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## Neutron reflectometry with micro-second time resolution

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We propose to implement a new modulation technique at NREX adding time resolution to polarized neutron reflectometry (PNR). The new technique is based on intensity modulation by a radio-frequency (RF) spin flipper, and shares some basic concepts with the MIEZE spin-echo technique. The aim is to resolve the kinetics of the nuclear and magnetic scattering length densities in periodic processes with a time resolution of a few micro-seconds, corresponding to an improvement of two orders of magnitude compared to conventional techniques. One main application of this new technique will be the study of so called magneto-ionic (MI) materials, which have a high potential in ultra-low-power neuromorphic computing applications. The electric and magnetic properties of magneto-ionic materials can be tuned or switched by a small gating voltage, which drives the transport of ions perpendicular to the layer boundaries. Oxygen, nitrogen, lithium, or hydrogen were used as mobile ions in MI materials, where hydrogen shows the highest mobility and thus allows for fast switching. Time resolved PNR will be a unique tool to study the switching process in MI materials in-situ, as both the hydrogen and the magnetization profiles can be determined with high accuracy. In addition, H/D contrast variation will permit to distinguish hydrogen migration from concurrent parasitic transport of other ions such as oxygen, a process which typically occurs in oxide materials.

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