EuroRis Net
European Research Infrastructures Network of National Contact Points
Success Stories
Issue 10 / June 2011

LAGUNA – basic science hand in hand with engineering

The LAGUNA project (Design of a pan-European infrastructure for large apparatus studying grand unification and neutrino astrophysics) addresses the feasibility of a new European research infrastructure hosting a deep underground neutrino detector, much larger and more sensitive than those presently used, for fundamental research in astrophysics and particle physics.

Neutrinos are very strange particles. Travelling with almost no interaction with matter, they can cross huge quantities of matter without being ever stopped. But why are neutrinos so important? Perhaps because they are among the most common particles in the Universe actually! As an example, each second billions of billions of such particles cross the Earth. And in a way, they are interesting to physicists precisely because they are not stopped easily. This means that they carry unique and original information about the processes that have occurred far away in the Galaxy and in the core of stars. What is inaccessible to telescopes "only" able to look at the surface of cosmic bodies with the light they receive becomes accessible to neutrino detectors, offering new crucial information from the Sun and exploding Supernovae.

Huge detectors required for fundamental particle physics research

Neutrinos can also be produced at accelerators and these beams, sent over distances of hundreds of kilometres, help to reveal extraordinary properties of these mysterious particles. The study of these beam neutrinos could provide an explanation of the observed, but unexplained, existing amount of matter in the Universe and the striking absence of its corresponding antimatter. But to really open a new window to probe the Universe with neutrinos, physicists have to think big.

Thus the principal goal of the LAGUNA project is to assess the feasibility of a new pan-European research infrastructure able to host the next generation of very large volume, deep underground neutrino observatory, in the range of 100,000 m^3 – a dimension that would host about 40 Olympic swimming pools. Why so big? Because physicists track very rare phenomena and the bigger the detector is the better is the chance to catch some of these elusive particles.

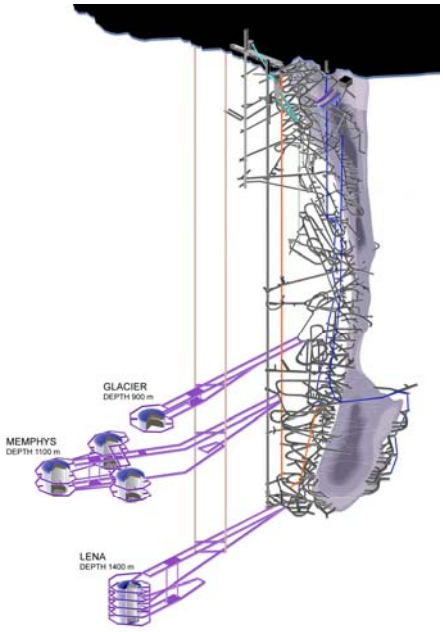
Besides enabling novel research in particle physics, the envisaged infrastructure may also lead to a verification of the Grand Unification Theory of fundamental interactions in Nature in an energy range inaccessible to existing accelerators.

A unique opportunity for testing the feasibility of building sites in Europe

The design and building of a huge apparatus cannot be conducted within one single project. As a first step in such a massive endeavour, possible locations have to be evaluated carefully. But even this is a major task, which needs to

be well coordinated between the countries where potential sites are located. Moreover, evaluation of building sites requires expertise from fundamental researchers and engineers.

The size of the proposed infrastructure, its importance for Europe, the fact that several countries and various types of expertize had to be involved qualifies such an endeavour for the FP7 Research Infrastructure sub-programme. The project LAGUNA was successfully submitted as a "Design study"-type project to an FP7 Research Infrastructure call in 2007. Design studies support the development of concepts for new research infrastructures with clear European dimension and interest. The project, coordinated by Professor André Rubbia, Head of the Institute for Particle Physics at the Swiss Federal Institute of Technology Zürich (ETHZ), unites 21 partners from universities, research organisations and industry. Seven prospective underground sites in Europe are being investigated, located in Finland, France, the UK, Italy, Poland, Romania and Spain. For each site, there are two partners: a scientific institute and a technical (engineering) partner. The role of the technical partner is to prepare the technical part of the design and to study the feasibility of the rock construction. The role of the scientific partner is to provide scientific expertise for the design, particularly outlining the requirements and preferences of the experiment. The site studies focus on the technical issues of underground large-scale civil engineering needed to host large volume instruments. The feasibility studies include geological studies of the sites, analysis of available rock samples and simulations of rock mechanics.



Schematic view of the LAGUNA neutrino observatory in the Pyhäsalmi site in Finland

Beyond LAGUNA

By the end of 2011, when LAGUNA comes to an end after three years, complete feasibility analysis in each site are expected to be available and compared. The main aim of the LAGUNA project – the choice of the most suitable location for a large-scale underground apparatus – will be achieved. Then European physicists will be able to discuss with partners from other continents, as building of the envisaged infrastructure would need global support. "It is important to have a mature project in Europe when global decisions will come" says André Rubbia.

Additional information

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