ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

Event Reconstruction in the KM3NeT/ORCA Detector

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on behalf of the KM3NeT Collaboration

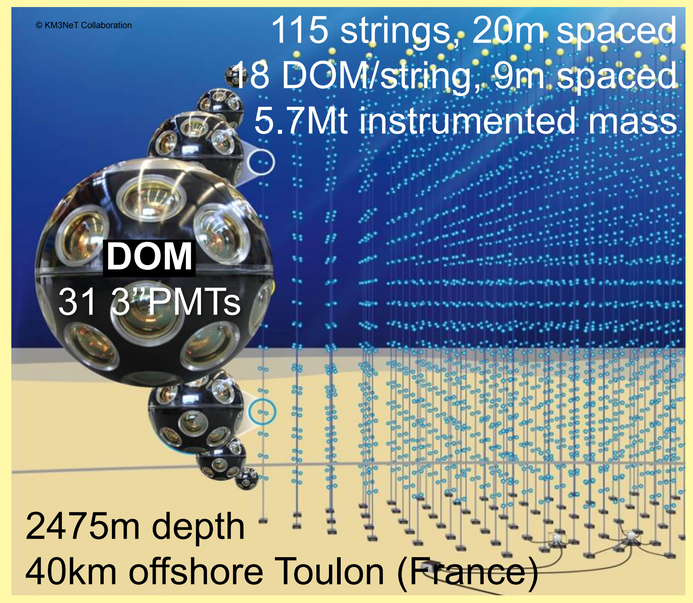
Measuring the neutrino mass hierarchy with KM3NeT/ORCA

KM3NeT is the next-generation underwater neutrino telescope in the Mediterranean Sea:

- **ORCA** → dense megaton-scale detector for neutrino mass hierarchy determination ➡ *talk by J. Brunner*
- ARCA → sparse gigaton-scale detector for high-energy neutrino astronomy ➡ *talk by M. Taiuti*

Same technology and detector design: 3D-array of multi-PMT digital optical modules (DOMs).
Letter of Intent of KM3NeT 2.0: *J.Phys. G43 (2016) no.8, 084001*

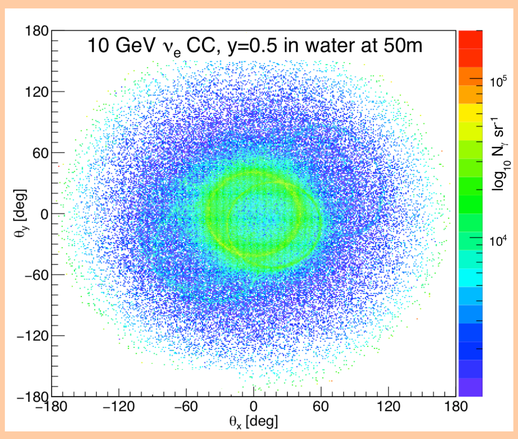
The **neutrino mass hierarchy** can be resolved with matter oscillation effects. ORCA is optimised for measuring the zenith-angle and energy-dependent oscillation pattern of few-GeV atmospheric neutrinos. Event reconstruction is a key task and substantial for this measurement.

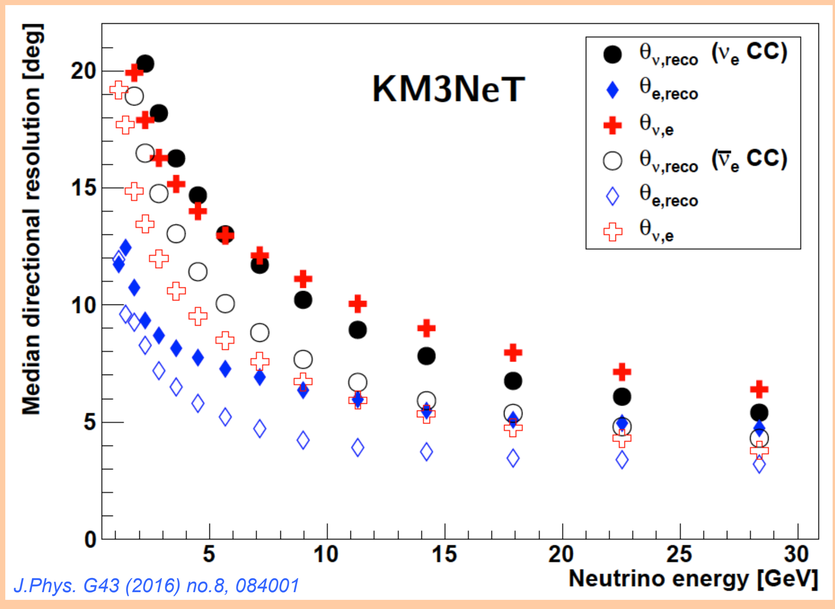


Shower Reconstruction

Phenomenology

- Cascades of energetic particles
- Initiated by $\overset{(-)}{\nu}_e$ CC, $\overset{(-)}{\nu}$ NC and $\overset{(-)}{\nu}_{\tau\to\text{not-}\mu}$ CC
- Point-like light emission (elongation≤5m)
- Cherenkov cone from each energetic particle
- Large event-by-event fluctuations
- Light signature conserved over large distances due to large photon scattering length in seawater





Direction Resolution

Reconstruction able to find electron direction in $\overset{(-)}{\nu}_e$CC events

→ neutrino direction limited by intrinsic ν-e scattering angle

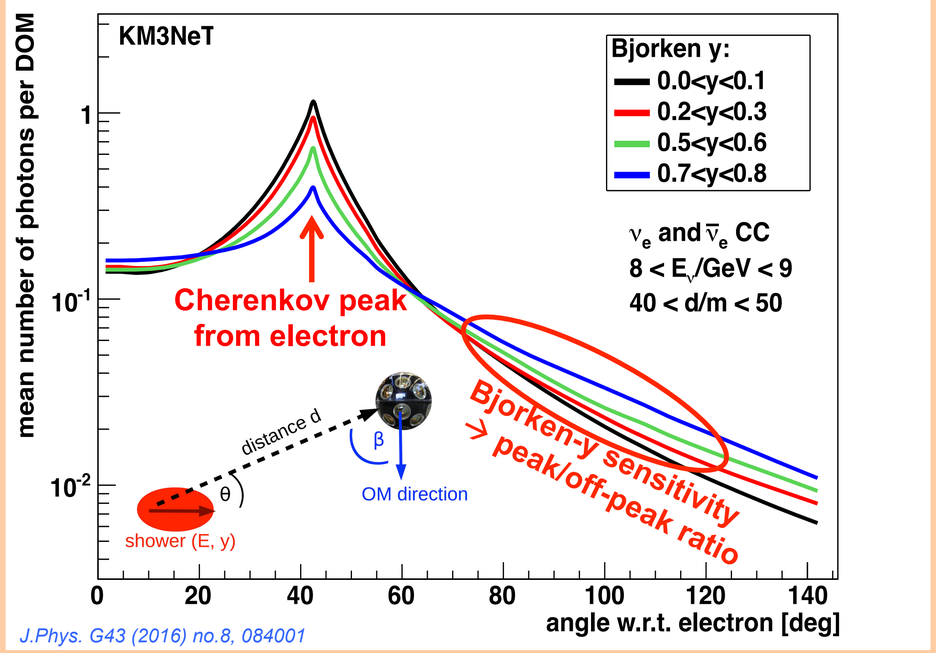
→ estimation of Bjorken-y feasible

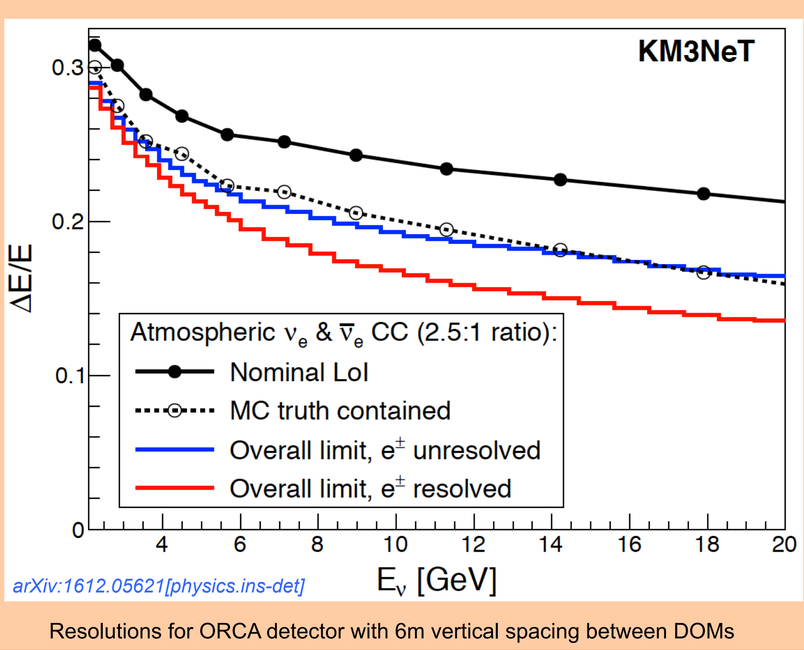
Energy Resolution

Gaussian-like and limited by intrinsic fluctuations of Cherenkov light yield (from hadronic shower component)

Methodology

- 1. vertex: based on hit time (assuming spherical light emission)
- 2. energy & direction & Bjorken-y: based on number and pattern of hits
- Designed to find brightest cone → electron in most $\overset{(-)}{\nu}_e$ CC events
- Expectation from simulated $\overset{(-)}{\nu}_e$ CC

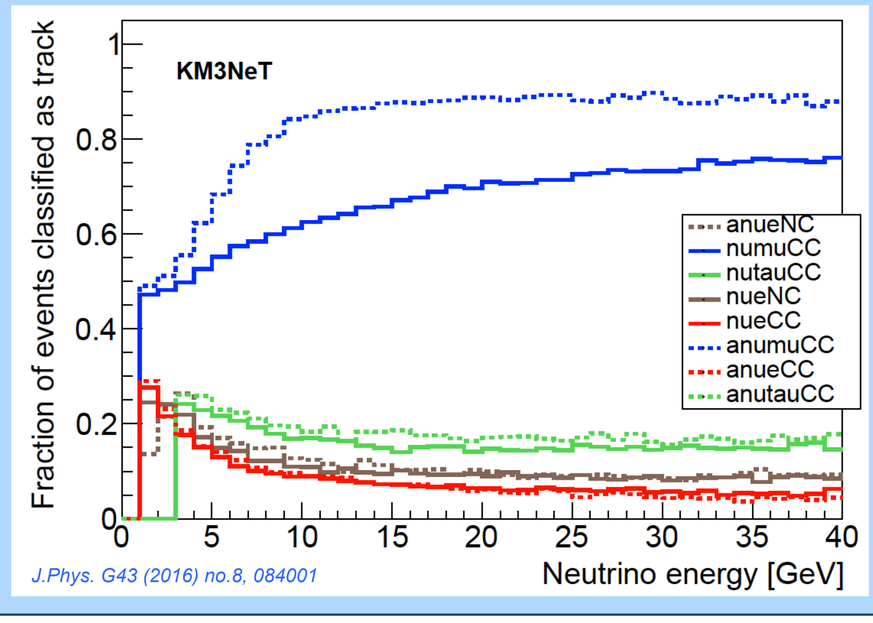




Resolutions for ORCA detector with 6m vertical spacing between DOMs

Track-Shower Separation

- Discrimination between shower-like ($\overset{(-)}{\nu}_e$CC, $\overset{(-)}{\nu}$NC, $\overset{(-)}{\nu}_{\tau\to\text{not-}\mu}$CC) and track-like event topologies ($\overset{(-)}{\nu}_\mu$CC, $\overset{(-)}{\nu}_{\tau\to\mu}$CC) based on reconstruction observables and hit time distributions
- Classification uses 'Random Decision Forest' as machine-learning algorithm
- Also suppression of atmospheric muons → few percent contamination in final neutrino event sample



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