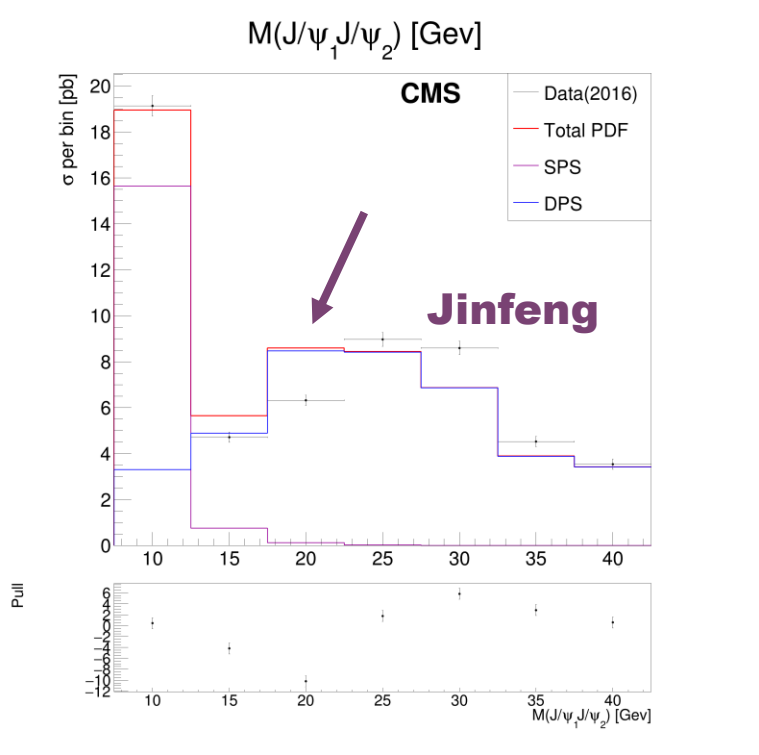
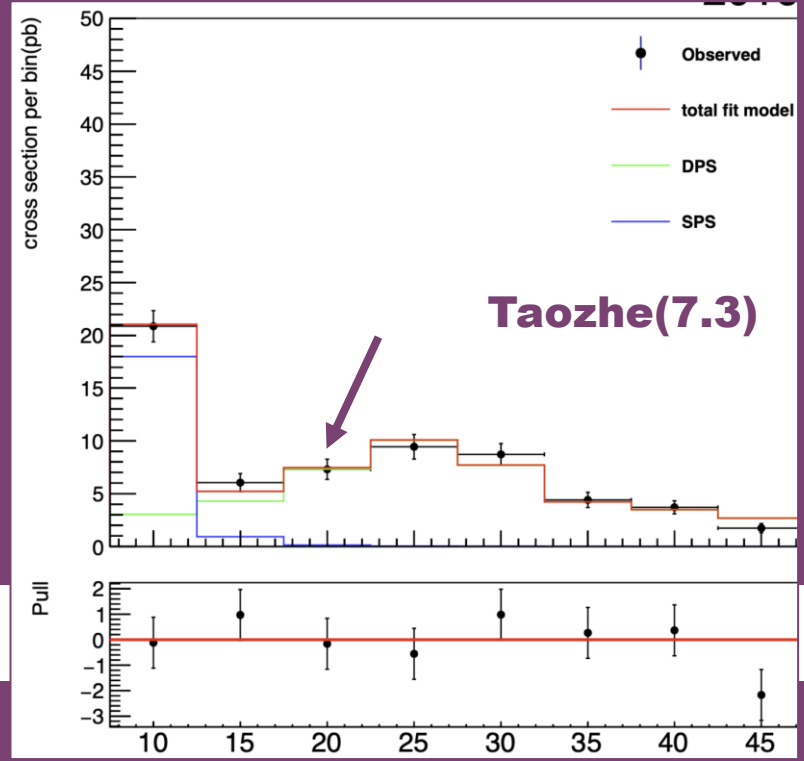
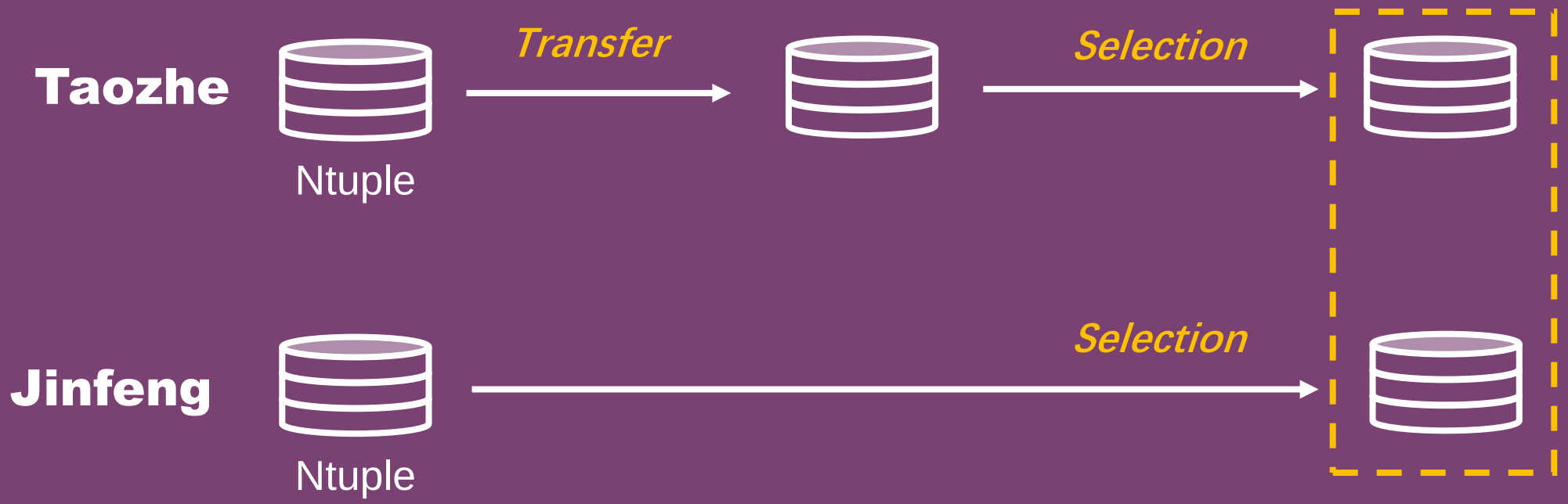
Difference of DPS sample

- We noticed difference of the template fit, especially for the $M(J/\psi J/\psi)$ dimension
- It seemed the difference was from the DPS sample, especially for the third bin
- We tried to figure it out





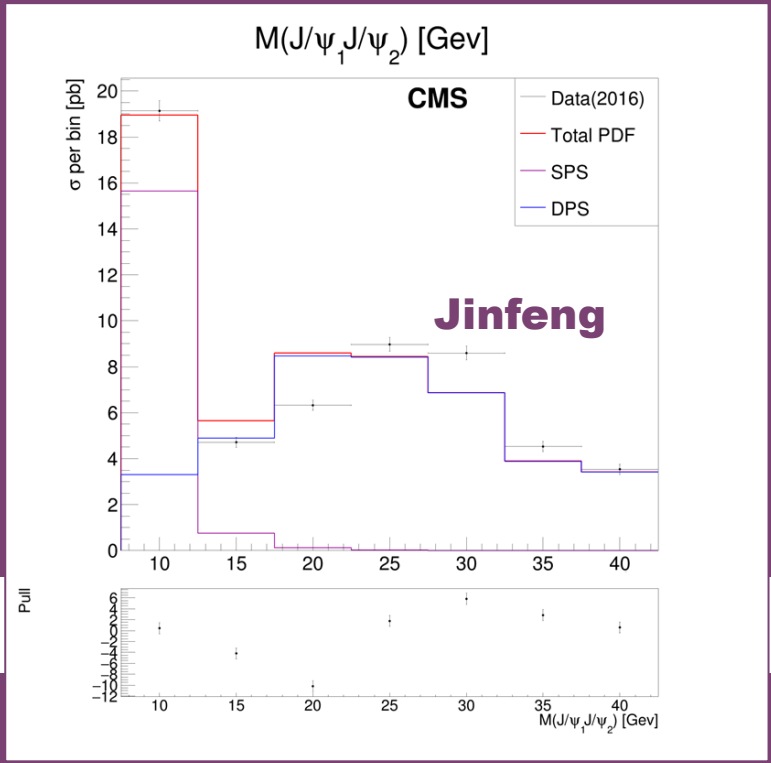
Difference of DPS sample

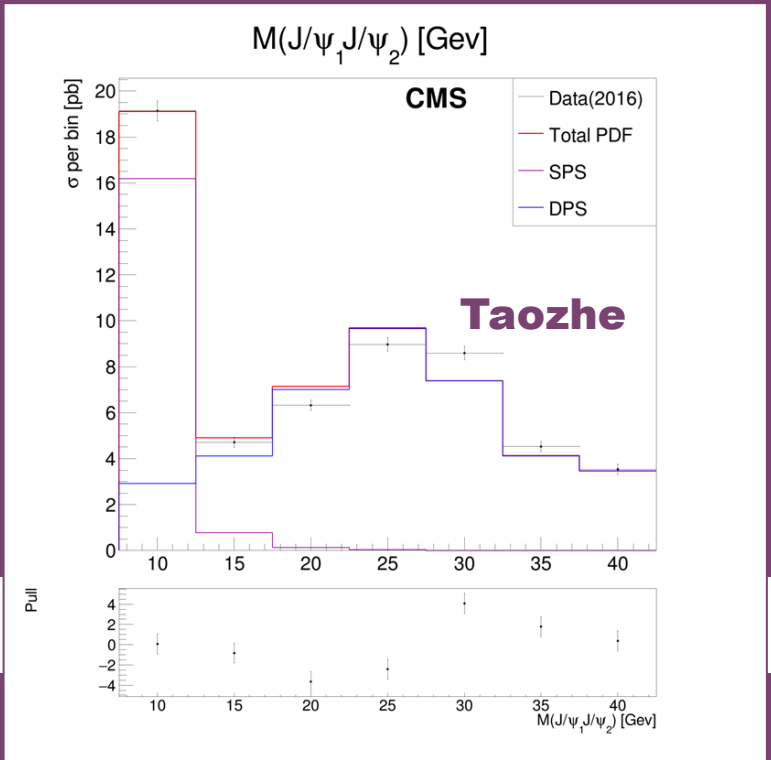


- We first checked the selected file

Difference of DPS sample

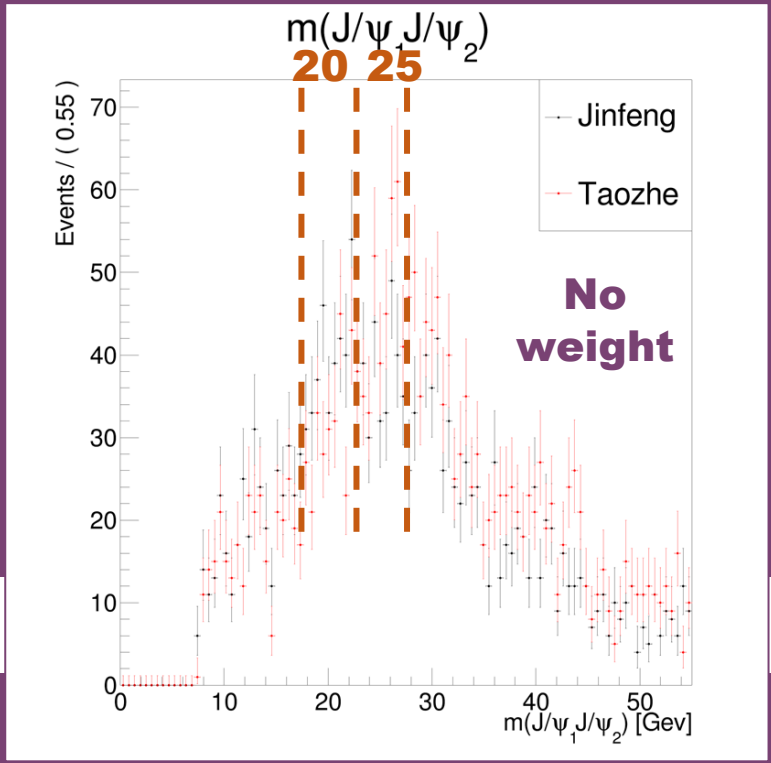
- Template fit was tried first
- It seemed that the problem did come from the sample itself, instead of the fitting or the code

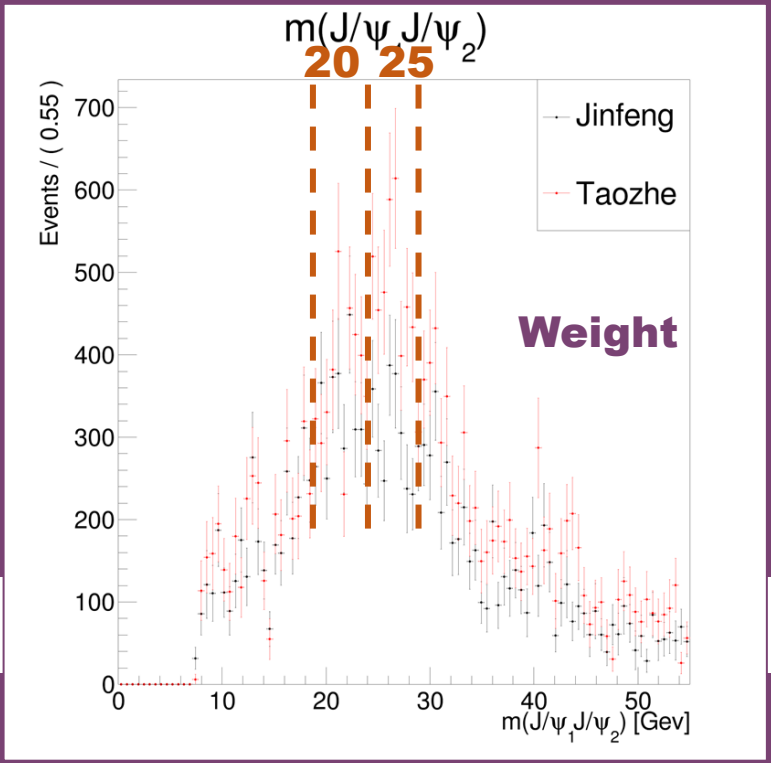




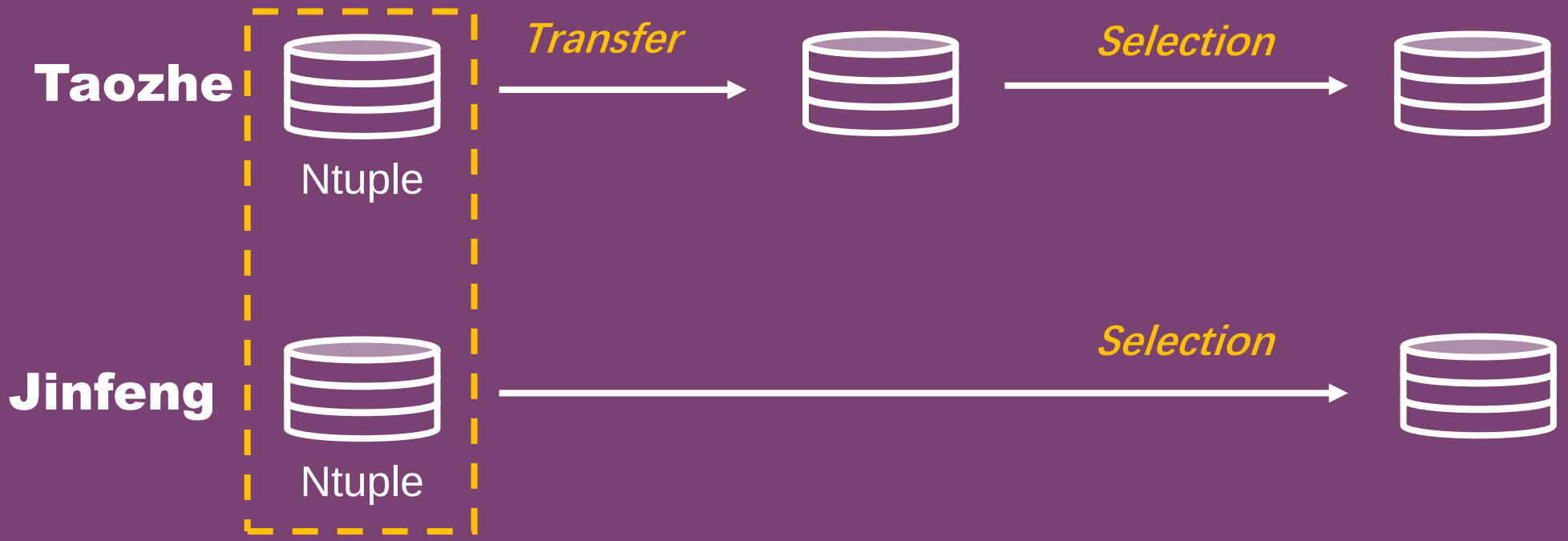
Difference of DPS sample

- Sample itself was checked
  - Both cases with or without weight were checked, the problem didn't come from the weight
  - It seemed the main discrepancies are from the bin around 25(4), instead of the 20(3)
  - But the two samples are totally different anyway





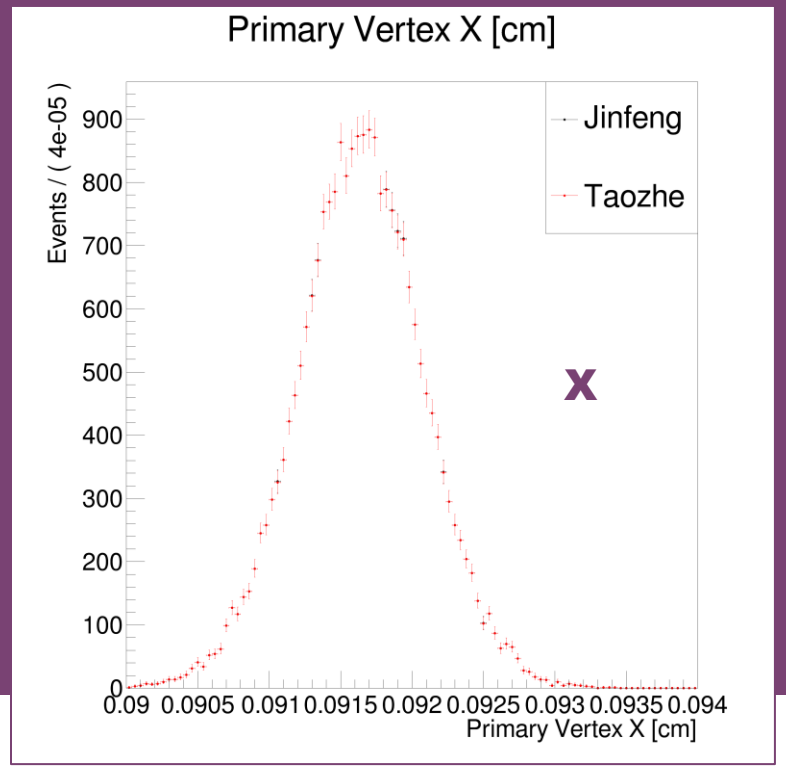
Difference of DPS sample

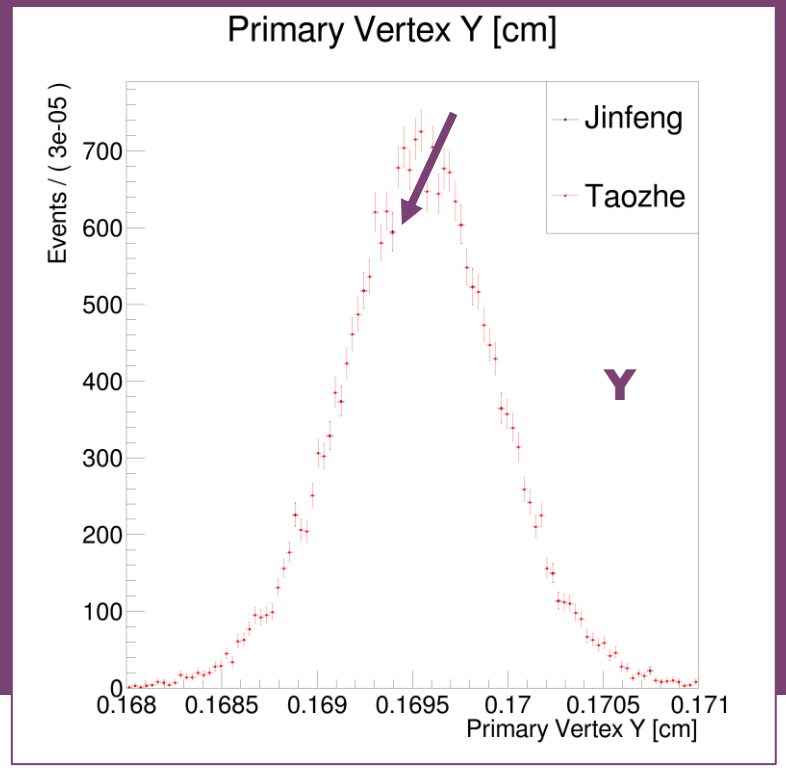


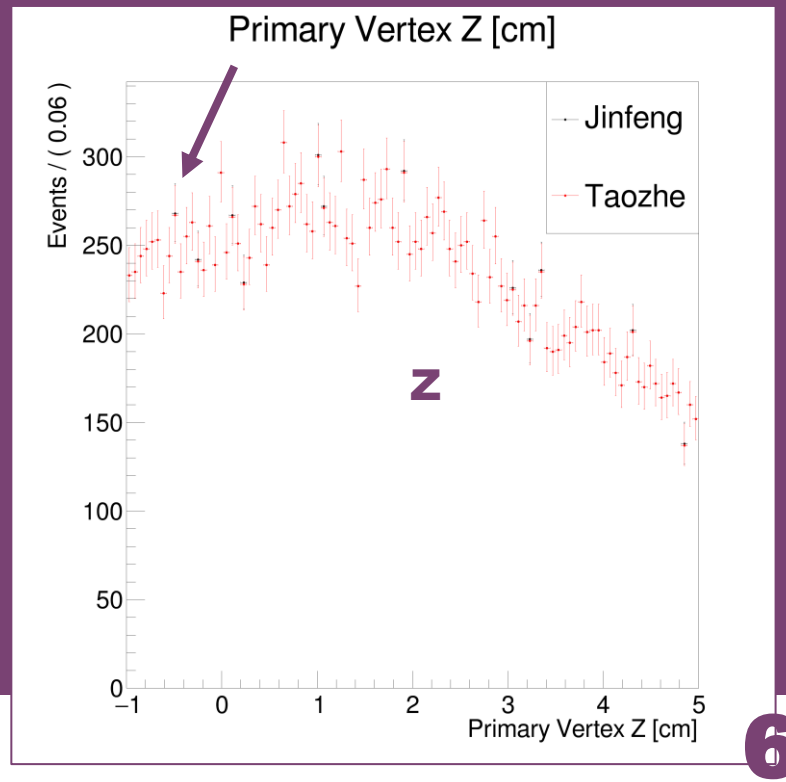
- We then checked the original Ntuple file

Difference of DPS sample

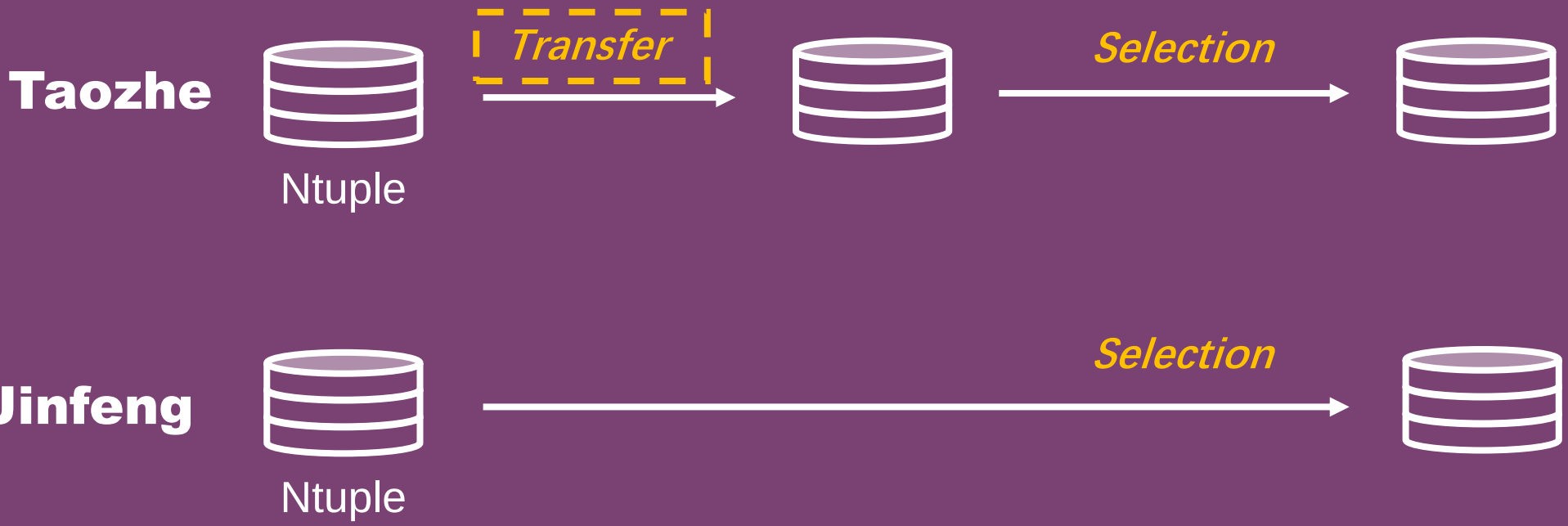
- The position of primary vertex was checked
- Small discrepancies can be noticed, but I tend to regard them as identical







Difference of DPS sample



- The two selection codes in this test are both provided by me, no problem should be arisen from which
- The difference is surely from the transferring step

Difference of DPS sample

- We compared the transferring code provided by Taozhe and the selection code from Jinfeng (since the ‘transfer’ work is done by the selection)
  - We use different variables for the $M(J/\psi J/\psi)$
    - For Taozhe, a Lorentz vector is made by four muon vectors and the mass is acquired from which;
    - For Jinfeng, the mass is from: (*fourMuFit_Mass)[0]
  - Other variables sources are also different, for example:

	Taozhe	Jinfeng
$p^T(\mu_1)$	fourMuFit_mu1Pt->at(0)	(*AllRecoMuons_Pt)[RECO_ups1_mu1_index]
$M(J/\psi_1)$	fourMuFit_ups1_mass->at(0)	ups1_mass_GenMatched_ID_OS_VTX
$\Delta(y(J/\psi_1) - y(J/\psi_2))$	abs(mupair1.Rapidity()-mupair2.Rapidity())	fabs((*fourMuFit_ups1_rapidity)[0] - (*fourMuFit_ups2_rapidity)[0])

Difference of DPS sample

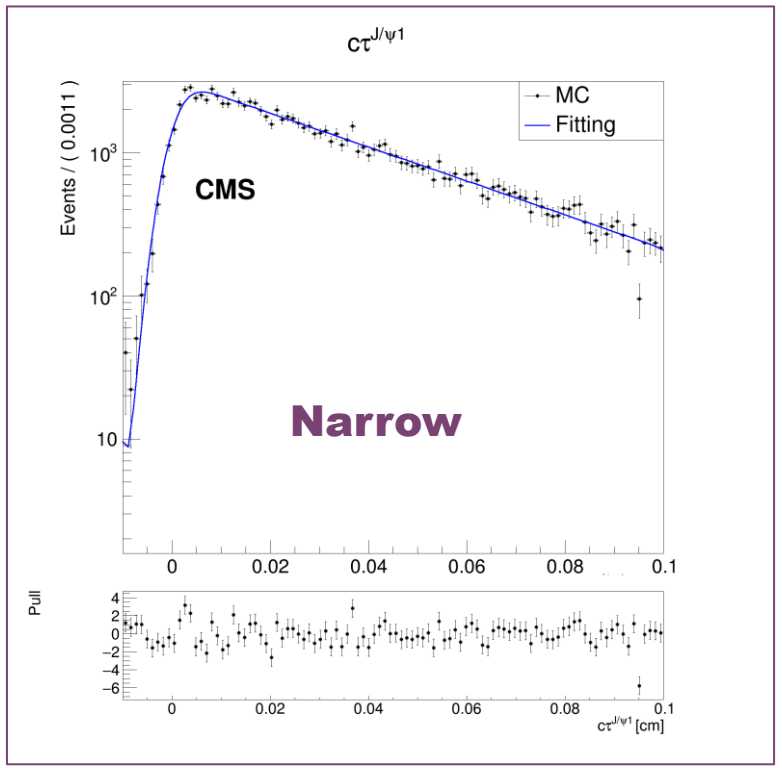
- The mass acquired from the merged vector is supposed to be the same as the mass acquired from the four muon vertex fit directly (since the vectors Taozhe uses is acquired from the fit)
- We checked the effect of using different variables

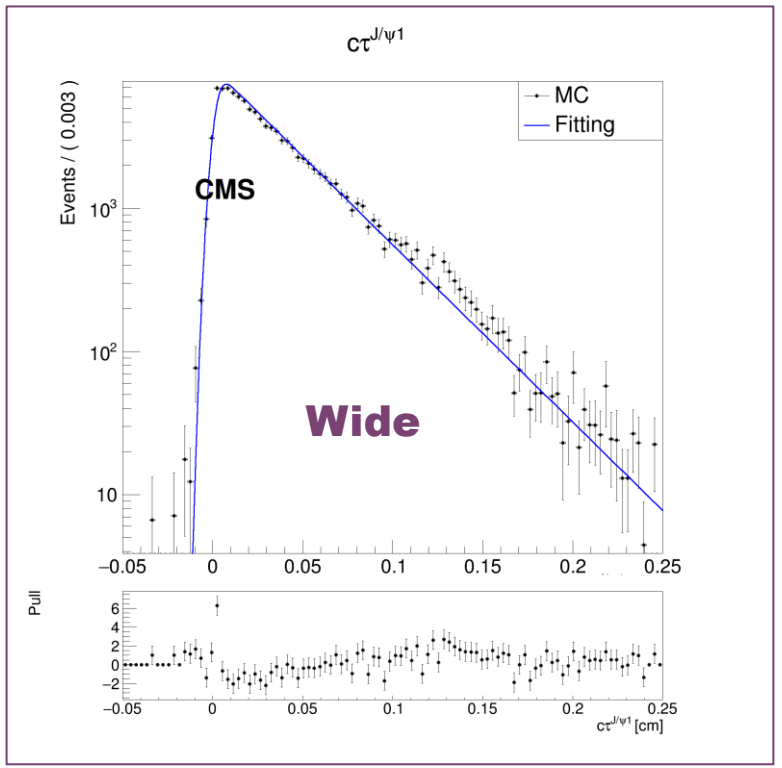
```
2
Mu1, Pt: 8.78948; 8.79093
Mu2, Pt: 3.45331; 3.45429
Mu3, Pt: 5.64083; 5.6387
Mu4, Pt: 4.42241; 4.4235
Mu1, Eta: 1.6639; 1.66388
Mu2, Eta: 1.14625; 1.14628
Mu3, Eta: -2.23929; -2.23939
Mu4, Eta: -2.35467; -2.35449
Jpsi1, Mass: 3.04913; 3.04983
Jpsi2, Mass: 3.09818; 3.09779
Jpsi1, Pt: 12.2079; 12.2079
Jpsi2, Pt: 9.59308; 9.59308
Jpsi1, y: 1.51567; 1.51567
Jpsi2, y: -2.28978; -2.28978
FourMuon, Mass: 76.7653; 77.3378
FourMuon, DeltaY: 3.80547; 3.80545
3
```

- For single muon and Jpsi, although different variables are applied, only small discrepancies can be found
- Similar for the $\Delta(y(J/\psi_1), y(J/\psi_2))$
- But the difference for $M(J/\psi J/\psi)$ can be more significant

$c\tau$ range

- For the last week, we modified the $c\tau$ range of the 4D fit, although which of the 1D fit didn't change [-0.01, 0.10] → [-0.05, 0.25]
- It was proposed to extend the range of the 1D fit
- For the non-prompt sample (uncertainties for wide range is too small):

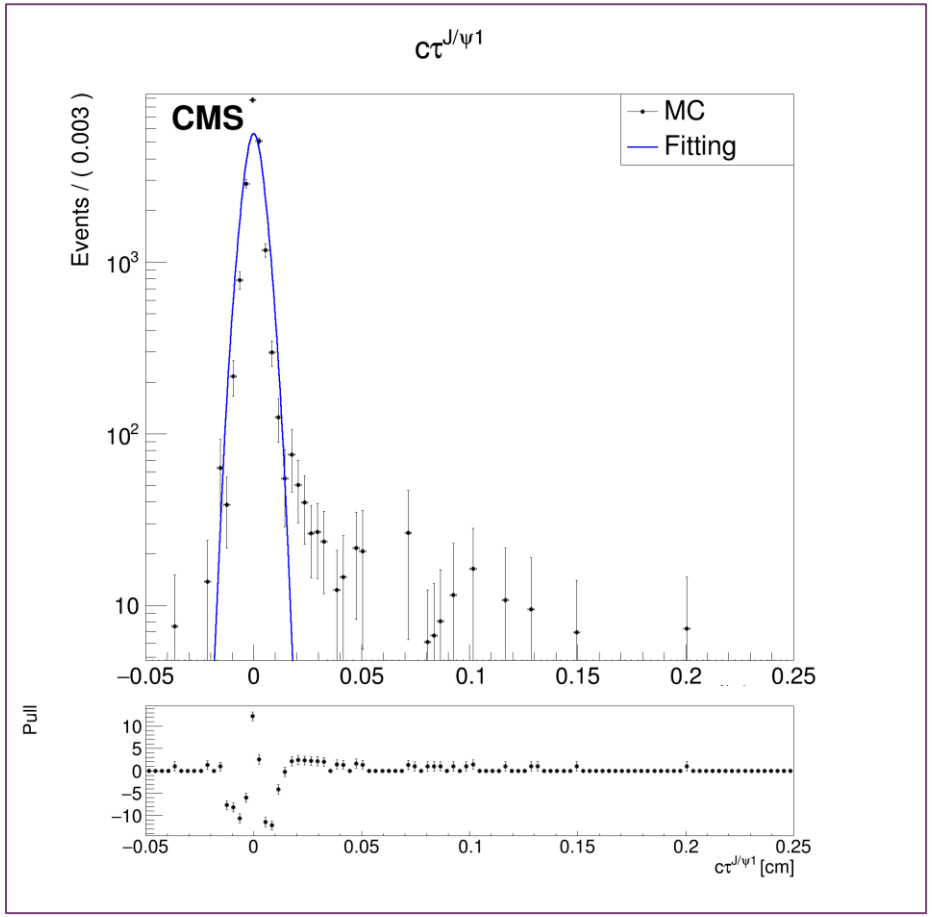




Parameter	Narrow	Wide
τ	-27.27 ± 0.14	-28.51
μ	$(4.0 \pm 0.5) \times 10^{-4}$	1.3×10^{-3}
σ	$(3.12 \pm 0.04) \times 10^{-3}$	3.7×10^{-3}

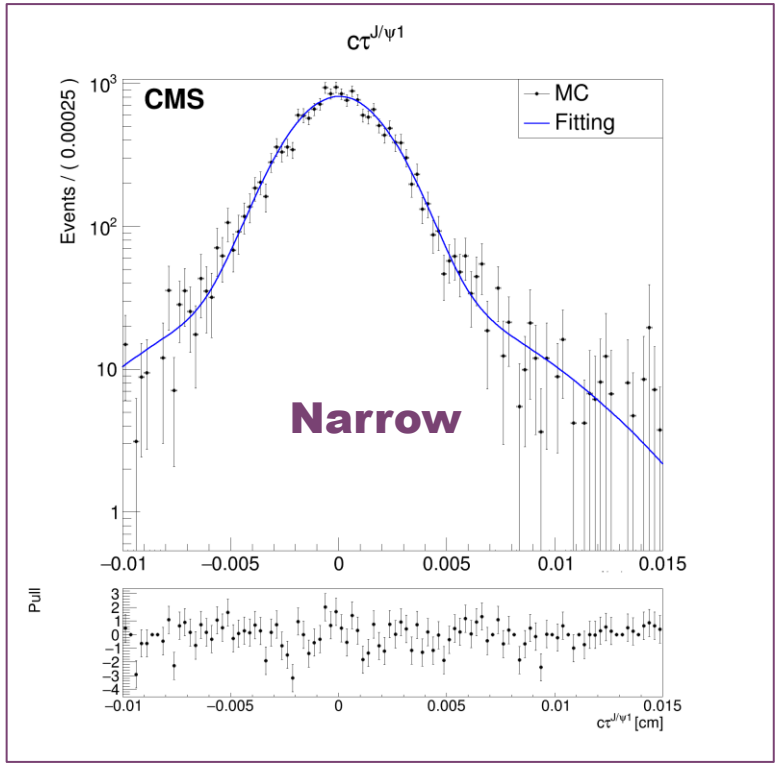
$c\tau$ range

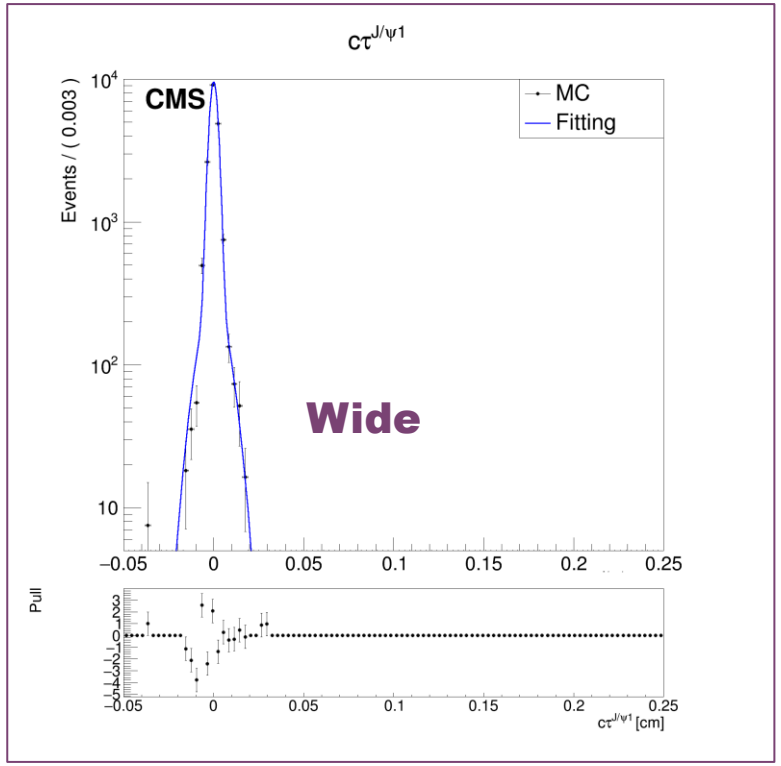
- For the prompt sample [-0.01, 0.015] → [-0.05, 0.25]
- SPS/DPS mixing sample with the wide range is unavailable (for the DPS tail)



$c\tau$ range

- For the prompt sample
- Using only SPS sample (SPS/DPS difference can be a problem)
- Small discrepancies of parameters can be noticed

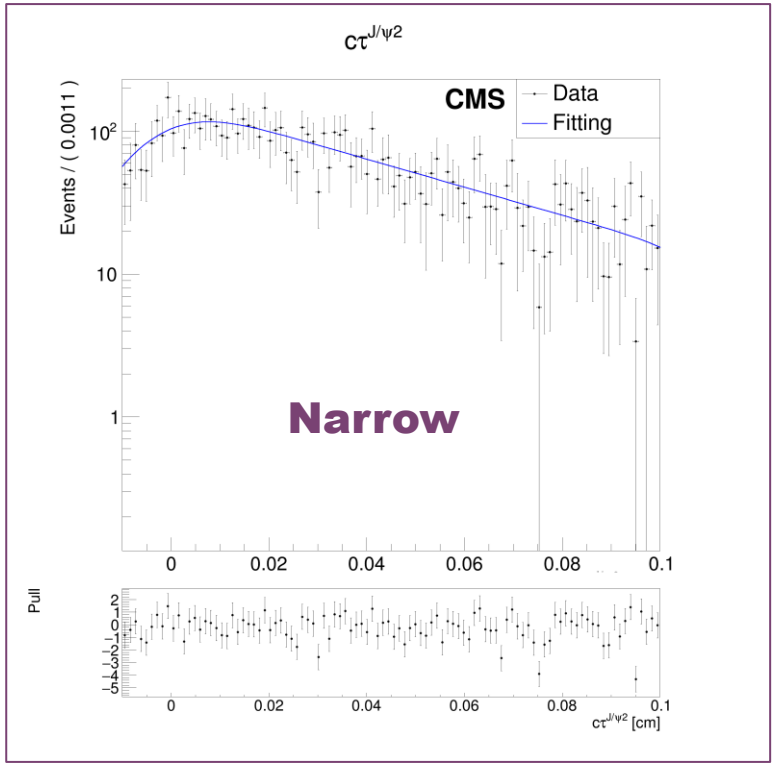


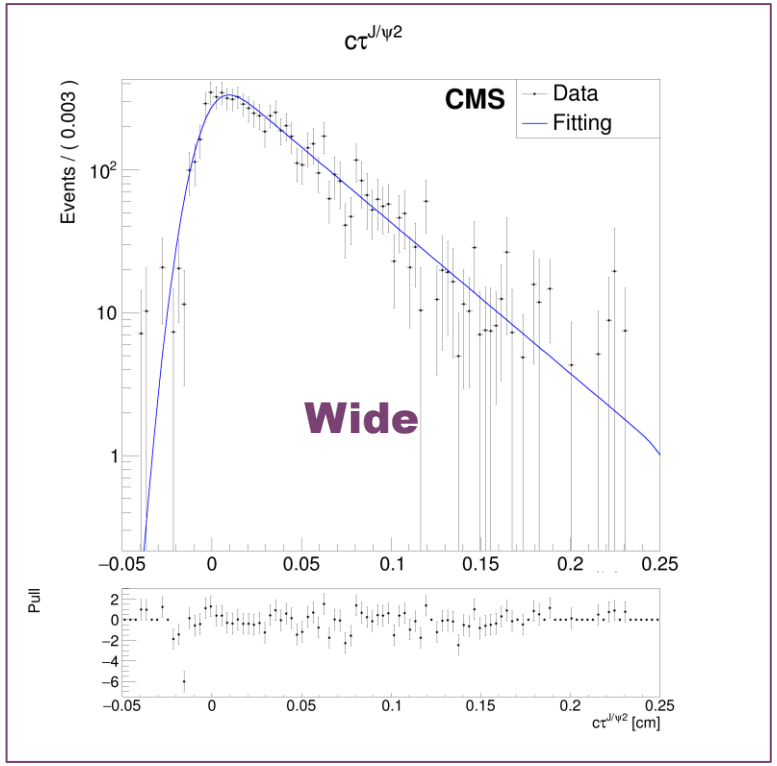


Parameter	Narrow	Wide
μ	$(2.7 \pm 1.8) \times 10^{-5}$	$(2.8 \pm 1.8) \times 10^{-5}$
σ_1	$(6.3 \pm 0.3) \times 10^{-3}$	$(7.4 \pm 0.2) \times 10^{-3}$
σ_2	$(2.06 \pm 0.02) \times 10^{-3}$	$(2.15 \pm 0.02) \times 10^{-3}$
f	0.121 ± 0.010	0.088 ± 0.005

$c\tau$ range

- For the side band sample (combinatorial background)
- $c\tau_2$ for $J/\psi_1\mu^+\mu^-$ sample (shape for $\mu^+\mu^-$)

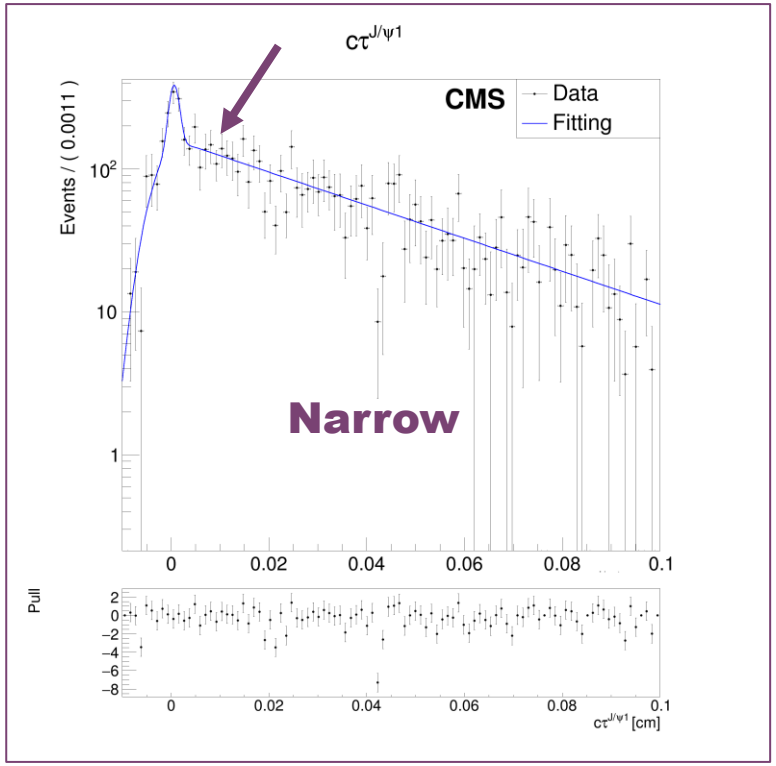


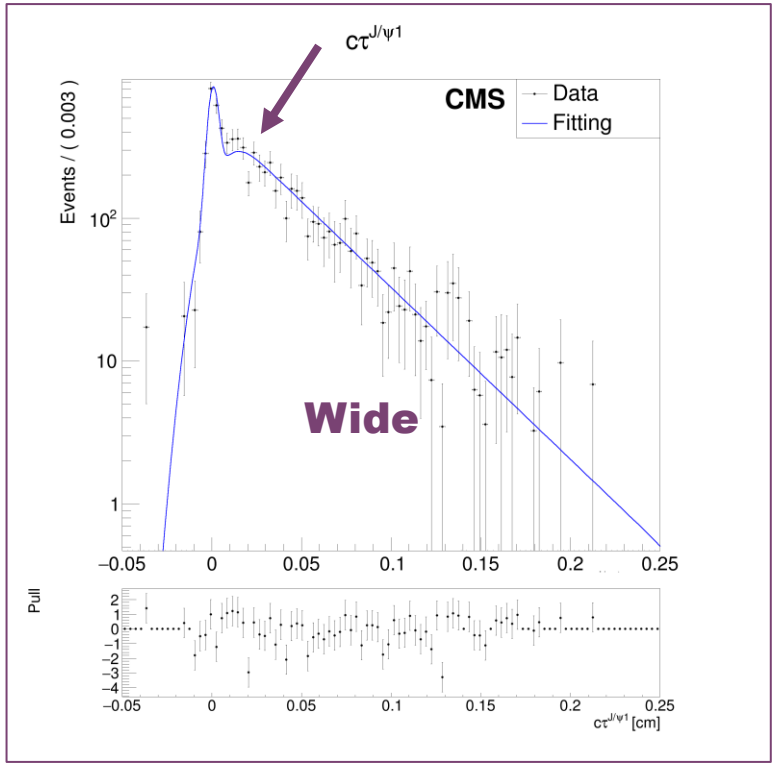


Parameter	Narrow	Wide
τ	-22.6 ± 0.6	-24.3 ± 0.4
μ	$-(6.3 \pm 0.6) \times 10^{-3}$	$-(4.0 \pm 0.4) \times 10^{-3}$
σ	$(1.02 \pm 0.05) \times 10^{-2}$	$(1.01 \pm 0.02) \times 10^{-2}$

$c\tau$ range

- For the side band sample(combinatorial background)
- $c\tau_1$ for $J/\psi_1\mu^+\mu^-$ sample (shape for J/ψ)
- The shape changes a lot



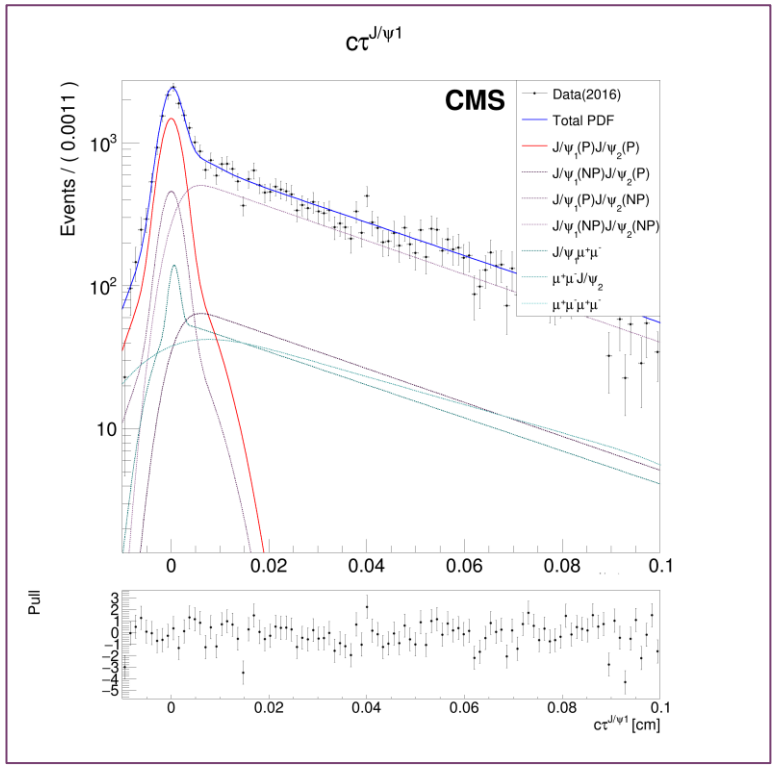


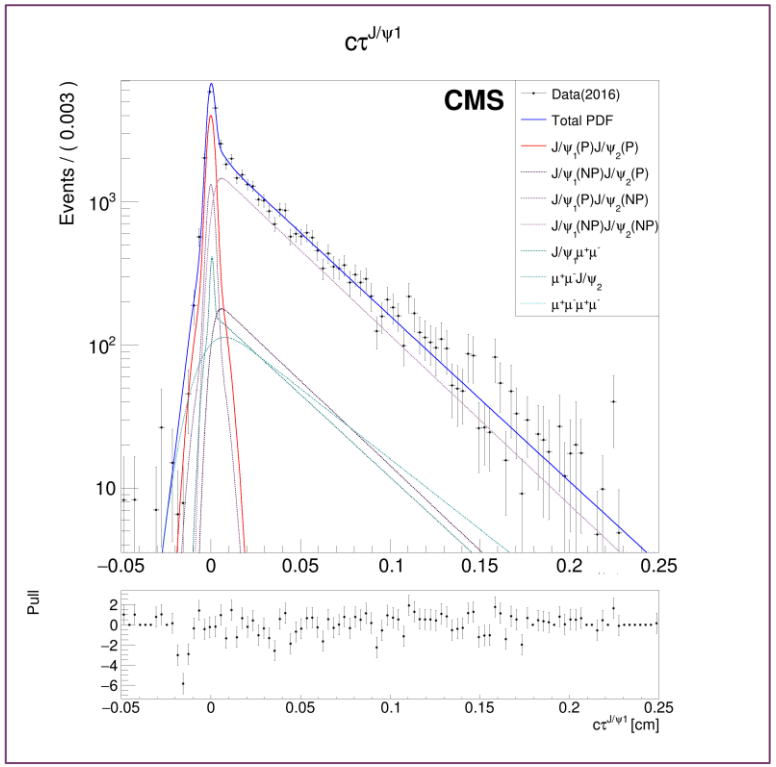
Parameter	Narrow	Wide
τ	-26.6 ± 0.5	-27.7 ± 0.5
μ_{cov}	$-(3.2 \pm 0.2) \times 10^{-3}$	$(2.5 \pm 0.5) \times 10^{-3}$
σ_{cov}	$(3.2 \pm 0.2) \times 10^{-3}$	$(9.7 \pm 0.3 \times 10^{-3}$
μ_{gaus}	$(6.1 \pm 0.8) \times 10^{-4}$	$(7.3 \pm 1.1) \times 10^{-4}$
σ_{gaus}	$(9.9 \pm 0.8) \times 10^{-4}$	$(2.65 \pm 0.12) \times 10^{-3}$
f	$(8.7 \pm 0.7) \times 10^{-2}$	0.204 ± 0.009
χ^2/ndf	1.76/6	0.99/6

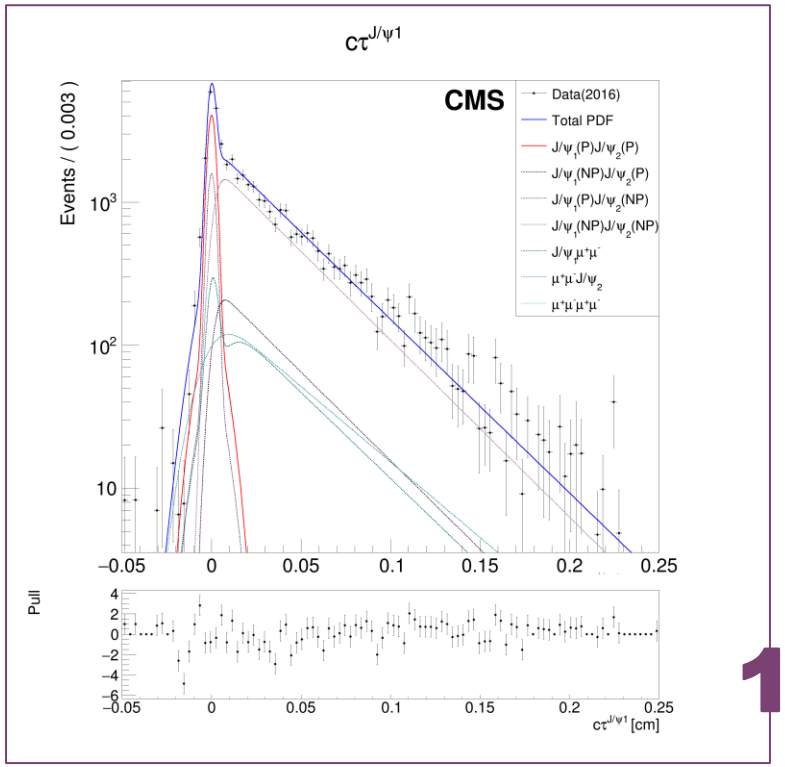
$c\tau$ range

- 4D fit is tried with different ranges

1D	Narrow	Narrow	Wide
4D	Narrow	Wide	Wide







$c\tau$ range

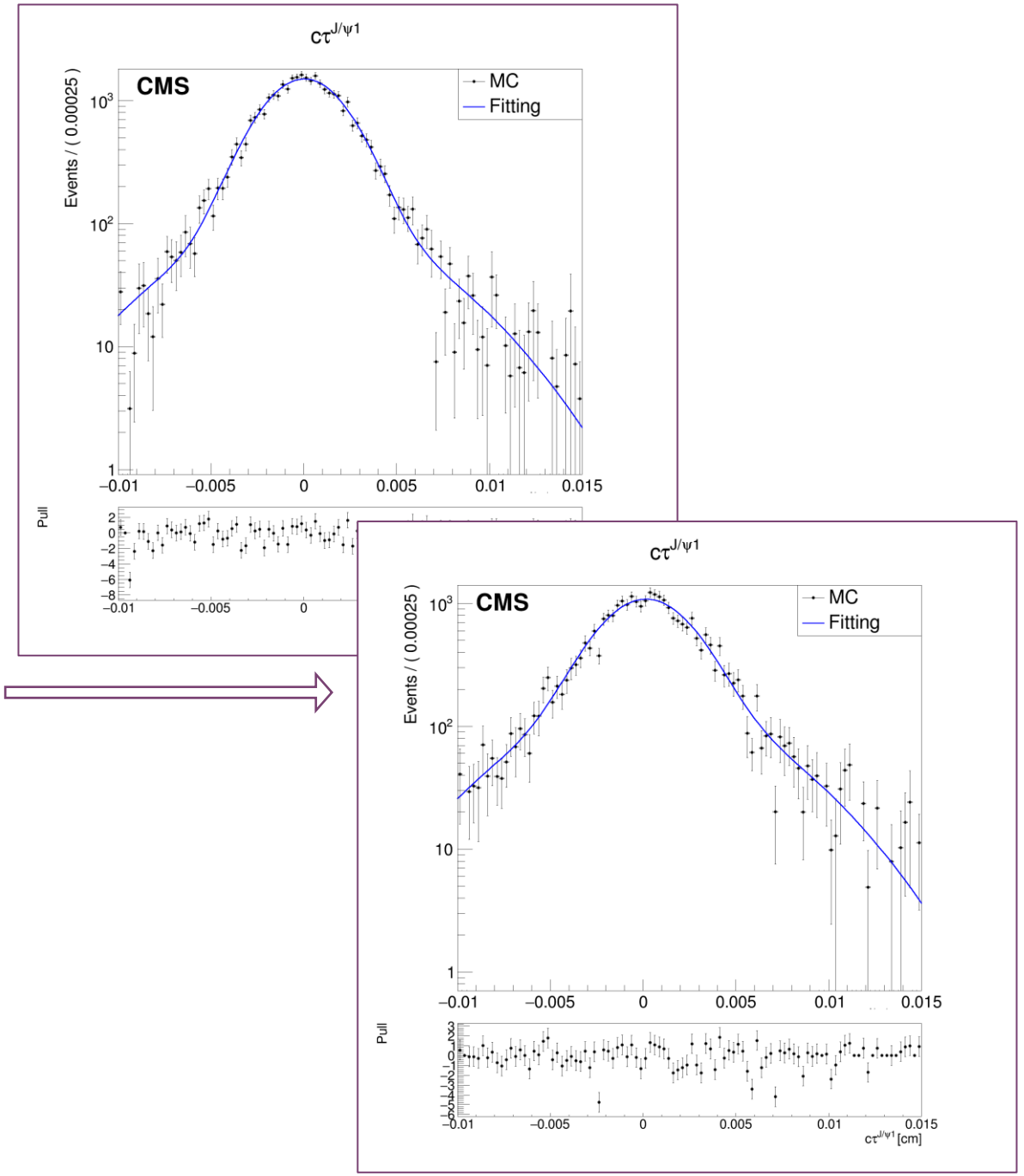
- 4D fit is tried with different ranges

1D		Narrow	Narrow	Wide
4D		Narrow	Wide	Wide
J/ψ_1 J/ψ_2	P+P	8053 ± 100	8065 ± 102	7672 ± 99
	P+NP	2493 ± 70	2651 ± 67	2669 ± 65
	NP+P			
	NP+NP	19560 ± 280	21623 ± 250	20447 ± 250
$J/\psi_1\mu^+\mu^-$		2301 ± 151	2542 ± 126	3356 ± 139
$\mu^+\mu^- J/\psi_2$				
$\mu^+\mu^-\mu^+\mu^-$		46 ± 51	44 ± 42	2 ± 279

Summary

- For the difference of the template fit
  - Previous study showed the problem was from the discrepancies of DPS samples
  - We checked the processing of the sample, and drew a conclusion that the discrepancies were from the variables we chose
- For the extending of the $c\tau$ range
  - We tried to extend the range of the 4D fit only last week
  - We tried to also extend the range of the 1D fit too
  - The mixing prompt sample we used previously can't be used anymore, which may cause problem
  - The shape for the combinatorial background greatly changed for the wide range
  - The yields of components are also greatly modified for this reason

Parameter	SPS	DPS
μ	$(3.0 \pm 1.3) \times 10^{-5}$	$(1.64 \pm 0.17) \times 10^{-4}$
σ_1	$(5.43 \pm 0.15) \times 10^{-3}$	$(5.46 \pm 0.14) \times 10^{-3}$
σ_2	$(2.084 \pm 0.019) \times 10^{-3}$	$(2.26 \pm 0.03) \times 10^{-3}$
f	0.150 ± 0.009	0.265 ± 0.015



	Taozhe	Jinfeng
$p^T(\mu_1)$	fourMuFit_mu1Pt->at(0)	(*AllRecoMuons_Pt)[RECO_ups1_mu1_index]
$\eta(\mu_1)$	fourMuFit_mu1Eta->at(0)	(*AllRecoMuons_Eta)[RECO_ups1_mu1_index]
$M(J/\psi_1)$	fourMuFit_ups1_mass->at(0)	ups1_mass_GenMatched_ID_OS_VTX
$y(J/\psi_1)$	fourMuFit_ups1_rapidity->at(0)	ups1_y_GenMatched_ID_OS_VTX
$p^T(J/\psi_1)$	fourMuFit_ups1_pt->at(0)	ups1_pt_GenMatched_ID_OS_VTX
$M(J/\psi_1 J/\psi_2)$	fourmu.M()	(*fourMuFit_Mass)[0]
$\Delta(y(J/\psi_1), y(J/\psi_2))$	abs(mupair1.Rapidity()-mupair2.Rapidity())	fabs((*fourMuFit_ups1_rapidity)[0] - (*fourMuFit_ups2_rapidity)[0])