The Measurements of the Reducing the Space Electromagnetic Noise Around the BES

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1999.6.10

ABSTRACT:

Space electromagnetic noise signals would be measured when e+/e- beams pass through the BES system. In order to search for the interference noise sources around the BES, time domain and frequency domain measurements and analysis were made for the electromagnetic interference signals to provide some significant data. Several measurement methods will be discribed in this paper.

(Key Words: BES Space electromagnetic noise Time domain Frequence domain Electrostator separator Electromagnetic Separator DC current transformer)

1.Introduction:

The measurement data obtained during the work of reducing the space electromagnetic noise in the last couple of years indicates that the following methods are very important for purifying the space electromagnetic environments around the BES. 1) A study group named “BES electromagnetic environment measurements and noise reduction techniques” has been esteblished by Prof. WangFeng since 1992. In cooperation with the Storage Ring Division in Jan. 1994, they used a coaxial structure instead of the original cable connector on the electromagnetic separator at the east side of the BES, and covered it with a shielding chamber. 2) The cable connector on the electromagnetic separator at the west side of the BES was also changed with the coaxial structure; meanwhile, the feriate rings were added beneath the out layer of the cable. The Storage Ring Division in May 1994 did this work. 3) A shunt current ring was installed on the flange of beam pipe into BES. It was proved effective later to improve the inner invironment of BES. 4) To search for the interference noise sources in a larger range around the BES, RRF003 measurement arraies have been made use of effectively since 1998. 5) A series steps of electromagnetic compatibility such as shielding the DCCT (DC current transformaer) have been obviously purifying the space electromagnetic environments around the BES, and increased the efficifency of the BES data collecting.

Prof. Olsen of University of Hawaii made some theoretic calculation based our experimental data. Both of his work and our experiments confirmed the Electrostatic SeParator (ESP) interference to the space electromagnetic environment around the BES.

2.Single point measurements:

The work of "BES electromagnetic environments measurements and noise reduction techniques" started by Prof. Wang Feng in 1992. The effect of the accelerating tube wall current was studied under the guidance of Prof. S. L. Olsen from Hawaii University. During this work, the electrostatic separator (ESP) interference to the space electromagnetic environments around the BES has been pointed out and then the high voltage input cable connector on the ESP at the east of the BES was changed with a coaxial structure. The ESP was also covered with a shielding chamber (But it was removed after the upgrades of BEPC). The ferrite rings were added beneath the out layer of the input cable when the connector on the ESP at the west of the BES was changed.

On the experiments on May 23, 1998, in order to analyze the space electromagnetic noises, we installed a pair of measuring pins (type RRF003) respectively near the ESP at the east and west of the BES. (RRF003 pin is a capacitive probe to measure the space electromagnetic noise. It's diameter D=10mm, the length L=60mm. The measuring frequency range: 150KHz~1000MHz.) The obtained signals were transferred passively to the BES Counting Room through a 36 meters long cable with the characteristic impedance of 50 Ohms. The time domain signals were read out from a Tektronix-2465 oscilloscope. The frequency domain signals were read out from a HP-8555A spectrum analyzer.

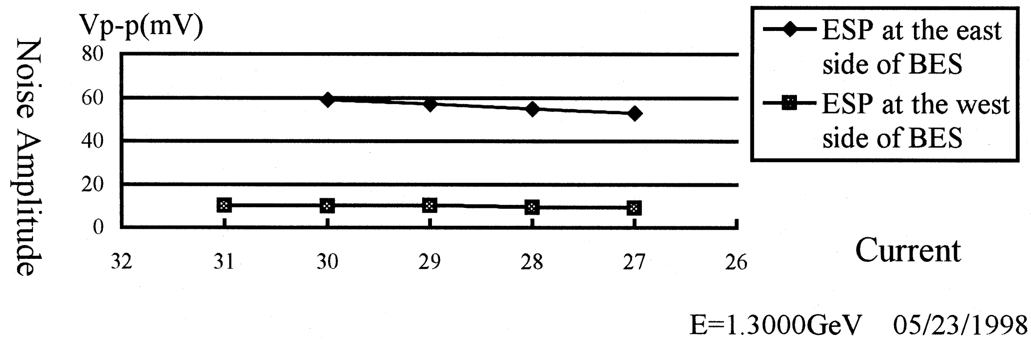


Fig.1 Noise Amplitude vs. Beam Current Density

The comparison of Fig.1 indicates that it is obviously effective to add the ferrite rings under the shielding layer of the ESP high voltage cable for reducing the ESP space electromagnetic radiation.

In order to compare the noise level accurately with different shielding methods, we changed the high voltage cable input connectors on the east side ESP back to the original shielding way with a plexiglass cover as those before Jan.4, 1994. When the accelerator was at the "mode of providing electron beam for synchrotron radiation ", we measured the space electromagnetic noise signals around the ESP at the east side of the BES.

The comparison in Fig.2 indicates clearly that after changing the plexiglass cover with the coaxial structure for the input cable shielding, the electromagnetic radiation to space from the ESP has been reduced to a reasonable low level on its amplitude and improved the electromagnetic environments significantly.

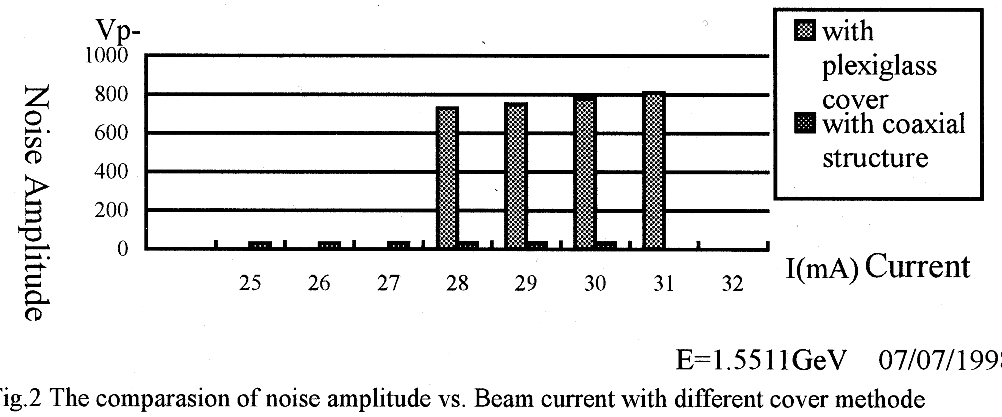


Fig.2 The comparasion of noise amplitude vs. Beam current with different cover methode

3.More points measurements:

The Storage Ring Division perfected the shielding system for the ESP at east side of BES with adding the new ferrite material to absorb the electromagnetic wave. To analyze the space electromagnetic environments in a larger area between BES and ESP, more point measurements were executed under the support of our institute director with a special budget. The RRF003 measuring pin array was arranged in a fan shape area extended from ESP to BES. The location of RRF003 measuring pinsbetween BES and ESP are shown in Fig.3.

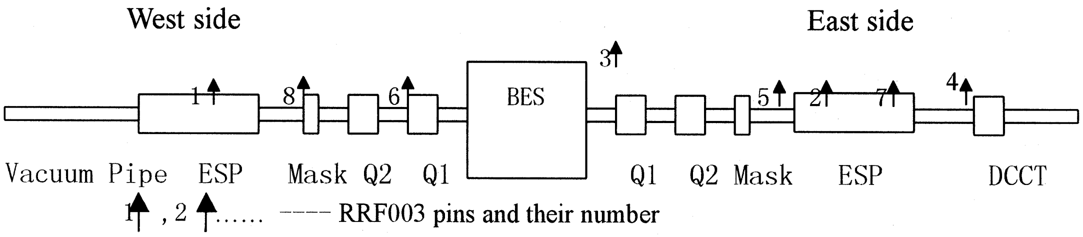


Fig.3 The location of RRF003 measuring pinsbetween BES and ESP

It is concluded that the electromagnetic radiation from ESP has been controlled and absorbed well after installing the new ferrite material. However, there still exist other noise sources around the BES. This could be proved by the noise amplitude distribution between the space of BES and ESP. It appears in a U type as shown in Fig.4.

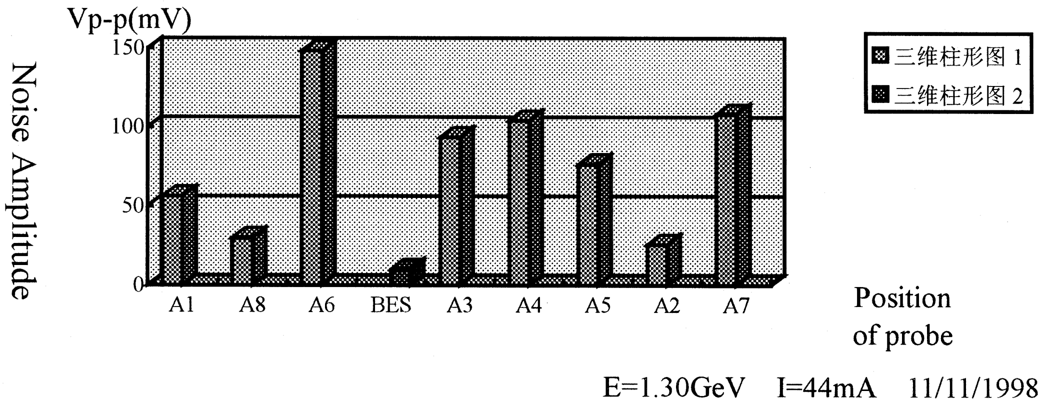


Fig.4 The noise amplitude after normalized vs.the horizontal position of the measuring pins

4. Finding new noise resource

In order to seek other space noise resource around BES, we adjusted arrangement of the Pin Array. We moved the pins toward east of BES, expanded our measure range, and then found the amplitude of space noise near DCCT, which locates in the eastern end of BES, was anomalous great. We reported the shielding effectiveness of ESP and noise phenomena near DCCT in the Electromagnetic Noise Restriction Meeting (ENRM), in which Prof. Tigner analyzed many kinds of possible noise resources near BES carefully and extensively.

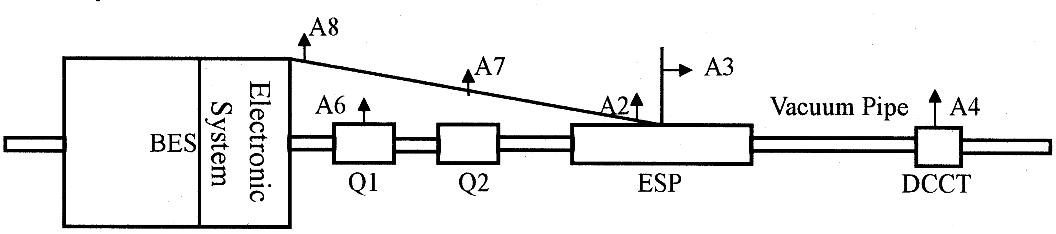
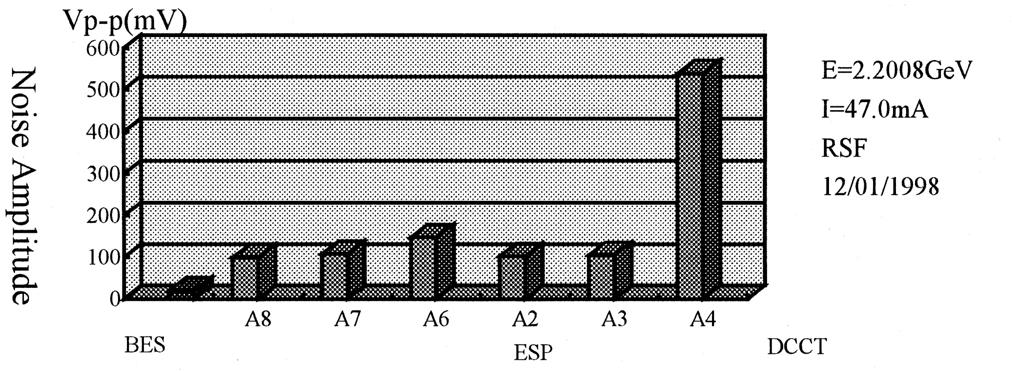
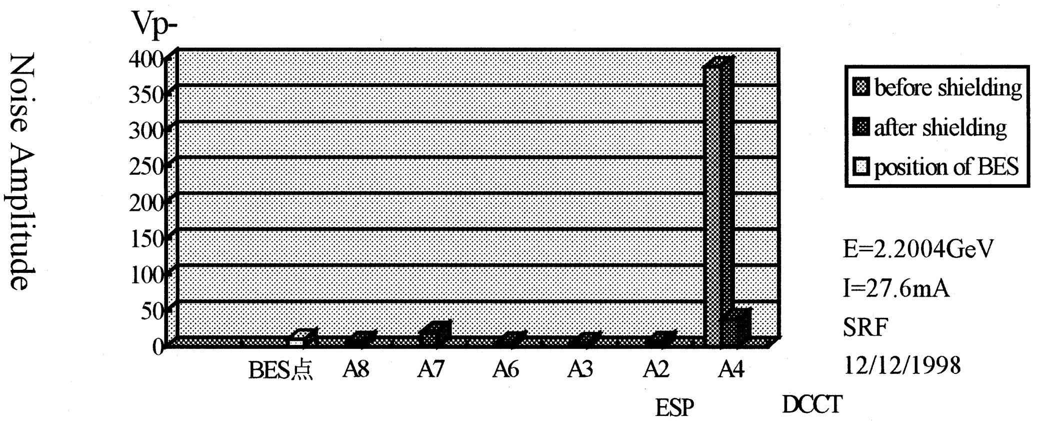


Fig.5 The location of RRF003 measuring pins at the east side of BES

Through the shielding experiments on DCCT, we cut down 90% of the space noise around DCCT on Dec. 12. The noise problem below 300 MHz was improved greatly. BES readout System could get high quality data and the threshold of MDC electronic readout reduced from 625 to 425. It's an important improvement for space noise restriction near BES.





5. Confirm interference frequency

On Dec. 29, the Accelerator Center install a shielding enclosure on DCCT, the noise above 300 MHz near DCCT was reduced obviously, but the noise above 300 MHz could not be reduced as obviously as our expectation. According to the data and photographic taken by our Pin Array, we confirmed that the mainly noise interference was the noise below 100 MHz leaked from Signal Transmission Cables of DCCT. In the ENRM of Dec. 31, we raised some suggestion below:

1) The shielding work must be focused on the Signal Transmission Cables and their output connector.

2) Link the out layers of cables with the shielding enclosure evenly.

3) Paste some copper braids onto both sides of all seams of the shielding enclosure to reduce electromagnetic wave's leaking

4) Install special ferrite rings around the cables come out from the shielding enclosure to absorb the electromagnetic wave radiated from the cables.

According to Prof. Tigner's analysis and our suggestion, some shielding work was done, and then the space electromagnetic environment was improved greatly. In the R-Value Measurement research of this year, MDC electronic readout system can still work smoothly under the beam above 70 mA, compared with below 30 mA of last year.

We'll do more theoretical research on Electromagnetic Compatibility and accumulate more experience and data.