IceCube study of down-going neutrinos for the spectral cutoff determination

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NEVTRINO 2018 Heidelberg 4–9 June

1 Motivation

The IceCube telescope has observed an excess of high-energy neutrinos above the atmospheric background opening a new era in astronomy [1-3]. The absence of events with energies E > ~3PeV can be seen as an argument for the presence of a spectral cutoff. Therefore, analyses of extremely high energy events are crucial to determine whether the absence of events is a statistical fluctuation or an indication of this phenomenon.

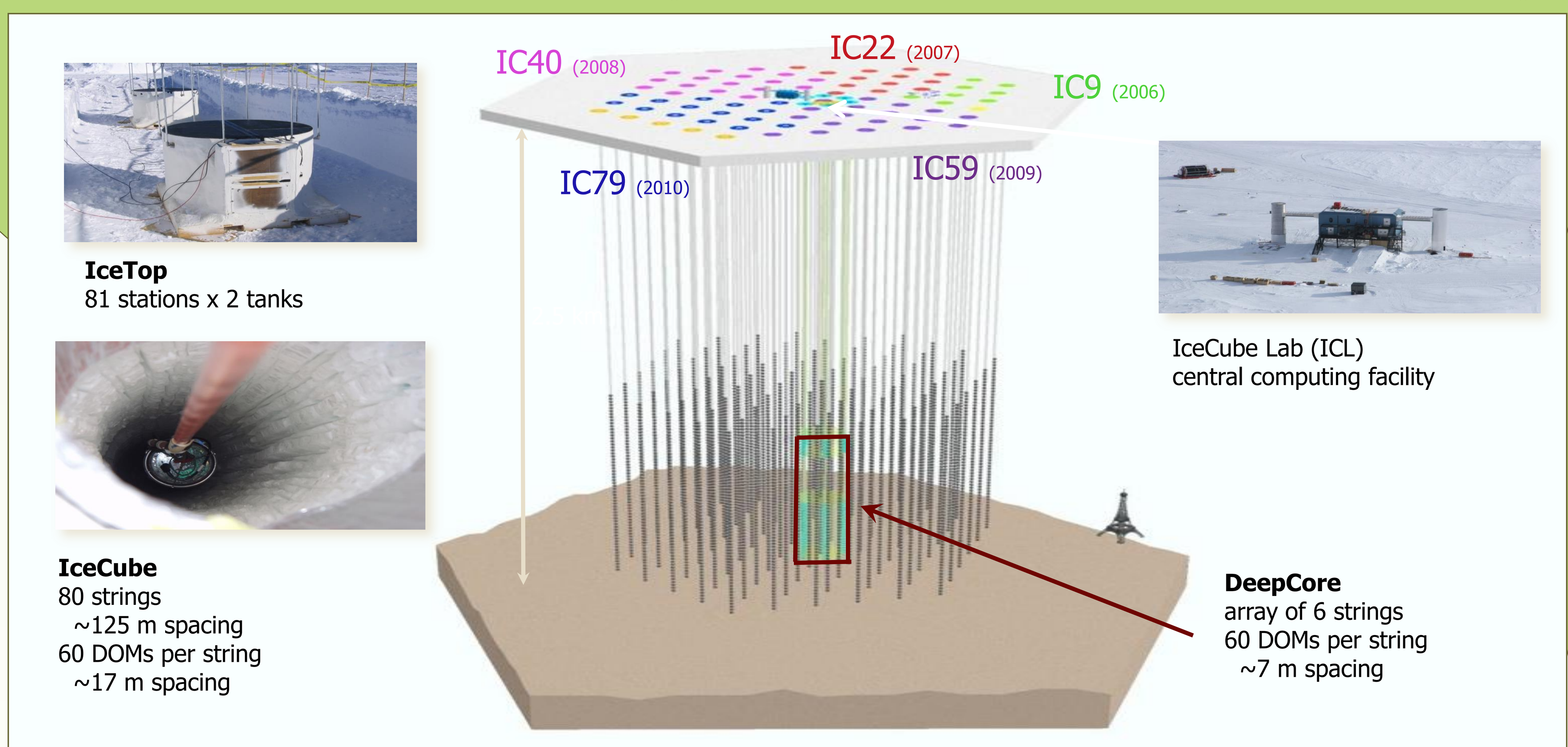
This poster presents a new event selection to search for down-going astrophysical neutrinos. To limit the cosmic muon background combination of three almost independent elements is used:

- IceTop (IT) veto
- Stochasticity cuts
- Cuts in cos(zenith) versus energy proxy

The cosmic muon background is determined from the data-driven technique that utilizes the fact of independence between IceTop veto and stochasticity cuts.

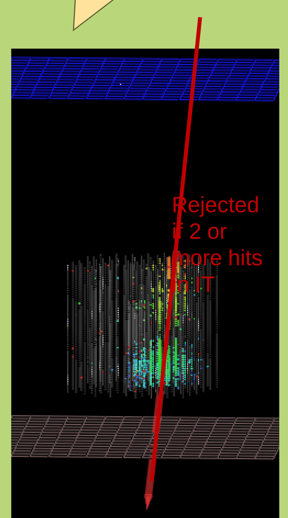
2 Detector

- IceCube is the world's largest neutrino telescope located at the South Pole in deep ice (1450 to 2450 m down) [4]
- Final fiducial volume of 1 km^3
- 5160 optical sensors (digital optical modules, DOMs) deployed on 86 strings, 60 per string
- The IceTop air shower array [5] consists of 81 stations located near the top of each in-ice string. A station consists of two frozen water tanks, each equipped with two optical sensors.
- Capable of measuring neutrino source direction within 1 deg

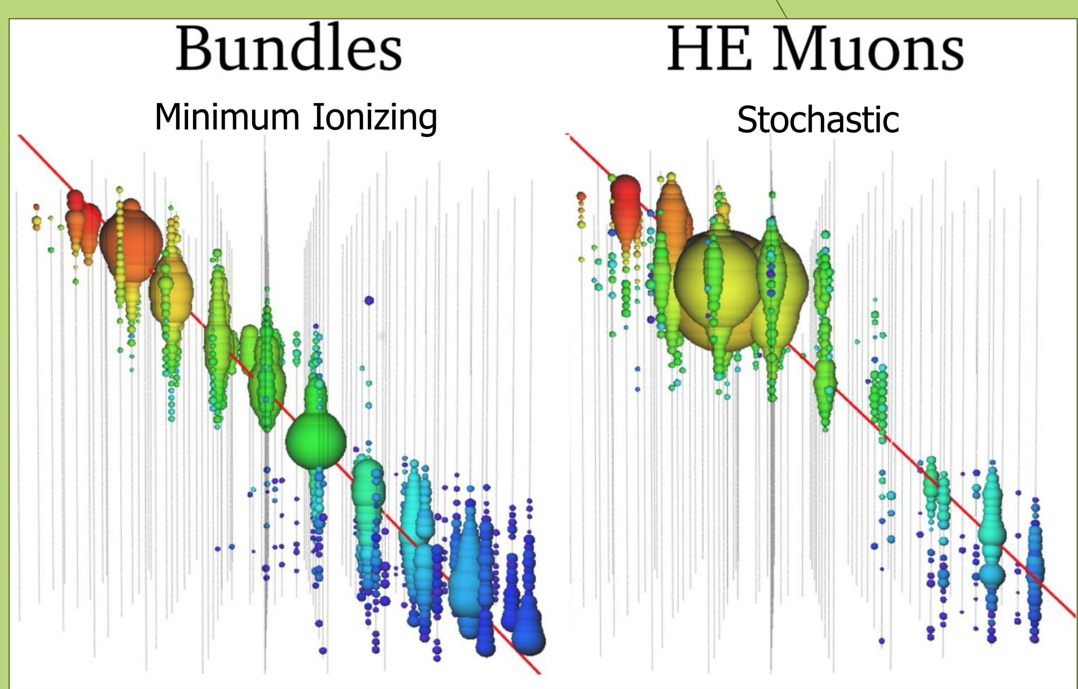


3 Cuts & Methods

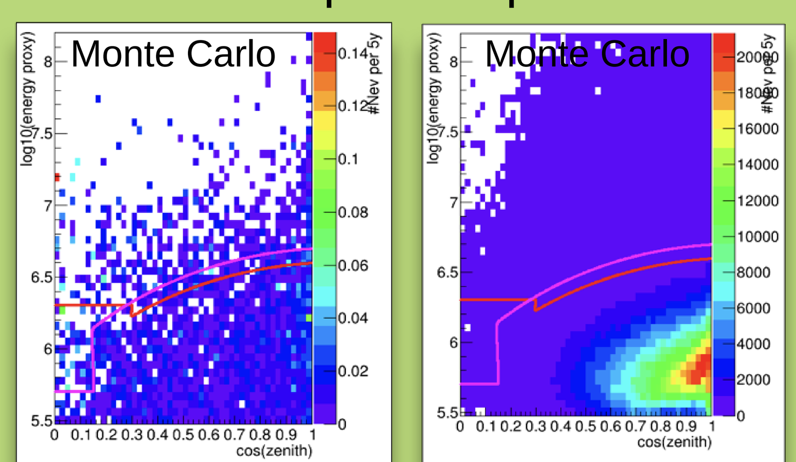
The cuts on stochasticity are used to reduce most of the muon background from bundles containing hundreds or thousands of muons.



IceTop (IT) detector is used as a veto only for events ("IT veto events") with small survival probability.



Astrophysical neutrinos and cosmic muons cover energy versus zenith phase space in a different way.



Astrophysical neutrinos (left): isotropic.

Cosmic muons (right): large contribution in low energy region peaked for fairly vertical events.

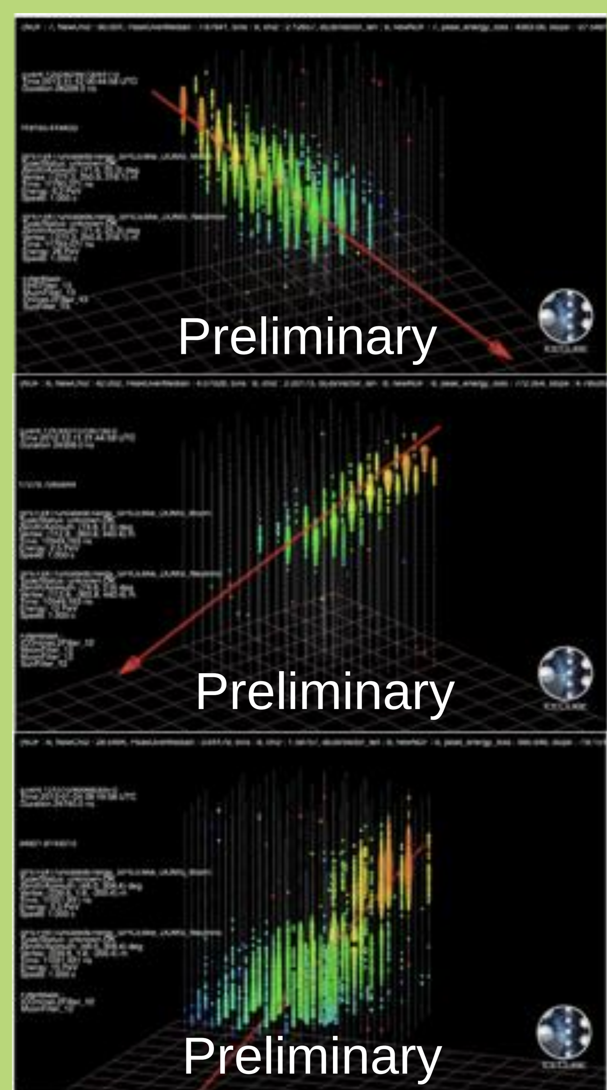
Cuts were optimized for "IT veto events" and "No IT veto events" separately

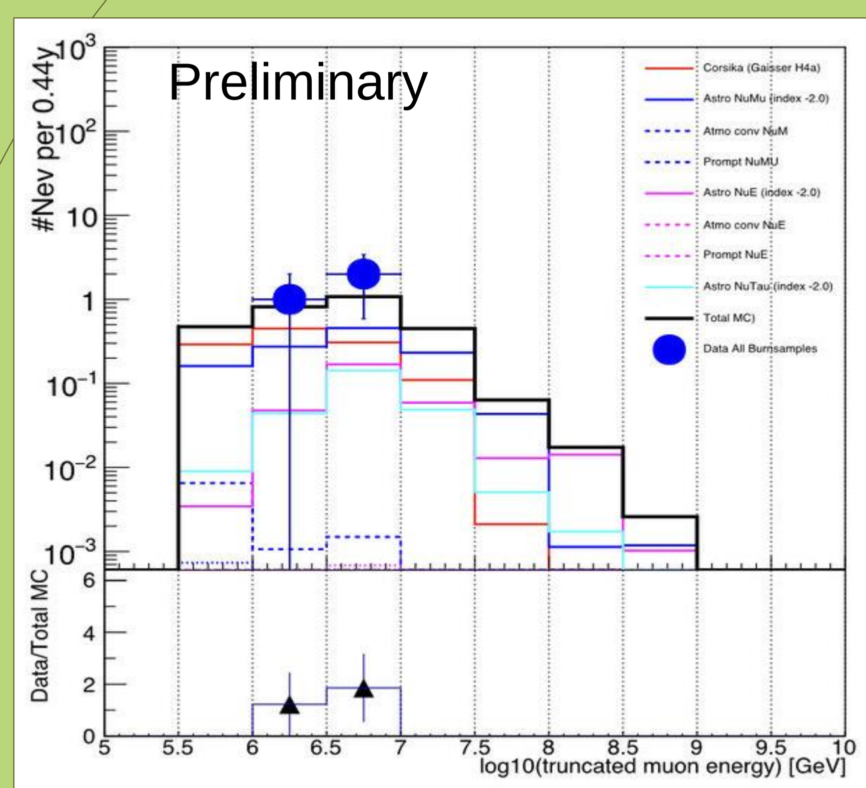
A binned maximum-likelihood fit will be performed to compare experimental data with two models differing in description of the cosmic neutrino flux: single power law with and with out exponential energy cutoff.

This analysis sample will be combined with the high-energy starting events (HESE) sample [6].

4 Burn Sample Results

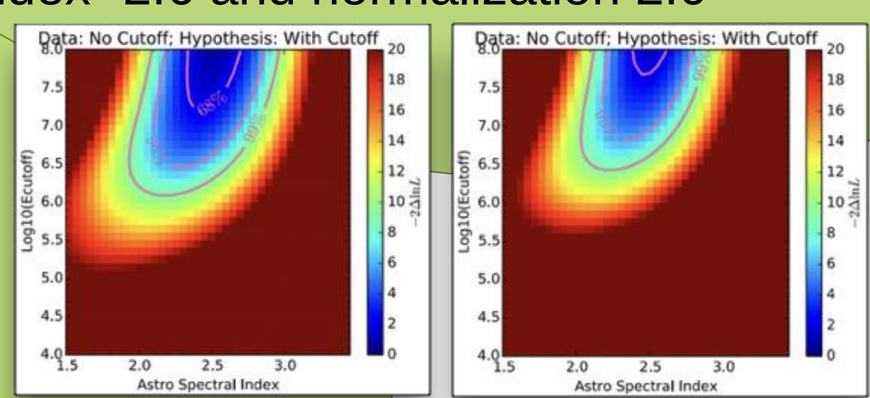
After final selection three events were found in the 5 year burn sample (158 days).





The energy proxy distribution with MC predictions for the final selection

Asimov assumption: Astrophysical spectral index -2.6 and normalization 2.0



HESE 5y

HESE 5y + This Analysis 5y

5 Conclusion

A new approach to study astrophysical neutrinos in the PeV region was developed.

The combination of cuts, that among others utilize IceTop detector as a veto and take into account differential energy losses that describe the stochasticity of an event, is performed to suppress the cosmic muon background.

Events from this analysis combined with HESE sample will be used to study PeV cutoff existence using a binned maximum-likelihood analysis.

Events from this analysis will also be used for the point source search. From the point source perspective, even a small number of events with good angular resolution is still interesting.

For small samples, the neutrino becomes the driver, and typical approach is to look for a source association in other (photon) data sets.

References

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