Mass fit of JpsiK*$^{+}$

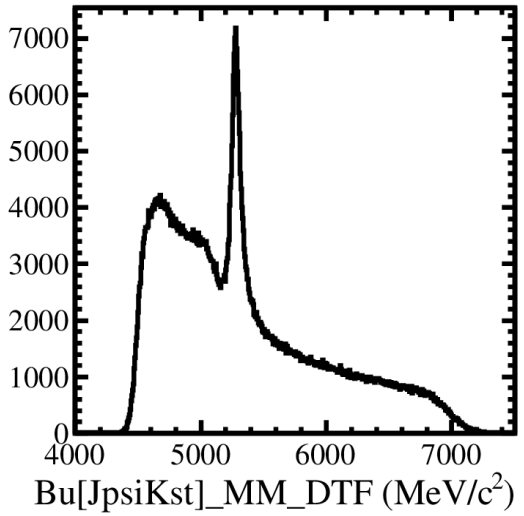
March 29th 2019, Annecy/Edinburgh meeting, M. Chefdeville

Status

- During last 2 weeks: try to better constrain the fit
  - Look at JpsiK invariant mass of JpsiK* candidates
  - Fix contributions from combinatorics (e.g. $\mu\mu$, $\gamma\gamma$)

    & a word on multi-dimensional mass fits

Reminder

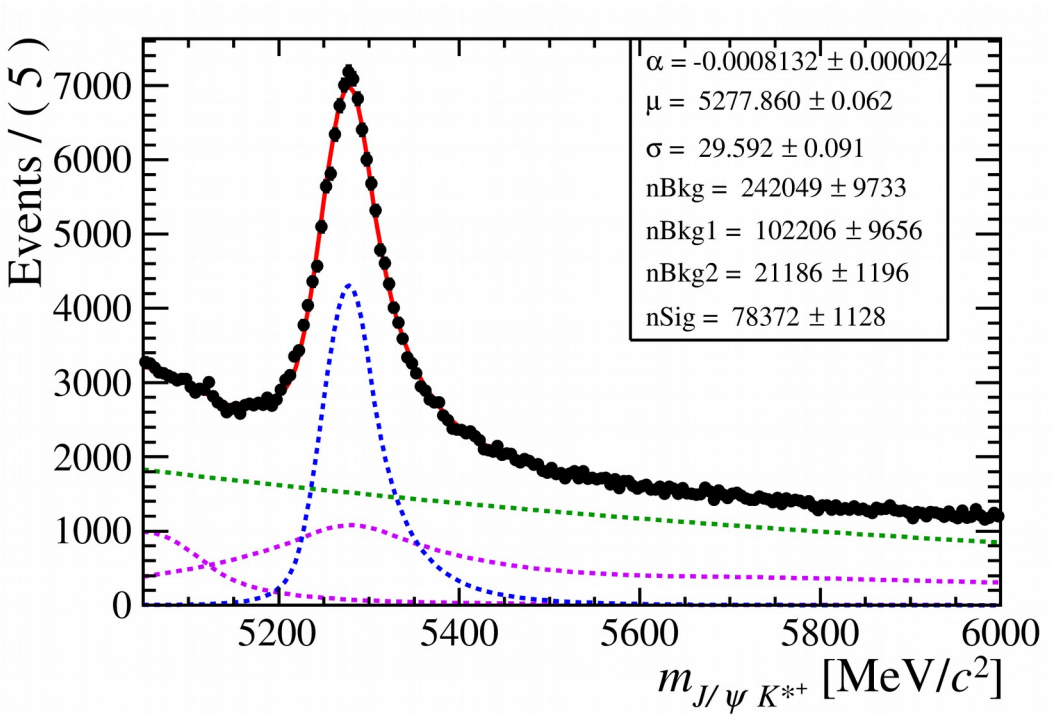


Run II data: rather loose cuts expect for pi0

CL(g1,g2)>0.05, PT(pi0)>1.5 GeV/c, PROBNNk(K^+)>0.1,
$\Delta m(K^{*+})$=150 MeV/c^2, Δm(pi0)=30 MeV/c^2, Δm(Jpsi)=100 MeV/c^2
DIRA>0.9995, IP<0.2, IPCHI2<20, VTXCHI2/NDOF<10
Fisher(B^+)>-1.1

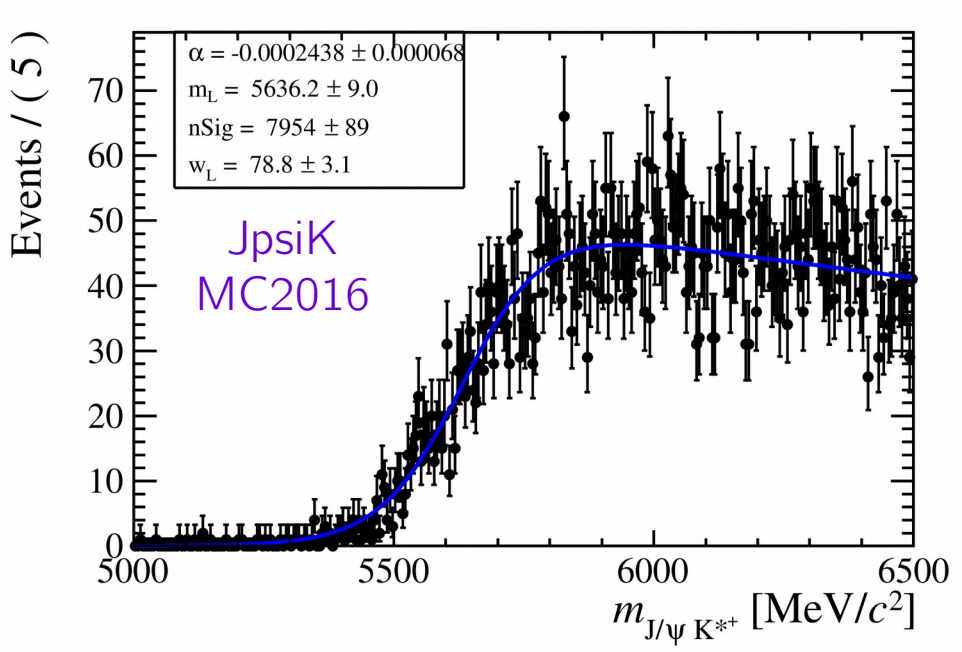
Current fit

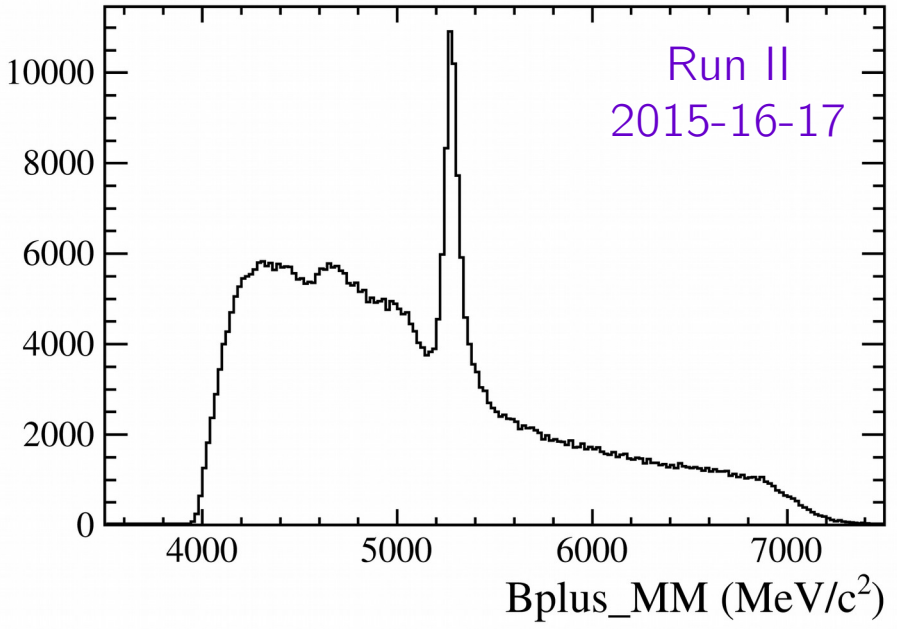
* Signal (expect twice more)
* Combinatorics (all kind...)
* $JpsiK_1$ and peaking bkg.
* Peaking bkg:
  - mix of JpsiK, JpsiK*[$g\bar{g}$], JpsiK*[$\overline{gg}$]
  - relative yields fixed to MC
  - yield relative to signal
    1.6 times higher than expected



Contribution from JpsiK

- Expected yield & shape from 2016 s28r1 MC sample
- No JpsiK mass in latest Ntuples, however, it was saved in a previous production:
  - Not possible to aligned the cuts exactly (small differences in vertex cuts & Fisher)
  - Fraction of Run II data: 2015-2016-2017 (didn't check the lumi yet...)
- A new 2017 production (with JpsiK mass) was launched for validation



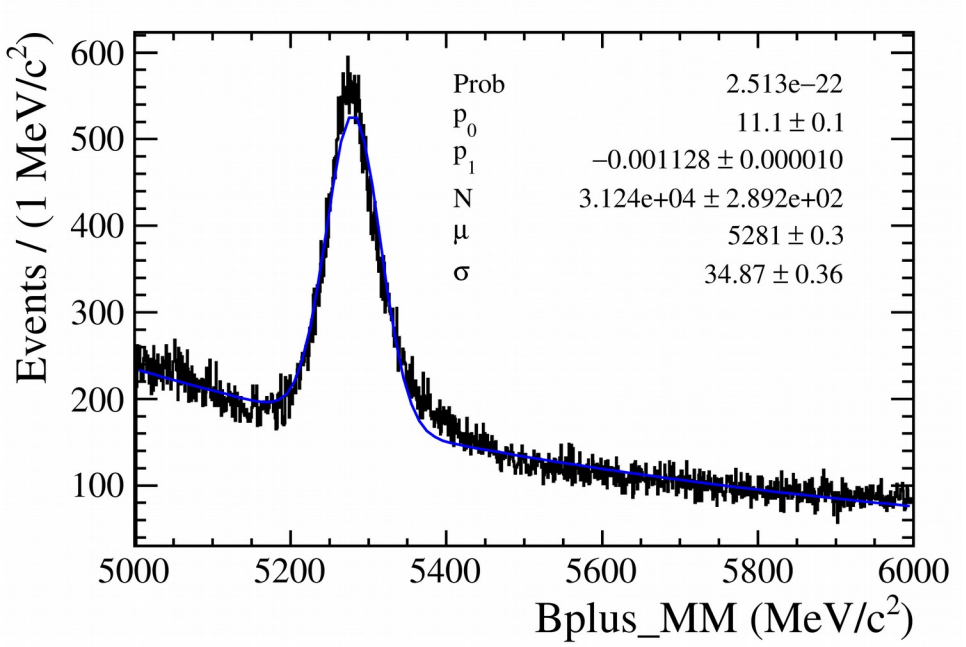


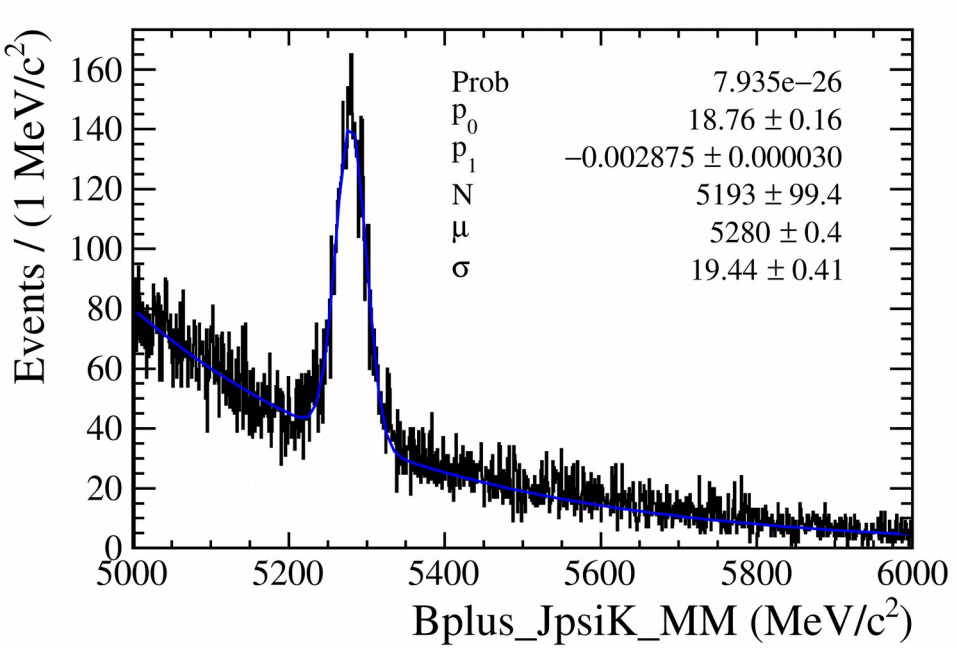
JpsiK yield

- Simplest fit used: exponential bkg + gaussian signal

  N(JpsiK*$^+$) = 31240 +/- 300 events, N(JpsiK$^+$) = 5193 +/- 100 events

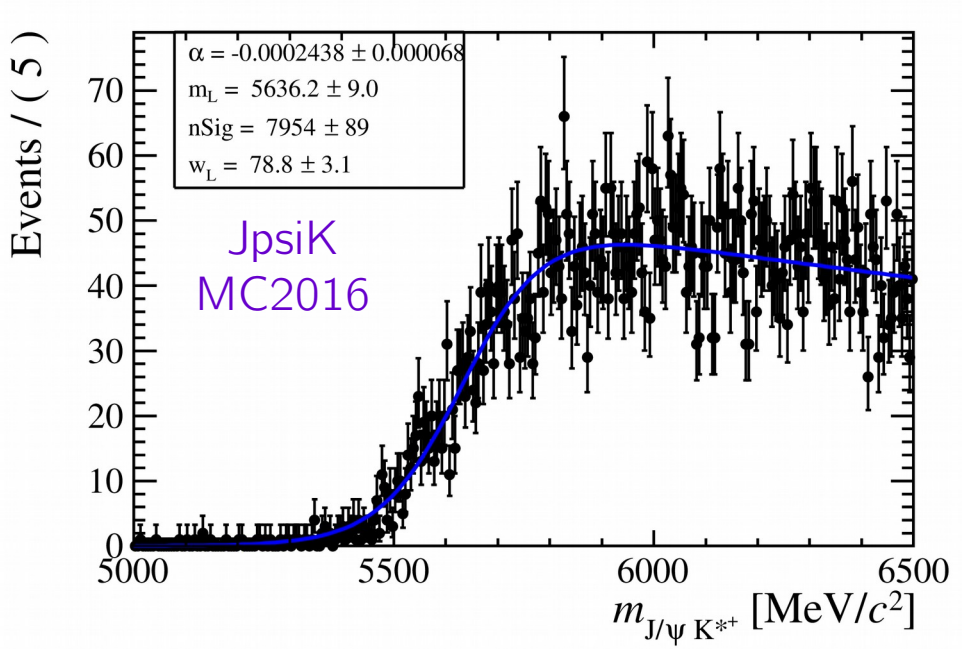
- Comparison of ratios: this fit result is close to MC predictions (modulo combinatorics)
  - This fit (below): N(JpsiK$^+$) / N(JpsiK*$^+$) = 16.6%
  - Full Run II fit: (nBkg1 . 18%) / nSig = (102206 . 18%) / 78372 = 23.5%
  - MC: ε.BR (JpsiK*$^+$) / ε.BR (JpsiK$^+$) = 14.3% (data/MC combi ratio of 1.17 → 16.7%)
- Relative yield seems correct → could fix peaking bkg yields to signal yield

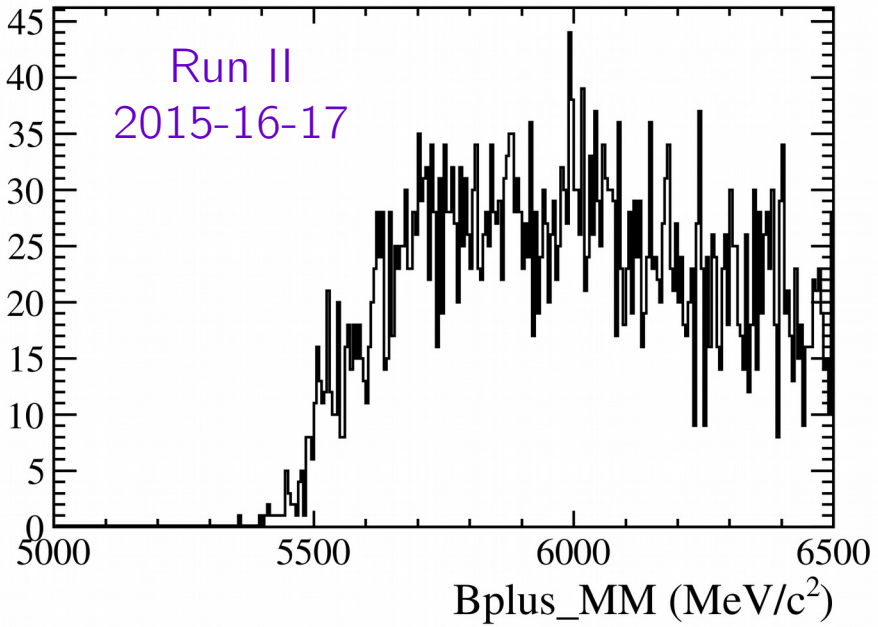




JpsiK shape

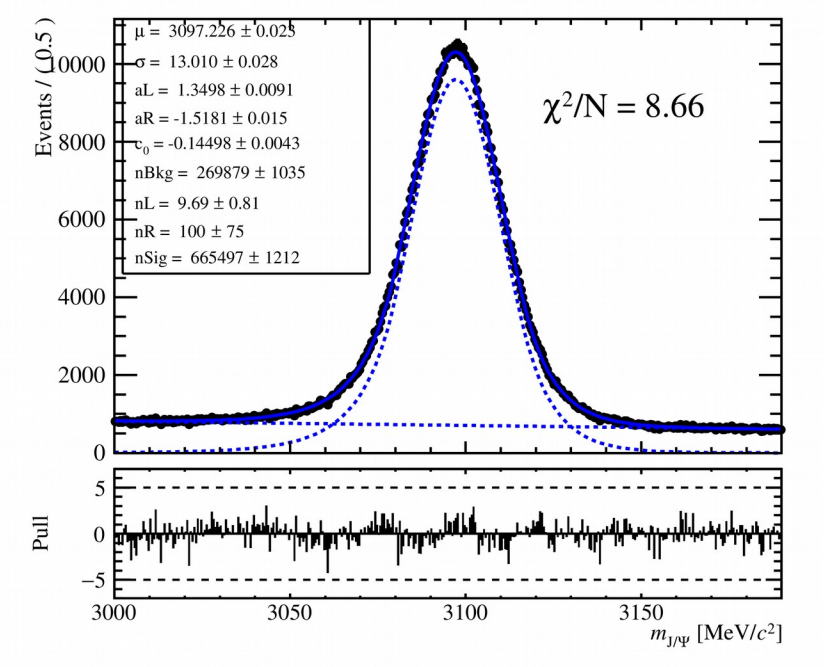
- Looking at JpsiK* mass for events around JpsiK peak @ 5280 MeV/c^2 (3σ cut $\rightarrow$ 120 MeV/c^2 wide mass window
  - Subtract combinatorial contribution using events centered @ 5380 MeV/c^2
  - Shapes are similar, in particular inflexion point and width
  - Will do the fit

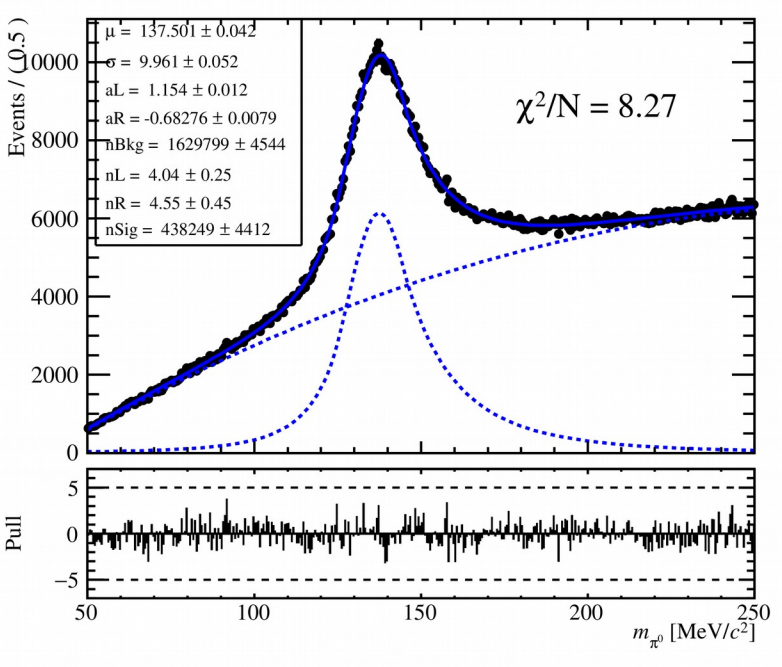




A focus on combinatorics

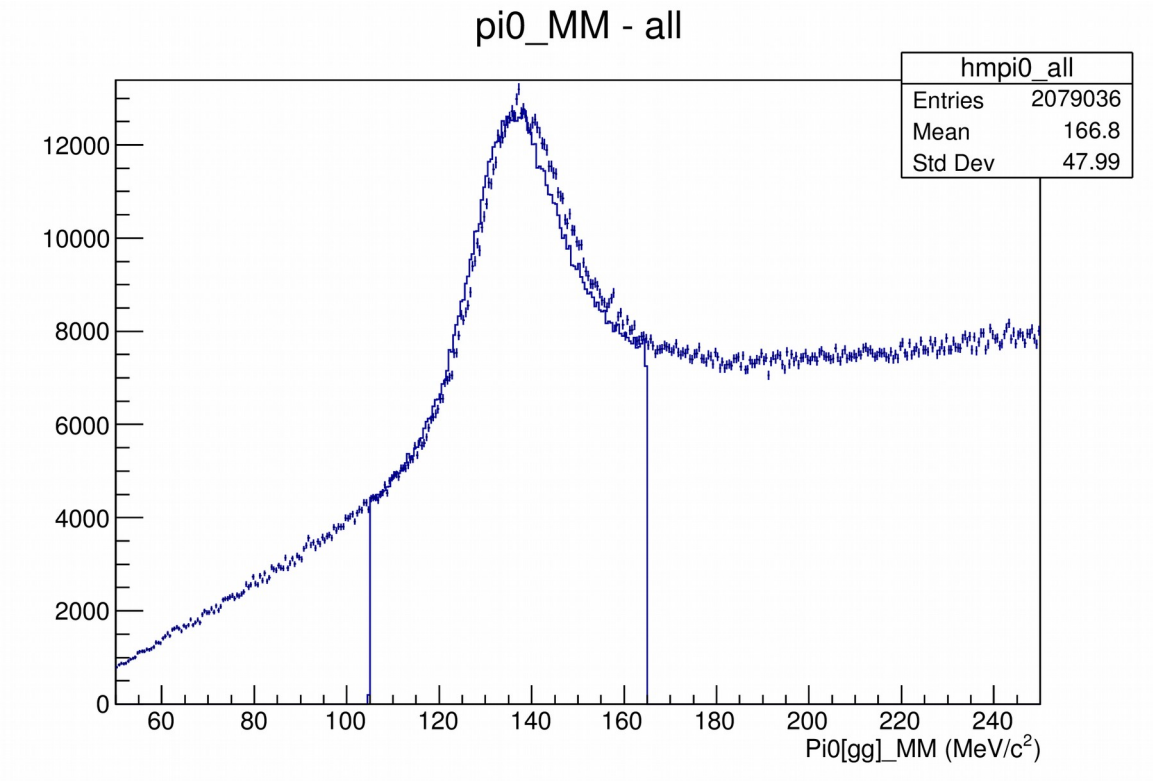
- Combinatorics: mainly $\gamma\gamma$, $\mu\mu$ ($\pi^0 K^+$)
  - Is a single exponential sufficient? Can we get rid of it without BDT cut?
- Know and fix its yield
  - Fit signal & bkg yields to Jpsi and pi0 mass distributions
- Use Run II Jpsi, and previous Run I production with large sideband pi0
  - Jpsi combinatorics: 29% of candidates are fake over full mass range
  - Pi0 combinatorics (tricky fit): 56% of fake over [105,165] MeV/c^2 range





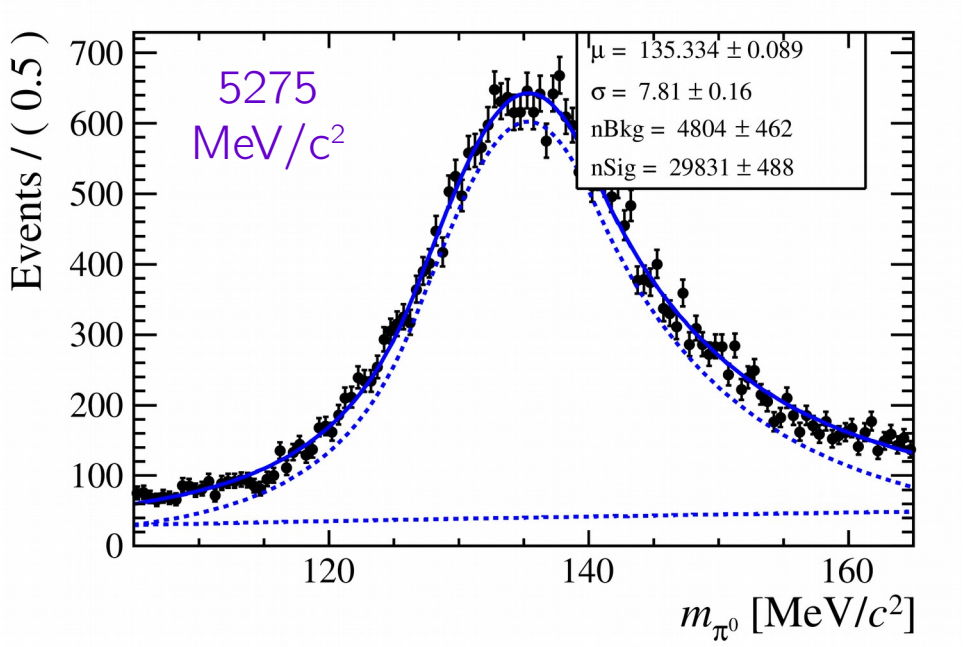
Apparté

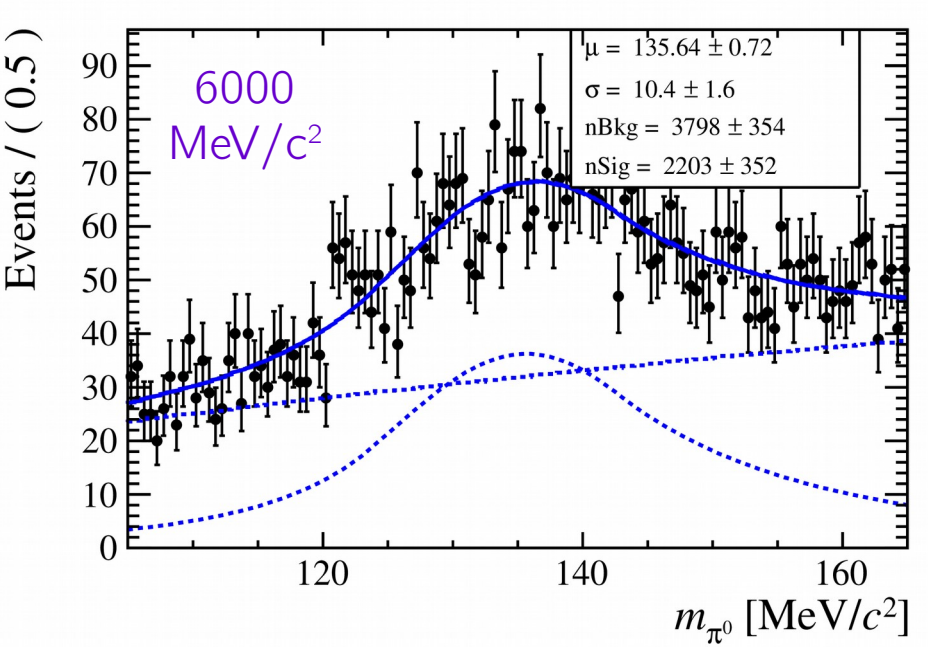
- Run I versus Run II pi0 mass distributions (from JpsiK* Ntuples)
  - Agree quite well (with PT > 1.5 Ge/c)
  - OK to use the Run I shape for Run II fit



Mass shapes from pi0-combinatorics

- We can now fix the relative yields of fakes Jpsi & pi0 wrt to true... OK.
- Further info: determine their shapes
  - Do the Jpsi and pi0 fits in bins of Bmass → nSig(Bplus_MM) & nBkg(Bplus_MM)
  - This also provides bkg-subtracted Bmass distributions
- Example: using 80 Bmass bins of 25 MeV/c^2
  - Use Jpsi & pi0 shapes from previous fits, let yields to float (& bkg c_0 for Jpsi)





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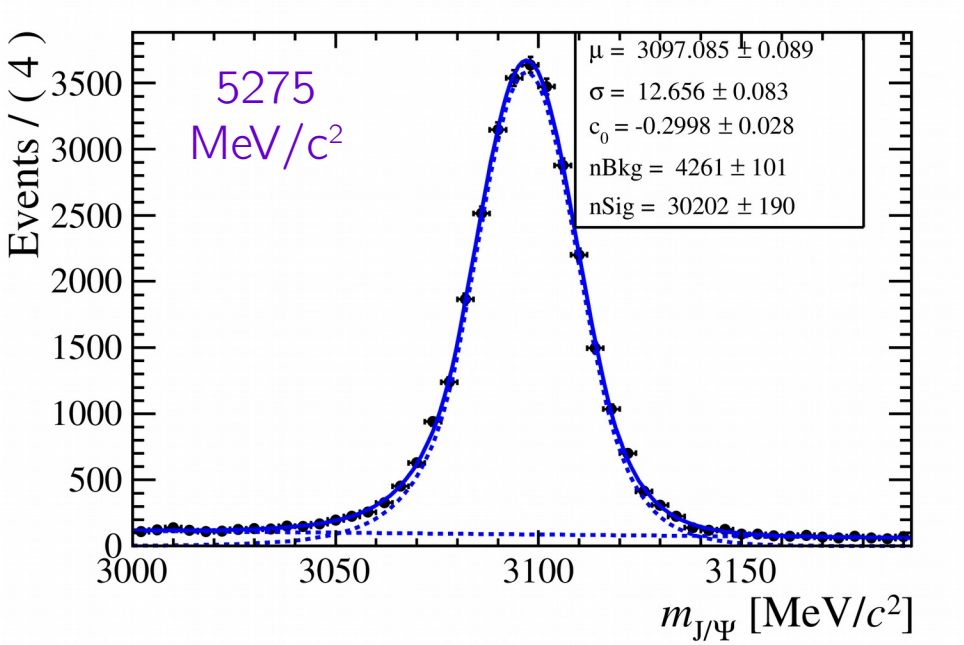
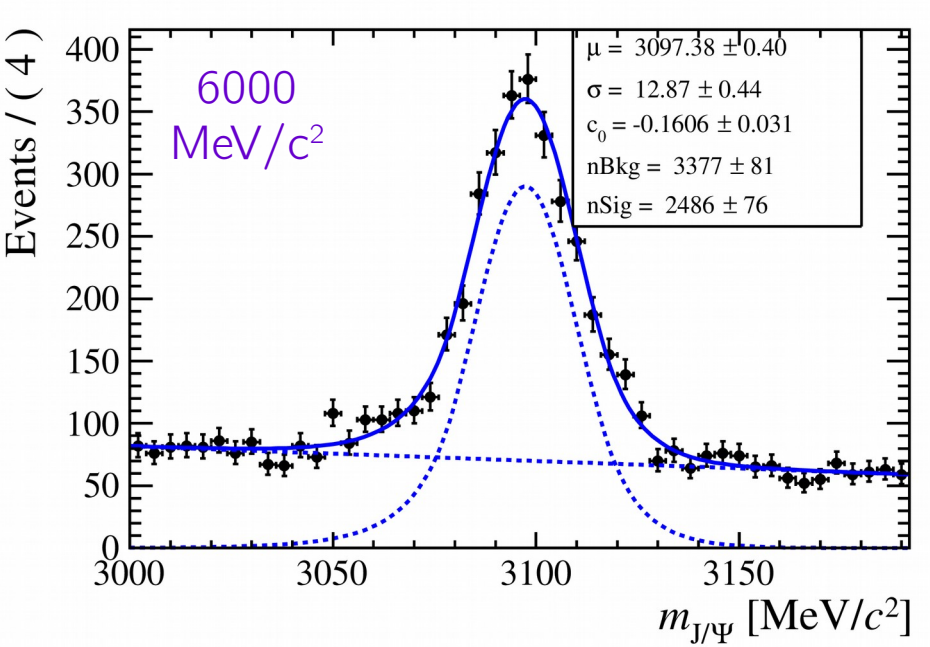
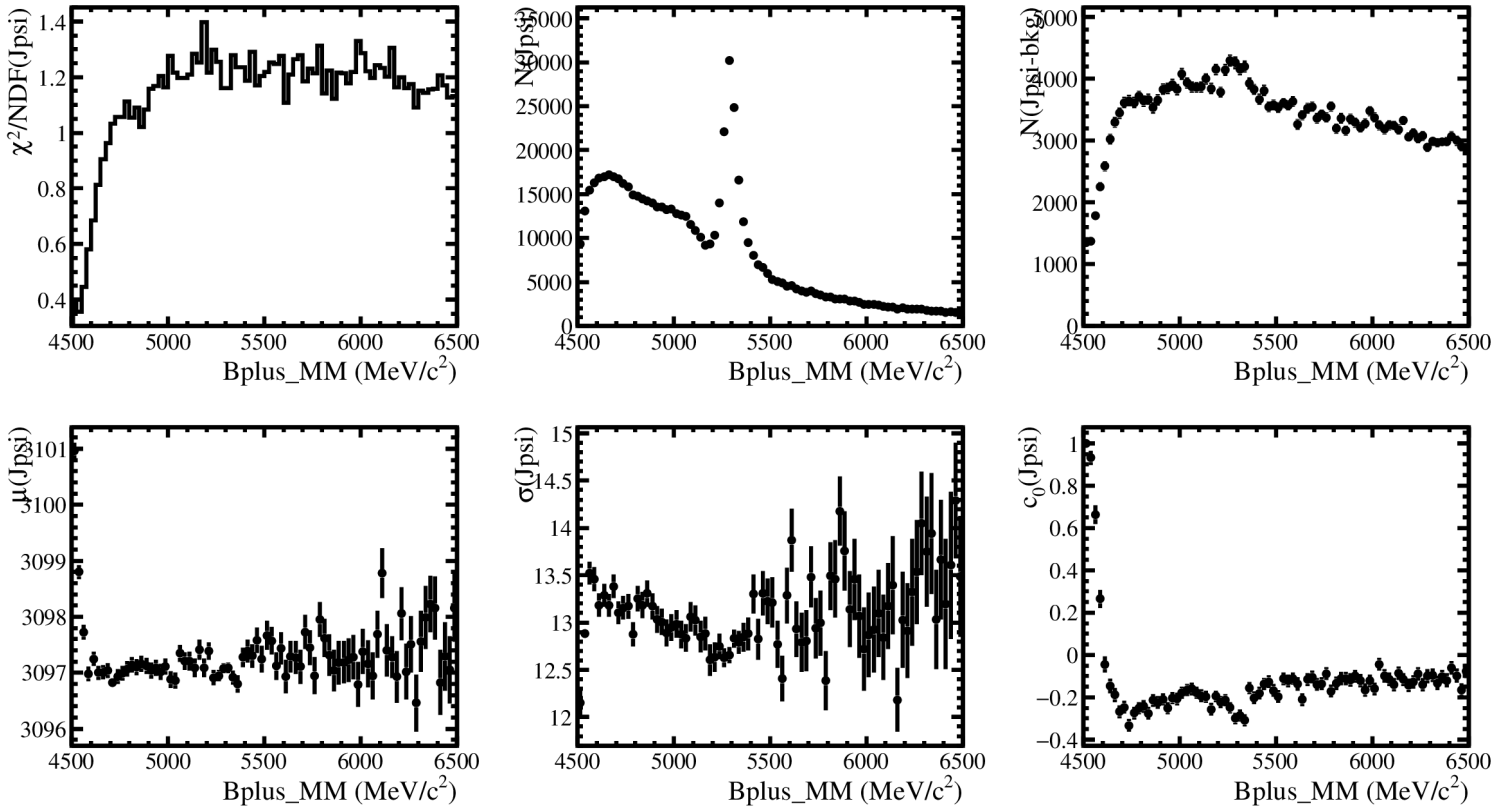




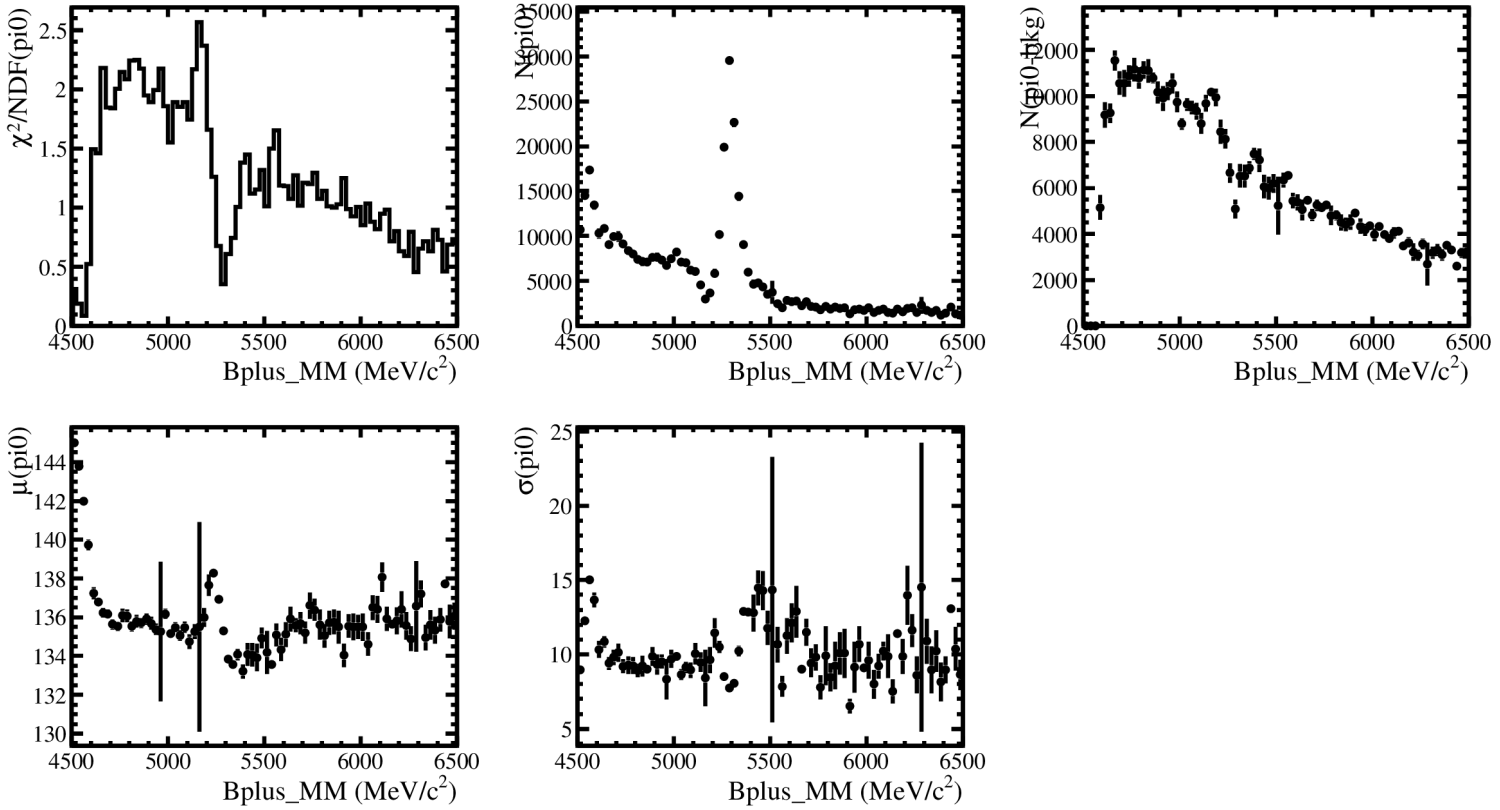
Jpsi-parameters per bins of Bmass

- Results with Jpsi (80 fits in backup):
  - an excess of bkg around Bmass, correlated with change of slope (too high for K*μμ)
  - Bmass distribution subtracted from μμ-combinatorial = nSig(M)
  - Can probably extract a slope from nBkg(M)



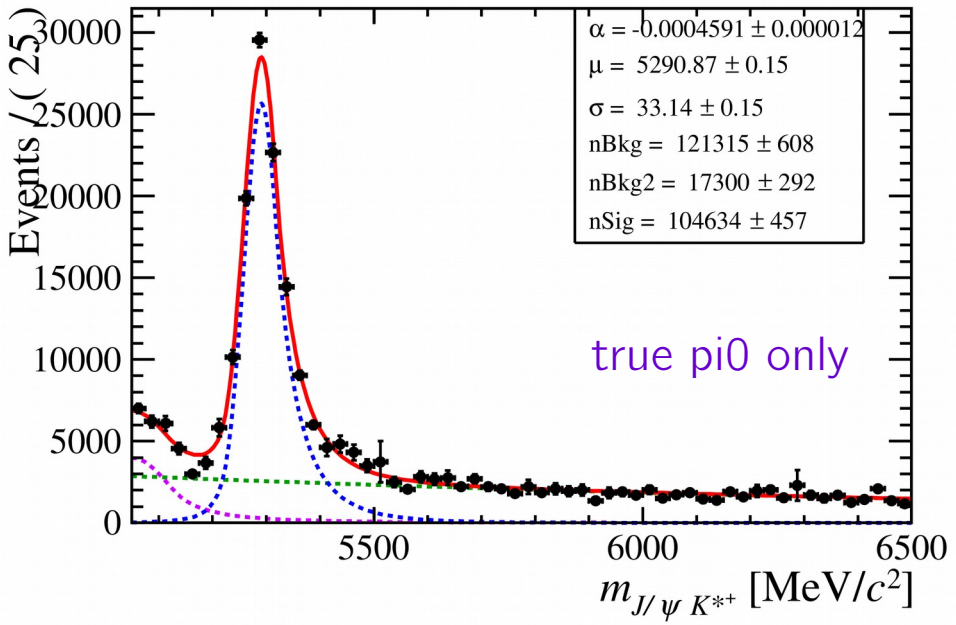
pi0-parameters per bins of Bmass

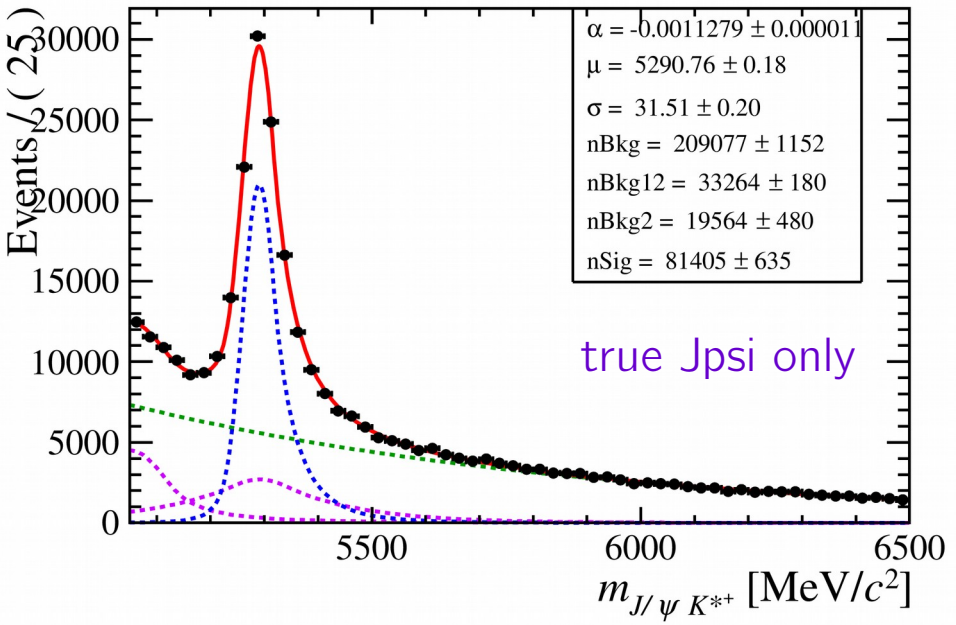
- Results with pi0 (80 fits in backup):
  - Signal shape sensitive to PT, varries over Bmass range (χ^2 not well behaved @ Bmass)
  - An excess of bkg around Bmass: $g\bar{g}$ peaking or just wrong fit? Fix sigma?
  - Can probably extract a slope from nBkg(M)



Combi-subtracted Bmass fits

- "How to use the previous info in Bmass fit" is under study...
- For now, we can fit the μμ or γγ combi-free distributions
  - For the γγ combi-free distrib.: remove all peaking bkg
  - For the μμ combi-free distrib.: remove all peaking bkg but $g\bar{g}$ (not quite right...)
- As most combi. come from pi0s, left plot is very clean (syst. from $g\bar{g}$ removed)
  - Yields 104.6 kevents (VS 78.4 k from non-subtracted Bmass fit), probably a bit more...



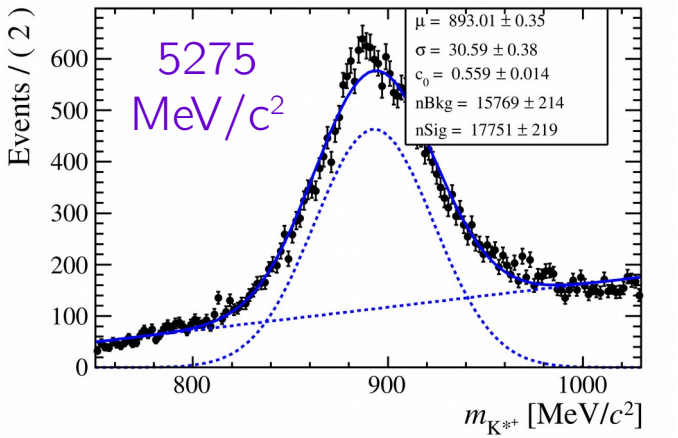


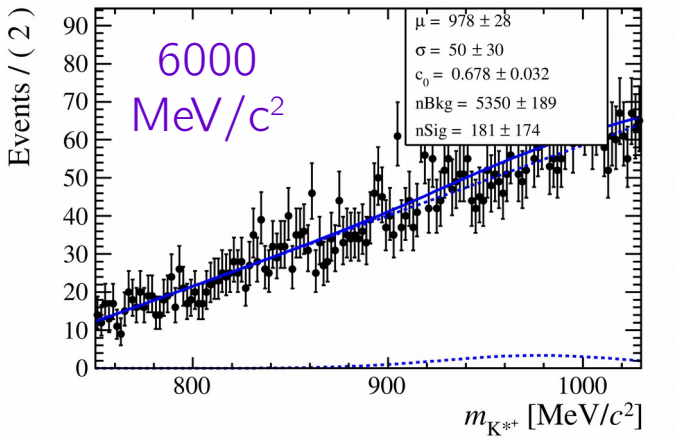
A try with K*+

- K* mass quite dirty: γγ-combi + $\pi^0 K^+$-combi + π^+-misID

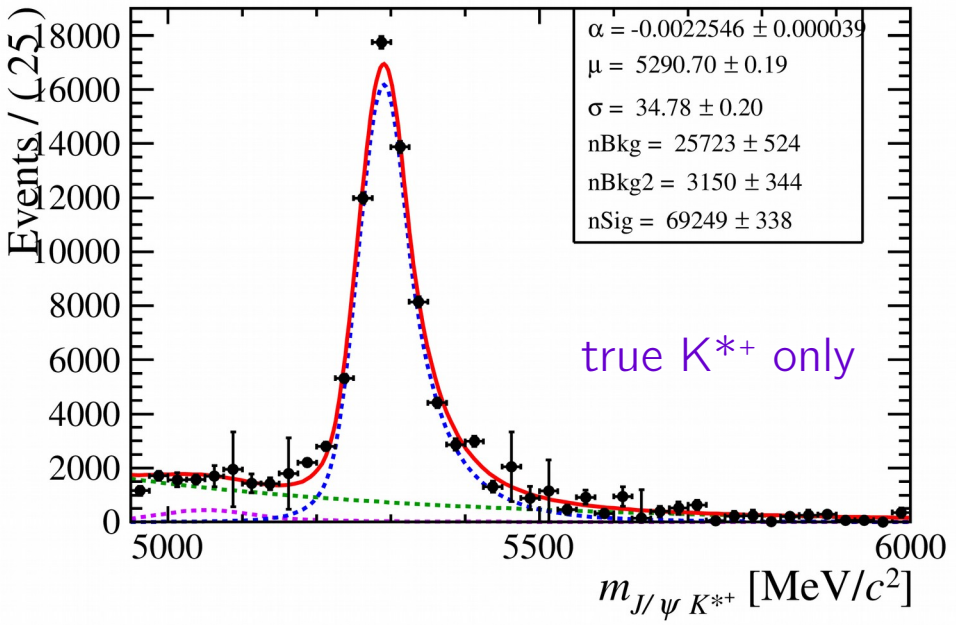
  But subtracted Bmass very pure (true K* almost = true B)

- Simple fit: Chebychev + gaussian, lots of room for improvement (next: param. from B region, or true pi0, use DTF-K* mass)





- Bmass fit: nBkg clearly overestimated, nSig should be higher



Outlook

- JpsiK*+ fit almost under control, then:
  - Move to BDT optimisation: BDT(vtx,kin,pid) VS BDT(vtx,kin) && pid
  - Apply it to other JpsiX^0

- Subtraction method, any worth?
  - Yes, to fix the yields from combinatorial bkg.
  - But, loose sPlot tool if fitting the bkg-subtracted Bmass distributions...

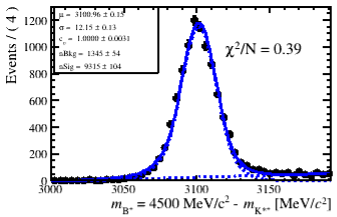
    ... which can be used for cross-checks (same yields from all the fits)
  - Potentially interesting for JpsiPi0, JpsiEta(') where $\gamma\gamma$(or γ)-combi dominates

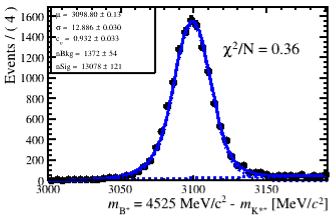
    $\rightarrow$ to be tried very soon
  - At the end, this is a simpler version of a multi-dimensional fit...

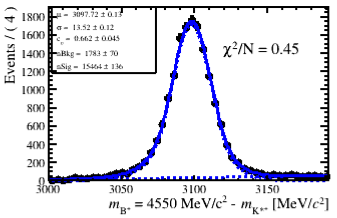
    ... which could be used to subtract all contributions in one go.

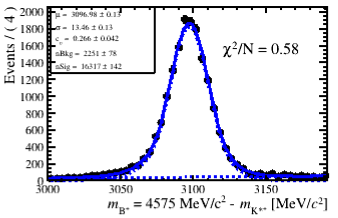
Backups

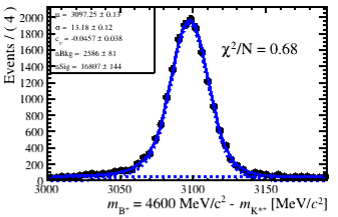
Jpsi fits in Bmass bins (1/4)

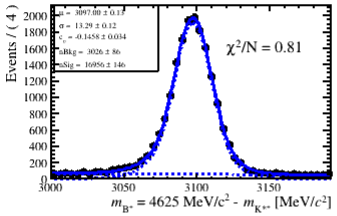


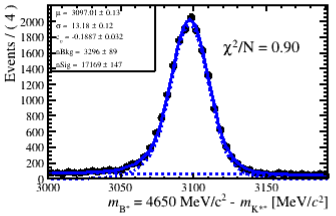


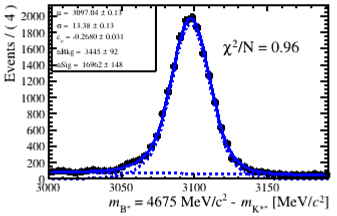


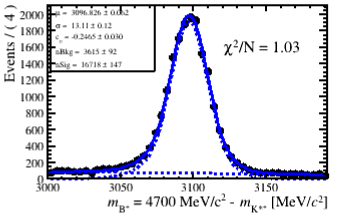


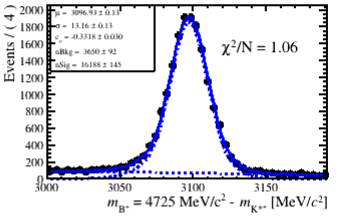


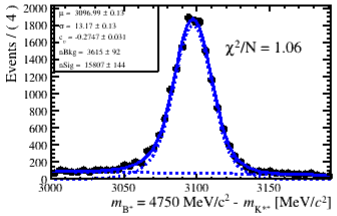


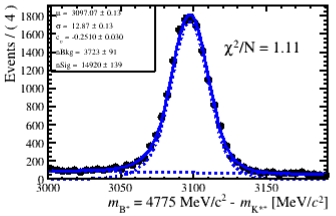


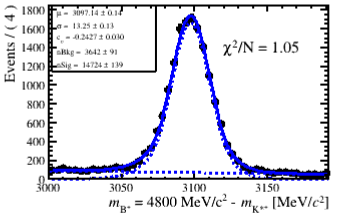


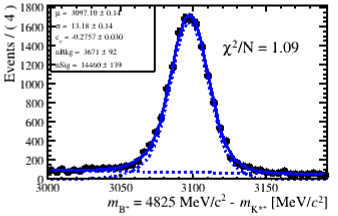


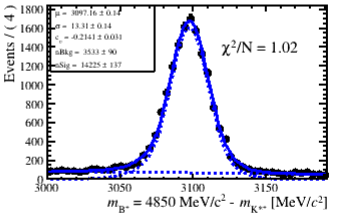


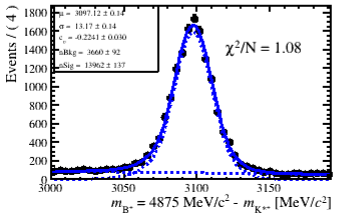


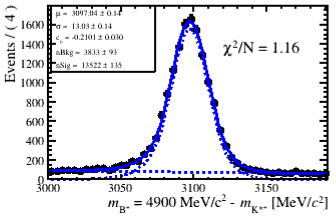


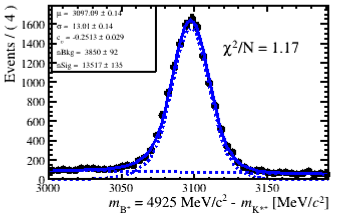


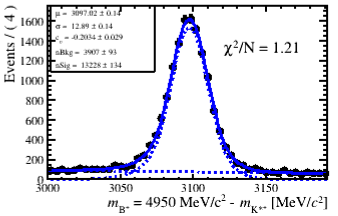


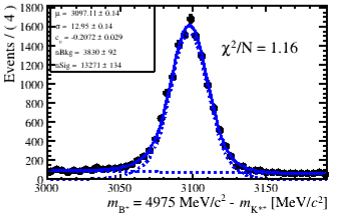




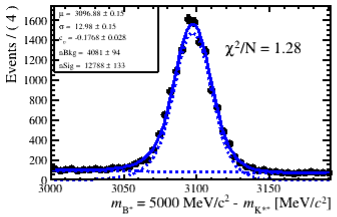


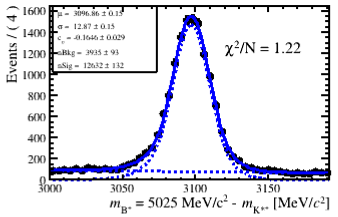


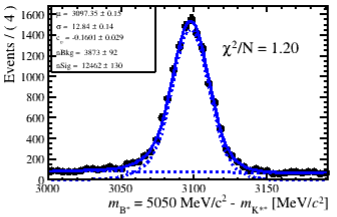


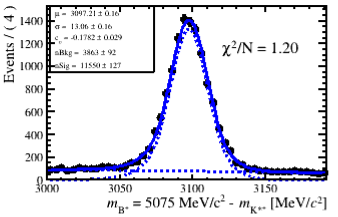


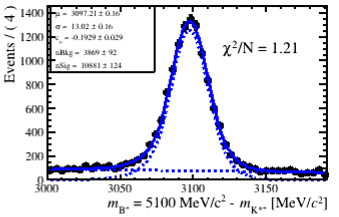
Jpsi fits in Bmass bins (2/4)

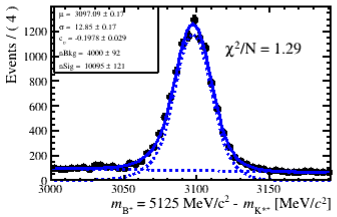


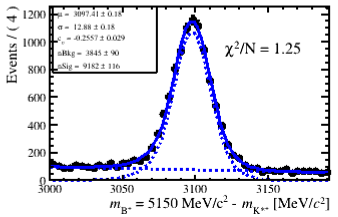


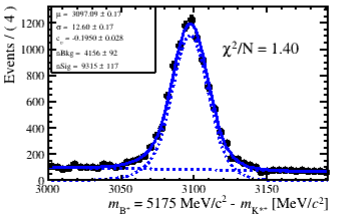


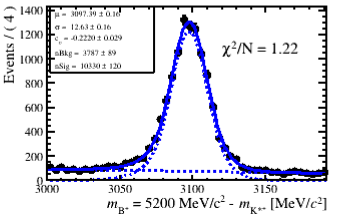


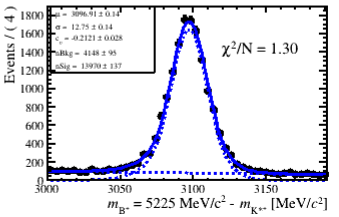


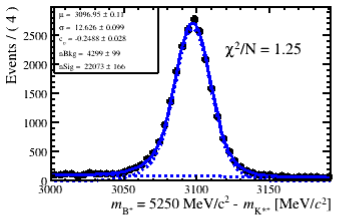


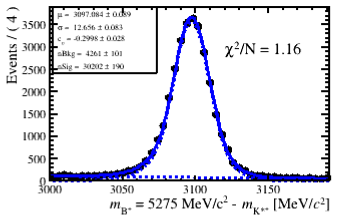


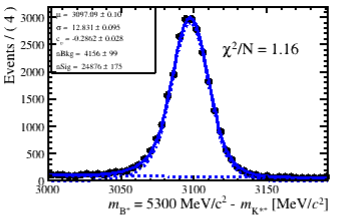


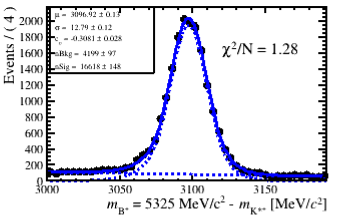


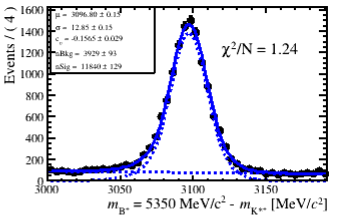


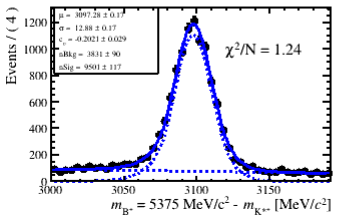


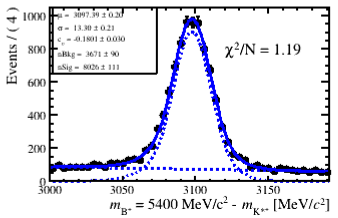


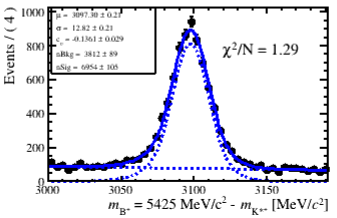


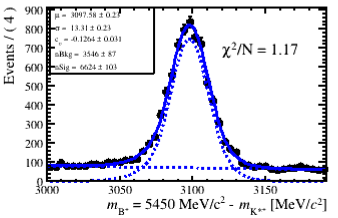


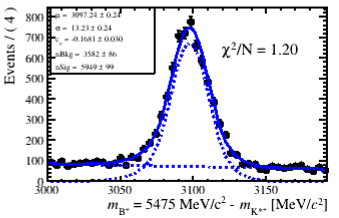




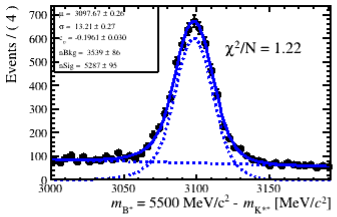


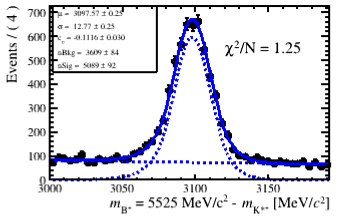


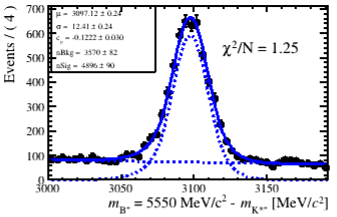


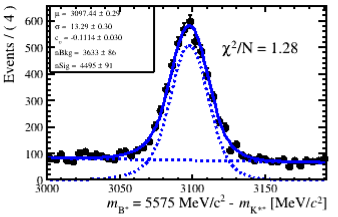


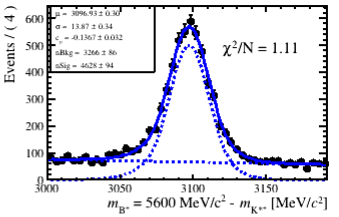
Jpsi fits in Bmass bins (3/4)

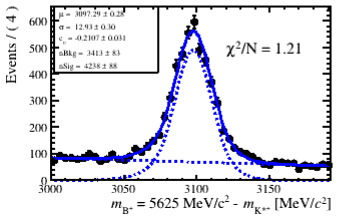


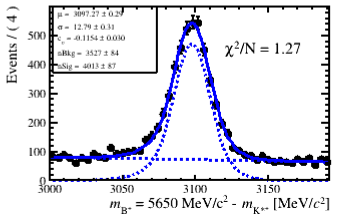


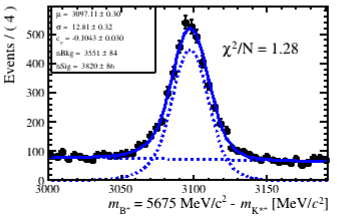


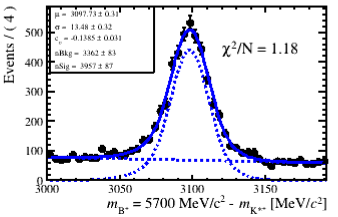


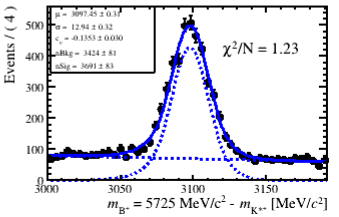


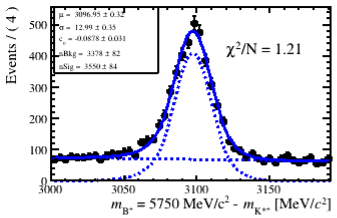


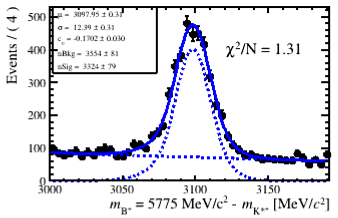


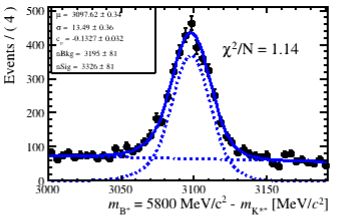


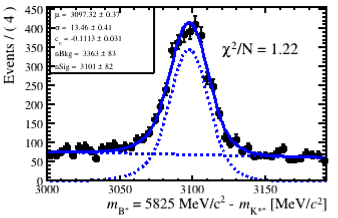


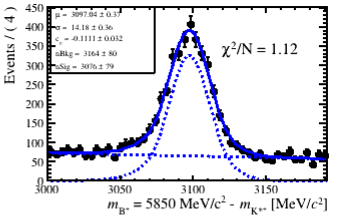


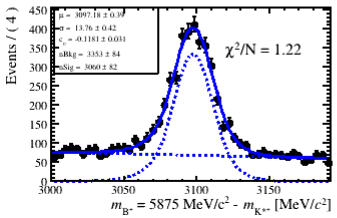


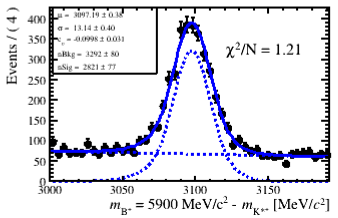


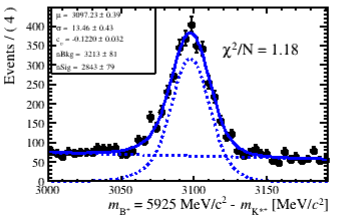


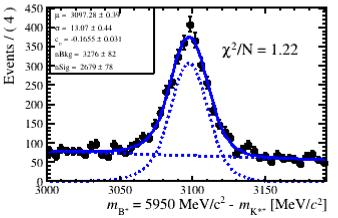


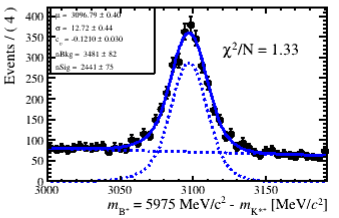




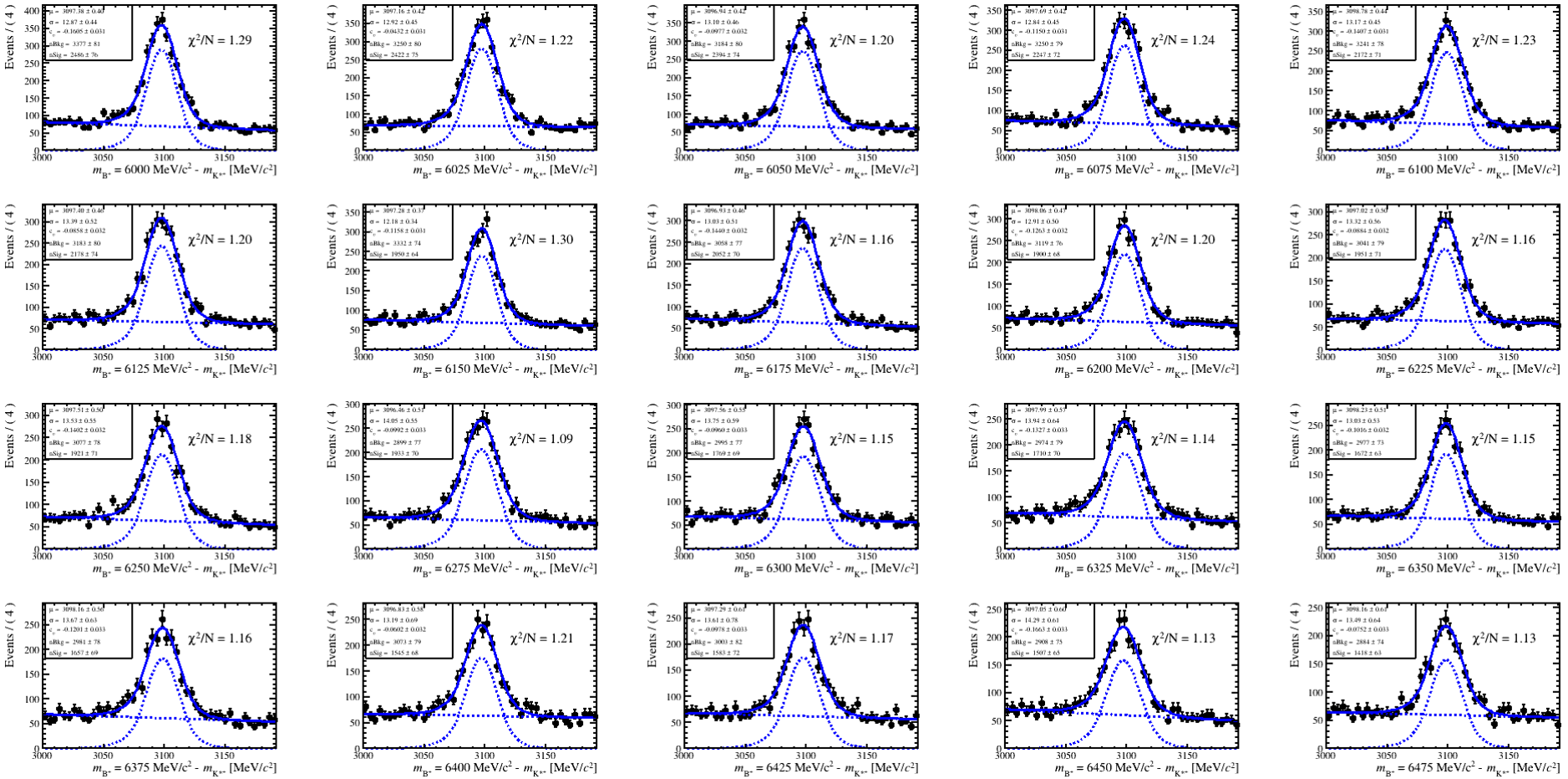




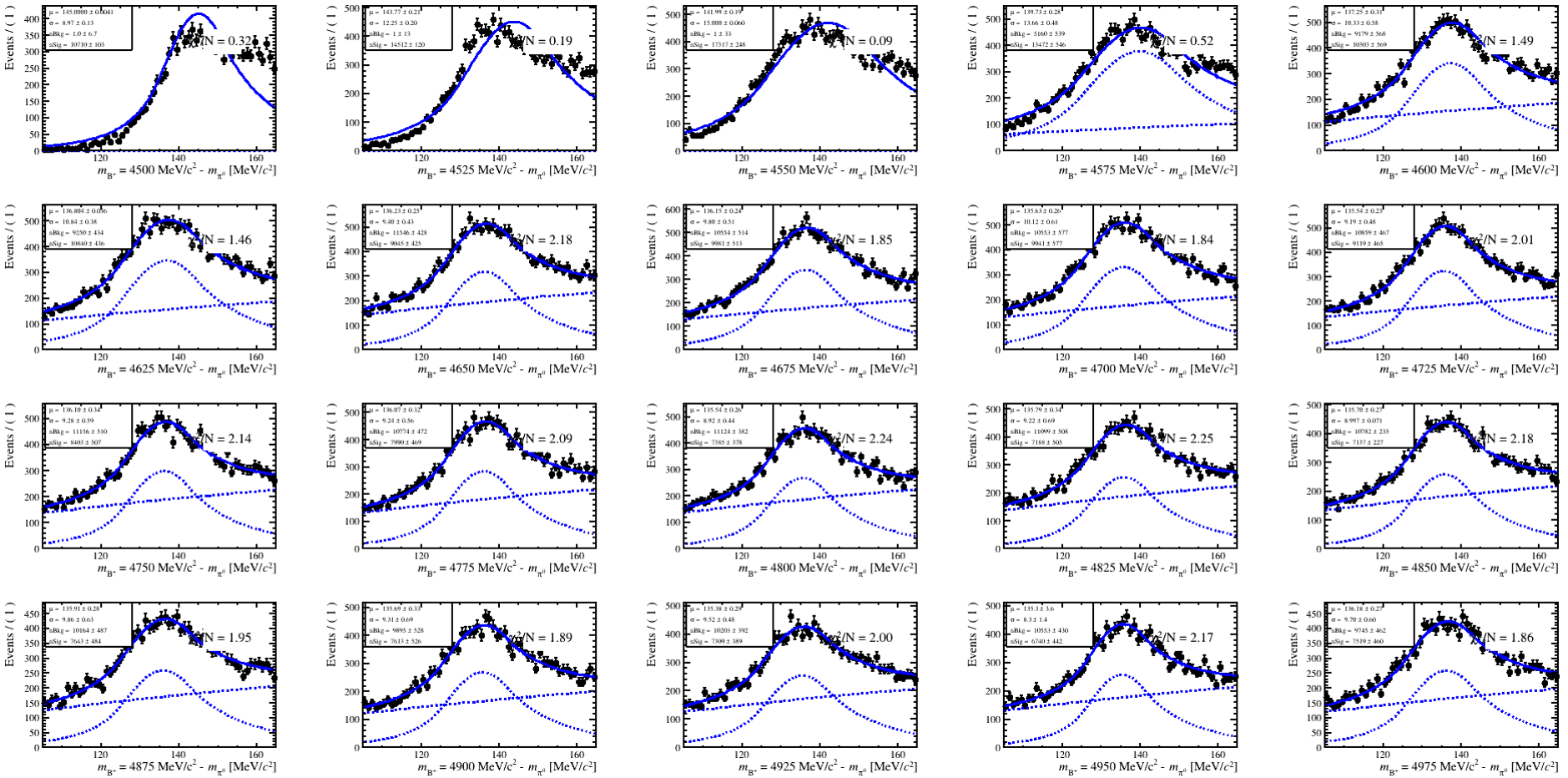




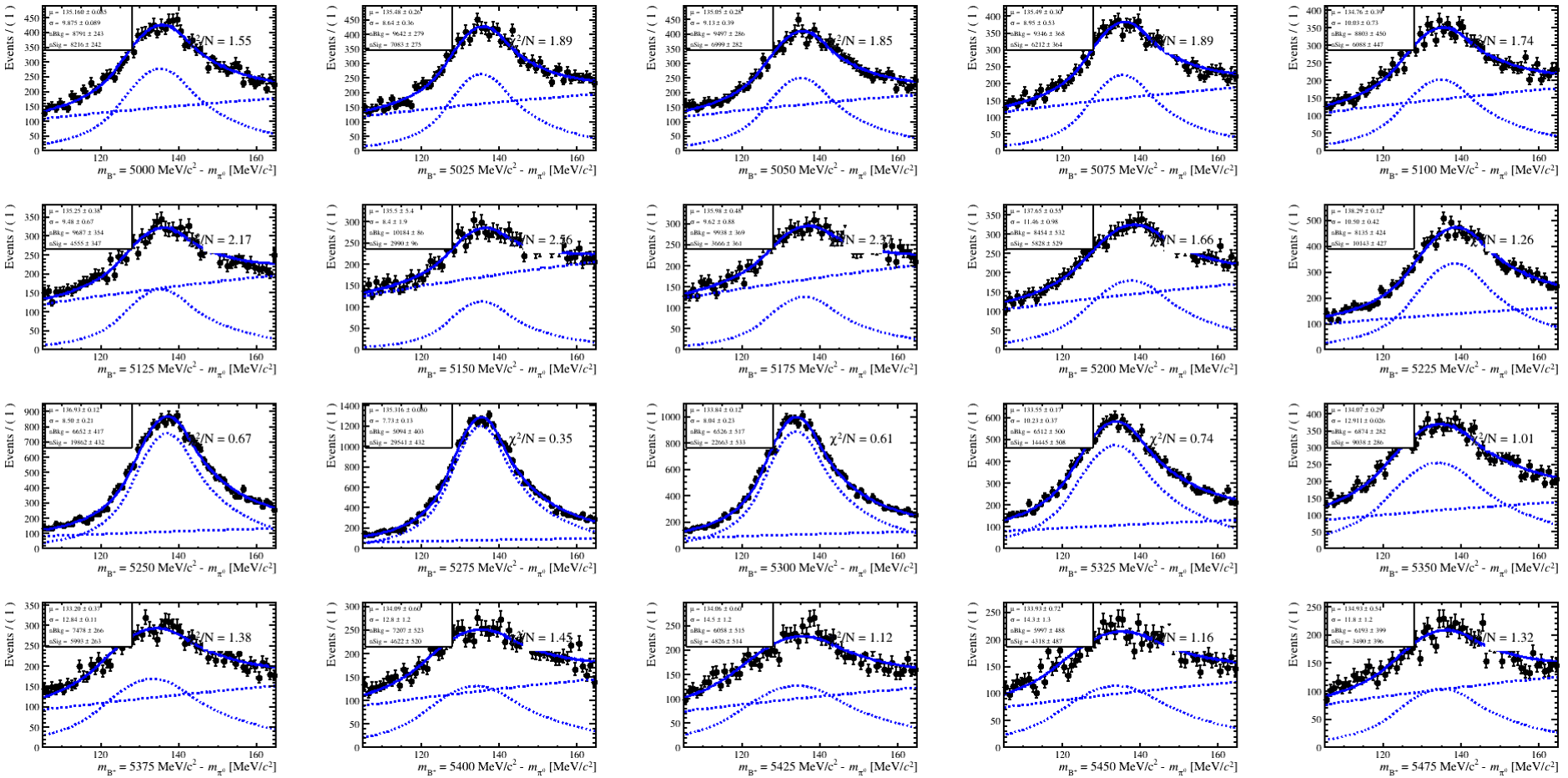
Jpsi fits in Bmass bins (4/4)



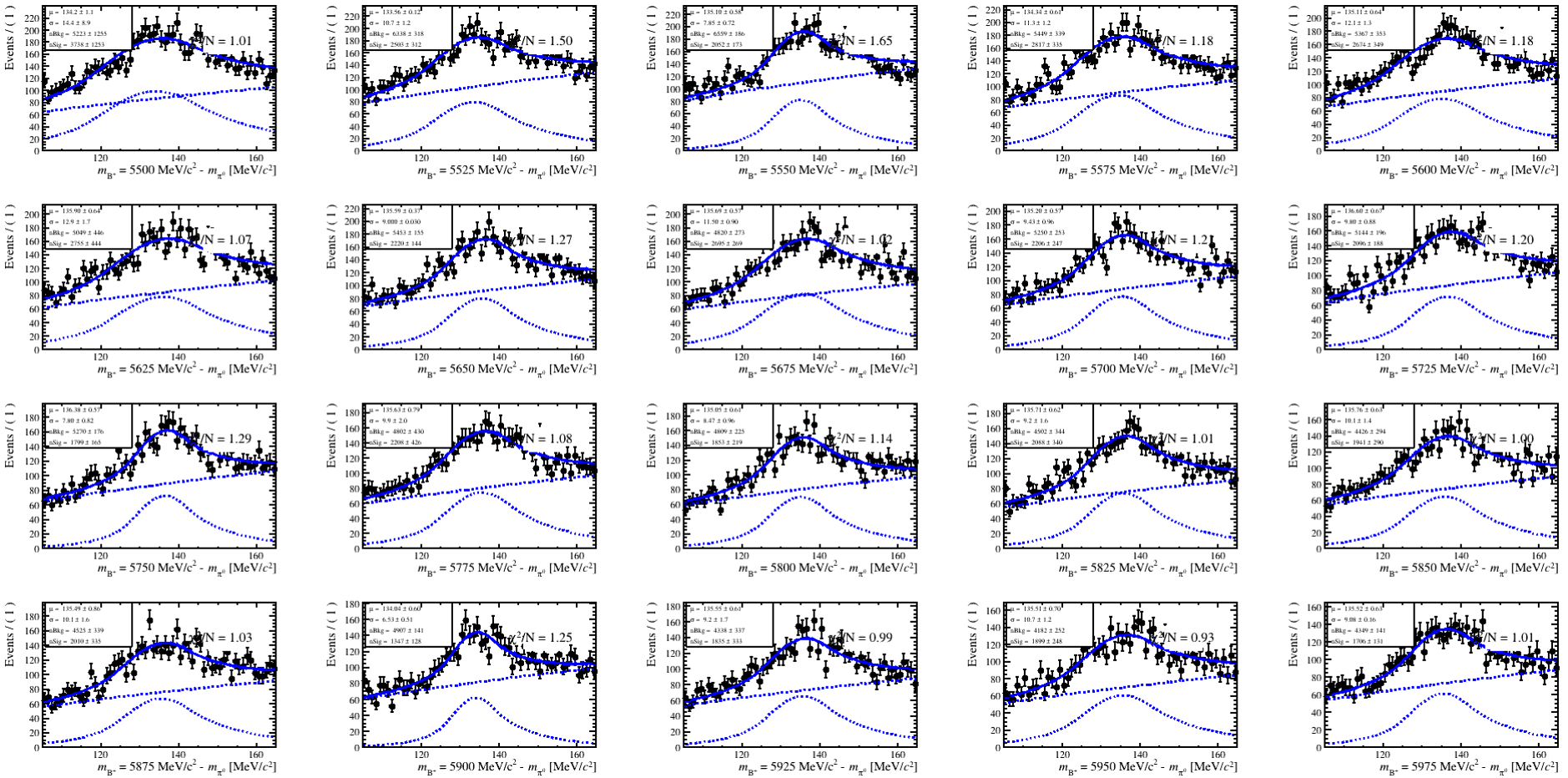
pi0 fits in Bmass bins (1/4)



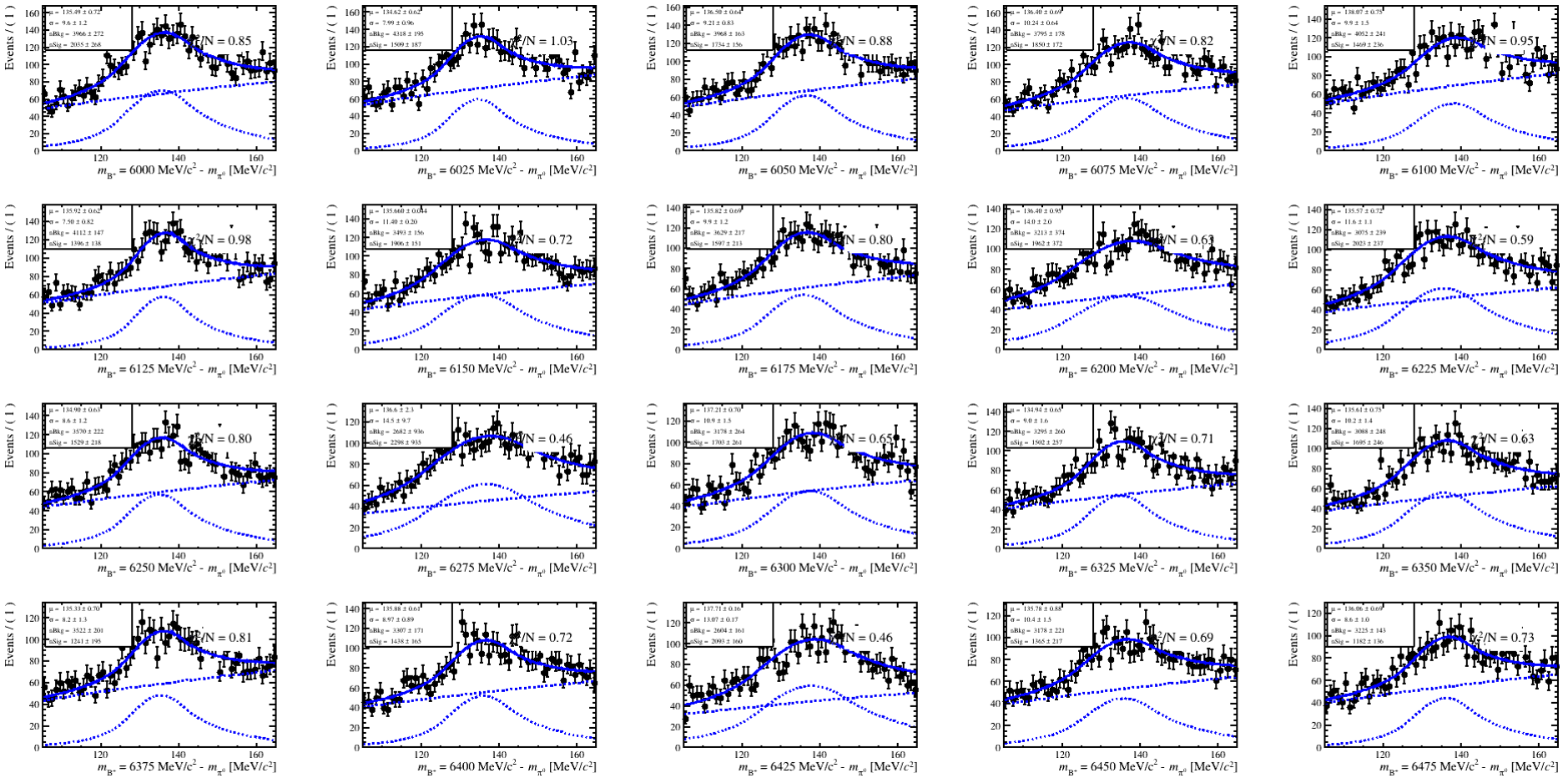
pi0 fits in Bmass bins (2/4)



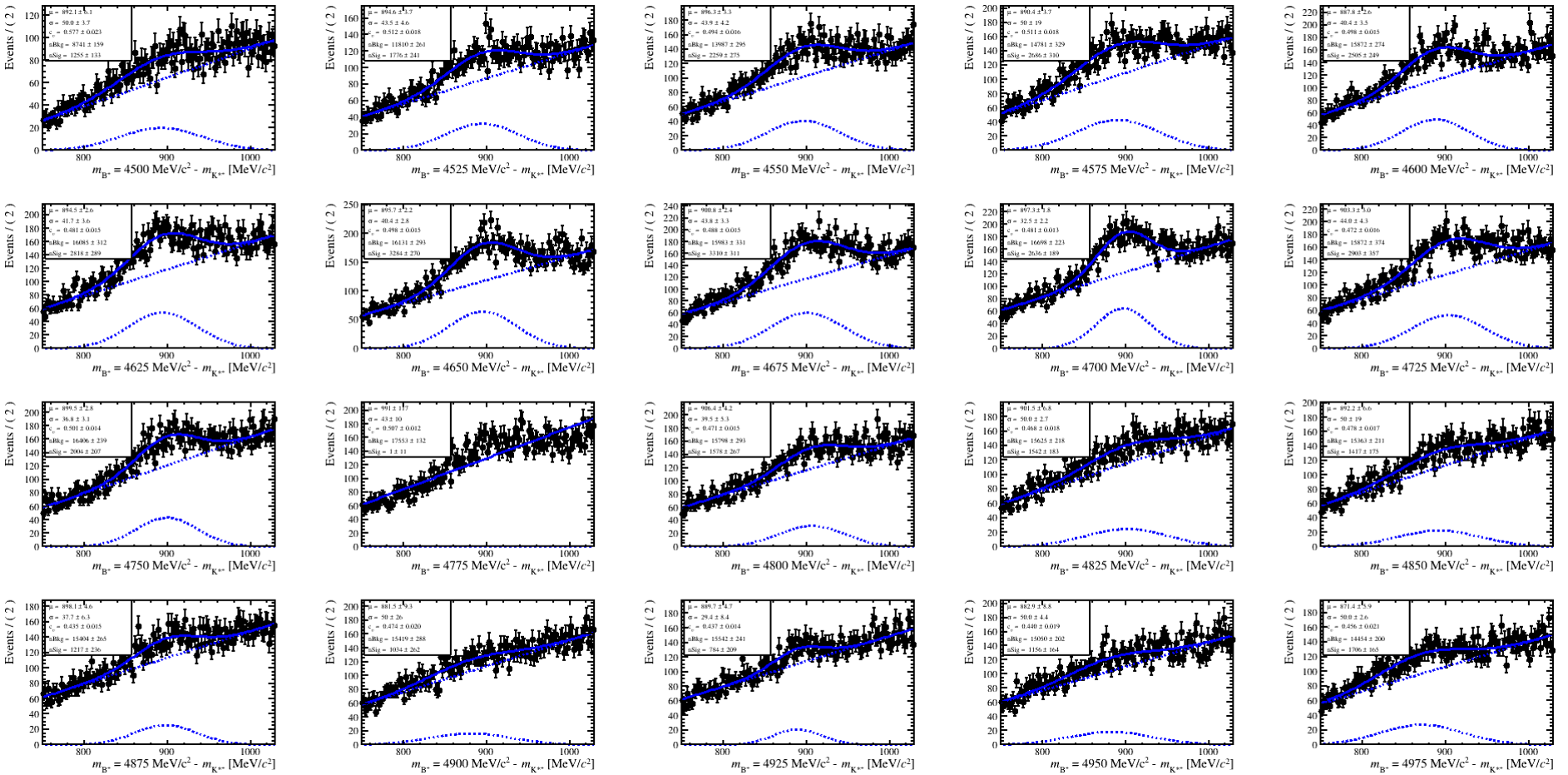
pi0 fits in Bmass bins (3/4)



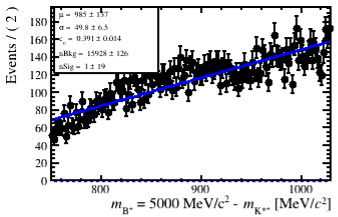
pi0 fits in Bmass bins (4/4)

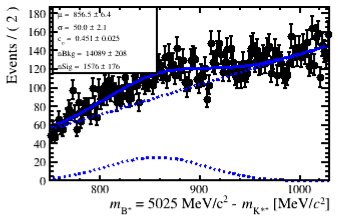


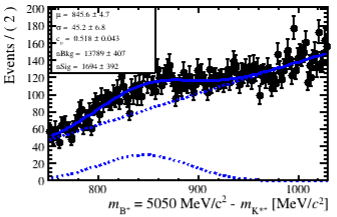
K*+ fits in Bmass bins (1/4)

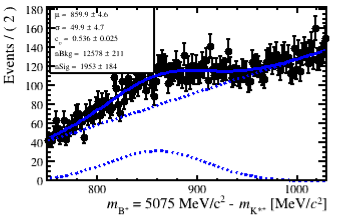


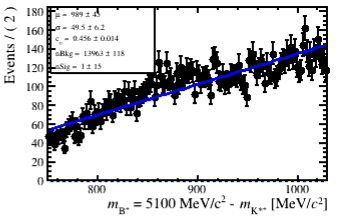
K*+ fits in Bmass bins (2/4)

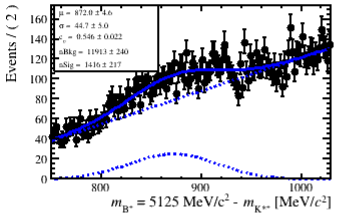


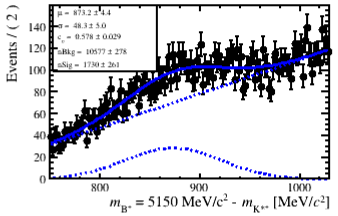


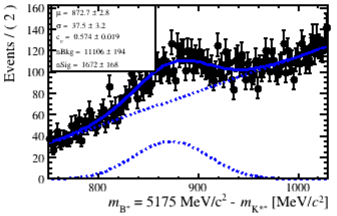


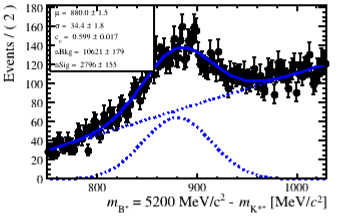


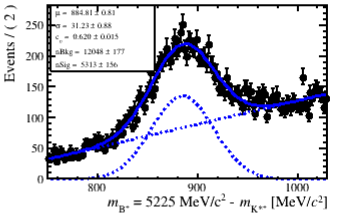


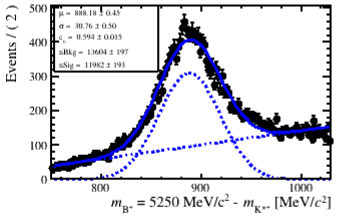


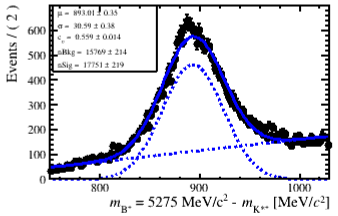


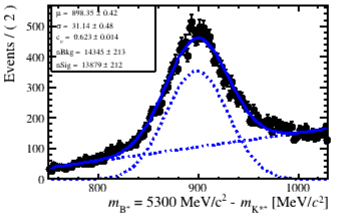


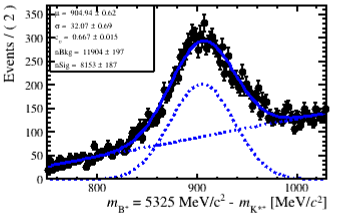


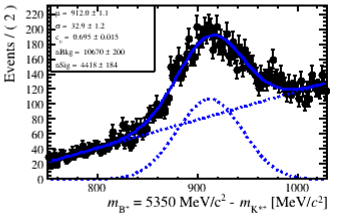


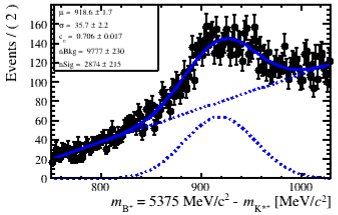


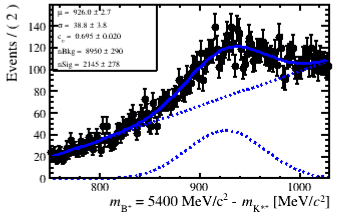


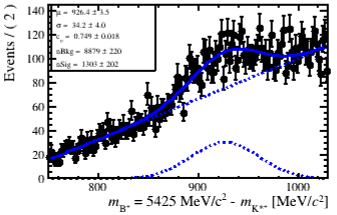


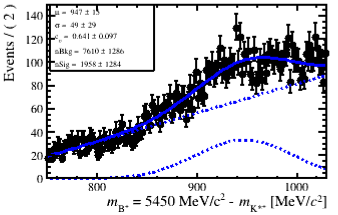


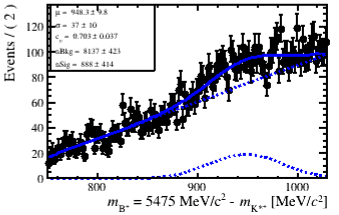




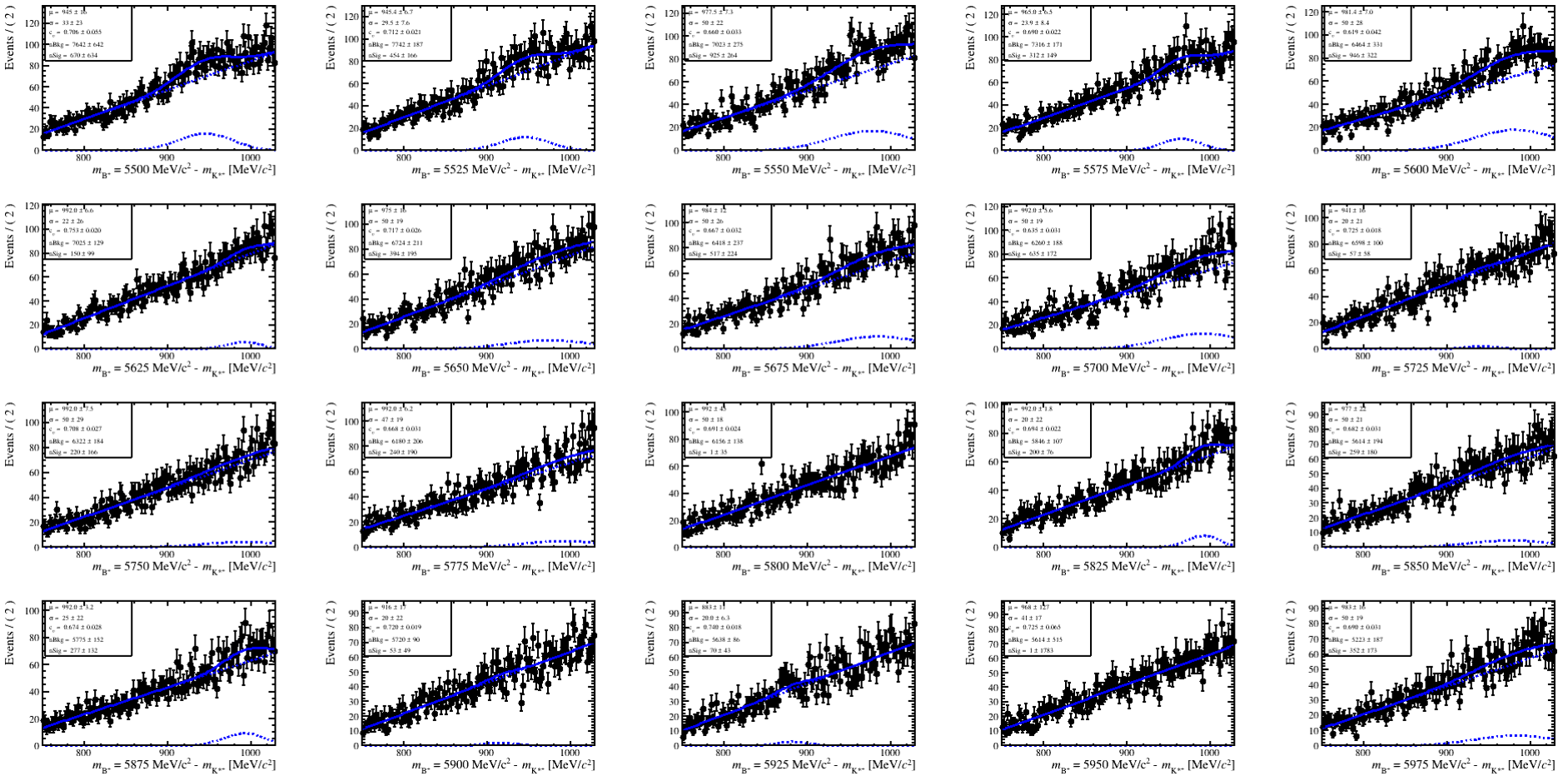








K^{*+} fits in Bmass bins (3/4)



K*+ fits in Bmass bins (4/4)