Error analysis for a general
optimization fit:

data (independent)

Minimize: $F(\vec{x}, \vec{u})$

parameters

Then for fitted $\vec{u}$,

$$\nabla_{\vec{u}} F(\vec{x}, \vec{u}) = \vec{0}$$

Thus, we have a solution surface: the set of $(\vec{x}, \vec{u})$ pairs exhibiting the above property.

Within the surface, we know that

$$\frac{\partial F}{\partial u_i} = 0,$$

Thus,

$$d\left(\frac{\partial F}{\partial u_i}\right) = 0;$$

$$\sum_j \frac{\partial^2 F}{\partial u_i \partial u_j} du_j + \sum_k \frac{\partial^2 F}{\partial u_i \partial x_k} dx_k = 0;$$

or,

$$\sum_j \frac{\partial^2 F}{\partial u_i \partial u_j} du_j = -\sum_k \frac{\partial^2 F}{\partial u_i \partial x_k} dx_k.$$

Let $M_{ij} = \dfrac{\partial^2 F}{\partial u_i \partial u_j}$, $\quad V_{ik} = \dfrac{\partial^2 F}{\partial u_i \partial x_k}$.

Then

$$du_j = \cancel{-(M^{-1}V)} - \sum_k (M^{-1}V)_{jk}\, dx_k;$$

thus, locally,

$$\frac{\partial u_j}{\partial x_k} = -(M^{-1}V)_{jk}.$$

Now you have partial derivatives, even though you don't have explicit expressions for your parameters!

General error propagation

For $x_1, \dots, x_m$ with standard errors $s_1, \dots, s_m$,

if $y = f(x_1, \dots, x_m)$ then

$$s_y^2 = \sum_{i=1}^{M} \left(\frac{df}{dx_i}\right)^2 s_i^2.$$

Put it together....

Fit for muon data:

~~An~~ A least-squares fit usually minimizes

$$\sum_i (y_i - \hat{y}_i)^2,$$

where y_i is the i^{th} data point and $\hat{y}_i$ is the predicted value of y_i.

However, because you are essentially fitting a discrete probability distribution, I recommend minimizing the χ^2 statistic:

$$\chi^2 = \sum_i \frac{(y_i - \hat{y}_i)^2}{\hat{y}_i}.$$