Status of BSC for $BESII$

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1 General status of BSC for $BESII$

The general status of BSC for $BESII$ is good and its performance is getting better and better after Summer 95 repairing and upgrading and since then $H.V.$ adjusting, even though it is *old*. Now its energy resolution is $\delta E/E \sim 20.6\ \%/\sqrt{E}$ (E in GeV). It is the best energy resolution ever reached since its operation in 1988. The reported values of BSC performance in BES paper are $\delta E/E = 22\ \%/\sqrt{E}$ (BES Detecter); $\delta E/E = 25\ \%/\sqrt{E}$ (BES 1st M_τ paper) and the even worse value near $BESI$ closed is $\delta E/E \sim (26-27)\ \%/\sqrt{E}$. So, the present value of the energy resolution for BSC is a big progress.

2 Counter repairing

Before 1995 Summer BSC repairing and upgrading BSC has operated for about seven years since BES started its commissioning and subsequent physics data-taking in Autumn 1988. During this period BSC basically kept its normal operation with the energy resolution of $\delta E/E \sim (22-25)\ \%/\sqrt{E}$ and made its contribution to BES physics run at J/ψ, ψ', τ and D_s. Meanwhile, BSC suffered wire broken, totally accumulated two hundred or more wires broken. Roughly estimated, it is only 1.5 % of total 13440 wires. However, its effect is far and away this number due to $H.V.$ parallel connection for two towers and signal grouping connection with two, three or twelve wires for different physical layers. So one broken wire would affect 48 wires of two adjacent towers due to $H.V.$ parallel connection or two, three or twelve wires if the $H.V.$ current-limiting resitance would cut off for the broken wire. In fact, we found 253 electrical channels dead or abnormal, *i.e.* about 7.5 % of the total 3360 electrical channels, most caused by wire broken and a few by cable broken or disconnection, according to the statistics obtained from the 1995 Summer repairing and upgrading records.

There are 56 dead channels for the first three inner channels (2 wires/channel), 53 dead channels for the mediate fourth and fifth channels (3 wires/channel) and 144 abnormal channels for the outer sixth channel (12 wires/channel). Of course, most of them were treated in past days by cutting off the $H.V.$ current-limiting resistance for saving other wires parallelly connected to the same $H.V.$ input cable. Even though it was done like this, the affected wires still amounted as $2 \times 56 + 3 \times 53 + 12 \times 144 = 1999$, that is, about 14.9 %

of the total 13440 wires affected. Undoubtedly, the energy resolution would be affected to some extent.

After 1995 Summer *BSC* repairing and upgrading, all of the 253 dead or abnormal electrical chanels were treated, but in different ways depending on their individual different damaged conditions. For a few dead channels due to cable broken or disconnection, it is easy to recover by replacing a new cable or re-welding the disconnection point. However, for most broken wires it is hard to treat in the same way mainly on account of their different physical position at the *BSC* sub-detector. First, for the channel 1 and 2 (corresponding to the physical layer 1 to 4) their feed-throughs are behind the huge fringe of the *BSC* inner cylinder, non-accessible and thus non-repairable, their *H.V.* current-limiting resistances have to be cut off to save other wires in the same *H.V.* chain, so total 35 channels of this kind still keep dead. Secondly, for channel 3 (the physical layer 5 to 6) their feed-throughs are just at the edge of the fringe, accesible but still hard repaired, the broken wires were pulled out and sealed by silicon rubber, and then re-welding the *H.V.* resistance, if it was cut off before, to save another wire parallelly connected with it, thus this channel survives again. Thirdly, for channel 4, 5 and 6 (the physical layer 7 to 24) they were repaired, only a few wires re-wired at a certain strenth, most wires pulled out and sealed, and re-welding the *H.V.* resistance to save other two wires, thus the channel.

Notice, most pulled-out broken wires, amounted to 154 wires, *i.e.* three fourths of the total pulled-out wires, belong to the outer sixth channel, and 109 wires, more than a half of the total, located at the mostouter two layers of the sixth channel, so it seems that there could not be a big effect to the *BSC* performance.

During 1995 Summer *BSC* repairing and upgrading, we made a careful record for the repairing and upgrading and a detailed statistics item by item. In summary, there are re-wiring 35 wires and pulled-out 203 wires to save 216 channels, left 37 channels dead, most at the non-repairable channel 1 and 2.

In general, after *BSC* repairing and upgrading 216 dead or abnormal channels were repaired and saved, left 37 non-repairable channels still dead. Compared with the one before repairing and upgrading, the bad channels decreased from $253/3360 \sim 7.5$ % down to $37/3360 \sim 1.1$ %. A complete and detailed repairing and upgrading records and statistics make the distribution of dead wires and dead channels very clear, providing a reliable base for further performance study of *BSC* and Monte Carlo simulation.

3 Gas system repairing

All of the aged tubes were replaced and a complete air-tight test for all counters and gas transportation system was made. In addition, the entrance and the exit of the gas flow was changed, entering from the original *west inner* inlet to the *east outer* inlet and exiting from the original *east outer* outlet to the *west inner* outlet, intending to make the gas flow more reasonable.

The effect of this change is very clear. Before repairing the difference of the high voltage for the top and bottom parts of *BSC* counter is about $210V$, but after repairing it is only $35V$ for the same *ADC* sum output.

In addition, the gas supply system was improved to make the temperature stability better.

4 $H.V.$ system upgrading

Before upgrading, there were only 280 $H.V.$ channels for whole BSC, each parallelly connected to 48 wires of two adjacent towers. As mentioned above, one broken wire will affect 48 wires, *i.e.* $\frac{1}{280}$ of the total wires. It was due to this kind of $H.V.$ connection mode that the twenty four physical layers from the innermost to the outermost, with different size of cells, were set to the same $H.V.$ value, appearing unreasonable.

After upgrading, the $H.V.$ system of BSC changed a lot. First, the total $H.V.$ channel increased to 1120 channels, four times of the original 280 channels, so the effect of one bad $H.V.$ channel would relatively be decreased. Secondly, for one tower from inner to outer layer there are four kinds of different high voltage corresponding to different cell size, making the working voltage more reasonable. It makes the effect caused by one broken wire degraded to a local area. A notice-worthy point is that this kind of upgrading needs all of the original 280 $H.V.$ input boards have to be modified *in situ*, really hard tasks.

New $H.V.$ system consists of two $H.V.$ power supplies (SY-127 A133P, 3KV, 3mA), four $H.V.$ distribution crates to provide four kinds of $H.V.$ (A, B, C, D), twenty four $H.V.$ fan-out boxes to fan-out $H.V.$ channels further, and two hundred and eighty modified $H.V.$ input boards.

More and different $H.V.$ channels make the BSC working condition tend to more reasonable, benefiting to the steady operation of BSC, so the better performance in energy resolution are expected. After careful adjusting of $H.V.$ setting the difference of the inner and outer layer corresponding to different cell sizes is about $30V$, which makes the ADC sum output more even.

5 Circuit boards, cables, output sockets and electronics

All of 560 $H.V.$ input and signal output circuit boards, 6720 cables and 288 output sockets for both ends of the counters were checked thoroughly. Three broken cables were found and replaced. Dead electronics channels decreased from more than 100 channels down to less than 10 channels.

6 Summary

All factors as mentioned above combined together to make the $BESII$ BSC performance improved and being getting better and better after repairing and upgrading. And a possible improvement of BSC off-line calibration as indicated by Zhao Haiwen at $BES97$ may further improve the BSC performance. So BSC as one of the important sub-detector of $BESII$ will have better performance, hoping to make more contributions to $BESII$ new physics.