



# PALS Avalanche

## a new PAL spectra analysis software



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### Abstract

A novel concept for tomography of human body developed by Jagiellonian Positronium Emission Tomography (J-PET) [1-5] project provides the possibility to combine metabolic information collected by standard PET with structural information obtained from Positronium lifetime, in a concept of morphometric image [6]. Therefore, there was a need to develop compatible software with J-PET Framework [7], for fast online analysis during imaging.

PALS Avalanche [8] is a software developed on UNIX system and based on ROOT software, which allows to decompose Positronium Annihilation Lifetime (PAL) spectra collected by both digital and analog electronics. An unique iterative procedure and parameterization of intensities, implemented in PALS Avalanche, will be presented.

### Lifetime component definition

Positron annihilation process with given mean lifetime  $\tau$  measured by a system with resolution characterized by Gauss Distribution ( $\mu, \sigma$ ) can be expressed by

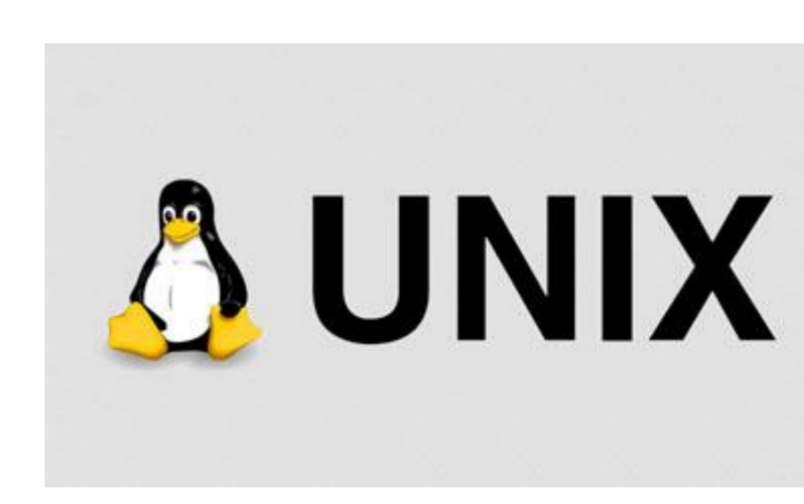
$$\frac{I}{2\tau} \exp\left(\frac{\sigma^2}{2\tau^2} - \frac{t-\mu}{\tau}\right) \left( \operatorname{erf}\left(\frac{t-\mu-\frac{\sigma^2}{\tau}}{\sqrt{2}\sigma}\right) - \operatorname{erf}\left(\frac{-\mu-\frac{\sigma^2}{\tau}}{\sqrt{2}\sigma}\right) \right)$$

$$\operatorname{erf}(x) = \frac{df}{\sqrt{\pi}} \int_0^x \exp(-p^2) dp \quad I - \text{Intensity(Probability)}$$

### Source files

PALS Avalanche files is located at

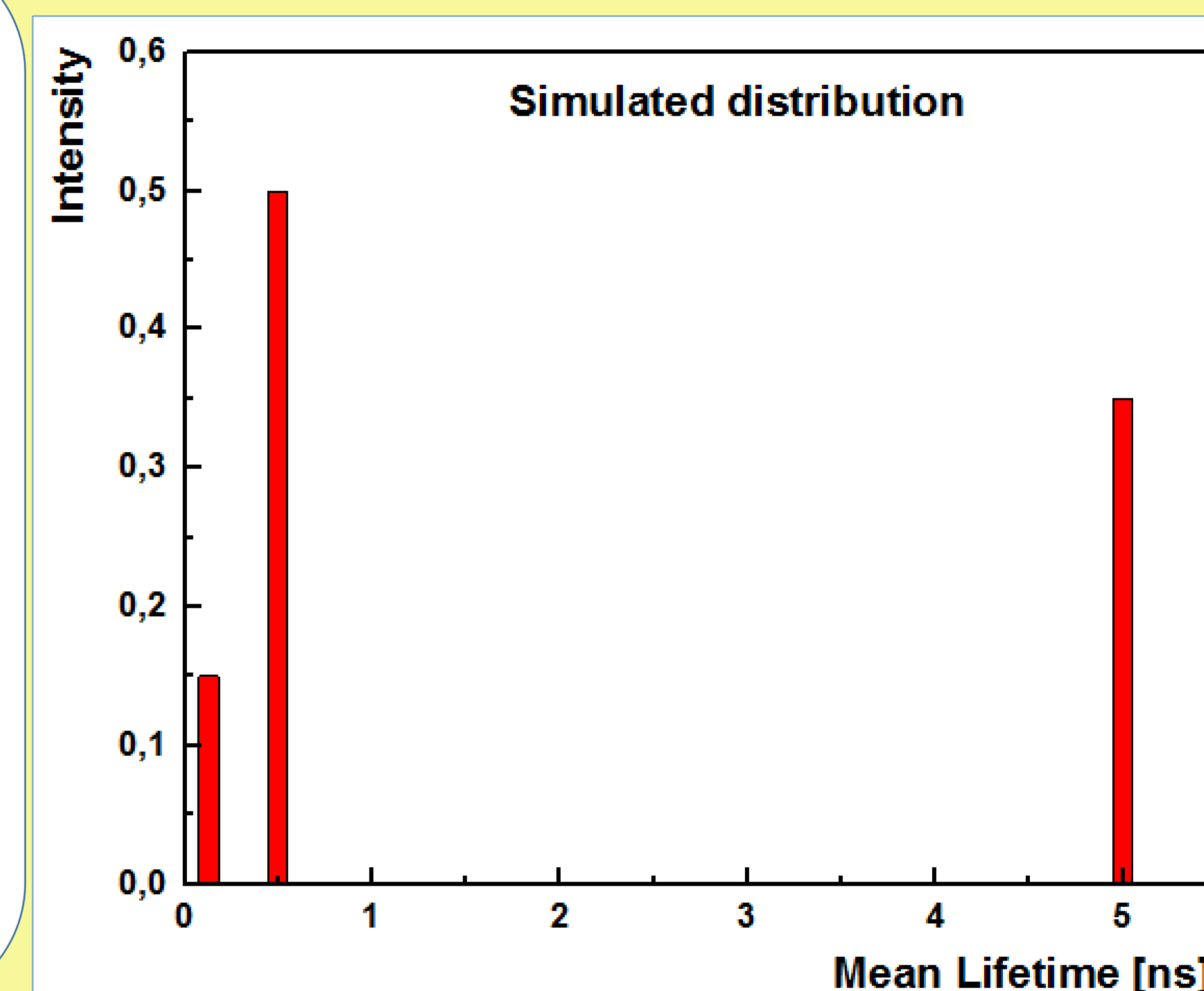
[https://github.com/kdulski/PALS\\_Avalanche](https://github.com/kdulski/PALS_Avalanche)



### Plots

What is saved:

- Distribution with fit
- Residuals
- Intensity vs Lifetime



### Simulation

Smeared by Gauss  
(6 ns, 0,1 ns)

Uniform  
distribution as a  
Background

### Fitting procedure

Initializing start parameters

Fit

Initializing  
parameters from the  
end of previous step

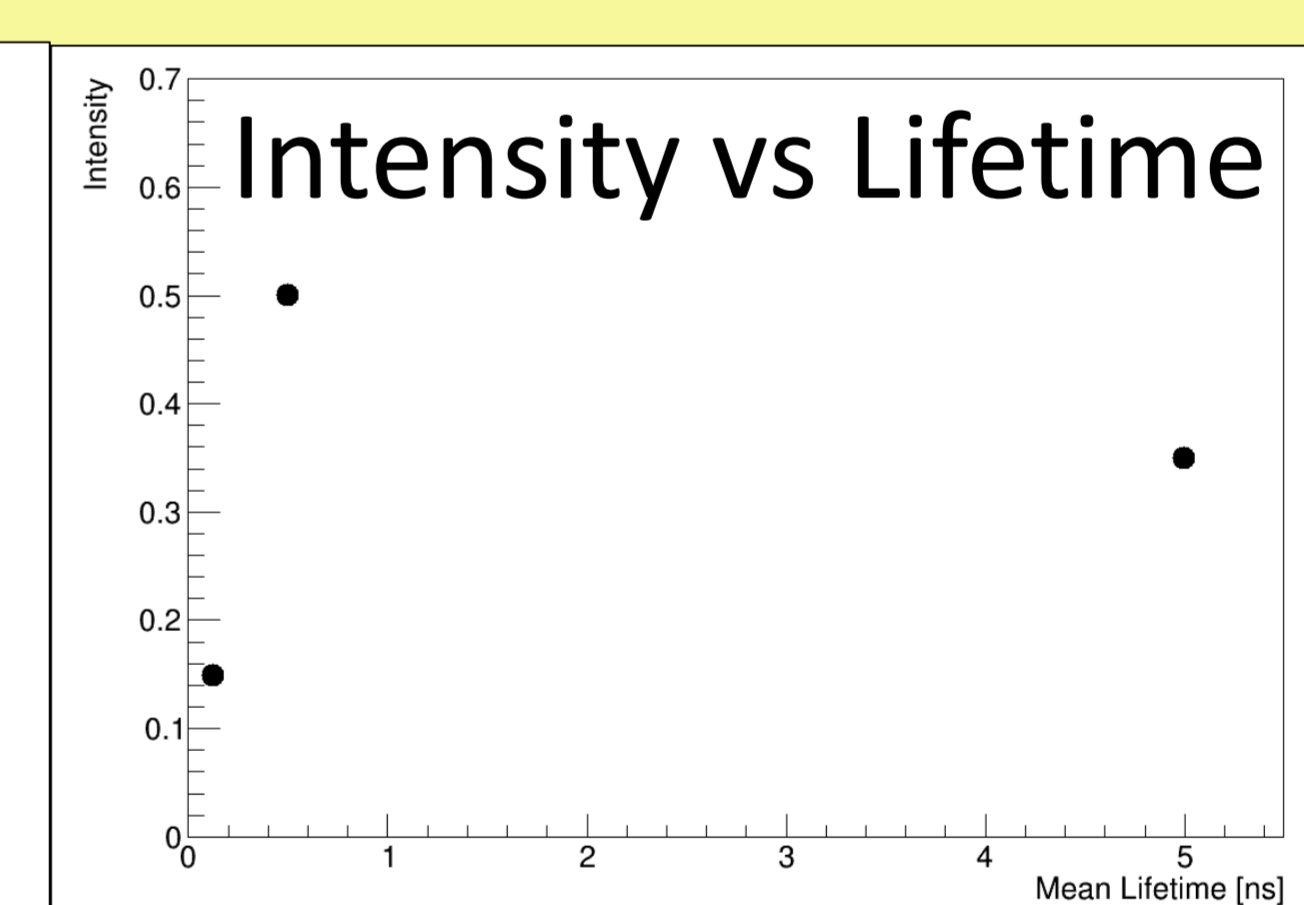
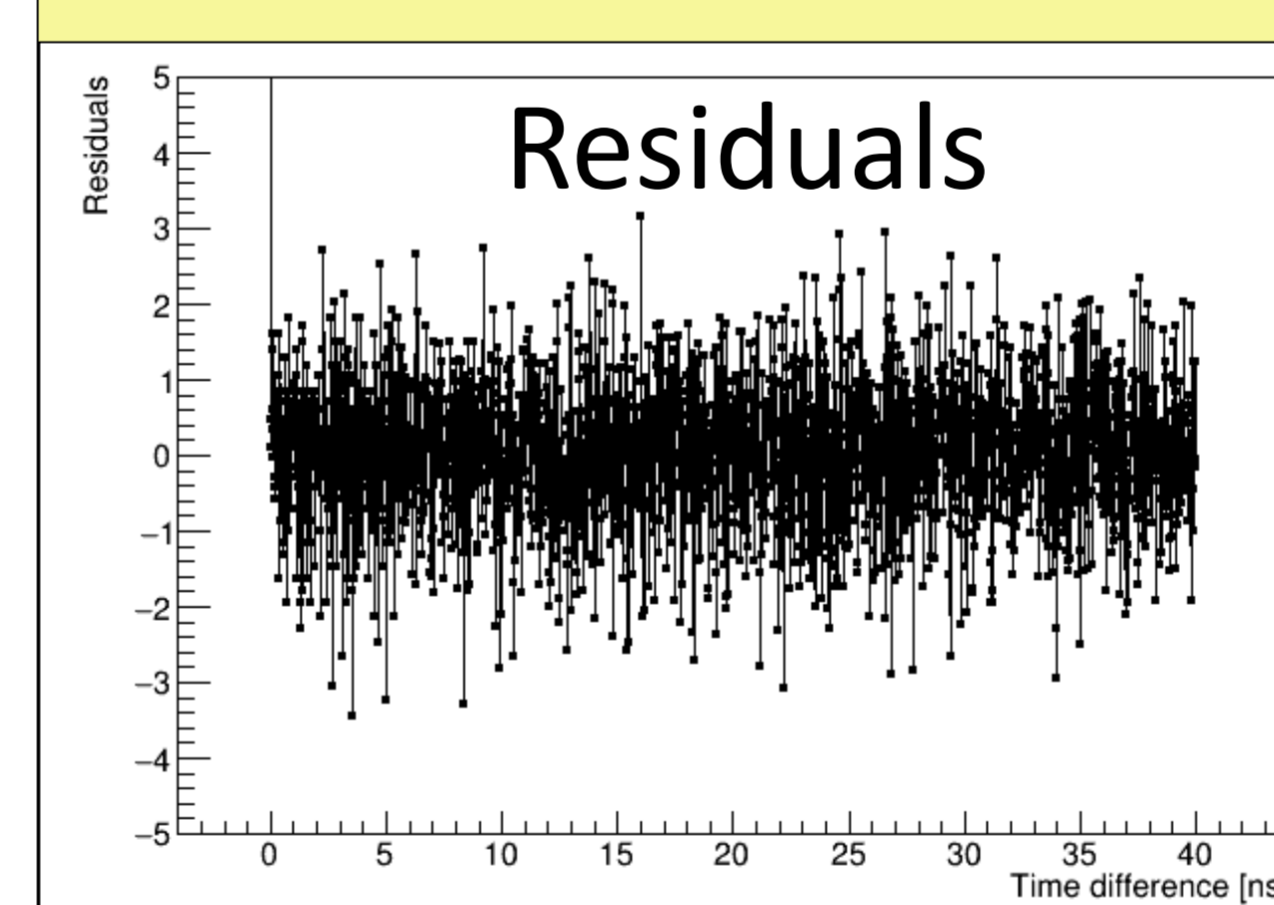
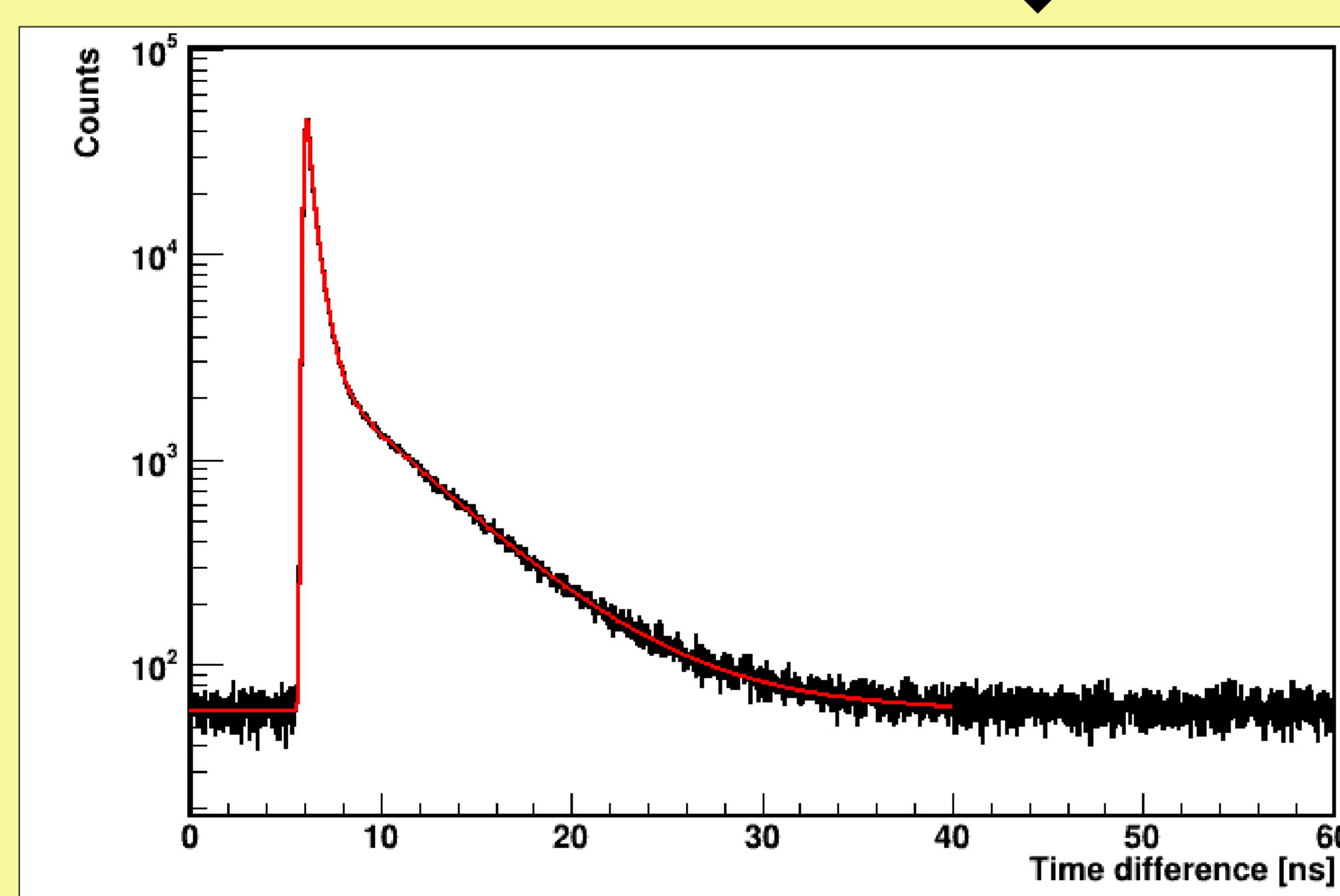
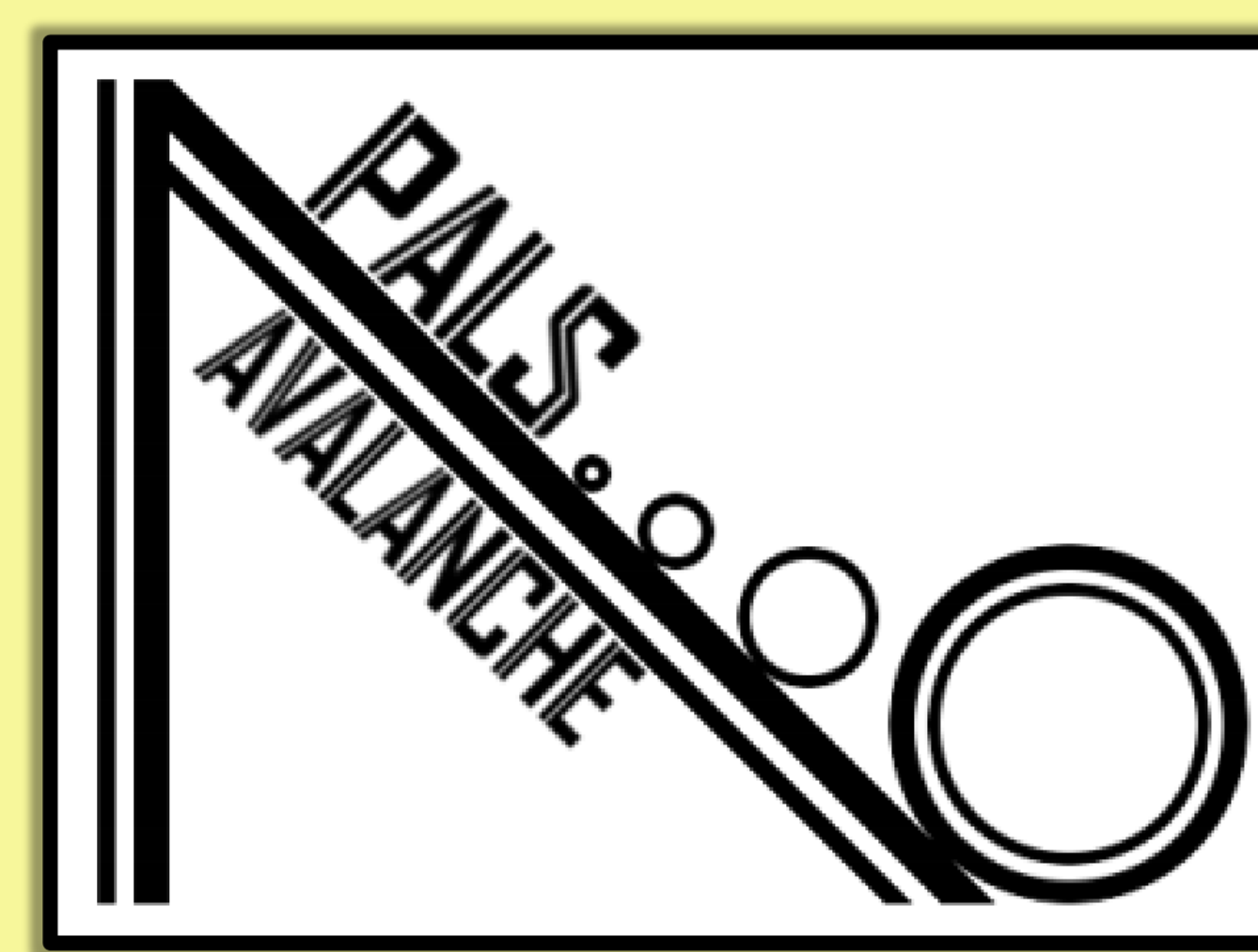
Fit

Passing fit  
results

Intilaizing previous  
fit onto the Lifetime  
Grid

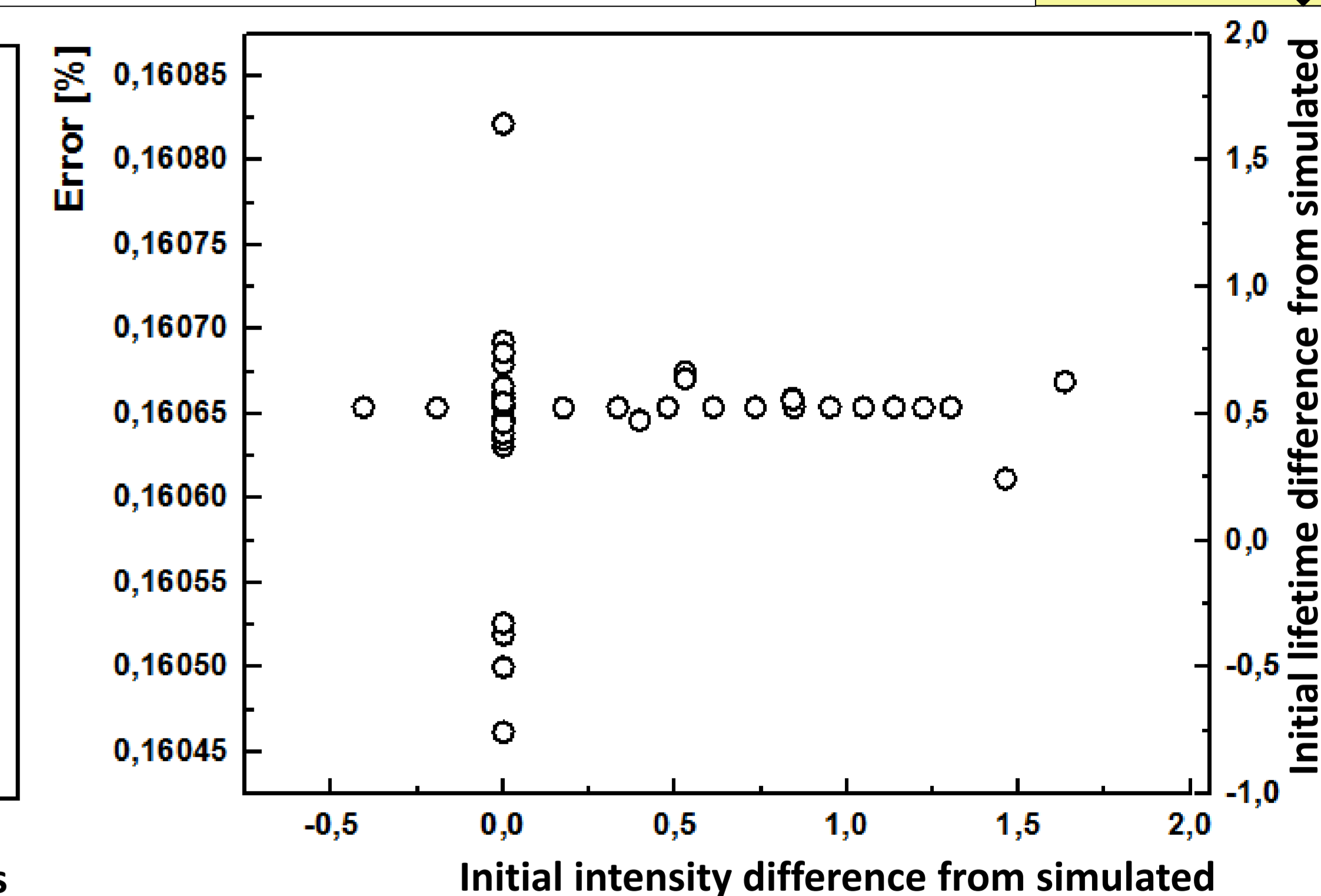
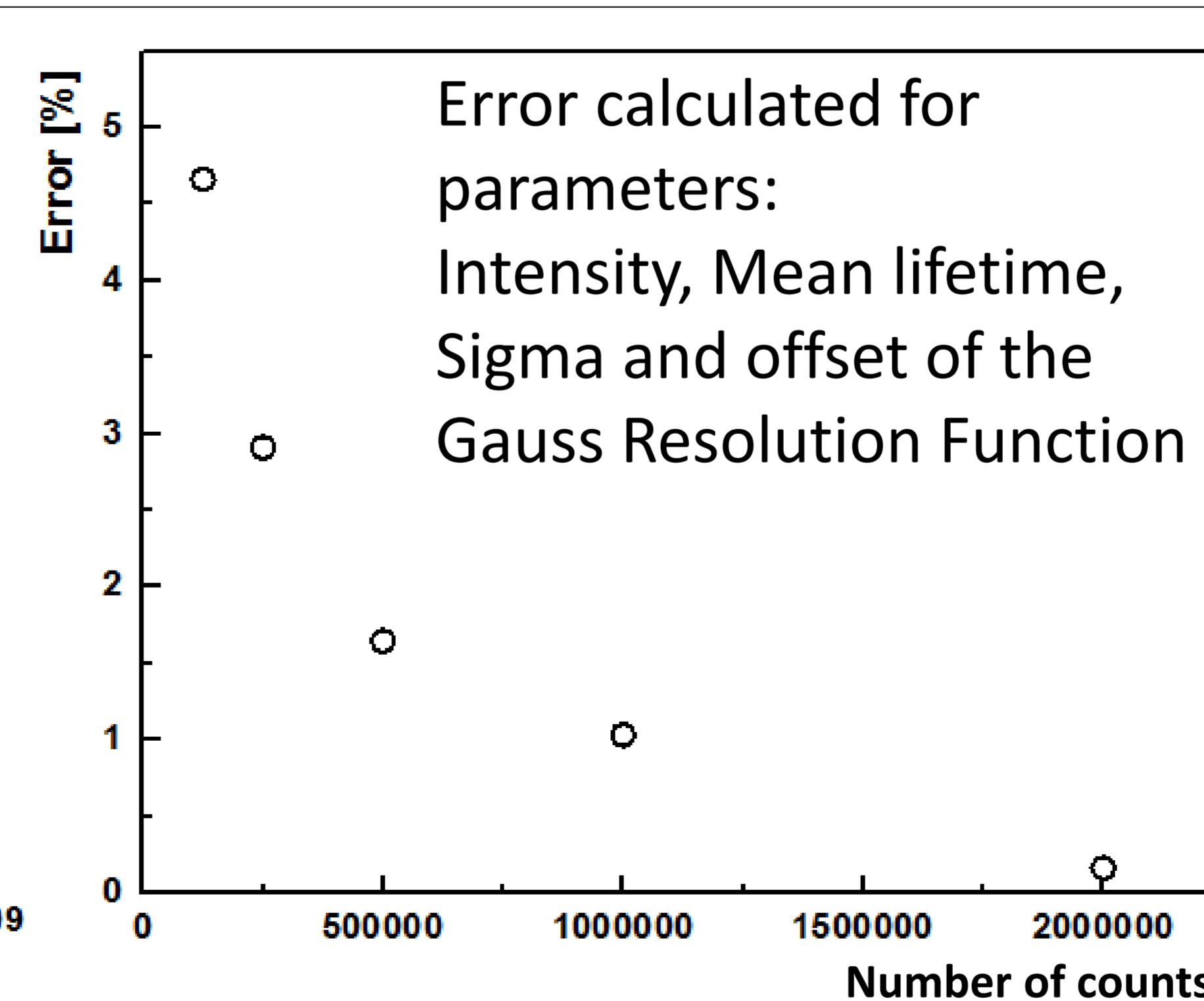
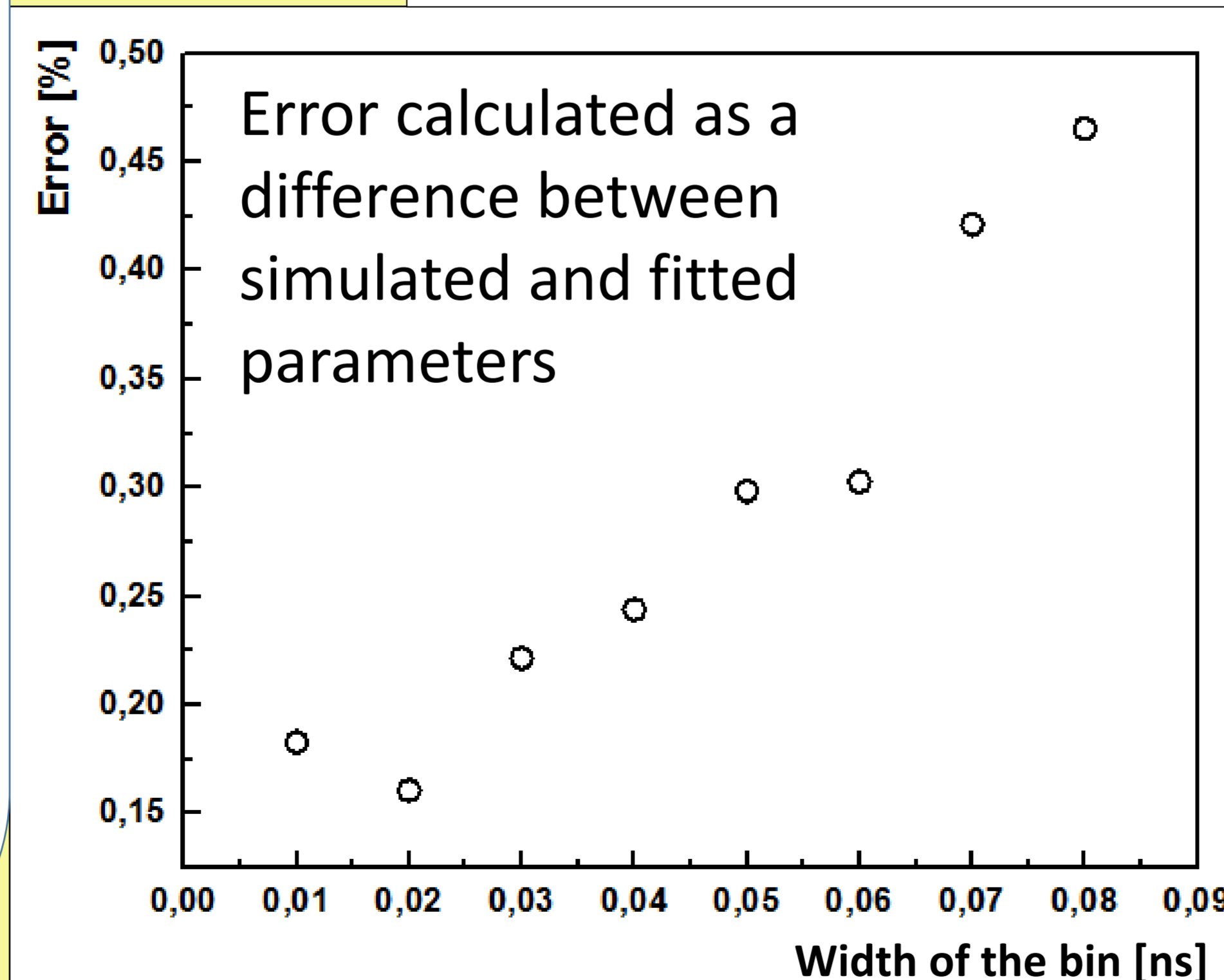
Quasi-  
continuous fit

End



Results from fit is saved to text file and in the table  
(possibility to analyze data in series)

Data from simulation is analyzed to estimate systematic uncertainty of the fit



- Iterative fitting helps stabilize fit results
- Lifetime grid defined by user

### Summary

PALS Avalanche is a software designed for J-PET Framework, that opens a possibility for fast lifetime analysis during imaging by J-PET Detector. Unique PALS Avalanche algorithm consisted of iterative procedure and parametrization of intensities allows to decompose PAL spectrum on discrete and quasi-continuous lifetime distributions.

### Acknowledgment

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### Bibliography

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