SHARAQ Project — Progress in FY2010 —

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This article reviews the progress of SHARAQ project in the fiscal year 2010. We have performed two physics runs at BigRIPS, high-resolution beam line [1] and SHARAQ spectrometer [2] in October 2010. To improve the performance of SHARAQ, we have also done several detector developments and ion optics studies for performed and upcoming physics experiments.

1. Optics study and detector development for experiments in SHARAQ

Prior to the experiment, we have studied the high-rate capability of beamline detectors LP-MWDC [3], and the plastic tracking detector [5]. To check performance of the LP-MWDC and to search operation parameters under the high-irradiate condition, we performed irradiation test by using the Pelletron beamline at RIKEN. The MWDCs is operational under intense beam of \(2 \times 10^6\) particle/sec and operated stably during the experiment. The detail is described in Ref. [4]. Plastic tracking detector is developed for beam tracking under the high-rate and high-dense condition such as an achromatic focus. The details of the tracker refer to Ref. [5]. In the experiments in October, 2010, the tracking detector was installed at the F3 achromatic focus of BigRIPS, which is the starting point of beam transport of SHARAQ. Beam spot at F3 is approximately 3 mm in diameter and beam flow reaches \(\sim 10^9\) counts/sec/mm\(^2\). The detector was also stably operated during the experiment. Combined with the LP-MWDC, RI beam tracking at F3 was successfully carried out.

In the optics study, we demonstrated dispersion-matching (DM) beam optics of RI beam for the first time. The momentum-independent tuning method [6] efficiently worked in momentum dispersive foci in beam tuning. The DM focus condition was achieved against widely momentum-spread beams. Conclusively we achieved the momentum resolution of approximately 1/5000. Further studies of improve the momentum resolution are in progress.

For upcoming experiments in SHARAQ, we started mainly two development projects. First, we studied two tracking capability of SHARAQ final focal plane system, which consists of Cathode-Readout Drift Chambers (CRDCs) and a three-layer plastic scintillator hodoscope [7]. To track two particles by this system, we needed to create two strobe triggers for CRDCs, because the hit timings of two particles are difference. We built a trigger logic circuit in FPGA module, demonstrated the two particle tracking. Details on the logic of the circuit are shown in Ref. [8]. Second, we developed the CVD diamond detector as detectors for SHARAQ beamline with extremely good timing resolution. The detector is expected to improve the resolution of time-of-flight very much, and we plan to measure of nuclear mass of short-lived nuclei far from stability, combined the high-momentum-resolution performance of the SHARAQ spectrometer. In January 2011, we examined irradiation test by using \(\alpha\) particles at 32 MeV, we estimated detection efficiency and timing resolution of the detector. Detail is reported in Ref. [9].

2. Physics runs: \(^{10}\text{C},^{10}\text{B}(T = 1)\) and \(^{12}\text{N},^{12}\text{C}\) experiments

Two physics programs on Isovector-type responses in nuclei by using BigRIPS, high-resolution beamline and SHARAQ spectrometer were performed in October 2010. Each program is characterized by its reaction selectivity of the RI-induced reaction: The \((^{10}\text{C},^{10}\text{B}(T = 1))\) reaction is a probe of \(\Delta T = 1\), \(\Delta S = 0\) mode, and therefore is considered to be sensitive to Isovector spin-non-flip monopole transition in nuclei; Meanwhile the \((^{12}\text{N},^{12}\text{C})\) reaction is a probe of \(\Delta T = 1\), \(\Delta S = 1\) mode with largely positive Q value, and therefore is considered to be sensitive to Isovector spin monopole transition in nuclei. In these experiments, we adopteddispersion-matched RI beams of \(^{10}\text{C}\) and \(^{12}\text{C}\) and analyzed the momenta of ejectiles from \(^7\text{Li}\) and \(^{90}\text{Zr}\) targets with the SHARAQ spectrometer. Details of these experiments are described in Refs [10, 11].

References