Brookhaven National Laboratory

MEMORANDUM

Date: 05/02/95

To: W. Christie, S. Musolino

From: A.J. Stevens ajs

Subj.: Verification of Sufficiency of Backwall Thickness at 6 O'clock

A previous memorandum[1] argued that the backwall thickness of 3 ft. of light concrete in the 6 o'clock hall was sufficient shielding given the geometry of the STAR shield wall design. This memorandum simply reports a CASIM calculation that verifies the sufficiency of that thickness. In addition, the formula used to obtain the required shield wall thickness

$$\text{rem/fault} = 410 \times e^{-d/.502}/R^2 \text{ (design intensity)}$$

which was extrapolated a considerable distance from the original calculation[2] on which the formula was based, was verified.

The CASIM calculation will not be described in detail. Fig. 1 shows a plan view cut on the midplane of an approximation of the current STAR enclosure design.[3] The structure is entirely made of light concrete. The back walls [designated (1) and (5) in the figure] and side walls [designated (2) and (4)] are 91 cm. (~3 ft.) thick, and the shield wall [designated (3)] 152 cm. (5 ft.). The only source considered was 250 GeV/c protons interacting along the DX magnet which is on the left hand side of Fig. 1. The approximation of the STAR detector described in Ref. [2] is made and rotational symmetry is assumed.[4]

Fig. 2 shows the star density, corrected for enhancement on the midplane due to magnetic field effects, at the back of the concrete walls indicated by the numbered arrows in Fig. 1. Thus the first series of data points is the star density at the back of the backwall nearest the source, the second series at the back of the sidewall nearest the source, etc. The backwall corners, where the star density drops significantly, have been omitted. The highest star density occurs at the back of the front shield wall, as expected. The errors shown near the maximum star density are the rms deviations from 3 CASIM runs. The maximum star density gives the following fault dose equivalent at 4 times the design intensity:

cf X Dasl

57X4

$$mrem/fault = \frac{57 \times 10^{11}\, p}{2} \times 4 \times 1.8 \times 10^{-2}\, mrem/star/cc/p \times 1.85 \times 10^{-9}\, star/cc/p$$

$$= 380 \text{ mrem}$$

1/2 Beam

$\phi = 56$

$2 \times 9 \times 10^{-3}$

5.4×10^{-3}

$9 \times 10^{-3} \times 2$?

In the above expression, the usual assumption of half the beam scraping DX is explicitly displayed. As usual, twice the star density to dose equivalent is used for design purposes. Use of 4 times the extrapolated formula given above (R = 13.96m) gives 407 mrem which is only 7% different. This is almost "too good" given the 10% error in Ref. [2] which was the origin of the formula. No position on the 3 ft. thick backwall is within a factor of 3 of the maximum.

References/Footnotes

1. Memorandum to W. Christie and S. Musolino from A.J. Stevens dated 05/04/94.

2. A. Stevens, "Local Shielding Requirements for the STAR Detector," RHIC/DET Note 5.

3. The approximation was read from a drawing. The result in the text should be scaled by the inverse of the square of the transverse radius from the beam line if the approximation is slightly in error.

4. This is a "2-D" calculation in the language of Ref. [2].

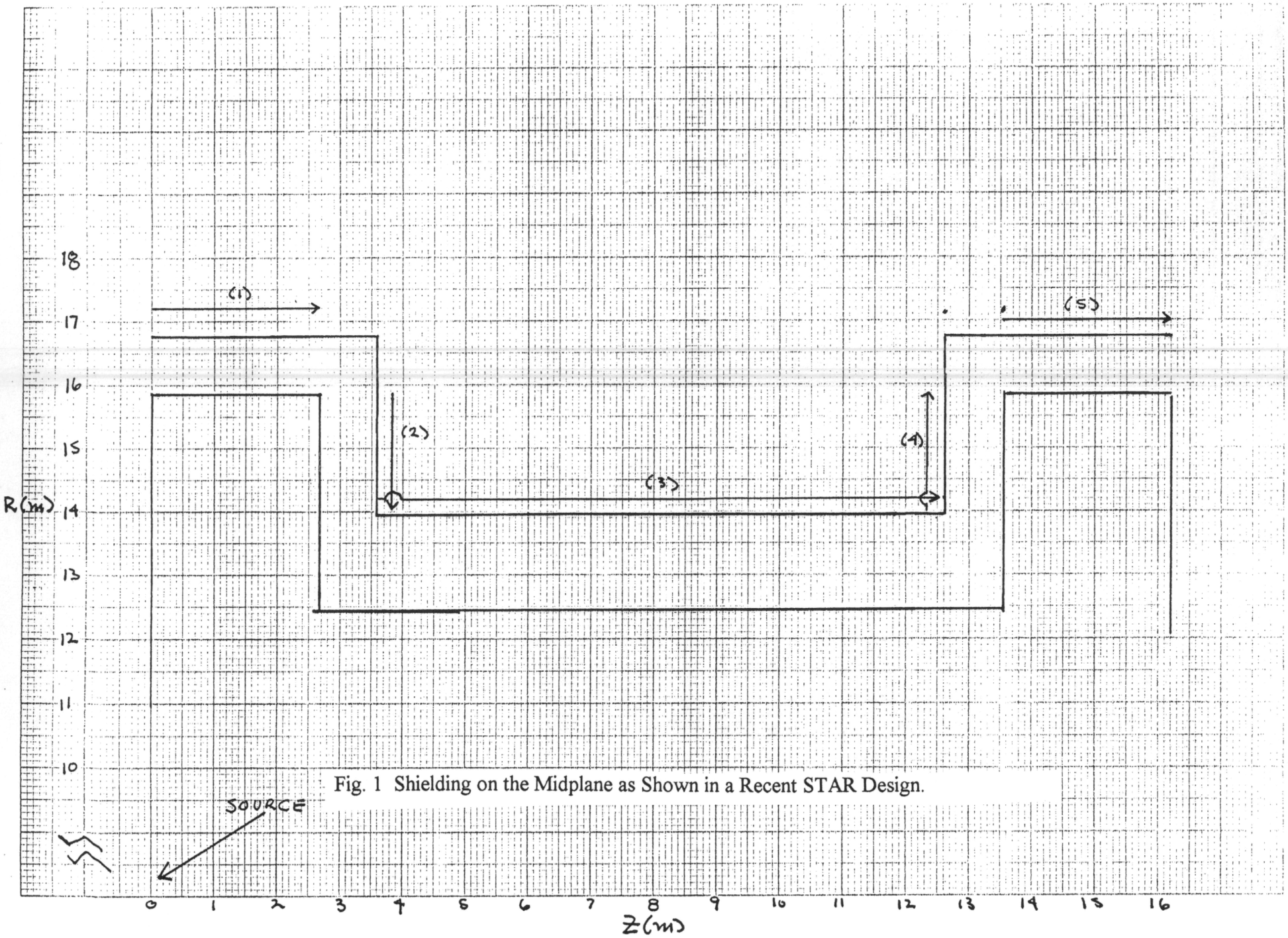

Fig. 1 Shielding on the Midplane as Shown in a Recent STAR Design.

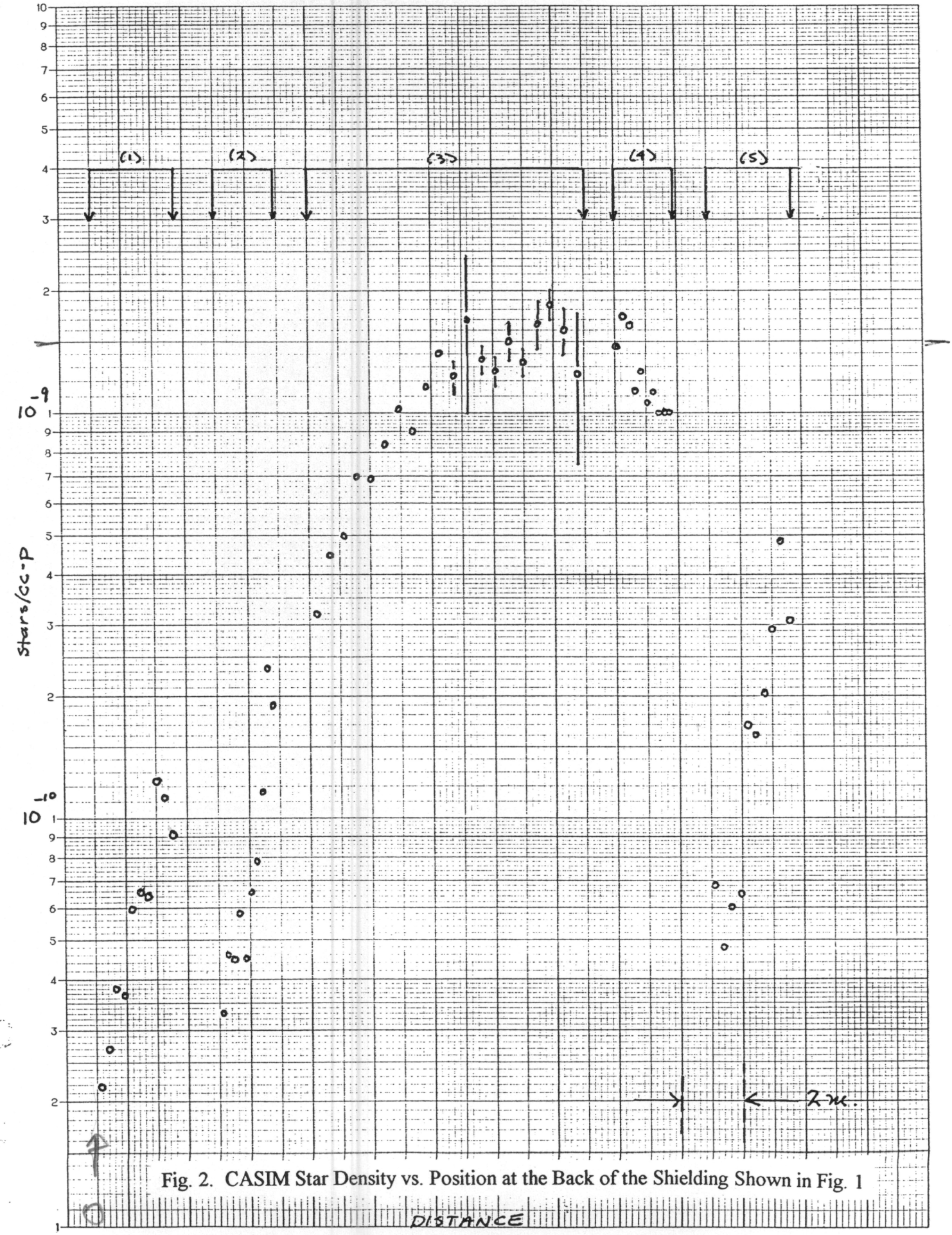

Fig. 2. CASIM Star Density vs. Position at the Back of the Shielding Shown in Fig. 1

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