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Science with Q3D mode of SAMURAI

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Study of three-nucleon forces (3NFs) is essentially important in clarifying nuclear phenomena. Few-nucleon scattering, e.g. deuteron-proton (dp) elastic scattering, dp breakup reactions, at intermediate energies ($E \sim$ 100-400 MeV/nucleon) is one attractive probe to investigate the dynamical aspects of 3NFs, such as momentum and/or spin dependences. Direct comparison between the data and the rigorous numerical calculations based on bare nuclear potentials provides information of 3NFs. So far large 3NF effects are theoretically predicted and experimentally confirmed in the cross section minimum for dp scattering at $\sim$ 100 MeV/nucleon. With the aim of clarifying roles of the 3NFs in nuclei the experimental programs with polarized deuteron beams at intermediate energies are in progress at RIBF. At RIBF polarized deuteron beams are available up to 400 MeV/nucleon by using the three cyclotrons, AVF, RRC and SRC. Highly polarized deuteron beams, typical values of which are 80% of the theoretical maximum values, have been obtained at 250 and 300 MeV/nucleon. In order to extract detailed properties of 3NFs high precision data are needed. The Q3D mode of the SAMURAI serves as a high-resolution spectrograph in which the triplet-Q-magnets STQ in conjunction with the SAMURAI dipole magnet are used as analyzer magnets. The momentum resolution of this mode is estimated to be $p/\delta p \sim 3000$. The angular range is covered from $0-5$ degrees in the laboratory systems. Charge collection of the deuteron beam is performed with the Faraday cup installed downstream of the SAMURAI dipole magnet. This system suits for the study of high momentum transfer region in dp scattering where effects of short range 3NFs are expected to be obtained. As the first measurement with polarized deuteron beams with the SAMURAI Q3D mode dp scattering at very backward angles 160°-180° in the center of mass system is planned.