Thermal Contraction of 40 mm SSC Magnet Collaring Key Material*

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A measurement was performed at Lab 2 in the village to assess the thermal contraction of the material used in 40 mm SSC tapered collaring keys.

This material is **Phosphor Bronze, 5% Grade A, Full Hard, ASTM B139 Alloy.** (See drawing 0102-ME-217916.)

The test piece was machined to a length of 2.012 +/- .0005 inches. The other dimensions of the piece were as shown in Figure 1. Dimension b was difficult to measure with the calipers, because of the direction of the taper.

The test piece was cooled in liquid nitrogen for 2 minutes, and then removed. Dimensions a and c, and the length (see Figure 1) of the piece were remeasured. Dimensions a and c showed no measureable change within the precision of our measurements (about 1 mil) from their room temperature values, but the length had changed to 2.008 inches.

Since the length of the piece had been measured last in the first dunk, we decided to dunk the piece again and to remeasure the length so as to allow as little warm up as possible following its removal from the liquid nitrogen. The length measurements are summarized in Table 1.

Table 1. Length of Test Piece

Room Temp	2.012 inches
LN2 Dunk 1	2.008 "
LN2 Dunk 2	2.005 "
LN2 Dunk 3	2.005 "

Using the values 2.005 and 2.012 inches, we obtain a unit thermal contraction between room temperature and LN2 temperature of **3.48 +/- .25 mils/inch.**

Since the stainless steel collars will contract thermally by about 3 mils per inch, the differential contraction between key and collar will be about .5 mils/inch times 1/2 the key thickness[1]. This corresponds to a pole stress change of much less than 1 kpsi, well within our current systematic errors.

Note: I am not certain that the unit thermal contraction along the short dimensions of the key will be the same as along the long dimension (because of anisotropy due to the extrusion of the key material?) Furthermore, there is a large and periodic shear stress on the collaring materials, which may have ramifications for the actual thermal contraction of the key material upon cooldown.

*** I would like to thank Mike Warren at Lab 2 for his assistance in this measurement. Finley Markley provided some comments on the thermal shrinkage of materials under differential stress.**

[1]The factor of 1/2 comes from the fact that the stress loss due to differential contraction is distributed over two quadrants of the magnet.

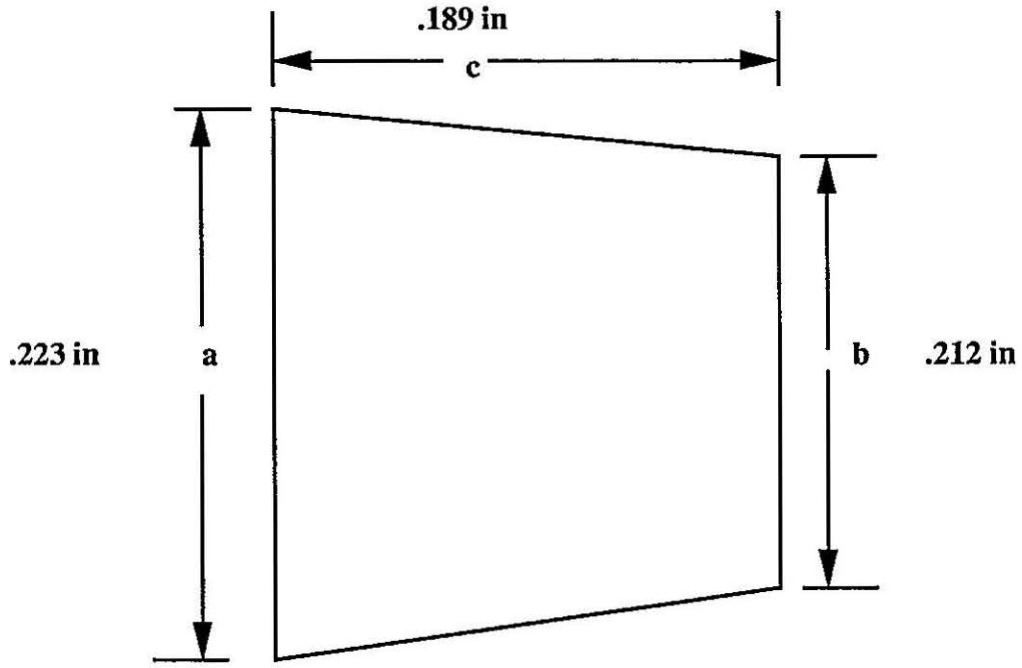

Figure 1. Dimensions of Test Piece

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