# Bulk trapped-field superconducting magnets arranged in a linear Halbach array: important points to achieve the full potential of the magnetized superconductors

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Bulk superconductors can act as very powerful permanent magnets, referred to as trapped-field superconducting magnets. These superconducting magnets can generate magnetic field gradients much larger than those typically achievable with conventional ferromagnetic materials [1]. This property is exploited for generating remotely a magnetic force in a number of engineering applications including magnetic separation or magnetic drug delivery [2]. Arranging trapped-field superconducting magnets with mutually perpendicular magnetization directions allows one to make a linear Halbach array. Building such arrays opens the prospect of generating magnetic field gradients exceeding significantly those generated by a single superconductor. One of the main challenges in achieving this goal is to ensure that the superconductors remain fully magnetized during the assembly process of the array [3]. In this communication, different solutions are described and compared to overcome the demagnetization of the trapped-field superconducting magnets. We consider either taking advantage of an additional superconductor removed at 90° from the axis of the array [4], using bulk superconductors with triangular cross-section or creating a vertical offset between the central and peripheral samples. Experimental results are presented on a linear array made of three magnetized bulk large grain melt-textured $YBa_2Cu_3O_{7-\delta}$ superconductors at 77 K. The experimental spatial distribution of the magnetic flux density above the assembly is compared to analytical calculations and finite-element simulations. In addition, arrangements involving non-cubic superconductors are characterized using a bespoke cryogenic 3-axis Hall probe [5]. We show how the various solutions modify the distribution of the magnetic flux density at reasonable distance from the assembly while ensuring a minimal demagnetization effect. By examining the ‘useful’ spatial zone where the magnetic field gradient exceeds a given threshold (e.g. 1 T/m), it is possible to obtain array configurations for which the extension of the useful zone is significantly larger than that of a single magnetized superconductor.

## References

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