Superconducting Magnet Division

Magnet Note

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Title: 77K Testing of HTS Solenoids for ERL

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77K Testing of HTS Solenoids for ERL

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Introduction

Two small solenoids have been fabricated from stainless steel clad BSCCO ribbon conductor insulated with a spiral wrap of Kapton film. This note summarizes the results of testing these coils in liquid nitrogen. The main coil has 180 turns and is layer wound from a single length of conductor. The “bucking” coil made from two equal pieces of conductor is a “double pancake” with a joint on the inner diameter.

Coil Parameters

Some details of the two solenoids are given in Table I below.

Table I: Design Parameters

	Main Coil	Bucking Coil
Inner Diameter, mm	175	175
Outer Diameter, mm	187	185
Length, mm	55	9
Number of turns	180	28 (2x14)
Conductor length, m	102	15.8 (2x7.9)

Test Procedure

The coils were tested immersed in liquid nitrogen in an open “bucket” type cryostat. Voltage taps were attached to the superconductor just inside the main current connections. Since the main coil is made from a single piece of ribbon, it has only two voltage taps while the smaller coil has taps at each end of its two lengths of conductor so that they can be measured individually. The magnets were powered with an Agilent type 6680A power supply.

Test Results

The voltage-current curves for the two coils in the “bucking” magnet are shown in Fig. 1 and are almost identical. Both coils operate stably well into the resistive region and were energized to over 90A where the average voltage gradient along the conductor is greater than 1μV/cm. Figure 2 is the voltage-current plot on “log-log scale”, where it shows the usual linear dependence. The slope of these curves, an effective “n” value for the coils was 15 for coil #1 and 12 for coil #2. The joint between the two coils measured less than 10 nano-ohms.

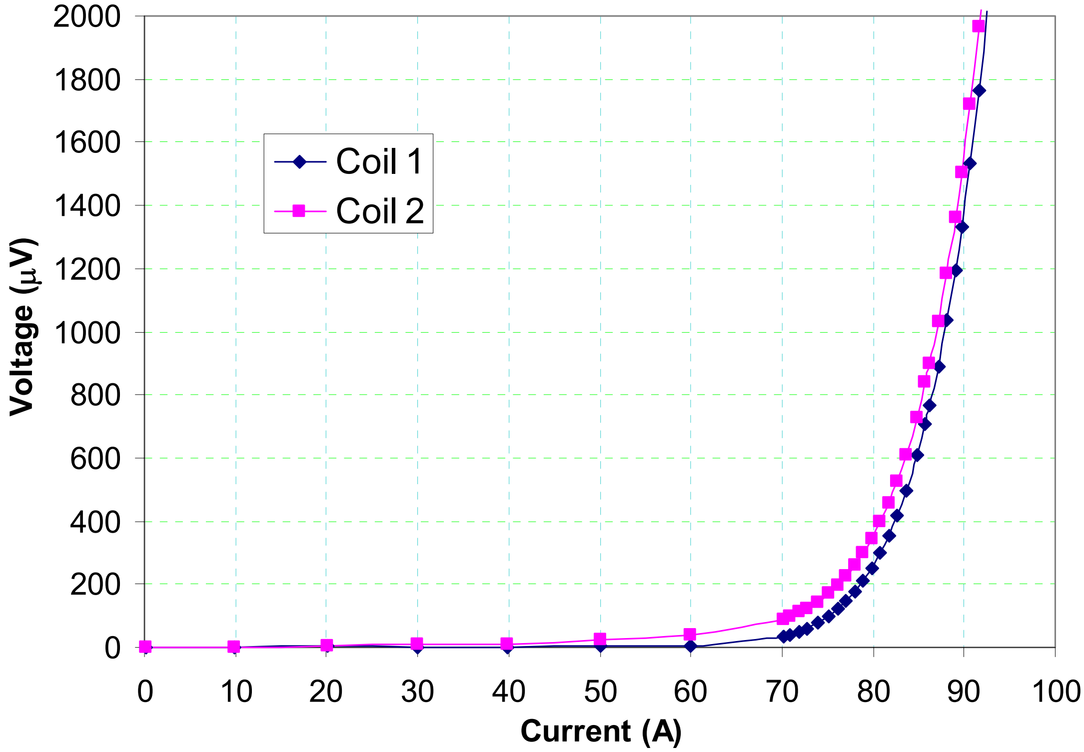

Fig. 1: Voltage-current curves for two bucking coils.

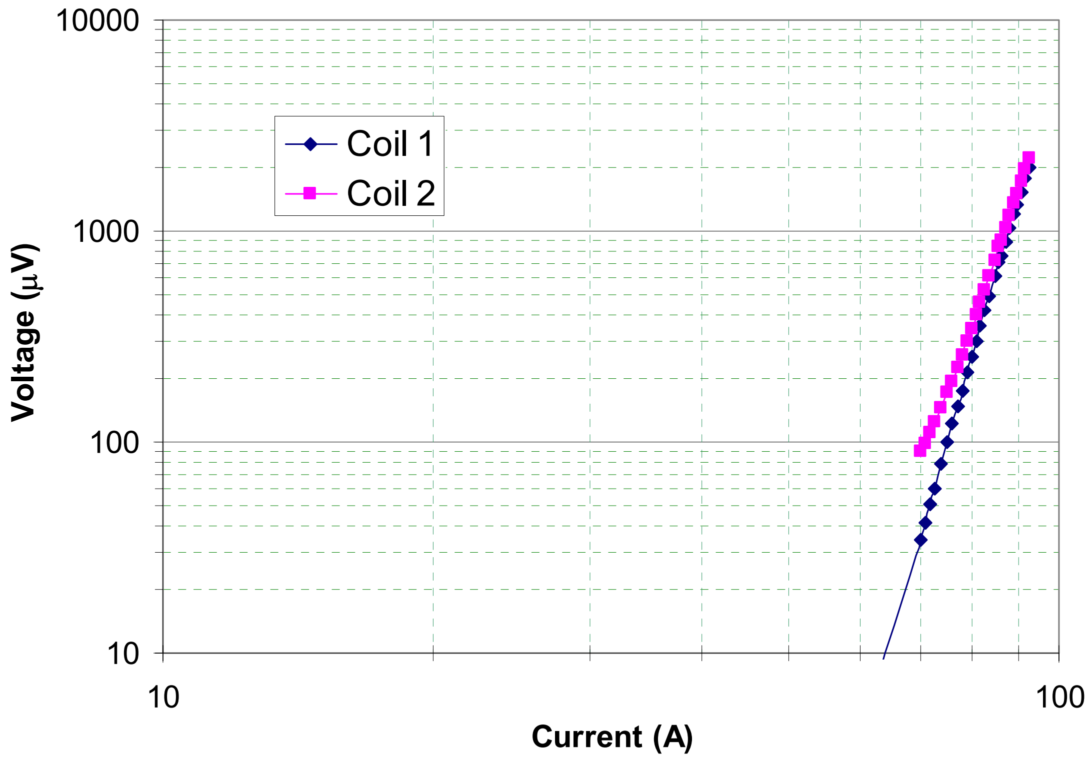

Fig. 2: Voltage-current curves for two bucking coils in log-log scale, where a usual linear dependence can be seen.

Figure 3 shows voltage vs. current for the main coil, which was powered to a maximum current of 65 amps well above the expected operating level of approximately 35 amps. The corresponding log V-log I plot is shown in Fig. 4. The effective "n" value of this coil is 13 much the same as the other coils.

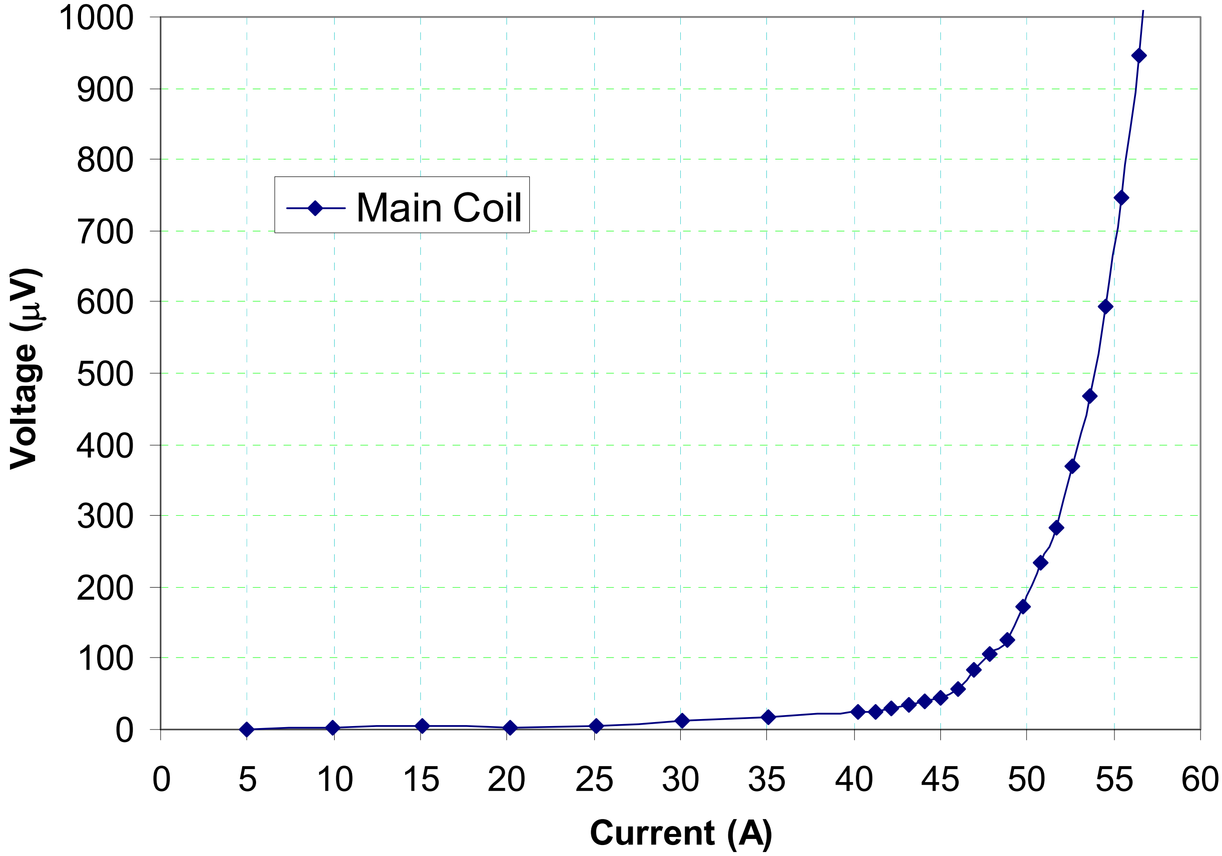

Fig. 3: Voltage-current curve for the main coil.

Table II: Coil Performance

	Current @ 0.1 μV/cm	Maximum Test Current	Nominal Operating Current
Main Coil	54A	65A	35A
Backing Coil #1	74A	93A	35A
Backing Coil #2	71A	93A	35A

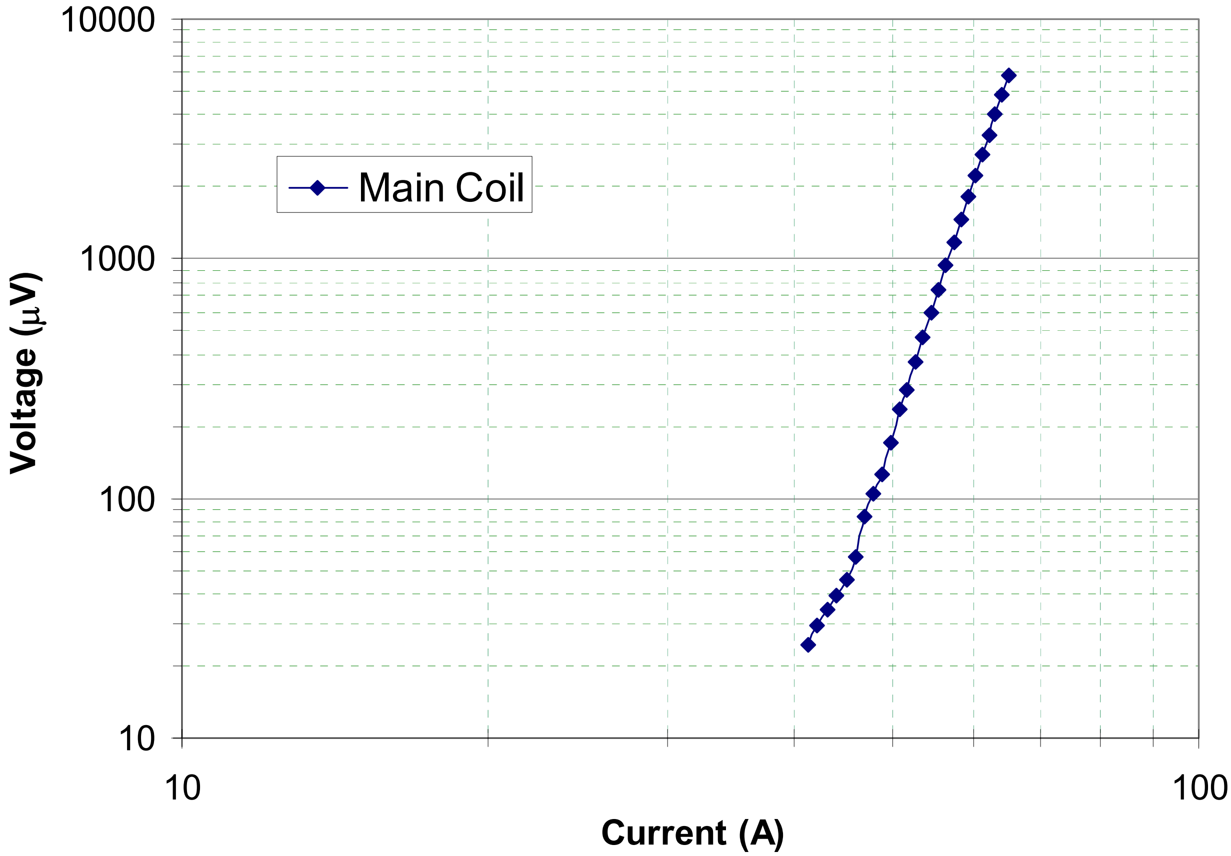

Fig. 4: Voltage-current curve for the main coil in log-log scale.

<u>Conclusion</u>

Both coils could be powered well above their required operating currents even at 77K. Table II, gives the current where the effective voltage gradient is 0.1 μV/cm over the total length of the conductor as well as the maximum current used in these tests and the nominal operating current for each of the coils. It should be noted that the expected operating temperature is approximately 10K where the potential of the coils is much higher so that they will be running at a very small fraction of their overall capability.

Additional information about the design of these coils and also on the design of HTS solenoid for ERL (Energy Recovery Linac) is available at:

http://www.bnl.gov/magnets/staff/gupta/talks/erl-talks.htm