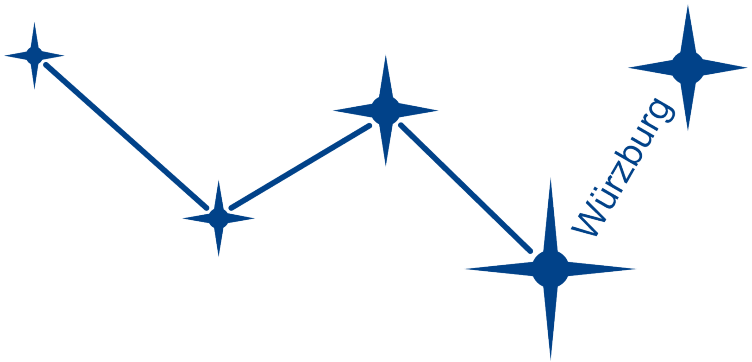
The AGN - Neutrino Connection

Annette Bremer

On behalf of the MessMapp group and Collaborators

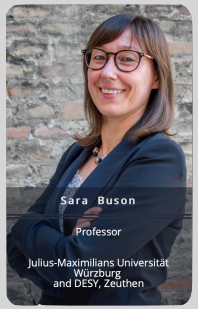
FRANCI Meeting 2025, Bamberg

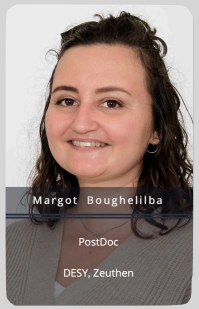
Based at:

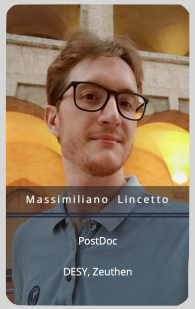


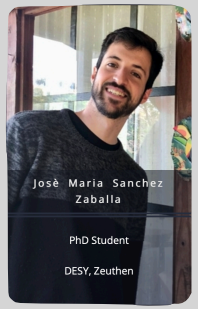
The MessMapp Research Team

☆ DESY, Zeuthen:



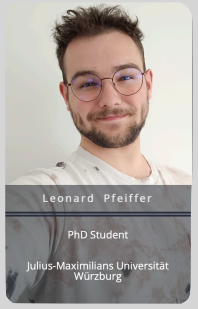






Visiting:
Giulia
Illuminati

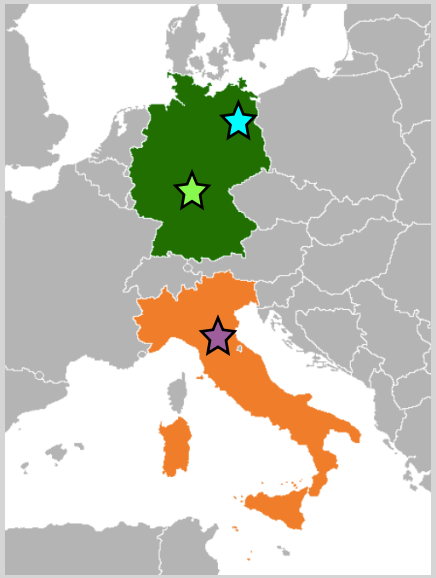
☆ JMU, Würzburg:



Annette
Bremer

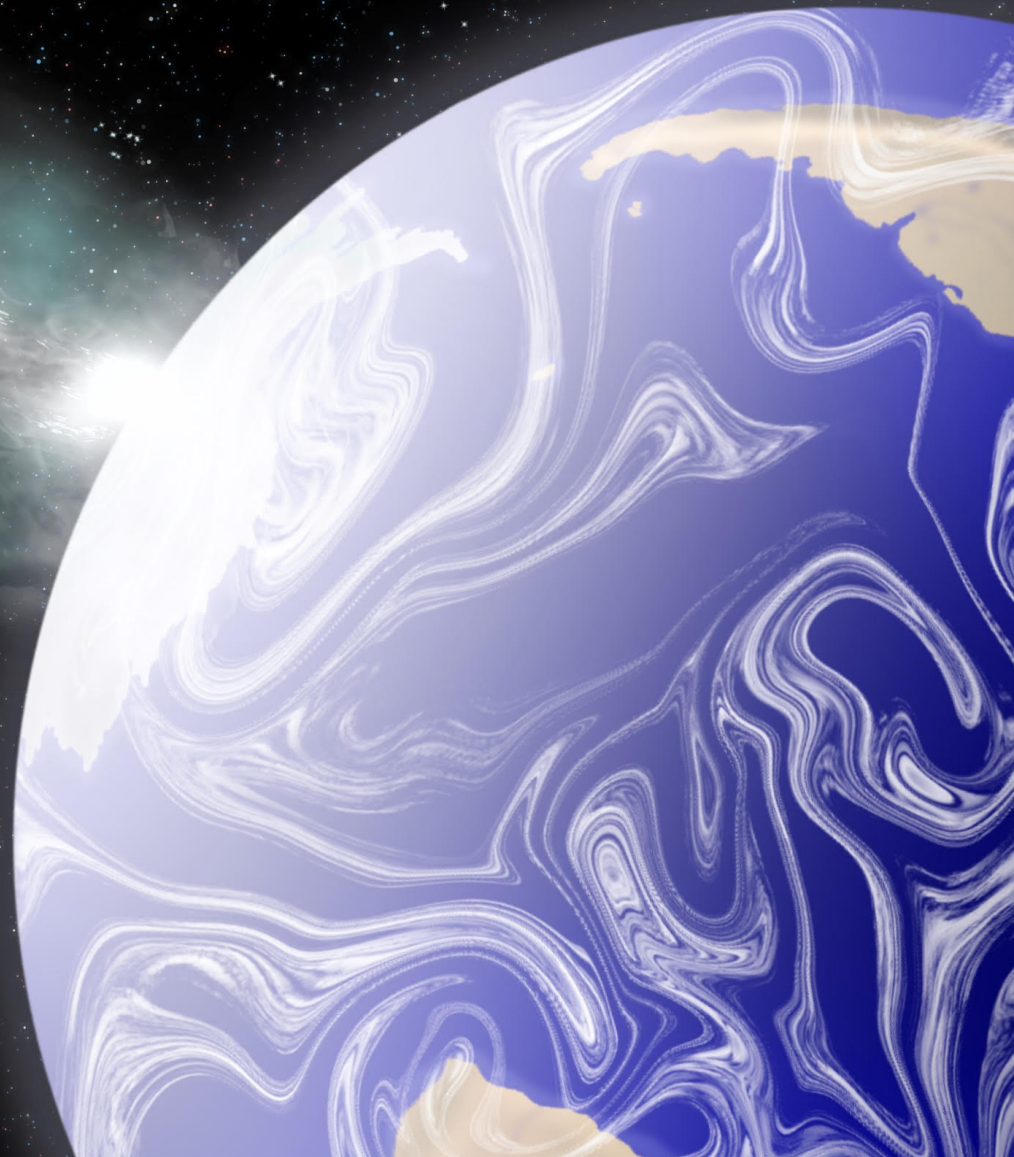
Pascal
Ludwig

Emilie
Kobsar



Collaborators:
M. Ajello, A. Coleiro, S. Marchesi,
M. Santander, A. Tramacere,
F. Vazza

Our Focus



AGN

Multiwavelength and multimessenger properties

Observational data + Theory

Here: focus on **neutrinos**

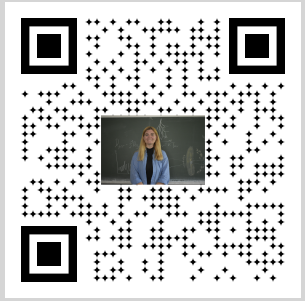
The physical properties of candidate neutrino-emitter blazars

Results

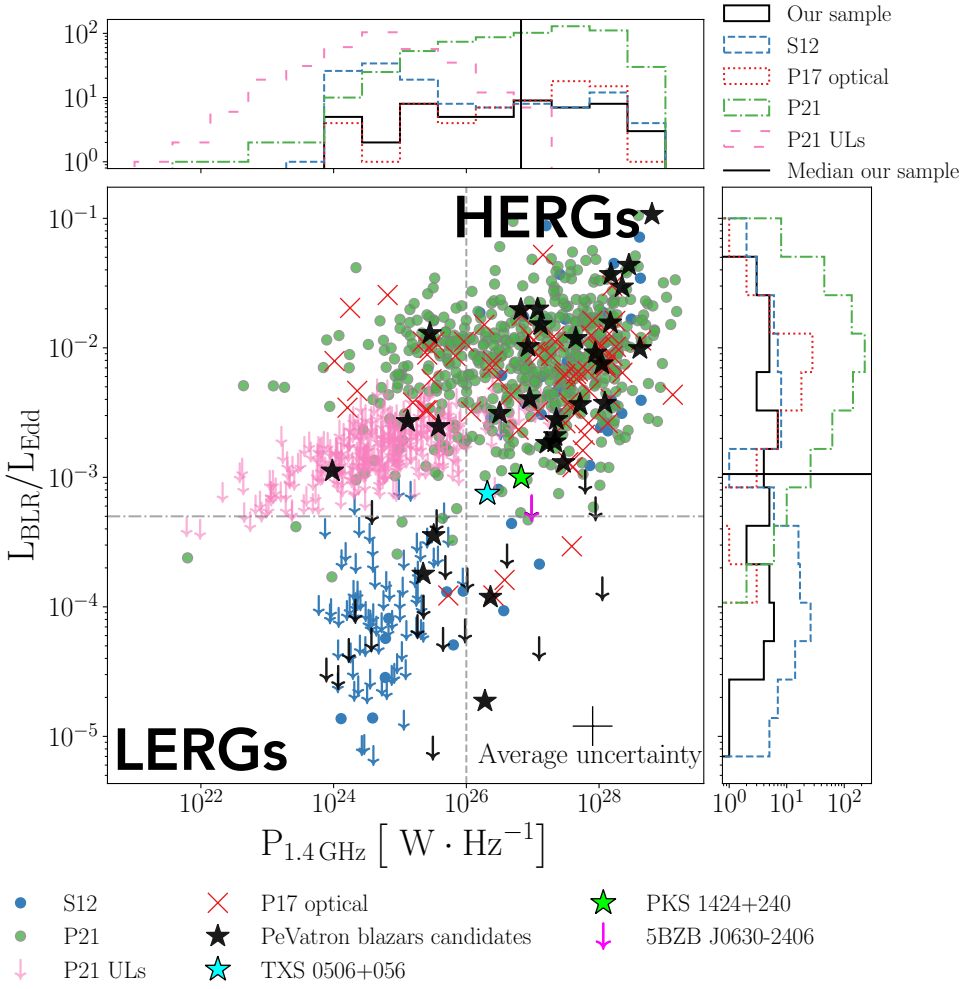
Mild tendency towards intense radiation fields and radiatively efficient accretion

Mild tendency towards powerful jets and high radio power

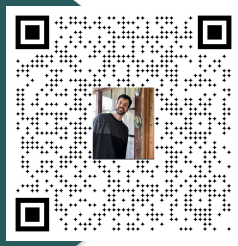
~60% HERG-like



Azzollini et al. 2025 (accepted)



X-Ray Spectral Variability as a Probe of Multimessenger Emission in Blazar 5BZB J0630−2406



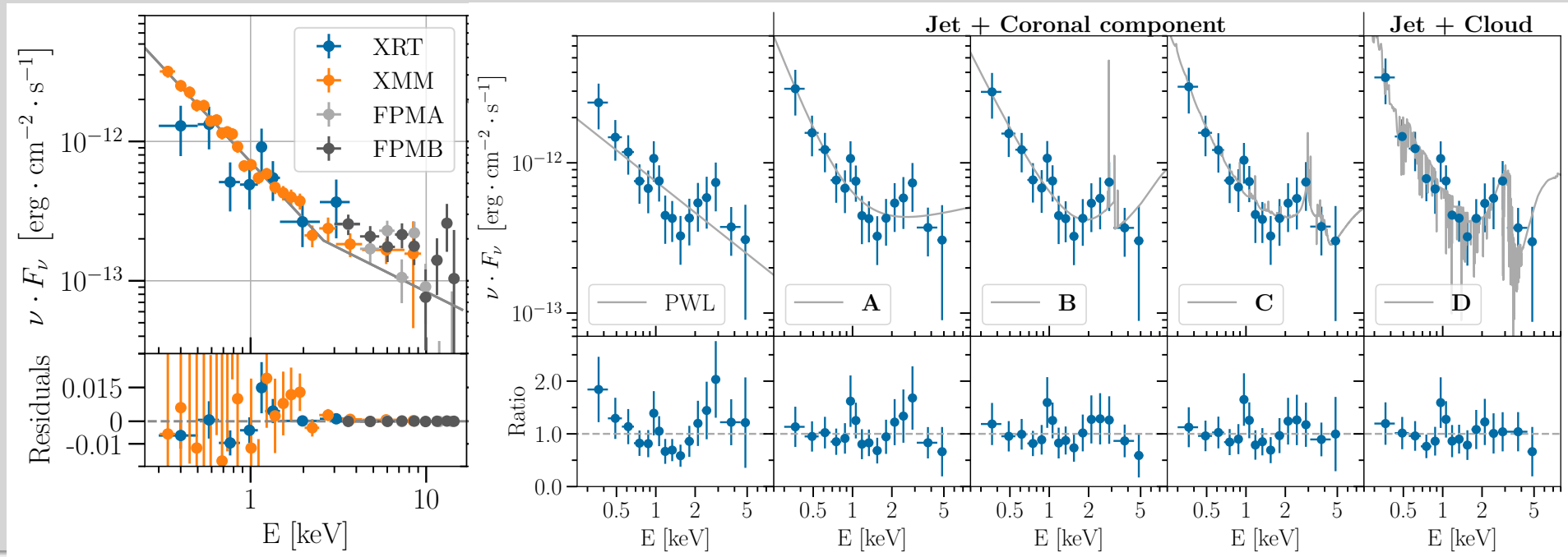
Additional component in low state spectrum

Compatible with coronal emission

Prompts similarities to NGC 1068

Hint for two neutrino processes

Sanchez Zaballa et al. 2025



IceCubePy

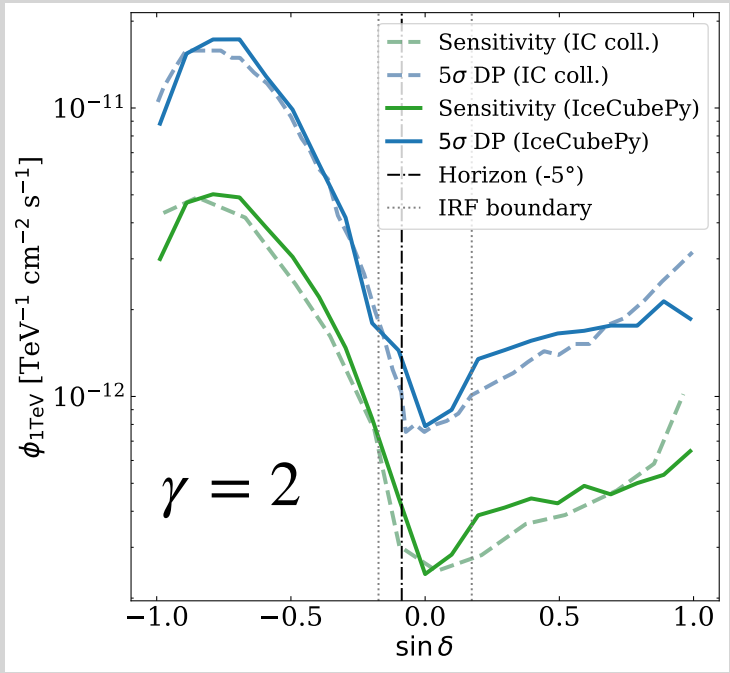
An open access software for neutrino data analysis

Python-based analysis tool using unbinned likelihood

10-year IceCube muon track dataset

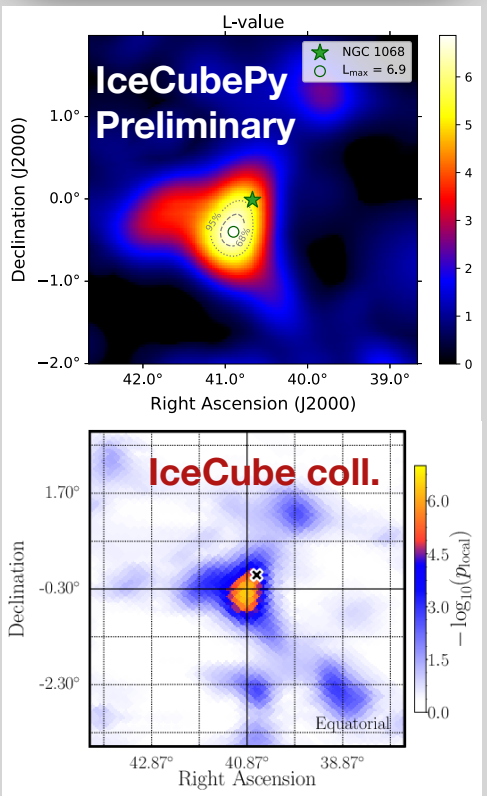
Reproduces IceCube collaboration results

Deviations can be attributed to the limited accuracy of the released instrument response



Lincetto, AB et al. in prep.

NCG 1068 Hotspot



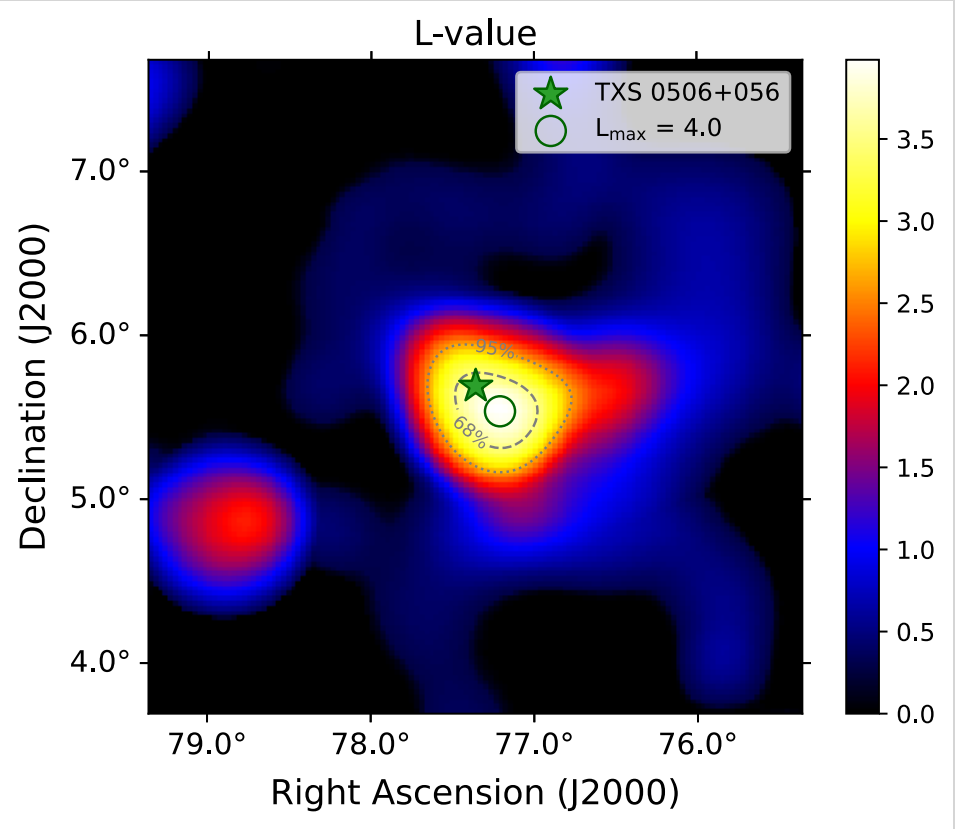
IceCubePy — TXS 0506+056 Hotspot

Map of local significance

L-value = - log10(p-value)

At TXS 0506+056 coords (77.36, +5.69):

- TS = 14.1
- n_s = 16.1
- γ = 2.3
- L-value = 3.5
  - IceCube coll. L = 3.72



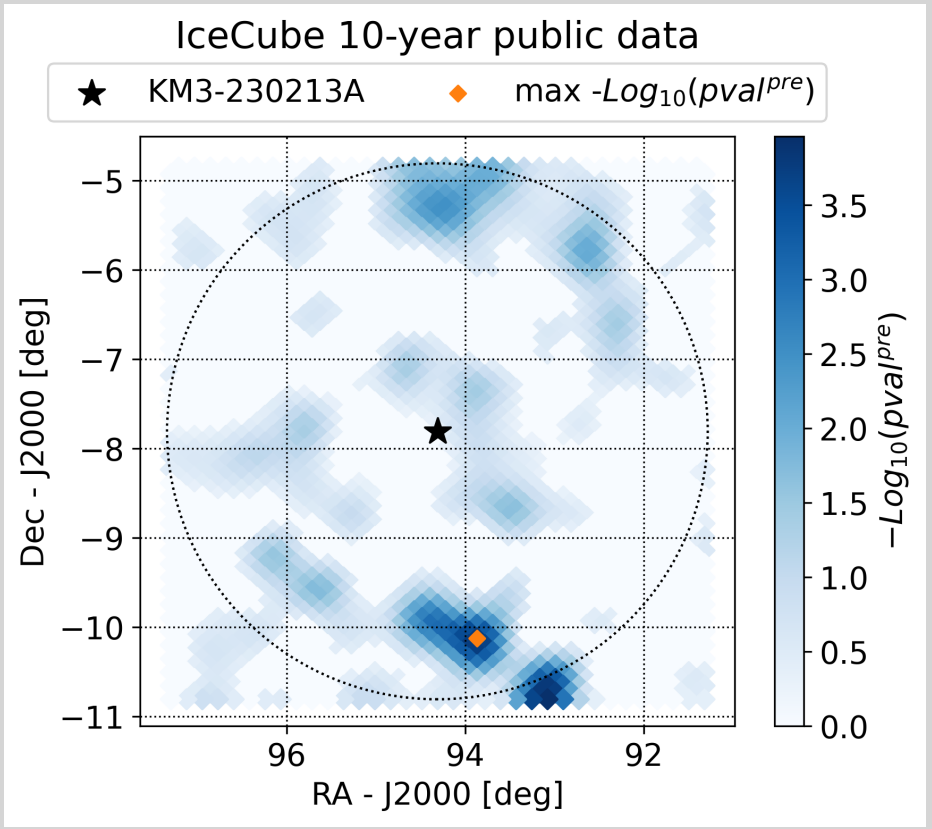
Lincetto, AB et al. in prep.

UHE Event KM3-230213A

Confidence region of KM3-230213A

IceCubePy produced most stringent upper limits on steady neutrino flux from UHE event direction

Dataset	n_{sig}	$-\log_{10}(p\text{-value})$	Flux Upper Limit [$GeV^{-1}cm^{-2}s^{-1}$]	(RA, Dec) [deg, deg]	Distance [deg]	P-value
ARCA6-21	0.4	0.044	1.8×10^{-8}	(94.3, −7.8)	0.0	-
	1.3	1.308	1.9×10^{-8}	(96.7, −6.8)	2.6	0.44
ORCA6-18	0	-	2.1×10^{-7}	-	-	-
ORCA18-23	0	-	2.3×10^{-6}	-	-	-
ORCA-combined	-	-	2.0×10^{-7}	-	-	-
ANTARES	0	-	1.1×10^{-8}	(94.3, −7.8)	0.0	-
	1.9	1.936	1.7×10^{-8}	(94.4, −5.3)	2.5	0.53
IceCube	1.4	0.327	1.2×10^{-9}	(94.3, −7.8)	0.0	-
	15.1	3.782	6.3×10^{-9}	(93.9, −10.1)	2.4	0.07



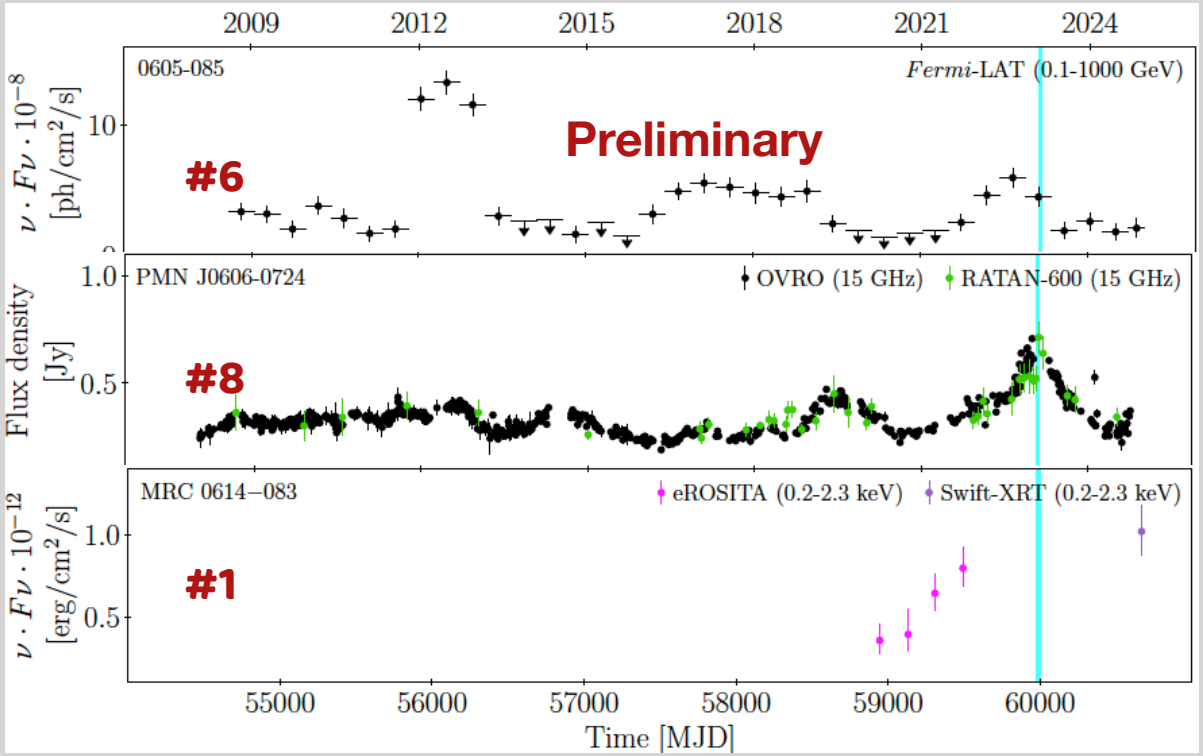
KM3NeT Collaboration et al. 2025, Nature

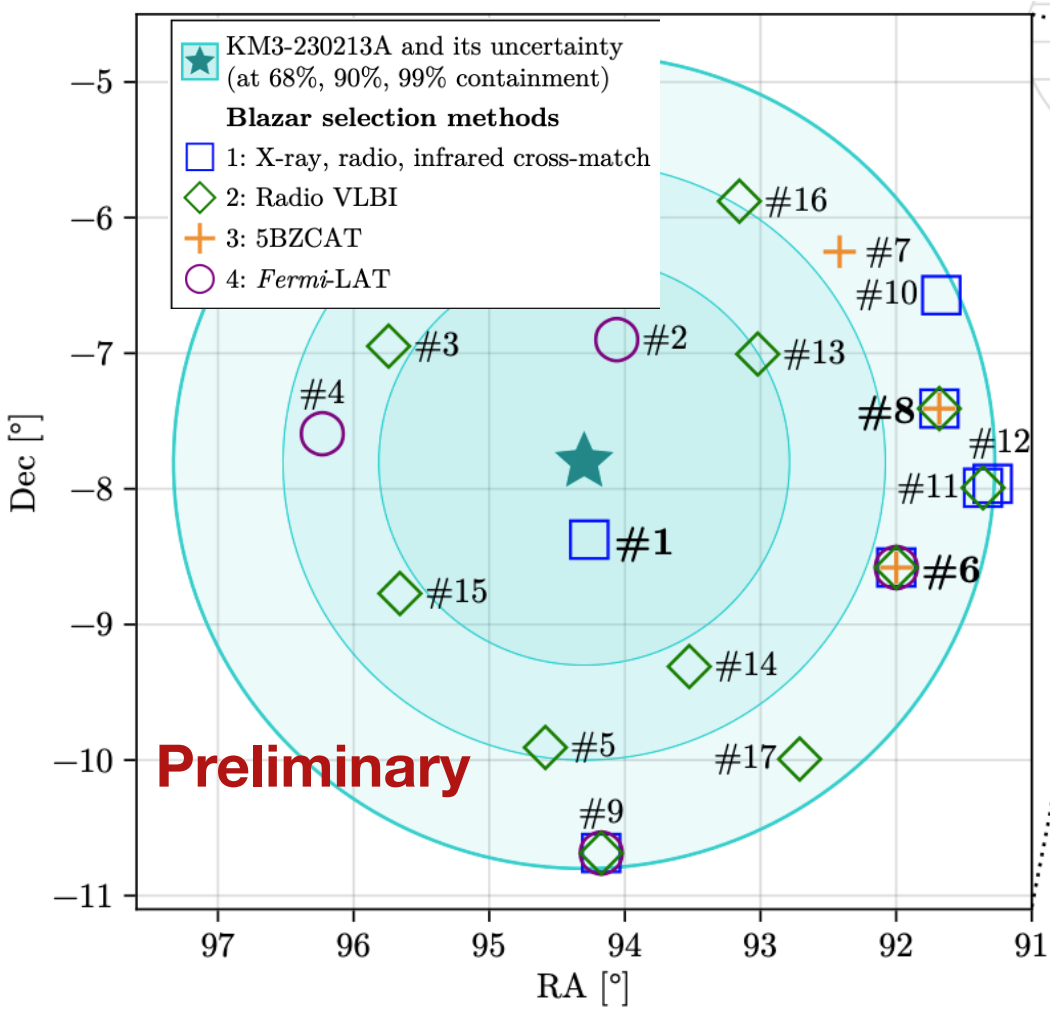
[PoS(ICRC2025)1099, PoS(ICRC2025)1110]

UHE Event KM3-230213A

17 potential blazar-like counterparts

No conclusive evidence for individual source





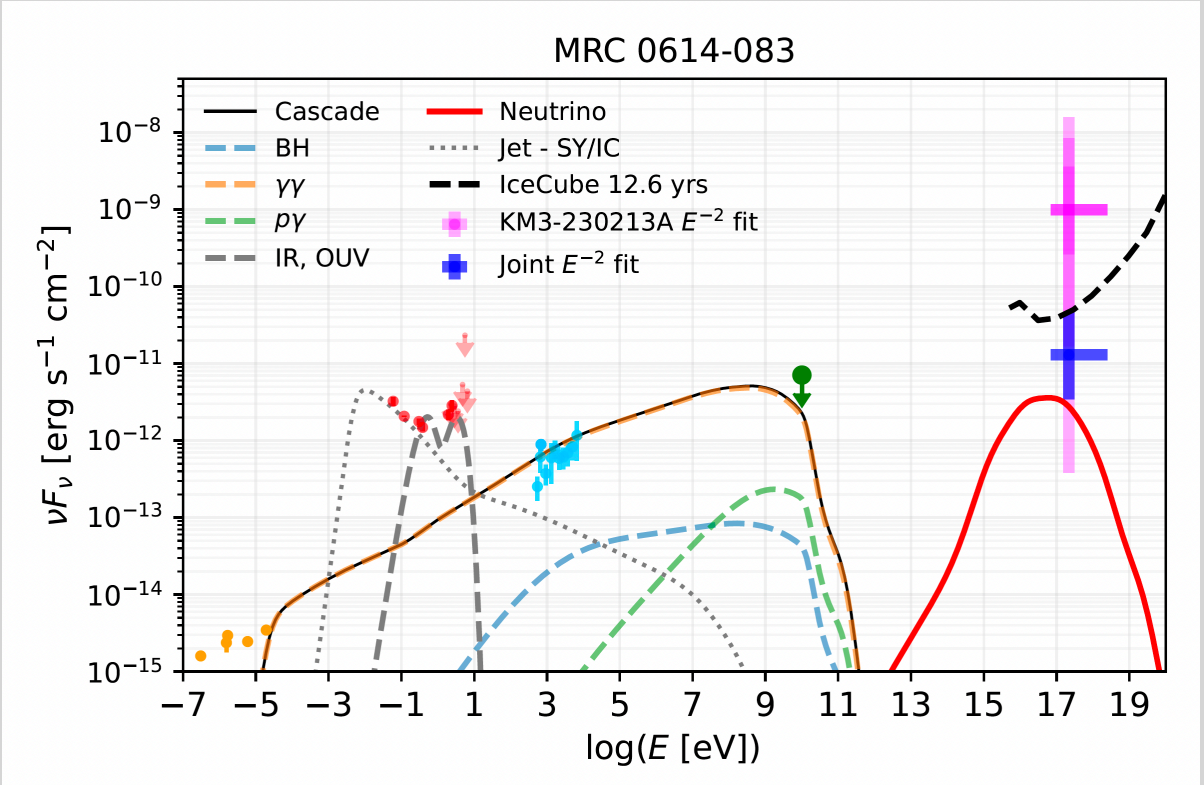
KM3NeT collaboration et al. (submitted)

KM3-230213A origin:
Accretion Flare Hypothesis

Closest Blazar to KM3NeT-230213A (#1)

SED and light curves described with accretion flare

Predicts X-ray flare and neutrino production



[Yuan et al. (submitted)]

Summary

We embrace a **Multimessenger** approach combining **Neutrino** observational approach (IceCube, KM3NeT), **Theoretical** angle (SED modeling: AM3) , **Multiwavelength** (photon) observations

- Analysis and results reproducible
- Datasets available via e.g. Zenodo
- Software hosted in GitHub: First public release: AM3, upcoming: IceCubePy
  GitHub.com/messmapp/IceCubePy-public