GNN Monthly
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Towards common neutrino data formats

During the MANTS meeting in Bochum, the initiative arose to start an exchange about developing common data formats for easier exchange of information between the neutrino experiments. At a first call in mid-April, already 16 people from the different collaborations came together and started landscaping the possible areas of cooperation (see indico event), which range from astronomy analysis and standardizing alert sending to machine learning data formats and oscillation studies.

After one hour, it was clear that we do not only want to follow up this first step but also involve all those interested in the exchange in the various fields. For the time being, we will continue these meetings at roughly 6-weekly intervals, which you will be able to find in the GNN indico space, and IceCube and KM3NeT are working on additional coordination channels beyond this first meeting. So, if you want to be part of the next steps towards a shared neutrino data future, join the group now!

For all suggestions, requests or questions, you can also contact Erik Blaufuss (blaufuss@umd.edu) or Jutta Schnabel (jutta.schnabel@fau.de).

(reported by Jutta Schnabel)

News from the Experiments

KM3NeT: ORCA sea operation

On Feb 4 2024, the KM3NeT/ORCA detector shut itself down due to a power overcurrent provoked by a short-circuit somewhere offshore in its network of cables and junction boxes on the seafloor. In order to investigate the issue, it was necessary to organize a sea campaign to localize the origin of the problem and hopefully to fix it.

Both ARCA and ORCA pay a yearly 'insurance' fee to the MECMA (Mediterranean Cable Maintenance Agreement), a network of cable ships around the Mediterranean that provide the capability to rapidly repair deep sea telecommunication cables in case of failure. Obviously, even a short period with loss of telecommunications is of strategic and economic importance to all the countries concerned. The MECMA boats are always 'on call' waiting to make such repairs and, fortunately for KM3NeT, both of the KM3NeT sites, La Seyne sur Mer in France and Catania in Sicily, are also bases for the Orange Marine and Elettra MECMA ships.

The sea operation took place during the period 13-22 March, 2024. Three ships were mobilized: the Sophie Germain - the cable repair boat from Orange Marine; the Janus from SAAS - the boat with the ROV; the Opale from Foselev - used for the precision acoustic positioning. Not knowing the location of the problem, we first recovered the Node 1, which necessitated the ROV to disconnect the 18 Detection Units connected to it. Once onboard (still connected to its main electro-optical cables), it was possible to confirm that the Node 1 was in good shape and that the location of the fault was most likely in the Earth and Sea science part of the network, downstream of Node 1. After some maintenance on the Node 1, and thanks to the long baseline acoustic positioning system, it was

successfully redeployed to within 1 meter of its original position and the Detection Units reconnected.

The origin of the problem was eventually found to be an electrical short in a cable connecting the Earth and Sea Science (ESS) junction box to the Ifremer junction box. Unfortunately, the short also damaged the ESS junction box, so it was necessary to recover it for eventual repair.

After an intense period of activity for the teams onboard the boats and onshore in the power hut and control room, the ORCA detector is operational again. It is hoped the Earth and Sea Science junction box can be reinstalled next year.

The three boats: Sophie-Germain, Opale, Janus

(reported by Paschal Coyle)

KM3NeT: Meeting of the astro-Working Group

The KM3NeT Collaboration had a face-to-face meeting of the astro WG of KM3NeT in Granada.

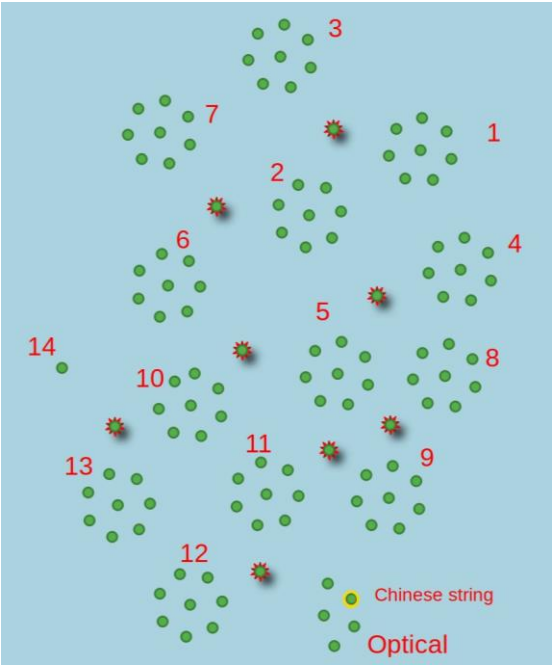
The meeting has been mainly organized by Agustín Sanchez-Losa, Emilio Pastor and Sergio Navas. It was the occasion to review most of the ongoing analyses and discuss the remaining points to be ready for the Neutrino 2024 conference. The mornings were dedicated to talks while the afternoons were mostly reserved for working sessions. Around 60 persons have participated in the workshop, among them 35 in person (see the picture left column, bottom).

Baikal-GVD

The 2024 season has been completed and all goals have been reached. Therefore, it is no surprise that the following summary coincides with the plans announced in last month's GNN Monthly:

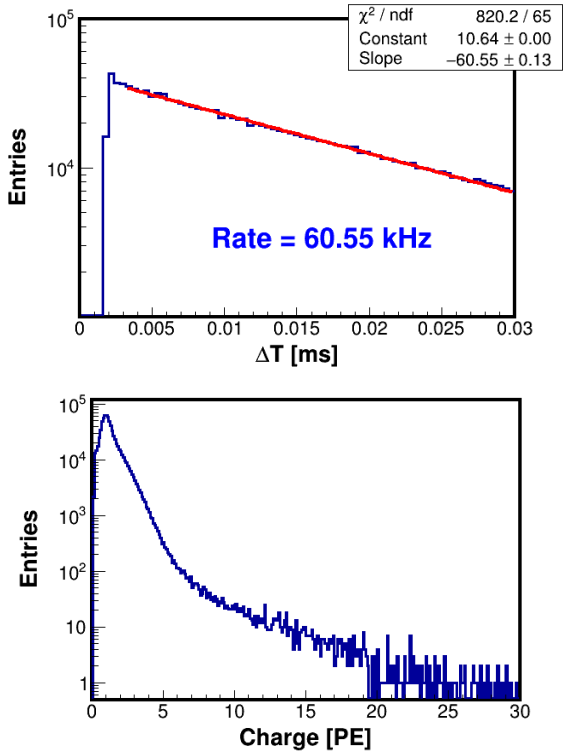
1. Installation of 3 remaining strings in cluster #12.
2. Laying two bottom cables for clusters #13 and #14
3. Installation of the full cluster #13 consisting of 9 strings, including an inter-cluster string.
4. Installation of an inter-cluster string connected to cluster #10.
5. Deploying the central (first) string of cluster #14.
6. Installation of two new strings on the "experimental cluster" to test fiber-optics, adding up to of 4 fiber strings with 36 optical modules each.
7. Installation of a 5th string in the experimental cluster, carrying 12 optical modules based on 20-inch PMTs made in China (see below)
8. Replacement of misfunctioning components in nine strings of various older clusters.

The top view of the present Baikal-GVD configuration shown next page has been provided by Dmitry Petukhov. The red numbers denote the cluster number (ordered according to the deployment year), the green symbols framed with red spines are the inter-cluster strings to fill the empty spaces between the clusters, improving the background rejection. Each of these inter-cluster strings are connected to one of the clusters and read out via the cluster's shore cable. Bottom right is the experimental cluster with optical fiber transmission (4 strings) and the "Chinese string" (yellow framed). The diameter of one cluster is 120 m.



Mingjun Chen from IHEP Bejing reports on the Chinese string: *The string consists of 12 optical modules with a diameter of 23 inches glass bulb, based on the 20-inch MCP-PMT design. The spacing between the optical modules is 30 meters. We utilize waveform digital data acquisition with a sampling rate of 500 MHz and "White Rabbit" clock synchronization system. The top of the detector string is aligned with the top of the GVD detector. Additionally, it includes 4 LED-based optical calibration modules and a centralized control module for remote control and data retrieval through an on-site server. The main purpose of this string is to study the operational status of the ultra-large aperture optical modules in the environment of Lake Baikal, including technical performance and signal observations consistent with GVD.*

The first installed 23-inch OM.



First impressions: Single-channel distribution of hit time differences, and the resulting counting rate (top) and amplitude spectrum (bottom) measured for a typical OM, (threshold ~ 0.5 PE). More detailed data will become available after completing the electronic firmware.

RNO-G

The RNO-G collaboration has comprehensive plans for the coming season. Anna Nelles (DESY Zeuthen/ECAP Erlangen) reports:

RNO-G is gearing up for another installation season, which will be the longest that RNO-G has seen, using almost all of the time available for science at Summit Station.

On May 9th the first drilling team will arrive on site starting with the assembly of the BigRAID drill, which delivers dry holes of 28 cm diameter down to 100 m. The drill has been upgraded with respect to the last drilling season in 2022, hoping to improving speed and reliability, which is needed to drill up to 12 stations in one season. Mid of June the first science installation team will then arrive at Summit to instrument the drilled holes. Equipment for 10 new stations will be shipped, the installation will depend on the drilling performance. Furthermore, an upgrade of the existing

stations is planned, installing new revisions of the DAQ boards and making changes to the power system, which allows for an annual raising of the battery boxes. RNO-G remains autonomously powered and the season will also see the installation of additional wind-turbines, which have shown good performance on the icy roof in Chicago. The hope is that RNO-G can achieve also an 80% up-time during the winter. Last winter, a heavy winter storm fully charged the batteries on one station, which is encouraging, however the turbines have not been fully reliable year-round.

The season is planned to end mid of August with a calibration team being the last to leave, who will address additional questions about the ice and its characteristics for radio signal propagation.

IceCube

Nothing new to be reported, therefore here just an unusual picture from the South Pole. Looks as if we heavily pollute the virgin, clean air of Antarctica by burning coal. But calm down: it's just steam from the station wafting in the wind, while red lights illuminate the background. Winter is coming!

Photo: Kalvin Moschkau

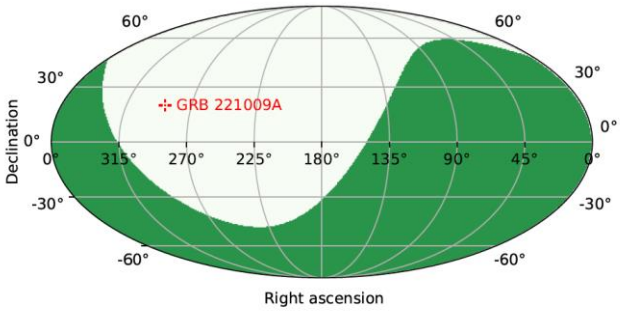
Erratum to the report on the winners of the IceCube Impact Prize, March edition of GNN Monthly: *Nora Valtonen-Mattila* is not at University Würzburg but at the University of Uppsala. (Sorry, Nora!)

Publications

The KM3NeT collaboration has posted a paper *Search for Neutrino Emission from GRB 221009A using the KM3NeT ARCA and ORCA detector* on 2404.05354.pdf (arxiv.org) (submitted to APJ Letters) Corresponding authors are Juan Palacios González (IFIC Valencia), Sebastian Le Stum and Godefroy Vannoye (both CPPM Marseille).

For the recent GRB 221009A event, identified as the brightest gamma-ray burst ever detected, no neutrino counterpart has been detected, neither by IceCube, nor by Baikal-GVD nor by KM3NeT. This paper summarizes the subsequent KM3NeT analyses, in a wide energy range from MeV up to a few PeV.

During the GRB, the source was above horizon for ARCA and ORCA, see the next figure.



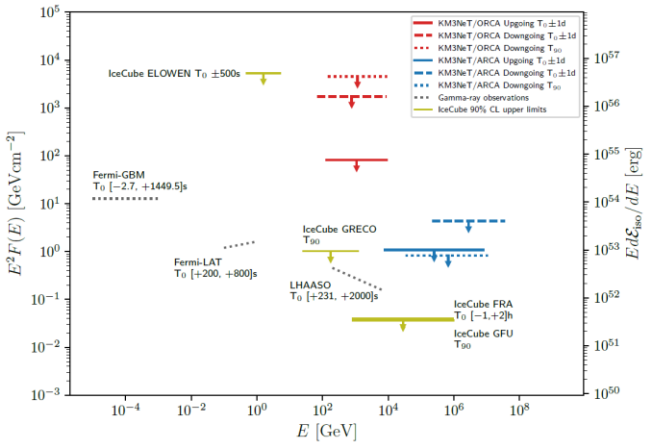
Skymap with the position of GRB 221009A in equatorial coordinates. The green shadowed region denotes the instantaneous visibility for upgoing events of ARCA at T0. The visibility region for ORCA is similar.

Therefore, four time windows are considered:

a) two short windows ([T0, T90] and [T0− 50 s, T0 + 5000 s], with the GRB above horizon,
b) two [T0±1 day] windows, one using only upgoing events (source below the horizon for 45% of the day), the other using only downgoing events.

ARCA data are used for the TeV-PeV search, ORCA data for the GeV-TeV search, exploiting both track and cascade events. The MeV method looks for a global increase in the rate of coincidences between PMTs in single DOMs, like the searches for supernova bursts.

No coincidences have been observed. Taking into account the effective area of the current ARCA/ORCA detector configurations, this leads to the upper limits on the neutrino emission shown in the next figure. Results for the total anti-ν_e flux between 5 and 15 MeV are given in a table (see paper).



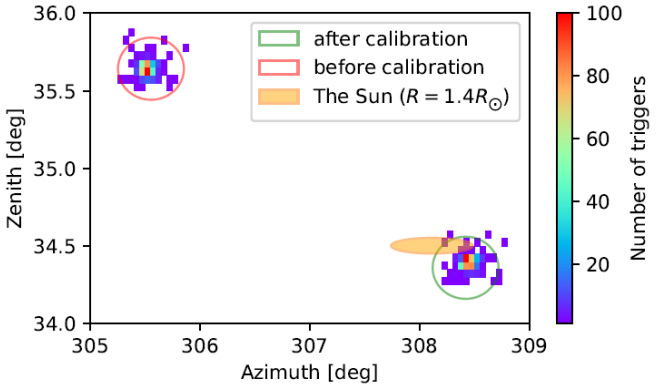
90%CL upper limits on $E^2F(E)$, the energy-scaled time-integrated per flavor neutrino flux from GRB 221009A, for KM3NeT/ORCA (red lines) and KM3NeT/ARCA (blue lines). The results from IceCube are also shown (green lines). Only the results for the T0±1 day and T90 searches are shown, using a neutrino spectral index γ = 2. For visualization purposes, the gamma-ray observations are also included (gray dashed lines), from Fermi-GBM, Fermi-LAT and LHAASO. The right axis indicates the differential isotropic equivalent energy.

The present size of the detectors is ~10% of the final KM3NeT configuration. With full KM3NeT, the sensitivity for cosmic neutrino detection in the coming years will be increased by one order of magnitude at least. For a significant detection it is crucial to continuously monitor the sky with full coverage, using events coming from both the upgoing and downgoing sky regions: a case for exploiting the complementarity sky visibilities of KM3NeT, Baikal-GVD, IceCube, together with a high duty cycle of the detectors.

The RNO-G collaboration has submitted a paper *Solar Flare Observations with the Radio Neutrino Observatory Greenland (RNO-G)* to Astronomy & Astrophysics (posted at 2404.14995.pdf (arxiv.org)). Corresponding authors are Steffen Hallmann (DESY) and Masha Mikhailova (Univ. of Kansas).

They use early RNO-G data from 2022 – 2023 and compare the observed solar flare radio characteristics to results from well-established solar observatories. A number of individual flares is used to highlight angular reconstruction and calibration methods. The authors observe clear signal excesses during solar flares reported by the solar-observing *Callisto* network and in coincidence with about 60% of the brightest excesses recorded by the *SWAVES* satellite, when the Sun is above the horizon for RNO-G. The observed flares show significant impulsivity in the time-domain.

The paper demonstrates that the solar flares can be used to calibrate the RNO-G absolute pointing on the radio signal arrival direction to sub-degree resolution – important for the neutrino program. The picture below demonstrates the calibration procedure. The nominal antenna positions yield the sun position wrong by 2°. Taking all solar bursts and trying to get the Sun at the right position, one has to shift the individual antennas by 10 – 20 cm, i.e. recalibrate the positions. Reconstructing then one burst with the new positions, one gets a result as shown in the figure. It doesn't fit perfectly, but firstly, solar bursts don't always come from the center of the sun and secondly, the ice model enters the reconstruction. Therefore, there is a systematic error that cannot be reduced to < 1 degree with so little data. Anyway: one degree is completely sufficient for neutrino events.



Impressum
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