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Superconducting YBCO Wollaston Prism for Spin Echo Scattering Angle Measurement

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Abstract

A Wollaston prism, consisting of two adjacent triangular prisms with perpendicular optic axes, causes the two polarization components of a light wave to diverge at the interface between the triangular prisms. A similar device, constructed using two triangular currentcarrying coils with opposite magnetic fields, produces the small angular separation between neutron spin states that is required for Spin Echo Scattering Angle Measurement (SESAME). Current designs of neutron Wollaston prisms using resistive wire have lower than optimal magnetic fields and place a significant thickness of aluminum wire in the neutron beam.

We have developed a new design which uses high temperature superconducting tape to carry current and a thin film of superconducting YBCO on sapphire as a Meissner screen. The device uses four triangular coils, each wound with six layers of YBCO superconducting tape (SuperPower®2G HTS Wire) to generate magnetic fields within the Wollaston prism. In the middle of the Wollaston prism there is an YBCO film (a 350 nm YBCO layer capped with 100 nm of gold on a 78 x 100 x 0.5 mm sapphire substrate, Theva, Germany). This film is mounted to provide a well-defined non-adiabatic field transition over a flat surface that is inclined to the average neutron beam direction, as required for SESAME. Two other YBCO films are installed on the sides of the Wollaston prism that are parallel to the neutron beam to help produce more uniform magnetic fields. In this design, the maximum neutron beam size that can be used is 2.5x5.5 cm^2. The device is encased in a helium filled aluminum vessel to provide good thermal contact between the cold head of a cryocooler (Cryogenic Refrigeration Systems, Sumitomo (SHI) Cryogenics of America, Inc.) and the YBCO components.

A prototype prism has been built and tested on the SESAME beam-line at the LENS neutron source at Indiana University and the results will be presented.

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