PRELIMINARY RESEARCH OF HLS II BLM SYSTEM *

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Abstract

Beam loss monitor(blm) system has been designed in many electron storages in order to indirectly measure lost electrons, which can be used to analysis beam loss mechanism and beam life. It can contribute to beam commissioning and improving stable operation of storage ring. According to lattice structure of the HLS II storage ring, 64 beam loss detectors have been located in the upper, lower, inner, outer side surfaces of vacuum chamber in the HLS II storage ring. Some preliminary researches based on the HLS II blm system have been done. The results in successfully stable operation and unsuccessfully stable operation in beam commissioning stage were compared. Analysis of a sudden lost beam phenomenon were carried out.

INTRODUCTION

Hefei Light Source II(HLS II) has been upgraded from August 2010 and now enter formal operational phase. It consists of a linac, a transport line and a storage ring. The energy of beam is accelerated to 800MeV when beam reaches the end of the linac and beam is injected into storage ring through the transport line. In order to protect machine, speed up commissioning, conventionally diagnose beam and study beam life, beam loss monitor system is designed for the HLS II storage ring. According to lattice of the HLS II storage ring, beam loss monitors are installed nearby quadrupole magnets[1, 2]. In order to monitor beam loss in different directions of the vacuum chamber, every 16 beam loss monitors are respectively mounted on upper and lower side surfaces of the vacuum chamber in vertical direction and on inner and outer side surfaces of the vacuum chamber in horizontal direction. The layout of beam loss monitors in the HLS II storage ring is shown in Fig. 1. Site installation diagram is shown in Fig. 2.

Bergoz's PIN-diode detectors are used as beam loss monitors in the HLS II storage ring. The detector is composed of two PIN-diodes mounted face to face to form a 2-channel coincidence detector in which MIPs (minimum ionizing particles) cause ionizations in both PIN-diodes, a coincidence occurs and an output pulse is generated[3].

BLM SYSTEM STRUCTURE

Beam loss monitor system structure is as shown in Fig. 3. The generated pulses in four blm detectors located in the upper, lower, inner, outer side surfaces of vacuum chamber are transmitted to Data Acquisition(DAQ) device to shape pulses, count pulses, and transmit results to PC via ethernet. Labview program on PC publishes results in epics environment and any PC via intranet can acquire blm results. Fig. 4 is Labview program main interface for blm. Blm results of four different orientations in each monitoring position display with histogram.

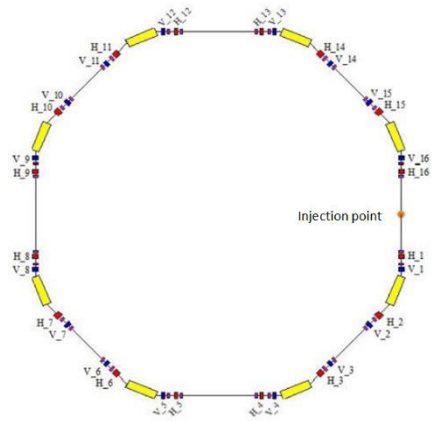

Figure 1: The layout of beam loss monitors in the HLS II storage ring.

Figure 2: Site installation diagram for beam loss monitors in the HLS II storage ring.

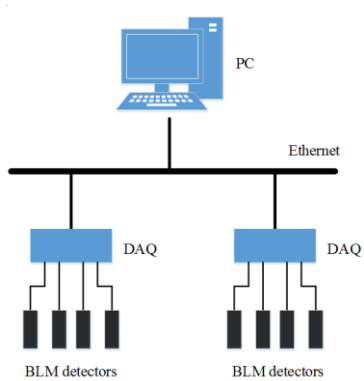

Figure 3: Beam loss monitor system structure diagram.

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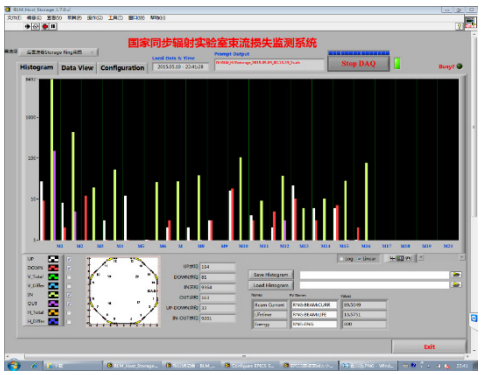

Figure 4: Labview program main interface for blm

DAQ device is R&D by National Synchrotron Radiation Laboratory of University of Science and Technology of China and Department of Engineering Physics of Tsinghua University. DAQ device is as shown in Fig. 5.

Figure 5: DAQ device for beam loss monitoring

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Preliminary Research On Comissioning Stage

In early April 2015 Vacuum leakage at straight section after the fifth bending magnet happened, which leaded to degree of vacuum deteriorated. So vaccum chamber of this place was maintenanced. When the vaccum chamber was reinstall beam couldn't be injected. Beam loss at this time was shown in Fig. 6. As is shown in Fig. 6, beam was mostly lost at injection point (injection point is between No.1 blm and No.16 blm position). The reason may be that injection system exist problems. Additionally, beam totally lost at No.6 blm position and the lost beam at the outer side is more than at the inner side. Thickness of outer wall is more thicker than thickness of inner wall for vacuum chamber, so beam was totally lost at the outer side of No.6 blm position. Possible reason is that orbit at No.6 blm position had lateral side deviation.

After adjustment of relevant parameters, distribution pattern of beam loss subtly changed. The result is shown in Fig. 7. It can be concluded that beam arrived No.12 blm position. But beam loss was also lost more seriously at the outer side of No.6 blm position than at the inner side and beam current can't be increased.

In April 18 researchers improved the previous problems and beam can pass the entire storage ring nicely. The result is shown in Fig. 8. The beam losses became less at No.15 and No.16 blm position.

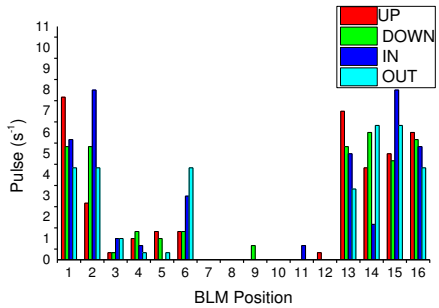

Figure 6: Site installation diagram for beam loss monitors in the HLS II storage ring.

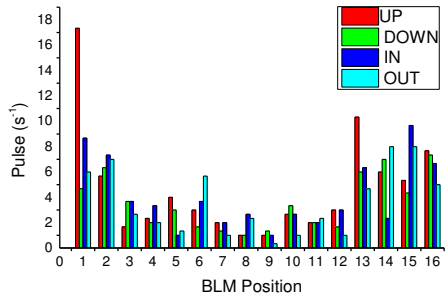

Figure 7: Beam loss distribution when beam can't be injected into storage ring at 16:05:53 17 April 2015.

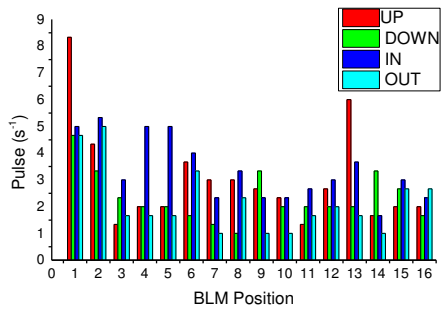

Figure 8: Beam loss distribution when beam passed the entire storage ring at 19:03:17 18 April 2015.

The above researches illustrate that blm system has a important role in beam commissioning stage. Firstly blm system can clearly show position which beam reaches at initial commissioning stage. Secondly blm system can find beam loss bottleneck. Finally blm system can provide beam loss distribution in different directions at worst place of beam loss and according to this result main cause of beam loss may be comprehensively determined.

Analysis Of A Sudden Lost Beam Process

At 9:20 on April 26, 2015 beam lost situation suddenly occurred and beam current decreased from 115mA to 75mA. The beam current and life at this time are shown in Fig. 9. Like this situation, process of beam loss occurred in specific details is difficult to be understood relying on traditional beam measurement method. But according to

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beam loss monitor system process of beam loss in specific details can be found. The result monitored by blm system at this time is as shown in Fig. 10. It can be concluded that beam loss mainly occurred on the upper and lower side of No.1 position(In front of the first bending magnet) and on the inner side of No.8 blm position(behind the fourth bending magnet).

Under the guidance of this information, operators can be targeted to troubleshoot the problem. Possible reasons include beam oscillation in vertical direction at No.1 position becoming too severe or power supply for the fourth bending magnet appearing problem or degree of vacuum at the output of the fourth bending magnet becoming deteriorated and so on.

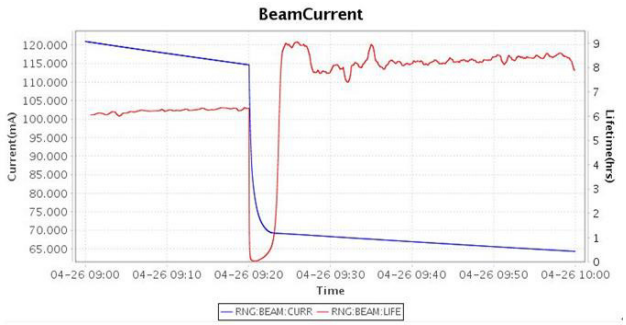

Figure 9: The beam current and life when beam lost at 9:20 on April 26, 2015.

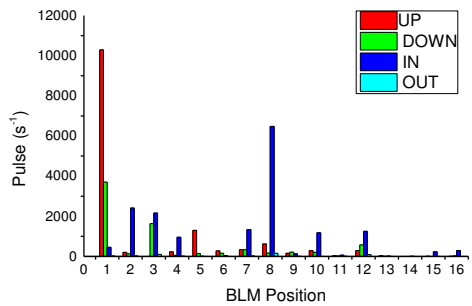

Figure 10: Beam loss distribution when beam lost at 9:20 on April 26, 2015.

CONCLUSION

Beam loss monitor system has been built for the HLS II storage ring. Beam loss detectors are located at the upper, lower, inner, outer side surfaces of vacuum chamber to measure beam loss due to different mechanisms. some researches for beam commissioning and analysising of a sudden lost beam based blm system were carried out.

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