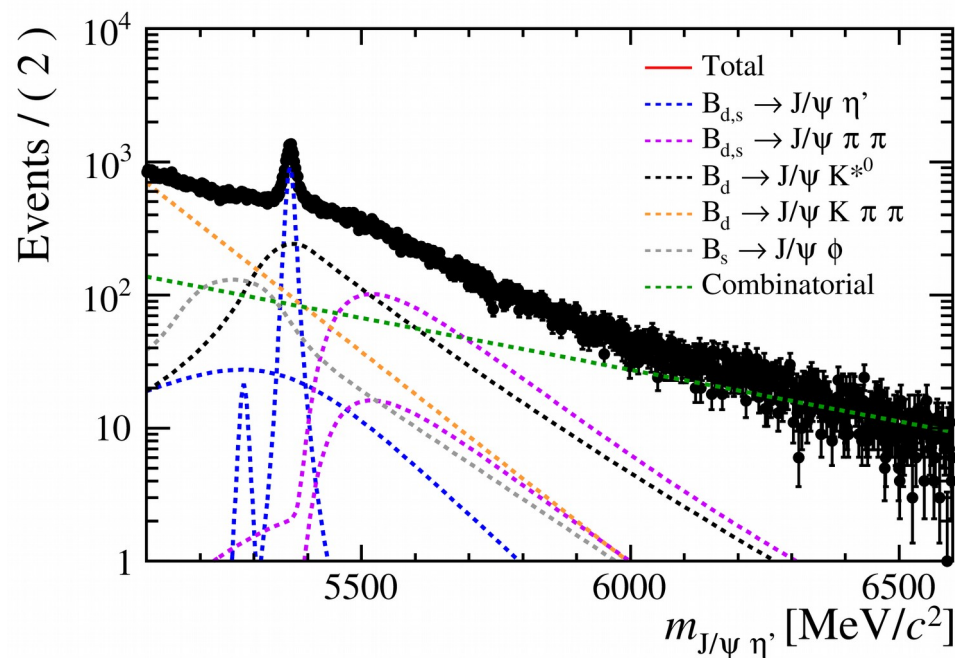


JpsiEtap, background vetoes

July 27th 2019, Annecy/Edinburgh meeting, M. Chefdeville

- Now, fit model has lots of components (which can't be checked against MC)
 - Improve purity: define optimal BDT cut for BR measurement (to be done)
 - Investigate impact of mass veto using DTF 4-vectors
 - Start with: Jpsipipi, Jpsipi
 - Other mass hypo: JpsiK, JpsiKpi, JpsiKK, JpsipK, Jpsippi
 - Also 2 -body mass: pipi, Kpi, KK, pK, piK
 - Pi0 veto against Phi2pipipi0 reco'ed as pipigamma + merged_pi0 bkg



Mass formula

- For 2-body decay to pi1pi2:

$$m^2 = (\text{pi1_PE} + \text{pi2_PE})^2 - (\text{pi1_PX} + \text{pi2_PX})^2 - (\text{pi1_PY} + \text{pi2_PY})^2 - (\text{pi1_PZ} + \text{pi2_PZ})^2$$

- Change mass hypo of pi1 to K1:

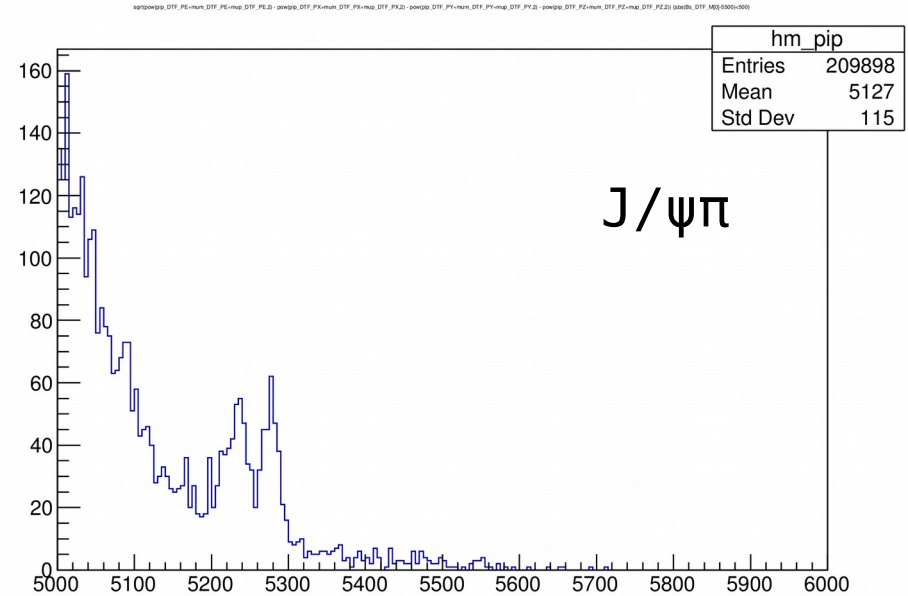
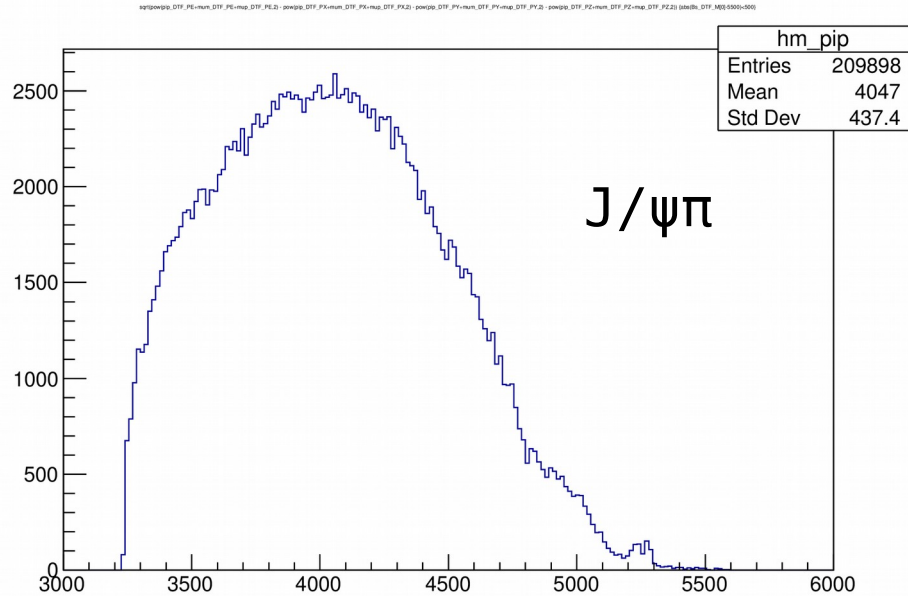
$$m^2 = (\sqrt{(\text{pi1_PX}^2 + \text{pi1_PY}^2 + \text{pi1_PZ}^2 + m_K^2)} + \text{pi2_PE})^2 - (\text{pi1_PX} + \text{pi2_PX})^2 - \dots$$

Jpsi h (h=pi)

- Use Run2 Ntuples with following cuts

$\text{PROBNNpi} \cdot (1 - \text{PROBNNk}) > 0.4 \ \&\& \ \text{abs}(\text{Jpsi_MM} - 3096) < 30 \ \&\& \ \text{abs}(\text{etap_MM} - 958) < 30 \ \&\& \ \text{BDT} > 0 \ \&\& \ \text{abs}(\text{Bs_DTF_M}[0] - 5500) < 500$

- Calculate Jpsih invariant mass for 1 of the 2 pions only. Can probably do better by choosing one according to its PID (but wasn't saved when slimming the Ntuples).

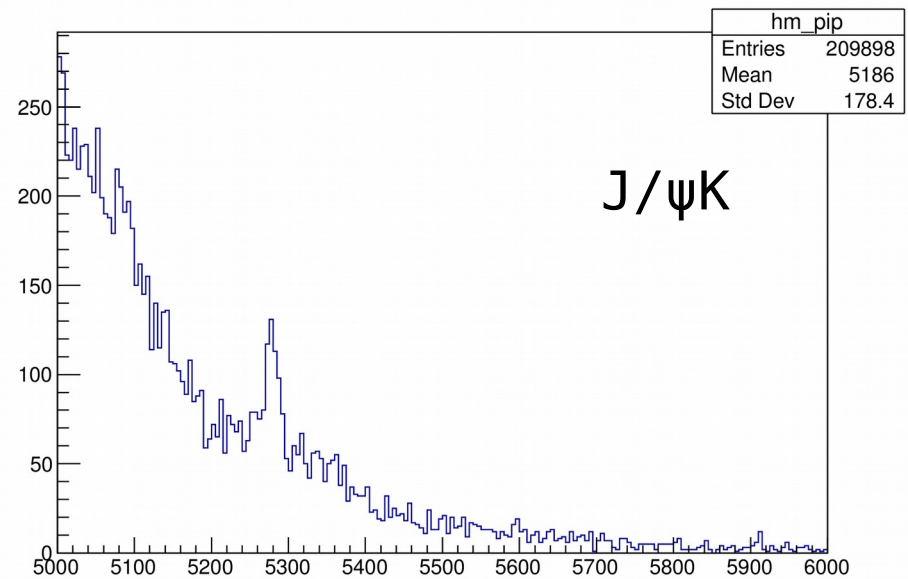
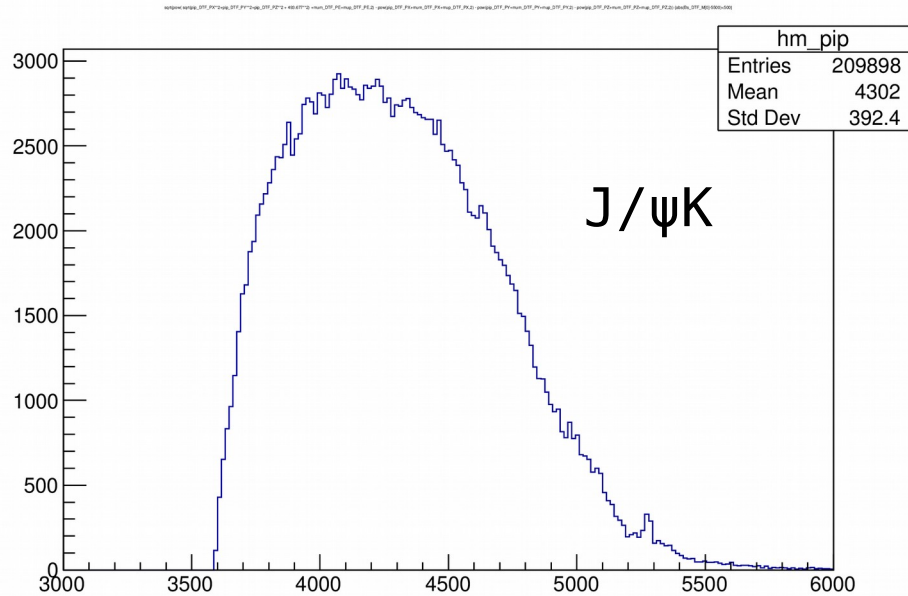


Jpsi h (h=K)

- Use Run2 Ntuples with following cuts

$\text{PROBNNpi} \cdot (1 - \text{PROBNNk}) > 0.4 \ \&\& \ \text{abs}(\text{Jpsi_MM} - 3096) < 30 \ \&\& \ \text{abs}(\text{etap_MM} - 958) < 30 \ \&\& \ \text{BDT} > 0 \ \&\& \ \text{abs}(\text{Bs_DTF_M}[0] - 5500) < 500$

- Calculate Jpsih invariant mass for 1 of the 2 pions only. Can probably do better by choosing one according to its PID.

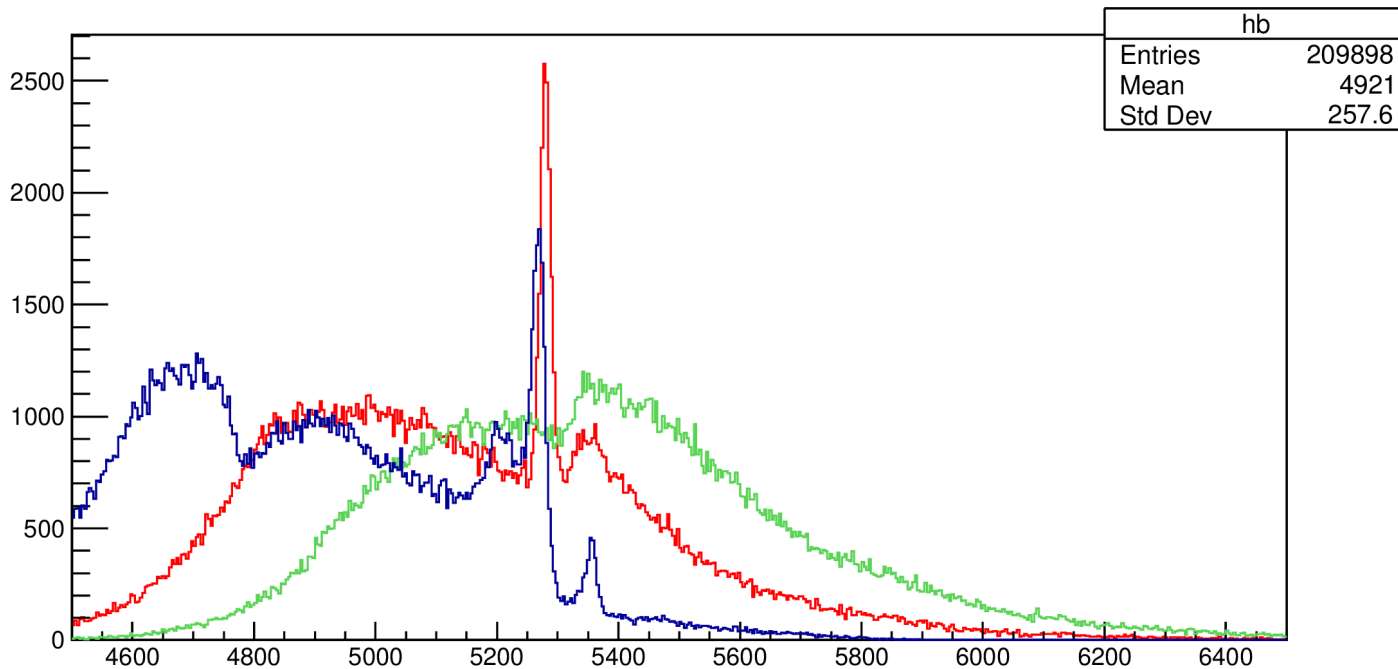


Jpsi hh (hh=pi pi, pi K, KK)

- Use Run2 Ntuples with following cuts

$$\text{PROBNN}_{\text{pi}} \cdot (1 - \text{PROBNN}_{\text{k}}) > 0.4 \ \&\& \ \text{abs}(\text{Jpsi_MM-3096}) < 30 \ \&\& \ \text{abs}(\text{etap_MM-958}) < 30 \ \&\& \ \text{BDT} > 0 \ \&\& \ \text{abs}(\text{Bs_DTF_M}[0] - 5500) < 500$$

- No PID substitution: $B(d,s)2J_{\psi}P_iP_i$.
- P_i -to- K substitution: $B(d,s)2J_{\psi}K^*$. Double substitution: small $J_{\psi}\Phi[KK]$?

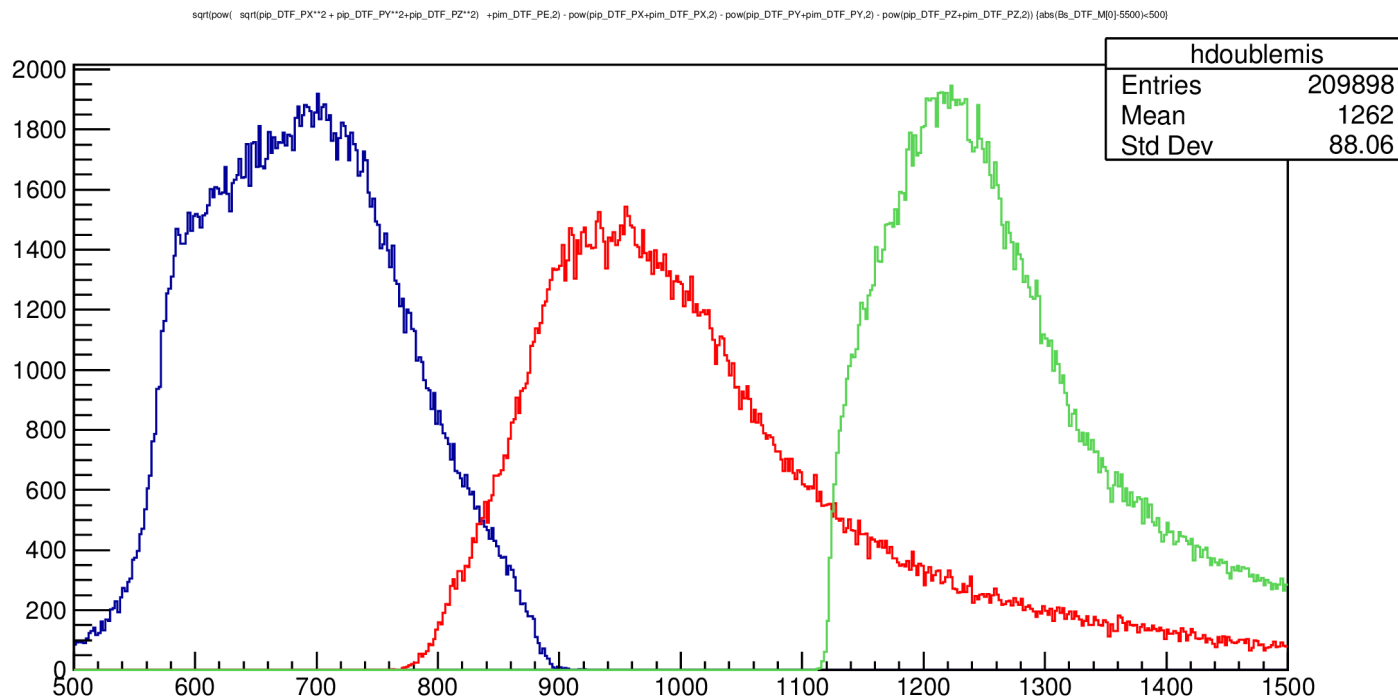


hh (hh= pipi, piK, KK)

- Use Run2 Ntuples with following cuts

$\text{PROBNN}_{\pi^i}(1-\text{PROBNN}_k) > 0.4 \ \&\& \ \text{abs}(\text{Jpsi_MM}-3096) < 30 \ \&\& \ \text{abs}(\text{etap_MM}-958) < 30 \ \&\& \ \text{BDT} > 0 \ \&\& \ \text{abs}(\text{Bs_DTF_M}[0]-5500) < 500$

- No PID substitution: resonant pipi mass around rho0
- Pi-to-K (double) substitution: no striking features (K^* hidden by bkg).

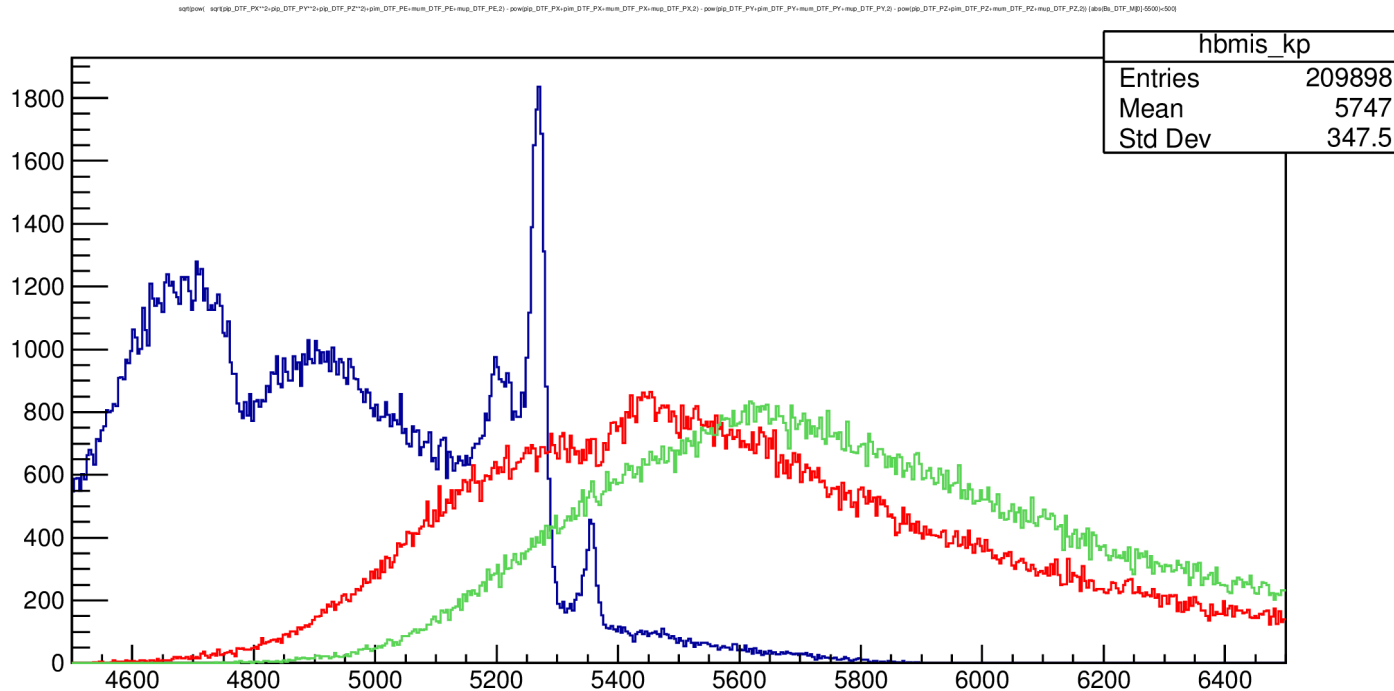


Jpsi hh (hh=pipi, pip, Kp)

- Use Run2 Ntuples with following cuts

$\text{PROBNNpi} \cdot (1 - \text{PROBNNk}) > 0.4 \ \&\& \ \text{abs}(\text{Jpsi_MM} - 3096) < 30 \ \&\& \ \text{abs}(\text{etap_MM} - 958) < 30 \ \&\& \ \text{BDT} > 0 \ \&\& \ \text{abs}(\text{Bs_DTF_M}[0] - 5500) < 500$

- No PID substitution: B(d,s)2JpsiPiPi.
- Pi-to-p (double) substitution: no striking features ($m(\Lambda_{b0}) = 5619 \text{ MeV}$).

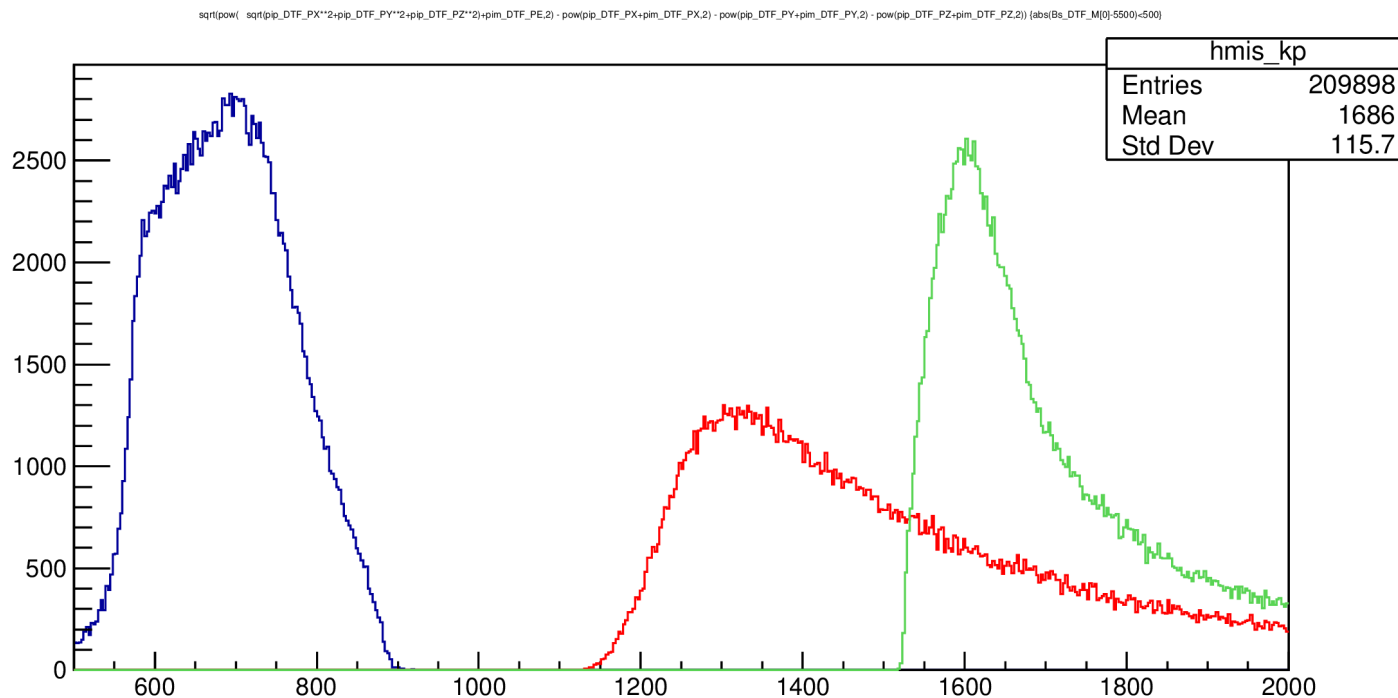


hh (hh=ppi, pip, Kp)

- Use Run2 Ntuples with following cuts

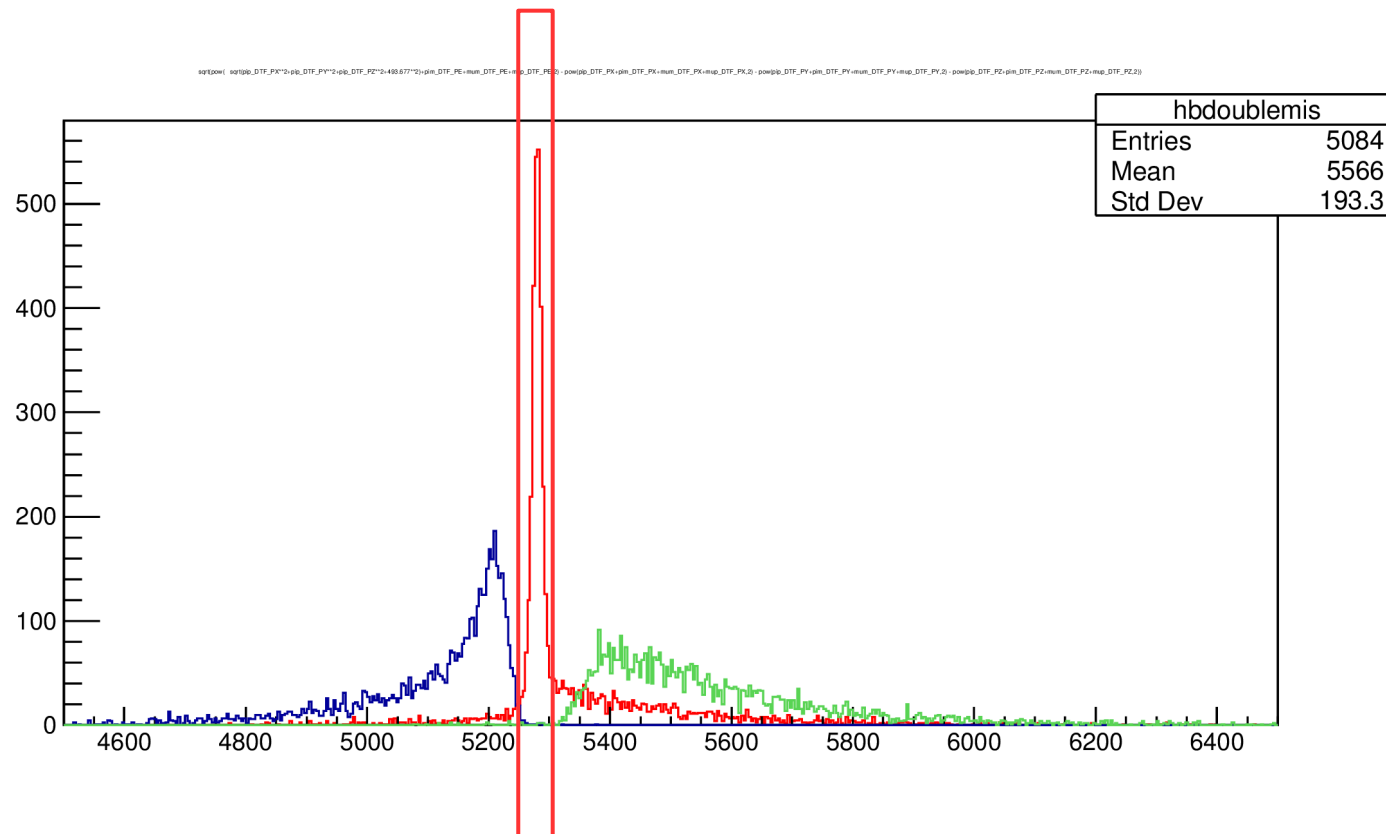
$\text{PROBNN}_{\pi^i} \cdot (1 - \text{PROBNN}_k) > 0.4 \ \&\& \ \text{abs}(\text{Jpsi_MM} - 3096) < 30 \ \&\& \ \text{abs}(\text{etap_MM} - 958) < 30 \ \&\& \ \text{BDT} > 0 \ \&\& \ \text{abs}(\text{Bs_DTF_M}[0] - 5500) < 500$

- No PID substitution: B(d,s)2JpsiPiPi.
- Pi-to-p (double) substitution: no visible structure ($m(\Lambda) = 1115 \text{ MeV}$).



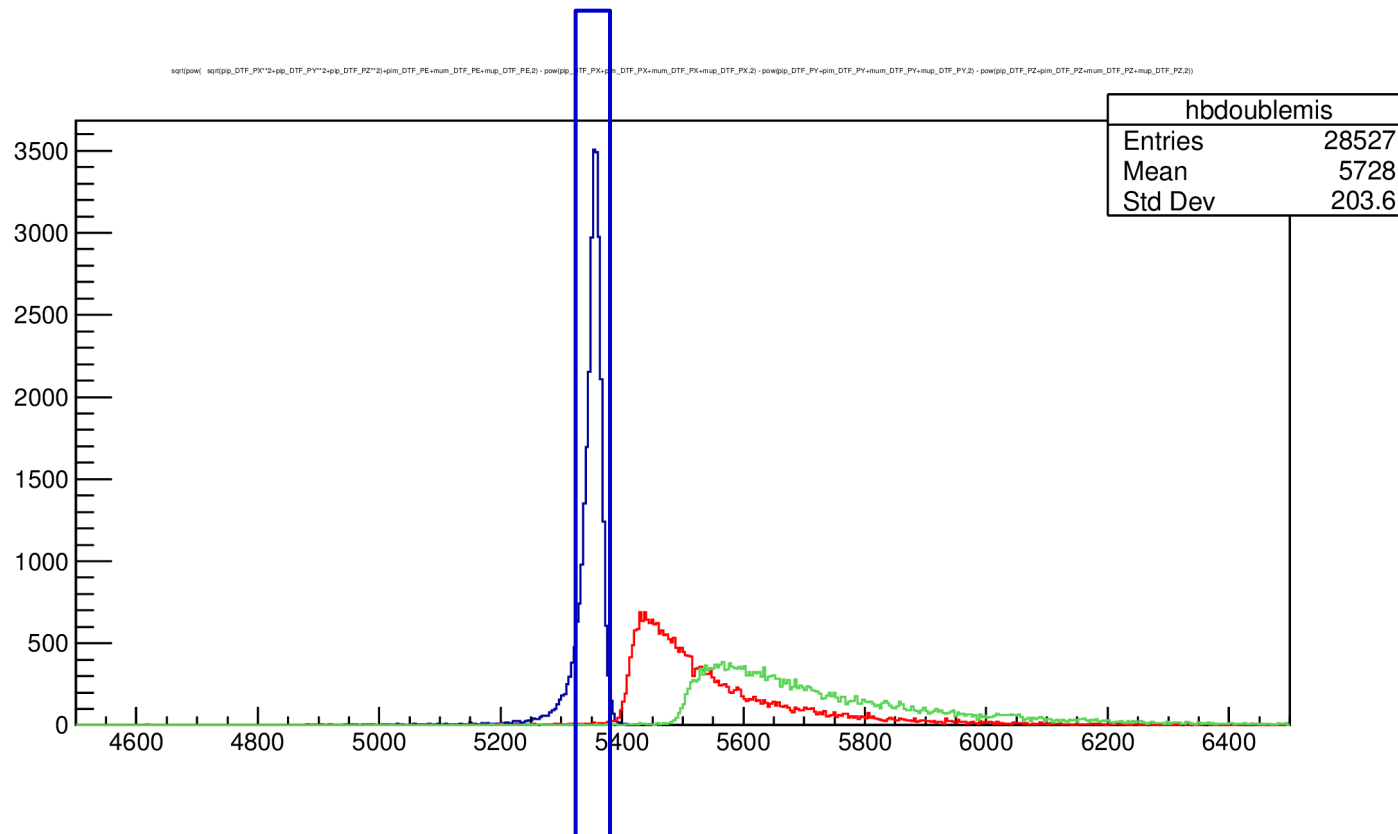
Jpsi hh(pi,K) on MC JpsiK*

- So far, only JpsiK* and JpsiPiPi vetoes seem useful
- Compare with signal



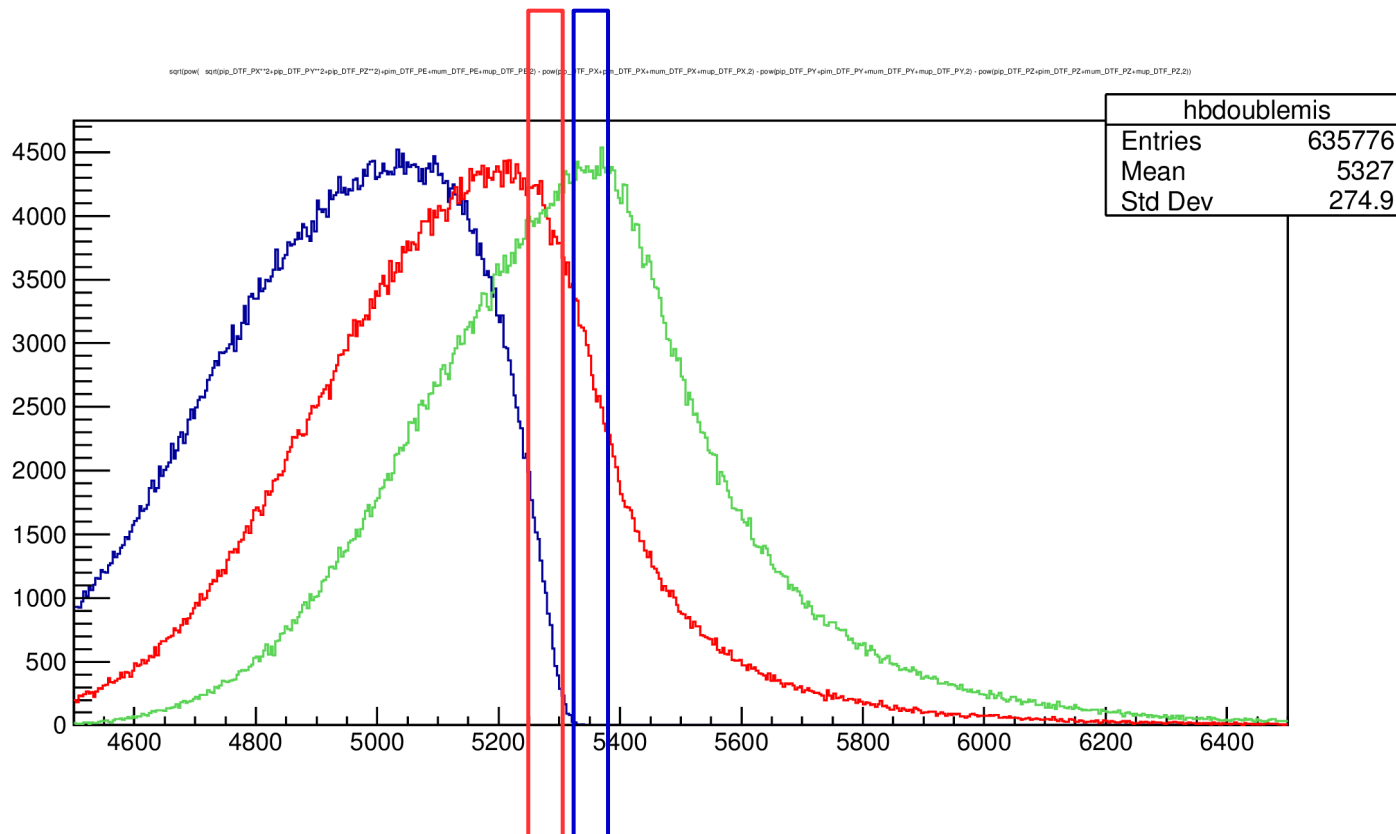
Jpsi hh(pi,K) on MC JpsiPiPi

- So far, only JpsiK* and JpsiPiPi vetoes seem useful
- Compare with signal



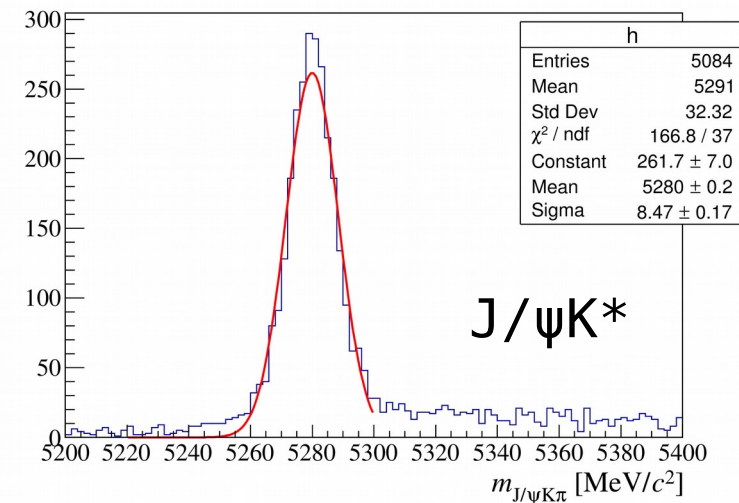
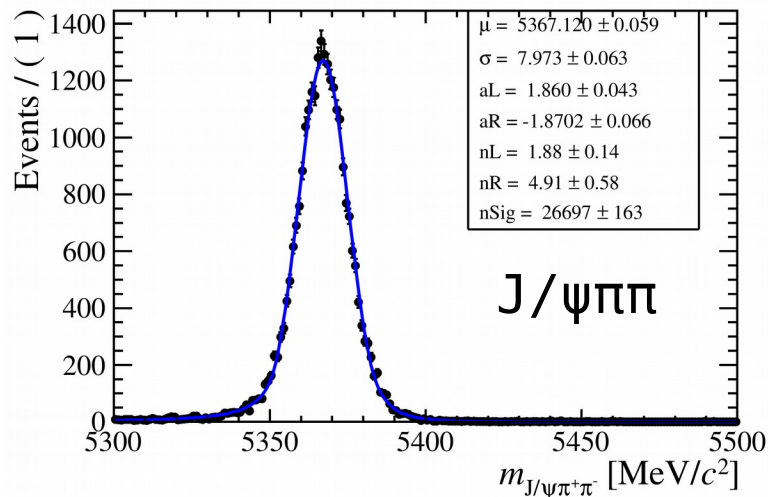
Jpsi hh(pi,K) on MC signal

- So far, only JpsiK* and JpsiPiPi vetoes seem useful
- Compare with signal



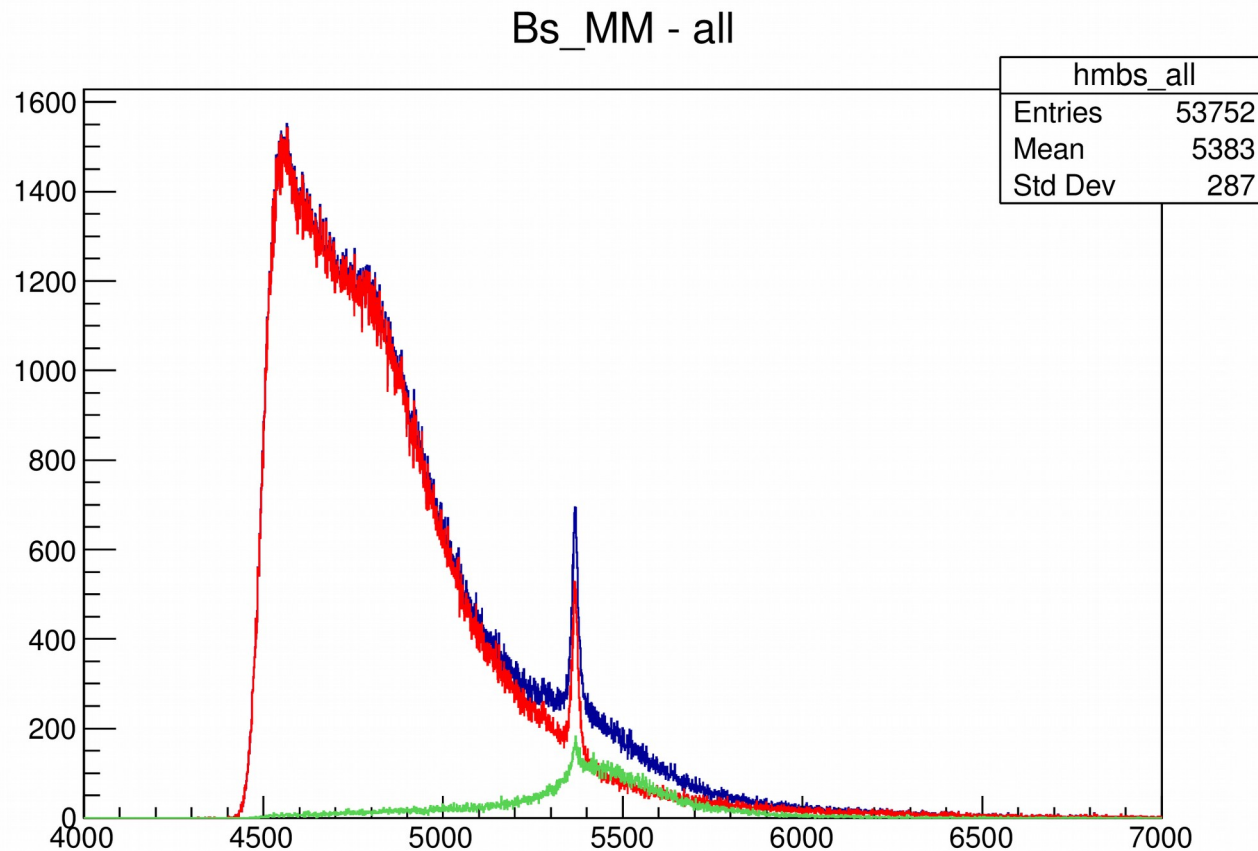
Mass veto

- JpsiPiPi veto, use 2σ window (left): $\text{abs}(m-m_B) > 16 \text{ MeV}$
 - MC efficiency for Bs mode of 9.8%
- JpsiK* veto (right): $\text{abs}(m-m_B) > 16 \text{ MeV}$
 - MC efficiency of 6.4%
 - Require Jpsipi1(pi2 $\rightarrow$ K2) or Jpsipi2(pi1 $\rightarrow$ K1) to fall in window



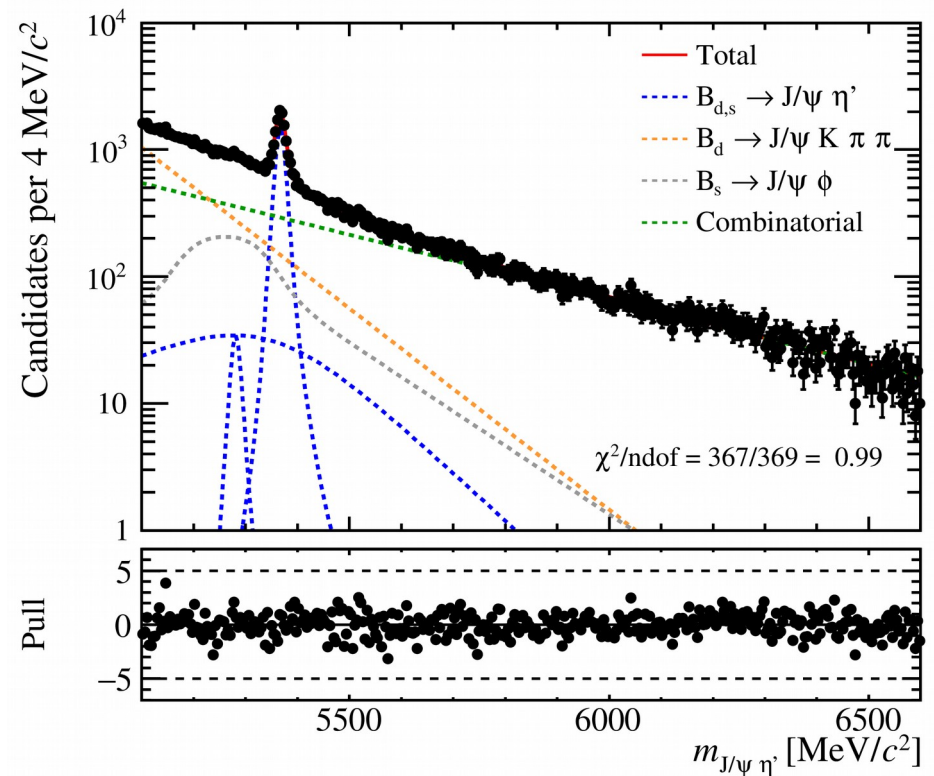
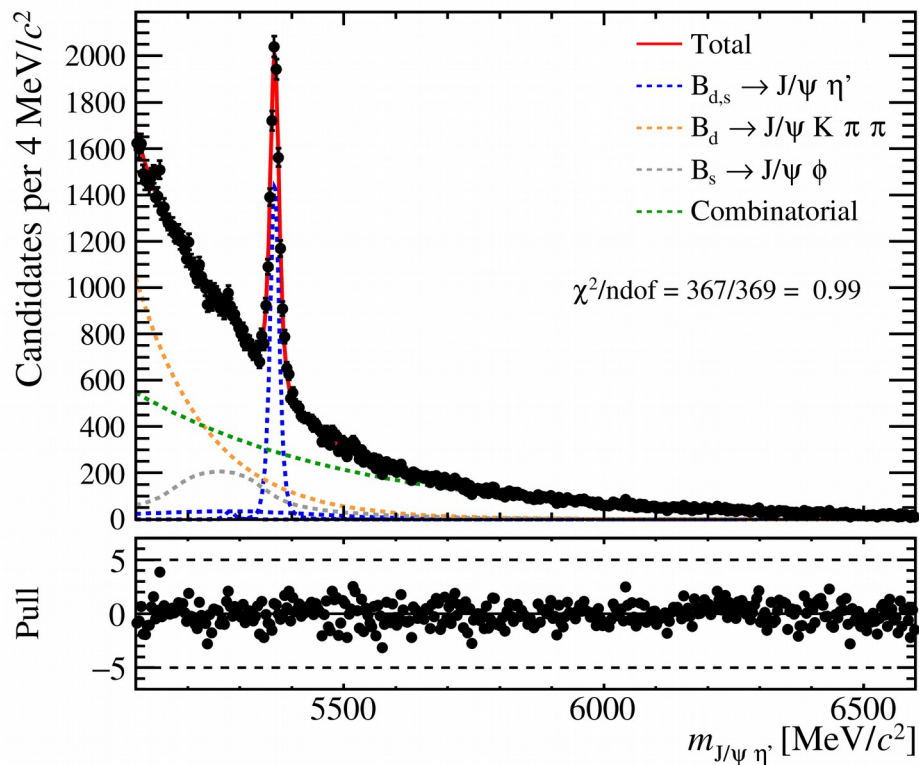
Apply on data

- In signal region $[5,6]$ MeV/c²: veto efficiency of 77%.
- Efficiency on MC signal: 87%



Mass fit

- Ignore JpsiPiPi and JpsiKst
- Keep JpsiPhi, JpsiKpipi and signal pdfs
- About 9k signal candidates



Outlook

- Fine-tune the mass windows used to veto bkg.
- $J_{\psi}K^*$: apply to pion with largest ProbNNk and not to both
- Replace PID cut against $J_{\psi}\Phi[KK]$ by veto? (PID signal efficiency of 92%)
- Study π^0 _veto: MC eff. for signal is 72%, VS 41% for $\Phi[\pi^+\pi^-\pi^0]$.
Check on data.
- Find optimal BDT cut using cut-and-fit method
- Normalise to $J_{\psi}K^*$ when new signal MC available (“no time estimate”)