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Tue-Mo-Po2.01-01 [1]: A large scale cryogen-free magnet for neutron decay research

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The design of a large purpose built cryogen-free magnet is reviewed. The system has been manufactured for the Fundamental Neutron Physics Beamline at the Spallation Neutron Source in Oak Ridge, Tennessee.

The magnet system will house a custom spectrometer and be used to measure a, the electron-neutrino correlation parameter, and b, the Fierz interference term in neutron beta decay.

The cryostat is cylindrical, 7.5m along its axis and 1.43 m in diameter. It houses a complex set of niobium-titanium superconducting windings which provide a varying magnetic field profile along a 320mm diameter gold-plated UHV bore. The bore tube extends along the full length of the cryostat and has orthogonal ports connected to the neutron beamline. A vacuum of $<3.10 \cdot 10^{-10}$ mbar is achieved.

The stray field generated by the magnet windings is compensated by a series of negatively wound co-axial windings which have approximately twice the diameter of the internal positive windings. The cryostat system will be housed in a passive steel shield to further compensate the stray field.

The magnet windings operate nominally at 4K and are cooled by four Gifford McMahon two-stage cryocoolers, each delivering 1.5W cooling power at their second stage. No liquid cryogenes are used for normal operation of the system. The cryostat design allows the magnet system to be operated in both horizontal and vertical orientations.

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