

MEASUREMENT OF THERMAL CONTRACTION OF A 4.5M CBA COIL  
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SUMMARY. The thermal contraction of a 4.5m CBA cable-magnet coil between room temperature and liquid nitrogen temperature (77K) has been measured to be 2.57 mils/inch. The uncertainty in the measurement is estimated to be 10%. A similar measurement of a copper pipe agrees with the published value.

INTRODUCTION. The longitudinal thermal contraction of a CBA coil was measured about two years ago. The measurement is being described in a formal way now because of interest in the thermal contraction of SSC magnets, which are made with quite similar conductor. The CBA conductor, which had the same design as the Tevatron conductor, had a 1.7:1 copper-to-superconductor ratio.

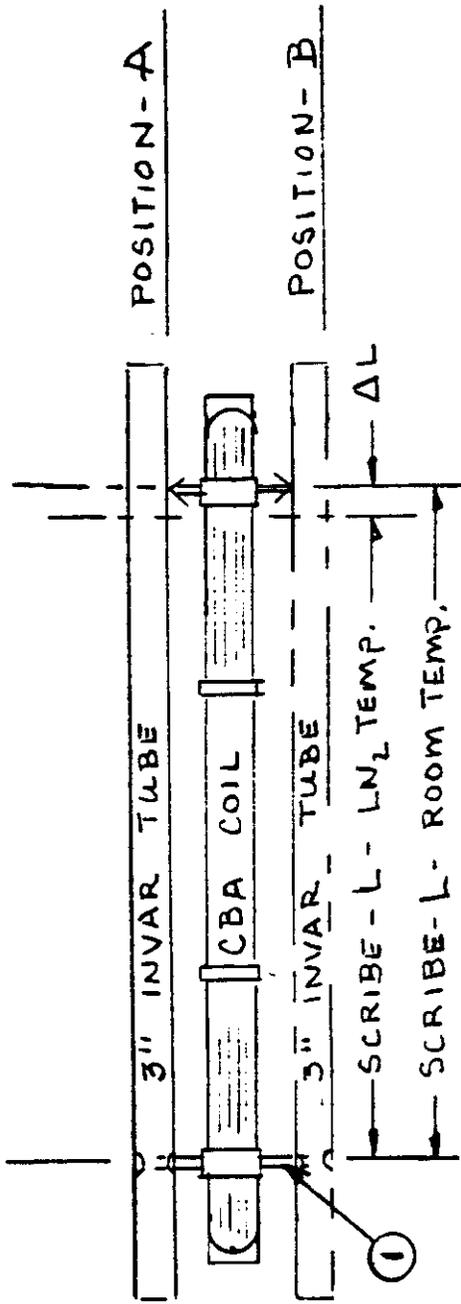
TEST SETUP AND DATA. A full 4.5m CBA coil (two inner windings, two outer windings) was banded together with stainless steel straps located at several places along its length. The straps held the coils firmly but with essentially zero prestress. The coil was rotated 90 degrees relative to its orientation in a magnet. Marking pins were placed in the ends of the "left" and "right" outer coils. The assembly was wrapped with standard 4"-thick fiberglass insulation. It was soaked for 1 hour in a horizontal bath of liquid nitrogen (see figure).

The distance between the pins (about 166") was recorded on an invar tube. A hole, sized to tightly fit the pin in the coil, was drilled through one end of the tube. With the tube pinned to the coil at one end, the location of the pin at the other end was then scribed on the invar. This procedure was followed for both left and right sides of the coil, at room temperature and at liquid nitrogen temperature. It took about 30 seconds to mark the invar bar after the coil was removed from the liquid nitrogen.

The distance between the marks on the invar was measured at the BNL Inspection Dept. The average of the left and right side measurements gave an integral thermal contraction of 2.57 mils/inch between room temperature and 77K. The length change on the left and right sides differed by 0.015", out of a total thermal contraction of about 0.430". This is a 3.5% difference between the two measurements. The overall uncertainty is estimated to be 10%.

MEASUREMENT OF A KNOWN MATERIAL. As a check for errors, the thermal contraction of a 2" o.d., 166"-long copper pipe was measured the same way. The result was 3.00 mils/inch, in agreement with the value in NBS49, also 3.00 mils/inch, for 77.3K. (This value was obtained by linearly interpolating between results at 70K and 80K.)

A potential systematic error in such a measurement stems from possible warming of the sample while the marks are made on the invar bar. If the copper pipe were at 87K instead of 77K, the thermal contraction would be too low by 0.08 mils/inch. The good agreement between the reference and measured values of thermal contraction suggests that this is not a serious problem with the measurement.



DETAIL FOR MEASURING  
COEFFICIENT OF CONTRACTION

NOTE: ① 1/4" O.D. PIN TO BE USED AT  
FIXED POSITION ON TEST PIECE  
HOLE IN INVAR TUBE TO  
ACCEPT FIXED PIN TO BE .257"

