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PROPOSED MODIFICATION TO COMBINED BUBBLE CHAMBER-SPARK CHAMBER SYSTEM

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An alternative proposal to the bubble chamber-spark chamber hybrid system (Report A. 3-68-12) is outlined below. Basically the idea is to make the bubble chamber with an axial magnetic field (B pointing along the beam axis). This orientation has several advantages:

(i) The charged particles are not magnetically bent away from the forward direction; this has the effect of decreasing the required solid angle and hence the cost of the forward spectrometer.

(ii) Tracks which go perpendicular to the forward direction (and hence to the magnetic field) become events with good momentum measurability. Thus one has the possibility of doing a very good job on tracks transverse to the forward direction, leaving the forward-going tracks to the forward spectrometer.

The addition of a large aperture quadrupole doublet (or triplet) would further minimize the aperture of the forward spectrometer. A detailed analysis would be required to determine if the added cost of the large aperture quadrupole could be more than offset by the savings in the spectrometer magnet.

For example, consider a 1-m long hydrogen bubble chamber whose center is located 4 m from the entrance principal plane of a quadrupole (doublet or triplet). Let the focusing effect be approximated by a thin lens. Leave 7 m free space between the quad and the 4-m diameter bending magnet. The minimum aperture is obtained by focusing at 7 + 4/2 + 1 = 10 m. Thus $f^{-1} = 10^{-1} + 4^{-1} = 0.350\ m^{-1}$. The magnetic fields are adjusted so that this focal length is obtained for the lowest momentum for which the forward spectrometer is to be used--assume 6 GeV/c (whose maximum production angle for 0.6 GeV/c transverse momentum would be 0.1 radian). Figure 1 shows the rays for the front, center, and end of the bubble chamber at this momentum and production angle. The same case for 24 GeV/c is also shown (with production angle of 0.6/24 = 0.025 radians) and 96 GeV/c at 0.006 radians. The indication is that the longer focal lengths at the higher momentum do not become a problem since the production angle shrinks fast enough to overcome this effect.

The solenoidal character of the bubble-chamber magnet will fuzz up the image a little bit. A rough calculation of this effect for the worst case is that at 0.6 GeV/c transverse momentum at 6 GeV/c momentum in 60 kG gives about 1/20th of a circle of revolution, 18°. The radius of curvature is 1/3 m; the particle' s apparent origin is shifted about 1 cm: and the quad system has a magnification of 2.5. Thus this effect increases the necessary aperture of the spectrometer magnet 5 cm, a negligible amount. Crude thin lens calculations indicate that a superconducting 40-kG doublet of quadrupoles, each about 1-m long and 1-m bore separated by 2/3 m will suffice to give the requisite focal length at 6 GeV/c. Since aberrations in this quadrupole are of no concern, this could be a nice initial application of superconducting techniques.

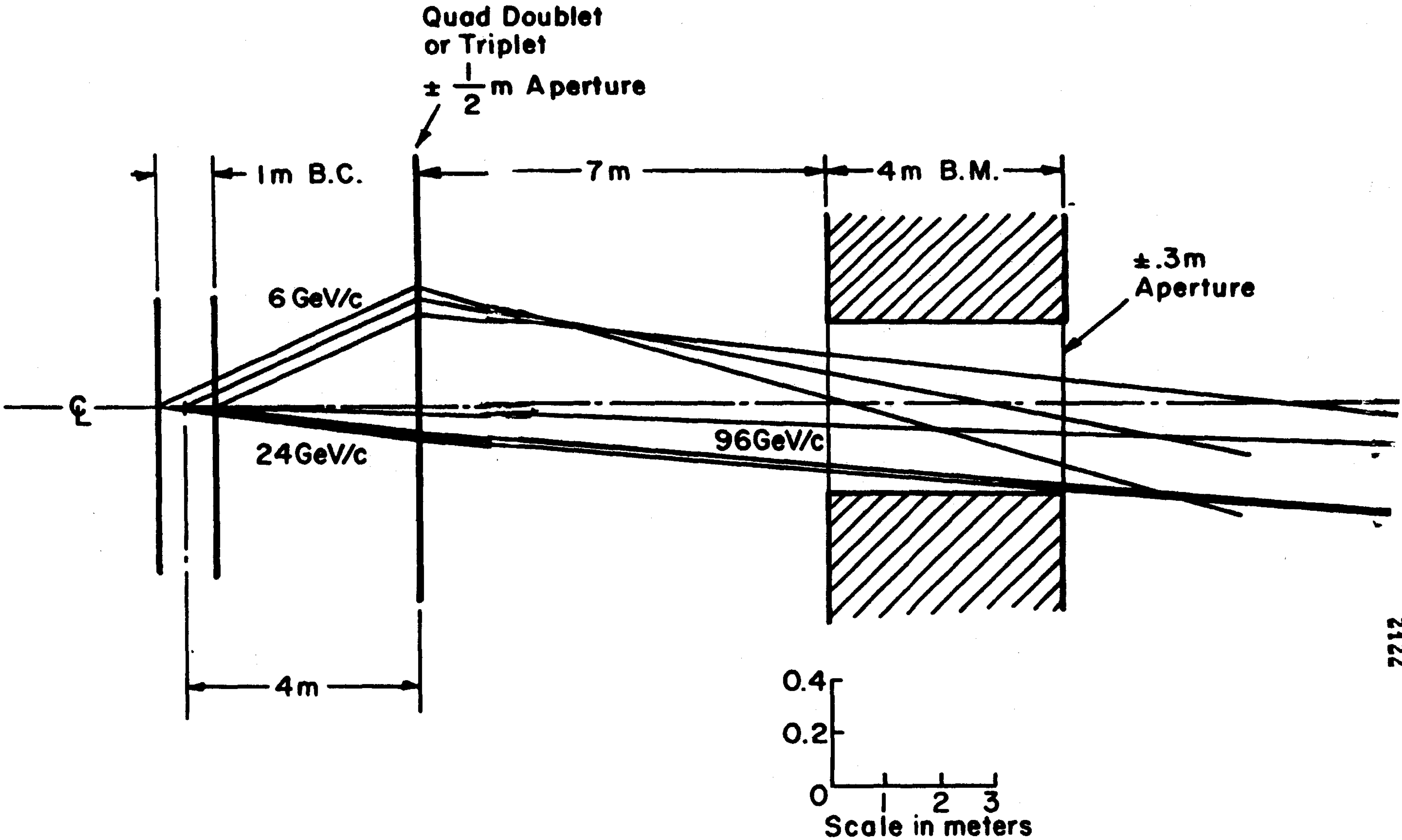

Fig. 1. The use of an axial magnetic field on the bubble chamber and a lens triplet in order to decrease the necessary aperture in a high-energy spectrometer.