

## Least squares

Least squares is an optimization paradigm for matching data ('fitting') with a parametrised model equation. A famous example is the linear regression used for finding the linear equation that best matches a given set of data points.

The least squares measure for the goodness-of-fit is 
$$\chi^2 = \frac{1}{N-n_p} \sum_{i=1}^N \frac{(D(t_i) - D_i^{\text{exp}})^2}{w_i}$$

$D_i^{\text{exp}}(t_i)$  is the  $i$ -th data point of an experimental data set consisting of  $N$  data points,  $D(t_i)$  is the model equation at the observed points  $t_i$  and  $n_p$  is the number of freely varying model parameters.

$w_i$  is some weighting factor describing the experimental uncertainty of each individual data point. For TCSPC data  $w_i$  is defined as

$$w_i = \sqrt{D_i^{\text{exp}}}$$

Least squares is a maximum likelihood estimator if the following preconditions are met:

- All data points  $D_i^{\text{exp}}$  are independent observations.
- The number of data points is sufficient (i.e. the model parameters are overdetermined).
- The experimental noise follows a [Gaussian distribution](#).
- There are no systematic errors, resp. the model describes the data correctly.
- The experimental noise along the time axis is negligible.

Copyright of this document belongs to PicoQuant GmbH. No parts of it may be reproduced, translated or transferred to third parties without written permission of PicoQuant GmbH. All information given here is reliable to our best knowledge. However, no responsibility is assumed for possible inaccuracies or omissions. Specifications and external appearances are subject to change without notice.



PicoQuant GmbH  
Rudower Chaussee 29 (IGZ)  
12489 Berlin  
Germany

P +49-(0)30-1208820-89  
F +49-(0)30-1208820-90  
info@picoquant.com  
www.picoquant.com