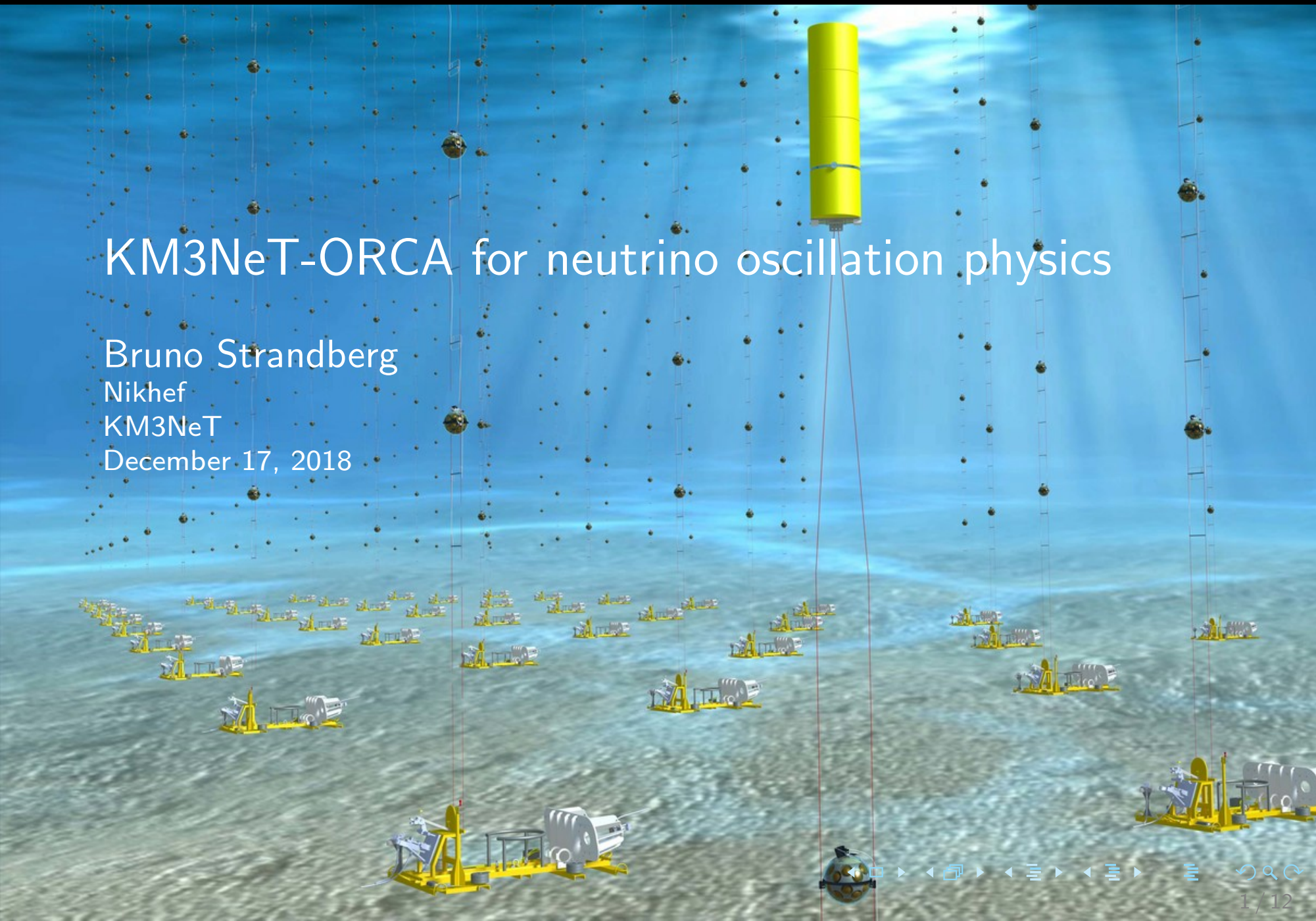

KM3NeT-ORCA for neutrino oscillation physics

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Nikhef
KM3NeT
December 17, 2018

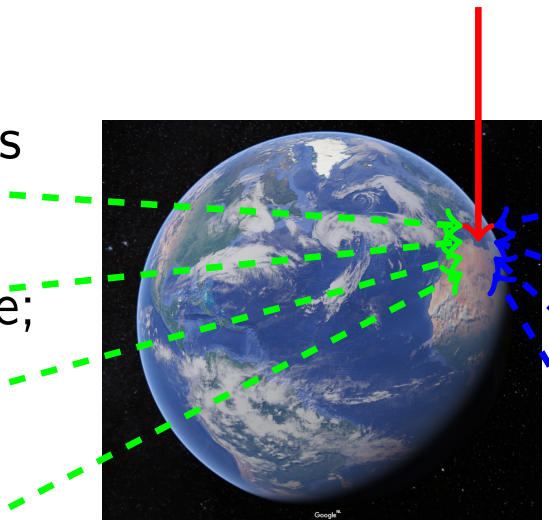
Outline

ORCA research programme

Sensitivity due to effects in Earth

ORCA

Sensitivity not dependent on Earth properties



- Neutrino mass ordering;
- ν_τ appearance;
- Non-standard interactions;
- Sterile neutrinos;

- Dark matter;
- Neutrinos from supernova collapses;
- Atmospheric muon flux (CR-physics).
- ...

Plus HE ν-physics with ARCA!

NMO analysis: What is detected?

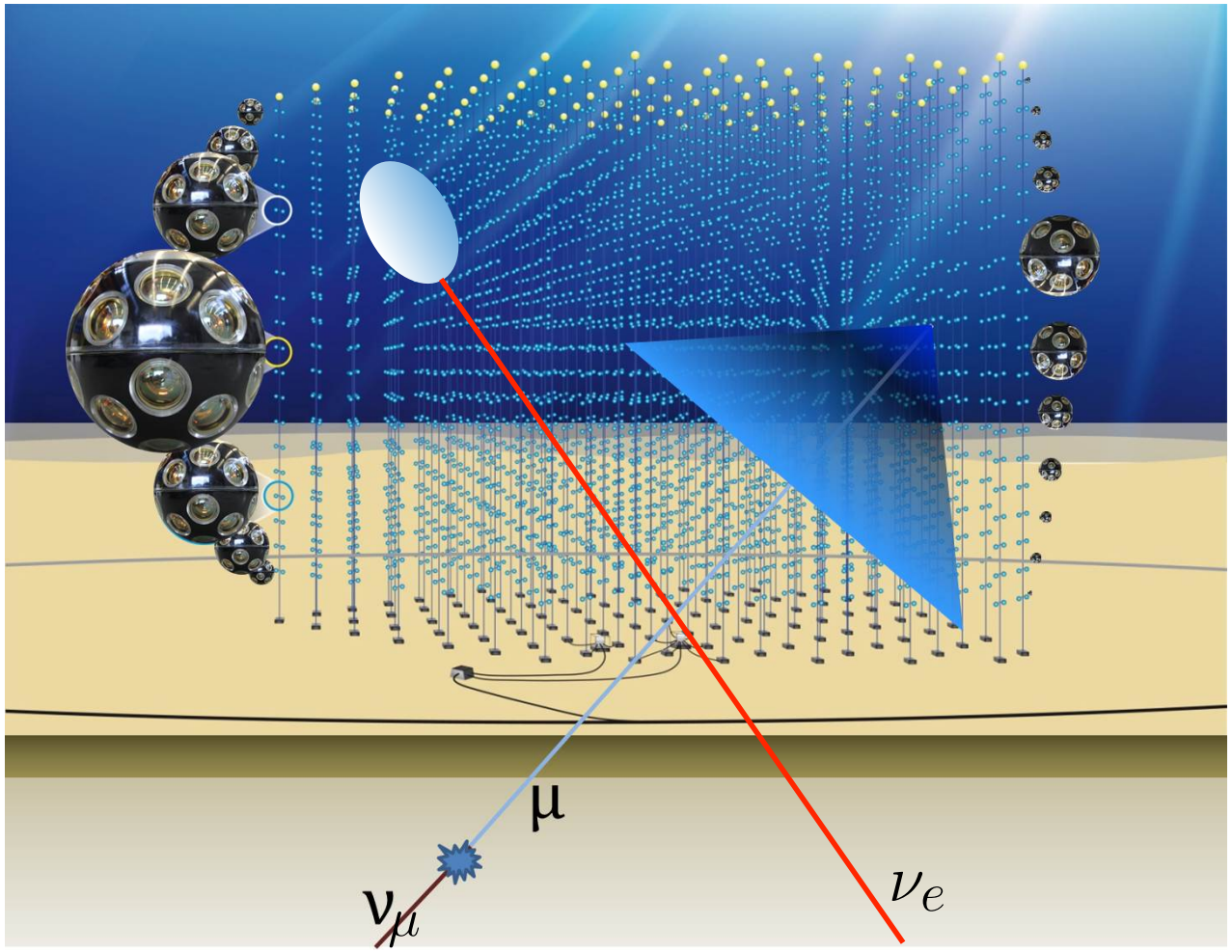


Figure: Illustration of ν_μ and ν_e event topologies.

NMO analysis: the problem

- ν oscillations mean $\nu_1 \neq \nu_2 \neq \nu_3$.
- Current experiments have determined Δm^2_{21} and Δm^2_{31}, but not mass-ordering.

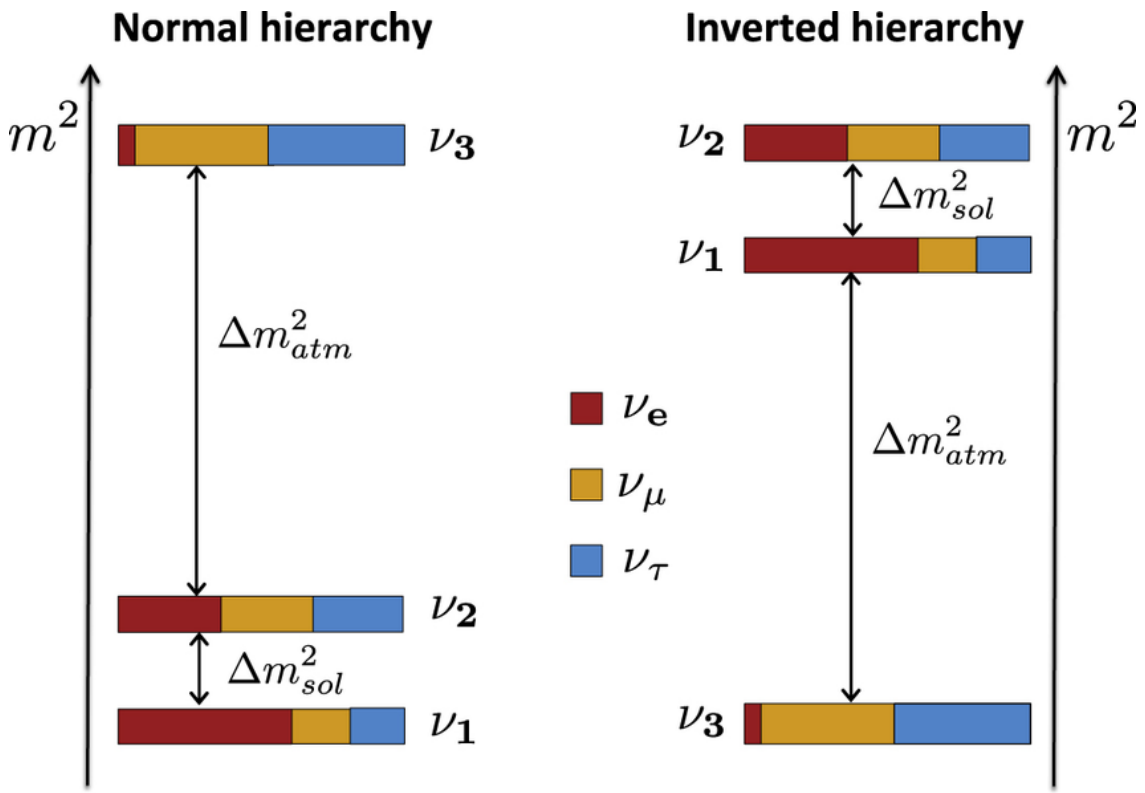
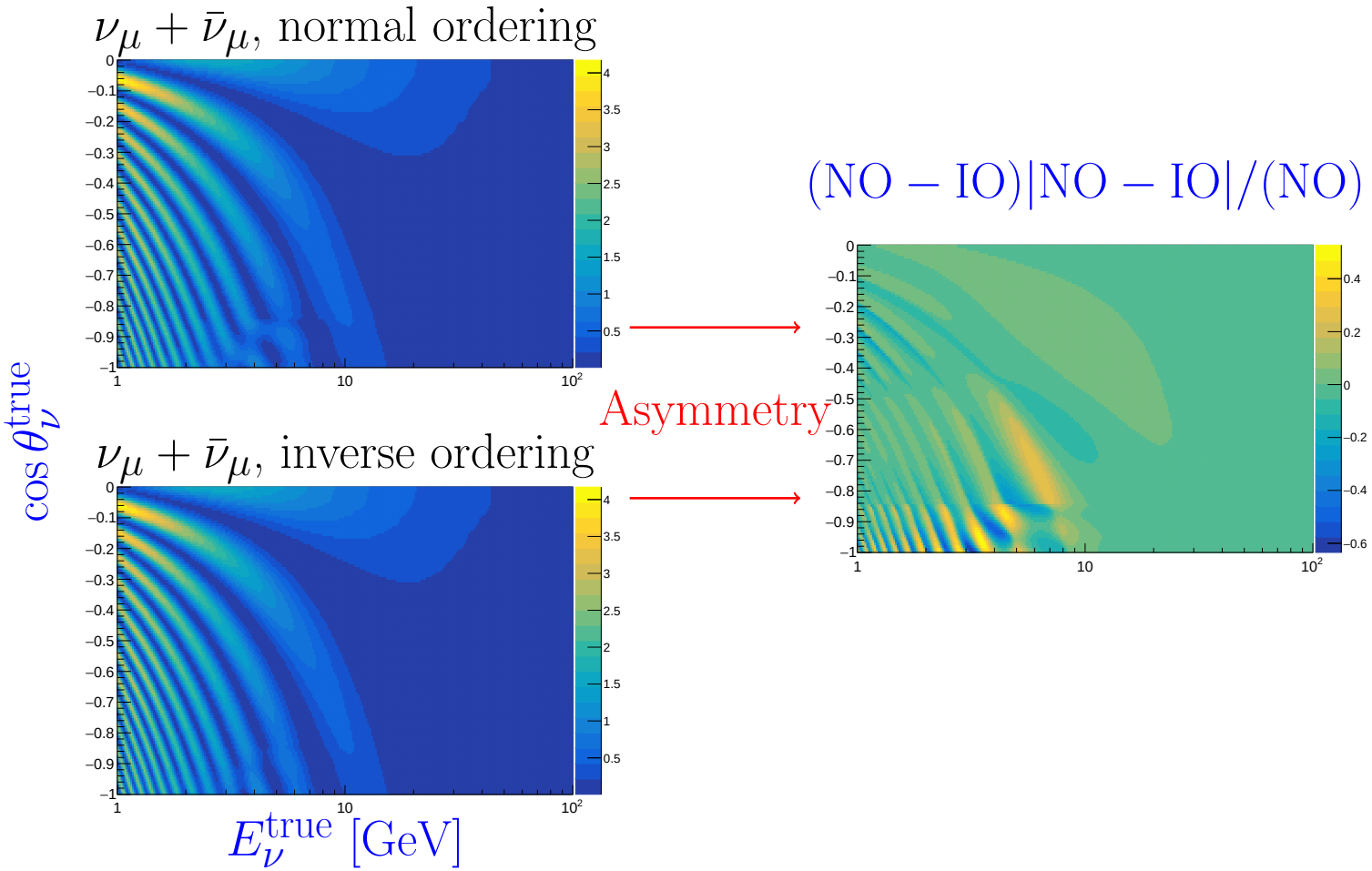


Figure: Illustration of two possible mass orderings.

NMO analysis: the principle

Osc. patterns in $(E_\nu,\ L,\ \rho_e) \equiv (E_\nu,\ cos\theta)$ are sensitive to the sign of Δm^2_{31}.

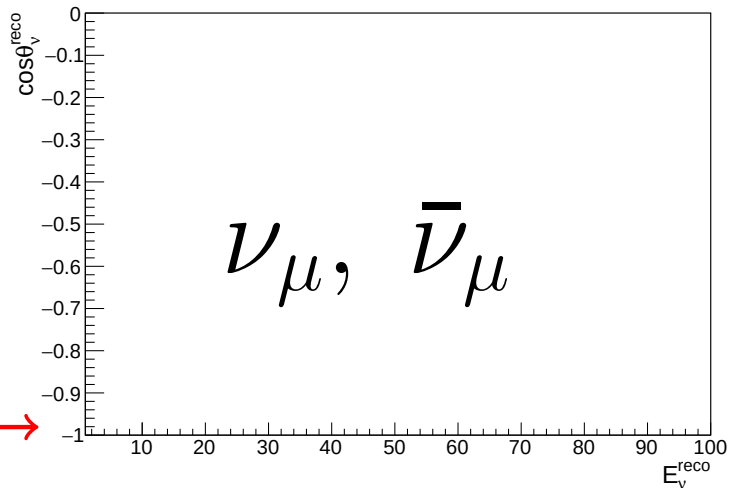


NMO analysis: how-to

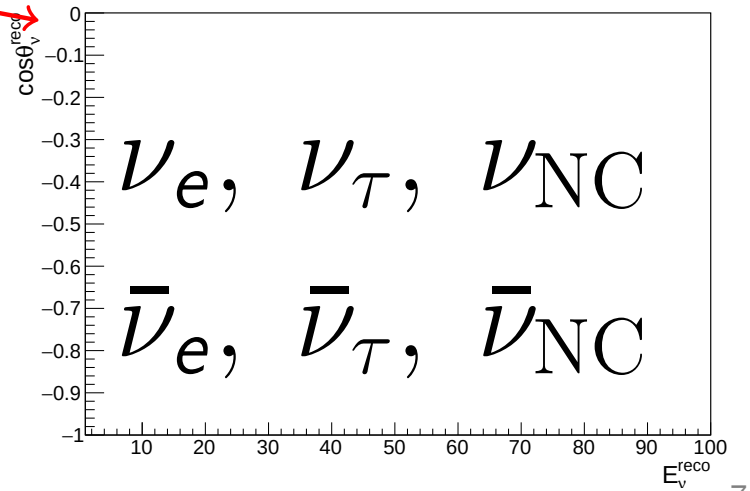
NMO measurement how-to:

1. Put lines in water and get data.
2. Separate events to track-like and shower-like.
3. Reconstruct E, $cos\theta$.
4. Fit a model to data to establish Δm^2_{31}.

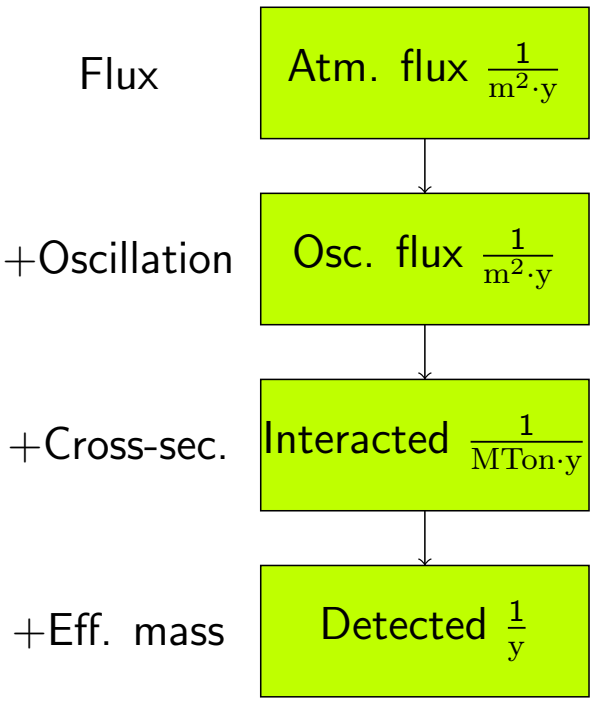
Tracks

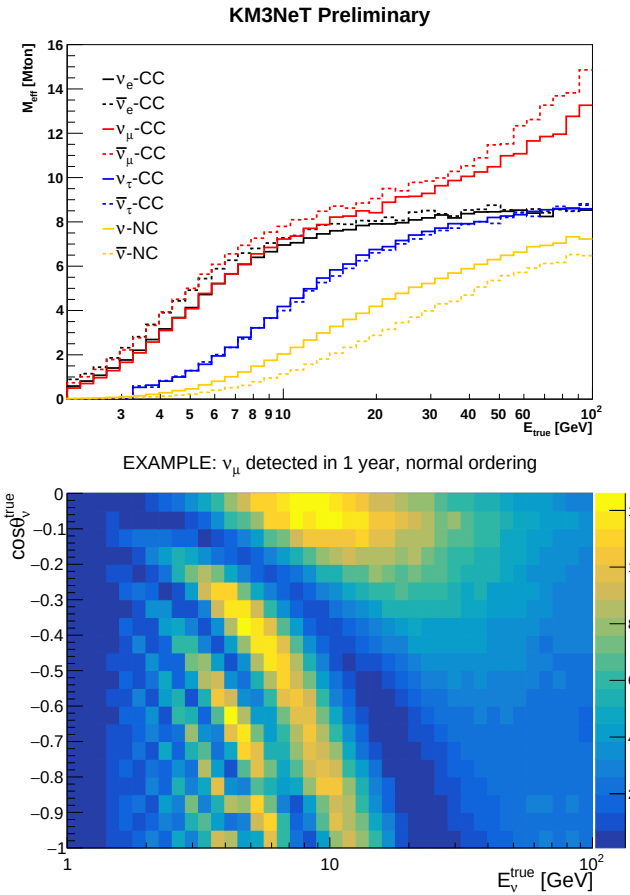


Showers



NMO analysis: the model





Leads to a predicted number of events for each $\nu_{e,\mu,\tau}^{\mathrm{NC/CC}}$ in $E^{\mathrm{true}}, \cos\theta^{\mathrm{true}}$ bins.

NMO analysis: sensitivity from the model

Final step (MC detector response):

$$E^{\text{true}}_{f,i}, \cos\theta^{\text{true}}_{f,i} \rightarrow E^{\text{reco}}_{c}, \cos\theta^{\text{reco}}_{c}, \tag{1}$$

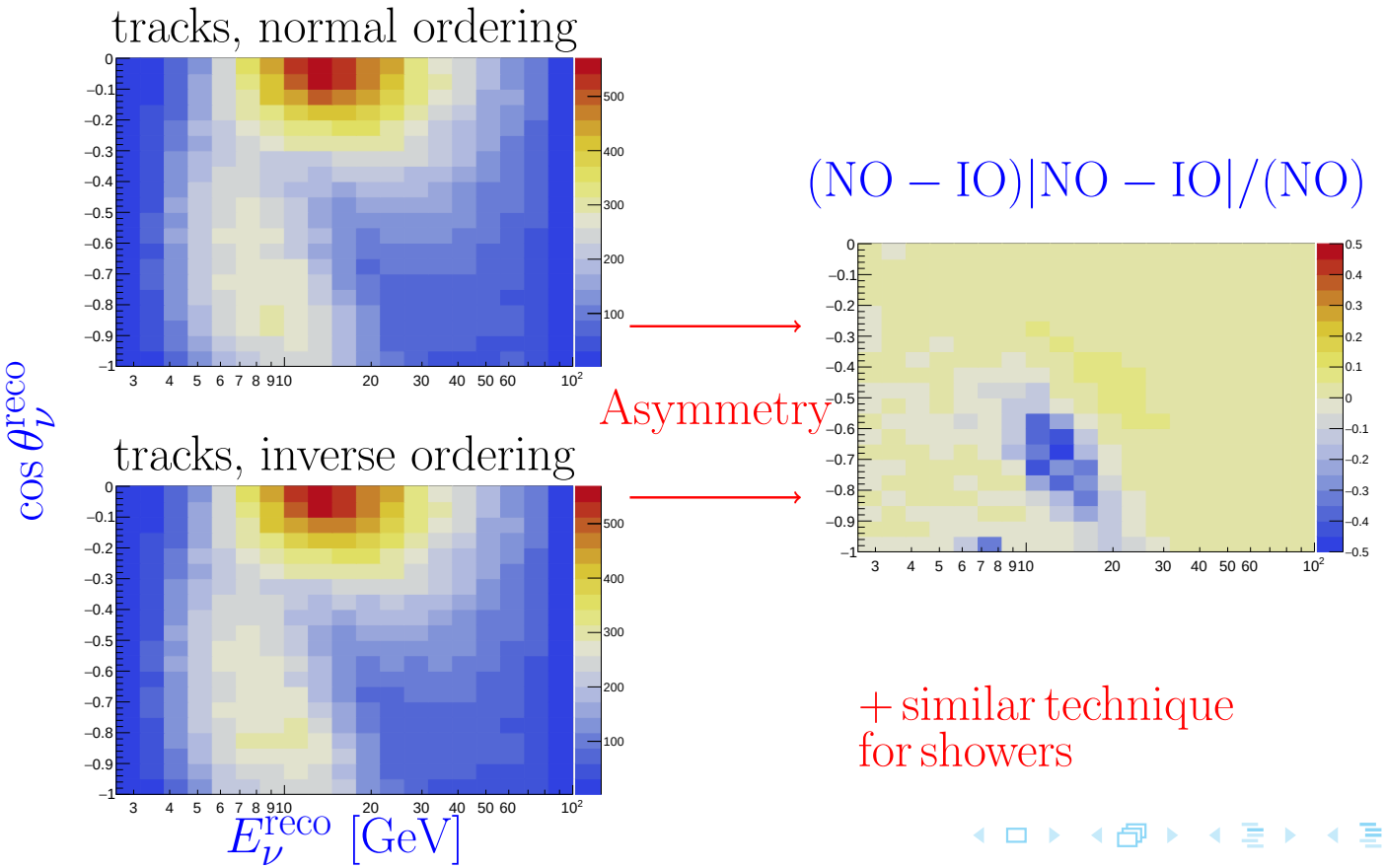
where f = flavor, i = NC/CC, c = reco class (track or shower).

NMO analysis: sensitivity from the model

Final step (MC detector response):

$$E^{\text{true}}_{f,i}, \cos\theta^{\text{true}}_{f,i} \rightarrow E^{\text{reco}}_{c}, \cos\theta^{\text{reco}}_{c}, \quad (1)$$

where f = flavor, i = NC/CC, c = reco class (track or shower).



ORCA 1-line results: neutrino analysis

Neutrino candidates from **1 ORCA line**.

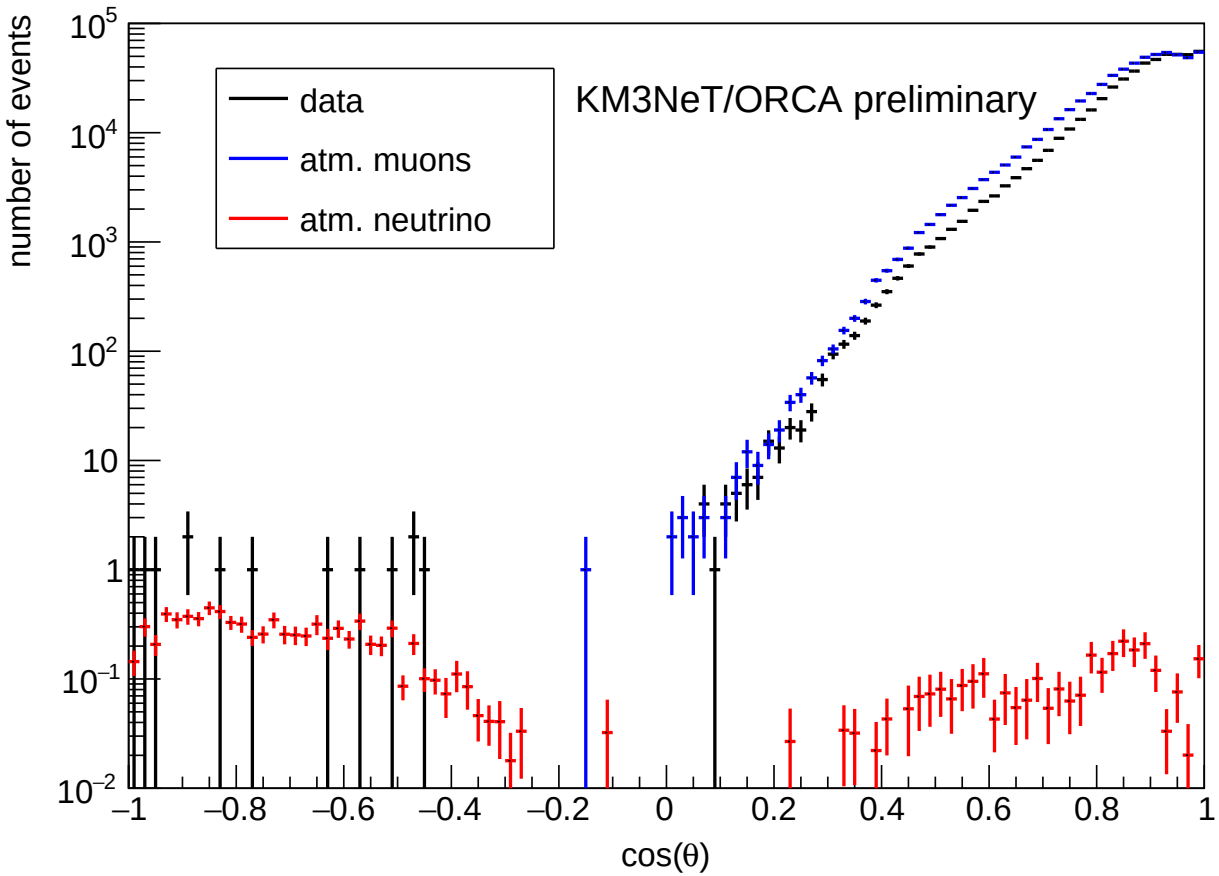


Figure: Comparison of Monte-Carlo end detected events with 82 days live-time with 1 ORCA line. Analysis by D. Zaborov *et. al.*

ORCA 1-line + ARCA 2-line results: muon rates

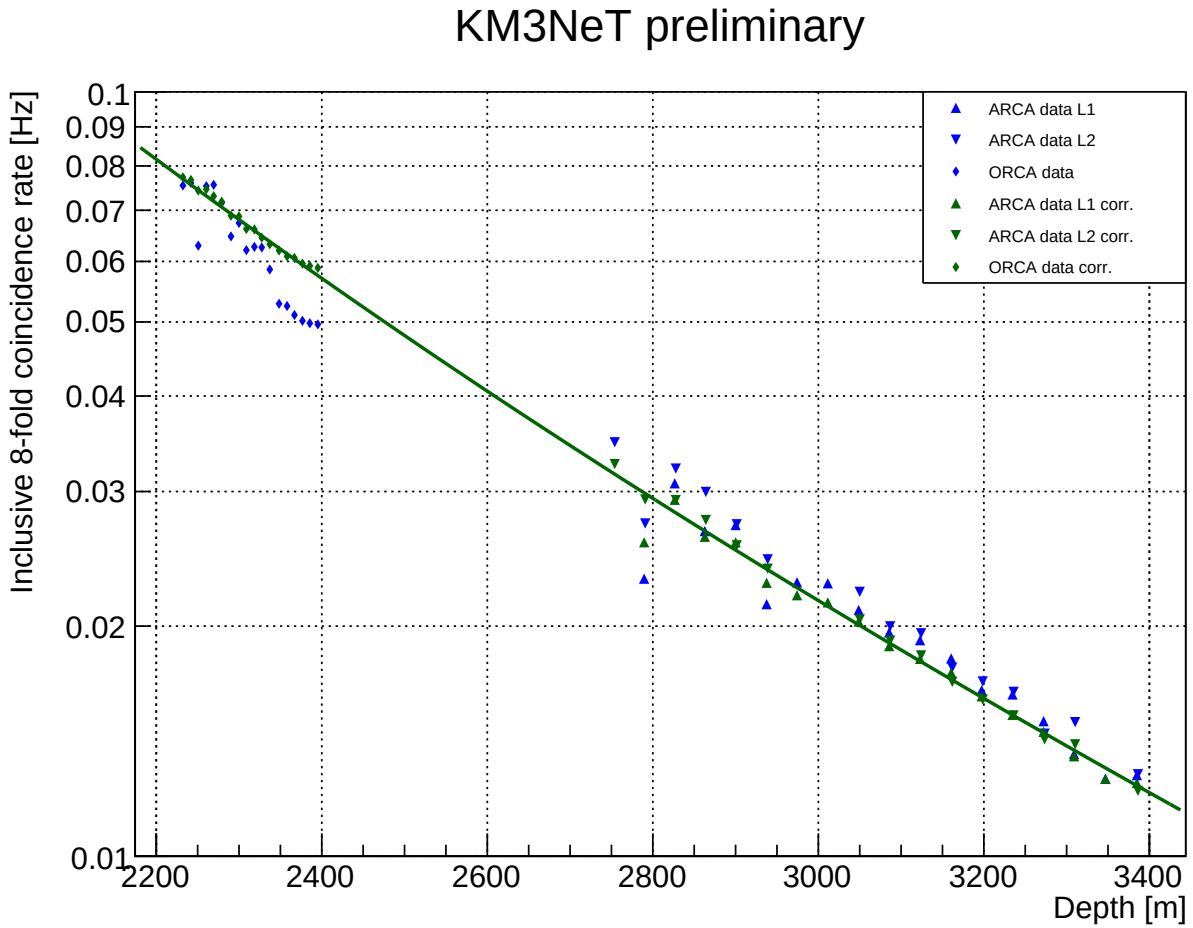


Figure: Atm. muon rate depth dependence measured by DOM multiplicities. Analysis by L. Massimiliano, K. Melis, *et. al.*

Summary & outlook

1. Main concepts for several analyses in place.
2. Expectation for new lines and new sea data in the immediate future (∼months)!
3. Physics can done already with a few lines.

Don't forget: there will also be the big ARCA detector!

Thank you for your attention!