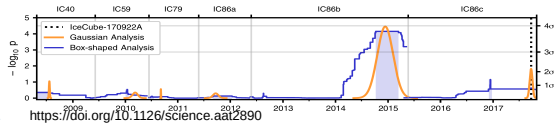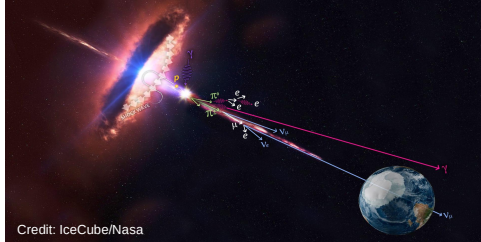# Search for high-energy neutrino sources from the direction of IceCube alert events

Martina Karl (martina.karl@tum.de), Philipp Eller, Anna Schubert for the IceCube collaboration

1. Neutrino flare from direction of high-energy Neutrino IceCube170922A (Direction of Blazar TXS0506+056)

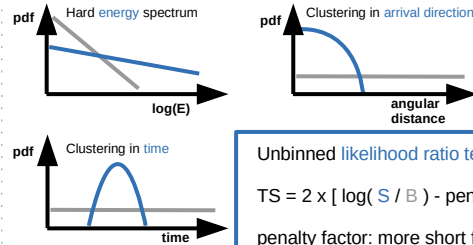Credit: IceCube/Nasa

https://doi.org/10.1126/science.aat2890

2. Are there neutrino sources at the arrival directions of other high-energy neutrinos?

IceCube realtime alert system: detection of high-energy neutrino event with high probability to be of astrophysical origin (~8 per year)

IceCube preliminary
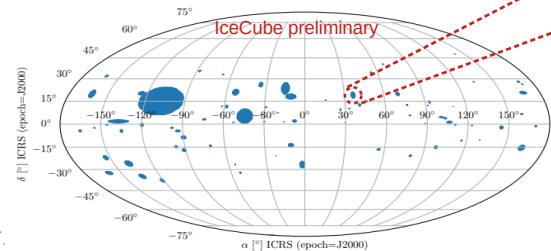
Use all high energetic tracks (alerts) as source-catalogue

3. Signal vs background

Hard energy spectrum

Clustering in arrival direction

Clustering in time

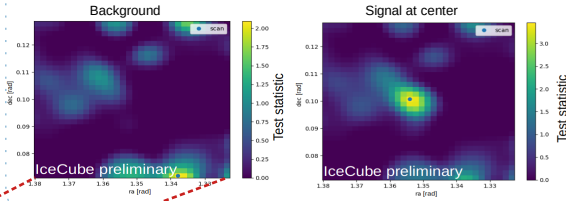**Unbinned likelihood ratio test**

TS = 2 x [log(S / B) - penalty factor]

penalty factor: more short flares than long flares → look elsewhere effect

4. Finding the source position in the uncertainty region of arrival direction

Background   Signal at center

IceCube preliminary   IceCube preliminary

Choose position with best test statistic (TS) value

5. Simulating neutrino flares: Parametrization of test statistic

How does the flare strength and flare duration affect the test statistic distribution median?

TS ∝ log (strength (= number of signal events n_s) / duration Δt)

Fitting function $a + b \cdot \log\left(\dfrac{n_s}{\Delta t}\right)$

We can parametrize the shift of the test statistic median for different flare properties.

6. Finding neutrino flares

Expectation maximization for finding neutrino flares

Use energy and spatial information to calculate signal over background ratio (S/B)

Background   Signal

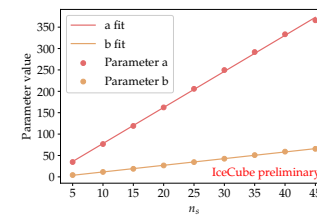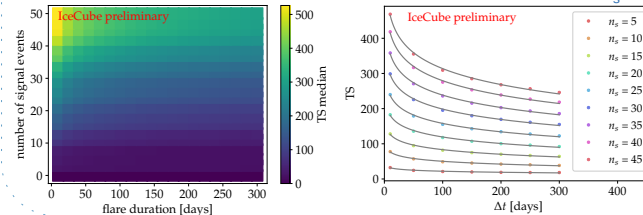## 7. Which sources could we see?
Mean 3σ discovery potential fluence ~ 2.7·10⁻²GeV/cm²

Fluence:
flux x time

3σ discovery potential fluence:
fluence with 50% chance to get p-value < 3σ

Time pdf shape	Duration of data taking period [days]	3σ discovery potential fluence [$\frac{GeV}{cm^2}$]
Gaussian	409	0.027
Gaussian	376	0.037
Gaussian	346	0.032
Gaussian	3304	0.026
Box	3304	0.026