Lab meeting

Yonsei University

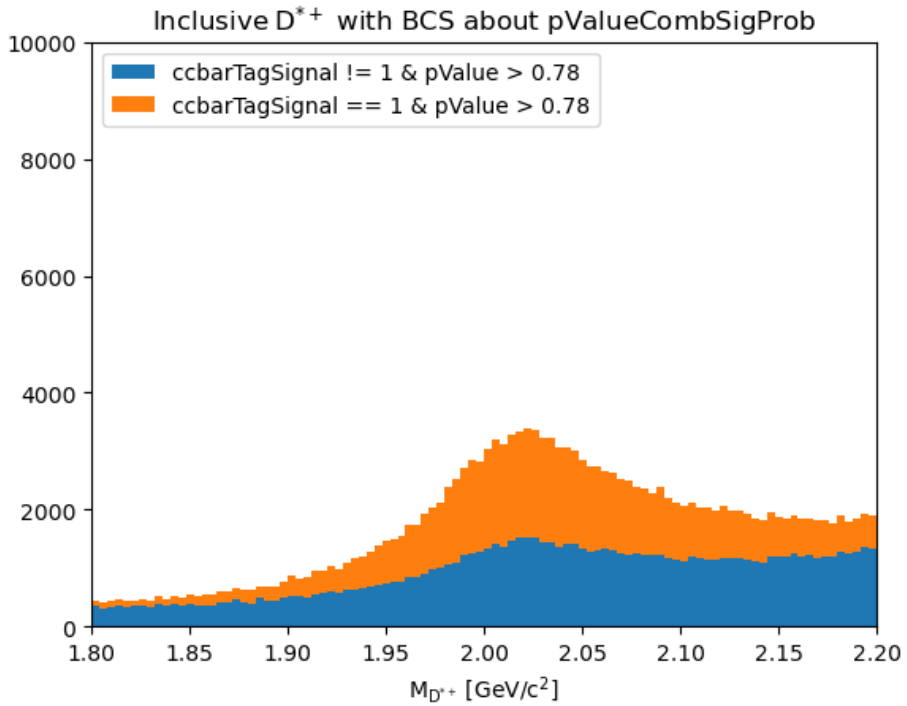
Chanho Kim

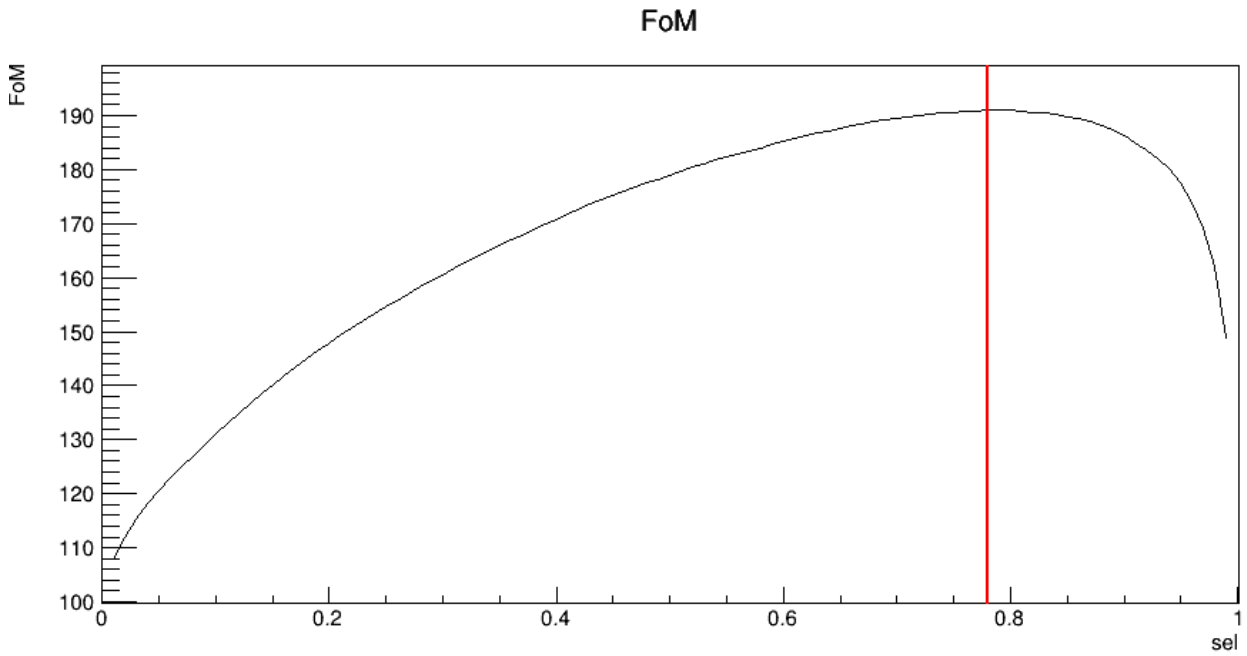
2024-12-03

Comparison my charm tagger and ccbarFEI

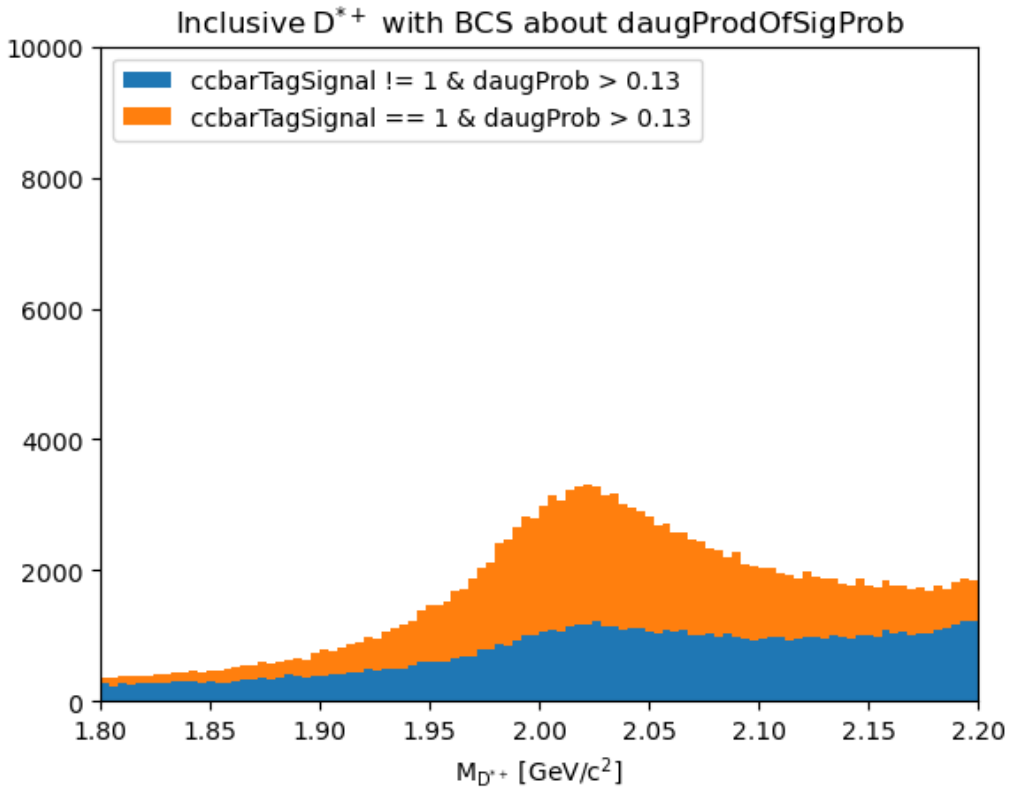
- Check on recoil mass distribution for signal side D^{*+}
  - Best candidate selection variables
    - ccbarFEI variables : pValueCombSigProb, daugProdOfSigProb
    - Opening Angle between momentum vectors of $D_{tag}^{(*)}$ and signal side $D^{*\pm}$ in the cm frame in my charm tagger
- Reconstruction on not skimmed signal MC($D^0 \to \nu\bar{\nu}$)
- Check on recoil mass distribution for signal side D^0
  - Best candidate selection variables
    - BCS with pValueCombSigProb on signal side D^{*+} and then BCS with daugProdOfSigProb on signal side D^0
    - BCS with daugProdOfSigProb on signal side D^{*+} and then BCS with pValueCombSigProb on signal side D^0

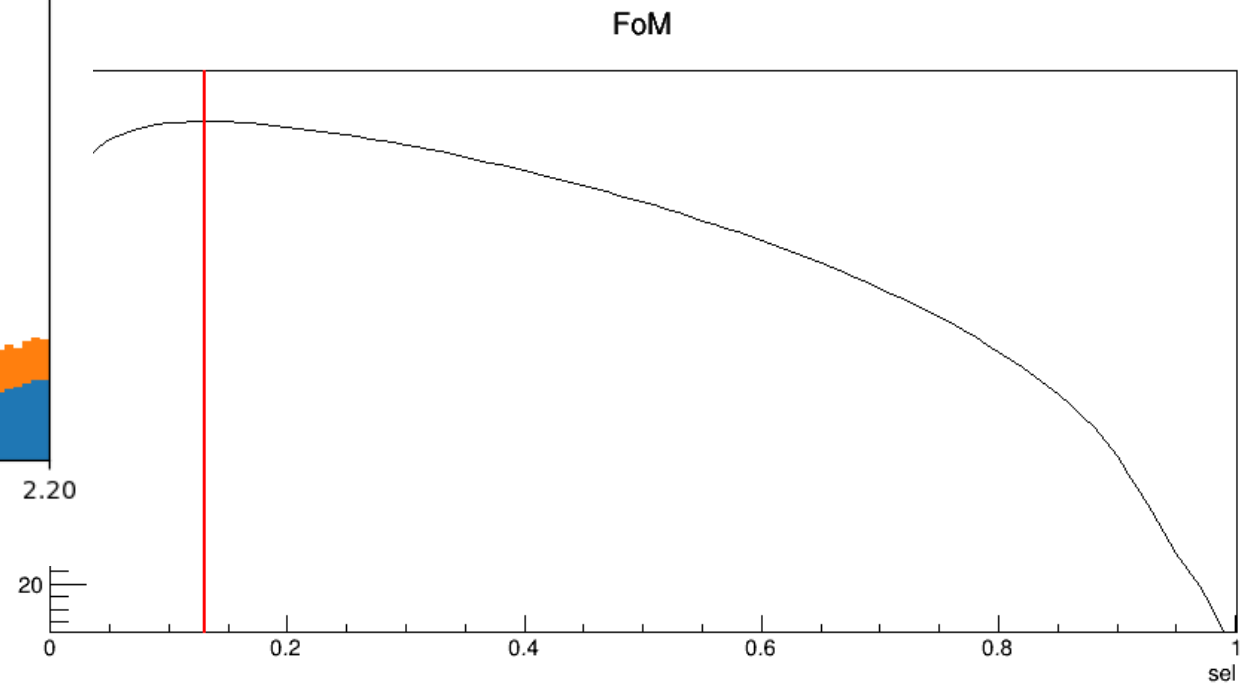
Optimization with pValueCombSigProb





Optimization with daugProdOfSigProb



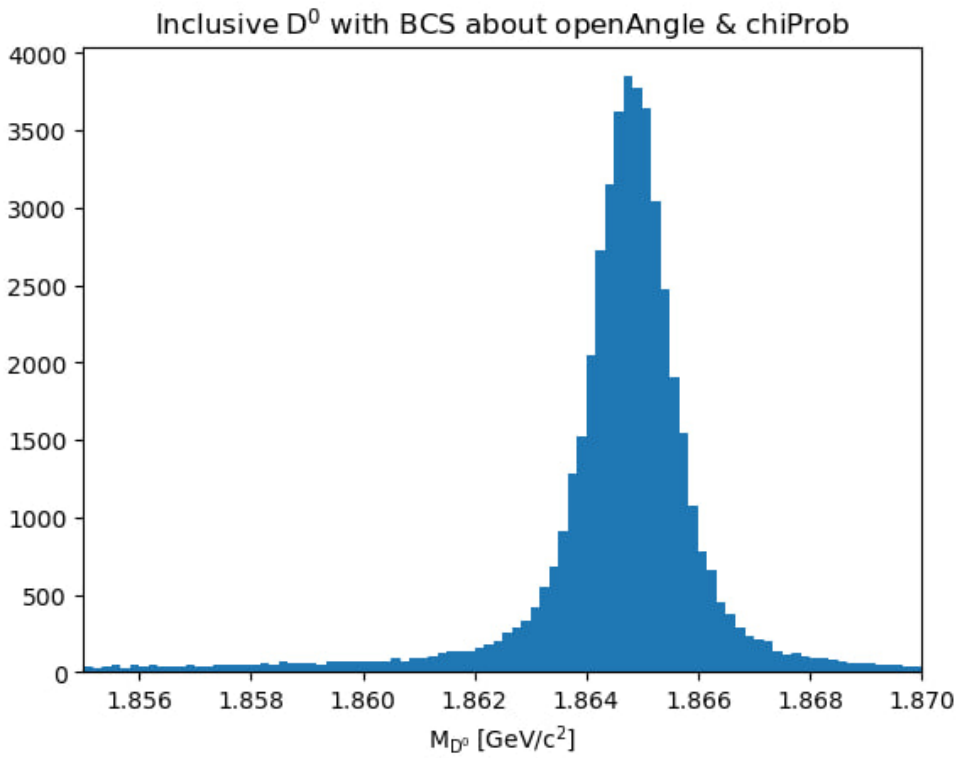


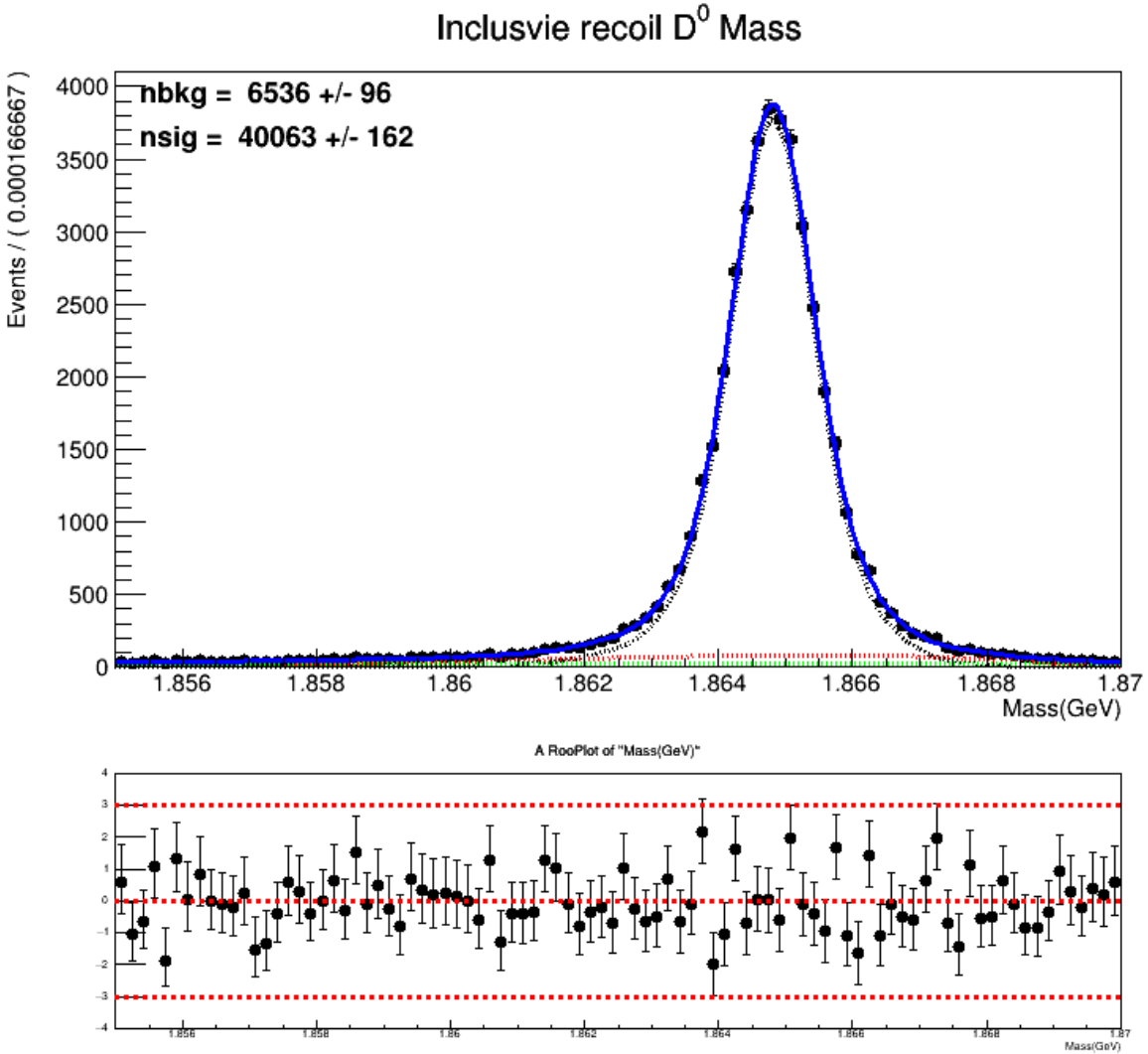
Fit strategy for extraction signal yield

- Signal PDF :
  - 2 gaussians + 1 bifurcated gaussian (with common mean value)
- Background PDF :
  - ccbarFEI : linear + exponential
  - Charm tagger : linear + argus (as usual)
- Note :
  T/F was classified by checking ccbarTagSignal (ccbarFEI target variable)
  & slowPion MC information (isSignal & genMotherPDG)

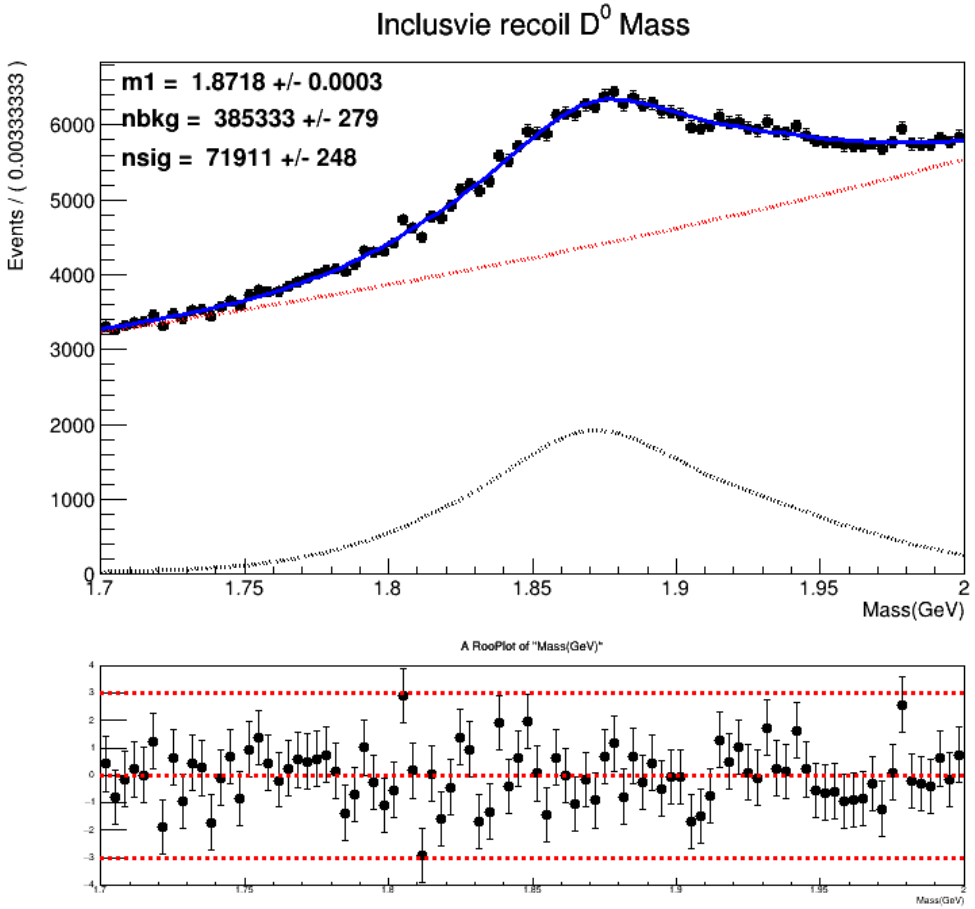
	True	Fake
Without optimization	68713	388534
With optimization	54520	53063

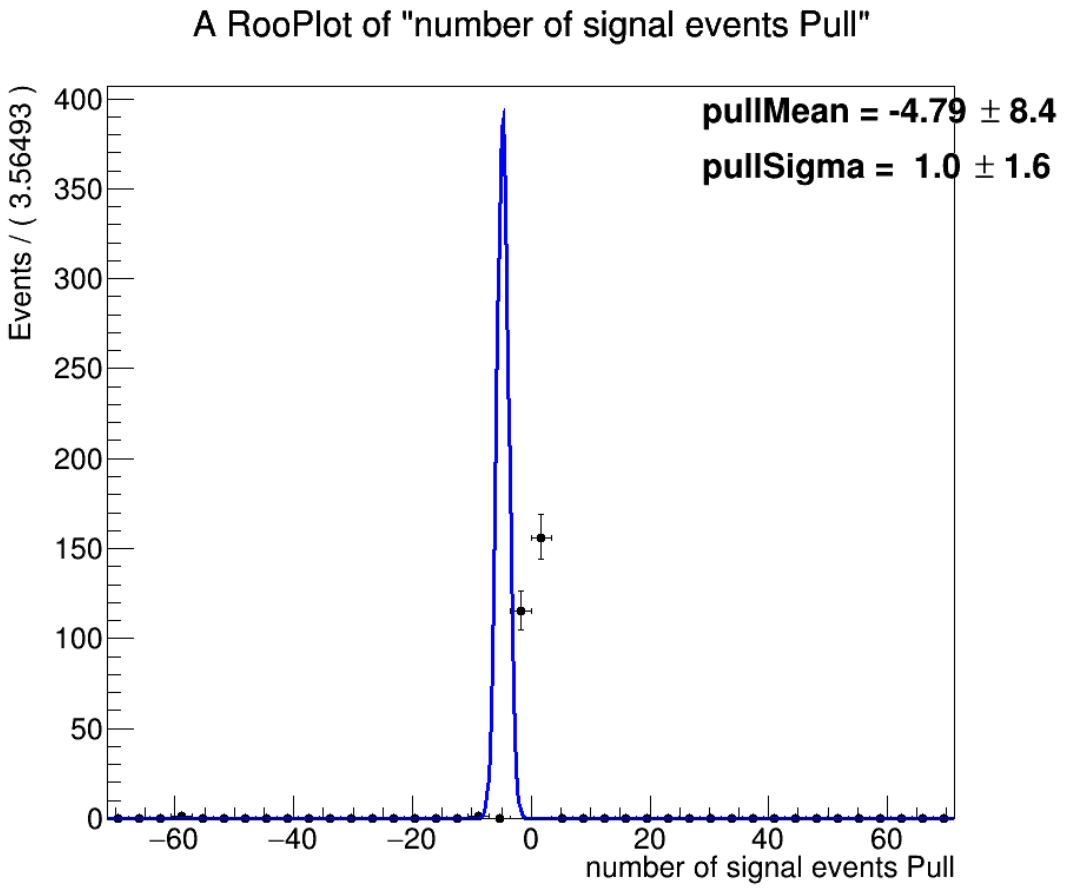
D^0 from my charm tagger





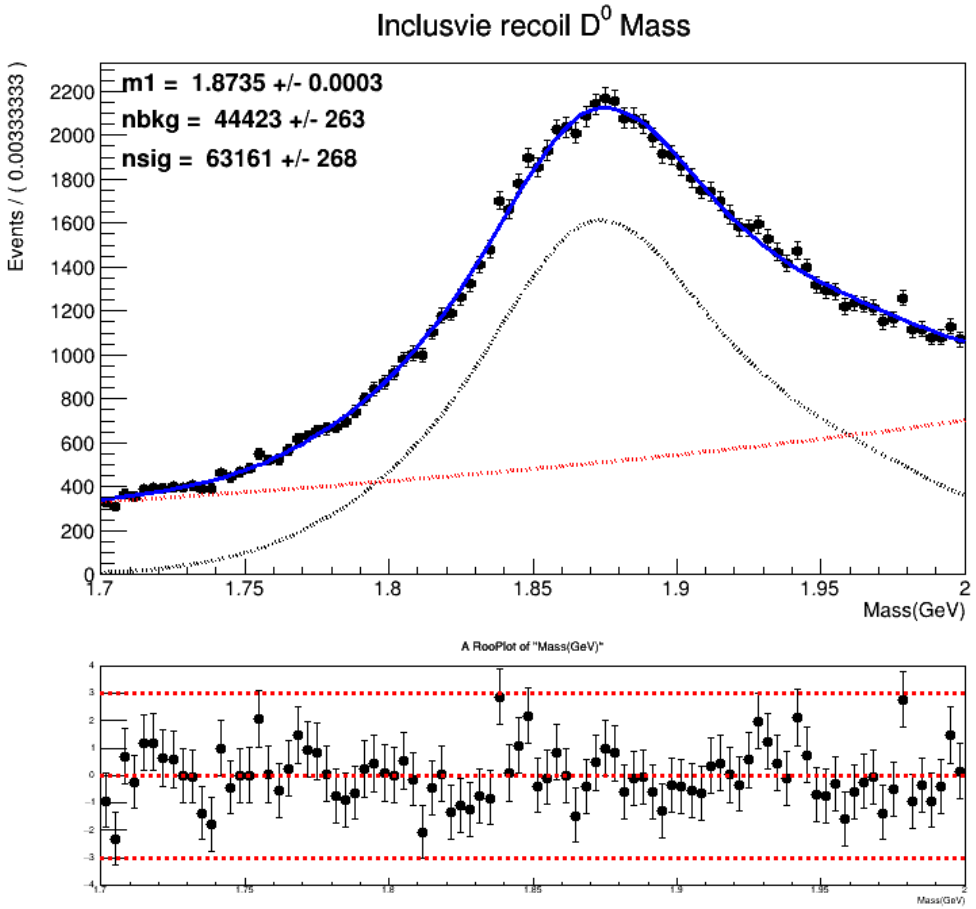
Inclusive D from ccbarFEI w/o optimization

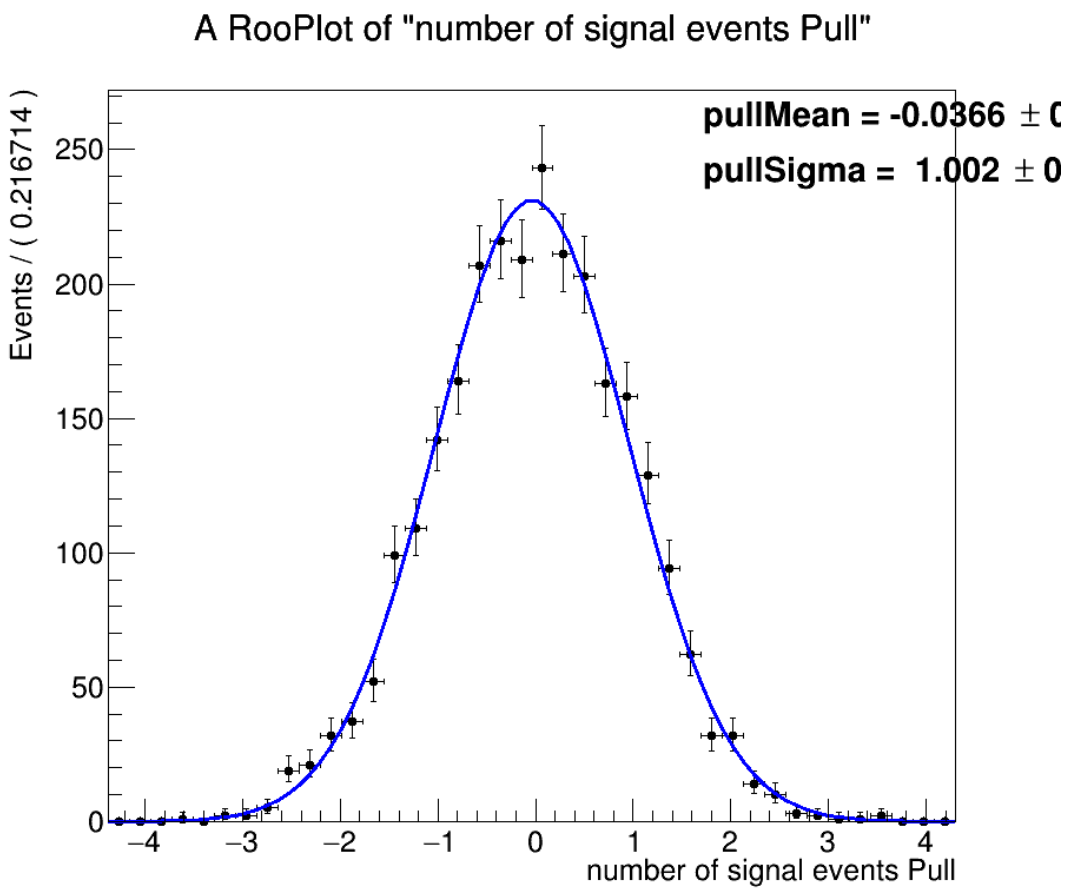




Fit result is in error state for every fit…

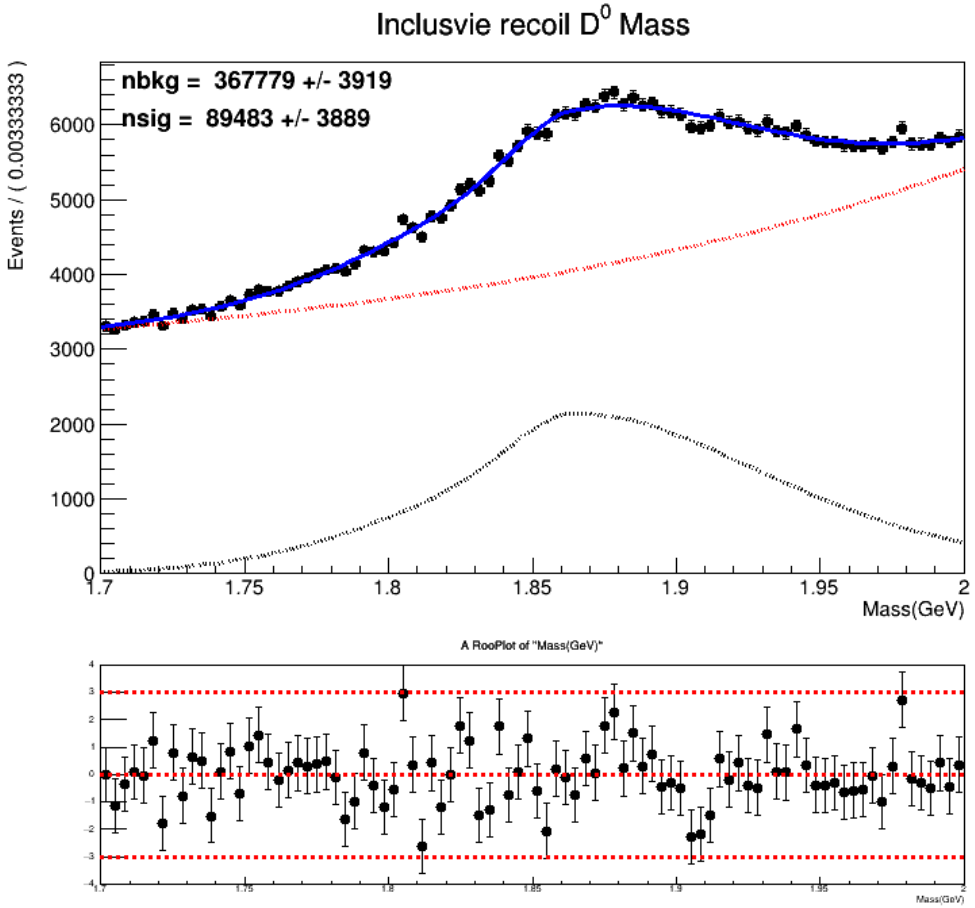
Inclusive D yield from ccbarFEI wtih optimization

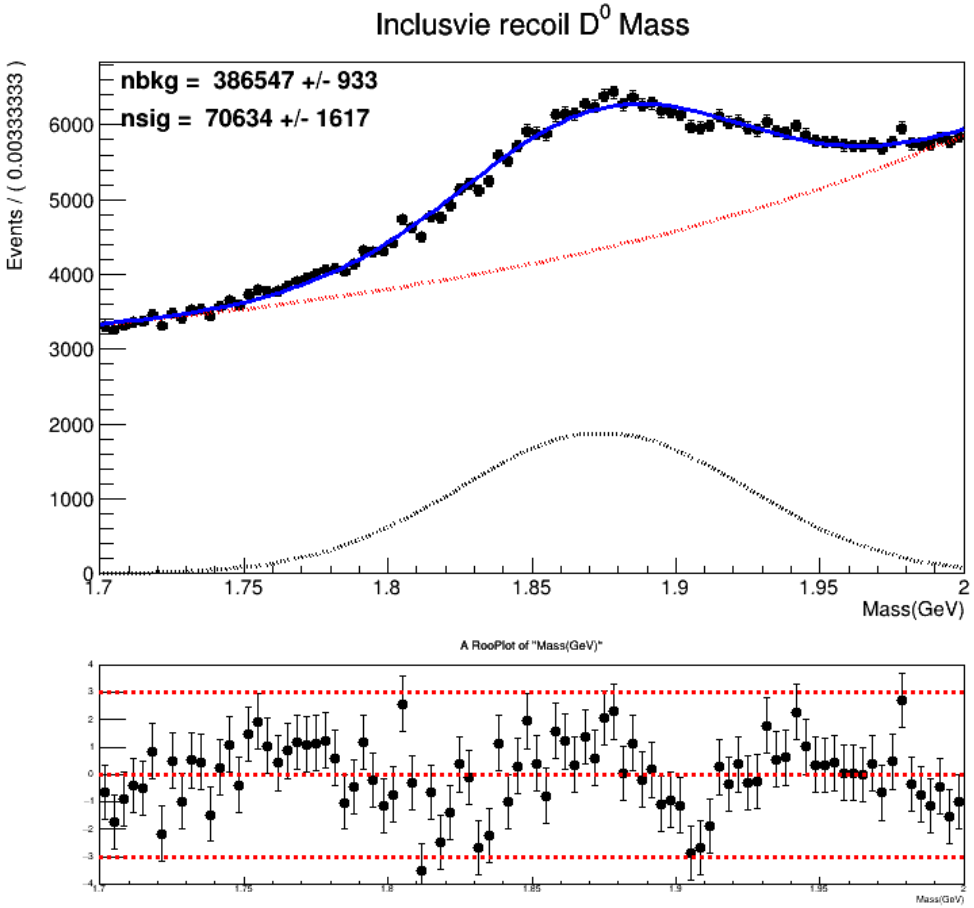




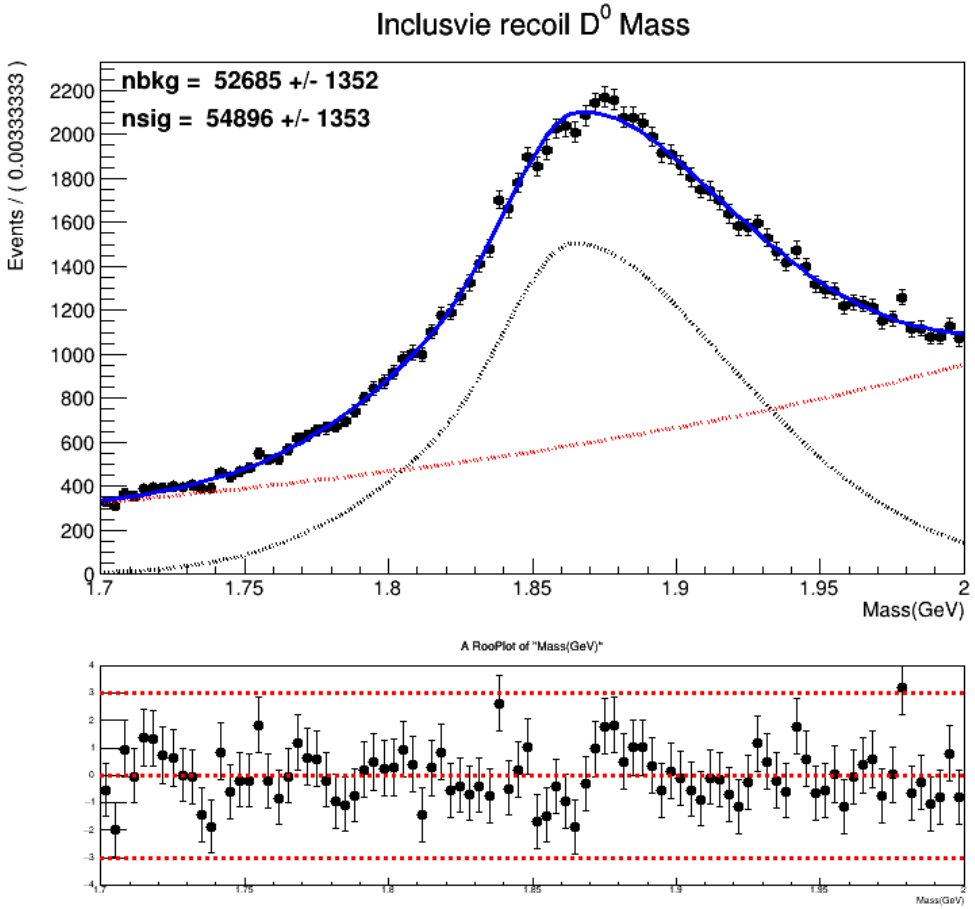
Fit result is in error state for many cases…
=> Toy MC test show also many fit error cases

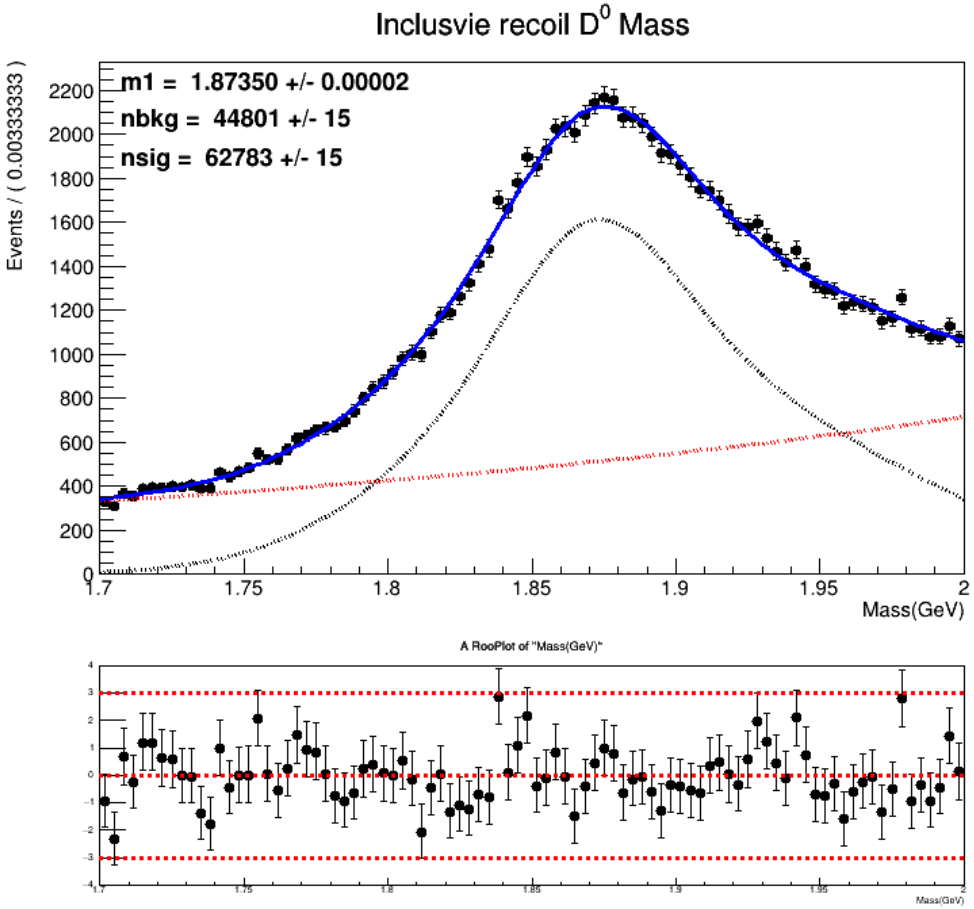
Unstable fit result (without optimization)





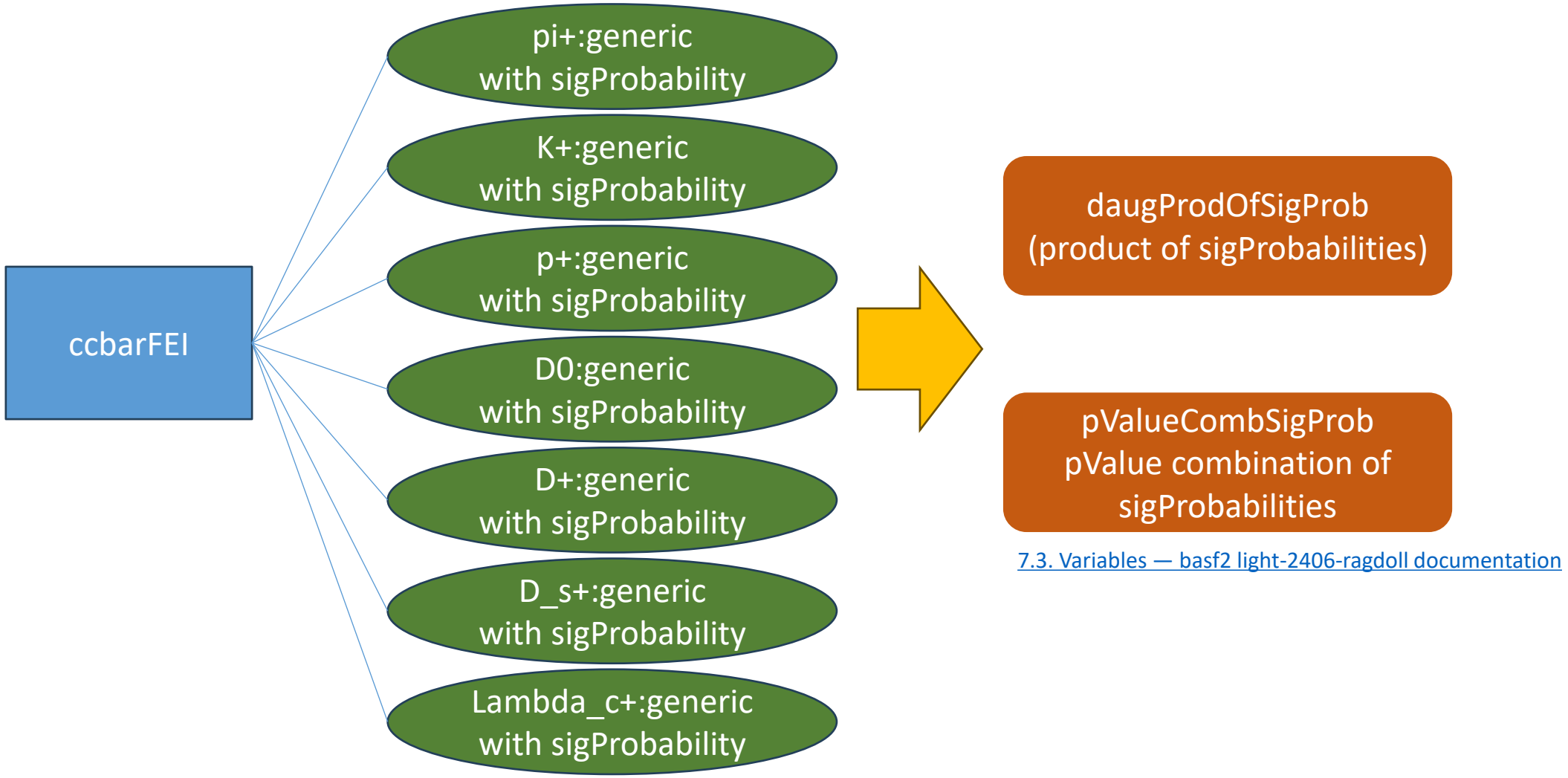
Unstable fit result (optimized case)





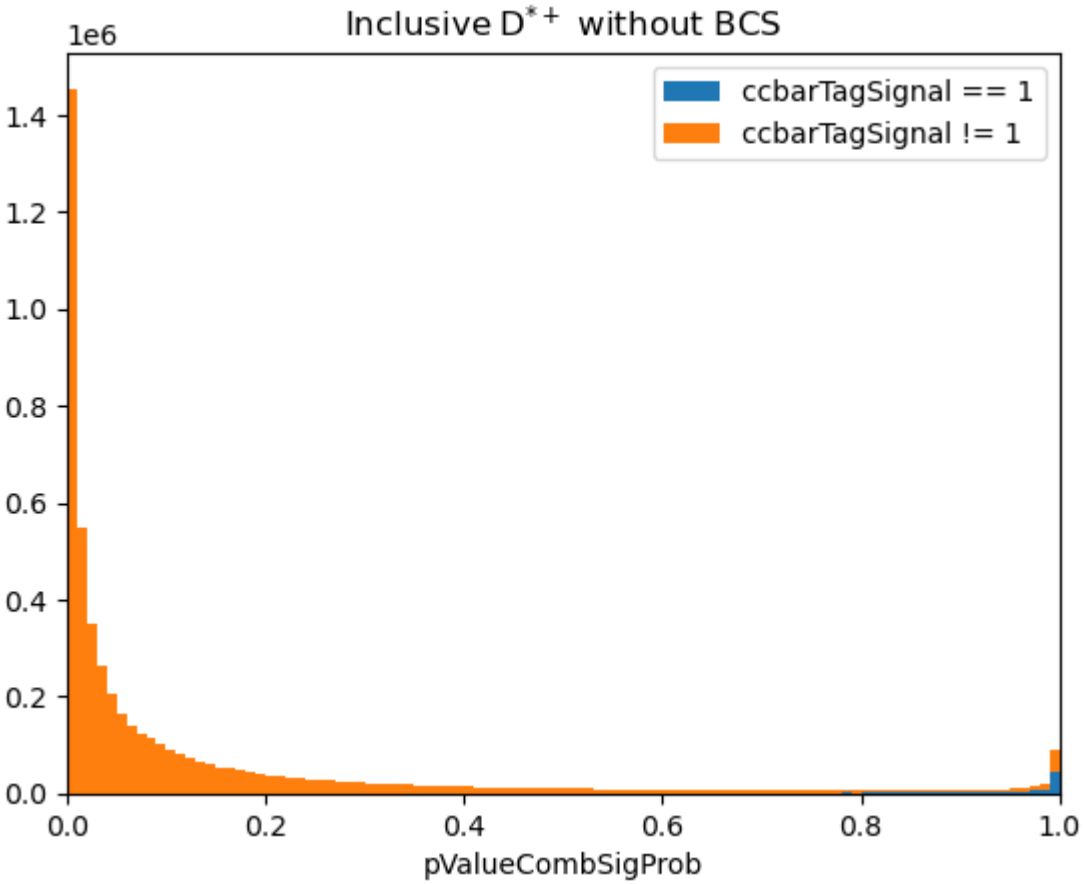
Almost fit results show the mean of gaussian is around 1.872~1.873

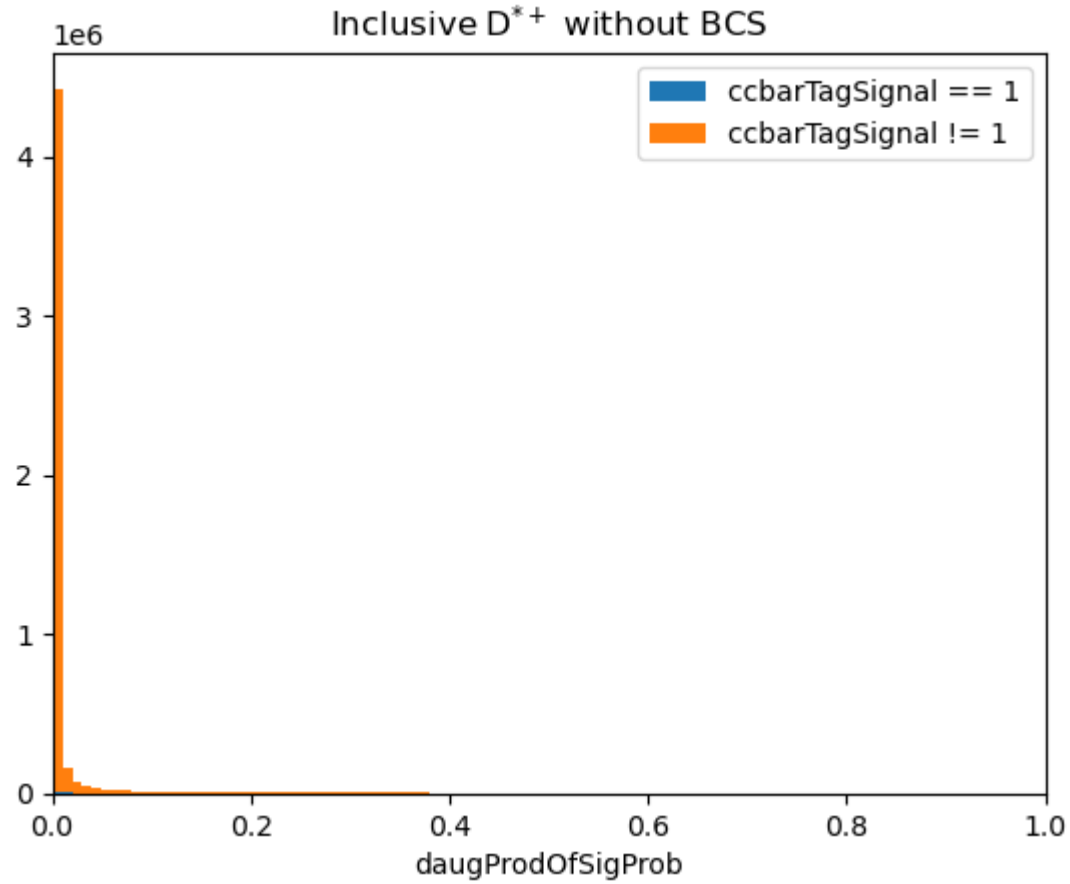
Reminder : ccbarFEI working



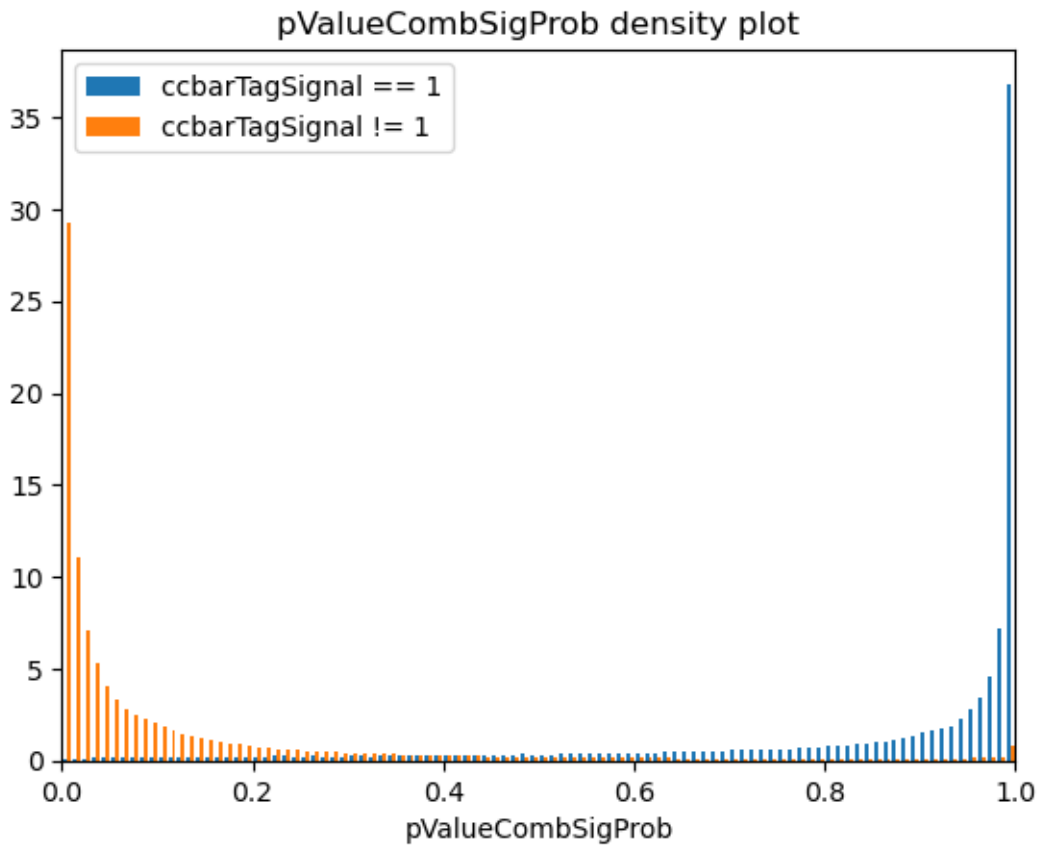
7.3. Variables — basf2 light-2406-ragdoll documentation

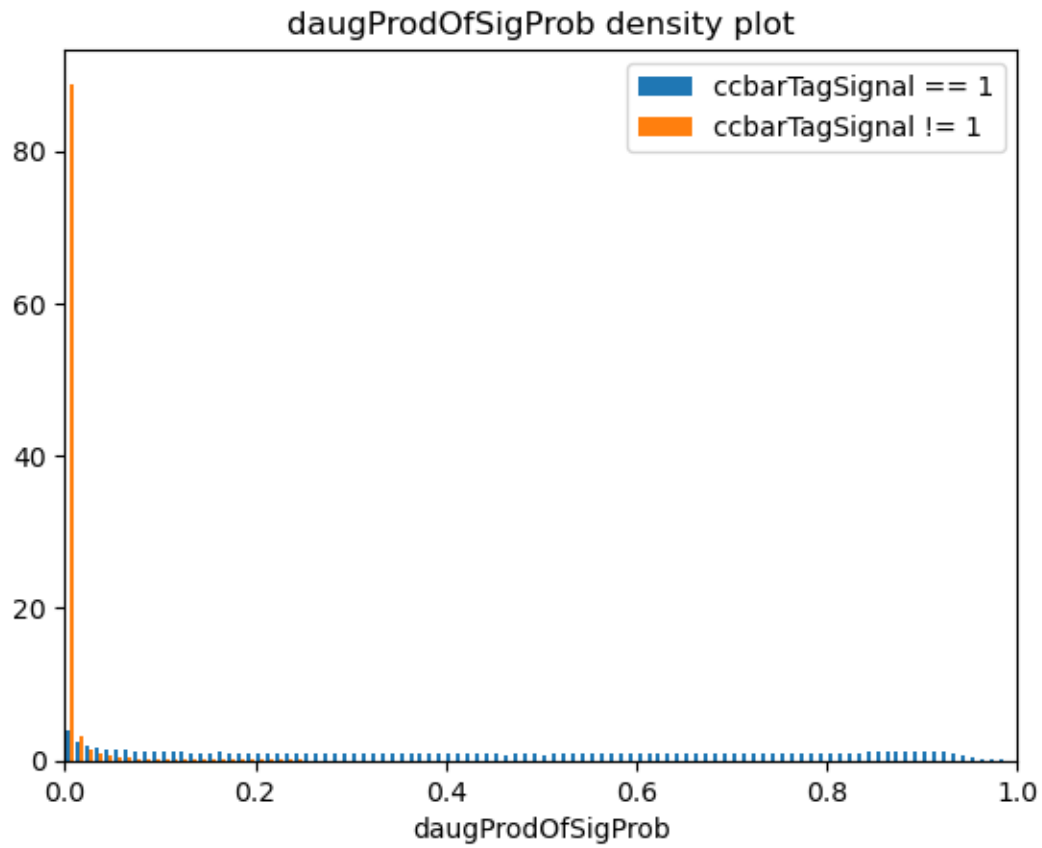
Reminder : ccbarFEI variables





Reminder : ccbarFEI variables





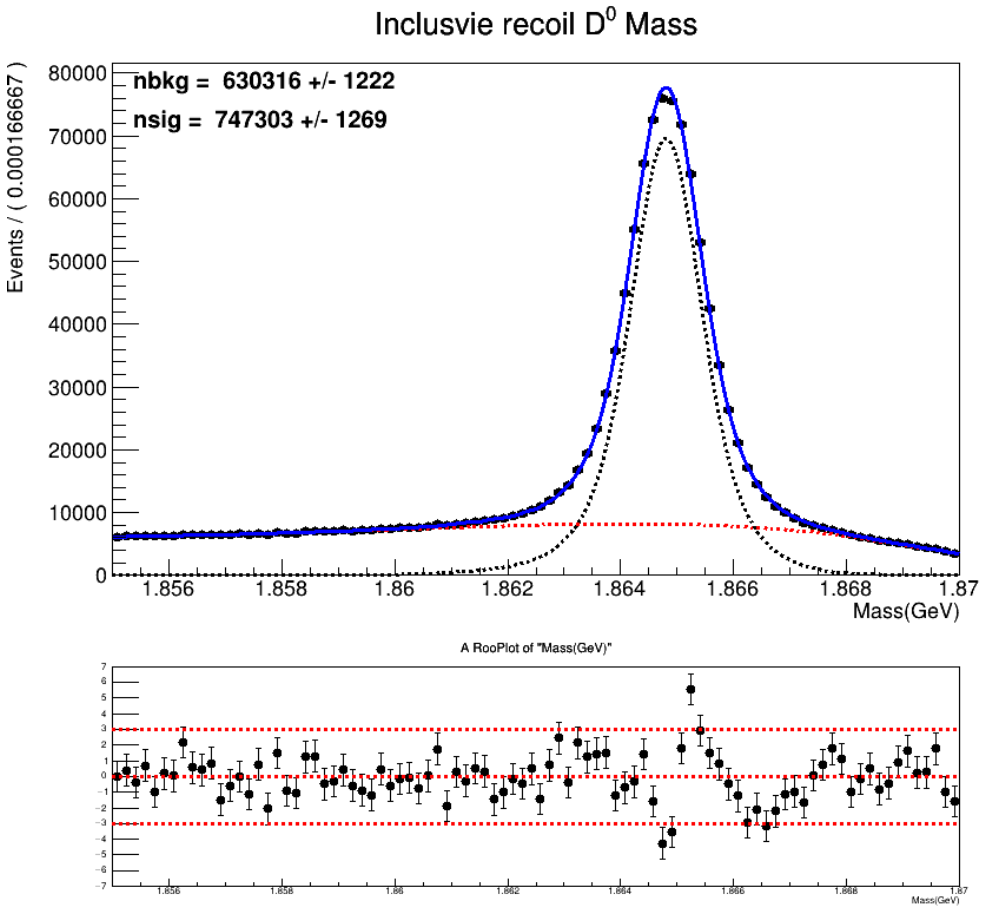
Status of my analysis

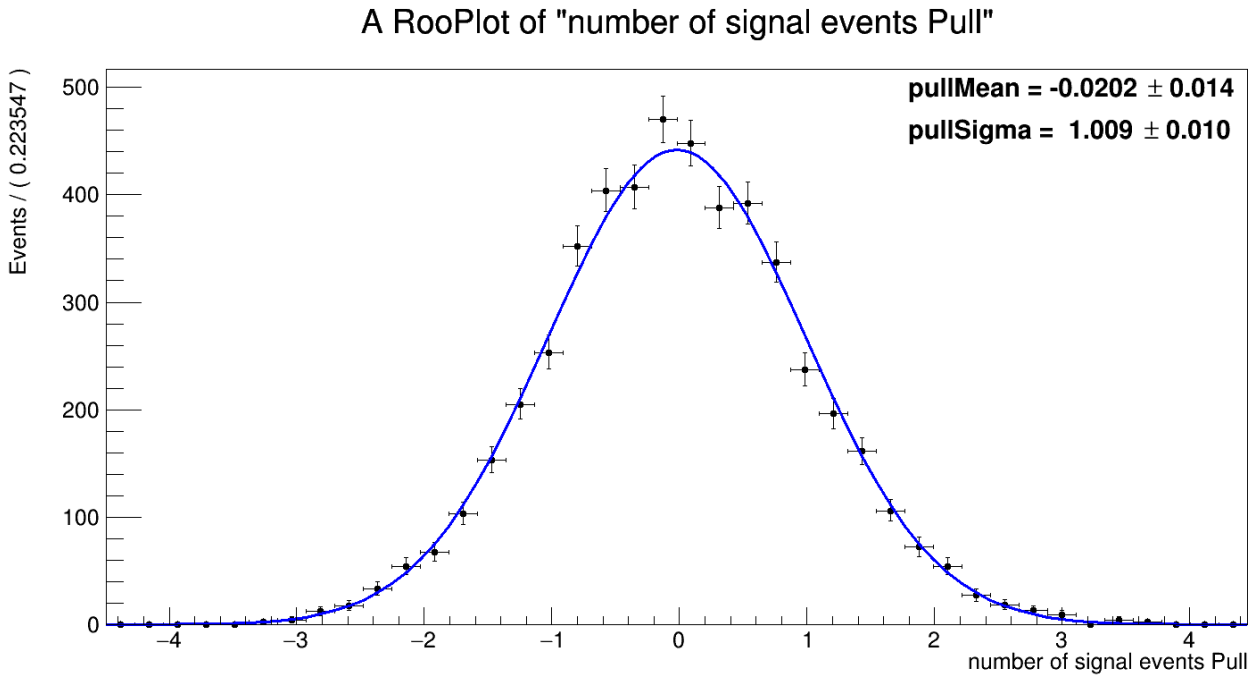
- Privately skimming about run-independent uds/mixed/charged MC were almost done
  (only ~ 100 files in charged/mixed were left)

- I found some mistakes in my upper limit estimation code
  => fit on binned histogram data type
  => but estimate on unbinned data set
  => fixed

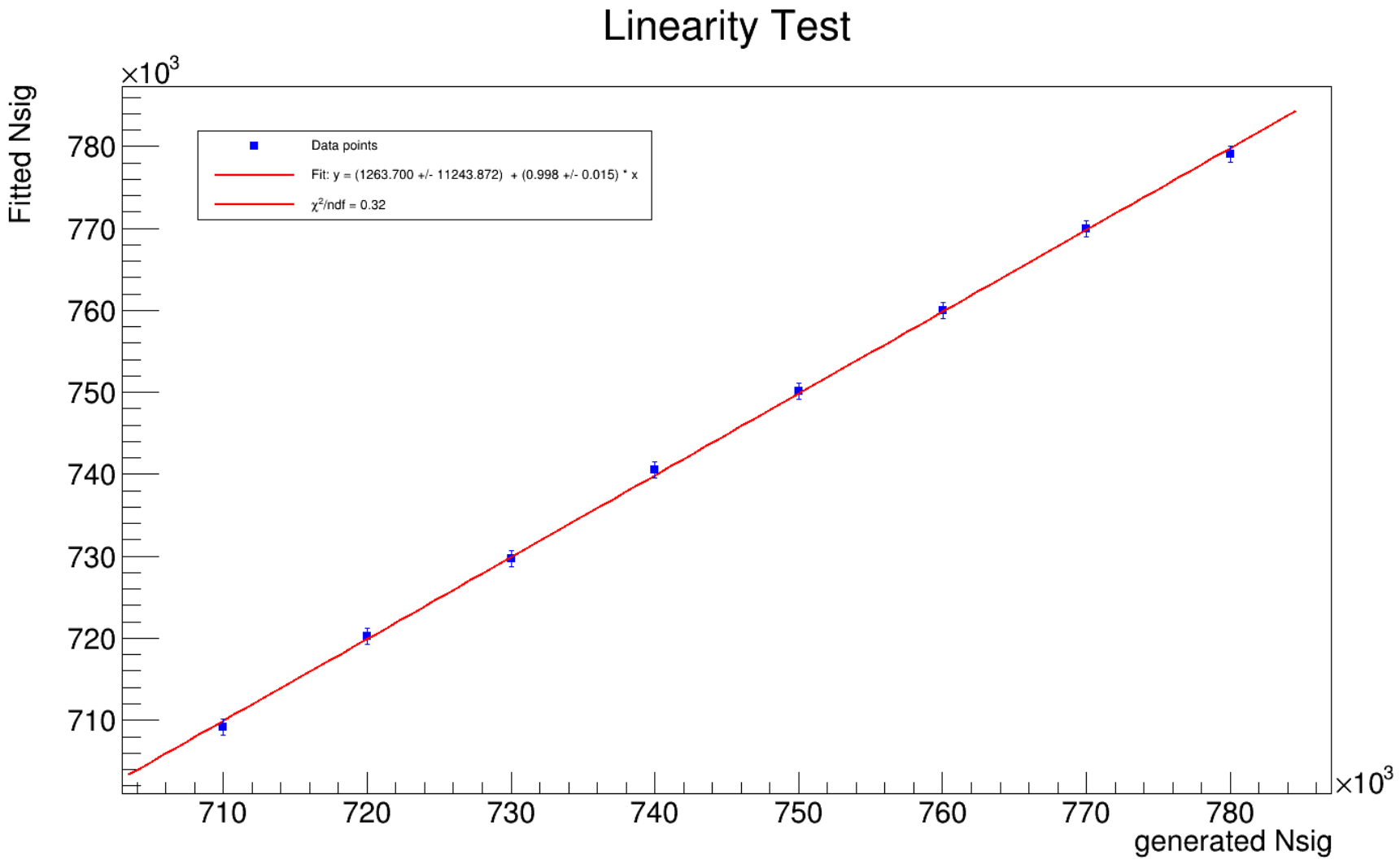
- With 200M privately generated background events for control sample study, 2D exclusive fit was tried again
  (now it does not show error state in fit result)

Inclusive D on generic MC

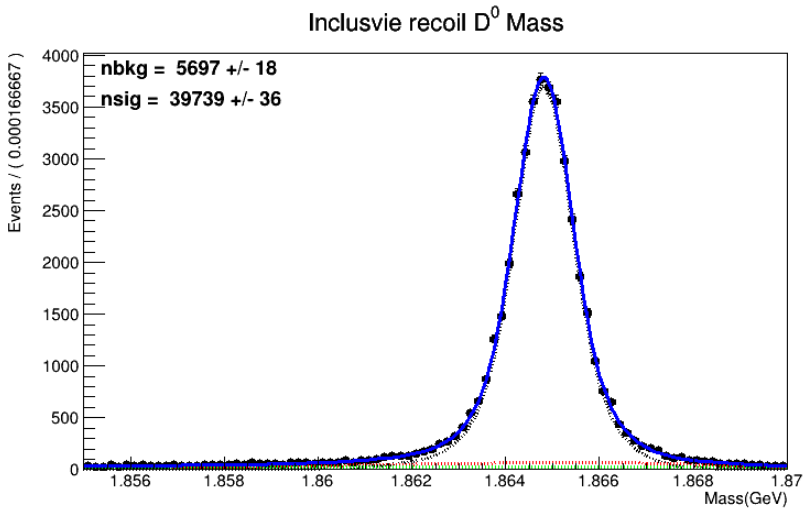


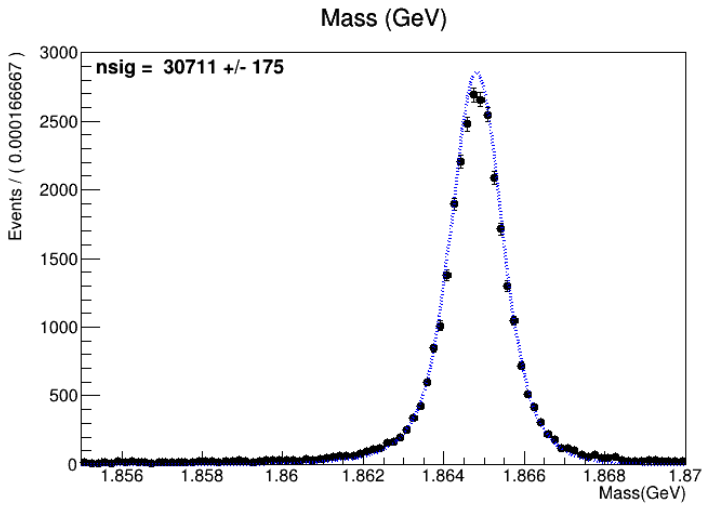


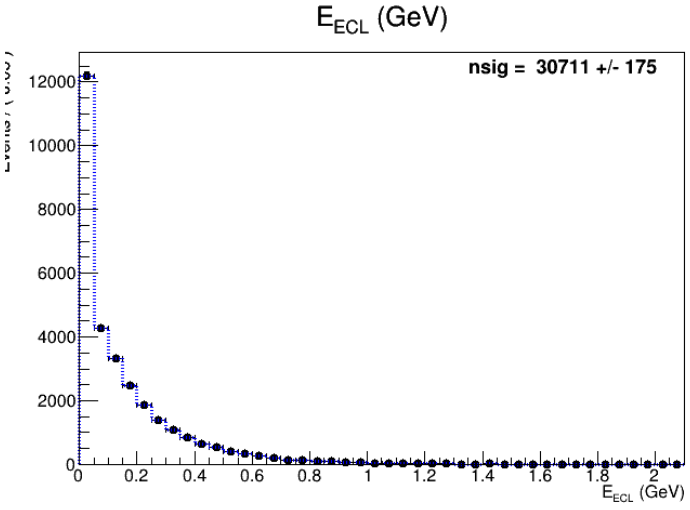
Linearity test of inclusive D fit on generic MC



Signal efficiency on signal MC

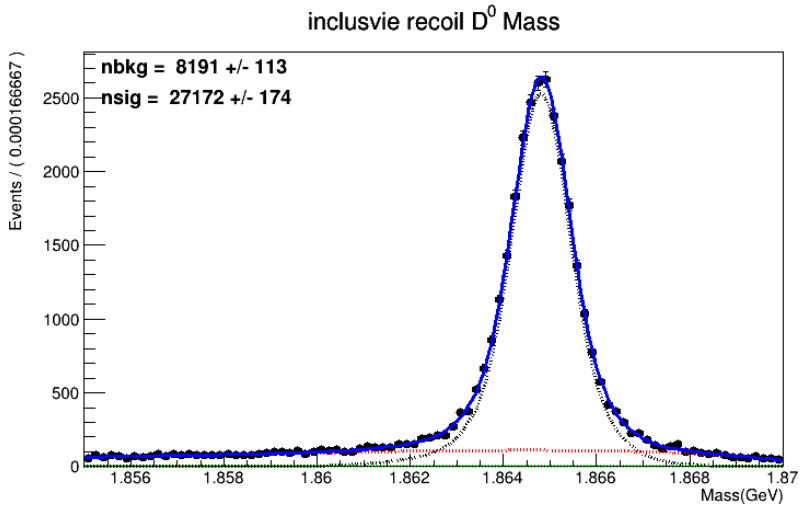


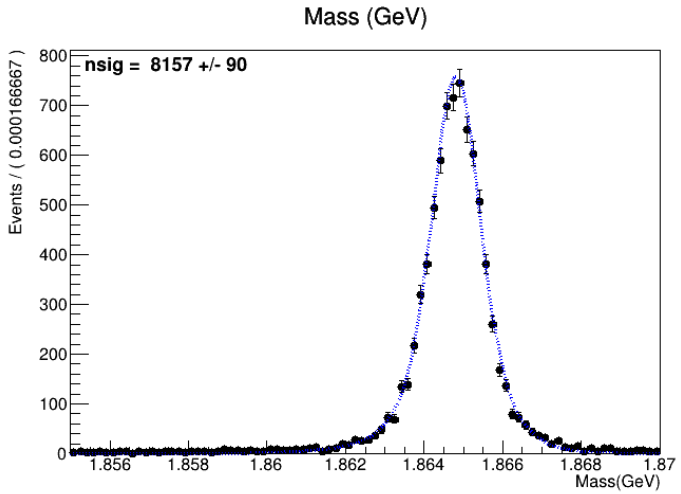


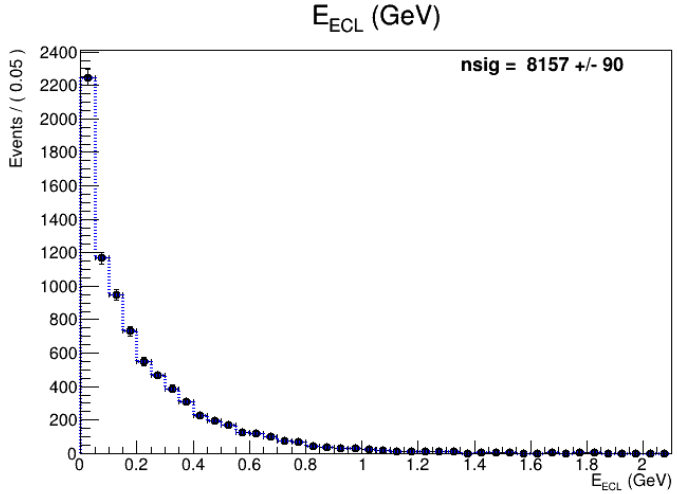


- Signal eff : $\frac{30711 \pm 175}{39739 \pm 36} = 0.77282 \pm 0.00446$

Signal efficiency on control sample

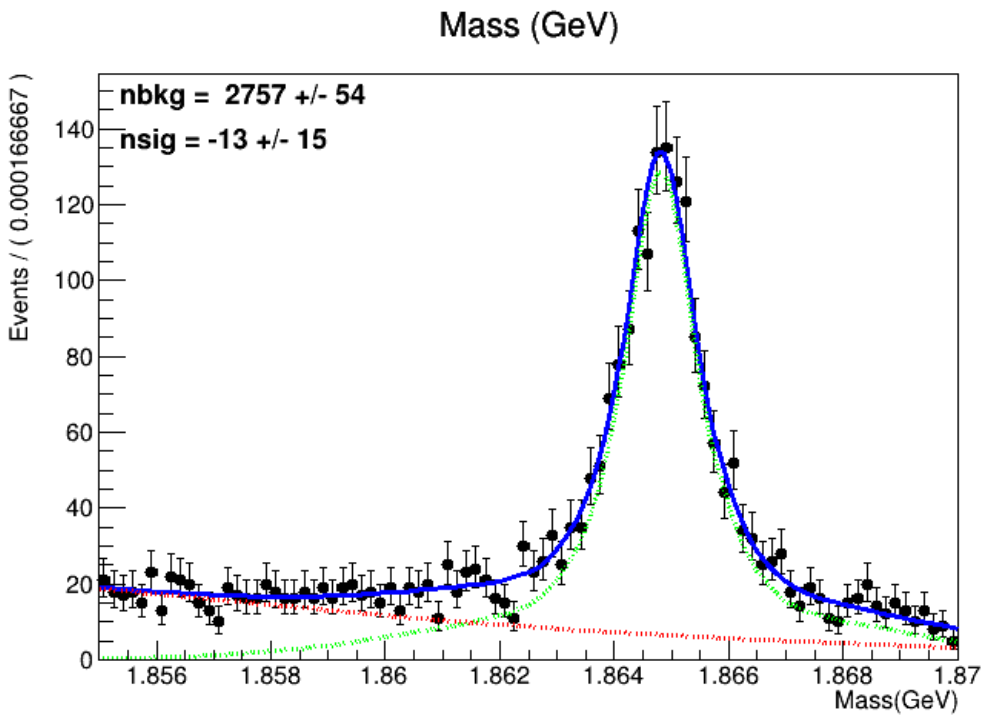


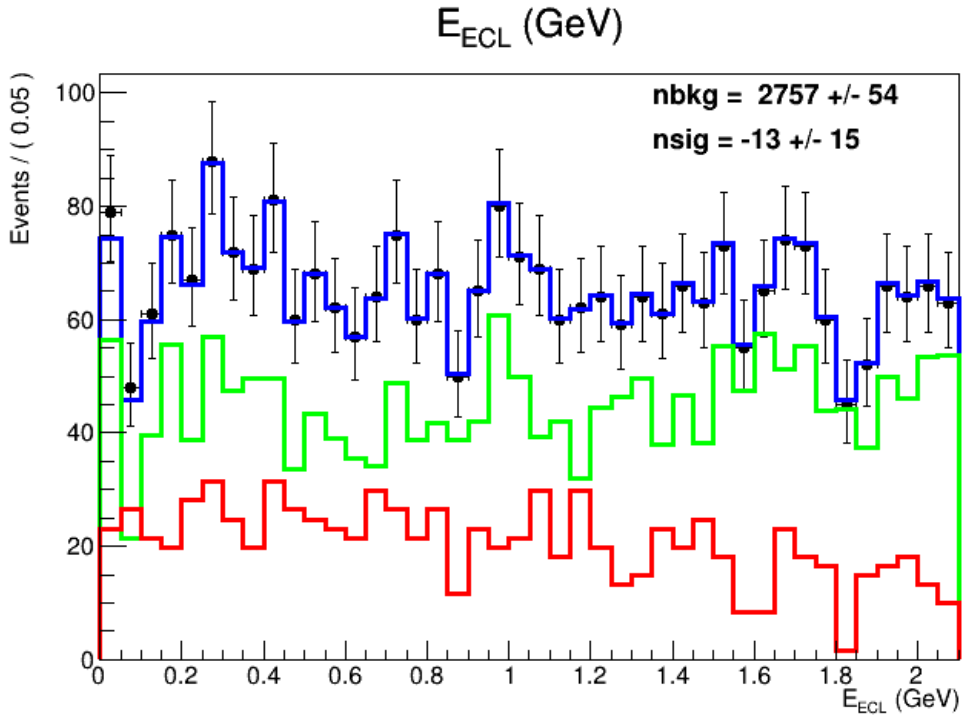




- Signal eff : $\frac{8157 \pm 90}{27172 \pm 174} = 0.30020 \pm 0.00383$

2D fit on generic MC for $D^0 \rightarrow$ invisibles





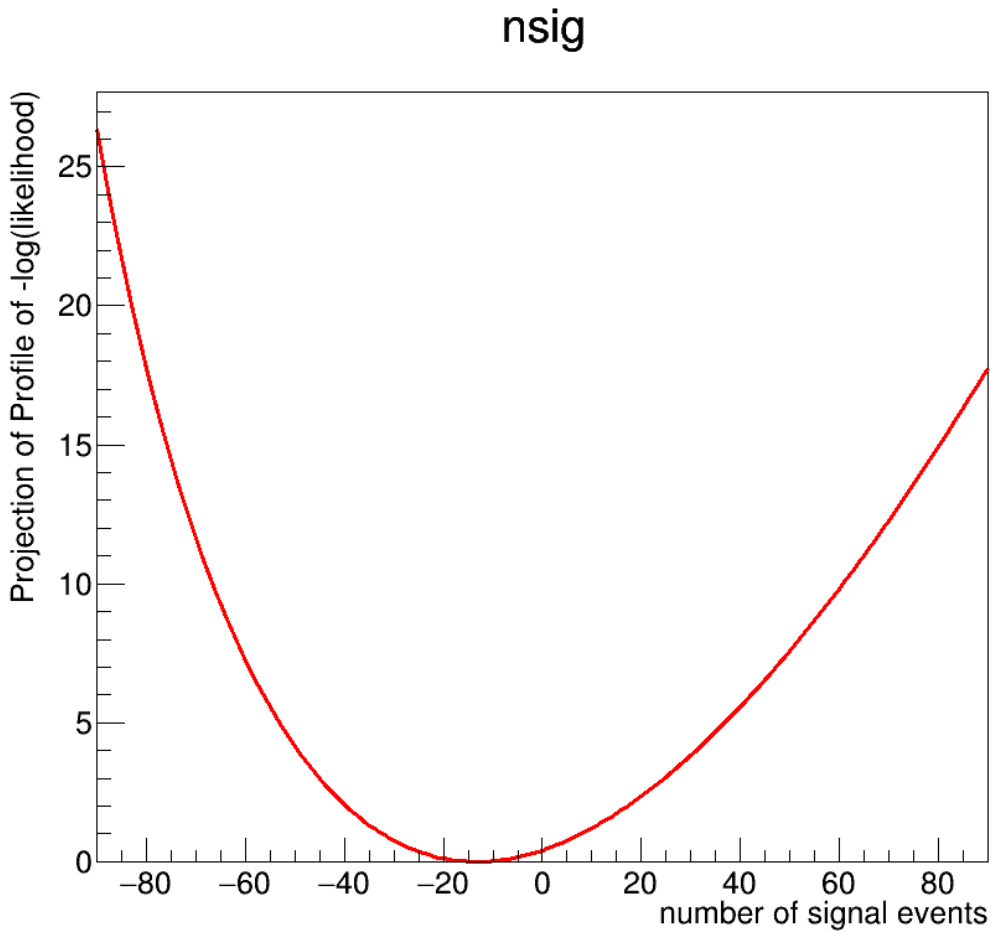
Upper limit estimation of $D^0 \rightarrow$ invisibles

- Way1) Upper Limit estimation by integration of likelihood function

$$\int_0^{N_{UL}} L\,(n)dn = 0.9 \int_0^{\infty} L(n)dn$$

$$N_{UL} = 11.4984$$

$$BR_{UL} = \frac{11.4984}{(747303 * 0.77282)} = 2.0 \times 10^{-5}$$

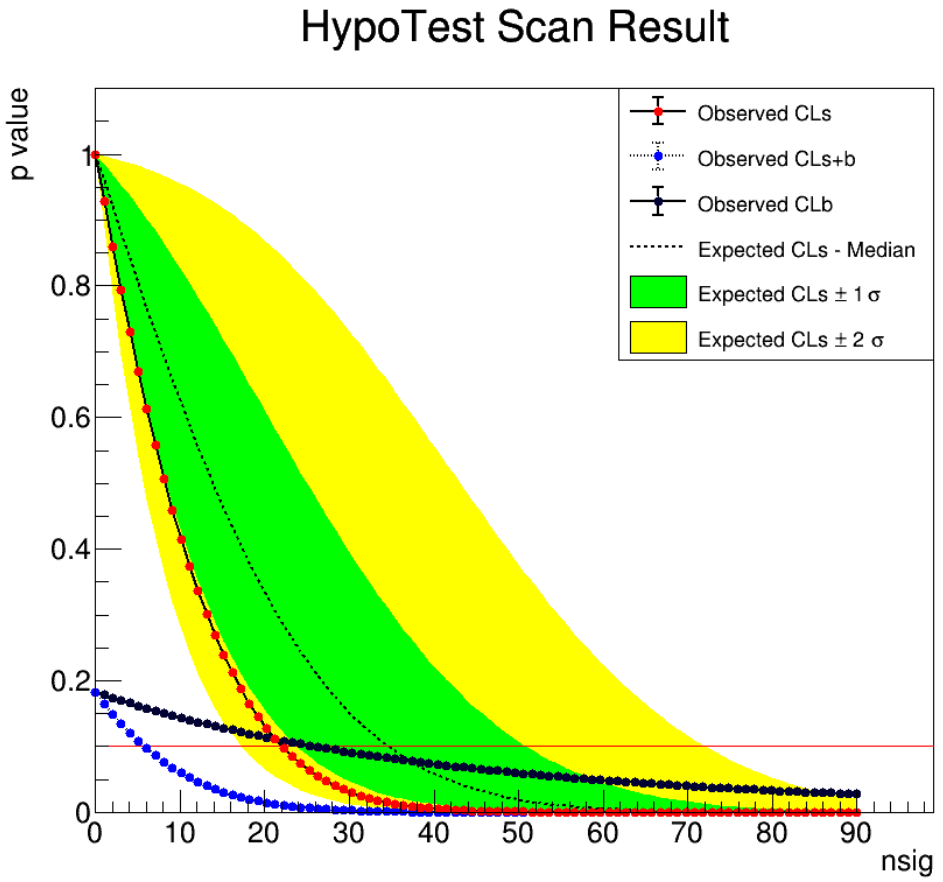


Upper limit estimation of $D^0 \rightarrow$ invisibles

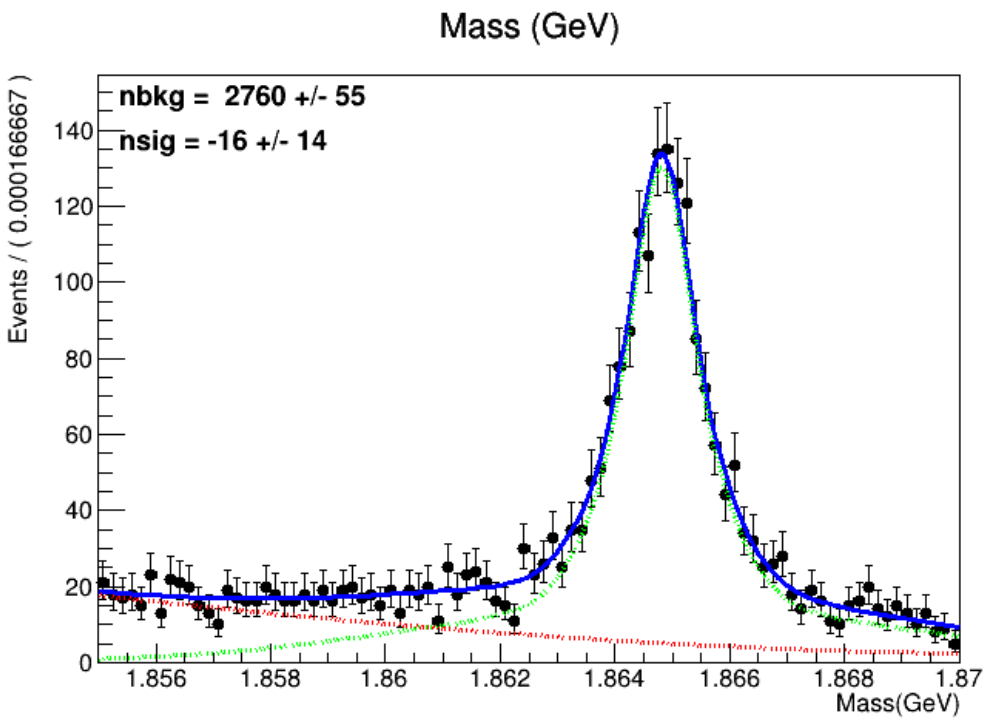
- Way2) Upper limit estimation by CLs method

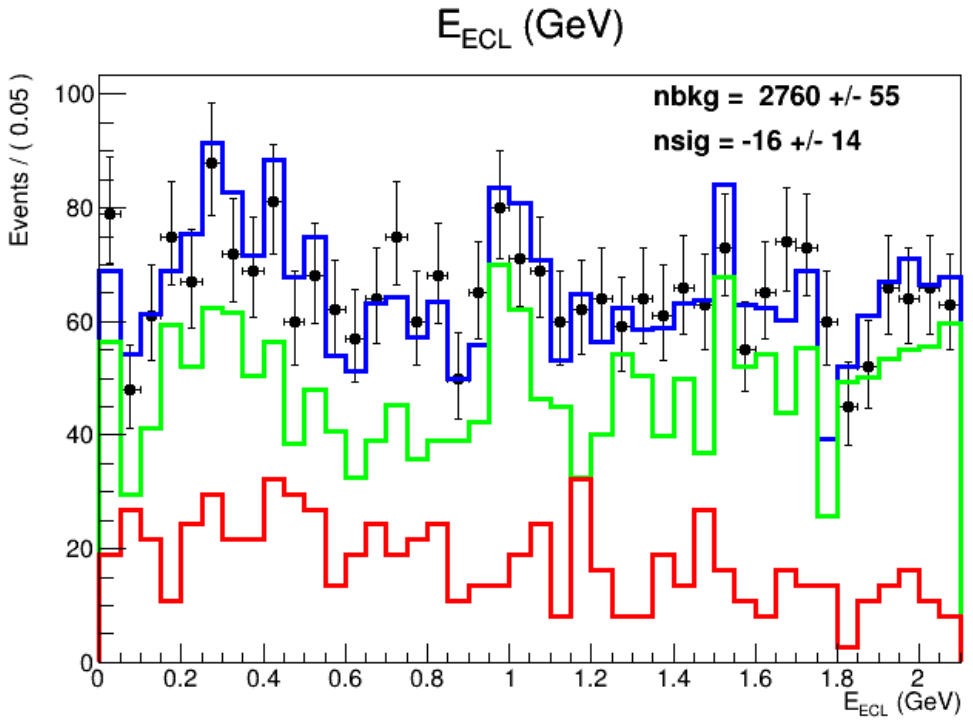
$$N_{UL} = 22.0664$$

$$BR_{UL} = \frac{22.0664}{(747303 * 0.77282)} = 3.8 \times 10^{-5}$$



With histogram PDF from 0.5/ab





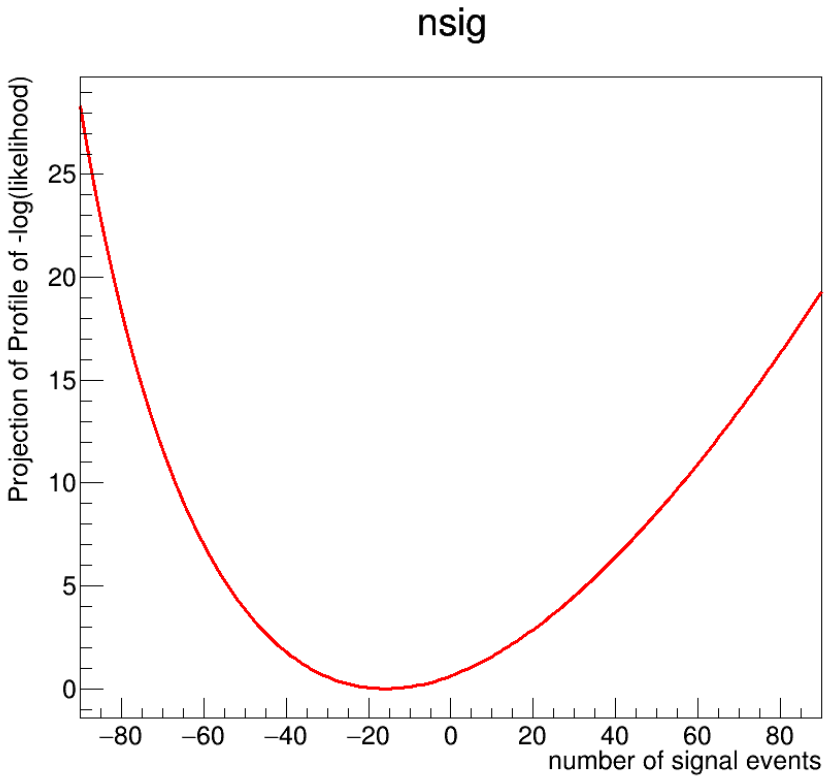
Upper limit estimation of $D^0 \rightarrow$ invisibles

- Way1) Upper Limit estimation by integration of likelihood function

$$\int_0^{N_{UL}} L\,(n)dn = 0.9 \int_0^{\infty} L(n)dn$$

$$N_{UL} = 8.07832$$

$$BR_{UL} = \frac{8.07832}{(747303 * 0.77282)} = 1.4 \times 10^{-5}$$

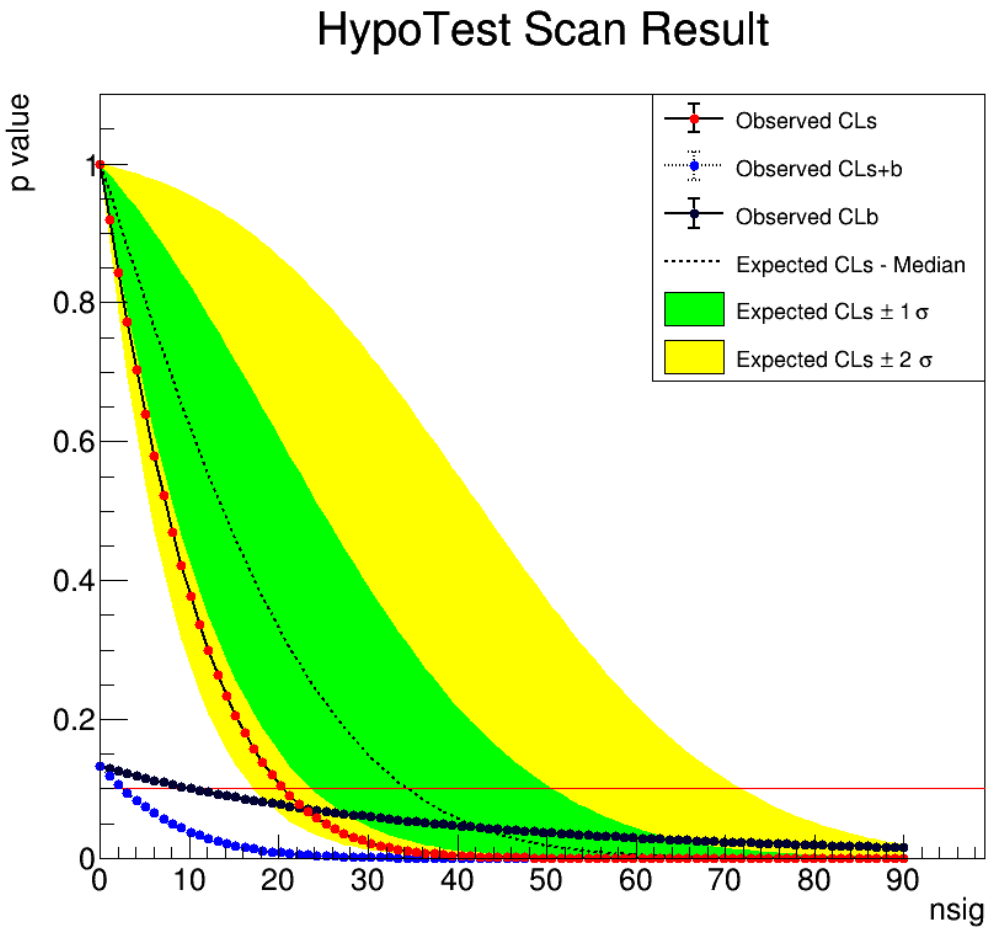


Upper limit estimation of $D^0 \rightarrow$ invisibles

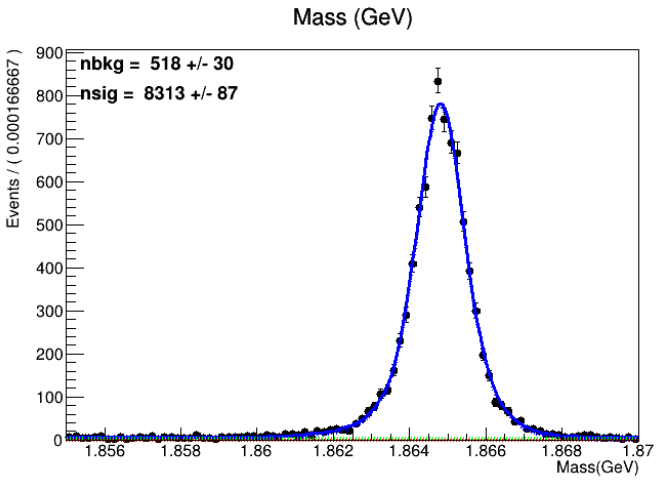
- Way2) Upper limit estimation by CLs method

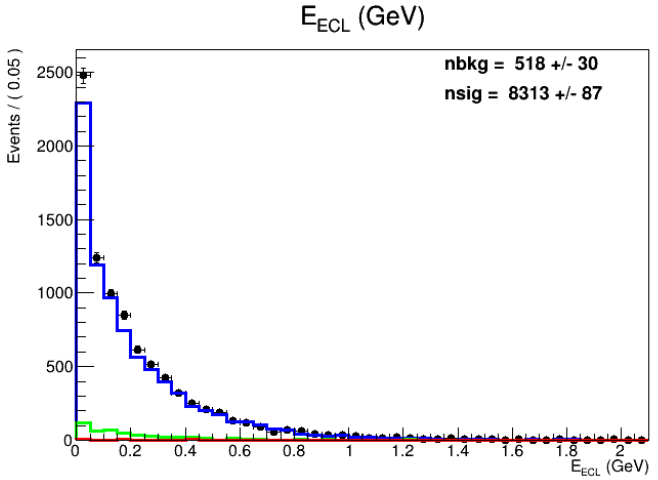
$$N_{UL} = 20.5291$$

$$BR_{UL} = \frac{20.5291}{(747303 * 0.77282)} = 3.6 \times 10^{-5}$$



BR measurement on generic MC(uds/mixed/charged)



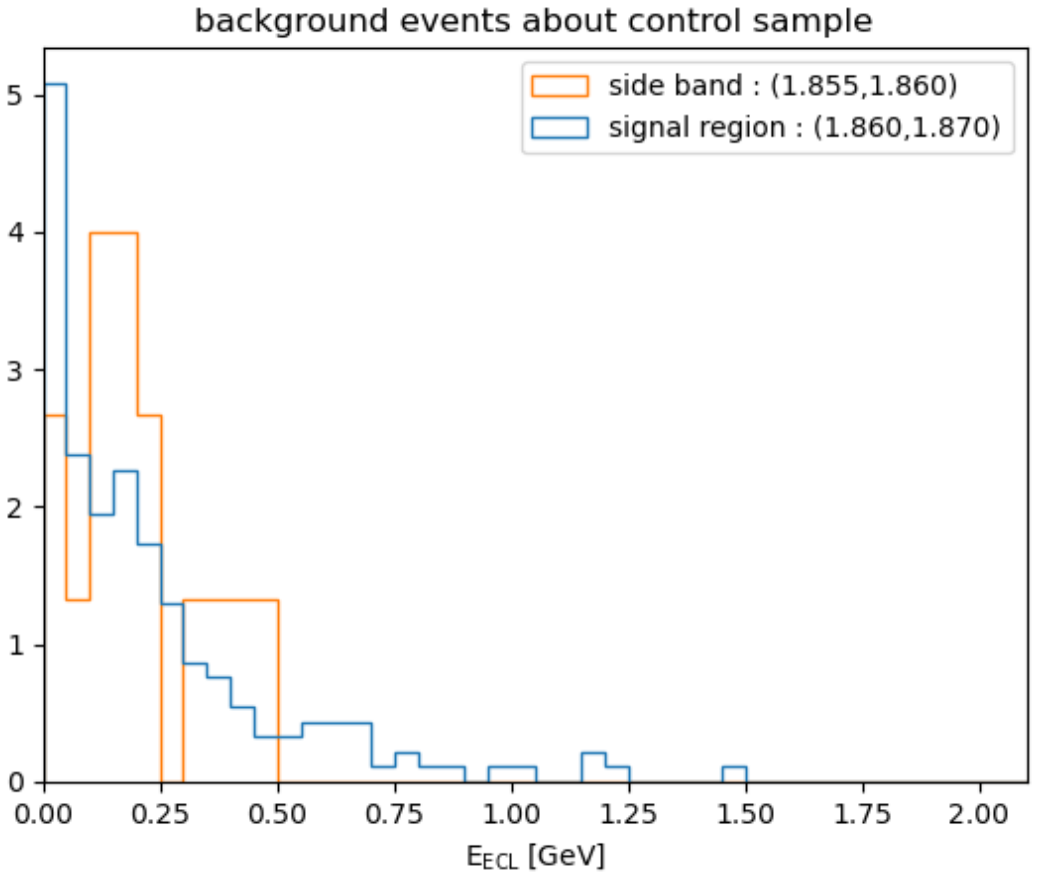


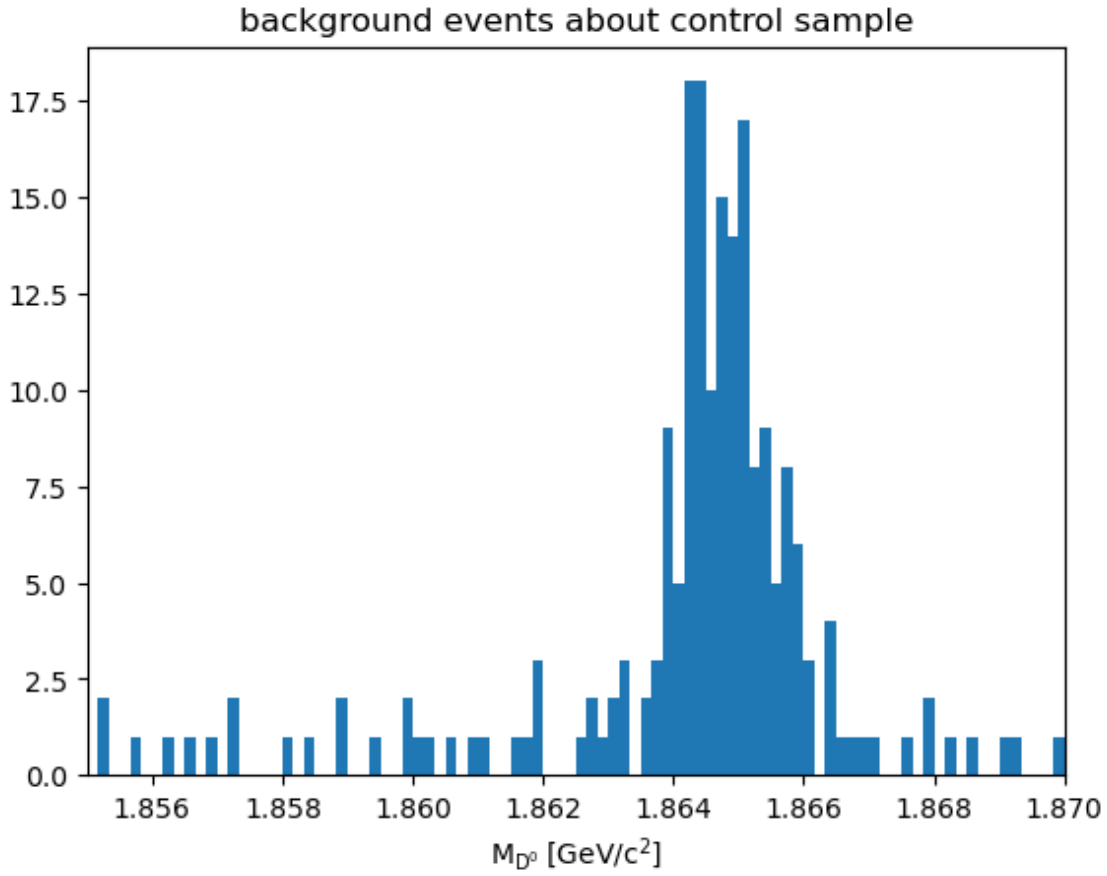
- $Br(D^0 \to K^-\pi^+) = \frac{N^{exclusive}}{N^{inclusive}*\epsilon_{sig}} = \frac{8313\pm87}{(747303\pm1269)*(0.30020\pm0.00383)} = 0.03706 \pm 0.00061$
  - Far from decfile BR value(0.0395) ~ 4σ
- The # of true signal event identified by TopoAna :

  $$8757 \pm 94 \Rightarrow Br(D^0 \to K^-\pi^+) = 0.03903 \pm 0.00065$$
- This difference seems to be from similarity of E_{ECL} shape for the peaking background component
  - Main source is

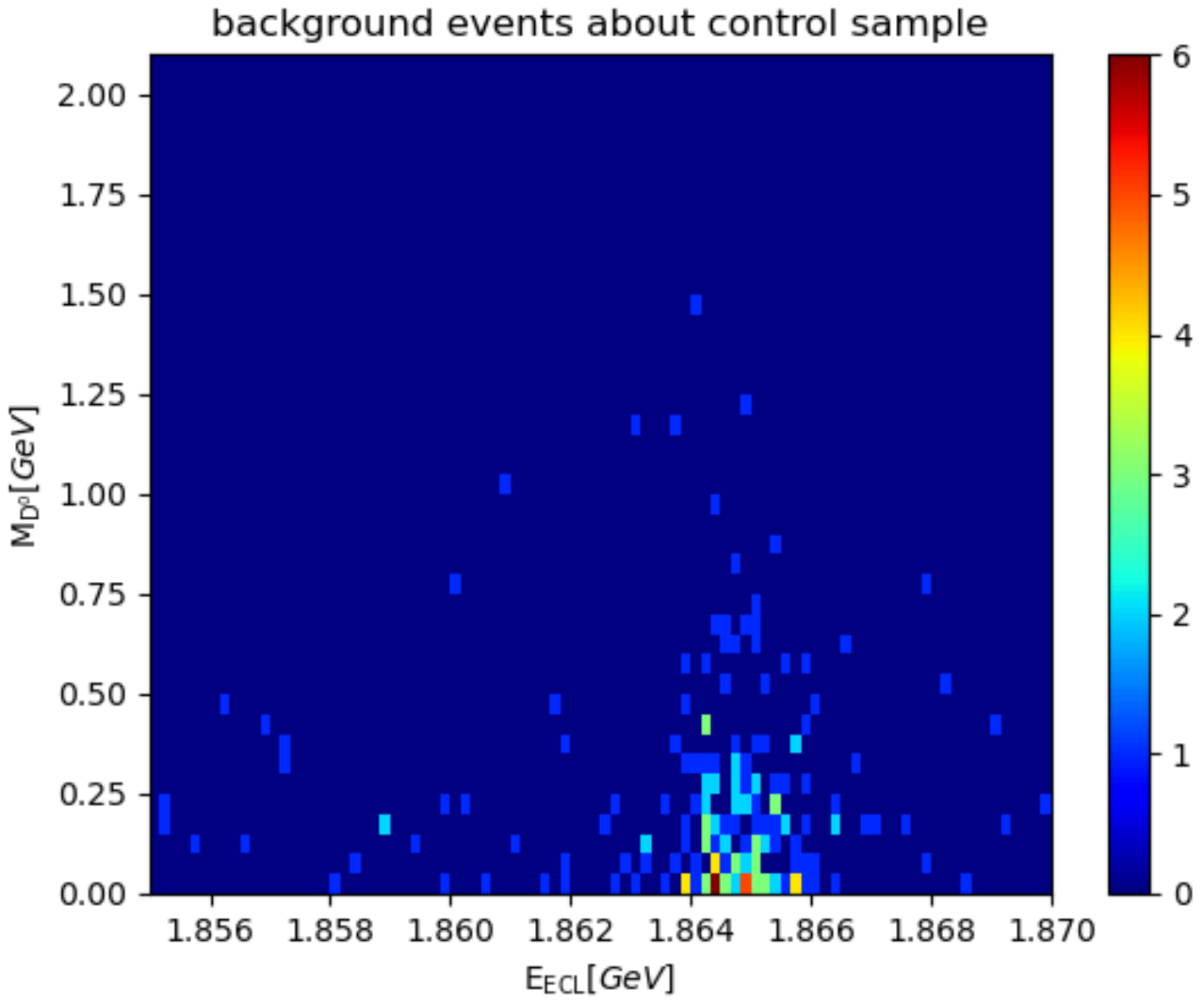
    $D^0 \to K^+\pi^-$, K^+K^-, $K^-\pi^+\pi^0$ consists of 80% of background events
  - It seems to be irreducible error with current fitting strategy…
  - For validation of charm tagger, it is also possible to apply other fit strategy only for signal extraction about this control sample study

Backup : Check on background events ($D^0 \to K^+\pi^-, K^+K^-, K^-\pi^+\pi^0$) about control sample study





Backup : Check (M_{D^0}, E_{ECL}) on background events about control sample study



Backup : pValueCombSigProb (x) vs daugProdOfSigProb (y)