Carbon Fibre Spherical Mirrors for the LHCb RICH 1 Detector

The Need for a RICH Detector.

The RICH, or Ring Imaging Cherenkov, detectors play a crucial role in the LHCb’s ability to distinguish between different particles. A charged particle travelling through a given medium, or radiator, faster than the speed of light in that medium emits Cherenkov radiation. The angle at which it is emitted depends on the particle’s velocity, information which, combined with a knowledge of the particle’s momentum, allows it to be identified. An example of the use of particle identification is shown to the right, in reducing background to \( B^0 \rightarrow \pi^+ \pi^- \) decays. There are two RICH detectors using a total of three radiators to identify particles over a momentum range of 1 to 100GeV/c.

The Spherical Mirrors

Cherenkov light emitted in the RICH 1 detector is reflected via a series of mirrors onto photon detectors. Spherical mirrors are used to focus the light. The mirrors must be light weight, because of constraints on the material budget, and have a high reflectivity. Carbon fibre mirrors meet these criteria.

Radiation Hardness and Resistance to \( C_4F_{10} \).

RICH 1 uses a \( C_4F_{10} \) radiator; it is important, therefore, that the mirrors do not degrade in quality in \( C_4F_{10} \). Similarly, the mirrors must be able to survive the high radiation environment.

The Reflective Coating.

The spherical mirrors need a reflectivity of > 85% in the wavelength range 250-600nm and > 70% in the range 200-250nm. This has been achieved with a coating of aluminium, protected by a layer of MgF2. Applying a suitable coating is not an easy procedure and reflectivity measurements had to be made on many different samples before we could be confident the mirrors would receive an suitable coating. Early coatings had poor reflectivities due to impurities in the coating due to a slowness of the coating evaporation, as well as insufficiently thick coatings.

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