$B^+ \to \rho^+\rho^0$ angular mismodelling

Riccardo Manfredi

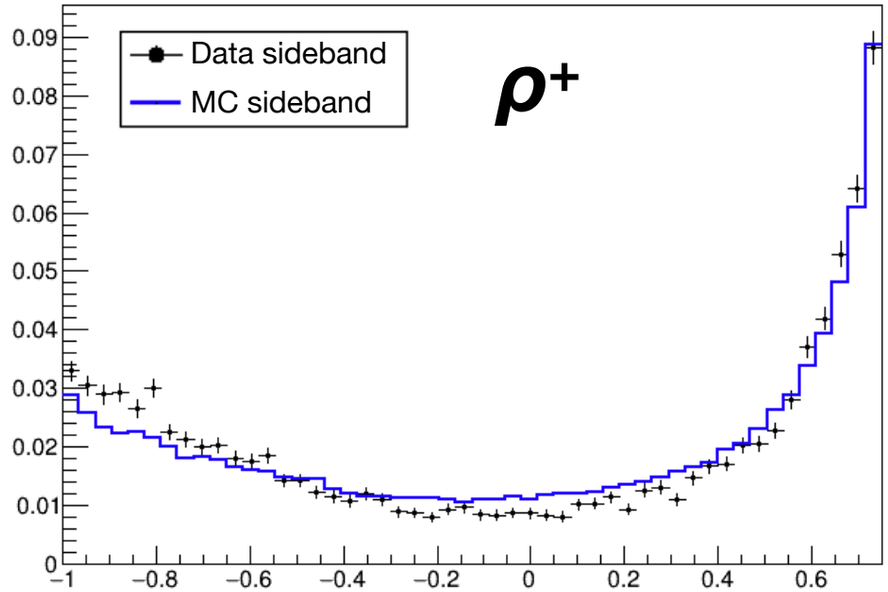
Starting point

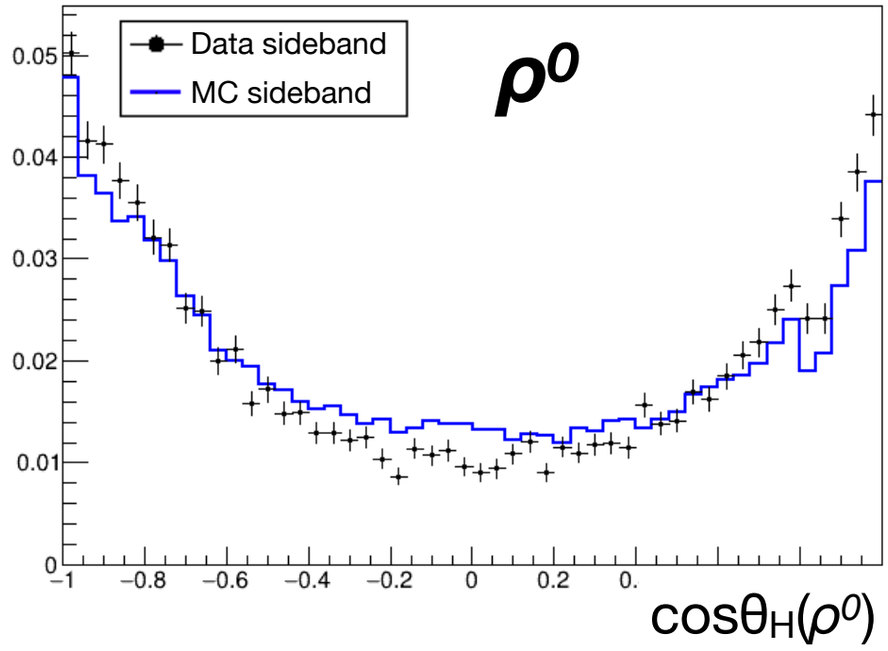
Disagreement in angular distributions.

Observed both in $B^- \to D^0 \rho^-$ and in sidebands.

Moriond solution:

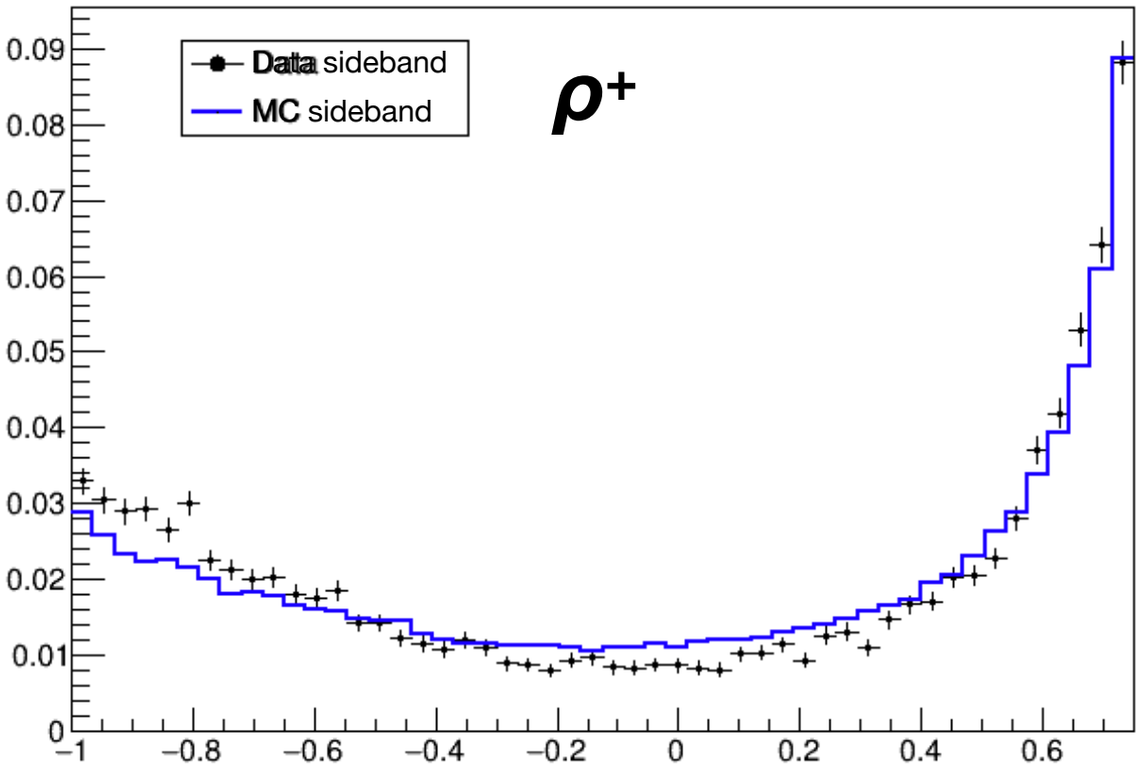
- Determine weights from observed helicity angles in sidebands;
- Generate samples with weighted BBbar component, continuum component, or all components;
- Fit with both, default and weighted models, and study biases → dominant systematics.

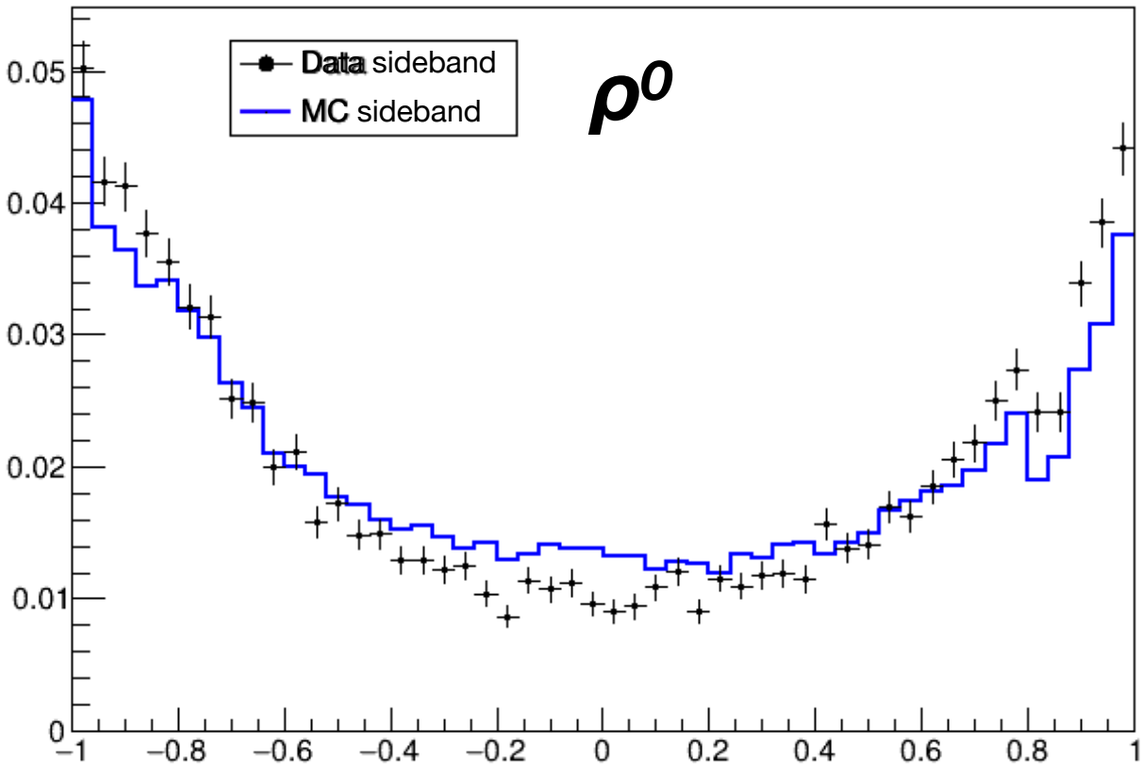


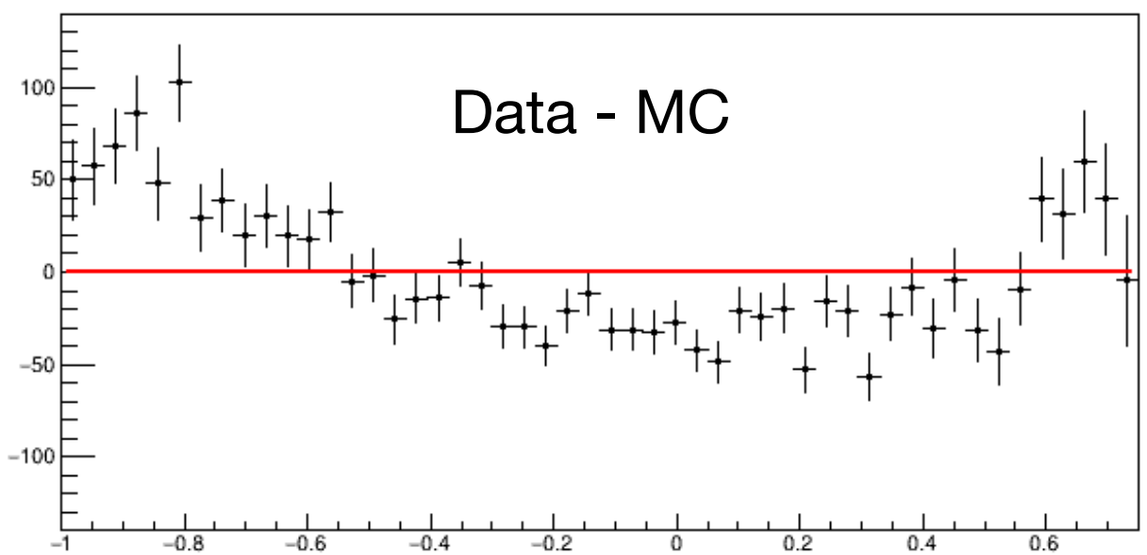


Goal: understand mismodeling causes to correct/include them in the analysis.

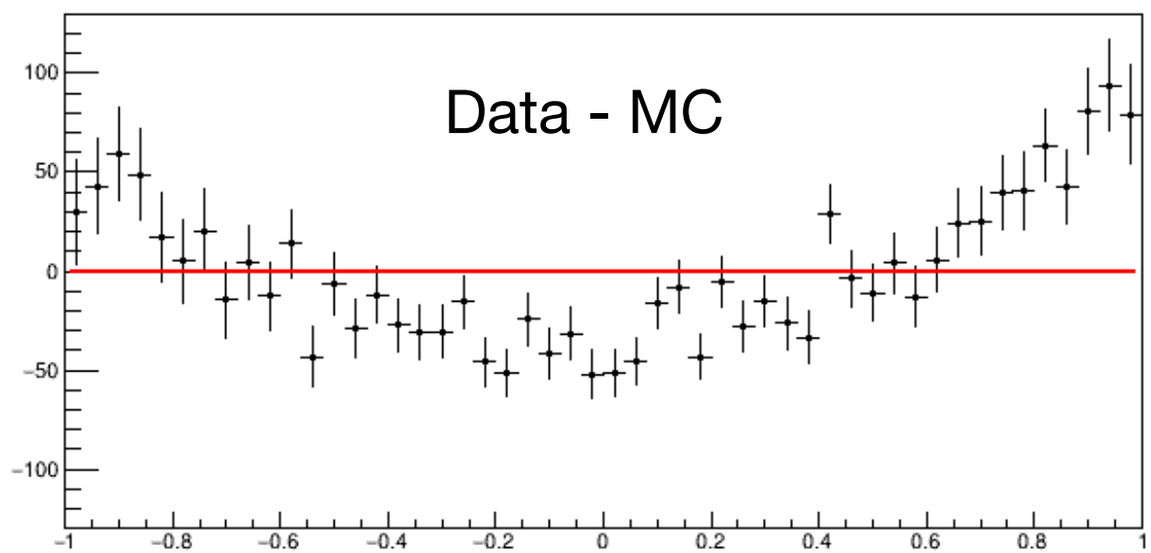
Starting point







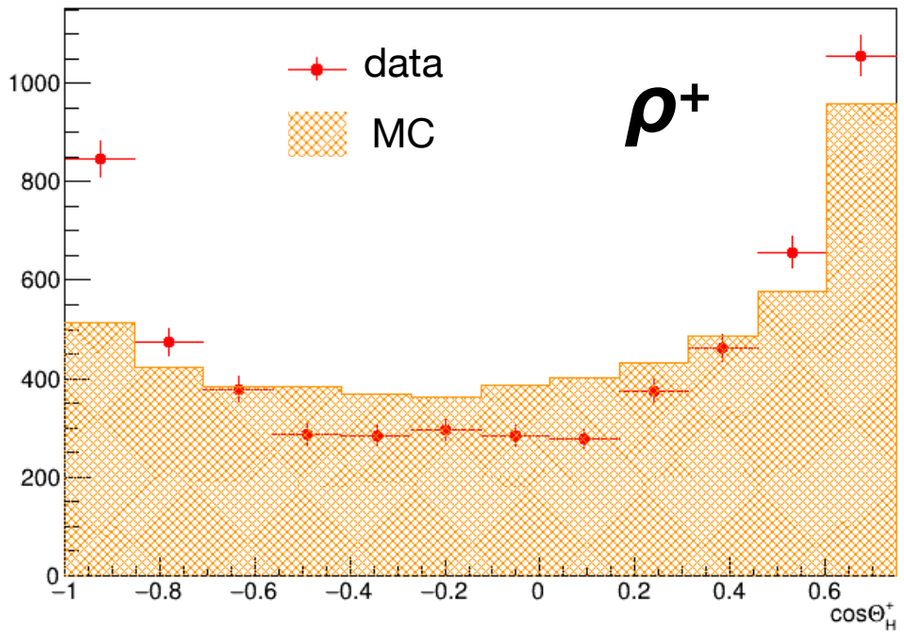
cosθH(ρ+)

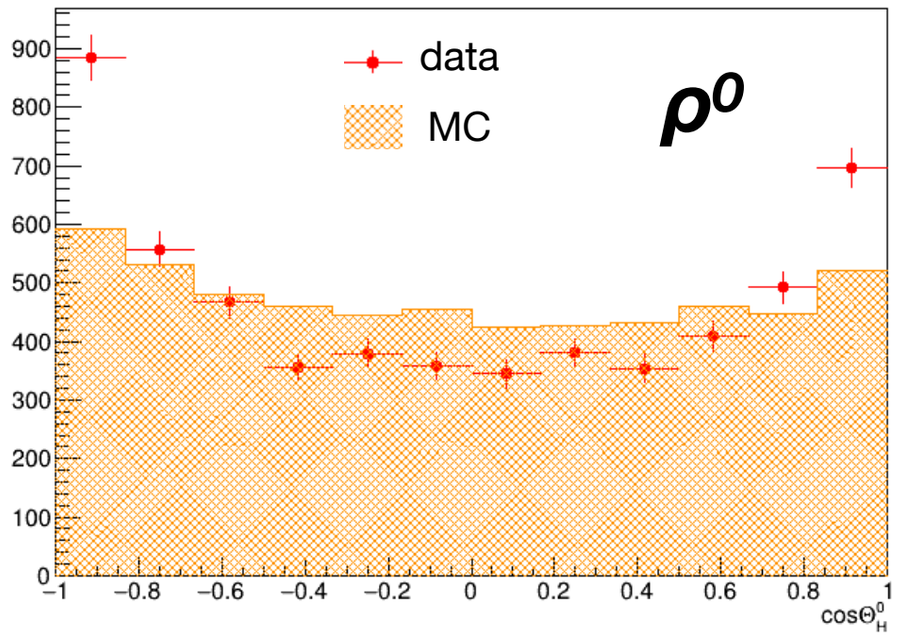


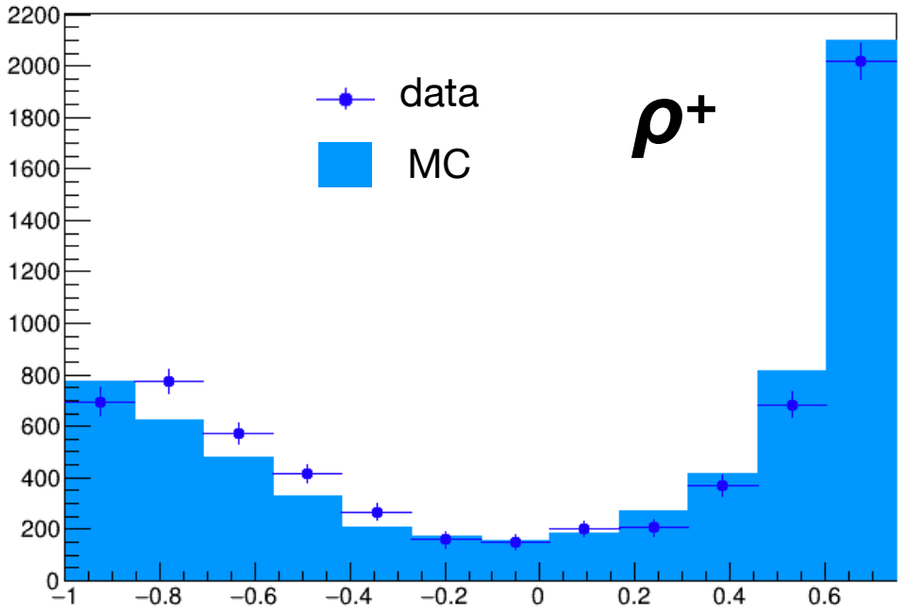
cosθH(ρ0)

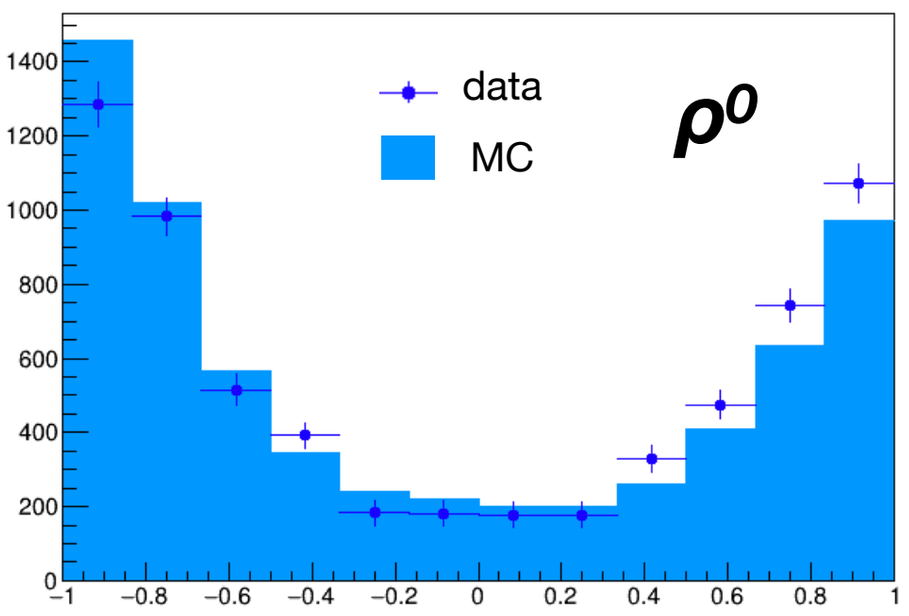
Pure components

Pure continuum: off-resonance data with loosen CS cut (CS>0.94, validation plots in backup). Subtract from sideband (out of ΔE-Mbc box, CS>0.97) to have pure BBbar, using proportions from sideband fit.









Observations

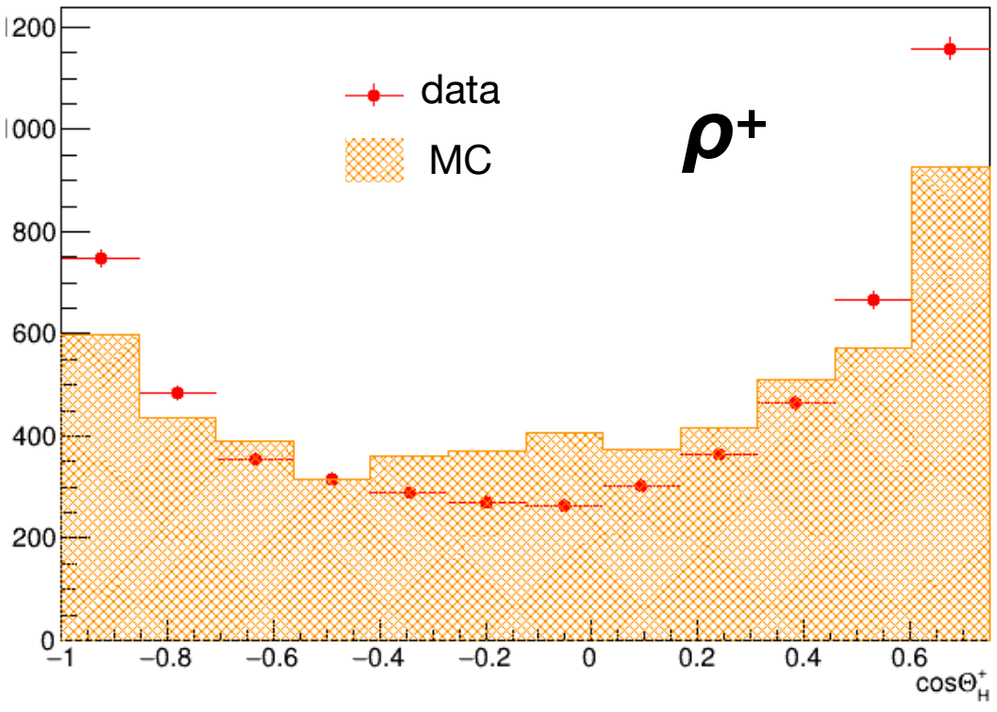
Mismodeling is mostly affecting continuum.
The mismodelling observed in slide 3 is very similar to the continuum one.

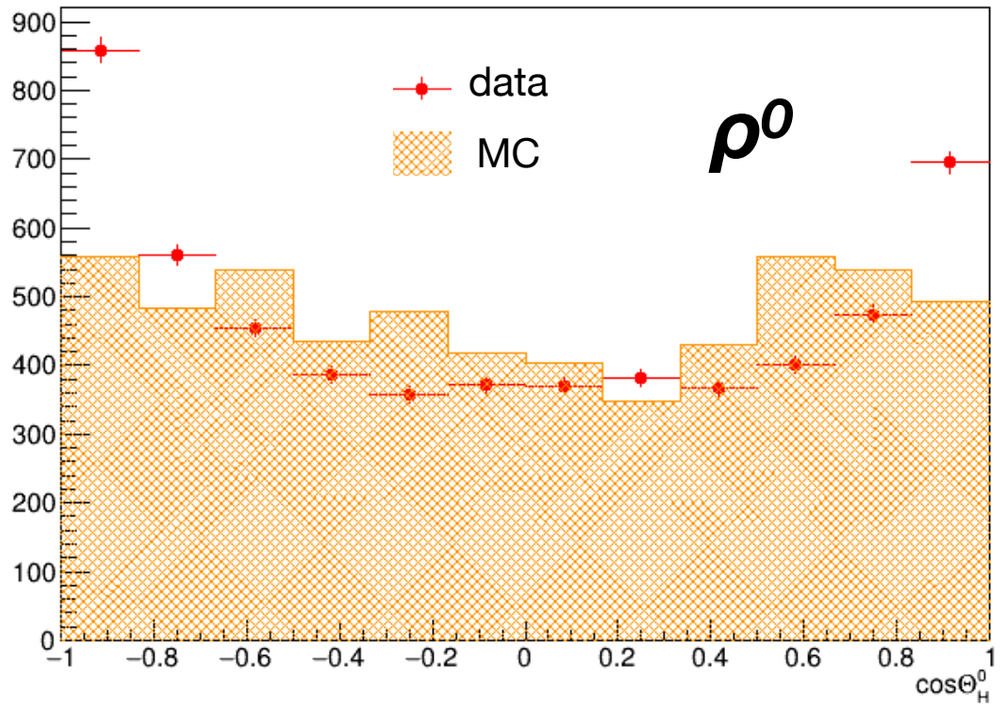
Possible causes

- Continuum wide resonances bug;
- Data-MC discrepancies on photons;
- Data-MC discrepancies on tracks;
- Acceptance;
- Fake ρ vs true ρ composition;
- …

Corrected continuum MC

Data: same pure continuum (offres data with loosen CS>0.94).
MC: 200 fb^{-1} with fixed bug on the resonance width.





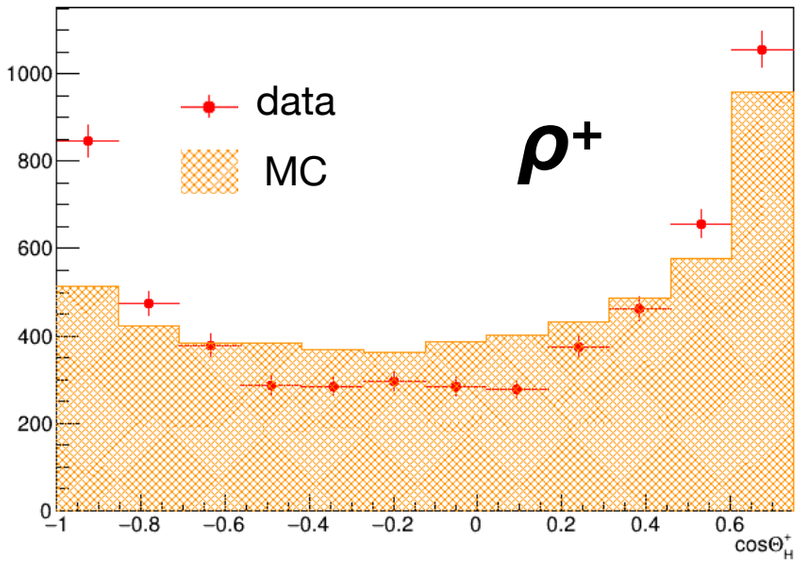
Still discrepant, angular mismodelling unrelated to mass width bug.

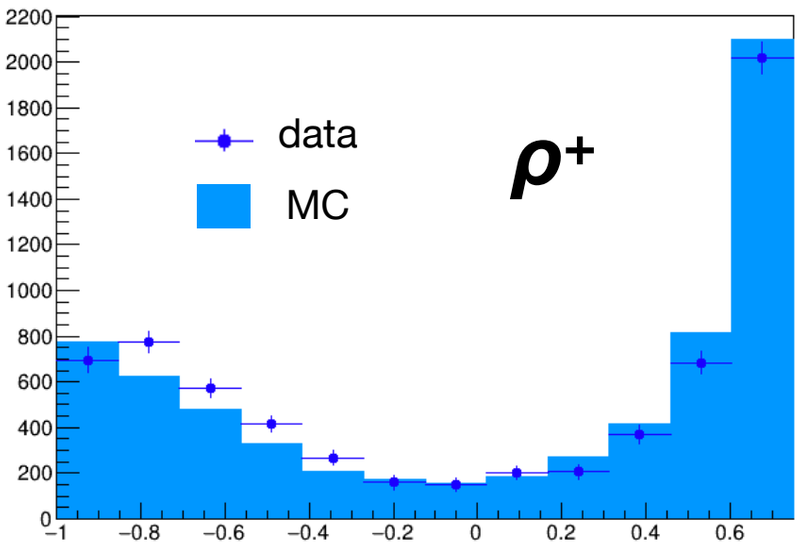
effects from γ/tracks

Discrepancies from photons

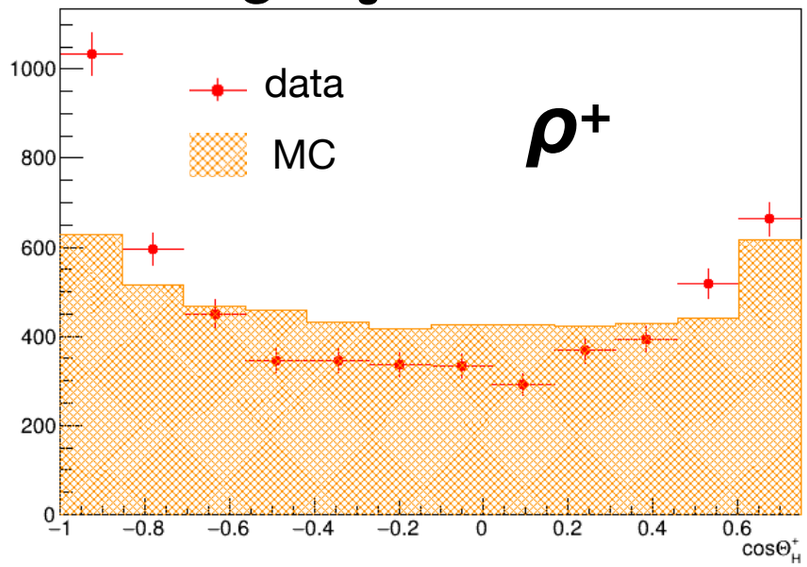
In the ρ+ρ- analysis they use a different approach, with tight photon cuts.
They see much smaller mismodellings in the angles.
What happens if I use their same tight selection (omit PhotonMVA only)?

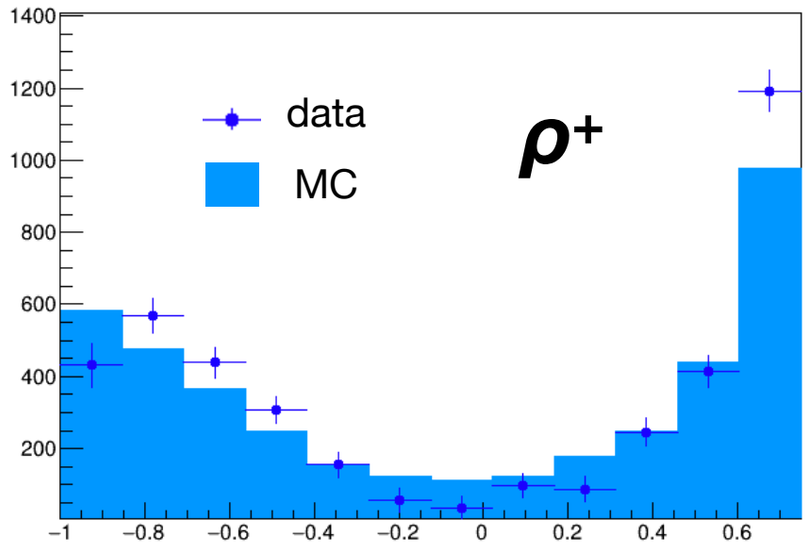
default





tight γ/π⁰ cuts

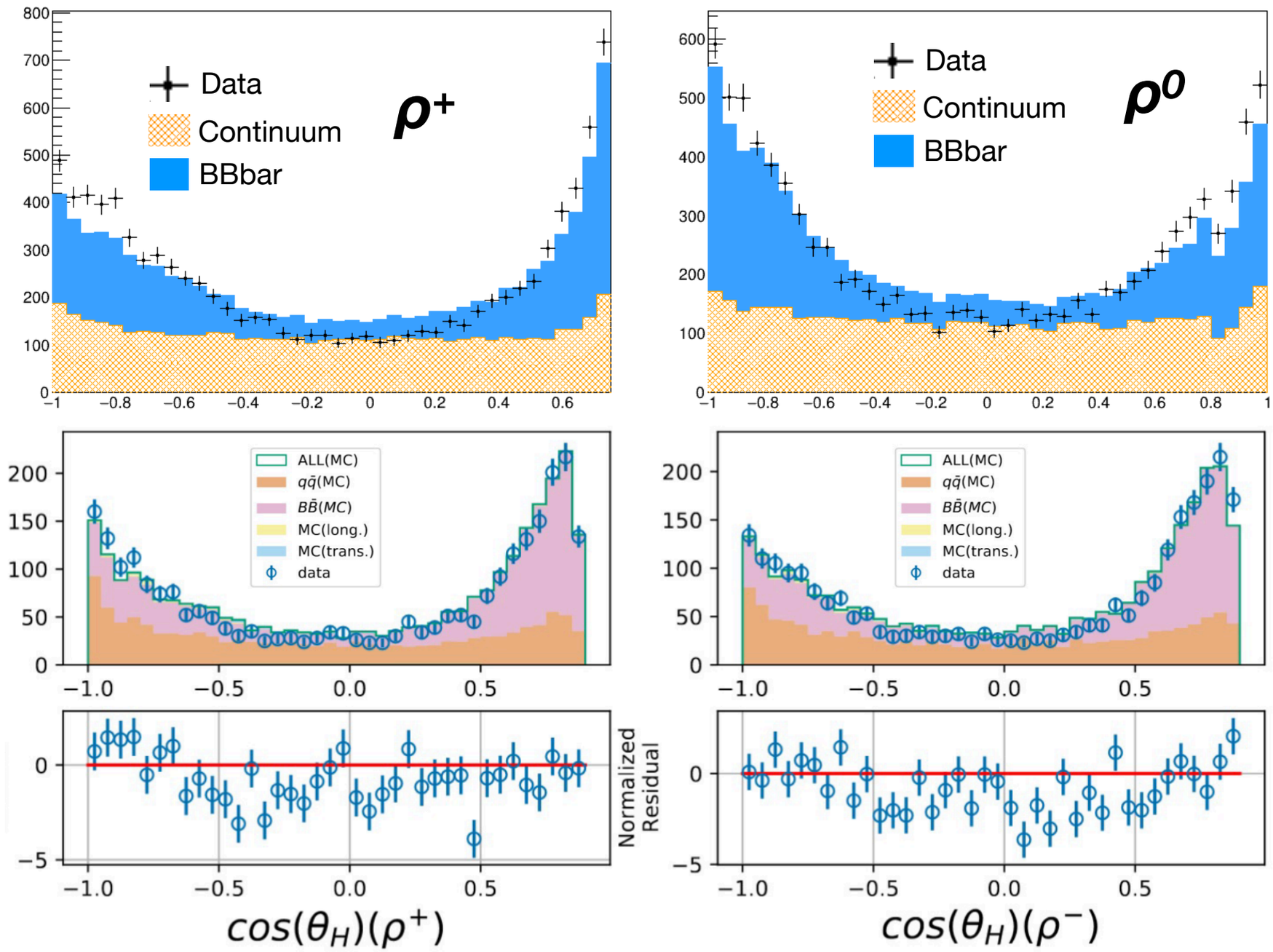




Expected cut on last bin, but mismodelling not affected/healed.

Discrepancies from photons

Compare w/ $\rho^+\rho^-$ plots, using same selection (tight on γ/π^0, no PhotonMVA).

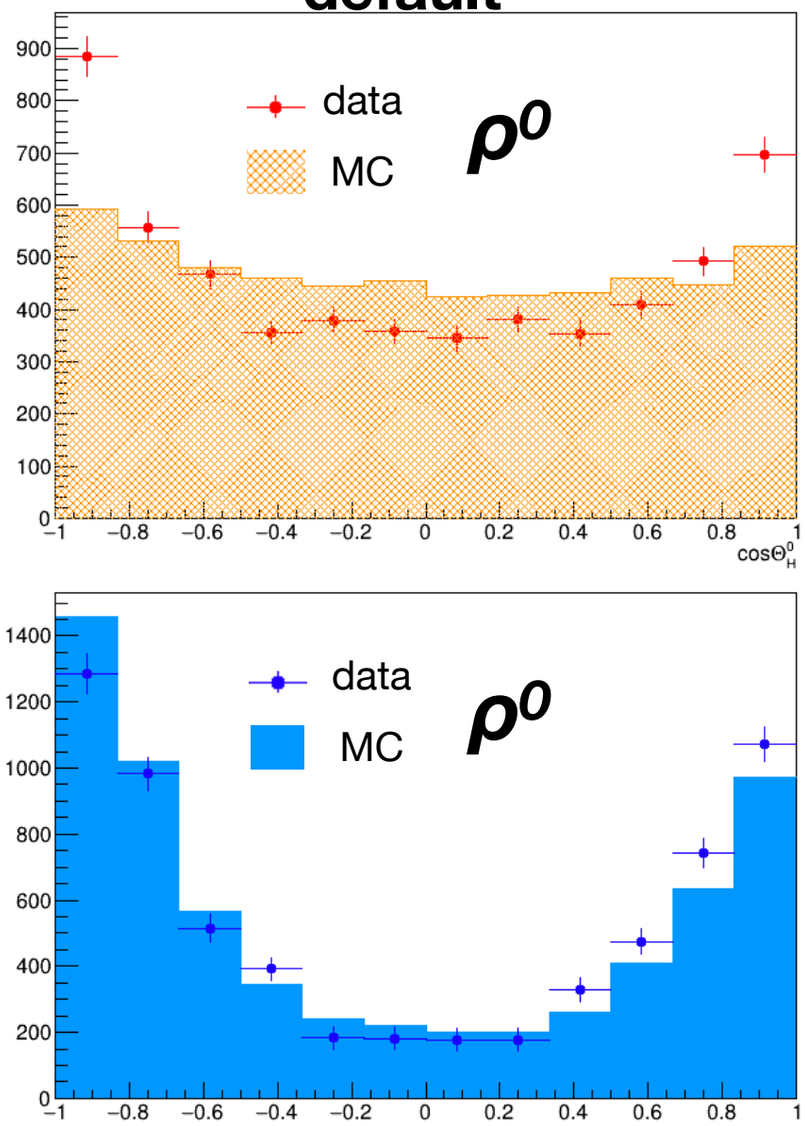


Our ρ^+ seems different from their ρ's, even with ~same selection&composition. Why?
This + mismodel in ρ^0: culprit is not (only) in ECL mismodelling.

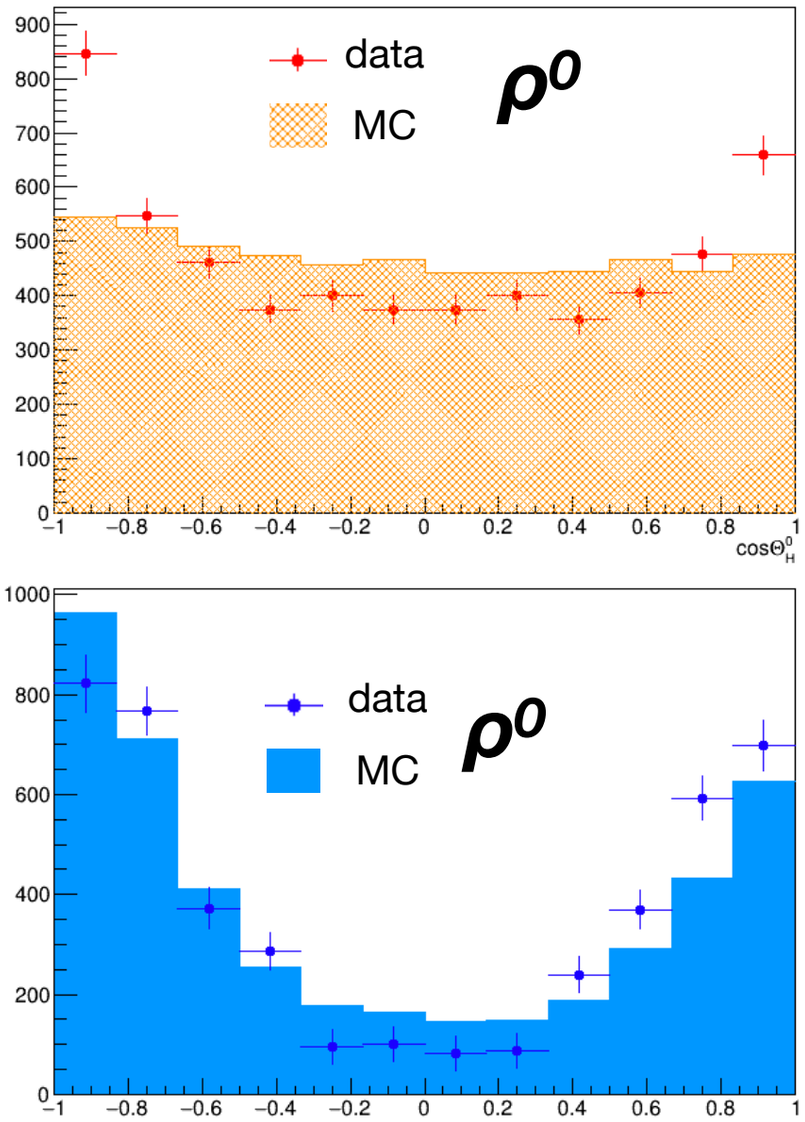
Discrepancies in azimuthal angle?

Repeat exercise: try to cut tight on tracks' cosθ and see if mismodelling is affected.

default



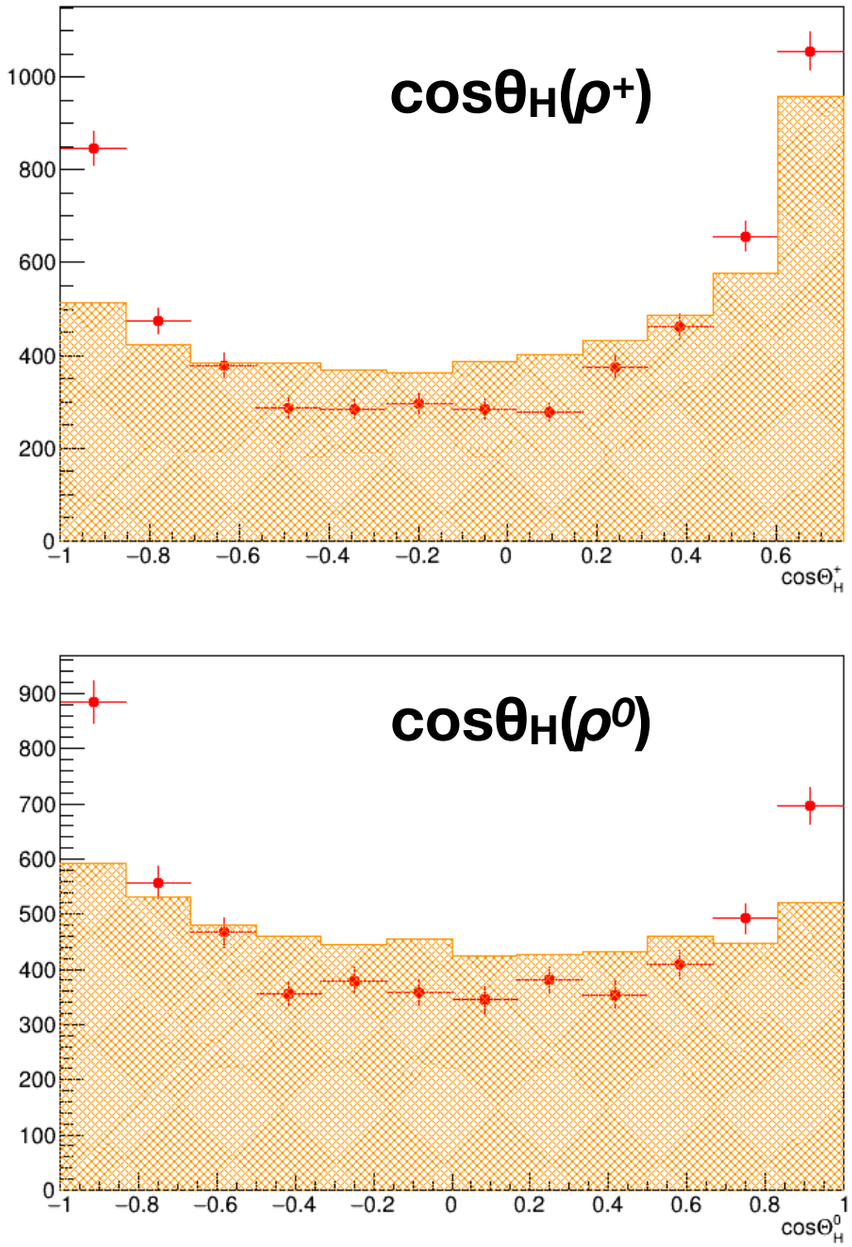
-0.75<cosθ<0.85



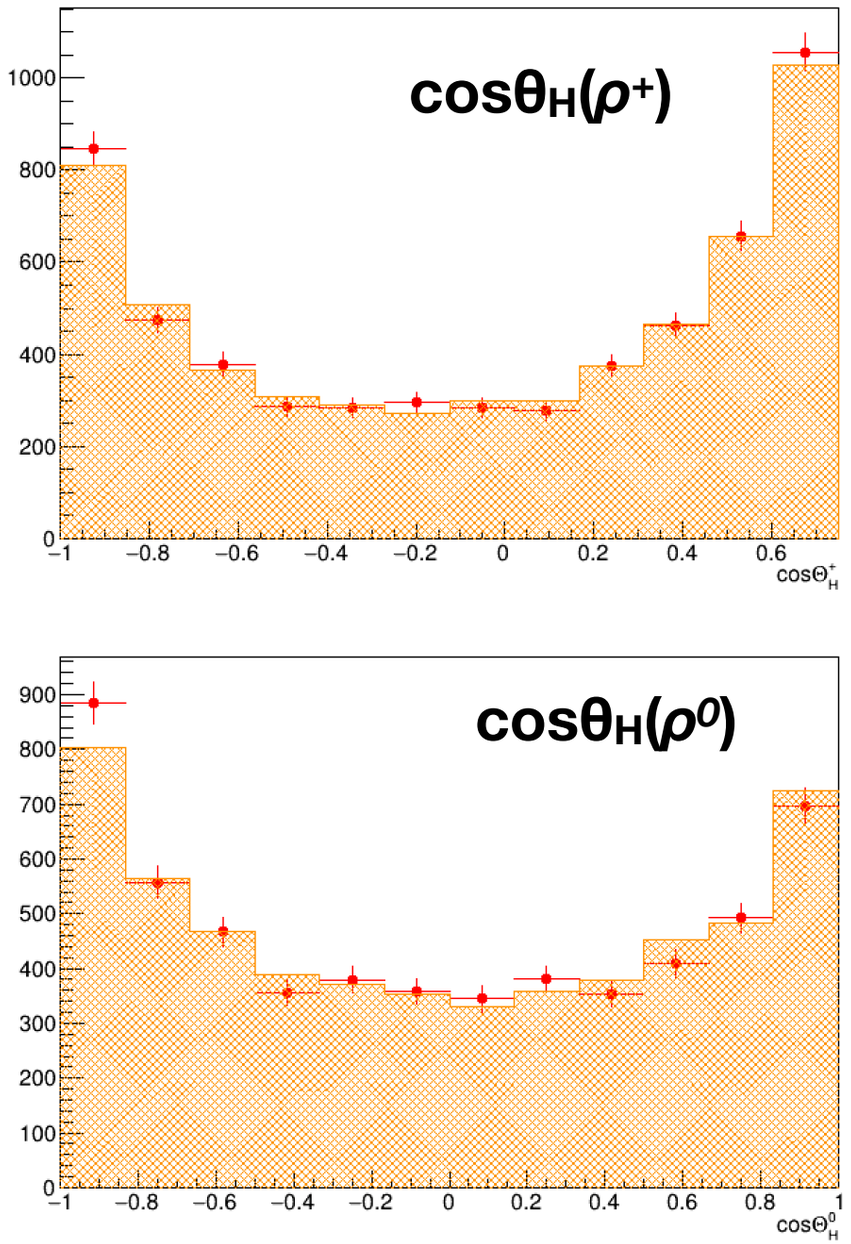
Mismodelling doesn't seem affected by this.

Impact of track momenta

We know that track momenta are highly correlated with angles. In fact track momenta show also large discrepancies (see backup). Does reweighting on momenta heal the angles? Use approach by Eldar: 2Dx2D weights based on each ρ's daughters momenta.

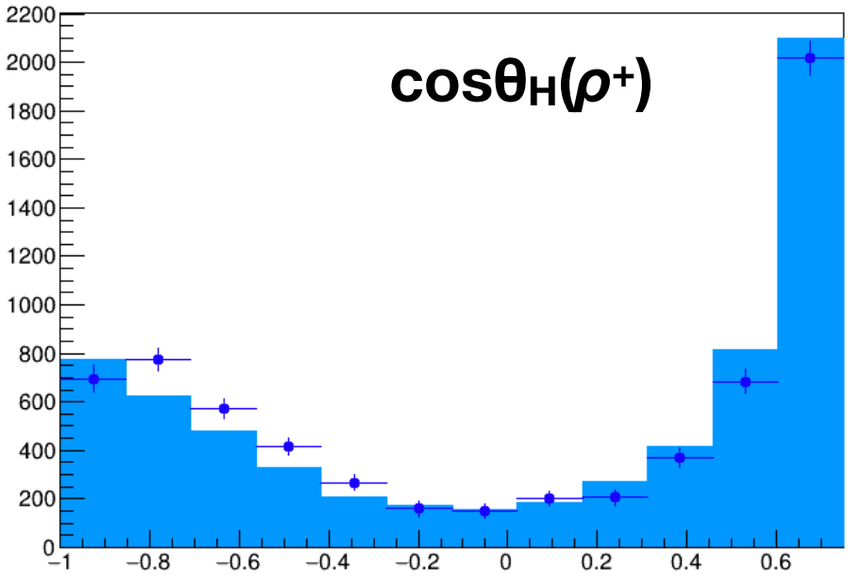


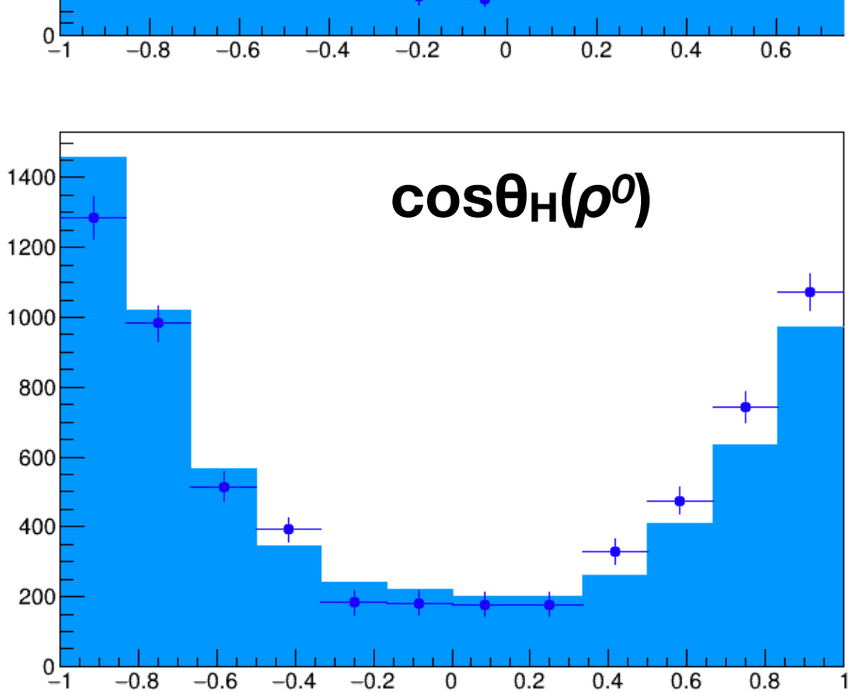
Weights



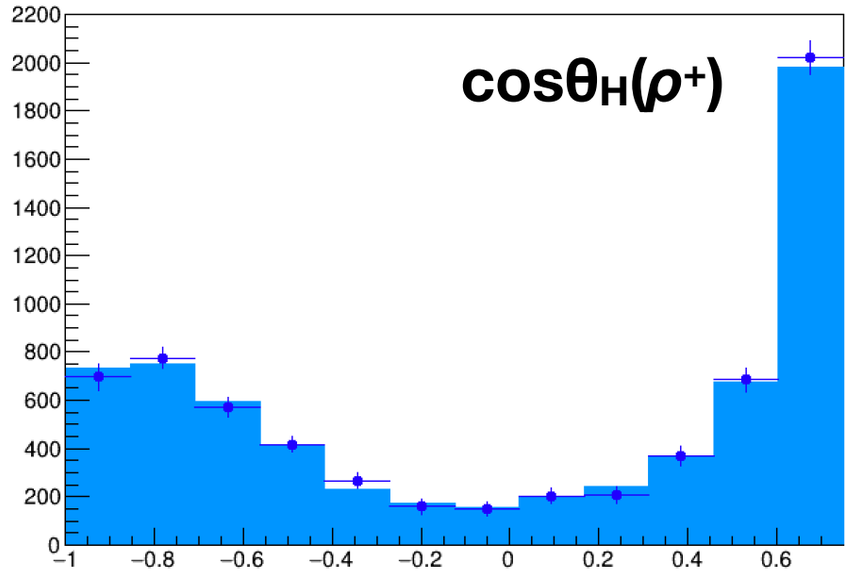
Improved but not fully healed. Is there something else entering?

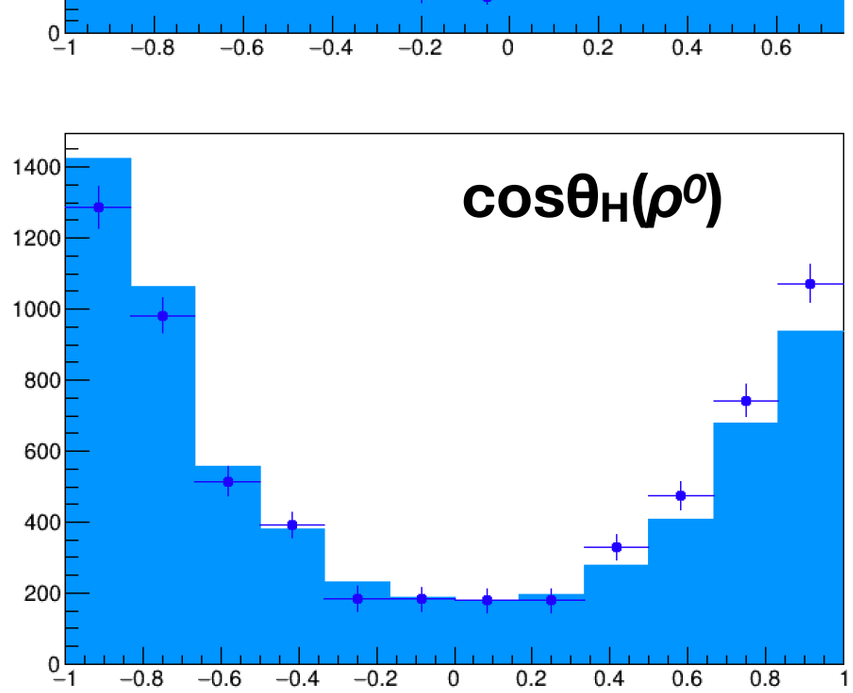
Impact of track momenta





Weights



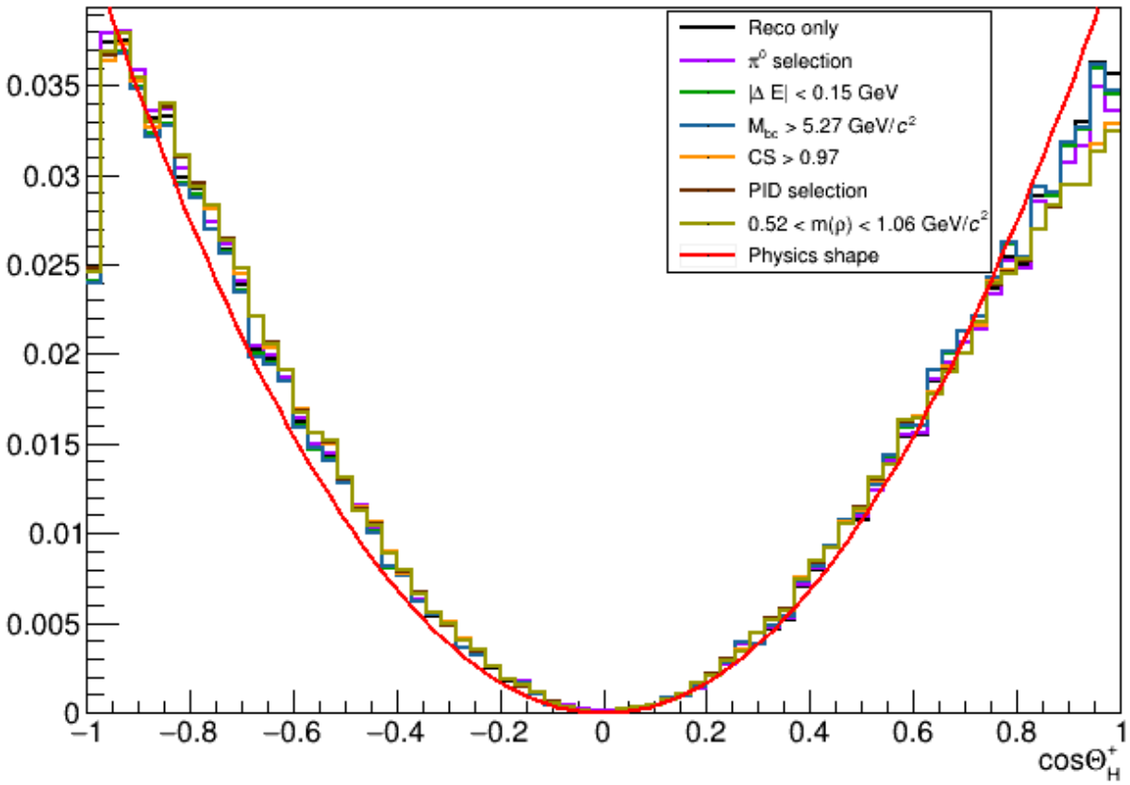


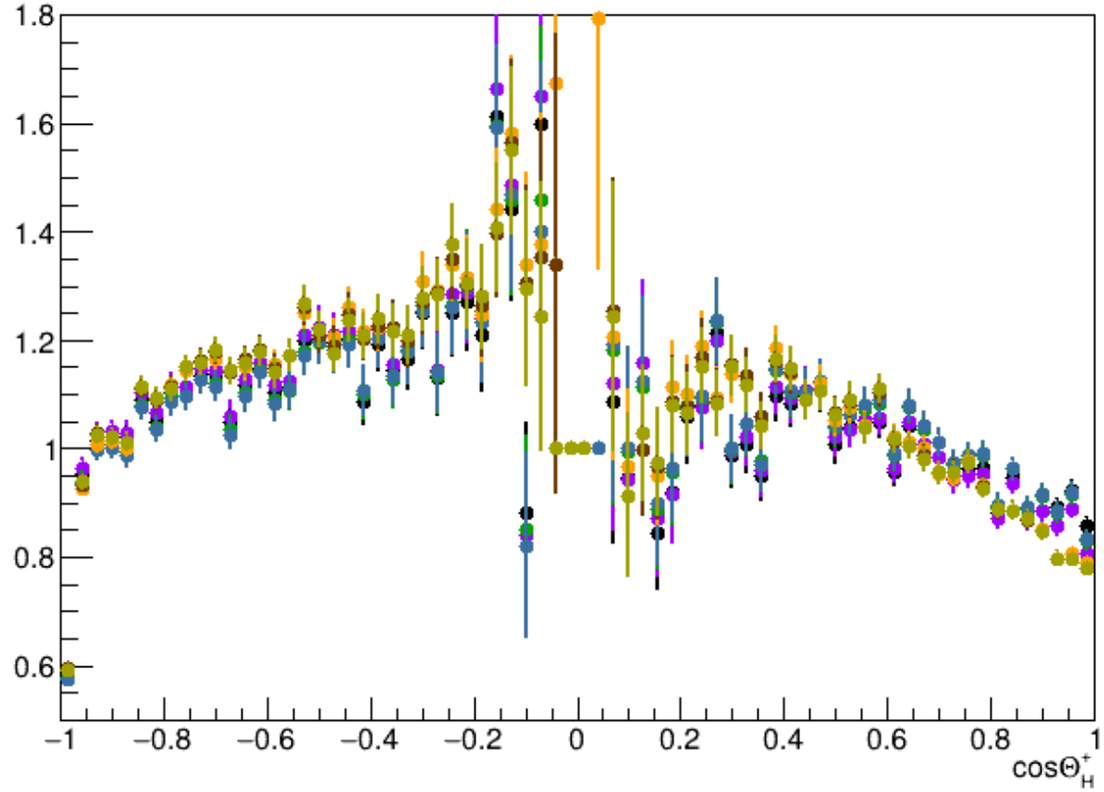
Improvement for ρ^+, less for the ρ^0 angle. Why not working?

acceptance

Acceptance variation vs cut (I)

Take $B \to D\rho$ isSignal=1 MC angle distribution and the predicted shape ($\propto \cos^2\theta$).
Compute acceptance as ratio of MC/physics shape, for every selection step.
Hope to find one variable that sculpts the acceptance and look at it in data.

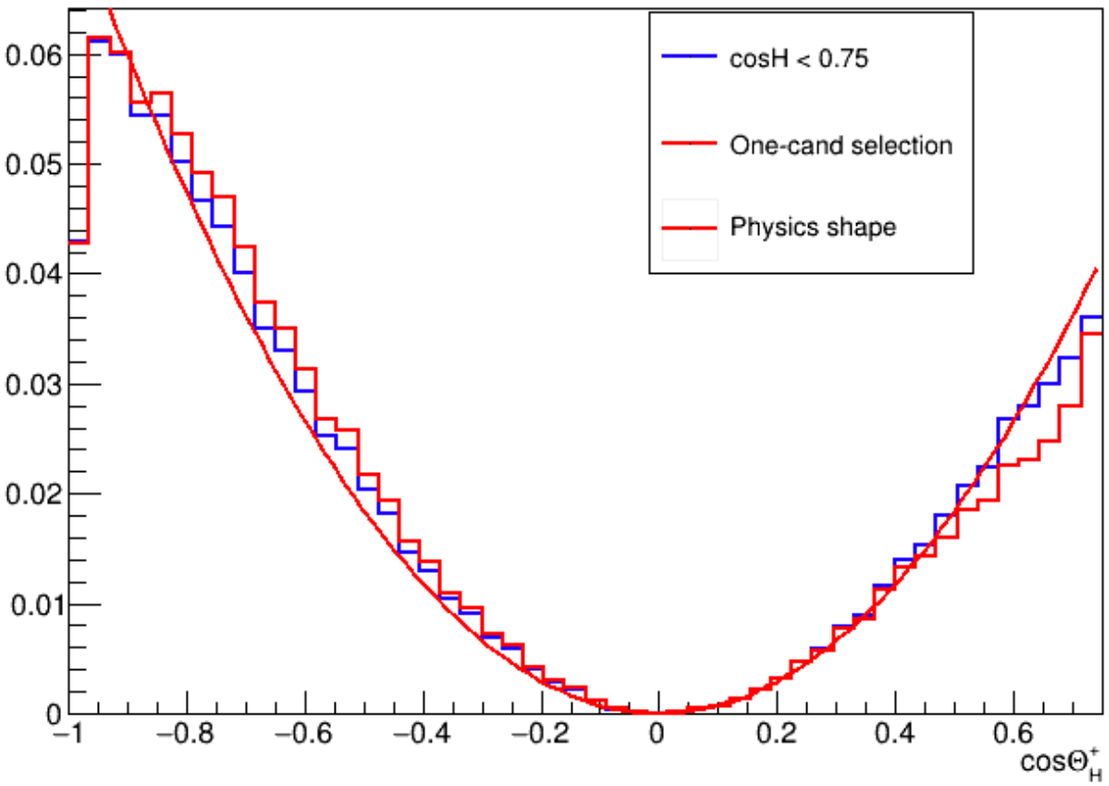


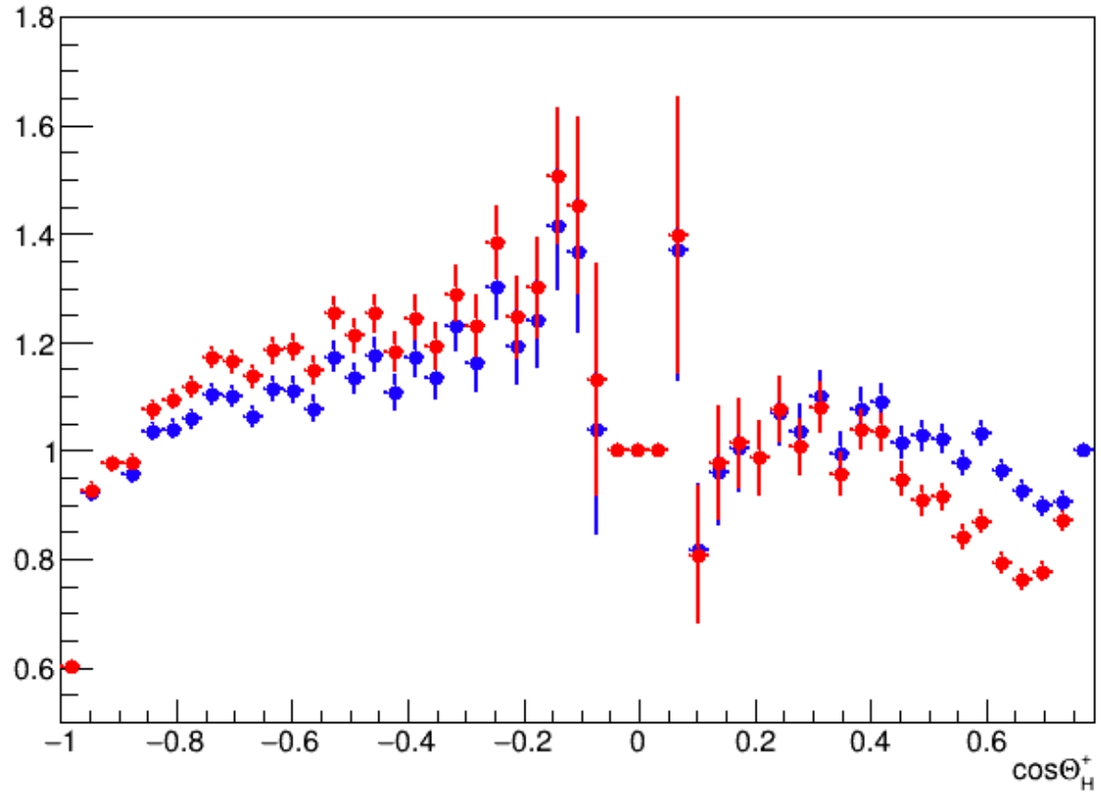


Not flat already after reconstruction level.
No evidence of a selection sculpting the acceptance.

Acceptance variation vs cut (II)

Issue in normalization (cosHel range changes), for now showing two different plots.
Here only final steps, i.e. cut on cosHel and best candidate selection.

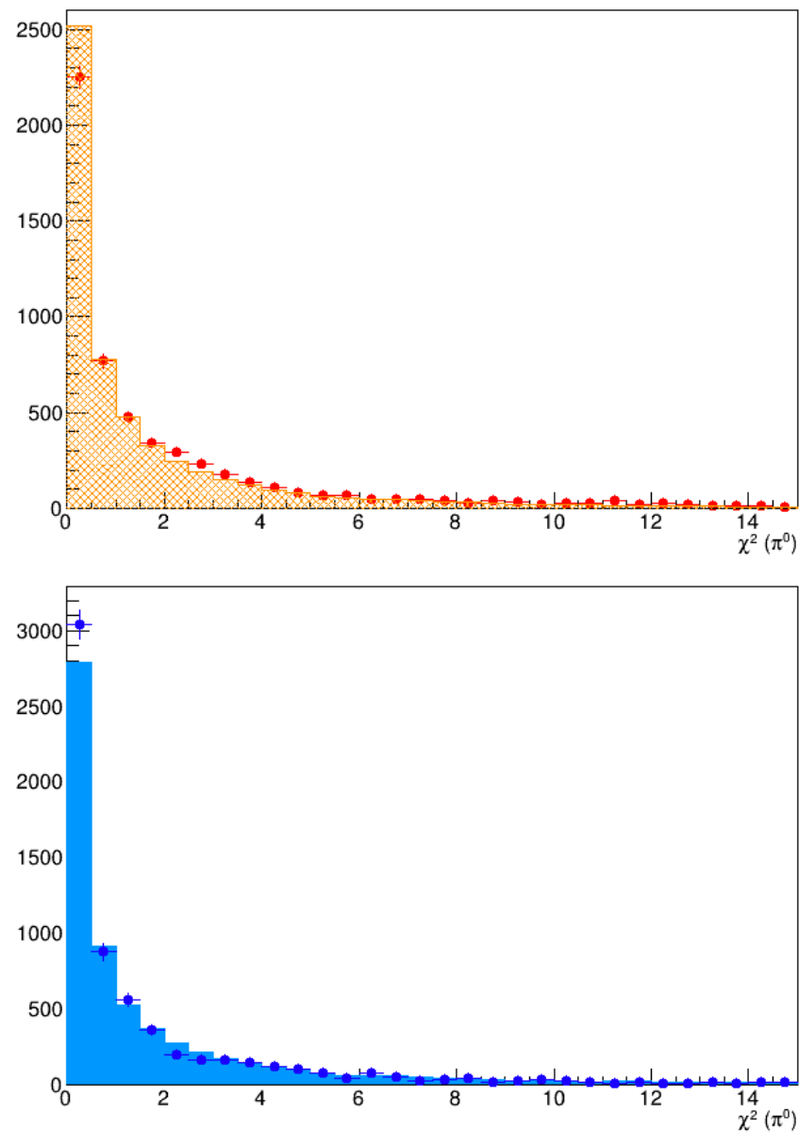


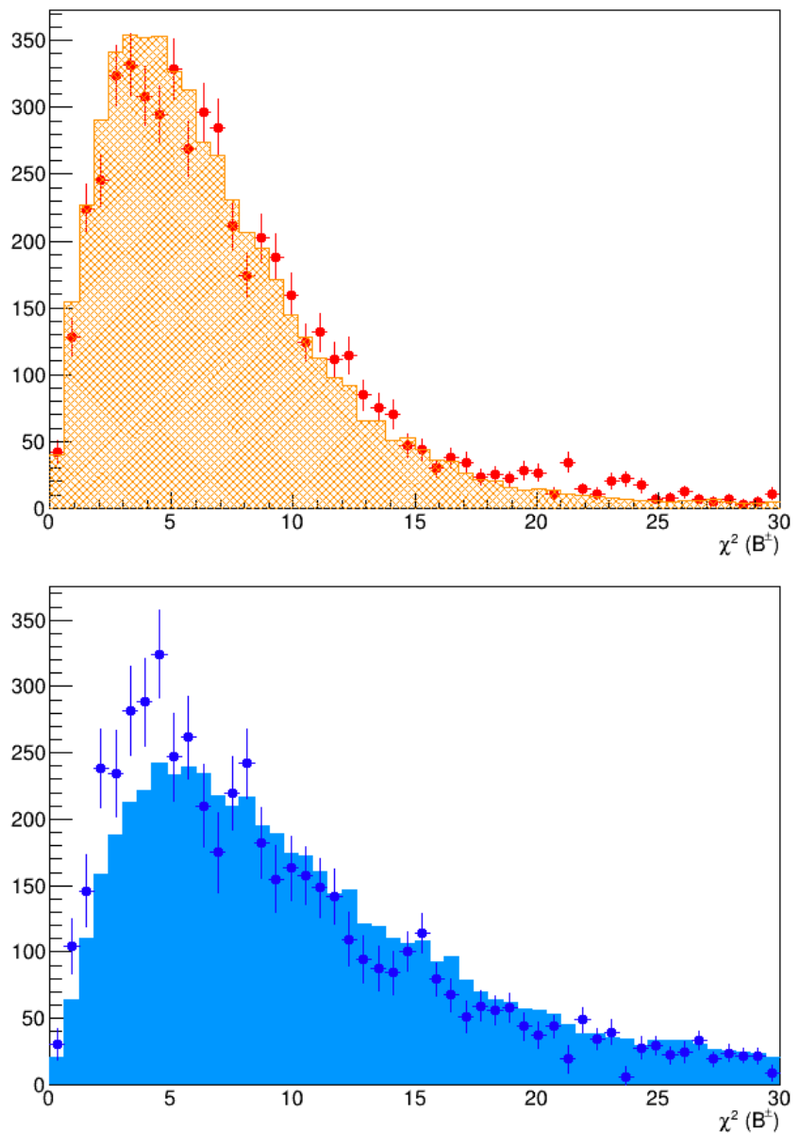


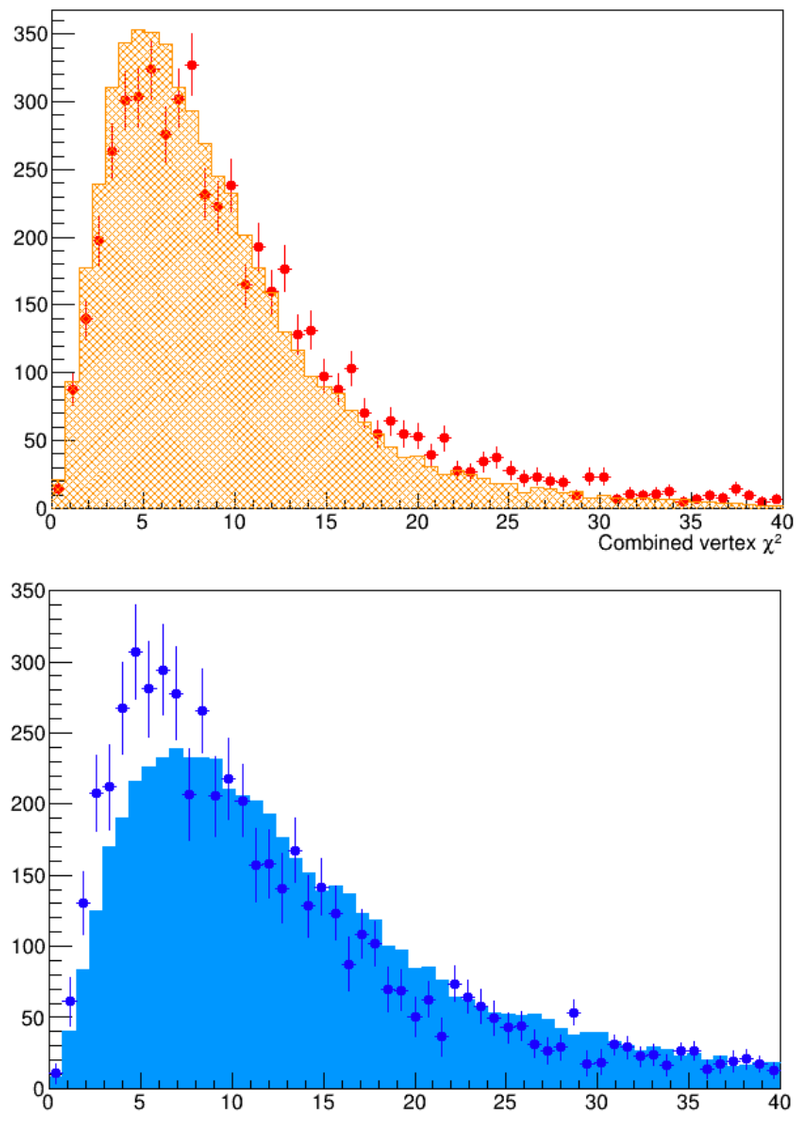
One-candidate selection sculpts a bit in [-0.8; -0.5] and over 0.5.

Vertex variables

BCS based on π^0 and B^+ vertices. Check variables in continuum and BBbar samples. Distributions in samples before applying the best-candidate selection.







Much larger differences in BBbar. Could explain the small angular mismodelling for BBbar, but not the one observed in continuum.

fake ρ - true ρ

Fake-ρ numbers

ρρ sideband	Real ρ^+	Fake ρ^+
Real ρ^0	1 % 1.5 %	5 % 10 %
Fake ρ^0	10 % 8.5 %	84 % 80 %

Continuum
BBbar

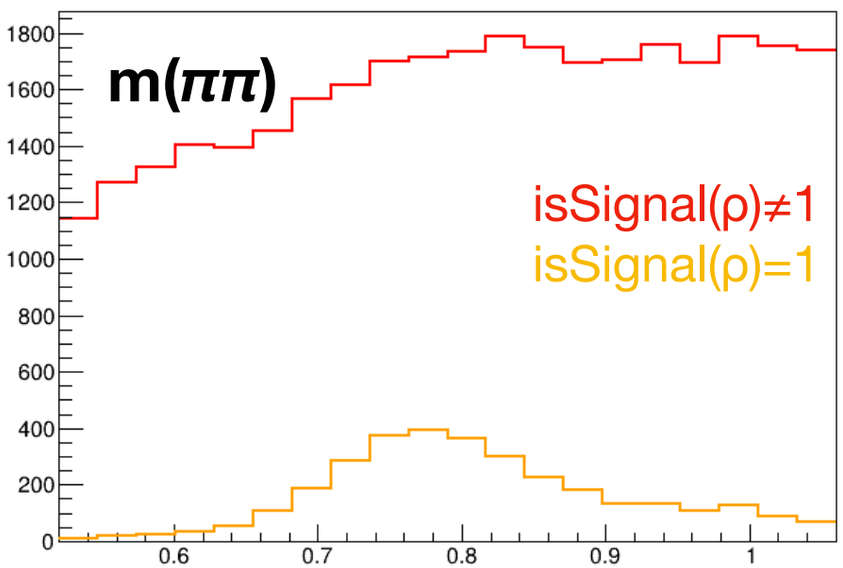
Dρ full isSignal≠1	Real ρ^+	Fake ρ^+
	20%	80%

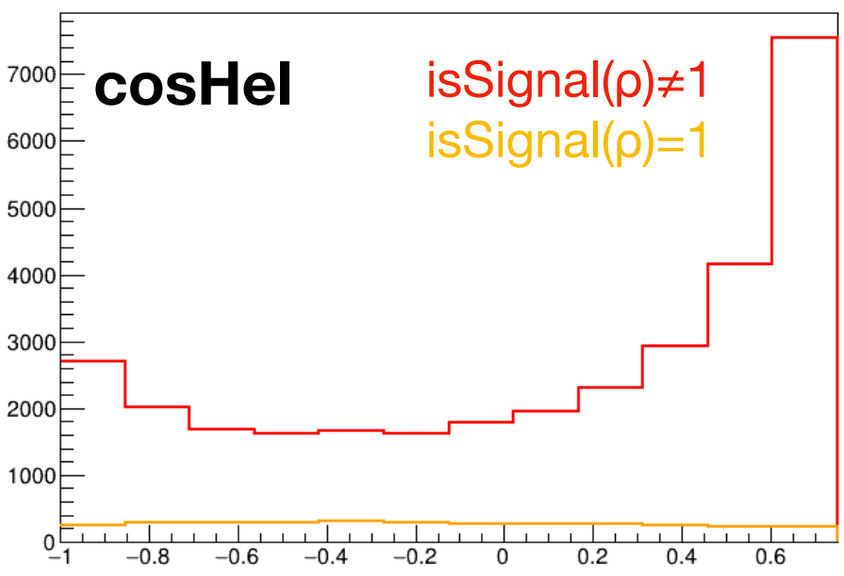
Effects may come from different fake/true proportions in data and MC, or from different shape of one component.

Continuum component

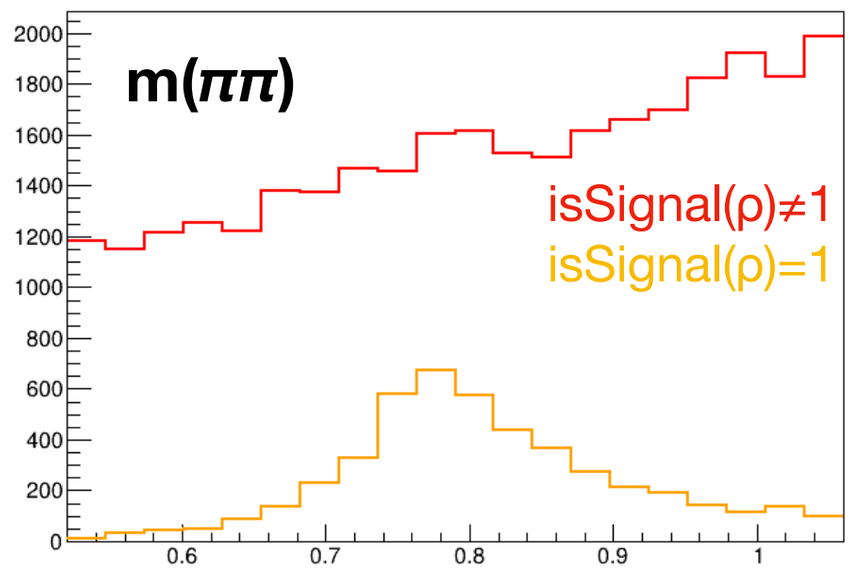
Continuum (w/ bug fixed) from sideband MC.
Realistic proportions. Normalized shapes in backup.

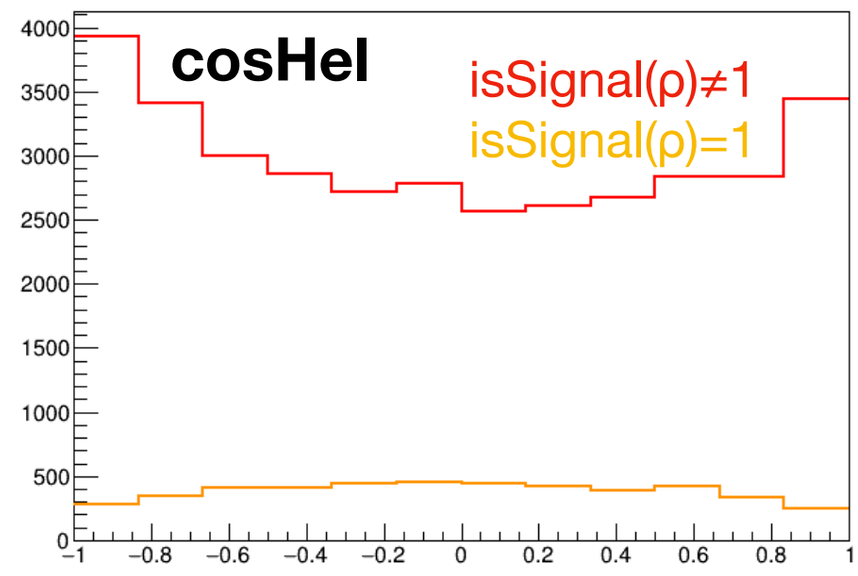
ρ^+





ρ^0



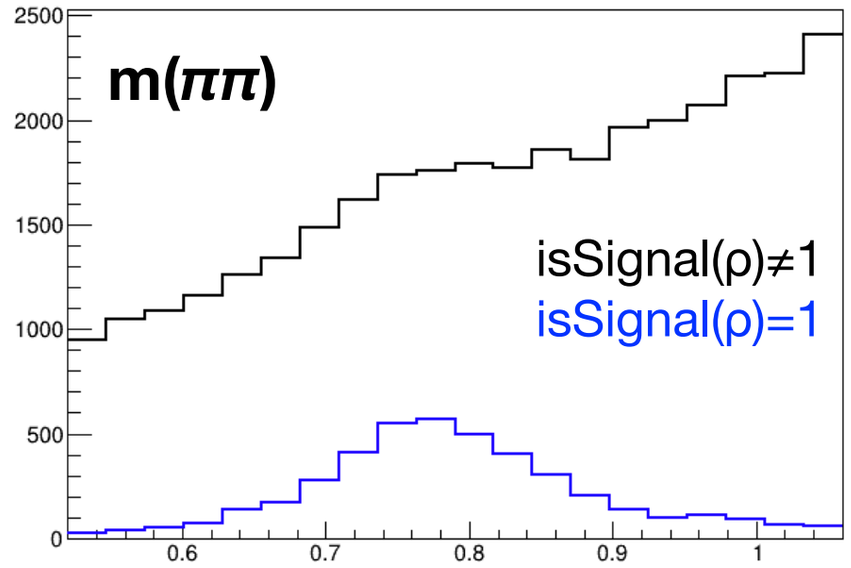


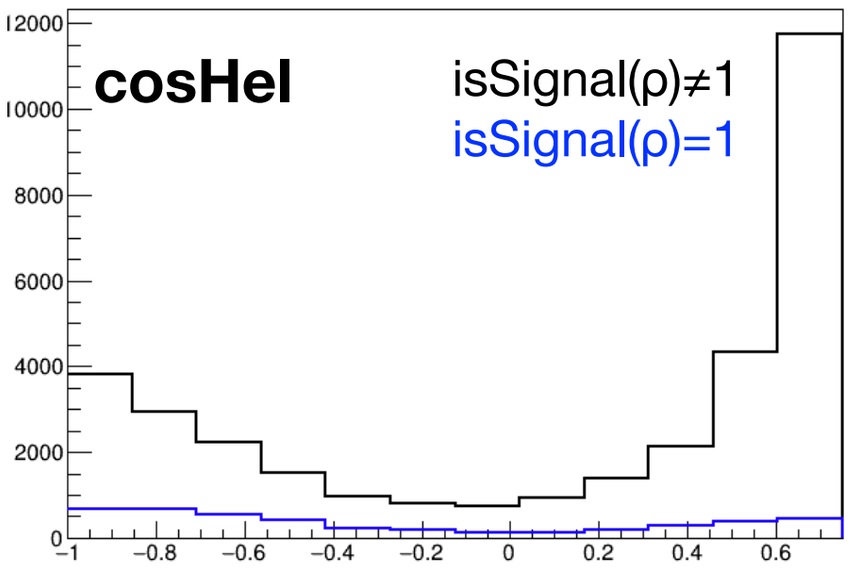
By eye: fake ρ angles seem distributed like data, wrong proportion/shape of real ρ can cause mismodelling.

BBbar component

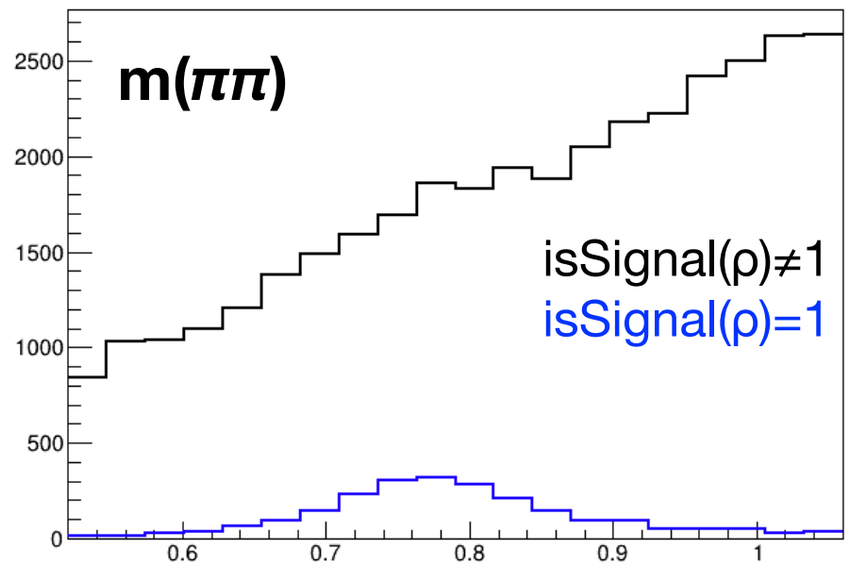
BBbar from sideband MC. Realistic proportions. Normalized shapes in backup.

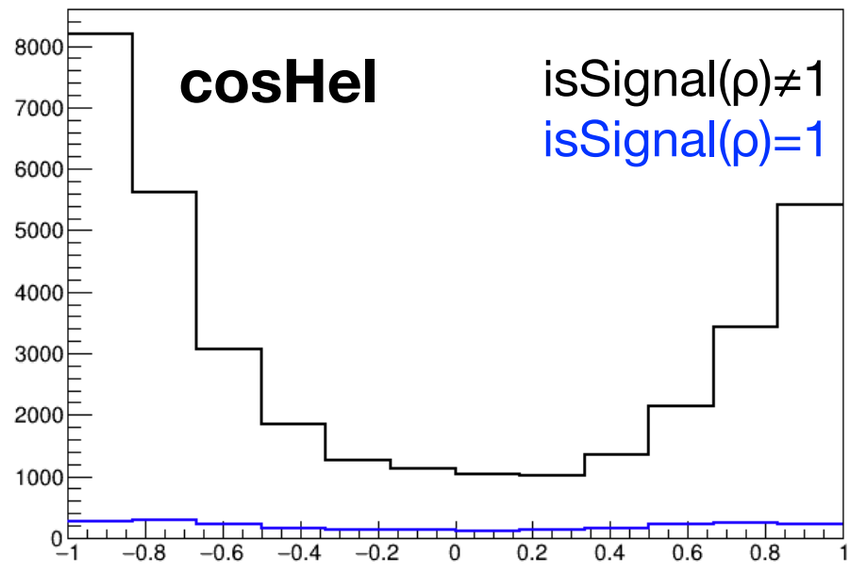
ρ^+





ρ^0





True/fake ρ angles more similar than in continuum.
Will investigate this effect now.

Status — open problems

Priorities indicated with '#'

Mismodeling is mostly affecting continuum.

Possible causes

- Continuum wide resonances bug; → no, present also with corrected MC
- Data-MC discrepancies on photons; → no, present also in ρ^0
- Data-MC discrepancies on tracks θ; → not affected by variation of azimuthal angle
- Acceptance; → non-flat after reconstruction, BCS should affect mostly BBbar (#4)
- Fake ρ vs true ρ composition; → need to investigate (#1)

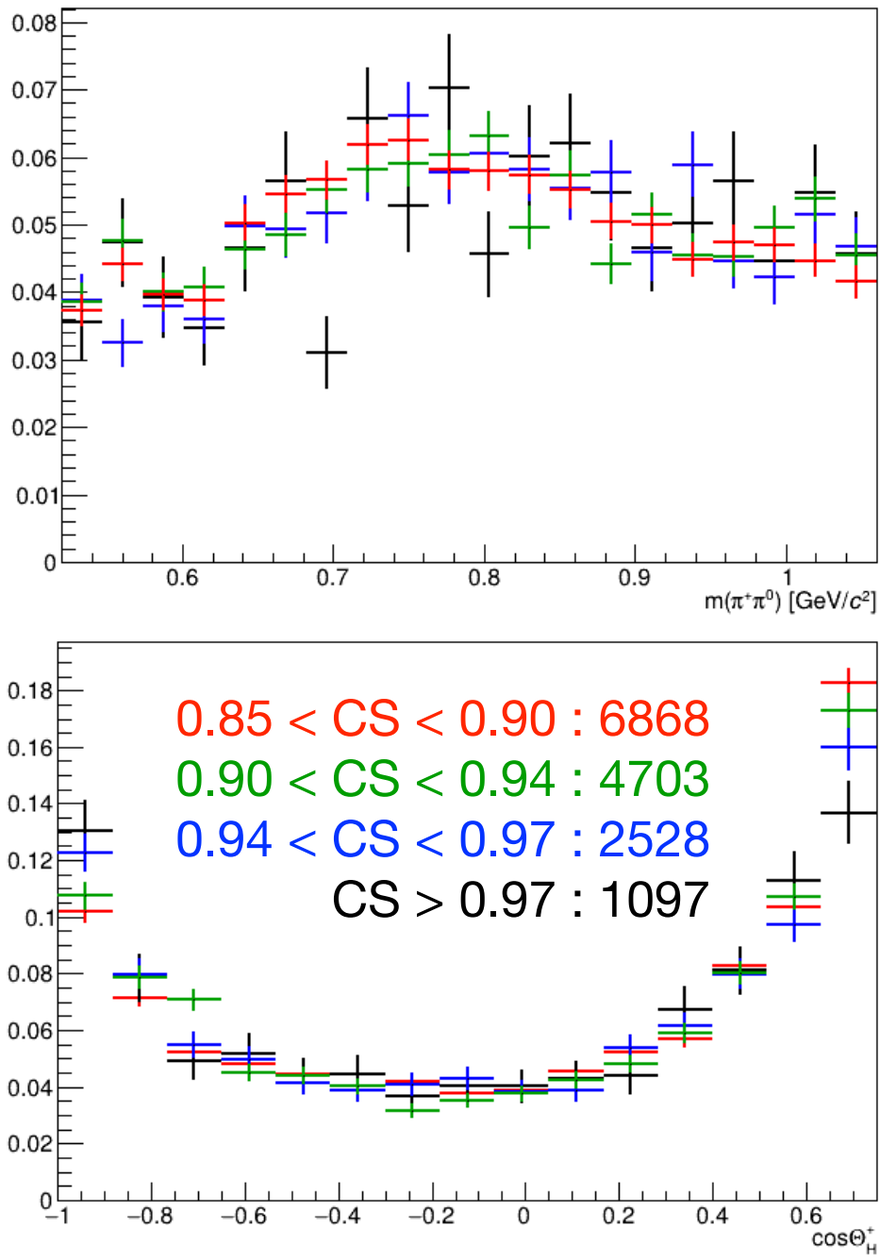
Extra

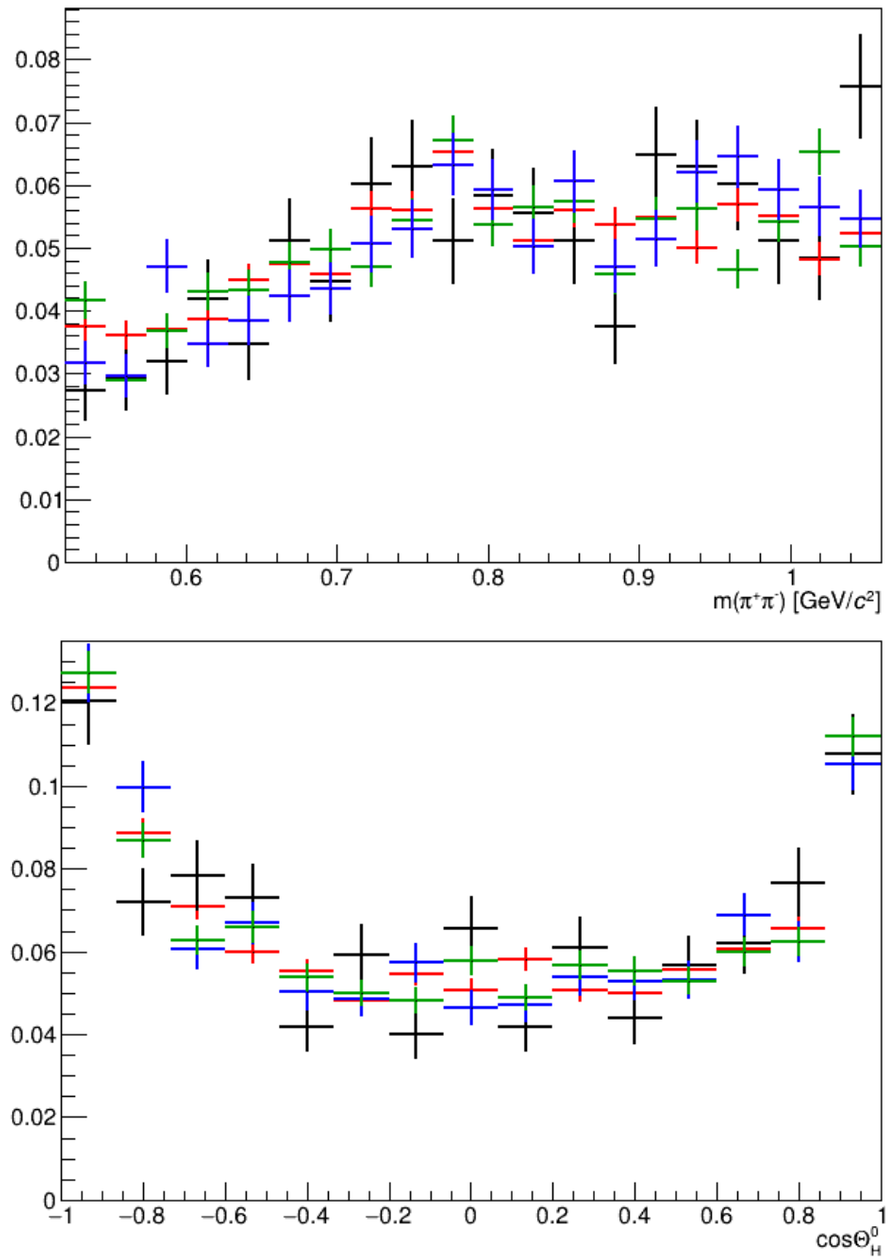
- Why reweighing à la Eldar doesn't fully work? (#3)
- Why we observe different angular distributions wrt $\rho^+\rho^-$? (#2)
- Found further bug in rho mass in continuum (see backup)

backup

Off-resonance data

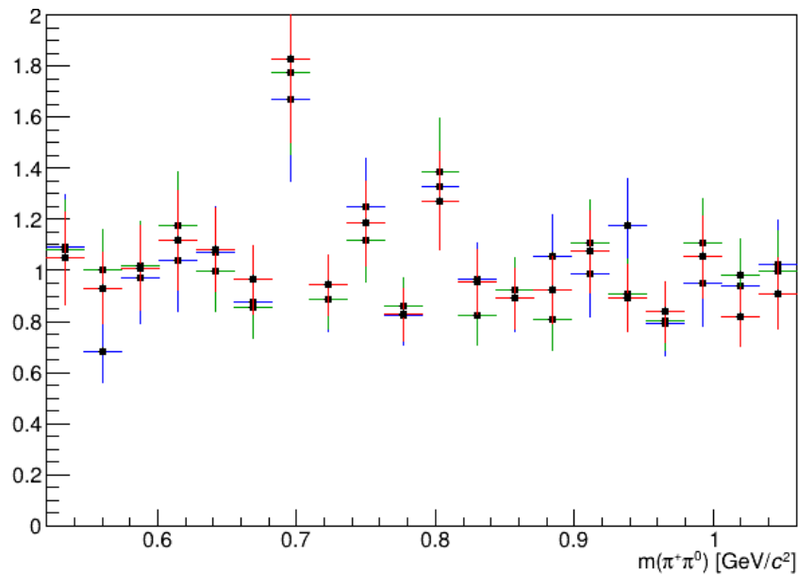
Recap: check if we can use other regions of CS directly from offres data.

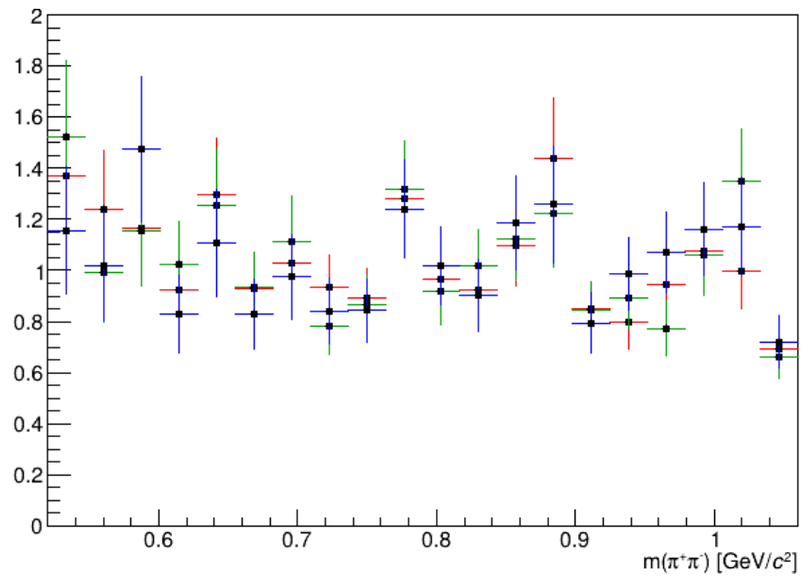


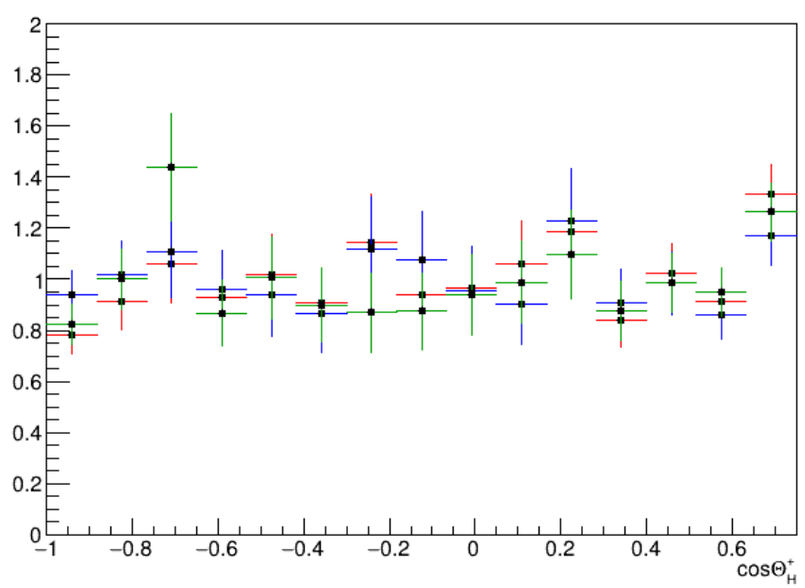


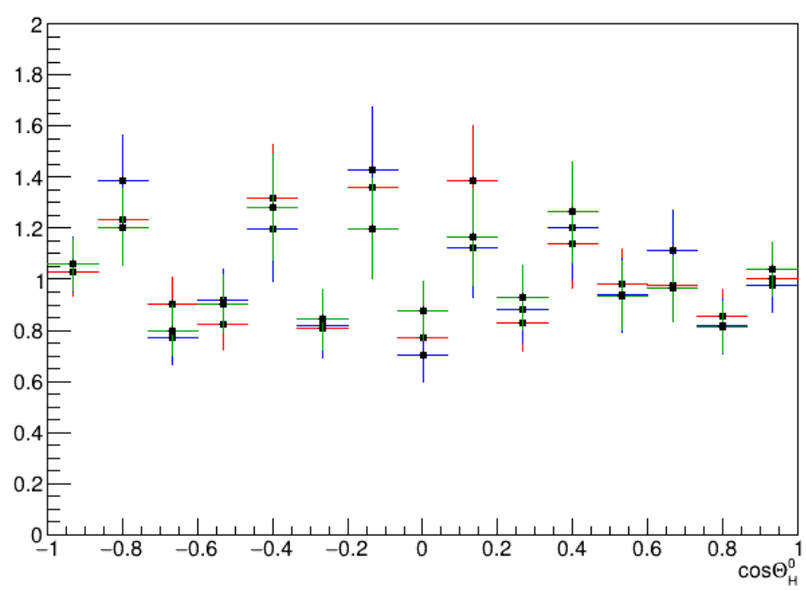
Consistent, although some bins look strange.

Off-resonance data (ratios)



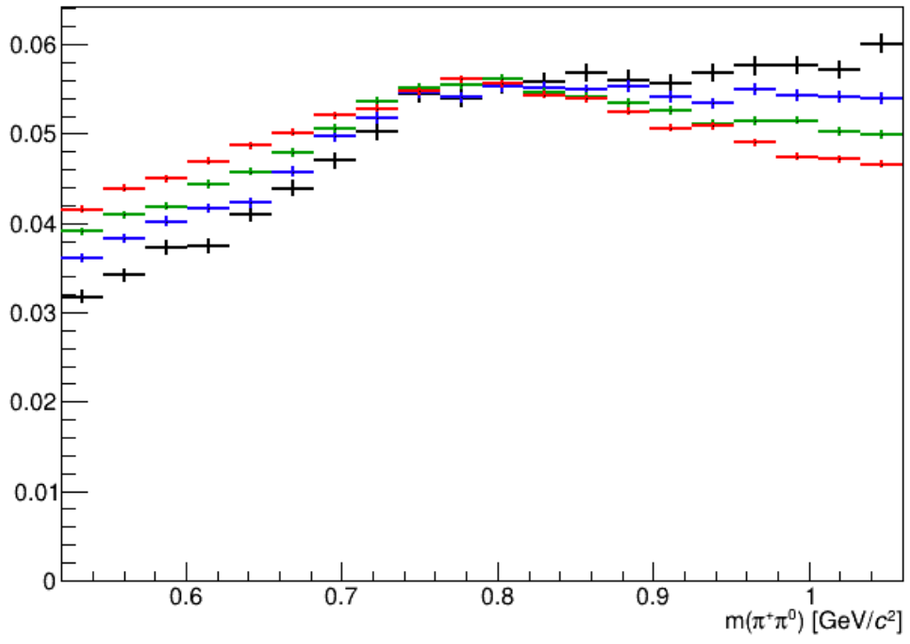


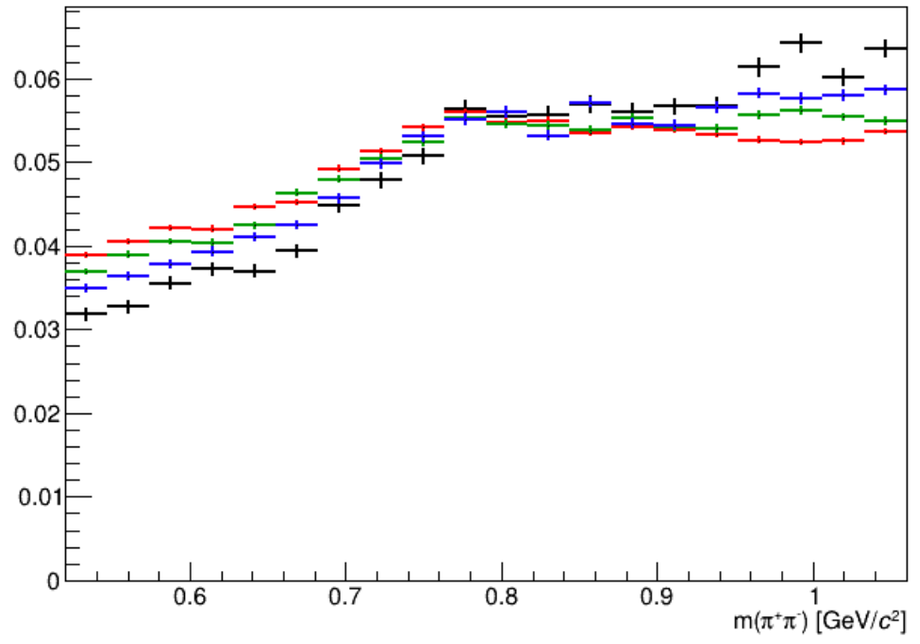


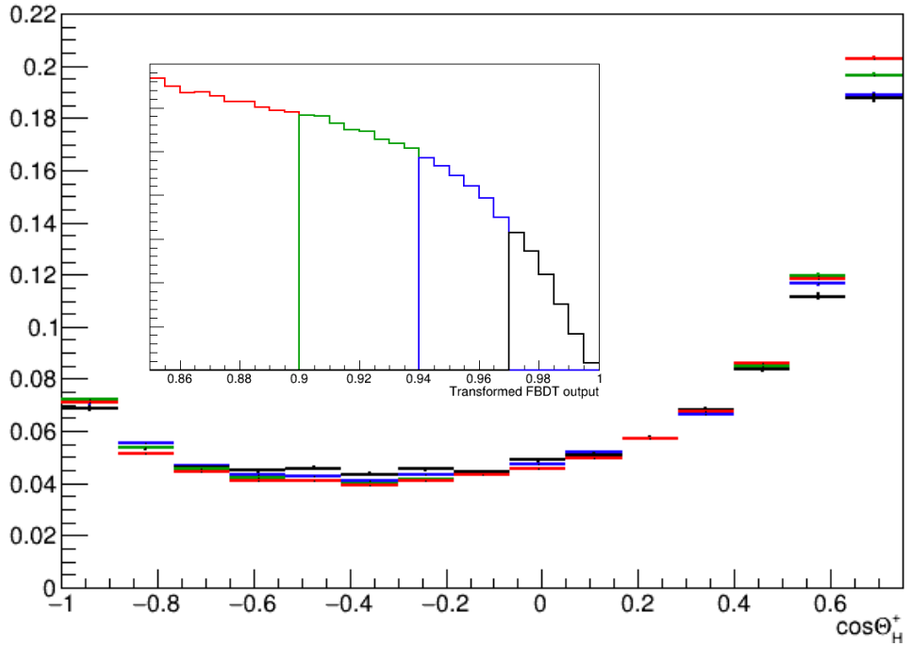


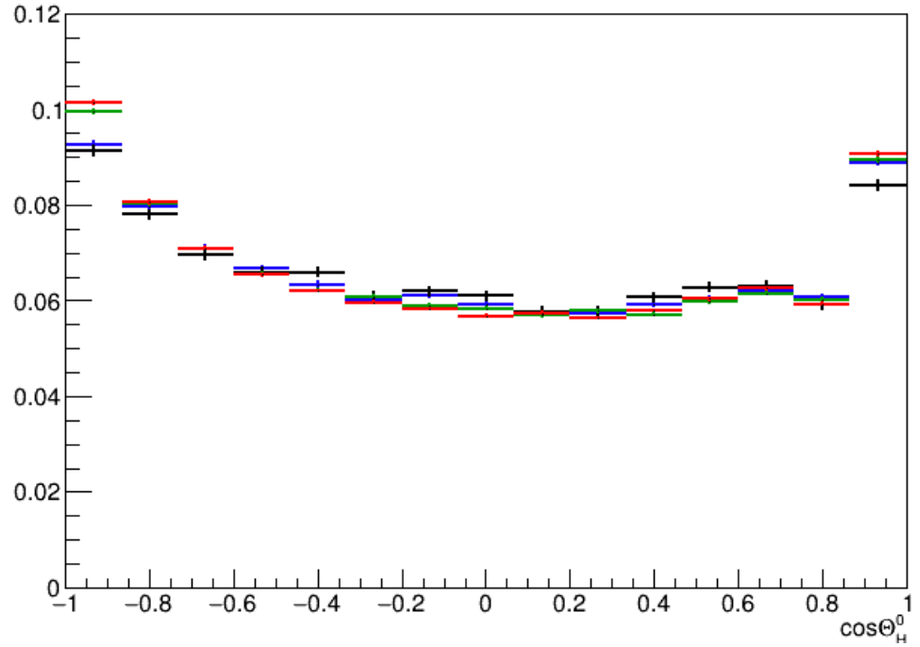
Dominated by low-stat of CS>0.97 sample.

Validate CS-extension on MC



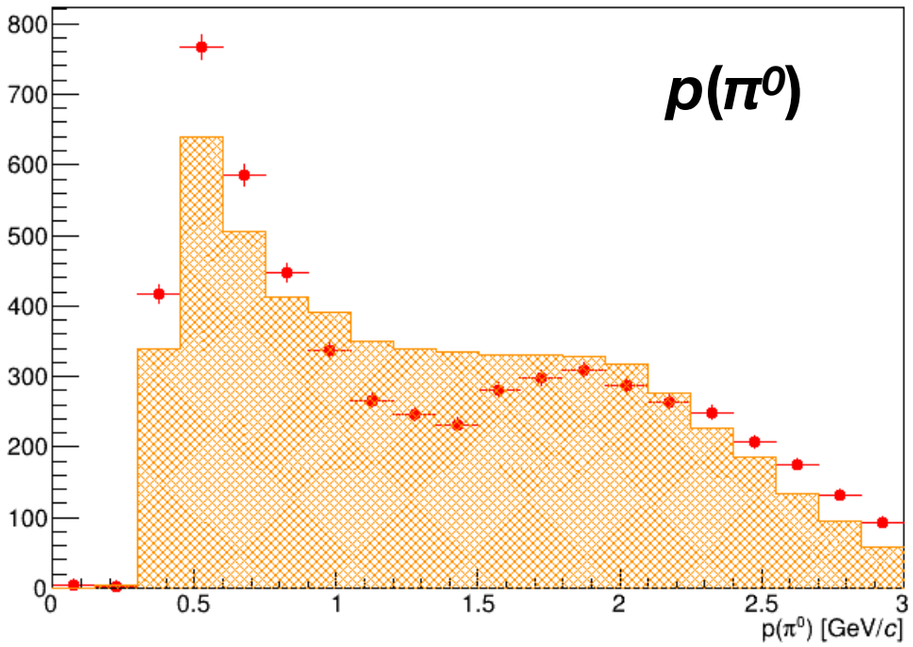


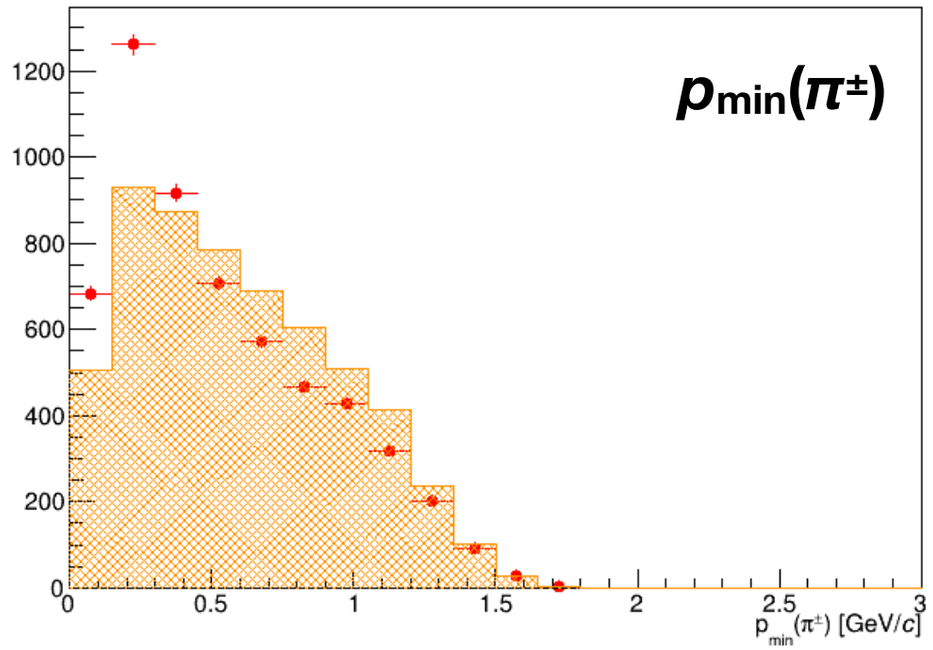


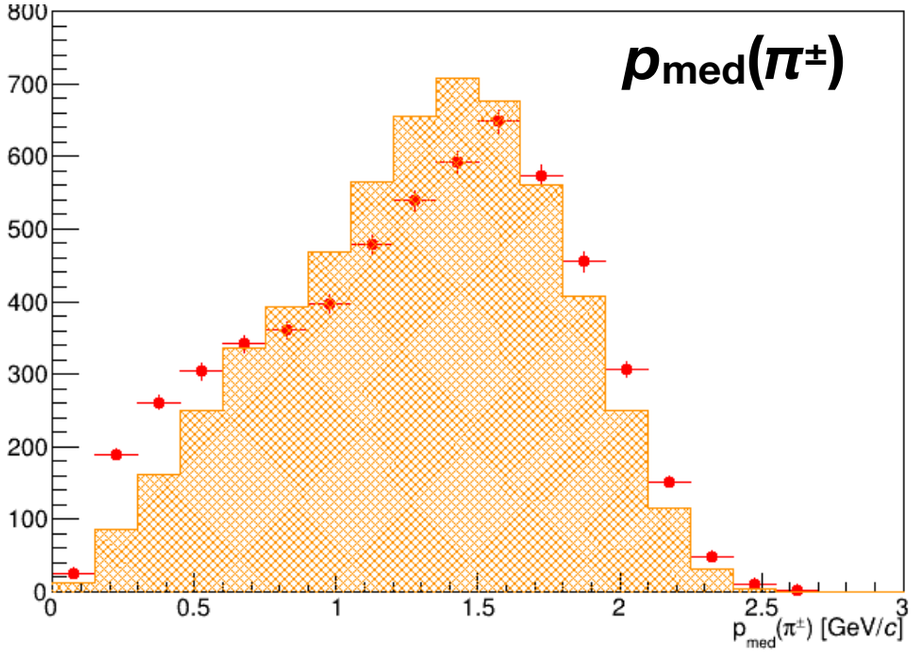


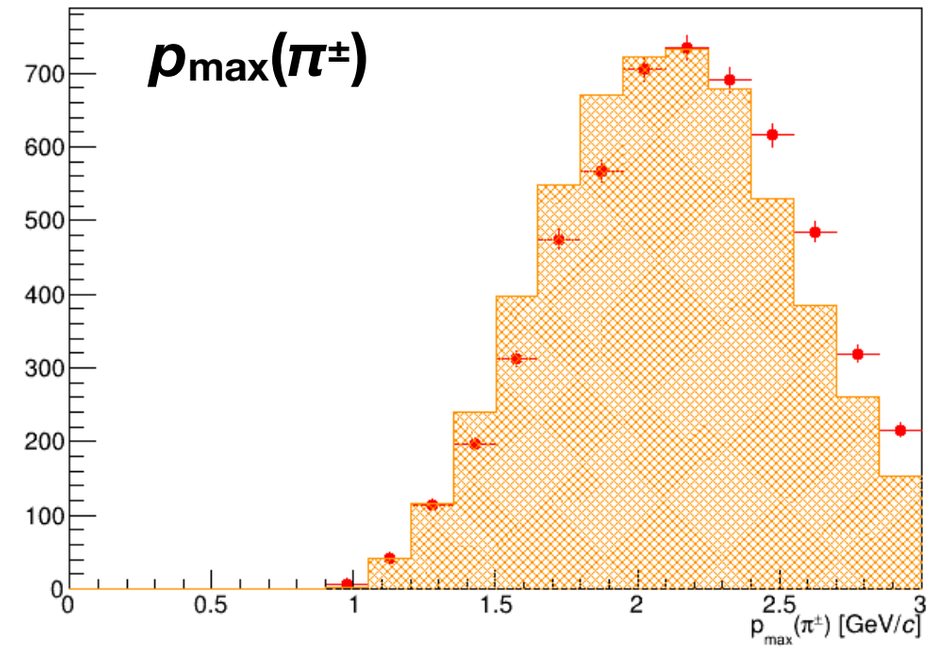
Angles look fine, could consider using only CS>0.94 region (black + blue).
Mass are different, but are also completely different wrt data.

Continuum momenta



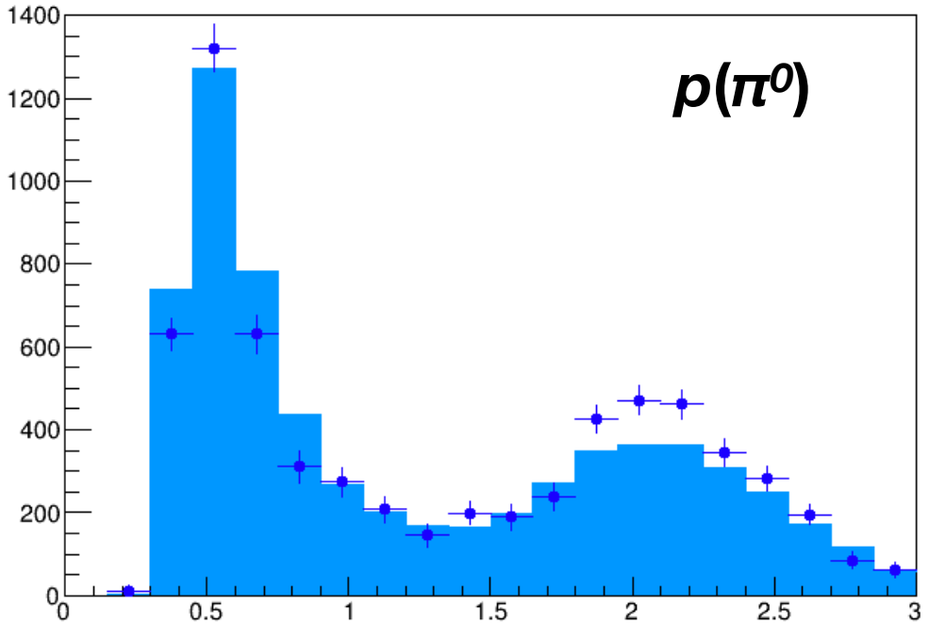


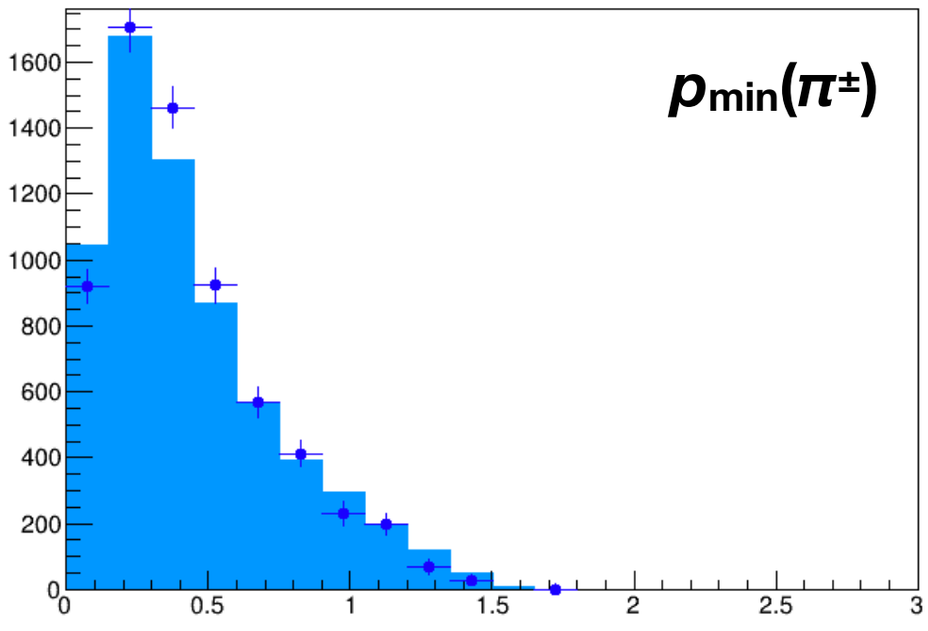


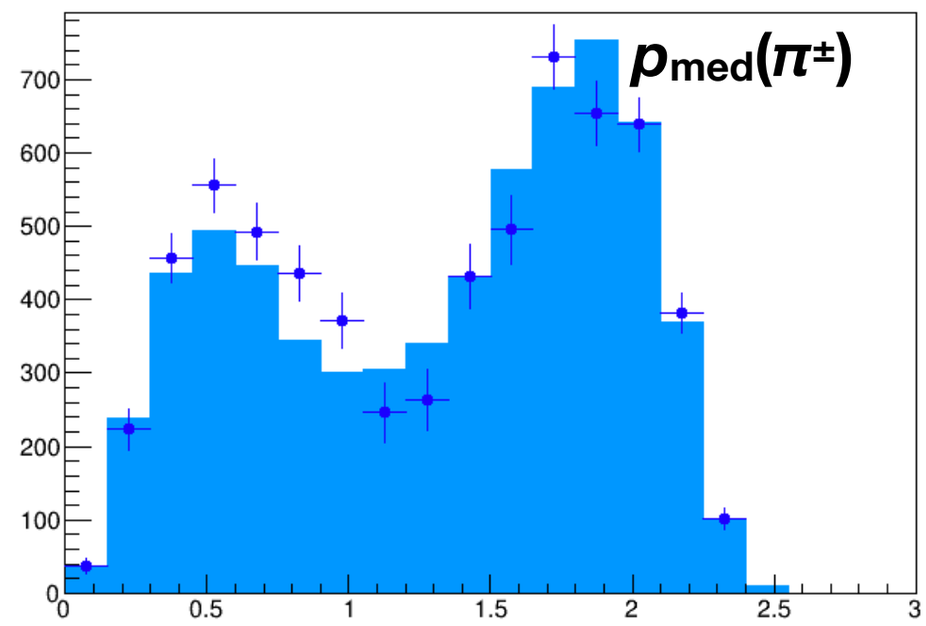


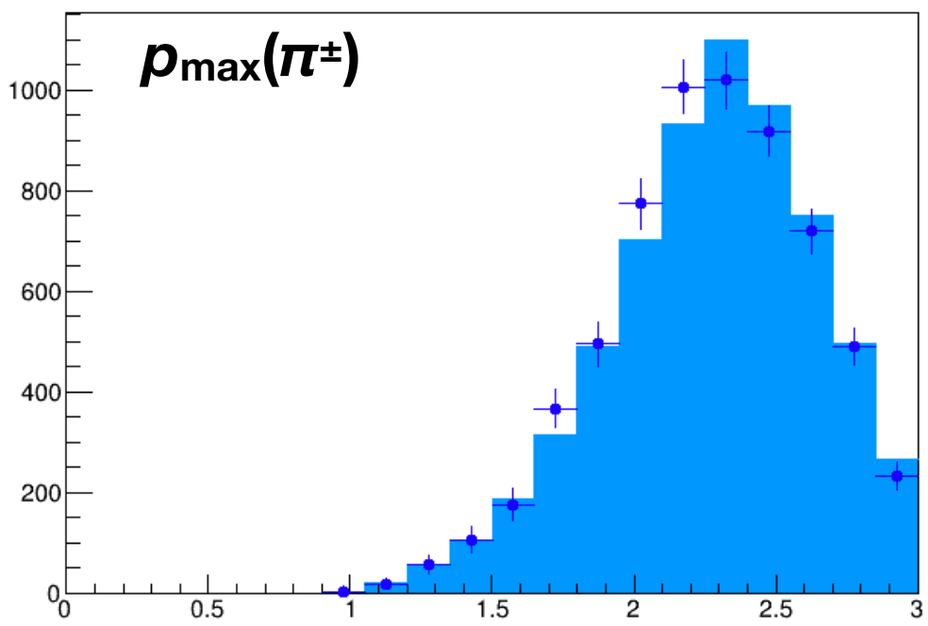
Largest discrepancies in π0 and low-p track momenta.

BBbar momenta







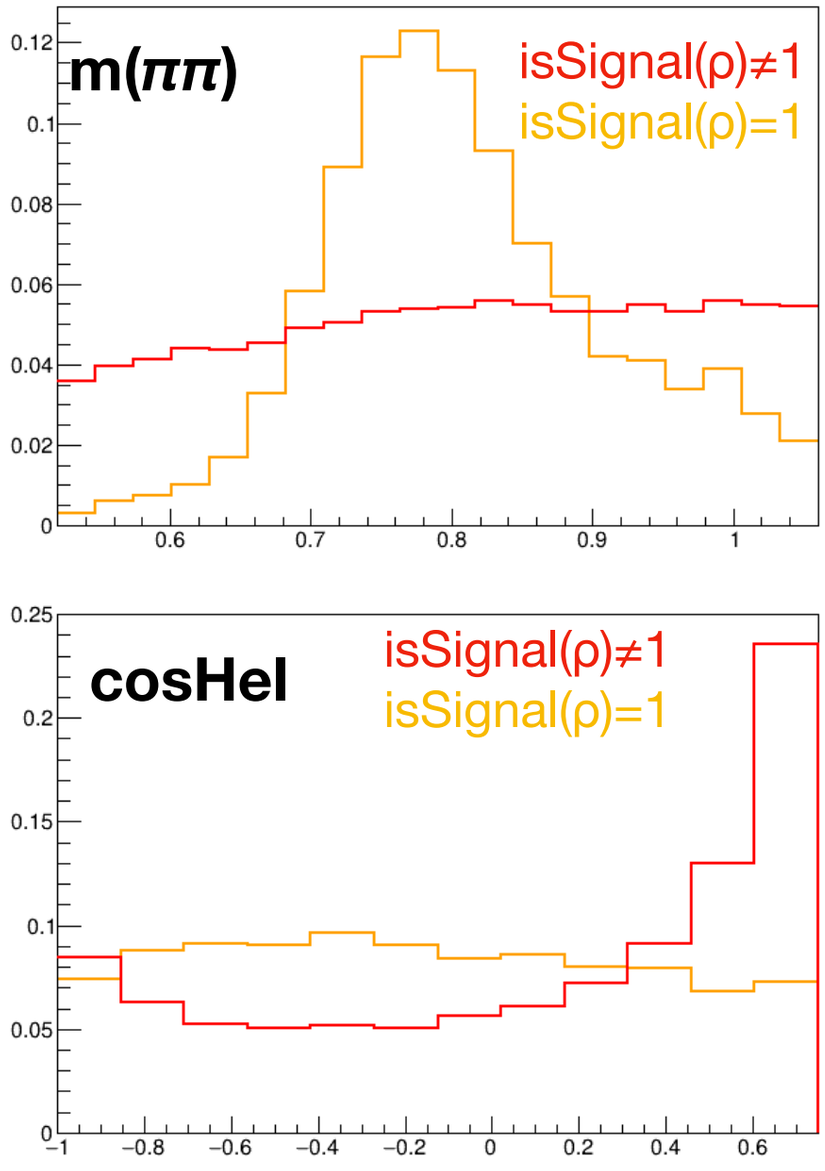


Less disagreement wrt continuum.

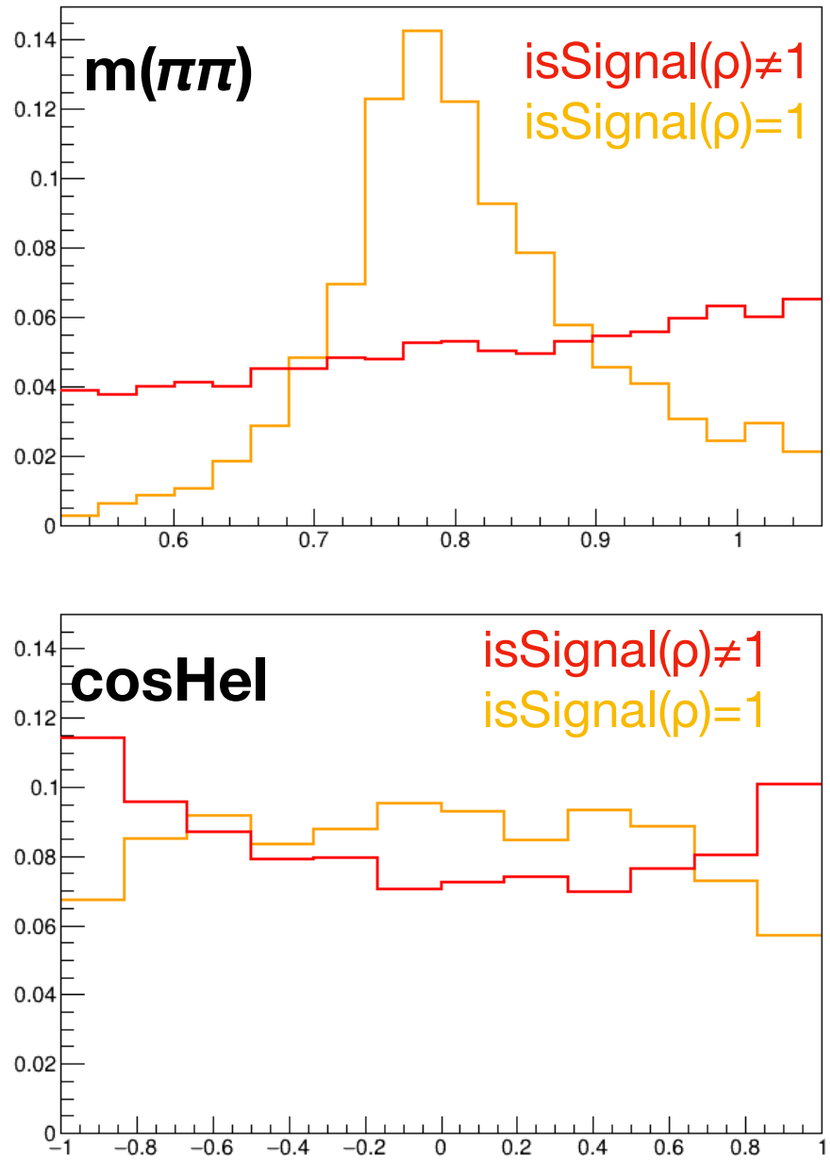
Continuum component

Continuum (w/ bug fixed) from sideband MC. Shapes normalized to same area.

ρ^+



ρ^0

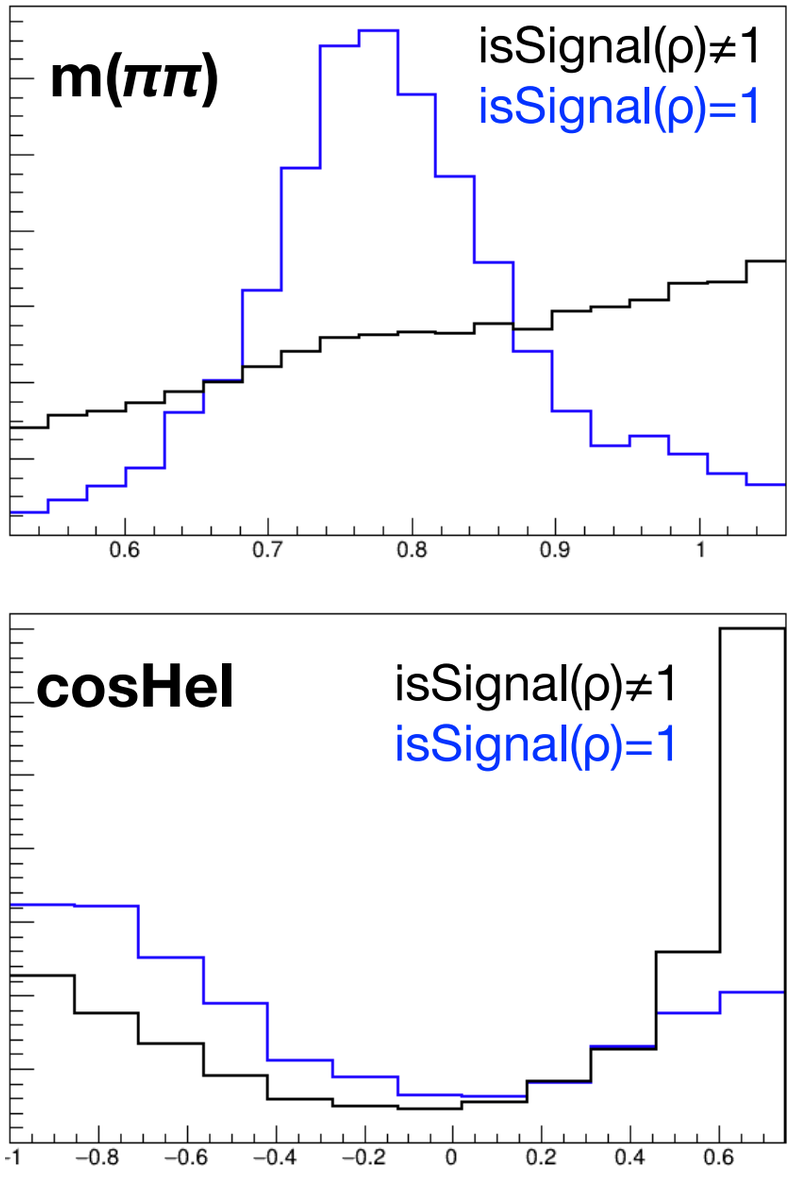


Real ρ seem to be generated with transverse polarization.
Wrong generator effect or data feature?

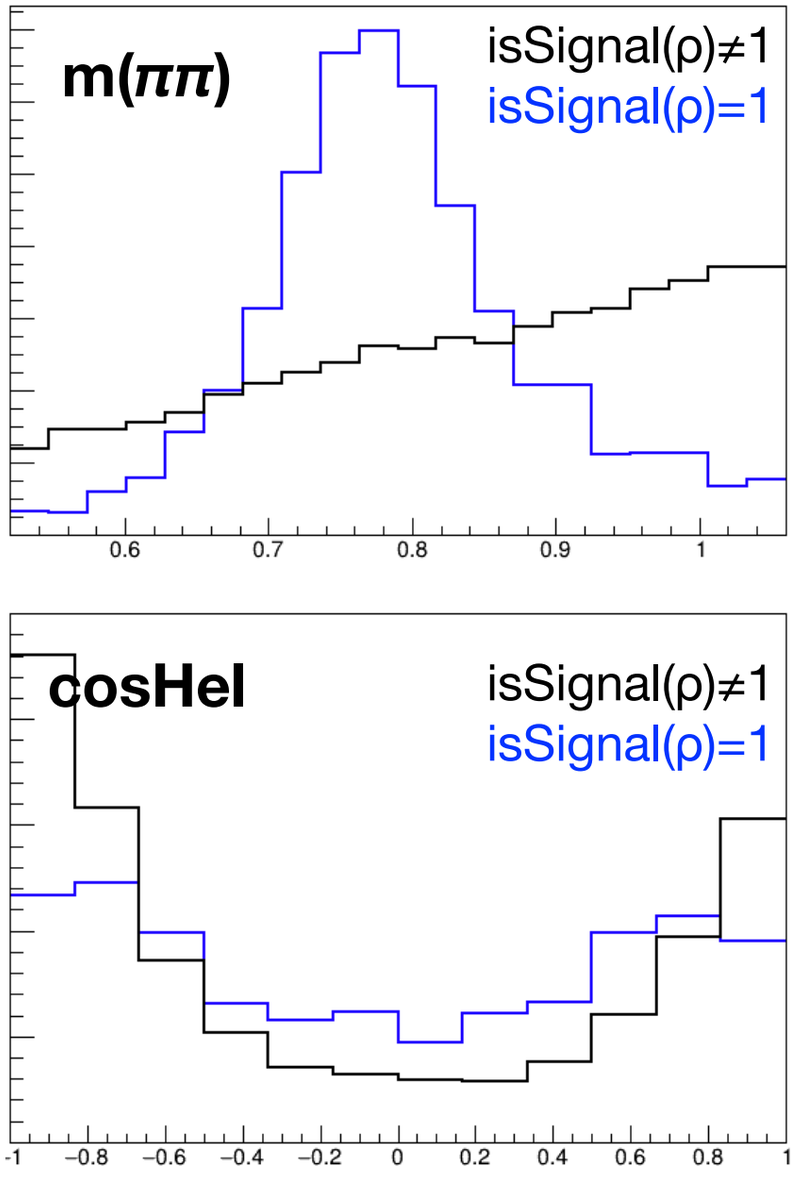
BBbar component

BBbar from sideband MC. Shapes normalized to same area.

ρ^+



ρ^0



Mass shapes in MC

ρ^+ Loose cut CS>0.85, rest is default. ρ^0