



KM3NeT neutrino observatory

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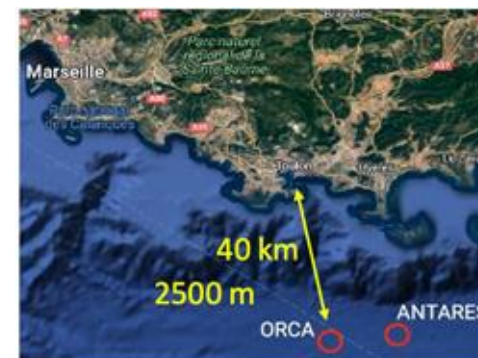
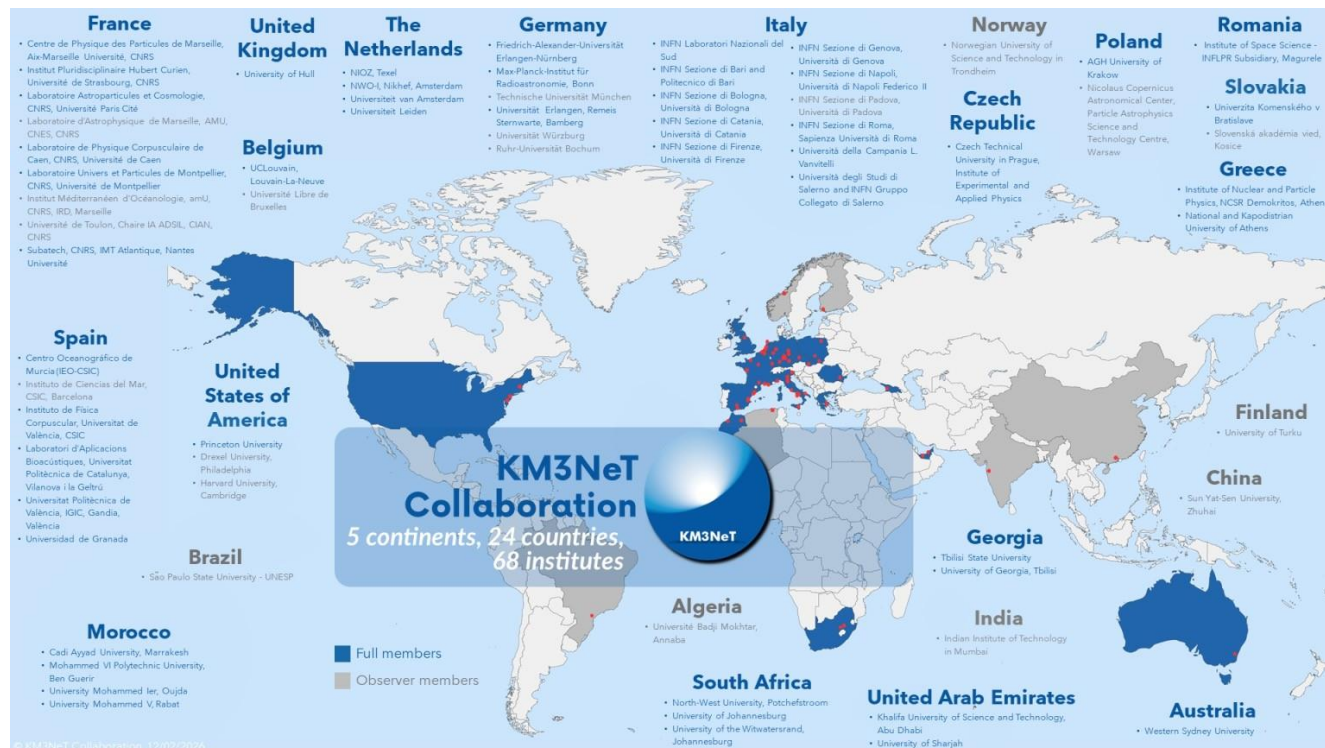
International School of Cosmic Ray Astrophysics - Erice, 29 July - 6 August 2026

KM3NeT is a research infrastructure in the Mediterranean Sea hosting two neutrino detectors:

KM3NeT/ORCA: Study of atmospheric neutrino oscillations

KM3NeT/ARCA: Discovery and observation of cosmic neutrino sources

Two different detectors but based on the same technology and operated by the same collaboration



ORCA:
Oscillation Research
with Cosmics in the Abyss

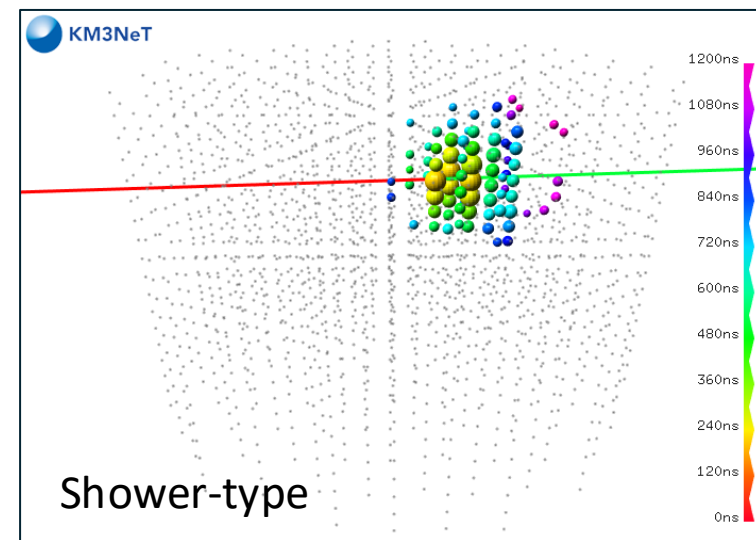
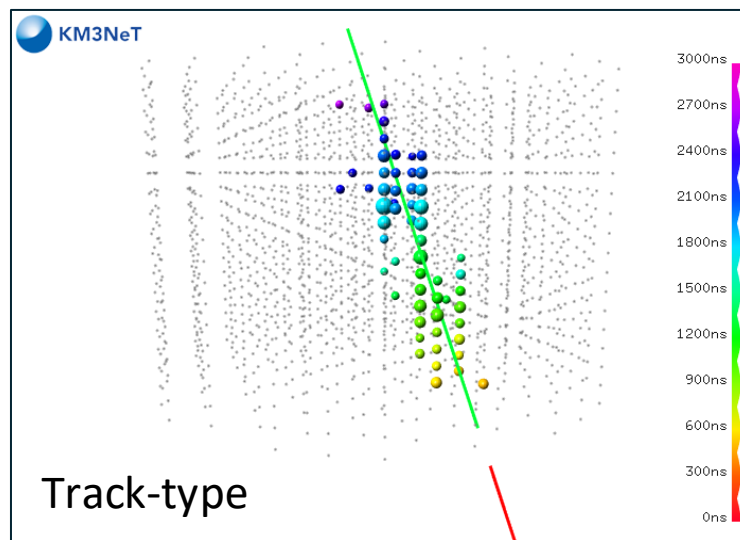
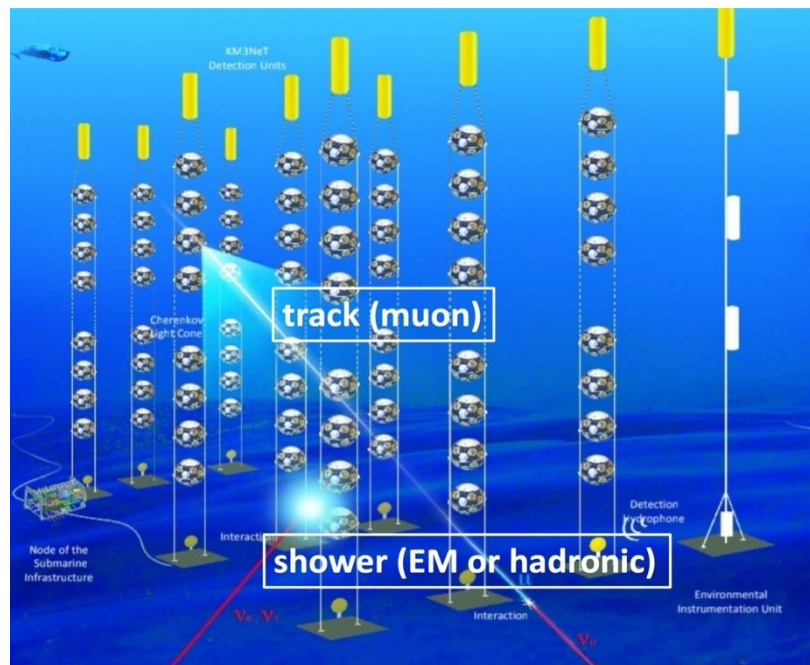


ARCA:
Astroparticle Research
with Cosmics in the Abyss

www.km3net.org

Detection of Cherenkov light emitted by neutrino induced charged particles

Neutrino event reconstruction and type discrimination based on event topologies



Tracks	Ang. res. below 0.1°	-	Energy res. $\sim$ factor 2
Shower	Ang. res. below 2°	-	Energy res. $\sim 6\%$

(KM3NeT, $E_\nu > 100$ TeV)

Digital Optical Module (DOM)



JINST 17 (2022)
P07038

- 31 x 3" PMTs in a 17" glass sphere
- LED beacon and acoustic piezoelectric
- Tiltmeter/compass
- Gbit/s fibre for data transmission
- White Rabbit for time synchronization

- Digital photon counting
- Directional information
- Wide angle of view
- Improved background rejection
- Compact and cost-effective design



Detection Unit (DU)

JINST 15 (2020) P11027

String:

- 1 Buoy
- 2 Dyneema ropes
- 18 DOMs

Electro-optical backbone:

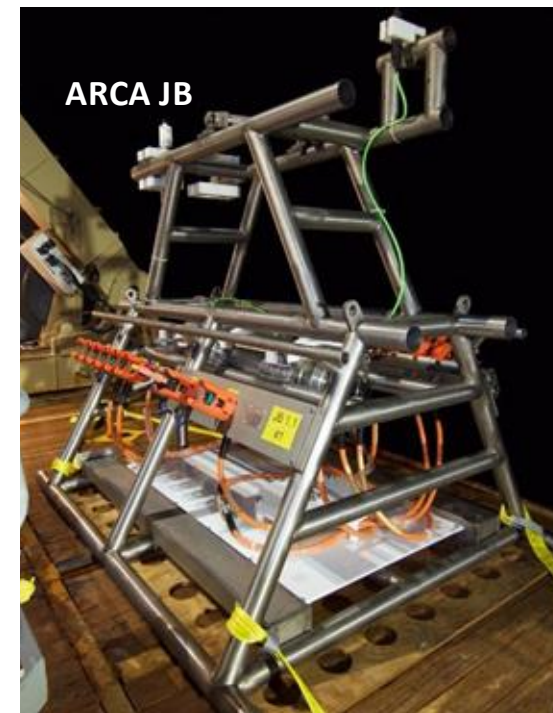
- Flexible hose 7mm
- Oil-filled
- 18 fibres
- 2 copper wires (375VDC)

Base:

- Anchor with electro-optical connector
- Base Module:
 - Central Logic Board (CLB, white rabbit timing)
 - Power control board
 - Optical amplifier
 - Hydrophone
 - LBL beacon

Seafloor network

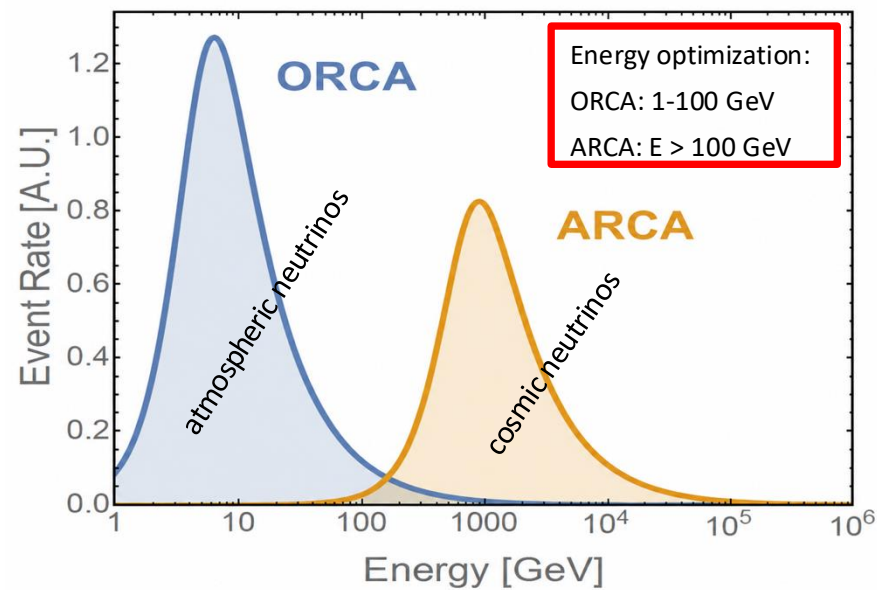
JINST 18 (2023) T02001



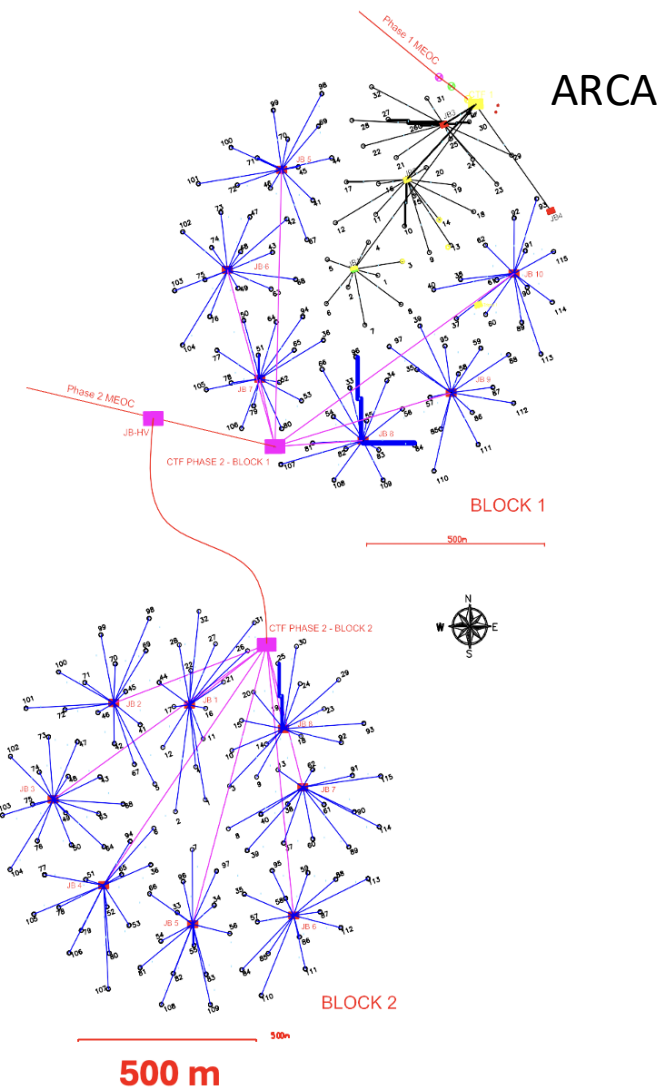
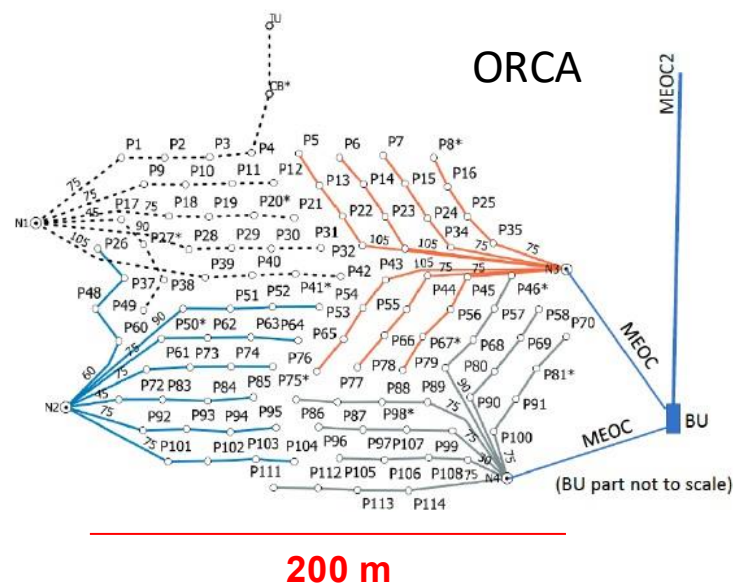
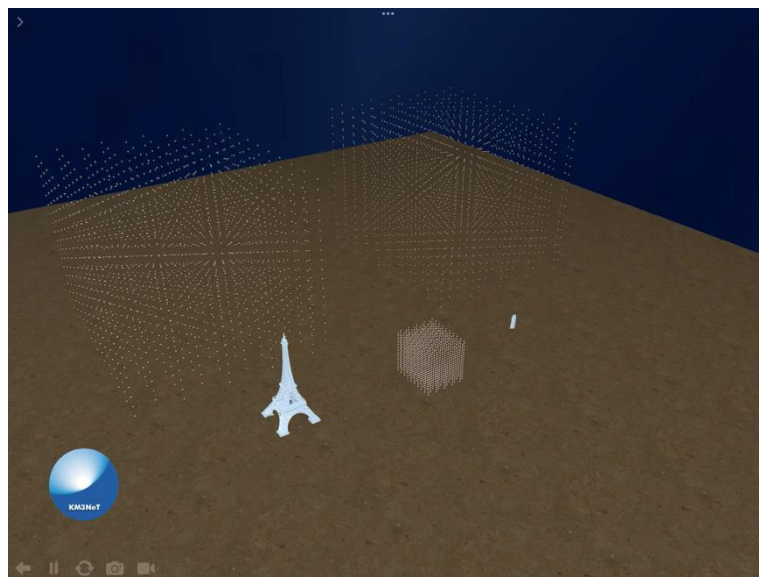
- Electro-optical cables from deep sea to the shore station
- Junction boxes (JB) to distribute power and optical fibres
- Interlink cables for connection of DUs to JBs and JBs to the main cable

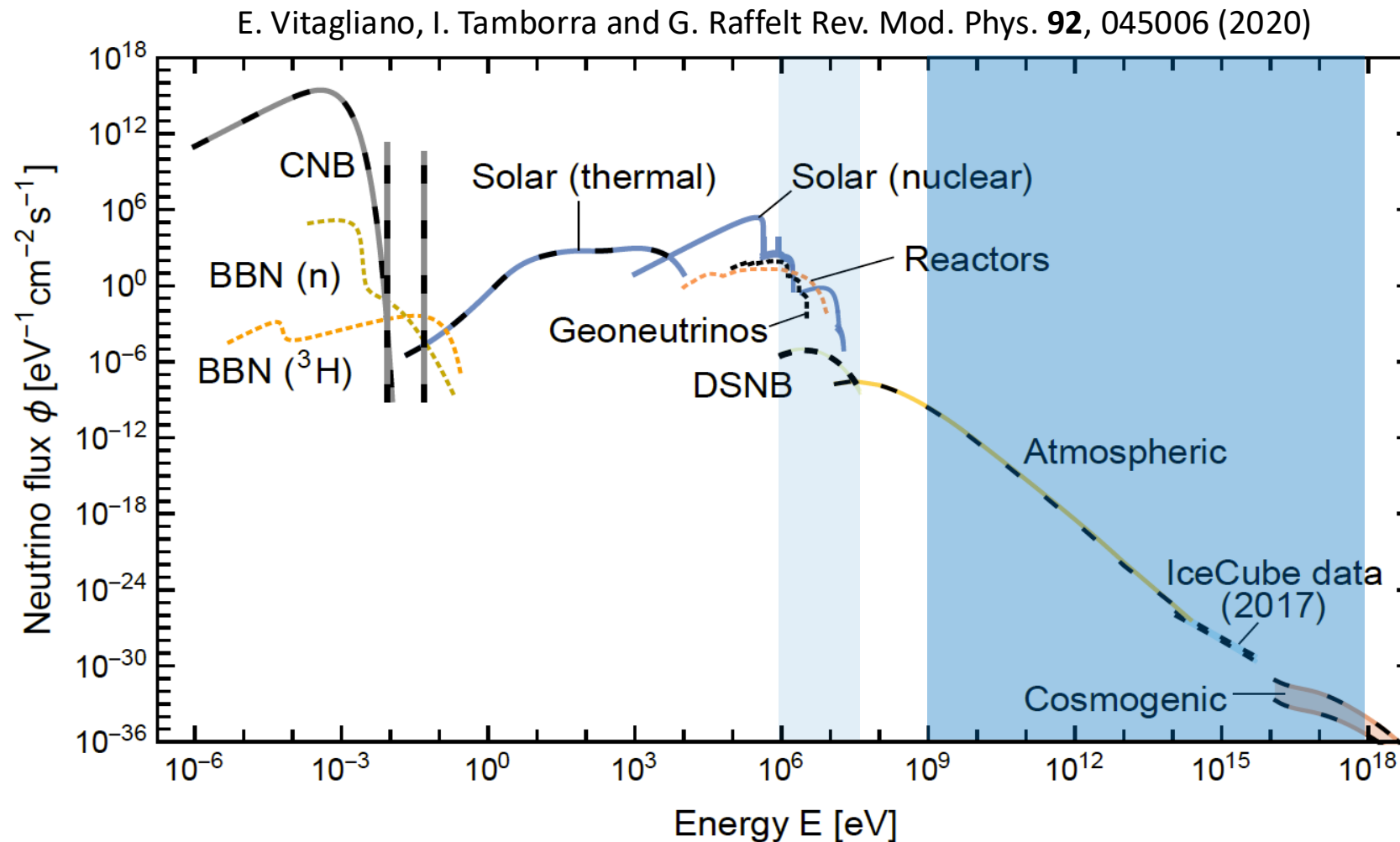


[JINST 15 \(2020\) P11027](#)



	ORCA	ARCA
DOM spacing	9 m	36 m
String height	200 m	700 m
String spacing	20 m	90 m
Strings	108	198
Building Blocks	1	2
Instrumented mass	6.5 Mton	1 Gton





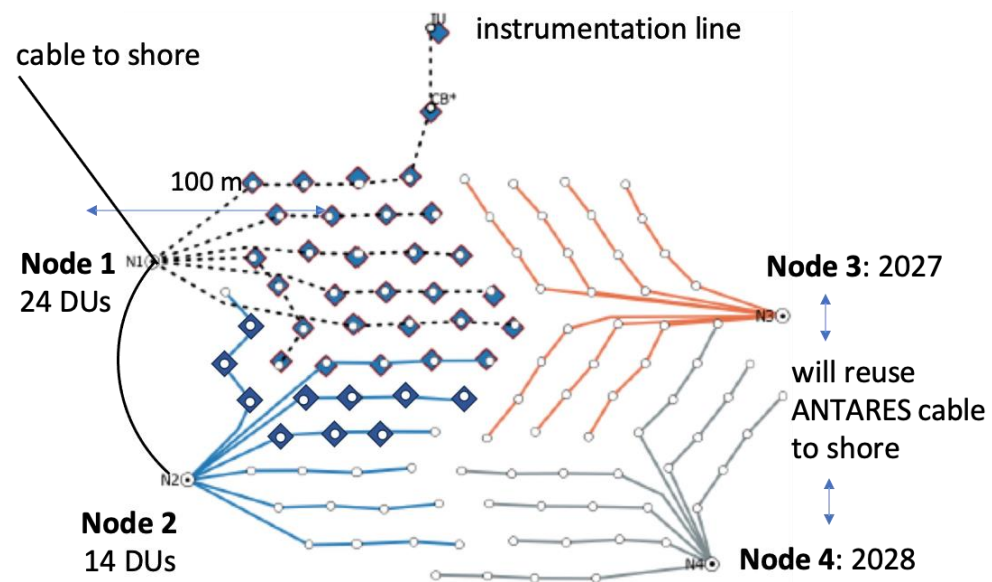
ORCA

42 DUs deployed

4 new DUs deployed in July

DU integration rate: 20/year

90% of the detector already funded



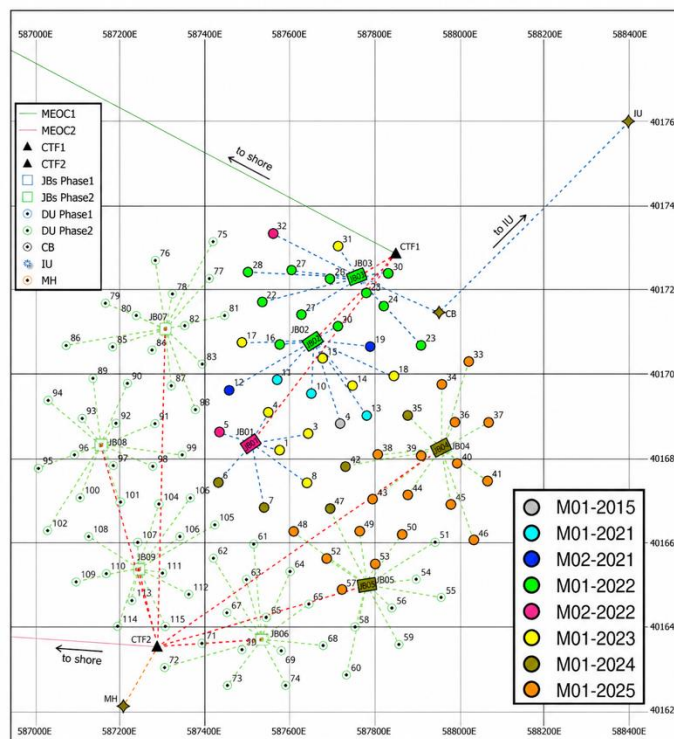
ARCA

51 DUs deployed

12 new DUs to be deployed in September

DU integration rate: 35/year

80% of the detector already funded



Completion of ORCA/ARCA DUs production: 2030

All digital PMT data are sent to shore and processed in real time on a computing cluster

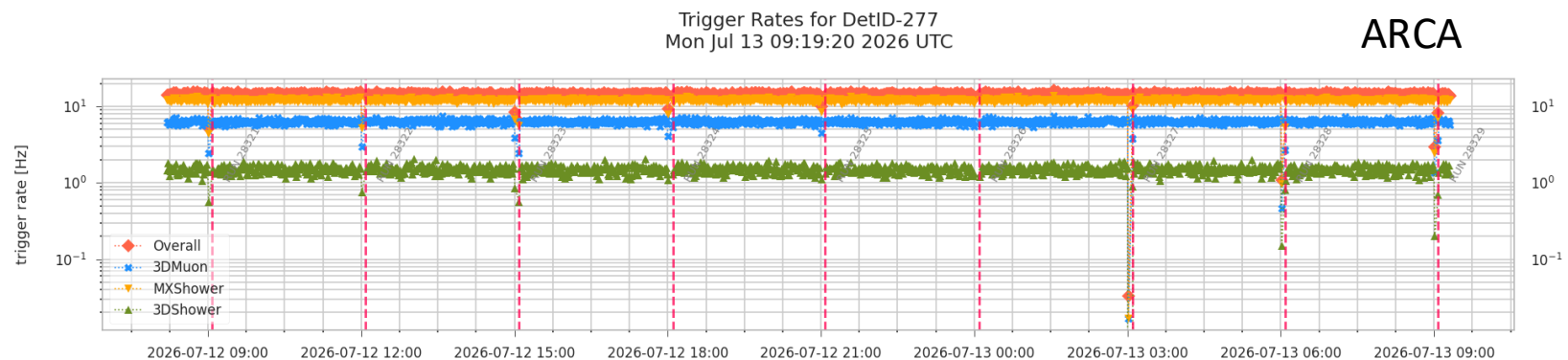
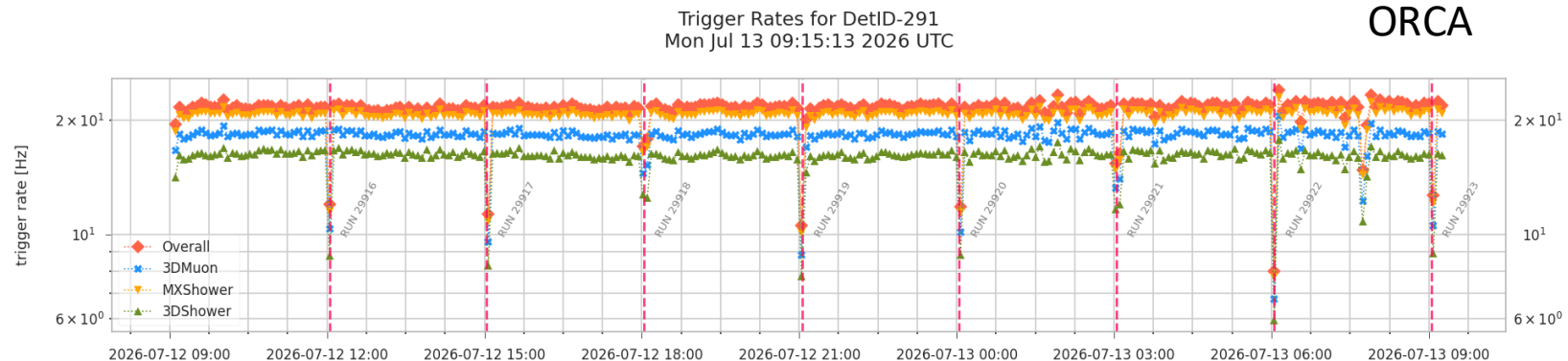
Set of trigger algorithms searching different event topologies

Data rate per building block amounts to about 25 Gb/s, reduced by a factor of 10^4 at the trigger level

Post-trigger processing:

Online: real-time event selection for transient and multi-messenger searches

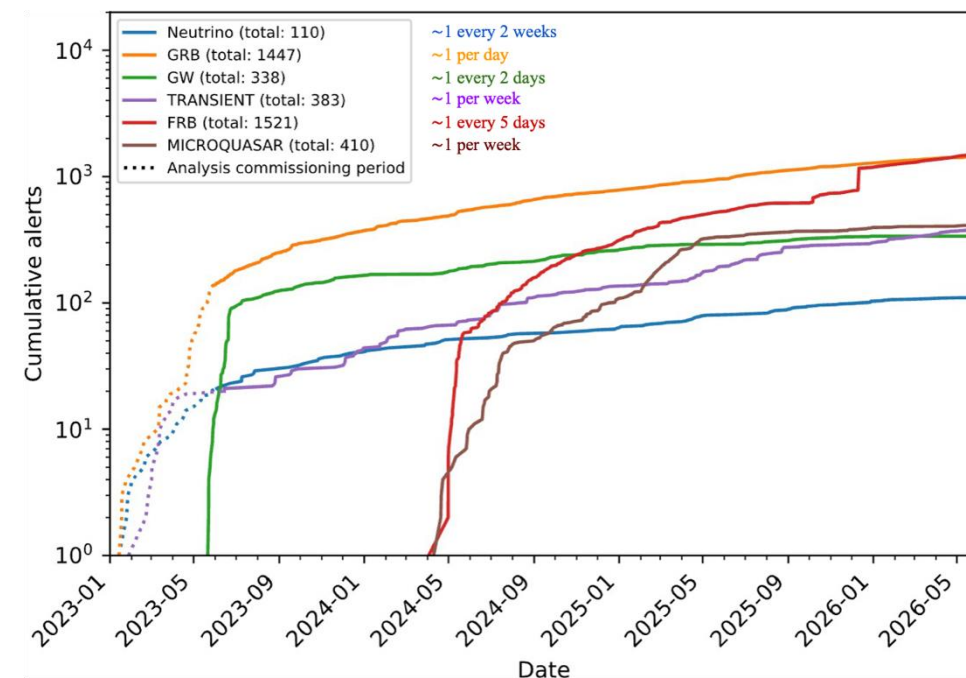
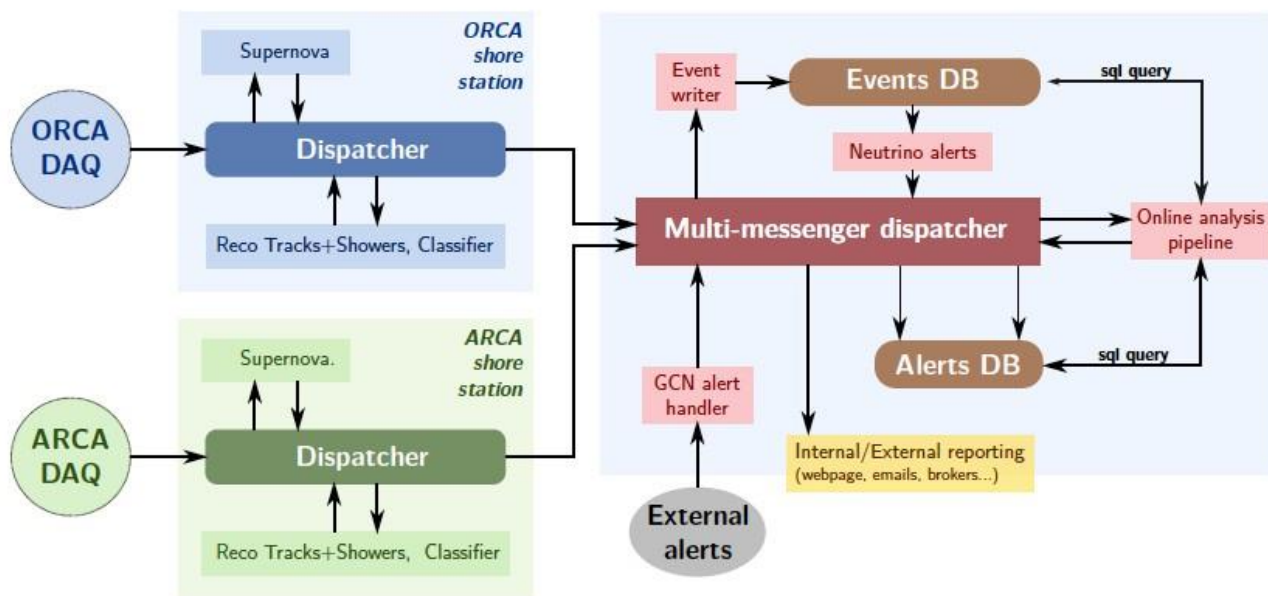
Offline: precision event reconstruction and physics analyses



[NIMA 1083 \(2026\) 171097](#)

KM3NeT Online Platform: real-time event reconstruction + multi-messenger dispatcher + analysis module

- Real-time processing of data with online calibration: **track & cascades** reconstruction + **classification**
- Triggered events are processed in real-time in **less than 7 s** for both ARCA and ORCA
- **Main analysis functionalities:** follow-up of external triggers (active), Supernovae alert pipeline (active), sending alerts (work in progress)



[Eur. Phys. J. C 82 \(2022\) 317](#)

[PoS\(ICRC2025\)1115](#)



POSITION CALIBRATION

Detection Units bend under sea currents, making the detector geometry time dependent.



Acoustic triangulation using seabed and DU-base emitters, with hydrophones on each DOM



Compass and **tiltmeter** measurements



Continuous reconstruction of the **3D position** and **orientation** of each DOM

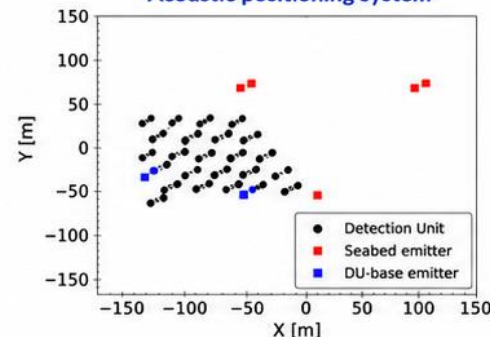


Geometry known with **~10 cm** precision

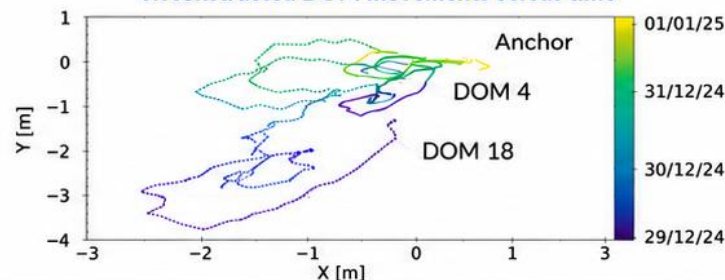


Each DOM records sound signals and its position is reconstructed in time

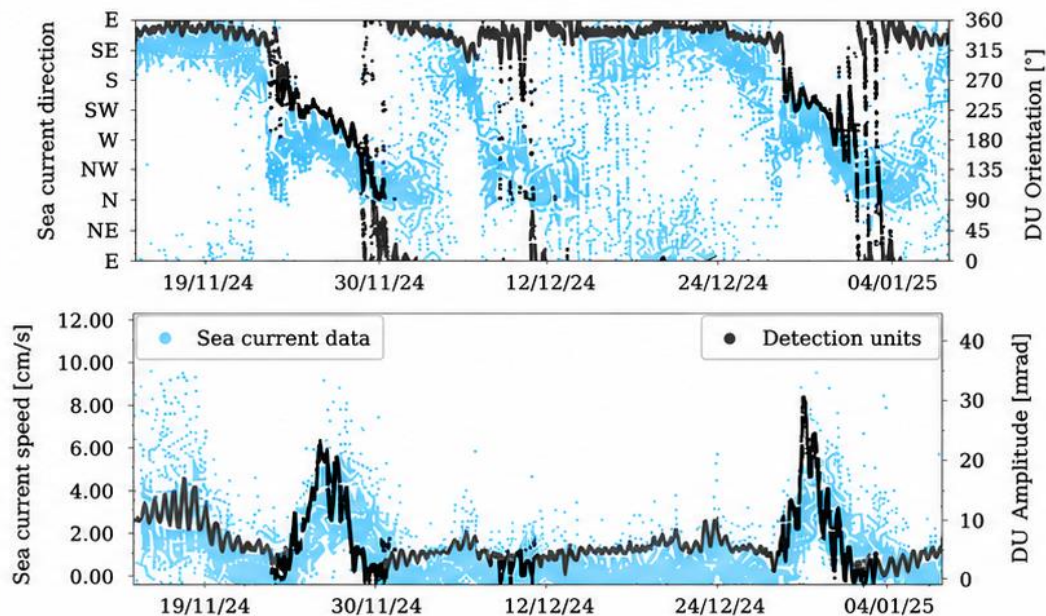
Acoustic positioning system



Reconstructed DOM movements versus time



Sea currents drive DU movements



Strong correlation between sea current and DU orientation/amplitude

DETECTOR CALIBRATION



POSITION (Geometry)

- Acoustic system (seabed & DU-base emitters)
- Compass
- Tiltmeter

Output: detector geometry



TIME (Timing)

- ^{40}K coincidences (intra-DOM timing)
- Nanobeacons (inter-DOM timing)

Output: time offsets



PMT RESPONSE

- Gain
- Efficiency
- Angular acceptance

Output: PMT parameters



OUTPUT

Detector calibration constants
(geometry + timing + PMT parameters)



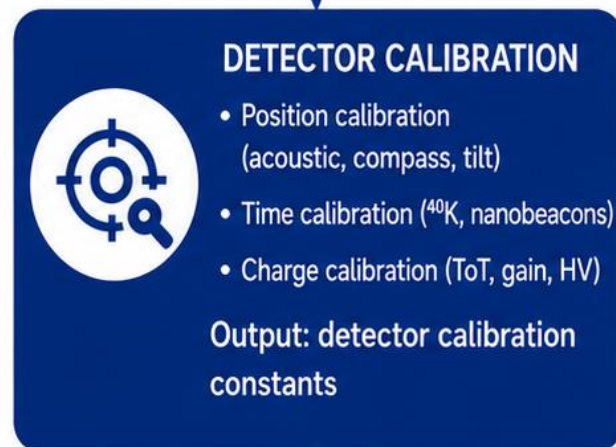
EVENT RECONSTRUCTION

The calibrated detector geometry, timing and charge response provide the detector conditions used for event reconstruction.

MONTE CARLO CHAIN



REAL DATA



RUN-BY-RUN DETECTOR SIMULATIONS

For each data run, dedicated atmospheric muon and neutrino simulations are produced using the corresponding detector and environmental conditions.

WHY DO WE SIMULATE?

Data - MC agreement is important for:



Good understanding of the detectors



Optimization of selection criteria for background rejection



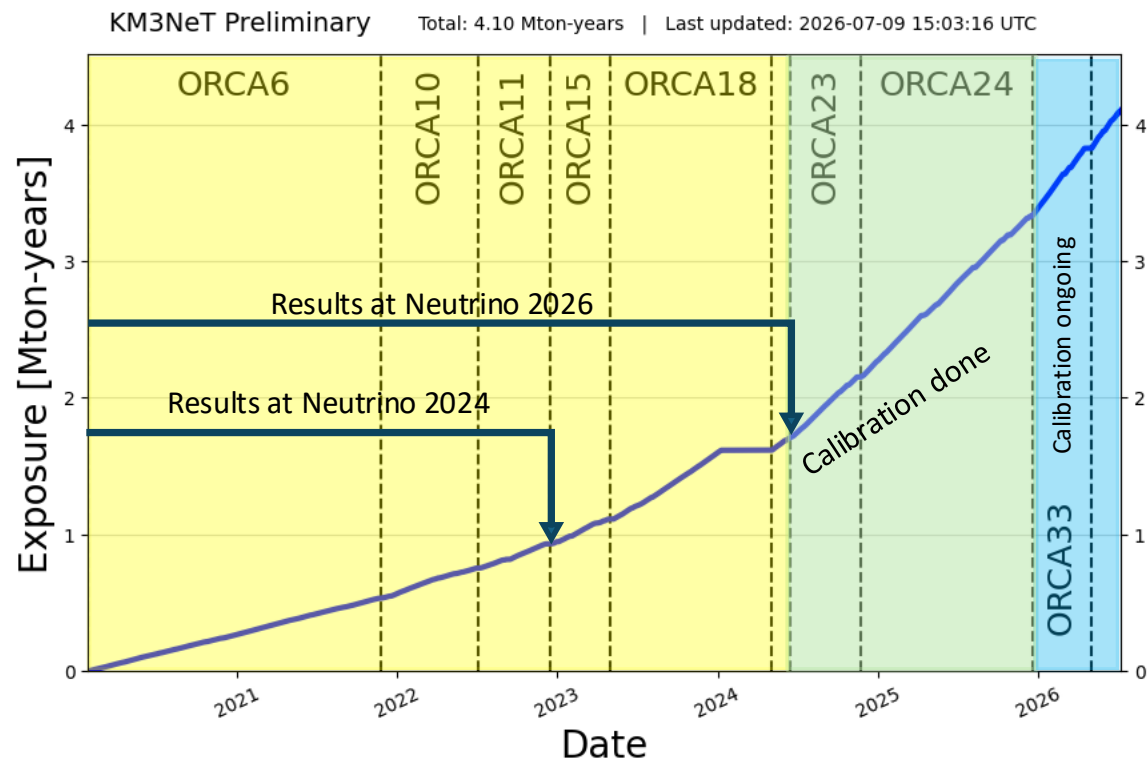
Neural network training for PID



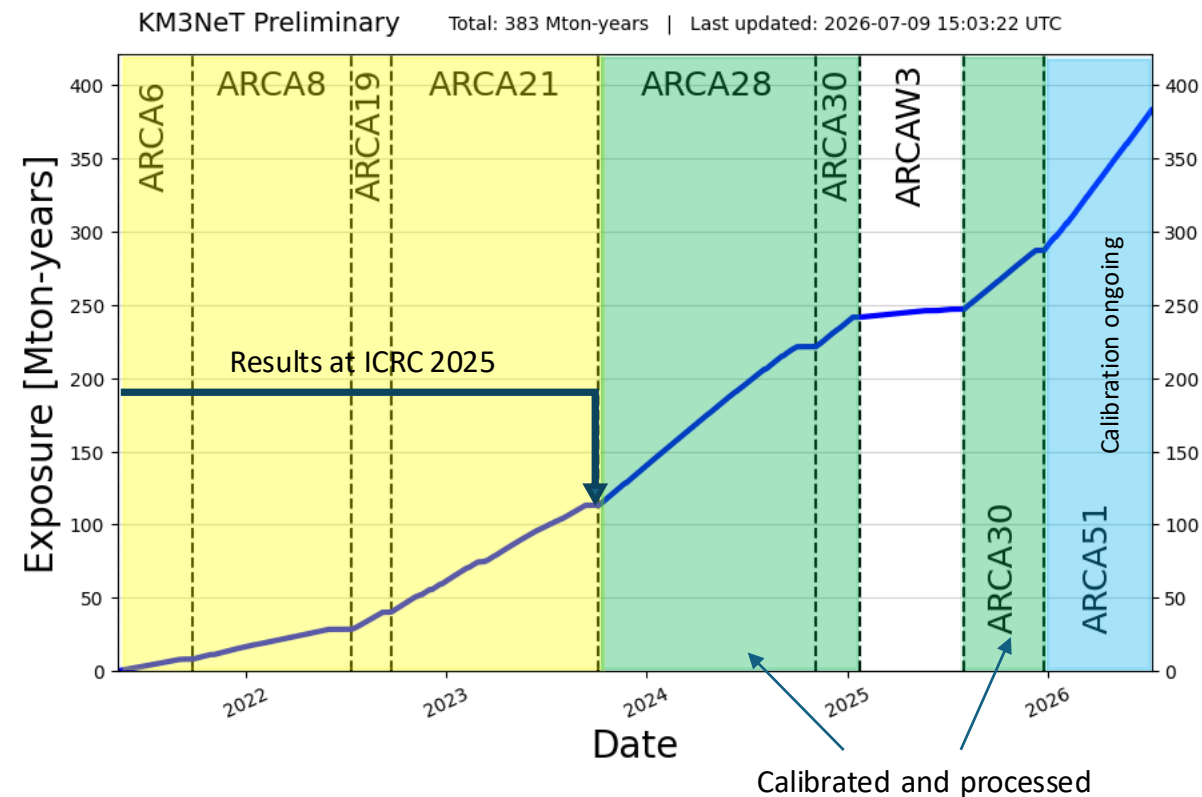
Application of statistical tests to evaluate the significance of a signal



Estimate of the detector response for the flux measurements

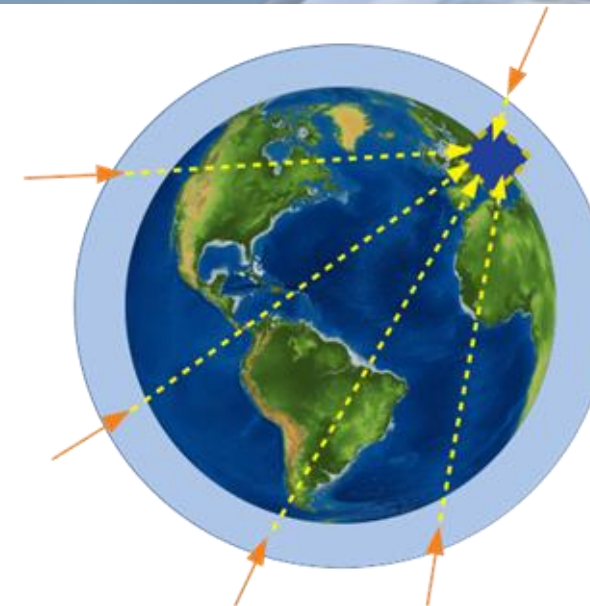


ORCA6-18 results presented at Neutrino 2026



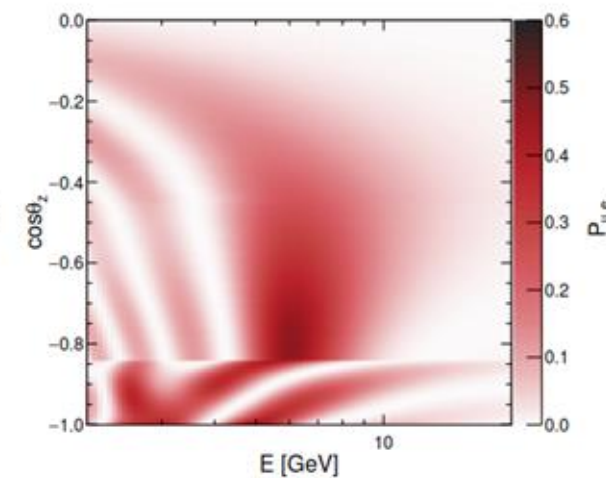
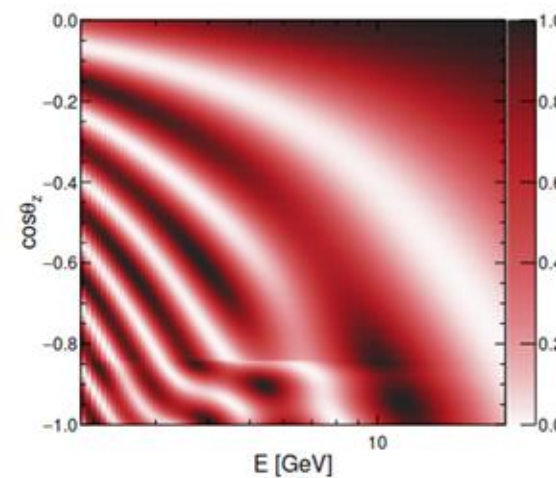
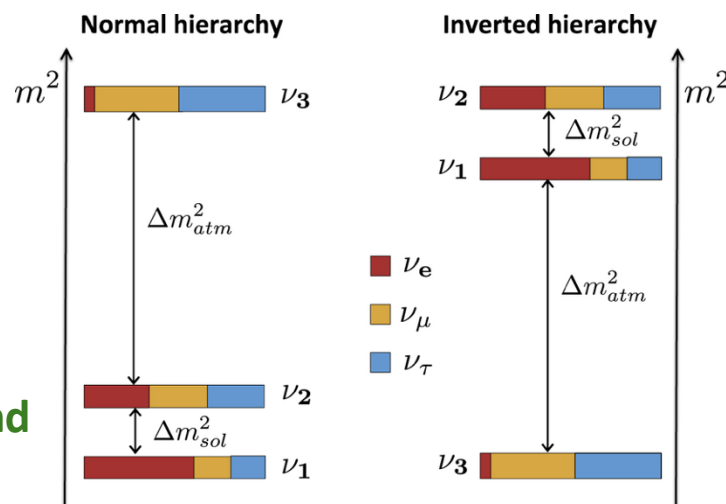
ARCA19-30 results will be presented at ICRC 2027

- Atmospheric flux of ν_e and ν_μ well known
- Wide range of neutrino energies
- Wide range of zenith angles $\rightarrow$ baselines (50 – 12,800 km)
- Distortion of the oscillation pattern due to matter effects in the Earth

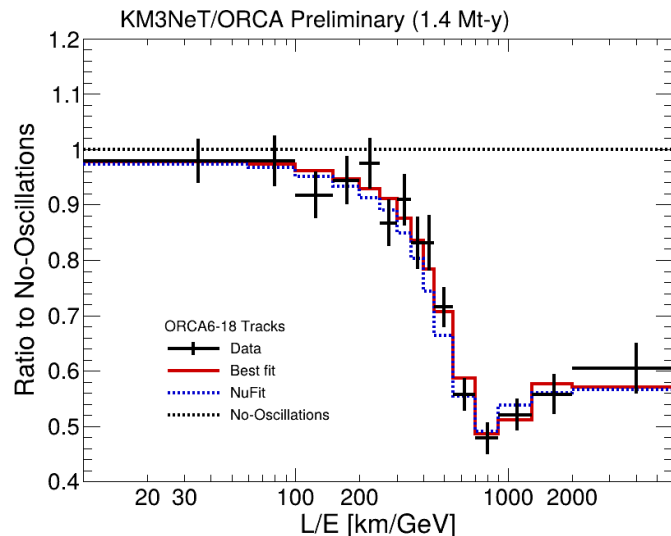


Primary goal:
neutrino mass hierarchy

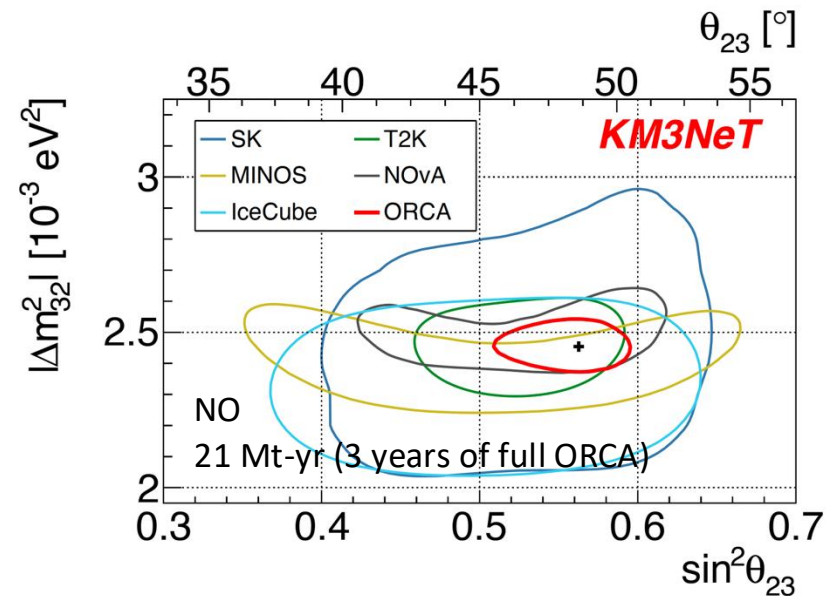
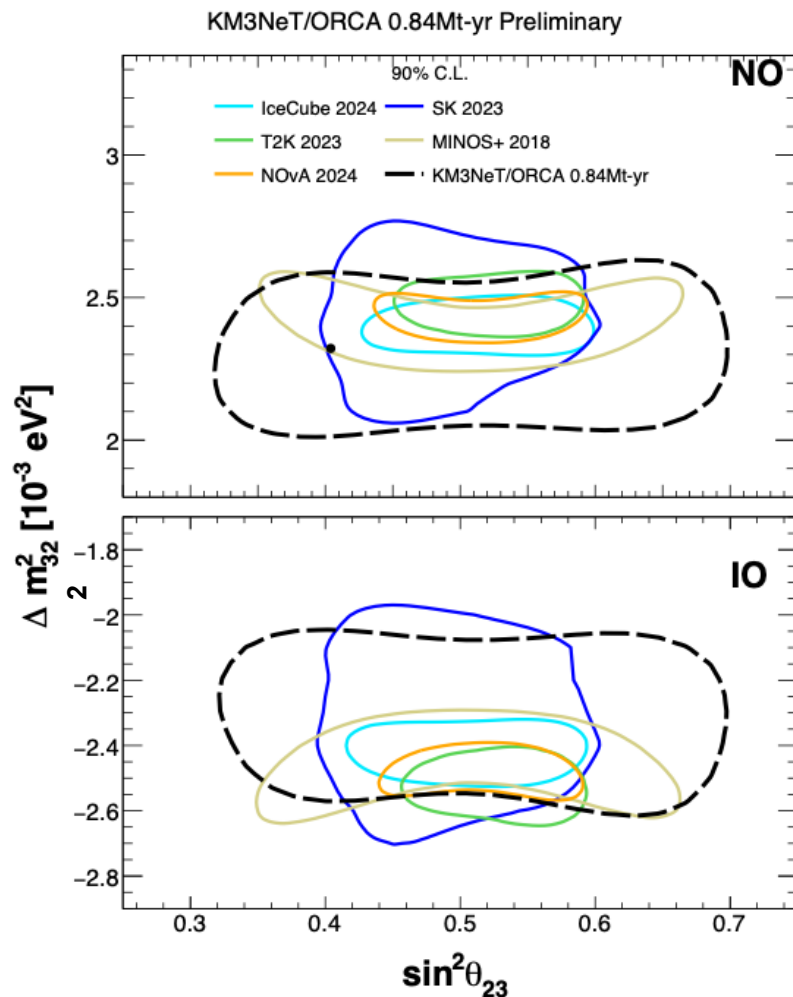
But also, unitarity, Beyond
Standard Model physics



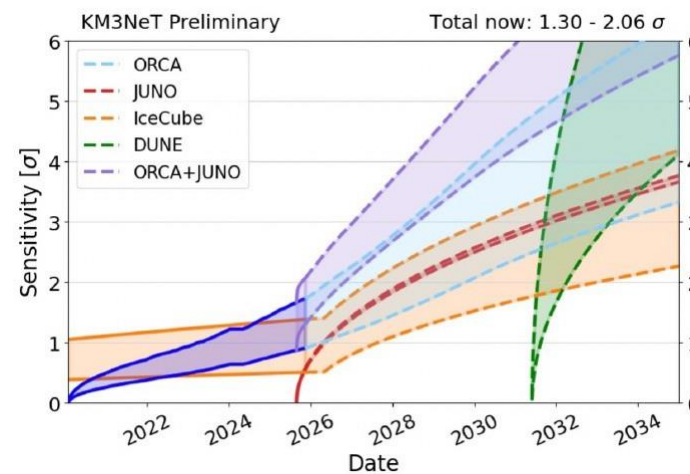
ORCA6-18



ORCA11-18



[Results from Neutrino 2026](#)

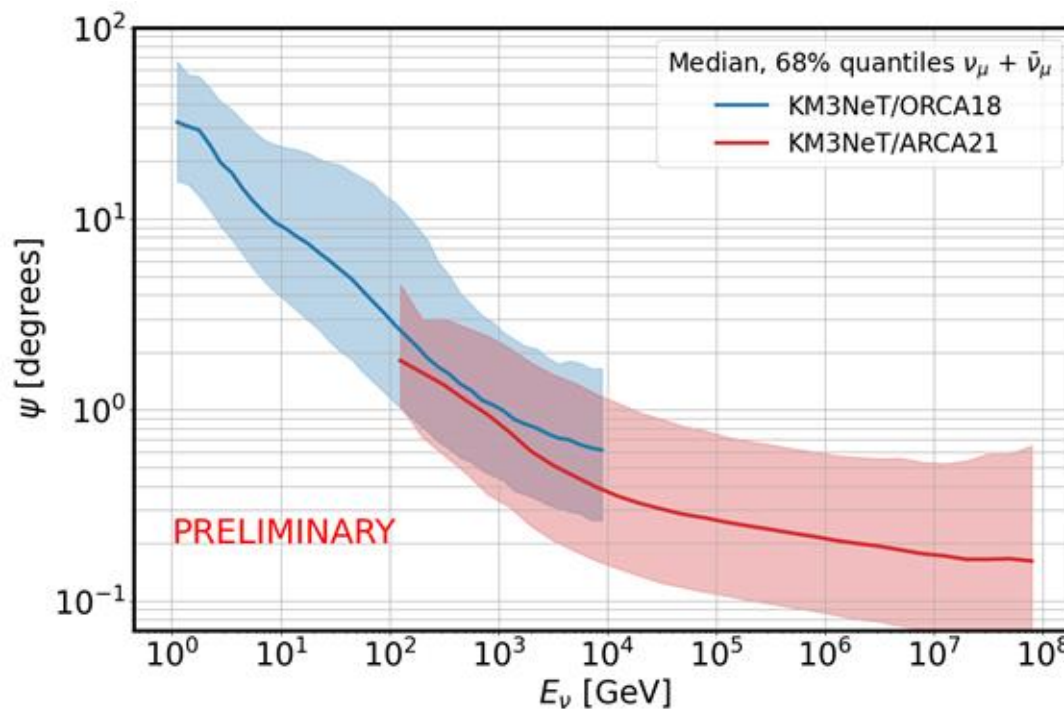
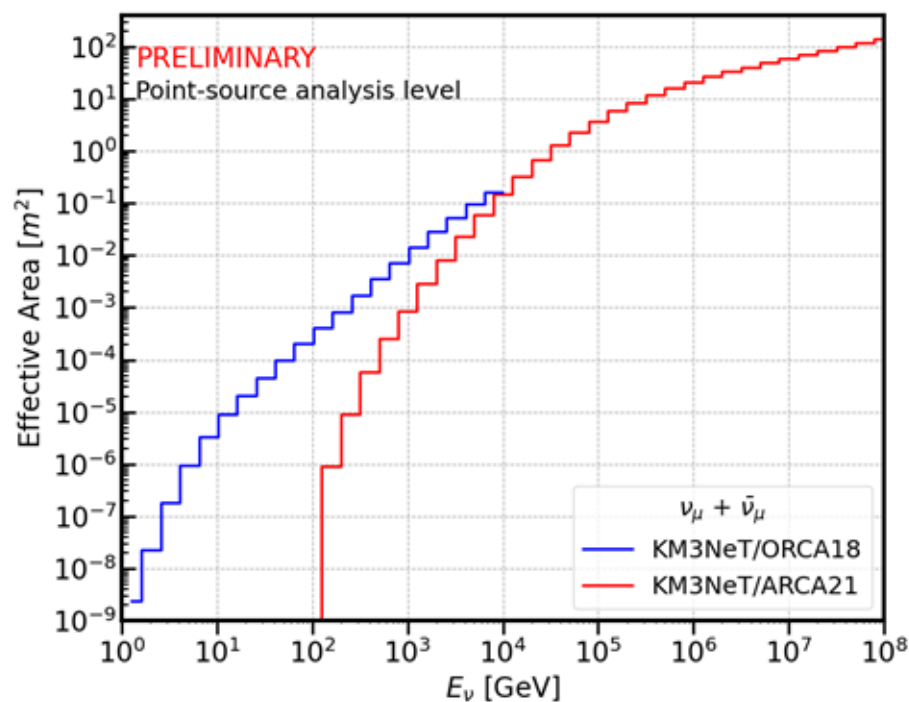


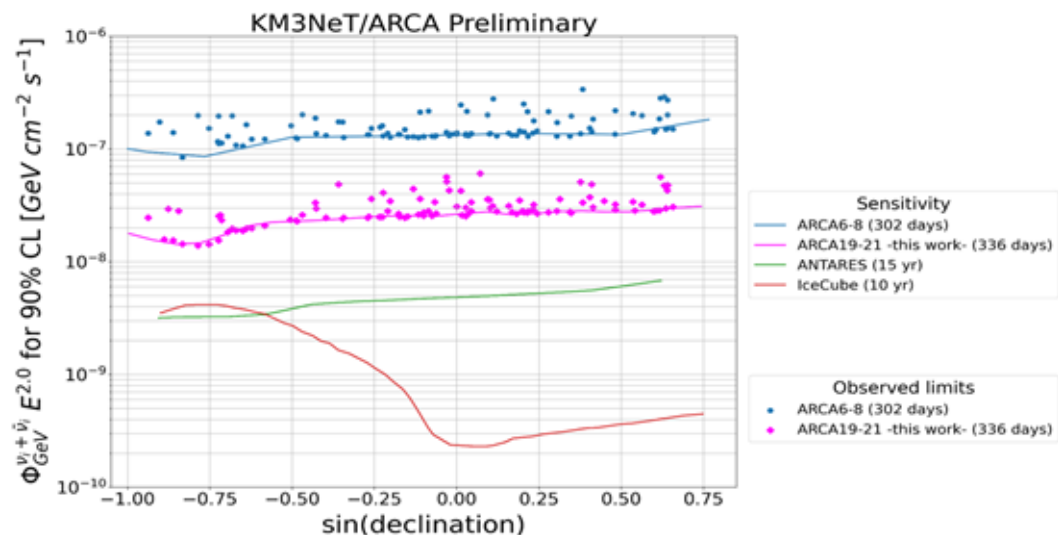
Eur. Phys. J. C 82, 26 (2022)

J. High Energ. Phys. 2022, 55 (2022)

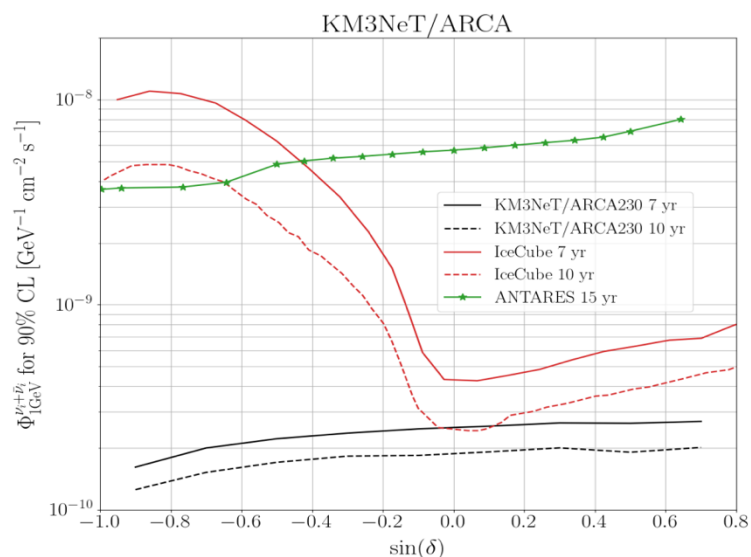
The KM3NeT astronomy program spans a broad range of analyses, including searches for point-like and extended sources, diffuse neutrino fluxes, source populations, and time-dependent or multi-messenger signals

Although ARCA is optimized for high-energy neutrino astronomy, ORCA complements the program by extending the sensitivity towards lower energies



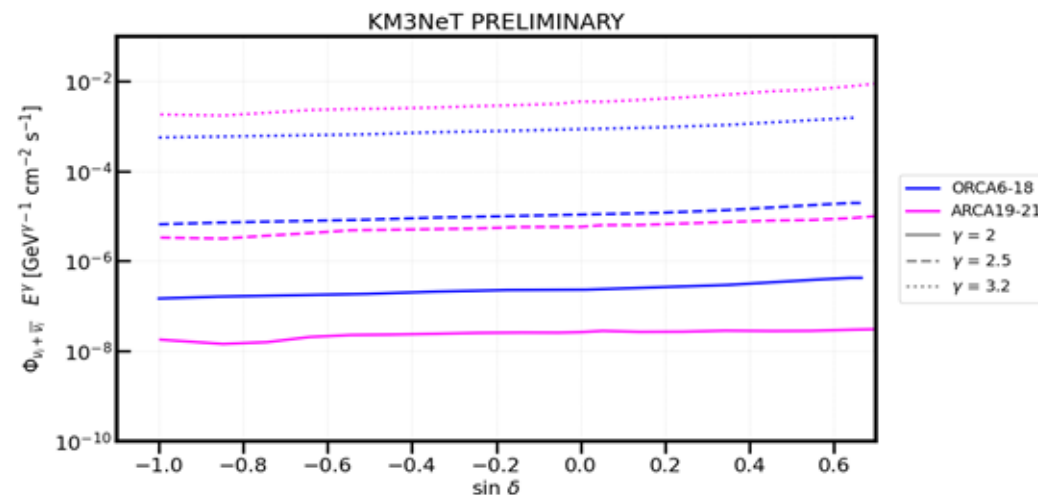


- The current ARCA detector already demonstrates the rapid increase in sensitivity as the detector grows.
- After 7–10 years of operation, the full ARCA detector is expected to achieve a point-source sensitivity about two orders of magnitude better than the current ARCA19–21 performance.
- ARCA and ORCA provide complementary sensitivity, with ORCA being particularly competitive for very soft neutrino spectra.



Projected sensitivity (full ARCA)

[Eur. Phys. J. C 84 \(2024\) 885](#)



[Review of KM3NeT Astrophysical Results – Neutrino 2026](#)

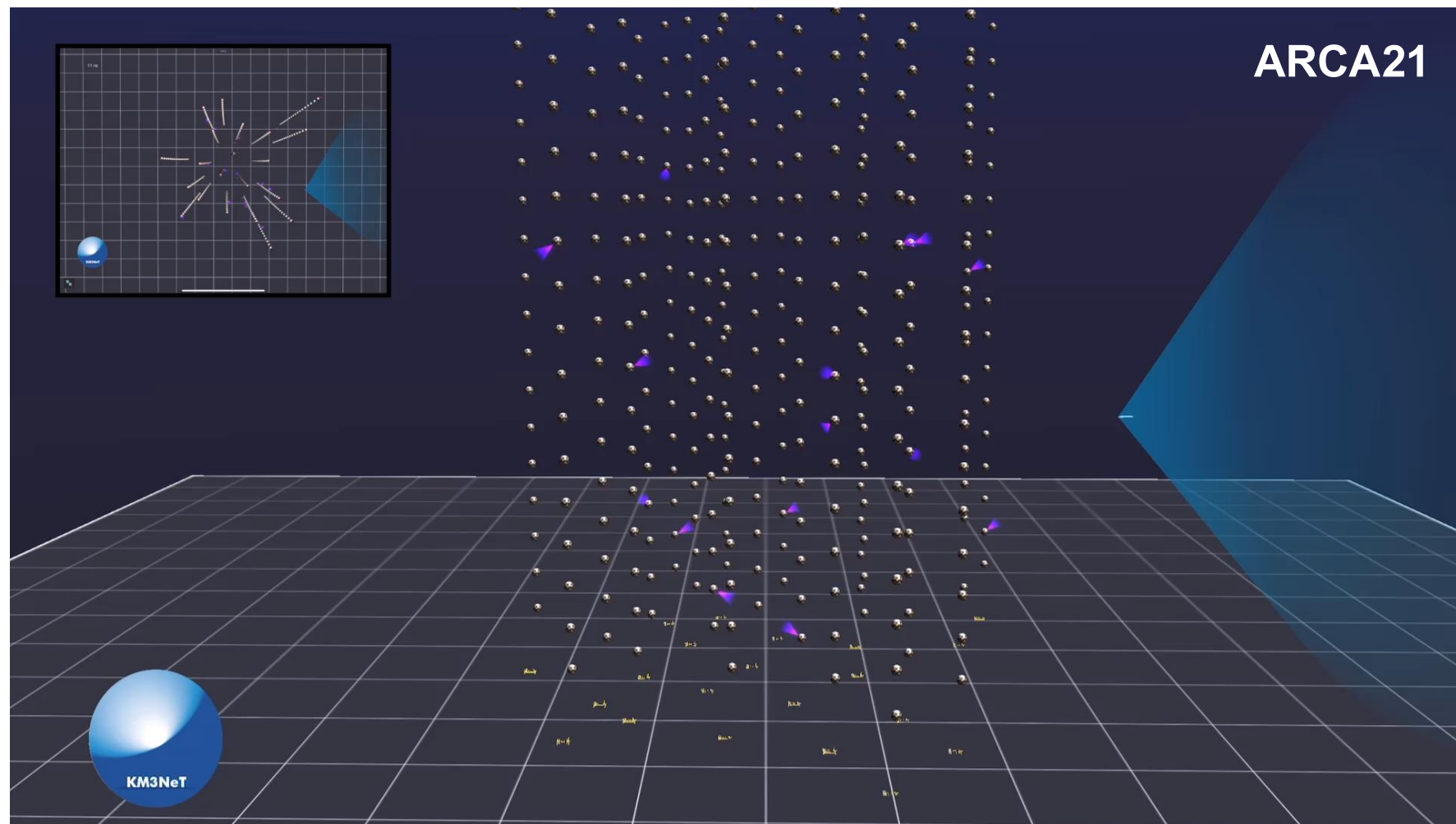
Feb 13, 2023, 01:16:47 UTC

28,086 PMT hits, recorded in all the 21 DUs

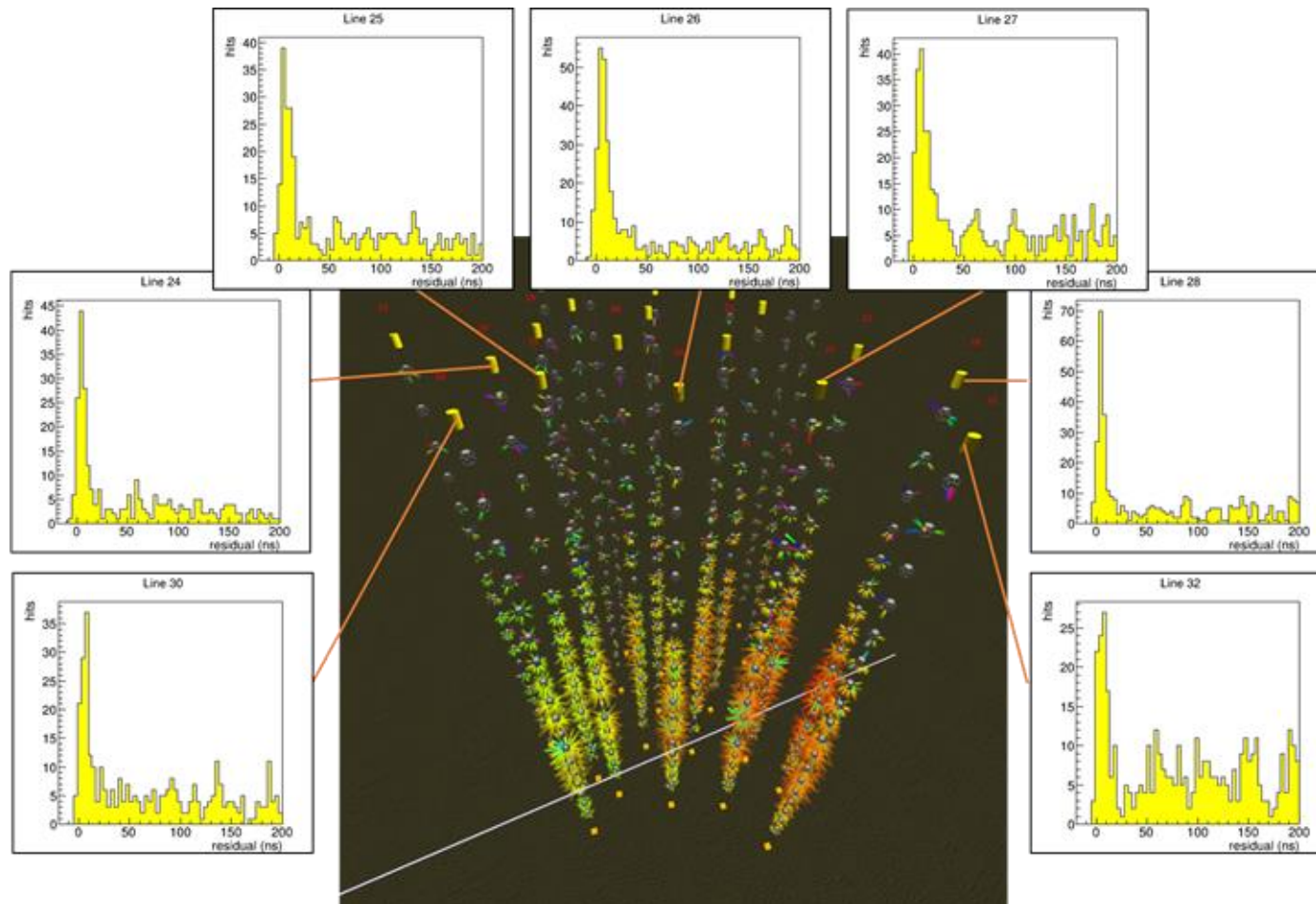
3672 PMTs (35%) participated at the triggering of the event

Brightest among 10^8 events collected in the 21-string configuration

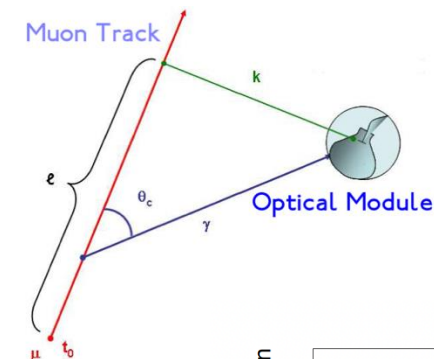
Horizontal track-type event with unprecedented high energy



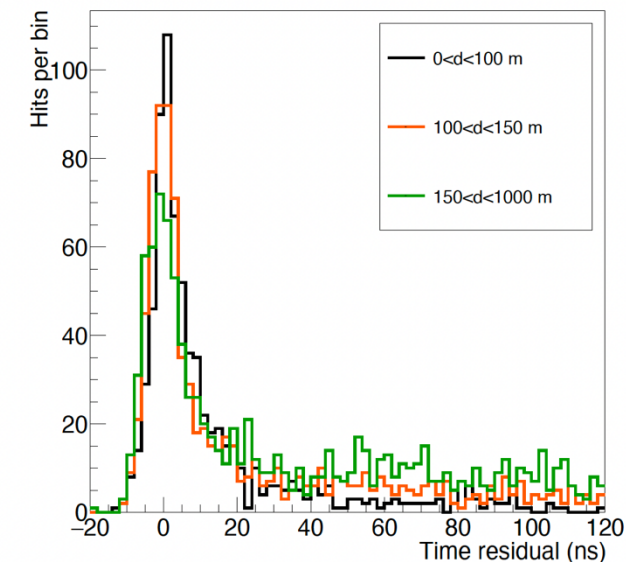
Time residuals



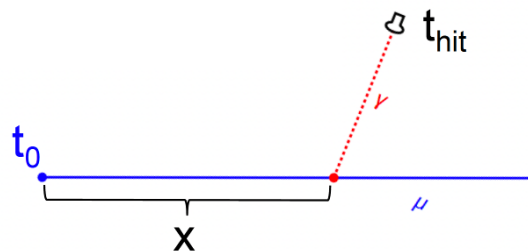
$$t_{th} = t_0 + \frac{1}{c} \left(\ell - \frac{k}{\tan \theta_c} \right) + \frac{1}{v_g} \left(\frac{k}{\sin \theta_c} \right)$$



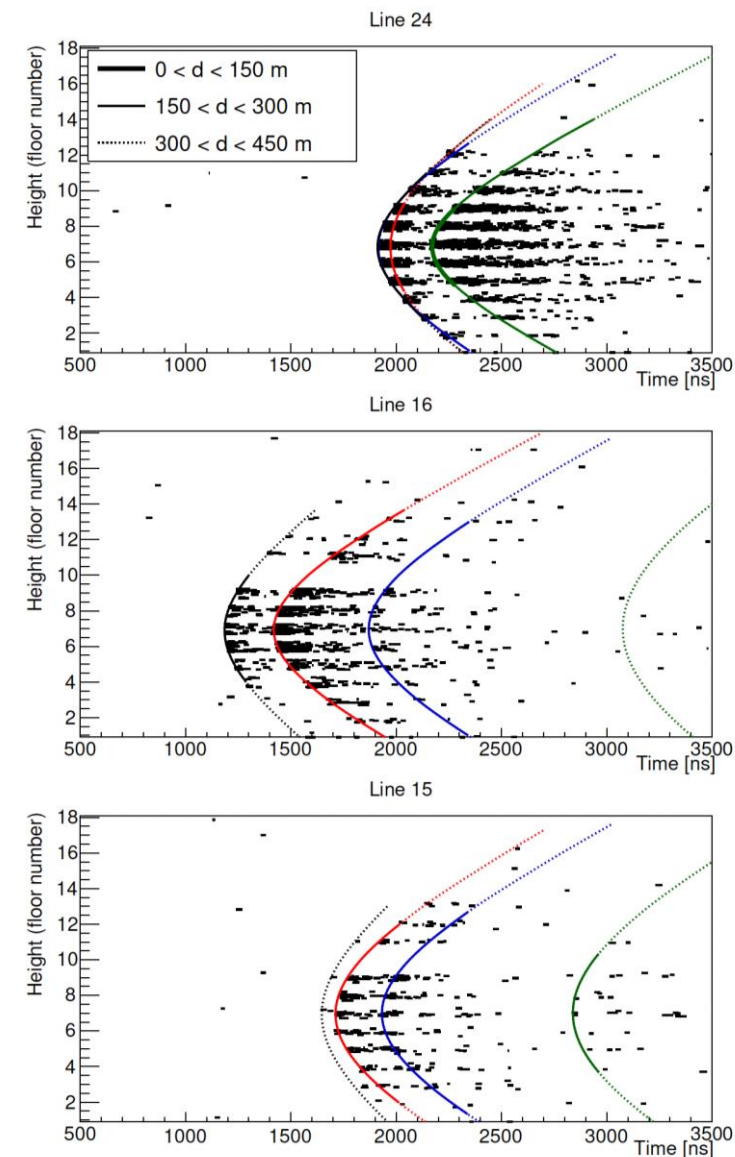
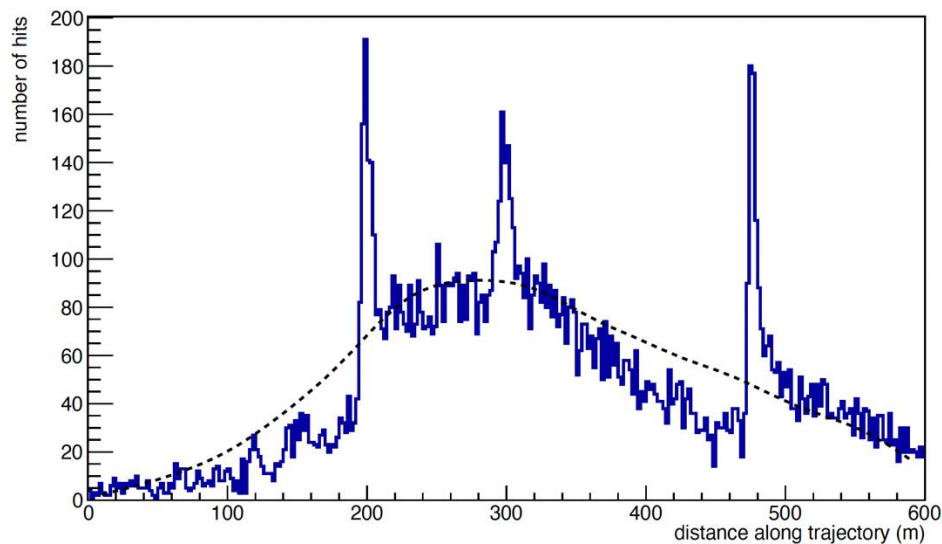
$$t_{res} = t_{det} - t_{th}$$



- Position of light emission along track consistent with hit time assuming direct light
- Light profile consistent with at least 3 large energy depositions along the muon track
- Characteristic of stochastic losses from ultra high energy muons
- Space-time distribution of light consistent with photons from Cherenkov emission



Position of light emission along track



The direction of the KM3-230213A event is reconstructed as near-horizontal

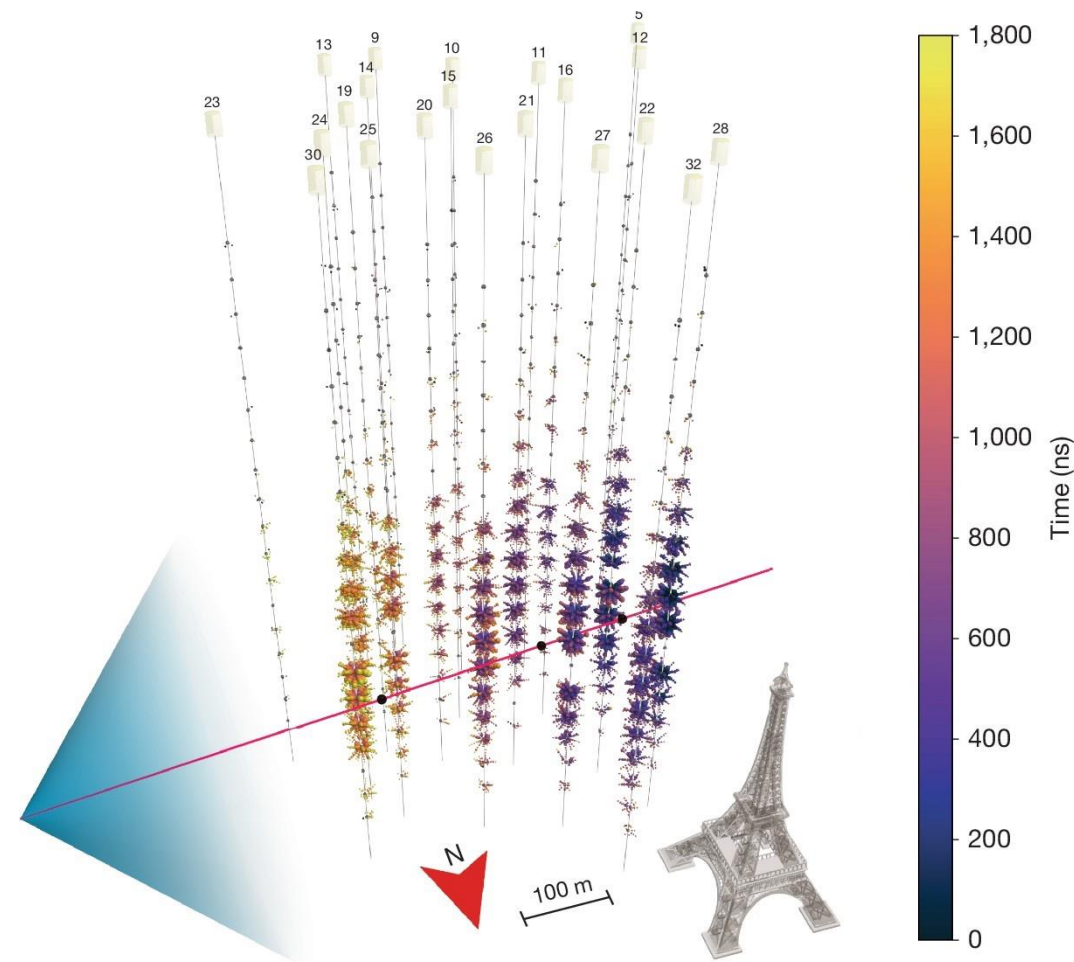
Altitude: 0.6°

Azimuth: 259.8°

The uncertainty is estimated to be **1.5°** (68% c.l.), dominated by the systematic uncertainty on the absolute azimuthal orientation of the detector at the time of the analysis

Detector positioning system upgraded during the 2025 sea campaign, providing improved knowledge of the detector element positions on the seafloor

After data recalibration, expected uncertainty close to the intrinsic statistical uncertainty on the muon direction of $\sim 0.1^\circ$



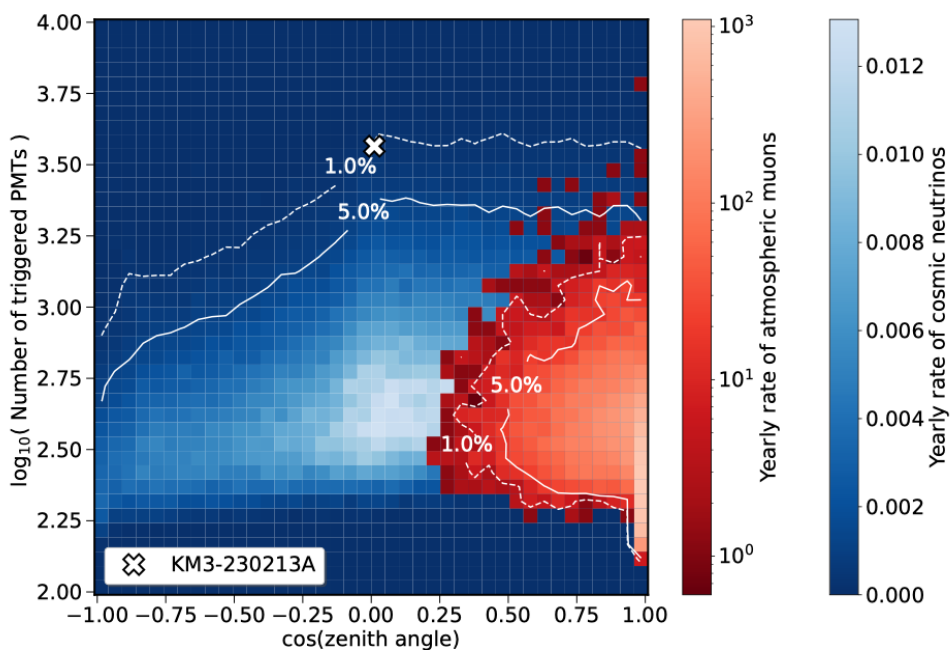
[Nature 638 \(2025\) 376](#)

The energy of muon with $E > \text{TeV}$ can be estimated by measuring its energy loss

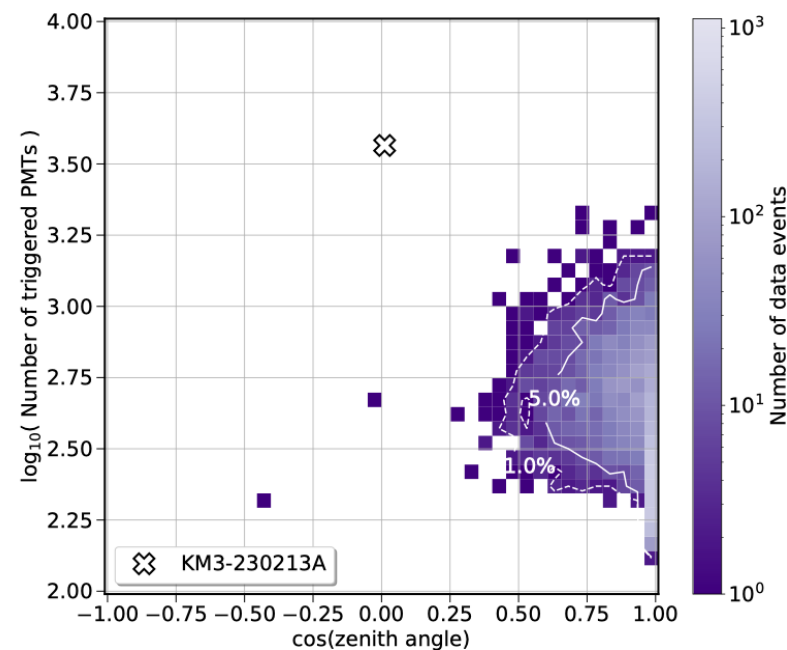
A saturation effect was visible in the PMTs within 100 m from the track (over 25% of the PMTs)

The muon energy is estimated by counting the number of PMTs participating at the triggering of the event

This quantity is robust against limitations of detector simulations and contamination from the optical background



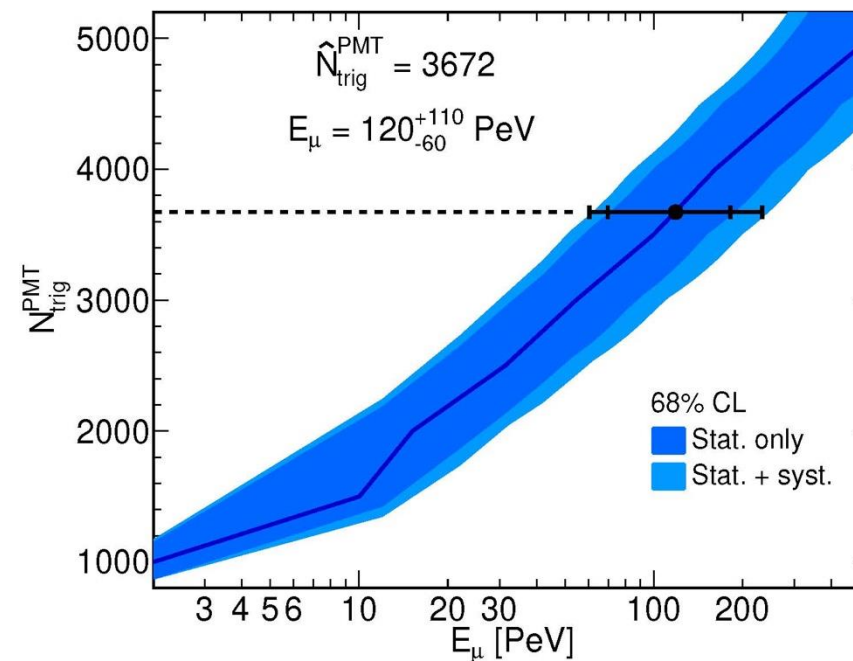
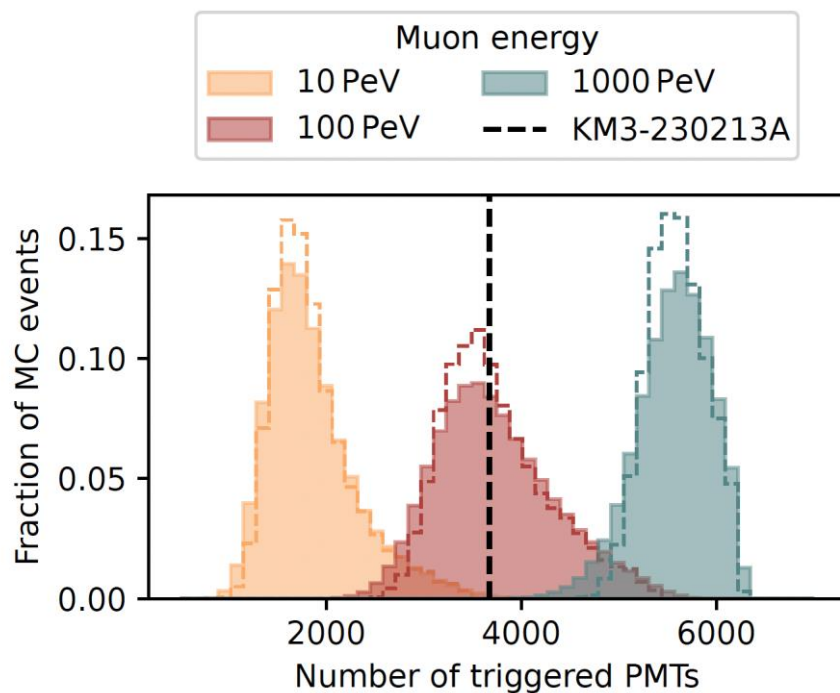
bright track event selection



Simulations of muons of various energies (from PeV to EeV) traversing the detector in the same direction and location as KM3-230213A

Simulations varying light absorption and scattering, and DOM efficiency

Building of frequentist confidence intervals on the true muon energy $\rightarrow E_\mu = 120_{-60}^{+110} \text{ PeV}$



[Nature 638 \(2025\) 376](#)

What about the neutrino energy?

We did not observe the interaction vertex: we do not know the muon energy at production or the energy transferred to the hadronic shower

We don't know where the muon originated: we do not know how much energy the muon lost before entering the detector

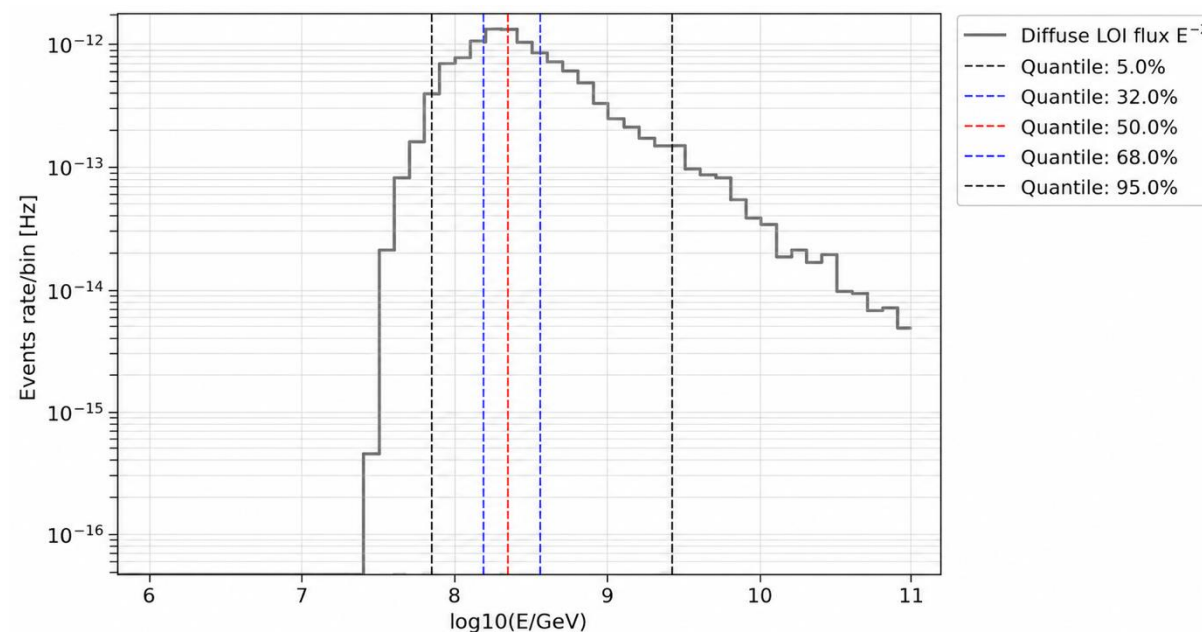
We need to assume an incoming neutrino energy spectrum:

the harder the spectrum $\rightarrow$ the more likely to have higher energy muons $\rightarrow$ they may have travelled more before we see them

Assuming muon neutrino with energy spectrum $\propto E^{-2}$:

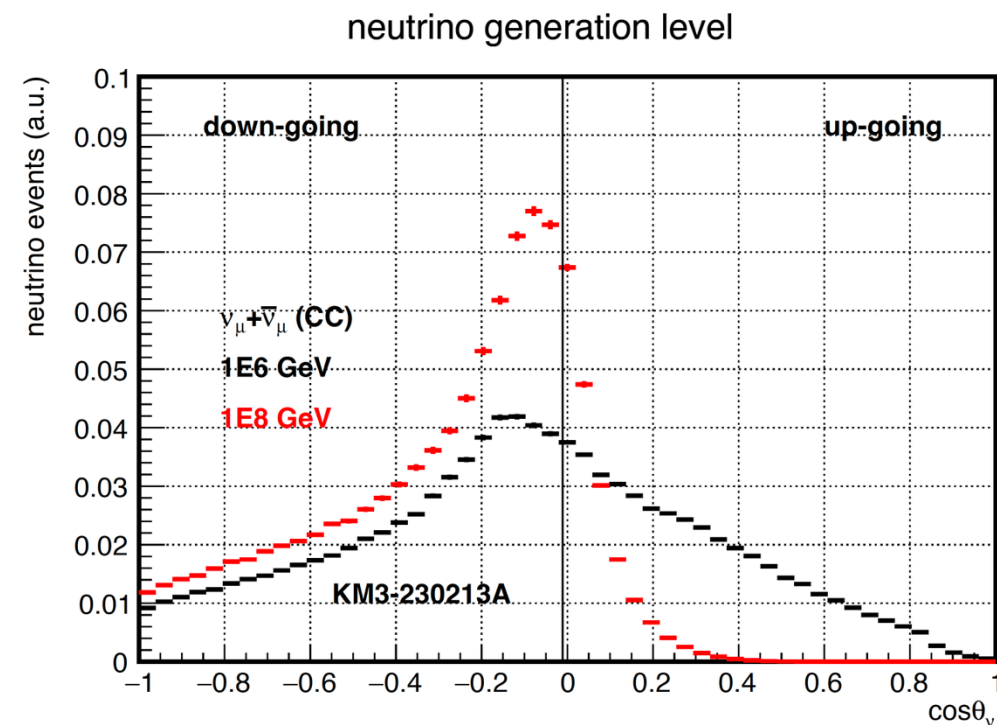
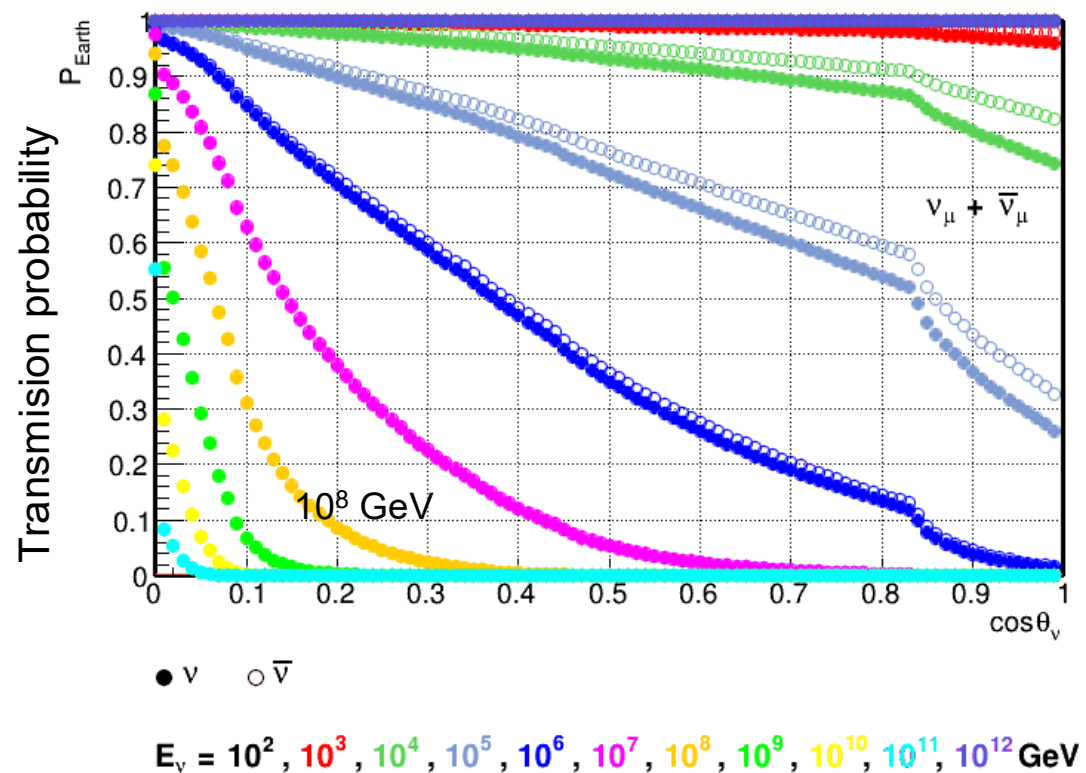
- median neutrino energy **220 PeV**
- 68% c.l. **110 – 790 PeV**

[Nature 638 \(2025\) 376](#)



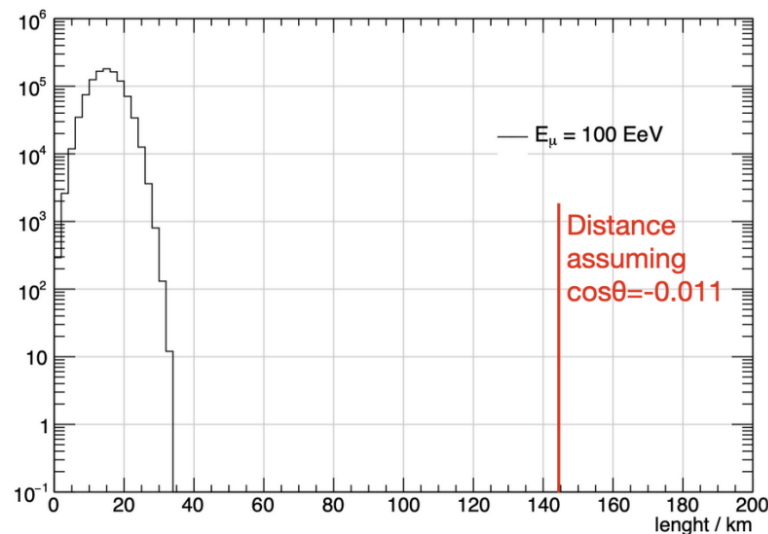
100 PeV neutrinos are mainly expected horizontal

The Earth becomes increasingly opaque for neutrinos above ~ 0.1 PeV



Simulations performed with the gSeaGen code

[CPC 256 \(2020\) 107477](#)

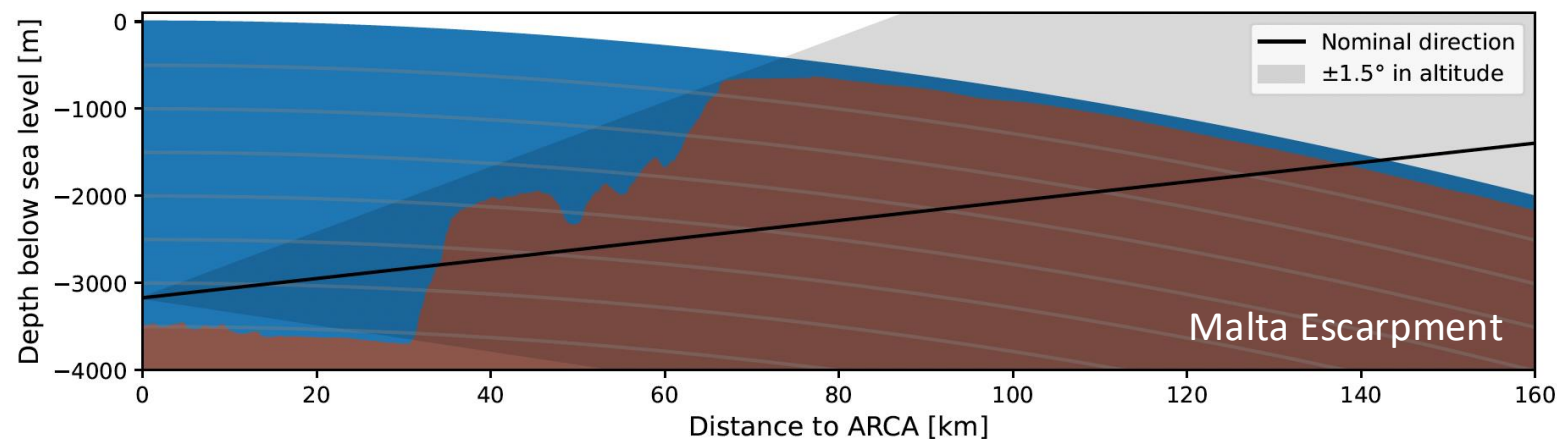
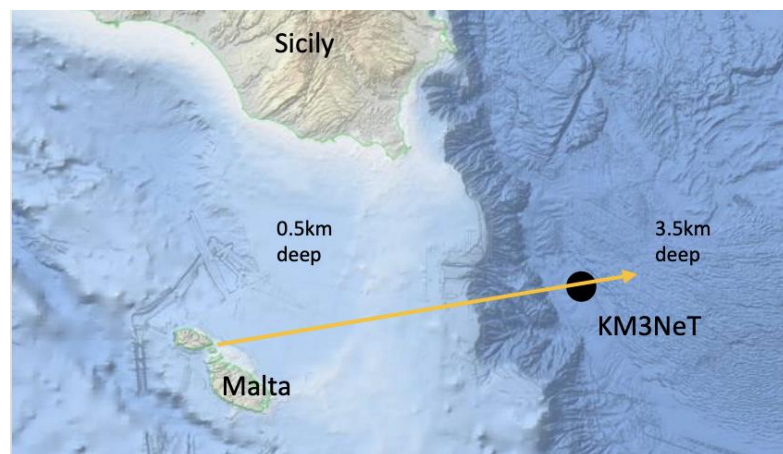


A muon with the observed direction would have traversed 300 km water equivalent of material, which exceeds the maxim range of atmospheric muons ($>10 \text{ PeV}$ at the detector)

Upper limit on muon contamination, assuming angular error of 2°
 10^{-10} events/year at the event energy

10^{-4} events/year slant 28 km w.e. at 5.6° above the horizon (5σ deviation)

Expected rate of an atmospheric neutrino (prompt component) is about 10^{-5} events/year



The effective area is the equivalent area of an ideal detector that would detect all incident neutrinos

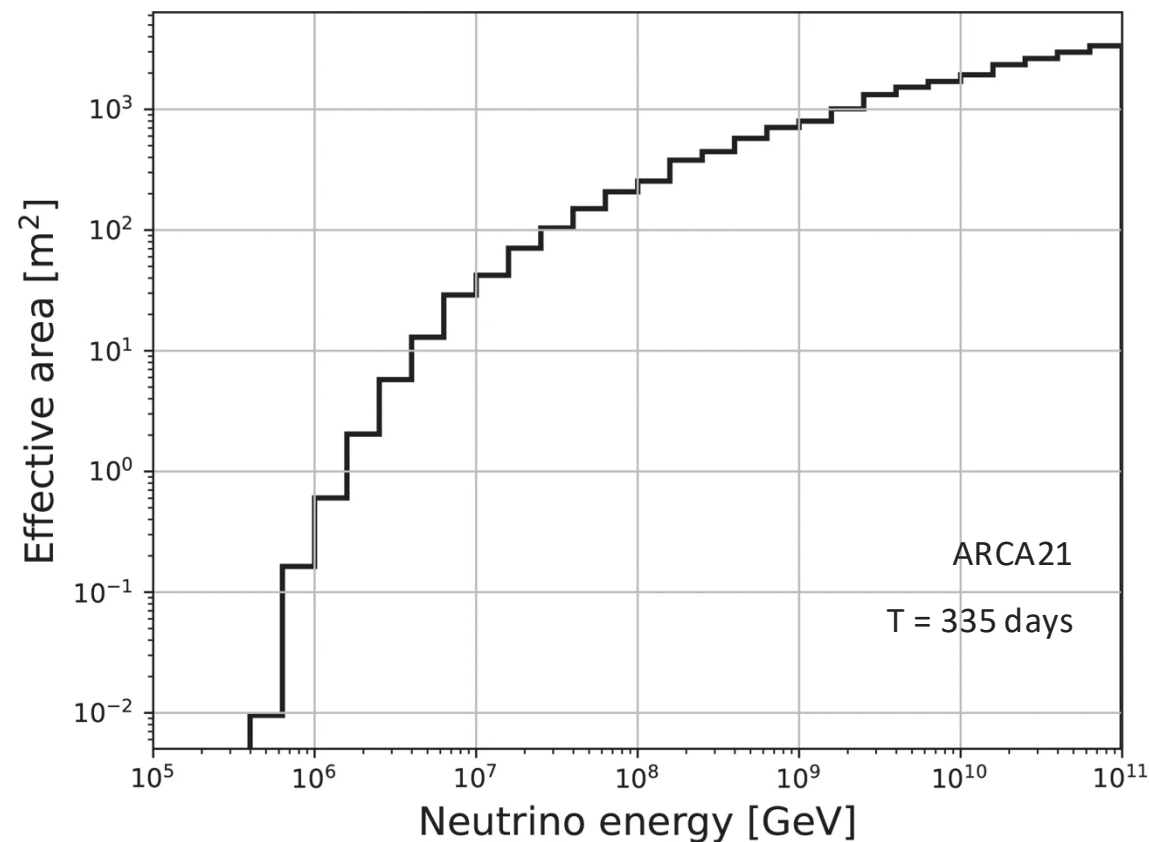
Exposure

$$\mathcal{E}(E) = 4\pi \times T \times A_{eff}(E)$$

Expected number of events

$$n_{evt} = \int_{E_{min}}^{E_{max}} \mathcal{E}(E) \times \Phi(E) dE$$

A_{eff} estimated using Monte Carlo simulations and used to evaluate the neutrino flux



- Considering the central 90% energy range [72 PeV-2.6 EeV] and assuming a steady isotropic flux E^{-2} over this energy range

$$E^2\Phi(E) = 5.8^{+10.1}_{-3.7} \times 10^{-8} \text{GeV}(\text{cm}^2 \text{s sr})^{-1}$$

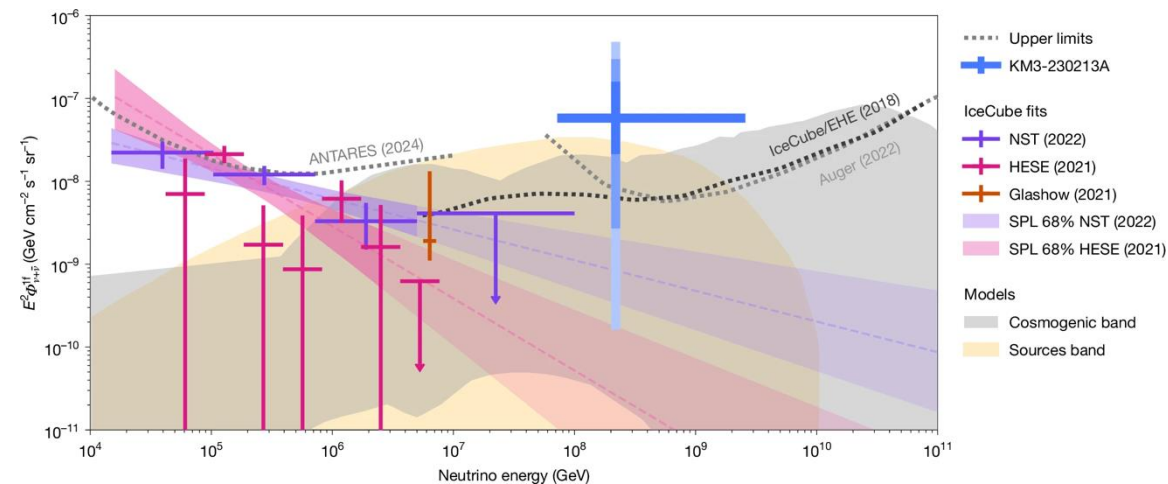
produces 1 event in the considered data. Uncertainties according to Feldman & Cousins

- Performing a joint fit of all experiments

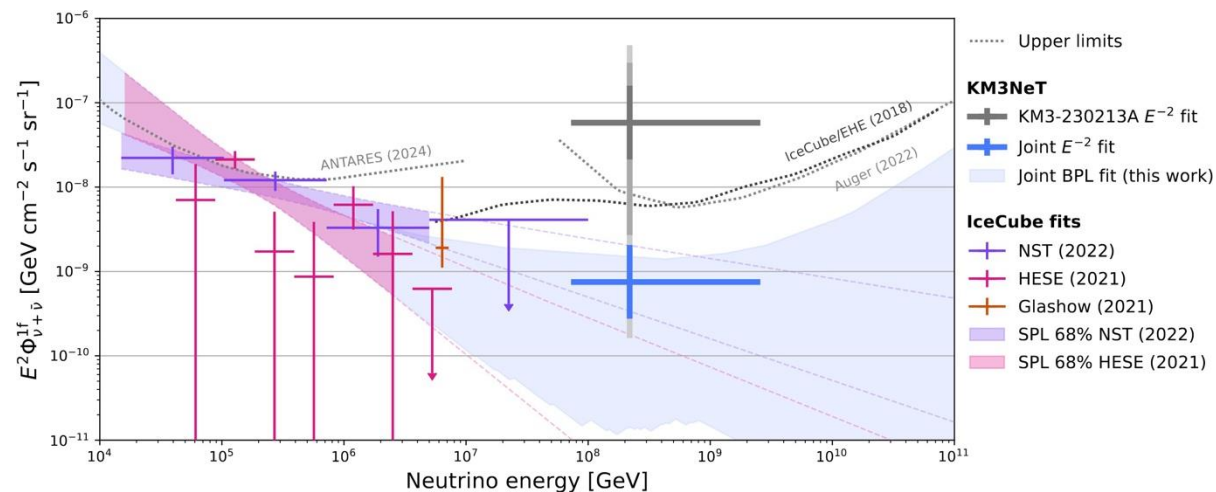
$$E^2\Phi(E) = 7.5 \times 10^{-10} \text{GeV}(\text{cm}^2 \text{s sr})^{-1}$$

- Observed tension of $\sim 2.5\sigma$
- Increased statistics are required to resolve this tension and better characterise the neutrino landscape at UHE

Nature 638 (2025) 376

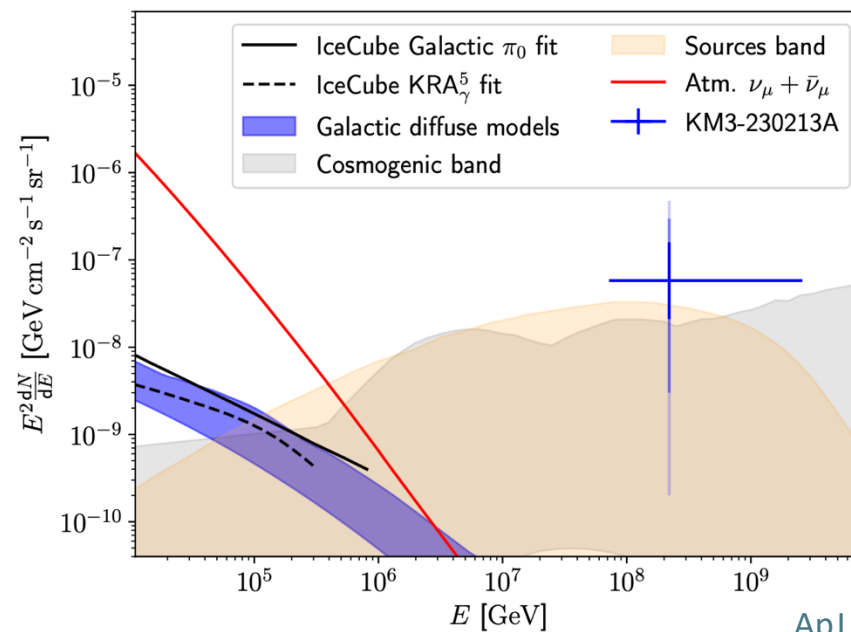
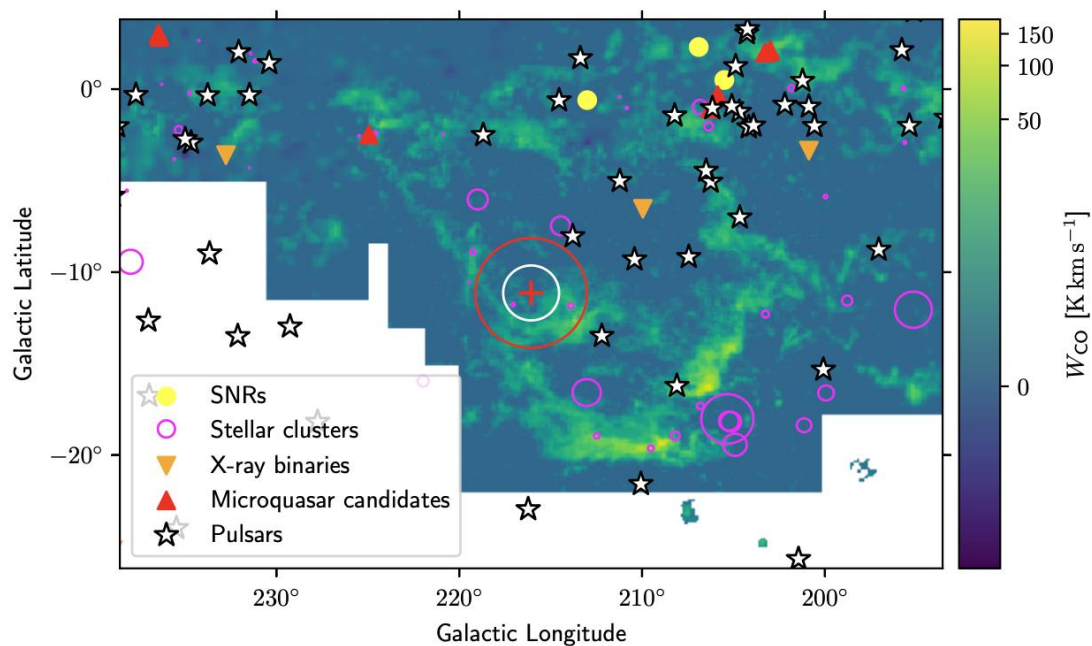


Phys. Rev. X 15 (2025) 031016



- KM3-230213A location is far from both the galactic centre and the galactic plane ($l = 216.1^\circ$, $b = -11.1^\circ$)
- Too low fluxes of the Galactic diffuse emission at these energies
- Lack of a nearby potential Galactic particle accelerator in the direction of the event
- Difficulty to accelerate particles to such high energies in Galactic systems

KM3-230213A is most likely of extragalactic origin

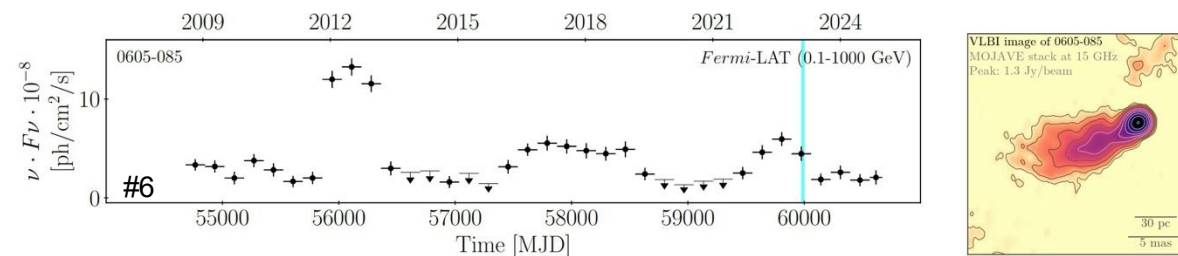
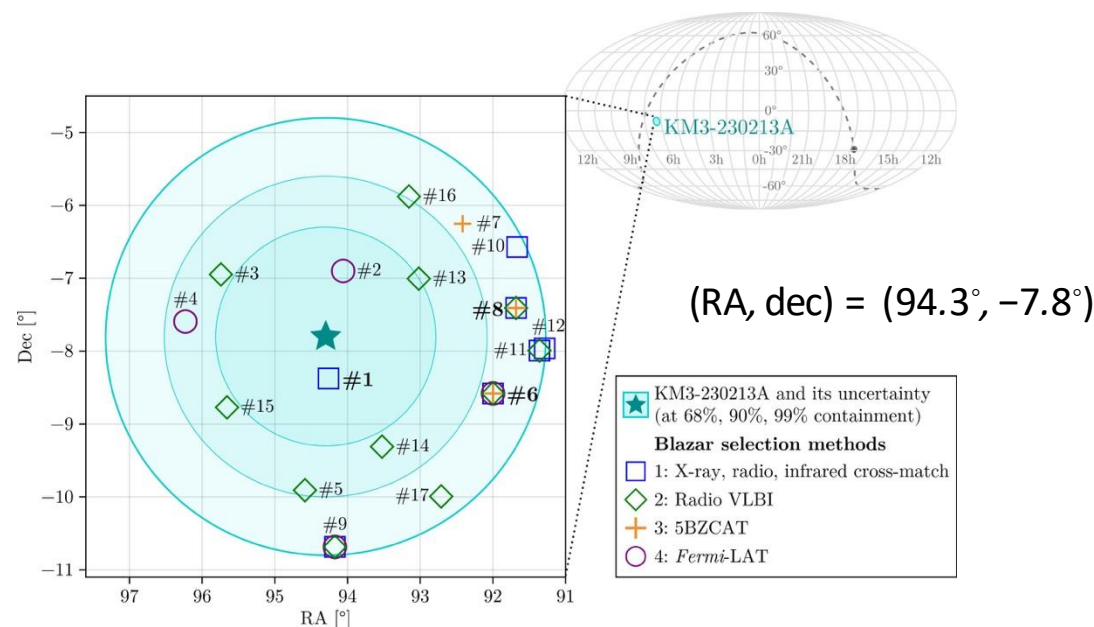


[ApJ 1003 \(2026\) 157](#)

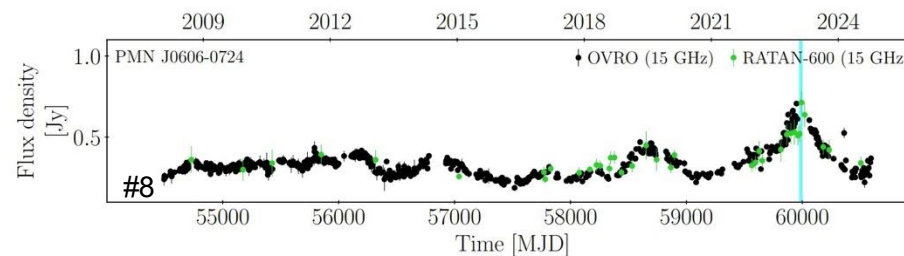
- Gamma-ray flare for the source 0605-085
- Major radio flare from PMN J0606-0724
- X-ray activity for MRC 0614-083

No conclusive statement given the large $R(99\%)$

The hypothesis that the event originates from a blazar is still viable



(a) The *Fermi*-LAT light curve and a VLBI image of 0605-085: the brightest radio source in the neutrino localization region that experiences a gamma-ray flaring activity around the neutrino arrival (Section 5.1).



(b) The radio light curve for PMN J0606-0724 that experiences a major flare in close coincidence to the neutrino arrival (Section 5.2).

[arXiv:2502.08484](https://arxiv.org/abs/2502.08484)

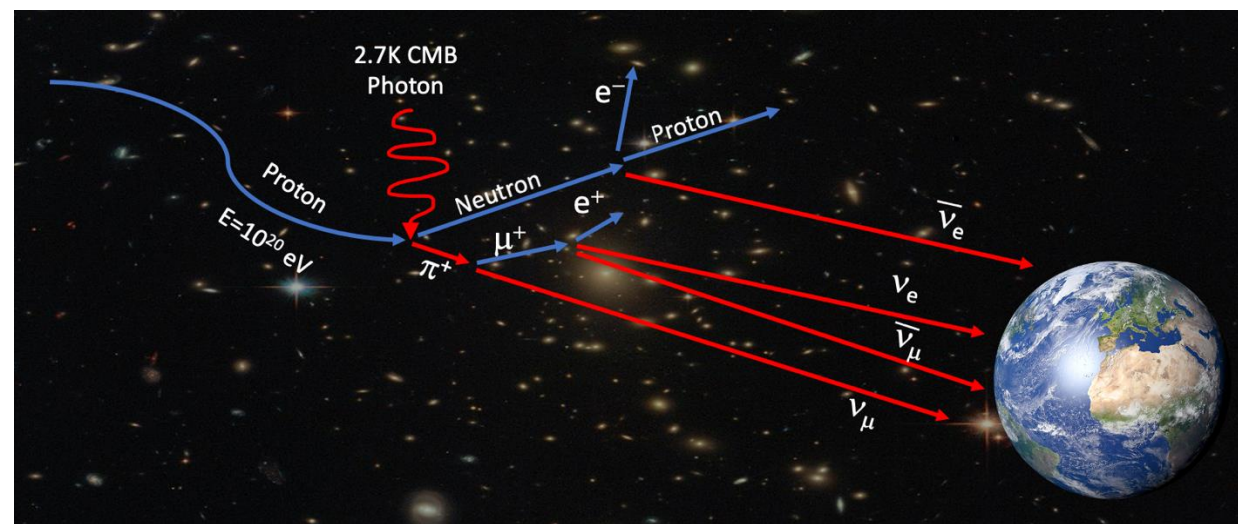
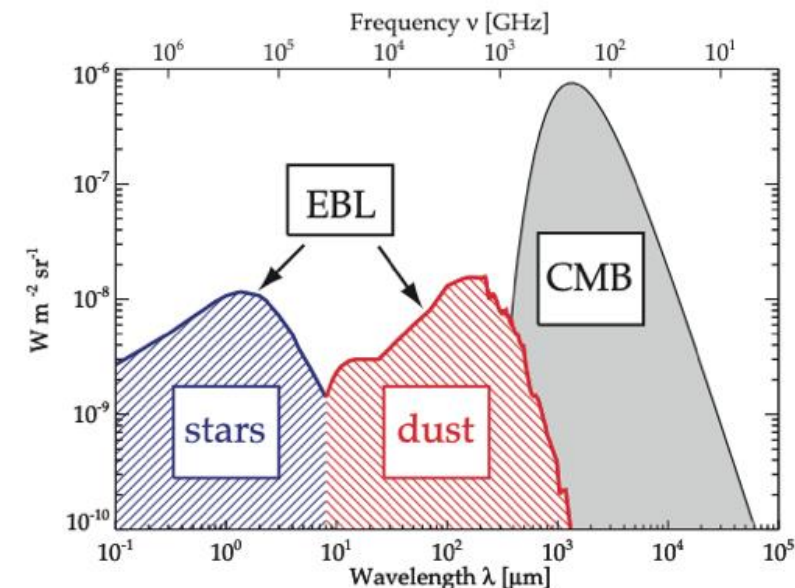
JCAP03(2026)033

Cosmogenic neutrinos are produced by interaction of cosmic rays with extra-galactic photon backgrounds (e.g. the Cosmic Microwave Background)

Large uncertainties in the predicted fluxes due to our limited knowledge of UHECR sources, composition, and propagation.

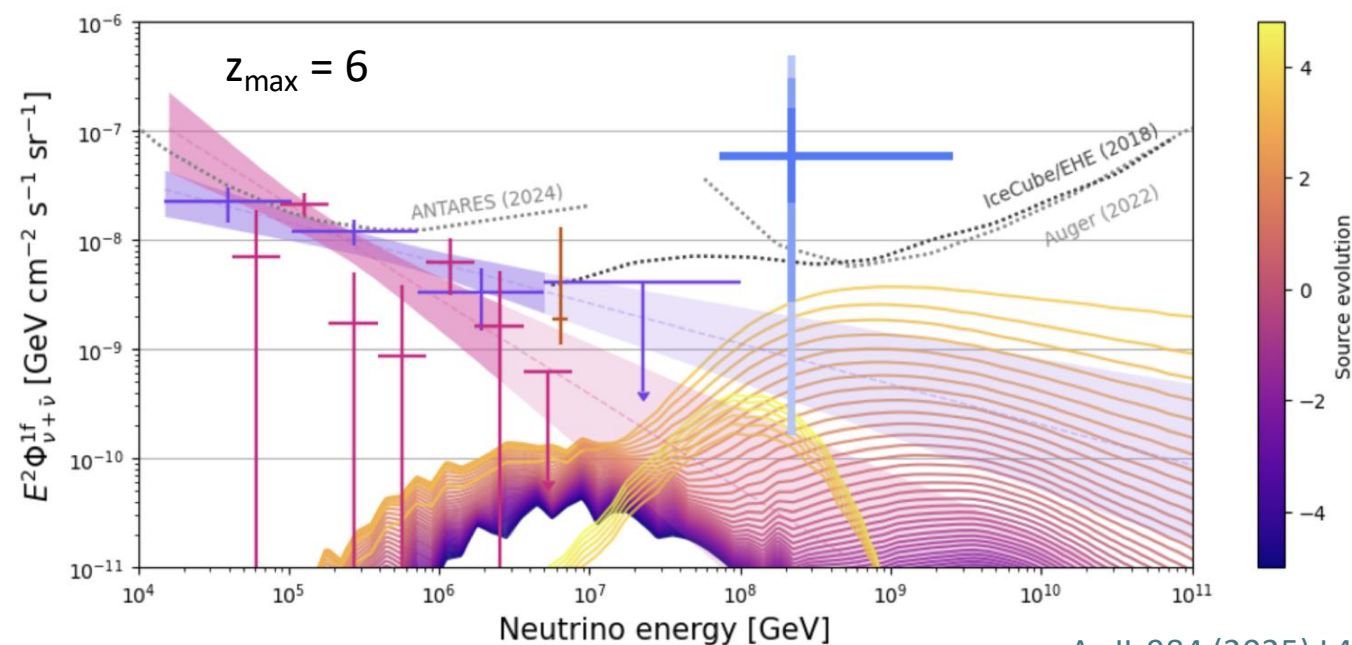
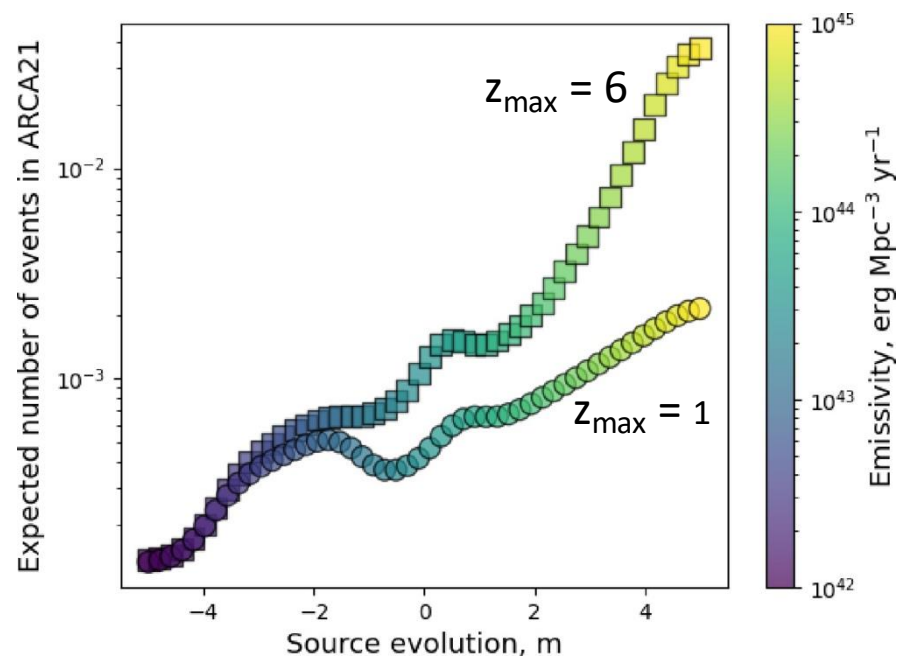
Important astrophysical parameters determining the shape and normalization of the cosmogenic neutrino flux:

- UHECR source emissivity
- Maximum acceleration energy
- Injection energy spectrum
- Cosmological evolution of UHECR sources
- UHECR composition at injection
- Spatial distribution of UHECR sources



The cosmogenic origin of KM3-230213A is compatible when

- looking into the deep sky ($z_{\text{max}} \simeq 6$)
- at strong positive cosmological source evolution ($m > 3$, source density $S(z) \propto (1 + z)^m$)
- and allowing for a non-negligible proton fraction at the highest energies.



[ApJL 984 \(2025\) L41](#)



Article

Observation of an ultra-high-energy cosmic neutrino with KM3NeT

<https://doi.org/10.1038/s41586-024-08543-1>

The KM3NeT Collaboration^a

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 Check for updates

The detection of cosmic neutrinos with energies above a teraelectronvolt (TeV) offers a unique exploration into astrophysical phenomena^{1–3}. Electrically neutral and interacting only by means of the weak interaction, neutrinos are not deflected by magnetic fields and are rarely absorbed by interstellar matter; their direction indicates that their cosmic origin might be from the farthest reaches of the Universe. High-energy neutrinos can be produced when ultra-relativistic cosmic-ray protons or nuclei interact with other matter or photons, and their observation could be a signature of these processes. Here we report an exceptionally high-energy event observed by KM3NeT, the deep-sea neutrino telescope in the Mediterranean Sea⁴, which we associate with a cosmic neutrino detection. We detect a muon with an estimated energy of 120^{+10}_{-10} petaelectronvolts (PeV). In light of its enormous energy and near-horizontal direction, the muon most probably originated from the interaction of a neutrino of even higher energy in the vicinity of the detector. The cosmic neutrino energy spectrum measured up to now^{5–7} falls steeply with energy. However, the energy of this event is much larger than that of any neutrino detected so far. This suggests that the neutrino may have originated in a different cosmic accelerator than the lower-energy neutrinos, or this may be the first detection of a cosmogenic neutrino⁸, resulting from the interactions of ultra-high-energy cosmic rays with background photons in the Universe.

Cosmic neutrinos may be produced either in the vicinity of the cosmic-ray source or along the cosmic-ray propagation path, leading to the production of secondary unstable particles, which subsequently decay into neutrinos. Cosmic rays interacting in the Earth's atmosphere produce atmospheric neutrinos, which form an experimental background to cosmic neutrinos. To detect cosmic neutrinos, very-large-volume neutrino observatories monitor natural bodies of water or ice for the Cherenkov light induced by the passage of the charged particles that result from neutrino interactions in or near the detector. The KM3NeT research infrastructure comprises two detector arrays of optical sensors deep in the Mediterranean Sea⁴. The ARCA detector is located offshore Portopalo di Capo Passero, Sicily, Italy, at a depth of about 3,450 m and connected by means of an electro-optical cable to the shore station of the INFN, Laboratori Nazionali del Sud (LNS). The geometry of ARCA is optimized for the study of high-energy cosmic neutrinos. The ORCA detector is located at a depth of about 2,450 m, offshore Toulon, France, and is optimized for the study of neutrino oscillations. Both detectors are under construction but already operational. Once completed, they will comprise 345 (230 for ARCA and 115 for ORCA) vertical detection lines, each holding 18 optical modules. Each module hosts 31 3-inch photomultiplier tubes (PMTs) pointing in all directions and ensuring 4π coverage⁹. Both detectors can identify all flavours of neutrino interactions: those producing long-lived muons, denominated 'tracks', and those producing electromagnetic and hadronic cascades at the neutrino interaction vertex, denominated 'showers'.

Of interest in this article are neutrino interactions that produce high-energy muons, which can travel several kilometres in seawater before being absorbed. These muons lose energy as they propagate mainly because of stochastic radiative processes such as bremsstrahlung, pair production and photonuclear reactions. The average energy loss per unit path length is proportional to the muon energy. Electromagnetic cascades arise from these stochastic energy losses; the number of charged particles that produce Cherenkov radiation in the cascades is proportional to the amount of energy lost by the muon in the process. The recorded time of arrival and time-over-threshold of the signals on the PMTs (denoted as 'hits') are used to reconstruct the muon direction and energy.

Although atmospheric neutrinos are more abundant at lower energies ($\leq$ TeV), cosmic neutrinos should become dominant at energies above 100 TeV. The neutrino energy is thus a crucial parameter for establishing a cosmic origin. The IceCube Collaboration announced the discovery of PeV cosmic neutrinos in 2013 (ref. 10). The most energetic neutrinos reported so far are a 6.05 ± 0.72 PeV electron antineutrino observed at the energy of the Glashow resonance¹¹ and a muon neutrino above 10 PeV from the observation of a 4.4-PeV muon¹.

The neutrino event KM3-230213A

An extremely high-energy muon traversing the ARCA detector was observed on 13 February 2023 at 01:16:47 UTC. This event is referred to here as KM3-230213A. At that time, 21 detection lines were in operation.

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Companion papers submitted/published:

- The ultra-high-energy event KM3-230213A within the global neutrino landscape, [Phys. Rev. X 15 \(2025\) 031016](#)
- On the Potential Galactic Origin of the Ultra-High-Energy Event KM3-230213A, [ApJ 1003 \(2026\) 157](#)
- Characterising Candidate Blazar Counterparts of the Ultra-High-Energy Event KM3-230213A, [arXiv:2502.08484](#)
- On the potential cosmogenic origin of the ultra-high-energy event, [ApJL 984 \(2025\) L41](#)
- KM3NeT Constraint on Lorentz-Violating Superluminal Neutrino Velocity, [Commun Phys 8 \(2025\) 457](#)
- Constraining gamma-ray burst parameters with the first ultra-high-energy neutrino KM3-230213A [A&A 710 \(2026\) A168](#)
- Blazars as a Potential Origin of the KM3-230213A, [JCAP03\(2026\)033](#)

Scientific interest in KM3-202313A

<https://arxiv.org/search/?query=KM3-230213A>

Up to July 2026: ~70 papers

- astrophysical counterparts
- heavy dark matter
- it's not a (normal) neutrino
- constraints on exotic stuff (LIV)
- evaporating black holes
- cosmogenic/connection to CR/y

The blazar PKS 0605-085 as the origin of the KM3-230213A ultra-high energy neutrino event

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KM3NeT Constraint on Lorentz-Violating Superluminal Neutrinos (The KM3NeT Collaboration)

Constraints on Lorentz invariance violation in neutrino sector from the ultra-high-energy event KM3-230213A

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Lorentz invariance is a fundamental symmetry of spacetime and serves as the cornerstone of modern physics, supporting the constancy of the speed of light. A crucial implication of this principle is that no particle can propagate faster than this universal speed limit. In this study, we present a stringent neutrino-based test of Lorentz invariance, utilizing the highest-energy neutrino ever detected, known as event KM3-230213A. The detection of this neutrino, with measured energy of approximately 220 PeV, allows us to establish a lower bound on the scale of second-order Lorentz invariance violation, quantified as $\Delta c/c > 5.0 \times 10^{-10}$ GeV at 90 % confidence level.

KM3-230213A: An Ultra-High-Energy Neutrino from a Year-Long Astrophysical Transient

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The KM3NeT collaboration has recently reported the detection of a neutrino event with energy in excess of 100 PeV. This detection is in 2.5-5e tens this energy imposed by IceCube and the Pierre Auger diffuse all-sky neutrino flux. We explore an alternative of an isolated source. We show that the data are consistent with the possibility of a neutrino flux $F \sim 3 \times 10^{-10} (1 \text{ yr/T}) \text{ erg/(cm}^2 \text{ s)}$. The protons responsible for the neutrino emission have energy range, or otherwise that the neutrinos are infrared photons. The all-sky rate of similar neutrino

On the potential cosmogenic origin of the ultra-high-energy event KM3-230213A

THE KM3NeT COLLABORATION

Cosmic-Ray Constraints on the Flux of Ultra-High-Energy Neutrino Event KM3-230213A

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Abstract

The detection of a ~ 220 PeV muon neutrino by the KM3NeT neutrino observatory to probe the Universe at extreme energies. We analyze the origin of this event, a transient point source, a diffuse astrophysical emission, and low-energy cosmic rays (LURIC). Our analysis includes the flux from IceCube, incorporating data from KM3NeT, IceCube, and Pierre Auger Observatory. From this analysis, we find a new population of transient that is energetic, point-like, and has a duration of $\sim 10^4$ s. The energy of this event is consistent with known ones. In the framework of diffuse astrophysical emission, we energy injection rate at > 4 EeV, assuming a proton primary, with the rate by Auger. This disfavors the KM3NeT-only fit at all models, while the joint fit remains consistent with known ones. For cosmogenic origin, we find that the event is consistent with known ones. For cosmogenic origin, we find that the event is consistent with known ones.

Linking the KM3-230213A Neutrino Event to Dark Matter Decay and Gravitational Waves Signals

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³Department of Physics, Chung-Ang University, Seoul 06971, Korea

Abstract

The KM3NeT collaboration recently reported the detection of an ultra-high-energy neutrino event, labeled KM3-230213A. This is the first observed neutrino event with energy of the order of 10^{11} GeV. We study its origin by linking it to dark matter decay and gravitational waves signals. We show that the event is consistent with the possibility of a neutrino flux $F \sim 3 \times 10^{-10} (1 \text{ yr/T}) \text{ erg/(cm}^2 \text{ s)}$. The protons responsible for the neutrino emission have energy range, or otherwise that the neutrinos are infrared photons. The all-sky rate of similar neutrino

'Dark' Matter Effect as a Novel Solution to the KM3-230213A Puzzle

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Superheavy dark matter from the natural inflation in light of the highest-energy astroparticle events

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³Department of Physics, Department of Astronomy & Astrophysics, Center for

Pseudo-Goldstone Dark Matter from Primordial Black Holes: Gravitational Wave Signatures and Implications for KM3-230213A Event at KM3NeT

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³Department of Physics, Department of Astronomy & Astrophysics, Center for

Does the 220 PeV Event at KM3NeT Point to New Physics?

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Explaining the KM3-230213A Detection without Gamma-Ray Emission: Cosmic-Ray Dark Radiation

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Astrophysical sources of dark particles as a solution to the KM3NeT and IceCube tension over KM3-230213A

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Cascaded Gamma-ray Emission Associated with the KM3NeT Ultra-High-Energy Event KM3-230213A

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Abstract

A neutrino-like event with an energy of ~ 220 PeV was recently detected by the KM3NeT/ARCA telescope. If this neutrino comes from an astrophysical source, or from the interaction of an ultra-high-energy cosmic ray in the intergalactic medium, the ultra-high-energy gamma rays that are co-produced with the neutrinos will scatter with the extragalactic background light, producing an electromagnetic cascade and resulting in emission at GeV-to-TeV energies. In this paper, we compute the gamma-ray flux from this neutrino source considering various source distances and strengths of the intergalactic magnetic field (IGMF). We find that the associated gamma-ray emission could be observed by existing imaging air Cherenkov telescopes and air shower gamma-ray observatories, unless the strength of the IGMF is $B \geq 3 \times 10^{-13}$ G, or the ultra-high-energy gamma rays are attenuated inside of the source

Cosmological Origin of the KM3-230213A event and associated Gravitational Waves

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Abstract

The KM3NeT collaboration recently reported the detection of an ultra-high-energy neutrino event, labeled KM3-230213A. This is the first observed neutrino event with energy of the order of 10^{11} GeV. We study its origin by linking it to dark matter decay and gravitational waves signals. We show that the event is consistent with the possibility of a neutrino flux $F \sim 3 \times 10^{-10} (1 \text{ yr/T}) \text{ erg/(cm}^2 \text{ s)}$. The protons responsible for the neutrino emission have energy range, or otherwise that the neutrinos are infrared photons. The all-sky rate of similar neutrino

What KM3-230213A events may tell us about the neutrino mass and dark matter

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Could a Primordial Black Explosion Explain the KM3NeT Event?

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Neutrinos from Primordial Black Holes in Theories with Extra Dimensions

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- KM3NeT is a distributed deep-sea neutrino observatory currently under construction, already taking data in partial detector configurations (ARCA51 and ORCA42).
- Both detectors are steadily expanding, with sensitivity continuously improving as new detection units are deployed.
- The complementary capabilities of ORCA and ARCA enable a broad scientific program, spanning neutrino oscillation physics, neutrino astronomy and multi-messenger studies.
- The detection of the ultra-high-energy neutrino KM3-230213A, the highest-energy neutrino ever observed, marks a major milestone for KM3NeT and opens a new window on the high-energy Universe.
- With construction progressing and the detector performance continuously improving, KM3NeT is entering an exciting era of precision measurements and discoveries.

STAY TUNED FOR UPDATES!