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A Hybrid Trapped Field Magnet Lens (HTFML): concept and experimental realization

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The concept of a Hybrid Trapped Field Magnet Lens (HTFML) is described, which exploits two different characteristics of type-II superconductors: the “vortex pinning effect” of an outer superconducting bulk cylinder, which acts as a trapped field magnet (TFM) using field-cooled magnetization (FCM), combined with the “diamagnetic shielding effect” of an inner bulk magnetic lens using zero-field cooled magnetization (ZFCM) [1]. The HTFML can reliably generate a concentrated magnetic field in the center of the lens that is higher than the trapped field from both the cylindrical bulk TFM and the external magnetizing field, even after the externally applied field decreases to zero. We predicted numerically a concentrated field of B_c= 4.73 T under an external magnetizing field of B_{app}= 3.0 T using an MgB_2TFM cylinder and GdBaCuO lens design with a single cooling stage, and a B_c= 13.5 T under an external magnetizing field of B_{app}= 10 T using an all-GdBaCuO cylinder and lens design using independent temperature control of each part [1]. In this presentation, we report the experimental verification of the HTFML using the MgB_2TFM cylinder and GdBaCuO lens design. Using an optimised lens design [2], a maximum concentrated magnetic field of B_c= 3.55 T was achieved experimentally at the central bore of the HTFML after removing an applied field of B_{app}= 2.0 T at T_s= 20 K. The HTFML effect is also reported using the all-GdBaCuO cylinder and lens design at 77 K. The HTFML device could prove useful to enhance the magnetic field for bulk NMR/MRI systems and to achieve a locally higher magnetic gradient for magnetic separation applications.

References
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