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Beamline and magnetic field preparation for correlation coefficients measurements in the BRAND experiment

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BRAND is a precision experiment that will investigate free polarized neutron beta-decay [1] at the PF1B cold neutron beamline of the Institut Laue-Langevin (ILL), which offers the world's highest cold neutron flux [2]. The experiment will perform simultaneous measurements of 11 correlation coefficients in neutron beta-decay [3], including five that have never been measured before. This enables a sensitive search for possible scalar or tensor interactions beyond the Standard Model through the analysis of transverse elec-tron polarization. The first beamtime for the BRAND-2 setup is planned in the first half of 2026, and will require both uniform magnetic field and targeted beamline preparations.

Neutrons are polarized by PF1B's supermirror polarizer which provides beam-averaged polarization up to 99.7% [4]. A highly uniform magnetic field of low magnitude is required within BRAND's fiducial volume in order to, on one hand, align and preserve the neutron polarization, and, on the other hand, to minimize deflections of charged decay products, facilitating accurate reconstruction of their trajectories. To achieve this, an Active Magnetic Shielding system (AMS), similar as [5,6], will fully enclose the BRAND detection apparatus. The AMS will actively compensate for static magnetic perturbations –such as the Earth's magnetic field –as well as dynamic fluctuations that can be caused by nearby instruments at the ILL. Addi-tionally, efficient spin transport is necessary between the polarizer, which operates with a transversal field, and the decay chamber, where a longitudinal field is needed.

BRAND aims for precision measurements of correlations between the momenta of decay products and the spins of both the neutron and the electron, requiring a high and precisely known neutron polarization. Measuring the polarization of the neutron, and conversely, deriving it from the measured beta asymmetry A, allows for cross-checks of the beam polarization. This makes neutron polarization one of the critical tools to validate the BRAND-2 setup, and assess systematic effects.

This poster presents the simulation results of the final design of the Active Magnetic Shielding system built for the BRAND experiment. It also includes results from McStas simulations of the PF1B beamline, aimed at improving the accuracy of the beamline model. Finally, the preliminary design of the beamline for the BRAND-2 setup, and the polarization measurement plans will be presented.

References

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