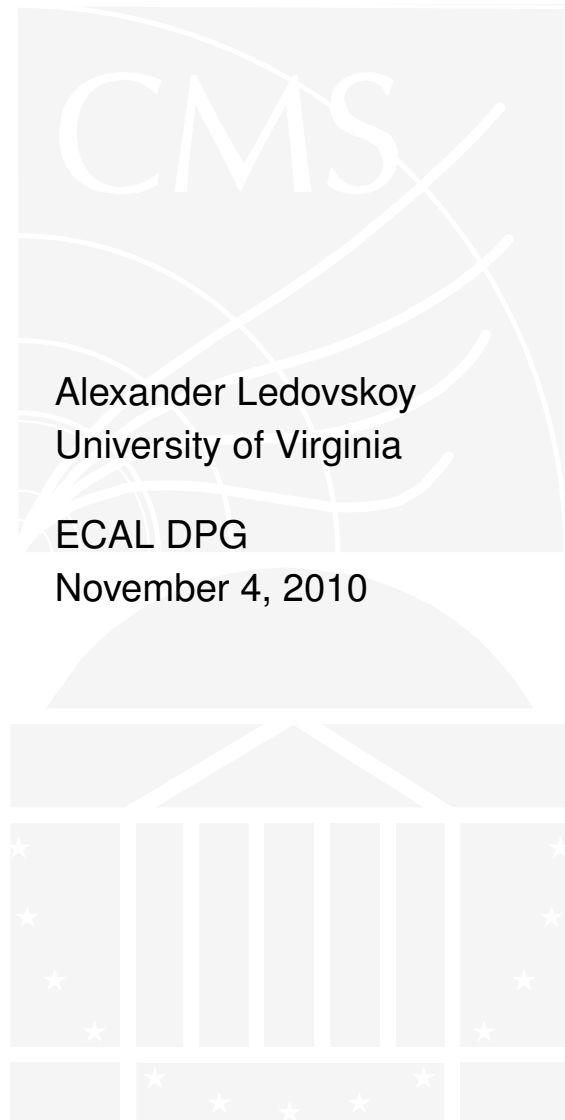


Ratio Method and MGPA non-linearity

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University of Virginia

ECAL DPG

November 4, 2010



Problem in time reco at high amplitudes

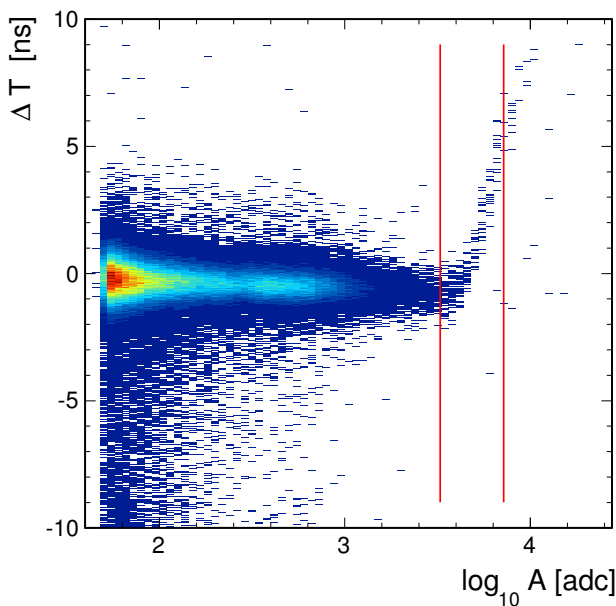
Hits from /Electron/Run2010B-EGMWZFilter-v2/RAW-RECO

Hit time vs hit amplitude

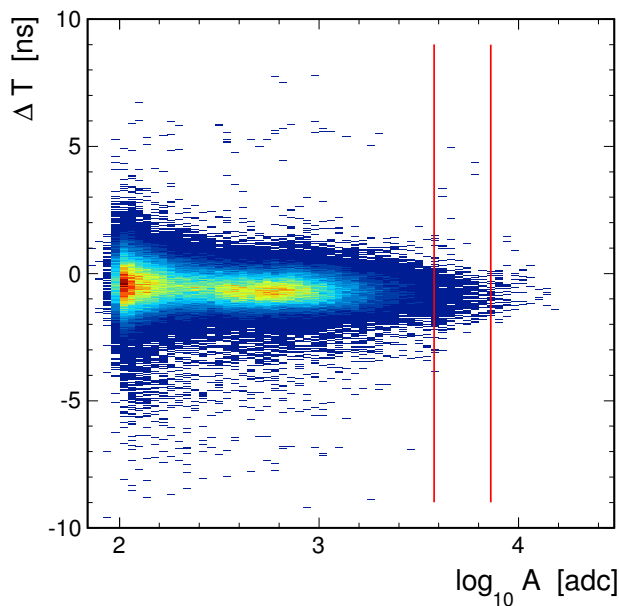
Red lines correspond to gain-switching amplitudes (approx)

Problem is in EB only

EB



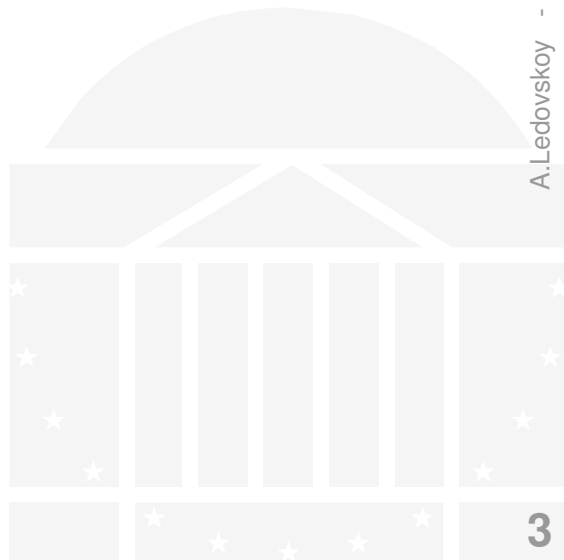
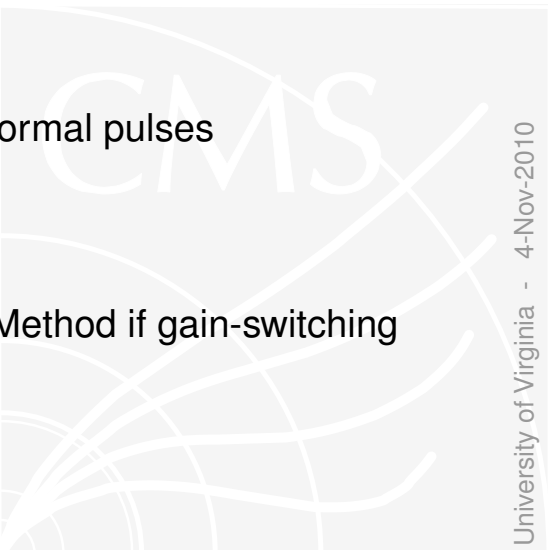
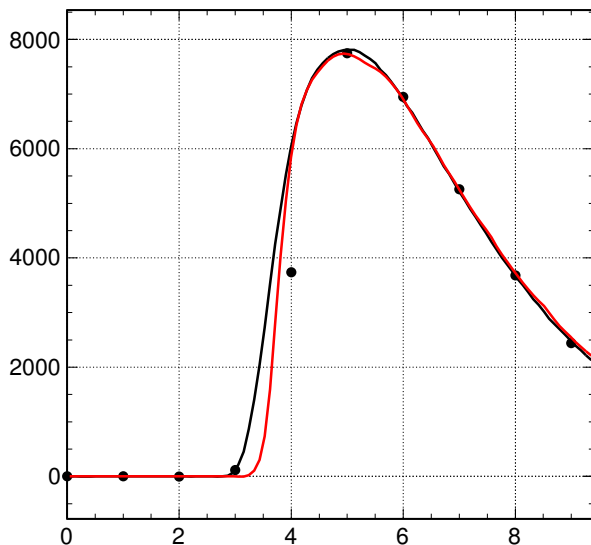
EE



Pulse-shape analysis confirms distortions for normal pulses
See more details in Appendix

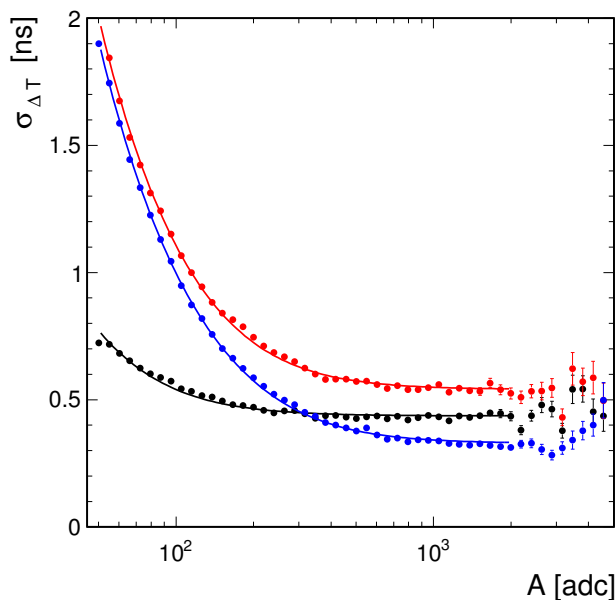
Approach:

Exclude sample on the rising edge from Ratio Method if gain-switching takes place.



Comparing reco with and without 5th sample

Increase $\times 3$ in noise term results in < 100 ps contribution at higher gains
There is also ~ 0.33 ns contribution as a constant term



Default Reco: T_{def}

Reco without 5th sample: T_{5th}

Distribution $T_{def} - T_{5th}$

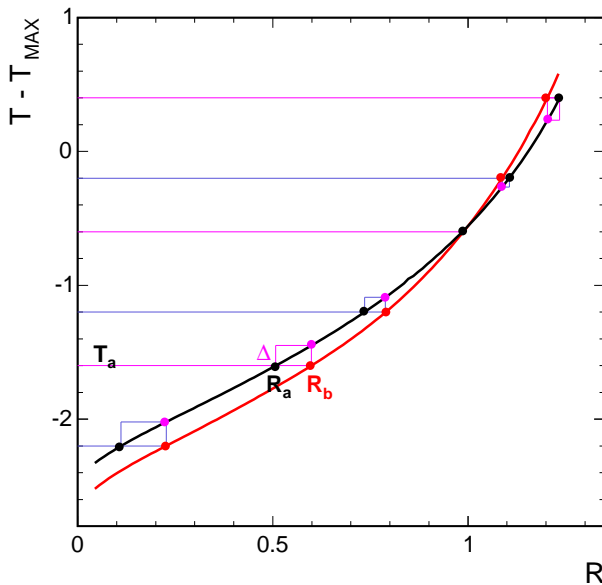
	N [ns]	C [ns]
default	31.8 ± 0.1	0.436
without 5th	96.4 ± 0.2	0.540
difference	94.1 ± 0.2	0.328

Systematics due to pulse shape

Difference between true (blue) and used (red) pulse shapes results in bias Δ for each ratio (R_b)

Default reco: Sum of three ratios (magenta horizontal lines)

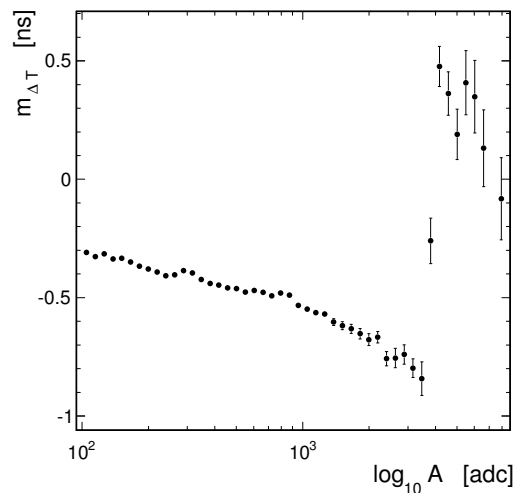
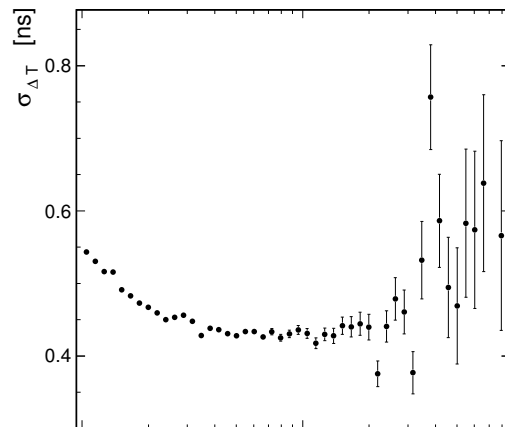
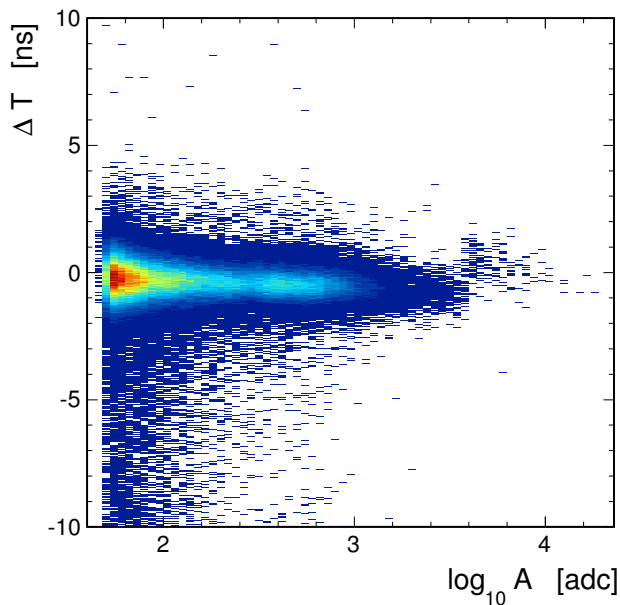
New reco: take R_b out, sum of two other ratios, new bias



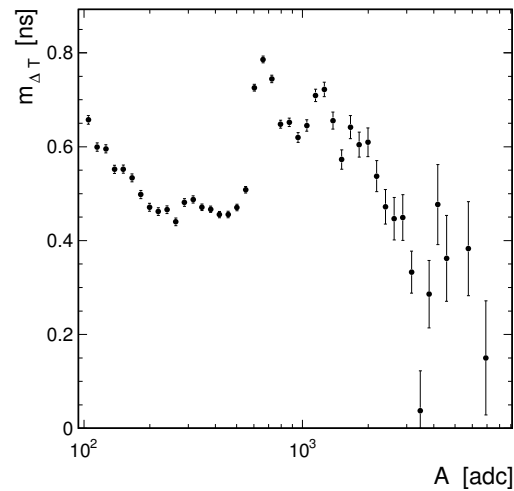
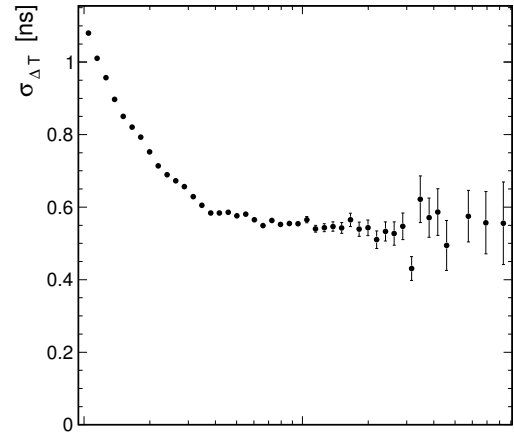
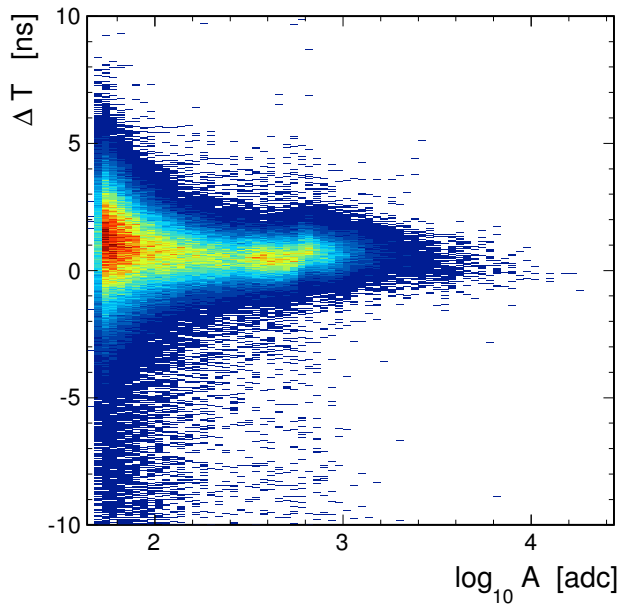
do not use a sample just before the
gain switch down

$\sigma_{\Delta T}$ from ~ 0.45 ns to ~ 0.6 ns as
expected from C term

m shift of ~ 1 ns, need recalib.



Calibration without 5th sample
using all hits at all gains. To be
used at gain switch only.



summary so far

- EE is fine at gain switching, only EB is affected
- Don't use sample just before gain switch. Increase time window to accommodate new bias of $\sim 1 \text{ ns}$ or...
- ...use second set of time calibration (without 5th sample) to reduce time window or ...
- ...solve the problem on algorithm level

What is the problem?

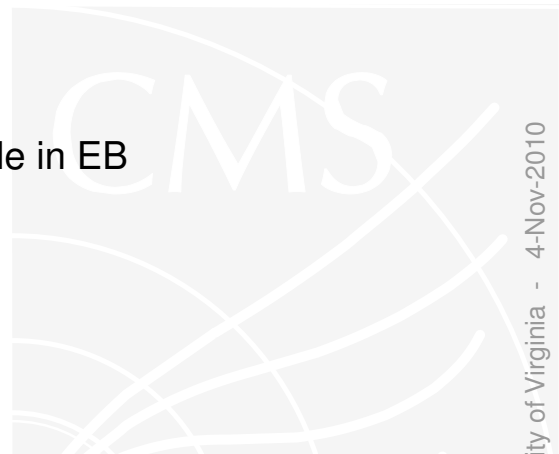
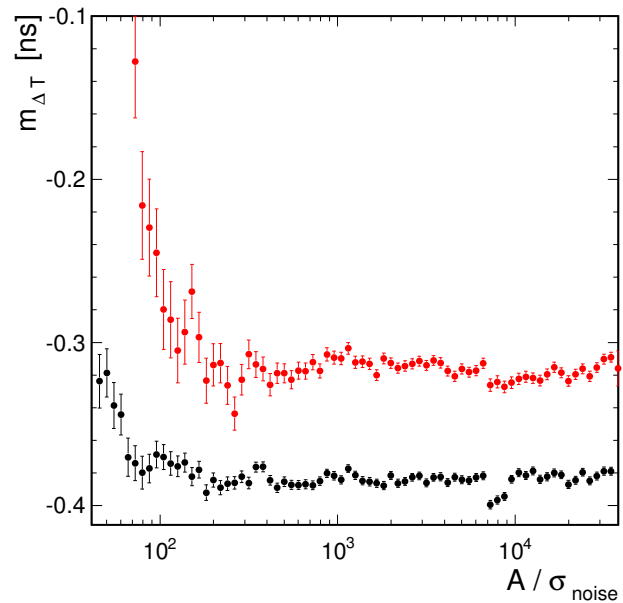
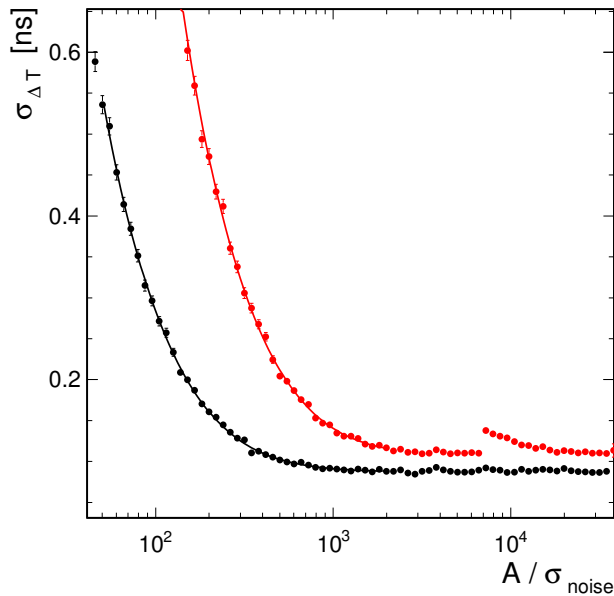
Using ToyMC I managed to reproduce bias vs amplitude. It is due to mismatch true and reco pulse shapes

CMS

ToyMC simulations

comparison of reco with and without 5th sample in EB

	N [ns]	C [ns]
default	27.0 ± 0.1	0.087
without 5th	91.6 ± 0.4	0.106



next steps

- **Eliminate average bias**

Measure average pulse shape for EB and EE using data from r/o scan

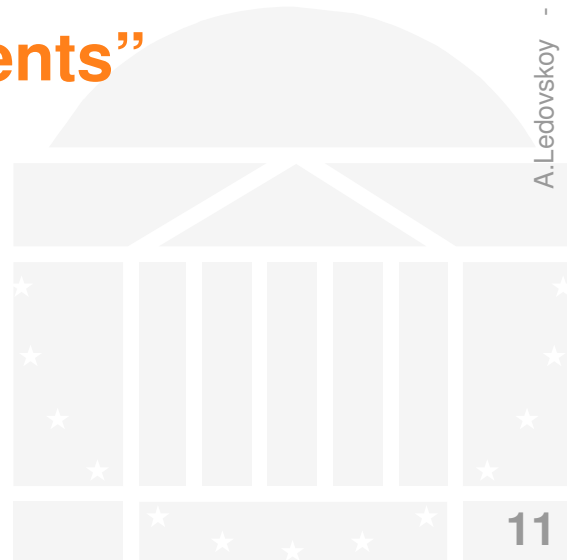
- **Reduce effect due to channel-to-channel variations**

Since MC reproduces the effect, it give a possibility to optimize Ratio Method algorithm.

CMS

Appendix

“Seventeen Events”



overview

There are 24 hits with amplitude above 2000 ADC in seventeen events from */uscms_data/d2/chiyoung/work/dijet_3_8_3/7TeV/Oct8th/383_ECAL_study/17_events_raw.root*
There is at least one such hit in each event.

The goal of this study is to determine whether a hit has spike or scintillation origin based on pulse shape information. The conclusion of this analysis is the following: none of these hits are spikes; all 24 pulses have shapes consistent with normal scintillation pulses resulting from in-time hits.

The other goal of this study is to observe the behavior of 5th sample as a function of pulse amplitude. This samples is on the rising edge of the pulse. It is observed that the higher the pulse amplitude the greater the deviation of the 5th sample from expected amplitude.

CMS

fits

All time samples, except the 5th one, from each pulse were fitted with *normal* and *spike* pulse shape (see my presentation at ECAL DPG on 26-Aug-2010). Pedestal values from *gainID*=1 were calculated as an average of first three samples. Pedestal values for *gainID*=2,3 were assumed 200 ADC. The fit has two parameters, A_{max} and T_{max} .

spike or normal?

This decision is based on two considerations:

1. comparison of χ^2 for *normal* and *spike* shapes. However, the quality of the fit also depends on assumption of pedestal at higher *gainID*s.
2. Amplitude of the 4th sample

in-time or not?

This decision is also based on two considerations:

1. T_{max} for *normal* fit. Again, the quality of the fit depends on pedestal assumptions.
2. Timing of the *normal* shape at 4th sample.

analysis of individual hits

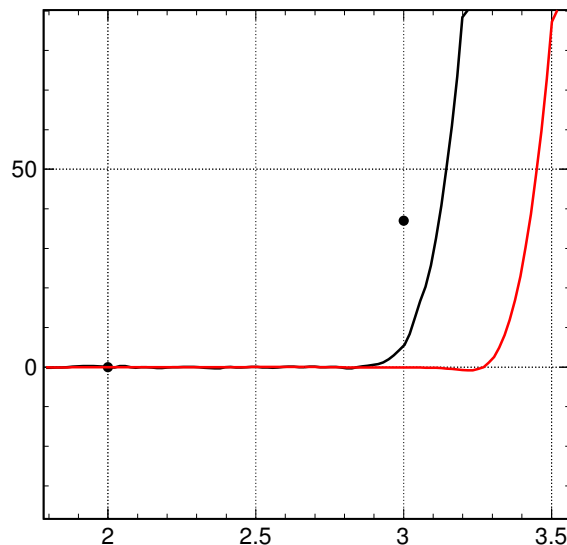
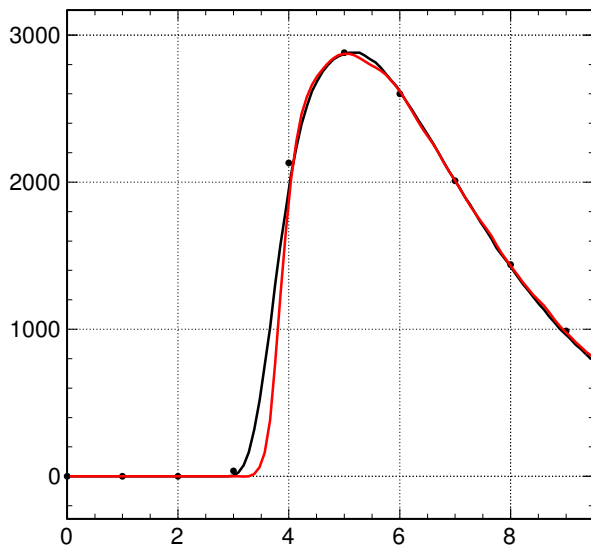
The following slides present details of the analysis. One slide per hit. The following information is presented on a slide:

- Top left. A table with run number, event number, and electronic coordinates of the hit: FED, Tower, VFE (slot) and channel
- Top right. Fit results: χ^2 for *spike* and *normal* shapes, T_{max} and A_{max} for *normal* fit
- Middle row: Ten samples *gainID:ADC*
- Bottom left: A plot with 10 samples (dots) and *normal* fit (black) and *spike* fit (red)
- Bottom right: Same plot as on the left, zoomed in on 4th sample

Run	1 40385
Event	95355808
FED	614
Tower	16
Strip	2
Chan	5

chi2 Spike	1885.89
chi2 Norm	2220.89
Tmax	5.15
Amax	2.88257e+03

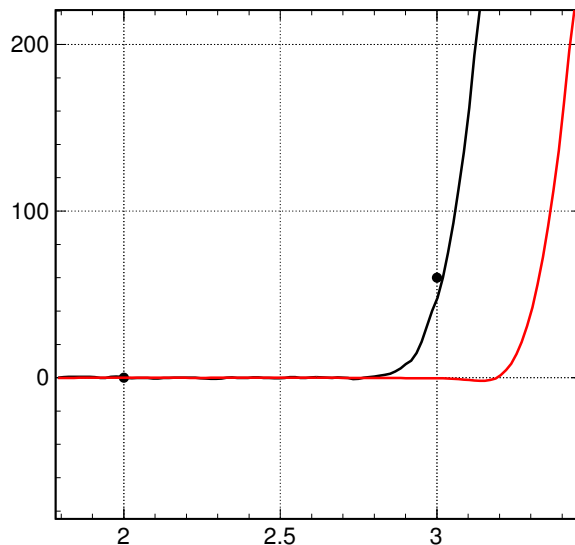
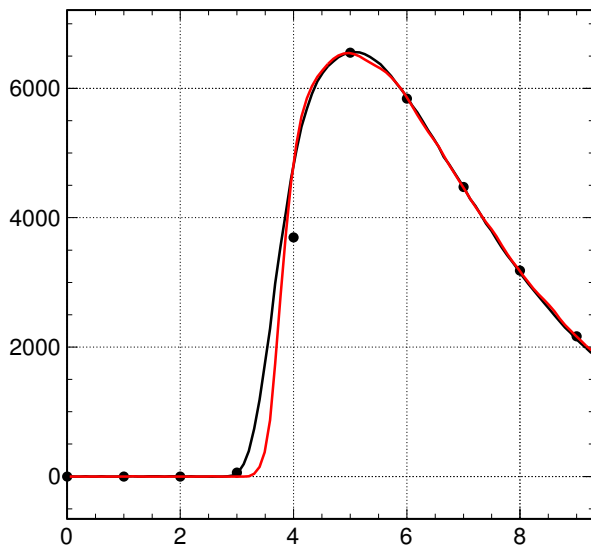
1:201 1:201 1:201 1:238 1:2332 1:3081 1:2802 1:2211 1:1641 1:1189



Run	140385
Event	95355808
FED	623
Tower	52
Strip	3
Chan	2

chi2 Spike	3801.73
chi2 Norm	1010.52
Tmax	5.08
Amax	6.56098e+03

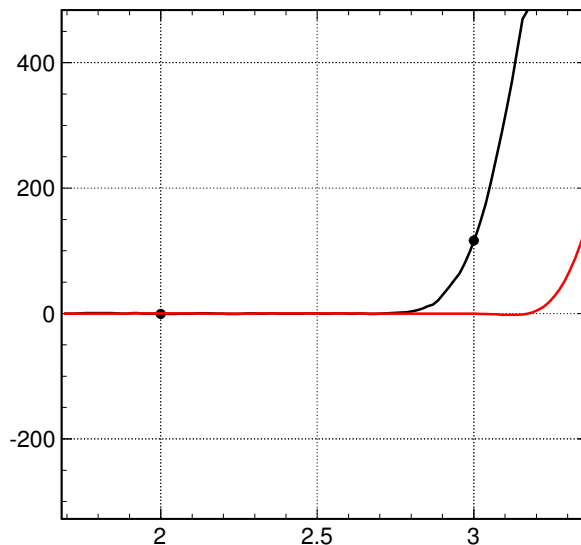
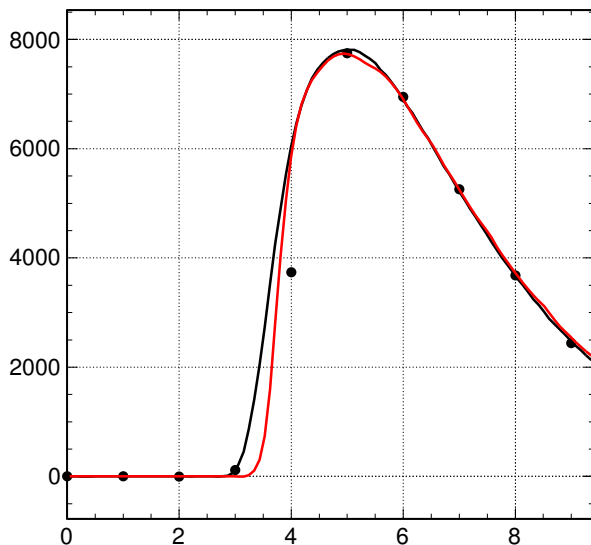
1:200 1:200 1:200 1:260 1:3895 2:3541 2:3179 2:2481 2:1822 2:1305



Run	142035
Event	121356067
FED	615
Tower	67
Strip	5
Chan	1

chi2 Spike	13748.4
chi2 Norm	83.07
Tmax	5.02
Amax	7.81641e+03

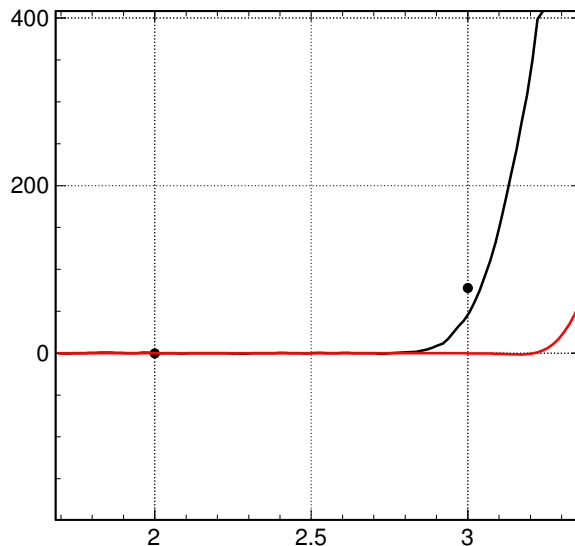
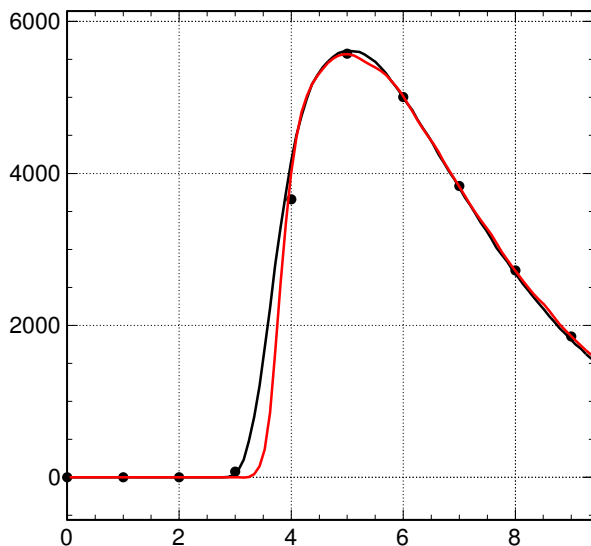
1:201 1:201 1:200 1:317 1:3938 3:928 3:855 3:701 3:557 3:444



Run	142663
Event	106929662
FED	614
Tower	61
Strip	2
Chan	4

chi2 Spike	6115.29
chi2 Norm	2198.99
Tmax	5.07
Amax	5.61392e+03

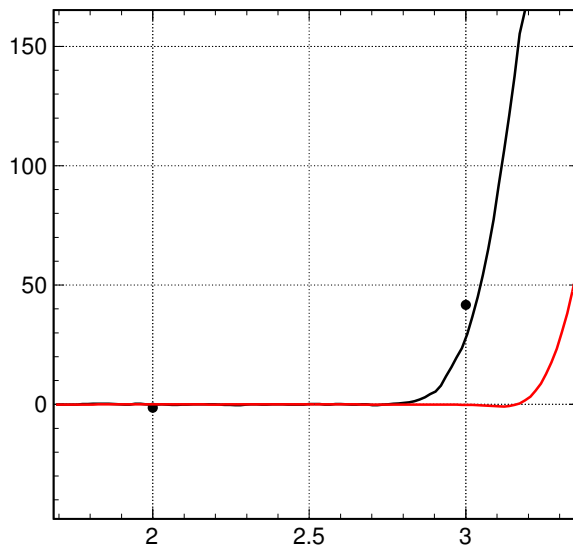
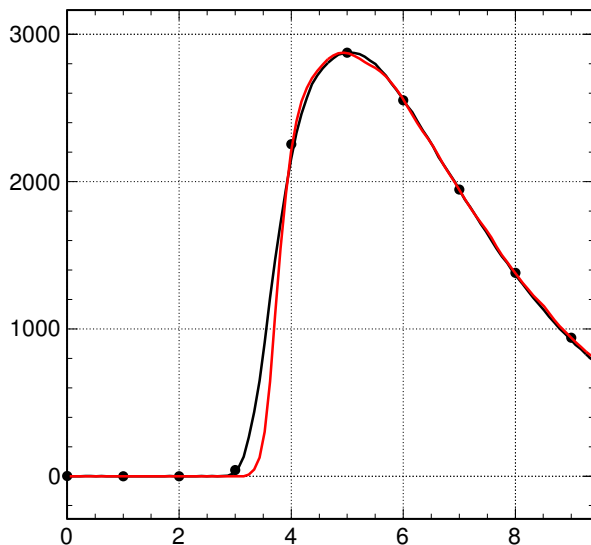
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Run	142663
Event	106929662
FED	614
Tower	61
Strip	2
Chan	5

chi2 Spike	1818.2
chi2 Norm	661.3
Tmax	5.05
Amax	2.87699e+03

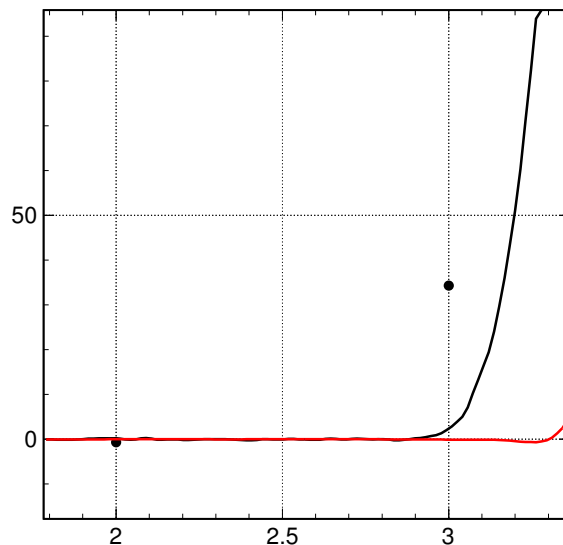
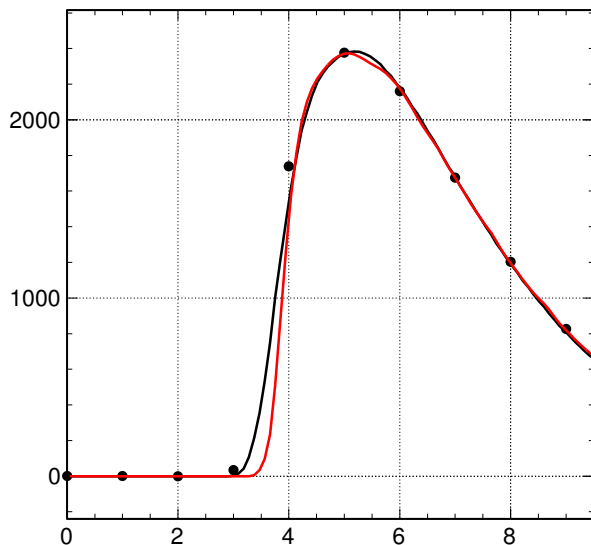
1:207 1:205 1:204 1:247 1:2460 1:3081 1:2757 1:2152 1:1587 1:1146



Run	142928
Event	162151278
FED	642
Tower	45
Strip	2
Chan	4

chi2 Spike	1589.19
chi2 Norm	1942.34
Tmax	5.19
Amax	2.38321e+03

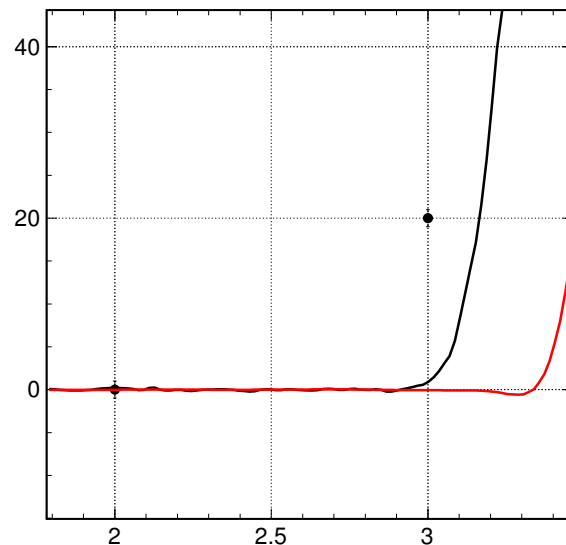
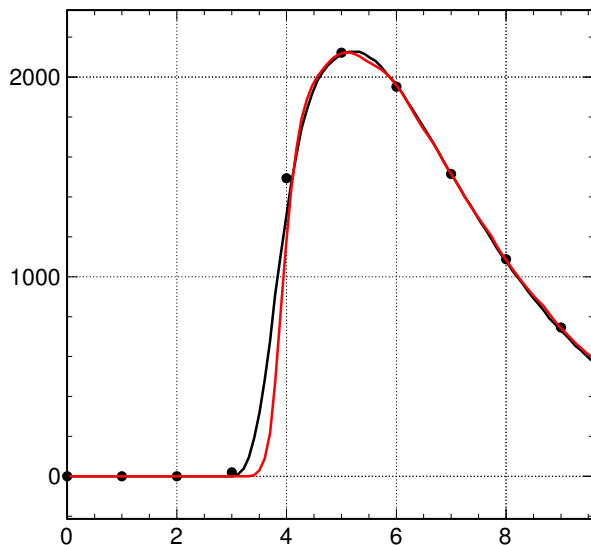
1:211 1:211 1:210 1:245 1:1950 1:2587 1:2371 1:1886 1:1414 1:1037



Run	142928
Event	162151278
FED	642
Tower	61
Strip	2
Chan	1

chi2 Spike	509.02
chi2 Norm	767.69
Tmax	5.22
Amax	2.12890e+03

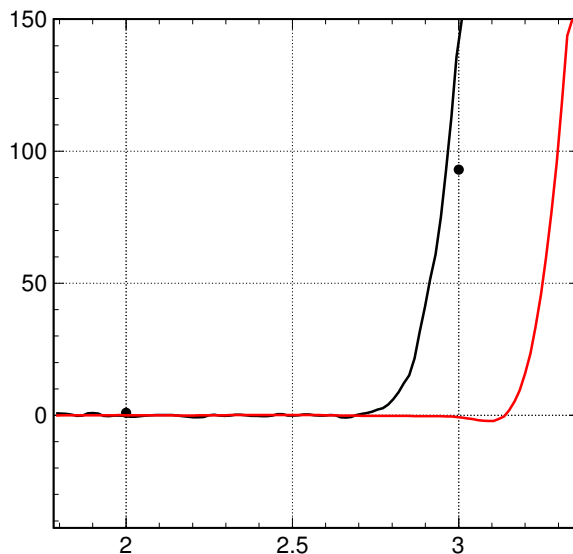
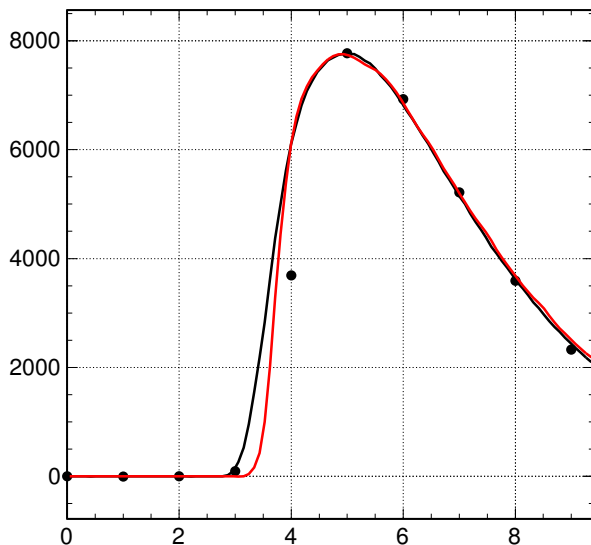
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Run	142928
Event	162151278
FED	642
Tower	61
Strip	2
Chan	2

chi2 Spike	9167.17
chi2 Norm	2913.12
Tmax	5.00
Amax	7.76106e+03

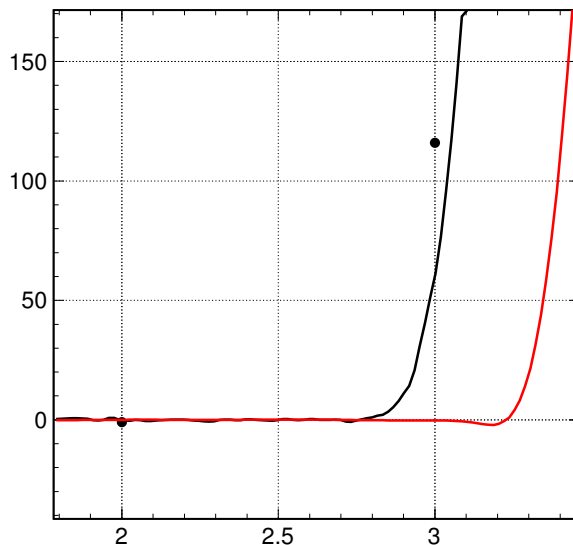
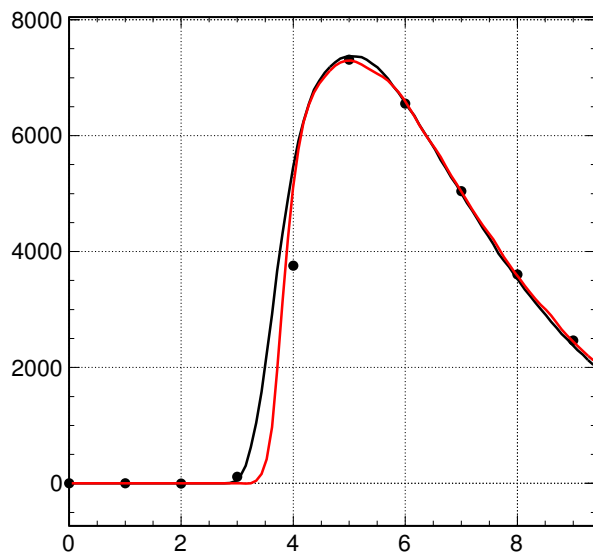
1:207 1:206 1:208 1:300 1:3897 3:930 3:853 3:697 3:549 3:434



Run	143665
Event	728044
FED	620
Tower	18
Strip	2
Chan	4

chi2 Spike	14191.3
chi2 Norm	7762.59
Tmax	5.07
Amax	7.37143e+03

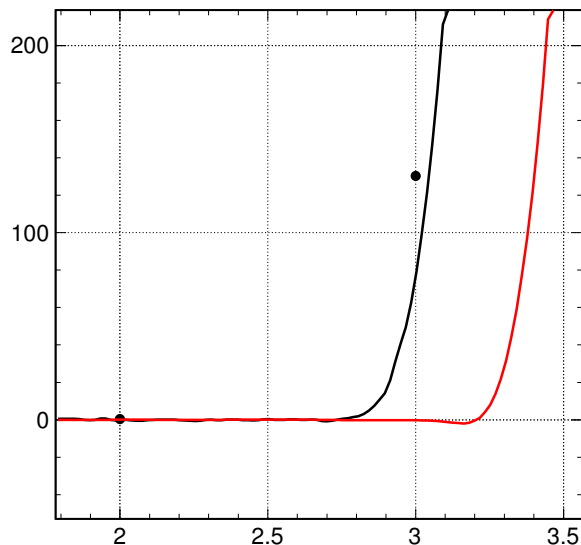
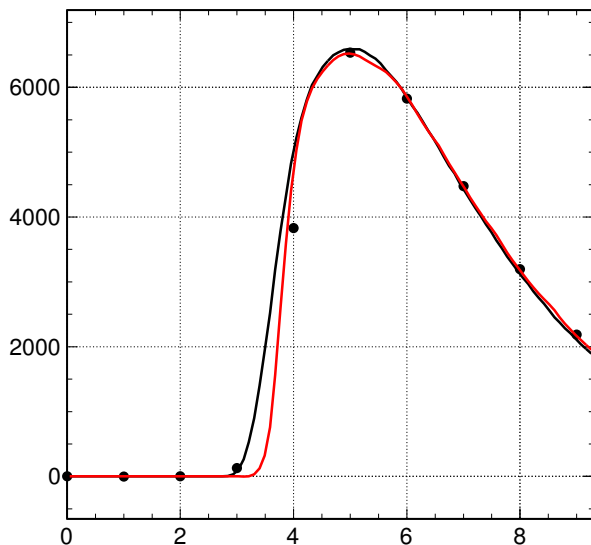
1:193 1:194 1:192 1:309 1:3949 2:3928 2:3541 2:2771 2:2037 2:1458



Run	143827
Event	505400842
FED	611
Tower	44
Strip	4
Chan	5

chi2 Spike	17595.4
chi2 Norm	7252.62
Tmax	5.04
Amax	6.59543e+03

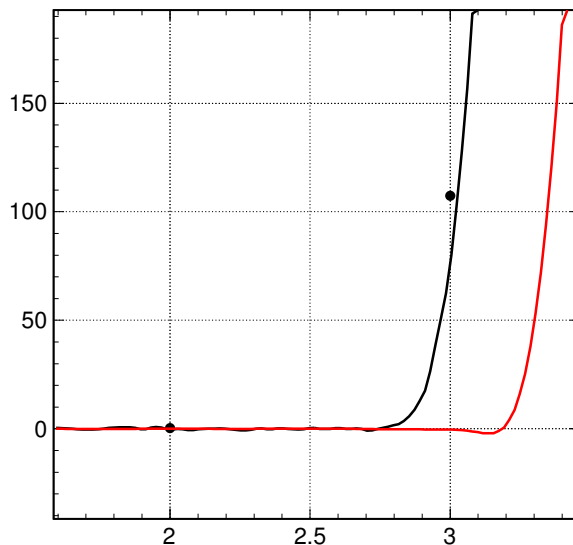
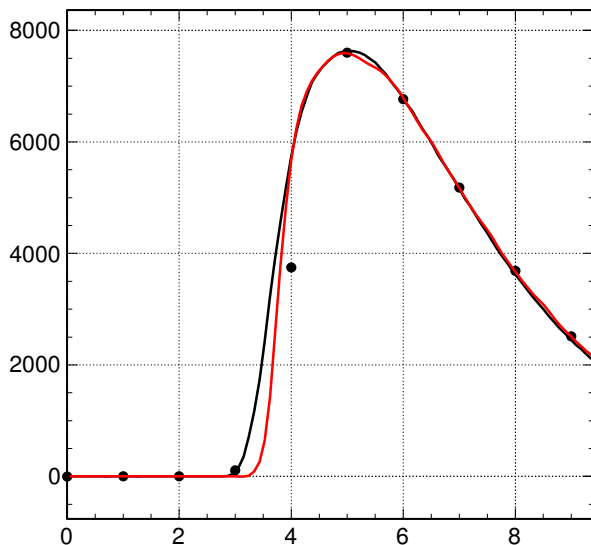
1:196 1:195 1:196 1:326 1:4023 2:3532 2:3172 2:2482 2:1829 2:1316



Run	143833
Event	361950128
FED	635
Tower	25
Strip	2
Chan	4

chi2 Spike	11895.3
chi2 Norm	3120.22
Tmax	5.05
Amax	7.63308e+03

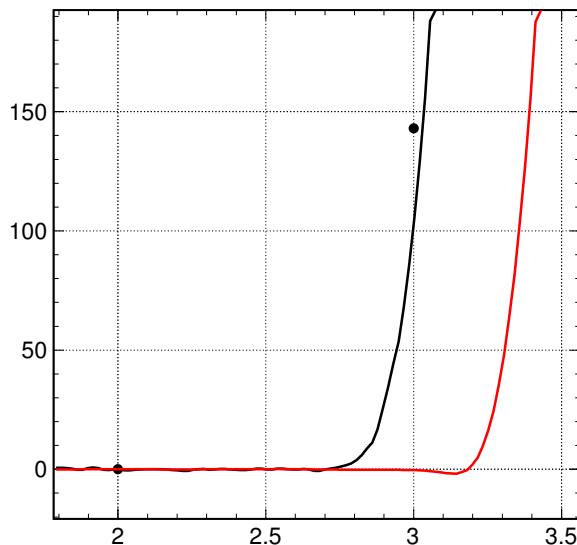
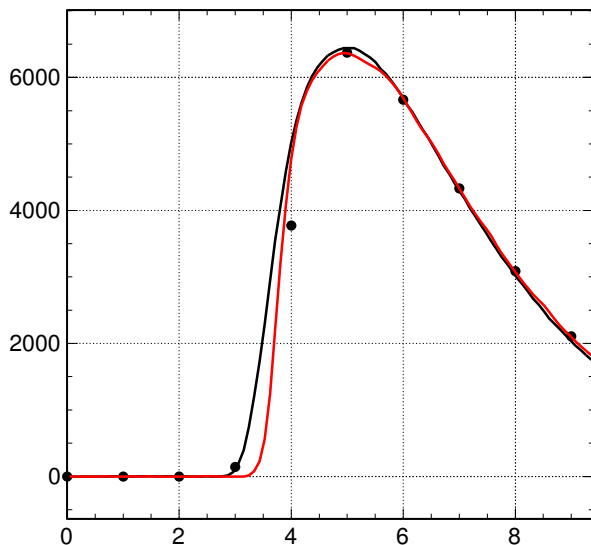
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Run	143960
Event	206229
FED	626
Tower	48
Strip	5
Chan	5

chi2 Spike	20774.4
chi2 Norm	6010.18
Tmax	5.01
Amax	6.44472e+03

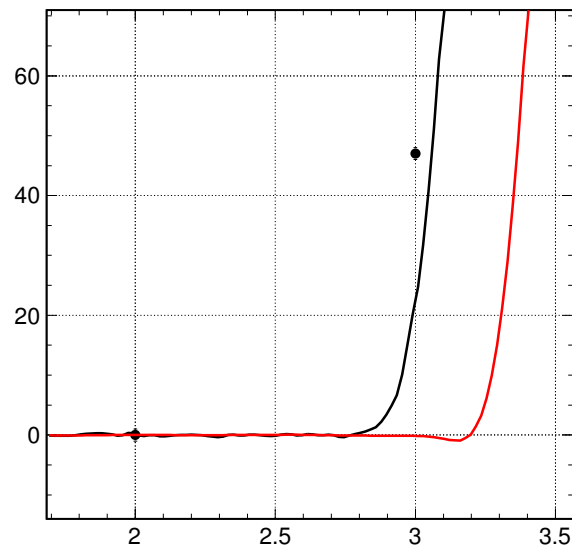
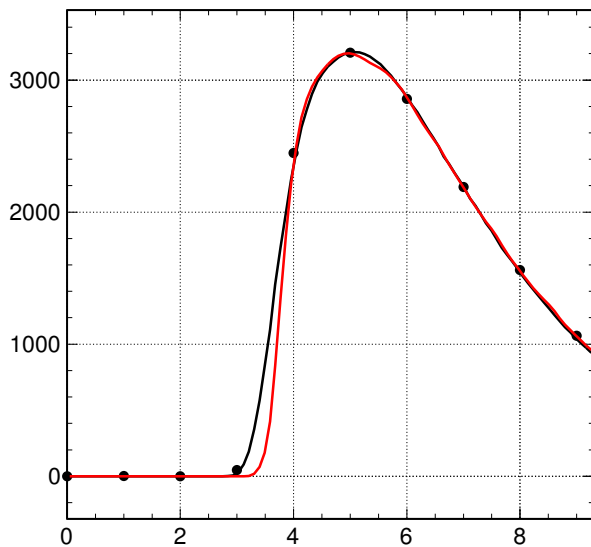
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Run	143960
Event	62333663
FED	610
Tower	20
Strip	1
Chan	3

chi2 Spike	2492.52
chi2 Norm	1658.28
Tmax	5.08
Amax	3.21118e+03

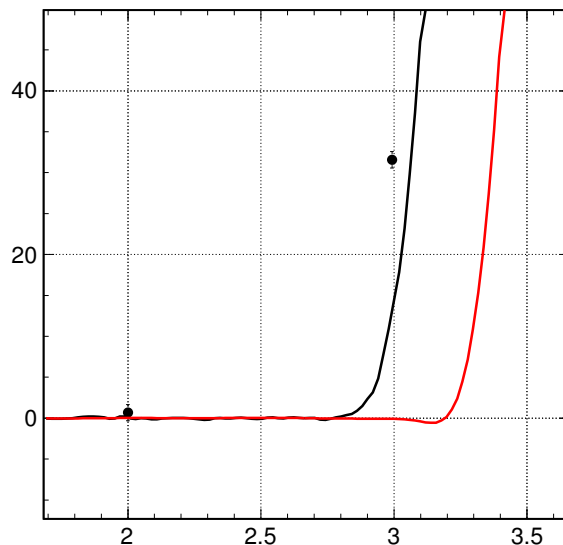
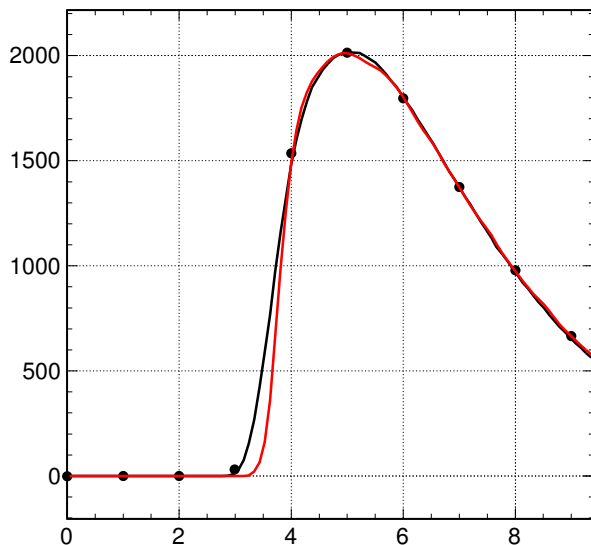
1:188 1:190 1:189 1:236 1:2636 1:3396 1:3047 1:2379 1:1750 1:1253



Run	143960
Event	62333663
FED	619
Tower	48
Strip	4
Chan	1

chi2 Spike	829.69
chi2 Norm	473.19
Tmax	5.08
Amax	2.01660e+03

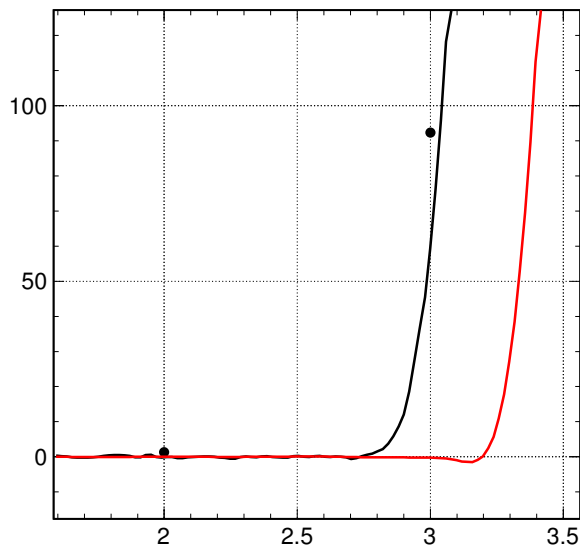
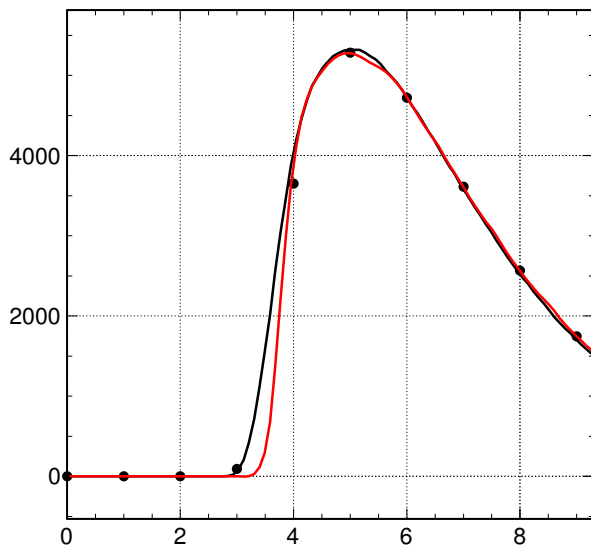
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Run	144089
Event	1541392246
FED	611
Tower	32
Strip	2
Chan	3

chi2 Spike	8631.34
chi2 Norm	2589.61
Tmax	5.04
Amax	5.32465e+03

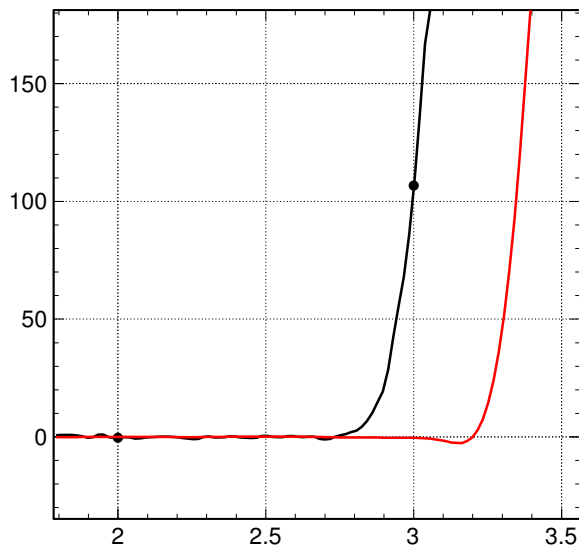
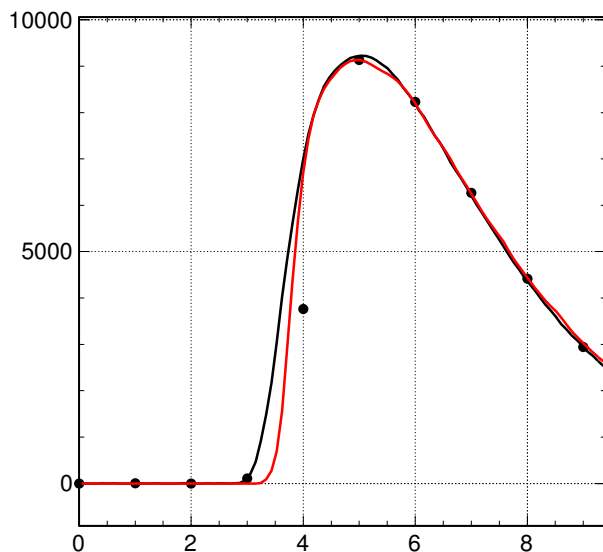
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Run	144112
Event	1056948905
FED	629
Tower	38
Strip	3
Chan	2

chi2 Spike	11532.8
chi2 Norm	125.338
Tmax	5.04
Amax	9.22450e+03

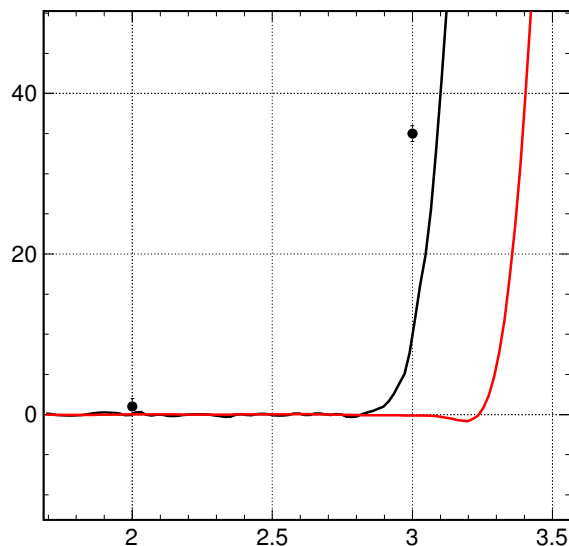
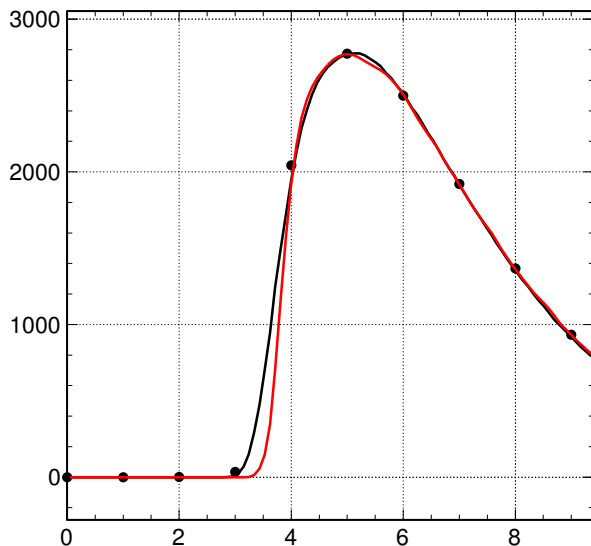
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Run	144112
Event	1056948905
FED	629
Tower	38
Strip	3
Chan	3

chi2 Spike	1315.83
chi2 Norm	1075.94
Tmax	5.12
Amax	2.77799e+03

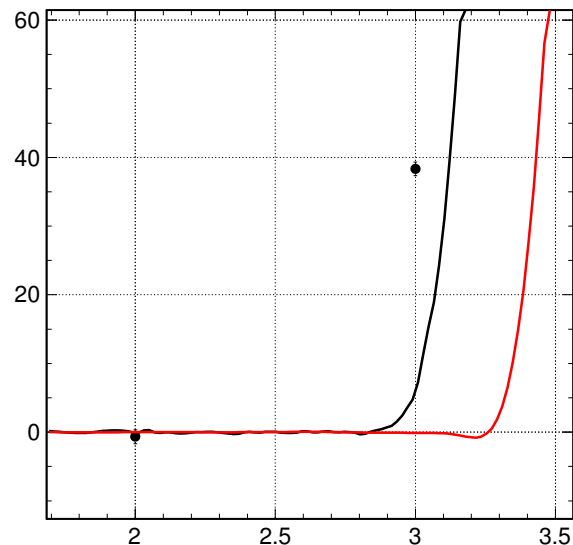
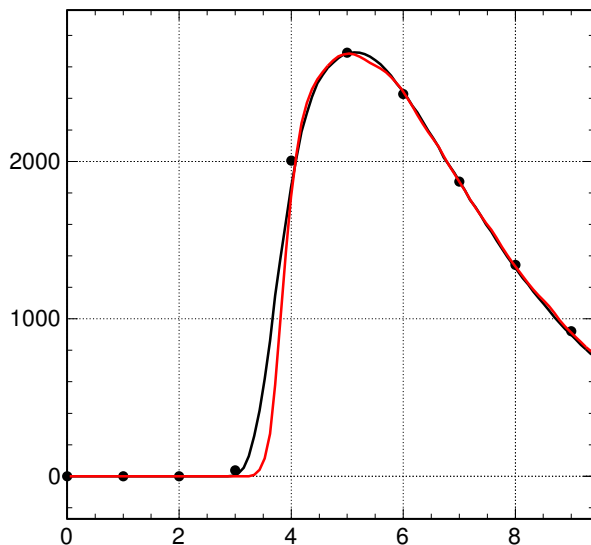
1:199 1:200 1:201 1:235 1:2242 1:2974 1:2700 1:2120 1:1568 1:1133



Run	143953
Event	147708136
FED	629
Tower	28
Strip	5
Chan	1

chi2 Spike	1875.66
chi2 Norm	2108.86
Tmax	5.14
Amax	2.69296e+03

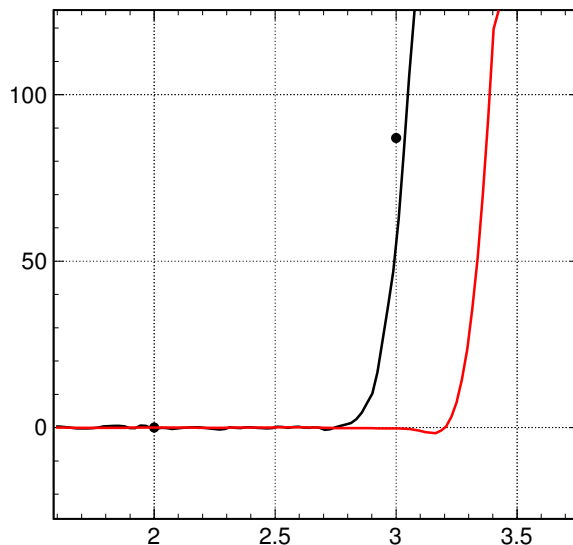
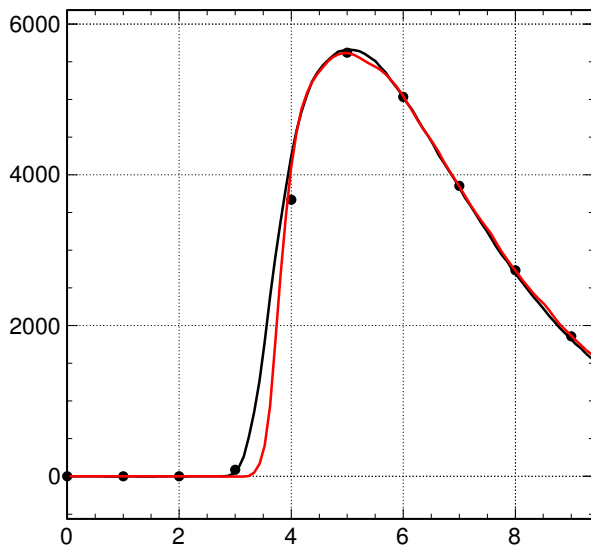
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Run	144089
Event	9162762
FED	629
Tower	48
Strip	1
Chan	5

chi2 Spike	7649.39
chi2 Norm	2333.59
Tmax	5.05
Amax	5.66150e+03

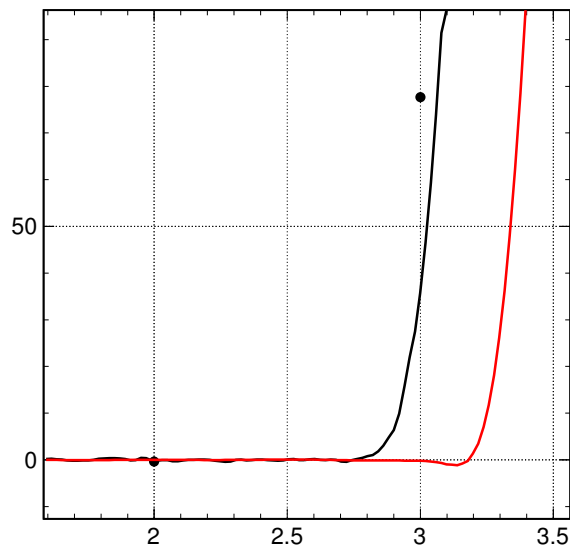
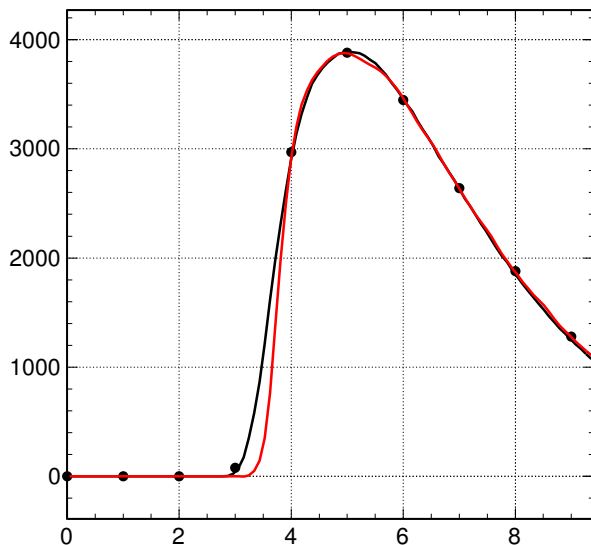
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Run	144089
Event	619306078
FED	640
Tower	9
Strip	4
Chan	1

chi2 Spike	6443.47
chi2 Norm	3486.56
Tmax	5.06
Amax	3.88888e+03

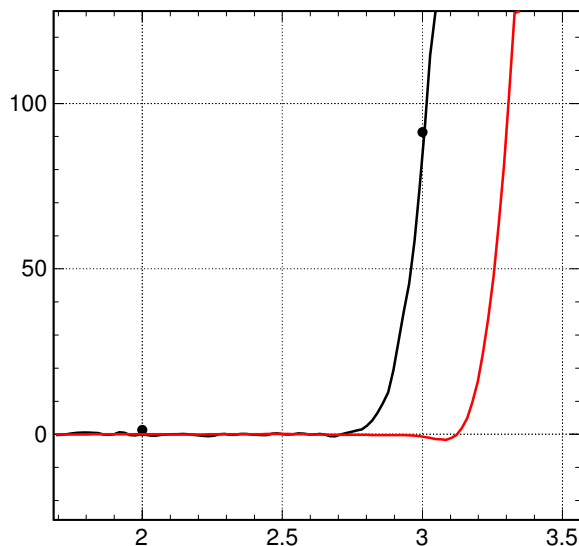
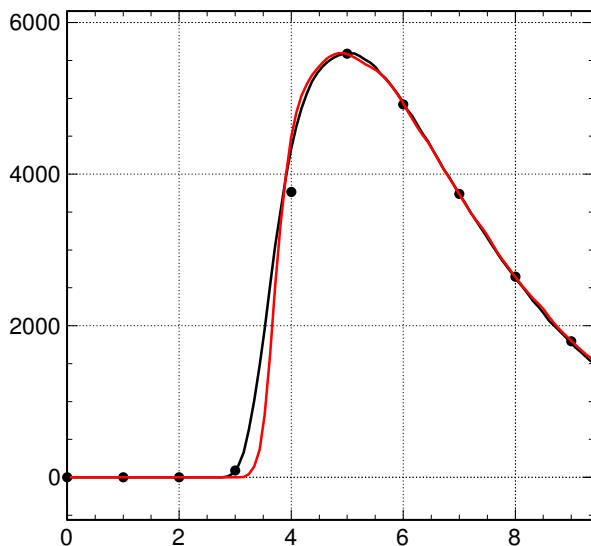
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Run	144112
Event	554477875
FED	625
Tower	27
Strip	3
Chan	3

chi2 Spike	8517.46
chi2 Norm	414.457
Tmax	5.02
Amax	5.59619e+03

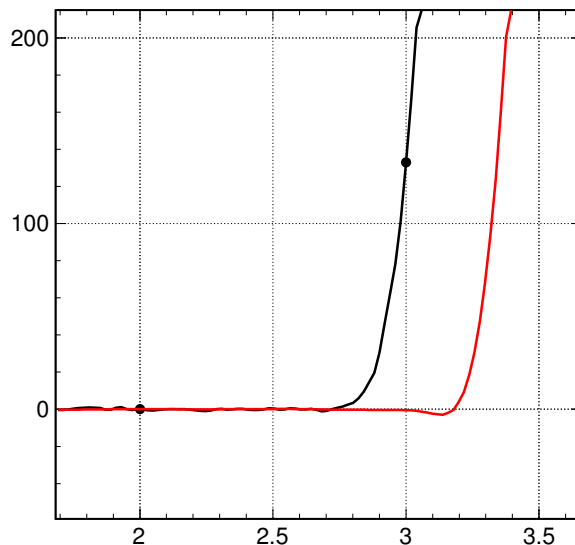
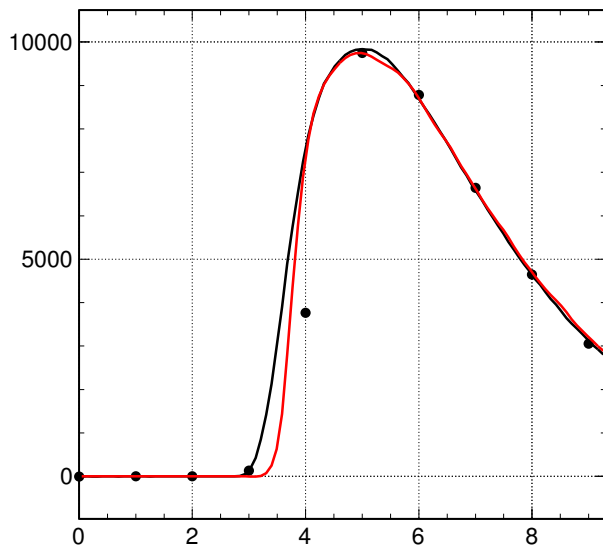
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Run	144112
Event	1351089138
FED	622
Tower	51
Strip	2
Chan	1

chi2 Spike	18083.3
chi2 Norm	192.46
Tmax	5.03
Amax	9.83756e+03

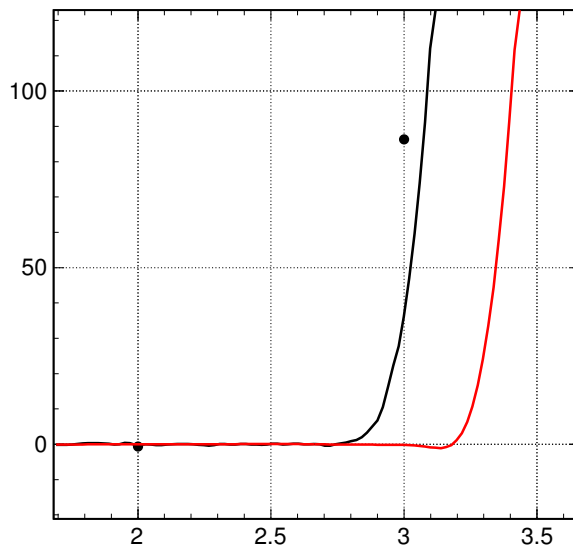
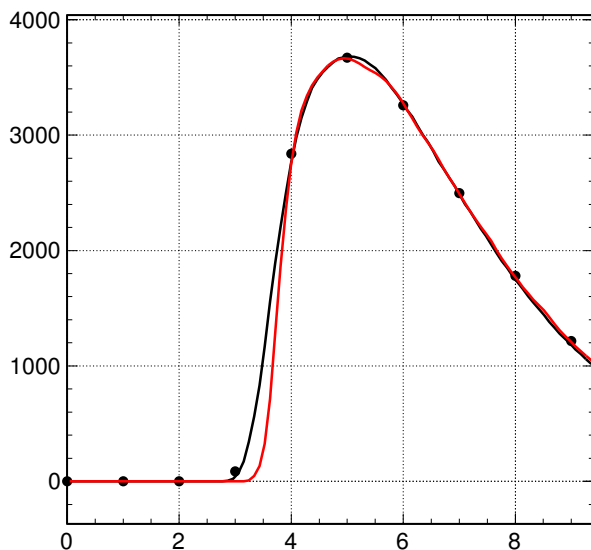
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Run	144112
Event	1351089138
FED	622
Tower	51
Strip	3
Chan	5

chi2 Spike	8038.08
chi2 Norm	4768.32
Tmax	5.05
Amax	3.68185e+03

1:211 1:211 1:210 1:297 1:3049 1:3882 1:3469 1:2707 1:1990 1:1427



Run	144112
Event	1485690403
FED	615
Tower	3
Strip	2
Chan	3

chi2 Spike	17897
chi2 Norm	11579
Tmax	5.02
Amax	3.26066e+03

1:207 1:207 1:206 1:338 1:2729 1:3433 1:3069 1:2402 1:1774 1:1279

