technische universität dortmund

Fakultät Physik

UNIVERSITÉ Clermont Auvergne

LPC Particules pLasmas Univers applicationS

Laboratoire de Physique de Clermont

Study of electroweak observables in the heavy flavour sector at FCC-ee

Willy Weber

(willy.weber@tu-dortmund.de)

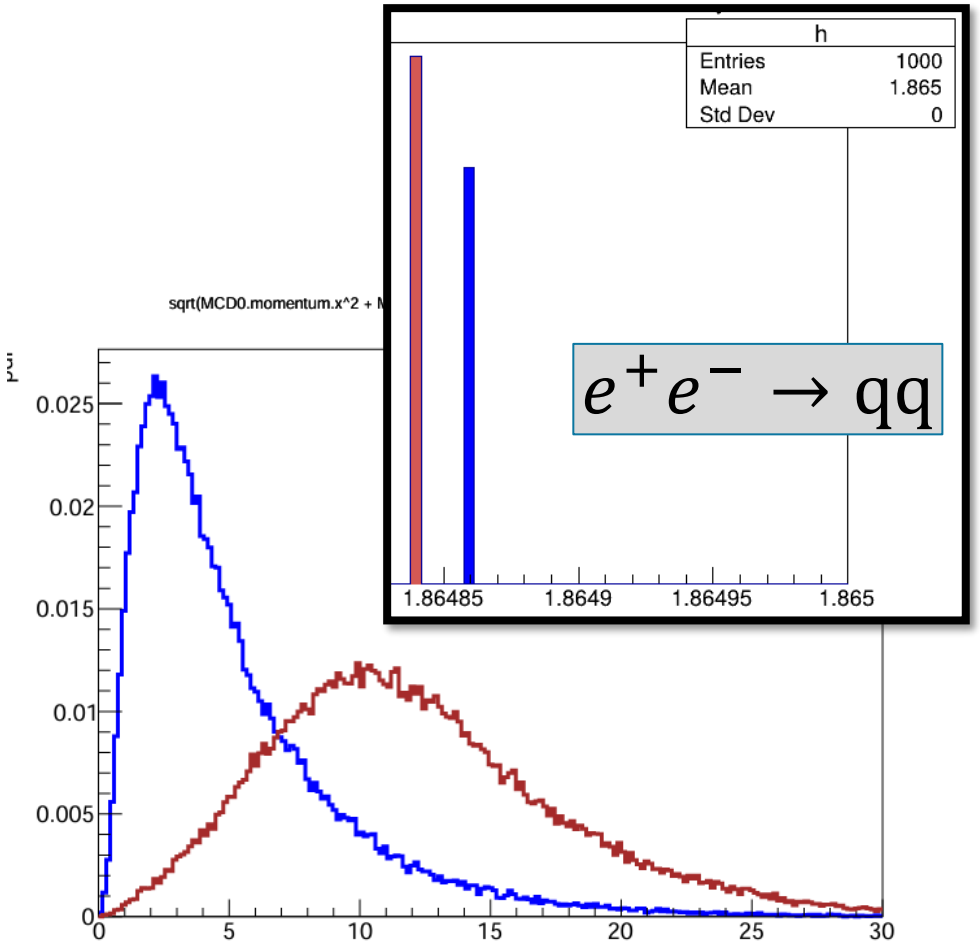
$$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$$

Administrative

- **Presentation « Journee Scientifique » (lundi 26 au mardi 27 mai 2025)**
  - Necessary ones for graduate school (This year or next one)
- **DPG (lundi 31 march au 4 april 2025)**
  - Other D-decay also mentioned in abstract: $D^+ \to \pi^+ \nu\bar{\nu}$
  - Additional days in Germany
- **Cotutelle:**
  - Last E-Mail: Cotutelle contract
  - Meeting (of us 3) with Kevin Kröninger

- Can I add the **CSI(?)-Committee** to **ADUM** or should I still wait?
- **Laptop**

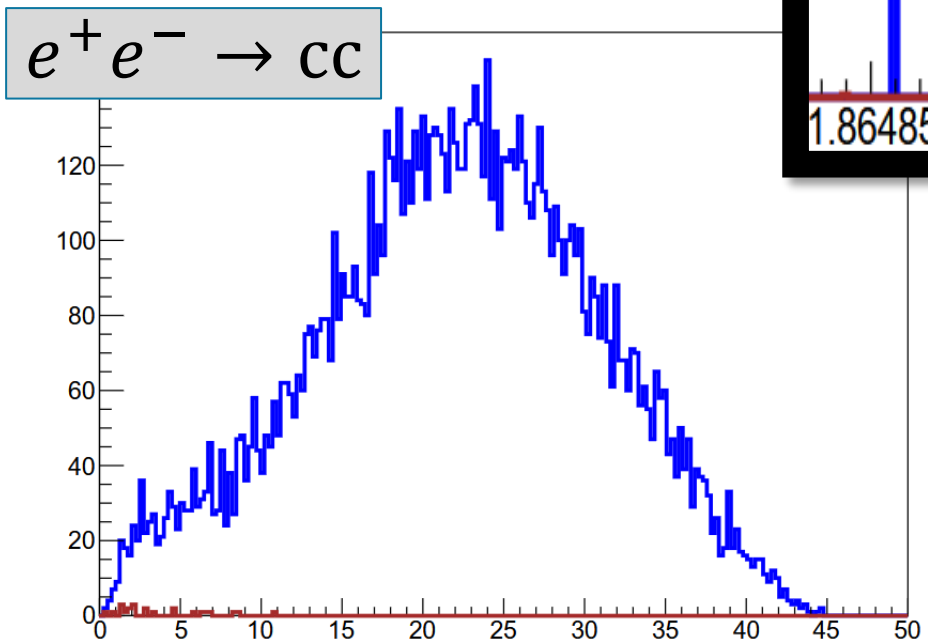
D0 populations in the samples

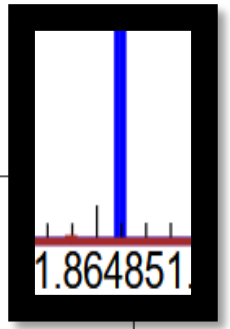


10000 events

11472 D0

23 red (0.2%)





Analysis of decay

$$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$$

D^0 DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
	Pionic modes		
Γ_{141}	$\pi^+\pi^-$	$(1.454 \pm 0.024) \times 10^{-3}$	S=1.4
Γ_{142}	$2\pi^0$	$(8.26 \pm 0.25) \times 10^{-4}$	

π^0 DECAY MODES

For decay limits to particles which are not established, see the appropriate Search sections (A^0 (axion) and Other Light Boson (X^0) Searches, etc.).

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	2γ	(98.823±0.034) %	S=1.5
Γ_2	$e^+e^-\gamma$	(1.174±0.035) %	S=1.5

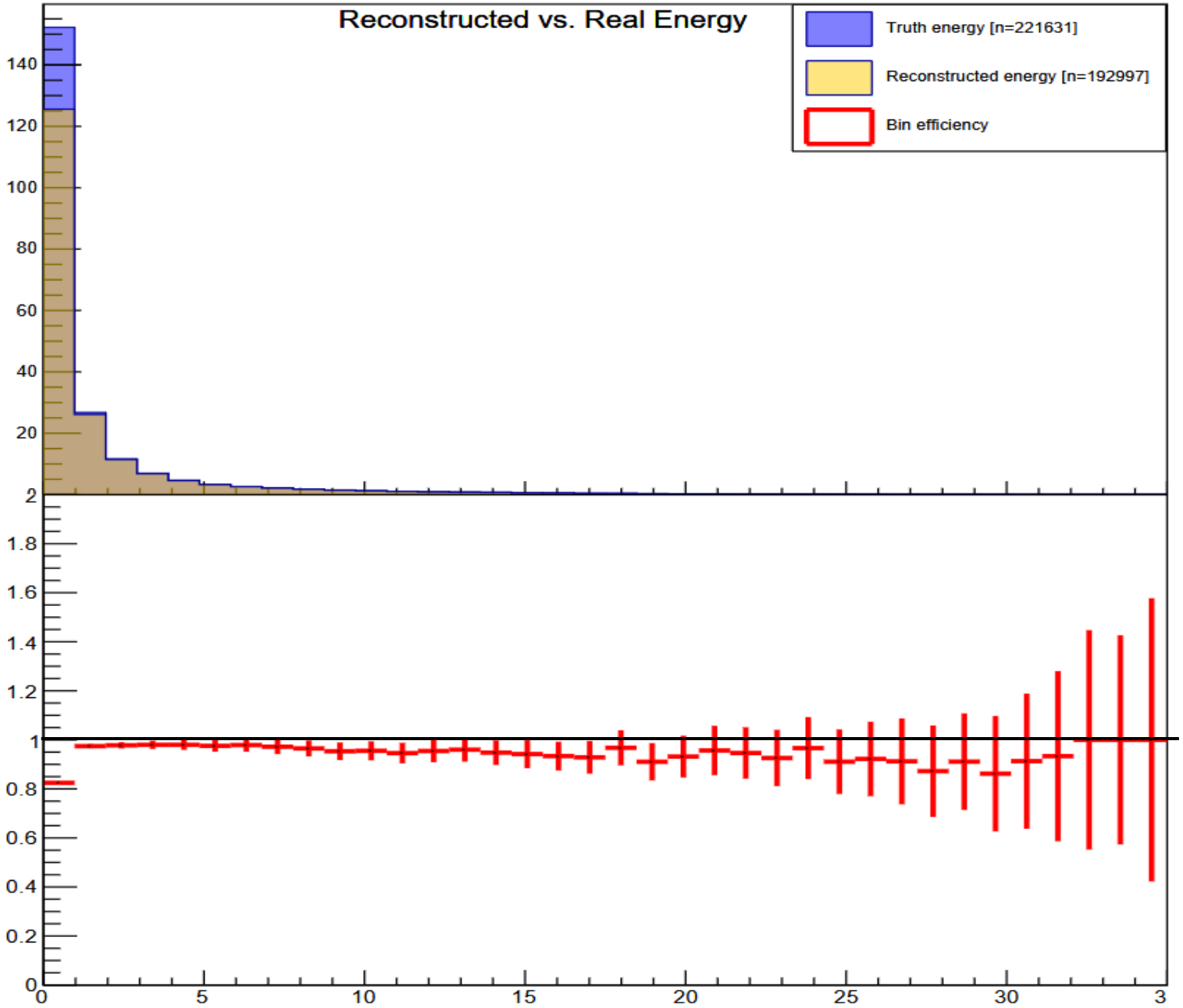
D02Pi0.dec 109 B

```
1  Decay D0
2      1.0    pi0  pi0        PHSP;
3  Enddecay
4  Decay anti-D0
5      1.0    pi0  pi0        PHSP;
6  Enddecay
7  End
```

Photon reconstruction effeciency

$$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$$

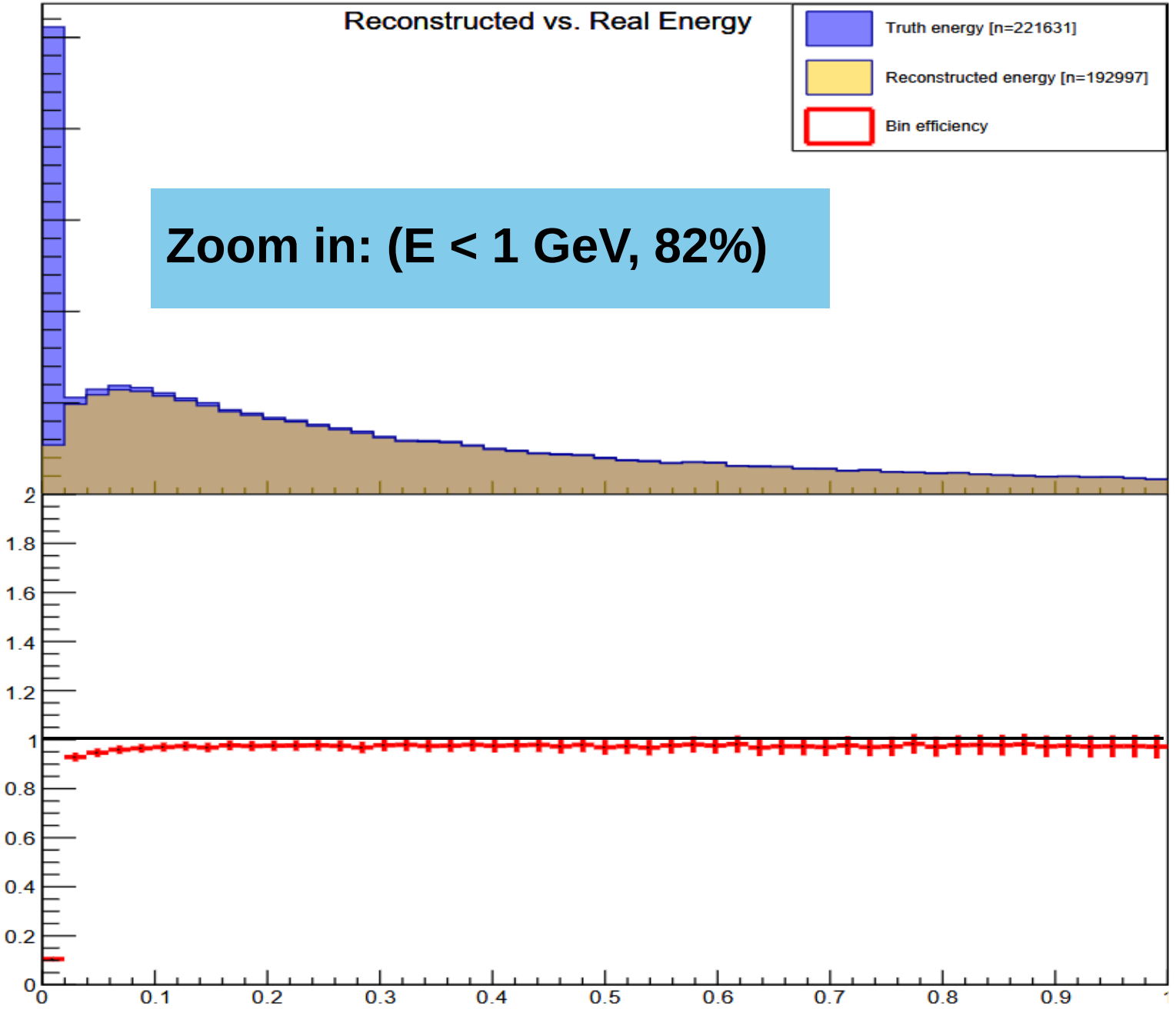
- **Bin-Wise** evaluated
- **Lowest** efficiency in first bin **(E < 1 GeV, 82%)**



Photon reconstruction effeciency

$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$

- **Split** first **bin** in 50**:**
- **Lowest** efficiency in first bin **(E < 10 MeV, 10%)**
- **minor role** in our analysis

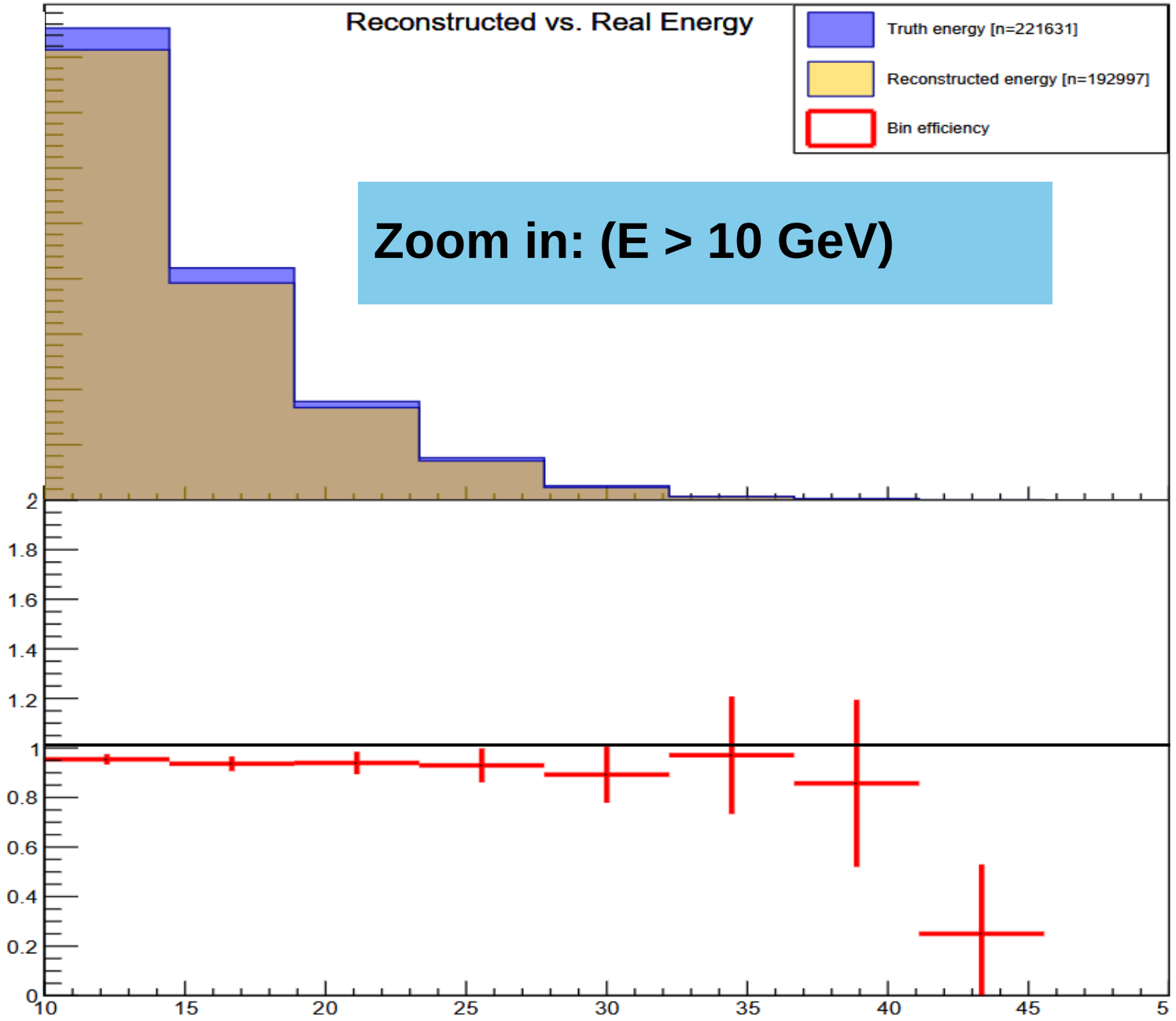


Photon reconstruction effeciency

$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$

- **Broader bins** because of the smaller samplesize
- **Low** efficiency in last bin **(E < 40 GeV, 27%)**

Why?

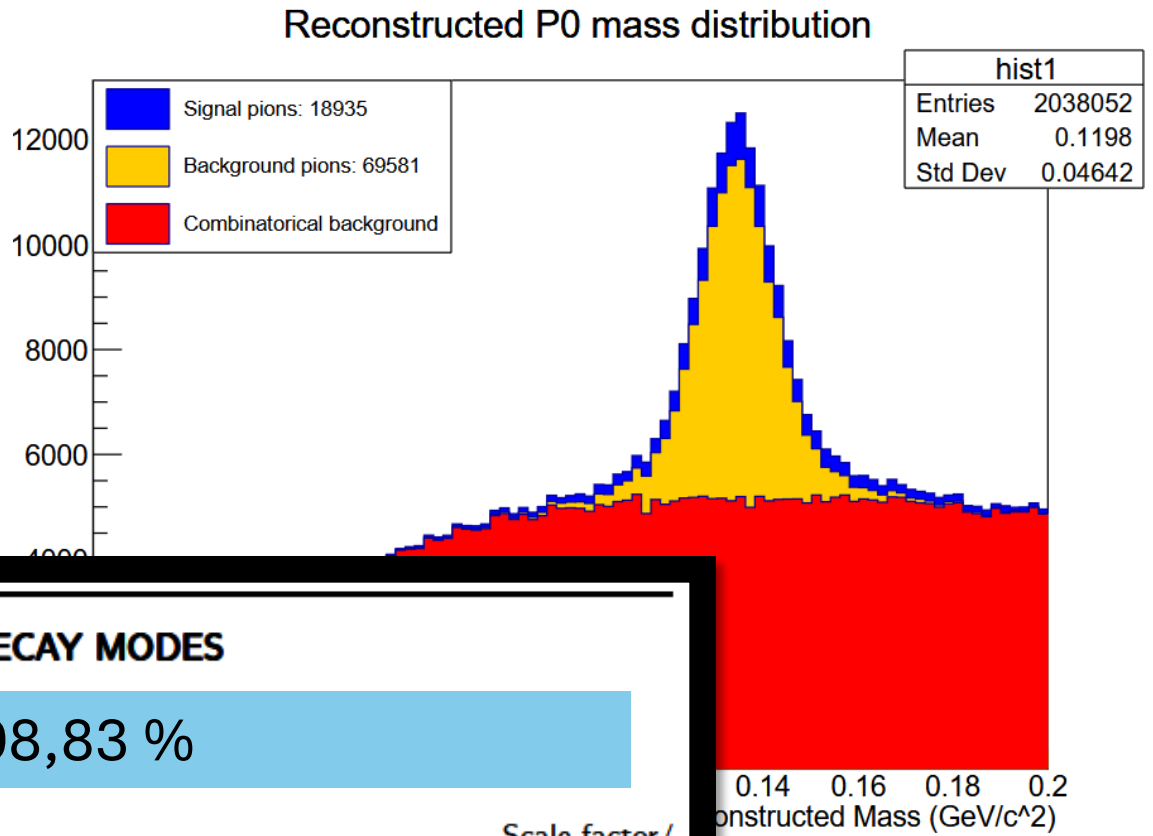


Pion reconstruction

$$\pi^0 \rightarrow \gamma\gamma$$

$$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$$

- **Pions** can be **reconstructed by pairing two** reconstructed **photons!**



π^0 DECAY MODES

Best possible: 98,83 %

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	2γ	(98.823±0.034) %	S=1.5
Γ_2	$e^+e^-\gamma$	(1.174±0.035) %	S=1.5

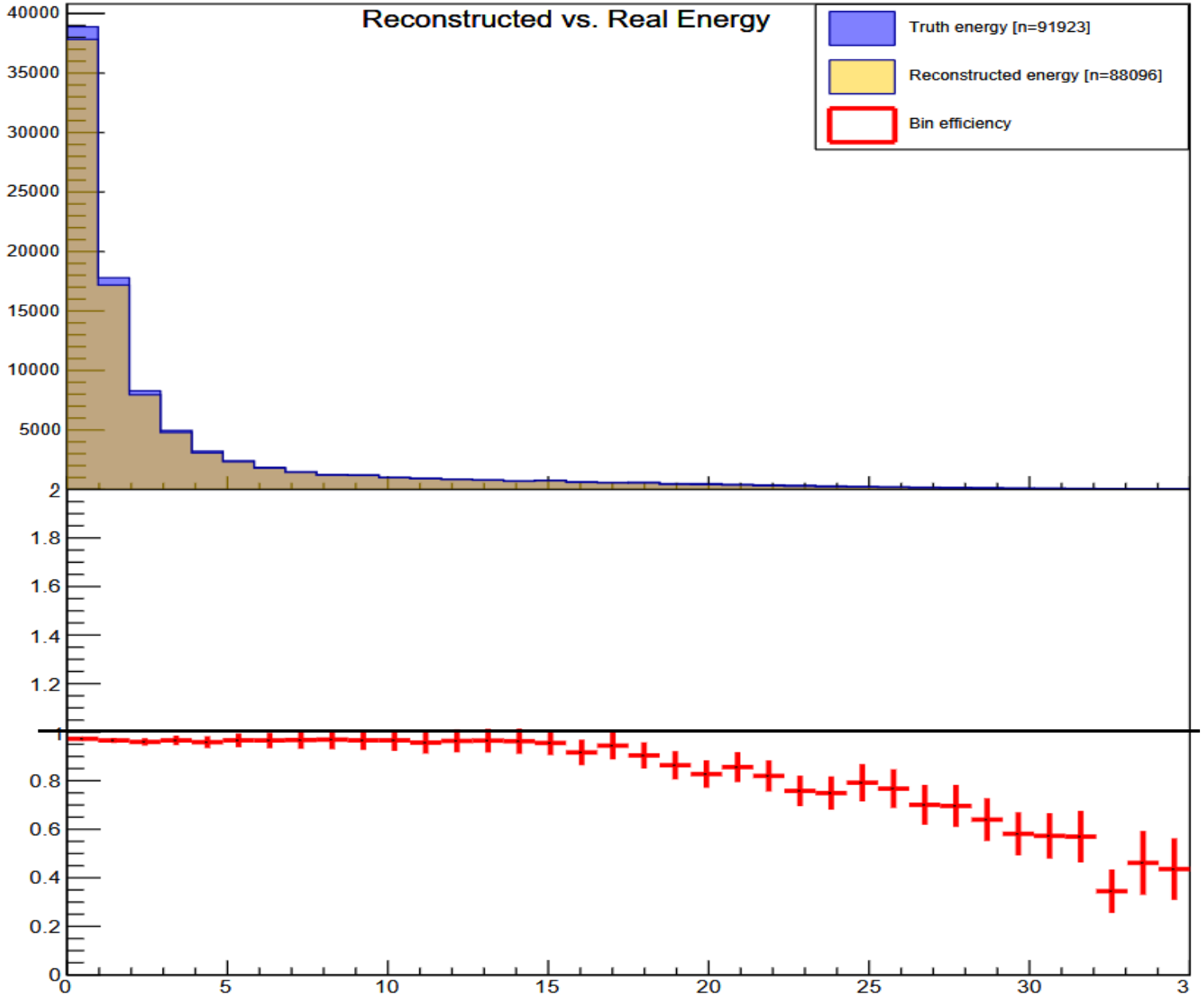
Pion reconstruction effeciency

$$\pi^0 \rightarrow \gamma\gamma$$

$$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$$

- **Efficiency decreases**

  steadily for **E > 15 GeV**



Pion reconstruction effeciency

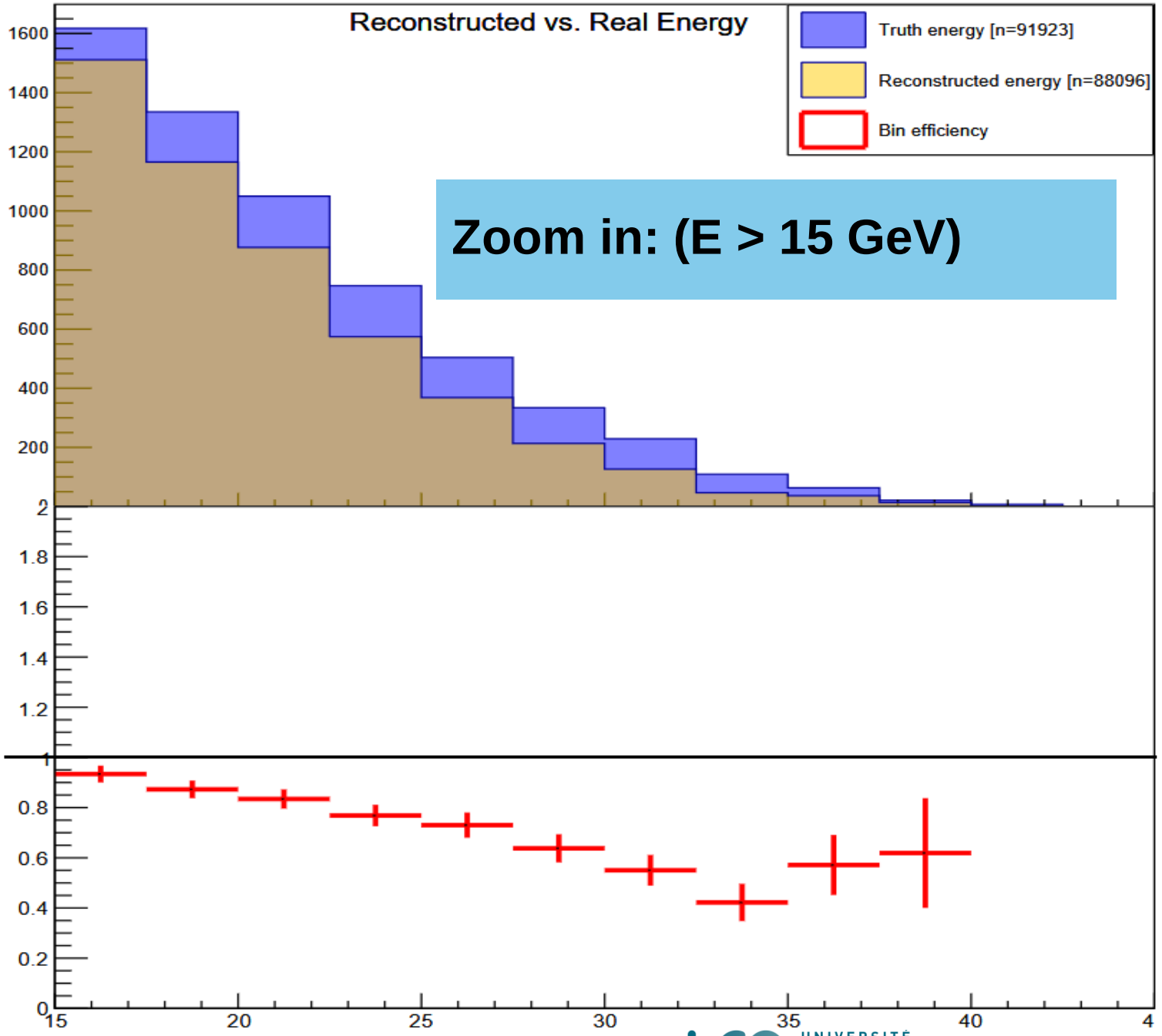
$$\pi^0 \rightarrow \gamma\gamma$$

$$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$$

- **Efficiency decreases** for

  E > 15 GeV

Why Increase for E>35 GeV?



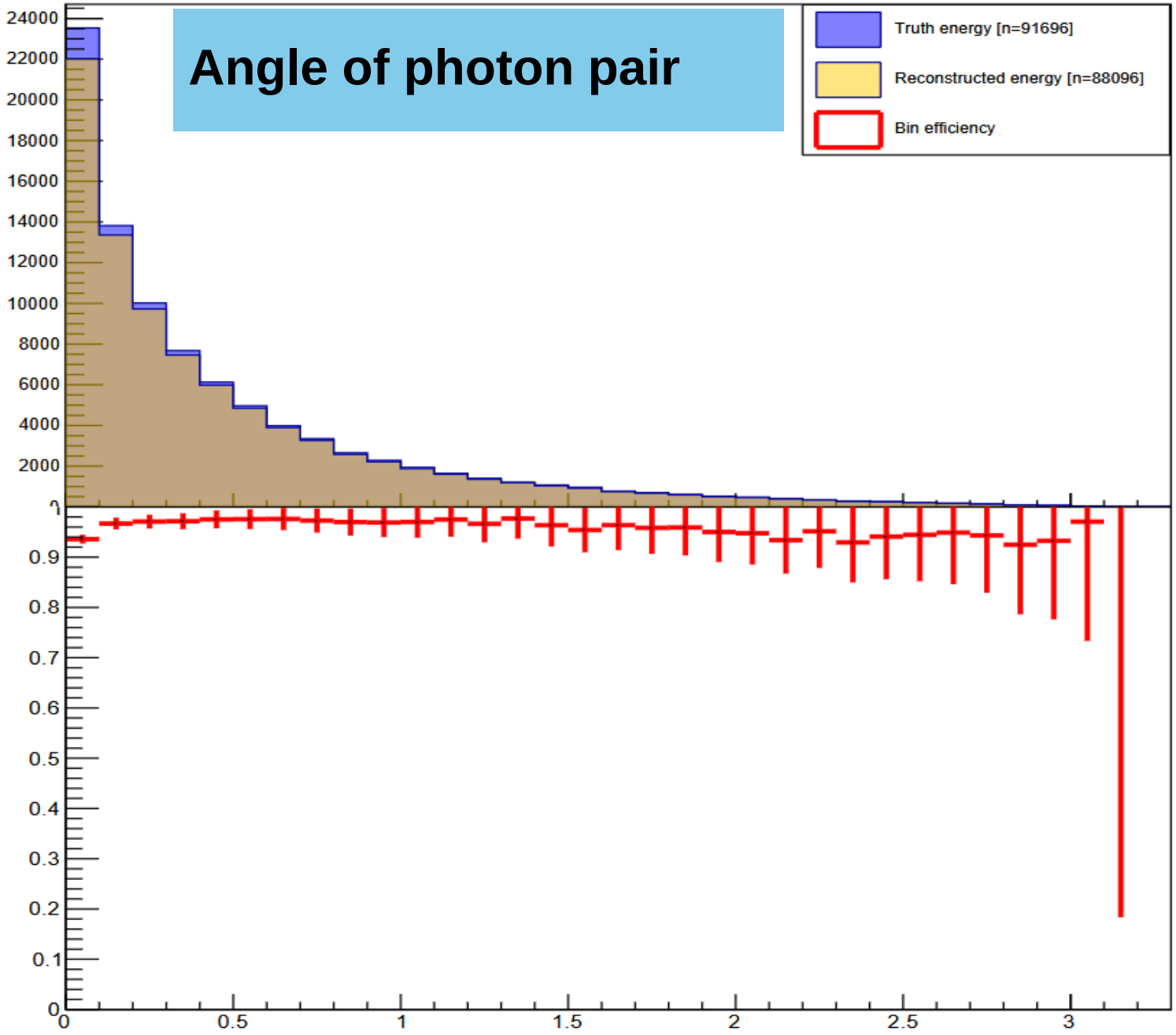
Pion reconstruction effeciency

$$\pi^0 \rightarrow \gamma\gamma$$

$$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$$

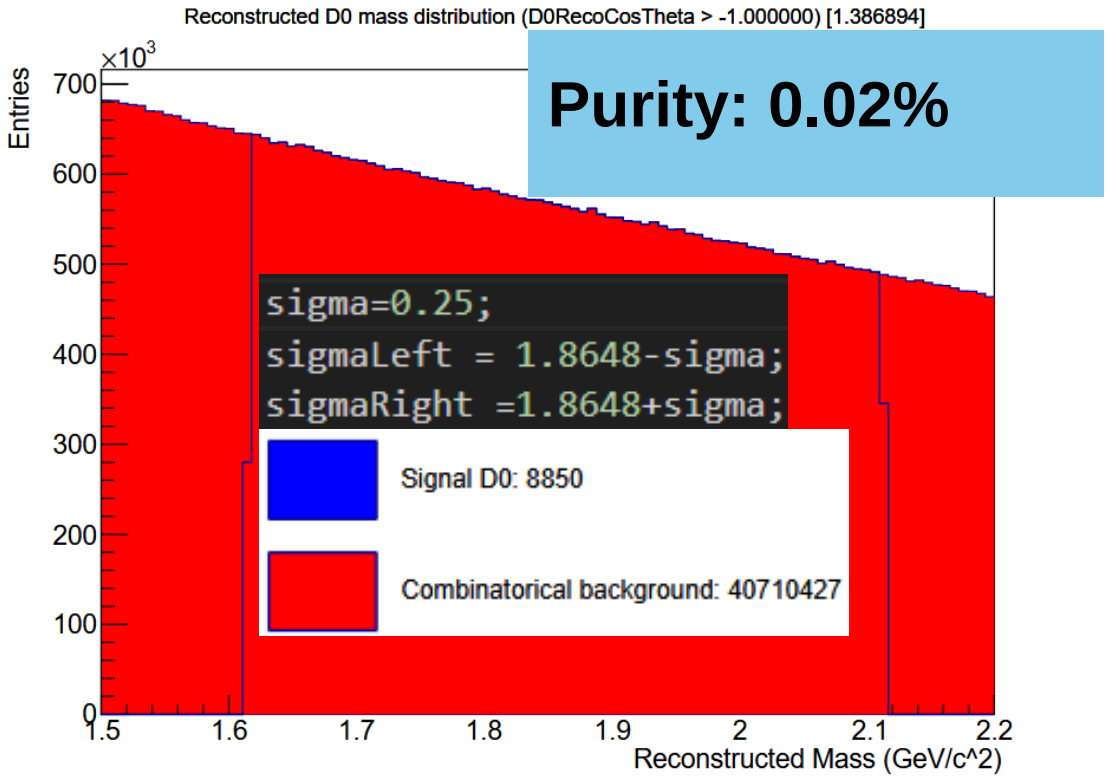
- **Efficiency** stable **high**
- ~~**Weird peak** at **Pi/2**~~

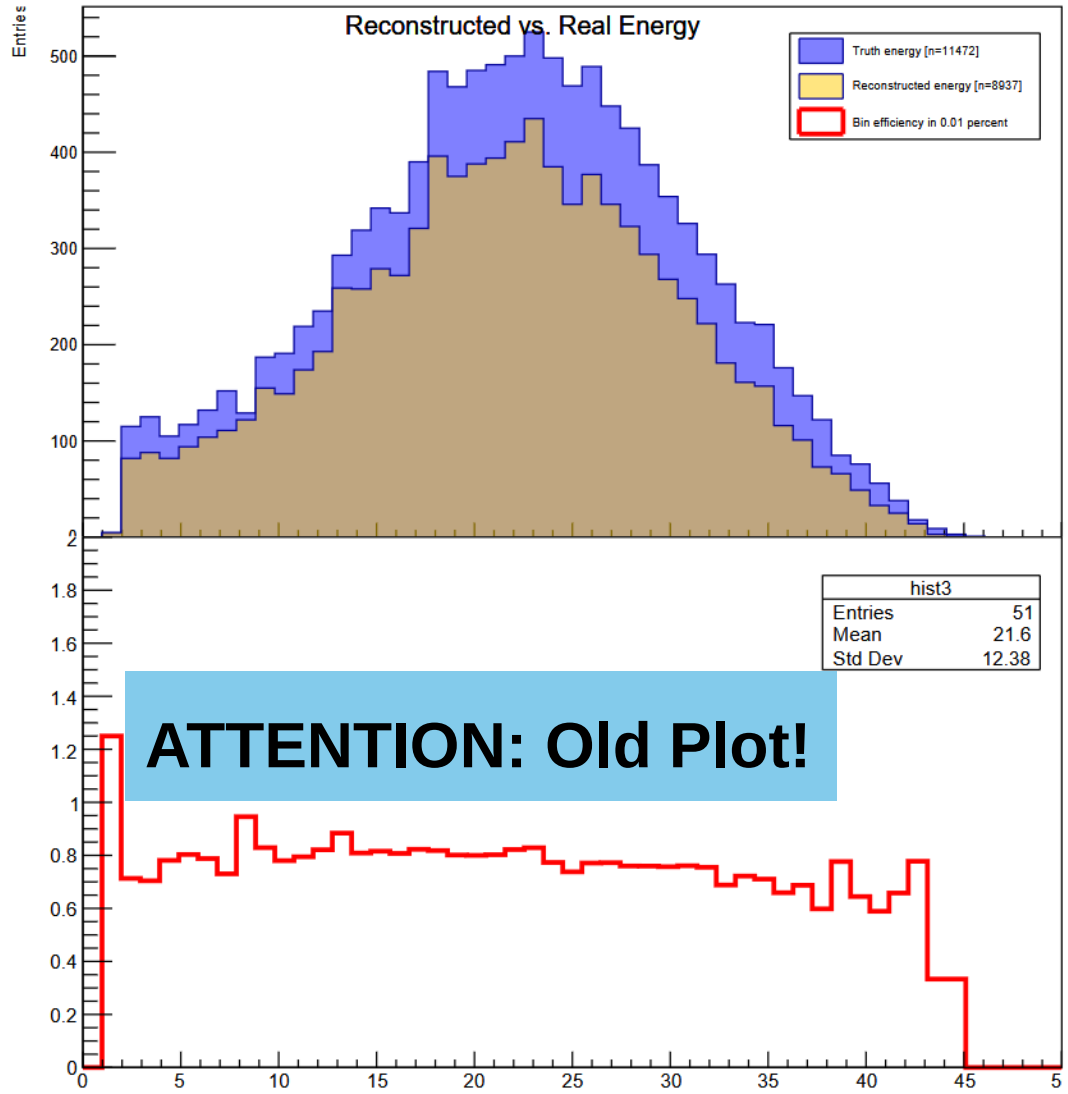
SOLVED ☺



D0 reconstruction effeciency

- **No Cuts applied: No D0 Peak!**



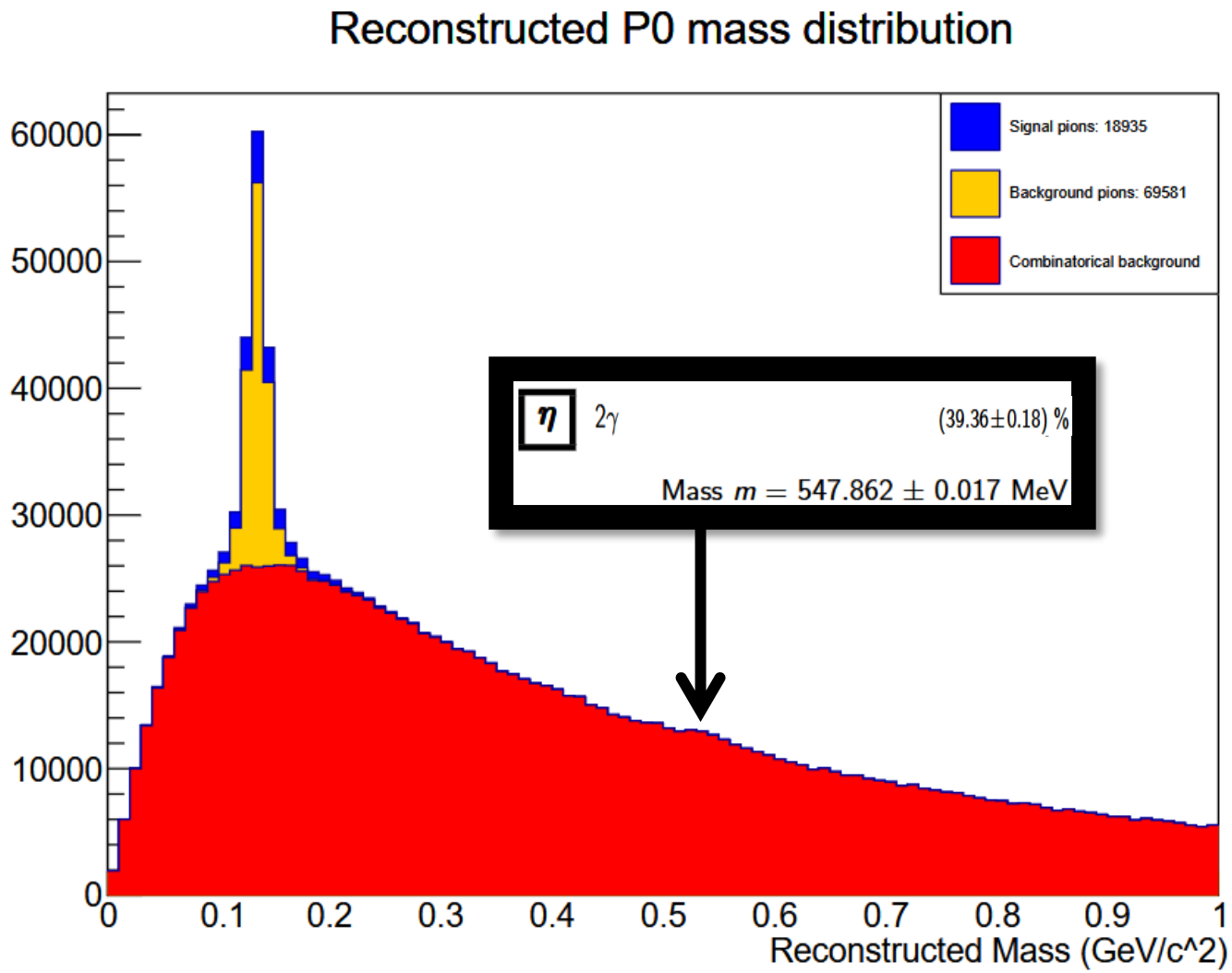


Pion decay: Background consideration

$$\pi^0 \rightarrow \gamma\gamma$$

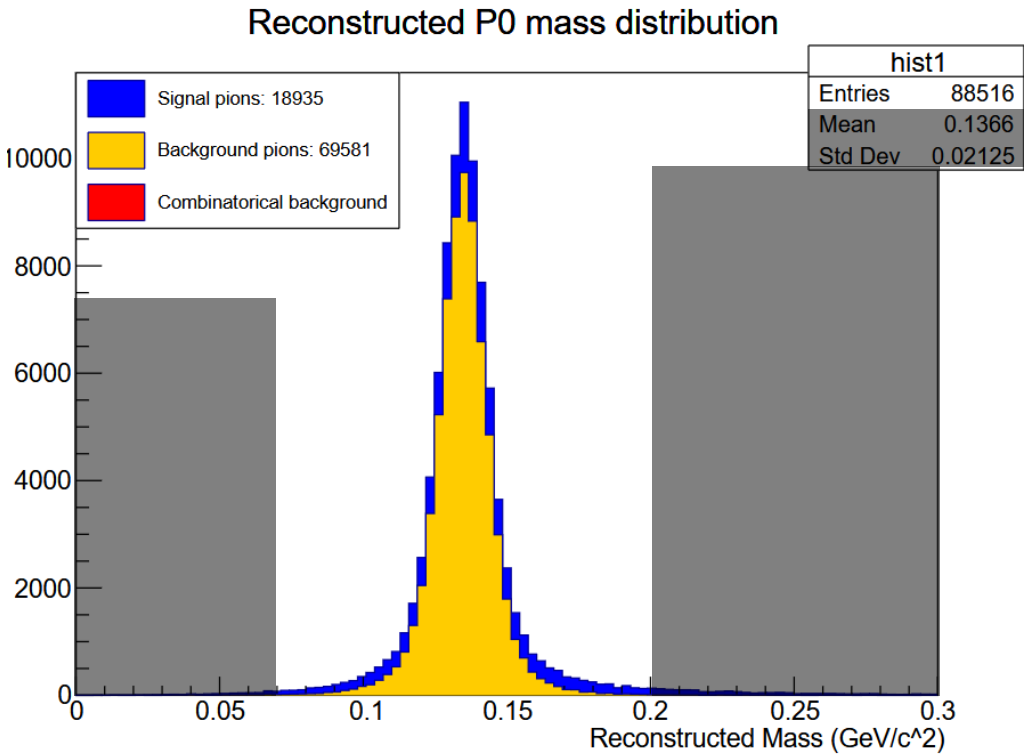
$$D^0 \rightarrow \pi^0\pi^0 \rightarrow 4\gamma$$

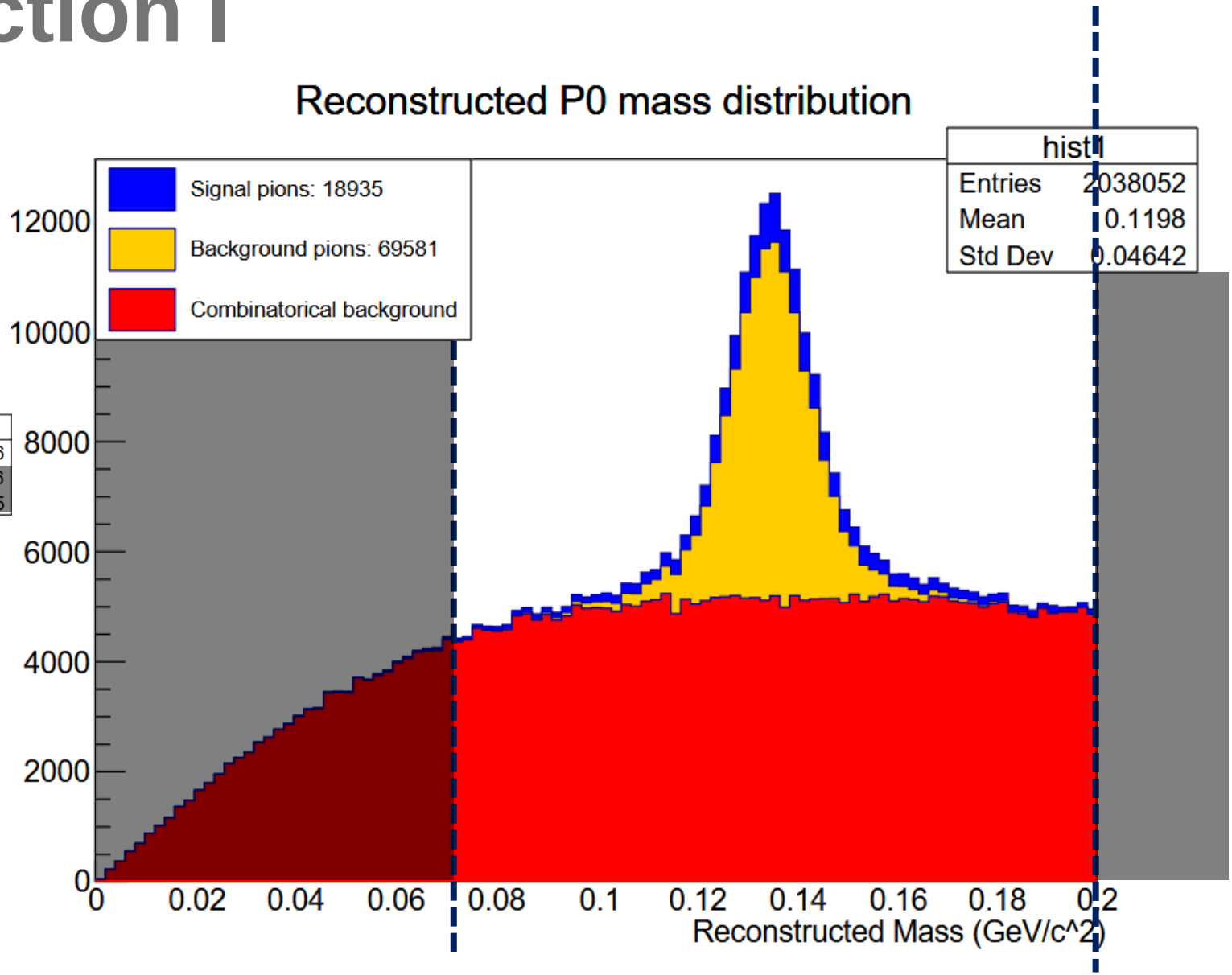
- D0-signal pions
- Pion background
- Combinatorical background



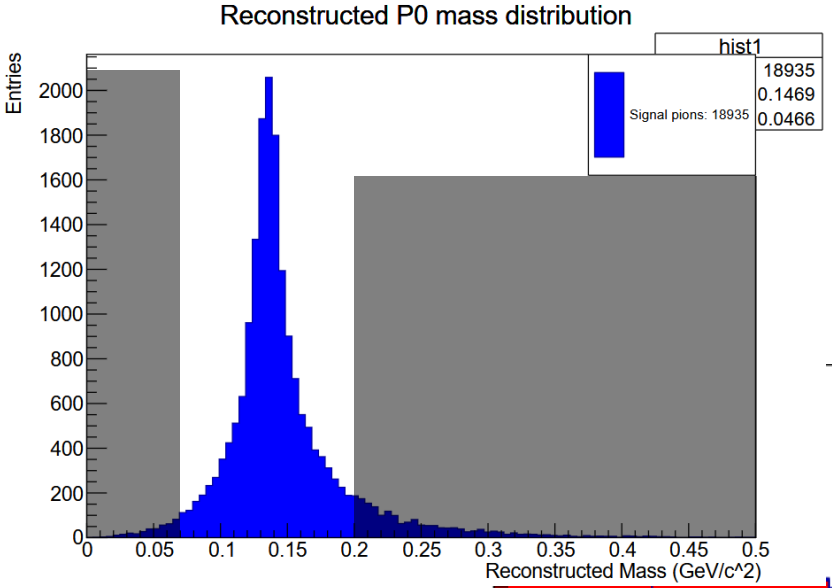
Background reduction I

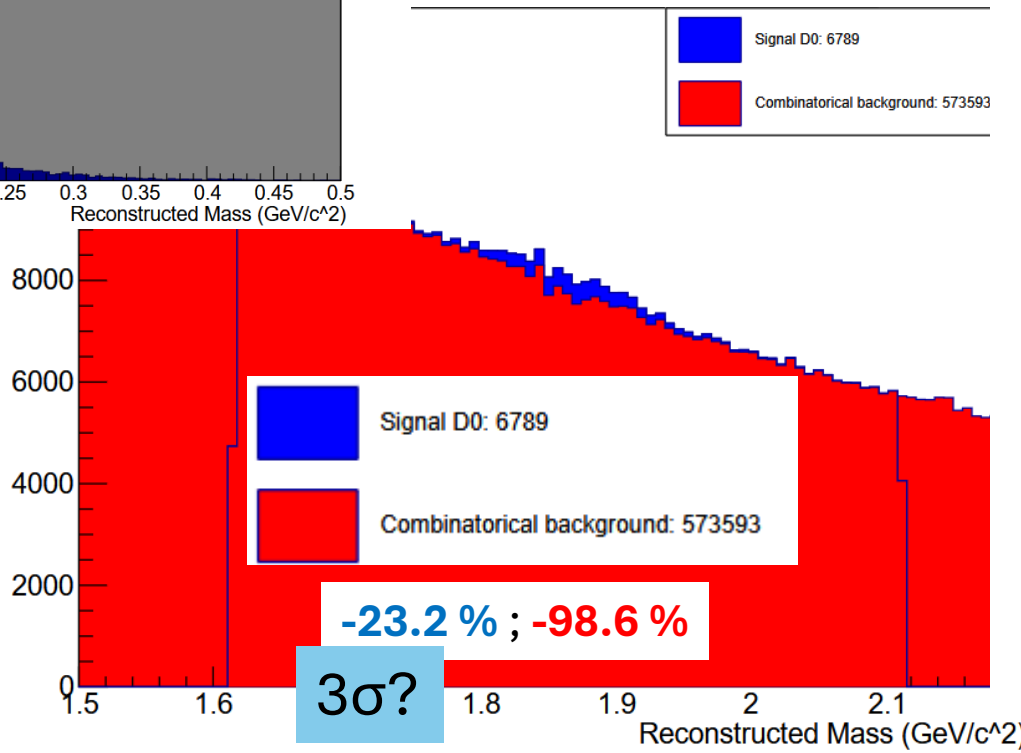
- Cutting off combinatorical background outside the peak region (3 sigma)

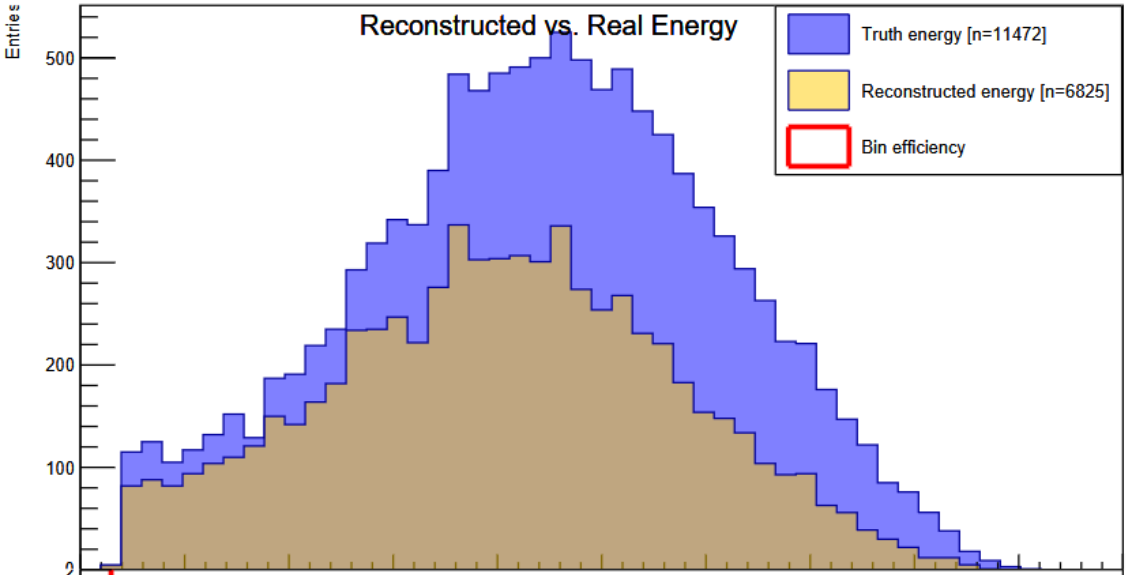


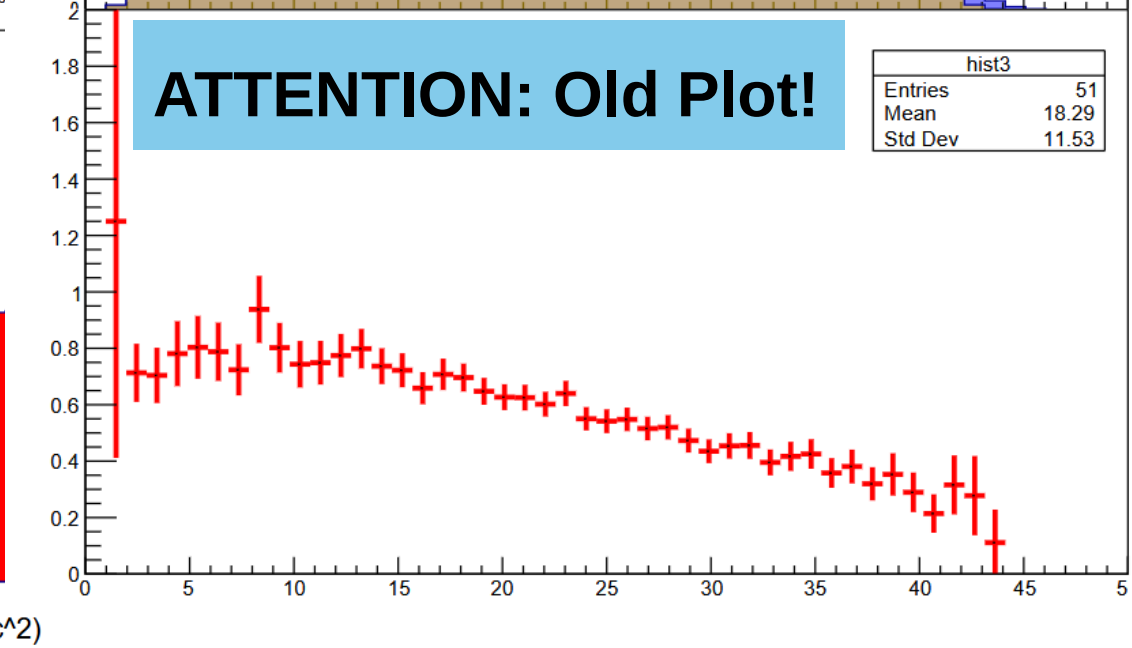


Background reduction I

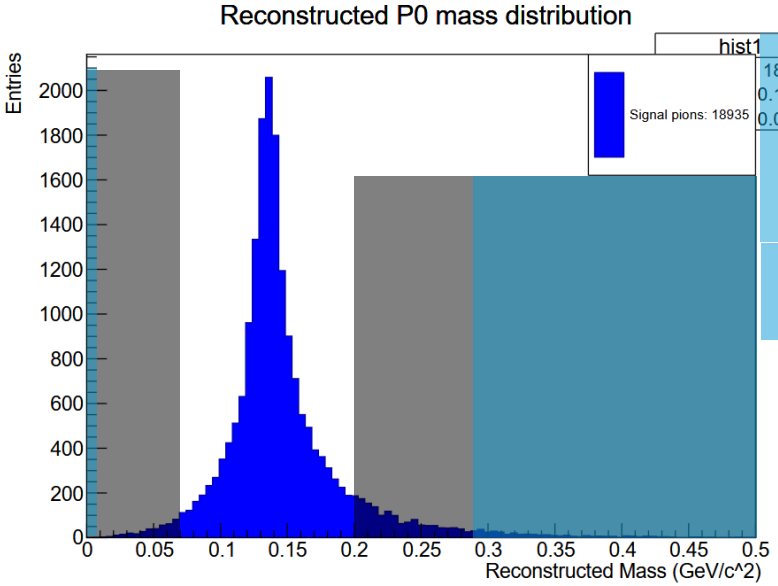








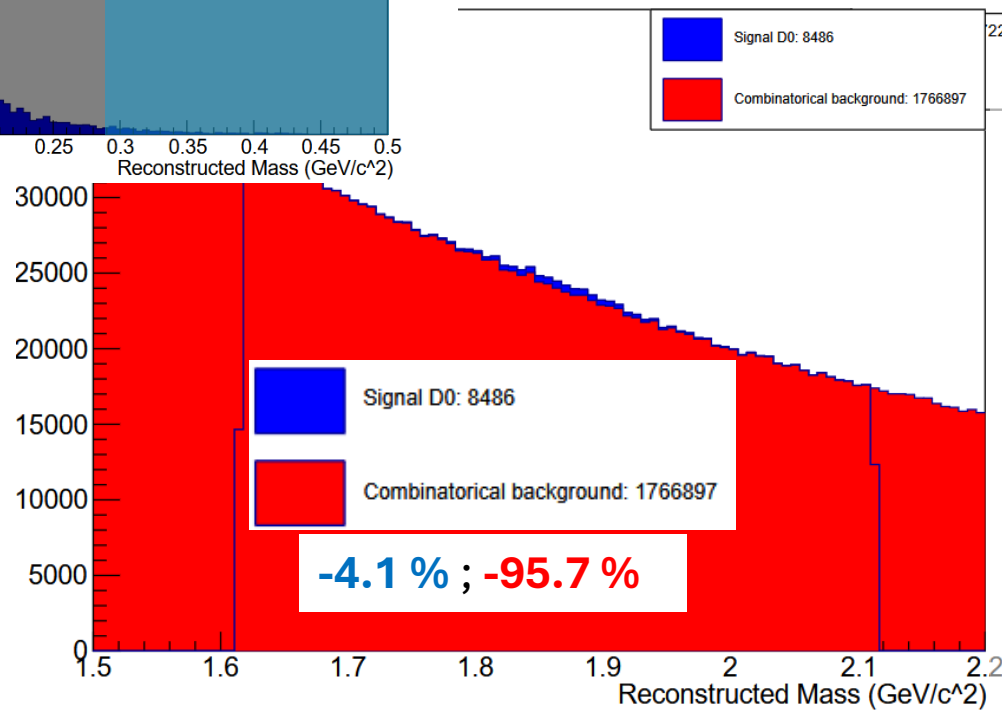
Background reduction I

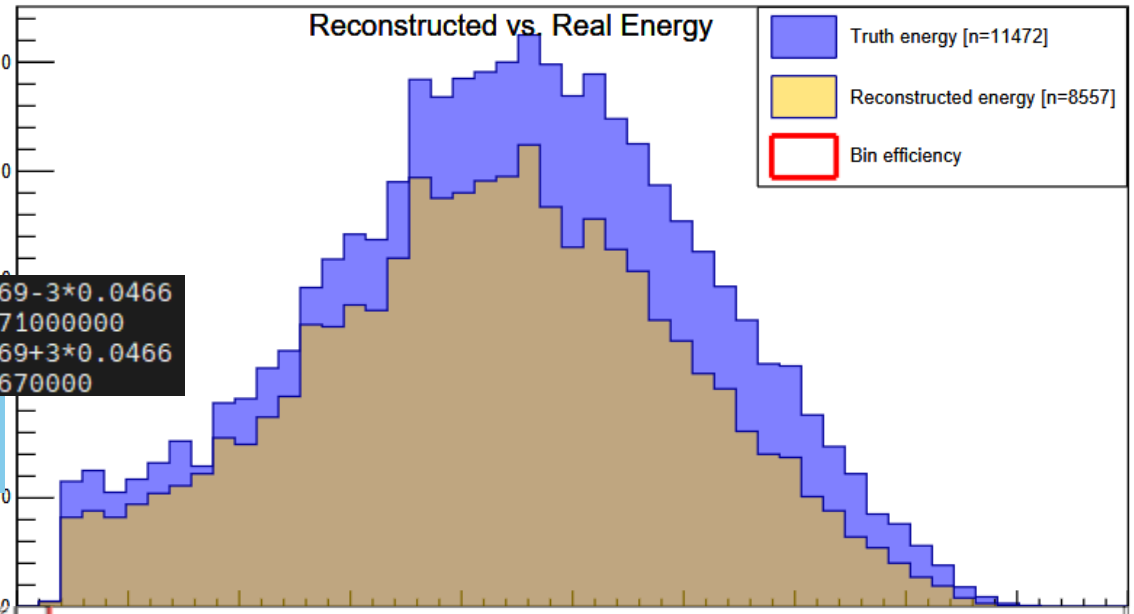


For now use that value, but seems odd

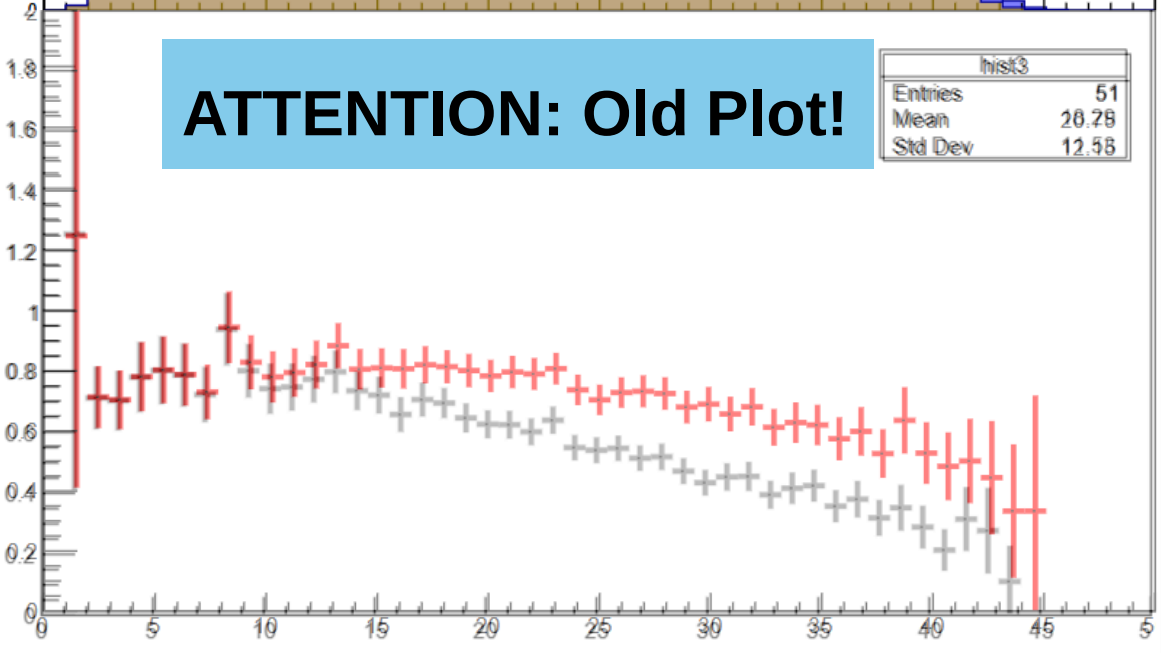
```
root [2] 0.1469-3*0.0466
(double) 0.0071000000
root [3] 0.1469+3*0.0466
(double) 0.28670000
```

P0 mass: 0.135 GeV!

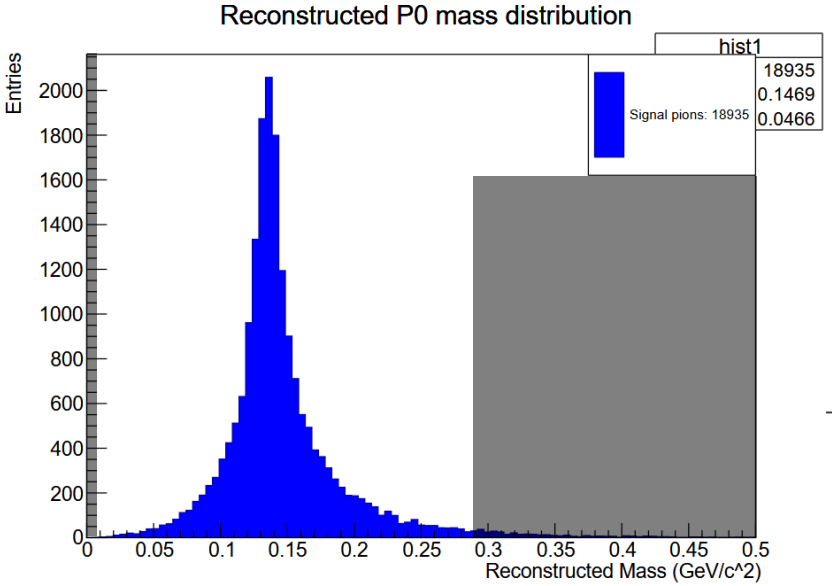


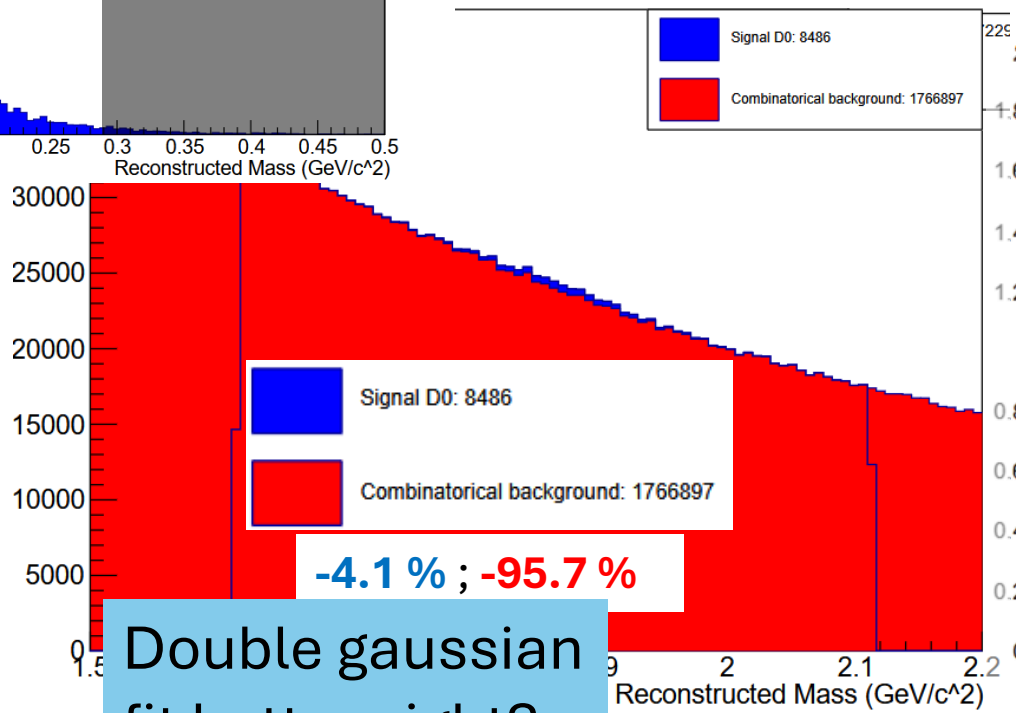


ATTENTION: Old Plot!

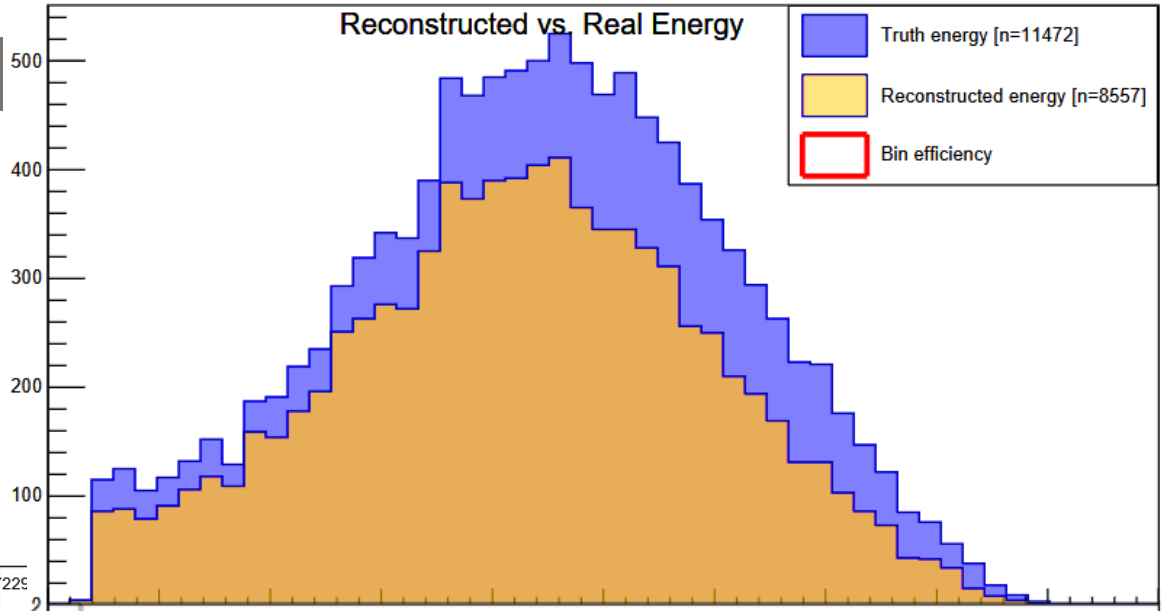


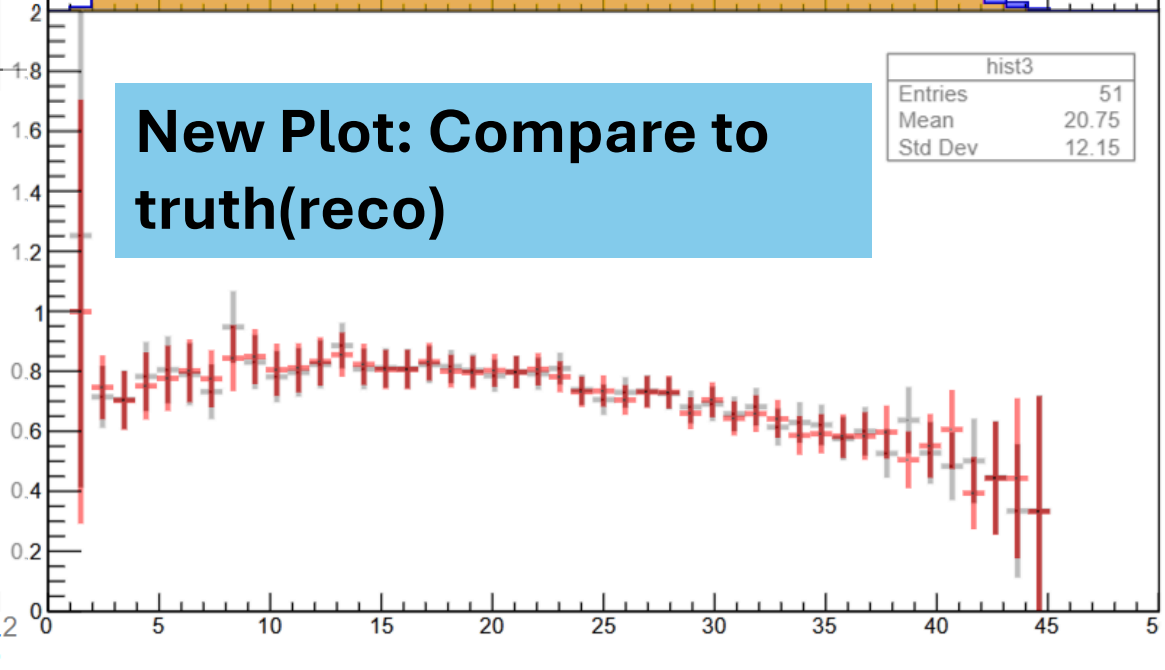
Background reduction I





Double gaussian fit better, right?



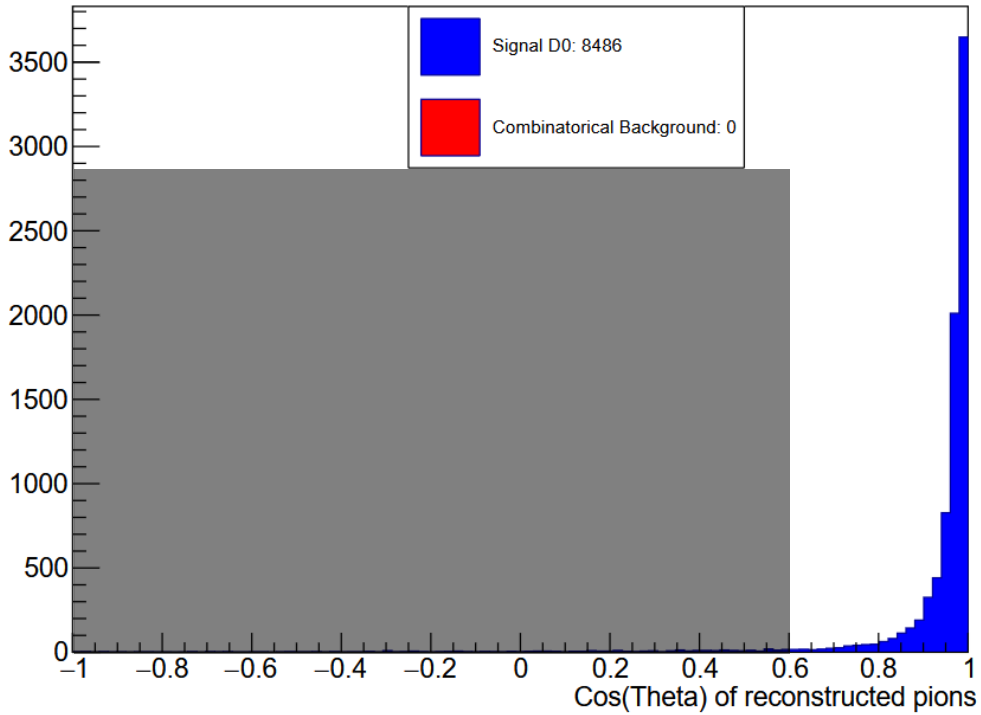


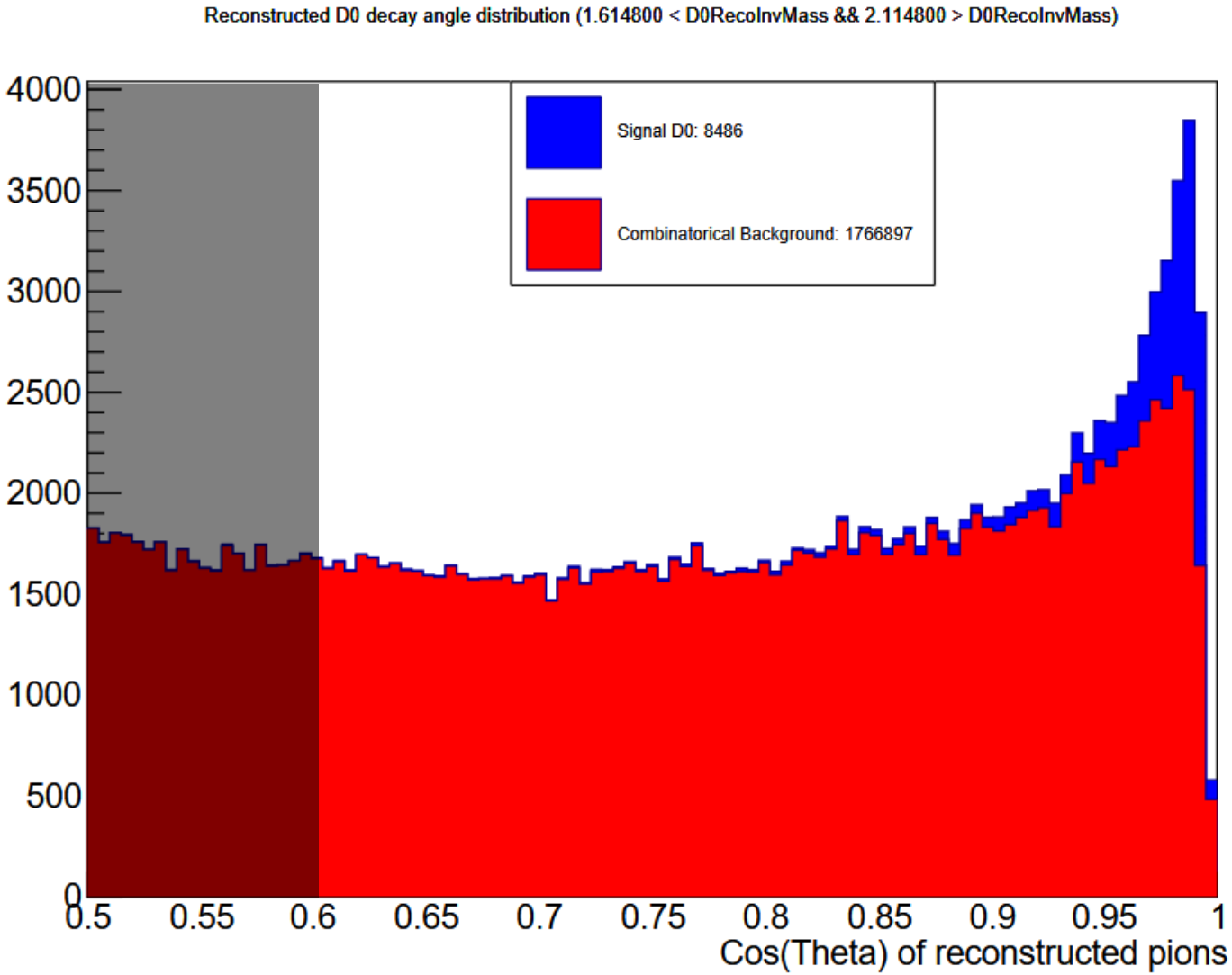
New Plot: Compare to truth(reco)

Background reduction II

- D0 Decay is boosted, because:

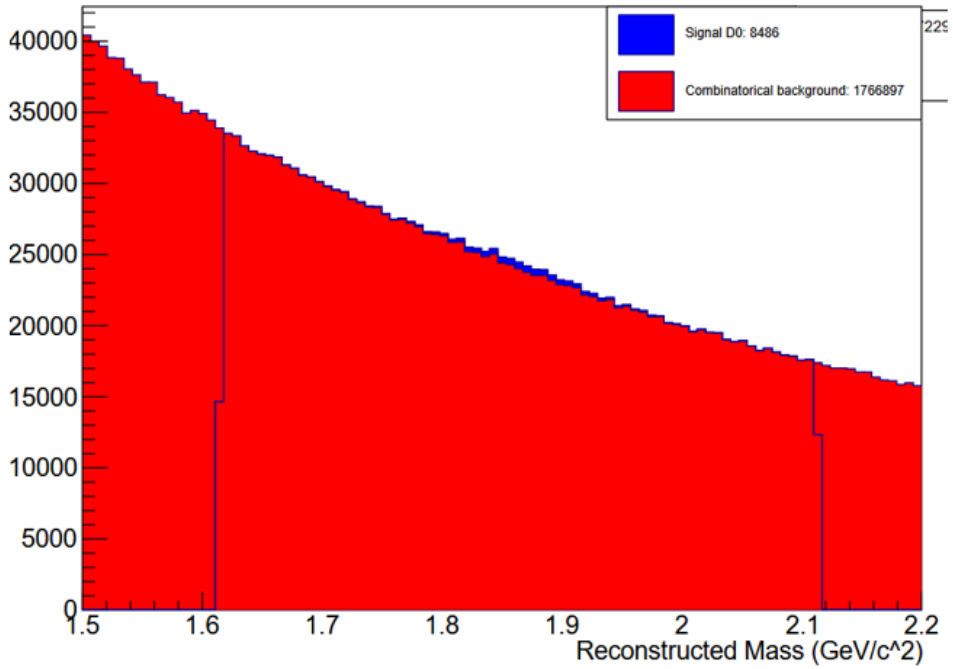
  m(D^0) = 1.8 GeV >> 0.1 GeV (π^0)

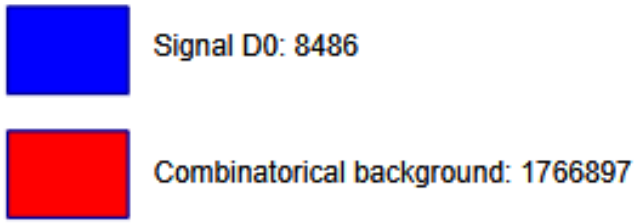




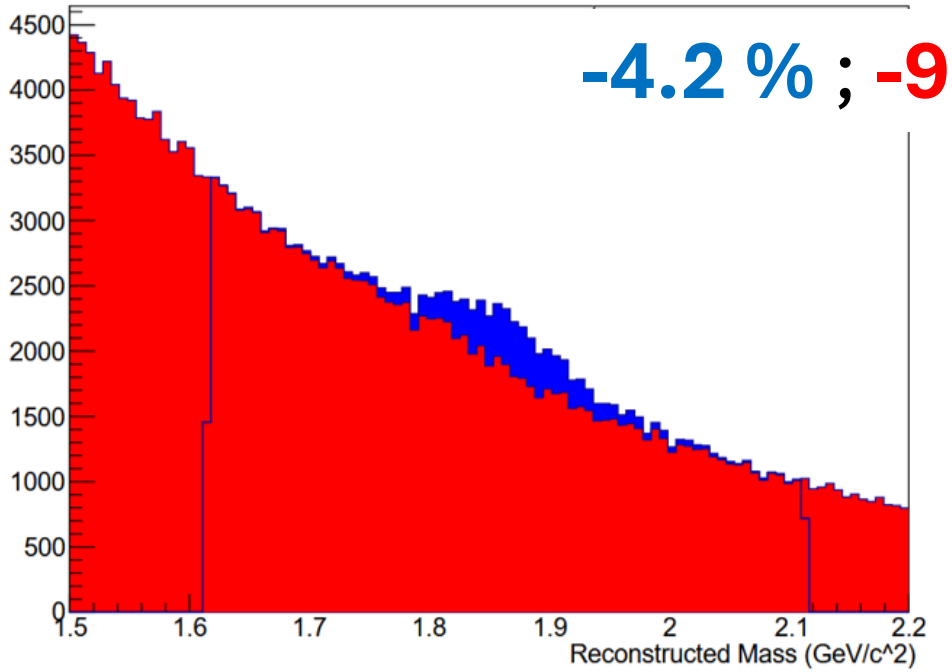
Background reduction II

Before:

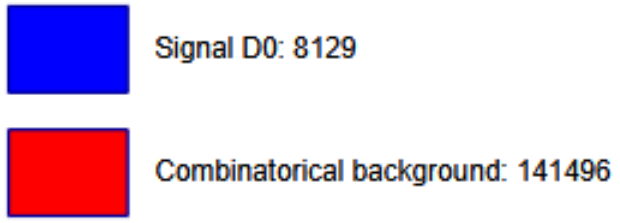




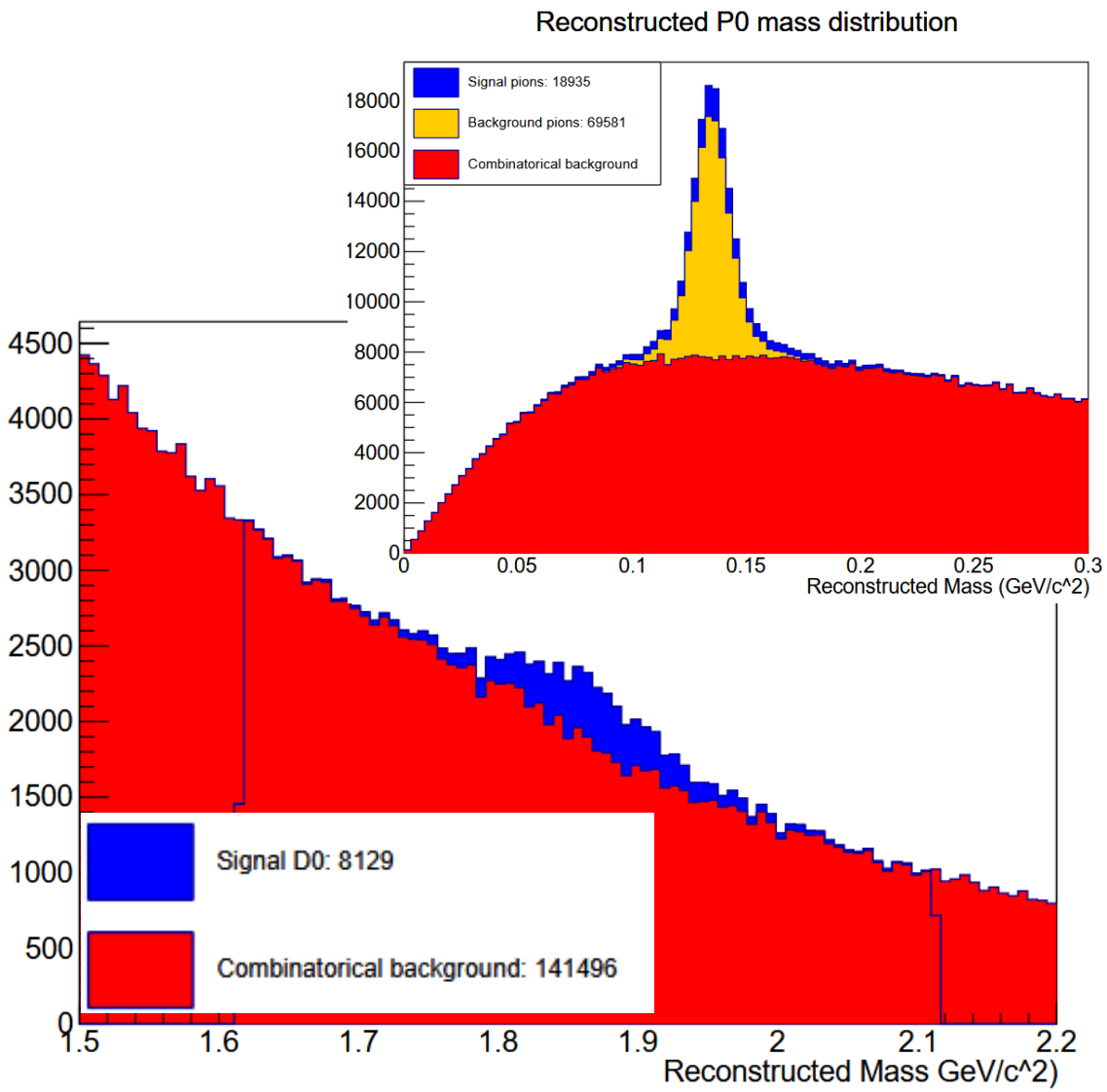
Cos(theta) > 0.6:



-4.2 % ; -92.0 %



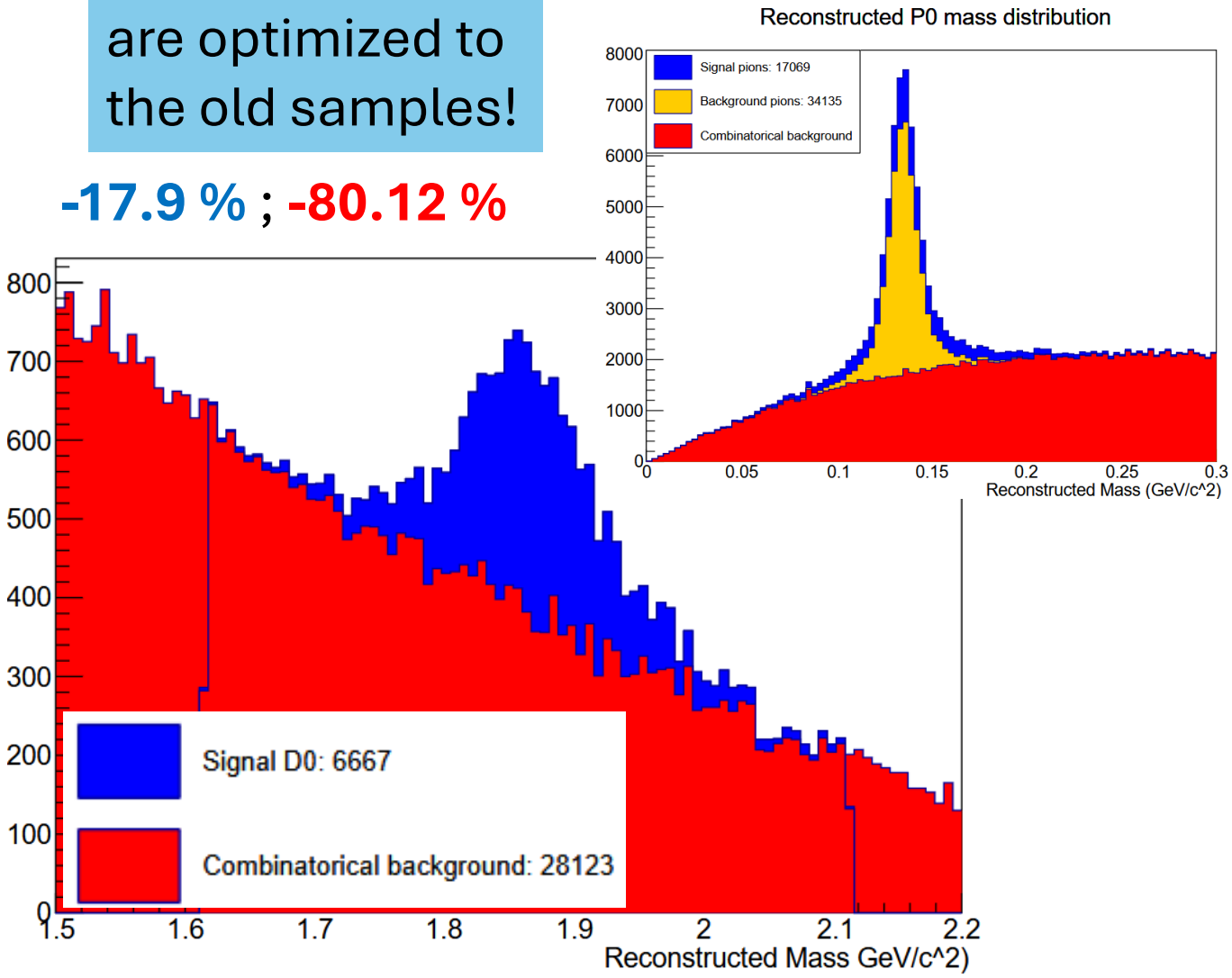
Less Cuts



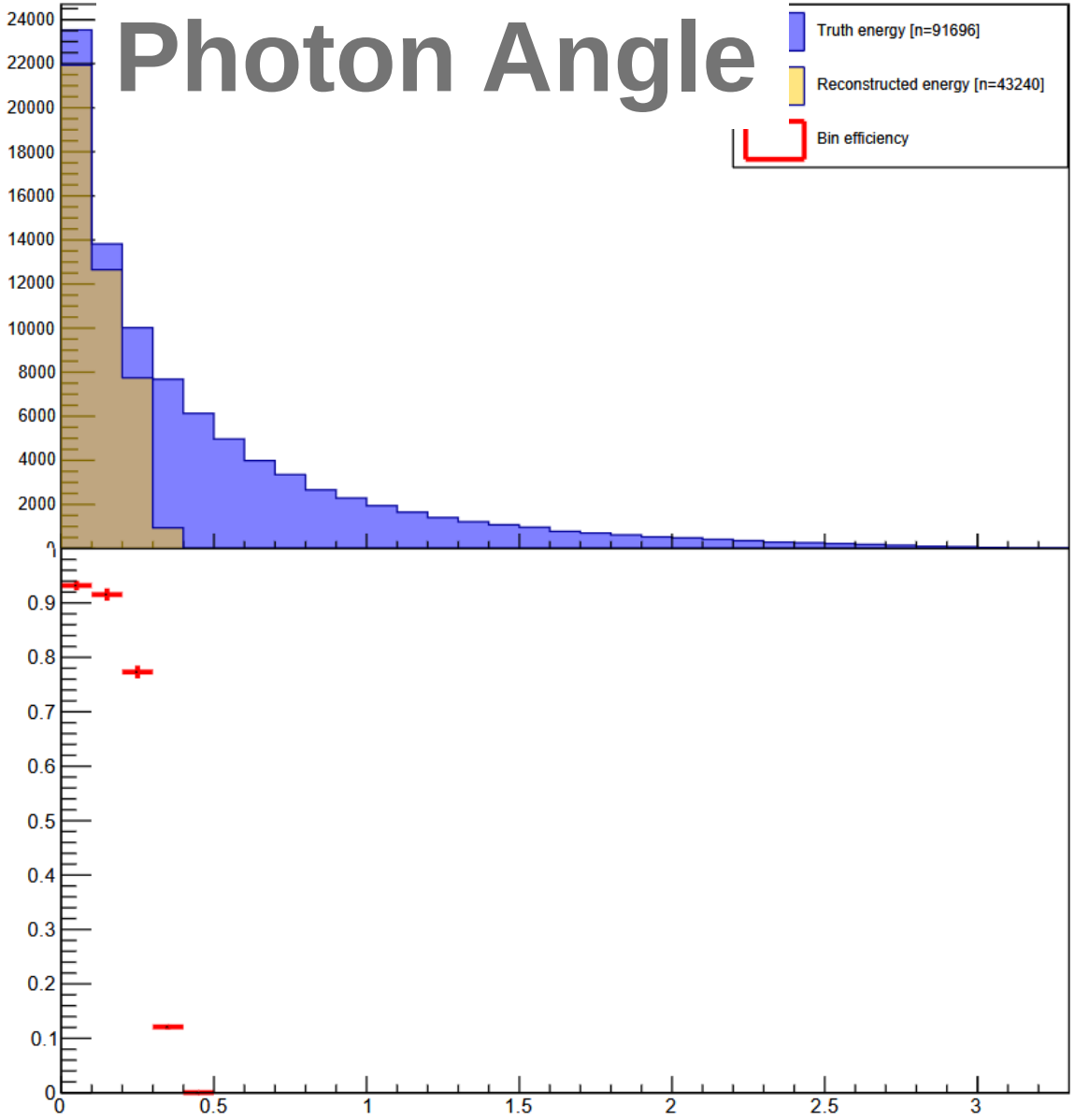
More Cuts

Attention: Cuts are optimized to the old samples!

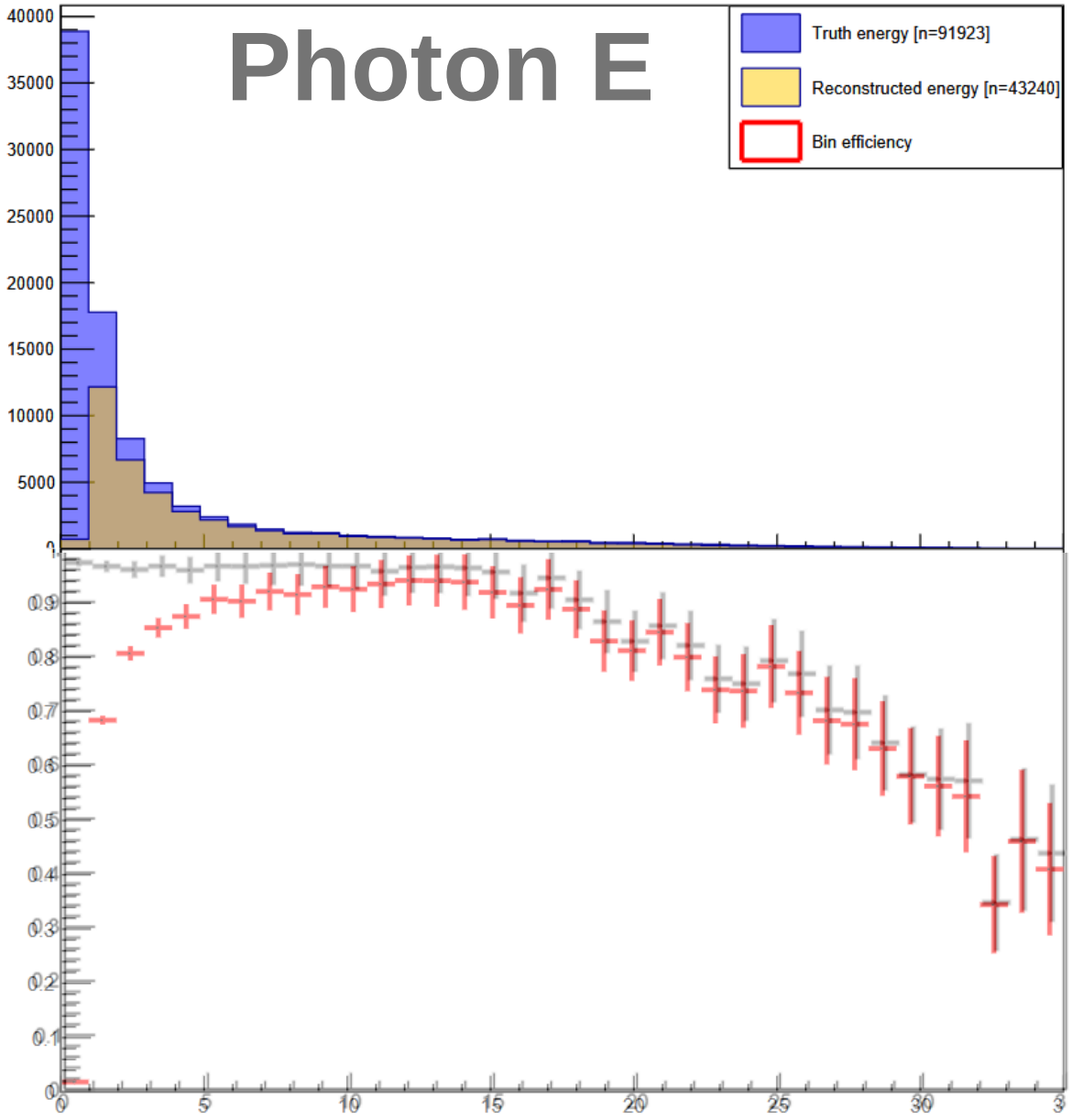
-17.9 % ; -80.12 %



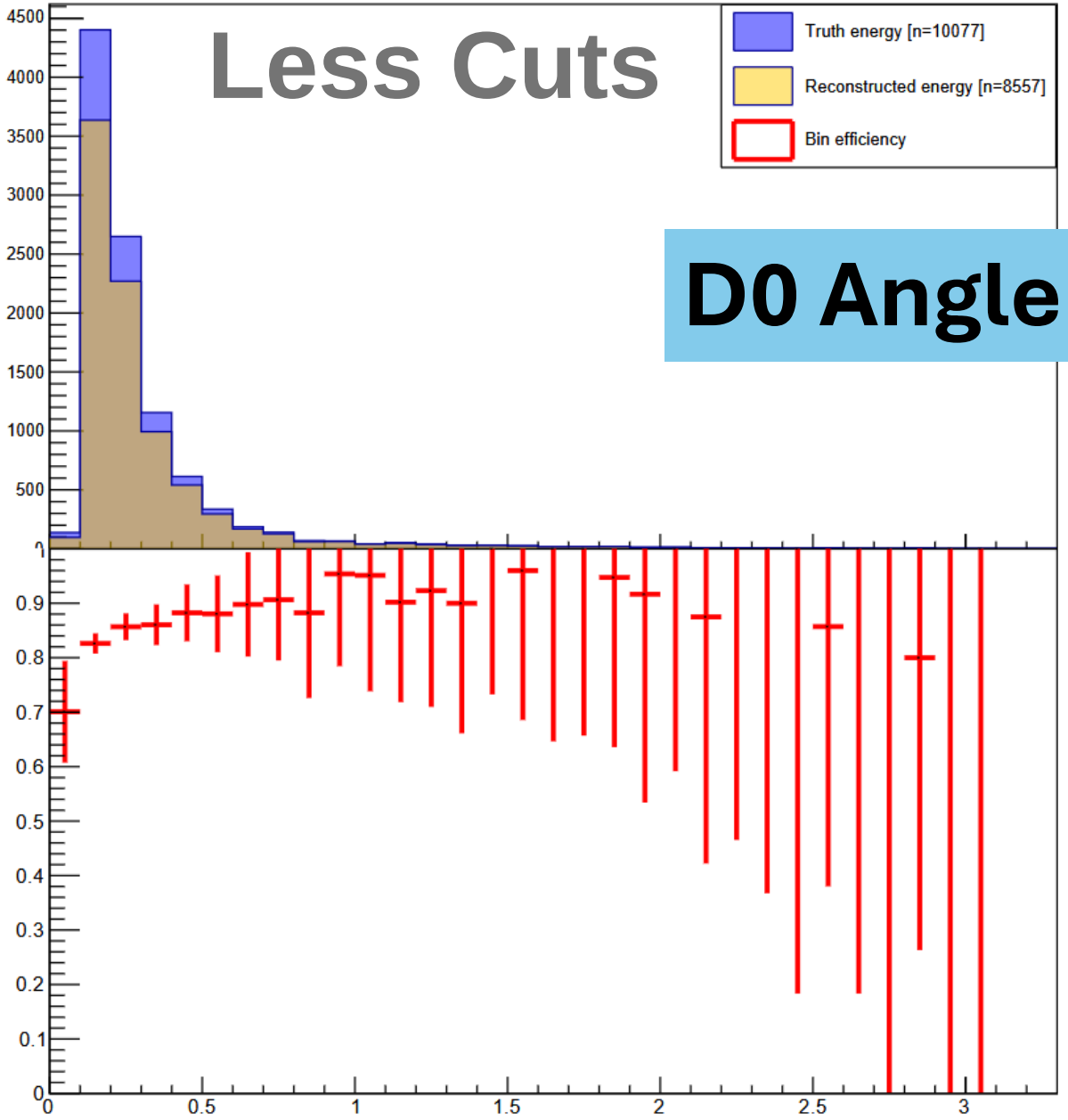
Photon Angle



Photon E

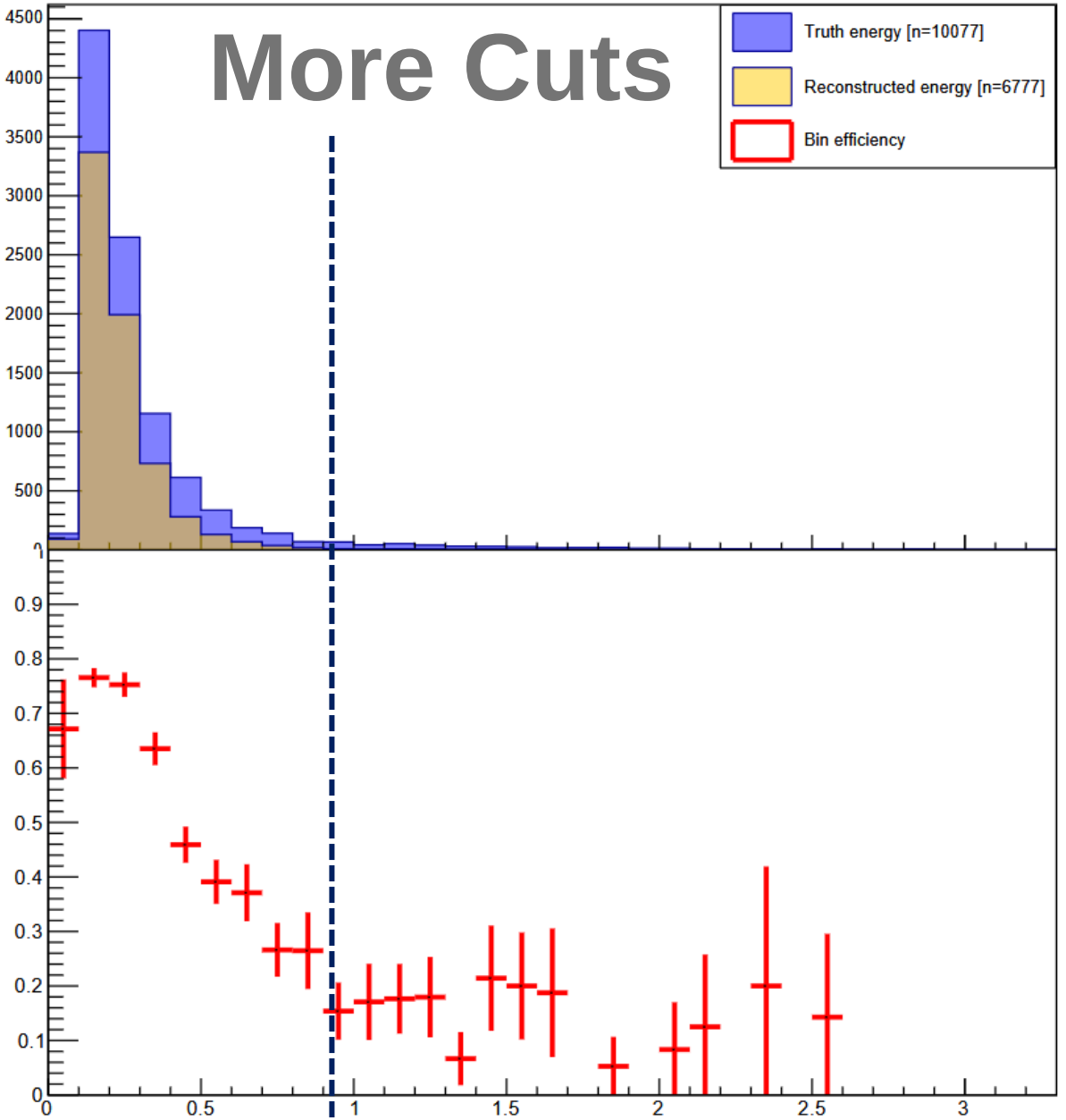


Less Cuts

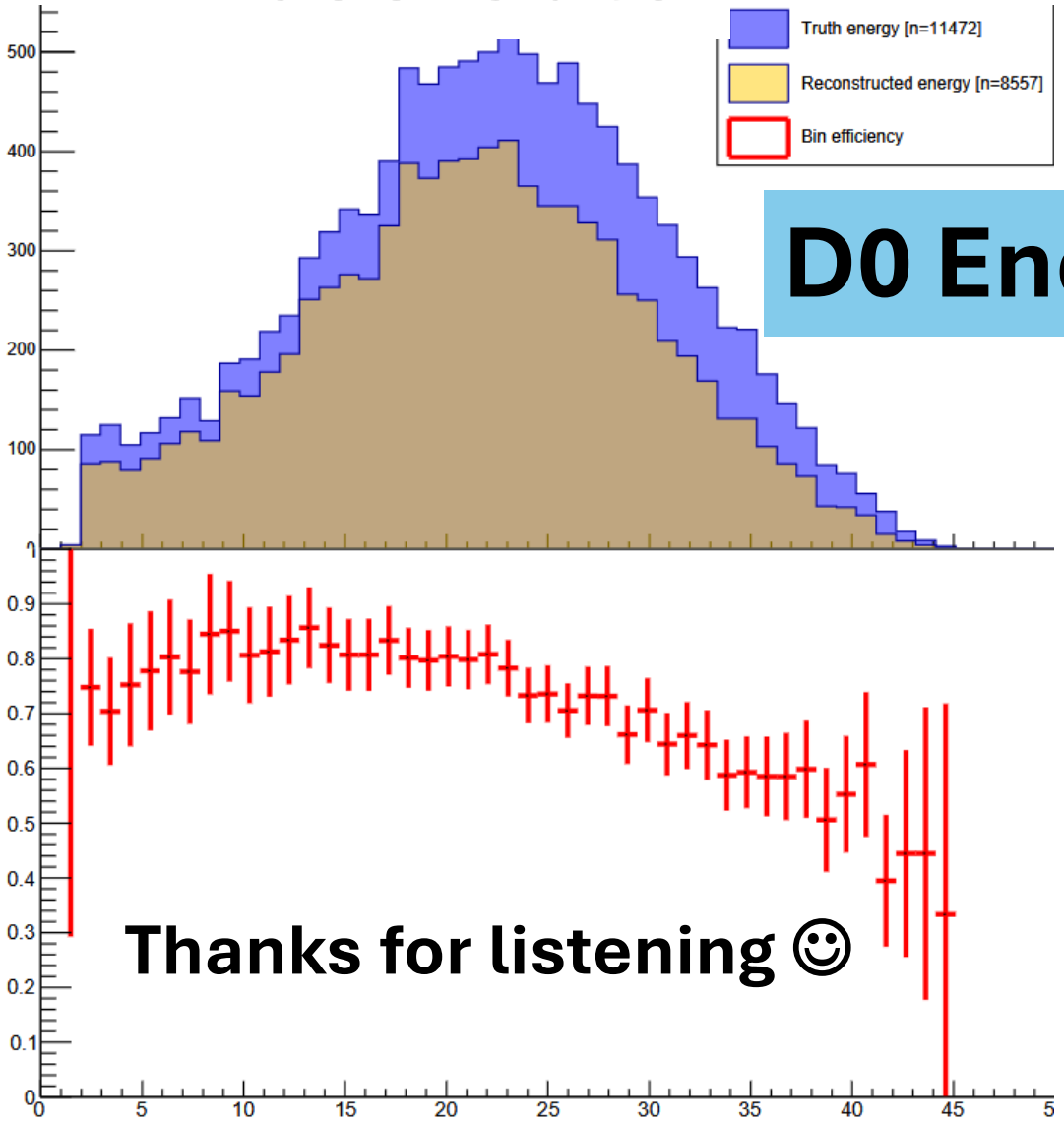


D0 Angle

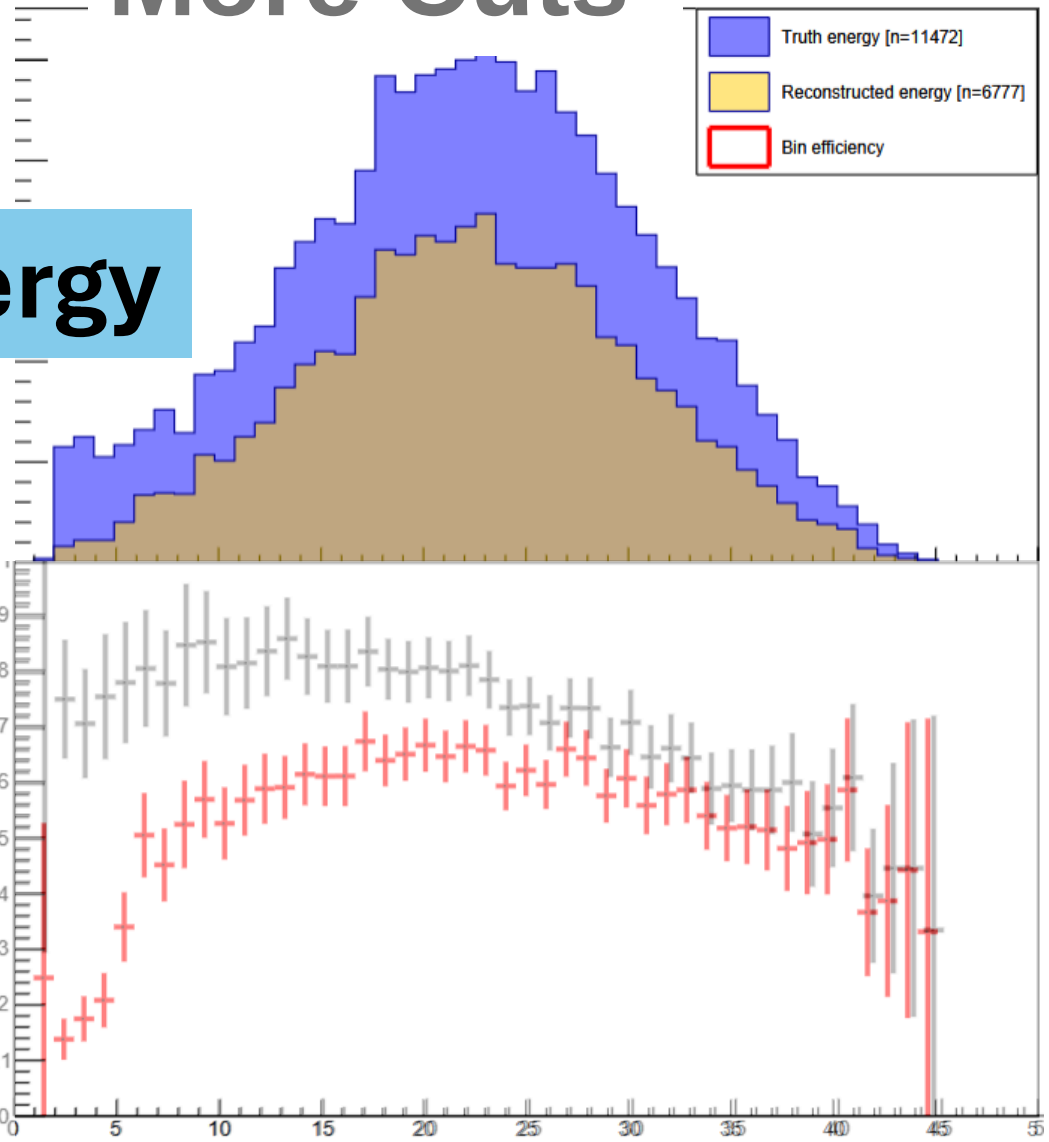
More Cuts



Less Cuts



More Cuts

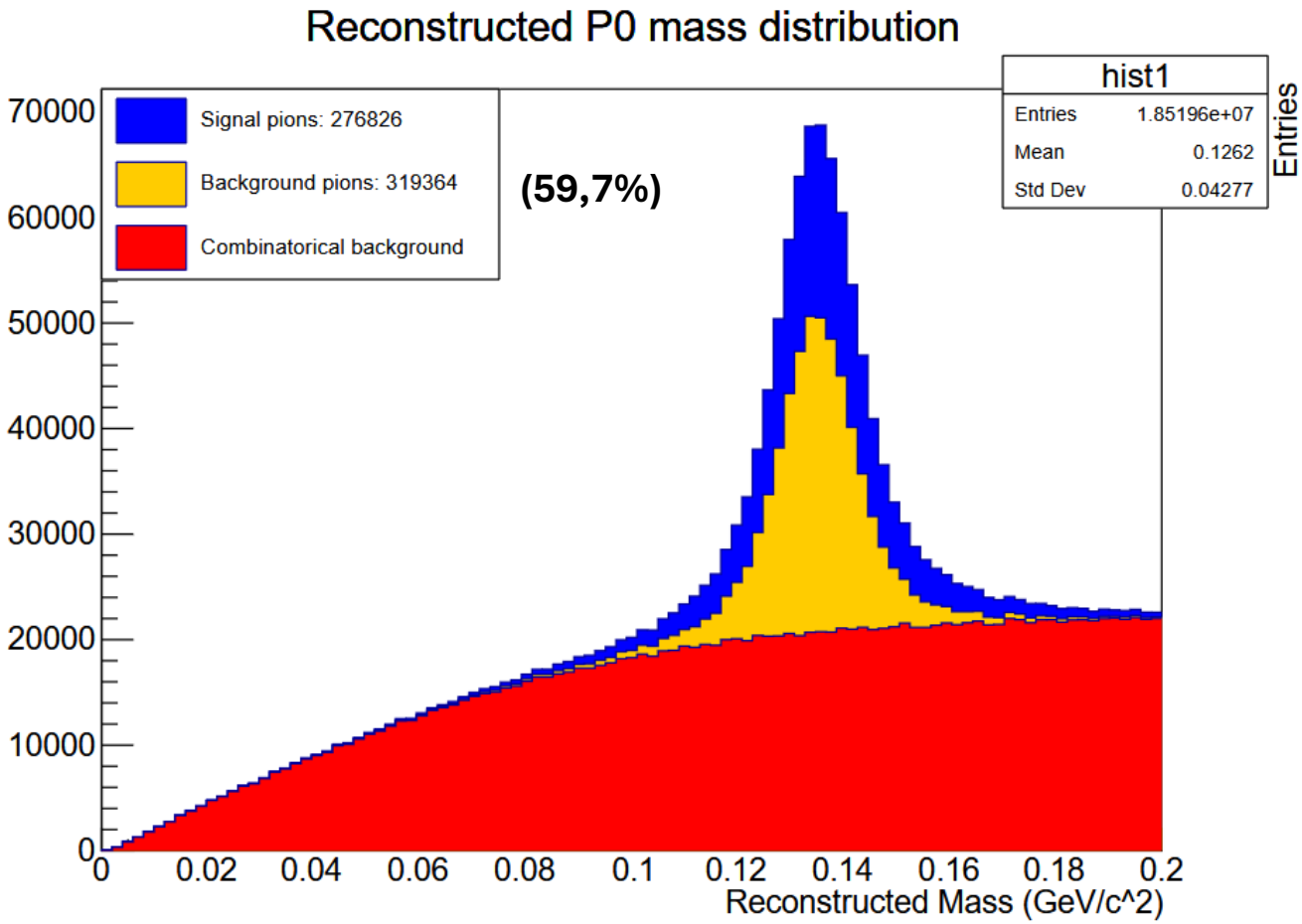


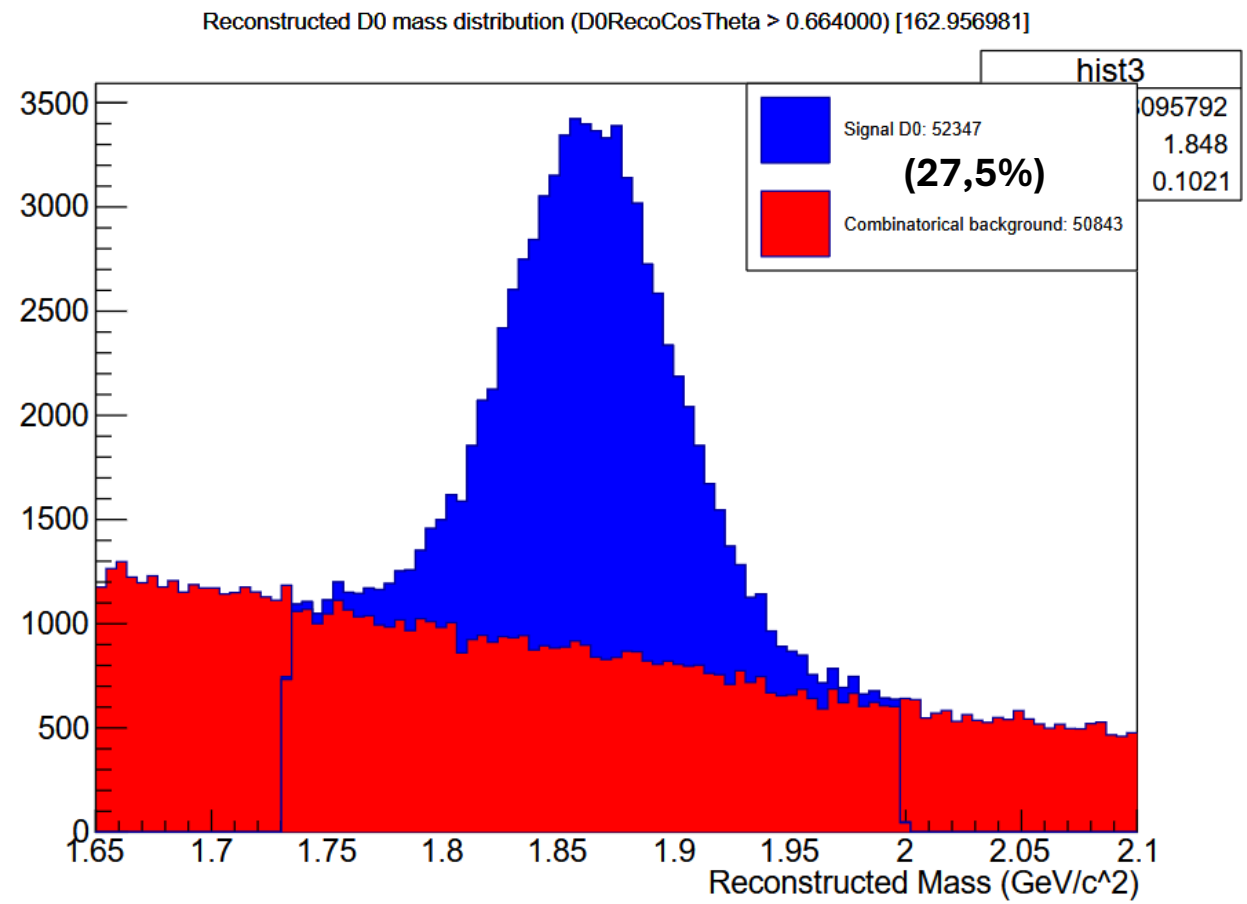
D0 Energy

Thanks for listening ☺

Annexe

Best result old sampls (purity: 18.75 (51% Signal))





(59,7%)^2 = 35,6 %

79220 Events, 998.817 P0, 189.933 D0

Picture of the whiteboard (next steps)