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Design of a novel pulsed spin resonator for the beta-decay experiment PERC

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The PERC (Proton Electron Radiation Channel) project searches for new physics beyond the Standard Model of particle physics via the beta-decay of free neutrons. The demand of precisely defined initial parameters for the neutron beam, i.e. wavelength, pulse width and degree of polarisation is achieved by using both a velocity selector and a neutron chopper in the "standard"set-up [1]. The use of a novel pulsed neutron magnetic spin resonator as a replacement for these two components will lead to a higher count rate and will give rise to a unique flexibility in triggering the standard machine parameters by purely electronic means. It is well known that the passage of polarised neutrons through a spatially alternating transverse magnetic field is leading to individual frequencies depending on the neutron velocity and the period of the alternating field. If this frequency equals the Larmor frequency, determined by the static guide field in the rest frame of the neutrons, a resonant spin flip will take place. This effect is used to monochromatise a polarised beam [2, 3]. We propose a novel design of such a resonator consisting of a sequence of separate modules, providing high homogeneity of the transversal field oscillations and fulfilling the specifications for fast electronic switching to allow a rapid chopping of the beam [4]. Both the selected wavelength and the respective wavelength resolution of this device can be changed in an instant as well as the time structure of the neutron pulse can be changed. In order to find the optimal resonator configuration we present a detailed analysis of various possible arrangements. Although motivated by the requirements of the PERC project this development could readily find applications in various fundamental precision experiments with cold neutrons.

References

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