

Techniques for Overlapped Pulse Discrimination

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—2019 Year End Presentation—

Motivation

- Some detectors have a high rate of accidentals
- Possibility of multiple decays in the same time

Scintillators or CsI Crystals



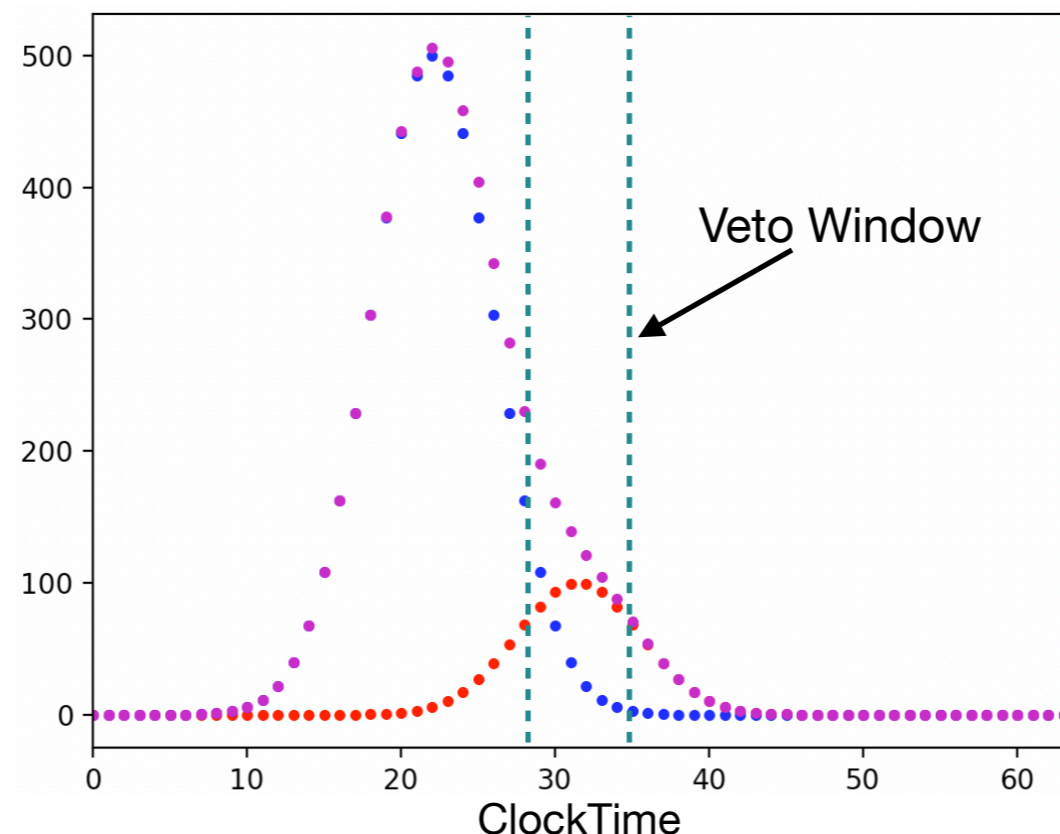
Photomultiplier Tubes



ADC

Motivation

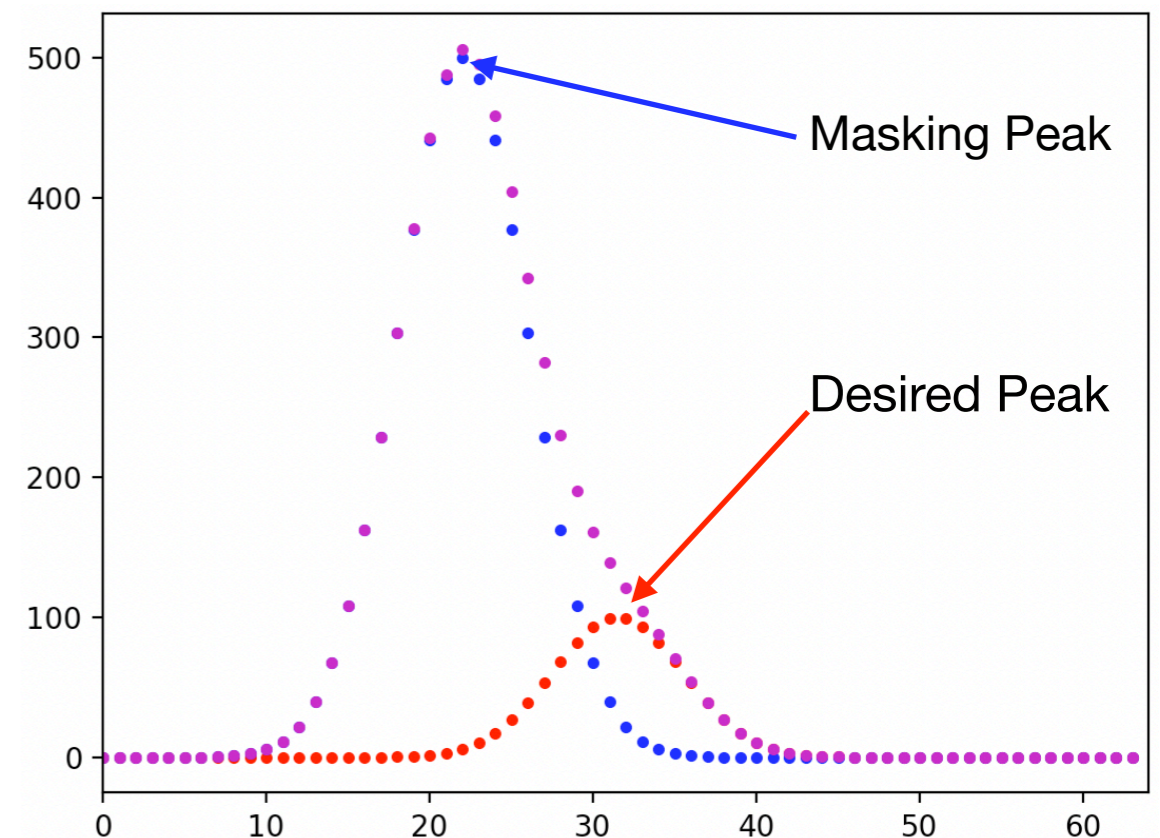
- Based on when the Kaon decays, the signal is expected to fall inside a certain timing range (veto window)
- Accidental hits that occur at similar times as the signal can alter the waveform
 - Can shift the peak, causing it to be outside the veto window
- Detect and separate waveform into its individual components



Sample Generation

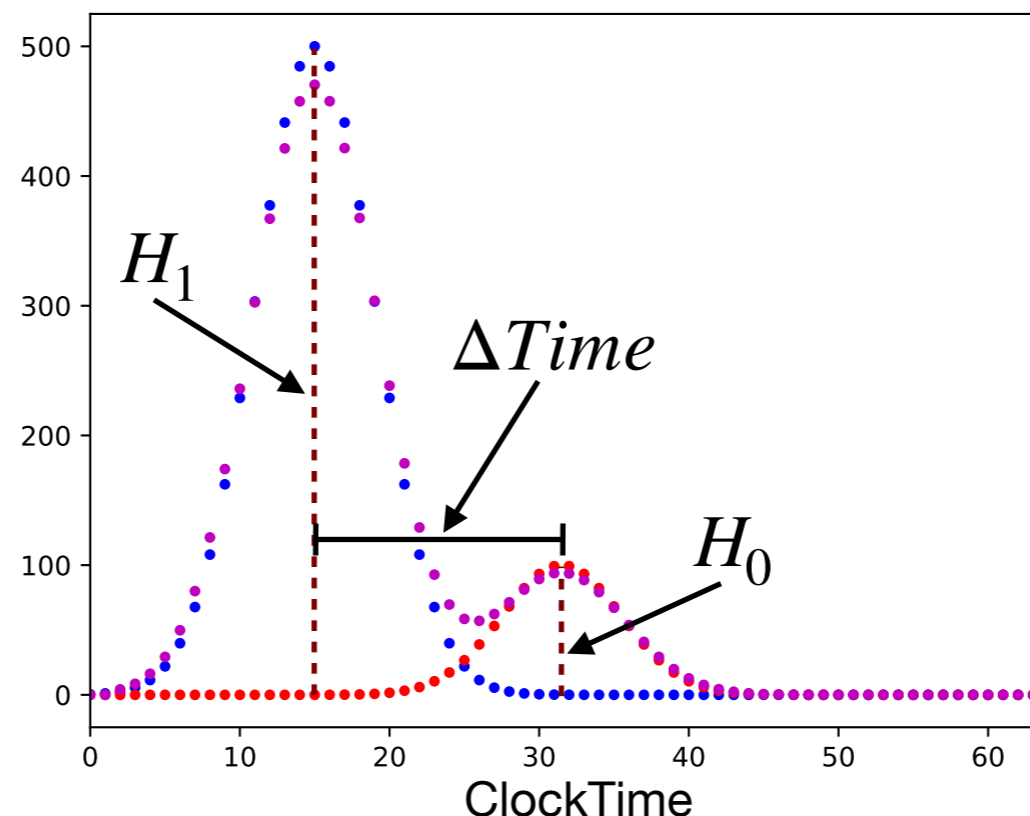
- Generated individual gaussian pulses over a 64 element array
- Combined individual pulses to generate a masked waveform
- ‘Desired Peak’ was held constant
 - (time = 31.5 clock, height = 100)
- ‘Masking Peak’ was varied from:
 - (time = 1 to 62 clock)
 - (height = 100 to 20,000)
- For each ‘Masking Peak’ a random number within $[-0.5, 0.5]$ was added to time to vary phase

~120,000 waveforms



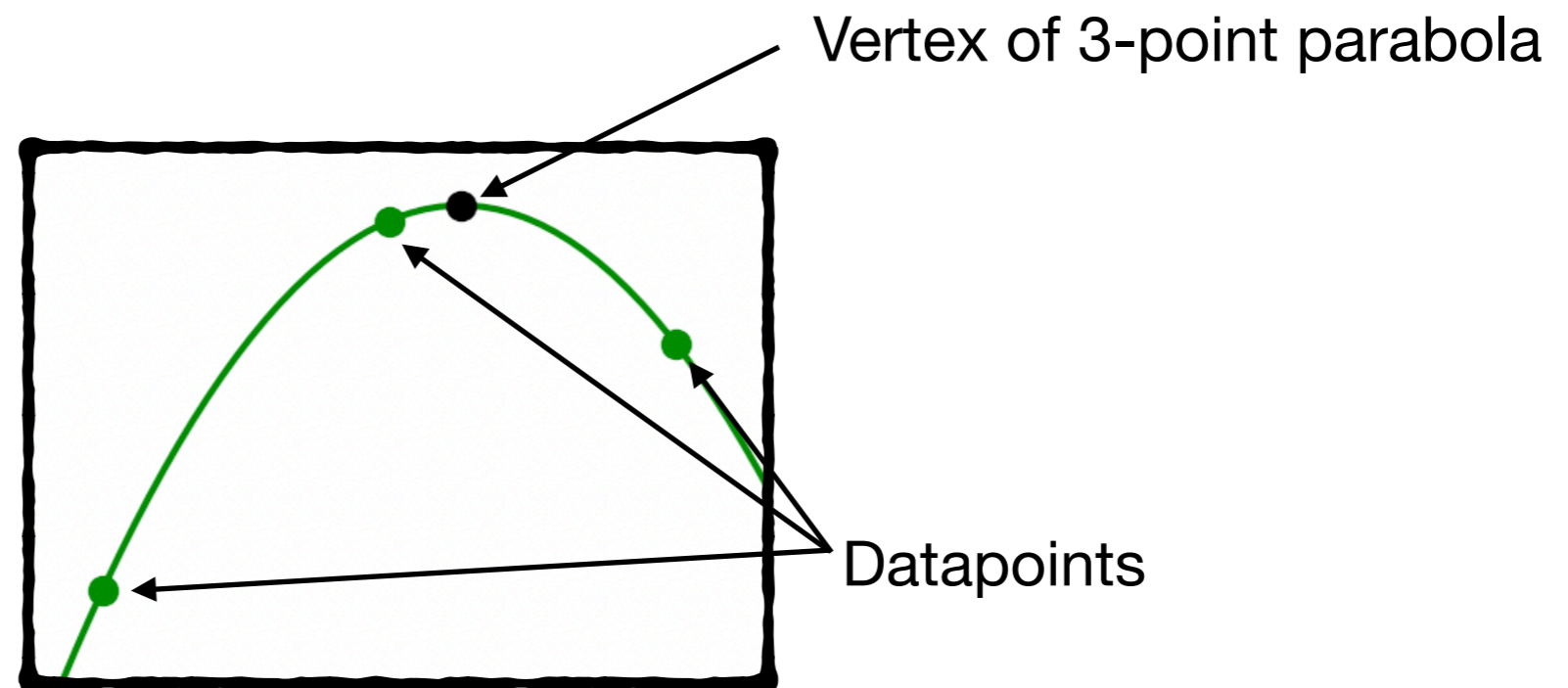
Peak to Area Comparison Method

- Single pulse waveforms should have a constant $\frac{Area}{Peak}$ ratio
- Overlapped pulse waveforms will have a larger $\frac{Area}{Peak}$ ratio corresponding to:
 - Individual peak height ratio - $\frac{H_0}{H_1}$
 - Absolute value of peak timing difference- $\Delta Time$



Peak Calculation

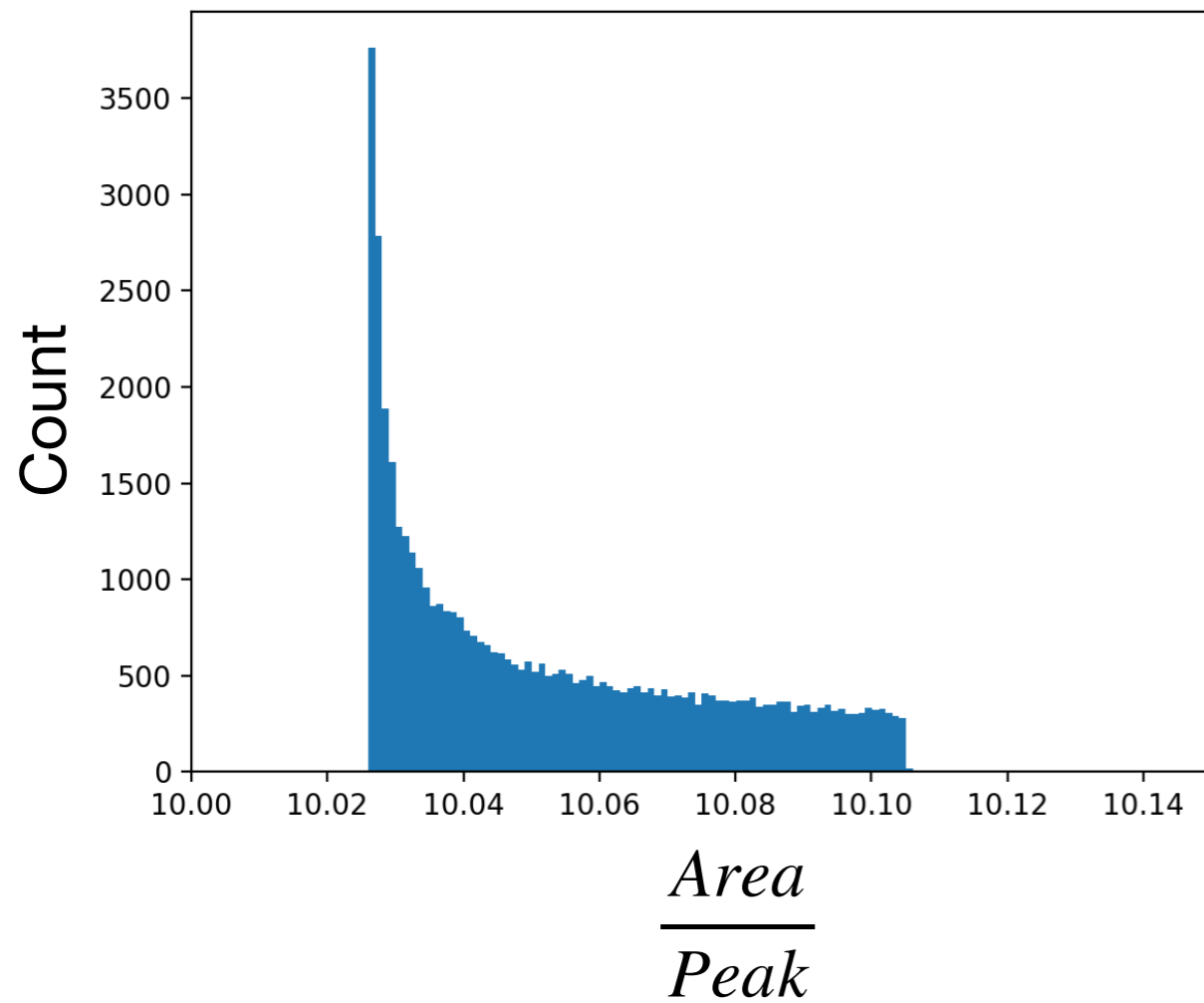
- For each point (t), checked if $\text{height}[t]$ was larger than $\text{height}[t - 1]$ and larger than $\text{height}[t + 1]$
- Two methods
 1. Selected $\text{height}[t]$ as the peak height and t as peak time (Highest Point)
 2. Used the two nearest points to calculate the vertex of a parabola. (Parabola Fitting)



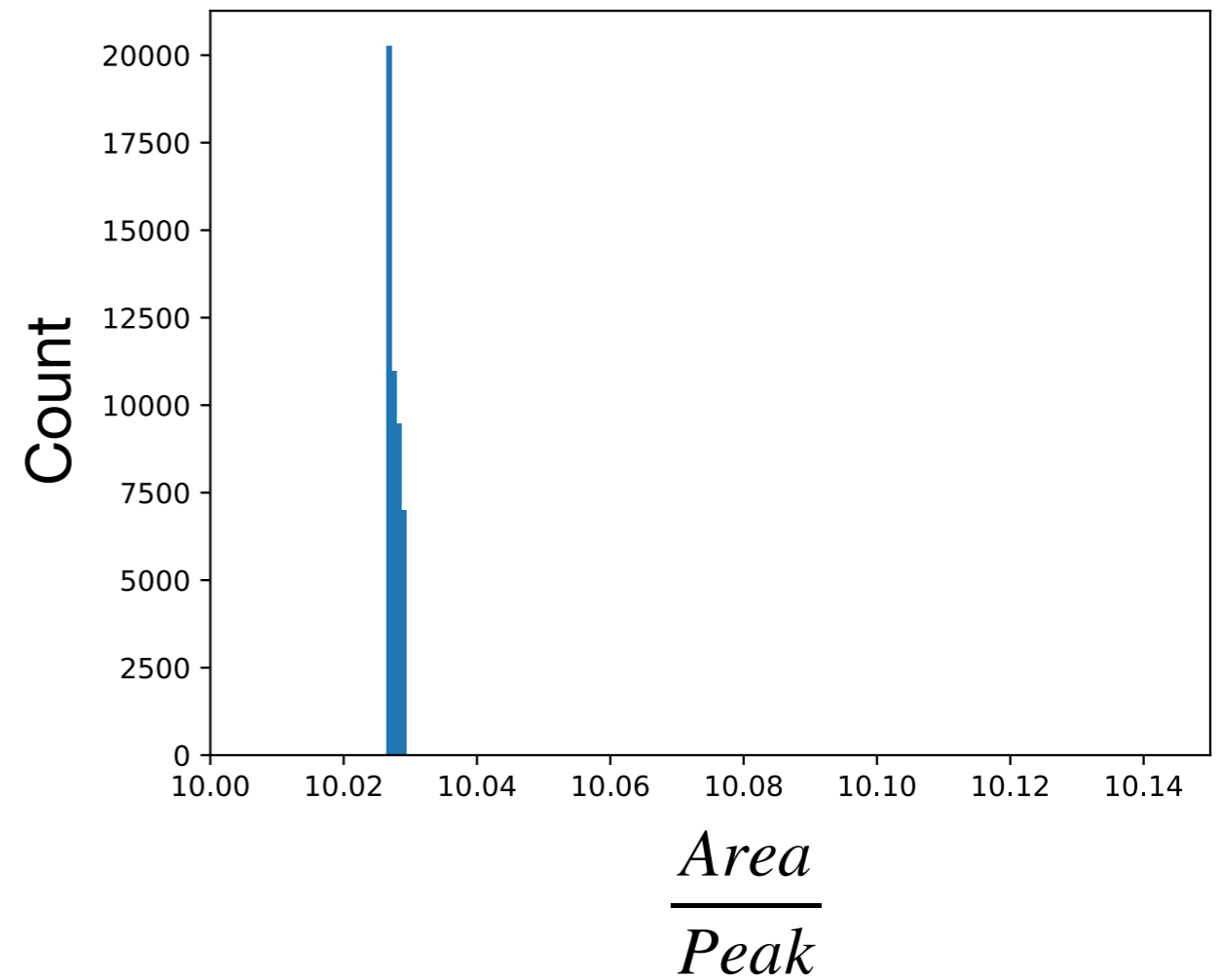
Peak Calculation

$\frac{Area}{Peak}$ ratio for Single Pulse Distributions

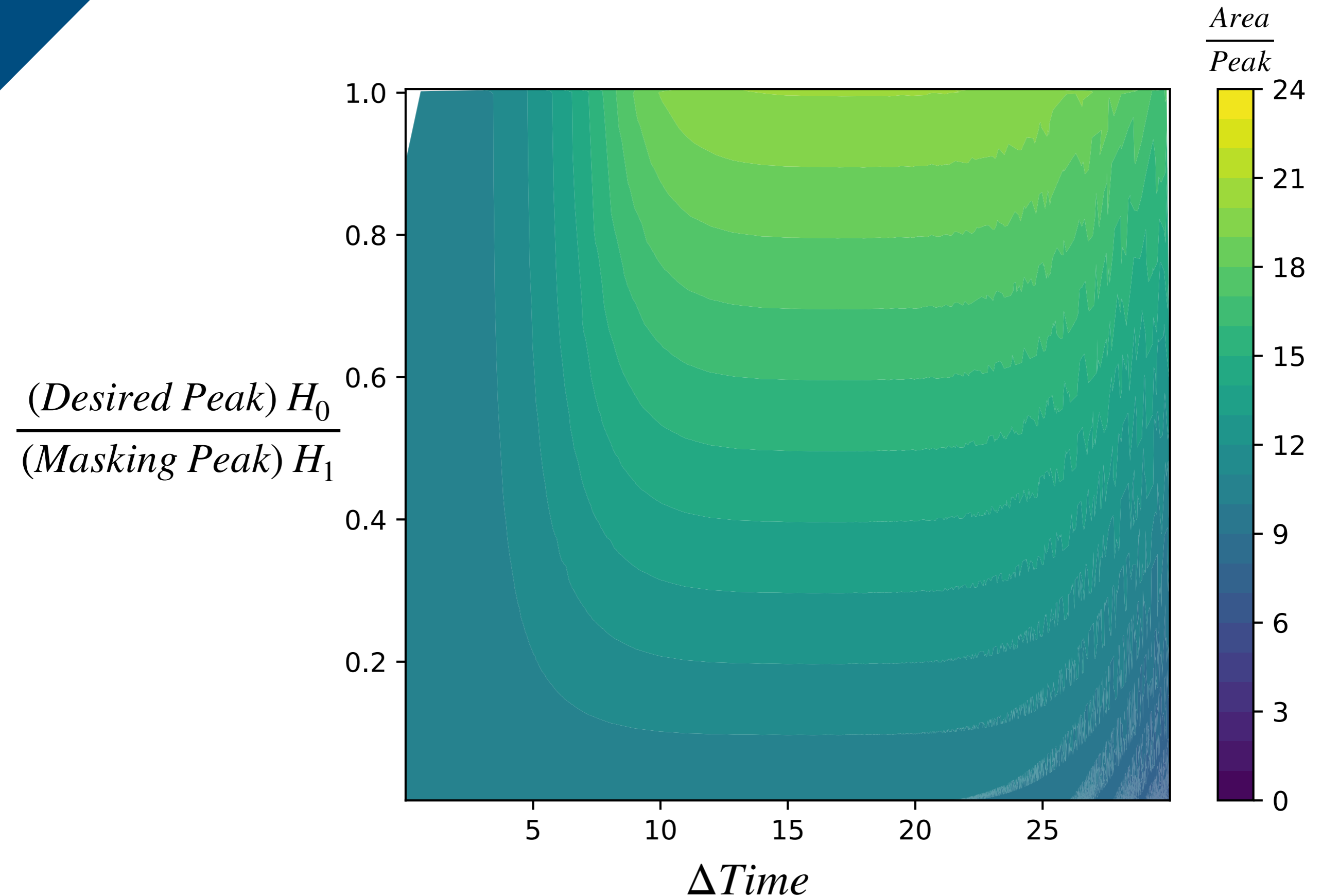
Highest Point



Parabola Fitting

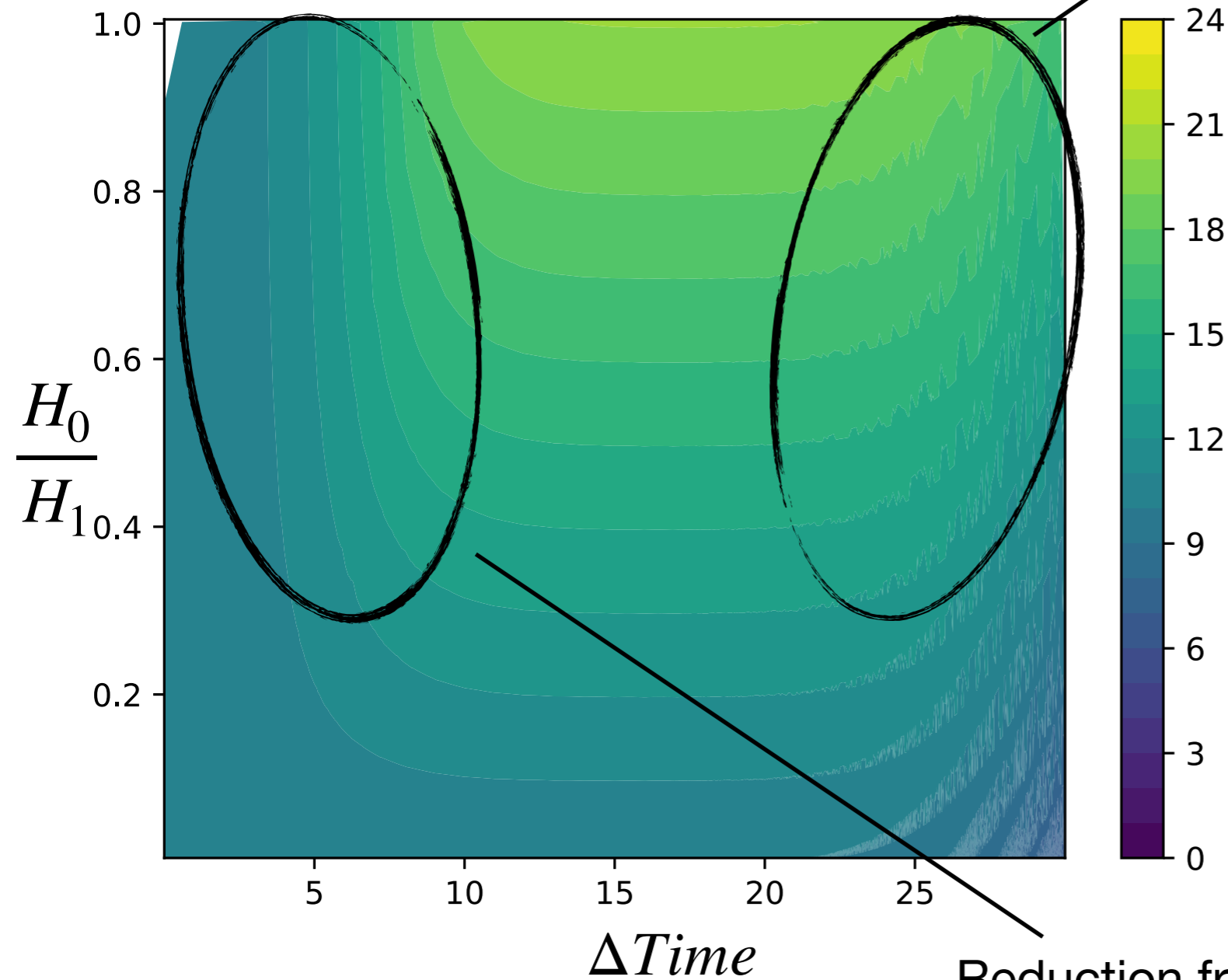


All Overlapped Waveforms

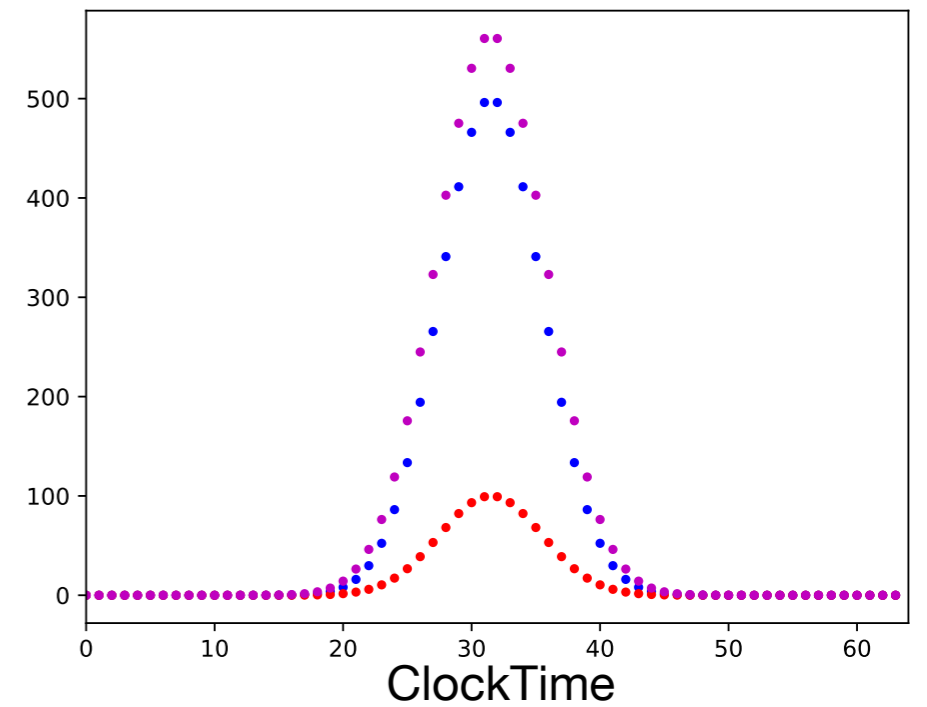
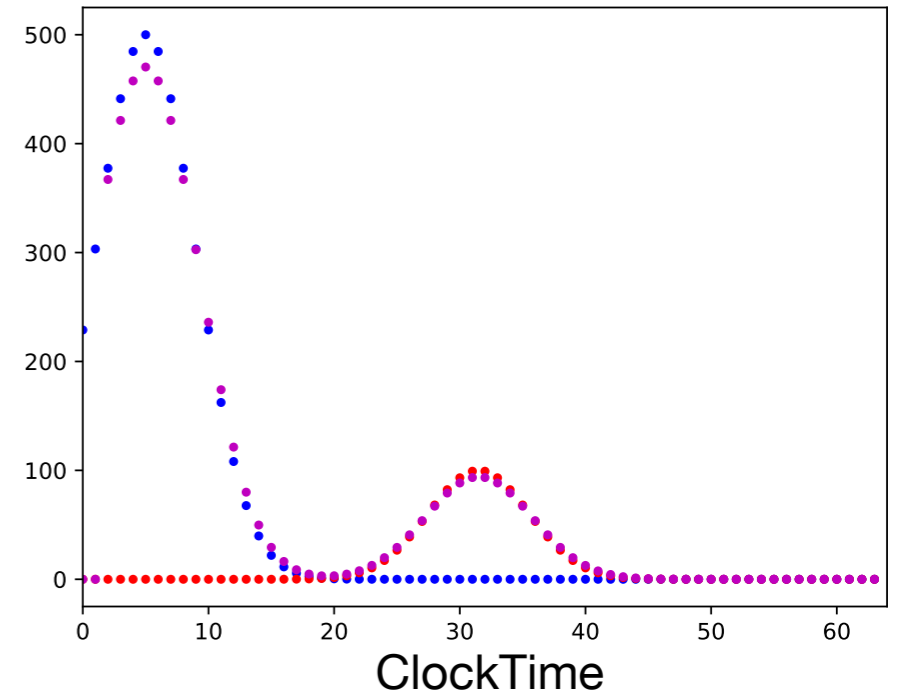


$\frac{\text{Area}}{\text{Peak}}$ Ratio for Overlapped Peaks

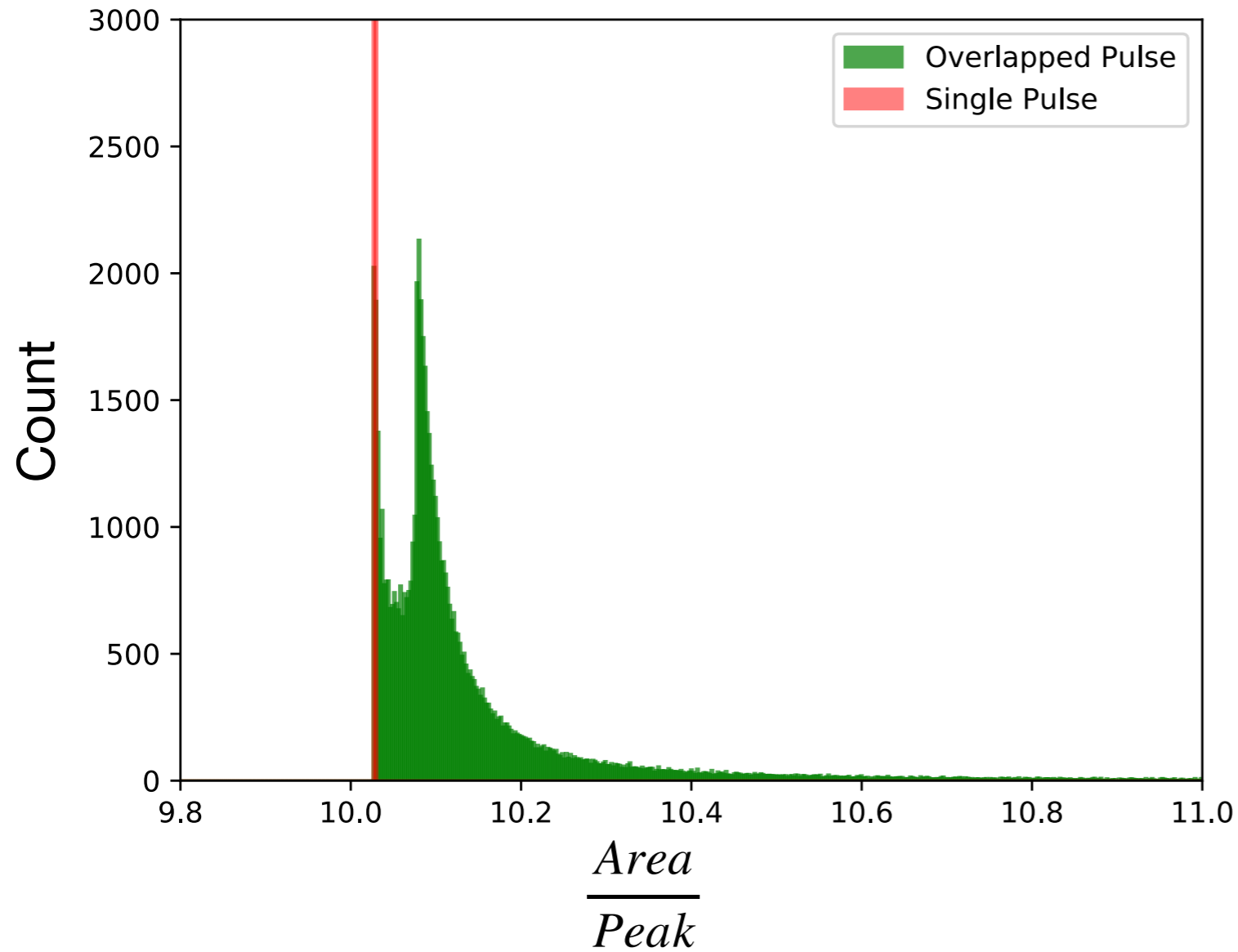
Area reduction from waveform being cut off



Reduction from peaks lining up

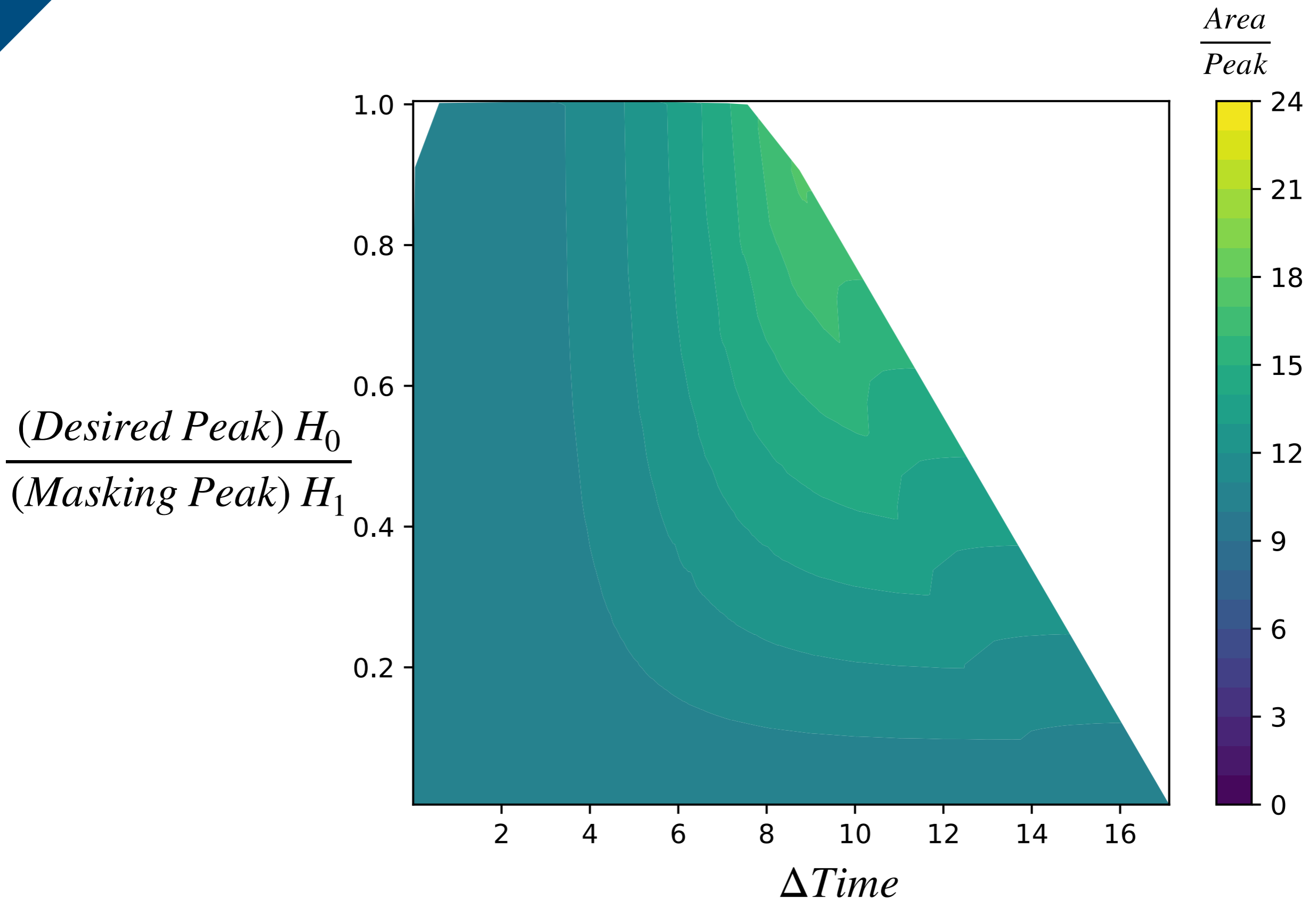


Waveforms with Only One Peak



Removed all waveforms that had
2 definitive peaks

Waveforms with Only One Peak



Next Steps

- Check distributions with noise
- Replace gaussian with a more accurate representation
- Check other discrimination methods that can decompose the waveform into its separate components

Backup

