Resolution of the \( E_{MC} \)
from symmetric Pi0 and Eta Decays

\( E_{MC} \) calib. mtg.

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- **Introduction**
  - The Method for Gaussian Errors
  - Modifications for non-Gaussian Errors

- **Data**
  - Symmetric Pi0 Decays
  - Symmetric Eta Decays

- **Extraction of the Resolution**
The Method for Gaussian Errors

Width of the Mass peak:

\[ \sigma_{\text{theo}} = \sqrt{\frac{m^2}{2} \left( \frac{\Delta E}{E} \right)^2 + \frac{E^4 \sin^2 \alpha}{m^2} (\Delta \alpha)^2} \]

- 'Measure' Mass and Width of \( \pi^0 \) and \( \eta \) decays to 2 photons with equal energy.

- Minimize

\[ \chi^2 = \frac{\left( \sigma_i - \sigma_{i,\text{theo}} \right)^2}{(\Delta \sigma_i)^2}, \]

with

\[ \frac{\Delta E}{E} = \frac{e_a}{4\sqrt{E}} \oplus e_b \]

and

\[ \Delta \alpha = \frac{\sqrt{2} t_a}{\sqrt{E}} + \sqrt{2} t_b \]

- Fitted values for \( e_{a,b} \) and \( t_{a,b} \) give the desired result.
Fit Result:

\[
\frac{\Delta E}{E} = \frac{(1.13 \pm 0.21)}{4\sqrt{E}} \oplus (0.6 \pm 1.2) \%
\]

\[
\Delta \alpha = \frac{\sqrt{2}(3.1 \pm 0.2)}{\sqrt{E}} + \sqrt{2}(1.9 \pm 0.1) \text{mrad}
\]
Toy MC with Bergen values and Novosibirsk tails $t = -0.7$

- blue curves show input resolutions
- dots show results after subtracting the expected angular (energy) contribution
- no tail correction has been done
- results are clearly wrong
Connection of Novosibirsk Sigma and RMS as a function of the Tail:

Modify:

\[
\sigma_{\text{theo}}^{\text{new}} = \frac{\text{RMS}}{\sigma} (t_{\pi^0}^{\text{meas}}) \sigma_{\text{theo}}^{\text{old}}
\]

\[
\frac{\Delta E}{E}_{\text{new}} = \frac{\Delta E}{E}_{\text{old}} \frac{\sigma}{\text{RMS}} (t_{\gamma}^{\text{MC}})
\]

\[
\Delta \alpha_{\text{new}} = \Delta \alpha_{\text{old}}
\]
Toy MC with Bergen values and Novosibirsk tails $t = -0.7$ II 6

- blue curves show input resolutions
- dots show results after subtracting the expected angular (energy) contribution
- tail correction has been done
- results are in good agreement with the input values
2001 Pi0 data from 30,000,000 isPhysics events
\[ \frac{\Delta E}{E} = \frac{\sigma_1}{E^{1/4}} \oplus \sigma_2 \]

\[ \sigma_1 = (2.36 \pm 0.03 \pm 0.3)\% \]

\[ \sigma_2 = (1.13 \pm 0.09 \pm 0.2)\% \]
\[ \sigma(\theta) = \frac{\sigma_1}{E^{1/2}} + \sigma_2 \]
\[ \sigma_1 = (4.16 \pm 0.04) \text{ mrad} \]
\[ \sigma_2 = (0.00 \pm 0.00) \text{ mrad} \]
• 2001 data looks better than 200 data

• Resolution parameters can be extracted from $\pi^0$ and $\eta$ decays

• Largest systematic comes from assumed (MC determined) tail for energy response to photons