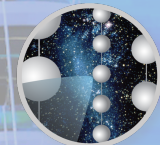


Overview of IceCube's physics results

Ignacio Taboada
Georgia Institute of Technology
(Atlanta)

VLVNT 2018, Dubna



ICECUBE



Overview

IceCube

Multimessenger astrophysics

The observation of TXS 0506+056

The 7.5 year HESE spectrum

7 year point Source search with IceCube

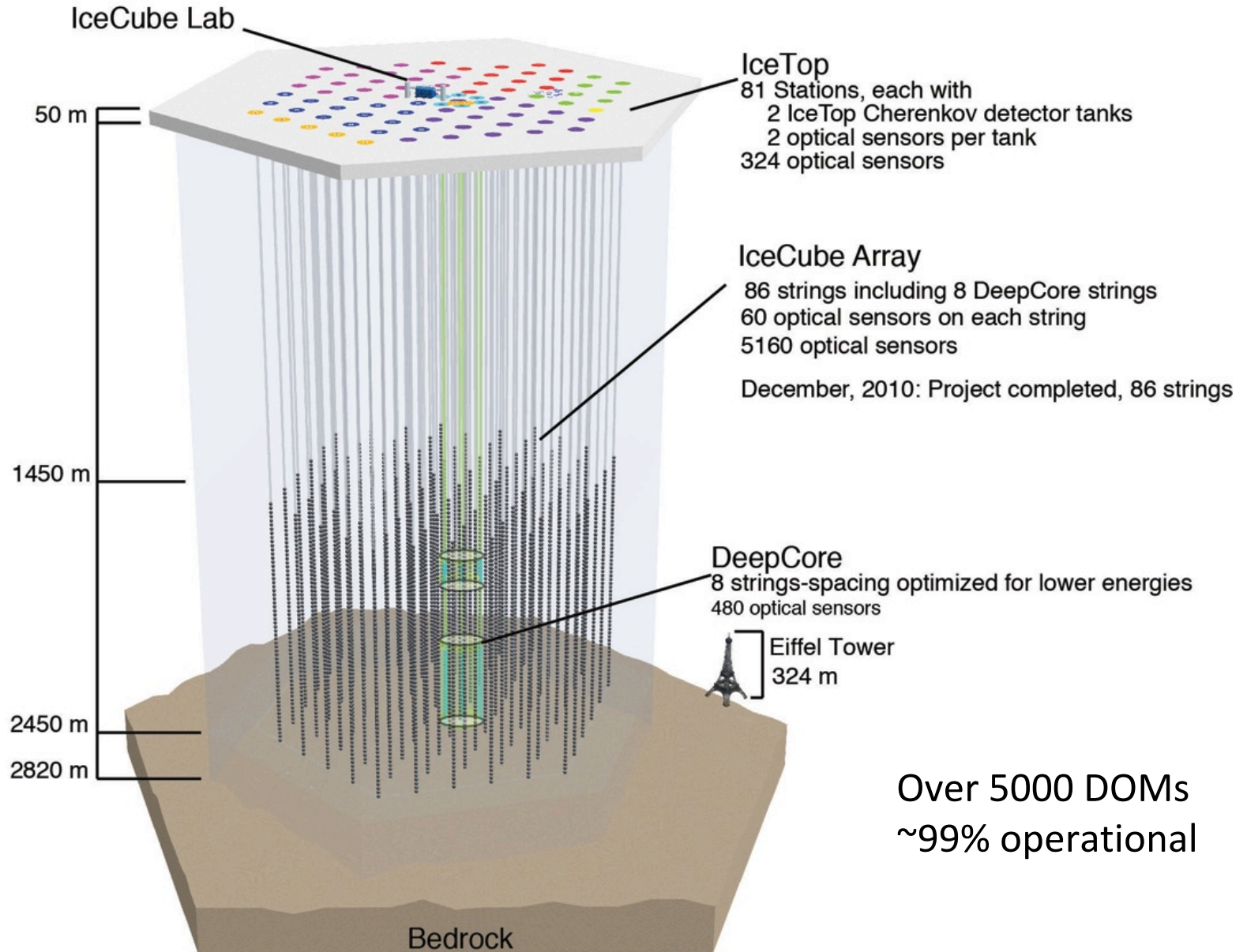
The galactic plane

A 5.9 PeV event in IceCube

Atmospheric ν_μ disappearance with DeepCore

Sterile neutrino constraints

IceCube



IceCube's Multi-messenger Activities

Real-time alerts. Since 04/2016, $\approx 6\text{--}8/\text{yr}$ (now)

Latency ~ 2 min.

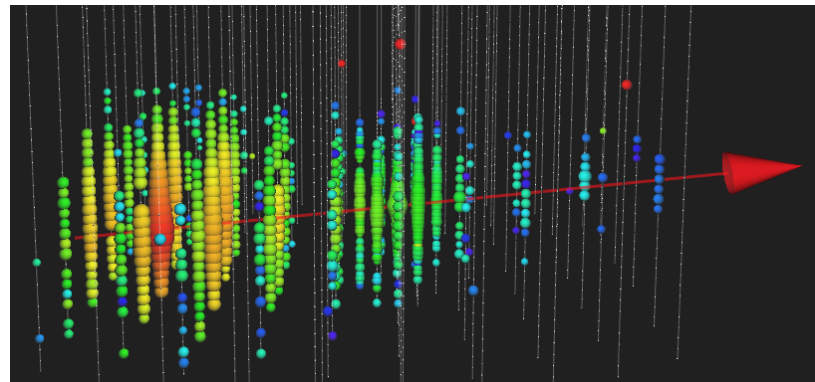
Improved Realtime alerts very soon

Good angular resolution ($0.5^\circ - 2^\circ$; 90%)

50% astrophysical ratio ($\approx 8 - 10 / \text{yr}$)

30% astrophysical ratio ($\approx 25 - 30 / \text{yr}$)

Astropart. Phys. 92 (2017) 30



First public ν Alert: IceCube-160427

Extensive real-time and offline follow up:

PTF, ZTF, HAWC, VERITAS, MAGIC, HESS, Fermi LAT, Fermi GBM, Swift, etc.

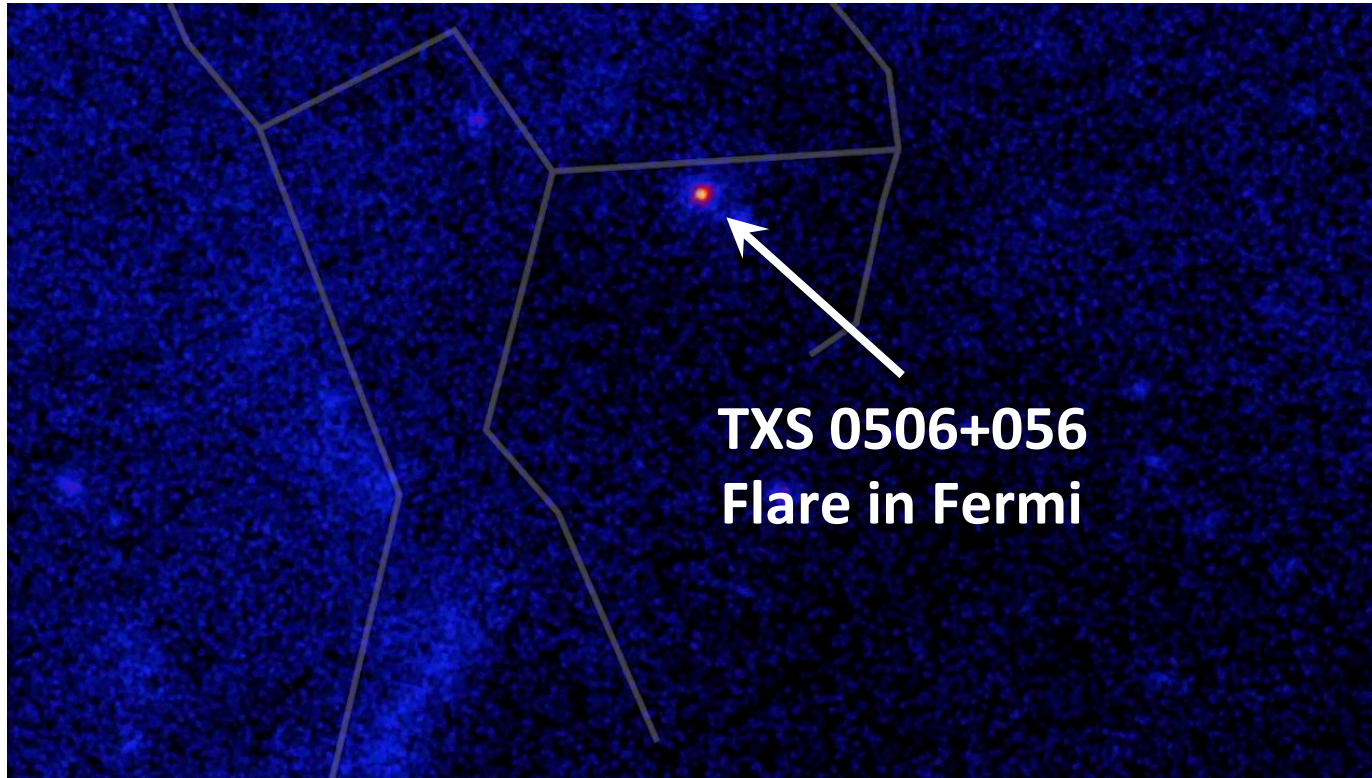
A&A 607 (2017) A115

See Talks by
C. Finley
A. Franckowiak

Real-time search for ν -GW coincidences

ApJ 850 (2017) L35

TXS 0506+056: First evidence of a ν source



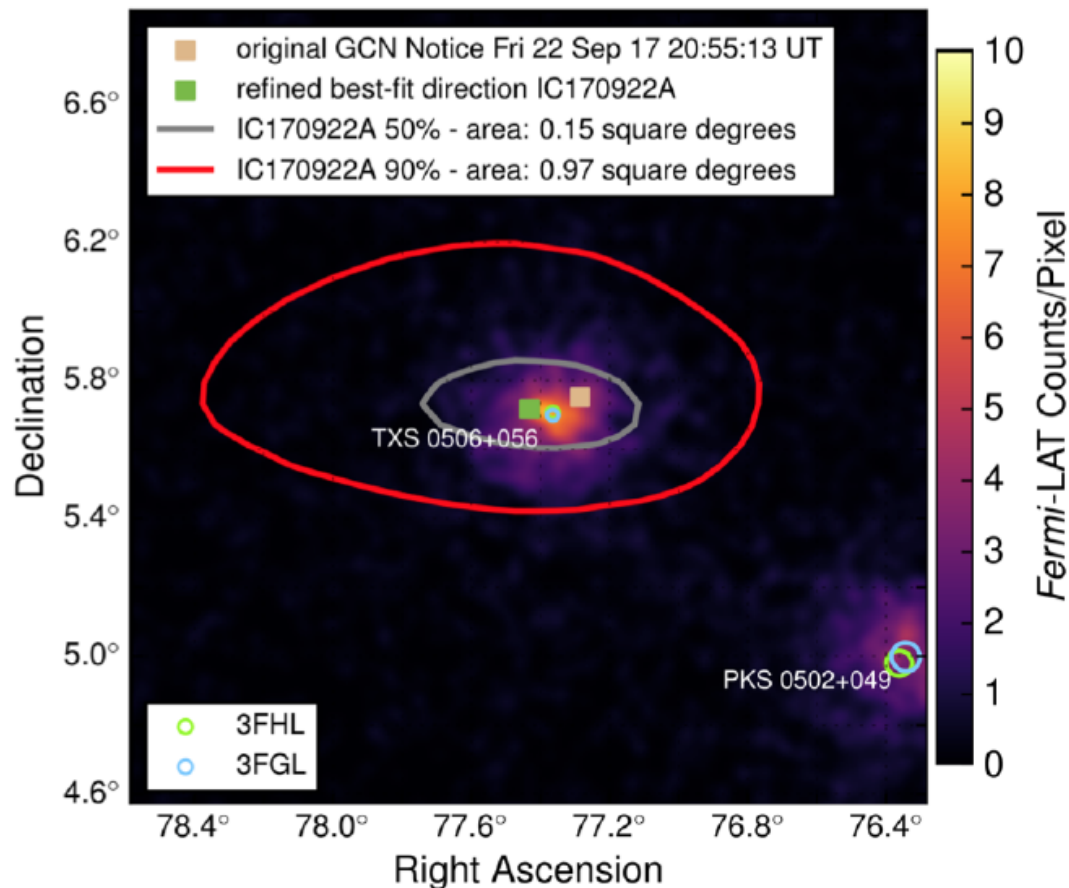
Science 361 (2018) eaat1378
Science 361 (2018) 147-151

IceCube-170922: a neutrino alert issued by IceCube

Fermi and MAGIC identify a spatially coincident flaring blazar (TXS 0506+056)

A ν -flare was found in archival IceCube data (10/2014 – 03/2015)

TXS 0506+056: First evidence of a ν source



See Talks by:
A. Franckowiak
C. Finley (today)

T. Glauch (HE 1)
C. Raab (HE 1)

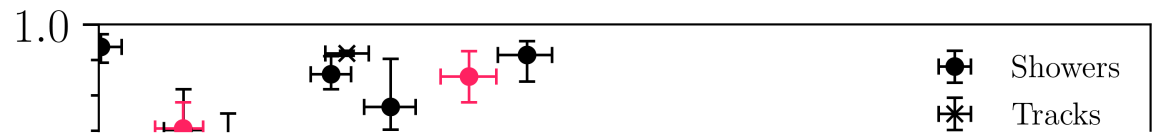
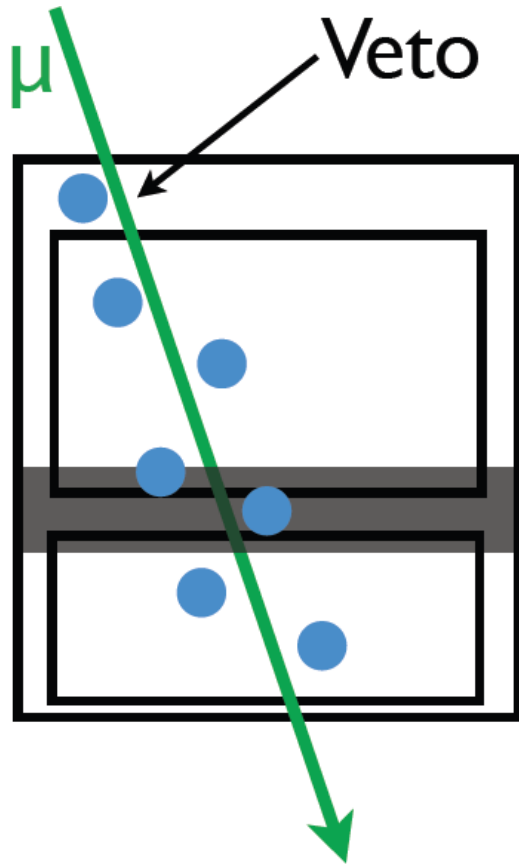
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High-Energy Starting Events (HESE) – 7.5 yr



New events

Prior result 6 years [ICRC 2017 arXiv:1710.01191](#)

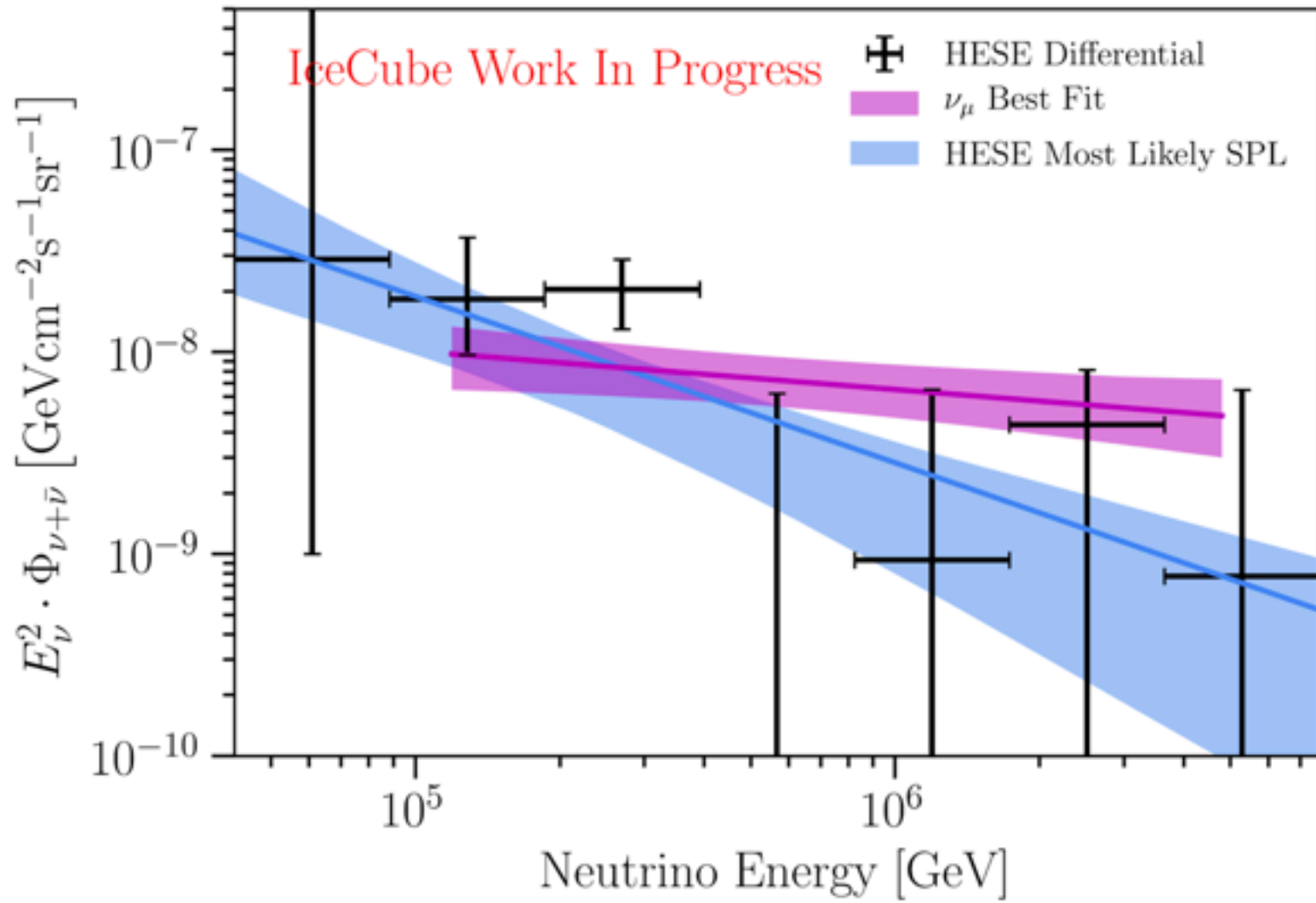
Updates to calibration and ice optical properties

103 events, with 60 events >60 TeV

→ Changes to RA, Dec, energy

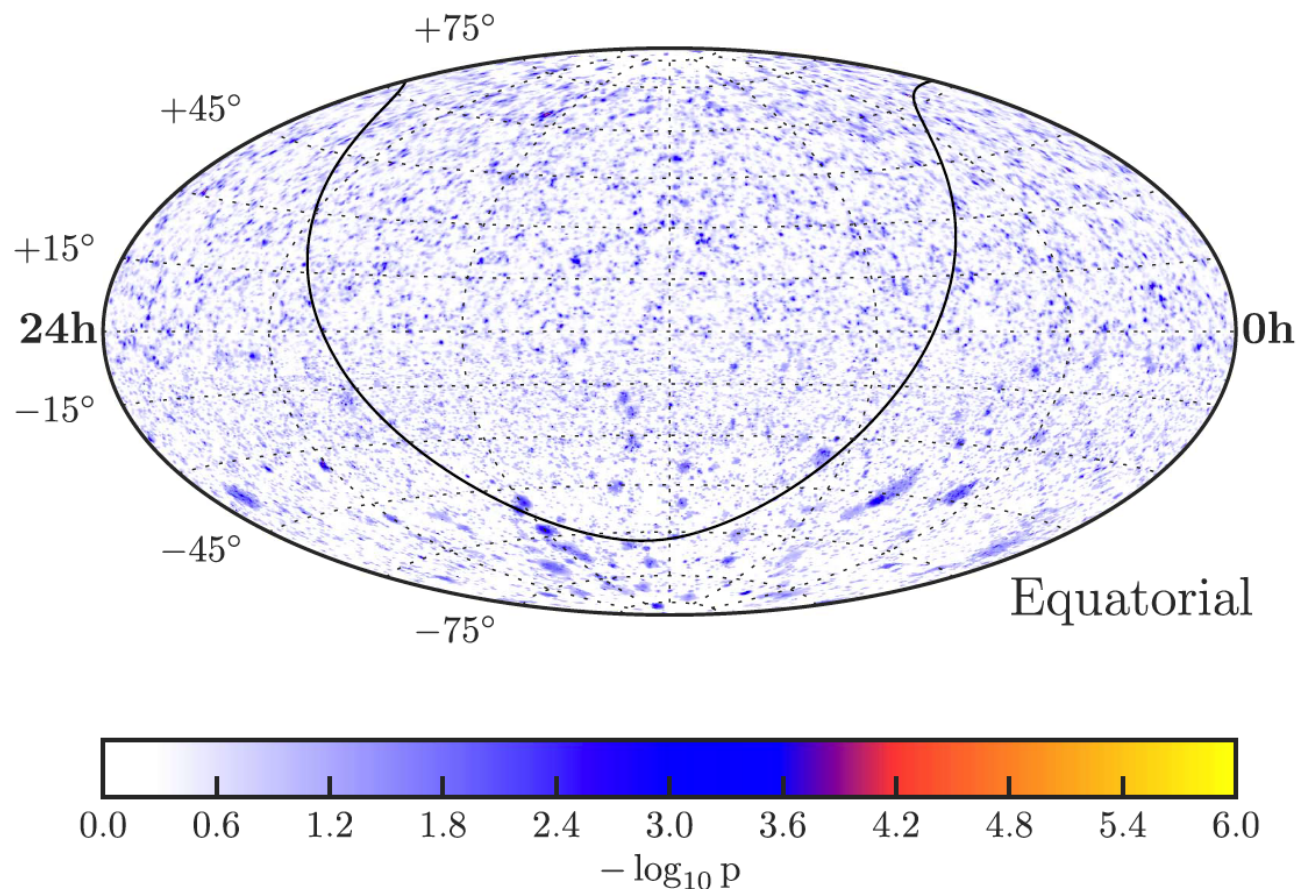
[IceCube. Nature volume 551 \(2017\) 596](#)

High-Energy Starting Events (HESE) – 7.5 yr



See talk by J. Stachurska for updates on HESE, inc. flavor ratio. Also see talk by D. Xu

IceCube - Point Sources – 7 years



No significant PS
reported

No correlation with list
of 74 sources in both
hemispheres. Galactic
& Extragalactic

Most recent data periods:

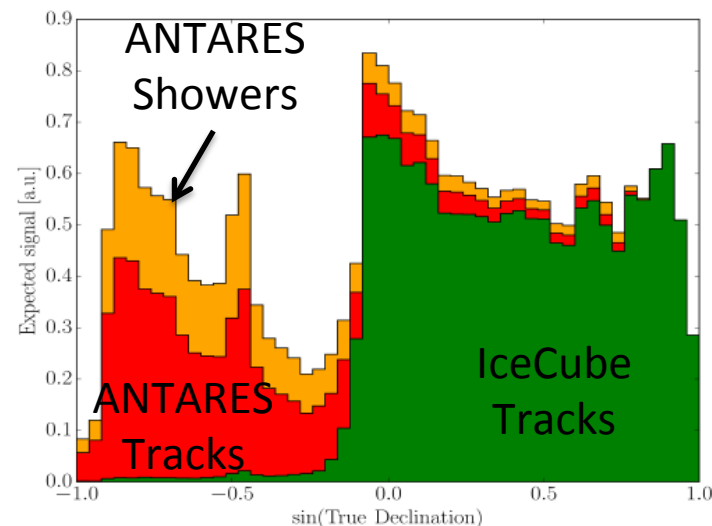
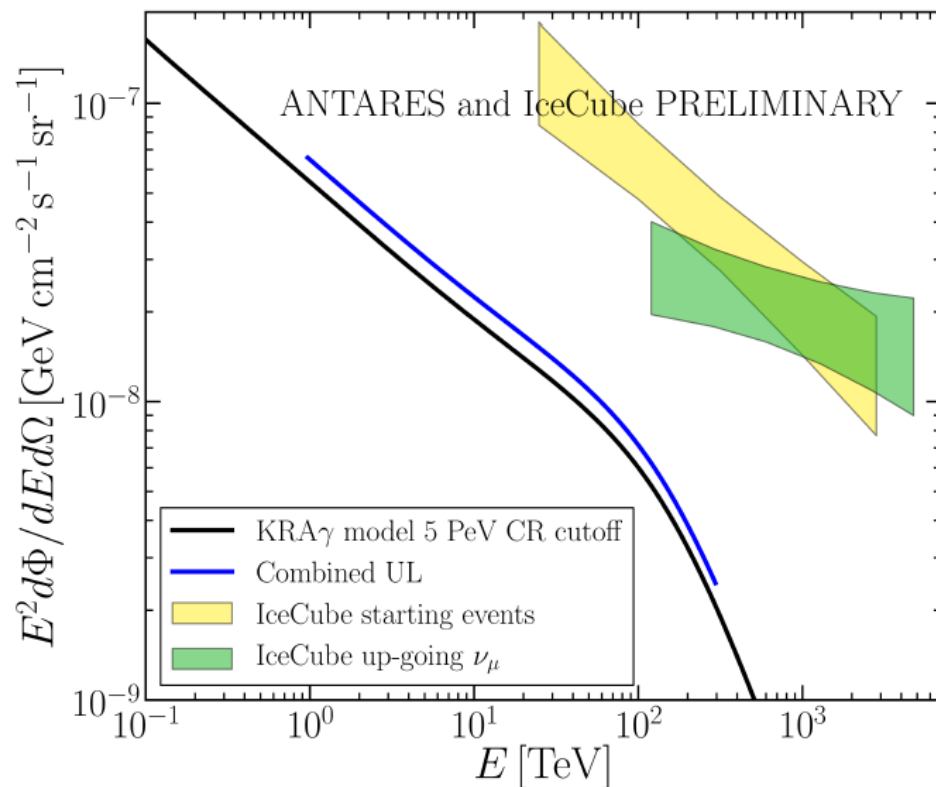
~80k northern hemisphere evt/yr (atm ν)

~35k southern hemisphere evt/yr (atm μ)

~200 starting tracks. Southern sky

ApJ 835 (2017) 151

ANTARES & IceCube Galactic Plane



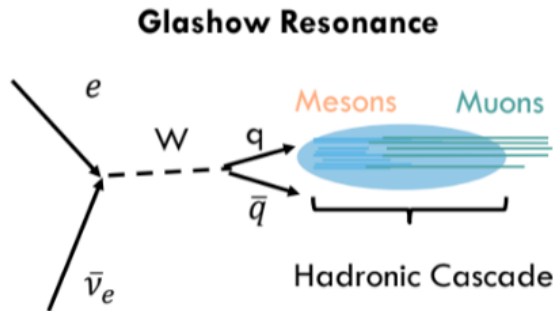
Expected Signal (Gaggero et al. PRL 2017, 119)
Relative contribution to sensitivity of
ANTARES and IceCube

Combined U.L. at 90% CL on the three-flavor
neutrino flux of the KRA- γ model with a 5 PeV cutoff.

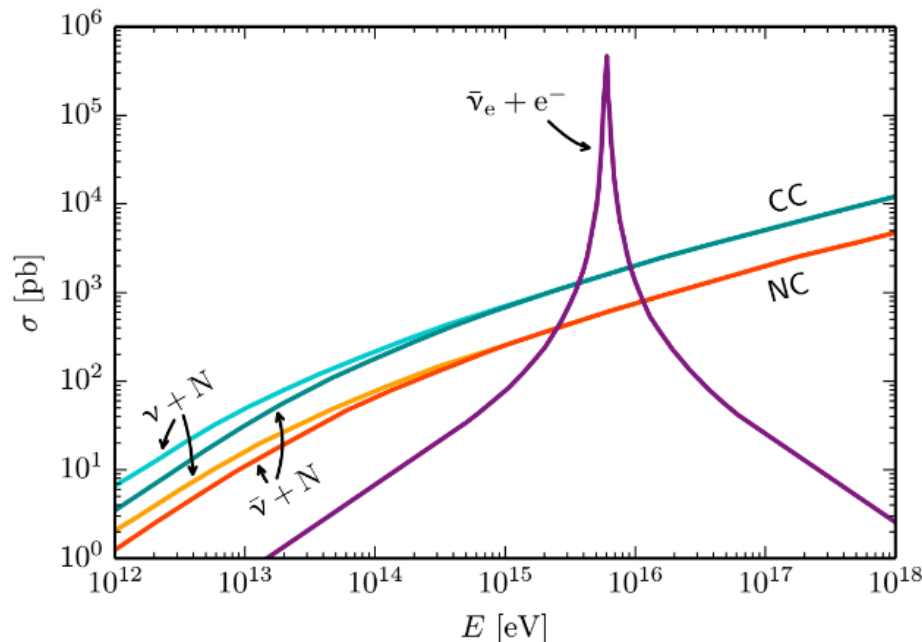
(ANTARES) Phys. Rev. D96 (2017) 062001
(IceCube) ApJ 849 (2017) 67

A 5.9 PeV event in IceCube

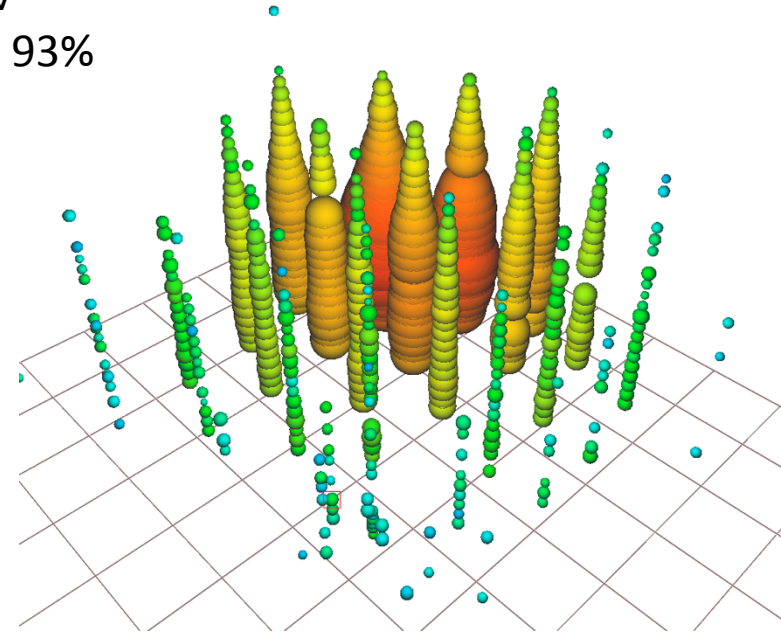
See talk by A. Ishihara (HE 3)



Resonance: $E_\nu = 6.3$ PeV
Typical visible energy is 93%



Work in progress



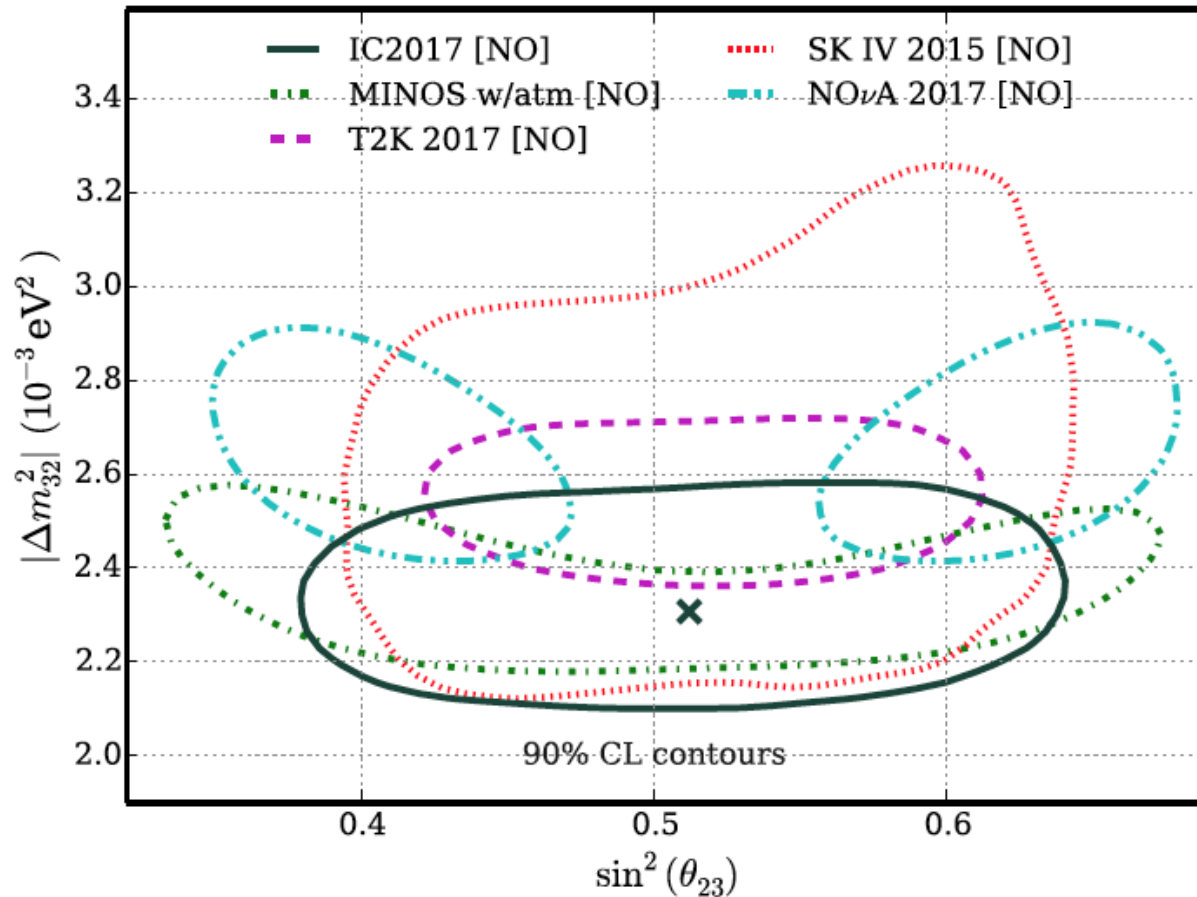
Event identified in a partially-contained PeV search (PEPE)

Deposited energy: 5.9 ± 0.18 PeV (stat only)

ICRC 2017 [arXiv:1710.01191](https://arxiv.org/abs/1710.01191)

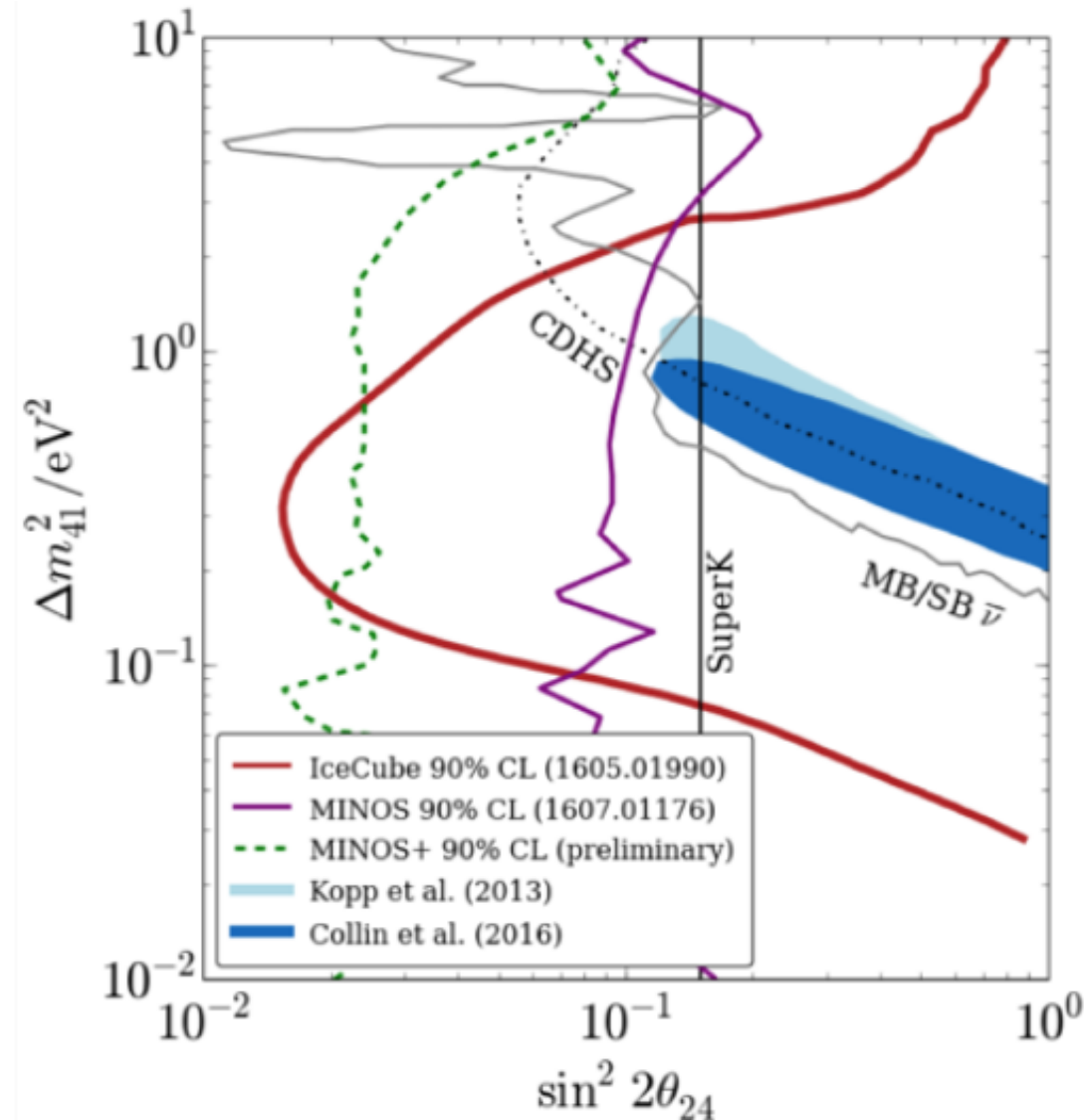
Potential hadronic nature of this event under study

Oscillations



Joint study of cascades and tracks in DeepCore to search for nm disappearance. 15-50 GeV range. Zenith angle and energy reconstruction.

Sterile neutrinos



Resonant matter effects
for TeV scale atm nm,
assuming $\Delta m_{41}^2 \approx 1 \text{ eV}^2$

In tension with LSND/
MiniBoone

Summary

IceCube has discovered an astrophysical neutrino diffuse flux

We have found the first evidence for a neutrino source:
Blazar TXS 0506+056 : Multi-messenger science

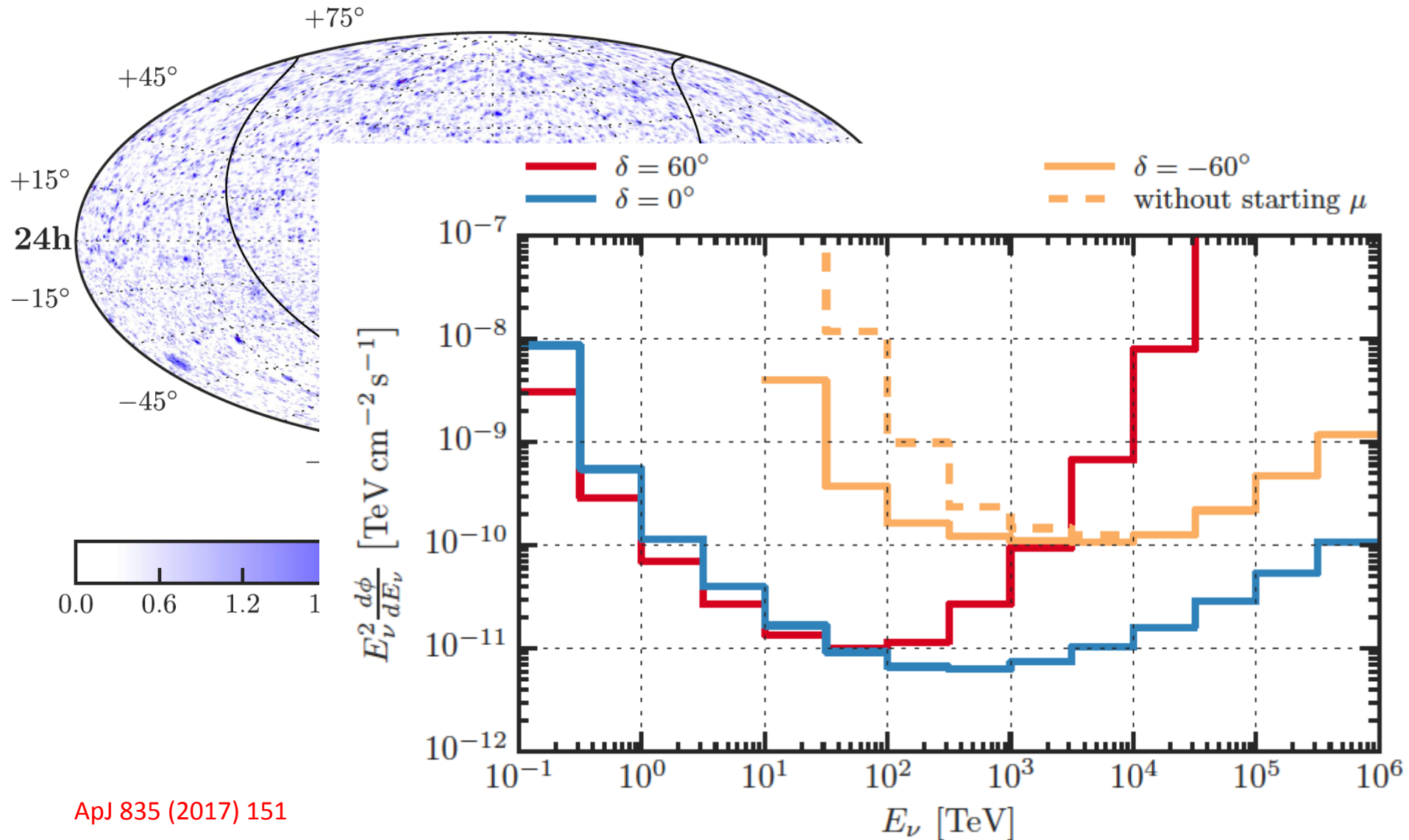
IceCube, with DeepCore, is a very competent Neutrino Physics instrument

IceCube has a very varied science portfolio that I didn't have time to cover

The IceCube upgrade (7 strings) has been funded!

We are planning IceCube Gen 2 to improve the Neutrino Physics and Astrophysics capabilities

IceCube - Point Sources – 7 years



ApJ 835 (2017) 151