Test Beam data analysis

HCal-ECal synchronization update

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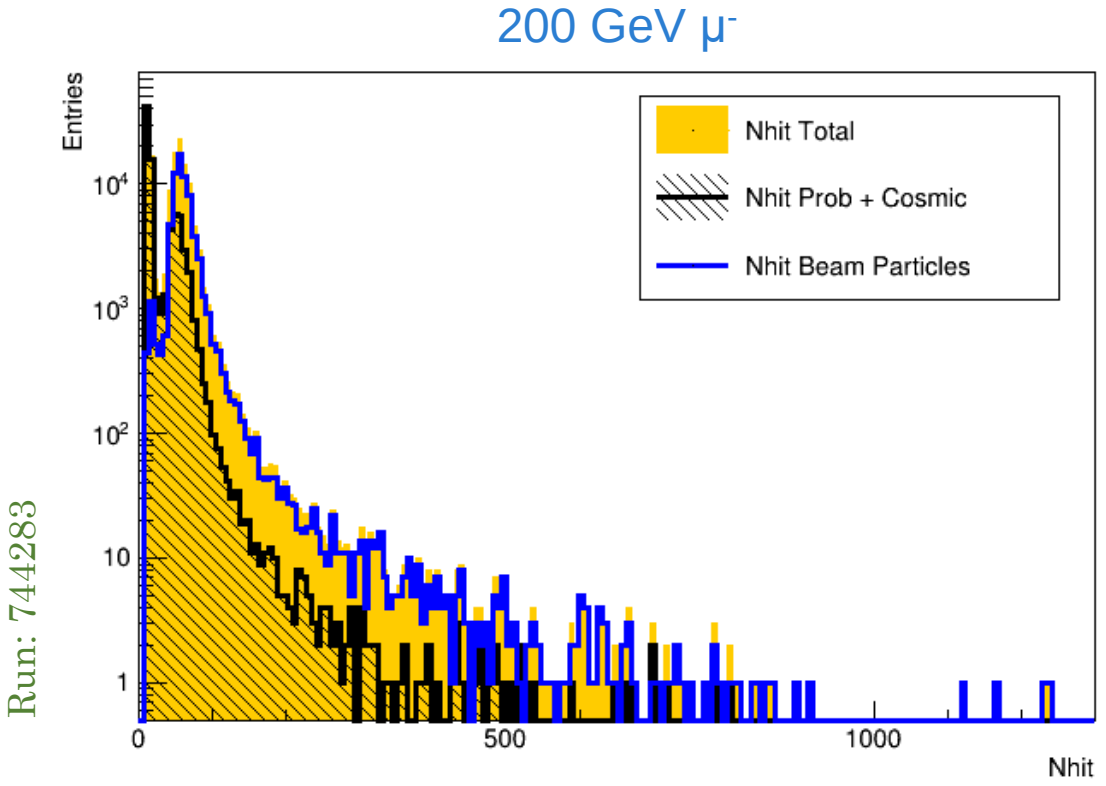
Contents

Changes from last analysis

- The new ROOT Files created with GG's code have been used as input removing the Aegis and Tricot data.
- All the ROOT macros have been updated to use the new names and sets of variables.
- Some bugs in the algorithms used for the particles selection, clusterization and trace reconstruction have been fixed.

HCal beam particles selection (muon runs).

- To reconstruct a physical process: $Nhits > 7$.
- We assume that there is signal in the first 2 layers.
- It is required 4 layers with signal between the first 10 and 3 among the first 6.
- To reconstruct the trace we require at least 5 close (less than 3 layers without signal in between) GRPCs with signal.
- Only one set of close RPCs with signal in the whole prototype.



HCal muons selection (muon runs)

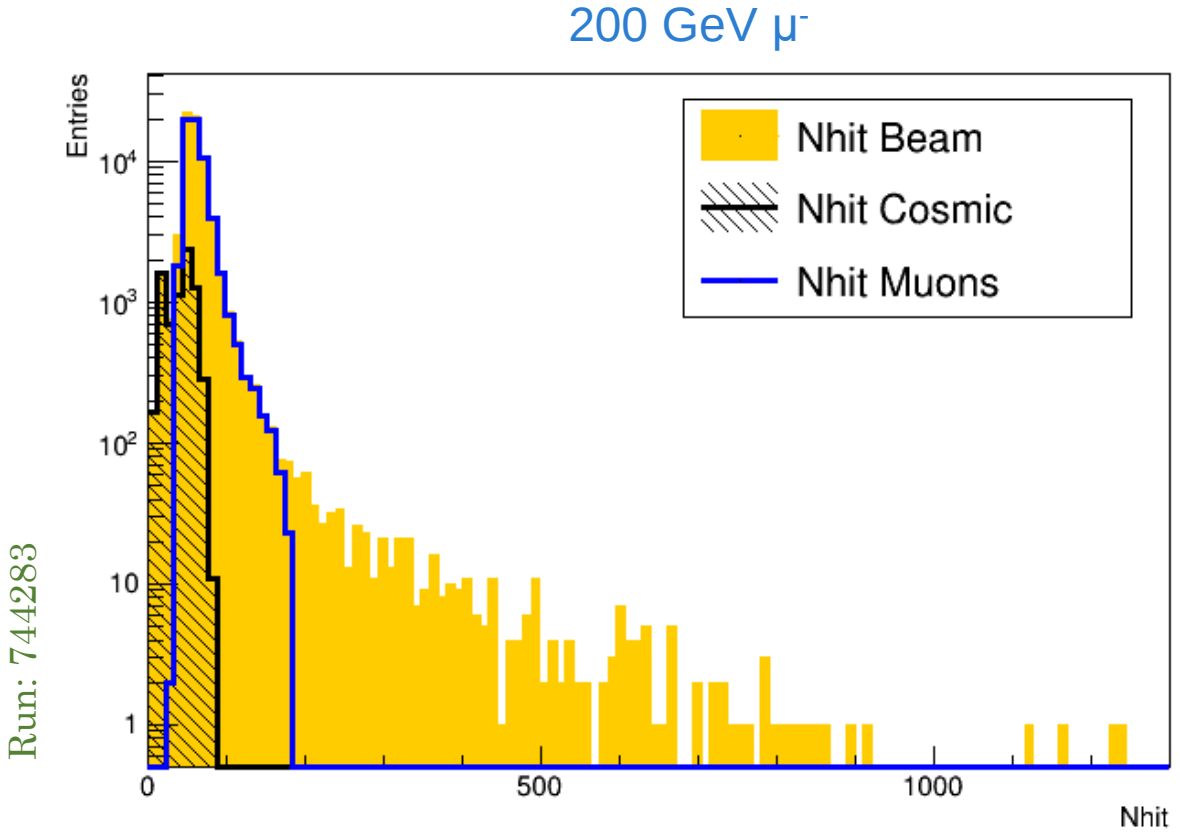
Density: **ρ**

Second nHit maximum in a single layer: $\boldsymbol{Hit_{Max2}}$

Penetrability condition: ***P.C.***

Muons → $(\rho < 2.2 \; or \; Hit_{Max2} < 5) + P.C.$

Muons with shower → $\rho < 5 + P.C.$

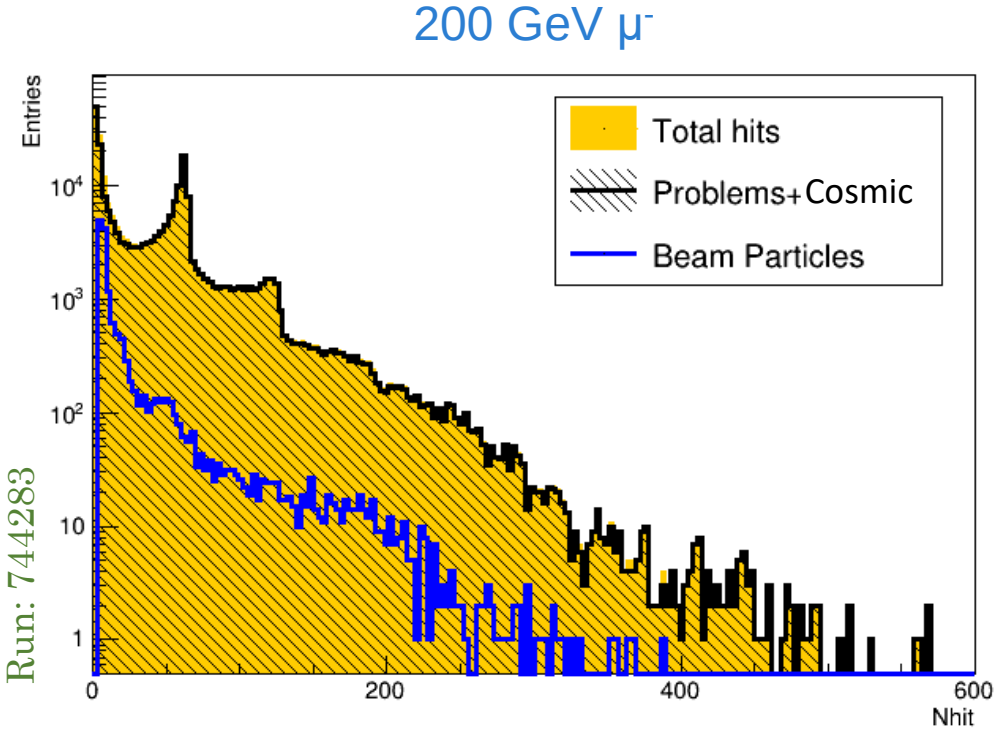


ECal beam particles selection (muon runs)

Data files taken from: /eos/project/s/siw-ecal/TB2018-09/Common/ECAL/Muon_200GeV/*__build.root

Following a similar procedure than the HCal:

- Signal in the first 2 layers required.
- At least 3 close layers with signal.



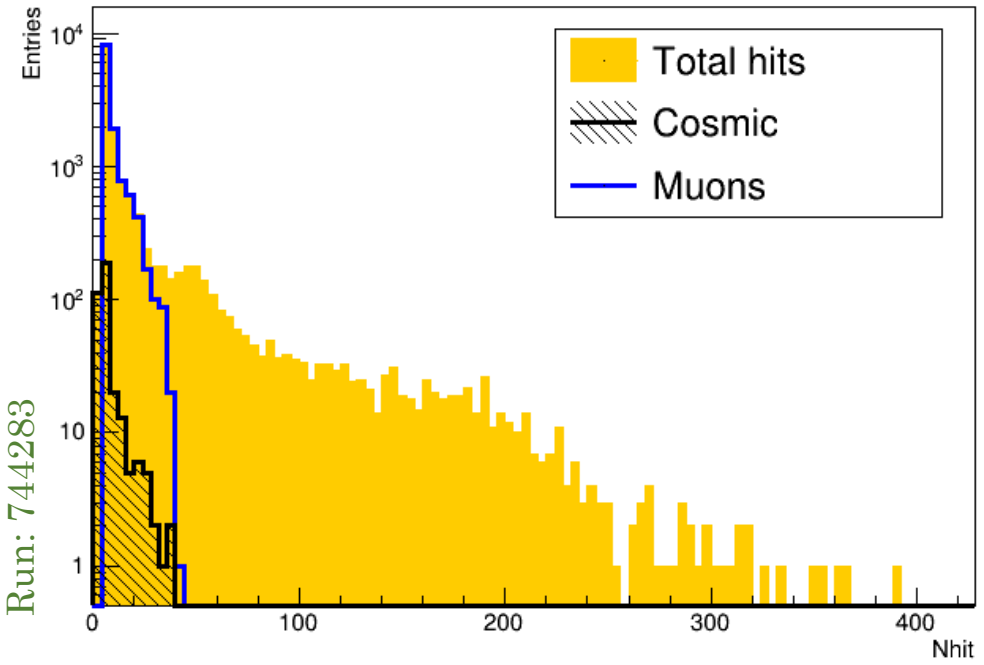
ECal muons selection (muon runs)

Density: **ρ**
nHit maximum in a single layer: $\boldsymbol{Hit_{Max}}$
Second nHit maximum in a single layer: $\boldsymbol{Hit_{Max2}}$
Penetrability condition: ***P.C.***

Muons → $(\rho < 2.5 \text{ or } (Hit_{Max2} < 5 \;\&\; Hit_{Max} < 32\,)\,) + P.C.$

Muons with shower → $\rho < 5 + P.C.$

200 GeV μ^-



Track reconstruction and cuts

The process of track reconstruction is made in a few steps:

- A first approximation by taking the mean value of all clusters in each layer
- This approximation is fitted to a straight line.
- Then the closest cluster with a distance less than 20.8 mm in X and Y to the previous approximation is selected for each layer. *(It is possible that a layer has no cluster selected)*
- The final track is the set of selected clusters fitted to a straight line.

Finally the following cuts are applied to select the tracks:

$$|\alpha_X| < 0.2 \ \ \& \ \ |\alpha_Y| < 0.2$$

No less than 5 layers with clusters selected

ECal-HCal synchronization cuts

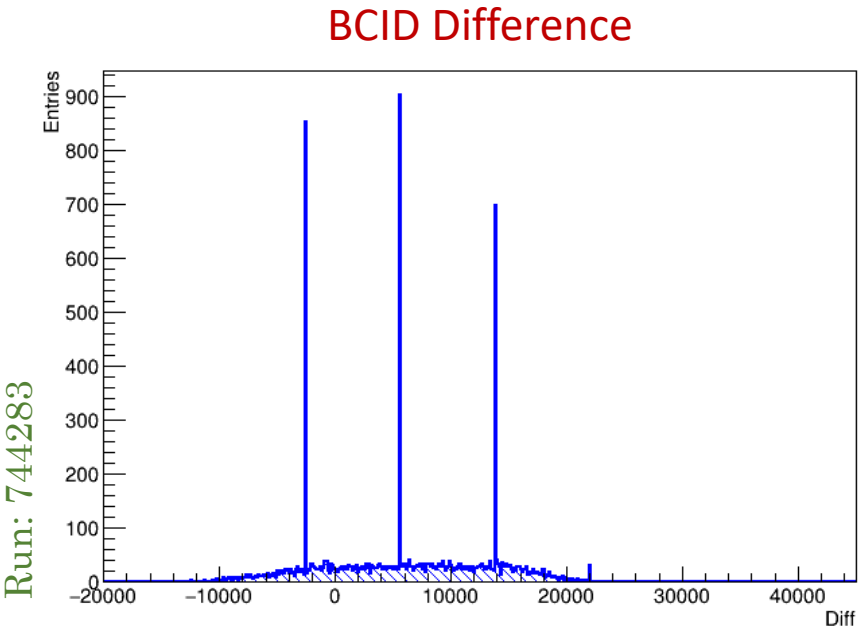
$$Diff = BCID_{HCal} - BCID_{ECal}$$

1 BCID = 200 ns

- Same muon run and events in the same spill.
- HCal tracks must go through the ECal boundaries at the origin:

$$227.75\ mm < x < 397.75\ mm$$
$$379.75\ mm < y < 550.25\ mm$$

- The two tracks with the closest set of parameters are selected as a match.



ECal-HCal tracks corrections

Using the matched tracks it is possible to try to find a correction by fitting to a Gaussian their differences.

$$X'_{HCal} = X_{HCal} - \mu_X$$

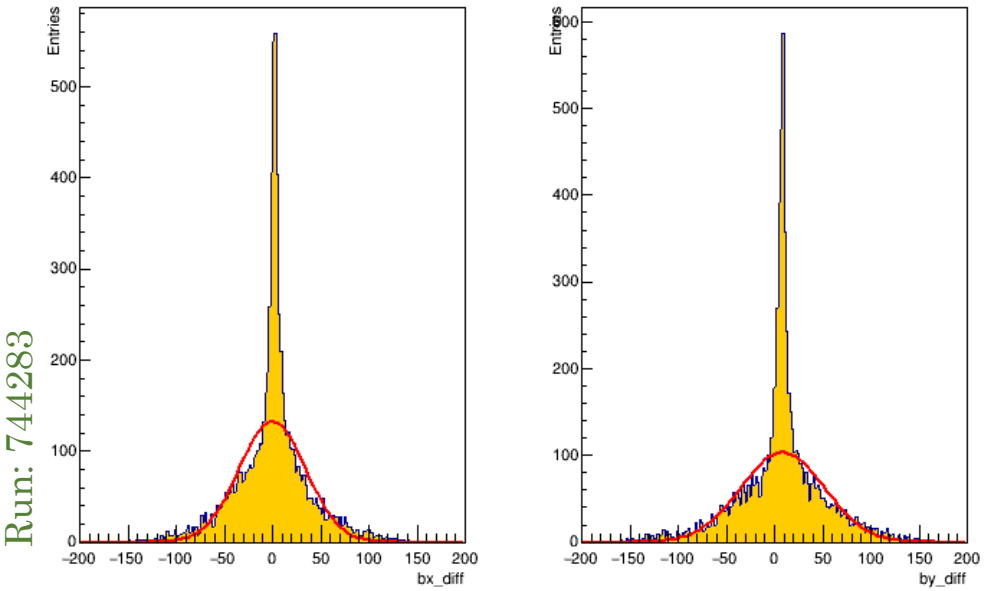
$$Y'_{HCal} = Y_{HCal} - \mu_Y$$

X: $\mu_X = 2.849$; $\sigma_X = 34.599$

Y: $\mu_Y = 8.325$; $\sigma_Y = 43.391$

Also the cases in which there is a difference of σ, or more, are unmatched.

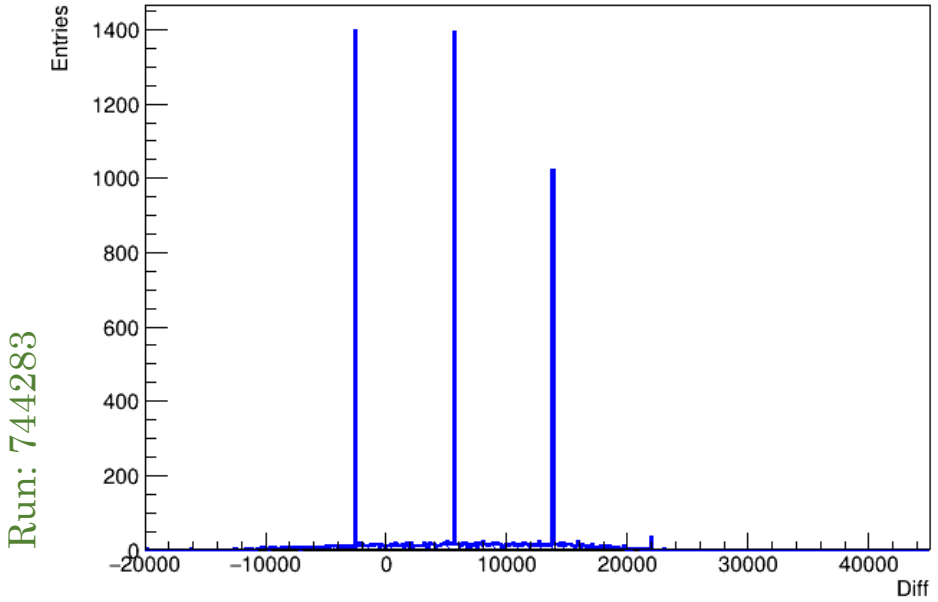
Track Difference



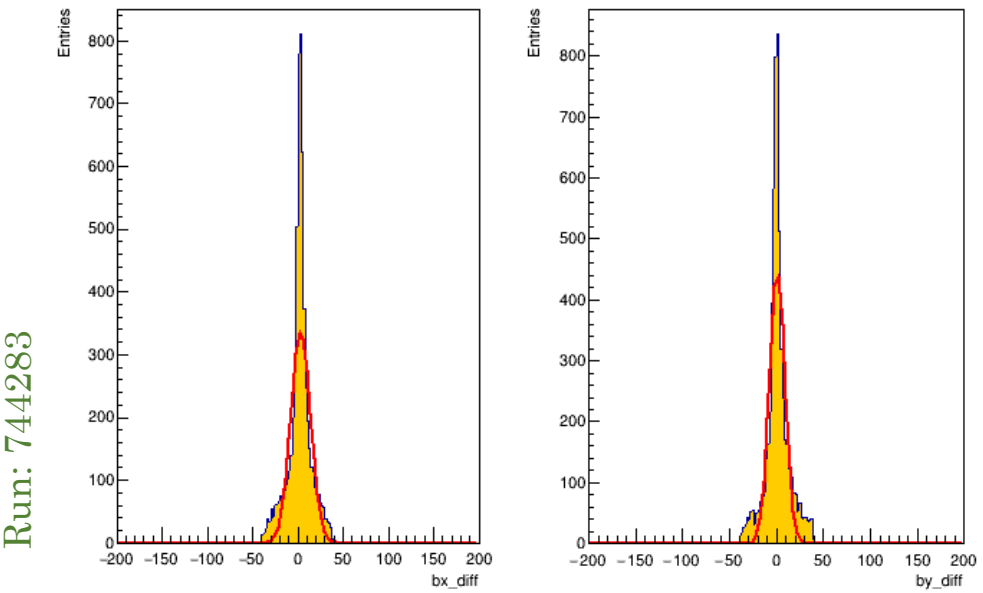
ECal-HCal corrected synchronization

Applying the synchronization to the corrected tracks results in a background reduction

BCID Difference



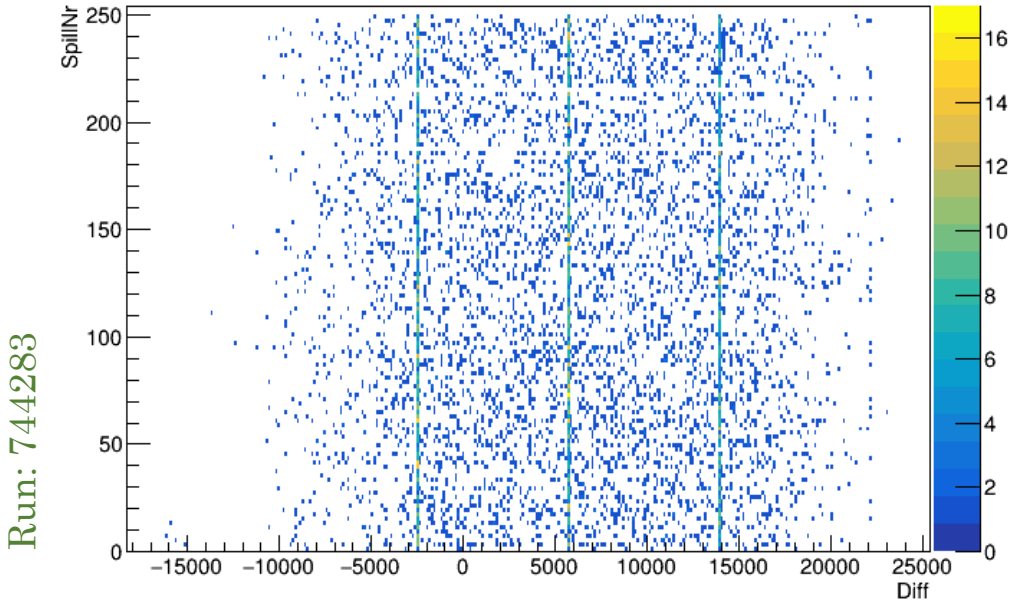
Track differences



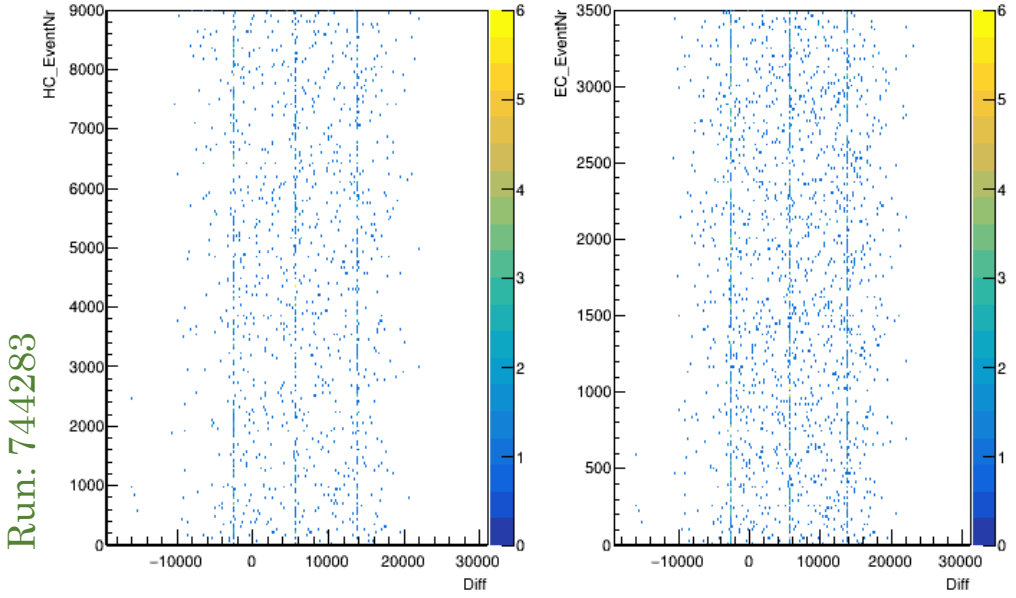
ECal-HCal spill and event number correlation

Additionally, no correlation has been found between the appearance of the BCID difference peaks and the accelerator spill or the event numbers.

Accelerator Spill



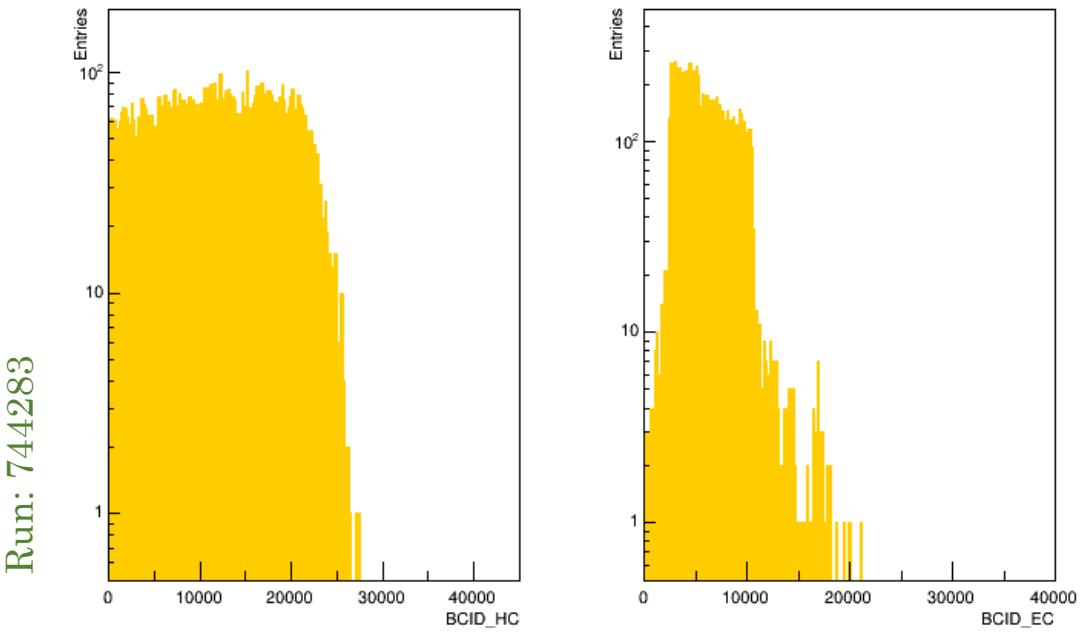
Event Number



Summary

- More work in the clean up and matching of the tracks haven't yield any changes in the presence of the BCID difference peaks.
- The BCID difference peaks are independent of run, spill and event numbers.
- No explanation for the shape of the ECal's BCID:

BCID Distributions



Backup

Test Beam

2018 vs 2012

- Lower high voltage. Previously 6.9 kV and 7.1 kV, now 6.7 kV.
- 37 working GRPCs, 11 less than before.
- Higher charge thresholds: 1) 114 fC → 120 pC, 2) 5 pC → 350 pC, 3) 15 pC → 500 pC.
- The gas mixture stays the same (93% TFE, 5% CO2 and 2% SF6).

Less hits recorded per event meaning a shift of the distributions.

HCal muons cut variables

Density: $\rho = \frac{nHit}{nLayers}$

$\boldsymbol{nHit} \rightarrow$ total number of hits in the detector.

$\boldsymbol{nLayers} \rightarrow$ number of layers with signal.

Second maximum of hits in a single layer: Hit_{Max2}

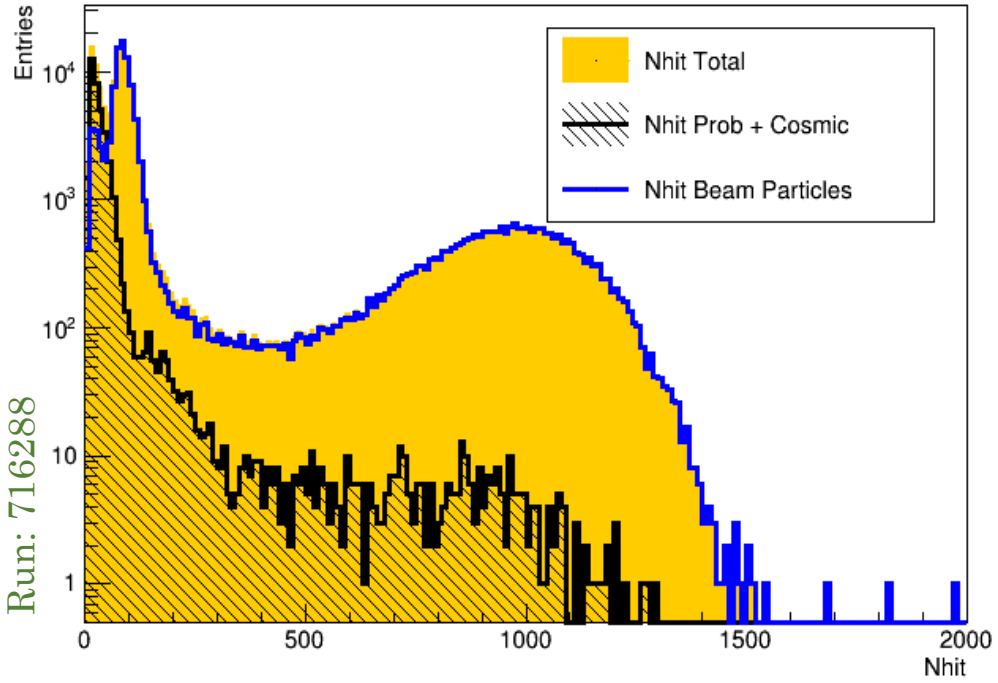
Penetrability Condition (P.C.):

- Layers 01-08: at least 6 with signal.
- Layers 09-16: at least 6 with signal.
- Layers 17-28: at least 7 with signal.
- Layers 29-37: at least 6 with signal.

Beam particles selection. 2012 vs 2018

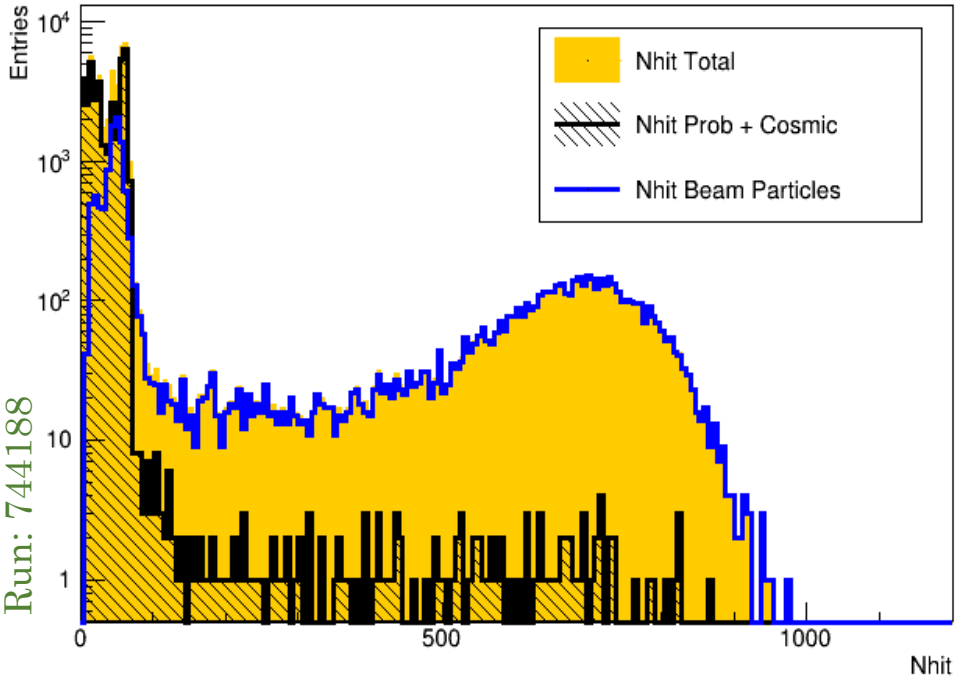
2012

70 GeV Π⁻



2018

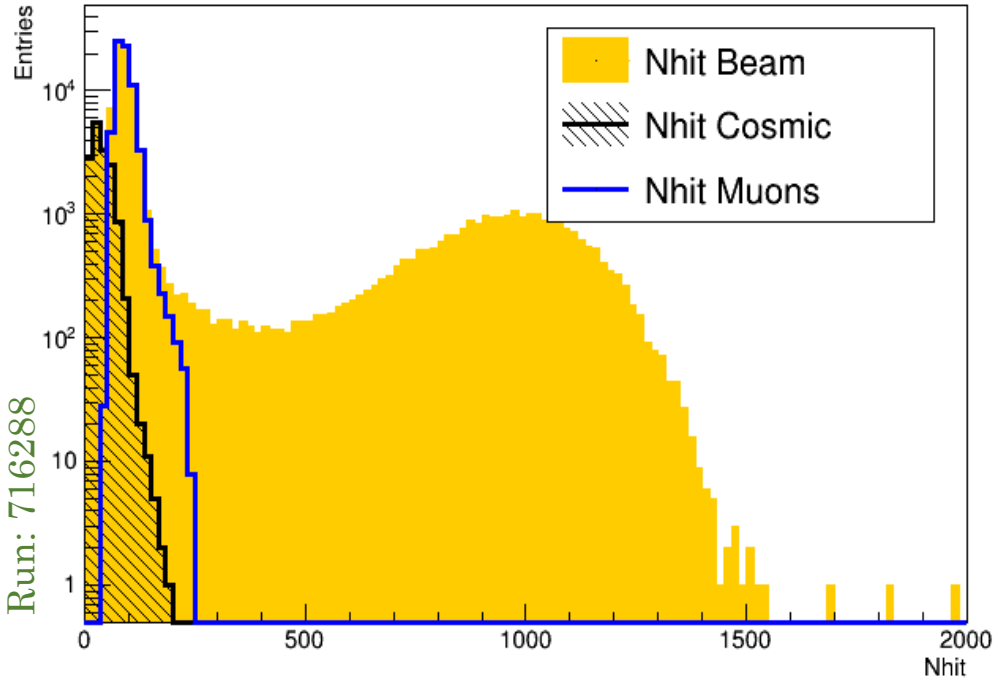
70 GeV Π⁺, no ECal



Muons selection. 2012 vs 2018

2012

70 GeV Π^-



2018

70 GeV Π^+, no ECal