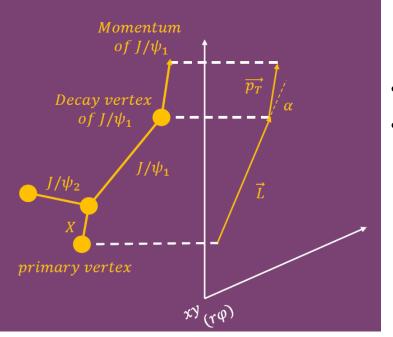# Double J/ψ work status

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Variable to distinguish prompt and non-prompt J/ψ

The L_{xy} is calculated as $\quad L_{xy}(J/\psi) = \vec{L} \cdot \vec{p}_T(J/\psi)/|p_T(J/\psi)|$

- $\vec{L}$ is the vector from the primary vertex to the J/ψ decay vertex in the $r - \phi$ plane
- $\vec{p}_T(J/\psi)$ is the transverse momentum vector

To reduce the dependence on J/ψ transverse momentum bin size and placement, a new variable $c\tau$, called pseudoproper decay time, is used instead of L_{xy} :

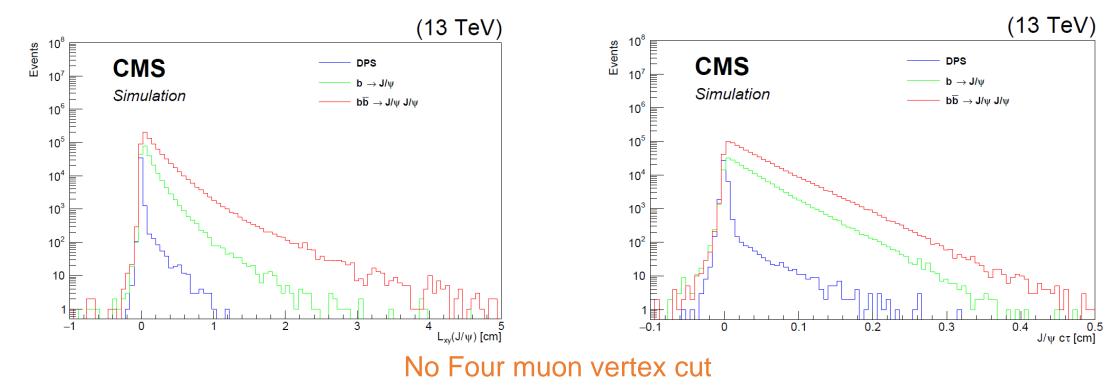$$c\tau = L_{xy}(J/\psi) \cdot M(J/\psi)/p_T(J/\psi)$$

- L_{xy} or $c\tau$ can be the variable to distinguish prompt and non-prompt J/ψ

- Using the official sample B meson ->J/ψ+x and private DPS and $b\bar{b}$ -> J/ψ J/ψ + X sample to compare J/ψ L_{xy} and $c\tau$ distribution:

| Prompt/Non-prompt	Sample
B meson -> J/ψ + X	/BsToJPsiPhi_JPsiToMuMu_PhiToKK_SoftQCDnonD_TuneCP5_13TeV-pythia8-evtgen/RunIISummer20UL18RECO-106X_upgrade2018_realistic_v11_L1v1-v2/AODSIM
bbbar -> J/ψ J/ψ + X	/Pythia8_BBartoJJ/jinfeng-MC2018_SKIM_JinfengLiu_bDecay-2c13f6522fd88ab3fbb3f545dbe011e8/USER
DPS	/Pythia8_DPStoJJ/jiayis-MC2018_SKIM_JinfengLiu_v2-1631c8025908d8822669ac074a24ab90/USER

No Four muon vertex cut
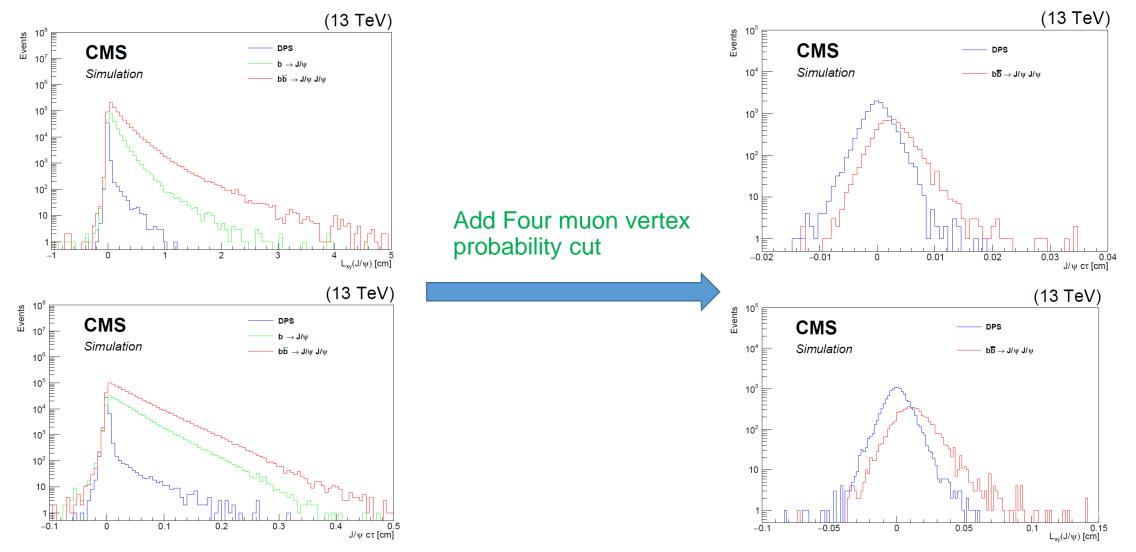
- We plot L_{xy} or $c\tau$ distribution without the four muon vertex cut

- The official B meson ->J/ψ+x sample have a similar distribution with private $b\bar{b}$ -> J/ψ J/ψ + X sample, that validities our private sample

Add Four muon vertex probability cut
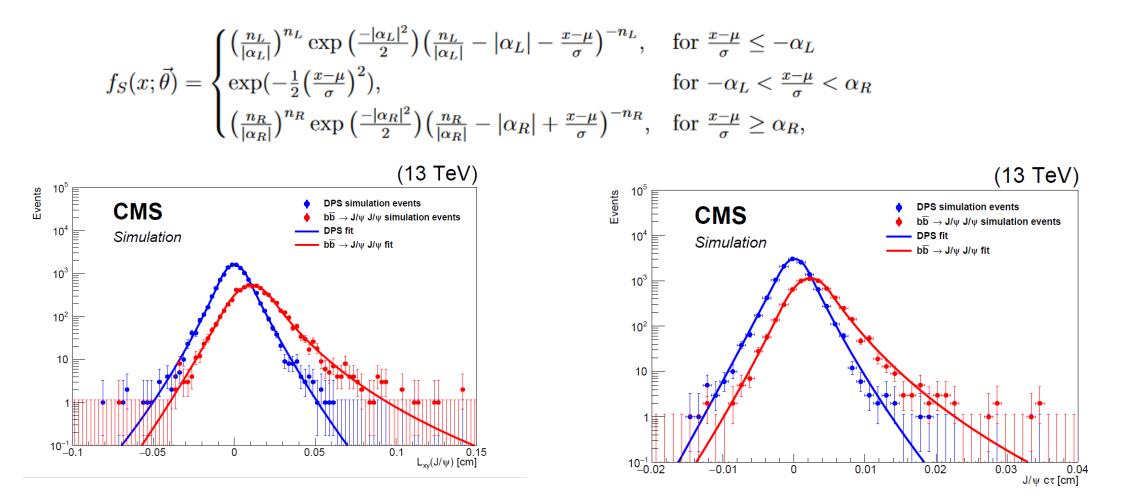
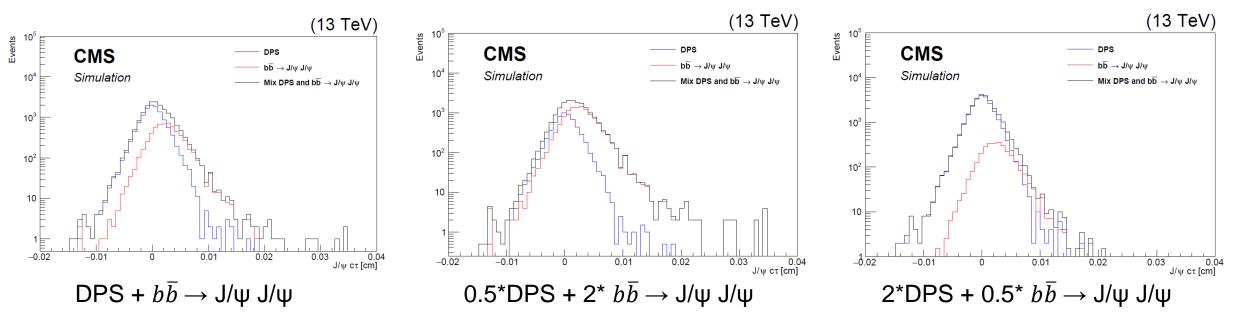• Long distance component may be highly depressed by the vertex requirement

Fit the prompt and non-prompt Double Jpsi

- Using double-sided Crystal Ball (DSCB) function to fit L_{xy} or $c\tau$ distribution

$$
f_S(x; \vec{\theta}) = \begin{cases} \left(\frac{n_L}{|\alpha_L|}\right)^{n_L} \exp\left(\frac{-|\alpha_L|^2}{2}\right) \left(\frac{n_L}{|\alpha_L|} - |\alpha_L| - \frac{x-\mu}{\sigma}\right)^{-n_L}, & \text{for } \frac{x-\mu}{\sigma} \leq -\alpha_L \\ \exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right), & \text{for } -\alpha_L < \frac{x-\mu}{\sigma} < \alpha_R \\ \left(\frac{n_R}{|\alpha_R|}\right)^{n_R} \exp\left(\frac{-|\alpha_R|^2}{2}\right) \left(\frac{n_R}{|\alpha_R|} - |\alpha_R| + \frac{x-\mu}{\sigma}\right)^{-n_R}, & \text{for } \frac{x-\mu}{\sigma} \geq \alpha_R, \end{cases}
$$

Closure test

DPS + $b\bar{b} \rightarrow$ J/ψ J/ψ

0.5*DPS + 2* $b\bar{b} \rightarrow$ J/ψ J/ψ

2*DPS + 0.5* $b\bar{b} \rightarrow$ J/ψ J/ψ
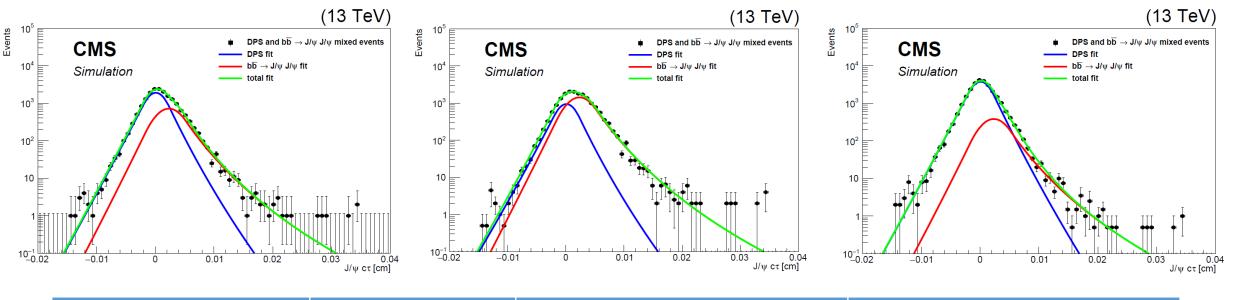
	DPS	$b\bar{b}$-> J/ψ J/ψ	total
DPS + $b\bar{b}$-> J/ψ J/ψ	11970	5955	17925
0.5*DPS + 2*$b\bar{b}$-> J/ψ J/ψ	5985	11910	17895
2*DPS + 0.5*$b\bar{b}$-> J/ψ J/ψ	23940	2977.5	26917.5

- We mix the DPS and $b\bar{b}$-> J/ψ J/ψ in some fraction to produce pseudo-data.
- We the pseudo-data to do closure test

Closure test

	total	DPS fraction	DPS number
DPS + $b\bar{b}$-> J/ψ J/ψ	17925	0.666 $\pm$ 0.009	11943.5 $\pm$154.9
0.5*DPS + 2*$b\bar{b}$-> J/ψ J/ψ	17895	0.33 $\pm$ 0.02	5962.4 $\pm$ 368.4
2*DPS + 0.5*$b\bar{b}$-> J/ψ J/ψ	26917.5	0.88 $\pm$ 0.03	23735.1$\pm$909.9

- We fix some parameters(mean, width, alpha) to fit the pseudo-data
- The DPS fraction and DPS events satisfy our expected

backup

Object and event selection

- We transfer to using AOD, so the whole analysis framework were updated
- We add the muon vertex information in the Event Selection

➤ **Trigger**

HLT_Dimuon0_Jpsi_Muon

➤ **Muon**

- Standard Soft muon ID
- pT(muon)>=3.5GeV
- |η(muon)|<=2.4
- Do the match with Gen muon
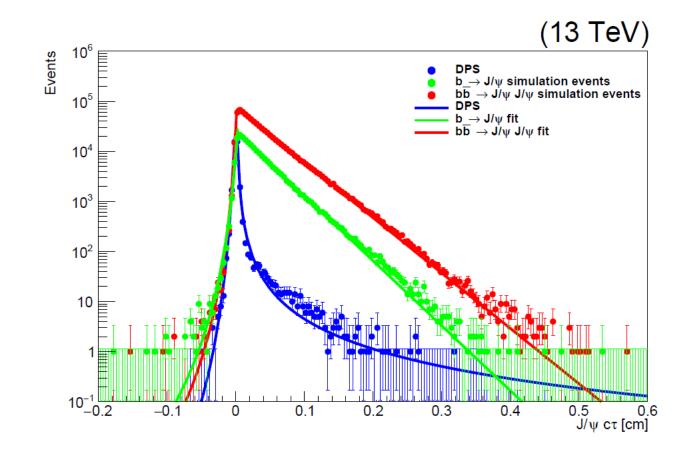 - DeltaR(Gen muon, RECO muon)<0.03

➤ **J/ψ**

- The J/ψ was reconstructed by two opposite sign muon

- The vertex probability of the 2 muons associated to the J/ψ is greater than 0.5%

- |m(dimuon) – 3.092|<0.3

➤ **J/ψ Pair**

- The vertex probability of the 4 muons is greater than 1%
- J/ψ1(muon12) and J/ψ2(muon34) do not share a common muon

Ctau fit without four muon vertex cut

- B meson ->J/ψ+x and $b\bar{b}$-> J/ψ J/ψ use the function to fit

double-sided Crystal Ball (DSCB) function and exponential function convolution