Neutrinos to Constrain the Emission of Cosmic Ray Accelerators

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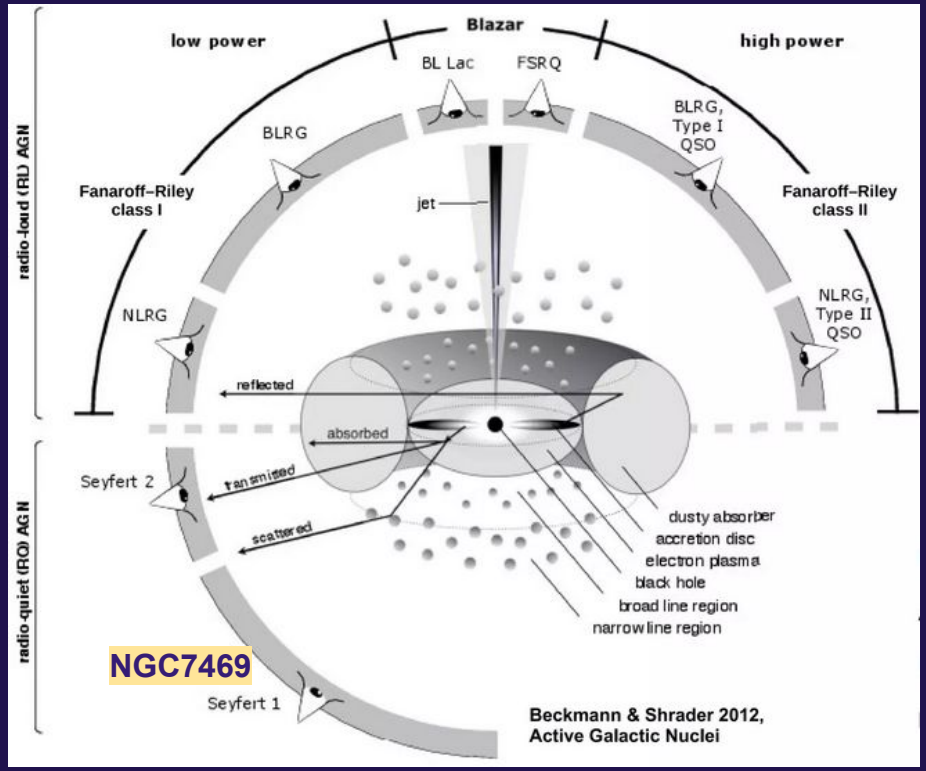

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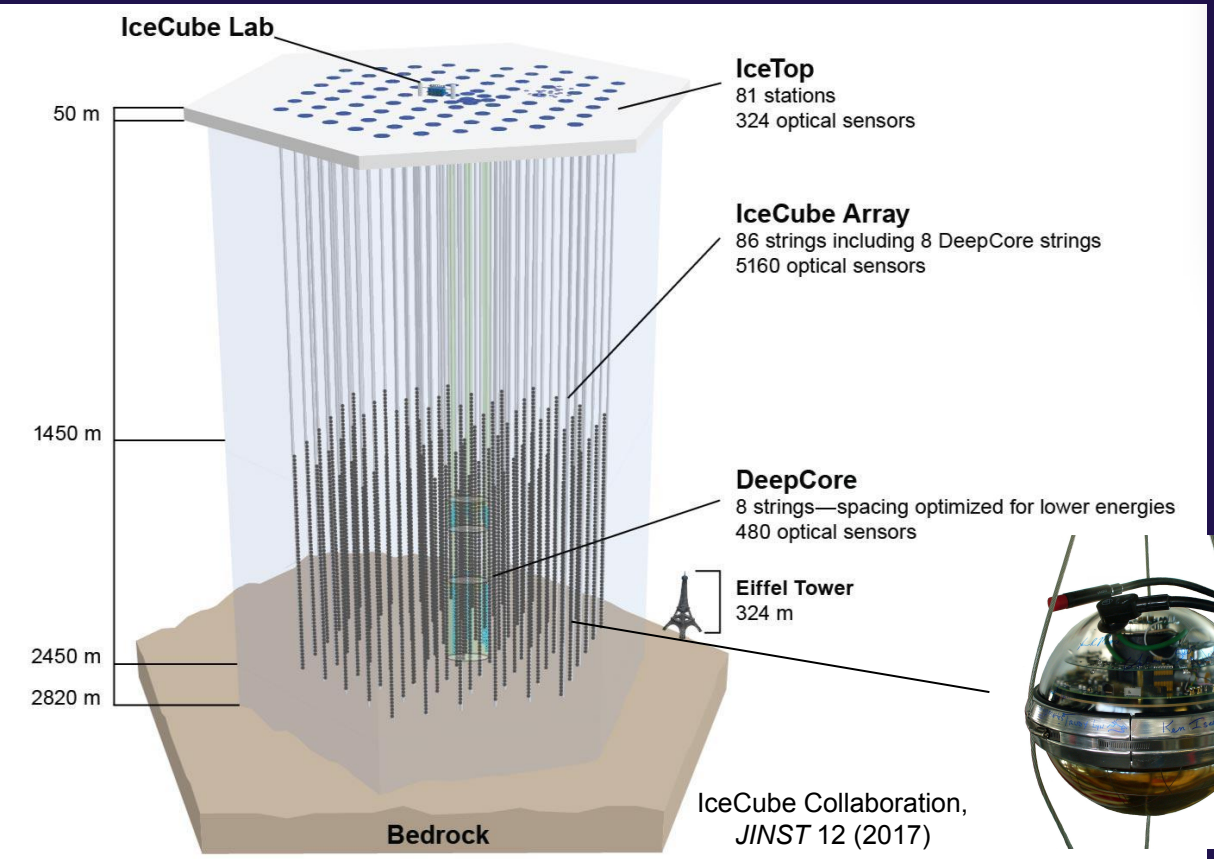
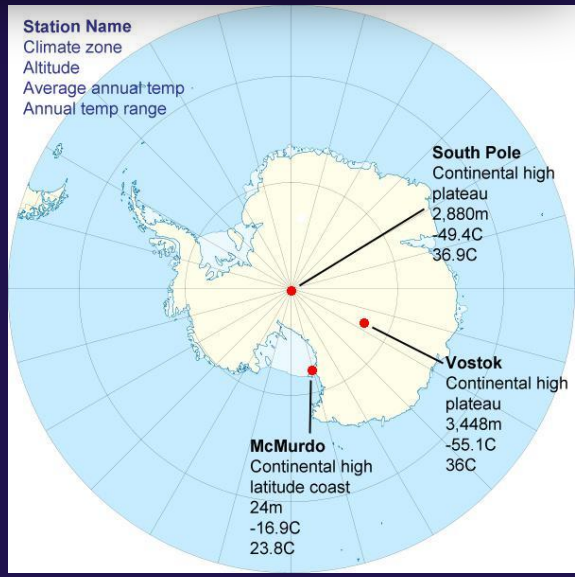
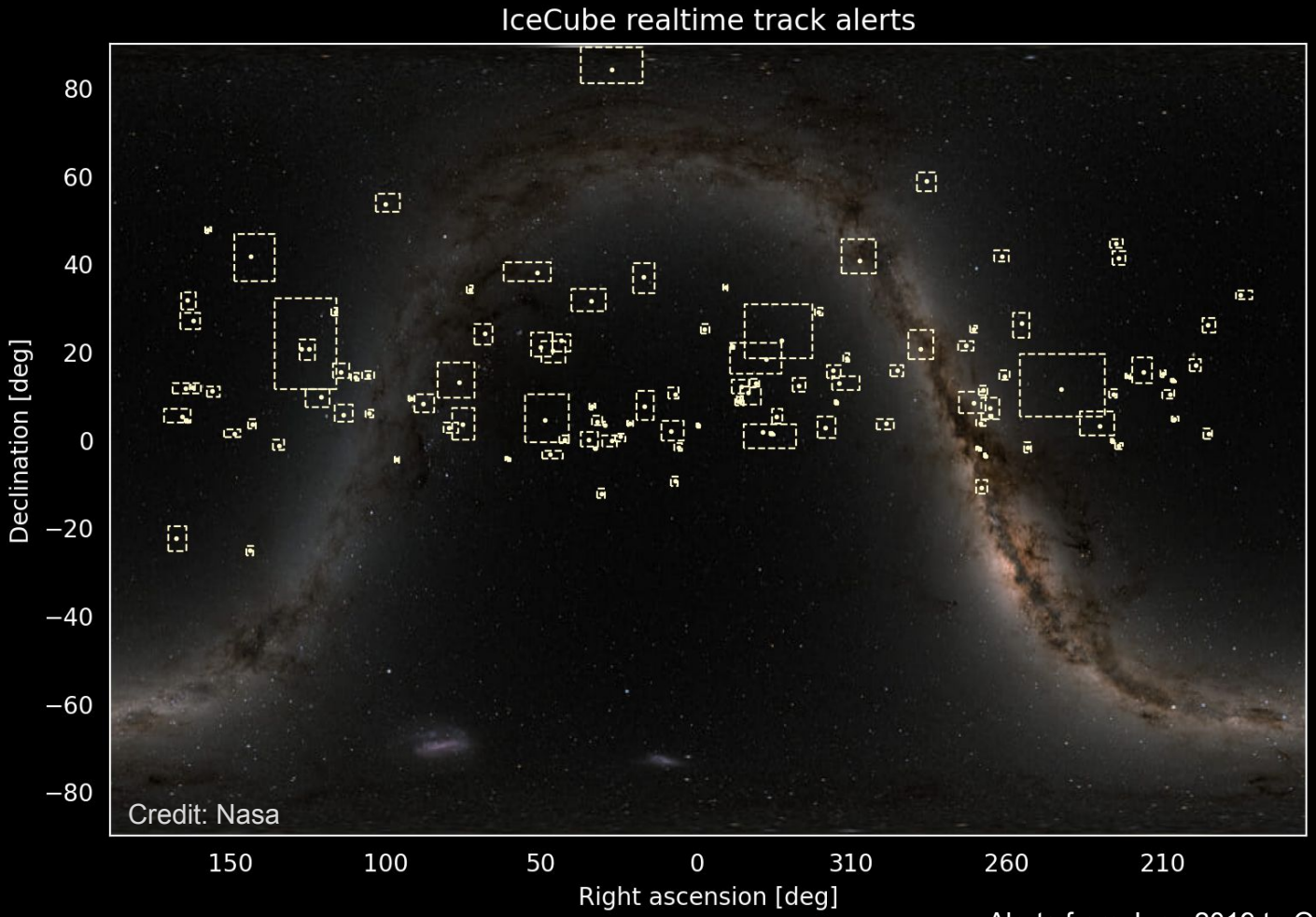
The IceCube Neutrino Observatory



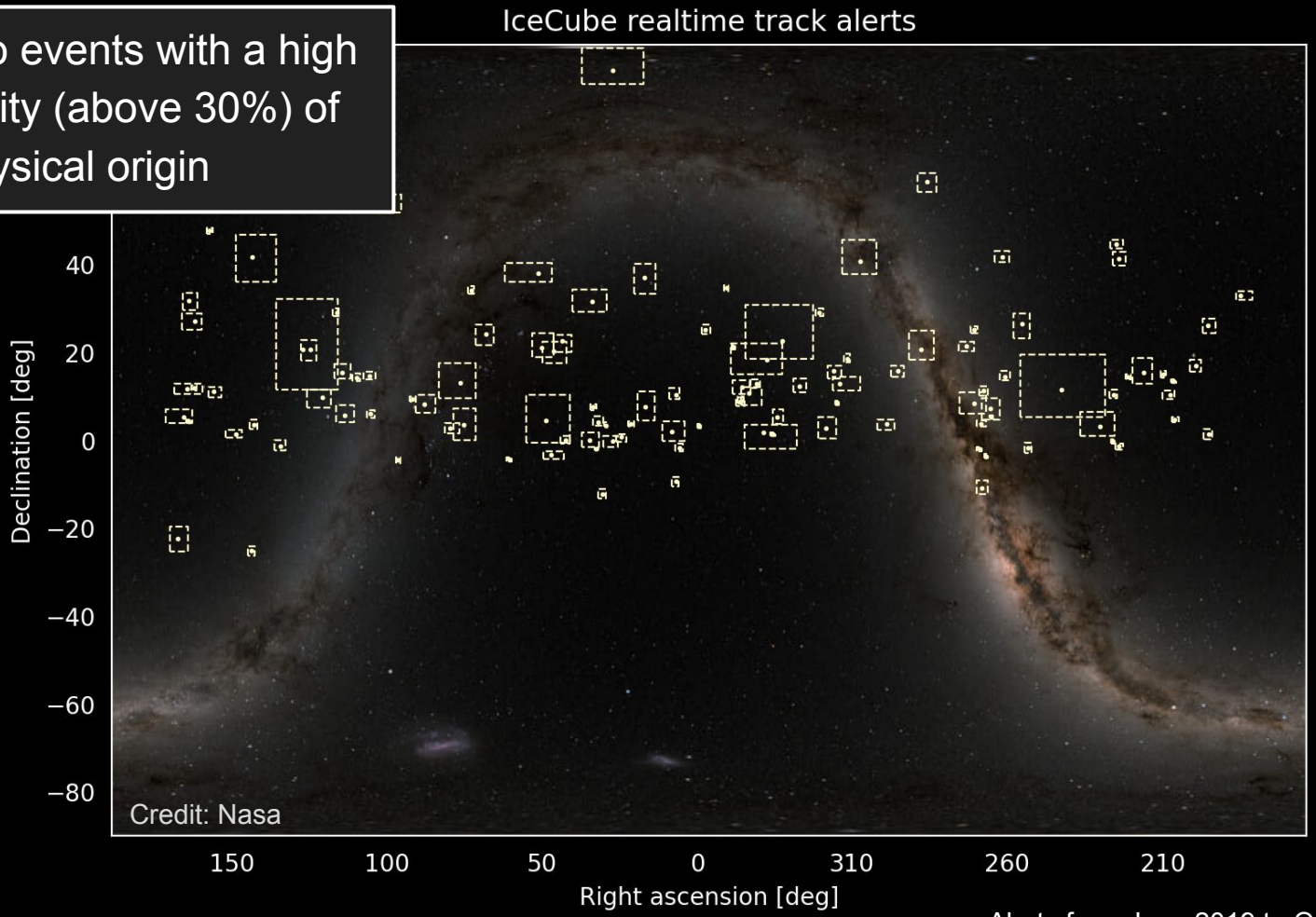
IceCube Collaboration, *JINST* 12 (2017)





Alerts from June 2019 to October 2023

Neutrino events with a high probability (above 30%) of astrophysical origin



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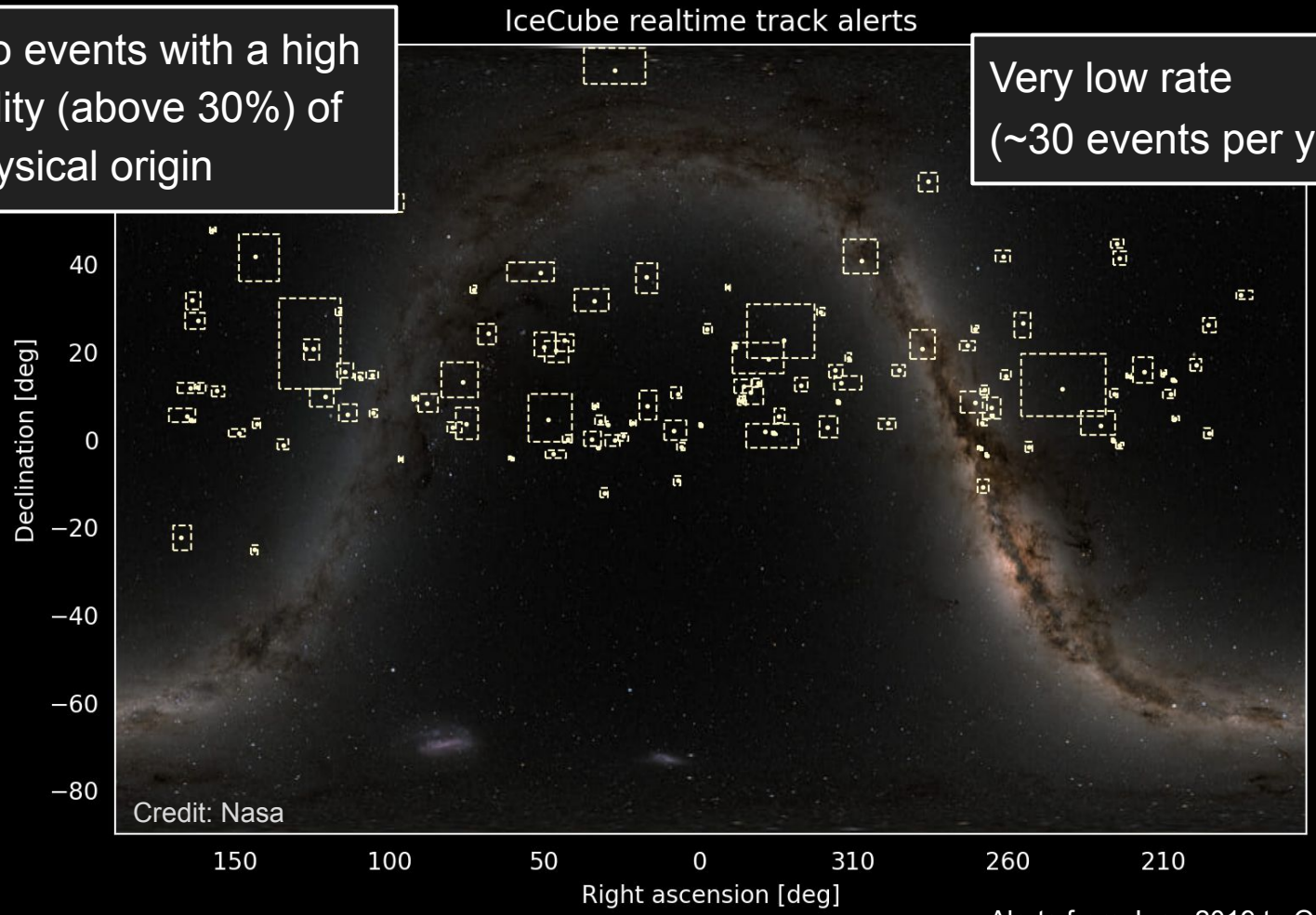
Very low rate
(~30 events per year)



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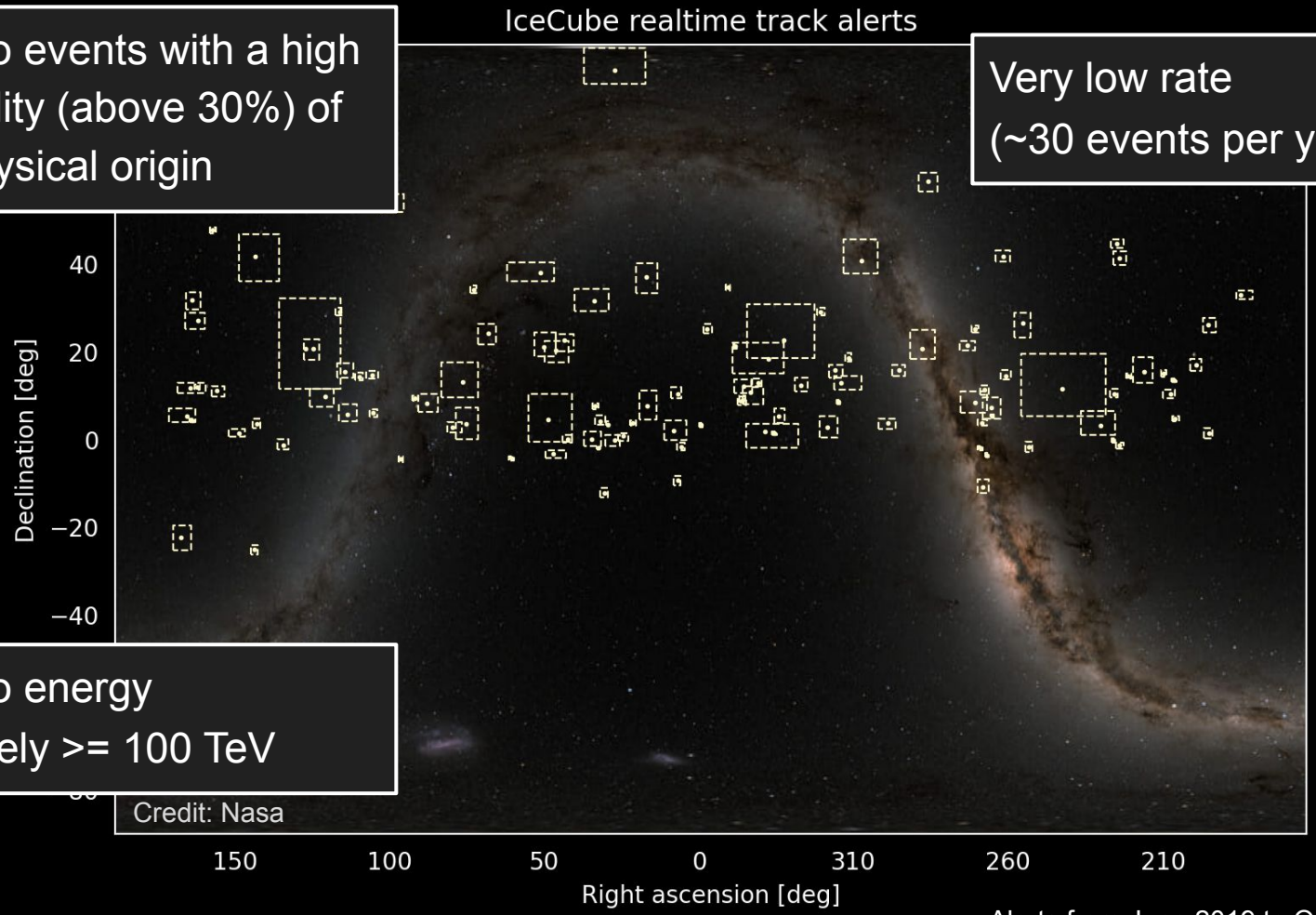

Neutrino energy
most likely >= 100 TeV

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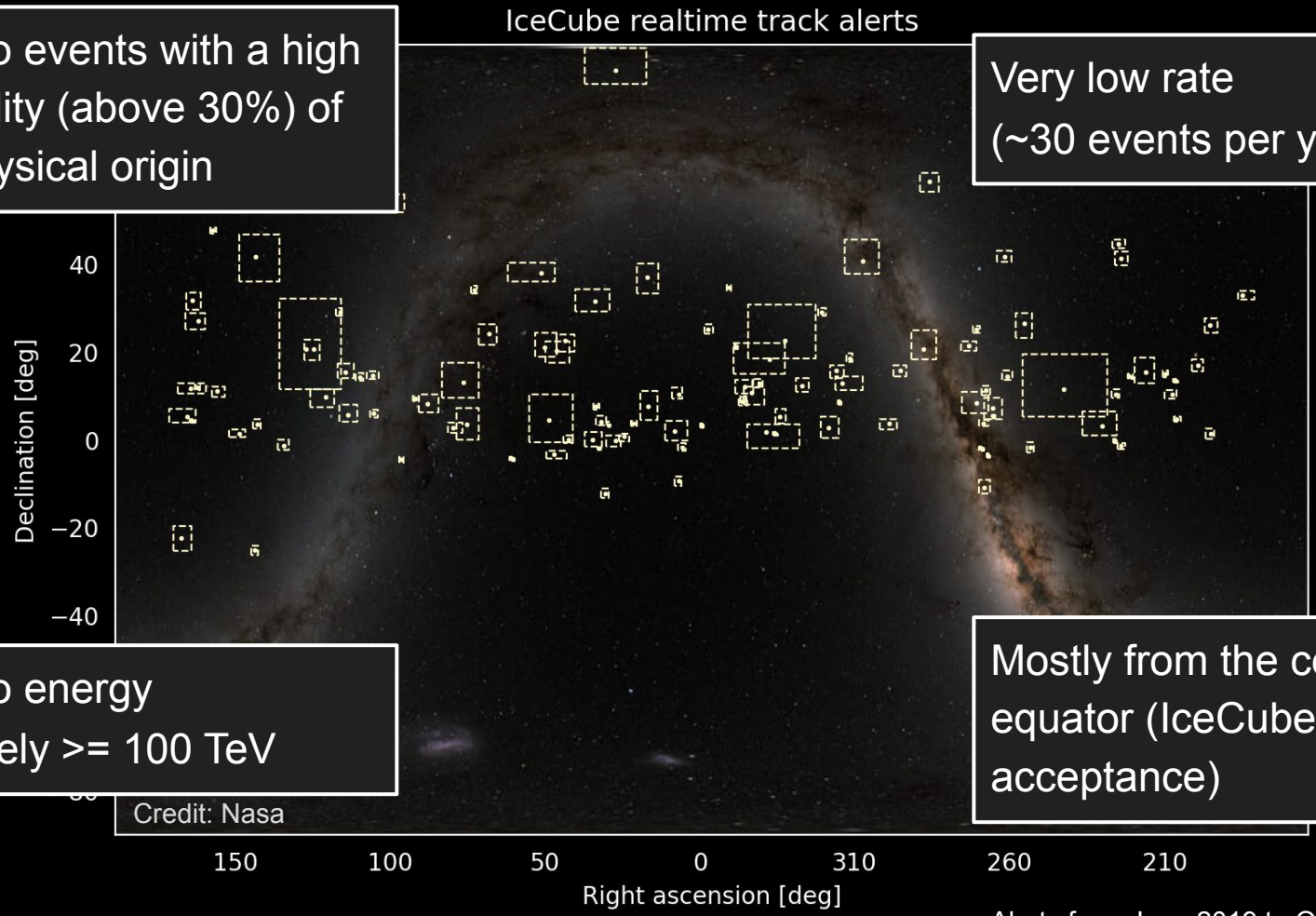
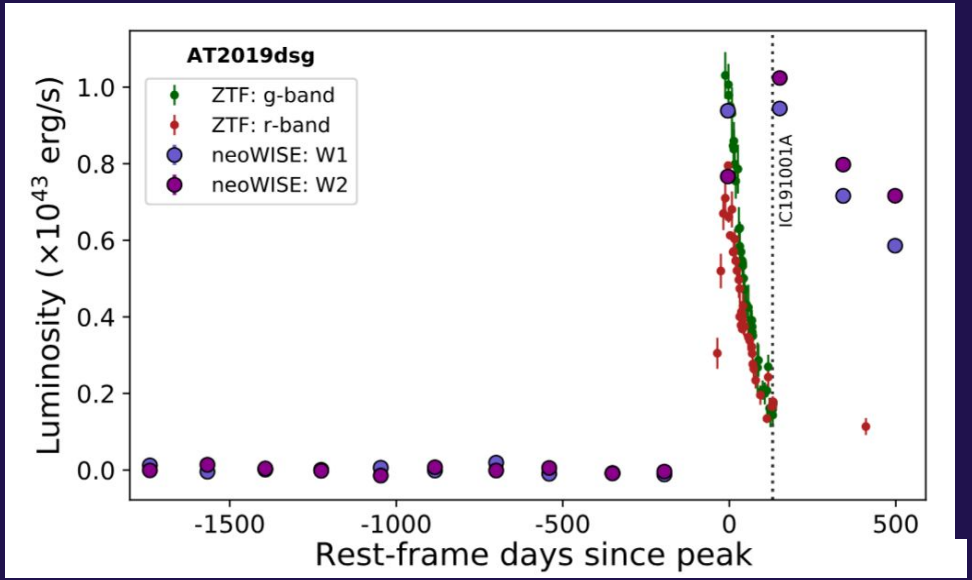


Neutrino energy
most likely >= 100 TeV

Mostly from the celestial equator (IceCube acceptance)

Alerts from June 2019 to October 2023

Alerts coincident with tidal disruption events (TDE)s (project A6)



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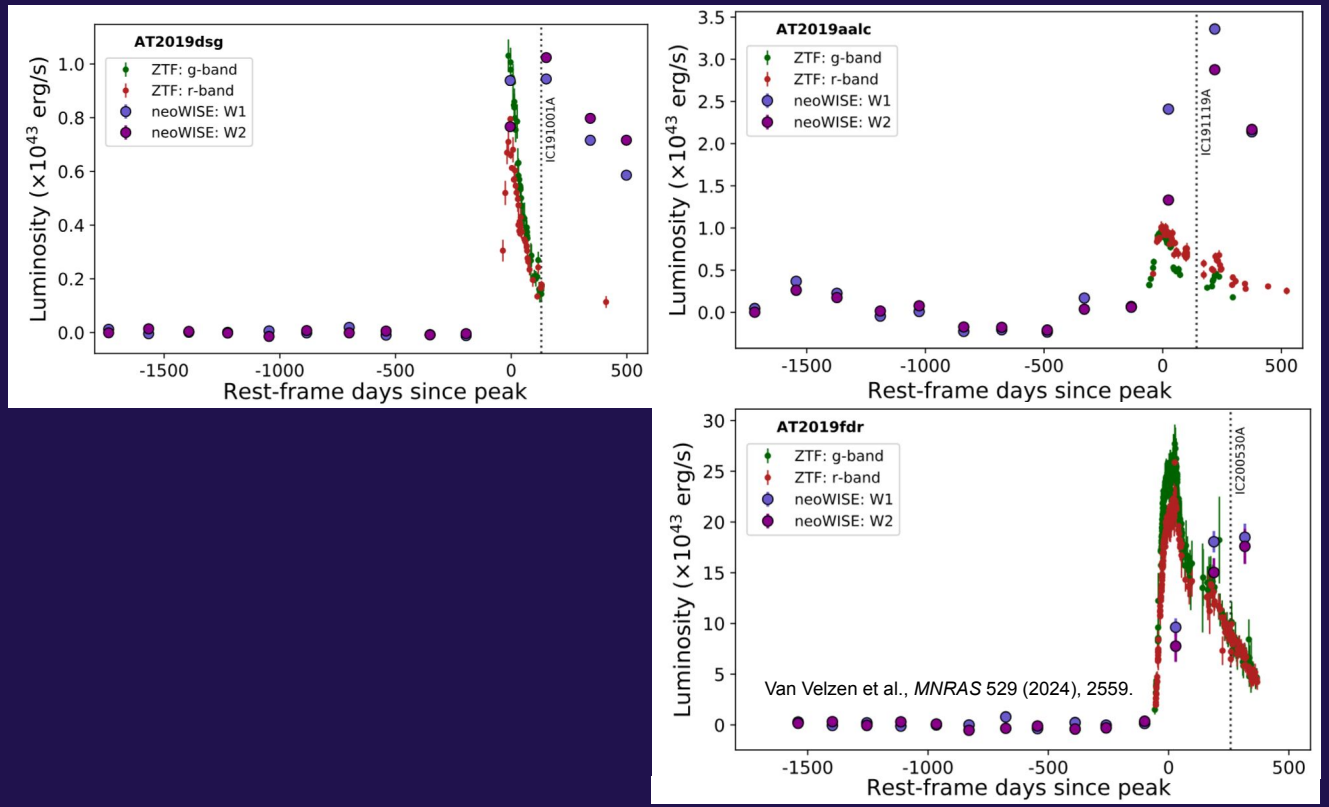
Three alerts spatially coincident with TDEs

All ~100 days after optical peak

All at the peak of infrared emission



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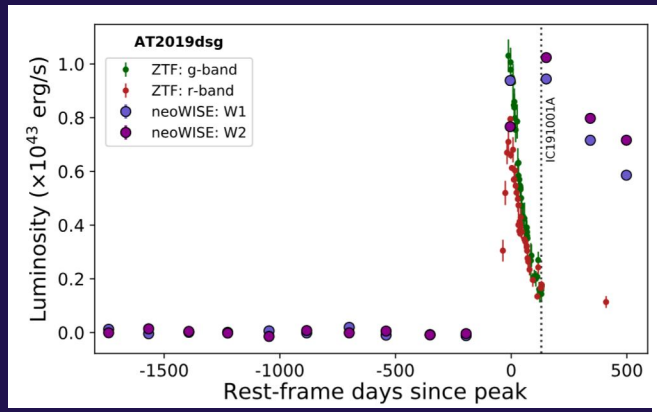
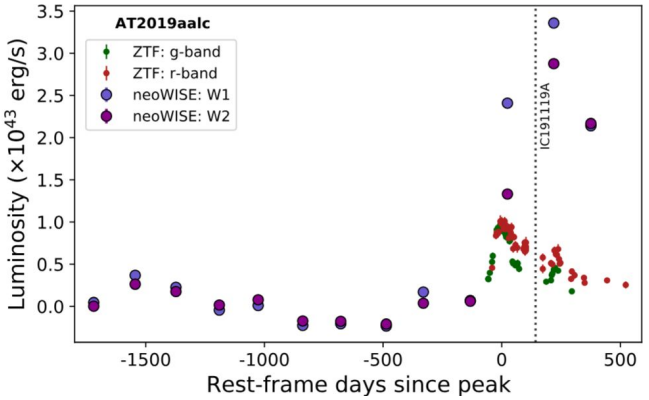
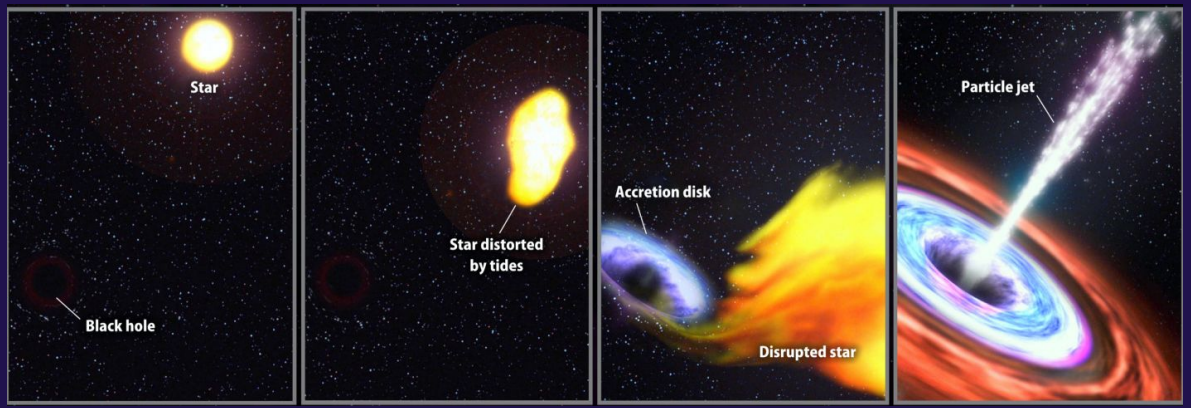
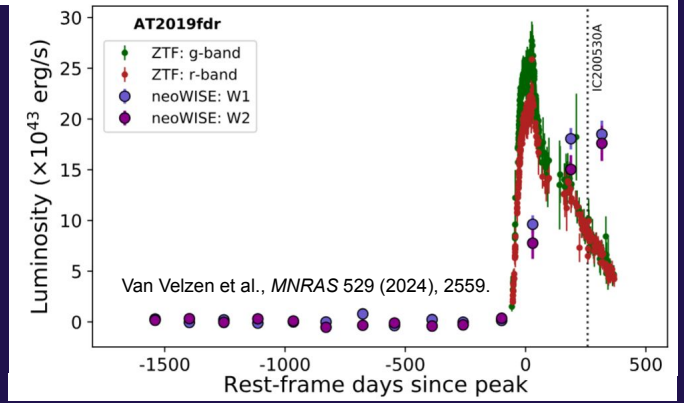


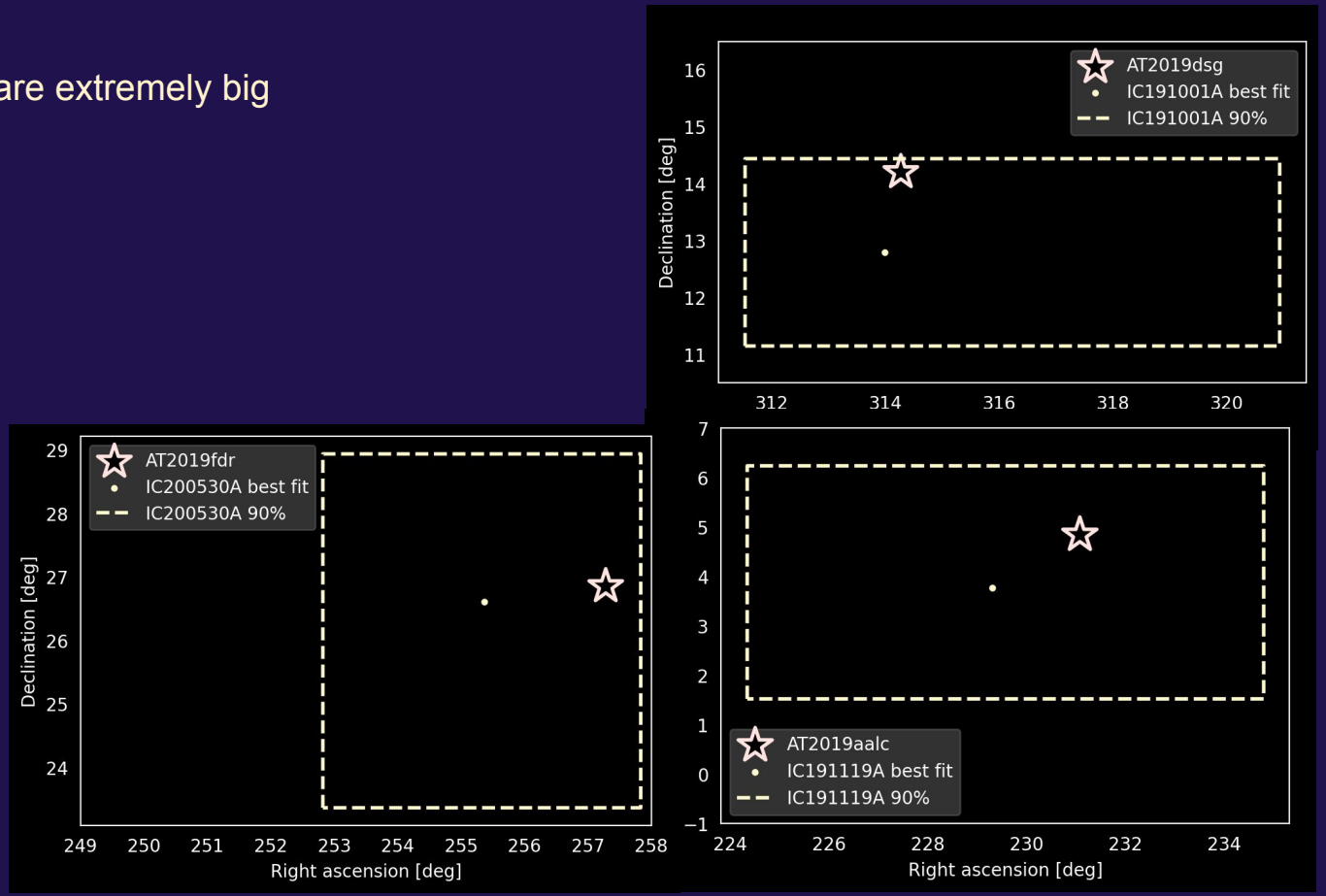






Alerts coincident with tidal disruption events (TDE)s (project A6)

Controversy: all contours are extremely big



Alerts coincident with tidal disruption events (TDE)s (project A6)

Controversy: all contours are extremely big

Overlapped size of the Moon: 

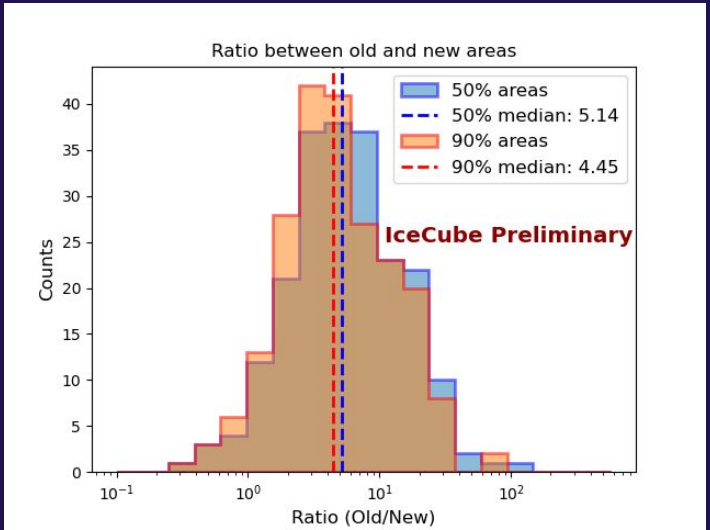
Improving the reconstruction in IceCube (project A6)

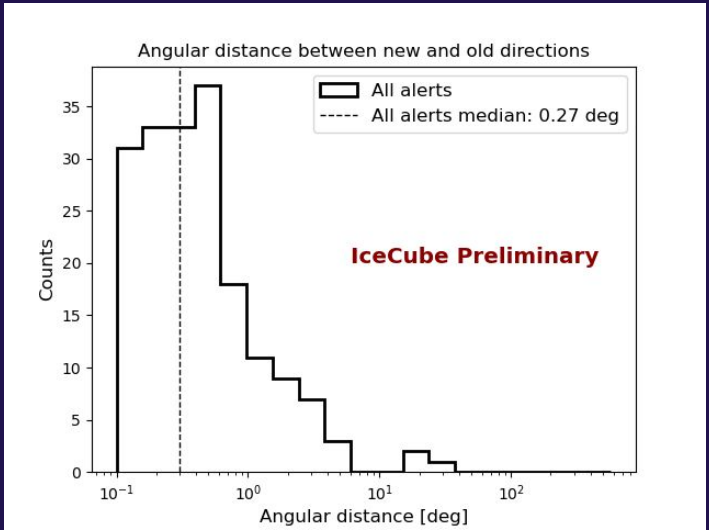
My work: significantly improved precision and accuracy of the reconstruction for IceCube alerts

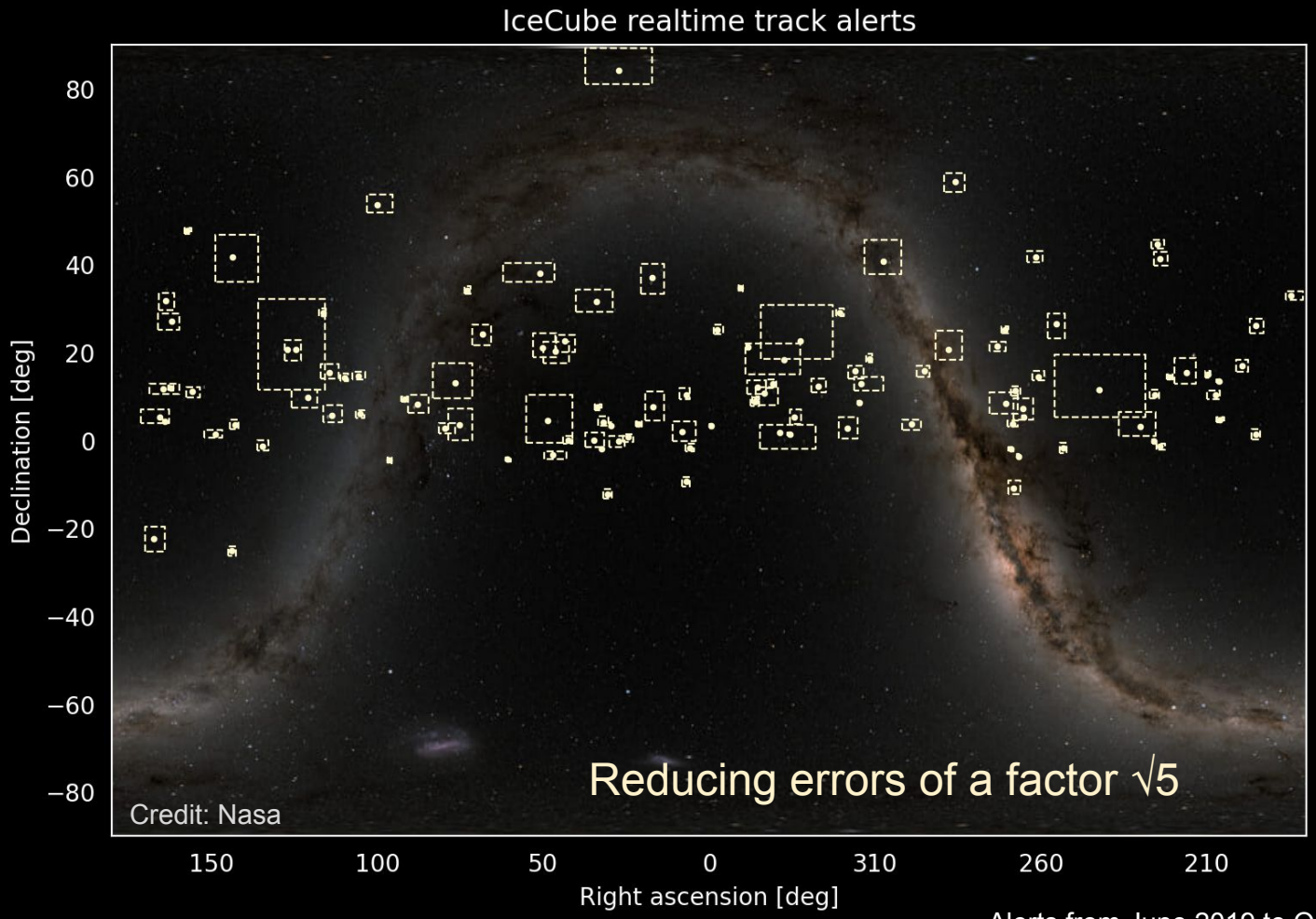
Updated reconstruction publicly announced (GCN Circular 38267)

The new alerts already have the new contours

For old alerts: coming soon

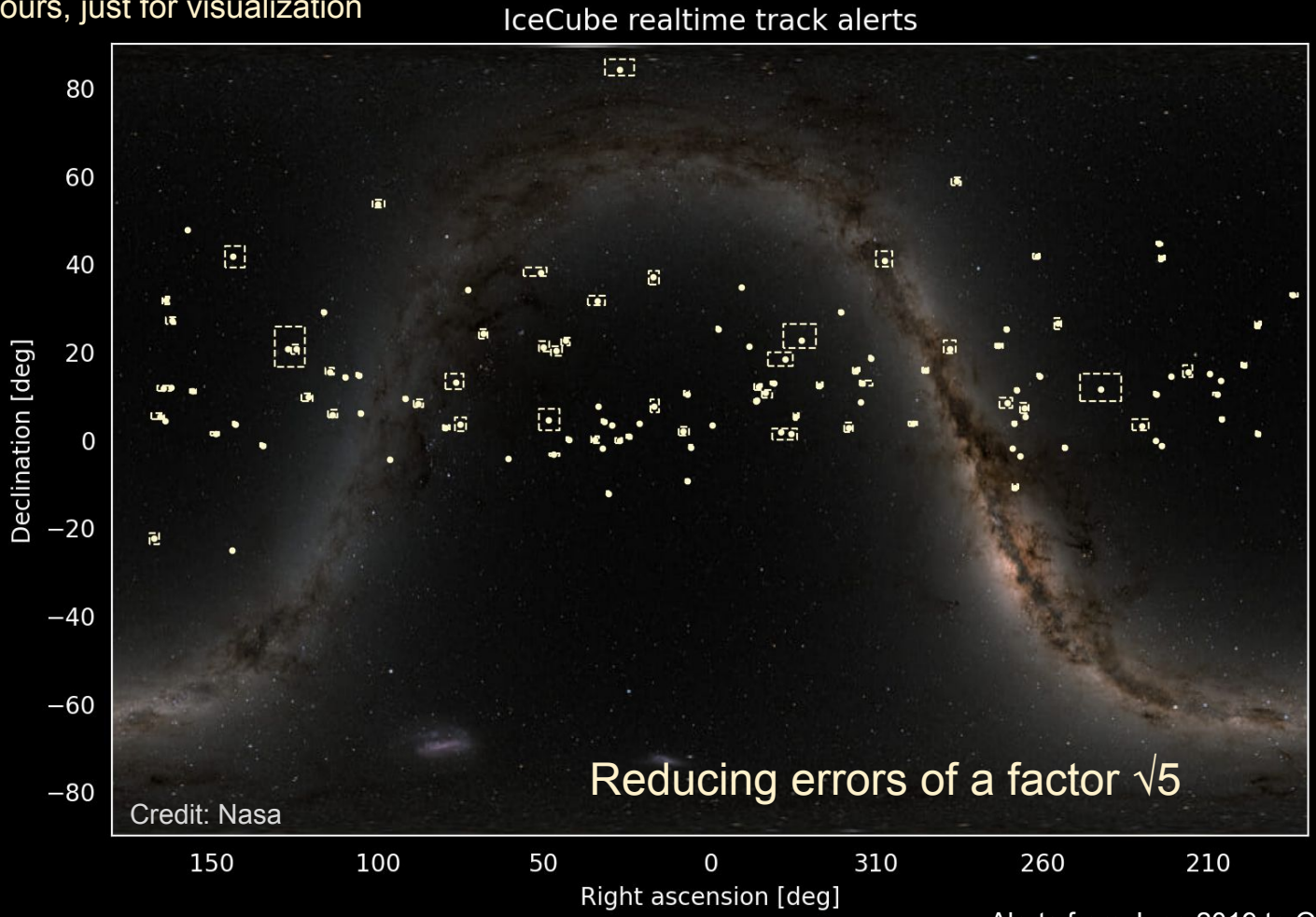






Alerts from June 2019 to October 2023

No real contours, just for visualization



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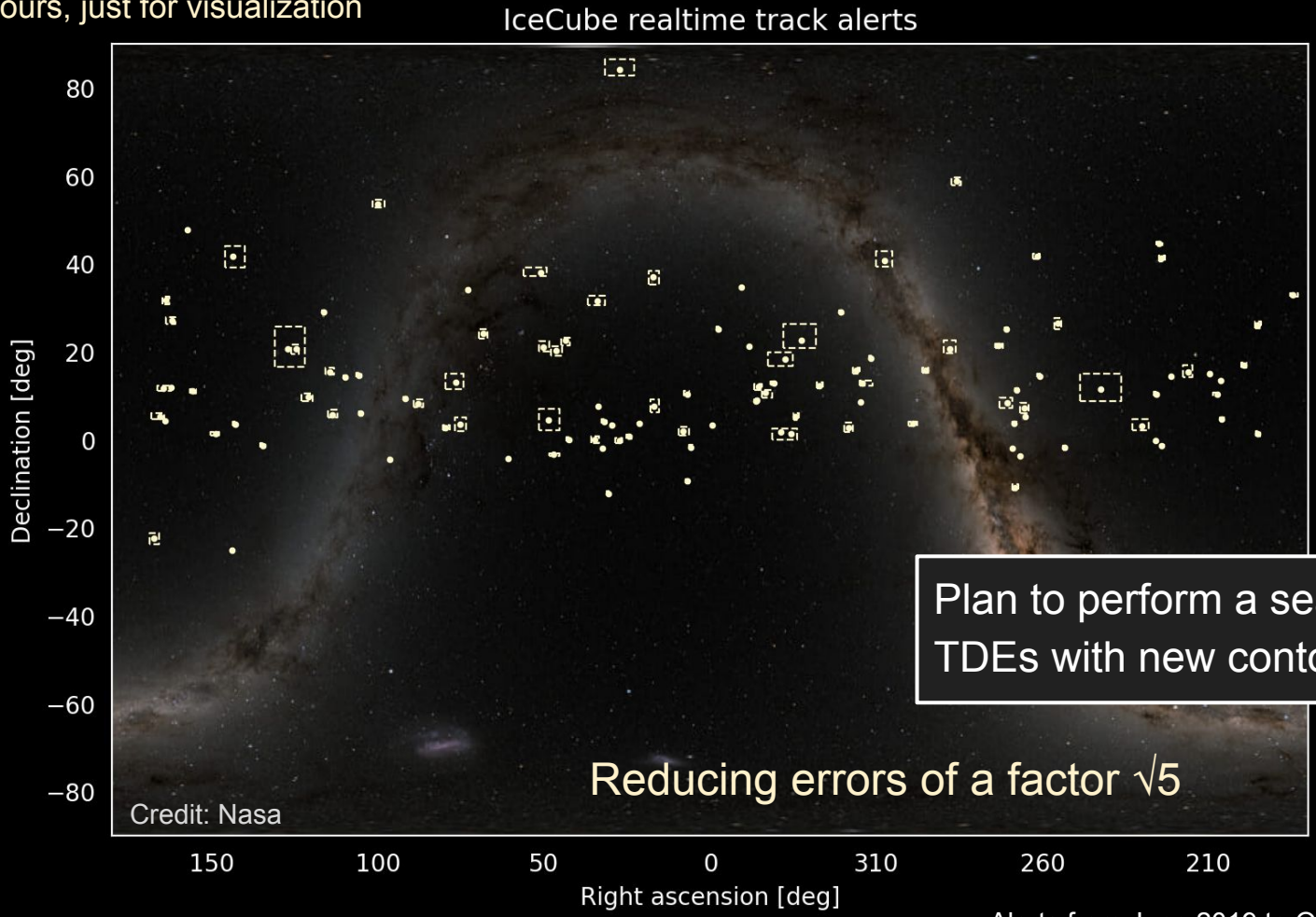
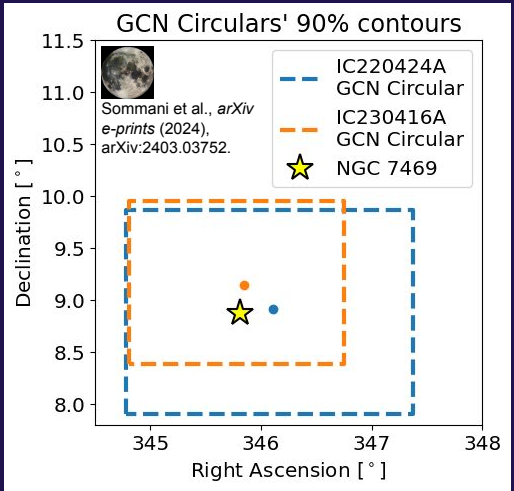


Plan to perform a search for TDEs with new contours

Alerts from June 2019 to October 2023

Evidence of neutrino emission from NGC 7469

- Two realtime alerts spatially coincident with NGC 7469



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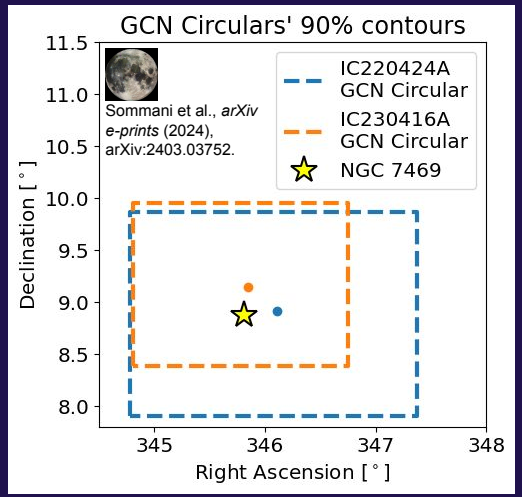

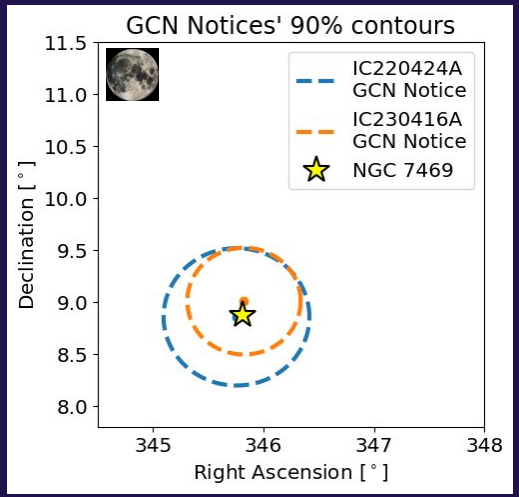

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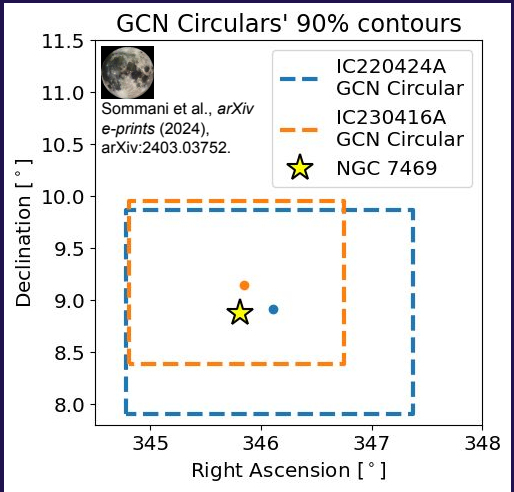

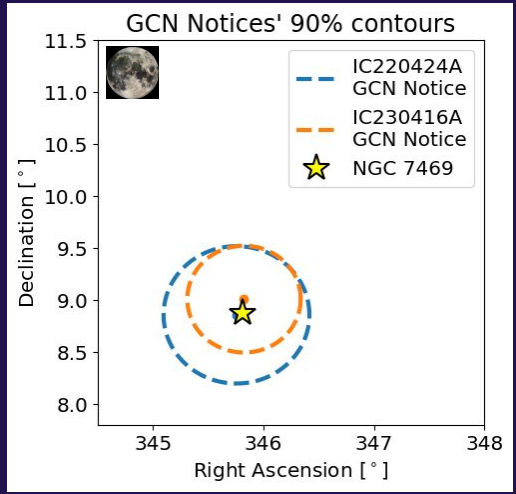

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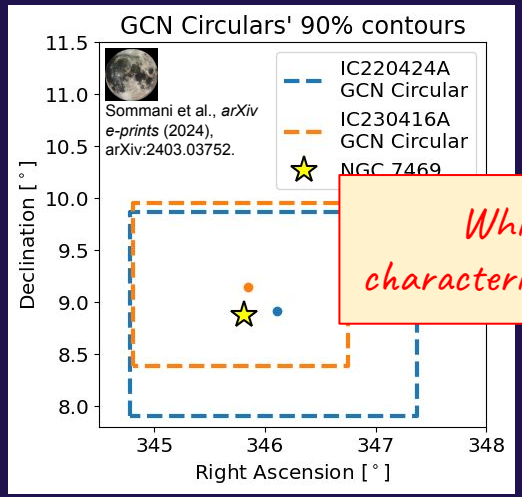
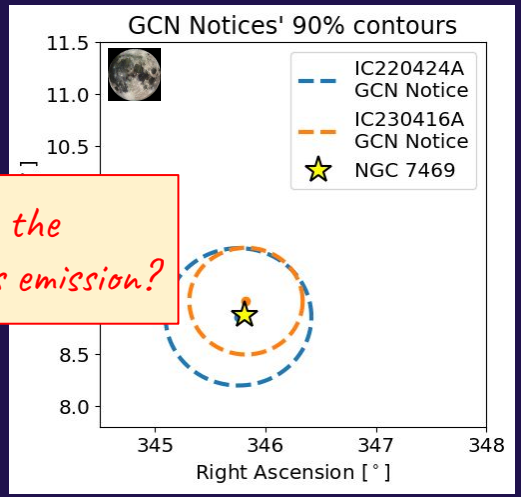
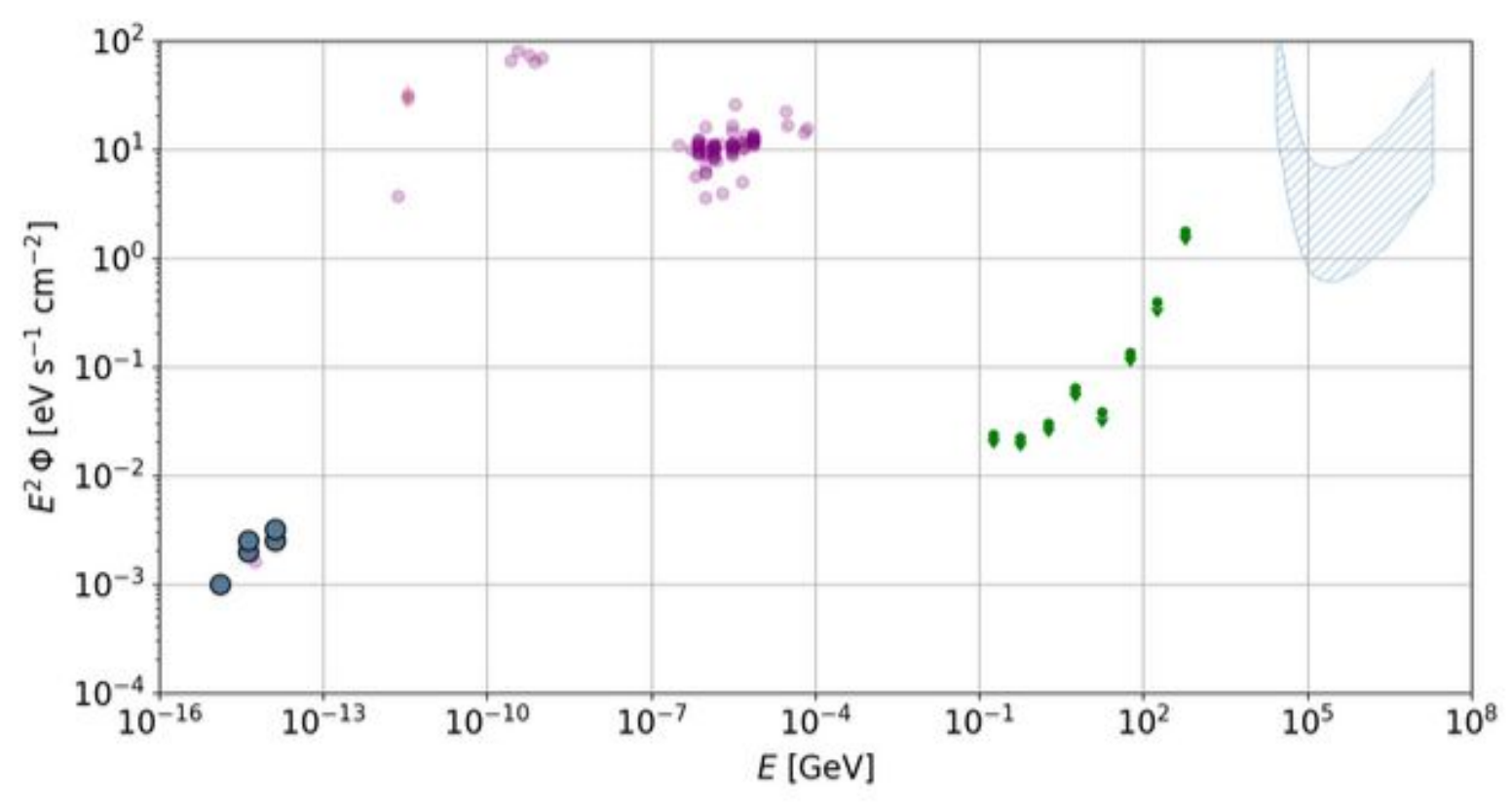




Which would be the characteristics of this emission?

Evidence of neutrino emission from NGC 7469 - neutrino flux

Spectral emission distribution from Silvia



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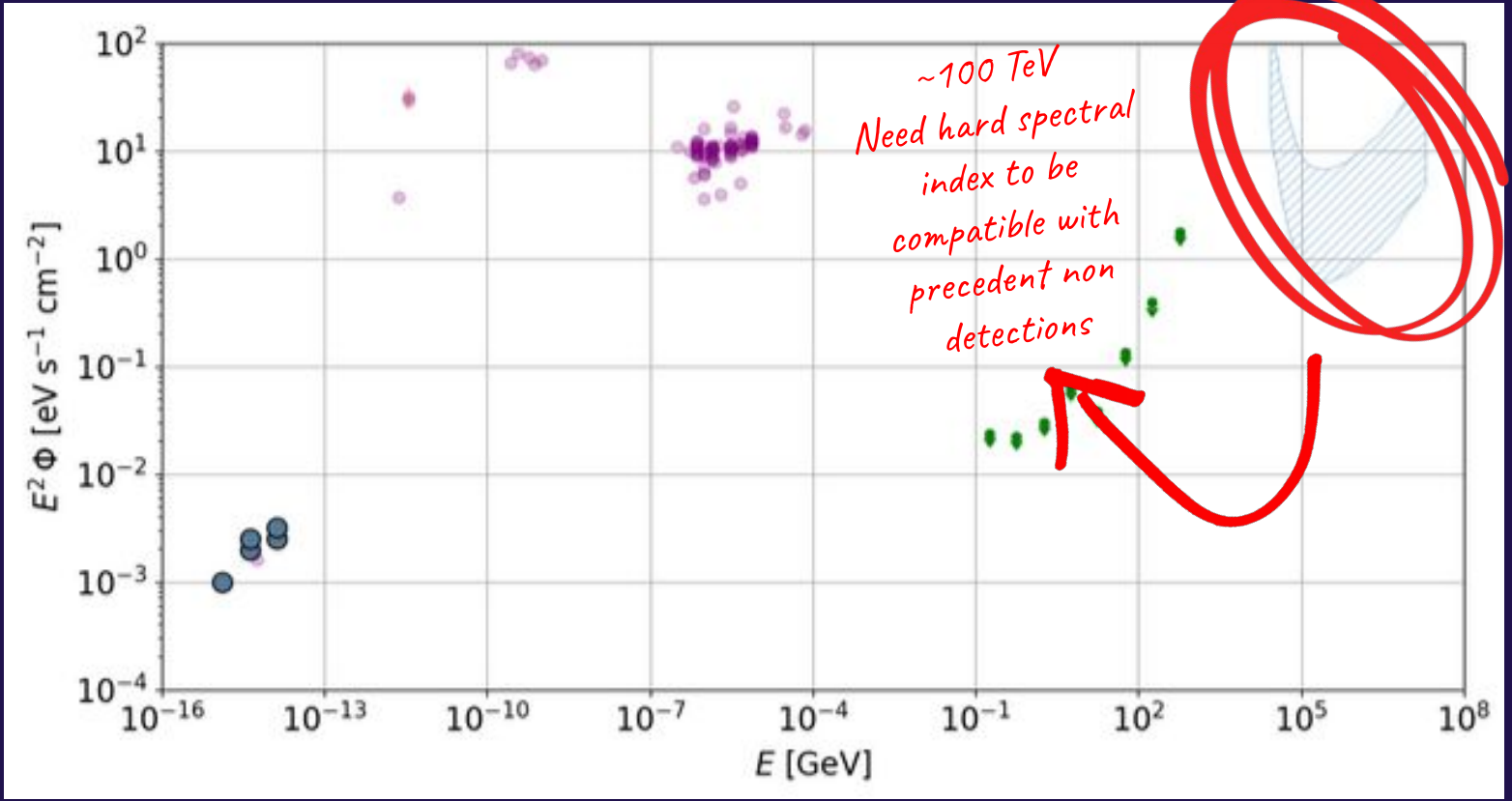
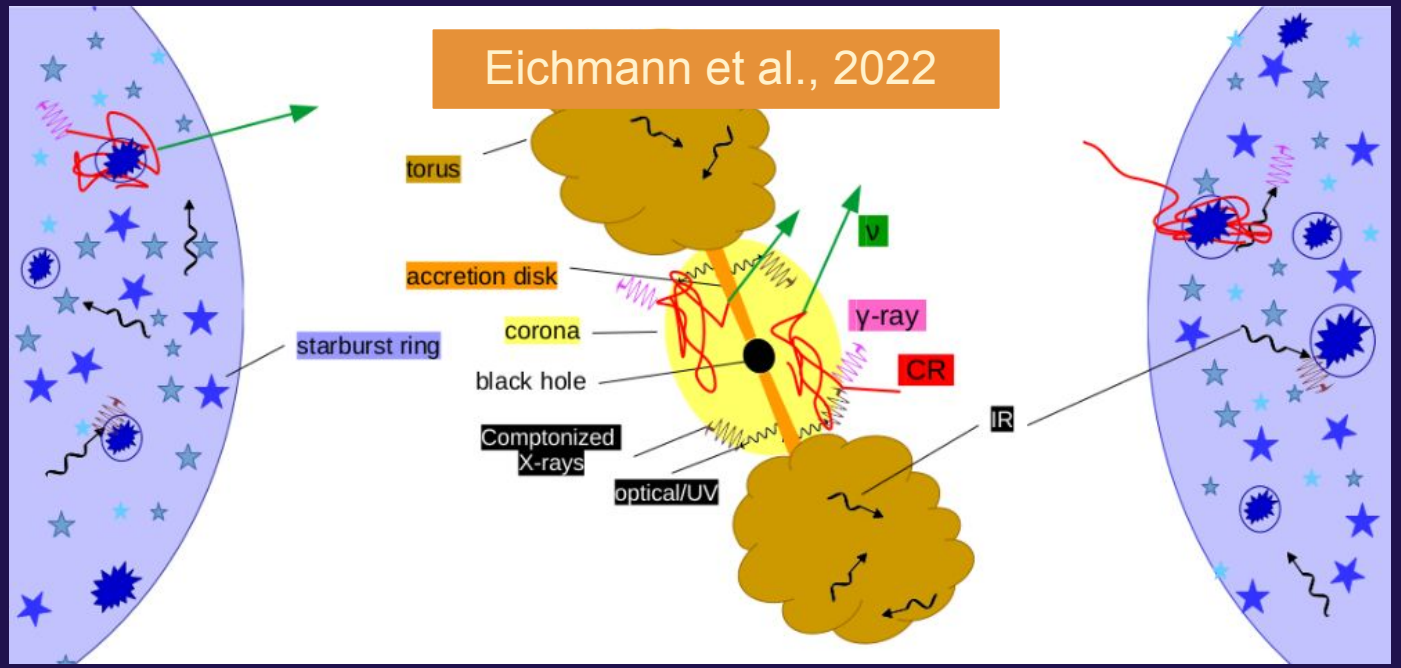


Modeling of NGC7469

- **A5**: description of multimessenger emission from Seyfert galaxies with an AGN-starburst composite model



Modeling of NGC7469

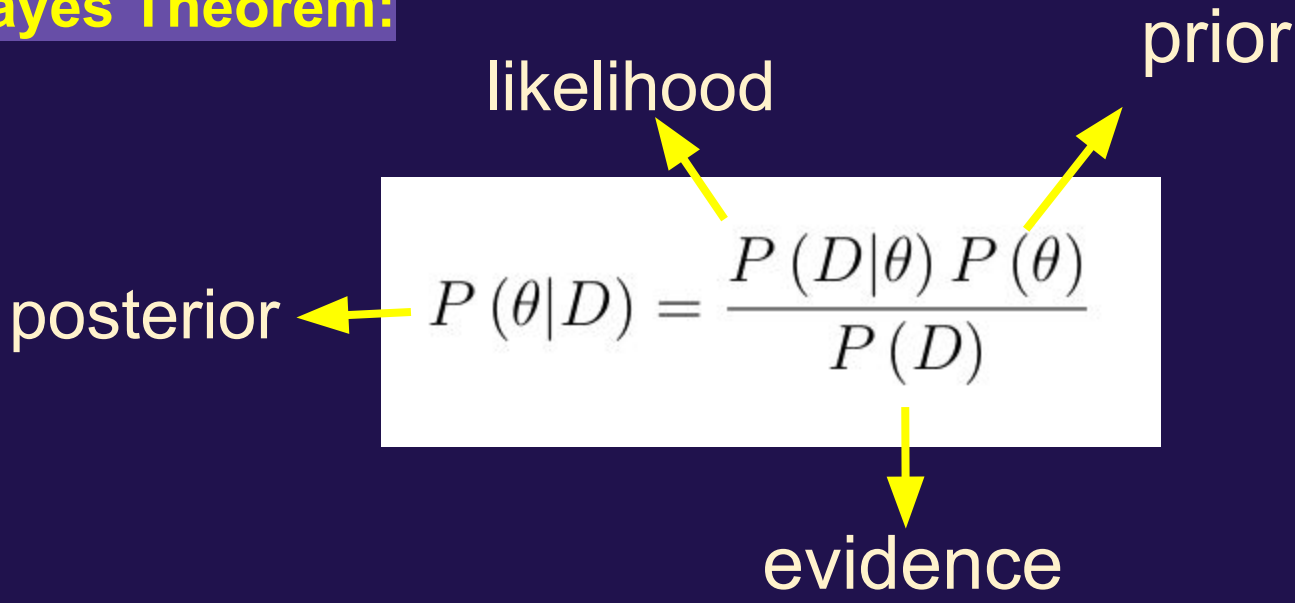
- **A5**: description of multimessenger emission from Seyfert galaxies with an AGN-starburst composite model

Eichmann et al., 2022

1. AGN → proper inclusion of SDA in the AGN corona (Walter and Eichmann, 2024 → new outcome: solving transport equation for whichever loss process)
2. The γγ pair production of secondary electrons and positrons has both hadronic and leptonic nature

Parameters study: MCMC

Bayes Theorem:



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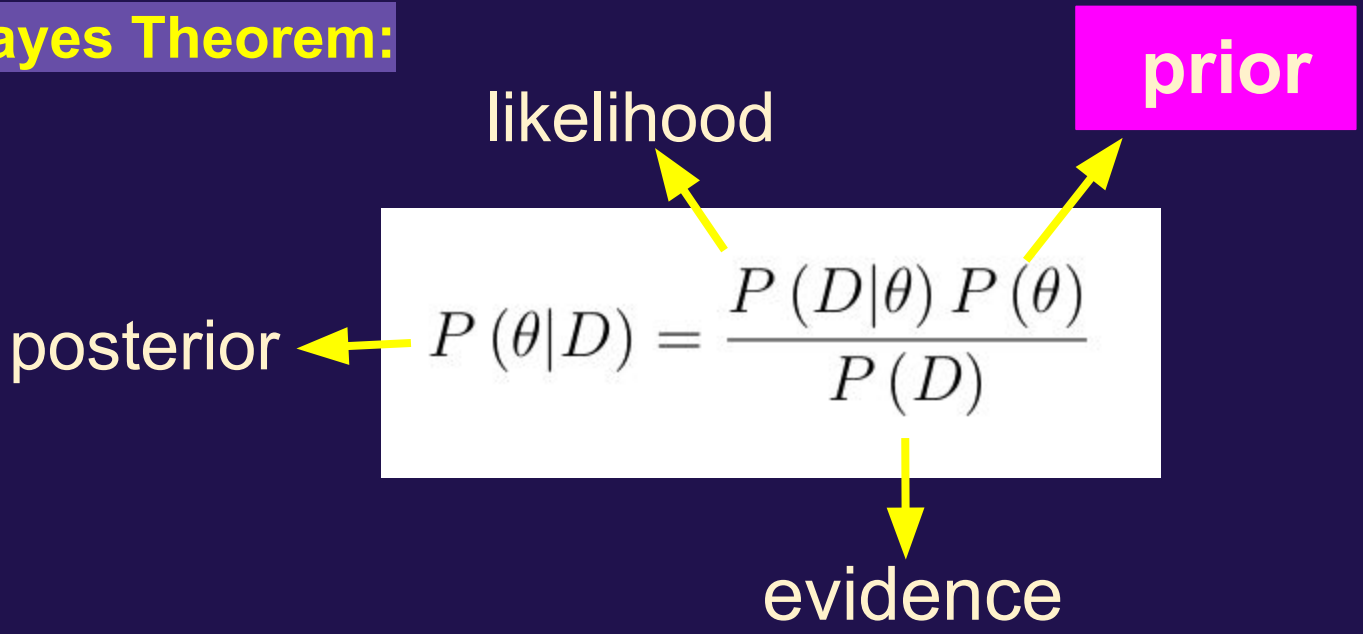
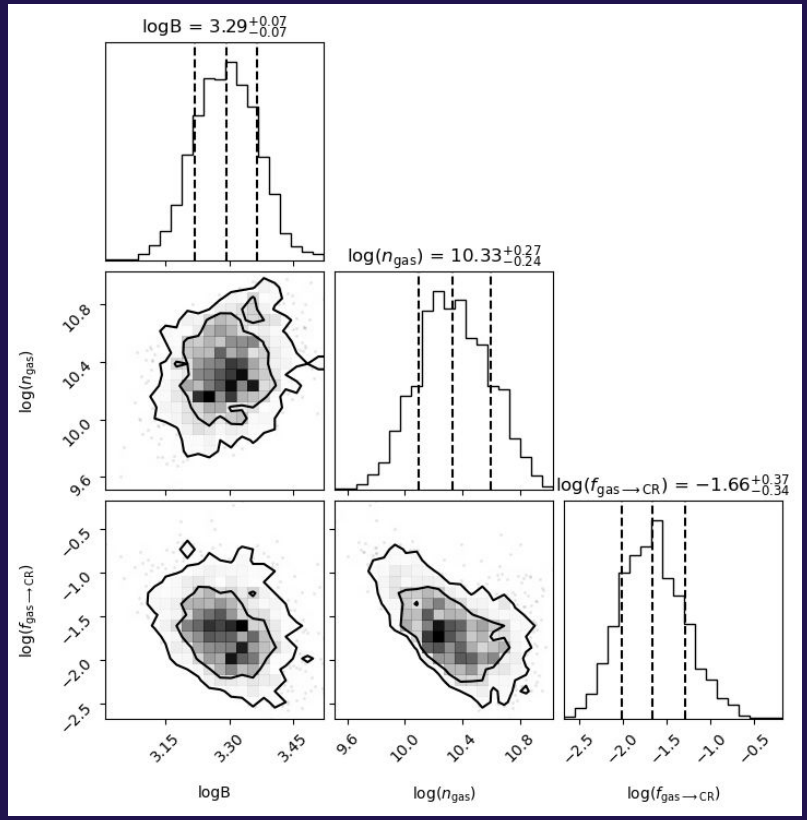


: lognormal / normal distribution → taken from NGC1068 previous results

Parameters study: MCMC

AGN

B, n_{gas}, $f_{gas \to CR}$



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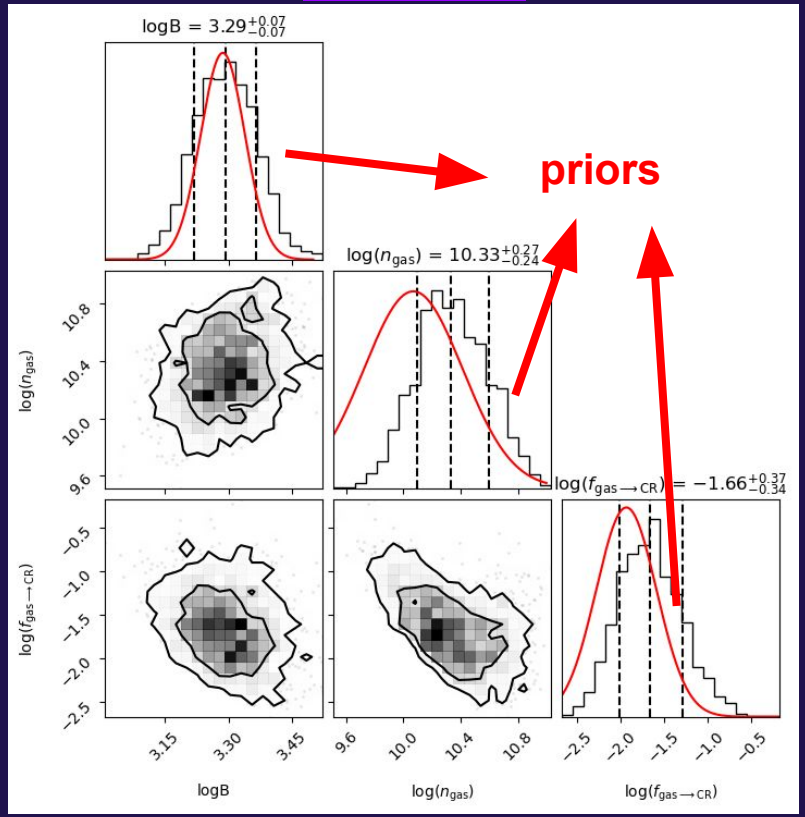

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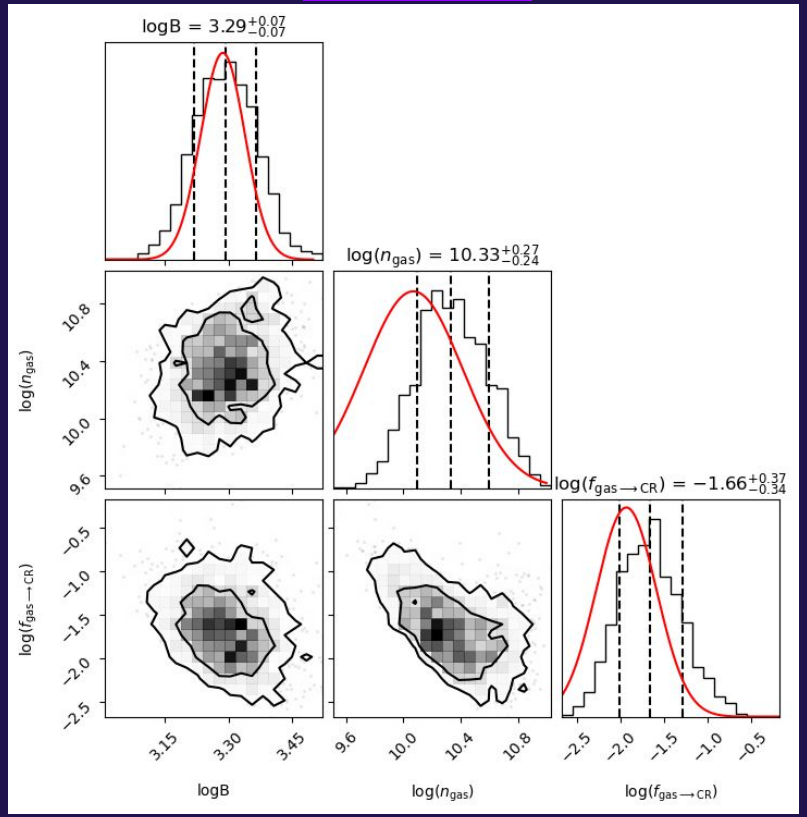
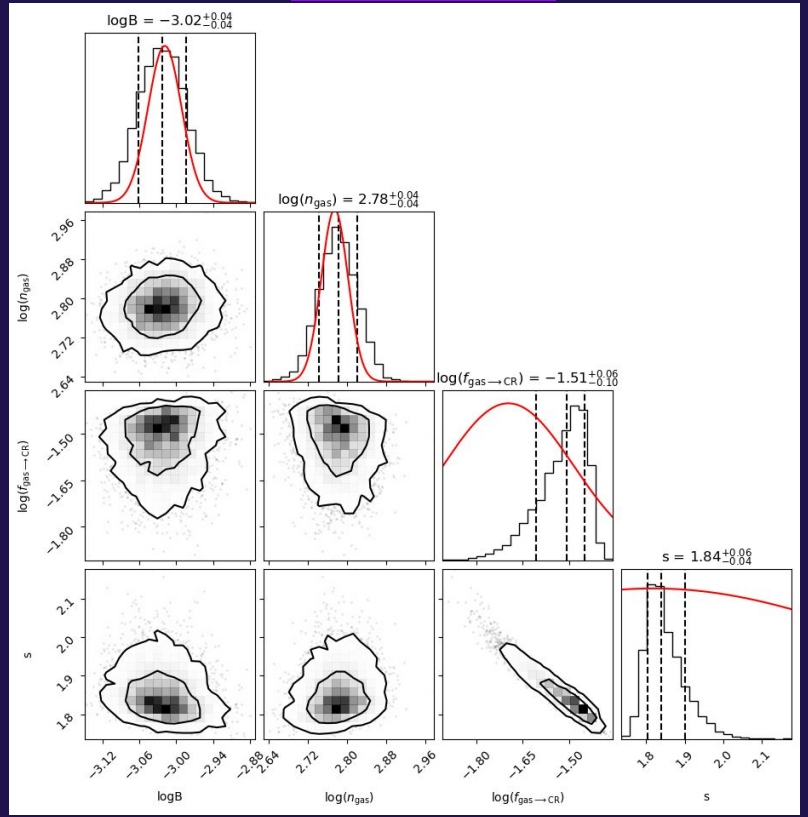
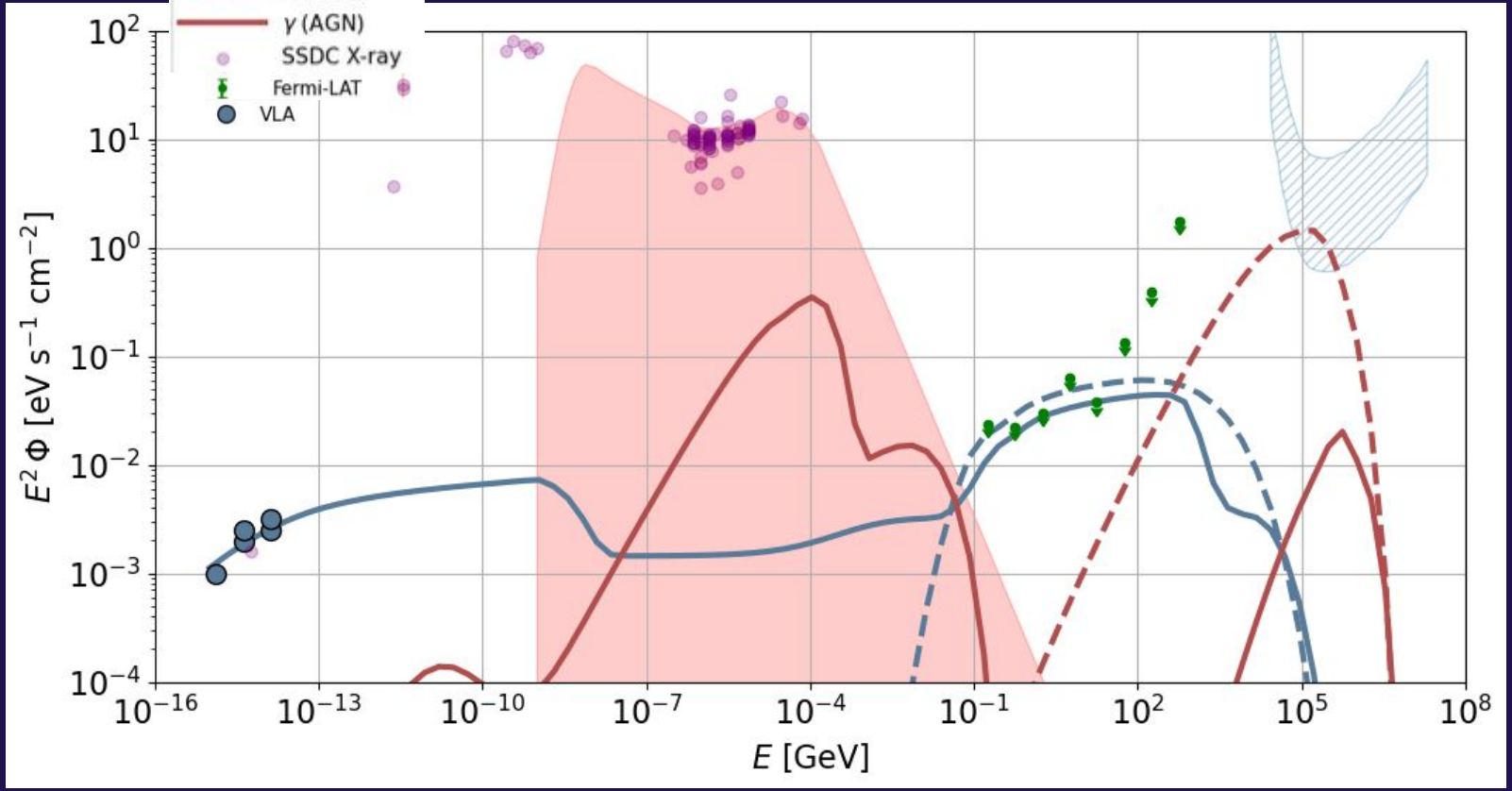


STARBURST

B, n_{gas}, $f_{SN \to CR}$, s



Fitting the SED



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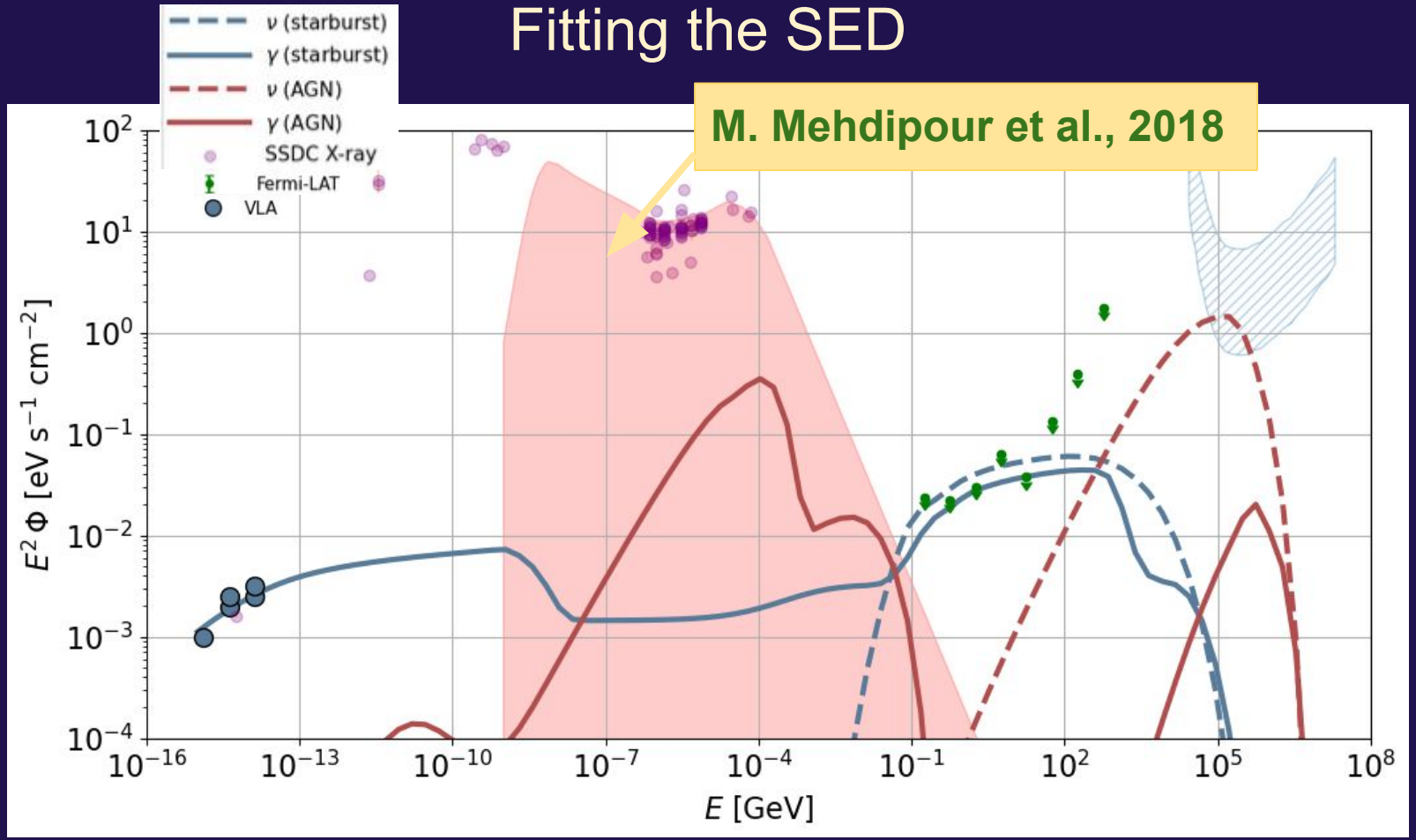

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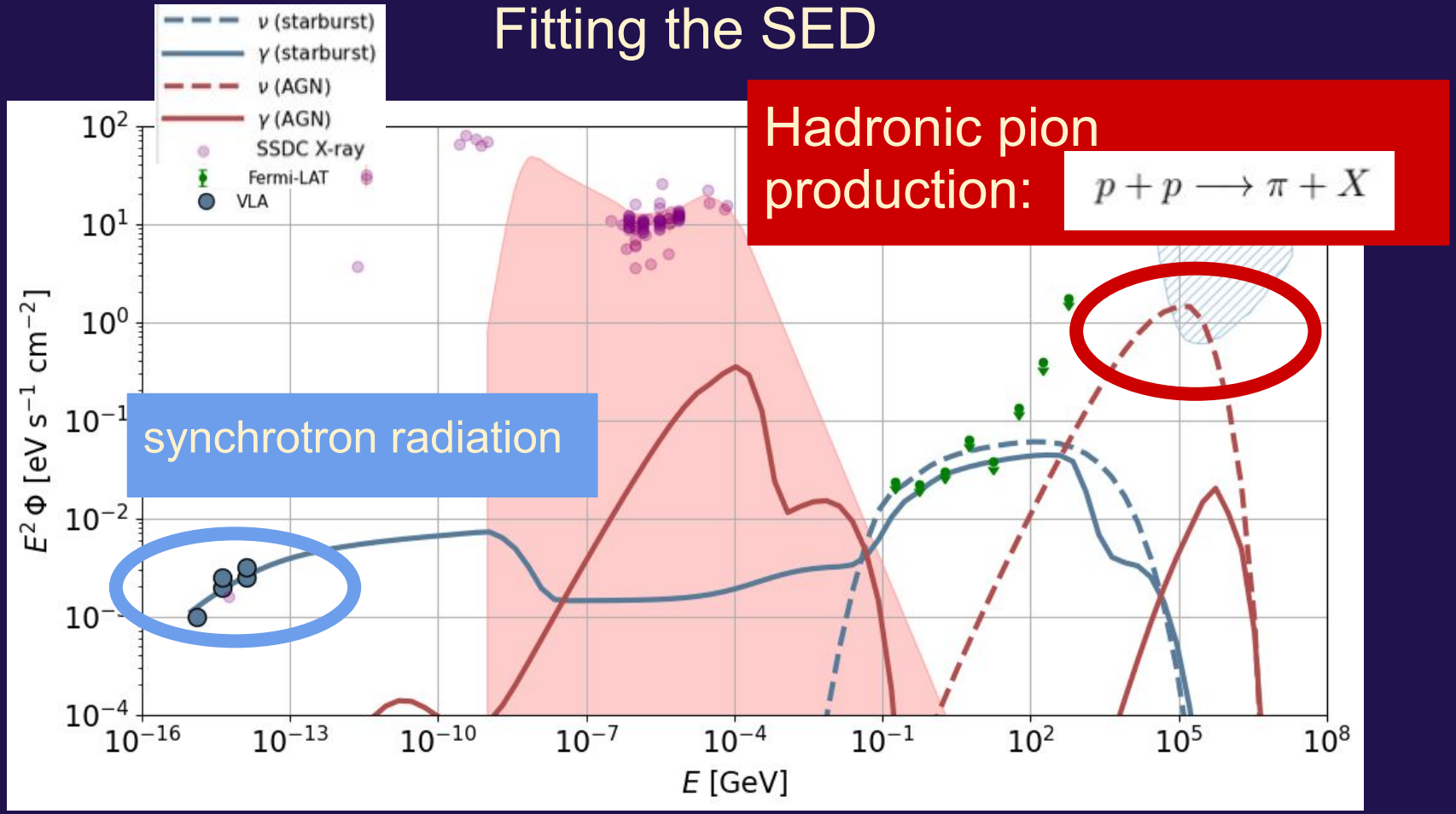
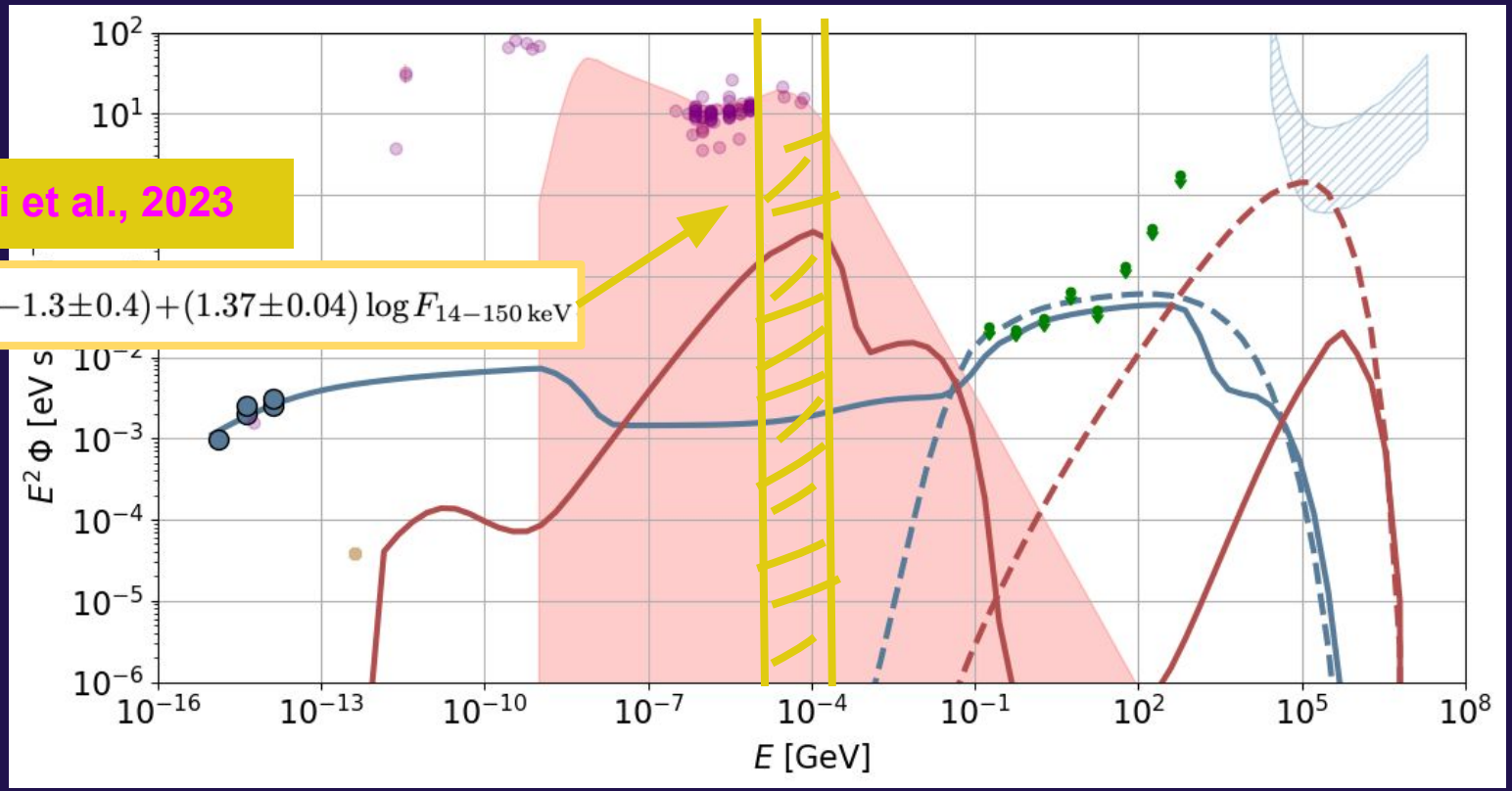


The mm-X-ray constraint



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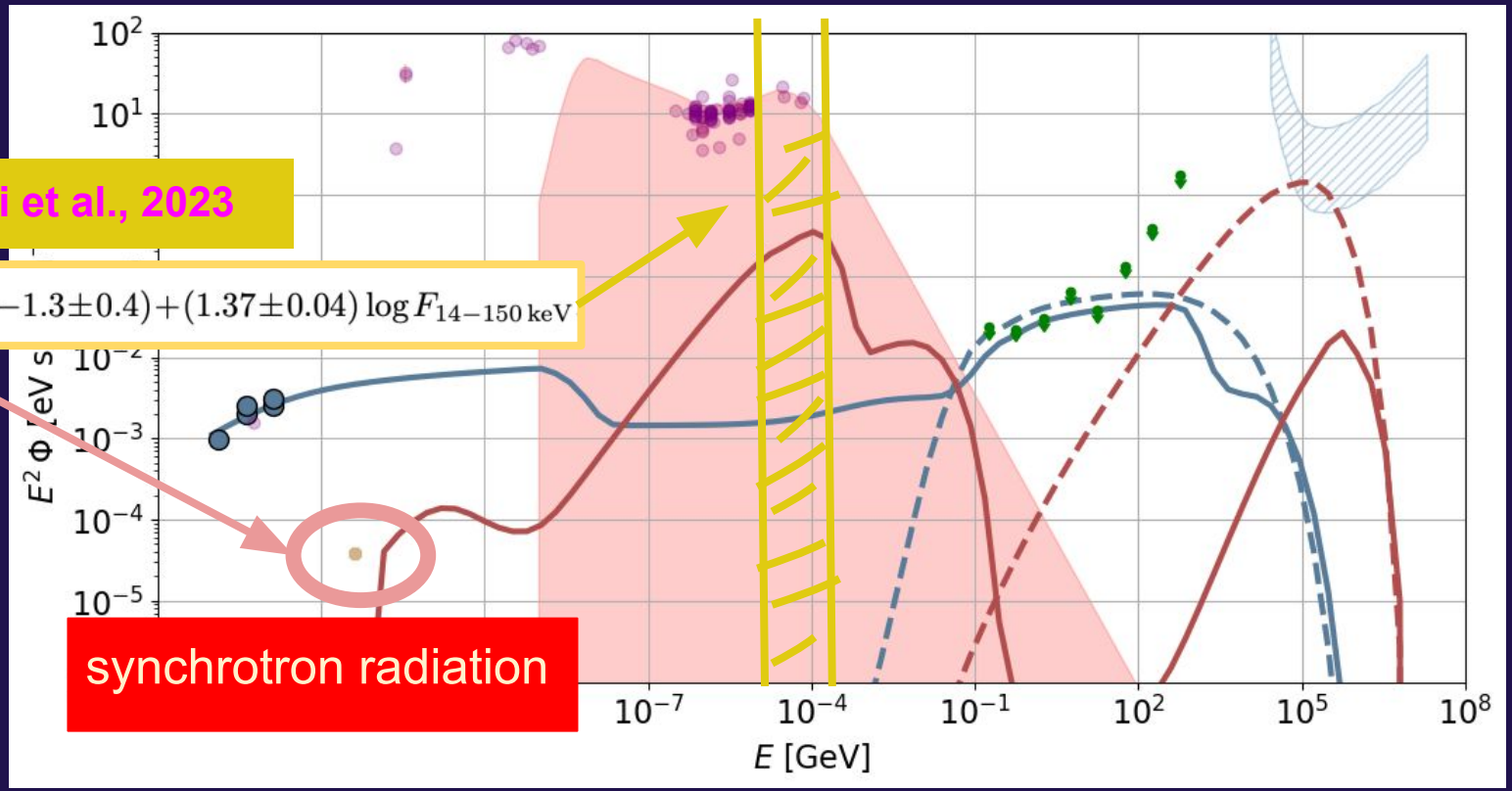

Conclusions

- Improved the reconstruction of IceCube alerts, now looking into TDEs
- With IceCube alerts, evidence of emission from NGC 7469
- The SED for NGC7469 is well explained by a two composite model (AGN+starburst ring) from radio to TeV energies
- We can theoretically explain the neutrino emission for NGC7469 through hadronic pion production in the AGN corona

Backup slides

The neutrino doublet

Two IceCube realtime alerts:

- IC 220424A,
  most-likely neutrino energy: 184 TeV;
  GCN Notice run 136565 evt 2186969 (v1), 24/04/22.
- IC 230416A,
  most-likely neutrino energy: 127 TeV.
  GCN Notice run 137840 evt 57034692 (v1), 16/04/23

Estimated chance probability: 3.3 σ