Fitting algorithm for Coincidence histograms in Offline

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IIHE-ULB

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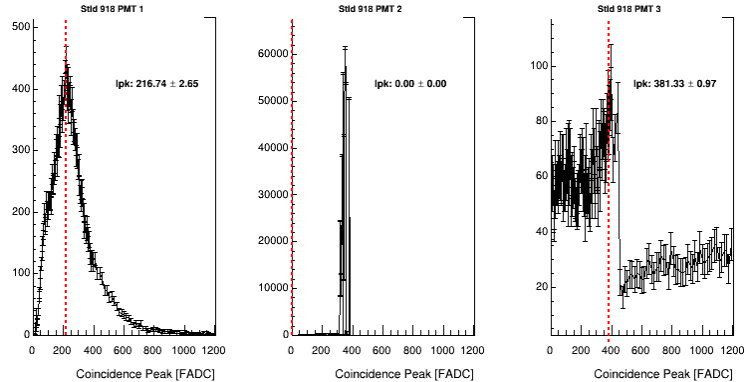
How to fit the coincidence histograms?

Let's start with height coincidence histograms, and fitting a second order polynomial

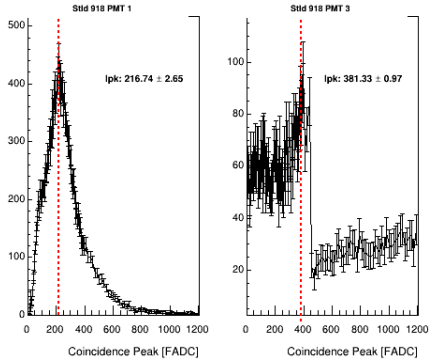


So, the first task is to identify wrong height coincidence histograms.

Identifying wrong height coincidence histograms

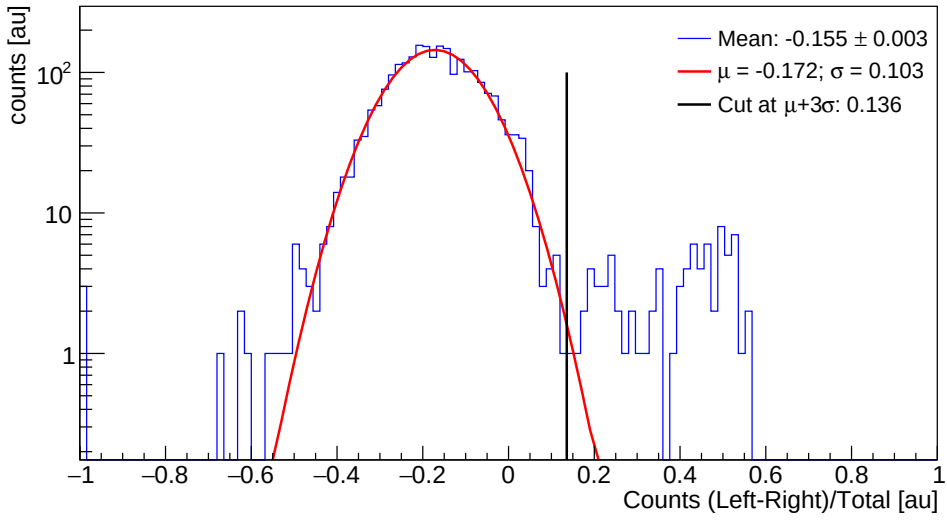
Using the symmetry of the coincidence histograms

- Find the bin with the maximum of counts (binMax)
- From bin 25 until 100 (beginning of big-bins), counts the number of entries leftward and rightward, respect the binMax.
- Plot the distribution of (EntrLeftward-EntrRightward)/TotEntr.



Identifying wrong coincidence height histograms: results

Using the symmetry of the height coincidence histograms



Setting the properly range to fit height coincidence histograms

Using the symmetry of the height coincidence histograms

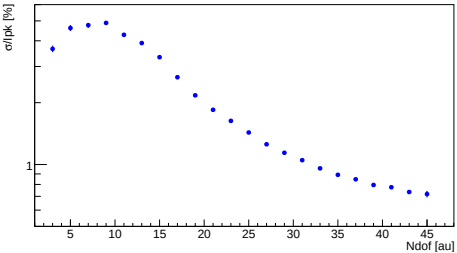
- Find the bin with the maximum of counts (binMax)
- From binMax, fit a second order polynomial from binMax - n to binMax + n.
- Check for the distribution of χ^2, error of fit as a function of the number of degree of freedom.

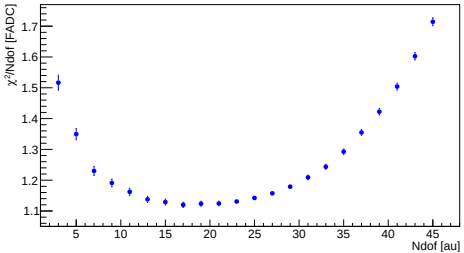
A temporary algorithm was implemented in the SdHistogramFitterKGB.cc module in order to find the best range:

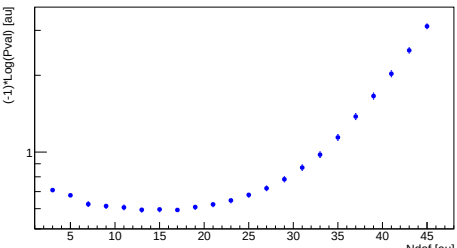
```
if ( cntsLeft-cntsRight/totCnts < 0.14 ) {
  for ( int nFADC=8; nFADC<100; nFADC+=4 ) {
    [...]
    MakeQuadraticFitter(coinciPeakHisto, binMax - nFADC, binMax + nFADC).GetFitData(qf);
    [...]
  }
}
```

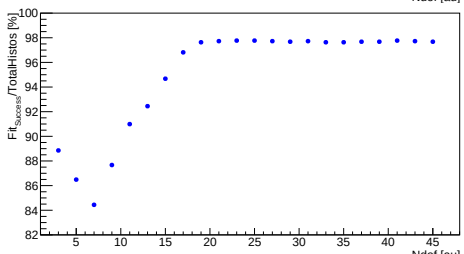
Setting the properly range to fit height coincidence histograms: results

Using the symmetry of the height coincidence histograms





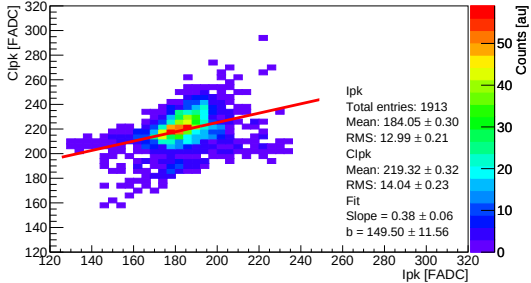


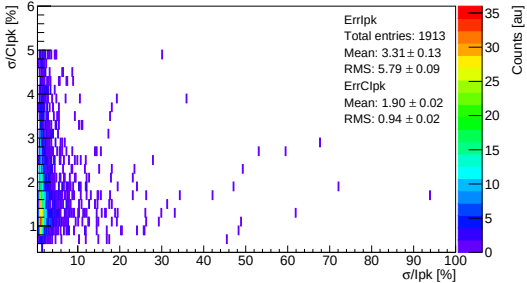


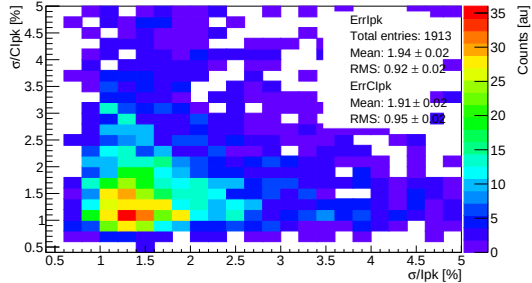
Algorithm to fit height coincidence histograms

1. Find the bin with the maximum of counts (binMax)
2. From binMax, fit a second order polynomial to range: binMax-44 (44 is equivalent to 19 Ndof).
3. Check if the previous range fulfill that: $\sigma/\text{Ipk} < 0.05$ and $\chi^2/\text{Ndof} < 2.0$
4. If not, steps 2 and 3 are repeated for the range: binMax-48.
5. The steps 2 and 3 are repeated until for some range the step 3 is fulfilled or until the final range of binMax-80 is reached. If it is the last case, so Ipk gets zero.

Results for height pulse histograms

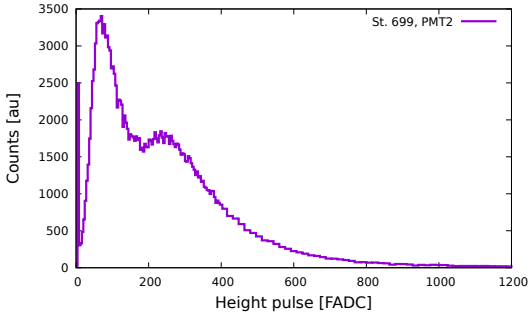


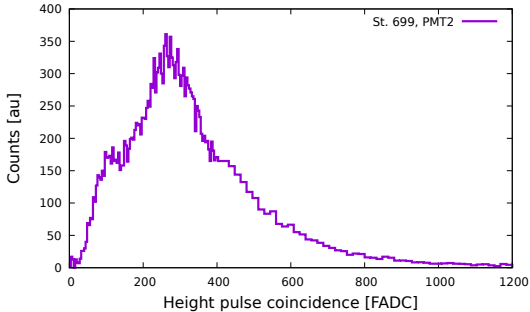




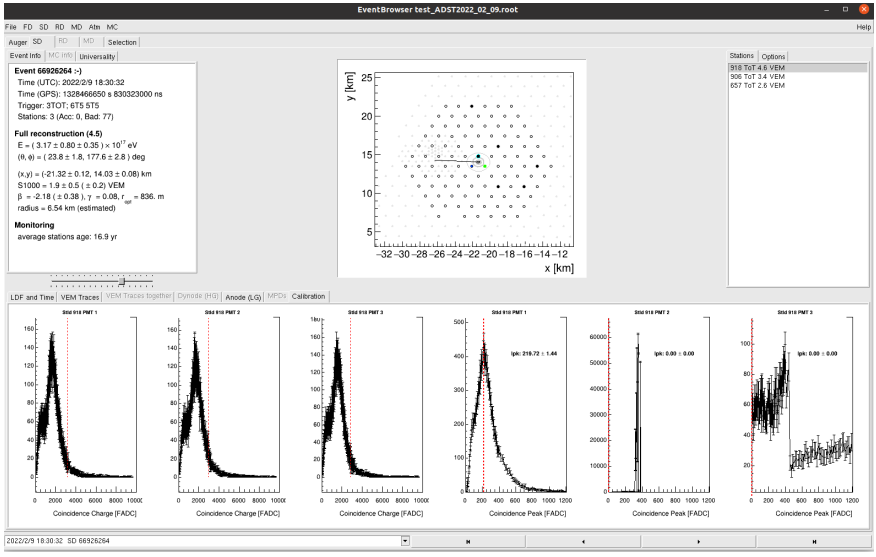
Results for height pulse histograms

Outliers





Algorithm to fit height coincidence histograms: results



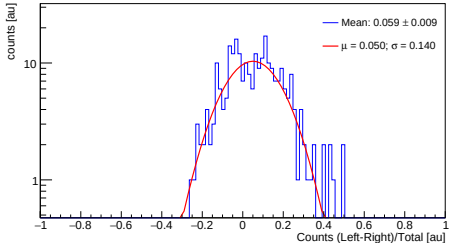
Doing for charge coincidence histograms

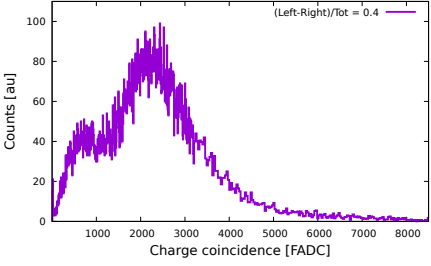
Checking for wrong charge coincidence histograms

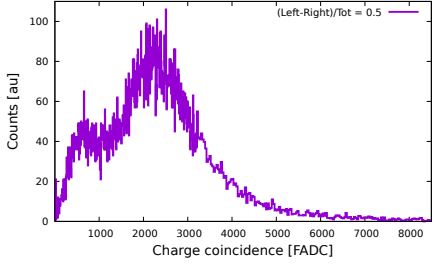
Using the symmetry of the coincidence histograms

- Find the bin with the maximum of counts (binMax)
- From bin 25 until 100 (beginning of big-bins), counts the number of entries leftward and rightward, respect the binMax.
- Plot the distribution of (EntrLeftward-EntrRightward)/TotEntr.

Checking for wrong charge coincidence histograms: results







Not wrong charge coincidence histograms, as there are for pulse height ones.

Setting the properly range to fit charge coincidence histograms

Using the symmetry of the charge coincidence histograms

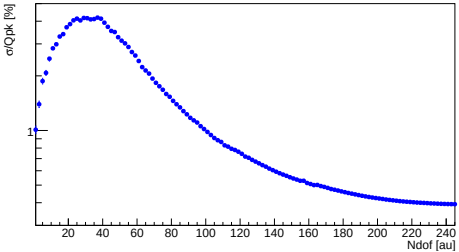
- Find the bin with the maximum of counts (binMax)
- From binMax, fit a second order polynomial from binMax - n to binMax + n.
- Check for the distribution of χ^2, error of fit as a function of the number of degree of freedom.

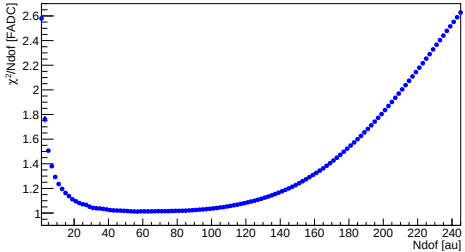
A temporary algorithm was implemented in the SdHistogramFitterKGB.cc module in order to find the best range:

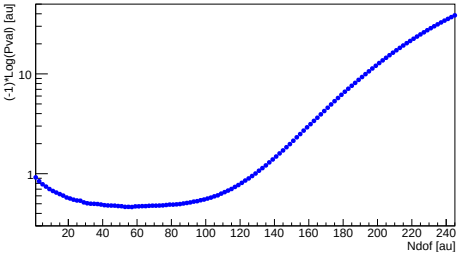
```
for ( int nFADC=16; nFADC<1000; nFADC+=8 ) {
  [...]
  MakeQuadraticFitter(coinciChargeHisto, binMax - nFADC, binMax + nFADC).GetFitData(qf);
  [...]
}
```

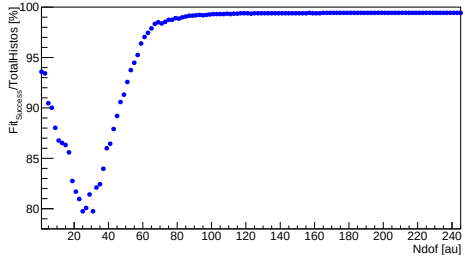
Setting the properly range to fit charge coincidence histograms: results

Using the symmetry of the height coincidence histograms





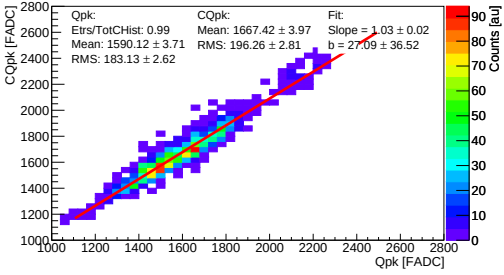


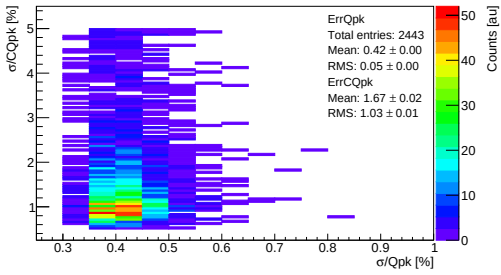


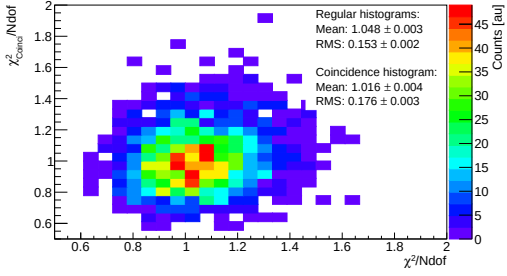
Algorithm to fit charge coincidence histograms

1. Find the bin with the maximum of counts (binMax)
2. From binMax, fit a second order polynomial to range: binMax-296 (296 is equivalent to 71 Ndof).
3. Check if the previous range fulfill that: $\sigma/\text{Ipk} < 0.05$ and $\chi^2/\text{Ndof} < 2.0$
4. If not, steps 2 and 3 are repeated for the range: binMax-304.
5. The steps 2 and 3 are repeated until for some range the step 3 is fulfilled or until the final range of binMax-496 is reached. If it is the last case, so Ipk gets zero.

Results for charge coincidence histograms

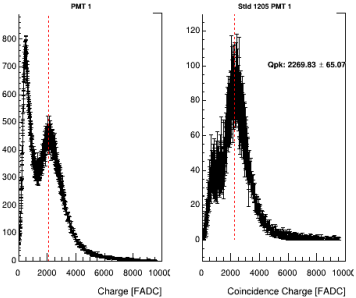






Results for charge coincidence histograms

Outliers



Event 66926832 :-)
Time (UTC): 2022/2/9 19:37:52
Time (GPS): 1328470690 s 873134000 ns
Trigger: 3TOT & 4C1; 6T5 5T5
Stations: 8 (Acc: 2, Bad: 6)

Full reconstruction (4.5)
$E = (3.31 \pm 0.38 \pm 0.13) \times 10^{18}$ eV
$(\theta, \phi) = (58.4 \pm 0.4, 250.7 \pm 0.4)$ deg

(x,y) = (-9.78 ± 0.06, 14.93 ± 0.12) km
S1000 = 9.1 ± 1.0 (± 0.3) VEM
β = -1.63 (± 0.29), γ = -0.01, r_{opt} = 921. m
radius = 14.16 ± 1.90 km

Monitoring
average stations age: 14.3 yr