π^0 Analysis Update

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November 21, 2018

1 Time Coincidence

Accidental events are to be subtracted from the main coincidence window [-3,3]. Unlike DVCS analysis where an accidental π^0 subtraction is needed, here an accidental photon subtraction is to be made. The windows selected for this subtractions contain pure randoms that are in [-11,-5], and [5,11], and combinations of [-11,-5], [5,11] and [-3,3] windows to fully subtract the accidentals. Figure 1 shows the distribution of arrival times of the two photons resulting from π^0 decay.

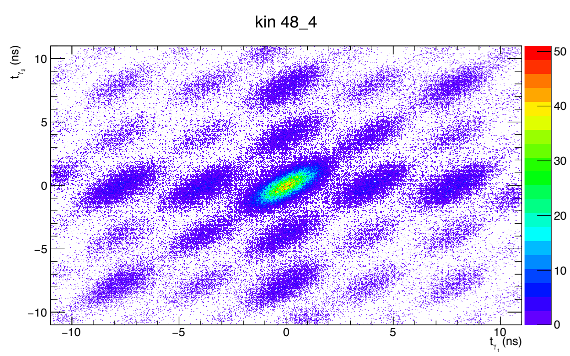


Figure 1: Arrival time distribution of γ_1 and γ_2 from $\pi^0 \to \gamma_1\gamma_2$ in kinematic 48_4. The window in the center [-3,3] contains true coincidences plus accidentals.

$$N_{acc1} = +[-11,-5]\&[5,11]_{acc3} \tag{1}$$

$$N_{acc2} = [-11,-5]\&[-3,3]\_acc2 + [-11,-5]\&[5,11]\_acc3 \tag{2}$$

The subtraction of photons from the true coincidences in windows [-3,3] is done by using Equation 4.

$$N_{acc1}+N_{acc2} = [-11,-5]_{acc1}+[-11,-5]\&[-3,3]\_acc2+2*[-11,-5]\&[5,11]\_acc3 \tag{3}$$

$$N_{\pi^0 accidentals} = N_{acc1} + N_{acc2} - N_{acc3} \tag{4}$$

N_{acc1} selects two-photon events in the the window [-11,-5]. N_{acc2} selects events with one photon in [-3,3] and one in [-11,-5]. N_{acc3} selects random photon events occurring in windows [-11,-5] and [5,11]. N_{acc3} is present in the relevant windows mentioned above, hence why the factor of 2 is included in Equation 3, and is implied in Equation 4.

2 M_x^2 and M_{π^0} Comparison

2.1 M_x^2 and M_{π^0} After Accidental Subtraction

Figure 2 shows the missing mass squared after accidental subtraction.

2.2 Comparison to Mongi's analysis for kinematic 36_1

Comparing background subtraction of kinematic 36_1 with Mongi's analysis.

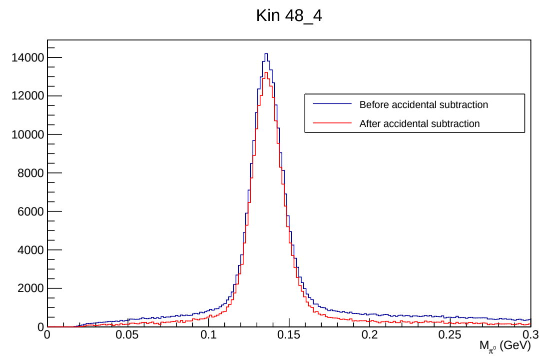
3 GEANT4 Simulation vs. DVCS3 Data

Figures 6 and 7 show the M_x^2 of the Geant4 π^0 simulation compared with the experimental data for kinematic settings 48_1 and 48_4, before smearing.

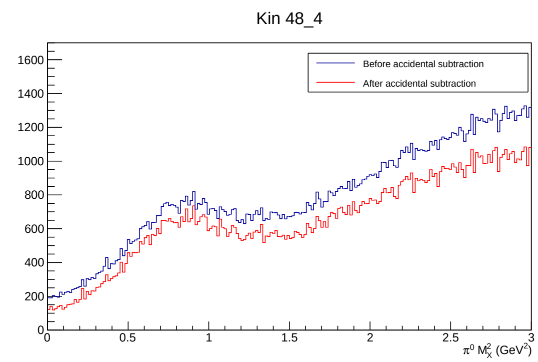
The goal is to smear the four vector energy of both photons hitting calorimeter after the π^0 decay. This relationship from the Monte Carlo simulation is best demonstrated by the transformation using the smearing coefficient, σ and calibration coefficient, μ also shown by Equation 5 for the "first" photon and 6 for the "second".

$$\begin{bmatrix} q_{x_1} \\ q_{y_1} \\ q_{z_1} \\ E_1 \end{bmatrix} = gaus(\mu, \sigma) \times \begin{bmatrix} q_{x_1} \\ q_{y_1} \\ q_{z_1} \\ E_1 \end{bmatrix} \tag{5}$$

$$\begin{bmatrix} q_{x_2} \\ q_{y_2} \\ q_{z_2} \\ E_2 \end{bmatrix} = gaus(\mu, \sigma) \times \begin{bmatrix} q_{x_2} \\ q_{y_2} \\ q_{z_2} \\ E_2 \end{bmatrix} \tag{6}$$



(a)



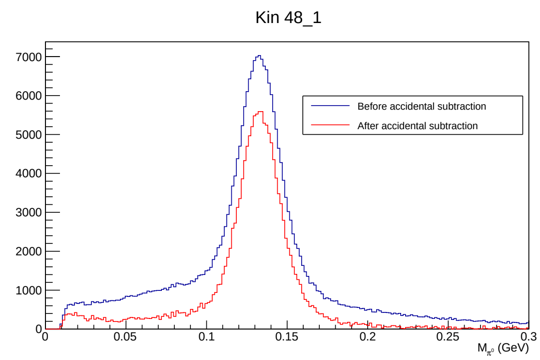
(b)

Figure 2: M_x^2 and M_{π^0} before and after accidental subtraction for kinematic 48_4.

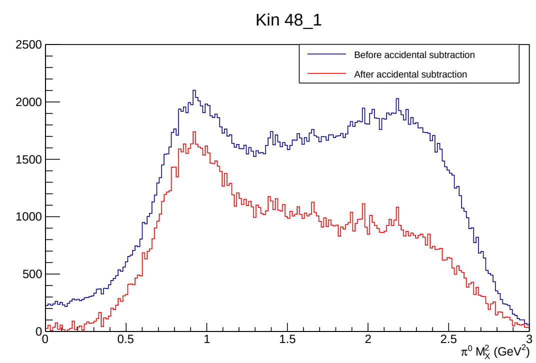
3.1 π^0 Simulation on github

Mongi's π^0 Geant4 simulation adopted from Maxime and Rafayel[1] with some additional optimization has been uploaded to github. The same instructions of how to run DVCS simulation (from Bill) apply. Go to `https://github.com/JeffersonLab/HallADVCS/tree/master/geant4_simulation/pi0sim` to use (pull request has been made).

[1]Link to "Implementation of the Hall A DVCS Calorimeter in Geant4": `https://userweb.jlab.org/~rafopar/HallA/Calo/Calo_Geant4.ps`

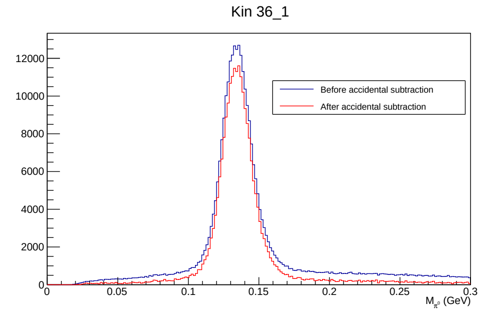


(a)

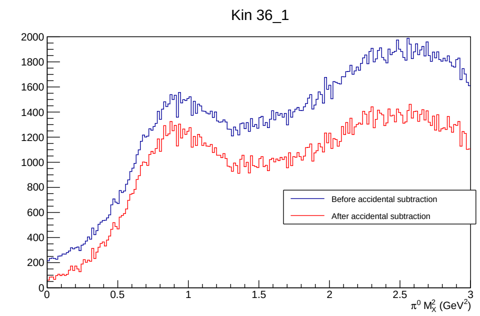


(b)

Figure 3: M_x^2 and M_{π^0} before and after accidental subtraction for kinematic 48_4.



(a)



(b)

Figure 4: $(M_x)^2$ and M_{π^0} shown for kinematic 36_1 (my analysis).

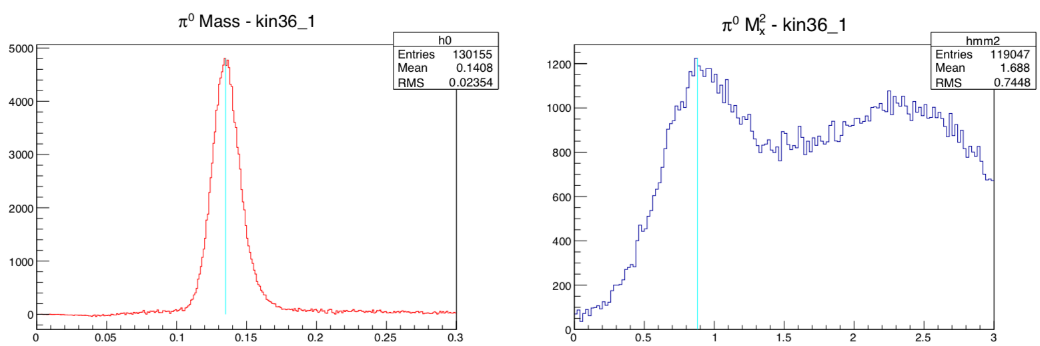
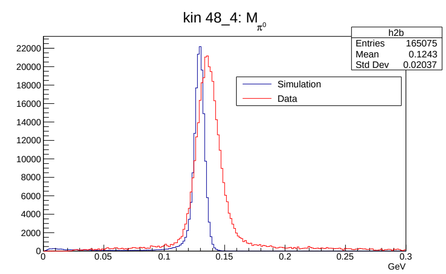
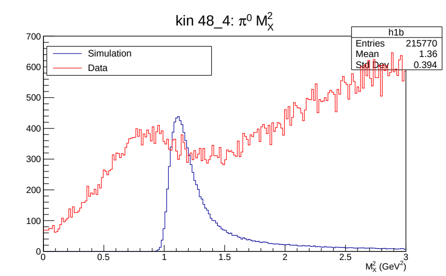


Figure 5: $(M_x)^2$ and M_{π^0} shown for kinematic 36_1 (Mongi).

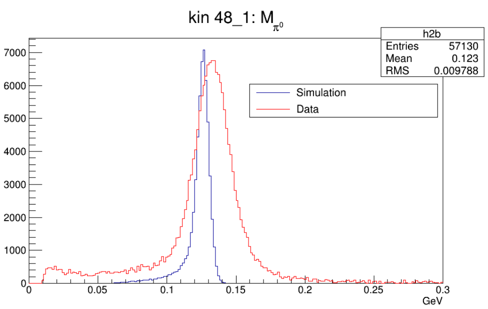


(a)

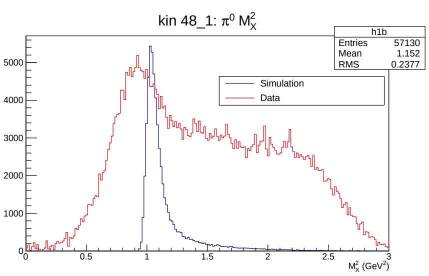


(b)

Figure 6: M_x^2 and M_{π^0} of the simulation vs. experimental data for kin48_4, before smearing.



(a)



(b)

Figure 7: M_x^2 and M_{π^0} the simulation vs. experimental data for kin 48_1 before smearing.