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Development of In-situ Polarizer and Analyzer for the POLI Instrument at FRM II

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POLI is a versatile two-axis single-crystal diffractometer at the FRM II, primarily dedicated to the investigation of magnetic structures in single crystals using polarized neutrons. Neutron polarization at POLI was previously realized via a MEOP (Metastability Exchange Optical Pumping) system. Recent tests have demonstrated that in-situ SEOP (Spin-Exchange Optical Pumping) polarizers can achieve polarization efficiencies exceeding 50%, significantly surpassing the performance of the MEOP system. To implement this improvement, two in-situ SEOP-based polarization devices—a polarizer and an analyzer—were developed. In these systems, polarized ^3He gas is heated to $200\text{ }^{\circ}\text{C}$ using an integrated oven with electrical heating elements and high-power laser pumping. The polarization cell and heating unit are enclosed in a magnetically shielded housing composed of precision-shaped mu-metal plates and copper coil windings, ensuring a stable magnetic holding field. To maintain external surface temperatures below $40\text{ }^{\circ}\text{C}$, an active cooling system was designed. Its required performance was determined through finite element thermal simulations, which guided the selection and integration of a suitable cooling unit. The aim of this development is to enhance the polarization capabilities of POLI and enable high-efficiency magnetic structure studies. The SEOP devices and auxiliary systems have been fully constructed and are currently undergoing commissioning and performance testing.

Primary author: BINGÖL, Kendal (JCNS at Research Center Jülich)

Presenter: BINGÖL, Kendal (JCNS at Research Center Jülich)

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