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Abstract: KM3NeT is proposed as a second-generation neutrino telescope to be built in the Mediterranean Sea. The basic detection unit (DU) of the apparatus is designed as a flexible structure built with two ropes keeping up to 20 digital optical modules (DOMs) over a height of almost 1 km. This design represents a step forward compared to the detection lines of ANTARES. The DU is designed so as to be packed into a compact launch vehicle for deployment on the sea bottom. The DU can then unfurl to reach their vertical configuration. An in situ qualification campaign is ongoing: as a first step a KM3NeT DOM has been integrated on the instrumentation line of ANTARES. The second step consists of a reduced-scale prototype of a KM3NeT DU to be installed and operated on a sea floor infrastructure in Sicily. The final step will consist of a complete DU equipped with all nominal components which will be connected to the KM3NeT sea floor network.

Keywords: neutrino, ANTARES.

1 First KM3NeT DOM

The new generation of optical module for the KM3NeT detector consists in a 17" pressure-resistant glass sphere containing 31 3" photomultiplier tubes and the associated electronics for production of the high voltage and for readout of the signals of the photomultipliers. The DOM forms a complete stand-alone detector that is connected to the outside world via 2 optical fibers and 2 wires providing electrical power.

The first DOM prototype has been built and, after extensive onshore tests, has been deployed in the sea integrated (see Figure 1) on one of the detection line of ANTARES which provides to it an optical point to point connection to the shore.

Since the DOM connection to shore in April 2013, the instrument is operated in situ successfully, showing a very stable and reliable behavior. The full characterization of its response (single and coincidence rates, after pulses, time resolution) is still undergoing but the run taken so far already permitted to calibrate the 31 PMT relative time offsets and muons have been detected with this single DOM.

This optical module will operated in the sea for a long period, providing also somes indications on the long term reliability of the inner components and the system.

Figure 1: First DOM deployment

2 Mechanical in situ qualification

The detection line consists of 18 optical modules distributed along the 800m line height. For the deployment on the sea bottom, it is designed to be packed into a compact launch vehicle, the so called Launcher of Optical Modules (LOM), a 2.02 m diameter sphere holding the 17"glass spheres that unroll the line to reach their vertical configuration. The LOM surfaces freely after emptying its contents and can be used again.

As a follow-up of the first unrolling tests of a compacted line in December 2009 and February 2011, further tests were performed in April 2013 in the Mediterranean Sea at 1000m depth. The entire deployment procedure was tested five times during 10 day of operation including a full underwater video inspection each time (see Figure 2). With respect to previous tests, data cables (pressure balanced oil-filled cable in which optical fibers and copper conductors) were added running along the lines and monitored continuously.

Attached to each optical module as well as on the LOM autonomous compass/accelerometer devices are mounted for precise analysis of the line dynamic behavior. The return of experience of this campaign has suggested some slight improvements on the design and the assembly procedures. After implementation of these modifications, a last sea test should provide the full validation of the technical solutions.

3 Reduced-scale prototype of a DU

After the PPM DOM, the second step on the in situ operation of KM3NeT instruments is to develop a real size prototype of a detection line with a real backbone cable and 3 DOMs.

This one is to be installed and operated on one of the KM3NeT sea floor infrastructures in Sicily at 3500m depth.

Figure 2: LOM deployment test

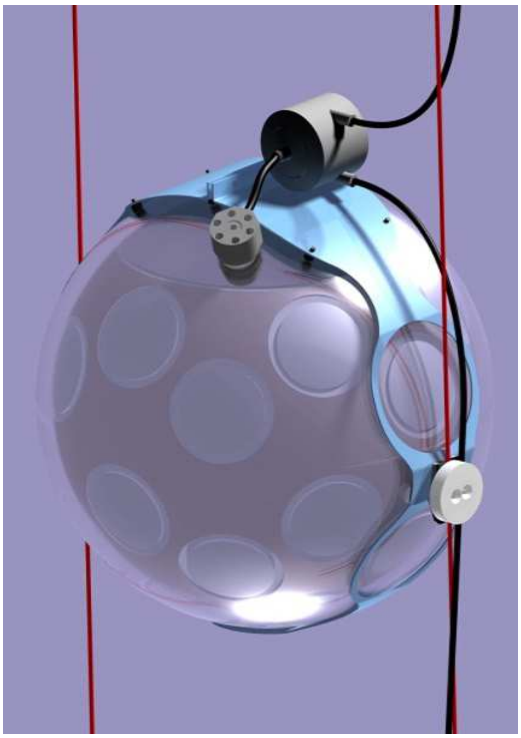

Figure 3: schematic of a DOM integrated in the detection unit

The deployment is planned for autumn 2013, using the launcher vehicle that has been tested during the spring sea campaign.

This prototype also permits to refine the assembly, tests and logistic processes which have to be established in view of the mass production of the lines.

For a period of around 3 months, in situ tests will be made once the DU has been connected to shore (including the measurement of the single hit and coincidence rates, time residual and synchronization between different optical modules).

This detection unit qualification step can be considered as the final step in the validation process.

4 First detection line

Once the full technical validation is achieved, together with the definition of the assembly processes and the choice of the production sites, the next step is to construct a real size full line which implements of the nominal components.

This first line is also a test bench for the production plans, and the related production sites, that have to be defined for the optical modules and the complete lines.

Moreover this line will be deployed at the Toulon site in FRANCE on the first fully dedicated KM3NeT infrastructure that also has to be tested. The operation of the 18 DOMs of this line will of course require a first real scale shore station facility and the associated analysis and slow control software.

5 Conclusion

Together with some laboratory qualification programs, the stepped processes described here will end up with the full qualification conceptual and technical solutions early 2015.

It will provide sufficient basis for the purchase of all the line components needed for the KM3NeT phase 1, which consists on few tens of detection units, and phase 2 applying to neutrino astronomy with up to 600 lines.

References

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