



Low energy (LE) timing cuts optimization

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How to proceed

- **Identify the problem**
 - Find and check datasample
 - Produce PFOs energy distributions
 - Define “figure(s) of merit”
- **Understand current approach**
 - Current documentation
 - Select variables needed
- **Improving**
 - Produce new correlation plots
 - Introduce new LE timing cuts
 - Evaluate the impact
 - Re-iterate if necessary
- **Outlook**



Work in progress

Improving: correlation plots

- **Main idea:**

Creating new processor called 'CLICPfoSelectorAnalysis', which creates a TTree with the PFO variables used in the CLIC selection and produce scatter plots of PFO cluster time vs PFO pT for:

- different particle "class":

Photons, charged particles, neutral hadrons

- different $\cos\theta$ regions:

central, forward

- **Prototype:**

<https://github.com/ebrondol/MarlinReco/tree/addCLICPfoSelTree>

- **Sample used:**

- ttbar

- Centre of mass energy = 380 GeV

- Overlay = 350 GeV

- More light quarks → dduy_y (with y = d,s,b)

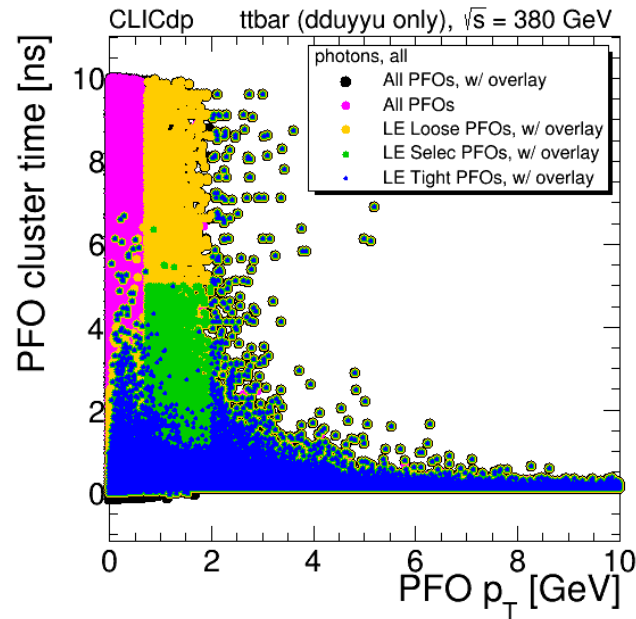
- all events

- This sample is particularly challenging!

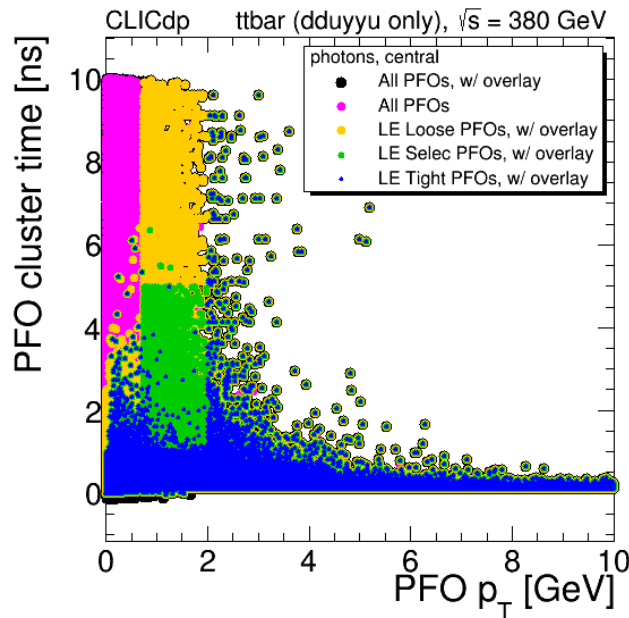
- **Effect of LE timing cuts**

Correlation plots

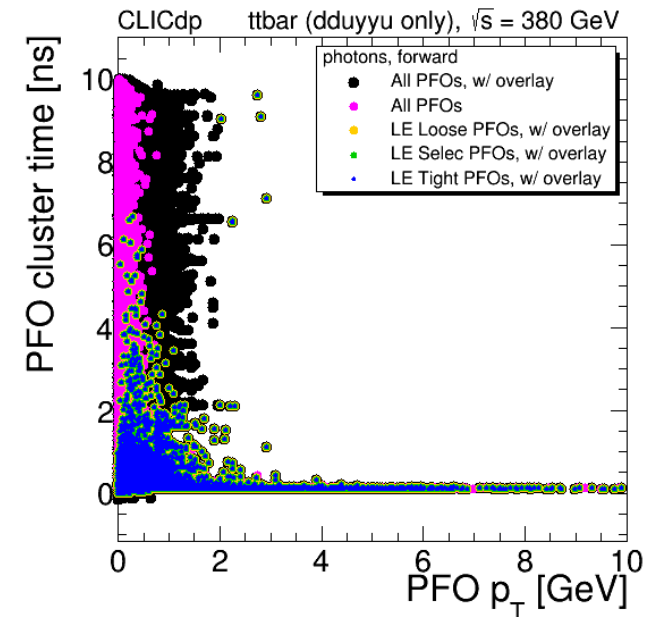
- Photons, all events



$\cos\theta < 0.975$

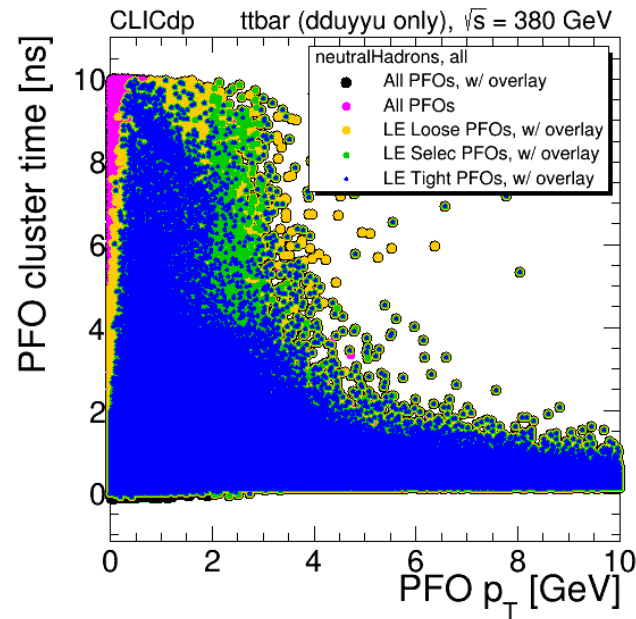


$\cos\theta \geq 0.975$

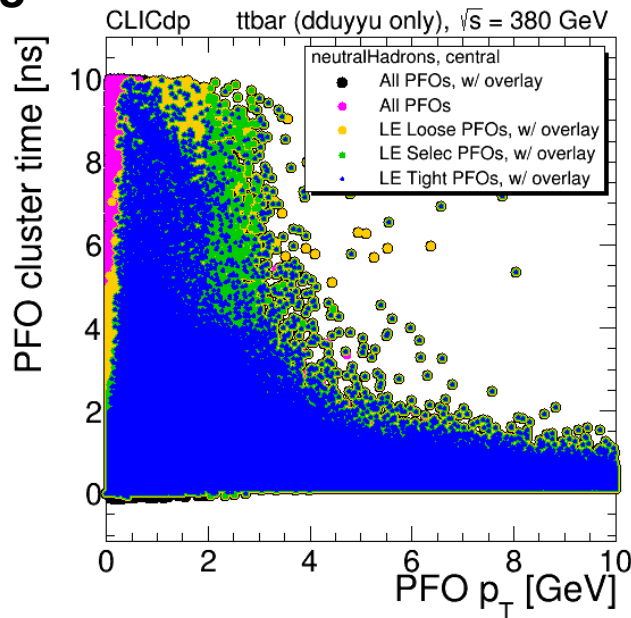


Correlation plots

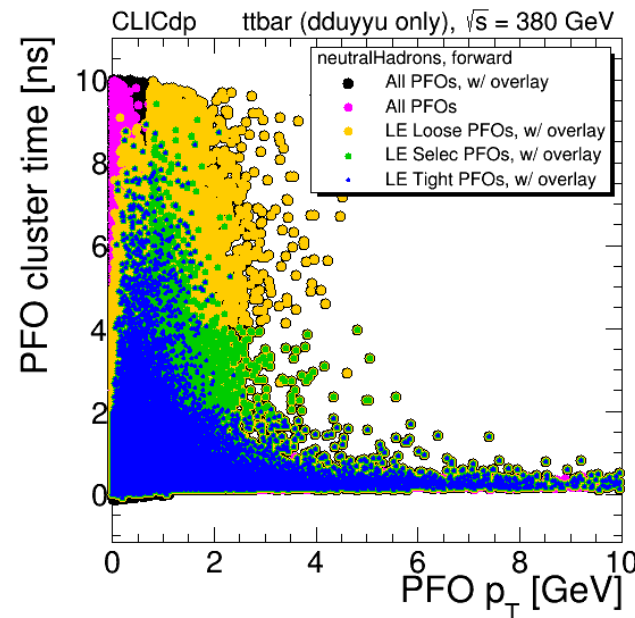
- Neutral hadrons, all events



$\cos\theta < 0.975$

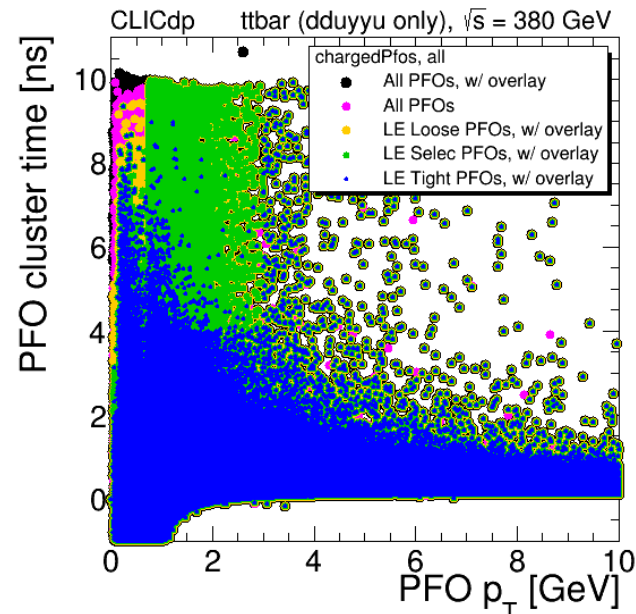


$\cos\theta \geq 0.975$

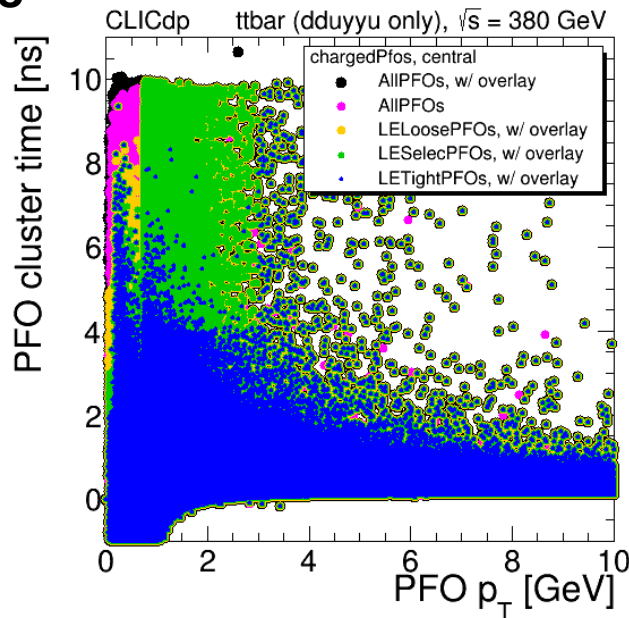


Correlation plots

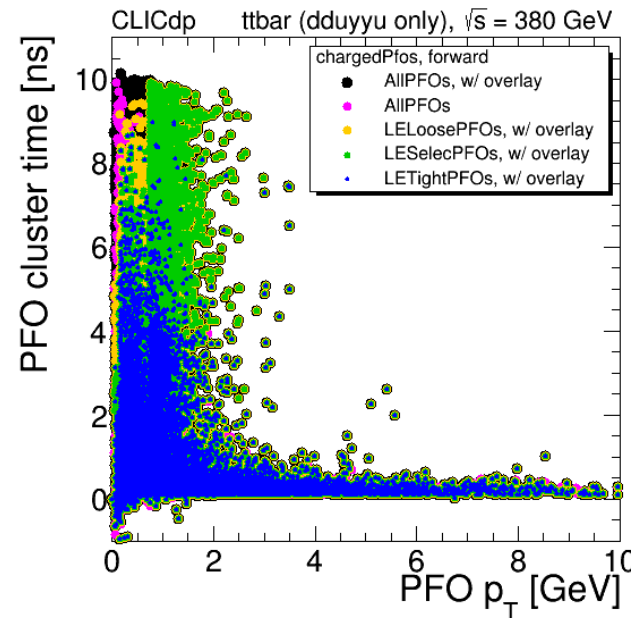
- Charged PFOs all events



$\cos\theta < 0.975$



$\cos\theta \geq 0.975$



LE timing cuts

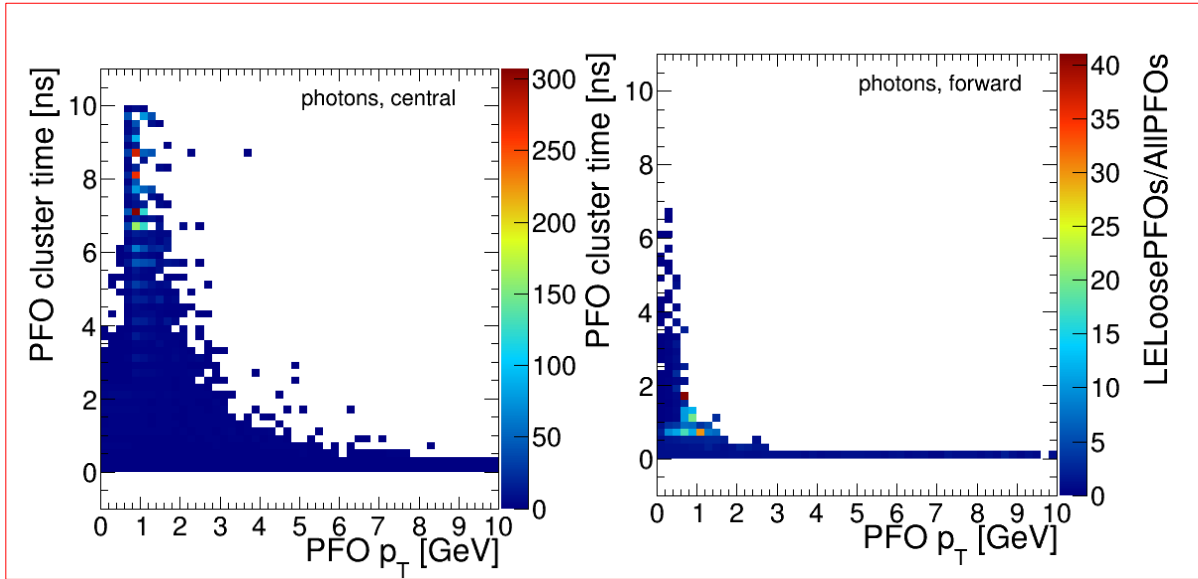
- **Low Energy Loose**

Table B.2: Cuts on the LooseSelectedPFO list in the mass production

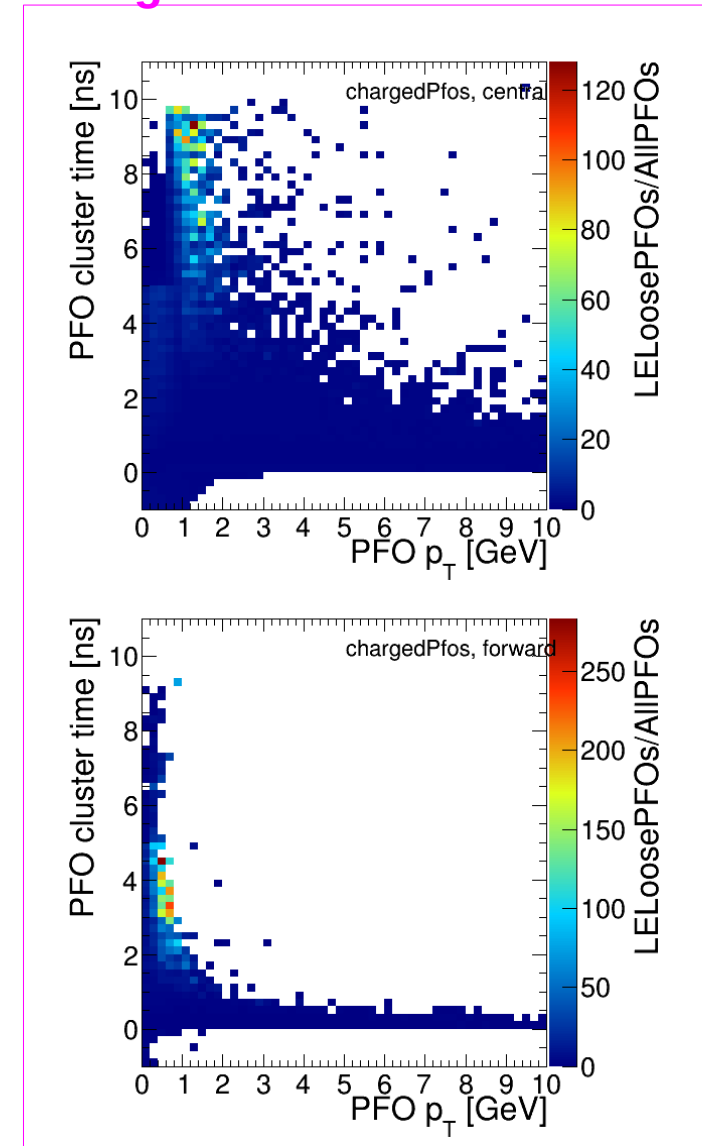
| Region | p_T range | time cut |
|--------------------------|---|----------------------|
| Photons | | |
| central | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 10 \text{ ns}$ |
| $\cos \theta \leq 0.975$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 2.5 \text{ ns}$ |
| forward | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 2.0 \text{ ns}$ |
| $\cos \theta > 0.975$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 1.0 \text{ ns}$ |
| neutral hadrons | | |
| central | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 10 \text{ ns}$ |
| $\cos \theta \leq 0.975$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 5 \text{ ns}$ |
| forward | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 10 \text{ ns}$ |
| $\cos \theta > 0.975$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 5 \text{ ns}$ |
| charged particles | | |
| all | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 10 \text{ ns}$ |
| | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 5 \text{ ns}$ |

LE timing cuts

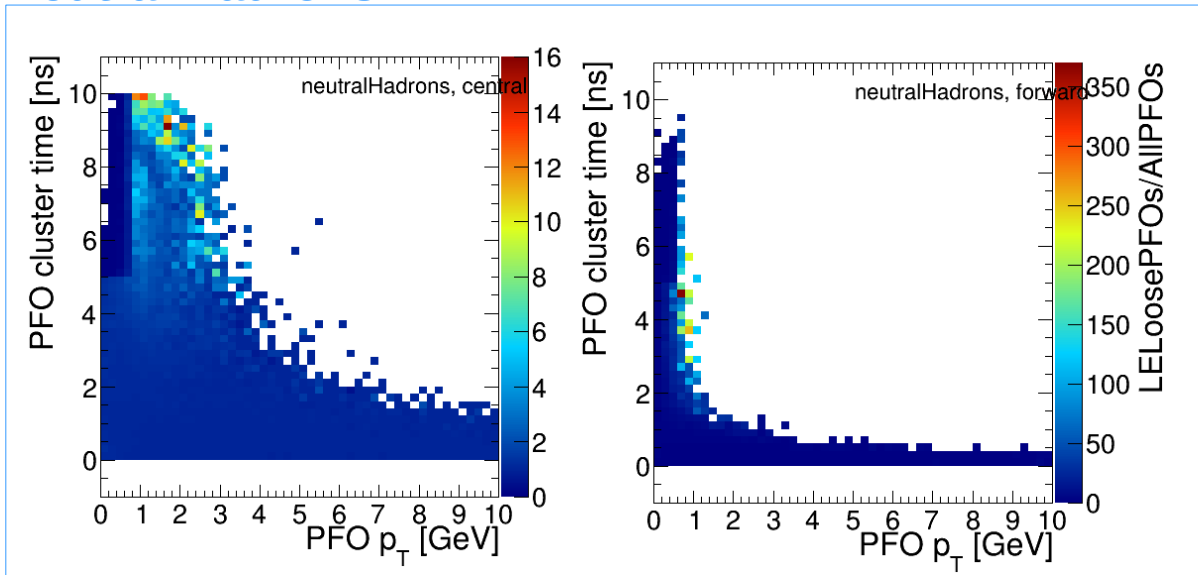
- Low Energy Loose Photons



Charged PFOs



Neutral Hadrons



LE timing cuts

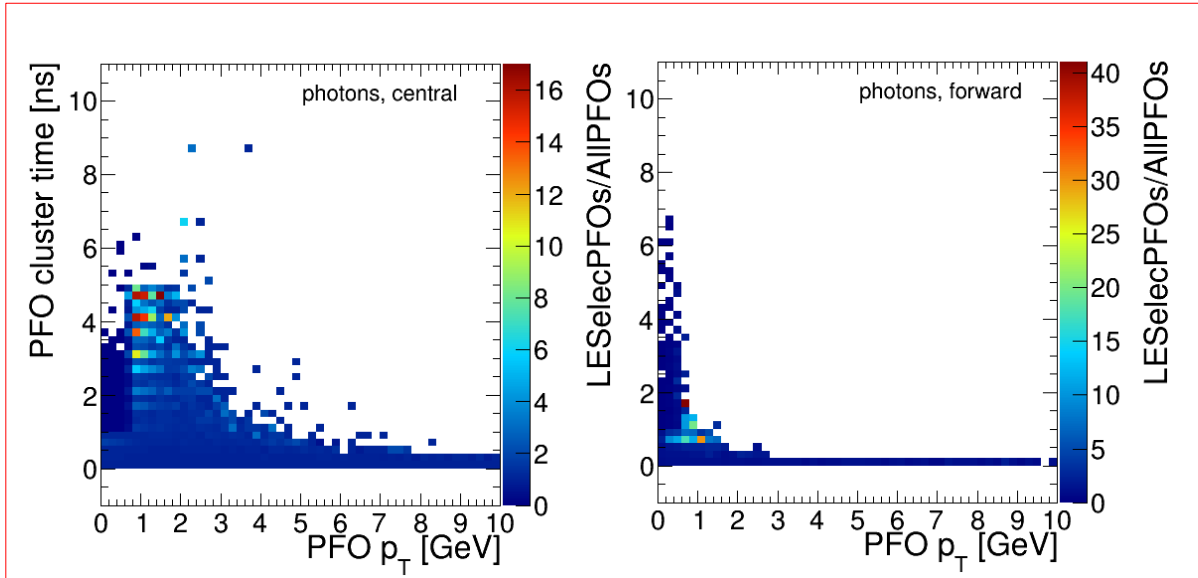
- **Low Energy Default**

Table B.1: Cuts on the `DefaultSelectedPFO` list in the mass production

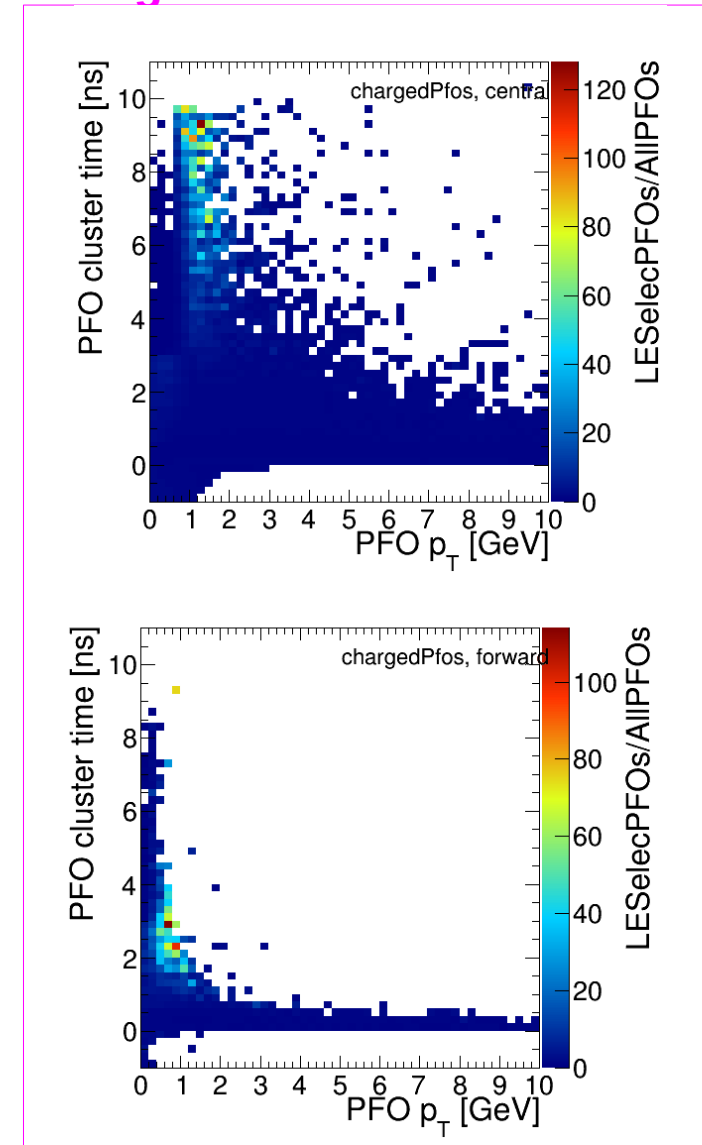
| Region | p_T range | time cut |
|-------------------------------------|---|----------------------|
| Photons | | |
| central $\cos \theta \leq 0.975$ | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 5 \text{ ns}$ |
| forward $\cos \theta > 0.975$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 1.0 \text{ ns}$ |
| central $\cos \theta \leq 0.975$ | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 2.0 \text{ ns}$ |
| forward $\cos \theta > 0.975$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 1.0 \text{ ns}$ |
| neutral hadrons | | |
| central $\cos \theta \leq 0.975$ | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 5 \text{ ns}$ |
| forward $\cos \theta > 0.975$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 2.5 \text{ ns}$ |
| central $\cos \theta \leq 0.975$ | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 4 \text{ ns}$ |
| forward $\cos \theta > 0.975$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 2 \text{ ns}$ |
| charged particles | | |
| all | $0.75 \text{ GeV} \leq p_T < 4.0 \text{ GeV}$ | $t < 10 \text{ ns}$ |
| | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 3 \text{ ns}$ |

LE timing cuts

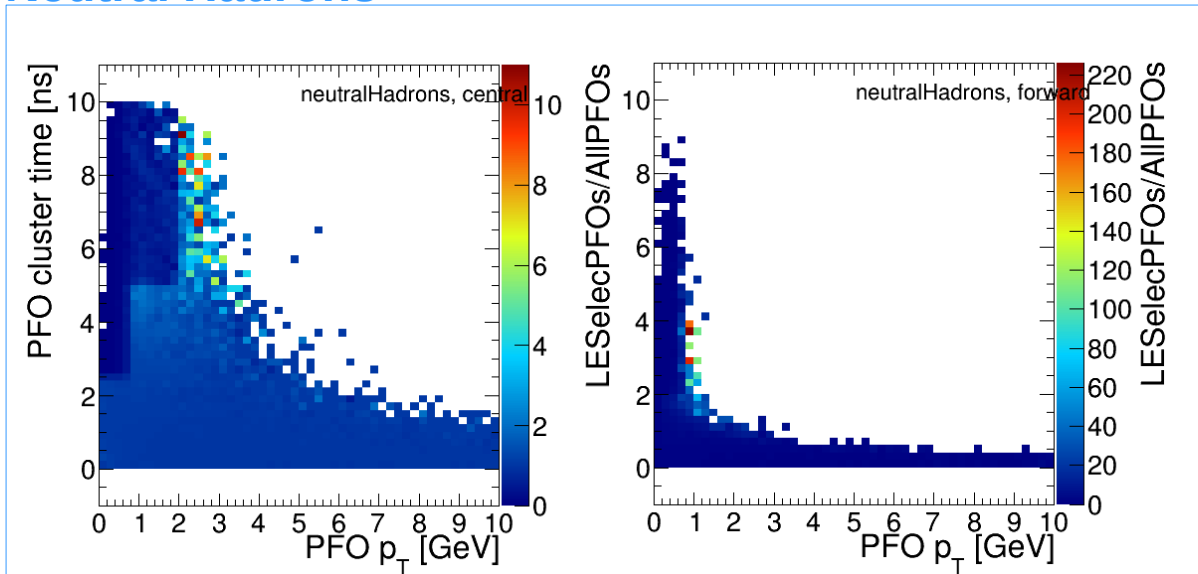
- Low Energy Default
Photons



Charged PFOs



Neutral Hadrons



LE timing cuts

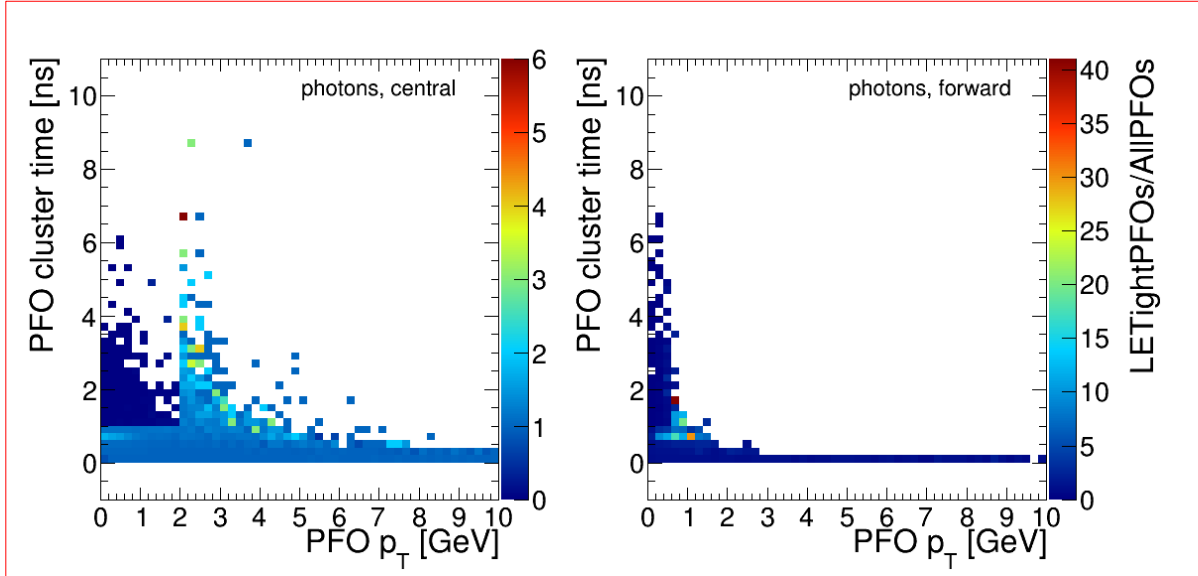
- Low Energy Tight

Table B.3: Cuts on the TightSelectedPFO list in the mass production

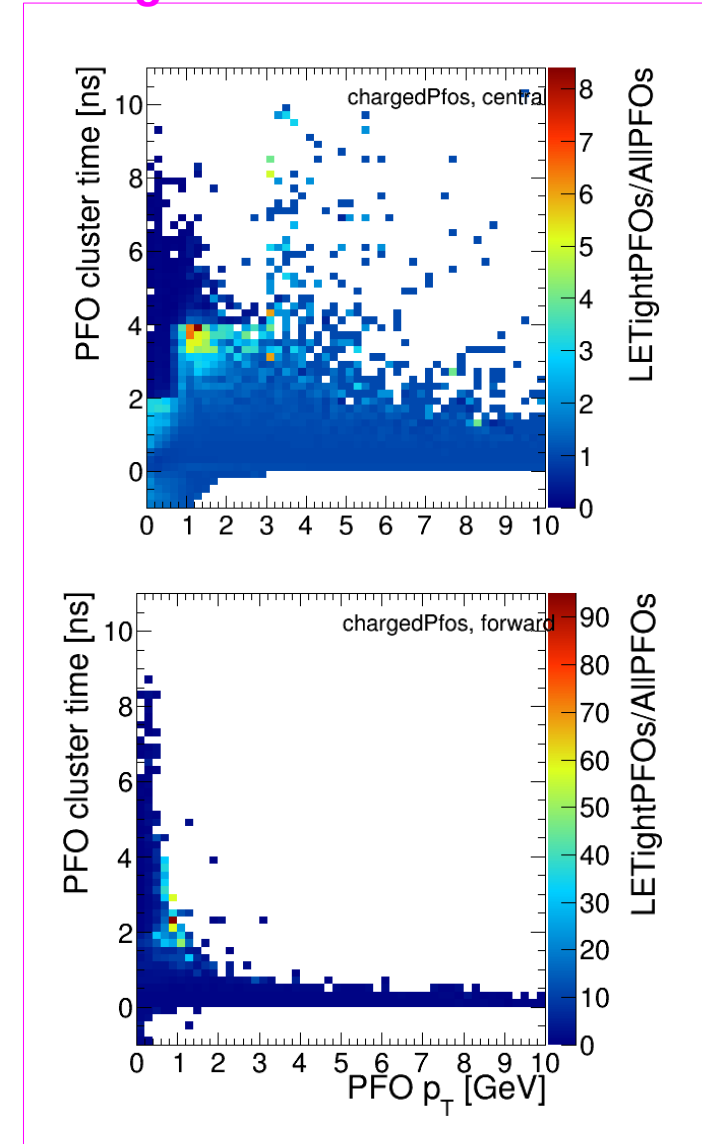
| Region | p_T range | time cut |
|-------------------------|---|----------------------|
| Photons | | |
| central | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 1 \text{ ns}$ |
| $\cos \theta \leq 0.95$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 1.0 \text{ ns}$ |
| forward | $0.75 \text{ GeV} \leq p_T < 2 \text{ GeV}$ | $t < 2.0 \text{ ns}$ |
| $\cos \theta > 0.95$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 1.0 \text{ ns}$ |
| neutral hadrons | | |
| central | $0.75 \text{ GeV} \leq p_T < 3.5 \text{ GeV}$ | $t < 4 \text{ ns}$ |
| $\cos \theta \leq 0.95$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 2 \text{ ns}$ |
| forward | $0.75 \text{ GeV} \leq p_T < 3 \text{ GeV}$ | $t < 2 \text{ ns}$ |
| $\cos \theta > 0.95$ | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 2 \text{ ns}$ |
| charged particles | | |
| all | $0.75 \text{ GeV} \leq p_T < 3 \text{ GeV}$ | $t < 4 \text{ ns}$ |
| | $0 \text{ GeV} \leq p_T < 0.75 \text{ GeV}$ | $t < 2 \text{ ns}$ |

LE timing cuts

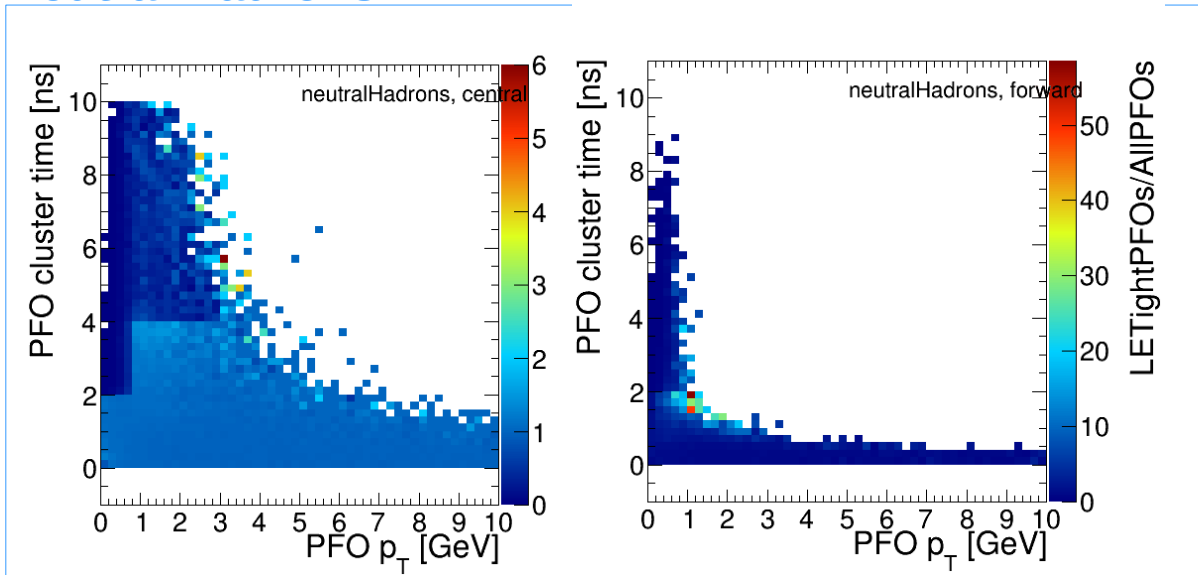
- Low Energy Tight Photons



Charged PFOs

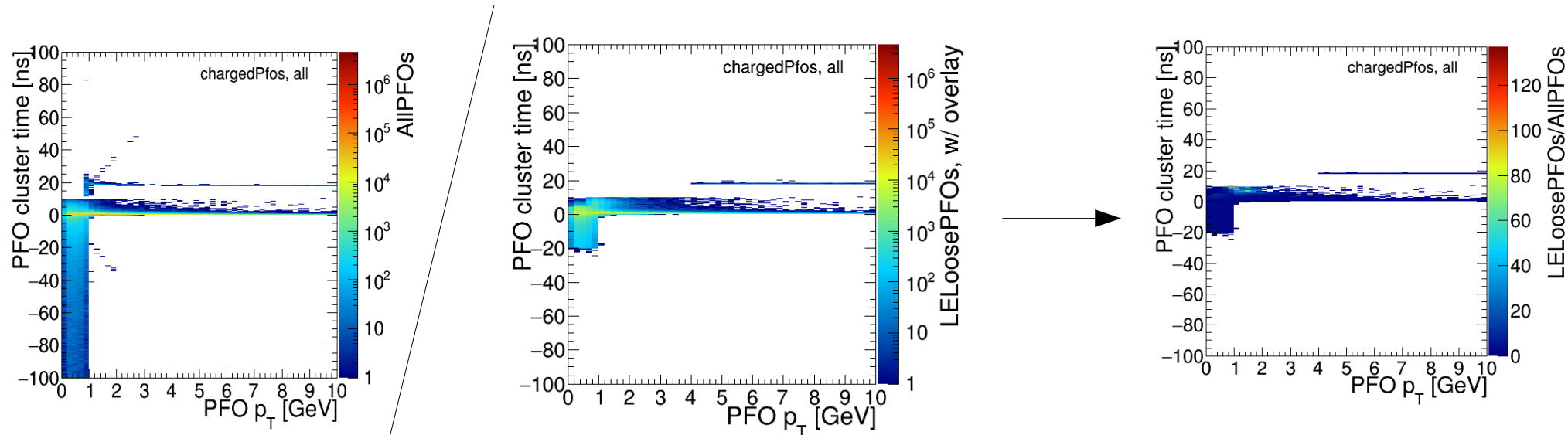


Neutral Hadrons



Conclusions (for today)

- Do we understand the cuts?
- Why some of them are not working?
- Variables are incorrect?
- Ratio is not the best



- ... any suggestion is welcome
- Negative cluster time is still under investigation ...



Thank you for the attention!