

## Marquardt-Levenberg

The Marquardt-Levenberg method is a means of optimising parameters in a least squares fit. It is used in our [FluoFit](#), [SymPhoTime](#) and a variety of other products (online-Fitting, FluoLib...).

Basically it works by examining how changes of a certain parameter affect the residuals trace, that means, it calculates a pointwise gradient of the residuals trace for each parameter. Marquard-Levenberg optimisation is fairly efficient and is regarded as state-of-the-art in least squares fitting.

## Shortcomings

ML is cannot be applied to any fitting method other than least squares (at least not in a straight-forward manner). Especially for the SymPhoTime software this is a severe limitation, since least squares assumes that the experimental noise follows a Gaussian distribution. Especially in [FLIM](#) measurements as analysed by the SymPhoTime software the number of photons for a given decay may be very small, so the experimental noise behaves more like a poisson distribution. For analysis of poisson distributed data least squares is strictly speaking not applicable any more and has to be replaced by [MLE](#) fitting.

When running a [MLE](#) fit the SymPhoTime software abandons the ML-fitting and switches to a gradient search.

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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