GNN Monthly
The Global Neutrino Network 92th Edition January/February 2025, Feb. 16, 2025

RNO-G: a new GNN member

After discussion among the existing five GNN collaborations, the RNO-G collaboration was admitted as sixth member. The decision was taken at a ZOOM meeting of the GNN Board on January 14. The process took a rather long time since it was accompanied by profound debates on the perimeter of GNN.
The RNO-G collaboration has meanwhile accepted the invitation to join GNN. **Welcome RNO-G!**

New spokespersons

IceCube

Erin O'Sullivan from the University of Uppsala has been chosen by a majority vote of all Ph. D. physicists in the collaboration to become the new IceCube Spokesperson. She will begin her term at the Uppsala collaboration meeting in May and take over from Ignacio Taboada who served the collaboration in this function for four years.

Erin O'Sullivan

Baikal GVD

The Baikal-GVD steering committee has elected Zhan-Arys Dzhilkibaev (INR Moscow) as spokesperson and Igor Belolaptikov (JINR Dubna) as deputy spokes-person of the Baikal GVD collaboration on January 20, 2025.

Zhan-Arys Dzhilkibaev

Igor Belolaptikov

GNN common data formats group advancing on common alert format

Jutta Schnabel (ECAP Erlangen) reports: At the latest regular meeting of the GNN in January, we got a first glimpse of what good cooperation between IceCube and KM3NeT on data formats could look like. Erik Blaufuss and Vincent Cecchini presented both perspectives on sending alerts from the two telescopes, along with the outcomes of previous discussions on a common core format.

As IceCube is restructuring its alert system and KM3NeT is establishing its own, this is the perfect time for both to align their approaches. They are moving in the same direction by adopting the interface provided by the General Coordinates Network (GCN) and its underlying JSON schema. With this shared infrastructure in place, the information exchanged through the interface becomes a key focus. A common neutrino schema could be developed for the GCN, ensuring consistency in core parameters. Discussions on this topic during the meeting will be followed up.

The second topic of the meeting was an update from Jutta Schnabel on the newly established High Energy Interest Group (HEIG) within the International Virtual Observatory Alliance (IVOA). This group brings together representatives from X-ray, gamma-ray, and neutrino experiments to extend IVOA standards into high-energy astrophysics. The group's topics and work plan were outlined in a dedicated IVOA note,

GNN Dissertation Prize

The GNN board is pleased to report that 10 theses have been submitted, 4 from IceCube and 6 from KM3NeT. This means firstly that our community is alive, secondly that the dissertation prize seems to be attractive, and thirdly, that there is much work to be done by the prize committee!

News from the experiments

KM3NeT

End of January, the KM3NeT collaboration has met, both in person and online, for its winter Collaboration Meeting , in Louvain-la-Neuve, Belgium.

It was also the occasion to welcome the new Management Team: Paul de Jong (Nikhef/University of Amsterdam) as Spokesperson, Damien Dornic (CPPM/CNRS) as Deputy Spokesperson, Rosa Coniglione (INFN) as Physics & Software Manager, and Antonio D'Amico (Nikhef) as Technical Project Manager.

Damien, Paul, Rosa and Antonio

The Collaboration also welcomed a new team, from INFN/Univ. of Florence, coordinated by Nicola Mori.

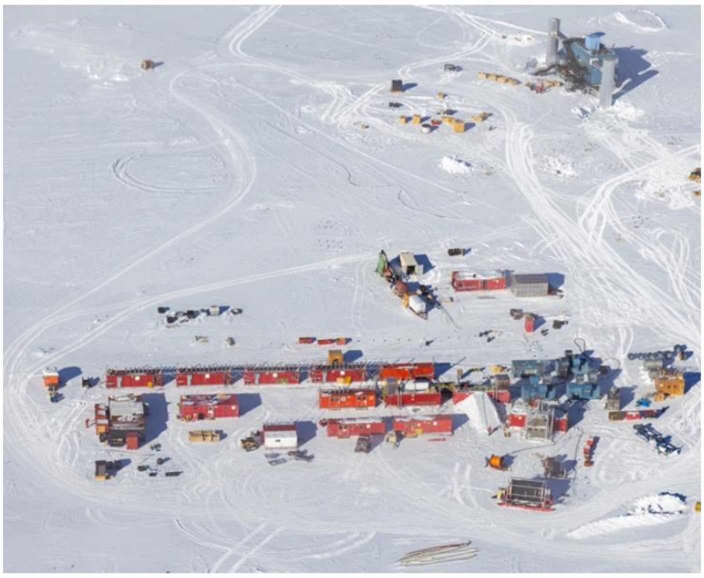
As it came to my attention only now, on November 6, long-standing KM3NeT collaboration member Vlad Popa, from the Institute of Space Science in Romania, passed away.

Deployment plans for the next months: a new deployment is planned at the ORCA site between March 10 and 23, with up to 7 DUs to be deployed.

IceCube

Let me start with a spectacular aerial photo featuring a 360-degree view from above the IceCube Lab, taken with a camera mounted to a kite. The picture has been taken by Matthew Petroff from the BICEP team.

The 2024/25 IceCube field season ended on February 10, and the last seven members of the team left the Pole. The drill team focused on completing the last tests in the tower, shutting down the camp, and winterizing it – see the next two pictures.



Aerial view of the drill camp on January 16, 2025 (photo: Michael Rayne/ASC-ARFF)

End of the season: Drill camp as empty and clean as you'll ever see it

Here is a summary of what has been achieved during this season:

1) The hot-water drill machinery has been prepared and thoroughly tested.
2) The holes for the seven Upgrade strings have been prepared by drilling through the firn layer down to a depth of ~ 40 meters. (From there on, the hot water drill will take over next season.)
3) Cable trenches have been excavated, and cables have been laid from the seven holes to IceCube Laboratory ICL. The cables were threaded through the towers left and right from the ICL.
4) The plans to prepare the electronics inside ICL have been fully achieved.
5) The Optical Modules at the Pole (all dual PMT modules assembled in Japan and a large part of the multi-PMT modules) have been tested and prepared to overwinter in a tempered building.
6) An ARA surface station was dug out (it is 2.5 meters below the snow surface) and repaired/modernized.
7) Two surface stations (8 scintillators and 3 antennas each) were deployed and commissioned.

There was a scary moment on January 31. The main power plant on the station went offline, and the backup generators were activated. These generators provide power for the station but not enough to keep all experiments at full power. The winterovers immediately transitioned IceCube into low power consumption mode. All equipment at the ICL was shutdown except for what is needed to keep power to the DOMs. The outage was, however, too long to keep even the DOMs powered. After about 12 hours, the station was restored and IceCube winterovers could start bringing the detector back online. Fortunately, all DOMs survived the very short period they were without power, and IceCube operates as perfect as before.

Here is a nice picture that shows that there are many actions requiring humans instead of machines:

Coiling the surface cable slack into the pit required all hands on deck. A string anchor is being installed in the background (Photo. C. Hill)

And finally, a picture showing the drum with the drill hose:

Members of the drill team with the heated drill hose. The drill must be heated to keep it at a tolerable temperature during the coming winter.

Baikal-GVD

The preparations for the expedition are in full fledge. 651 optical modules are already in Baikalsk and are waiting to be transferred to the shore station. 46 additional OMs are ready and tested but will arrive a bit later. A truck with underwater electronics will leave Moscow on February 21.

The first expedition team (the "early bird group") is planned to arrive at the shore station on February 24, a second group of people on February 28.

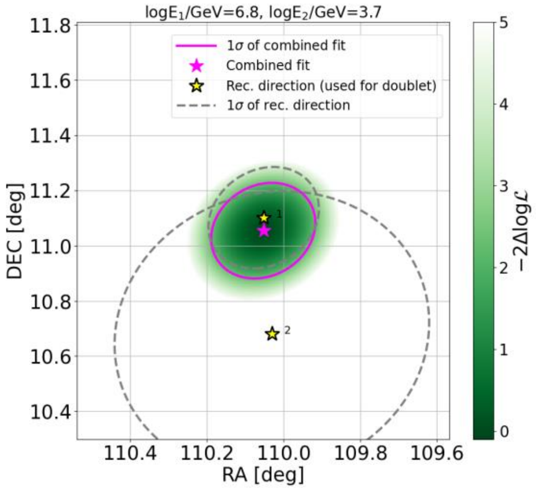
So, everything is on track. The ice is not as good as it was in the last few years, but the experienced expeditioners are optimistic anyway.

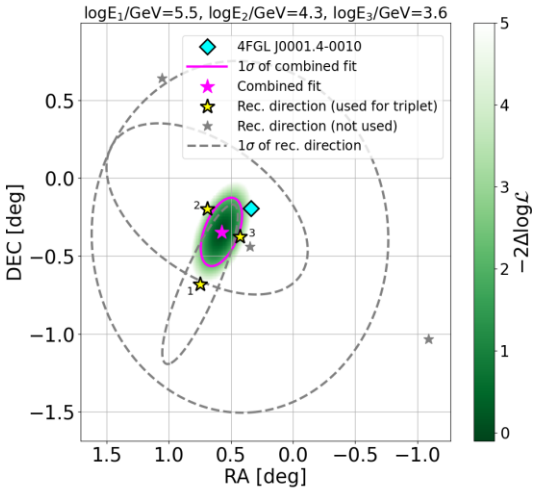
Publications

The IceCube Collaboration has submitted a paper *Search for neutrino doublets and triplets using 11.4 years of IceCube data* to ApJ (posted at 2501.09276). The analysis has been performed by Nobuhiro Shimizu (Chiba University, Japan).

This search focuses to multiplets which cluster in a certain direction within 30 days. A new search method optimized for transient neutrino emission with a monthly time scale is employed, providing a higher sensitivity to neutrino fluxes than in previous analyses. The result is sensitive to neutrino transient emission, reaching per-flavor flux of approximately 10^{-10} erg cm^{-2} sec^{-1} from the Northern sky in the energy range $E \gtrsim 50$ TeV. The number of doublets and triplets identified in this search is compatible with the atmospheric background hypothesis and consequently just results in upper limits on the nature of neutrino transient sources with emission timescales of one month.

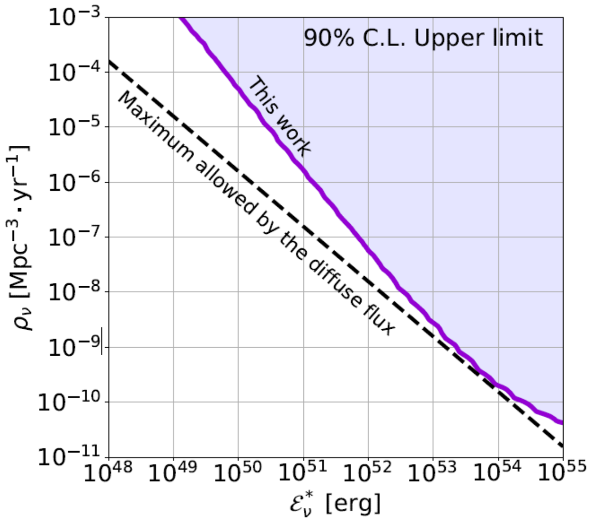
The two most interesting multiplets, with the lowest false alarm rate (FAR) are shown below, a doublet (top) and a triplet (bottom). The fitted triplet location is close to the position of the *Fermi source 4FGL J0001.4-0010.*





Contour plots of the direction of the two most significant multiplets, top the doublet and bottom the triplet. Yellow stars indicate the directions of neutrino events to form the multiplets, while magenta stars denote the fitted directions of the multiplets. The dashed lines outline 68% containment uncertainty regions of each event determined by assuming Gaussian distribution, while magenta solid lines represent that of the fitted directions. The background color scales represent the residuals of the signal likelihoods. Small gray stars in the second panel represent neutrino events observed around the time of multiplet detection (from MJD59007 to MJD59047), but are not included in the multiplet found by the seed event method (see the paper for details). In the lower panel, the cyan diamond represents the direction of a Fermi source 4FGL J0001.4 which is separated by 0.28◦ from the best fit direction.

Transient sources should also contribute to the diffuse neutrino flux, their contributions of course must be less than the total observed diffuse flux intensity, resulting in parameter constraints on (ε^*_ν , ρ_ν), where ρ_ν is the burst rate density and ε^*_ν the all-flavor neutrino isotropic emission energy per source, see the following figure.



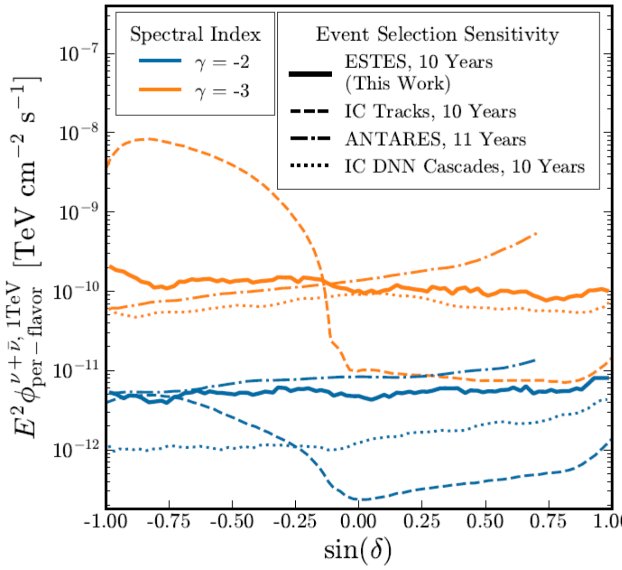
Contours of excluded region of neutrino transient source parameters (E^*_ν , ρ_ν) at 90% confidence level when ΔT_{max} = 30 days, and the spectral indices are 2.3. The area above the curves is excluded at the 90% confidence level. The diagonal lines correspond to upper limits implied from the diffuse flux when the signal source spectrum has γ = 2.3. These diffuse flux constraints are determined so as not to overshoot the energy distribution of the measured diffuse neutrino flux.

The IceCube Collaboration has submitted a paper *Time-Integrated Southern-Sky Neutrino Source Searches with 10 Years of IceCube Starting-Track Events at Energies Down to 1 TeV* to ApJ (posted at 2501.16440). The analysis has been performed by y Sarah Mancina (University Padova) and Manuel Silva UW Madison).

The analyses presented in this paper use the new IceCube Enhanced Starting Track Event Selection (ESTES), which identifies events likely generated by muon neutrino interactions within the detector geometry, focusing on neutrino energies of 1-500 TeV with a median angular resolution of 1.4°. Selecting starting track events filters out not only the atmospheric-muon background, but – in the southern sky – also the atmospheric-neutrino background. The advantages of the ESTES event selection come from the improved properties of energy resolution, pointing resolution, and background rejection for starting-track events. This improves IceCube's muon neutrino sensitivity to southern-sky neutrino sources, especially for Galactic sources that are not expected to produce a substantial flux of neutrinos above 100 TeV. It increases the purity of the astrophysical neutrino sample in the southern equatorial sky (δ < −15◦), resulting in an atmospheric background rate approximately 1 order of magnitude larger than the astrophysical neutrino rate compared to 4 orders of magnitude in the case of previous track selections. In this work, the ESTES sample was applied for the first time to searches for astrophysical sources of neutrinos, including a search for diffuse neutrino emission from the Galactic plane (assuming spectral indices less than -2.0 or energy cutoffs). No significant excesses were identified from any of the analyses; however, constraining limits are set on the hadronic emission from TeV gamma-ray Galactic plane objects and models of the diffuse Galactic plane neutrino flux.

Although no new sources of astrophysical neutrinos were identified in the analysis of the ESTES data, the paper provides some of the strongest constraints for potential neutrino sources in the southern sky, including a 90% statistics-only upper limit of 85% of the KRAγ 5 PeV model prediction for the diffuse Galactic plane neutrino emission.

The following figure gives the resulting sensitivity for point sources:

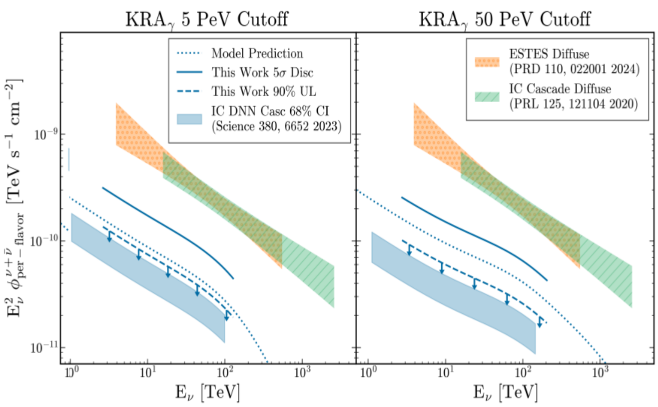


The sensitivity neutrino and anti-neutrino per-flavor flux at 1 TeV for a steadily emitting point source versus declination for the ESTES analysis (solid lines) for two different source spectral index hypotheses (γ = −2.0 in blue and γ = −3.0 in orange). The ESTES sensitivity is compared to that from the the 10 year IceCube tracks sample (2022), the 11 year ANTARES sample and the (2019) and the IceCube Deep Neural Network (DNN) selected Cascades search (2022)

The following table and the figure summarize for one (KRA_γ 5 PeV) respectively two (KRA_γ 5 PeV and KRA_γ 50 PeV) Galactic plane models the sensitivity, upper limits and p-values (table) and the 5σ discovery potential and 90% statistics-only upper limit (figure).

	KRA_γ 5 PeV Cutoff		
Event Selection	$MF^{sens}_{90\%}$	$MF^{UL}_{90\%}$	$-\log_{10}(p)$
ESTES (This Work)	53%	85%	0.78
DNN Cascades	16%	–	5.2
IC Tracks, 7 Years	–	–	–
ANTARES and IC Tracks	81%	119%	0.54
ANTARES 2023	93%	199%	1.31

Comparison of the ESTES Galactic Plane results to the IceCube Deep Neural Network (DNN) selected Cascades, 7 years of IceCube tracks, the joint ANTARES and IceCube tracks analysis, and the ANTARES 2023 results. The three models tested were the Fermi-LAT π^0 model (assuming a power law spectral index of γ = −2.7 and the KRAγ model assuming a 5 PeV and 50 PeV exponential energy cutoff on the cosmic-ray spectrum. Shown here are only the KRAγ 5 PeV results (see the paper for all three models). The sensitivity and upper limits are given as a percentage of the model flux (MF) given in the paper of Torre et al. 2022. The p-values reported are the pre-trial's corrected p-values.



The 5σ discovery potential (Disc) and 90% statistics-only upper limit (UL) neutrino and anti-neutrino per-flavor flux for the ESTES analyses compared to the confidence intervals (CI) from the IceCube DNN Cascades (IC DNN Casc) analysis (2023) for two of the three Galactic plane template models: KRAγ (de la Torre 2022) with a 5 PeV (left) and 50 PeV (right) cosmic-ray exponential cutoff. The ESTES upper limits rule out the KRAγ model prediction at 90% confidence (de la Torre 2022). For added comparison, the astrophysical diffuse fits for ESTES (2024) and the diffuse cascade selection (2022) are included. The energy range shown for this work is defined by simulating the source hypotheses and finding the central range where 90% of the simulated events lie. The energy range for the DNN Cascades is calculated from the central range where 90% of the contributing data events lie.

The ESTES sample has other future uses for both multi-messenger astronomy and particle physics. This concerns, for instance, neutrino alerts to the astrophysical community for follow-up of events with a high likelihood of being astrophysical in origin. Due to the atmospheric-neutrino background, most of these events must have energies of around 100 TeV or greater to be sent as an alert. However, with ESTES, this energy threshold can be lowered due to the atmospheric-neutrino veto in the southern sky and the improved energy resolution of starting tracks over incoming events. By sending out starting-track alert events using ESTES, IceCube can provide neutrino alert events with a 50% or greater likelihood of astrophysical origin with energies in the tens of TeV.

For particle physics, the ESTES starting-track events provide a sample of over 10,000 muon neutrino CC interactions from 1 TeV to 500 TeV contained inside the detector geometry. These events can be used to measure the inelasticity – the ratio of energy transferred to the hadronic shower to the initial neutrino energy – which gives insight into the atmospheric neutrino-to-anti-neutrino ratio.

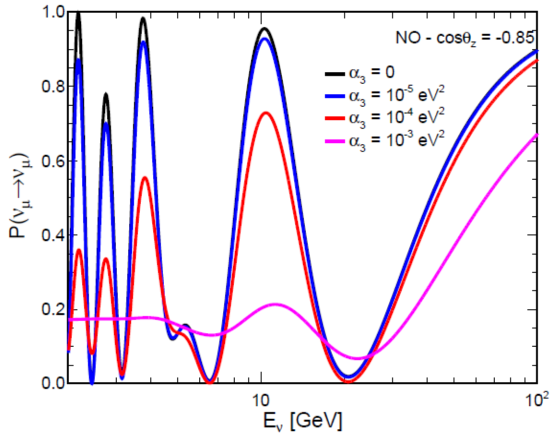
The KM3NeT collaboration has submitted a paper *Probing invisible neutrino decay with the first six detection units of KM3NeT/ORCA* to JHEP (posted at 2501.11336). The corresponding author is Victor Carretero University of Amsterdam and Nikef).

Neutrino decays can be phenomenologically classified into visible or invisible channels. Invisible decay occurs when the decay products remain undetected, either because they are sterile neutrinos or because they have such low energy that they fall below the detection threshold of the experiment. This paper, focuses on the scenario of invisible neutrino decay, regardless of the specific decay model or products. This is mainly motivated by the fact that the expected decay signal in atmospheric neutrino telescopes is already at the lowest detectable energy threshold, meaning that any non-sterile decay products would likely fall below the experimental sensitivity.
The invisible decay of neutrinos can be described by a depletion factor $D = \exp(-t/\tau_i)$ where τ_i is the rest-frame lifetime of the neutrino mass state m_i. In the case of relativistic neutrinos, this can be expressed as $D = \exp(-m_i L/\tau_i E)$, representing the fraction of neutrinos with energy E that survive after travelling a distance L. The invisible neutrino decay is then characterized by the parameter $\alpha_i = m_i/\tau_i$, which is expressed in natural units of eV^2.

The Hamiltonian that describes the propagation of a neutrino through matter, incorporating the effect of invisible decay, can then be written as:

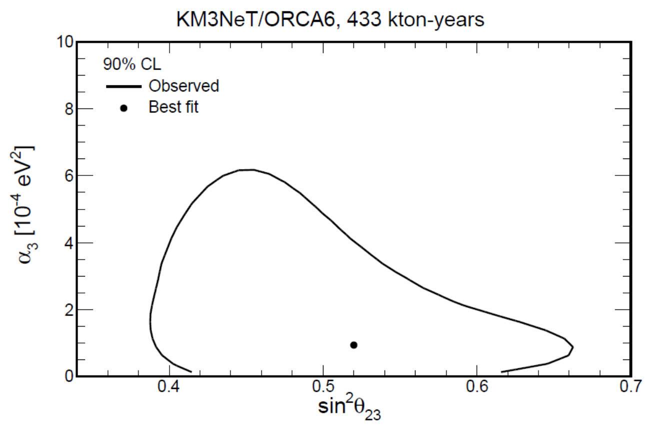
$$\frac{1}{2E}\left[U\begin{pmatrix}0 & 0 & 0\\ 0 & \Delta m^2_{21} & 0\\ 0 & 0 & \Delta m^2_{31}\end{pmatrix}U^\dagger + U\begin{pmatrix}0 & 0 & 0\\ 0 & 0 & 0\\ 0 & 0 & -i\alpha_3\end{pmatrix}U^\dagger\right] + \begin{pmatrix}V & 0 & 0\\ 0 & 0 & 0\\ 0 & 0 & 0\end{pmatrix}$$

with U being the PMNS matrix and $V = \sqrt{2}N_eG_F$ the matter potential. The effect on the survival probability can be seen in the next figure for muon neutrinos.



Probability of muon neutrino survival for normal ordering, cos θ_z = 0.85 and four values of α_i.

The data come from of 510 days of ORCA6, the six-string version of ORCA, and have been taken from January 2020 to November 2021 (5828 events). Here is the result:

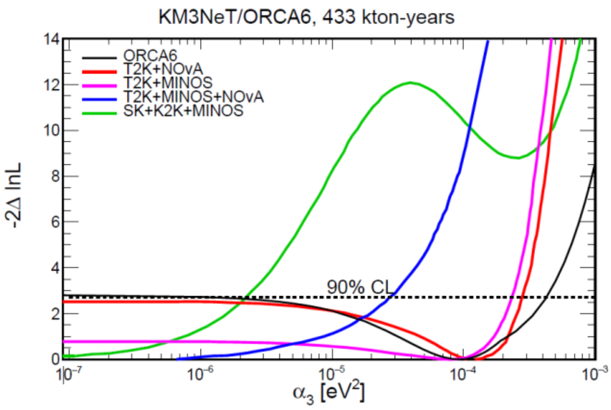


Allowed region at 90% CL obtained from ORCA6 data for the $\vartheta_{23} - \alpha_3$ parameters. The dot gives the best-fit value.

The best value is $\alpha_3 = 0.92^{+1.08}_{-0.57} \times 10^{-4}\ \mathrm{eV}^2$.

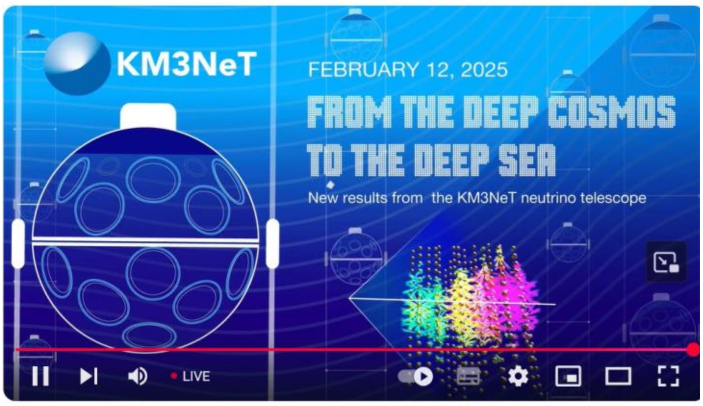
The corresponding likelihood ratio value is 2 ln(Lα/LSM) = 2.8 and the associated p-value is (3.9 ± 0.4) %, corresponding anyway to a 2.1 σ compatibility with the Standard Model hypothesis of no neutrino decay,

The next figure demonstrates that the constraint on the invisible decay parameter obtained in this study is compatible with results from combined fits with data from long-baseline neutrino experiments and is of the same order of magnitude. This result indicates that even at early stages of KM3NeT/ORCA, with a small detector and limited statistics, the potential to probe scenarios beyond the Standard Model is significant.



The observed profiled log-likelihood scan (black) compared with combined fits using data from: T2K+NOvA , T2K+MINOS, T2K+MINOS+NOvA and SK+K2K+MINOS.

The "200-PeV event" KM3-230213A



On February 12, the KM3NeT collaboration has published the following paper in Nature:

S. Aiello et al. (The KM3NeT collaboration) *Observation of an ultra-high-energy cosmic neutrino with KM3NeT*, Nature 638 (2025) 376.

It is accompanied by four papers which have been posted at February 12/13.

1) O.Adriani et al. (The KM3NeT Collaboration*), On the potential cosmogenic origin of the ultra-high-energy event*, arXiv:2502.08508

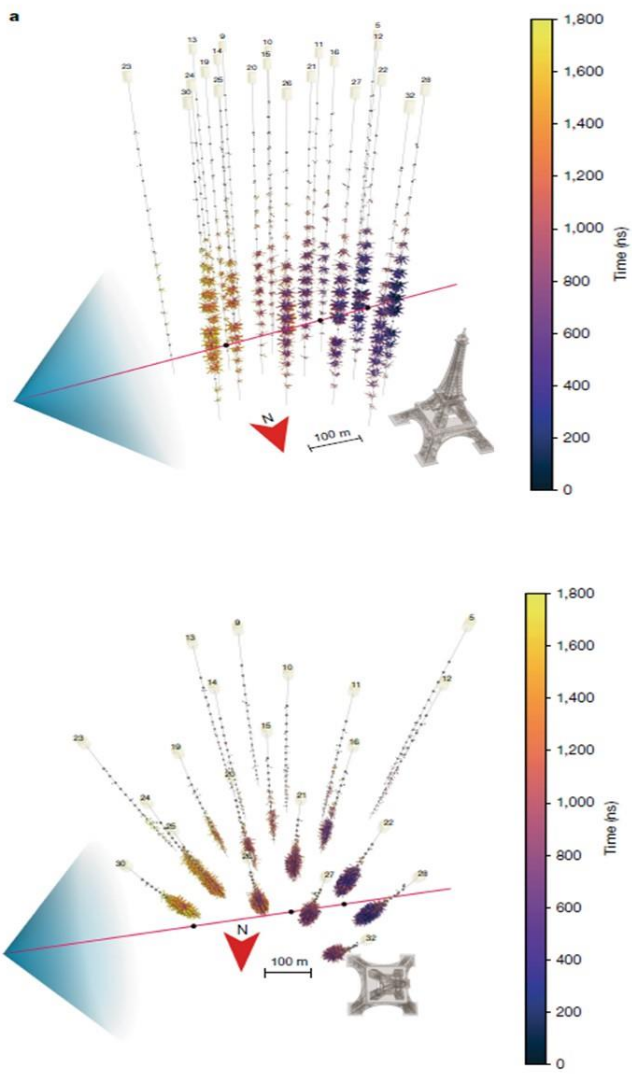
2) O. Adriani et al. (The KM3NeT Collaboration), *The ultra-high-energy event KM3-230213A within the global neutrino landscape*, arXiv:2502.08173

3) O. Adriani et al. (The KM3NeT Collaboration), *On the Potential Galactic Origin of the Ultra-High-Energy Event KM3-230213A*, arXiv:2502.08387

4) O. Adriani et al. (The KM3NeT Collaboration), *Characterising Candidate Blazar Counterparts of the Ultra-High-Energy Event KM3-230213A*, arXiv:2502.08484.

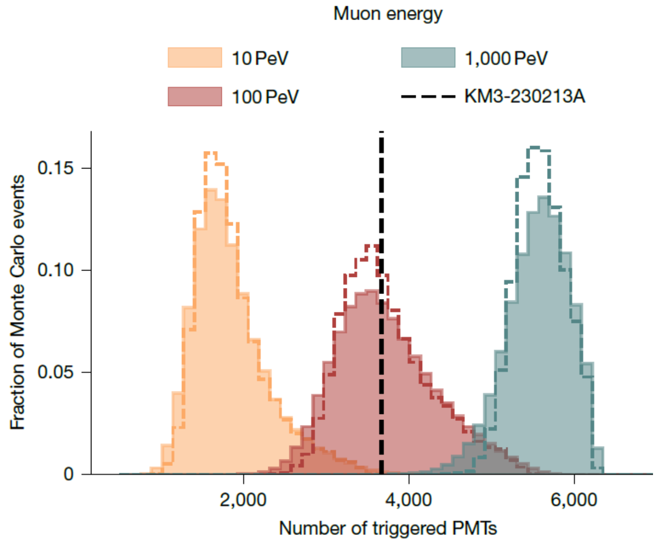
Here is a short and preliminary summary of the results: On February 13, 2023 (almost exactly two years ago) an extremely high-energy muon traversing the ARCA detector was observed. This event is referred to as KM3-230213A. At that time, 21 detection lines were in operation. KM3-230213A is visualized in the next figure. A total of 28,086 hits were registered by the 21 detection lines (note: one optical module contains 31 PMTs). Owing to the large amount of detected light, the PMTs closest to the muon trajectory are saturated. As expected for very-high-energy muons, large showers (here at least three) due to energy-loss processes like bremsstrahlung etc., are observed along the track.

The direction of KM3-230213A is reconstructed as near-horizontal, originating 0.6° above the horizon. The uncertainty on the direction is estimated to be 1.5° (68% confidence level), dominated by the present systematic uncertainty on the absolute orientation of the detector.



Side and top views of the event. The reconstructed trajectory of the muon is shown as a red line, along with an artist's representation of the Cherenkov light cone. The hits of individual PMTs are represented by spheres stacked along the direction of the PMT orientations. The spheres are colored according to the detection time relative to the first triggered hit. The size of the spheres is proportional to the number of photons detected by the corresponding PMT. The locations of the secondary cascade are indicated by the black spheres along the muon trajectory. The north direction is indicated by a red arrow.

The muon energy at the detector is estimated by counting the number of PMTs that participate in the triggering of the event. This quantity is robust against limitations of the detector simulations. The estimated muon energy is 120 (-60, +110) PeV, with a 90% confidence level interval of 35–380 PeV (see the next figure).

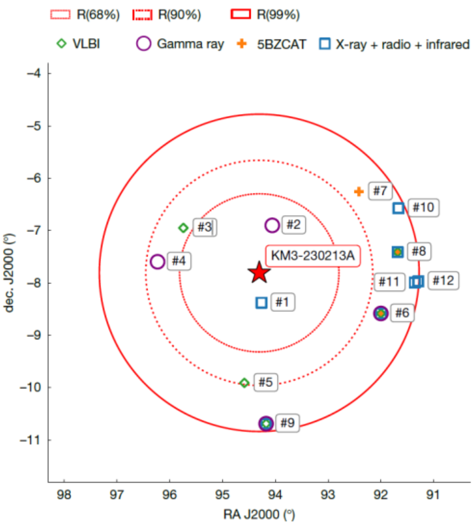


Number of PMTs in the event. *The normalized distributions of the number of PMTs participating in the triggering of the event for simulated muon energies of 10, 100 and 1,000 PeV. The vertical dashed line indicates the observed value in KM3-230213A, N_{trig} = 3,672 PMT. The dashed histograms represent the distributions from the nominal simulations, whereas, in the filled histograms, systematic uncertainties are included by weighting the simulations according to a normal distribution, centered at the nominal value of the nuisance parameter and with a 10% uncertainty. At the highest energy, the distributions seem to be truncated around N_{trig} = 6,000 PMT because the track crosses the detector in its periphery.*

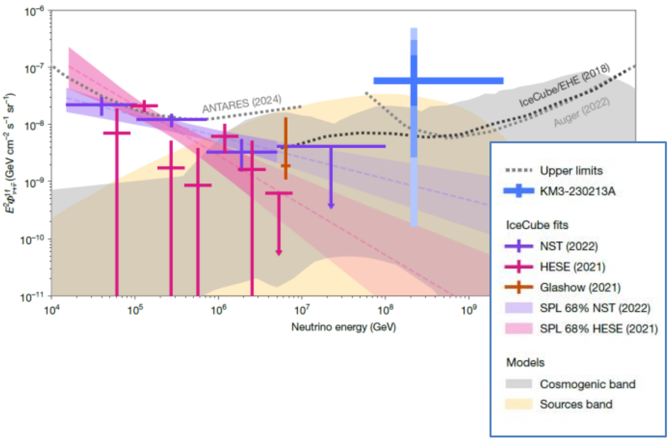
Given the estimated muon energy and its uncertainty, the median neutrino energy that produces such muons in the simulations of the ARCA detector is 220 PeV; 68% (90%) of simulated event from the whole sky fall in the 110–790 PeV (72 PeV–2.6 EeV) energy range, under the assumption that the incoming neutrino energy spectrum is $\propto E_\nu^{-2}$.

The equatorial coordinates of KM3-230213A are: RA = 94.3°, dec. = −7.8°. The different containment radii are: R(50%) = 1.2°, R(68%) = 1.5°, R(90%) = 2.2° and R(99%) = 3.0°, dominated by the systematic uncertainty on the absolute orientation of the detector. No clear correlation with know sources has been found, see next figure.

The second following figure shows how this event fits into the flux landscape. See the caption for explanation. Considering the central (90%) 72 PeV–2.6 EeV energy range, the steady isotropic flux that would produce 1 event is $E^2\Phi(E)$ = 5.8 (+10.1,-3.7) × 10^{-8} GeV cm^{-2} s^{-1} sr^{-1} . The 95% and 99.7% confidence level intervals are [0.30–29.8] and [0.02–47.7] × 10^{-8} GeV cm^{-2} s^{-1} sr^{-1}, respectively.



Sky map in the direction of KM3-230213A. *KM3-230213A is indicated by the red star, with the error regions within R(68%), R(90%) and R(99%) shown as dotted, dashed and solid contours, respectively. The directions of the selected source candidates are shown as colored markers, whose colors and marker type indicate the criterion according to which the source was selected (see the paper for details). The sources are numbered according to their proximity to KM3-230213A.*



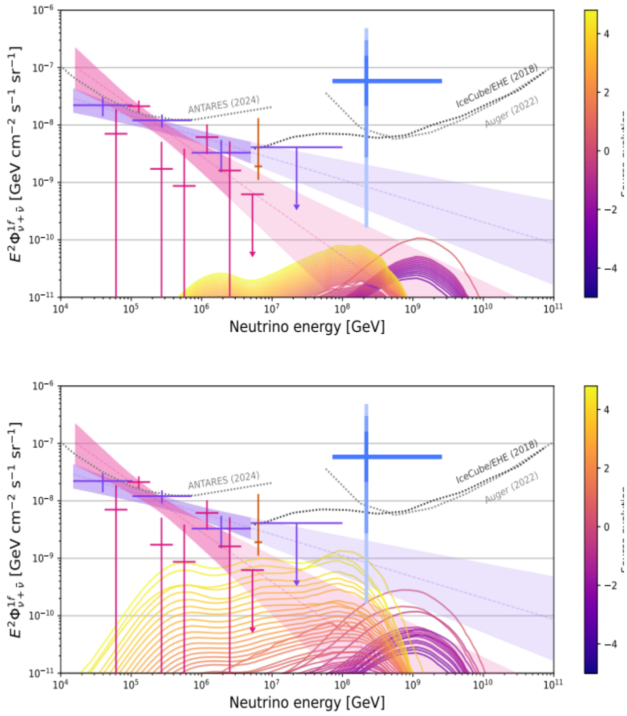
Energy-squared per-flavour astrophysical flux *derived from the observation of KM3-230213A with measurements and theoretical predictions, assuming equipartition (ν_e:ν_μ:ν_τ = 1:1:1). The blue cross corresponds to the flux needed to achieve the one expected event KM3-230213A. Vertical bars: 1σ, 2σ and 3σ Feldman–Cousins confidence intervals. Purple and pink shaded regions: 68% confidence level contours of the IceCube single-power-law (SPL) fits (Northern Sky Tracks, NST) and High-Energy Starting Events (HESE), respectively: the darker-shaded regions are the respective 90% central energy range at the best fit (dashed line), whereas the lighter-shaded regions are extrapolations to higher energies. The purple and pink crosses are the piece-wise fit from the same analyses, whereas the orange cross corresponds to the IceCube Glashow resonance event. The dotted lines are upper limits from ANTARES (95% confidence level), Pierre Auger (90% confidence level, for an E^{-2} neutrino spectrum) and IceCube (90% confidence level, estimated assuming an E^{-1} neutrino spectrum in sliding one-decade bins). The grey-shaded band comprises a variety of cosmogenic neutrino expectations following several models of cosmic-ray acceleration and propagation, whereas the yellow-shaded band comprises several scenarios of diffuse transient and variable extragalactic sources.*

So much for now on the Nature paper.

Here is a short summary of the other 4 papers. This newsletter would become much too long if I would make the attempt to go in more details. Therefore, only a summary and one figure per paper.

On the potential cosmogenic origin of the ultra-high-energy event, arXiv:2502.08508

A diffuse cosmogenic component is expected to originate from the interactions of ultra-high-energy cosmic rays with ambient photon and matter fields. The flux level required by the KM3NeT/ARCA event is however in tension with the standard cosmogenic neutrino predictions based on the observations collected by the Pierre Auger Observatory and Telescope Array over the last decade of the ultra-high-energy cosmic rays above the ankle (hence from the local Universe, z ≲ 1). The paper shows that both observations can be reconciled by extending the integration of the equivalent cosmogenic neutrino flux up to a redshift of z ≃ 6 and assuming a subdominant fraction of protons in the ultra-high-energy cosmic-ray flux, thus placing constraints on known cosmic accelerators.

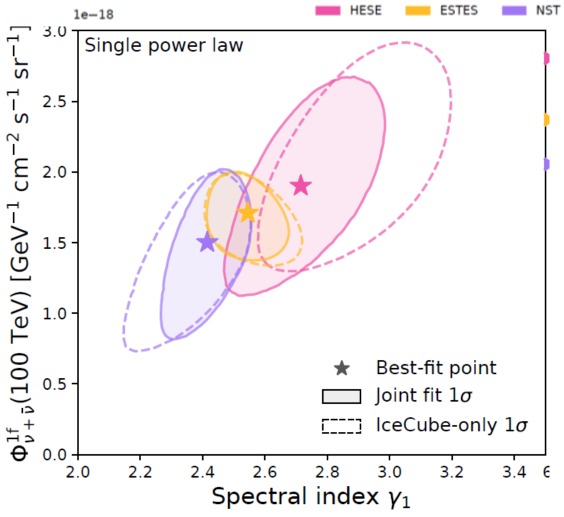


See the figure caption on the next page.

Figure caption for figure on previous page: Expected neutrino fluxes as a function of energy for different source evolutions (colour code) for two different maximum redshift values: z_{max} = 1 (top) and z_{max} = 6 (bottom). The blue cross corresponds to the flux needed to produce one expected event in the central 90% CL range of neutrino energy associated with the KM3-230213A event (horizontal span); the vertical bars represent the 1, 2 and 3σ Feldman-Cousins confidence intervals. The purple- and pink-filled regions represent the 68% confidence level contours of the IceCube single power-law fits (Northern-Sky Tracks, and High-Energy Starting Events, respectively): the darker-shaded regions are the respective 90% central energy range at the best fit (dashed line), while the lighter-shaded regions are extrapolations to higher energies. The purple and pink crosses are the fit from the same analyses, while the orange cross corresponds to the IceCube Glashow resonance event. The dotted lines are upper limits from ANTARES (95% confidence level), Pierre Auger and IceCube.

The ultra-high-energy event KM3-230213A within the global neutrino landscape, arXiv:2502.08173

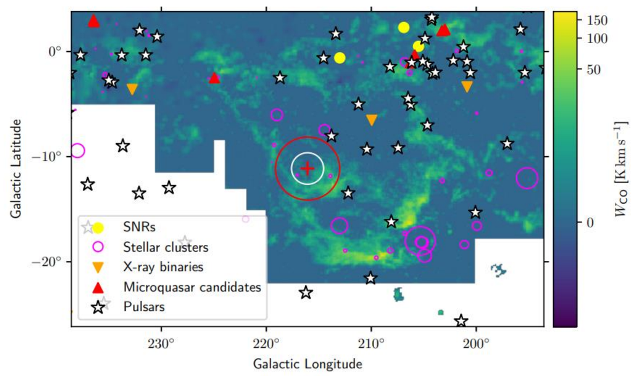
This article discusses the event in light of null observations above tens of PeV from the IceCube and Pierre Auger. Performing a joint fit of all experiments under the assumption of an isotropic E^{-2} flux, the best-fit single-flavour flux normalisation is $E^2\Phi = 7.5 \times 10^{-10}$ GeV cm^{-2} s^{-1} sr^{-1} in the 90% energy range of the KM3NeT event. Furthermore, the ultra-high-energy data are then fit together with the IceCube measurements at lower energies, either with a single power law or with a broken power law, allowing for the presence of a new component in the spectrum. The joint fit including non-observations by other experiments in the ultra-high-energy region shows a slight preference for a break in the PeV regime if the "High-Energy Starting Events" sample is included, and no such preference for the other two IceCube samples investigated. A stronger preference for a break appears if only the KM3NeT data is considered in the ultra-high-energy region, though the flux resulting from such a fit would be inconsistent with null observations from IceCube and Pierre Auger. In all cases, the observed tension between KM3NeT and other datasets is of the order of 2.5σ – 3σ, and increased statistics are required to resolve this apparent tension and better characterize the neutrino landscape at ultra-high energies.



Joint fit of IceCube measurements in the TeV–PeV region, and KM3NeT / IC / Auger UHE measurements. Bayesian fit with a <u>single power law</u> in the spectral index/flux plane. The filled regions indicate the 1σ contours. The star markers are the best-fit points and the 1σ contours from IceCube priors are also shown in dashed lines

On the Potential Galactic Origin of the Ultra-High-Energy Event KM3-230213A, arXiv:2502.08387

The paper discusses if the neutrino could have been produced within the Milky Way. Considering the low fluxes of the Galactic diffuse emission at these energies, the lack of a nearby potential Galactic particle accelerator in the direction of the event and the difficulty to accelerate particles to such high energies in Galactic systems, the event is most likely of extragalactic origin.

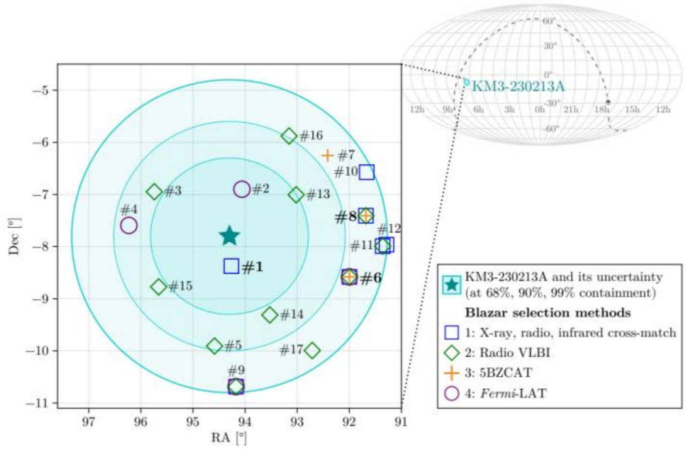


Different known potential CR accelerators in the region around KM3-230213A: The yellow dots represent SNRs from Green's SNR catalogue, the magenta circles show young stellar clusters, the sizes of the circles correspond to the cluster sizes. X-ray binaries and microquasars are displayed with the orange and red triangles, and pulsars from the ATNF pulsar catalogue as white stars with black edges. The background is the velocity-integrated CO brightness temperature which traces the molecular gas.

Characterising Candidate Blazar Counterparts of the Ultra-High-Energy Event KM3-230213A, arXiv:2502.08484

The neutrino arrival direction has a 99% confidence region of 3° radius centered at RA 94.3°, Dec −7.8° (J2000). A sample of seventeen candidate blazars located in this region was selected through their multiwavelength properties, and studied using archival data and dedicated observations. Among them, the three most interesting candidates MRC 0614-083, located 0.6° away from the best-fit neutrino position. It shows also an indication of an X-ray flare. Object 0605-085 is one of the fifty brightest blazars on the sky on parsec scales. A long-term gamma ray flare peaking before the neutrino arrival is observed. Object PMN J0606-0724 shows a major radio flare, which peaks at 15 GHz within 5 days from the neutrino arrival time. The pre-trial chance coincidence p-value is estimated to be 0.26 %.

Based on the findings of this study, the KM3NeT event KM3-230213A can not be conclusively associated with an episode of enhanced multiwavelength emission from a blazar. The hypothesis that the KM3NeT event originates from a blazar is still viable, with several blazar-like catalogued objects reported as potential counterparts in the neutrino field.



Summary of KM3-230213A and its candidate blazar counterparts selected by the authors. Both the location of the KM3NeT event in equatorial coordinates (J2000) and its uncertainty regions are shown. The markers indicate the criteria used for the inclusion in the list of candidates as presented in Section 3 of the paper. Source numbers refer to Table of the paper 1; the three blazars discussed in more detail are labelled in bold: #1 (MRC 0614-083), #6 (0605-085), #8 (PMN J0606-0724)

And finally, for everybody who likes fancy titles, a paper from outside GNN: ***Clash of the Titans: ultra-high energy KM3NeT event versus IceCube data*** Shirley Weishi Li, Pedro Machado, Daniel Naredo-Tuero and Thomas Schwemberger, 2502.04508.

Impressum
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