VERY PRELIMINARY

Psi2S in PbPb 2015 + 2018

- Standard fit and event mixing approach

- First signal extraction vs centrality and vs pT
  - 4 bins in centrality (0-20, 20-40, 40-60, 60-90%)
  - 5 bins in pT (0-2, 2-4, 4-6, 6-8, 8-12 GeV/c)

- First look into
  - Single Psi2S/Psi ratio
  - Double ratio
  - RAA

  as a function of centrality

Data sample

Physics Selection

DIMUON:

- -4<y_dimu<-2.5
- pT dimu<12 GeV/c

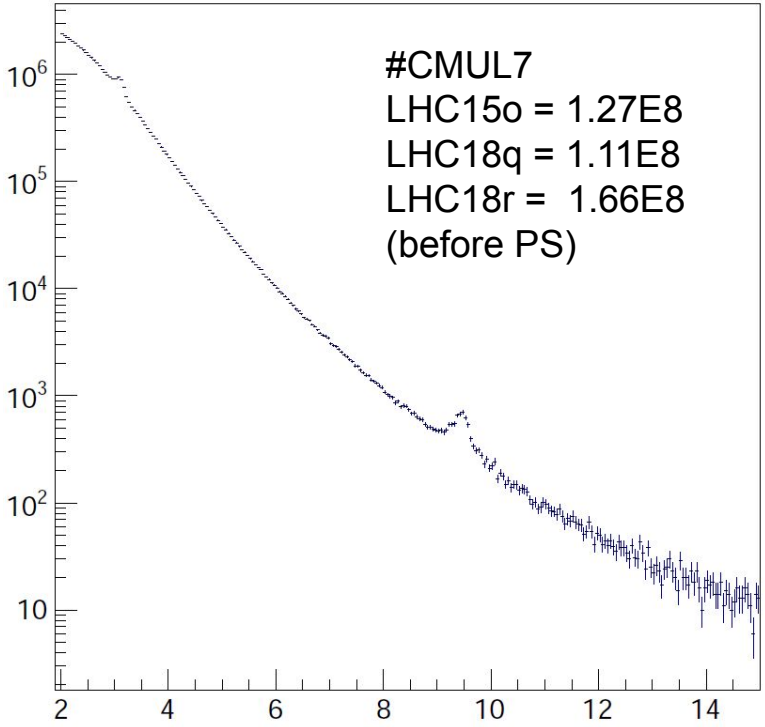
MUON:

- matching
- -4<eta_mu<-2.5
- PDCA
- 17.6<RAbs<89.5

Trigger:

- for direct fit: CMUL7
- for mixed events: CMLL7 || CMUL7 + downscaling factor for CMLL in LHC18q and LHC18r

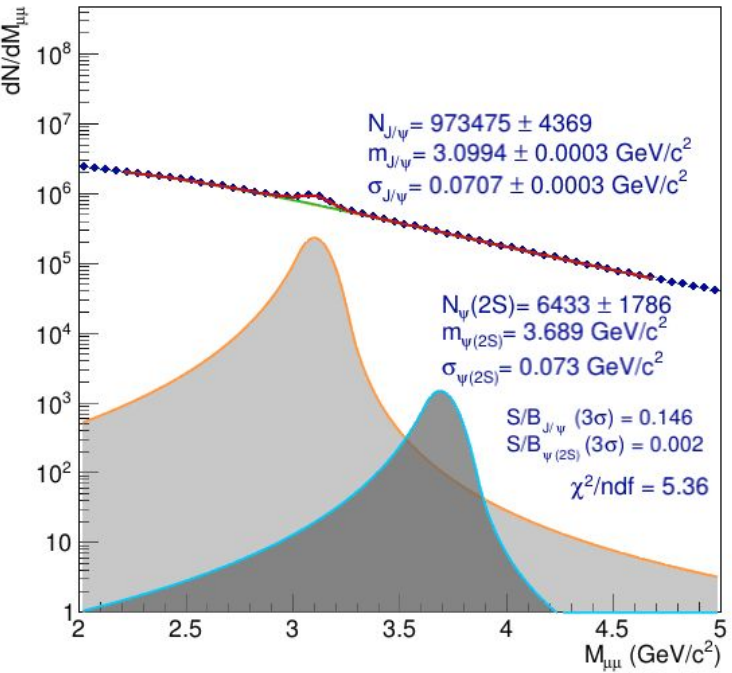
LHC15o + LHC18q + LHC18r



Integrated spectrum, 0-90%

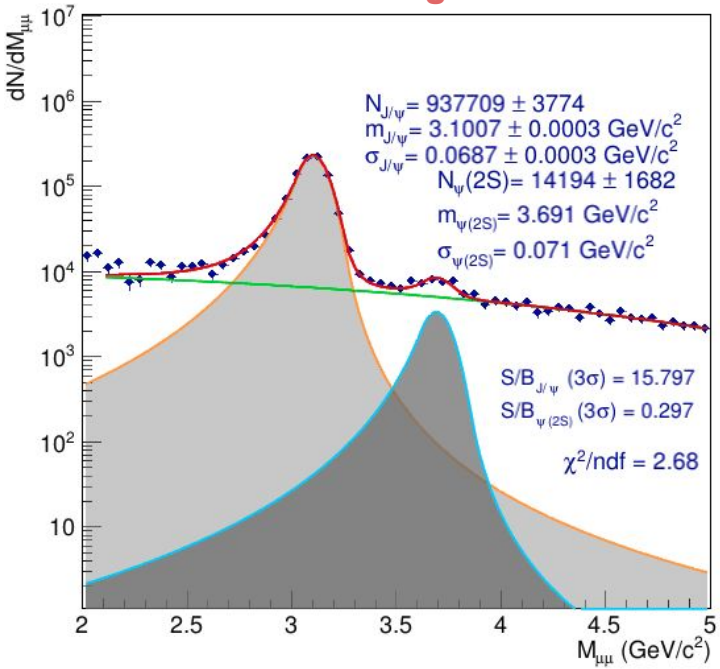
- Functions: double CB + VWG
- Psi2S Sigma fixed to JPsi/Psi2S ratio in MC
- Psi2S mass fixed to difference in PDG
- JPsi and Psi2S tails identical and fixed to MC

Standard fit



Significance J/Psi = 334
Significance Psi2S = 3.6

Event mixing fit



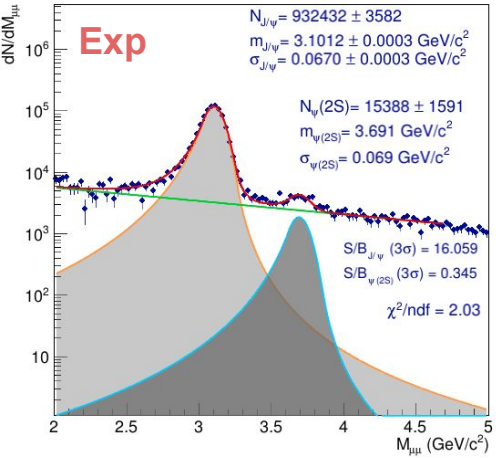
Significance J/Psi = 886
Significance Psi2S = 53

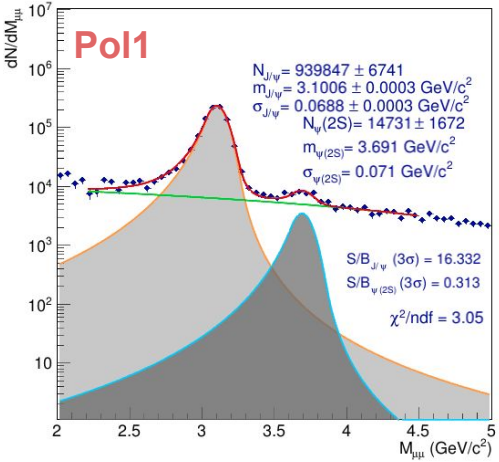
- compatible number of JPsi in the two approaches
- in ev mixing fit: clearly visible Psi2S peak and significant improvement in Psi2S significance

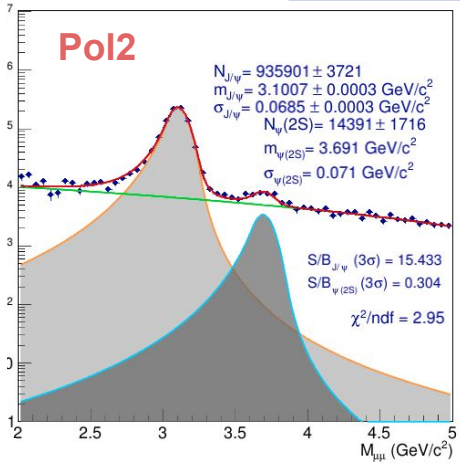
use only ev mixing fit

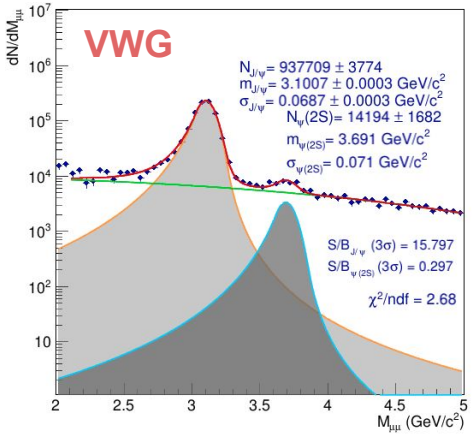
Event mixing: 0-90% - test different backgrounds

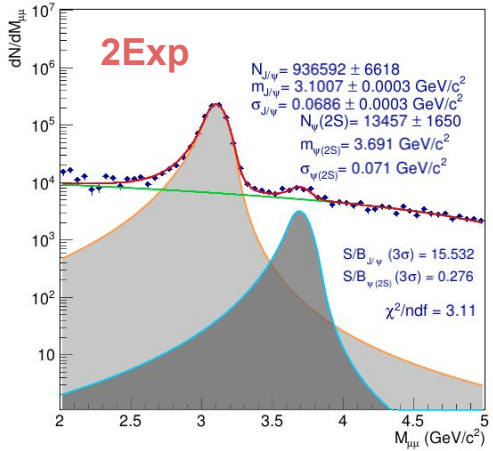
- Functions: double CB + background
- Psi2S Sigma fixed to JPsi/Psi2S ratio in MC
- Psi2S mass fixed to difference in PDG
- JPsi and Psi2S tails identical and fixed to MC







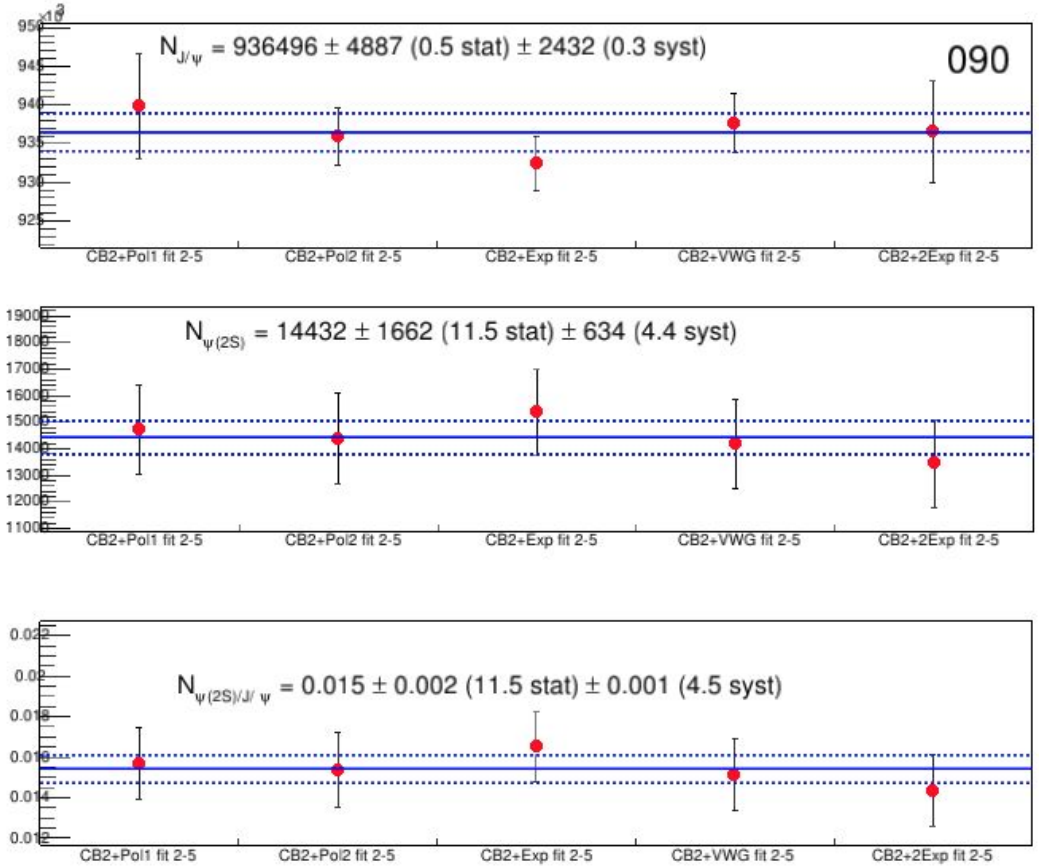




Rather good quality of the fits with all background shapes

JPsi signal almost insensitive to details of background shape

Signal extraction in 0-90%



So far, only background shapes have been changed

Number of JPsi from ChunLu AN:

0-20% = 591968 +- 4294 (stat)
20-40% = 233434 +- 1972 (stat)
40-90% = 100074 +- 734 (stat)
corresponding to 4.04e8 CMUL7 before PS

Total ~ 925476 (based on more tests)

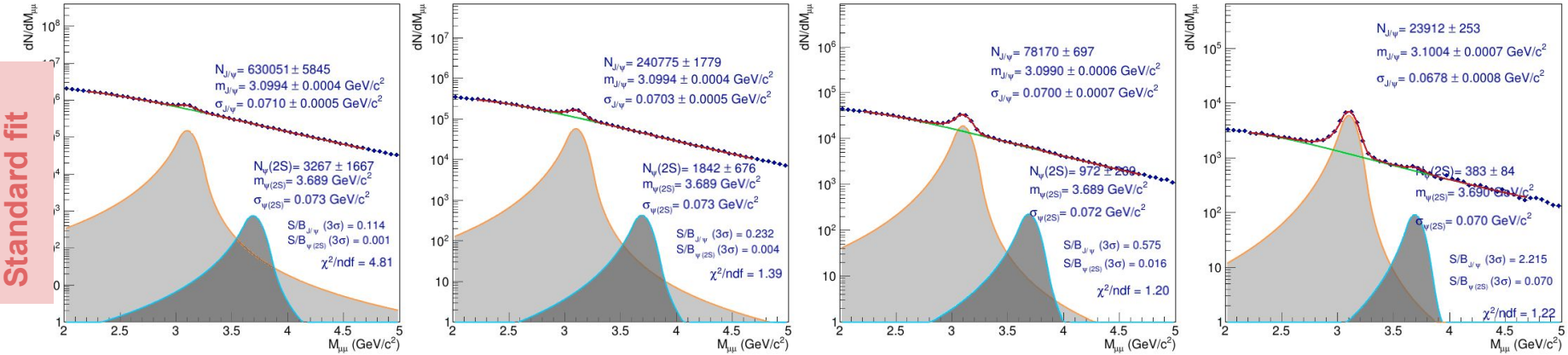
1% difference in the number of JPsi between me and ChunLu

Signal extraction vs centrality

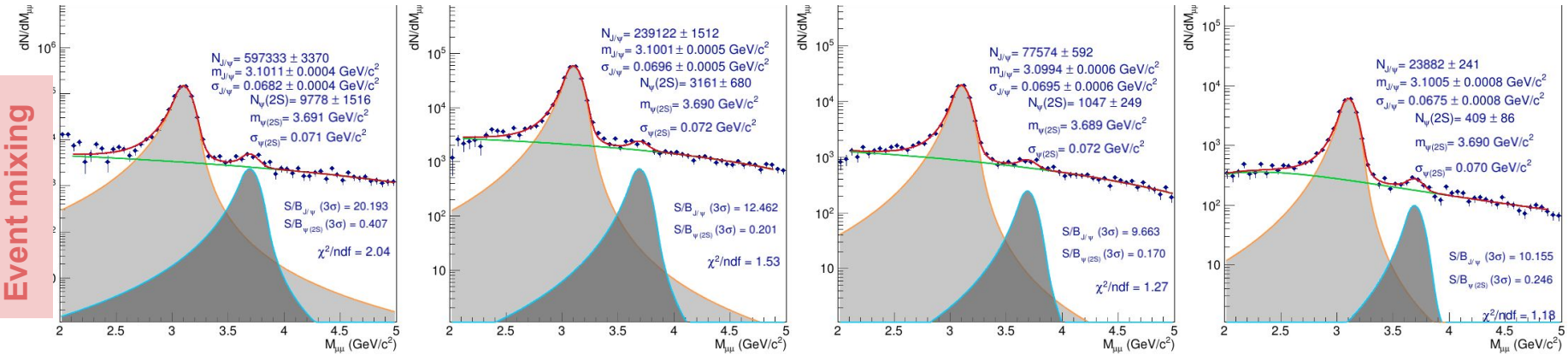
- Functions: double CB + VWG
- Psi2S Sigma fixed to JPsi/Psi2S ratio in MC
- Psi2S mass fixed to difference in PDG
- JPsi and Psi2S tails identical and fixed to MC

0-20% | **20-40%** | **40-60%** | **60-90%**

Standard fit



Event mixing

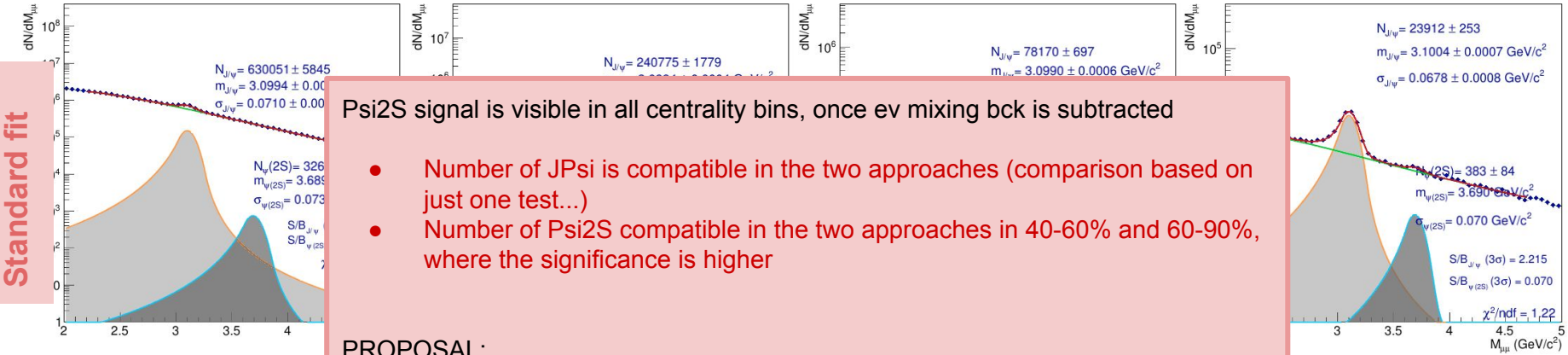


Signal extraction vs centrality

- Functions: double CB + VWG
- Psi2S Sigma fixed to JPsi/Psi2S ratio in MC
- Psi2S mass fixed to difference in PDG
- JPsi and Psi2S tails identical and fixed to MC

0-20% | 20-40% | 40-60% | 60-90%

Standard fit

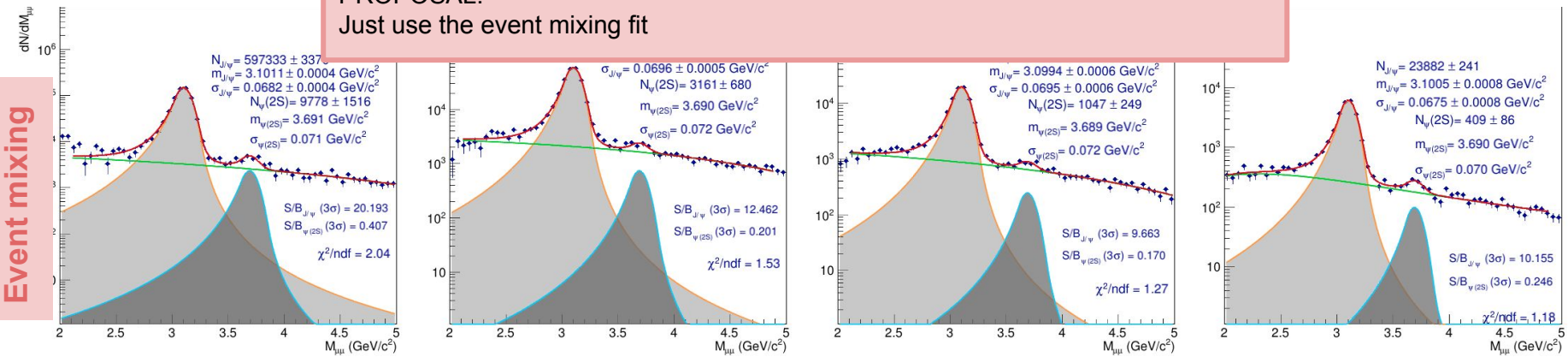


Psi2S signal is visible in all centrality bins, once ev mixing bck is subtracted

- Number of JPsi is compatible in the two approaches (comparison based on just one test...)
- Number of Psi2S compatible in the two approaches in 40-60% and 60-90%, where the significance is higher

PROPOSAL:
Just use the event mixing fit

Event mixing

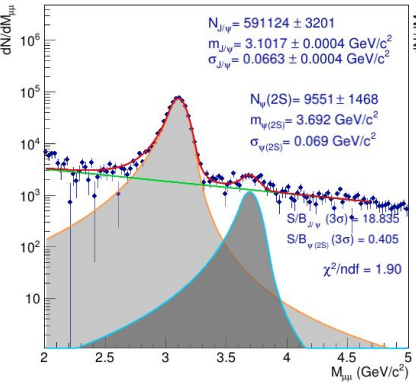


Event mixing: 0-20%

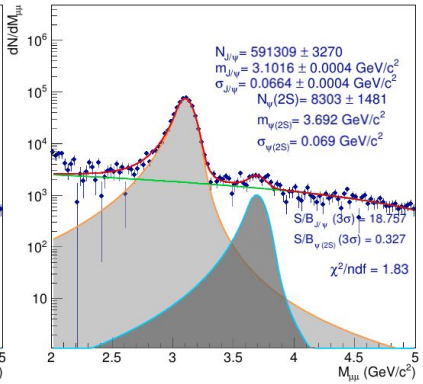
- Functions: double CB + background
- Psi2S Sigma fixed to JPsi/Psi2S ratio in MC
- Psi2S mass fixed to difference in PDG
- JPsi and Psi2S tails identical and fixed to MC

Signal extracted with 5 different background shapes

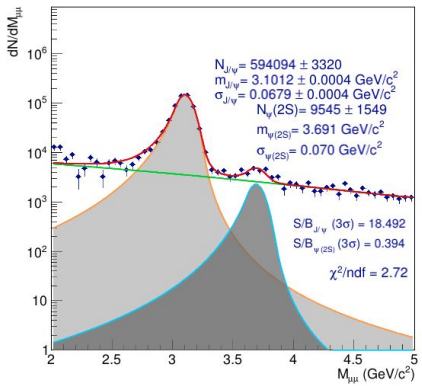
Exp



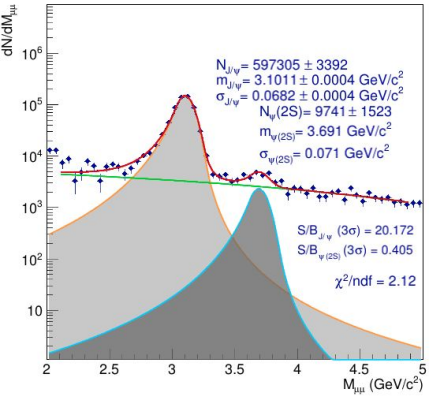
Pol1



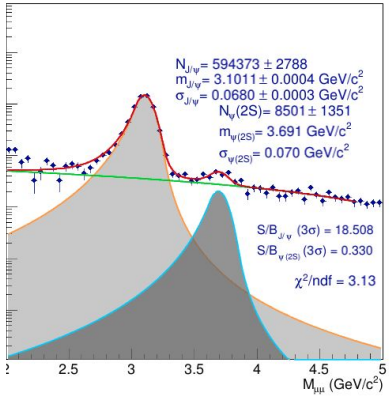
Pol2

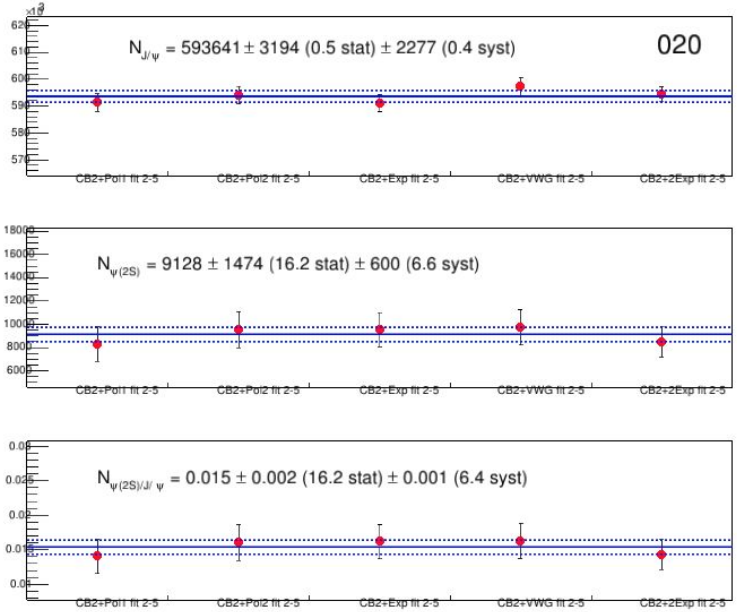


VWG



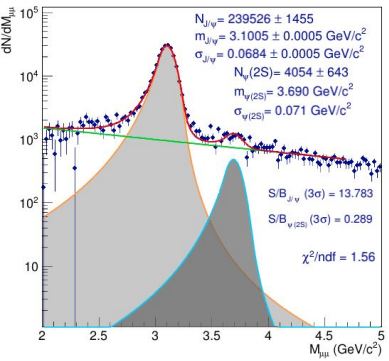
2Exp



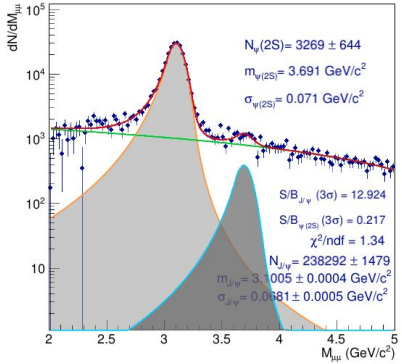


Event mixing: 20-40%

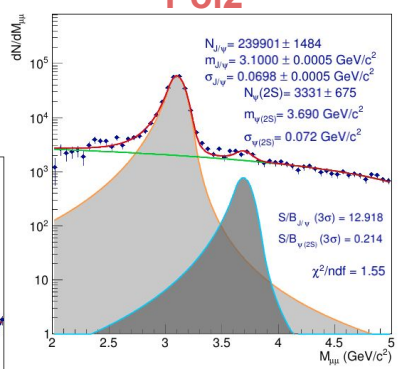
Exp



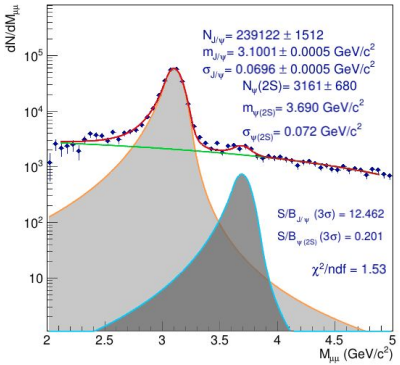
Pol1



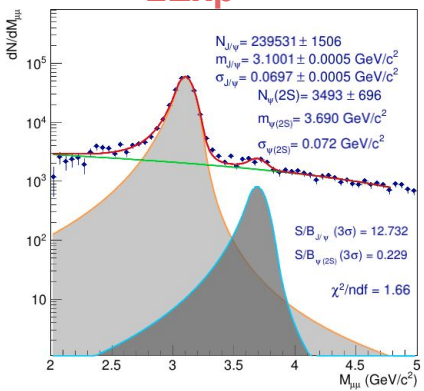
Pol2

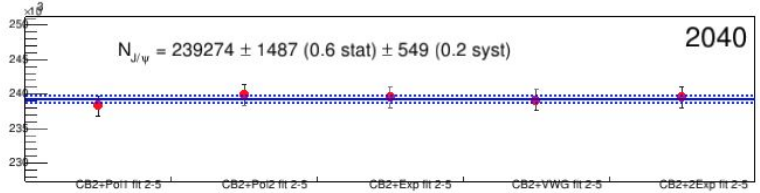


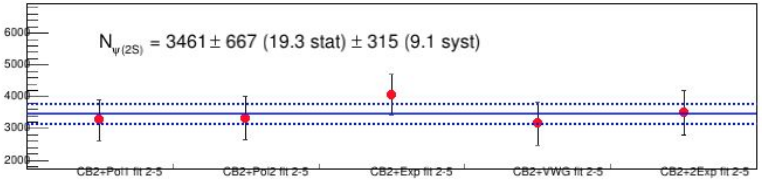
VWG

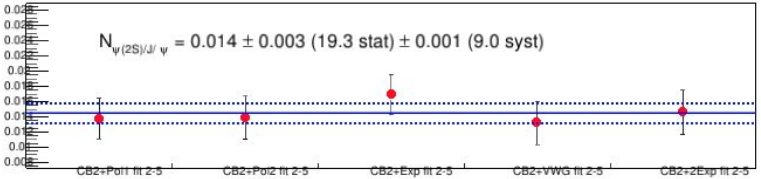


2Exp



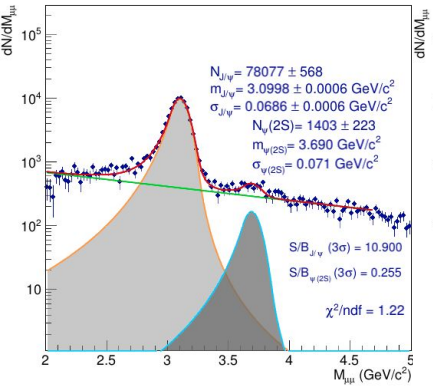




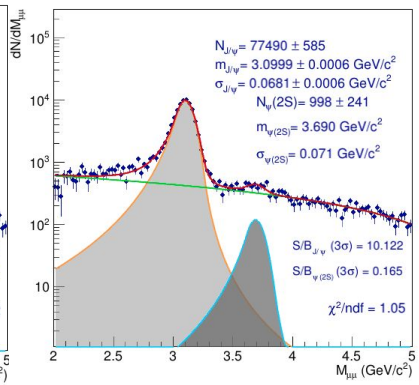


Event mixing: 40-60%

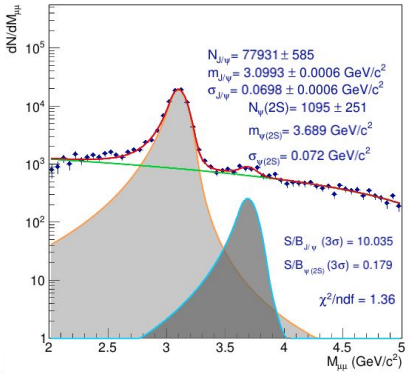
Exp



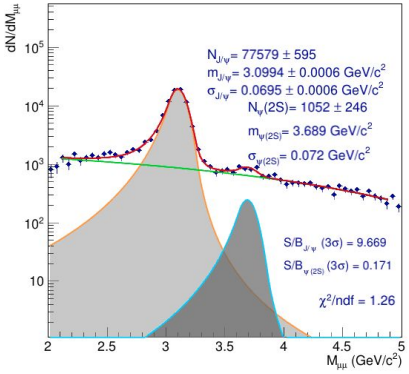
Pol1



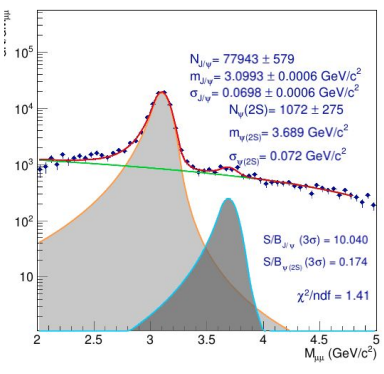
Pol2

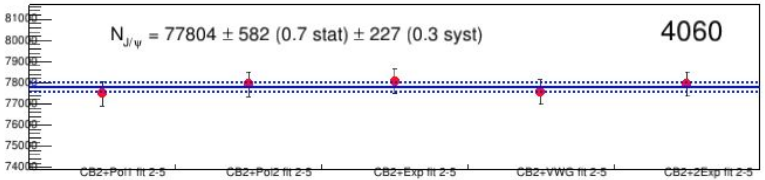


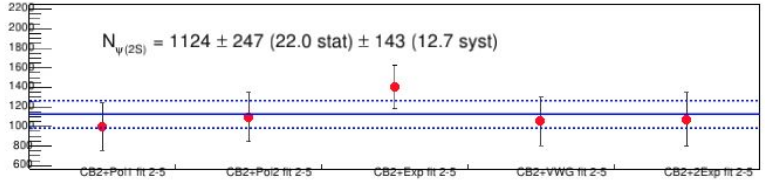
VWG

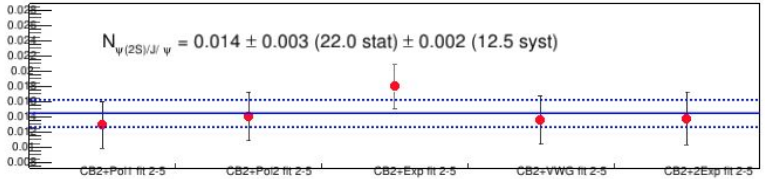


2Exp



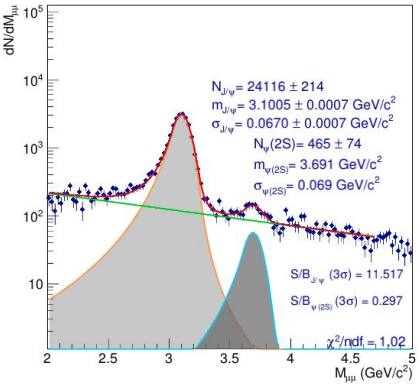




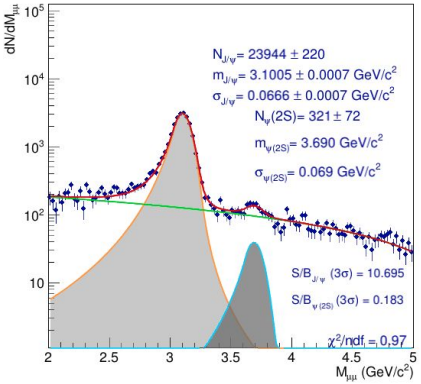


Event mixing: 60-90%

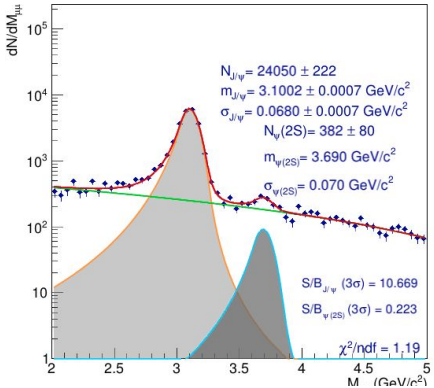
Exp



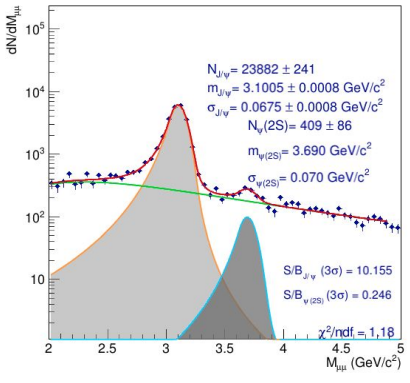
Pol1



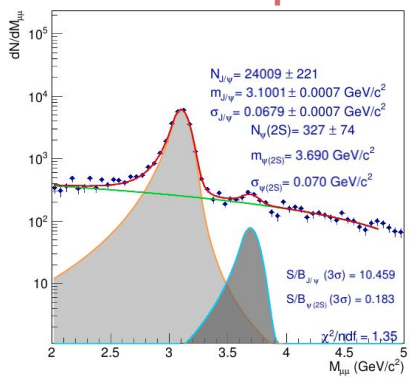
Pol2

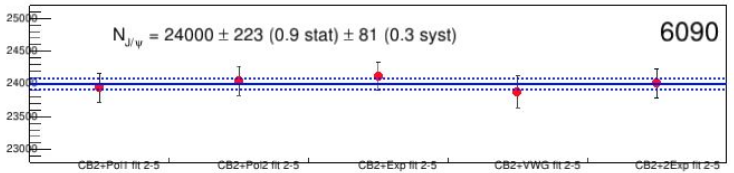


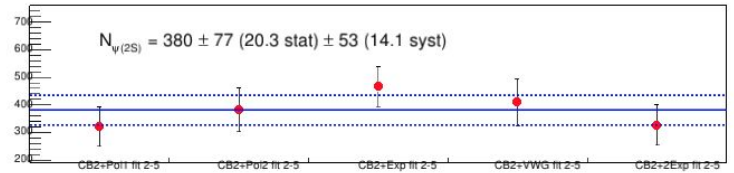
VWG

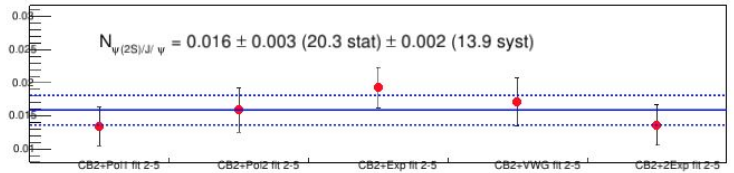


2Exp









Checks on signal extraction vs centrality

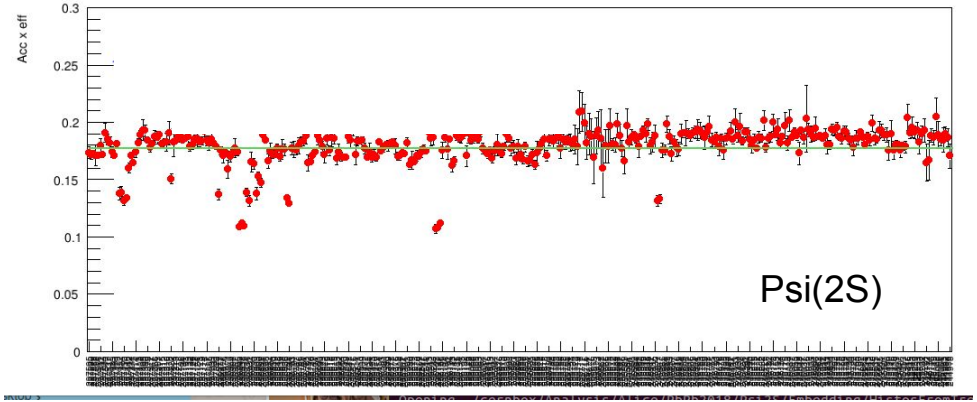
	JPsi (*)	Psi2S (*)
0-20%	593641 +/- 3194 (0.5% stat) +/- 2277 (0.4% syst)	9128 +/- 1474 (16% stat) +/- 600 (7% syst)
20-40%	239274 +/- 1487 (0.6% stat) +/- 549 (0.2% syst)	3461 +/- 667 (19% stat) +/- 315 (9% syst)
40-60%	77804 +/- 582 (0.7% stat) +/- 227 (0.3% syst)	1124 +/- 247 (22% stat) +/- 143 (13% syst)
60-90%	24000 +/- 223 (1% stat) +/- 81 (0.3% syst)	380 +/- 77 (20% stat) +/- 53 (14% syst)
sum centr. bins	934719	14093
0-90%	936496 +/- 4887 (0.5% stat) +/- 2432 (0.3% syst)	14432 +/- 1662 (11% stat) +/- 634 (4% syst)

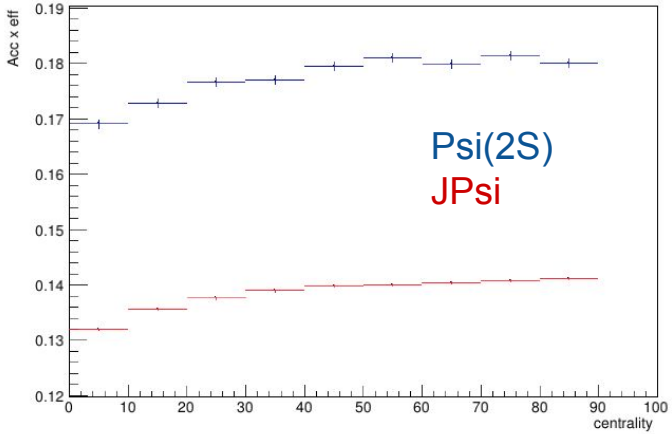
The sum of the JPsi (Psi2S) values in centrality bins is consistent within ~0.2% (2.5%) wrt the values obtained directly in 0-90%

(*) syst. unc. only based on bck shapes

Acceptance x efficiency

Obtained from PbPb embedding MC (LHC16e2, LHC16e2_plus, LHC19a2)





embedding is done in CINT7 events
→ two weights are needed, to account for:

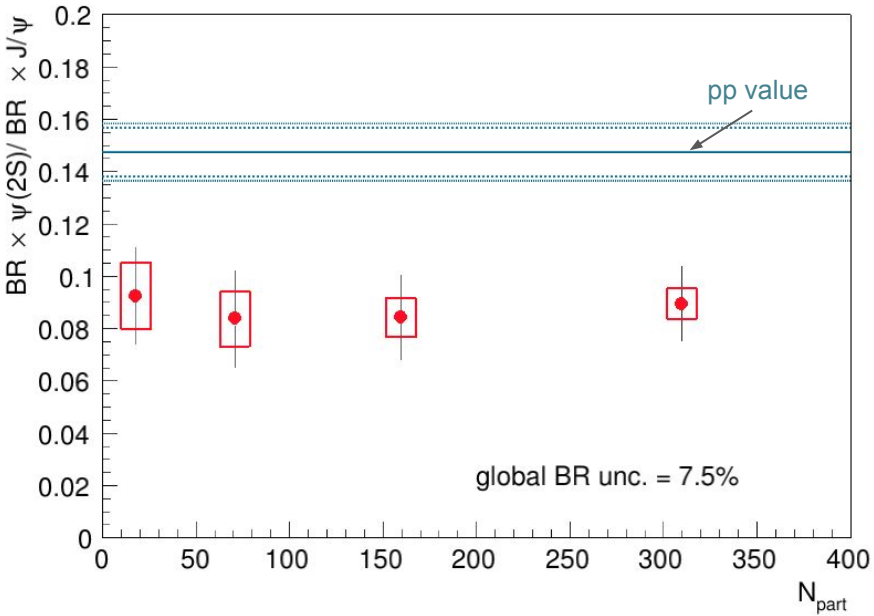
1) number of CMUL7 in each run

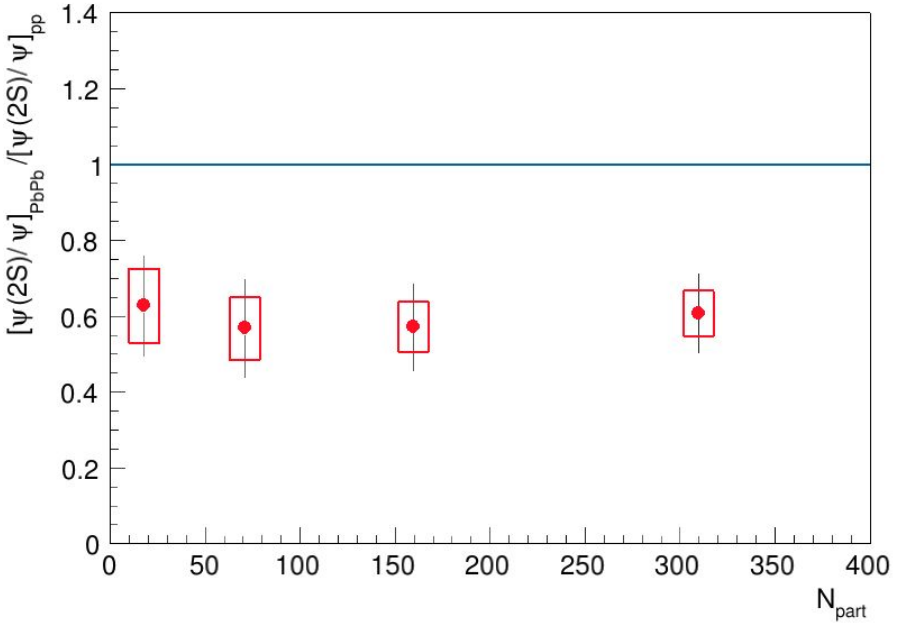
2) centrality dependence

Psi2S Acc x eff = 0.173

J/Psi Acc x eff = 0.135

Psi2S/Psi single and double ratios



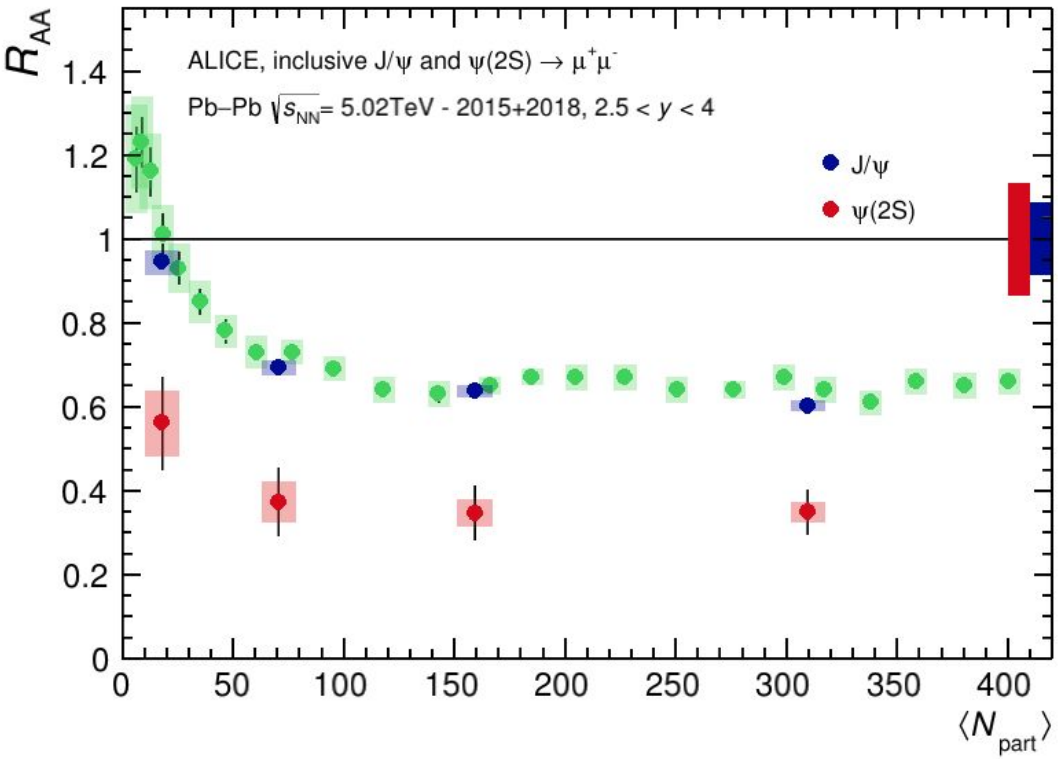


Visible Psi2S/Psi suppression wrt pp collisions, no significant centrality dependence

Systematics only include (partial) signal extraction

pp values from Psi2S AN in https://alice-notes.web.cern.ch/node/941

Psi2S RAA



JPsi and Psi2S systematics include contributions from

- (partial) signal extraction from this work
- MC input, trigger, tracking, matching, centrality, FNorm based on past analyses

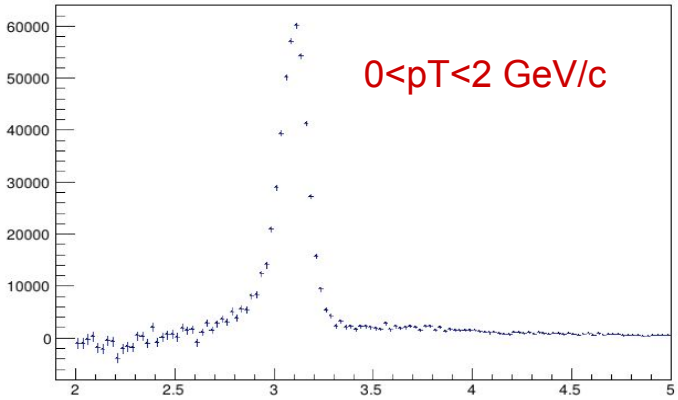
→ to be optimised

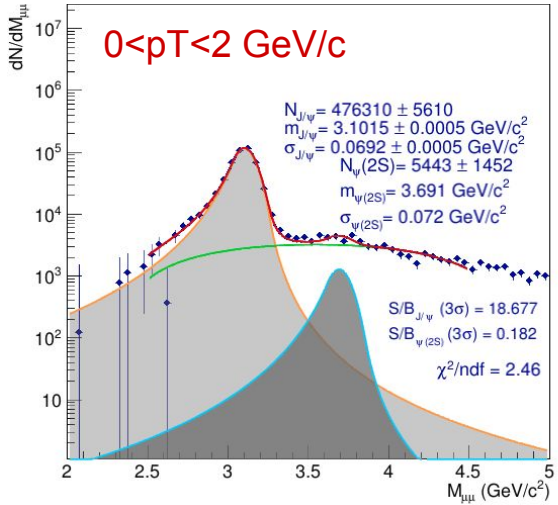
pp values from Psi2S AN in https://alice-notes.web.cern.ch/node/941

JPsi results from this work in good agreement with published 2015 RAA

Psi2S suppression stronger than the JPsi one, being rather flat from NPart~75 onwards

Event mixing in pT bins, 0-90%





Very preliminary attempt to extract the signal in pt bins

All bins in pT are rather difficult to fit, given to the pT shape of the background

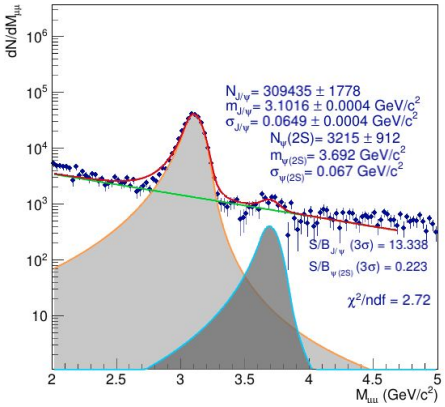
No Psi2S signal visible in 0<pT<2

Next step: apply a centrality cut to improve significance, test a different pt binning...

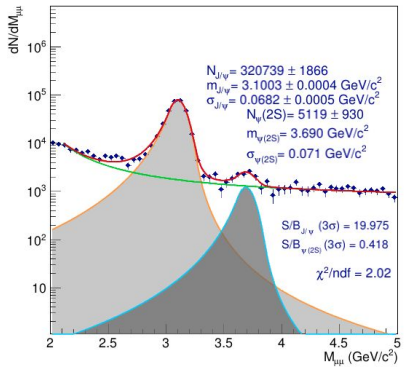
Event mixing: 2<pT<4 GeV/c, 0-90%

- Functions: double CB + bck
- Psi2S Sigma fixed to JPsi/Psi2S ratio in MC
- Psi2S mass fixed to difference in PDG
- JPsi and Psi2S tails identical and fixed to MC (no pT dependence yet)

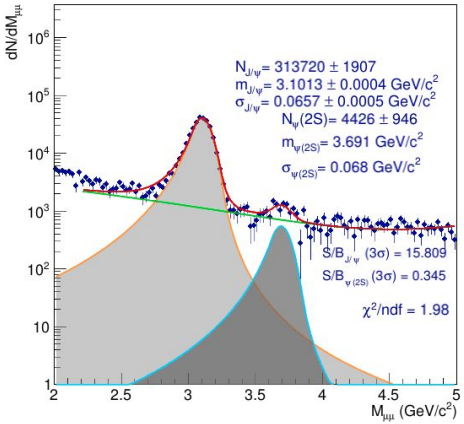
Exp



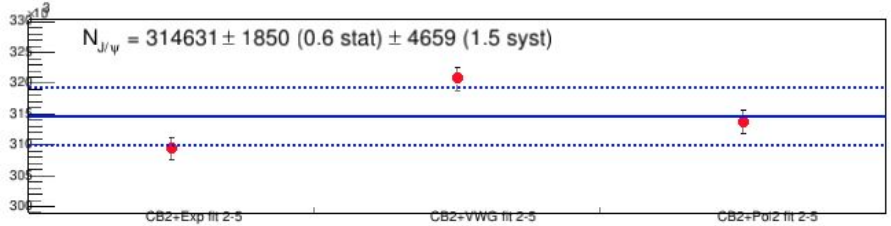
VWG

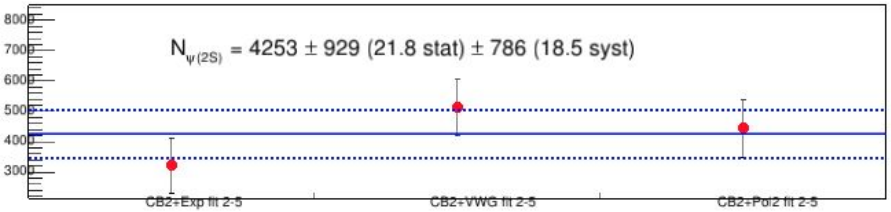


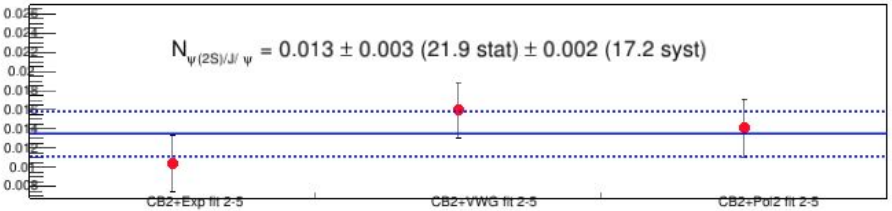
Pol2



Not all the previous background shapes can be use

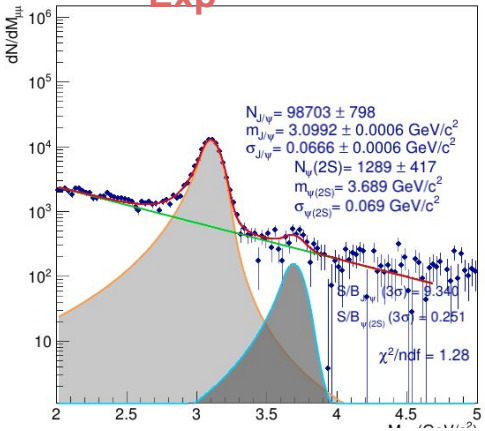




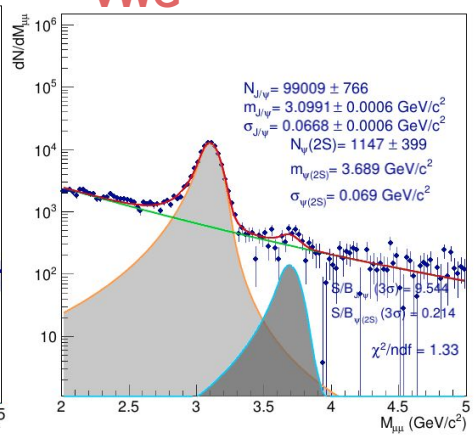


Event mixing: 4<pT<6 GeV/c, 0-90%

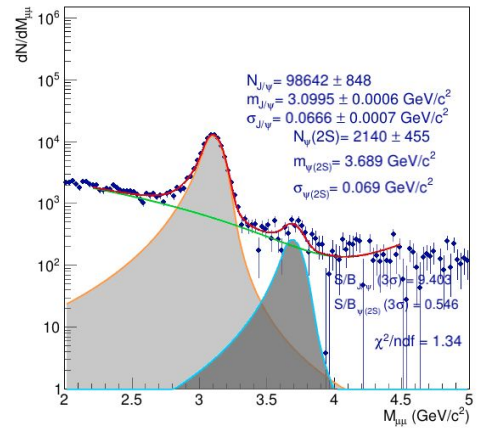
Exp

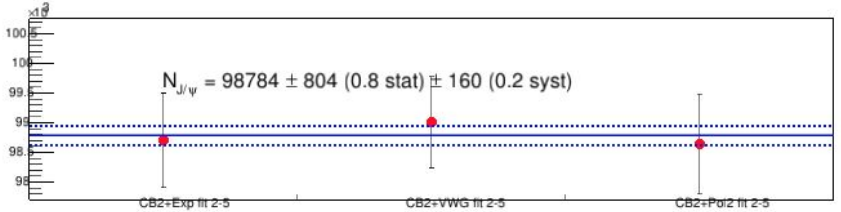


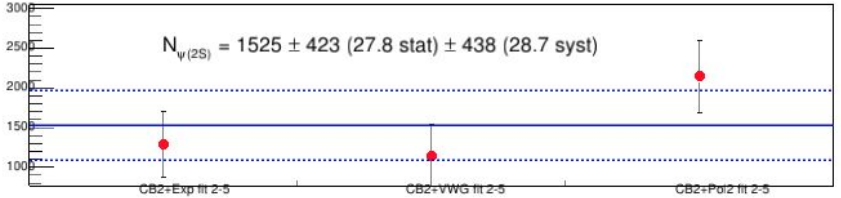
VWG

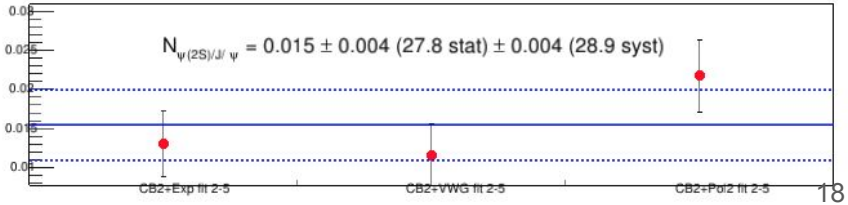


Pol2



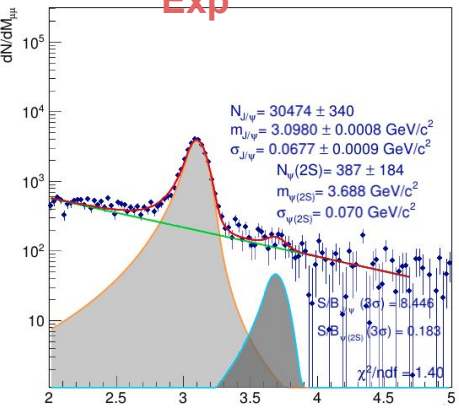




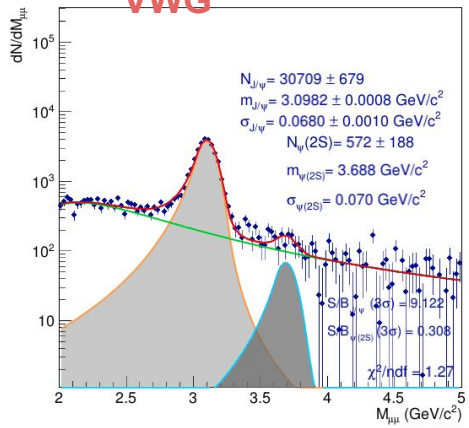


Event mixing: 6<pT<8 GeV/c, 0-90%

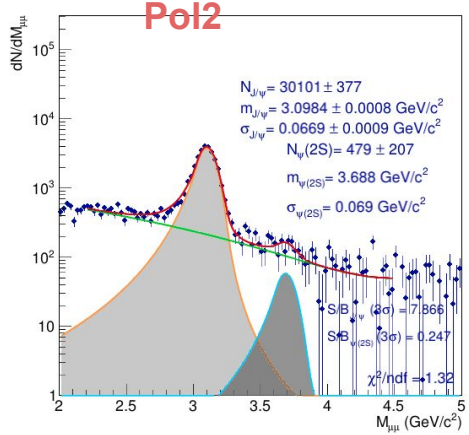
Exp

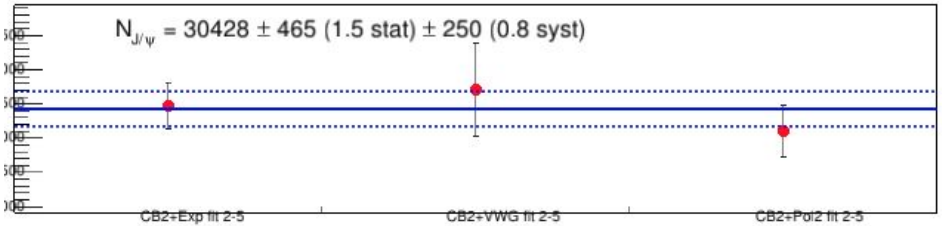


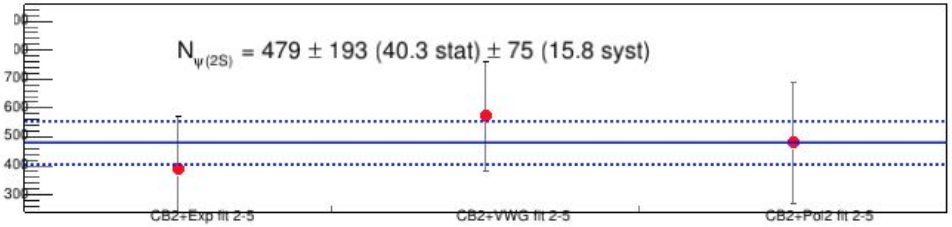
VWG

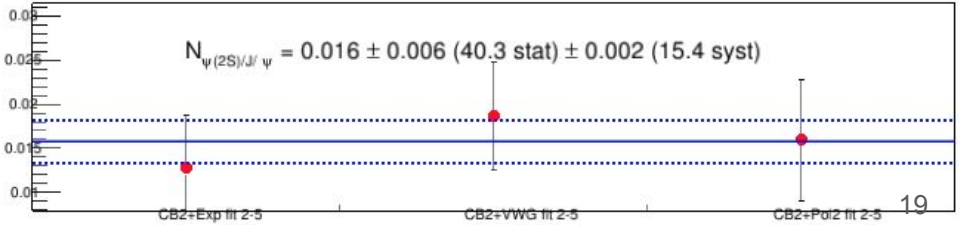


Pol2



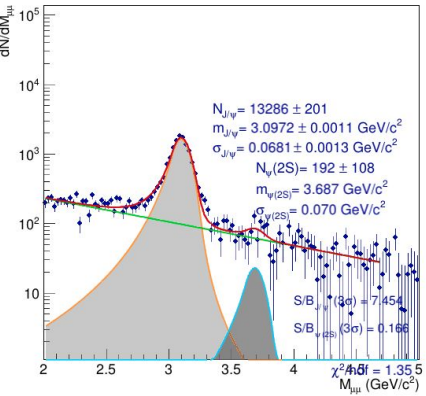




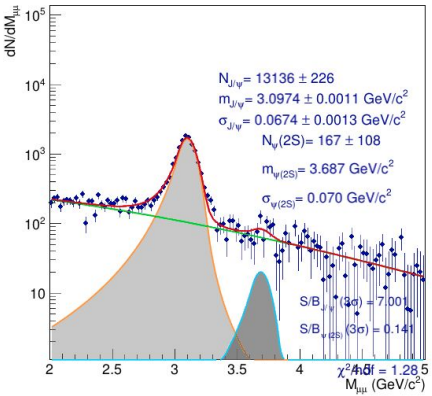


Event mixing: 8<pT<12 GeV/c, 0-90%

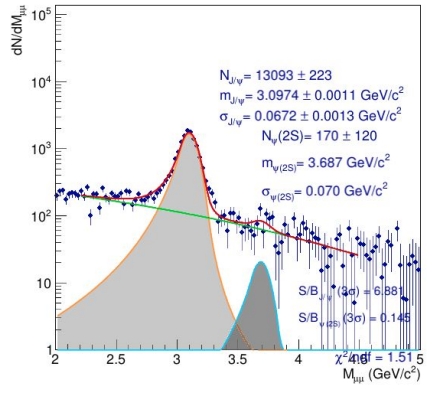
Exp



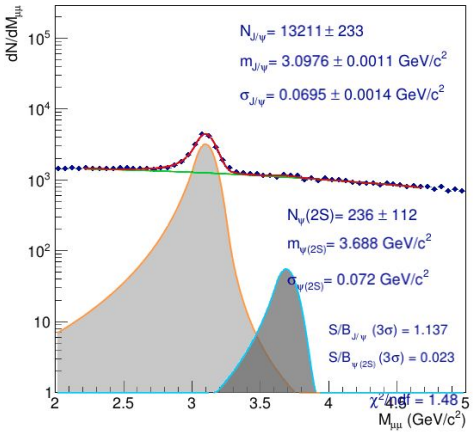
VWG

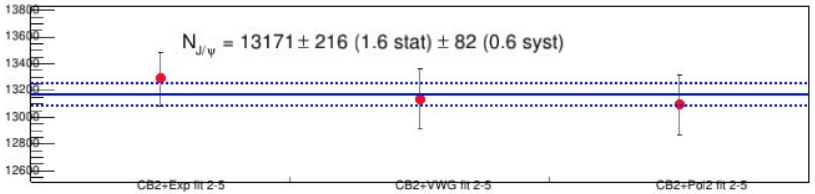


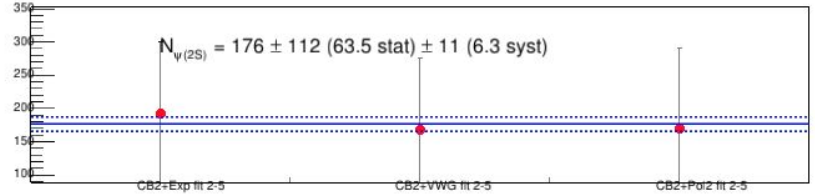
Pol2

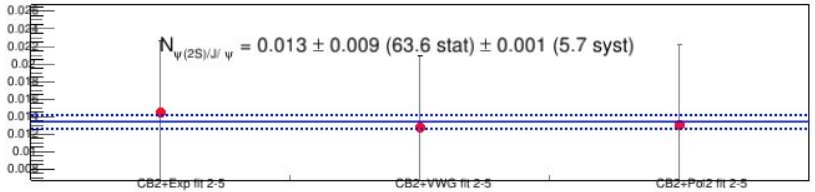


Check: standard fit









In 8<pT<12 GeV/c the Psi2S significance is ~2
→ standard fit is compatible with ev. mixing approach

Checks on signal extraction vs pt

	JPsi (*)	Psi2S (*)
0-2	476310 +/- 5610 (stat) (1 fit only)	5443 +/- 1452 (stat) (1 fit only)
2-4	314631 +/- 1850 (0.6% stat) +/- 4659 (1.5% syst)	4253 +/- 929 (22% stat) +/- 786 18% syst)
4-6	98784 +/- 804 (0.8% stat) +/- 160 (0.2% syst)	1525 +/- 423 (28% stat) +/- 438 (13% syst)
6-8	30428 +/- 465 (1.5% stat) +/- 250 (0.8% syst)	479 +/- 193 (40% stat) +/- 75 (16% syst)
8-12	13171 +/- 216 (1.6% stat) +/- 82 (0.6% syst)	176 +/- 112 (63% stat) +/- 11 (6% syst)
sum pt. bins	933324	11876
0-12	936496 +/- 4887 (0.5% stat) +/- 2432 (0.3% syst)	14432 +/- 1662 (11% stat) +/- 634 (4% syst)

The sum of the JPsi values in pt bins is consistent within ~0.3% wrt the values obtained in 0<pT<12

Still large difference for the Psi2S → room for improvement in the Psi2S fits
Alternative bins to be checked

Next steps

Psi2S vs centrality:

1. Finalise the signal extraction
2. Use final version of pp reference
3. Check systematic uncertainties

Psi2S vs pT:

1. Finalise the signal extraction, improving fits, binning, applying low pt cut, cutting in centrality
2. Use final version of pp reference
3. Check systematic uncertainties
4. Compute single and double ratio, RAA...

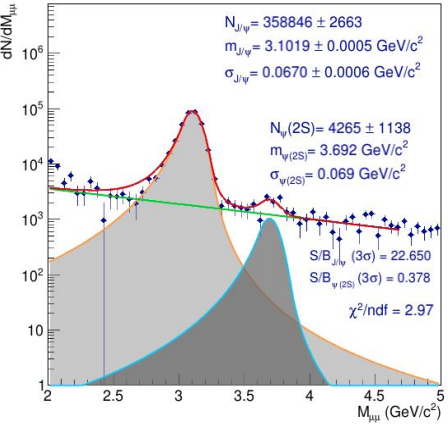
(Not yet a complete list)

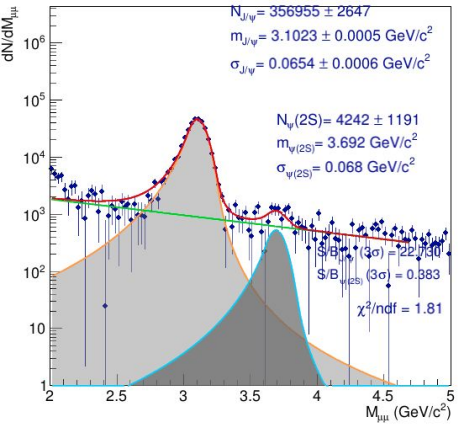
Backup slides

Event mixing: 0-10%

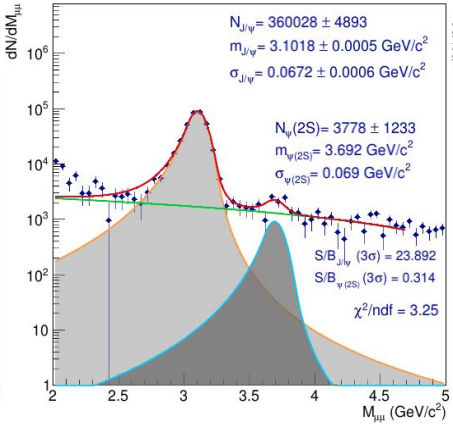
- Sigma fixed to JPsi/Psi2S ratio in MC
- Mass fixed to difference in PDG
- Signal: Double CB

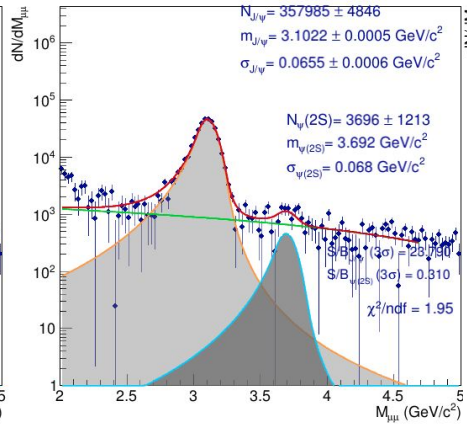
Exp



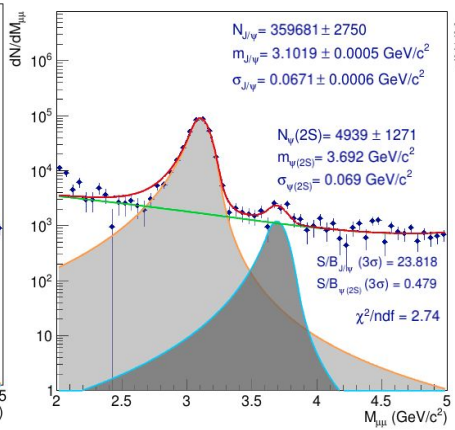


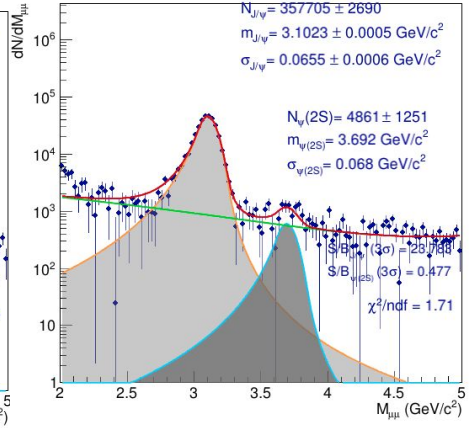
Pol1



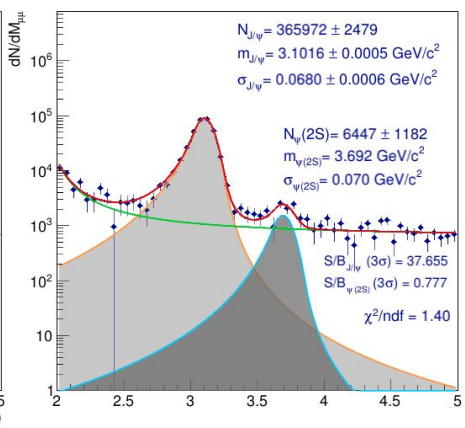


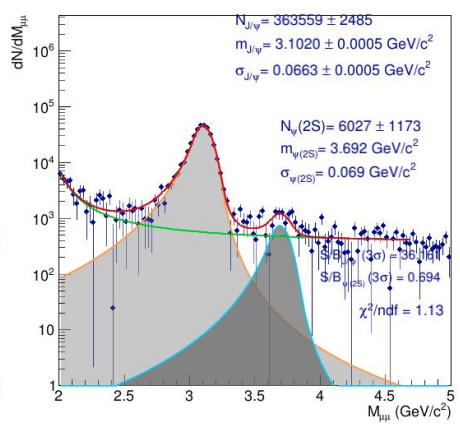
Pol2





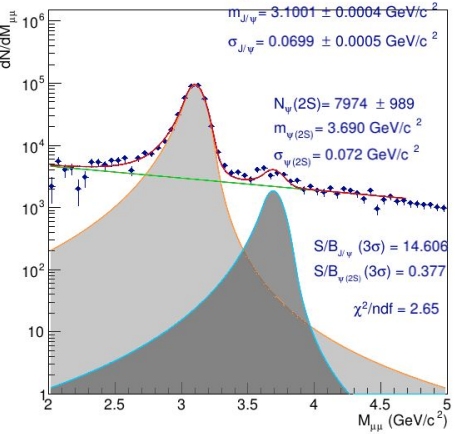
VWG



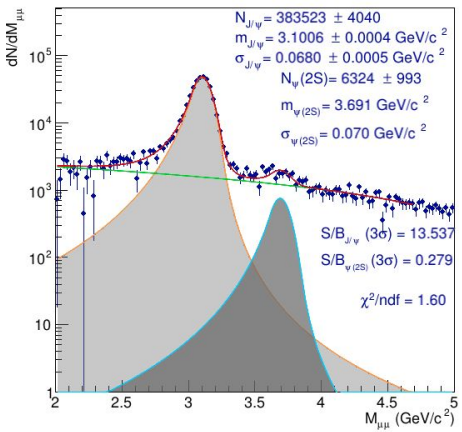


Event mixing: 10-30%

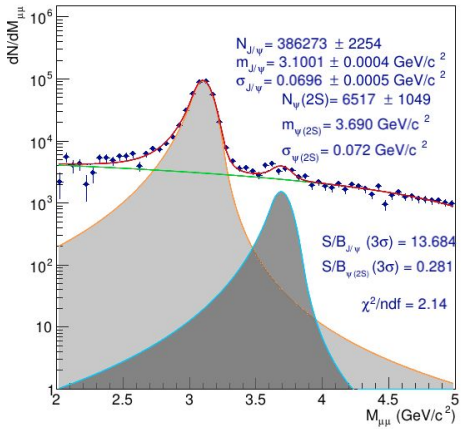
Exp



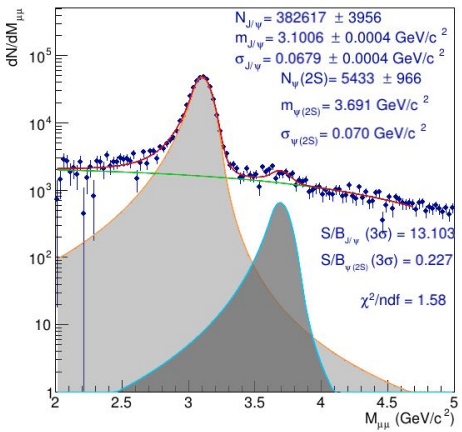
Pol1



Pol2

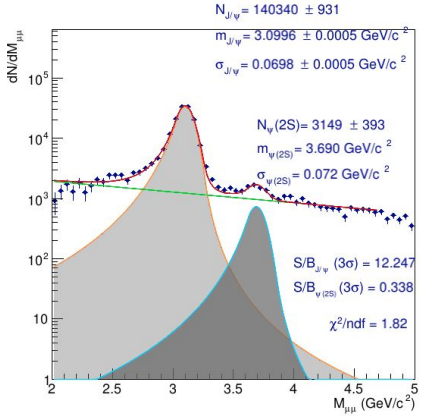


VWG

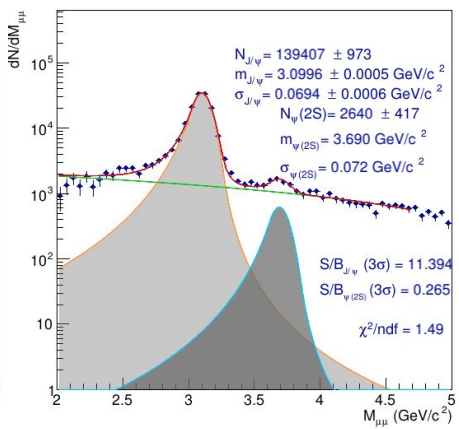


Event mixing: 30-50%

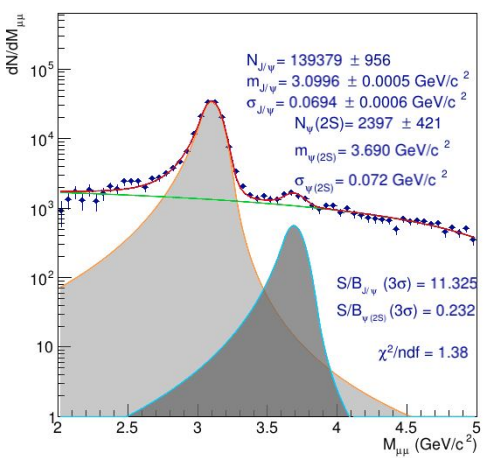
Exp



Pol1



Pol2



VWG