An Analysis of Pulses from a Scintillation Counter

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Detector Pulses: Overall Mechanism

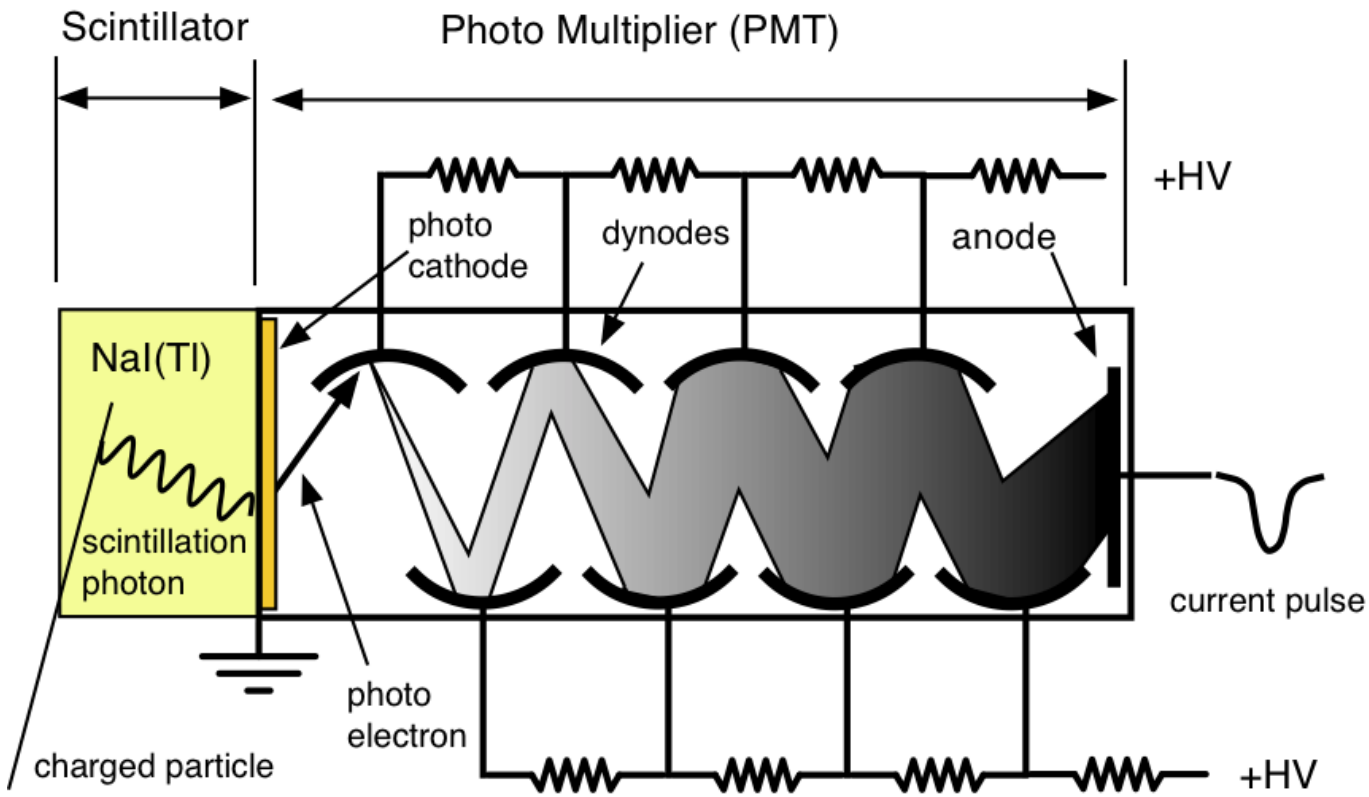

Figure 1: Source: http://wanda.fiu.edu/teaching/courses/Modern_lab_manual/scintillator.html

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- Signal empirically also fit to Landau distribution
- Two other characteristics:
  - Baseline: Initial voltage, voltage with no signal
  - Jitter: Small, statistical fluctuations

Landau Distribution

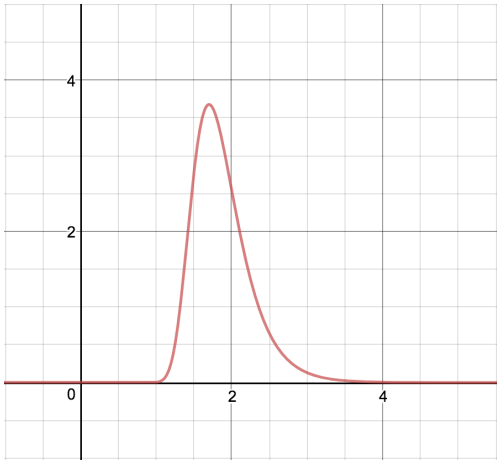
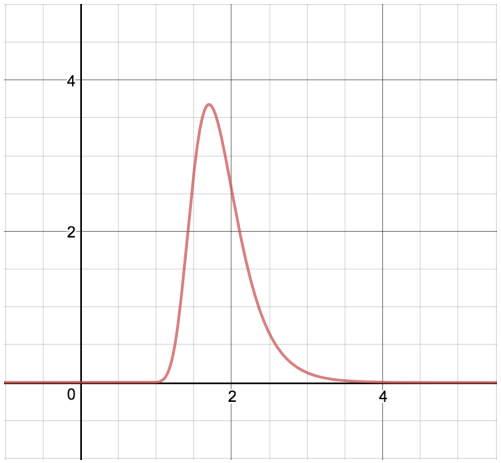


Figure 2: An example of the Landau distribution

Landau Distribution



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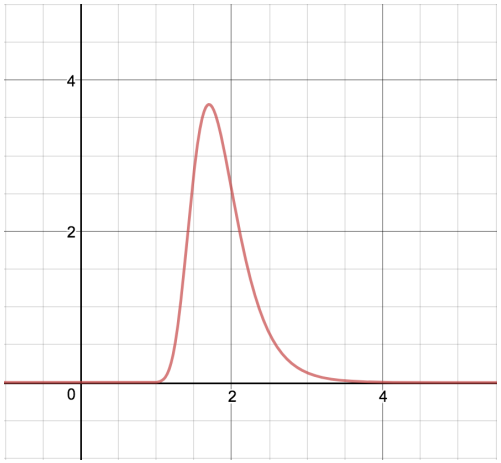

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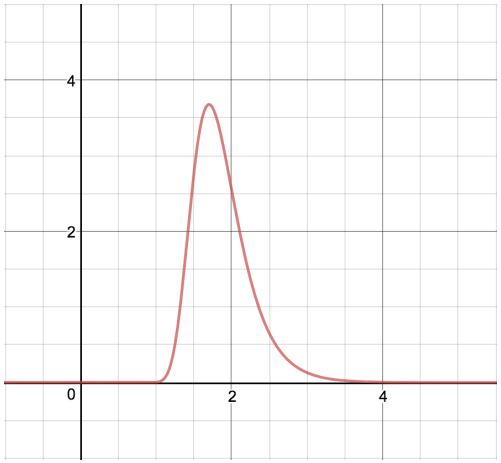

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- Asymmetric, fat-tailed distribution
- Very high rise rate
- Parameters A (height), μ (center), η (width):

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Identify the number of pulses which pass through a photomultiplier

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- Use regression to fit Landau distributions to existing pulses
- Analysis in parameter-space of these distributions
- Simulate new pulses from known statistics
- Write an algorithm to identify pulses, tested on these simulated data

Regression

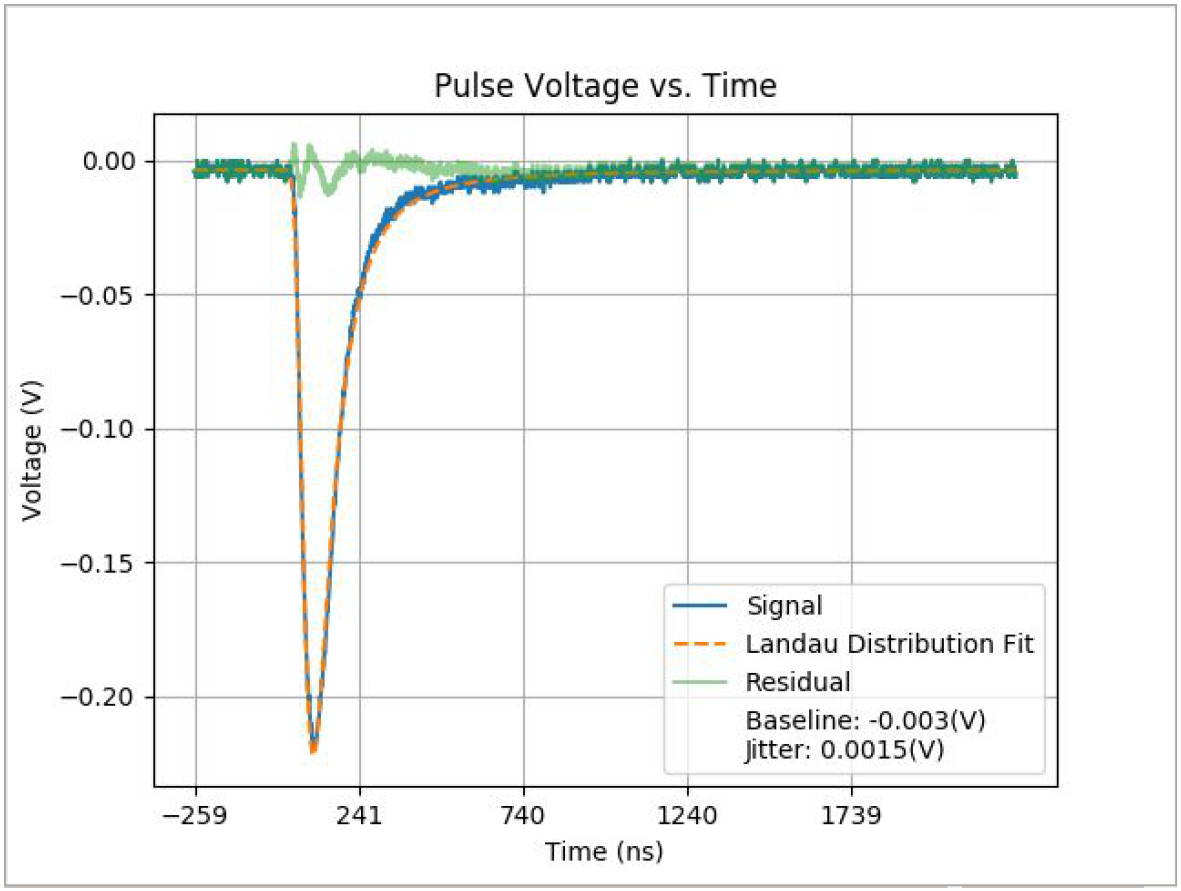

Figure 3: A graph of the signal from a single pulse, fitted to the Landau distribution. The baseline voltage and statistical jitter are also shown.

Regression Parameters

- Around 450 data files analyzed

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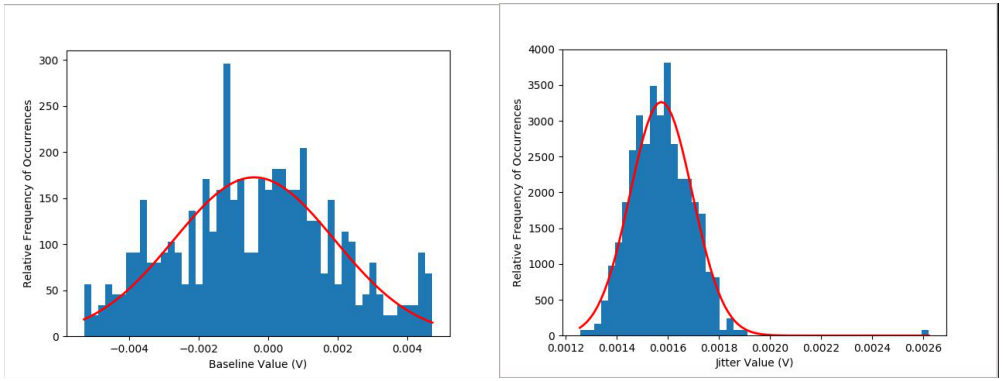
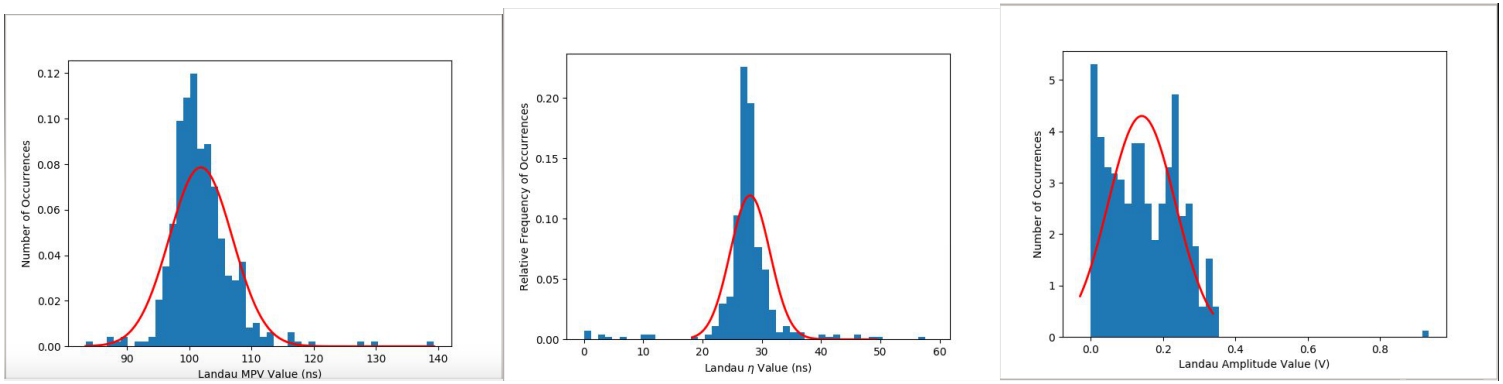
- Histograms used to generate random values for simulated curves

Analysis of Regression Parameters



(a) Baseline (b) Jitter



(c) Peak Position (d) η (e) Amplitude

Figure 4: Regression Parameters. Blue = Histogram Data. Red = Gaussian Fit.

Simulation

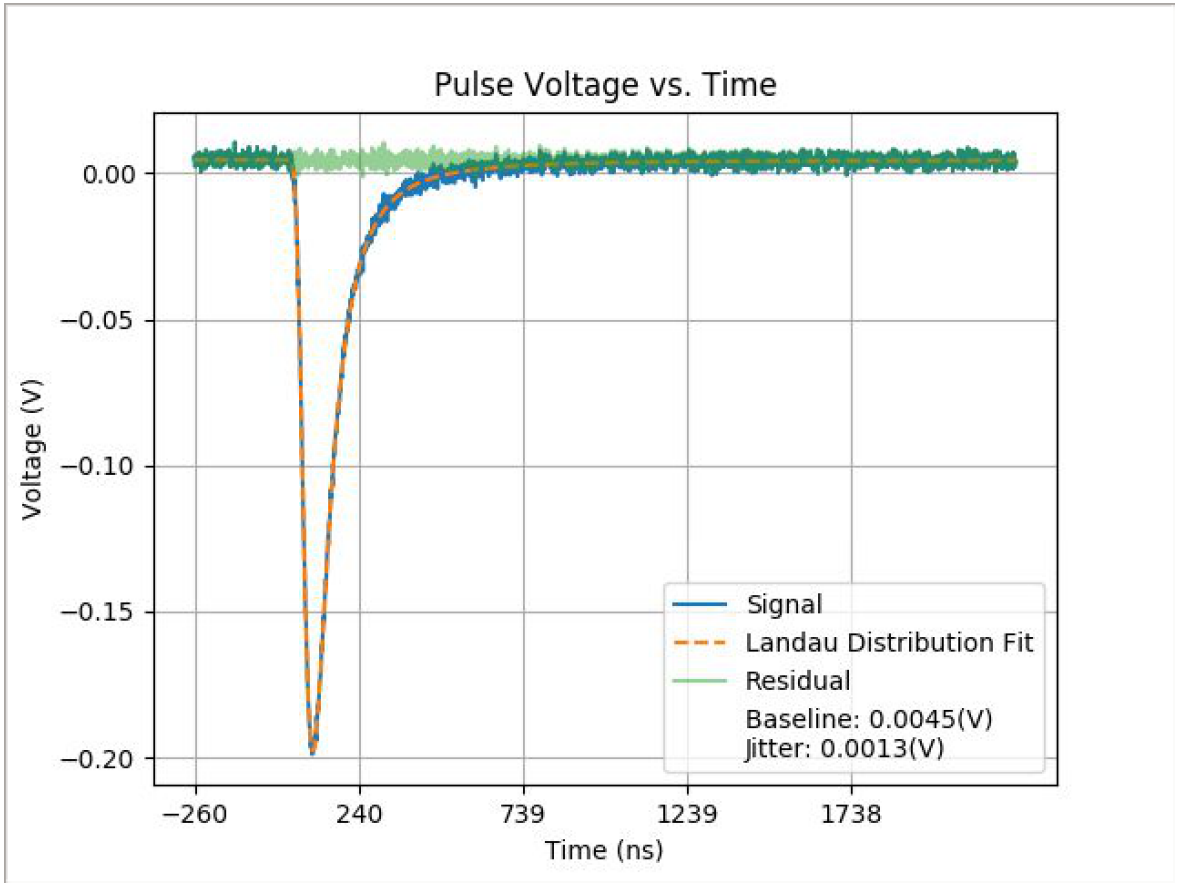


Figure 5: A graph of a simulated signal from a single pulse fitted to a Landau distribution. Note the absence of a perturbation in the residual.

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  - Make changes to parameters

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- High-powered methods do not produce substantial improvements

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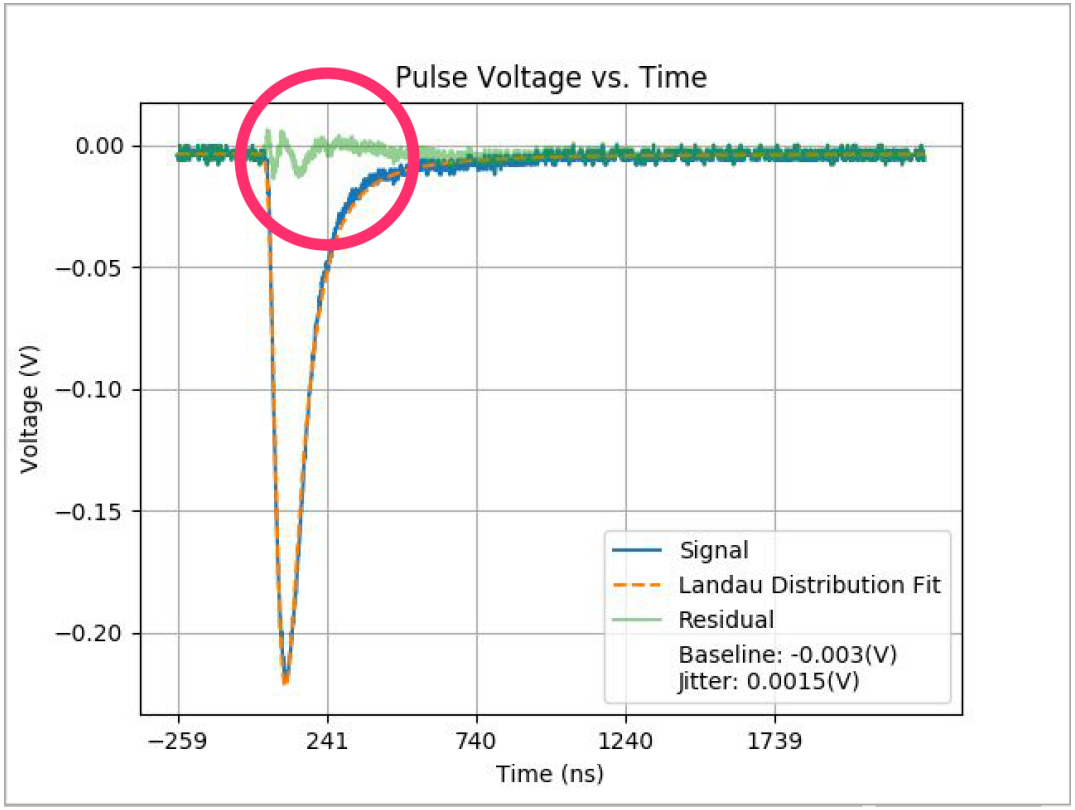
- Efficient method of generating simulated pulses
- Useful for analyzing particle counts from PMTs, but more work needed

Future Work: Improvements on the Model



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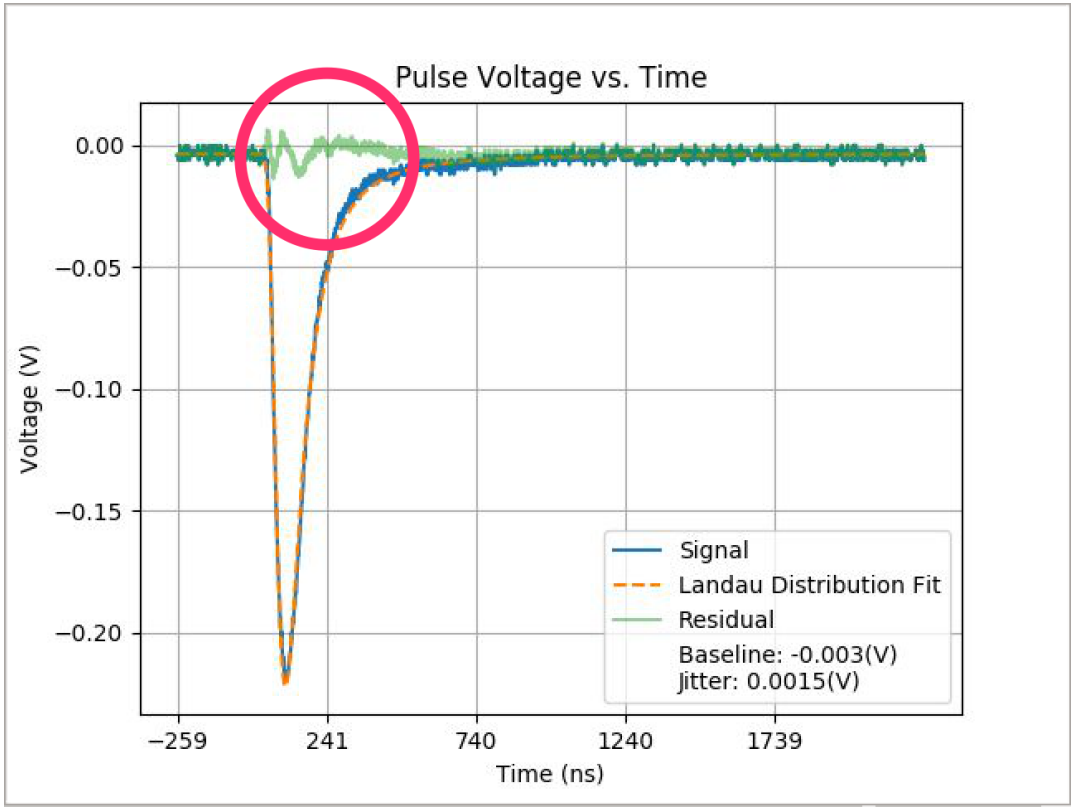

- Perhaps an incorrect distribution fit?

Acknowledgements

- Dr. Christoph Paus
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