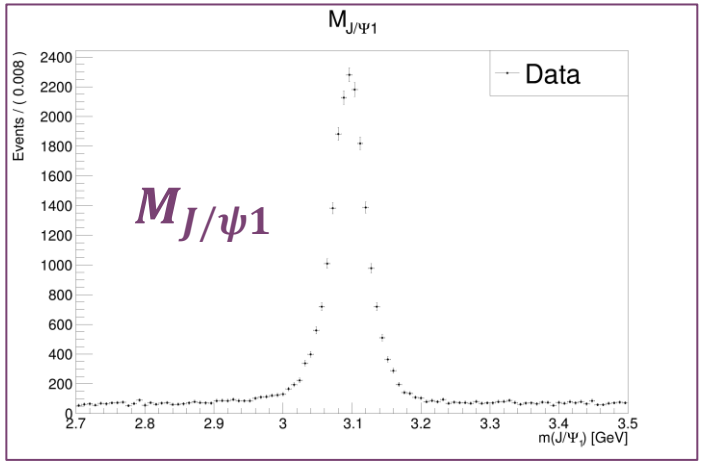
Review of the last week

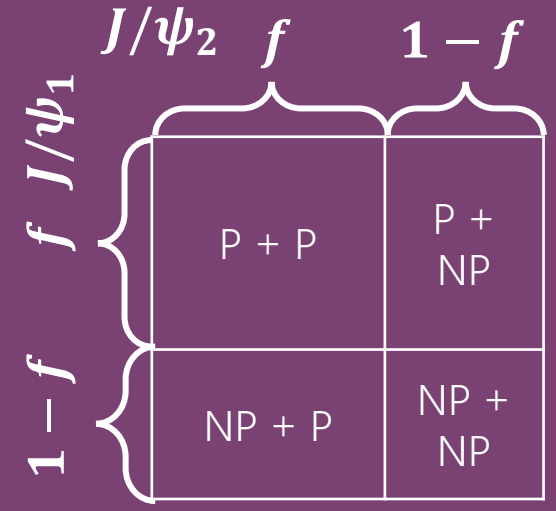


The artificial sample
(projection on the M_1)

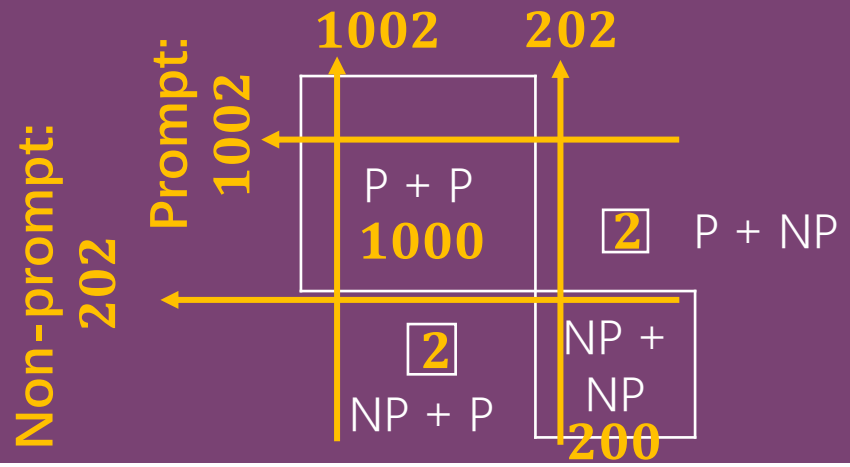
- Discussion about prompt + non-prompt combination
  - Using square of the single dimension fraction
  - Using greater lifetime variable out of two
  - Doing 4D fit
- Discussion about whether the parameters should be fixed
  - Mass: width will be fixed/float in different conditions
  - Lifetime: non-prompt shall be fixed, prompt shall be float between SPS/DPS
- An artificial combinatorial background sample has been made

Prompt + non-prompt components

——square of 1D fraction?



- $^{p+p}/_{All} = f^2$
- A fatal assumption: J/ψ_1 and J/ψ_2 are not related to each other

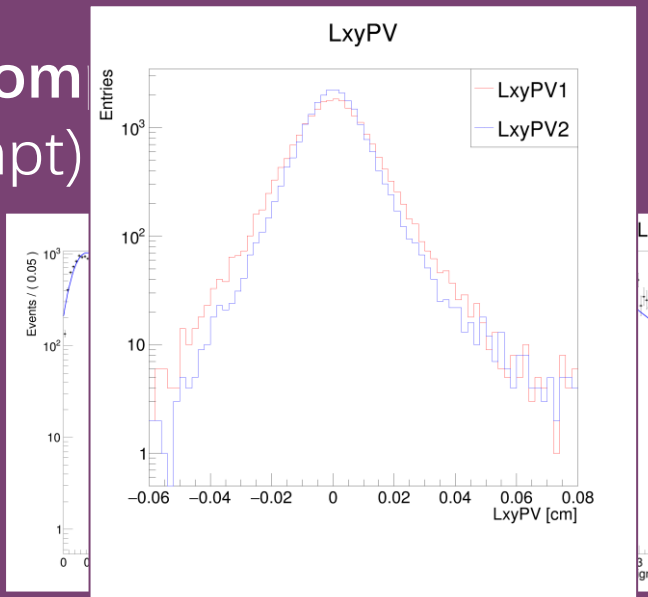


- True value: $^{p+p}/_{All} = {}^{1000}/_{(1000+2+2+200)} = 83\%$
- f acquired from 1D: $f = {}^{1002}/_{(1002+202)} = 83\%$
- $f^2 = 0.83^2 = 69\%$

Prompt + non-prompt components

——using the greater lifetime variable?

- **Advantage: we can keep the 3D fit and no additional com**
  will be added (P+NP, NP+P, NP+NP will all be non-prompt)
- **Issues need to be solved:**
  - We have reached an agreement on the Sig_{Lxy}, but there may be no significant rank between prompt and non-prompt J/ψ
    - We may need to change the distinguishment variable
  - Non-prompt lifetime variable (e.g. $L_{xy}PV$) is not certainly larger than the prompt one
    - May regard it as an error
    - 4D fit may help
  - The sorting may change the shape of the distribution
    - We need to redo all the 1D fit
    - We have no idea what will be the shape of the prompt + non-prompt components after the sorting
  - We can not validate this method

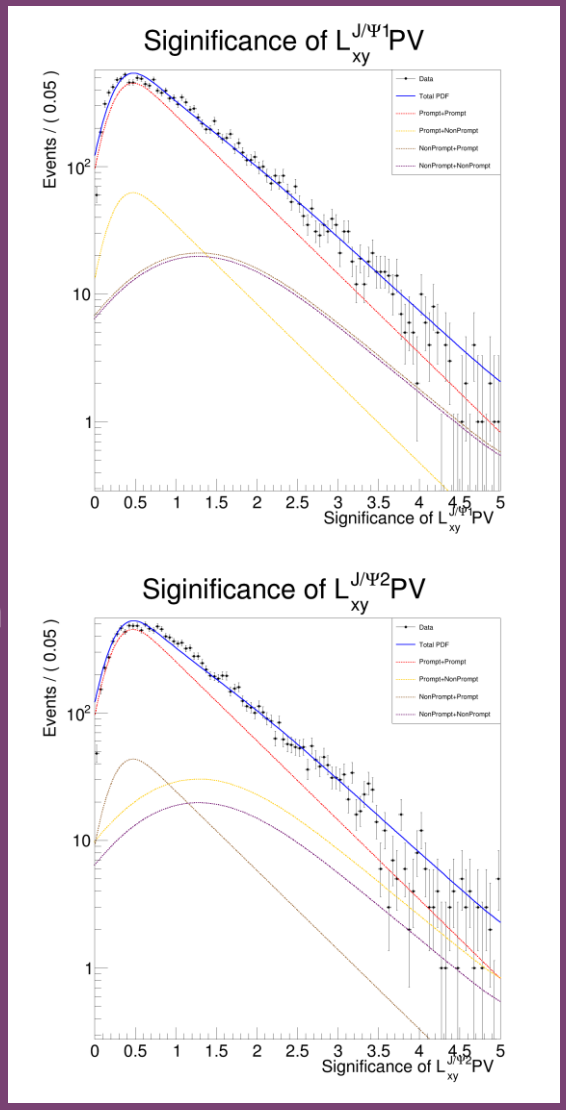


$L_{xy}PV$ distribution

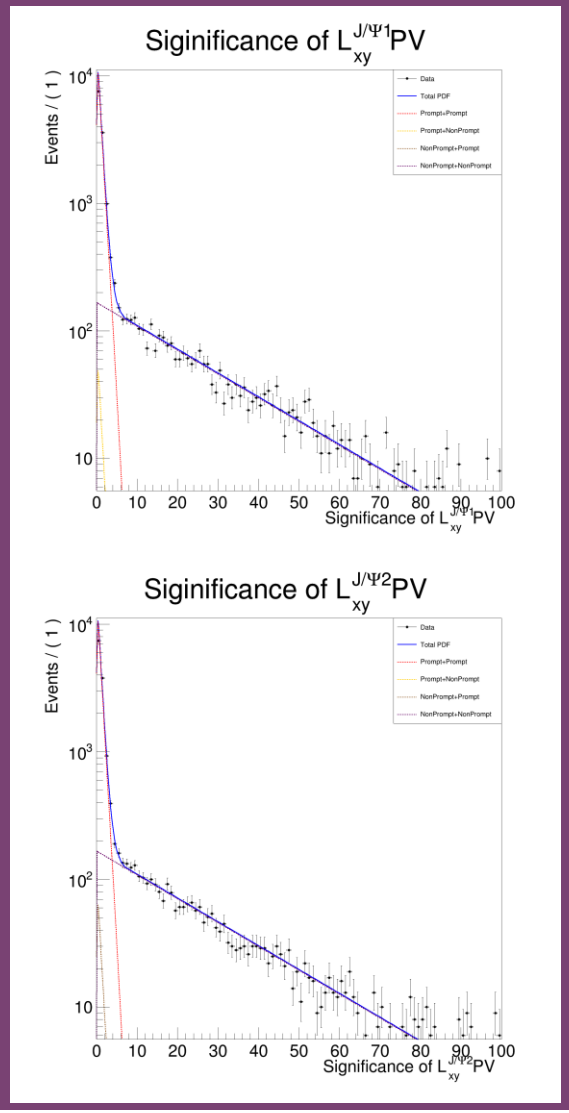
Prompt + non-prompt components

——4D fit?

- May be the only available method as for now
- Issue need to be considered:
  - The shape of the prompt and non-prompt is similar after the vertex cut, which may cause big uncertainty in the fitting
- We may need to take a step back and do the fit without the vertex cut



2D fit with the vertex cut

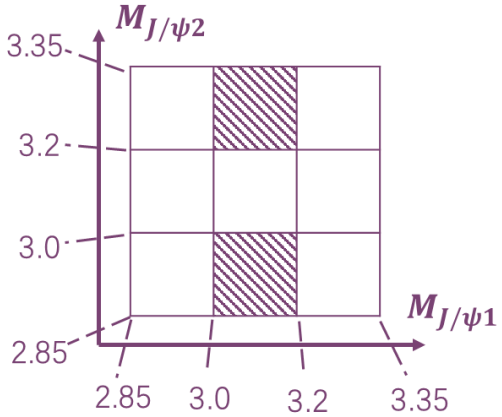


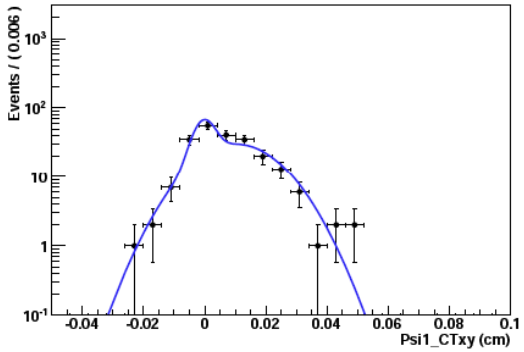
2D fit without the vertex cut

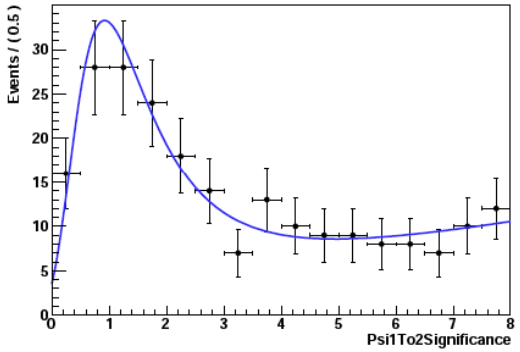
Distribution of the combinatorial background on the lifetime dimension(s)

- Using the sub-range dataset to determine the distribution

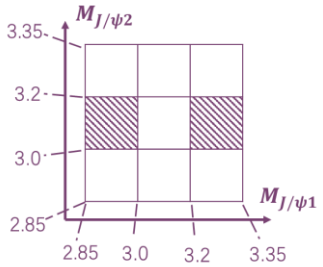
$J/\psi\mu^+\mu^-$:

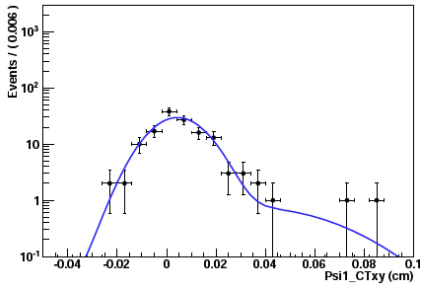


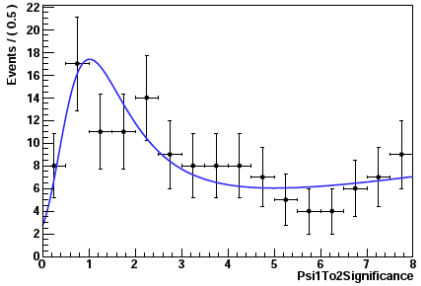




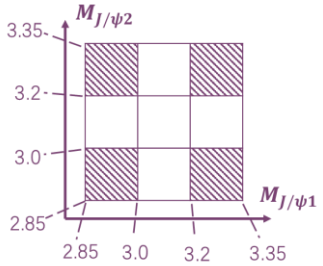
$\mu^+\mu^- J/\psi$:

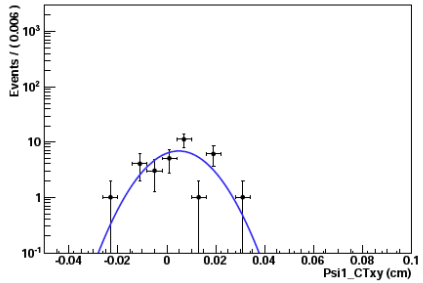


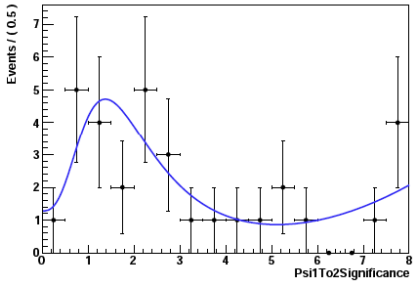




$\mu^+\mu^-\mu^+\mu^-$:



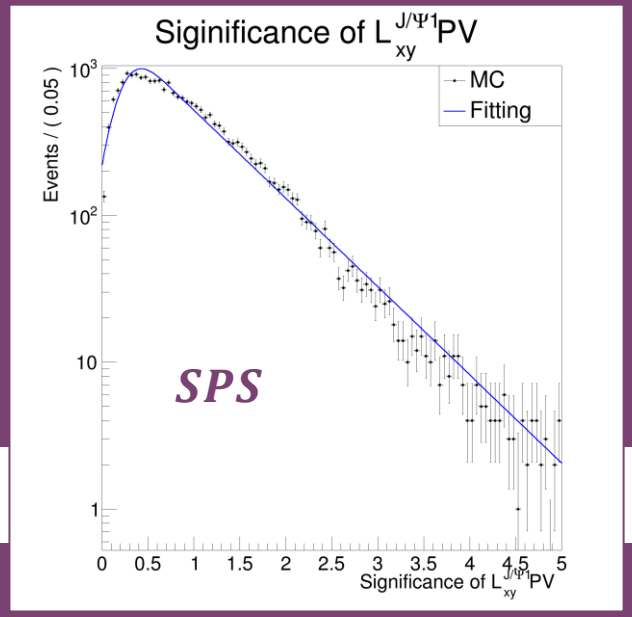


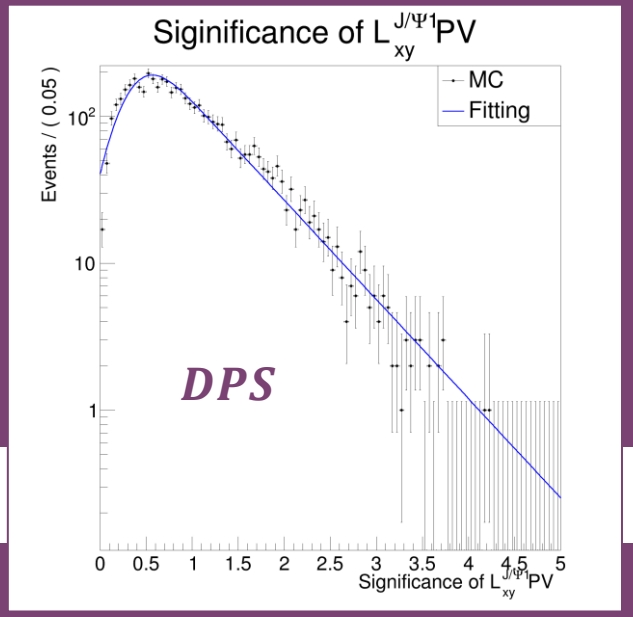


- Greatly decrease the components in the fitting

Float the prompt sample shape parameters

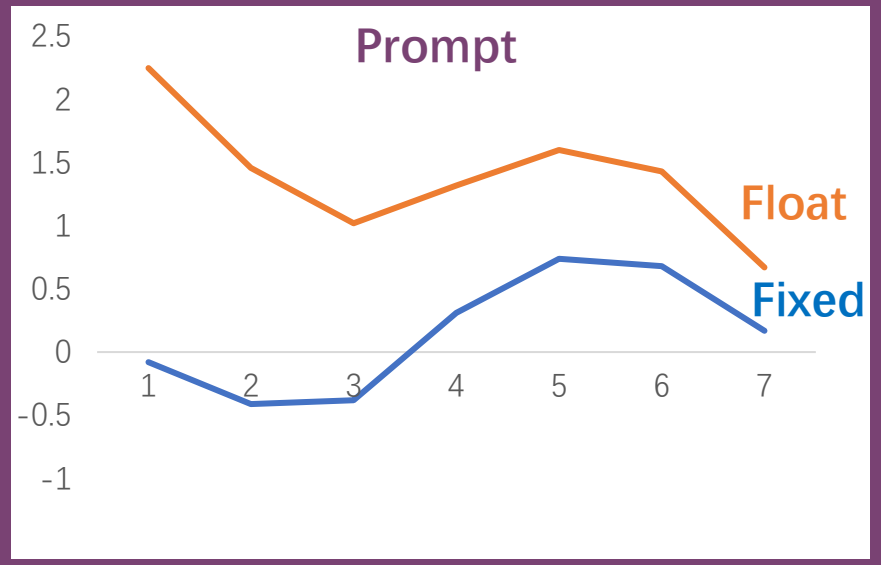
- **The parameters for the prompt component used to be fixed** (by a 8K SPS:4K DPS mixing sample) **in the final fitting**
- **Since slight discrepancies were noticed between SPS and DPS shape, we tried to float the shape parameters between SPS and DPS**
- **Only tried Sig_{Lxy}**
- **1D fit to SPS and DPS:**

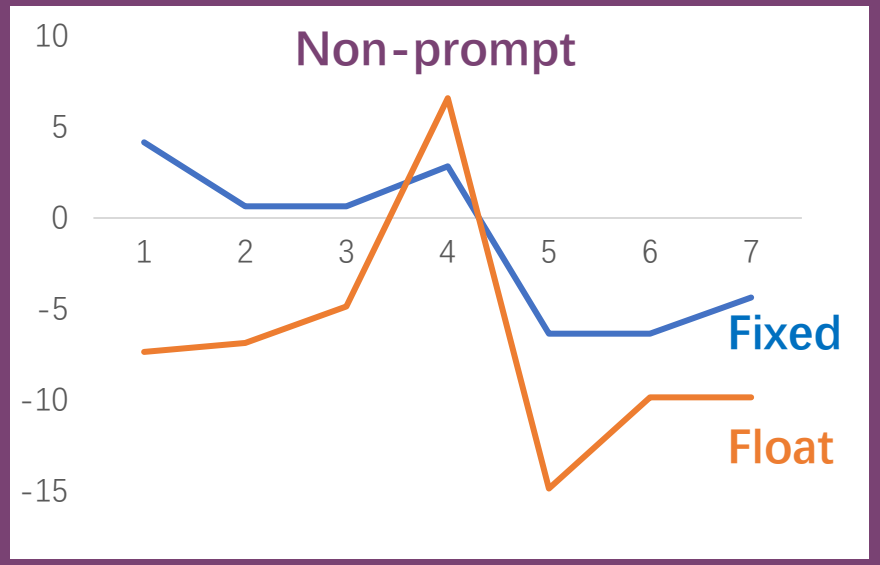




Float the prompt sample shape parameters

- Relative error [%]



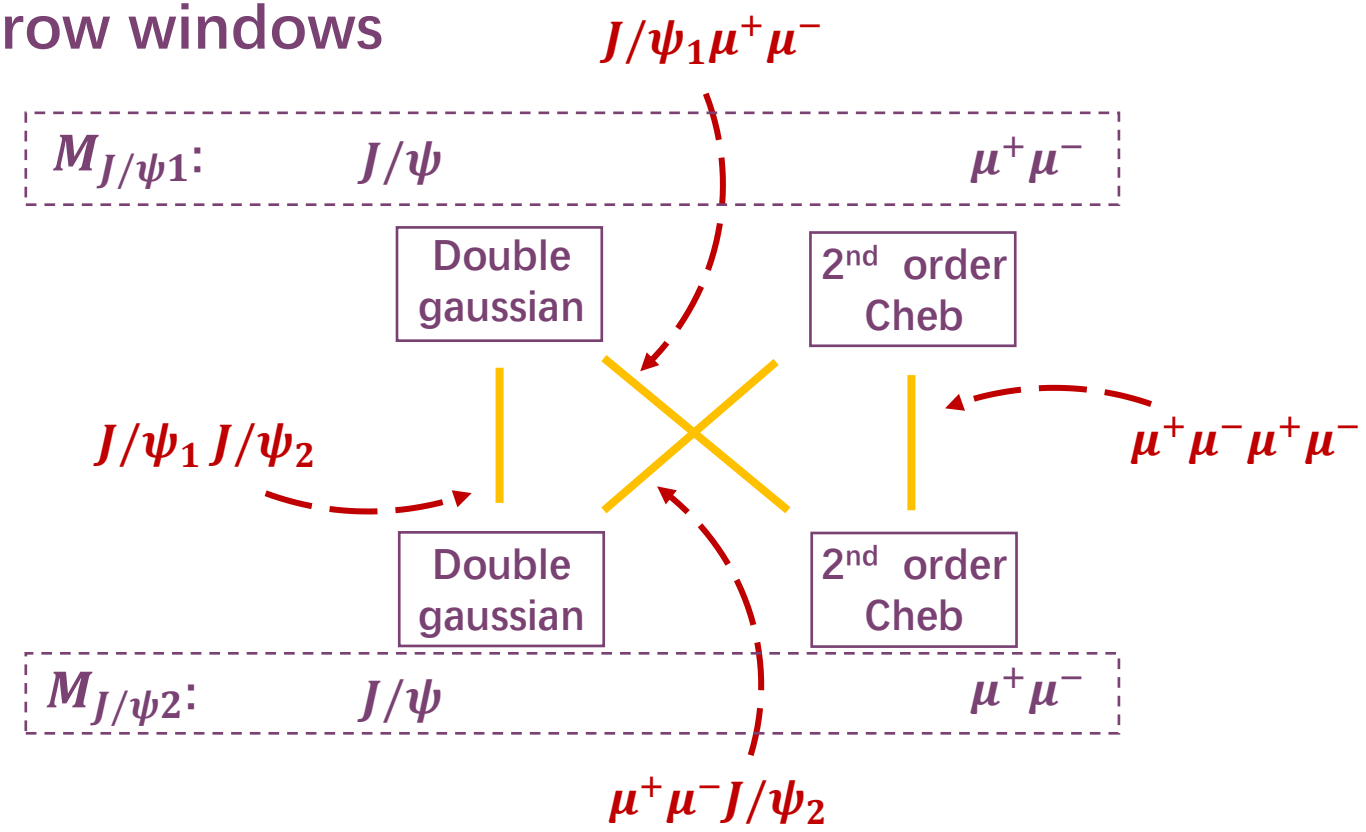


~	Prompt	Non-prompt
1	6K	2K
2	8K	2K
3	10K	2K
4	12K	2K
5	14K	2K
6	16K	2K
7	20K	2K

- Floating the parameters cause a much worse estimation
- A much larger uncertainty can also be noticed in some cases
- Propose to keep it fixed

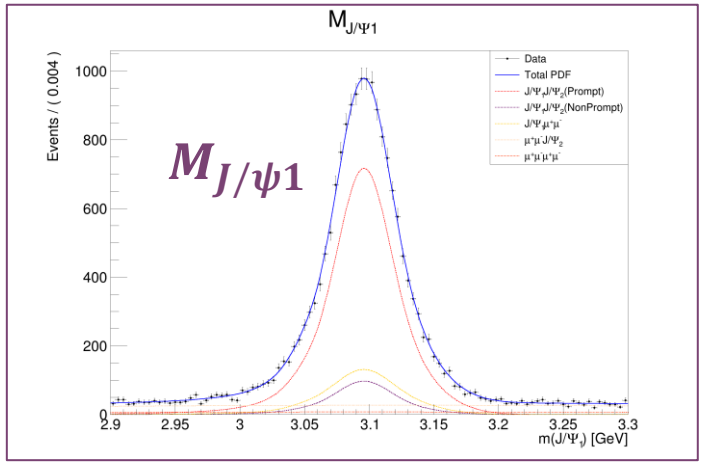
Fitting to the artificial sample

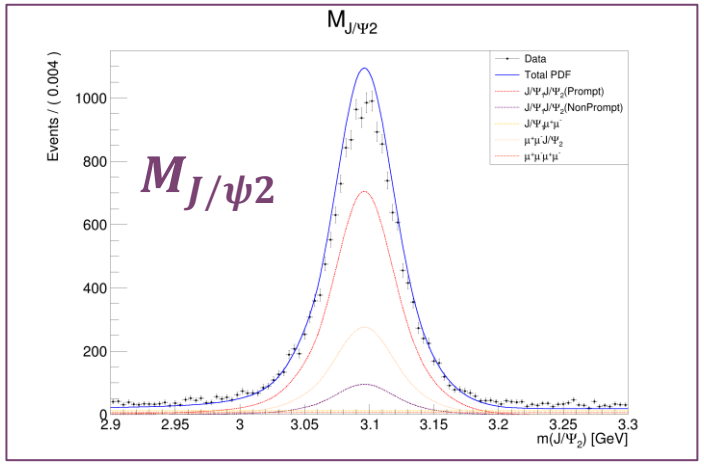
- The side band can be noticed in the “narrow” mass windows: directly fit in the narrow windows

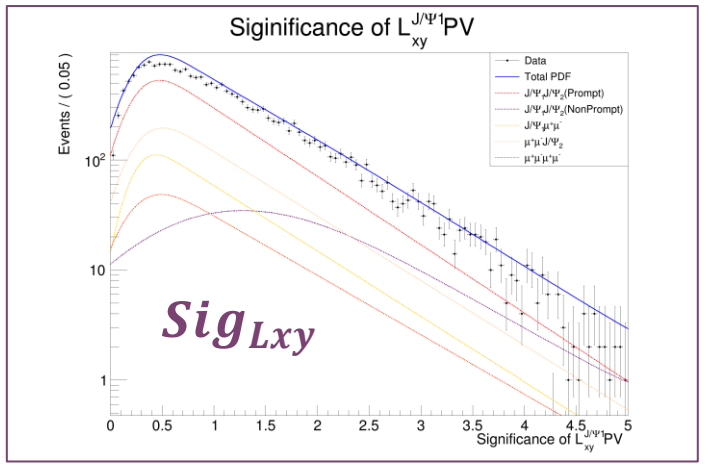


- The shape parameters of mass dimensions are left to float
- The distributions of lifetime dimensions of the combinatorial background are determined by the sub-range dataset

Fitting to the artificial sample







- Fitting quality is still not satisfying
- Estimation:
  - prompt: 12000 ± 200 (compare to 12K)
  - Non-prompt: 1630 ± 140 (compare to 2K)
- Prompt estimation is much better, but the non-prompt one is worse

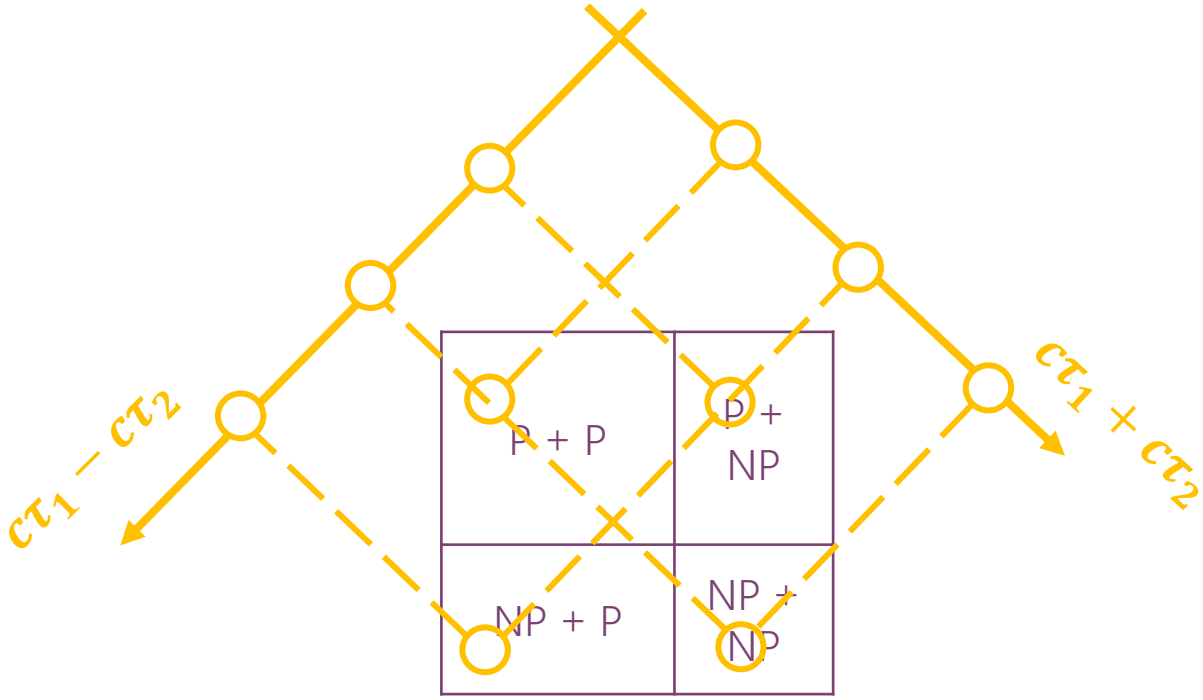
Summary

- Prompt + non-prompt component
  - Square of the 1D fraction is not suitable
  - Too many issues need to be solved if we want to use greater $c\tau$
  - 4D fit (without the vertex cut) may be available
- Lifetime shape of combinatorial background
  - Propose to determine from by the sub range datasets
- Test the distinguishment with the float prompt parameters
  - Result is worse than fixed parameters
- Continue to fit to the artificial sample
  - Result is better than the last week, but still unsatisfying

Back Up

Prompt + non-prompt components

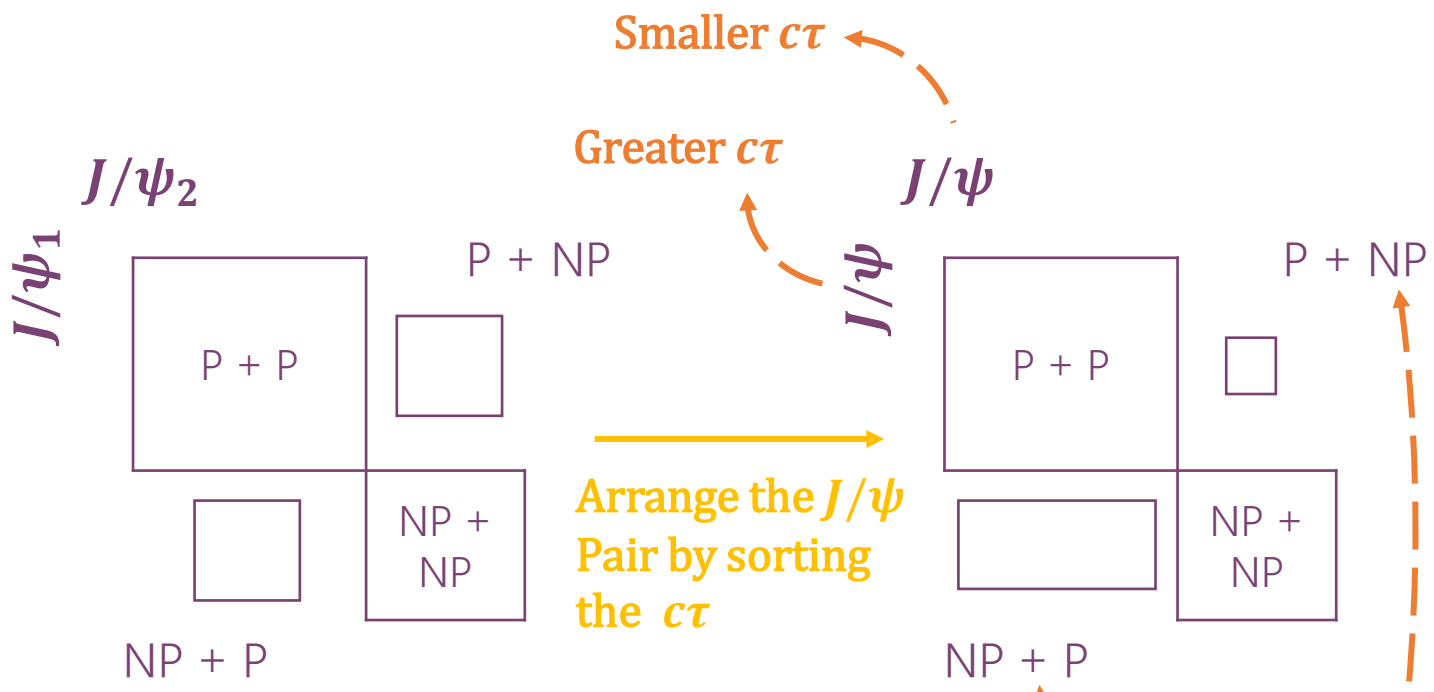
——An interesting proposal?



- By using the $c\tau_1 + c\tau_2$ (or $c\tau_1 + c\tau_2$) we can finish the distinguishment in 1D
- The most significant problem is that we have less idea about how the $c\tau_1 \pm c\tau_2$ distributes for the prompt non-prompt components

Prompt + non-prompt components

——4D fit using the greater(smaller) $c\tau$?



- With sorted $c\tau$, most of the prompt non-prompt combination candidates become non-prompt + prompt
- Although some candidates are still prompt + non-prompt. Thus we may need 4D fit to solve this issue

Compare between different distinguishment variables

- Average relative error [%] between samples

Wide mass windows

	w/ vertex cut						
	$L_{xy}PV$	$c\tau$	Sig_{Lxy}	$d^{J/\psi}$	$c\tau$ & $d^{J/\psi}$	Sig_{Lxy} & $d^{J/\psi}$	$L_{xy}PV$
Prompt	1.15	1.27	0.15	3.71	3.71	7.37	0.41
Non-prompt	6.82	6.54	2.07	19.6	19.6	42.6	4.85

	w/o vertex cut				
	$L_{xy}PV$	$c\tau$	Sig_{Lxy}	$d^{J/\psi}$	$c\tau$ & $d^{J/\psi}$
Prompt	1.04	0.13	0.35	0.60	0.42
Non-prompt	0.85	3.41	1.44	0.52	1.37

About the fitting parameters

- Thesis

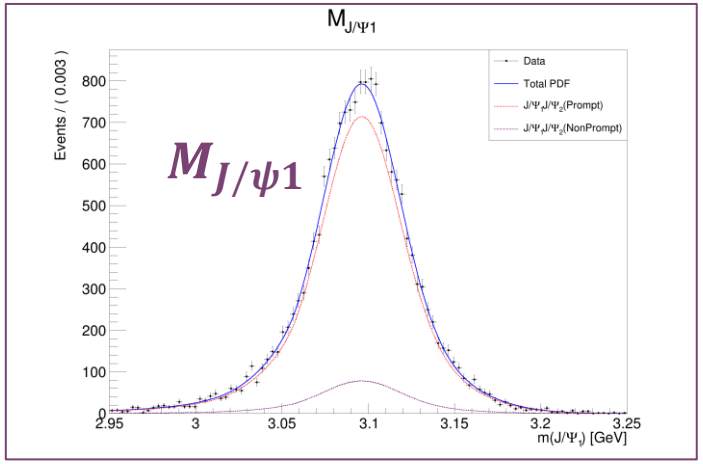
	JJ (prompt)	*JJ* (non-prompt)	Combi
$M_{J/\psi}$	Mean float Sigma fixed from MC		Fixed from side band
Lifetime	Fixed from MC	Float	Fixed from side band

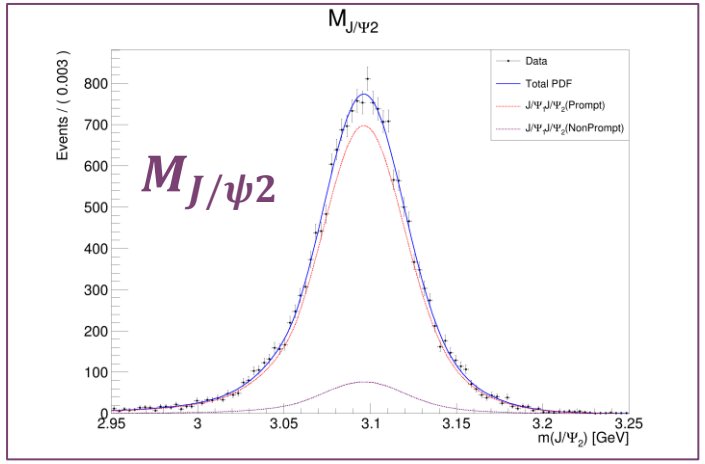
- Our current strategy

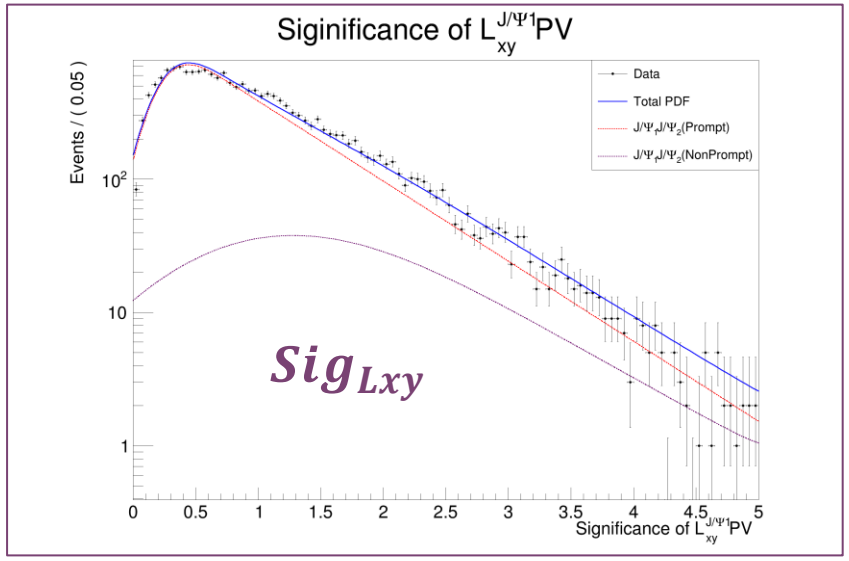
	JJ (prompt)	*JJ* (non-prompt)	Combi
$M_{J/\psi}$	Mean float Sigma float		Fixed from side band
Lifetime	Fixed from MC	Fixed from MC	Fixed from side band

- 1:
  - Will be float in the overall fitting, but fixed in the binned fitting
- 2:
  - May solve the uncertainty in the MC
  - May cover the prompt + non-prompt component
  - Our previous study was carried out with the fixed parameters
  - With the vertex cut, the shape of prompt and non-prompt components are similar, free the parameters may cause some issues

Representative fitting plot in the distinguishment test

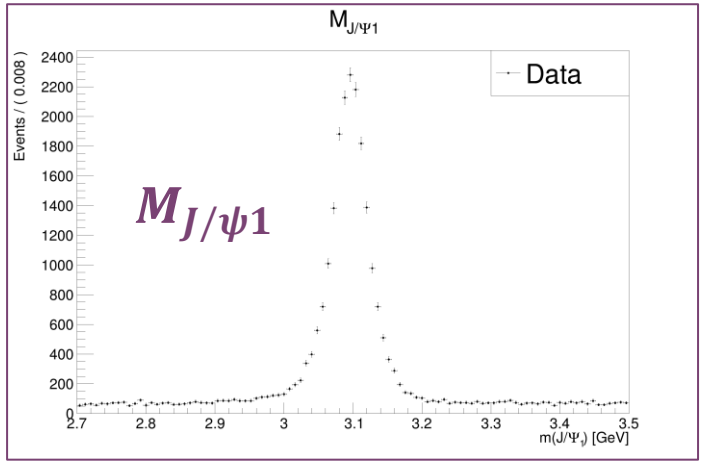


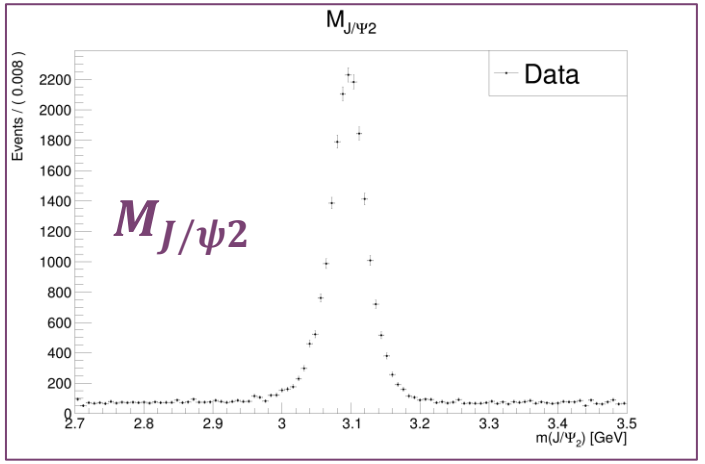


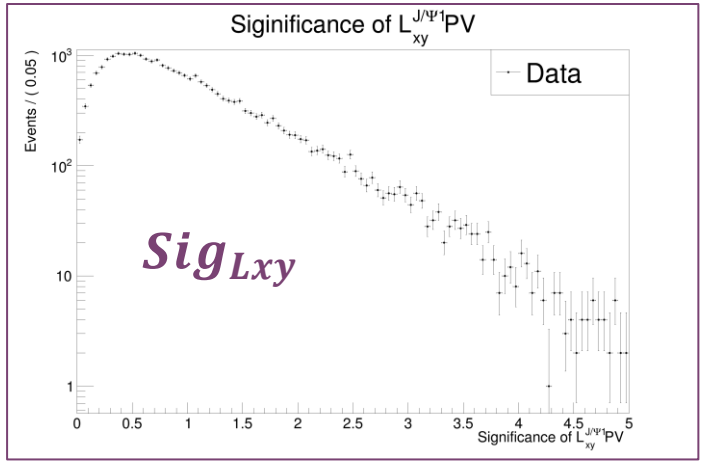


- Sample:
  - Prompt: 16000 (12KSPS+4KDPS)
  - Non-prompt: 2000
- Estimation:
  - prompt: 16200 ± 400
  - Non-prompt: 1800 ± 400

Artificial sample

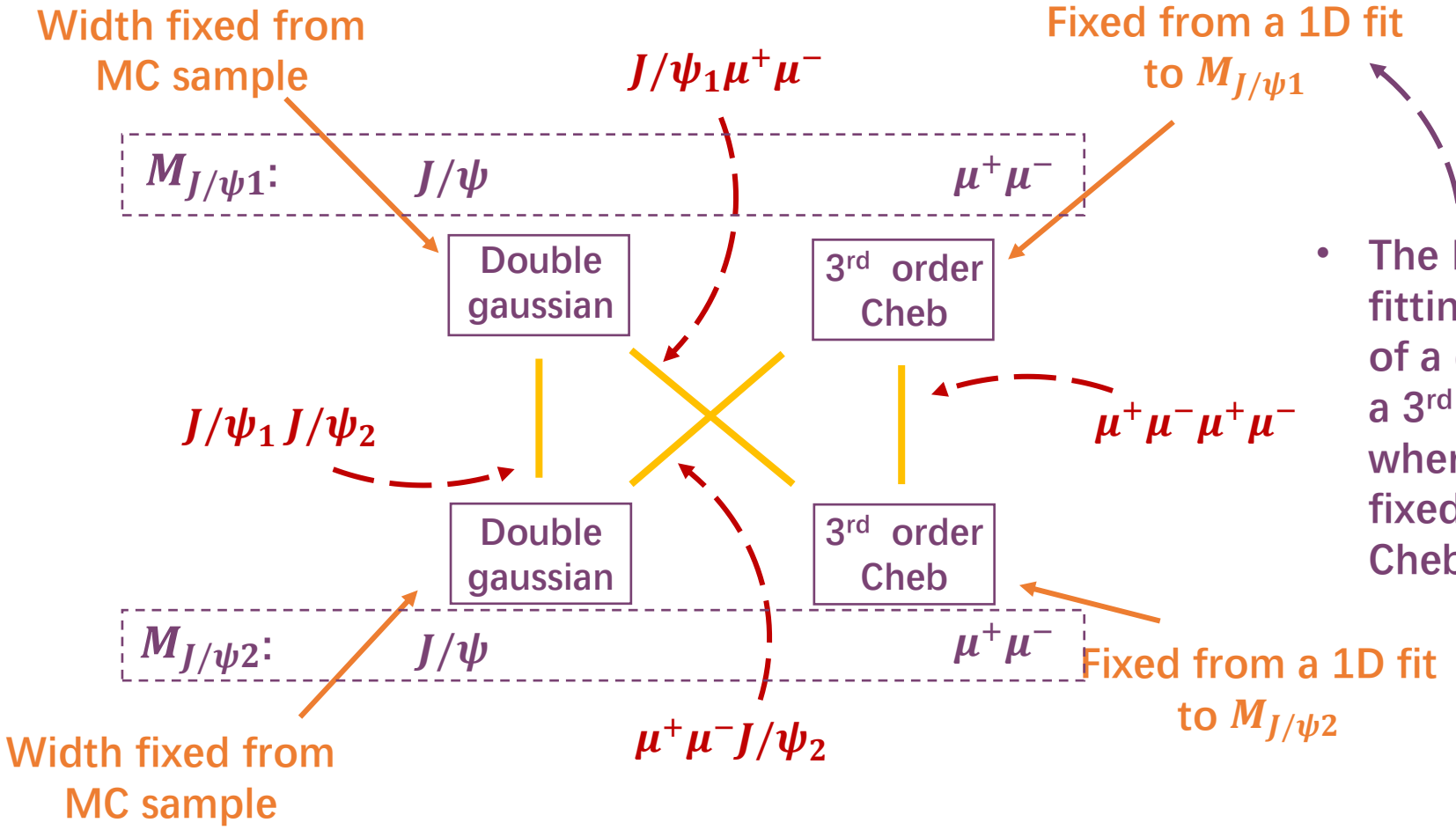






- 8K SPS+4K DPS+2K B decay (mixing of MC sample)
- 5K $J\mu\mu$+5K $\mu\mu J$+2K $\mu\mu\mu\mu$ (generated dataset)

Combinatorial background determination in the thesis



- The PDF used in this fitting is a combination of a double gaussian and a 3rd order Chebyshev, where the gaussian is fixed by the MC and the Chebyshev is float

- The distributions of lifetime dimensions of the combinatorial background are determined by the sub-range dataset