Systematic on photon-energy bias correction

Photon-energy-bias corrections: instructions for users

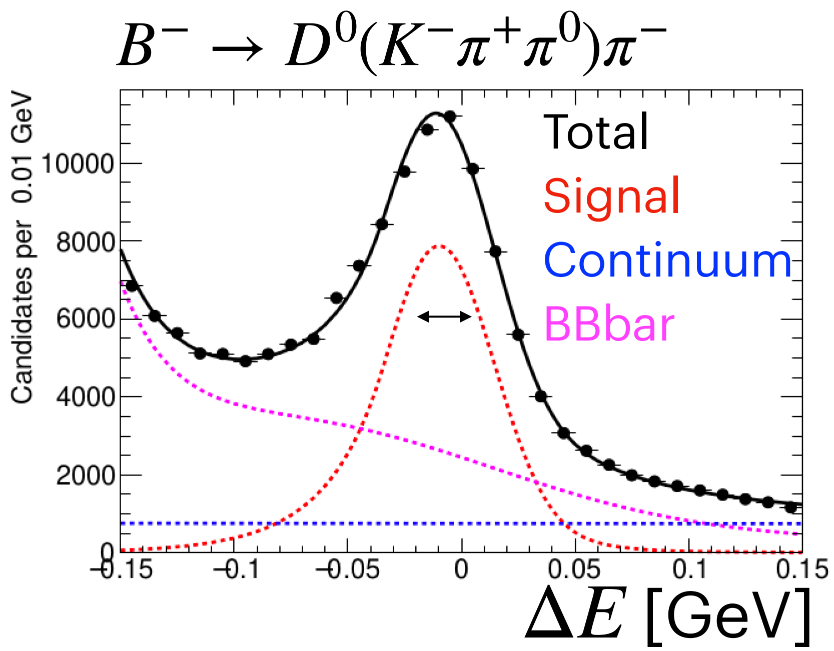
Analyses with π^0 in final state have a ΔE bias due to π^0 miscalibration. One must apply energy bias corrections to photons and then measure residual shift from a control channel. CorrectEnergyBias module should be called (only for data!) directly after loading the photon list (before any energy selection and before reconstructing the π^0).

```
import modularAnalysis as ma

#Latest GT required to access energy bias corrections payload
#Global tag should be analysis_tools_light-2212-foldex or later
b2.conditions.prepend_globaltag(ma.getAnalysisGlobaltag())

# example photon list
fillParticleList('gamma:sel','',path=my_path)

# energy bias correction applied to photon list.
TableName = "PhotonEnergyBiasCorrection_MC15ri_Nov2022"
# TableName = "PhotonEnergyBiasCorrection_MC15ri_Nov2022_lower" # correction -1sigma
# TableName = "PhotonEnergyBiasCorrection_MC15ri_Nov2022_upper" # correction +1sigma

ma.correctEnergyBias(inputListNames=['gamma:sel'], tableName=TableName , path=my_path)

Energy selections, π0 reconstruction...
```

See also https://confluence.desy.de/pages/viewpage.action?spaceKey=BI&title=Neutrals+Performance

Systematic estimation

Systematic uncertainty due to corrections: apply bias corrections shifted up/down by their uncertainties. Compare results.



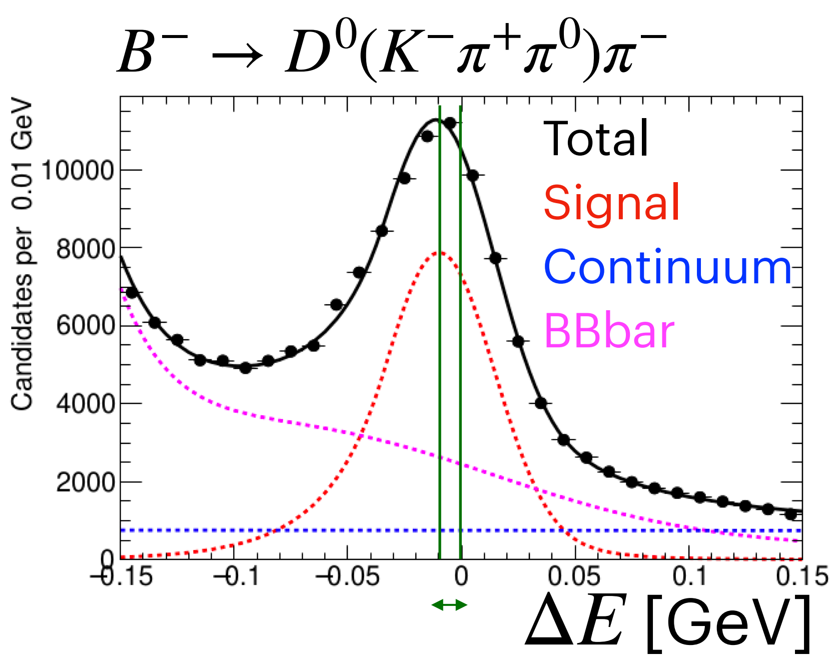
Shift (central): -2.8 ± 0.2 MeV

Shift (upper): -2.6 ± 0.2 MeV

Shift (lower): -3.1 ± 0.2 MeV

Syst = $^{+0.2}_{-0.3}$ MeV

Systematic uncertainty due to residual shift: take uncertainty on residual shift found in control channel (after correction).

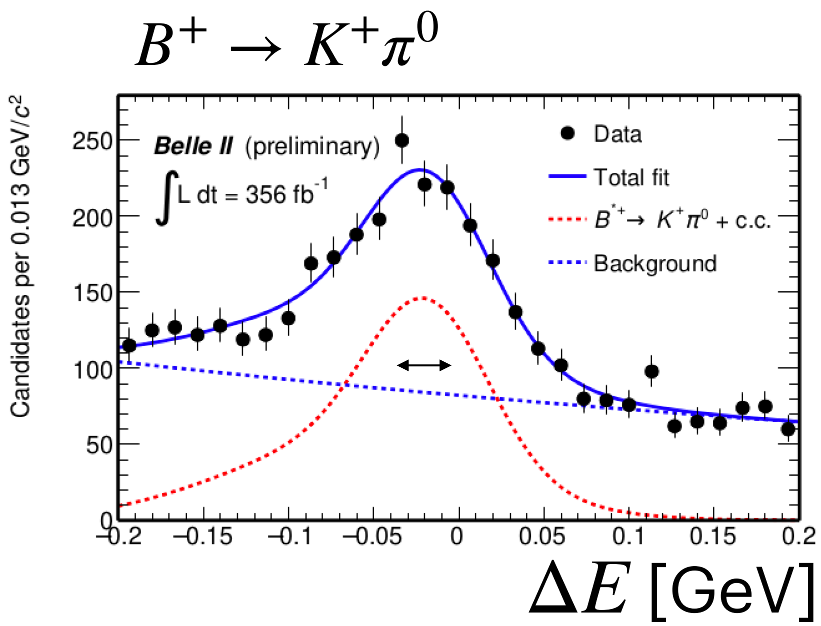


Shift (central): -2.8 ± 0.2 MeV

Syst = 0.2 MeV

Low-stat channel

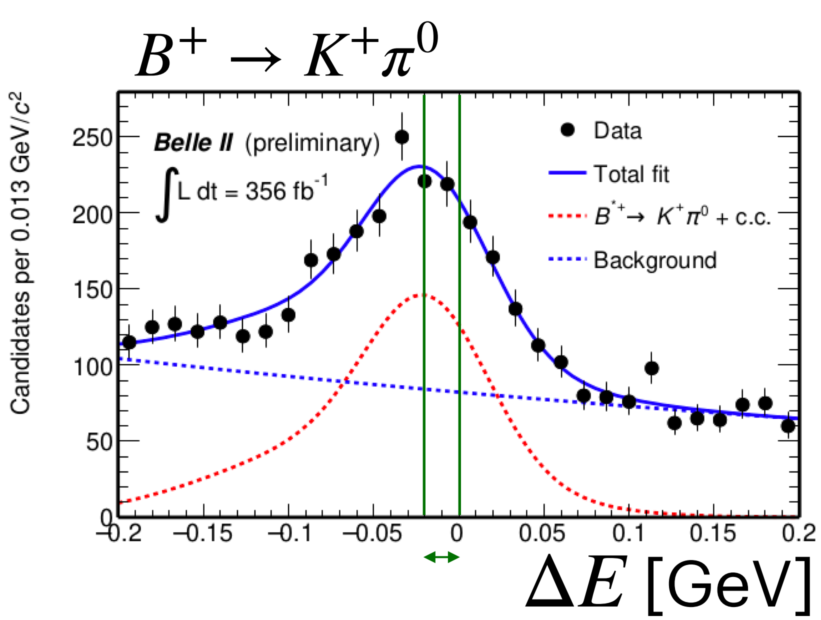
Systematic uncertainty due to corrections: apply bias corrections shifted up/down by their uncertainties. Compare results.



Shift (central): -4.7 ± 3.0 MeV
Shift (upper): -2.8 ± 3.0 MeV
Shift (lower): -5.8 ± 3.0 MeV

Syst = $^{+1.9}_{-1.1}$ MeV

Systematic uncertainty due to residual shift: take uncertainty on residual shift found in control channel (after correction).



Shift (central): -4.7 ± 3.0 MeV

Syst = 3.0 MeV

Proposal for an approach

We have two different sources of systematics:

- Systematic uncertainty due to corrections: negligible — dominated by the statistical uncertainty on the shift measurement.

- Systematic uncertainty due to residual shift and fudge factor.

Apply energy bias corrections to photons in data. Measure residual shift and fudge factor from a control channel. Include them in the signal channel fit with gaussian constraints (take into account their correlation). Take their uncertainties as systematic.

If no suitable control channel is available, leave mean shift and fudge factor free in the fit. If not possible, think about new possibility (control channels from other analysis, additive uncertainty on extrapolation, likelihood scan, ...).

$B^0 \to \pi^0\pi^0$ fitter

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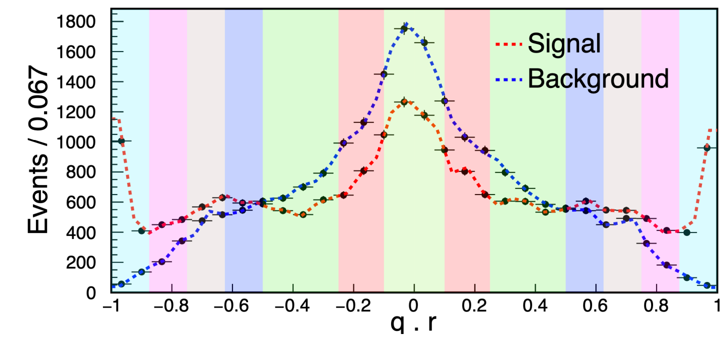
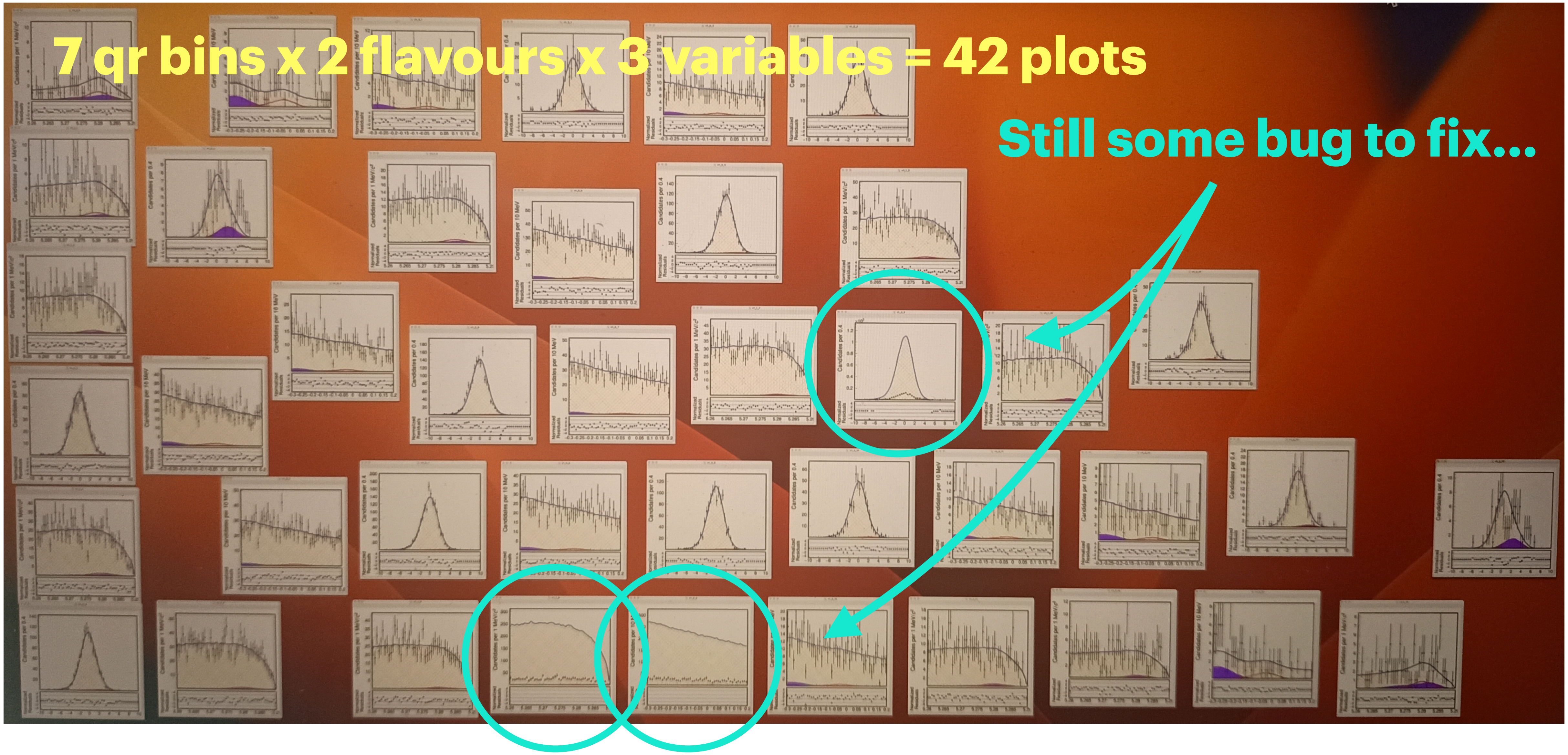


Plotter is fixed now (working for multibins).

Likelihood is written (7 bins of qr with fixed flavour tagger parameters).

First preliminary result on simulation (just a technical check):



π^0 efficiency with double ratio

π^0 efficiency with double ratio

Observed excess (+15%) in the measured signal yield in data with respect to MC expectations in reconstructed samples of $D^+ \to K^0_S \pi^+$ decays.

Reconstruction of $D^{*+} \to D^+[\to K^0_S \pi^+]\pi^0$ decays is still ongoing since 5 days now (slow grid again).

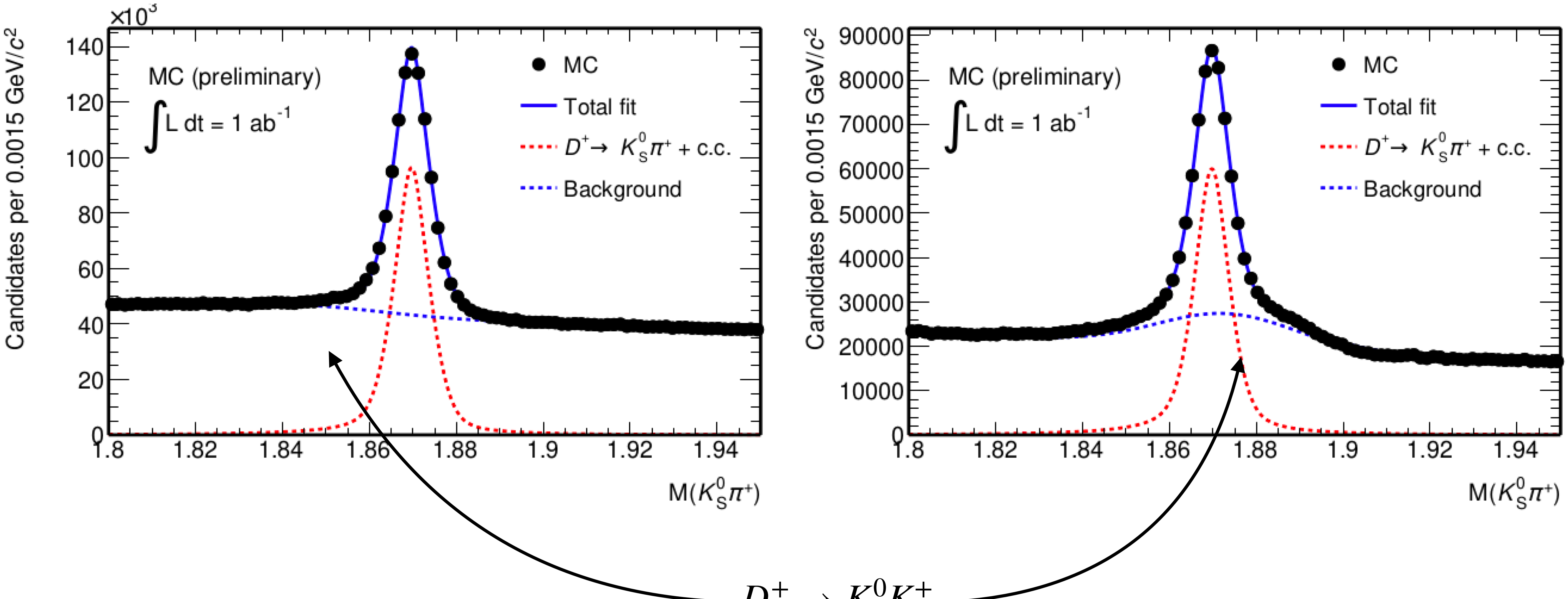
Wanted to generate and reconstruct $D^+ \to K^0_S \pi^+$ signalMC to check fitted *BF* in MC and data (and compare with PDG). Generated 40000 signal events, but reconstruction gives me 6 events. Something wrong or very very low efficiency?

Angelo and Michel also observe (smaller — 5/8%) excess in their samples. Angelo suggests role of known MC mismodelings in (misID'd) D_S bkg component.

$D^+ \to K_S^0 \pi^+$ fit

Fit components: signal (shape fixed from MC), Ds background (shape fixed from MC), and combinatorial (shape is free). All yields are free in the fit.

Bin 1 (low momentum π) Bin 1 (high momentum π)



$D_S^+ \to K_S^0 K^+$

misID'd

D_S MC mismodelings

Apply very hard cut on π PID (>0.95) to remove misID'd kaons: data/MC ratio passes from 1.15 to 1.02. Culprit found?

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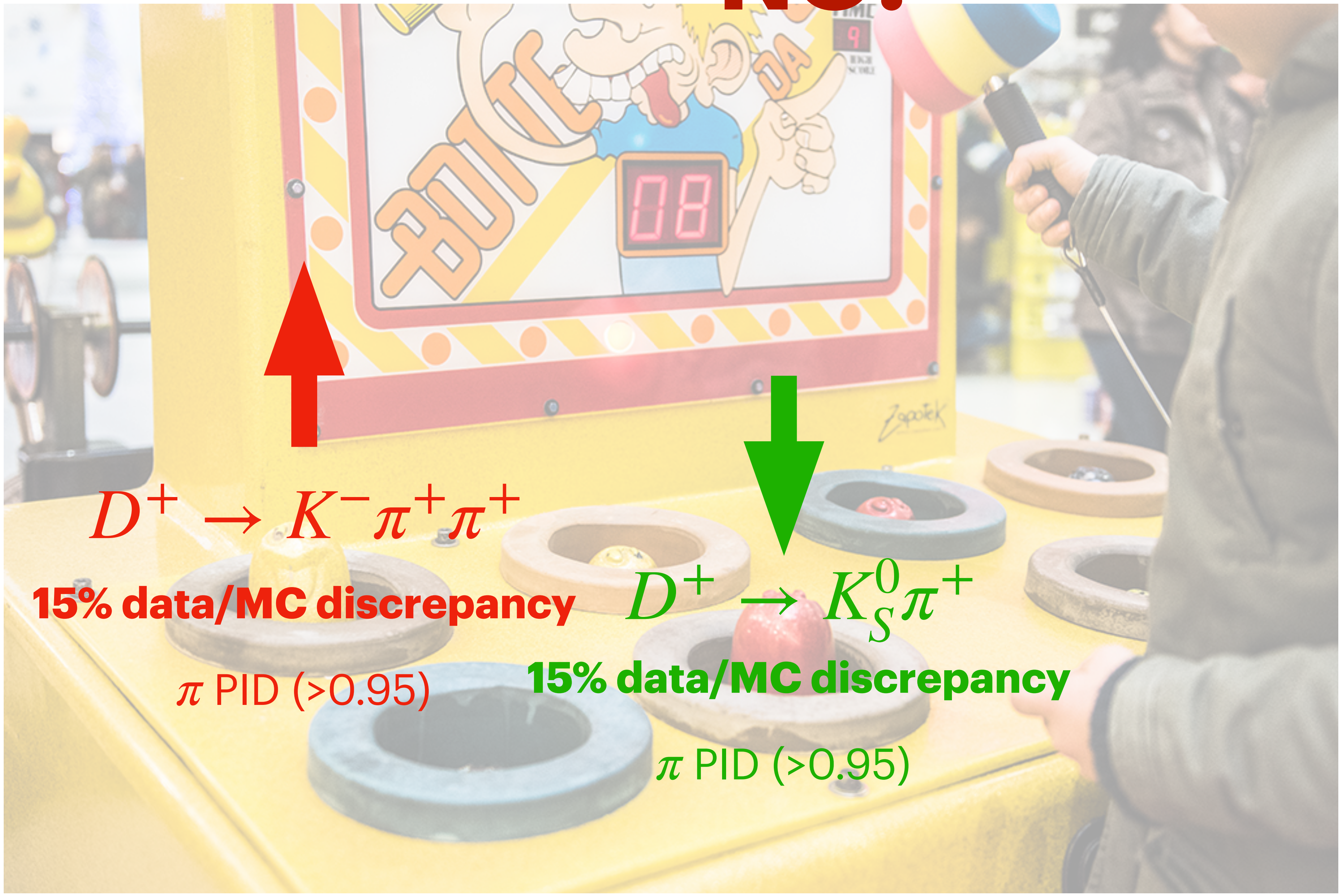
NO!



$D^+ \to K^-\pi^+\pi^+$

15% data/MC discrepancy

π PID (>0.95)

$D^+ \to K^0_S\pi^+$

15% data/MC discrepancy

π PID (>0.95)

Possible solutions

- Maybe PID corrections for 0.95 cut will fix this discrepancy

- Use $D^{*+} \to D^+[\to K_S^0\pi^+]\pi^0$ to avoid misID'd D_S bkg

- Veto D_S by assigning to the $D^+ \to K_S^0\pi^+$ pion the kaon mass and vetoing the $K_S^0 K^+$ invariant mass.