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Activate Me! Air activation estimates for the g-2 target area

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Experimental Planning and Support Division Technical Note

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Activate Me!*

Air Activation Estimates for the g-2 Target Area.

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January 29, 1990

Estimates of the air activation for a preliminary design of the g-2 target station are presented. These estimates are intended to be crude but sufficient for preliminary environmental impact assessments.

The Monte Carlo program CASIM[1,2,3] has been used to generate the hadron cascade and calculate the number of air stars produced in the target cave area. The geometry of the target area is greatly simplified relative to the preliminary designs.[4] A description of this model area is given in a previous note[5] for soil activation estimates. The only change is that air has been explicitly added as a material in the cave volume.

Air was represented as being a medium for $A = 14.4$, $\rho = 0.0012$ gm/cm^3 and $Z = 7.2$.[6] In addition, the hadron cascade calculation was terminated at the cave wall surface. This neglects a small contribution to air activation caused by secondaries produced from stars which occur outside the cave volume.[7] A plan view of the target cave model is given in Figure 1.

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* Please *not* at BNL--I can't take the paperwork.

The radially integrated air stars per interacting proton in the target per 20.1 cm Z bin are shown in Figure 2 as a function of Z. A total of 0.019 air stars are produced in the tunnel air per proton interacting in the target. From Figure 2 a substantial portion comes from the air immediately downstream of the target. This illustrates the point made by A. Rindi and G.R. Stevenson[7] to minimize the path length of secondaries in air in the forward direction to reduce air activation. The star density for Z = 5.9 meters as a function of radius is shown in Figure 3. The large star density is due to the 8Q48. Figure 4 shows the star density as a function of radius at Z = 9.75 meters, between the 18D72 and the shield wall. Again, it is clear that the air activation comes from the forward region.

The primary beam may pass directly through air in the primary transport. Normally these air gaps would occur near the target. For the purposes of this note, we assume that the secondaries produced from such interactions have the same effectiveness of producing air stars as secondaries produced in the target. We assume that all the primary beam goes through the air gap (no target attenuation accounted for). The total number of air stars produced per primary proton is (L/λ_A) $(1 + 0.019)$, where L is the length of air and λ_A is the absorption length of air. The ratio of air stars caused by primary proton interactions in air to interactions in the target is

$$(L/\lambda_A)(1 + 0.019)/[T\ 0.019]$$

where T is the target thickness in percent absorption lengths. If we take L =2 meters, λ_A = 675 meters,[8] and T = .5, then this ratio is .32.

Isotope production can be estimated from the CASIM air stars.[6] Table I gives the number of each isotope per star. Table II gives the rate of isotope production assuming 2×10^{13} protons/sec, 2 meters of air in the primary transport, a 50% interaction length target, and the numbers in Table I.

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. D. Beavis, "Soil Me! Soil Activation Estimates for the g-2 Target Area and Beam Dump," AGS/EP&S/Tech. Note No. 135 (1989).

6. A.J. Stevens, "Air Activation in the Booster Tunnel," Booster Tech. Note No. 86 (1987).

7. A. Rindi, and G.R. Stevenson, "Air Activation in Target Stations of the SPS," CERN LAB II, RA/Note/73-3 and Addendum (1973).

8. Review of Particle Properties. Phys. Lett. Vol. 75B, No 1 (1978).

TABLE I (directly from Ref. 6.)

Isotope Production per Air Star

Isotope	*Number/star*
^{35}S	.0004
^{32}P	.0005
^{28}Al	.0002
^{22}Na	.0002
^{15}O	.030
^{14}O	.0008
^{13}N	.035
^{11}C	.032
^{7}Be	.032
^{3}H	.107

TABLE II

Isotope production rate for 2×10^{13} 28 GeV/c protons per second with 2 meters of air in the primary transport and 50% interaction length target.

Isotope	*Atom/sec*
^{41}Ar *	1.9×10^{9}
^{35}S	1.0×10^{8}
^{32}P	1.3×10^{8}
^{28}Al	5.0×10^{7}
^{22}Na	5.0×10^{7}
^{15}O	7.5×10^{9}
^{14}O	2.0×10^{8}
^{13}N	9.0×10^{9}
^{11}C	8.0×10^{9}
^{7}Be	8.0×10^{9}
3H	2.7×10^{10}

* The ^{41}Ar number was obtained following the discussion of A.J. Stevens[6], section VI, except a value of .01 ^{41}Ar per CASIM star is used. In addition, only the stars from secondary interactions are used.

Figure Captions

1. Elevation view of the target area geometry. The numbers 1 and 4 signify iron and air respectively.

2. The radially integrated air stars per 20.1 cm Zbin per 28 GeV/c proton interacting in the target as a function of Z.

3. The star density per interacting proton at Z = 5.9 meters as a function of radius.

4. Same as 3, except at Z = 9.75 meters.

CROSS SECTION OF GEOMETRY FOR CONSTANT Y= 0.00 CM
ROM X= -50[illegible] TO X= 500.00 CM (VERTICAL) AND
ROM Z= [illegible] TO Z= 1700.00 CM (HORIZONTAL)

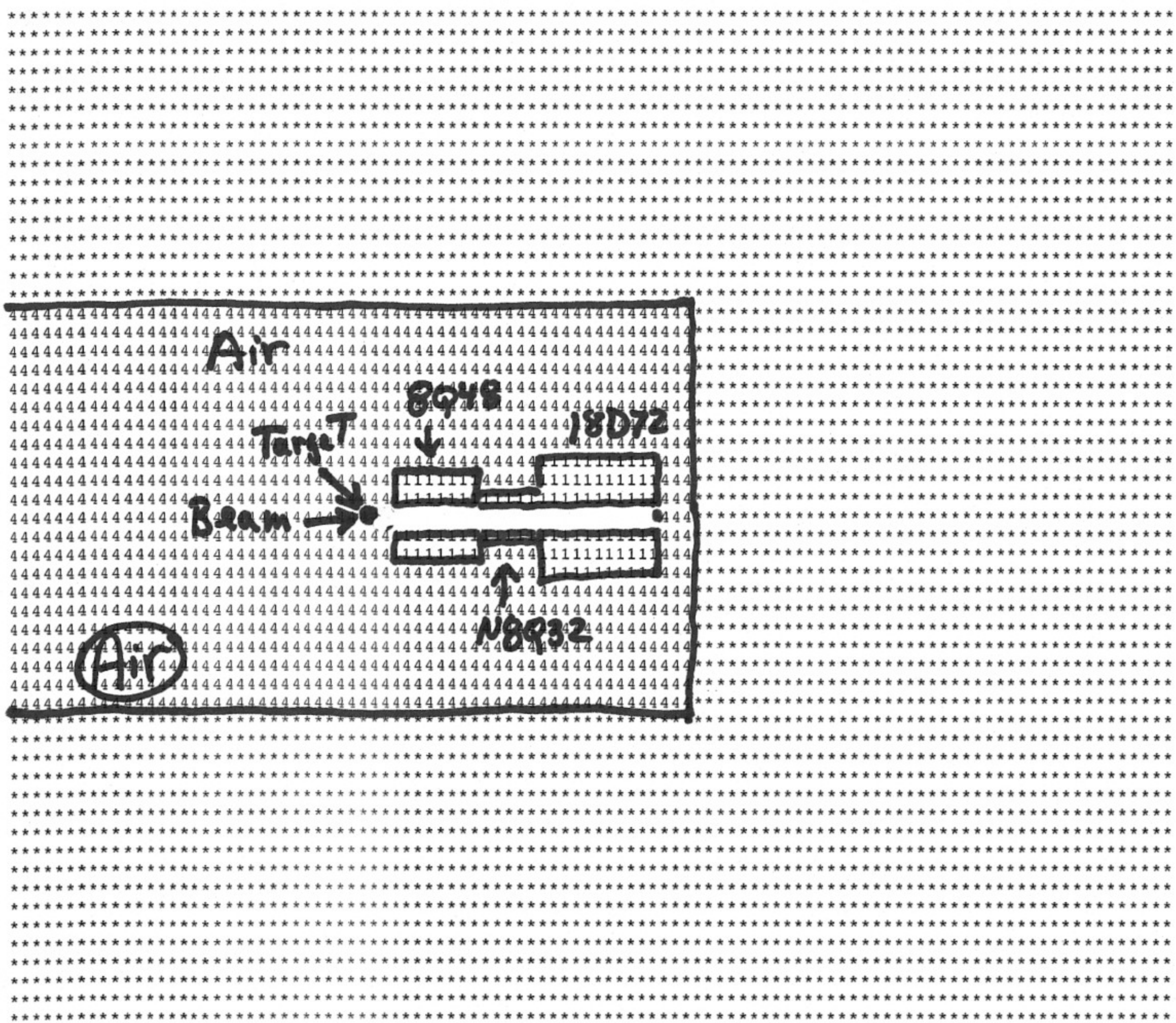

FIG. 1

air stars for model g-2 target area

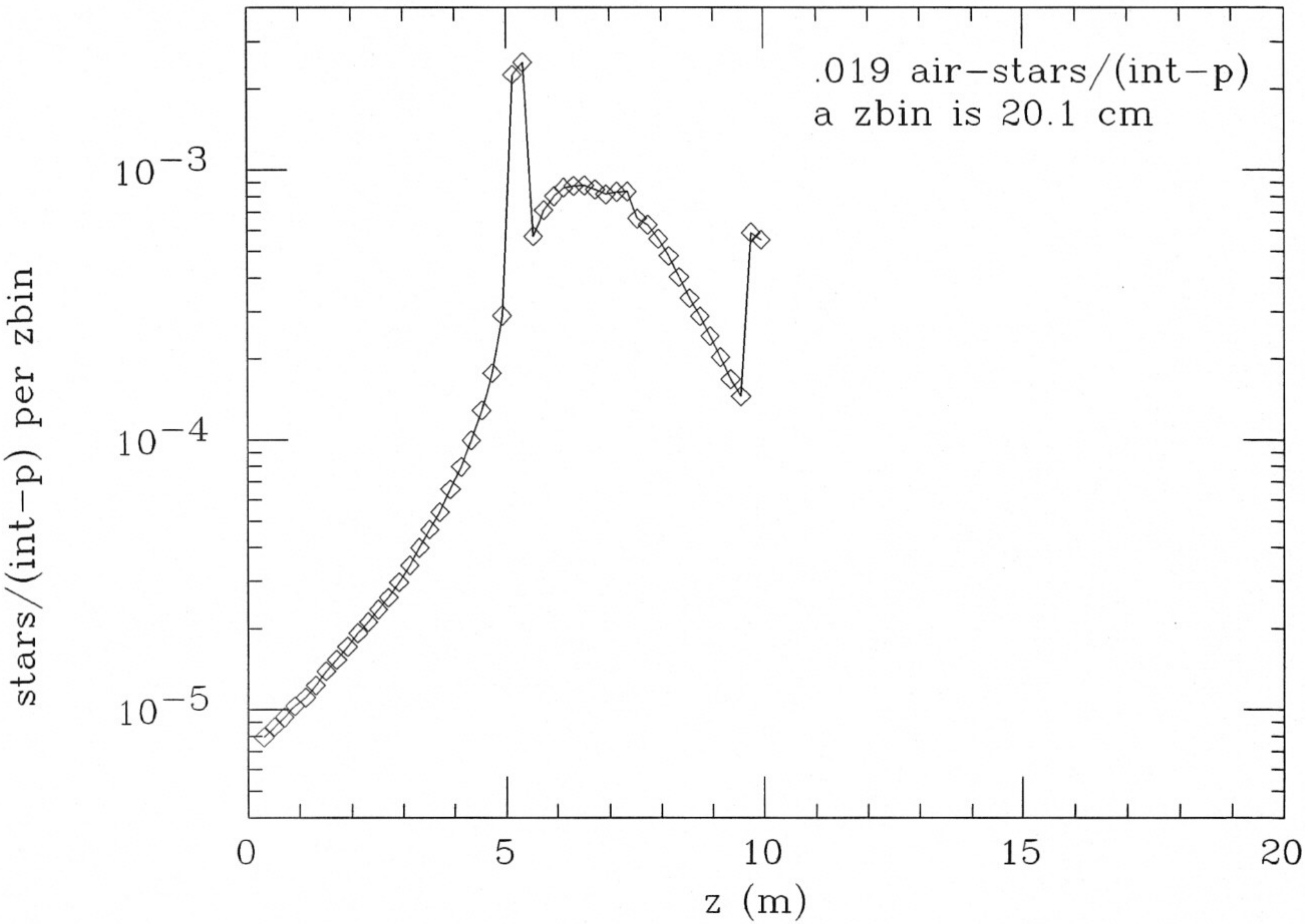

FIG 2

stars for model g-2 target area

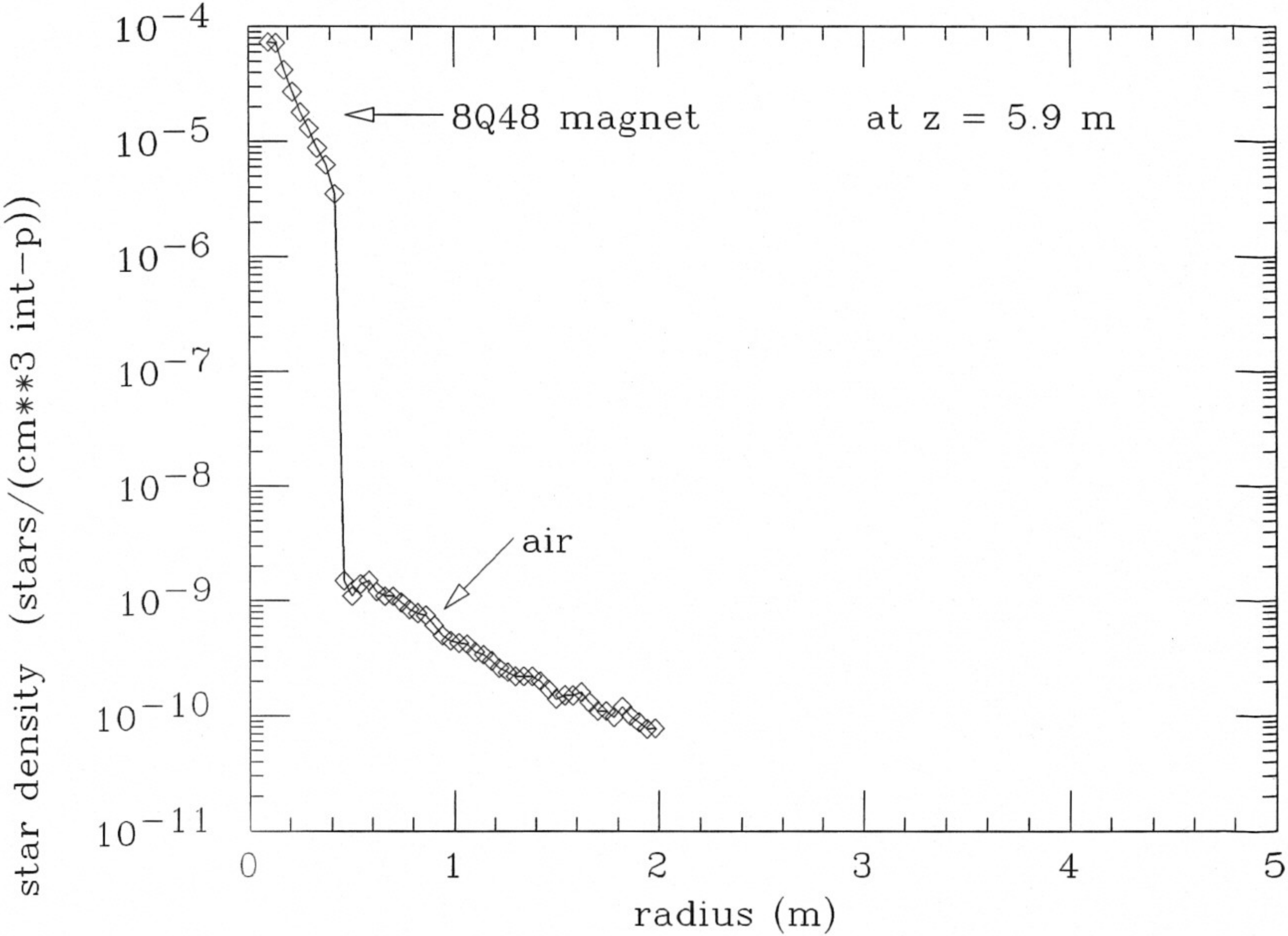

FIG 3

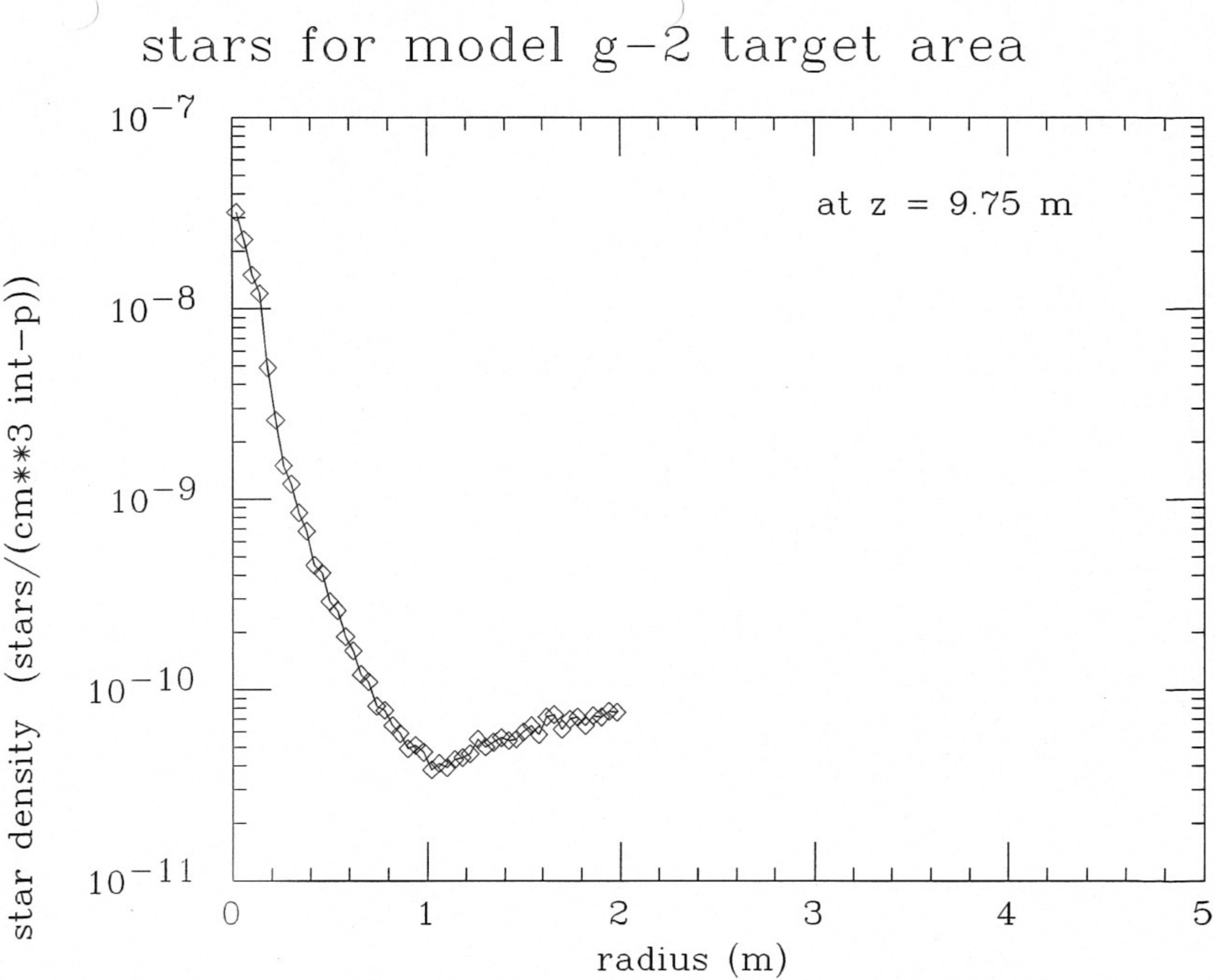
stars for model g−2 target area
at z = 9.75 m
10−7
10−8
10−9
10−10
10−11
star density (stars/(cm**3 int−p))
0
1
2
3
4
5
radius (m)

FIG 4