



Application Of Decision Tree Algorithms To Classify Signal And Background Events In Imaging Atmospheric Cherenkov Telescopes (IACTs)

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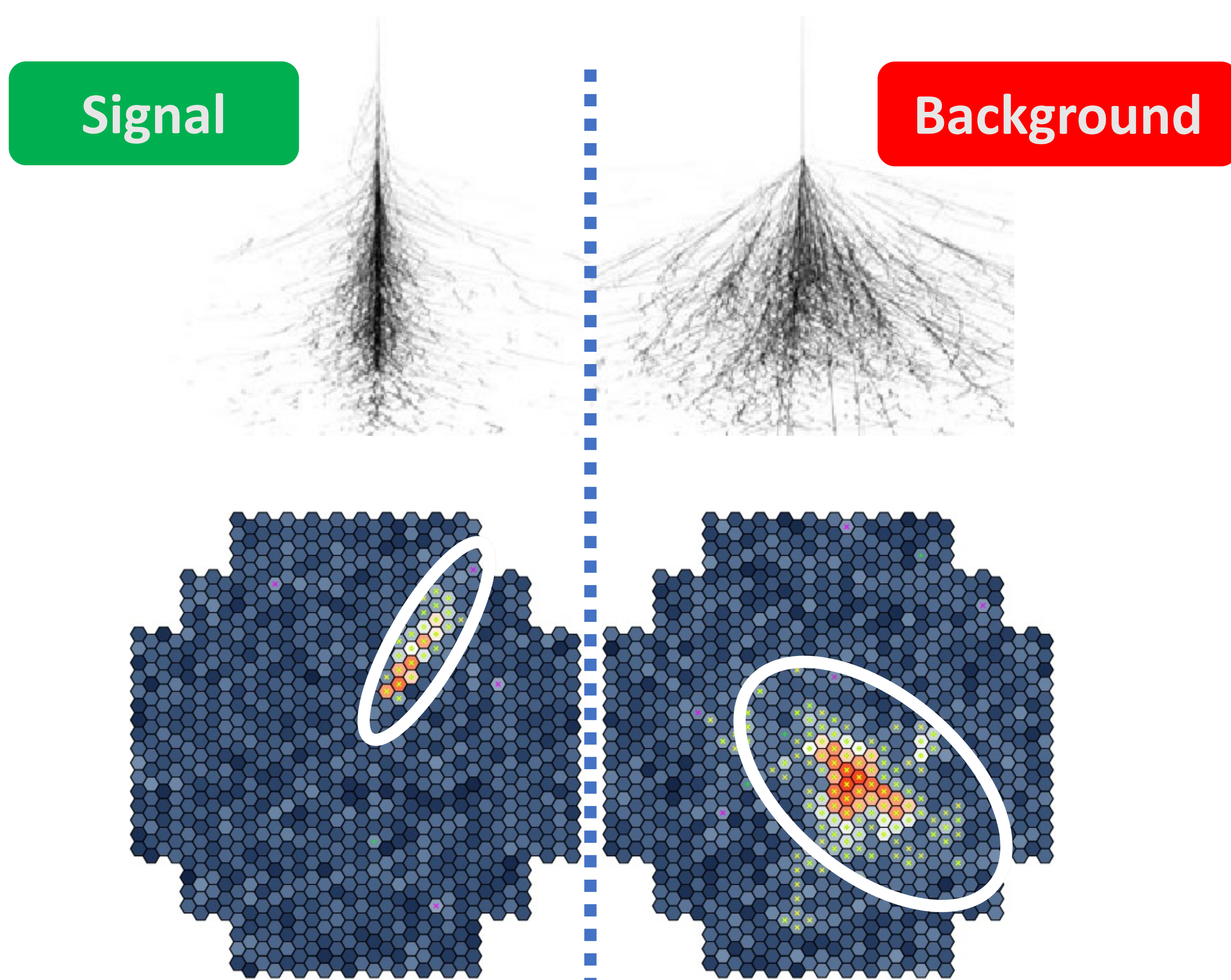
Detection Technique

- IACTs are ground based telescopes used to detect gamma rays and cosmic-ray particles (mostly electrons and protons)
- These particles upon entering Earth's atmosphere initiate a cascade of secondary particles, also called Extensive Air Shower (EAS)
- When travel through the atmosphere, these secondary particles produce faint blue Cherenkov light
- This light is then detected by multiple telescopes on ground (**VERITAS telescopes**)



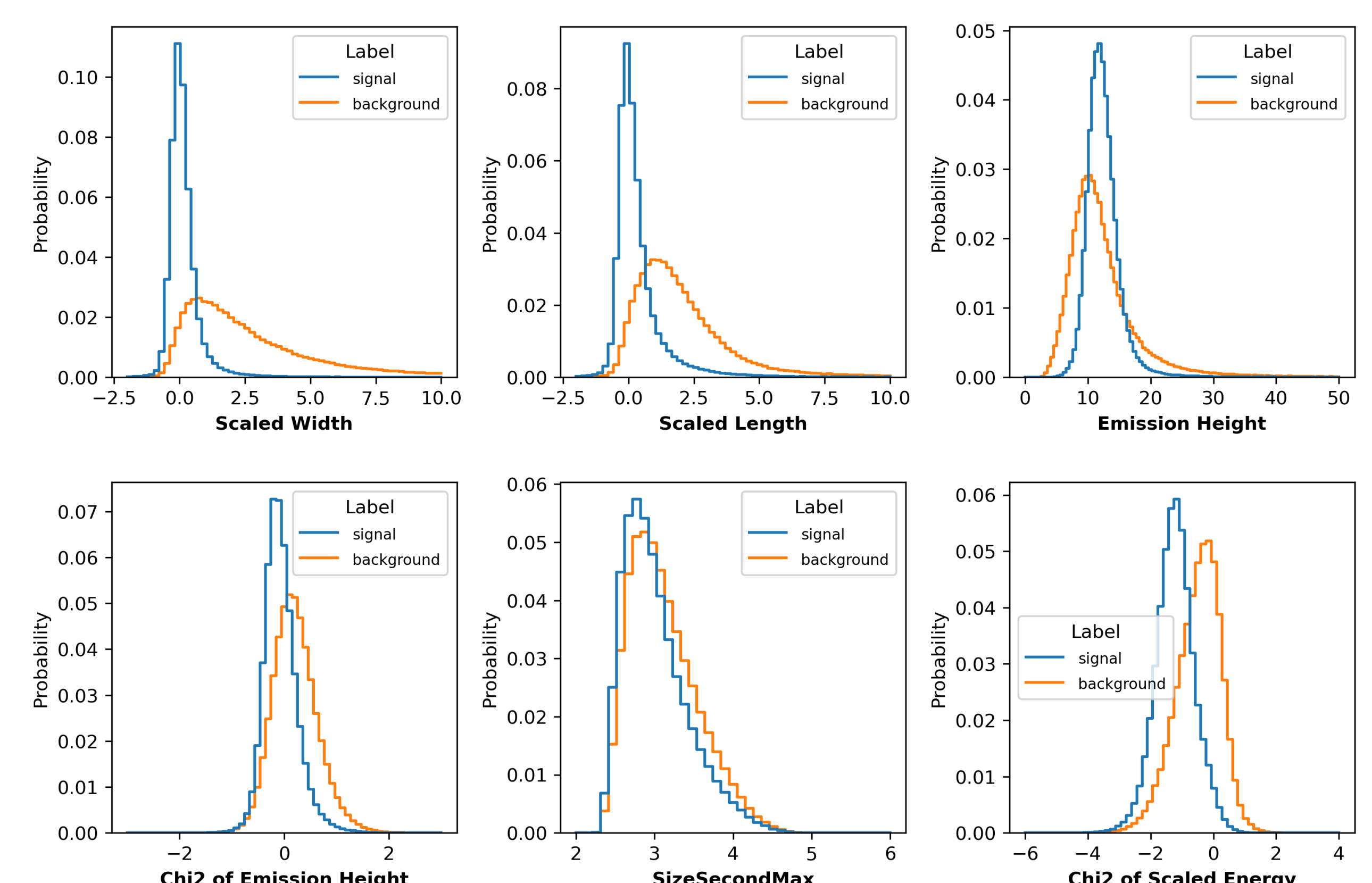
Signal And Background

- Difference between shower development is exploited to classify signal and background
- In 30 mins exposure, we have about 720000 background events for roughly 300 signal events from one of the strongest source *Crab Nebula*



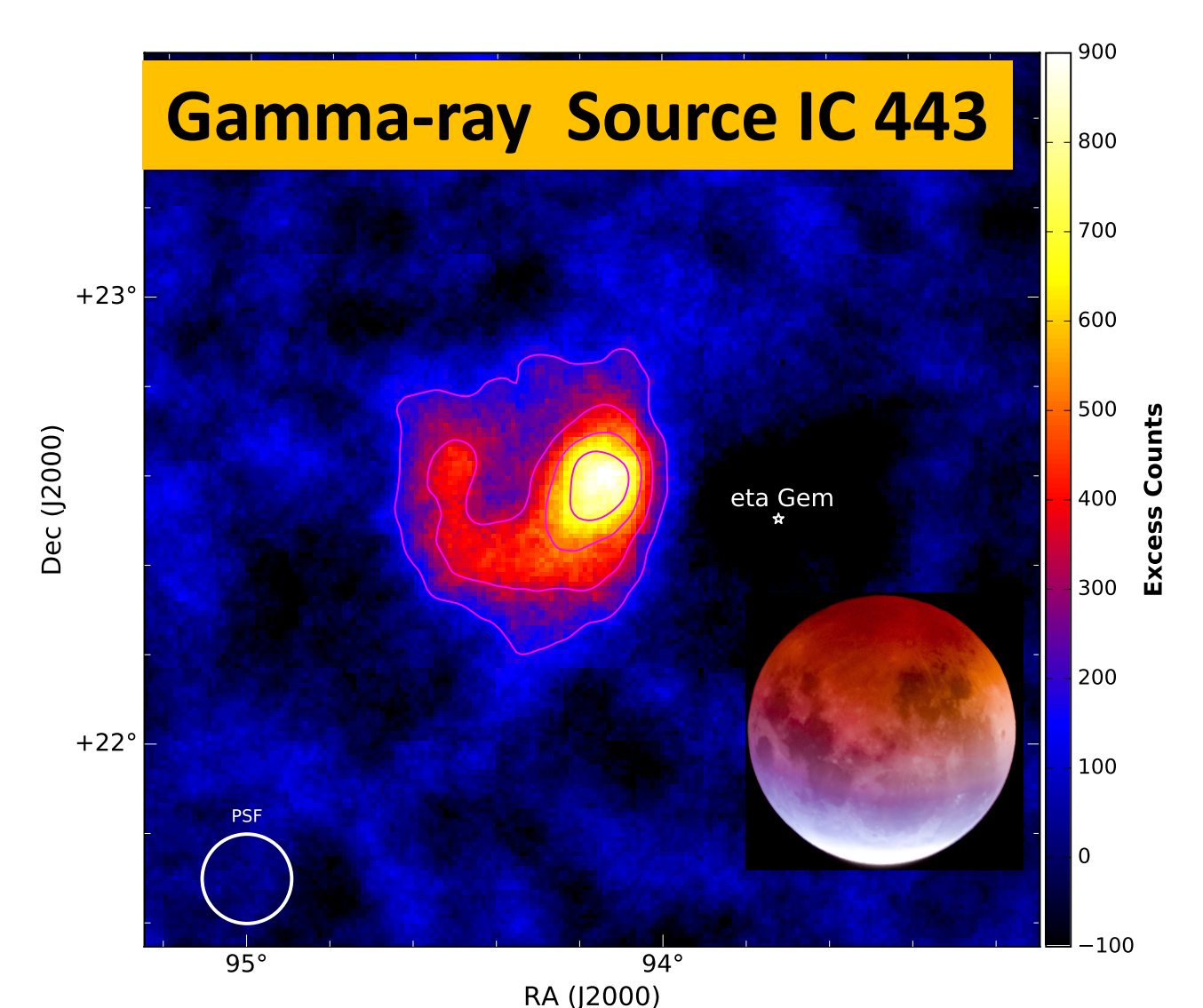
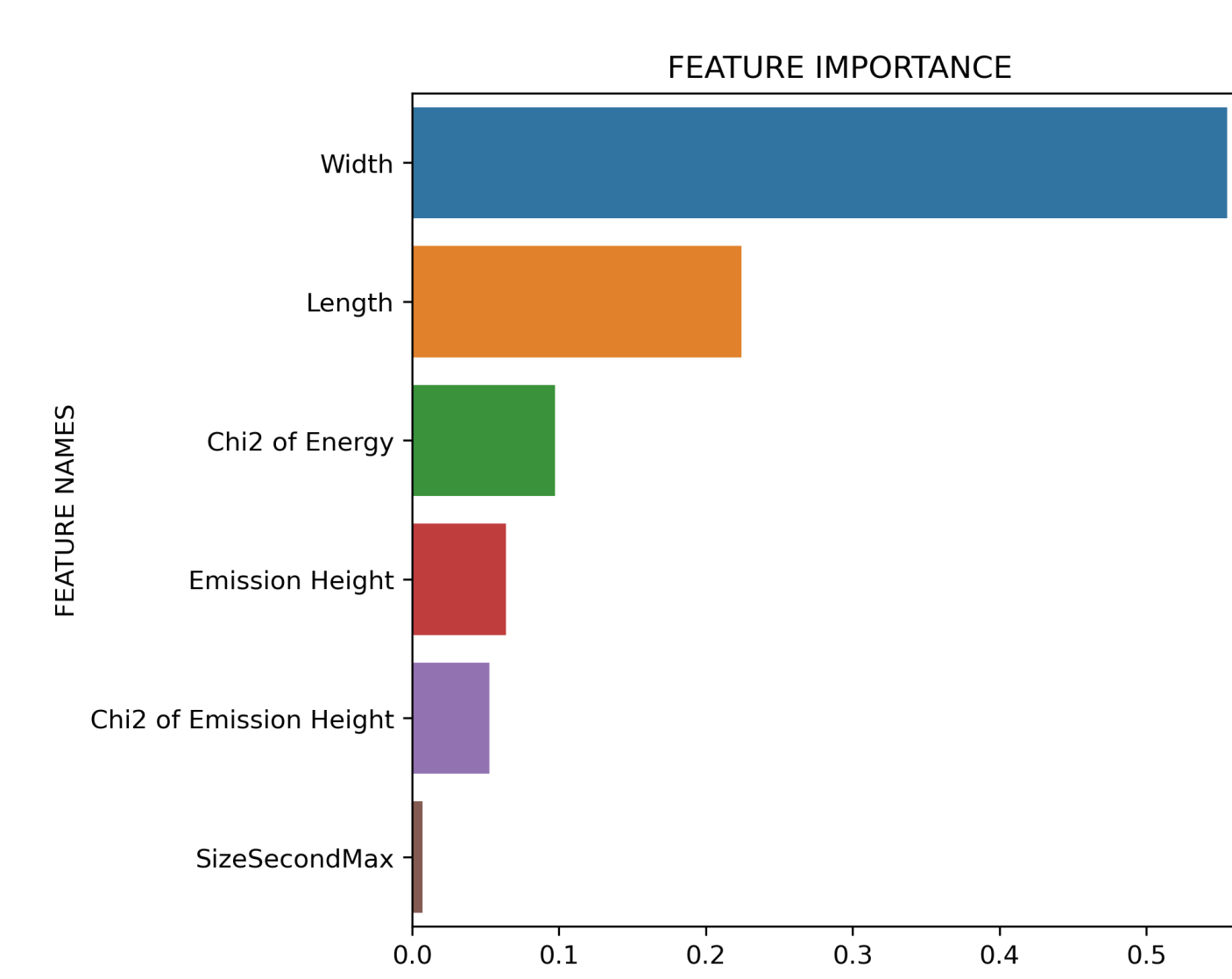
Training Parameters

- **Half a million simulated events** are used in training ML model
- Shower properties such as width, length, shower height, energy etc. are calculated using parametrization of images in the camera



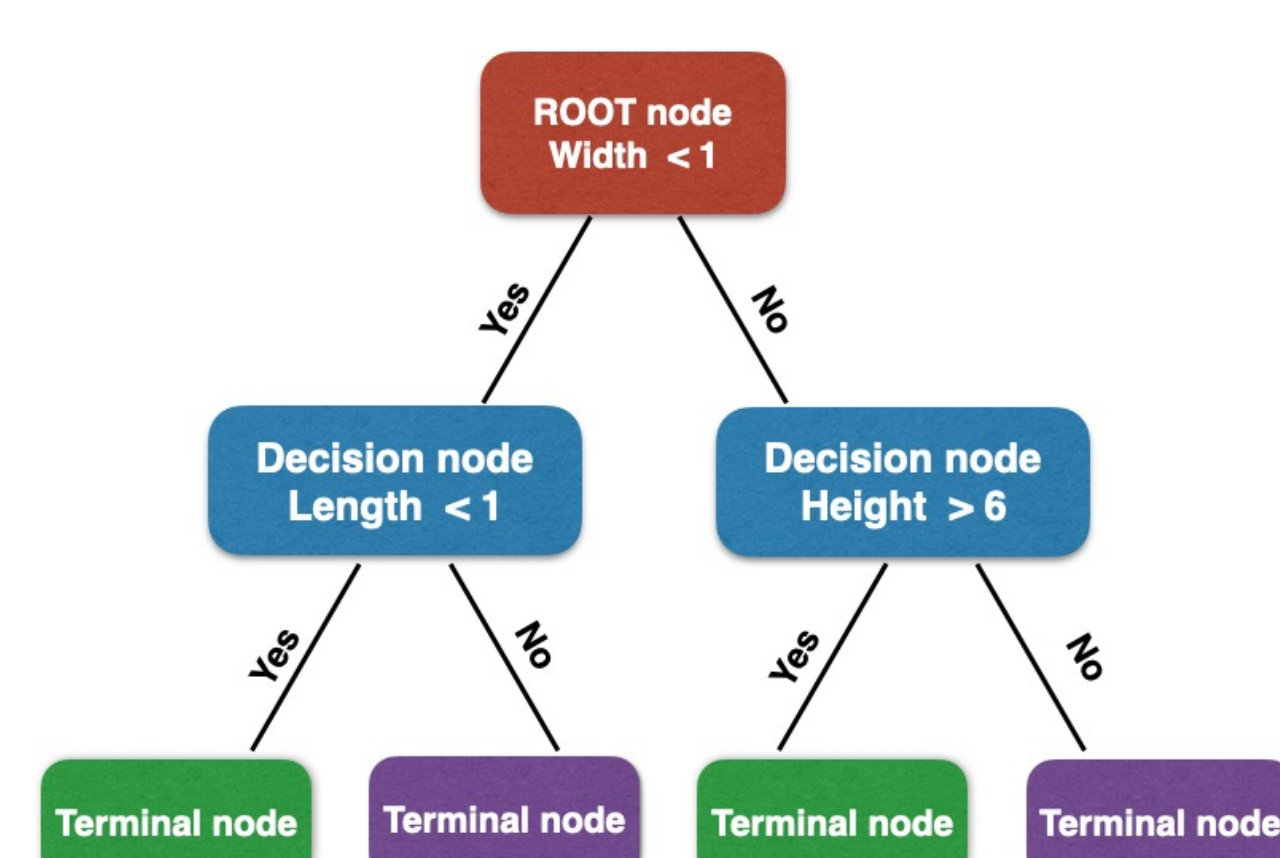
Results

Model type	Max depth	Accuracy (Train)	Accuracy (Test)
Random Forest	3	0.87	0.87
Boosting Tree	3	0.89	0.88



Decision Tree Algorithm

- Decision trees (DT) are supervised learning algorithms
- A tree is built by making a series of binary splits of training samples into the nodes of increasing signal and background purity



References

1. Krause, M. et. al <https://doi.org/10.1016/j.astropartphys.2017.01.004>
2. <https://scikitlearn.org/stable/modules/generated/sklearn.tree.DecisionTreeClassifier.html>
3. Bernlohr, K, <https://link.springer.com/article/10.1007%2Fs10686-009-9151-z>