

Neutrino emission from the direction of the blazar TXS 0506+056 prior to the IceCube-170922A alert

IceCube Collaboration

Science, 361, 147, 2018

Multimessenger observations of a flaring blazar coincident with high-energy neutrino IceCube-170922A

The IceCube Collaboration, Fermi-LAT, MAGIC, AGILE, ASAS-SN, HAWC, H.E.S.S., INTEGRAL, Kanata, Kiso, Kapteyn, Liverpool Telescope, Subaru, Swift/NuSTAR, VERITAS, and VLA/17B-403 teams

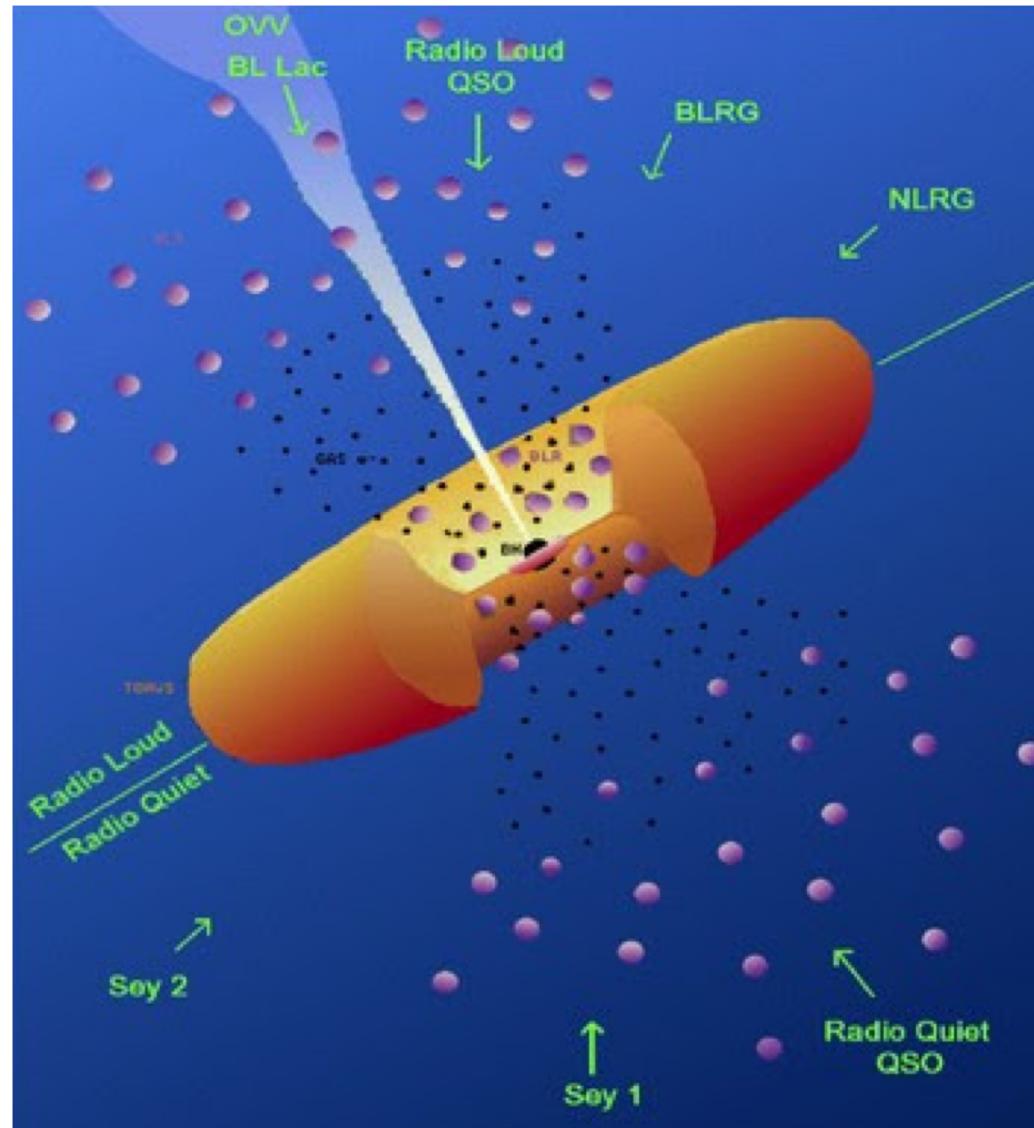
Science, 361, 147, 2018

Personal Background

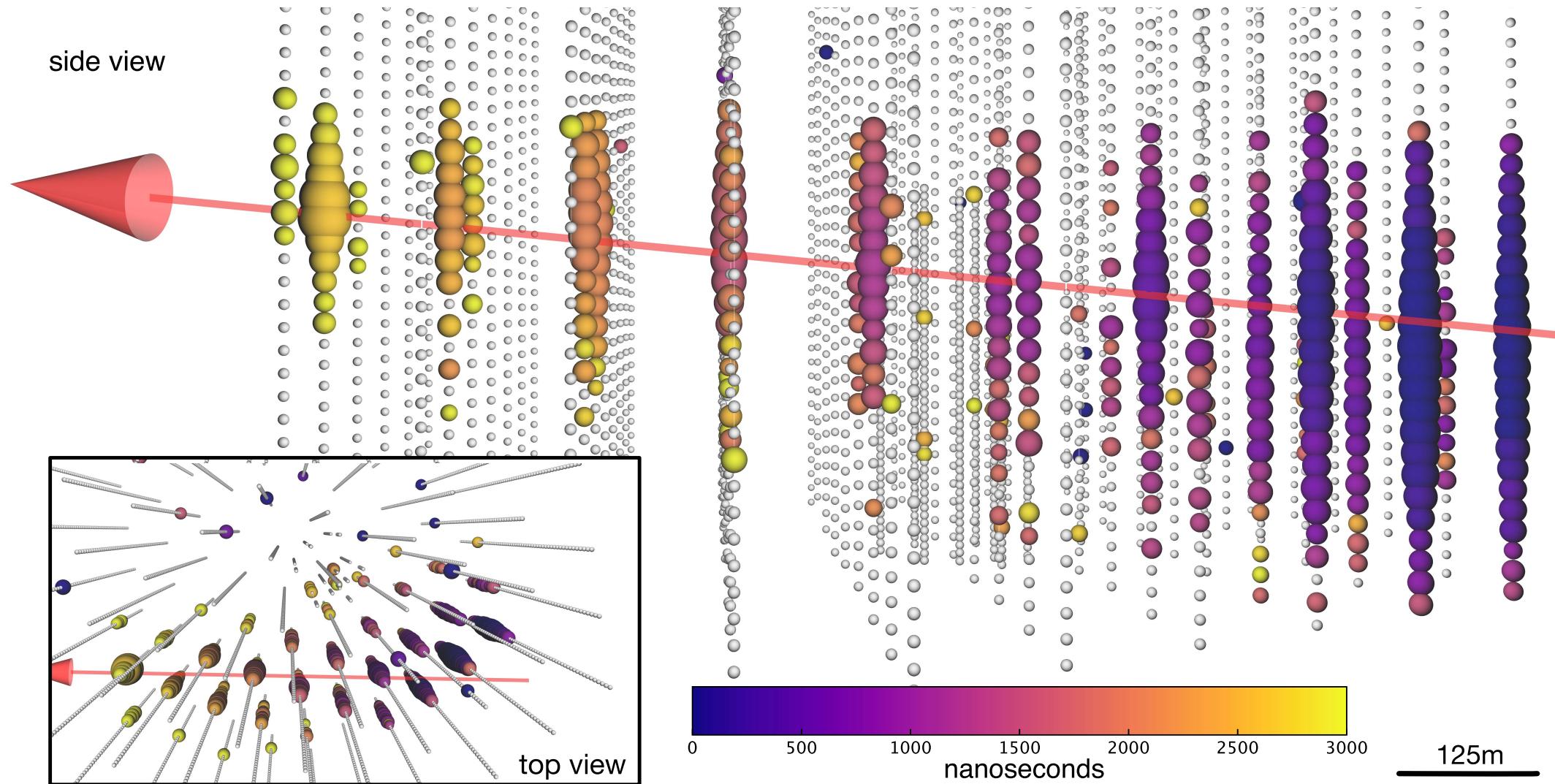
- BS in Physics
- MS in Nuclear Physics Theory
 - Thesis: Gamma-ray Bursts
- Ph.D in Computational Astrophysics
 - Thesis: Multi-Dimensional Special Relativistic Radiation Hydrodynamics Code
- Post-Doc
 - Hydrodynamics with non-equilibrium ionization
 - High velocity clouds and diffuse ISM
- Research Interests
 - Hydrodynamics with chemical reactions: star forming cloud and evolved stars
 - Hydrodynamics with nuclear reactions: stellar evolution, explosive phenomena near compact objects (e.g., X-ray bursts)
 - Gravitational wave, neutrino astrophysics, and nuclear astrophysics

Introduction

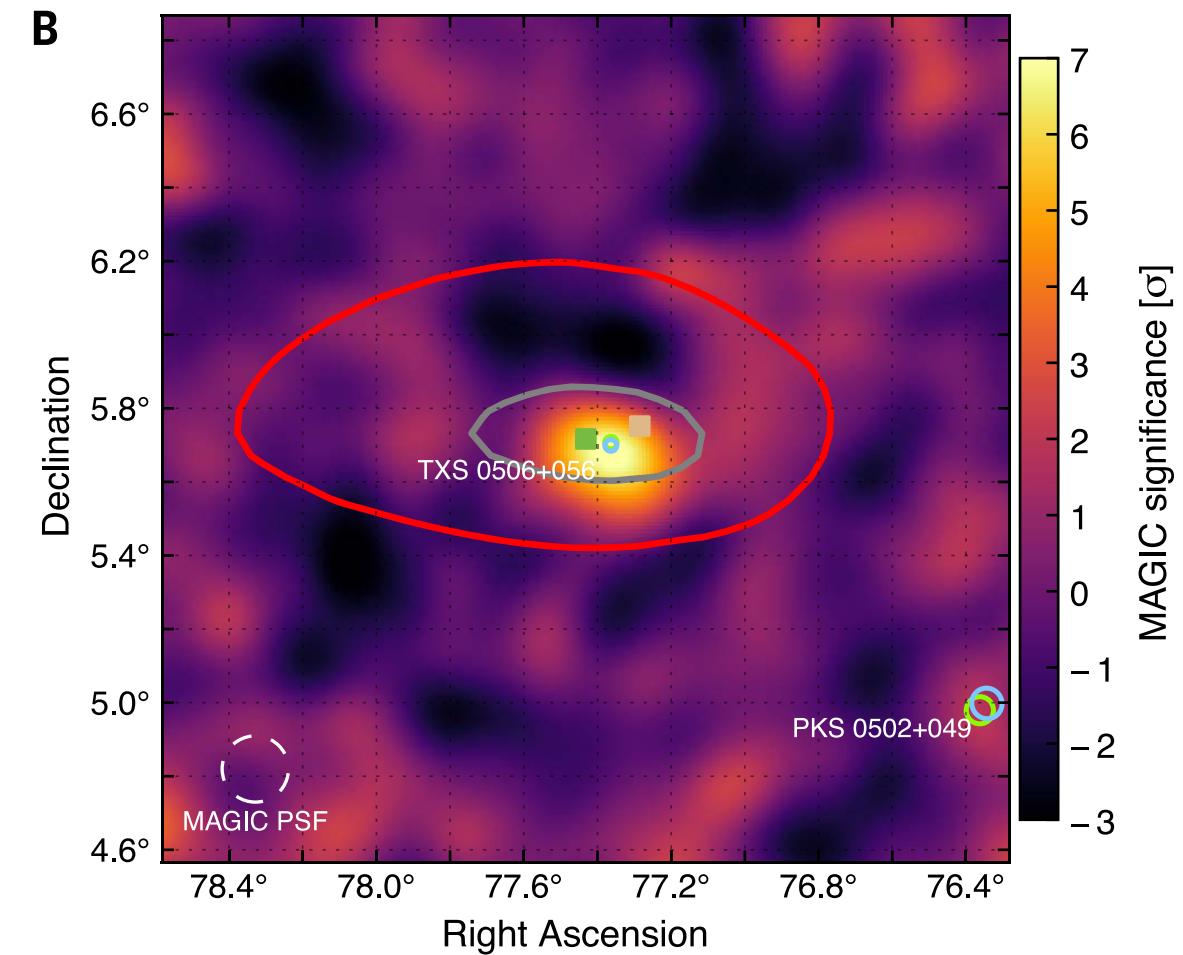
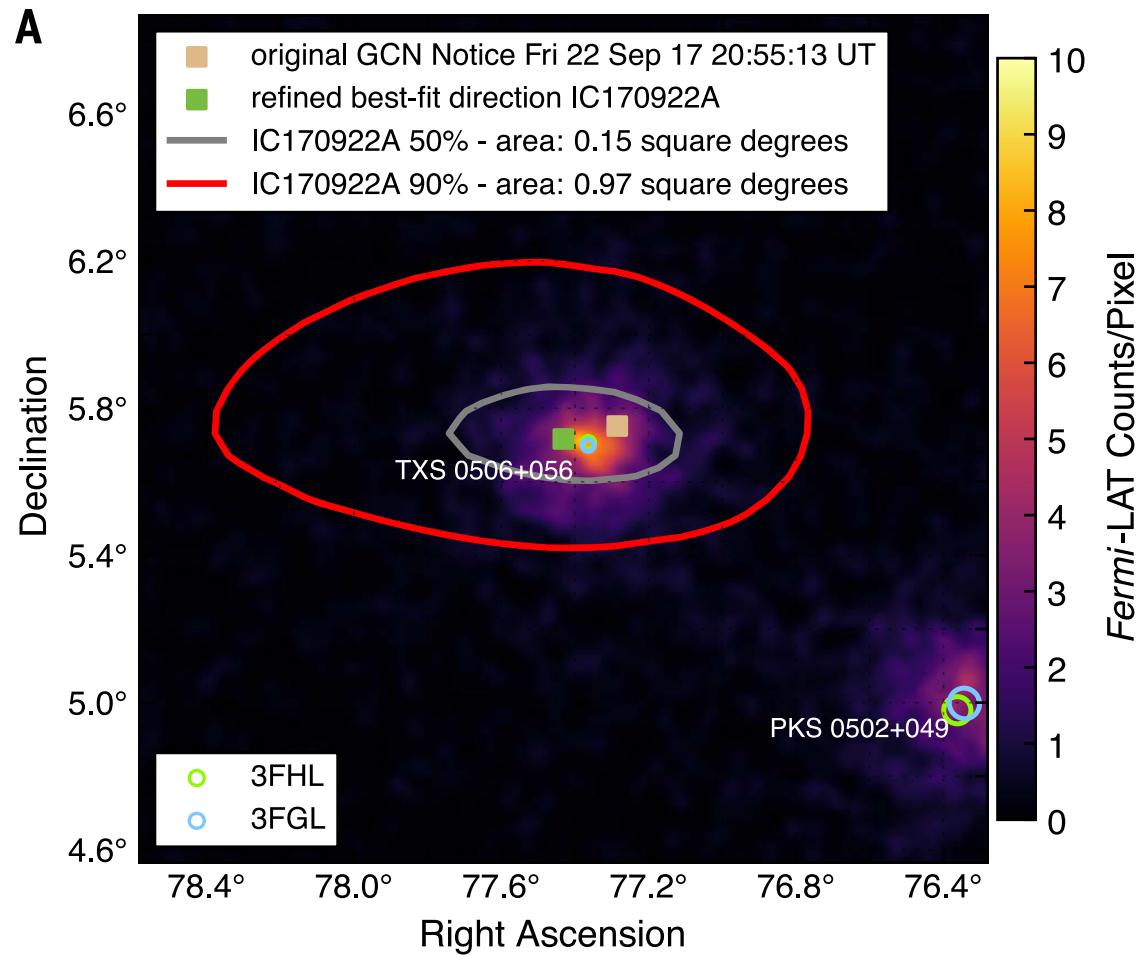
- Blazar as an active galactic nuclei (AGN)
- In the relativistic jet, protons and/or nuclei are accelerated -> cosmic rays
- Protons (nuclei) + photons -> neutral and charged pions -> photons and (muons + neutrinos)
- Neutrinos + nuclei in ice/water -> muons. Charged muons move faster than speed of light in the medium and radiate visible photons via Cherenkov radiation.



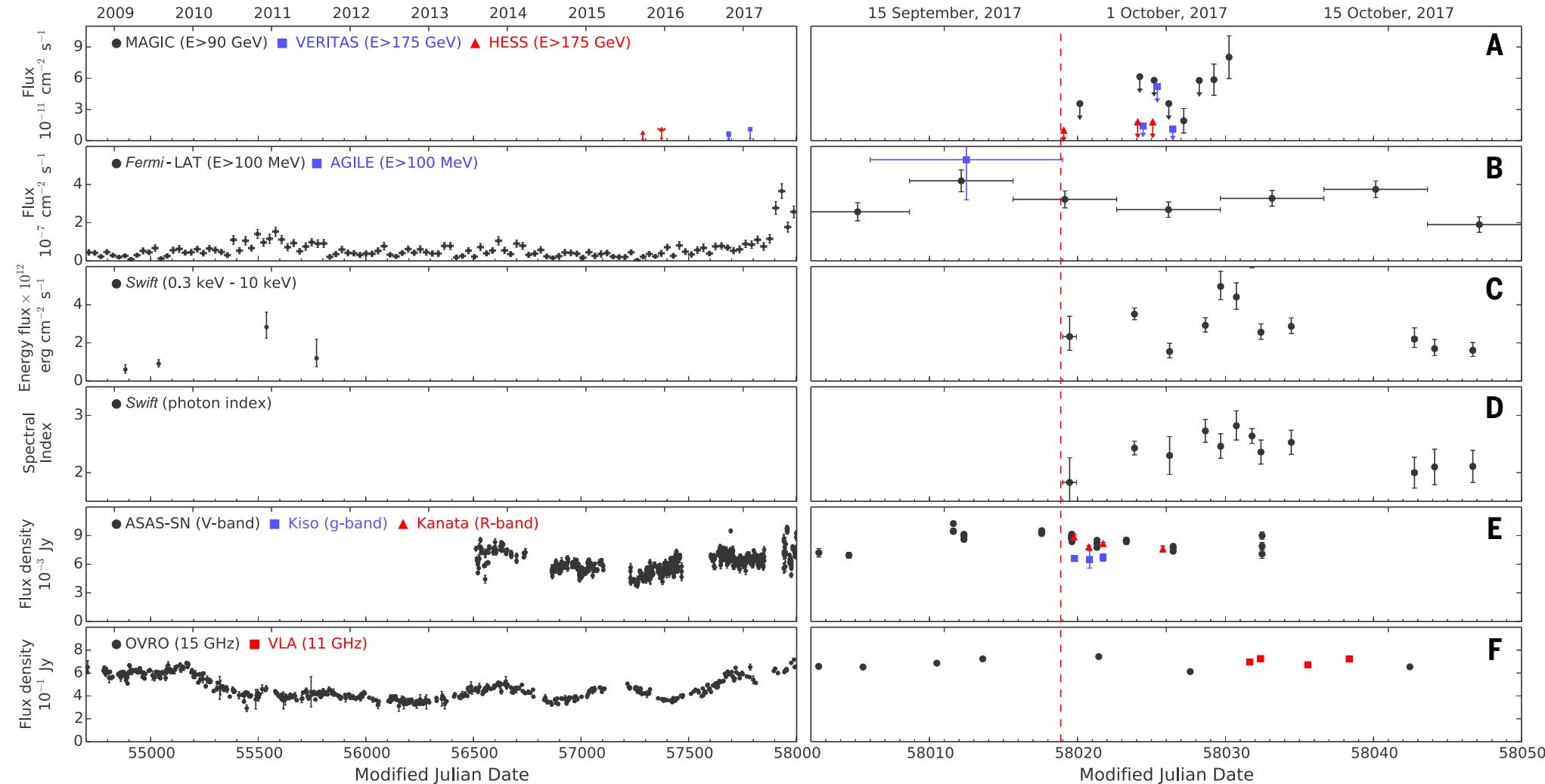
IceCube-170922A



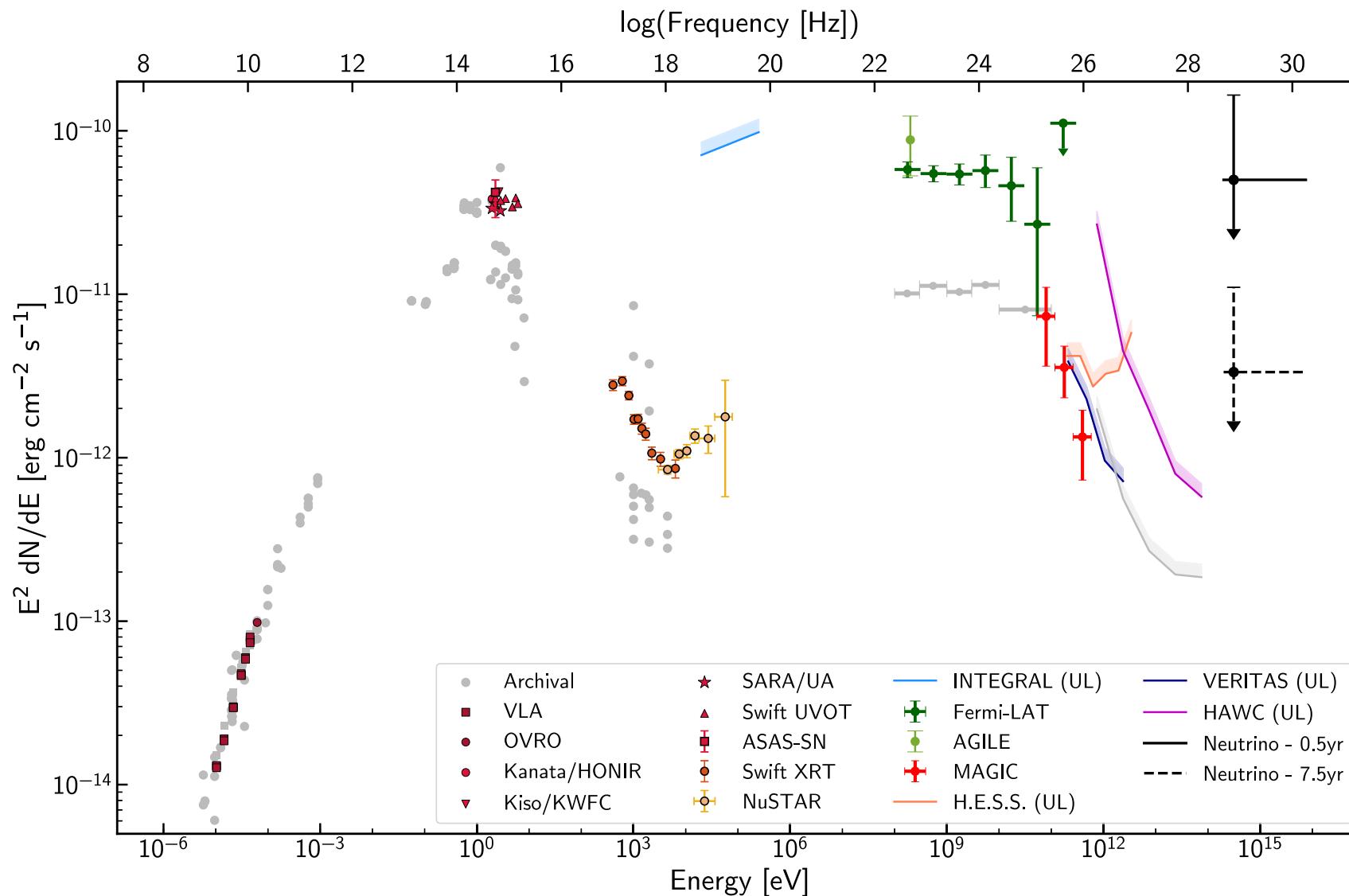
Multi-messenger observations: location



Multi-messenger observations: lightcurve



Multi-messenger observations: spectrum



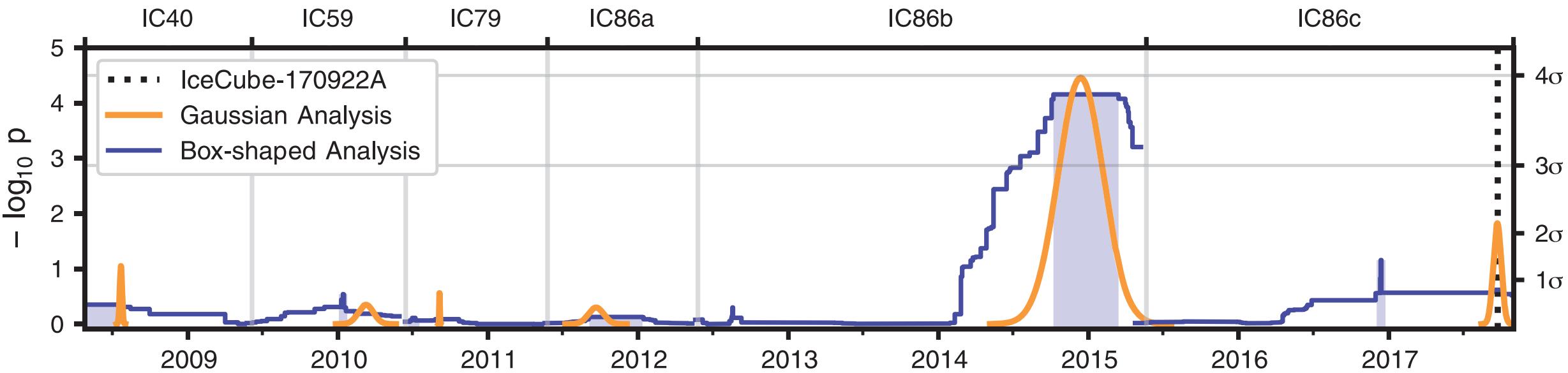
Neutrino emission from the direction of the blazar TXS 0506+056 prior to the IceCube-170922A alert ?

- Search signal by using four parameters (Φ_{100} , γ , T_0 , T_W)
 - Astrophysical neutrinos have different spectral index than atmospheric neutrinos
- Time-dependent and time-integrated search

New event found

Time-dependent search

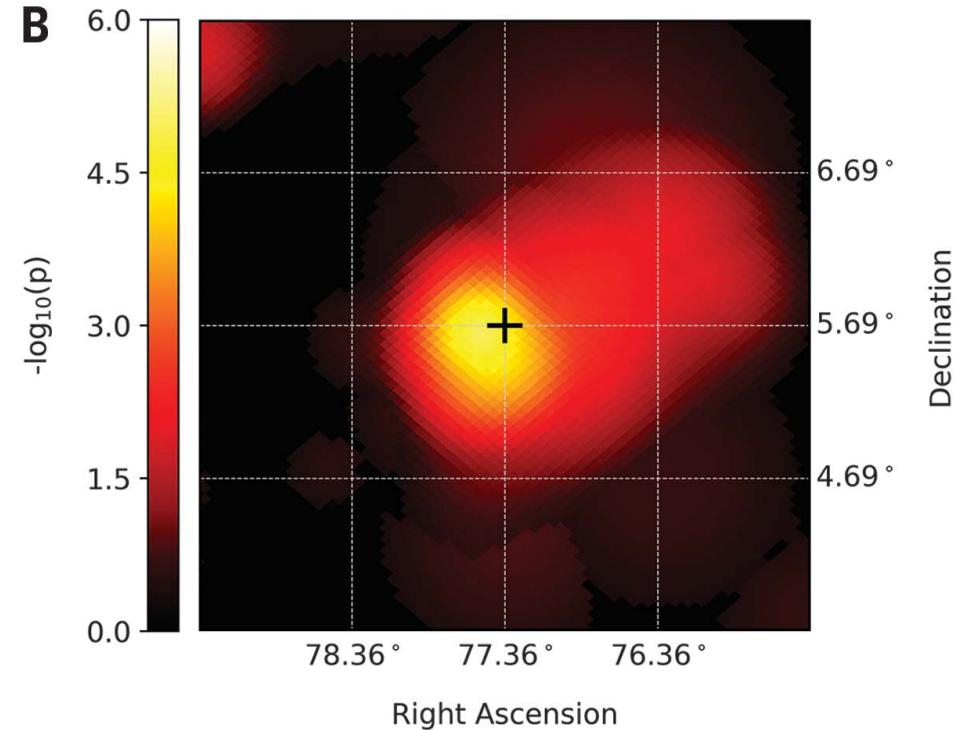
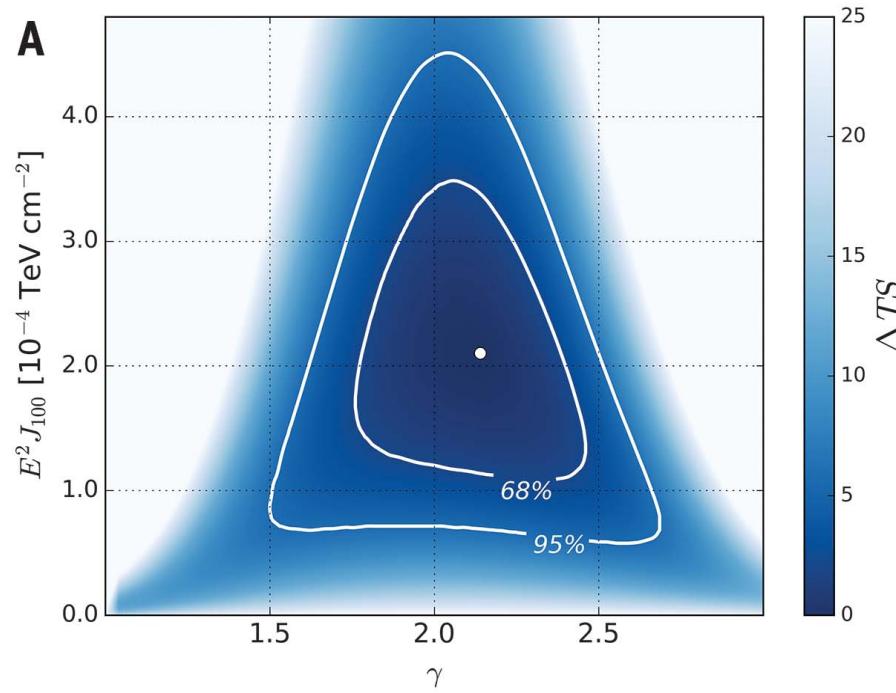
Sample	Start	End
IC40	5 April 2008	20 May 2009
IC59	20 May 2009	31 May 2010
IC79	31 May 2010	13 May 2011
IC86a	13 May 2011	16 May 2012
IC86b	16 May 2012	18 May 2015
IC86c	18 May 2015	31 October 2017



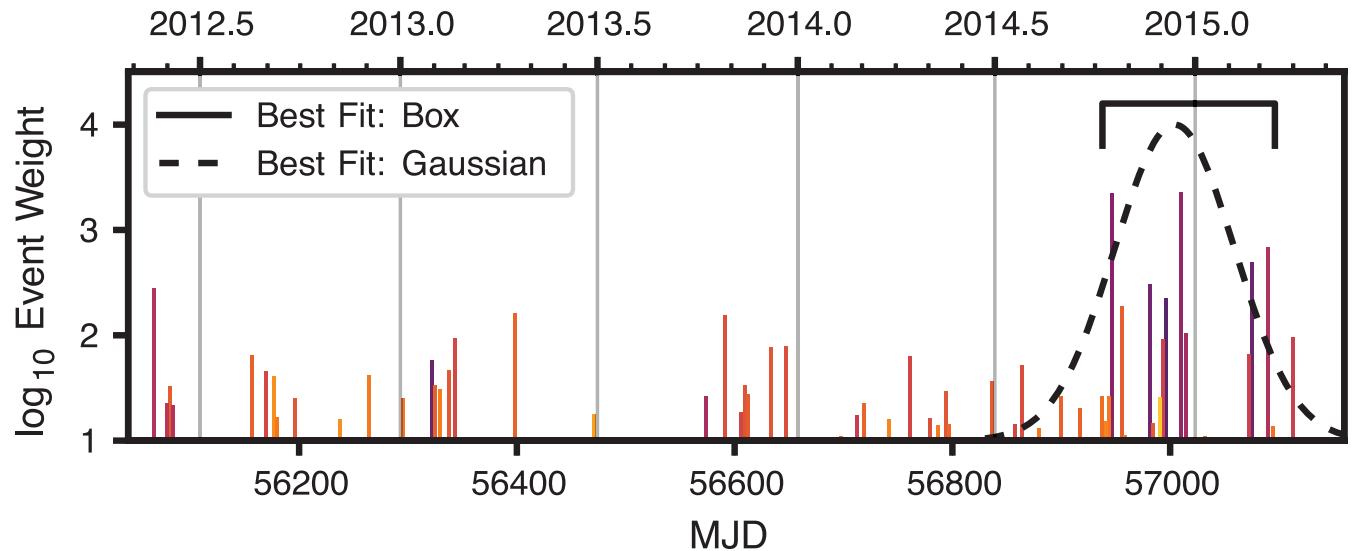
Estimating parameters

Time-dependent search

Using IC86b data

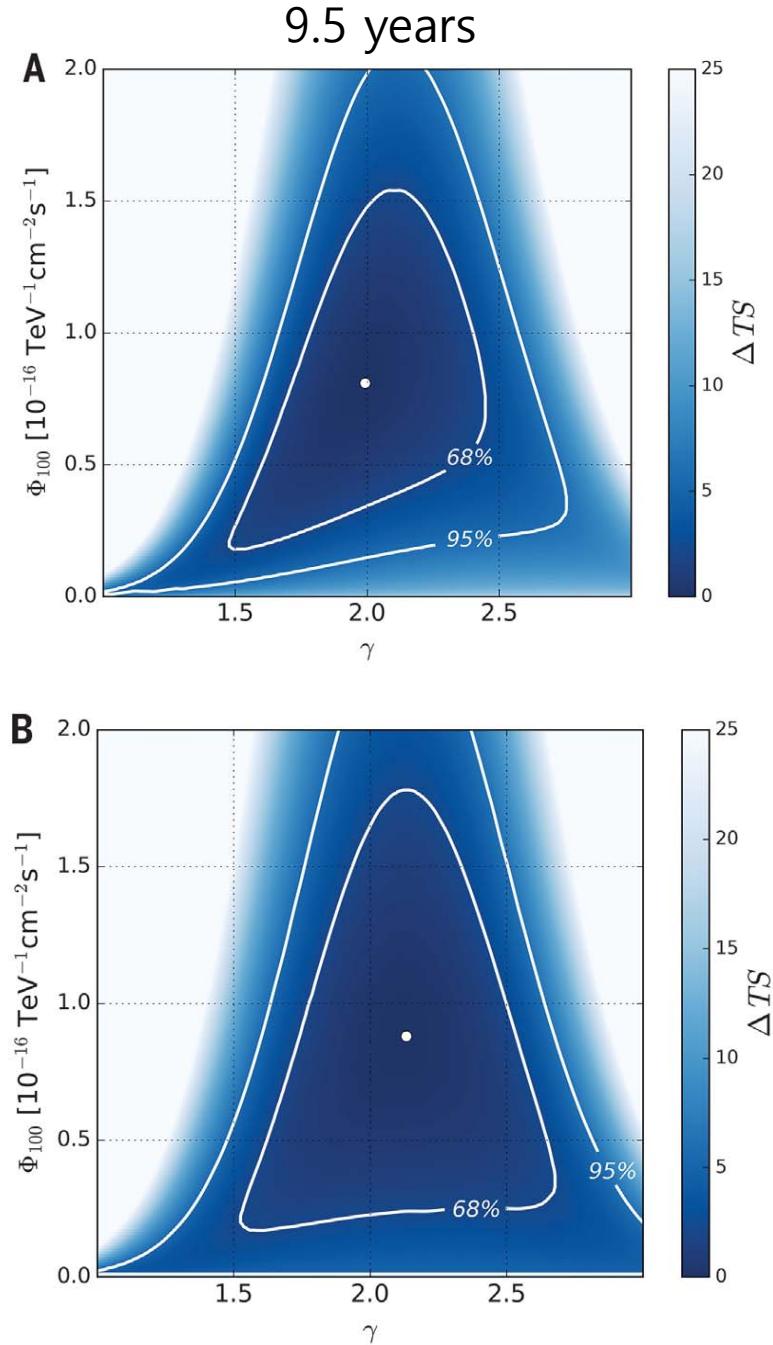


Time-integrated search



Meson Energy Proxy (TeV)

7 years



Blazars as neutrino sources

- Observed luminosities in gamma-ray and neutrino are different
 - Neutrino luminosity $\sim 1.2\text{e}47 \text{ erg s}^{-1}$ during 158 days
 - Gamma-ray luminosity $\sim 0.28\text{e}47 \text{ erg s}^{-1}$ during the same period of time \sim similar to the long-term luminosity between 0.1 and 100 GeV
- Uniqueness of TXS 0506+056
 - Gamma-ray bright
 - Location with respect to IceCube