
Isolated photon analysis in pp collisions at 13 TeV analysis status

--- new XTalk + calibration update

ranxu

Last presentation

- ✦ comparing mainly analysis result between EMCal and DCal

 - after acceptance normalization, combined spectrum ratio ~ 0.8 (DCal / EMCal).

 - efficiency ratio around 0.7 which comes from reconstruct level.

- ★ there is an active investigation on the discrepancy, that investigation per SM and per SM sub-regions is not conclusive yet. (More information in [here](#))

Outline

- ✦ Updated configure check

 - ✦ remove GJ evt with $p_{T,prompt}/p_{T,hard} > 2$

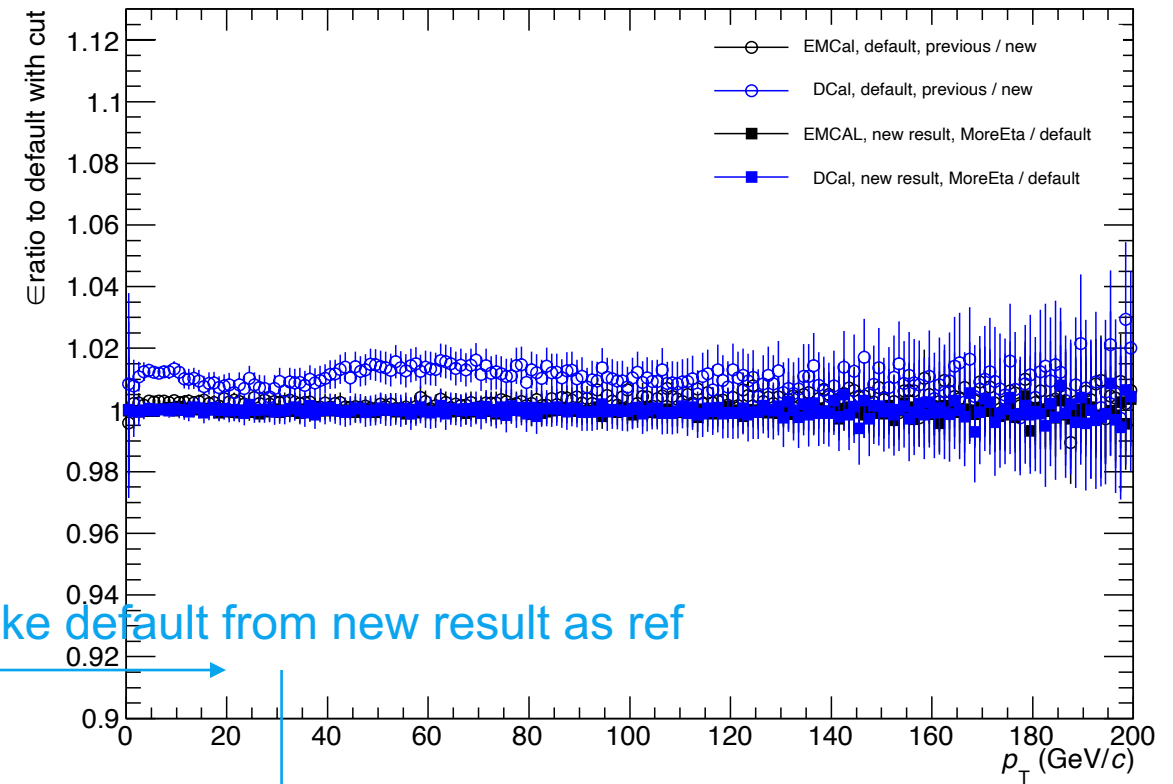
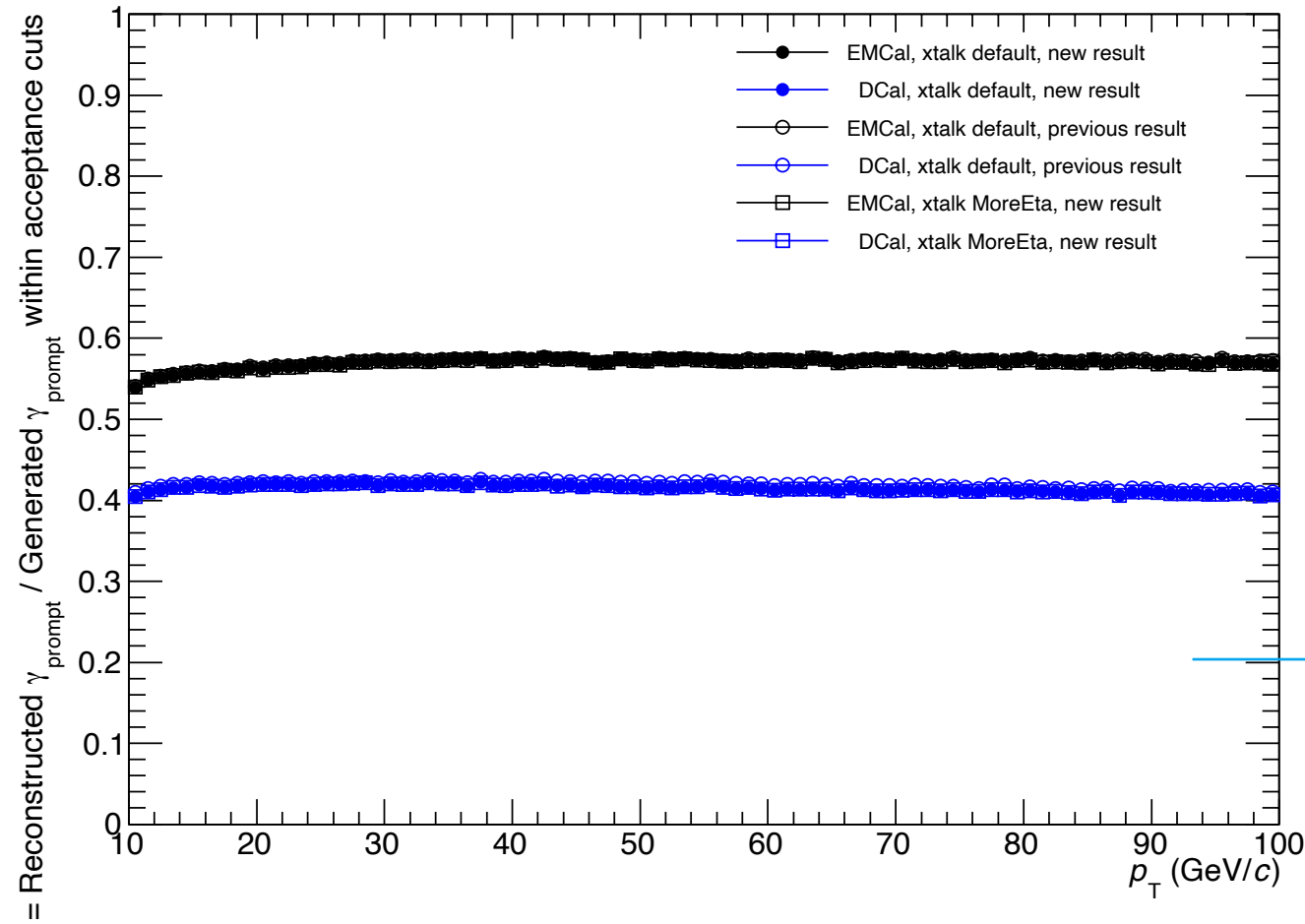
 - ✦ Update XTalk Parameter (MoreCenEta)

- ✦ Analysis main plot update

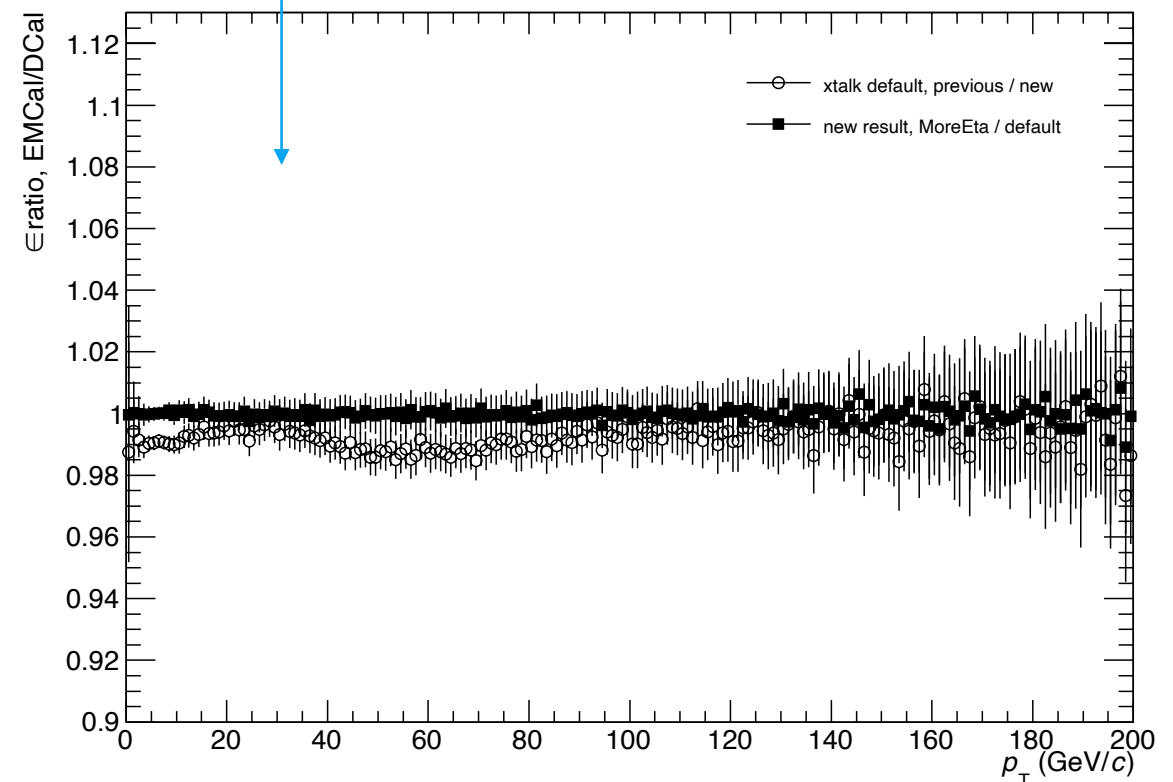
 - ✦ results with different XTalk

 - ✦ results comparison (to previous result, to 7TeV result)

Generated prompt photon efficiency

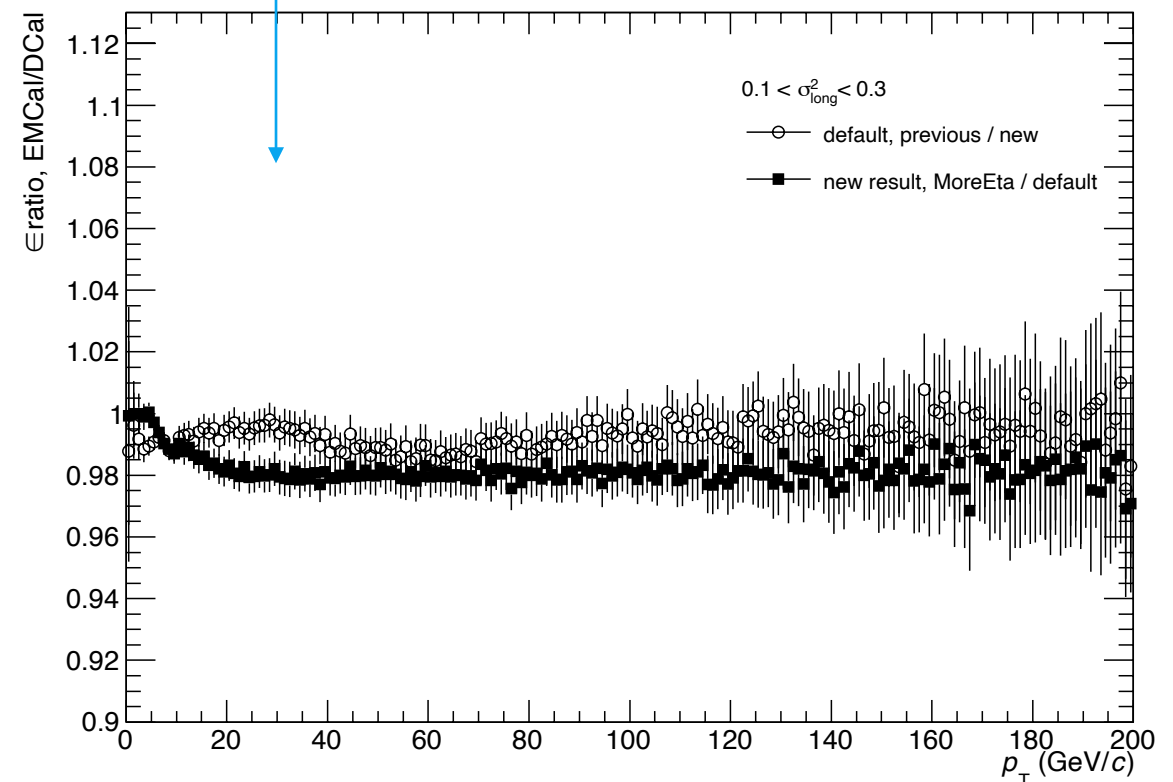
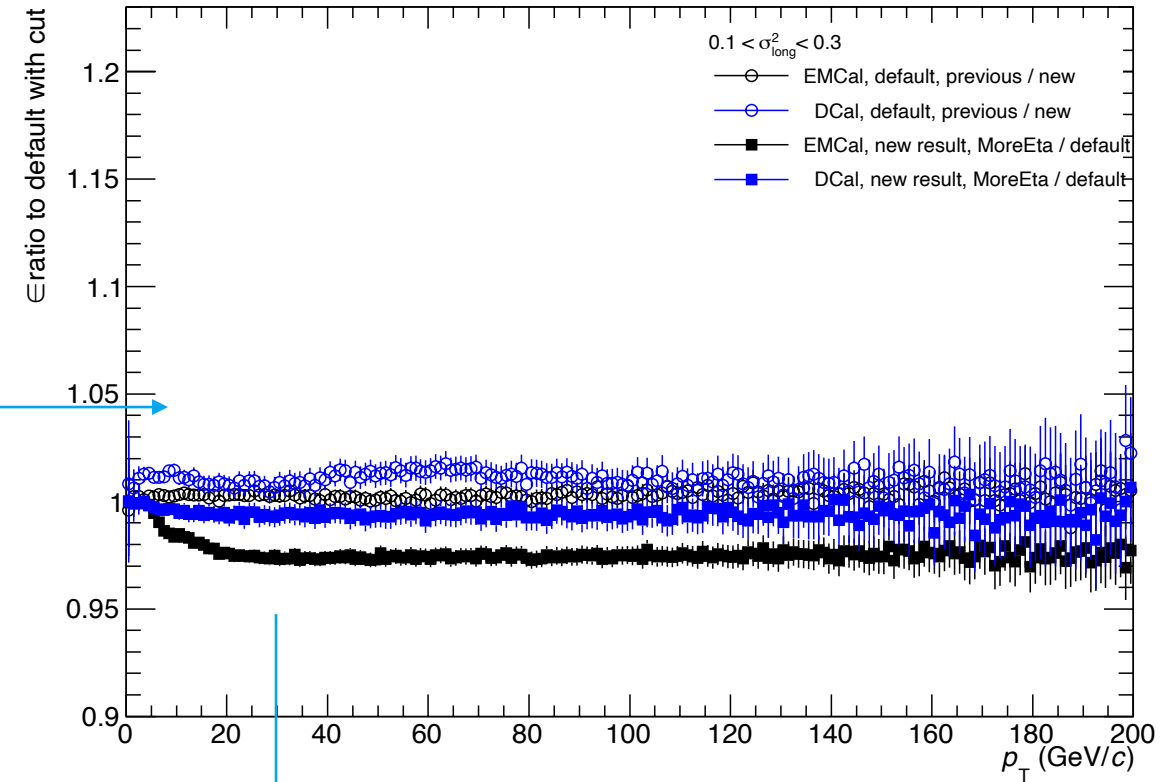
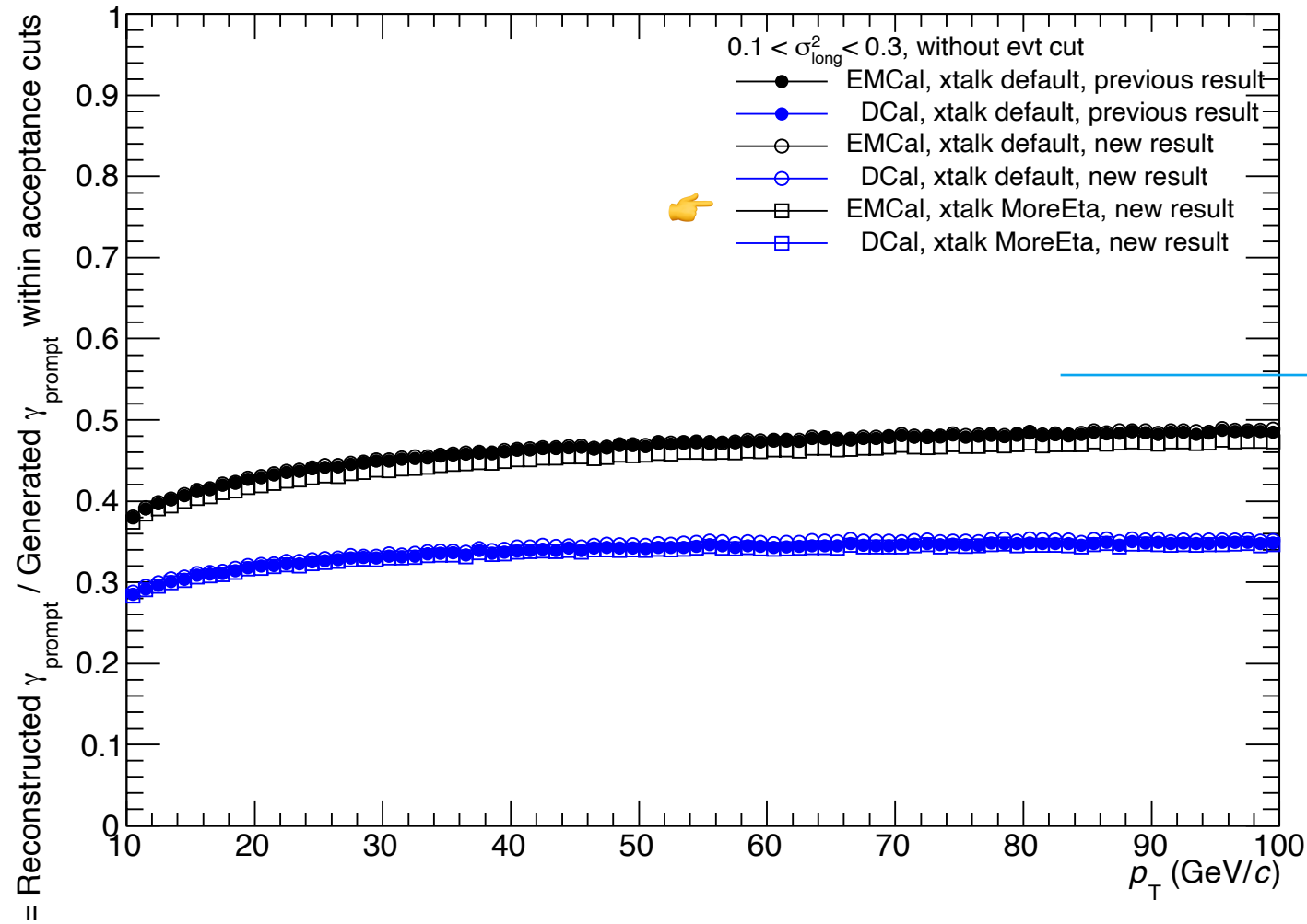


Take default from new result as ref



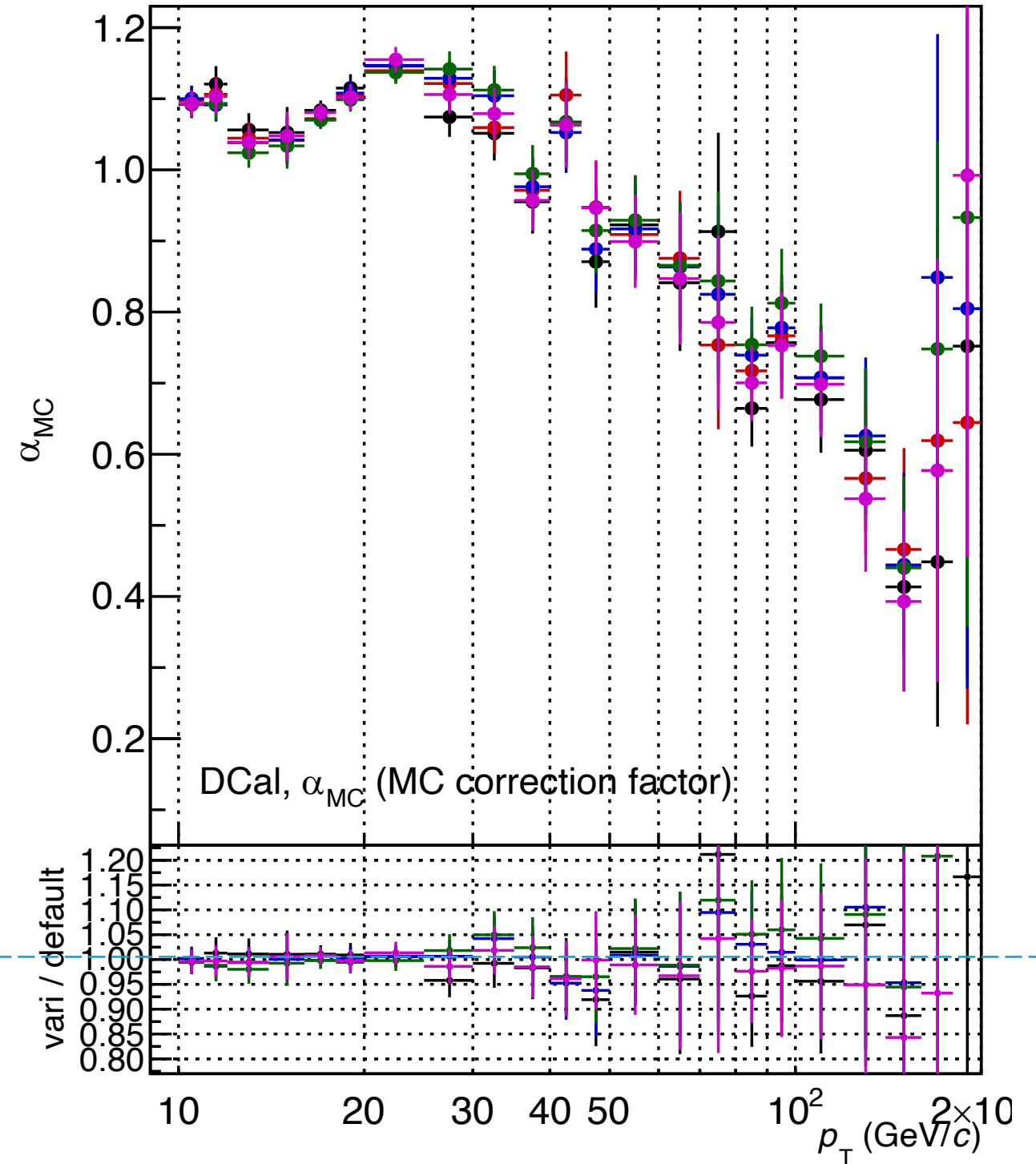
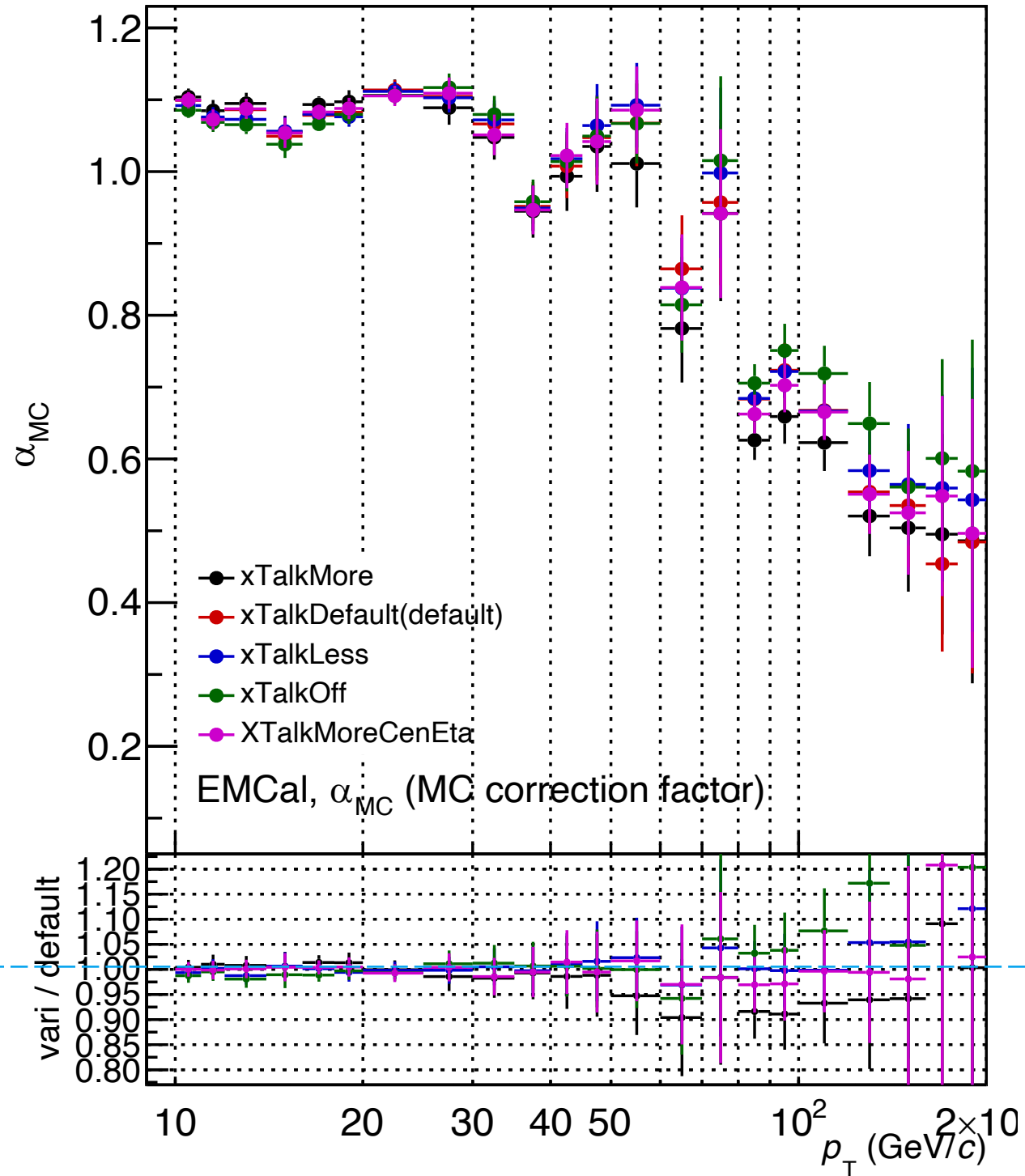
- Raw cluster efficiency, no shower shape cut applied.
- No rapidity cut, just pure detector acceptance
- XTalk default distribution lower than before in DCal, need check?
(it is ~ 1.0 after signal shower shape cut, see next slides)

Generated prompt photon efficiency, signal cut



- Raw cluster efficiency, no shower shape cut applied.
- No rapidity cut, just pure detector acceptance
- No obvious different between previous and new default cases
- EMCal changes after MoreCenterEta xtalk apply, as expect

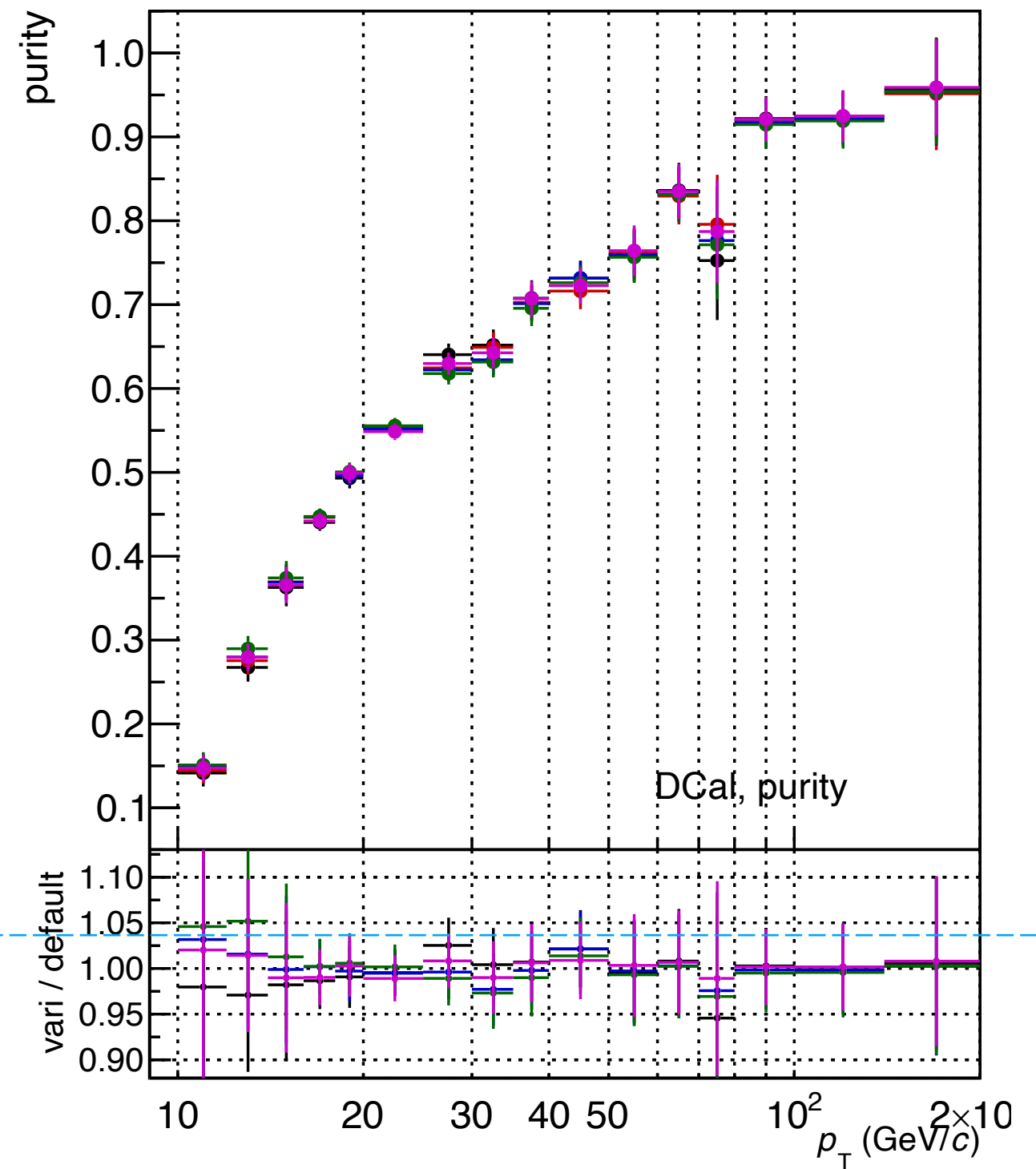
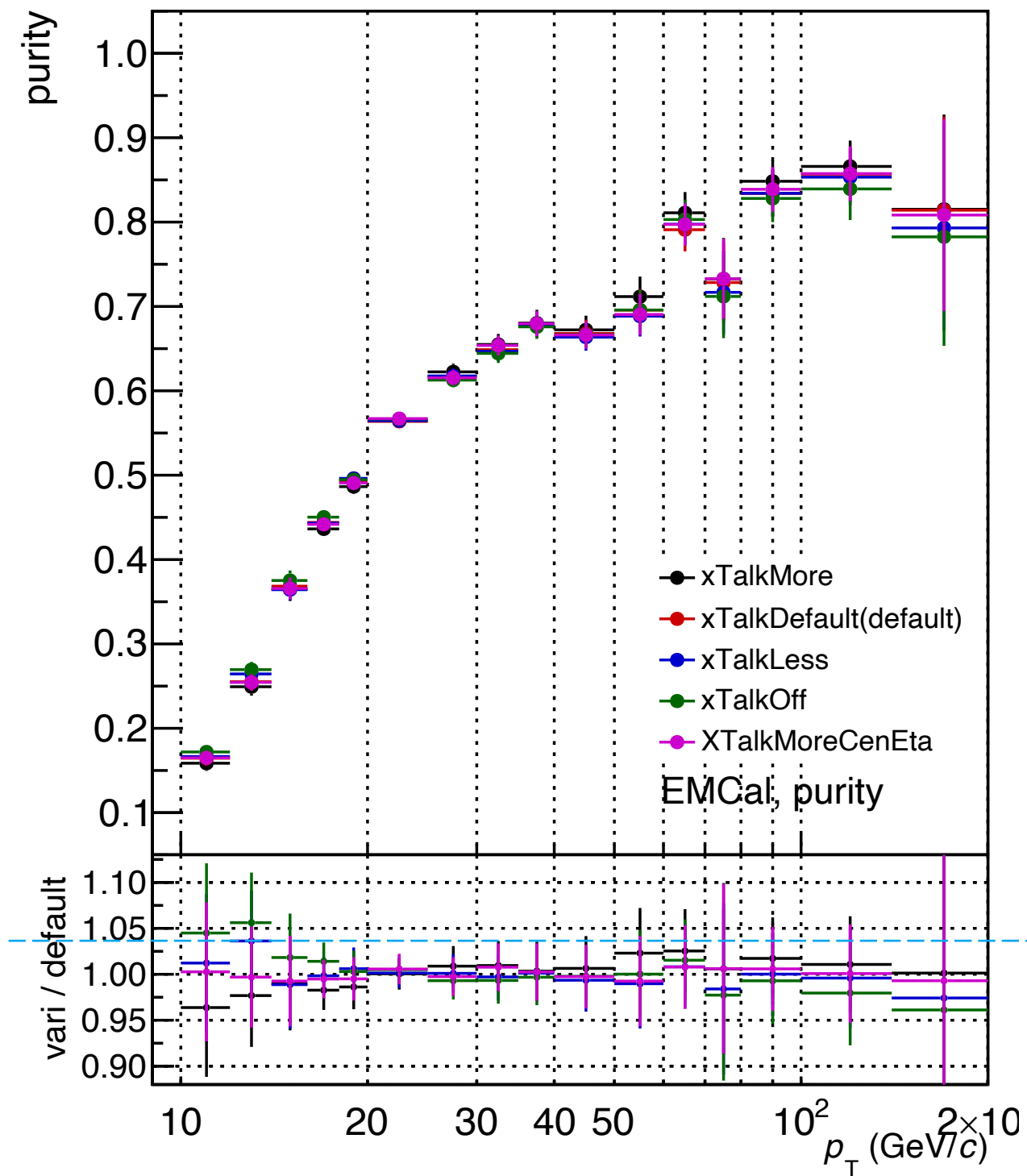
Purity component



No significant differences for different XTalk in EMCal and DCal.

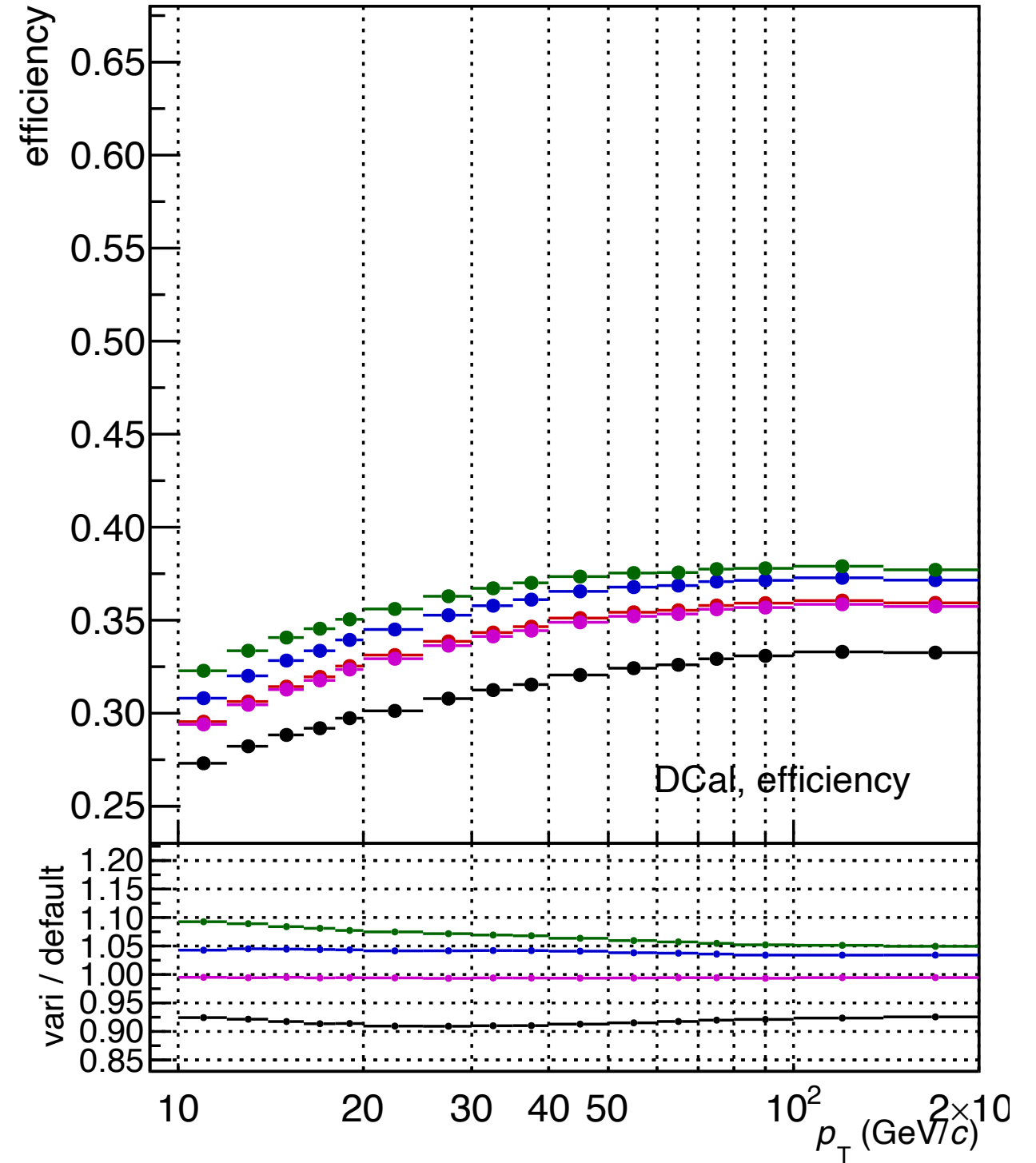
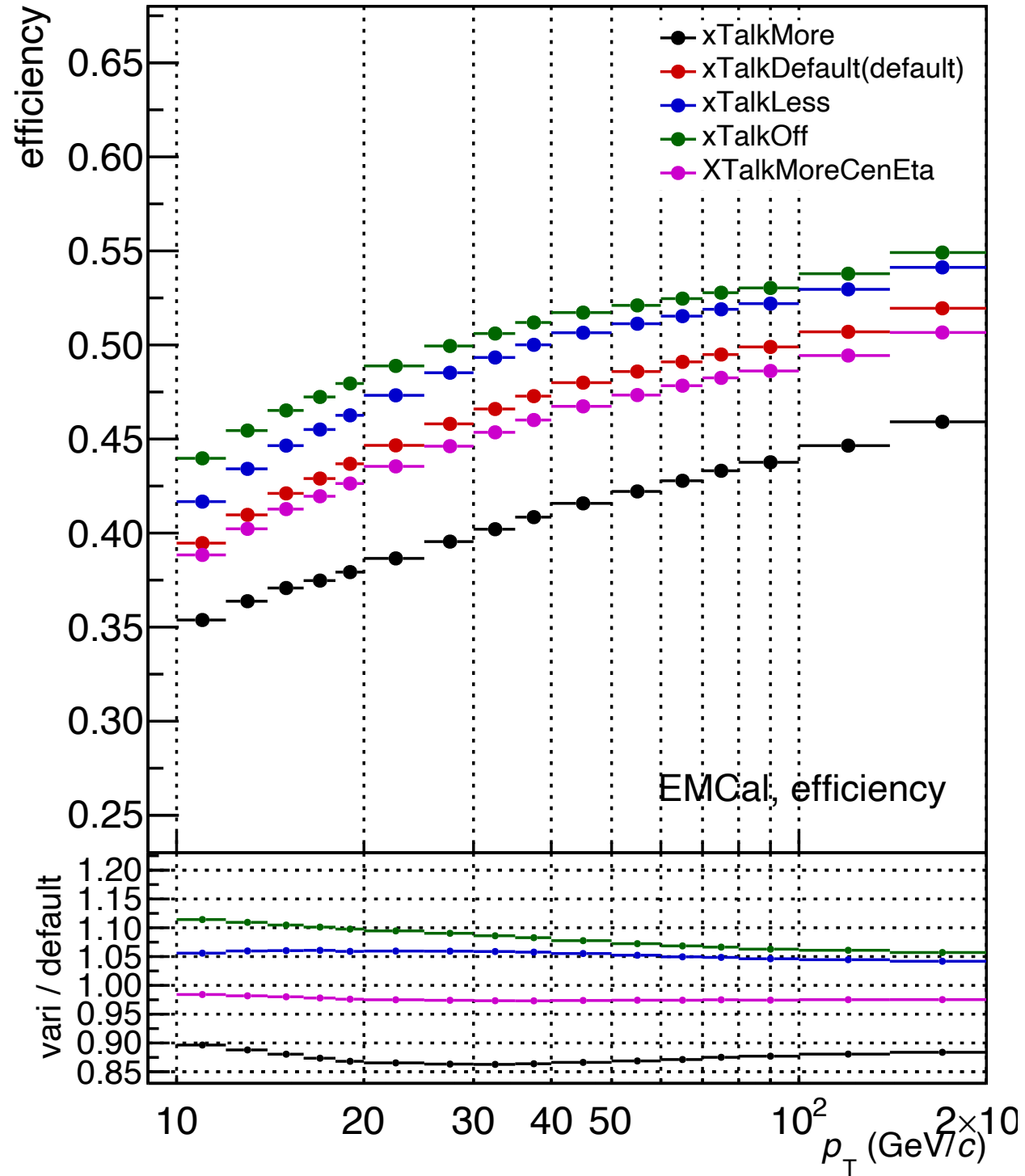
Purity by data-driven doesn't affect by XTalk, compare to previous see [back up](#).

Purity



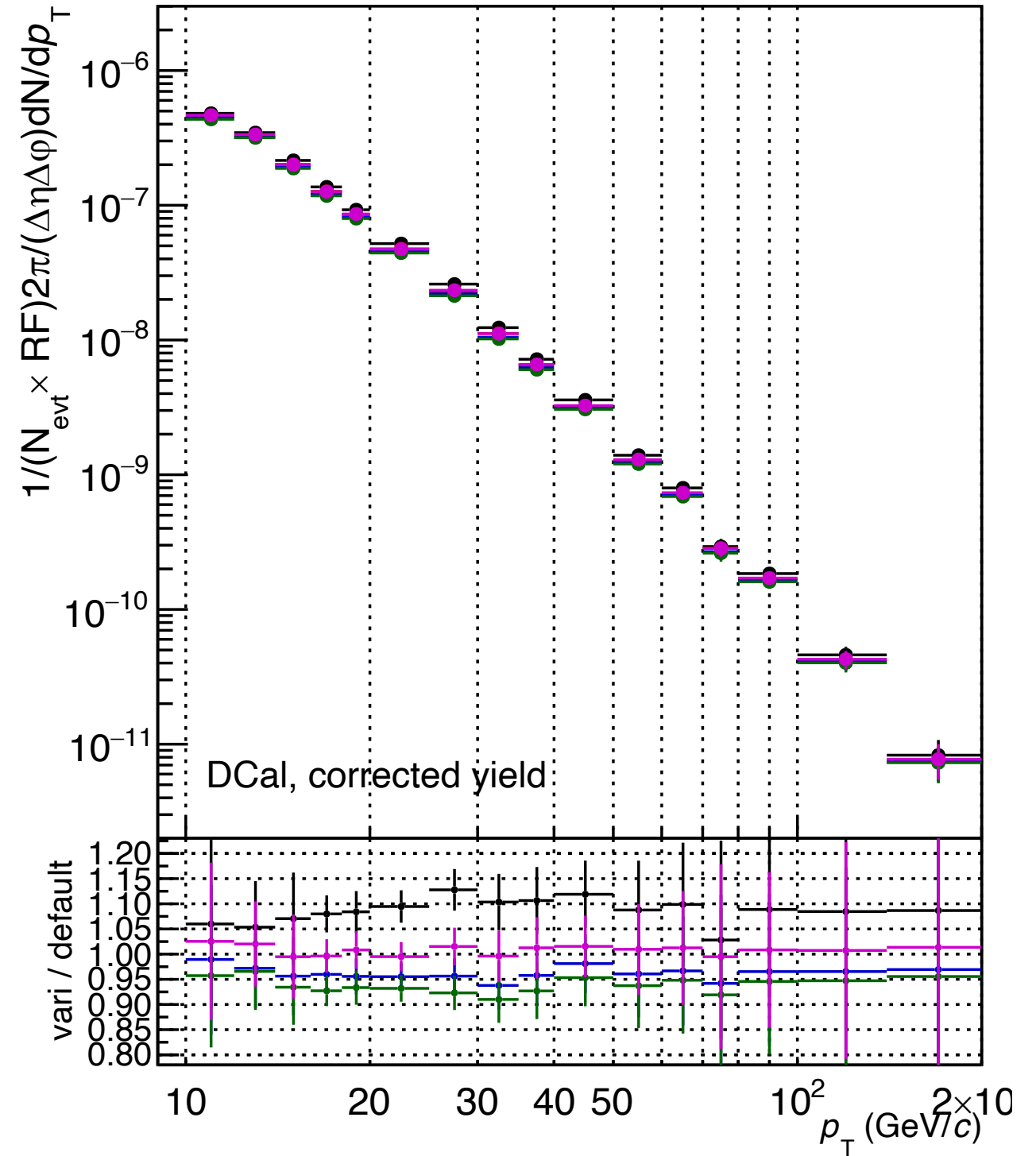
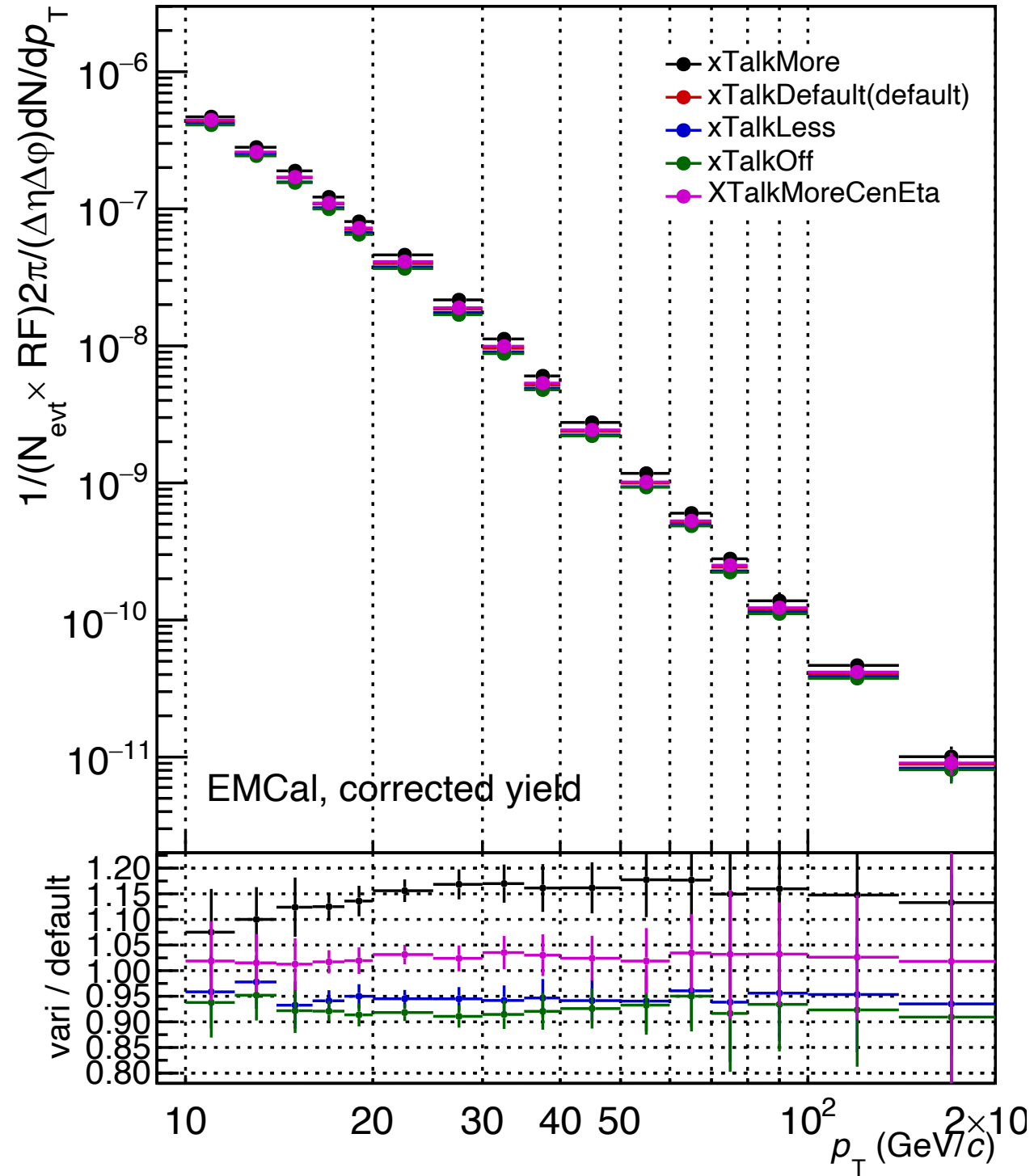
No significant differences for different XTalk in EMCal and DCal

Efficiency



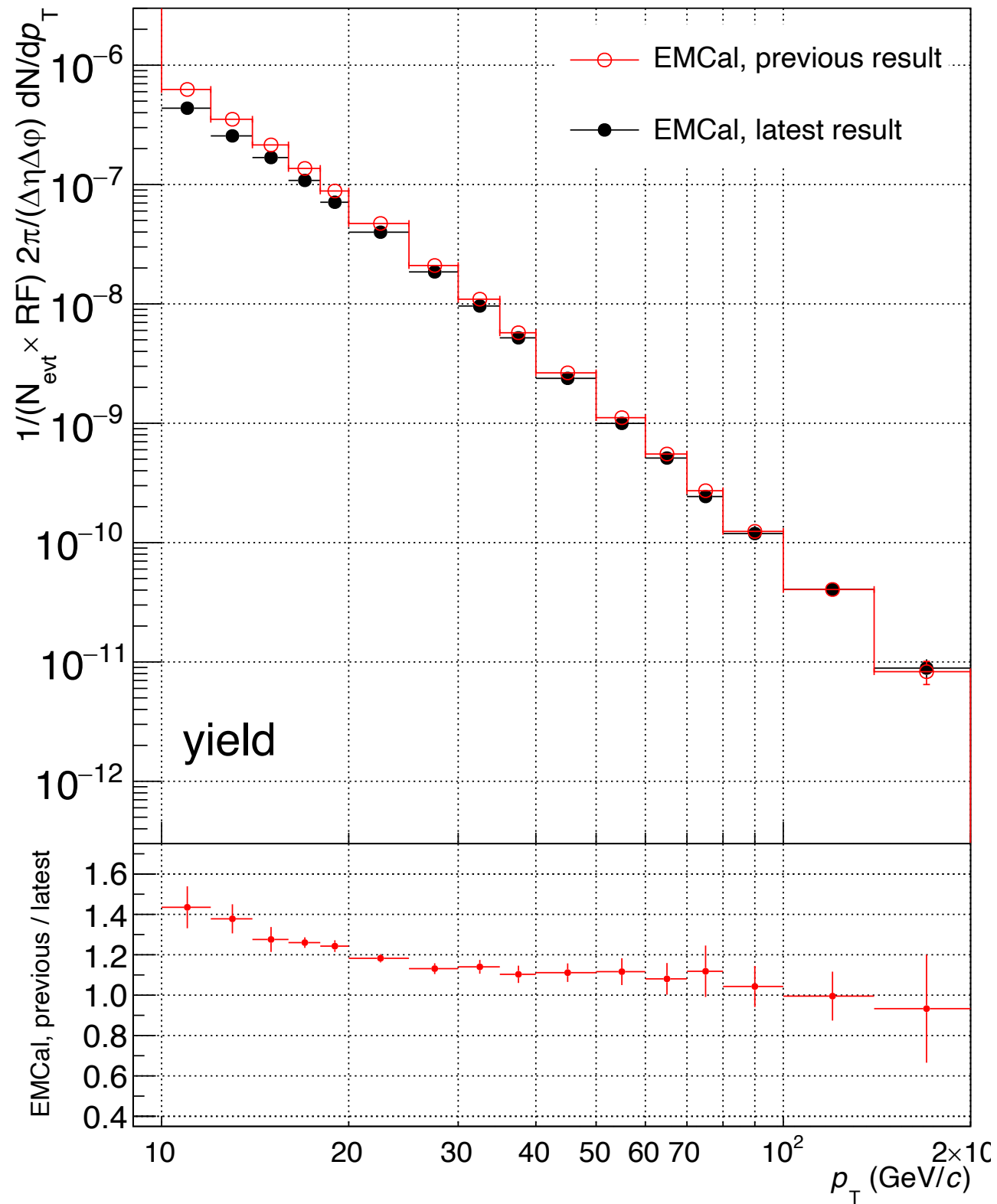
XTalk MoreCentEta are between default and More, as expect

Corrected yield

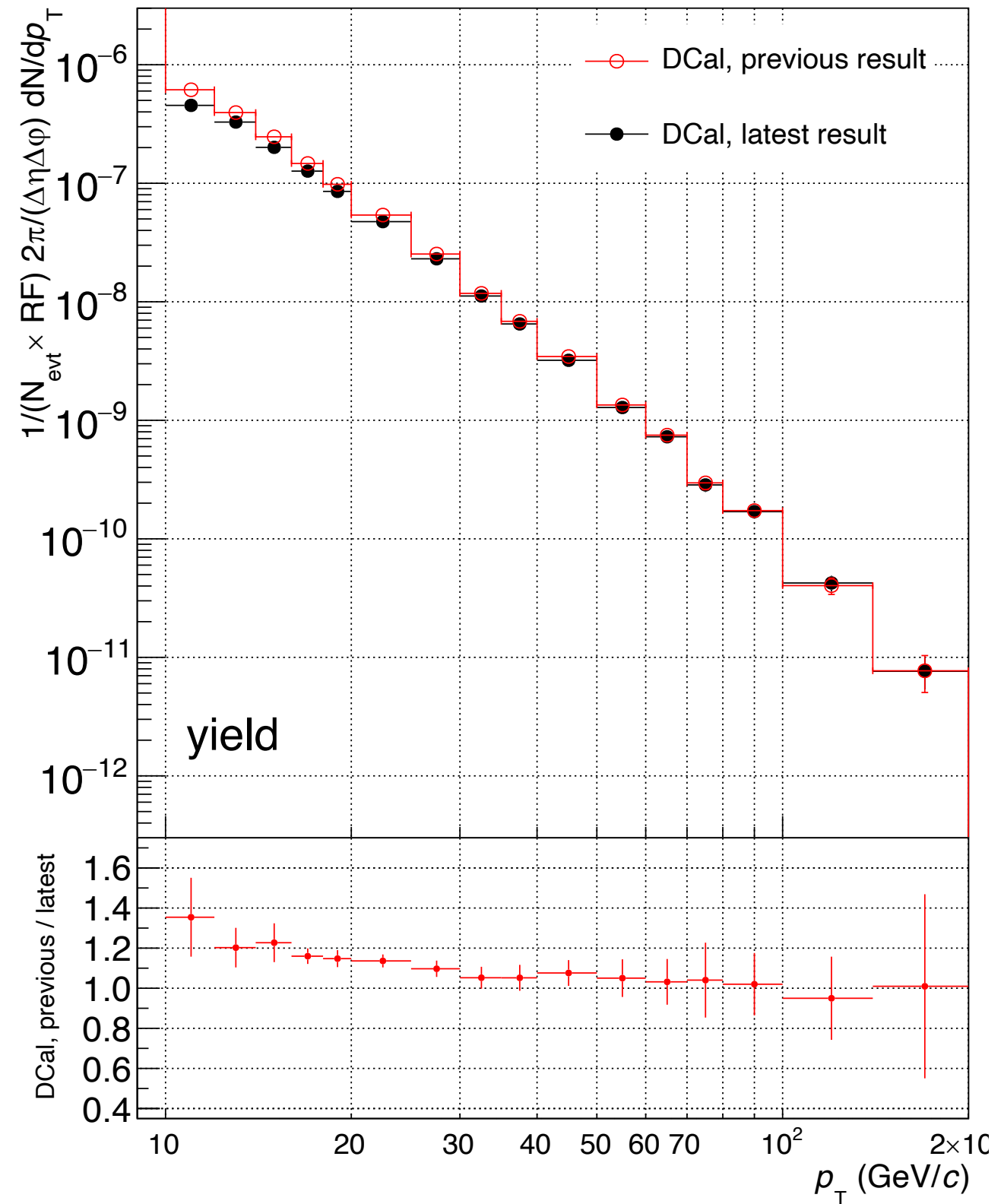


XTalk MoreCentEta are between default and More, as expect

Compare to previous result, XTalk default

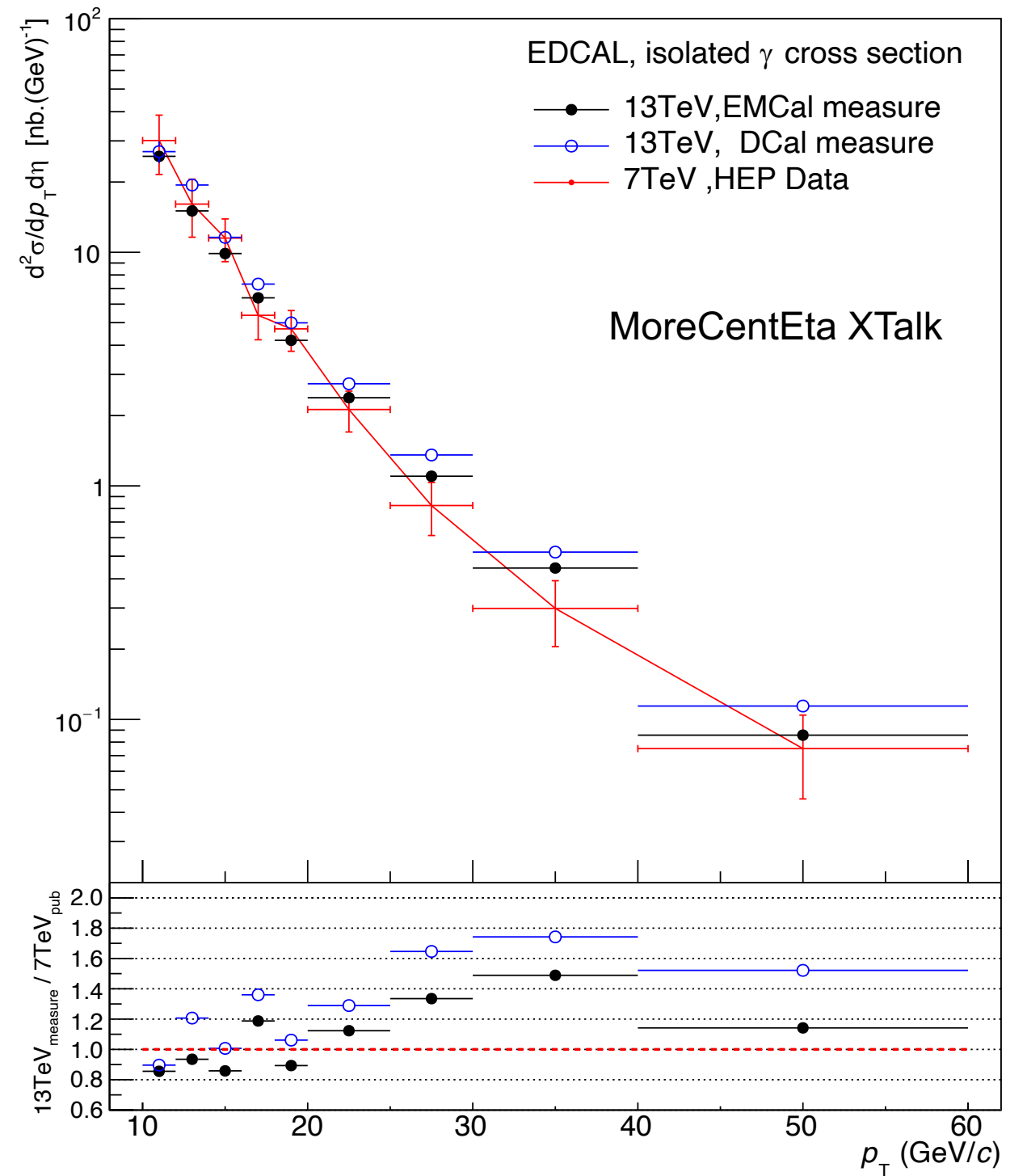
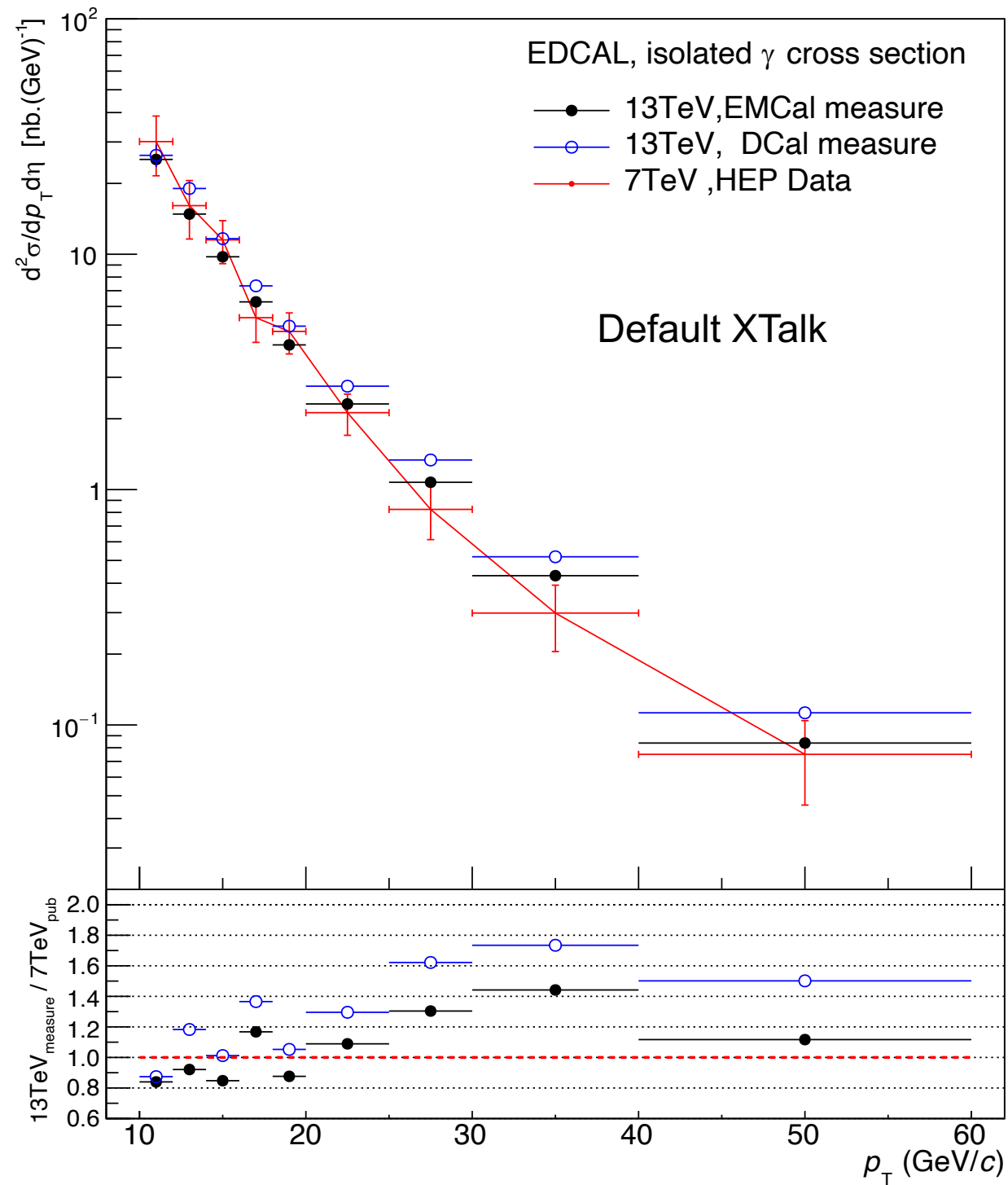


Shape change from raw spectrum



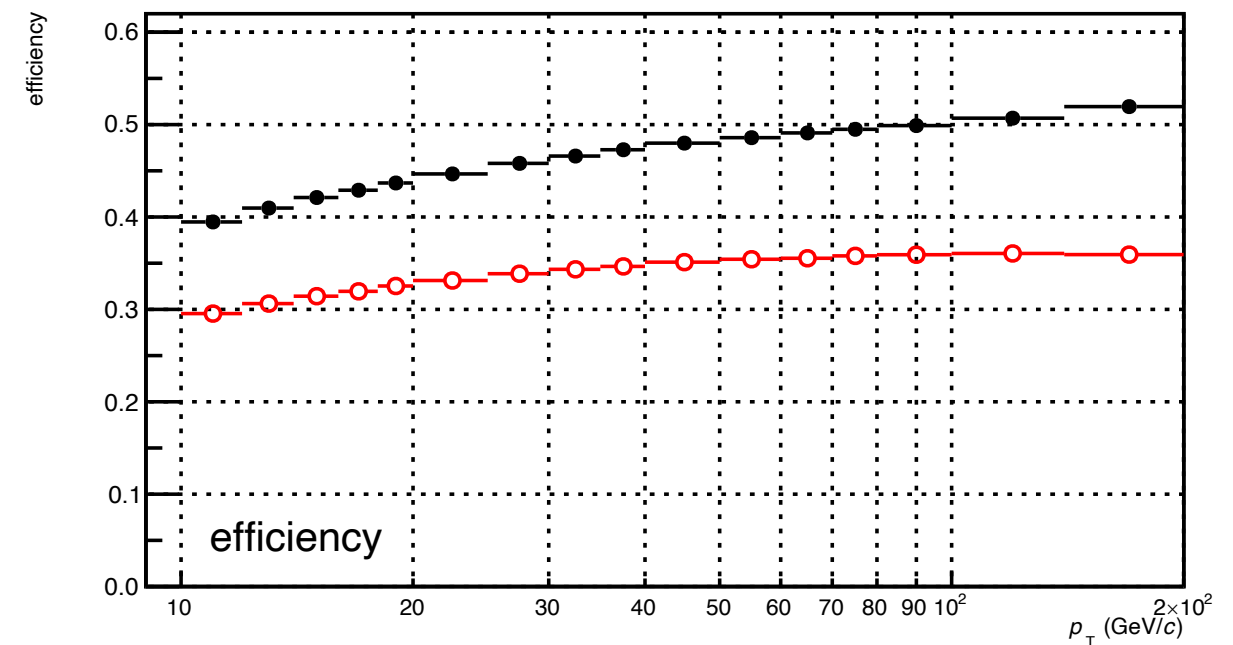
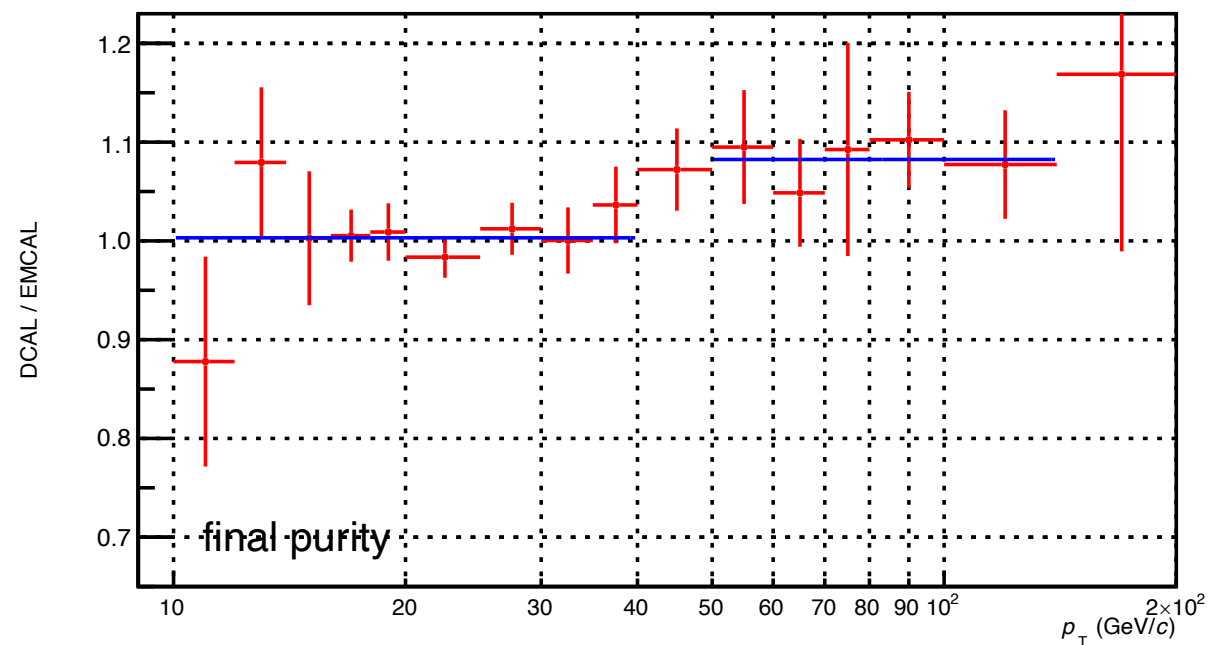
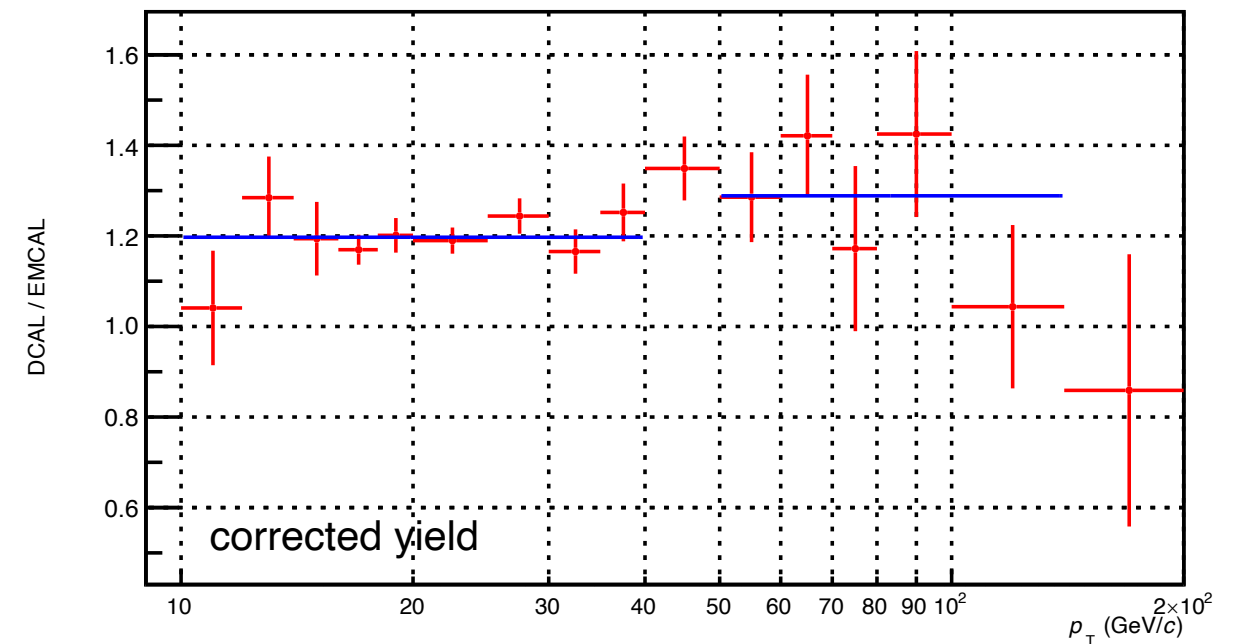
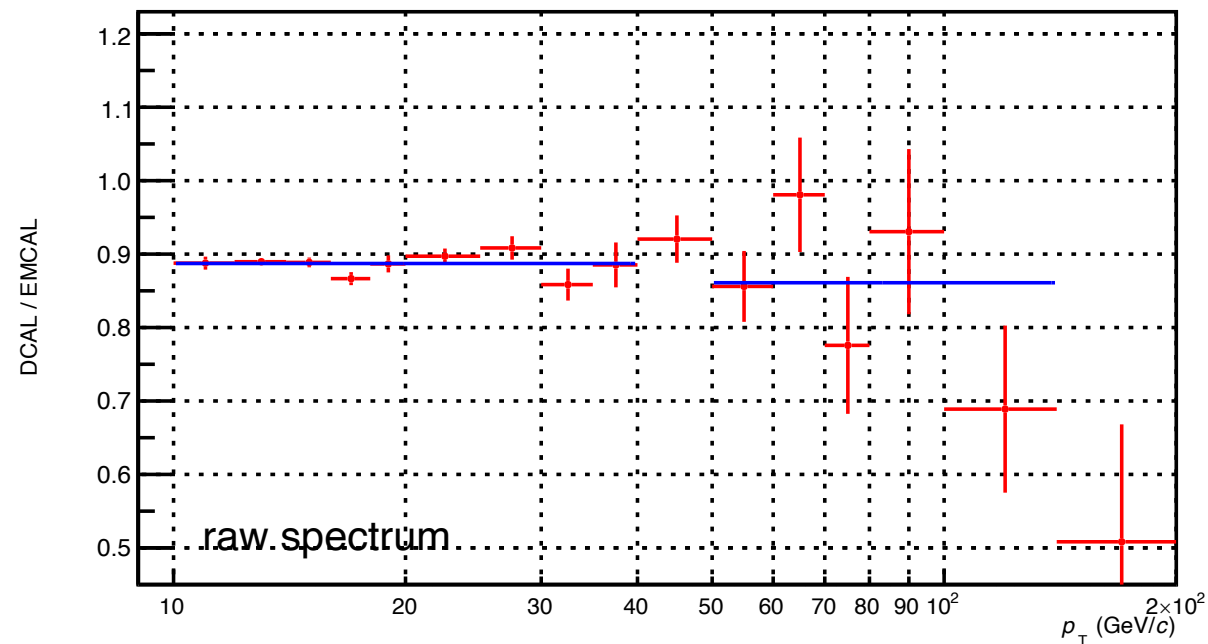
Similar plot for raw distribution in [back up](#)

Compare to 7TeV published



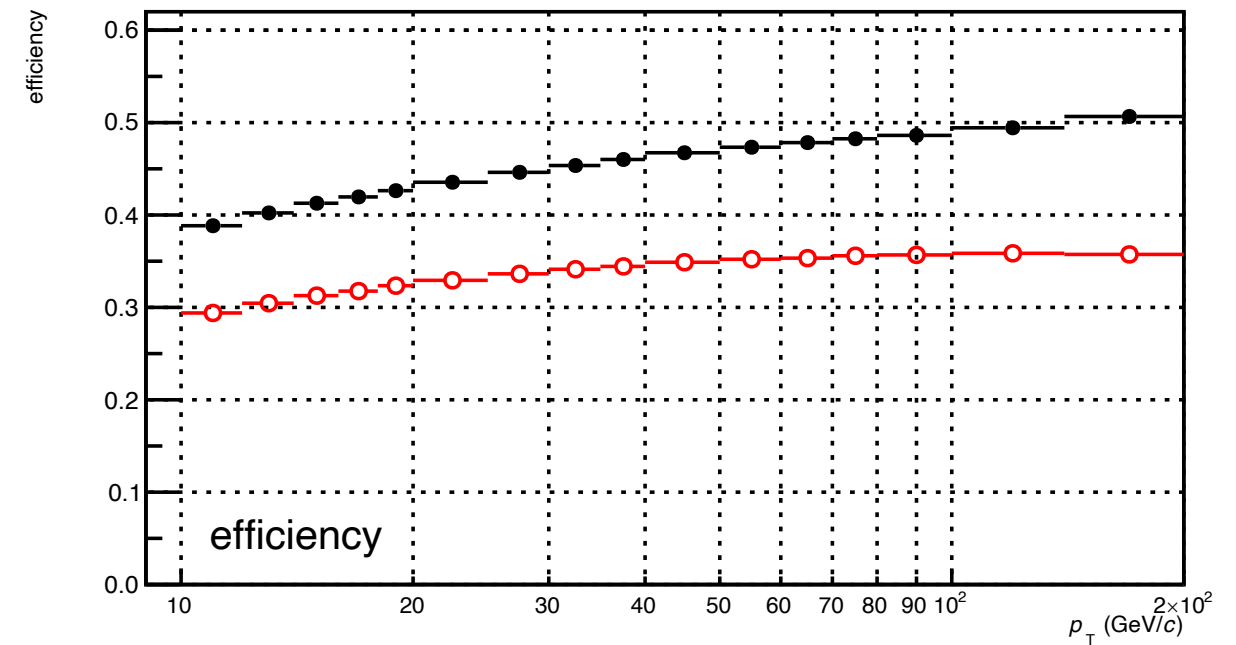
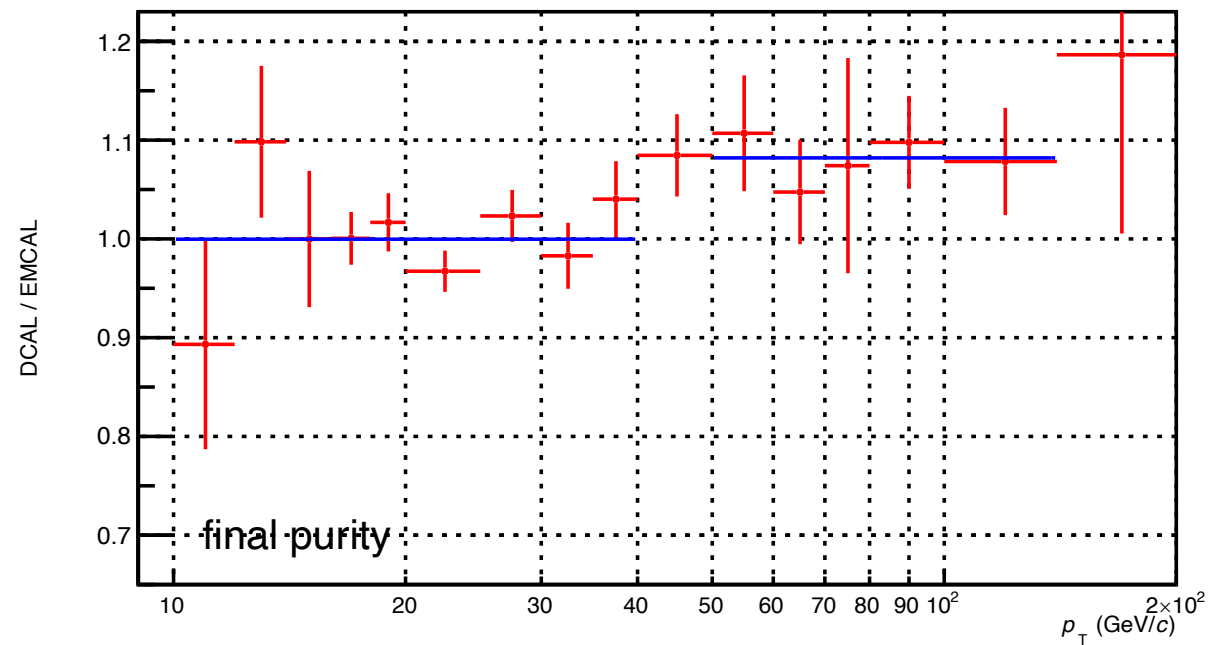
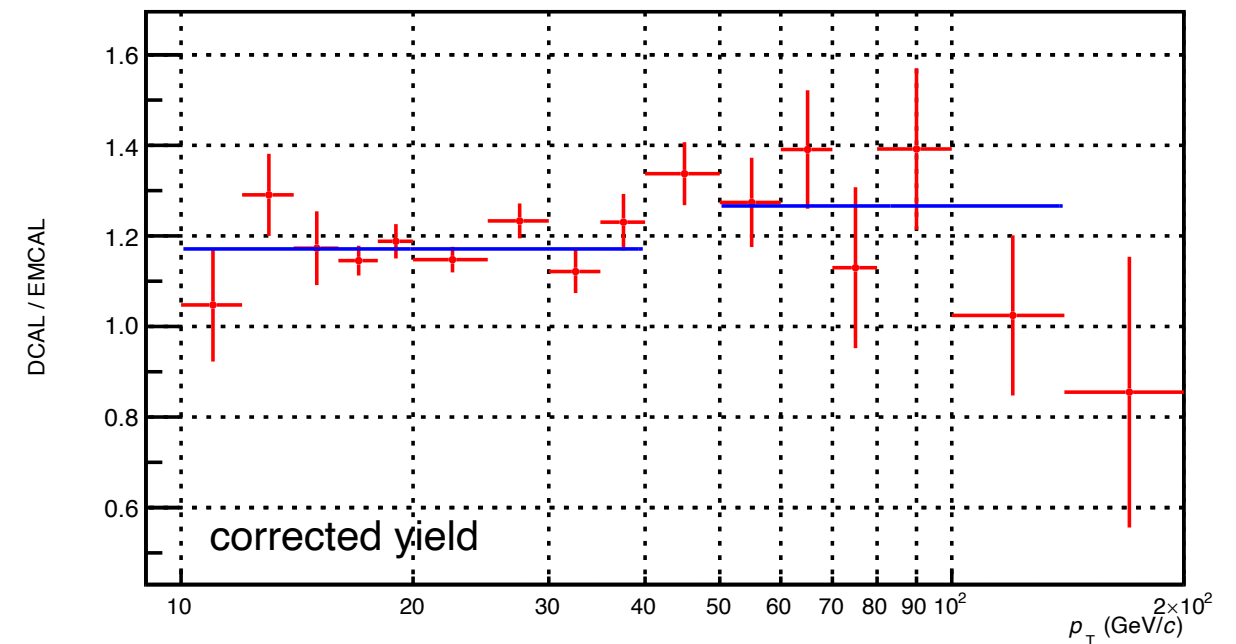
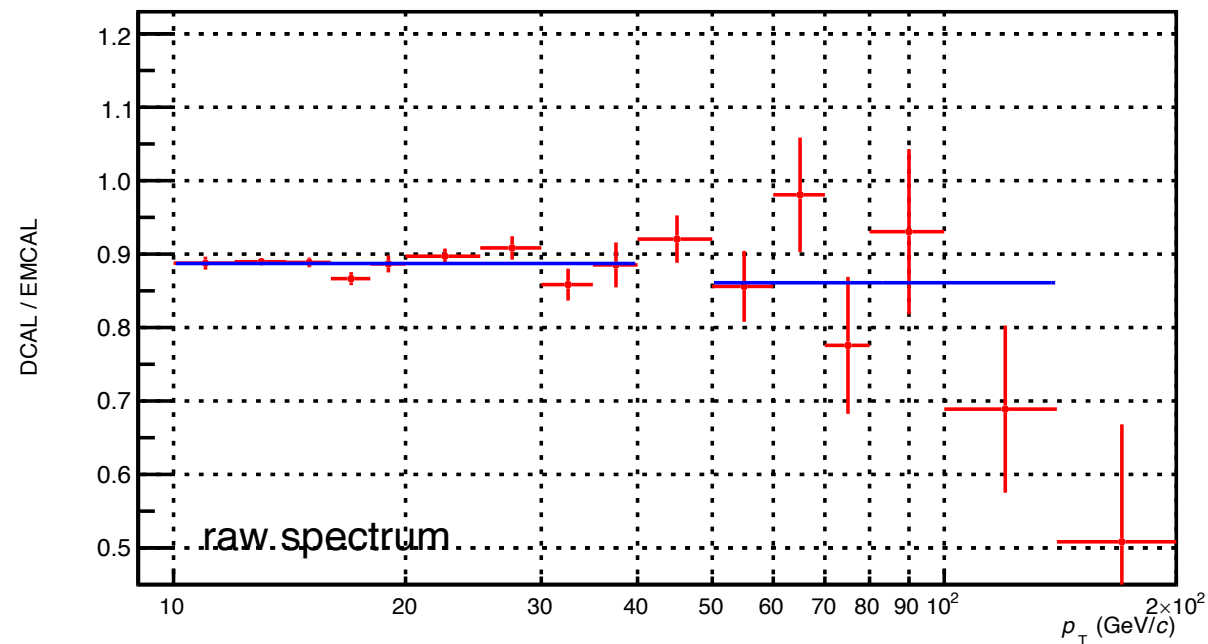
Difference from EMCal and DCal still comes from efficiency, need more check

Analysis result EMCal DCal comparison, XTalk default



	raw spectrum	corrected yield	purity
[10, 40]	0.887 ± 0.003	1.197 ± 0.015	1.003 ± 0.011
[50, 140]	0.861 ± 0.034	1.289 ± 0.064	1.082 ± 0.026

Analysis result EMCal DCal comparison, XTalk MoreCent

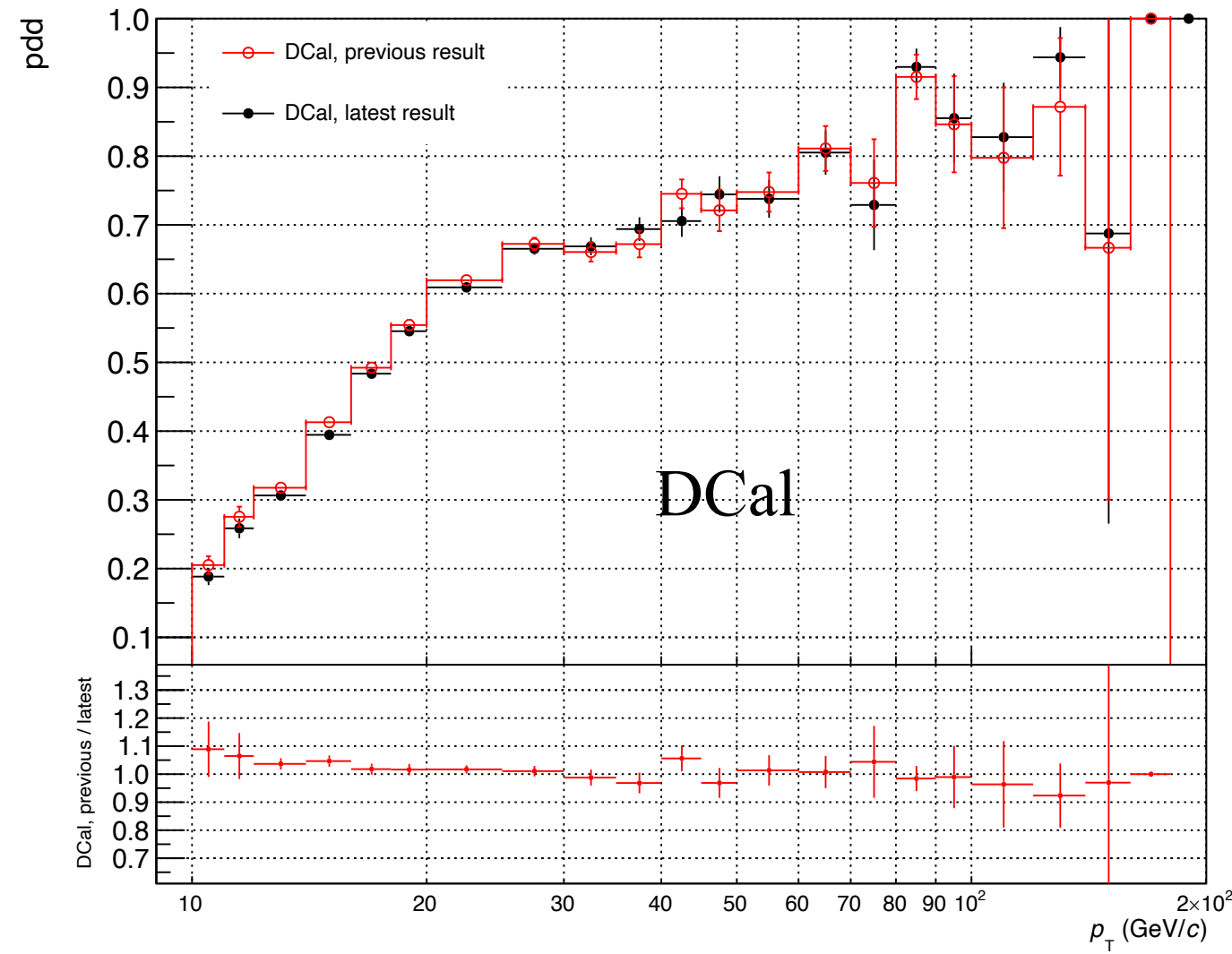
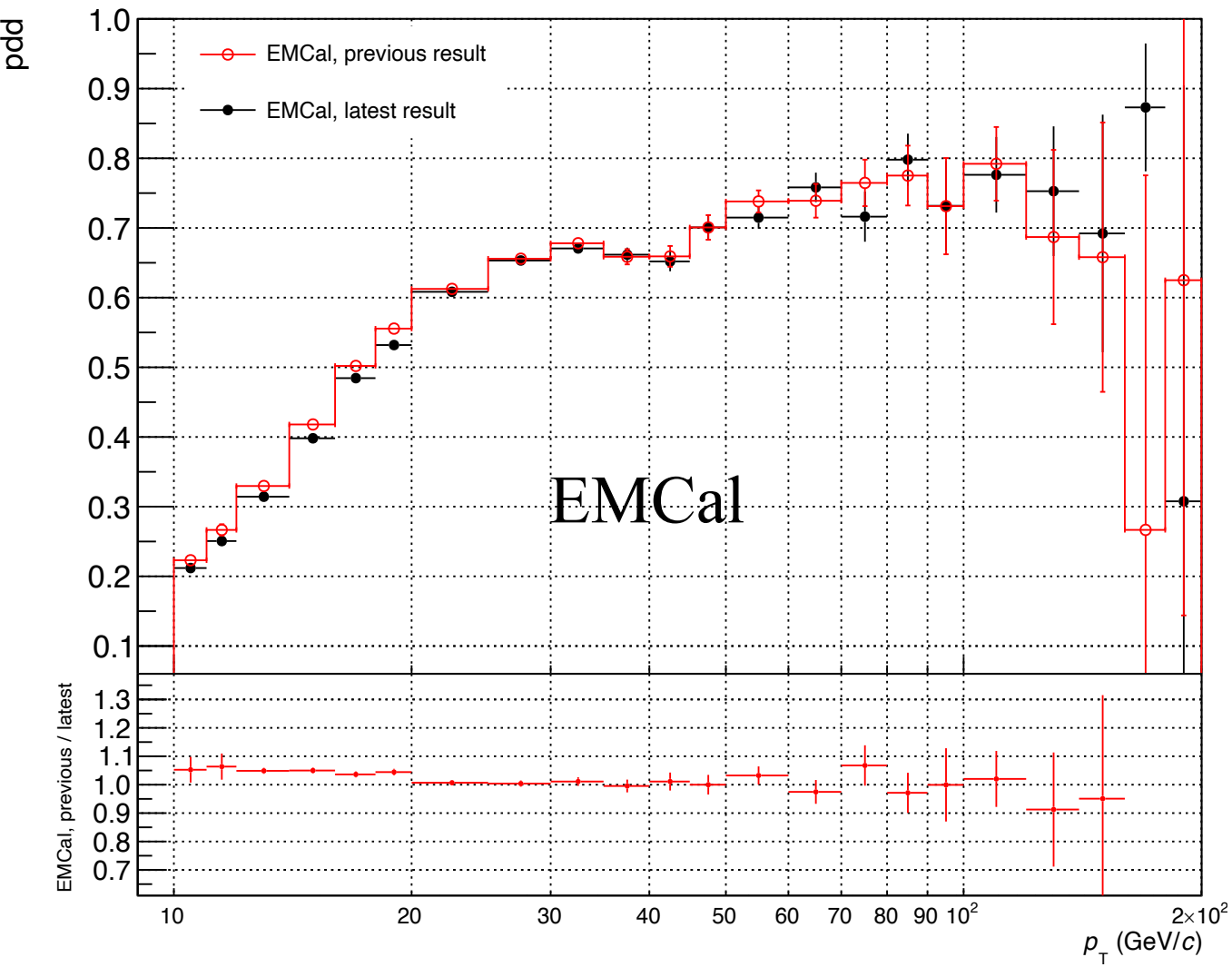


✨ Ratio, DCal/EMCal, has no significant change to the default one !

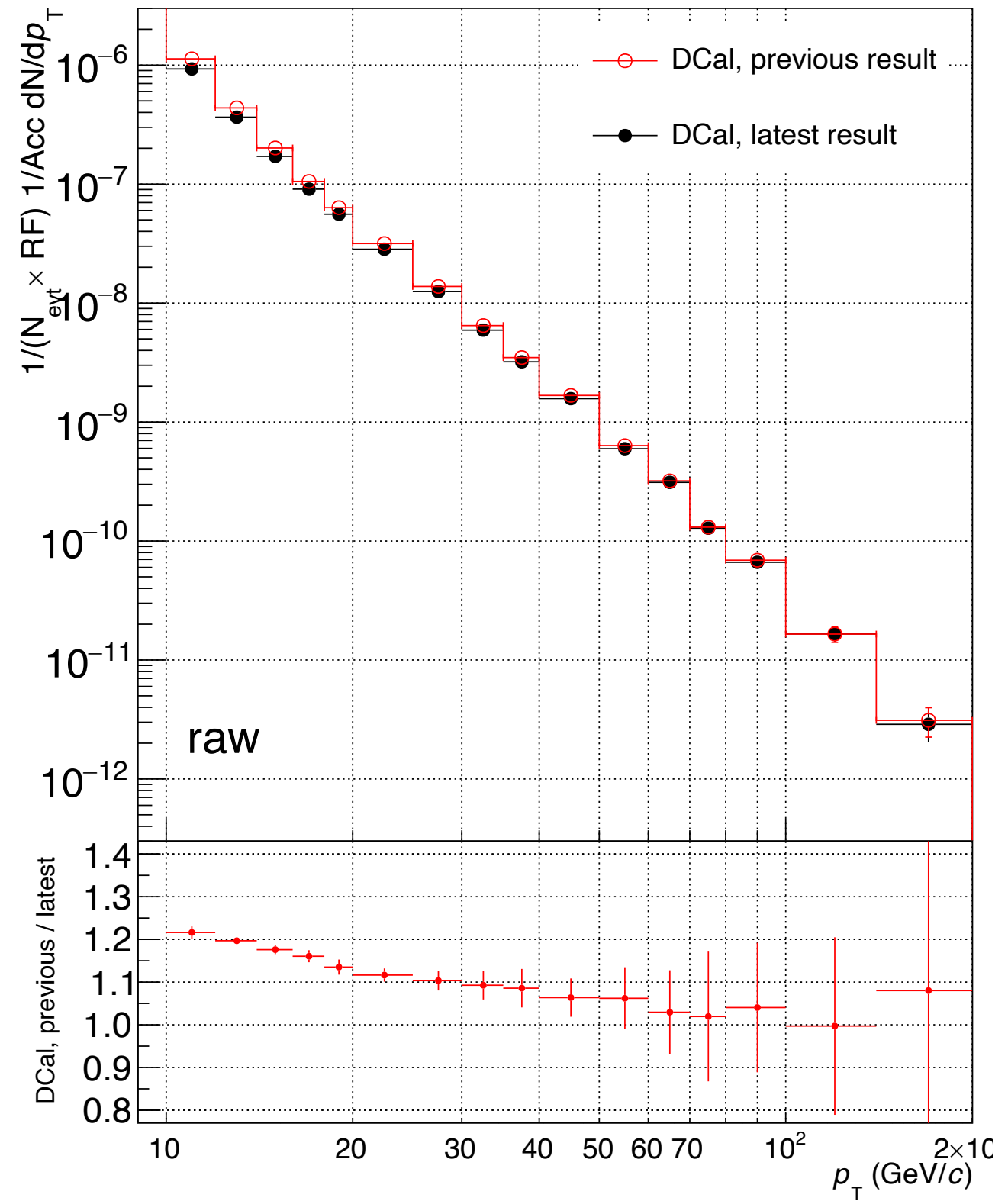
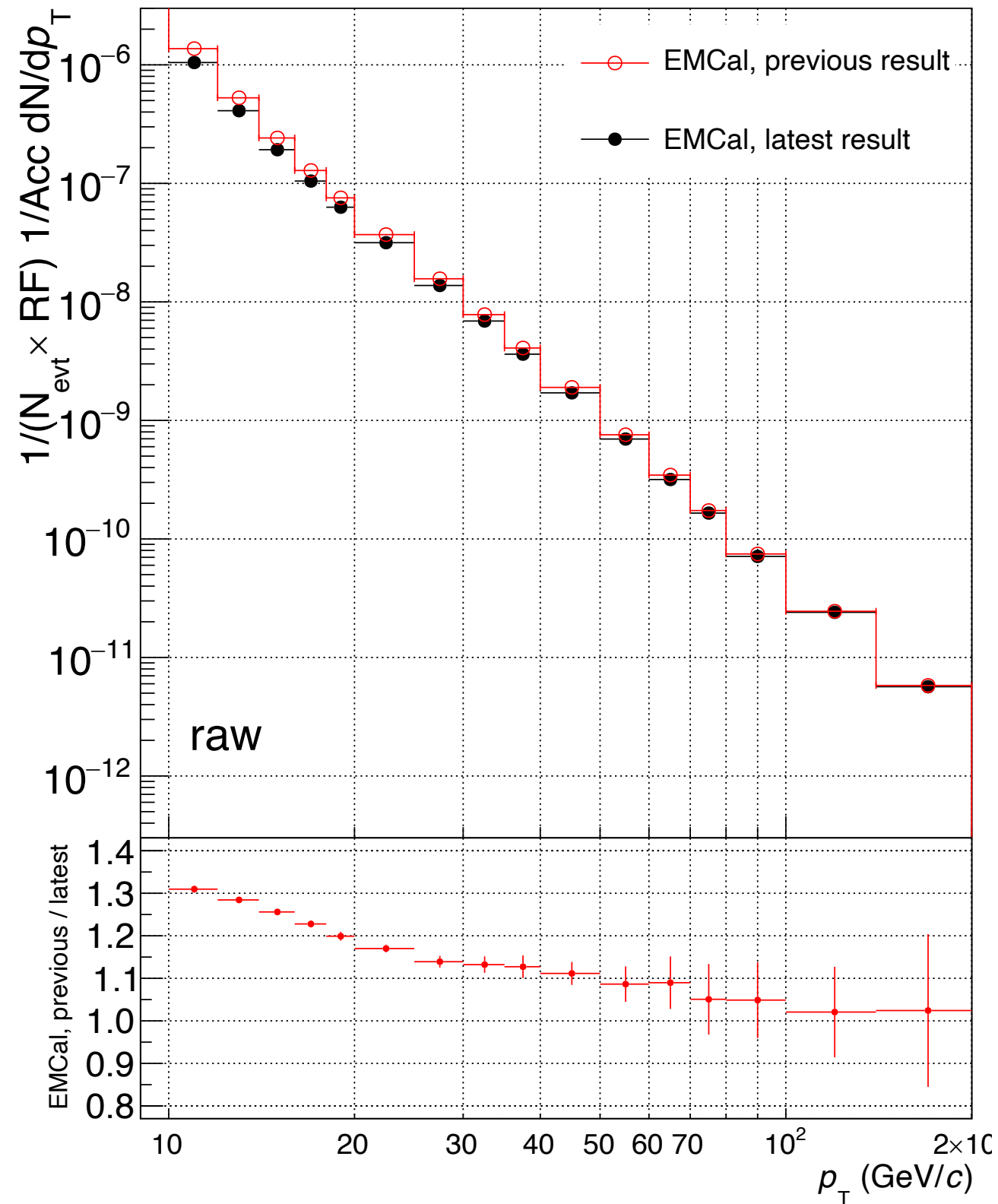
	raw spectrum	corrected yield	purity
[10, 40]	0.887 ± 0.003	1.171 ± 0.015	1.000 ± 0.011
[50, 140]	0.861 ± 0.034	1.266 ± 0.062	1.082 ± 0.026

Back up

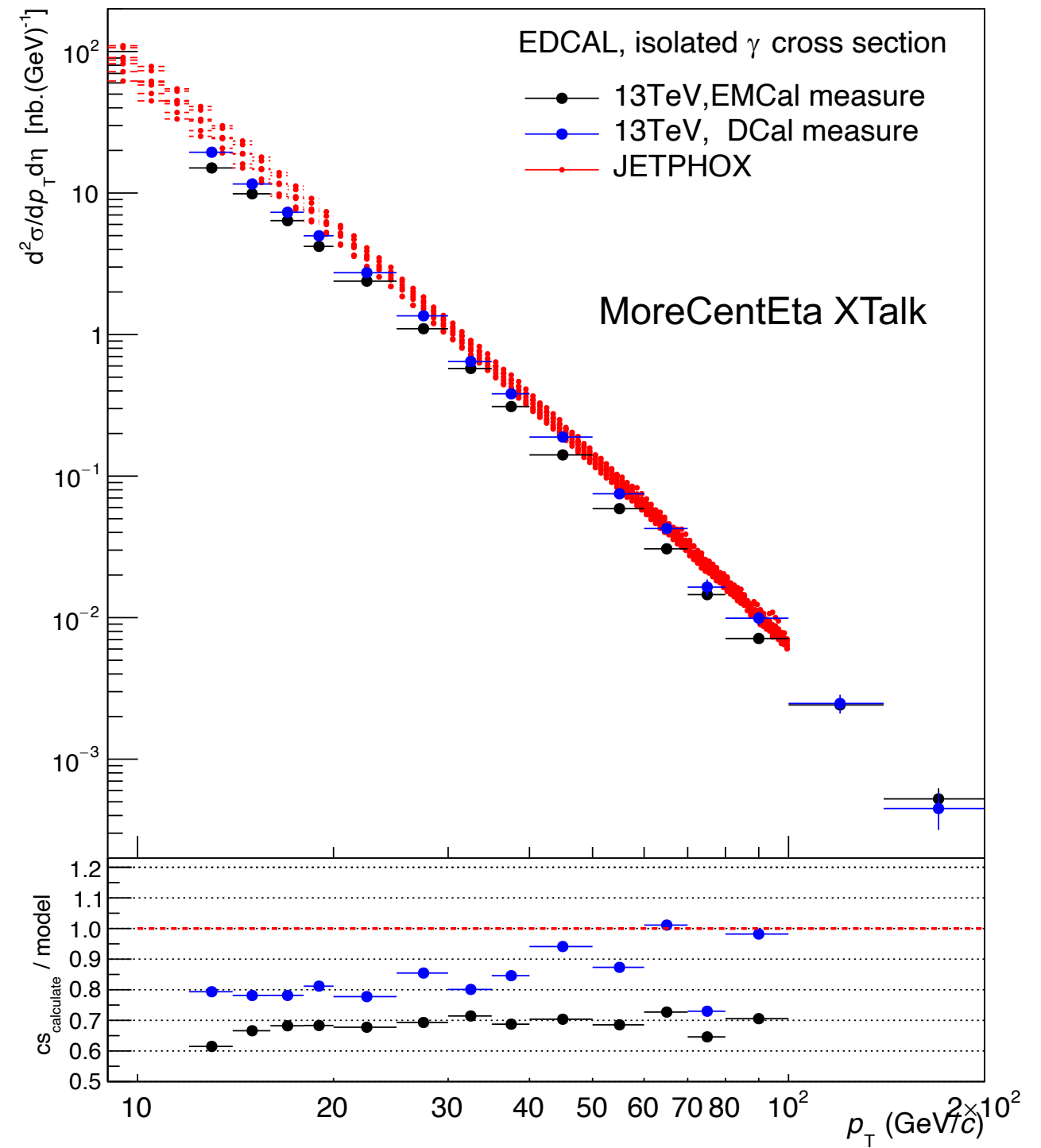
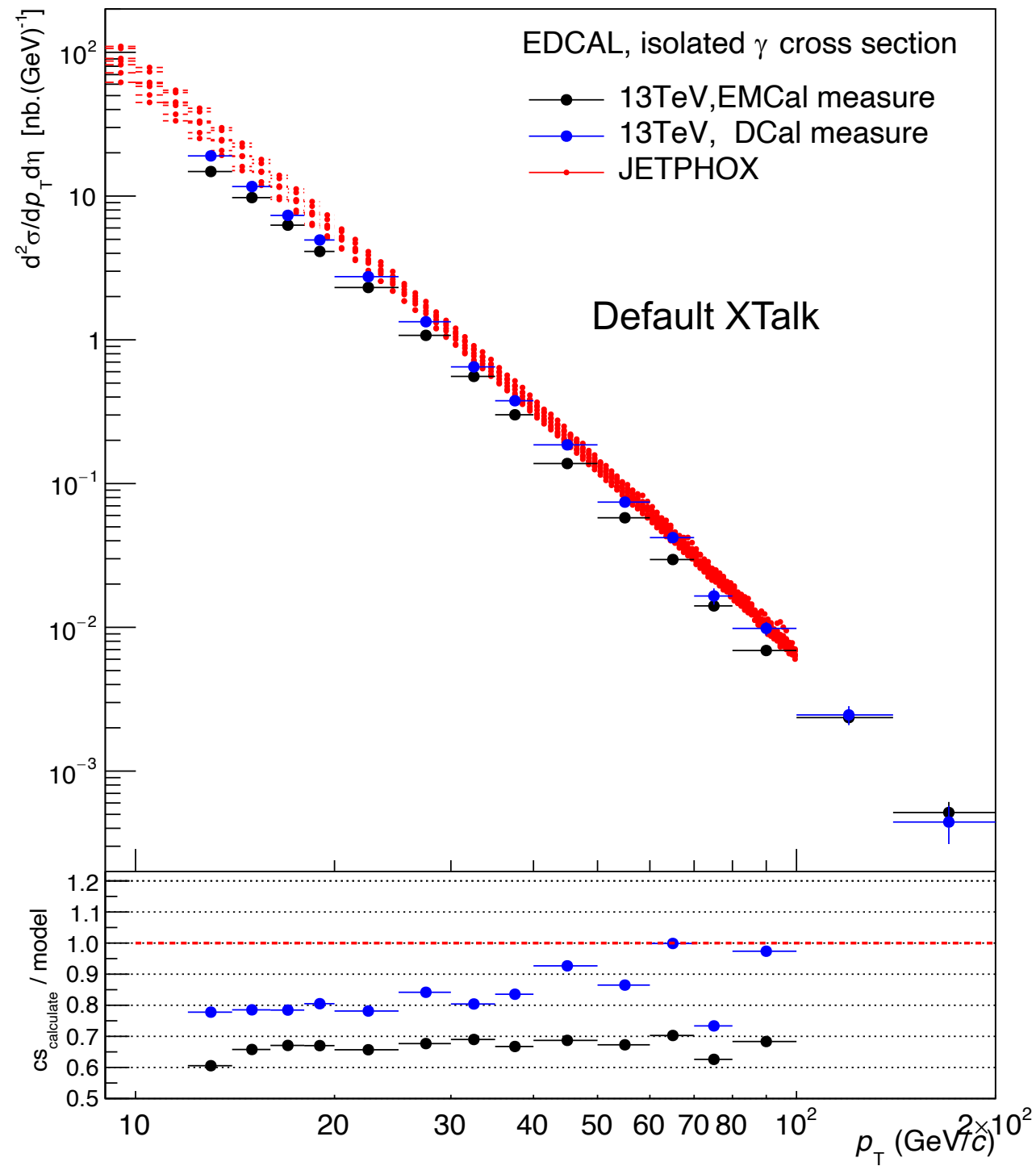
Purity by data-driven



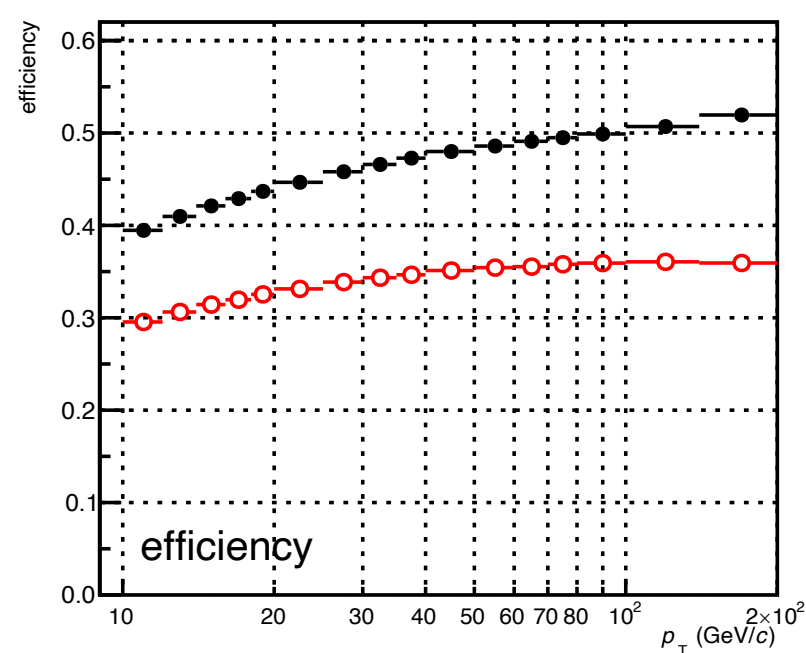
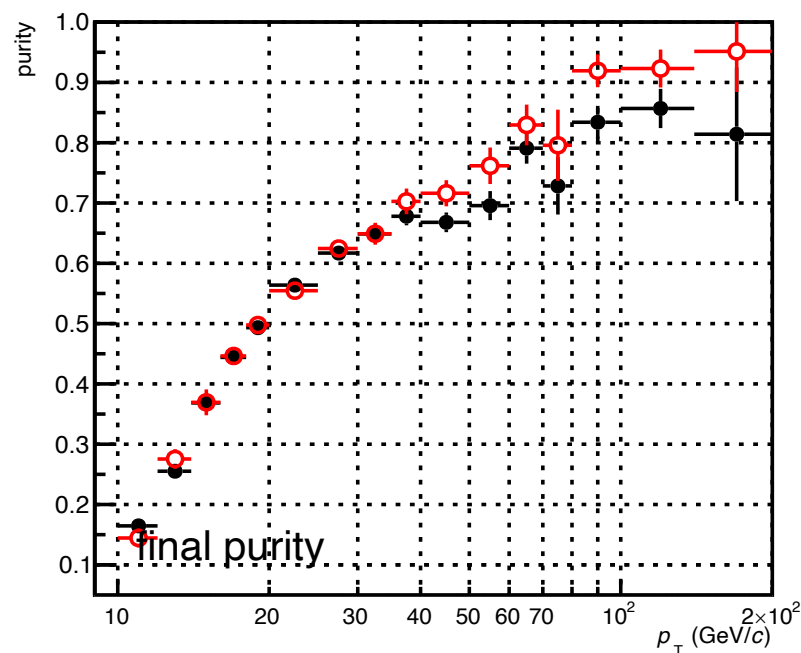
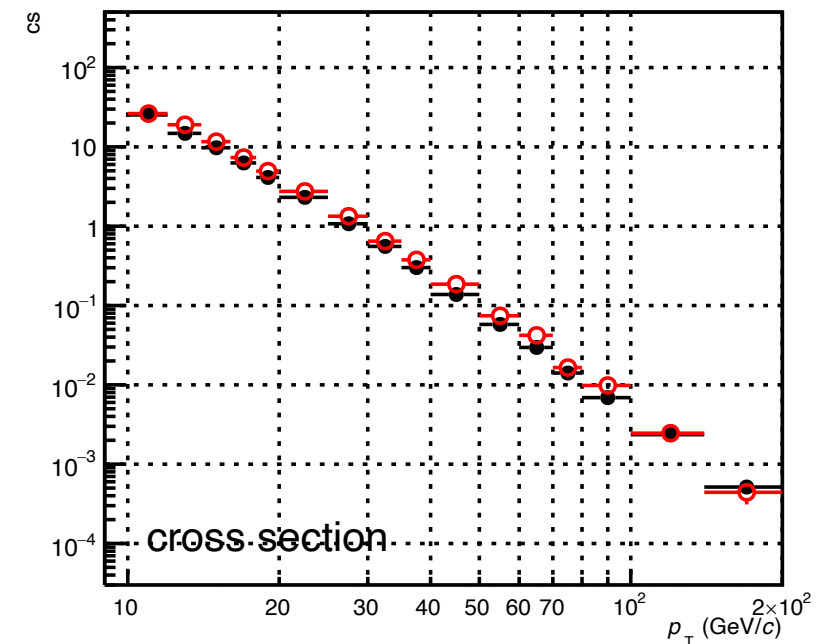
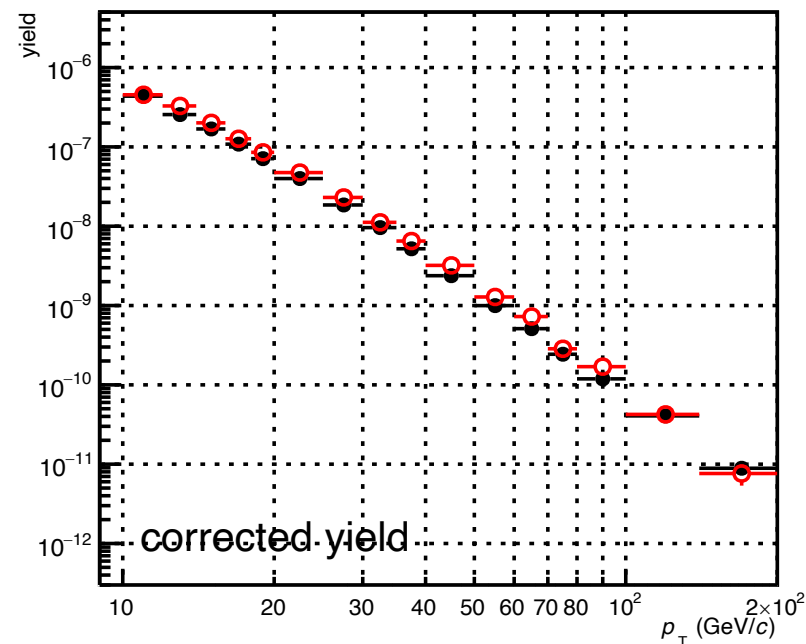
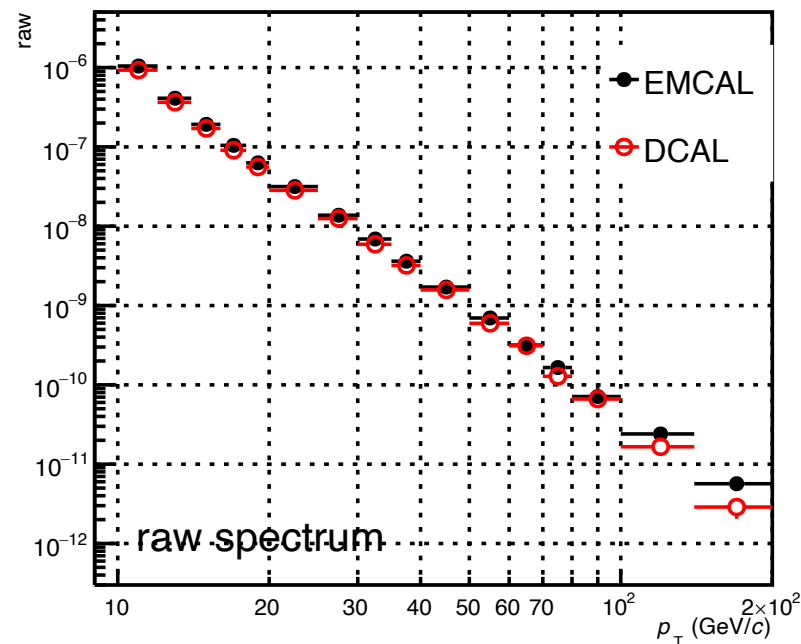
Compare to previous result, raw spectrum



Compare to JETPHOX

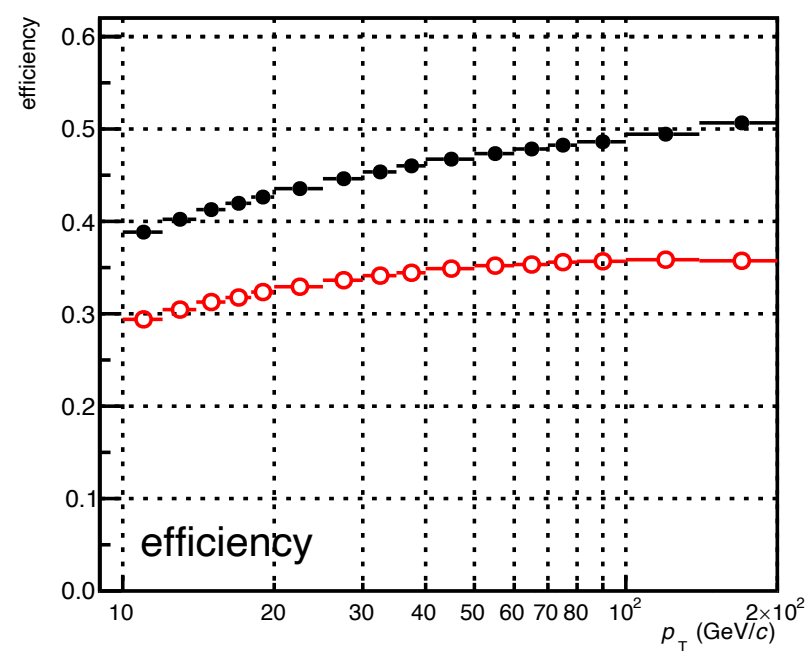
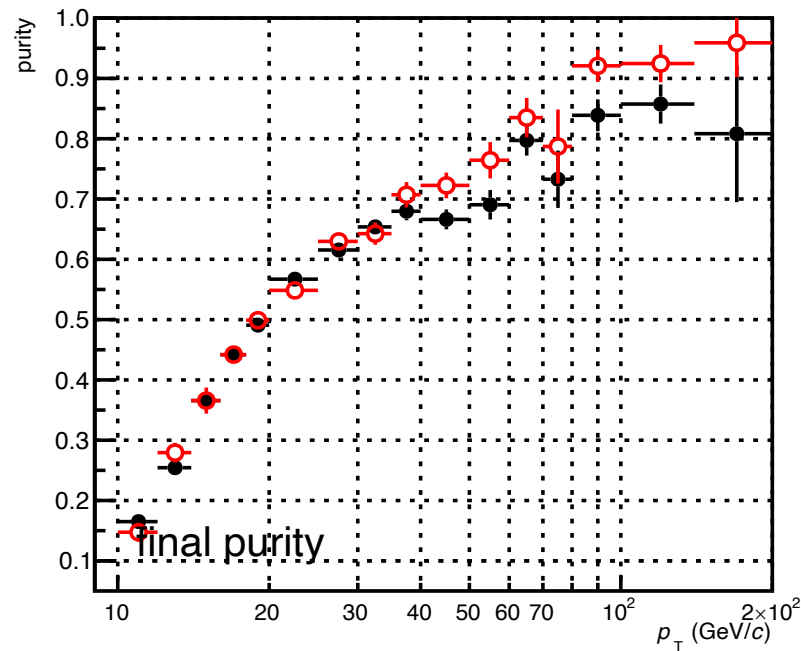
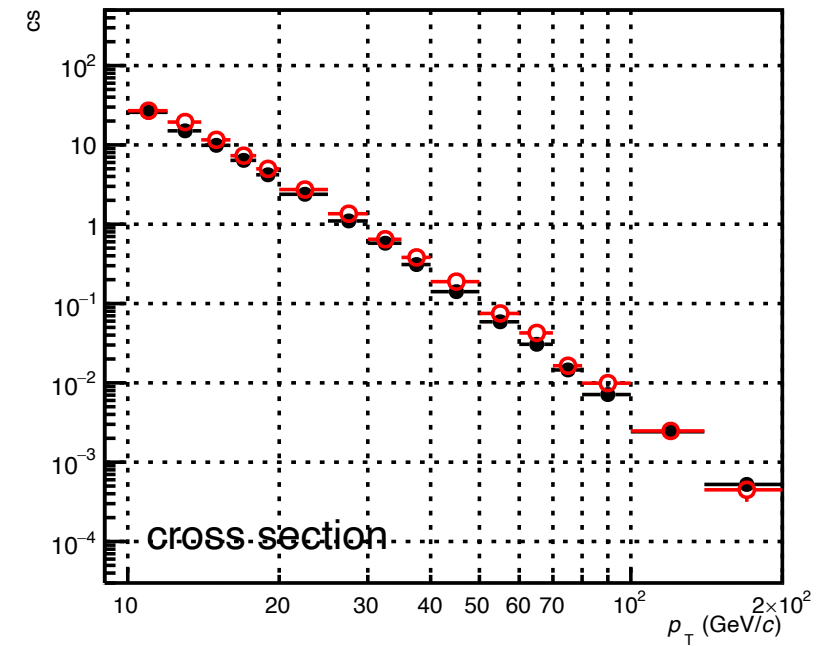
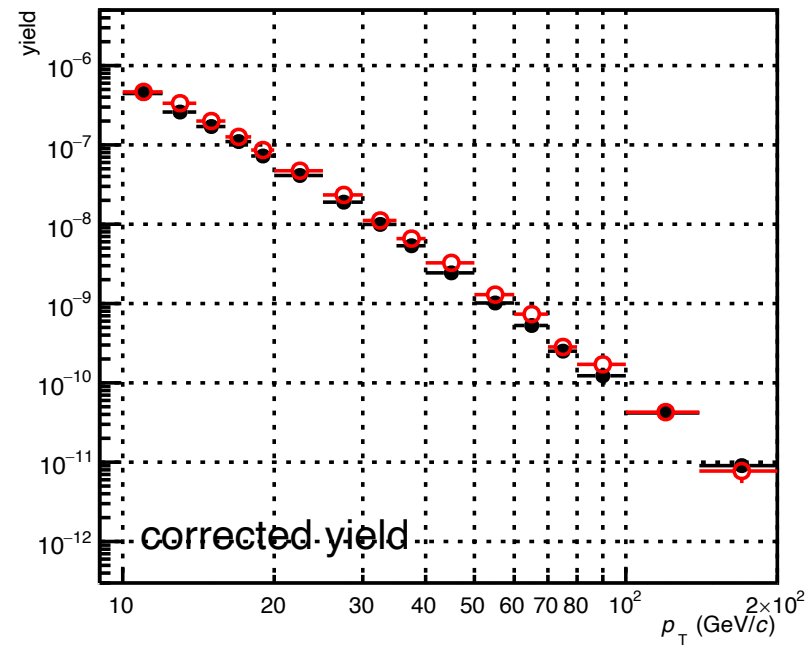
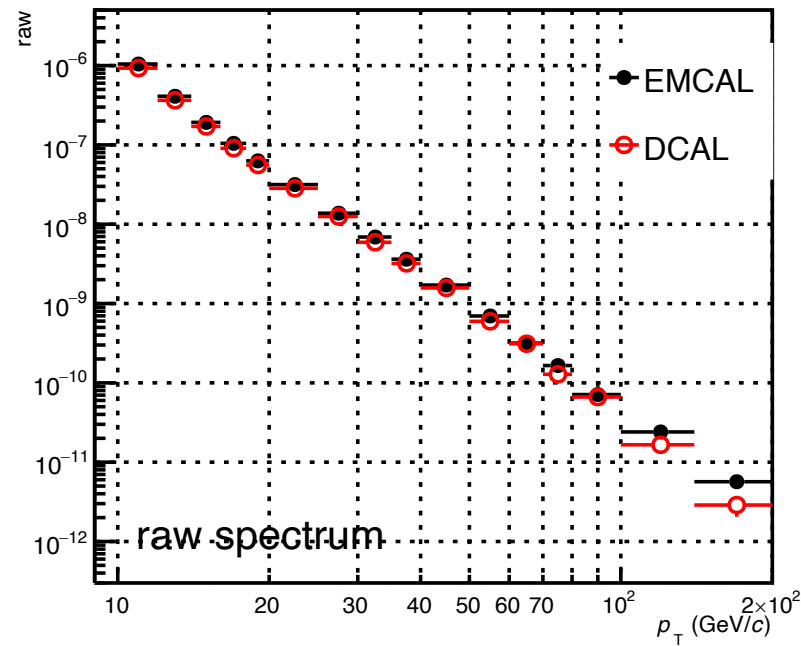


Analysis result EMCal DCal comparison, XTalk default



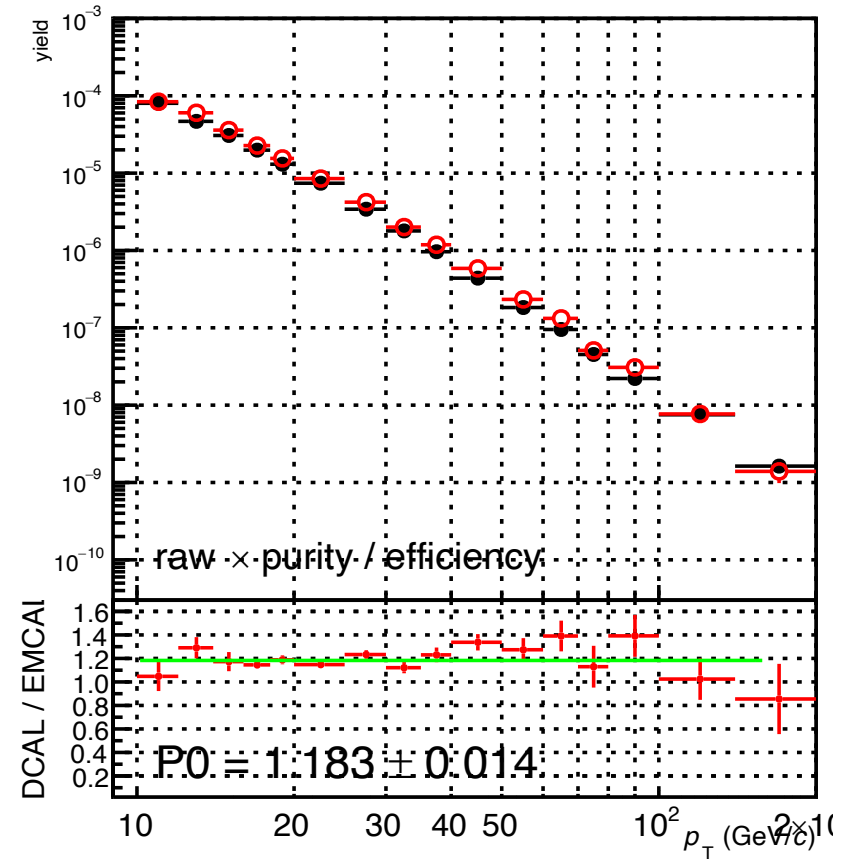
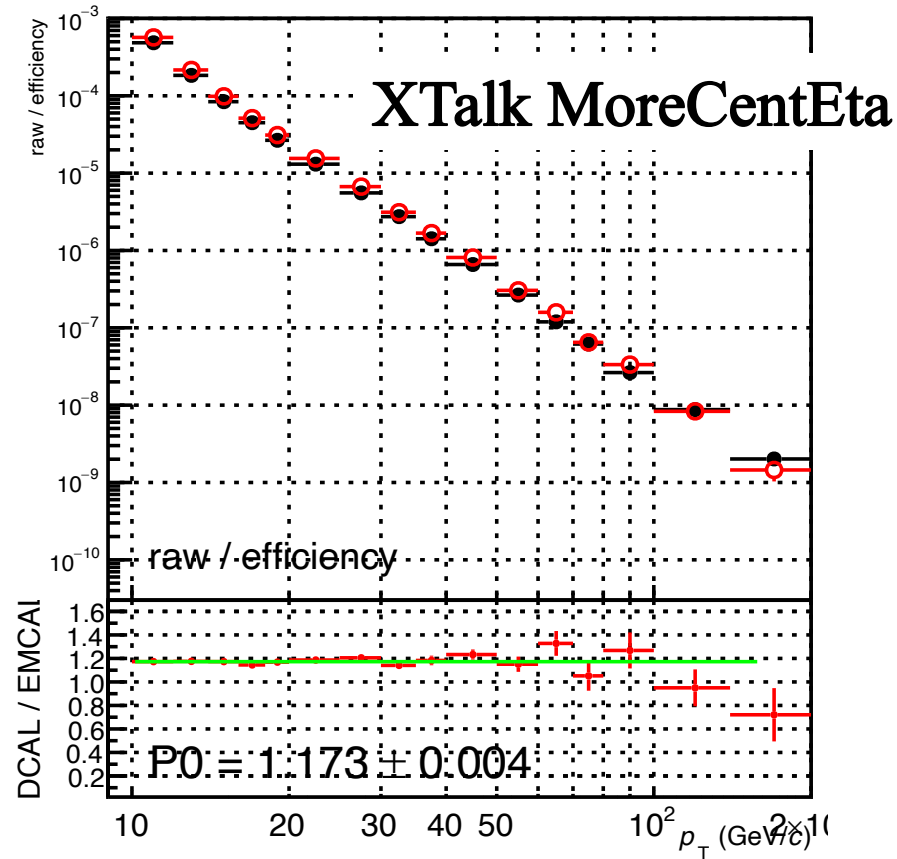
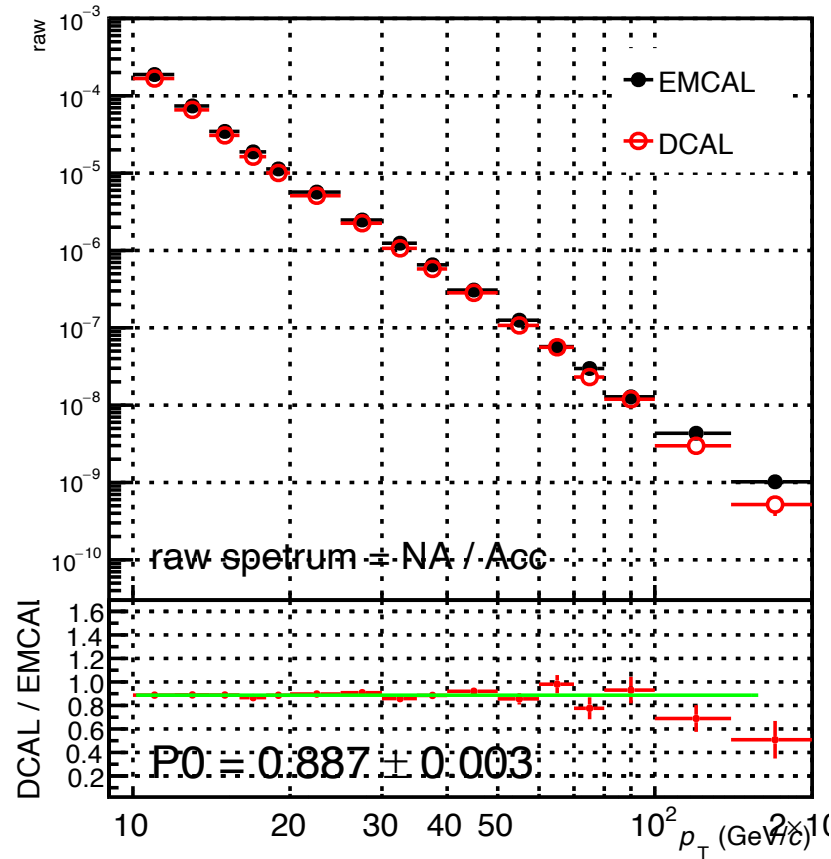
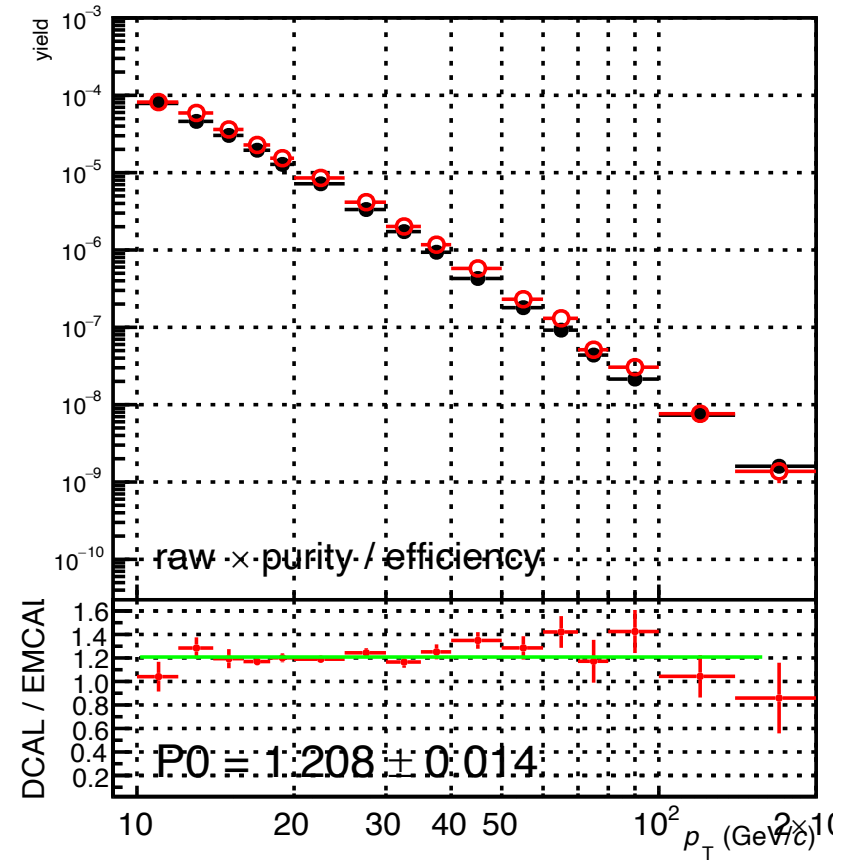
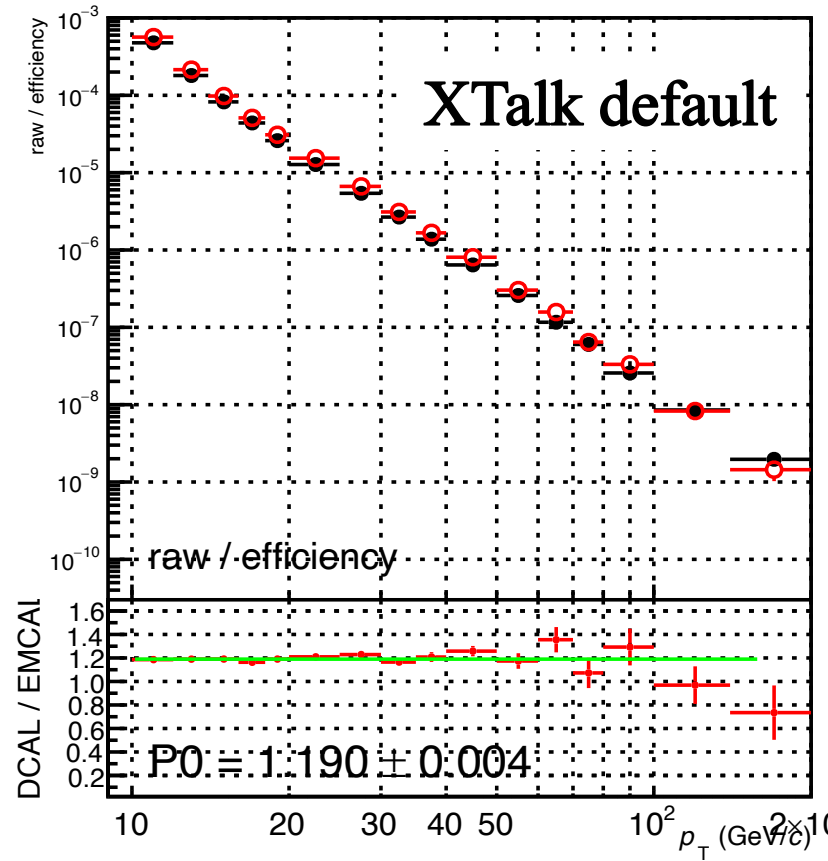
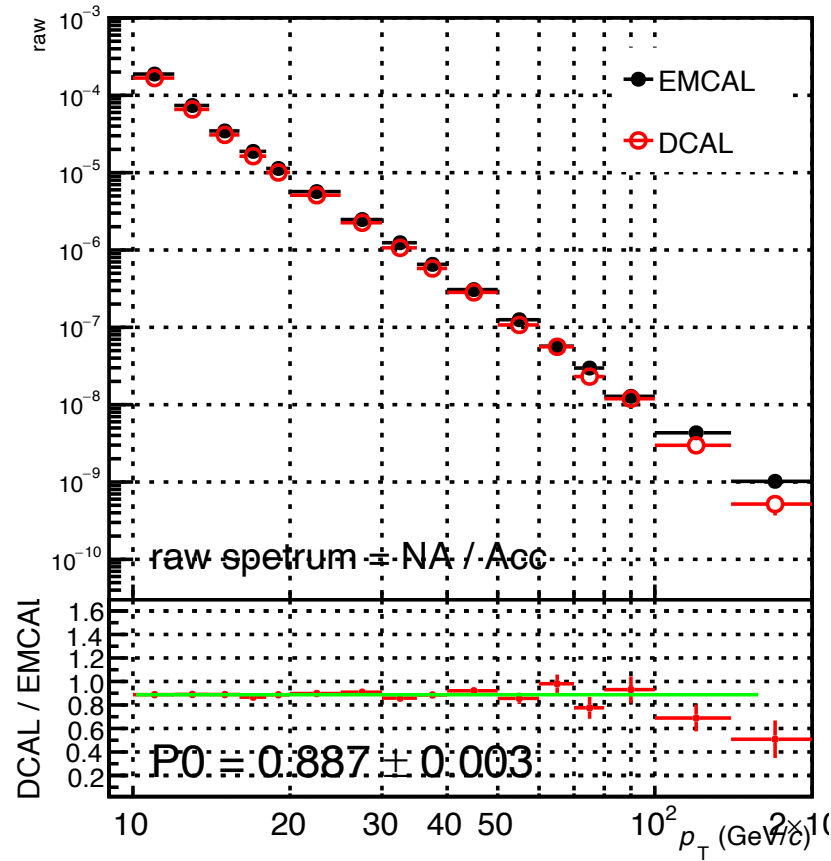
Pol0 fit	raw spectrum	corrected yield	purity
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Analysis result EMCal DCal comparison, XTalk MoreCent



	raw spectrum	corrected yield	purity
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Analysis result EMCal DCal comparison



Last presentation

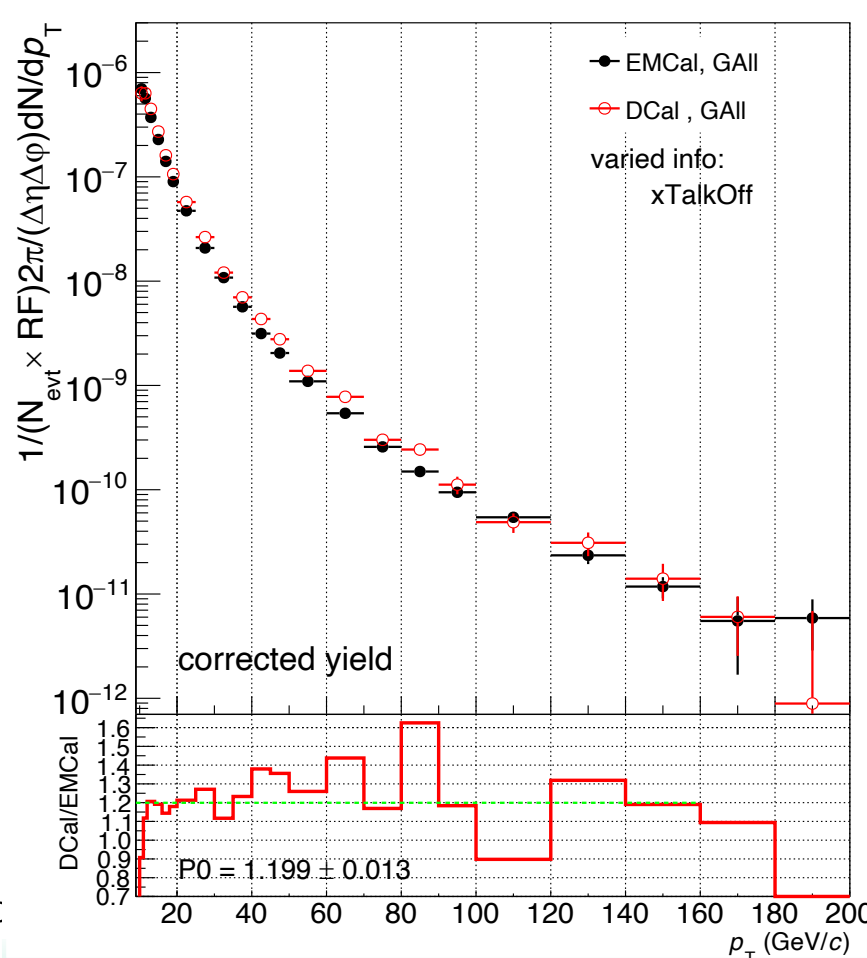
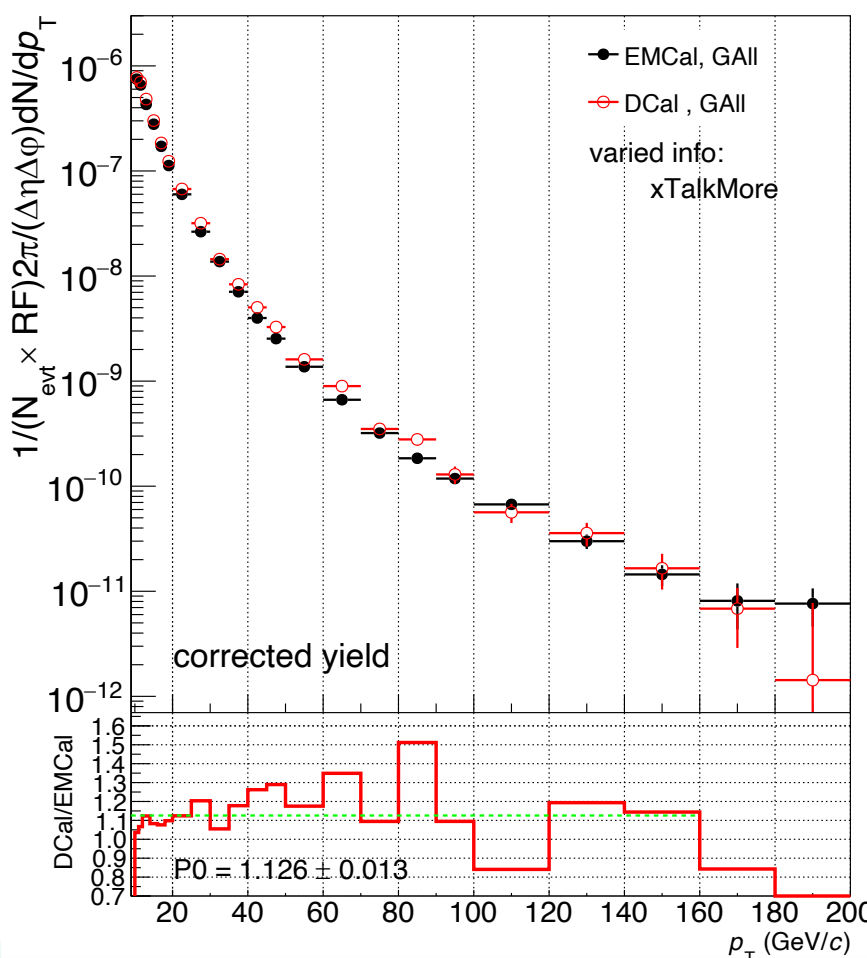
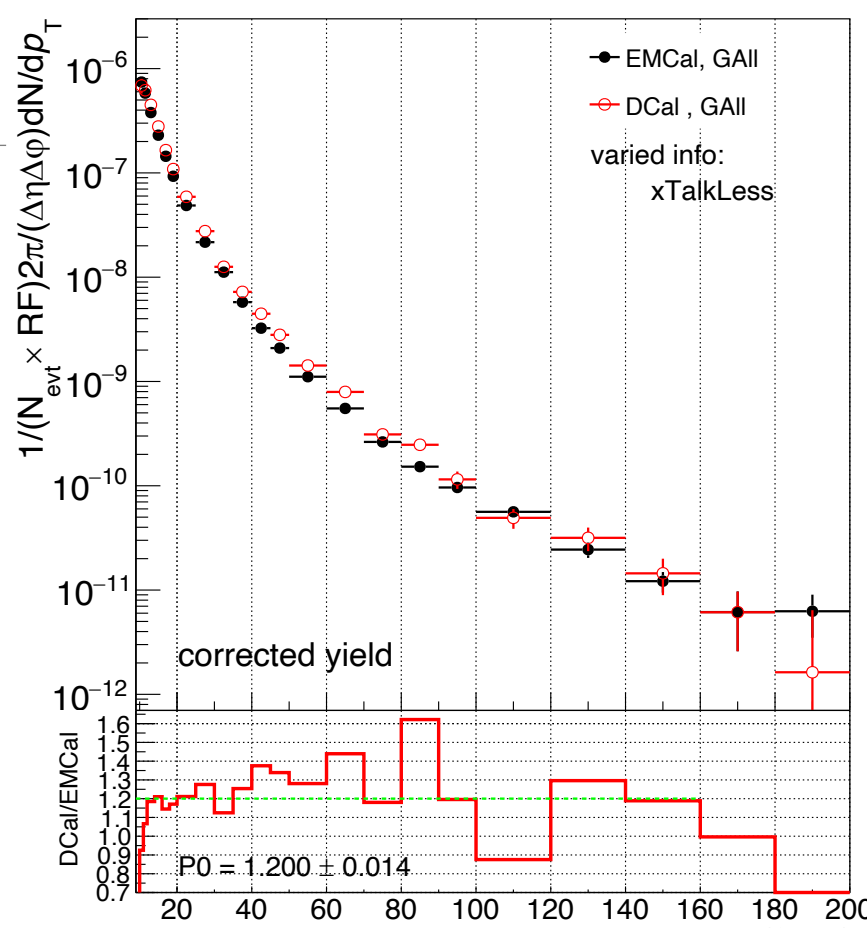
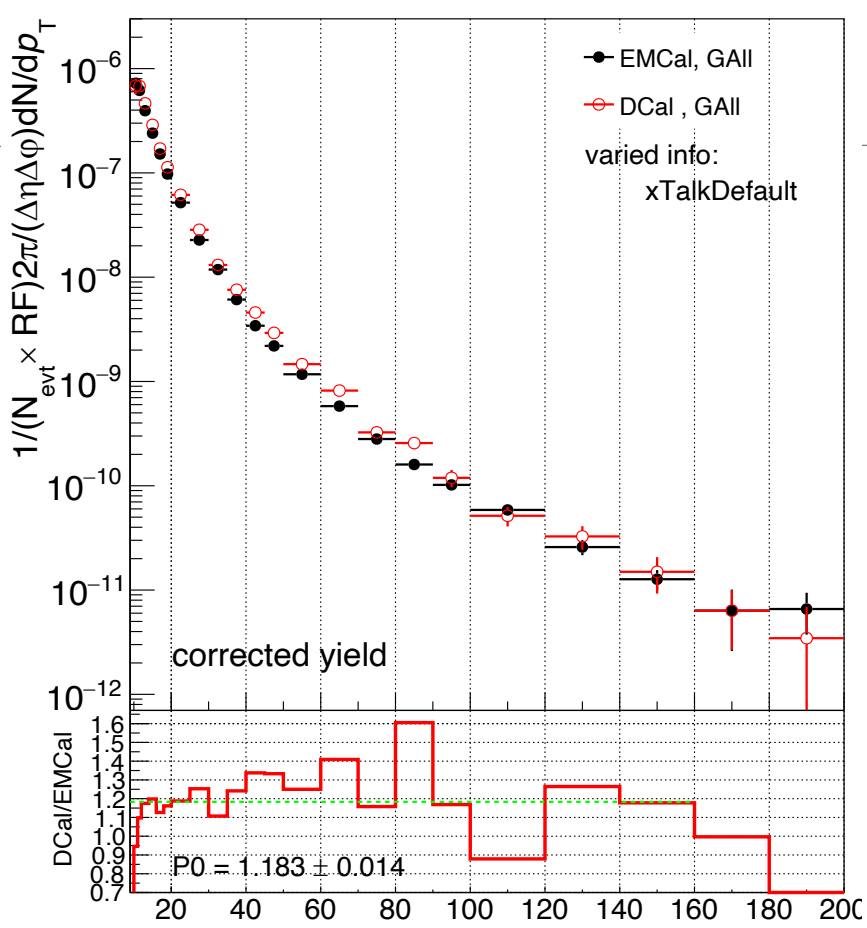
Last presentation

- ✦ comparing mainly analysis result between EMCal and DCal
 - after acceptance normalization, combined spectrum ratio ~ 0.8 (DCal / EMCal).
 - efficiency ratio around 0.7 which comes from reconstruct level.
- ✦ check distribution between EMCal and Dcal
 - dead/bad regions mask: MC can reproduce data
 - p_T^{iso} : MC can reproduce data
 - effect of time cut: No large impact ($\sim 1\%$ when decreasing to ± 20 ns)
 - shower shape cut for signal: not sensitive to shower shape parameter

Outline

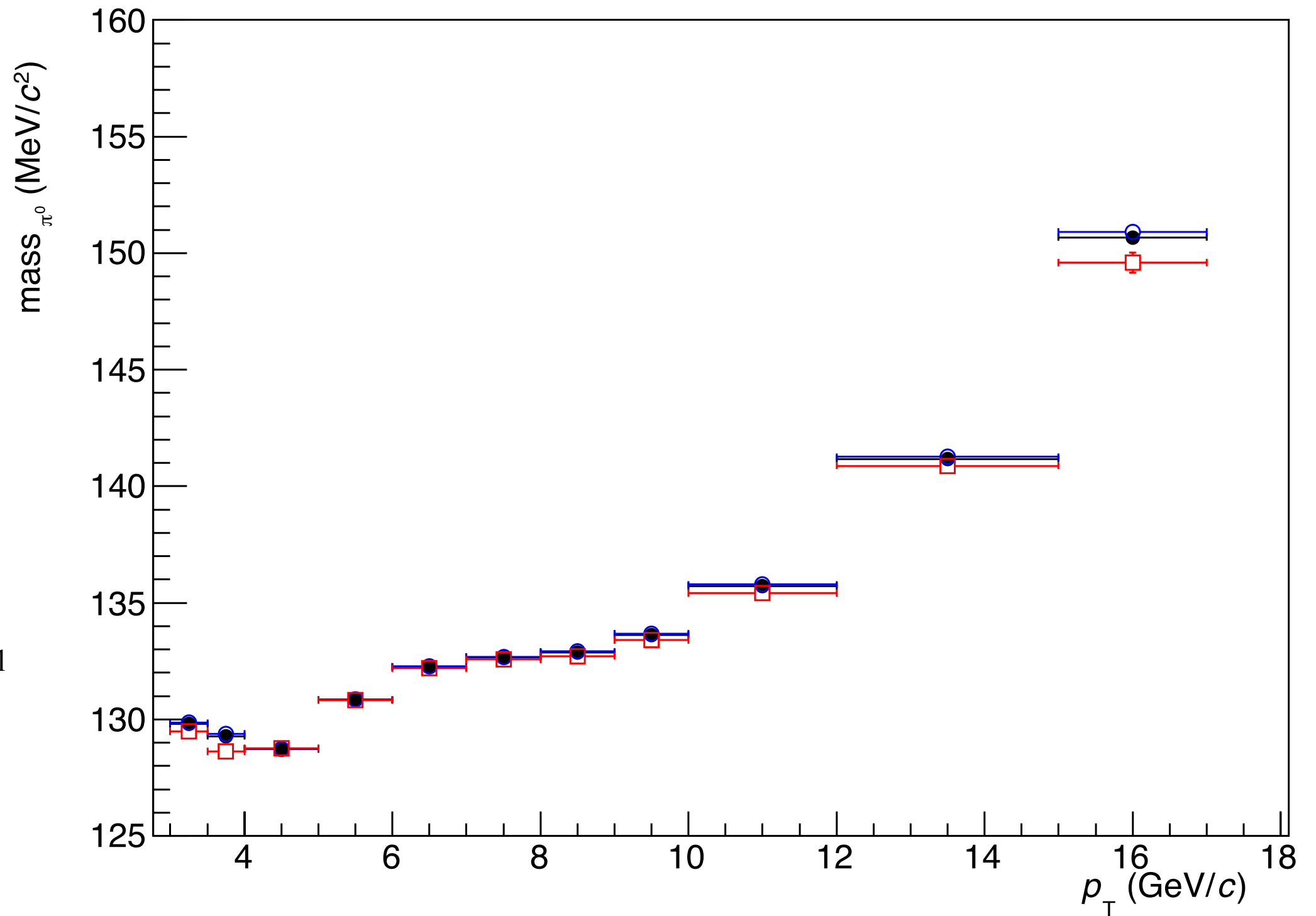
- ✦ Different XTalk
- ✦ π^0 InvMass check

xTalk	Pol0 fit value (DCal/EMCal)
Default	1.183 ± 0.014
More	1.126 ± 0.013
Less	1.200 ± 0.014
Off	1.199 ± 0.013



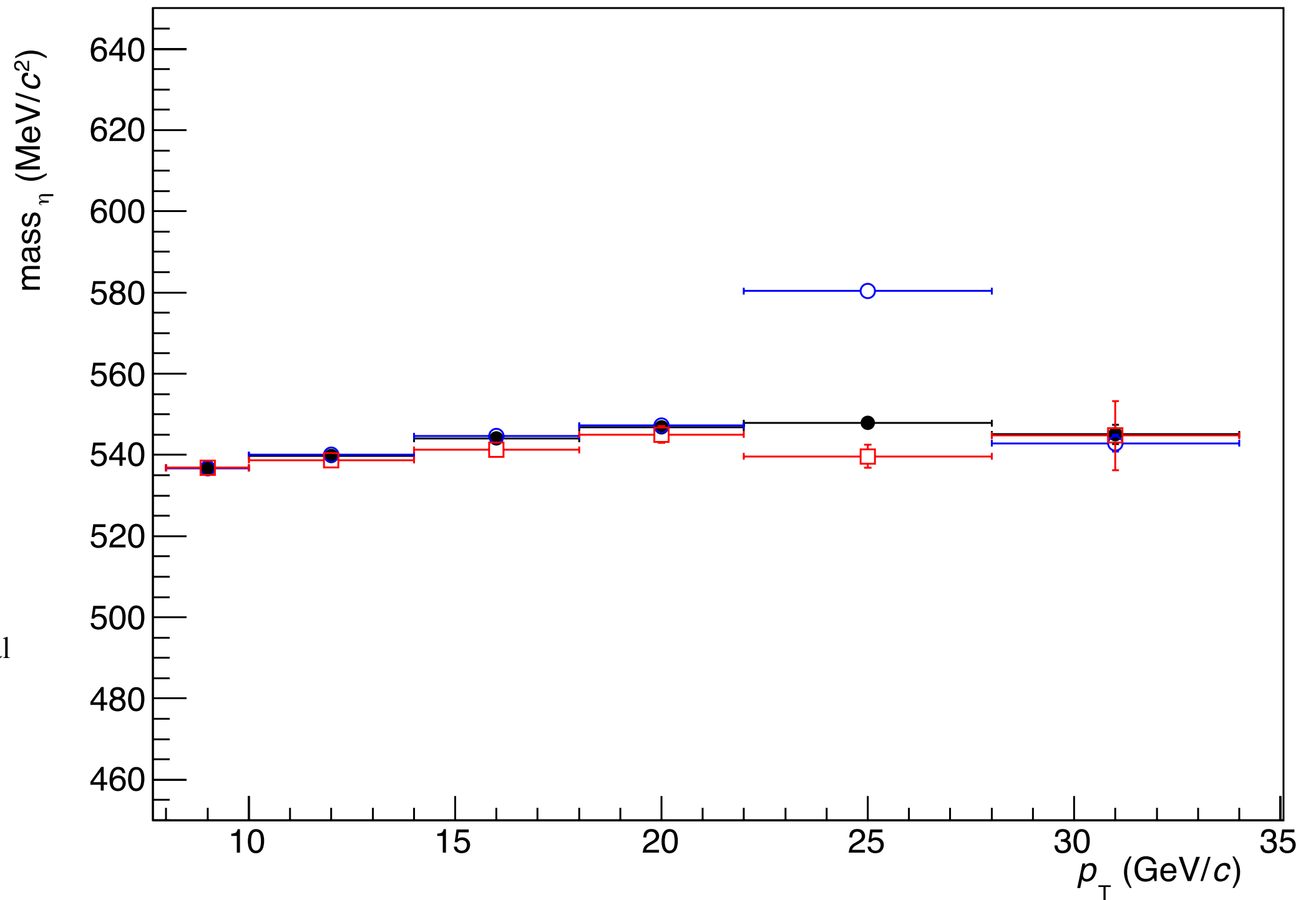
Pi0 Invmass comparison

mass vs p_T of reconstructed π^0 , both clusters in same SM



Eta Invmass comparison

mass vs p_T of reconstructed η , both clusters in same SM



Red: Dcal

Blue: EMCal

Black: EMCal+DCal

Summary

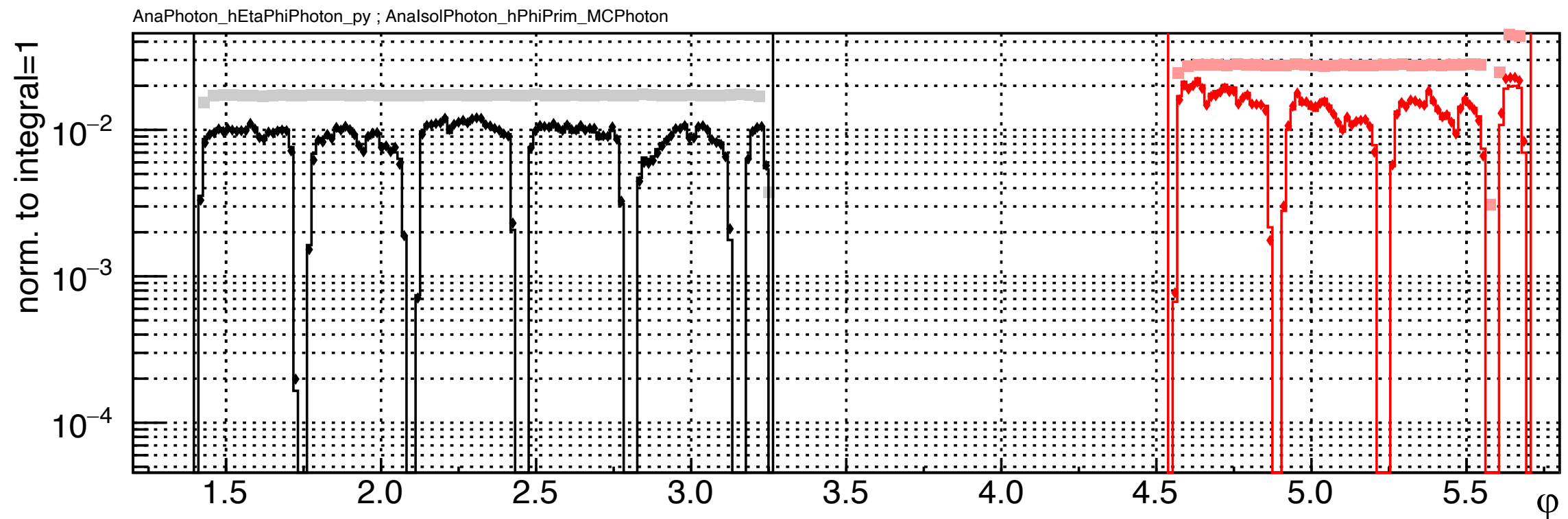
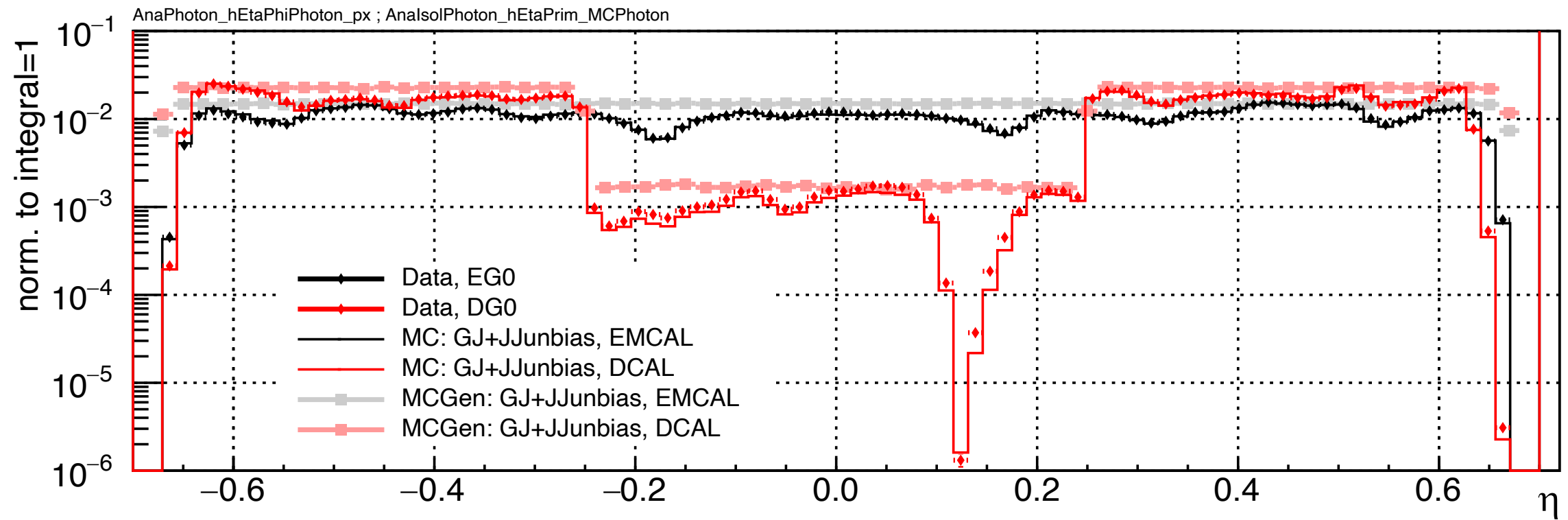
- ✦ check distribution between EMCal and DCal
 - cross talk parameter: not sensitive to XTalk parameter
 - detector calibration: well for EMCal and DCal

Next step:

- check EMCal/DCal ratio with other cluster selection cut variations:
 - ▷ using different EMCal and DCal subregions
 - ▷ without distance to bad channel applied
 - ▷ with different track matching cuts
 - ▷ with different NLM cut
 - ▷ with different exoticity cut
 - ▷ ...

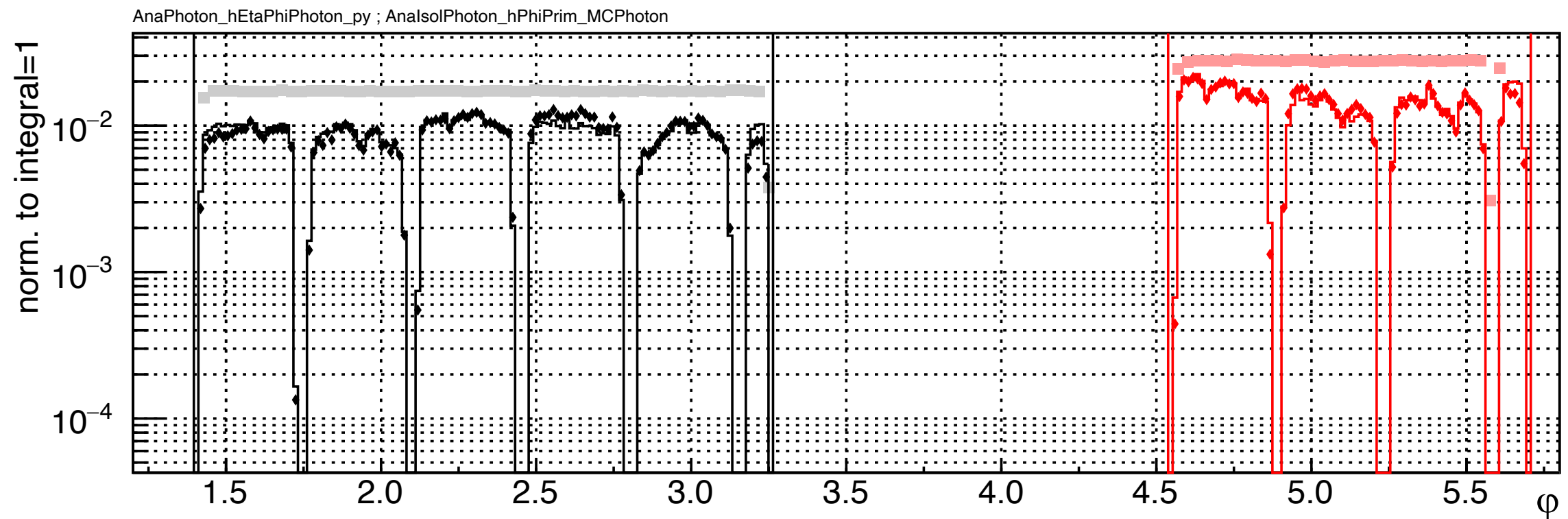
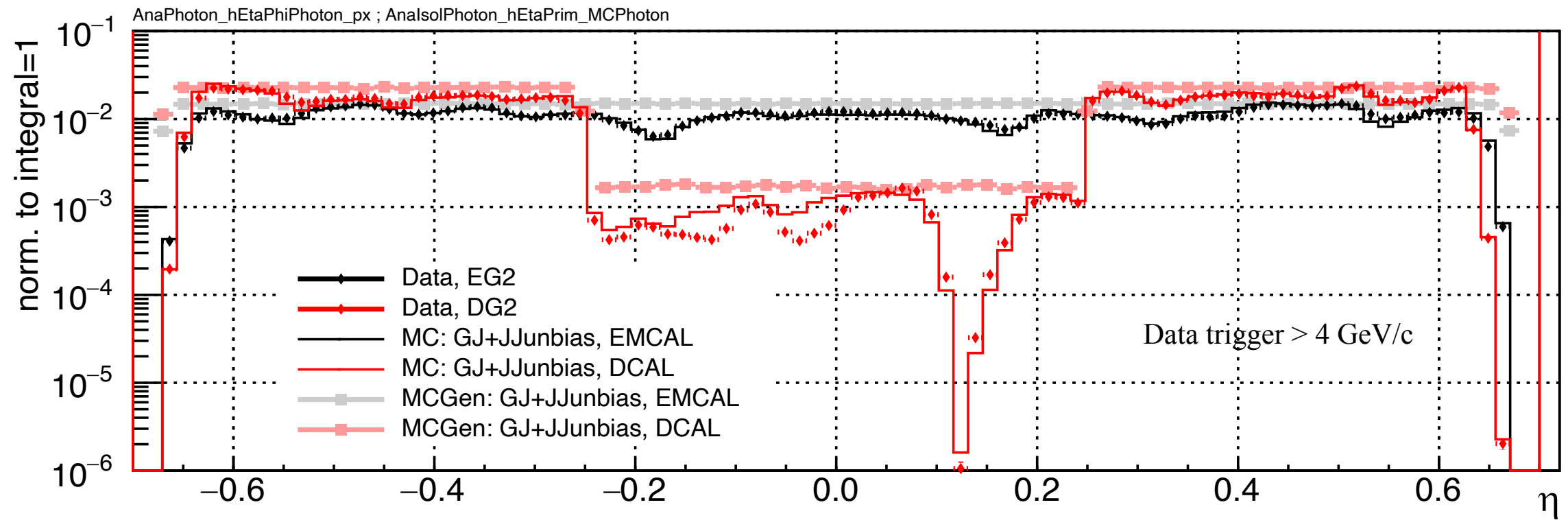
BACK UP

Eta(Pi) distribution, combined MB V.S. GJ+JJunb V.S. Gen



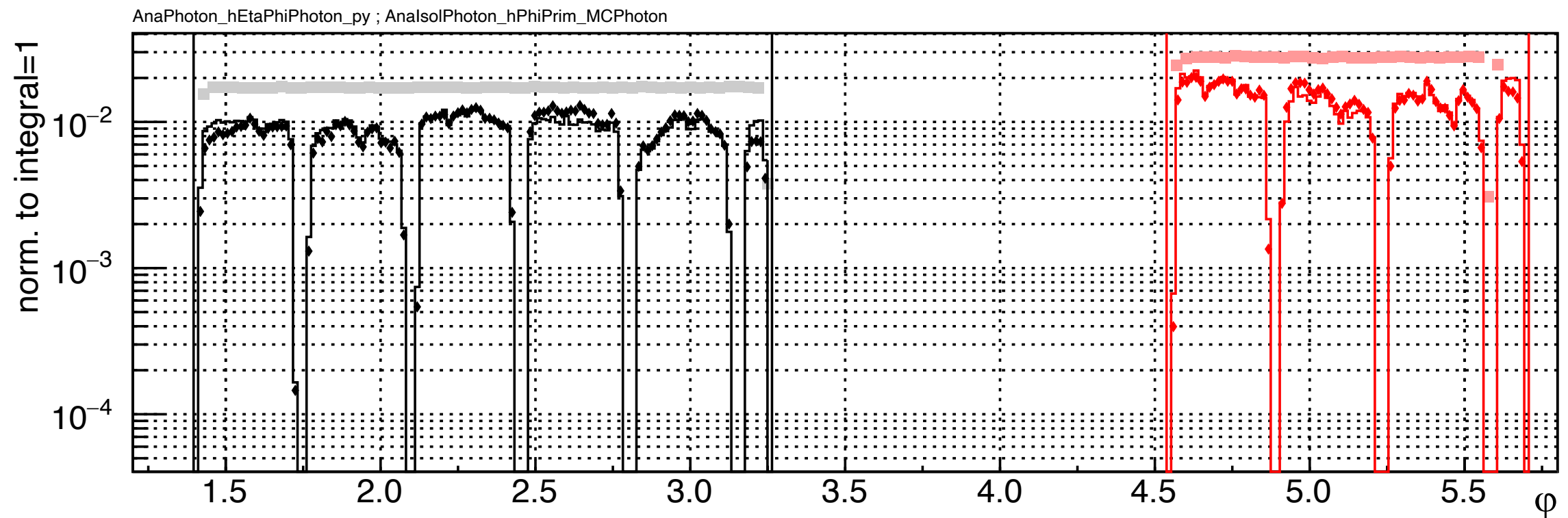
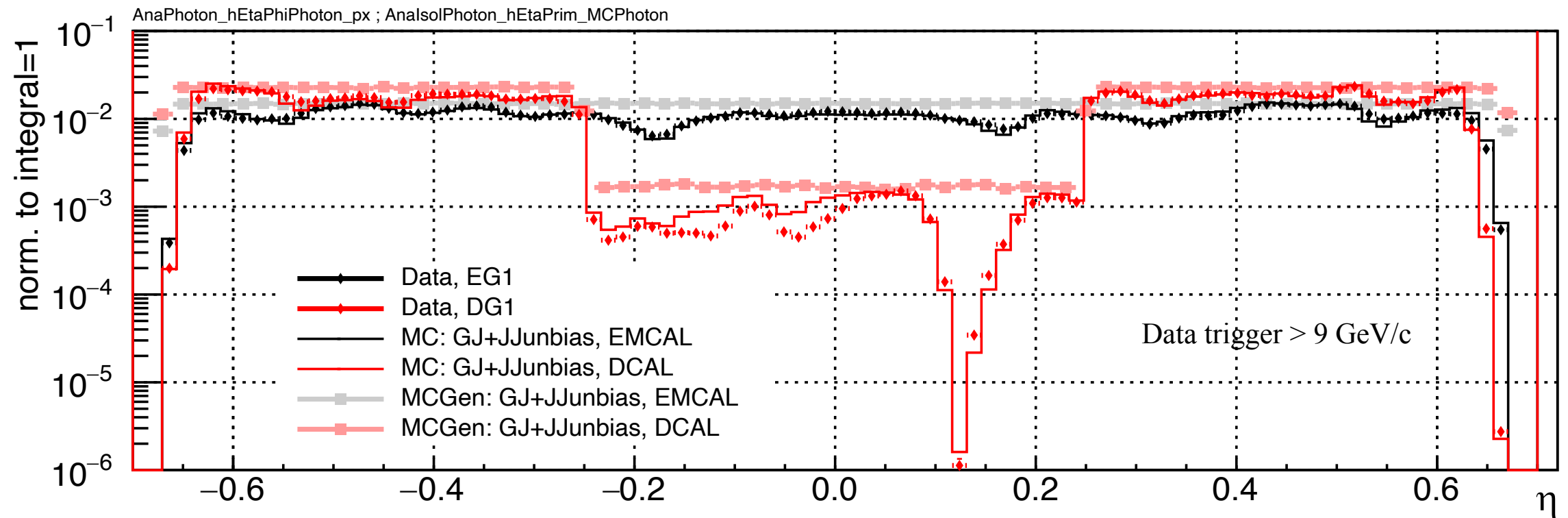
Gen level has similar distribution with data and MC rec level in η and ϕ distribution

Eta(Phi) distribution, combined G2 V.S. GJ+Jjunb V.S. Gen



Gen level has similar distribution with data and MC rec level in η and ϕ distribution

Eta(Pi) distribution, combined G1 V.S. GJ+Jjunb V.S. Gen



Gen level has similar distribution with data and MC rec level in η and ϕ distribution

Mainly ana results presentation

Data set and analysis mainly cut

Analysis dataset:

- Data: ALICE data taken from 2016,17,18
 - MB: EMCAL $\sim$ 1023.9M / 1066.6M ; DCAL $\sim$ 1027.0M / 1066.7M
 - G2 : EMCAL $\sim$ 79.0M / 204.3M ; DCAL $\sim$ 36.6M / 204.3M
 - G1 : EMCAL $\sim$ 54.7M / 204.3M ; DCAL $\sim$ 26.7M / 204.3M
- Simulation: Gamma-Jet event + Jet-Jet events

Cluster selection: (clusterizer V1)

- Ncells/cluster ≥ 2
- distance to bad channel > 2 cell
- time cut: [-30, 30]ns
- cells energy: Eseed = 500 MeV , Ecell = 100 MeV
- NLM ≤ 2
- Trackmatch: : p_T dependent
- Emulation of cross-talk T-Card in MC applied

Photon selection:

- Showershape: $\sigma_{long}^2 < 0.3$

Isolation criterion:

- particle in cone: charg+neutral
- track p_T in Isolation cone: $p_{T,track} > 0.2$ GeV
- $|\eta| < 0.52$, φ (1.57,3.11)
- isolation crite: $R = 0.4$

$$p_T^{iso} \equiv \Sigma p_{T,track} < E_T^{th} = 1.5 GeV/c$$

$$\overline{p_T^{iso}} \equiv \Sigma p_{T,track} > E_T^{th} = 2.5 GeV/c$$

Cluster rejection factor

$$\clubsuit \quad RF = \left(\frac{1}{N_{evt}} \frac{dN_{cluster}}{dP_T} \right)_{trigger} / \left(\frac{1}{N_{evt}} \frac{dN_{cluster}}{dP_T} \right)_{MB}$$

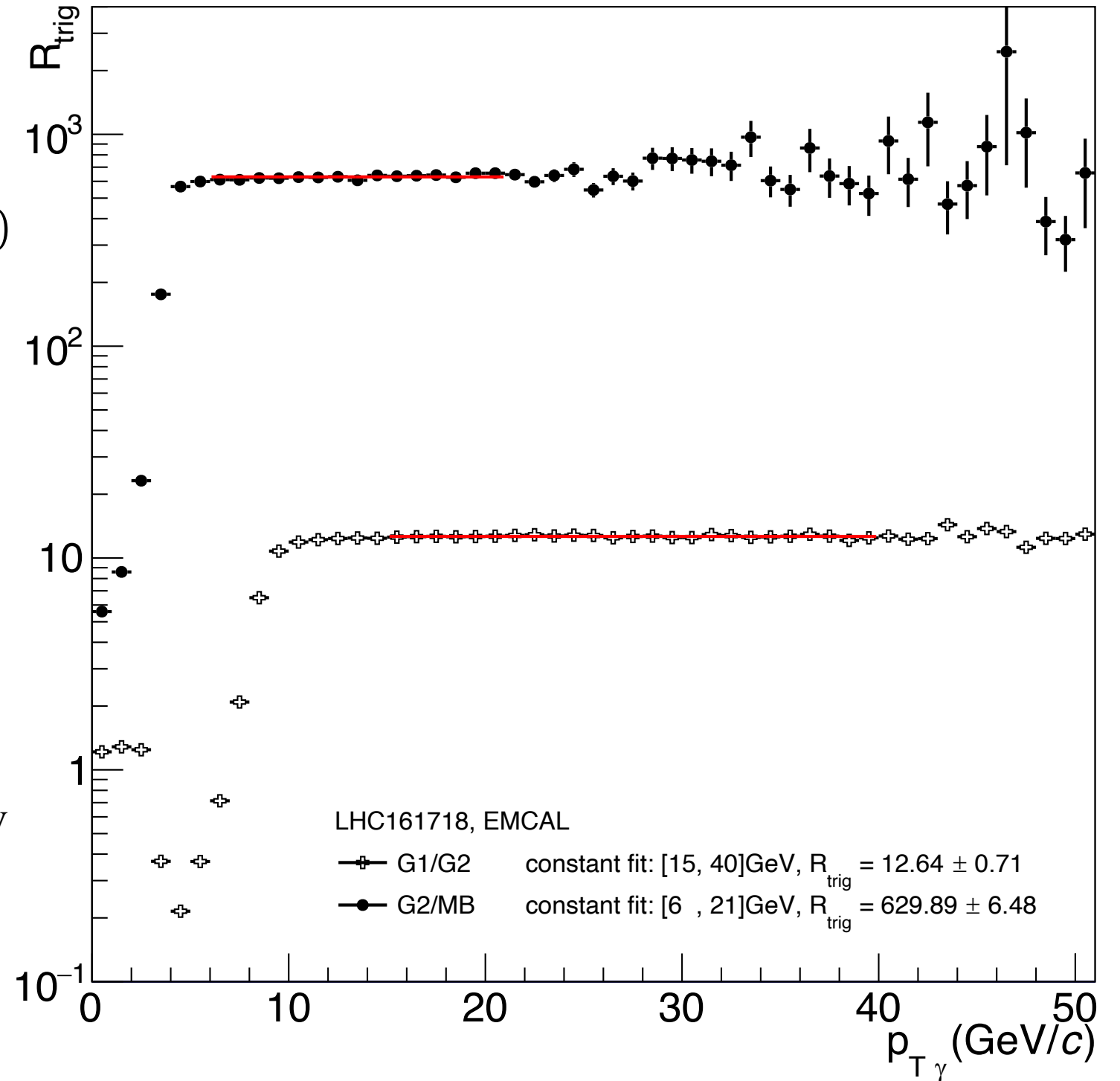
✦ Trigger sample normalize:

$$\left(\frac{1}{N_{evt}} \frac{dN}{dp_T} \right)_{norm.} = \left(\frac{dN}{dp_T} \right)_{trigger} / (N_{evt,trig} * RF)$$

	EMCAL	DCAL
G2/MB	629.89 ± 6.48	1280.87 ± 9.24
G1/G2	12.64 ± 0.71	12.04 ± 0.69
G1/MB	7962.73	15427.31

Cluster selection: (clusterizer V1)

- cells energy: Eseed = 500 MeV , Ecell = 100 MeV
- Ncells/cluster >= 2
- distance to bad channel > 2 cell
- time cut: [-30, 30] ns
- NLM <= 2
- Trackmatch: : p_T dependent
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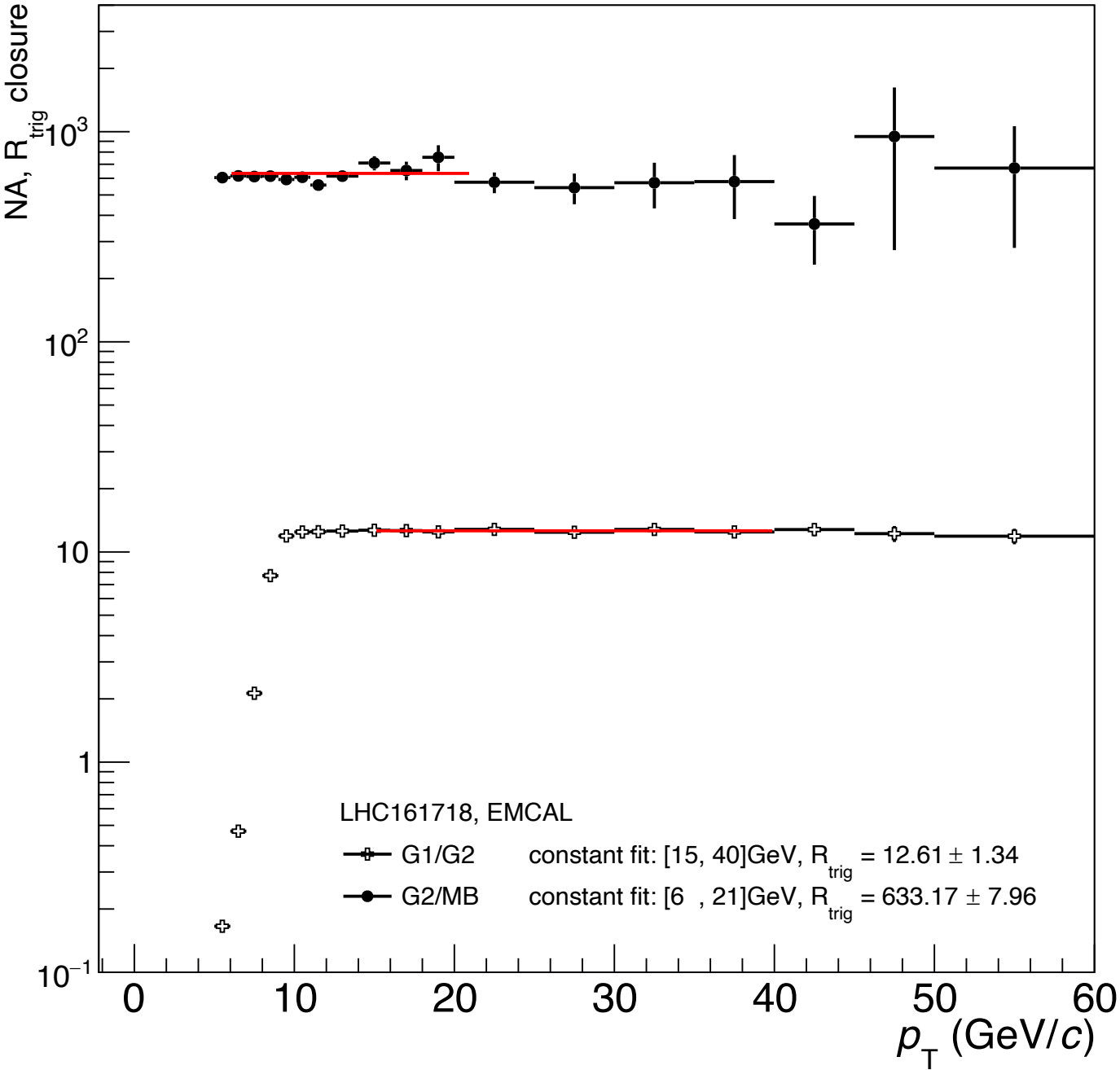
DCal RF plots in backup

Isolated photon rejection factor

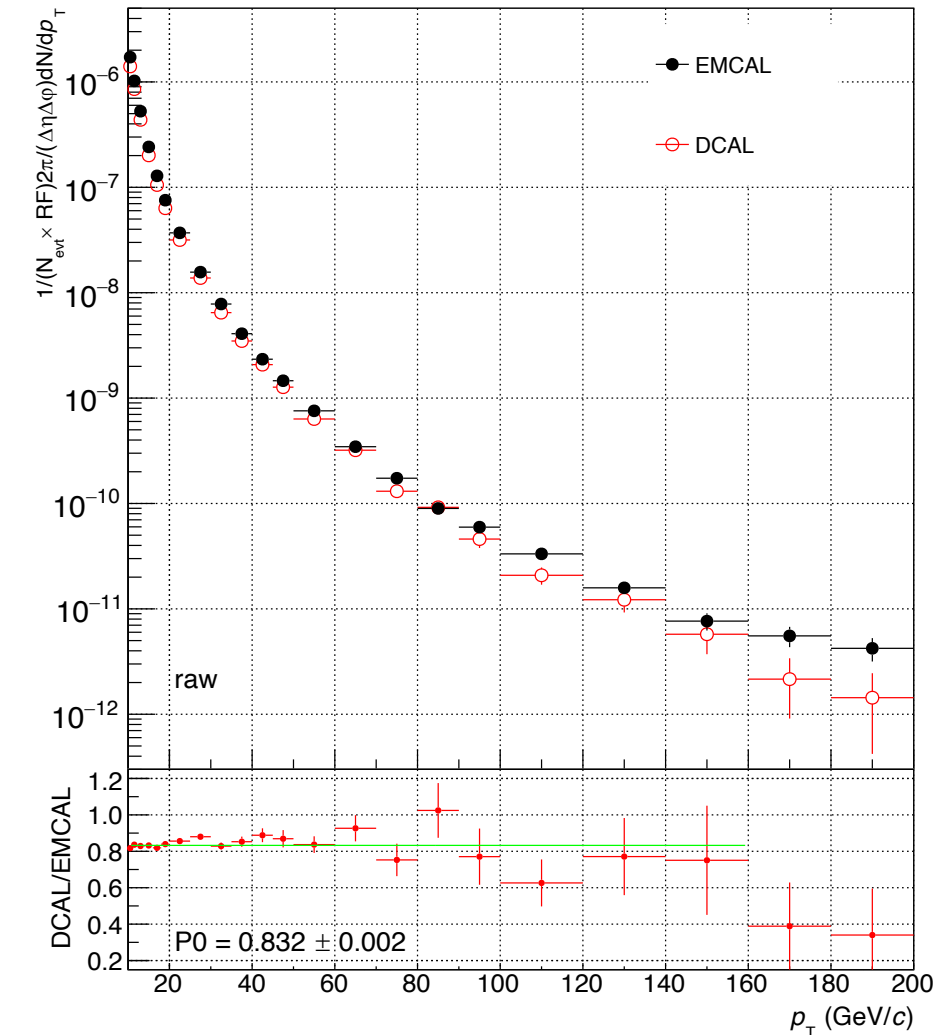
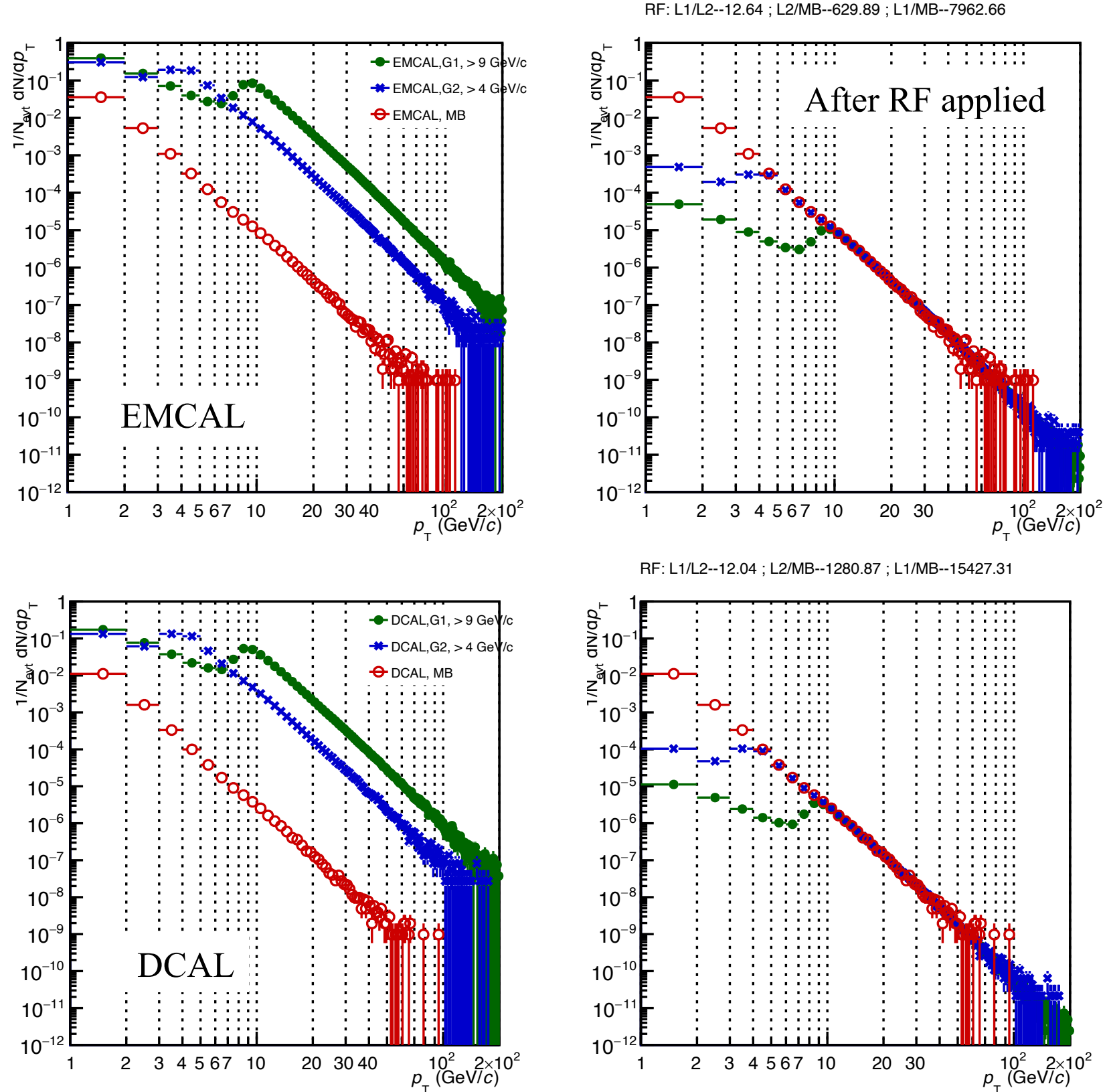
$$RF = \left(\frac{1}{N_{evt}} \frac{dN}{dP_T} \right)_{trigger} / \left(\frac{1}{N_{evt}} \frac{dN}{dP_T} \right)_{MB}$$

		cluster RF	Iso photon RF	Cluster/ IsoPhoton
EMCAL	G1 / G2	12.64±0.71	12.61±1.34	1.002
	G2 / MB	629.89±6.48	633.17±7.96	0.995
	G1 / MB	7962.73		
DCAL	G1 / G2	12.04±0.69	12.49±1.34	0.964
	G2 / MB	1280.87±9.24	1229.58±11.09	1.042
	G1 / MB	15427.31		

The rejection factor works equivalent in cluster and isolated photon.

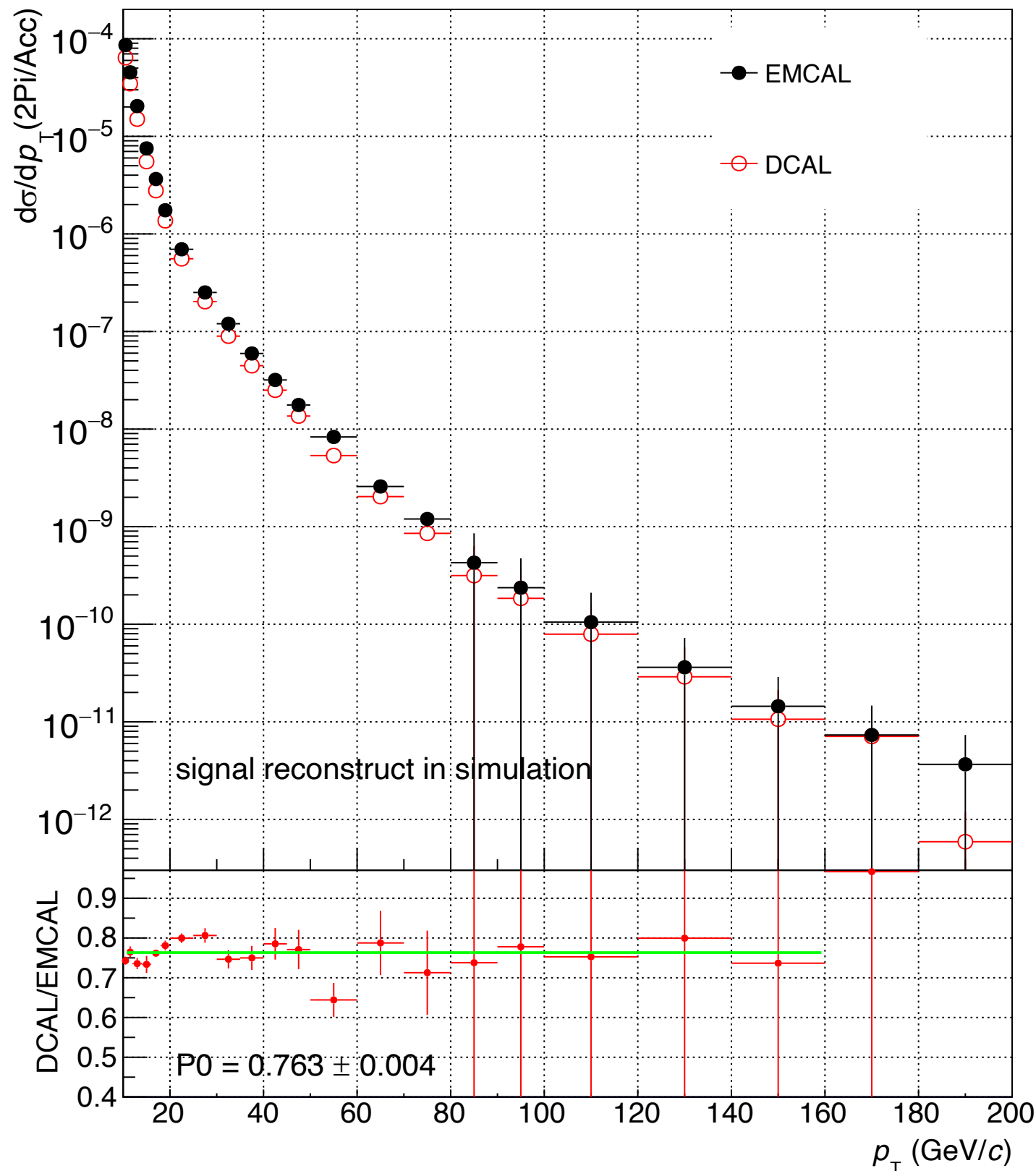


Isolated photon pt distribution



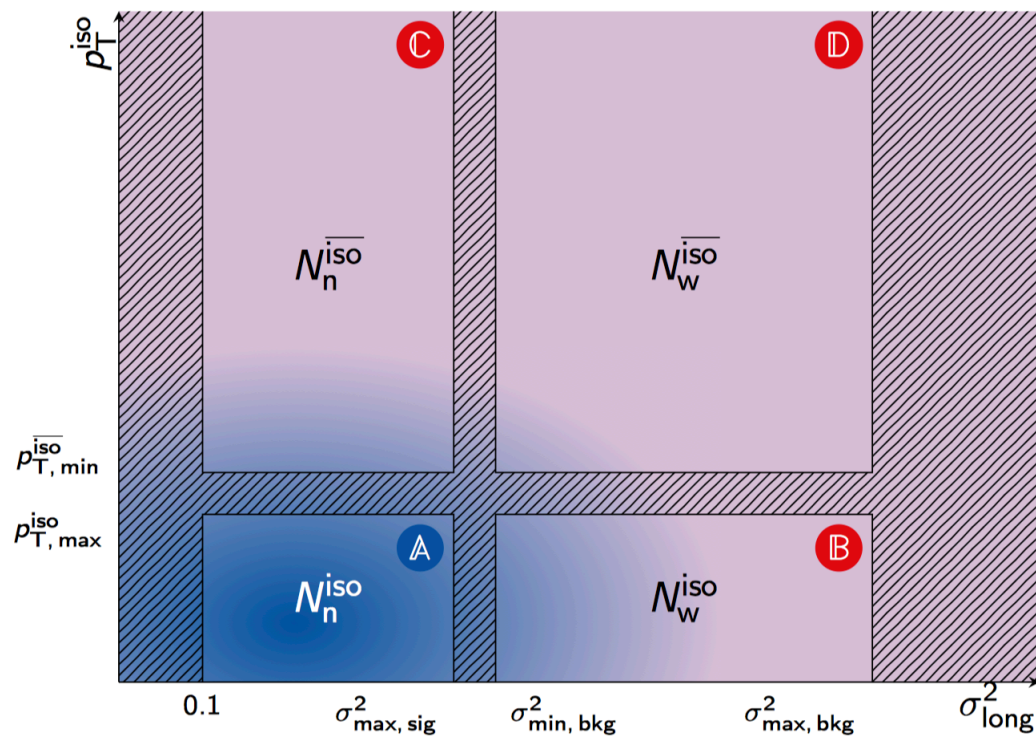
- After the cluster rejection factor applied, different samples similar to each other.
- Combined sample after acceptance normalized, DCAL/EMCAL around 0.83. because different masked regions not considered in acceptance correction factor.

Isolated photon pt distribution in MC



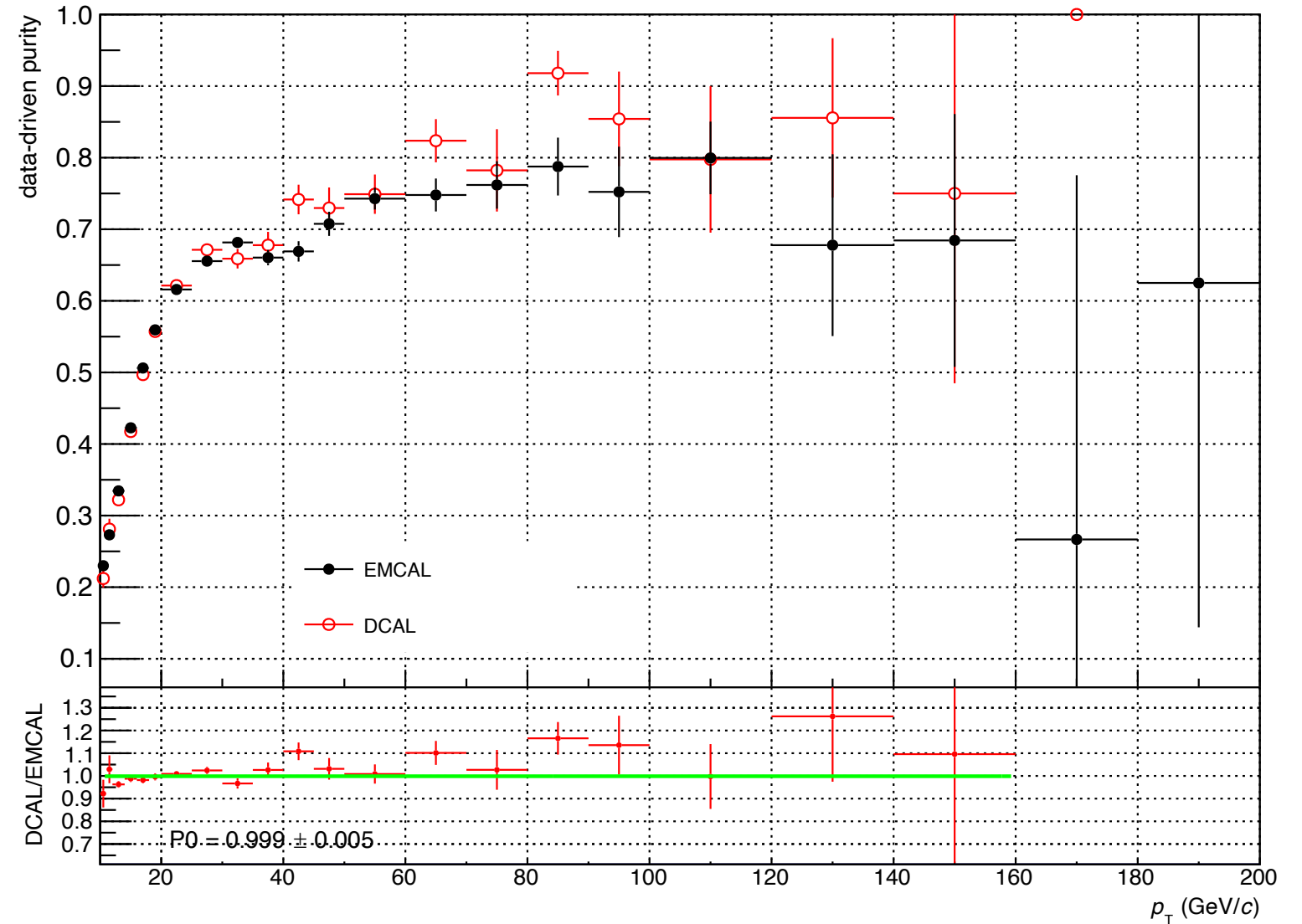
- In MC, the reconstructed signal in different calorimeters are close to each other after acceptance
Combined sample after acceptance normalized.
- Ratio, DCAL/EMCAL is 0.76 in GJ but in data is 0.83.

Data driven purity in different detector



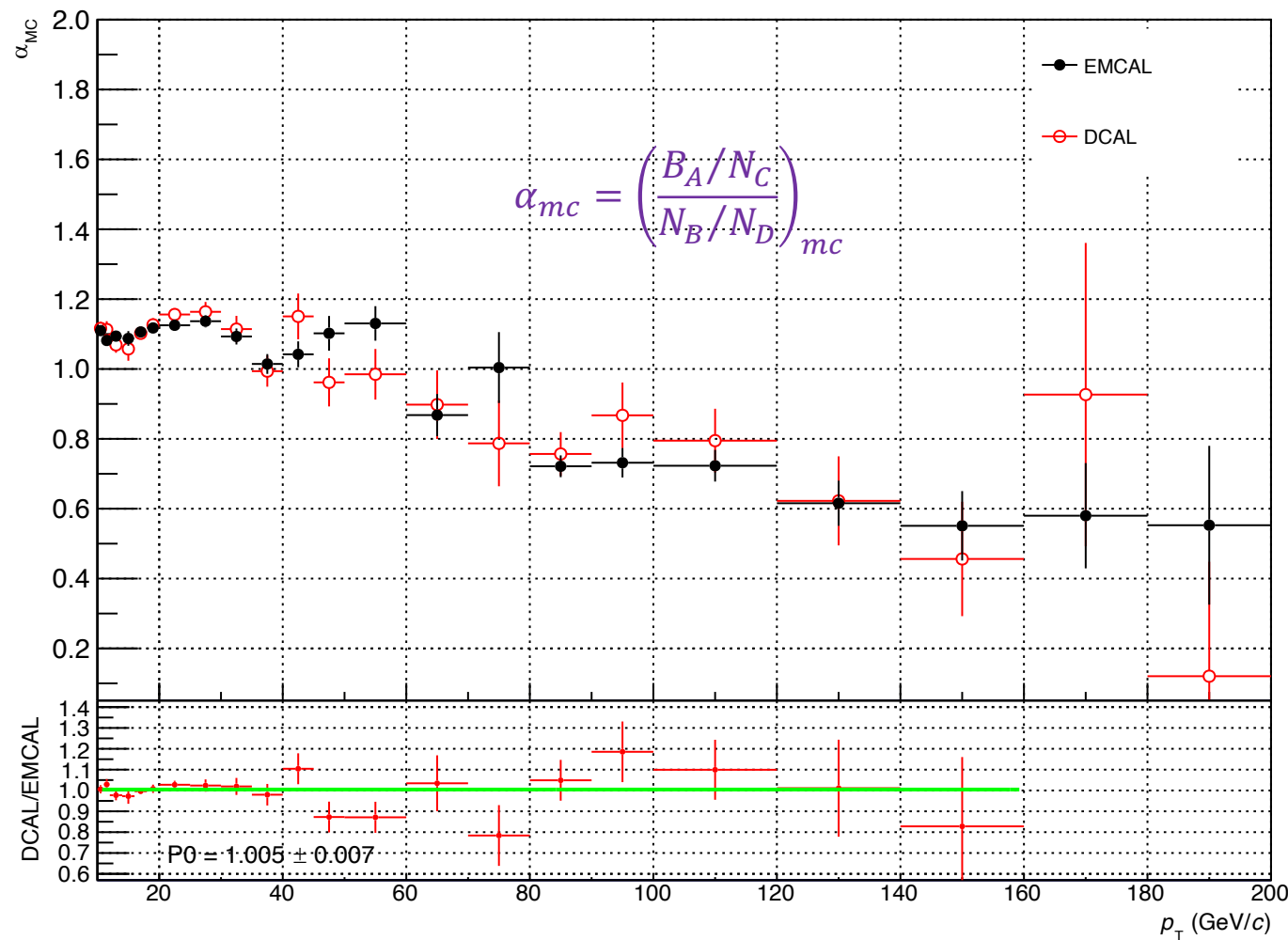
$$purity = \left[1 - \left(\frac{N_c/N_A}{N_D/N_B} \right)_{data} \right] \times \left(\frac{B_A/N_C}{N_B/N_D} \right)_N$$

purity by data-driven



- ✧ Data-driven purity is equivalent between EMCal and DCal.
- ✧ Data-driven purity DCAL/EMCAL pol0 fit value: 0.999 ± 0.006 .

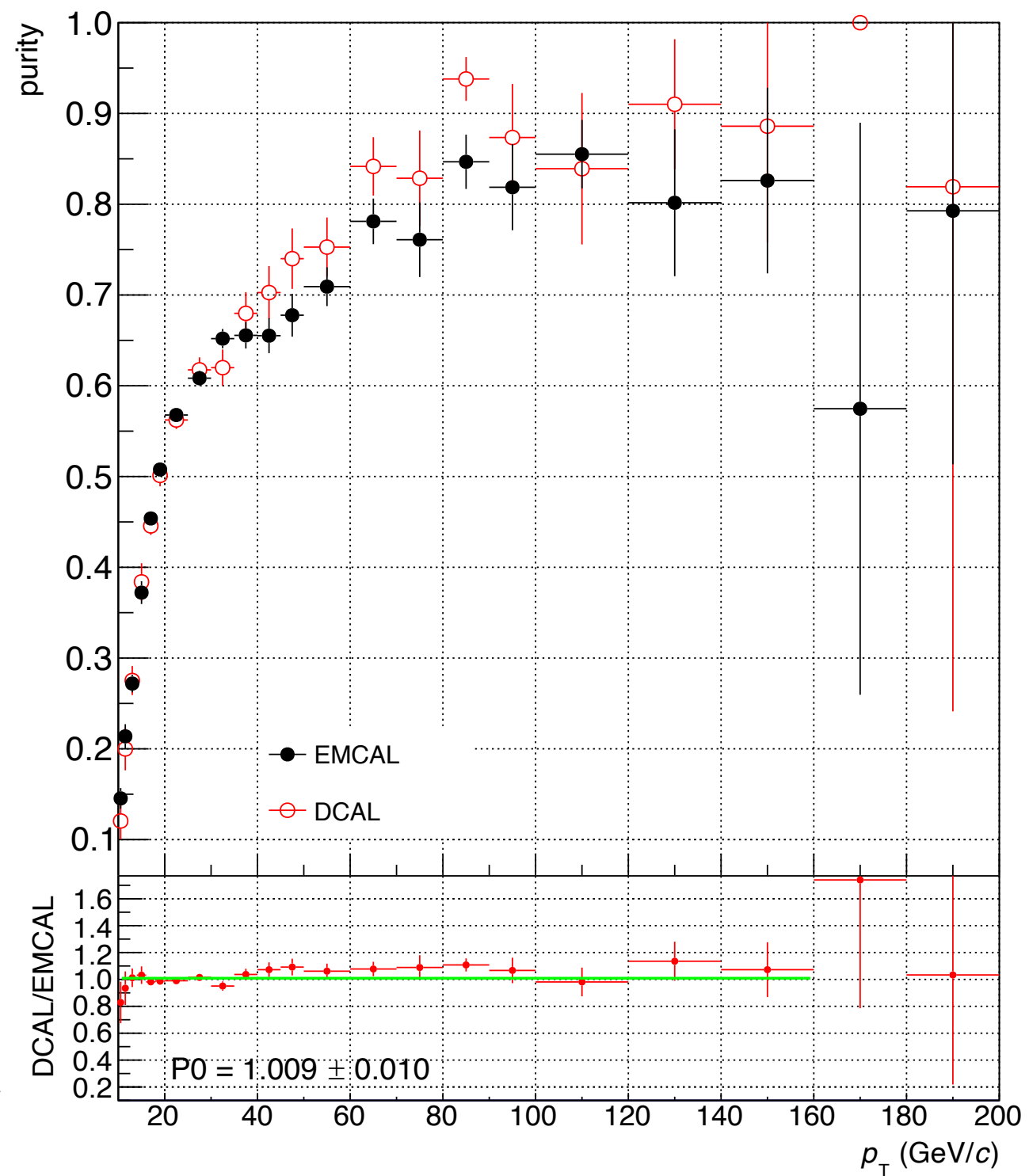
MC correction factor and final purity



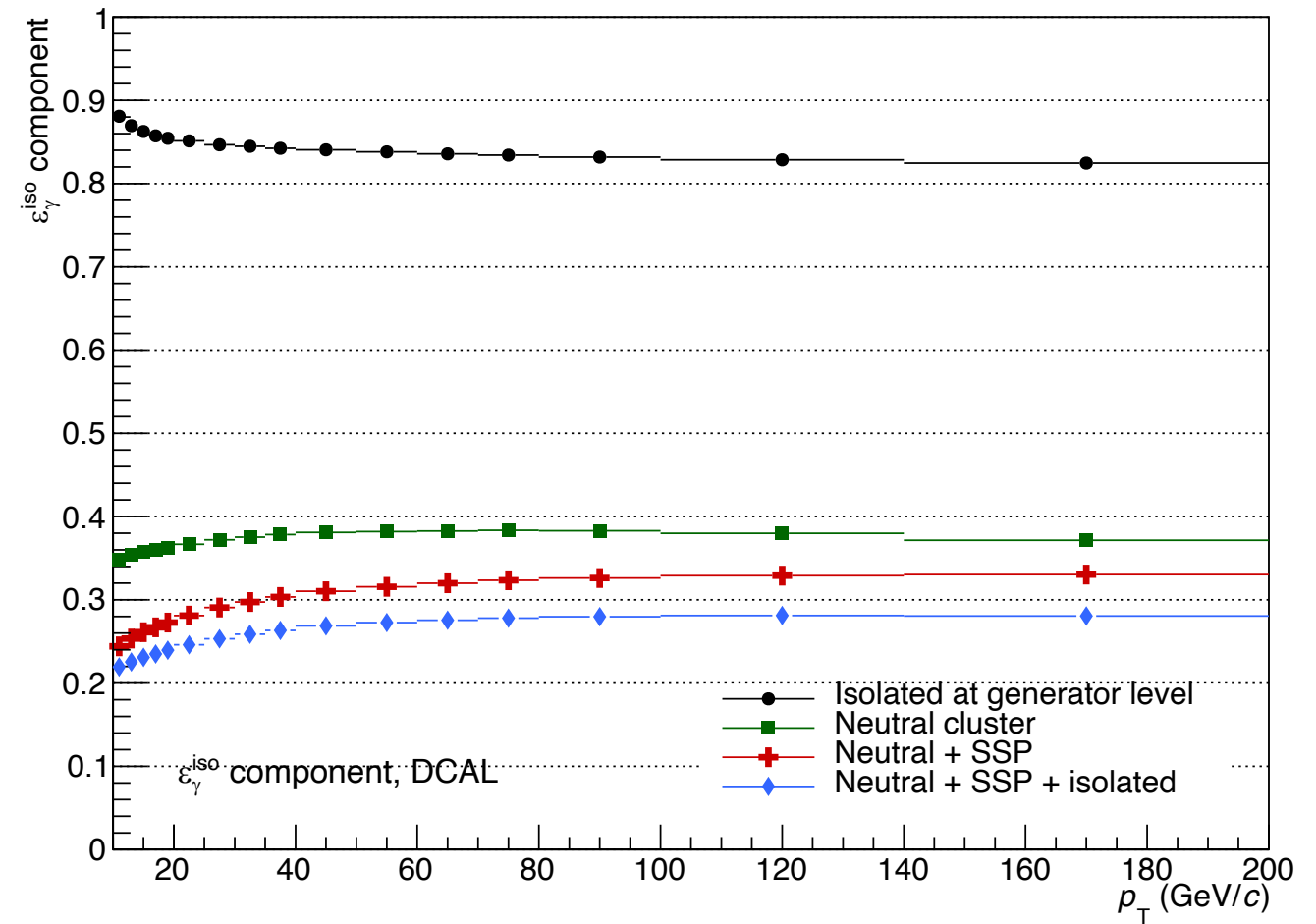
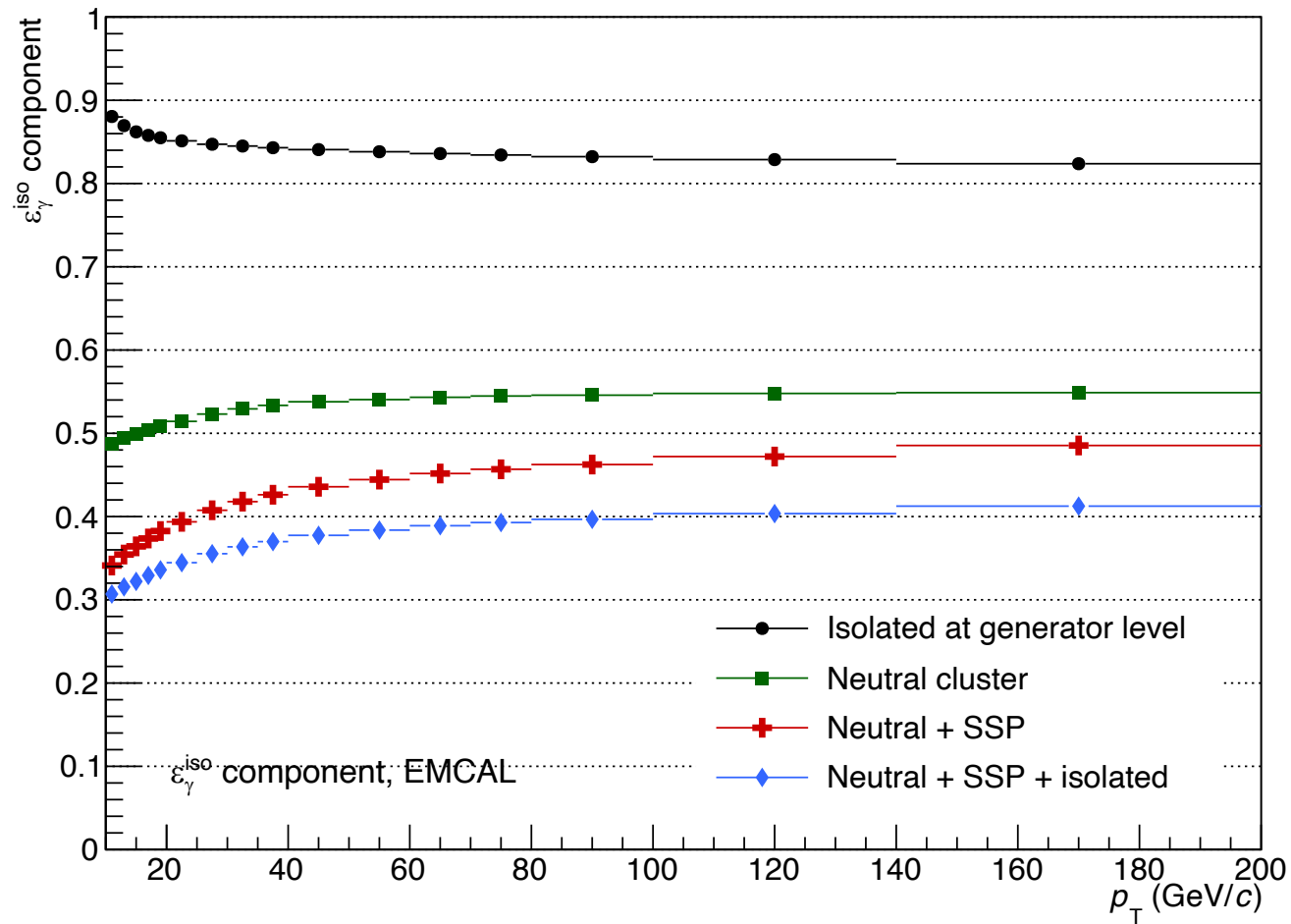
$$purity = 1 - \left(\frac{N_c/N_A}{N_D/N_B} \right)_{data} \times \left(\frac{B_A/N_C}{N_B/N_D} \right)_{mc} \alpha_{mc}$$

✦ MC correction factor is similar between EMCal and DCal. Pol0 fit: 1.005 ± 0.007

✦ Purity ~ 1 after 160 GeV/c in DCal due to data having less statistic.



Efficiency component



- Less neutral cluster can be reconstructed in DCal, because the different masked regions

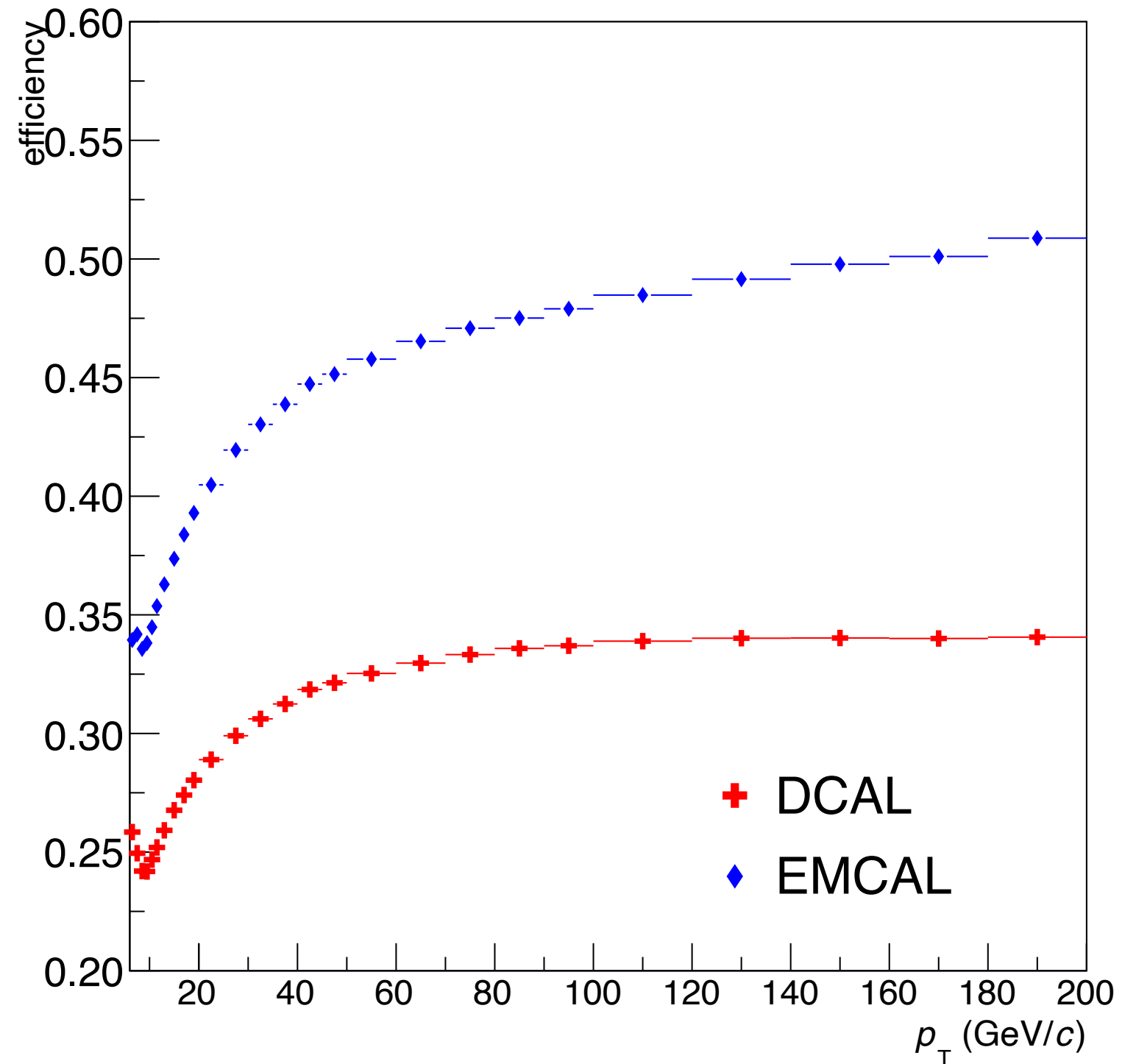
Efficiency comparison

- Efficiency correction:

$$\varepsilon_{\gamma}^{iso}(p_T) = \frac{dN_{\gamma iso}^{reco}}{dp_T^{gen}} \bigg/ \frac{dN_{\gamma iso}^{gen}}{dp_T^{gen}}$$

Photon reconstruction, identification and isolation.

- Efficiency on EMCal is around 0.5 and DCal is 0.35.
 - due to the less neutral cluster can be reconstructed in DCal.



Cross section comparison

cross section =

$$\sigma_{total} \times \frac{2\pi}{\Delta\eta\Delta\phi} \cdot \frac{1}{\sum(N_{evt,i} \times RF_i)} \sum \frac{dN}{dp_T} \times \frac{purity}{efficiency}$$

– $\frac{2\pi}{\Delta\eta\Delta\phi} \cdot \frac{1}{\sum(N_{evt,i} \times RF_i)} \sum \frac{dN}{dp_T}$ is raw spectrum

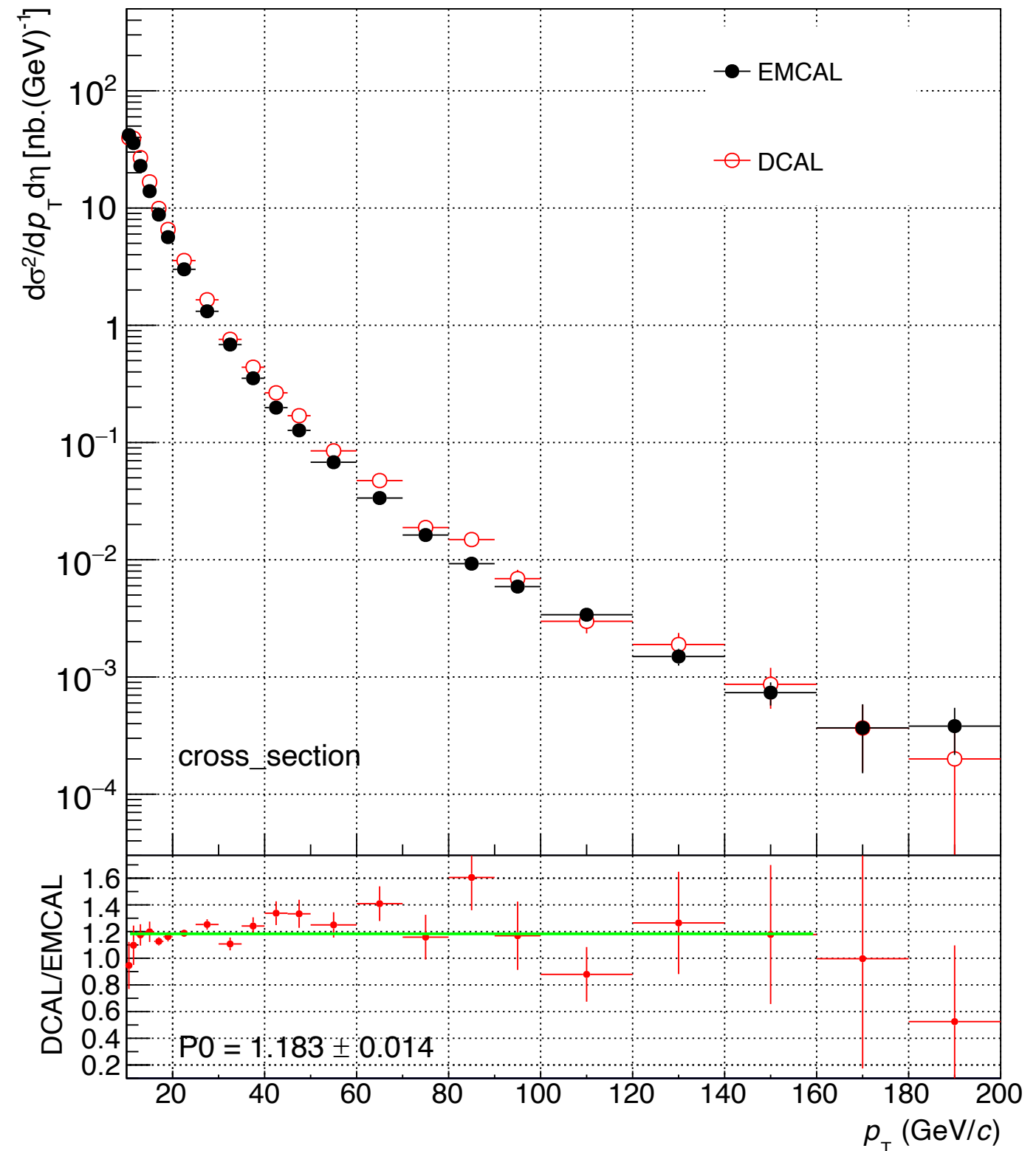
- Ratio DCAL / EMCAL around 1.18

ratio fit information:

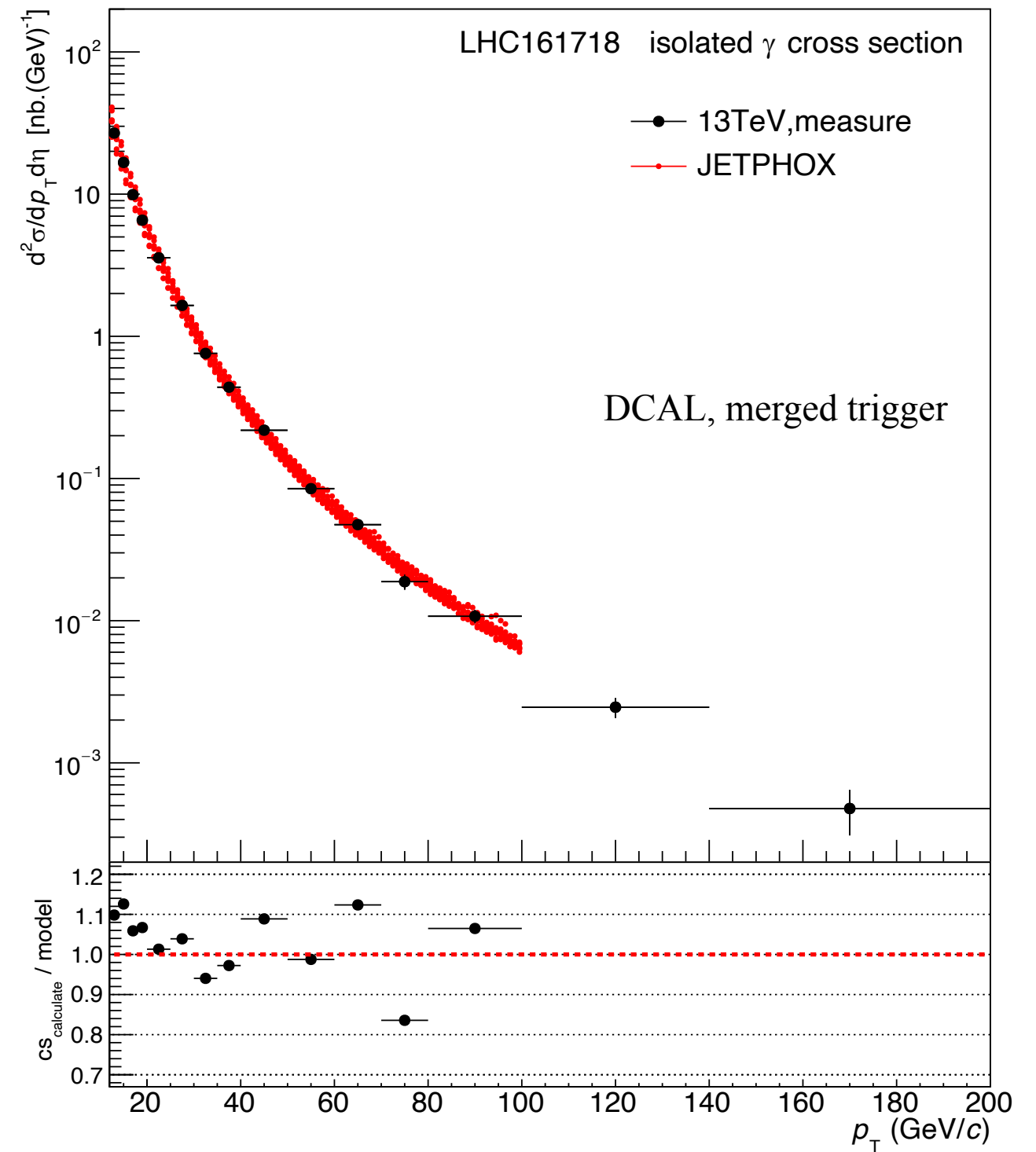
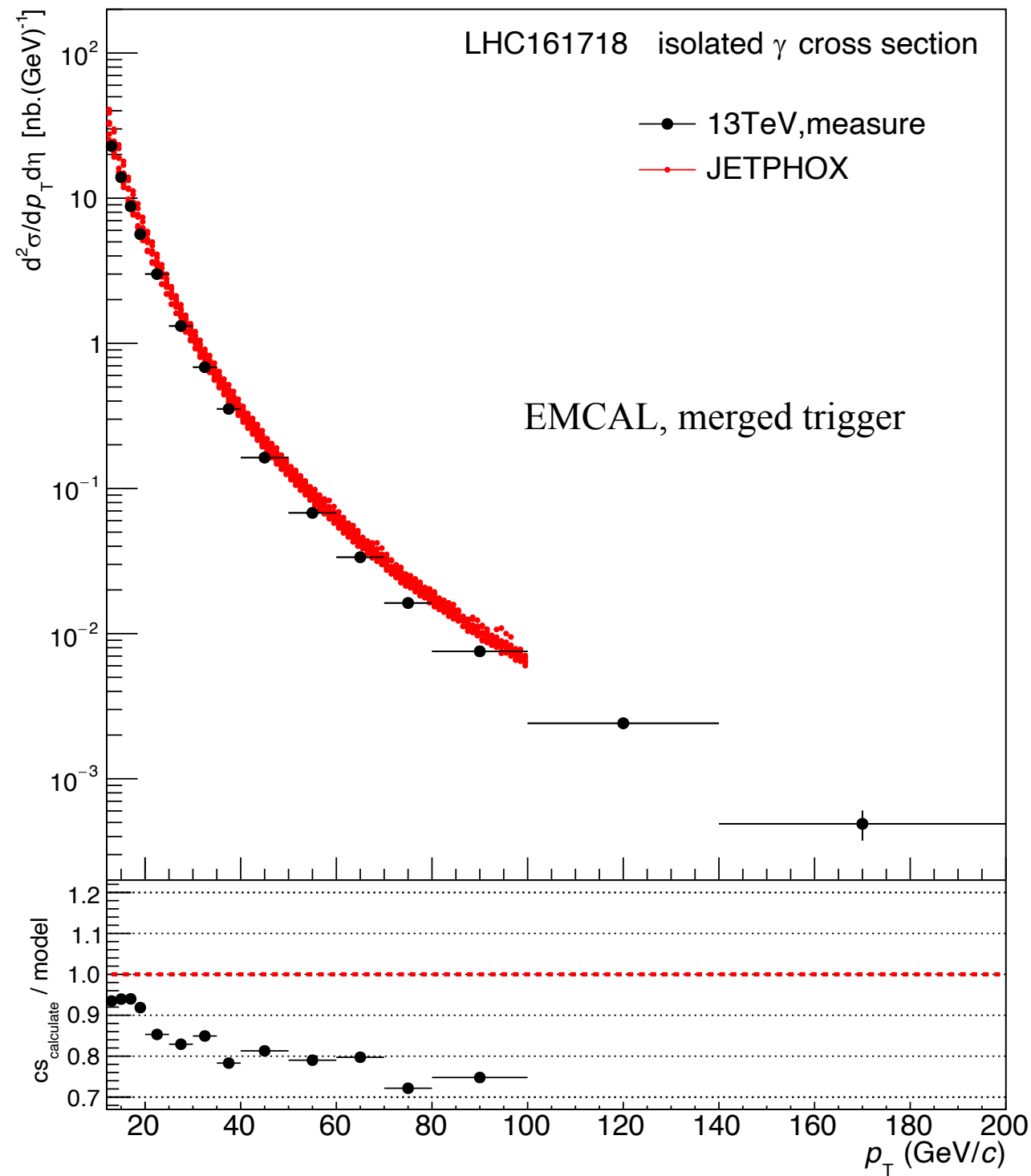
-- fit function: pol0

-- fit range: [10. , 160.]

-- fitted para: 1.183 ± 0.014 .



Cross section, EMCAL & DCAL



- Not sure the settings of the jetphox configuration settings, I will try to run jetphox and produce the theory points

Summary

✦ comparing mainly analysis result between EMCal and DCal

→ after acceptance normalization, combined spectrum ratio ~ 0.8 (DCal / EMCal).

→ purity has similar distribution between EMCal and DCal.

→ efficiency ratio around 0.7 which comes from reconstruct level.

→ yield and cross section ratio around 1.17 which equal to ratios from each analysis procedures

$$\text{cross section} = \sigma_{total} \times \underbrace{\left(\frac{2\pi}{\Delta\eta\Delta\phi} \cdot \frac{1}{\sum(N_{evt,i} \times RF_i)} \sum \frac{dN}{dp_T} \right)}_{\text{yield, ratio} \sim 1.17} \times \frac{\text{purity}}{\text{efficiency}}$$

raw, ratio ~ 0.8

← ratio ~ 1.0
← ratio ~ 0.7

Next step:

1. check closely all the steps of the analysis to understand difference between EMCal and DCal
2. obtain theory curve running jetphox
3. prepare analysis note