# Notes From the Visit with Ken Foley and Jim Mills at Brookhaven Concerning the STAR Solenoid Magnet

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A number of questions should be answered before the January review. Many of these questions can be answered by Ross Schluter after he has done the appropriate runs using POISSON. These questions are as follows:

1. What is the effect of pole deflections on the quality of the field in the TPC? The pole deflection are thought to be small (of the order of 320 microns). Is the effect of these pole deflections on the quality of the field large enough to justify doing a full blown finite element calculation of the deflections caused by magnetic forces?

2. Can POISSON and its related magnet program packages calculate a magnetic force diagram for the STAR solenoid coils and the iron?

3. How accurately do the coil packages have to be placed in the axial direction? An axisymmetric POISSON run with no symmetry around Z = 0 plane should be able to answer this question. Can a similar calculation be done for the radial placement error?

4. What will be the effect of a radial clearance of 6.35 mm (0.25 inch) between the pole tip and the support ring on the field quality in the TPC? There appear to be a number of related issues which include the effect of pole tip radial placement errors within the 6.35 mm clearance and the effect of pole tip tilt with respect to the support ring. The related issues may be more important than the 6.35 mm gap.

5. What effect do the TPC electronics and coolant feed troughs in the region of the pole and end ring interface have on the quality of the field within the TPC? This problem should be looked at in two ways: 1) One can assume that the interface region contains no iron and the wires are routed through an aluminum ring between the pole and the end ring. (Note: this is a variation of the radial clearance problem talked about in the previous question.) 2) One can assume that the feed trough ring between the iron pole and the iron end ring is made of iron with between 30 and 40 percent of its volume cut out for feed through holes. These holes will have to be uniformly distributed around the feed through ring in the azimuthal direction.

6. Are the corrections coils which are located in the end coil packages powered to full current with adjustment about full current or are they at a nominal current of zero with adjustment around zero? Can these coils be counted as part of the coils which contribute to the total ampere turns need to produce the central field of the solenoid? If these coils do not nominally carry the full current, the rest of the turns must carry more current which means that the power required to operate the magnet goes up.

7. The corollary question to question 6 is; can the whole end coil be the correction coil combined with the end coil which carries its full compliment of ampere turns? If one does this, how does the field quality in the TPC change, and if it does change by how much does it change?

The STAR solenoid coils will be manufactured as two in one double pancakes. At only two points in the coil as one goes around it will the coil have the ideal cross-section. At point ninety degrees azimuthally from the points of perfect coil cross-section one layer of the pancake will be shifted one turn with respect to the other layer. Since all of the pancakes will be identical, and since all of the pancakes will be lined up so that electrical and water connections can be made with ease, this shift in one pancake layer with the other will be seen in the same azimuthal position around the whole coil. Does this shift have a significant effect on the field quality in the TPC? To first order it should not, but there may be second order effects. Brookhaven proposes to look at field measurements made in a magnet which is similar. Beyond this should a TOSCA run be made to model the field? Who should do this run? Will TOSCA solve this kind of problem with sufficient accuracy to be believable?

The bend radius of the pig tails on each coil is an important issue for two reasons. 1) Sharp bed radii will result in keystone formation in the copper conductor. (Note: aluminum conductor is much less prone to keystone formation upon bending.) The keystone formation at the bends may be detrimental to the nesting of the coils and water circuits. It is assumed, at this time, that the coil to coil electrical connections and the water hose connections will be made outside of the iron return bars. (Note: It is not clear that the extra conductor has been included in the magnet power calculations (a 5 percent effect).) The coil pig tails will point down and away from the detector so that water leaks will not damage detector components. These coil pig tails should not interfere with the light fibers from the calorimeters. 2) If the pig tail bend radius is too large, the return iron bars will have to be chamfered in order for the coils to fit inside of the iron. Either that, or the iron return bars have to be moved radial outward and larger iron end rings will have to be fabricated. If the chamfered return bars are used, do all bars have to be chamfered in order to insure azimuthal symmetry or does only a subset of bars have to be chamfered (say in six positions azimuthally around the magnet)? If chamfered return bars are required, the iron fabrication cost will go up.

For the purpose of answering the question set forth previously, Brookhaven preliminary drawings are included in this note. Figures 1 and 2 show the arrangement of the iron proposed by Brookhaven for the STAR solenoid magnet. Figure 3 shows the proposed arrangement of the coils for the STAR solenoid magnet. All dimensions on the Brookhaven drawing are given in inches. The coil cross-section is taken at a point which is 180 degree azimuthally from the pig tails which run out of the coil. The iron cross-section shown in Figure 1 and Figure 3 is taken at the center of one of the iron return bars which is closest to the point in the coil which is 180 degrees azimuthally from the coil pig tails.

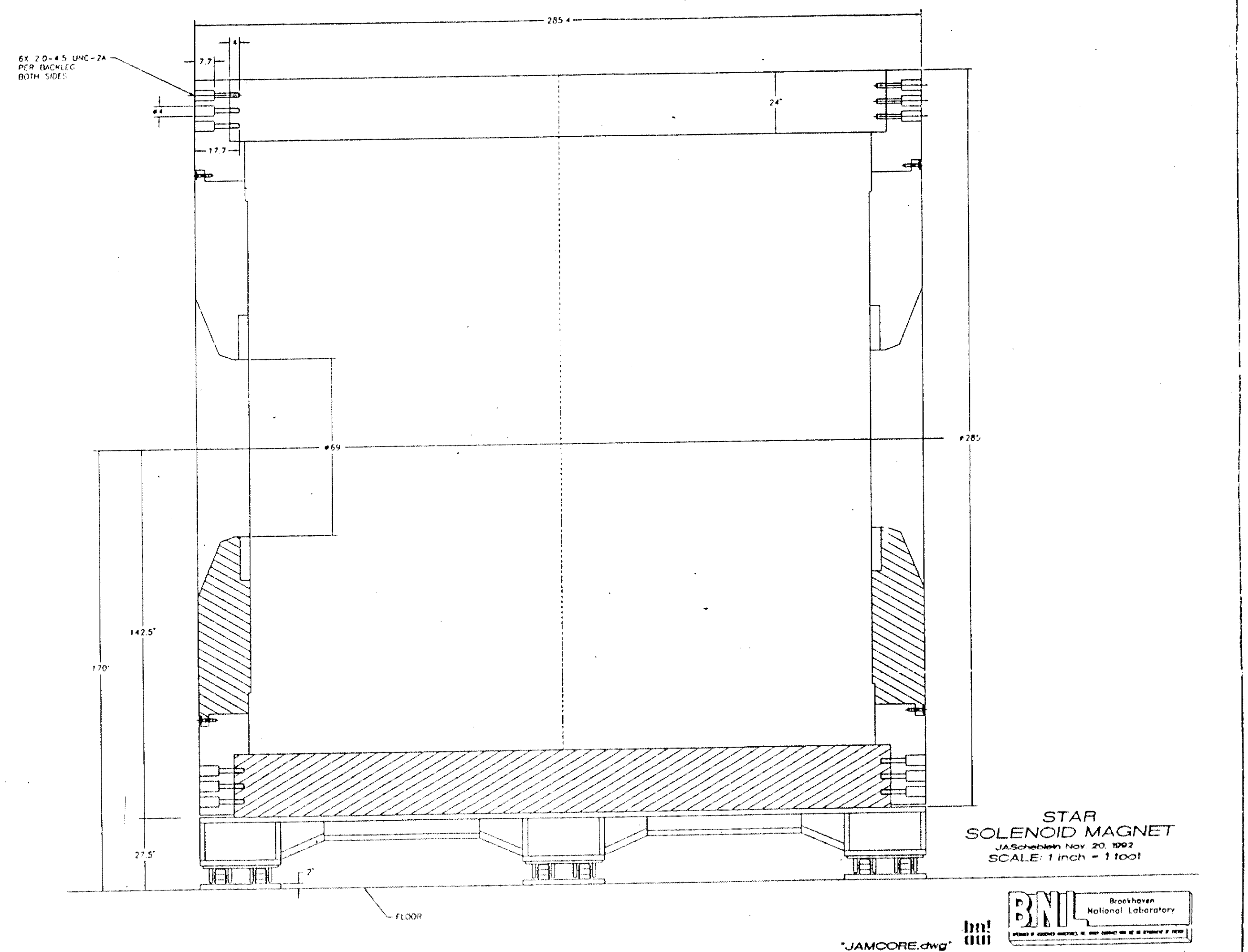
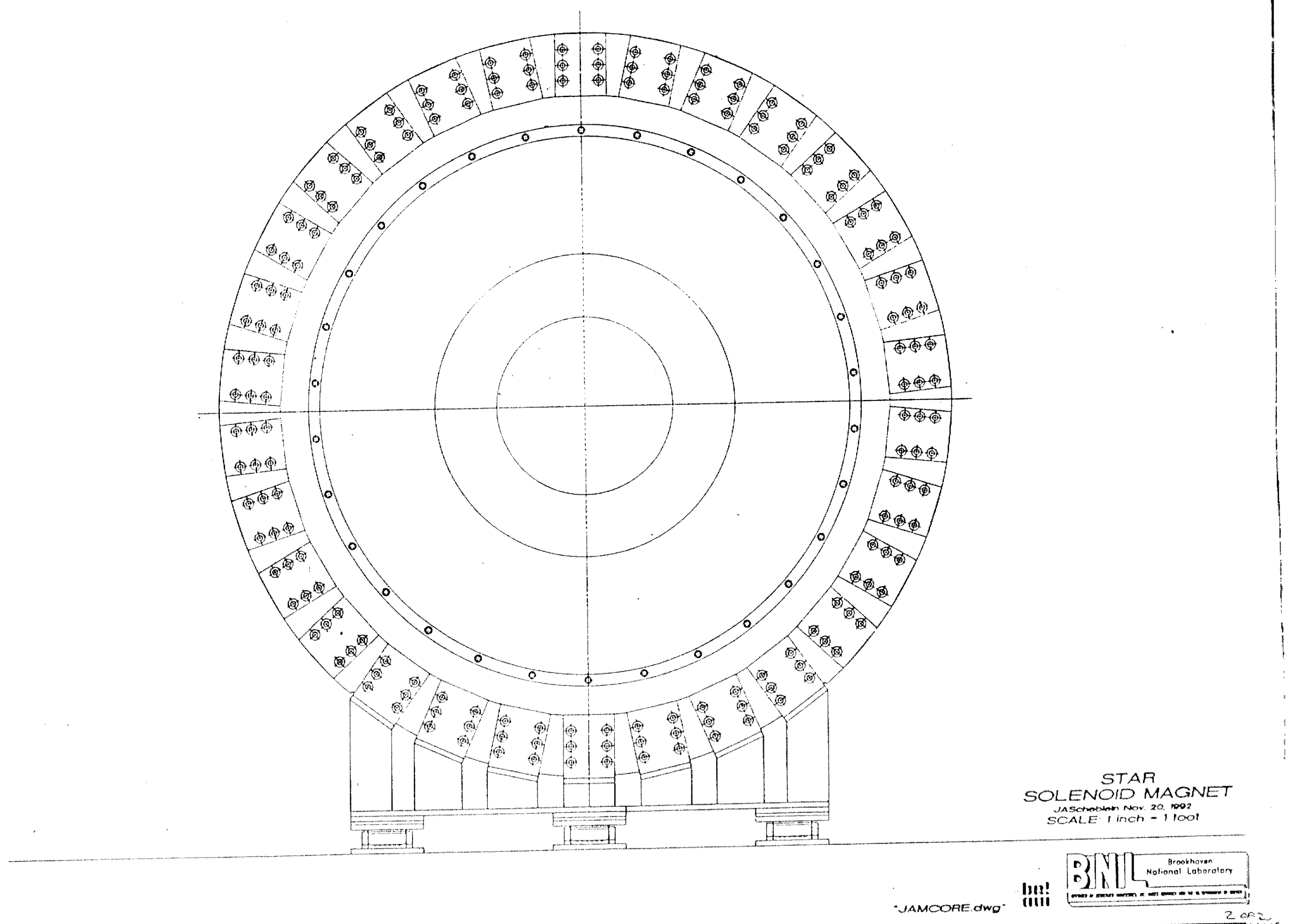



Figure 1. A Cross-section for STAR Magnet Iron Yoke

Figure 2. An End View of the STAR Magnet Iron



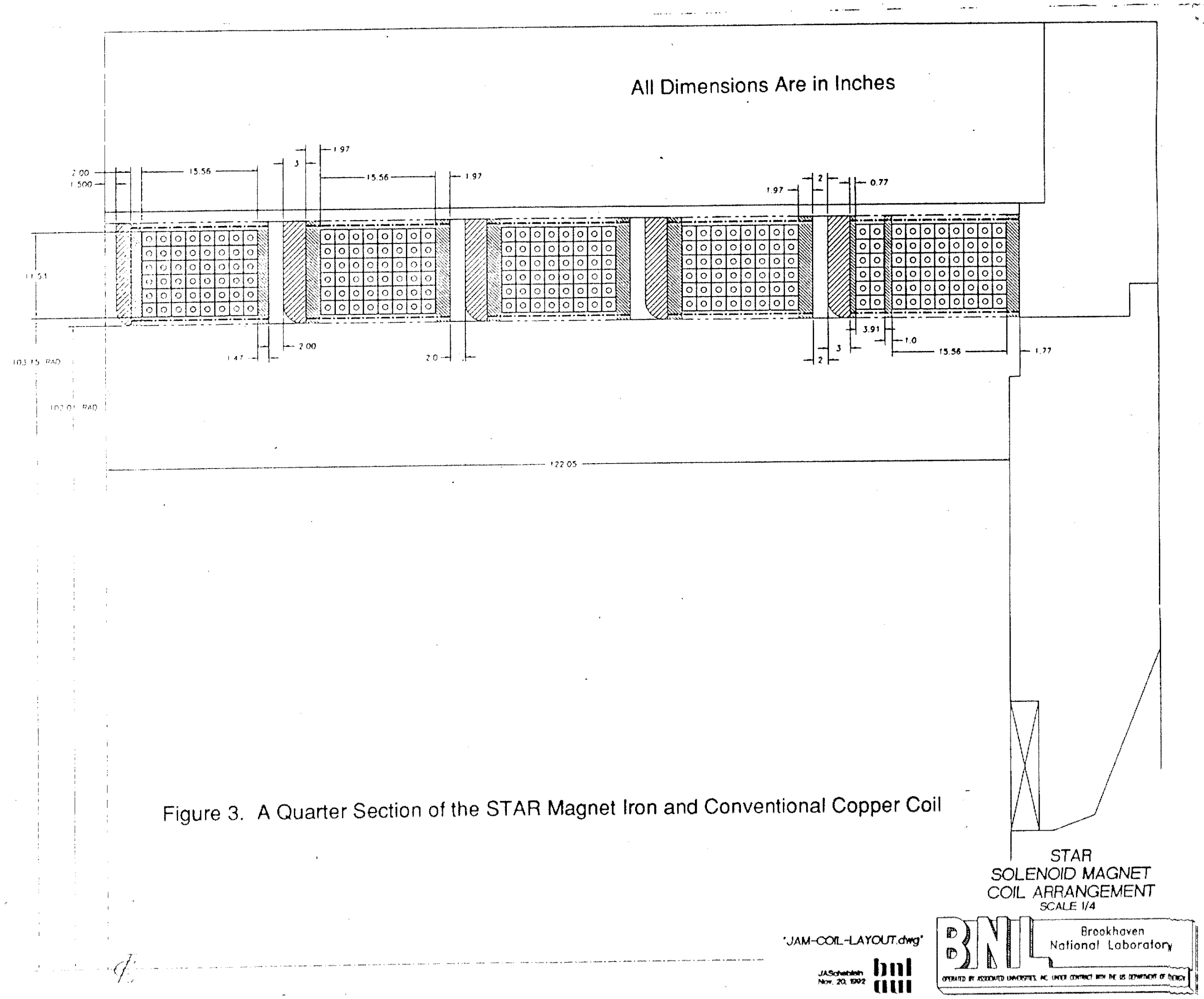



Figure 3. A Quarter Section of the STAR Magnet Iron and Conventional Copper Coil



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