KM3NeT unveils detailed plans for largest neutrino telescope in the world

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KM3NeT - a European collaboration pioneering the deployment of kilometre cubed arrays of neutrino detectors off the Mediterranean coast - has reported in detail on the scientific aims, technology and costs of its proposal in the *Journal of Physics G: Nuclear and Particle Physics*.

Neutrinos are ideal messengers from the cosmos. These stable, sub-atomic particles can travel long distances without being disturbed by matter or magnetic fields in their path. Their detection is prized by astronomers as neutrino-emitting sources such as the remnants of Super Nova explosions provide important clues to the evolution of our universe. The study of neutrinos could also help in expanding our knowledge of atomic physics. However, there is a catch.

"The weak interaction between neutrinos and normal matter is a blessing and curse," commented Maarten de Jong, who has been involved in the KM3NeT project since the first design study in 2006 and is spokesperson for the collaboration. "It makes detecting them notoriously difficult, which is why you need a giant detector."

It's a big undertaking. To detect neutrinos from the cosmos you need a massive site, which can then be used as a converter target as follows -

Firstly, a neutrino interacts with an atomic nucleus in the target medium to produce relativistic charged particles. Secondly, the passage of these relativistic charged particles through the medium produces so-called Cherenkov light (the typical blue light on pictures of nuclear reactors).

And lastly, the Cherenkov light is detected by a 3-dimensional spatial array of incredibly sensitive photo-sensors.

Fortunately, Mother Earth is able to lend a helping hand in bringing down the cost of developing such a huge structure. "It turns out that the deep waters in the Mediterranean are ideal," explained de Jong. "These natural waters come for free, are very transparent to the Cherenkov light, and sufficiently accessible to allow the deployment of strings of photo-sensors."

At a depth of several kilometres there is no more daylight, which means that KM3NeT's optical modules can be placed in darkness for maximum sensitivity to the neutrino-signalling Cherenkov light. Also, under these conditions the neutrino telescope can be operated 24 hours a day, 7 days a week.

The KM3NeT collaboration has developed what it believes is a cost-effective plan for building out this research infrastructure at the bottom of the sea. The phased rolled-out will consist of three so-called building blocks, where each building block comprises 115 strings of 18 optical modules (glass spheres containing 31 outward-facing photomultiplier tubes).

The strings, which can extend for several hundred metres, are anchored on the seabed and kept vertical by the buoyancy of the optical modules and the use of an additional buoy at the very top. These long chains of detectors are important, because they allow the scientists to reconstruct the trajectory of the incoming neutrinos. This data can then be used by researchers to identify the locations of the corresponding sources in outer space.

The array will provide a large piece of the puzzle required to monitor the whole of the sky for incoming neutrinos, linking existing telescopes based under the South Pole (IceCube) and in Lake Baikal, Russia (Gigaton Volume Detector - GVD).

In December 2015, the KM3NeT collaboration successful tested the deployment of a string of its latest optical modules. It has already raised EURO 31 million to begin phase one of the project. The work builds on experience gained through ANTARES (a 12 string array based off the coast of France).

More information: *Journal of Physics G: Nuclear and Particle Physics.* [DOI: 10.1088/0954-3899/43/8/084001](https://doi.org/10.1088/0954-3899/43/8/084001)

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