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β-SRF —A Facility for Depth-Resolved Characterization of the Magnetic Field Screening in Superconducting RF Materials

A new beamline called "β-SRF" has been built at TRIUMF, allowing for the near surface characterization of materials with β-radiation-detected nuclear magnetic resonance (β-NMR) in applied magnetic fields up to 200 mT parallel to the sample surface. These capabilities are relevant for the study of Nb superconducting radiofrequency (SRF) cavities - common components in particle accelerators - where subtle modifications to their subsurface (i.e., the first ~100 nm) due to processing can drastically affect their RF dissipation and limit their maximum accelerating gradient. Understanding the mechanisms behind these surface modifications is imperative for large scale superconducting linear accelerators (linacs), as they impact both their capital and operating costs. Here, the details of the "β-SRF" beamline, along with its first measurements on two Nb samples with surfaces that mimic high-performance SRF cavities, are presented. The samples show contrasting evolution in their magnetic field screening as the applied field is increased. These unique measurements provide insight into how the impurities generated from cavity surface treatments affect Meissner screening in Nb, as well as how this dissipative field penetration evolves with increasing field.

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