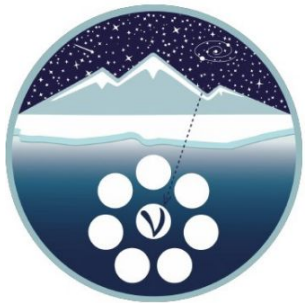


Status of the Baikal-GVD Neutrino Telescope

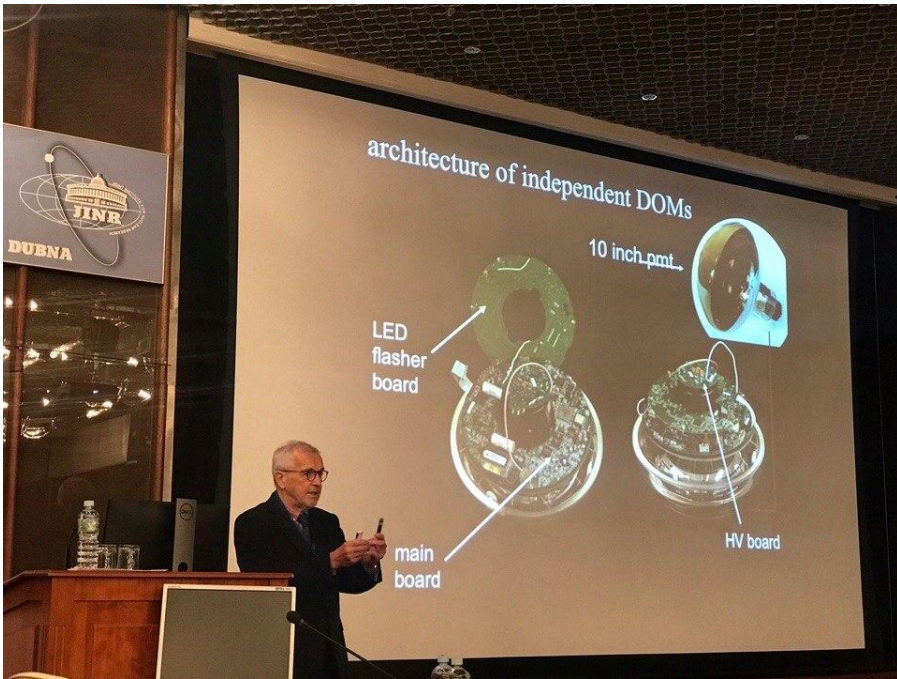
Viktoriya Dik (JINR)
for the Baikal-GVD collaboration

IceCube Particle Astrophysics Symposium 2026

15.10.2026



Francis Halzen receiving the Bruno Pontecorvo Prize, 2019, JINR, Russia



**Congratulations to Francis Halzen
on the Nobel Prize!**



The Baikal-GVD experiment

The Baikal-GVD is a 1 km³ - scale neutrino telescope being built in Lake Baikal

Collaboration consists of 15 institutions and ~85 scientists

Saint-Petersburg

Saint-Petersburg Marine Technical University
University of Information Technology, Mechanics and Optics *



Joint Institute for Nuclear Research

Dubna

Institute for Nuclear Research RAS
Skobeltsyn Institute for Nuclear Physics
National Research Nuclear University MEPhI
Lebedev Physics Institute RAS *

Irkutsk State University

Irkutsk

Baikal-GVD

Moscow

Belgorod

Belgorod State University *

Prague

Bratislava

Belgrade

Nalchik

Almaty

Institute of Nuclear Physics ME RK

Kabardino-Balkarian State University *



Czech Technical University (Prague)
Comenius University (Bratislava)
Astronomy Observatory (Belgrade)*

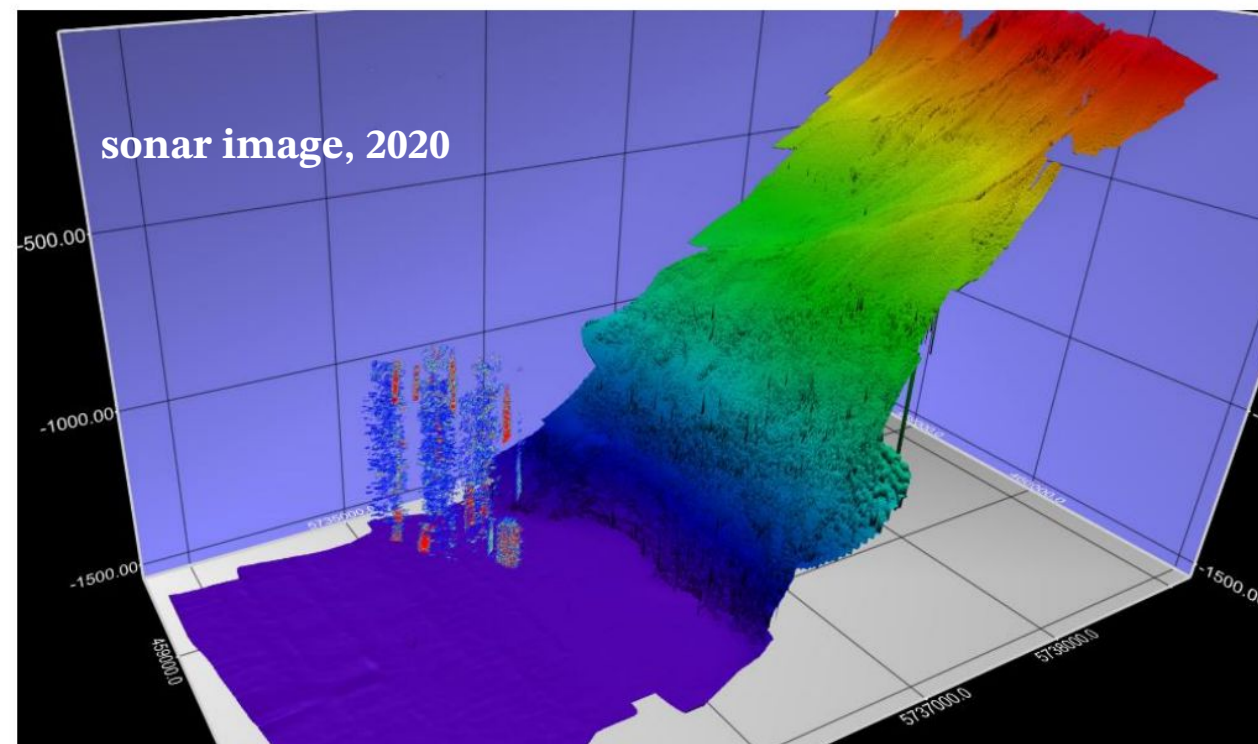
* Associate members



The detector site

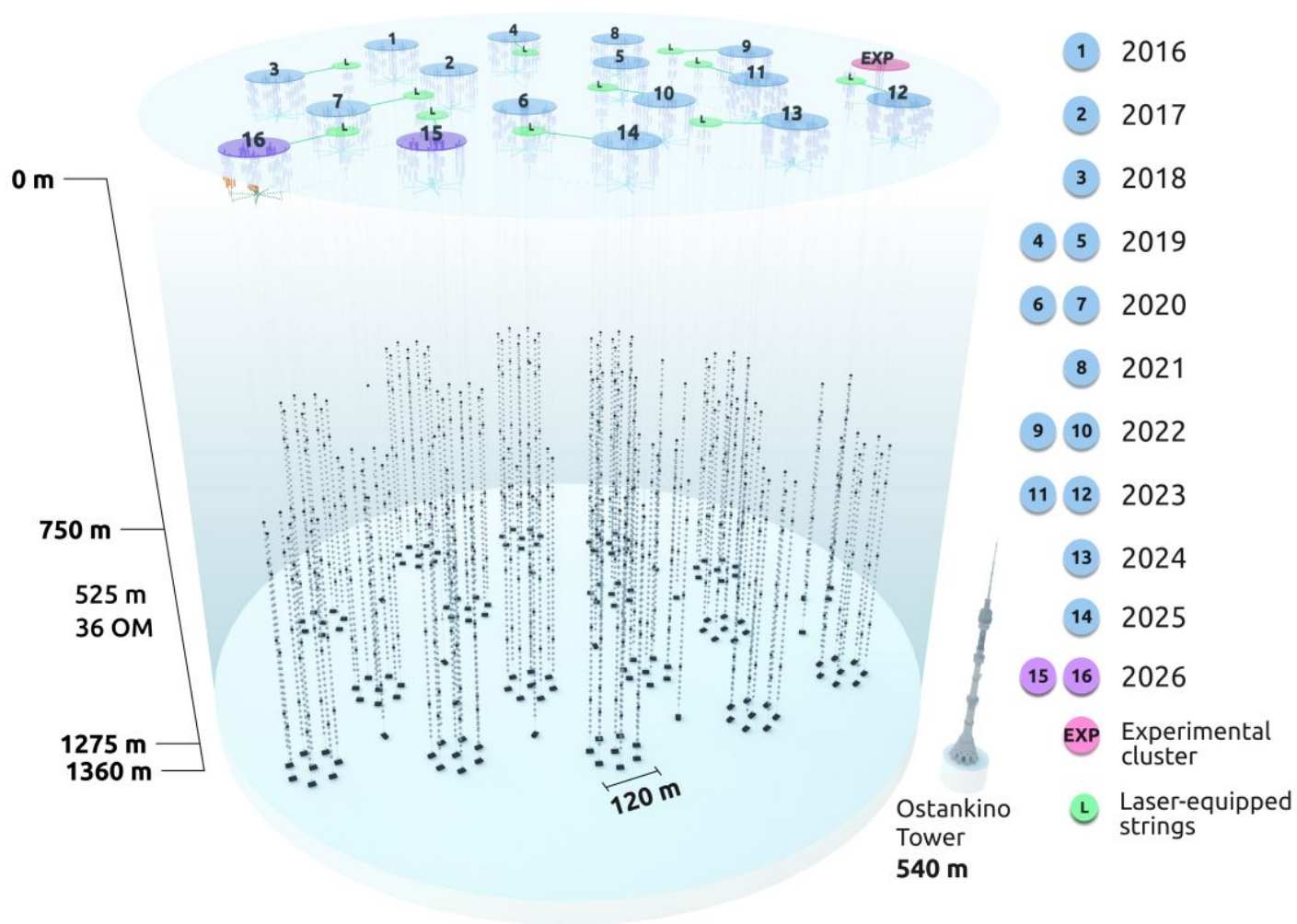
- Southern part of Lake Baikal
- Platform “Ivanovka” of Circum-Baikal railway
- Telescope is located 3.6 km away from shore

- Constant lake depth: ~1360 m
- Water transparency:
 - Peak absorption length: 22 m
 - Scattering length: 60 - 80 m
- Stable ice cover over 7 - 8 weeks in Feb - April:
 - detector deployment and maintenance





The detector status



After the 2026 deployment campaign:

- 135 vertical strings
- 16 independent clusters
- 4896 optical modules (OM)
- 0.8 km³ detection volume (1 PeV cascades)



Key components



String: carries 36 optical modules (OMs)

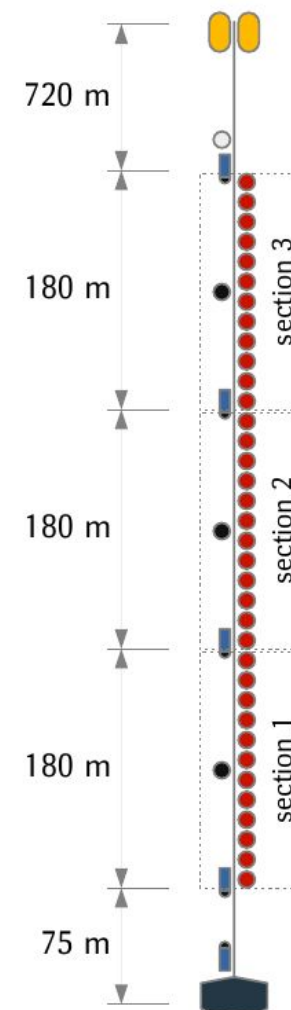
- 10-inch high-quant.-eff. PMT
- 15 m vertical spacing
- OM facing the lake bottom
- 3 readout sections, 12 OMs each
- Section master module digitizes analog signals from each of 12 OMs

Positioning system

- Acoustic modems on each string
- OM positioning precision ~20 cm

Time calibration systems

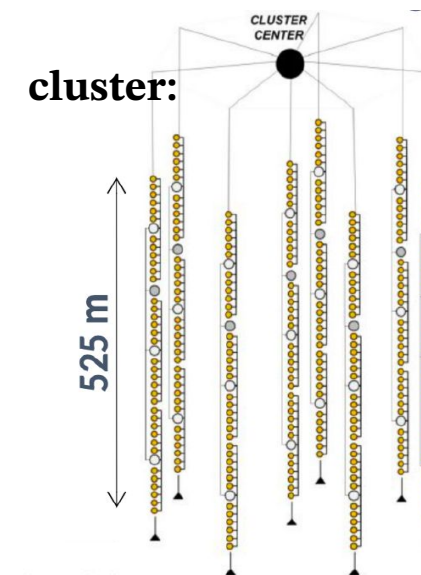
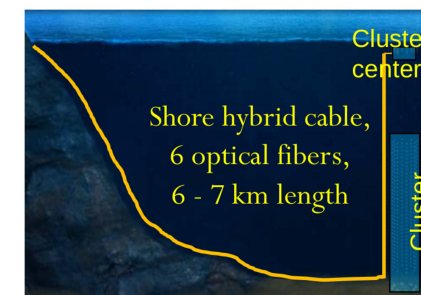
- LED in each OM
- LED beacons
- Laser beacons between clusters
- Calibration precision ~2 ns



- buoy
- string master module
- section master module

- optical module
- acoustic modem
- anchor

Each cluster sends triggered events to the shore center via its own opto-electric cable



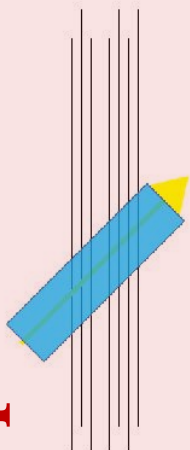


Event reconstruction pipelines

In this report

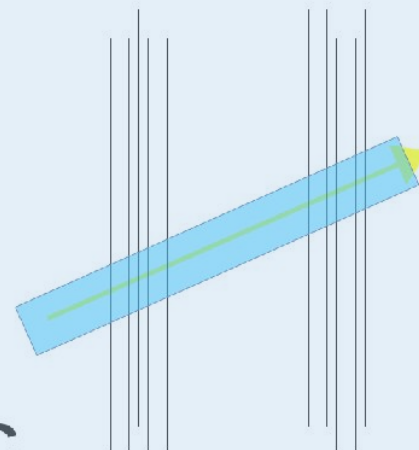
in development

Single-cluster tracks



- ✓ Low energy threshold
- ✓ Optimal sensitivity to nearly vertical tracks
- ✓ 90% of recorded track events

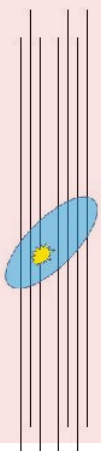
Multi-cluster tracks



- ✓ Moderately low energy threshold
- ✓ Optimal sensitivity to inclined tracks
- ✓ Best angular resolution

ν_μ CC

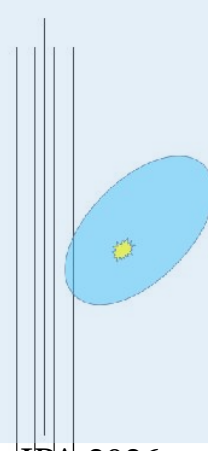
Single-cluster cascades



- ✓ High energy threshold
- ✓ Good energy resolution
- ✓ Relatively rare events

NC, ν_e CC

Multi-cluster cascades

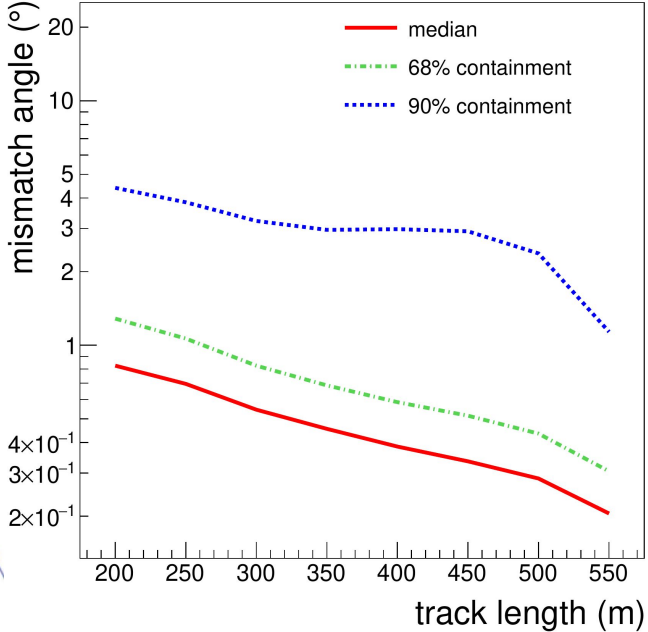


- ✓ Very high energy threshold
- ✓ Excellent energy resolution
- ✓ Very rare events



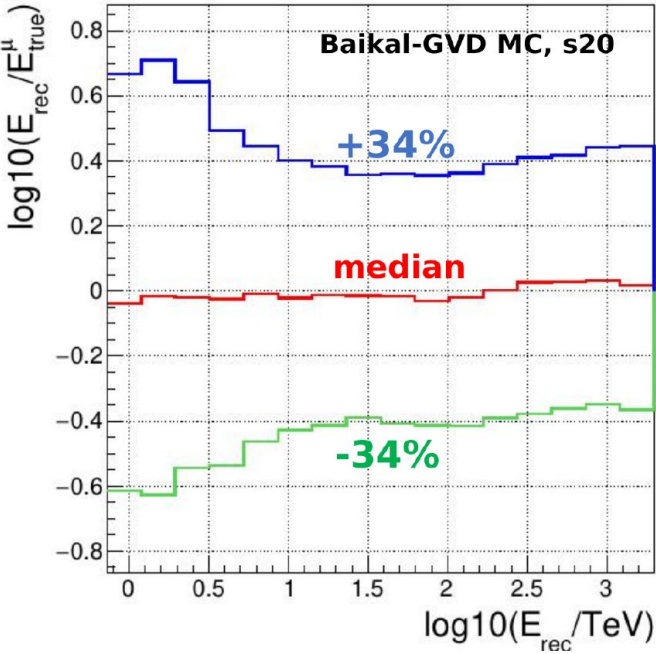
Single-cluster reconstruction precision

Track angular resolution:
 $\sim 0.8^\circ$ - $\sim 0.2^\circ$ for tracks
longer than 200 m

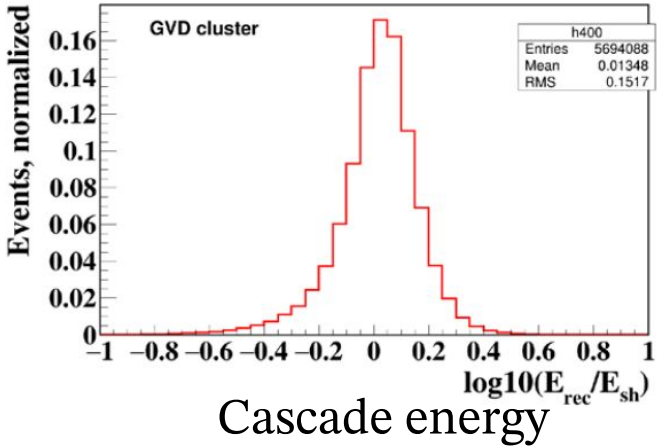
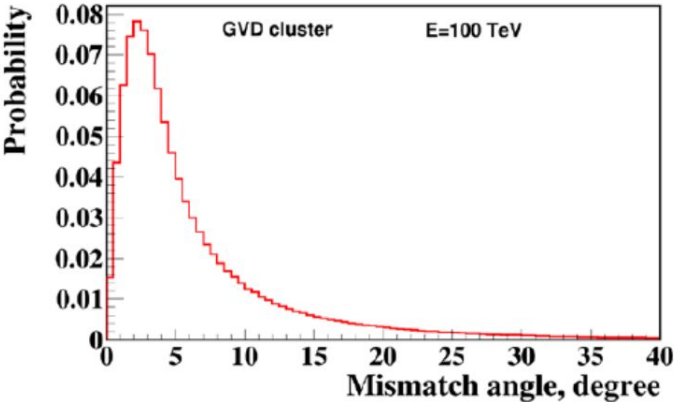


track-like,
data 2019

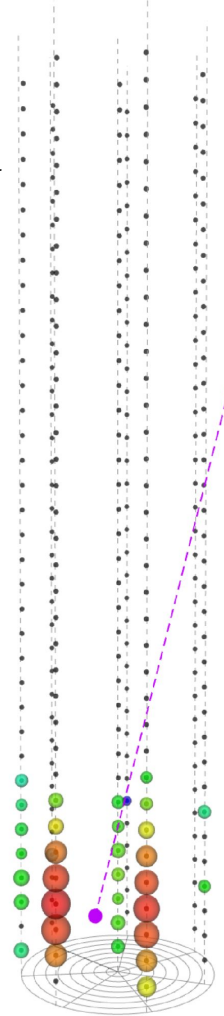
Muon energy resolution:
factor 2.5
for $E^\mu > \sim 10$ TeV



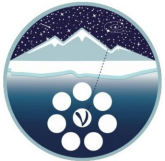
Cascade angular resolution:
 $\sim 2-4^\circ$ depending on energy and
cascade location



Cascade energy
resolution 10-30%



cascade-like,
data 2022



Results with cascade events



Diffuse astrophysical neutrino flux

Analysis of the 6-year data, April 2018 - March 2024

- Upgoing cascade events: lower atmospheric background
- Main selection requirements:

$$E_{\text{sh}} > 15 \text{ TeV} \ \&\& \ N_{\text{hit}} > 11 \ \&\& \ \cos\theta < -0.25$$

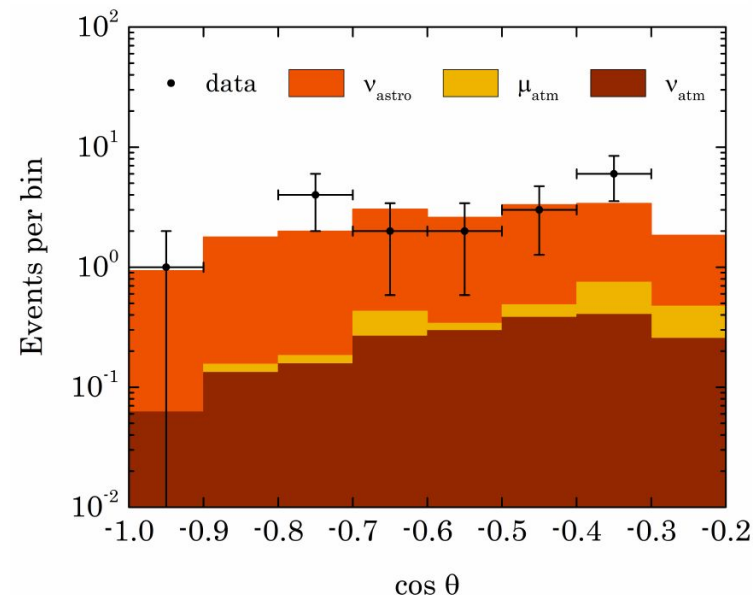
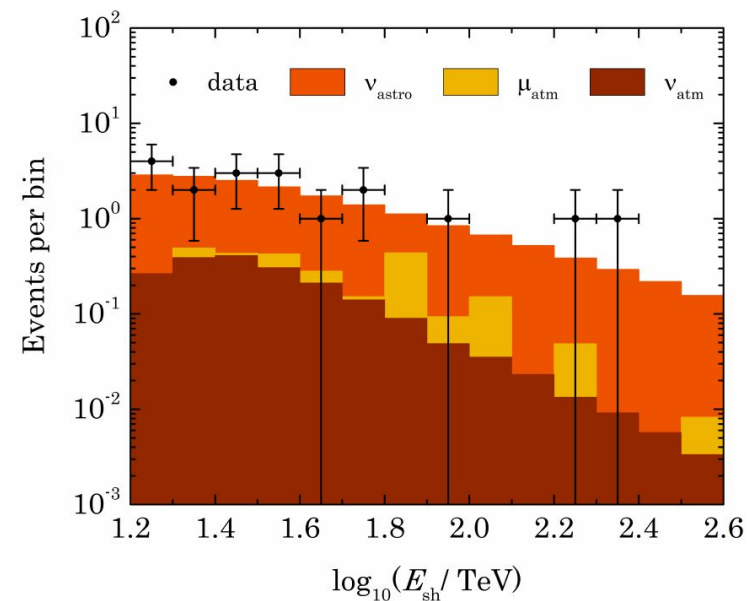
&& downgoing muon veto

N_{data}	N_{bg}	P-value	Significance (no syst.)	Significance (stat.&syst.)
18	2.8	2.1×10^{-7}	6.24σ	5.10

<https://arxiv.org/abs/2507.01893>

Previous version of analysis (4-year dataset):

[Phys.Rev.D 107 \(2023\) 4, 042005](#)





Diffuse astrophysical neutrino flux

- Extraction of one-flavour single-power-law flux:

$$\Phi_{\nu+\bar{\nu}}^{\nu+\bar{\nu}} = \phi_{astro} \left(\frac{E_{\nu}}{100\text{TeV}} \right)^{-\gamma_{astro}}$$

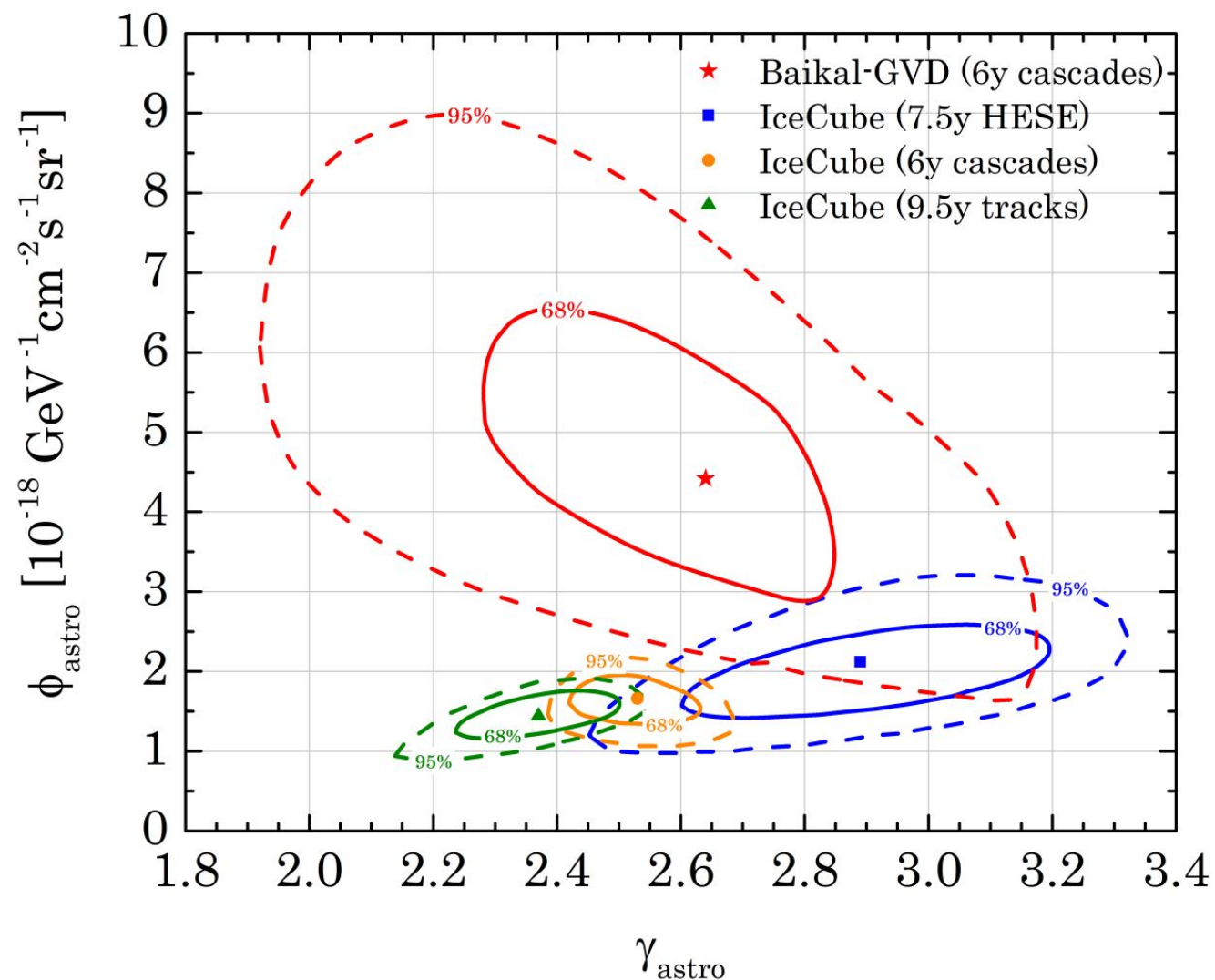
- Best-fit parameters:

$$\gamma_{astro} = 2.64_{-0.11}^{+0.09}$$

$$\phi_{astro} = 4.42_{-1.29}^{+2.31} (10^{-18} \text{GeV}^{-1} \text{cm}^{-2} \text{s}^{-1} \text{sr}^{-1})$$

- The spectral index is in agreement with IceCube measurements.
- Spectrum normalisation is in general larger than IceCube.

<https://arxiv.org/abs/2507.01893>

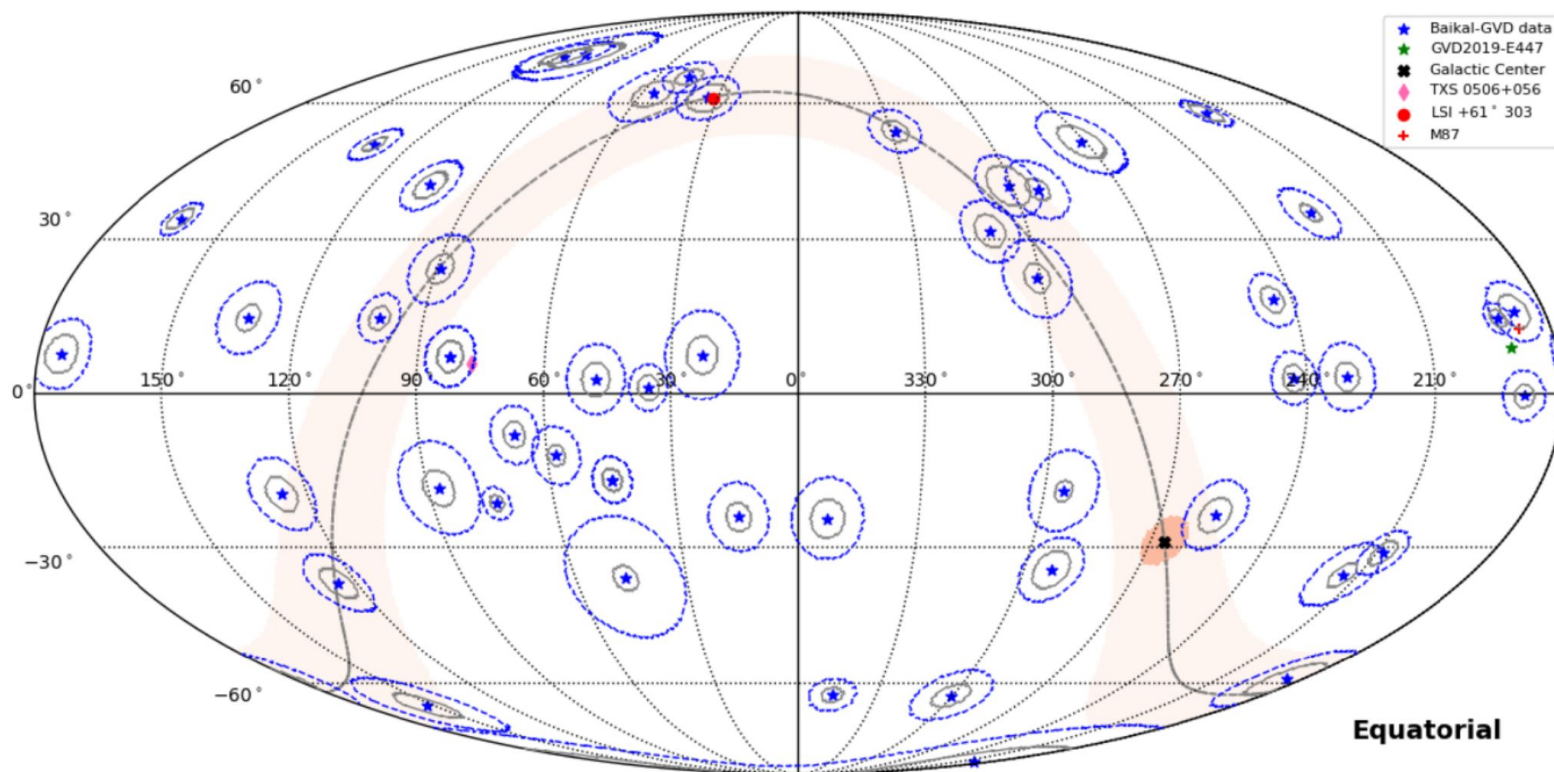




Neutrino source searches

Search for neutrino association using 4-year cascade data [MNRAS 526, 942 \(2023\)](#)

- Catalogue of VLBI-bright blazars
- Examination of promising coincident sources: galactic and extragalactic
- Largely no conclusive results

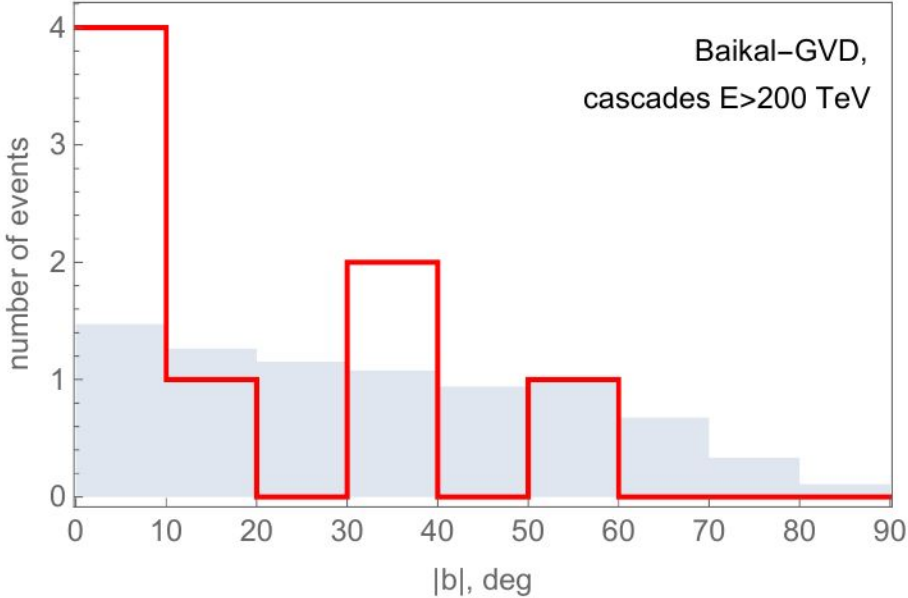
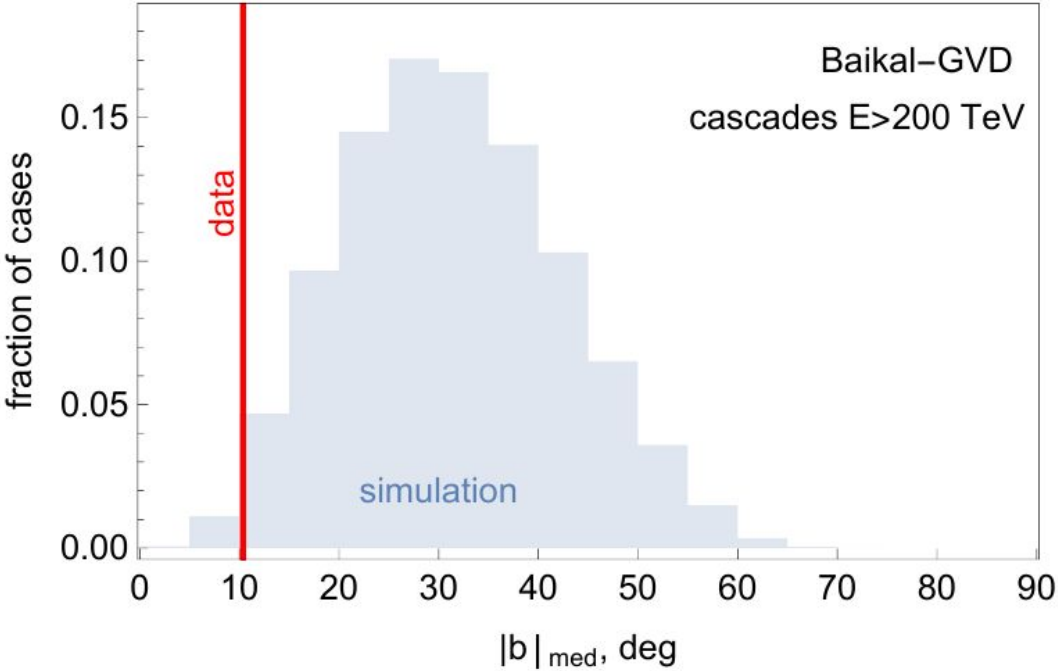


Cascade events from the 6-year dataset (Apr 2018 - March 2024)



Cascade association with galactic plane

- Analysis is inspired by independent analysis of public IC data in [ApJL 940, L41 \(2022\)](#)
- High-energy cascades April 2018 - March 2024 (6 years)
- Test the Galactic excess for cascades with $E_{sh} > 200 \text{ TeV}$
- Used the sample of 8 events, 64% of astrophysical origin
- Simple model-independent test using median of galactic latitude $|b|_{med}$
- Null hypothesis is excluded with a significance of 2.5σ



Baikal-GVD data was combined with IceCube producing stronger hint for event association with the galaxy

Sample	$ b _{med}$	$\langle b _{med} \rangle$	p
	observed	expected	
Baikal-GVD cascades	10.4°	31.4°	$1.4 \cdot 10^{-2} (2.5\sigma)$
IceCube cascades	12.4°	31.9°	$8.7 \cdot 10^{-3} (2.6\sigma)$
combined cascades	12.4°	31.5°	$1.7 \cdot 10^{-3} (3.1\sigma)$
IceCube tracks	24.7°	36.0°	$1.8 \cdot 10^{-3} (3.1\sigma)$
all cascades+tracks	23.4°	35.0°	$3.4 \cdot 10^{-4} (3.6\sigma)$



Multi-PeV neutrino flux limits

6-year cascade dataset:

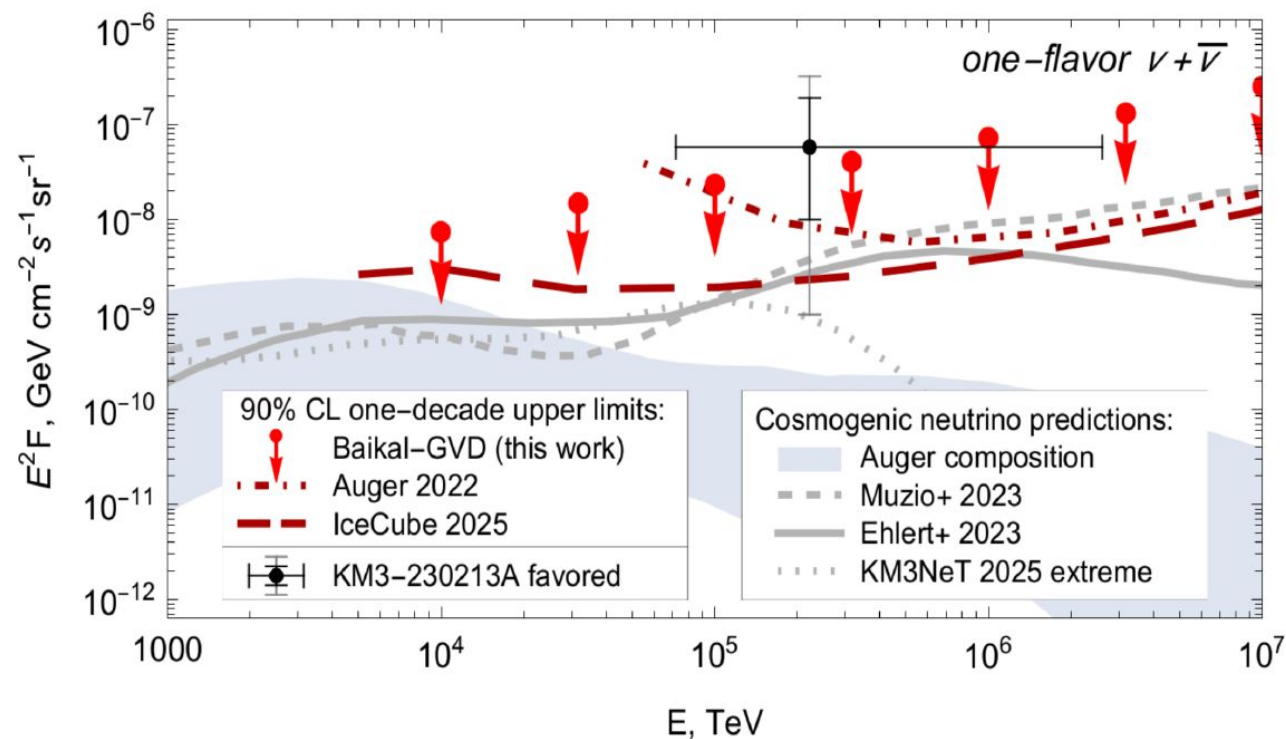
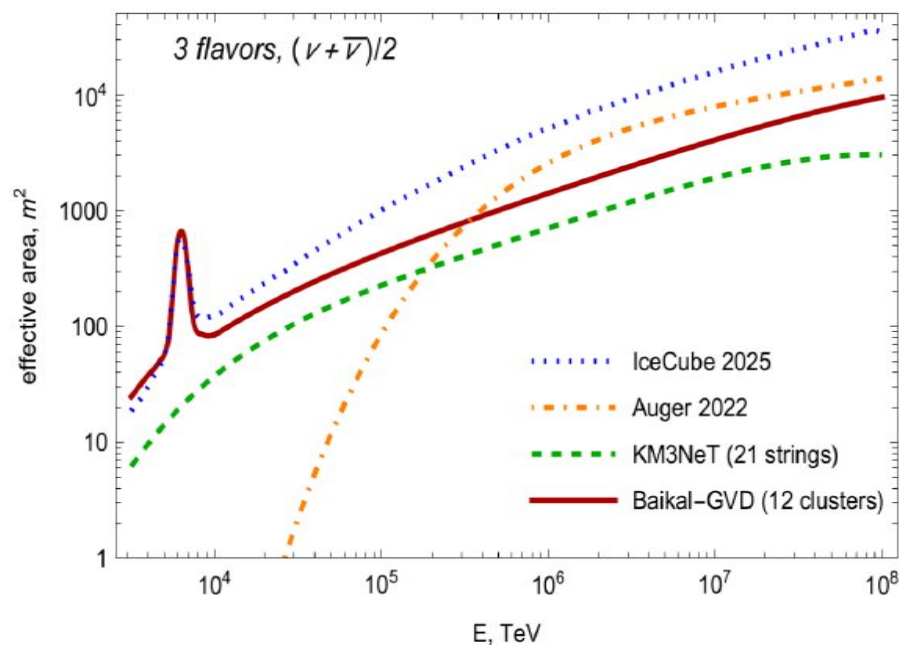
- Exposure: 26.8 years of one cluster operation
- All-sky selection largest cascade energy - 1.2 PeV
- Non detection above this energy can be used to constrain flux of Multi-PeV neutrino

Confront recent Multi-PeV neutrino detection by KM3NeT: **KM3-230213A**

Constraints are weaker than ones from the IceCube due to smaller exposure.

The constraint do not contradict KM3-230213A flux estimate.

Effective area in cascade channel



[Phys.Rev.D 112, 083025 \(2025\)](#)



Track results



The 5-year track dataset

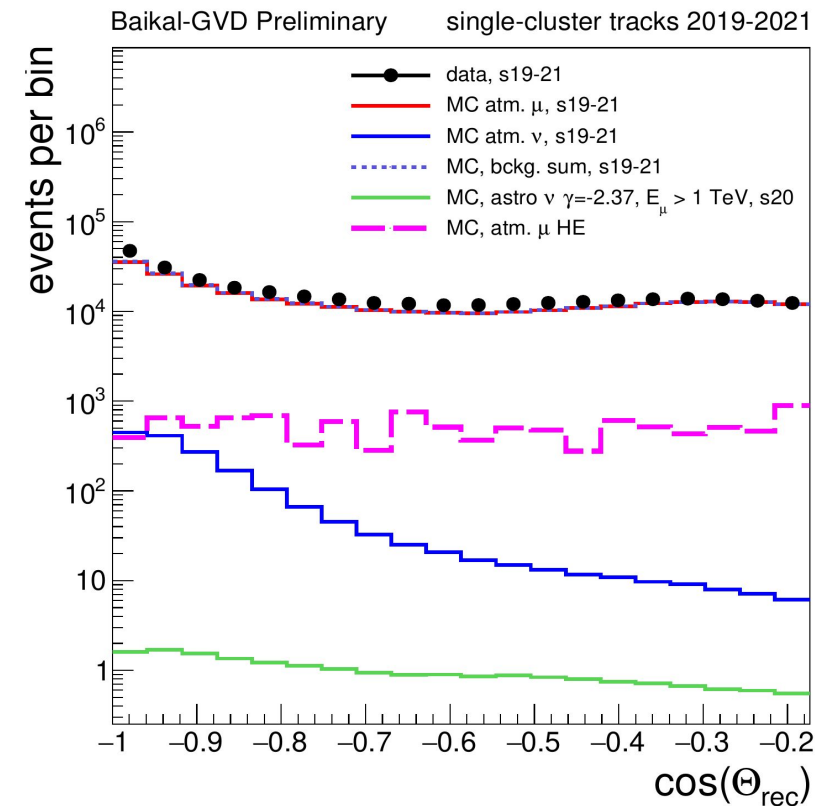
The data from Apr 2019 to March 2024 were processed with track reconstruction algorithms in single-cluster regime

- Equivalent of 30 yr. of one cluster operation.

The 5-year dataset allowed to perform first probe for diffuse flux and point source search (later in the talk).

Analyses with this dataset are restricted to upgoing tracks.

Cosine zenith angle before the neutrino selection



Dominated by muon bundles

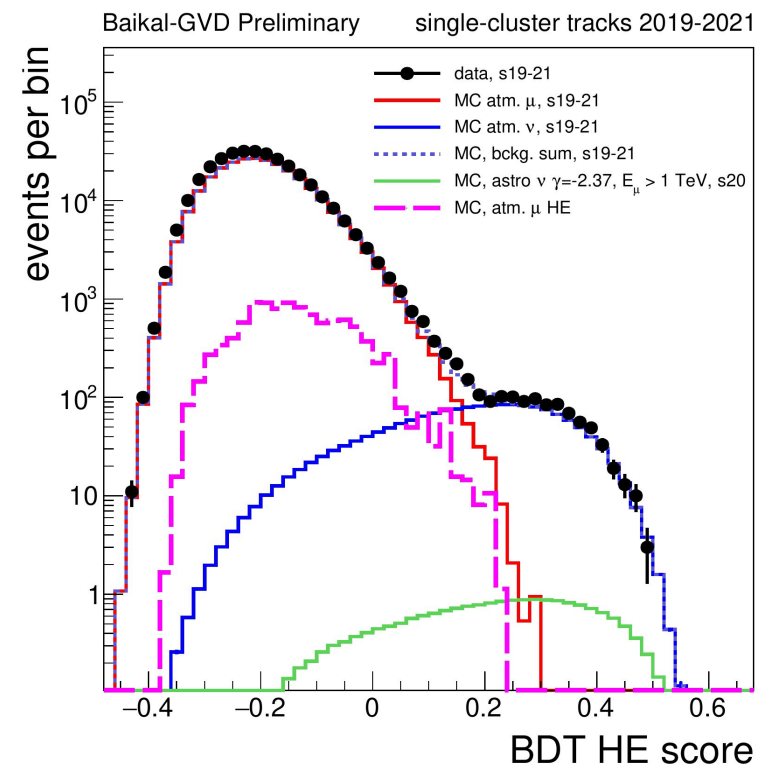
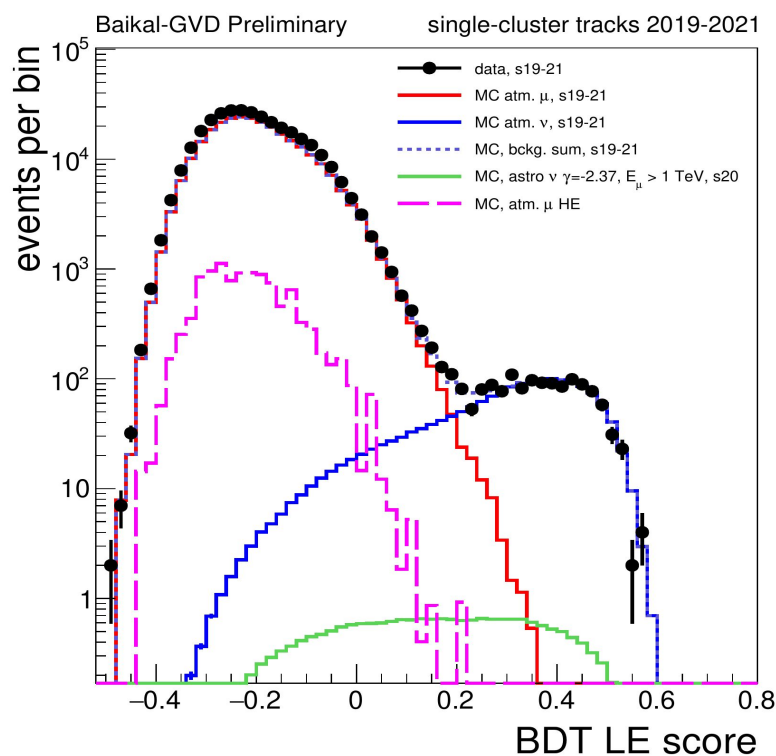


The 5-year track dataset

- Misreconstructed atmospheric muon bundle events are suppressed with BDTs
- Low-energy BDT ($E_\mu < 10\text{TeV}$) and high-energy BDT ($E_\mu > 10\text{TeV}$)
- To strengthen the background suppression training samples were enriched with high-energy muon bundles with leading muon energy $E^\mu > 100\text{TeV}$

BDTs evaluated over the sample of
upgoing tracks
before selection:

[PoS\(ICRC2025\)1162](#)





Probe for diffuse fux

Probe for the diffuse flux with **cut-based event-counting analysis**.

Cuts are optimized for spectrum $\gamma=2.37$.

Optimization result: $E_{\text{rec}}^{\mu} > 45 \text{ TeV}$, $\text{BDT_HE} > 0.26$.

Event counts:

MC atm. μ	1.4
MC atm. ν	23.5
Observed	38

P-value of the excess: 0.0087, significance: 2.39σ ,
no systematics is taken into account yet.

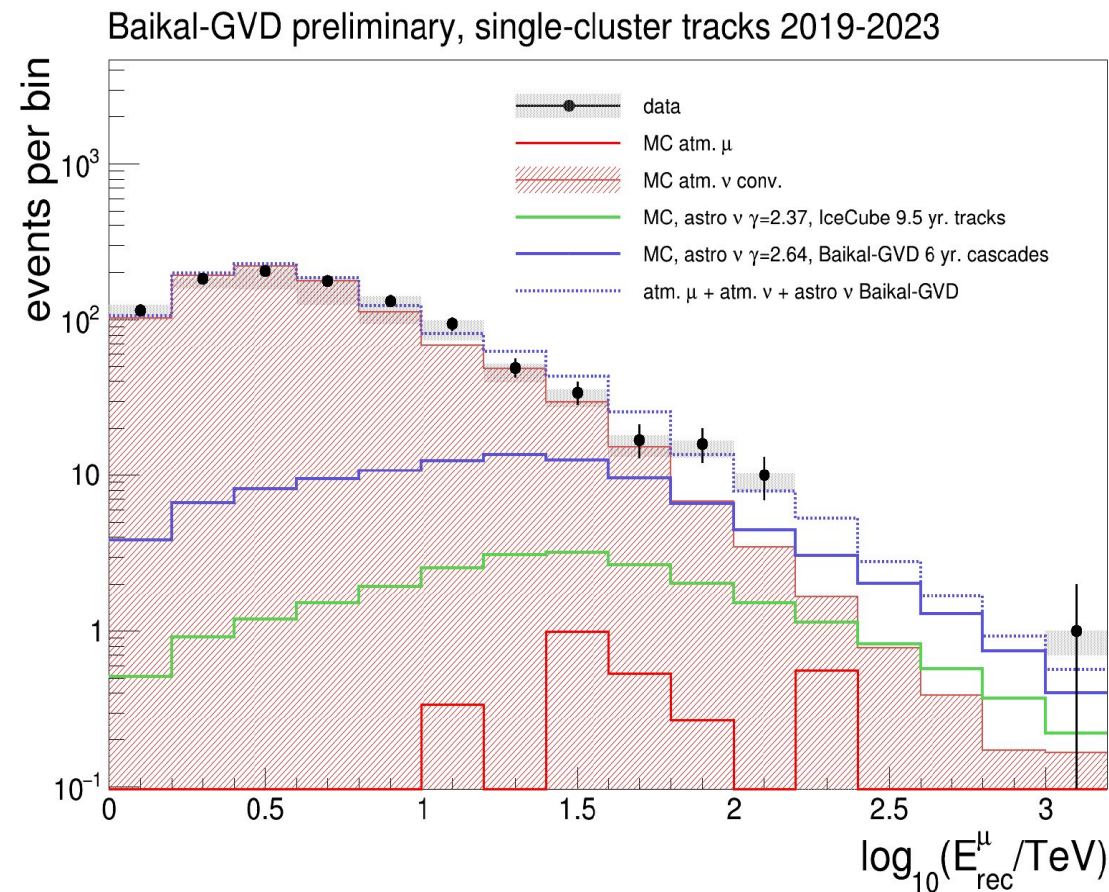
The 90% CL one-flavour flux limits for $\gamma=2.37$:

$$0.59 < \varphi_0 < 3.95 (10^{-18} \text{ GeV}^{-1} \text{ cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1})$$

do not contradict IC and cascade Baikal-GVD results.

Likelihood-based analysis is in development.

Energy distribution for tracks passing the selection





Point source search

Guided search over a list of 92 objects

Cut-based: BDT cut was optimised for the best sensitivity to E^{-2} spectrum

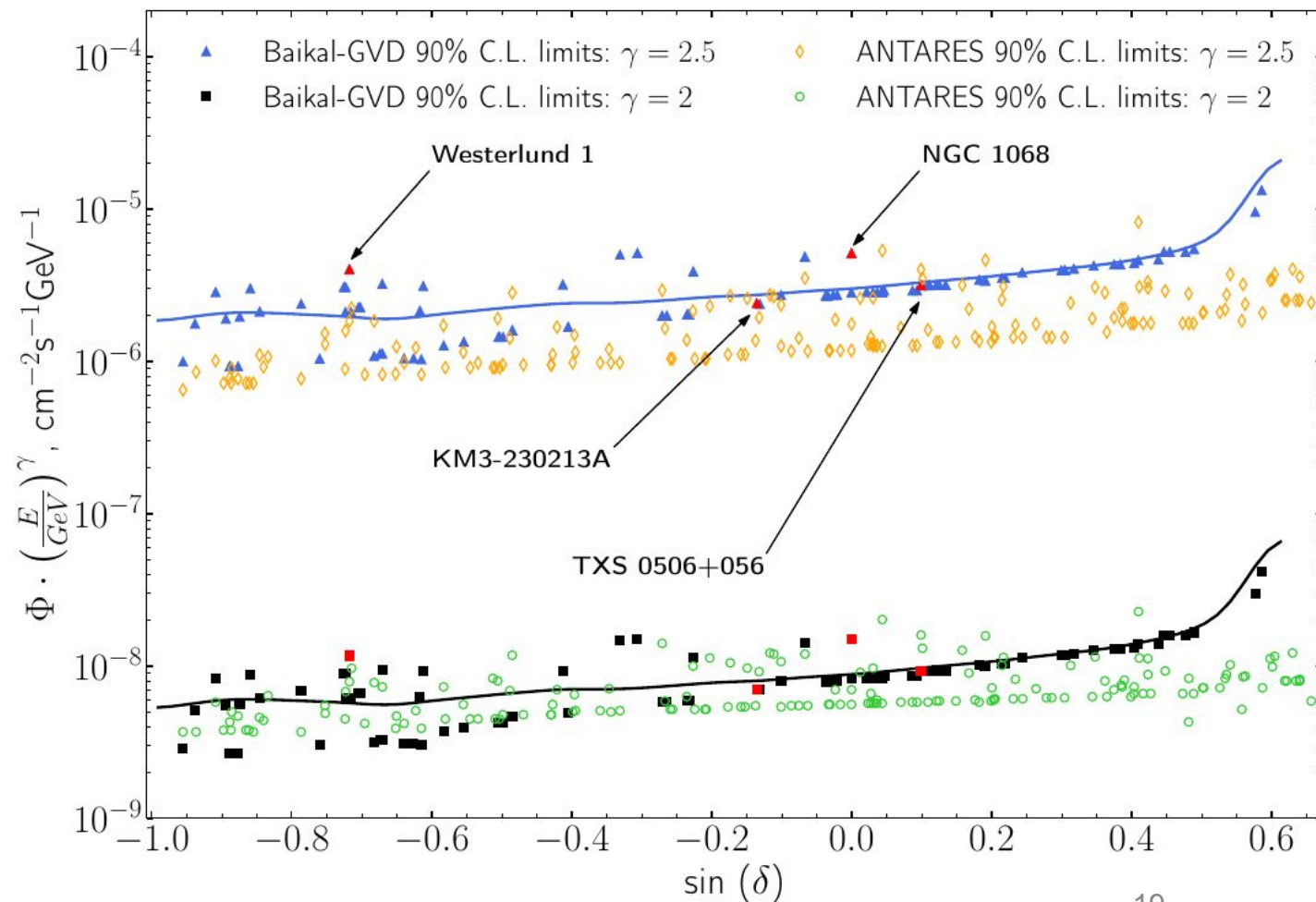
Background was estimated using scrambling
of data events in right ascension

Count events in 2° cone around each object,
estimate excess over the background

The object with most coincidences:
young massive stellar cluster **Westerlund 1**
with three coincidences,
background expectation - 0.98 events,

pre-trial significance - 2.7σ

<https://arxiv.org/abs/2603.21261>



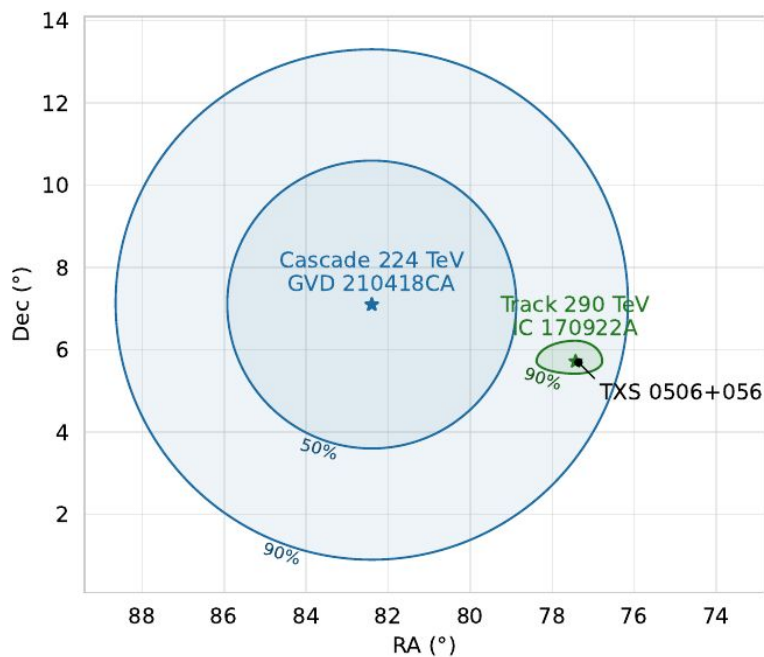


Multimessenger analyses



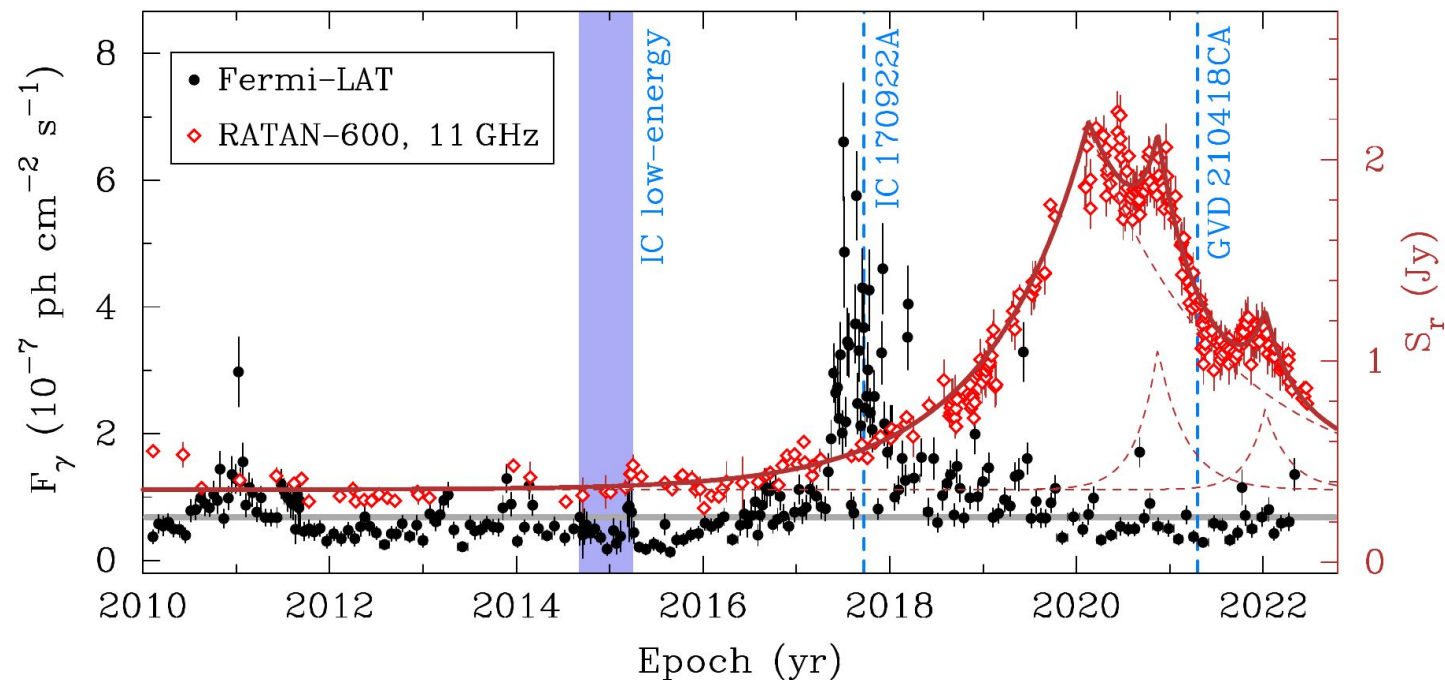
Cascade from TXS0506+056 direction

- Upgoing cascade analysis, highest energy event
GVD210418CA: 224 TeV, 24 hits, 99.67% astro origin.
- IceCube neutrino source candidate TXS 0506+056 is within 90% containment circle.



Analysis of RATAN-600 [\[https://rat.sao.ru/en/\]](https://rat.sao.ru/en/) radiotelescope data indicated increased activity at the time of event

- IC event registered during γ flare
- Baikal event during radio flare
- The observed event counts are consistent with the assumed flare scenario, with probabilities of 8% (E^{-2}) and 13% ($E^{-2.5}$)



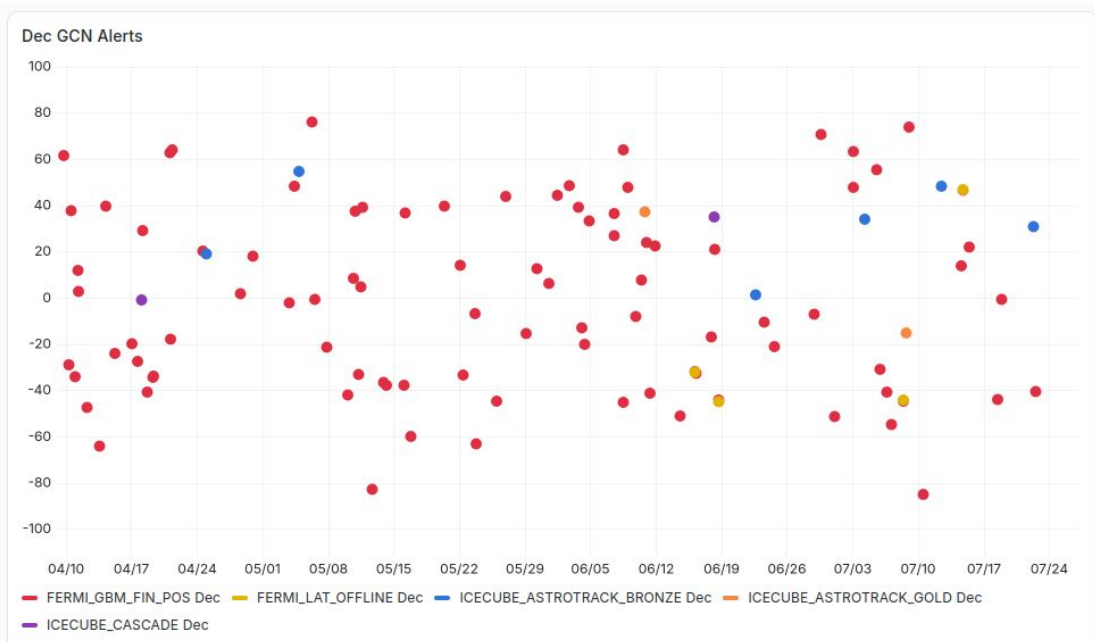
[MNRAS 527, 8784 \(2024\)](#)



Multimessenger alert follow-up

Follow-up with GCN:

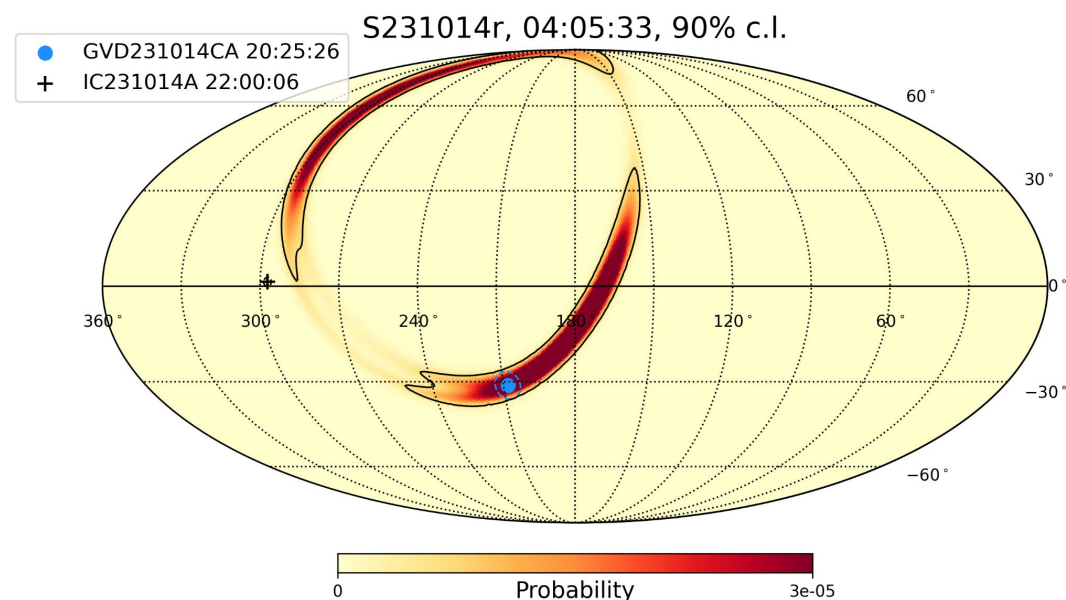
- IceCube neutrino alerts: > 180 since 2020
- LIGO-Virgo-KAGRA: 350 alerts in run O4
- Fermi GRB: > 300 alerts since Nov. 2024



- No significant coincidences with alerts.
- Upper limits for fluence derived for IC neutrino alerts: up to $0.5\text{-}0.7 \text{ GeV}\cdot\text{cm}^{-2}$ (2025).

GW: LIGO S231014r, BH merger event

- GVD231014CA: upgoing cascade with $E \sim 35 \text{ TeV}$
- 16 h later than the alert
- 90% circle of GVD231014CA is 5.5% of 90% region of S231014r



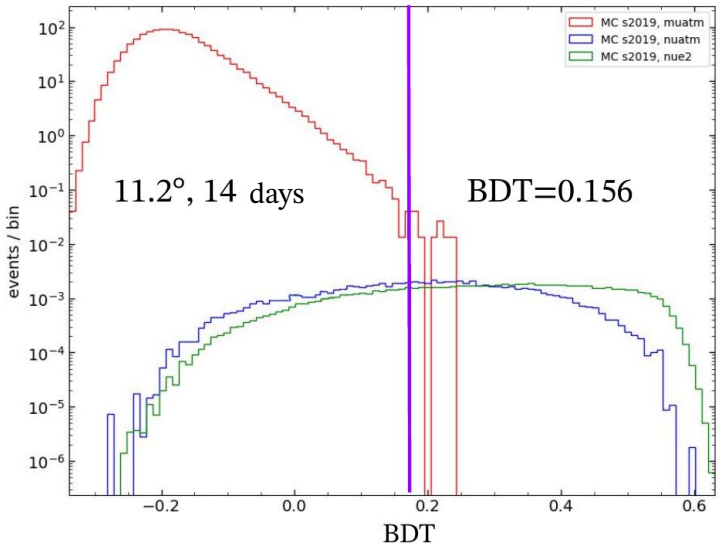
Background: 0.25, significance: 0.77σ



Multimessenger alert follow-up

Track selection optimization,
ON/OFF bckg. estimation

$R_{\text{on}}, ^\circ$	Time interval	Optimal BDT cut
0.7	+/- 1 d	- 0.022
5	0, +1 d	0.017
11.2	0, + 14 d	0.156

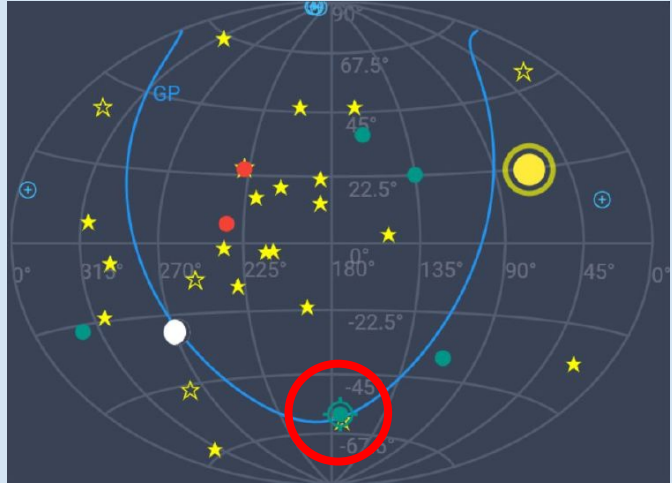


Distribution of MC events and
BDT-optimum value

Fermi-GBM coincidence

GRB 260516C

2026-05-16, 19:34:38 UTC,
RA=172.57°, Dec = -59.89°,
Err=3.19°,
 $T_{90} = 33.28 \pm 11.493$ s



Upgoing track-like event in
Baikal-GVD:

- $E = 4$ TeV
- $\delta = 2.8^\circ$ to GRB 260516C
(within 90% containment),
- **9.5 hours after the GRB**

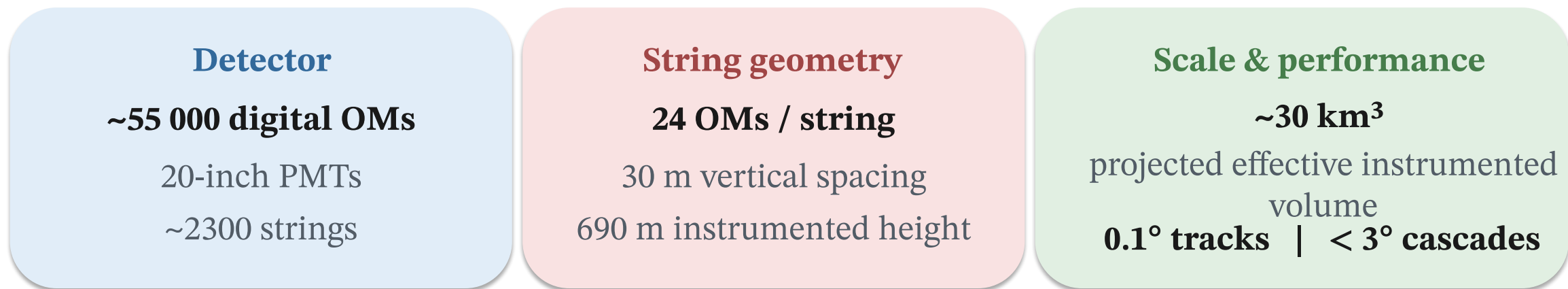
[V. Dik, RCRC 2026](#)

selection	N_{back} (jan-may 2026)	significance (pre-trial)
BDT > 0.017 (Poisson)	$9.8 \cdot 10^{-3}$	2.34σ
BDT > 0.15 (Gauss)	$5.2 \cdot 10^{-4}$	3.27σ

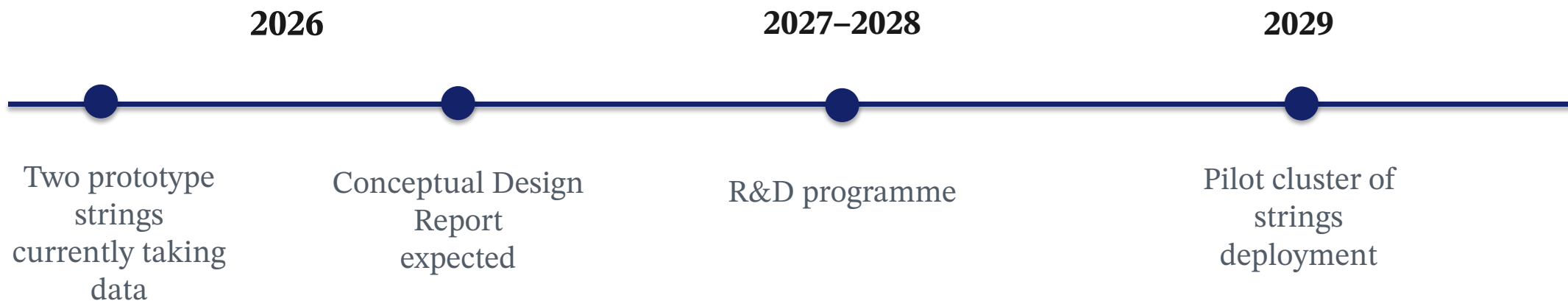


Towards the next-generation neutrino telescope in Lake Baikal

A potential development pathway is a joint Russian–Chinese initiative to establish a next-generation neutrino telescope in Lake Baikal.



Development status





Summary

After the 2026 deployment campaign the Baikal-GVD neutrino telescope incorporates 16 clusters instrumented with 4896 optical modules

The 6-year cascade dataset:

- The diffuse astrophysical neutrino flux observation in cascade channel.
- The hint on substantial galactic component in high-energy cascades .

The 5-year track dataset:

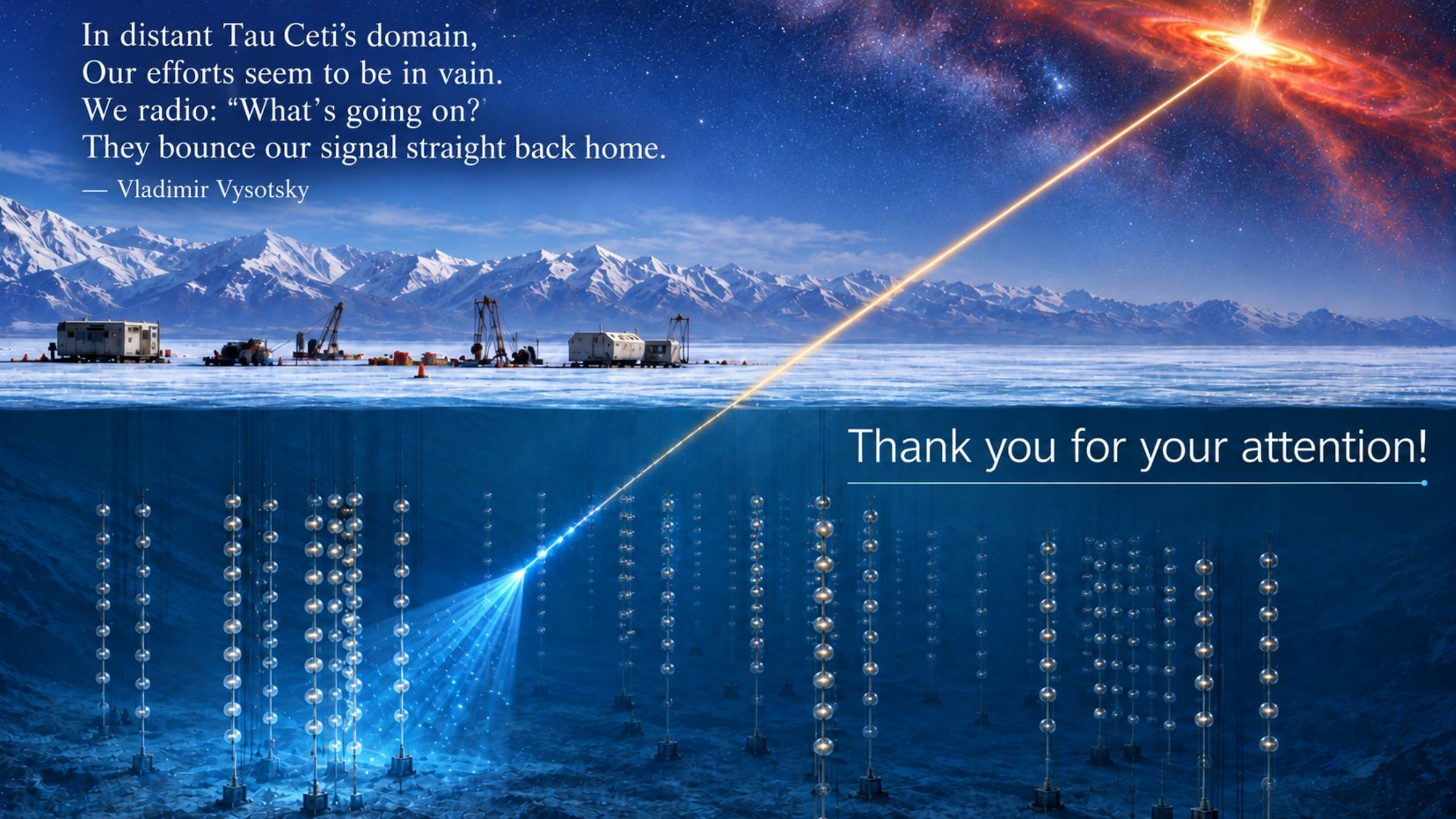
- First hints on the diffuse flux in track channel.
- First point source search competitive with full ANTARES dataset.

Routine follow-up of multimessenger alerts was commissioned.

In distant Tau Ceti's domain,
Our efforts seem to be in vain.
We radio: "What's going on?"
They bounce our signal straight back home.

— Vladimir Vysotsky

Thank you for your attention!



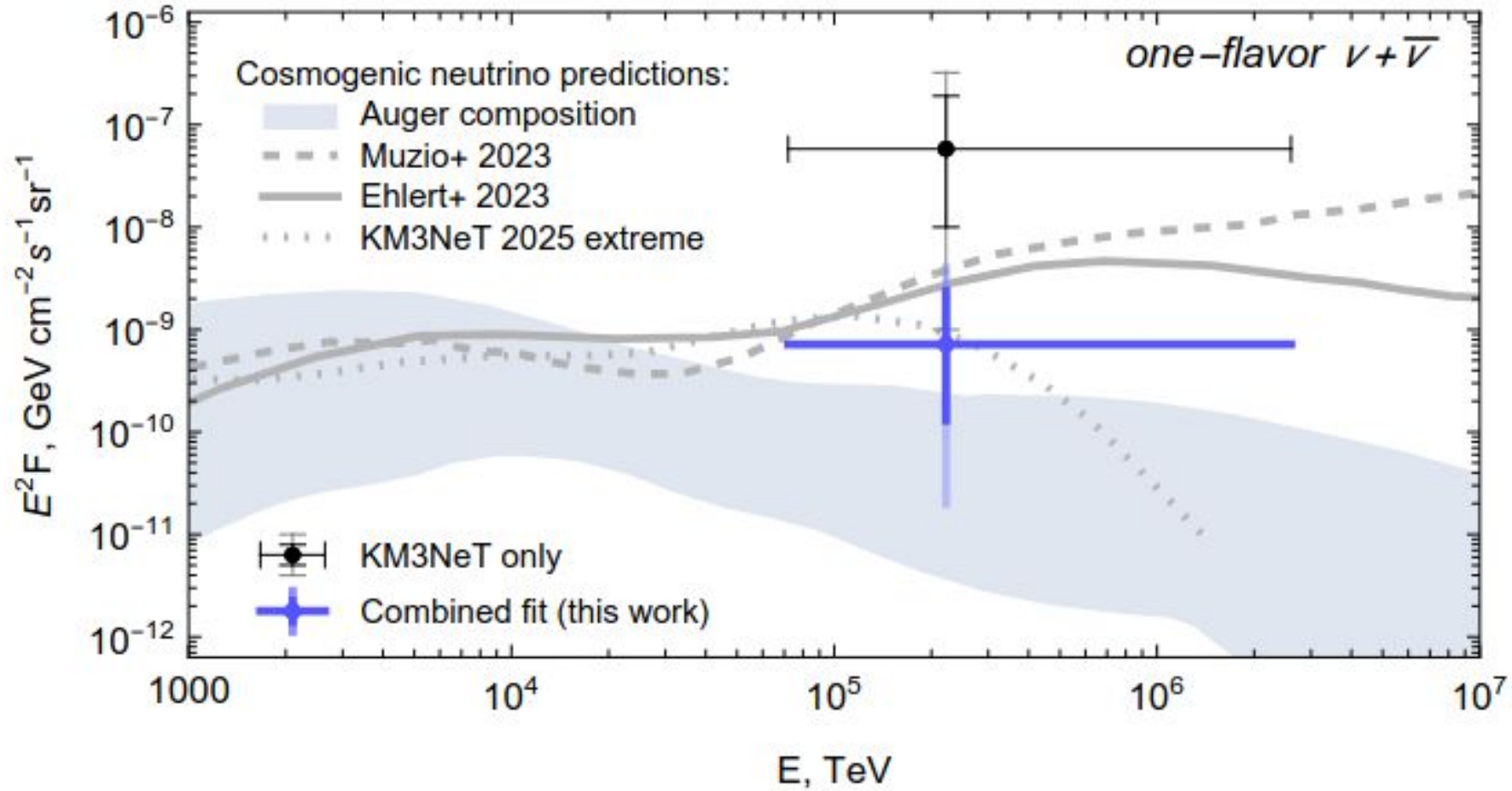


Figure 5. Very high energy diffuse neutrino fluxes per one flavor, sum of neutrinos and antineutrinos (assuming isotropic flux and flavor equipartition). The blue cross represents the result of the combined fit of four experiments (darker – 90% CL in energy, 68% CL in flux; lighter – 95% CL in flux), see the text for details. Other notations are the same as in Figure 3.

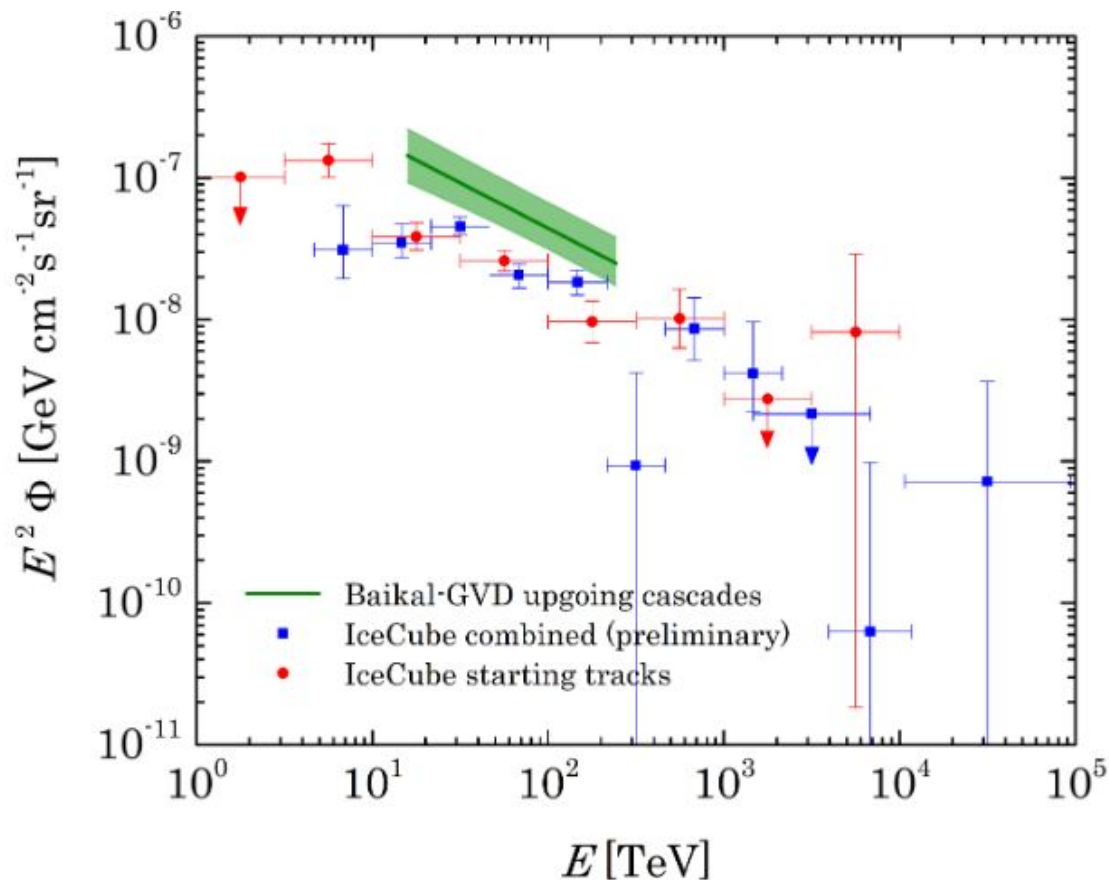


FIG. 4. Measurements of the diffuse astrophysical neutrino flux: the green line shows the fitted spectrum for this analysis of the Baikal-GVD upward-going cascade sample and the uncertainties are shown by the shaded region. The red points show differential data points of the latest IceCube analysis of starting tracks sample [37], while the blue points represent the IceCube preliminary result of their combined analysis [38].