

AstroPix algorithms

08/04/2026

Background

- Current: Weighted average of all hits in astropix, weighted by energy.
- Was told that taking position of the pixel with max-e-dep in a cluster improves resolution.
- Test astropix algorithm with gamma single track simulation.
- Gamma is neutral, doesn't bend in B-field. Phi and eta of cluster center can be compared to initial gamma phi.

Test condition

- Single track gamma, originates from origin (0, 0, 0).
- $80 \text{ deg} < \theta < 100 \text{ deg}$.
 - The most performant phase space.
- 2π azimuth, uniform.
- $0.01 < E < 20 \text{ GeV}$, uniform.
- Standard clustering algorithm.

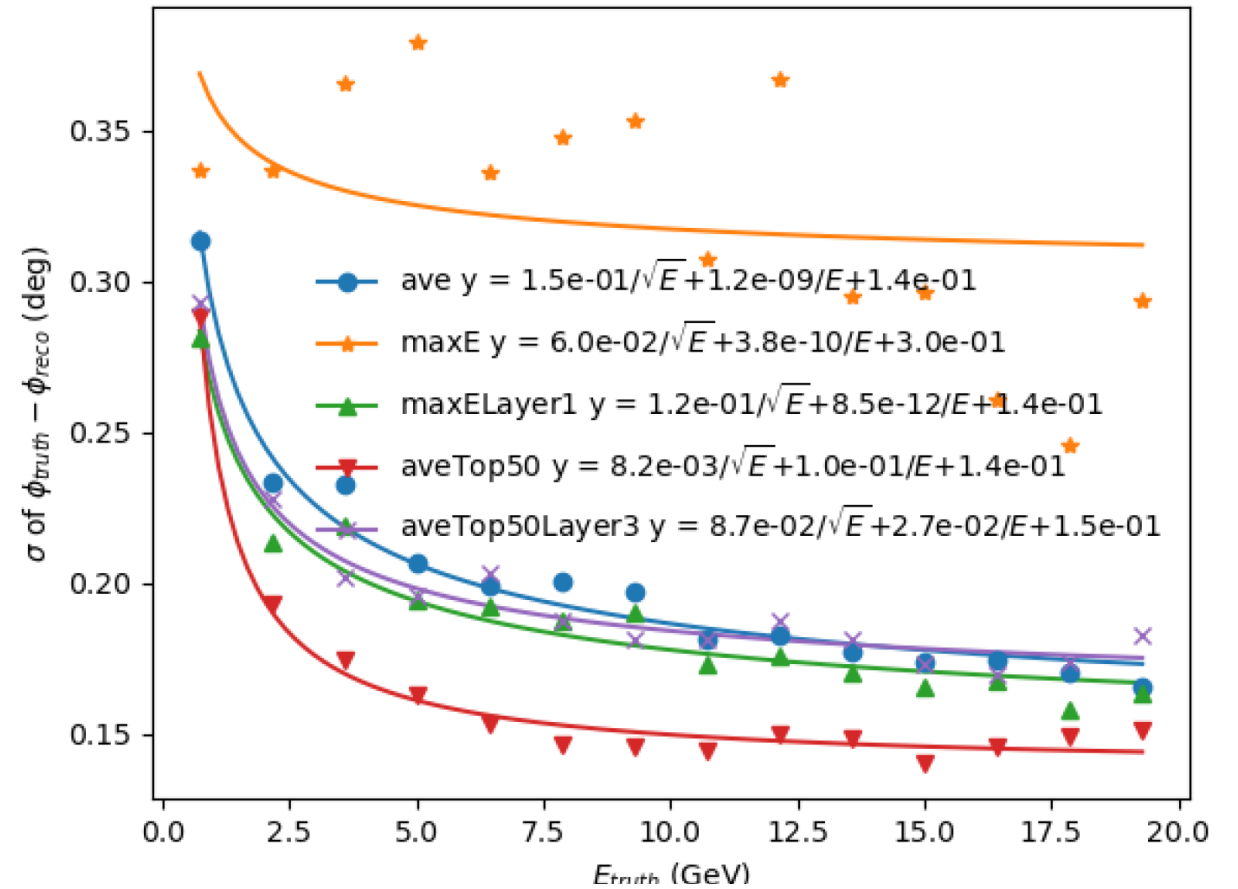
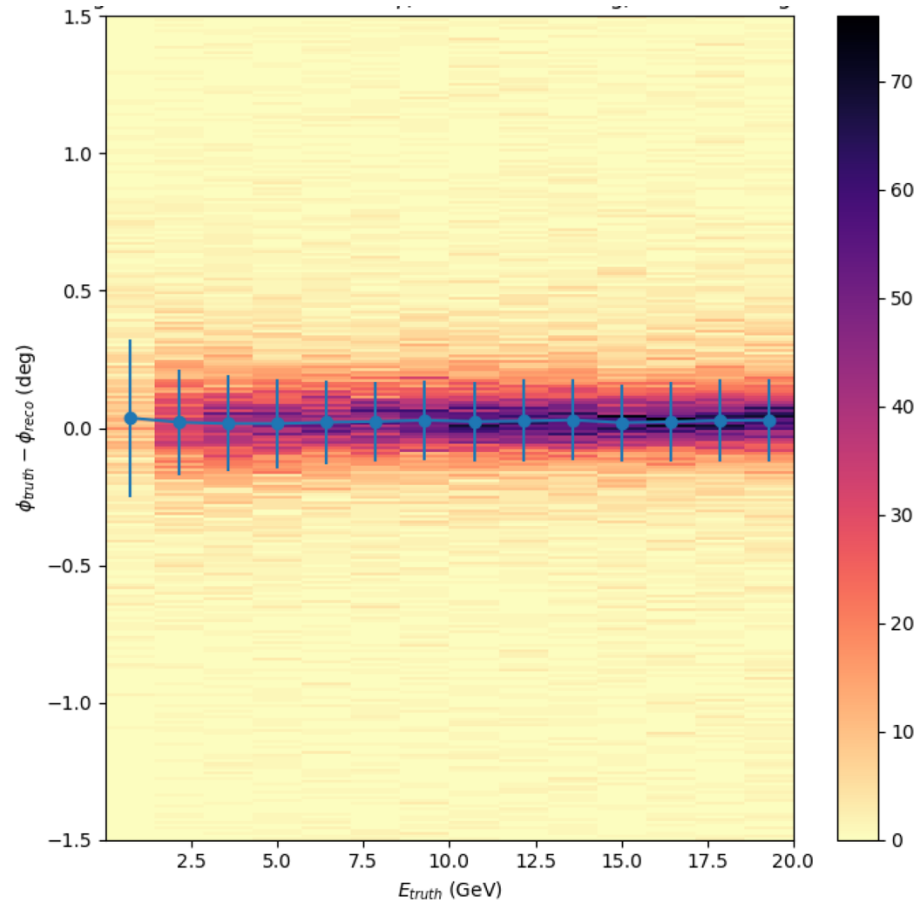
Algorithm tested

1. Ave: weighted average of all astropix points.
2. MaxE: Pixel location of the largest E-dep in a cluster.
3. MaxELayer1: Same as MaxE, but only consider pixel in layer 1.
4. AveTop50: Truncated average, only consider hits with top 50% percentile in edep.
5. AveTop50Layer3: Same as AveTop50, but only consider hits in layer 1 and 3.

Clear winner for aveTop50???

Phi_truth - Phi_reco distribution for aveTop50

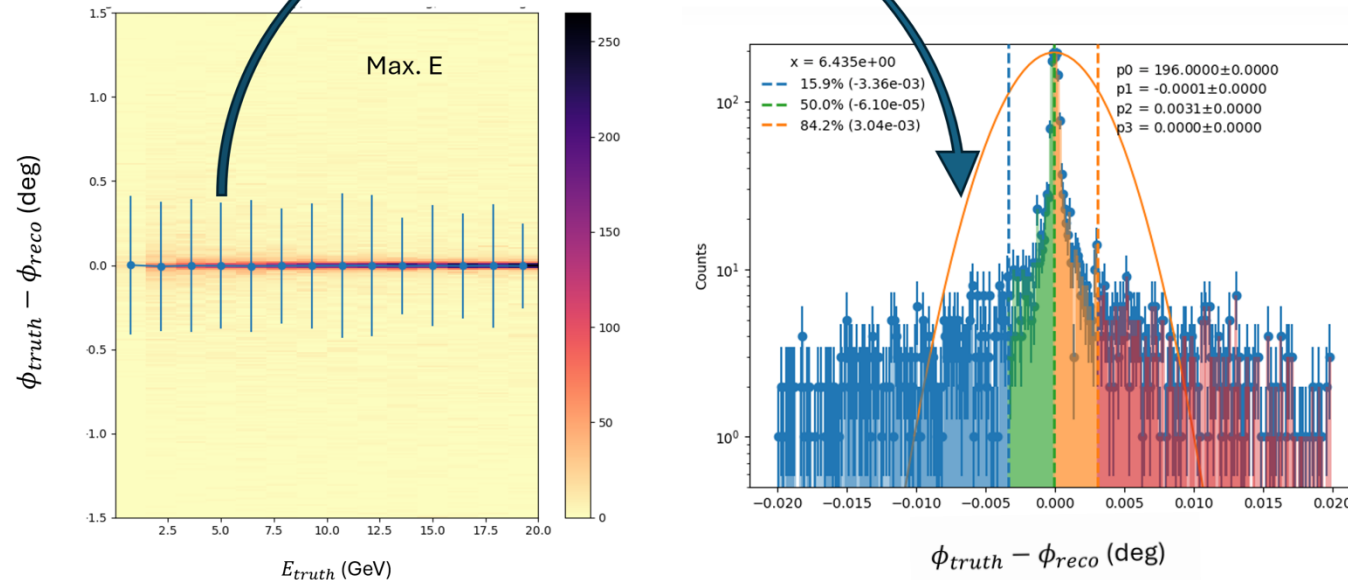
Error bar = 68.3% Confidence Interval



Potential improvement

- Definition of error bar = 68.3% confidence interval.
- Shape of phi-residual for maxE is HIGHLY non-Gaussian
- Can we cut of the tail of maxE to create a better algorithm?

Percentile plot



ScFi layers also have phi resolution

Tail clipping:

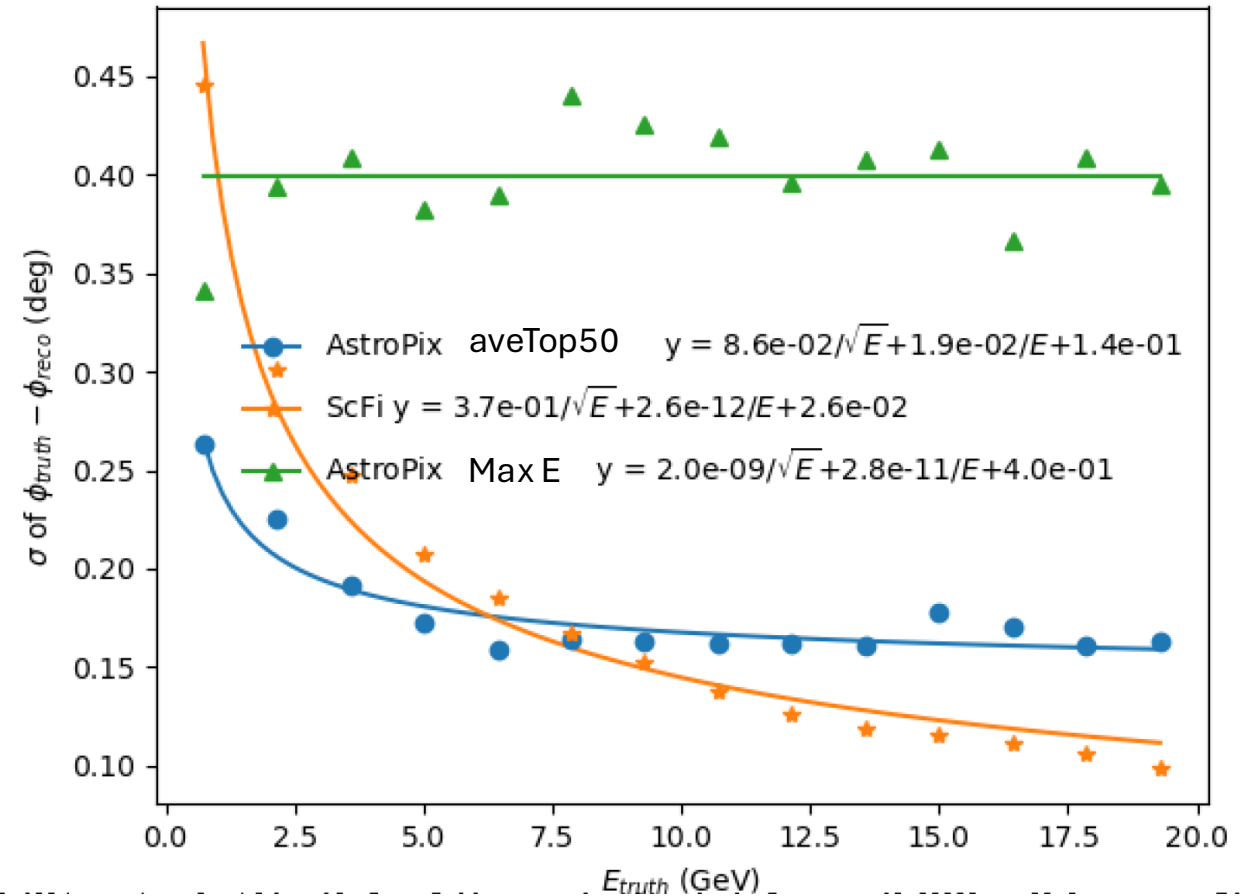
When $|\text{ScFi phi} - \text{AstroPix phi}| < 0.2$ deg:

- Take AstroPix phi

Else

Take ScFi phi

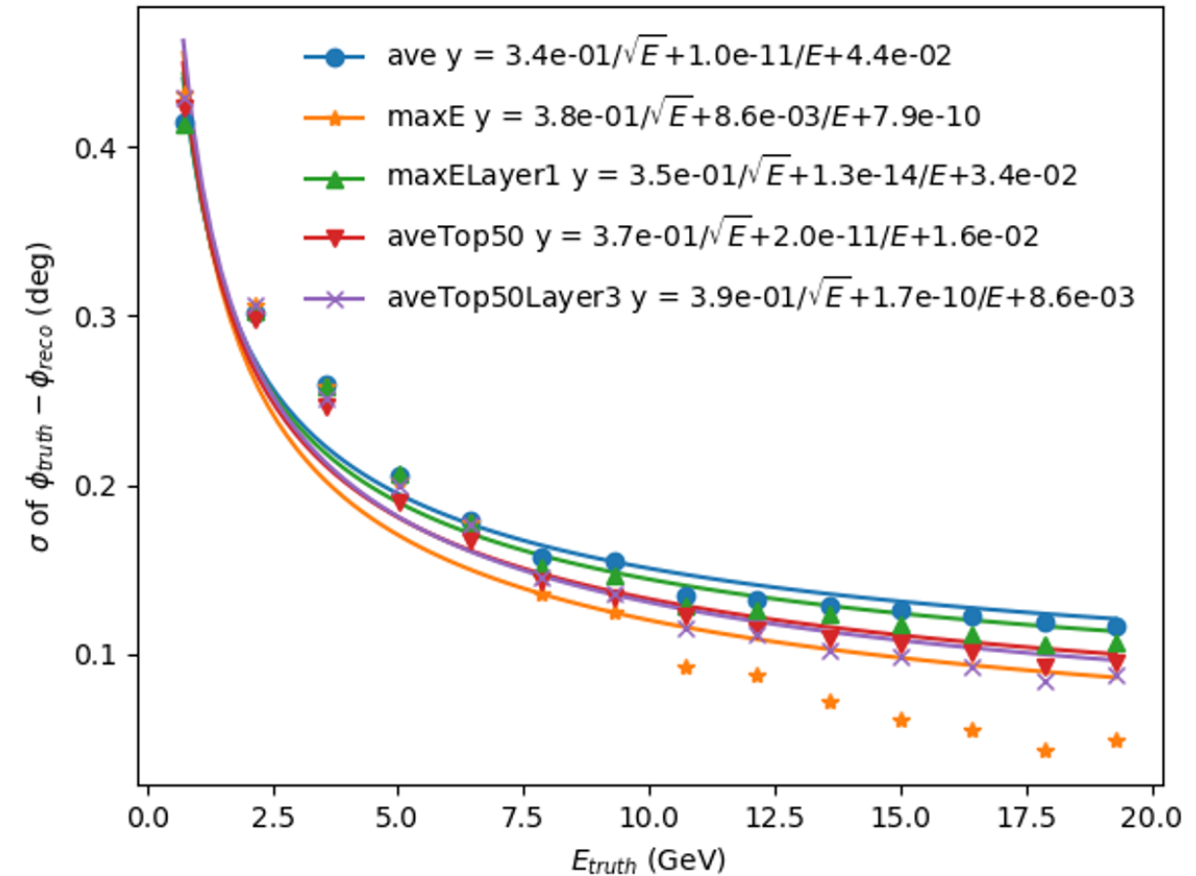
When they disagree, ScFi can cut out the tails.



Performance (with tail clipping)

Now MaxE wins, especially at $E > 10$ GeV.

But could tail clipping worsen performance at low E ?



Performance

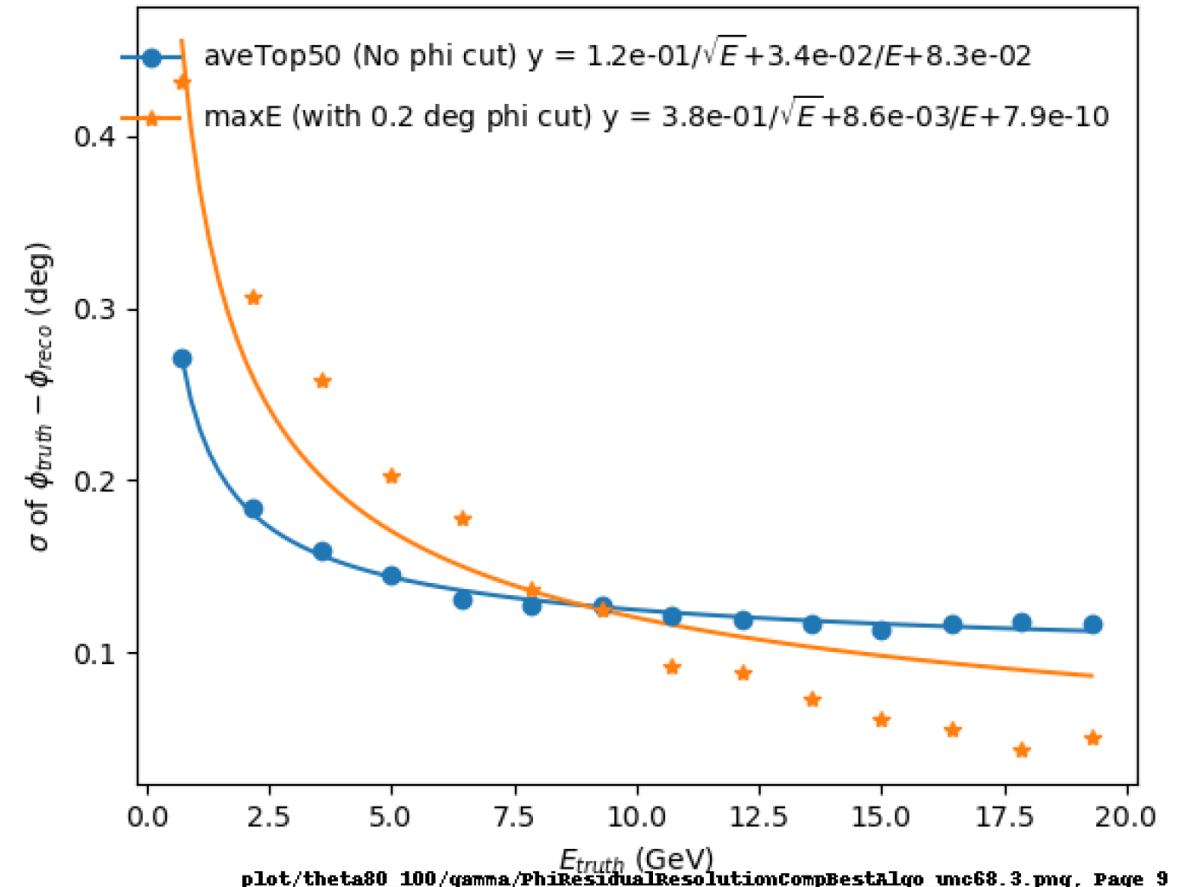
At $E < 7.5$, aveTop50 WITHOUT tail clipping wins

At $E > 7.5$, maxE with tail clipping wins

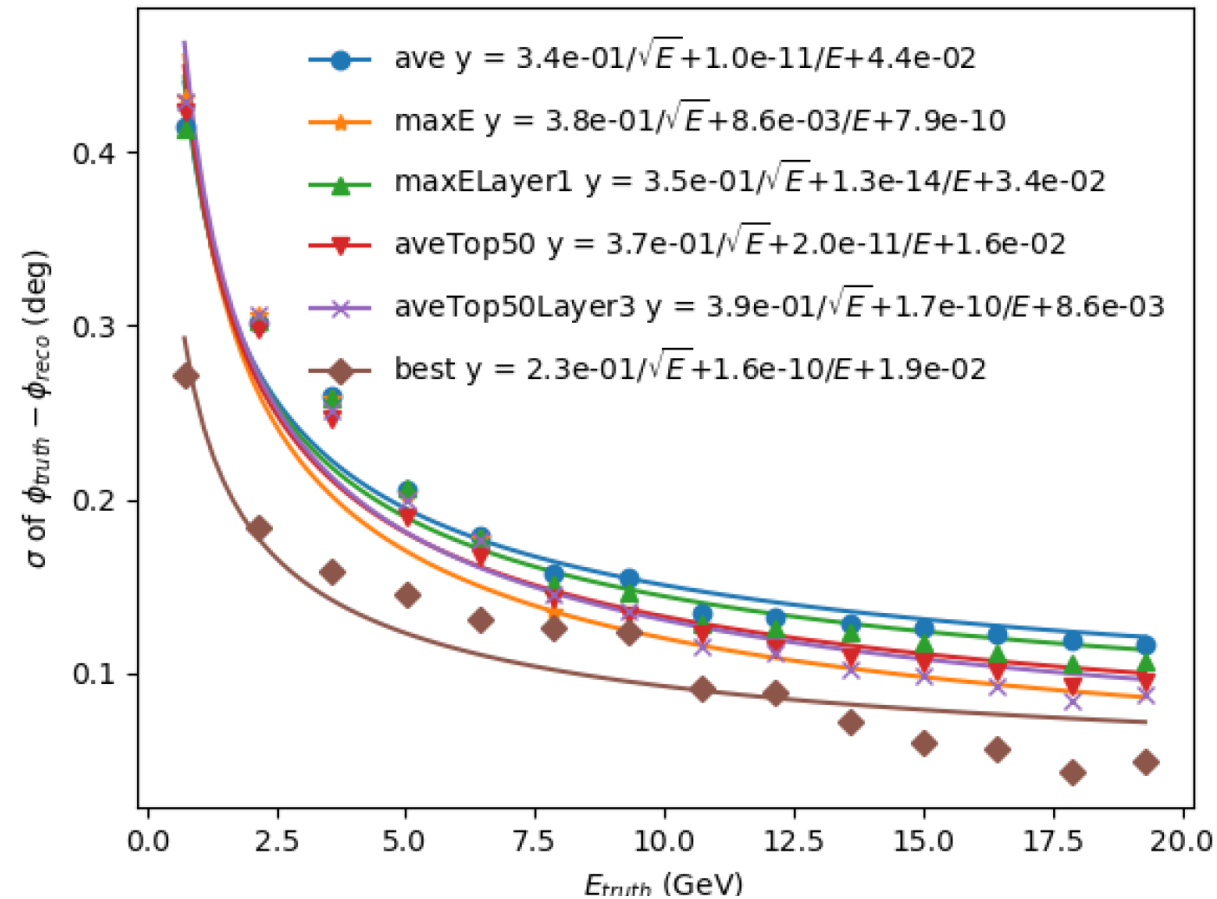
Proposing improved phi algorithm:

AveTop50 without tail clipping at $E < 7.5$ GeV

MaxE with tail clipping at $E > 7.5$ GeV



Best (brown diamond)



Algorithm test on DIS events

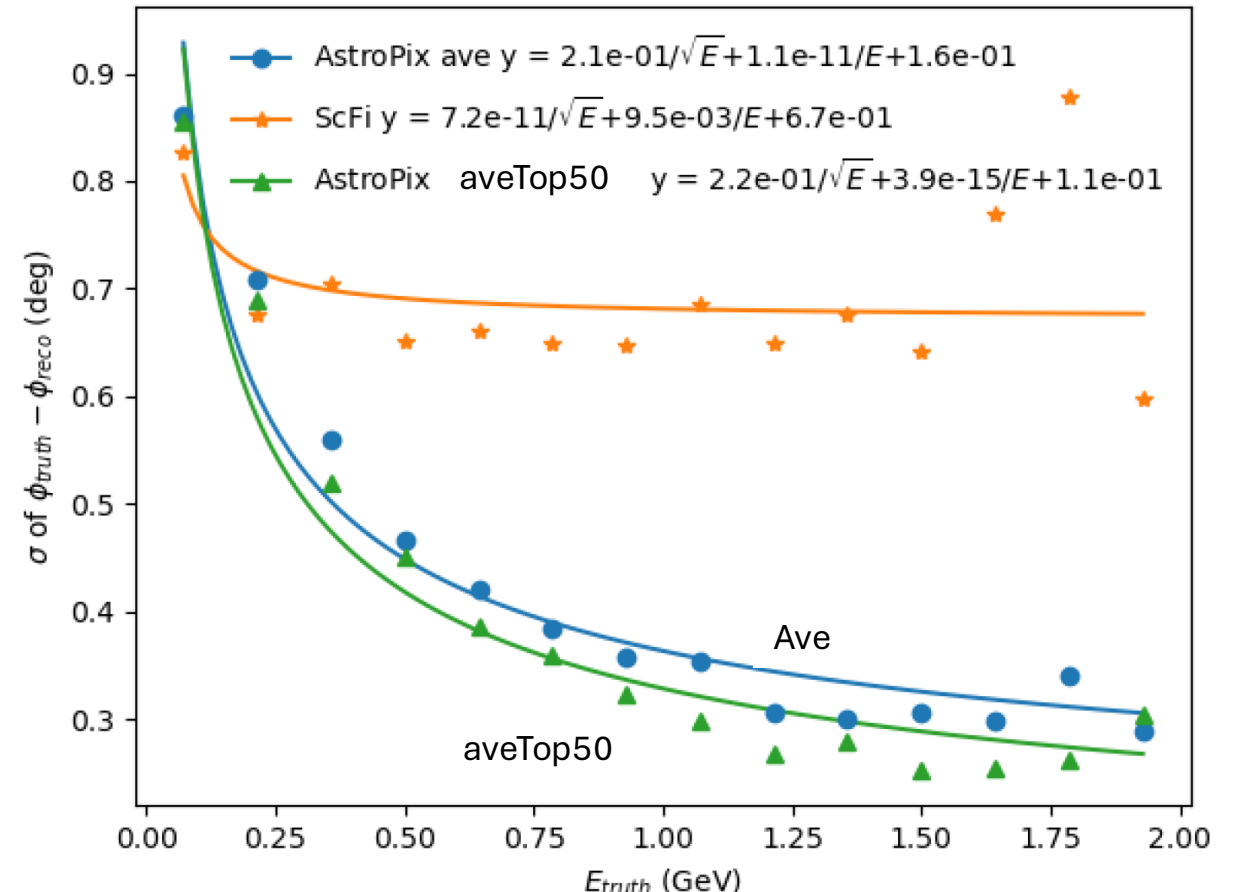
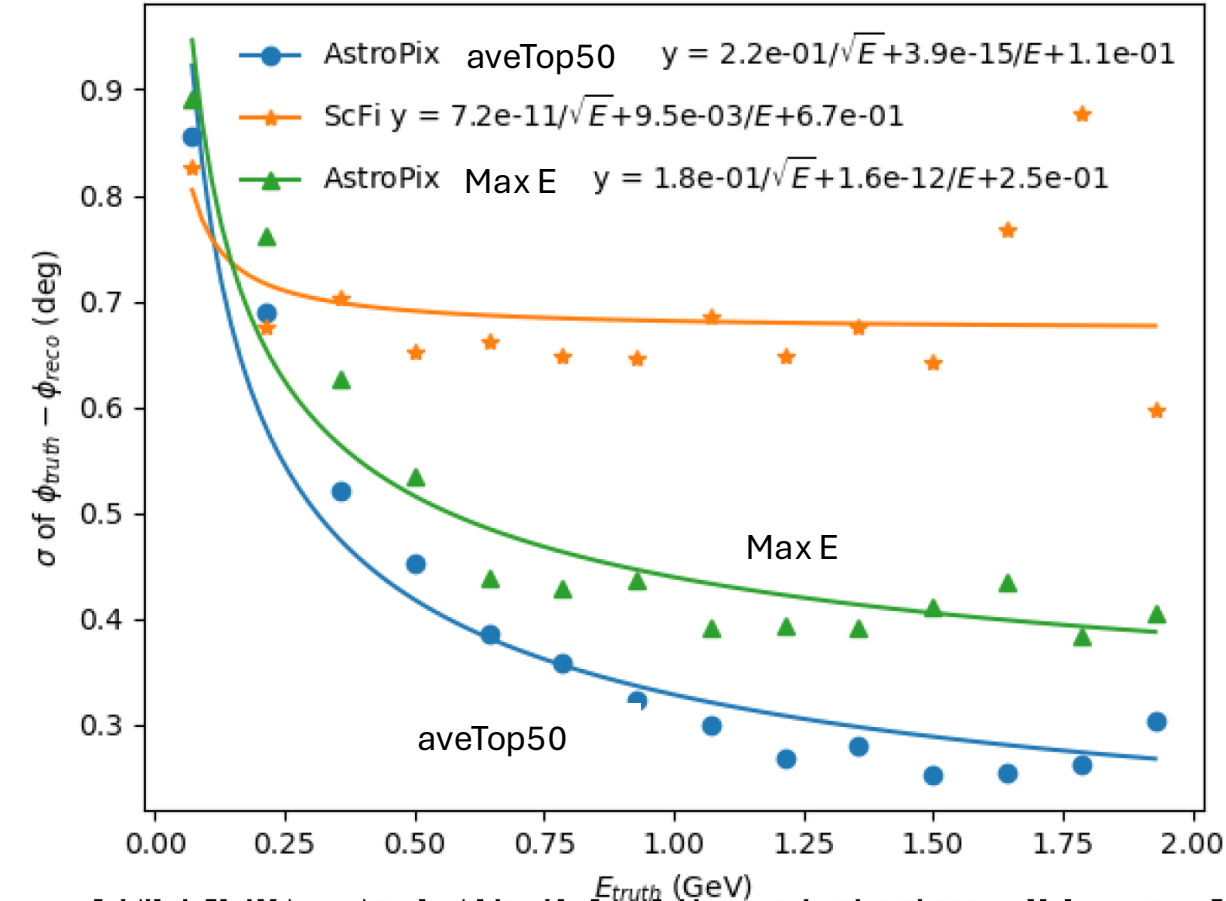
Does algorithm hold up in more complicated data?

Gamma phi resolution Q2 = 1 GeV

No tail clipping (energy too low)

Performance: **aveTop50** < **ave y** < **max E**

AveTop50 is still the best algorithm, but not my much

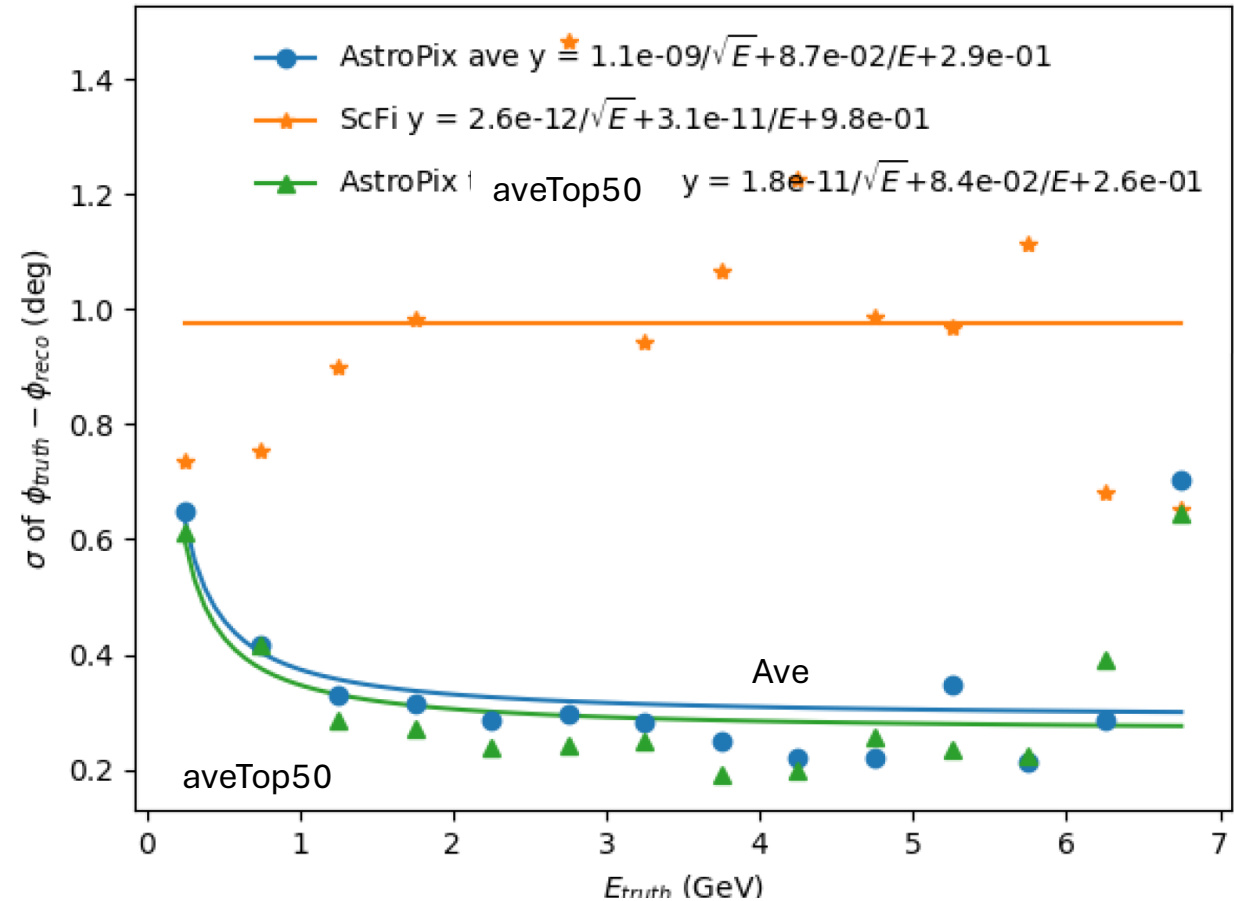
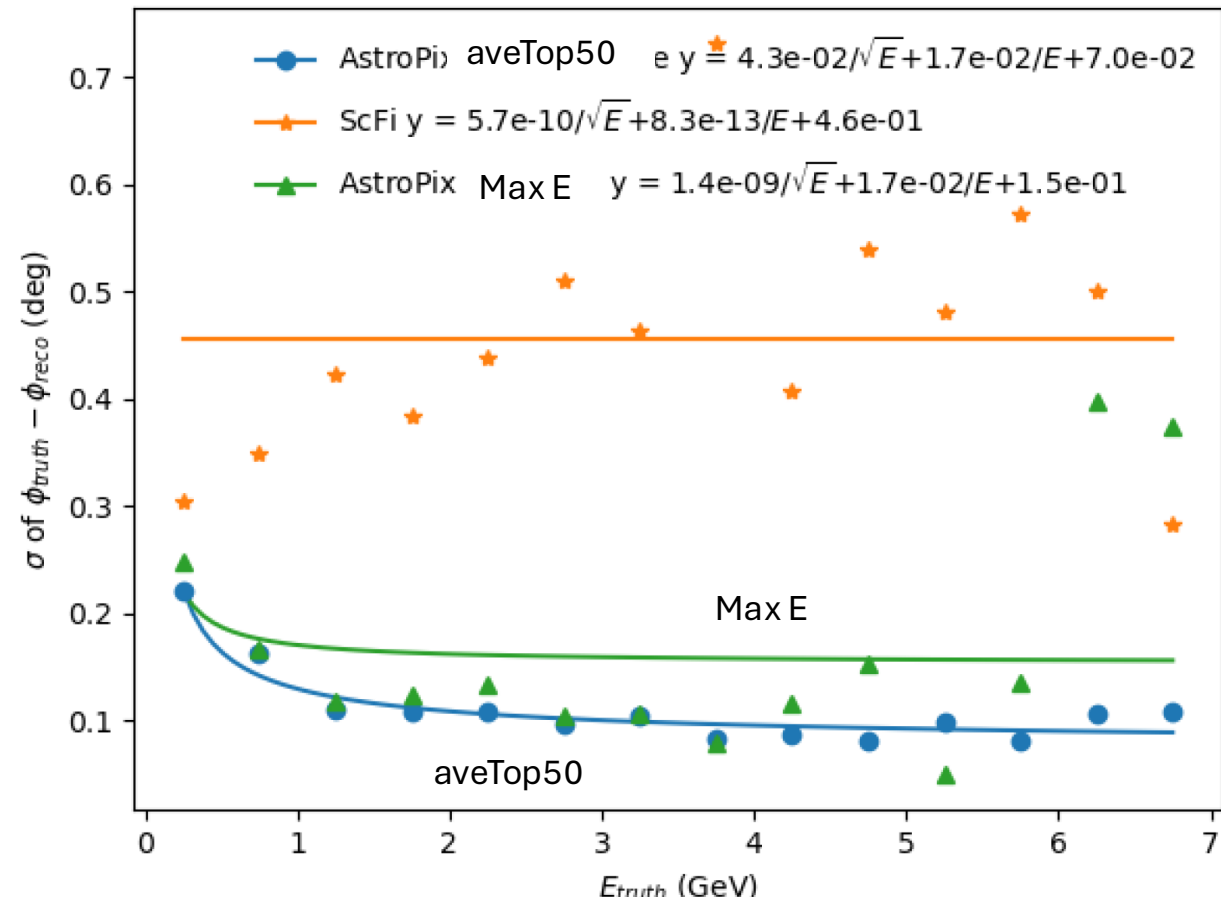


Gamma phi resolution Q2 = 100 GeV

No tail clipping (energy STILL too low)

Performance: **aveTop50** < **ave y** < **max E**

AveTop50 is still the best algorithm, but not by much



Conclusion

- For phi-resolution,
 - $\text{aveTop50} < \text{ave everything (current default)} < \text{maxE}$ (smaller is better)
- But maxE resolution can be improved with tail clipping using ScFi.
- Suggestion: Use hybrid algorithms for position resolution
 - At $E < 7.5 \text{ GeV}$, use aveTop50
 - At $E > 7.5 \text{ GeV}$, use maxE with tail clipping