UNIVERSITY
OF TRIESTE

INFN

Toward $\mathcal{B}(B \to D^0 \rho)$

TS analysis meeting
june 2022

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Overview

- Changes in the preselection cuts
- Previous selection results
- New selection + results of 3D optimization
- BB-bar background composition
- Summary

Preselection

Made on MC14 (200 fb^{-1})

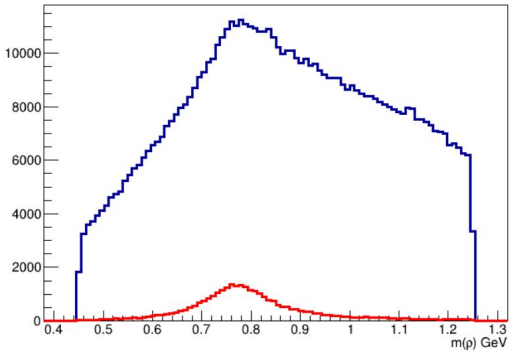
General cuts:

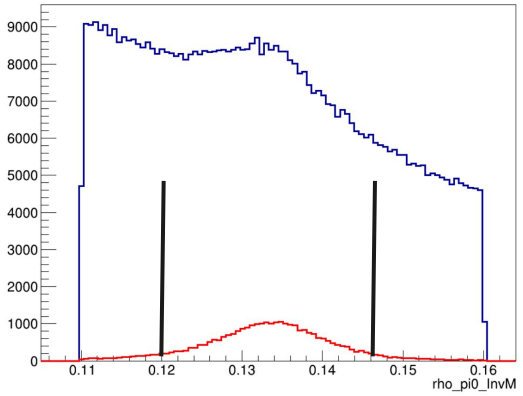
- ➔ Mbc > 5.27 GeV
- ➔ 1.85 < m(Kπ) < 1.88 (~3 σ) GeV
- ➔ binary kaon PID from D^0 > 0.2
- ➔ binary pion PID from D^0 < 0.8
- ➔ binary pion PID from ρ < 0.8
- ➔ **-0.15 < ΔE < 0.15 GeV**
- ➔ **0.12 < m(π^0) > 0.145 (2σ) GeV**
- ➔ **0.45 < m(ρ) > 1.25 GeV**
- ➔ **photon0E >0.04**
- ➔ **photon1E>0.05**

new or modified

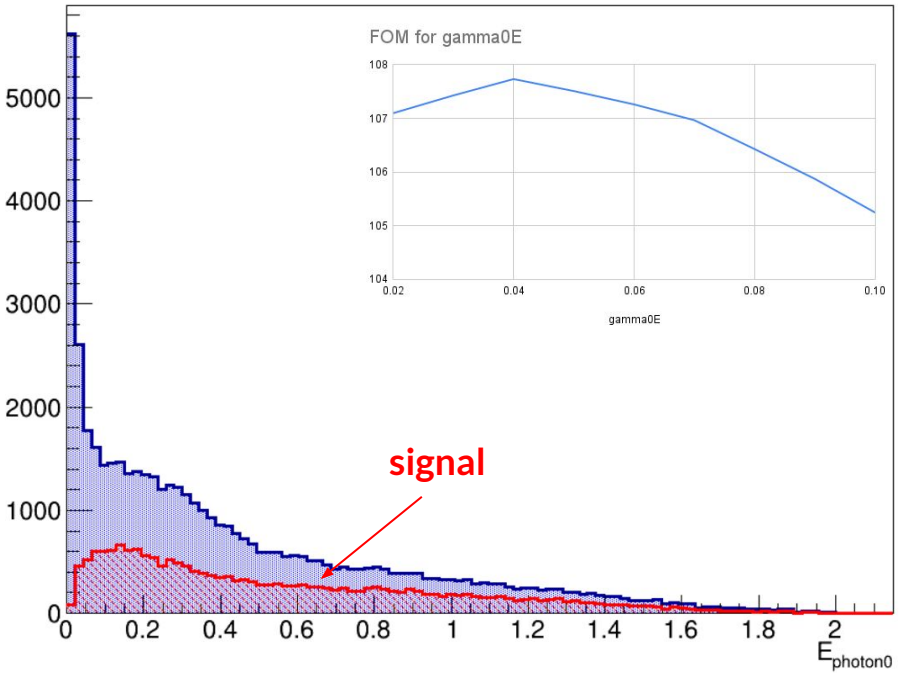
π^0 candidates are taken from *stdPi0s_winter2020* list

The vertex of the signal *B* candidate was reconstructed using *tree fitter*

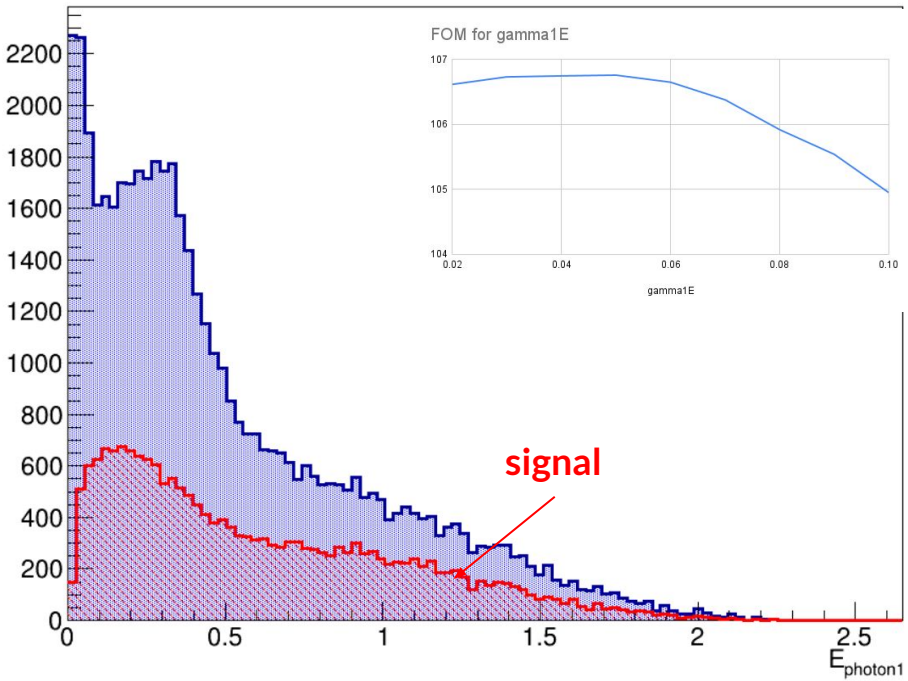




Photon energy optimization

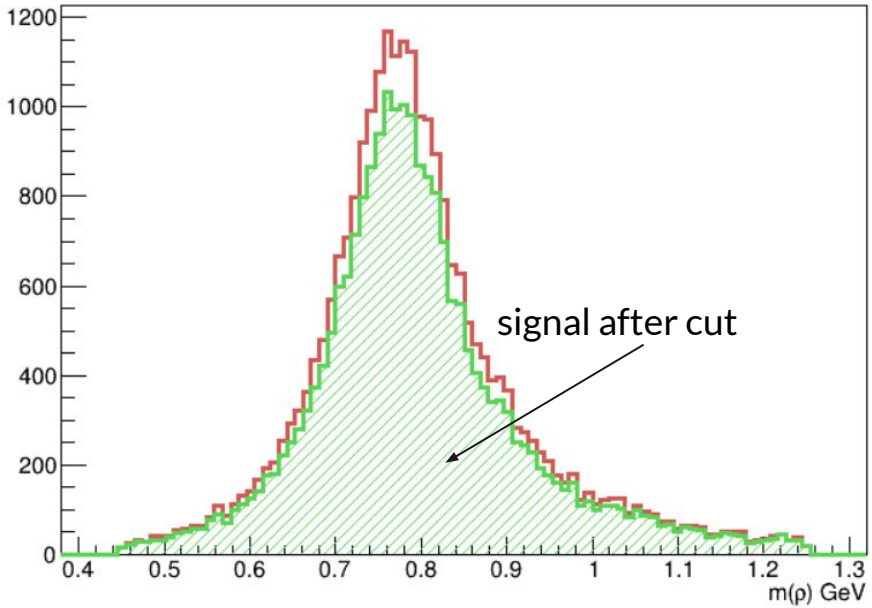


Ephoton0 > 0.04

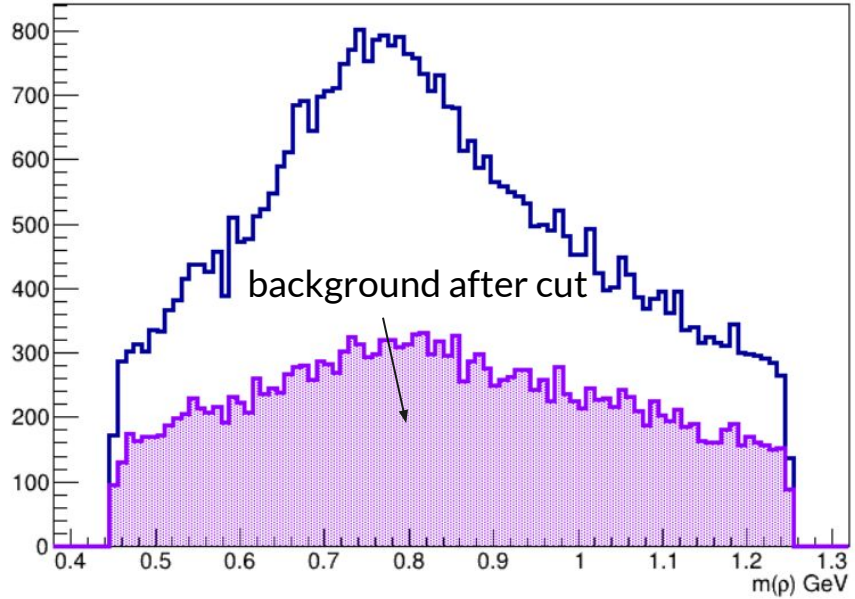


Ephoton1 > 0.05

m(ρ) signal and background after applying photon/pi⁰ cuts



88% of signal remains



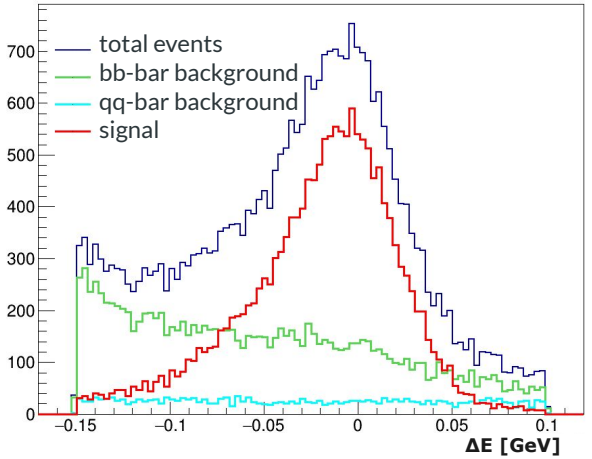
53% of background is rejected

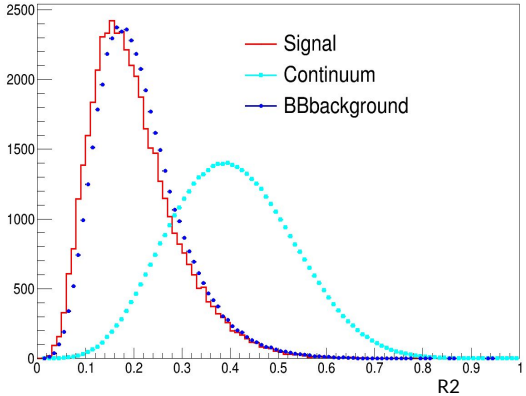
Old Selection criteria

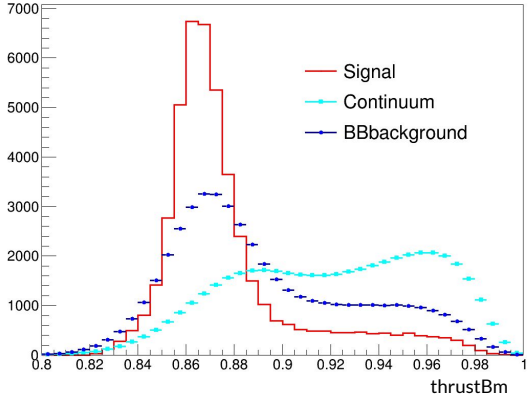
- ➔ R2 < 0.28
- ➔ thrustBm > 0.83
- ➔ thrustBm < 0.9

➔ $\cos\Theta_{\pi\pi 0} < 0.62$

- 1D FOM based optimisation of $\cos\Theta_{\pi\pi 0}$,
- cuts of R2 and thrustBm based on the shape only

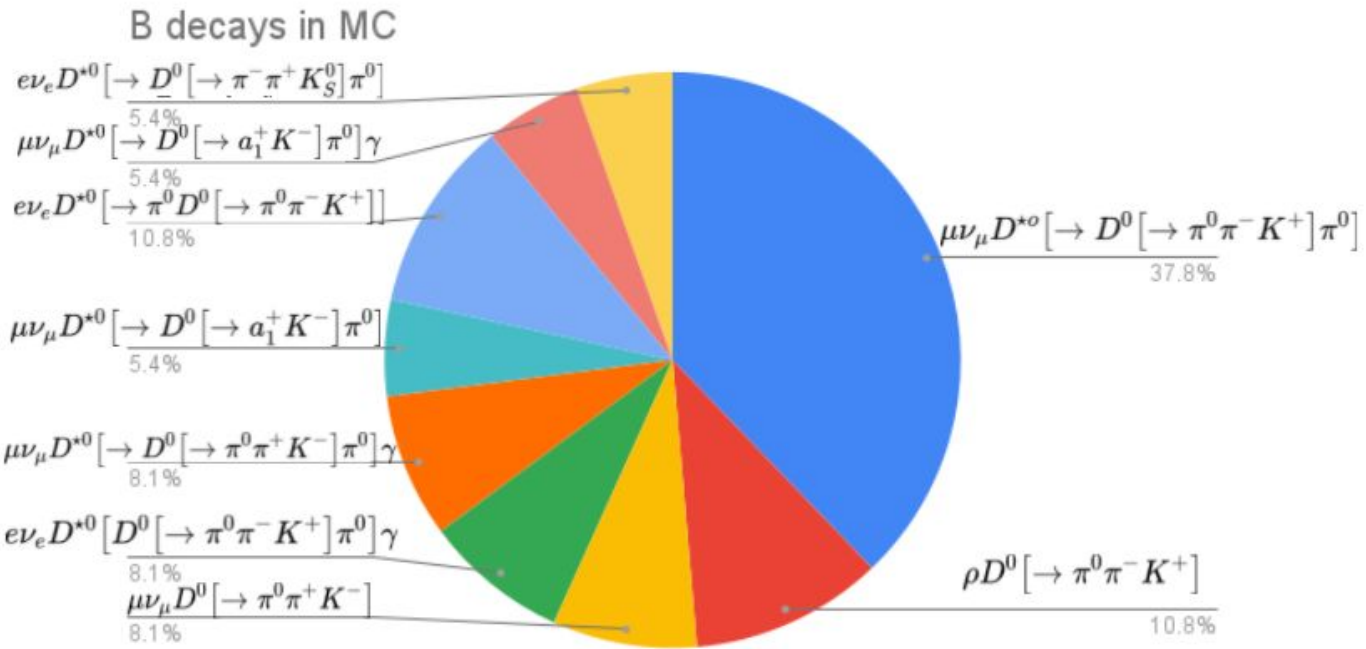






Composition	Fraction
Signal	0.59
Continuum	0.13
BB-bar bkg	0.28

Result of the topology analysis



The most frequent B- decays go through $D^{*0} \to D^0 pi^0$

Selection variables

Focus on three variables for background suppression: $\cos\Theta_{\pi\pi^0}$, R2 and D^0_{mom}:

$\cos\Theta_{\pi\pi^0}$

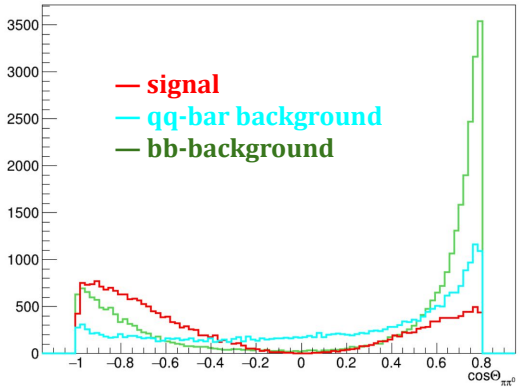
Cosine helicity angle between B momentum and pion momentum in the ρ reference frame

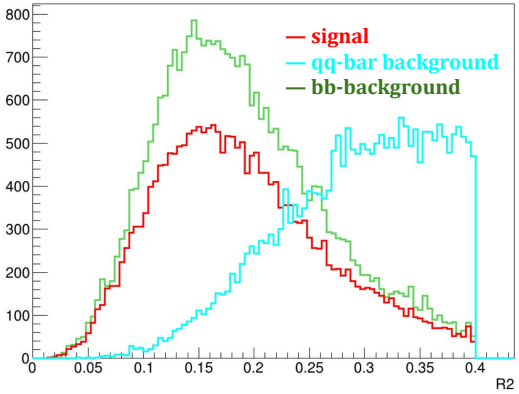
R2

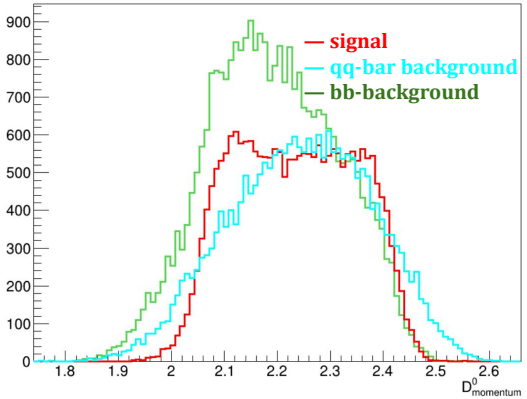
$\mathcal{R}2 = \mathcal{H}_2/\mathcal{H}_0$

D^0_{mom}

D^0 momentum in CMS



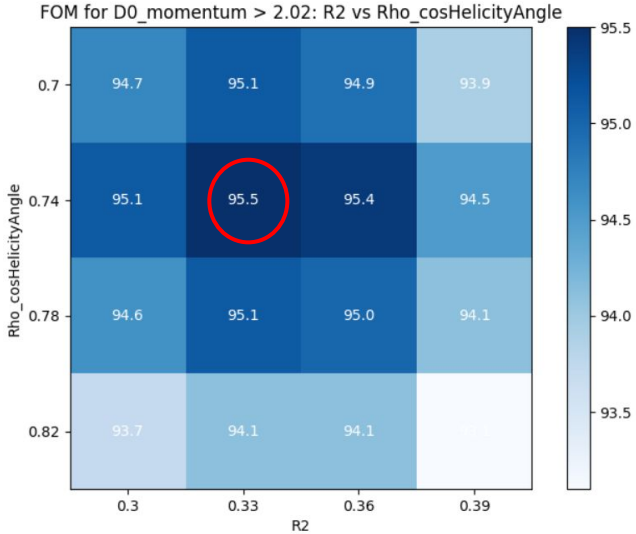


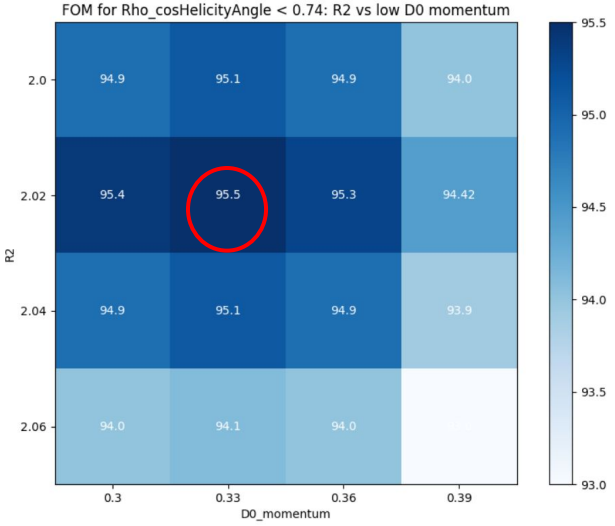


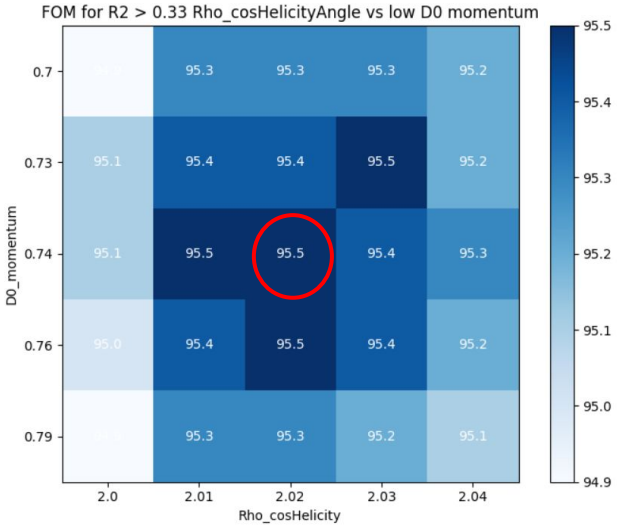
New selection

Results of 3D optimisation of $\cos\Theta_{\pi\pi 0}$ vs R2 vs D^0_{mom};

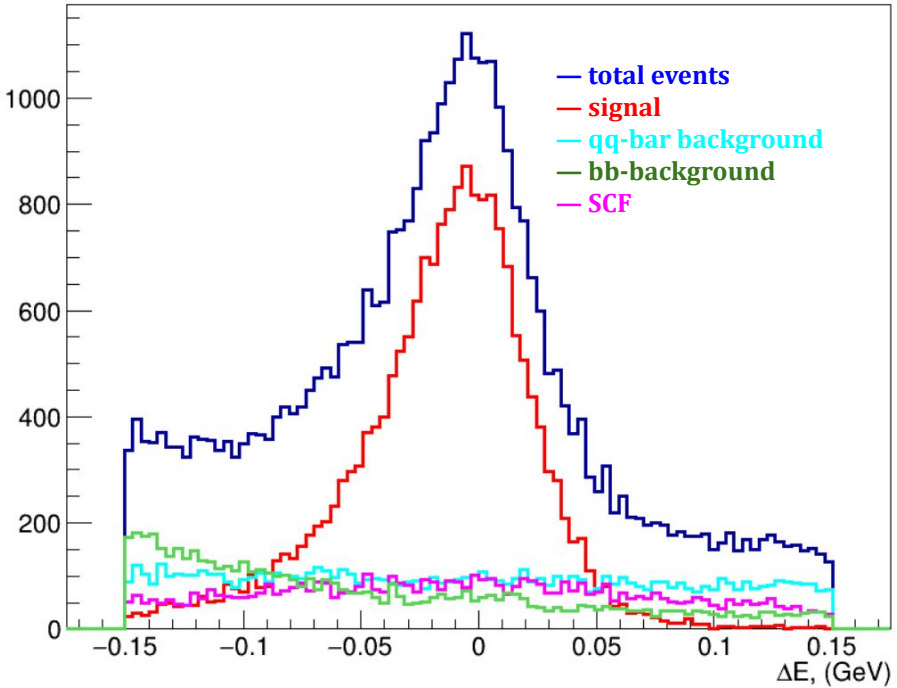
- ➔ R2 < 0.33
- ➔ $\cos\Theta_{\pi\pi}$ < 0.74
- ➔ D^0_{mom} > 2.02





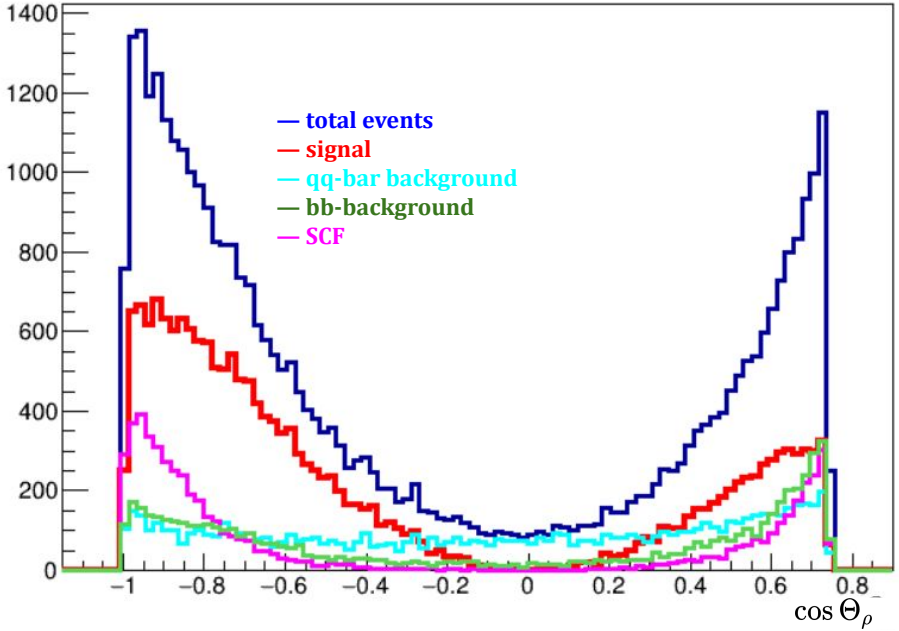


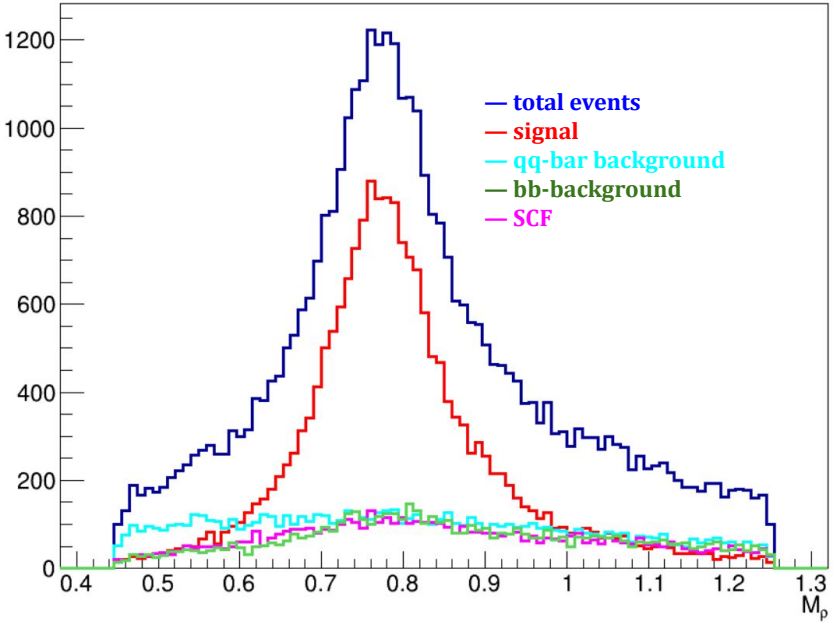
Result



Composition	Fraction
Signal	0.48
Continuum	0.21
SCF	0.16
BB-bar bkg	0.15

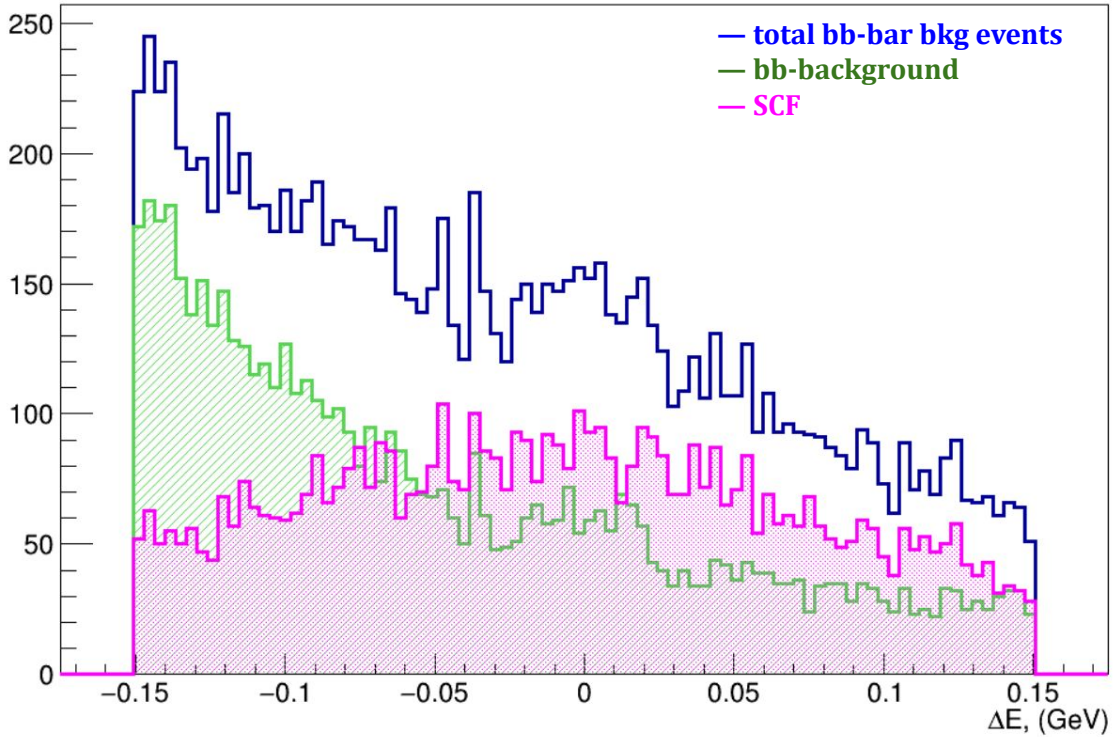
Result (2)



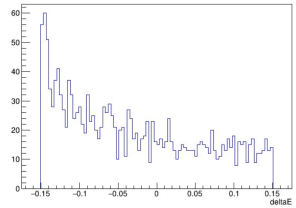


shapes between the 4 components look different in cosTheta_rho. We can use it's discrimination power in a 3D fit to (deltaE, m(rho), cosHel).

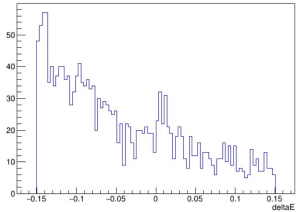
BB-bar background composition



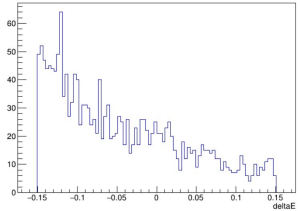
BB-bar background and SCF compositions



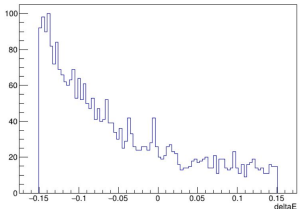
Rest (B0B0-bar)
13.1%



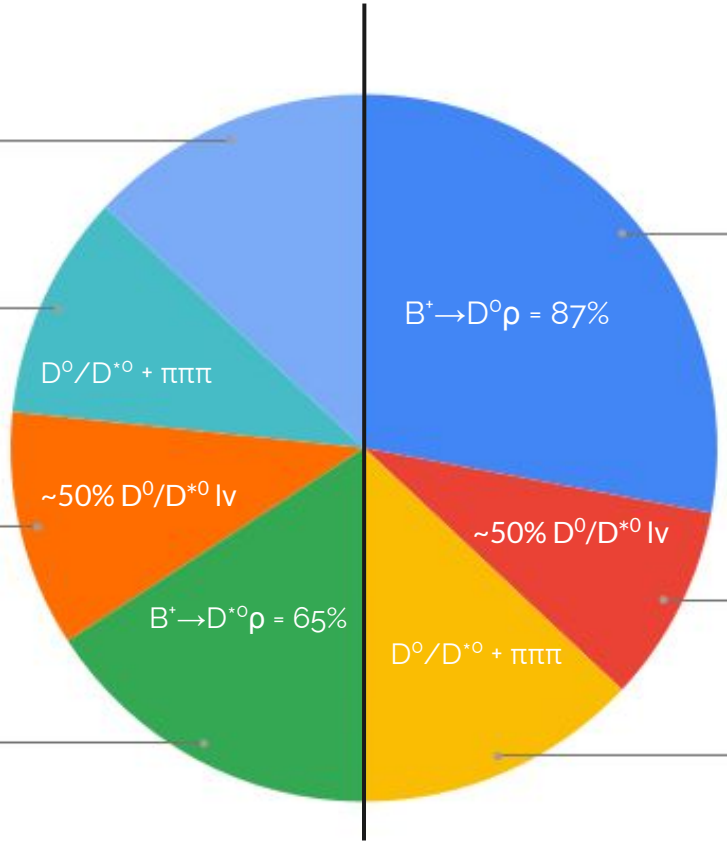
Rest(>3-body
10.3%

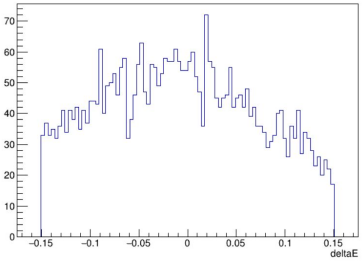


Rest(3-body
10.8%

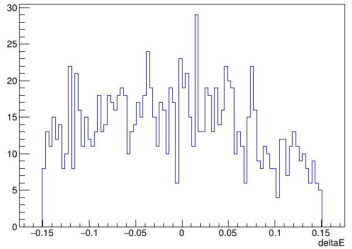


Rest(2-body
15.8%

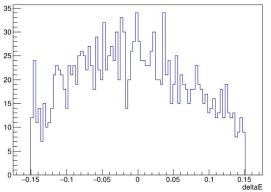




SCF(2-body
27.9%



SCF(3-body
9.0%



SCF(>3 body
13.0%

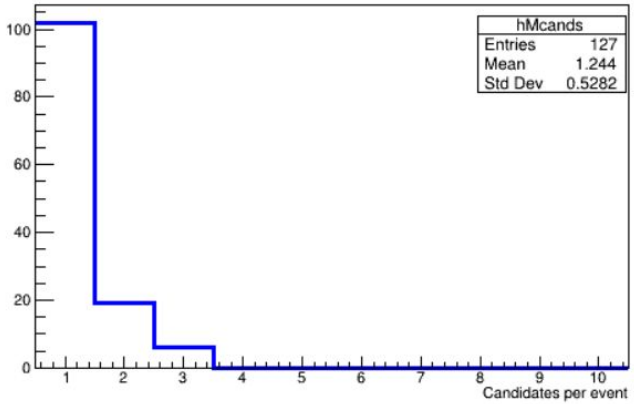
Summarizing table for MC 200 fb^{-1}

	Before preselection	After preselection	After preselection + selection
Signal eff (ε)	~41%	~24%	~17%
Background rejection	–/–	99.56%	99.94%

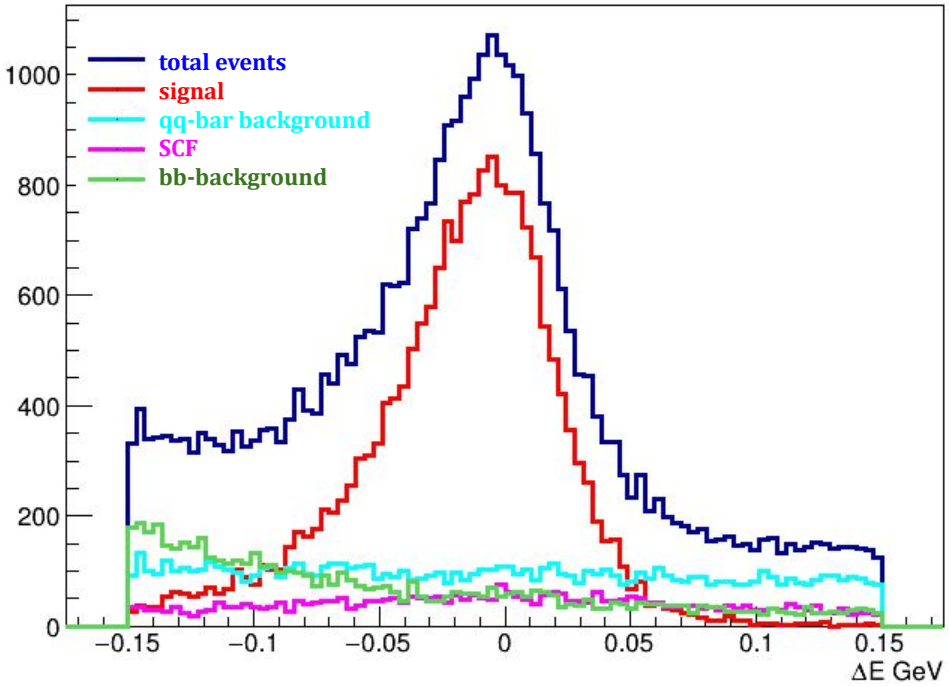
We expect to see in data (200 fb^{-1}) (events):

$$N_{signal} = L \times \epsilon = 19700$$

Candidate multiplicity was studied on a small generic MC dataset after applications of all selection criteria



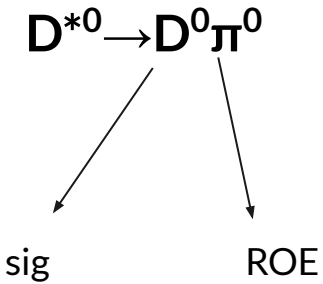
ΔE after one candidate selection

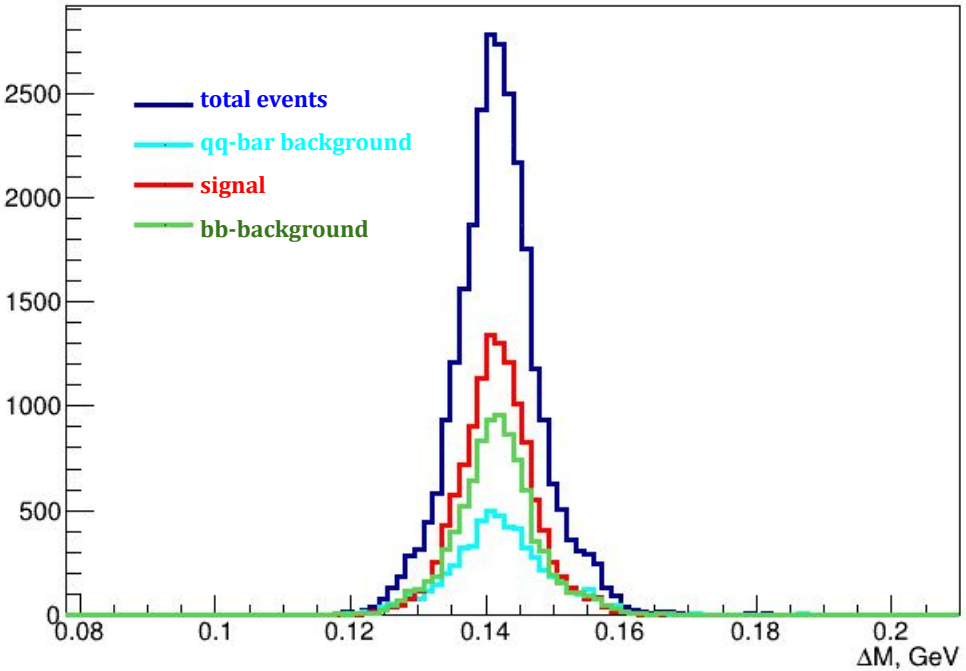


Composition	Fraction
Signal	0.52
Continuum	0.22
SCF	0.10
BB-bar bkg	0.16

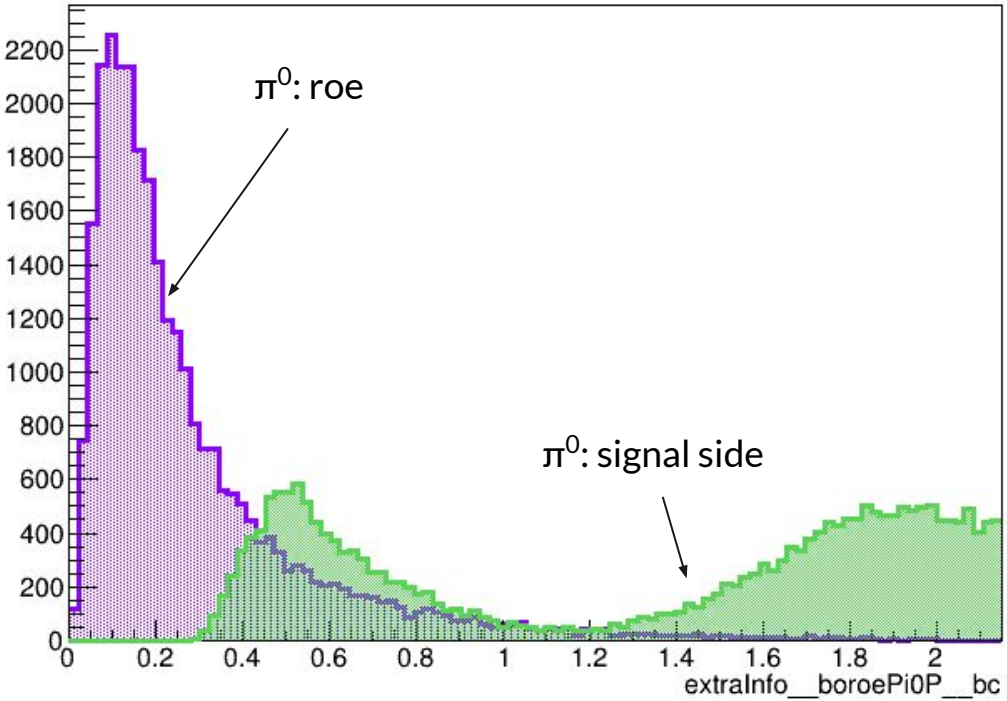
D*⁰ veto

$$\Delta M = m_{D^{*0}} - m_{D^0} = 0.142\,MeV$$

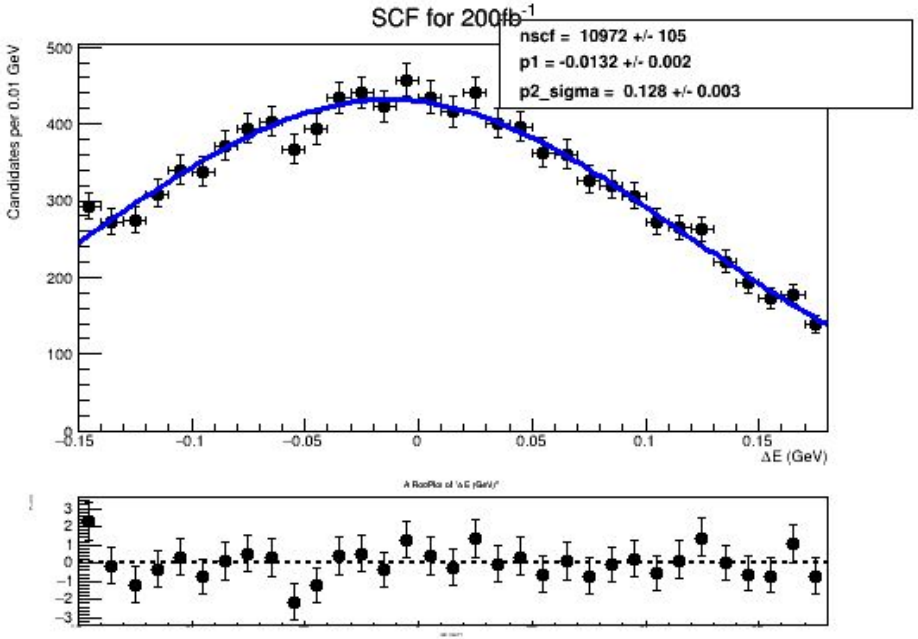




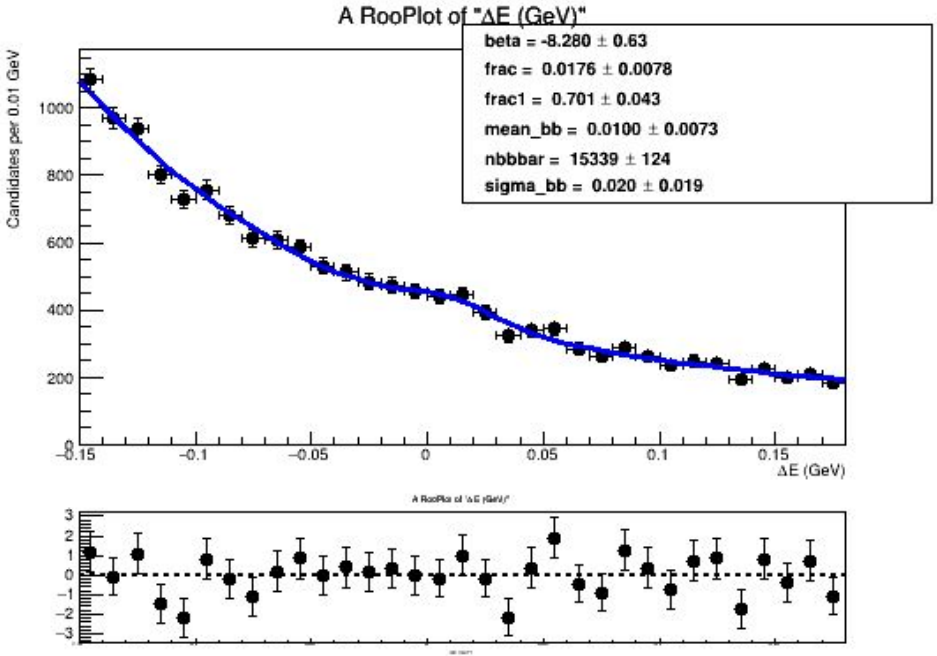
D*⁰ veto: π⁰ momenta



Fits for SCF and BBbar of deltaE (200 fb-1)

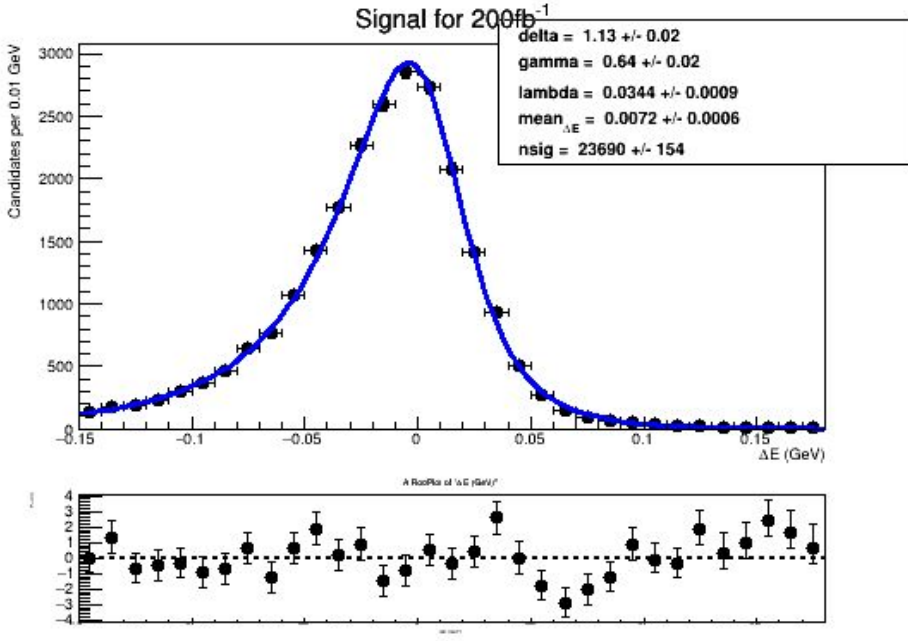


rooGaussian

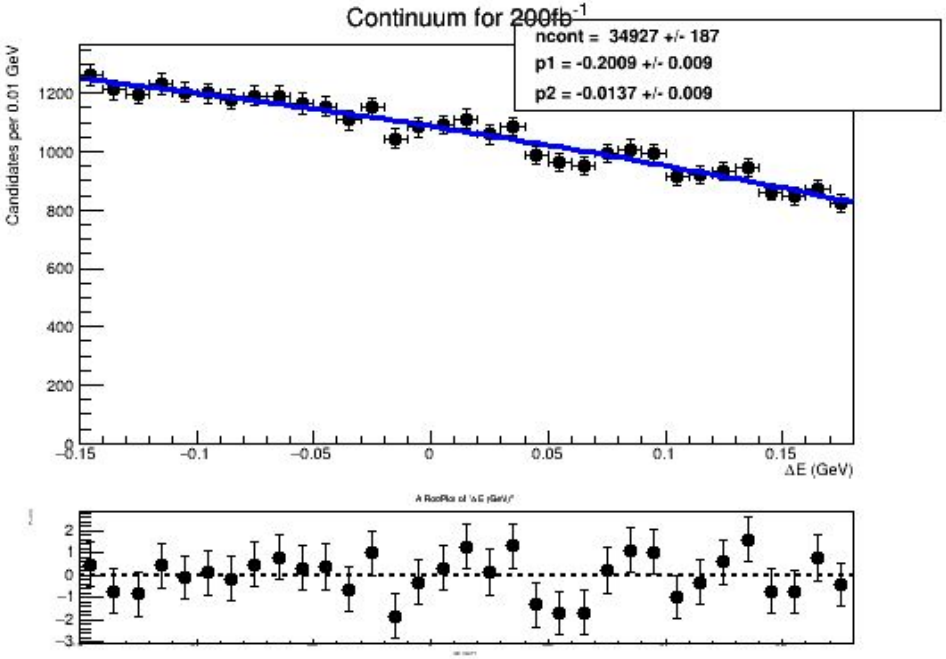


rooExponetial x rooChebyshev(0) x rooGaussian

Fits for signal and continuum of deltaE (200 fb-1)

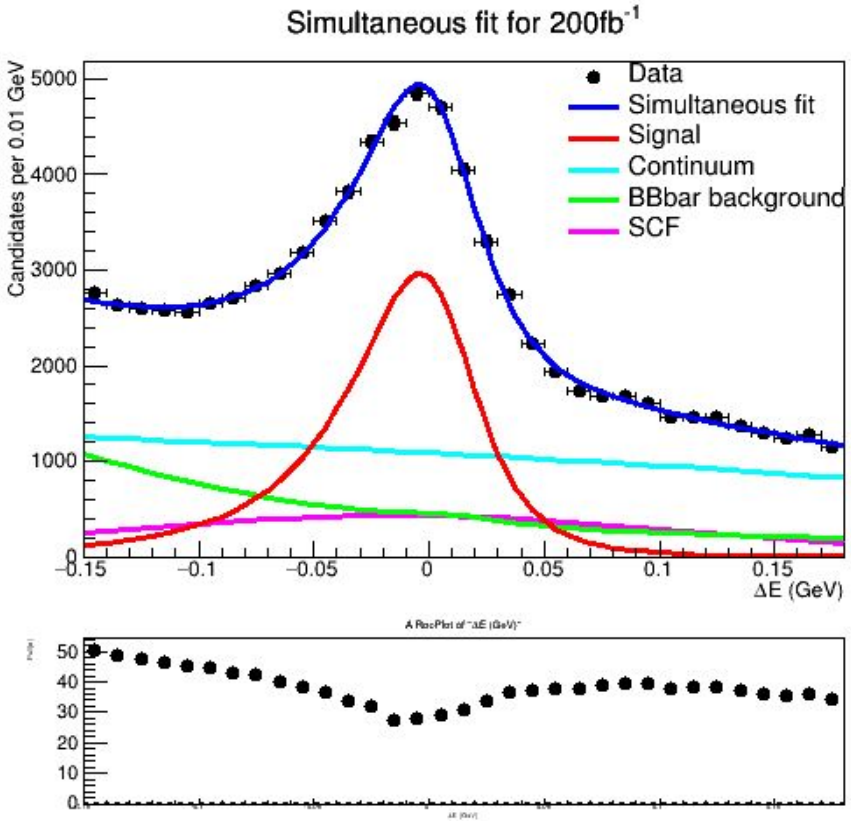


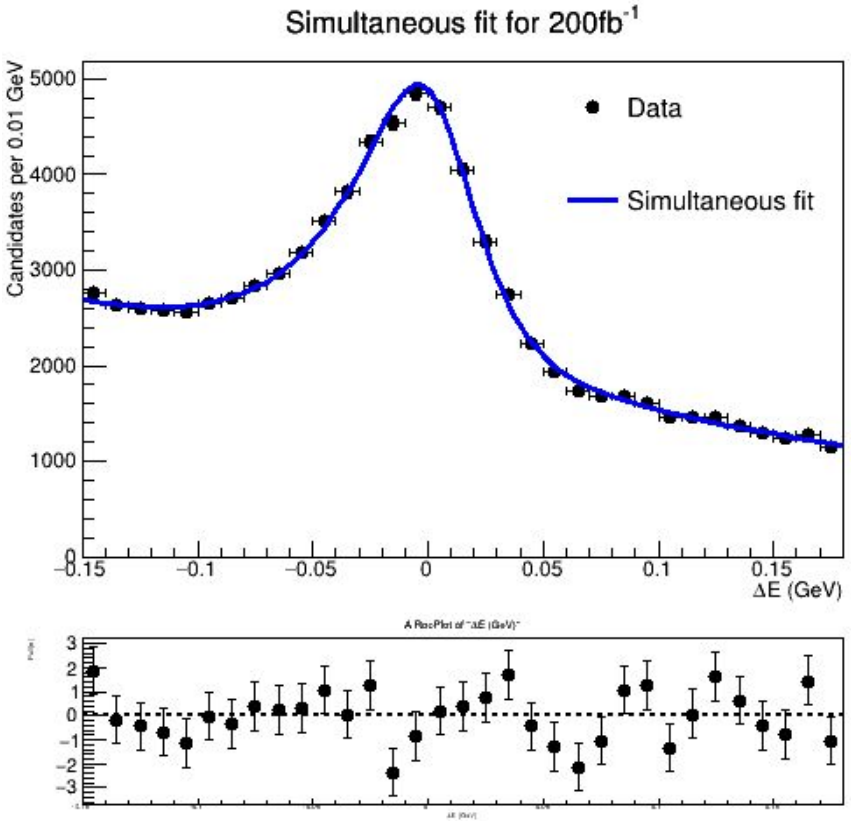
rooJohnson



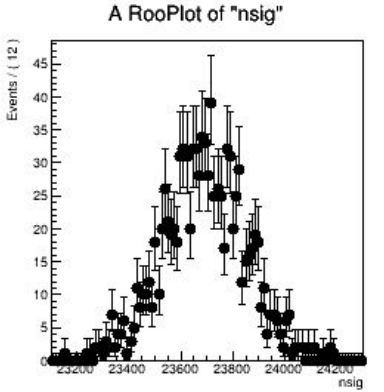
rooChebyshev (2)

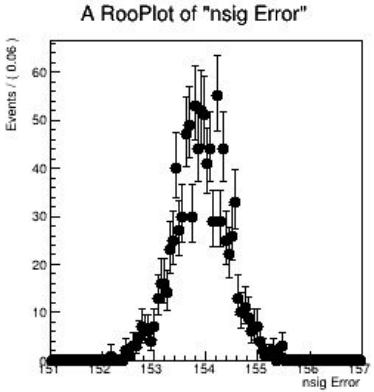
Simultaneous fit of deltaE

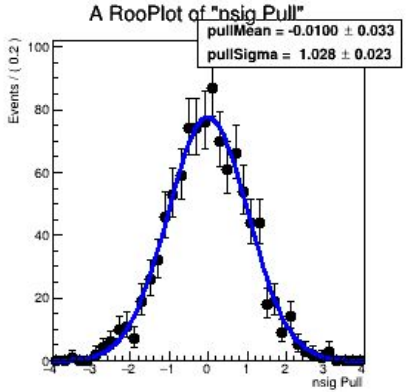


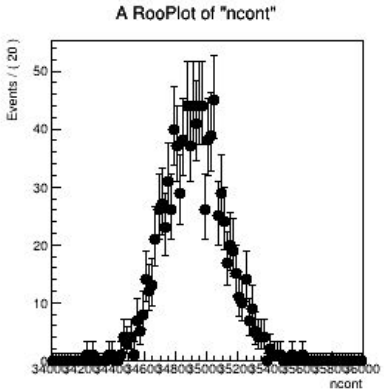


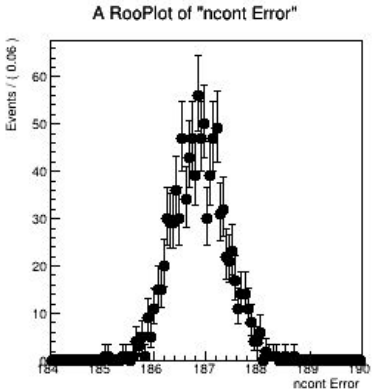
TOYs for Simultaneous fit (Signal and Continuum)

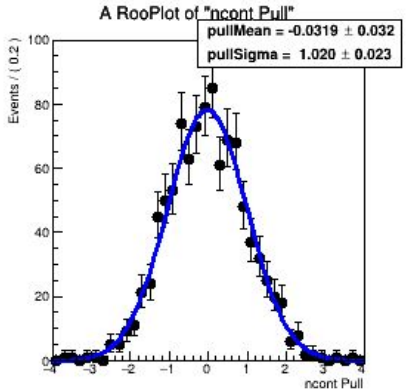




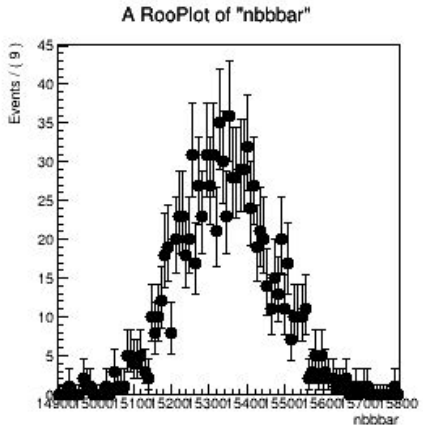


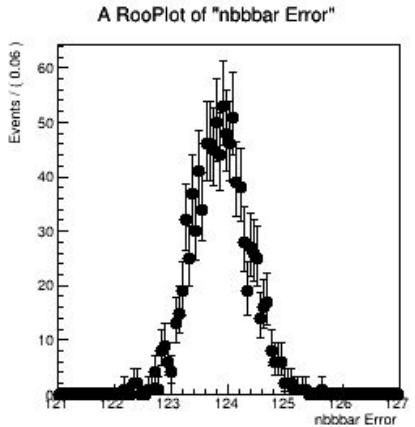


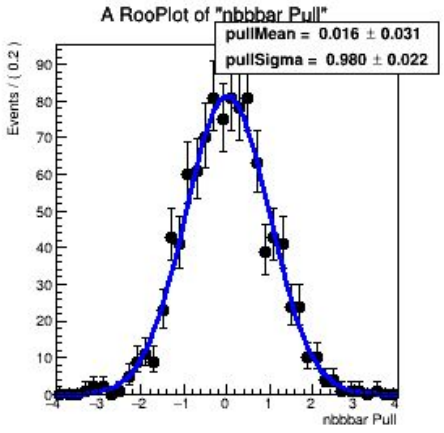


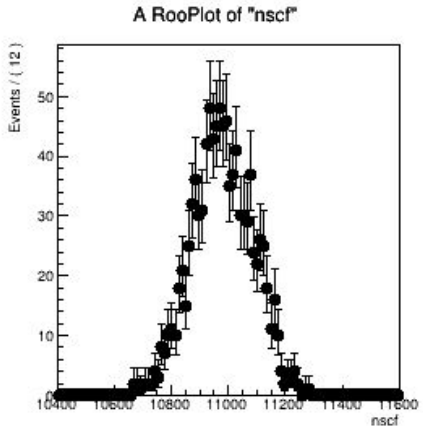


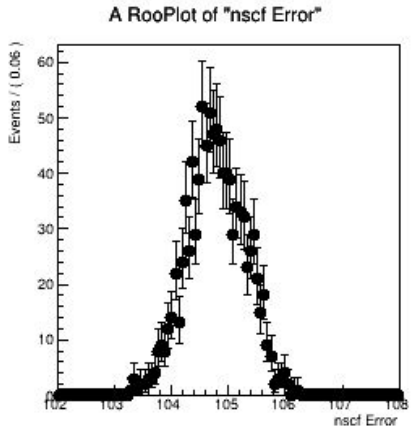
TOYs for Simultaneous fit (BBbar and SCF)

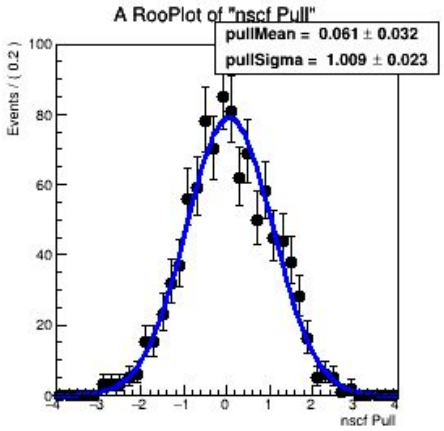






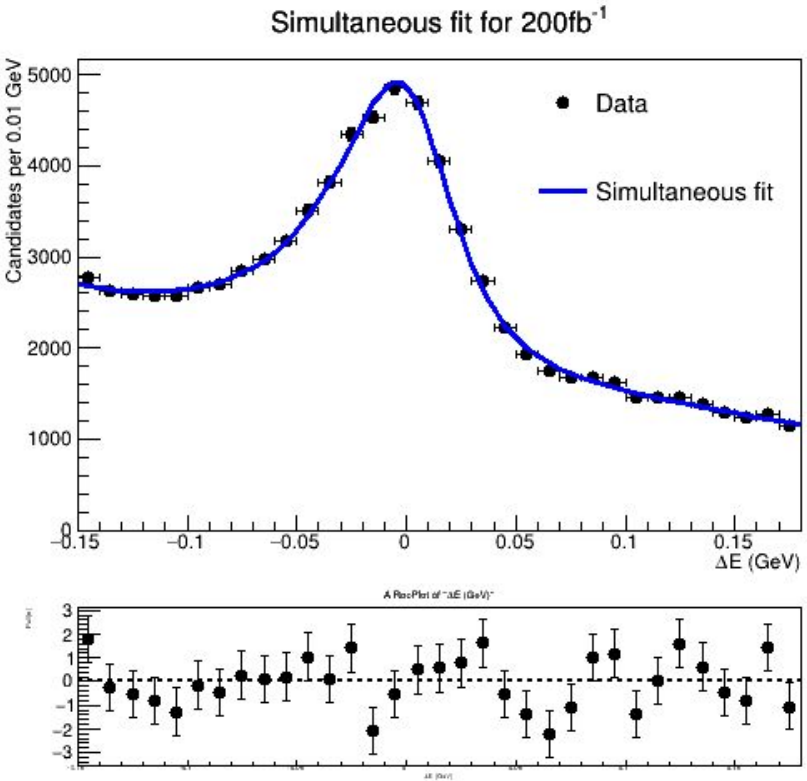


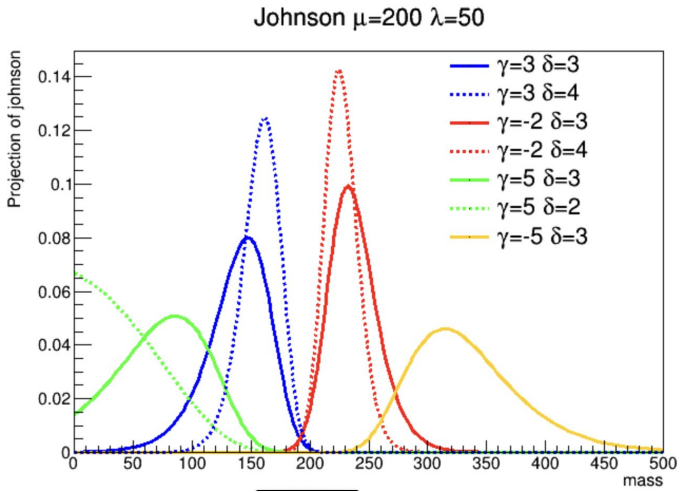


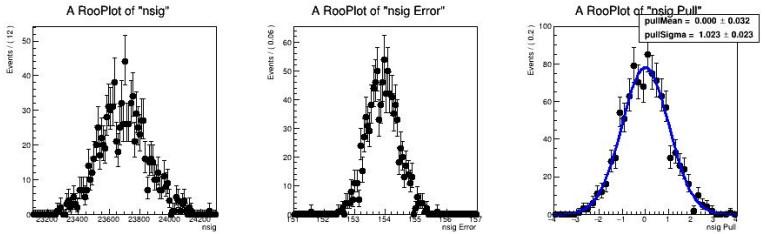


Update 03/06/2022

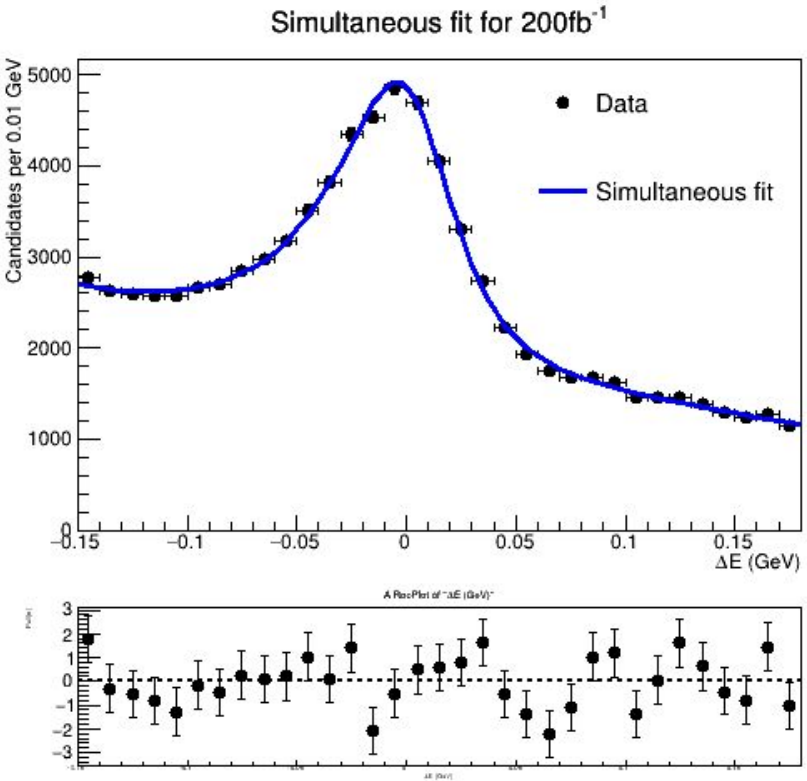
Simultaneous fit with 2 float parameters

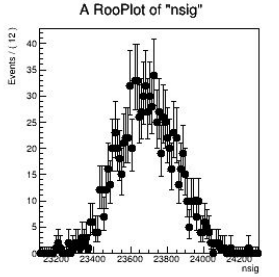


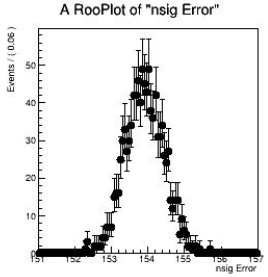


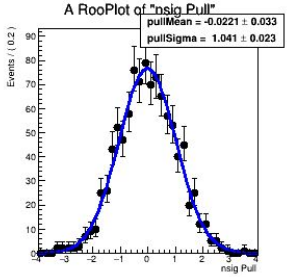


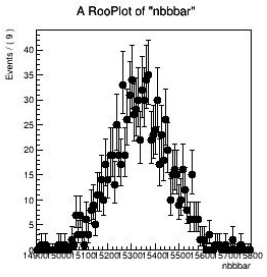
Simultaneous fit with 3 float parameters

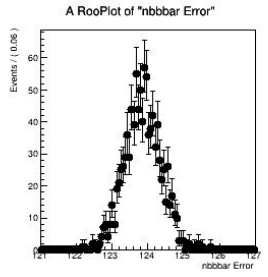


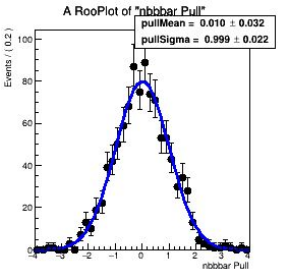




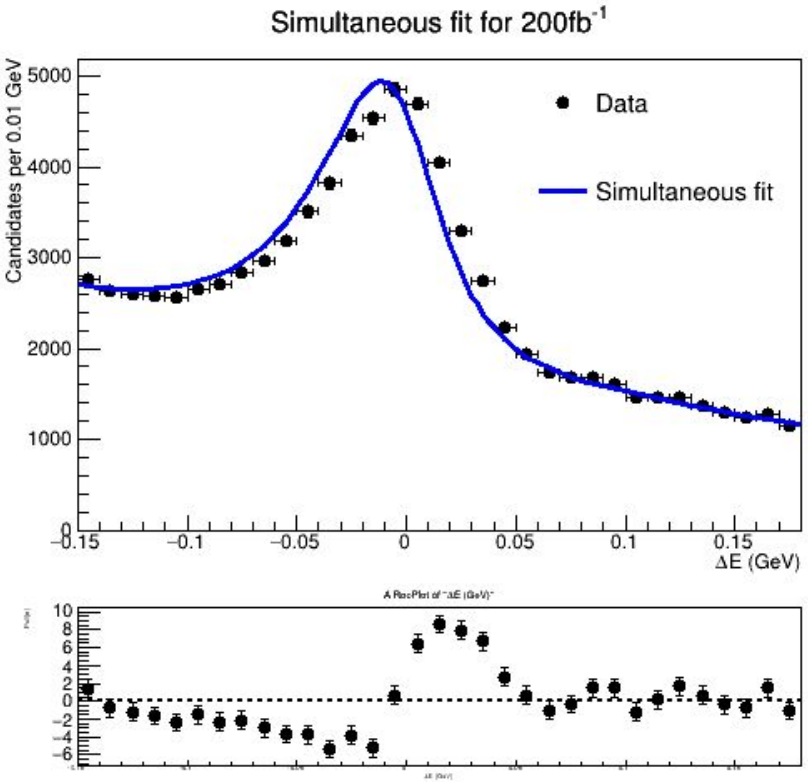


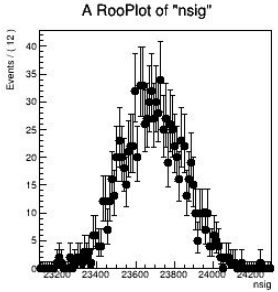


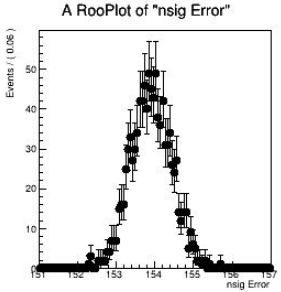


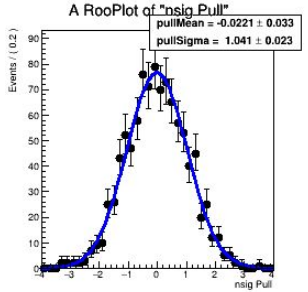


Simultaneous fit with 3 float parameters in Sig PDF



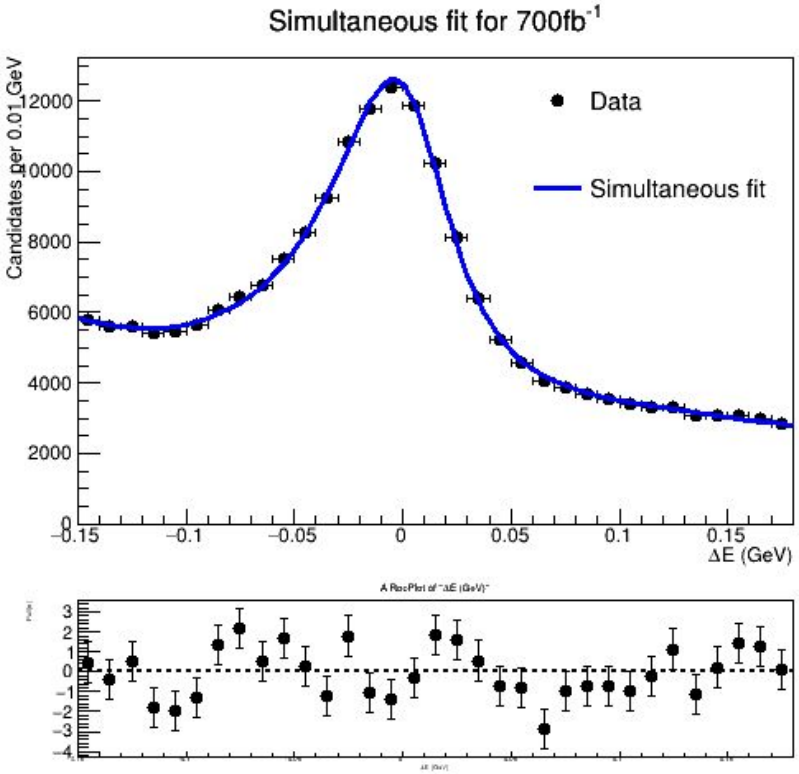


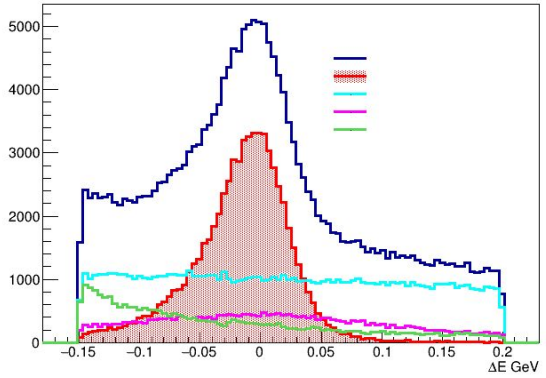




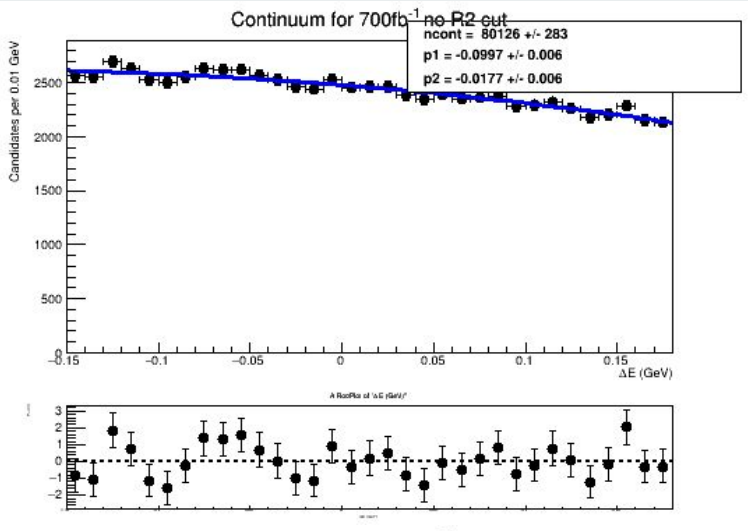
float parameters: delta, gamma, mean

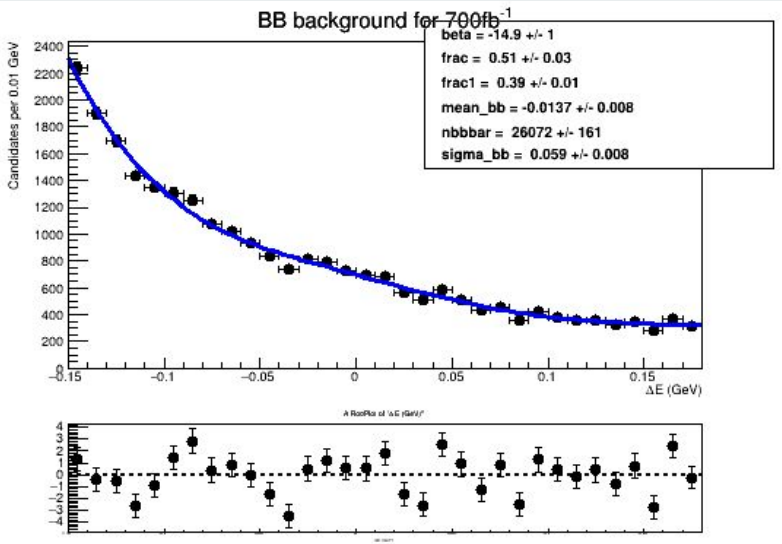
Simultaneous fit of deltaE for 700 fb-1 without R2 cut

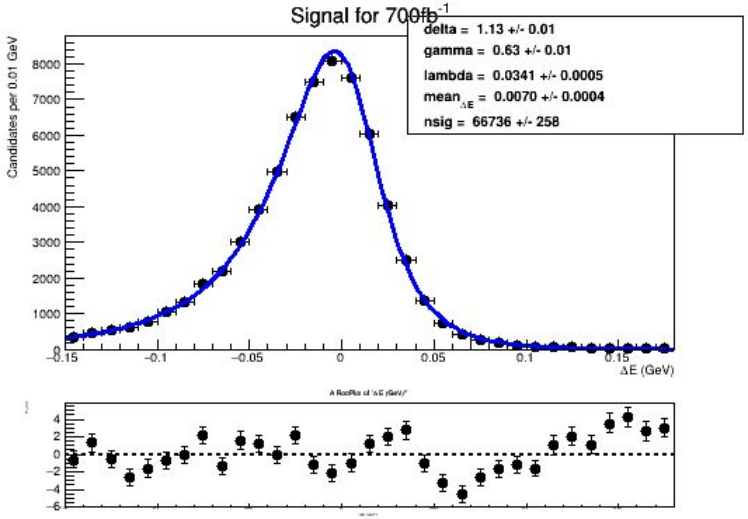


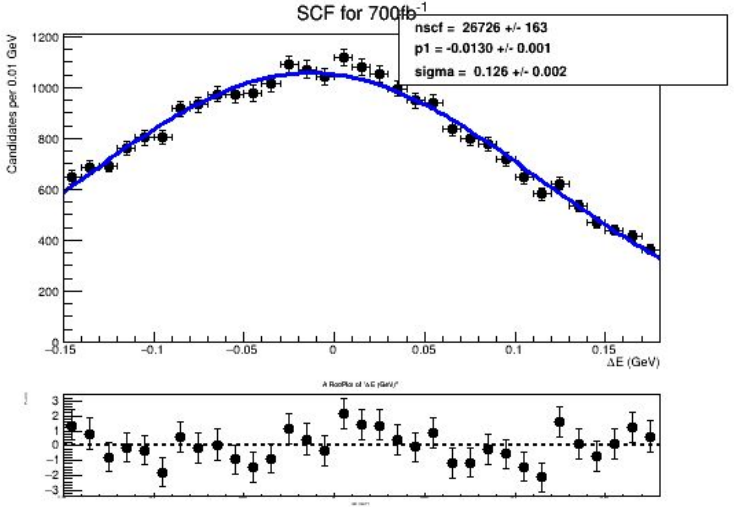


Composition	Fraction before fit	Fraction after fit
Signal	0.32	0.33
Continuum	0.41	0.4
SCF	0.13	0.13
BB-bar bkg	0.13	0.13


Continuum for 700fb^{-1} no R2 cut
ncont = 80126 +/- 283
p1 = -0.0997 +/- 0.006
p2 = -0.0177 +/- 0.006
Candidates per 0.01 GeV
ΔE (GeV)


BB background for 700fb^{-1}
beta = -14.9 +/- 1
frac = 0.51 +/- 0.03
frac1 = 0.39 +/- 0.01
mean_bb = -0.0137 +/- 0.008
nbbbar = 26072 +/- 161
sigma_bb = 0.059 +/- 0.008
Candidates per 0.01 GeV
ΔE (GeV)


Signal for 700fb^{-1}
delta = 1.13 +/- 0.01
gamma = 0.63 +/- 0.01
lambda = 0.0341 +/- 0.0005
mean$_{\Delta E}$ = 0.0070 +/- 0.0004
nsig = 66736 +/- 258
Candidates per 0.01 GeV
ΔE (GeV)


SCF for 700fb^{-1}
nscf = 26726 +/- 163
p1 = -0.0130 +/- 0.001
sigma = 0.126 +/- 0.002
Candidates per 0.01 GeV
ΔE (GeV)

Backup

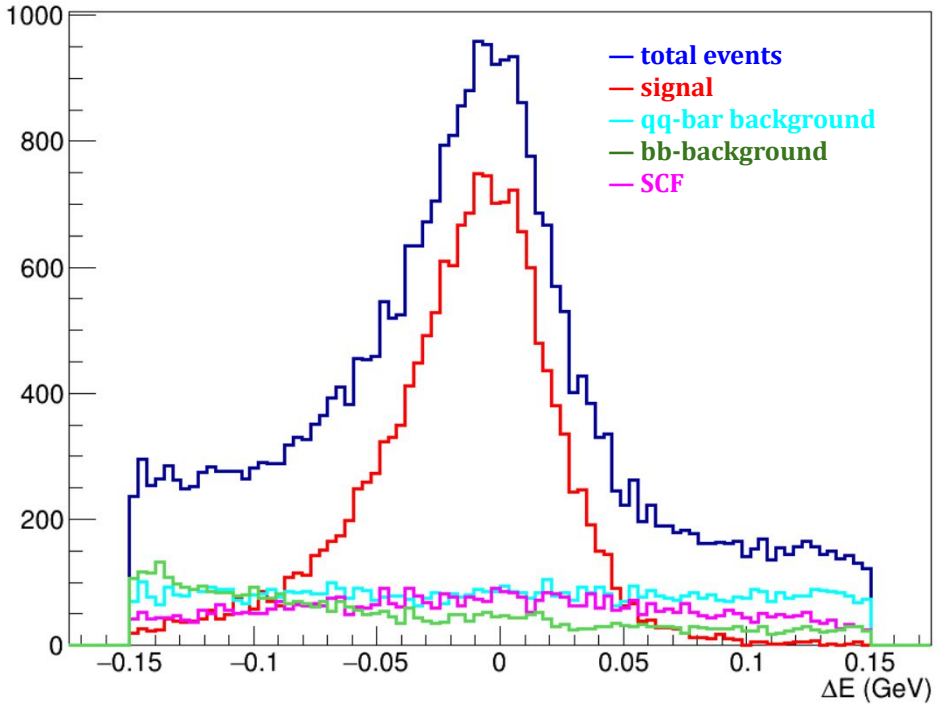
Conclusions

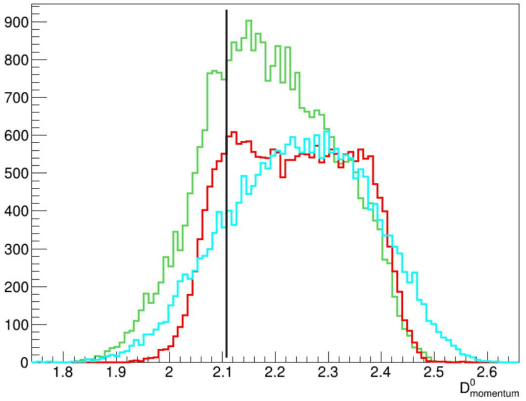
- Additional pre-selection cuts were taken into account
- New optimized selection criteria were applied
- Analysis of the BB-bar background composition was performed
- With new cuts we are able to keep higher reconstruction efficiency (~20%) with smaller background fraction

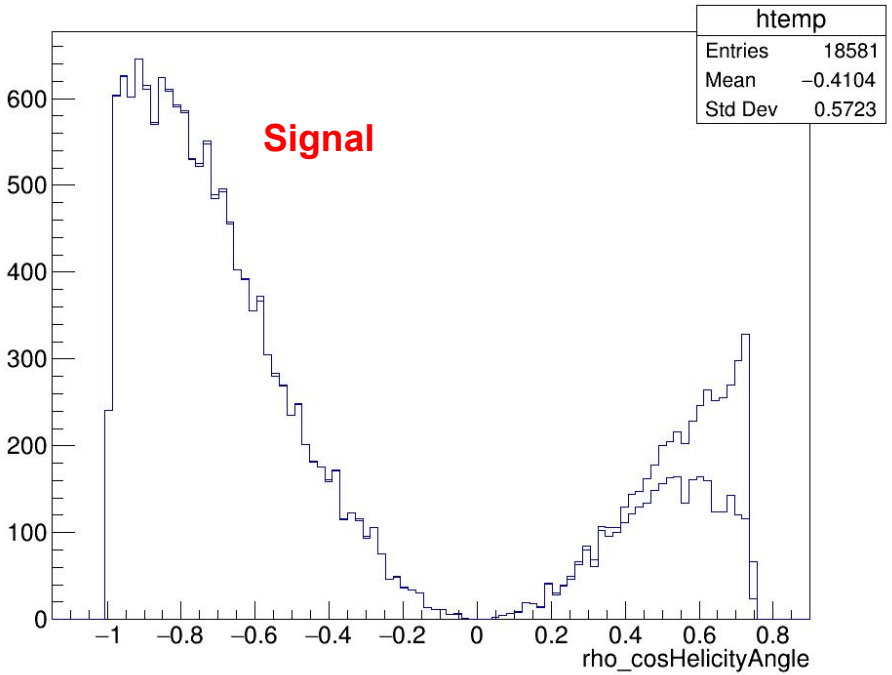
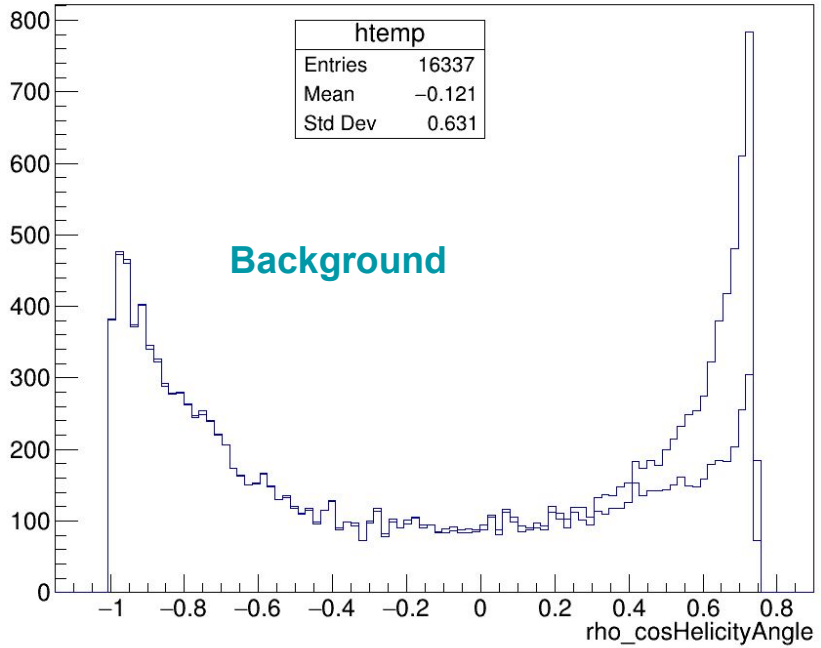
To do:

- Determine the $B \to D\pi\pi^0$ signal yield by fitting the deltaE distribution.
- Will inspect $m(\pi\pi^0)$ mass to separate ρ and non-ρ contribution to the signal
- Will consider if using also $\cos\theta_{\pi\pi}$ in the fit.

Delta E with harder cut on p(D⁰)>2.1





Composition	Share
Signal	0.49
Continuum	0.22
SCF	0.16
BB-bar bkg	0.13

Possible cut on the angle difference between 2 photons