Study of kinematic fit efficiency

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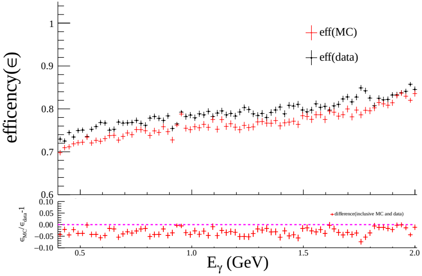
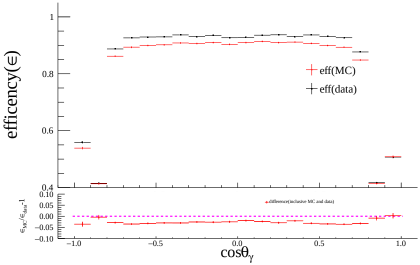
Problems met before

- The photon efficiency has been studied using the $\mu^+\mu^-\gamma_{ISR}$ as the control sample and we have tried to combine the 4c kinematic fit of ISR photon with it. However as the figure(a) and figure(b) show the efficiency of data is systematically higher than the MC which is mainly caused by the kinematic fit. More detailed checks are needed.

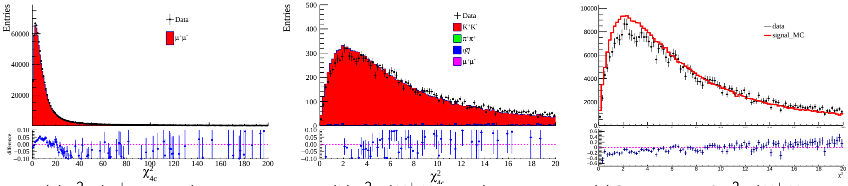


(a)



(b)

Check of 4c kinematic fit



(a)χ^2_{4c} ($\mu^+\mu^-\gamma_{ISR}$) (b)χ^2_{4c} ($K^+K^-\gamma_{ISR}$) (c)Comparison of χ^2_{4c} ($K^+K^-\gamma_{ISR}$)

- Figure(a) shows that the χ^2_{4c} of the $\mu^+\mu^-\gamma_{ISR}$ in data is more concentrated around 0 than MC.

- Figure(b) shows that the in the region of the low χ^2 the $K^+K^-\gamma_{ISR}$ is background free.

- Figure (c) shows that the χ^2_{4c} of the $K^+K^-\gamma_{ISR}$ in MC is more concentrated around 0 than data which is not same as $\mu^+\mu^-\gamma_{ISR}$. We try to give a detailed check by selecting the $K^+K^-\gamma_{ISR}$ without doing kinematic fit.

Selection of $K^+K^-\gamma_{ISR}$ without kinematic fit

Good charged tracks, Good photons, Vtxfit:

- The conditions are same as nominal tagged $K^+K^-\gamma_{ISR}$ selections.

PID:

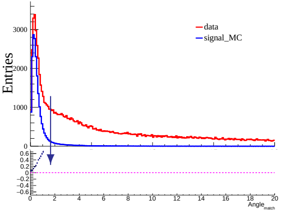
- $Prob_K > Prob_\pi \&\& Prob_K > Prob_p, N_{K^+} = N_{K^-} = 1$

Match Angle:

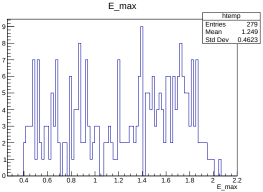
- From figure(a), the angle between the recoiled direction and the reconstructed ISR photon should be smaller than 1.5°

Energy of ISR photon:

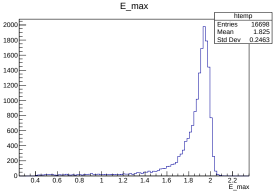
- From figure (b) and (c), the energy of γ_{ISR} should be larger than 1.6 GeV to veto hardronic backgrounds.



(a)Angle between $\gamma_{recoiled}$ and $\gamma_{reconstructed}$



(b)$E_{\gamma_{ISR}}$ of hardron background.

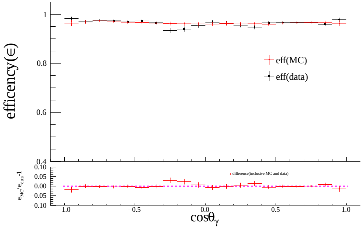


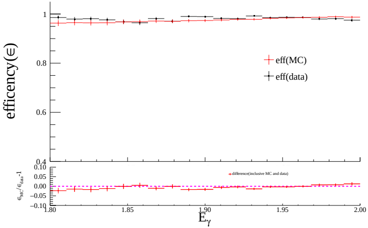
(c)$E_{\gamma_{ISR}}$ of data.

Selection Result

Data/MC sample	N_{gen}	N_{sur}	L_{int}	σ_{obv}	scale factor	N_{sur_scale}
Data		15064	3194500		1	15064
$K^+K^-\gamma_{ISR}$	1000000	425294	3194500	0.1	0.0348	14804
$\pi^+\pi^-$	1000000	90	3194500	1.00	0.32	29
hadron	2000000	85	3194500	24.08	4.04	343
$\mu^+\mu^-$	10000000	14	3194500	2.7974	0.8936	13
e^+e^-	271000000	0	3194500	424	4.99	0

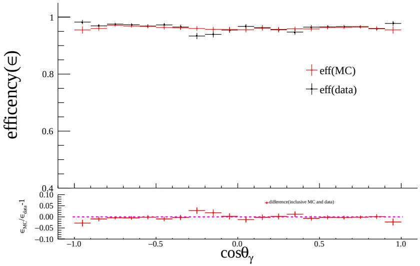
- Signal-background ratio is about 97.5%.
- Then we do the 4c kinematic fit as KK's nominal selection and calculate the efficiency.



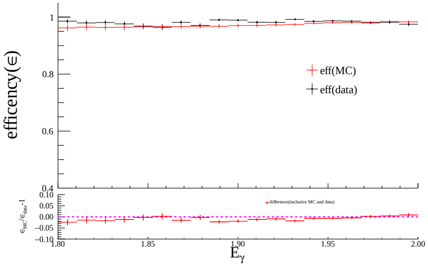


- The efficiency of data doesn't show enhancement to MC.

efficiency after corrections of K^+K^-



(a)



(b)

- The situation of kinematic fit efficiency still exists.

Event selection

The new control sample we choose is $e^+e^-\gamma_{ISR}$
Good charged tracks:

- $|V_z| < 10$ cm, $V_r < 1$ cm and $|cos\theta| < 0.93$
- 0.8$< E_{deposited}/p <$1.2, $E_{deposited}$ is the deposited energy of charge track
- N_{Good} =2, $\sum Q_{track} = 0$
- The p/E_{beam} ratio of at least one track should be larger than 0.95, here E_{beam} is the beam energy.

Good photons:

- EMC time:$0 < t < 700$ ns
- $|cos\theta_\gamma| < 0.86$ for the barrel and $E_\gamma > 25MeV$
- $0.86 < |cos\theta_\gamma| < 0.92$ for the endcap and $E_\gamma > 50MeV$

A photon is called a good photon if it satisfies these conditions.

- The largest energy of all good photons should be larger than 0.4 GeV.

Event selection

Vertex Fit:

- Successful vertex fit for the two charge tracks

Further Selection:

- The total deposited energy in EMC should be larger than $0.9E_{cm}$.

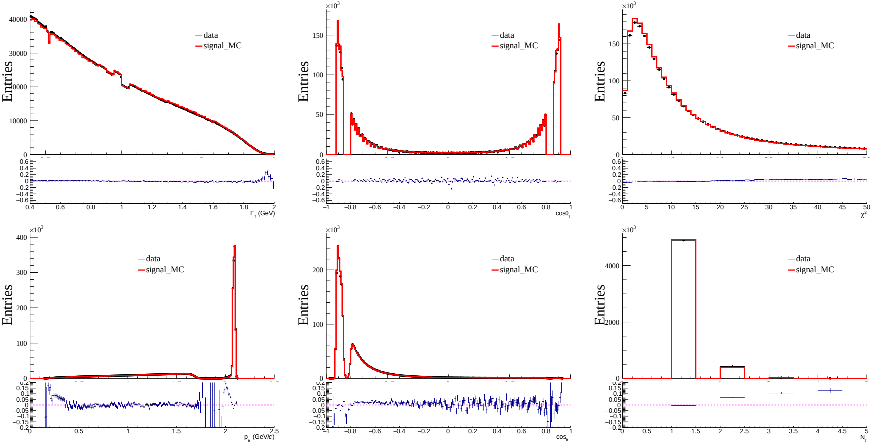
Kinematic Fit:

- Using the nominal ISR photon and the good charge tracks to do the 4c kinematic fit and the $\chi^2_{4c,\gamma}$ should be smaller than 50.

The event number got without doing the kinematic fit is N1 and the event number after requiring the χ^2 is N2. The kinematic fit efficiency of ISR photon is:

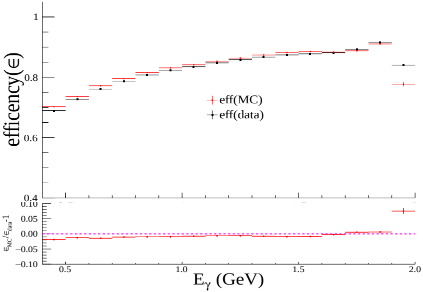
$$\epsilon = N2/N1, \text{ and the error is } \text{err}_\epsilon = \sqrt{\frac{\epsilon(1-\epsilon)}{N_1}}$$

Comparisons between data and MC

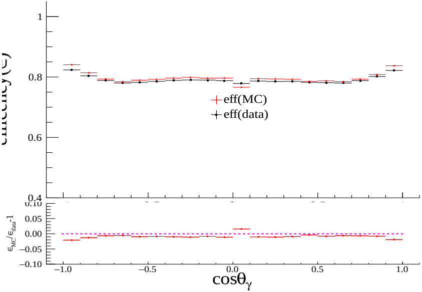


- The background level is estimated to just about 0.5% by Tiantian Lei's work. The MC and data match well with each other.
- The χ^2_{4c} of the $e{+}e^-\gamma_{ISR}$ in MC is more concentrated around 0 than data which is same as $K^+K^-\gamma_{ISR}$.

efficiency varies with momentum and cosθ



(a)

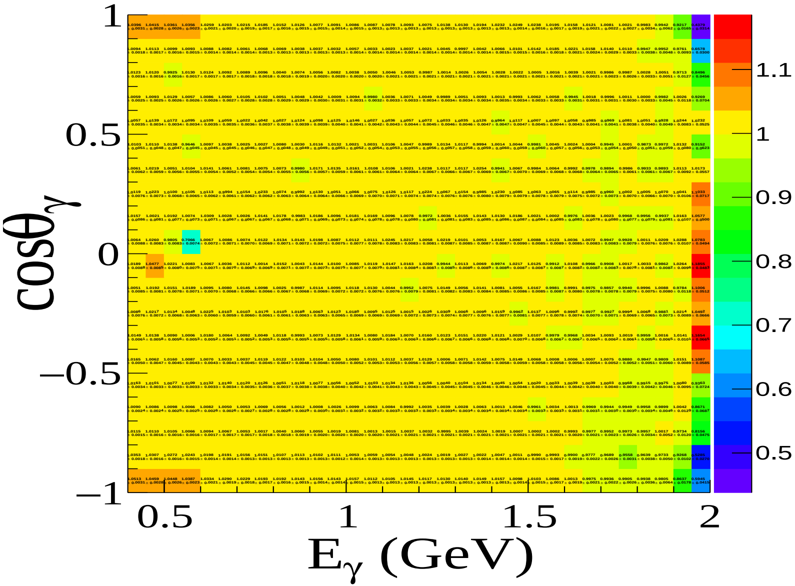


(b)

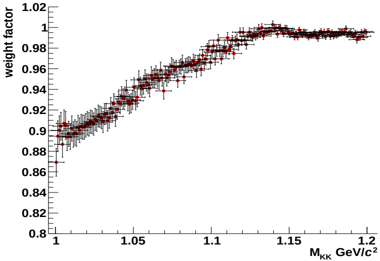
- Figure(a) is the photon efficiency varying with the energy of photon. The efficiency of data and MC shows great agreement with each other except for the region near 2 GeV.

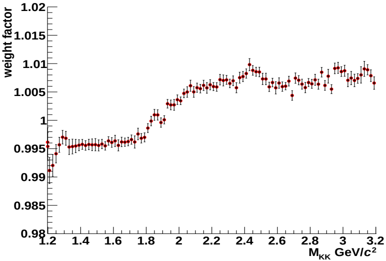
- Figure(b) is the efficiency varying with the cosθ of photon. Little difference between data and MC.

efficiency (2D)



weight factor varies with M_{KK}

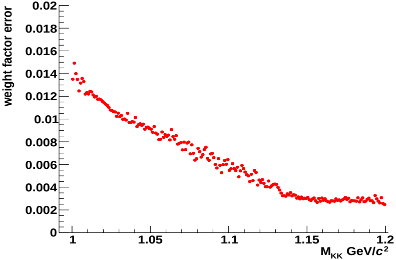


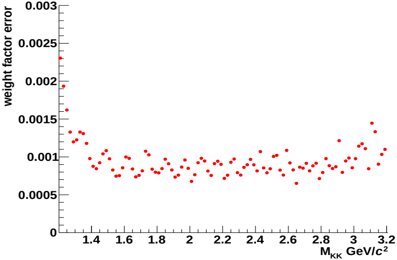


How to get the weight factor varying with M_{KK}:

- Get the $cos\theta_{\gamma}$ and E_{γ} 2D distribution of different M_{KK} bins.
- Then calculate the ratio of each 2D bin to the total event number of the M_{KK} bin and get the corresponding weight factor.
- Sum over the product of the weight factor and the ratio, then we can get the weight factor of the MKK bin. The error of it is calculated as: $err = \sqrt{\sum(ratio * err_{weight})^2}$

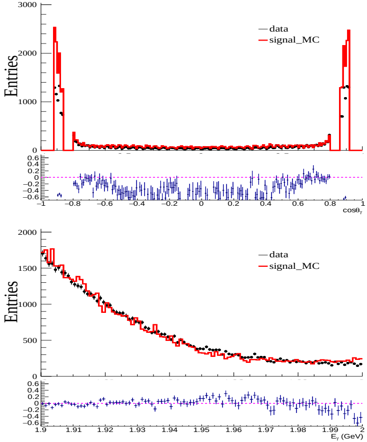
Systematic uncertainties of kinematic fit of photon





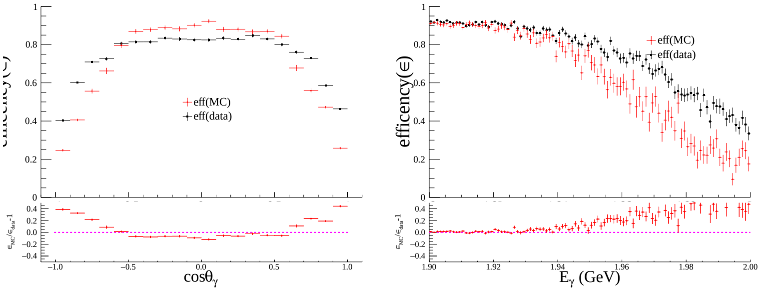
- Large errors are found near 1 GeV which is probably caused by the low statistics. This is not acceptable for this region is which we focus on.
- Detailed check at the region: $E_\gamma > 1.9$ GeV is needed.

Detailed check of the region: $E_\gamma > 1.9$ GeV



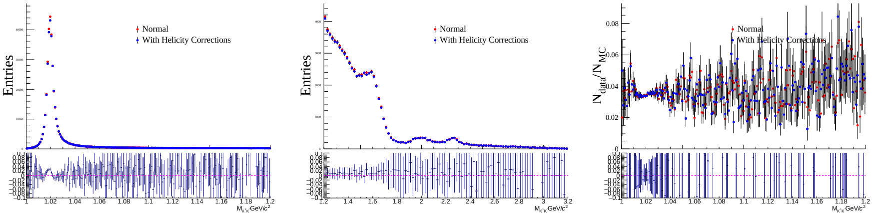
- The top two pictures are the distributions of $cos\theta_\gamma$ before and after the χ^2 requirements.
- The top bottom pictures are the distributions of E_γ.

Detailed check of the efficiency: $E_\gamma > 1.9$ GeV



- The efficiency of data is obviously higher than MC especially at the region near the boundary of MDC, but lower at the barrel.
- The efficiency of data is obviously more and more higher than MC as the energy of ISR photon rising.

Uncertainties of charged Kaon's kinematic fit



(a) (b) (c)

- We change the charged tracks' parameters and take half of the efficiency difference as the systematic uncertainty.
- For the region outside the ϕ peak the two efficiencies don't show the systematic difference as the figure(b) shows. The systematic uncertainty is about 0.5%.
- However, the normal kmfit is systematically higher than the MC after the corrections, so we use the difference of the ratio of the data and MC as the systematic uncertainty. The systematic uncertainty is about 0.2%.