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Recent results from the KM3NeT experiment

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KM3NeT is a European research infrastructure project currently under construction at two locations in the Mediterranean Sea. The project aims to detect the neutrinos in the energy range from a few GeV up to a few PeV with two detectors: ORCA (Oscillation Research with Cosmics in the Abyss) for low energy neutrinos and ARCA (Astroparticle Research with Cosmics in the Abyss) for high energy neutrinos. ORCA detector is optimised for neutrino physics, whereas ARCA is designed for neutrino astronomy. This poster describes recent results from the KM3NeT experiment obtained with six deployed detection units of ARCA and ORCA, respectively. Although these configurations represent a small fraction of final ORCA (115 detection units) and ARCA (2x115 detection units) telescopes, promising results have been obtained for neutrino oscillations and neutrino astronomy.

KM3NeT/ARCA and KM3NeT/ORCA configurations and their status

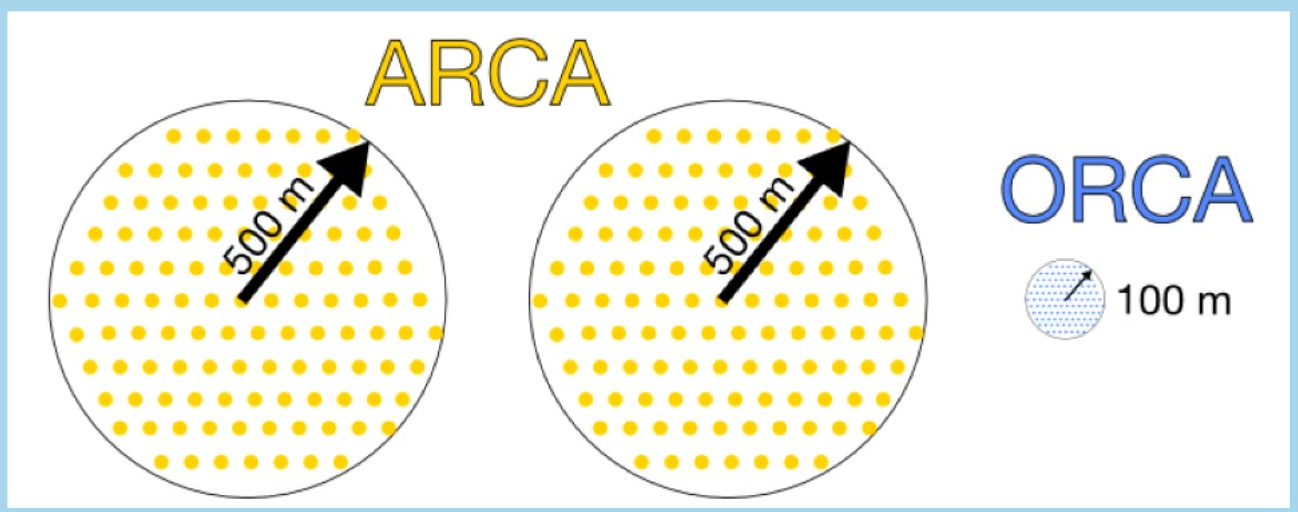

Fig.1 KM3NeT/ARCA and KM3NeT/ORCA footprints

Detector	Depth	Horizontal spacing	Vertical spacing	Detection unit	Volume
ARCA	3500 m	90 m	36 m	2 x 115	1 km³
ORCA	2500 m	20 m	9 m	115	~0.005 km³

Both detectors share the same technologies with identical optical modules [1]. The difference between these two telescopes is their geometrical configuration. They are optimized for the different energies of neutrinos.

Currently, **21** detection units (DUs) of ARCA and **11** detection units of ORCA are deployed in the Mediterranean Sea. The results shown here are obtained using data taken with different detector configurations, as DUs are being deployed gradually.

Typical events in KM3NeT neutrino telescope

Neutrinos are reconstructed with the Cherenkov photons induced in the seawater along the path of the relativistic charged particles produced in neutrino interactions close to the detector.

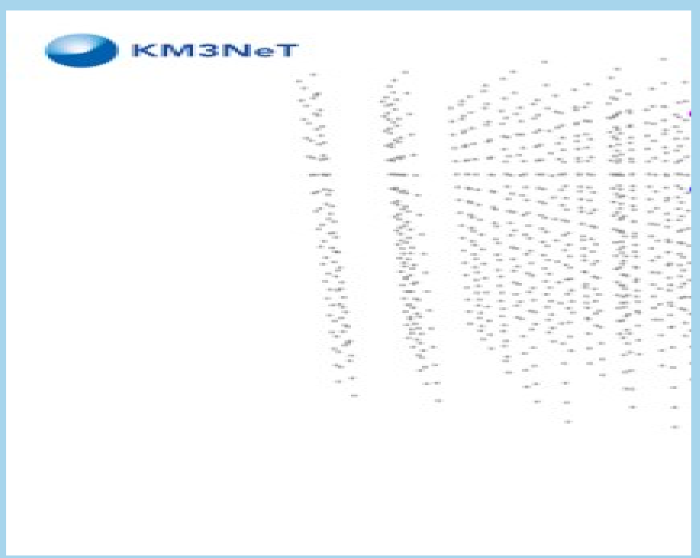

Fig.2 Track-like event caused by a muon neutrino interacting with seawater through charged current interaction. The muon produced can travel hundreds of meters depending on its energy [1].

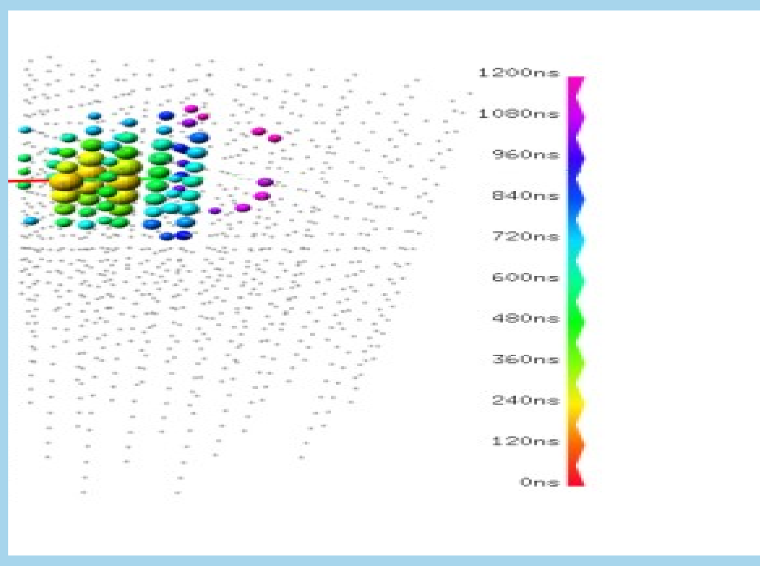

Fig.3 Shower-like event caused by the neutrinos interacting with seawater through neutral current interaction or charged current interaction of electron neutrino [1].

Dependence of atmospheric muon flux on seawater depth

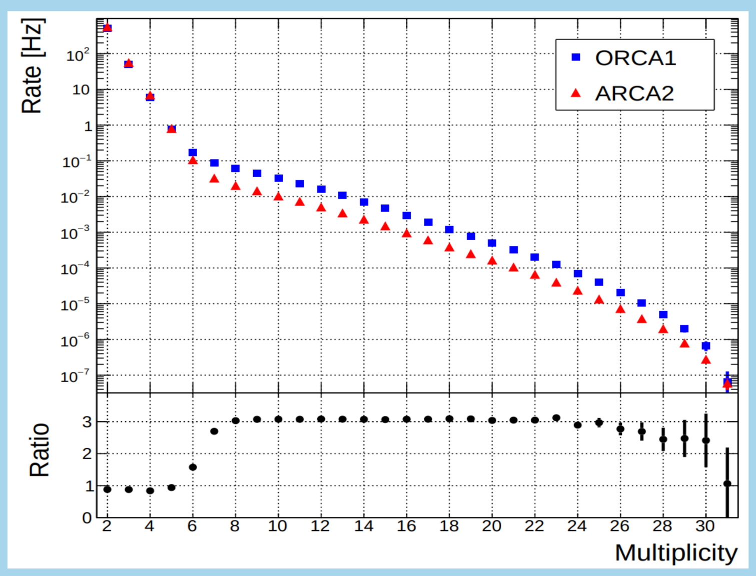

Fig.4 Coincidence rates as a function of the multiplicity for the ORCA1 and ARCA2 detectors averaged over all the DOMs of each detector [2].

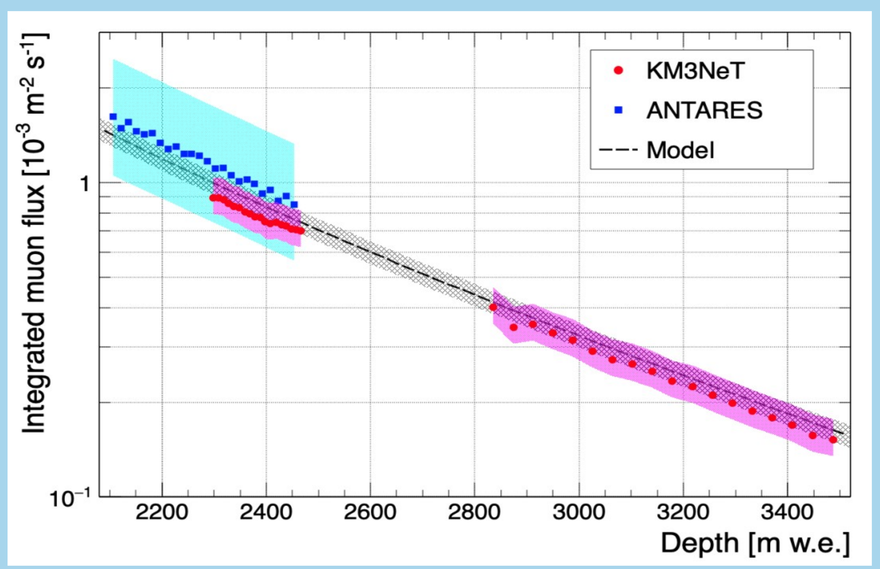

Fig.5 Integrated atmospheric muon flux measured with the ORCA1 and ARCA2 detectors as a function of depth below the sea level. The systematic errors are displayed as light red shadowed areas. The Bugaev model of the atmospheric muon flux is drawn with a dashed black line [2].

Atmospheric Neutrino candidates from KM3NeT/ARCA6 and KM3NeT/ORCA6

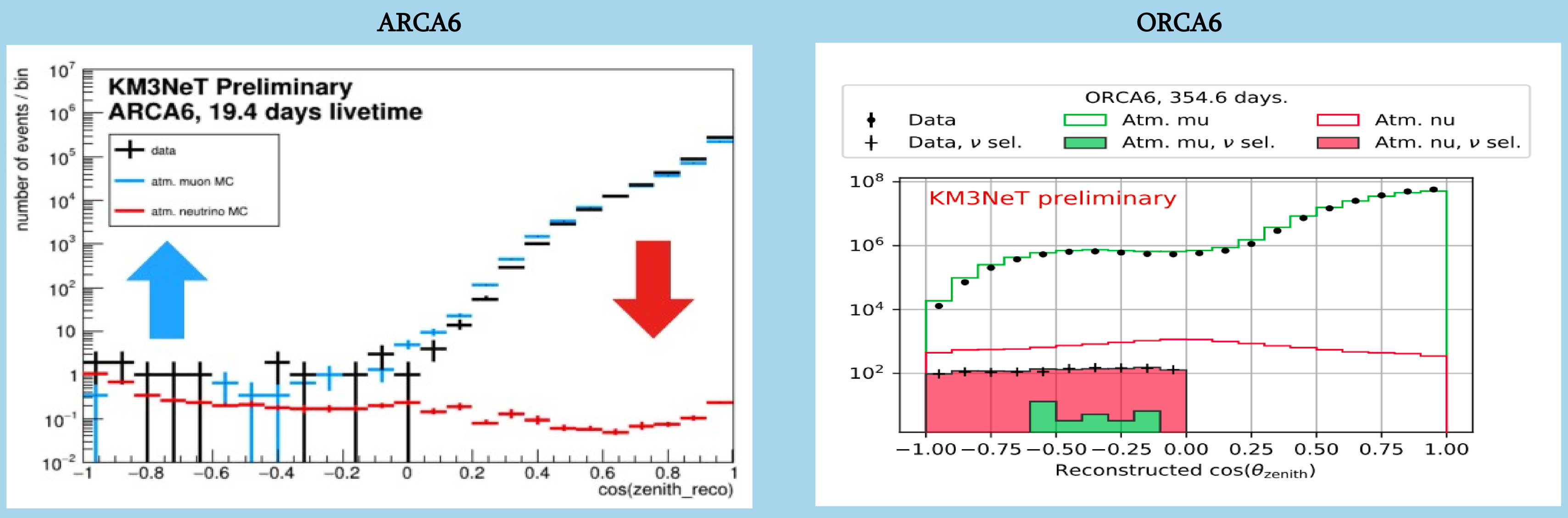

Fig. 6 Atmospheric neutrino candidates for ARCA6 (left) and ORCA6 (right) [3], [4].

After applying the selection cuts, the muon background is reduced and atmospheric neutrino candidates are observed for both ARCA6 and ORCA6 data.

First results on neutrino oscillations

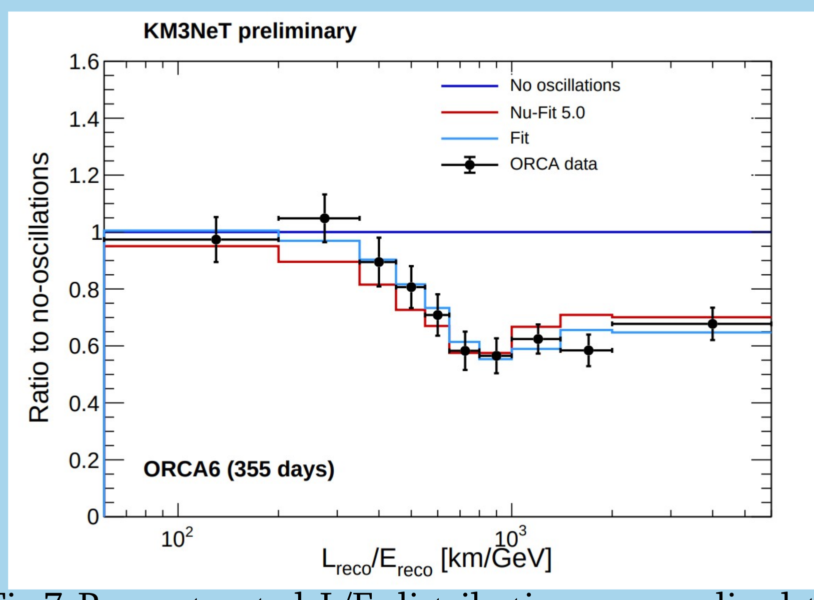

Fig.7 Reconstructed L/E distributions, normalized to the no-oscillation hypothesis. The points are showing the data, while the full lines shows the fitted model (blue) and the NuFit 5.0 scenario (red) [4].

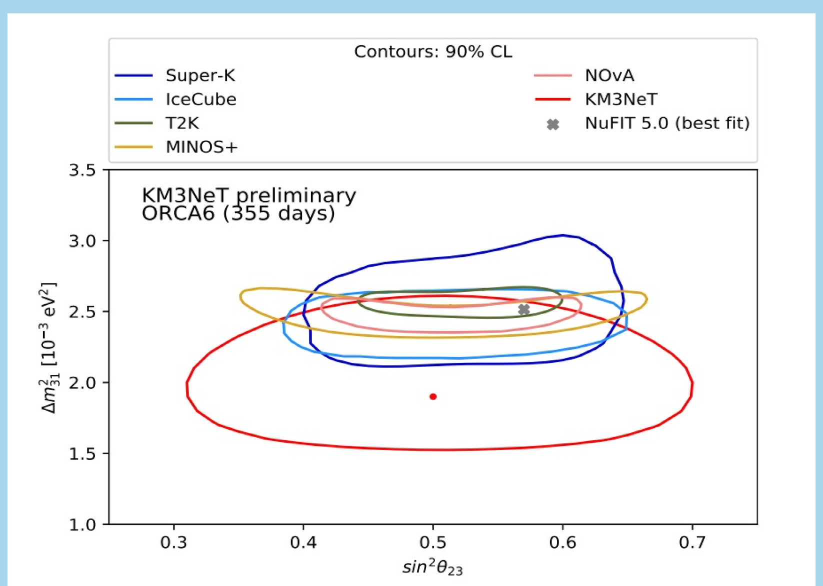

Fig.8 Contour at 90 % CL of ORCA6 for the oscillation parameters and θ_{23} [4] $\Delta m^2_{3,1}$

Neutrino astronomy with KM3NeT/ARCA6

The ARCA6 dataset of 92 days was used for the comparison of reconstructed neutrino directions with the selected 46 potential sources .

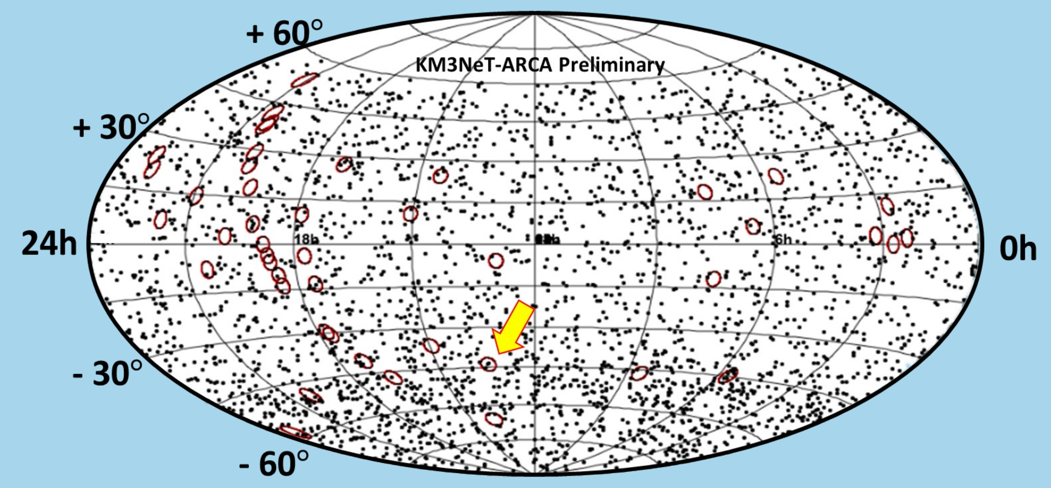

Fig.9 Skymap of neutrino events. Selected potential sources are shown with red circles [5].

Lowest p-value of 0.02 observed for radio galaxy Centaurus A, indicated with yellow arrow, is compatible with background.

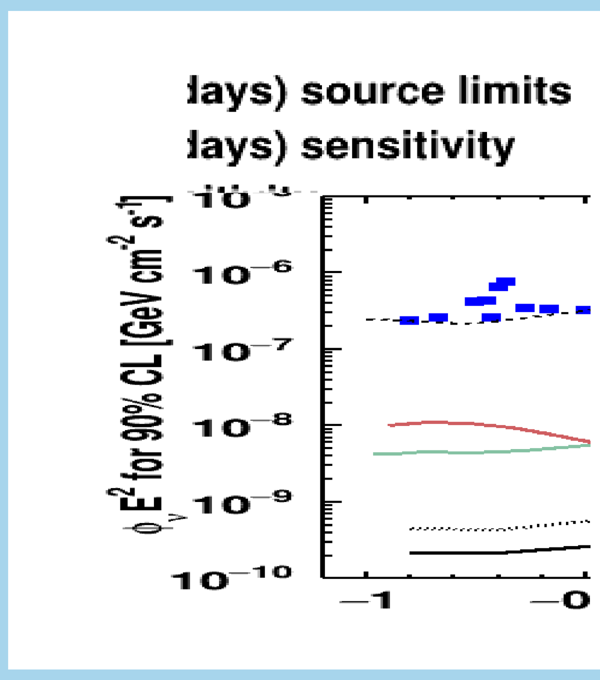

Fig.10 Limits and sensitivities of cosmic neutrino flux versus declination [5].

[1] KM3NeT Coll., Letter of intent for KM3NeT 2.0, J.Phys.G 43 (2016) 8, 084001
[2] KM3NeT Coll., Dependence of atmospheric muon flux on seawater depth measured with the first KM3NeT detection units, Eur.Phys.J.C 80 (2020) 2, 99
[3] KM3NeT Coll., The KM3NeT neutrino telescopes: status and perspectives, PoS(EPS-HEP2021)091
[4] KM3NeT Coll., First neutrino oscillation measurement in KM3NeT/ORCA, PoS ICRC2021 (2021) 1123
[5] KM3NeT Coll., Search for cosmic neutrino point sources and extended sources with 6 lines of KM3NeT/ARCA, 10.5281/zenodo.6805394

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