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New Tilted-Foils Plus beta-NMR Setup at REX-ISOLDE. Polarized Nuclei for Nuclear and Solid-State Physics Experiments.

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The possibility of obtaining spin-polarized nuclei is an essential asset for performing nuclear physics experiments with radioactive nuclei. The nuclear magnetic-dipole and electric quadrupole moments are of key importance for the profound understanding of the nuclear structure, especially when one moves away from the stability line. Obtaining an ensemble of polarized nuclei is a primary requirement for this type of experiments.

One way to obtain an ensemble of polarized nuclei is by the use of the Tilted Foils (TF) technique [1] in which an atomic spin-polarization is obtained via the surface interaction of ions traversing a multifoil stack at an oblique angle. The atomic polarization thus produced is subsequently transferred to the nuclear spins. The TF polarization technique has been used up to now for nuclear-moment measurements [1] and the experimentally observed polarization has been of the order of 1%. Much more favourable conditions for the application of the TF technique can be achieved at beam energies of about 1 MeV/u. Therefore we are planning to install a TF setup after REX-ISOLDE followed by a beta-NMR setup that will be provided by HMI, Berlin. The new setup will alleviate numerous conceptual and technical issues that hampered previous experiments at ISOLDE on the High-Voltage platform [1].

An additional possibility is to use the TF + NMR setup for solid-state physics applications; for this, a polarization of the order of 10% or higher is required. Provided that such conditions are feasible, this presents great advantage for solid-state physics experiments since a beta-NMR experiment with polarized nuclei increases the sensitivity over a conventional NMR by more than 10 orders of magnitude. This would provide the ability to probe, for example, surface states and thin film layers, such as those increasingly being considered for next-generation magnetic devices, e.g. single molecule magnets [2].

The necessary developments in order to make the project a success will be discussed together with the perspectives for nuclear- and solid-state physics programs that can profit from the installation of such a setup at ISOLDE.

[1] L. Baby et al., J. Phys. G 30, 519 (2004); and references therein.
[2] Z. Salman et al. Nano Letters 7(6) 1551 (2007).

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