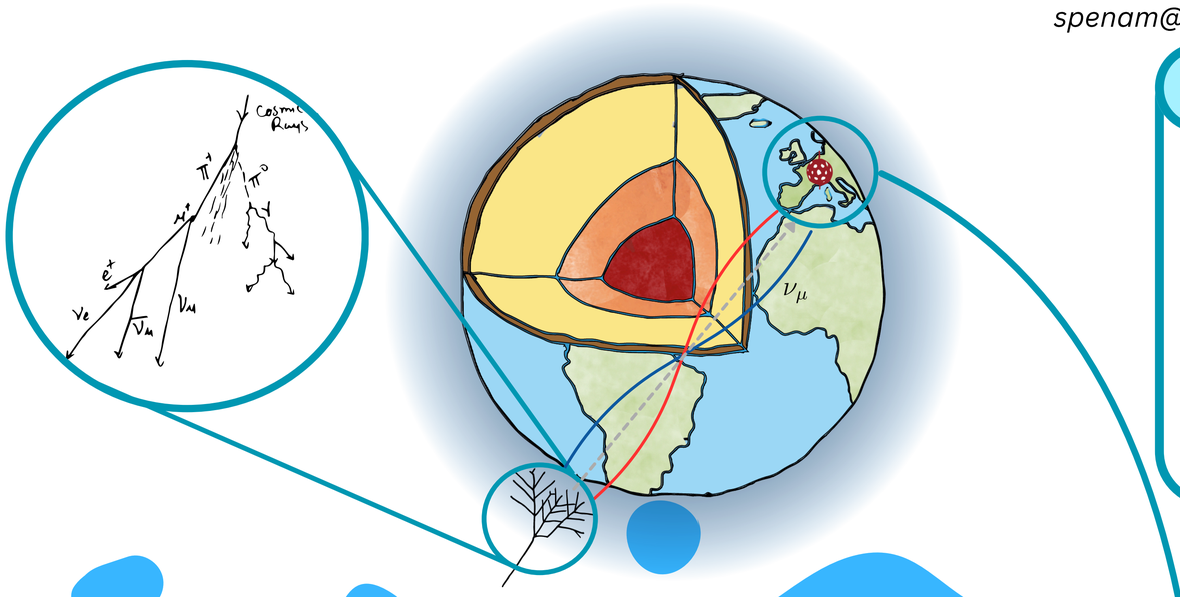
Updated measurement of atmospheric neutrino oscillation parameters with KM3NeT/ORCA

Santiago Peña Martínez [1] **on behalf of the KM3NeT Collaboration**

[1] *Université Paris Cité, CNRS, Astroparticule et Cosmologie, F-75013 Paris, France*
spenam@apc.in2p3.fr



KM3NeT/ ORCA

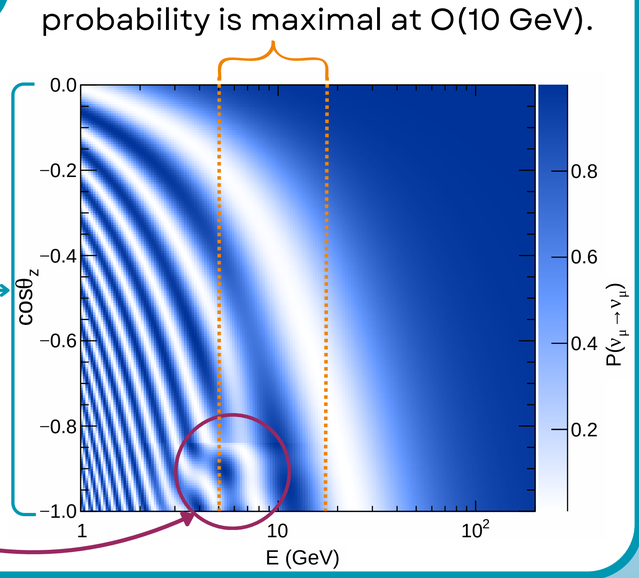
- KM3NeT/ORCA will be a 7 Mton water-Cherenkov neutrino detector.
- The full detector will have 115 strings with 18 DOMs each, one DOM houses 31 PMTs.
- Its main goal is to determine the neutrino mass ordering as well as measuring oscillation parameters for the atmospheric neutrino sector.
- **For this contribution data from 715 kt-y of exposure were analysed. Data comes from 3 configurations: 6, 10 and 11 strings.**

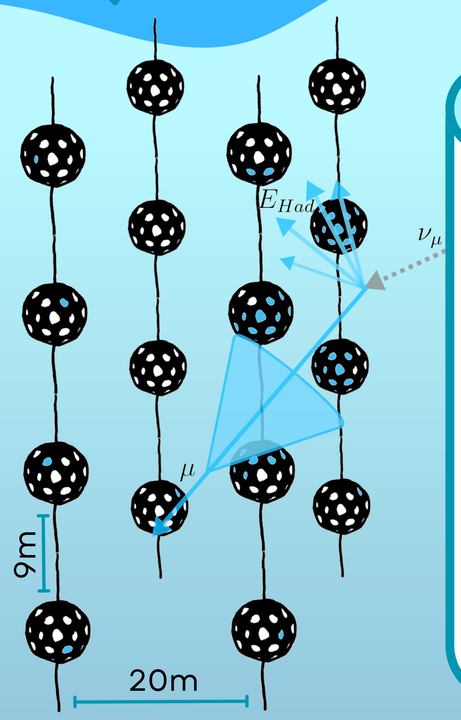
Background

Atmospheric muon ν disappearance probability is maximal at O(10 GeV).

Multiple baselines allow to probe wide phase space.

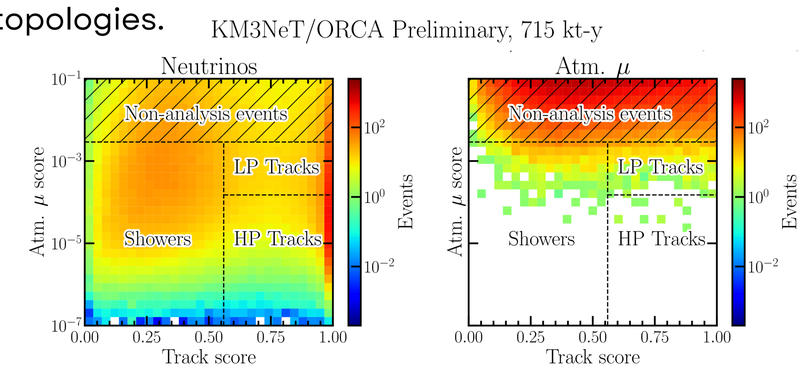
$P(\nu_\mu \rightarrow \nu_e)$ and $P(\bar{\nu}_\mu \rightarrow \bar{\nu}_e)$ from matter effects make ORCA sensitive to mass ordering, signal at ~ 7GeV.





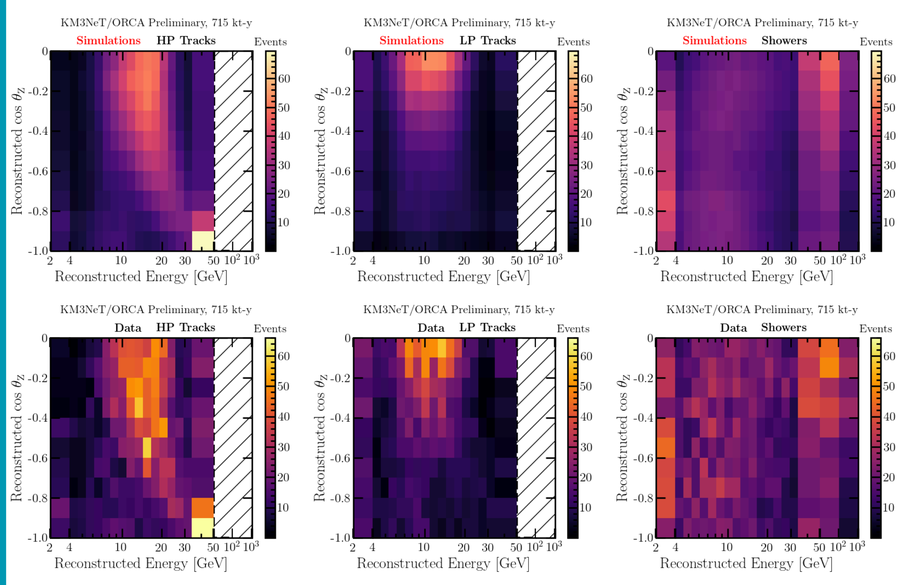
Data selection

- Optical noise and atmospheric muons are rejected using scores from Boosted Decision Trees (BDTs).
- An additional BDT score allows to split in event topologies.

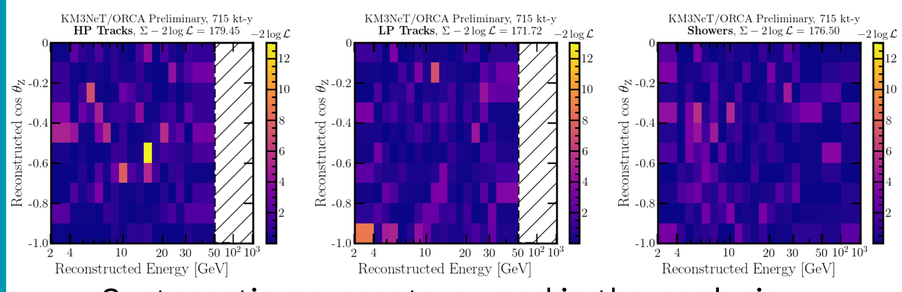


Analysis method

Events are binned in three different classes using scores from BDTs. Analysis done in 2D space of reconstructed energy and zenith direction.



Negative log-likelihood maps for distributions above

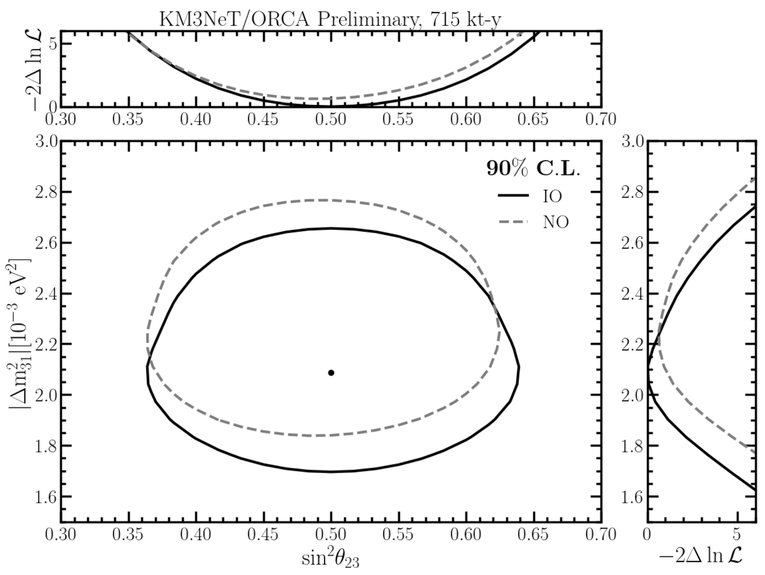


Systematic parameters used in the analysis

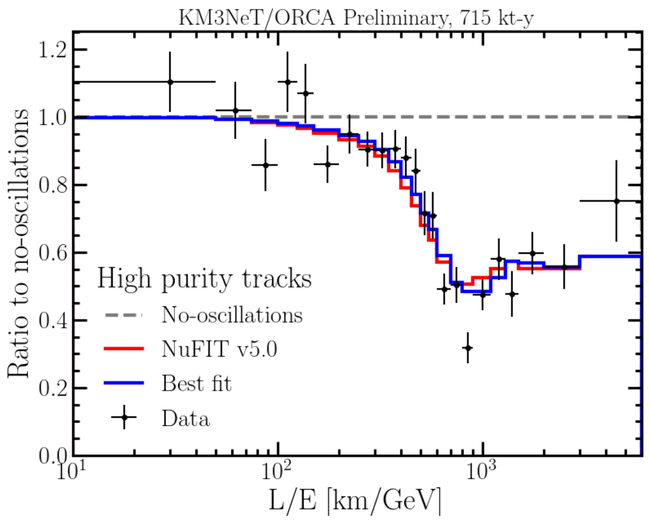
Fit parameter	Prior uncertainty
Energy Scale	9%
Overall Norm	Free
Shower Norm	Free
HP Track Norm	Free
Spectral Index	0.3
HE Light Simulation	20%
Muon Norm	Free
NC Norm	20%
ν_τ-CC Norm	20%
$\nu_e/\bar{\nu}_e$	7%
ν_μ/ν_e	2%
$\nu_\mu/\bar{\nu}_\mu$	5%
ν_{hor}/ν_{ver}	2%

Results

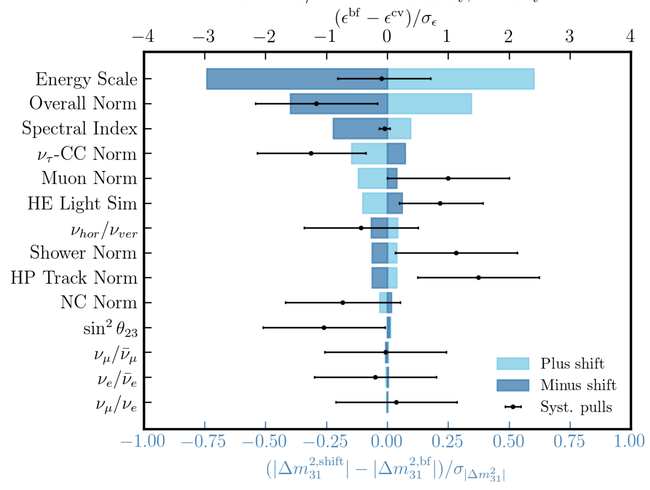
Best fit at **Inverted Ordering** (IO) and **maximal mixing**.

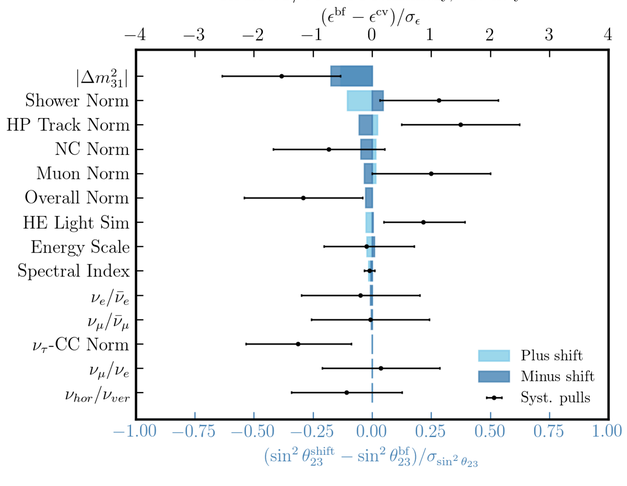


First oscillation minimum from atmospheric muon ν disappearance visible in main analysis class. Best fit is shown compared to NuFIT v5.0.



The biggest impact in measurement of mass splitting comes from the uncertainty of the energy scale, which is dominated by uncertainties in the water properties





Summary

- The latest measurement of the KM3NeT/ORCA detector with 715 kt-y of exposure is reported.
- Dataset using 3 different detector configurations: 6, 10 and 11 strings.
- Preference for IO. Maximal mixing.

$$\sin^2\theta_{23} = 0.50 \pm 0.07$$

$$\Delta m^2_{31} = \begin{cases} -2.09^{+0.17}_{-0.21} \times 10^{-3}\text{eV}^2, & \text{IO} \\ [2.10, 2.37] \times 10^{-3}\text{eV}^2, & \text{NO} \end{cases}$$

$$2\log(\mathcal{L}_{IO}/\mathcal{L}_{NO}) = 0.61$$

References

[1] Adrian-Martinez, Silvia, et al. "Letter of intent for KM3NeT 2.0." Journal of Physics G: Nuclear and Particle Physics 43.8 (2016): 084001.

[2] Aiello, Sebastiano, et al. "Determining the neutrino mass ordering and oscillation parameters with KM3NeT/ORCA." The European Physical Journal C 82.1 (2022): 26