Cluster Counting Update

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Overview

Here I present recent results in the cluster counting efforts. Pulse rise time measurements have been obtained.
All results were obtained at high flow-rate (125cc/min) to reduce the effects of the gas leaks and with $70 : 30$ $He : CH_4$ gas. The impact parameter is 0mm, through 4 copper sheets.

The Algorithm

```
FOR EACH i IN timeidx:
 SmoothedVoltage(i) =
(Voltage(i-1)+Voltage(i)+Voltage(i+1))/3
 Deriv(i) = Voltage(i)-SmoothedVoltage(i-2)
 IF (Deriv(i) < Threshold)
 AND (Deriv(i-1) > Threshold):
 AND (Voltage(i-1) > Baseline+2*RMS):
 THEN NClusters = NClusters + 1
```

Special Attention

The first few voltage sames are removed because they frequently fluctuate, triggering the counting of a cluster.

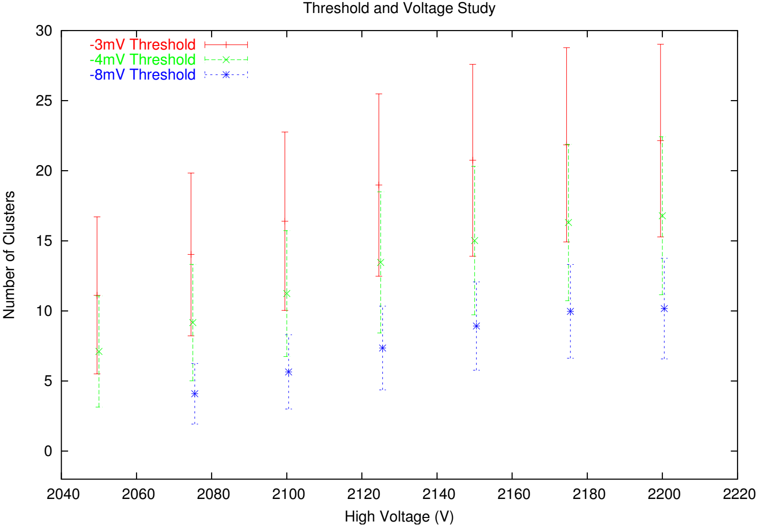
Similarly, the oscilloscope inputs often see large positive pulses which (on their trailing edge) trigger the algorithm. These are removed by the third requirement in the algorithm.

I will mostly show data from *run*0085 taken at 2075V. It has high statistics that allows better resolution of trends (34056 events). It is at relatively low voltage however, so I will also show data from *run*0090 taken at 2200V but which only has 2022 events. As you will soon see, the algorithm threshold was chosen to be -4mV.

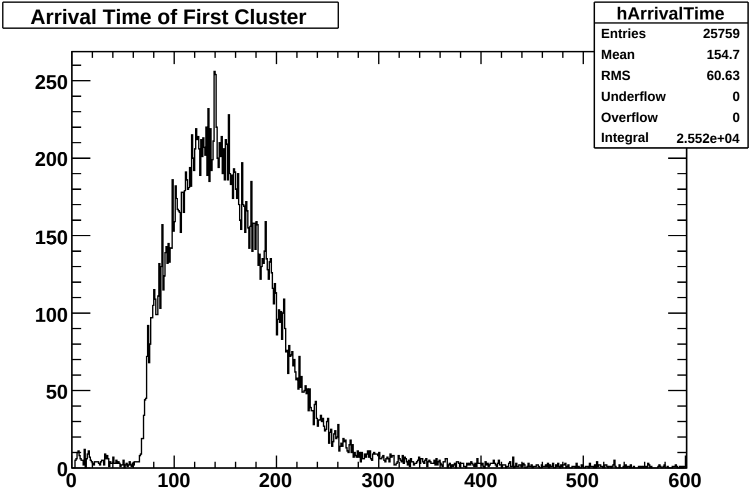
Baseline Acquisition

The median and RMS of the first 40 voltage samples are taken. The samples are 1ns wide. If the next 40 samples contain no wildly fluctuating values (more than 1 RMS away), then a new median and RMS is taken which now includes 80 samples. The process is repeated again until up to 120 samples are included. This determines the pre-triggering voltage baseline.

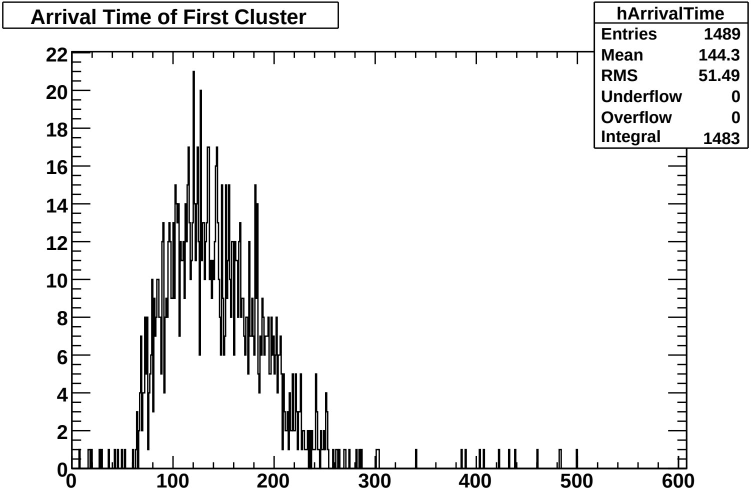
Number of Clusters Counted (excluding 0 clusters)



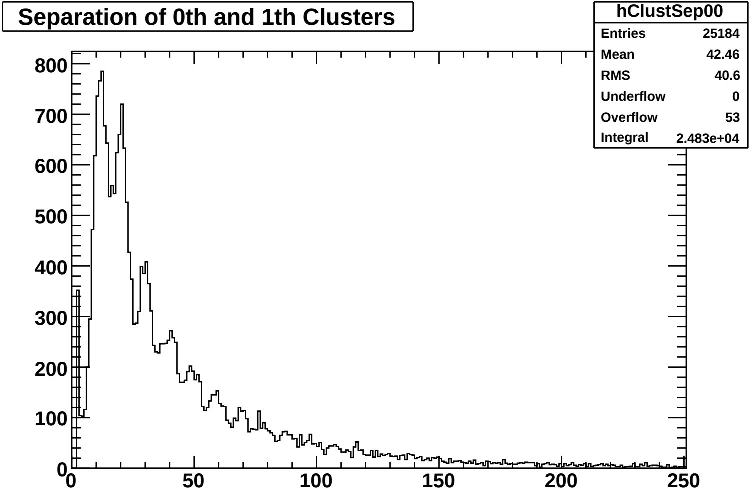
Arrival Time of First Cluster (2075V,-4mV



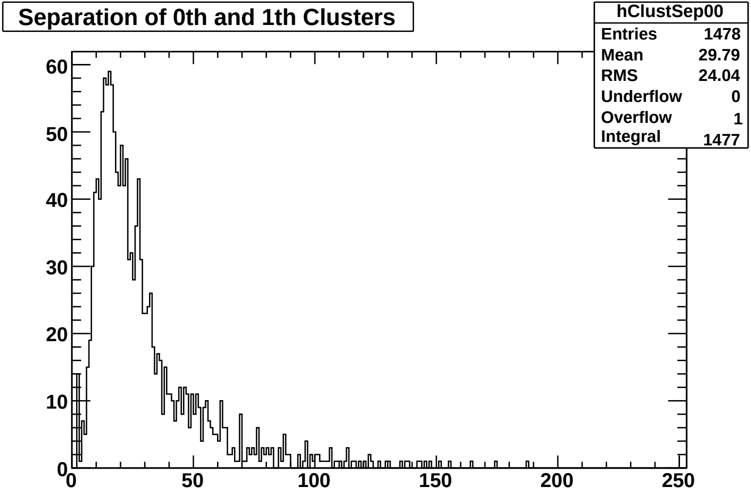
Arrival Time of First Cluster (2200V,-4mV



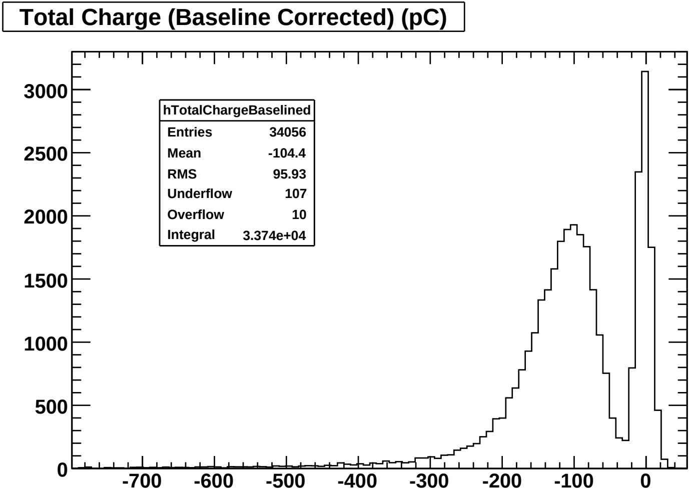
Cluster Separation (Echoes?) (2075V,-4mV)



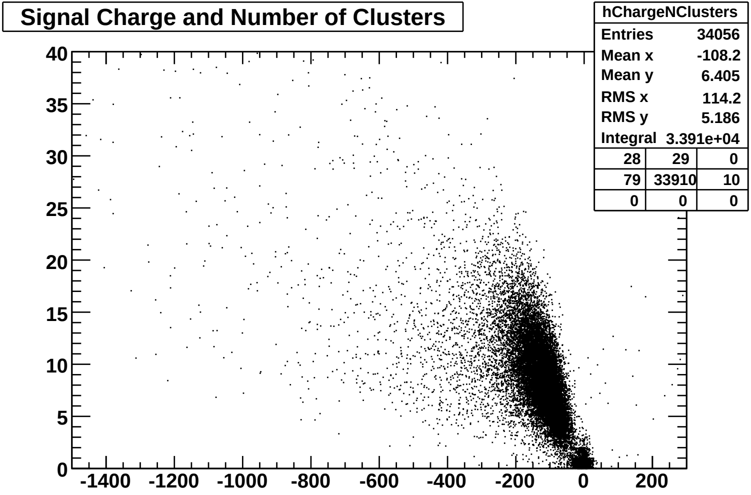
Cluster Separation (2200V,-4mV)



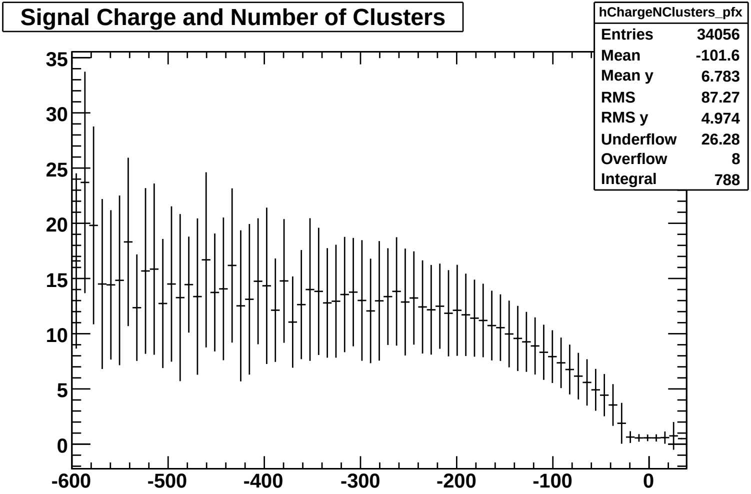
Charge of Signal (50Ω input) (2075V,-4mV)



Charge of Signal with Clusters Counted (2075V,-4mV)

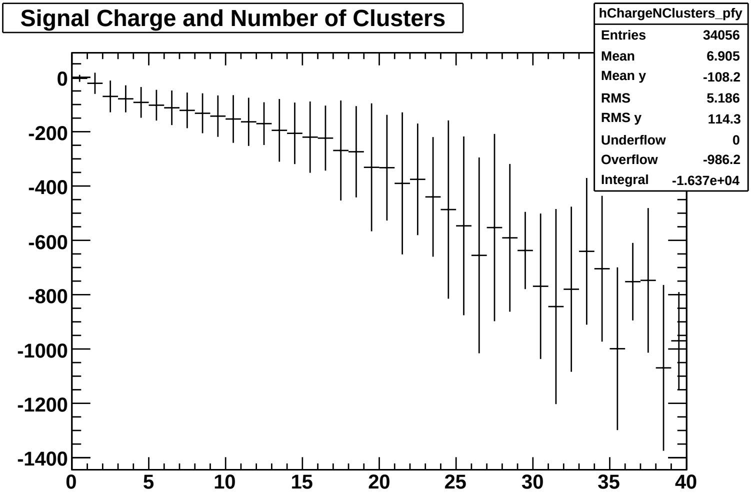


Charge of Signal with Clusters Counted (Profile) (2075V,-4mV)



This result is encouraging. It indicates that for large-charge signals, the individual clusters are simply larger (assuming that we are counting all of them). It could also indicate that for the large-charge signals, the clusters become more difficult to count.

Charge of Signal with Clusters Counted (Profile) (2075V,-4mV)



Pulse Rise Time

Standard measurement of rise time is 10%-90% of the peak amplitude from the baseline level. The arrival time is required to be more than 5ns to ensure good clusters. The algorithm finds the "shortest possible" rise time when ambiguities occur due to segmentation. The peak amplitude is simply the largest voltage reading between the arrival time of the first cluster and the second cluster (or the end of the trace, if only 1 cluster is found).

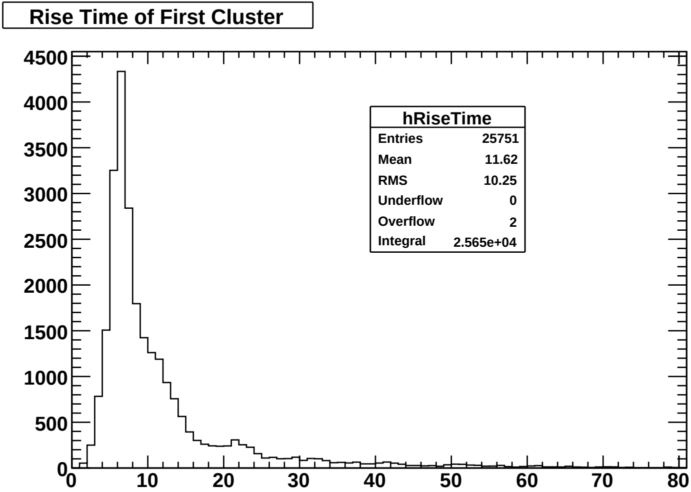
Rise Time Algorithm

Starting from the peaking time, the algorithm searches backwards for the first sample which is less than 10% of the peak-baseline amplitude. This is $t10$.

Starting from $t10$ and searching forwards, the algorithm finds the first sample which is greater than 90% of the peak-baseline amplitude. This is $t90$.

The rise time is $t90 - t10$.

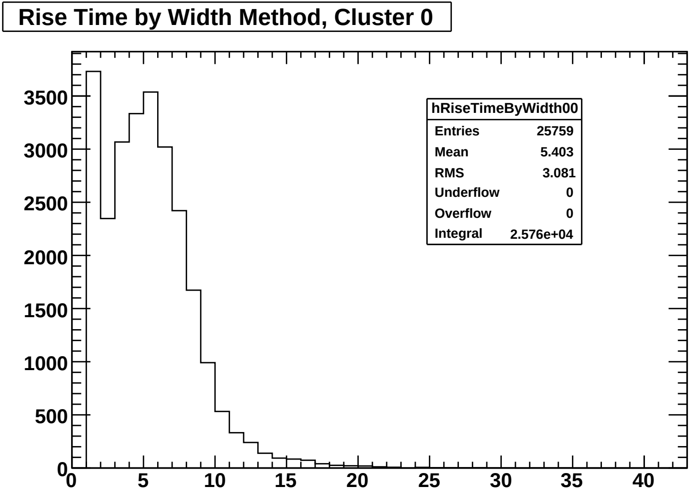
Rise Time (2075V,-4mV)



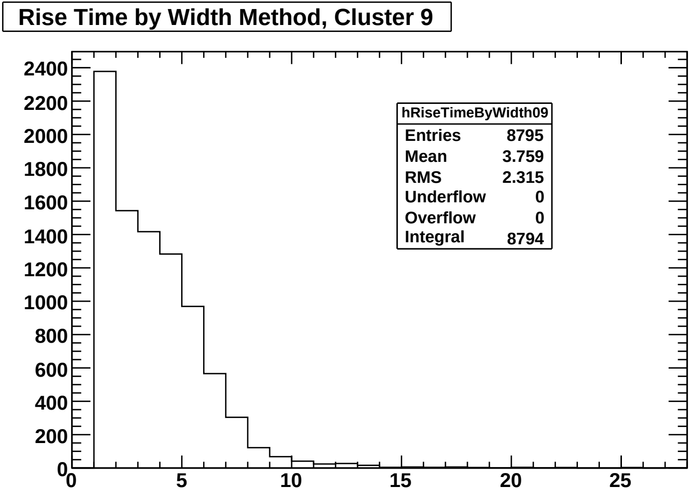
Rise Time by Width Method

Since we identify clusters by a downward-crossing of a threshold of $\frac{dV}{dt}$, we can also use this to identify the "steep part" of a pulse. By simply counting the time spent below the threshold, we can estimate the rise time. An advantage is that this method does not require a careful baseline acquisition and can be done for each cluster, not just the first one. A disadvantage is that this is a non-standard definition of the rise time of a pulse, and may not be well-founded.

Rise Time of 0th Cluster by Width (2075V,-4mV)



Rise Time of 1st Cluster by Width (2075V,-4mV)



Conclusions

The "width" method for rise time gives more favourable results, for this reason we should be very suspicious.
There appears to be ringing in the aparatus, showing up in the cluster separation histograms. This only appears once a large number of events (20k instead of 2k) have been recorded. We will perform a high-statistics run at the higher voltage to confirm.