Noise Study at BES/BEPC

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1 Noise Study Motivation

In the last run (March 1998 to May 1998), there are hot channels in MDC-T when the e^+e^- beam current is high (about 30mA or more). There is no hot channels in MDC-E. And there are hot channels in VC when the e^+e^- beam current is higher (40mA or more). At higher beam energies (more than about 2.3GeV), the VC leakage current (HV) is very high (could be greater than 200μA, while it is less than 10μA in normal case). These hot channel problem and high leakage current problem limited the e^+e^- colliding beam current to about 25mA (20mA at high energies) for the last run. This problem should be solved, or it will limit the datataking efficiency for the future runs.

2 Study of the MDC hot channels

2.1 Cosmic ray test

The cosmic ray test has been done for several times during the last run. If there is no beam, there will be no hot channels in MDC and VC. If the MDC HV is turned off, (even to the safe-HV) there will be no hit in the MDC. The decision, that the hot channel does not come from the feedthrough of MDC or the HV power source, can be got. It is sure that the hot channel is caused by the beam.

2.2 MDC hot channels is block distributed

In the last run, in some block, which corresponding to the MDC main-amplifier crates, the hot channel are more serious. For the same layer, some cells are hot channels, some are not. It correlates with the MDC main-amplifier crates. This indicates that the hot channel is relevant to the MDC main-amplifier crates. Fig1 is one typical MDC hit map of 3rd layer.

2.3 Single beam test

Six day were used to study the noise (hot challel problem). The higher the beam current, the more the MDC hot channels. 30mA e^+ or e^- single beam is much more serious than 30mA e^+e^- (with 15mA each).

The MDC-E and MDC-T information were investigated. The input signal to MDC 7003/7004 (MDC ADC/TDC) were abserved with LeCroy 9361 digital storage Oscillascope. Fig2 is the MDC-E signal with e^+ beam current 30mA. Fig3 is the MDC-E signal with e^- beam current 30mA. Fig4 is the MDC-T signal with e^+ beam current 30mA. Fig5 is the MDC-T signal with e^- beam current 30mA. This is the same wire (MDC 7003/7004: Crate 2, Module 4, Channel 2). In each figure, another channel of the oscilloscope is the time reference for the detecter, which is also the time reference in the interaction point.

Comparing fig3 (fig5) and fig2 (fig4), it can be seen that the e^- beam induced hot channel is earlier than that of e^+ beam. Similar result can be got from fig7 and fig6, which are the channel 9 time information of 30mA e^- and e^+ beams seperately. The difference is about 80ns. That is to say, if the beam causes noise when the beam passes the same point on the beam orbit, the point should be about 12m from the interaction point. In the south interaction point, it is 12m to the east (nothing particular there); in the north interaction point, it is 12m to the west (BEPC RF Cavity), because the e^- runs in clock-wise and e^+ runs in anti-clock wise direction.

Comparing fig5 (fig4) and fig3 (fig2), the noise of MDC-T and MDC-E channels are consistant with each other. The noise frequency is about 35MHz.

2.4 VC hot channels

At higher beam current, the VC has also hot channels. Fig8 is a typical hot channel distribution of layer 5. About half are hot-channels. This corresponding to the cells readout in the east side. (for VC readout, refer to BES96 Annual meeting proceedings). This supports that the noise is more serious in the east side than that in the west side.

2.5 Other phenomena

For the same counter of Barrel TOF, there is more noise in the east side cables than that in the west side cables. See fig9. The 35MHz noise level is about the same, and the east-side cable pick-up noise is slower than that in the west-side.

The space electro-magnetic detecter also shows that the noise in the east side of BES is higher than that in the west side.

2.6 Information from BEPC and electronics people

The BEPC people confirm that the East Seperator is poorly shielded. The electronics people confirm that the spare power filter capacitor for MDC main-amplifier crates is ineffective.

3 Study of VC high leakage current

From the R measurement running, the higher the beam current, the higher the leakage current. And the leakage current is approximately proportional to the beam current. The BEPC people have tuned the beam orbit. It affects the leakage current very much (from about 50μA to 200μA for the same beam current). Fig10 is a typical plot of layer 5-8 hit map of VC in the R-measurement experiment at 2.5GeV (beam energy). There is more hits in the horizental direction than that in the vertical direction. And from the figure, the hit map in the south is more sharp than that in the north direction, so it supports that the hits are caused by radiation, other than lost particles. Anyway, this needs more detailed study. The signal to noise ratio of luminosity monitor will change when the beam tuned. So the VC high leakage current may be caused by the innappropriate beam orbit.

4 Work done

In early July, 1998, the BEPC people has shielded the east seperator by ferromagntic absorption material. This has not improved the MDC noise. From the electromagnetic field detector, the higher frequency ($\geq$ about 100MHz) electromagnetic field were absorbed.

The electronics peoples has replaced two MDC main-amplifier crates with new filter capacitors. There is also no improvement of MDC noise (hot channels).

The MDC people has cut off the reluctant HV cables, especially the cables to the sense wire in late July.

5 Work to be done

5.1 Noise source location

Use more spatial EM detecter to locate the radiation source of the about 35MHz EM field in space. If located, shield the source with proper materials. It is very important to study the difference caused by the electron and positron beams.

5.2 VC high leakage current study

Visually scan the event in R-measurement at 2.5GeV, to verify the particle which causes the high leakage current, that is charged particle, which is a track like hits in VC, or neutral particle, (low energy radiation photons), which is a random hit in VC.

5.3 VC efforts

Re-arrange the HV cables of Vertex Chamber, so that it will seperate the inner layers from the outer layers of VC. In case the leakage current is very high, the inner layer HV can be adjusted to lower voltage or be turned off easily.

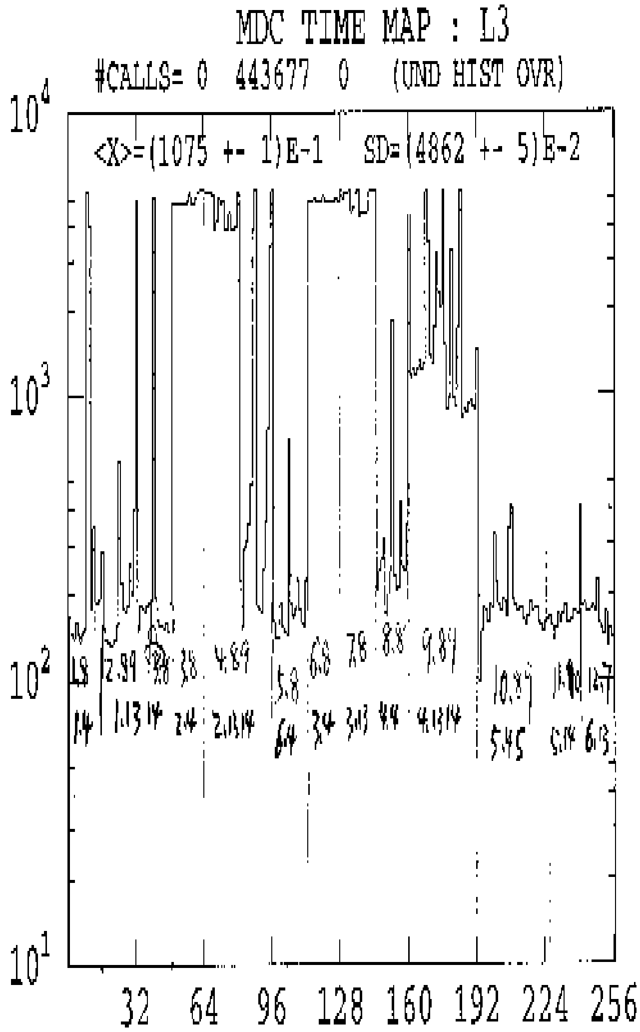

Figure 1: Hit map of MDC-T 3rd layer

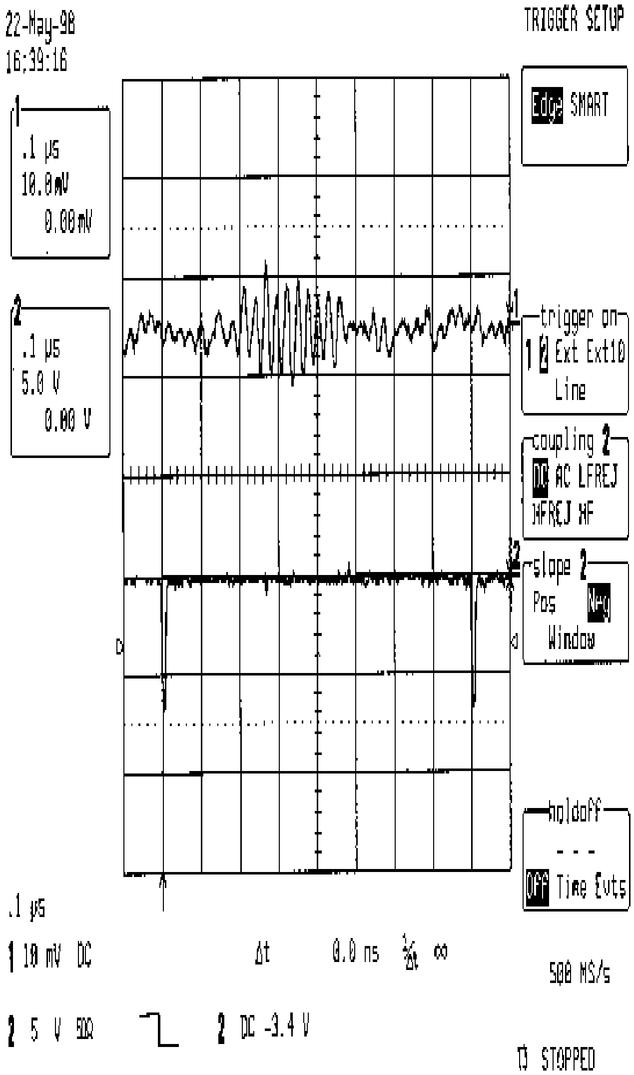

Figure 2: MDC-E signal of 7003 Crate2, Module4, Channel2 at 30mA positron

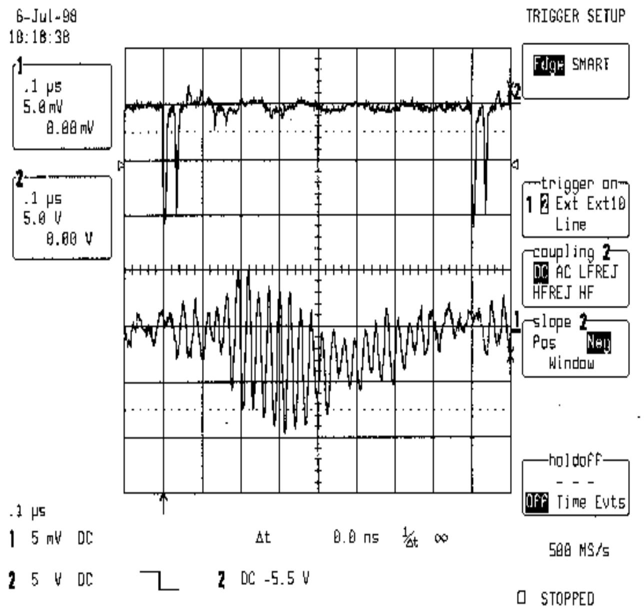

Figure 3: MDC-E signal of 7003 Crate2, Module4, Channel2 at 30mA electron

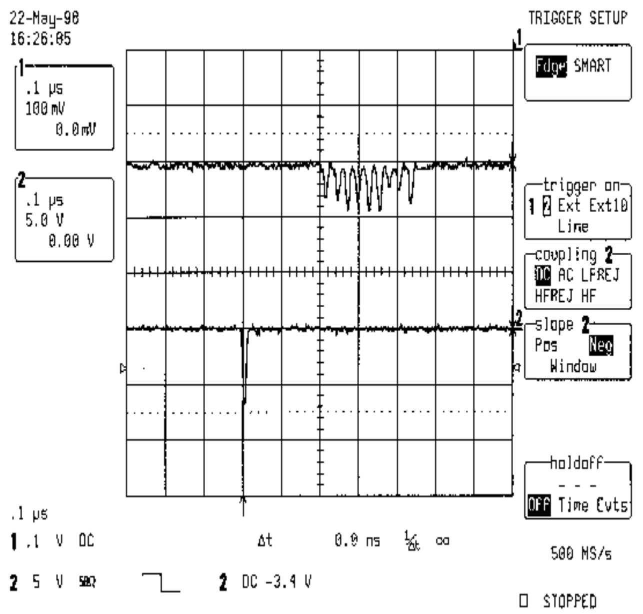

Figure 4: MDC-T signal of 7003 Crate2, Module4, Channel2 at 30mA positron

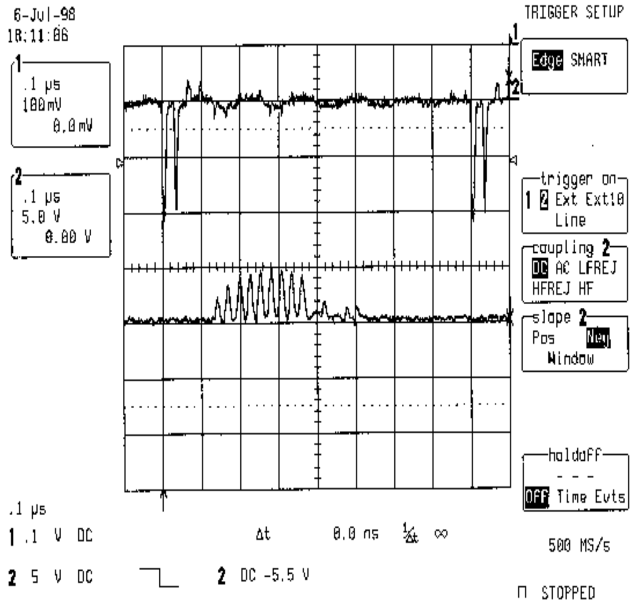

Figure 5: MDC-T signal of 7003 Crate2, Module4, Channel2 at 30mA electron

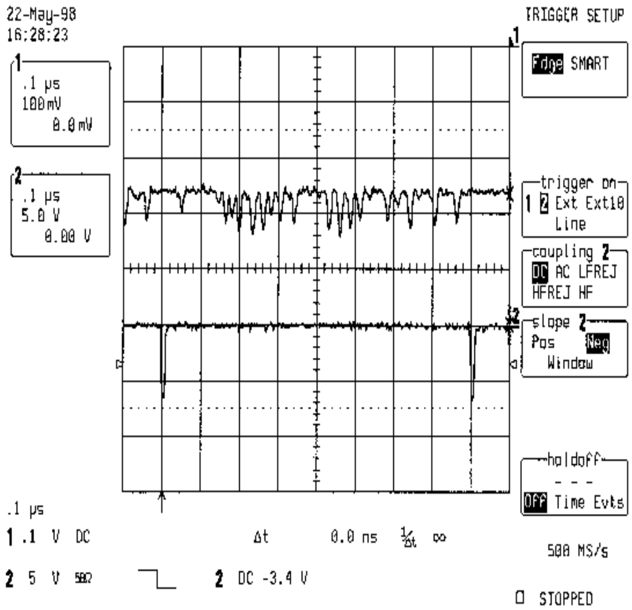

Figure 6: MDC-T signal of 7003 Crate2, Module4, Channel9 at 30mA positron

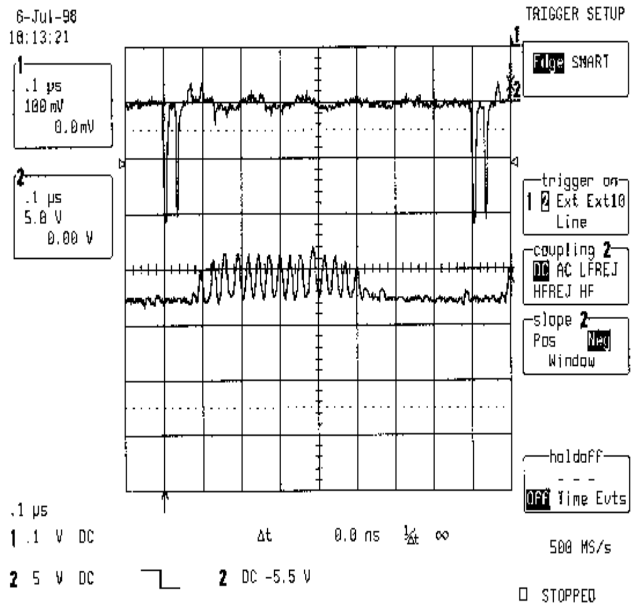

Figure 7: MDC-T signal of 7003 Crate2, Module4, Channel9 at 30mA electron

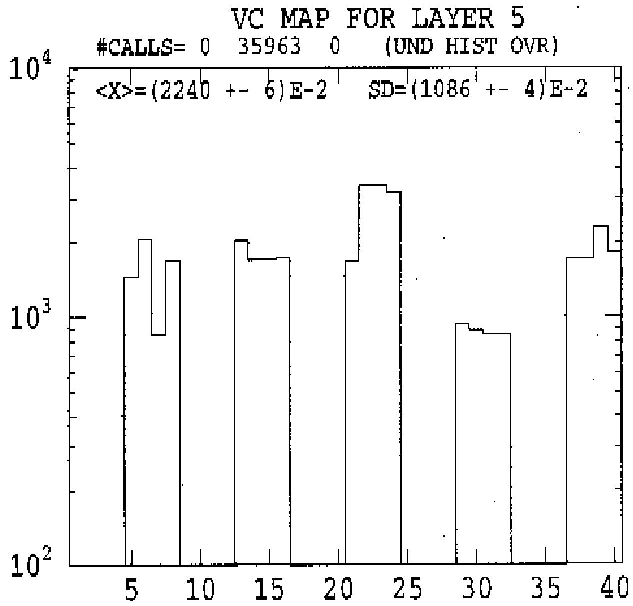

Figure 8: VC hit map of 5th layer at high beam current

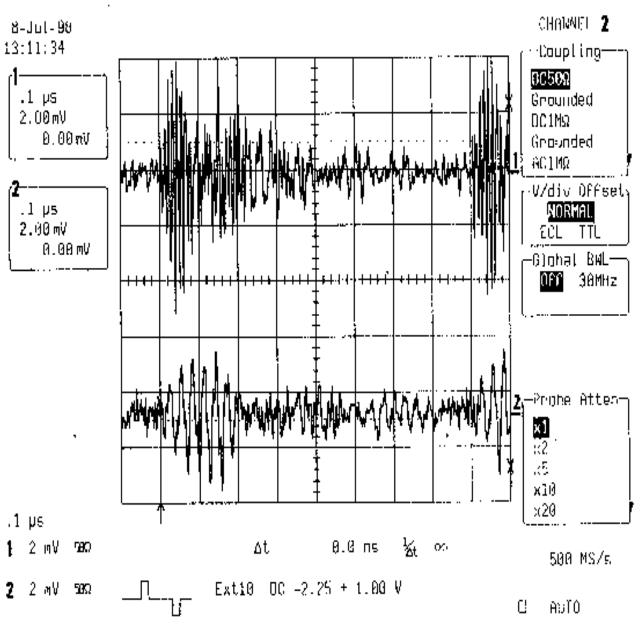

Figure 9: TOF cable pick-up noise by B-TOF counter 1

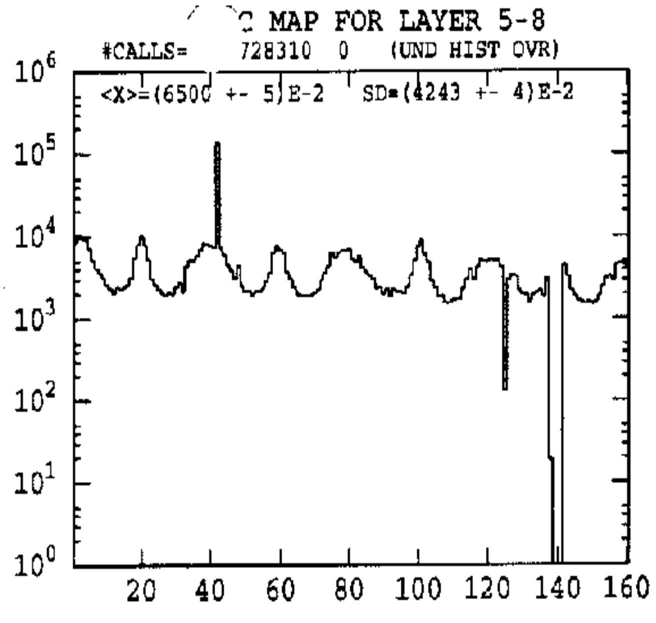

Figure 10: VC hit map of layer 5-8 at high beam energy (2X2.5GeV)