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PFA Diagnostics tools and benchmark performance

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Introduction

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- Diagnostic tools are developed to test the PFA performance at each step of the algorithm:
  - Track-seed matching:
    - Matching quality, properties of unmatched tracks.
  - DTree sub-clusters:
    - Purities and energy contributions.
  - Link properties:
    - Variables used for scoring.
    - Scores before and after the first cone.
- Next steps.
- Data:
  - 10’000 500 GeV qq events

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Track-Seed Matching

Track-Seed Matching: Definitions

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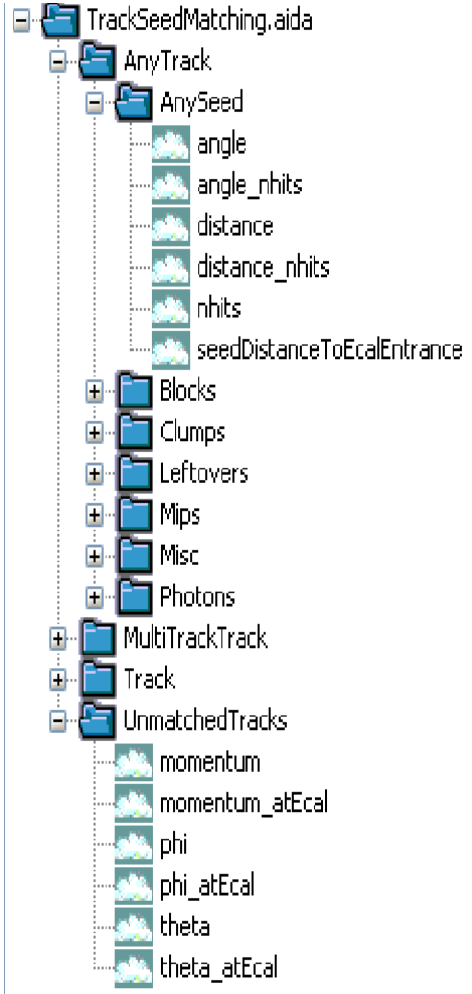
- Tracks are extrapolated to the innermost layer with hits from the seed:
  - Angle is computed between the seed direction from energy tensor calculation and the tangent to the extrapolated track.
  - Distance is computed between the track interception point and the closest hits in the cluster on the same layer.
- Seed distance to Ecal entrance is the depth of the innermost layer with hits from the seed.
- Plots are made per seed type and also separating simple from multiple tracks.
- Multiple tracks:
  - Angle and distance to seeds are computed using extrapolation results averaged on sub-tracks.
  - Angle is the maximum angle between “sub-tracks” at the extrapolation layer.
  - Distance is the maximum distance between interception points.
- For unmatched tracks:
  - Momentum, theta and phi are plotted for all unmatched tracks and for those that reach the Ecal.



Track-Seed Matching

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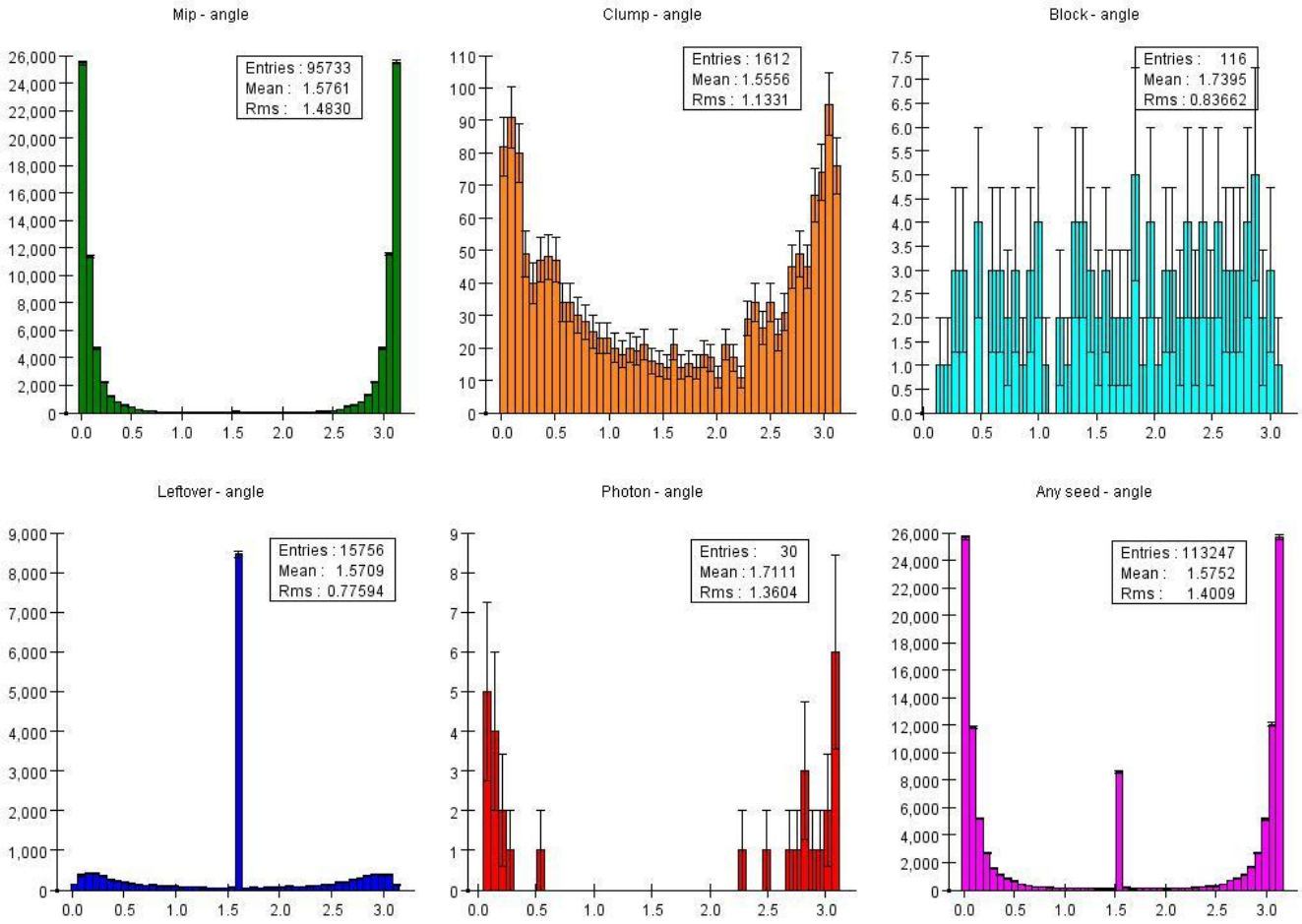
Matching efficiency to a mip:
84.5%

Fraction of seeds with <4 hits:
7.5%

Type	rate
Mips	84.5%
Leftovers	14%
Other	1.5%



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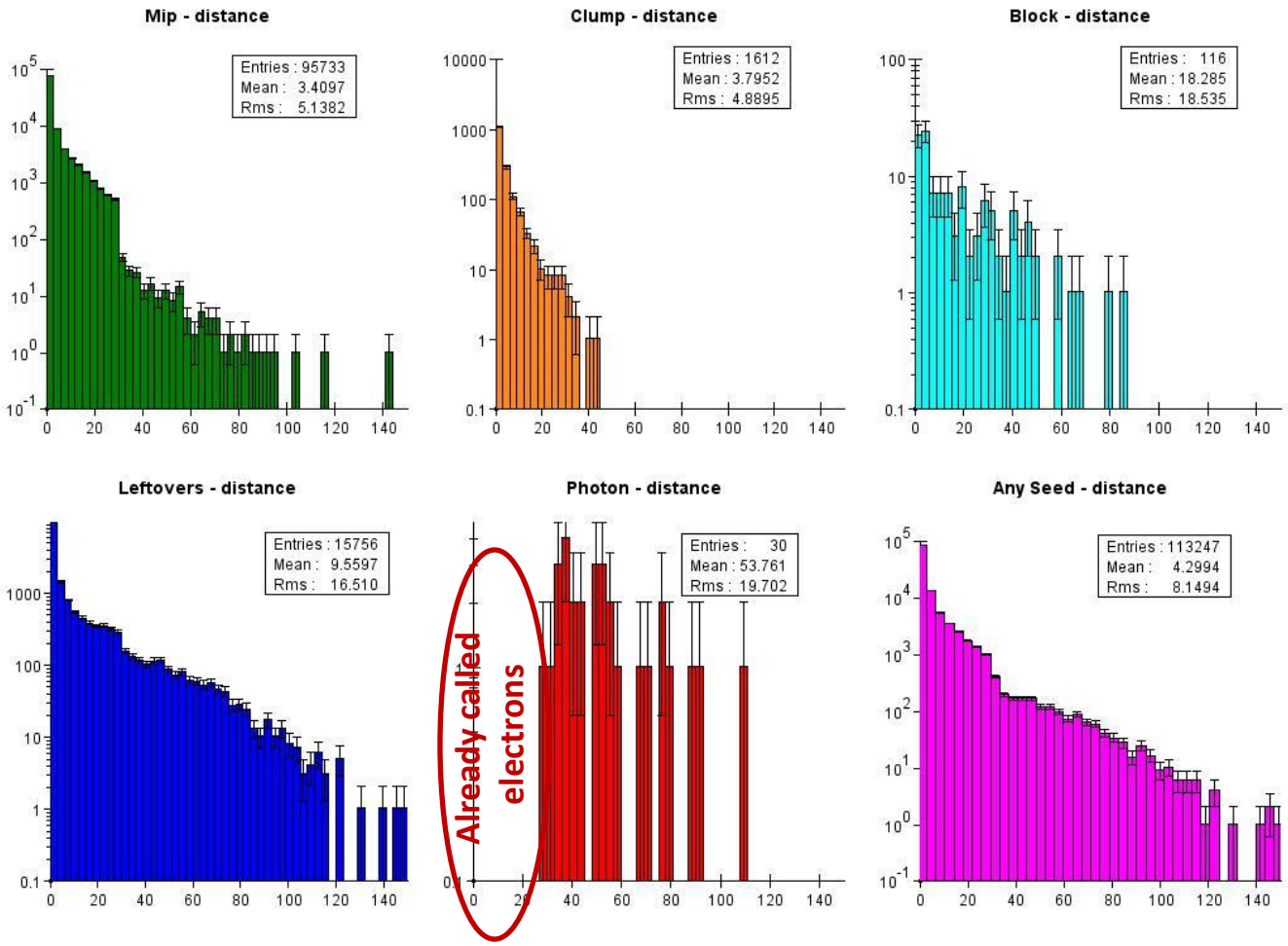

Track-Seed Matching: Unmatched tracks

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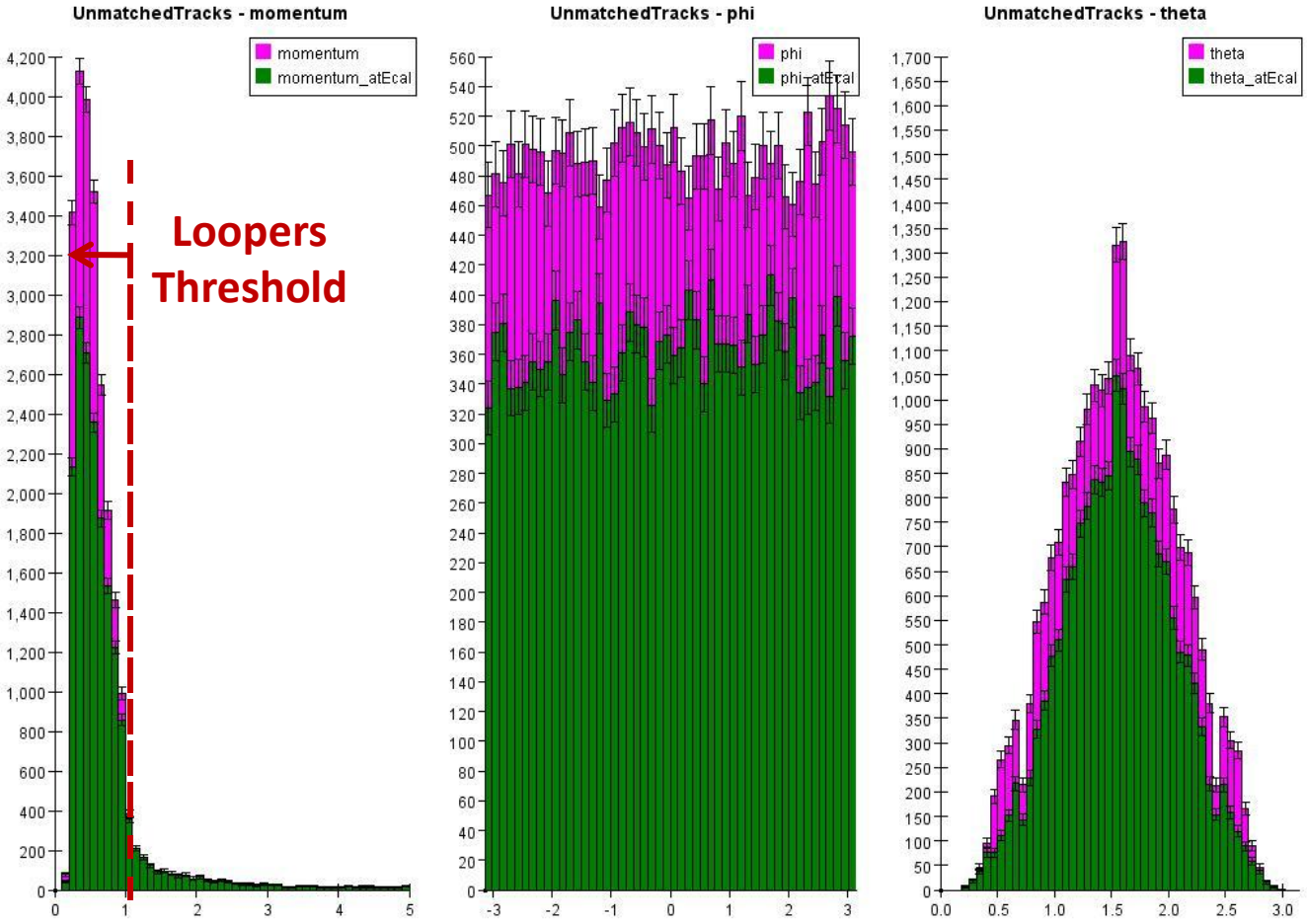
Fraction of unmatched tracks:
18%

Fraction of unmatched tracks with p<1 GeV:
90%

Fraction of unmatched tracks that reach Ecal:
75%



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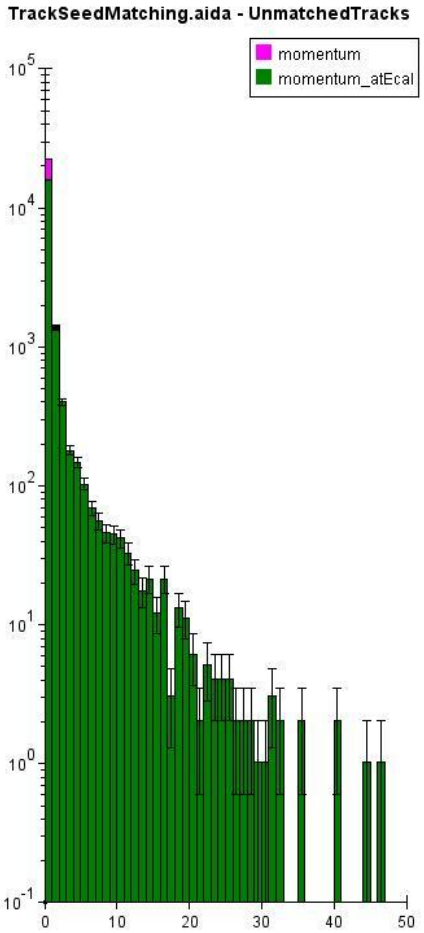
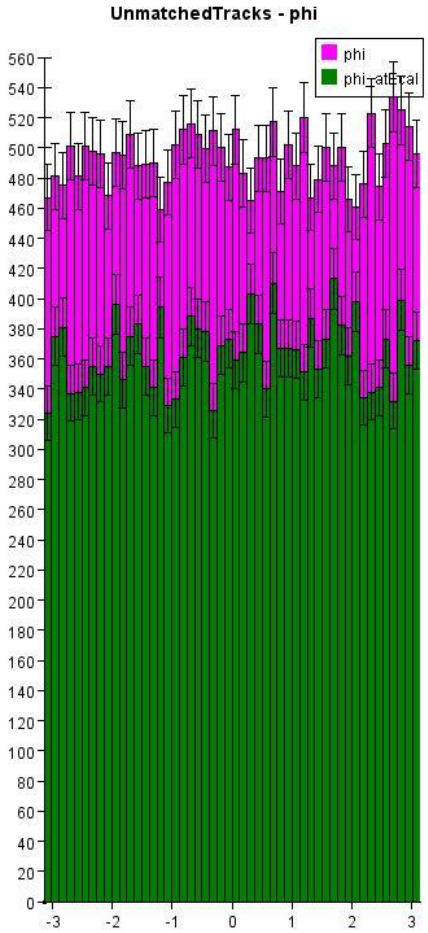
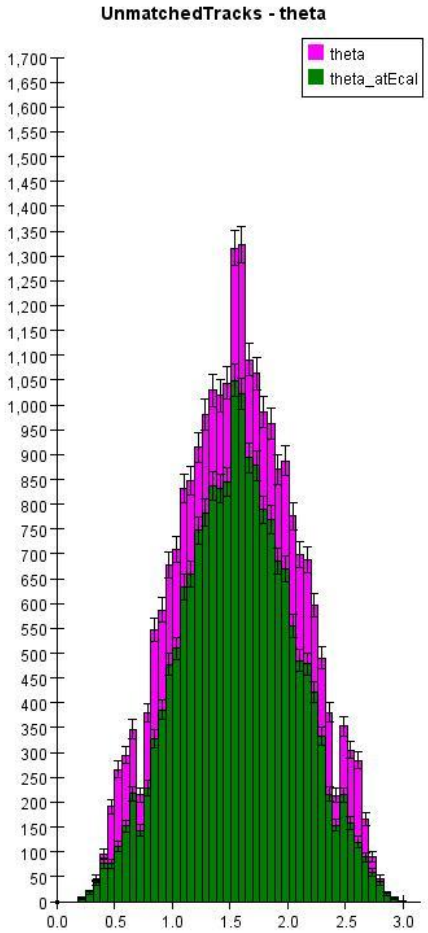
Momentum tail up to 50 GeV







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DTree Sub-Clusters

DTree Sub-Clusters: Definitions

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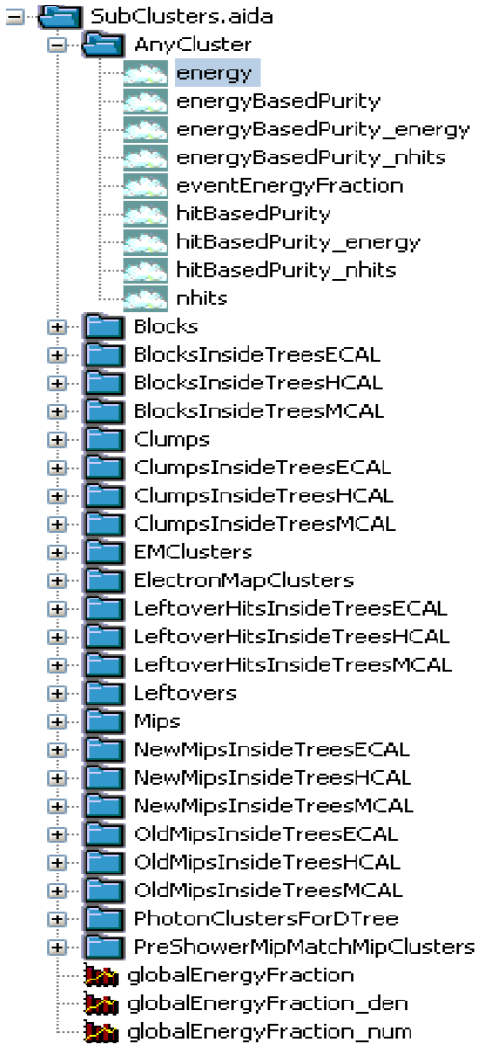
- Plots are defined per cluster type.
- Energy fraction ignores energy from non-listed cluster types (missing muons):
  - The total energy is computed by summing up cluster energies from listed types.
- Defined a “per-event” energy fraction and a “global” energy fraction.
- Two definitions for purity:
  - Hit based purity

    # hits from dominant particle / # hits in cluster
  - Energy based purity:

    Energy from dominant particle / cluster energy



DTree Sub-Clusters: Energy contributions

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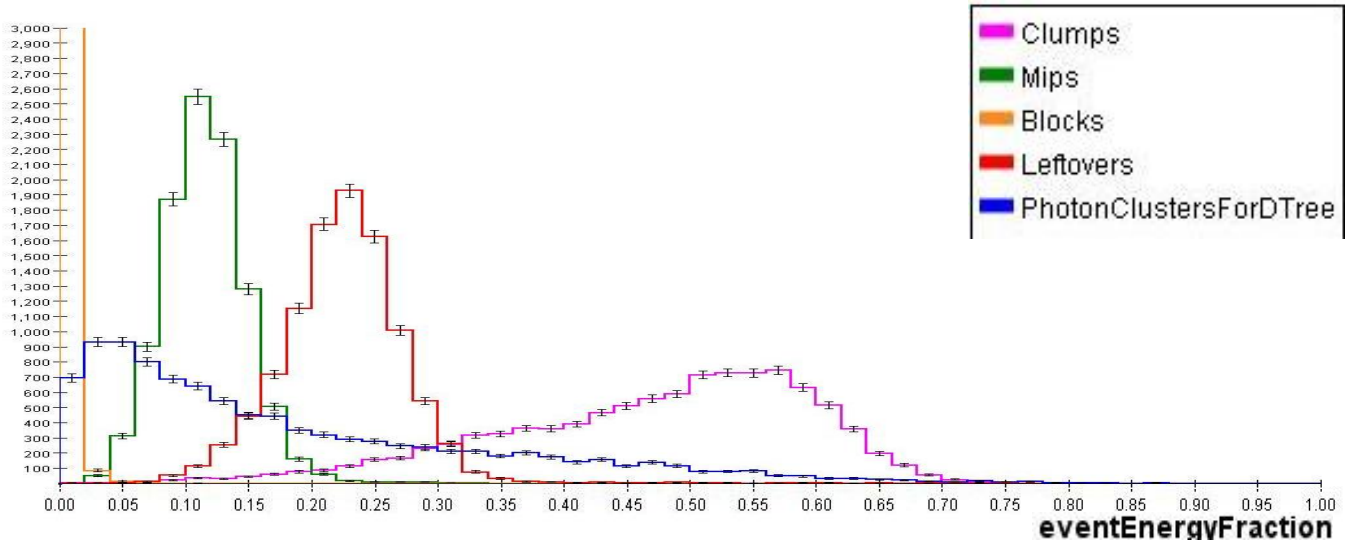
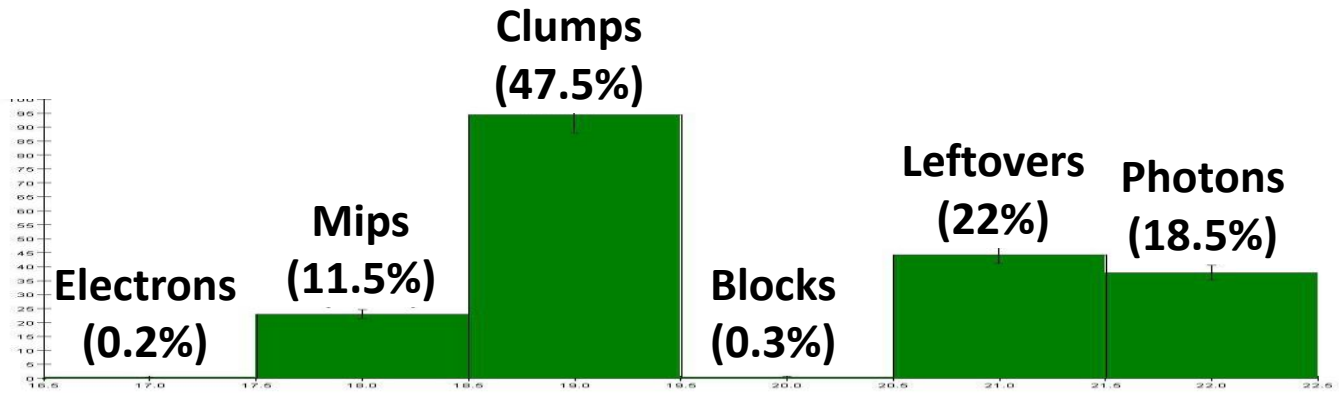
Most of the energy goes to clumps:
47.5%

Significant amount of energy is shared:
22 %

Blocks are rare:
0.3%

Photon distribution peaks at low fractions but have a large tail.





DTree Sub-Clusters: Purities

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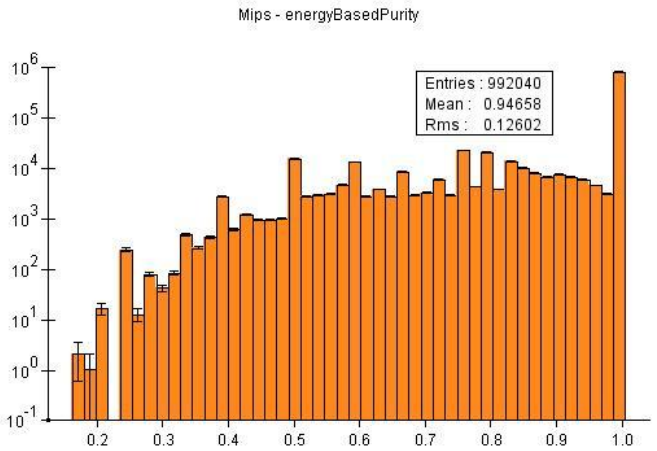
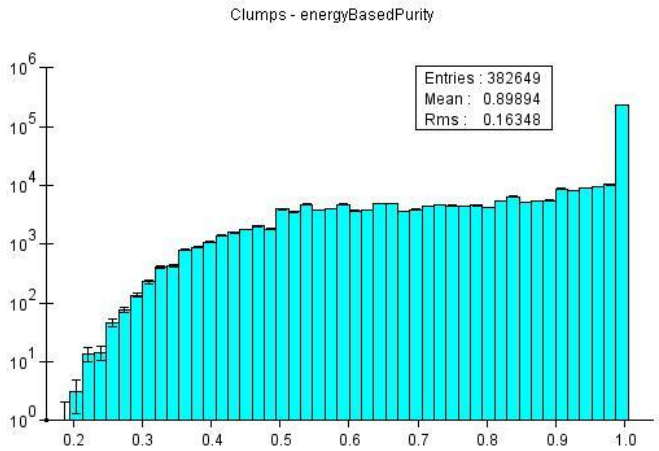
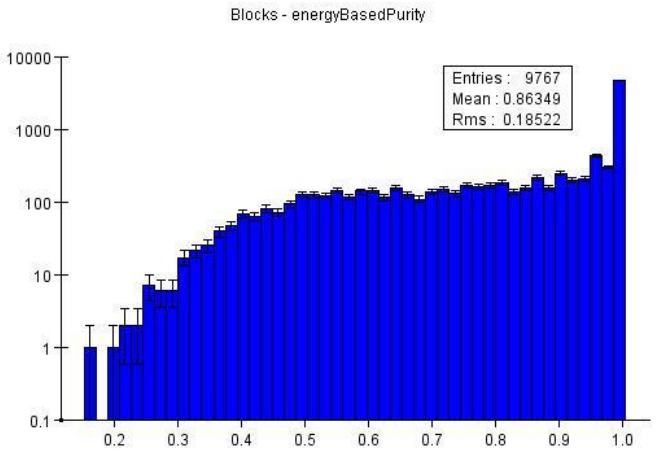
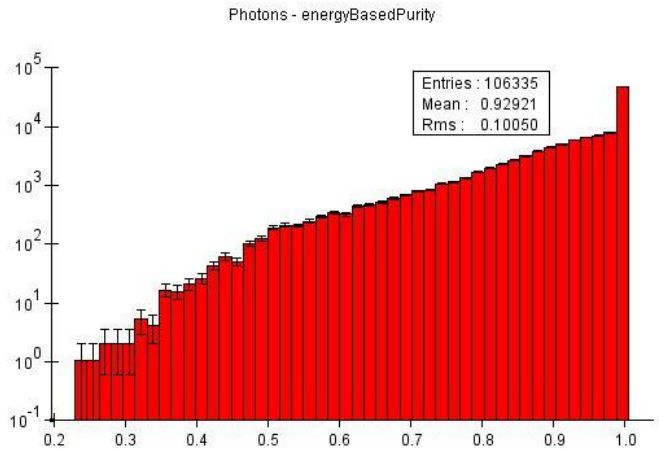
Showing energy based purities.

Type	Purity
Mips	95%
Clumps	90%
Blocks	86%
Photons	93%









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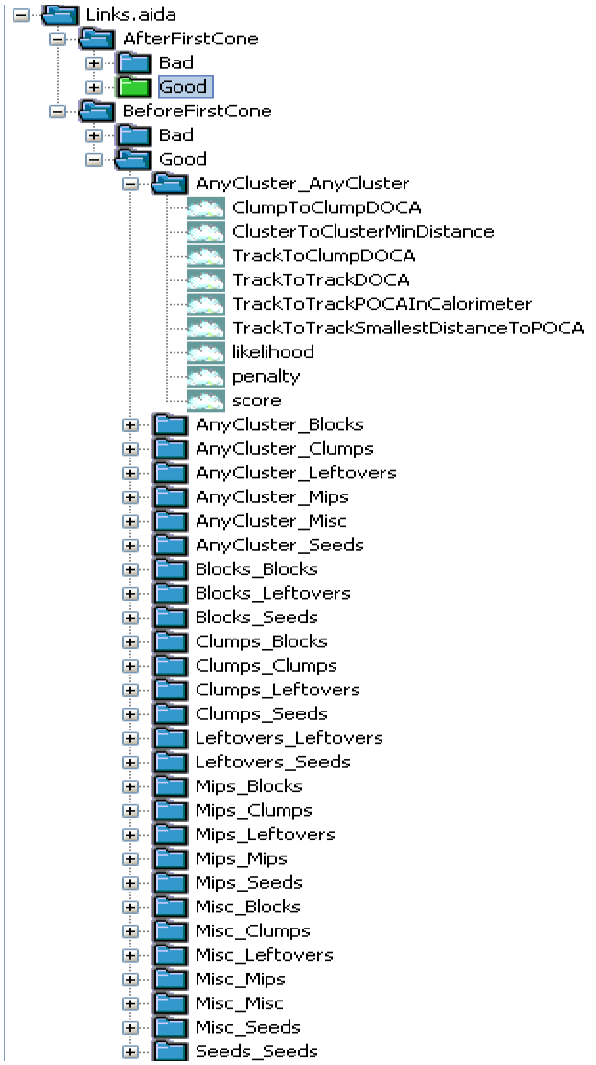
Link Scoring

Link Scoring: Definitions

- Plots made per link type.
- A “good” link is a link where both sub-clusters have dominant energy contributions from the same MC particle.
- Made plots for variables used in likelihood:
  - To be compared with the plots in the Data-base.
- Some penalty factors are applied during scoring:
  - Penalty for belonging to separate DTree clusters: 0.8*cos(angle)
  - Penalty for proximity (not applied for mip-mip links): a/R^2
  - Other penalties depending on link type.
  - penalty = score / likelihood
- Clump-Clump likelihood is not used !?!
  - Score only computed based on angle and proximity + other types of penalties.



Link Scoring: Variables

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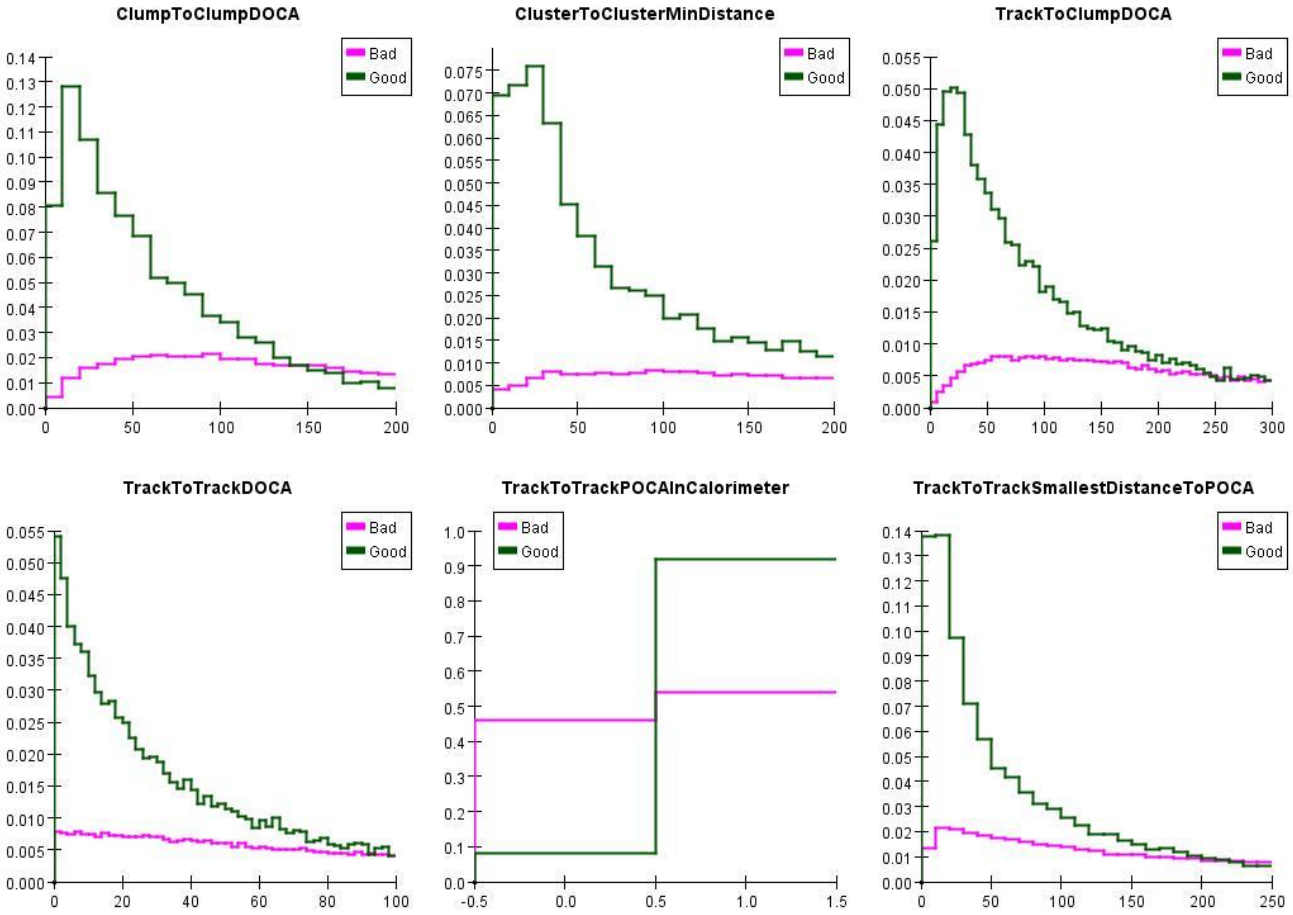
Only relevant links enter each distribution.



Link Scoring: Scores
All links

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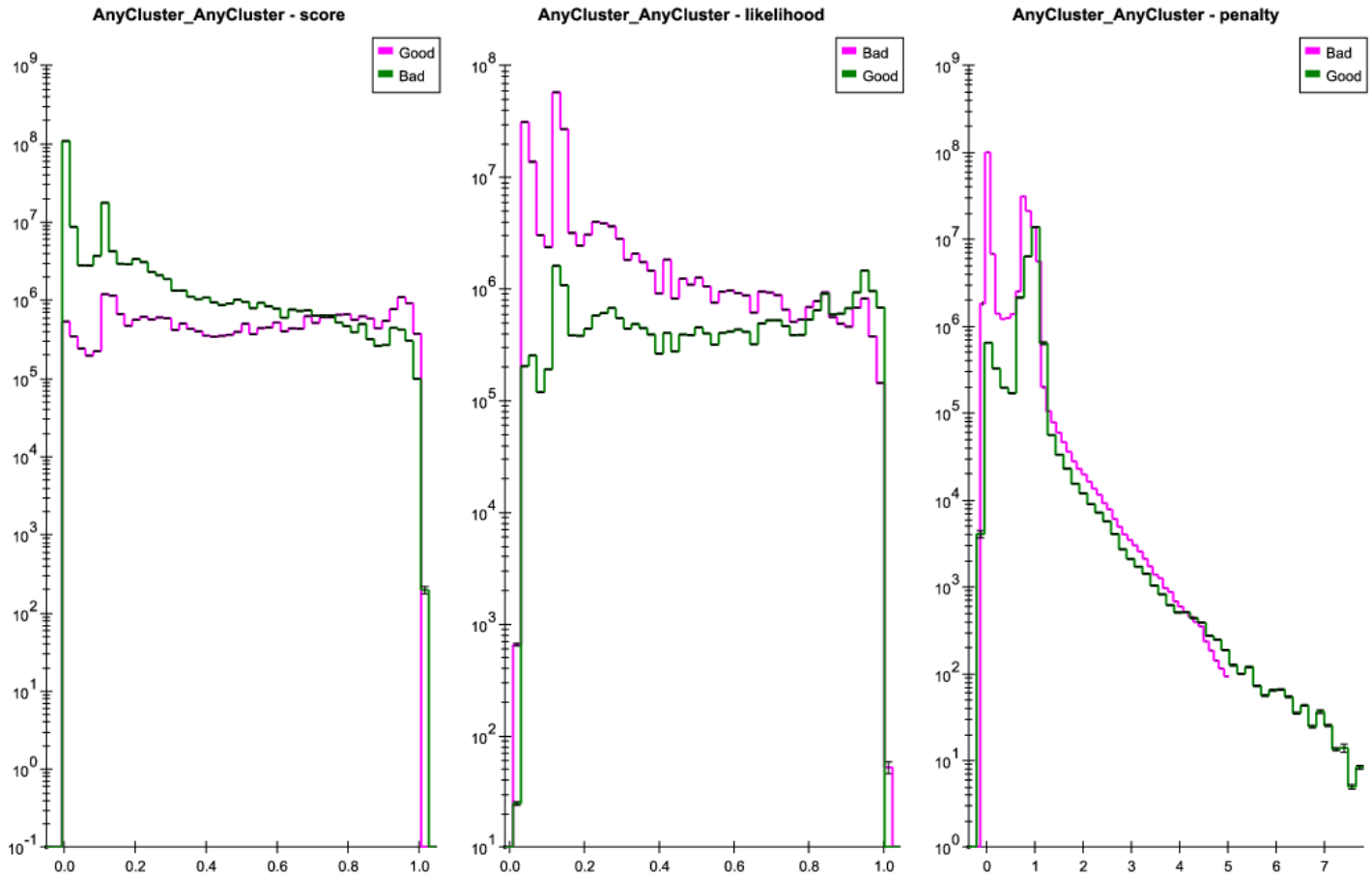
Scoring can be improved!

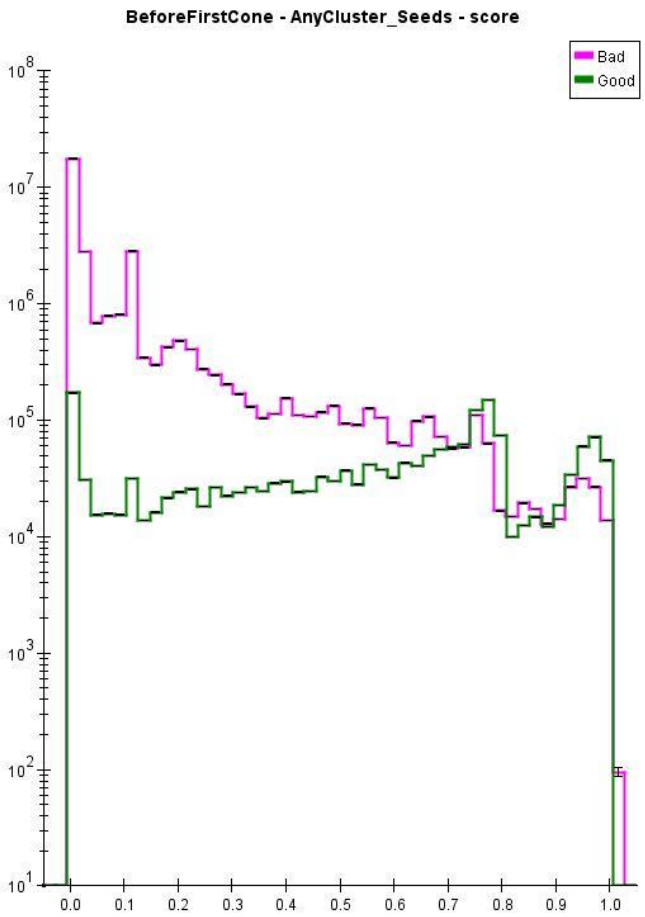


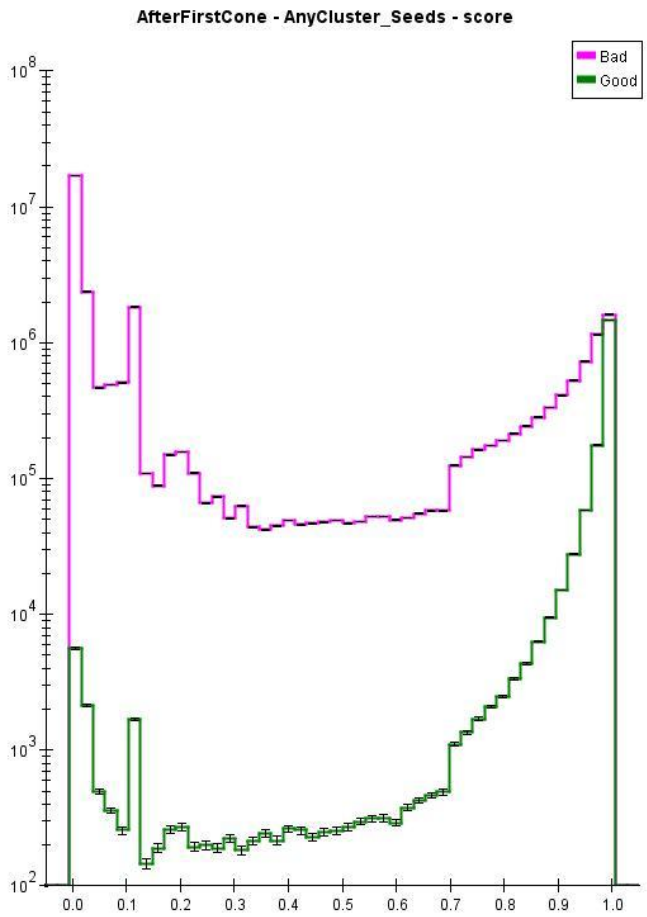
Link Scoring: Scores
Links to seed before/after cone

The University of Iowa

The cone algorithm is rather aggressive.

We already know that!!!





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Next steps

Conclusion and next steps.

- Diagnostic tools for PFA performance quantification are ready.
- Benchmark performance on 500 GeV qqbar events with current PFA setup done.
  - Tacks-seed matching seems to perform OK:
    - Most of unmatched tracks are below 1 GeV.
  - DTree re-clustering performance in terms of purities:
    - Need to know if 22% of leftover hits is problematic or not for the PFA.
    - Need to know if 90% purity in sub-clusters is enough for the PFA.
  - Looking at performance for single pions as well.
- Next steps:
  - Link scoring needs to be given a “quick” look at:
    - Need a better definition for a “good” link: no great ideas yet!
    - Revisit likelihood calibration: now done using a different DTree re-clustering algorithm than the one used in the PFA.
    - Should not be a show-stopper at this point.
  - Start implementing algorithm changes as described in the previous meeting.