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Improved Estimates of Fault Dose Exterior to the PHENIX South Side Shield Configuration

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RHIC PROJECT

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I. Introduction

Previous estimates of the potential fault dose near the shield block configuration on the south side of the PHENIX assembly hall indicated that the shielding is slightly thinner than required for a high occupancy area (at 4 times design intensity) restricted to radiation workers.[1] This has long been the case, and the assumption has been that this region would be a low occupancy area since the only activity anticipated here is monitoring and maintenance of the PHENIX gas system.[2] Recently, PHENIX personnel have expressed concern about the possibility that the gas systems might require more than ½ hour per shift scheduled occupancy, which has been the RHIC Project definition of low occupancy. This note presents the results of more detailed calculations intended to estimate the distance away from the shield wall where high occupancy would be permissible.

II. Method of Calculation

The method here is the same as used previously to estimate the dose (equivalent) outside the worst case vents on the berm.[3] Both the CASIM and MCNPX Monte Carlo programs are used in an approximation of the geometry which is fully three dimensional. In the case of CASIM, the "star density" is calculated and a star density to dose conversion factor applied. Because CASIM does not perform low energy transport properly, and because the geometry being investigated contains a large penetration though which low energy neutrons can be readily transmitted, the dose from neutrons below 20 MeV is calculated using MCNPX, and the result added to the CASIM estimate. In both cases, the conventional dose estimates are multiplied by 2 to take into account the possibility that the neutron quality factor may be doubled at some time in the future.

A plan view of the relevant geometry is shown in Fig. 1. Although several sources were examined, the worst case for a DBA fault[4] at 4 times design intensity is the Q2 magnet shown very schematically in Fig. 1 with the beam going left to right in the figure, i.e., towards the IR. The dark circles in Fig. 1 represent the positions of "point detectors" in the MCNPX calculations. Although the CASIM estimate is continuous in the beam (Z) direction at a given transverse (X) value, the MCNPX program samples the dose only at the discrete points indicated. Although not indicated in Fig. 1, the dose was always estimate at a vertical (Y) distance corresponding to a point 6 ft. higher than ground level.

III. Results

The transverse distance of X = 955 cm. indicated in Fig. 1 is the existing fence line. Fig. 2 shows the CASIM estimate at this transverse distance as a function of the Z coordinate. The dip at Z of about 1250 cm. is quite real, being caused by the highest Z block which forms the labyrinth shown in Fig. 1. The error bars shown in Fig. 2 are simply the rms values of the results from multiple runs. Another series of CASIM runs sampling the star density at X = 1219 cm. was consistent with $1/R_T^2$ scaling, which is (essentially) always observed in CASIM calculations.

Fig. 3 shows the MCNPX results at the point detectors indicated in Fig. 1. Note that the second (in Z) detector at X = 955 cm. gives a very low result because of the shadow from the same block that causes the dip Fig. 2. The error bars (again, simply the rms from multiple runs) are shown for only one of the X values. The dose decreases rapidly as a function of the both the transverse dimension X and the distance away from the labyrinth exit in Z.

When the results at the current fence line are added, the peak occurs in front of the labyrinth (Z = 1100 cm.) and is about 650 mrem, satisfactory for a low occupancy area, but above the 500 mrem criteria for an area which does not satisfy the low occupancy criteria. However, by the X = 1219 cm position, less than 9 ft. distant from the current fence, the sum of the contributions has dropped to about 350 mrem. **It would therefore appear that regions 10 ft. or more from the existing fence line can be regarded as suitable for high occupancy.**

References/Footnotes

1. Minutes of Meeting: RSC sub-committee, Subj: "PHENIX Side Shield Wall," 01/21/98.

2. Memorandum from P. Kroon to A. Stevens, Subj: "Personnel Access Near Shielding Southeast of Bldg. 1008," 03/20/98.

3. A.J. Stevens, "Improved Estimation of Dose Near Vent Exits in the RHIC Collider Tunnel," AD/RHIC/RD-122, August, 1998.

4. In the case of Q2, a DBA fault is the loss of the entire beam on the magnet. At 4 times design intensity, this is taken to be the equivalent of 2.28×10^{11} Au ions. The calculations here were done for 100 GeV protons, so that the DBA fault is 4.49×10^{13} 100 GeV protons.

9.5 inches on drawing = 1800 cm.

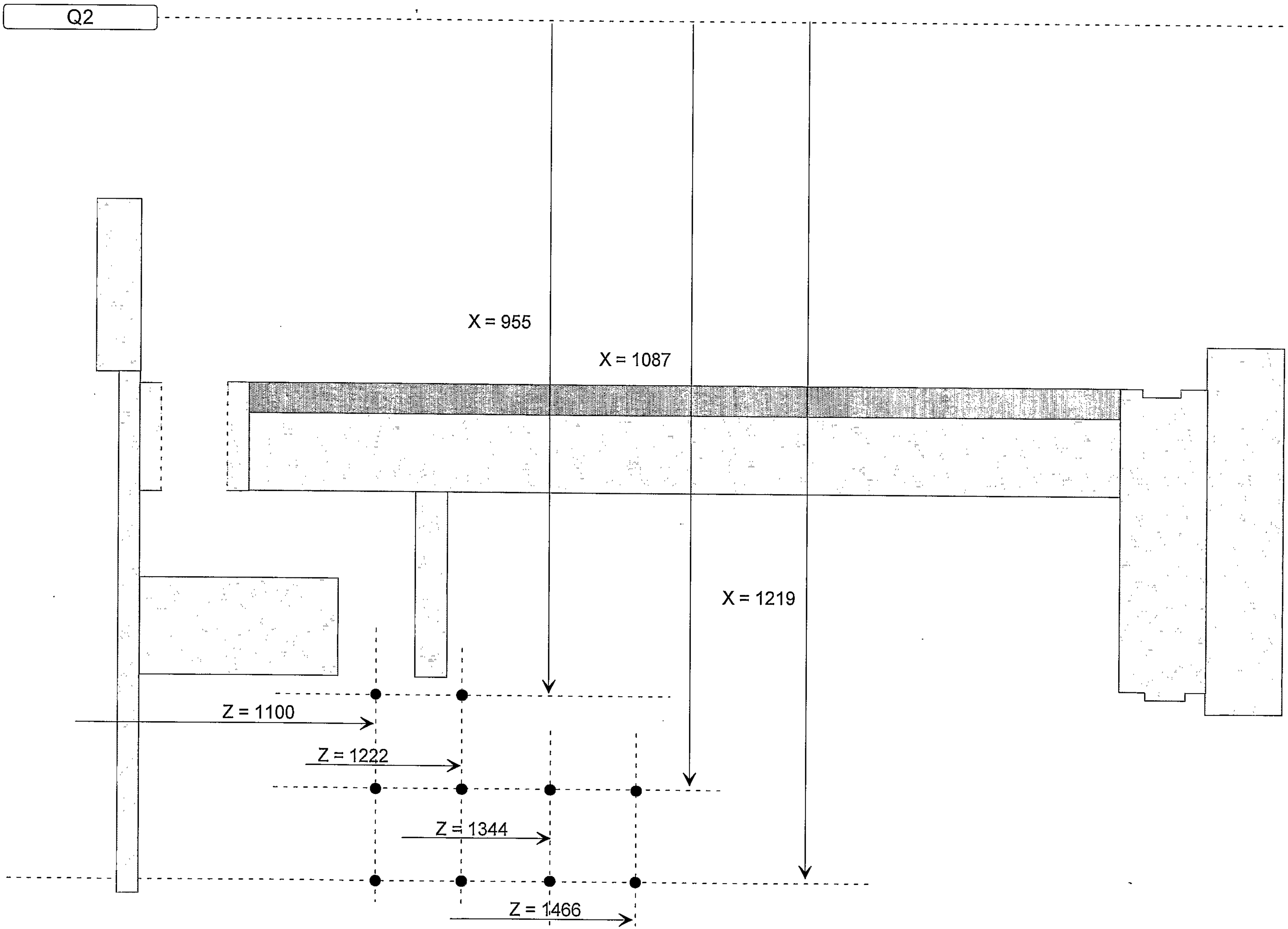
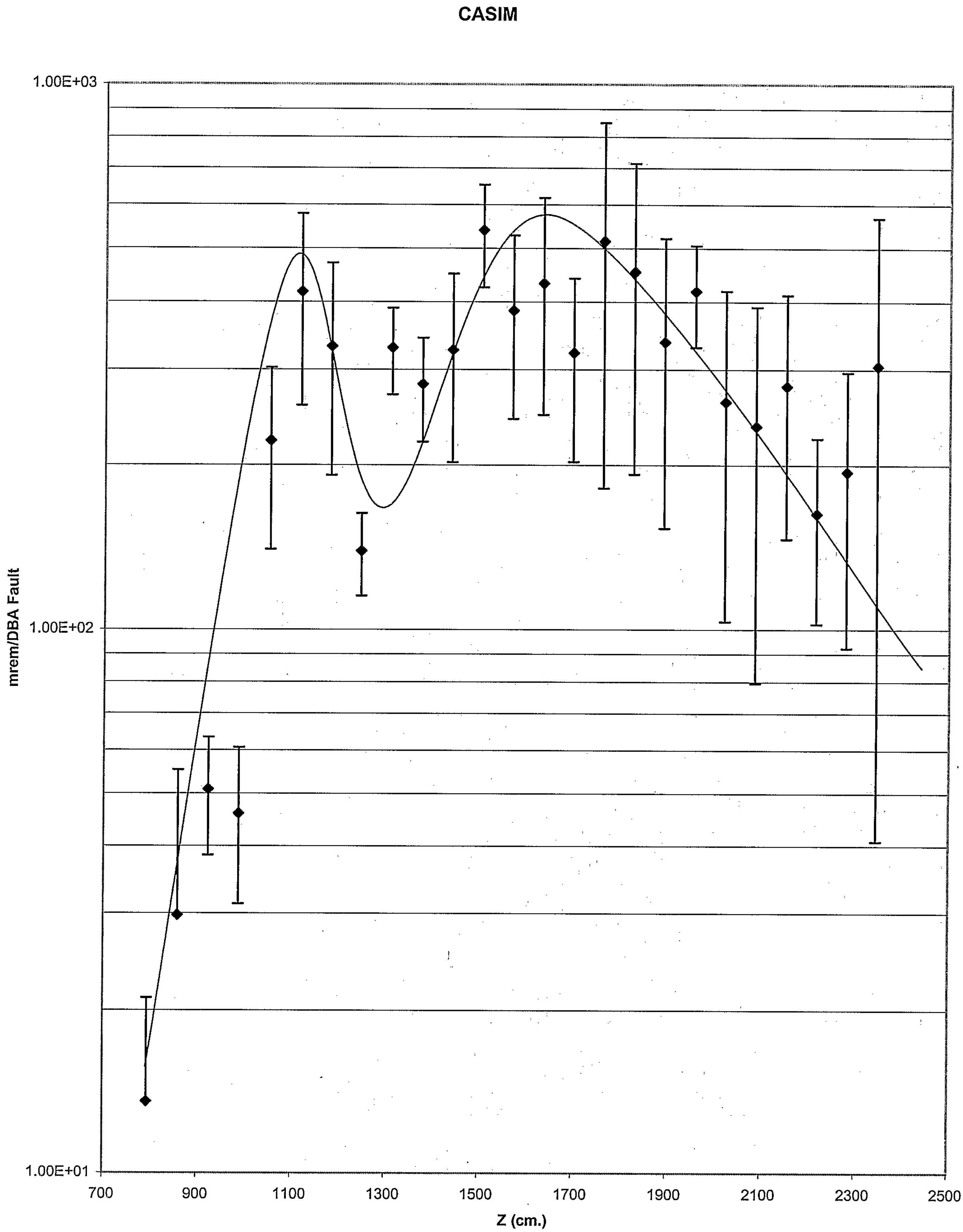


Fig. 1 Plan View of the Geometry. The circles show Point Detector Locations



CASIM
1.00E+03
1.00E+02
1.00E+01
mrem/DBA Fault
700
900
1100
1300
1500
1700
1900
2100
2300
2500
Z (cm.)

Fig. 2

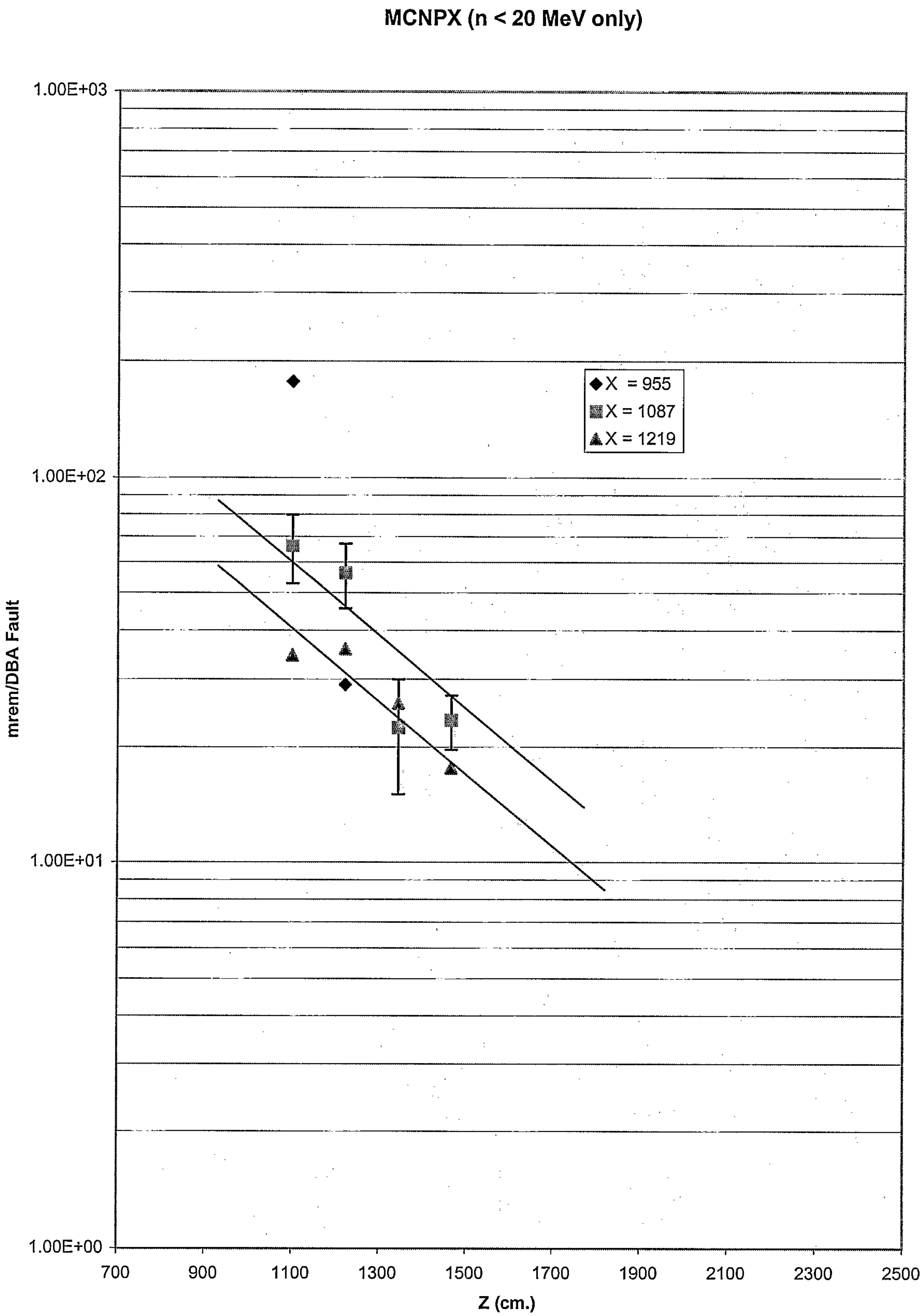

MCNPX (n < 20 MeV only)
1.00E+03
1.00E+02
1.00E+01
1.00E+00
mrem/DBA Fault
X = 955
X = 1087
X = 1219
700
900
1100
1300
1500
1700
1900
2100
2300
2500
Z (cm.)

Fig. 3