

Search for Astrophysical Neutrino Transients with IceCube DeepCore



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1. Astrophysical neutrino transients

- **Choked gamma-ray bursts** (duration < 1,000 s)
 - Insufficiently energetic jet or massive surrounding envelope of material
 - May occur at a higher rate than GRBs
 - Suppressed fluence of high-energy neutrinos due to energy losses of mesons and muons before decay
 - Other unexpected transient sources from cataclysmic astrophysical events

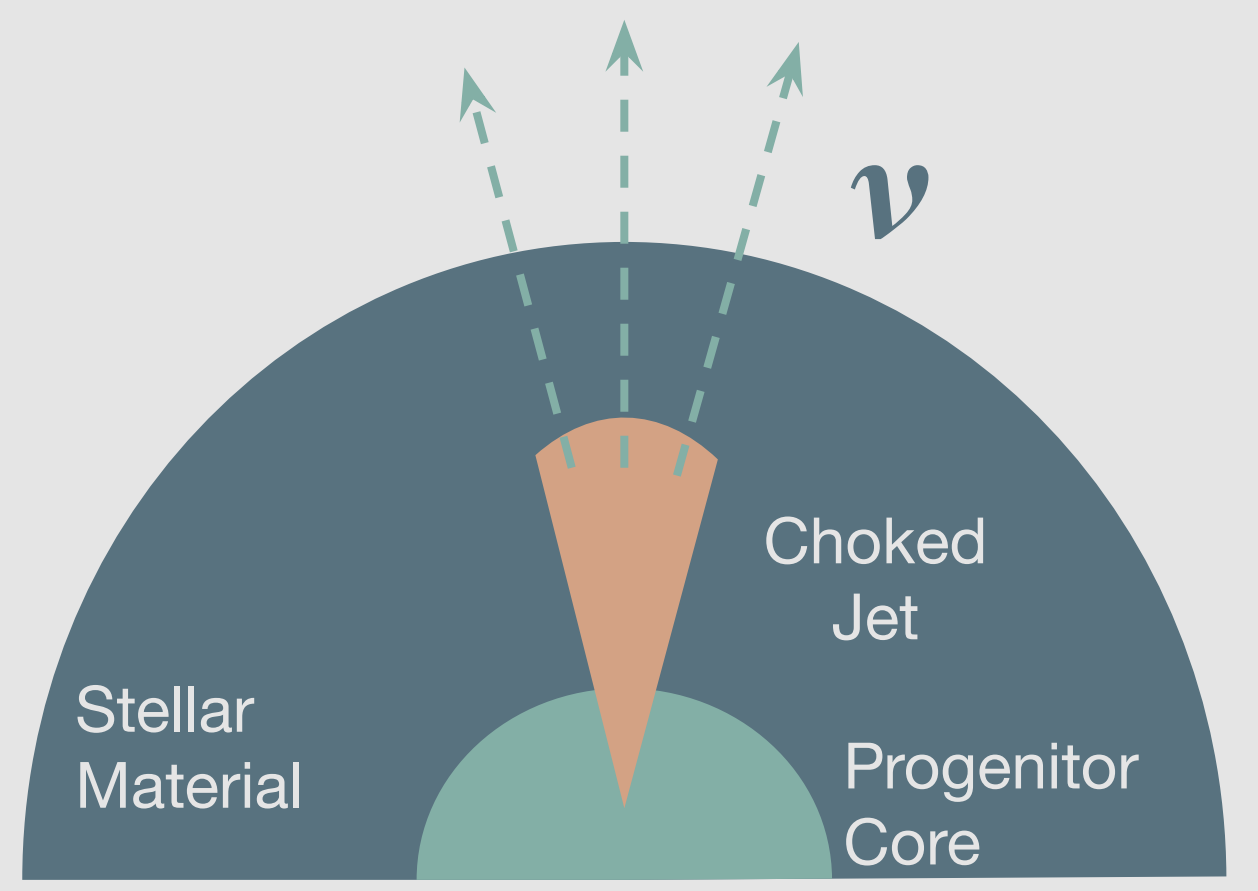


Fig 1. Simple diagram showing the choked jet

2. IceCube and DeepCore

- IceCube
 - km³-scale neutrino detector at geographical South Pole
 - 86 strings, 5,160 DOMs deployed in the ice
- DeepCore
 - Denser sub-detector
 - Low energy threshold ~ 10 GeV

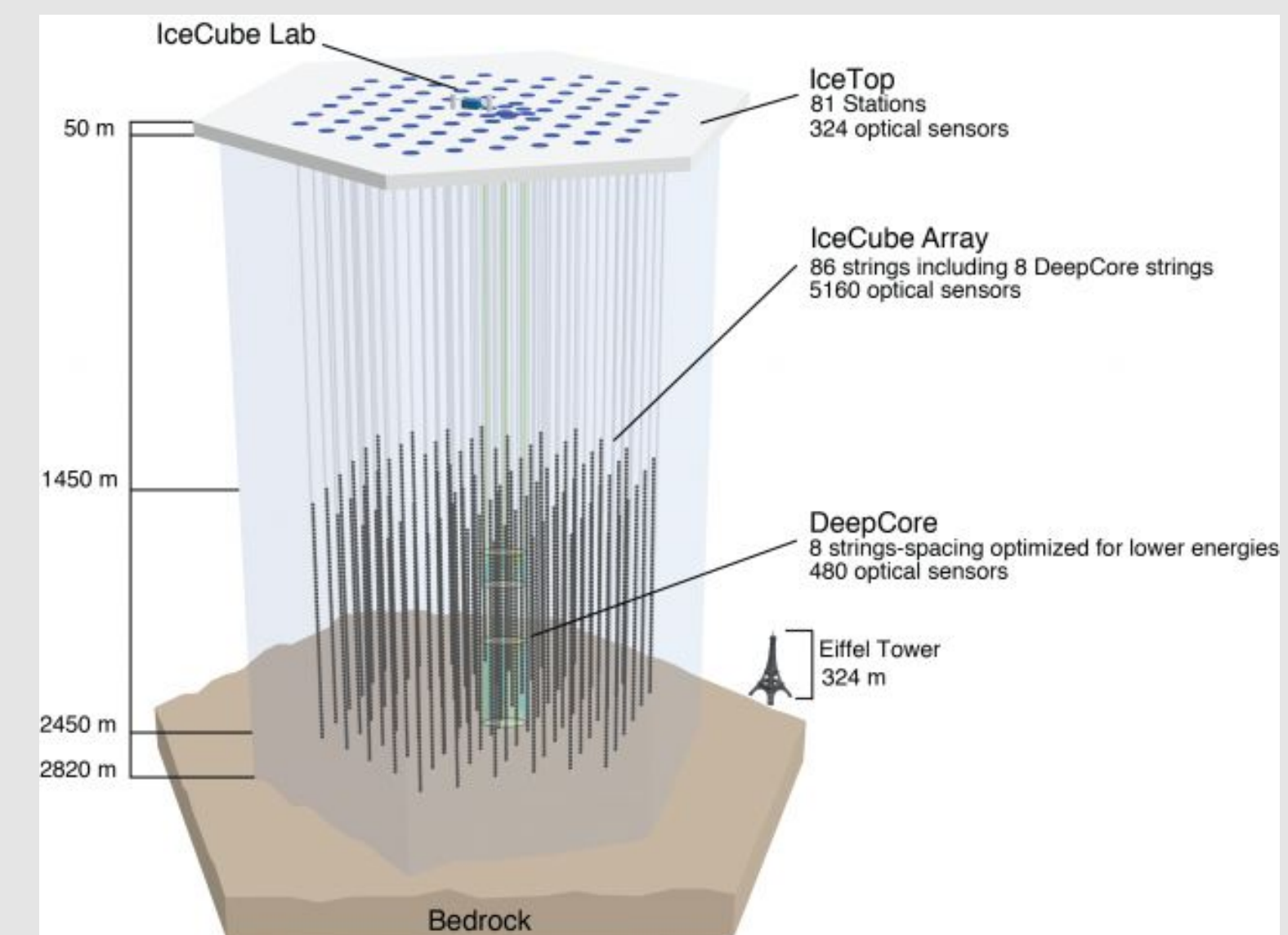


Fig 2. Diagram of the IceCube Neutrino Observatory

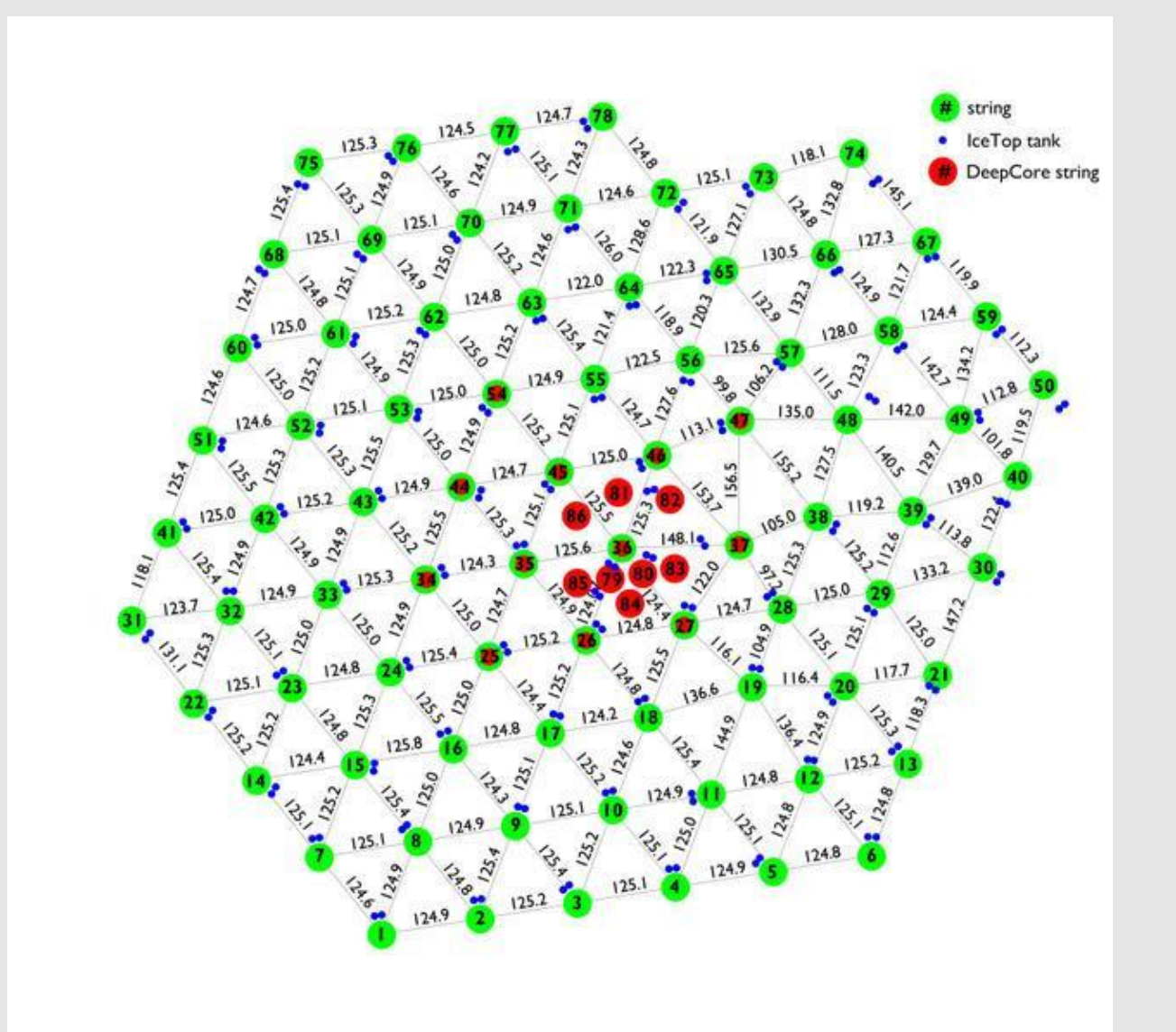


Fig 3. Top View of IceCube Arrays (red: DeepCore arrays)

3. Dataset: >10 GeV energy neutrinos

- High-statistics data sample also used for neutrino oscillations.
 - Both up-going and down-going, all sky
 - Tracks and cascades: all flavors
 - Final level event rate ~ 4 mHz

See poster of M. Larson #280

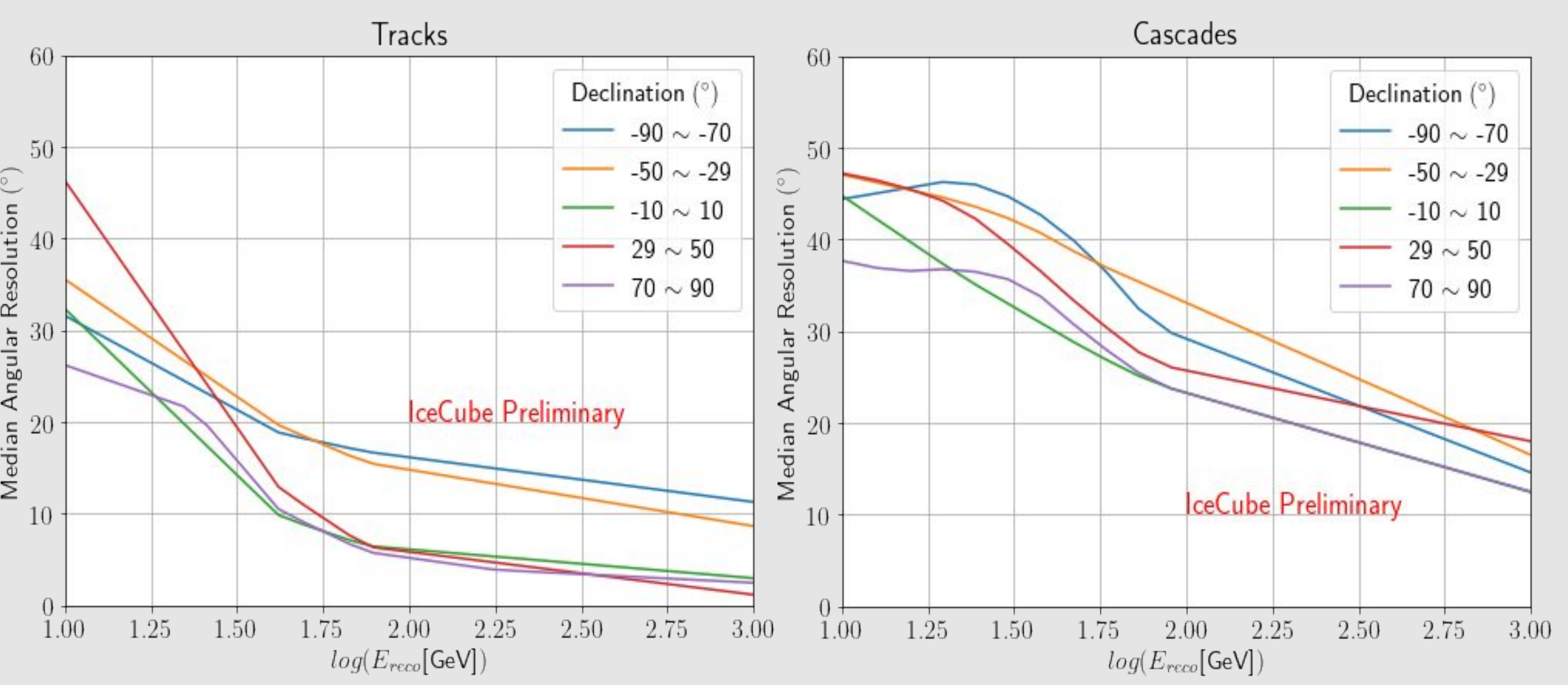


Fig 4. Per-event angular uncertainty vs. reconstructed Neutrino energy at several declination

- **Event-wise angular uncertainty** (left: tracks; right: cascades)
 - PID classification based on reconstructed track length
 - median angular resolution derived from spline functions of declination and reconstructed energy
 - weighted according to atmospheric energy spectrum

4. Sensitivity and discovery potential for >10 GeV transients

- Triggered time-dependent search for flares
 - Flare in a fixed-width (ΔT) box centered at a known time t_0
 - Best fit of number of signal events, spectral index, flare width

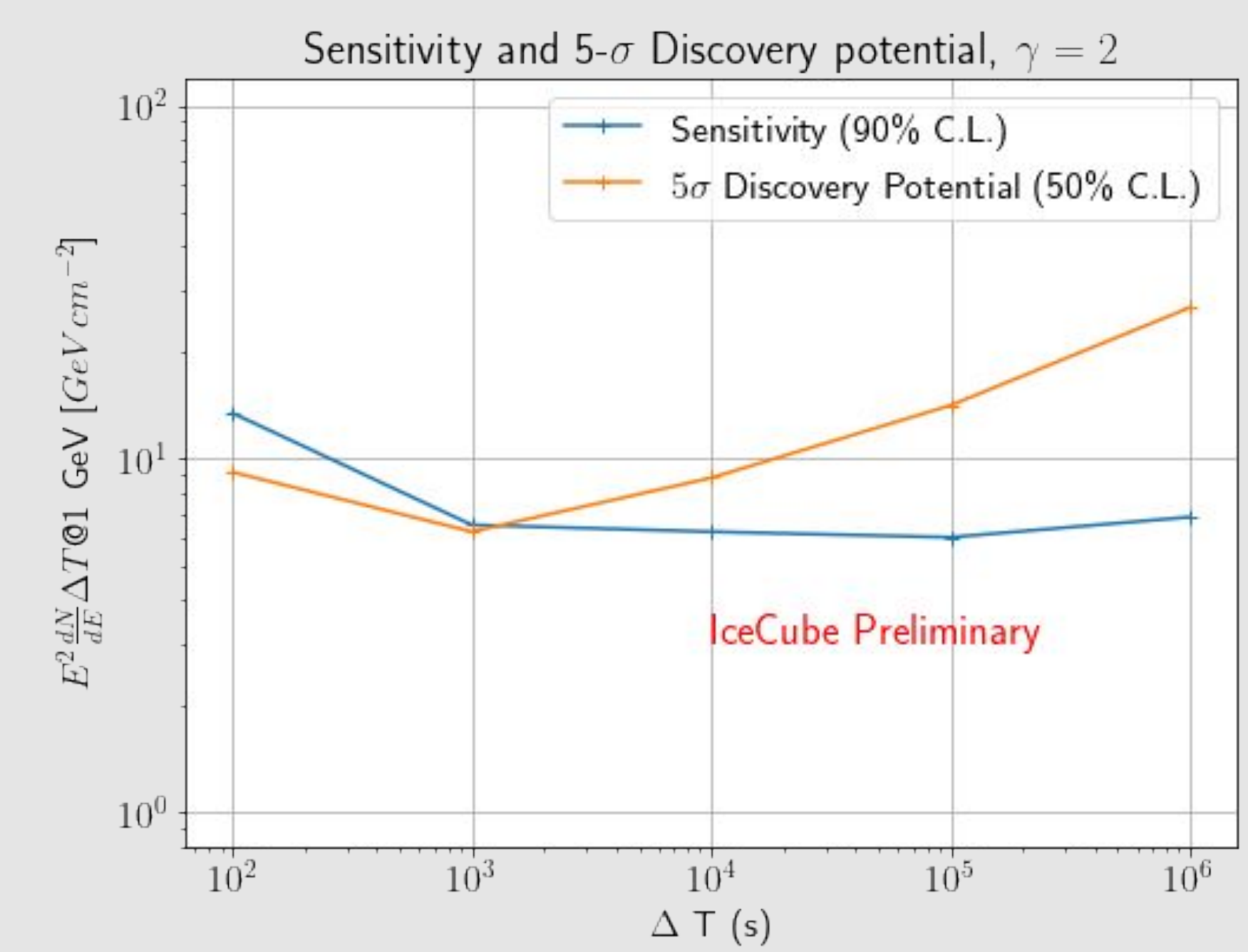


Fig 5. Results from different ΔT s

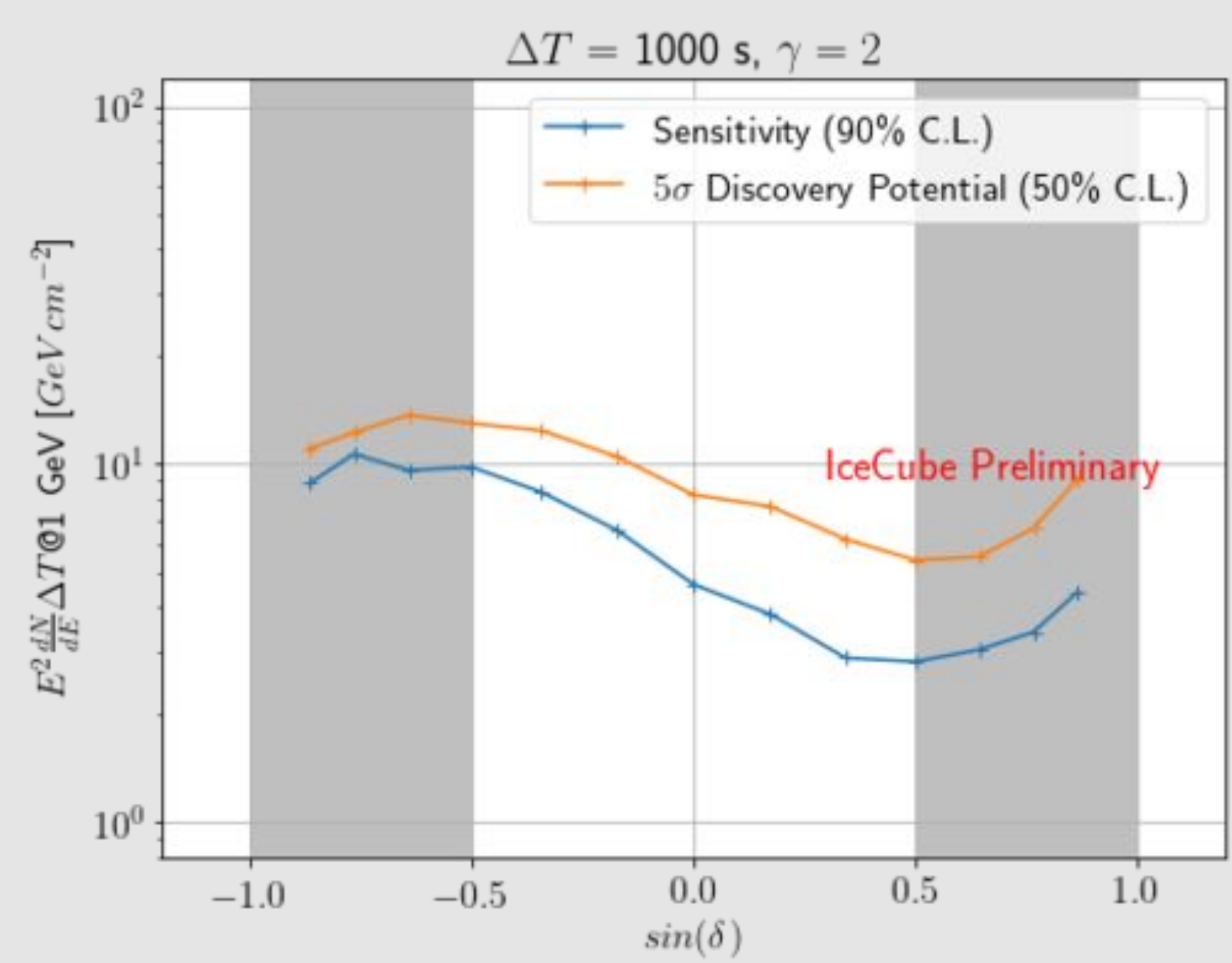


Fig 6. Results at different declinations

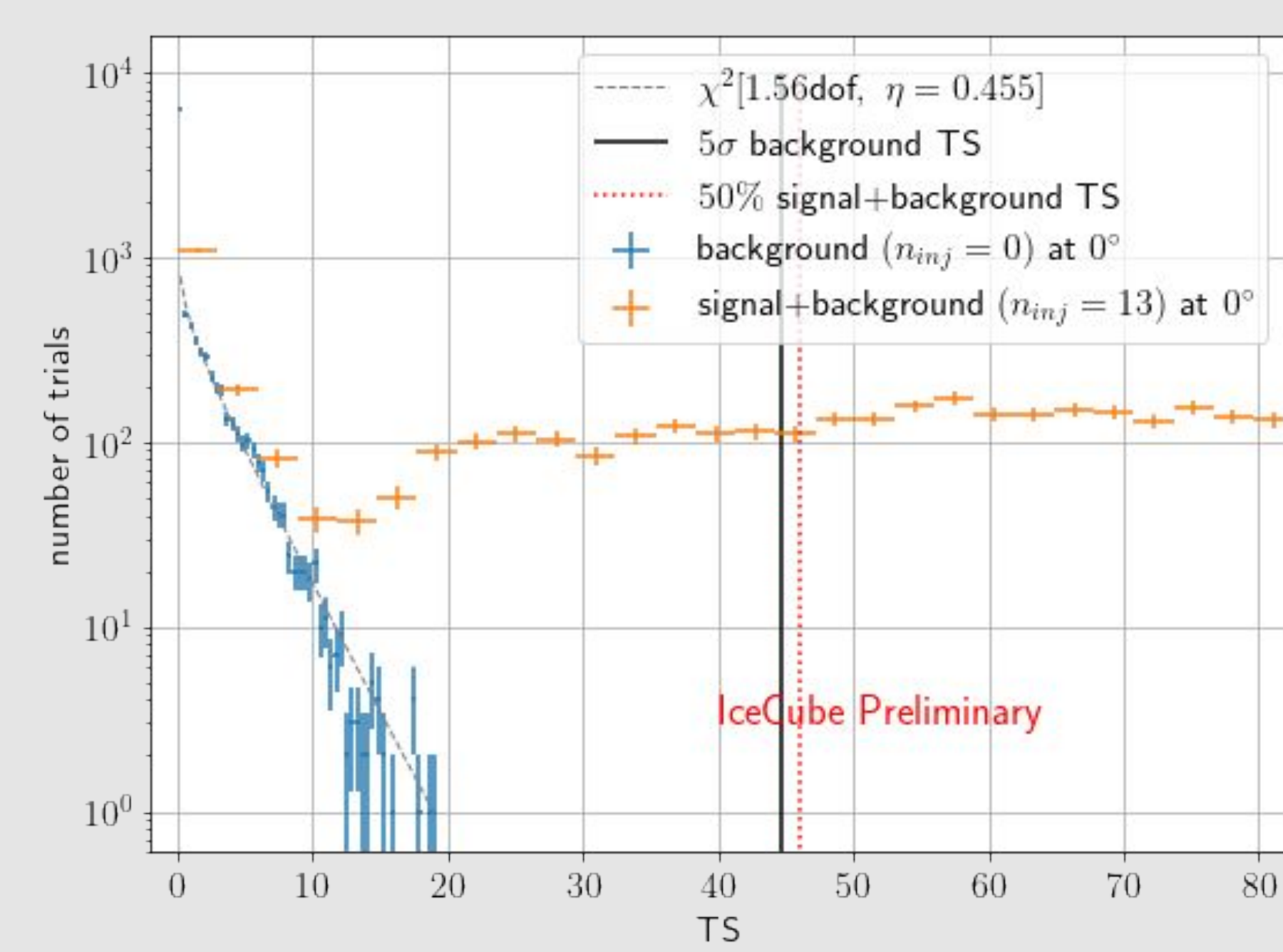


Fig 7. An example of TS distributions

- **Time-integrated flux** (the 5- σ background TS is estimated using Wilk's theorem)
 - **Left:** fluence sensitivity and 5- σ discovery potential as a function of injected time window width at declination = 0°
 - **Middle:** results at different declinations when injected time window width is fixed as 1,000 seconds. For declinations near poles, results are not reliable due to large angular uncertainty
 - **Right:** an example graph of background test statistic (TS) distribution and signal + background TS distribution when injected time width is fixed to 1,000 seconds

5. Discussion

- Better options for estimating the event angular resolution
- Gaussian time window not tested yet
- Fitting flare center with fixed flare width
- All-sky untriggered analysis and more
- Tend to improve previously published work

References

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