Contribution ID: **316** Type: **Poster**

Feasibility Study of Hybrid Magnetic Cloak for Accelerator Magnets

Tuesday, 26 May 2015 17:58 (0 minutes)

It is well known that superconducting (SC) materials repel magnetic field, whereas paramagnetic ones concentrate flux lines in their interior. By using concentric tubes of the two materials, the magnetic field inside a cylinder is canceled without modifying the external applied field. Analytical solutions exist, which provide a relation between the thickness of the paramagnetic material and the relative permeability necessary for a complete cloaking. In this paper we perform a feasibility study on whether this concept works to shield large magnetic fields, by using bulk MgB2 superconductor prepared by the Reactive Liquid Infiltration (RLI) in-situ process. With conventional ovens, it is possible to produce large superconducting bulk pieces using this patented technology. A number of paramagnetic materials have been searched for, and their magnetic permeability measured. Tube junctions have been studied, as well as effects of tube ends, geometry and flux jumps. A successful hybrid cloak would find immediate application at FNAL in the Muon g-2 experiment, which presently relies on a SC inflector magnet to cancel the 1.5 Tesla storage ring field seen by the muon beam at injection.

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Session Classification: Applied Superconductivity in HEP - Poster Session

Track Classification: S3 - Applied Superconductivity in HEP