Design and Construction of a Radio Frequency (RF) Neutron Spin Flipper

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The Spallation Neutron Source is a proton accelerator-based neutron source that provides neutron beams for materials research. Neutrons have nonzero magnetic moment that can be aligned using magnetic field bias. The alignment can be altered by applying an orthogonal radio frequency (RF) field bias to be used in the Magnetism Reflectometer for certain neutron scattering experiments. An RF neutron spin flipper, which can perform the function mentioned above on the spin of neutrons, has been designed and being manufactured. The new neutron spin flipper has greater cross sectional dimensions (12 cm x 12 cm) and length (30 cm) of a square solenoid compared to those currently being used in the experiments. The spin flipper provides a fixed transversal DC magnetic field with a longitudinal gradient and an AC magnetic field inside the square solenoid. We achieved the particular DC magnetic field distribution with an axial gradient by optimizing the spatial distribution of the permanent magnet elements. The uniformly wound square solenoid operates at ~ 150 kHz RF. The low resistance of the solenoid winding needs an impedance-matching network to maximize power delivery from the power amplifier. The DC and AC magnetic designs were performed using the CST design suite, a 3-D finite difference time domain code package. The neutron spin flipper is now under construction, and final measurements are being performed, making adjustments of the fields based on design values.