A progress report on the analysis of pico-MM test beam data

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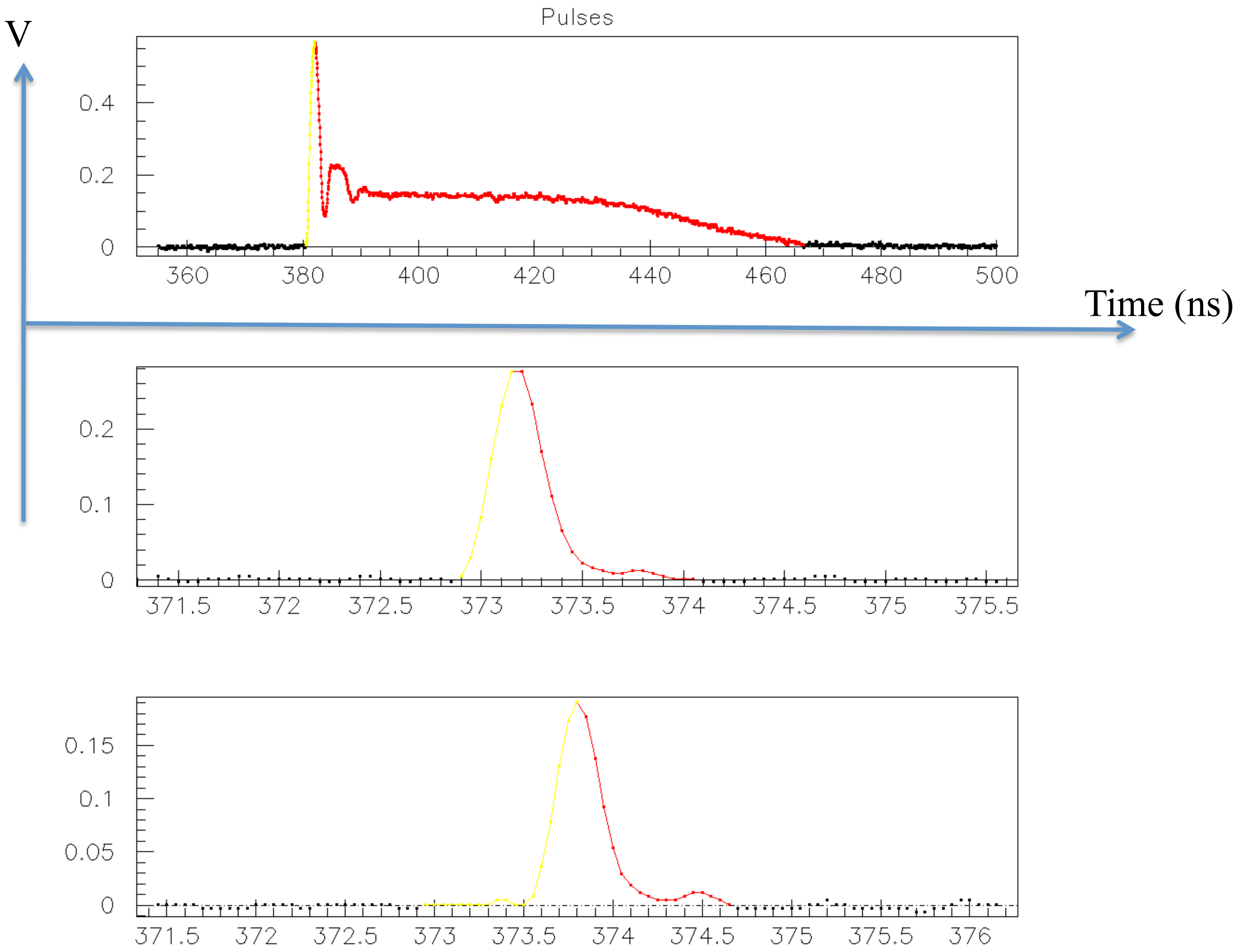
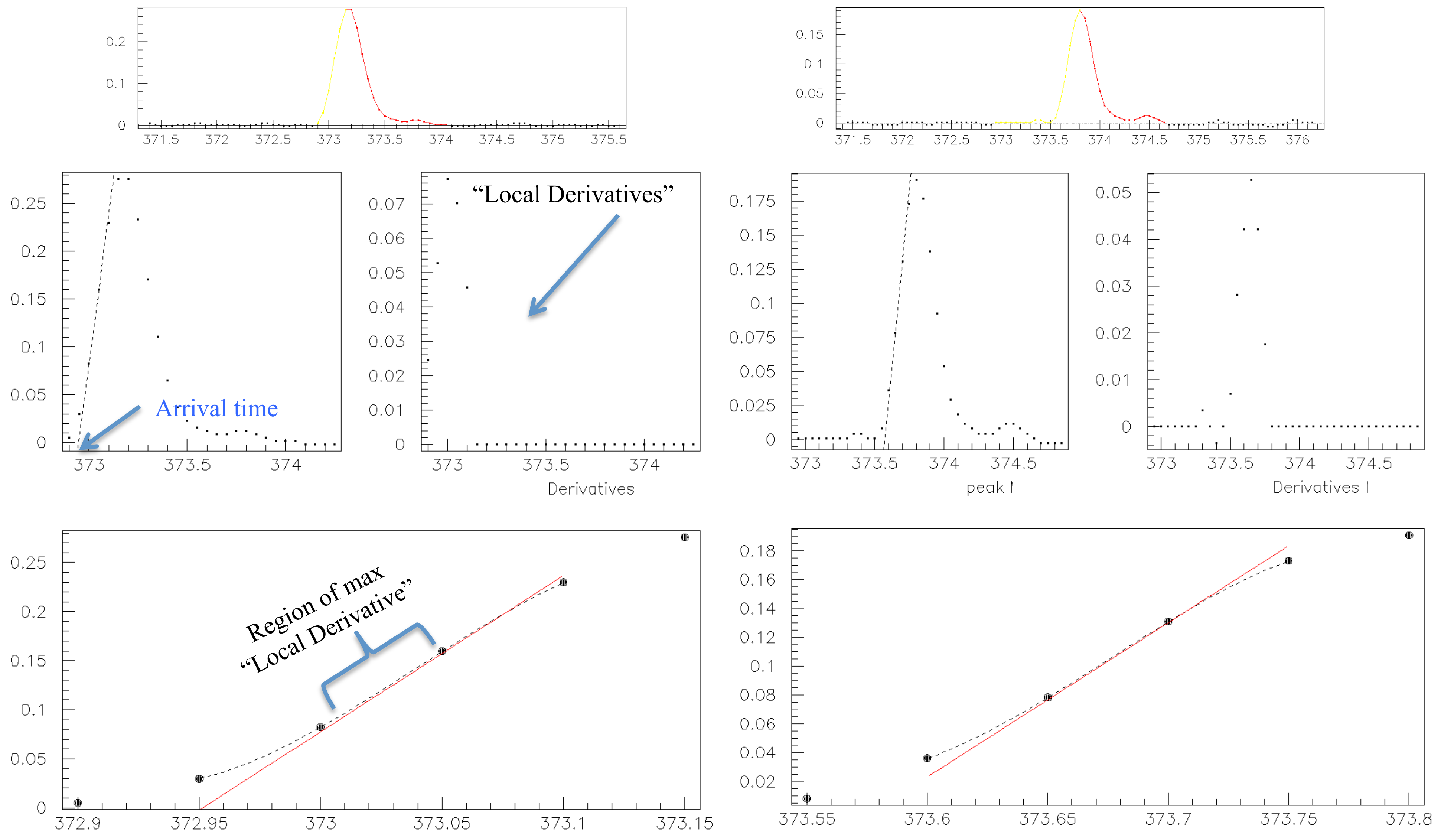
RUN 284



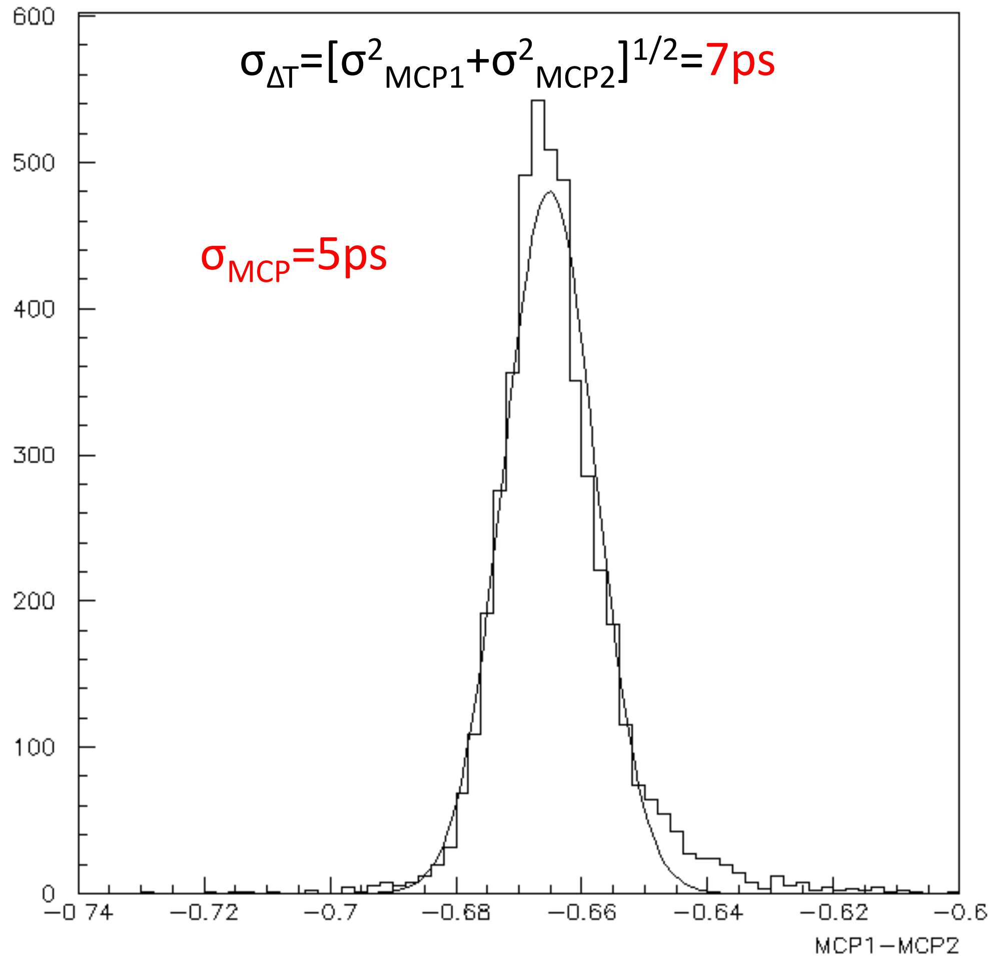
Pulses
V
Time (ns)
0.4
0.2
0
360
380
400
420
440
460
480
500
0.2
0.1
0
371.5
372
372.5
373
373.5
374
374.5
375
375.5
0.15
0.1
0.05
0
371.5
372
372.5
373
373.5
374
374.5
375
375.5
376

“precise” MCP Timing

MCP -1 | MCP -2

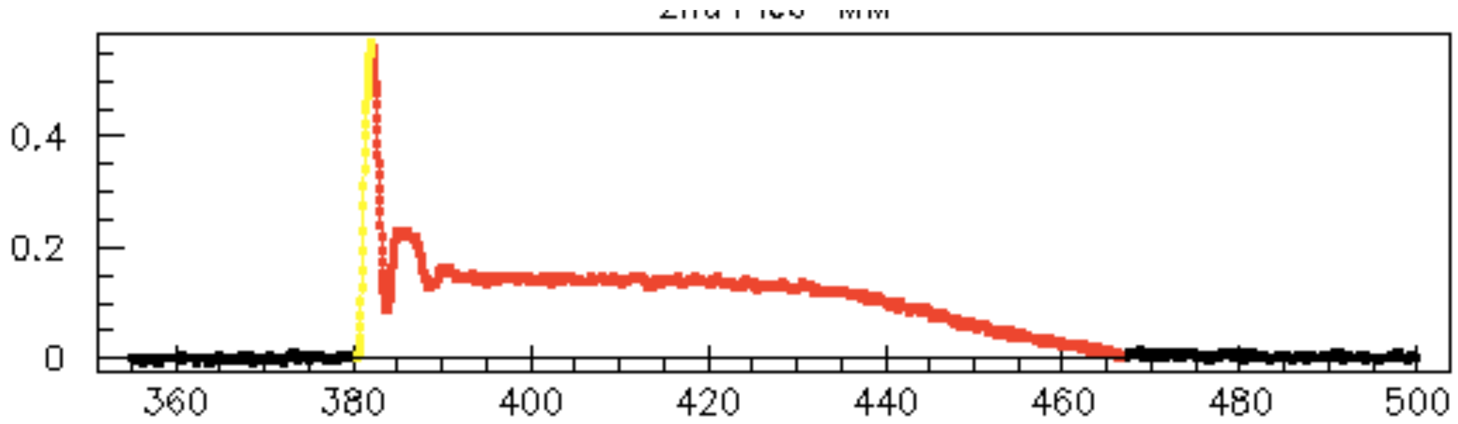


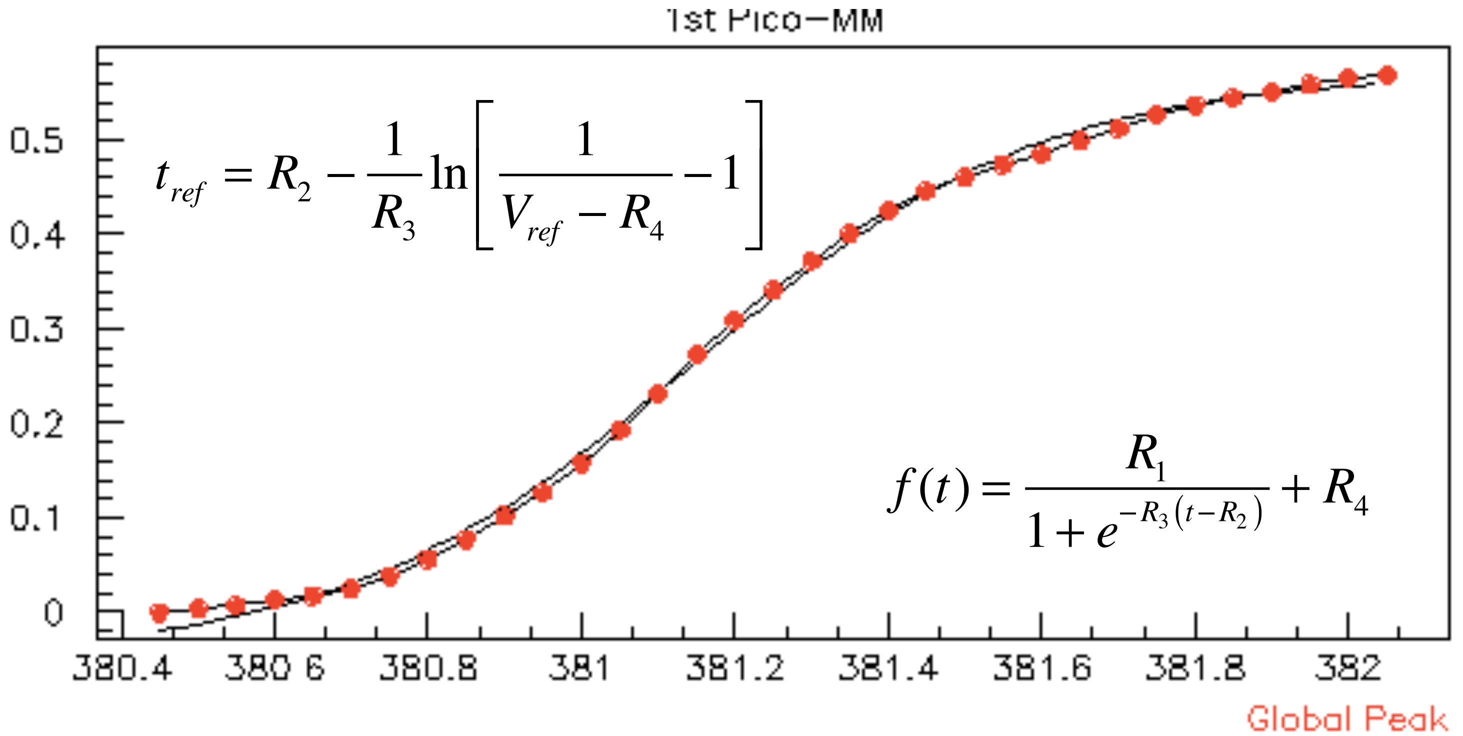
MCP Resolution



In the following $T_0=(T_{MCP1} + T_{MCP2})/2$ *($\sigma_0 = 3.5$ ps)*

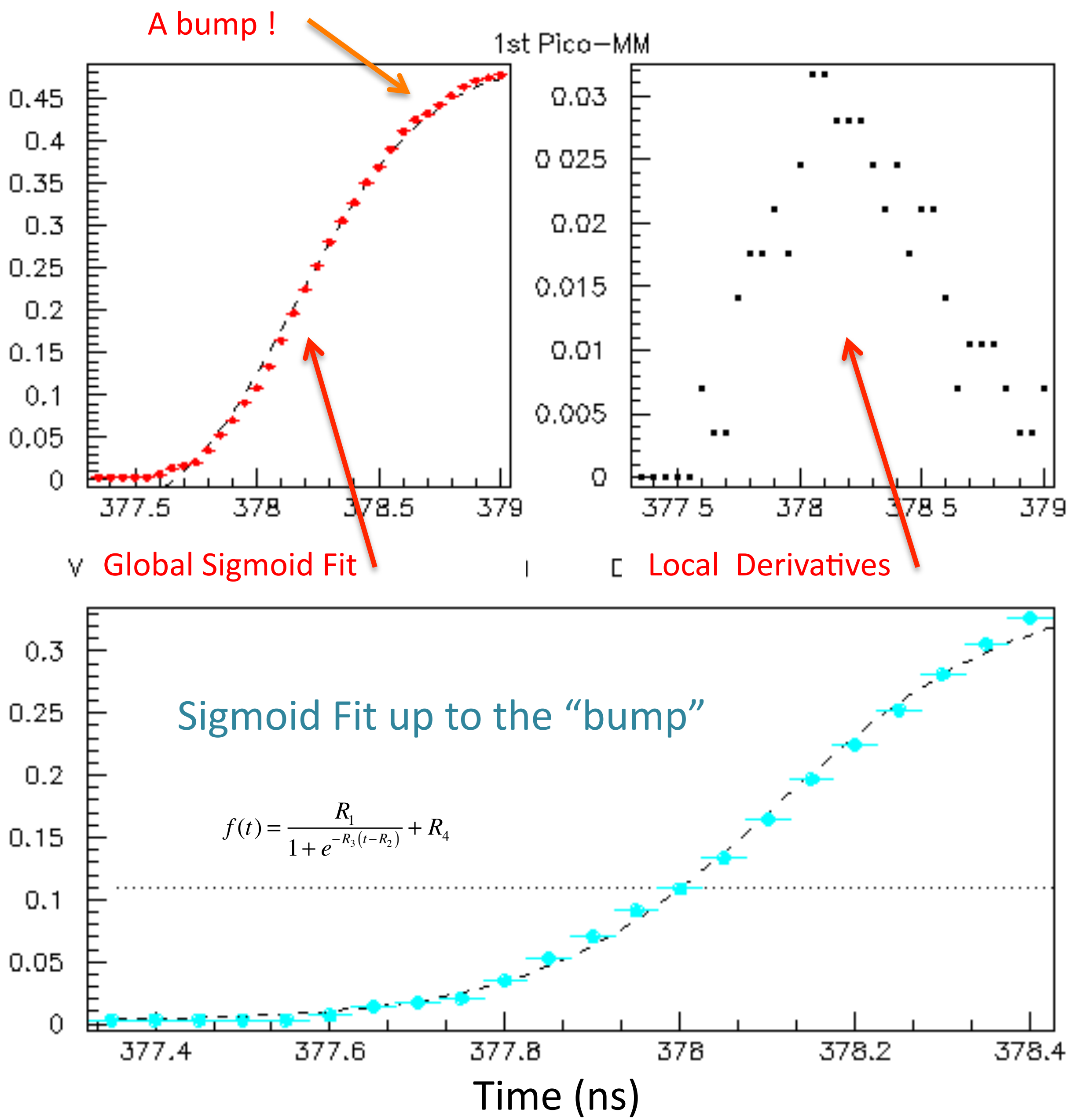
Global “sigmoid” fit to picoMM e-peak – examples using RUN 284



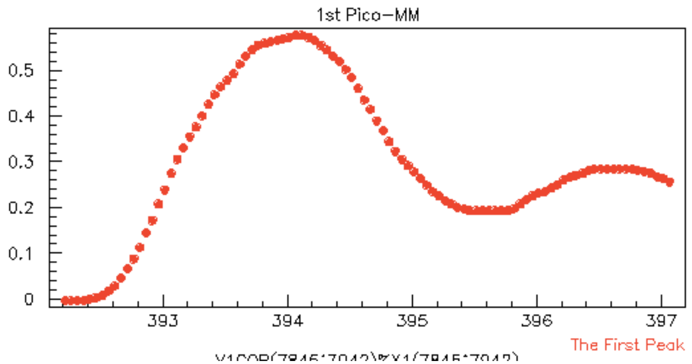


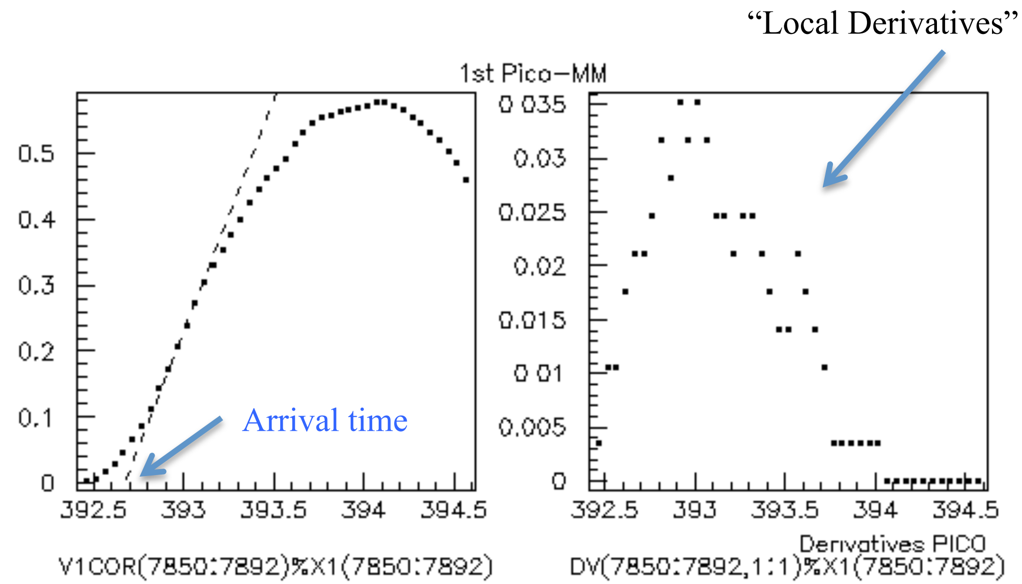
In the following we will use $V_{ref} = 0.2V_{peak}$

Local "sigmoid" fit to picoMM e-peak

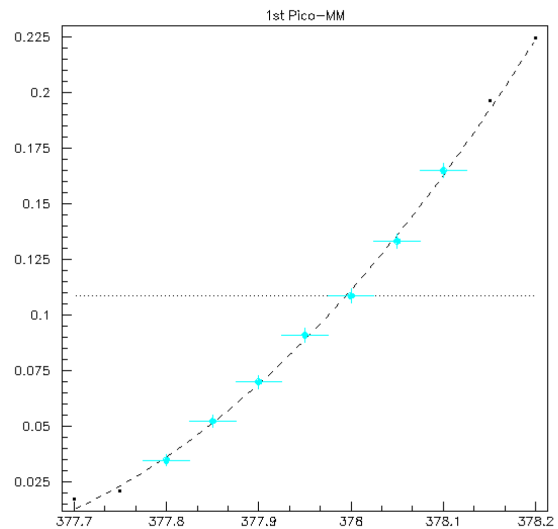


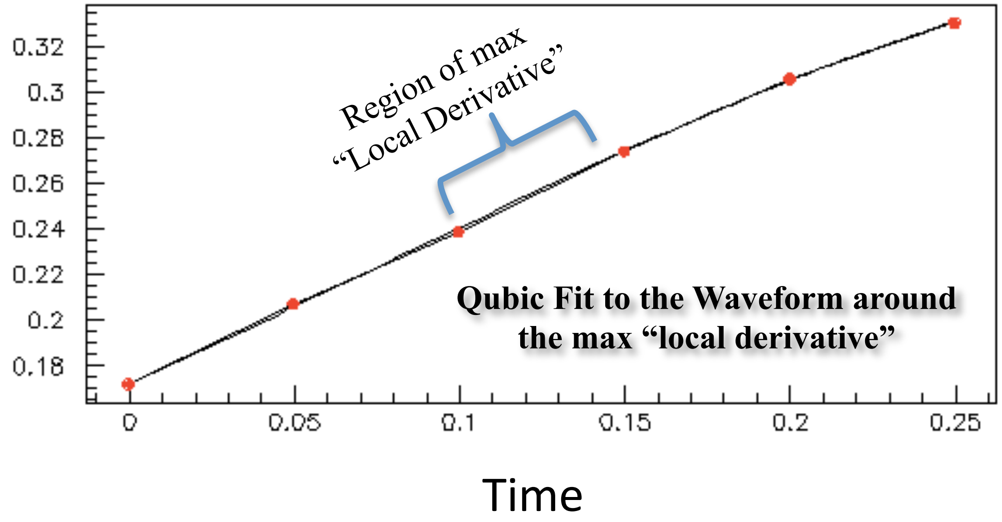
Local Polynomial Fit to e-peak – using the Inflection Point





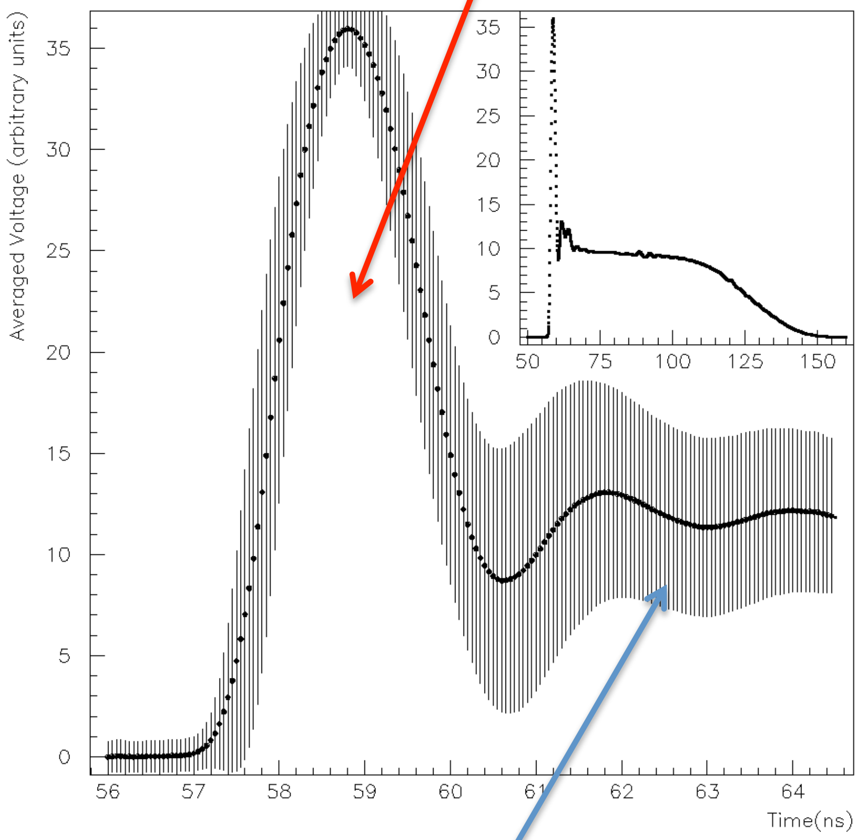
Polynomial Fit up to the inflection Point



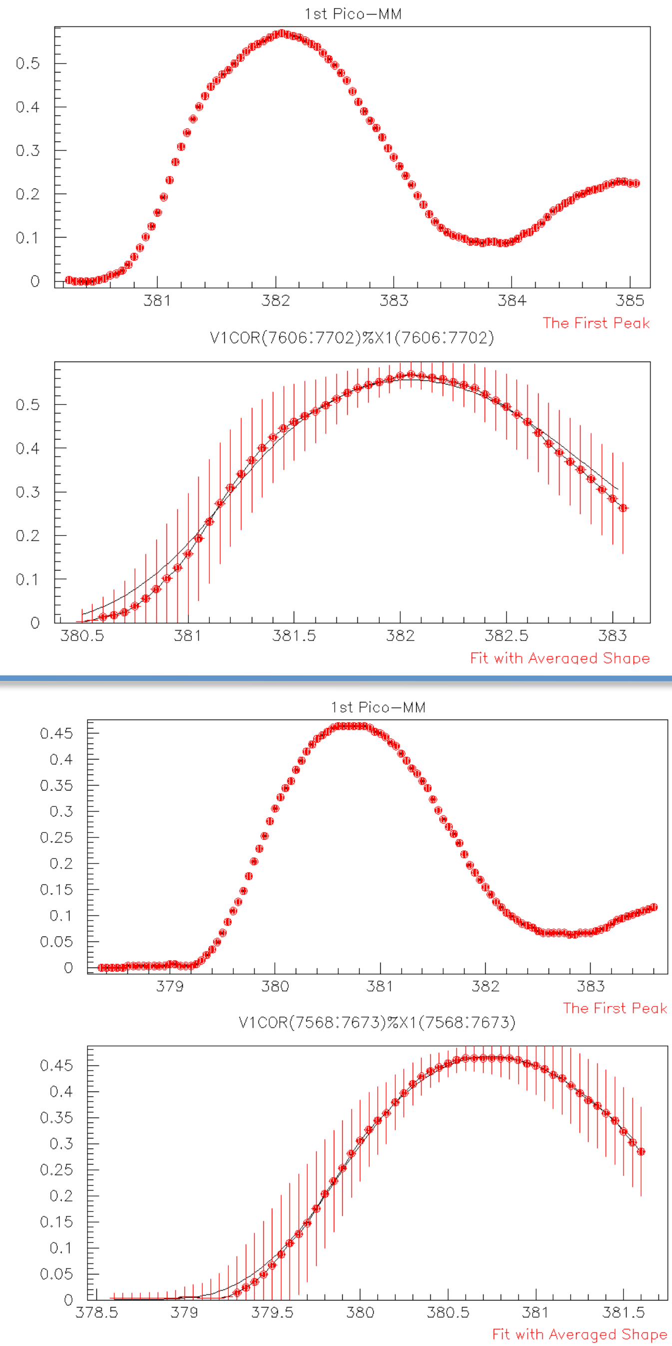


Global "Average Pulse Profile" Fit to e-peak

Each individual waveform is added normalized to according to the e-peak "charge"



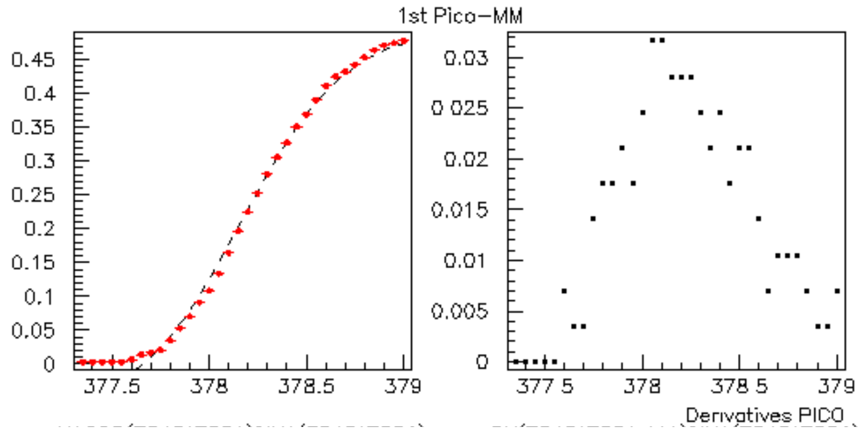
Vertical bars represent correlated errors



Fit Examples

Four Fitting Strategies
Timing at C.F. (20% of the Peak)

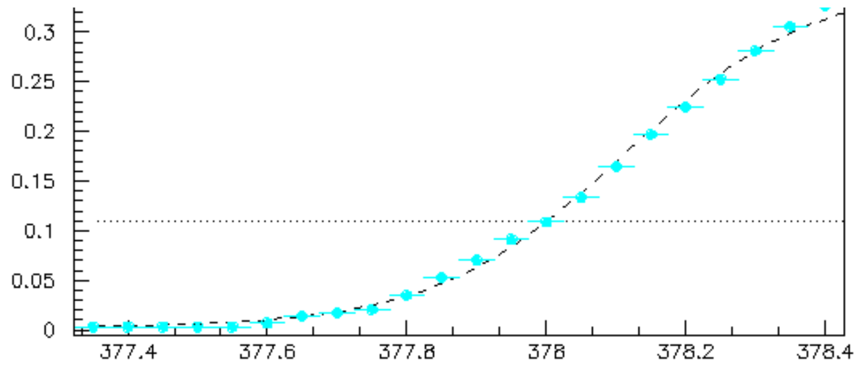
- Global Sigmoid



- Earlier Sigmoid

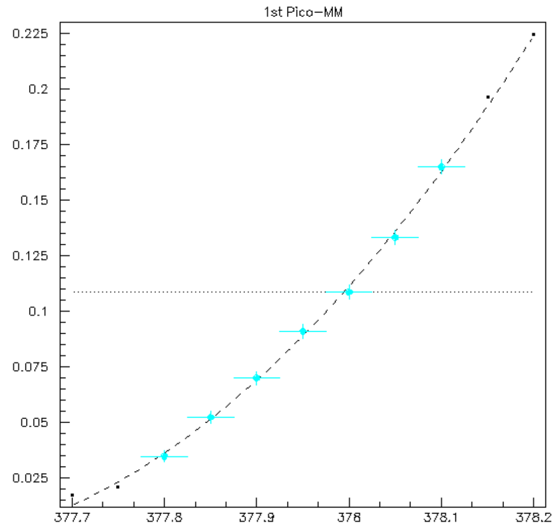
(the inflection point is also a middle point)

$$f(t) = \frac{R_1}{1 + e^{-R_3(t-R_2)}} + R_4$$



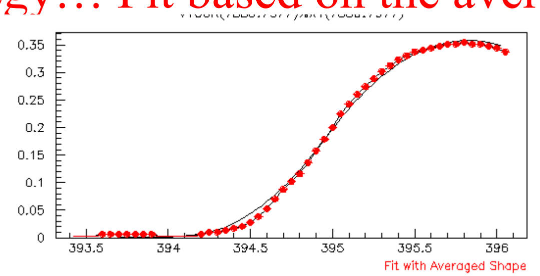
- Polynomial Fit up to the inflection Point

- Linear Interpolation



An extra strategy… Fit based on the average shape

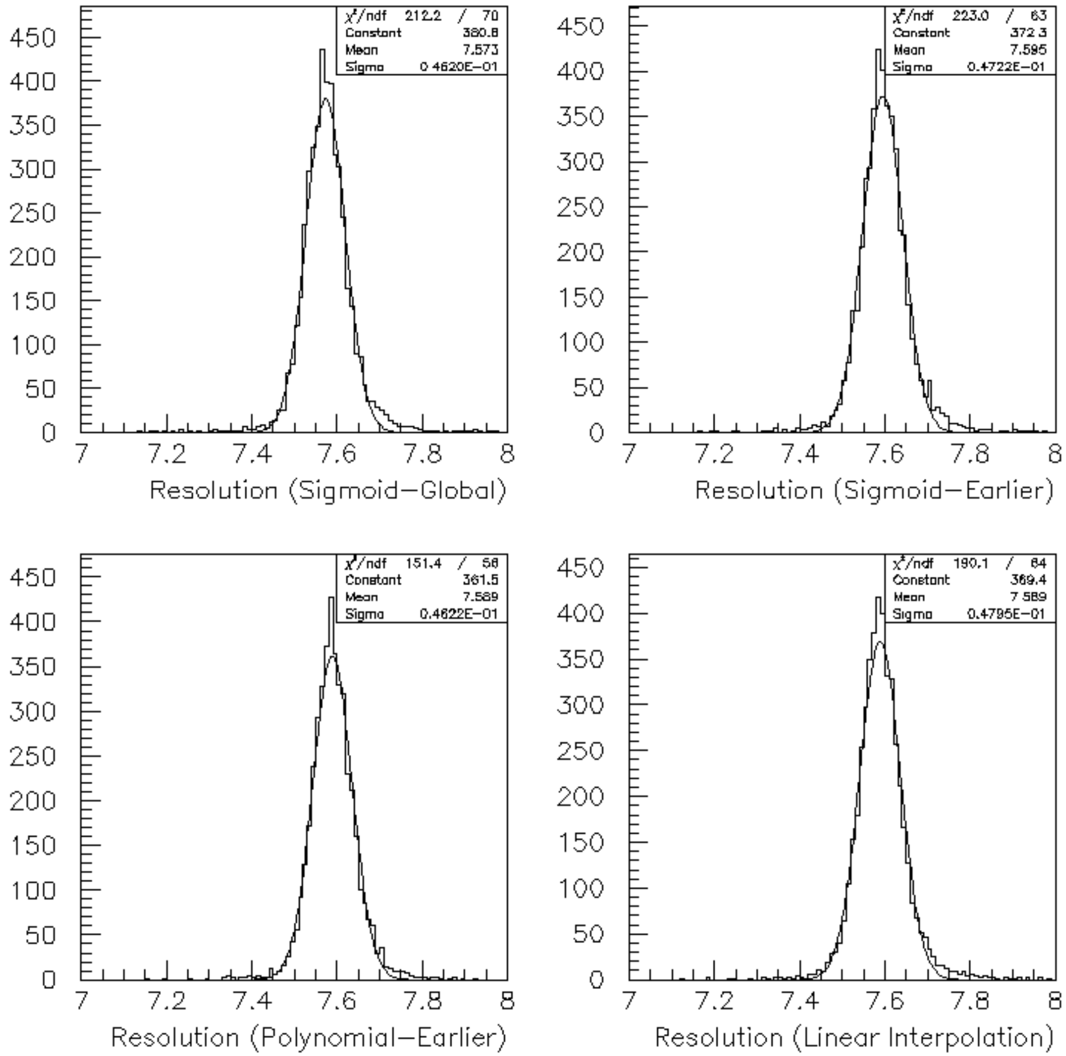
See later….



C.F. Strategies for the Arrival Time Estimation give similar results, almost 100% correlated (~47 ps resolution, when ΔT distributions are parameterized by a single Gaussian (errors in resolution estimation <1.5 ps))

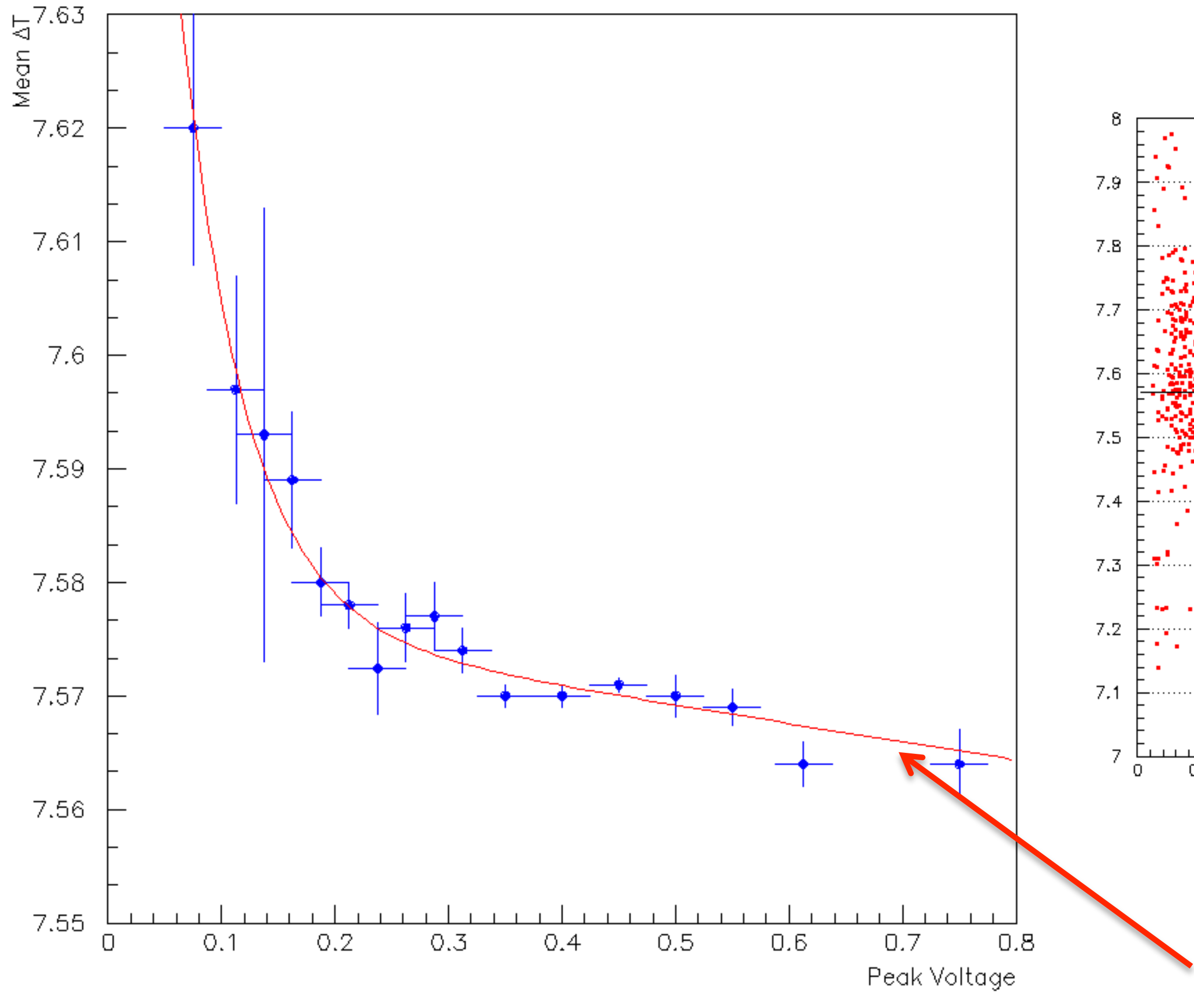
Why is there an asymmetry?

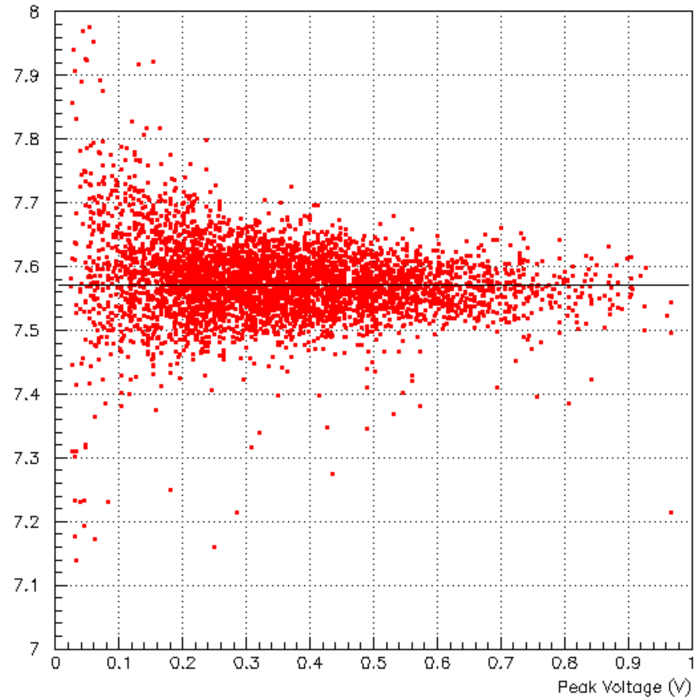
Why the resolution peak – shape is not Gaussian?



Why is there an asymmetry ?

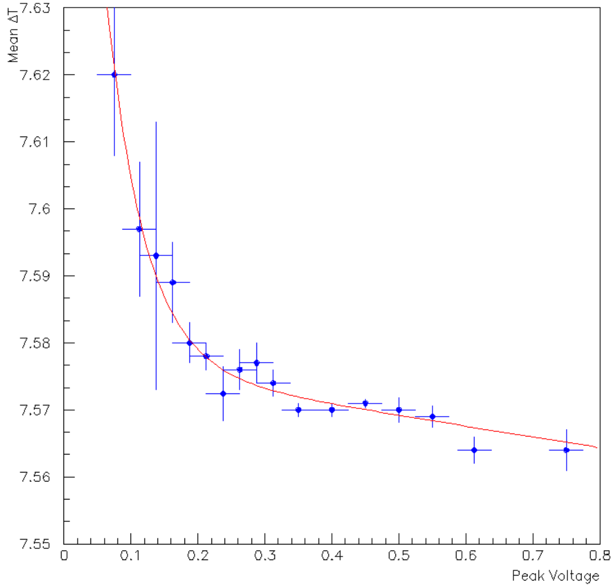
Slewing: check ΔT distributions vs e-peak Voltage



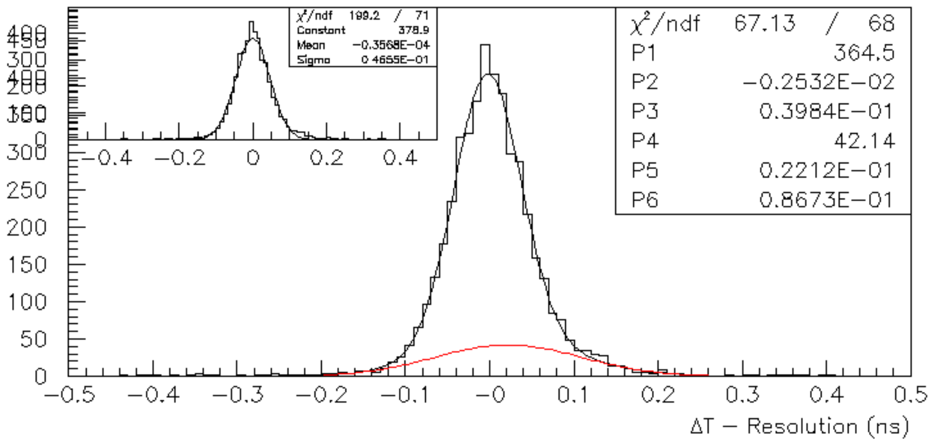


Empirical parameterization

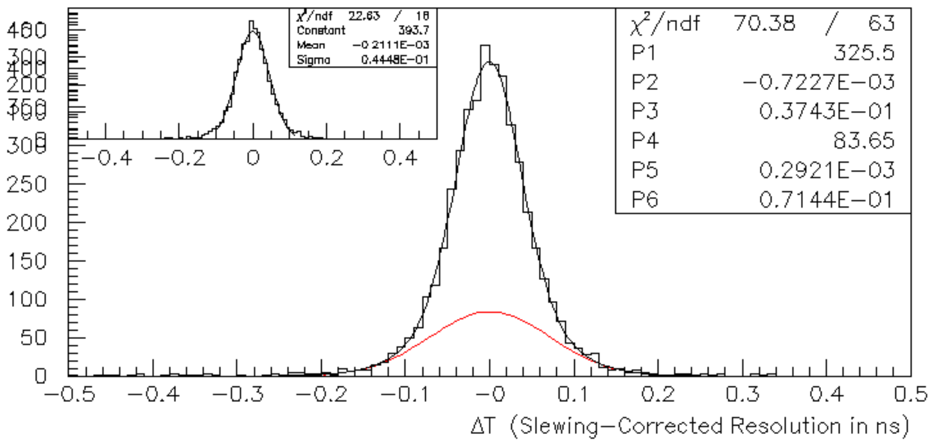
Use the “slewing parameterization” to correct the time difference…
Fit the resolution distributions with two Gaussians and a constant (violation of Ocham’s razor !)



Before



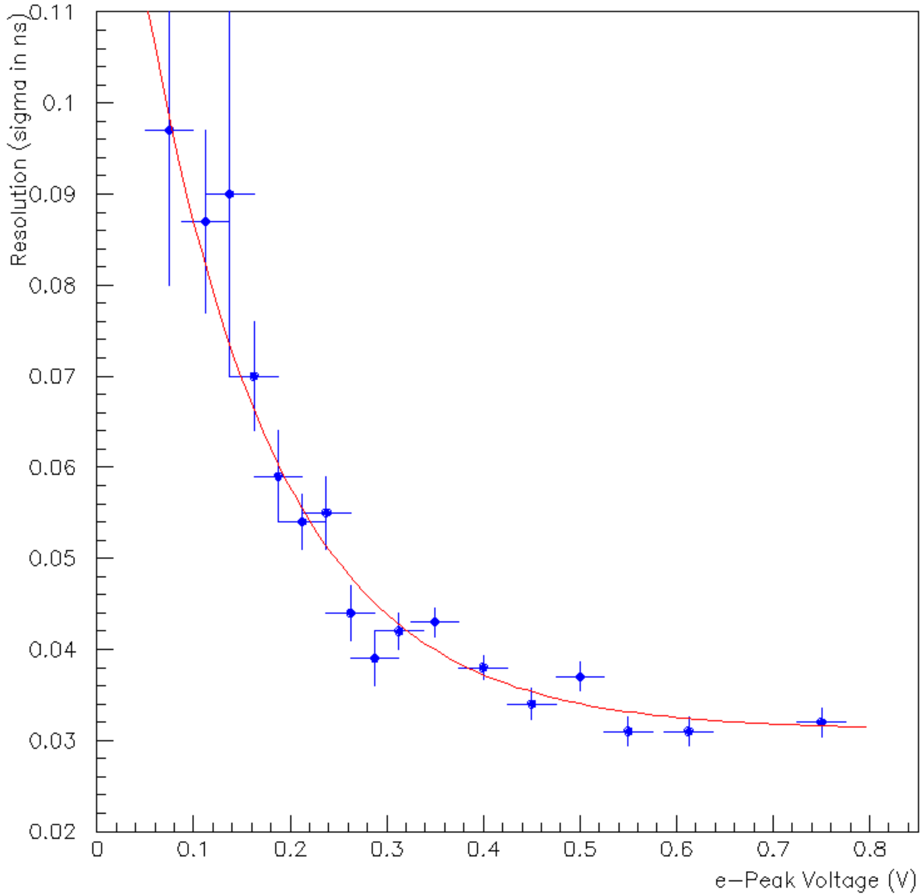
After



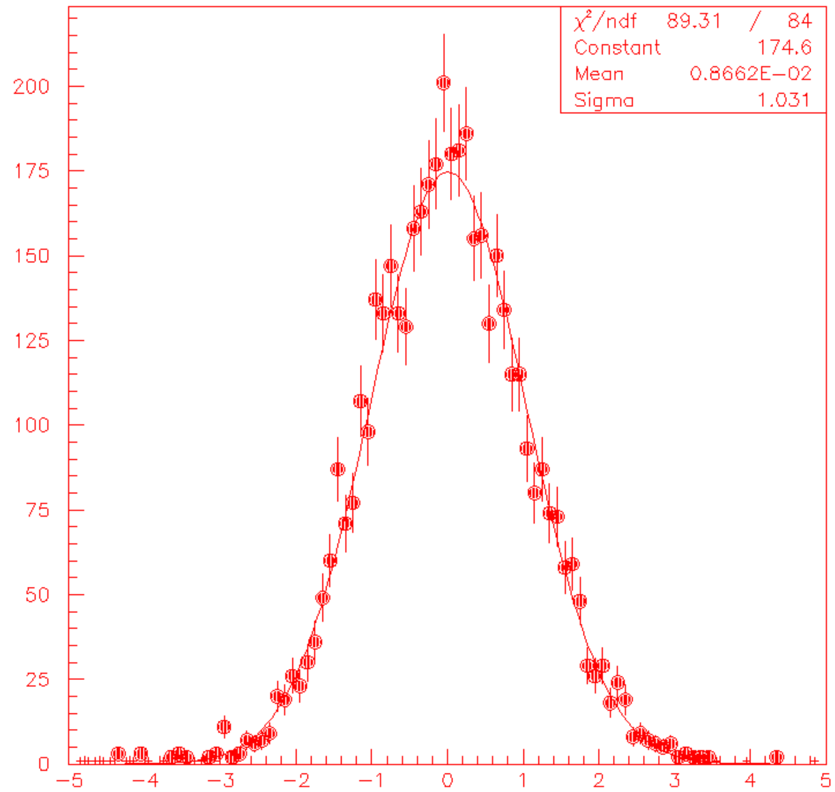
The asymmetry is due to the slewing effects… but why do we need two (instead of a single) Gaussian to fit ?

Resolution vs Peak Amplitude

Naturally… the Resolution depends on the size of the signal

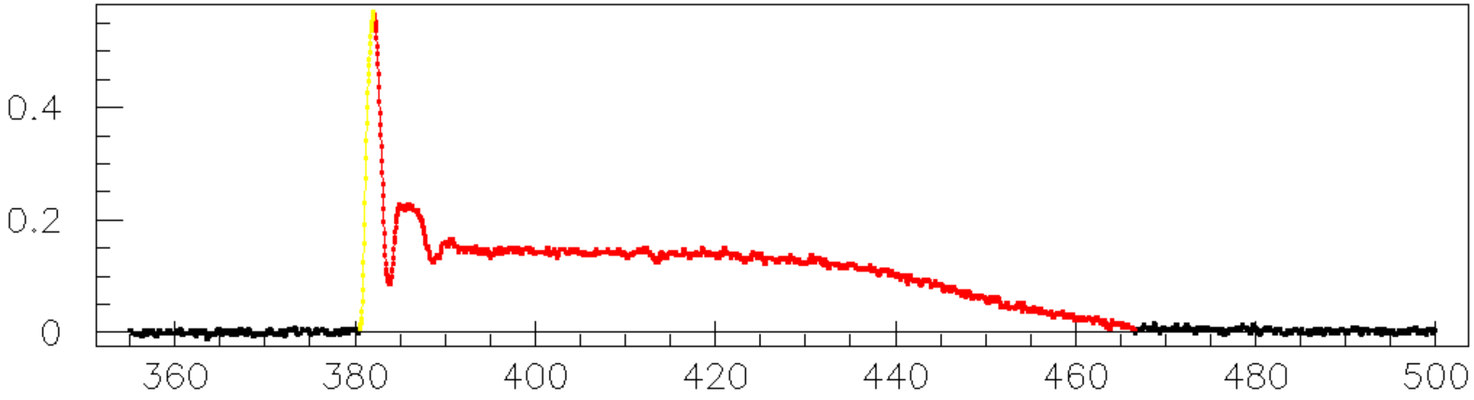


Almost a 1/sqrt(N) behavior (+ a constant)



$\Delta T_{corrected}/\sigma(V_{peak})$

The Pull Distribution is Normal with mean and sigma consistent with 0 and 1 respectively

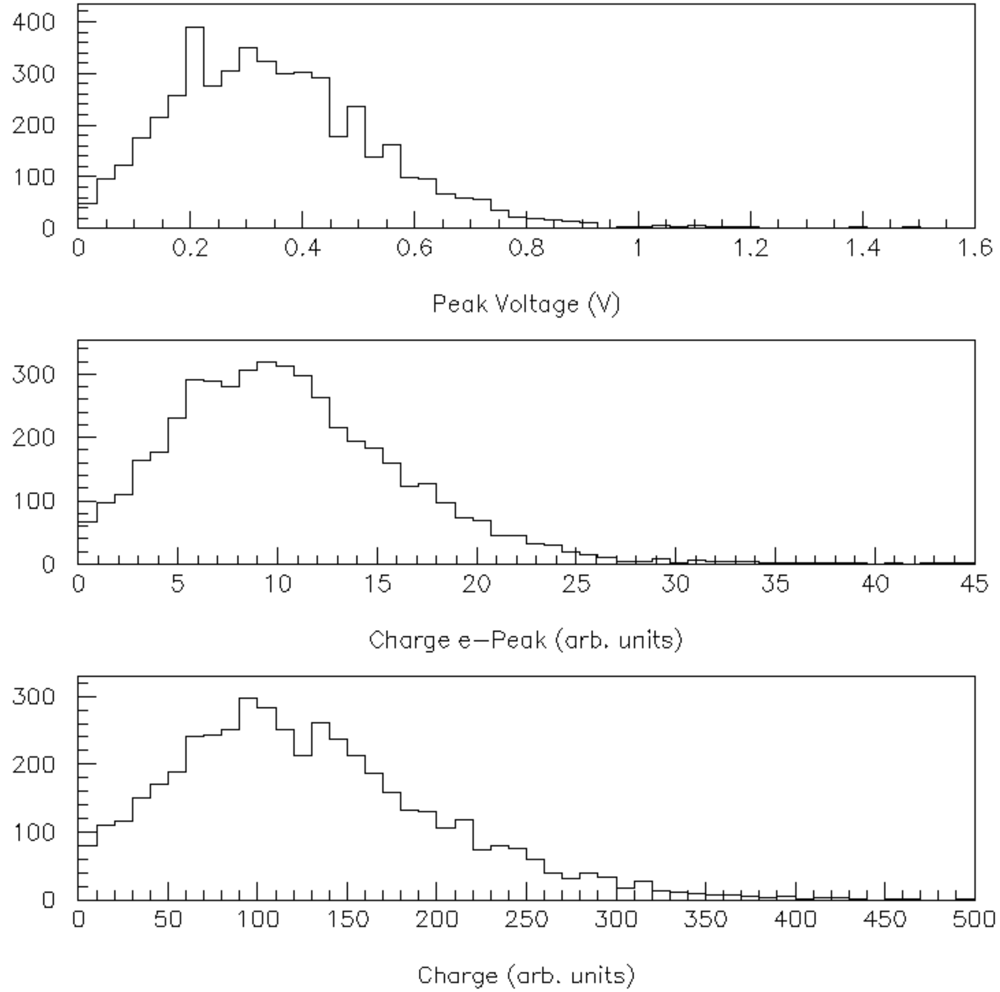


• Charge is estimated assuming 50 Ω termination

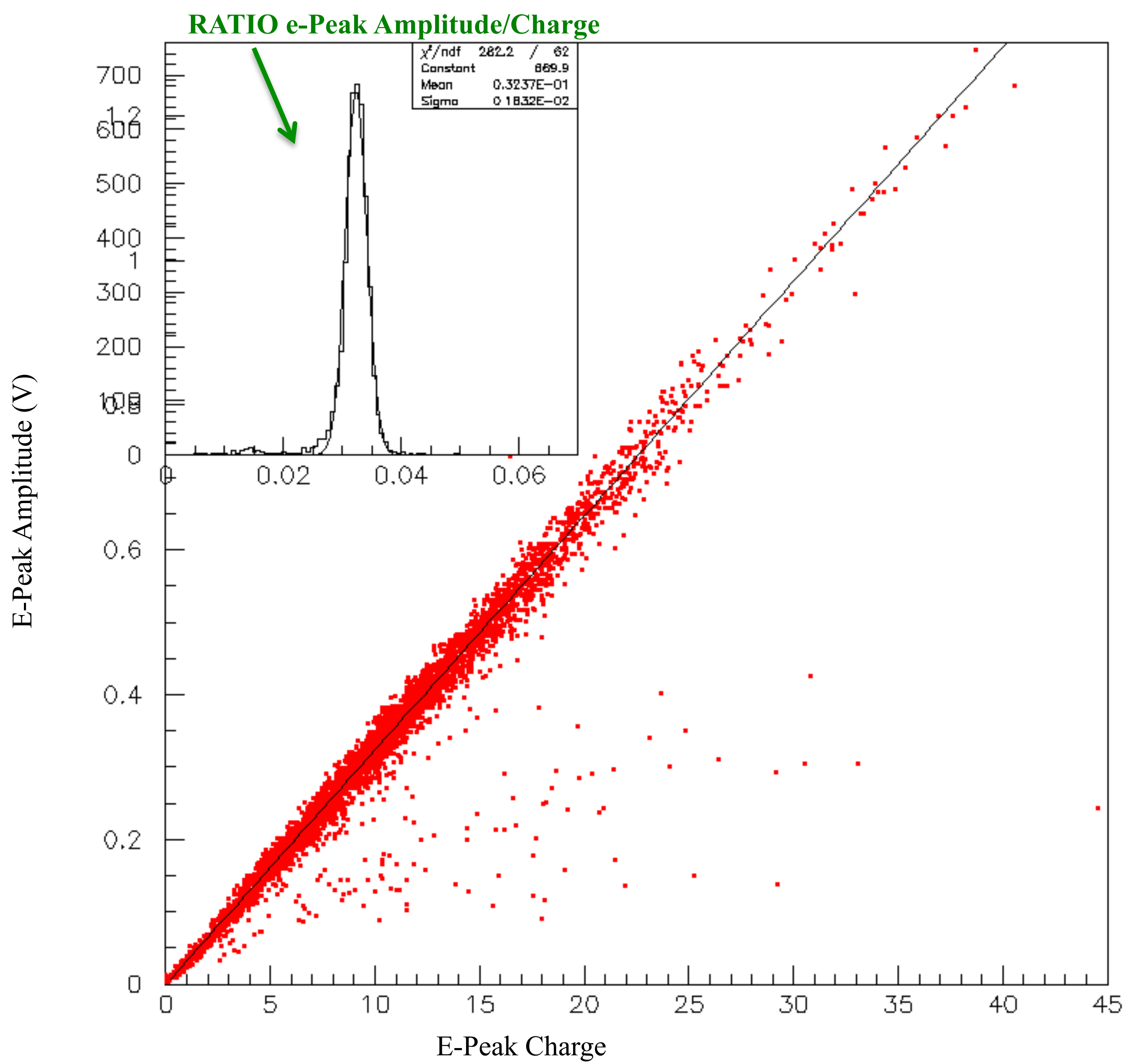
•Total charge is estimated from the integral of the “colored” part of the waveform

• e-Peak Charge is estimated from the integral up to the peak maximum plus 750ps (15 points)

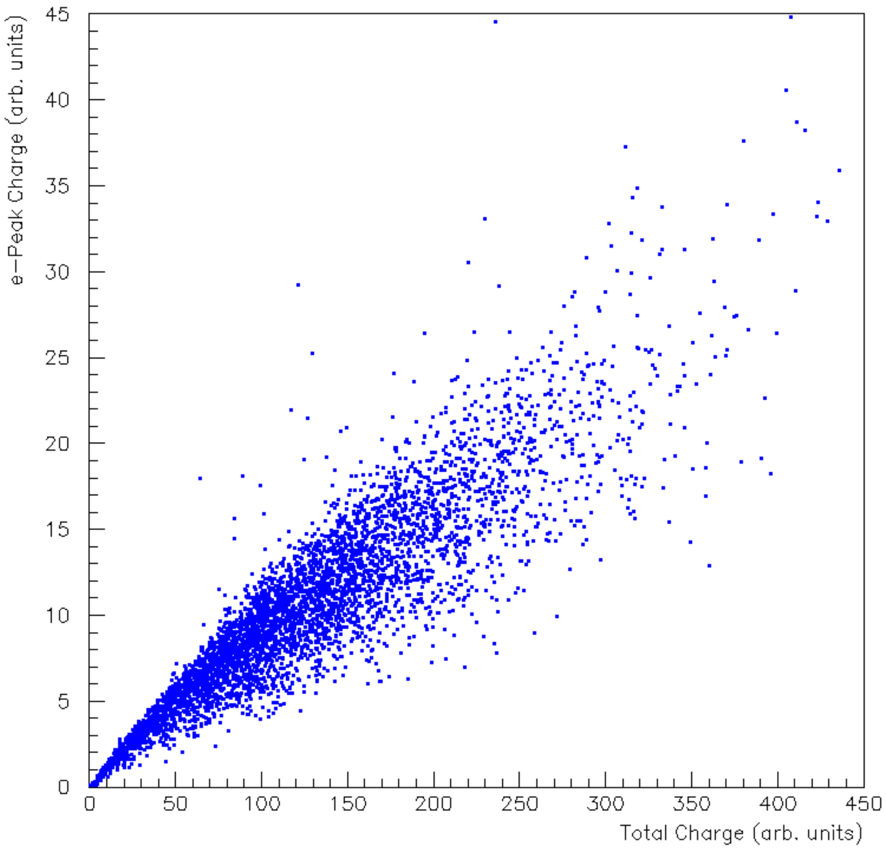
• the “start” of the waveform is defined as the latest point, before the e-Peak, which exceeds the ground level by 1 RMS-noise (after ground level correction)

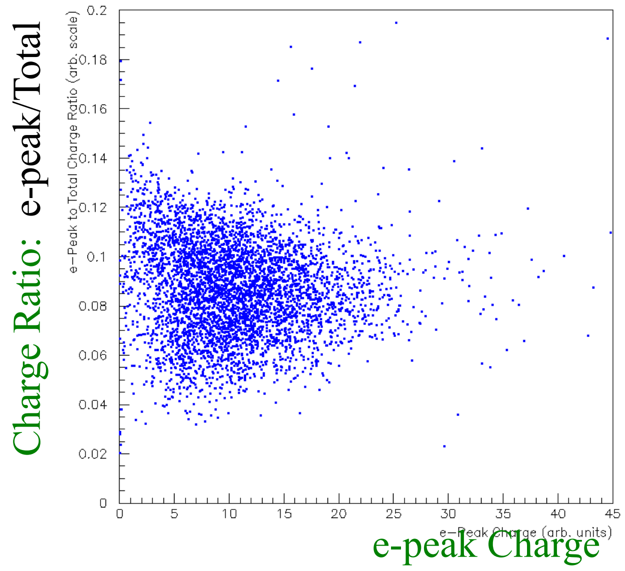


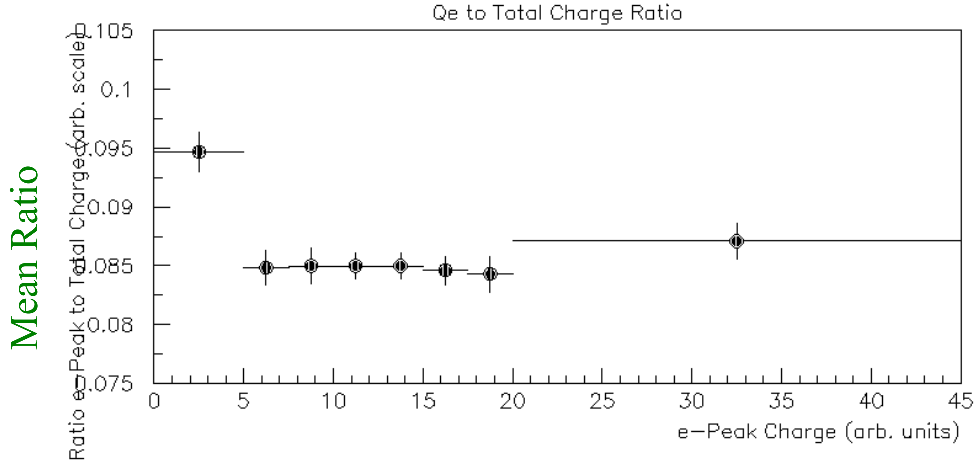
e-Peak Amplitude vs e-Peak Charge

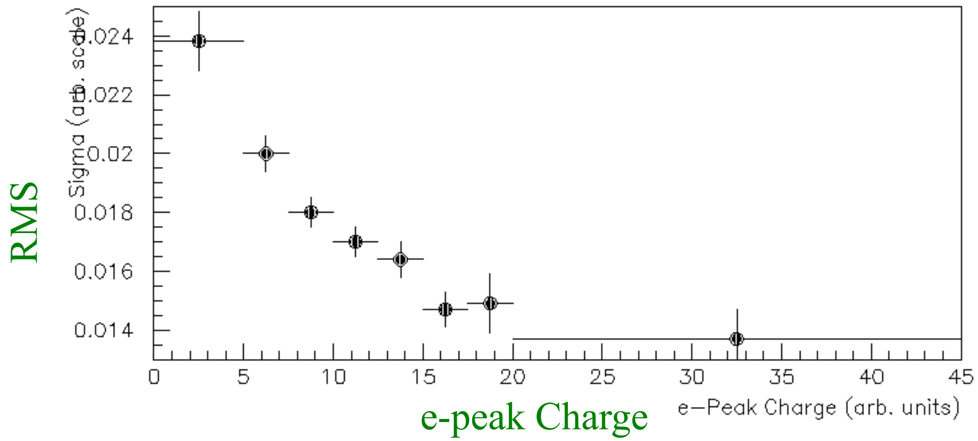


e-Peak Charge (arbitrary units) vs Total Charge

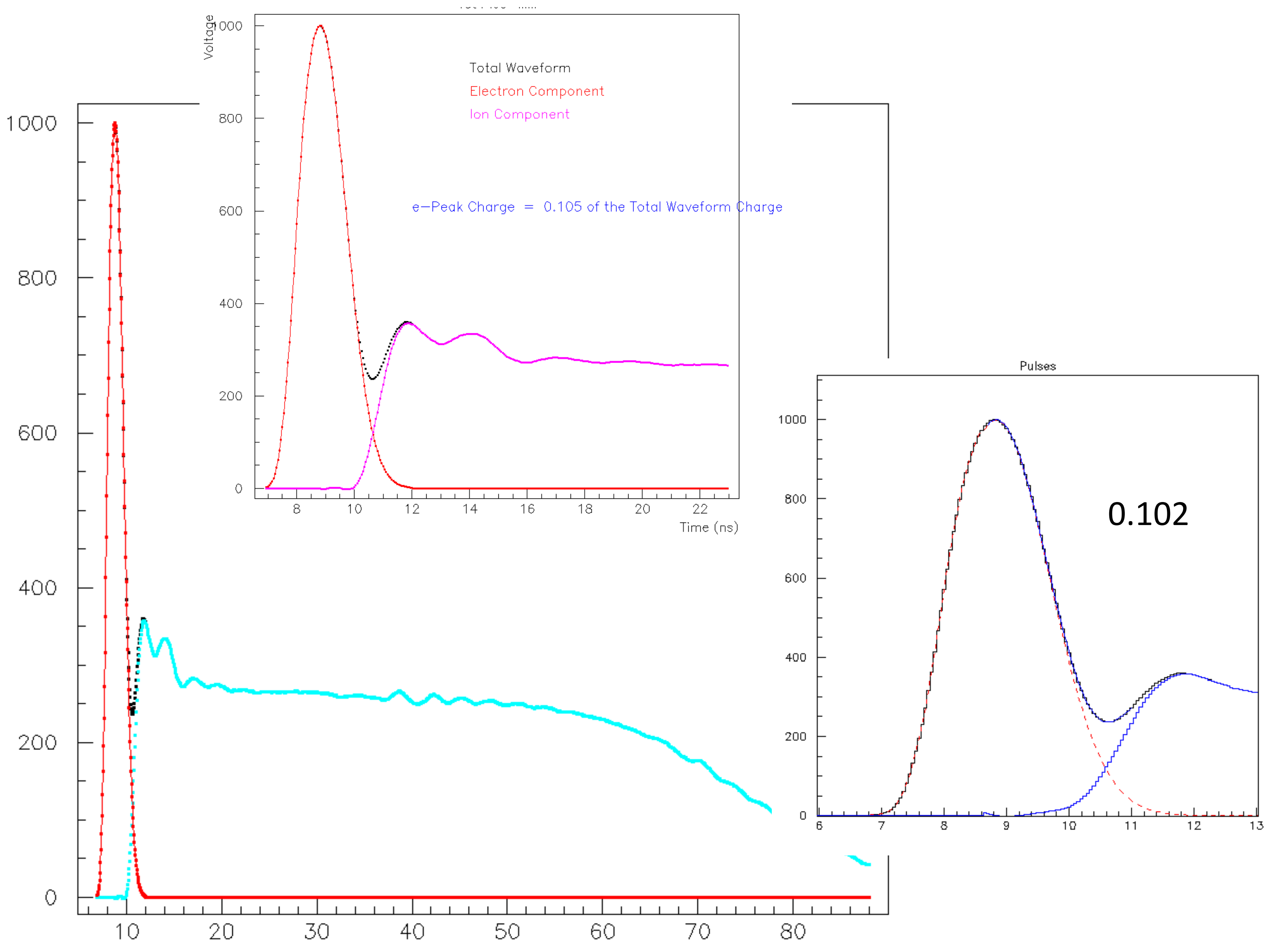






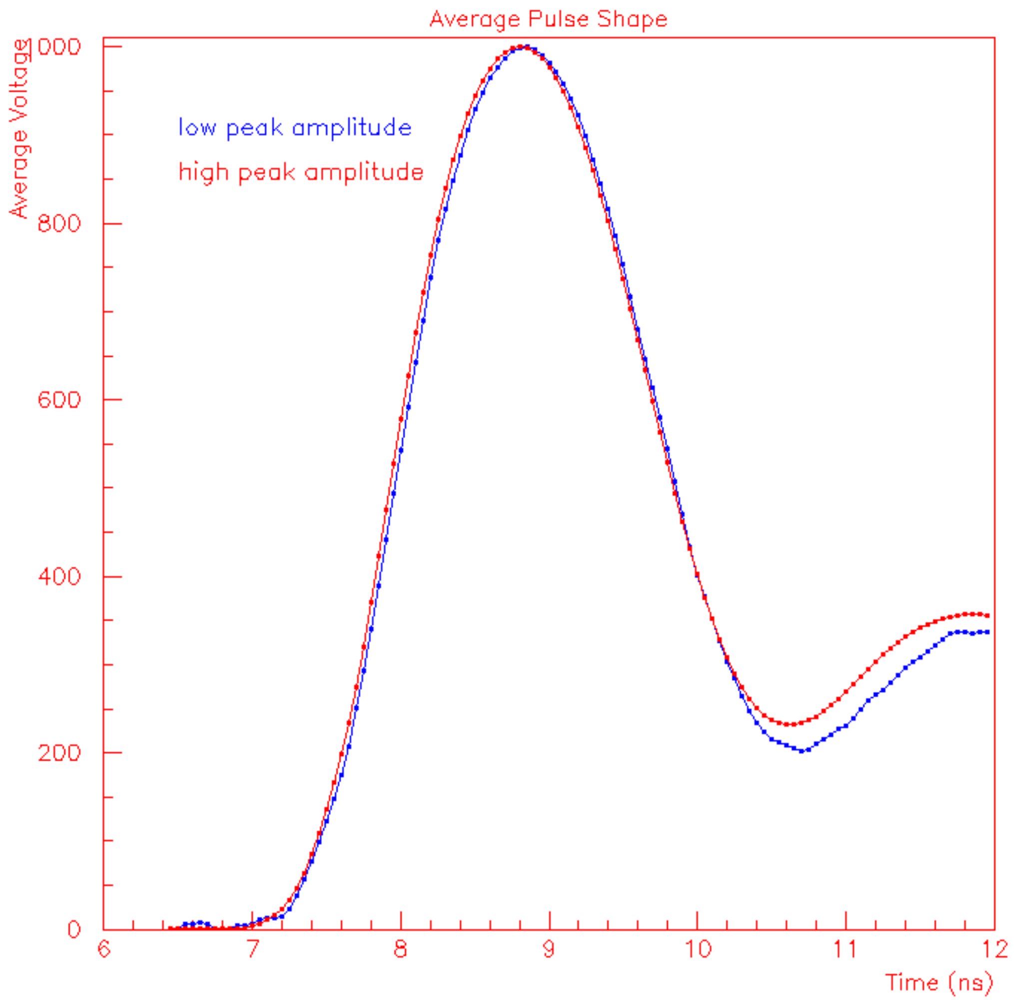


Estimation of the absolute e-Peak to Total Charge Ratio



However, the average waveform shape depends on the e-Peak amplitude

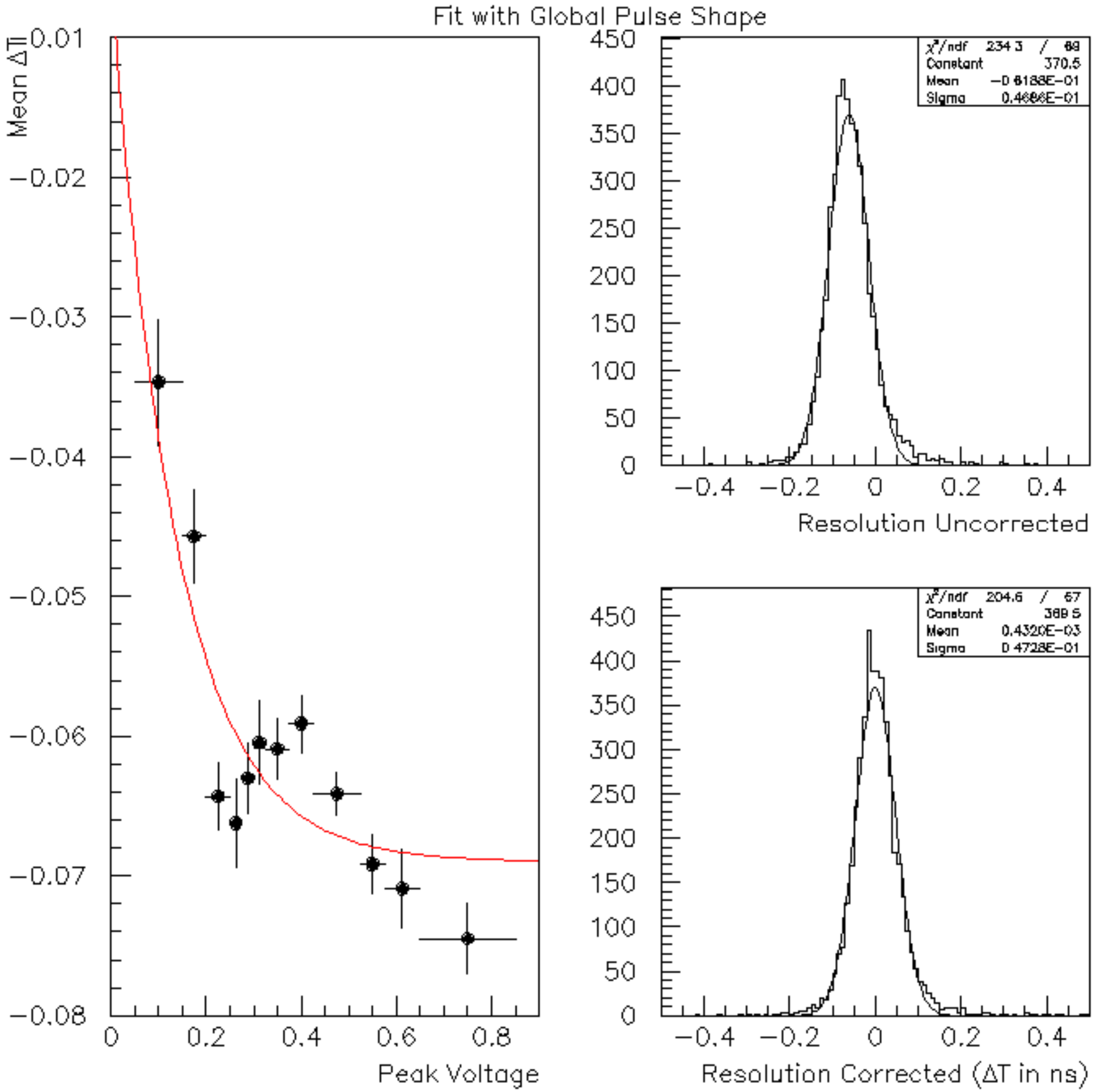
Does the timing by fitting an average pulse shape suffers from slewing?



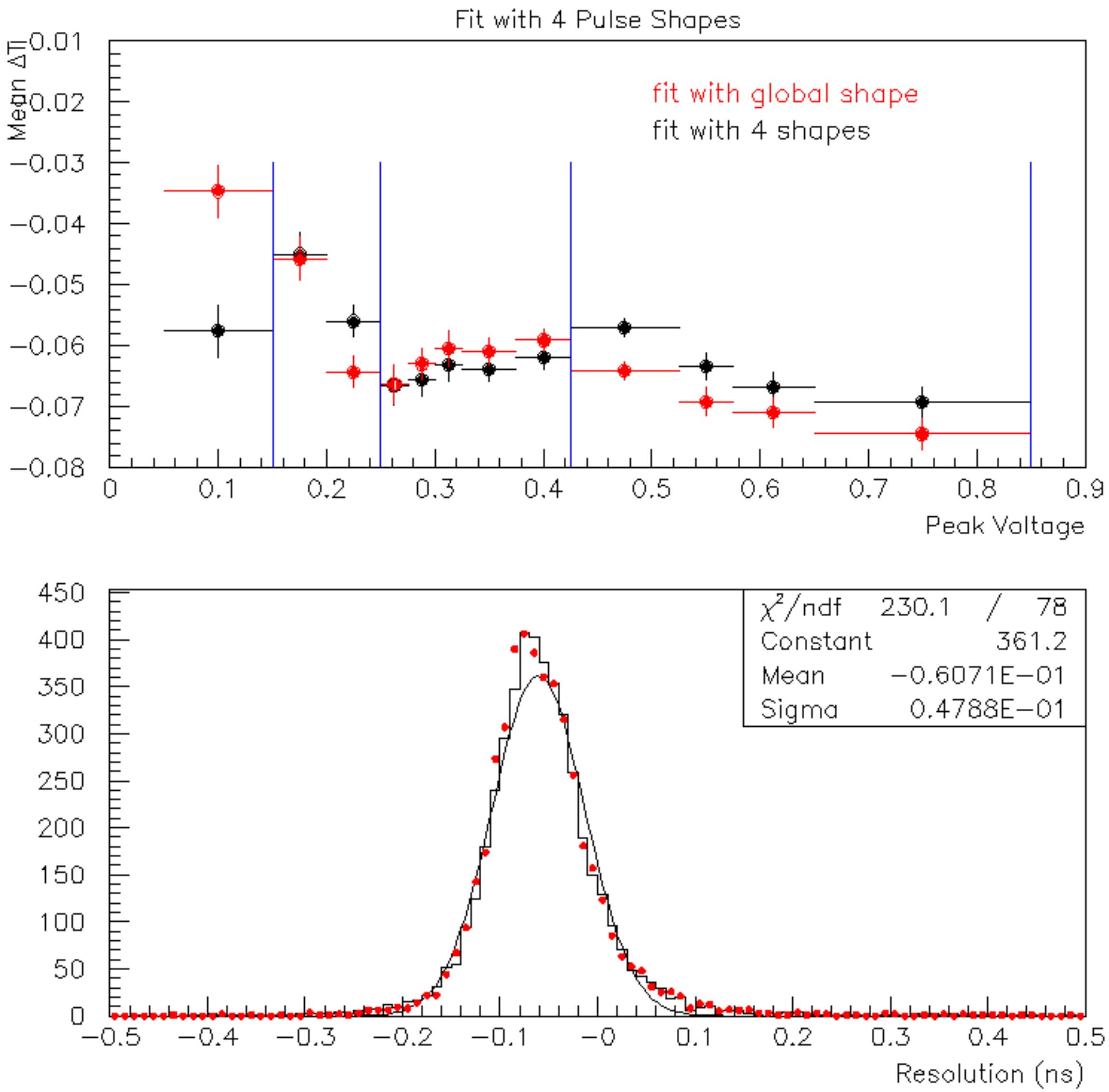
Low: V_{peak}<0.15V

High: V_{peak}>0.425V

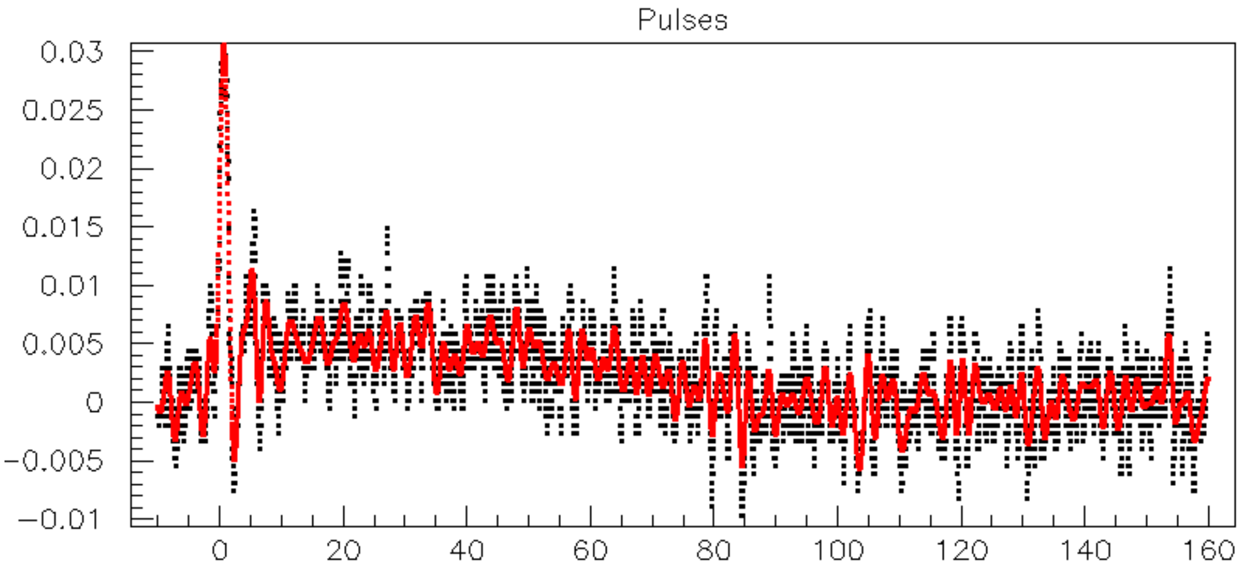
The timing by fitting an average pulse shape suffers from slewing !

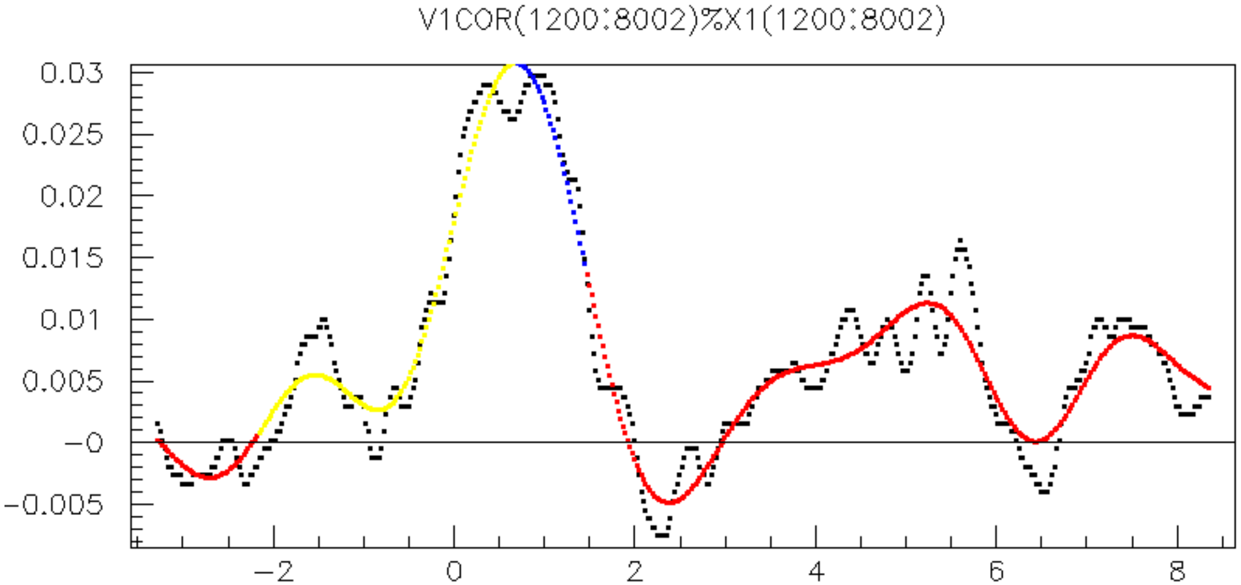


An attempt to fit with e-peak' amplitude depended shapes

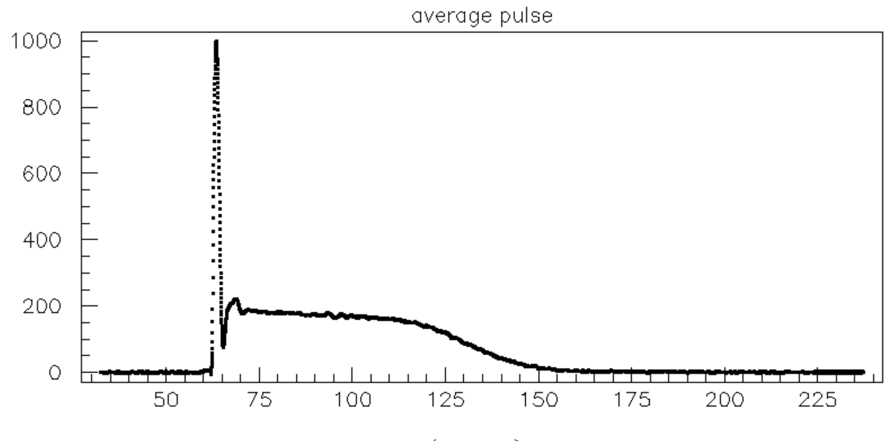


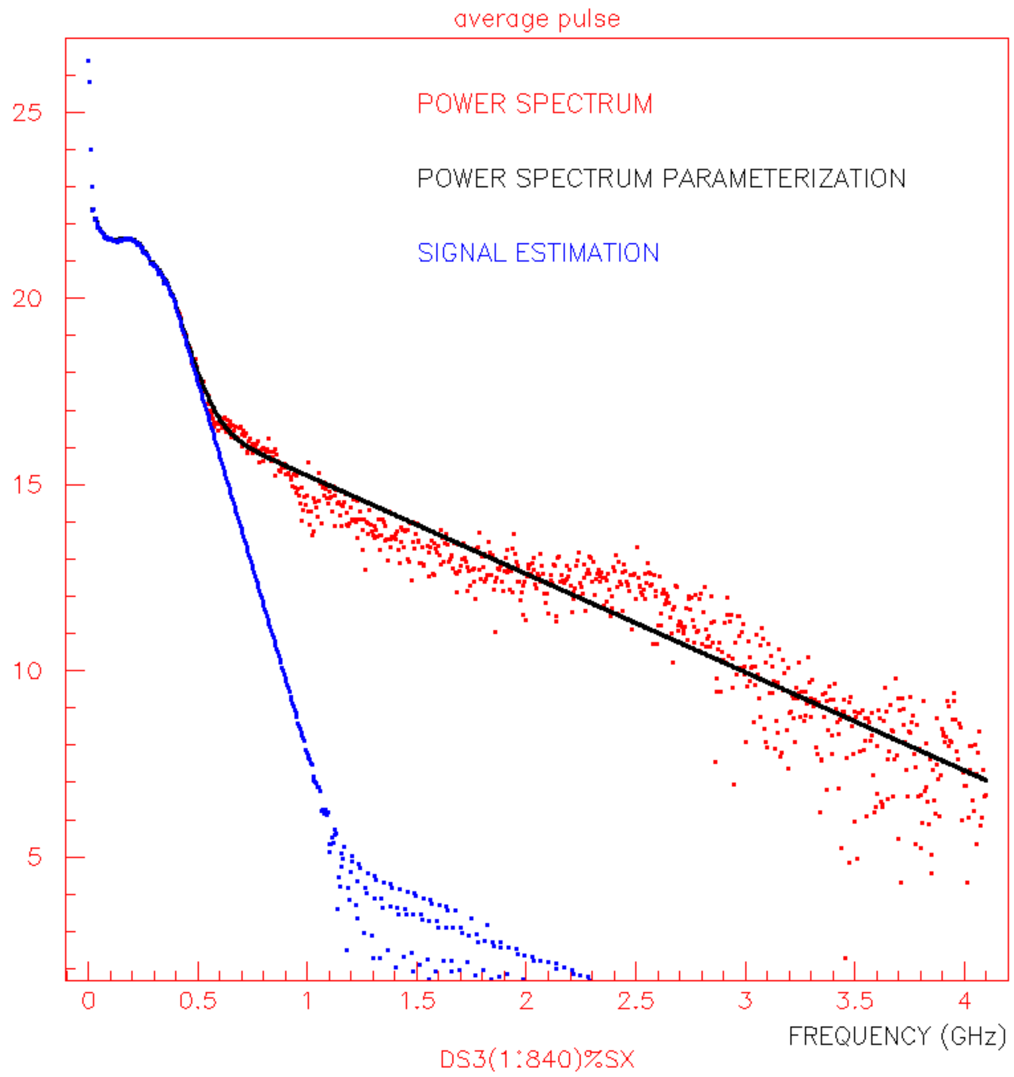
Calibration Analysis --- Very Preliminary

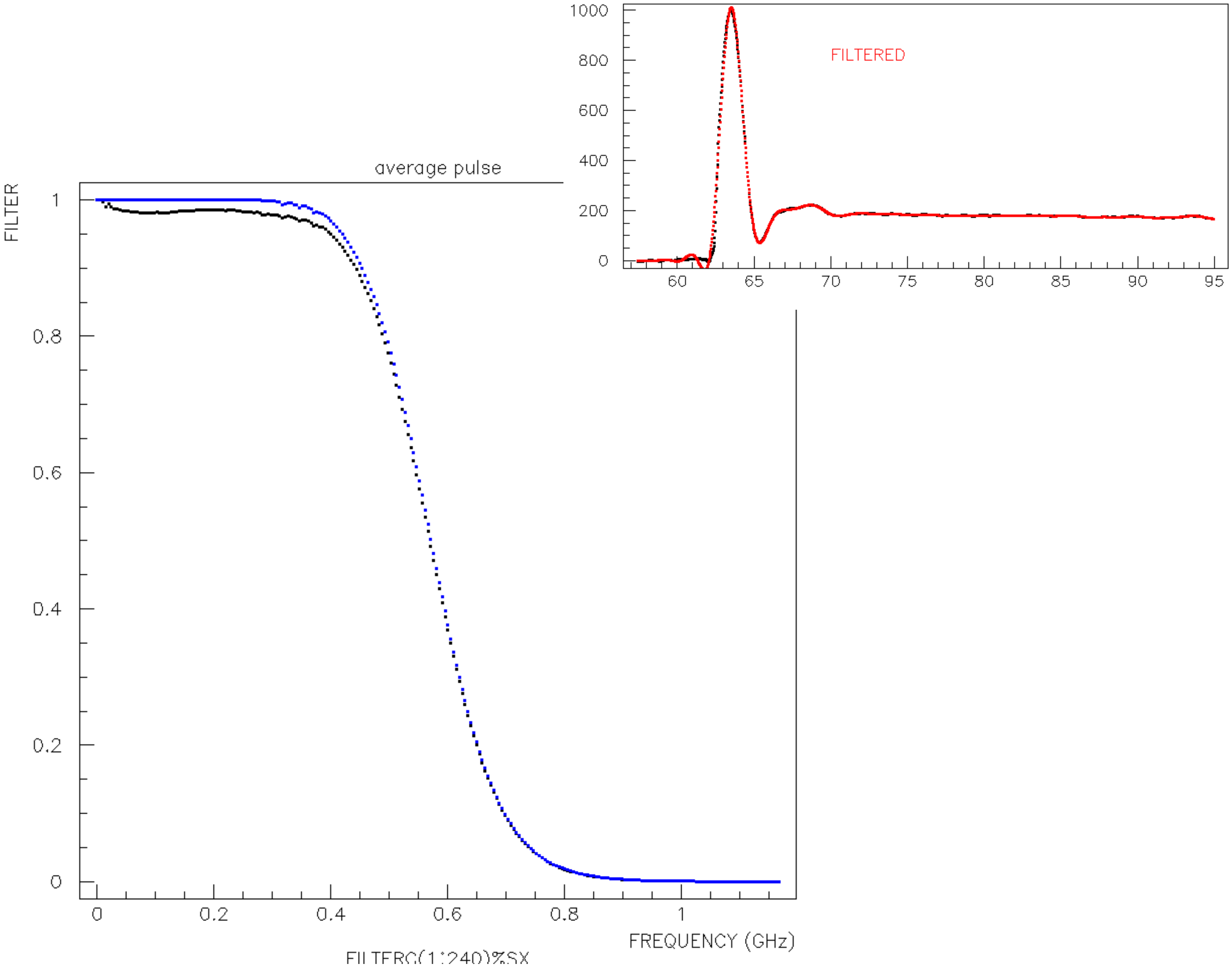




Calibration Analysis --- Very Preliminary







1000
800
600
400
200
0
60
65
70
75
80
85
90
95
FILTERED
average pulse
FILTER
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
FREQUENCY (GHz)

WITHOUT any filtering