Status of MVD

Tsukuba-Yonsei Workshop
December 4-5, 2000

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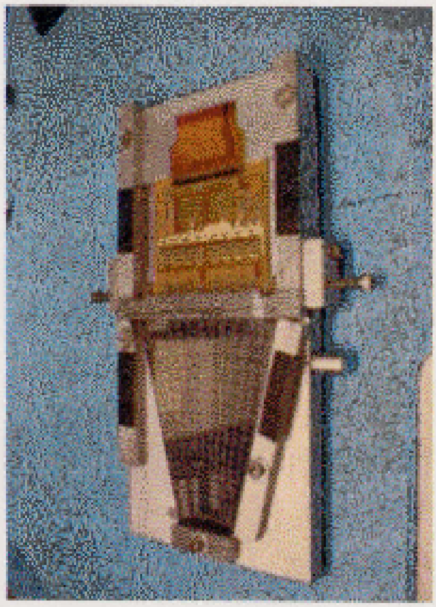
OVERVIEW

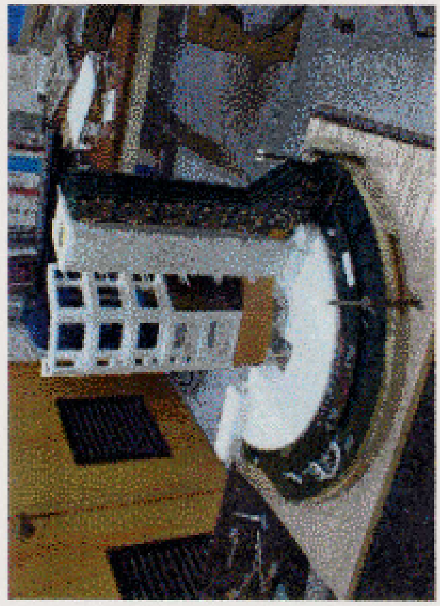
- First year MVD configuration and MVD problems
- Some MVD data from last run
- MVD configurations for the second year
- Performance of MVD vertex finding for pp events

SILICON DETECTOR ASSEMBLIES

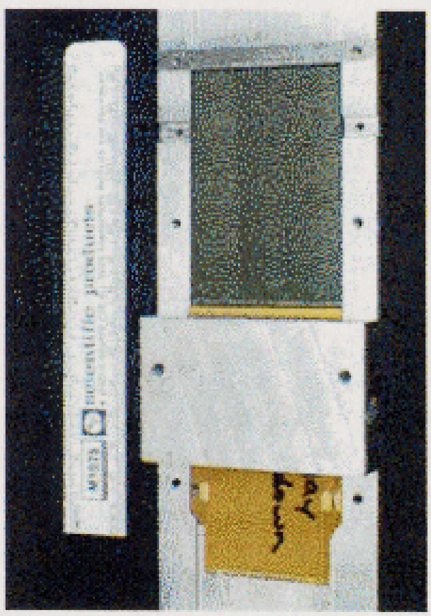
한국물리학회 2000/10/27 포항



PAD DETECTOR-MCM



ASSEMBLY STACK



STRIP DETECTOR

STRIP DETECTOR-MCM

Configuration and problems for the first year MVD

- For the first year MVD, only 42 MCM's (out of total 136 MCM's) were installed as only those MCM's finished fabrication and testing.

- MVD data collection was very unstable because TCIM Glink could not be locked properly mainly due to overloaded regulator (which was found out after the run).

- Because of such electronics problems, MVD data were taken only at the end of the run (run12397-12568).

- Due to the same problem, we got meaningful data only from two runs (12397, 12399) and also there were only two MCM's working properly.

- Some data were taken before putting into the main partition. At that time there were four working MCM's, two from inner barrel and two from outer barrel, so that the vertex finding would be possible.

MVD year 1 configuration

Currently only a limited amount of readout electronics is available. An optimal configuration has been implemented to obtain best physics results.

- Only north part of the MVD has been instrumented.
- North endcap completed (12 MVD pad detectors).
- Each instrumented C-cage section has at least one Si detector in inner and outer barrel.
- Azimuthally complete inner barrel is preferred if possible.

Number of Si detectors in all sections - North East part:
4 4 4 2 2 0

Number of Si detectors in all sections - North West part:
4 4 4 2 0 0

Vertex finding - OK
Multiplicity measurements $dN_{ch}/d\eta$ - OK
Reaction plane studies (elliptic flow) - OK

- Still possible to obtain fast physics !

First year MVD data and more problems in MVD

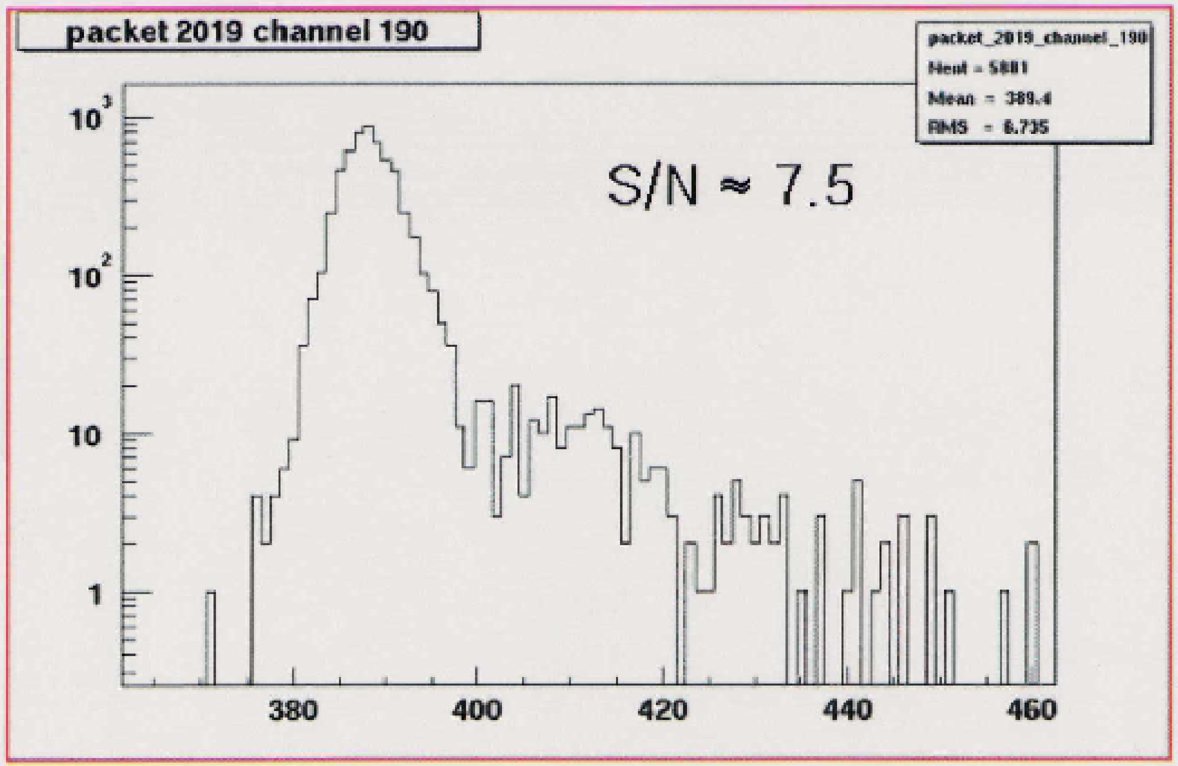
- Signals above the pedestal, the expected clump size depending on Δz, and correlation with other detector were observed.

- It could be possible for us to do some physics analysis as just two MCM's in the middle could cover $-0.88 < \eta < 0.88$ for $\Delta\theta = 60^o$ so that the expected number of track multiplicity could be up to about 170 for central collisions.

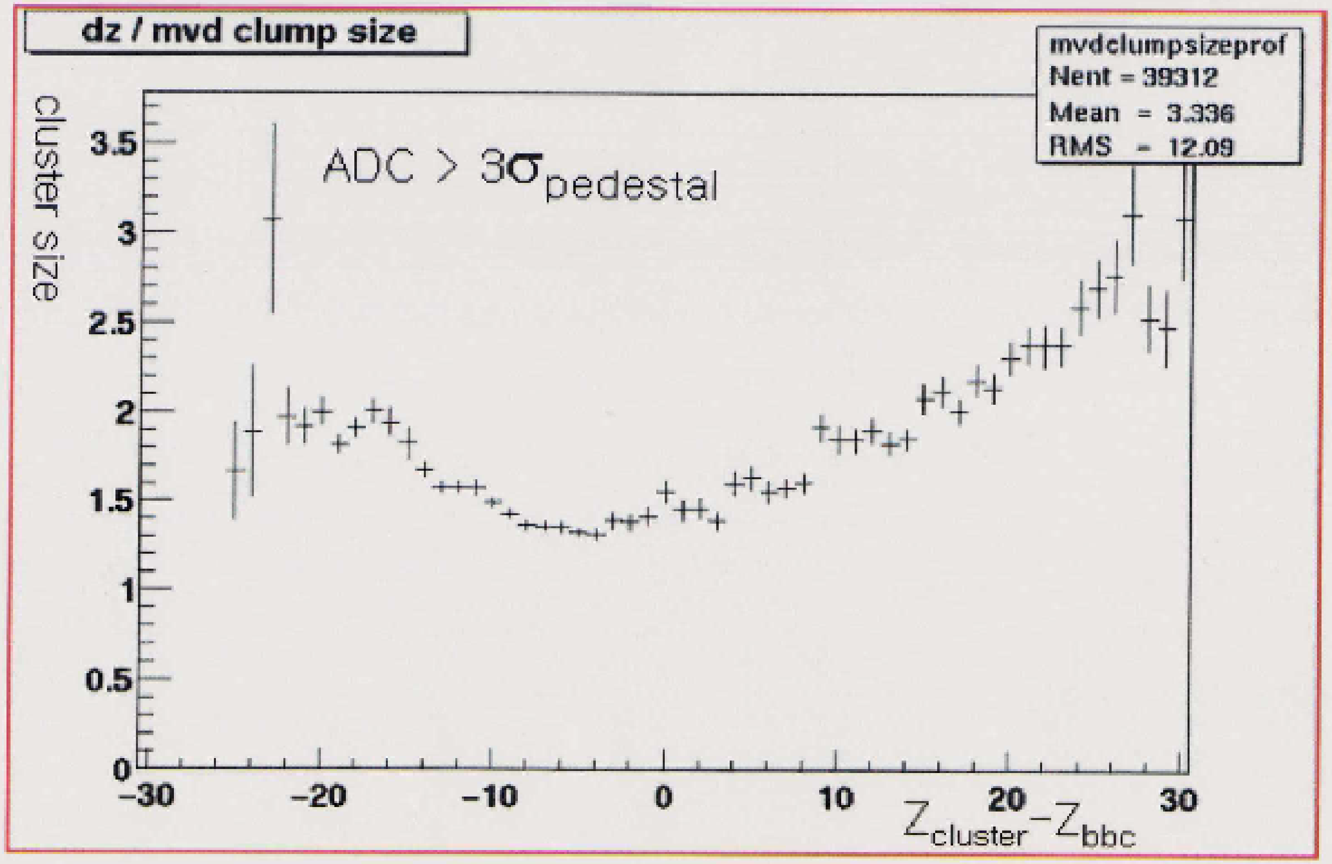
- Unfortunately, MVD still had more problems in the geometry because deformation of the rohacell support structure was found after removing the MVD from the beam pipe. MVD has a cooling system using fan and chiller to cool electronics and some negative pressure was built up in the enclosure due to blocked airflow.

- It would require too much work to figure out the real geometry during the run for the data which was already marginal due to the limited runs and coverages.

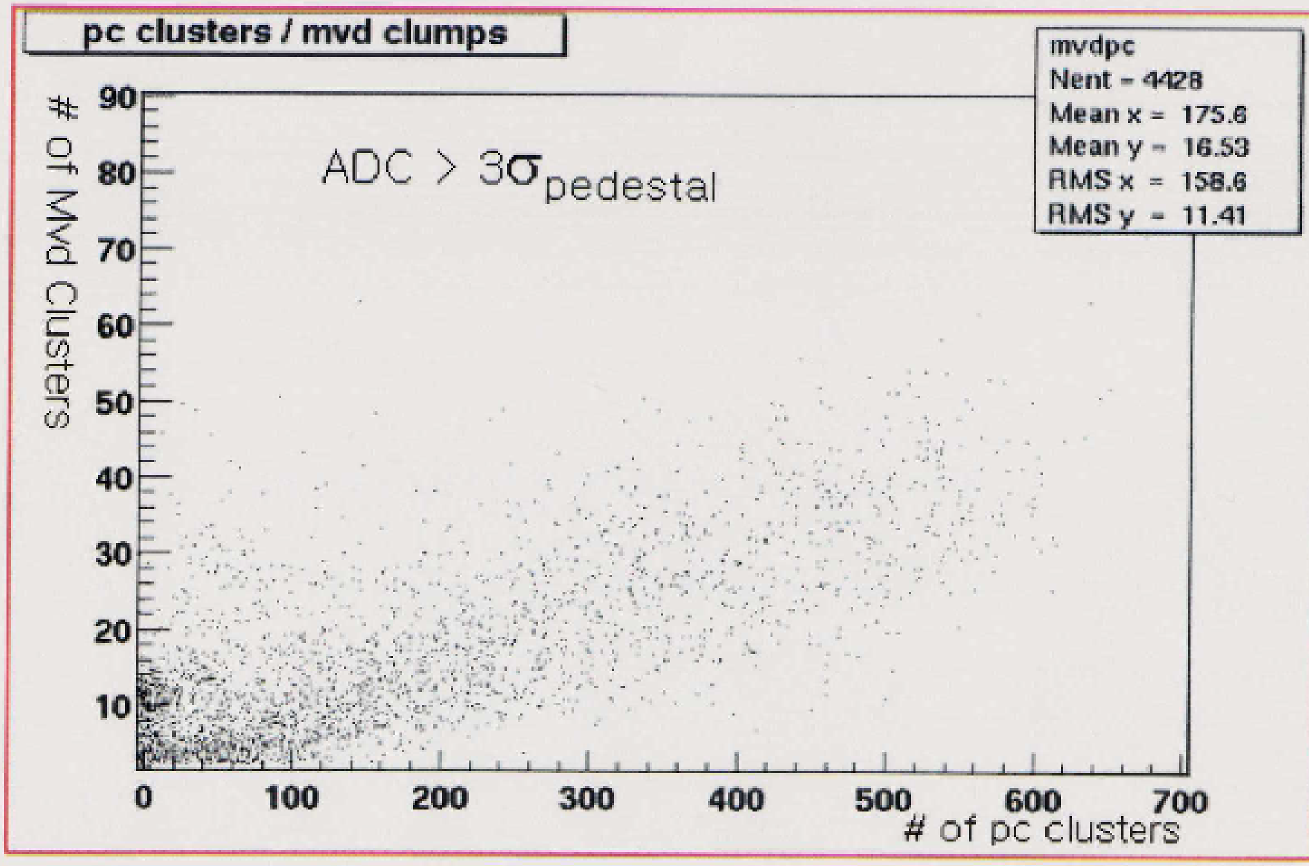
TYPICAL ADC DISTRIBUTION



MVD CLUSTER SIZE



CORRELATION between MVD and PAD CHAMBER



MVD configuration for 2nd year

- We are going to install 84 MCM's in the next year, while the remaining will be available for the following run.
- It has to be carefully optimized to get the best physics results using these.
- There are two competing physics issues; more coverage in the η and θ, or good vertex finding capability.
- Vertex finding is crucial for the pp events whose track multiplicities are very low.

MVD year-1 Configuration

The year-1 configuration was proposed in a message to the MVD listserver on 14-Feb-2000. There were some minor changes in the final year-1 configuration (shown below).

In shorthand notation from that note the configuration was:

side	S endcap (#MCMs)	barrel -- #MCMs at each position												N endcap (#MCMs)
East:	0	0	0	0	0	0	0	4	4	3	2	0	0	6
West:	0	0	0	0	0	0	0	4	4	4	2	2	0	6

In words, we populated the north endcap and part of the north end of the MVD. In populating the north end of the MVD, we made as many "C-cages" with 4 active detectors (3 on inner barrel plus outer barrel bottom) as possible. The constraints were what was already glued when this process started and the total number of MCMs available.

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updated 11-Oct-2000

MVD year-2 Configuration

For year-2, we propose to continue the year-1 logic, but on the south half of the MVD. That is, we will complete the south endcap pads and then make as many C-cages as available MCMs (currently 41) permit. This would give us something like the following configuration:

side	S endcap (#MCMs)	barrel -- #MCMs at each position												N endcap (#MCMs)
East:	6	0	0	2	4	4	4	4	4	4	2	0	0	6
West:	6	0	0	2	4	4	4	4	4	4	2	2	0	6

This gives us a complete set of pad detectors. We hope this gives us a good and easy to understand multiplicity measurement. The central part of the barrel will give us the ability to find the vertex for most vertex positions inside the pole tips and to make flow plane determinations for z between about +-15 cm.

One of John's arguments in favor of this configuration is: We agreed that this was a good way to configure the north half of the MVD, why not apply the same reasoning to the south half?

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updated 11-Oct-2000

MVD year-2 Configuration

Two alternative configurations have been proposed (see message at phenix-dc-l).

Configuration 1 maximize vertex-finding efficiency -- this means instrumenting as much of the inner and outer Si strip layers on the bottom 1/3 of the MVD as possible

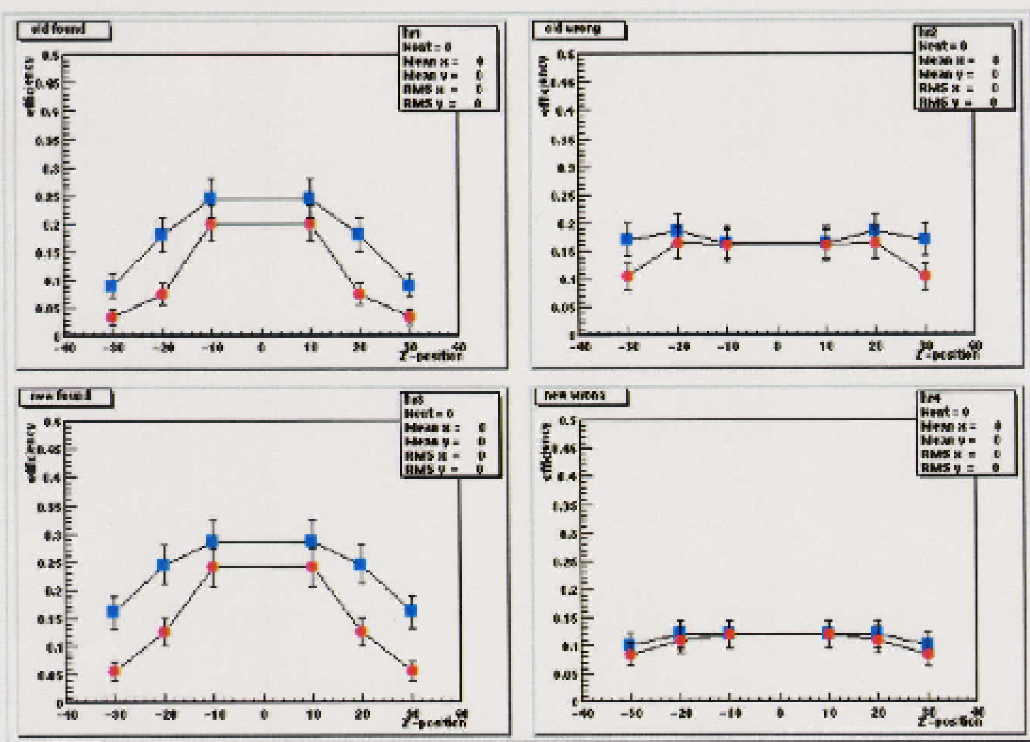
side	S endcap (#MCMs)	barrel -- #MCMs at each position												N endcap (#MCMs)
East:	0	2	2	2	4	4	4	4	4	4	2	2	2	6
West:	0	2	2	2	2	4	4	4	4	4	2	2	2	6

Configuration 2 maximize ability to measure flow angles -- this means instrumenting as many azimuthally complete inner barrel segments as possible.

side	S endcap (#MCMs)	barrel -- #MCMs at each position												N endcap (#MCMs)
East:	0	0	4	4	4	4	4	4	4	4	4	2	0	6
West:	0	0	4	4	4	4	4	4	4	4	4	4	0	6

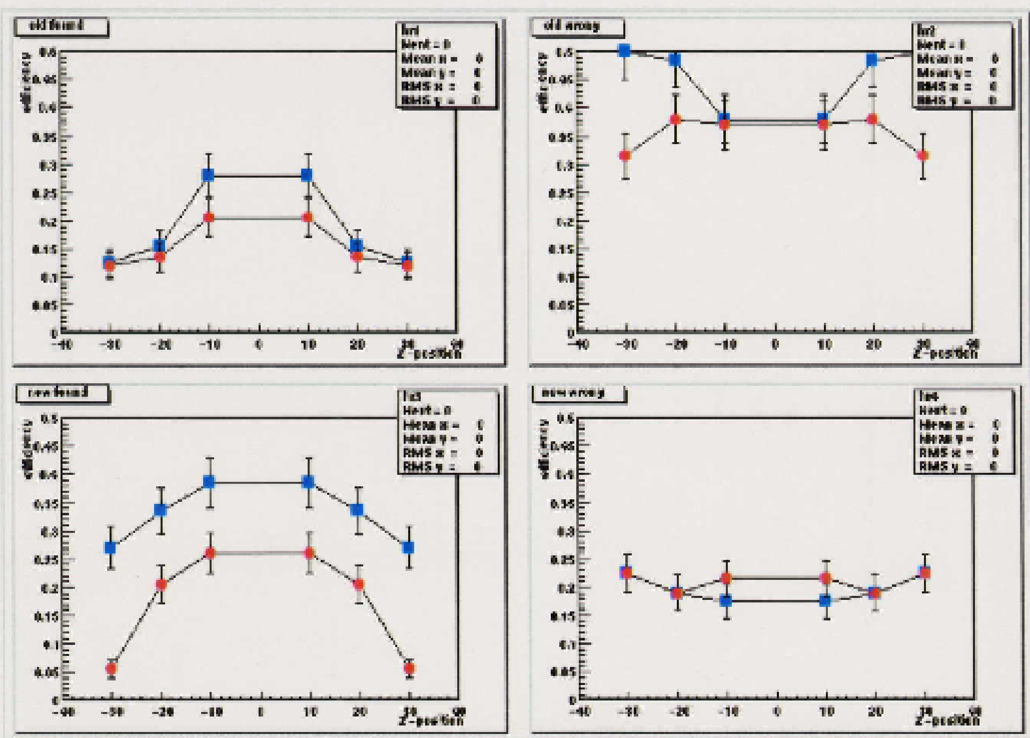
1. Vertex finding efficiencies for pp events (Ideal Case)

The following shows vertex finding efficiencies assuming perfect situation which is free from noises (or pedestals) and threshold cuts to remove those. Actually this is the best results we can get from MVD and two left plots are showing vertex finding efficiencies as a function of Z-position for configuration_1 (blue square) and configuration_3 (red circle). Two right plots are showing the probability of getting the wrong vertex due to the vertex finding algorithm. Two top plots are obtained by using old algorithm, in which vertex is found after projecting onto the Z-axies using two space points of all possible pairs of hits (one from the outer layer and the other from inner layer) and then choosing the most likely candidate as the vertex. Unfortunately, for pp events there are not many real hits in the outer layer of MVD and there are some background hits (probably beam related as we may not need to worry about noises in this case). It is possible for accidental pairs to form a wrong vertex and also is not easy for us to distinguish the real candidate from the background candidates as most of them have just one entry within some interval of Z. In the old algorithm, the one near the center is picked if there is no dominant candidate. In the new algorithm, each entry has some weighting factor calculated by the expected dE/dx for the pairs using the polar angle determined by (z2-z1) and (r2-r1). The two bottom plot are results after using the new algorithm. (To save time, positive points were copied from negative points.)



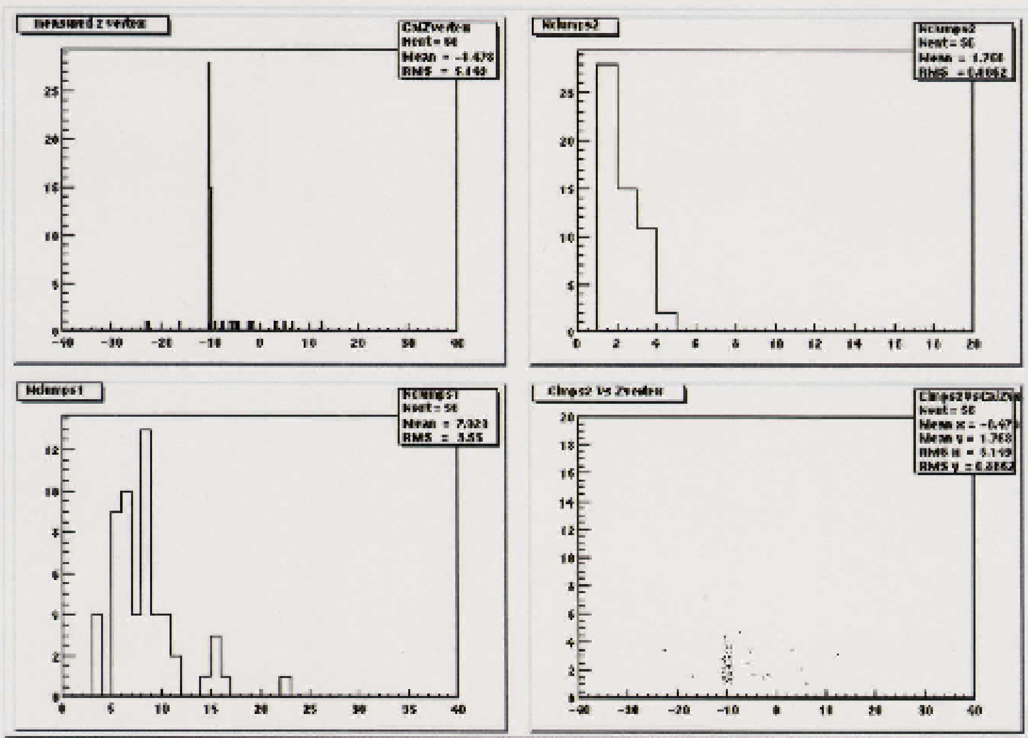
2. Vertex finding efficiencies for pp events (Realistic Case)

The following shows vertex finding efficiencies assuming realistic case having noises (or pedestals) and threshold cuts to remove the pedestals. 5 channels of pedestal width and 30 channels of average mip were assumed and then 3 sigma (5*3=15) cut to remove pedestals was applied. Those parameters are estimated by looking at the real data obtained from last run. Again, two left plots are showing vertex finding efficiencies as a function of Z-position for configuration_1 (blue square) and configuration_3 (red circle). Two right plots are showing the probability of getting the wrong vertex due to the vertex finding algorithm. Two top plots are obtained by using old algorithm which is already described in the previous page. In this case, we have more background hits from pedestals above the threshold and some times we lose real hits due to threshold cut (remember sharing of mip between adjacent strips for the tracks of smaller polar angle). Again two bottom plots are obtained after using the new algorithm. The most noticeable difference from the previous results is the probability of finding wrong vertices, which becomes much bigger especially when the old algorithm was used. By looking at the bottom left plot, the efficiencies for configuration_3 seem to little big compared to the ideal case (picking up more backgrounds?). Probably we may need to find a way to evaluate candidates using the values like confidence level. (Again, the positive points are mirror images of negative points. Accidentally, the last two points in the bottom left plot are the same for both configurations.)



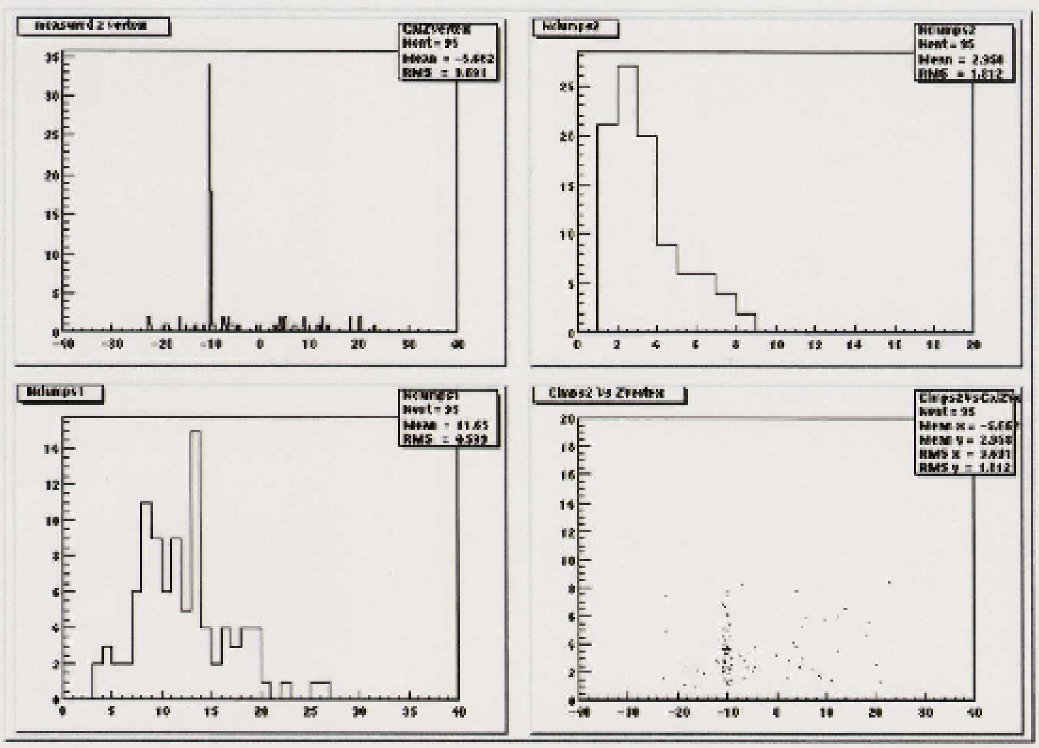
3. Vertices with number of clumps (Ideal Case)

200 events having vertex at z=-10cm were used to study vertex finding efficiencies for the perfect situation which is free from noises (or pedestals) and threshold cuts to remove those. Also configuration_3 was assumed for the year_2 MVD geometry. Top right plot shows measured vertices and we can see a clear peak at the expected z-position from which the vertex finding efficiency was calculated. We can also see some events whose vertices are different from the input value. Using those events the probability of finding wrong vertex was estimated. Top left and bottom left plots are showing number of clumps in the outer layer and inner layer respectively. Remember that outer barrel covers only 120 degree of azimuthal angle while inner barrel covers full azimuthal angle. Of course we need both layers for vertexing and bottom left plot may not be relevant at this moment except it can give us better idea for the total multiplicity distribution of pp events. Later on hits in the inner barrel could be used to estimate the confidence level of vertex candidate. The bottom right plot is the scatter plot for the number of clump size versus measured vertex. It is hard to tell the dependency on the multiplicity of hits in the outer layer.



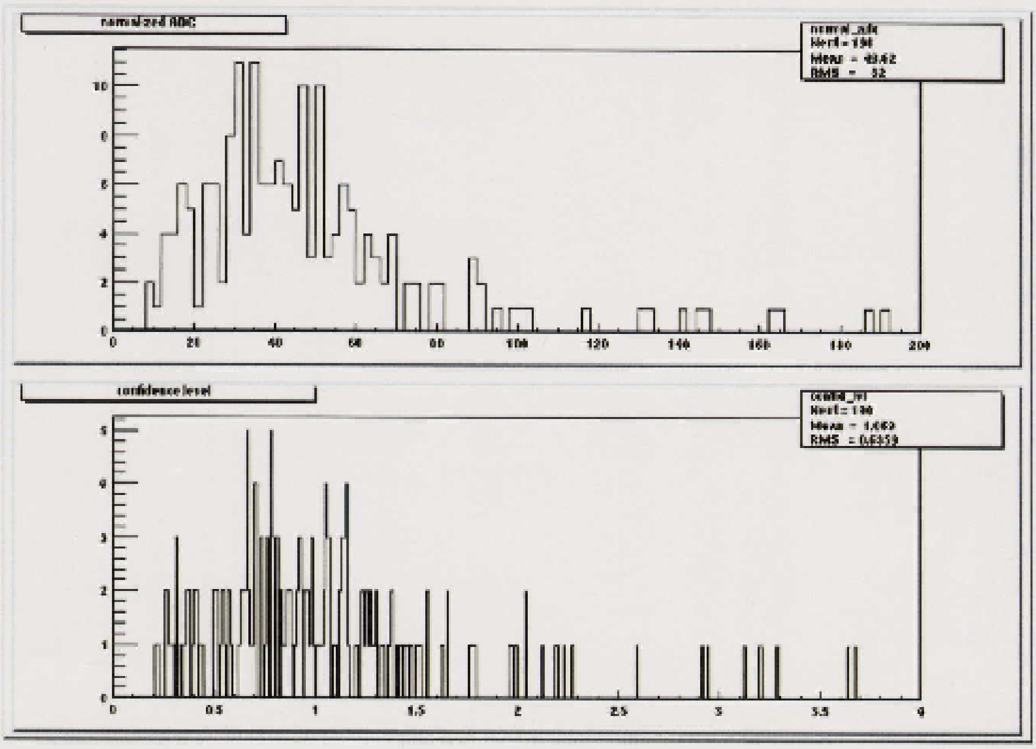
4. Vertices with number of clumps (Realistic Case)

In this case 200 events having vertex at z=-10cm were used to study vertex finding efficiencies for the realistic situation with noises (or pedestals) and threshold cuts to remove those. The same values as on the page 2 were used for noises, mip, and threshold cut. Also configuration_3 was assumed for the year_2 MVD geometry. Top right plot shows measured vertices and we can see a clear peak at the expected z-position from which the vertex finding efficiency was calculated. We can also see some events whose vertices are different from the input value. Using those events the probability of finding wrong vertex was estimated. Top left and bottom left plots are showing number of clumps in the outer layer and inner layer respectively. Remember that outer barrel covers only 120 degree of azimuthal angle while inner barrel covers full azimuthal angle. Compared to the previous results for ideal case, the number of clumps in both of outer and inner layer are increased as expected. Again, bottom right plot is the scatter plot for number of clump size in the outer layer versus measured vertex and it is hard to tell the dependency on the multiplicity of hits in the outer layer.



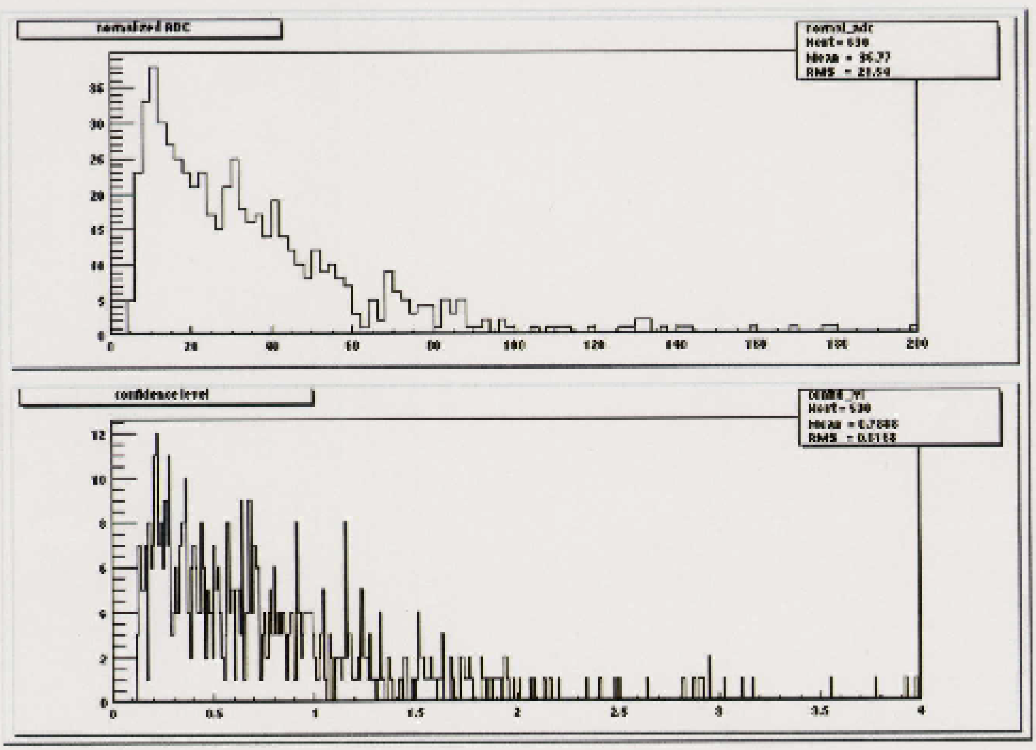
5. Normalized ADC distributions (Ideal Case)

The normalized ADC values was calculated after adding two ADC values of inner and outer hits (or clumps) which are making a vertex candidate, and then multiplying by cos(theta) to get the energy deposition expected for normally incident tracks. The mean value of about 50 is not much off from the expected value of 60 (=30*2) considering that background pairs are also included in this distribution. The top plot shows the normalized ADC distribution for perfect situation which is free from noises (or pedestals) and threshold cuts to remove those. The bottom plot is obtained after dividing by 45 to get some normalized number close to one, which can be used by the new vertex finding algorithm described on page 1 and 2. It was hoped that less fluctuating Landau distributions could be obtained by adding two very thin layers of silicon.



6. Normalized ADC distributions (Realistic Case)

The normalized ADC values which was described in the previous page was calculated for the realistic case with 5 channels of pedestal width, 30 channel of average mip, and 3 sigma (5*3=15 channels) of threshold cut. As we multiplied by cos(theta) to get the energy deposition corresponding to normally incident tracks, there are some ADC values below 15. Remembering the previous plot for the pure signals, we can easily find the second peak near 40 over the exponentially decreasing pedestals. Again the bottom plot is obtained after dividing by 45 to get some normalized number. Then pairs having this value greater than 0.6 were only counted as the vertex candidate and the entry was incremented by this number if the projected position is within some interval of Z. In the old algorithm, any pair giving projected position within certain interval was counted and the entry was just incremented just by one. Of course the interval having the biggest entry will be picked as the vertex. As many people already realize by now, this algorithm or even old algorithm is pretty much depend on the width of pedestal and average channel number for mip. Anyway, I have tried to used the best estimated values available at this moment.



7. Things to be tried later to get better results

I think we can improve MVD vertex finding performance by employing much more sophisticated weighting factor for the new algorithm. First, we can use a kind of maximum likely function obtained from the ADC distribution of pairs making a vertex candidate, instead of just monotonic increasing weighting factor used in the current version. And then we can explore the possibility of utilizing all the hits in the inner barrel which has much bigger coverage than the outer layer. Only about one third of the inner barrel is making overlap with the outer layer for the azimuthal coverage to find the vertex. Once we know the vertex position using pairs of hits in the overlapping region, we can estimate the expected ADC distribution for any hits in the MVD, including the region which has only one layer of barrel. Thus it is possible for us to utilize additional likely functions for each vertex candidate. Probably, to remove random noises, we may need to require the clump size of more than one. Of course, such modifications would require more efforts and also much more cpu time to find a vertex.