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SOIL ME!
Soil Activation Estimates for the g-2 Target Area and Beam Dump

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Estimates of soil activation for the preliminary designs of the g-2 target area and primary beam dump have been done. These estimates are intended to be used for preliminary environmental impact assessments and to provide a guide to modifications of the design.

The Monte Carlo program CASIM[1,2,3] has been used to generate the hadron cascade and calculate the number of stars produced in the soil. The geometry used for these calculations has been greatly simplified compared to preliminary designs[4] but these simplifications should not have a significant effect on the intended use of the results. The geometry is given cylindrical symmetry. The stars produced in soil from 28 GeV/c proton interactions in an iron target are calculated. A separate CASIM simulation estimates stars produced in soil for the primary proton beam interacting in the dump. The appropriate weighing and linear superposition of these separate simulations (target interactions and beam dump interaction) can be done to give the combined total stars produced. Minor inconsistencies exist between the target area and beam dump geometries. Dimensions of both the target area and beam dump are given in Tables I and II respectively.

A plan view of the target area is shown in Figure 1. A total of 4.6 stars/per proton interacting in the target are produced in the soil. Figure 2 gives the radially integrated soil stars as a function of z. It is clear from Fig. 2 that most of the soil stars are produced between the target cave end cap and the beam dump. Star densities are given in Figures 3 and 4.

The results of the CASIM simulation of the beam dump are shown in Figures 6, 7, and 8. A total of 0.033 stars per incident proton on

the beam dump are produced in the soil. Figure 6 shows the radially integrated soil stars as a function of z. Note the beam strikes the dump at z = 4.3 meters. Star densities as a function of radius are shown in Figures 7 and 8.

The production of radioactive isotopes can be estimated from the star densities.[5] The production values[6] of

^{3}H 0.075 atoms/(soil-star)

^{22}Na 0.02 atoms/(soil-star)

were used. Thus, based on the simple design model:

	Atoms in soil/incident proton	
	Target	Dump
^{3}H	.35	.0027
^{22}Na	.09	.00066

The figures can be used to get concentrations where desired. Superposition of the target and dump results can be done to get the combined contribution.

The most obvious results of this study suggest that there should be no soil in the forward direction from the target. Wall thickness can be adjusted to achieve a desirable limit to the amount and concentration of ^{3}He and ^{22}Na produced in the soil. Consideration of decommissioning the target station at the completion of the g-2 project may also affect the design.

References

1. A. Van Ginneken and M. Awschalom, "High Energy Interactions in Large Targets," Fermilab, Batavia, IL (1975).

2. A Van Ginneken, "CASIM. Program to Stimulate Hadronic Cascades in Bulk Matter," Fermilab FN-272 (1975).

3. A.J. Stevens, "CASIM on VAX," AGS/ADD Technical Note 287 (1987).

4. Drawing D14-1407C6.

5. A.J. Stevens, "Booster Soil, Component and Water Activator," AD Booster Technical Note No. 89.

6. J.D. Cossairt, "Review of the Abort Dump Shown in the SSC Conceptual Design Report, FNAL TM-1460, April 1987.

TABLE I - Target Area Dimensions

Cave	
Location	z = 0 (start)
Length	10 m
Radius	2 m
Wall thickness	.60 cm heavy concrete
End Cap wall #1	.60 cm iron
End Cap wall #2	.60 cm heavy concrete
Target (Iron)	
Location	z = 5 m
Length	1 cm
Outer radius	1 cm
Magnets	
8Q48 (Iron)	
Location	z = 5.6 m (start)
Length	1.22 m
Inner radius	.10 m
Outer radius	.43 m
N8Q32 (Iron)	
Location	z = 6.8 m (start)
Length	.81 m
Inner radius	.10 m
Outer radius	.28 m
18D72 (Iron)	
Location	z = 7.6 m (start)
Length	1.82 m
Inner radius	.15 m
Outer radius	.71 m
Transport tube to dump	
Location	z = 11.2 m (start)
Length	5 m
Radius	.30 m
Dump (Iron)	
Location	z = 16.2 (start)
Length	3.8 m
Radius	1.5 m
Soil	
Every outside above locations	
See Figure 1.	

TABLE II - Beam Dump Dimensions

Transport Tube		
Location	z = 0	(start)
Length	3.0 m	
Radius	.30 m	
Re-entrant Cap (Heavy Concrete)		
Location	z = 3 m	(start)
Length	.6 m	
Inner radius	.3 m	
Outer radius	1.5 m	
Front Cap (Heavy Concrete)		
Location	z = 3.6 m	(start)
Length	.6 m	
Radius	1.5 m	
Dump (Iron)		
Location	z = 4.2	(start)
Length	12.2 m	
Radius	1.5 m	
Soil		
Everywhere else (see Fig. 5).		

Figure Captions

1. Elevation view of the target area geometry. The numbers 1, 2, and 3 signify iron, heavy concrete and soil respectively.

2. Radially integrated soil stars produced per proton interacting in the target as a function of z per 40 cm Z_{bin}.

3. The star density per interacting proton in the target at z = 7.4 meters as a function of radius.

4. Same as Fig. 3, except z = 13.8 meters.

5. Elevation view of the primary beam dump. The numbers 1, 2, and 3 signify iron, heavy concrete, and soil respectively.

6. Radially integrated soil stars as a function of Z per proton interaction in the beam dump per 40 cm Z_{bin}.

7. Star density per proton interaction as a function of radius at z = 2.6 meters.

8. Same as Fig. 7, except z = 7.0 meters.

CROSS SECTION OF GEOMETRY FOR CONSTANT Y= 0.00 CM
ROM X= -500.00 TO X= 500.00 CM (VERTICAL) AND
ROM Z= 0.00 TO Z= 1700.00 CM (HORIZONTAL)

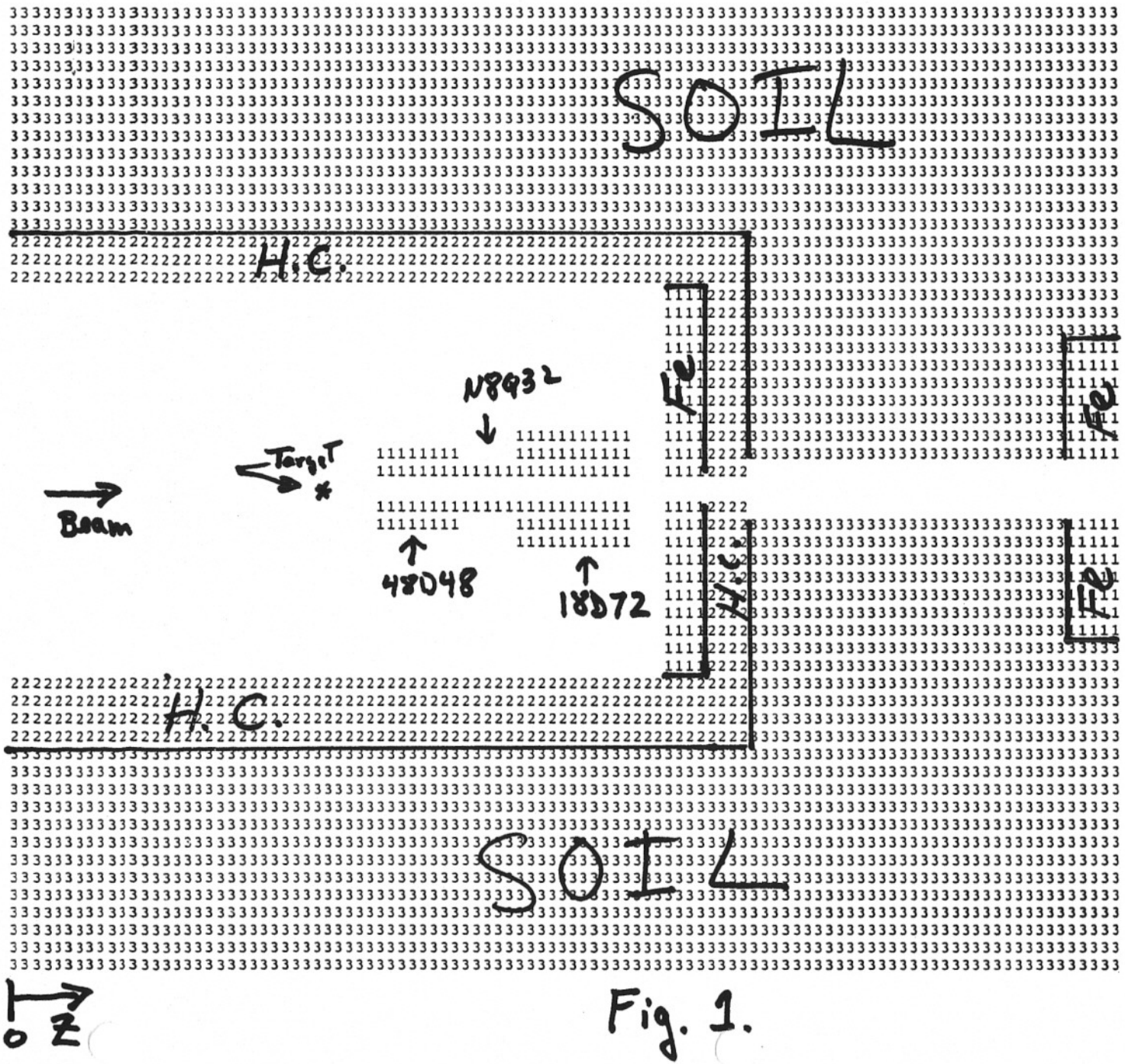

Fig. 1.

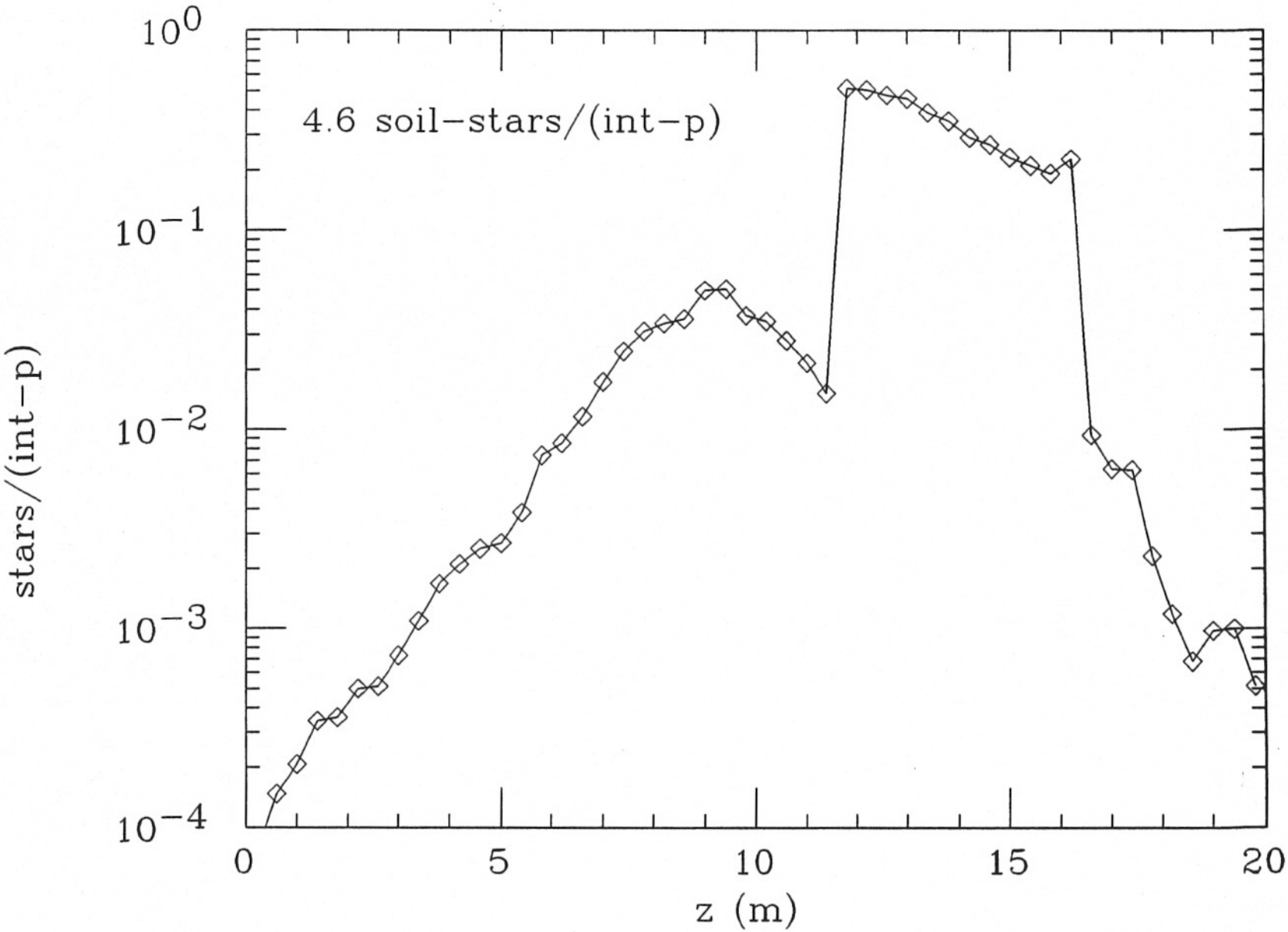
soil stars for model g−2 tgt area
4.6 soil−stars/(int−p)
stars/(int−p)
z (m)
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0
5
10
15
20

FIG. 2

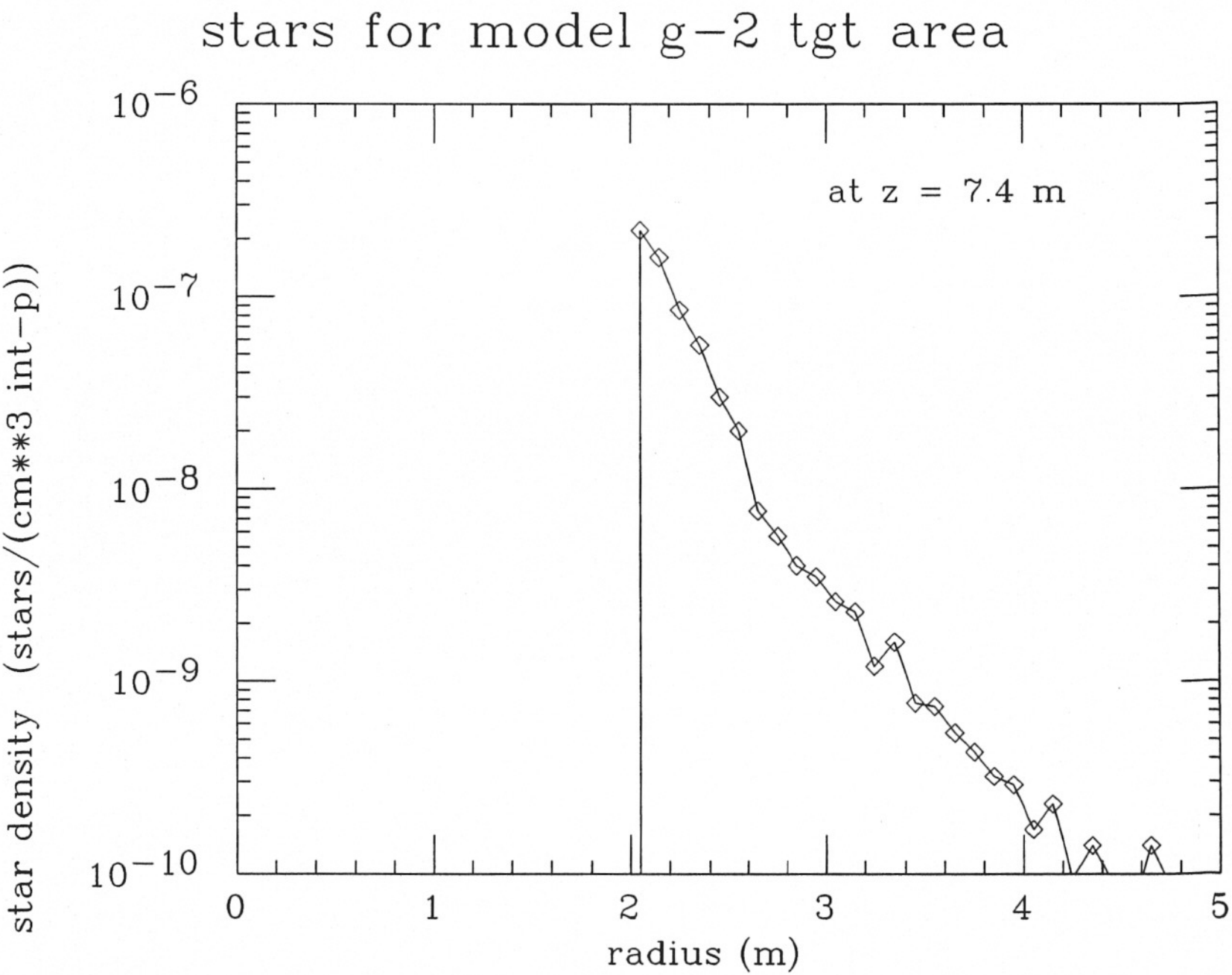
stars for model g−2 tgt area
at z = 7.4 m
star density (stars/(cm**3 int−p))
radius (m)
10−6
10−7
10−8
10−9
10−10
0
1
2
3
4
5

FIG. 3

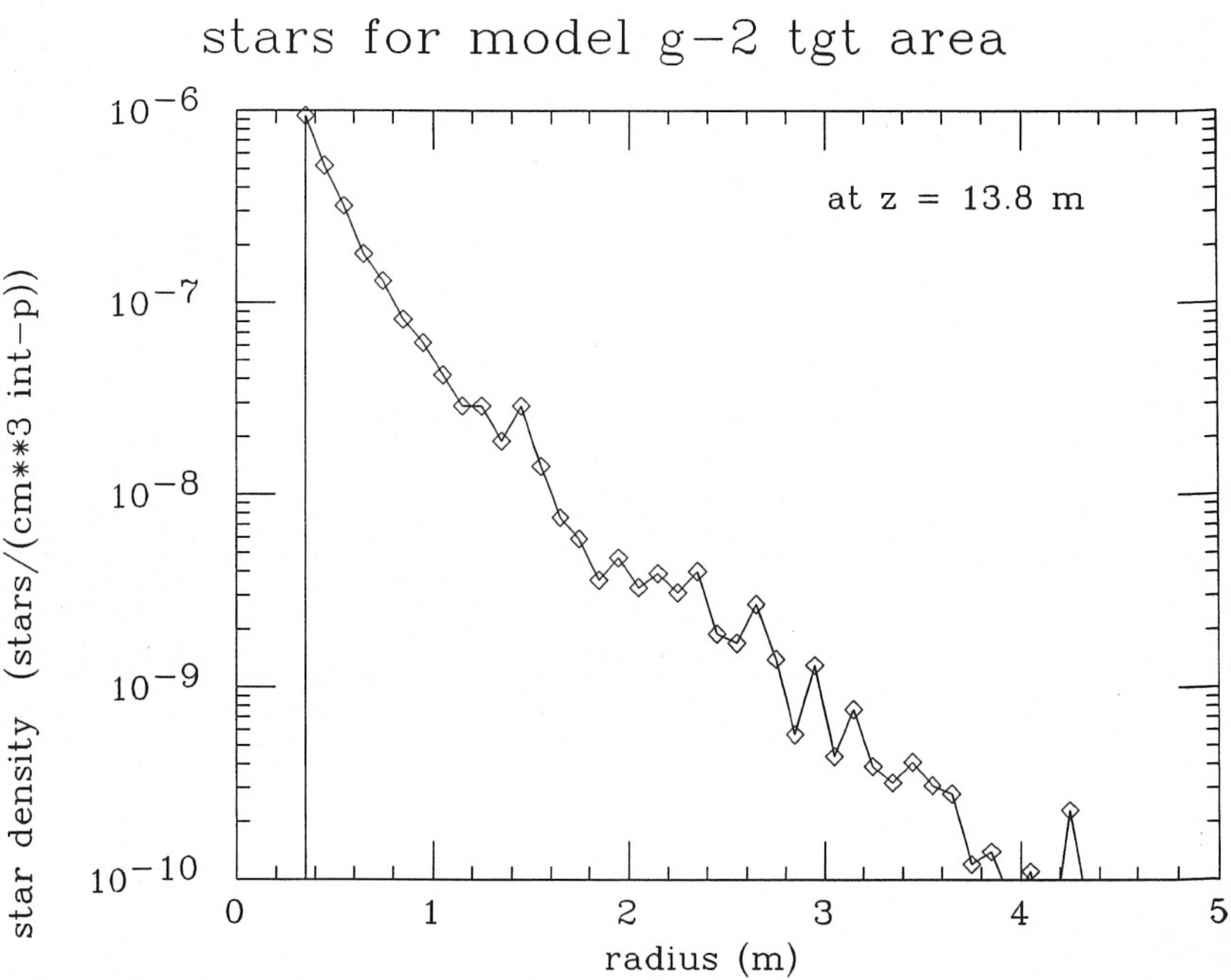
stars for model g−2 tgt area
at z = 13.8 m
star density (stars/(cm**3 int−p))
radius (m)
10−6
10−7
10−8
10−9
10−10
0
1
2
3
4
5

FIG. 4

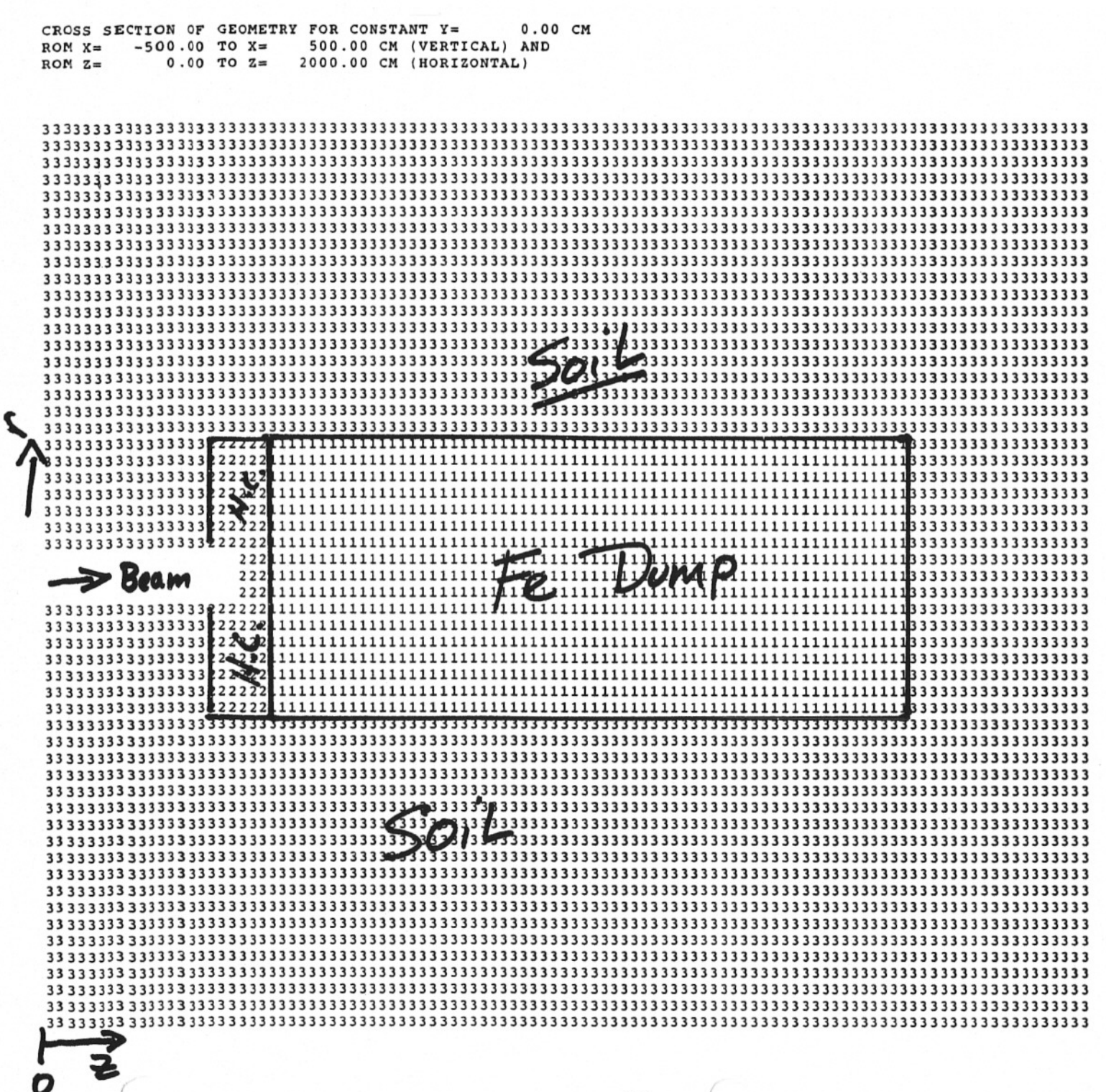
CROSS SECTION OF GEOMETRY FOR CONSTANT Y= 0.00 CM
ROM X= -500.00 TO X= 500.00 CM (VERTICAL) AND
ROM Z= 0.00 TO Z= 2000.00 CM (HORIZONTAL)
Soil
Beam
Fe Dump
Soil
0
Z

Fig 5

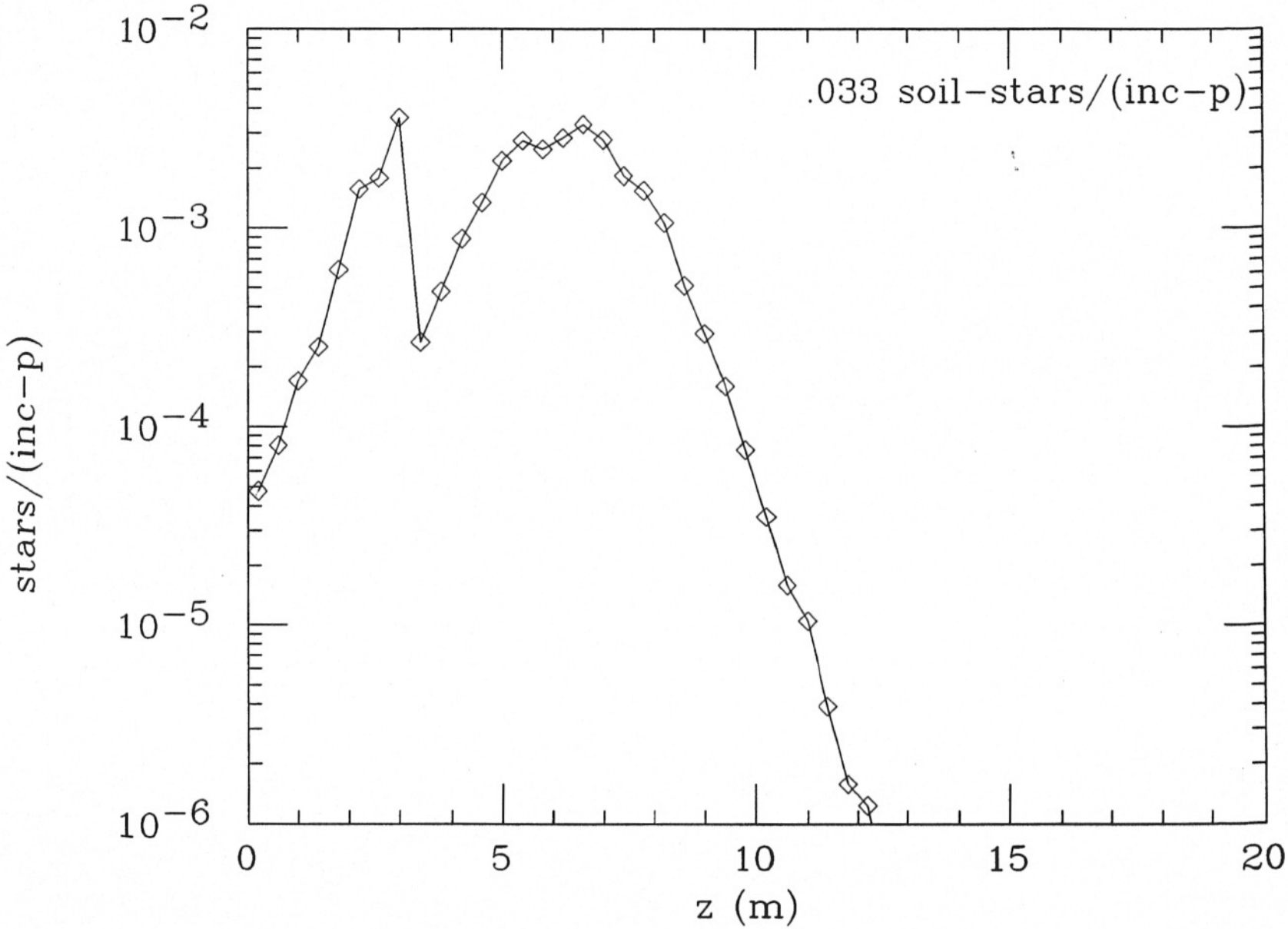
stars for model g−2 beam dump
.033 soil−stars/(inc−p)
stars/(inc−p)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0
5
10
15
20
z (m)

FIG. 6

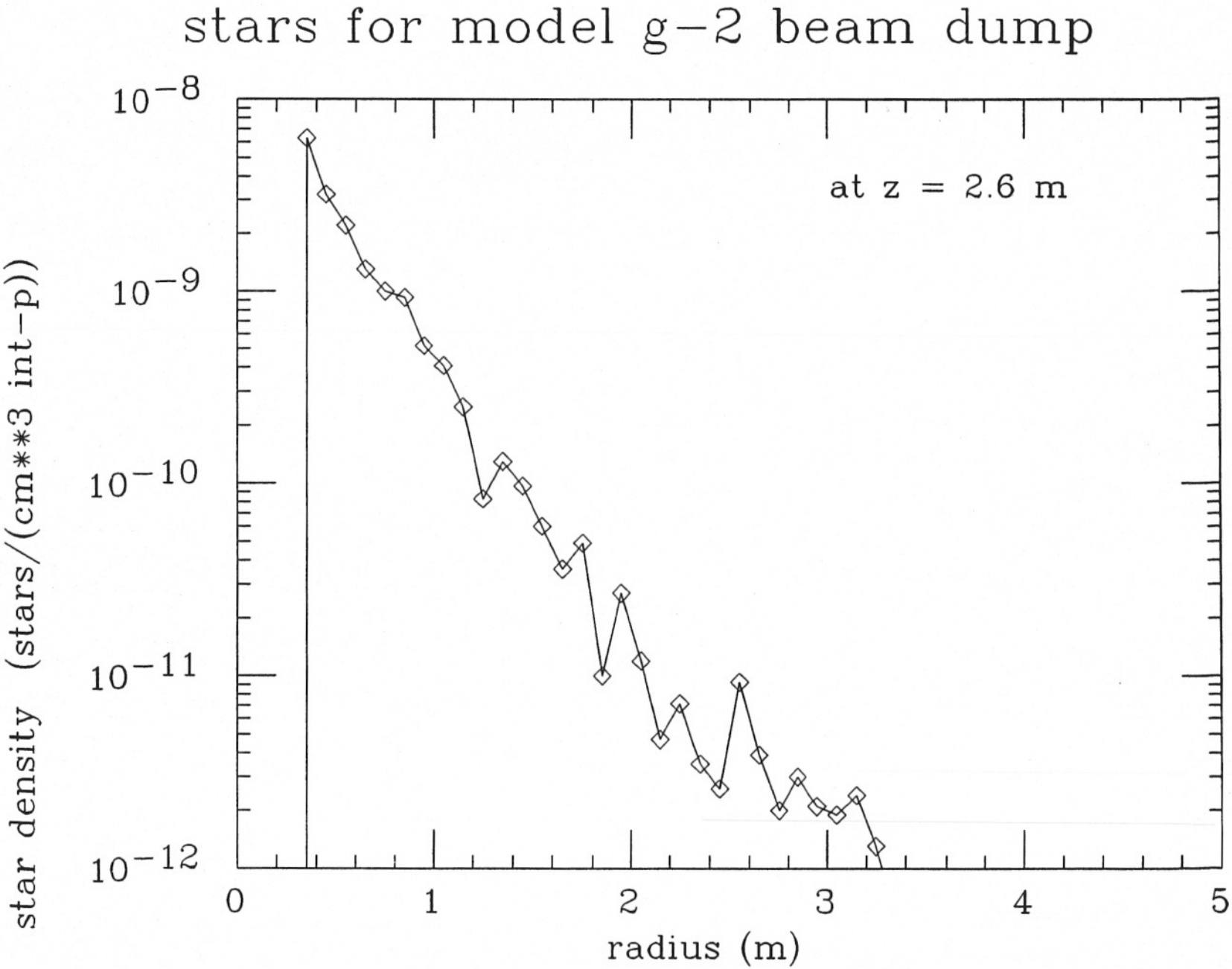
stars for model g−2 beam dump
at z = 2.6 m
star density (stars/(cm**3 int−p))
radius (m)
10^−8
10^−9
10^−10
10^−11
10^−12
0
1
2
3
4
5

FIG. 7

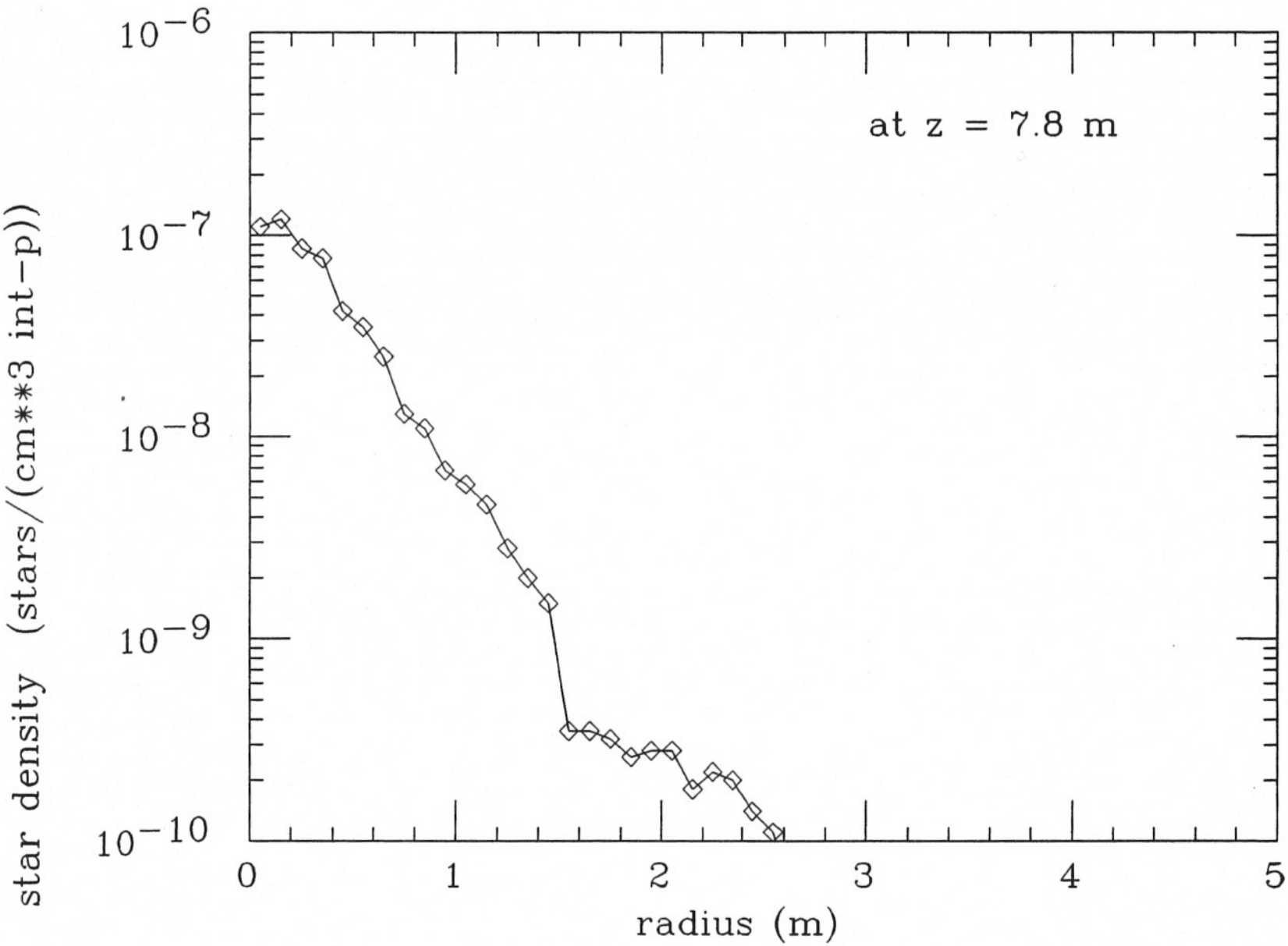
stars for model g-2 beam dump
at z = 7.8 m
star density (stars/(cm**3 int-p))
radius (m)
10^-6
10^-7
10^-8
10^-9
10^-10
0
1
2
3
4
5

FIG. 8