# An improved pulse-fitting procedure for calorimeter event reconstruction in the Muon g-2 experiment at Fermilab


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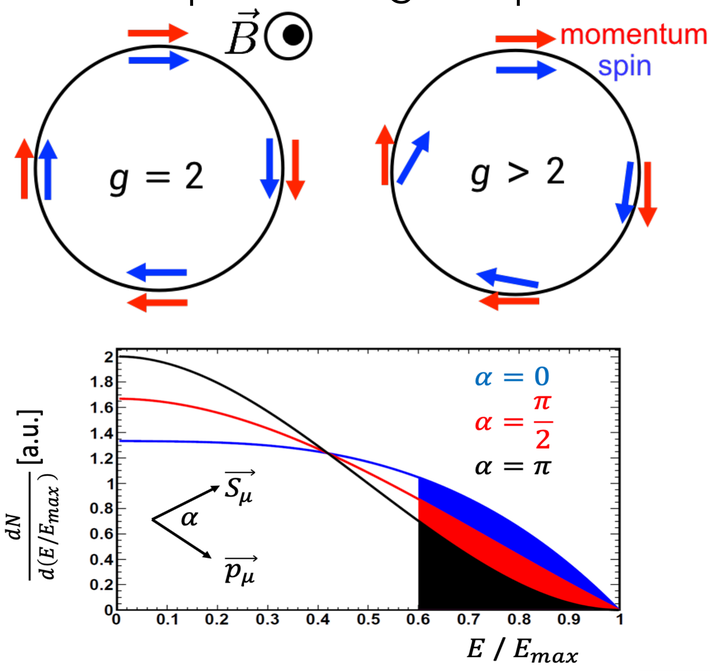
## I.The Muon g-2 experiment and the $K_{loss}$ puzzle[1][2]

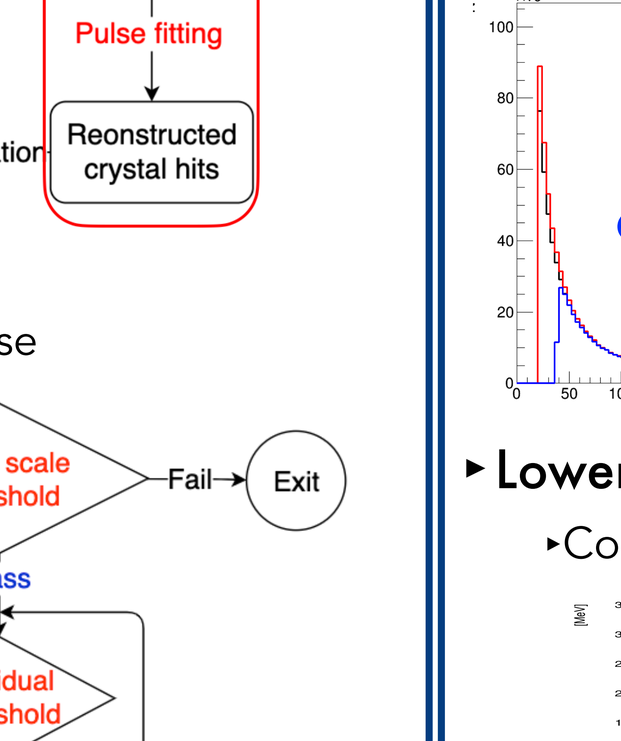
▸Principal of the g-2 experiment



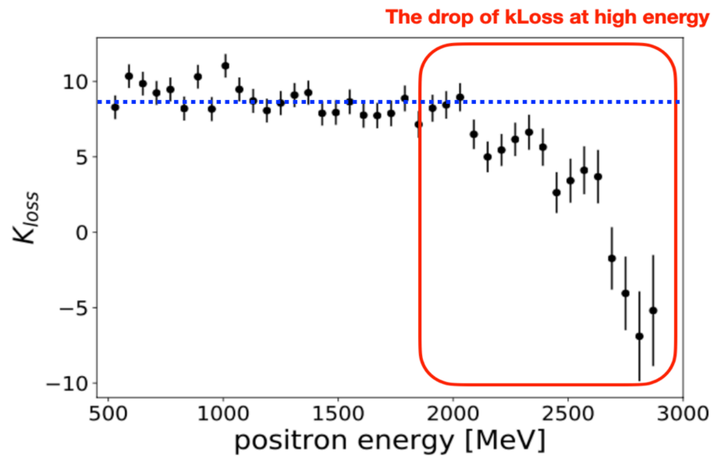

▸The $\omega_a$ fitting and **Muon loss**

$$F(t) = N_0 \cdot N_x(t) \cdot \Lambda(t) \cdot e^{-t/\tau} \cdot (1 + A(t) \cdot \cos(w_a \cdot t + \phi(t)))$$

$$\Lambda(t) = 1 - K_{loss} \int_0^t e^{t'/\tau} L(t') dt'$$



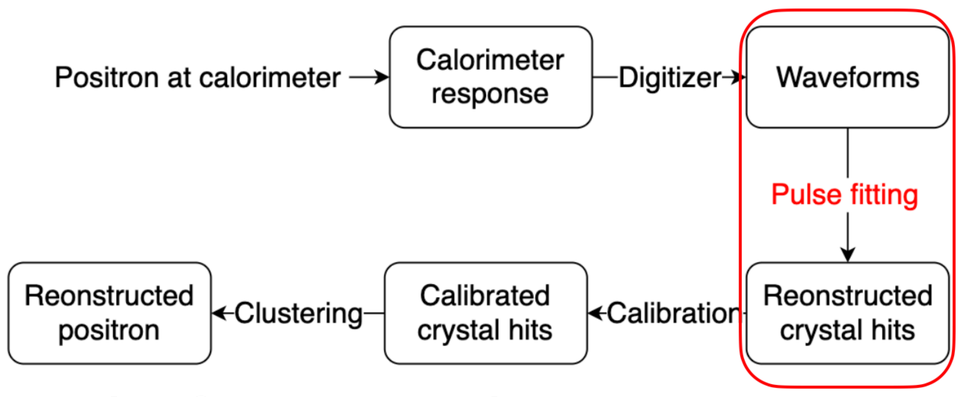

▸The $K_{loss}$ is used to account for the fraction of lost muons due to the interaction with material




▸**The $K_{loss}$ puzzle**: unphysical "muon gain" versus time

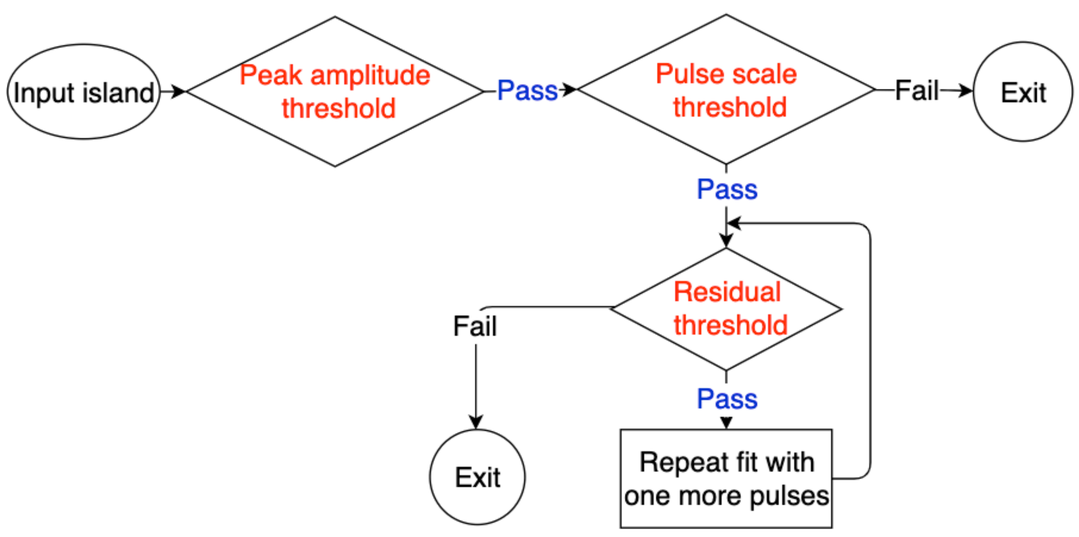
## II. Calorimeter reconstruction and the pulse fitting procedure[3]

▸**The full reconstruction chain**




▸**The Pulse fitting procedure**

▸Thresholds used to avid fitting the noise

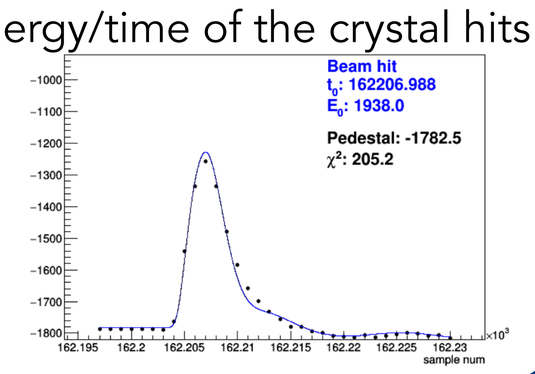



▸Template fitting to extract the energy/time of the crystal hits

Scale (energy) Template function

$$f(t) = s \cdot T(t - t_0) + P$$

time Pedestal

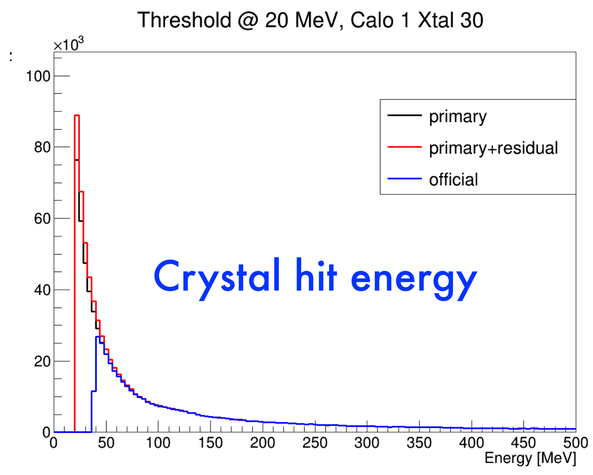


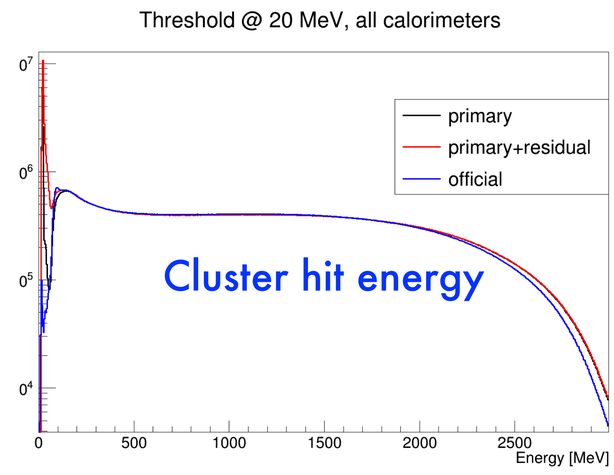

## III.Improvements of the pulse fitting

▸**Unifying the thresholds to eliminate the early-to-late effect**

▸Same thresholds for both primary and secondary pulses

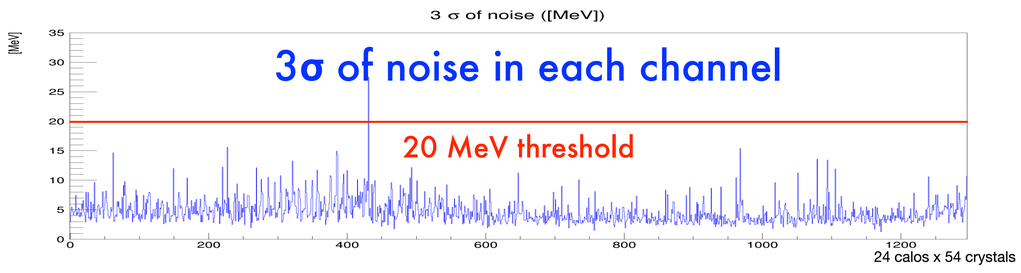
▸Using thresholds in MeV units by applying energy calibration and time-dependent gain corrections

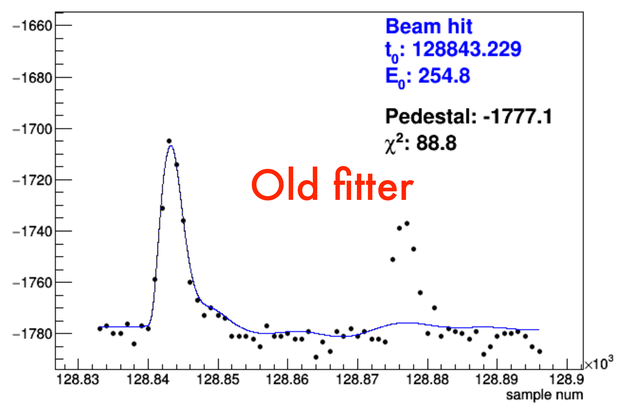


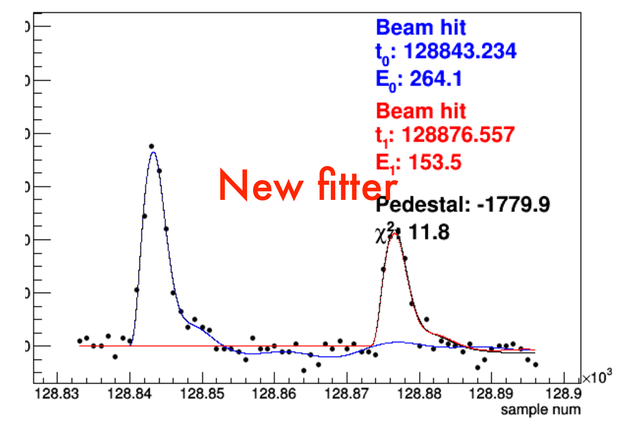




▸**Lowering the thresholds to recovery extra hits**

▸Consider the noise level of each crystal channel



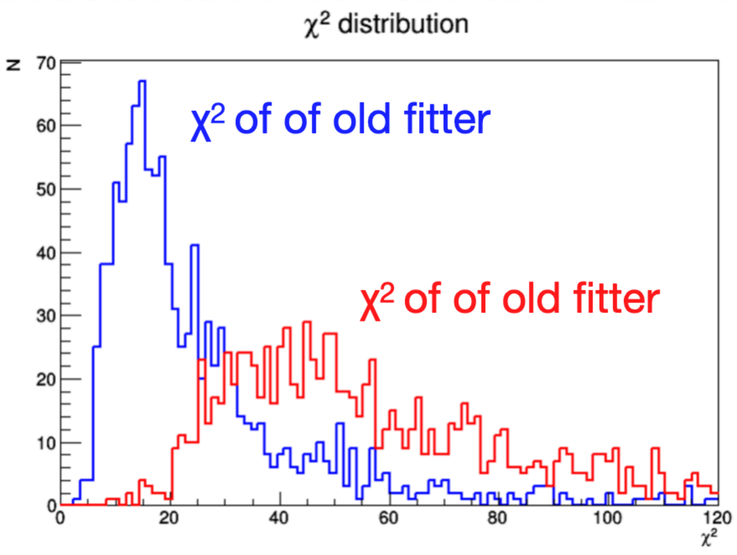



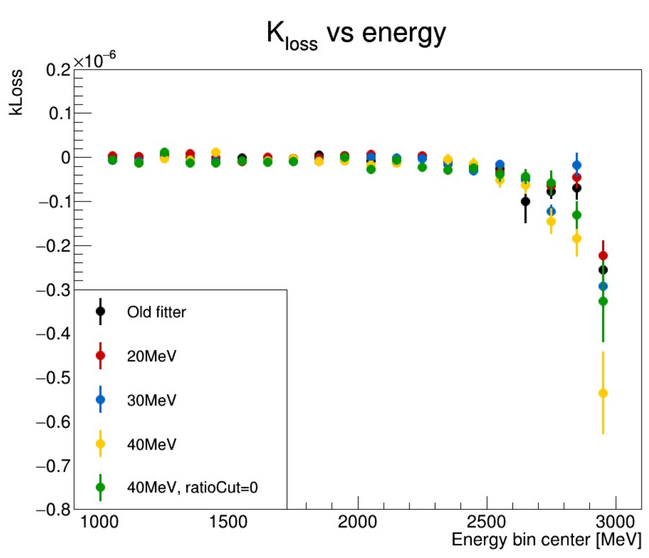

## IV.Performance of the new fitter

▸Recovered low energy crystal hits and reduced corresponding $\chi^2$

▸Improved the $K_{loss}$ vs energy shape (less gradient)

Not solving the $K_{loss}$ puzzle completely, we are still investigating the possible issues





References

[1] Muon g-2 collaboration, PHYSICAL REVIEW D 103, 072002 (2021)

[2] A. Fienberg, Measuring the precession frequency in the E989 Muon g − 2 Experiment, Ph.D. thesis, University of Washington (2019)

[3] K.S. Khaw, M. Bartolini et.al., Nuclear Inst. and Methods in Physics Research, A 945 162558 (2019)