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Search for Sterile Neutrinos with KM3NeT/ORCA and ANTARES



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For the **ANTARES** and
KM3NeT Collaborations

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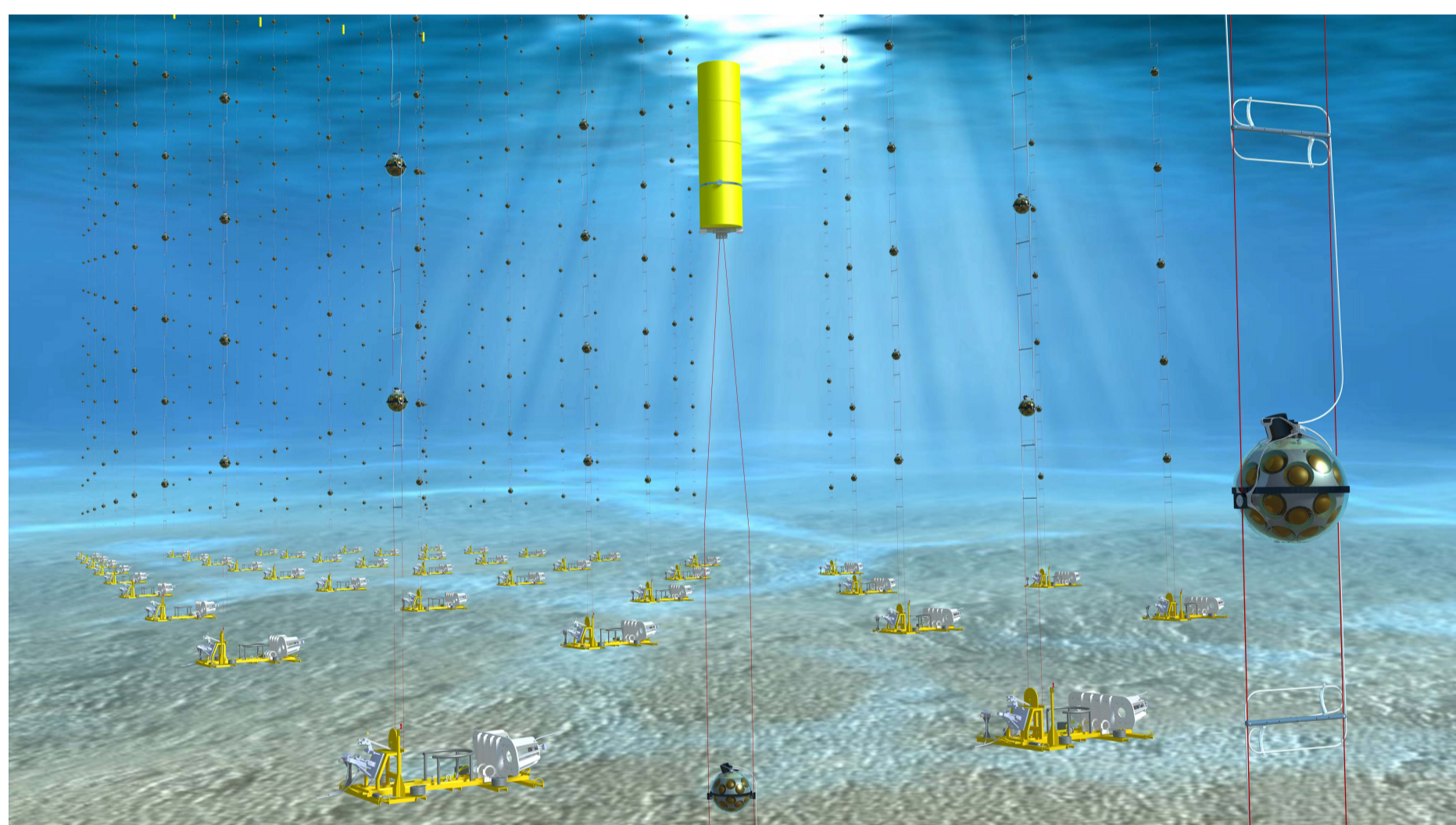
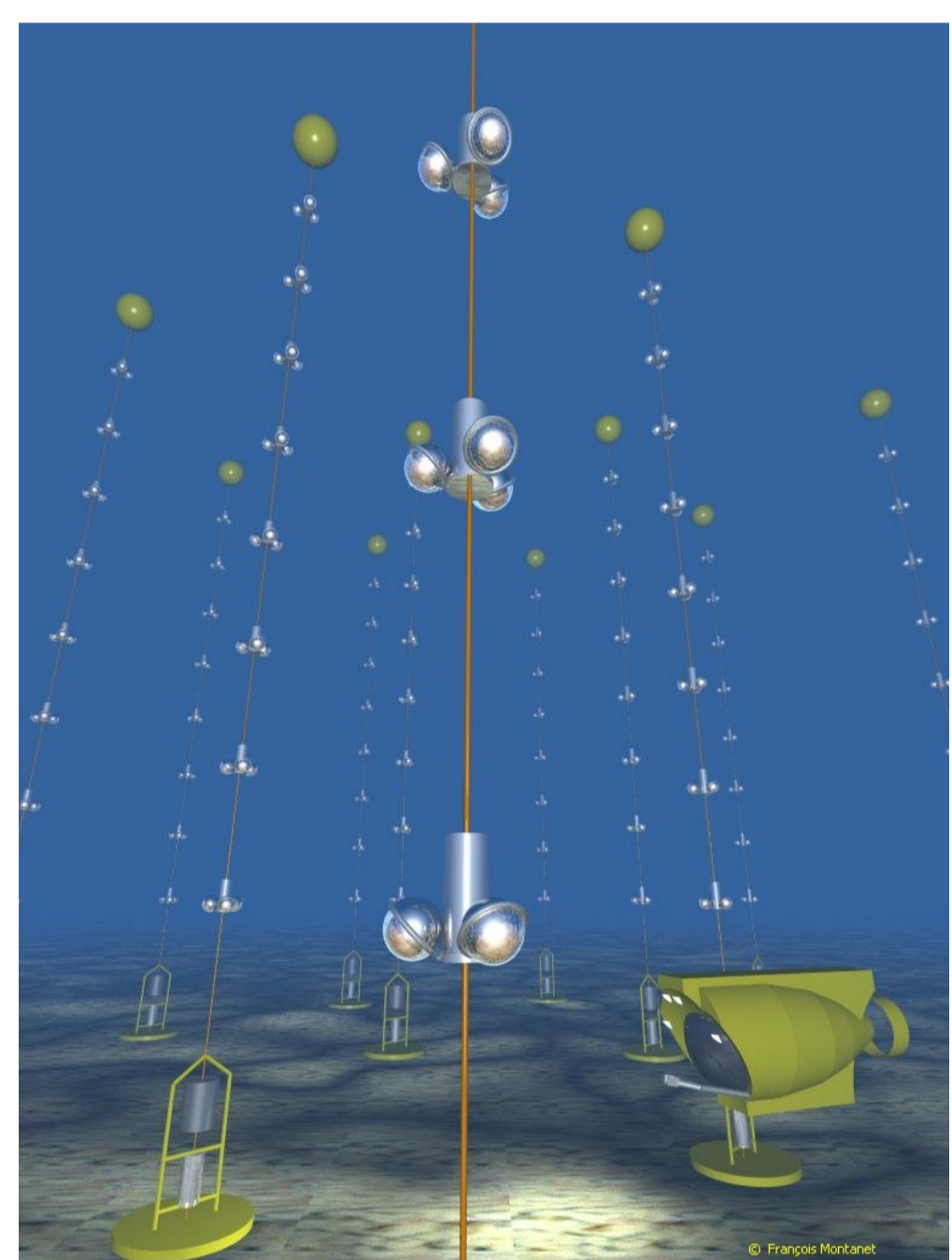
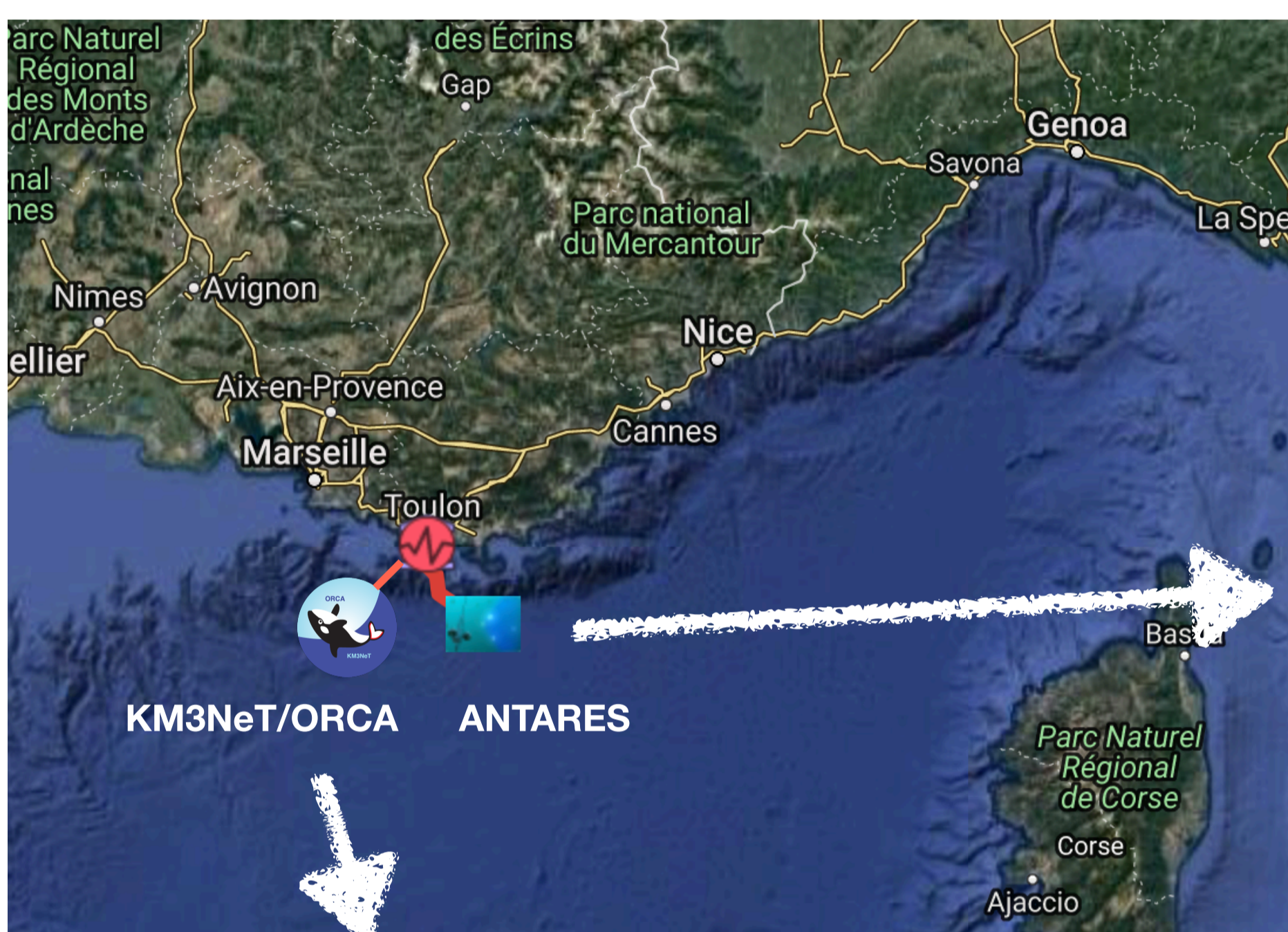
⁴ LAL, Univ. Paris-Sud, CNRS/IN2P3, Université Paris-Saclay, Orsay, France.

Anomalies in few reactors and short/long baseline experiments could be a hint of the presence of a light sterile neutrino (with mass ~ 1 eV).

The investigation of these anomalies is a top priority in neutrino physics \rightarrow we can exploit the multi-potential of neutrino telescopes for this purpose!

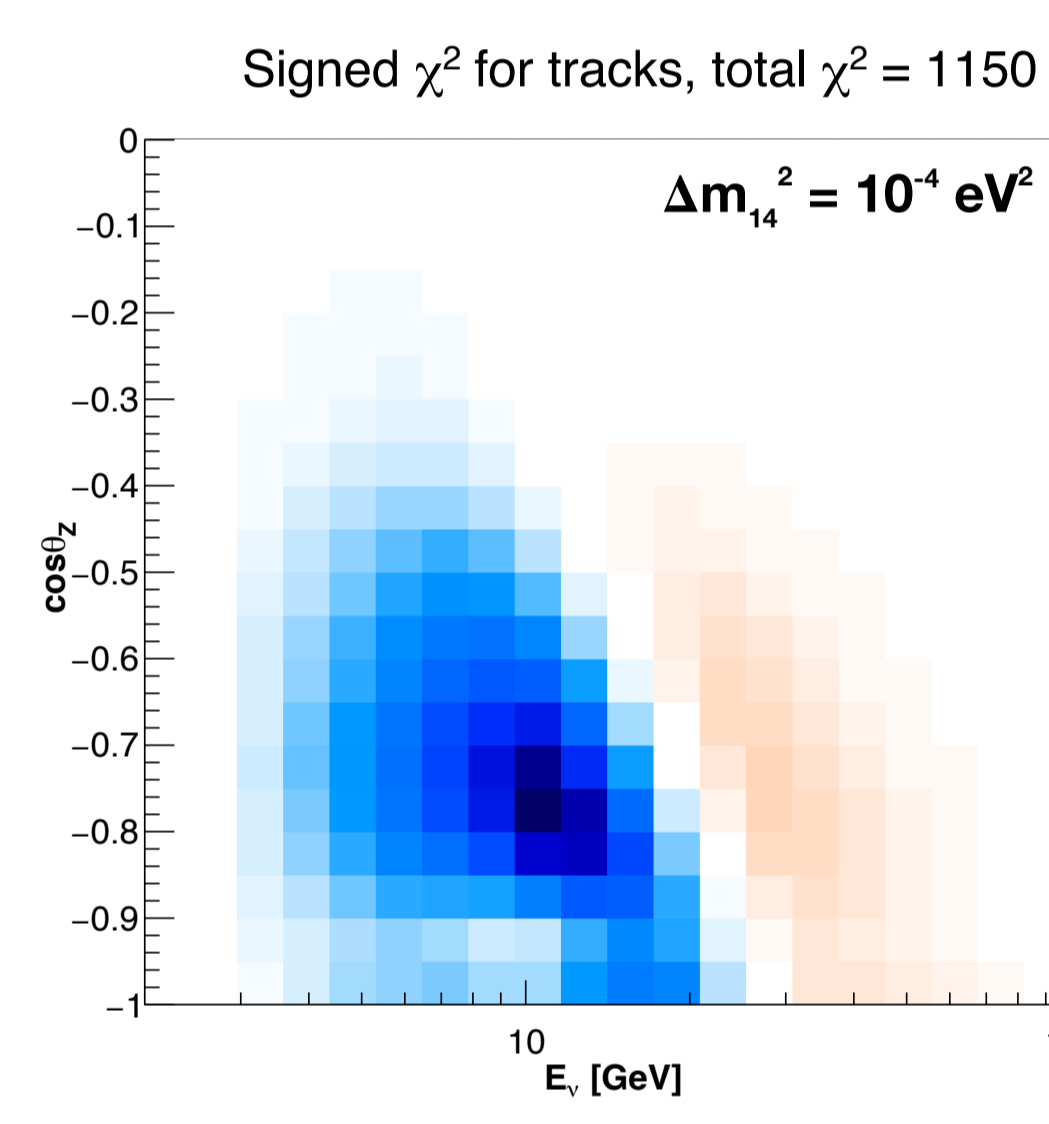
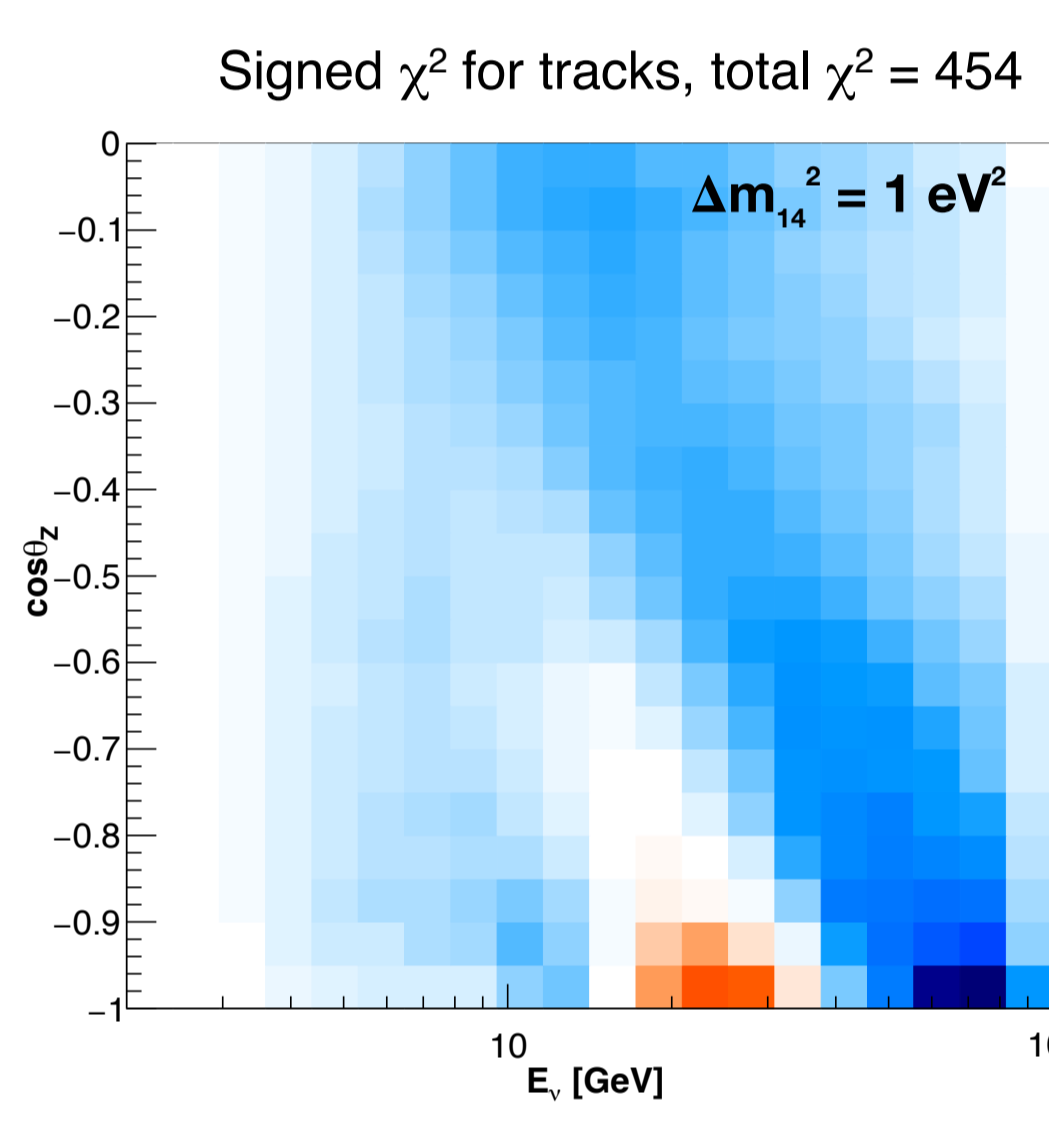
ANTARES Data Sample: from 2007 to 2016 (2830 days of livetime) [5].

ORCA Detector Response: a multi-dimensional response matrix is built from MC, taking into account triggering, reconstructions and particle identification and uncorrelated smearing of reconstructed energy and zenith angle..



ANTARES [1] and KM3NeT/ORCA [2]: deep sea neutrino telescopes in the abysses of the Mediterranean Sea. Neutrino detection possible by detecting the Cherenkov light emitted from the charged particles produced in neutrino interactions in the water. Use of PMTs (17" for ANTARES, 3" for ORCA).

$$\text{signed-}\chi^2 = \frac{(HP_{\text{Sterile}} - HP_{\text{Standard}})|HP_{\text{Sterile}} - HP_{\text{Standard}}|}{\sqrt{HP_{\text{Standard}}}}$$



ANTARES Analysis

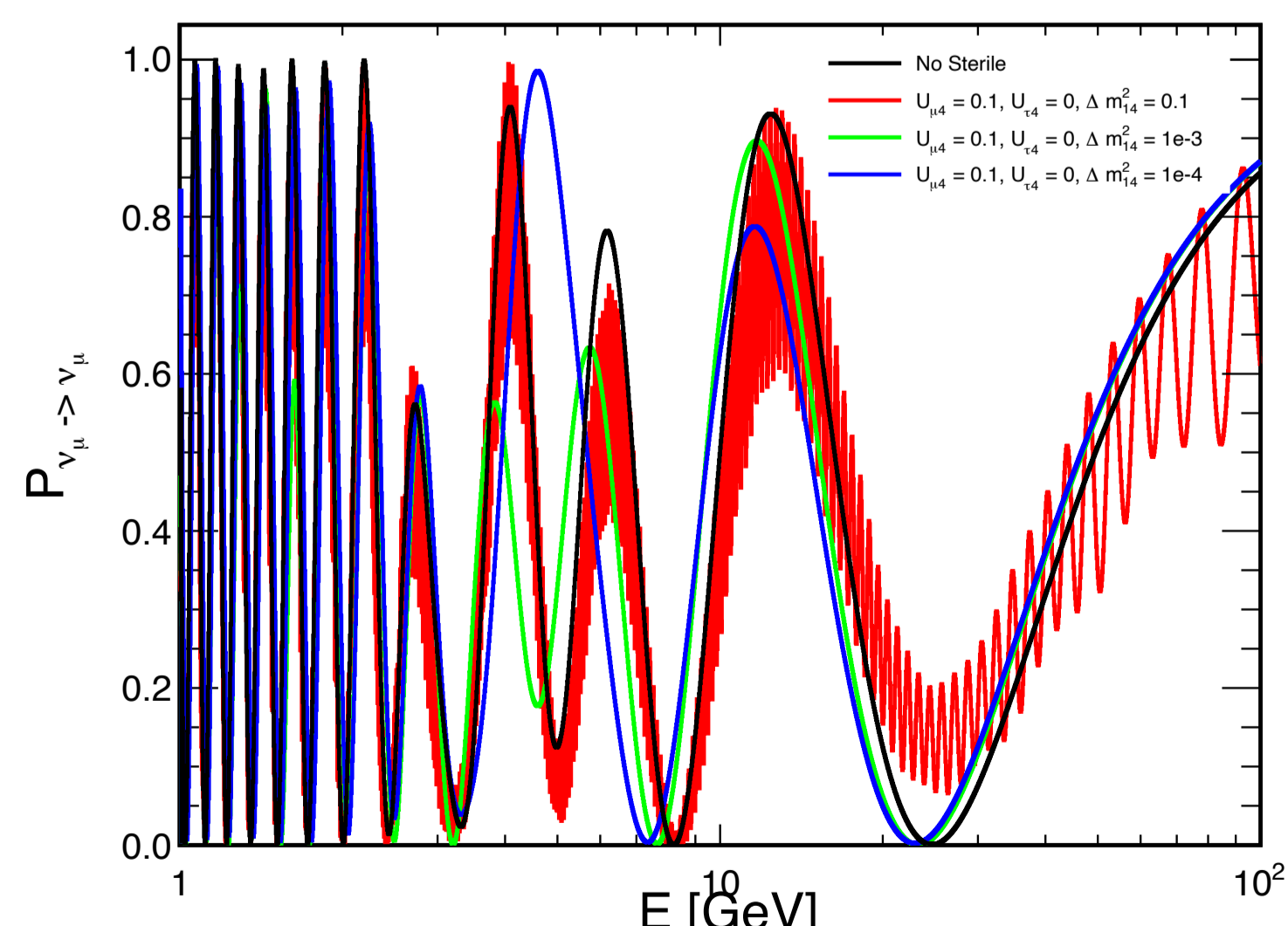
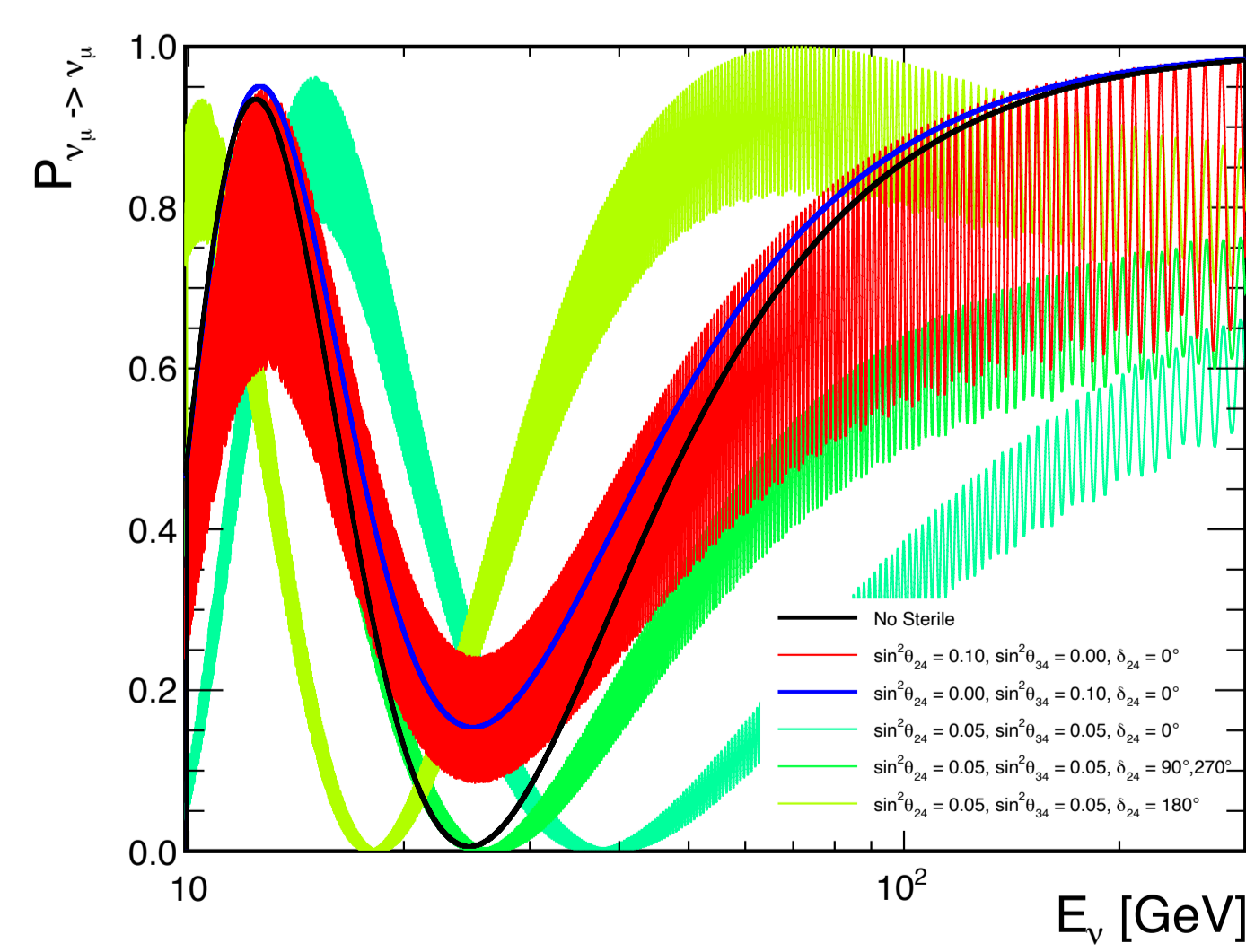
Parameter	Prior	Fit NH	Fit IH
θ_{24} [°]	none	$1.5^{+2.0}_{-5.0}$	$1.5^{+2.0}_{-5.0}$
θ_{34} [°]	none	$25.9^{+5.1}_{-4.2}$	$25.9^{+5.1}_{-4.2}$
δ_{24} [°]	none	180 ± 71	0 ± 72
n_ν	none	$0.84^{+0.10}_{-0.09}$	$0.84^{+0.10}_{-0.09}$
$\nu/\bar{\nu}$ [σ]	0.0 ± 1.0	$1.07^{+0.63}_{-0.55}$	$1.07^{+0.63}_{-0.55}$
$\Delta\gamma$	0.00 ± 0.05	-0.011 ± 0.036	-0.011 ± 0.036
Δm_{32}^2 [10^{-3} eV ²]	none	$3.0^{+0.8}_{-0.6}$	$-3.0^{+0.6}_{-0.8}$
θ_{23} [°]	none	52 ± 8	52 ± 8
θ_{13} [°]	8.41 ± 0.28	8.41 ± 0.28	8.41 ± 0.28
M_A [σ]	0.0 ± 1.0	$0.11^{+0.93}_{-0.97}$	$0.11^{+0.93}_{-0.97}$

ORCA Analysis

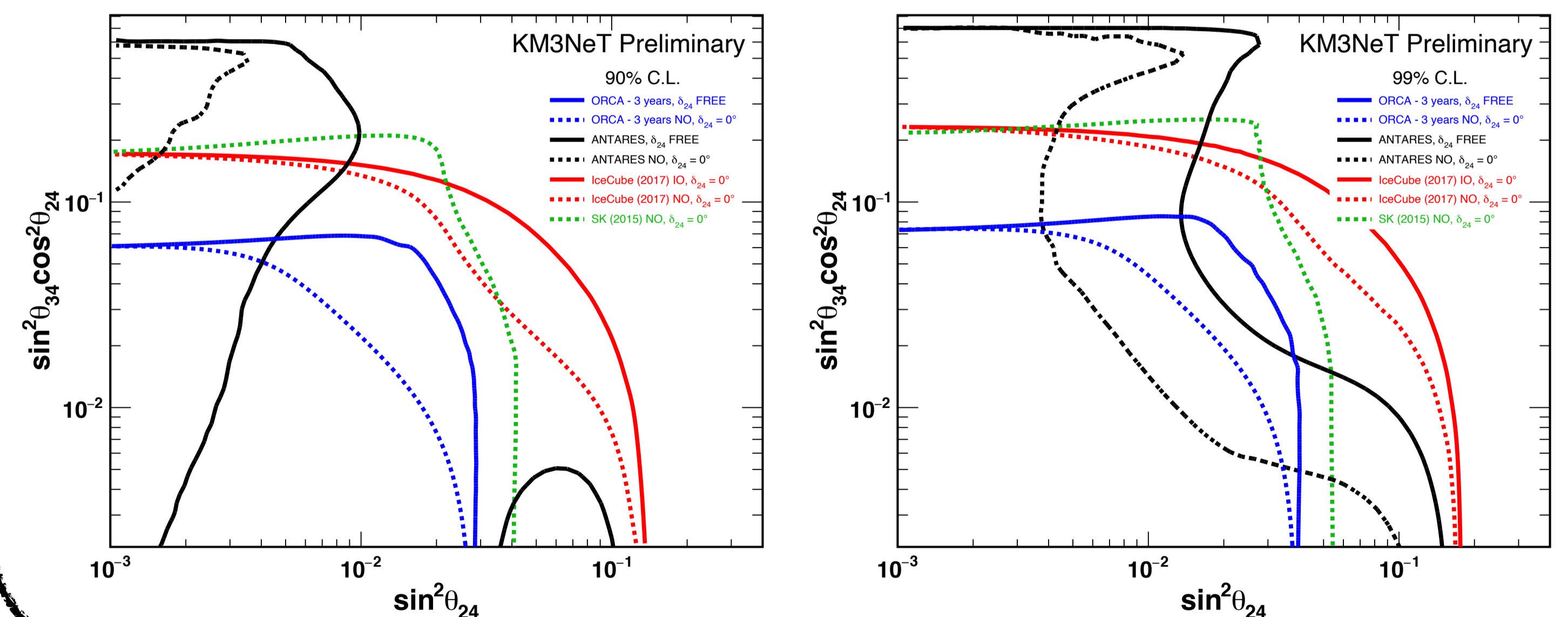
Parameter	Prior
θ_{13}	$8.54^\circ \pm 0.15^\circ$
$\frac{\Delta m_{21}^2}{10^{-3} \text{eV}^2}$	2.49 ± 0.5
Flux Norm	1 ± 0.10
NC Scale	1 ± 0.05
ν_μ/ν_e Skew	0 ± 0.05
$\nu/\bar{\nu}$ Skew	0 ± 0.03
Energy Slope	0 ± 0.05
Energy Scale	1 ± 0.03

Atmospheric Neutrino Flux (HKKM 2014 - Gran Sasso site [3]) used as input for this analysis.

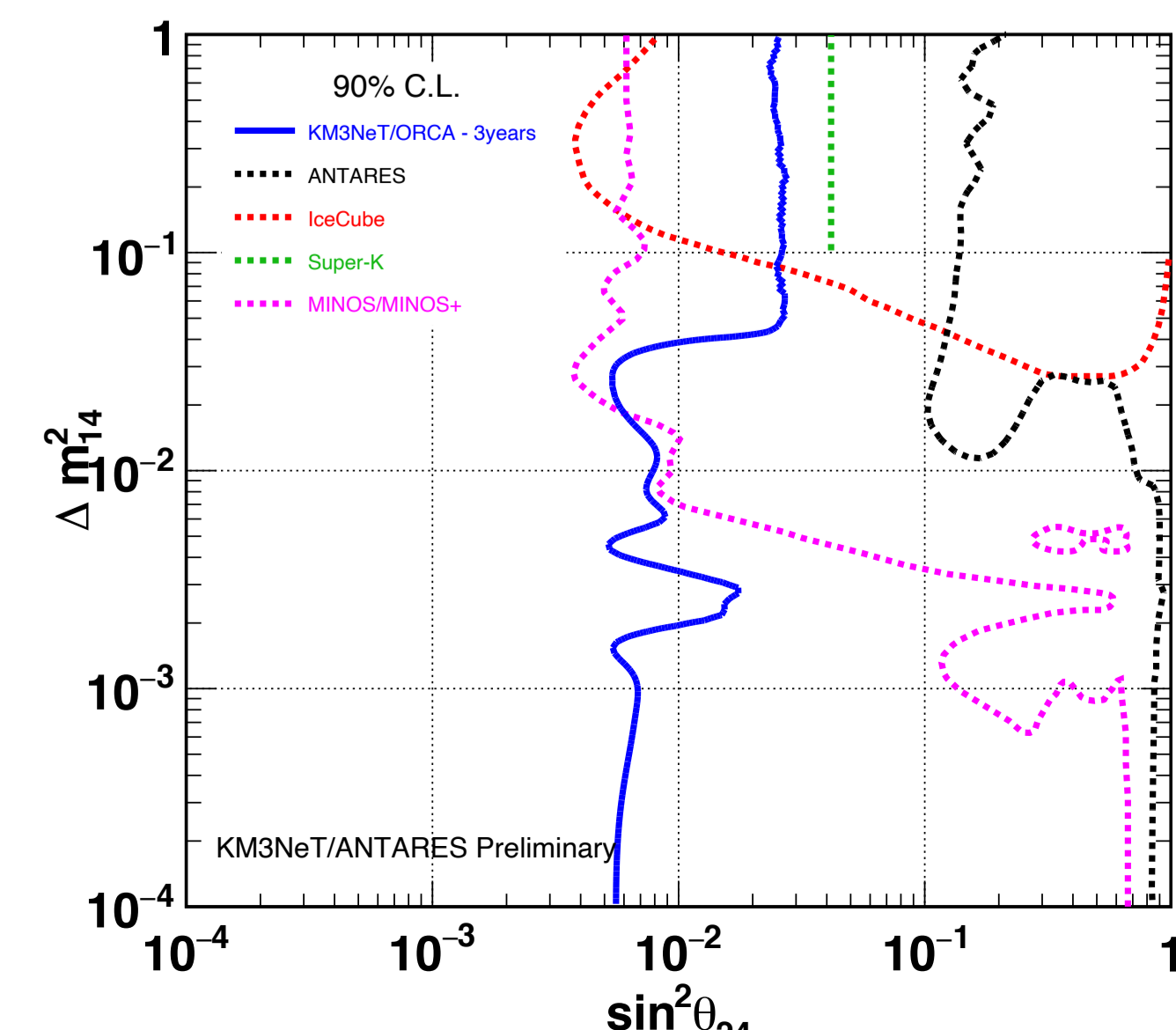
Oscillation pattern distorted by Earth's Matter effects, the **PREM Model** [4], with 42 layers and realistic Z/A values is used for this analysis. \rightarrow The possible presence of a light sterile neutrino changes the ν oscillation probability.



ORCA Sensitivity and ANTARES Upper Limits to Sterile Mixing Angles



ORCA Sensitivity and ANTARES Upper Limits to Low Sterile Masses



- [1] The ANTARES Collaboration, ANTARES: the first undersea neutrino telescope. Nucl. Instrum. Meth. A 656 (2011) 11.
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- [4] Adam M. Dziewonski and Don L. Anderson. Preliminary reference Earth model. Physics of the Earth and Planetary Interiors, 25(4):297-356, 1981.
- [5] The ANTARES Collaboration, Measuring the atmospheric, neutrino oscillation parameters and constraining the 3+1 neutrino model with ten years of ANTARES data. J. High Energy. Phys. (2019) 2019: 113.