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Magnetic flux expulsion lens: concept and measurements

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The trapping of magnetic flux during the transition of a superconducting radio frequency (SRF) cavity can substantially increase RF dissipation in the cavity walls, leading to a reduction in Q0, that in turn can increase cryogenic costs. The impact of trapped magnetic flux can be reduced by either suppressing the ambient magnetic field or by limiting/removing the influence of pinning sites in the material. The former involves custom engineering solutions, the latter requires an understanding of the magnetic response of the cavity material. To quantify magnetic trapping of cavity material, a magnetic flux lens (MFL) has been developed at CERN. This device is based on topological conduction cooling for small samples, allowing repeatable cooling dynamics to analyse the spatial thermal gradients and velocity of the superconducting wavefront. Each thermal cycle investigates the magnetic flux trapping on a macroscopic scale. A program of quantitative measurements of magnetic flux expulsion on flat samples has been used to assess the expulsion efficiency of bulk Nb, cold worked bulk Nb with and without heat treatments, sputtered Nb on Cu, sputtered Nb3Sn on Cu and SIS multilayer structures. An overview of the results are reported. Our concept offers a stand alone means to control the dynamics of the Meissner effect, and the MFL can be used both for material qualification and for investigation of the magneto-thermal behaviour of the RF layer.

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Footnotes

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Author: TURNER, Daniel (European Organization for Nuclear Research)

Co-author: MACPHERSON, Alick (European Organization for Nuclear Research)

Presenter: TURNER, Daniel (European Organization for Nuclear Research)

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