HadronSelection Processor for software compensation study

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Motivation

Preparation of the first paper about AHCAL energy resolution for hadrons

- **What we already have in hands:**
  - **results on AHCAL EM response, EM calibration and EM energy resolution**
  - **two techniques of software compensation for AHCAL published in CAN**
- **To be presented in this meeting:**
  - **processor for hadron event selection (Marina)**
  - **discussion and results of run set selection (Katja)**
- **What follows:**
  - **application of software compensation techniques to selected runs**
  - **paper about hadronic resolution and software compensation**

Processor chain

...CALICE calibration processors (v04-01)...

⇓

ExtractBeamEnergyProcessor (Katja Seidel)

(extracts beam energy and particle type from database and appends it to event info)

⇓

MultiBitGenerator

(sets MultiAmplitude parameter)

⇓

eventSelector (David Ward)

(selects events by trigger bits required - beam trigger ON used)

⇓

HadronSelection (Marina Chadeeva)

(rejects empty, muon, multiparticle and not identified events)

⇓

MappingProcessor & CellNeighboursProcessor (Beni Lutz)

(fill cell neighbours map)

⇓ ⇓

Software Compensation (Marina) Software Compensation (Katja)

(prepare root trees for software compensation study)

Hadron selection scheme (by Vasiliy)

Empty events ⇐ $(N_{ECAL} < 25)$ **AND** $(N_{HCAL} < 25)$

⇓ ⇐ **Shower Start Finder (same as in PTF v04.02)**

Muon selection ⇐ **Primary Track Finder method used to find track**

⇓

Multiparticle events ⇐ **Parallel tracks (from Track Finder)**
OR Front noise (> 1.9 GeV or > 13 hits
in first 5 HCAL layers outside 320-mm ring)
OR $E_{reco} > E_{beam} + 4 \cdot 0.6\sqrt{E_{beam}}$

⇓ ⇐ **Primary Track Finder applied to find track**

Not identified ⇐ $E_{reco} < 0.1 \cdot E_{beam}$
OR $N_{ECAL} < 15$
OR (ShowerStartLayer > 3 **AND no track found)**

⇓

Electron identification: not implemented yet

Muon identification criteria

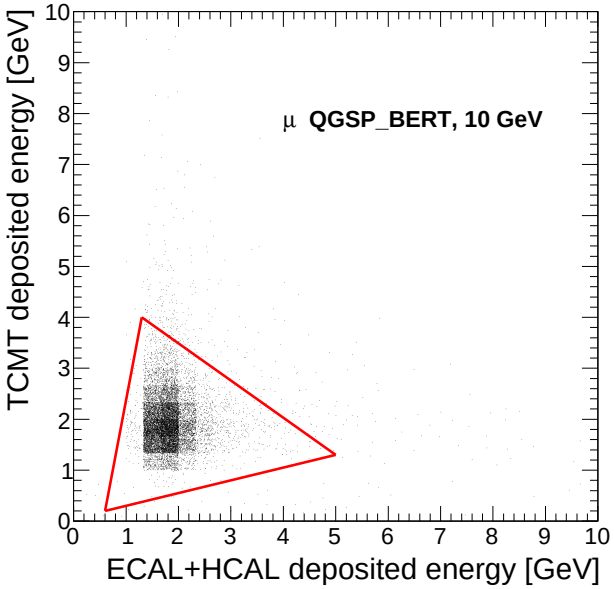
$N_{HCAL} > 25$ **AND** $N_{TCMT} > 10$

AND **inside triangle on** $(E^{ECAL}_{reco} + E^{HCAL}_{reco})$ **vs.** E^{TCMT}_{reco} **plane with vertexes:**

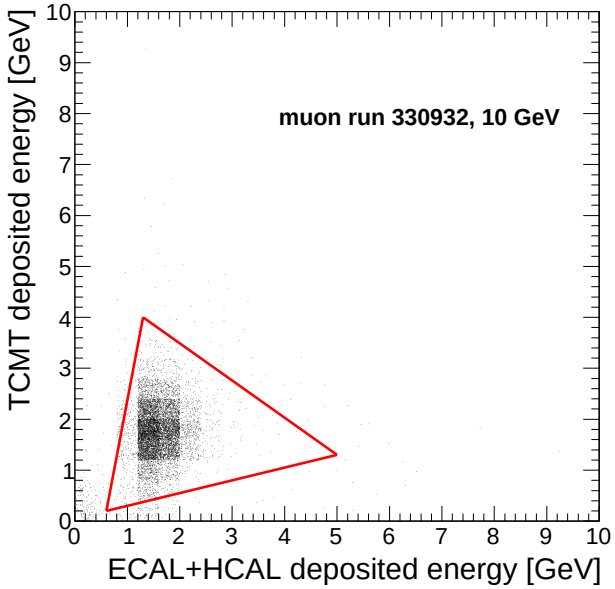
$(\ 0.6\ ;\ 0.2\ )\ (\ 0.4 \cdot E_{beam} + 1.\ ;\ 1.3\ )\ (\ 1.3\ ;\ 0.4 \cdot E_{beam}\ )$

AND **track found**

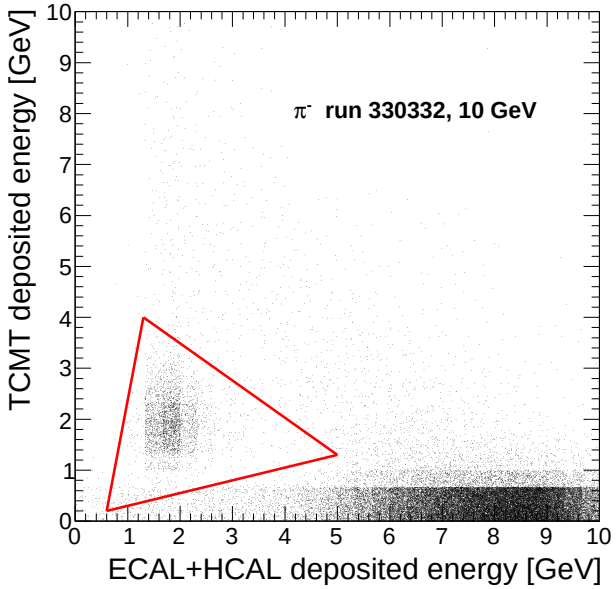
MC



muon run



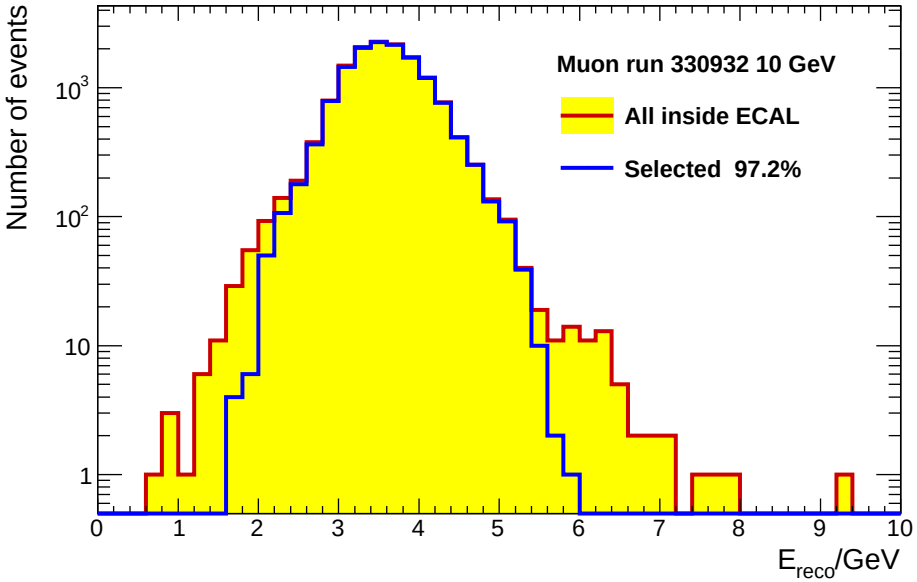
pion run



Efficiency of muon identification at 10 GeV

Only muons going through ECAL are considered: $N_{ECAL} > 15$.

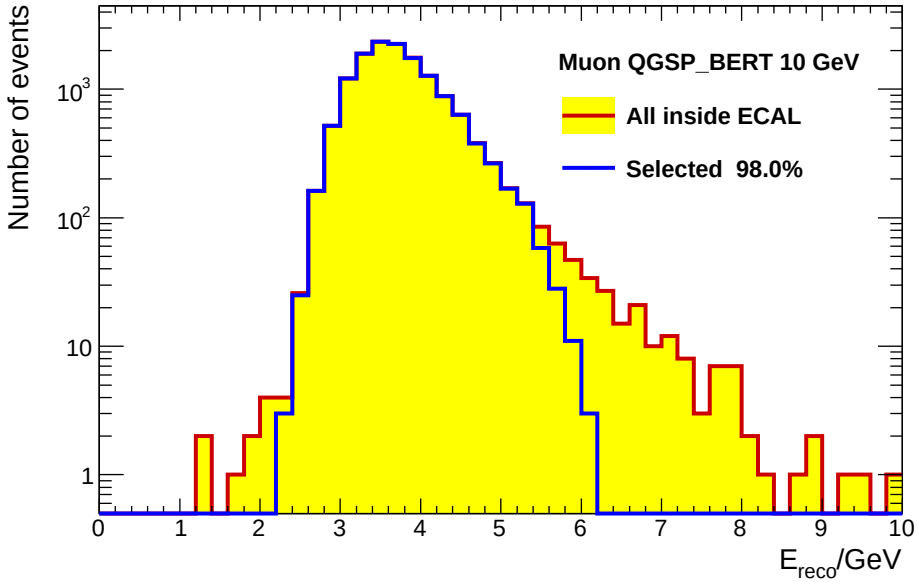
Data



Efficiency: ∼97.2%

Inefficiency for right tail: <1.5%

MC



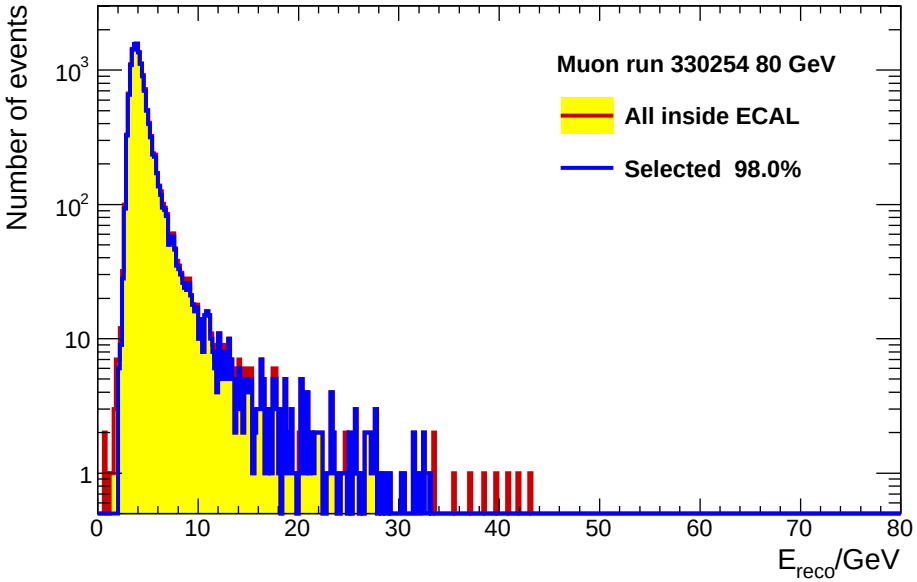
Efficiency: ∼98.0%

Inefficiency for right tail: <2%

Efficiency of muon identification at 80 GeV

Only muons going through ECAL are considered: $N_{ECAL} > 15$.

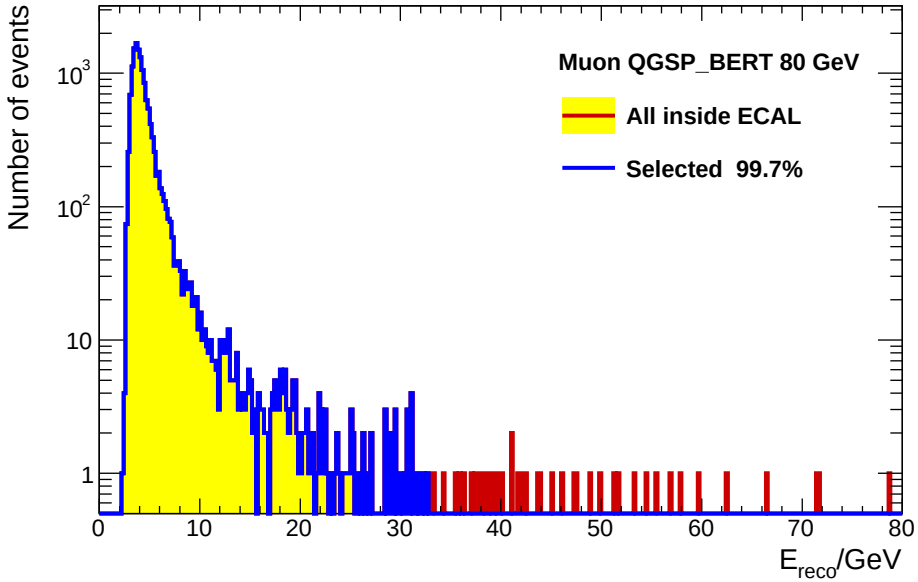
Data



Efficiency: ∼98%

Inefficiency for right tail: <1.5%

MC

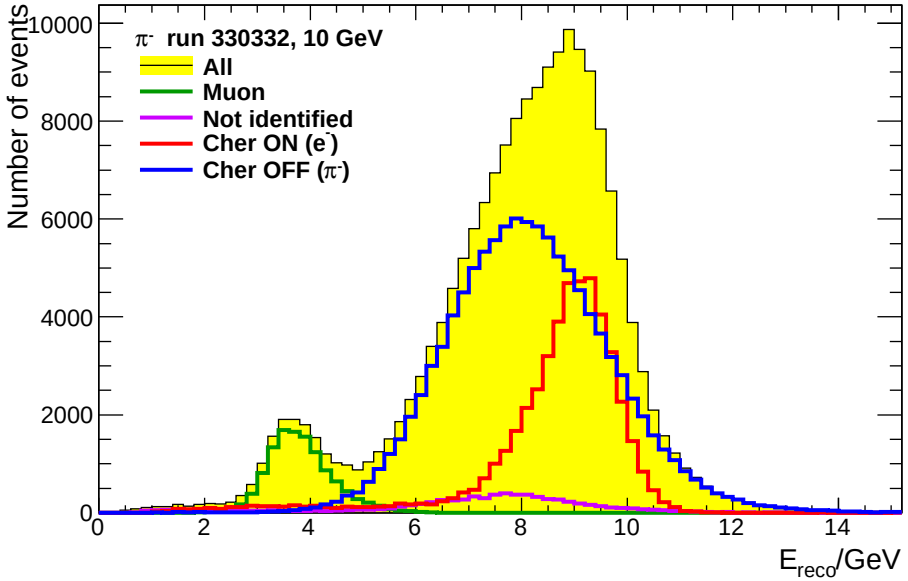


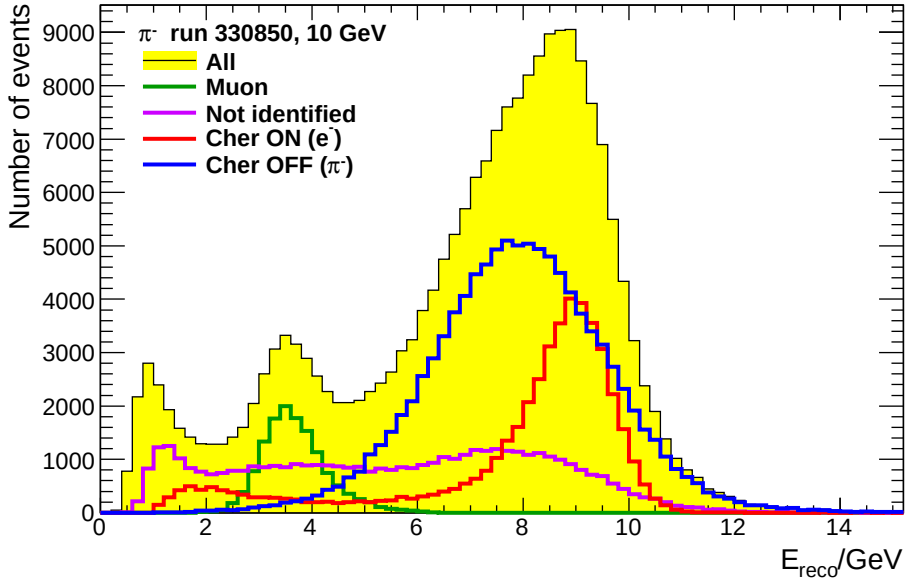
Efficiency: ∼99.7%

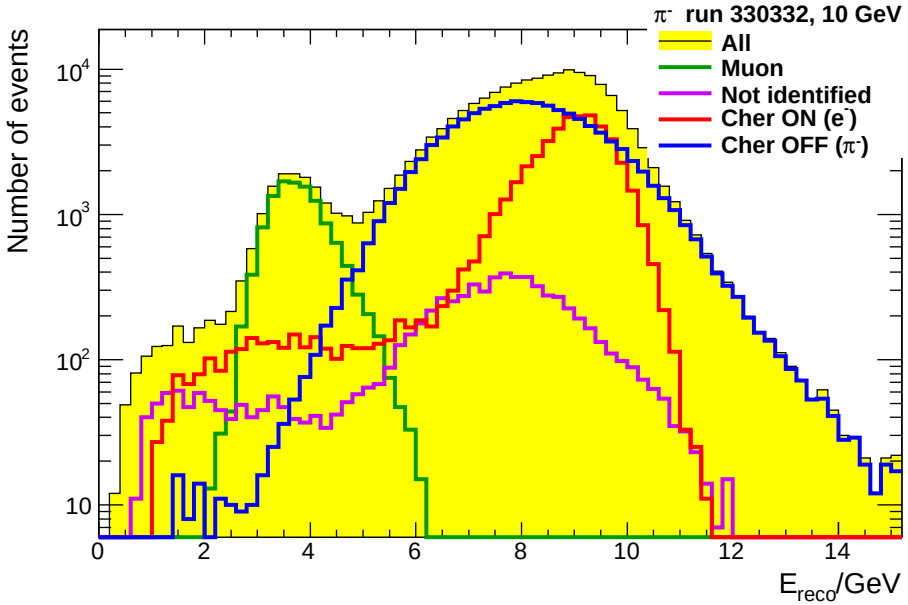
Inefficiency for right tail: <0.3%

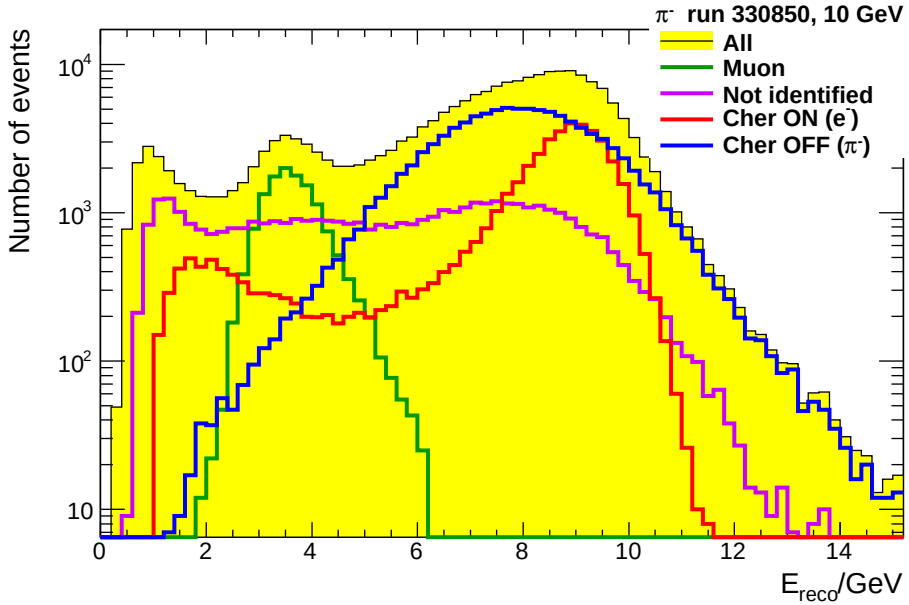
For 32-GeV MC sample efficiency is ∼99.5% and inefficiency for right tail is ∼0.5%

Fractions in 10-GeV π^- runs

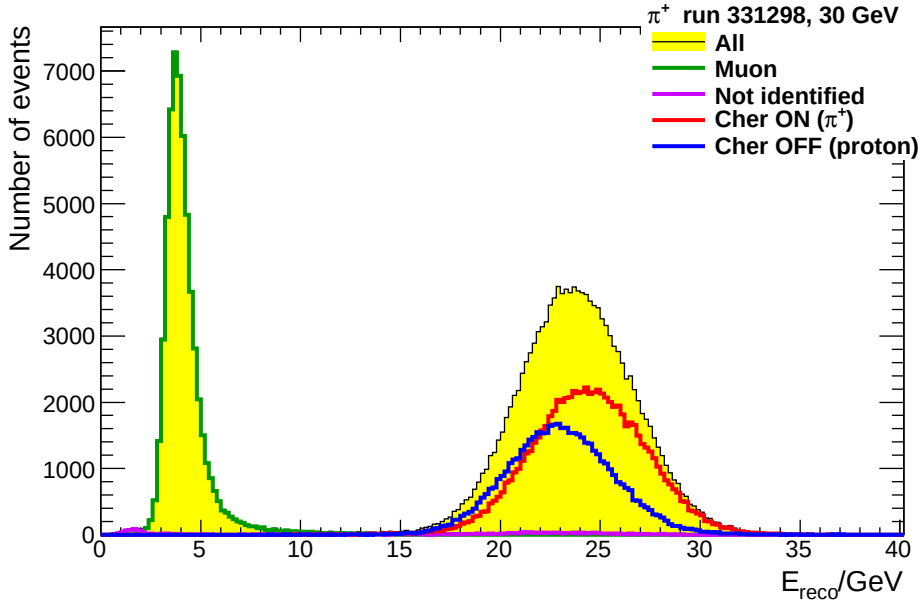


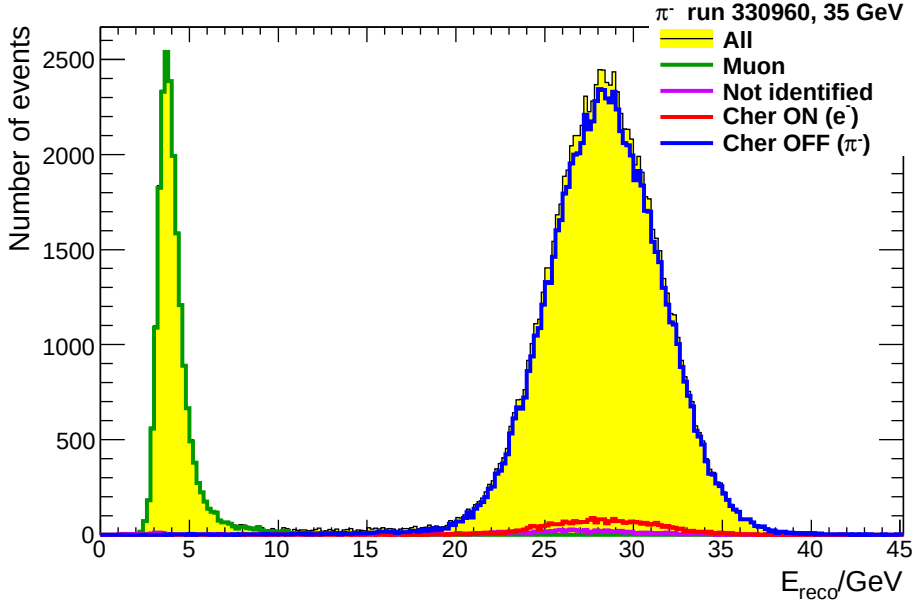


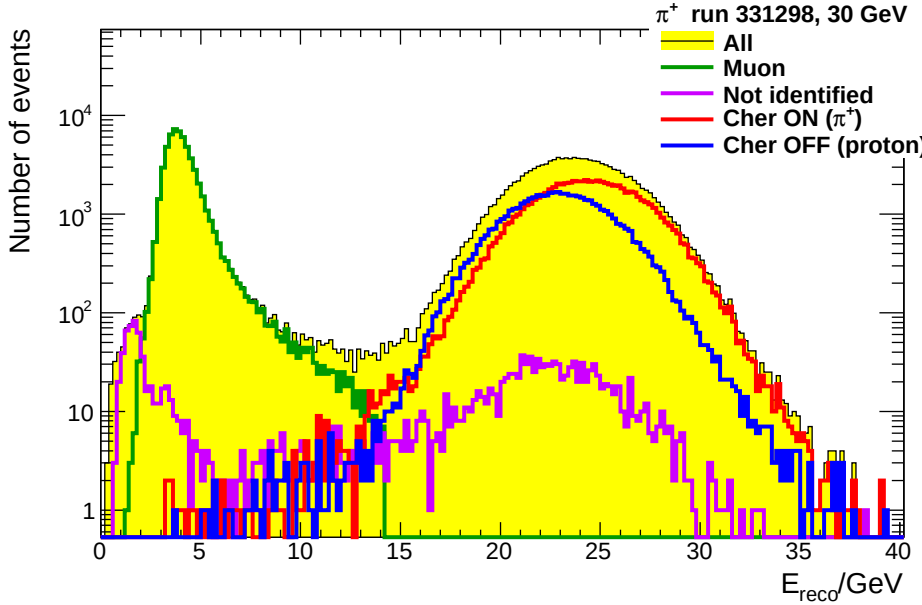


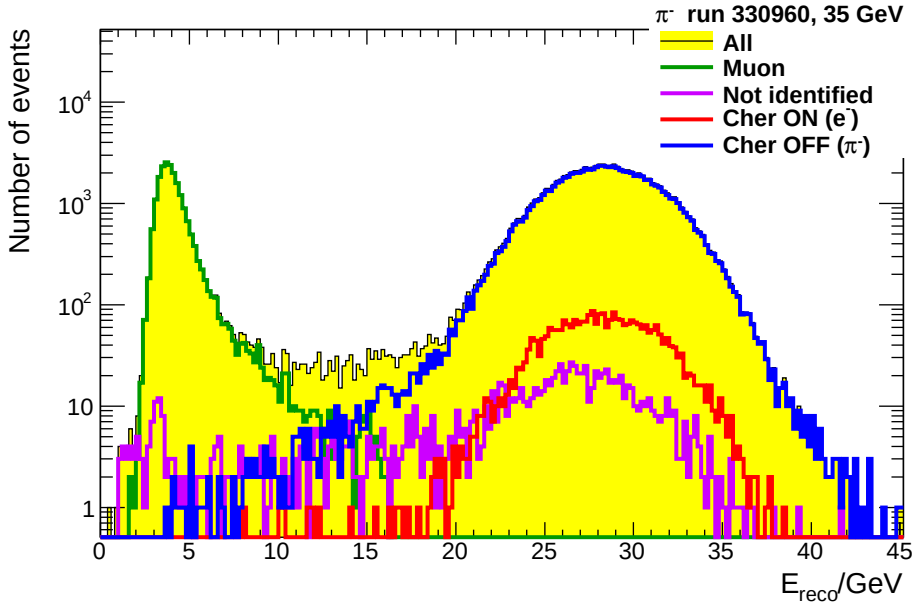


Fractions in 30-GeV π^+ and 35-GeV π^- runs

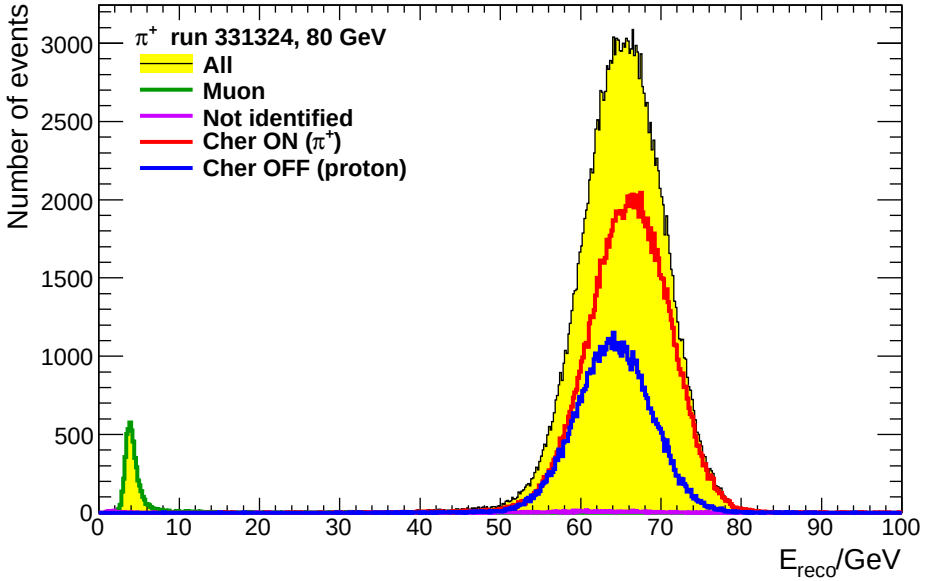


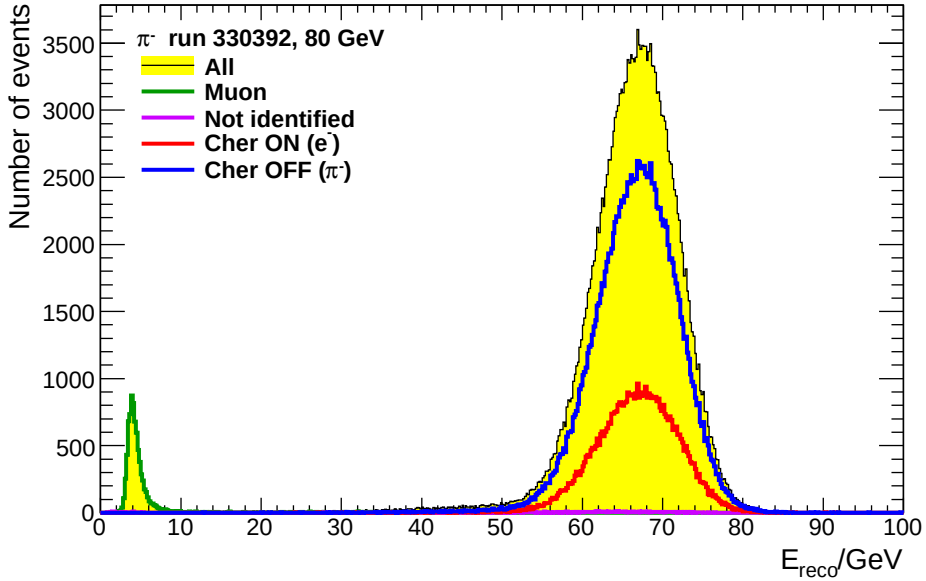


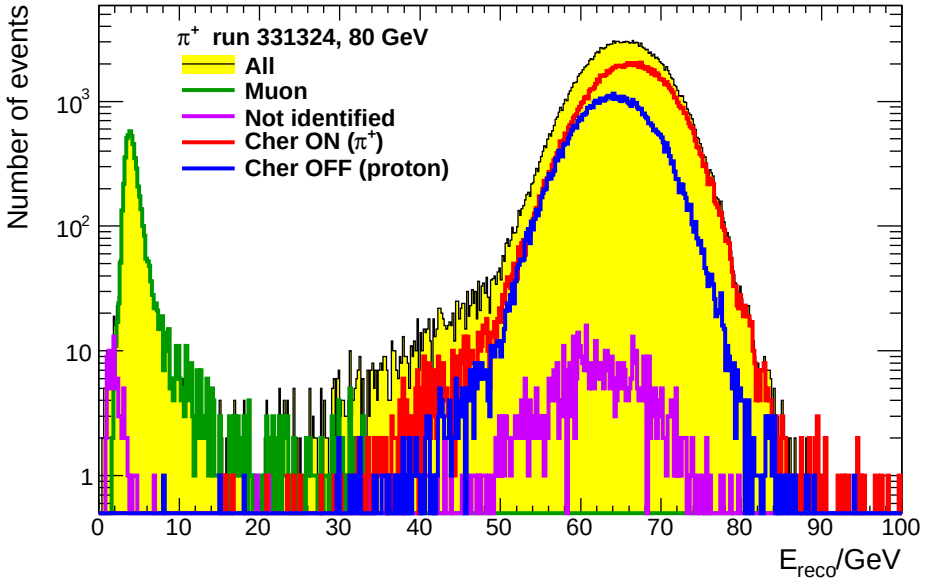


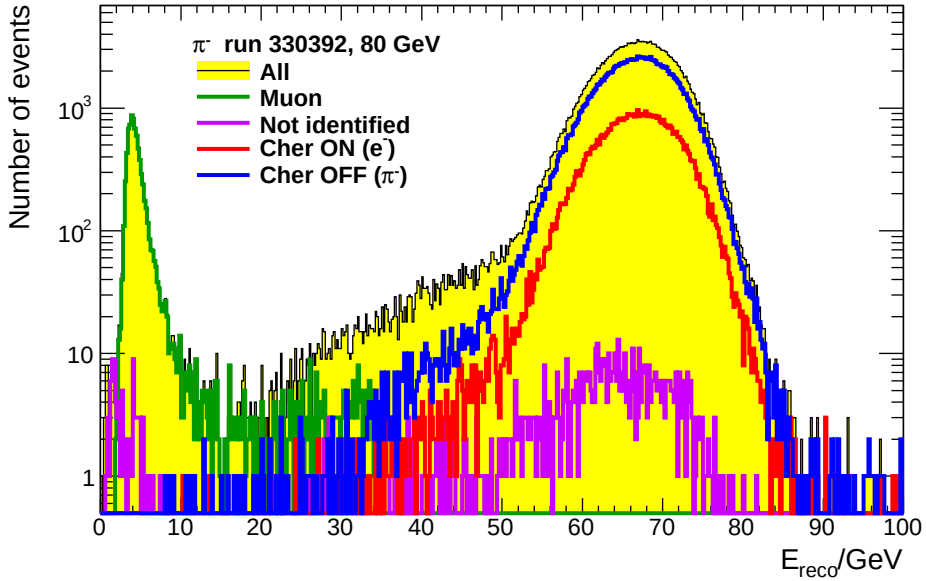


Fractions in 80-GeV π^+ and π^- runs









Examples of selection statistics

Run #	E_{beam}, GeV	Empty	Muon	Mult	Not ID	Cher ON	Cher OFF π^-
330332	10	0.17%	6.56%	0.12%	3.94%	26.93%	62.27%
330850	10	3.05%	6.32%	0.12%	20.71%	21.92%	47.88%
330326	20	0.02%	6.10%	0.42%	4.00%	13.20%	76.26%
330960	35	0.003%	17.64%	0.82%	1.06%	2.67%	77.81%
330412	40	0.01%	5.04%	0.89%	2.07%	45.38%	46.61%
330558	50	0.01%	4.66%	1.10%	0.54%	0.22%	93.47%
331568	60	0.005%	3.84%	0.78%	2.64%	0.44%	92.29%
330392	80	0.01%	3.50%	1.79%	0.33%	24.63%	69.73%

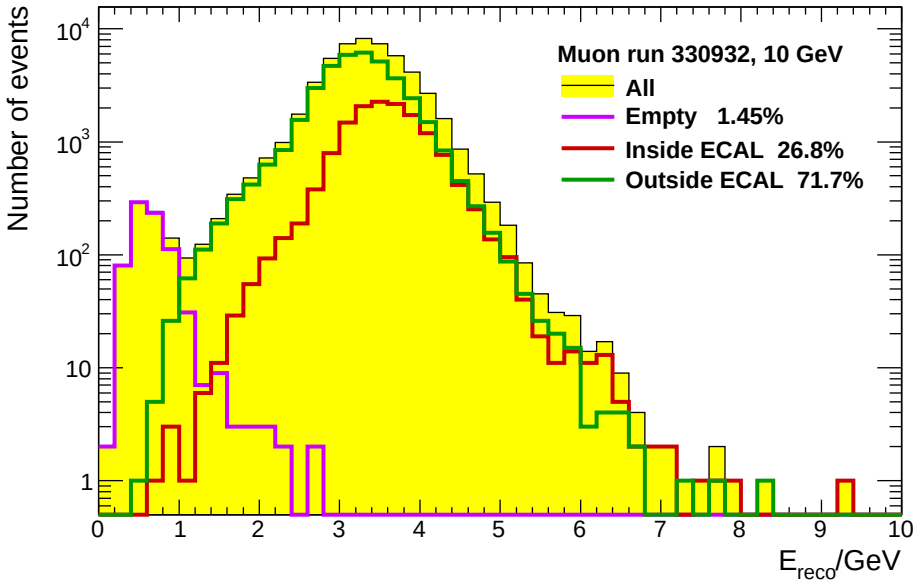
Run #	E_{beam}, GeV	Empty	Muon	Mult	Not ID	Cher ON π^+	Cher OFF
331298	30	0.04%	30.27%	0.36%	0.96%	40.52%	27.85%
331339	40	0.01%	4.55%	0.57%	0.43%	76.60%	17.84%
331335	50	0.01%	4.38%	0.67%	0.34%	78.90%	15.70%
331334	60	0.01%	3.77%	0.82%	0.40%	74.60%	20.40%
331324	80	0.01%	2.74%	1.14%	0.35%	63.51%	32.26%

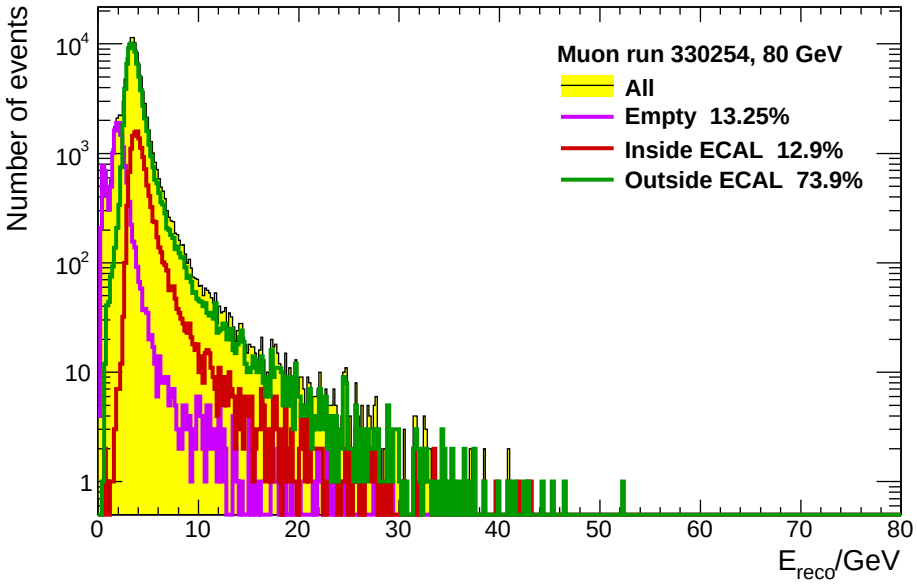
Conclusions

- HadronSelection processor was developed to reject empty, muon and multiparticle events. It was tested on CERN 2007 test beam data samples in the energy range from 10 to 80 GeV.
- Muon selection procedure was adjusted using real and MC muon samples. For selected pion samples a muon admixture is estimated to be $<0.5\%$.
- HadronSelection processor creates an additional collection that includes:
  - Cherenkov trigger value for further electron or proton separation;
  - found shower starting layer;
  - x and y coordinates of primary track (if found);
  - 6 energy sums in MIPs for all calorimeter parts.
- For compensation study only events with shower start at the beginning of HCAL and track in ECAL are used.

Backup slides

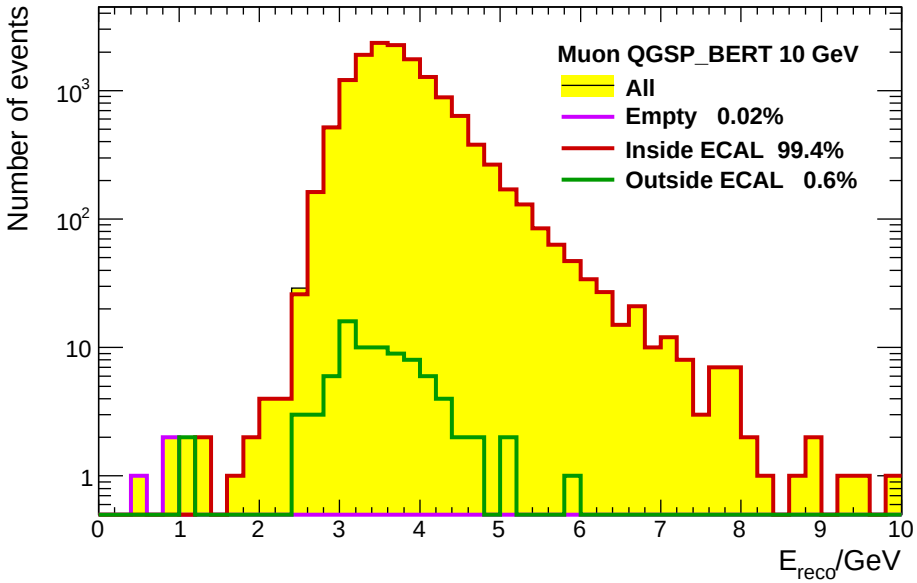
Structure of muon runs

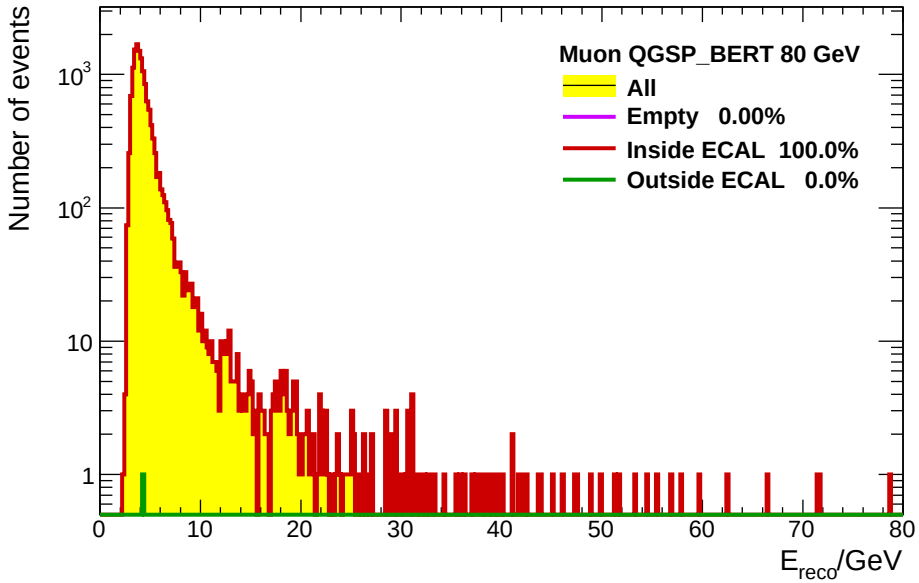




In data runs >70% of muons are outside ECAL.

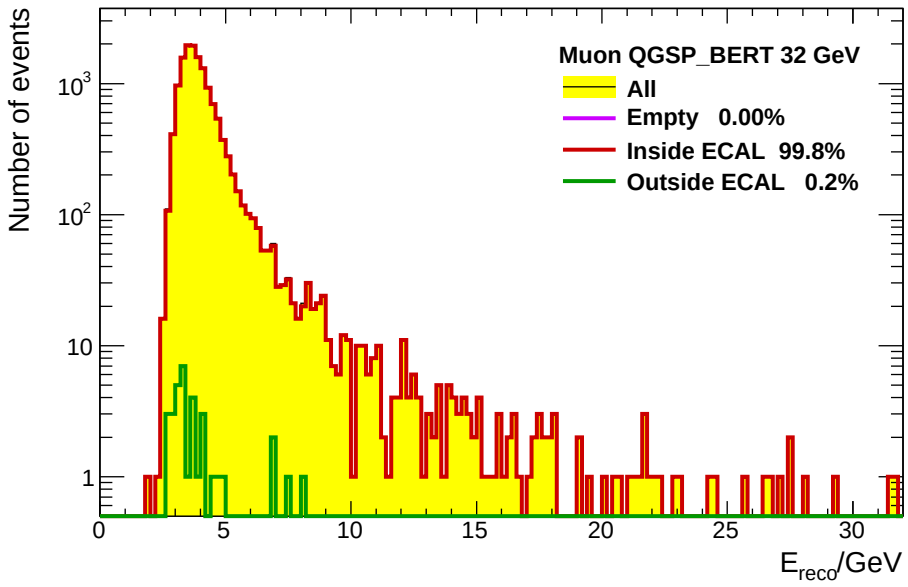
Simulated muons

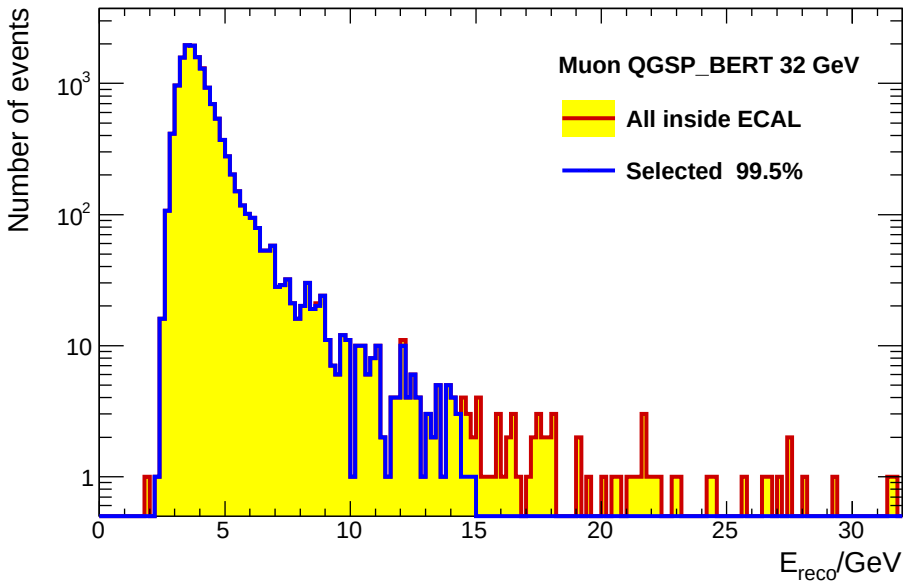




Simulated muons are mostly going through ECAL.

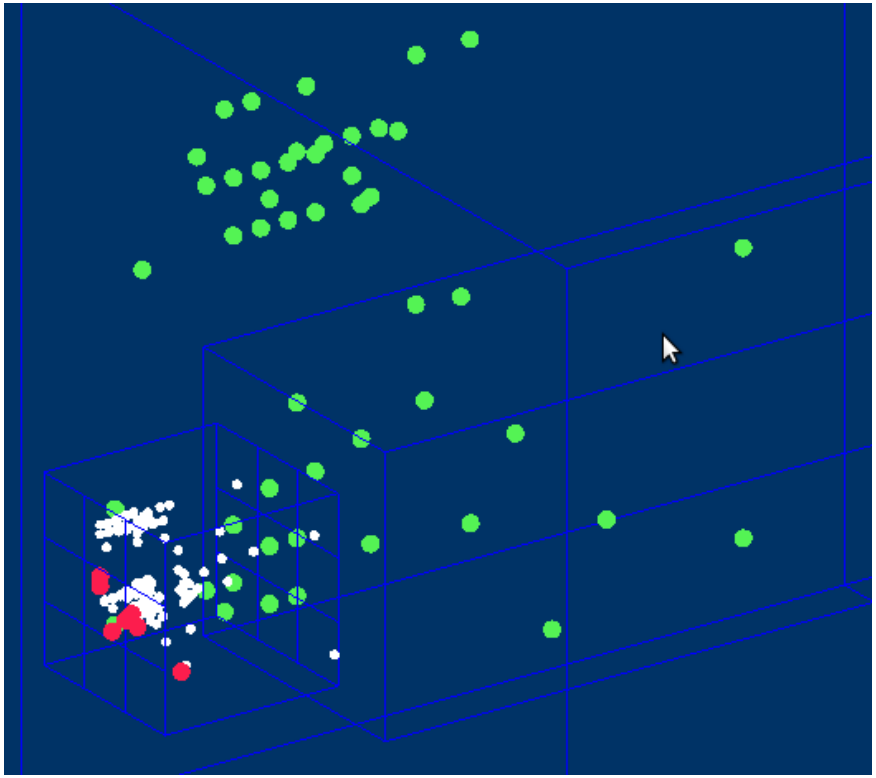
Efficiency for 32-GeV simulated muons



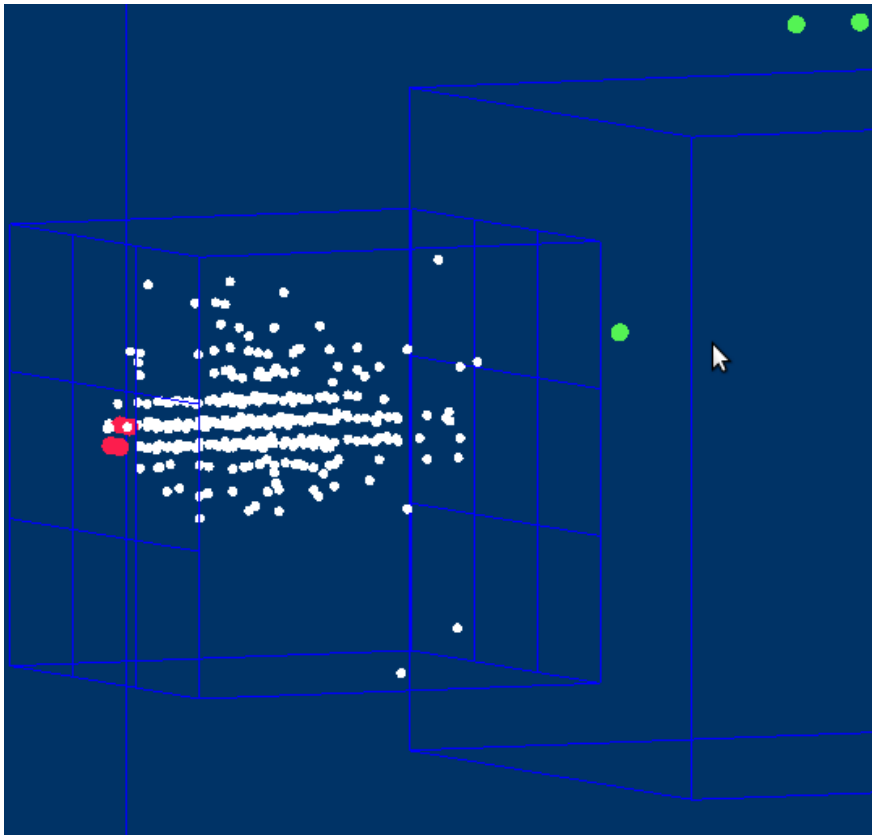


For 32-GeV MC sample efficiency is ∼99.5% and inefficiency for right tail is ∼0.5%

Examples of rejected events for 10 GeV π^-

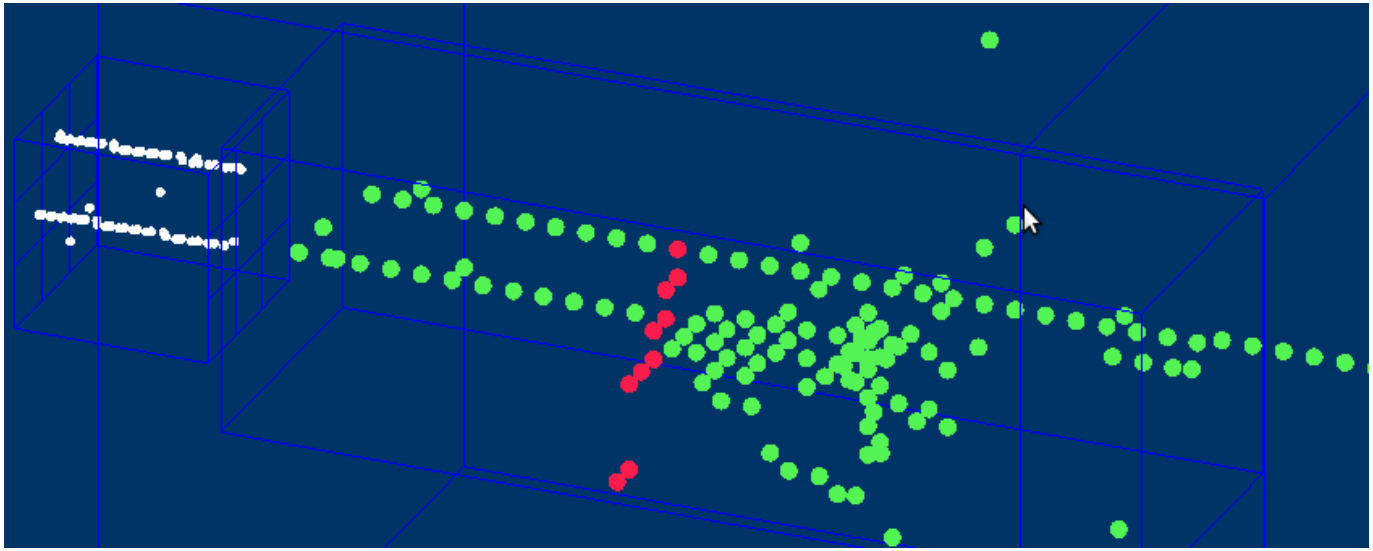


Event with high front noise rejected as multiparticle.

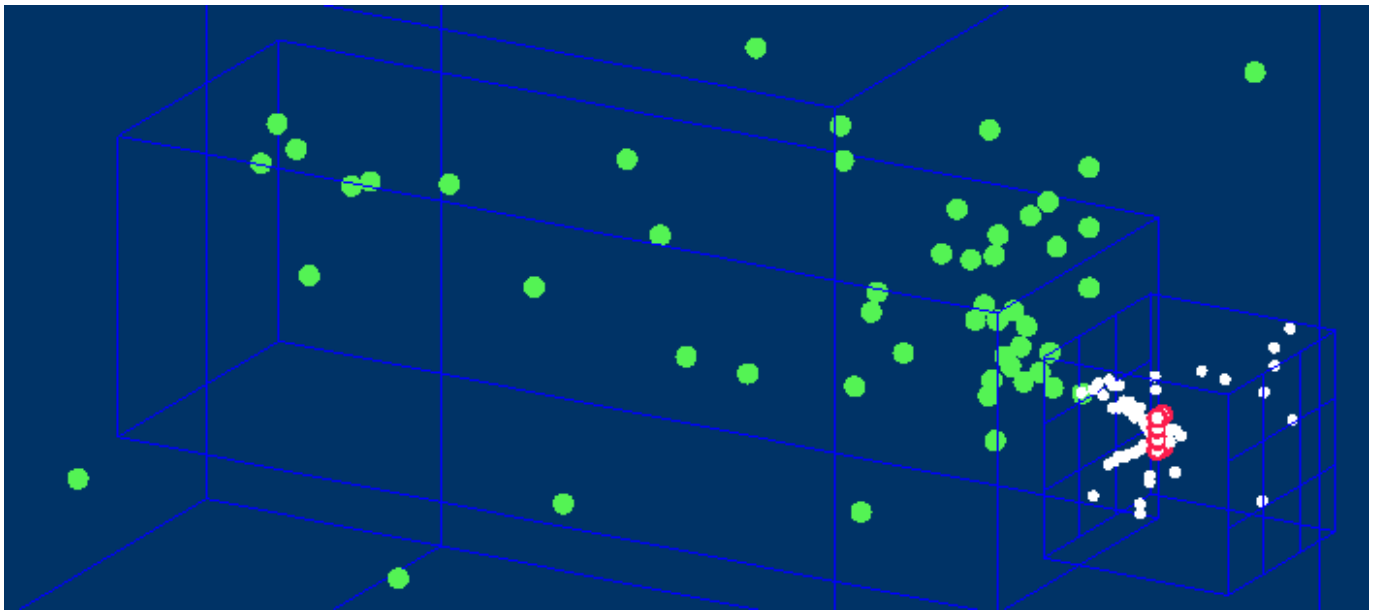


Event with deposition >3000 MIP (>18 GeV) rejected as multiparticle.

Examples of rejected events for 10 GeV π^-



Event with parallel ingoing track candidates found rejected as multiparticle.



Event with shower start far in ECAL but without primary track found rejected as not identified.