Astroparticle Physics European Consortium

December 2015

A note from the Chair: A great year comes to an end

What have the years 1988, 1995, 2002 and 2015 all got in common? A neutrino related Physics Nobel Prize! The 2015 prize was "for the discovery of neutrino oscillations which shows that neutrinos have mass". And despite these four Nobel Prizes, we still do not know the absolute neutrino masses, we do not know if the neutrino and the anti-neutrino are identical particles ("Majorana") or different particles ("Dirac"), we wonder if the neutrino mixing matrix could be at the origin of matter-antimatter asymmetry in the Universe and we still ponder how to observe the primordial neutrino background released shortly after the Big Bang and now floating around us. These are just some of the challenges addressed in astroparticle physics research.

Also in other respects 2015 was an eventful year. After many years of uncertainty, the prospects for long baseline neutrino beams to study neutrino oscillations in detail are bright with a strongly endorsed programme in the USA (LBNE/DUNE), a high-tech R&D and prototyping programme at CERN and an ambitious programme under evaluation in Japan (T2K/Hyper-Kamiokande). In the direct search for dark matter, a major step forward was the inauguration of the XENON1T experiment in the deep underground Gran Sasso laboratory in Italy. In the coming years the XENON1T collaboration will frantically hunt for dark matter signals. The worldwide high-energy gamma-ray community celebrated the convergence of the site selection process for their next generation infrastructure, the Cherenkov Telescope Array – CTA: Chile and La Palma will host CTA in the Southern and Northern hemisphere, respectively. Actual serial production of the three telescope types (small medium and large) is expected to start soon.

Also KM3NeT, the future multi-cubic kilometres neutrino telescope deep in the Mediterranean Sea, passed a major milestone with the successful deployment of its first full-size detector string (800 metres tall) in the Capo Passero site of the coast of Sicily, Italy. And last but not least, exactly one century after Einstein published his theory of General Relativity in 1915, the gravitational wave interferometers operated by the LIGO Virgo Consortium (LVC), two in the USA and one in Europe, completed installation of their upgrade programs, which should bring the direct detection of a gravitational wave in reach. Advanced LIGO (USA) already completed commissioning and recently started data taking while Advanced Virgo (Europe) is expected to start data taking in the Summer of 2016. In space LISA Pathfinder, the ESA mission precursor of the space-based eLisa gravitational wave interferometer, was launched successfully.
So astroparticle physics is in full swing. Game changing and Nobel Prize worthy discoveries are around the corner. To keep the European astroparticle physics community also positioned well in the next decade, APPEC is working on an update of its roadmap and has scheduled a Town Meeting for 6 and 7 April 2016 in Paris. We urge everyone interested to actively participate in this important event.

Best wishes to everyone for another successful year in 2016!

Frank Linde

RECENTLY IN THE NEWS:

- ### Cherenkov Telescope Array

On 26 November 2015, a prototype telescope proposed for the Cherenkov Telescope Array, the Gamma-ray Cherenkov Telescope (GCT), recorded CTA's first ever Cherenkov light while undergoing testing at l'Observatoire de Paris in Meudon, France. The GCT is proposed as one of CTA's small size telescopes (SSTs), covering the high end of the CTA energy range, between about 1 and 300 TeV (tera-electronvolts). Another SST prototype, the ASTRI telescope, captured the first optical image in May 2015 with its diagnostic camera.

"With the tough weather conditions, we only had about an hour-long window to gather as much data as we could," said GCT Camera Coordinator Dr. Richard White. "We look forward to clearer, darker skies so we can test the camera's performance in more ideal conditions.

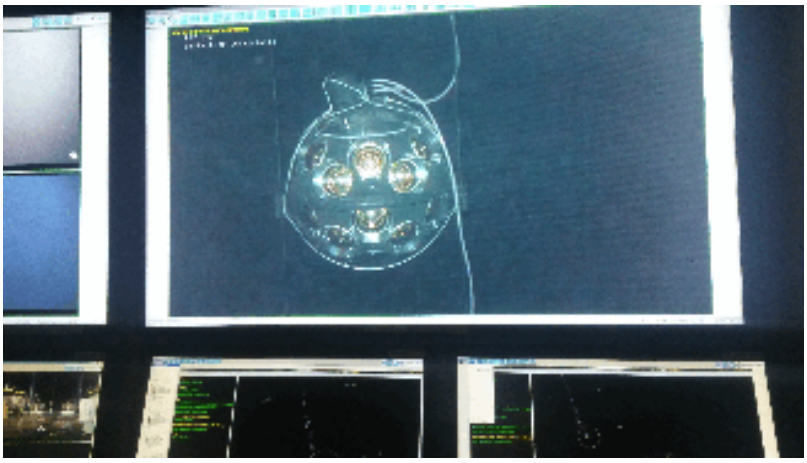
"This is a major milestone for the GCT and we hope for CTA." said GCT Spokesperson Prof. Tim Greenshaw. "Our design for the CTA telescopes that will detect the highest energy light hitting the earth's atmosphere from space has been proven to work; we are one step closer to developing a deeper understanding of where and how that light is produced."

Hélène Sol, Research Director at Centre National de la Recherche Scientifique (CNRS) and GCT Deputy Spokesperson added: "I would like to congratulate all the GCT team who have made this possible, especially the group who worked day and night over the last couple of weeks to get these pictures."

An inauguration event for the telescope in Meudon was held on 1 December and attended by by representatives from l'Observatoire de Paris, Centre National de la Recherche Scientifique (CNRS), Science and Technology Facilities Council (STFC), Region Ile-de-France, the CTA and GCT consortia.

- *Also on the CTA website and featured on Phys.org,and Symmetry Magazine*

KM3NeT

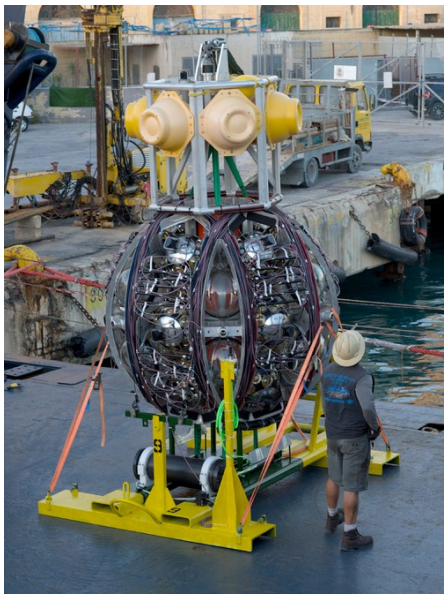


In the early morning of 3 December 2015, scientists and engineers started the installation of KM3NeT, which once completed, will be largest detector of neutrinos in the Northern Hemisphere. Located in the depths of the Mediterranean Sea, the infrastructure will be used to study the fundamental properties of neutrinos and map the high-energy cosmic neutrinos emanating from extreme cataclysmic events in the Universe.

Neutrinos are the most elusive of elementary particles and their detection requires the instrumentation of enormous volumes: the KM3NeT neutrino telescope will occupy more than a cubic kilometre of seawater. It comprises a network of several hundred vertical detection strings, anchored to the seabed and kept taut by a submerged buoy. Each string hosts 18 light sensor modules equally spaced along its length. In the darkness of the abyss, the sensor modules register the faint flashes of Cherenkov light that signal the interaction of neutrinos with the seawater surrounding the telescope.

On board the Ambrosius Tide deployment boat, the first string – wound, like a ball of wool, around a spherical frame – arrived at the location of the KM3NeT-Italy site south of Sicily. It was anchored to the seabed at a depth of 3500 m and connected to a junction box, already present on the seafloor, using a remotely operated submersible controlled from the boat.

The junction box is connected by a 100 km cable to the shore station located in Portopalo di Capo Passero in the south of Sicily. Marco Circella, the technical coordinator of KM3NeT explains, "The large depth of sea water shields the telescope from particles created by cosmic rays in the atmosphere above the telescope. Constructing such a large infrastructure at these depths is a tremendous technical challenge. Making the underwater connections requires custom-designed electrical and fibre optic connectors. The crew of the Ambrosius Tide are experts in performing such delicate submarine operations."



After verification of the quality of the power and fibre optic connections to the shore station, the go ahead was given to trigger the unfurling of the string to its full 700 m height. During this process, the deployment frame is released from its anchor and floats towards the surface while slowly rotating. In doing so, the string unwinds from the spherical frame, eventually leaving behind a vertical string. The string was then powered on from the shore station and the first data from the sensor modules started streaming to shore. Rosanna Cocimano who coordinates the power systems for KM3NeT: "An electro-optical network of cables distributes the high-voltage power from the shore station to the sensor modules in the deep sea. The measured light signals are digitised by the sensor modules and the resulting data returned to the shore station via optical fibres."

The successful acquisition of data from the abyss with the novel technology developed by the KM3NeT Collaboration is a major milestone for the project. It represents the culmination of more than ten years of research and development by the many research institutes comprising the international Collaboration. Maarten de Jong, spokesperson and director of KM3NeT, said: "This important step in the verification of the design and the technology will allow the KM3NeT Collaboration to proceed with confidence toward the mass production of detection strings and their installation at the sites in the Mediterranean Sea off-shore from Italy and France. A new era in neutrino astronomy has begun".

- *Also on the **KM3Net website**, **ingenieur.de**, and **astronews**.*

- ## DULIA-Bio

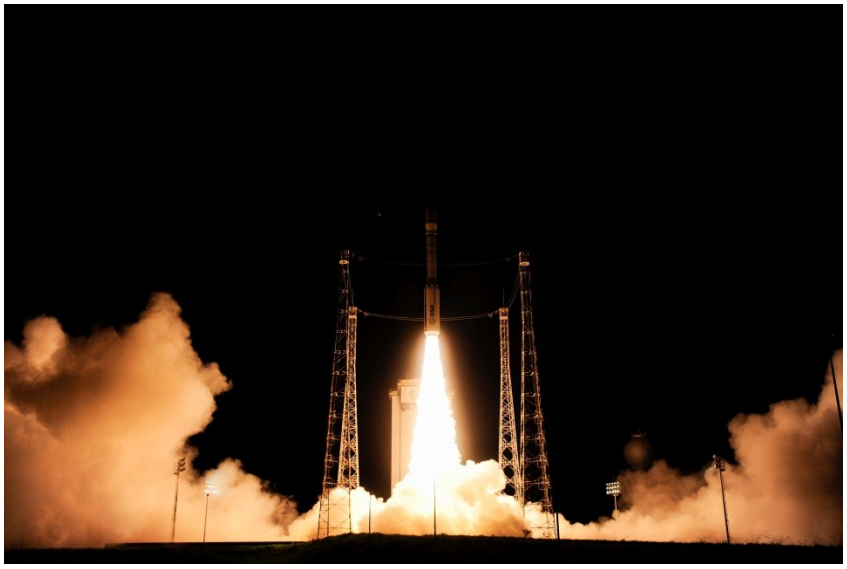
The workshop DULIA-bio (Deep Underground Laboratories Integrated Activities in biology) took place in Canfranc (Spain) on 13 and 14 October with the aim of establishing a common path for European underground laboratories in deep life studies and its application to astrobiology. On the opening day, LSC director Aldo Ianni delivered a talk on the Canfranc Underground Laboratory, followed by lecture on "Deep Science at the UK's Boulby Underground Laboratory" given by Sean Pauling (Boulby Underground Laboratory Director). Antonella Tabocchini (Istituto Superiore di Sanità, Rome) discussed "The underground biology at the Gran Sasso National Laboratory: from Pulex to Cosmic Silence", while Fabrice Piquemal (LSM Director) presented "The IRIS project at LSM" followed by a lecture by Johanna Kutuniva (University of Oulu, Finland) on the "New underground laboratory in Pyhäsalmi Mine – CallioLab".

After a lunch offered at the LSC premises, the afternoon session included lectures by Thomas Kieft (Professor of New Mexico Tech) on "Probing the Deep Biosphere: Mines Are Useful But Dedicated Underground Laboratories Will Be Even Better", Chris Thome who connected via Skype from SNOlab in Canada to talk about "Examining the biological effects of ultra-low background radiation exposure within SNOLAB", Manuel Martinez (IFIC, Valencia) lecturing about "Unveiling the microbial dark matter through single cell genomics" and a final Skype connection with Thomas Merritt (Laurentian University, Canada) who gave the talk "Flies in a Mine: the metabolomics of working deep underground".

On the second day attendees enjoyed lectures from Cristina Vilanova (Valencia University) taking about "The Gollum Project: Characterising subterranean bacterial communities in depth(s), Hugo Castillo (New Mexico State University) over "Below Background Radiation Experiments on Biological Cells at the U.S. Waste Isolation Pilot Plant (WIPP)", Juan Manuel Gonzalez (CSIC, Seville) on "Microbes at extreme environments and the Spanish Network on Extremophiles", Ricardo Amils (Universidad Autonoma de Madrid) giving a lecture on

"Geomicrobiology of the Iberian Pyrite Belt Subsurface" followed by Jennifer Wadsworth (UKCA, University of Edinburgh) taking about "Petri-dishing the Dirt: An Overview of Astrobiology Projects at Boulby" and finalizing the lectures Juan Perez Mercader connected via skype from Harvard University to give "Some Lessons Taught by Searching for Life in the Universe". The presentations may be downloaded from the event website.

- ## LISA Pathfinder



The European Space Agency's LISA Pathfinder mission was launched in early December and is travelling towards the first Sun-Earth Lagrange point, L1, where it will operate.

LISA Pathfinder is designed to demonstrate that free particles follow geodesics in space-time. It will do this by tracking two test masses in free fall using very precise laser interferometry. The spacecraft faced the challenge of keeping the test masses safe during the launch, whilst then being able to keep them in space with no external forces acting on them.

The distance between the test masses on board the spacecraft is too small to detect gravitational waves, but it is designed to show the technologies needed for a future mission that would be large enough to make the effects of a low-frequency gravitational wave measurable.

- ***Also on the BBC, The Guardian, Slate and euronews; latest from ESA SciTech.***

Please send news or event items for inclusion to Ruth McAvinia, APPEC Communications and Outreach Coordinator, based at STFC.

EVENTS & MEETINGS:

- **APPEC GENERAL ASSEMBLY MEETING**
  Rome, 8 January 2016

- **INSTITUTE OF PHYSICS JOINT HIGH ENERGY PARTICLE PHYSICS AND ASTROPARTICLE PHYSICS MEETING**
  Brighton, 21 March 2016

- **APPEC TOWN MEETING - EUROPEAN ASTROPARTICLE PHYSICS ROADMAP**
  Paris, Grand Amphitheatre de Sorbonne, 6 & 7 April, 2016