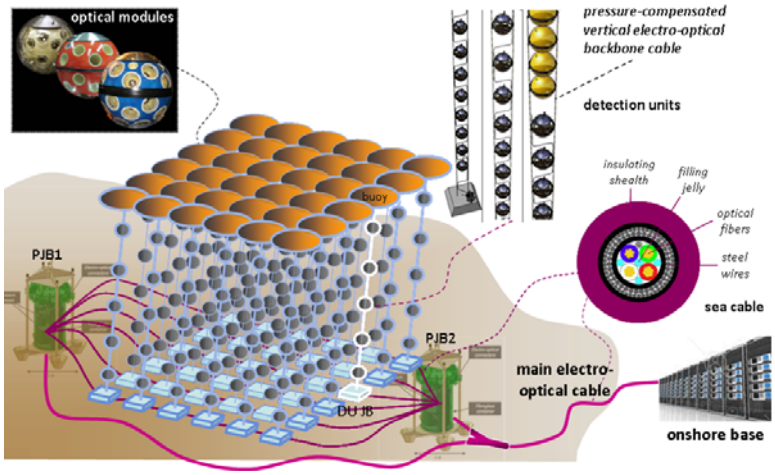
Dependability analysis of a very large volume neutrino telescope

The SRISL performed the dependability analysis of a very large volume neutrino telescope in the KM3NeT project (EU FP6 KM3NeT Design Study, Contract no. 011937), as part of the work group on «Risk assessment and quality assurance». The KM3NeT is an over M€300 European project involving 40 institutes or university groups from 10 countries, to design, install and operate a deep-sea research infrastructure hosting a neutrino telescope with a volume of at least one cubic kilometer at the bottom of the Mediterranean Sea.



The neutrino detector will consist of several thousand optical sensor modules placed on mechanical structures connecting them in vertical assemblies. The sensors will be inter-connected via watertight and pressure-resistant connectors. Their measured data will travel through an underwater network of specially designed multiplexed passive optical or active electronic equipment and optical fibers to the onshore base.

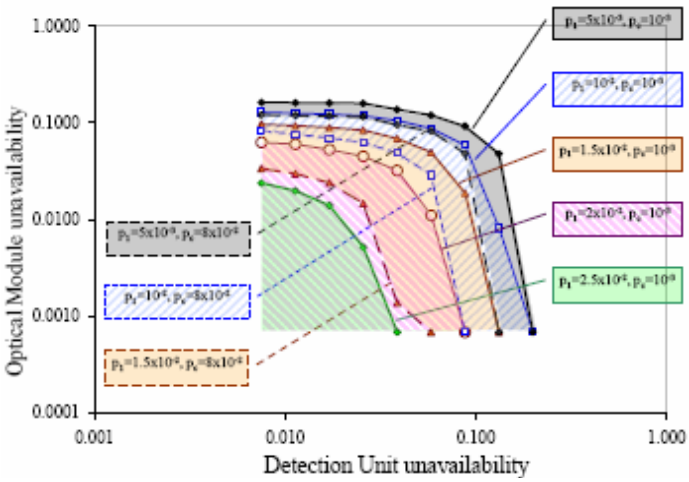
Challenges in the availability features of this system rise from the extreme deployment, operation and maintenance conditions at depths of 3500 to 5500 meters (depending on the site location).

The dependability analysis performed in the SRISL was a first order steady state approximation and consisted of the following steps:

- Treat the neutrino telescope as a complex system; identify the system components and their operational interdependencies, and the required function of the telescope system.
- Develop an appropriate mathematical model to estimate the telescope unavailability based on the unavailabilities of its components and a set of steady state unavailability evaluation correlations depending on possible component repair/test characteristics.
- Obtain results for a variety of alternative detector network configurations, and distances of the detector from the onshore facilities.

The final study presented ranges and combinations of possible component unavailability values that satisfied a fixed unavailability requirement for the telescope system. It also developed dependability requirements for major components and/or subsystems consistent with an overall system performance target.

The results depicted the dependence of the system unavailability on the number of optical modules and the alternative deep sea infrastructure configurations for transferring the measured signals.



This work has been presented as a detailed report on the dependability of the telescope, and will be included in the telescope technical design report which is still in preparatory phase.

Further research is under way to establish a realistic perspective on the practically attainable component reliability ranges, and develop suitable cost-reliability correlations to depict the trade-offs between component cost and reliability. These correlations will collaborate with the developed unavailability model to enable a cost-based optimization towards optimal telescope configurations.