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Status of the ANTARES project

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The ANTARES collaboration is building a neutrino telescope in the Mediterranean sea close to the French coast. The project aims to detect atmospheric and extraterrestrial neutrinos with energies above 10 GeV by means of the Cherenkov light that is generated in water by charged particles which are produced in neutrino interactions. The project and its physics potential will be described and the construction status will be illustrated.

1. Introduction

The ANTARES collaboration has been set up in 1996. Today it involves groups from France, United Kingdom, Spain, Italy, The Netherlands, Russia and Germany. From 1996 to 1999 an extensive R&D program had been successfully performed to prove the feasibility of the detector concept. The environment parameters at various deep sea sites have been studied and a deployment site of the experiment has been chosen[1]. It is 10 km south of the Hyeres archipelago at 42^o 50' N, 6^o 10' E. It combines the advantage of an important depth of 2475 m with the vicinity to the coast and infrastructure (harbors of Toulon and La Seyne).

2. Detector design

After the successful R&D phase the construction of the ANTARES detector has been decided in 2000 and is progressing. The detector consists of 12 lines and a junction box which distributes the power and clock synchronization signals to the lines and collects the data. The junction box is connected to the shore by a 42 km electro-optical cable. The lines have an equipped vertical length of 350 m starting 100 m above sea floor. Their horizontal distance is about 65 m and they are arranged to form a regular octagon on the sea floor. Each line is connected to the junction box with the help of a submarine using wet-mateable connectors. It is composed of 25 storeys with a vertical distance of 14.5 m. The lines are kept

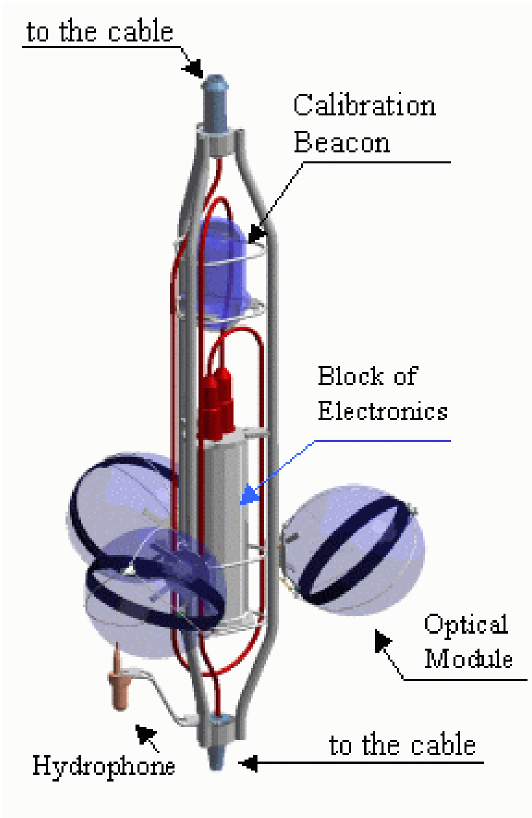

Figure 1. Key element of the detector: The storey

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straight by the floating force of a buoy at the top and an anchor at the bottom. They float in the sea current and the positions of the active detector elements are permanently monitored by an acoustic calibration system.

Each storey (see Fig. 1) contains three 45^o downward looking 10” photomultipliers inside pressure resistant glass spheres - the optical modules (OM) [2]. The electronic cards are inside a titanium cylinder at the center. Some of the storeys contain supplementary calibration equipment like acoustic or optical beacons.

The signals of each photomultiplier are readout by two ASICs. For simple pulses charge and arrival time are digitized and stored for transfer to the shore station. For more complex pulses the pulse shape can be digitized with 1 GHz sampling frequency. The time stamps are synchronized by a clock signal which is sent in regular intervals from the shore to all electronic cards. The overall time calibration is better than 0.5 nsec. Therefore the time resolution of the signal pulses will be limited by the transition time spread of the photomultipliers ($\sigma \sim$1.3 nsec). All data are sent to the shore station. With a noise light rate of 70 kHz on the one photon level this produces a data flow of 1 Gbit/sec to the shore. In the shore station a PC farm performs a data filtering to reduce the data rate by at least a factor 100.

3. Construction status

From November 1999 to June 2000 a ”demonstrator line” had been operated to prove the feasibility of the foreseen project. Its most important result was the verification that the acoustic position system is able to locate each OM with a precision of 5 cm with respect to a grid of fix points on the sea floor.

In October 2001 the final electro-optical cable was deployed over a length of 42 km from the foreseen ANTARES site to La Seyne where the power station and the control room are located.

In December 2002, the junction box was connected to the remote cable end and was deployed. Since its deployment it is permanently monitored and has flawlessly functioned.

During the same period a first prototype line had been assembled. It represents 1/5 of a full line, 5 storeys with 15 OMs. Extensive tests of this line have been performed. The most important result was the verification of the timing accuracy which can be reached by the system. The time resolution of the pulses has been confirmed to be 1.3 nsec at the single photoelectron level.

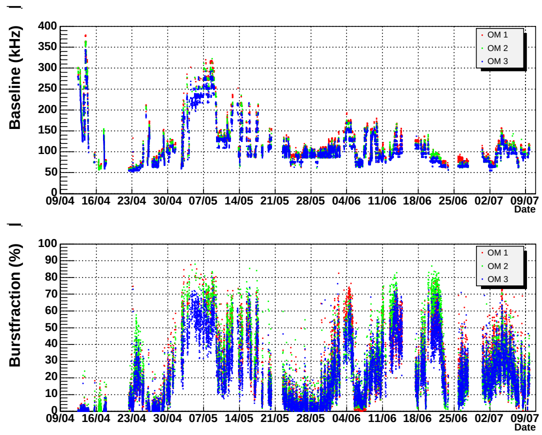

Figure 2. Monitoring of single photoelectron counting rates during the three months operation of the prototype line in 2003. Signals from all three OMs of one storey are shown. Above: Baseline rates averaged over 5 minutes. Below: Fraction of time for which the measured rate is significantly higher than the baseline rate (burst fraction)

In December 2002 the prototype line was deployed followed by another short line which contained supplementary devices to monitor environment parameters (sea currents, sound velocity, salinity, water transparency) or to serve as calibration elements for the prototype line (laser and LED beacons).

In March 2003 both lines were successfully connected to the junction box by the manned submarine ‘Nautile’. The prototype line took continuously data for three months until its recovery in July 2003. One of its results is the measurement of the counting rates of the photomultipliers which is illustrated in figure 2.