Model parameter fits with MC-supported gradient method to BaBar collaboration Tau lepton data

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Outline

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2. Technical aspects.
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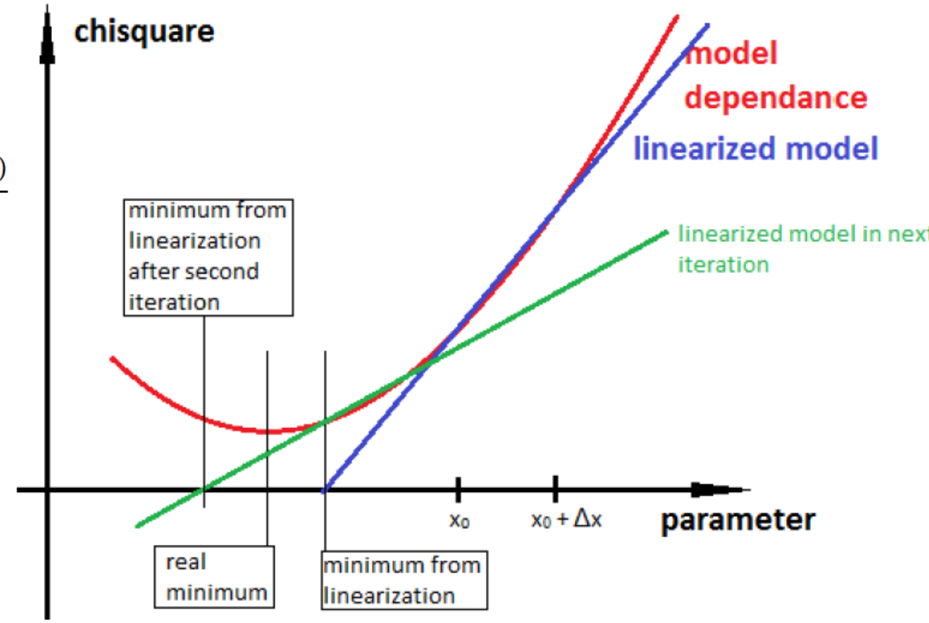
Why gradient method?

- Well known method, used for decades.
- Can be used for fitting ***not*** unfolded data and with experimental cuts
- Can be used with multidimensional distributions.
- Can be used when fitting analytical function is impossible.
- Can be possibly used for TauSpinner?

Technical aspects

$$\left.\frac{\partial f(a_1, a_2, a_3, \ldots, a_n)}{\partial x_i}\right|_{\Delta} = \frac{f(a_1, a_2, \ldots, a_i + \Delta x_i, \ldots, a_n) - f(a_1, a_2, a_3, \ldots, a_n)}{\Delta x_i}$$

$$f(x_1, x_2, x_3, \ldots, x_n) = f(a_1, a_2, a_3, \ldots, a_n) + \sum_i (x_i - a_i) \left.\frac{\partial f(a_1, a_2, a_3, \ldots, a_n)}{\partial x_i}\right|_{\Delta}$$



By use of gradient we linearize model dependence on parameters.

Thanks to MC-generation we can treat each event separately and recalculate it's weight after every change of parameters - $\frac{M^2(a_i, \ldots)}{M^2(a_i + \Delta_i, \ldots)}$

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Technical aspects

- Method's main weakness is jumping around local minima, and reweighting is time consuming. Moreover, it's sensitive to starting point.
- To minimize influence of those defects we limit range of parameters and size of iteration steps by estimation of second derivative with quadrative terms only and we don't allow it to exceed certain value (Minuit by default uses very similar algorithm).

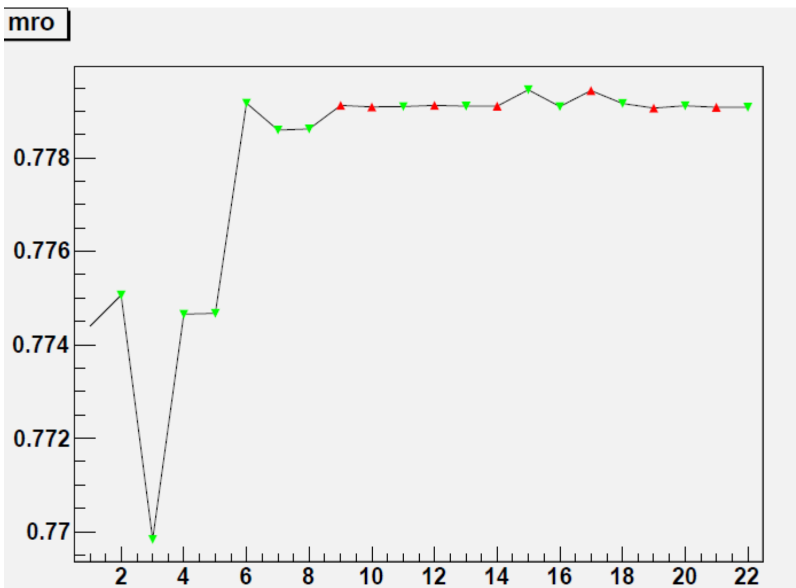
$$f''(x)\big|_{x_0} = \frac{\frac{f(x_0+\Delta x)-f(x_0)}{\Delta x} - \frac{f(x_0)-f(x_0-\Delta x)}{\Delta x}}{\Delta x} = \frac{f(x_0+\Delta x)-2f(x_0)-f(x_0-\Delta x)}{(\Delta x)^2}$$

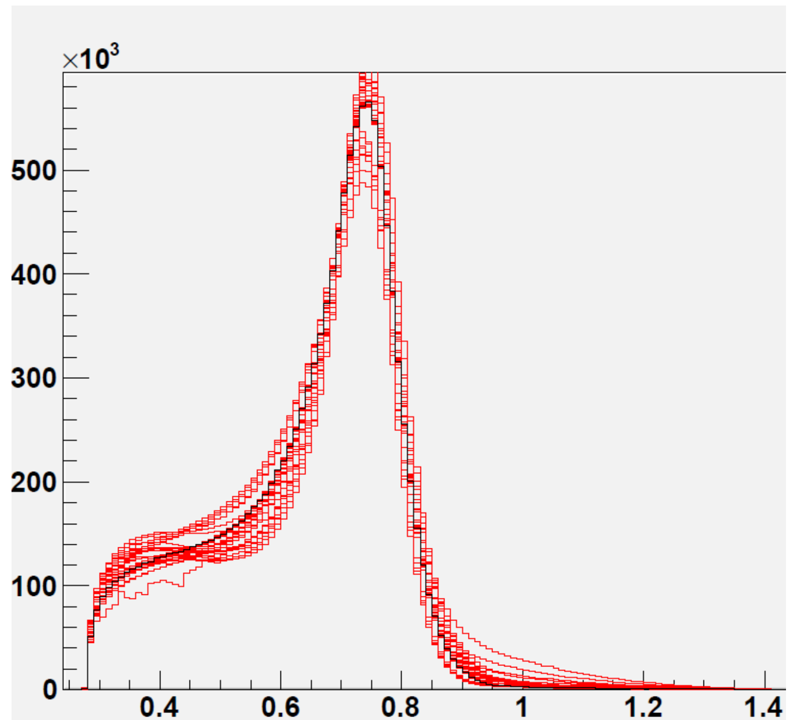
$$f(x) = f(x_0) + f'(x_0)\cdot(\mathrm{x}-x_0) + \frac{1}{2}f''(x_0)\cdot(\mathrm{x}-x_0)^2$$

$$f'(x_0)\cdot(\mathrm{x}-x_0) > L\cdot\frac{1}{2}f''(x_0)\cdot(\mathrm{x}-x_0)^2 \quad \rightarrow \quad (\mathrm{x}-x_0) < \frac{2\cdot f'(x_0)}{\mathrm{L}\cdot f''(x_0)}$$

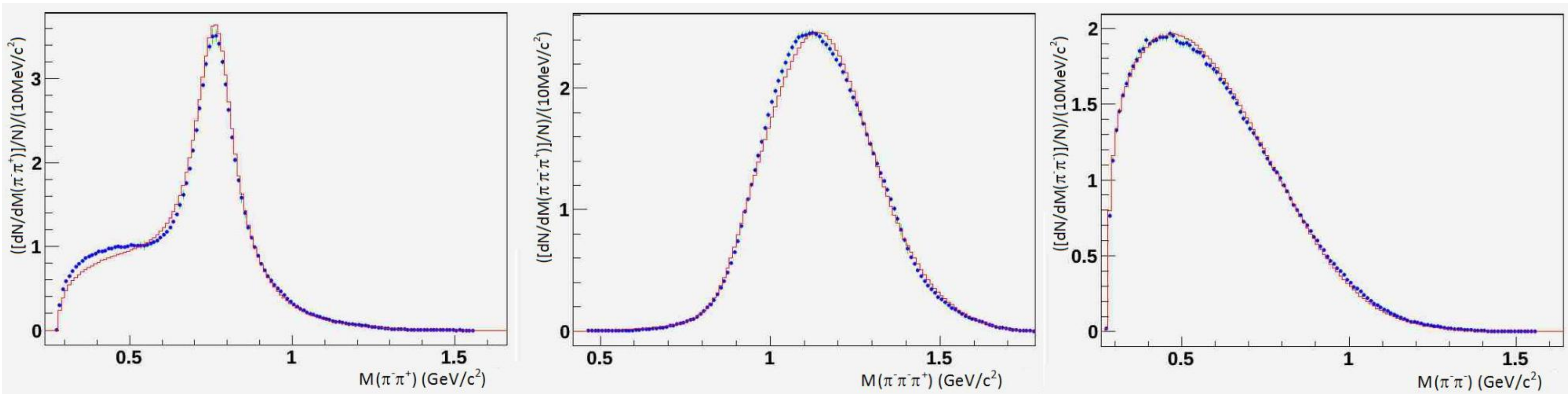
Technical aspects

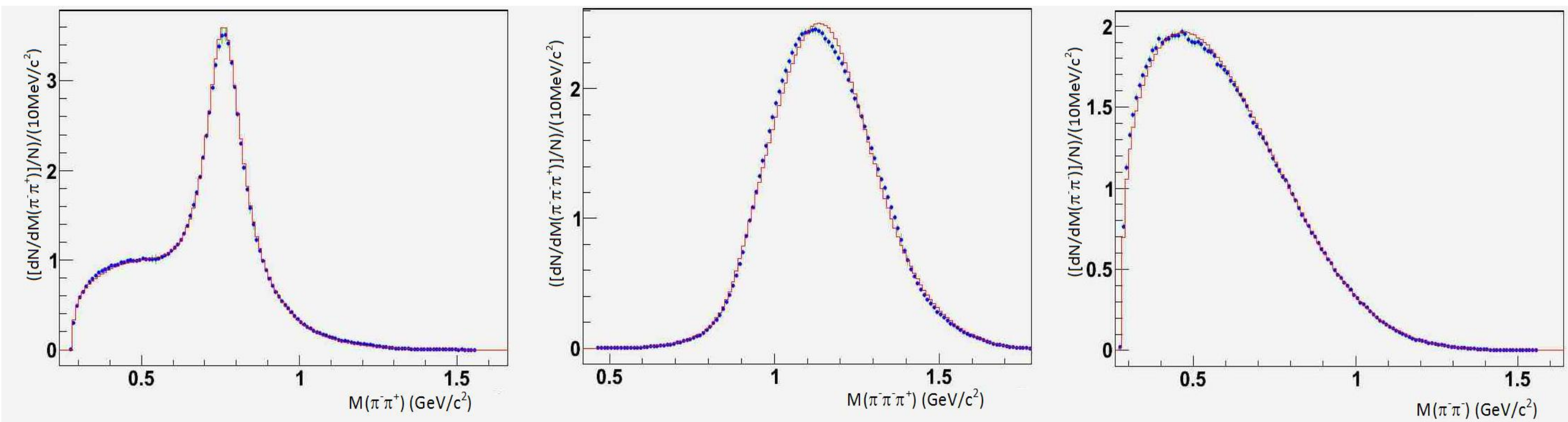
In order to see better what's happening during the fitting we can make additional plots:





Some results





Summary

- Fitting procedure is ready for further use.
- Already achieved results are encouraging.
- Any ideas what else we could improve?