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Magnetic Moment Measurement of ^{11}Be with ppm Accuracy

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β-detected Nuclear Magnetic Resonance (β-NMR) is a method for measuring the nuclear magnetic moment of unstable nuclei. It allows investigations of short-lived isotopes with a sensitivity inaccessible to conventional NMR. This increased sensitivity is gained by combining hyperpolarization of the nuclear spin generated through optical pumping, and an efficient detection exploiting the asymmetry in emission of β-particles from the decaying polarized isotopes. A β-NMR experiment to measure the magnetic moment of ^{11}Be is planned in a November 2024 beamtime at VITO. ^{11}Be is of interest because it is a single neutron halo nucleus. Measuring the magnetic moment of ^{11}Be with ppm level accuracy will help to give insights into the nuclear magnetization distribution of ^{11}Be and thus directly confirm its halo structure.
To enable such ppm level accuracy measurements, the VITO beamline has undergone multiple major upgrades and extensions in the past, such as, the installation of a superconducting solenoidal magnet with sub-ppm homogeneity and the ability to measure in liquid samples [1]. The beta detectors are an essential component; their purpose is to detect the asymmetrically emitted β-particles from the hyperpolarized decaying isotopes. For the ^{11}Be beamtime a new detector setup will be used. Unlike the previous setup, this new detector system will be capable of measuring the energies of the detected β-particles. This is useful because in ^{11}Be the two most intense transitions, the transition to the ground state and the first excited state have opposite beta asymmetry parameters and cancel each other out [2]. Measuring only the higher energy decay to the ground state will result in an increased measured β-decay asymmetry. Another upgrade for the ^{11}Be measurement is an optical pumping scheme that aims to achieve a higher degree of nuclear polarization by using two transitions.

[1] Gins, W. & Harding, R et al., NIM A: 24, 925 (2019)
[2] C. D. P. Levy et al., Hyperfine Interact 196, 287–294 (2010)

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