Thoughts Concerning Vacuum in the Fixed Target Meson Area

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ABSTRACT

We calculate the effect of vacuum on beam loss, energy deposition, and emittance blow-up in the MCenter beamline. We show that for reasonably achievable vacuum the effects are insignificant.

1. Introduction

There are presently two operating beamlines in the Meson area: MTest and MCenter. This paper will focus on the MCenter primary beam.

The MCenter primary beamline is approximately 1350 feet long. It is assessed for 6E12 protons per hour. The typical spill is 1E11 protons for 4 seconds every minute. The beam is 120 GeV protons.

We assume the PDG values for dry air: density of 1.205E-3 g/cm^3, nuclear collision length of 61.3 g/cm^2, and radiation length of 36.62 g/cm^2.

2. Beam Loss Due to Vacuum

We make two simplifying assumptions: any collision results in beam loss, and the vacuum is at 1 mTorr. Thus, 1350 feet of air represents 1.06E-6 collision length. Assuming 1E11 protons per spill, this is a loss of 1.06E4 protons. At 120 GeV, this equals 2.05E-3 J. If one then averages over the length of the beamline for the 60 second cycle time, one finds that the power lost per meter is 8.29E-8 W/m.

3. Emittance Blow-Up Due to Multiple Scattering

Again, we assume 1 mTorr vacuum. At this pressure, 1350 feet of air equals 1.78E-6 radiation lengths. This gives an RMS scattering angle of 7.52E-5 mRadian. Assuming all the scattering occurs at the beginning of the beamline would result in a 3.09E-2 mm broadening of the beam. This represents an increase in the 95% normalized emittance of 1.79E-3 mm*mRadian.

4. Conclusion

The following table shows fractional beam loss, power loss, and emittance blow-up for three values of vacuum in the MCenter beamline.

Vacuum	Fractional Beam Loss	Power Loss	Emittance Blow-Up
mTorr	[]	[W/m]	[mm*mRadian]
1	1.0E-6	8.3E-8	1.8E-3
10	1.0E-5	8.3E-7	1.8E-2
100	1.0E-4	8.3E-6	1.8E-1

In conclusion, even at 100 mTorr the effect of vacuum on MCenter beamline is insignificant.