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The Energy Deposition Downstream of Target Stations by Hadrons

The application of superconductivity in high energy physics is becoming very popular. There are, however, a few problems in connection with the application, one of which is the radiation heating by the particles. There are a few reports concerning the problem.[1,2] In this note we made an order of magnitude calculation of what is the density of particles striking the area downstream of the target station.

According to the Monte Carlo calculation,[3] the energy deposition by the hadrons is proportional to the energy of the particle in first order. Therefore, the total energy of the particles striking the unit area has some relevance to the problem. In the framework of scaling behavior of the hadrons, we think it is useful to normalize the energy to the incident particle energy. We made the calculation for the AGS energy of 30 GeV/c incident proton momentum. In first order it should scale with the energy of the particle.

Included in the calculations are:

A) The diffraction scattered proton which is very important in the range of angle below $\sim$ 50 milli radians.

B) The charged pion production which becomes important for more moderate angles.

We further assumed

C) The neutral pion production which contributes as the γ-ray source is one half of the charged pion production.

D) The number of the protons produced, other than those elastically or quasi-elastically scattered, to be three times the positive pion production.

E) The neutron production is the same as D.

F) All other particle productions can be ignored.

We made a numberical integration of Sanford and Wang[4] production curves for the charged pion production. In each case, we calculated:

$$\frac{\Delta\Omega}{P_o} \int P \frac{dn}{dpd\Omega} dp$$

where $\Delta\Omega$ is the solid angle subtended by unit area, and Po and p are the momenta of the incident particle and secondary particle respectively. The Figure 1 shows the number of equivalent primary protons per unit area per interacting proton at one to eight inches from the beam axis, and up to 1400 inches downstream of the target.

As can be seen in the figure, each ΔX has a minimum where the elastic or quasi-elastic and multi particle productions are comparable. The up-stream side of the minimum is dominated by the particle production and the downstream side is dominated by diffraction scattering. When the element is placed too close to the target, particle production dominates, and the diffraction scattering dominates when placed far downstream. It seems that an optimum place exists where the superconducting element receives the least amount of radiation.

References

1. Accelerator Department Internal Report AGS 69-7
2. Accelerator Department Informal Report EP&S 73-1
3. W.V. Jones, Nuclear Instr. and Methods 72 173(1969)
4. Accelerator Department Internal Report BNL 11299

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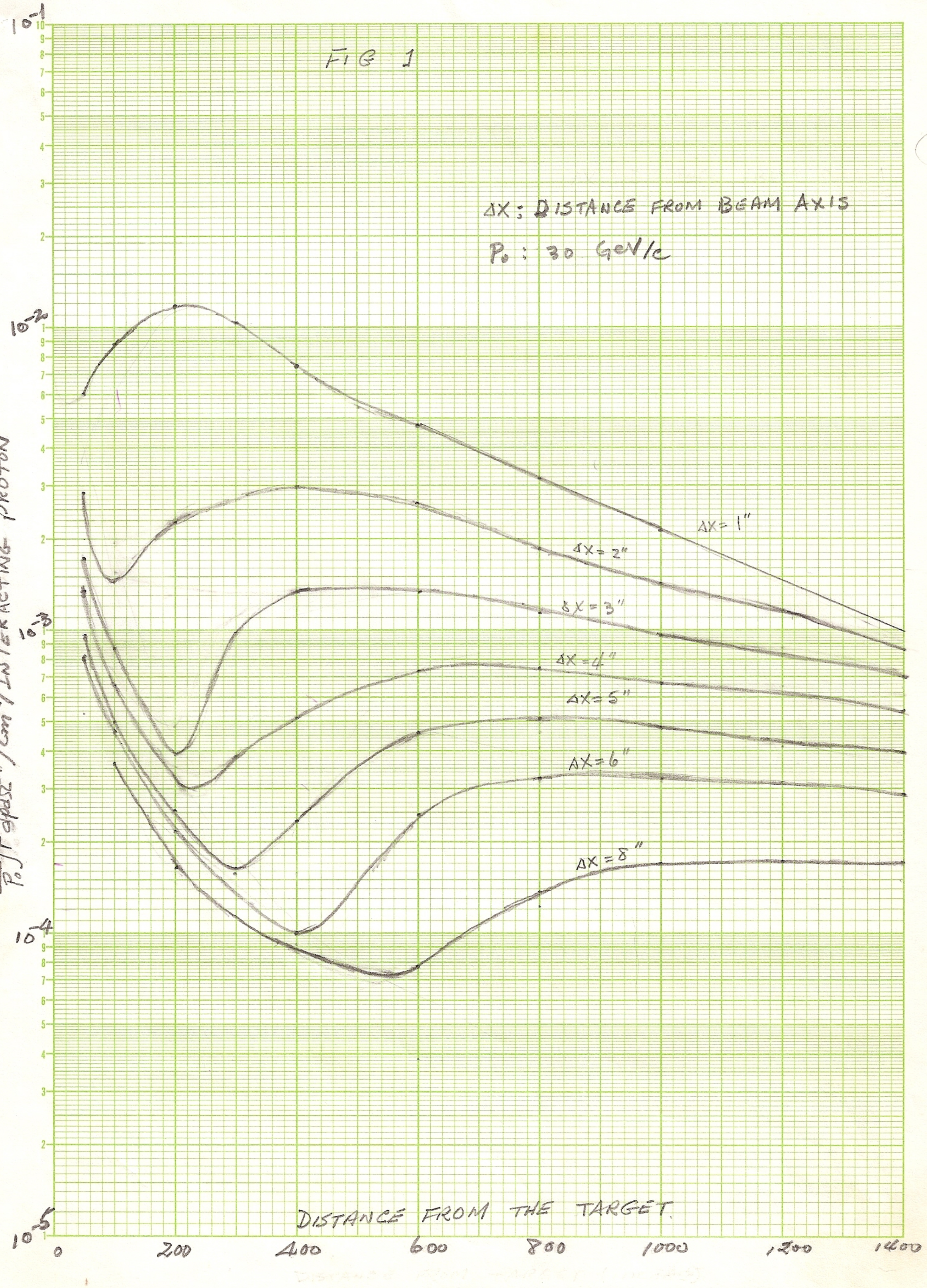

FIG 1
ΔX: DISTANCE FROM BEAM AXIS
P₀: 30 GeV/c
ΔX = 1"
ΔX = 2"
ΔX = 3"
ΔX = 4"
ΔX = 5"
ΔX = 6"
ΔX = 8"
DISTANCE FROM THE TARGET
0
200
400
600
800
1000
1200
1400
10-1
10-2
10-3
10-4
10-5
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