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[Invited] Portable, desktop high-field magnet systems using bulk high-temperature superconductors

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Magnetised bulk superconductors can be used as super-strength, stable permanent magnet analogues capable of providing magnetic fields of several tesla in a compact and portable magnet system. In addition to a large magnetic field, B, the magnetic field gradients (dB/dz, dB/dr) are naturally large. This makes them attractive for a number of engineering applications that rely on high magnetic fields and/or field gradients, including desktop nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI), magnetic separation and magnetic drug delivery systems.

In this presentation, we report our recent developments in the Bulk Superconductivity Group, University of Cambridge, in portable, desktop high-field magnet systems using bulk high-temperature superconductors, including:

- Cryogenic system design that emphasises flexibility and portability, with operating temperatures down to sub-50 K;
- A compact pulsed field magnetisation (PFM) system, including pulse waveform control to modify the shape of the applied field waveform, and solenoid- and split-type magnetising coil configurations.

We report a detailed summary of our recent experimental results, including comparisons of solenoid- and split-coil PFM and single- and multi-pulse (including multi-temperature) PFM, for a range of (RE)BCO bulk superconductor samples (Y, Gd and Eu) fabricated in-house and by commercial suppliers. In particular, we describe the reliable trapping of magnetic fields greater than 3 T in disc-shaped bulks and record-high trapped fields in ring-shaped bulks greater than 1 T using optimised multi-pulse, multi-temperature PFM with pulse waveform control.

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