π^0 Analysis for kin 484

DVCS-3 Collaboration Meeting
February 4, 2019

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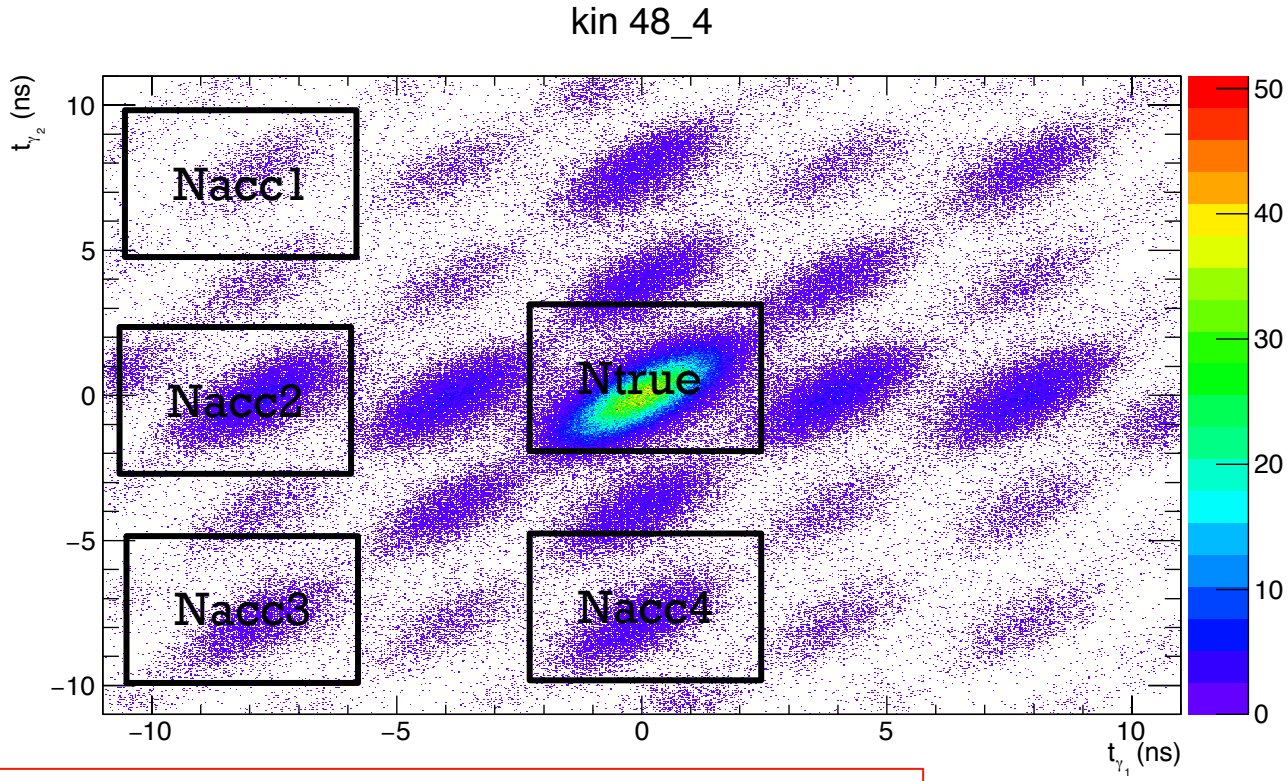
Accidental Subtraction: t_{γ_1} and t_{γ_2}

- **Distribution of photons' arrival time $\pi^0 \rightarrow \gamma_1\gamma_2$**
  - **Ntrue = Nacc1 + Nacc2 + Nacc3 + Nacc4**
  - **Nacc1=[-11,-5] $_{\gamma_1}$ ∪ [5,11] $_{\gamma_2}$**
  - **Nacc2=[-11,-5] $_{\gamma_1}$ ∪ [-3,3] $_{\gamma_2}$ + Nacc1**
  - **Nacc3=[-11,-5] $_{\gamma_1}$ ∪ [-11,-5] $_{\gamma_2}$ + Nacc1**
  - **Nacc4=[-3,3] $_{\gamma_1}$ ∪ [-11,-5] $_{\gamma_2}$ + Nacc1**
  - **Nacc3+Nacc4= =[-11,-5] $_{\gamma_1}$ ∪ [-3,3] $_{\gamma_2}$ + [-3,3] $_{\gamma_1}$ ∪ [-11,-5] $_{\gamma_2}$ +2*Nacc1**

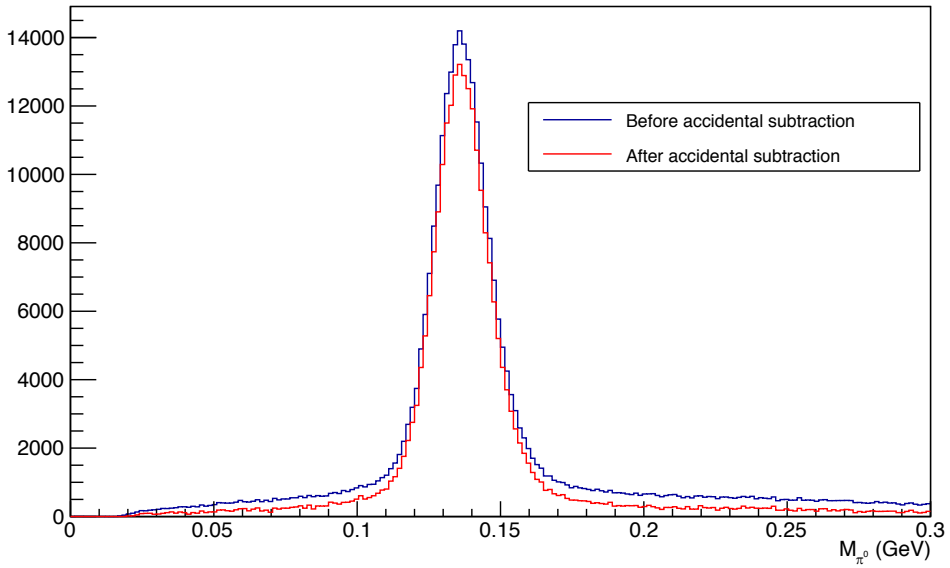


NaccTotal = Nacc3+Nacc4-2*Nacc1

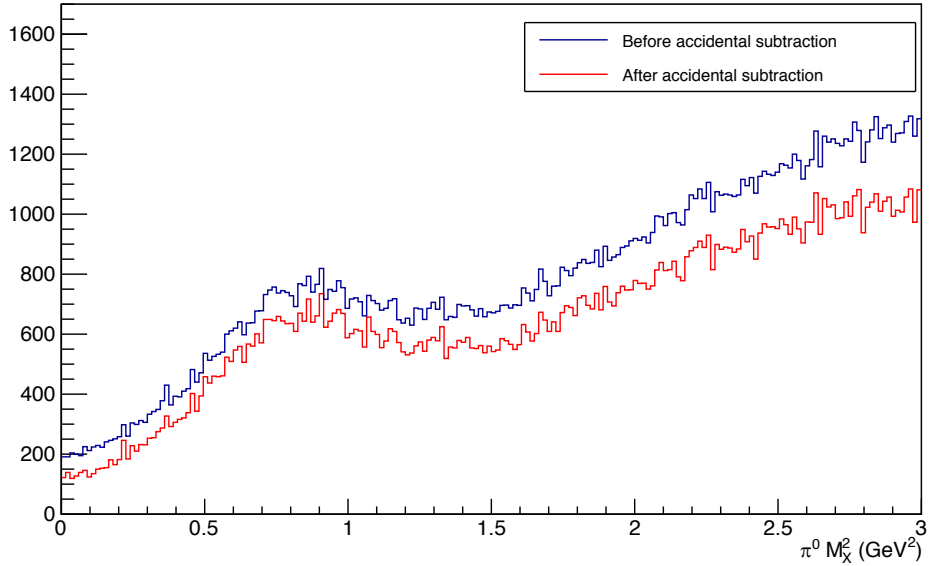
Ntrue-NaccTotal=Ntrue-(Nacc3+Nacc4-2*Nacc1)

Accidental Subtraction: application to m_{π^0} and M_X^2

Kin 48_4



Kin 48_4

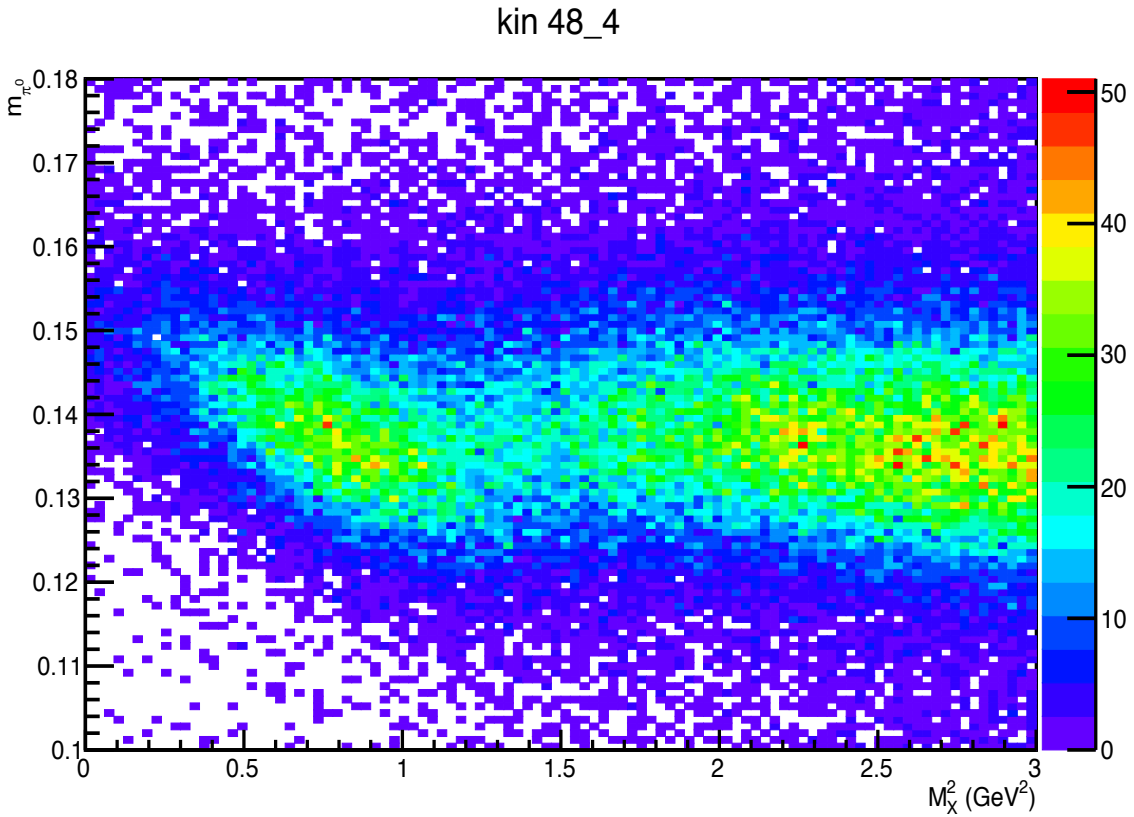


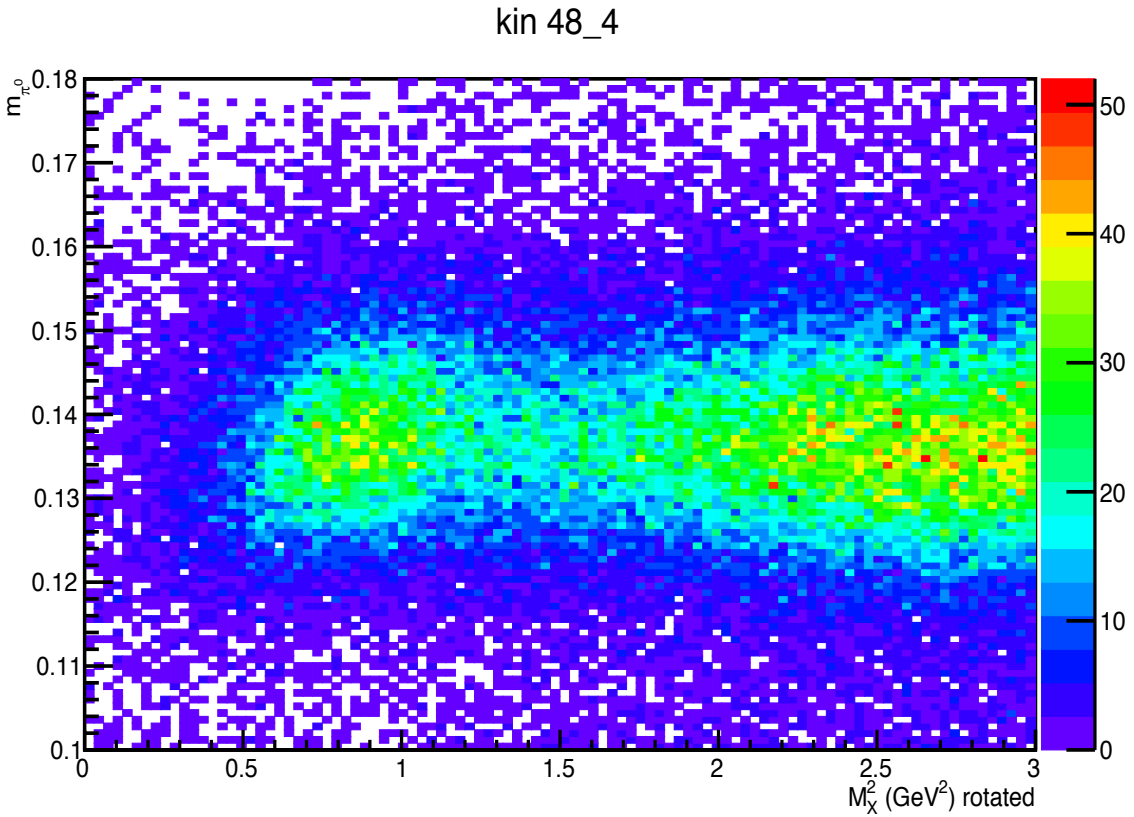
- Cuts applied in addition to accidental subtraction:
  - Applied to data: calorimeter, z-vertex cuts, Pion Rejector cuts (pr1>600; pr2>200), r value (>0.0025), cer >150, tracking cuts
  - Applied to simulation only: Calorimeter cuts, z-vertex cuts

Removal of m_{π^0} and M_X^2 Correlation

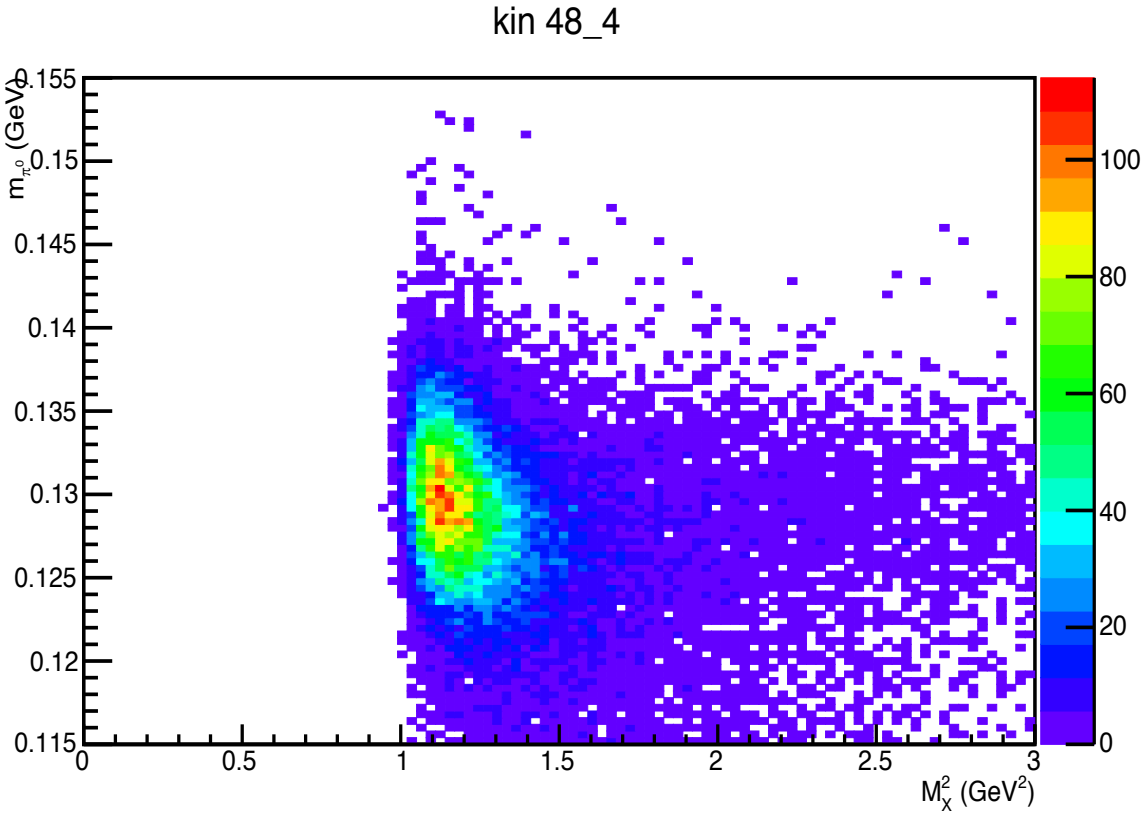
- Remove correlation by "rotating" missing mass squared
- Correct missing mass (from M. Mazouz)
  - M_X^2 **corr** $= M_X^2 + \mathbf{C} \cdot (m_{\gamma\gamma} - m_{\pi^0})$
    - $m_{\gamma\gamma}$ = ideal π^0 mass ; m_{π^0} = avg π^0 mass
    - $\mathbf{C} = \frac{2}{m_{\pi^0}} [(m^{\pi^0})^2 - 2\sqrt{2}(\nu + m_{\gamma\gamma} - q\cos\theta_{\pi\gamma}) \frac{E_1 E_2}{E_1 + E_2}]$

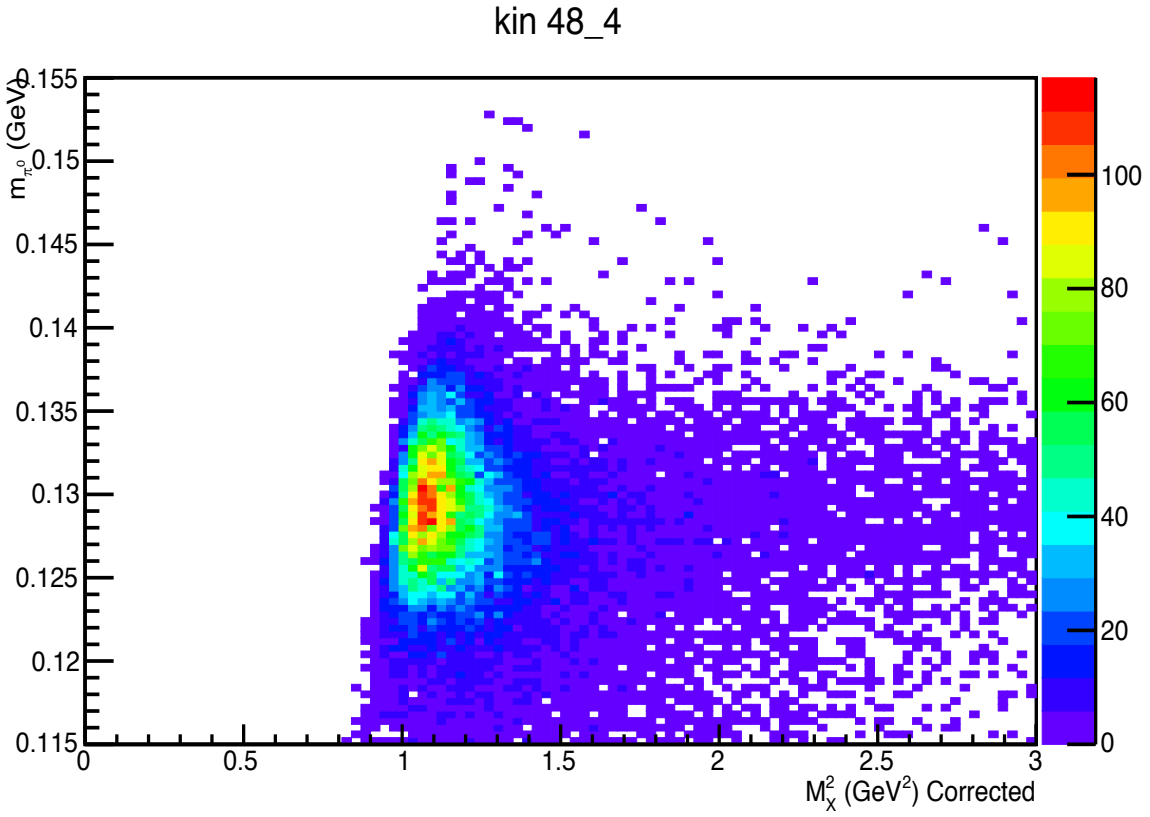
Removal of m_{π^0} and M_X^2 Correlation: Application to data

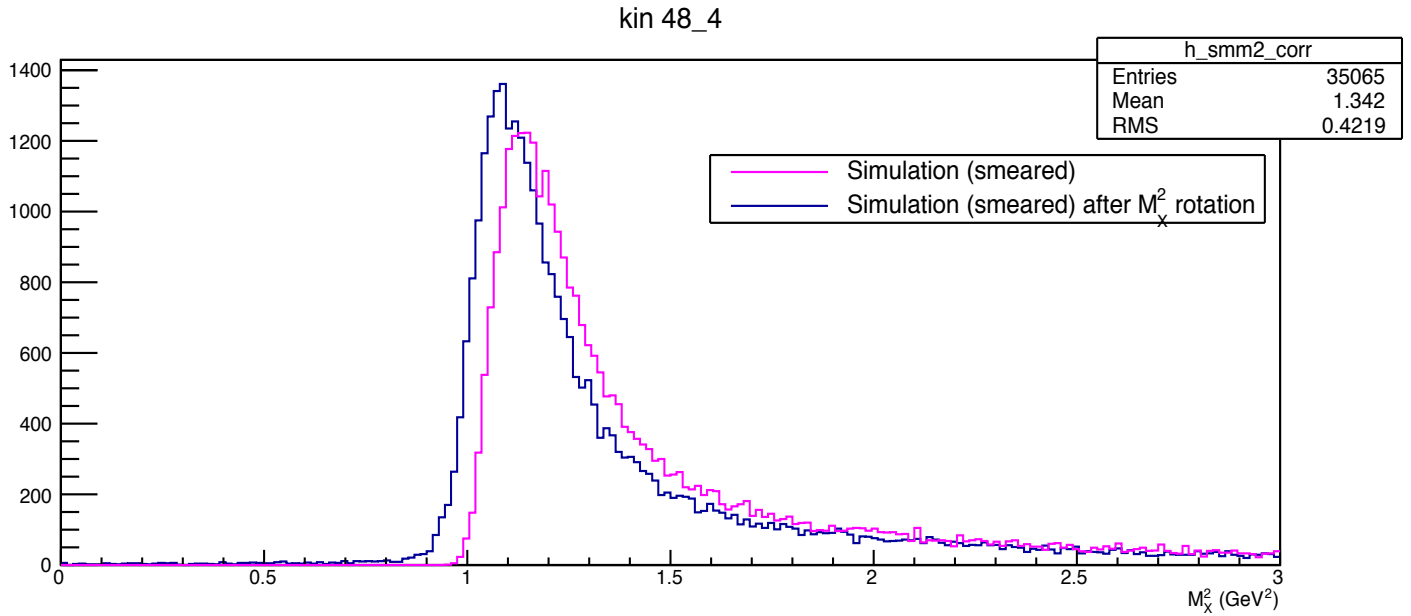


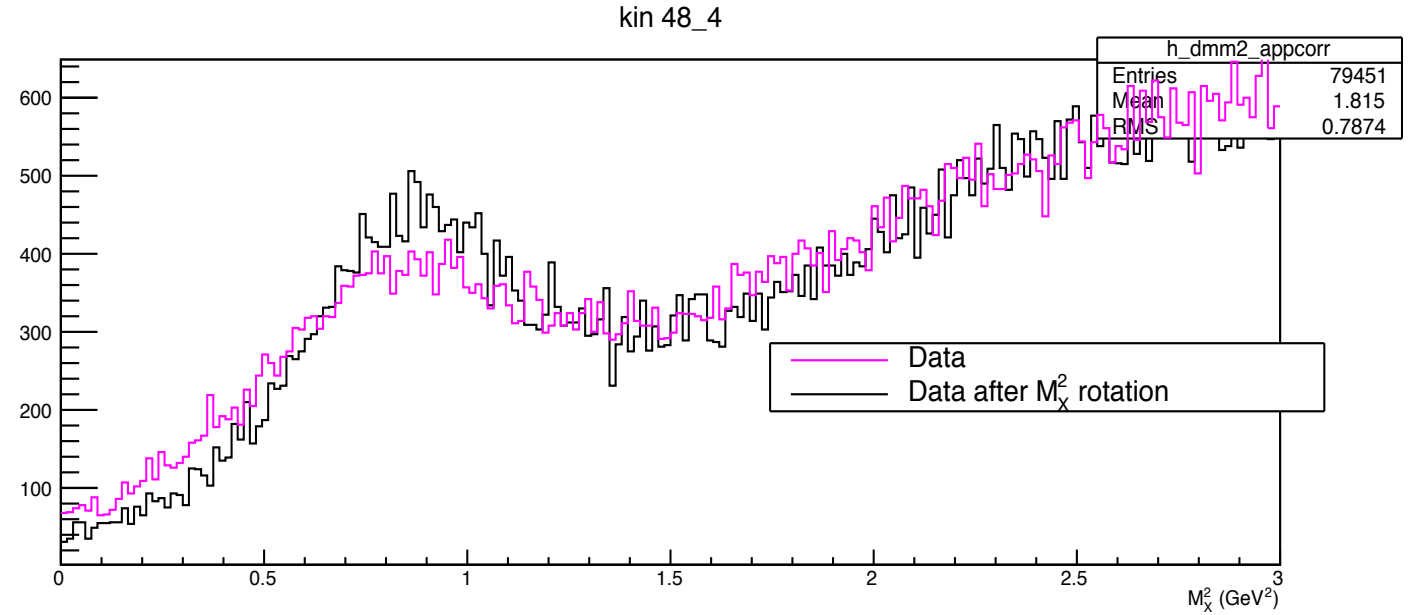


Removal of m_{π^0} and M_X^2 Correlation: Application to simulation



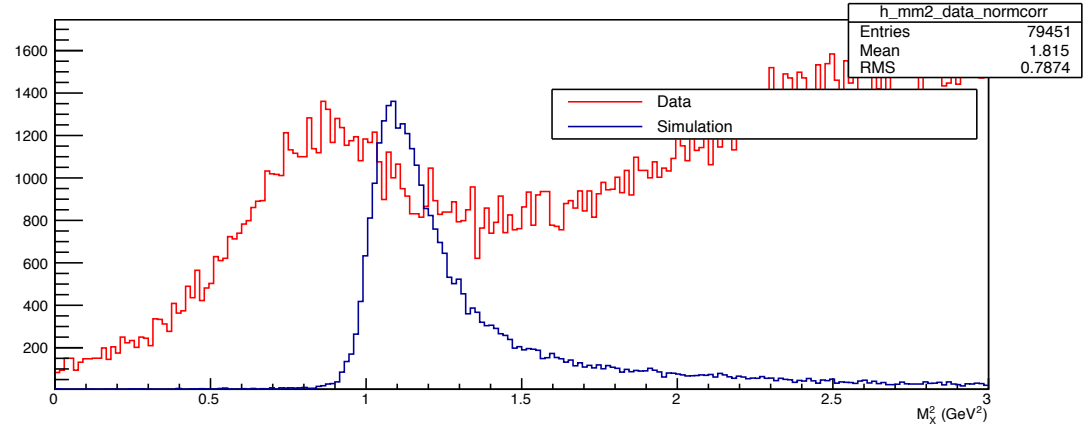


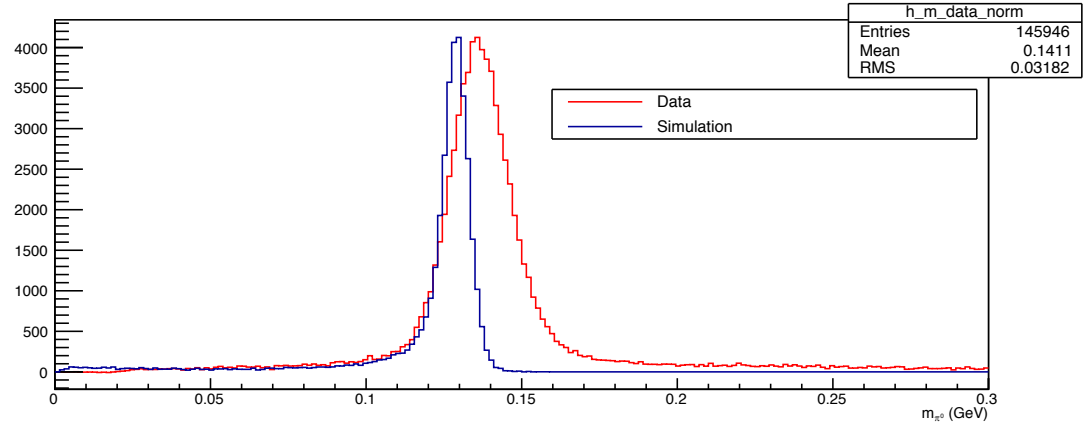

kin 48_4
h_smm2_corr
Entries 35065
Mean 1.342
RMS 0.4219
Simulation (smeared)
Simulation (smeared) after M_x^2 rotation
M_x^2 (GeV^2)


kin 48_4
h_dmm2_appcorr
Entries 79451
Mean 1.815
RMS 0.7874
Data
Data after M_x^2 rotation
M_x^2 (GeV^2)

Smearing of π^0 energy and momentum

- Smear π^0 energy and four-momentum from MC simulation, $q_1(E_1,\vec{q}_1)$ and $q_2(E_2,\vec{q}_2)$ via Gaussian
  - Gaussian(μ,σ) * $q_1(E_1,\vec{q}_1)$
  - Gaussian(μ,σ) * $q_2(E_2,\vec{q}_2)$
- Vary μ and σ to find best match to data

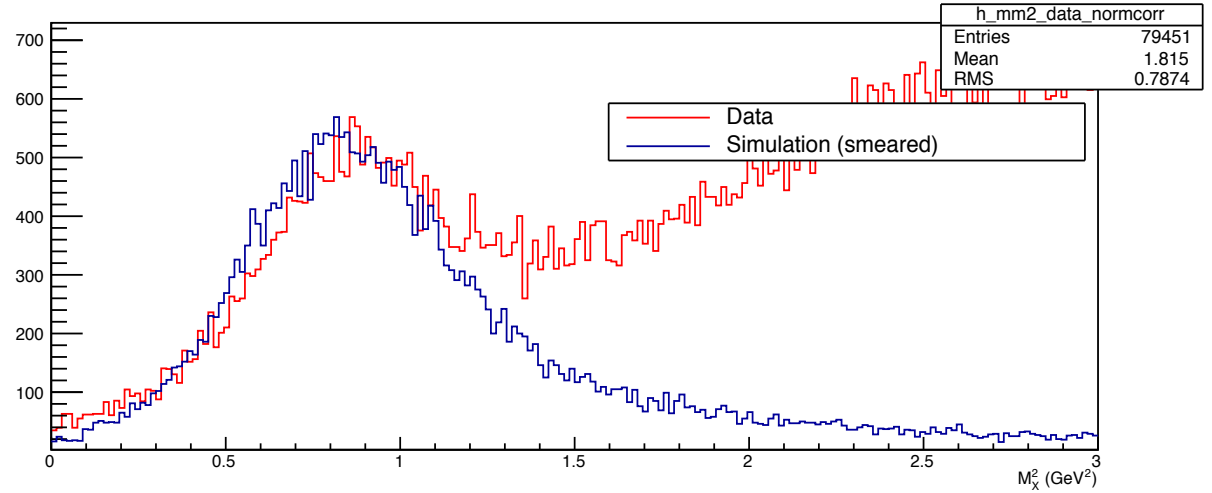


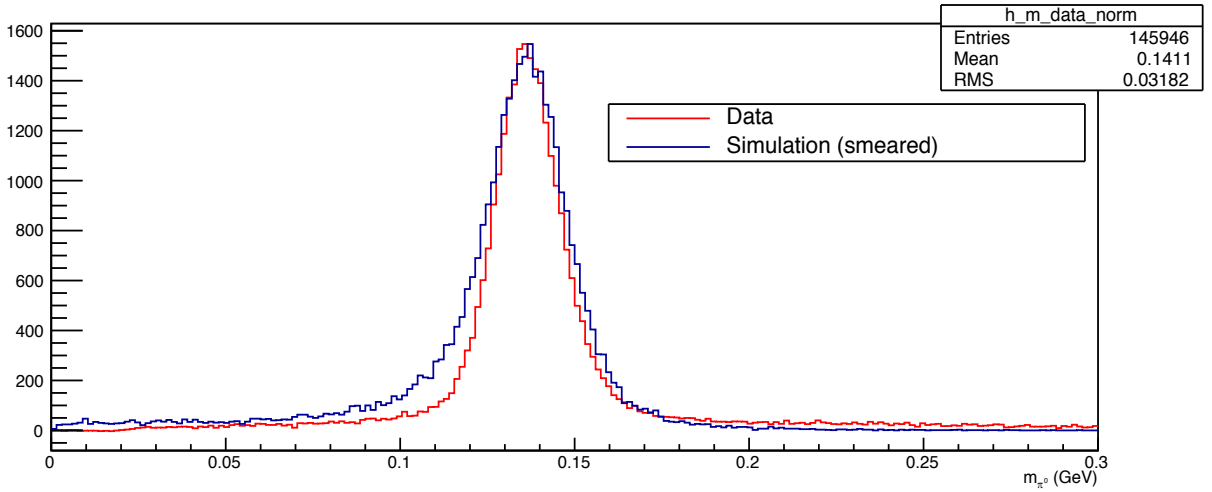


Smearing of π^0

- 40K events from simulation.

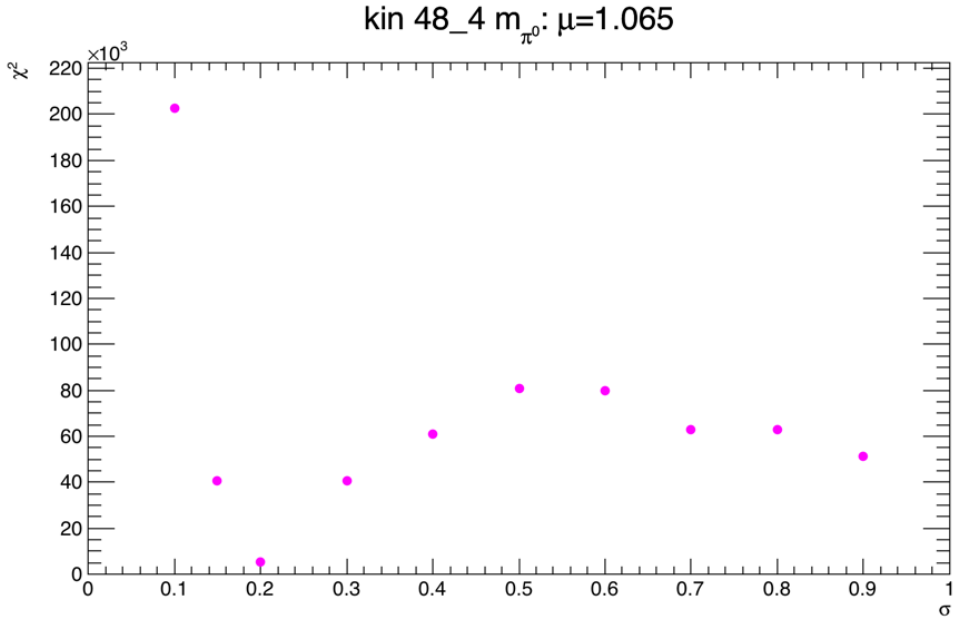
$$\mu = 1.065$$
$$\sigma = 0.26$$





- Mapping over area of calorimeter.

Smearing: χ^2 Test



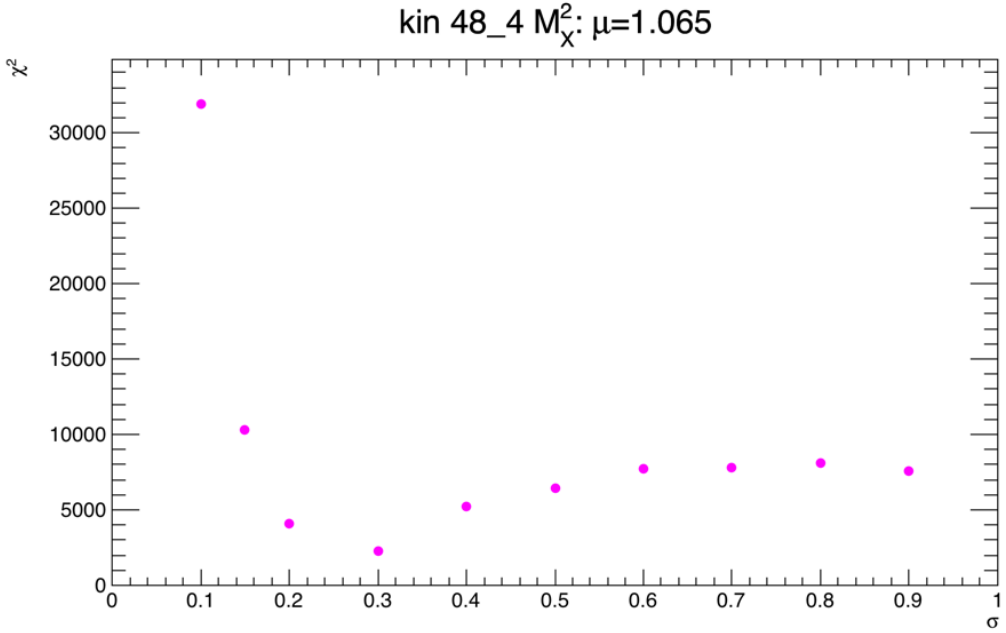
$$\chi^2 = \sum_{i=1}^{n} [MCHisto(x_i) - DataHisto(x_i)]^2$$

n = bins in range

For M_X^2: 0 to 1.1 GeV^2

For m_{π^0} : 0.115 to 0.155 GeV

- Relying on the fit of Monte Carlo simulation to data to determine μ and σ parameters.



Outlook and Next Steps

- MC simulation and data fitting - optimize χ^2 test
  - Normalization with luminosity
- Smear each of 49 areas of calorimeter
- Interpolate final values of μ and σ based on photon impact point in calorimeter
- π^0 cross section analysis

Backup

Removal of m_{π^0} and M_X^2 Correlation: Application to smeared simulation