Presentation 55

Masks and Collimators

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55.1 Introduction

A high voltage breakdown across the electrode gap of an electrostatic separator leads to the complete loss of all stored bunches [1]. Electrical breakdowns can occur due to pure high voltage processes or due to external sources, particularly synchrotron radiation photons. Although little quantitative knowledge of the effect of synchrotron radiation on high electrical field devices exists, and therefore no upper limit for synchrotron radiation photons hitting the separator plates can be given, a dramatic increase of the spark rate of the LEP separators by four orders of magnitude has been observed when the separator plates where moved out of their collimator protection [1]. Horizontal separators in direct view of the strong arc dipole radiation therefore must be carefully shielded.

55.2 LEP 200 Pretzel Scheme

The horizontal separator plates for the multi bunch pretzel scheme must be protected by collimators against synchrotron radiation photons from the arc dipoles and straight section quadrupoles. Figures 55.1 and 55.2 show the location of the separators and the proposed protection collimators for the LEP200 case [2].

55.3 The Situation in 1991

In 1991 only half of the horizontal pretzel separators ZX, near quadrupoles QS11 will be installed [3]: one separator each on the left side of IP2 and IP6 and on the right side of IP4 and IP8 (see Figure 55.3, taken from [3]). The LEP200 protection collimators will however not be ready before 1993. The separators must therefore be protected provisionally as much as possible by fixed masks. Lead masks will be placed around the vacuum chambers located between the ZX separators and QS11 quadrupoles. The horizontal physical aperture in the bending arcs scaled to this location is 50 mm. In order to keep the full aperture available at injection fixed masks must have an aperture of 100 mm.

In points 2 and 6, 100 mm diameter vacuum chambers with lead masks placed around them will be installed. With the separator gap opened to nominal 125 mm this arrangement will completely protect the plates from direct photons radiated in the arc dipoles. The plates will however be hit by synchrotron radiation photons that have been scattered off the surrounding vacuum chamber walls (see Figure 55.4).

The rates of scattered photons have been estimated as several 10^{11} s^{-1} from a 1 mA positron beam at 46 GeV. The critical energy of the arc dipole photon spectrum at this beam energy

is 70 KeV. In addition a certain number of photons radiated in the straight section quadrupole fields by the electron beam will be incident on the separator plates. This photon flux can only be calculated with complex beam simulation methods, however, the expected contribution from quadrupoles will be much smaller than that from scattered dipole radiation.

In points 4 and 8 a standard elliptical vacuum chamber of 131 mm width surrounded by a lead mask is installed between the ZX separators and quadrupoles QS11. This is not adequate. At a nominal gap of 125 mm the outer separator plate will be hit by the direct photon flux radiated by the electron beam in the arc dipoles. To avoid this direct photon radiation the exterior electrode could be opened up to 80 mm. In order to improves this situation the elliptical chambers in IP4 and IP6 will be replaced by round 100 mm chambers at the earliest possible moment. Like in points 2 and 6 the separator plates in points 4 and 8 will be hit by scattered photons from arc radiation (induced by the electron beam) and by synchrotron radiation from straight section quadrupoles (induced by the positron beam).

55.4 Machine Development Experiments

It is planned to carefully study the effects of synchrotron radiation on the performance of the LEP horizontal pretzel separators in LEP MD experiments during this year. The partial pretzel system available during 1991, provides an ideal situation for these studies, as the effects of different radiation sources can be separated by the choice of the experimental set-up. The different conditions are summarized in Table 55.1

Beam	Radiation source	separators in IP	ZX-gap	RF
e+	Arc scattered	2 & 6	nominal	off
e+	Quadrupoles	4 & 8	nominal	off
e-	RF + quad's	2 & 6	nominal	on/off
e-	Arc direct	4 & 8	variabel	off

Table 55.1: Radiation sources available for studies

Positron beams allow simultaneous study of effects due to scattered arc photons and due to photons from insertion quadrupoles, while the effects of direct arc photons and of X-rays from the adjacent CuRF cavities can be studied with electron beams. Further parameters are of course the beam intensity and beam energy as well as the separator gap and voltage across the gap.

References

[1] Commissioning and Operating Experience with the Electrostatic Beam Separation System of the LEP e+e- Collider. W. Kalbreier, N. Garrel, M. Laffin, V. Mertens, G. Rogner, G. von Holtey, EPAC Nice (1990)

[2] The LEP Energy Upgrade, Chapter 16, CERN-AC/91-01

[3] The Separator System for the LEP Pretzel Scheme, this Proceedings, W. Kalbreier

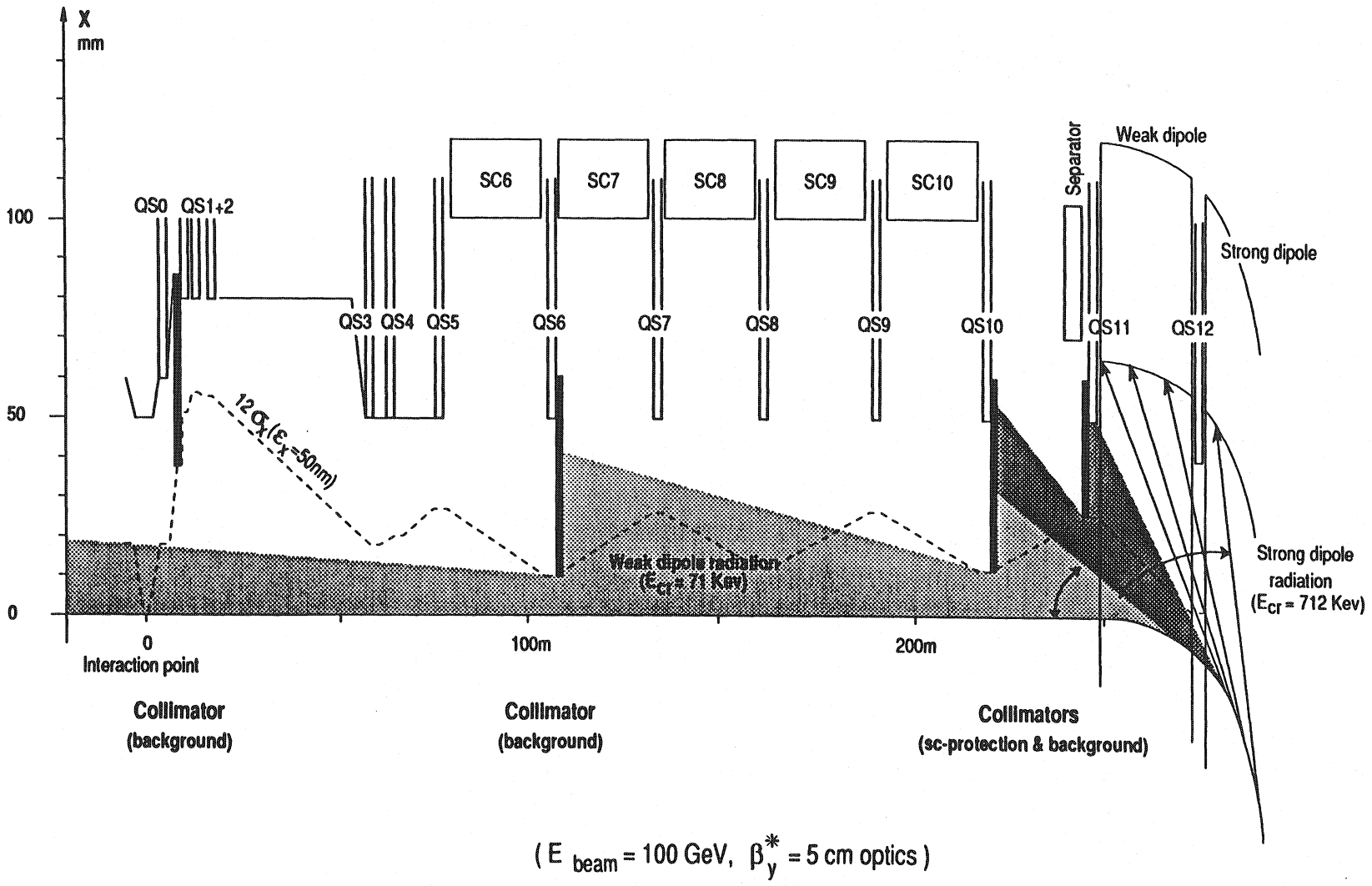

Figure 55.1: Layout of LEP separators and protection collimators.

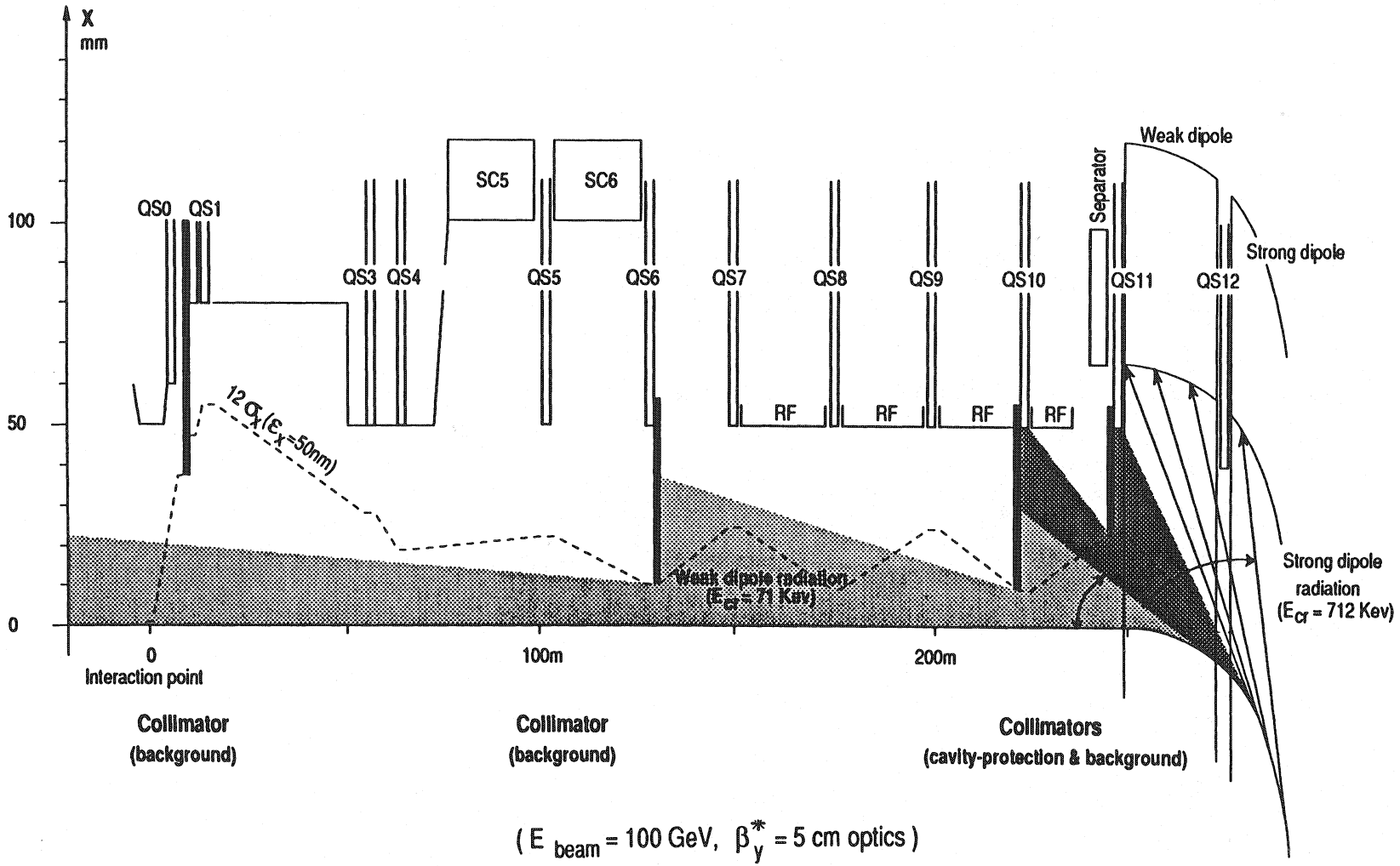

Figure 55.2: Layout of LEP 200 separators and protection collimators.

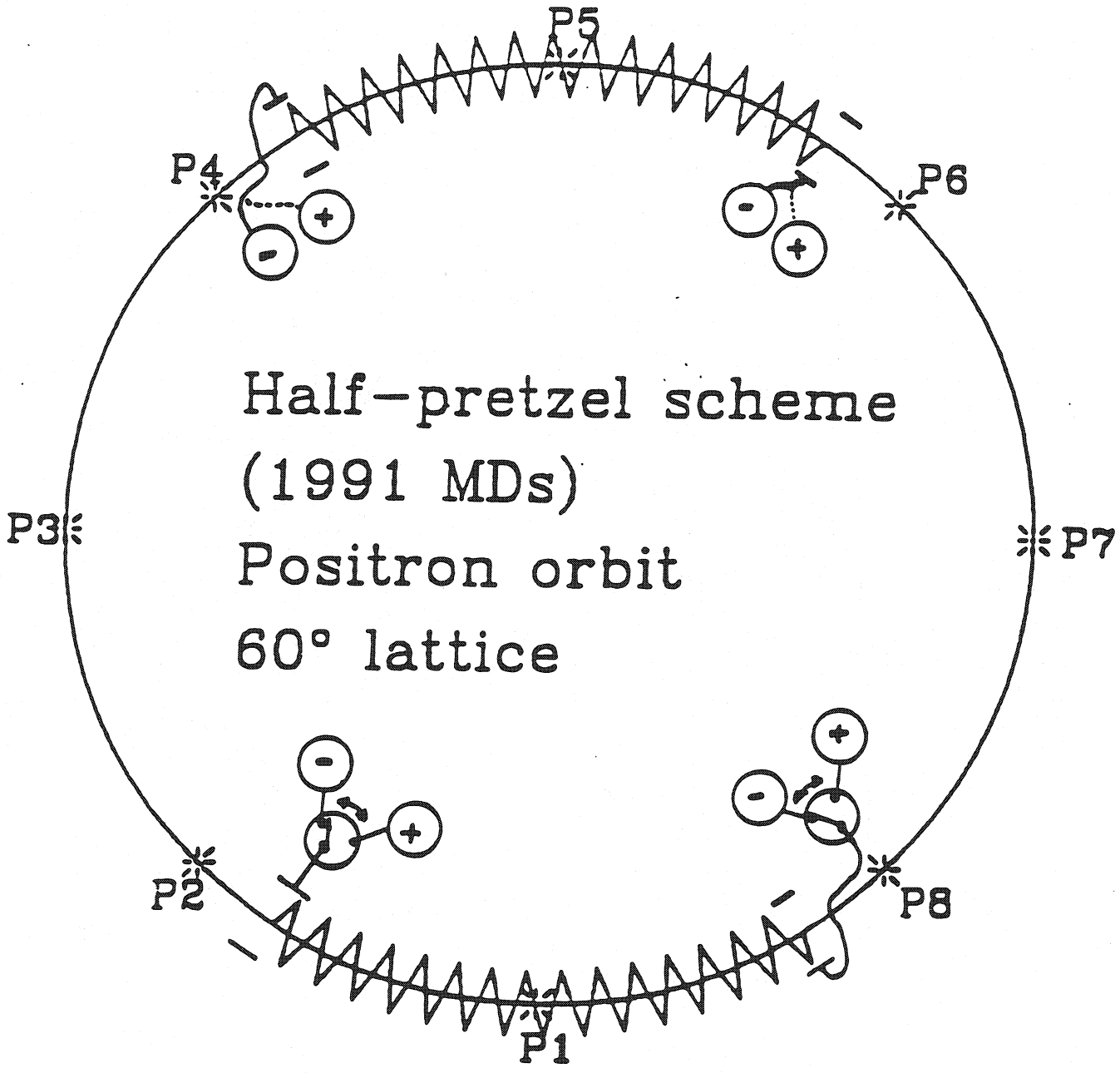

Figure 55.3: The Pretzel scheme layout

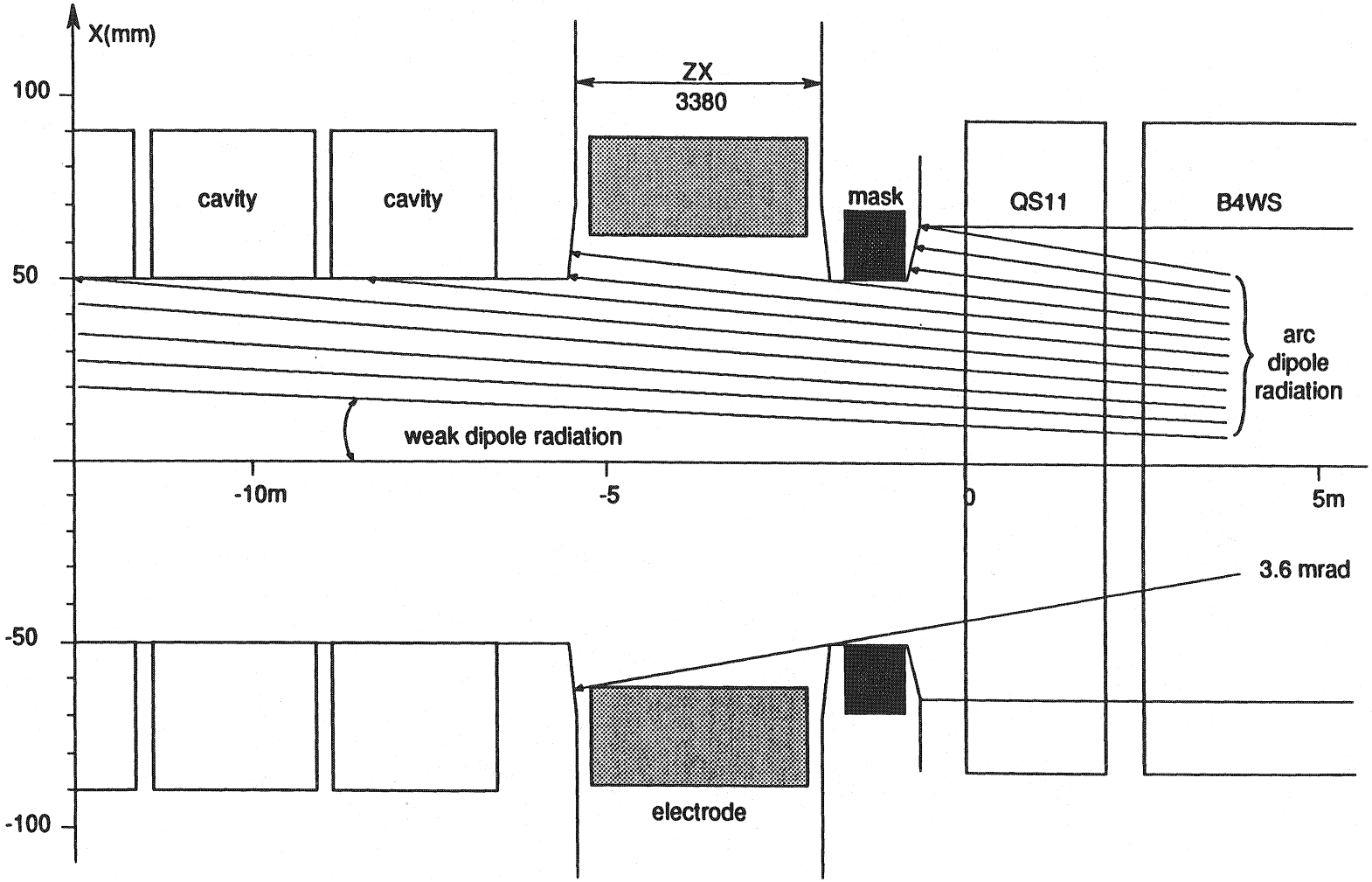

Figure 55.4: Scattering of synchrotron radiation off the vacuum chamber walls.