Track PID purity and energy fraction study from simulation track

Xilin Liang

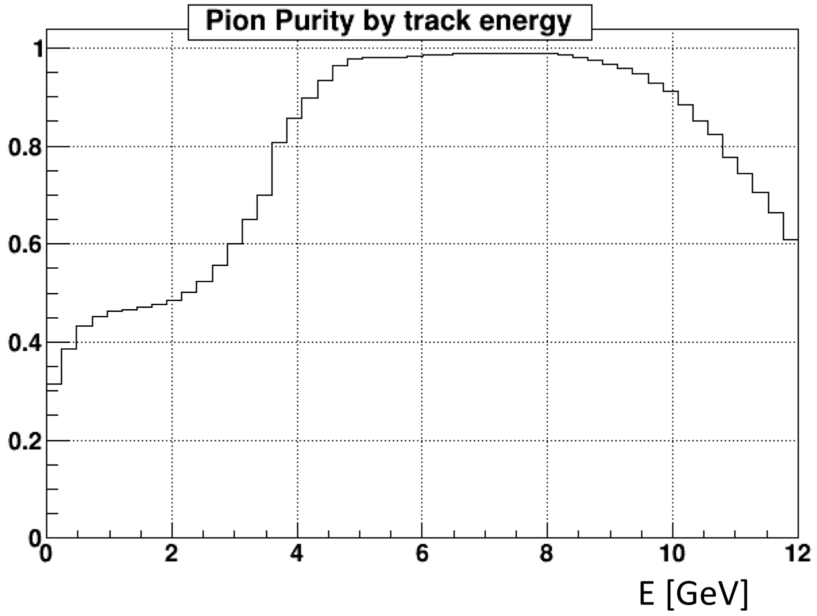
July 27, 2021

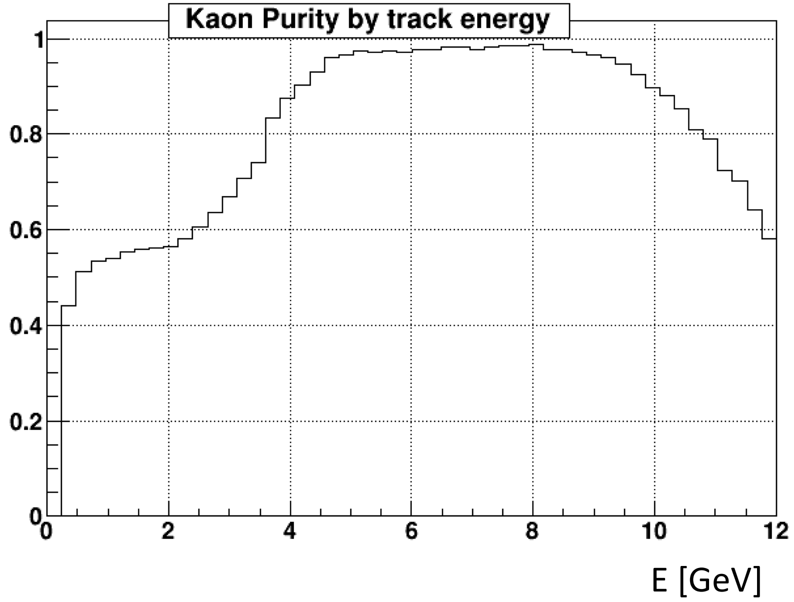
Goals and datasets

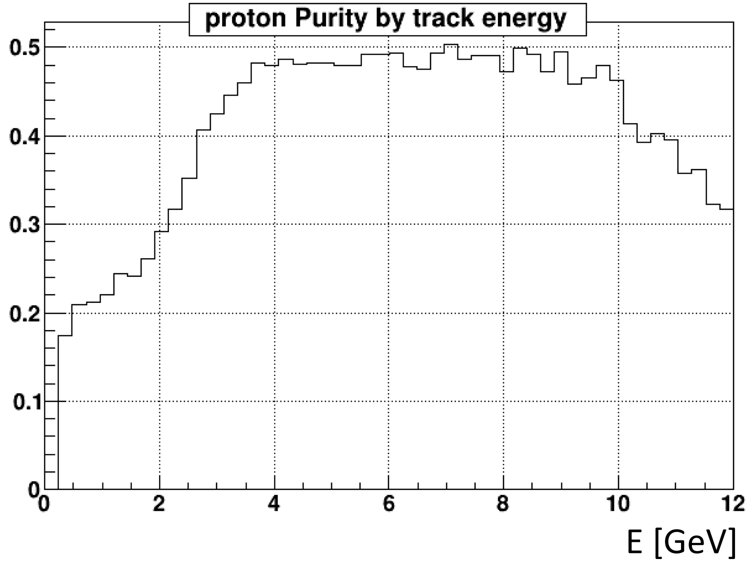
- Goals: check with Eflow tracks PID purity and energy fraction for Pion, Kaon and proton tracks separated by the PID system coverage.
  - PID purity: $\frac{number\ of\ correctly\ identified\ track\ in\ PID\ system}{number\ of\ all\ track\ within\ PID\ system\ coverage}$
  - Code : TrackA->Particle.GetObject() == TrackB->Particle.GetObject()
  - Track energy fraction (borrowed from SIDIS): $z = \frac{p_{Pr} \cdot p_h}{p_{Pr} \cdot q}$, where $q = k - k'$
- PID systems coverage:
  - dualRICH_aerogel: $1 < \eta < 3.5$, $P < 12\ GeV$
  - dualRICH_c2f6: $1 < \eta < 3.5$, $P > 12\ GeV$
  - barrelDIRC: $-1 < \eta < 1$
- Datasets: 1M DIS simulation events.
  - Delphes card: **delphes_card_allsilicon_3T.tcl**

Check Eflow tracks with dualRICH_aerogel tracks

- Range of Eflow tracks for checking matching with dualRICH_aerogel tracks.
  - Particle type: Pion, Kaon, proton (from PID number)
  - $1 < \eta < 3.5$, $P < 12\ GeV$

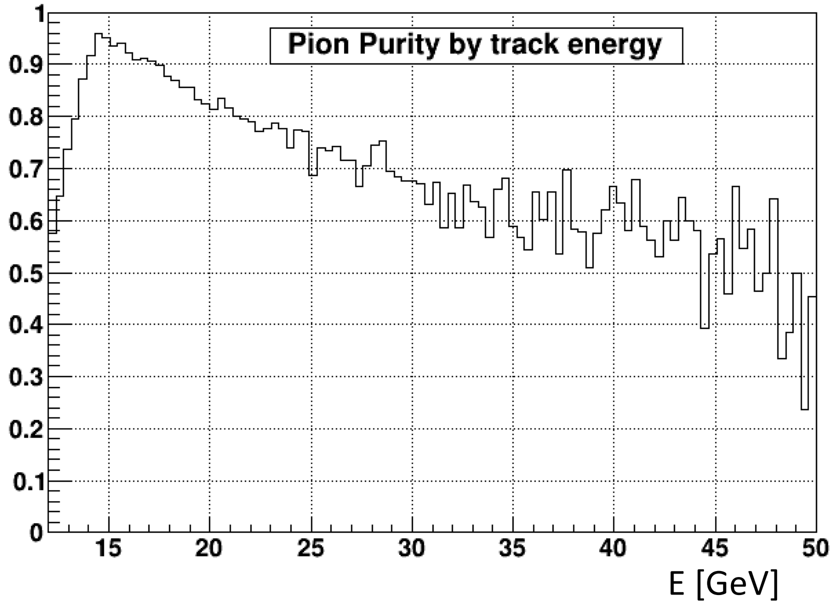


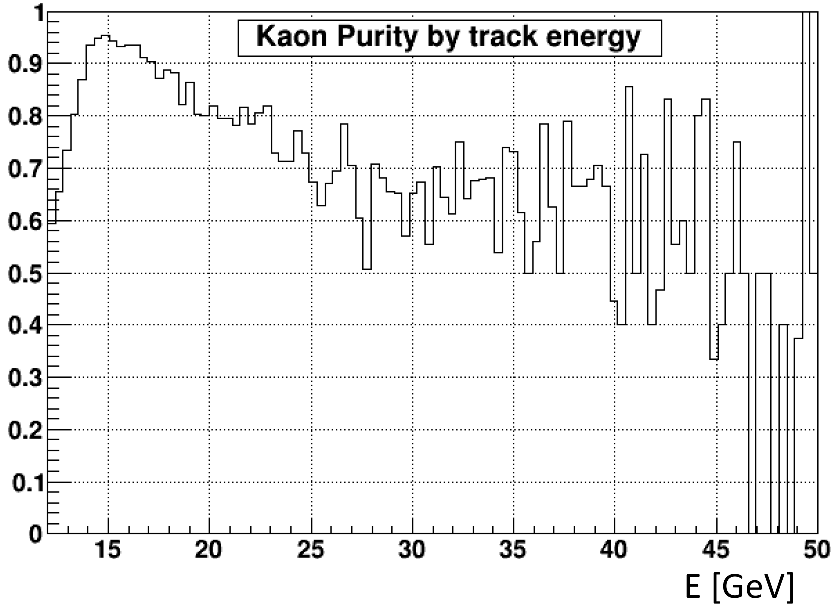


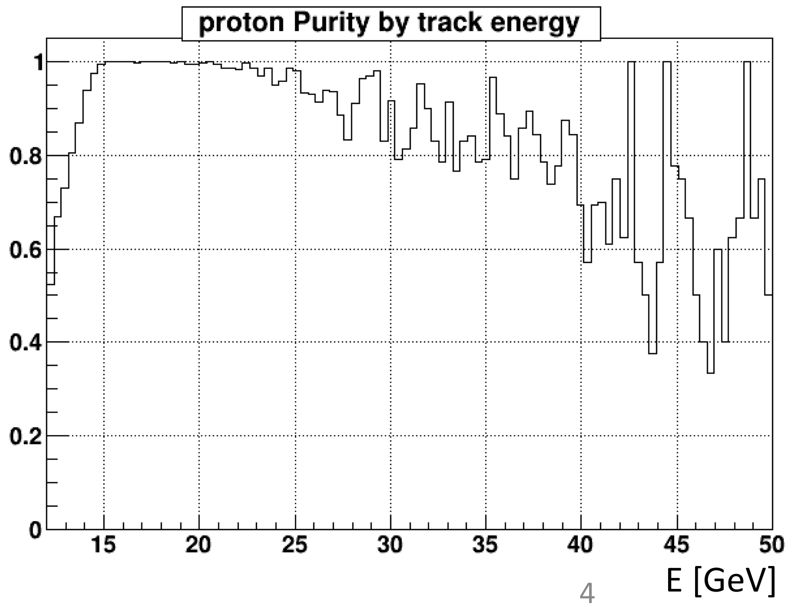


Check Eflow tracks with dualRICH_c2f6 tracks

- Range of Eflow tracks for checking matching with dualRICH_c2f6 tracks.
  - Particle type: Pion, Kaon, proton (from PID number)
  - $1 < \eta < 3.5$, $P > 12\ GeV$

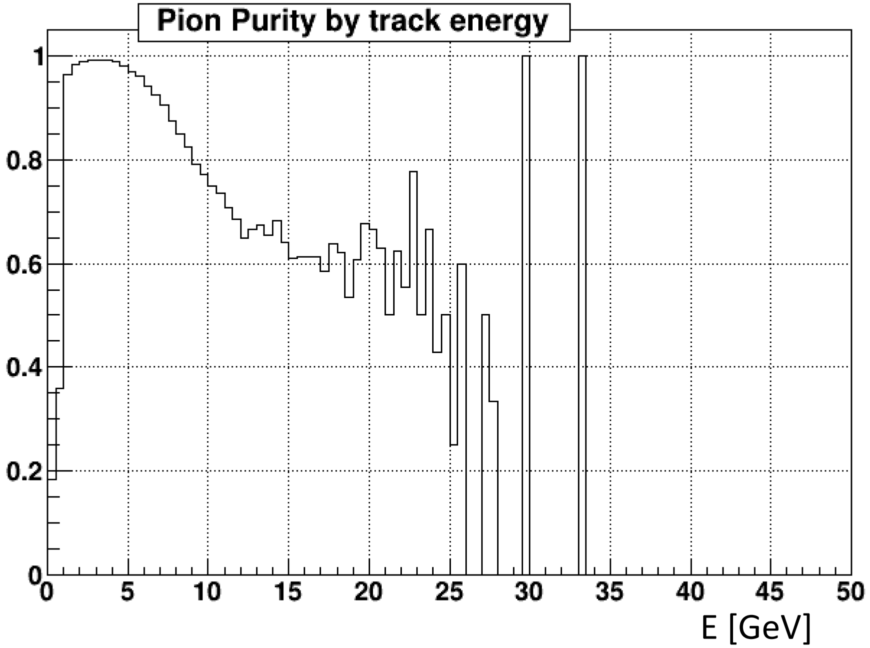


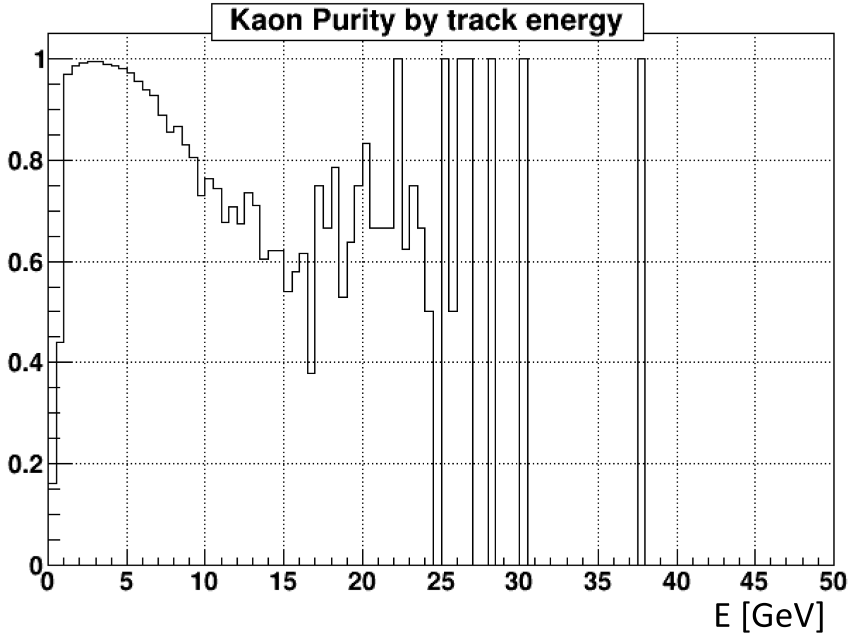


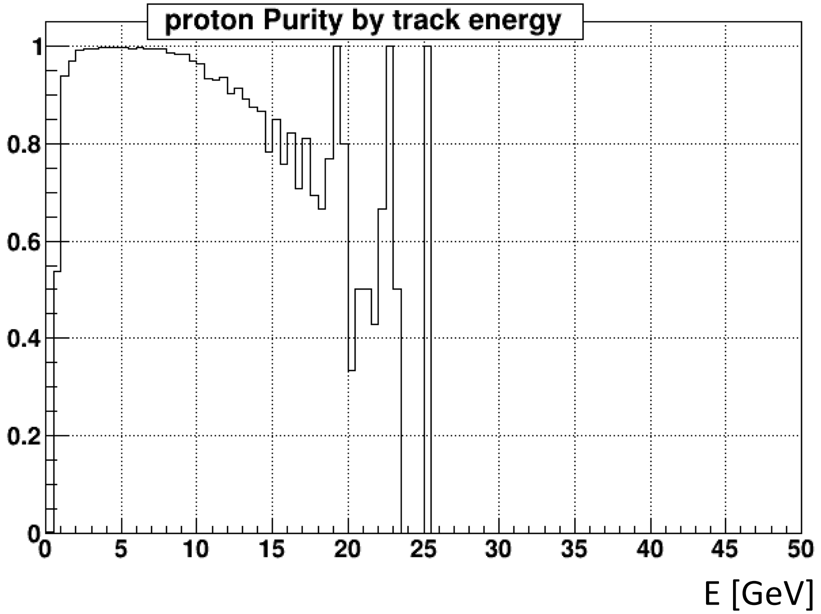


Check Eflow tracks with barrelDIRC tracks

- Range of Eflow tracks for checking matching with barrelDIRC tracks.
  - Particle type: Pion, Kaon, proton (from PID number)
  - $-1 < \eta < 1$







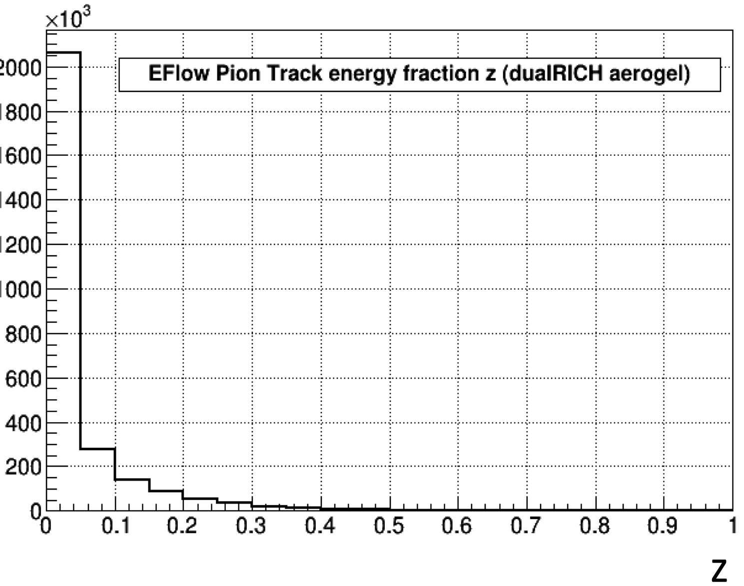
Track energy fraction z

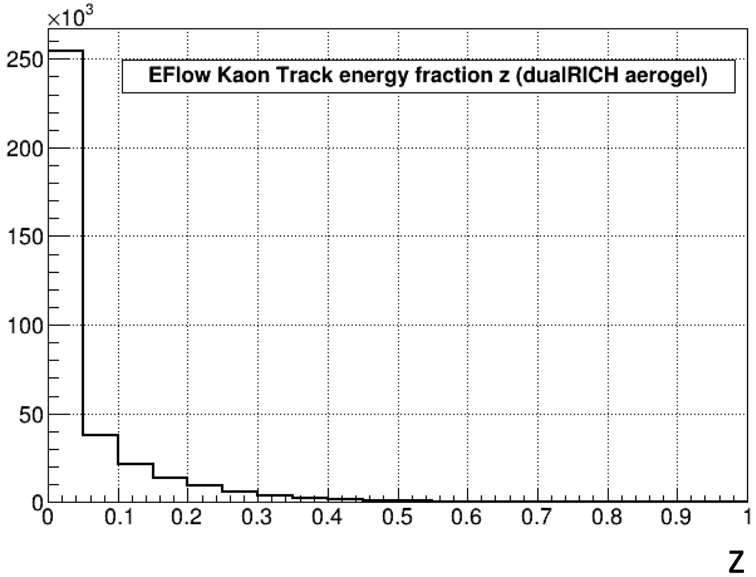
- Goal: check the track components and the purity in the simulation by looking into the track energy fraction z in the collision simulation.
- Source of track: EFlowTrack
- Track energy fraction: $z = \frac{p_{Pr} \cdot p_h}{p_{Pr} \cdot q}$, where $q = k - k'$
  - p_{Pr} is the initial proton 4 momentum: obtain from id No.0 from particle list
  - k is the initial scattered electron 4 momentum: obtain from id No.3 from particle list
  - k' is the final scattered electron 4 momentum: obtain from id No.5 from particle list
  - p_h is the EflowTrack 4 momentum.

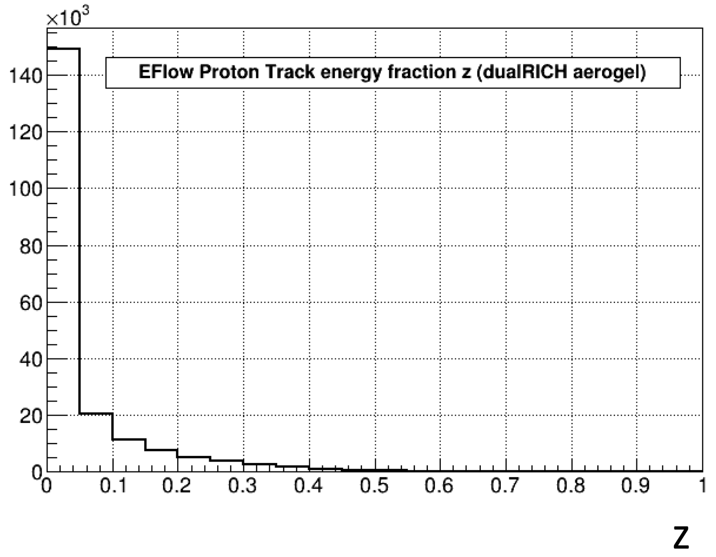
```
0 Status:4   PID:2212
1 Status:4   PID:11
2 Status:21  PID:2
3 Status:21  PID:11
4 Status:23  PID:2
5 Status:1   PID:11
6 Status:51  PID:2
7 Status:51  PID:21
8 Status:53  PID:2
9 Status:51  PID:21
```

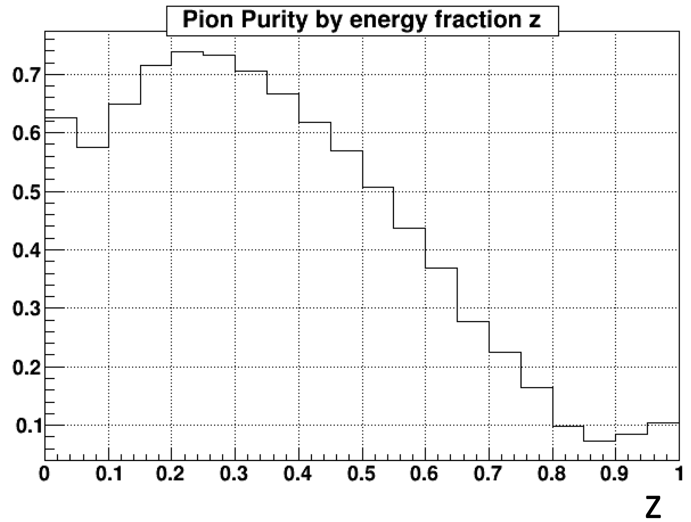
Eflow track energy fraction z

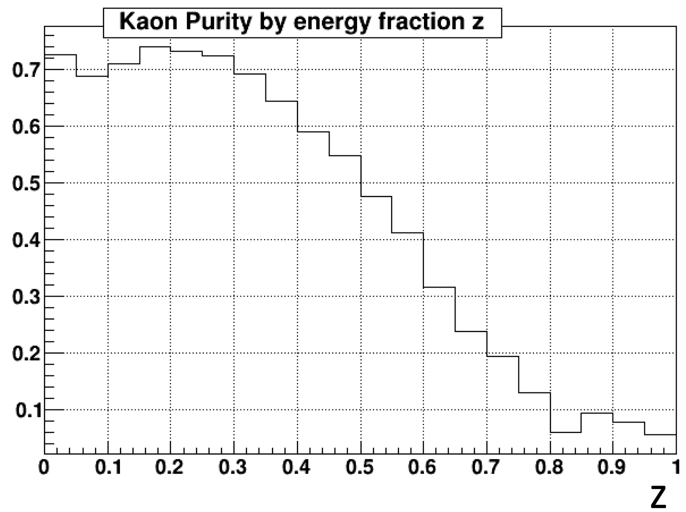
- dualRICH_aerogel: $1 < \eta < 3.5$, $P < 12\ GeV$

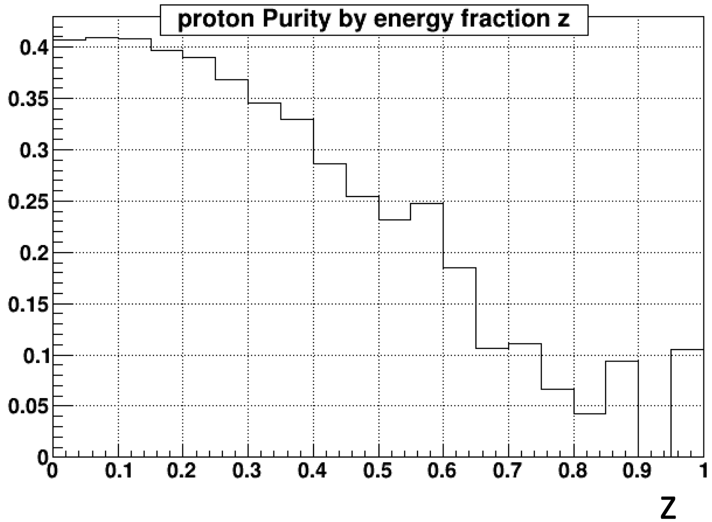






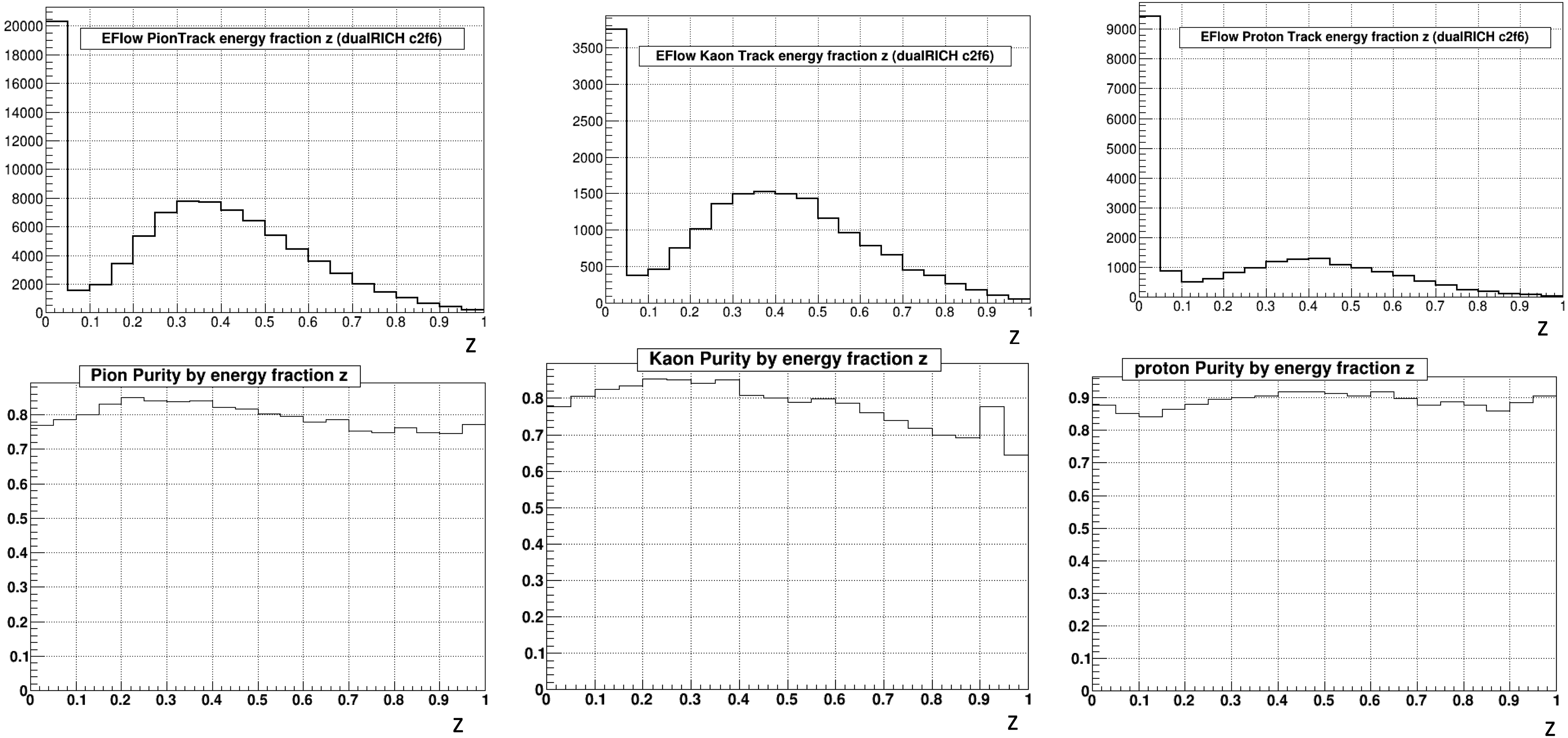






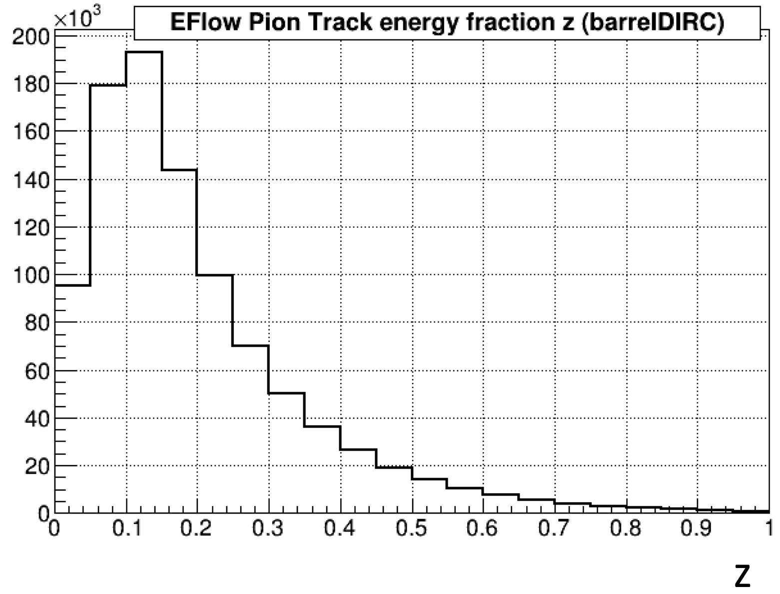
Eflow track energy fraction z

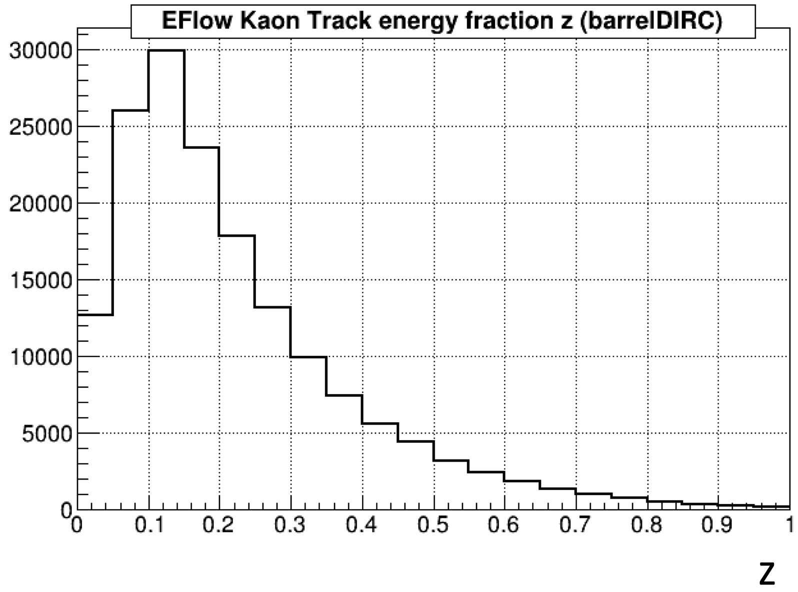
- dualRICH_c2f6: $1 < \eta < 3.5$, $P > 12\ GeV$

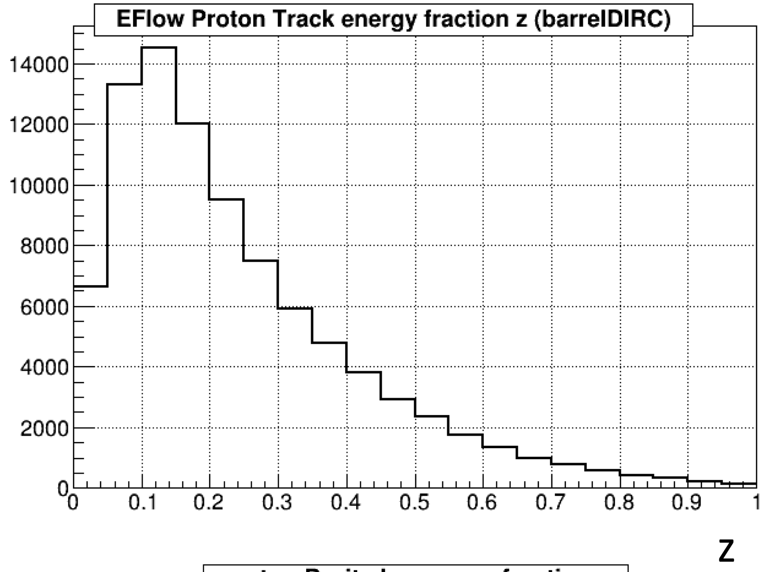


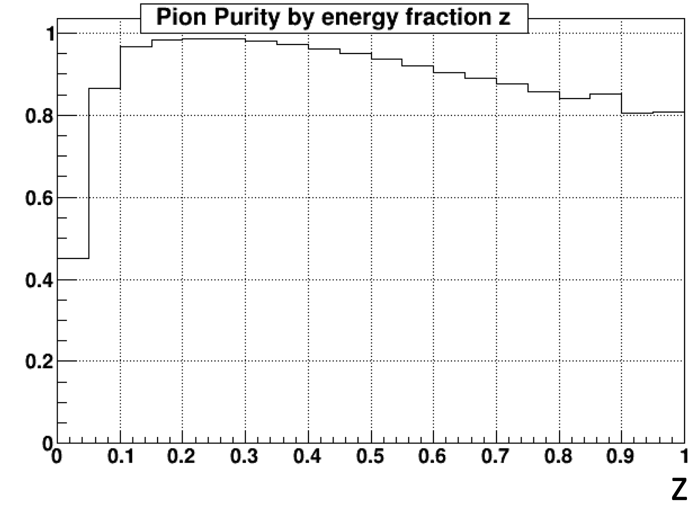
Eflow track energy fraction z

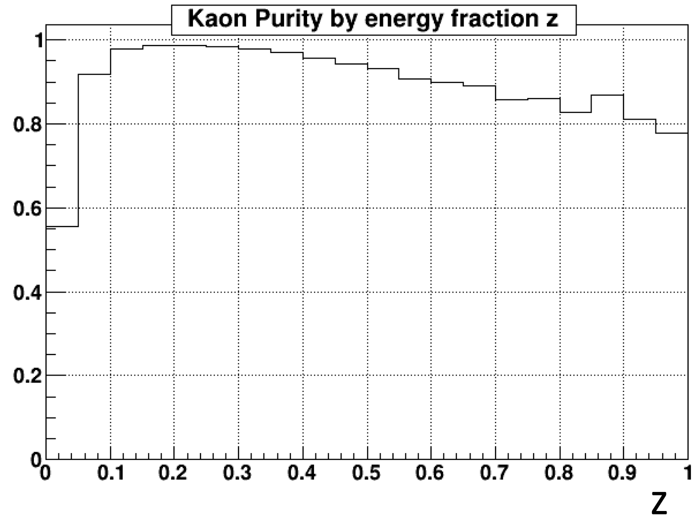
- barrelDIRC: $-1 < \eta < 1$

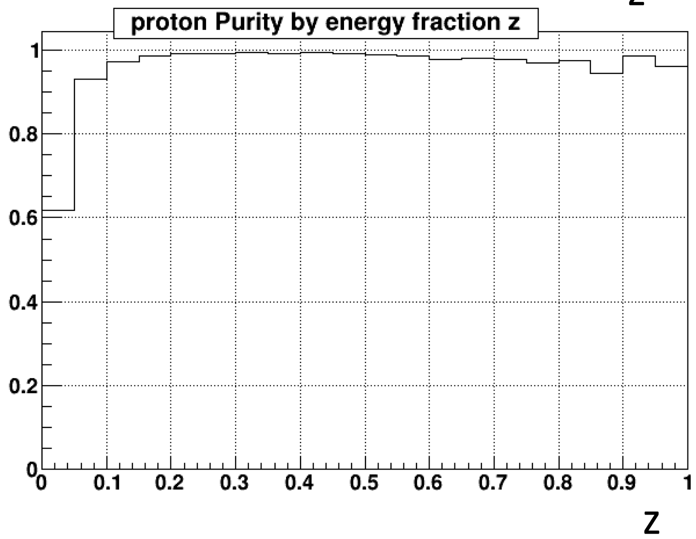












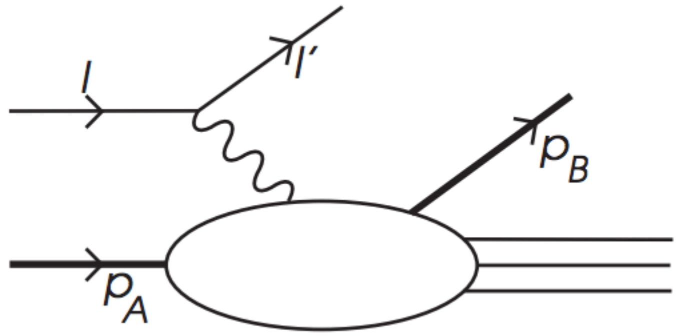
Conclusion

- The Eflow track purity roughly match with the purity for tracks in the jets.
- The PID purity is closed to the PID efficiency in the Delphes card. But it is effected by the track misidentification.

Back up

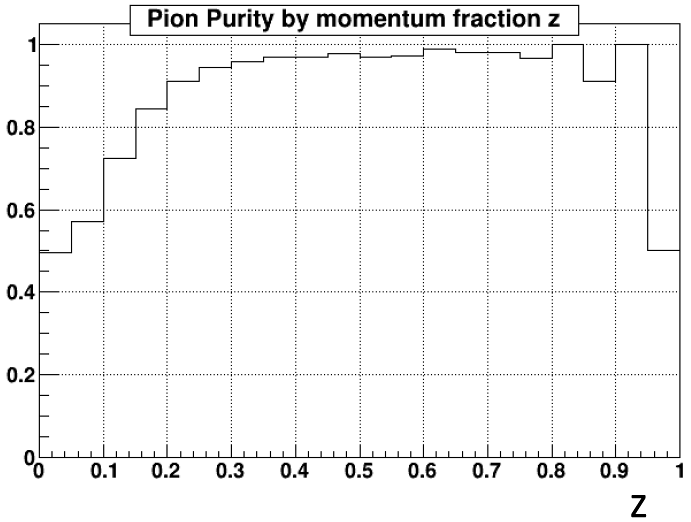
Data set

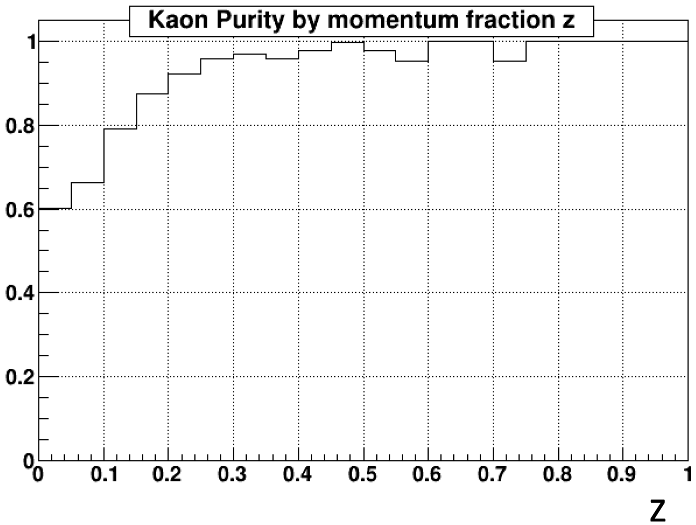
- Use Pythia8 and Delphes to simulate DIS process
- Delphes card: **delphes_card_allsilicon_3T.tcl** . Based on EIC Delphes card.
- Number of event generated: 200 k
- E_{proton} = 100 GeV
- $E_{electron}$ = 10 GeV
- Q^2 > 100 GeV

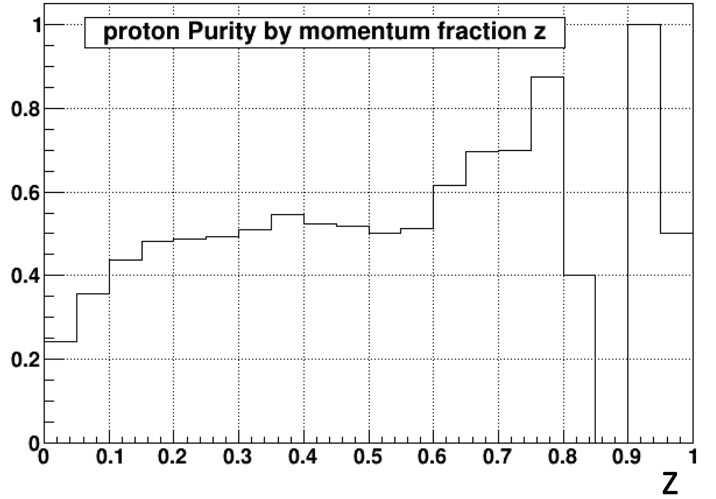


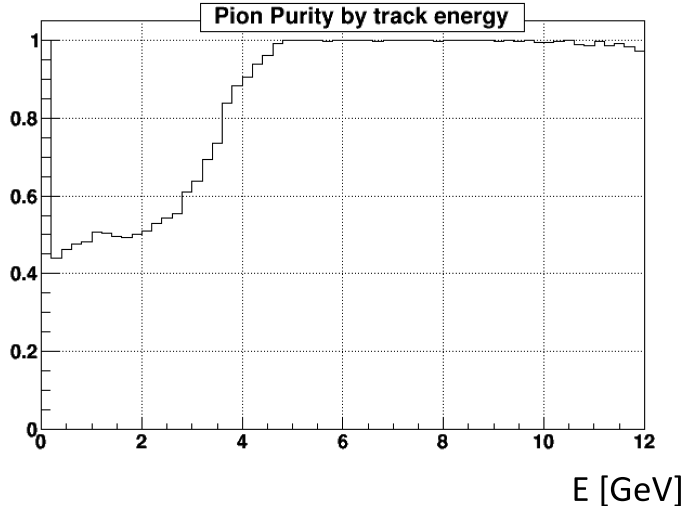
Check tracks in jets with dualRICH_aerogel tracks

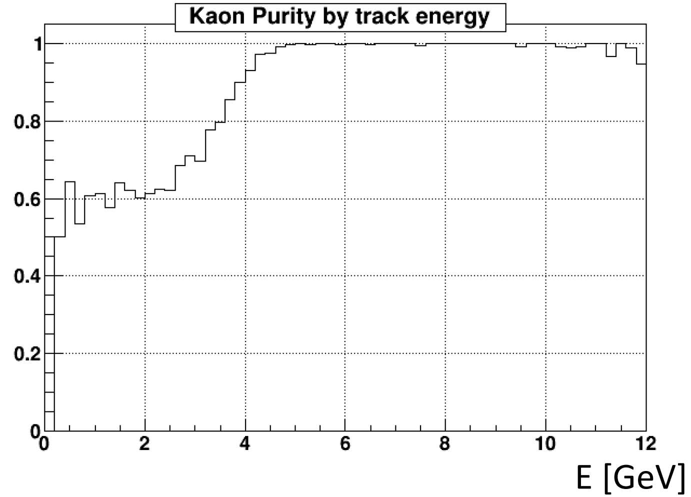
- Jet finding: Anti-kT algorithm, R<1
- Z: track momentum fraction from the jet

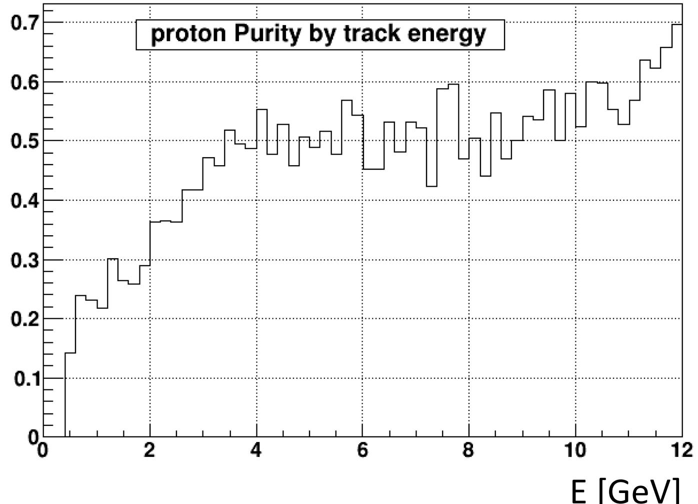






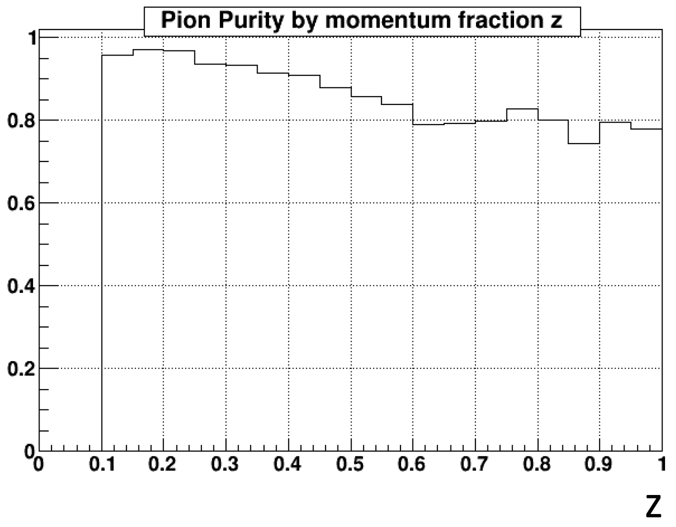


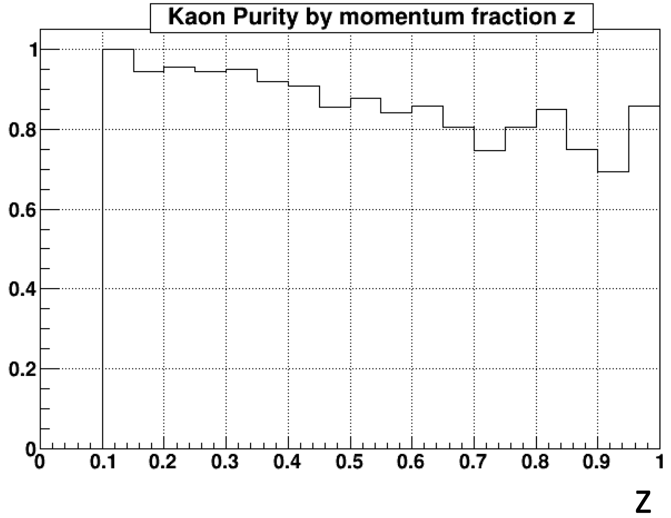


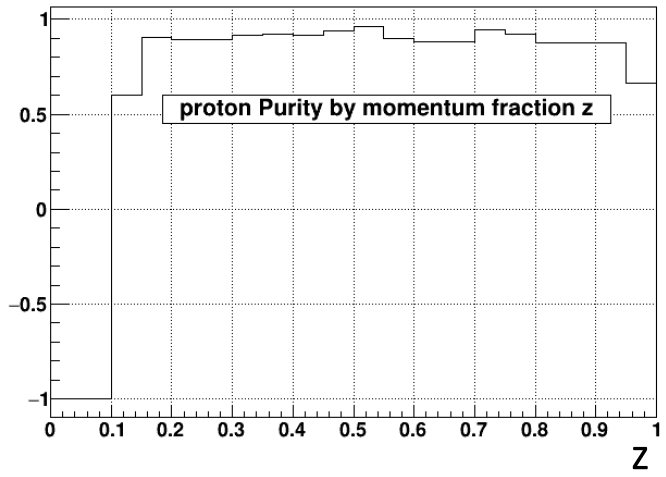


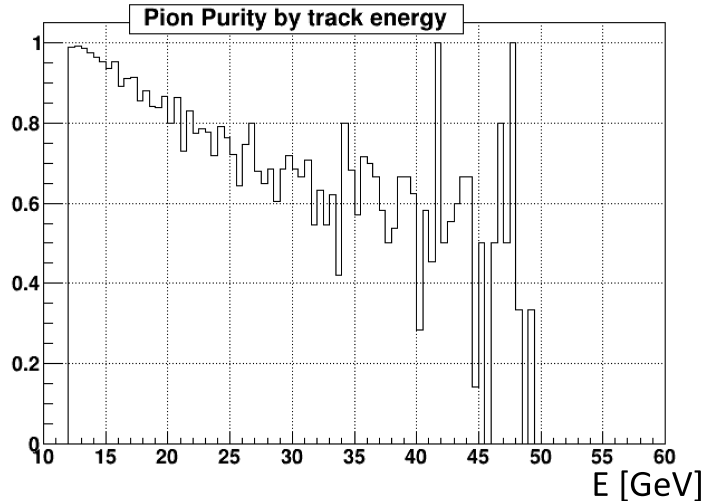
Check tracks in jets with dualRICH_c2f6 tracks

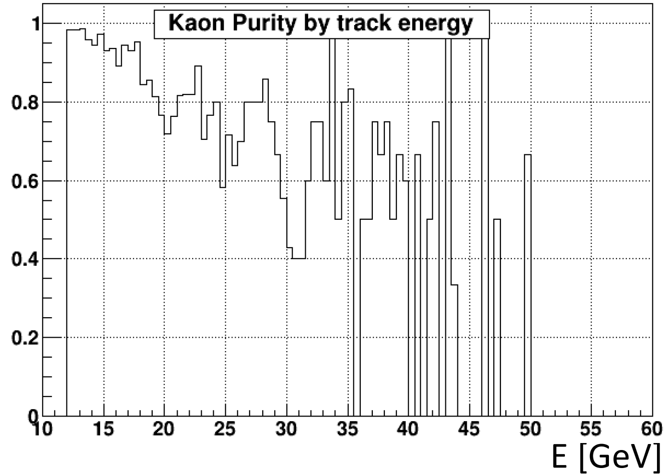
- Jet finding: Anti-kT algorithm, R<1
- Z: track momentum fraction from the jet

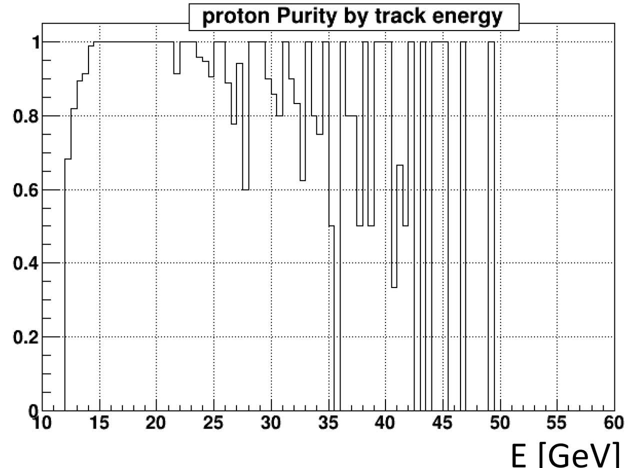






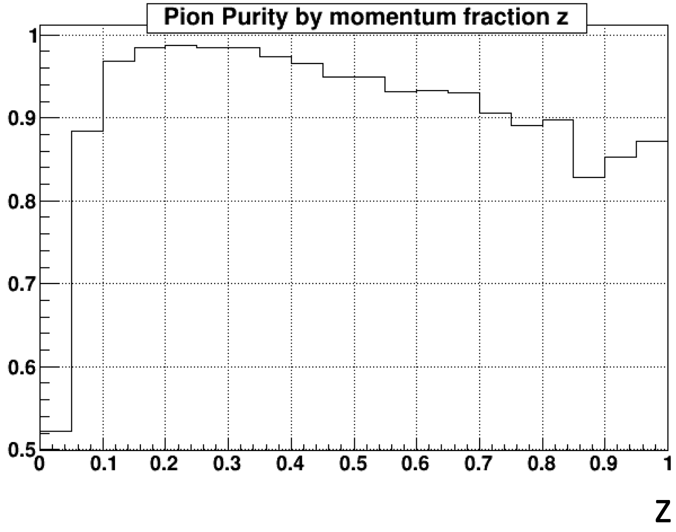


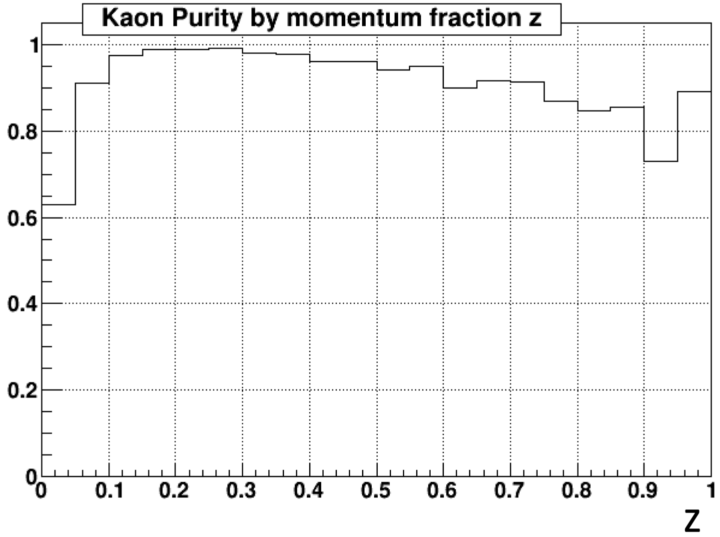


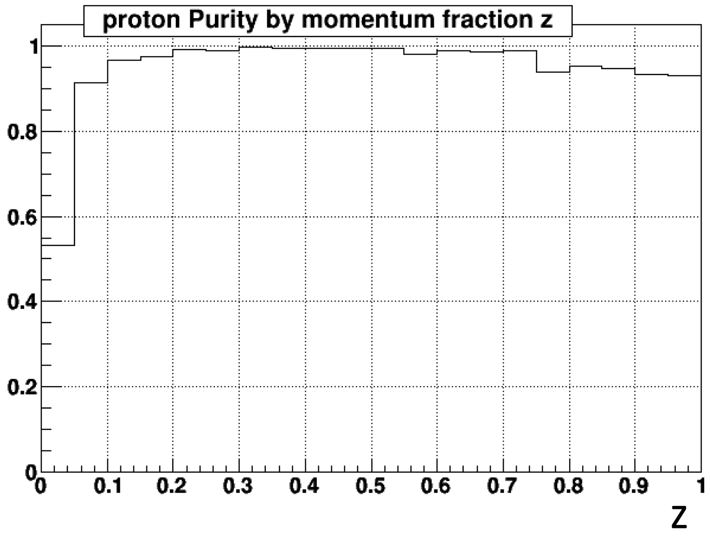


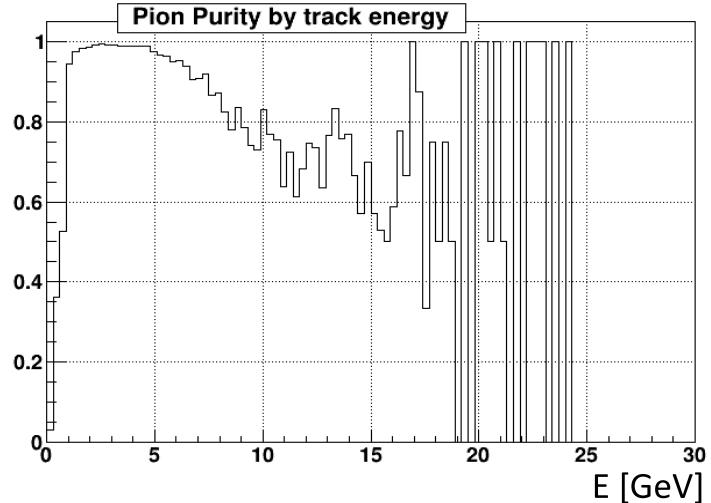
Check tracks in jets with barrelDIRC tracks

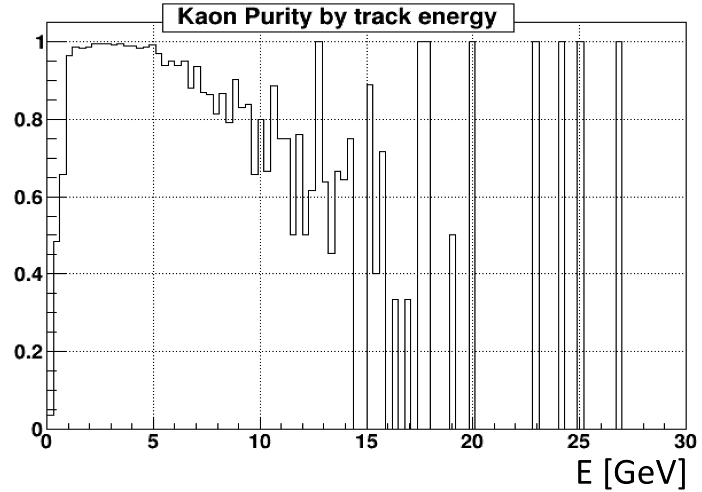
- Jet finding: Anti-kT algorithm, R<1
- Z: track momentum fraction from the jet

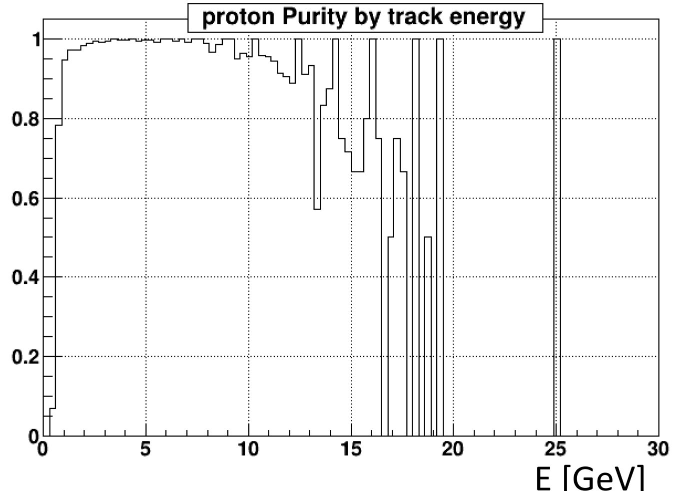






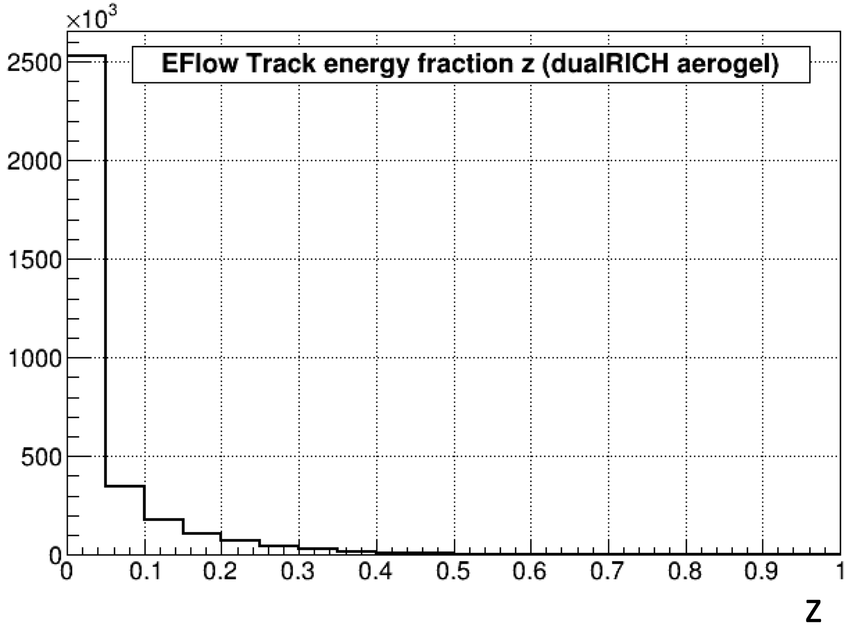


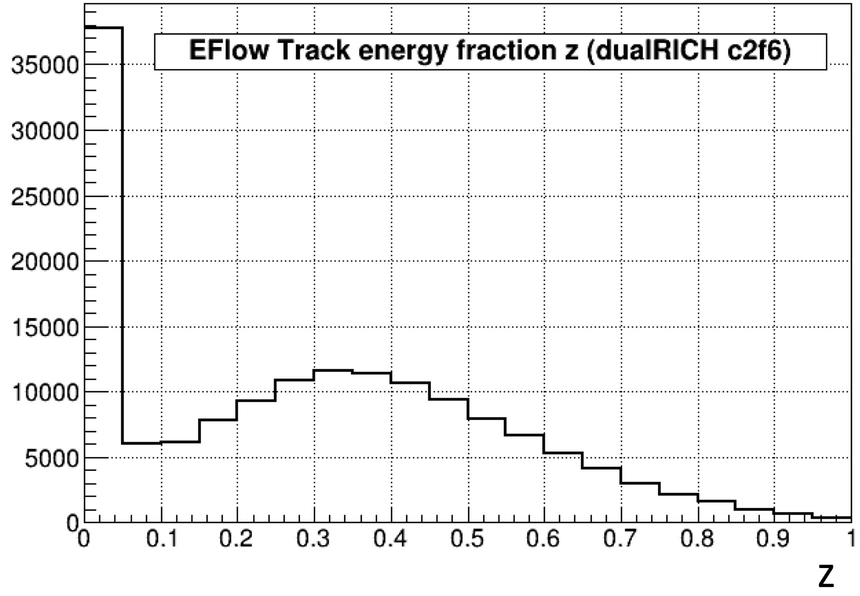


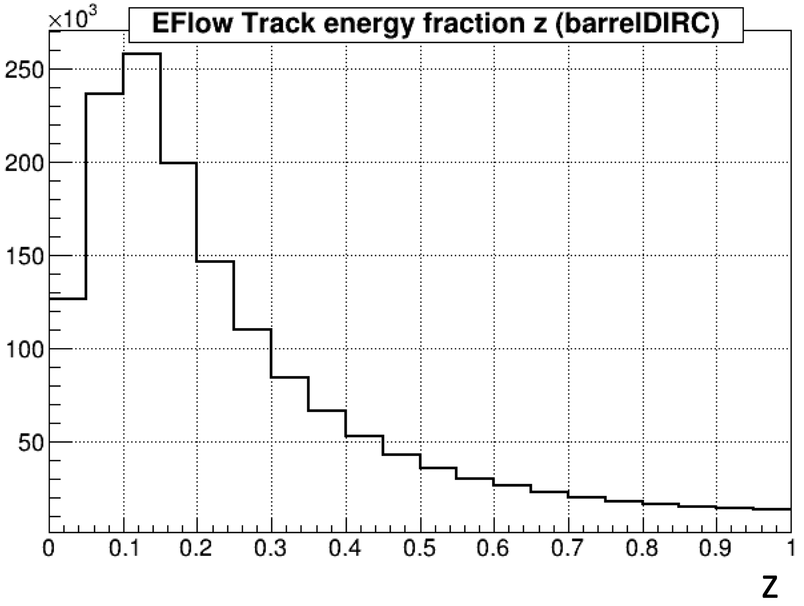


Sort all track fraction z by different detector system coverage

- dualRICH_aerogel: $1 < \eta < 3.5$, $P < 12\ GeV$
- dualRICH_c2f6:$1 < \eta < 3.5$, $P > 12 GeV$
- barrelDIRC: $-1 < \eta < 1$

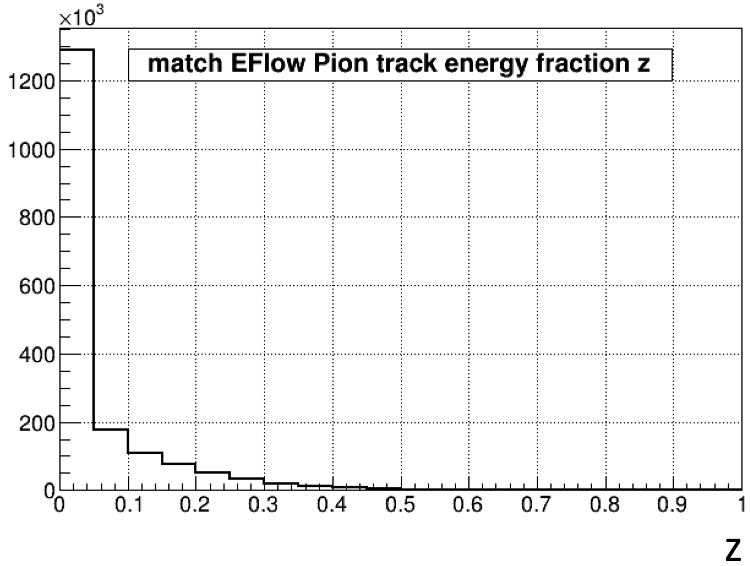


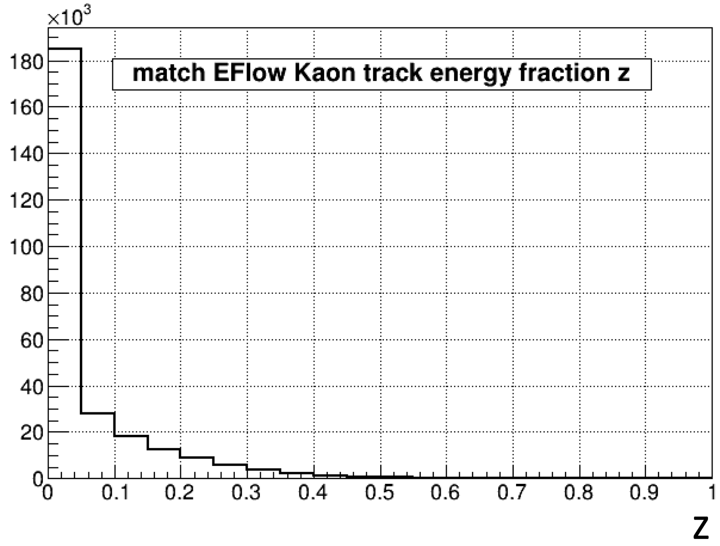


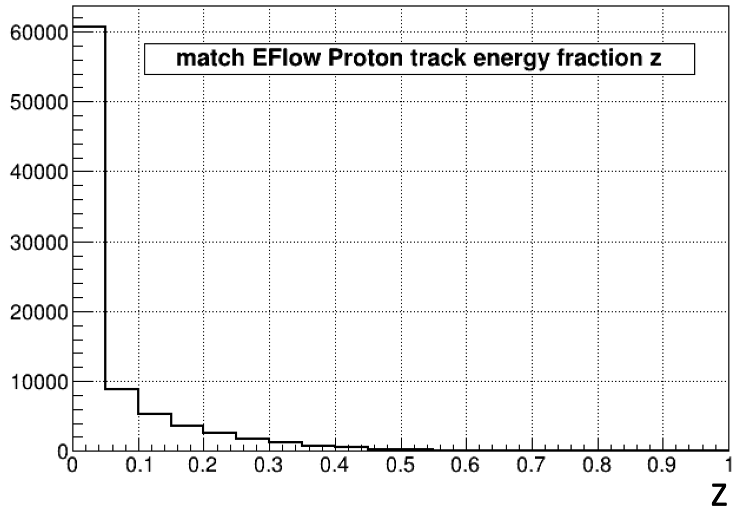


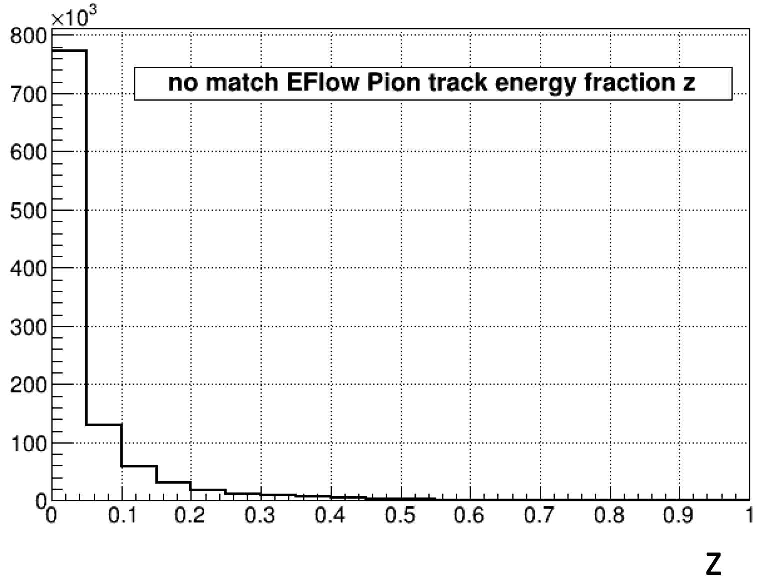
Eflow track energy fraction z

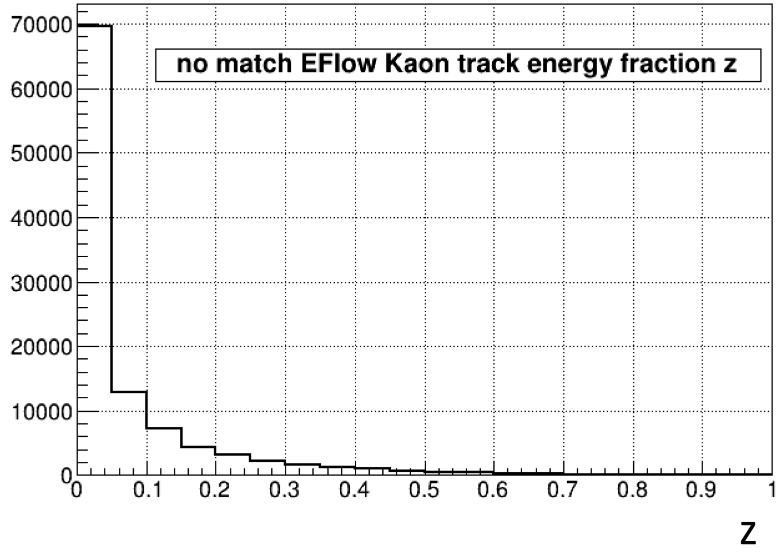
- dualRICH_aerogel: 1 < η < 3.5 , P < 12 GeV

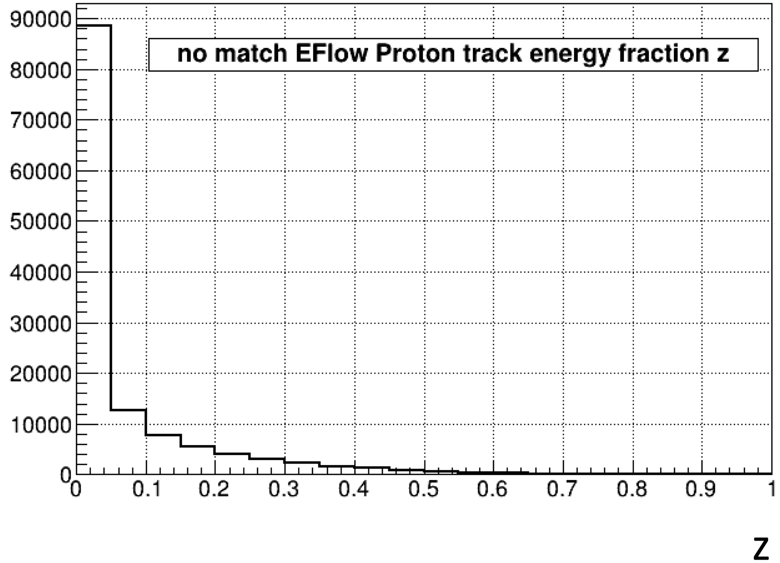






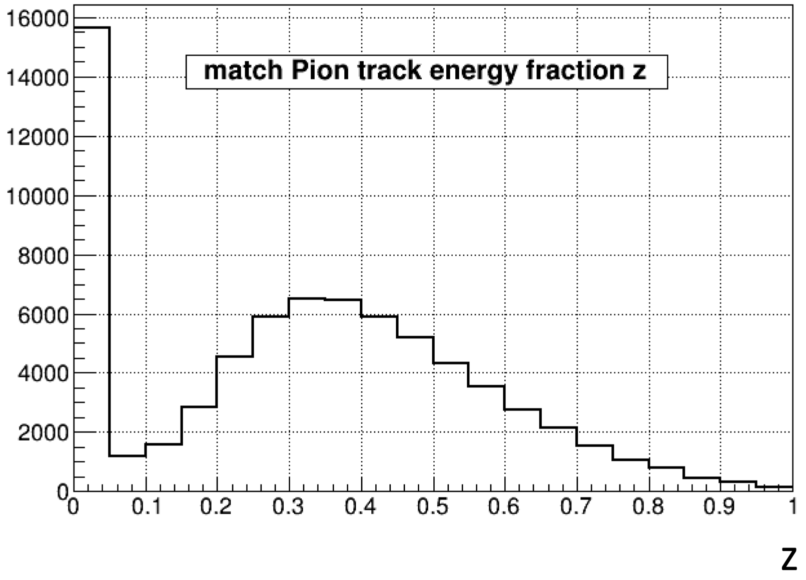


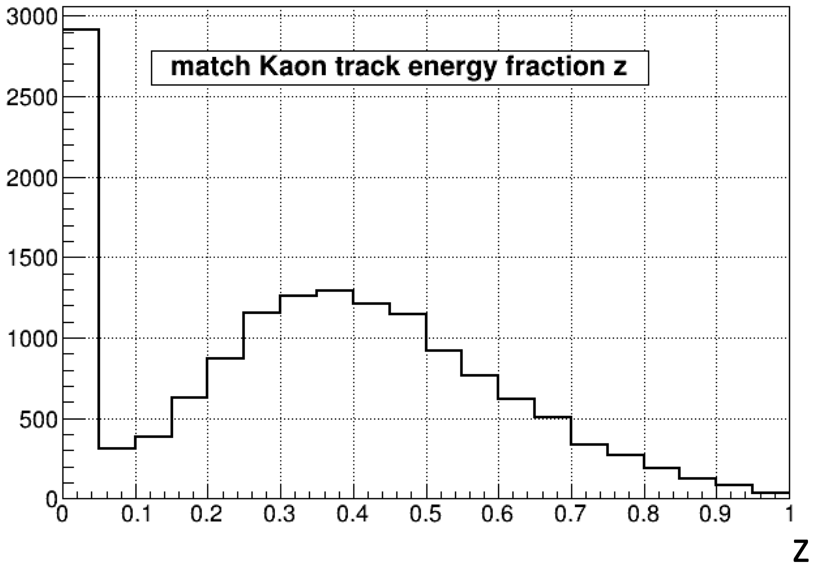


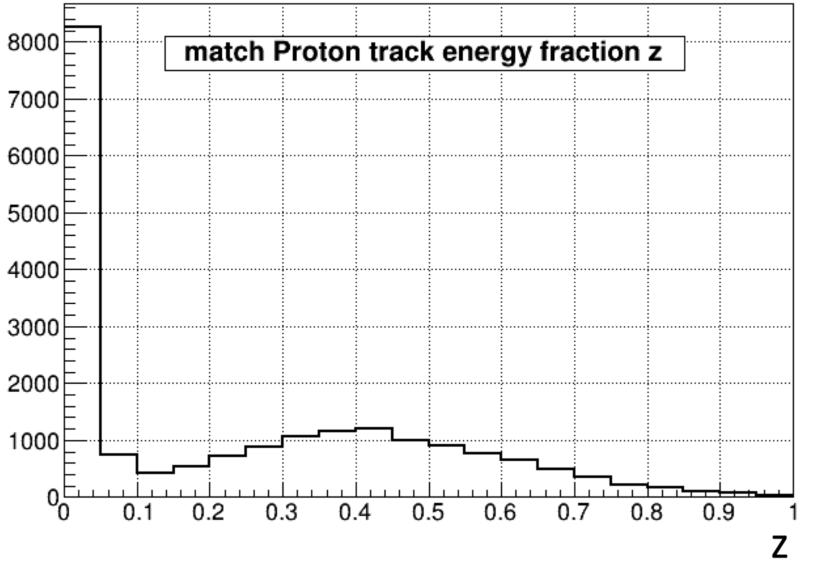


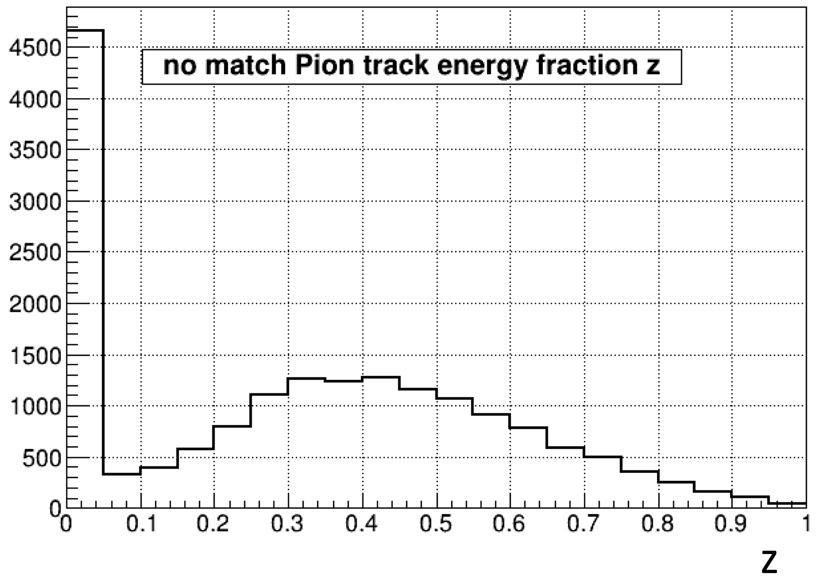
Eflow track energy fraction z

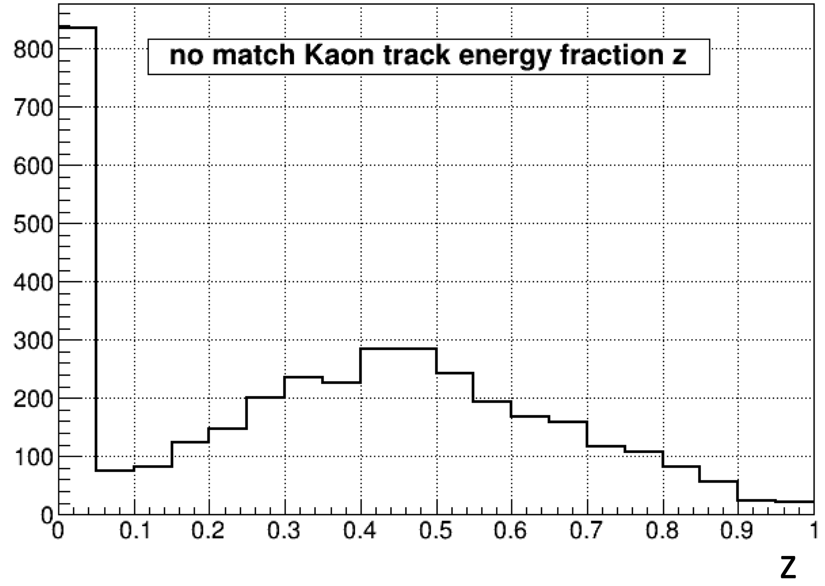
- dualRICH_c2f6: $1 < \eta < 3.5$, $P > 12\ GeV$

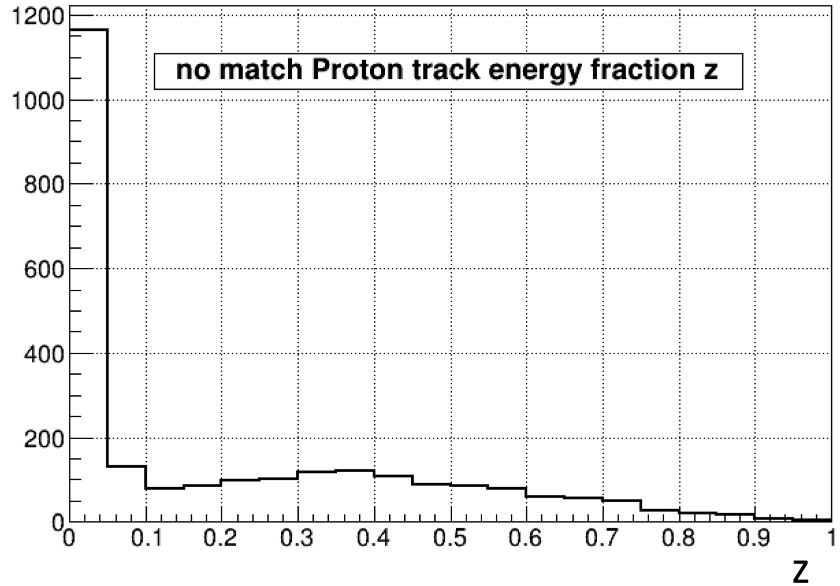












Eflow track energy fraction z

- barrelDIRC: $-1 < \eta < 1$