

KM3NeT webinar

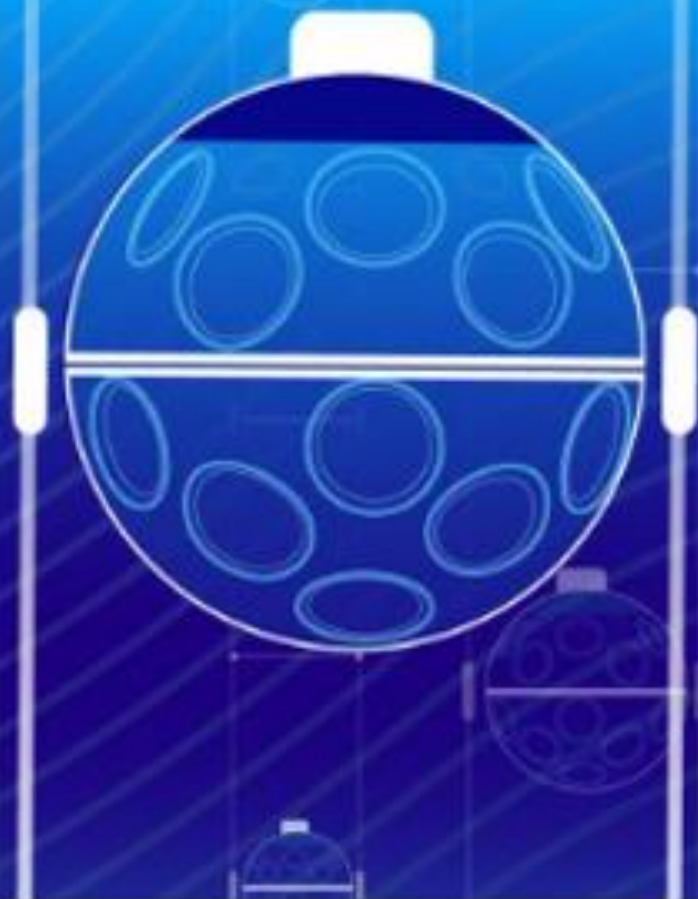


KM3NeT

FEBRUARY 12, 2025

FROM THE DEEP COSMOS TO THE DEEP SEA

New results from the KM3NeT neutrino telescope



France

- CNRS Nucléaire et Particules
- Astroparticle and Cosmology Laboratory, Université Paris Cité, CNRS
- Centre for Particle Physics of Marseille, Aix-Marseille Université, CNRS
- Laboratoire d'Astrophysique de Marseille
- Mediterranean Institute of Oceanography, CNRS Terre et Univers, Marseille
- Université de Toulon
- Institut Pluridisciplinaire Hubert Curien, Université de Strasbourg, CNRS
- Subatech, IMT Atlantique, Nantes Université
- Laboratoire Univers et Particules de Montpellier
- Laboratoire de Physique Corpusculaire de Caen, Université de Caen, CNRS

United Kingdom

- University of Hull

Belgium

- UCLouvain, Louvain-La-Neuve
- Université Libre de Bruxelles

The Netherlands

- NWO-I, Nikhef, Amsterdam
- Universiteit van Amsterdam
- Universiteit Leiden
- NIOZ, Texel
- TNO, Technical Sciences, Delft

Germany

- Friedrich-Alexander-Universität Erlangen-Nürnberg
- Max-Planck-Institut für Radioastronomie, Bonn
- Universität Würzburg
- Universität Erlangen, Reims Sternwarte, Bamberg
- Universität Münster

Italy

- INFN, Laboratori Nazionali del Sud, Sezione di Catania
- INFN, Sezione di Firenze
- INFN, Sezione di Genova, Università di Genova
- INFN, Sezione di Napoli, Università della Campania, Università di Napoli
- INFN, Sezione di Roma, Università di Roma La Sapienza
- INFN, Sezione di Bari, University of Bari
- INFN, Sezione di Bologna, Università di Bologna
- Università degli Studi della Campania L. Vanvitelli
- Università di Padova
- Università degli Studi di Salerno, INFN Gruppo Collegato di Salerno

Slovakia

- Univerzita Komenského v Bratislave
- Slovenská akadémia vied, Kosice

Czech Republic

- Czech Technical University in Prague, Institute of Experimental and Applied Physics

Poland

- AGH University of Krakow
- NCBJ - National Centre for Nuclear Research, Warsaw
- Nicolaus Copernicus Astronomical Center, Particle Astrophysics Science and Technology Centre, Warsaw

Romania

- Institute of Space Science - INFLPR Subsidiary, Magurele

Greece

- Institute of Nuclear and Particle Physics, NCSR Demokritos, Athens
- National and Kapodistrian University of Athens

Cyprus

- University of Cyprus, Nicosia

Spain

- Consejo Superior de Investigaciones Científicas (CSIC)
- Instituto de Física Corpuscular, Universitat de València, CSIC
- Universitat Politècnica de València, IGIC, Gandia, València
- Universidad de Granada
- Centro Oceanográfico de Murcia (IEO-CSIC)
- Laboratori d'Aplicacions Bioacústiques, Universitat Politècnica de Catalunya, Vilanova i la Geltrú
- Instituto de Ciencias del Mar, CSIC, Barcelona

United States of America

- Harvard University, Cambridge
- Drexel University, Philadelphia

Morocco

- University Mohammed V, Rabat
- National Center of Energy of Sciences and Nuclear Techniques, Rabat
- University Mohammed Ier, Oujda
- Cadi Ayyad University, Marrakesh
- Mohammed VI Polytechnic University, Ben Guerir

Algeria

- Center of Research in Astronomy, Astrophysics, and Geophysics, Bouzareah
- Université Badji Mokhtar, Annaba
- University of Constantine
- Mohamed Boudiaf University, M'sila

KM3NeT Collaboration

5 continents, 21 countries, 68 institutes

■ Full members

■ Observer members

South Africa

- University of Johannesburg
- University of the Witwatersrand, Johannesburg
- North-West University, Potchefstroom

Georgia

- Tbilisi State University
- University of Georgia, Tbilisi

United Arab Emirates

- University of Sharjah
- Khalifa University of Science and Technology, Abu Dhabi

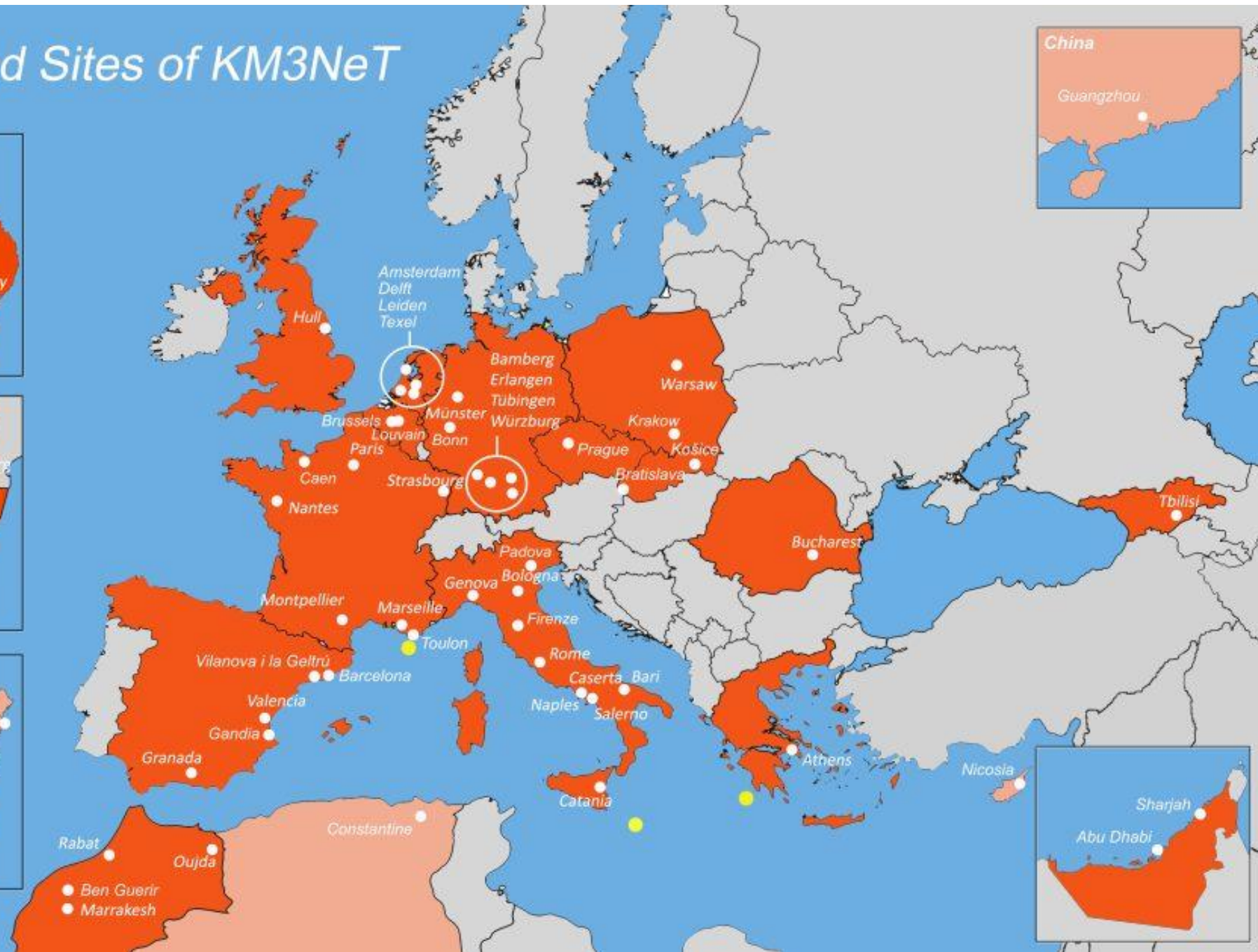
Australia

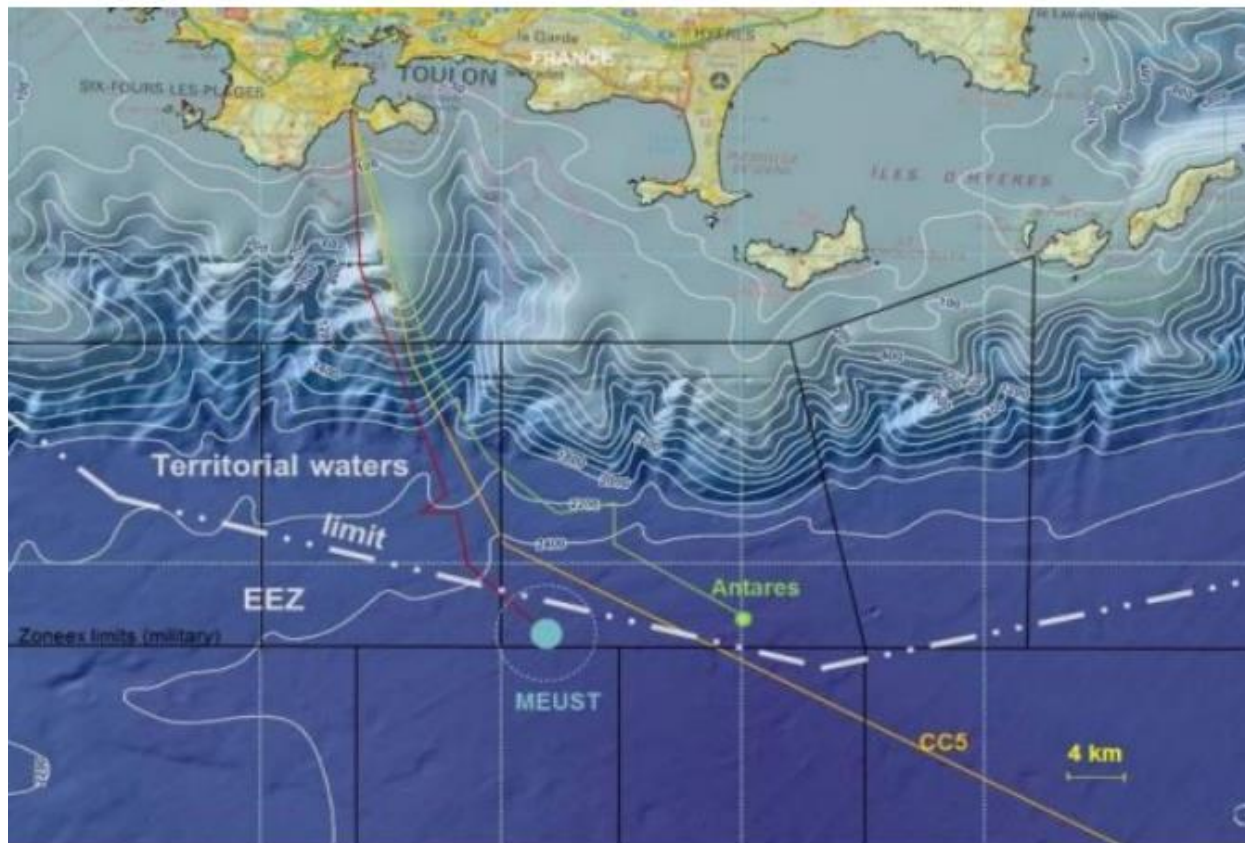
- Western Sydney University

China

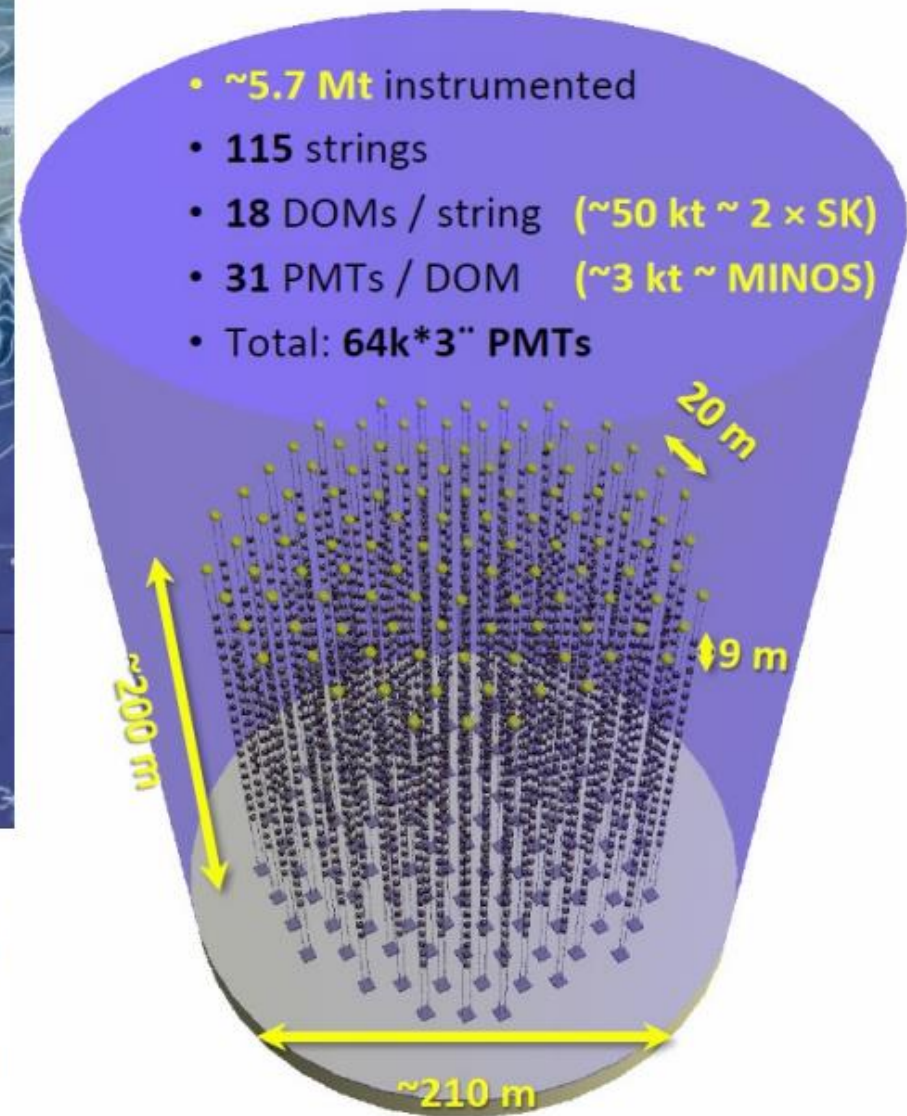
- Sun Yat-Sen University, Zhuhai

Cities and Sites of KM3NeT





KM3NeT/ORCA დეტექტორი წყალქვეშა მეცნიერებების და ტექნოლოგიების ხმელთაშუა ზღვის ევროცენტრის ინფრასტრუქტურის ძირითადი ნაწილია (MEUST: Mediterranean Eurocentre for Underwater Sciences and Technologies). განლაგებულია 2500 მ სიღრმეზე, ქ. ტულონიდან (საფრანგეთი) დაახლოებით 40 კმ-ს დაშორებით.



KM3NeT/ORCA დეტექტორის სქემა.

[ORCA: Oscillation Research with Cosmics in Abyss]

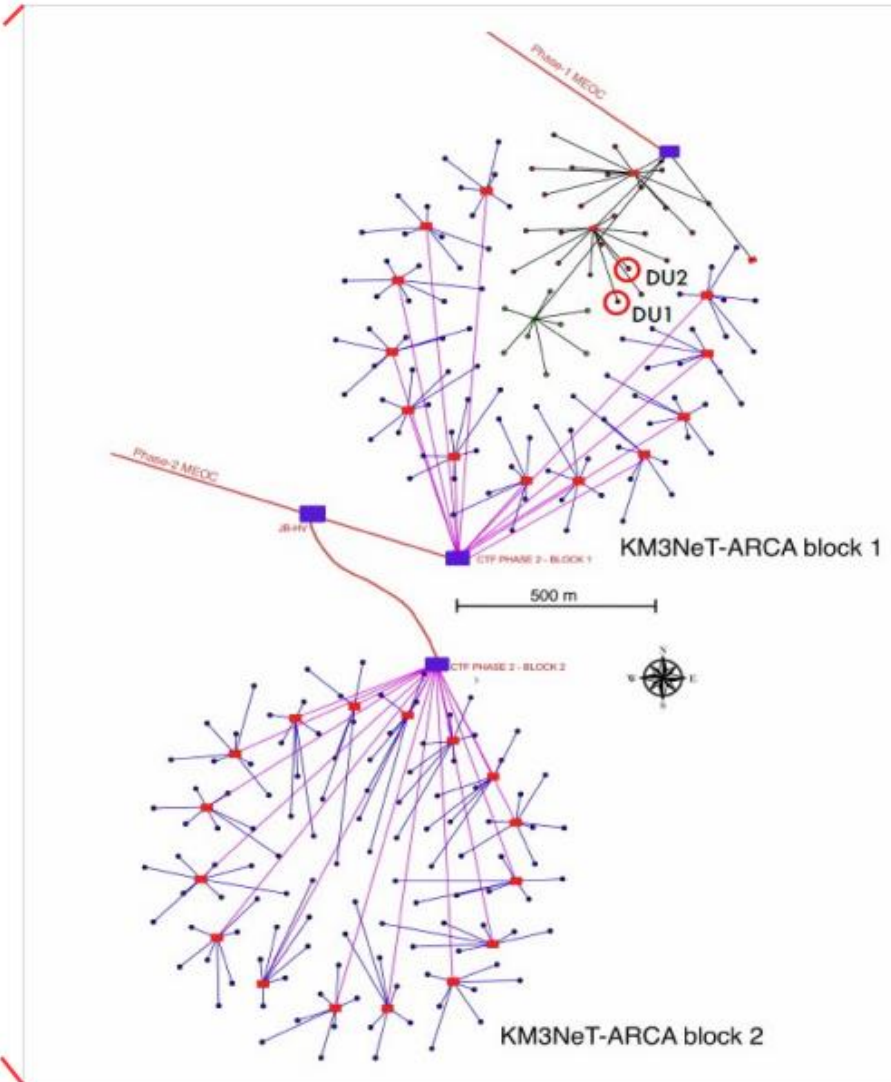
KM3NeT/ARCA დეტექტორი განლაგებულია სიცილიის სანაპიროდან (ქ. პორტო პალო დი კაპო პასერო) დაახლოებით 100 კმ-ის დაშორებით, 3500 მ სიღრმეზე.

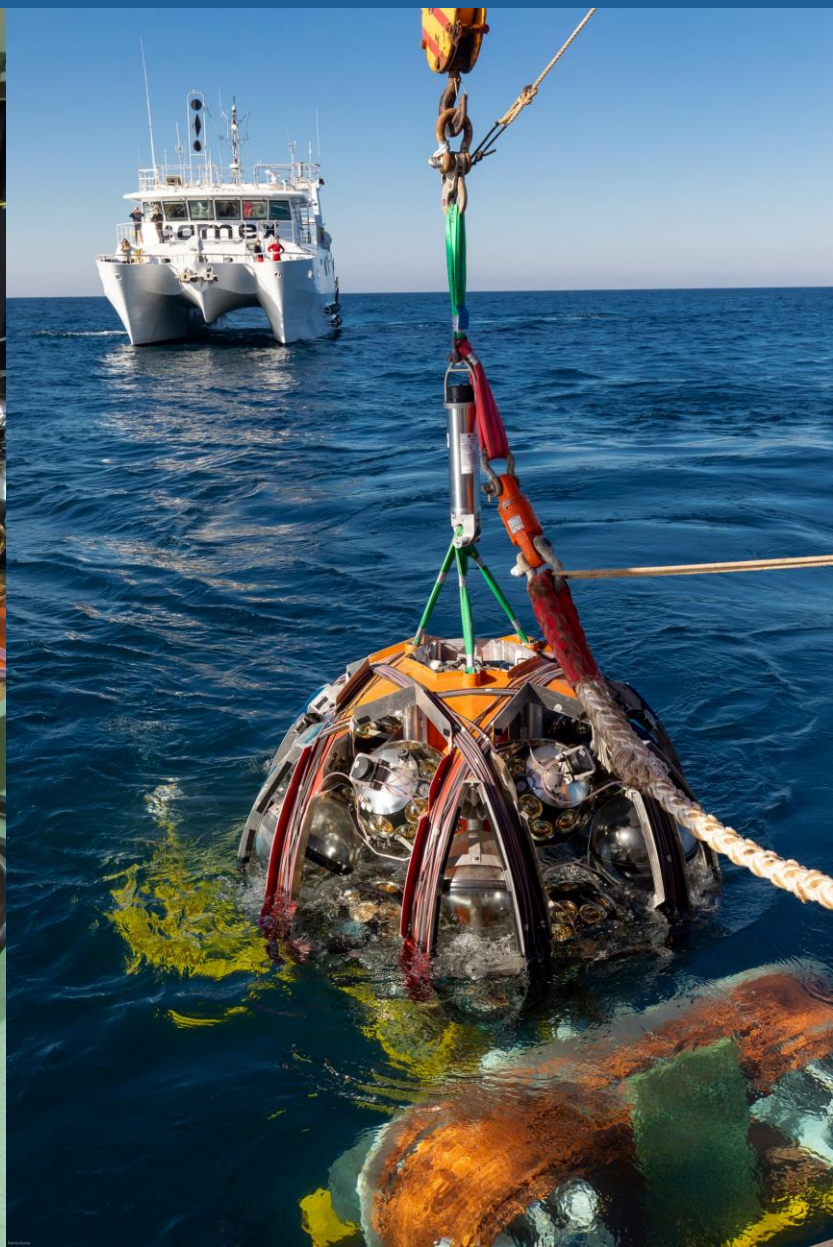
[ARCA: **A**stroparticle **R**esearch with **C**osmics in **A**byss]



KM3NeT/ARCA: 2 ბლოკი, თვითოეული 115 ხაზით (detection unit, DU). ხაზზე მოთავსებულია 18 მოდული (DOM).
1 ბლოკი: 2070 მოდული, 64170 ფეხ.

დეტექტორის მოცულობა დაახ. 1 კმ³.
მანძილი ხაზებს შორის - 90 მ, მოდულებს შორის: 36 მ





თბილისის სახელმწიფო უნივერსიტეტი KM3NeT კოლაბორაციაში

2017

თებერვალი თსუ გახდა KM3NeT კოლაბორაციის ასოცირებული წევრი
ANTARES/KM3NeT კონფერენციის მიტინგი ათენში (საბერძნეთი)

2018

მაისი თსუ ჯგუფის გახდა KM3NeT კოლაბორაციის სრული წევრი
ANTARES/KM3NeT კოლაბორაციის მიტინგი გრანადაში (ესპანეთი)

21 სექტემბერი ხელი მოეწერა მეომერანდუმს, თბილისის სახელმწიფო უნივერსიტეტსა და KM3NeT
კოლაბორაციას შორის.
დაიწყო გადახდა KM3NeT საერთო ფონდში.



ANTARES და KM3NeT კოლაბორაციების ვორკშოპი

2019, 25 თებერვალი-1 მარტი, თბილისის სახელმწიფო უნივერსიტეტი

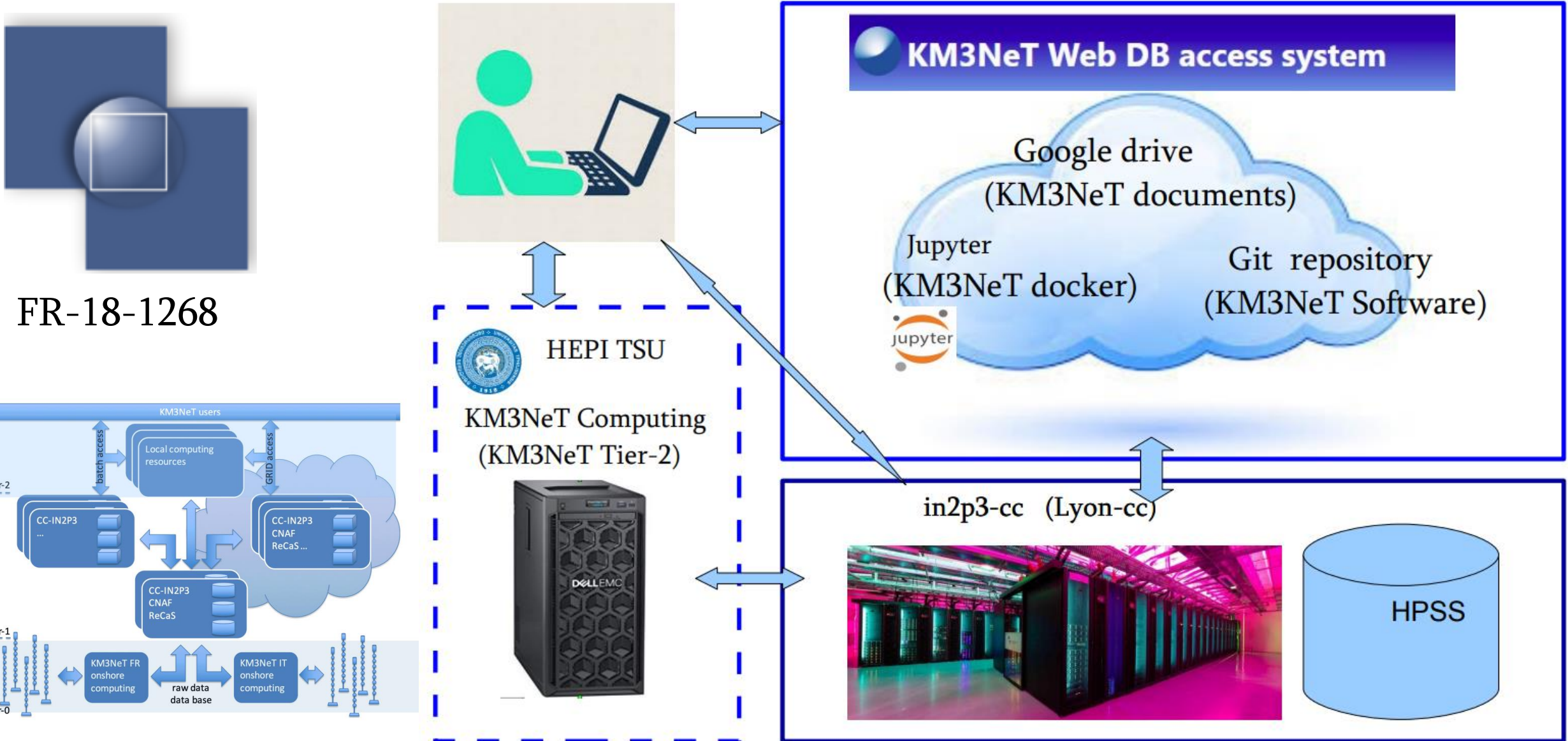


MG-ISE-18-804





KM3NeT-ის ჯგუფი (Tier-2 კომპიუტინგი)

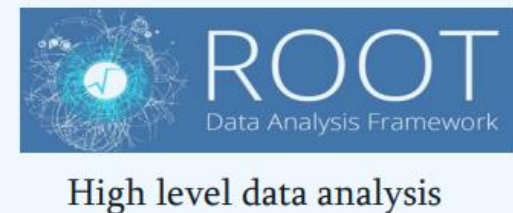


KM3NeT-ის ჯგუფი (Tier-2 კომპიუტინგი)



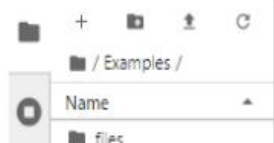
FR-18-1268

KM3NeT	DU	Events ($\times 10^6$)	Period	L-days
ORCA	6	280	27/01/2020- 3/03/2021	367.5
ARCA	6	108	23/04/2021- 18/06/2021	53.6

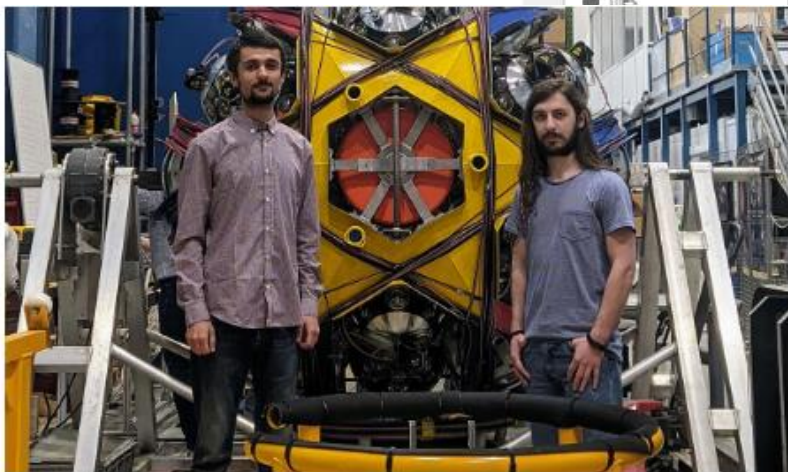
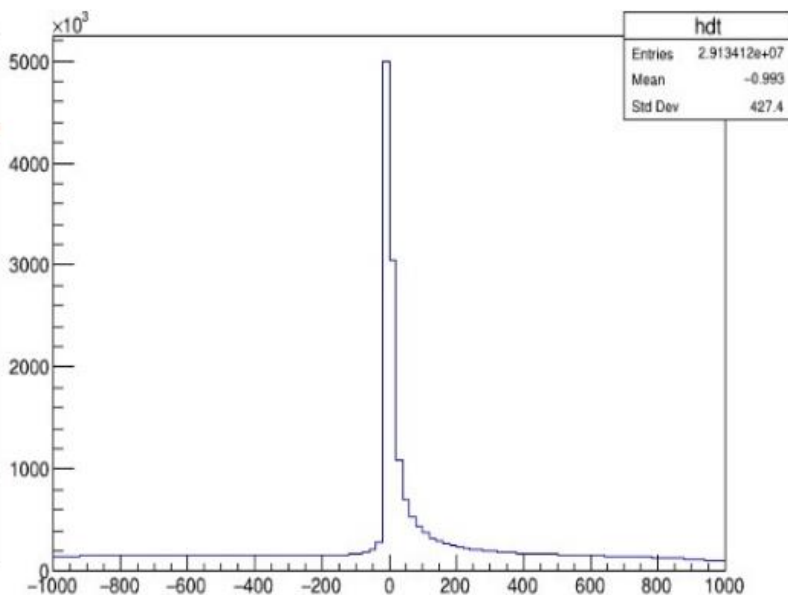


← → ↻ ⚠ Not secure | t2.km3net.tsu.ge:9999/user/papalashvili/lab?

File Edit View Run Kernel Tabs Settings Help



```
cher_tipyntb x
[1]: import aa, ROOT
from ROOT import EventFile, TH1D, cherenkov_pars, Det, gPad, double
f=EventFile("/home/km3net/repo/data/KM3NeT_00000049/v6/datav6_ORCA_test.jchain.aar")
det=Det("/home/papalashvili/bootcamp/KM3NeT_00000049_00000070.detx")
hist_dt=TH1D("hdt", "time residuals", 100, -1000, 1000)
d_track=double(-999.9)
d_photon=double(-999.9)
d_closest=double(-999.9)
cos_angle=double(-999.9)
phot_dir=double(-999.9)
time=double(-999.9)
for evt in f:
    if len(evt.trks)>0:
        trk=evt.trks[0]
        det.apply(evt)
        for h in f.evt.hits:
            cherenkov_pars(trk, h.pos, h.dir, time, d_track, d_photon, d_closest,
                            hist_dt.Fill(h.t-time))
hist_dt.Draw()
gPad.Draw()
```



KM3NeT-ის ჯგუფი (AI მეთოდები კვლევაში)

TBILISI STATE
UNIVERSITY

11. FEB. 2025

Determination of Multi-muon event rates in KM3NeT with the Transformer-Based Deep Learning Models

NIKOLOZ BUJIASHVILI
TAMTA KHVICHIA



FR 22-13708

FR-22-13708

KM3NeT-ისუ ჯგუფი

სტუდენტური ნაშრომები:

სადოქტორო დისერტაცია 1

გოგიტა პაპალაშვილი

სამაგისტრო ნაშრომი 3

გ. ქისტაური, თ. ხვიჩია, დ. ჯანეზაშვილი

საბაკალავრო ნაშრომი 3

გ.ქაჩლიშვილი, დ. ბანდური, ნ. ხარაზიშვილი

პუბლიკაციები (12/2/2025)

რ შანიძე 53

გ. პაპალაშვილი 43

გ. ქისტაური 36

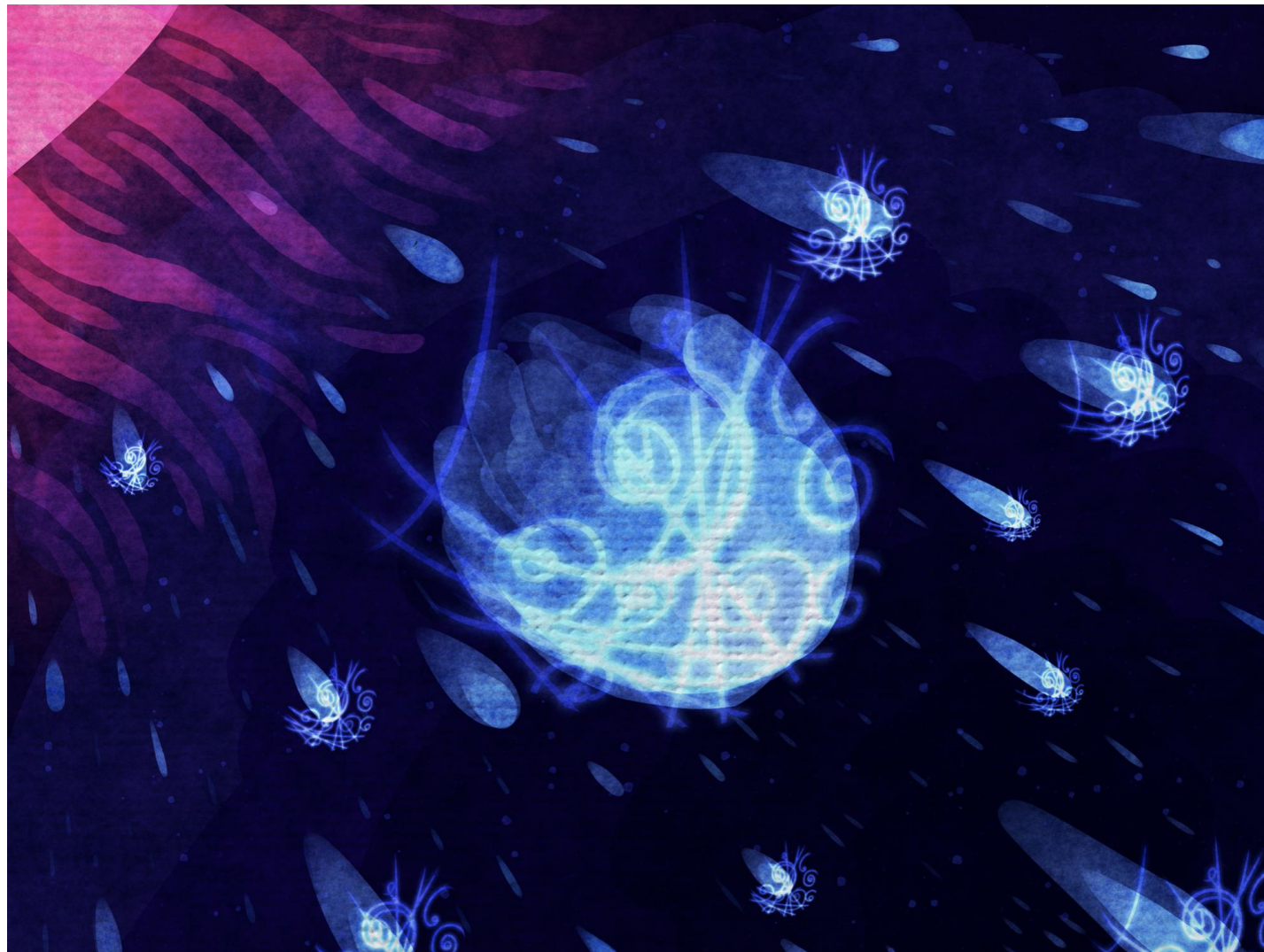
დ. ჯანეზაშვილი 15

გ. თაყაძე 4

ვ. კიკვაძე 2

ხ. მოდებაძე 1

ლ. ხარხელაური 1



**Thanks, grazie, merci, gracias,
danke, شكرا على, ευχαριστώ, dank U,
dziękuję, mersi, მადლობა!**

The international journal of science / 13 February 2025

nature

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neutrino with highest energy
ever recorded

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Safety catch

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adaptations help bats
to tolerate viruses

WILL RUSSELL
REUTERS

Article

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

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

The KM3NeT Collaboration*

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Open access

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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^{+110}_{-60} 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 ($\approx$ 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 muon¹².

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.