8th CLHCP, Nanjing, China

Inclusive J/ψ J/ψ cross section measurement

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Introduction

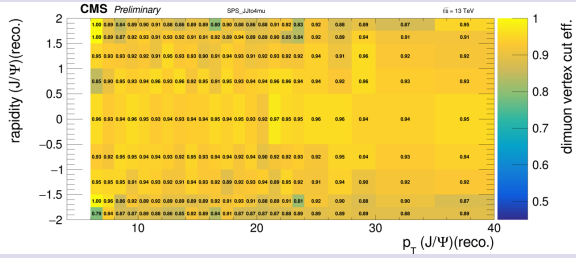
- Aim: measure inclusive cross section for prompt $J/\psi J/\psi$
- The cross section has been measured at several energy points by CMS:
  - *7 TeV data analysis: published (BPH-11-021)*
  - *8 TeV data analysis: thesis approved (BPH-17-001)*
  - *13 TeV 2016 data analysis: superseded (BPH-17-002)*
- Our analysis works on 13 TeV with full RunII data
  - *Inclusive J/ψJ/ψ cross section will be measured*
  - *Fraction of SPS and DPS will be measured*
- Channel: $pp \rightarrow anything \rightarrow J/\psi J/\psi \rightarrow \mu^+\mu^-\mu^+\mu^-$
- $\sigma(pp \rightarrow J/\psi J/\psi) = N_{event}/[L \times \varepsilon \times BR^2(J/\psi \rightarrow \mu^+\mu^-)]$
  - *N_event will be obtained from RunII data*
  - *L is integrated luminosity (~137 fb^{-1} for RunII for 13 TeV)*
  - *ε = acceptance × ε_{RECO} × $SF_{\mu ID}$ × SF_{HLT}*
  - *$BR(J/\psi \rightarrow \mu^+\mu^-)$* is obtained from PDG

Acceptance/Efficiency

Map

- Acceptance/efficiency maps have been calculated by MC samples, e.g.

Efficiency of $\mu^+\mu^-$ vertex cut: SPS 2018 (first J/ψ)



Closure Test

- A closure test has been carried out and the model independence has been demonstrated:

Closure test for acceptance:

	Weighted by:	SPS	DPS	Mix weight
SPS	cut	N_{obs}	N_{corr}(SPS)	N_{corr}(DPS)	N_{corr}(Mix)
	$\lvert\eta(\mu)\rvert < 2.4$	576430.0	$575826.91^{+1994.34}_{-1988.52}$	$573975.22^{+3647.59}_{-3621.85}$	$575456.22^{+2324.93}_{-2316.39}$
	$p_T(\mu) > 3.5$	69385.0	$69166.62^{+2706.06}_{-2638.36}$	$68216.61^{+9807.88}_{-8976.23}$	$68977.75^{+4097.79}_{-3946.88}$

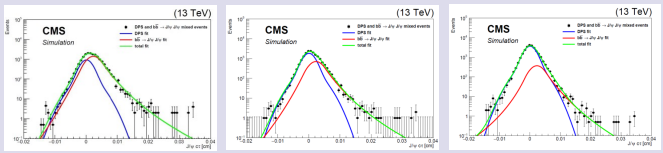
DPS	cut	N_{obs}	N_{corr}(SPS)	N_{corr}(DPS)	N_{corr}(Mix)
	$\lvert\eta(\mu)\rvert < 2.4$	52362.0	$52703.87^{+184.76}_{-184.43}$	$52316.16^{+175.57}_{-175.29}$	$52626.22^{+182.91}_{-182.6}$
	$p_T(\mu) > 3.5$	211.0	$185.61^{+9.22}_{-8.95}$	$178.9^{+16.15}_{-15.31}$	$184.26^{+10.61}_{-10.25}$

Distinguishment

- The non-prompt (b decay) components may not get completely excluded by the $\mu^+\mu^-\mu^+\mu^-$ vertex cut only
  - *Some variables related to the vertex position or distance may help to differentiate the two components*
- Four variables are extracted for this purpose:
  - $L_{xy}PV$, $c\tau$, $Sig_{L_{xy}}$, $d^{J/\psi}$
  - *The variables can be added as the third dimension (besides $M_{J/\psi 1}$ and $M_{J/\psi 2}$) of the fitting, and the best one out of four will be selected as the main distinguishment variable*
- The method was tested by some artificial mixing MC samples
  - *Two cases (with/without $\mu^+\mu^-\mu^+\mu^-$ vertex cut) were tested*

Closure Test

- We fix some parameters to fit the mixed histograms
  - *Prompt sample: mean and width*
  - *Non-prompt sample: mean, width and alpha*



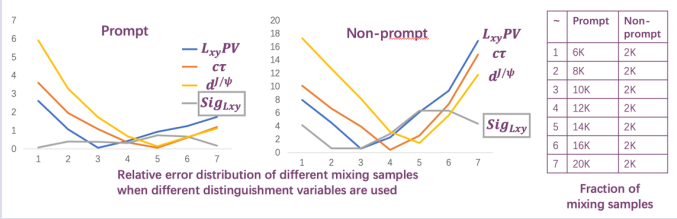
	DPS input fraction	DPS fitted fraction	DPS input number	DPS fitted number
DPS + $b\bar{b}$-> J/ψ J/ψ	0.668	0.67 ± 0.01	11970	12000.9 ±178.4
0.5*DPS + 2*$b\bar{b}$-> J/ψ J/ψ	0.334	0.34 ± 0.01	5985	6073.5±197.5
2*DPS + 0.5*$b\bar{b}$-> J/ψ J/ψ	0.889	0.88 ± 0.03	23940	23812±792

- The fitted prompt (DPS) fraction and number of events are consistent with input values

Select Variable

- Relative error [%]

with $\mu^+\mu^-\mu^+\mu^-$ vertex cut



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

- $Sig_{L_{xy}}$ will be selected as the main distinguishment variable

Future Plan

- Data Ntuples are in production.
- 3D fitting code with combinatorial background component.
- AN is in preparation.