

KM3NeT

The neutrino telescope in the deep seas of the
Mediterranean

XXX-th International Workshop on
High Energy Physics
23-27 June 2014, Protvino, Russia

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FOR ASTROPARTICLE
PHYSICS

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On behalf of the KM3NeT Collaboration

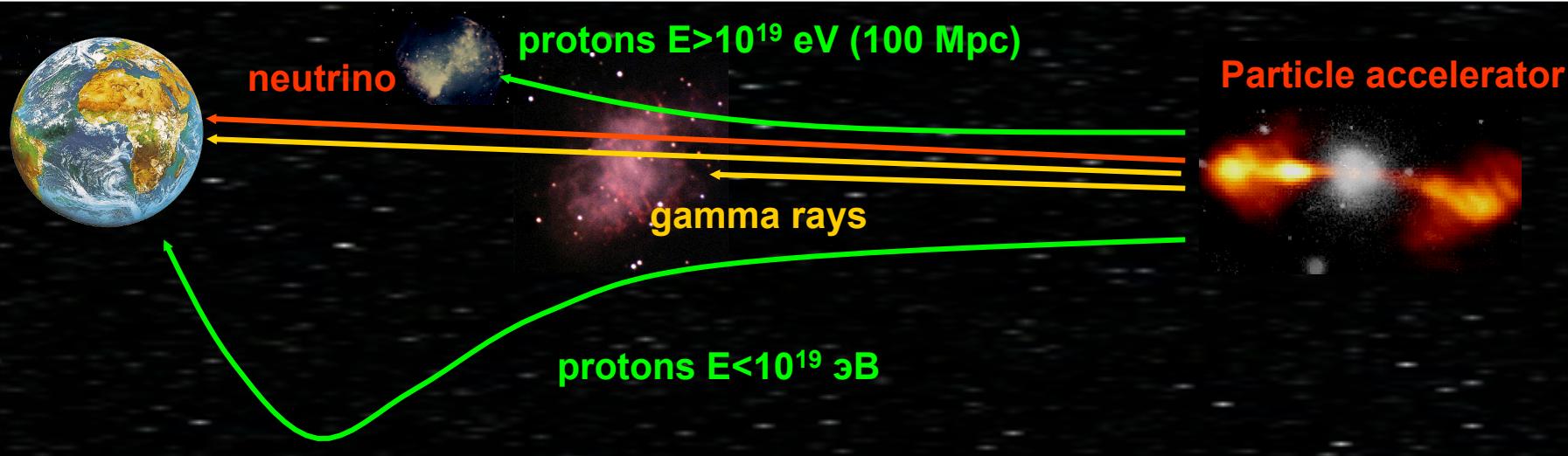


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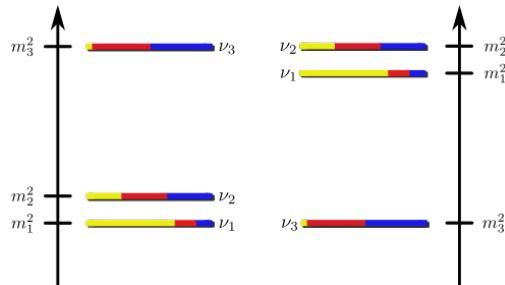


Physics with high energy neutrinos

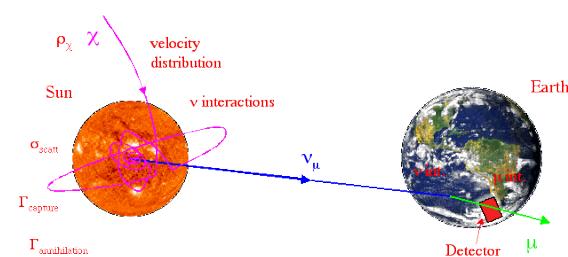
Astrophysics: cosmic rays accelerators



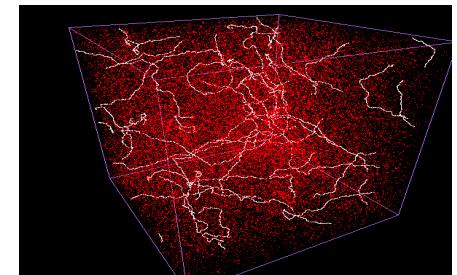
Neutrino physics:
mass hierarchy



Particle physics:
dark matter



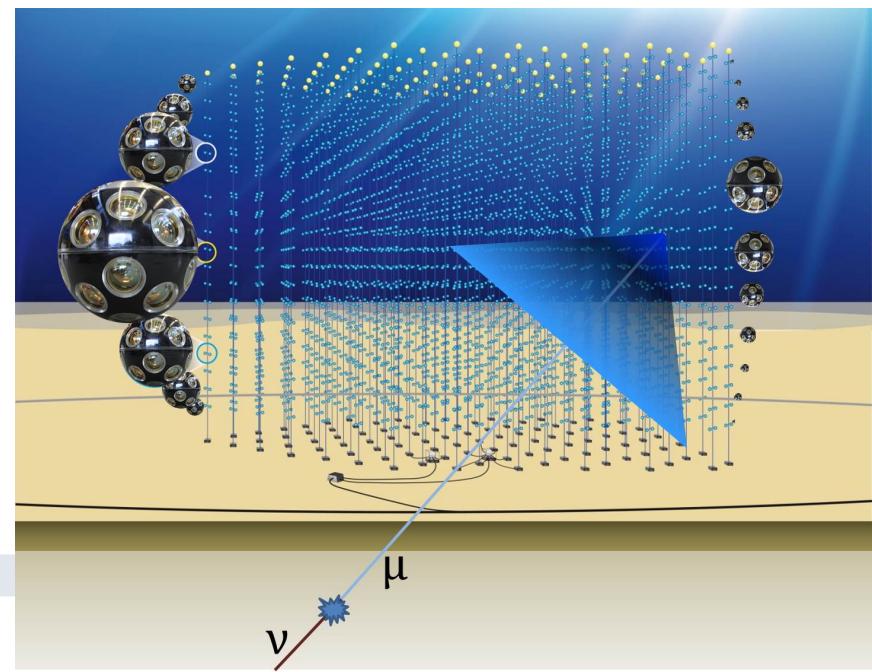
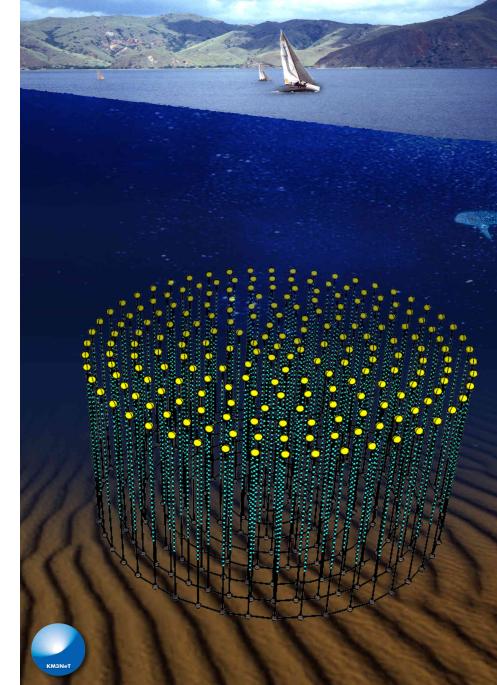
Exotics: strings,
magnetic monopoles



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KM3NeT design

- Six separated building blocks to permit an operation simultaneously with further maintenance
- Detection unit (DU) – vertical slender string with multi-PMT digital optical modules (DOMs)
- 18 mPMT DOMs supported by two parallel ropes
- Power and data cables separated from ropes; single backbone cable with breakouts to storeys
- Distances between DOMs = 36 m
- The lowest DOM at 100 m above the seabed
- The total height of the DU ~700 m



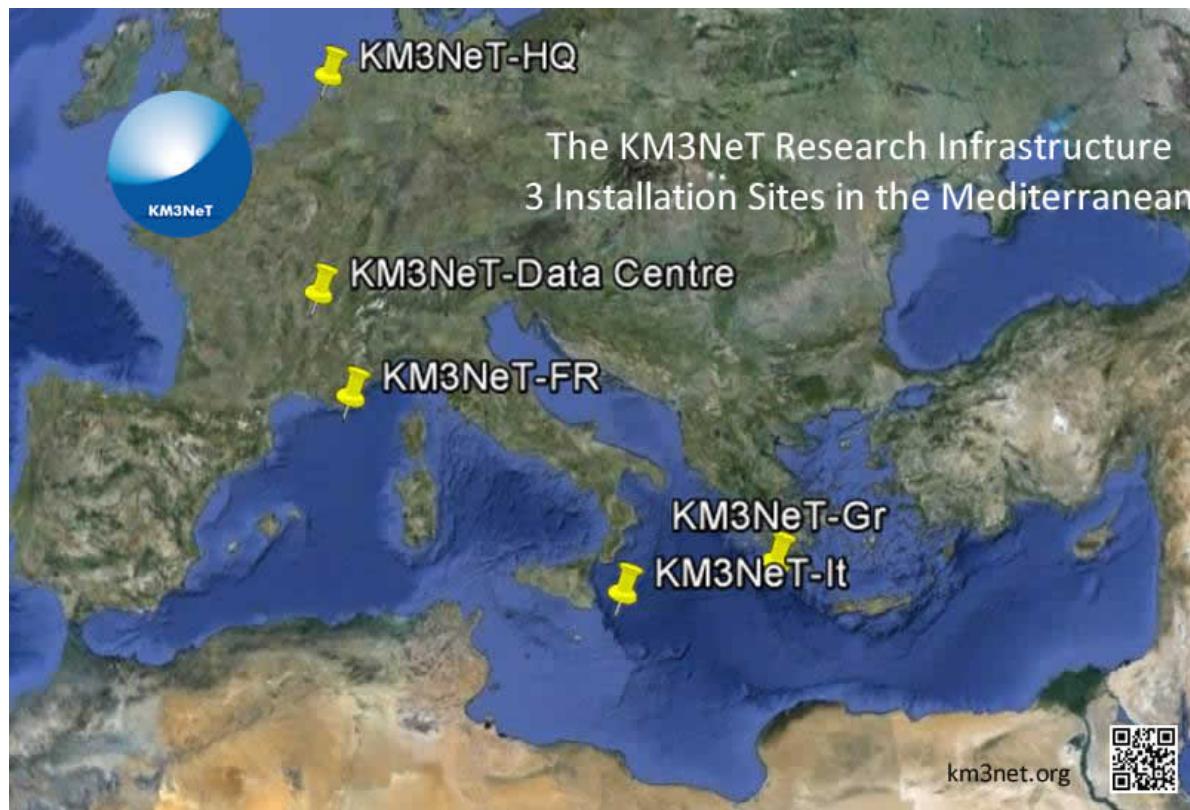
KM3NeT: multi-site concept

KM3NeT-Fr: 2500m depth, 45km offshore Toulon, France

KM3NeT-It: 3500m depth, 100km offshore Portopalo di Capo Passero, Sicily, Italy

KM3NeT-Gr: 3500-5000m depth, 20km offshore Pylos, Peloponnese, Greece

Identical technical design at all sites

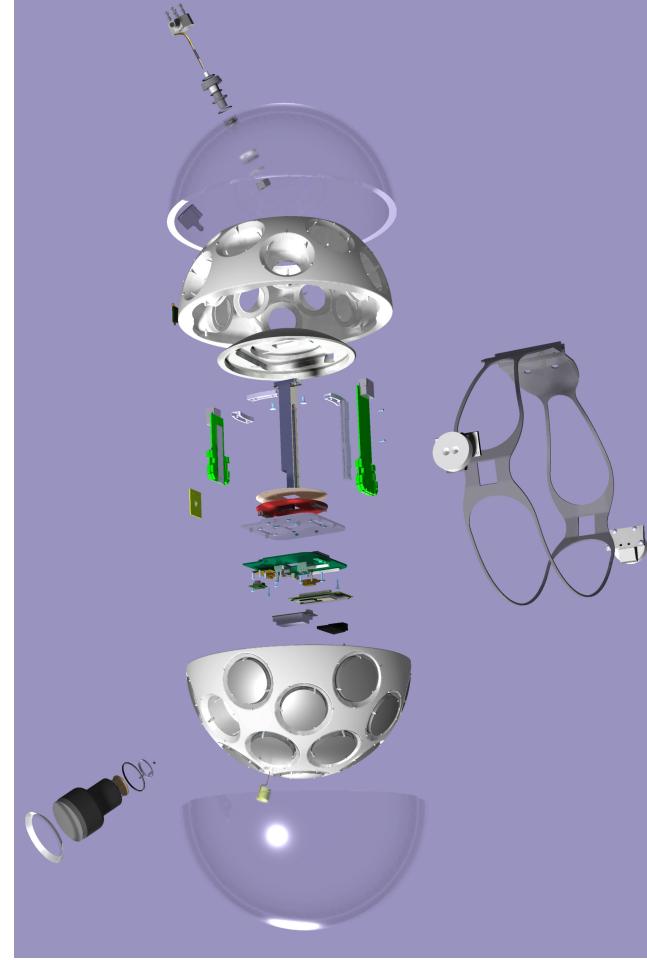


Multi-PMT DOM

- 31 3" PMTs with reflectors in 17-inch
- glass sphere (cathode area ~3x10" PMTs)
 - 19 in lower, 12 in upper hemisphere
 - Suspended by support structure
- 31 PMT bases (total ~140 mW)
- Aluminum cooling shield and stem
- Piezo, Nano-beacon (LED), compass, tiltmeter
- FPGA readout
- 2mm optical gel (ANTARES-type)

PMTs:

- 86mm ETEL D792FLA
- 80mm Hamamatsu R12199-02
- 76mm HZC (China) XP53 (former Photonis)

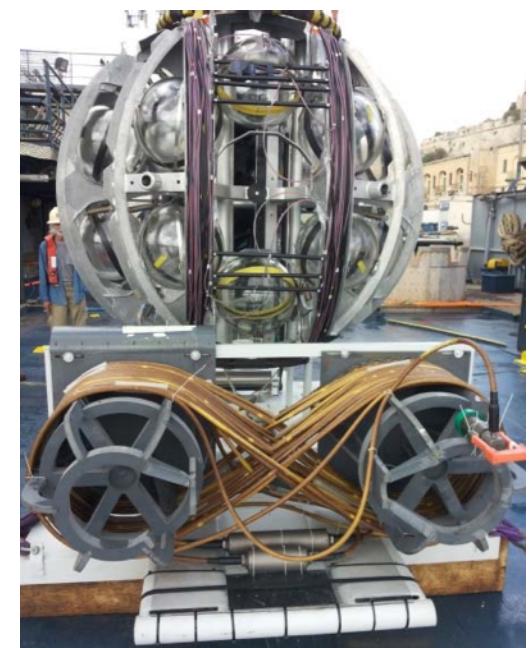


KM3NeT: way to full scale detector

- **PPM* DOM** – operational in Antares since April 2013. **Multi-PMT Digital Optical Module design proved.**
- **PPM DU** – operational at KM3NeT-IT since May 2014. **Detection unit designed proved.**
- **Phase 1** – 25 full scale DUs at KM3NeT-FR and KM3NeT-IT. Funded, ordering of components and integration started in 2014. **Proof of feasibility of network of neutrino telescope.**
- **Phase 1.5** – km³ scale detector. Letter of Intent. **Measurement of neutrino signal reported by IceCube.**
- **Phase 2** – a few km³ scale detector. ESFRI# road map. **Neutrino astronomy.**

* PPM – Preproduction module (prototype)

ESFRI – the European Strategy Forum on Research Infrastructures



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1st Prototype: PPM DOM

3" ETEL PMTs D783FLA

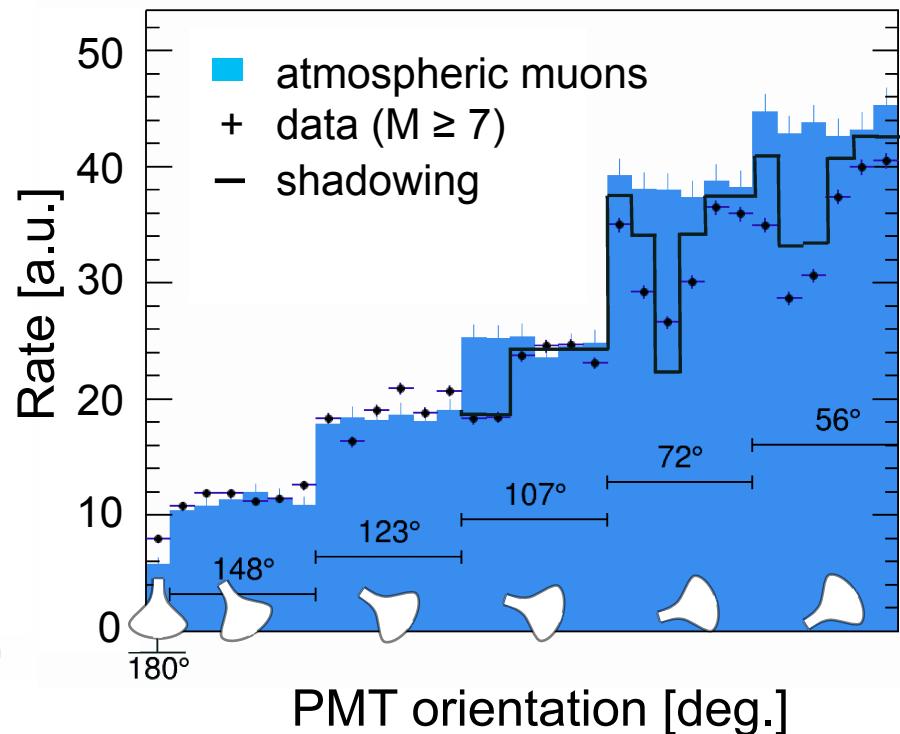
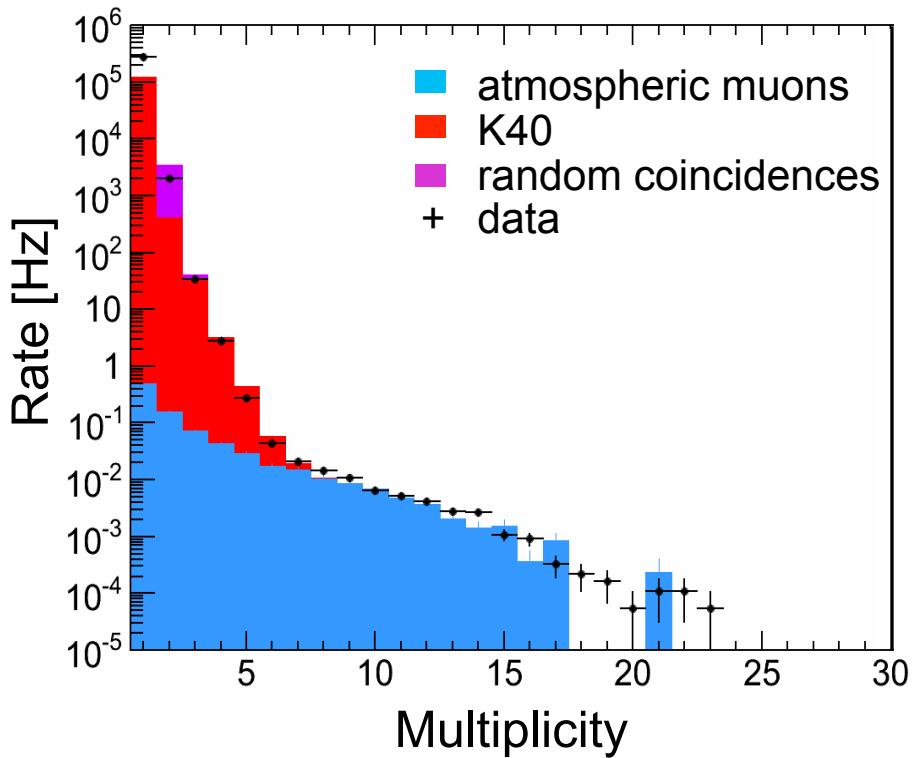
Deployed at the KM3NeT-It site with Antares instrumentation line at 2500m depth

Operational since April 2013



PPM DOM: first results

Atmospheric muon signatures in a single optical module!



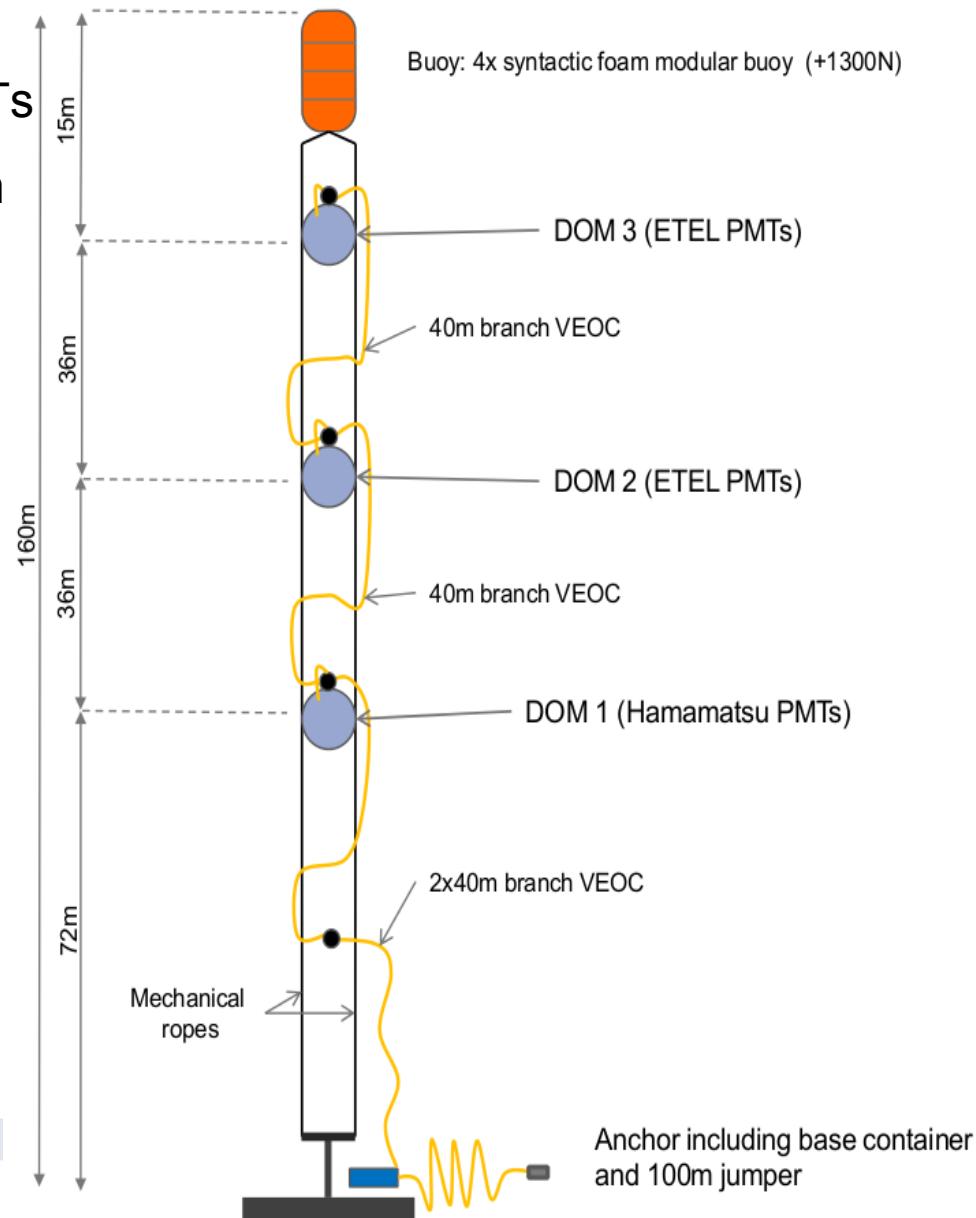
2nd Prototype: PPM DU

2 DOMs with ETEL D783FLA PMTs

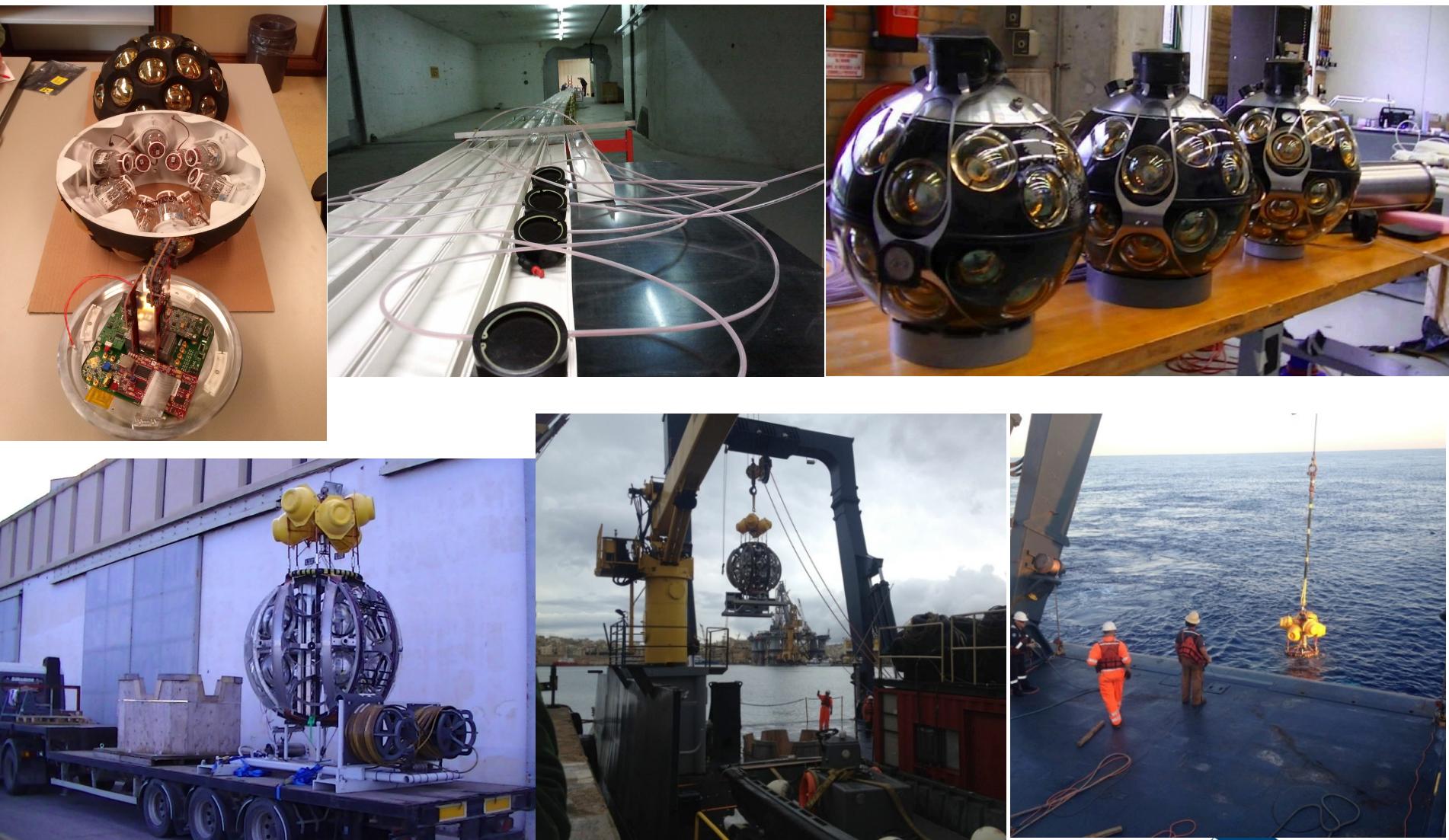
1 DOM with Hamamatsu R12199-02 PMTs

Deployed at the KM3NeT-It site at 3500m depth

Operational since May 2014

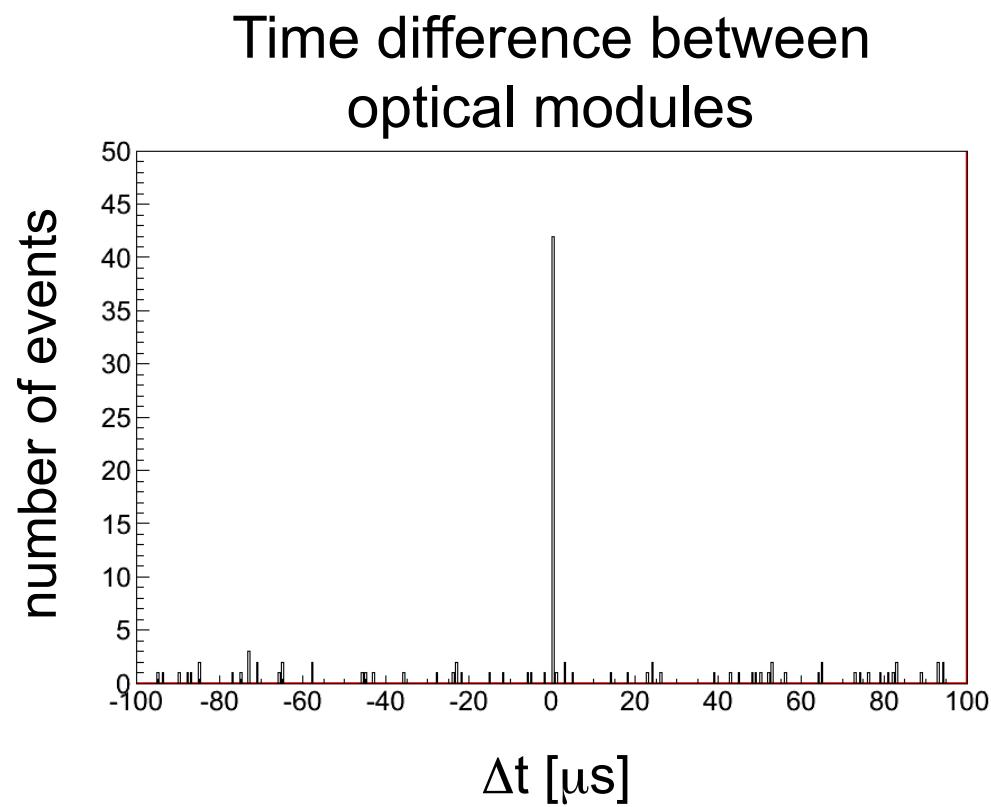
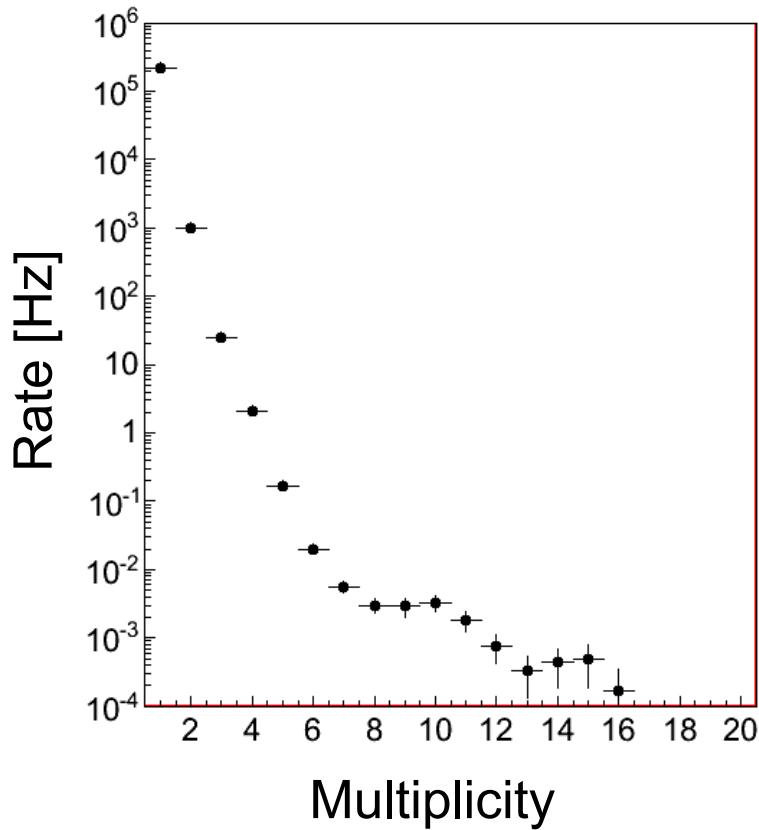


PPM DU integration & deployment



PPM DU: first results

Atmospheric muon signatures



KM3NeT phase-1

Proof of feasibility of network of neutrino telescope

Beginning in January 2014

Funded with 31 million Euro

Sites: KM3NeT-It, KM3NeT-Fr

25 detection units will be deployed in 2015-2016

KM3NeT phase-1.5

Measurement of neutrino signal reported by IceCube

~115 detection units

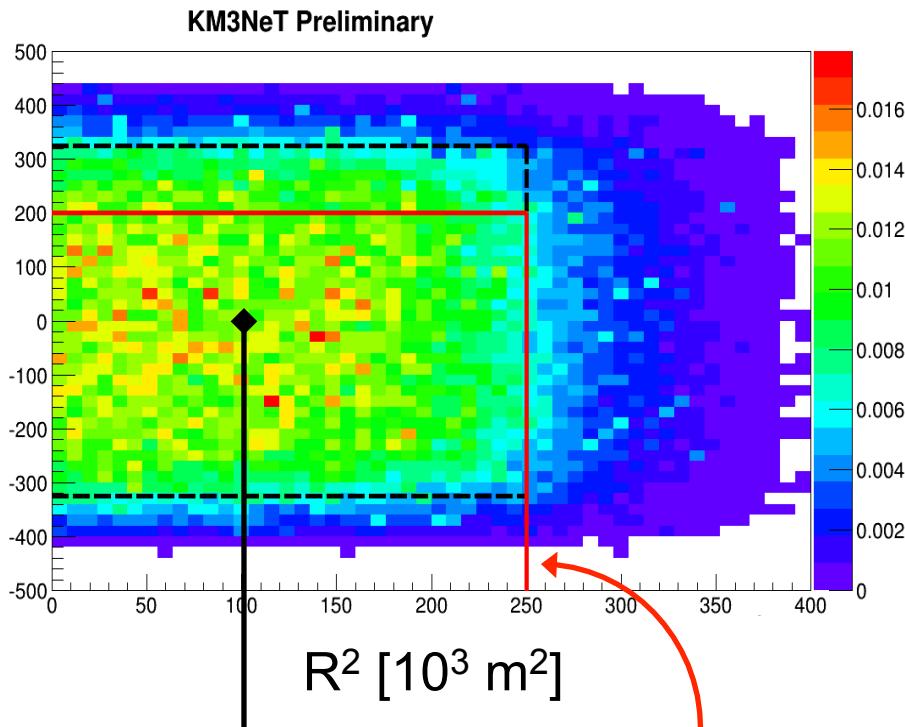
80-90 million Euro needed

Cascade analysis – cut & count

- **Online data filter:** ≥ 5 coincidences between PMTs in the same optical module, $\Delta t=10\text{ns}$
- **Event filter:** number of hits ≥ 2000
- **Atmospheric muon veto:** (pseudo) vertex cut
- **Energy cut:** total time-over-threshold $\geq 15 \mu\text{s}$
- **MRF/MDP cut:** 2D cut based on Boosted Decision Tree & energy estimate

Atmospheric muon veto

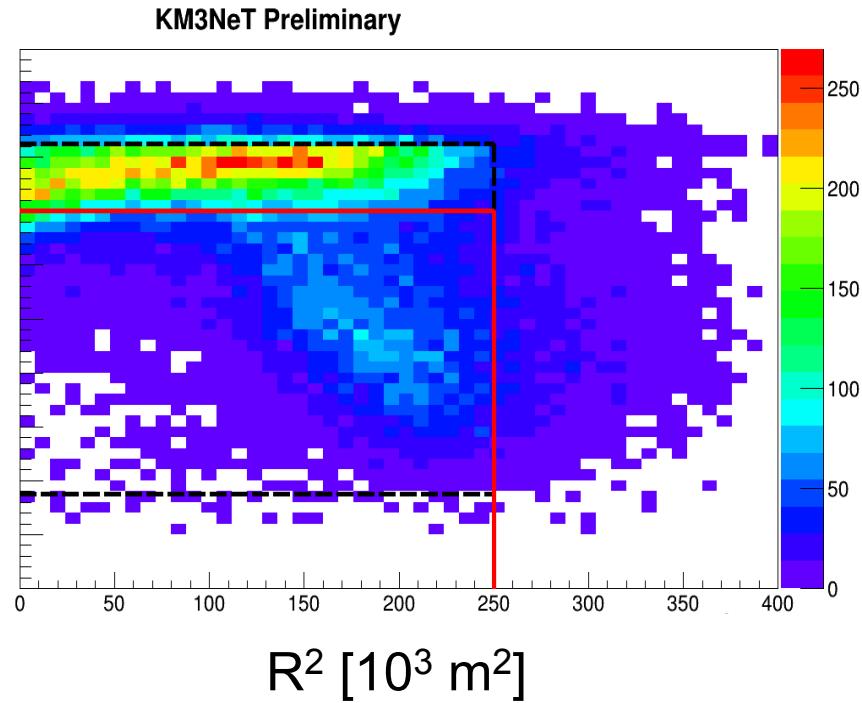
cosmic neutrinos



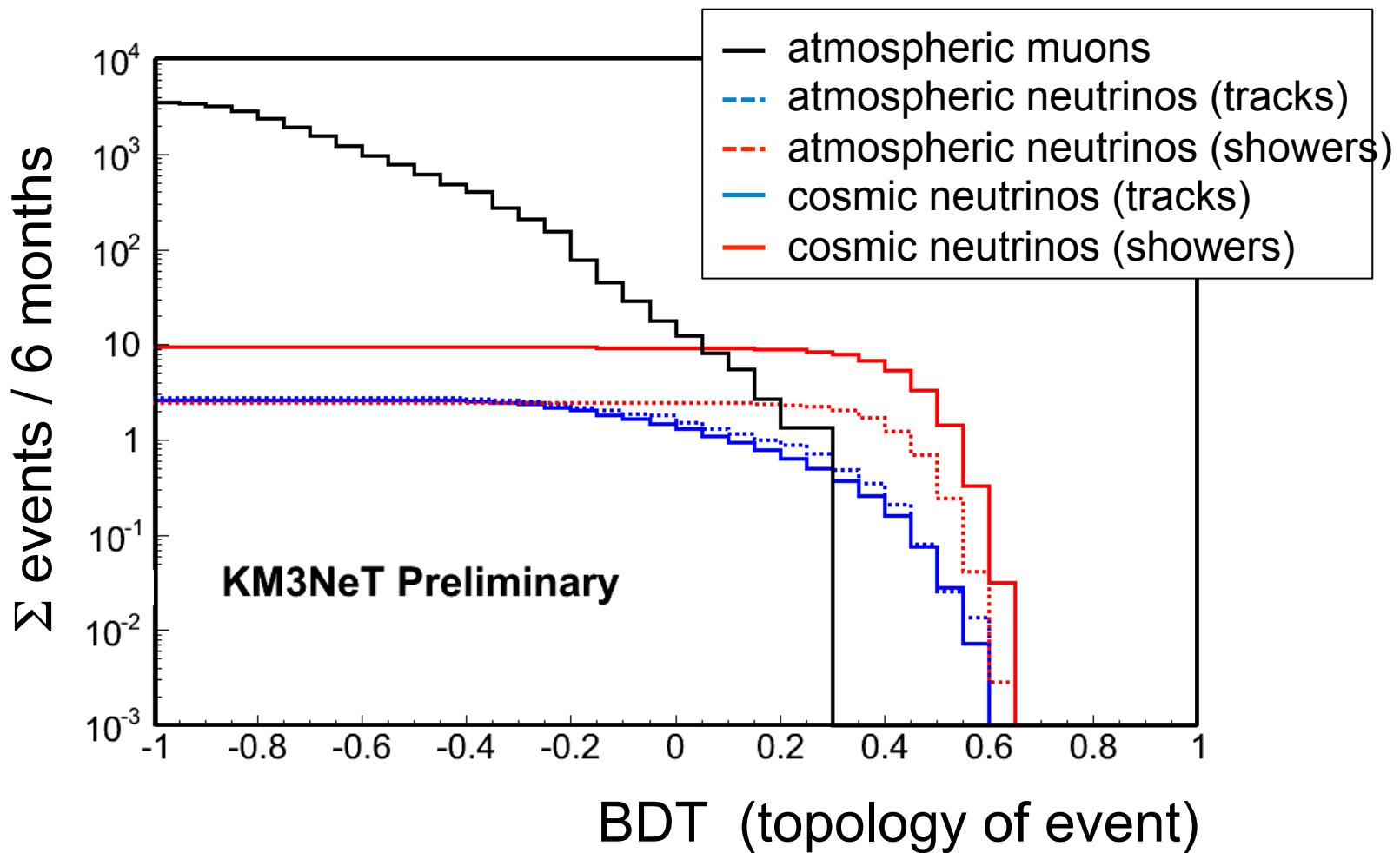
detector volume

vertex cut

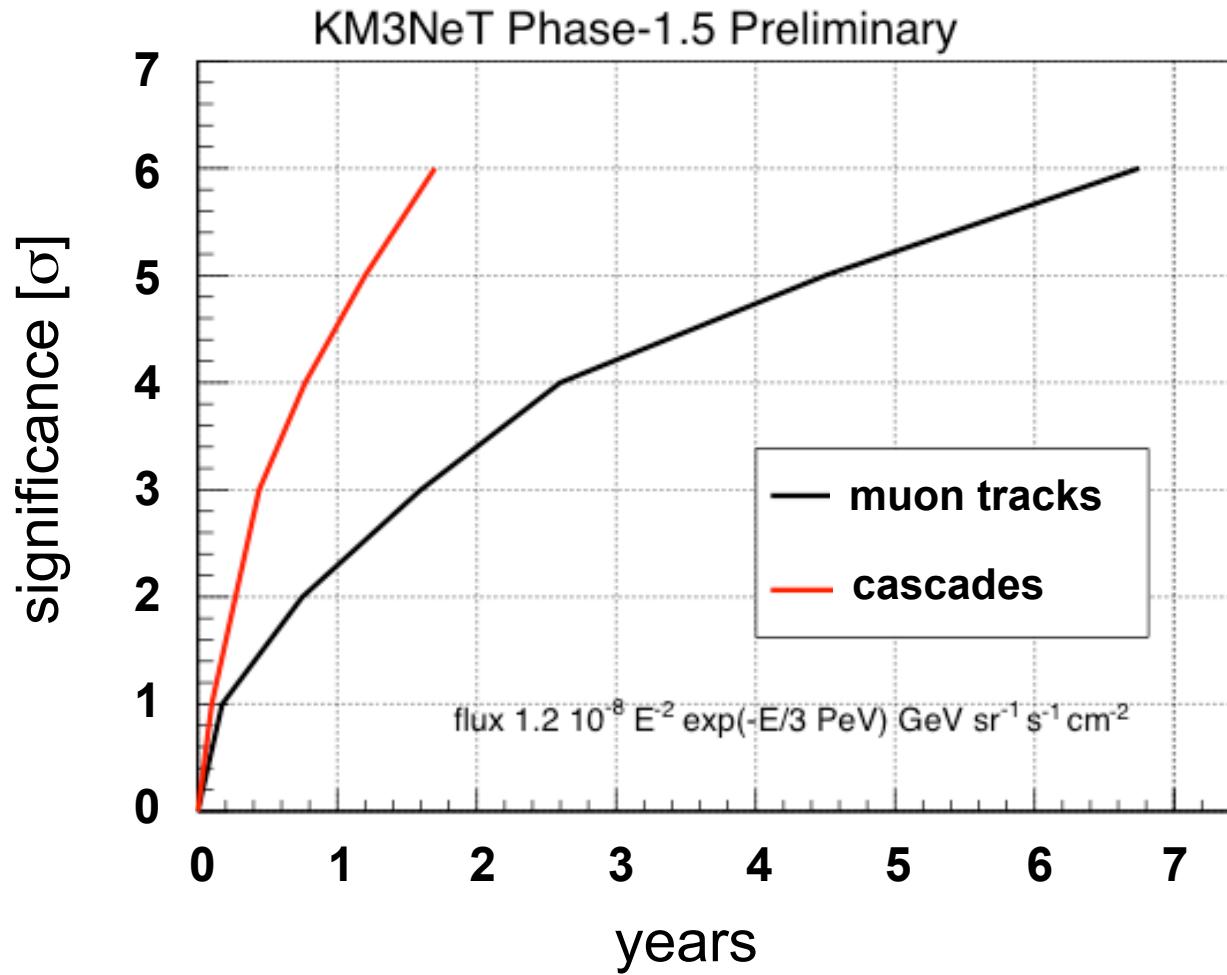
atmospheric muons



Signal/noise



Sensitivity

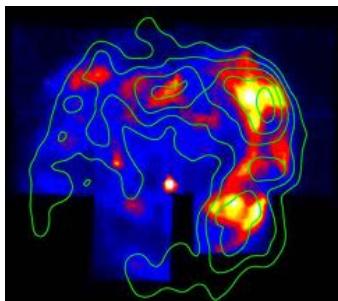


KM3NeT phase-2

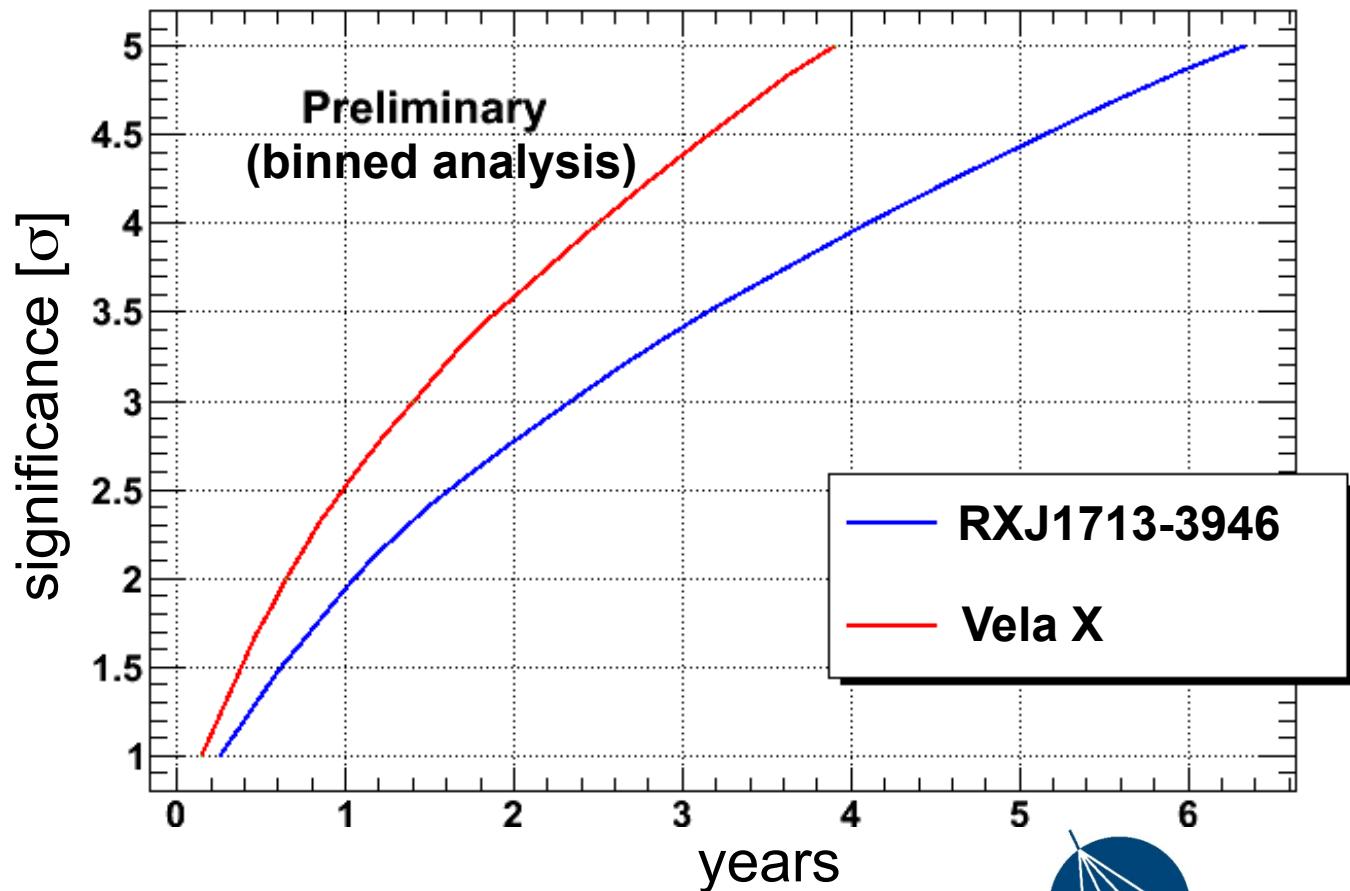
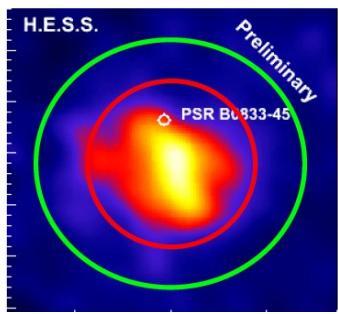
Neutrino astronomy

Galactic sources of cosmic rays (?)

RXJ1713



Vela X

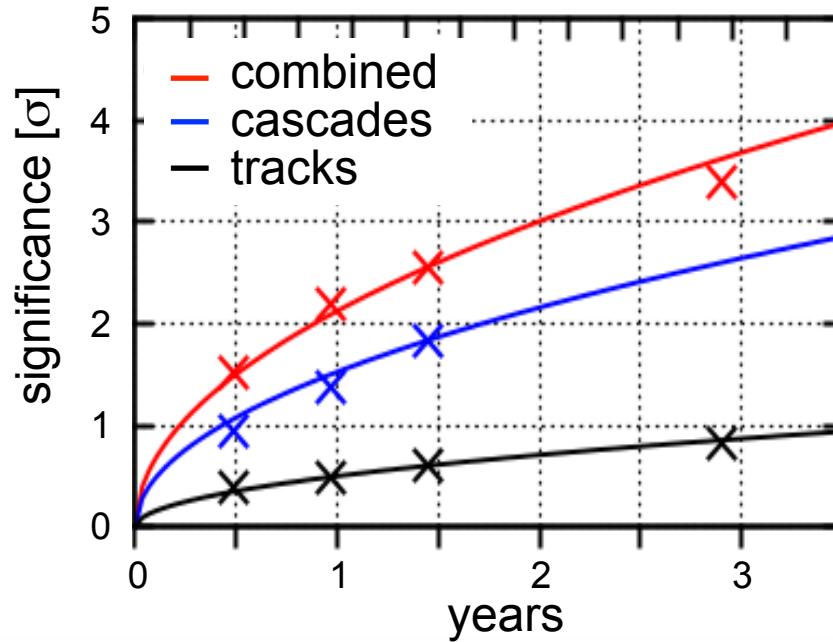
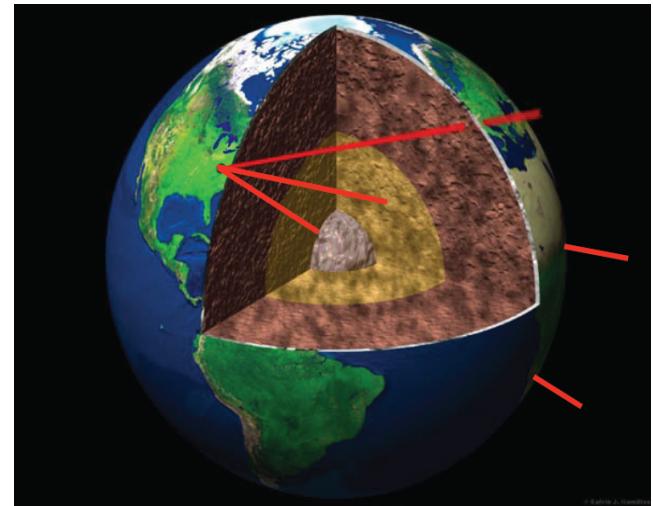


ORCA: “low” energy option

Neutrino mass hierarchy

Dense detector using KM3NeT technology

- inst. volume: 1.8Mton sea water
- 50 strings with 20 OMs each
- height 114m, diameter 140m
- 20m (mean) horizontal string distance
- 6m vertical distance between OMs



Summary

Prototypes successfully deployed

Phase-1 funded and started in 2014

**Phase-1.5: measurement of neutrino signal reported by
IceCube expected**

Phase-2: Neutrino astronomy