Newsletter Focus

THE ANTARES ADVENTURE HAS COME TO AN END: THE BATON GOES TO KM3NeT



In mid-February 2022, after 16 years of operation, the scientific and technological adventure of ANTARES, the first neutrino underwater telescope ever built in the sea, came to an end. Situated 40 km off the coast of La Seyne-sur-Mer, near Toulon (France), ANTARES, the result of а European collaboration that included INFN among its main contributors, has in fact completed its mission, demonstrating the validity of the technological solutions of KM3NeT, the ambitious multi-site research project under

construction in the waters of the Mediterranean Sea, which aims to create a large network of undersea neutrino detectors.

The Antares (*Astronomy with a Neutrino Telescope and Abyss Environmental RESearch*) adventure began in the late 1990s, when the creation of a proto-collaboration was followed by preliminary feasibility studies for an undersea neutrino telescope. Indeed, the first exploration campaigns of potential installation sites and the simulation activities aimed at optimising the design of the apparatus date back to this period. Investigations that led to the choice of the sea space off La Seyne-sur-Mer and the adoption of detectors consisting of triplets of optical modules. On the other hand, the laying of the main cable of the experiment and the installation, at a depth of 2475 metres, of the submarine box, intended to operate continuously for nearly 20 years and responsible for the electro-optical connection of the telescope, date back to 2001-2002. Upon completion of its installation in 2008, ANTARES appeared as an array of 12 strings, each 400-metre-high and consisting of 25 triplets of optical modules, anchored to a seabed area approximately 250 metres in diameter.

Thanks to its configuration and its particular location, ANTARES made it possible to validate the neutrino detection principle in seawater, which is based on the observation of the glow (Cherenkov light) induced in the medium crossed by charged particles produced by neutrinos interacting with water near the telescope optical modules. The same principle will be adopted by KM3NeT. However, the successes of ANTARES, demonstrated by the decision to postpone its decommissioning for six years, initially scheduled for 2016, have not been solely of a technological nature.

From its position in the Northern Hemisphere, ANTARES has for many years been the most sensitive detector in scanning the Southern Hemisphere sky, contributing significantly to the new field of investigation of

multimessanger astronomy and to high-neutrino astrophysics. power. A diffuse component of cosmic neutrinos reaching Earth was first identified in 2013 by IceCube, the large neutrino telescope hosted in Antarctica, which uses ice as a transparent medium. ANTARES has provided useful information to interpret these observations, in particular by contributing to the study of the neutrinos fraction having a Galactic origin.

The results obtained by ANTARES therefore seem to predict a future full of important discoveries for its successor KM3NeT, which is of larger size, with new generation sensors and covers a wider energy range, thus making it possibile to shed light on the type of galactic and extragalactic sources responsible for the emission of high energy neutrinos and on the physical mechanisms responsible for their production.

The decommissioning of ANTARES will happen together with the immersion and activation of the new KM3NeT strings, in two sites in the Mediterranean Sea: the apparatus ARCA (*Astroparticle Research with Cosmics in the Abyss*), aimed at the search for high-energy cosmic neutrinos, is being installed off the coast of Sicily, while the apparatus ORCA (*Oscillation Research with Cosmics in the Abyss*), designed for the study of neutrino oscillations, is under construction at a site close to that of ANTARES. A handover that is also demonstrated by the names of the European scientific institutions and researchers that today are part of the KM3NeT collaboration, mostly coming from the ANTARES experience. INFN is the protagonist of this more than twenty-year commitment to neutrino research in the Mediterranean Sea with the inolvement of several divisions and from the National Laboratories of the South.