EXPERIMENTAL BACKGROUND STUDY IN THE BEPCⅡ/BESⅢ*

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Abstract

Experimental beam-related background study is introduced with the BEijing Spectrometor (BESⅢ) [1] off the interaction region (IR) of the BEPCII [2]. Only safety issues are studied carefully so far for the not good enough detector`s accuracy. Various experiments are carried out and effective ways to reduce the doses to the IR are found. The results show that the BESⅢ is safe enough when it is pulled to the IR.

Key words: background, BEPCⅡ, BESⅢ, collimator, injection

GENERAL DESCRIPTION

With the progress of the BEPCⅡ commissioning, experimental beam-related background study becomes very urgent. There are two related issues, one is the safety of the detectors, especially for the CsI crystals (<500rads/year) since they will always be exposed to the radiation doses, the other is the data acquisition environment for physics studies. Pin Diodes [3] and RADFETs [4] are used to measure the doses. Beam Loss Monitors (BLM) [5] are used to measure the rate of charged particles. With the large integrated doses during the commissioning of the BEPCⅡ, the accuracy of the two types of detectors gets worse and worse, which cannot fulfil the requirements of steady run backgrounds. So, only safety issues are studied in detail. Simulation study for steady run backgrounds is provided in Ref. [6].

The commissioning of the BEPCⅡ in the past has two phases. One is from the late of 2006 to the summer of 2007 with the backup lattice (two normal quadrupoles and one normal dipole instead of the two superconducting Quadrupoles – SCQ) used in the IR, the other is from the autumn of 2007 to the beginning of 2008 with the two SCQs there.

In the phase Ⅰ running, no collimators are installed and only measurements are done. In the phase Ⅱ running, some movable and fixed collimators are installed, experiments are designed and done.

RESULTS FROM PHASE Ⅰ RUNNING

Measurements from the phase Ⅰ running show that backgrounds due to injections are much more serious than those due to steady runs and the total integrated doses are much higher than the safety margin of the CsI crystals. Integrated doses to the crystals within one day can be 15 rads, which is about 10 times the safety margin per day.

Fig. 1 and Fig. 2 show the dose rate of a pin diode and integrated doses of 4 RADFETs respectively. The pin diode in Fig. 1 locates at the crotch pipe upstream of the interaction point (IP) for the electron beam. The RADFETs in Fig. 2 locate at 1.75m upstream of the IP for the electron beam and 30 to 60cm from the centerline of the BESⅢ in downward direction. The distance between the inner most crystals and the centerline of the BESⅢ is about 50cm.

The positron beams have little affection to the detectors in the electron beam side as seen from the two figures.

How to reduce backgrounds due to injections to guarantee the safety of the crystals when they are there becomes one of the central tasks in the phase Ⅱ running.

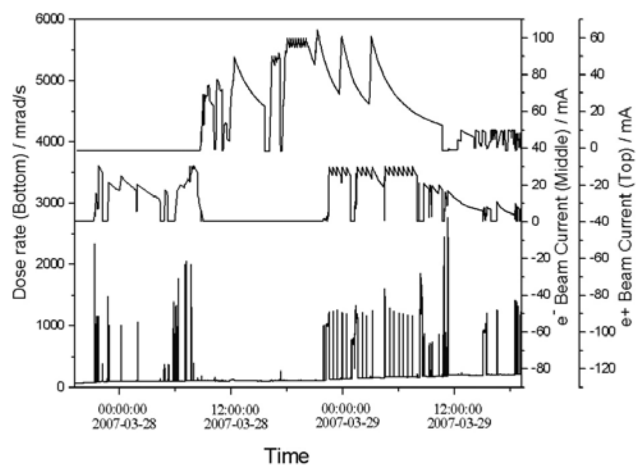

Figure 1: Pin diode dose rate to beam current.

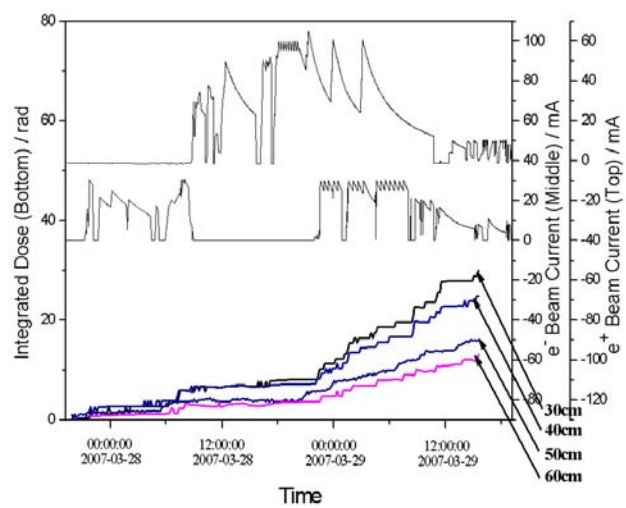

Figure 2: Integrated doses near the crystals.

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RESULTS FROM PHASE Ⅱ RUNNING

To get as clear as possible understanding of the backgrounds, the following experiments are done with the results illustrated.

1. Aperture adjustment of the collimator about 8m upstream of the IP for the electron beam. For the half aperture down to 11σ, no obvious effects are seen to reduce injection backgrounds.

2. Aperture adjustment of the collimators downstream of the IP for the electron beam. No obvious effect to reduce injection backgrounds is found. Injection rate is stable with half apertures down to 12σ in both horizontal and vertical directions. Injection rate gets 30% lower with a 10σ half aperture in vertical direction.

3. Aperture adjustment of collimators on the transport line. With an aperture of ±0.3% for energy dispersion collimator and that of ±3mm (±1.7σ) for emittance one, the integrated dose of one electron injection to the pin diode reduces from several rads to point several rads at the upstream crotch pipe and the rates from Beam Loss Monitors at the same position decrease with a factor of about 10 as shown from Fig. 3 to Fig. 5. Assuming 20 injections per day, the integrated dose is less than 10rads at the crotch pipe, and that to the crystals should be less than 0.3 rad, which is well below the safety margin.

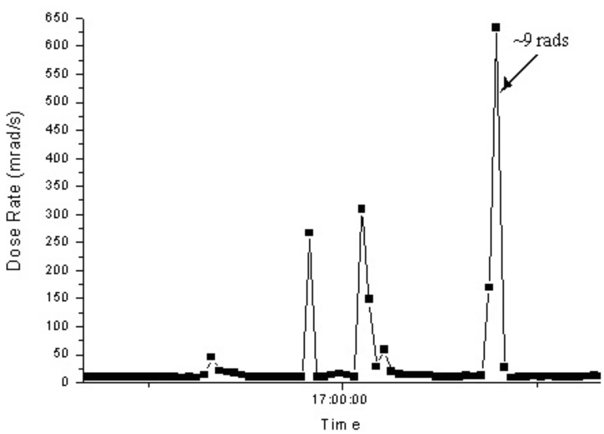

Figure 3: Dose rate at the upstream crotch pipe with the collimators on the transport line opened.

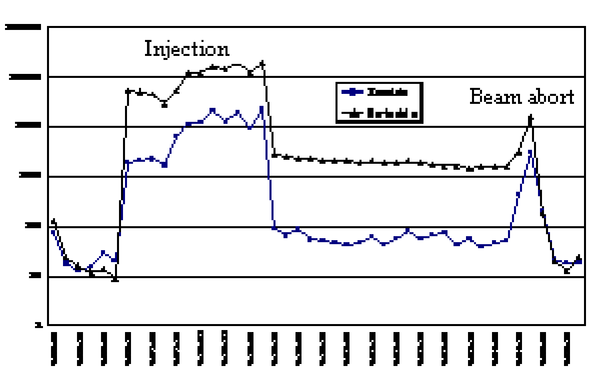

Figure 4: Rates of BLM at the crotch pipe with the collimators on the transport line opened.

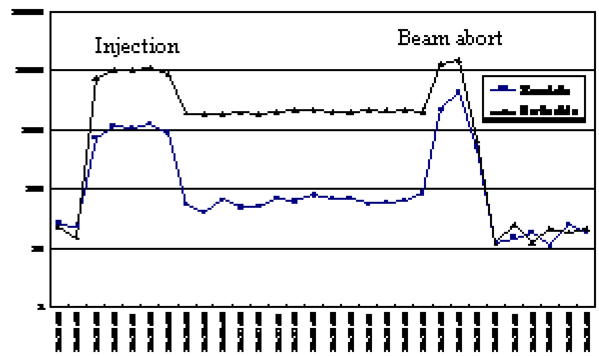

Figure 5: Rates of BLM at the crotch pipe with the collimators on the transport line closed.

4. Beam abort experiment. At first, only one of two injection kickers is used to abort the beam and large dose rates to the IR are seen. After that, two kickers are used to abort the beam. There is no obvious dose rate to the IR from then on.

5. Lead bricks experiment. In real case, there are iron plates neighboured to the crystals in the longitudinal direction and lead pieces just under them in the radial direction. Five lead bricks are used to simulate the real situation as shown in Fig. 6. With the lead bricks, doses to the crystals decrease about 50%.

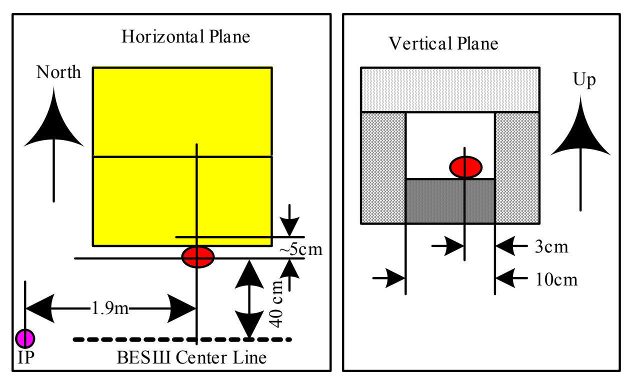

Figure 6: Arrangement of the lead bricks.

6. Doses due to synchrotron radiation runs. BEPC II provides dedicated synchrotron radiation runs besides colliding experiments. So, doses to the crystals due to these runs should be studied. Normally, there are 3 injections per day. From the results of pin diodes and RADFETs, doses due to injections are negligible as shown in Fig. 7.

FURTHER STUDIES

The BESIII detector will be rolled in the IR in mid-April. In order to reduce background for detector safety and clean data acquisition, as much as possible shielding and pin diodes & RadFETs for radiation and background diagnostics will be mounted in the IR. In the storage rings, more collimators will be installed. Beam injection will be further optimized especially for electrons. Fast beam abort system will be applied when beams are dumped. A luminosity-based collision feedback (x, y, y') will be developed for improving integrated luminosity, providing operational stability, reducing injection and beam-beam backgrounds. Finally, different background sources such as beam-gas scattering, Touscheck effect, luminosity background as well as beam-beam interactions will be investigated experimentally together with vacuum pressure and optimisation of orbits and lattice parameters in order to reduce the background in the BES III .

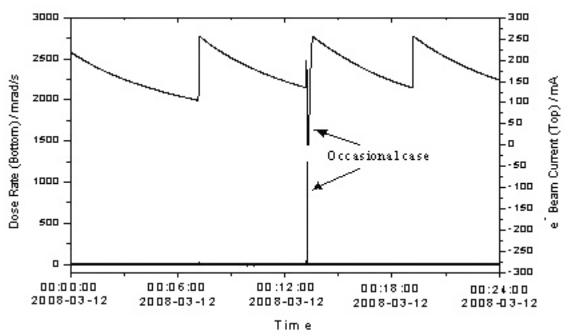

Figure 7: Dose rates of pin diodes in the IR during synchrotron radiation runs.

SUMMARY

Various experiments are done to study the behaviour of the backgrounds and means to reduce them are found. The results from both colliding and synchrotron radiation operation show that it is safe for the BESIII to be pulled to the IR. The backgrounds due to steady runs and ways to reduce them should be studied thoroughly in the BEPC II /BESIII joint experiments.

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