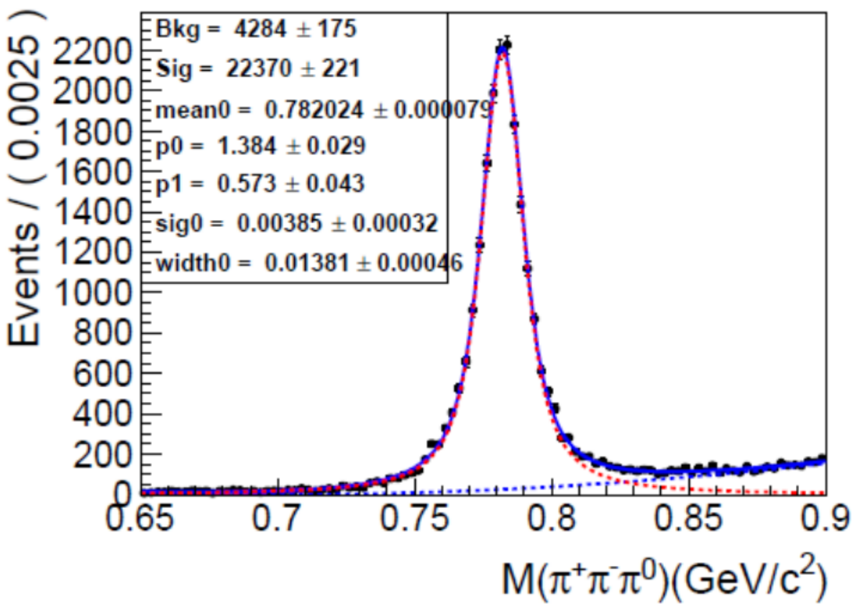
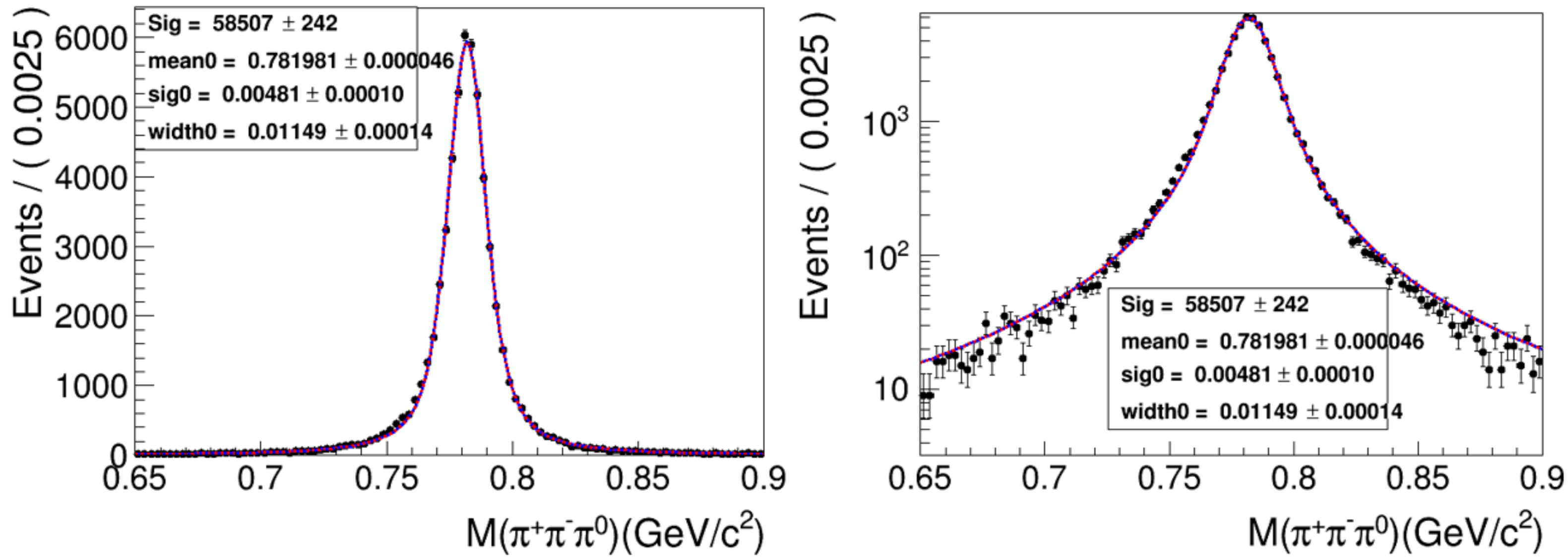
First round of questions

-) Slides 16, why the width is larger than that of PDG? One possible reason is that the background shape could not be described well with the polynomial function. You may check the fitting plot with the log scale to see if the polynomial function actually distorted the background shape, in particular for the region under the omega peak.



Consist with PDG Value:
Mass(ω) = 782.65 ± 0.12MeV
Width = 8.49±0.08MeV

Using BW $\otimes$ Gaussian to fit the MC shape



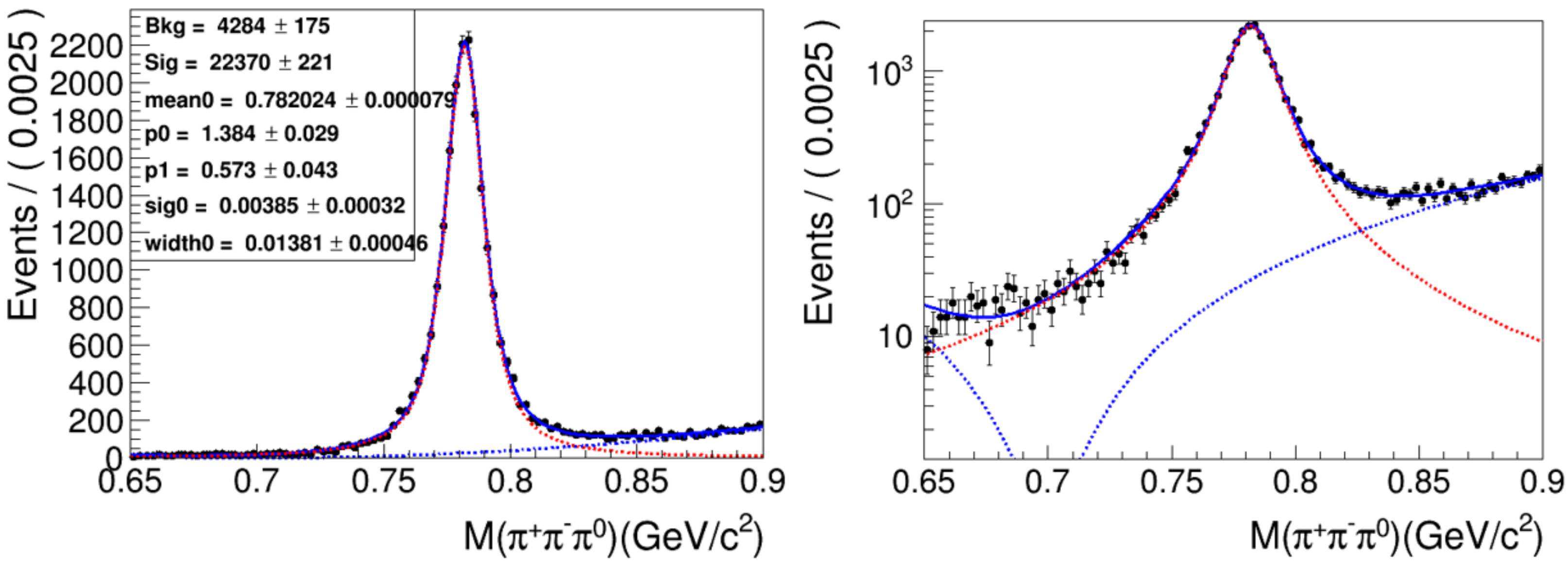
Reply:

The omega is reconstructed by $\pi^+\pi^-\pi^0$, where the π^0 have slight asymmetry resolution. It would make it hard to distinguish the resolution and width for omega. For example, if we use BW$\otimes$Gaussian to describe the omega signal from MC, the fitted width is 11.5 $\pm$ 0.1 MeV while the set width is 8.49 MeV from PDG.

Distorted background

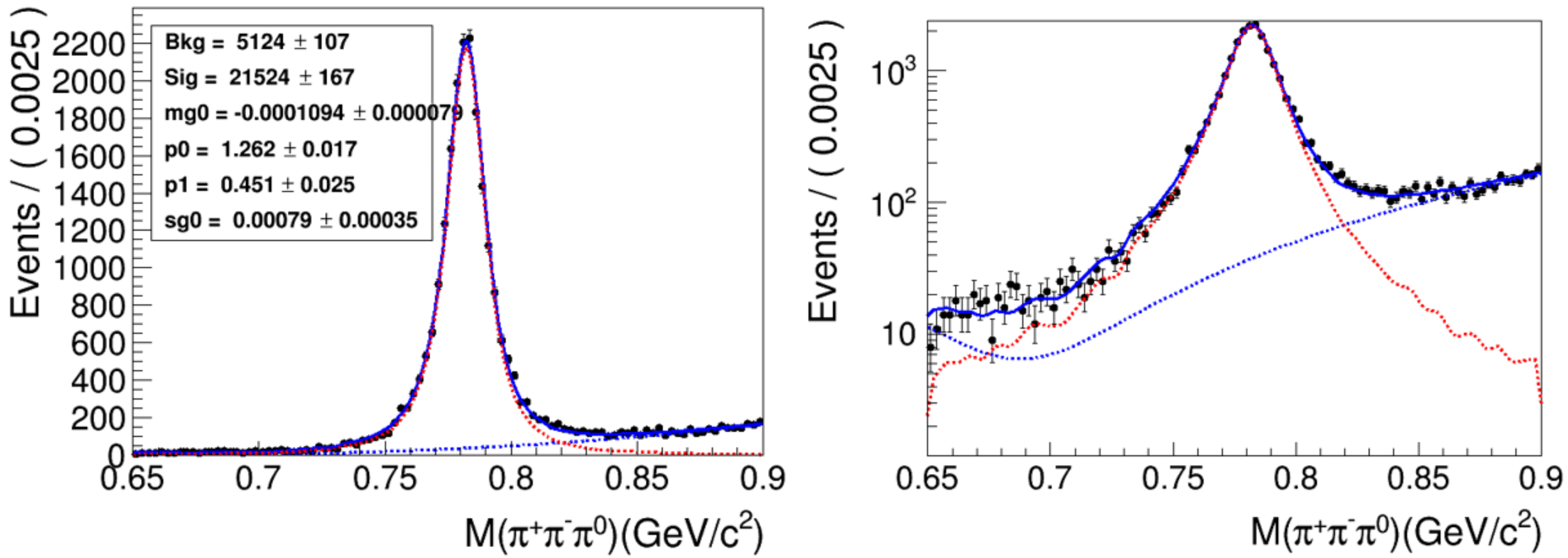
And for the second question about the distorted background shape. We think this is because the omega signal is not well described.

(1) For the fit described by BW ⊗ Gaussian + 2nd Chebychev polynomials, the background shape is heavily distorted by the polynomial function as shown in the following two pictures.



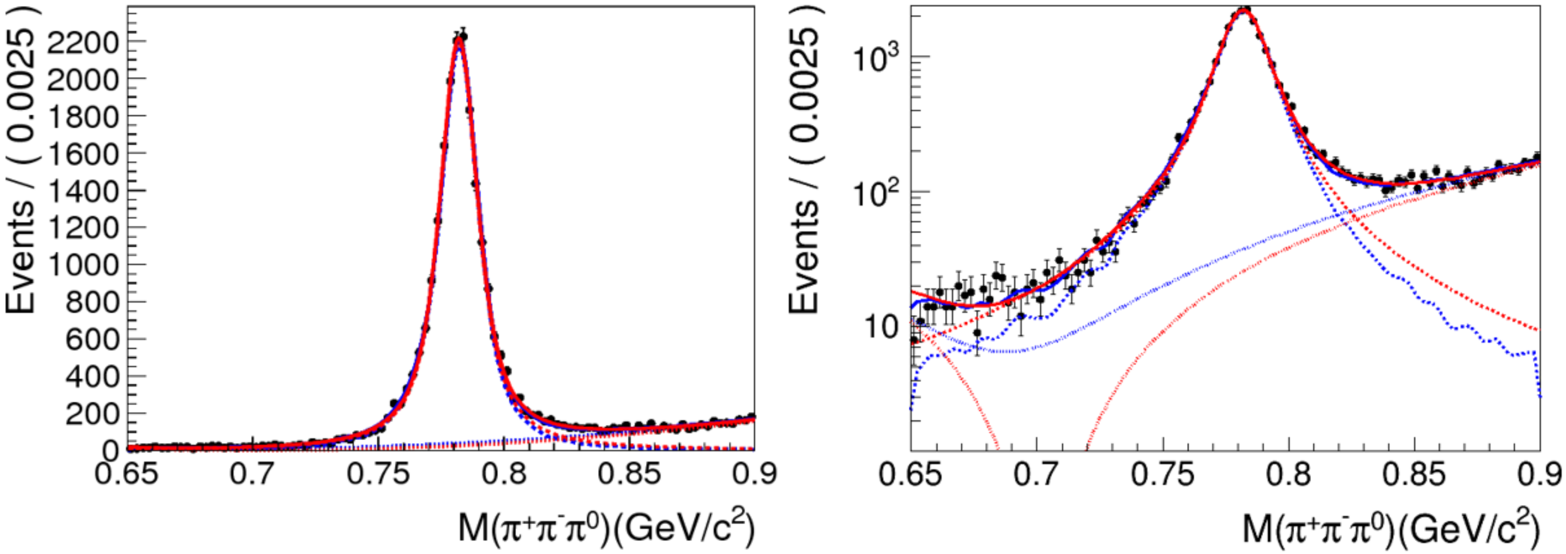
Distorted background

(2) For the fitting described by MC shape ⊗ Gaussian + 2nd Chebychev polynomials, the background shape is slightly distorted by the polynomial function as shown in the following two pictures.



Comparison of two methods

The comparison of the two fitting methods are plotted in the following two pictures. The lines with red color are fitted result using BW ⊗ Gaussian + 2nd Chebychev functions and lines with blue color are fitted result using MC shape ⊗ Gaussian + 2nd Chebychev functions.

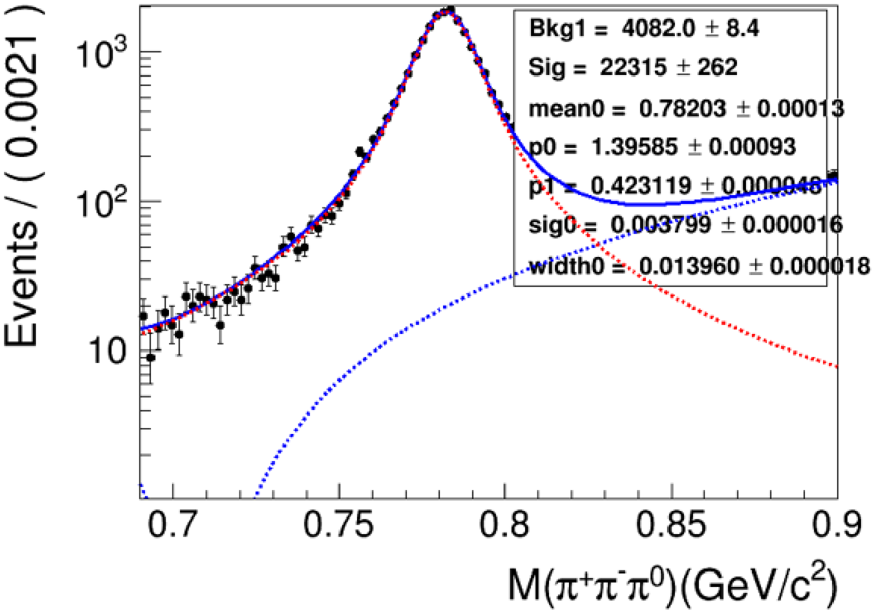


From the comparison, the distorted background may come from the bad description for background itself or the bad fitted omega signal, especially for the width, leads to the distorted background.

Many methods have been tried as shown in the following pictures.

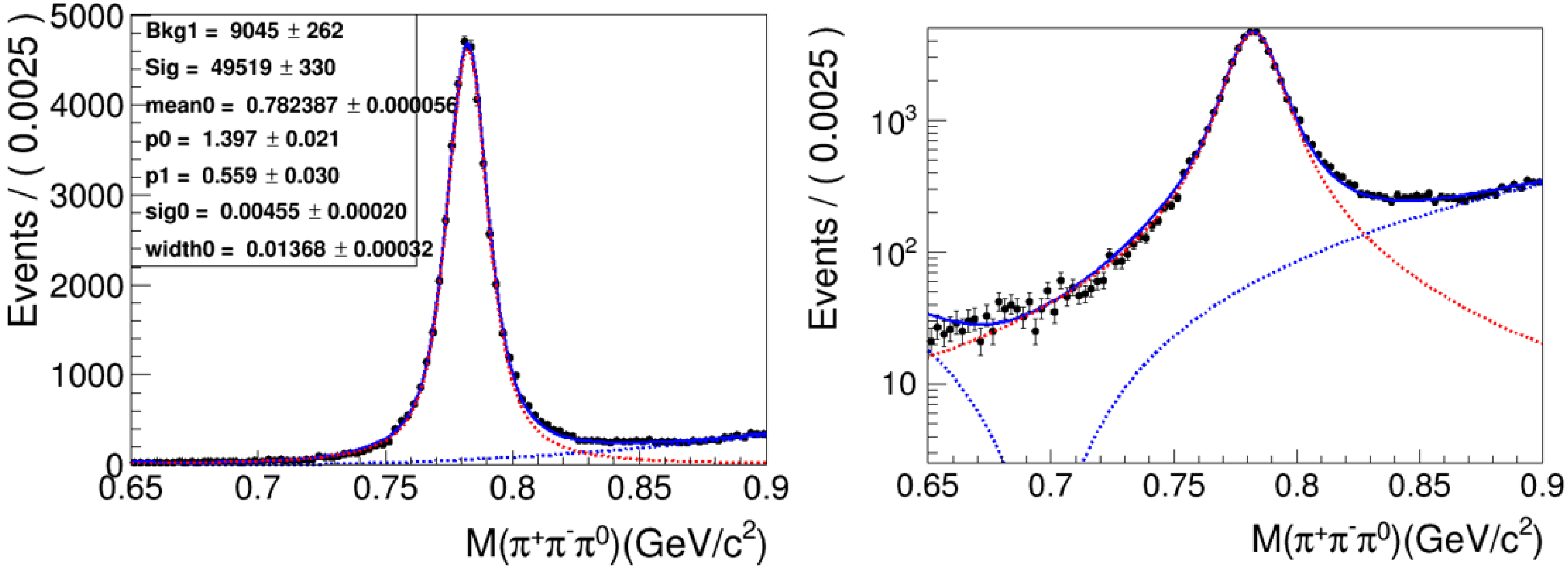
Bad background description

(1) BW ⊗ Gaussian + 2^{nd} Chebychev with fitting range varied to be [0.69,0.9].



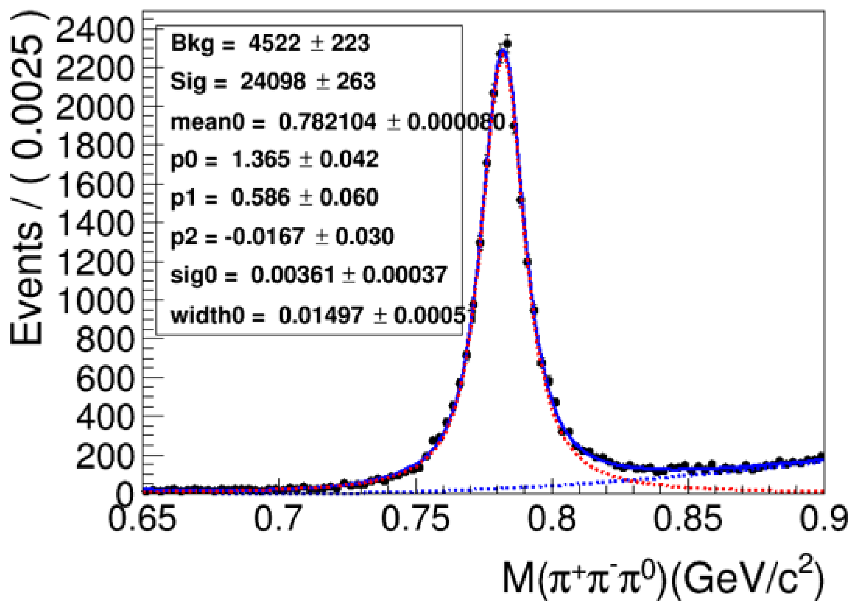
Bad background description

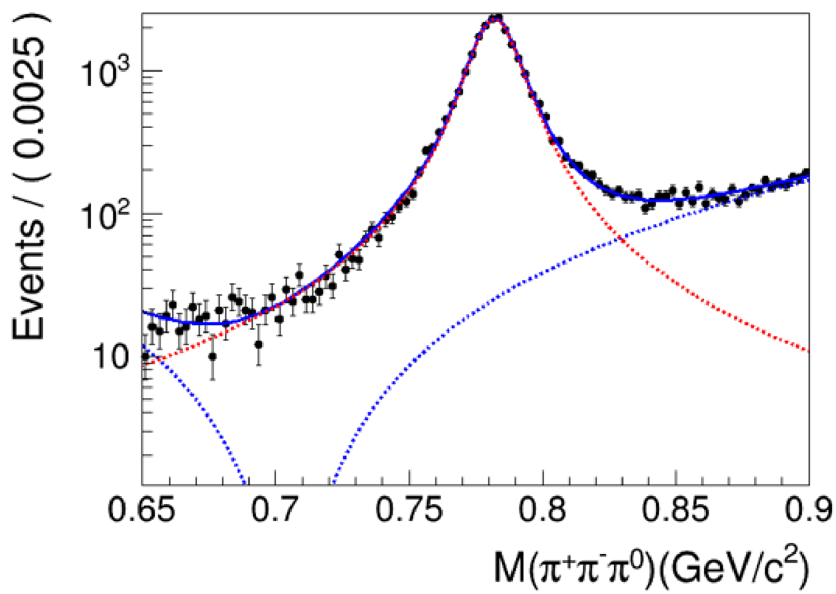
(2) BW ⊗ Gaussian + 2nd Chebychev with all data (2-3.08GeV) combined.



Bad background description

(3) BW ⊗ Gaussian + 3rd Chebychev

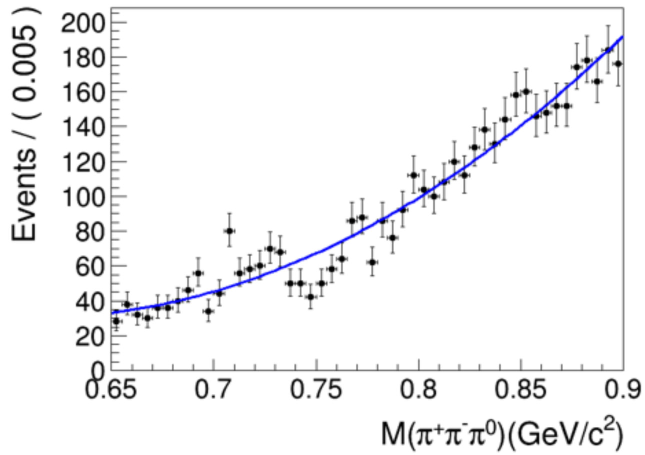


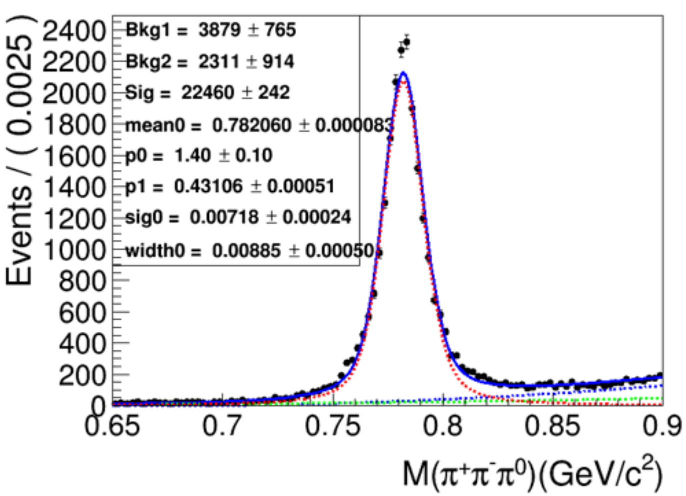


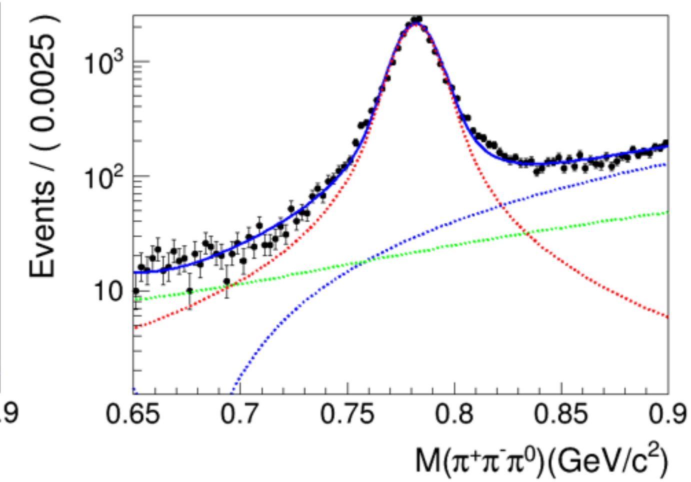
Bad background description

(4) BW ⊗ Gaussian + 2^{nd} Chebychev + fixed shape from $\rho\pi\pi$.

Most events at [0.65,0.7] GeV come from $\rho^-\pi^+\pi^0$ and $\rho^+\pi^-\pi^0$ processes. The line shape are extracted from the MC distribution and fixed in the data fitting.

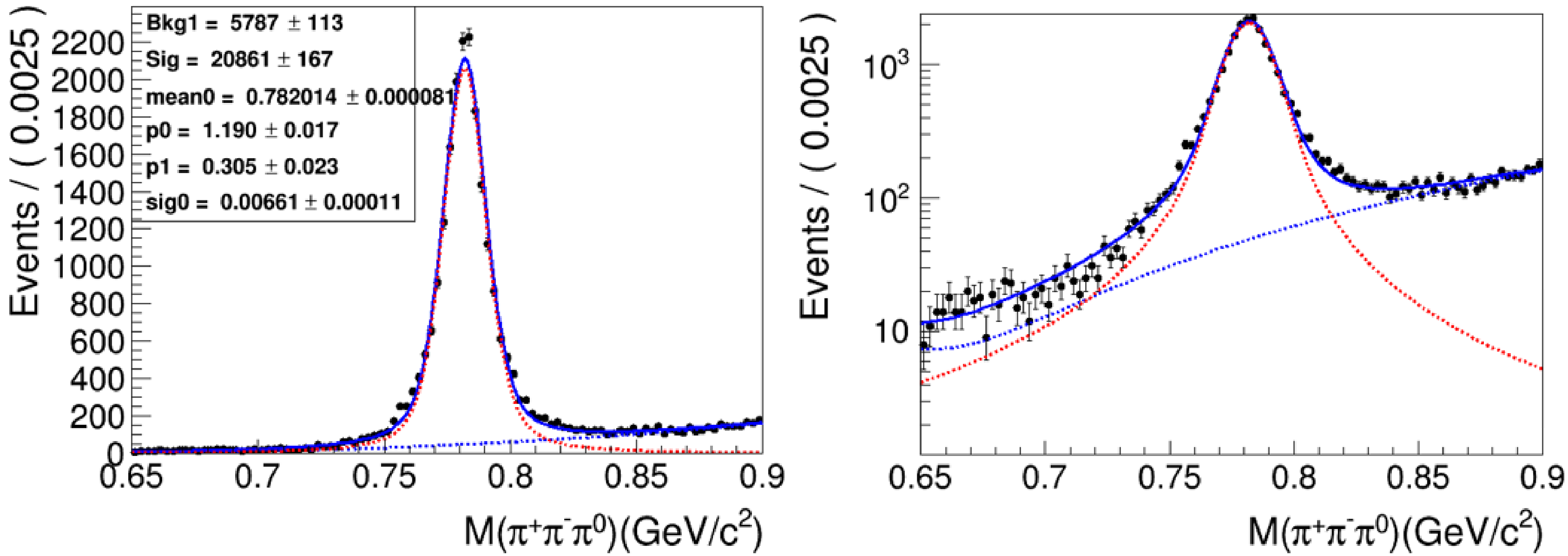






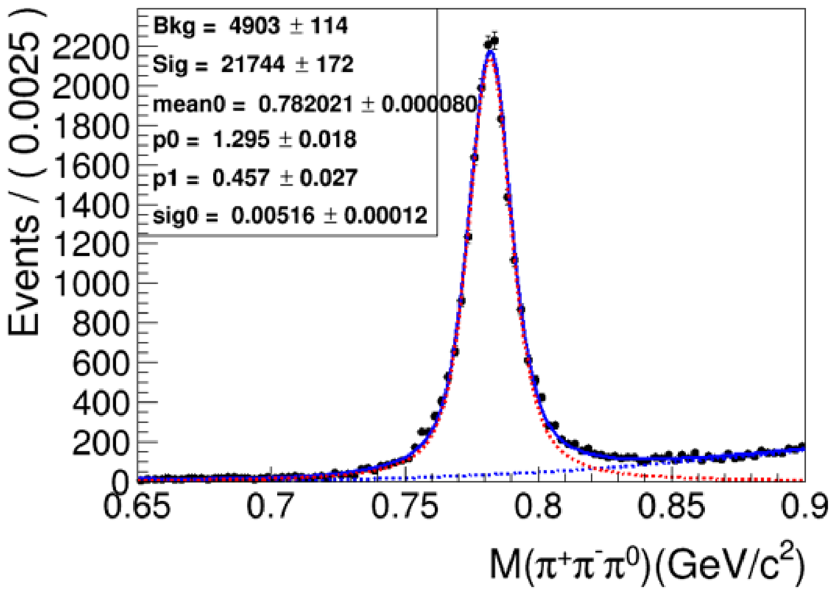
Bad omega signal fit

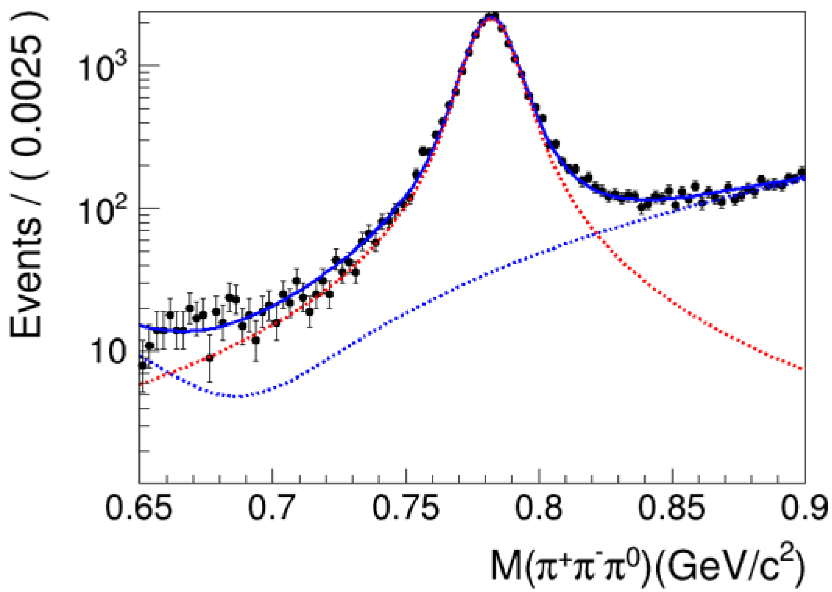
(1) BW ⊗ Gaussian + 2nd Chebychev with width fixed using PDG value.



Bad omega signal fit

(2) BW ⊗ Gaussian + 2^{nd} Chebychev with width fixed at 11.49 MeV.



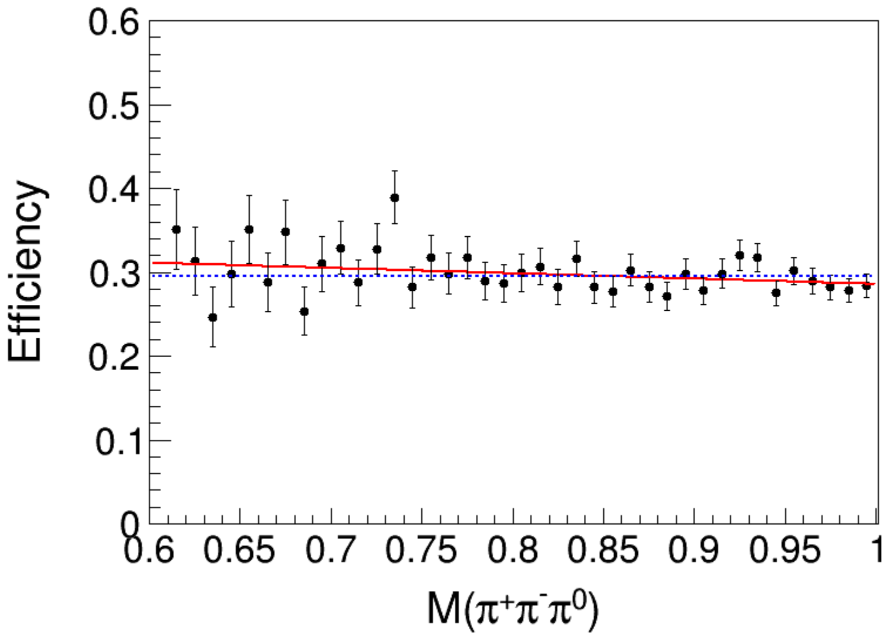


It seems that if the omega signal is well described, the distorted shape improve largely.

In the last, we suggest to use MC shape as the fitting function for omega signal and 2^{nd} polynomials for the background.

Second round of questions

-) It was also pointed out that the acceptance's difference between the low mass region and high mass region of omega because M(pi+pi-pi0) at low mass region is close to pi+pi-pi0 mass threshold. It would be great to perform a check by including the acceptance curve in the fit. **(Question from Ismail)**

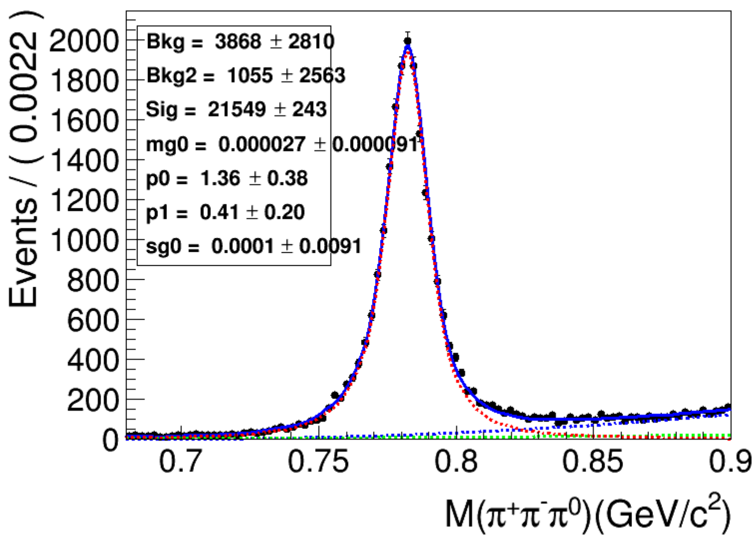


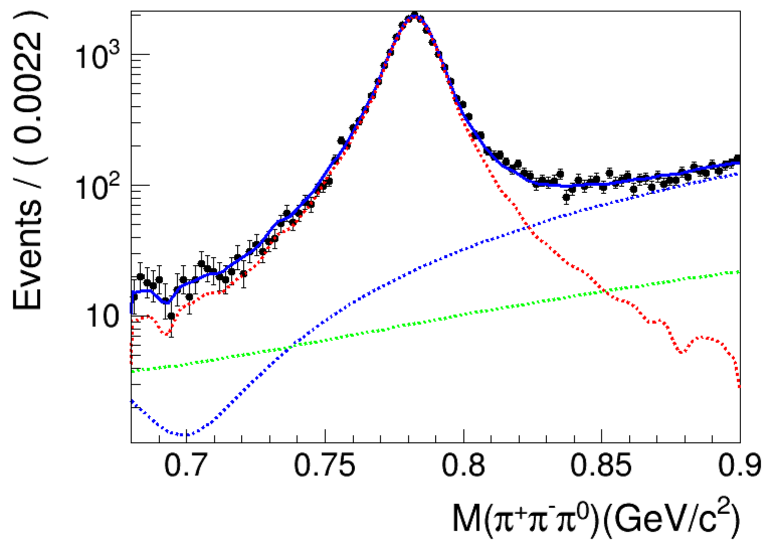
Reply:

The efficiency curve is shown in the above picture, where the red solid line is the fitted result using the first order of polynomial, i.e. -0.06.4*M($\pi^+\pi^-\pi^0$)+0.35. The blue dashed line is the constant line (zero order of polynomial). The efficiency curve is almost constant line, and there is no need to include it in the omega fitting, considering the omega's narrow width.

-) Based on the study, it was found that the background shape could be distorted if only polynomial functions were used, which may have an impact of few percent on the signal yields. Suggest to make a further study to choose a proper way to describe the background and signals.

(1) MCshape + fixed shape ($\rho\pi\pi$) + 2nd polynomials



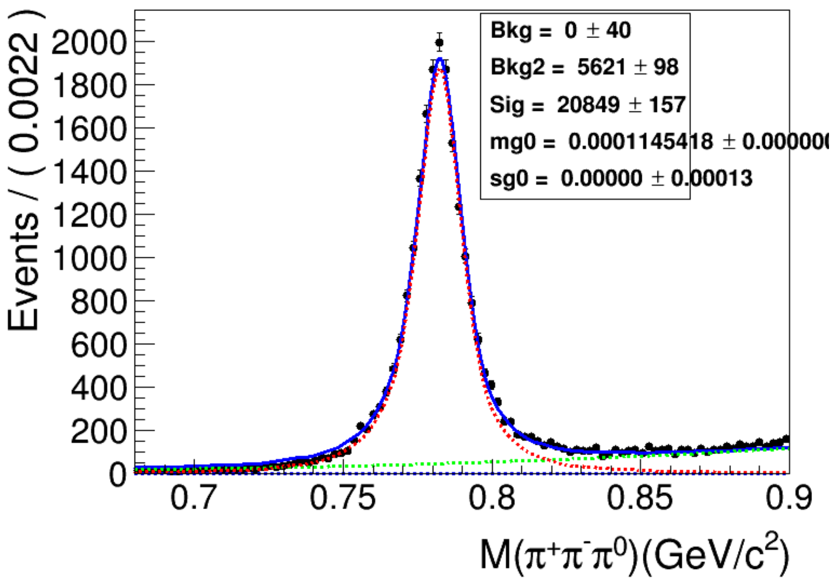


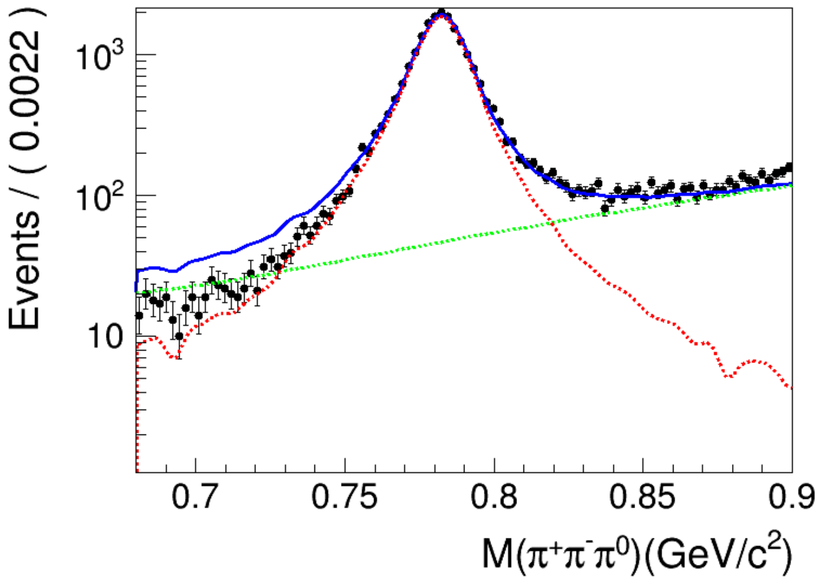
Reply:

The fit to data with omega signal described by the MC shape and the background described by fixed $\rho\pi\pi$ shape and 2nd polynomials is shown above. Here the solid blue line is the total fit, the red dashed line is the omega signal, green dashed line is the fixed $\rho\pi\pi$ shape and blue dashed line is 2nd polynomials contribution with parameters allowed to vary.

The fit result is still not good.

(2) MCshape + fixed shape ($\rho\pi\pi$) + fixed shape ($\pi^+\pi^-\pi^0\pi^0$)



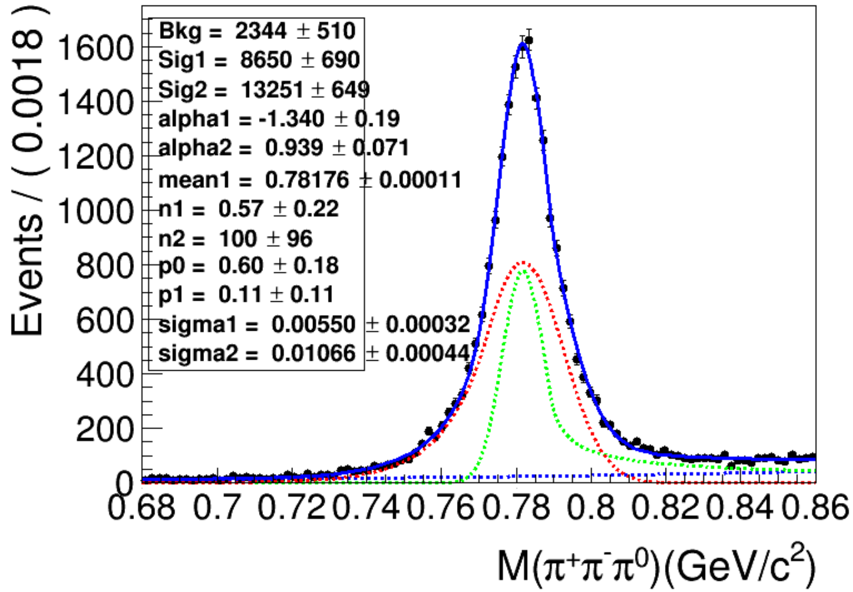


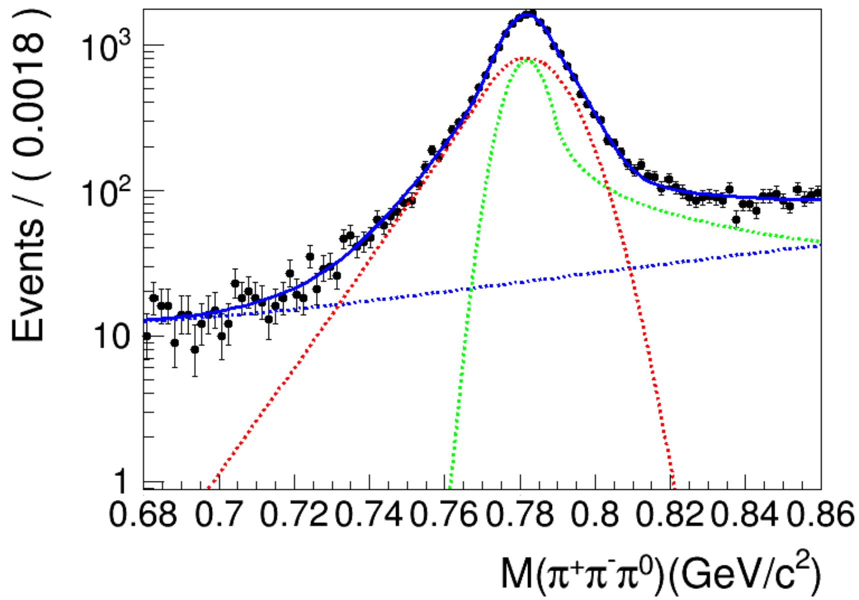
Reply:

Considering the most contribution from background at [0.6,0.9] GeV are $\rho\pi\pi$ and $\pi^+\pi^-\pi^0\pi^0$ processes. The fit to data with omega signal described by the MC shape and the background described by fixed $\rho\pi\pi$ shape and fixed $\pi^+\pi^-\pi^0\pi^0$ shape have been tried and is shown above. Here the solid blue line is the total fit, the red dashed line is the omega signal, green dashed line is the fixed $\rho\pi\pi$ shape and blue dashed line is the fixed $\pi^+\pi^-\pi^0\pi^0$ shape.

The fit result is still not good.

(3) Double Crystal ball functions + 2^{nd} polynomials





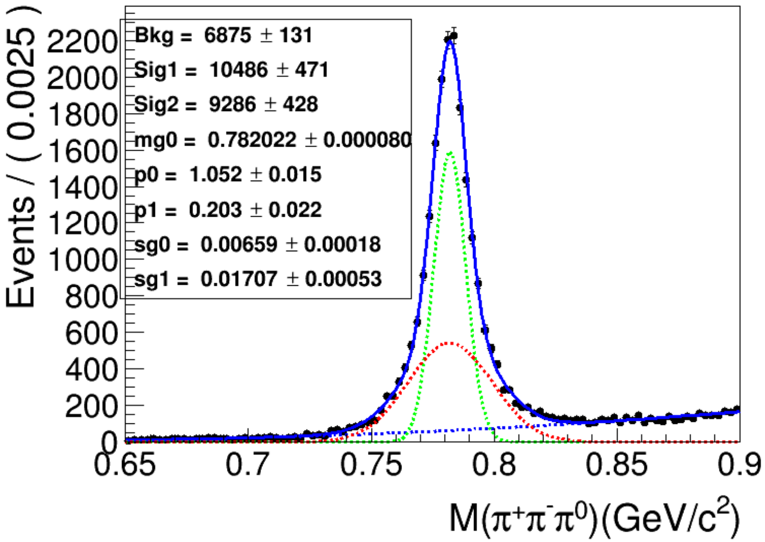
Reply:

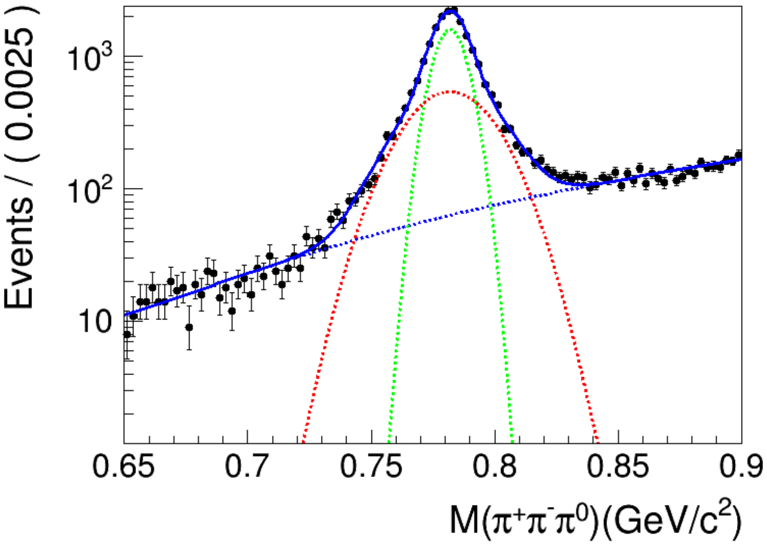
Two crystal ball functions to omega signal and 2^{nd} polynomials to background are also performed.

The fit have too many parameters and is not stable especially for the signal contribution, which subsequently effect the background contribution.

The is not a good choice even the total fit seems good.

(4) Double Gaussian functions + 2^{nd} polynomials





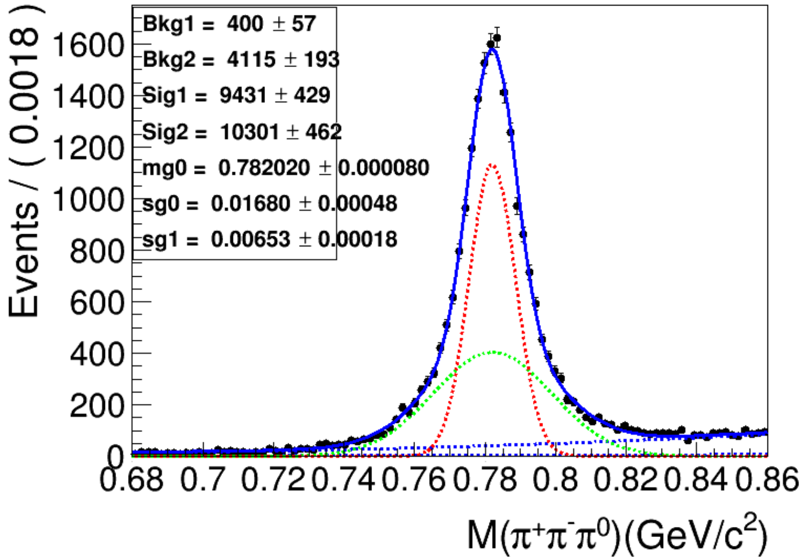
Reply:

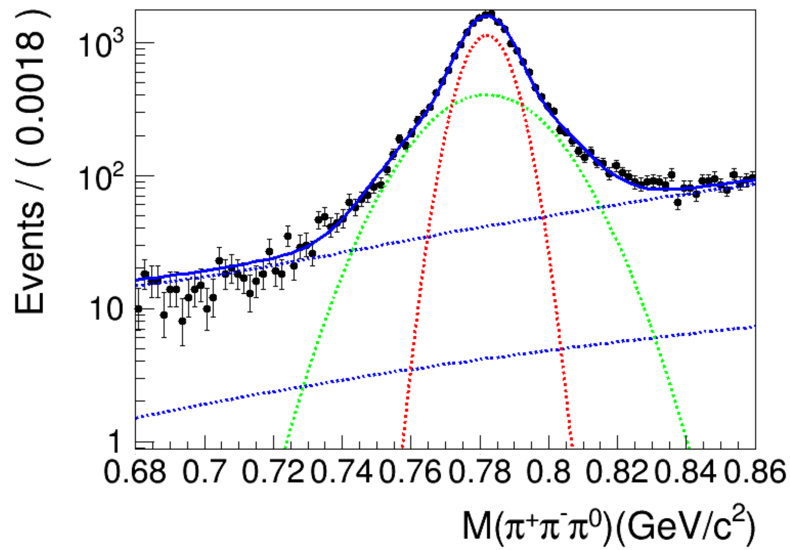
Two Gaussian functions to omega signal and 2^{nd} polynomials to background are also performed.

The fit seems good and the different Gaussian contributions may be explained by the different omega resolutions.

We will pick up this fit as the final result.

(5) Double Gaussian functions + fixed shape ($\rho\pi\pi$) + fixed shape ($\pi^+\pi^-\pi^0\pi^0$) (double check)



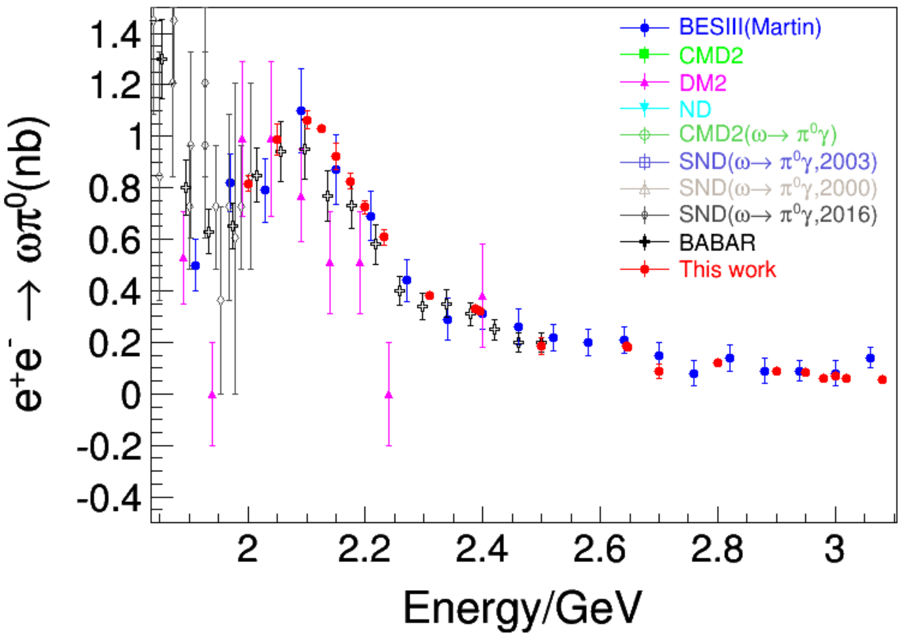


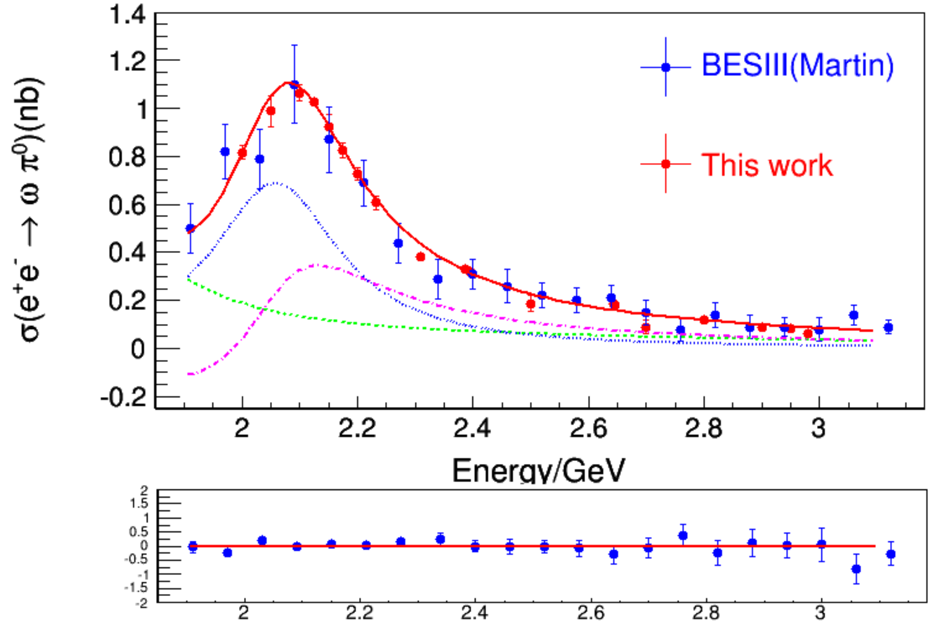
Reply:

Considering the most contribution from background at [0.6,0.9] GeV are $\rho\pi\pi$ and $\pi^+\pi^-\pi^0\pi^0$ processes. The fit to data with omega signal described by the double Gaussian functions and the background described by fixed $\rho\pi\pi$ shape and fixed $\pi^+\pi^-\pi^0\pi^0$ shape have been tried as a double check and is shown above.

The total fit seems good and the fitted omega signal has 19732 events, which is consistent with that of double Gaussian functions + 2nd polynomials (19772 events).

Comparison between our result and Martin's measurement





Reply:
From the left plot, we can find our measurement and Martin's measurement are consistent well.
Also we try to fit the line shape with only our cross section. The comparison between the fitted line and Martin's measurement are shown in the right plot. The subplot gives the relative differences and the red line is the zero constant line.

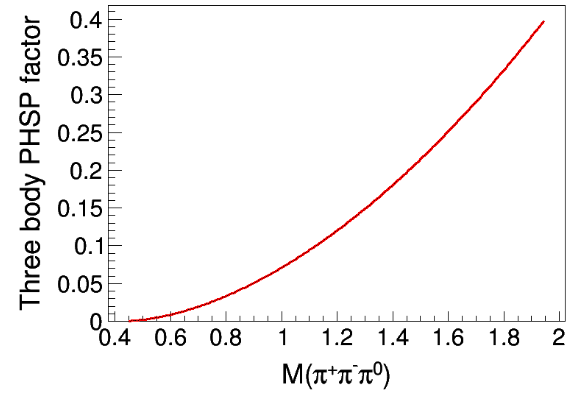
Third round of questions

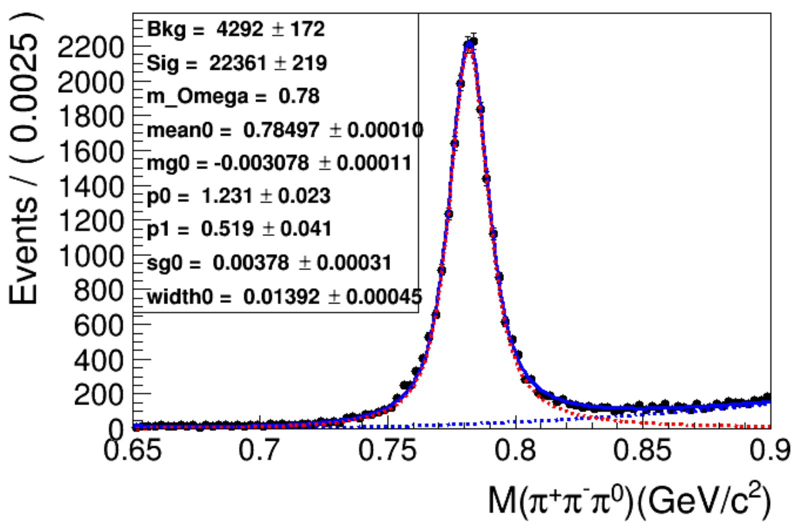
-) Please check if the fit becomes better after including the phase space factor. Just now I also forward an e-mail from Ismail who concerns about the efficiency correction.

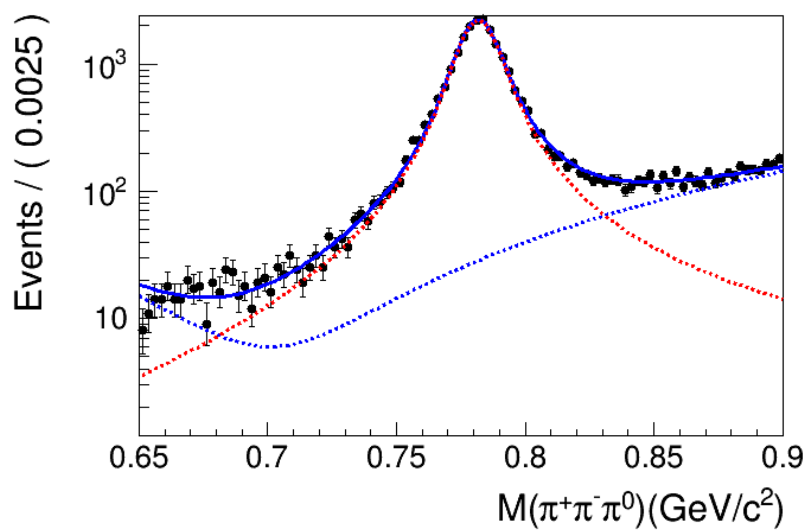
Fitting Function: $$\left|\frac{\sqrt{m\Gamma(m)}}{m^2 - m_0^2 + im\Gamma(m)}\right|^2 \times q$$

$$\Gamma(m) = \Gamma_0 \cdot \frac{V_m}{V_{m0}}$$

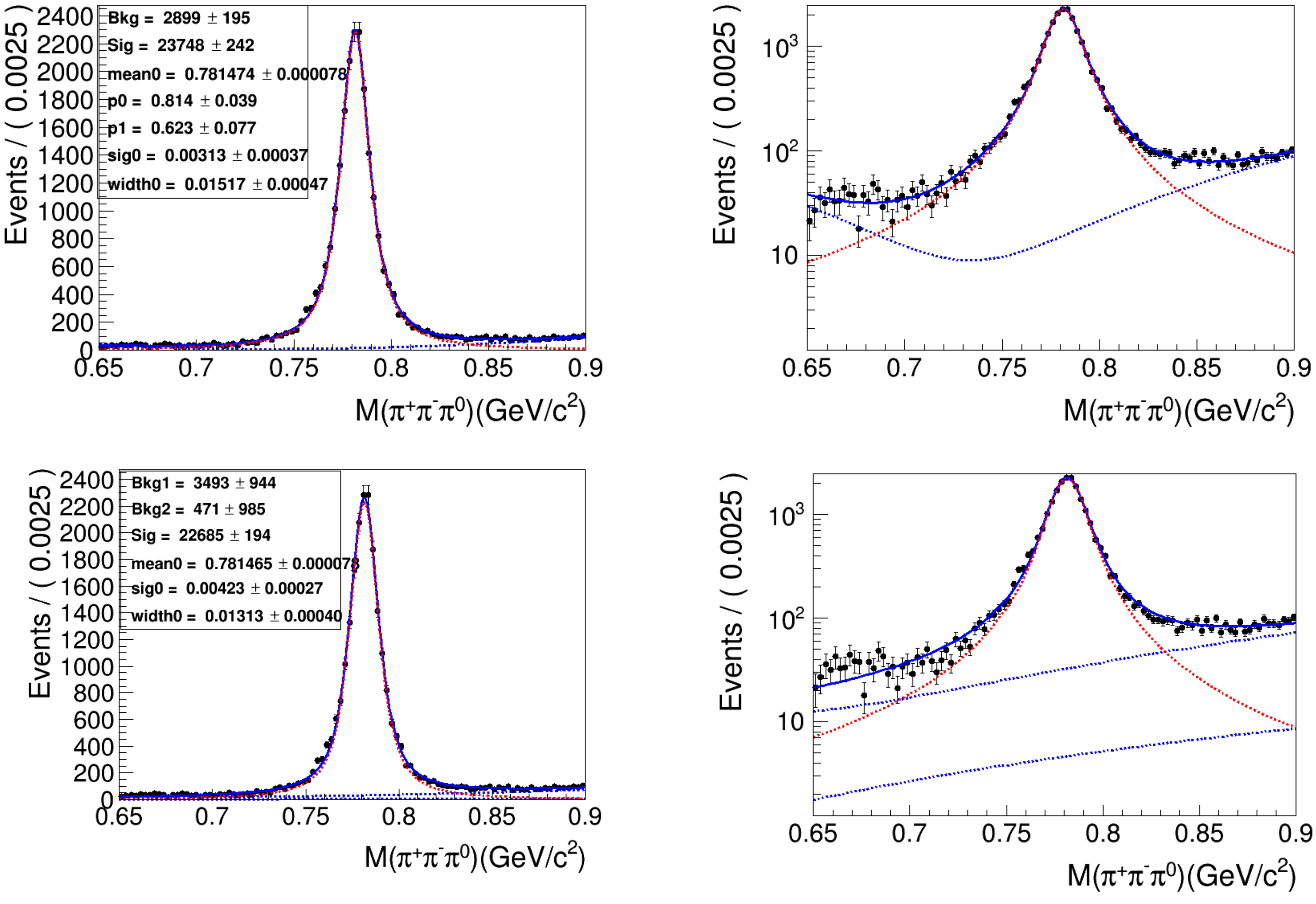
V_m is the three body PHSP space factor







Fits are still not good.

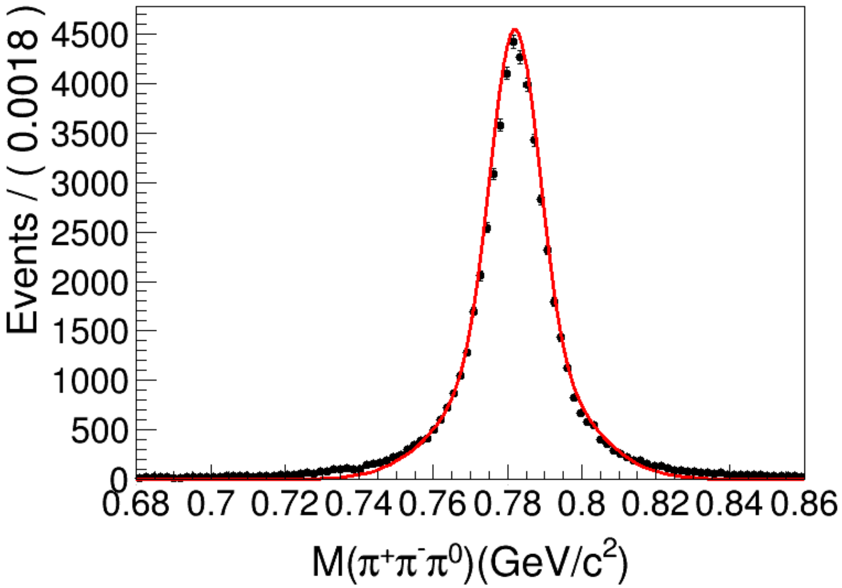


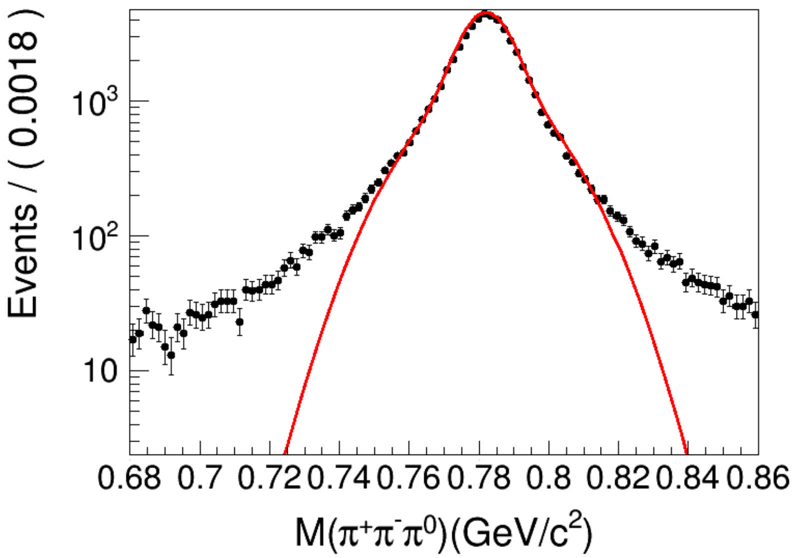
Bkg = 2899 ± 195
Sig = 23748 ± 242
mean0 = 0.781474 ± 0.000078
p0 = 0.814 ± 0.039
p1 = 0.623 ± 0.077
sig0 = 0.00313 ± 0.00037
width0 = 0.01517 ± 0.00047
Events / (0.0025)
M(π+π-π0)(GeV/c2)
Bkg1 = 3493 ± 944
Bkg2 = 471 ± 985
Sig = 22685 ± 194
mean0 = 0.781465 ± 0.000078
sig0 = 0.00423 ± 0.00027
width0 = 0.01313 ± 0.00040

-) The present fit with two Gaussians seems better, but I wonder if the background is overestimated. Based on the background curve, it seems the background function can not describe the high mass region.

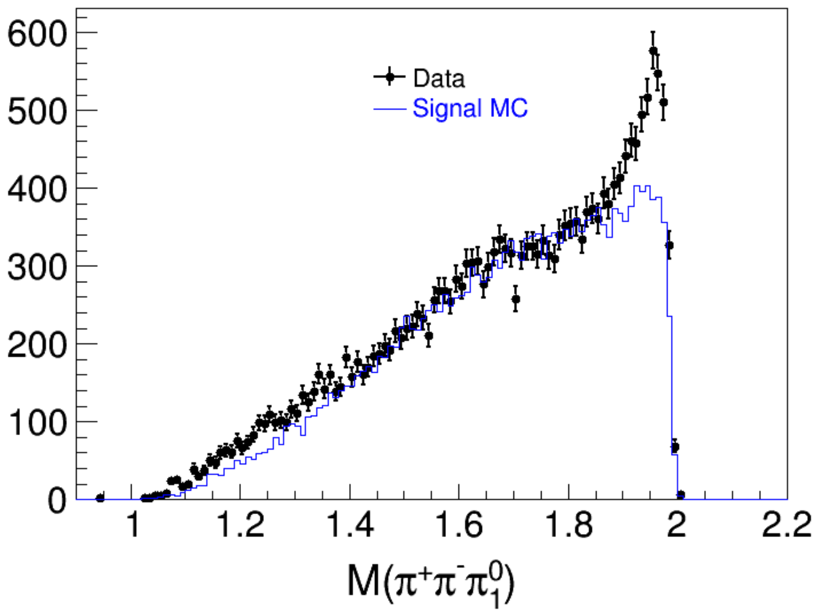
-) You may make a check by fixing the signal shape from data and then to compare with the MC shape. Usually, the MC shape is a little bit narrower than that of data. In this way, you may provide a proof if the background events are overestimated or not. If the signal shape from data is narrower than that of MC, we should take serious on the fit since it has a large impact on the final results (sometimes about 10% based on your study, which is higher than the systematic uncertainty).

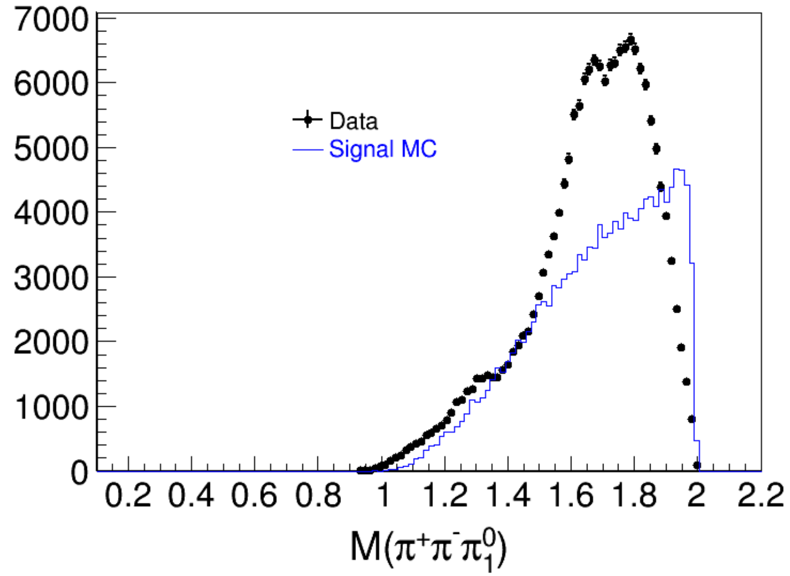
Comparison of MC and fixed shape from data fit

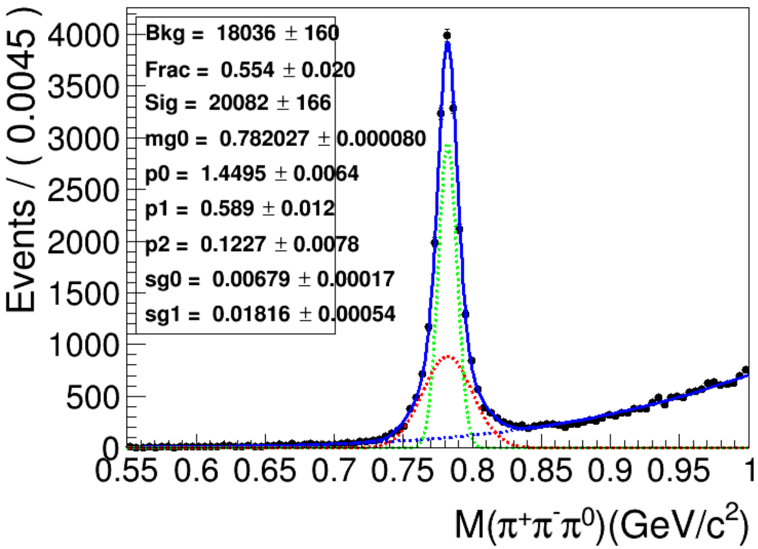


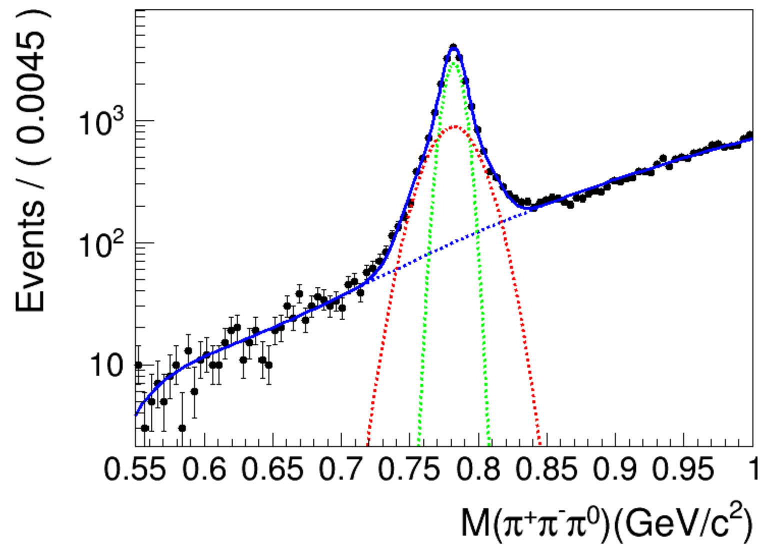


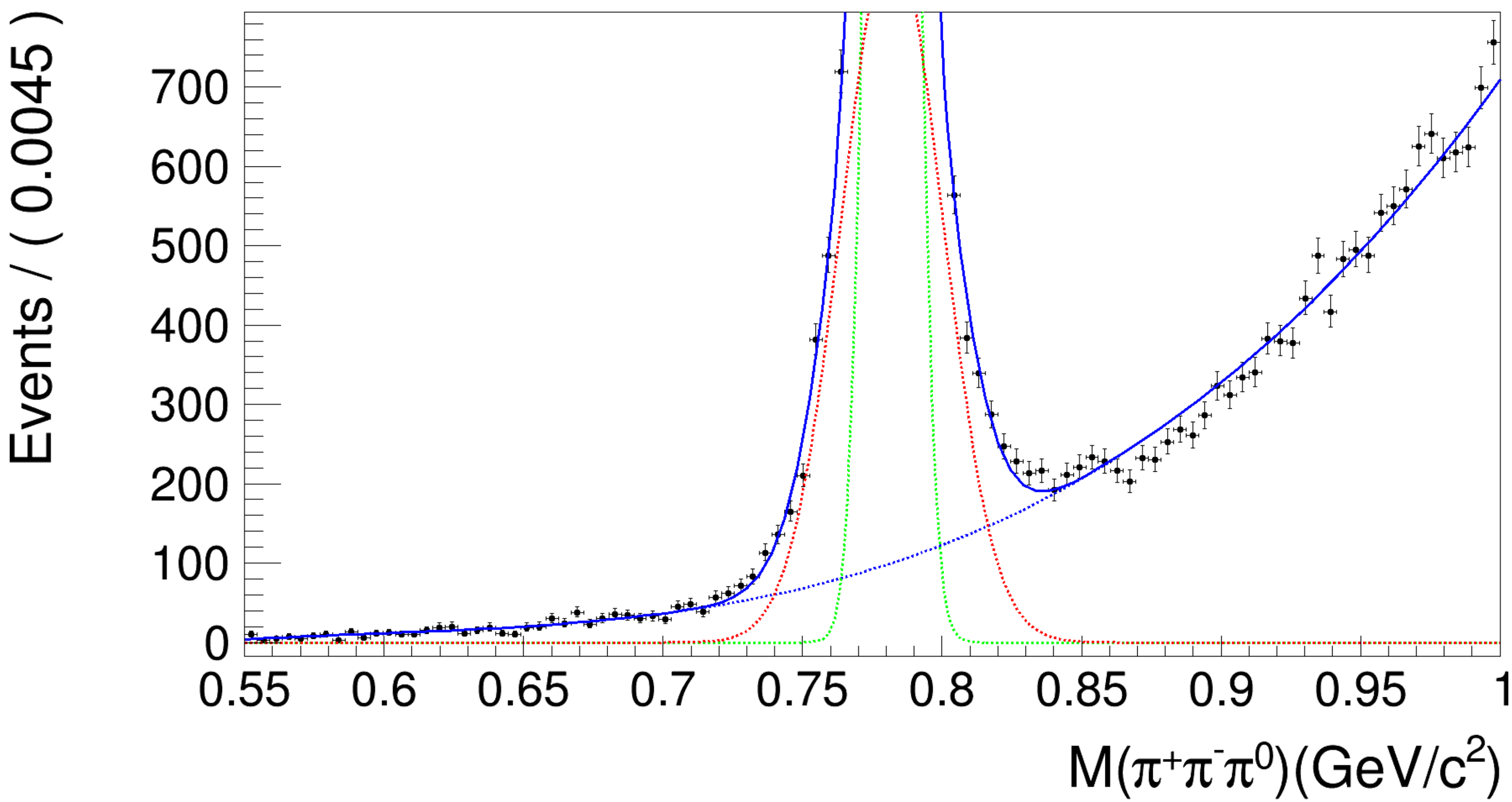
Black dots are the Signal MC and red line is the fixed double Gaussian shapes from data fit.
Fitted double Gaussian shapes are wider than signal MC


Data
Signal MC
M(π⁺π⁻π⁰₁)

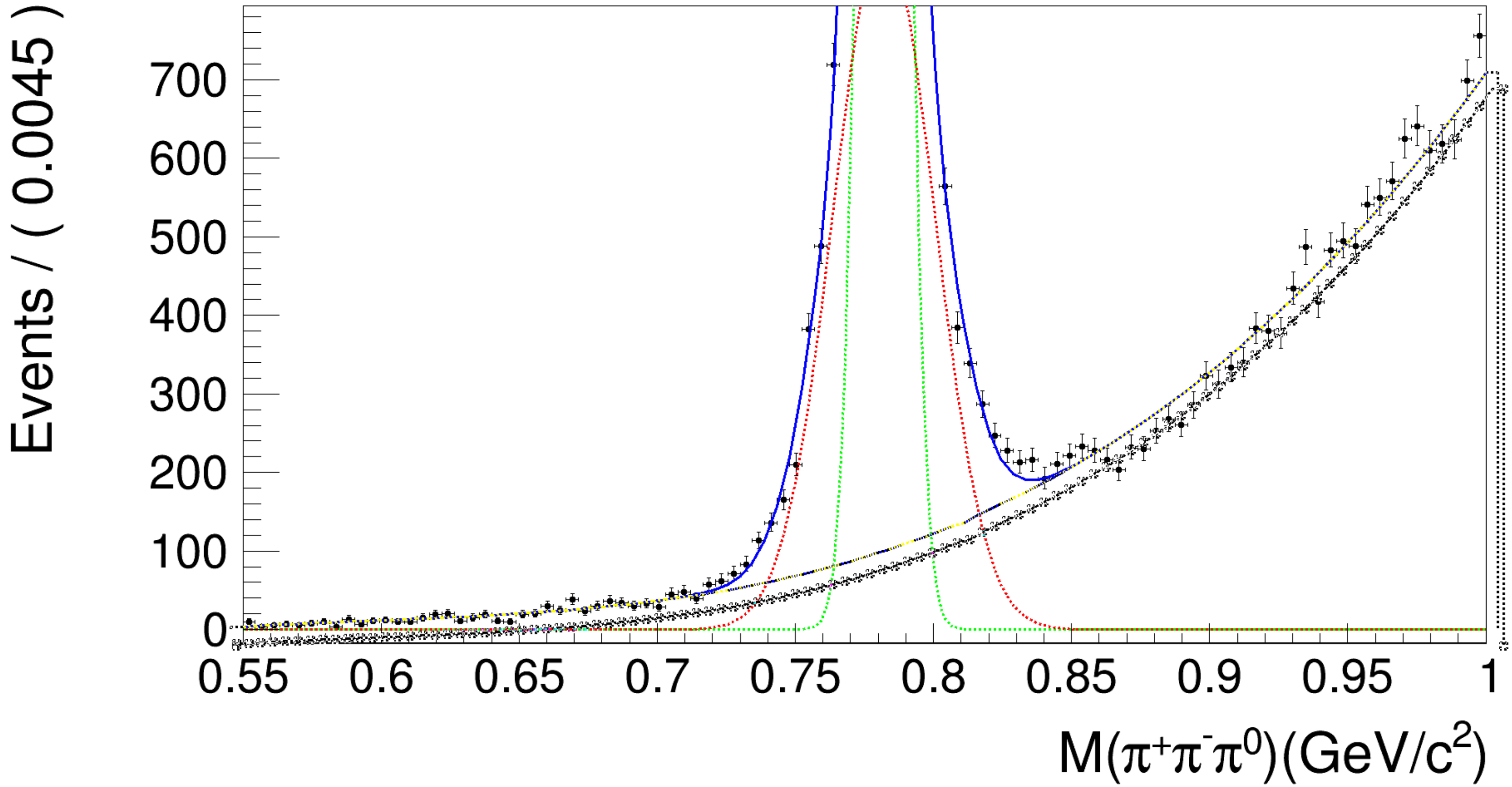

Data
Signal MC
M(π⁺π⁻π⁰₁)


Bkg = 18036 ± 160
Frac = 0.554 ± 0.020
Sig = 20082 ± 166
mg0 = 0.782027 ± 0.000080
p0 = 1.4495 ± 0.0064
p1 = 0.589 ± 0.012
p2 = 0.1227 ± 0.0078
sg0 = 0.00679 ± 0.00017
sg1 = 0.01816 ± 0.00054
Events / (0.0045)
M(π⁺π⁻π⁰)(GeV/c²)

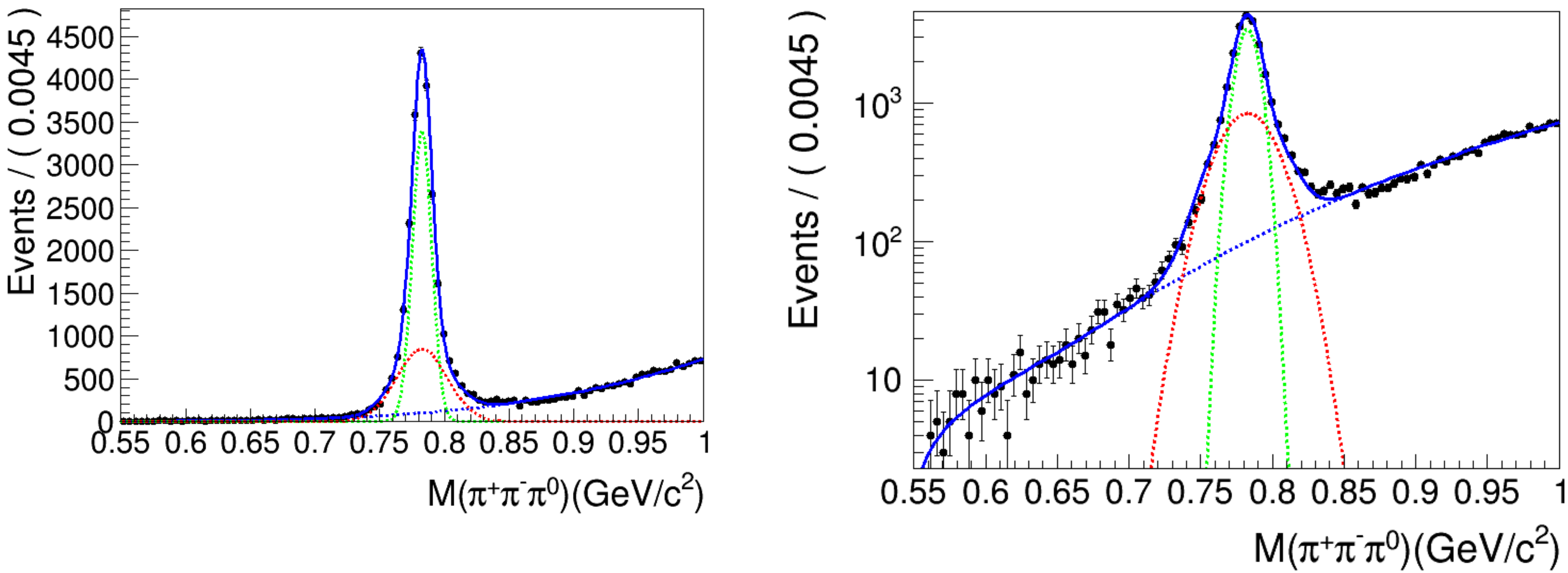

Events / (0.0045)
M(π⁺π⁻π⁰)(GeV/c²)



Events / (0.0045)
0
100
200
300
400
500
600
700
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
M(π+π-π0)(GeV/c2)



Underestimate 720 events



Events / (0.0045)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95 1
M(π+π-π0)(GeV/c2)
Events / (0.0045)
10³
10²
10
0.55 0.6 0.65 0.7 0.75 0.8 0.85 0.9 0.95 1
M(π+π-π0)(GeV/c2)