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ABSORBED DOSE LEVELS IN THE LHC-B DETECTOR

Calculation of the absorbed dose levels in the LHC-B electronics

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Abstract

The results of the absorbed dose levels in the LHC-B detector calculations using IHEP MARS program are presented. The detector geometry corresponds to the SICB version 1.07. Radial distributions of the absorbed dose levels in the model of the LHC-B electronics for all detector sensitive elements are given.

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1 Introduction

The LHC-B detector [1] is designed to cover for small angles region — currently the minimal acceptance of tracking and muon systems is supposed to be 10 mrad. This means that even at the luminosity more than 20 times lower than for other, high luminosity LHC experiments, one could expect quite high levels of particles fluxes in the detector sensitive elements [2] and hence high levels of the absorbed dose in the readout electronics placed close to them.

2 Detector geometry

The detector geometry used in the calculations corresponds to the SICB geometry description of version 1.07. The positions of tracking and muon chambers correspond to the ones from SICB database files `wtrk.cdf` and `muon.cdf` that can be found under `/afs/cern.ch/lhcb/sim/v107/db/`.

The silicon of the readout electronics was simulated as a 0.7 mm thick plate [3] placed behind each sensitive detector element. So there were 11 plates in the tracking system, one behind each calorimeter and 5 in the muon system included in the simulations. The positions of silicon plates in the geometry of calculations are given in Table 1.

Silicon plate	**Positioned after**	**At Z, cm from IP**
SP01	TS01	94.5
SP02	TS02	252.
SP03	TS03	317.
SP04	TS04	382.
SP05	TS05	462.
SP06	TS06	552.
SP07	TS07	712.
SP08	TS08	812.
SP09	TS09	862.
SP10	TS10	912.
SP11	TS11	962.
SP14	MU01	1189.
SP12	ECAL	1250.
SP13	HCAL	1410.
SP15	MU02	1479.
SP16	MU03	1589.
SP17	MU04	1699.
SP18	MU05	1809.

Table 1: Positions of the silicon plates in the geometry of calculations.

3 Conditions of simulations

In this note are presented the results of absorbed dose levels in the LHC-B detector calculations using IHEP MARS [4] program. Monte-Carlo simulation of particles fields was done using 10 MeV energy threshold for hadrons and 200 keV for electrons and gammas.

This means that the contribution of electrons from the 'n–γ capture' channel was not included since this channel becomes active at neutrons transport down to the thermal energy (10^{-5} eV). From the previous calculations it is known that the fraction of these electrons is relatively small in the tracking system region, but is dominanting in calorimeters and the muon system. Hence the presented results are good estimates of absorbed dose levels for the electronics close to the tracking systems and lower estimates for the calorimeters and muon system. Also the discussion of the possible contribution to the radiation damage of silicon from neutrons and particle induced displacement damage is left beyond the scope of this note.

4 The results

Radial distributions of calculated absorbed dose levels in the silicon plates as functions of distance from beam axis are presented on Fig.2–4. The results are normalised to an IP8 interaction rate of 4×10^7 ev/s (that corresponds to luminosity of 5×10^{32} cm^{-2} s^{-1}) and a detector operational year of 10^7 s. 3D plot presenting the overview of absorbed dose levels distribution along the LHC-B detector is given on Fig.1 [1]. Colour version of this plot is available as `/afs/cern.ch/user/v/vtalanov/public/siliconedose.ps`. Conclusion on the LHC-B front-end electronics design based on it's operating conditions can be found in [5].

Acknowledgements

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References

[1] LHC-B Letter of Intent, CERN/LHCC 95-5, August 1995.

[2] LHC-B notes 97-003 and 97-009—012.

[3] J. Christiansen, private communication.

[4] "Development of MARS Code Package for Radiation Problems Solution of Electro–Nuclear Installations Design", I. Azhgirey, I. Kurochkin and V. Talanov, in: Proc. of XV Conference on Charged Particles Accelerators, Protvino, October 22-24 (1996); also MARS program WWW page at `http://wwwinfo.cern.ch/~talanov`.

[5] "An overview of the LHC-B experiment and it's electronics", J. Christiansen, and "Background Report", G. von Holtey, in: Proc. of LHC-B plenary meeting, CERN, September 18, 1997.

[1] Please note that the number of bins per each silicon plate on this plot and Fig.2–4 is different. The size of the bin on Fig.1 is 5 cm, while on Fig.2–4 it varies from 2 cm up to 23 cm (20 bins/plate).

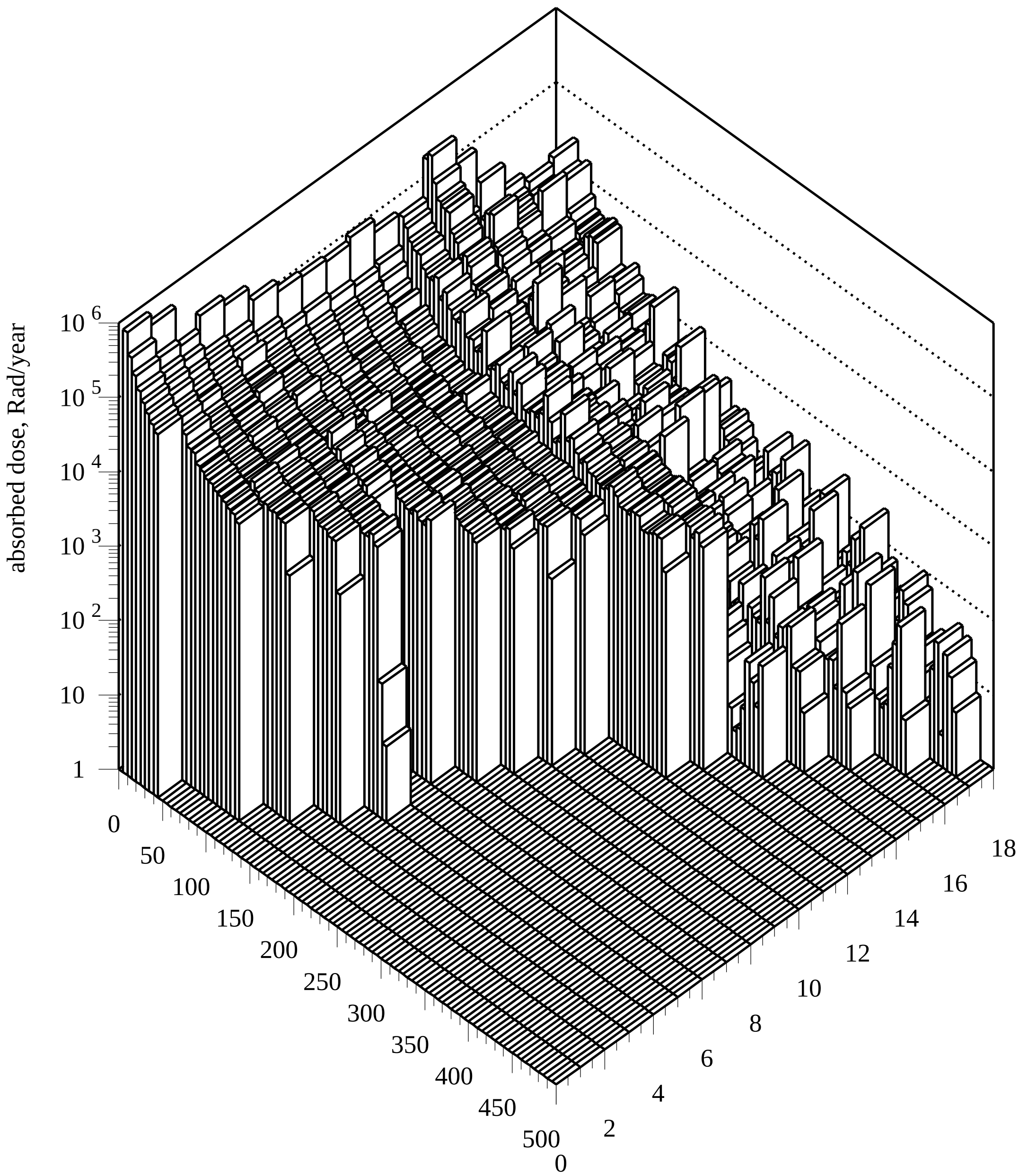

Figure 1: LHC-B absorbed dose level map, Rad/year, as a function of distance from beam axis (r, left axis) and silicon plate number (right axis).

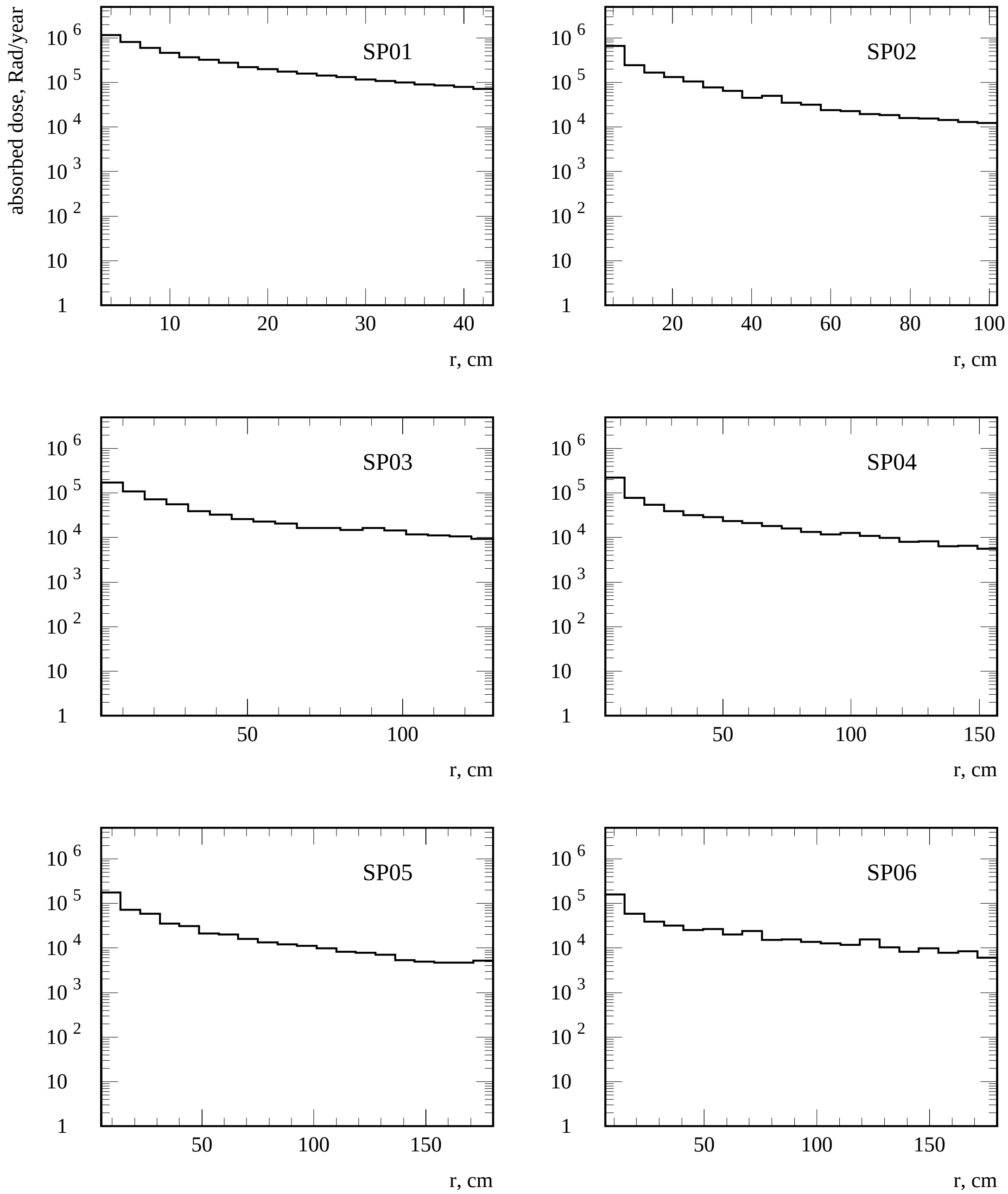

Figure 2: Absorbed dose level, Rad/year, as a function of distance from beam axis (r), for silicon plates no.1–6.

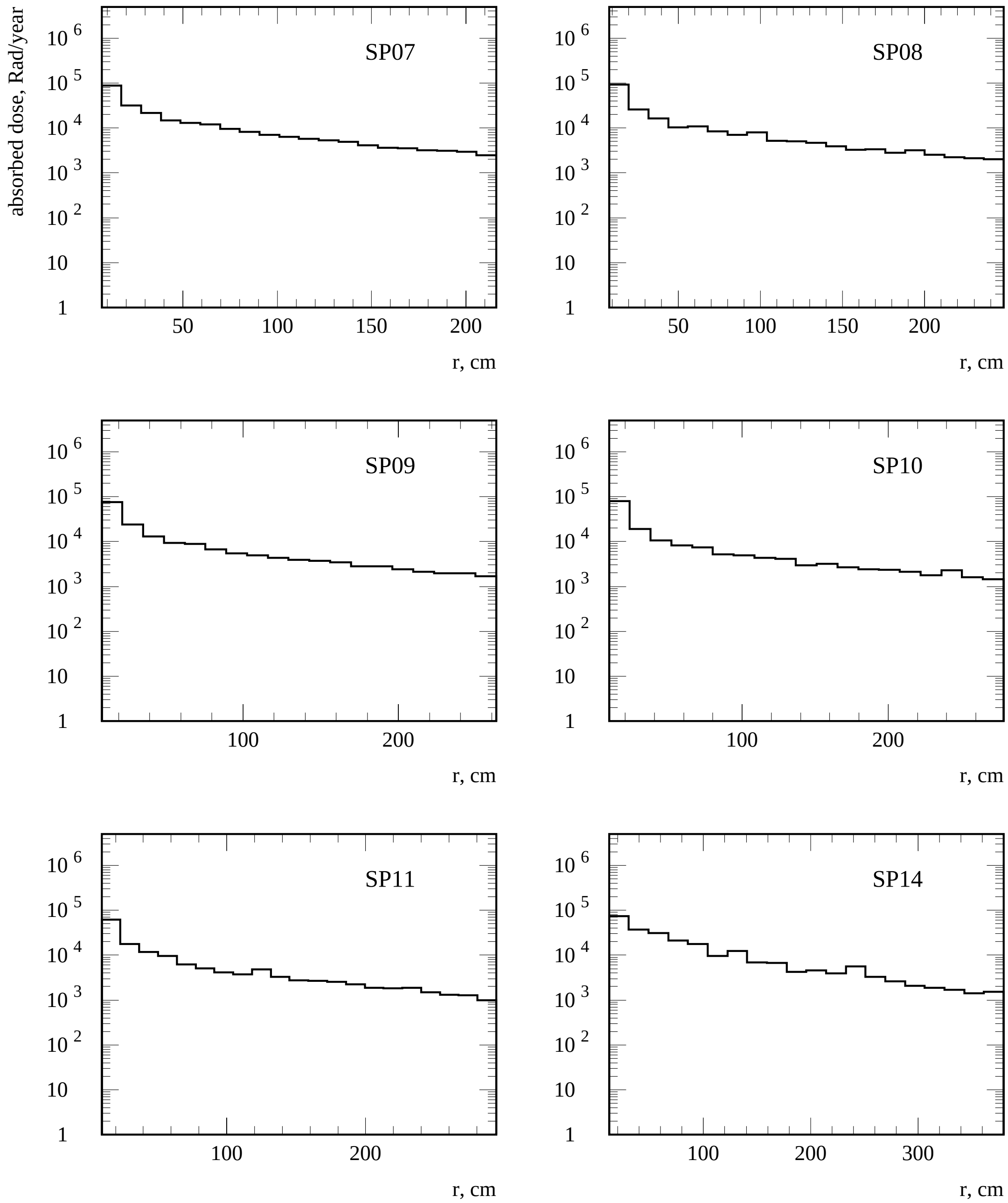

Figure 3: Absorbed dose level, Rad/year, as a function of distance from beam axis (r), for silicon plates no.7–11 and 14.

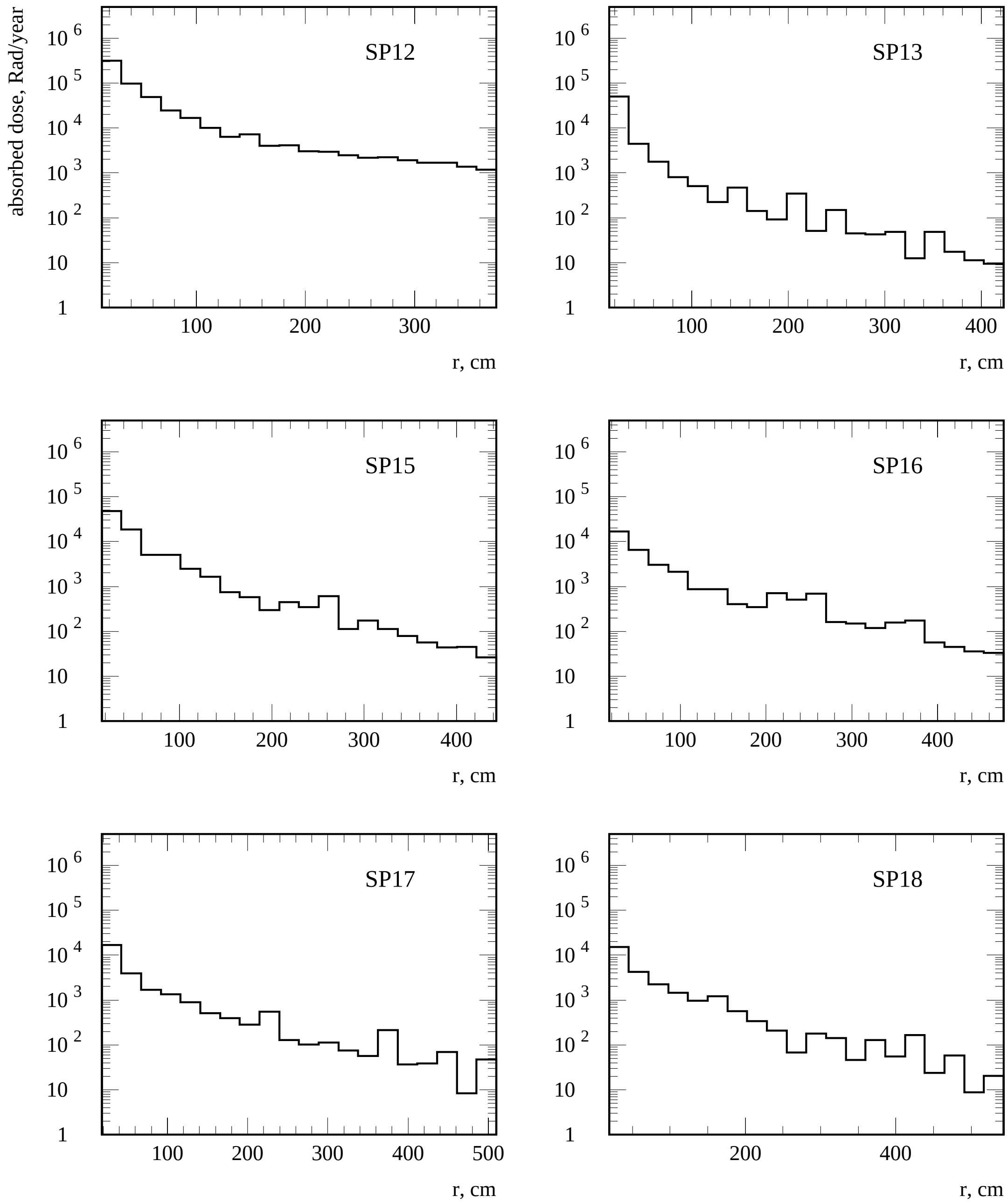

Figure 4: Absorbed dose level, Rad/year, as a function of distance from beam axis (r), for silicon plates no.12, 13 and 15–18.