中国科学院高能物理研究所
Institute of High Energy Physics
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Double Jpsi

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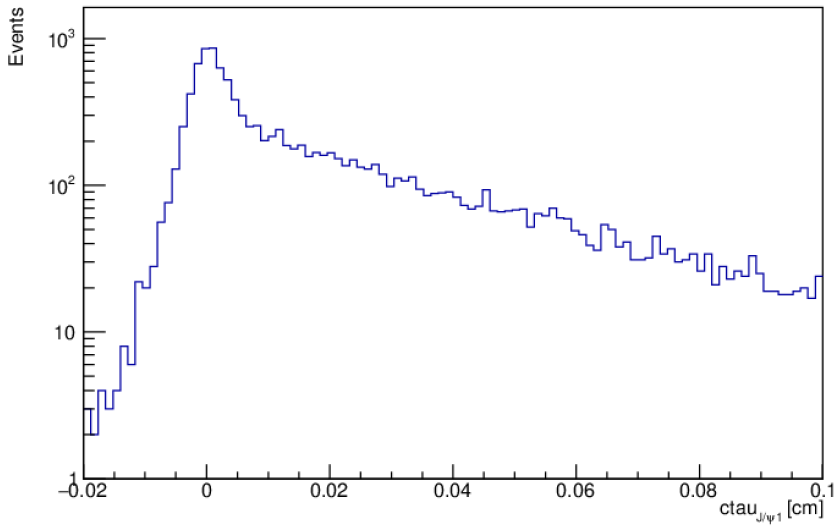
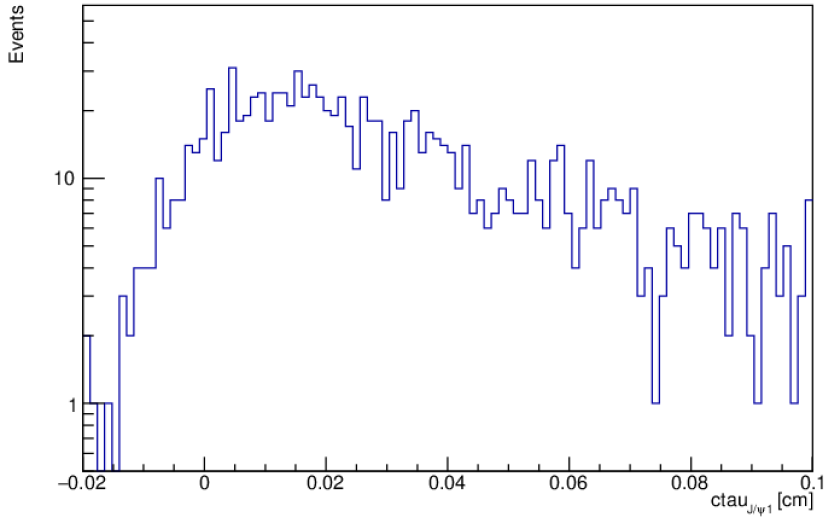
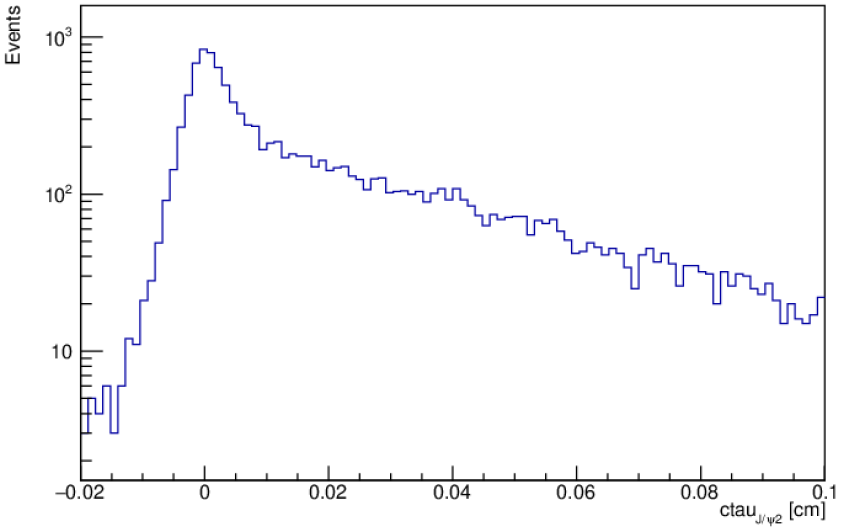
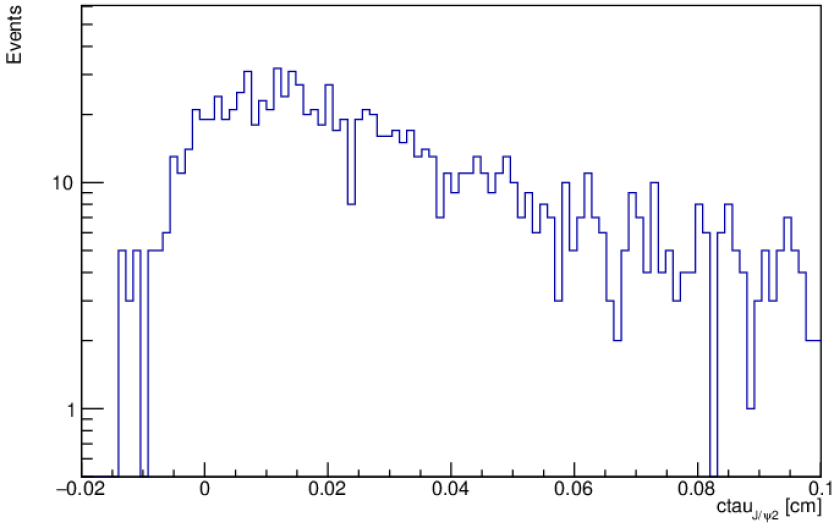
Ctau distribution in signal region and sideband region







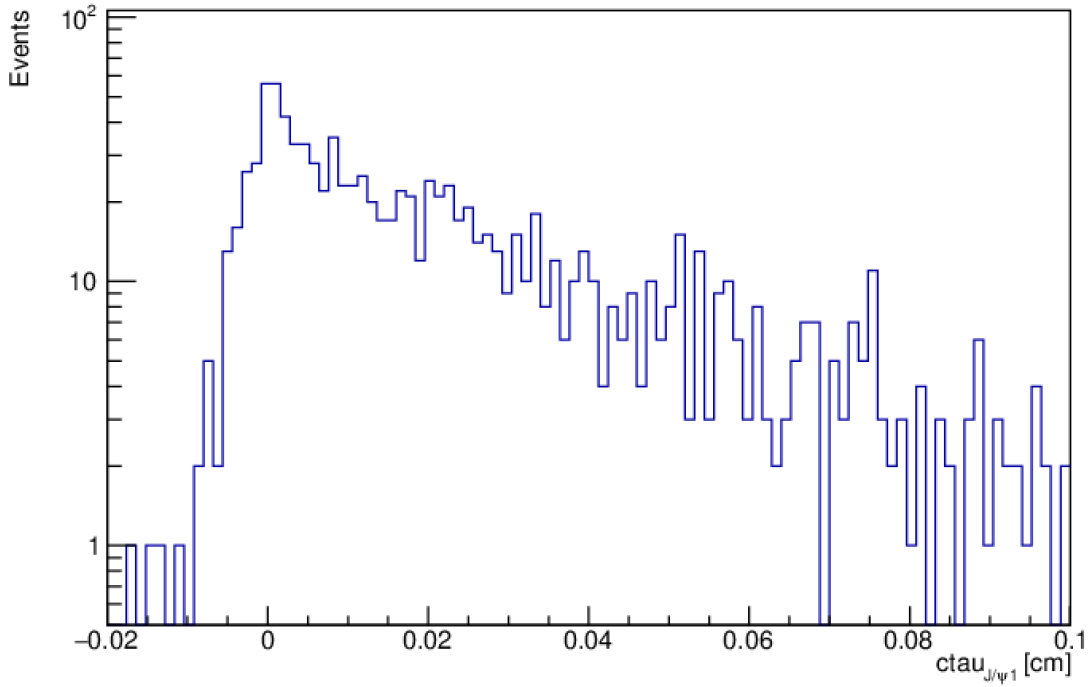


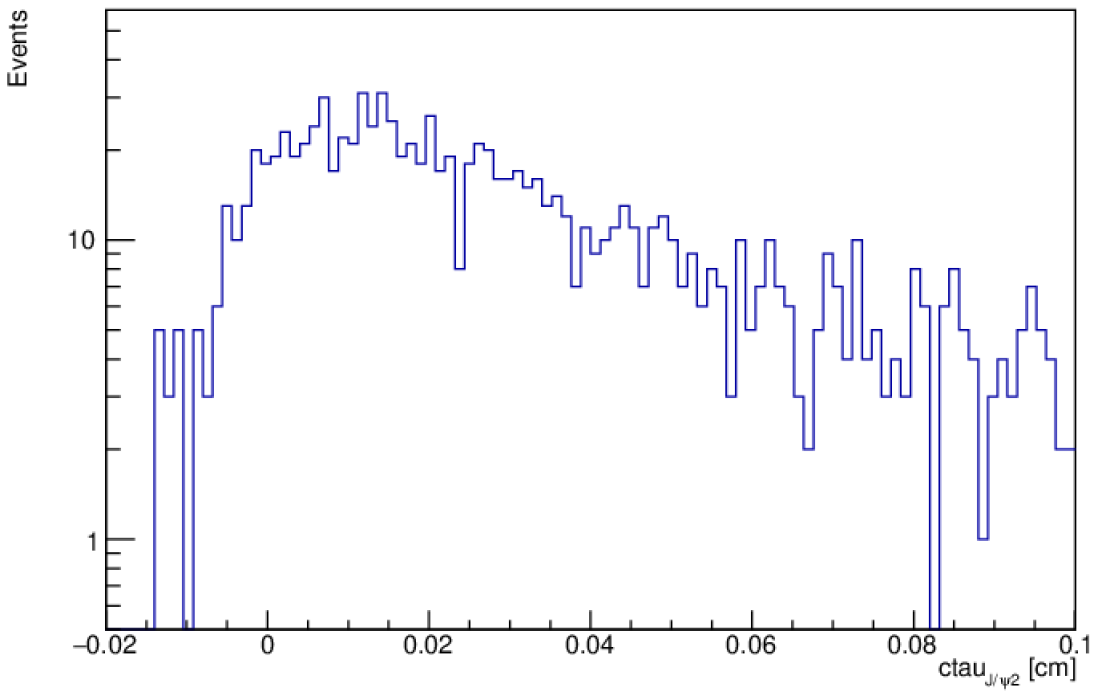
- I compare the signal region and sideband region ctau distribution
- The signal region ctau distribution is prompt + non-prompt
- The comb. components ctau distribution is more like non-prompt.

J/ψ mass ∈ [2.95, 3.25]GeV

J/ψ mass ∈ [2.7, 2.95]∪[3.25, 3.5]GeV

Ctau distribution in signal region and sideband region

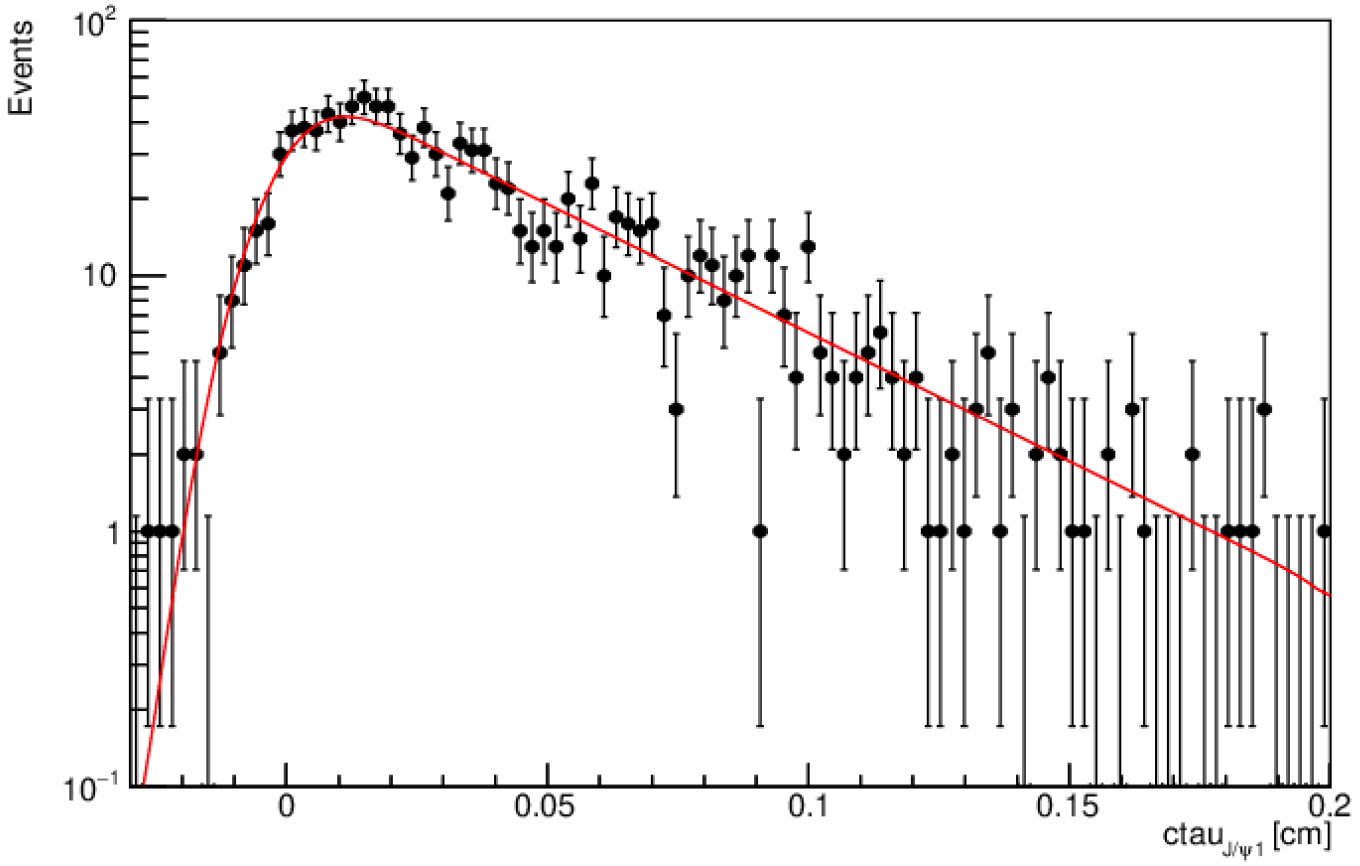




J/ψ1 mass ∈ [2.95, 3.25]GeV
J/ψ2 mass ∈ [2.7, 2.95]∪[3.25, 3.5]GeV

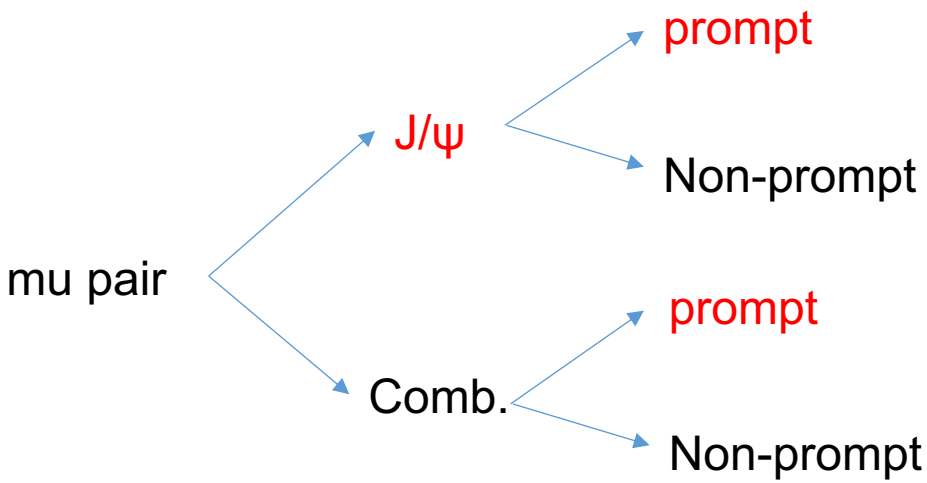
- The signal region ctau distribution is prompt + non-prompt
- The comb. components ctau distribution is more like non-prompt.

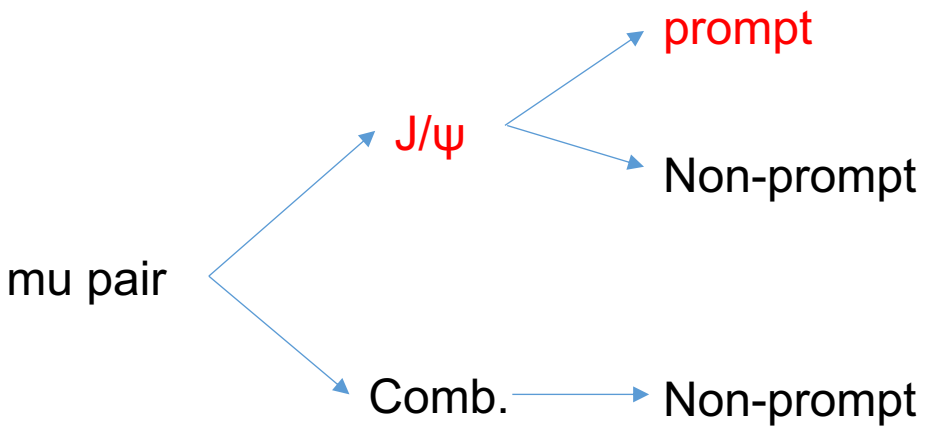
Comb. ctau distribution fit

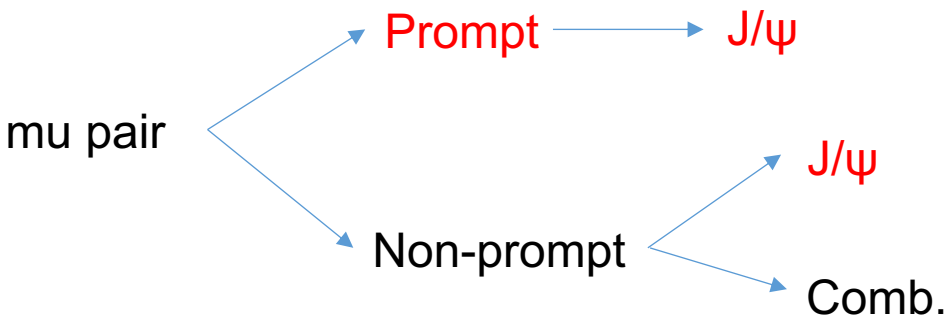


- The comb. ctau can use Exp⊗Gauss function to fit, its distribution like non-prompt component's.
- But comb. function's parameters are different from J/ψ non-prompt's

Events components







➢Old components:

- mass distribution and ctau distribution are uncorrelation
- There are 16 categories

➢New components:

- mass distribution and ctau distribution are correlation
- There are 9 categories

The 4D fit PDF

➢J/ψ + J/ψ

$$f_{Jpsi1} * f_{Jpsi2} * g_{prompt1} * g_{prompt2}$$

$$f_{Jpsi1} * f_{Jpsi2} * g_{non-prompt1} * g_{prompt2}$$

$$f_{Jpsi1} * f_{Jpsi2} * g_{prompt1} * g_{non-prompt2}$$

$$f_{Jpsi1} * f_{Jpsi2} * g_{non-prompt1} * g_{non-prompt2}$$

- I use f to stand for J/ψ or comb. mass PDF, use g to stand for J/ψ ctau distribution, use h to stand for comb. ctau distribution
- Compare to old PDF, the J/ψ + J/ψ component PDF don't change.

The 4D fit PDF

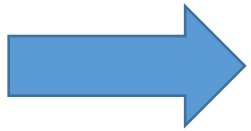
➢J/ψ1+ comb.

$f_{Jpsi1} * f_{comb2} * g_{prompt1} * g_{prompt2}$

$f_{Jpsi1} * f_{comb2} * g_{non-prompt1} * g_{prompt2}$

$f_{Jpsi1} * f_{comb2} * g_{prompt1} * g_{non-prompt2}$

$f_{Jpsi1} * f_{comb2} * g_{non-prompt1} * g_{non-prompt2}$



$f_{Jpsi1} * f_{comb2} * g_{prompt1} * h_{Non-prompt2}$

$f_{Jpsi1} * f_{comb2} * g_{non-prompt1} * h_{Non-prompt2}$

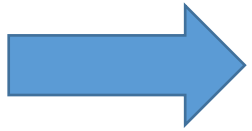
➢comb.+ J/ψ2

$f_{comb1} * f_{Jpsi2} * g_{prompt1} * g_{prompt2}$

$f_{comb1} * f_{Jpsi2} * g_{non-prompt1} * g_{prompt2}$

$f_{comb1} * f_{Jpsi2} * g_{prompt1} * g_{non-prompt2}$

$f_{comb1} * f_{Jpsi2} * g_{non-prompt1} * g_{non-prompt2}$



$f_{comb1} * f_{Jpsi2} * h_{Non-prompt1} * g_{prompt1}$

$f_{comb1} * f_{Jpsi2} * h_{Non-prompt1} * g_{non-prompt1}$

- Compare to old PDF, the J/ψ + comb. component PDF change.

The 4D fit PDF

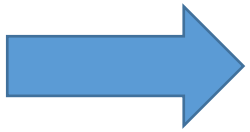
➢Comb.+comb.

$f_{comb1} * f_{comb2} * g_{prompt1} * g_{prompt2}$

$f_{comb1} * f_{comb2} * g_{non-prompt1} * g_{prompt2}$

$f_{cpmb1} * f_{comb2} * g_{prompt1} * g_{non-prompt2}$

$f_{comb1} * f_{comb2} * g_{non-prompt1} * g_{non-prompt2}$

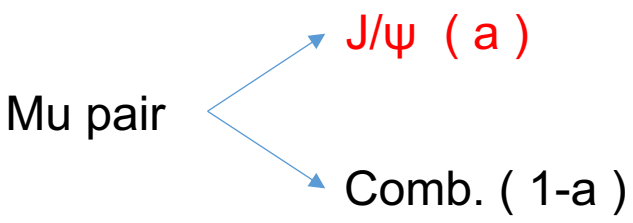


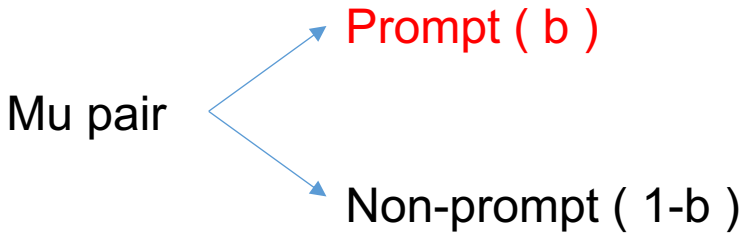
$f_{comb1} * f_{comb2} * h_{Non-prompt1} * h_{non-prompt1}$

- Compare to old PDF, the comb. + comb. component PDF change.

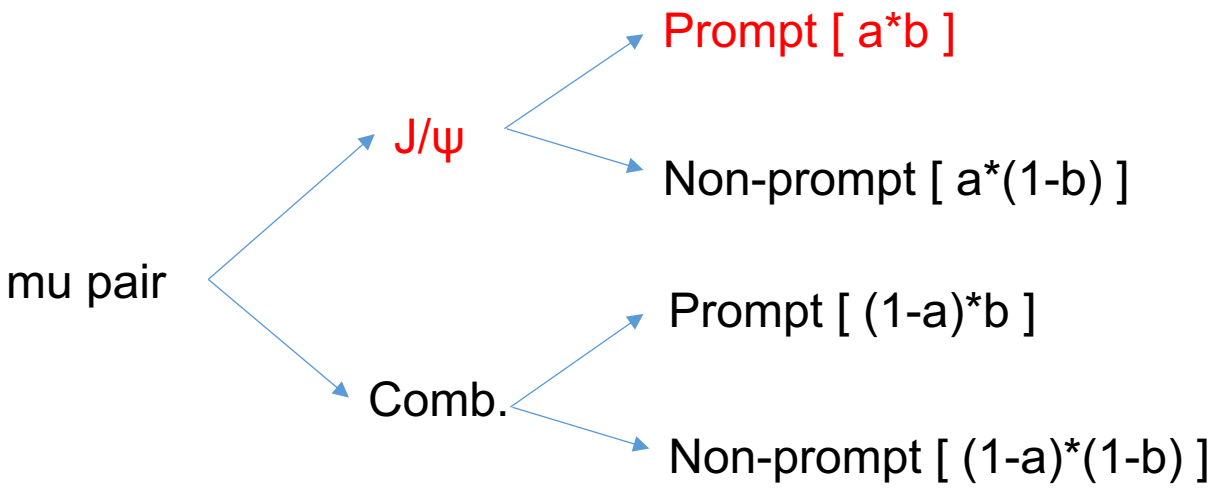
Old Fractions

- In old strategy, we do 2D fit in mass dimension to get the J/ψ fraction a ; do 2D fit in ctau dimension to get prompt fraction b



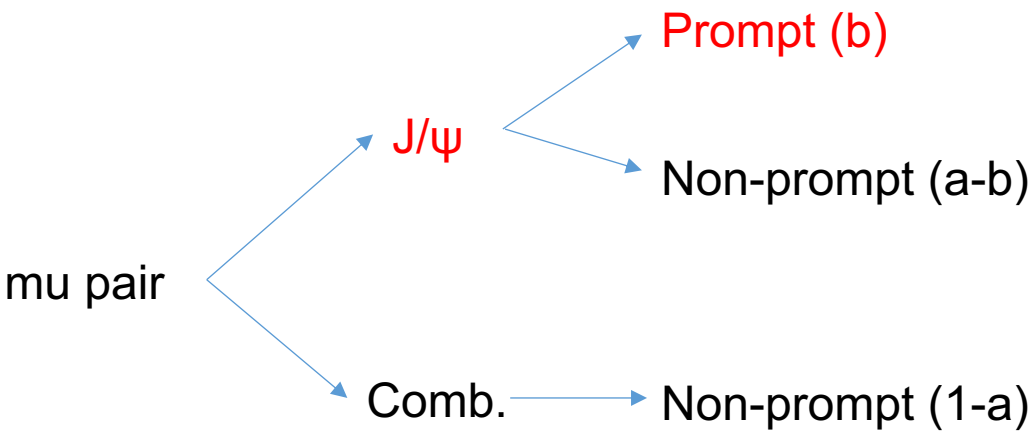


- The mass dimension and ctau dimension are uncorrelation, so we multiply the two dimension's fractions directly to get each total components' fraction



New Fractions

- We first do 2D fit in mass dimension to get J/ψ fraction a, then we do 2D fit in ctau dimension to get prompt fraction b. Then we can get all 9 components' fraction



The new PDF and its coefficient

- J/ψ + J/ψ

$$b * b * f_{Jpsi1} * f_{Jpsi2} * g_{prompt1} * g_{prompt2}$$

$$(a-b) * b * f_{Jpsi1} * f_{Jpsi2} * g_{non-prompt1} * g_{prompt2}$$

$$b * (a-b) * f_{Jpsi1} * f_{Jpsi2} * g_{prompt1} * g_{non-prompt2}$$

$$(a-b) * (a-b) * f_{Jpsi1} * f_{Jpsi2} * g_{non-prompt1} * g_{non-prompt2}$$

- J/ψ1 + comb.

$$b * (1-a) * f_{Jpsi1} * f_{comb2} * g_{prompt1} * h_{Non-prompt2}$$

$$(a-b) * (1-a) * f_{Jpsi1} * f_{comb2} * g_{non-prompt1} * h_{Non-prompt2}$$

- comb. + J/ψ2

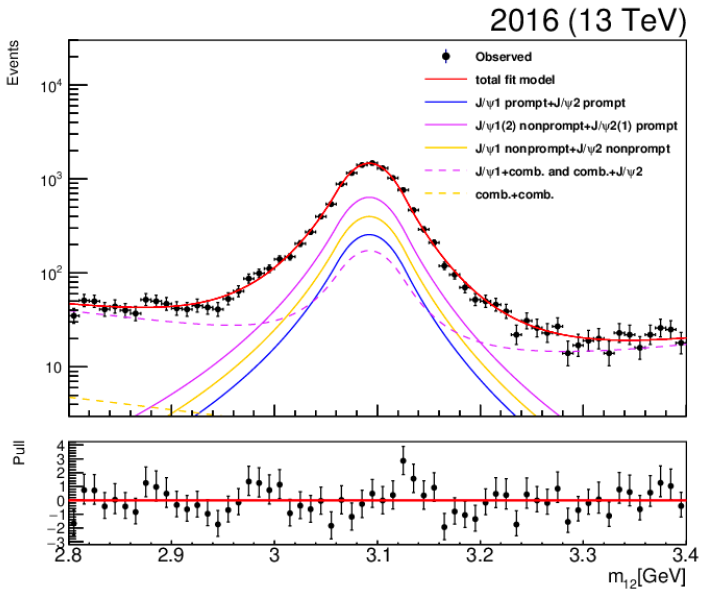
$$(1-a) * b * f_{comb1} * f_{Jpsi2} * h_{Non-prompt1} * g_{prompt1}$$

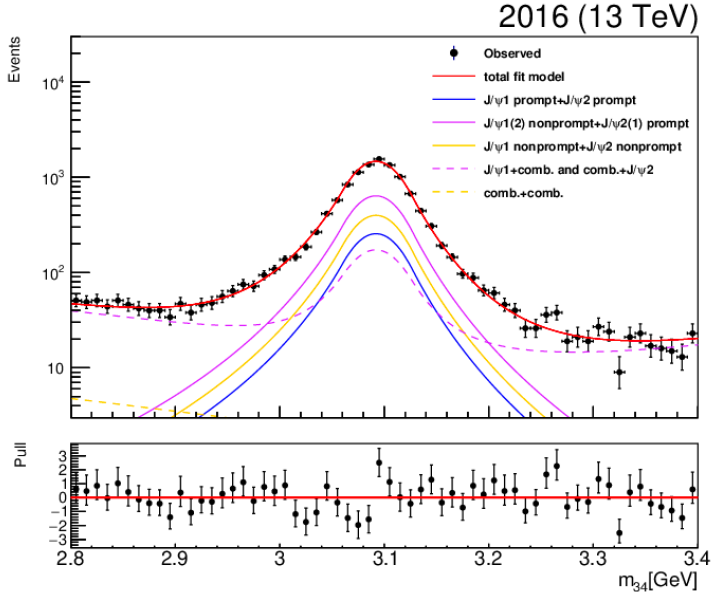
$$(1-a) * (a-b) * f_{comb1} * f_{Jpsi2} * h_{Non-prompt1} * g_{non-prompt1}$$

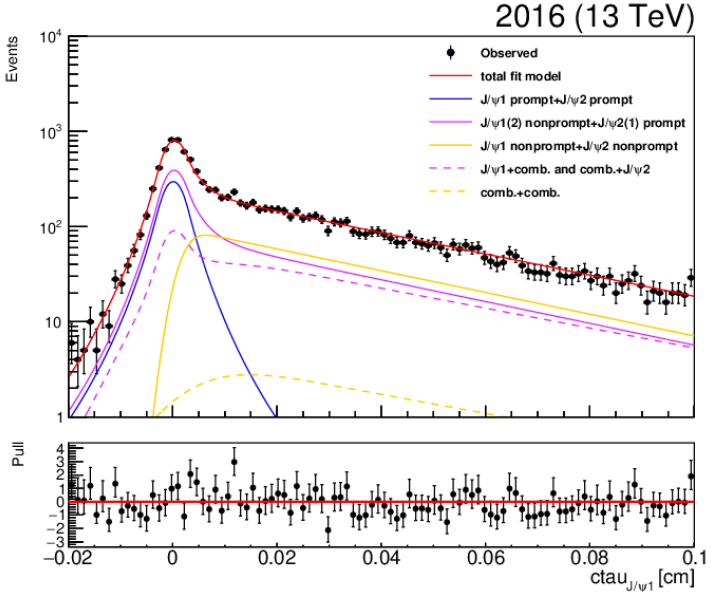
- comb. + comb.

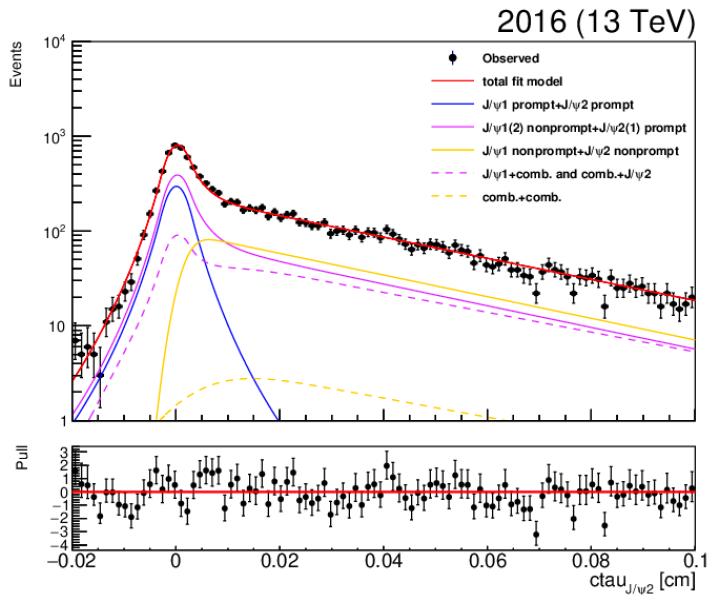
$$(1-a) * (1-a) * f_{comb1} * f_{comb2} * g_{non-prompt1} * g_{non-prompt2}$$

New 4D fit









- Total number of events in this region is 11254
- Double Jpsi fraction is 0.80 ± 0.02
- Double prompt fraction is 0.157 ± 0.002
- Prompt Jpsi pair frac is 0.157 ± 0.002
- Prompt Jpsi pair events is 1771 ± 25

		2016	2018 – part
Luminosity (fb^{-1})		37.9	14.04
$J/\psi_1 J/\psi_2$	P+P	2630 ± 60	1350 ± 40
	P+NP	960 ± 50	400 ± 30
	NP+P	920 ± 50	490 ± 30
	NP+NP	5020 ± 90	2140 ± 70
$J/\psi_1 \mu^+\mu^-$		410 ± 40	510 ± 50
$\mu^+\mu^- J/\psi_2$		510 ± 50	450 ± 50
$\mu^+\mu^-\mu^+\mu^-$		26 ± 14	36 ± 15

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