BDT for JpsiX⁰

April 17th 2019, Annecy/Edinburgh meeting, M. Chefdeville

Status

- Combinatorics subtraction
 - Improve pi0 fit with larger mass sidebands (new DiMuon Run II data prod.)
- Back to the BDTs
 - Split vertex and isolation variables
 - 2 lever-arms: fight combinatorics and improve neutral resolution

Reminder: combinatorics subtraction

- Fit daugther mass in bins of B+ mass (\rightarrow Jpsi K*+)
 - $\mathsf{nsig}(\mathsf{m}) \to \mathsf{bkg}\text{-subtracted Bmass}$
 - $\mathsf{nbkg}(\mathsf{m}) \to \mathsf{yield}$ and shapes of combinatorial bkgs
 - For pi0: nbkg(m) also tells about ggbar bkg.
- Useful for cross-checks: same signal yield from pi0(m), Jpsi(m), $K^{*+}(m)$



Improved pi0-fit

- Previous pi0 fit:
 - DiMuon Ntuples, narrow mass window: 135 +/- 30 MeV/c2
 - Fix signal and bkg shapes on data from Run I old prod. with [0,250] $\mbox{MeV/c2}$
- New fit: new DiMuon Ntuples for 2016-17-18 with larger sidebands
 - Fix signal shape (Gauss with expo tails after $a_{\rm L,R})$ on Bmass bin @ 5275 +/- 12.5 MeV/c2
 - Let bkg shape to float (Chebychev order 2)
 - Nsig points have smaller errors... similar B+ yield at the end



Back to BDTs, PID cuts

- Mass fit and BDT: parallel developments. Better fit with better purity:
 - Use narrower mass window for pi0 and K*+ than +/- 30 & 150 MeV/c² resp.
 - New Ntuples: window became [0,250] and +/- 250 MeV/c2 resp.
- New offline PID selections:
 - Kaon PID: some contamination from Jpsip+? (in DV: ProbNNk>0.1)
 - New cut: ProbNNk*(1-ProbNNpi) > 0.5



PID cuts

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Mass windows

- Mass fit and BDT: parallel developments. Better fit with better purity:
 - Use narrower mass window for pi0 and K*+ than +/- 30 & 150 MeV/c² resp.
 - New Ntuples: window became [0,250] and +/- 250 MeV/c2 resp.
- New offline mass window selections:
 - Also saved Kst_MM_DTF with pi0-mass contrain \rightarrow signal in quite small region
 - New cut: +/- 22 & 76 MeV/c² for pi0 & K^{*+} resp. (= roughly 2σ)



New B⁺ mass fit

- Using extra PID and mass cuts, MC expectations:
 - Signal: -25% (mainly mass cuts)
 - Bkg ggbar: -54%
 - Bkg gbargbar: -61%
 - Less systematics on the fit \rightarrow good for BDT calibration
- New fit model: signal + combinatorial + JpsiK₁



Back to BDT

- From previous BDT, split variable sets into 2:
 - Vertex variables \rightarrow against combinatorics
 - Occupancy variables (remove IsNotE) \rightarrow improve neutral resolution
- Training samples (with PID cut):
 - Signal: MC truth (2015-16)
 - Background: use data sidebands: $(\Delta m(pi0)>22) \& (\Delta m(K^{*+})>76) \& (m(B^+)>6650)$ (= pink distribution on slide 8)



Two BDTs



3 : Jpsi IP : 1.444e-01 4 : min MIPCHI2DV : 1.412e-01 5 : Jpsi DIRA : 1.388e-01 6 : Bplus IP : 1.232e-01 7 : Bplus VTXCHI2 : 1.100e-01



:	Rank :	: Variable	:	Variable Importance
:	1 :	: Bplus PT	:	1.890e-01
:	2 :	: log(Bplus_SmallestDeltaChi2OneTrack)	:	1.519e-01
:	3 :	: pi0_PT	:	1.419e-01
:	4 :	: min_IsNotH	:	1.084e-01
:	5 :	: pi0_0.40_nc_mult-2+pi0_0.40_cc_mult	:	1.022e-01
:	6 :	: max_IsNotH	:	9.452e-02
	7 :	: Bplus_NumVtxWithinChi2WindowOneTrack	:	7.505e-02
:	8 :	: pi0_0.40_IT	:	6.919e-02
	9 :	: min_gamma_PT	1	6.798e-02

Performance

- Fit B⁺ mass for various BDT[1,2] cuts to calculate signal efficiency (bkg efficiency (in red) and MC efficiency calculated by counting events passing the cut)
 - Vertex variables provide more discriminating power
 - Occupancy variables show stronger data/MC mismatch (less powerfull in data)



BDT for JpsiPi0

- From previous BDT, split variable sets into 2:
 - Vertex variables \rightarrow against combinatorics
 - Occupancy variables (remove IsNotE) \rightarrow improve neutral resolution
- Training samples:
 - Signal: MC truth (2015-16), 105 k events (PT(pi0) > 2 GeV/c)
 - Background: use data sidebands: ($\Delta m(pi0)>22$) & ($m(B^+) = 6500-6550$)



Two BDTs, JpsiPi0



5 : Jpsi DIRA : 1.333e-01

6 : Jpsi IP : 1.131e-01

7 : B0 VTXCHI2 : 1.058e-01



Input variable: pi0_PT

78 8 82 84 86 88

pi0_PT

e: min_gamma_PT

min_gamma_PT

Signal

0.8

Backar

Input variable: B0_PT

First performance

• Some correlation for signal (right plot)



First performance

• "Random" cut: no combinatorial, signal & part. reco. only



Outlook

- Optimise BDT for best S/N ratio with JpsiK*+
 - Add variables, remove, change PT cut, split by calo section or photon type?
 - Apply it to Jpsi $\pi^{_0}$
 - Next on the list is Jpsi $\eta[\gamma\gamma]$
- Aside: additional small production of JpsiEtap only with Stefano's variables:
 - 2018MagUp available @ /afs/cern.ch/work/c/chefdevi/public/Stefano
 - Please check, I can process more years.