Toward $\mathcal{B}(B{\rightarrow}D^{o}\rho)$

Mirco Dorigo
Riccardo Manfredi
Olga Werbycka

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**
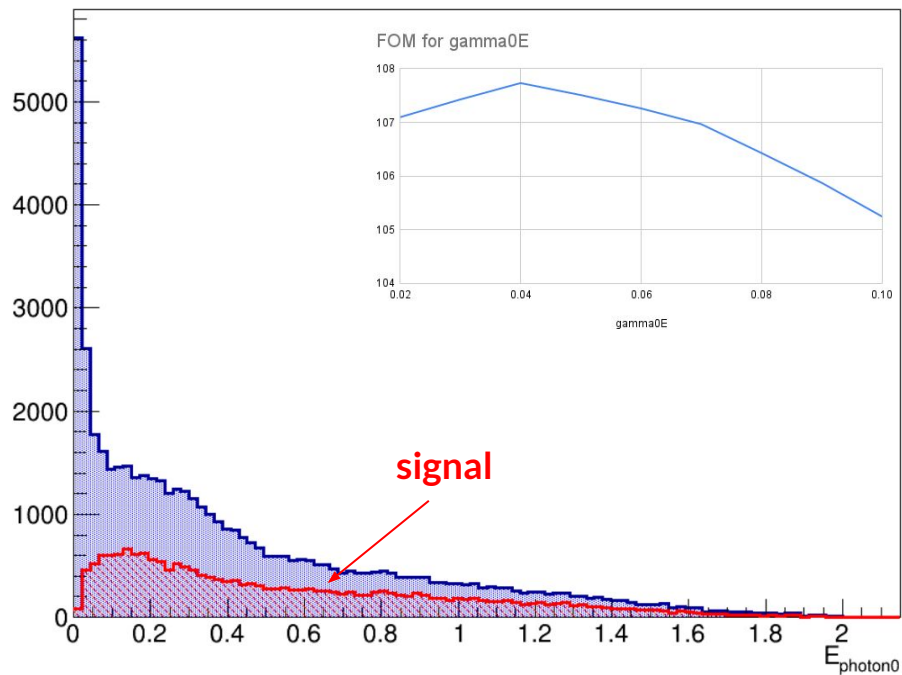➜ **photon0E >0.04**
➜ **photon1E>0.05**

new or modified

π^0 candidates are taken from *stdPi0s_winter2020* list
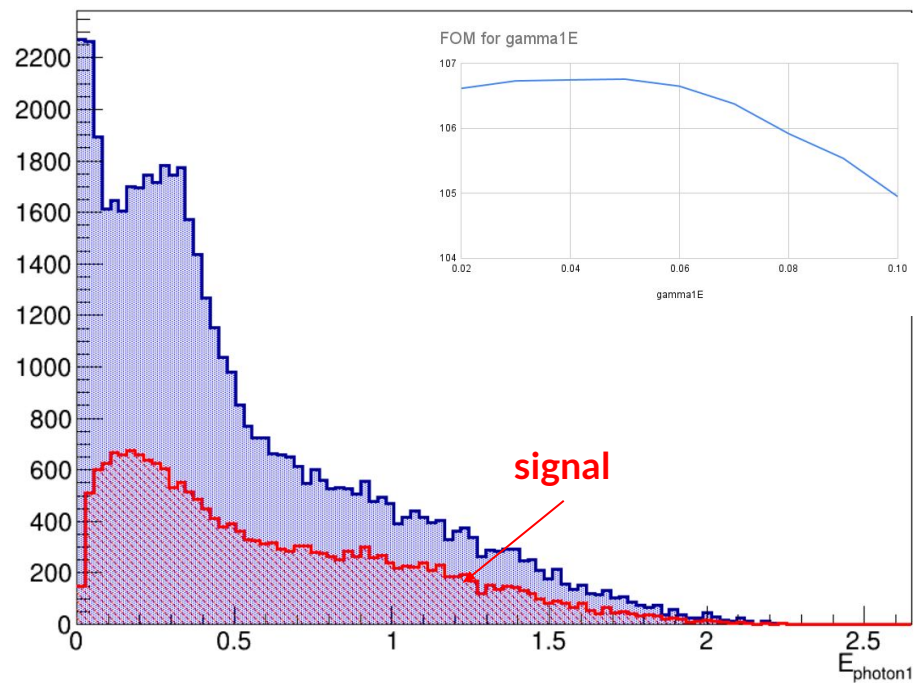
The vertex of the signal *B* candidate was reconstructed using *tree fitter*
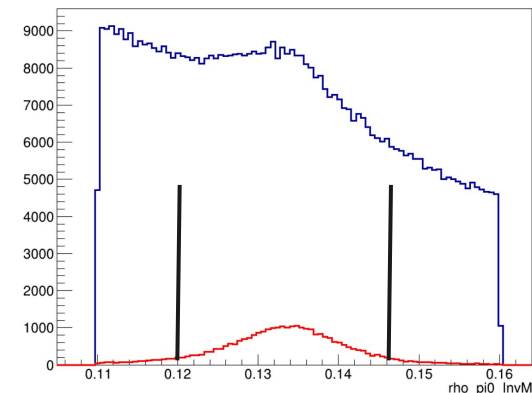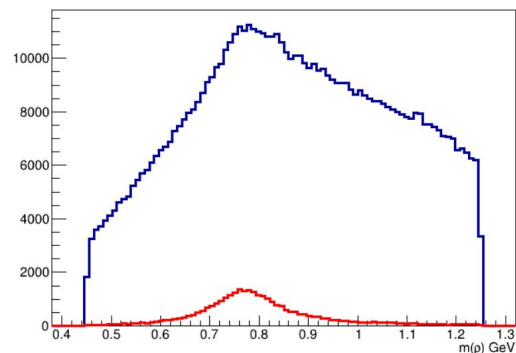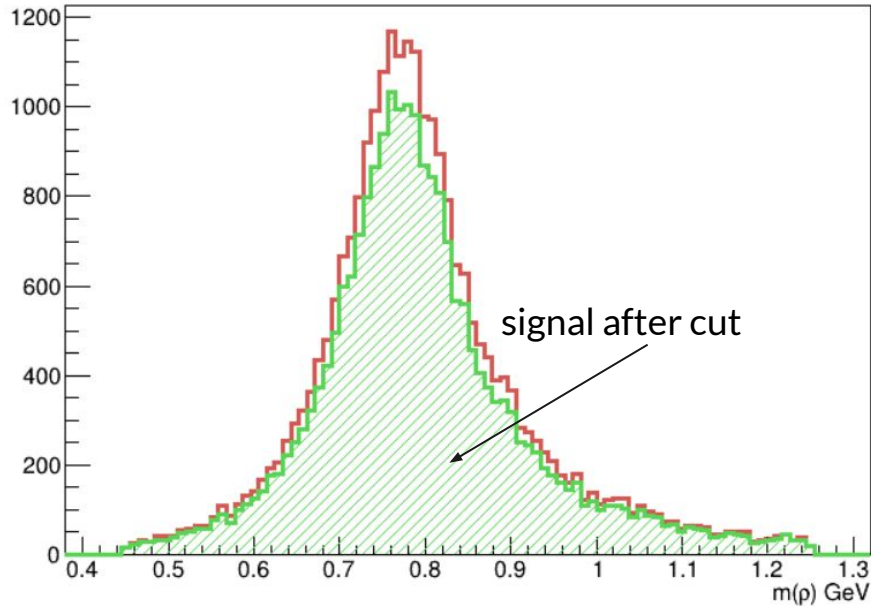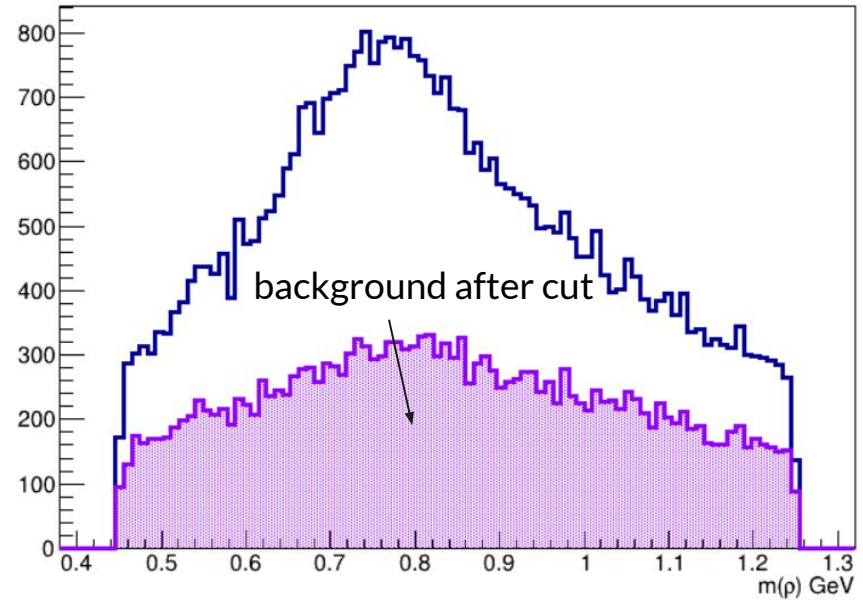
Photon energy optimization

Ephoton0 > 0.04

Ephoton1 > 0.05

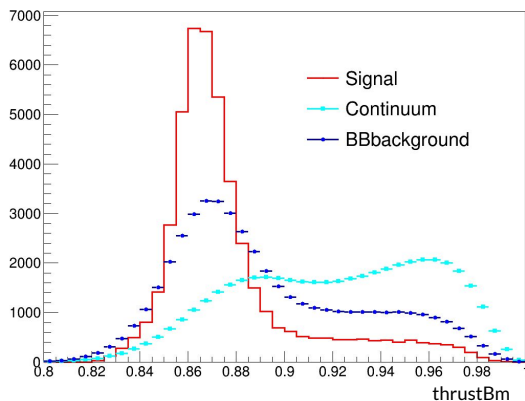# m(ρ) signal and background after applying photon/pi⁰ cuts

signal after cut

88% of signal remains

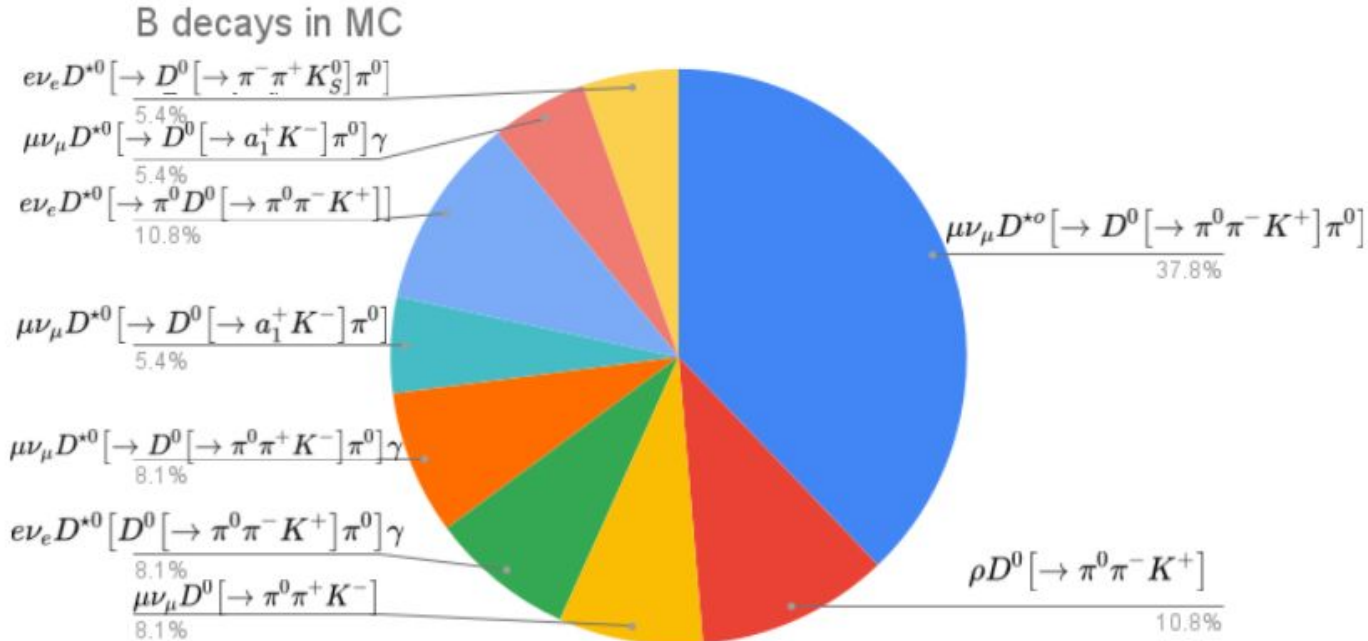background after cut

53% of background is rejected

Old Selection criteria

➔ R2 < 0.28

➔ thrustBm > 0.83

➔ thrustBm < 0.9

➔ $\cos\Theta_{\pi\pi0}$ < 0.62

- 1D FOM based optimisation of $\cos\Theta_{\pi\pi0}$,
- cuts of R2 and thrustBm based on the shape only
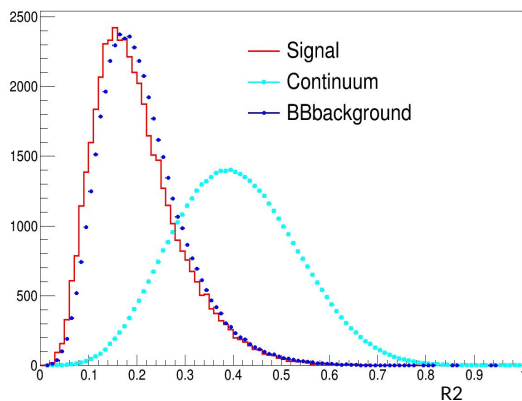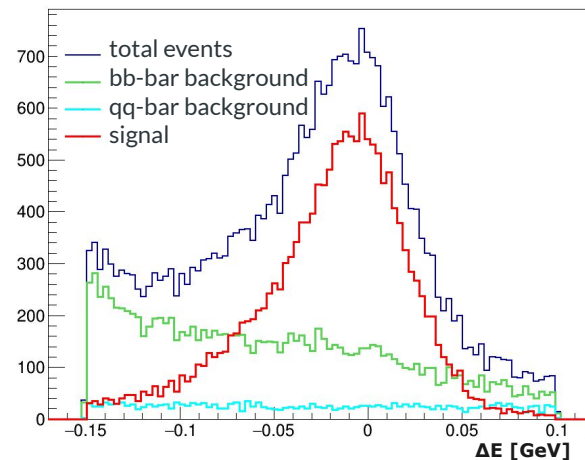
Composition	Fraction
Signal	0.59
Continuum	0.13
BB-bar bkg	0.28

Result of the topology analysis

B decays in MC

$e\nu_e D^{*0}[\to \underline{D^0}[\to \pi^-\pi^+ K_S^0]\pi^0]$ — 5.4%

$\mu\nu_\mu D^{*0}[\to \underline{D^0}[\to a_1^+ K^-]\pi^0]\gamma$ — 5.4%

$e\nu_e D^{*0}[\to \pi^0 D^0[\to \pi^0\pi^- K^+]]$ — 10.8%

$\mu\nu_\mu D^{*0}[\to D^0[\to a_1^+ K^-]\pi^0]$ — 5.4%

$\mu\nu_\mu D^{*0}[\to \underline{D^0}[\to \pi^0\pi^+ K^-]\pi^0]\gamma$ — 8.1%

$e\nu_e D^{*0}[D^0[\to \pi^0\pi^- K^+]\pi^0]\gamma$ — 8.1%

$\mu\nu_\mu D^0[\to \pi^0\pi^+ K^-]$ — 8.1%

$\mu\nu_\mu D^{\star o}[\to D^0[\to \pi^0\pi^- K^+]\pi^0]$ — 37.8%

$\rho D^0[\to \pi^0\pi^- K^+]$ — 10.8%

The most frequent B- decays go through D*0 ➤ D0pi0

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Selection variables

Focus on three variables for background suppression: **cosΘ$_{\pi\pi0}$**, **R2** and **D$^0_{mom}$**:

cosΘ$_{\pi\pi0}$

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

R2

$$\mathcal{R}2 = \mathcal{H}_2/\mathcal{H}_0$$
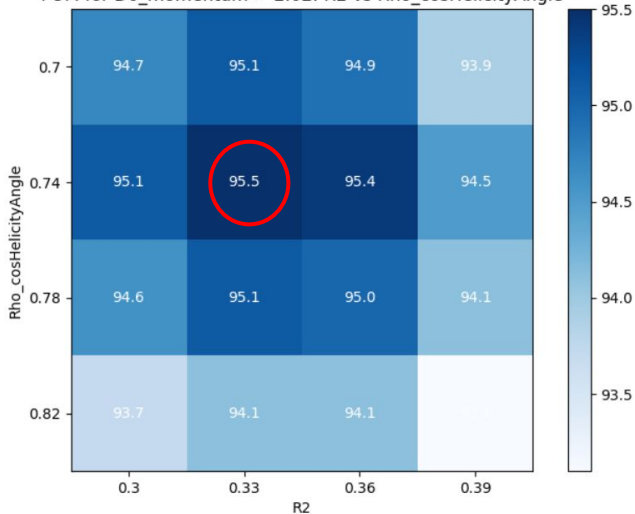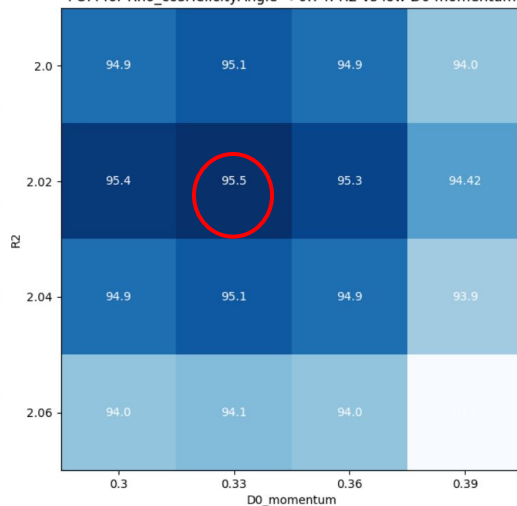
D$^0_{mom}$

D^0 momentum in CMS
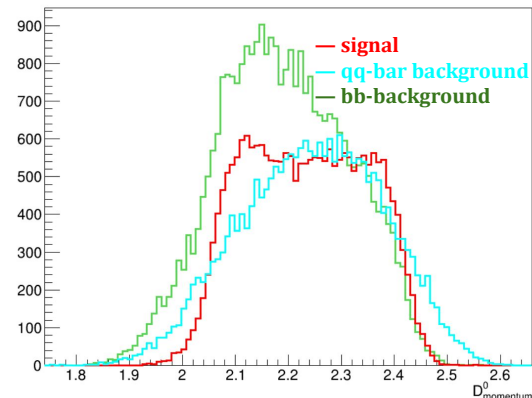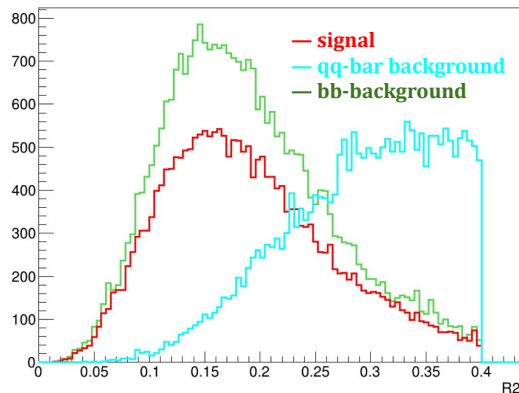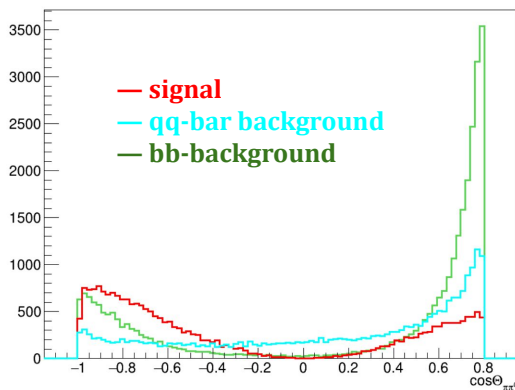
New selection

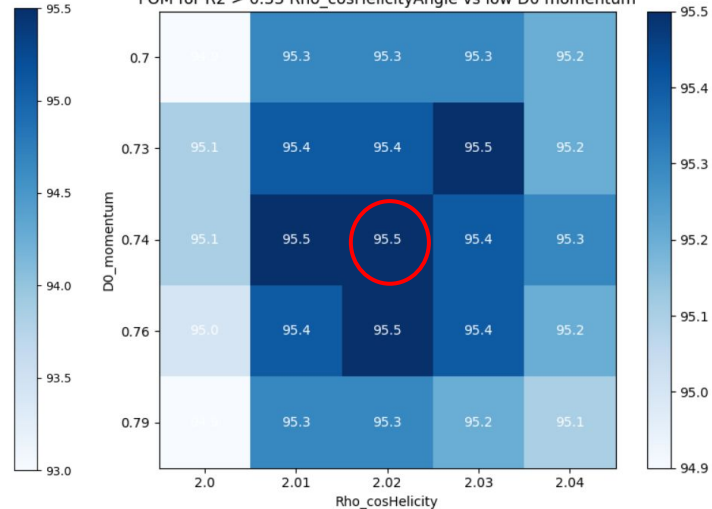Results of 3D optimisation of $\cos\Theta_{\pi\pi 0}$ vs **R2** vs D^0_{mom};

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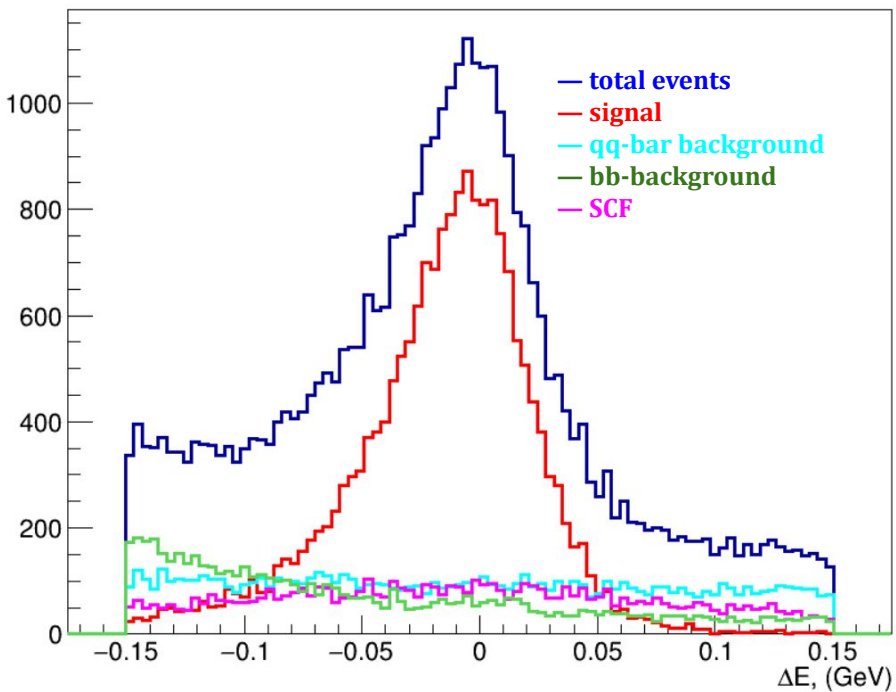
Result

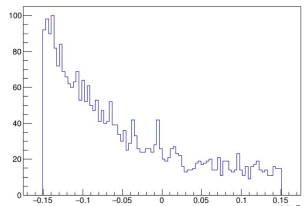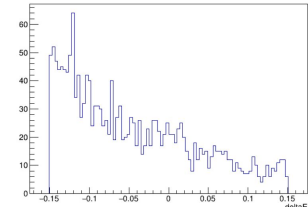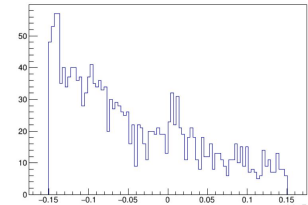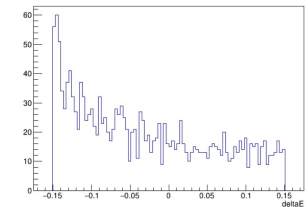| Composition	Fraction
Signal	0.48
Continuum	0.21
SCF	0.16
BB-bar bkg	0.15

Result (2)
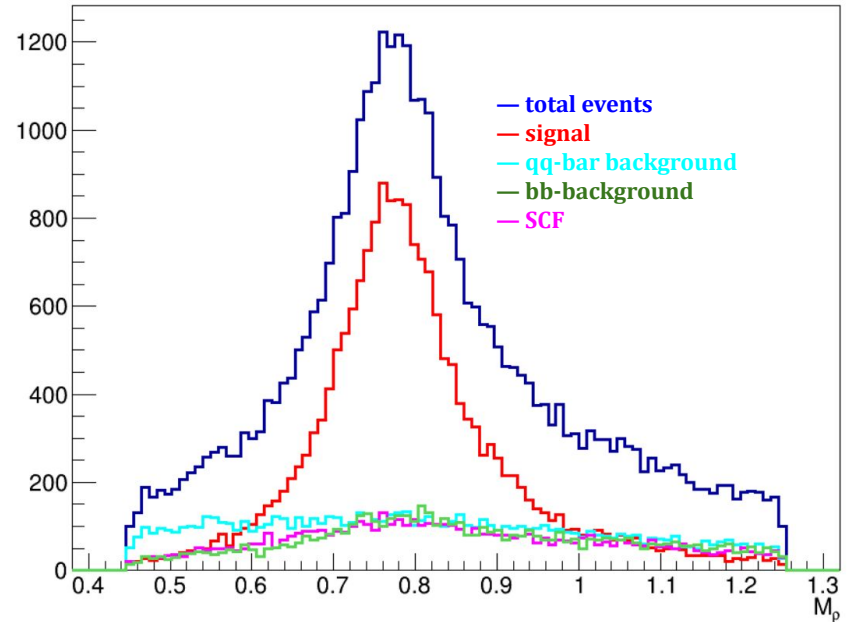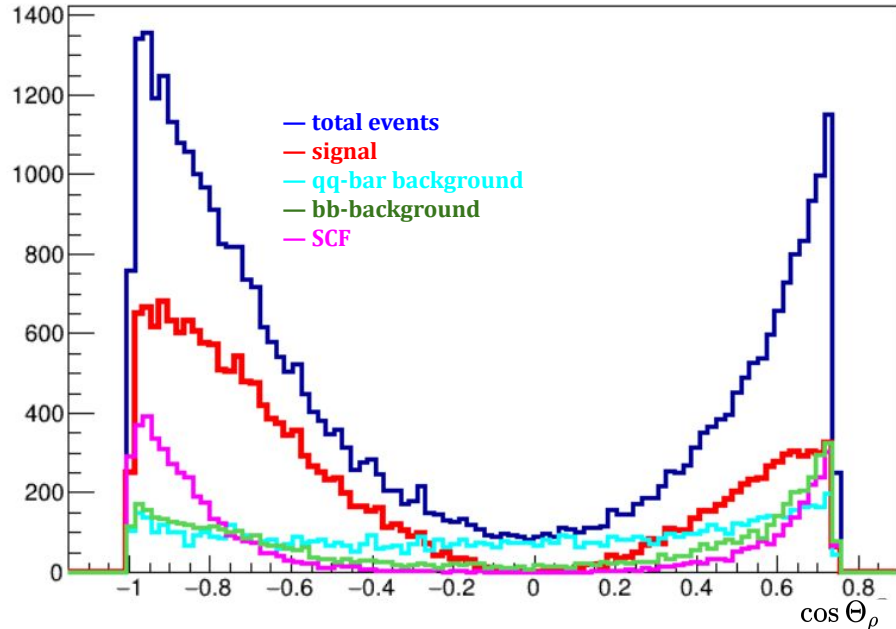
shapes between the 4 components look different in cosTheta_rho. We can use it's discrimination power in a 3D fit to (deltaE, m(rho), cosHel).

BB-bar background composition
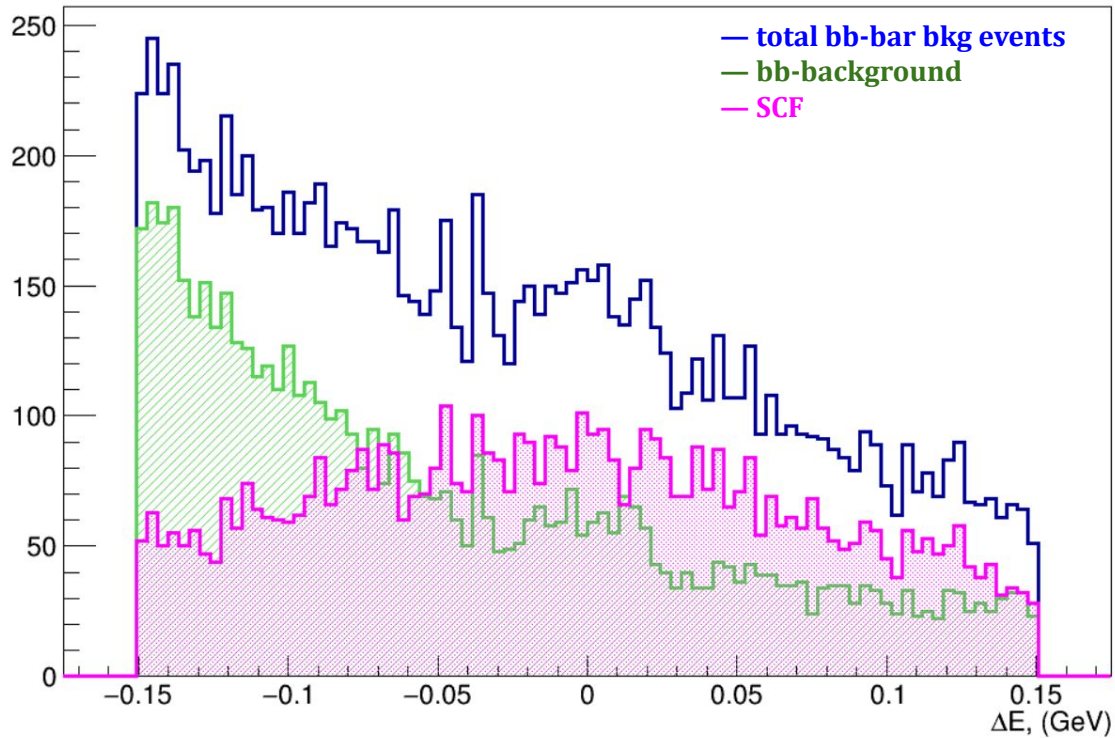
BB-bar background and SCF compositions

Rest (B0B0-bar)
13.1%

Rest(>3-body
10.3%

$D^0/D^{*0} + \pi\pi\pi$

Rest(3-body
10.8%

~50% D^0/D^{*0} lv

$B^+ \to D^{*0}\rho = 65\%$

Rest(2-body
15.8%

SCF(2-body
27.9%

$B^+ \to D^0\rho = 87\%$

~50% D^0/D^{*0} lv

SCF(3-body
9.0%

$D^0/D^{*0} + \pi\pi\pi$

SCF(>3 body
13.0%

13
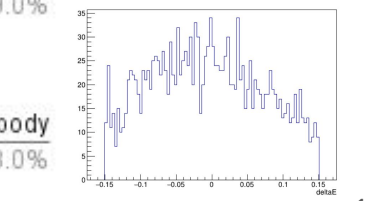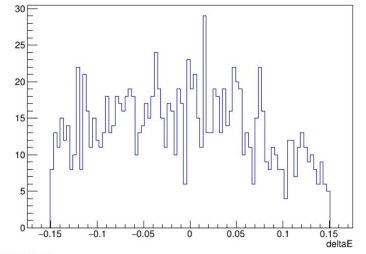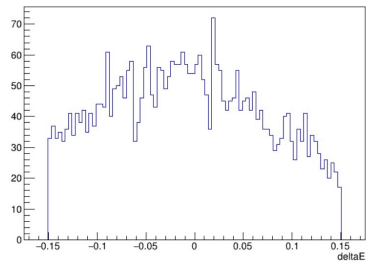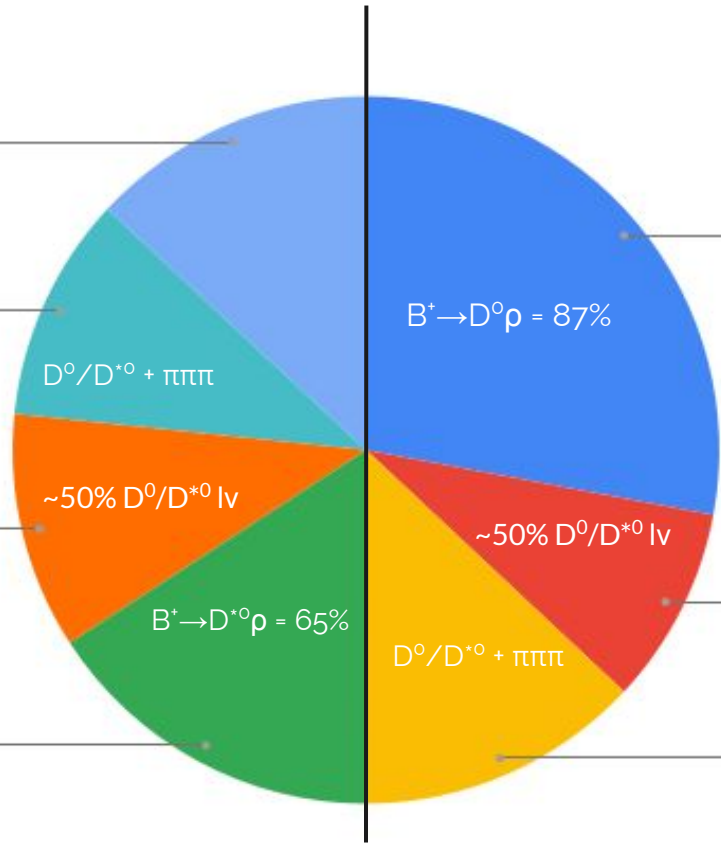
Summarizing table for MC 200 fb⁻¹

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

Candidate multiplicity was studied on a small generic MC dataset after applications of all selection criteria
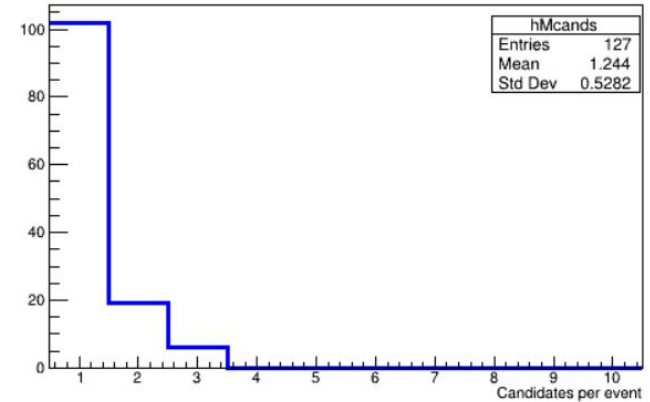
We expect to see in data (200 fb⁻¹) (events):

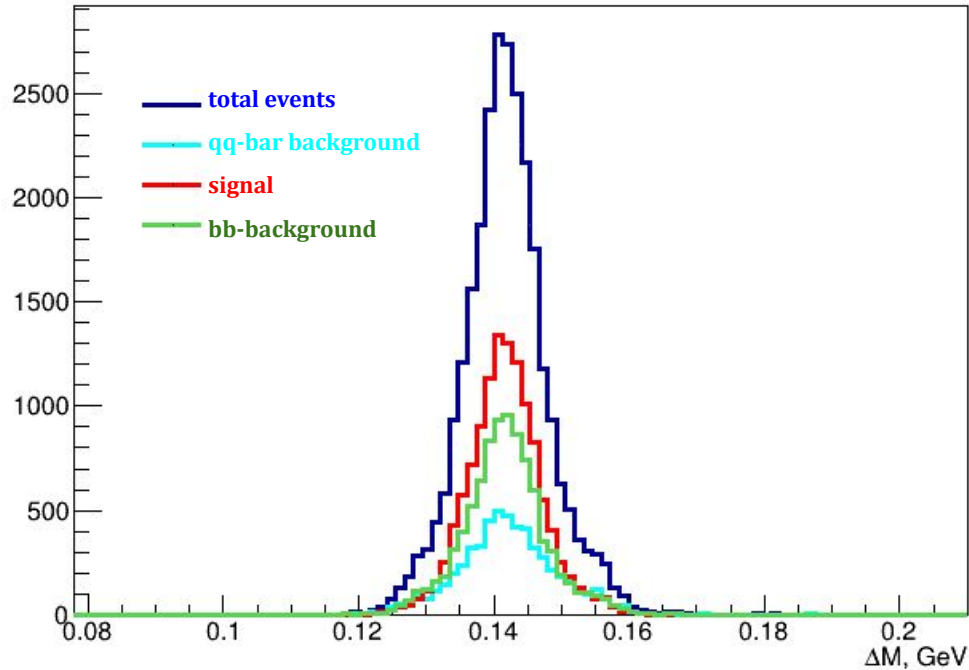$$N_{\mathrm{signal}} = L \times \epsilon = 19700$$

ΔE after one candidate selection
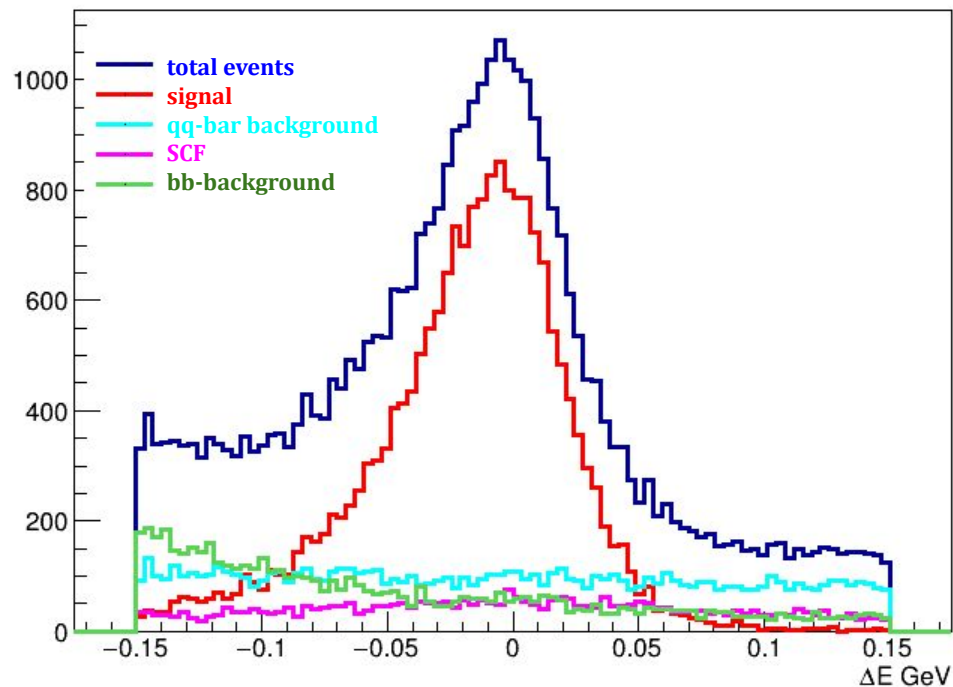
Composition	Fraction
Signal	0.52
Continuum	0.22
SCF	0.10
BB-bar bkg	0.16

D*⁰ veto

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

D*⁰→D⁰π⁰

sig   ROE

D*⁰ veto: π⁰ momenta

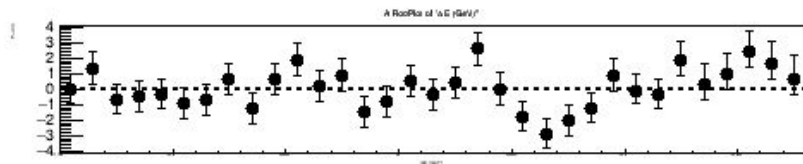π⁰: roe

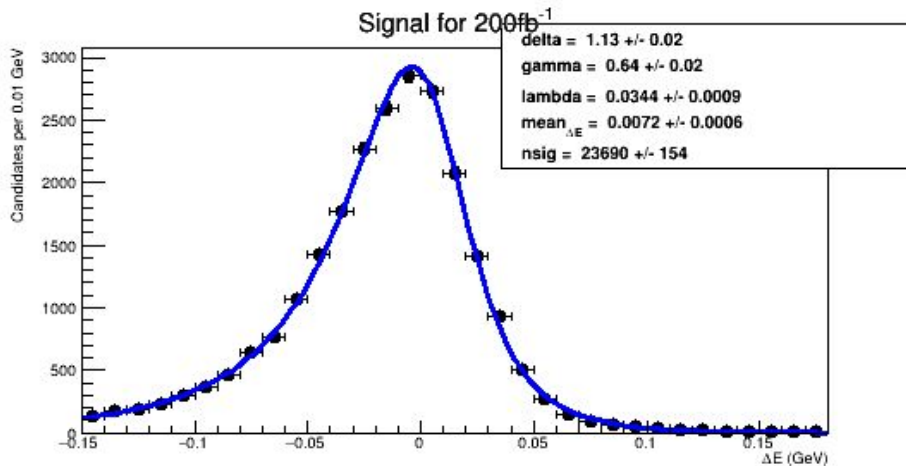π⁰: signal side
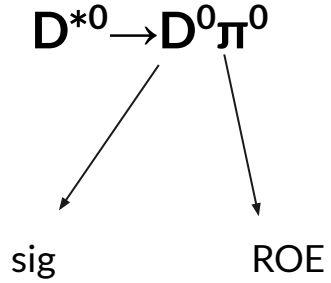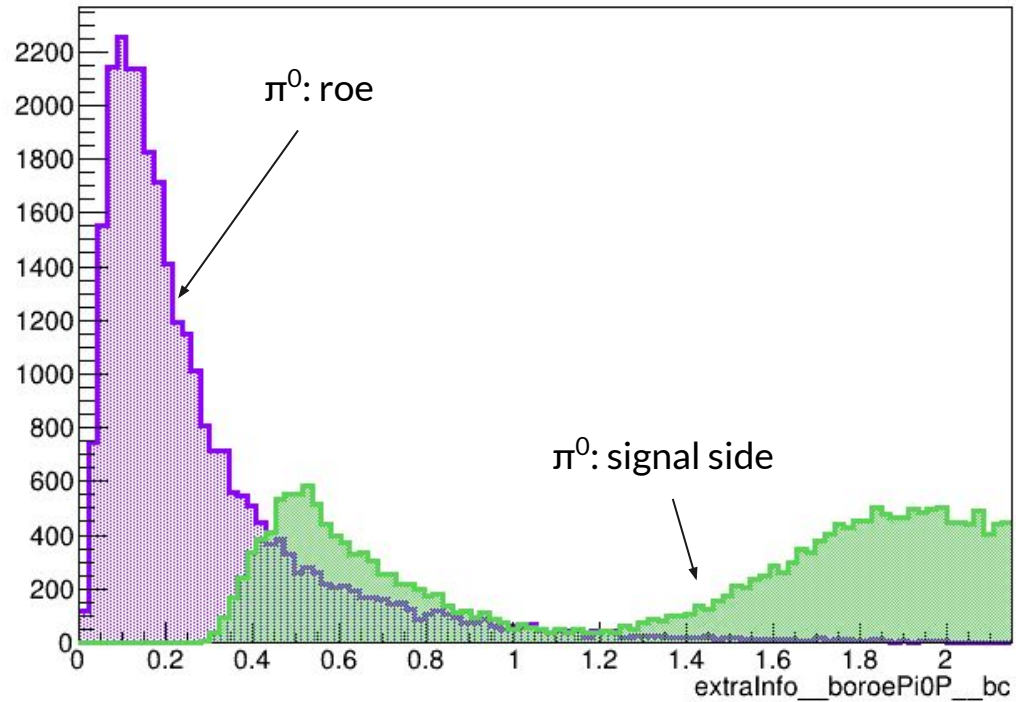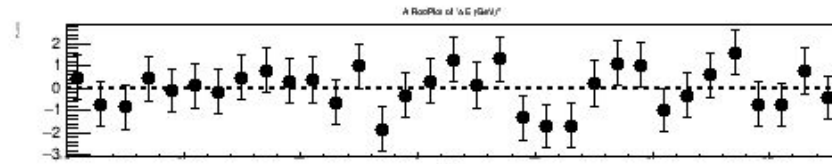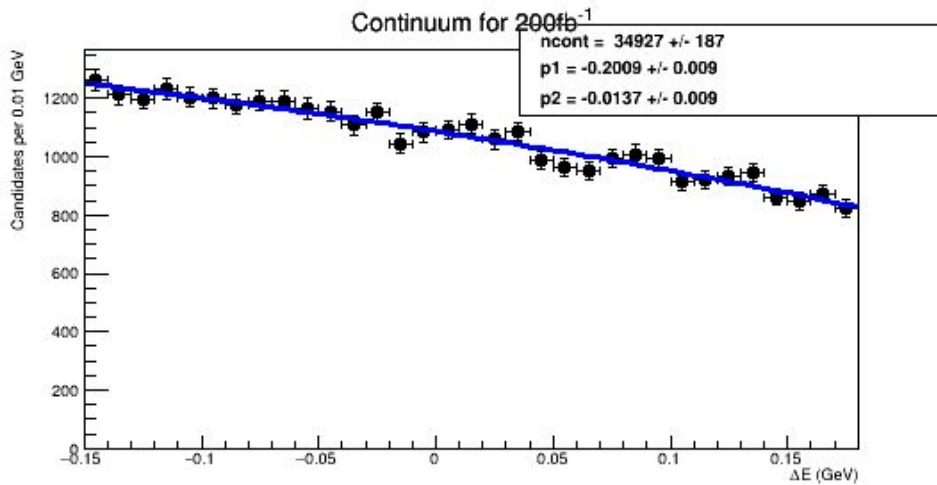
Fits for SCF and BBbar of deltaE (200 fb-1)
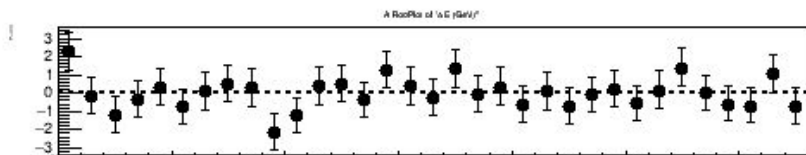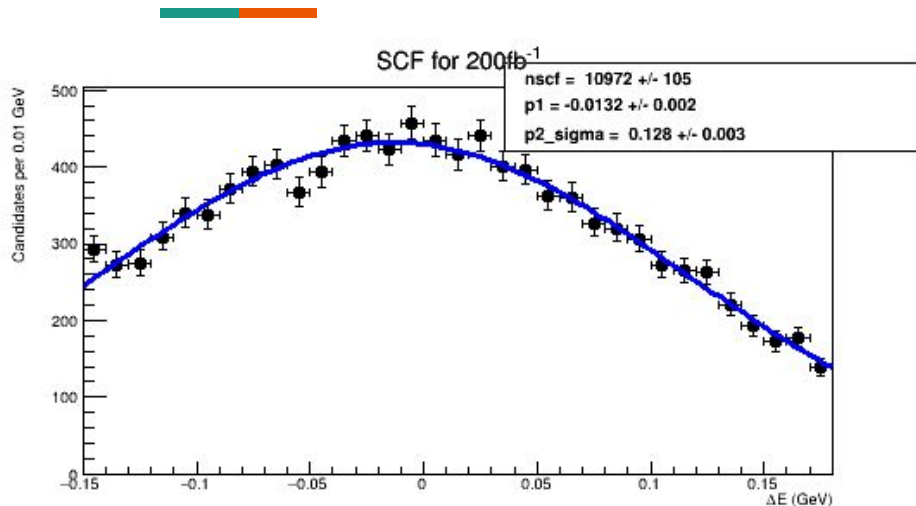
rooGaussian
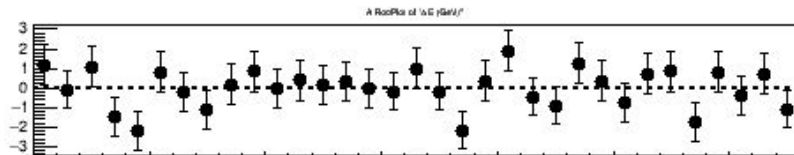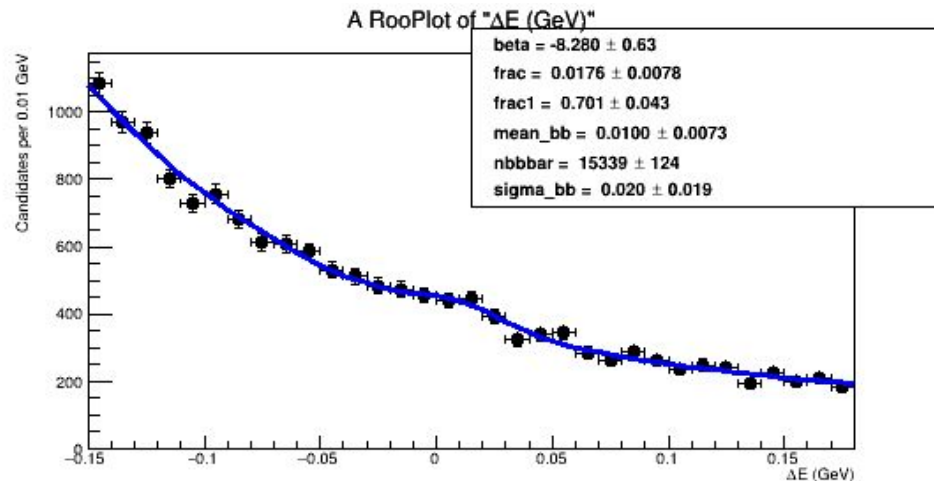
rooExponetial x rooChebyshev(0) x rooGaussian
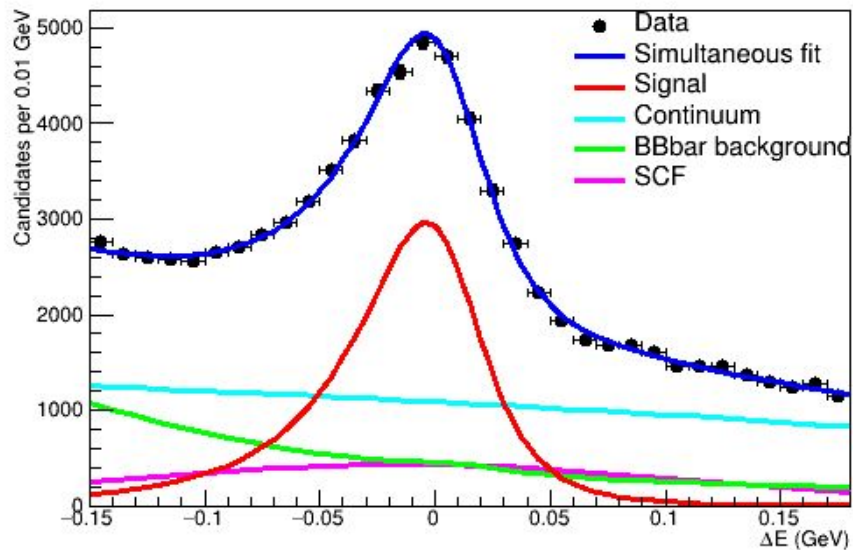
Fits for signal and continuum of deltaE (200 fb-1)

rooJohnson

rooChebyshev (2)

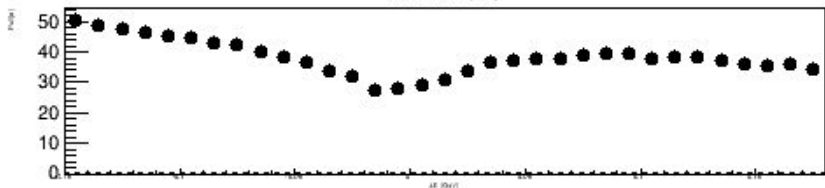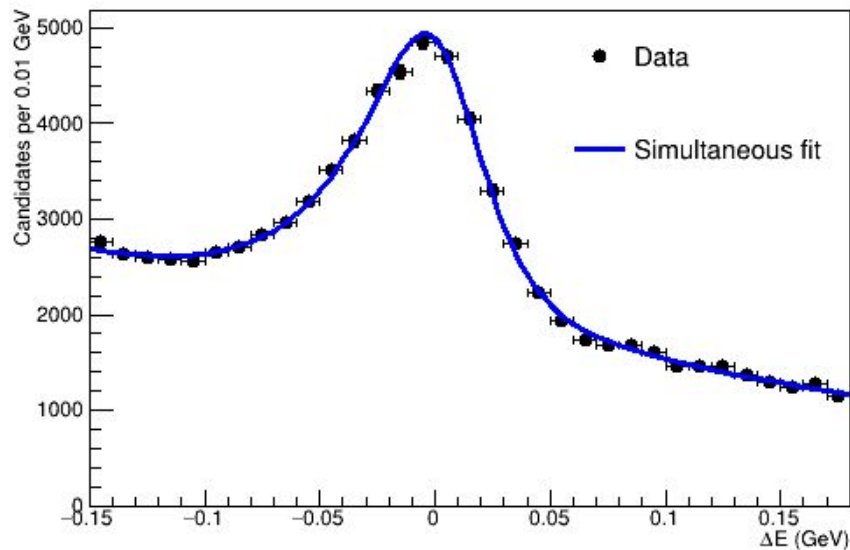# Simultaneous fit of deltaE
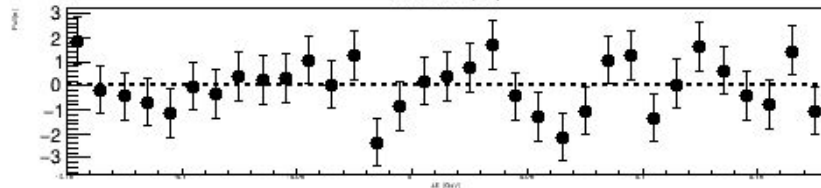
TOYs for Simultaneous fit (Signal and Continuum)
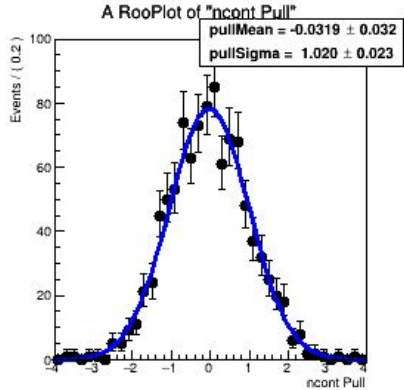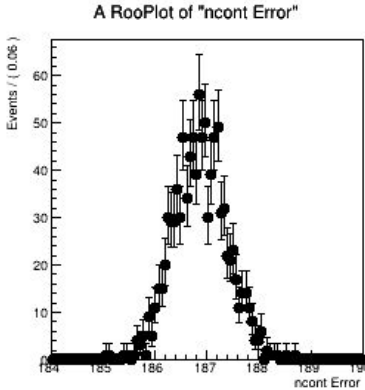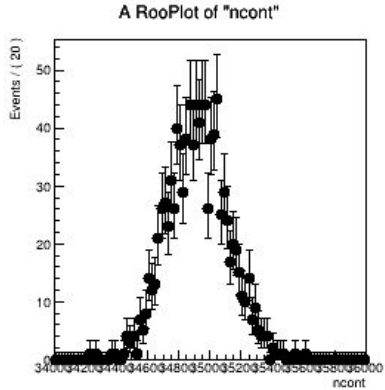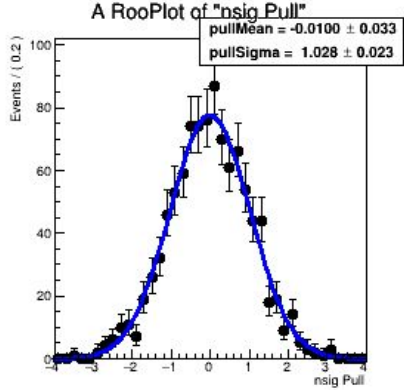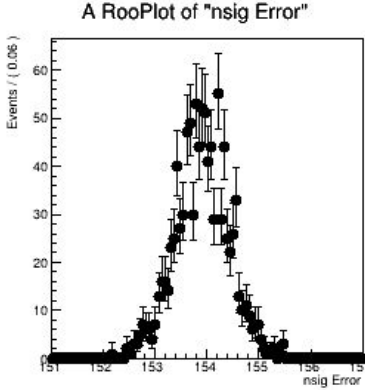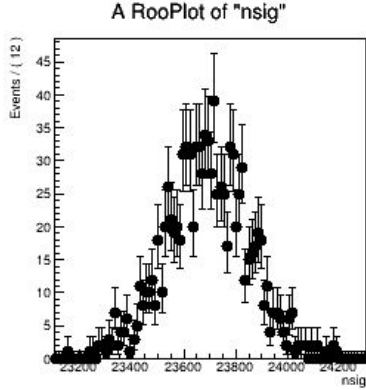
TOYs for Simultaneous fit (BBbar and SCF)

Backup

A RooPlot of "ΔE (GeV)"

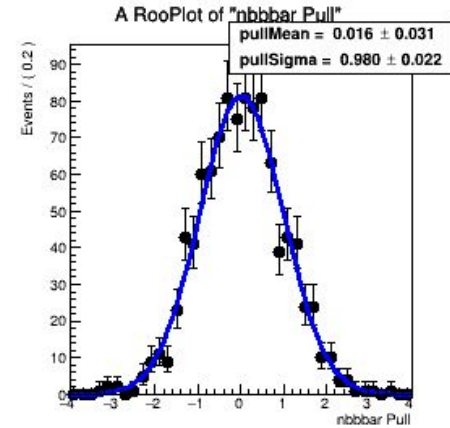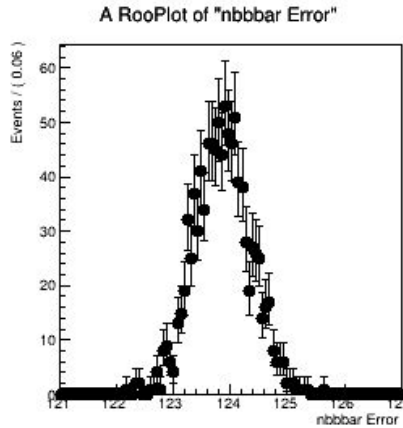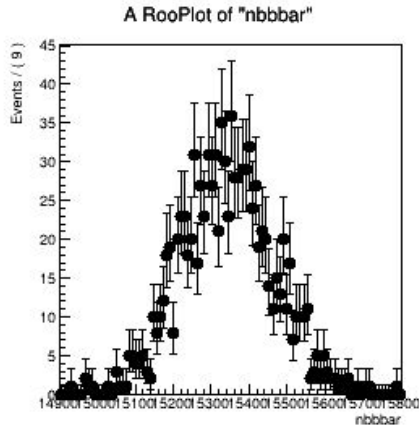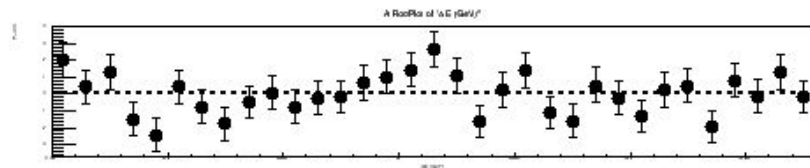nbbbar = 15339 ± 124
p1 = -0.8222 ± 0.013
p2 = 0.222 ± 0.012
p3 = -0.0474 ± 0.012
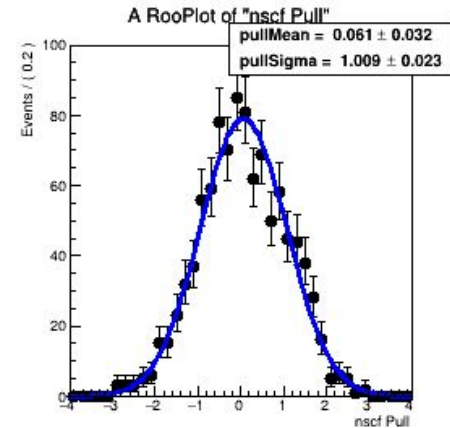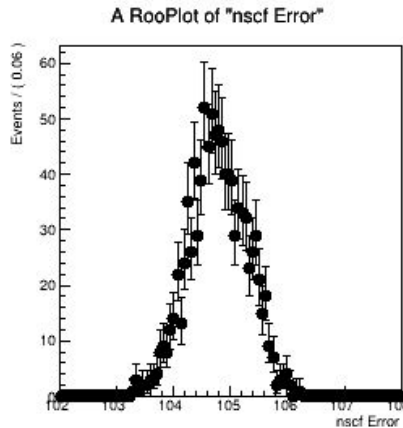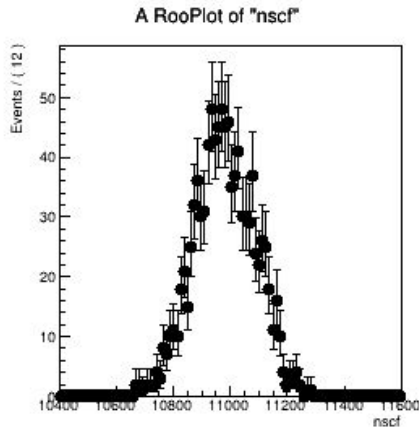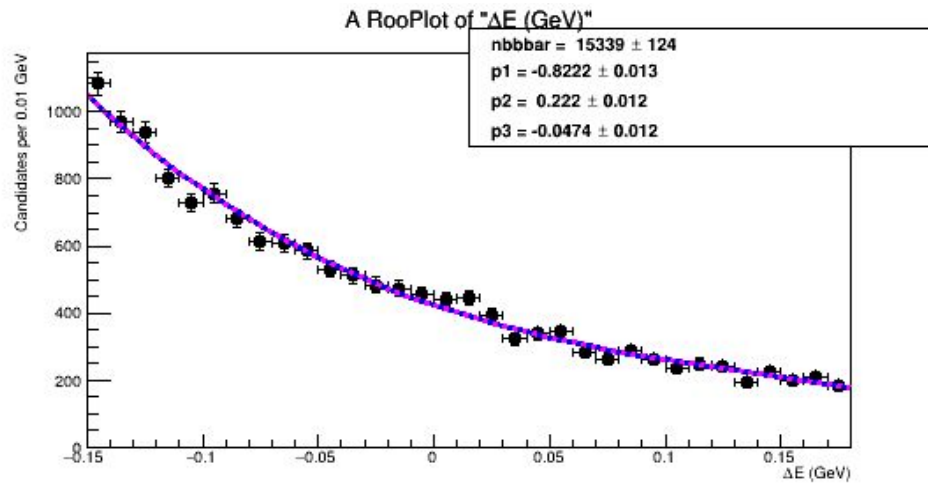
Conclusions

➢ 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→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 cosθ_$\pi\pi$ in the fit.

Delta E with harder cut on p(D⁰)>2.1
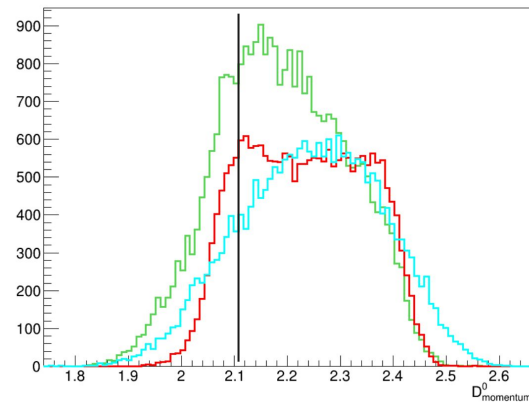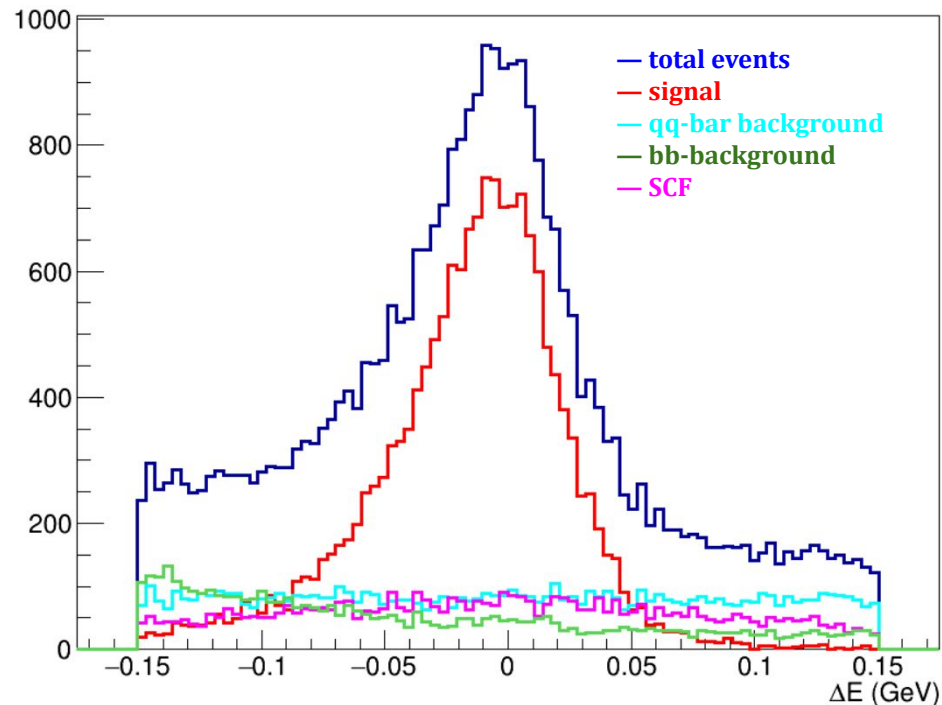
Composition	Share
Signal	0.49
Continuum	0.22
SCF	0.16
BB-bar bkg	0.13

Possible cut on the angle difference between 2 photons