MDC-II Noise Analysis

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Jun. 9 1997

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1 Indroduction

During the last running of BES II, big random noise from MDC was found. The noise source was finally positioned at the feed-throughs. It mainly appears in time channel as a time signal without charge information in charge channel. The charge signal was cut out in MDC readout due to it is too small to pass a pad in BADC shown in Fig. 1

We can see a Bhabha event very clearly from charge channel, but it is not so clearly to see in time channel, some extra hits acompanying there, like Fig. 2 and Fig. 3 shown.

To simply evaluate the MDC noise level, we investigated directly the MDC raw data with concentrating on the time channel. We will see some behaviors of MDC noise qualitatively later.

The split high voltage resolution to the noise problem is considering now. To see the feasibility, some runs with about half high voltage under no-beam condition with random triggering were taken.

To understand how much noise the MDC-II had at full voltage and at half high voltage, comparisions have been made to BES I beam running. Some preliminary results will presente here.

2 Basic Definition

1. Noise Level R
   We emploied R a ratio of number of noise hits from T channel and signal hits from coincident Q and T channels to define the noise level:

$$R = \frac{N_t}{N_{qt}}$$

   for single layer

$$R_{lay.} = \frac{N_t}{N_{qt}} / N_{tew}$$

   N_t is total number of hits in time channel without charge signal,
   N_{qt} is total number of hits in charge and time channel simultaniousely,
   N_{tew} is a effective wire number correspoding N_t.

   Because of the different number of wire in different layer, we have to to normalize the R_{lay}. to a single wire for comparision.

2. Three types of noise
   For further study of MDC-II noise 3 types of noise were defined:

   * Noise 1:
   which found only in one fired layer which has continual 3 fired cells in MDC at least when the BES II was triggered. Fired cell demands at least one wire fired once triggered.

   * Noise 2:
   which found in two continual fired layers, and there must be one fired cell overlaped at least between those two fired layers.

   * Noise 3:
   which found in three or more than three fired layers, it demands two continual fired layers all have fired cell overlaped.

   The 3 types of noise were shown in Fig. 4 symbolically.

   The noise level R for those three types of noise is:

$$Ri = \frac{N_i}{N_{event}}$$

i=1,2,3
N_i is a total number of noise signal,
N_{event} is a total event number in a certain data file.

3 Basic Method

1. Take off "DEAD" "HOT" channels.
   "DEAD" channel doesn't work for MDC at all.
   "HOT" channel is fired always.
   some cuts for them:

$$0 < X(j,i) < N_{trg}/6$$

   X(j,i) is a number of total hits on the i_{th} wire in the j_{th} layer for a whole RUN,
   N_{trg} is the total triggered number of the RUN .

2. 3 σ
   Used 3 σ to limit the X(j,i) when take account the hit number on a single wire into R calculation i.e.

$$(X(j,i) - \bar{X}) < 3\sigma$$

   $\bar{X}$ is a average of X(j,i) for the whole MDC.

Fig. 5 shows how the cuts work.

4 Results

1. MDC-II noise increase with MDC-II running time

   Fig. 6 shown the noise level R veriation with run number in (a), with run date in (b). Curve in Fig. 6 covered about the whole last running of BES II.

   Some breaken in the curve caused by high voltage adjusting, after run number 10657 the high voltage was down to 95% of full.

   The curve shown the R increases with run number or running date can be understood the MDC-II noise increases with its running time.

2. MDC-II noise relates to high voltage on layer.

   Fig. 7 shows some difference of the noise level R between layers run by run.

   Fig. 8 shows the noise level R_{lay}. veriation with layer number for BES I and BES II. The R_{lay}. for the 10_{th} layer was omitted due to its unnormal.

   Comparing the R_{lay}, we found it is not change lots between 9 layers in BES I, but in BES II it did change very much. Espercially in the first 4 layers, the R_{lay}. increases with the layer number.

   The voltage on the first 4 layers increases progressively, on the last 6 layers it is about constant. So the MDC-II noise relates to the voltage on layer.

3. Noise from multi-layer is more in BES II than BES I

Table 1: Noise level for 3 types of noise

RUN	Nevts	N1	R1	N2	R2	N3	R3	BES
10300	456	141	0.3092	106	0.2325	183	0.4013	II
10450	858	162	0.1888	240	0.2797	473	0.5513	
10500	844	158	0.1872	151	0.1789	510	0.6043	
5650	951	351	0.3691	83	0.0873	75	0.0789	I
5670	672	265	0.3943	96	0.1429	57	0.0848	
5680	379	141	0.3720	63	0.1662	71	0.1873	
7350	1742	655	0.3760	158	0.0907	100	0.0574	
7360	1652	590	0.3571	178	0.1077	95	0.0575	
7380	1451	595	0.4101	156	0.1075	112	0.0772	

   Results in Table 1 were obtained from selected Bhabha events. Run 10300-10500 were taken by BES II at J/Psi energy, run 5650-5680, 7350-7380 were taken by BES I at 4.03 GeV.
   R3 is a typical value shown how often the big noise appears in MDC. From Table 1 we can see the R3 in MDC-II is higher than that in MDC-I.

4. MDC-II noise level is reduced in half high voltage

   Table 2-1 is the results from the MDC-II noise test run in BES II running without beam at random trigger condition. Roughly half voltages were used in the field wires of the MDC-II.
   The detail test run conditions are listed in Table 2-2.

   Fig. 9 shows the veriation of the Noise 3 with the field wire voltage under defferent T-threshoulds.

Table 2-1: Noise in MDC-II Test Run.

RUN	Ntrg	R1	R2	R3	V_f(kv)
20001	6235	0.1934	0.0709	0.1366	2.3
20002	5842	0.1683	0.0517	0.1248	2.2
20003	6029	0.1561	0.0504	0.0984	2.1
20004	5676	0.1371	0.0403	0.0791	2.0
20005	4988	0.1034	0.0293	0.0441	1.8
20006	3972	0.0604	0.0149	0.0093	1.5
20007	2992	0.1390	0.0424	0.1026	2.0
20008	2007	0.1599	0.0468	0.1231	2.1
20009	1853	0.1722	0.0621	0.1457	2.2
20010	2006	0.1889	0.0588	0.1810	2.3
20012	4942	0.1679	0.0500	0.1109	2.0
20013	5259	0.1166	0.0363	0.0693	1.8
20014	5042	0.0855	0.0232	0.0286	1.6
20015	4810	0.1532	0.0472	0.1042	2.0
20016	2520	0.0492	0.0079	0.0226	2.0
20017	2396	0.0317	0.0058	0.0008	2.0
20018	2759	0.0000	0.0000	0.0000	0.0
20019	5025	0.0896	0.0265	0.0398	1.6
20020	5067	0.1352	0.0339	0.0724	1.8
20021	5044	0.1723	0.0543	0.1235	2.0
20022	5125	0.2014	0.0599	0.1171	2.0
20023	5092	0.1520	0.0385	0.0705	1.8
20024	5197	0.1026	0.0235	0.0375	1.6

Table 2-2 Conditions for MDC-II noise test run.

RUN	V_f(kv)	V_p	V_g	$T_e(0c)$	T_w(0c)	Thr.	B (kGS)
20001	2.3					775	2.0
20002	2.2					775	2.0
20003	2.1					775	2.0
20004	2.0					775	2.0
20005	1.8					775	2.0
20006	1.5					775	2.0
20007	2.0					625	2.0
20008	2.1					625	2.0
20009	2.2					625	2.0
20010	2.3					625	2.0
20012	2.0	1.6	0.32	22.8		625	2.0
20013	1.8	1.6	0.32	22.8		625	2.0
20014	1.6	1.6	0.32	22.8		625	2.0
20015	2.0	0.0	0.0	22.8		625	2.0
20016	2.0(7th)	0.0	0.0	22.8		625	2.0
20017	2.0(10th)	0.0	0.0	22.8		625	2.0
20018	0.0	0.0	0.0	22.8		625	2.0
20019	1.6	1.6	0.32	25.8	23.4	625	4.0
20020	1.8	1.6	0.32	25.8	23.4	625	4.0
20021	2.0	1.6	0.32	25.8	23.4	625	4.0
20022	2.0	1.6	0.32	23.7	24.8	625	4.0
20023	1.8	1.6	0.32	23.7	24.8	625	4.0
20024	1.6	1.6	0.32	23.7	24.8	625	4.0

Comparing the Table 1 to Table 2, some typical R3 values are relisted here.

RUN	V_f(kv)	R3
10300	Full (BES II)	0.401
20007	2.0	0.102
20012	2.0	0.111
20021	2.0	0.124
20022	2.0	0.117
5650	Full (BES I)	0.078

Obviously, the R3 from half high voltage is smaller than it from BES II and close to that from BES I.

5 Conclusions

1. The MDC noise is much higher in BES II than BES I.

2. Noise Level relates to the HV of field wires.

3. The lower voltage on the field wire, the lower noise in the MDC-II in the half high voltage test run.

4. The noise level from multi-layer (R3) in the half high voltage is close to BES I.

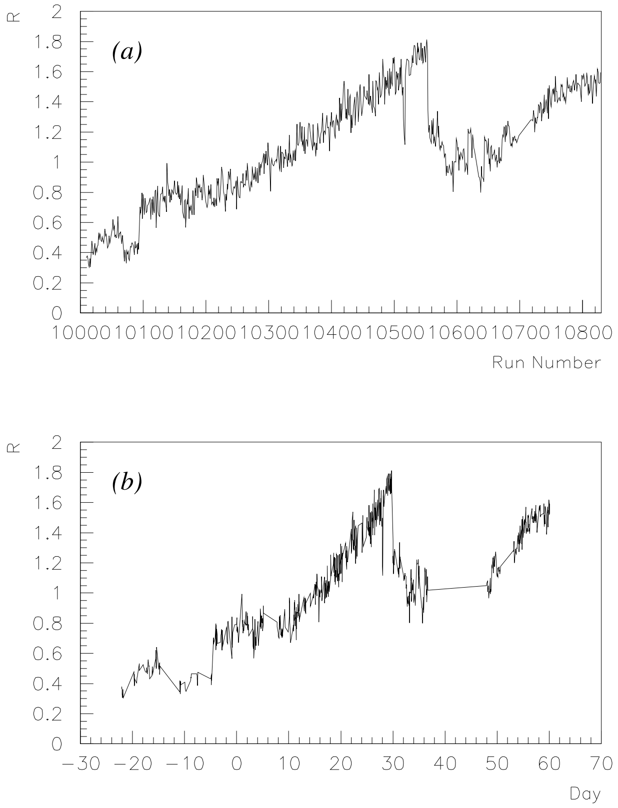

Figure 6:

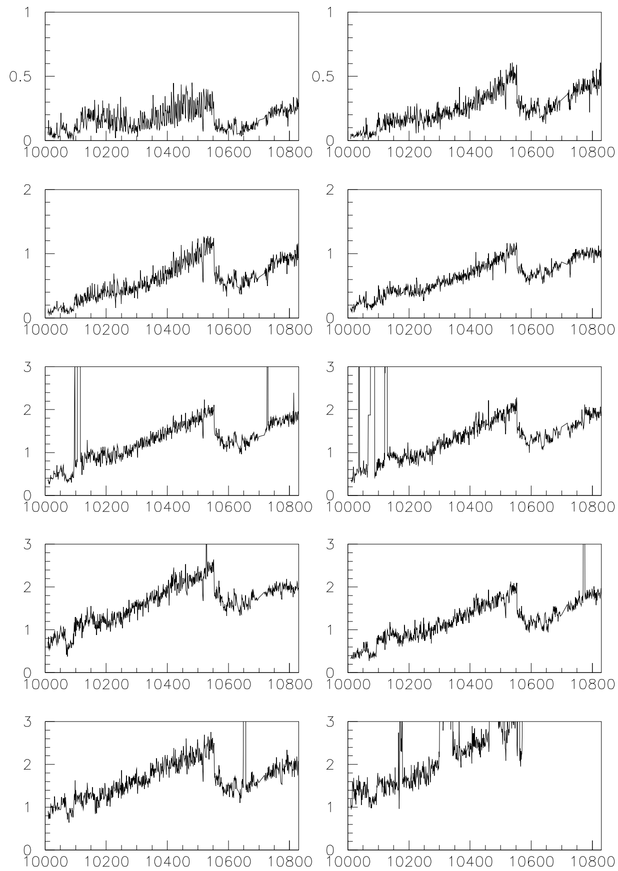

Figure 7

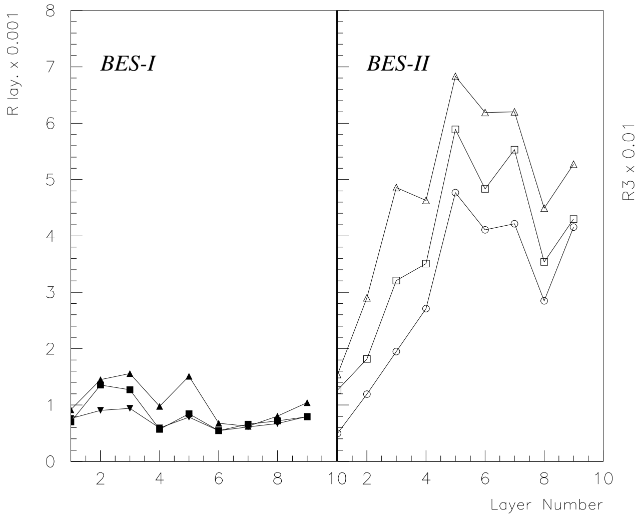

Figure 8:

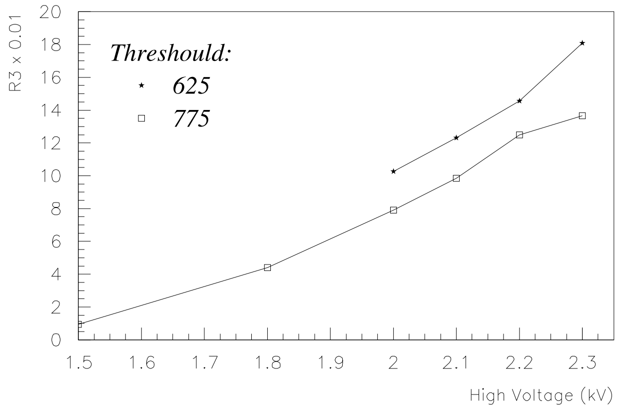

Figure 9