



BNL-105773-2014-TECH

EP&S No. 60;BNL-105773-2014-IR

The energy deposition downstream of target stations by hadrons

Y. Y. Lee

April 1973

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No.AT(30-1)-16 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, New York

EP&S DIVISION TECHNICAL NOTE

No. 60

Y.Y. Lee

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 ~ 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 numerical integration of Sanford and Wang⁴ production curves for the charged pion production. In each case, we calculated:

$$\frac{\Delta\Omega}{P_0} \int P \frac{dn}{dpd\Omega} dp$$

where $\Delta\Omega$ is the solid angle subtended by unit area, and P_0 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 upstream 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

Distribution:

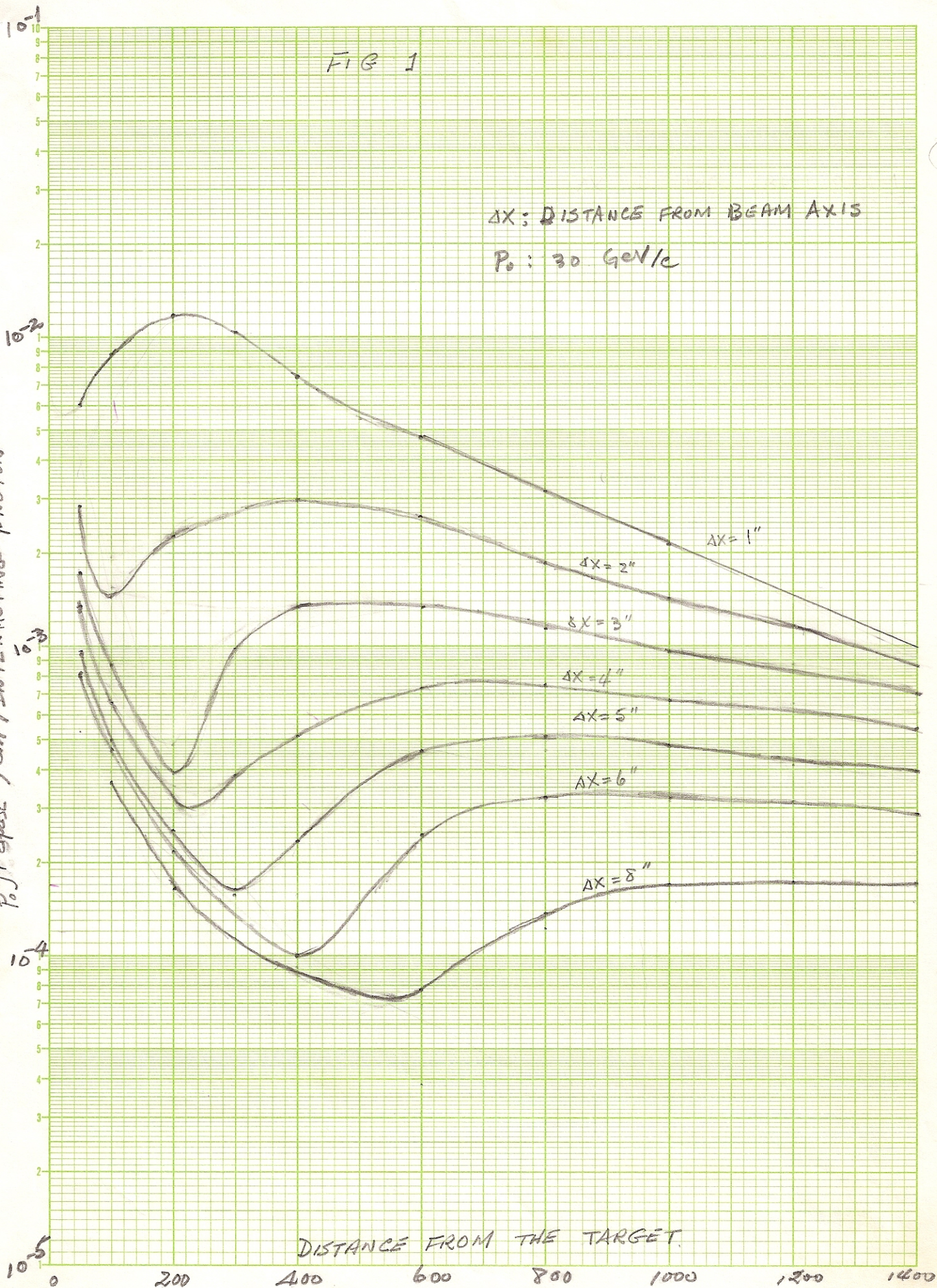
Administration
B1 (Limited)

FIG 1

ΔX : DISTANCE FROM BEAM AXIS

P_0 : 30 GeV/c

$\frac{dN}{P_0 \rho dx} \frac{dN}{dP} \frac{dP}{dX}$ / INTERACTING PROTON



DISTANCE FROM THE TARGET.

GRAPH PAPER GRAPHIC CONTROLS CORPORATION Buffalo, New York
SEMI-LOGARITHMIC 4 CYCLES X 70 DIVISIONS AD-0843-C0