

A Simple Cluster Algorithm to detect Anisotropies in the Arrival Directions of UHECRs

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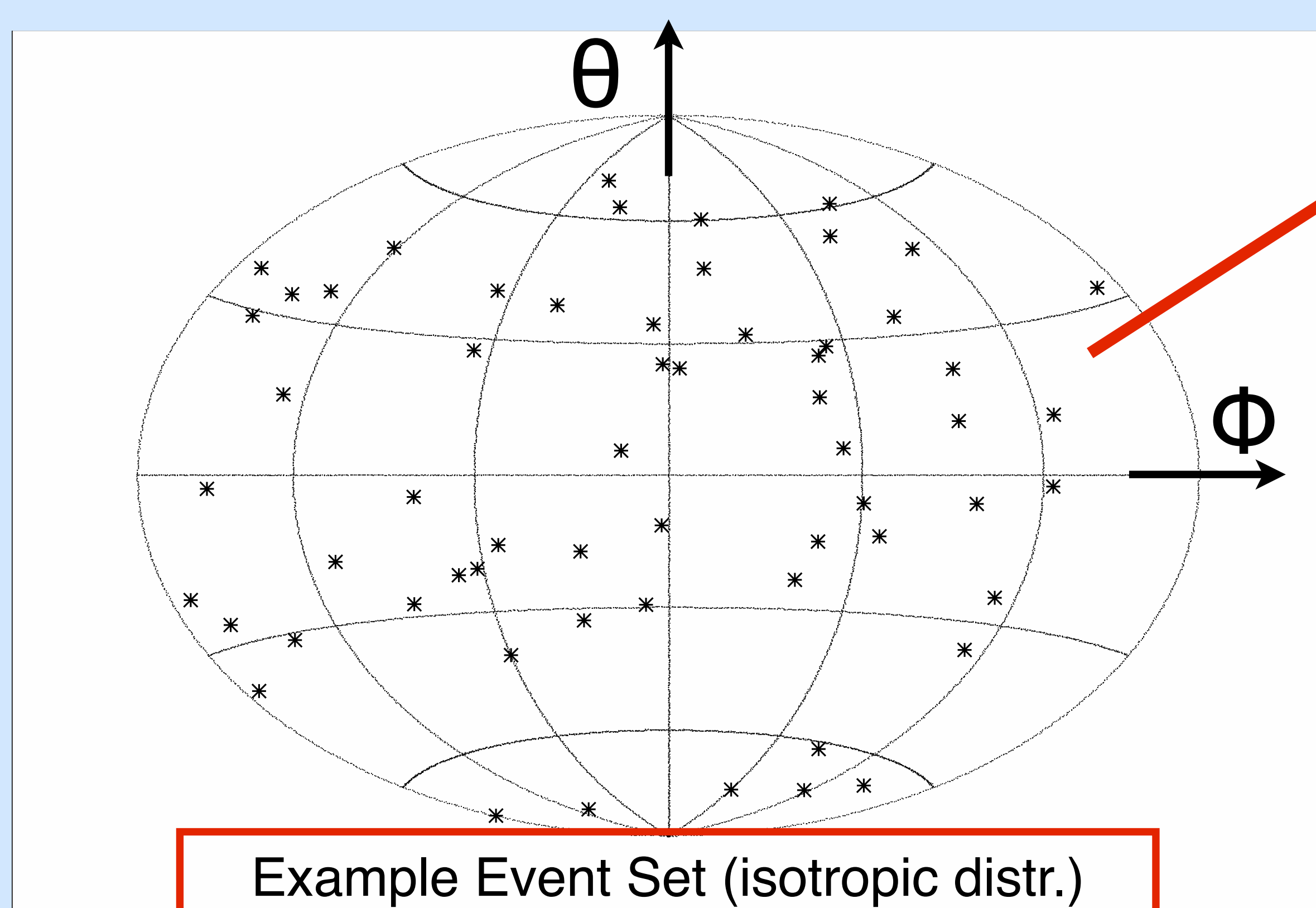
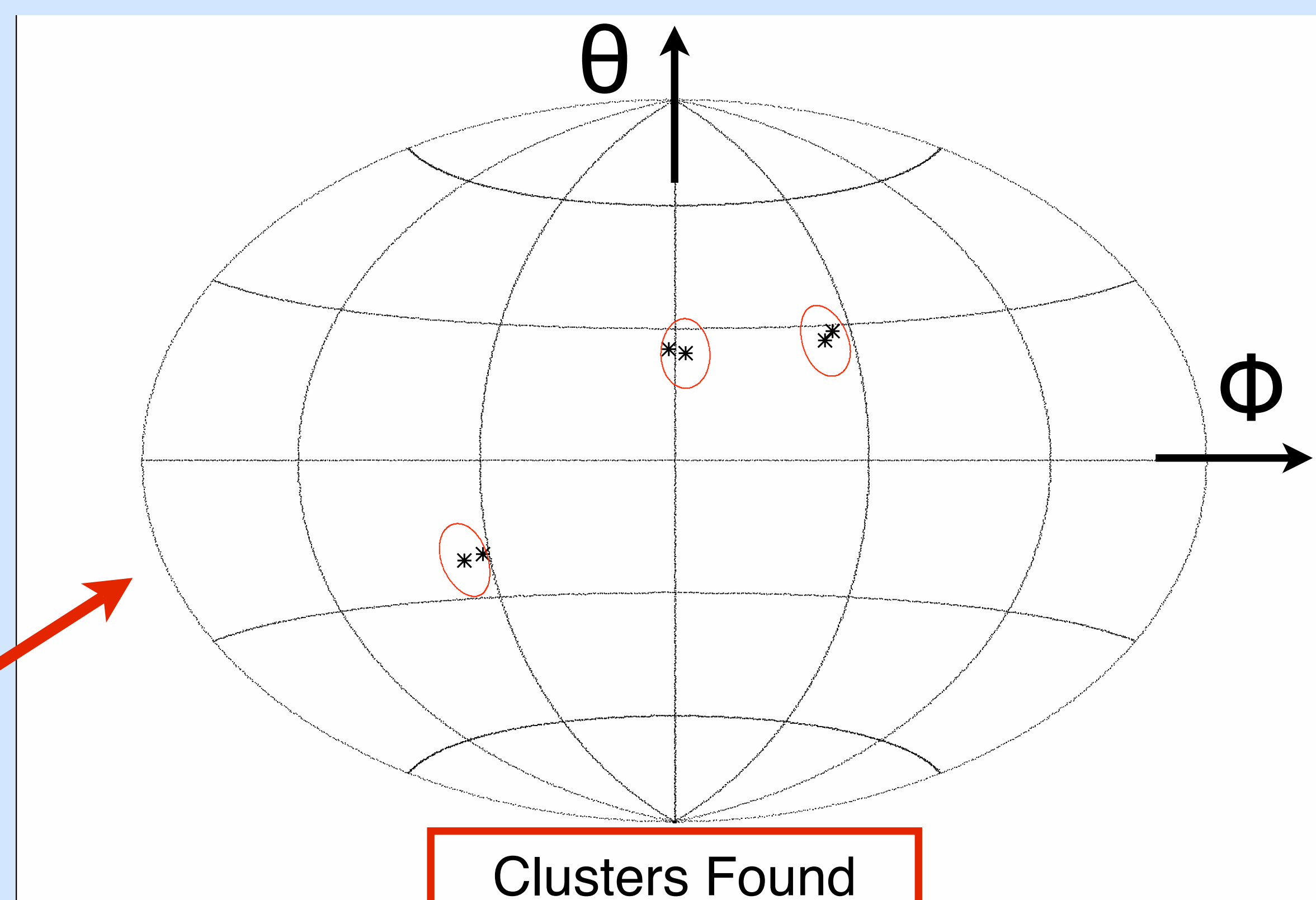
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In 2007 the Pierre Auger Observatory reported a correlation of the arrival directions of UHECRs with the positions of AGNs for energies above 57 EeV.

The Cluster Algorithm, motivated by similar algorithms in accelerator particle physics, can be used to search for these anisotropies on small scales in both catalogue-dependent and -independent ways, since it is able to identify the directions of interesting regions. Thus, under the assumption of small deflections due to magnetic fields a visible overabundance of events and clusters is visible close to the sources.

Definition of the Method

- All events are seeds for the cluster search in the Φ - θ -plane
- A cluster contains at least two events closer than a predefined angular distance α
- Multiple counted clusters are removed



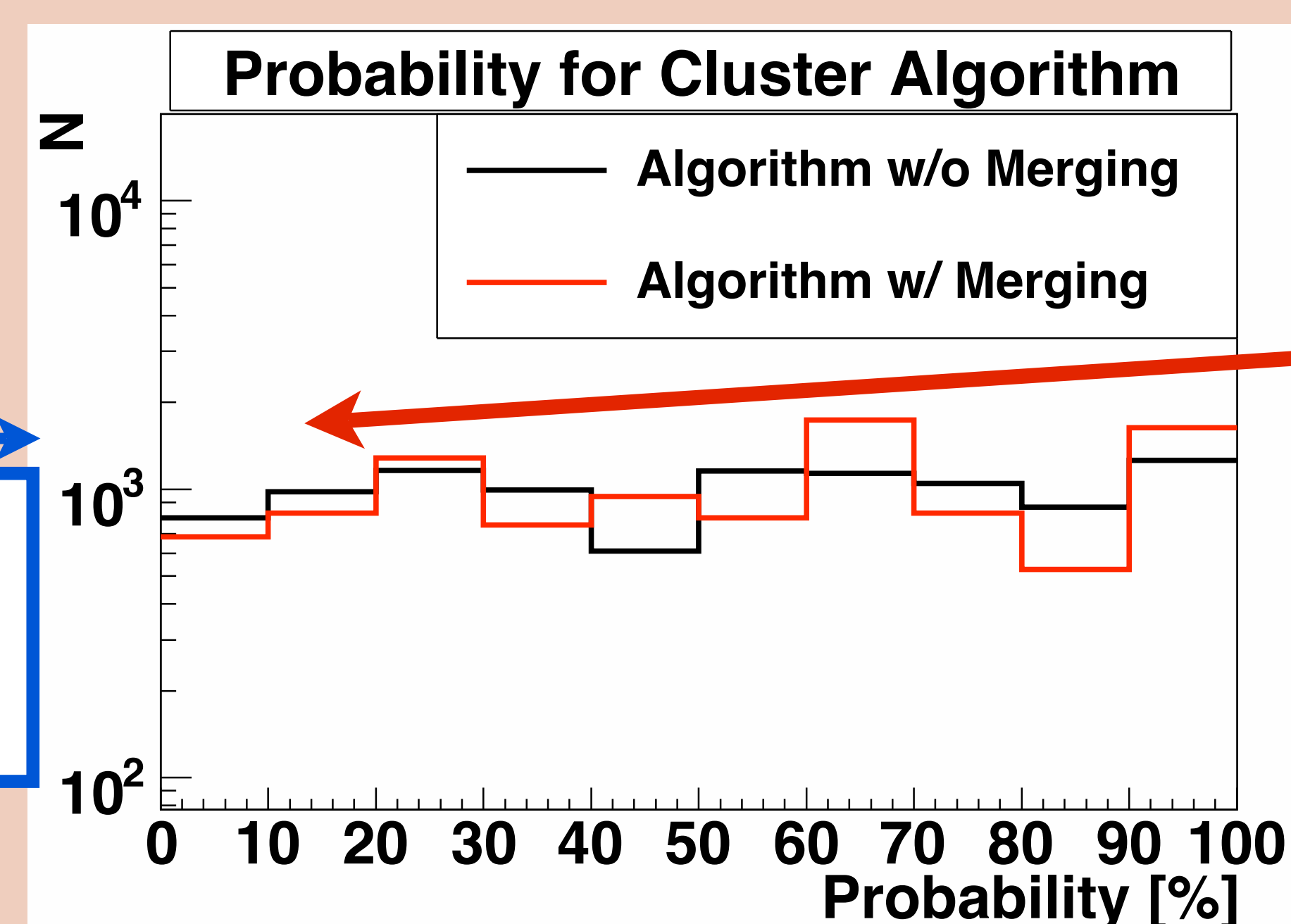
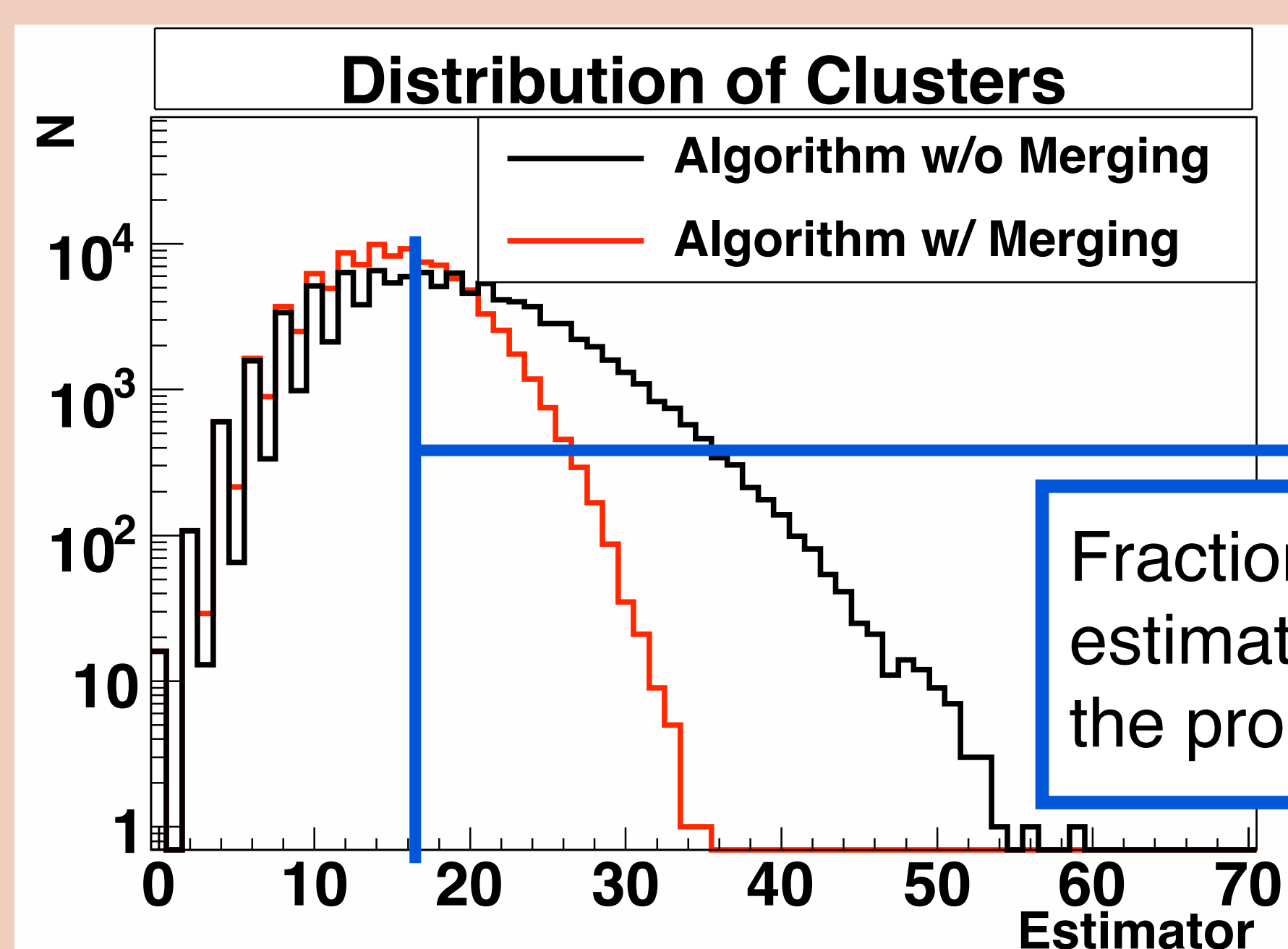
- Overlapping clusters are possible
- Merging of clusters is also possible
- Anisotropy estimator is the number of events within a cluster, i.e. the higher the estimator the more anisotropic is the data set

Used Specifications

- To use the Algorithm **Energy Cut** and **Angular Scale** have to be chosen in the beginning. Here:
 - $E > 50 \text{ EeV} \rightarrow 60 \text{ Events}$
 - $\alpha = 8^\circ$

Isotropic Model

Use two samples of 100,000 sets each containing 60 events from an isotropic distribution to test the **Cluster Algorithm**.

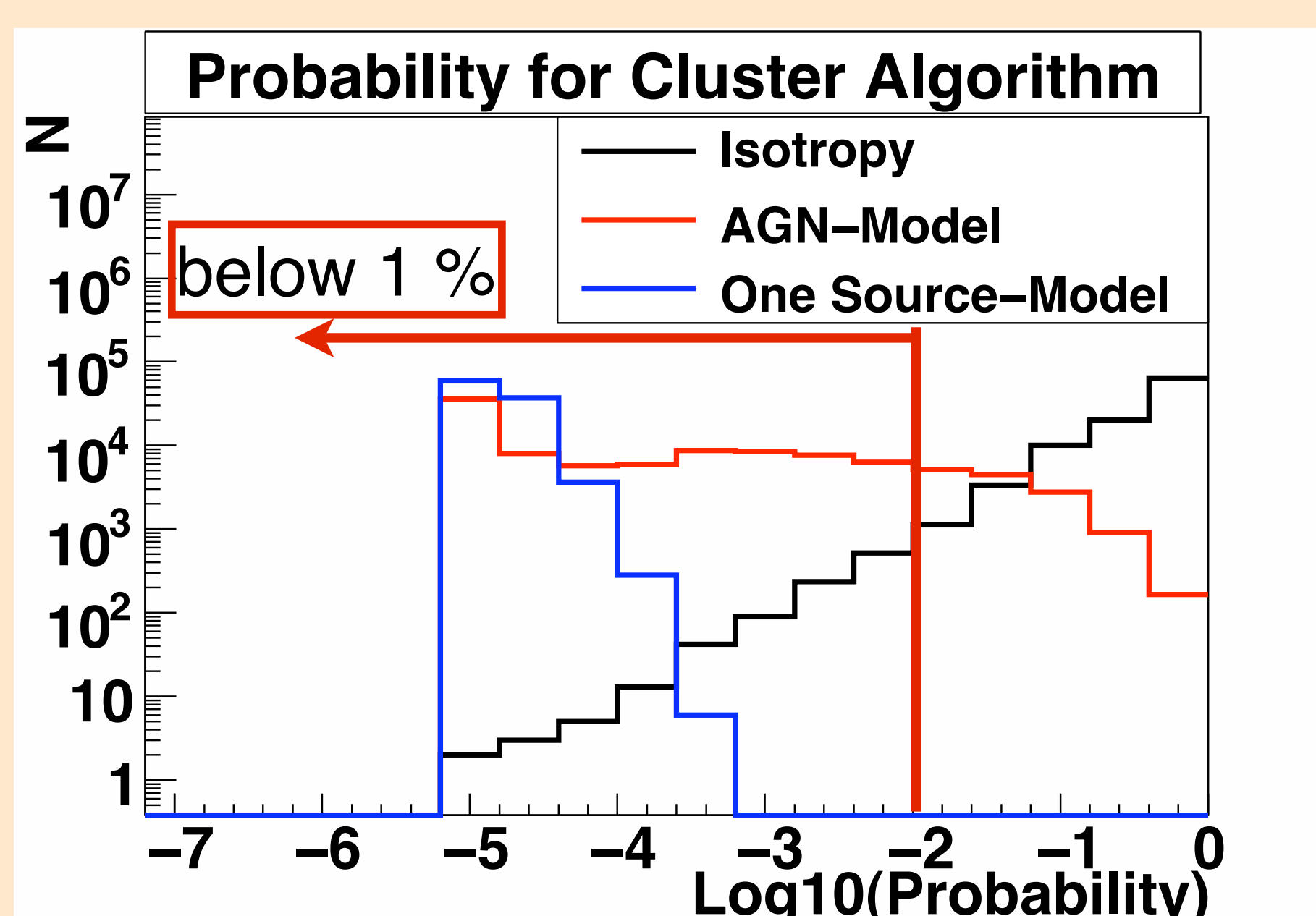


In the end a flat distribution is obtained as expected.

Source Models

Here the sensitivity of the method (w/ and w/o merging) is tested for two source model with the same parameters as above.

- 1.Model:** One source is used (Gen A) with a width of 4° . Isotropic background of 50 %.
- 2.Model:** AGNs from the Veron-Cetty&Veron-catalogue were used up to $z \leq 0.025$, their flux weighted with $1/z^2$ and a width of 4° around each. Isotropic background of 20 %.



Summary & Outlook

- New method to search for anisotropy in astro-particle physics introduced
- It is able to distinguish different source models from isotropy
- There are many possibilities to improve this method, e.g. by weighting the clusters by the inverse of the exposure at their position in the sky

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