中国科学技术大学
University of Science and Technology of China

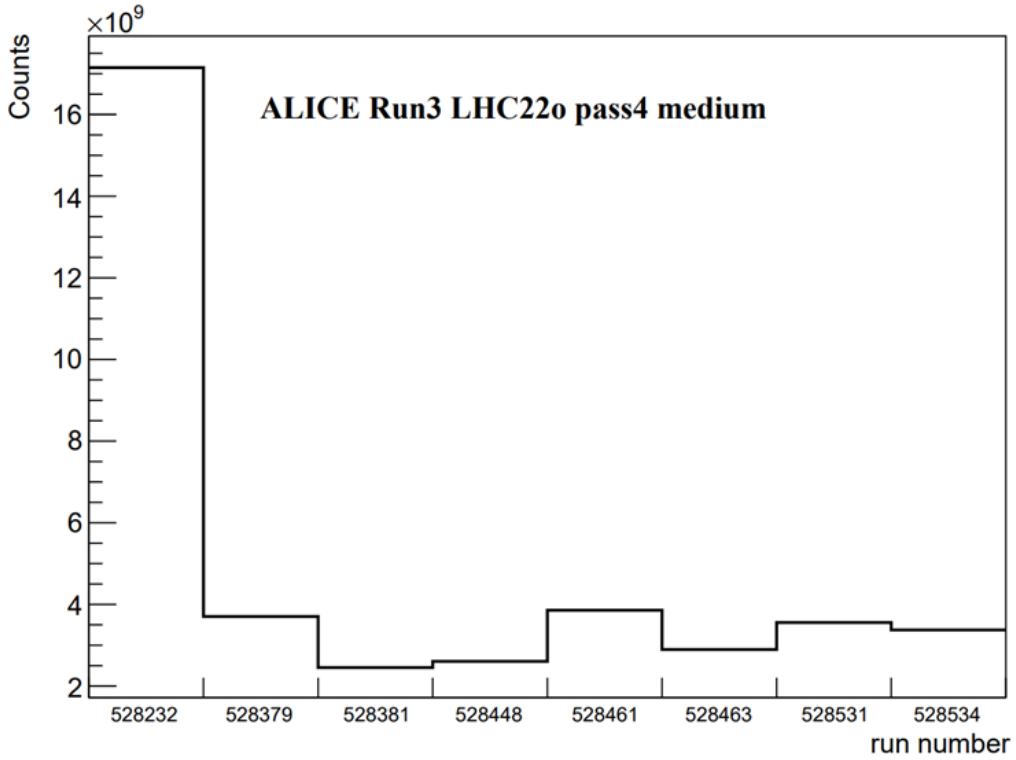
ALICE

Updates on ψ(2S) to J/ψ ratio in pp collisions 13.6 TeV at midrapidity

Yuan Zhang

Datasets

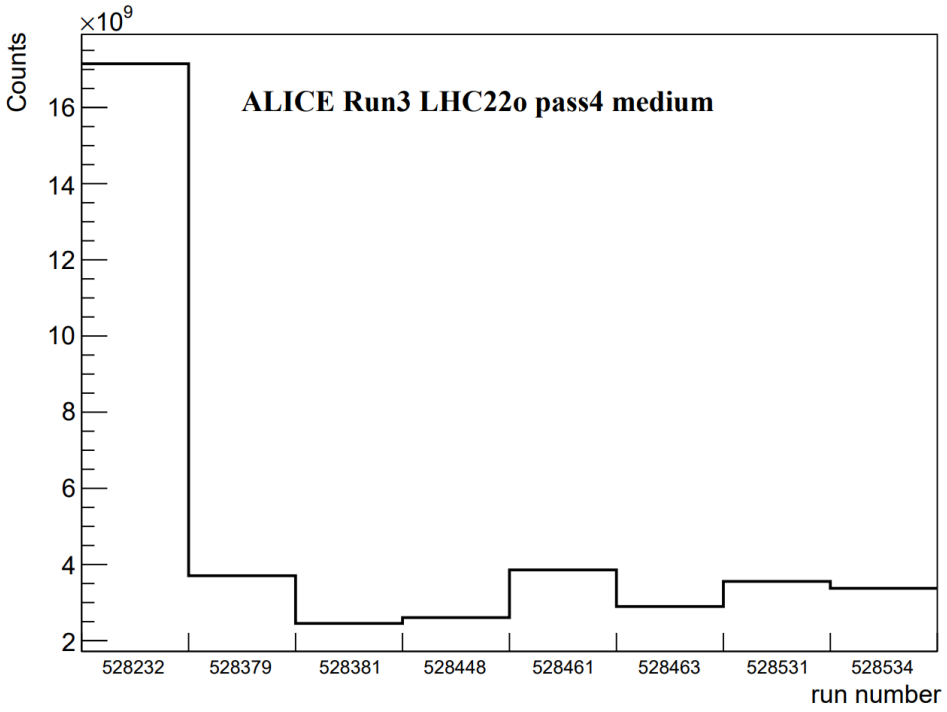
- LHC22o pass4 medium
  - 528232, 528379, 528381, 528448, 528461, 528463, 528531, 528534
    - 2 runs added in LHC22o pass4 medium

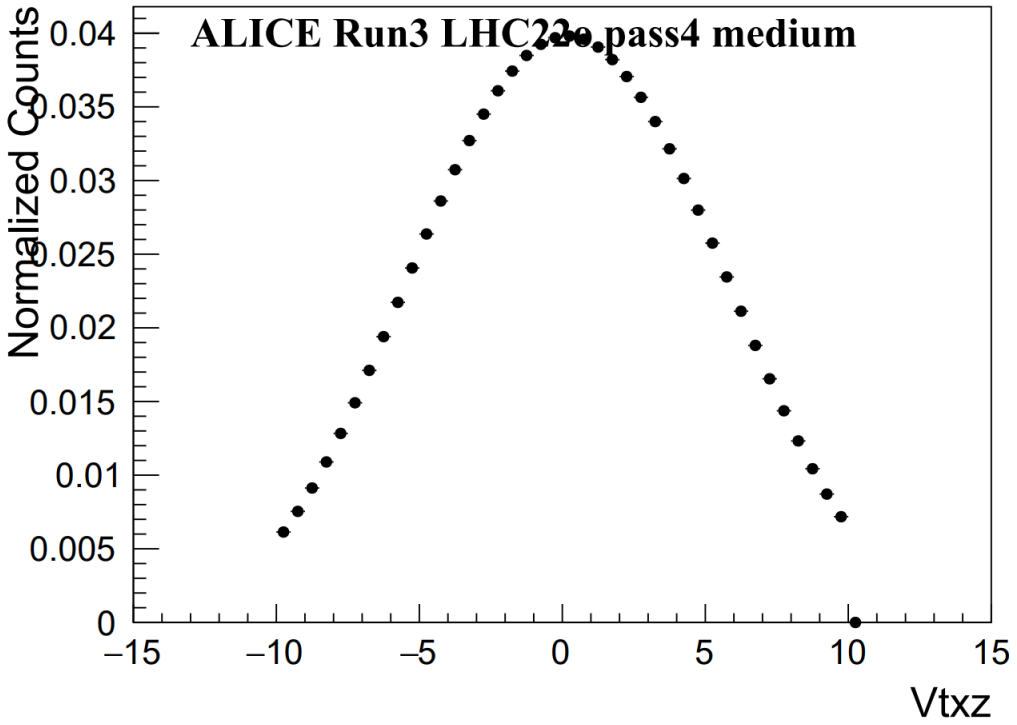


Analysis cuts

- Event selection:
  - -10 cm < VtxZ < 10 cm
- Track selection:
  - pT >1 GeV/c
  - |η| < 0.9
  - TPCncls > 90
  - TPCchi2 < 4
  - ITSncls > 2
  - ITSchi2 < 36
  - SPDany
- PID:
  - -3 < TPC$n\sigma^{e}$ < 3
  - TPC$n\sigma^{p}$ > 3
  - TPC$n\sigma^{\pi}$ > 3

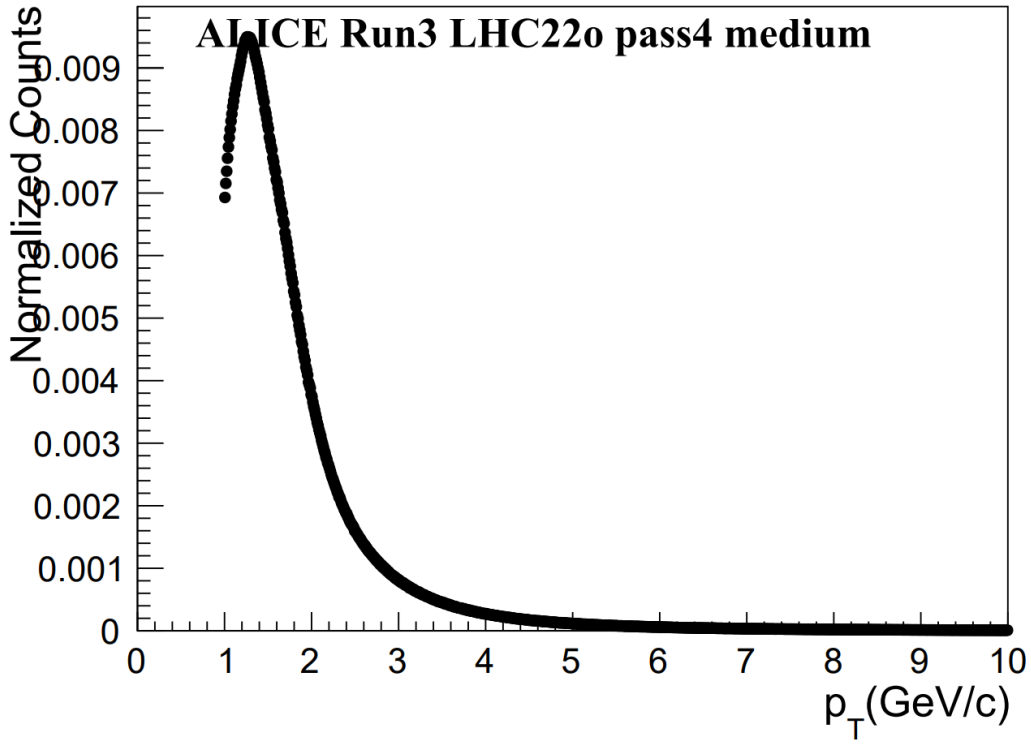
Event selection

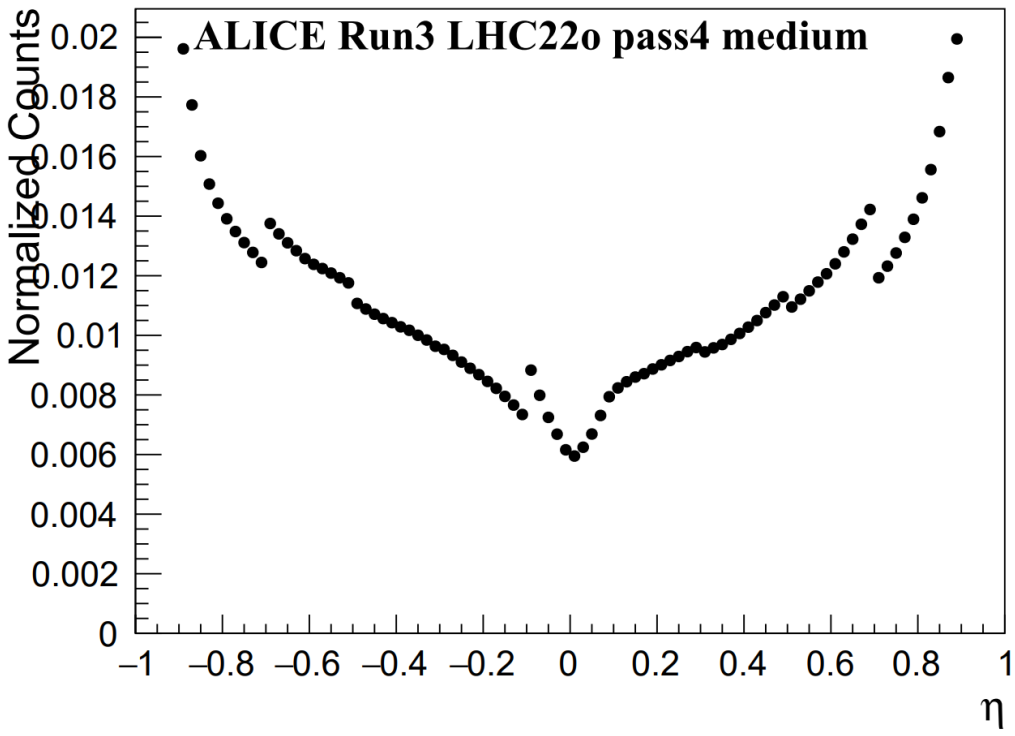




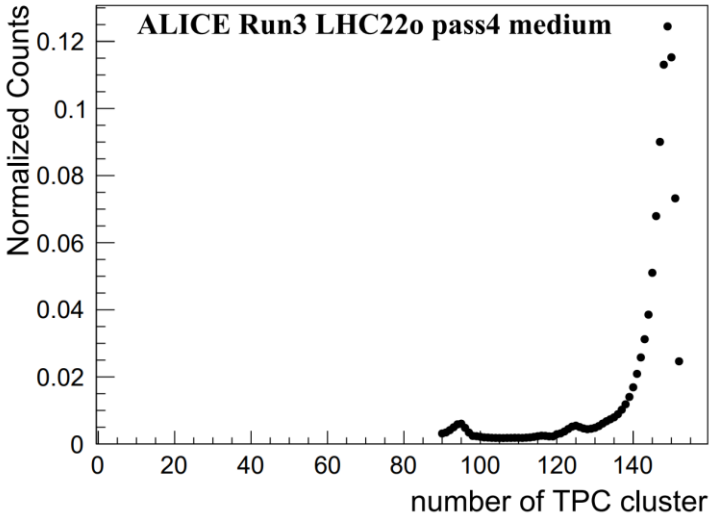
- 39.17 B events after selection

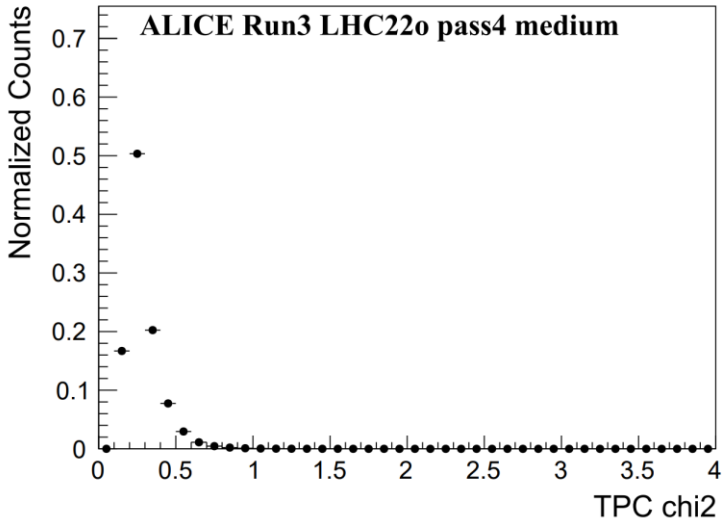
Kinematics distribution

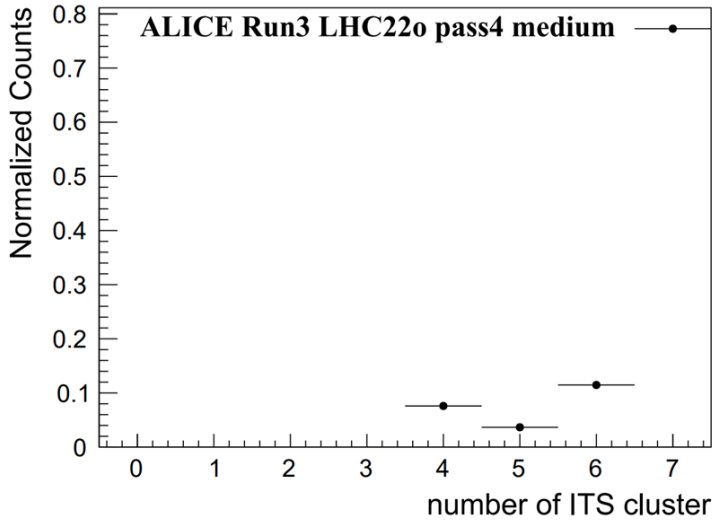


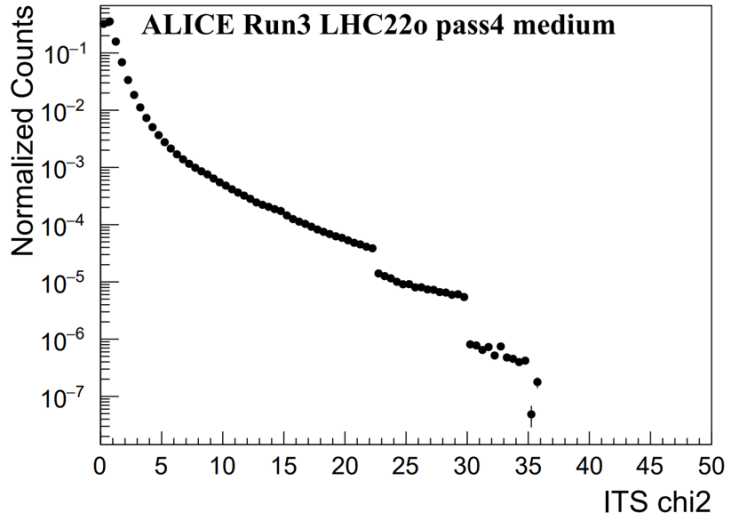


Track quality



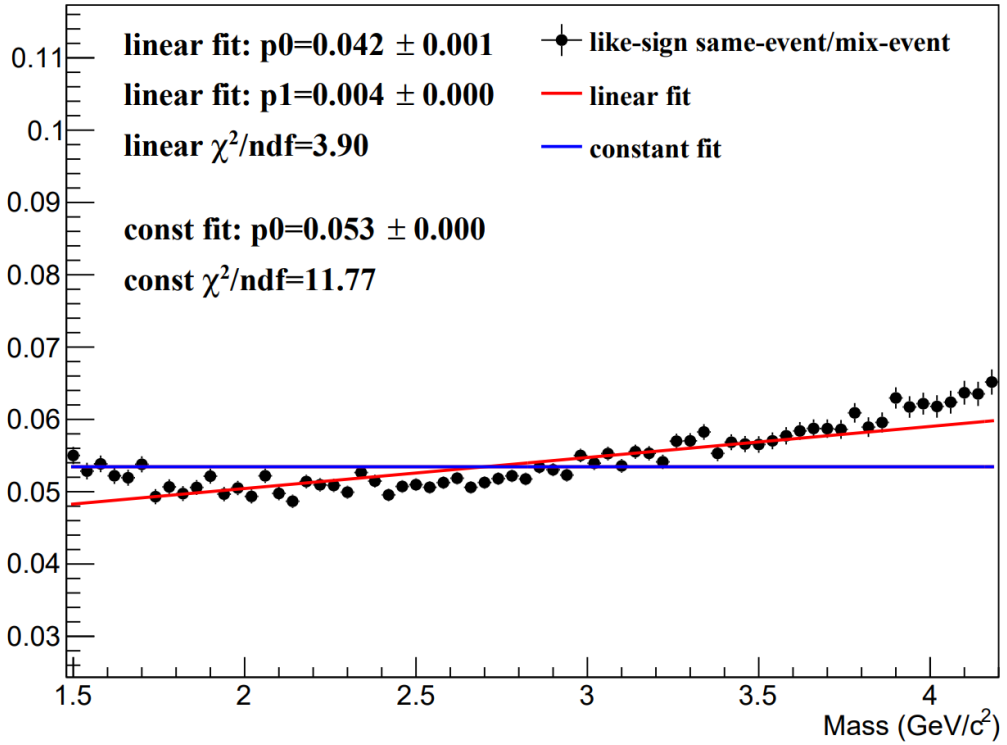


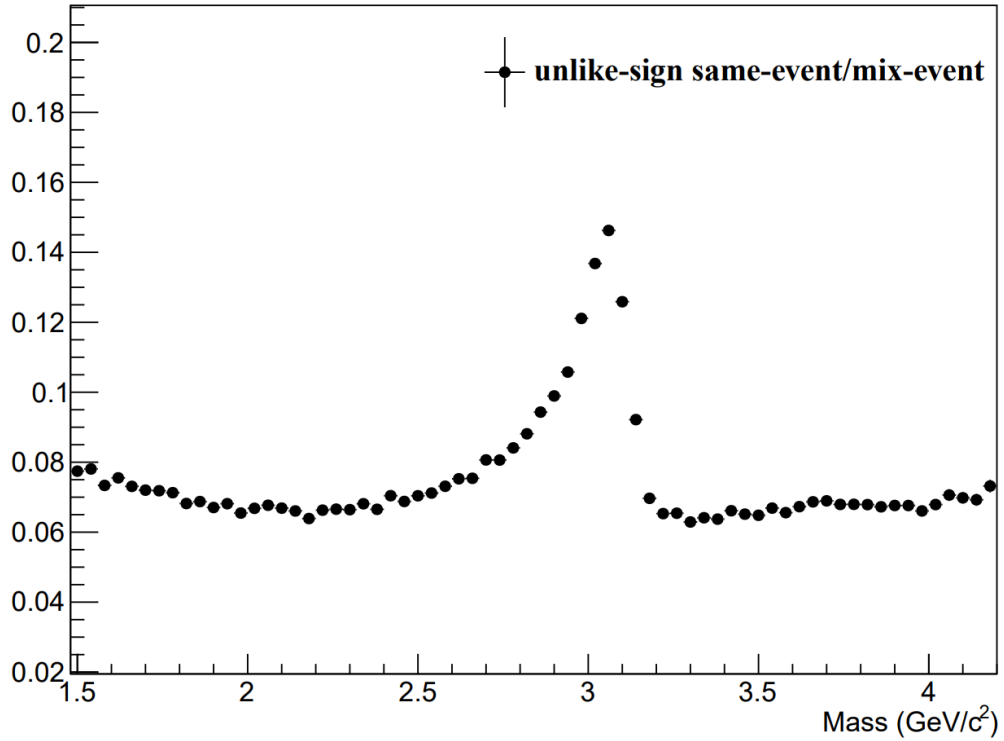




Mix event check

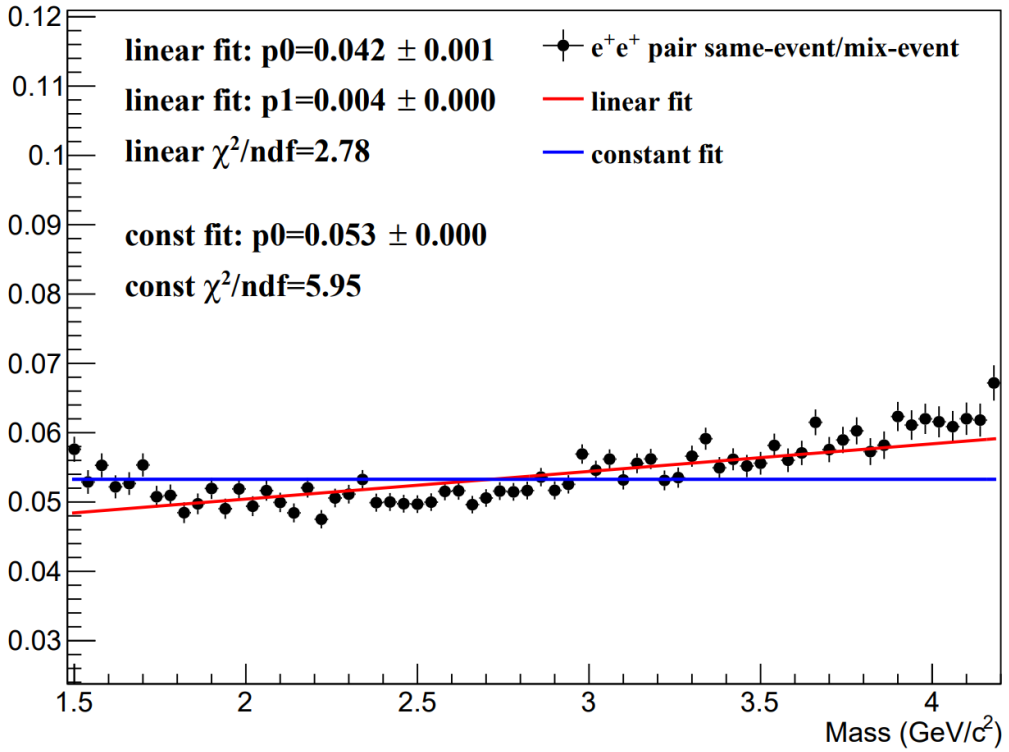
- MixingDepth: 25
- MixingVars: Vtx2
  - VtxZ(cm): (-10, -5, 0, 5, 10)

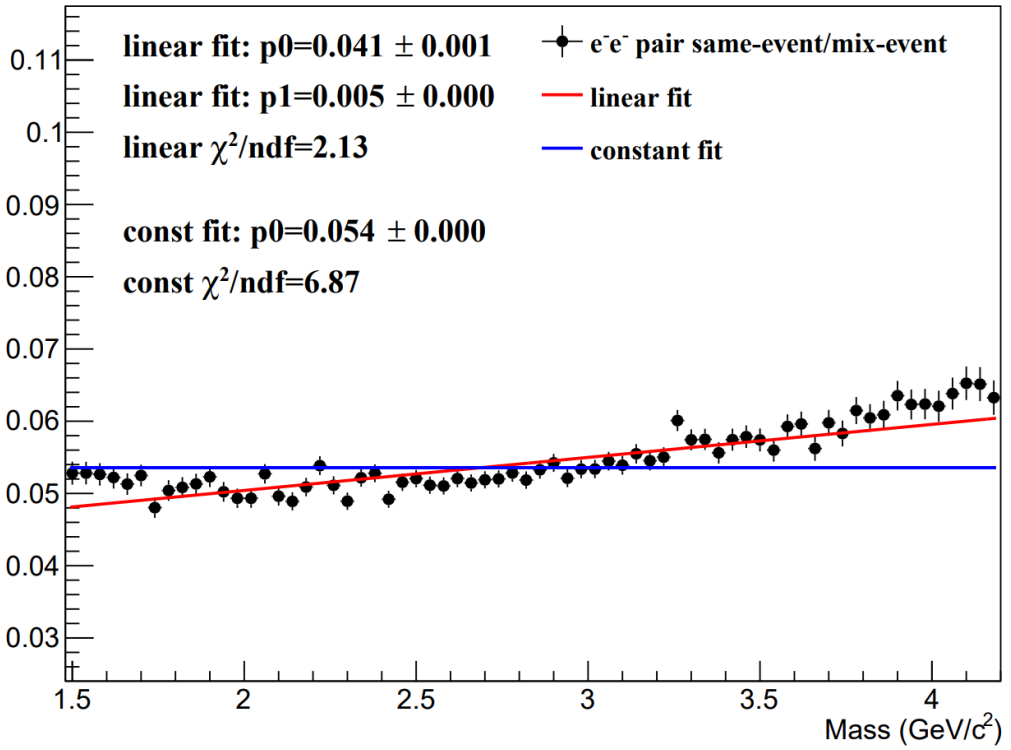




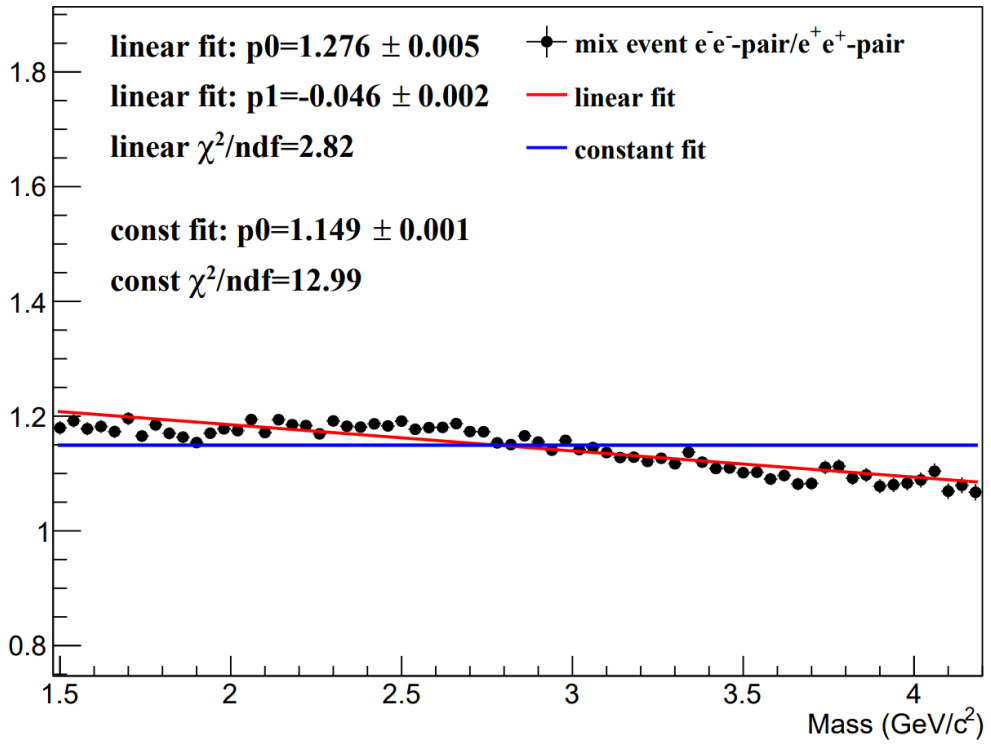
- The ratio of same event like-sign pair and mix event like-sign has some mass dependence.

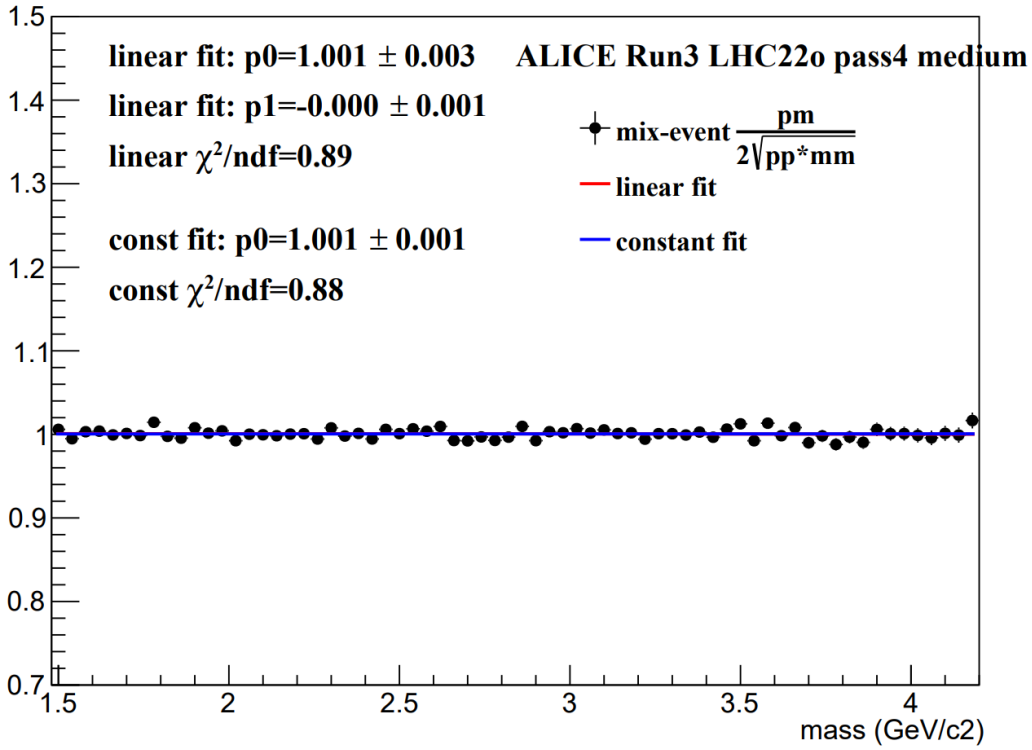
Mix event check





Mix event check

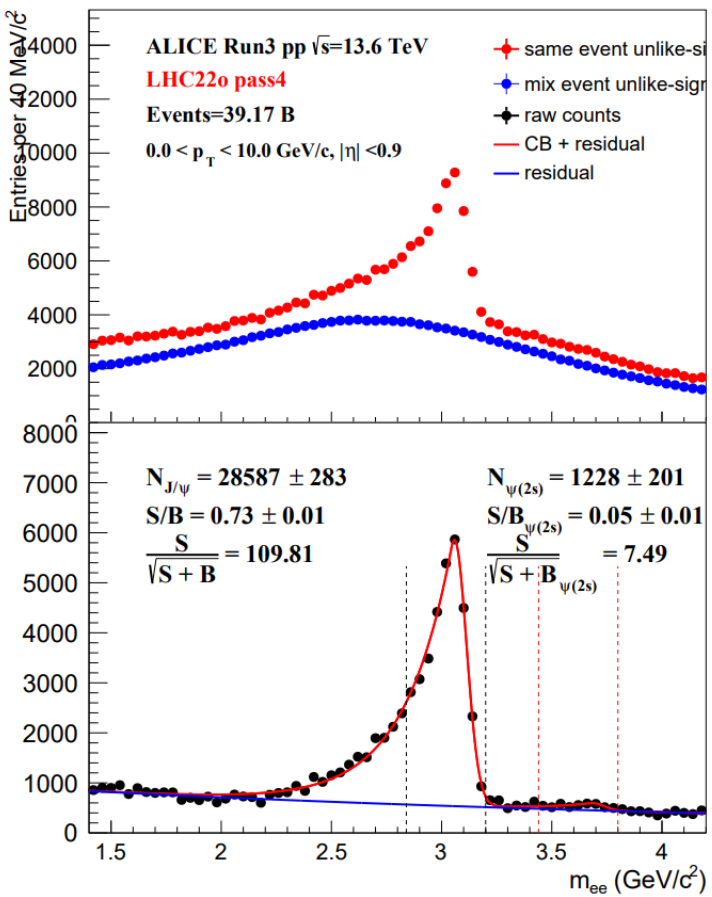


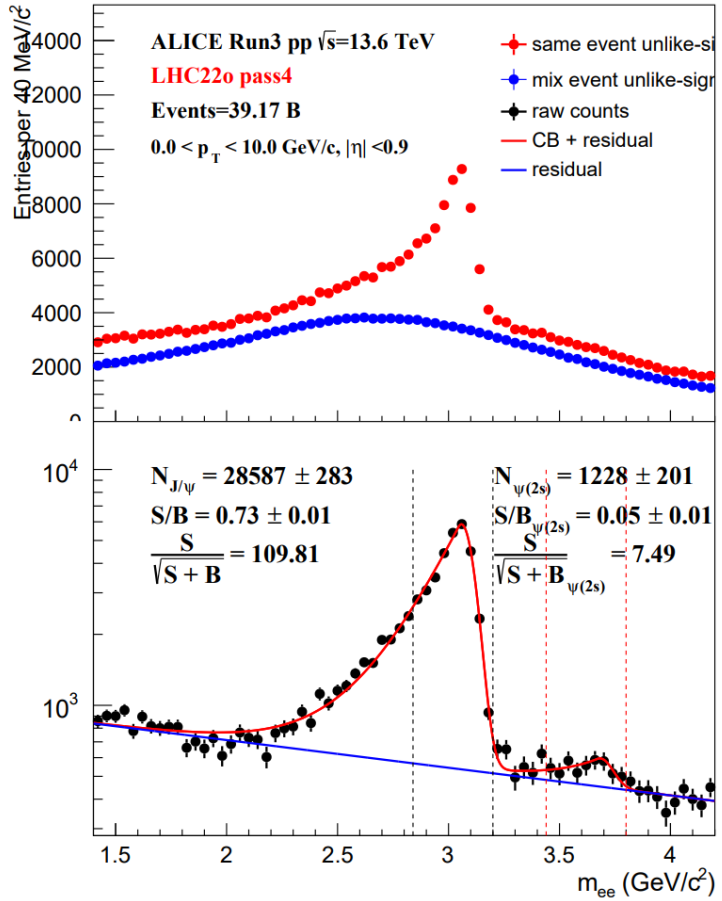


- The influence of the fit range will be shown later.
- The reason for the mass dependence still need further check.

Signal extraction

- Using mix-event unlike-sign pair to subtract the combination background.
- Scale factor is calculated from integral of same-event like-sign divided by the mix-event like-sign.
- The default mass window(GeV/c^2) is
  - (2.84, 3.2) for J/ψ
  - (3.44, 3.8) for ψ(2s)
- The default fit range(GeV/c^2) is (1.4, 4.2)

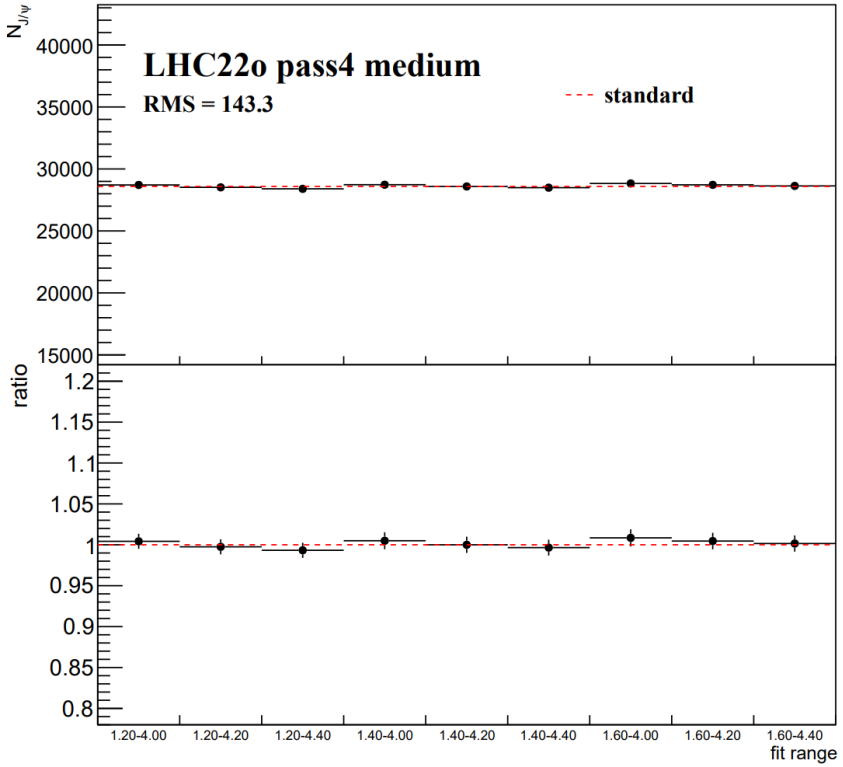




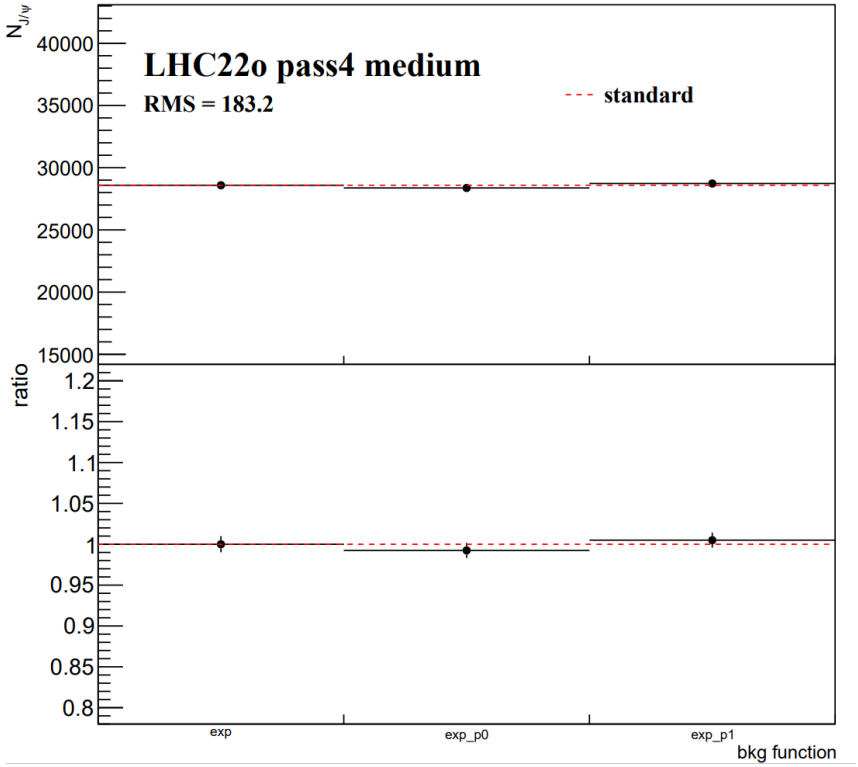
Systematic uncertainty

- Some source of the systematic uncertainty of the ratio of production
  - Mass window
  - Fit range
  - Background fit function
  - Tracking and PID efficiency
  - Tracking and PID cuts

Systematic uncertainty



$RMS/N_{standard}$ 0.5%

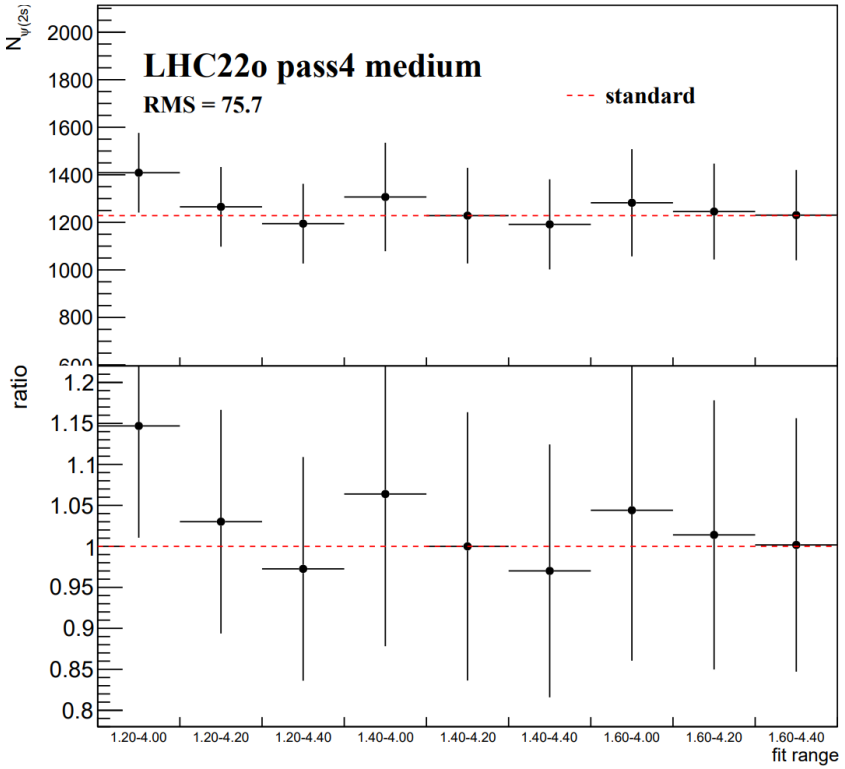


0.6%

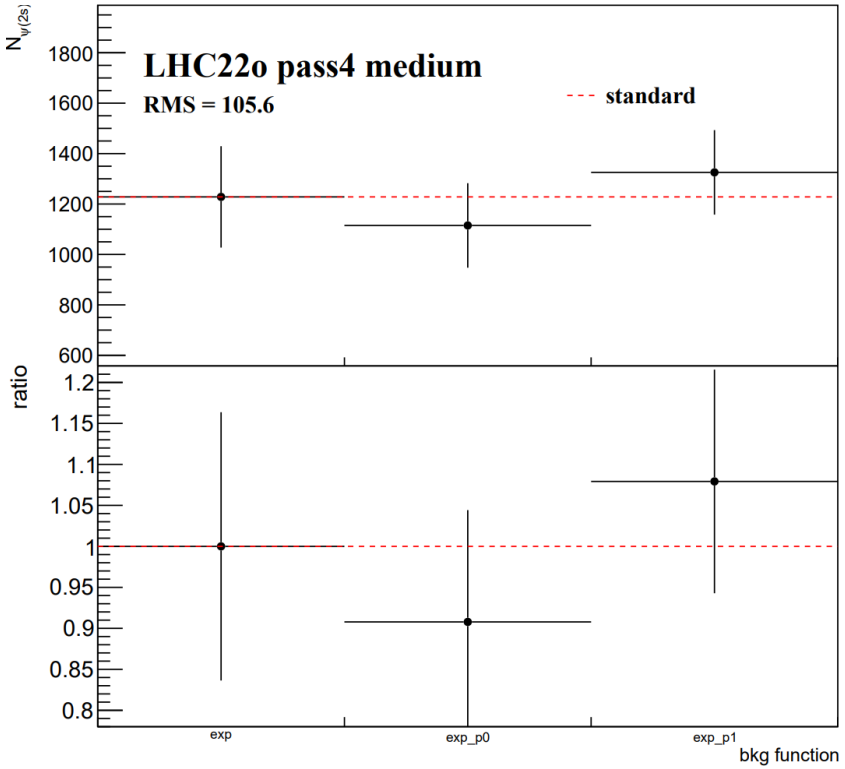
- Standard fit range(GeV/c²): 1.4 – 4.2
- Standard bkg fit function: exp

- exp: Ae^{Bx}
- exp_p0: $Ae^{Bx} + C$
- exp_p1: $Ae^{Bx} + C + Dx$

Systematic uncertainty



$RMS/N_{standard}$ 6.2%

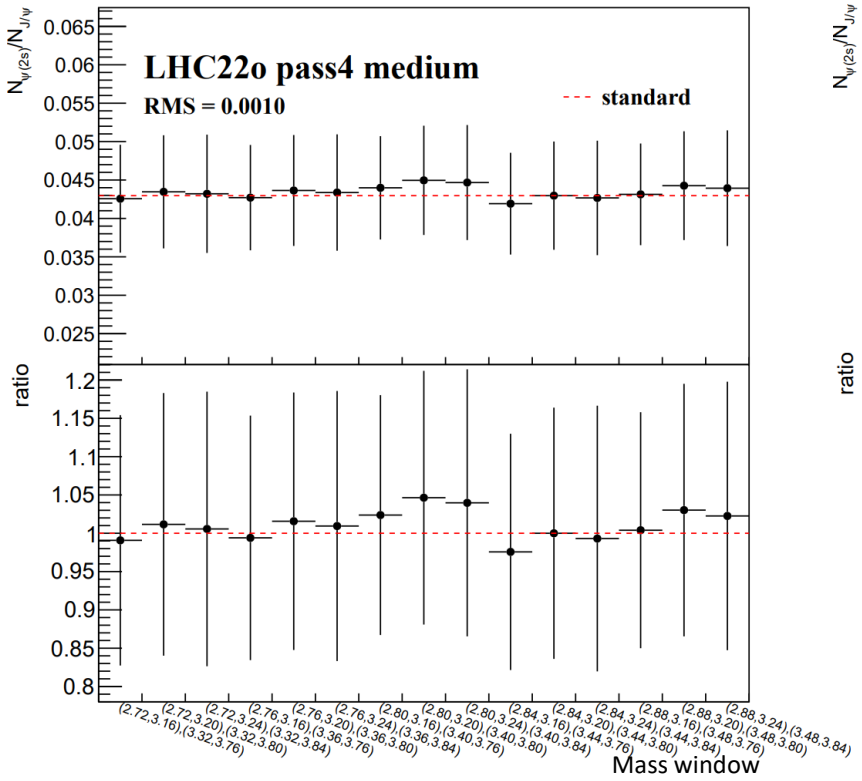


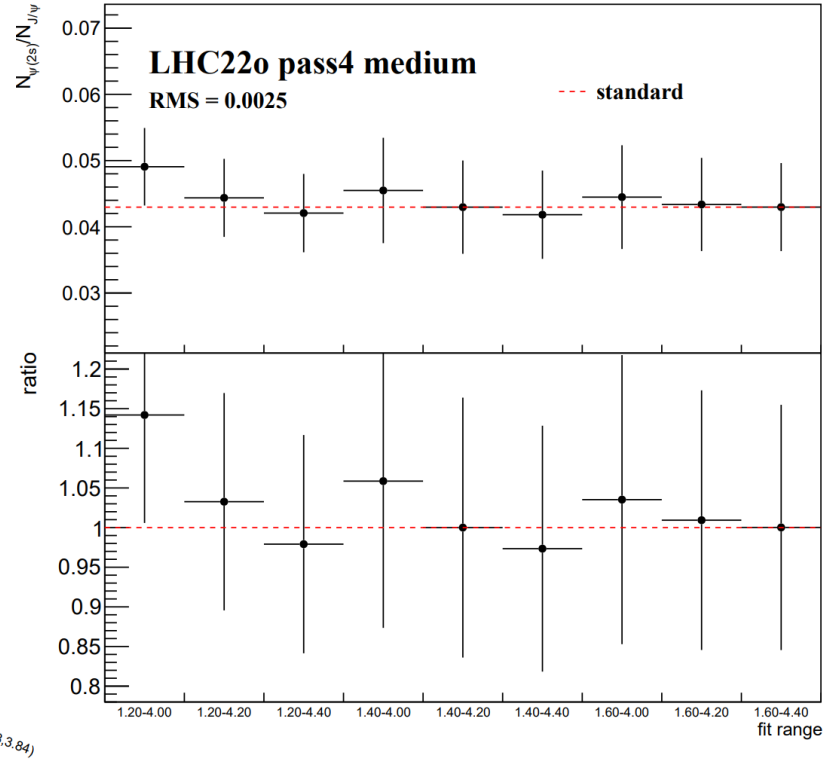
8.6%

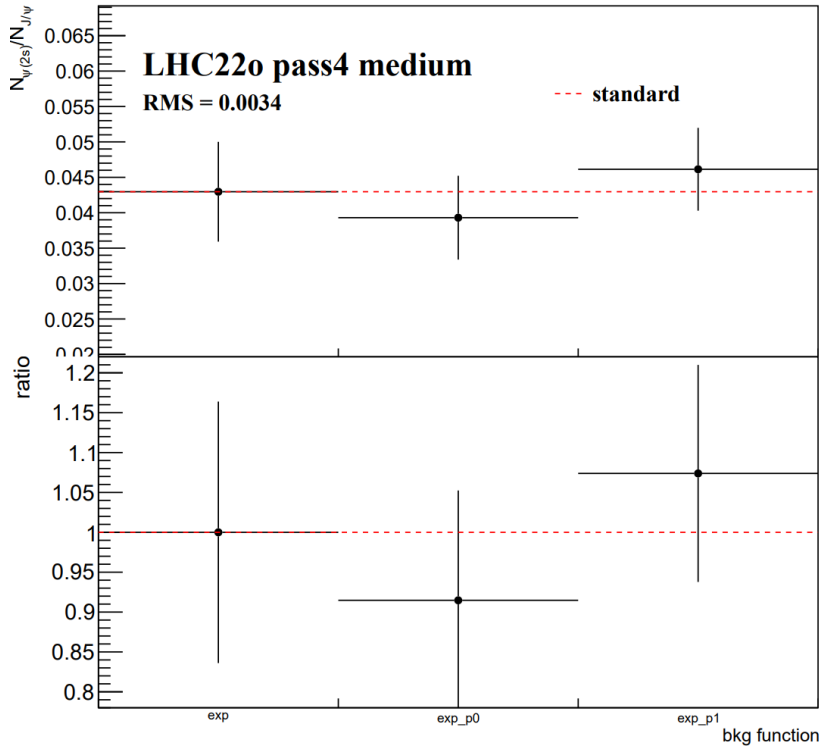
- Standard fit range(GeV/c²): 1.4 – 4.2
- Standard bkg fit function: exp

- exp: Ae^{Bx}
- exp_p0: $Ae^{Bx} + C$
- exp_p1: $Ae^{Bx} + C + Dx$

Systematic uncertainty







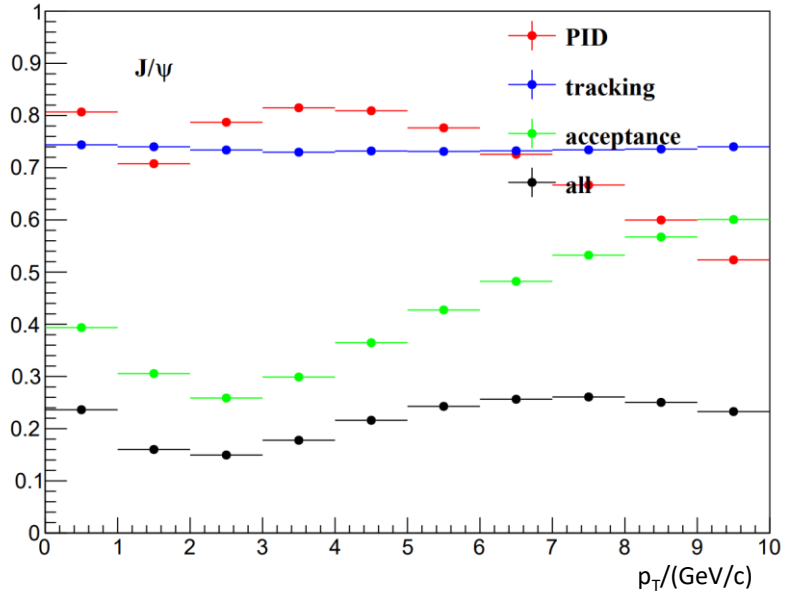
Systematic uncertainty: 2.2% 5.8% 7.9%

- Standard mass window(GeV/c^2): (2.84, 3.2) for J/ψ, (3.44, 3.8) for ψ(2s).
- Standard fit range(GeV/c^2): 1.4 – 4.2
- Standard bkg fit function: exp

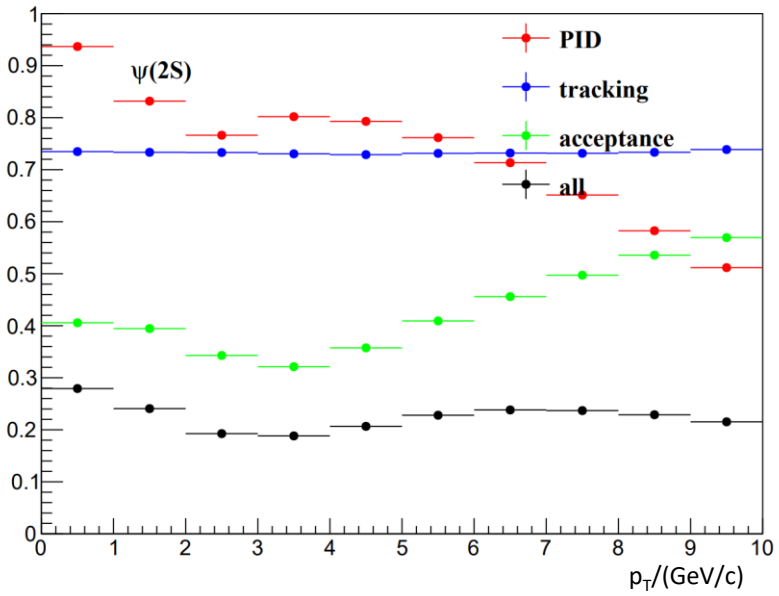
- exp: Ae^{Bx}
- exp_p0: $Ae^{Bx} + C$
- exp_p1: $Ae^{Bx} + C + Dx$

The influence of the efficiency

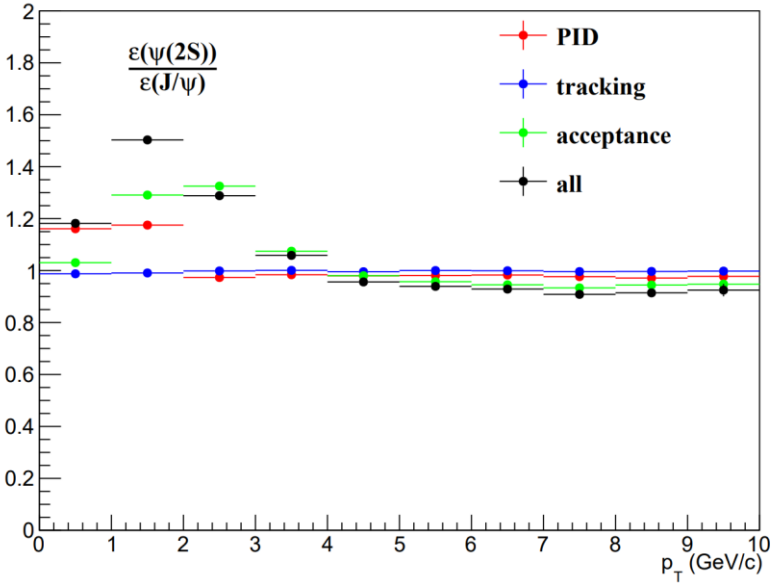
efficiency



efficiency



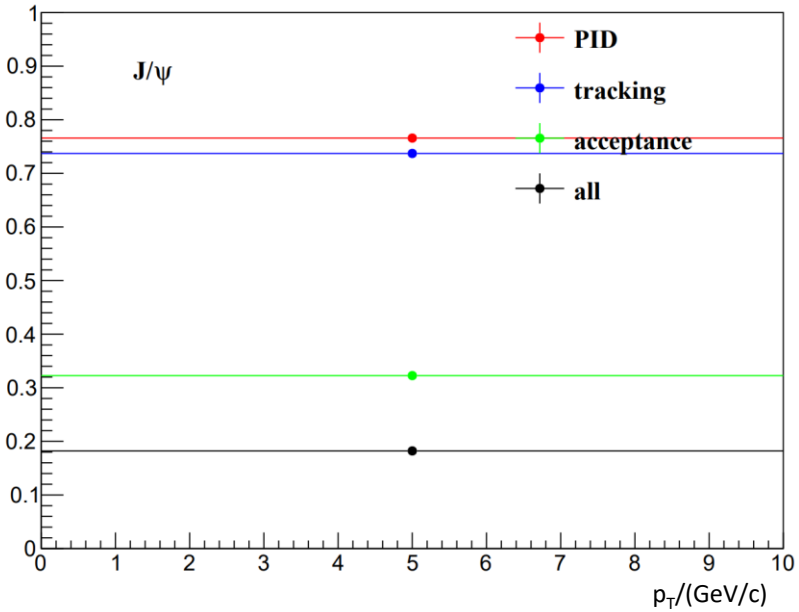
Ratio of the efficiency



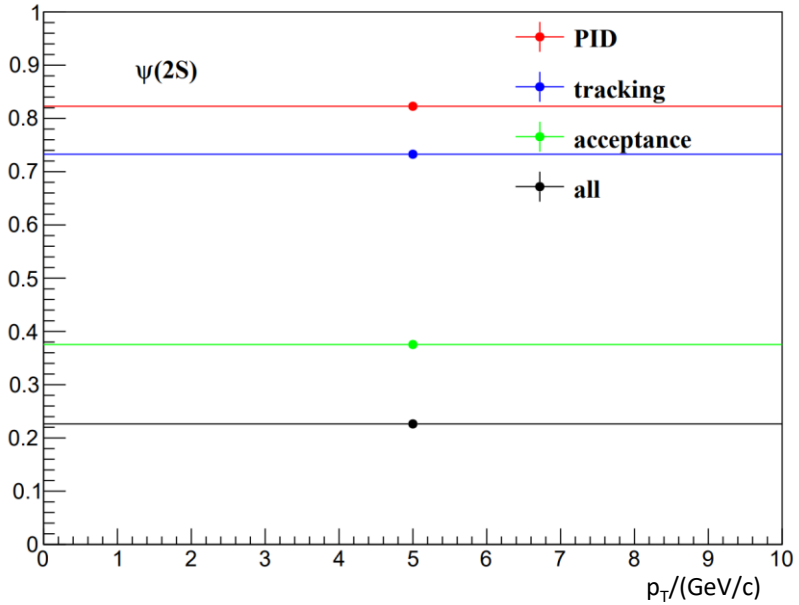
- The single track efficiency is obtained from Run2 MC, and is passing to J/ψ and ψ(2s) using toyMC.
- The difference of the efficiency between J/ψ and ψ(2s) is large in low p_T, but will get small in high p_T.

The influence of the efficiency

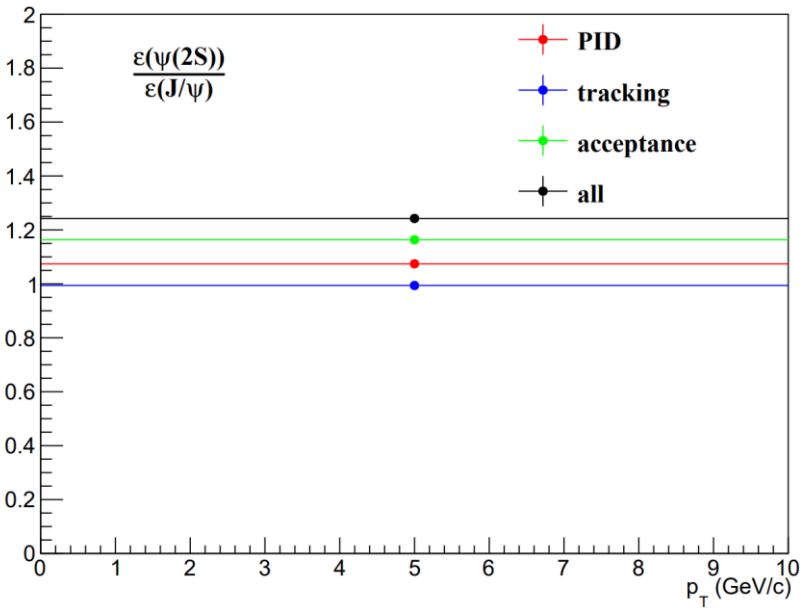
efficiency



efficiency



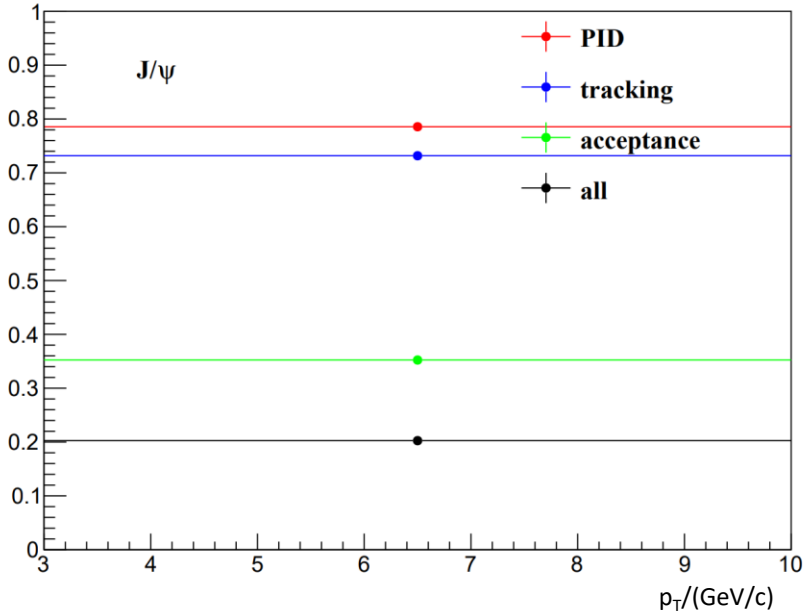
Ratio of the efficiency



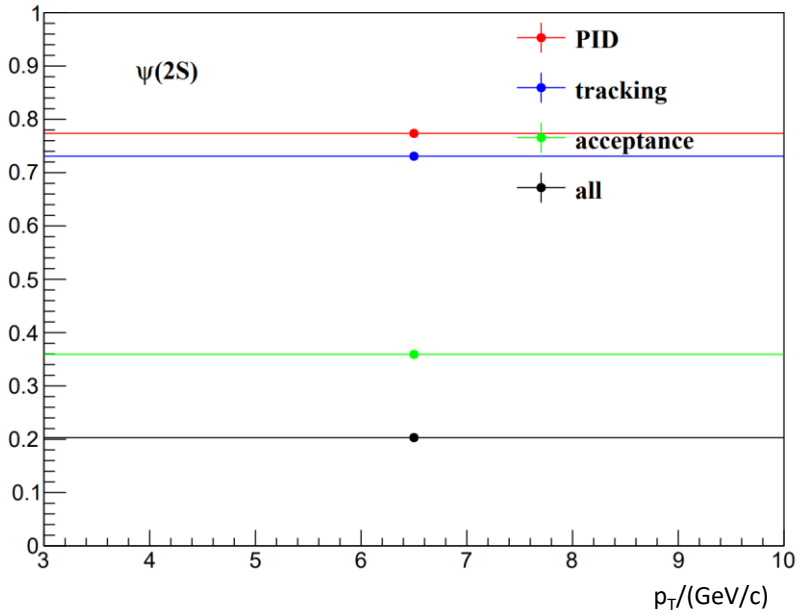
- The difference of efficiency between ψ(2s) and J/(ψ) is ~25% in integrated p_T range.

The influence of the efficiency

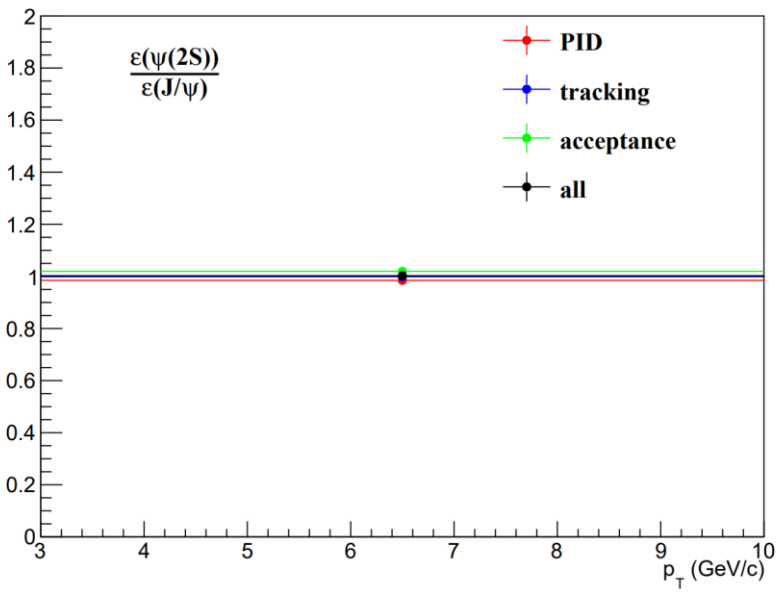
efficiency



efficiency



Ratio of the efficiency

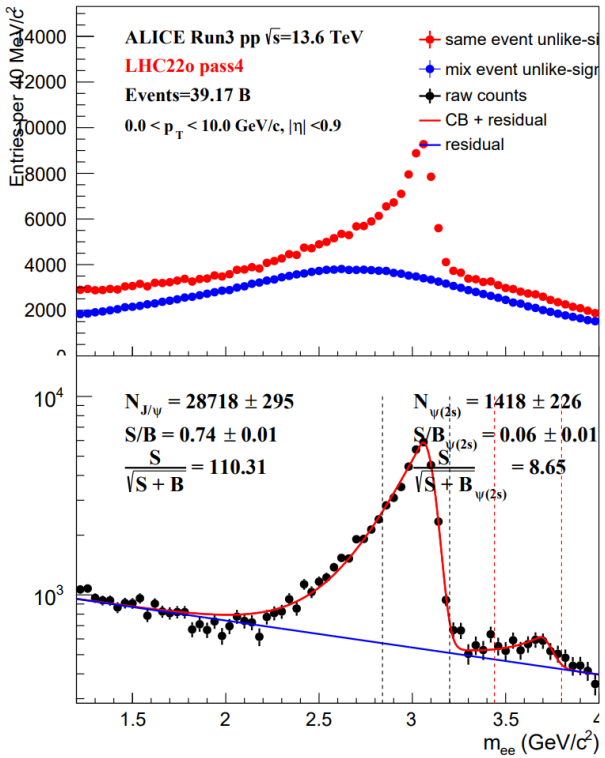


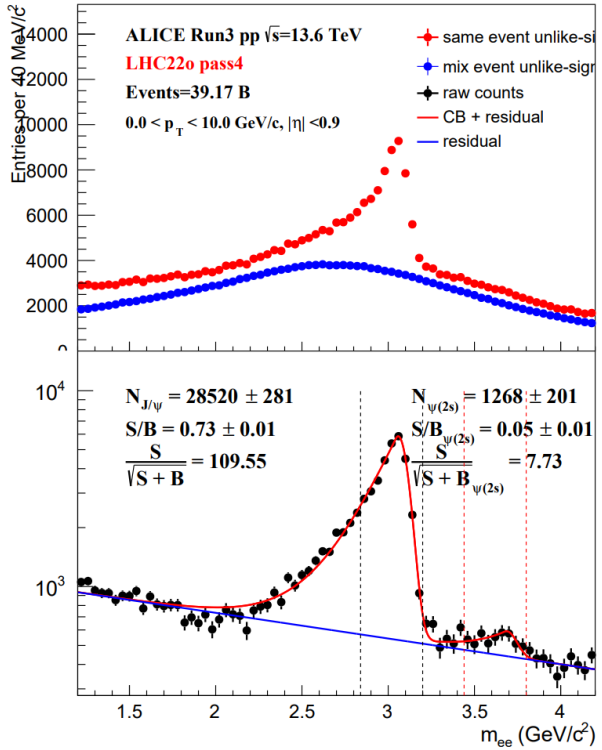
- The difference of efficiency between ψ(2s) and J/ψ will reduce to ~0.5% when we take p_T > 3 GeV/c.

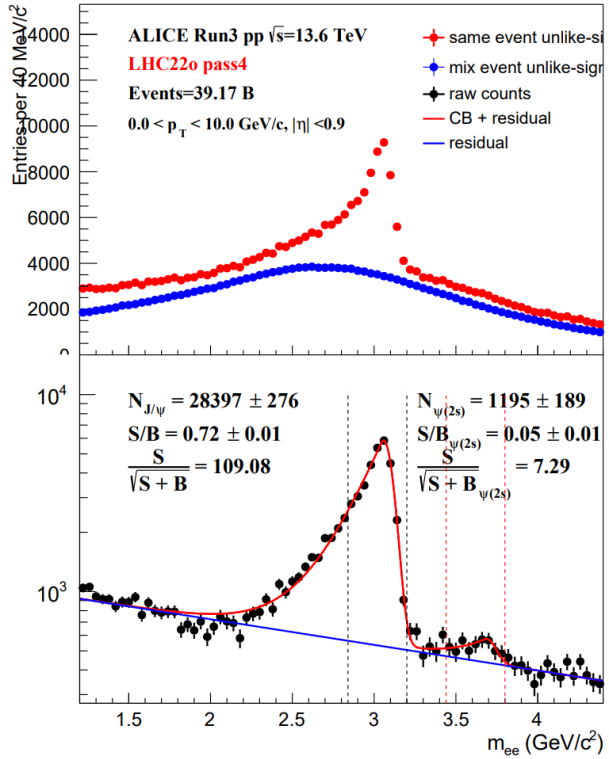
Summary

- Only ~7% of the total statistics are used for now. Xiaozhi is working on producing reduced tree.
- The mix event method is used for signal extraction, and the significance is improved. But the matching between mix event and same event is not very good, and it will be checked.
- Some source of systematic uncertainty are studied, and the study on other part of systematic uncertainty is ongoing.

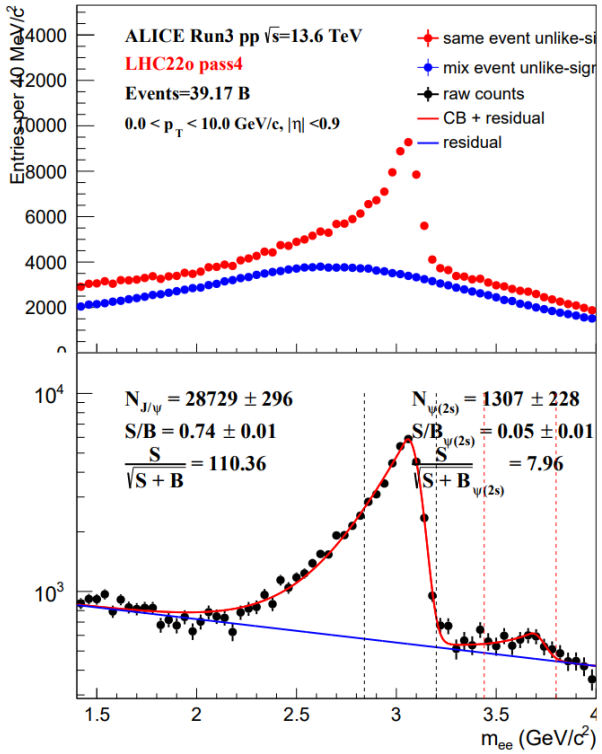
Back up

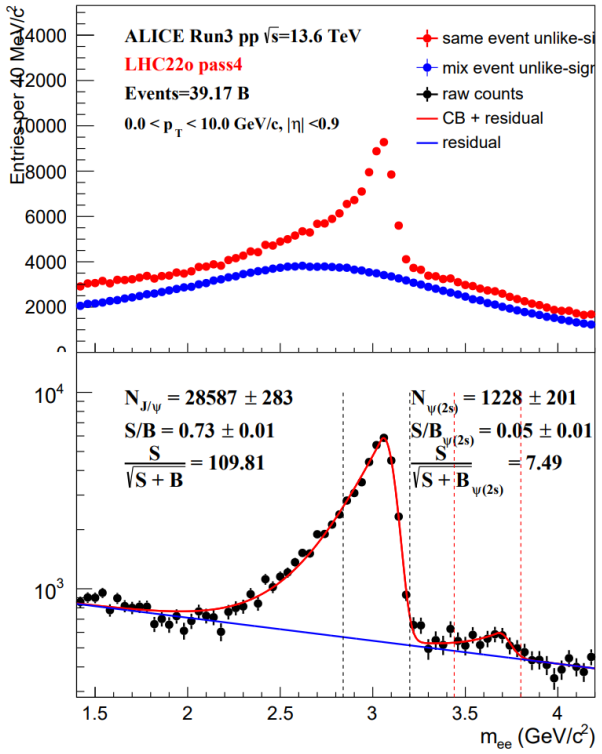

ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28718 ± 295
S/B = 0.74 ± 0.01
S/√(S+B) = 110.31
N_ψ(2s) = 1418 ± 226
S/B_ψ(2s) = 0.06 ± 0.01
S/√(S+B)_ψ(2s) = 8.65
m_ee (GeV/c²)

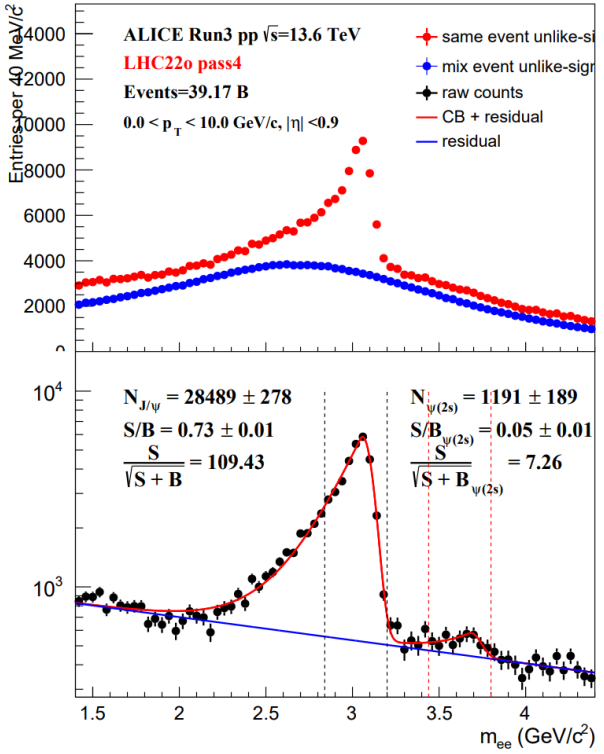

ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28520 ± 281
S/B = 0.73 ± 0.01
S/√(S+B) = 109.55
N_ψ(2s) = 1268 ± 201
S/B_ψ(2s) = 0.05 ± 0.01
S/√(S+B)_ψ(2s) = 7.73
m_ee (GeV/c²)


ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28397 ± 276
S/B = 0.72 ± 0.01
S/√(S+B) = 109.08
N_ψ(2s) = 1195 ± 189
S/B_ψ(2s) = 0.05 ± 0.01
S/√(S+B)_ψ(2s) = 7.29
m_ee (GeV/c²)

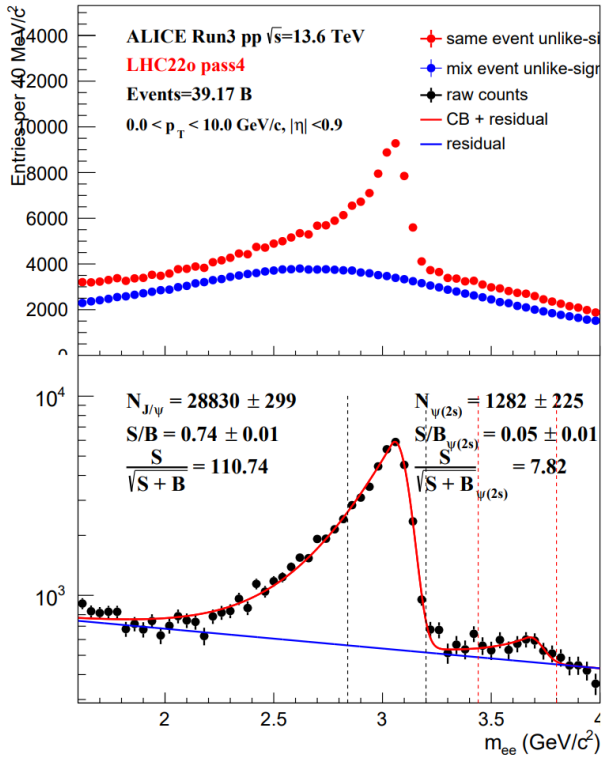
Back up

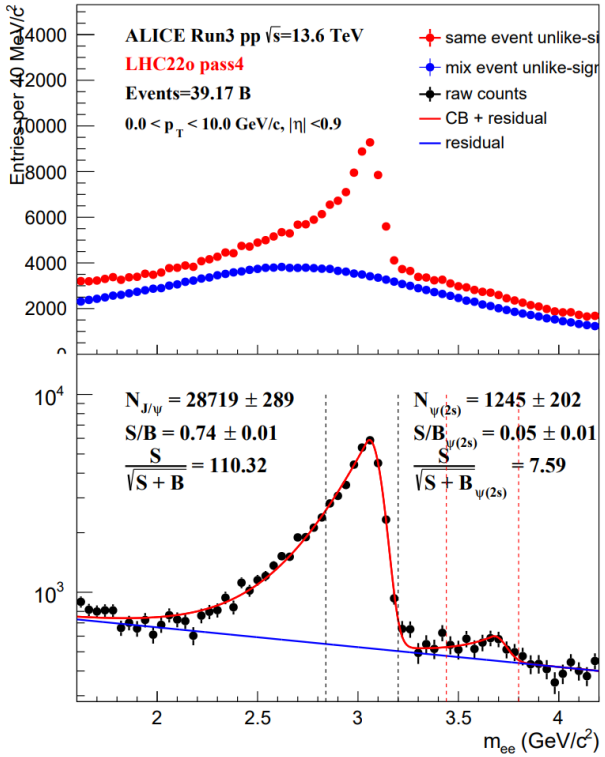

ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28729 ± 296
S/B = 0.74 ± 0.01
S/√(S+B) = 110.36
N_ψ(2s) = 1307 ± 228
S/B_ψ(2s) = 0.05 ± 0.01
S/√(S+B)_ψ(2s) = 7.96
m_ee (GeV/c²)

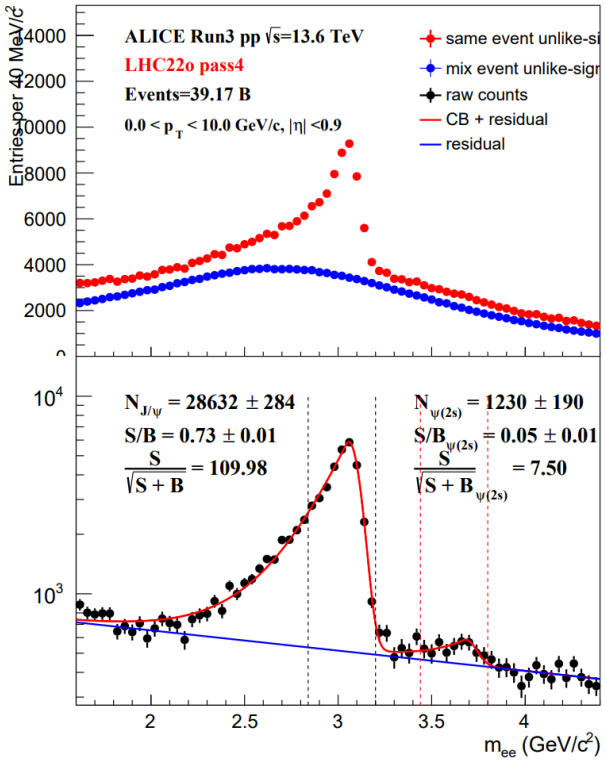

ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28587 ± 283
S/B = 0.73 ± 0.01
S/√(S+B) = 109.81
N_ψ(2s) = 1228 ± 201
S/B_ψ(2s) = 0.05 ± 0.01
S/√(S+B)_ψ(2s) = 7.49
m_ee (GeV/c²)


ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28489 ± 278
S/B = 0.73 ± 0.01
S/√(S+B) = 109.43
N_ψ(2s) = 1191 ± 189
S/B_ψ(2s) = 0.05 ± 0.01
S/√(S+B)_ψ(2s) = 7.26
m_ee (GeV/c²)

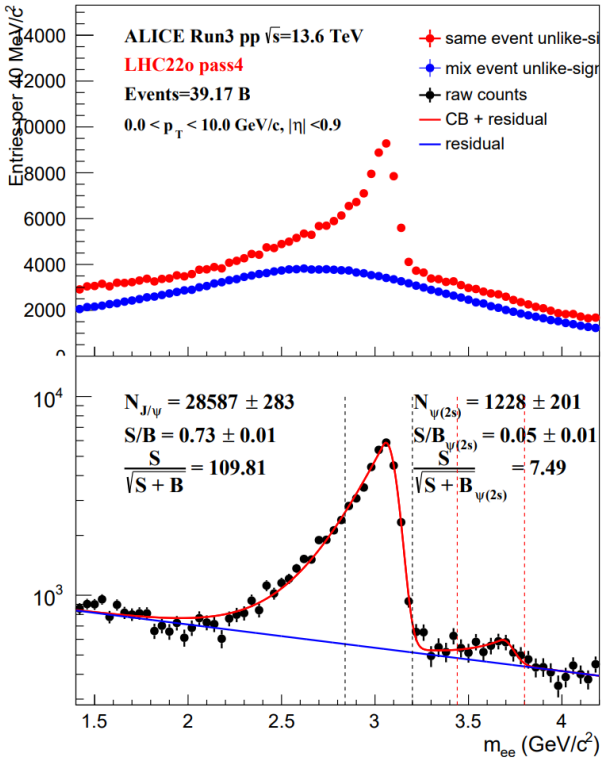
Back up


ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28830 ± 299
S/B = 0.74 ± 0.01
S/√(S+B) = 110.74
N_ψ(2s) = 1282 ± 225
S/B_ψ(2s) = 0.05 ± 0.01
S/√(S+B)_ψ(2s) = 7.82
m_ee (GeV/c²)

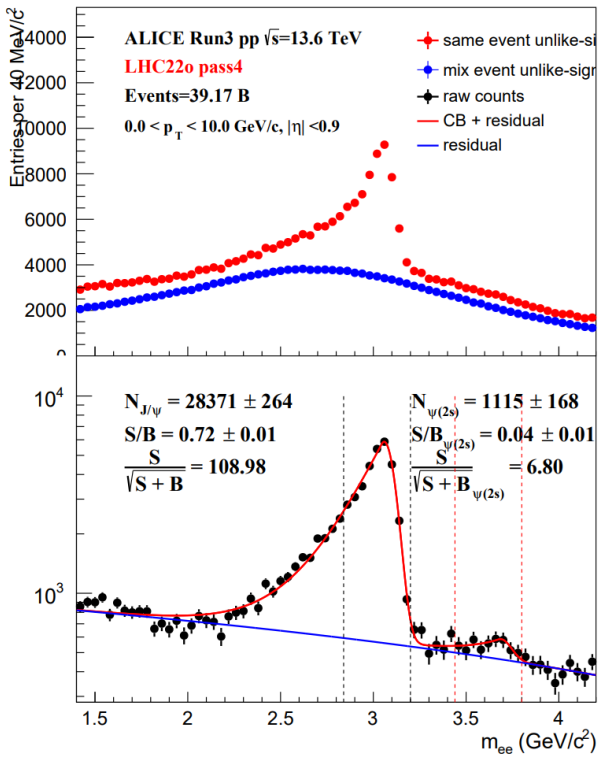

ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28719 ± 289
S/B = 0.74 ± 0.01
S/√(S+B) = 110.32
N_ψ(2s) = 1245 ± 202
S/B_ψ(2s) = 0.05 ± 0.01
S/√(S+B)_ψ(2s) = 7.59
m_ee (GeV/c²)


ALICE Run3 pp √s=13.6 TeV
LHC22o pass4
Events=39.17 B
0.0 < p_T < 10.0 GeV/c, |η| <0.9
same event unlike-si
mix event unlike-sign
raw counts
CB + residual
residual
Entries per 40 MeV/c²
N_J/ψ = 28632 ± 284
S/B = 0.73 ± 0.01
S/√(S+B) = 109.98
N_ψ(2s) = 1230 ± 190
S/B_ψ(2s) = 0.05 ± 0.01
S/√(S+B)_ψ(2s) = 7.50
m_ee (GeV/c²)

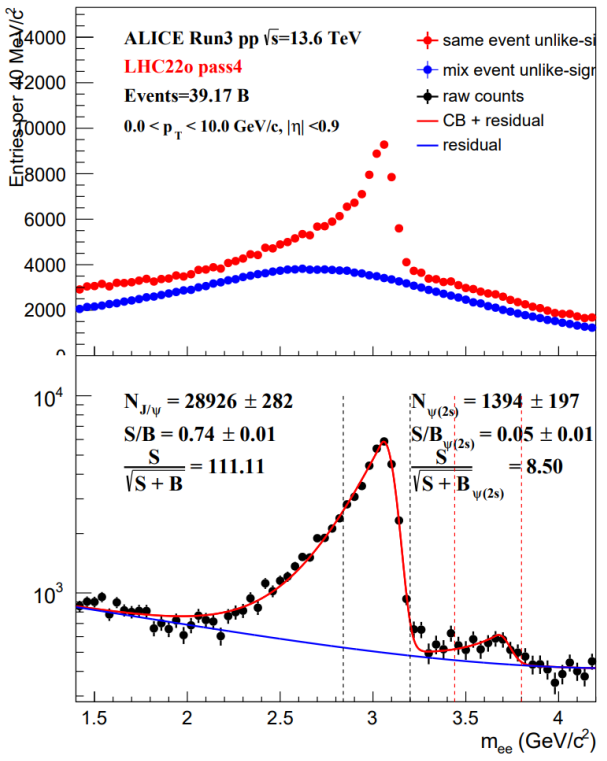
Back up



exp



exp_p0



exp_p1