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Fiber laser design and measurements for fiber optical hydrophones in their application for ultra-high energy neutrino detection

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The detection of ultra-high energy neutrinos with energies above 10ˆ18 eV requires a neutrino telescope that is at least an order of magnitude larger than what has been achieved today [1]. A potential technology for a large scale neutrino telescope, which is sensitive enough to detect the low thermo-acoustic signals induced by the cosmic rays in water, is offered by fiber optical hydrophones [2].

Optical fibers form a natural way to create a distributed sensing system in which several transducers are attached to a single fiber. The detection system in this case will consist of several transducers, erbium doped fiber lasers and an interferometric interrogator. Next to the advantage of having multiple sensors on a single fiber, this technology has a low power consumption and no electromagnetic interference with other read-out electronics. Maybe even more important, fiber optics technology provides a cost-effective and straightforward way to implement a large number of hydrophones.

In this paper we will show the results of investigations on one of the key components of the technology, i.e. the optical fiber laser. For the targeted application in a fiber optical hydrophone, the fiber laser technology requires a development beyond the present state of the art. In this light, design studies on in the various laser types and laser geometries have been carried out and trade-offs are made, supported with lab measurements. Moreover the multiplexing and cross-talk between several lasers on a single fiber have been investigated. Finally, the integration of the fiber laser in to the acoustical transducer will be shown.

[1] E.Waxman. Neutrino astrophysics: A new tool for exploring the universe. *Science*, 315(5808):63-65, 2007.

[2] E. J. Buis et al. Fibre laser hydrophones for cosmic ray particle detection. *Journal of Instrumentation*, 9(03):C03051, 2014.

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