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A NAIVE COMMENT ON CHANGING SSC PERSISTENT CURRENT SEXTUPOLE THRU METALURGICAL CHANGES IN THE SUPERCONDUCTOR

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In a paper[1] for the 1984 SSC Workshop at Snowmass, Brown and Fisk examined the persistent current sextupole contributions to the field uniformity of a superconducting dipole. Although the paper emphasized a particular solution to the problem of persistent current fields, a number of related conclusions can be reached from that discussion. Let me state even the familiar ones in order to make my point more clearly. The persistent current sextupole moment:

1. Depends linearly on the diameter of the superconducting filaments.

2. Due to the doublet nature of the source currents, it falls with coil effective radius with one more power of radius than other sextupole terms (the angular dependance also includes a different dependance on the source angle).

3. Depends linearily on the superconducting current capacity J_c at the field of interest.

Major emphasis of the existing design efforts for SSC involve minimizing effects due to items 1 and 2. The angular dependance of the contributions is the basis for the improvements suggested by Brown and Fisk. In this note, I would like to concentrate on the third item. Note that the design feature which has driven the metalurgy of the superconductor for accelerator applications is the J_c at HIGH field. This property determines the quantity of superconductor which must be used to produce a given bend field for a given coil radius. The deleterious effects of producing undesired persistent current effects is due to the J_c at LOW field. The trade-off to be considered now is an increased radius to reduce persistent current fields at the expense of less field for a given high field current carrying capacity. Could the metalurgy be changed to reduce this problem?

Present cable fabrication involves preparing the superconductor with a series of heat treatments and cold working steps to modify the J_c

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vs B properties. We illustrate this generically with Figure 1. The upper curve represents the current carrying capacity of the superconductor after cold working and heat treating; the lower curve represents material before the treatments. The possibiltity of achieving a curve which reaches nearly the same capacity at high field but a low field J_c which is much lower is illustrated by the third curve (dotted) on Figure 1. This possibility[2,3] would greatly reduce the magnet design problems associated with persistent currents. The magnitude of other efforts (added passive cable, small filament size) suggests that a trade-off in which the high field (6 Tesla) J_c is reduced by 10% in order to reduce the low field (.3 Tesla) J_c by a factor of 4 would probably be favorable.

References:

1. B. C. Brown and H. E. Fisk, "A Technique to Minimize Persistent Current Multipoles in Superconducting Accelerator Magnets. Submitted to Proceedngs of Snowmass 1984.
2. David Larbalestier, Private communication. (September 1984) Some of the possibilities were discussed including reducing the amount of heat treatment to reduce precipitates as a source of high J_c at low field.
3. These concepts are not new or original. The papers by M. A. Green (see reference 1) appealed for the same result. This note is intended merely to focus attention on a previously suggested solution by attempting to make the issues as concrete as possible.

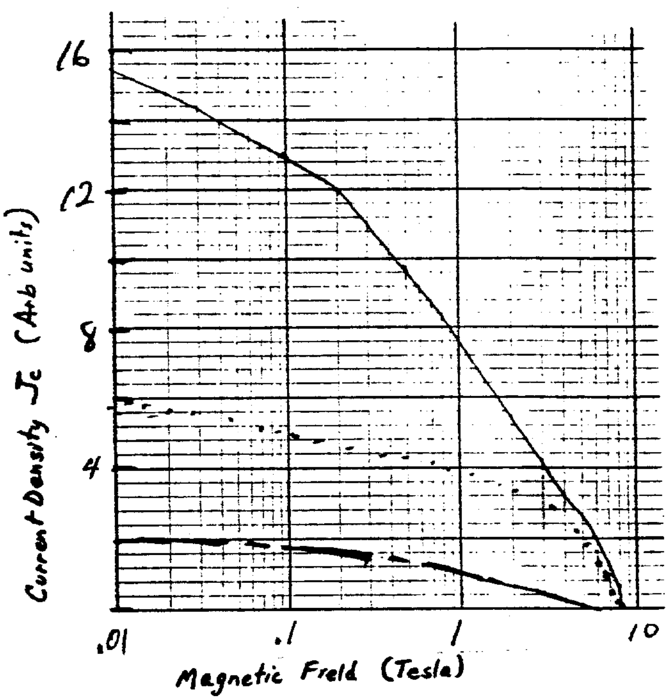

Figure 1 Critical Current Density J_c for superconducting cable vs. external magnetic field B.