SSC DETECTOR SOLENOID DESIGN NOTE #28

TITLE: Present Coil Design and Some Thoughts Regarding It

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PRESENT COIL DESIGN

The attached sketch gives the dimensions of the present coil design. This is the design described in the paper presented at ASC-88. The 8, 2-m coil modules are connected electrically in series with one fast dump resistor and one power supply. The conductor is 18 x 26 mm, wound the hard way. The maximum hot spot temperature on a quench is about 100 K. (The conductor dimensions are calculated from a total inductance of 120 H.) Each 2-m coil module has 7 layers of 93 turns each.

The dimensions of the four symmetric current blocks are: IR = 4.727 m; OR = 4.921 m; ΔR = 0.194 m; length = 1.812 m.

The axial location of the four current blocks are:

Coil 4 From 0.304 to 2.116 m
Coil 3 From 2.254 to 4.066 m
Coil 2 From 4.204 to 6.016 m
Coil 1 From 6.154 to 7.966 m.

These axial dimensions do not contain an allowance for conductor tolerance build-up, which could add up to 10 mm.

The maximum current density in a 2-m module is:

$$J = (7 \times 93 \times 5000\ A)/\ (0.194\ m \times 1.812\ m) = 9.26 \times 10^6\ A/m^2.$$

The ground insulation thickness are:

On coil OD (first layer) = 12.5 mm
On coil ID (final layer) = 22 mm
On sides of coil = 24 mm

The turn and layer insulation thicknesses are:

Turn-to-turn, buttons on a string = 1.5 mm
Layer-to-layer = 2 mm

An axial preloading push bar of stainless steel, 20 mm thick, is located on one side of each 2-m coil module.

We hope that this coil design contains enough ampere-turns to generate 2 T on the axis with finite-μ iron.

THOUGHTS ABOUT THIS COIL DESIGN

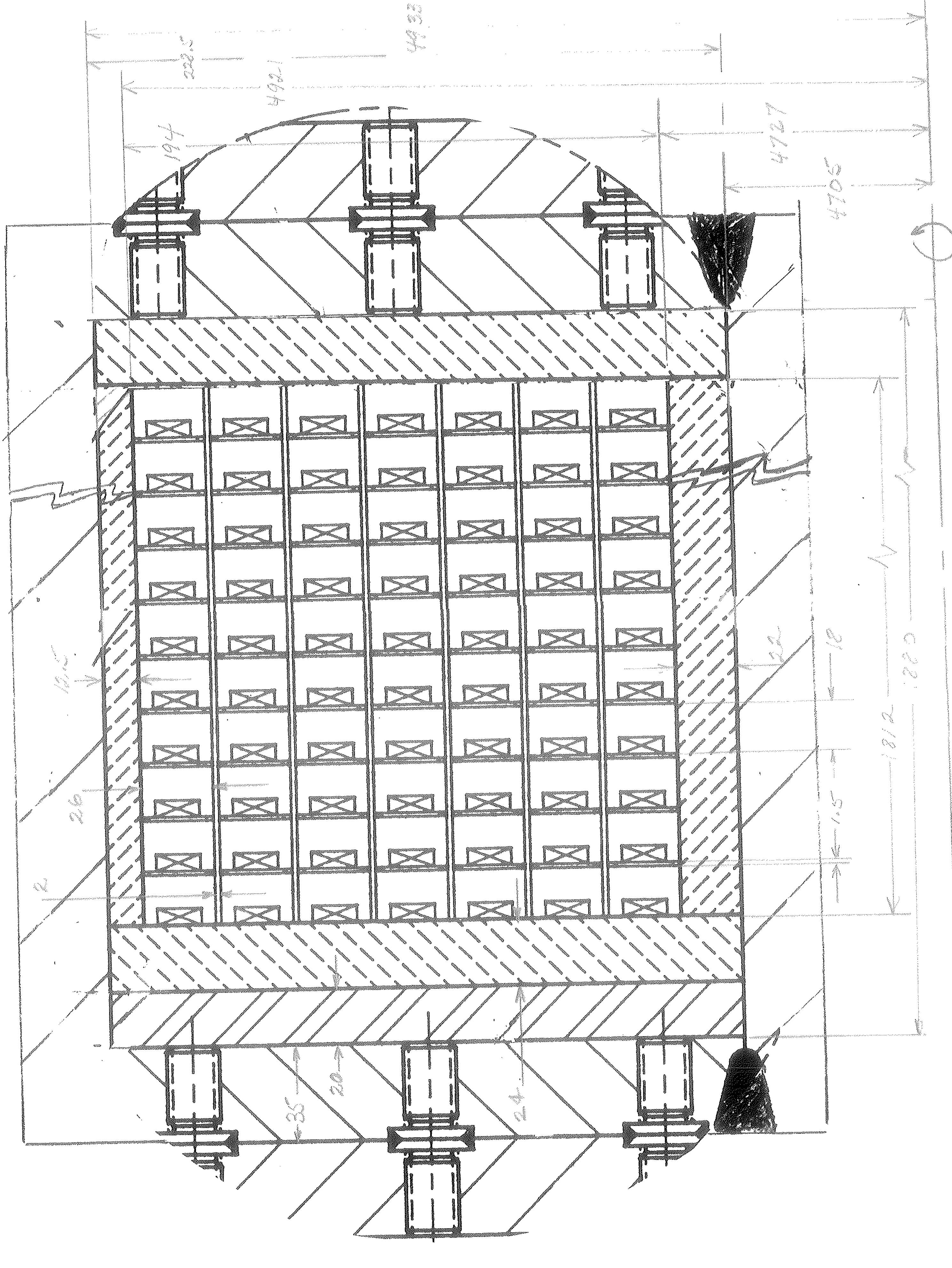
I have thought a little bit about the lead-in and lead-out bus. The bus would be a prefabricated copper piece with a groove for the cable. The cable would be unsoldered from the 18 x 26 mm conductor and soldered into the groove in the bus. The copper bus would be welded to the copper of the conductor. The lead-in bus must make three 90-degree bends and lead into the first turn. It is routed from the chimney to the first turn through the insulation on the coil OD. It seems to me that the present thickness of this insulation (12.5 mm) is much to small for the bus and the bends it must make. I propose it be increased to 25 mm thick. In fact I propose that all the ground insulation be made 25 mm thick. Remember that since this insulation is slotted for LHe access to the vessel walls, or at least was in the MFTF solenoid design, effective "ground insulation" is a mixture of G-10 and LHe. MFTF used 6 layers of five-mil Kapton tape as the real ground insulation--I would recommend ten times that for us, at least 6 to 8 mm.

I have also thought a bit about the axial and radial loading on the conductor during winding and the final axial and radial preloading of the coil. We haven't yet determined what these preloads must be for predictable coil charging. My concern at this point is whether the push bars are thick enough.

I haven't found any reason yet that the coil design should be changed to an even number of layers. However, if the final preload deflects the end of the coil by very much, then to avoid stress on the lead-out bus, it may be wise to have an even number of layers so that both lead-in and lead-out bus can be on the end with no preload deflection, the right side in the sketch, away from the push bar.

I would like to see as much ground insulation as possible, an inch (25 mm) seems like the minimum that I'd feel comfortable with. I would like to increase the turn-to-turn and layer-to-layer insulation, both for electrical reasons and to permit more helium flow through the coil pack. Perhaps the conductor could be down-sized by 1 mm in both dimensions without compromising too much on the maximum hot spot temperature, especially since my calculation was super conservative in the first place.

Once I know how many ampere-turns are needed for 2 T, I'll go back and reconsider the conductor and coil design.



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