ACCELERATOR SEMINAR

Beam Positioning and Beam Polarization Monitor Based on Large Area HTS Pickup Coils

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Non-destructive sensing of position of low-current charged particle beams is a critical component of high-energy and nuclear science experiments and in some medical accelerator applications. A popular solution, RF beam position monitor (BPM), relies on detection of electromagnetic resonant modes in an RF cavity. The method requires a bunched beam and has a sensitivity limit.

Superconducting Quantum Interference Device (SQUID) can detect very small, (fT, 10^{-15} tesla), variations of magnetic field. A SQUID can in theory detect the position of a DC beam by reading the magnetic field of the beam. Low-temperature SQUIDs require cooling down to liquid helium temperature, which is difficult to realize in a beamline device. High-Temperature Superconductivity (HTS) enables SQUID devices that operate at a practical liquid nitrogen temperature. However, HTS-SQUIDS are manufactured as small, typically 10x10 mm chips, which cannot be effectively electromagnetically coupled to a particle beam.

In this development, Brookhaven Technology Group (BTG) in collaboration with STAR Cryolectronics designed and developed a novel BPM prototype that combines and HTS SQUID with a persistent large area HTS coil structure. In this project, we leverage the recent availability of wide large area epitaxial HTS films deposited on flexible non-magnetic substrates. The device has one-dimensional sensitivity with an electrical zero (or null), which allows for design of a compact and sensitive BPM.

In Phase I, we demonstrated the feasibility of the method. Wide area tapes were laser-cut into seamless, fully persistent pick-up loops or antennas that were magnetically flux coupled to an HTS SQUID gradiometer. The prototype demonstrated 100 nA resolution and linear response to the wire displacement.

In the presentation we will discuss results of the electromagnetic modeling and the coil optimization. Results of Phase I prototype performance tests using a wire with electric current will be discussed Further we outline design of a beamline device and possible use of the technology for non-invasive measurement of a particle beam polarization.

Monday, November 7, 2016
11:00 a.m.
CEBAF Center, Room F113

Coffee before seminar beginning at 10:45 p.m.

Jefferson Lab

For further info, please contact Joe Grames at x7097