Performance of MUlti-Sampling Ion Chamber (MUSIC) for particles identification of light neutron-rich isotopes.

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We are developing a MUlti-Sampling Ion Chamber (MUSIC) similar to the one constructed before [1] for use in identification of charges (proton numbers) of light neutron-rich isotopes. We are studying the proton-density distribution radii of the p-sd shell neutron-rich isotopes using a new experiment method, namely charge changing cross section (CCCS) measurements. The CCCS's will be measured using the transmission method. In this method, we measure the incident radioactive-istope (RI) beam, as well as the outgoing particles with the same proton number as the incident beam. In our previous experiments [2], we used silicon detectors for the identification of the outgoing particles. In the coming experiments, we plan to use MUSIC instead of Si detectors in order to avoid channeling effect in the silicon crytal, to reduce energy loss of particles as well as energy straggling in detectors, and to increase the number of ΔE signals.

We have constructed the MUSIC detector and performed a test experiment to study the performance of the detector. Figure 1(a) shows the layout the MUSIC detector, which consists of 17 electrode plates tilted at 60 degree. There are eight anodes and nine cathodes, which corresponds to eight ΔE detectors inside a chamber. The detector was filled with 1 bar PR10 gas and operated at voltages between 500 – 1000 V. In this report, we present the results of the test experiment.

The experiment was performed at the RCNP EN course [3]. A primary ^{36}Ar beam at 53A MeV bombarded a ^{9}Be target. Secondary beams produced via projectile fragmentation reaction were momentum analyzed and separated using the projectile-fragment separator at the EN course. For testing MUSIC, the isotopes with ratio of $A/Z = 2.125$ were selected. The secondary beams were transported to the MUSIC after going through beamline detectors, which include parallel-plate avalanche counters, Si detector, and plastic scintillators (PLs). The incident nuclei were identified using the time of flight (TOF) and ΔE information; the ΔE and TOF were measured using a 320 μm-thick Si and a 200-μm-thick PL (F2PL) incorporating the RF signal from the AVF cyclotron. Further particle indentifications (PIs) were performed using MUSIC as well as two 500-mum-thick Si detectors and/or a 7-cm-thick NaI placed after MUSIC. This setup allowed us to compare the PI using the ΔE-TOF and $E - \Delta E$ methods, as wel as to evaluate the resolution for proton number Z identification of MUSIC. Figure 1(b) shows a scatter plot of analogue signal of one of the ΔE values of MUSIC and TOF of particles 4 m after F2PL. The resultant Z distribution of the selected ejectiles with $2.15 < A/Z < 2.5$ is shown in Fig.1(c). The resolution was about 0.25 – 0.30 (in r.m.s.) between $Z = 5$ and 8, sufficient for Z separation for the p-sd shell nuclei in our planned CCCS measurements.

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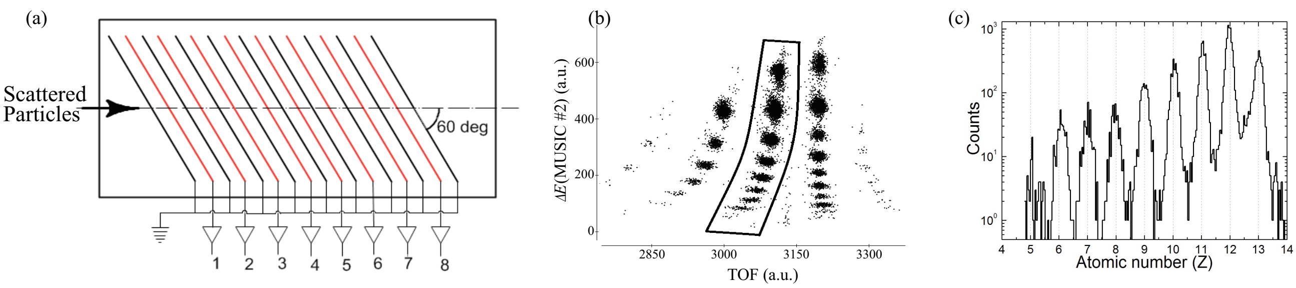

Figure 1: (a) MUSIC, (b) PID using ΔE-TOF, and (c) Z distribution for the isotopes selected in (b).

References

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