

# 5D Calorimetry

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# Slow neutrons Study

## ❑ Source of Slow Neutrons

Some neutrons produced during proton-proton (P-P) collisions undergo inelastic scattering, causing them to lose momentum and gradually slow down. As their energy decreases, they may not have sufficient energy to participate in further interactions, and consequently, they continue moving until they eventually decay.

❑ Time scale (ns- minutes)

❑ Slow Neutron energy scale?

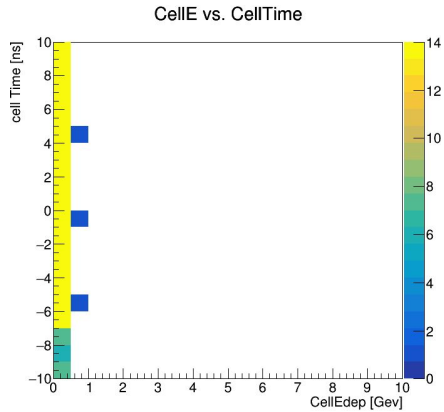
# Strategy

- ❑ Calorimeter
  - ❑ LAr
  - ❑ Tiles
    - ❑ Layers
    - ❑ Rapidity
- ❑ Comparing the results before time correction and after time correction

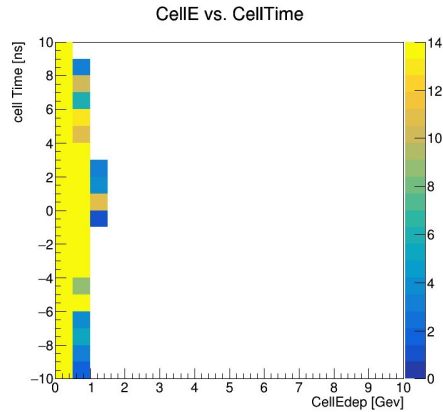
Note: All results exclusively for **pi- events**

# CellE vs Time

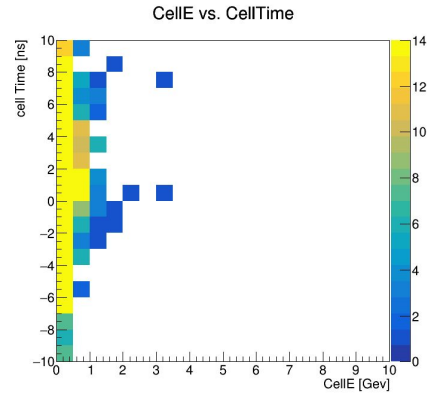
cellEdep  $\geq 0.001$  && cellTime  $\neq 0$



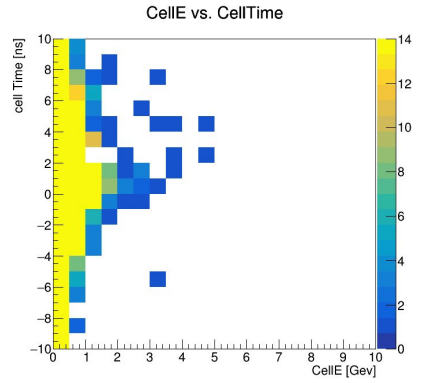
$0 < \text{truthE} < 1$



$0 < \text{truthE} < 2$



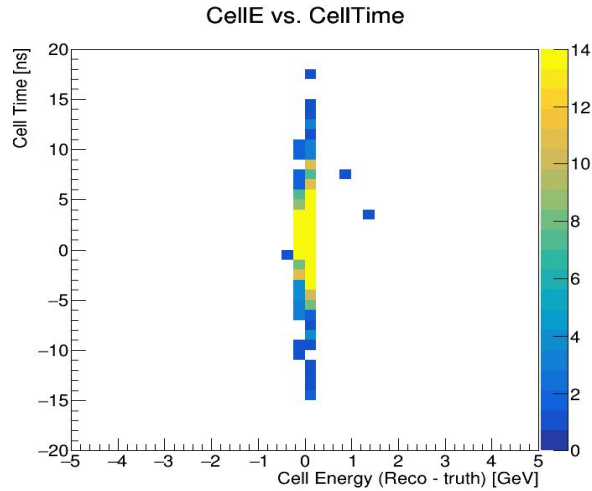
$0 < \text{truthE} < 1$



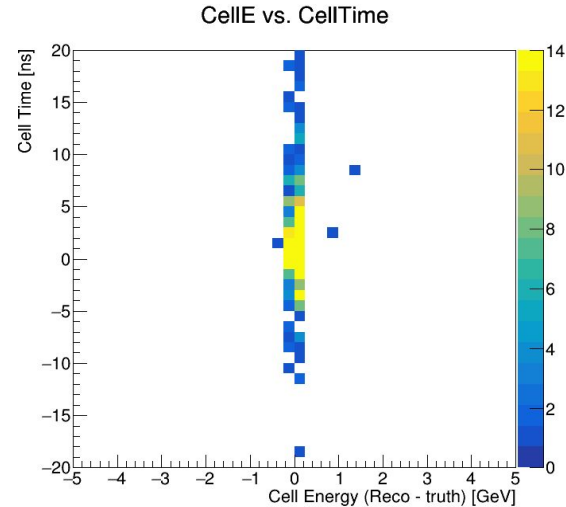
$0 < \text{truthE} < 2$

# Cell Reco levelE - cellTruthE (Layer 1)

$\text{cellEdep} \geq 0.001 \ \&\& \ \text{cellTime} \neq 0 \ \&\& \ \text{Pion Energy at Truth level} < 1$



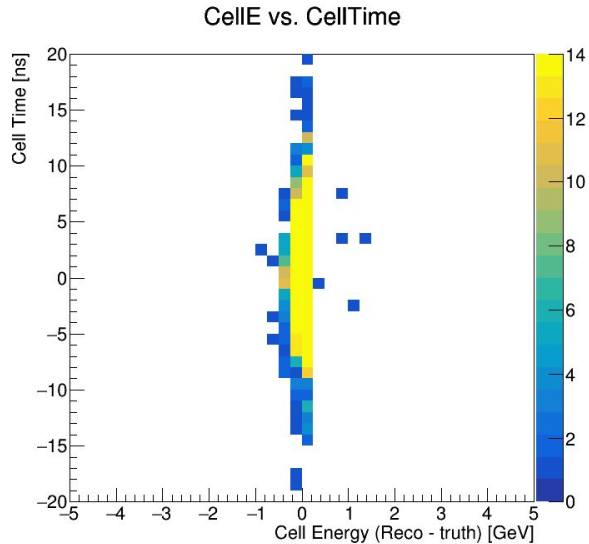
Before correction



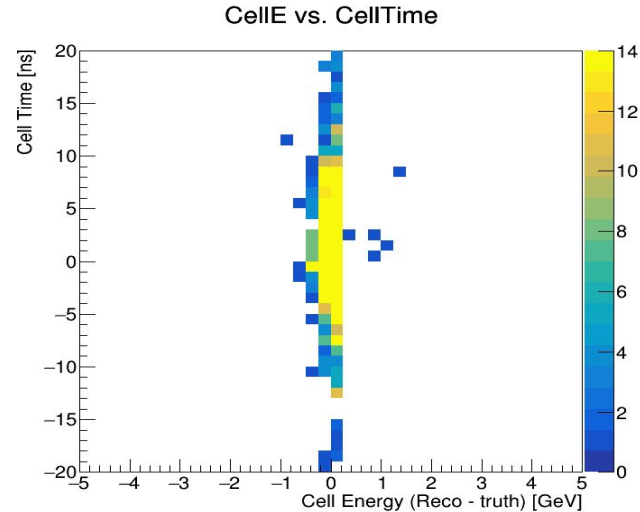
After correction

# Cell Reco levelE - cellTruthE (Layer 1)

$\text{cellEdep} \geq 0.001 \ \&\& \ \text{cellTime} \neq 0 \ \&\& \ \text{Pion Energy at Truth level} < 2$



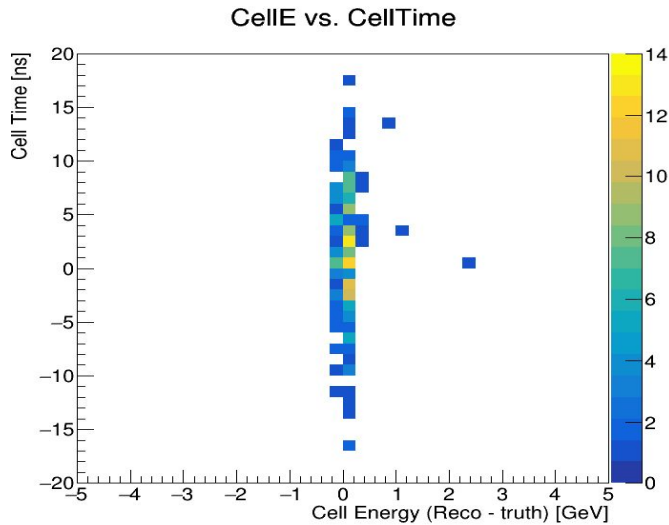
Before correction



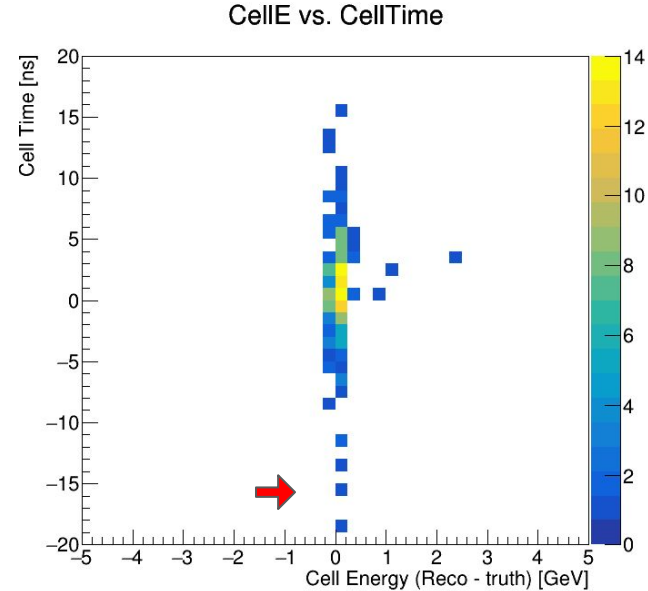
After correction

# Cell Reco levelE - cellTruthE (Layer 2)

cellEdep  $\geq$  0.001 && cellTime  $\neq$  0 && Pion Energy at Truth level  $<$  1



Before correction



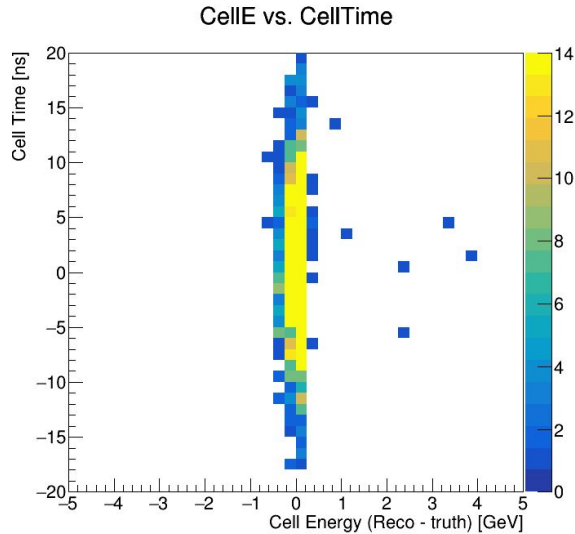
Could those single points be slow neutrons?

Their Energy is very low and cellTime is high

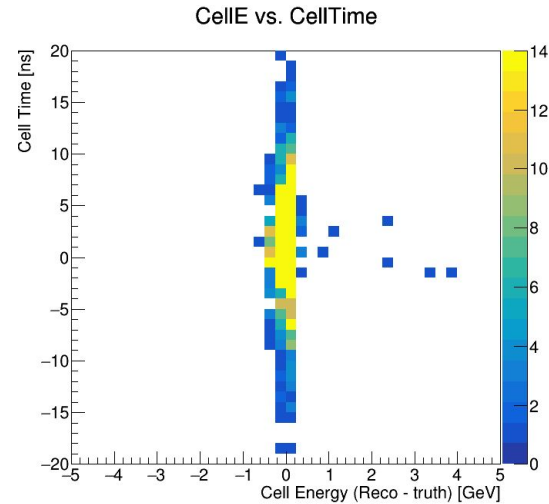
After correction

# Cell Reco levelE - cellTruthE (Layer 2)

cellEdep  $\geq$  0.001 && cellTime  $\neq$  0 && Pion Energy at Truth level  $<$  2



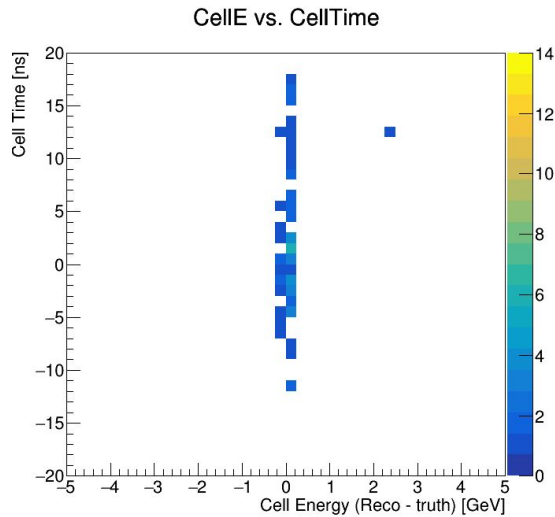
Before correction



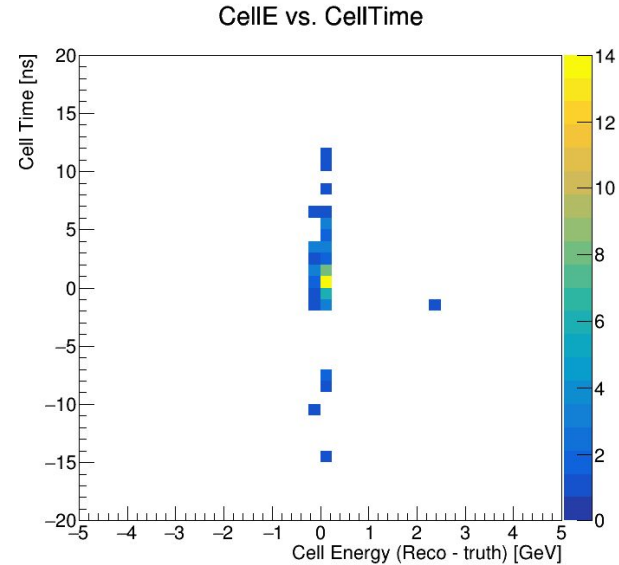
After correction

# Cell Reco levelE - cellTruthE (Layer 3)

cellEdep  $\geq 0.001$  && cellTime  $\neq 0$  && Pion Energy at Truth level  $< 1$



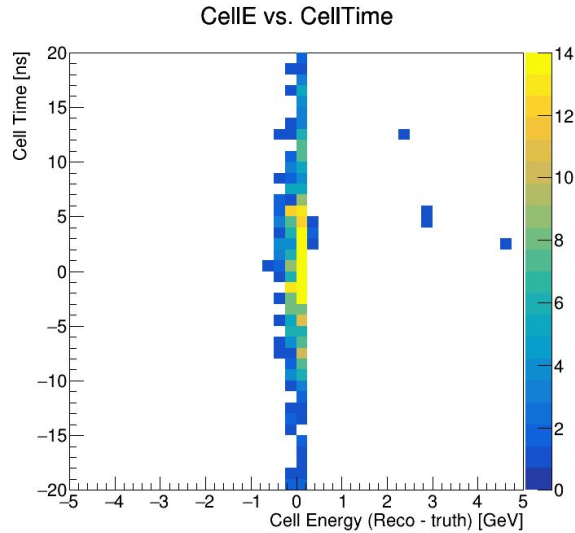
Before correction



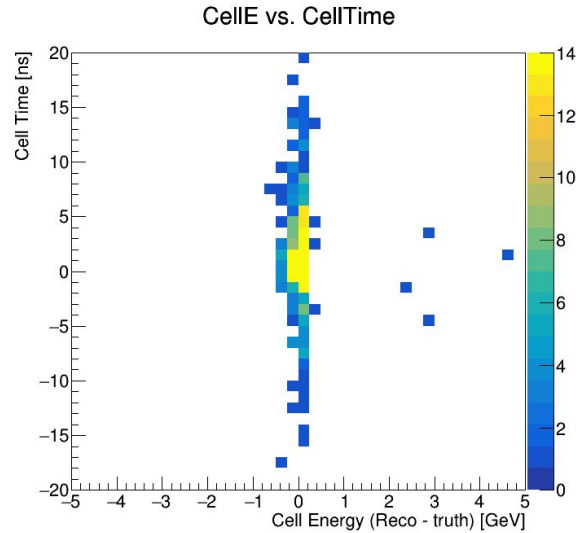
After correction

# Cell Reco levelE - Cell TruthE (Layer 3)

$\text{cellEdep} \geq 0.001 \ \&\& \ \text{cellTime} \neq 0 \ \&\& \ \text{Pion Energy at Truth level} < 2$



Before correction



After Correction

# New data set for single Neutron

DS Ids for single (anti-)neutrons without pile-up. Here "etaLT25" means " $|\eta_{\text{particle}}| < 2.5$ " and "etaGT25" means " $|\eta_{\text{particle}}| > 2.5$ ".

```
mc16_13TeV.901917.PG_neutron_logE1p0to2000_etaLT25.recon.ESD.e8470_e7400_s3170_r14501
mc16_13TeV.901918.PG_antineutron_logE1p0to2000_etaLT25.recon.ESD.e8470_e7400_s3170_r14501
mc16_13TeV.901933.PG_neutron_logE1p0to2000_etaGT25.recon.ESD.e8470_e7400_s3170_r14501
mc16_13TeV.901934.PG_antineutron_logE1p0to2000_etaGT25.recon.ESD.e8470_e7400_s3170_r14501
```

Also, I added 3 new branches to the ntuple corresponding to the corrected\_cellTime for each layer, the script will be added to gitlab.

CellE vs. CellTime

