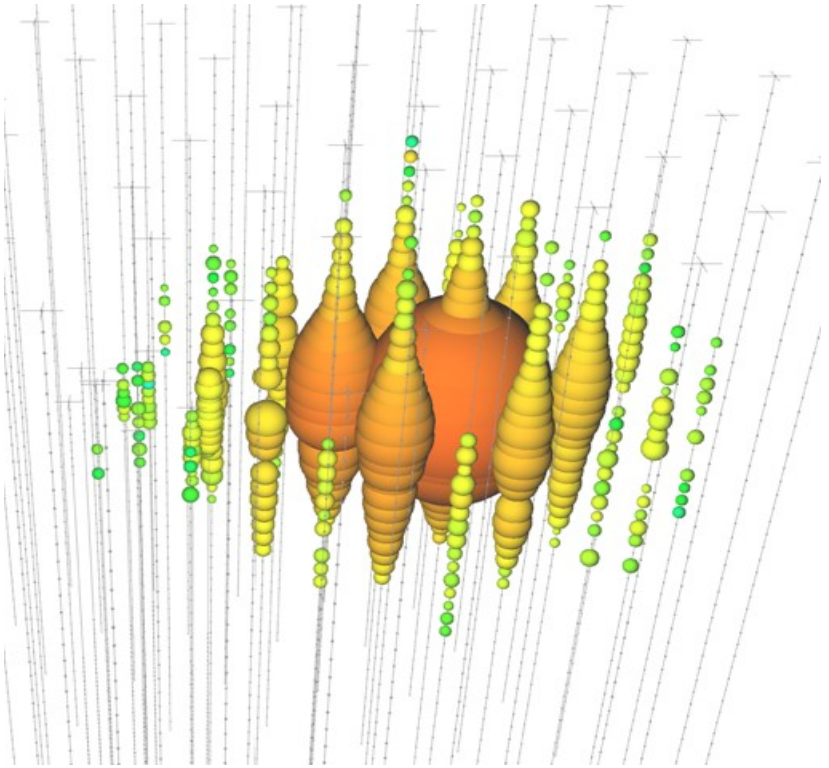
Spatial Clustering Analysis of the High-Energy Contained Vertex Events



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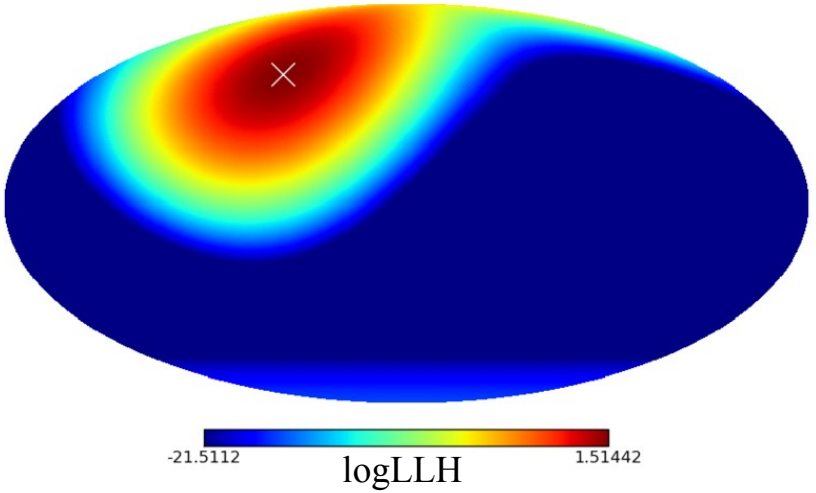
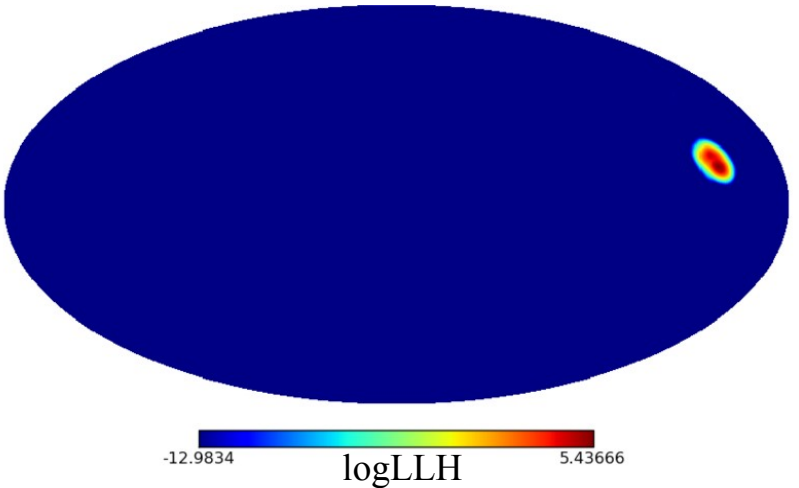
for the IceCube Collaboration

Each Event Observed Gets Full-sky Reconstruction Treatment

Reconstruction map of a ~60 TeV shower-like event in local coordinates



Reconstruction map of a ~90 TeV track-like event in local coordinates



Directional Reconstruction

- As C. Kopper mentioned in the previous talk, each event gets a full-sky likelihood reconstruction
- Every PMT timing profile used for fit
- Systematic effects are studied and included by further applying a Gaussian smearing
- Cross-check with different fit methods performed

Likelihood Search for a Point Source
- Test Statistic (TS) Calculation -

Maximize the likelihood L at every point in the sky x

Total # of events = 28

# of events from source Varied to maximize L

$$L(x) = \prod_{i}^{n_{tot}} \left[\frac{n_s}{n_{tot}} \times S_i(x) + \frac{n_{tot} - n_s}{n_{tot}} \times B_i(x) \right]$$

Reconstruction map value at position x from event i

Uniform value for each event at every position

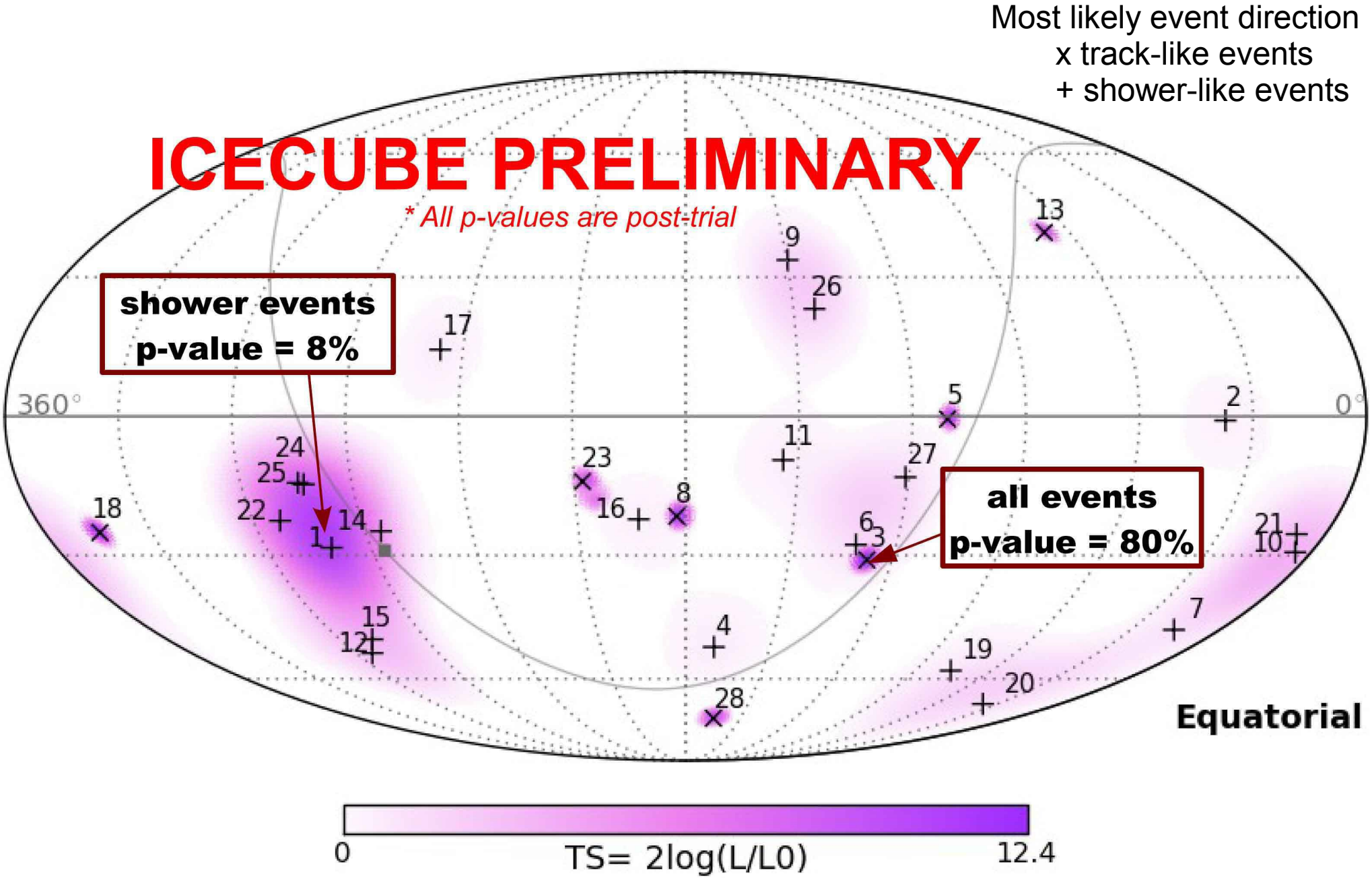
** Events' energies not used in the likelihood*

TS is calculated for every point in the sky x

$$TS(x) = 2 \times \log\left(L(x) / L_0(x) \right)$$

where $L_0 = L(x, n_s = 0)$

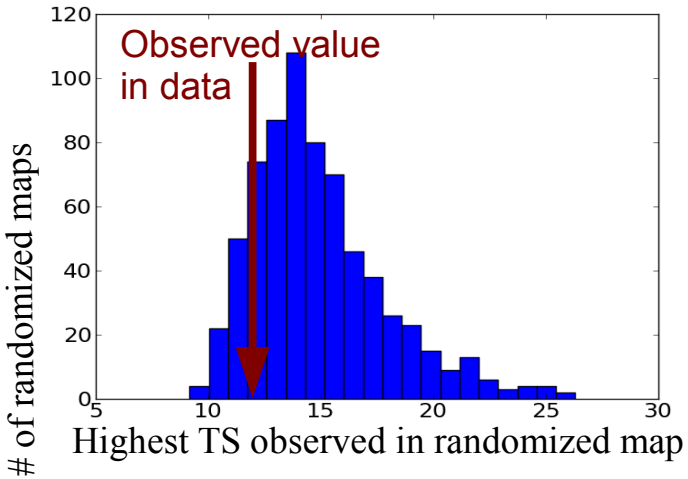
Resulting Test Statistic Map

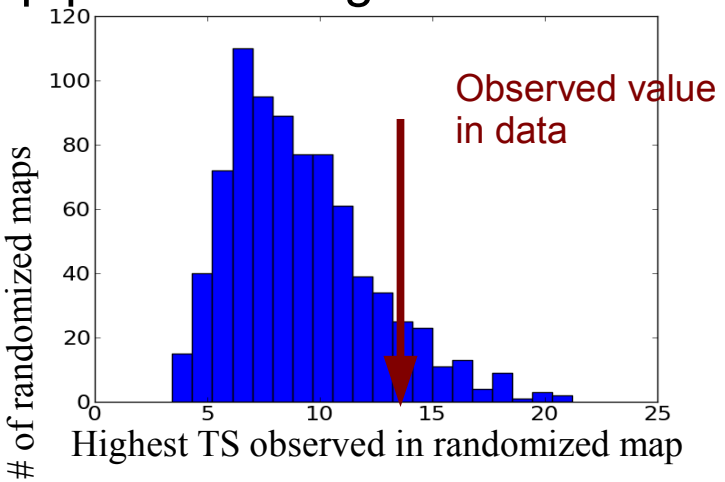


Likelihood Search for a Point Source - Scrambling & Significance Calculation -

- Randomize right ascension (RA) of event reconstruction maps
- Repeat the likelihood calculation at every point in the sky to obtain a TS map
- Compare the highest TS value obtained to the highest TS value actually observed

Fraction of times randomized map produced higher TS





all events
p-value = 80%

shower events
p-value = 8%

** All p-values are post-trial*

- Simulation-free estimation of the significance of the highest TS observed
- Significance derived only from RA clustering (clustering in declination not included in scrambling)
- Significance does NOT include signal/background event separation

→ Simply a significance against the hypothesis of uniform event distribution

Conclusions

- First point source analysis in IceCube to include all 3 flavor neutrinos (both track-like and shower-like events)
- First point source analysis in IceCube that pushes the energy threshold in the Southern sky to ~50 TeV
- No evidence of spatial clustering

Stay tuned for a complete overview plenary talk

by N. Whitehorn tomorrow!