Design of High Resolution SHARAQ Spectrometer at RIBF

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The high-resolution SHARAQ spectrometer is now under construction at RI Beam Factory (RIBF) of RIKEN. The spectrometer will be used in nuclear physics experiments in combination with a variety of radioactive isotope (RI) beams from BigRIPS [1]. Among physics programs proposed, the most characteristic one is a new missing mass spectroscopy with an RI beam used as a “probe” [2].

RI beams have a variety of isospin (T), internal energy (mass excess) , and spin (S), while light stable beams such as proton, deuteron, and $^{3,4}\mathrm{He}$ have $T, S < 1$ and the minimum internal energies among isobars. Due to the properties, RI-beam induced reactions can have a unique potential to be used to investigate nuclear many body systems. RI beams produced in RI beam factory (RIBF) at RIKEN will have an energy ranging 100–300 MeV/A which is most appropriate for spectroscopic purposes. It is well known that, at these energies, nucleon-nucleon interaction is weakest and thus a nucleus is most transparent. Particular emphasis should be also placed on additional advantange of 100–300 MeV/A beams that the spin-isospin modes are most strongly excited relative to the spin-isospin independent ones. By full use of these unique properties of RI beams from RIBF, one can explore little-studied giant resonances, such as isovector spin monopole resonances and double Gamow-Teller resonances. It will also permit spectroscopic studies of tetra-neutron states, n^4, and super heavy hydrogen isotopes.

The SHARAQ spectrometer is designed to achieve a momentum resolution of $\delta p/p = 1/15000$ and an angular resolution of $\Delta\theta < 1$ mrad for particle with magnetic rigidity of $B\rho = 6.8$ Tm at maximum. Normal-conducting dipole magnets with an orbital radius of 4.4 m combined with superconducting doublet quadrupoles and one normal-conducting quadrupole are used to meet the design criterion.

In a measurement using the high resolution spectrometer, a momentum spread of a secondary beam usually limits the resulting energy resolution. A dispersion matching technique and/or an event-by-event monitoring of the beam momentum will be introduced for the purpose to compensate the momentum spread of the RI beam.

After a brief overview of the proposed physics programs, details of the spectrometer design and a dispersion-matched beamline will be presented.

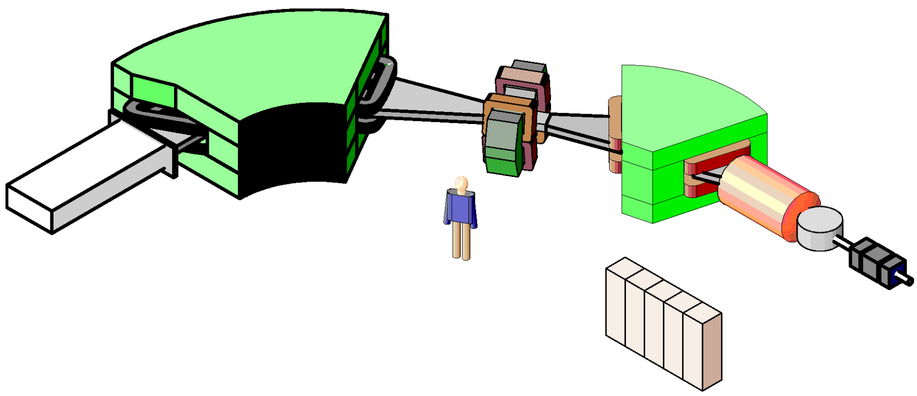

Figure 1: *Overview of the SHARAQ spectrometer.*

[1] T. Kubo, Nucl. Instrum. Methods B **204** (2003) 97.
[2] S. Shimoura et al., proposal for RIBF International Advisory Committee, 2004.