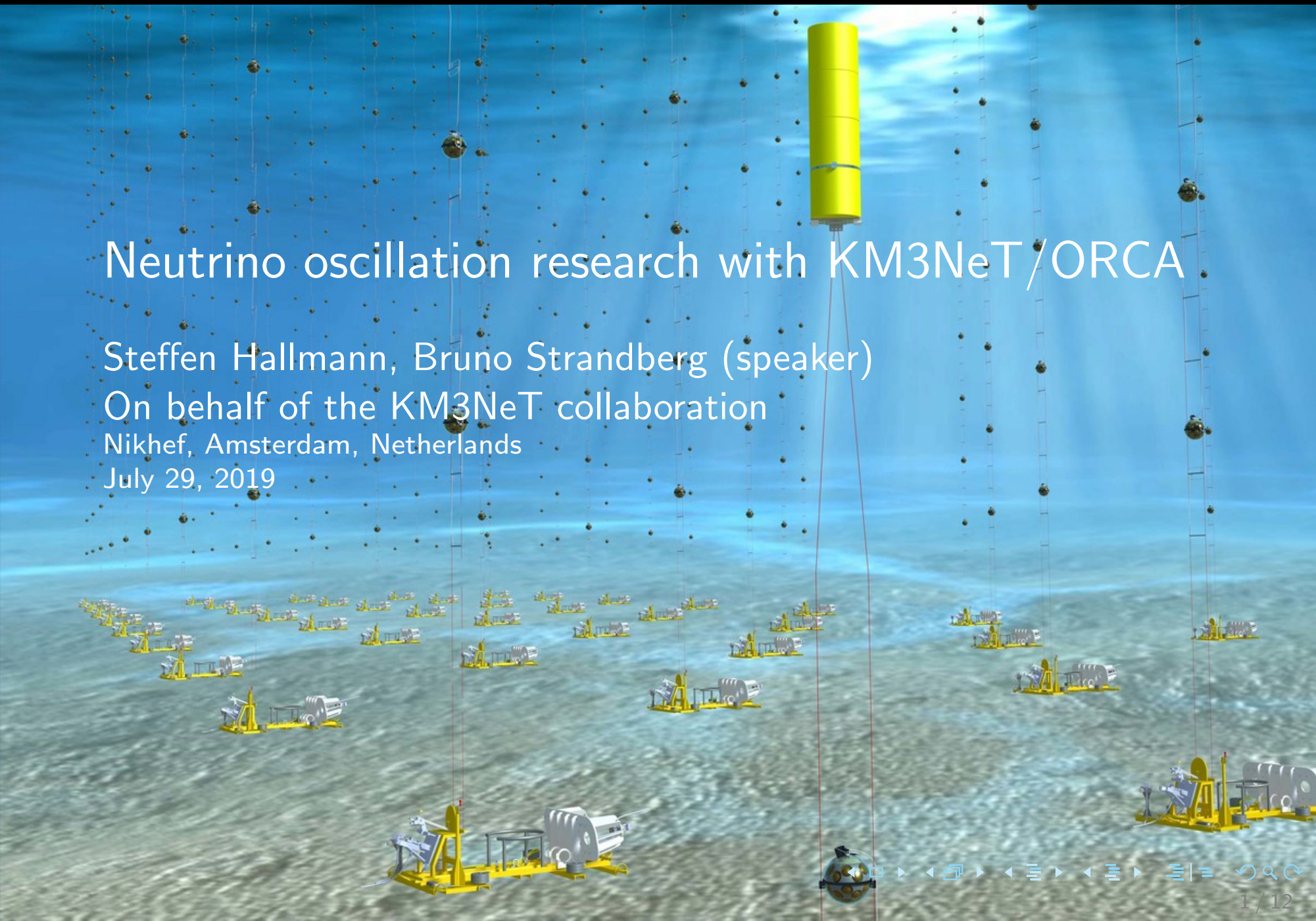


Neutrino oscillation research with KM3NeT/ORCA

Steffen Hallmann, Bruno Strandberg (speaker)
On behalf of the KM3NeT collaboration
Nikhef, Amsterdam, Netherlands
July 29, 2019

Outline

Introduction to KM3NeT

KM3NeT - large volume neutrino telescopes at the bottom of the Mediterranean.

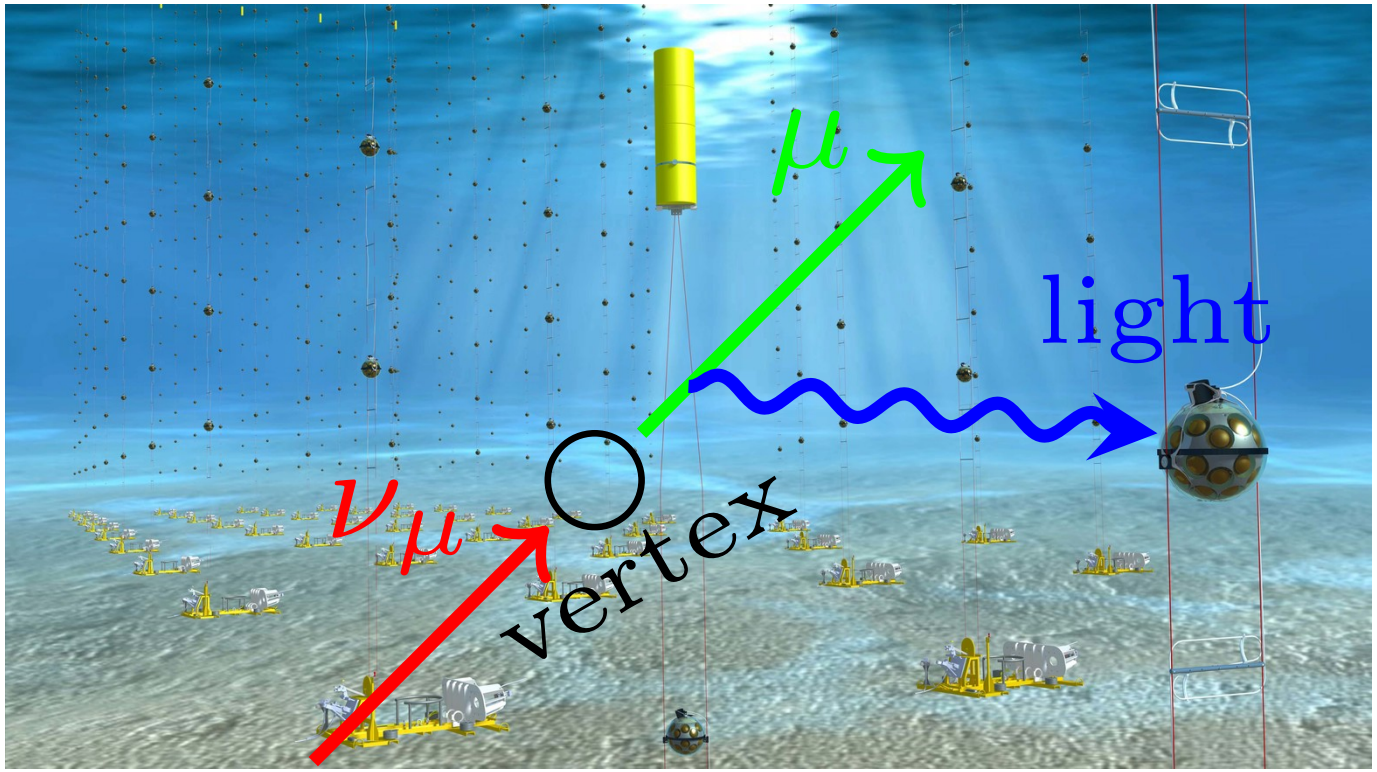


Figure: Illustration of KM3NeT & ν_μ detection.

Currently 4 ORCA DUs collecting data.

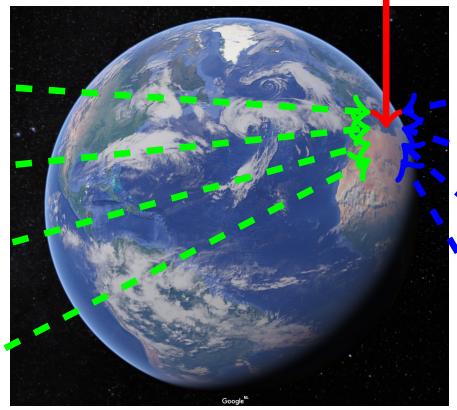
ORCA research programme

Sensitivity due to effects/baseline in Earth

ORCA

Sensitivity not dependent on Earth properties

- **Neutrino mass ordering** [1];
- ν_τ appearance [1]
- Non-standard interactions [2];
- Sterile neutrinos [3];



- Dark matter [4];
- Neutrinos from supernova collapses [5];
- Atmospheric muon flux [6].
- ...

NMO analysis: intro

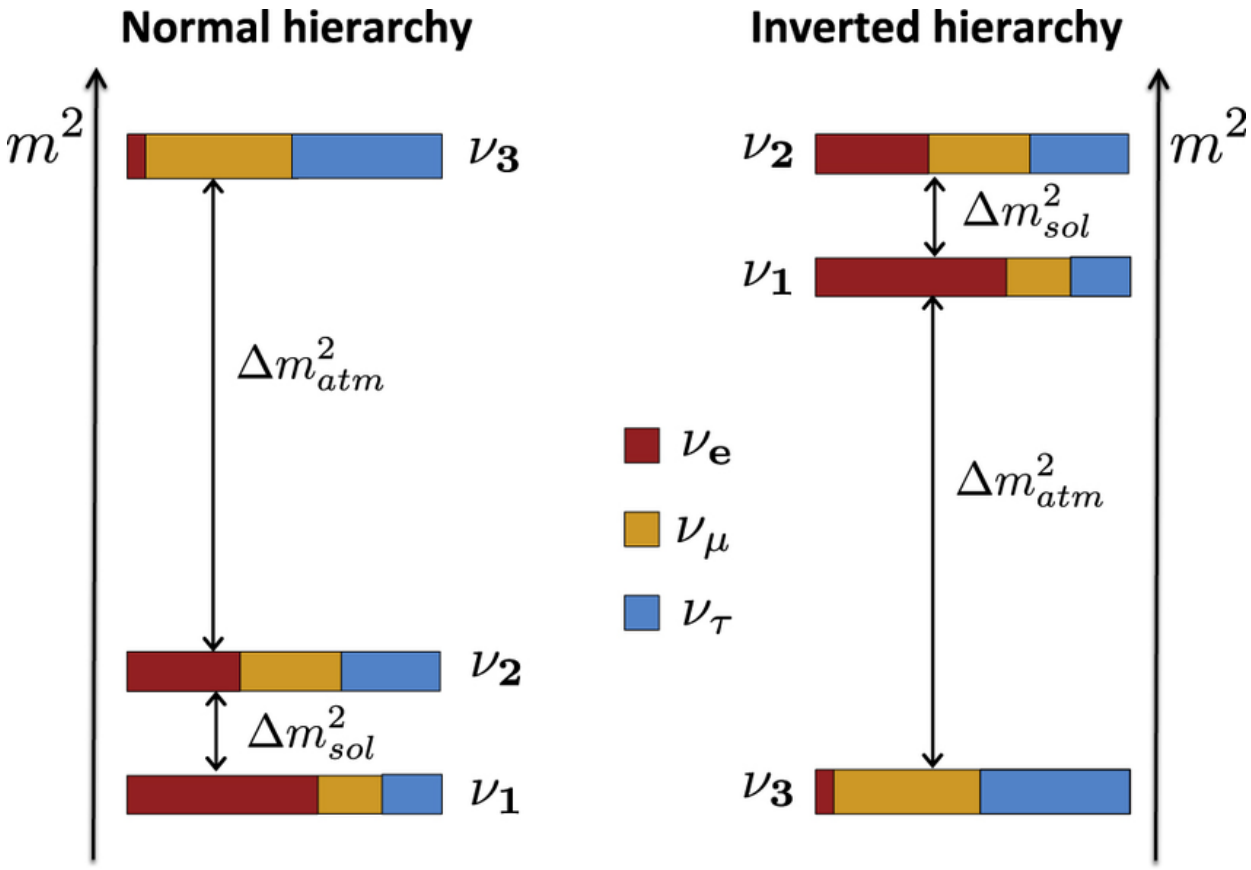


Figure: Illustration of two possible mass orderings [7].

NMO analysis: origin of the sensitivity

ν-oscillation probabilities through Earth are sensitive to the NMO.

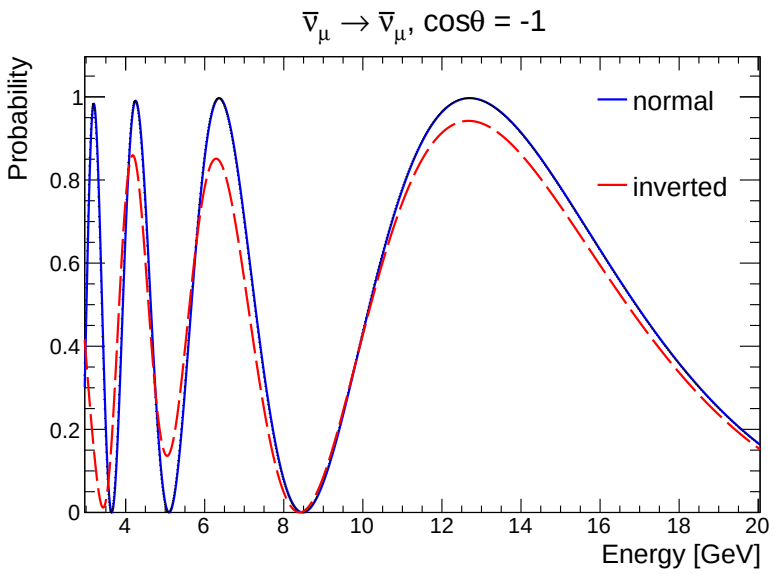


Figure: $\bar{\nu}_\mu \rightarrow \bar{\nu}_\mu$ probability, depending on the NMO.

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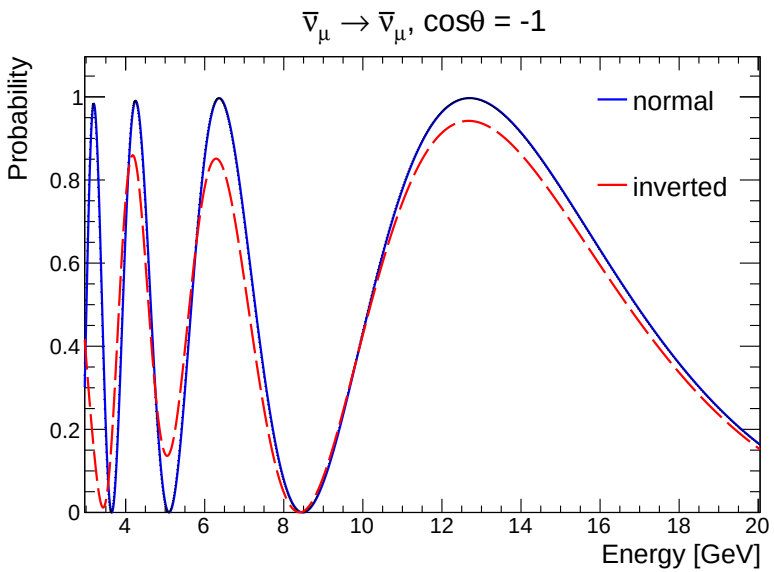

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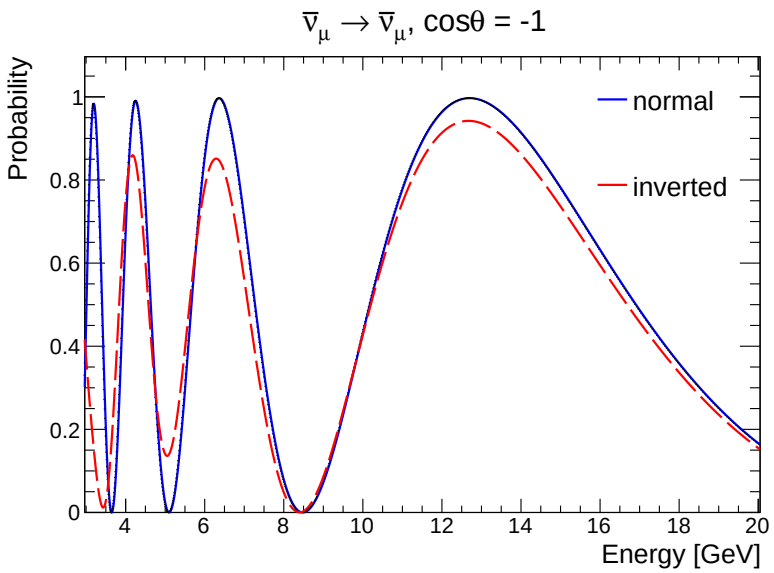

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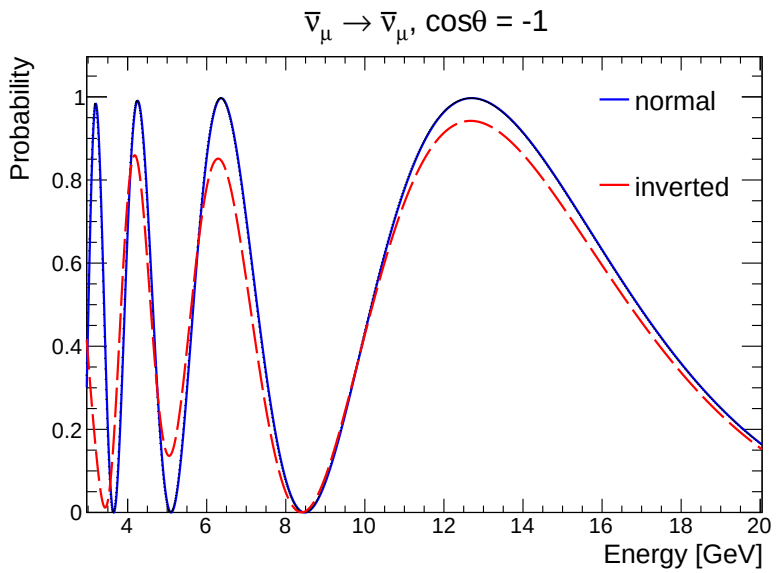

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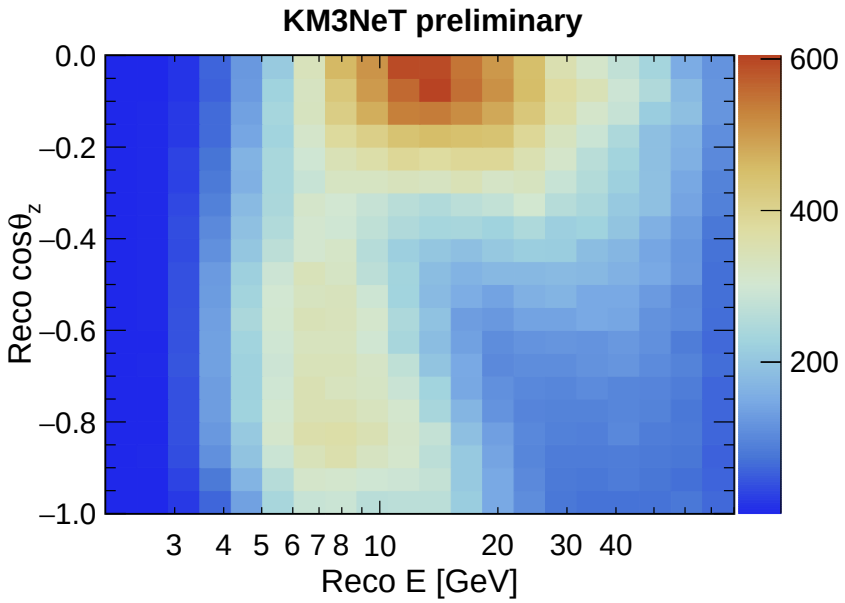

Figure: Example of expected track-like neutrino events after 3 years [8].

NMO analysis: sensitivity

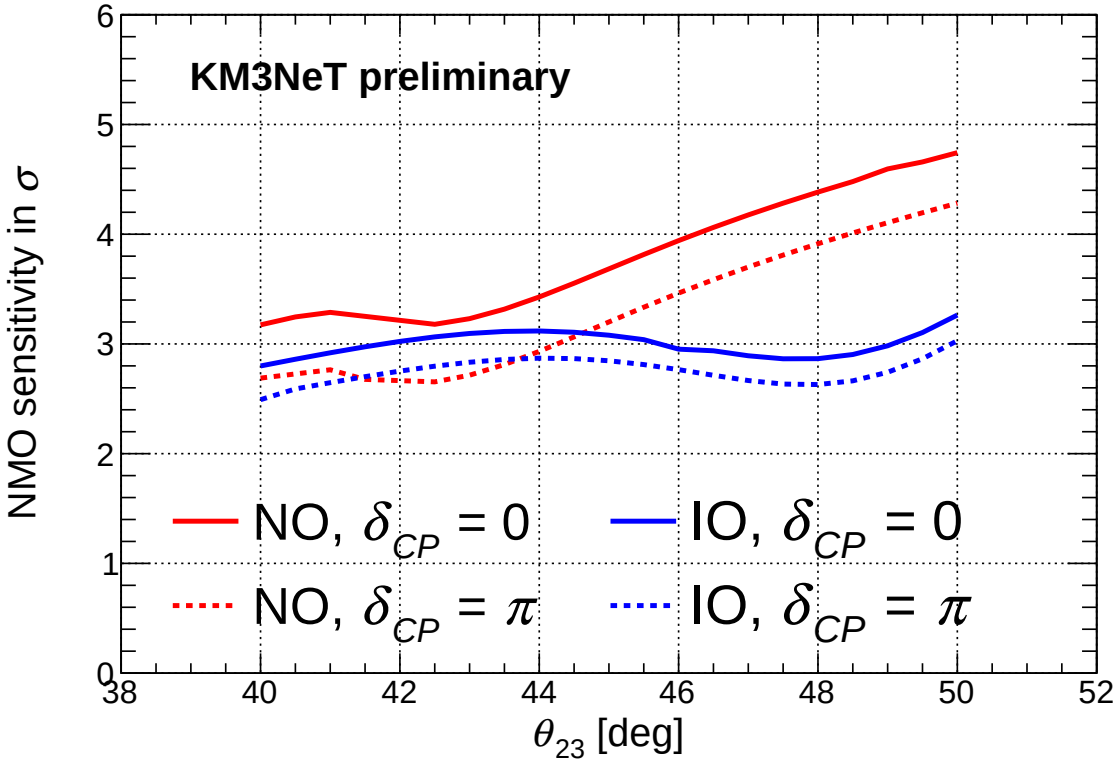

Figure: KM3NeT/ORCA projected sensitivity to the NMO after 3 years of data taking.

Message: $\sim 2.5 - 4.5\sigma$ sensitivity for the NMO can be achieved after 3 years of data taking.

Early physics: intro

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- It will take time to reach 115-DU ORCA detector.

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- sensitivity to ν_τ charged-current (CC) normalisation.

Early physics: Δm^2_{32}, θ_{23} with 7-DU ORCA after 1 year

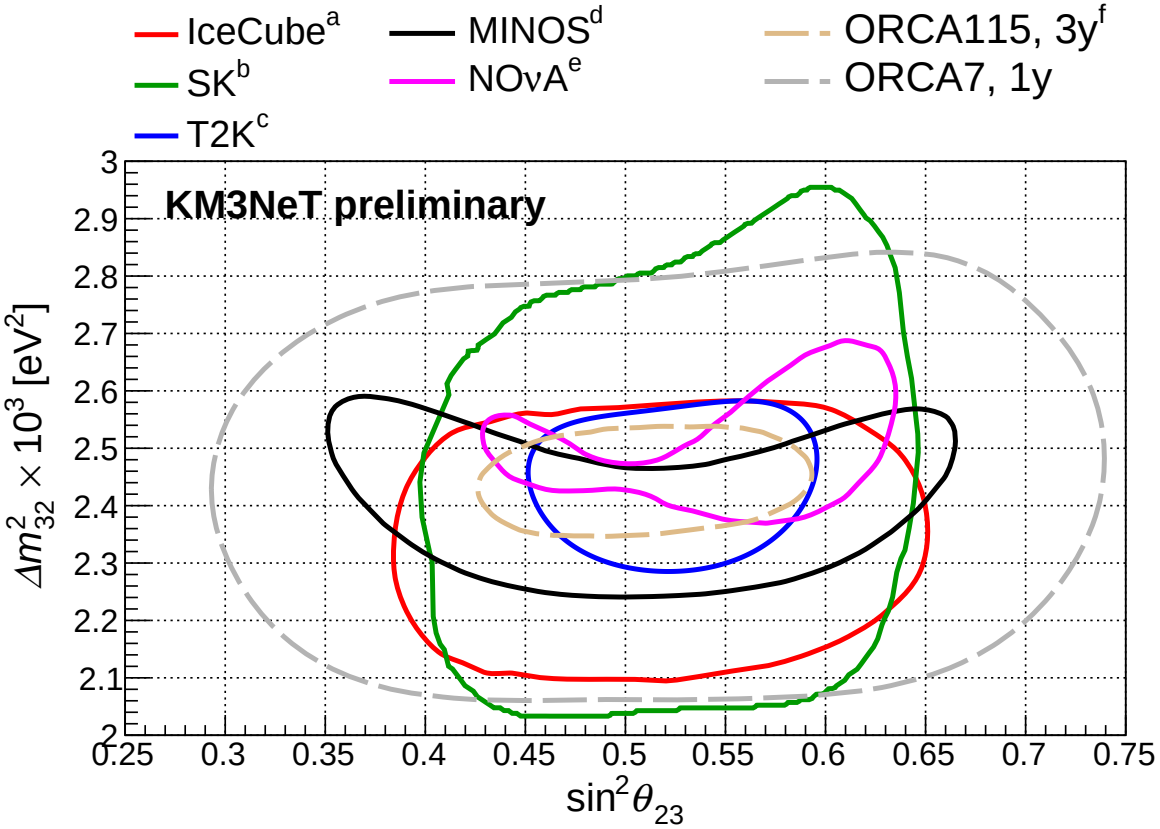

Figure: 90% CL contours, reference map: a [9], b [10], c [11], d [12], e [13], f [8].

Message: potential input to global fits.

Early physics: ν_τ CC norm.

N_τ^{cc} scales the expected nr. of ν_τ CC interactions.

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N_τ^{cc} scales the expected nr. of ν_τ CC interactions.

$N_\tau^{\mathrm{cc}} \neq 1$ could indicate:

- Physics outside 3×3 ν oscillation.
- Deviations from the predicted cross-section for ν_τ CC.

Early physics: ν_τ CC norm. with 7-DU ORCA after 1 year

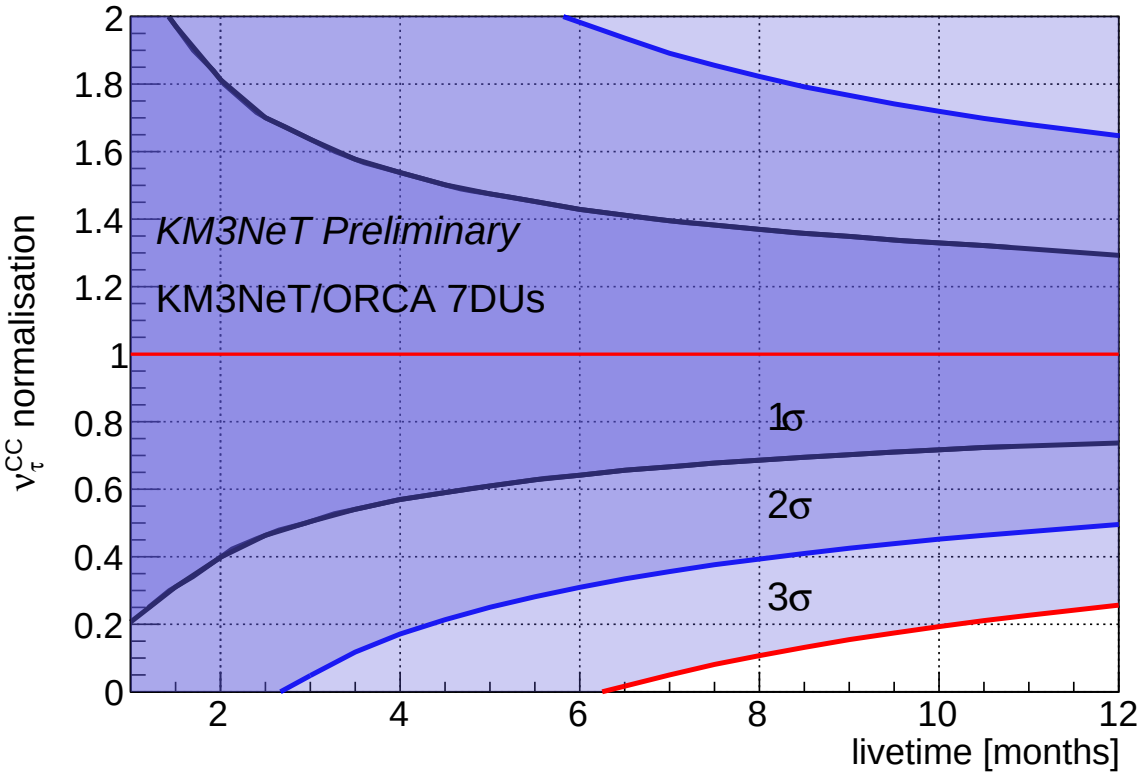

Figure: The sensitivity to N_τ^{cc} of the 7-DU ORCA, depending on the data accumulation period.

Message: early measurement of N_τ^{cc} is possible.

Summary & outlook

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Thank you for your attention!

Appendix: parameter configuration

Configuration of oscillation and systematic parameters for Figs. 5 and 6. See [1] for more info.

Parameter	fixed/prior/free ORCA	fixed/prior/free sub-array
Δm^2_{21}	fixed to $7.4 \cdot 10^{-5}$ eV^2	fixed to $7.4 \cdot 10^{-5}$ eV^2
$\sin^2\theta_{12}$	fixed to 33.62°	fixed to 33.62°
$\sin^2\theta_{13}$	8.54°, 0.15° prior (NO), 8.58°, 0.14° prior (IO)	fixed to 8.54°
δ_{CP}	free	fixed to 234°
flux $\nu_\mu \leftrightarrow \bar{\nu}_\mu$ skew	10% prior	10% prior
flux $\nu_e \leftrightarrow \bar{\nu}_e$ skew	10% prior	10% prior
flux $\nu_\mu \leftrightarrow \nu_e$ skew	10% prior	10% prior
flux E-tilt	free	free
flux $\cos\theta$-tilt	free	free
NC cross-sec. norm.	10% prior	10% prior
norm. track-like	free	free
norm. shower-like	free	free
norm. middle sample	free	free

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