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Measurement of Radiation Dose Rates at LEP Aperture Collimators

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Summary

Remanent dose rates have been measured at all aperture limiting collimators in LEP. The results allow for the interpretation that the life time losses during physics runs occur predominantly in the vertical plane.

Measurements

Remanent radiation dose rates have been measured at all aperture limiting collimators in LEP on the 14 October, one week after the end of the physics period and two days after the MD session.

The measurements have been done with a 'IPAB' dosimeter, which is equipped with a plastic scintillator and counts photon rates from the induced isotopes decay. The complete data are contained in [1]. A summary of measured dose rates, corrected for the local background pedestal (25 to 35 nSv/h) are given in Table 1. The error on the measurements is of order 10nSv/h.

The measurements clearly identify three loss points. The horizontal aperture limiter in IP5 (COLH.IP5 with D_x=0), the "beam dump" collimator COLH.QF33.L3 (with D_x=1.18m) and, surprisingly high in relative terms, the vertical aperture limiting collimator COLV.QD32.L3. The secondary collimators COLH.QS9's in the horizontal plane and COLV.QD22 and 42 in the vertical plane see typically 12% or less of the corresponding primary collimators.

Collimator		Remanent dose rate (nSv/h)				
name	jaws	up	down	inside	outside	total
COLH.QS9.R5	in/out	117	6	5	13	141
COLH.IP5	in/out	808	142	86	114	1150
COLH.QS9.L5	in/out	166	8	10	8	142
COLH.QF31.L3	--/out	3	0	1	0	4
COLH.QF33.L3	in/---	106	78	87	97	368
COLV.QD22.L3	up/down	5	0	3.	3	11
COLV.QD32.L3	up/down	3297	1631	1538	2279	8745
COLV.QD42.L3	up/down	83	5	6	32	126

Table 1 Radiation dose at aperture collimators

Interpretations
One would expect to find the highest dose rate from COLH.QF33, into which all high energy fills are dumped, also those which are dumped by the radiation trigger from ALEPH. Why is the dose rate at the vertical aperture limit 24 times larger than at the beam dump? Is there a mysterious horizontal aperture limit hidden in the vertical aperture collimator COLV.QD32?

The puzzle is solved by remembering that the remanent dose rates where measured several days after the last exposure and that all collimators have tungsten jaws, except the "dump collimator", which has a jaw made from aluminium.

The decay time of the induced isotopes in tungsten are many days, while those from an Al target are much less than one day. As the overwhelming majority of the activity is produced by photon induced (γ,n) reactions, one can use Fig.32 of reference [2] to estimate the expected remanent dose rates for constant loss power from W and Al after several days of decay time. The obtained dose ratios for W over Al is a factor of about two after one day and a factor of about 200 after one week of non exposure. This explains the striking difference!

To make a meaningful measurement one should measure, within the first hour after the end of the physics period, the distribution of the radiation from the different isotopes activated in the collimators.

Still, when examining table 1 and considering only tungsten collimators, one can make several conjectures:

i) The loss rate during physic runs is several times larger at the vertical aperture limit (COLV.QS32) than at the horizontal aperture limit (COLH.IP5)

ii) The secondary collimators in the vertical plane seem not to be efficient as they see only 1.5% of the loss measured at their primary collimator. This is not surprising, as in the 90° optics they are no longer located at the optimum phase advance from their primary collimator.

iii) The secondary collimators around IP5 see about the expected fraction of radiation hitting the primary collimator in IP5.

iv) The distribution of measured remanent dose rates at the collimators in the plane transverse to the beam direction does not give a clear picture. As the dose measured depends strongly upon the distance of the detector from the target, distortions in the radial distribution are to be expected. Whether the systematically higher rates found above the objects is real can not be concluded.

References

[1] J.C. Gaborit, Rapport de surveillance, RSR/SL/92-32, 15 Octobre1992

[2] A. Fasso et al., Radiation Problems in the design of the large electron-positron collider (LEP). CERN 84-02