isotopes[1)]. Recently the masses of ^{53}Ca and ^{54}Ca were measured, and the shell closure at $N = 32$ was established[2)]. The present work aims at studying the nuclear shell evolution at $N = 32, 34$ by direct mass measurements of neutron-rich nuclei in the vicinity of ^{54}Ca.

The experiment was performed at the RIKEN RI Beam Factory (RIBF). The masses were measured directly by the TOF-$B\rho$ method. Neutron-rich isotopes were produced by fragmentation of a ^{70}Zn primary beam at 345 MeV/nucleon in a ^{9}Be target. The fragments were separated by BigRIPS, and transported in the High Resolution Beam Line to the SHARAQ spectrometer. The beam line and SHARAQ were operated in the dispersion matching mode allowing a momentum resolution of 1/14700.

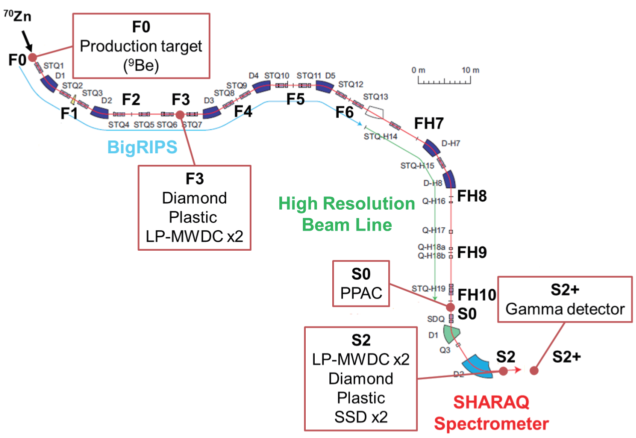

Fig. 1. Schematic view of the beamline and the detectors used in the experiment.

A schematic view of the beamline with the detectors used in the experiment is shown in Fig. 1. The TOF was measured with newly developed diamond detectors[3)] installed at BigRIPS-F3 and the final focal plane of SHARAQ (S2). The flight path length between F3 and S2 is 105 m along the central ray. We installed two low pressure multi-wire drift chambers (LP-MWDCs)[4)] at both F3 and S2 to correct the flight pass lengths using the tracking information on an event-by-event basis. The $B\rho$ value was measured by a parallel plate avalanche counter (PPAC) located at the target position of SHARAQ (S0). At S2, we mounted two silicon strip detectors for identification of the atomic numbers of the fragments. To identify the isomers, which leads to a systematic shift towards higher masses, we placed a plastic stopper downstream of S2 and a γ-detector array consisting of 2 Ge clover and 16 NaI(Tl) detectors. Details of this system can be found in Ref.[5)].

Figure 2 shows the preliminary particle identification of the secondary beams. The total yield of ^{55}Ca was on the order of several thousands. Many species of reference nuclei over a broad range of A and Z were observed, which were used in the mass calibration. Further analysis is in progress.

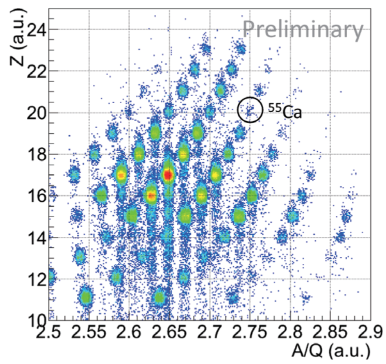

Fig. 2. Particle identification of the secondary beams.

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