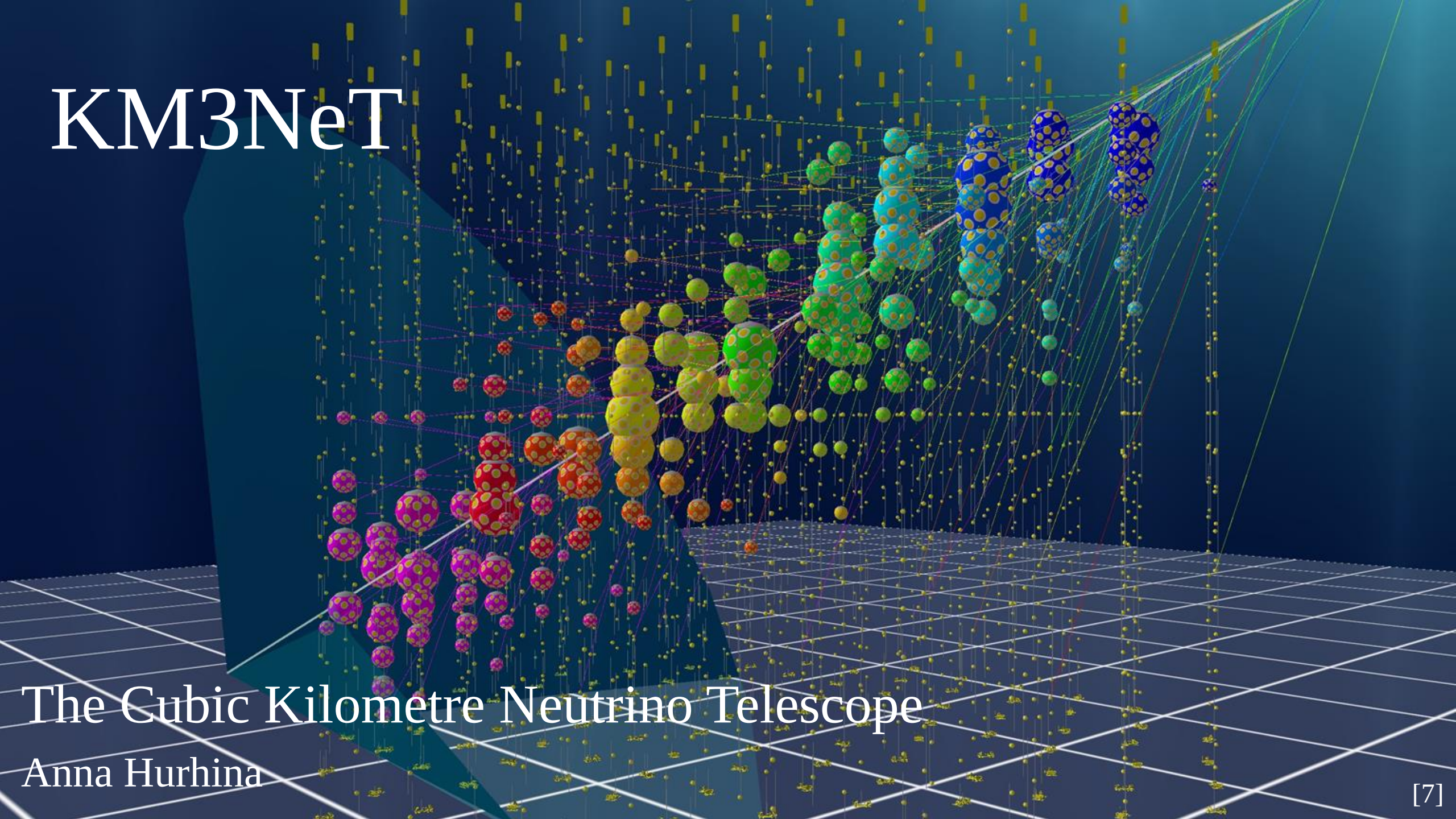


KM3NeT

The Cubic Kilometre Neutrino Telescope

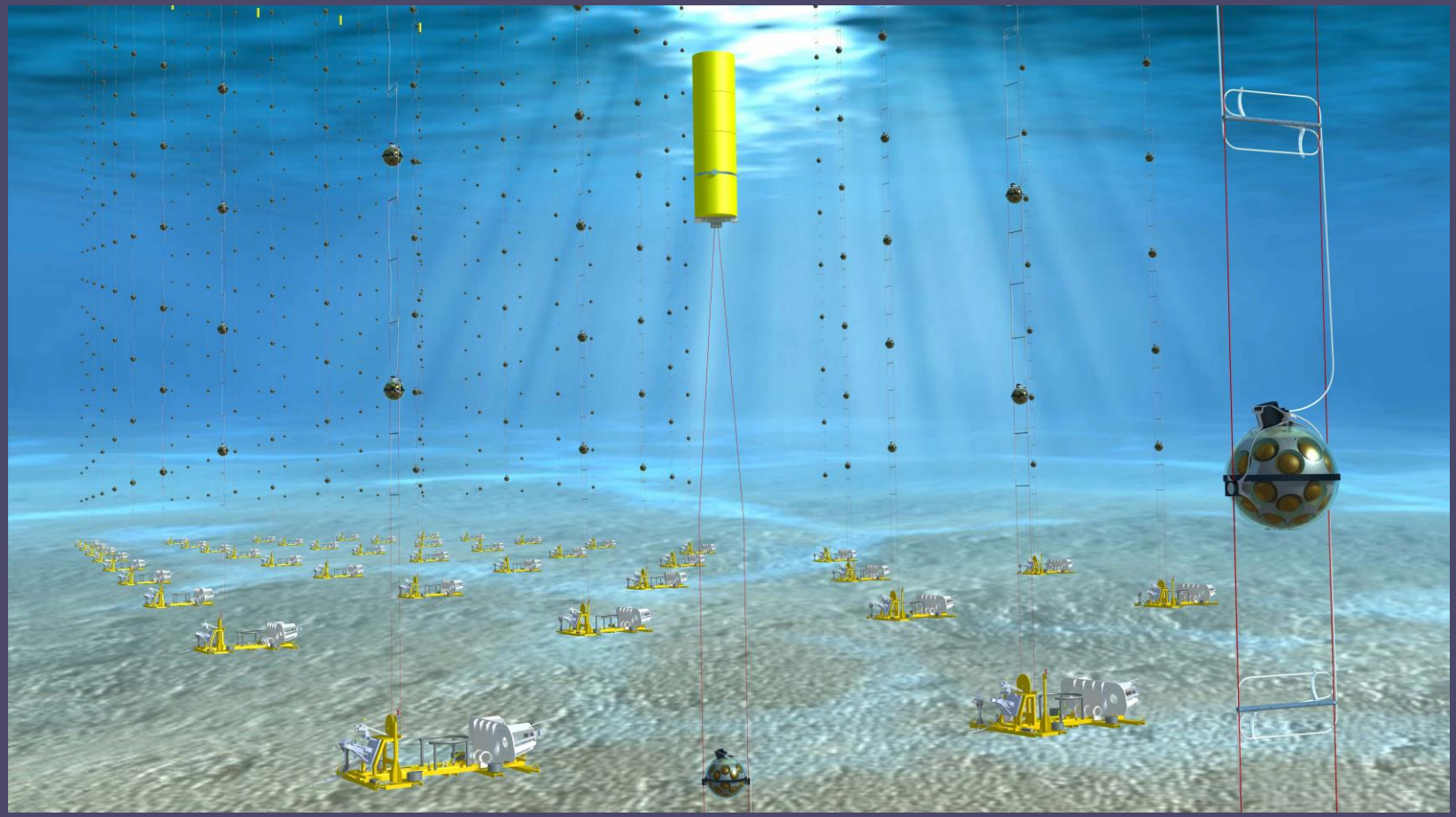
Anna Hurhina

[7]

Introduction

Cubic Kilometre Neutrino Telescope:

- Water Chereknov detector.
- Detects products of neutrino – water interactions.
- At the bottom of the Mediterranean Sea.
- Several km^3 of instrumented volume.



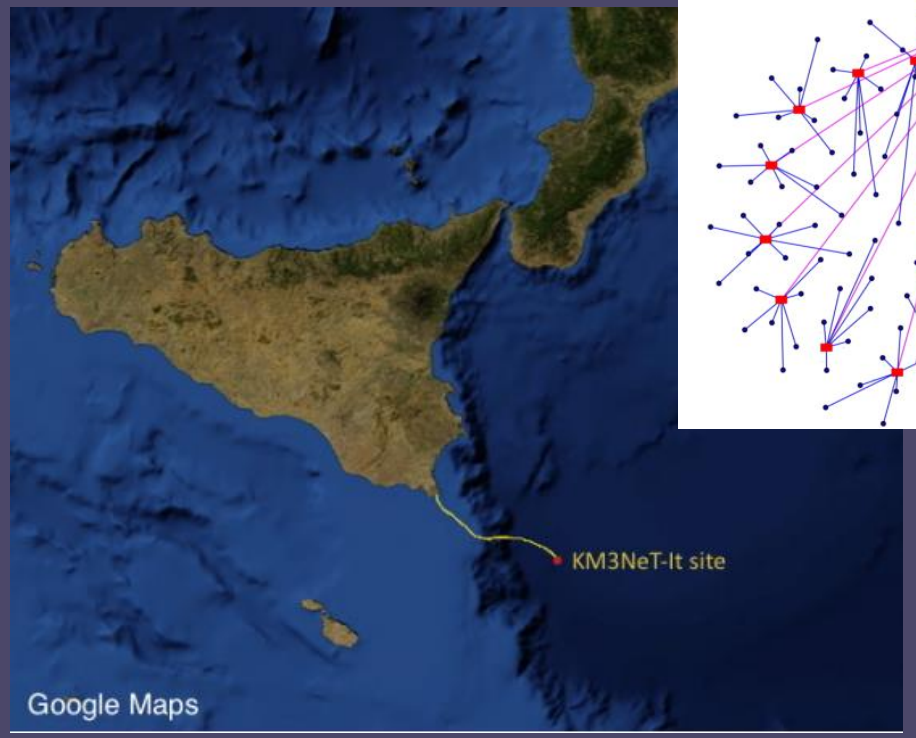
[7]

ARCA

Astroparticle Research with Cosmics in the Abyss:

- Study high-energy neutrino sources in the Universe.
- 2 building blocks.
- At 3500 m depth, 100 km offshore Italy.
- Horizontal spacing 95 m.
- TeV neutrino energies.

[1] [2]



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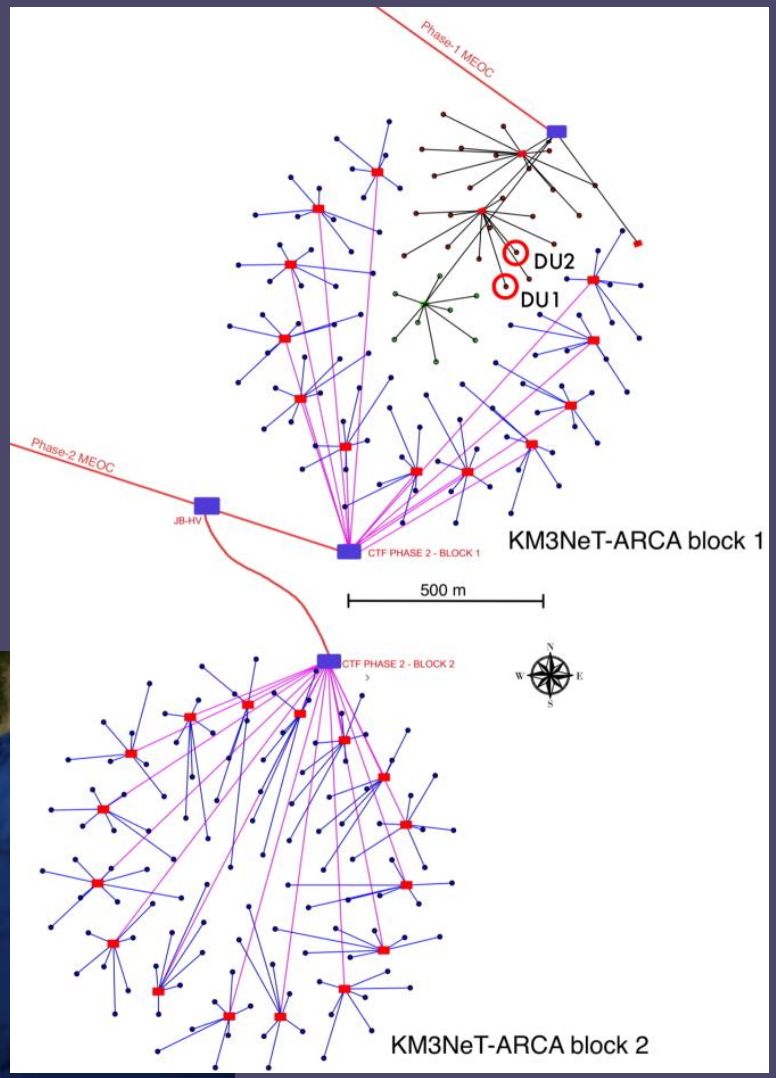


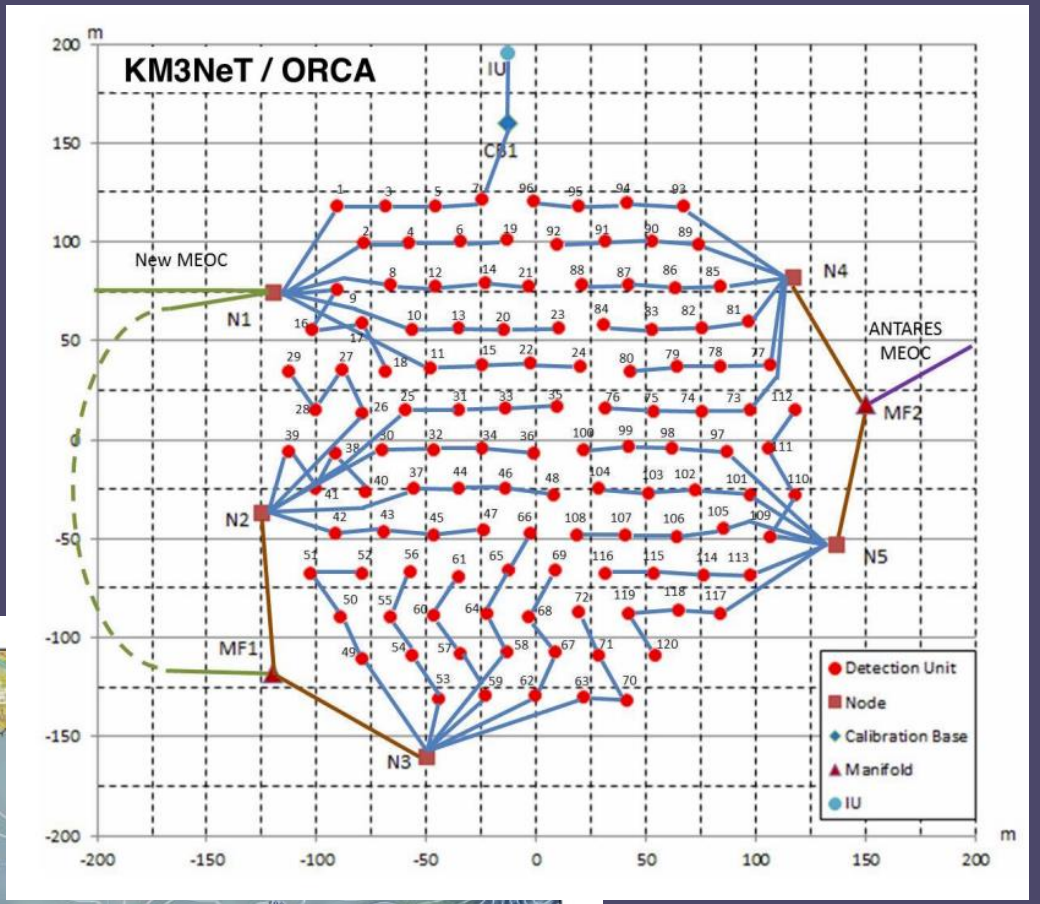
[1]

ORCA

Oscillation Research with Cosmics in the Abyss:

- Study of neutrino flavour oscillations and the neutrinos mass hierarchy.
- At 2450 m depth, 40 km offshore France.
- 1 building block.
- Horizontal spacing 20 m.
- GeV neutrino energies.

[1] [2]



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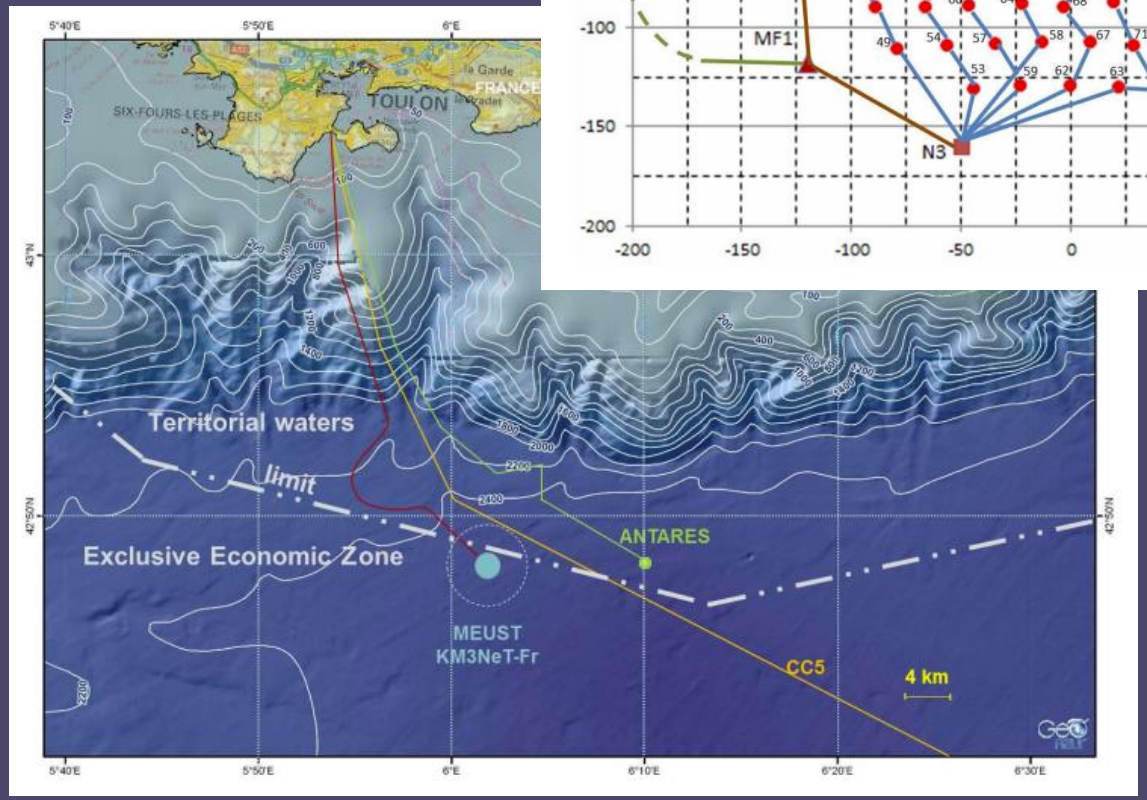

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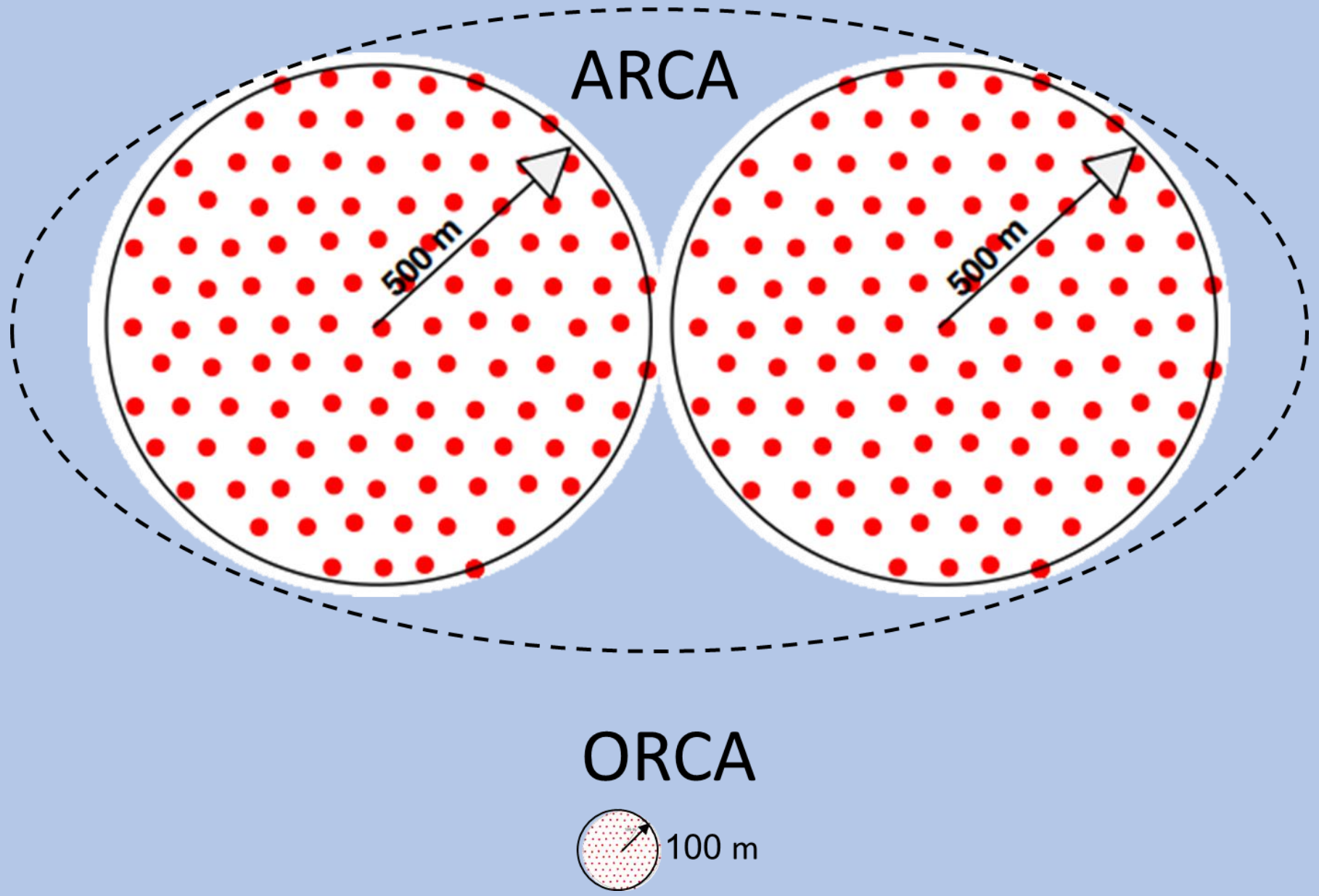
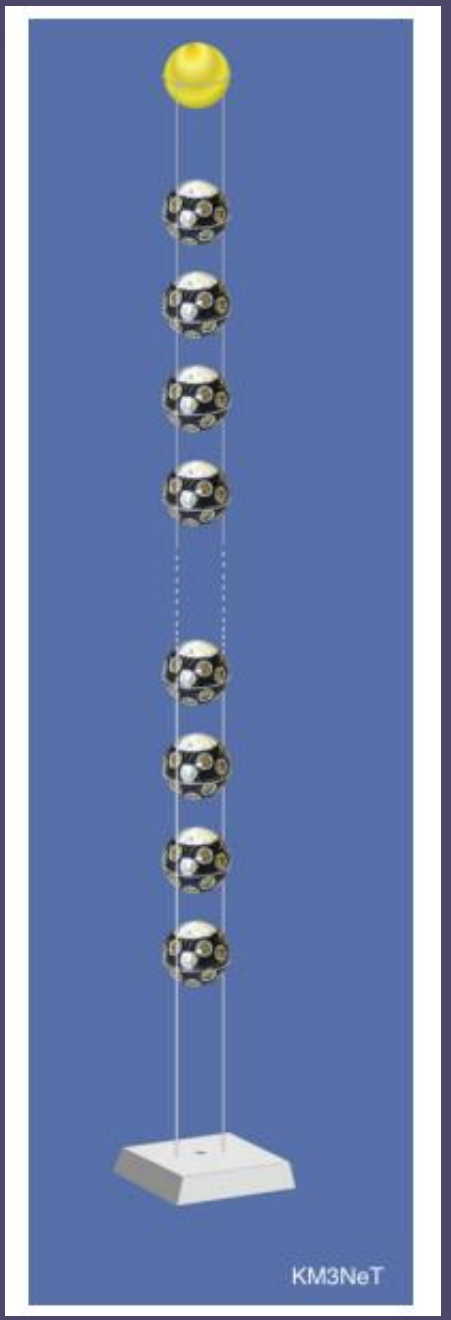


[7]

Detection String

- Each block has 115 strings.
- Each string has 18 digital optical modules (DOMs).
- ARCA: spread out configuration; height: 700 m with DOMs vertical spacing 36 m.
- ORCA: dense configuration; height: 200 m with DOMs vertical spacing 9 m.
- Cables for power and data transmission.
- Float at the top.
- Calibration equipment in the base.

[1] [2]



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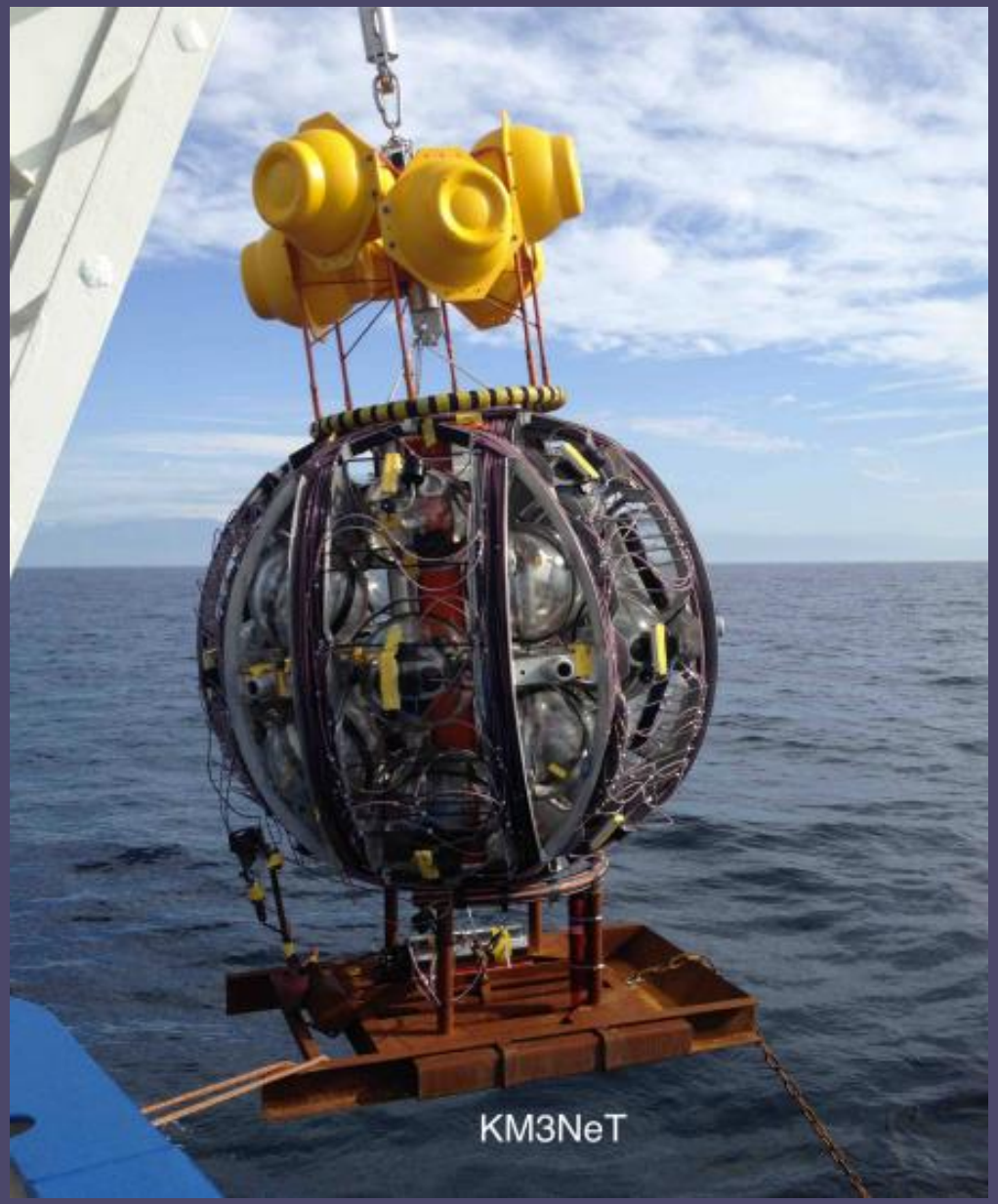
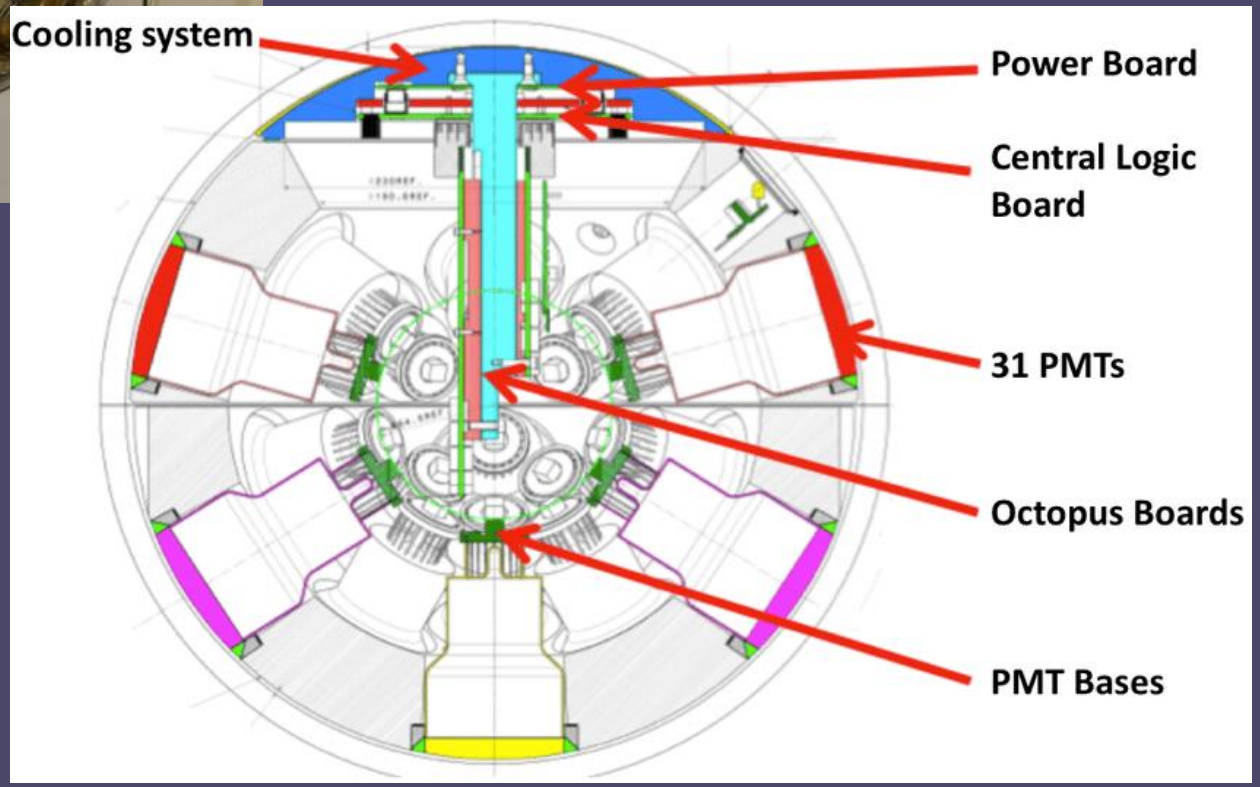


[7]

[7]

The DOM

[7]

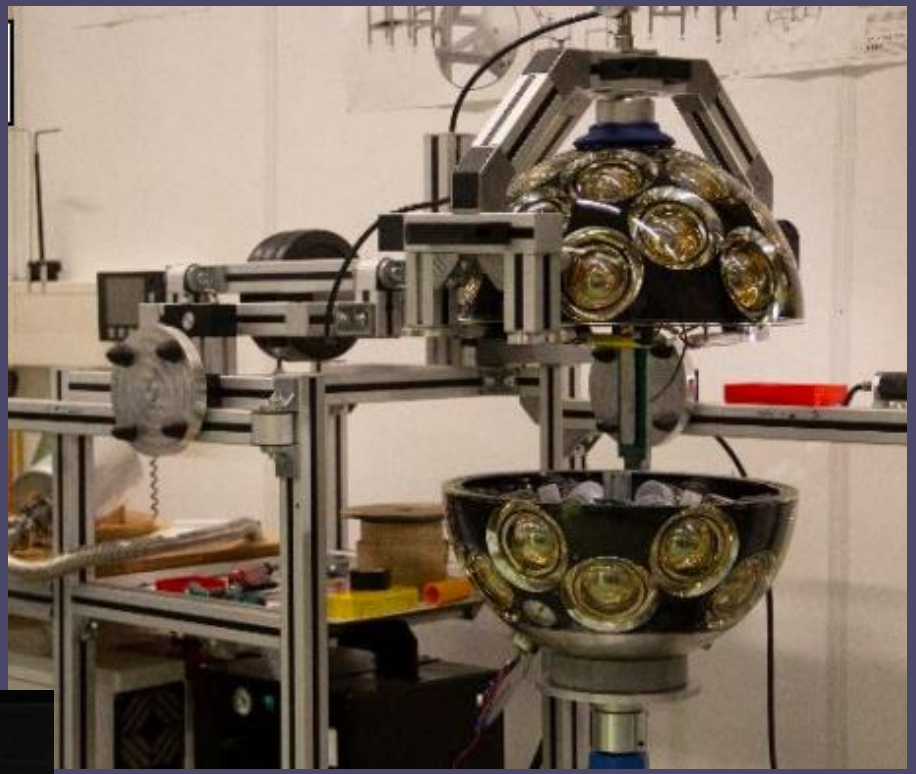


[8]

- 44 cm in diameter.
- Pressure-resistant glass sphere.
- 31 PMTs.
- Optical gel to fill all cavities.
- Calibration sensors: LED nano beacon, compass, tilt-meter and acoustic sensor.

[1] [2] [5]

[7]



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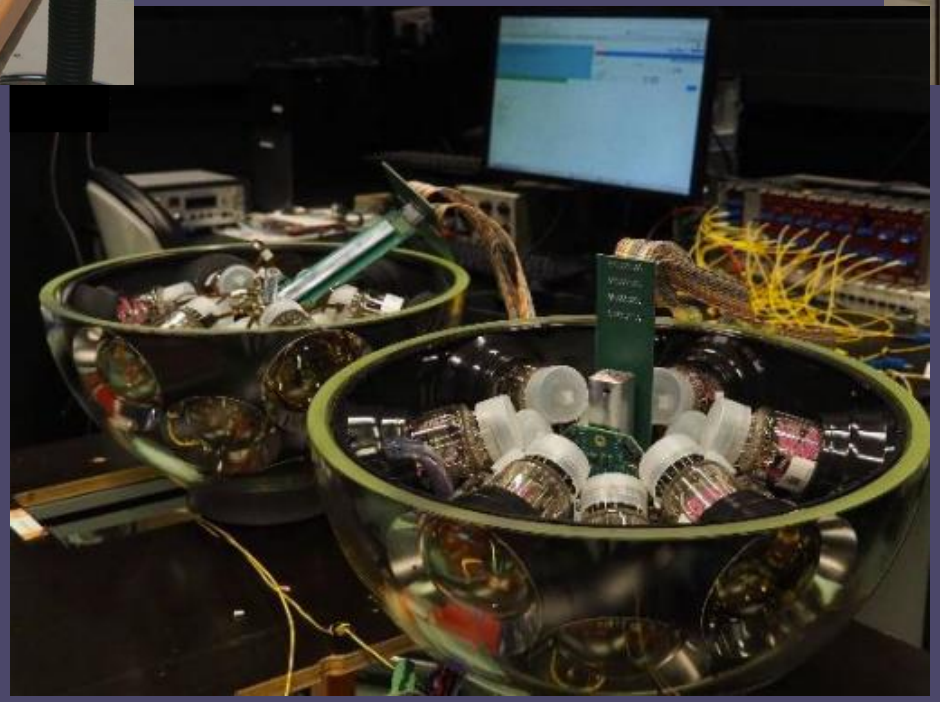
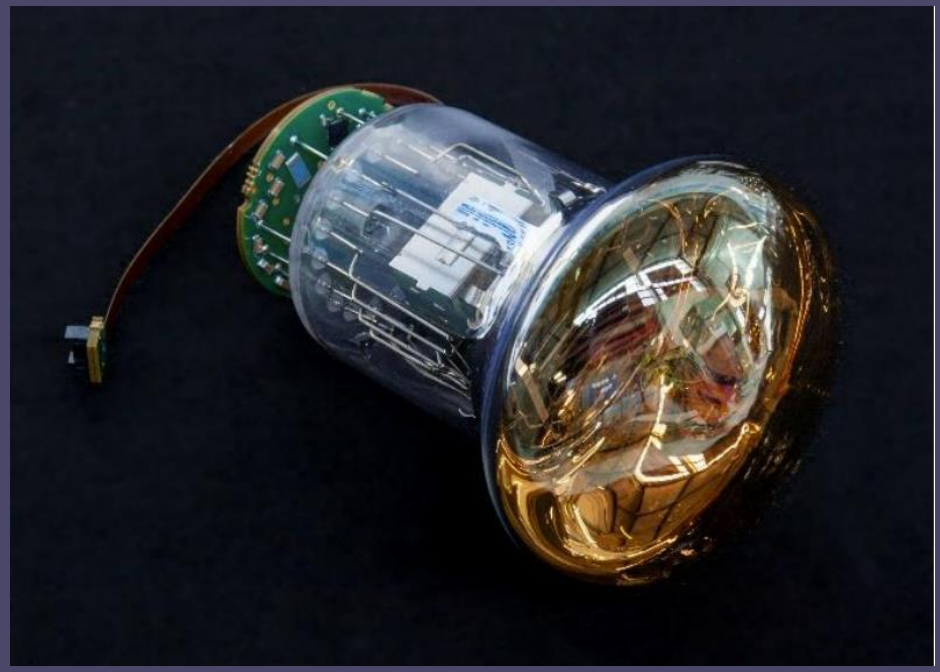


[7]

PMT Characteristics

- Minimum gain 10^6.
- Photocathode diameter 72 mm + reflector ring.
- Length 122 mm.
- Small dark count rate.
- High quantum efficiency.
- Time resolution <5 ns.
- Individual HV base with integrated amplification and tuneable signal discrimination.

[1] [3] [4]



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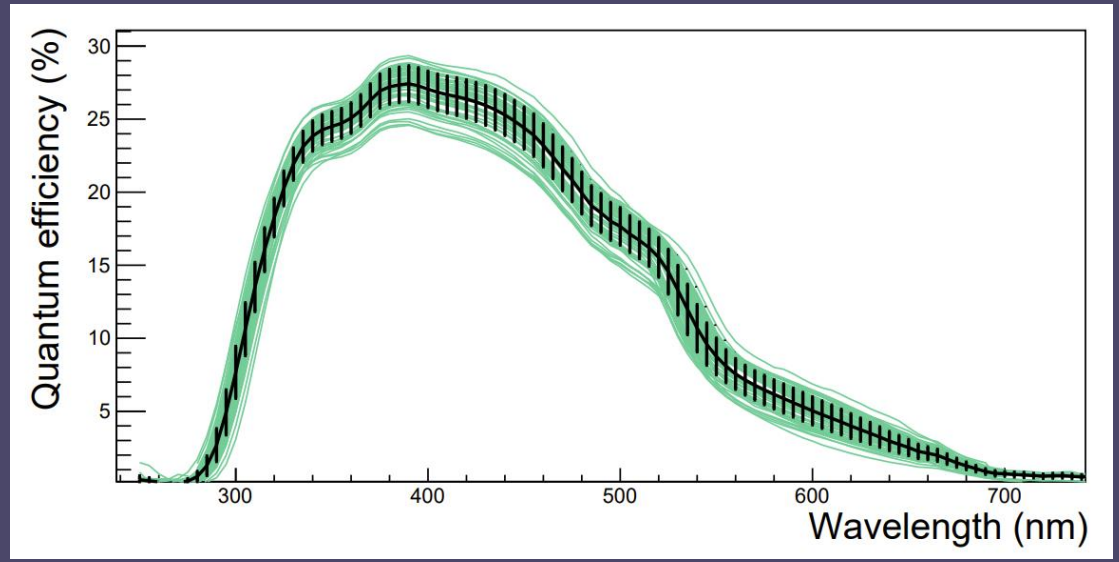


[3]

Interactions

Charged current events:

$\nu_e + N \rightarrow e + X$ EM + hadronic shower

$\nu_\mu + N \rightarrow \mu + X$ Muon track + hadronic shower

$\nu_\tau + N \rightarrow \tau + X$ Hadronic shower + 2nd decay signature

$\tau \rightarrow \nu_\tau \bar{\nu}_\mu \mu$ / $\tau \rightarrow \nu_\tau \bar{\nu}_e e$ / $\tau \rightarrow \nu_\tau$+ hadrons

[2]

Neutral current:

$\nu + N \rightarrow \nu + X$ Hadronic shower

Scattering:

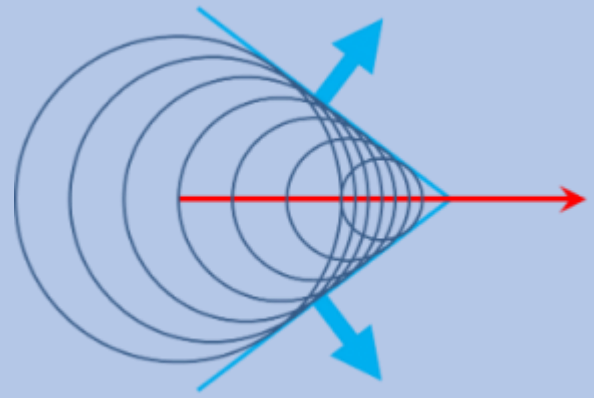
$\bar{\nu}_e + e \rightarrow \bar{\nu}_e + e$ EM shower

[2]

Cherenkov Radiation

Emission angle of Cherenkov radiation:

$$\cos(\theta) = \frac{1}{n\beta}$$



β is the ratio of particle speed over the speed of light in vacuum.

Frequency spectrum of Cherenkov radiation given by Frank-Tamm equation:

$$\frac{d^2E}{dxd\omega} = \frac{q^2\mu(\omega)\omega}{4\pi}\left(1 - \frac{1}{\beta^2 n^2(\omega)}\right)$$

Amount of energy E emitted from Cherenkov radiation, per unit length travelled x and per frequency ω.

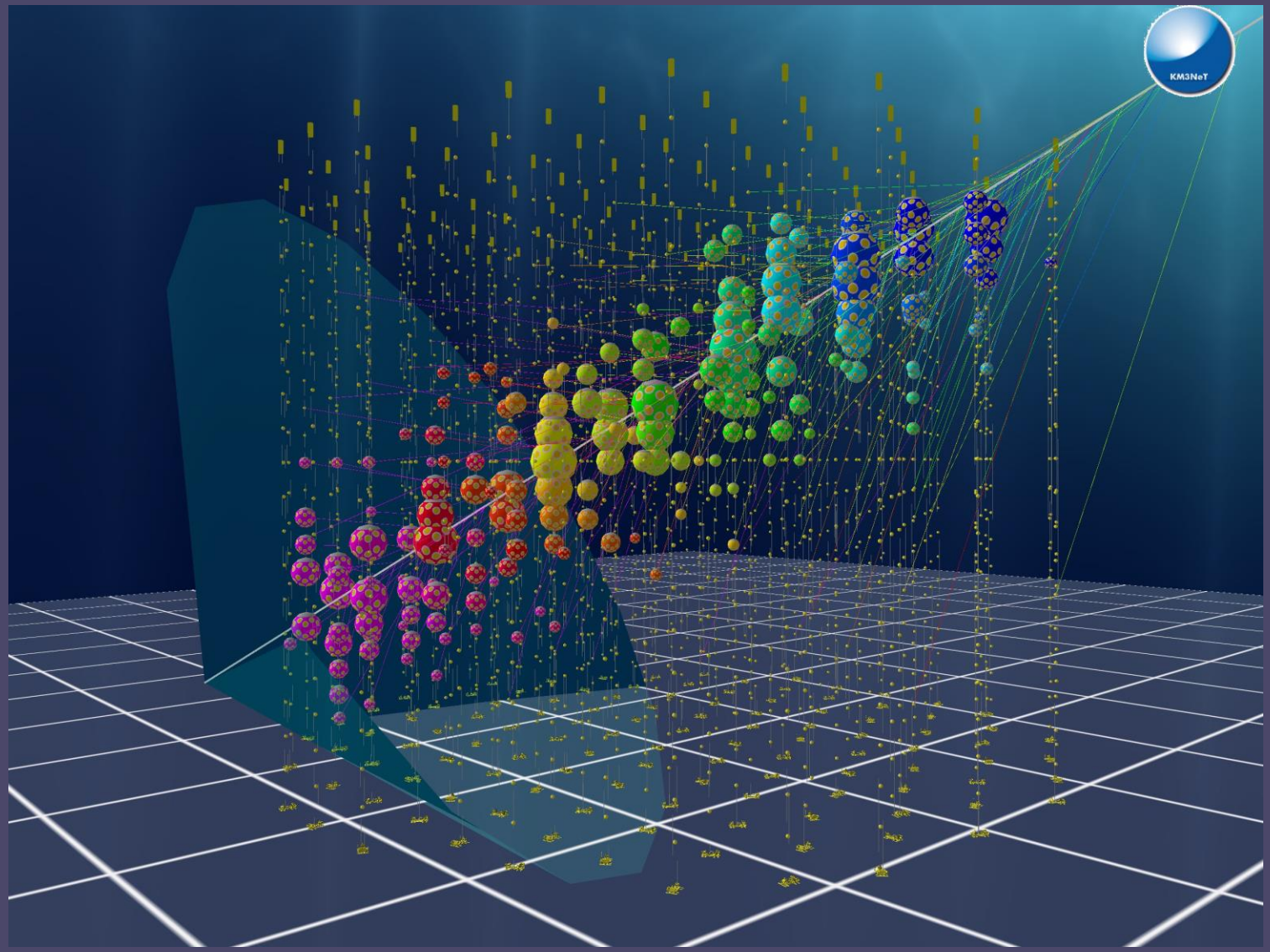
μ(ω) is permeability and n(ω) is frequency dependent index of refraction.

[6]

Event

- Measurement: time of arrival and TOT.
- Each PMT – individual time-to-digital converter.
- Each measurement: 6 B from PMT + position and orientation from calibration equipment.
- Information sent to shore: 1B for PMT address, 4B for time and 1B for TOT.

[1]



[7]

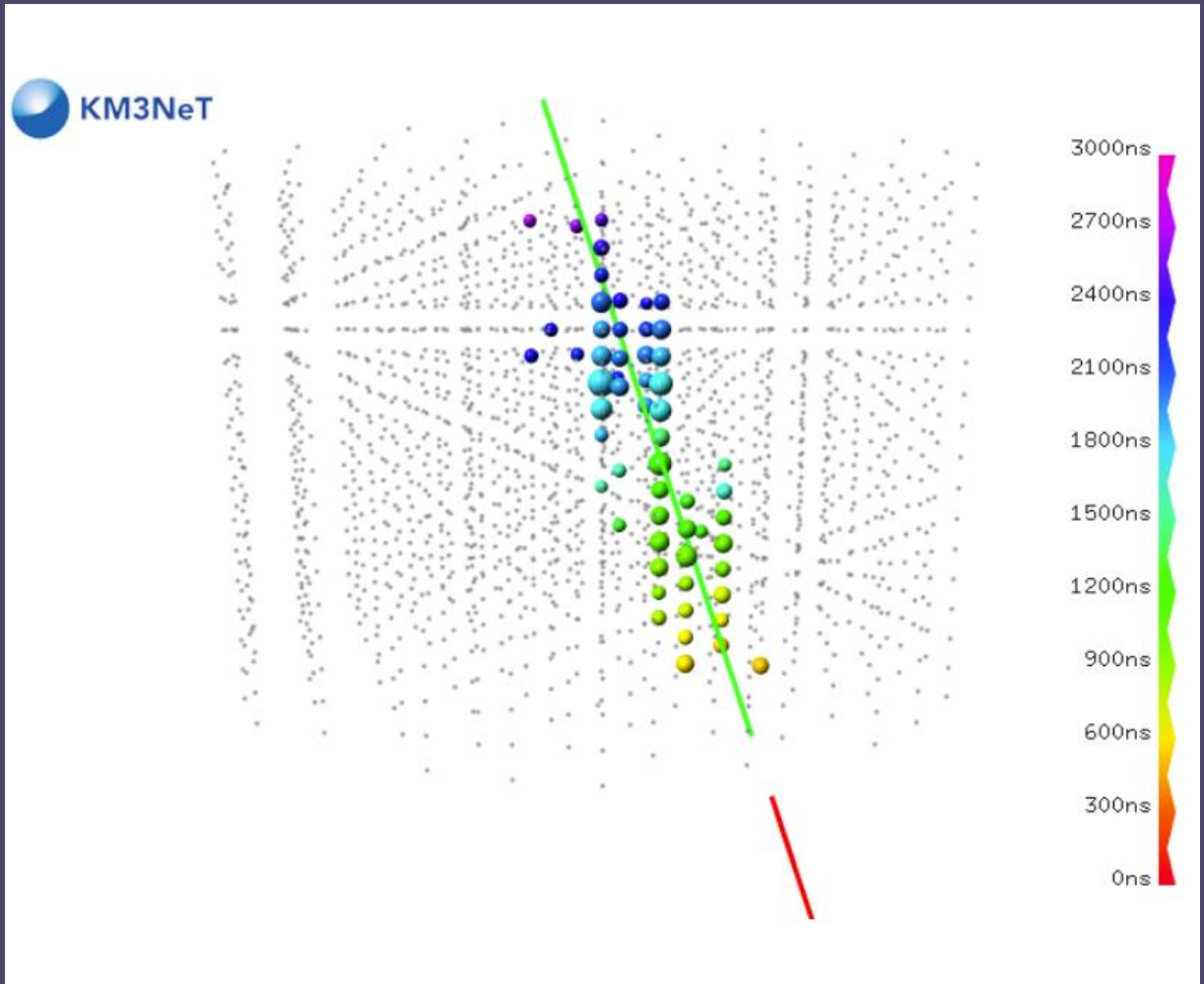
Track

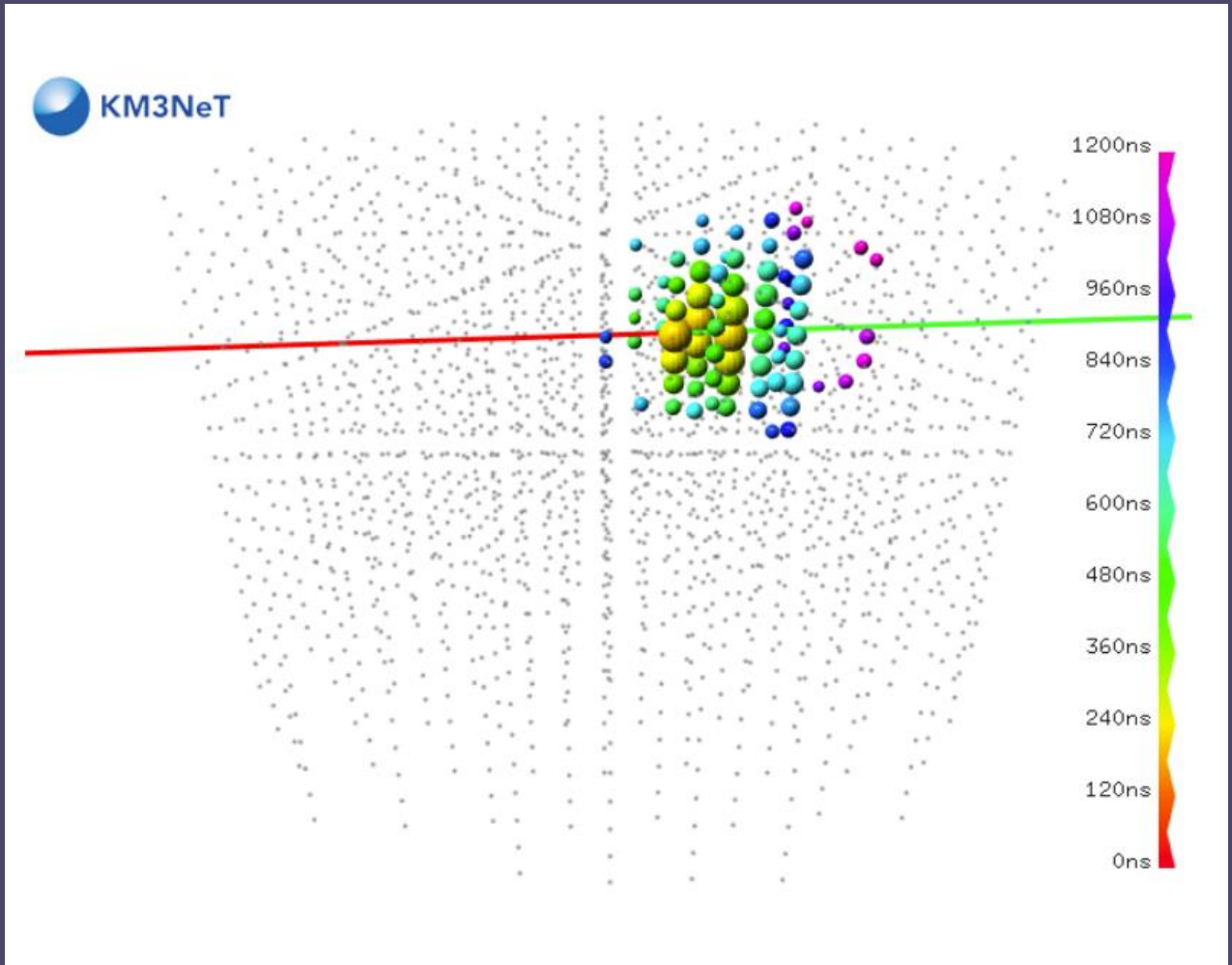
Good direction measurment, not good energy measurement.

Cascade

Good energy measurment, bad direction measurement.

[7]

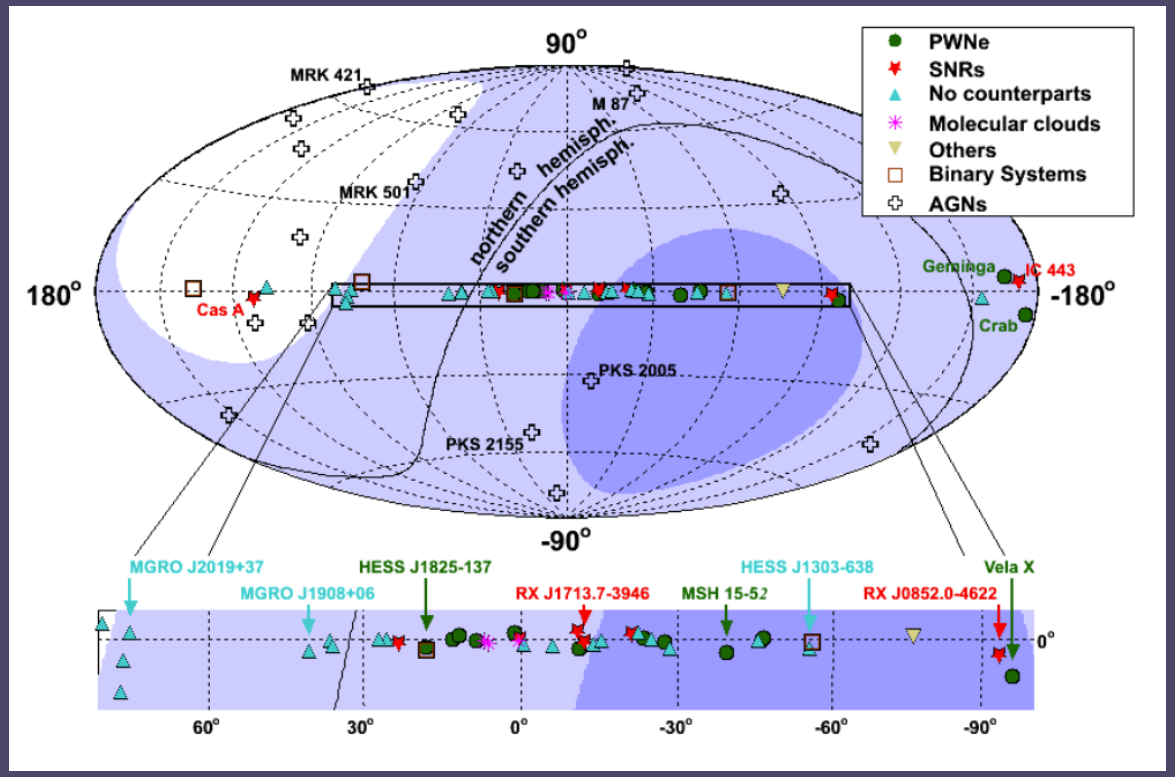




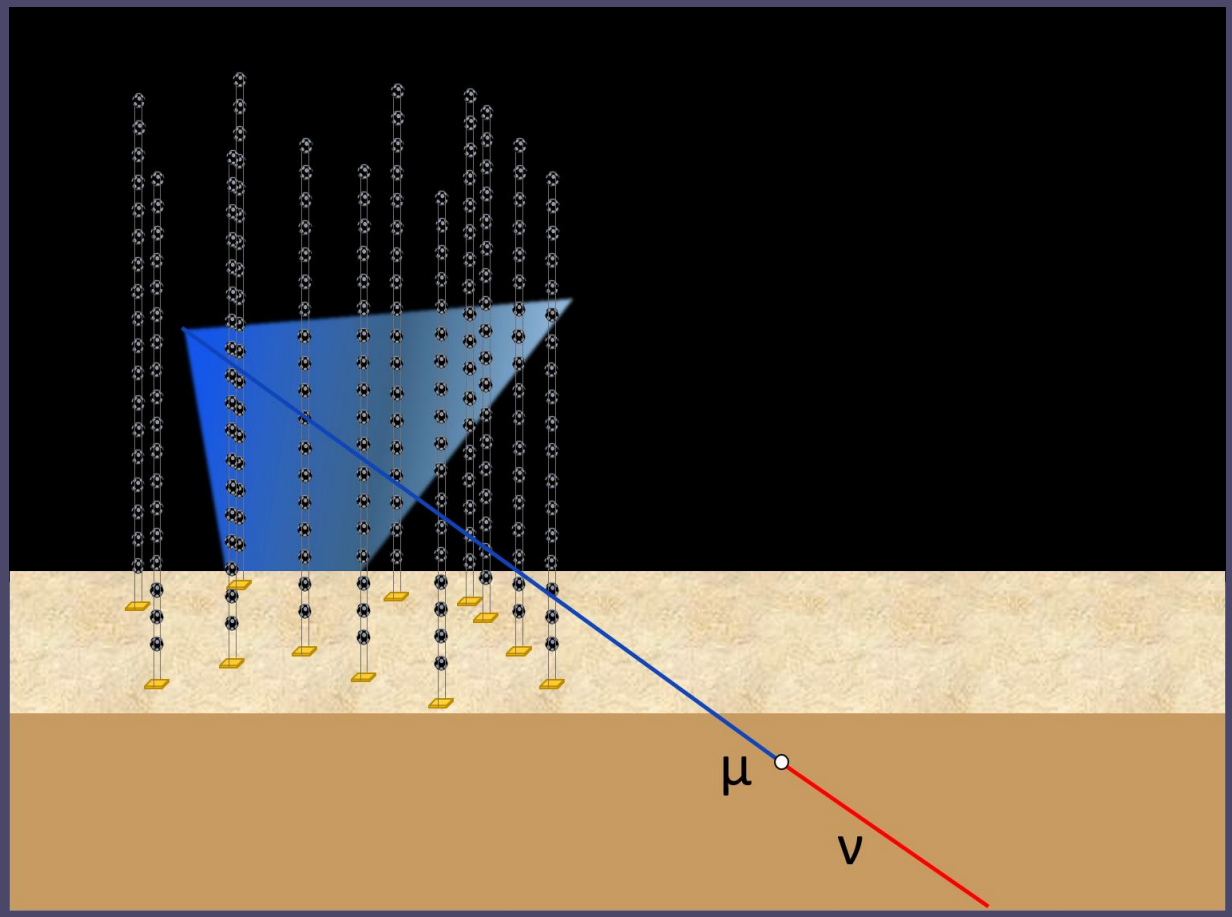
Background

- ^{40}K β-decay.
- Bioluminescence.
- Atmospheric muons and neutrinos.

[1] [2]



[2]

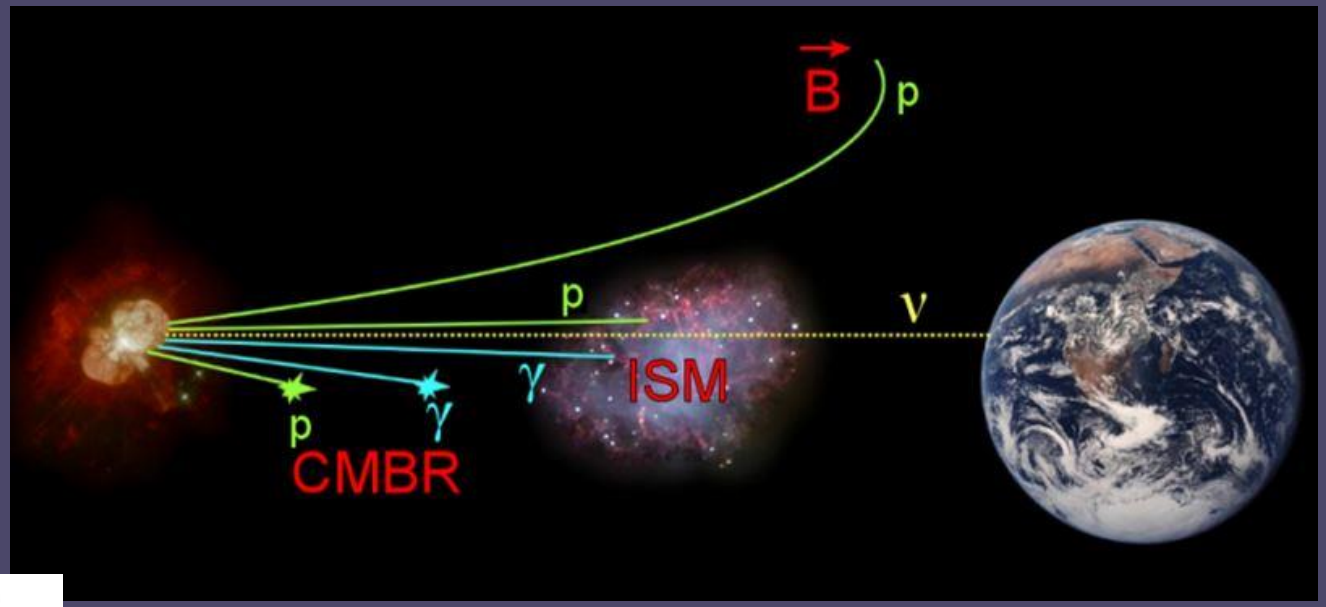


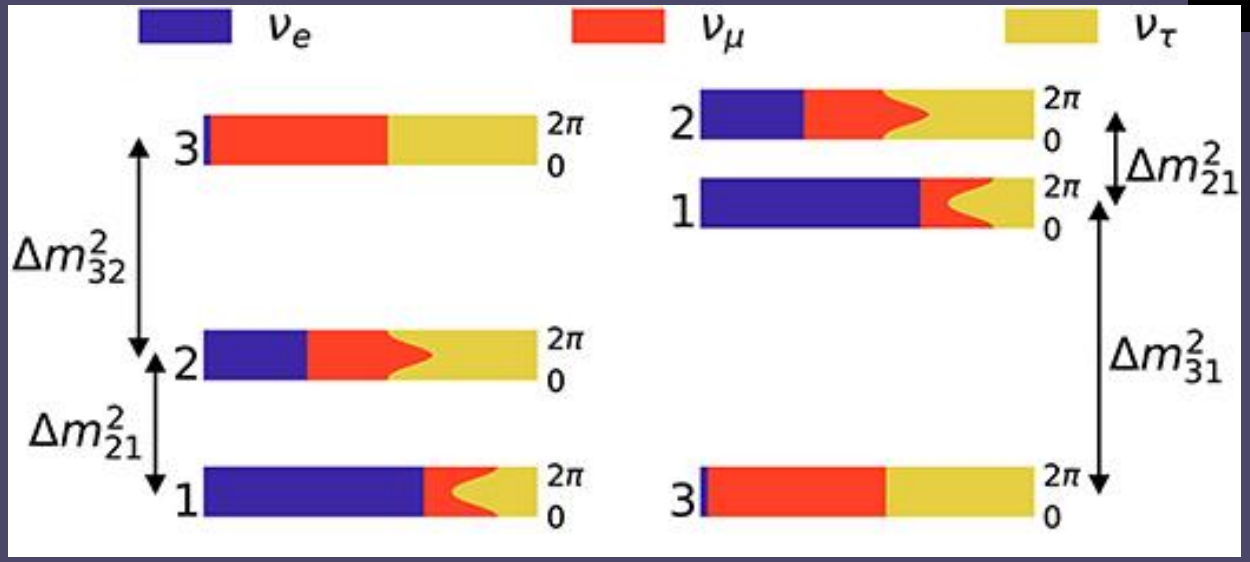
[7]

The Science

- Point-like neutrino sources.
- Diffuse galactic neutrino flux.
- Multi-messenger astronomy.

[1] [2]





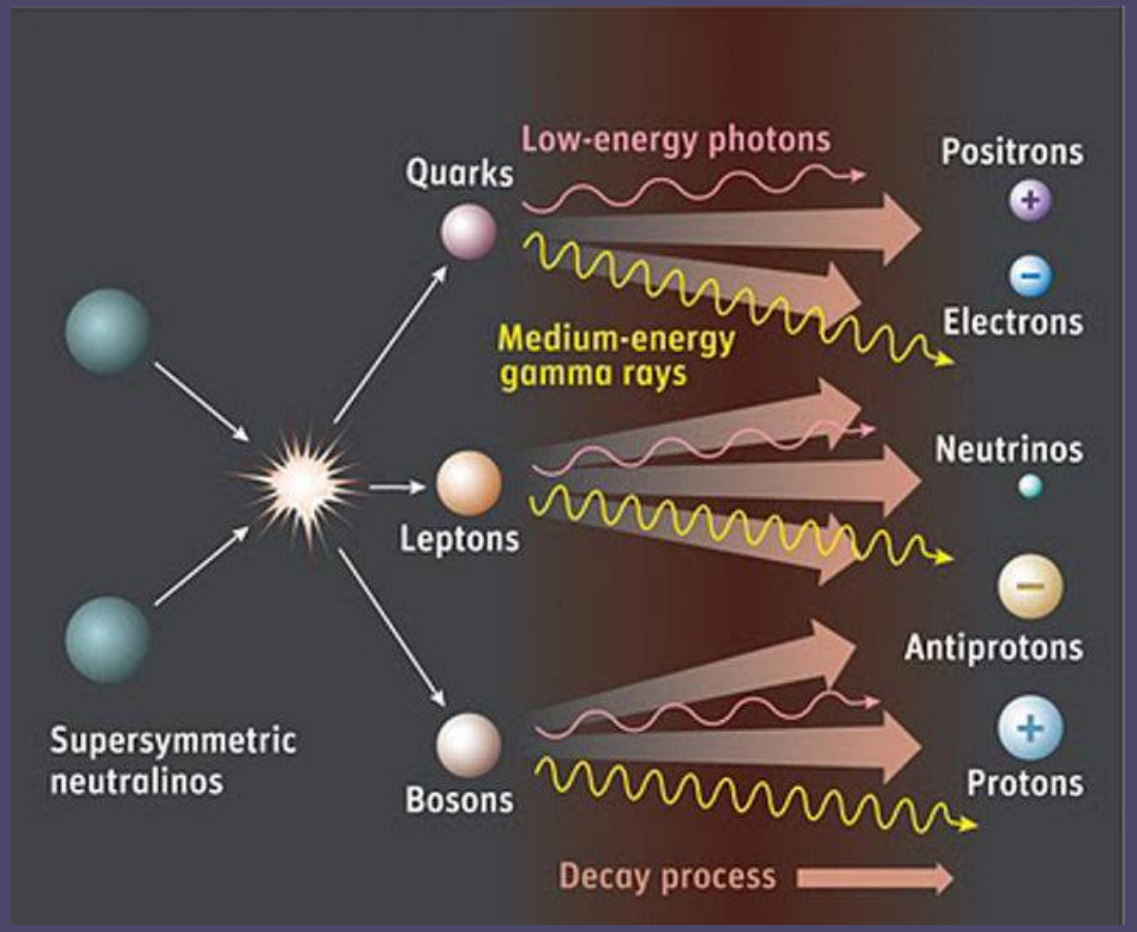
- Neutrino flavour states oscillations.
- Order of neutrino mass states.

[1] [2]

Exotic Science

- SUSY Neutralinos (neutrinos flux)
- Magnetic monopoles (Cherenkov radiation)
- Nuclearites – strange quark stable matter from cosmic rays (black-body radiation)
- Violation of Lorentz Invariance (unexpected interference in neutrino oscillation patters)

[1] [2]



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[7] Credits KM3NeT (as per their official copyright policy for their media files)

[8] Biagi, S., 2015. The data acquisition system of the KM3NeT detector. PoS (ICRC2015), 1172.

Thank you for attention!