

Data Analysis for Bo VST

Linearity Tests and Filter Kernel Improvements

Talk 5 of 6

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Linearity Tests

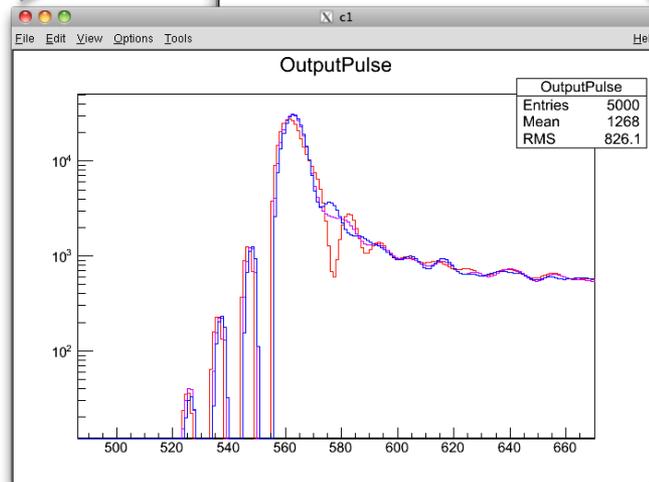
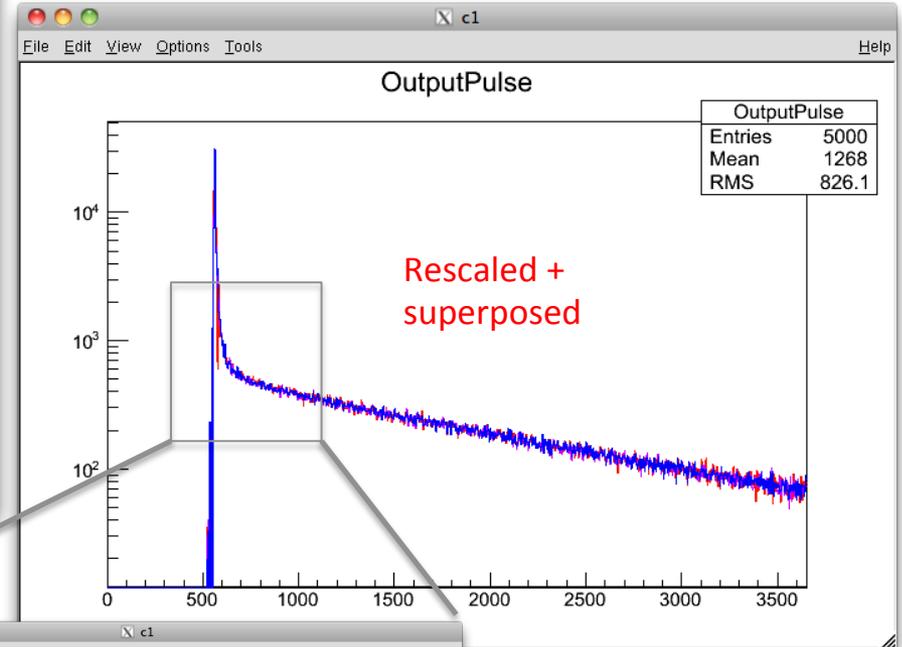
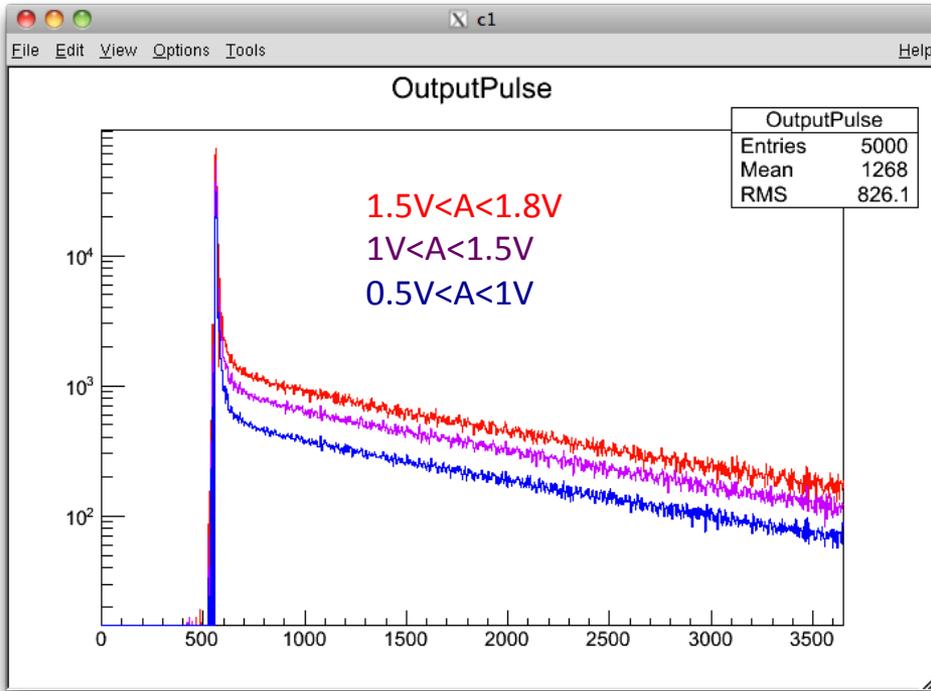
Fourier methods assume a linear system. If we had pulse nonlinearities, these would manifest themselves as shape distortions.

This would also affect template based fit methods to be described later.

Two tests :

- 1) Divide cosmic sample up by pulse height, compare pulse shape in different subsamples. If a nonlinearity artifact, expect more intermediate component in upper half.
- 2) Compare impulse response shapes for LEDs pulsed at different intensities. If all identical up to a scale factor, response in this range is linear. Note that this will not necessarily be true over the whole range of data, since LED intensity range is limited.

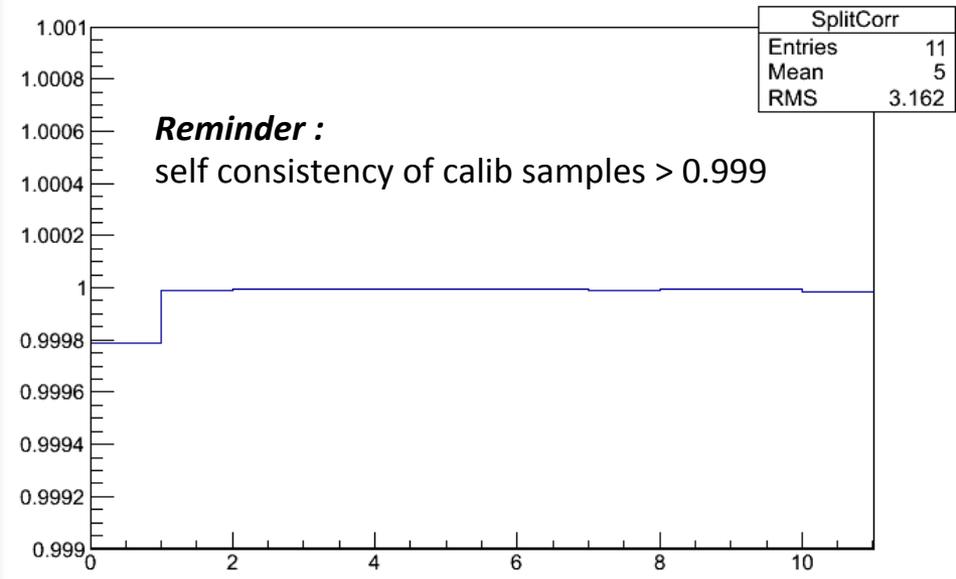
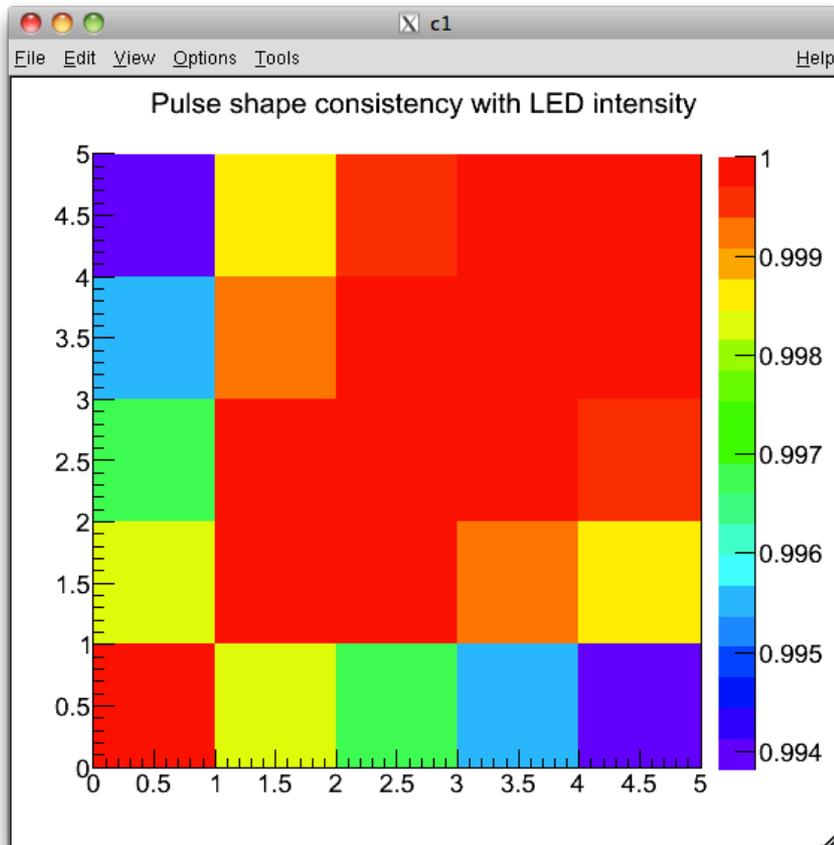
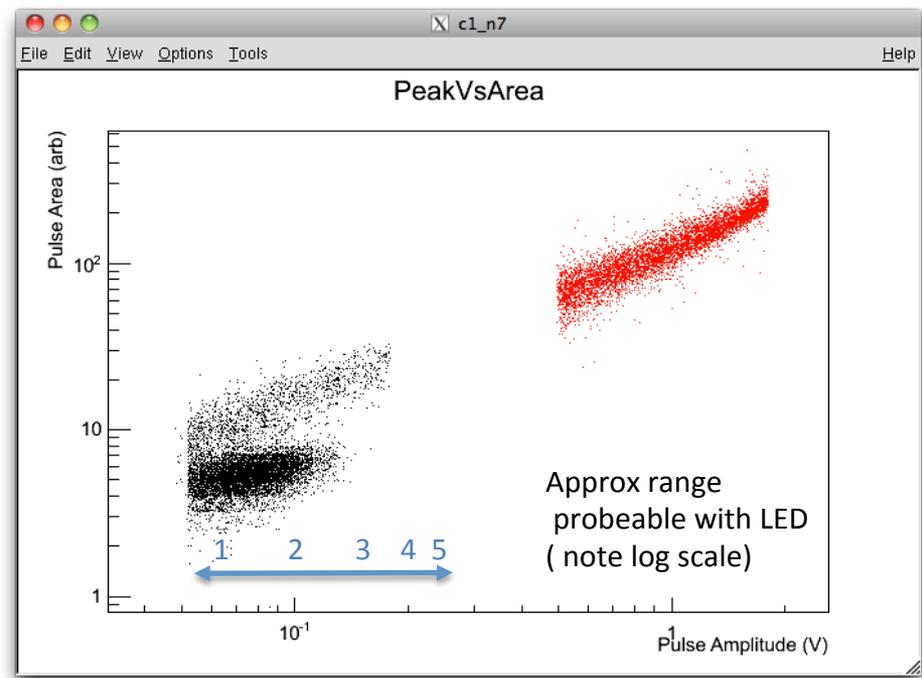
Divide cosmics sample into three parts

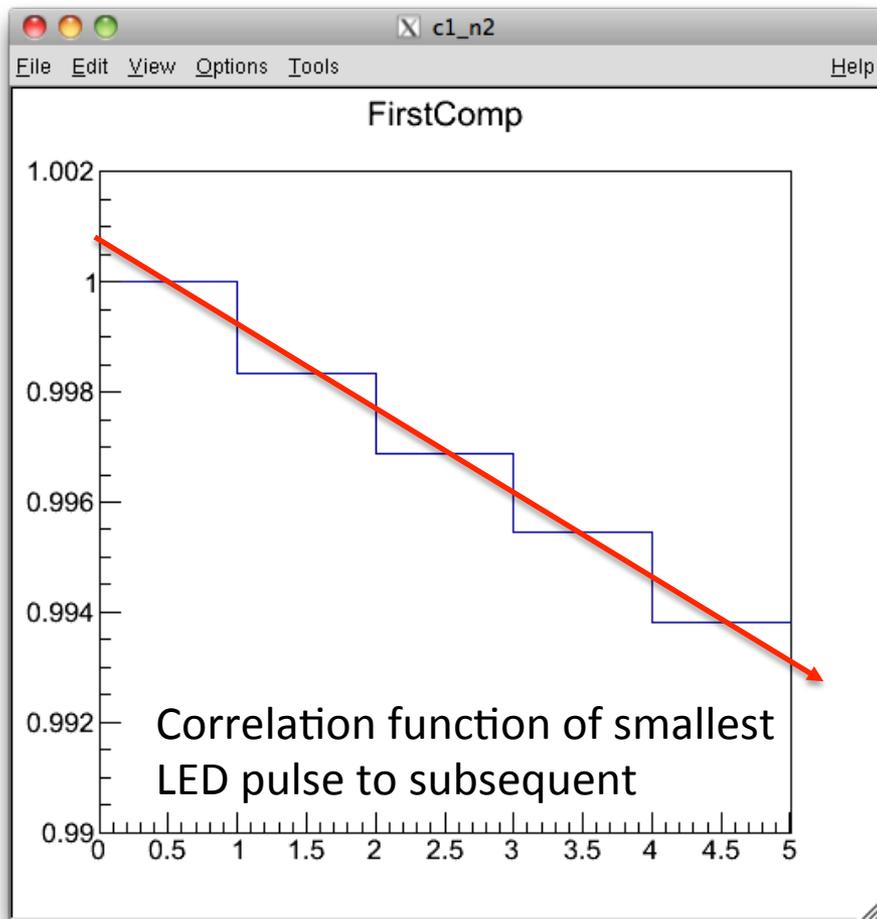


This ringing is an obvious saturation artifact.

Intermediate light is possibly unaffected... but shape discrepancy here is troubling

Pulsed LED Linearity Test





(note : not a rigorous treatment)

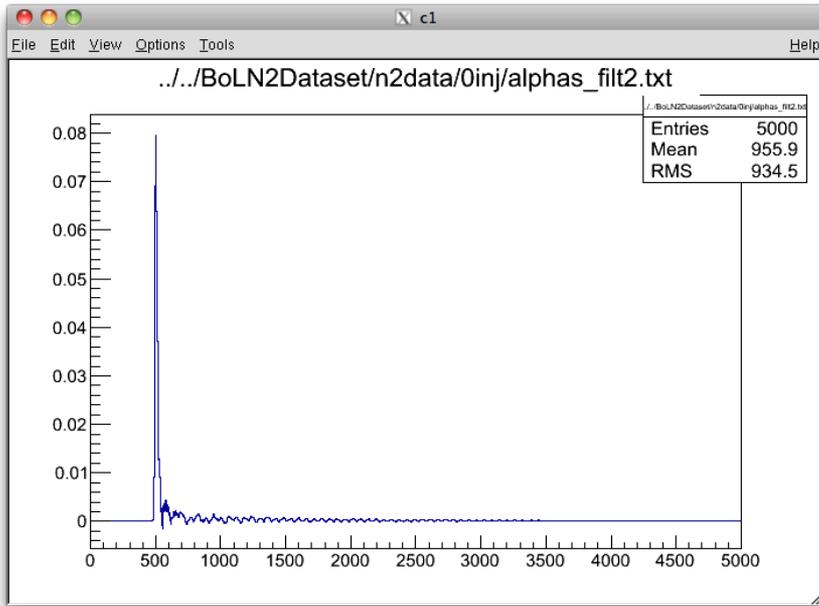
The LED measurements span a $\sim 0.2V$ region and see a 0.6% deviation in pulse shape.

If we extrapolate linearly from here up to cosmic (1V) region, we can expect $O(3\%)$ shape distortions between signal and deconvolution kernel.

This could be enough to account for intermediate light as a nonlinearity effect.

These preliminary indications are suggestive. More investigations are underway.

Alphas and pulse shape

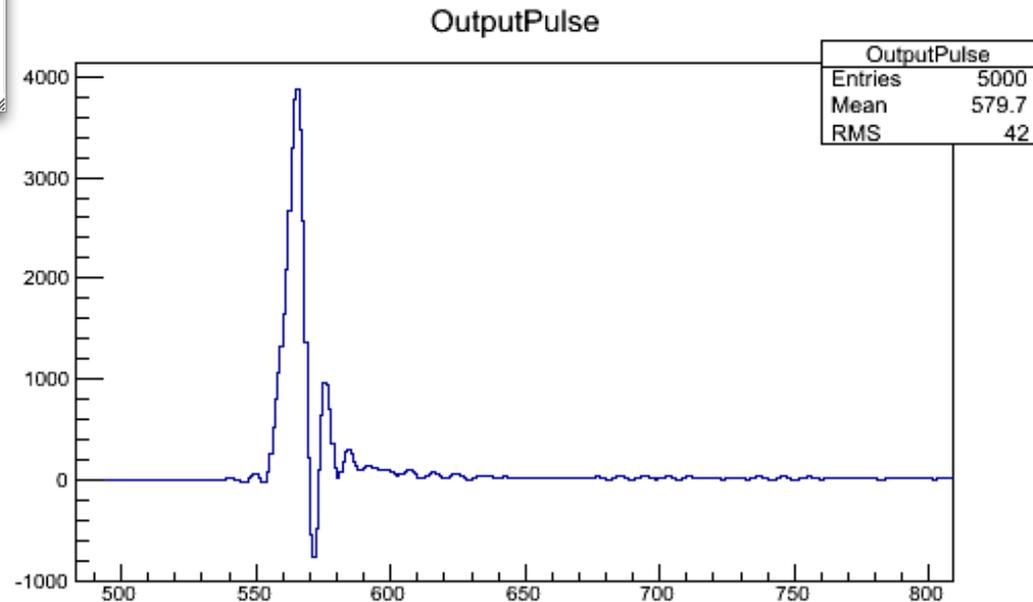


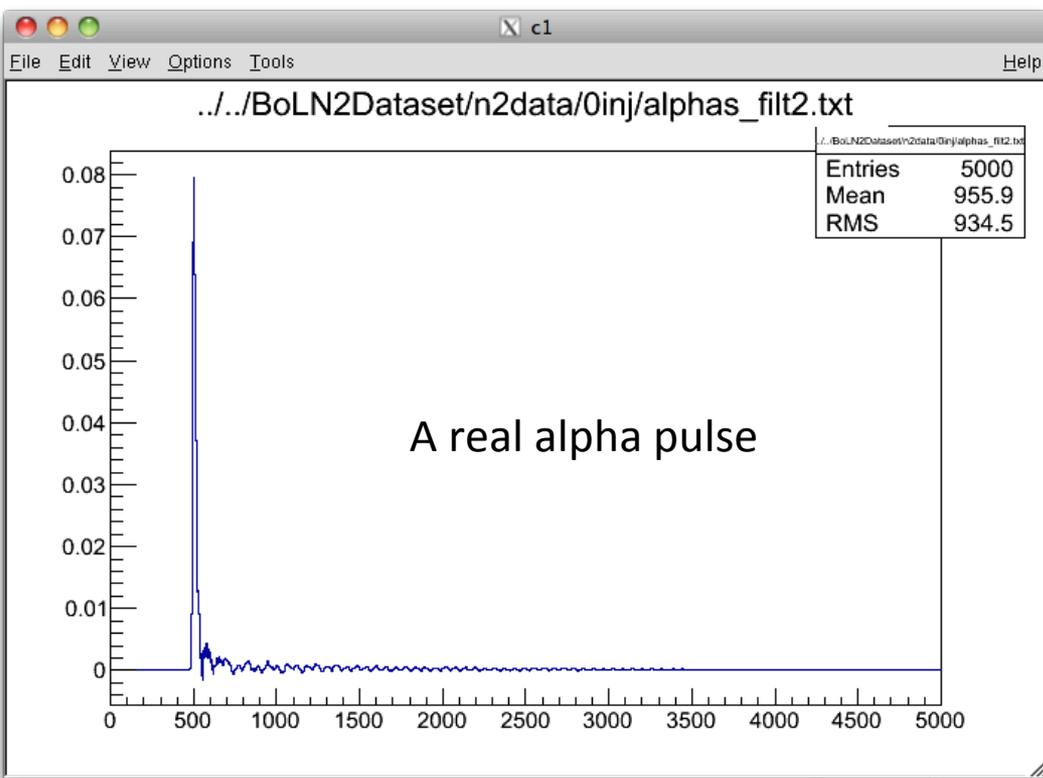
Alpha samples always deconvolve badly.

We had interpreted this as a frequency cut effect, since the alpha pulse is much sharper.

We can test this using the toy model described previously.

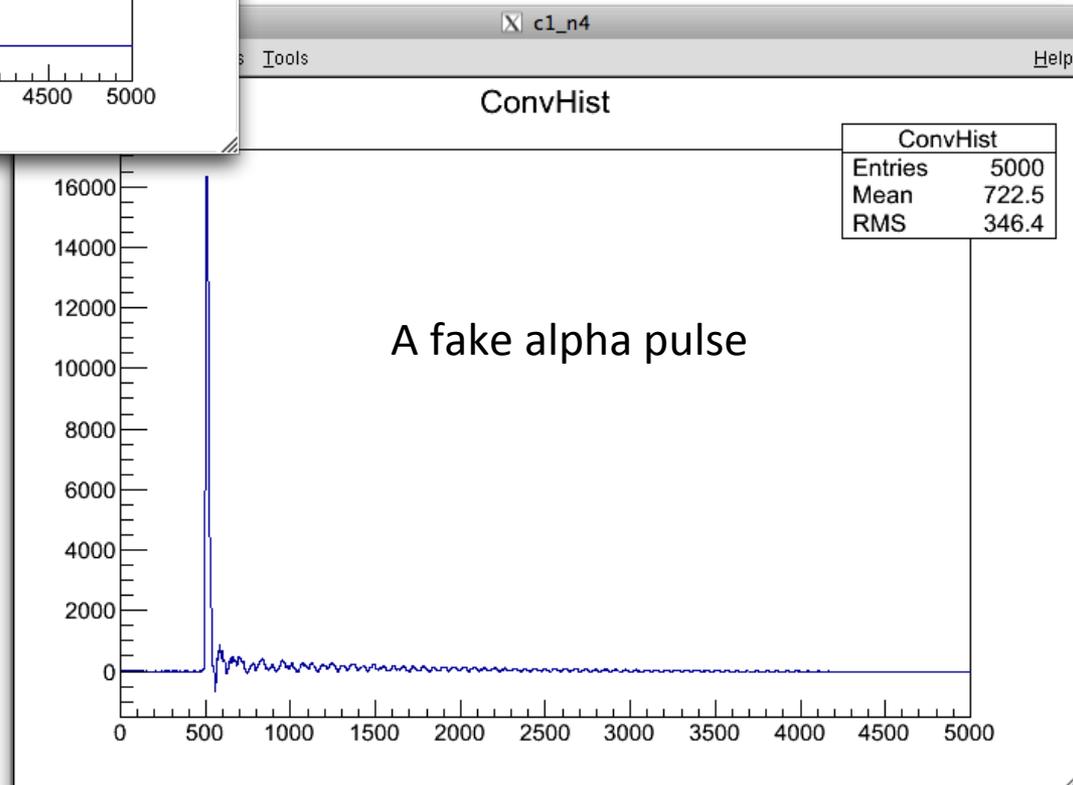
Deconvolve



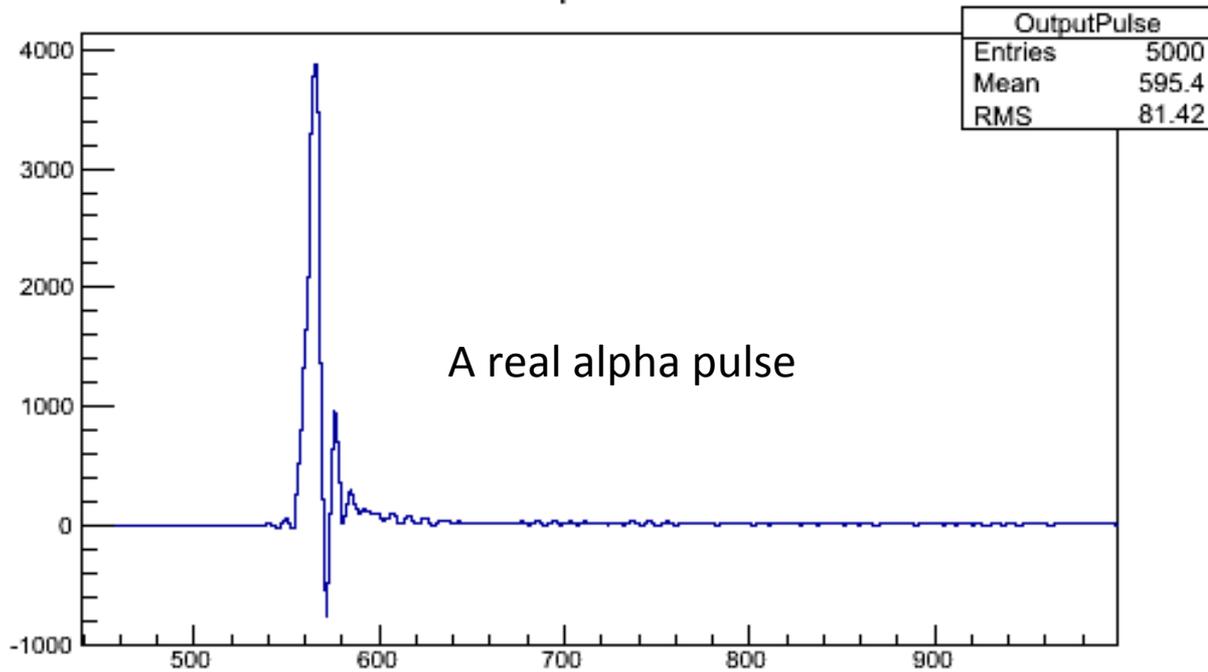


“Manufacture” an alpha pulse using the toy model we described previously

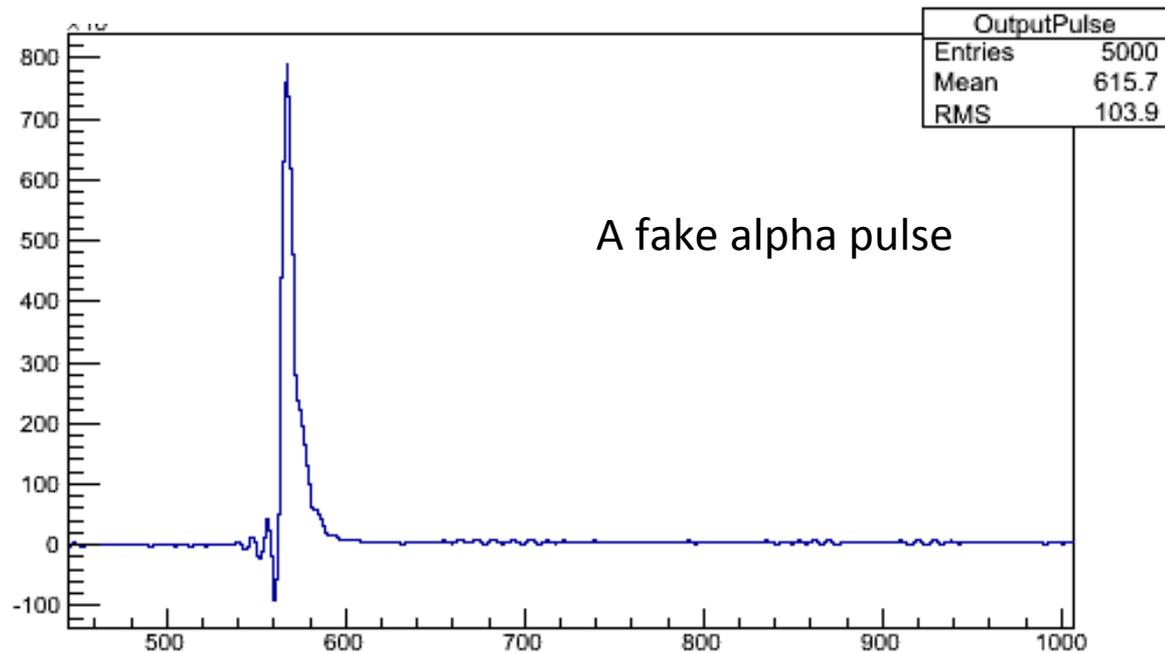
(we assume 2 time constants, 1640 and 7ns)



OutputPulse



ulse



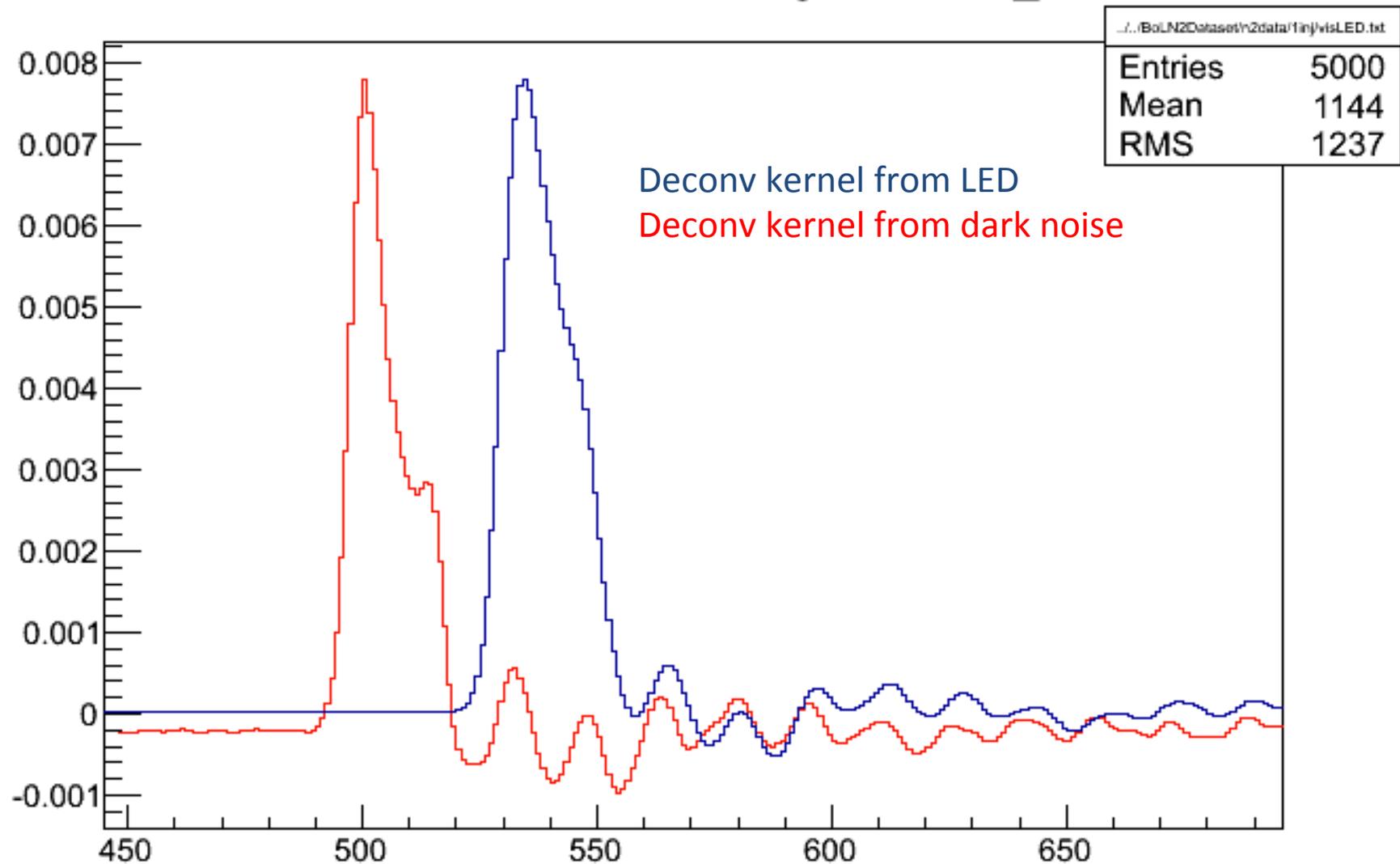
Major ring in falling tail does not appear to be a consequence of frequency cut.

Deconvolution Kernel Improvements

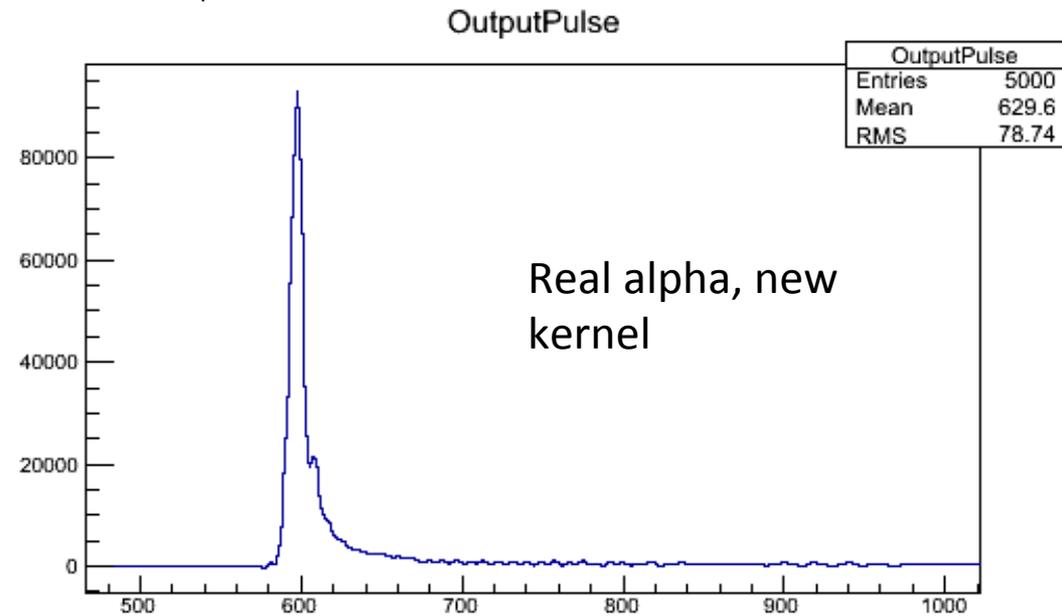
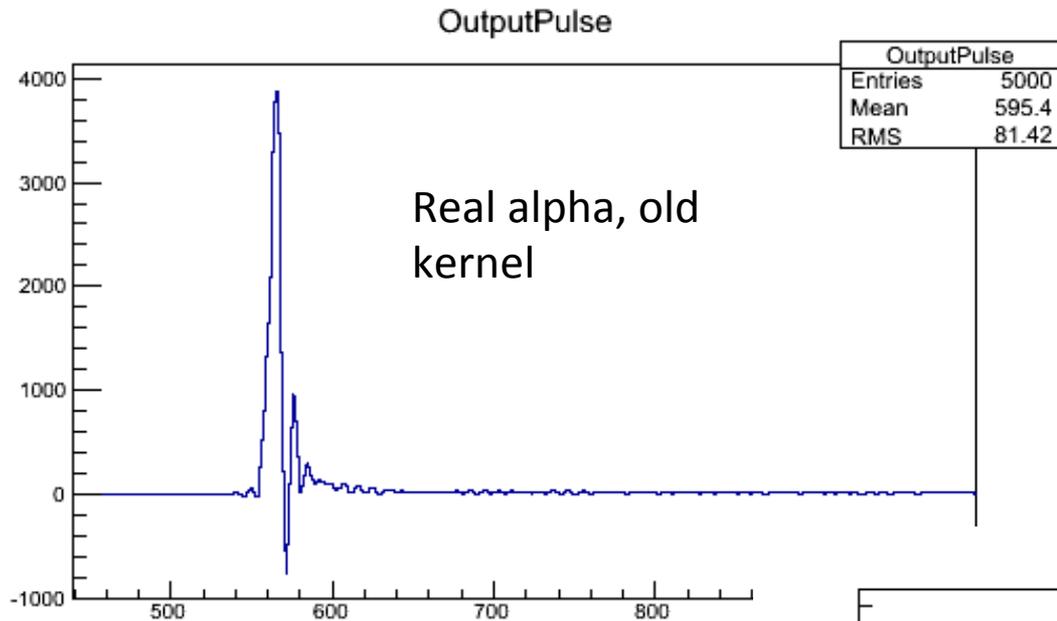
Warning : hot off the press

- Also possible that the deconvolution kernel obtained with the pulsed LED is the cause of the alpha problem
- Analysis of voltages on the LED pulser board suggests that even when driven with a 1ns pulse, the LED time profile is a 20ns wide with nontrivial shape
- Light production profile from this pulse is likely nontrivial
- This has prompted us to investigate other methods for obtaining the deconvolution kernel (central to both analysis methods)
- We have made a major effort at closing light leaks, and now single PE based kernel may be possible

../../BoLN2Dataset/Calib/SinglePEDark_filt2.txt



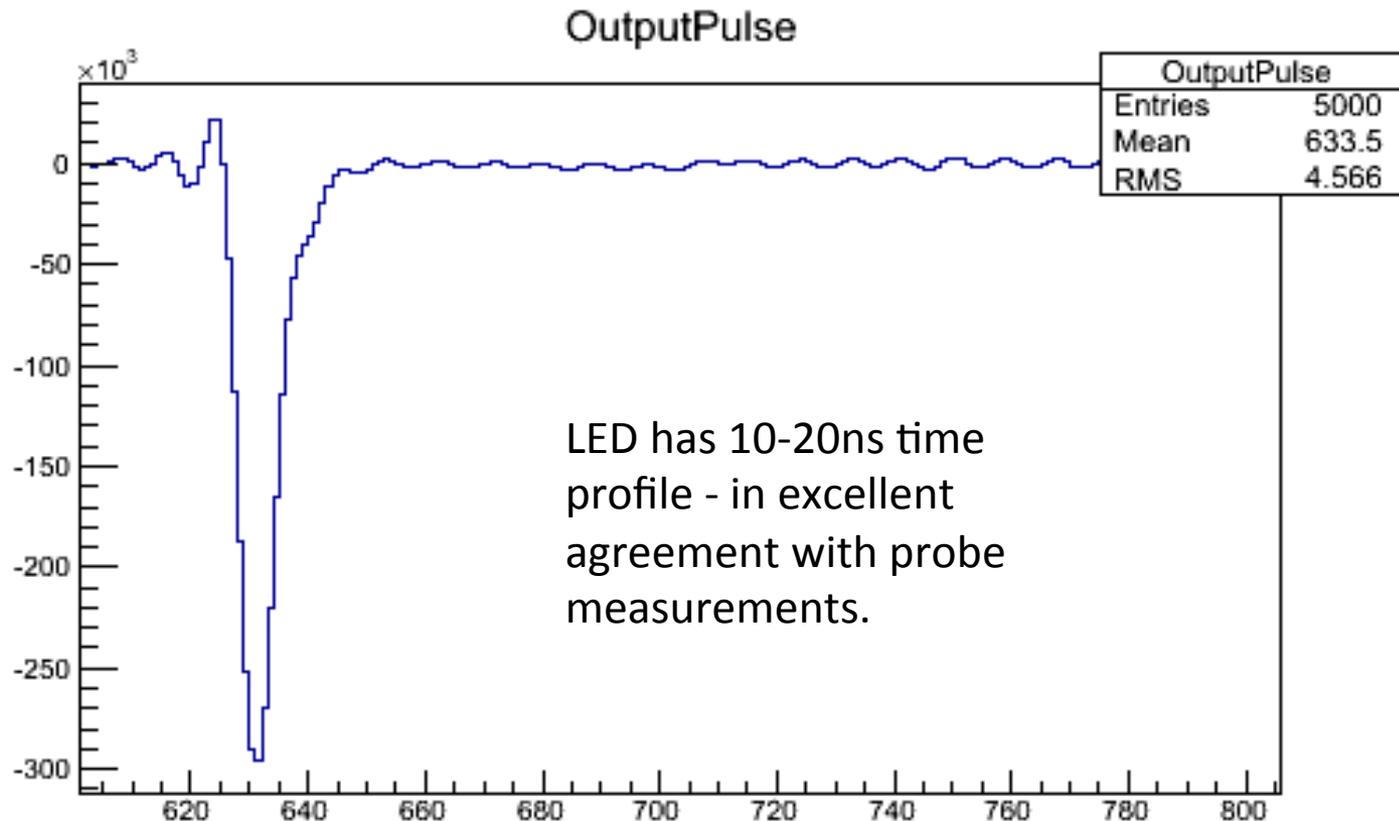
Improvement of Alpha Deconvolution

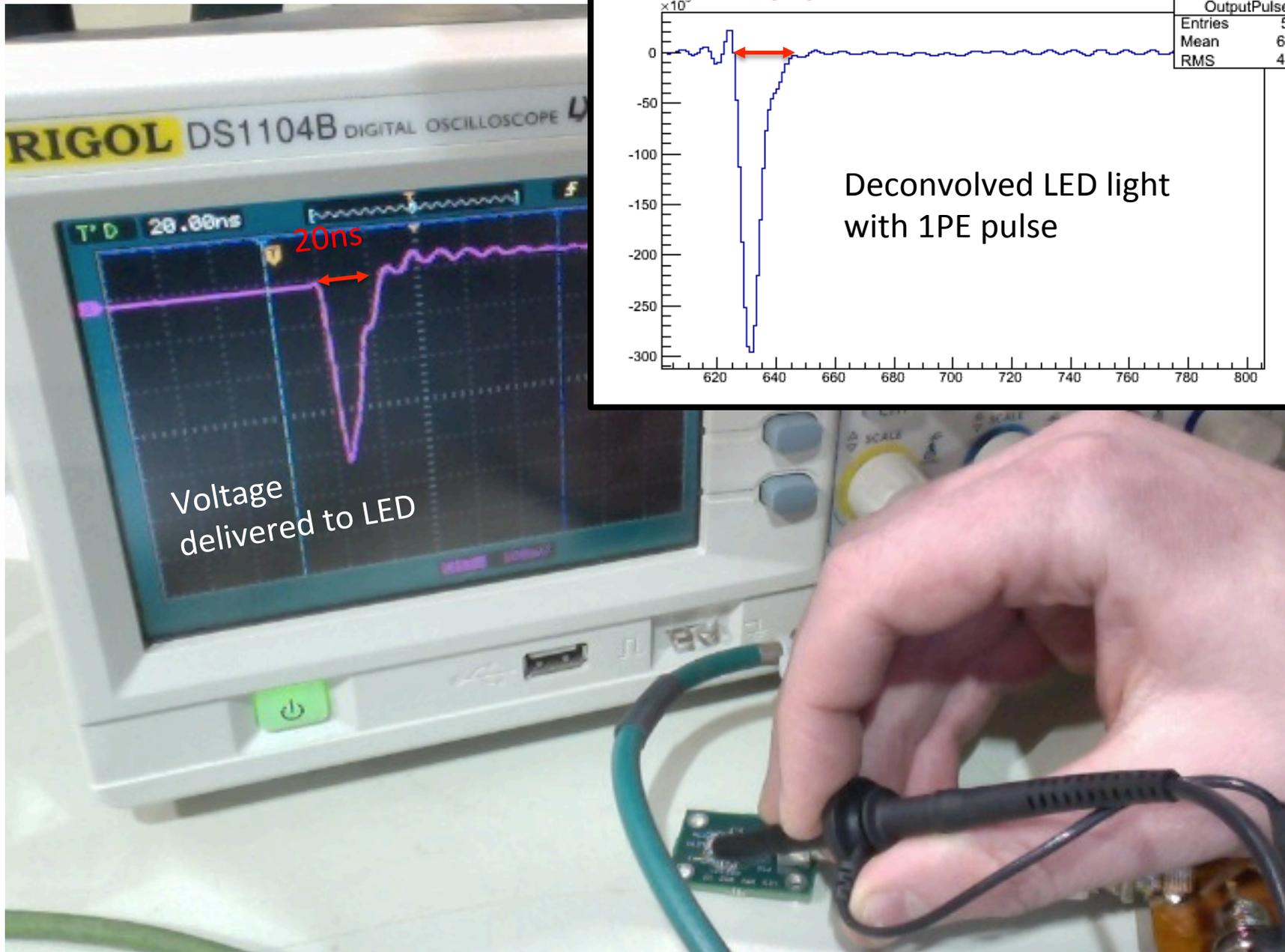


A BIG improvement.

What is the time profile of the LED?

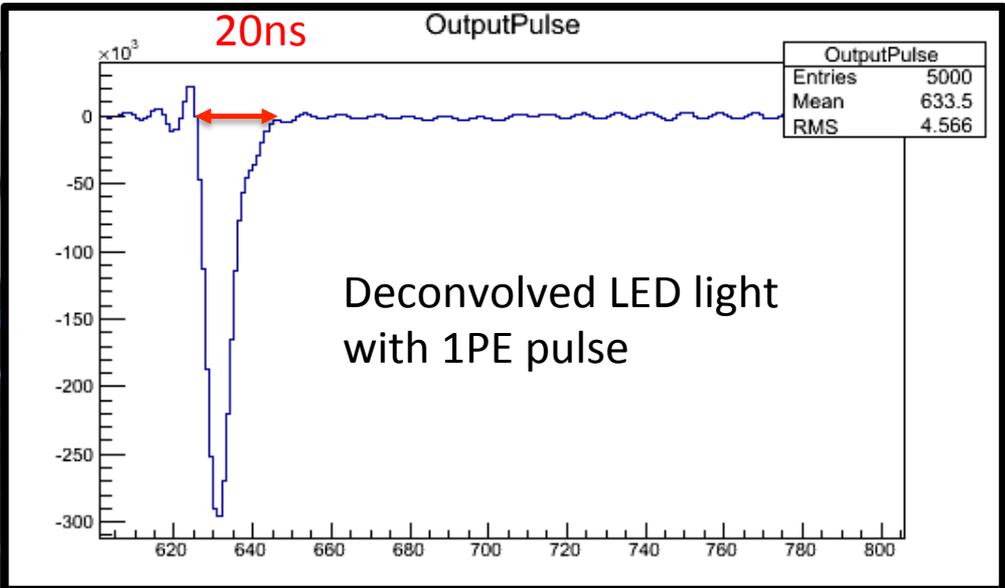
- So what were we using as an impulse response before?? Deconvolve with dark pe function to find out!





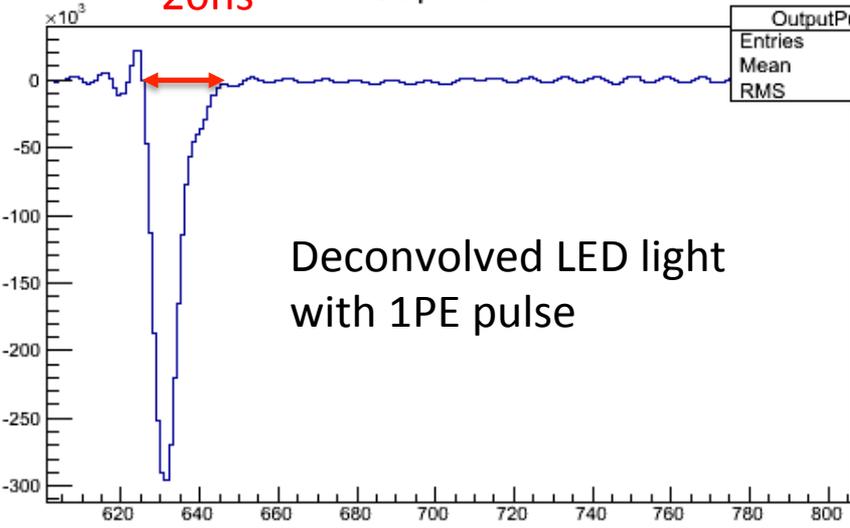
Voltage delivered to LED

20ns



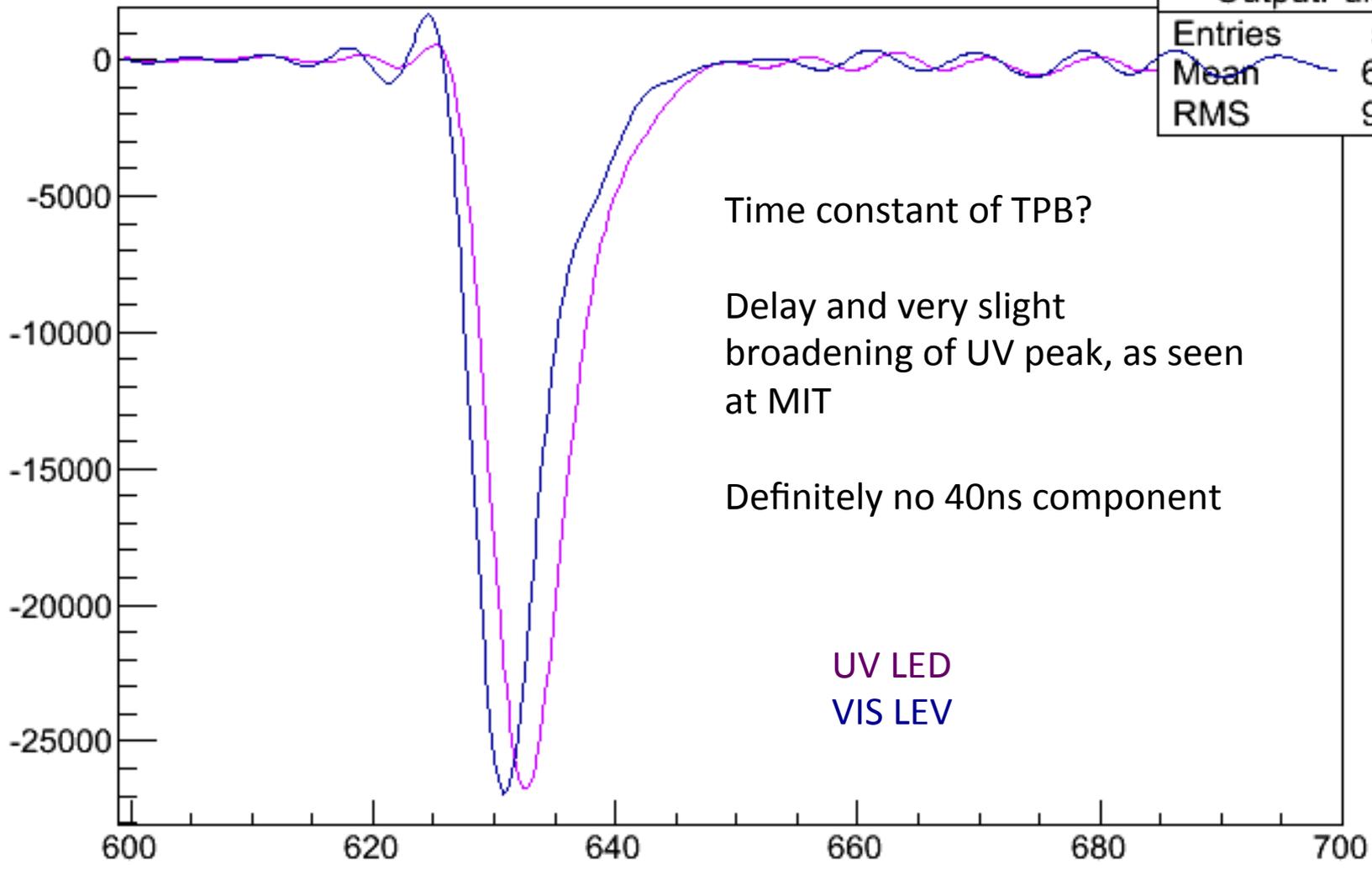
20ns

OutputPulse



OutputPulse

OutputPulse	
Entries	5000
Mean	635.6
RMS	9.154



Time constant of TPB?

Delay and very slight broadening of UV peak, as seen at MIT

Definitely no 40ns component

UV LED
VIS LEV

Summary

- Troubling nonlinearity issues are the final major systematic in understanding the pulse shape
- Some of them solved by improving deconvolution kernel by understanding LED time profile and a better 1PE determination
- Some remain problematic (cosmic sample nonlinearity in particular).
- In our opinion, no strong statement about the 40ns component can be made until this issue is closed.
- Latest improvements have not filtered through analysis chain yet – we expect improvements across the board soon.