HELMHOLTZ Young Investigators

Studies of systematic uncertainty effects on IceCube's real-time angular uncertainty

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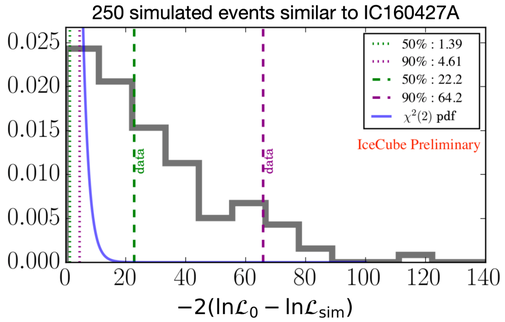
Motivation and previous work

IceCube's neutrino alerts

- IceCube's alerts are high-energy tracks with a high probability of being astrophysical in origin.
- They are reconstructed with a computationally expensive reconstruction method that produces a likelihood landscape. Simulations are needed to derive error contours from it.

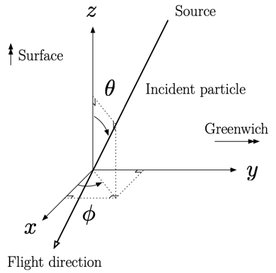
Re-simulation of IC160427A

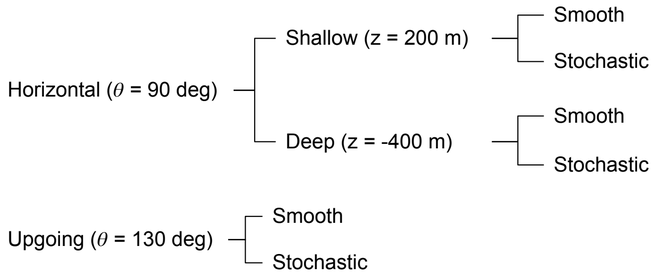
- 250 neutrinos similar to IC160427A were re-simulated and reconstructed.
- The difference in likelihood between the best-fit and the simulated direction is used to create a distribution.
- The 50% and 90% percentiles are the correction values that calibrate the likelihood.
- The same correction values are applied to every neutrino alert.



Simulation of tracks

- To check the validity of the current correction values and create an array of dedicated correction values for different topologies 6 types of muons were re-simulated.
- The categories were defined to represent the majority of tracks detected in IceCube's real-time program.
- Each category is re-simulated 100 times varying the ice systematics.



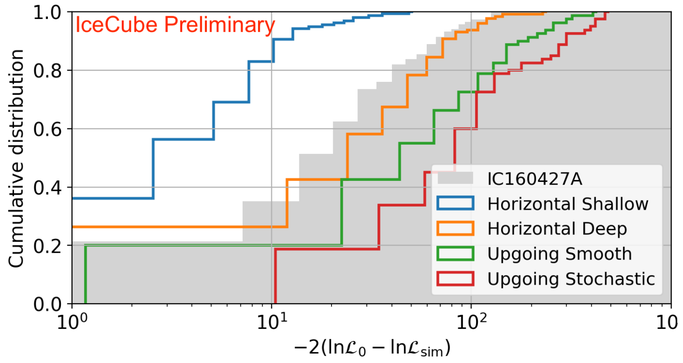


Results

Likelihood distribution

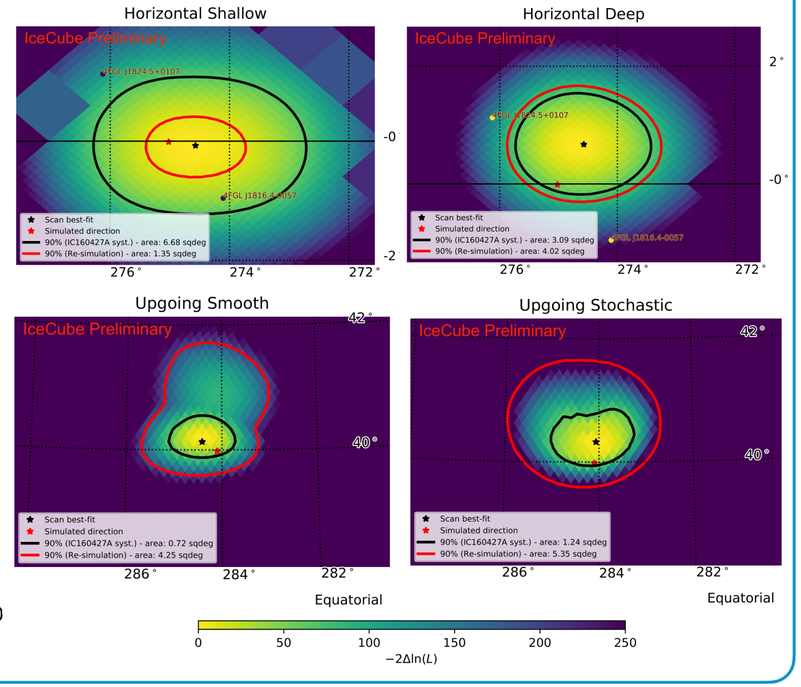
- Horizontal smooth and stochastic categories are merged based on a Kolmogorov-Smirnov test.
- Correction values for the different categories are not compatible.

Category	50 %	90 %	Number of events
Horizontal Shallow	4.5	12.5	158
Horizontal Deep	31.9	83.2	129
Upgoing Smooth	51.8	193.8	80
Upgoing Stochastic	88.9	301.7	80
IC160427A	22.2	64.2	250



Error contours and likelihood maps

- The effect on the error contours depends on the shape of the likelihood map.
- Examples of 4 randomly selected events with the contours calculated with dedicated re-simulations and with IC160427A are shown below.



Outlook

Summary

- The error contours of IceCube's alerts are derived from the reconstruction's likelihood maps using correction values.
- The current re-simulation values used do not properly account for systematic error variations observed in different parts of the detector.

Next steps

- More neutrinos will be simulated with different properties (zenith angle, depth, energy, etc.).
- Other less computationally expensive reconstruction methods will be considered.
- New correction values will be soon implemented in future neutrino alerts.

References

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