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Informal Report

INTERSECTING STORAGE ACCELERATOR NOTES

RADIATION FROM 200-GeV PROTONS AND ITS POSSIBLE USEFULNESS

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Abstract

The properties of synchrotron radiation from 200-GeV protons are reviewed. Their possible use in ISA diagnostics is suggested.

Introduction

While it has been shown that synchrotron radiation energy losses for 200-GeV protons are small, an appreciable amount of energy is radiated and it appears that this radiation might be useful in beam diagnostics. In electron synchrotrons the radiation pattern is a valuable diagnostic tool, showing at a glance the shape of the electron beam and easily exposing errors in beam position or beam blowup phenomena. For 200-GeV protons, the peak of the spectrum lies far below the visible spectrum but should still be readily detectable. In this note we have assembled the leading parameters of the radiation.

It would seem that the synchrotron radiation might be useful also at NAL and at CERN II.

Rate of Energy Loss

The rate of energy loss is given by

$$6.033 \times 10^{-9} \gamma^4 / R \text{ electron volts per revolution .}$$

γ for a 200-GeV proton is 214. R , the radius of curvature in a 40-kG magnet, is 151.8 m. Hence the energy loss is 8.36×10^{-2} eV/revolution.

The total rate of energy loss for 6×10^{14} protons is almost exactly 1 W.

Angular Distribution

Most of the radiation is contained in a cone whose half angle is $1/\gamma$. This angle is about 1/4 degree. Hence a detector which subtends an angle of 1/2 degree will intercept 1/720 W or 1.4 mW.

Spectral Distribution

The peak of the spectral distribution will occur at a wavelength given in meters by

$$\lambda_{\max} = 1.76 R/\gamma^3 = 2.72 \times 10^{-5} \text{ m} = 0.027 \text{ mm} .$$

The half power points in the spectrum will be at 0.014 mm and 0.69 mm.

Detection of the Radiation

The radiation levels of over a milliwatt mentioned above are easily detectable by bolometers or thermocouples. Sensitivities many orders of magnitude above this are available and are used in many applications; probably the most demanding application is in astronomy.

An array of detectors covering the radiation cone could give a continuous presentation of the shape of the circulating beam.

Acknowledgement

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