

Report ANTARES spokesperson

A. Kouchner

APC

Important items for this meeting - Status of New Monte Carlo production, data Monte Carlo Comparisons, HE atmospheric muon production, calibration procedures improved, faster procedure seems efficient; Data taking - shift list extended until end of 2019, run until about end of Ligo-Virgo science run 03. Publications - more should come based on ICRC proceedings. Time to fill the list of institute priorities for speakers: please inform CC if not done yet interest in upcoming conferences of your group members, list of priorities for speakers/topics. Plenary / Astrophysics / Dark matter & diverse physics / ESS & Acoustics: indicate possible constraints (e.g. due to funding limitations), you can/should also fill in directly the KM3NeT table. 26 conferences (2017: 18), 43 contributions (9 at Neutrino and 6 at VLVnT), 5 invited, 34 talks 9 posters (all at Neutrino). Speakers distribution: 28 Seniors, 8 post-docs, 7 Ph D. students, 9 contributions from 4, 34 contributions from 24, 17 joint presentations ANTARES/KM3NeT.

KM3NeT Astroparticle & Oscillation Research with Cosmics in the Abyss (ARCA & ORCA)

Mauro Taiuti

The «new» management since January 31, 2019: Spokeperson M.T., Deputy Aart Heijboer, Technical Coord. Miles Lindsay Clark, Scientific Coord. Paschal Coyle; News: Markus Boettcher application of North-West University, Potchefstroom, South Africa for observer status, Dmitry Zaborov application of ITEP, Russian Federation for observer status, Harold Yepes Ramirez application of YachayTech, Imbarura, Ecuador for Observer status. ARCA and ORCA are back in operation! ORCA replacement of the cable during two different sea campaigns in October (12-16 and 22-26); Installations of 1 DUs done in Feb 14-17. Operation terminated due to a failure of the winch of the deep-sea cable

ORCA sea campaign

D. Dornic, P. Lamare

CPPM

Sea operation with Castor boat from Foselevand Janus boat with Apache ROV from Comex in 24h/24h (new). Several attempts since mid Nov. but sea operations cancelled due to bad weather. Finally all conditions fulfilled to perform the sea operation from 16/02 to 19/02 (despite a last minute change in authorizations). Some ideas to unblock the LOM using a tool with the ROV. Corrective action for the 3 DUs ready to be deployed. One DU installed and working nominally. Deployment without top structure easier, test to recover a furled DU to be done. Some problems with acoustic positioning and communications, improvements to perform.

KM3NeT Detector Operation ARCA & ORCA

S. Biagi, A. Enzenhöfer
INFN, CPPM

Result of the KM3NeT sea operation at the KM3NeT-Fr site from 16/02/2019 to 18/02/2019 (see dedicated presentation today)! One ORCA DU (ORCA-DU1) operational_Electrical parameters and optical parameters of the infrastructure stable and nominal since the beginning. No DAQ related issues during restart of data taking. Reasonable data from day one. A total of 4 DOMs got stuck each time shortly after run start during the first two days of operation. Toggle backbone was necessary to recover. Stable operation since then. Commissioning phase started and currently ongoing. Proposal to fill the shift-table on a yearly base (like ANTARES). KM3NeT DB have to be updated with institution quotas.

Technical Project Manager Report

Miles LINDSEY CLARK
APC

Procurement Officer (Help from M.Circella) provide help with finalising the procurement plan, be the main interface for procurements and associated logistics, organise periodic meetings to follow and report on the timelines and the progress of procurements, make sure that all the procurement documentation is clearly identified and well stored in Gdrive. Almost all the parts have been qualified (ARCA Phase IDU bases pressure qualified this week). Difficulties with the PMT support structures (Moulding solution foreseen: Edward working hard on it). New OFP penetrators for the VEOC (more reliable). We will soon open an NRB process for: «Sparking DOMs», «ORCA DU1 LOM» deployment anomaly and “Out of sync.”

Outreach

Status ORCA site

P. Coyle, PLamare for the CPPM team
CPPM

New cable without screen (LWS type) ordered and delivered to replace the part of the cable with steel screen (LWP type). Powered on few hours at the end of the sea operation - everything nominal, sea current in the MEOC lower than previously (7.5A vs 9.2A) due to new MEOC cable capacitance, powered on from time to time up (about once a month) to DU installation; Node frame in titanium manufactured and available: Titanium sphere, some holes to be machined. Power items: components received except the transformer under quotation (critical path). Planning: assembly expected to start around mid March up to July, deployment from July to Oct. before installation and connection of the Secondary JB (ESS) planned early Nov. with Ifremer boat.

MECMA 2019 new contract for 4 years started on 01/01/2019. KM3NeT cables are under a scientific network composed by CNRS, INFN, INGV and HCMR to share the new fees. ORCA power review initiated (documents in GD).

Multi-messenger group @ KM3NeT

D. Dornic

CPPM

4 main items in the multi-messenger group: transient and variable sources, multi-messenger, real-time physics analysis, MeV neutrino from SN. Goal for ORCA6: be ready to start physics analysis (few GeV-few TeV) after the commissioning phase to have 1st results for summer conferences. Need a high-energy MC for ORCA115 and ORCA6 between 100 GeV - 50 TeV. KM3NeT Open Public Alert message: VO Event (same format used in ANTARES, Implement only one KM3NeT alert provider with different brokers for the neutrino streams. Use GCN for the notice transmission. Organize a multi-messenger workshop end 2019 (in link with INFRADEV WP6 and 7).

Online CCSN trigger + light curve background simulation

Massimiliano Lincetto

Aix-Marseille Universit_e, CNRS/IN2P3, CPPM, Marseille (France)

Supernova light curve studies (and possible other low-energy analyses) rely on the analysis of the aggregate detector hit rate on a time scale of few hundreds ms. Since bioluminescence induces space and time correlated effects, the background cannot be modeled as a stationary poissonian or Gaussian noise process. Raw data is available for 1-2 lines, but we do not have a model to extrapolate this to a 115 lines detector. Different analysis approaches have been explored in order to exploit the L0 and L1 hit rates for supernova physics studies. A randomised upscaling technique has been developed to simulate a full-sized detector starting from single DU raw data.

CCSN light-curve studies using L0/L1 data

Marta Colomer Molla

IFIC

Using real L0 data, one cannot resolve the signal light-curve. Bioluminescence burst mimic the signal shape, and the rate is higher. L1 selection: events producing at least two hits in coincidence within 5ns. Going from L0 to L1 decreases signal statistics by a factor of 30 (only ~25 events per time bin of 2ms @10kpc), but bg is decreased by a factor of 400 and the bioluminescence impact is reduced. Standing Accretion Shock Instability (SASI): hydrodynamical instabilities during CCSN ccretion phase predicted by state-of-the-art 3D simulations. Enhances the neutrino heating favoring the explosion and could explain the neutron star kick observed. Need to think on a efficient way to reduce L1 bg. No time correlated bg (Poisson like) needed for better resolution of the light-curve: more important than lower rate.

GeV astrophysical neutrino searches

Gwen DW., Veronique VE.

APC, CNRS, France

Main steps of the selection – remove as much background as possible to minimize the baseline: 1) (sub-threshold) atmospheric muons - use a veto / deeper DOMs, 2) bioluminescence - exclude group of DOMs that see bright and long flashes, 3) K40 - the biggest issue... To-do list: Run sub-threshold atmospheric muons simulations and search for muon tunnels in the detector. Effective area changing over time.

KM3NeT QA/QC status update

GIORGOS ANDROULAKIS

Develop an automatically DB generated ADP for DUs - contents of ADP under definition. Integrate DOM and DU functional and acceptance test sheets with the DB. Automatic check if the right version of firmware on CLBs; Further improvements on notifying e-mails, overall aesthetics, functionality, attachments to SRSs. Overall debugging: Most affected are SRSs, products disappear; versioning of forms disappears; Excel forms loading and parsing not possible; Warnings not being mandatory.

Multi – energy astrophysical neutrino searches

Gwen DW., Veronique VE.

APC, CNRS, France

ORCA HE (100 GeV, TeV): follow up in HE before ARCA fully built, link between ARCA and ORCA NMO; All flavor)shower-like+track-like selections, likelihood (E, zenith). What is the effective area ORCA HE 7L Li&Ma calculates the significance of a counting exp. when both signal and bkg rates are described by a Poisson process.

HE ORCA115 Simulations

Gogita Papalashvili, Rezo Shanidze

HEPI, Tbilisi State University

Low energy simulations: 1- 100 GeV. All neutrino flavors (ne, nm, nt) CC and NC interactions. Light propagation and PMT hits: km3sim. High energy simulations: 50 - 100000 GeV muon neutrino nm CC-interactions. Light propagation and PMT hits: Km3sim (50-5000 GeV). High energy (50 GeV- 1 PeV) neutrino nm / nm -CC were simulated for the KM3NeT/ORCA detector, using KM3NeT MC software. All simulation data are stored in Lyon-CC SPS. Neutrino events were generated with gSeaGen (50 – 5000 GeV) and genhen (50 GeV – 1 PeV) software. Light propagation and PMT hits were simulated with km3, Jsirene and km3sim (50-5000 GeV) software. Standard KM3NeT trigger and reconstruction software was used for the simulated neutrino events. Next step: analysis of the simulated data and study of KM3NeT/ORCA performance at high energies.

High Energy MC production for ORCA7DU

Luigi, Gwenhael, Marta & Nhan

APC group

Studying the sensitivity of ORCA7 to astrophysical searches - covering from 50 GeV up to HE range of 5 TeV. On testing phase with small samples, neutrino event generator: gSeaGen (ν_e CC, ν_μ CC, NC) 30-70 GeV, 180-220 GeV, 800-1200 GeV; Three light generators for checking consistency: KM3Sim, KM3, JSirene; Diverse features among three light generators. Discrepancy between 3 light generators in terms of light efficiency, PMT distribution of hits. Need to produce more checks and cross-check with other ORCA HE simulation groups

Simulation for HE (50 GeV – 5 TeV) ORCA 7 lines

Giuliano Maggi

CPPM

A high energy sample has been produced for ORCA 7 lines. This has to be checked. A purpose is to make neutrino astronomy with ORCA (multi messenger). APC group is also working on this HE regime for ORCA. An effective area for ORCA 7 lines has been presented. This is compared with a low energy (3-100 GeV) sample produced by the oscillation group: `/in2p3/km3net/mc/atm_neutrino/KM3NeT_ORCA_7_23m_9m/v0.0/JTE`. This needs to be checked.

TIME-DEPENDENT SENSITIVITY FOR TXS0506+056 WITH ARCA115

ANKUR SHARMA & ANTONIO MARINELLI

INFN

We calculate a time-dependent sensitivity and discovery potential for TXS 0506+056. Need to assume an emission model to move from the γ -flux to neutrino. We assume the model of (Petropoulou et al. MNRAS2015), where the γ -rays are the products of Pion-decay cascades (see A. Marinelli's presentation at the Caserta Collaboration Meeting for more details). The Fermi-LAT flux, between (1 – 300 GeV), scaled to 1 TeV under the assumption of E⁻² spectrum, is used for normalization in the sensitivity calculation. New dedicated MC production (v5.1_src) for the declination of the source, in point mode. Analysis only with track event topology (source and atmospheric ν), for one building block of ARCA (ARCA115).

To get the neutrino flux for normalization, we apply the (Petropoulou et al. 2015) model to the Fermi-LAT γ -ray flux during the flaring period. We obtain values for the 5σ and 3σ discovery potential, and sensitivity for TXS 0506+056 during the flare of 2017, with one block of ARCA. ARCA has the potential to better constrain the (Petropoulou et al.) model due to gain at higher energies for this declination compared to IceCube

ANTARES Astrophysics Working Group

Dorothea Samtleben, Nikhef

Thomas Eberl, ECAP

ANTARES 9 years and IceCube 7 years Point Source Combined Analysis (G. Illuminati); new IceCube sensitivities for Southern sky recently published; ANTARES only point source analysis update (G. Illuminati); Stacking source analysis (J. Aublin); Search for neutrinos from Eta

Carinae (J. Aublin, S. Razzaque); Paper finalized, today on arXiv 190209462A : (G. Illuminati); ANTARES neutrino search for time and space correlations with IceCube highenergy neutrino events; Ongoing activities: diffuse Fluxes; Update all-sky diffuse flux analysis (L. Fusco); Fermi Bubble low-latitude analysis (S. Hallmann, M. Bissinger); Search for neutrinos from the Loop-1 structure (L. Fusco)

KM3NeT Collaboration Meeting

Daniele Vivolo

INFN Section of Naples

25 more DOMs are ready to be integrated. 18 will be integrated in Catania (Phase1 goal). Integration will start as soon as a final agreement about shipment of residuals for Phase1 DOM components will be taken (approximate integration time is 2 months). 7 will be used for the 2nd edition of the DOM Integration Workshop. Candidate sites are Strasbourg, Erlangen, Nantes, Napoli (after the QA/QC visit of last week, the proposal of Strasbourg has been endorsed by the PSC, informal discussion with local director: it will be very welcome and all local support will be guaranteed). The goal of the KM3NeT DOM Integration subgroup is to reach and maintain mass production capability all over the DOM Integration sites. All DOM Integration Sites are getting benefit from Phase1 DOM Integration to discover the current bottlenecks and customizing dedicated upgrades.

ECAP: DOM integration status (sub-talk)

Oleg Kalekin

FAU

DOM integration laboratory is fully equipped with all tools needed: line C DOMs are under integration. The last needed components – collars and CLBs/PBs – have been received recently (10 DOMs are just before gel pouring, 8 DOMs – electronics to be mounted). Upgrade plan - in 2021, ECAP will move into new building; DOM integration laboratory; DOM packaging and storage places are planned to be there. Upgrade of DOM integration tool is planned as well.

DOM Assembly (subtalk)

H. Carduner

SUBATECH

Phase 1 - still 6 DOMs to integrate. 1st Step: Integration of 4 DOMs in parallel (March). 2nd Step: Integration of the 2 other DOMs (PMTs needed). Phase 2 - all “small” components for 7 DUs available. Order for PMTs is one the way (CPPM), for the other components discussions with CPPM and NIKHEF in progress.

DOM Assembly (subtalk)

Safia Kihel

IPHC - Strasbourg

After a 5 months break since the integration of our 1st DOM, the integration resume in November. Receipt of components for 8 DOMs produced before the summer. Last design of PMT supports structure (top 3.4.1.4.1.1/S-HALF/1.8 ; bottom 3.4.1.4.1.2/S-HALF/1.7). Some pins on the support structure are a little bit large useful to position the structure in the hemisphere before inserting the PM, in order to adjust the tool used to handle the support structure in the best way. Currently, the pigtail is fixed to the base of PMT and cannot be removed. Recommendation of several colleagues: for each PMT, add two welding points to strengthen the mechanical holding of the connector to the PMT's pigtail.

DU Integration

I. Sgura

INFN

The DU review belongs to the general frame work of the review plan described in the document KM3NeT_PRR_2018_002 v3 The DU review was coordinated by M. Circella. The scope and the modalities of the DU review process are described in the document KM3NeT_PRR_2018_001-v3. Applicable documents: the teams have to be strictly followed during DU integration activities. These documents: i) are approved after preparation; ii) will be updated only after the appropriate DCR process; iii) contain a list of reference documents. The goals are to: train teams not experienced with the new tools, refresh the experience acquired by the teams that does not operate since one year, allow the teams to work together and uniform the competencies.

Updates from the Calibration WG

G. Riccobene

INFN – LNS

Procedures for Dark Room Calibration available (software and operational). Procedures for Sea Room Calibration under finalisation (software and operational). Merging between documents to be finalized. Tables to be filled during DU calibration defined. Nneed to be interfaced with Database properly. Calibration Base - Electronics Defined and available (FMC V3 plus standard DU base electronics). Power electronics CB_BPS under definition (small upgrades wrt to BPS_v02 for DU bases). Firmware developments: Found candidate at IFIC. Procurement and construction in charge to INFN (ARCA) and CPPM/APC (ORCA). Calibration Unit (CU) and Deep-Sea Instrumentation - Defined and already filled into the DB (Hydrophones, LBL Beacons, RAPS LBL autonomous beacon assembly (tripod)). Defined and under approval of QA / Tech Coord (CU interconnection, Calibration Base, Instrumentation Unit, Laser Beacon).

Inter – DOM time calibration using cosmics in the dark room & PMT efficiency cross-check

Dorothea Samtleben

Outlook for cosmics calibration cross check in the dark room: add matrix calculation into MonitorL1 routine, add adjustment of detectorfile for the new time offsets, provide Calibration

script. Advantages: does not require laser-splitter setup and extra data taking, does not require different runs for K40 intra-DOM and inter-DOM calibration, similar accuracy as laser calibration. PMT efficiency cross check - standard efficiency calibration in situ via K40 correlations. Possibly (small) biases introduced via external structure, imperfect rate modelling i.e cross check of determined efficiencies valuable. Bare PMT efficiency (without impact of glass, DOM structures) should correlate with the quantum efficiency (QE). Only for few PMTs full QE measurements available i.e. use Hamamatsu specifications (cathode luminous/blue sensitivity) as measure. Fast-decreasing ToTs observed in several ORCA DOMs requires regular retuning, undesirable. Hypothesis: real HV change, humidity plays a role, potentially condensation on PMT base, since effect seen reversible when back on shore - 15% lower K40 efficiencies observed in several ORCA DOMs compared to other ORCA DOMs (and ARCA DOMs).

Search for neutrino counterparts of the HAWC point-source sky map

Giovanna Ferrara (INFN LNS)

Luigi Fusco (APC)

HAWC data written in HEALPIX pixelization scheme (ROOT format). New pixelization with the pixel dimension corresponding to the ANTARES angular resolution in the GeV-TeV energy range ($0.1^\circ - 1^\circ$). Since the HAWC's sensitivity and energy response varies with the source declination - cut on declination of point sources and cut on the HAWC test statistic to consider the point sources with a 3σ significance. Differences in the ingredients and sensitivity respect to the PS Analysis 2007-2017 due to the different MC productions.

Likelihood method for muon calibration in water

Daniel Guderian

WWU, Munster (Institut für Kernphysik)

Automatic procedure - provide a script that automatically does the calibration using this method (as user-friendly as possible): time, x, y and z offset independently in one go re-iterate with found values as input parameters (i.e. 2nd iteration for time offset has x, y and z values set from the iteration before) until convergence is found create outputs to check if the procedure ran correctly (user supervision needed!). Planned extensions - add stretching factor and rotation of the string; Consistency check: add option to apply the procedure "backwards" on older DUs after determining the calibration of the newly added DU (does it change again?).

ORCA Calibration Base

Alin ILIONI

APC FR

Environment and conditions of use on the ORCA French site - operating pressure 250 bars, test pressure 310 bars, storage temperature $-10^\circ\text{C} / 60^\circ\text{C}$, seawater temperature 13°C . Mechanical Constrains - vibration and shocks during transport, dynamic constraints generated during

deployment, recovery, handling or assembly. ORCA calibration base, planning, design and Documentation - 2 internal reviews of the mechanics of the structure realized (Oct 2018 and Jan 2019); Design finalized this month and ready for an external review; Documentation almost finished - PBS database implementation in progress; Quotations in progress; CLB Firmware in progress; Product Readiness Review -> Mid -April 2019. Start of manufacturing in May 2019 - BPS_CB still in development. The laser beam goes through a transparent quartz rod before getting out of the container (special mechanic design needed). Electronics boards are now being tested at APC.

Point Source stacking analysis with ANTARES

Julien Aublin

APC

Two different stacking methods – 1) Individual stacking i.e an independent fit is performed for each source, then TS are summed up (used for IC HE tracks) and 2) Template stacking i.e. a global fit is performed, signal term is the sum of individual source contributions (used for catalogs). Obscured AGN - has 11 BL Lac present in Fermi 3LAC and the ULIRG Arp220 in the StarForming; The Radio Galaxies catalog has also 1 common BL Lac (PKS B0251- 365) with Fermi. All « sources » are independent (small nb of targets): source position is free in the fit within $\pm 2\sigma$ of each track position uncertainty and an equal weight is used ($w_{\text{model}}=1$). Stacking analysis sensitive to global excess from population of sources: can detect flux/source several order of magnitude lower than for a standard PS search; Analysis is ready for IC tracks (Individual stacking, $w_{\text{model}}=1$). Template method more suited for catalogs with high nb of sources (Fermi 3LAC): refereeing needed for the latest modifications (new catalogs, weighting schemes).

KM3NeT Electronics Status

Diego Real Máñez

IFIC-UV

All 250CLBs have been produced by EES - 200forCHIPS, 50forKM3NeT, 28 CLB+PB pair have been delivered toAthens for compass calibration, 5CLBs have been modified for DUbases ready to beshipped.2 of the previous CLBs have NCRs caused by some glue flow in the SFP cage (solved), other CLBs passed burn-in and now in functional test

Updates on the diffuse flux analyses

Luigi Antonio Fusco¹, Federico Versari²

¹Laboratoire APC

²INFN & Universita di Bologna

Signal is 2fold for getting the same contamination as for the old analysis, already cutting only in the likelihood. Using 2Dx2D seems to outperform (for low contaminations) the 3Dx1D (?) Some

work to do on the shower selection, with corresponding data/mc agreement to be studied - optimisation of the event selection to be determined, at the moment the whole thing is going on almost smoothly/no bottleneck in sight.

A different look at Antares (GRB) data

Maarten de Jong

Search for low-energy (MeV) periodic neutrino signals, apply Fast Fourier Transform (FFT) to level zero (L0) data. Antares DAQsystem includes a GRB satellite trigger: a)write real-time (about) two minutes of level zero (L0) data to local disks of data filter applications, b)collect all data from different disks into single -ROOT formatted-GRB file, c)QA/QC via Nikhefserver, d)archive automatically in CC-Lyon, e)update Antares database. More than 1000 GRB files have been archived so far. FFT analysis applied to Antares L0 data (for the first time?) - strong signal in frequency domain corresponding to frame time, apparent signal at 100 Hz (from electrical power mains?), no astrophysical signal found so far, Could set limits on astrophysical signals with some external input.

Status of the ANTARES MC

Luigi Antonio Fusco

Laboratoire APC

Boosted MUPAGE MC sample - first study by Federico (see diffuse flux analysis), files available at /in2p3/mc/rbr/v4/test/mu_HE and subfolders, please use them and report any findings, ~8000 runs which represent the whole livetime (and correspond to ~5yr of, equivalent livetime), consider the equivalent livetime of the corresponding run and then scale it up to the livetime you're actually taking into account. Anue NC events missing the Glashow resonance in the Earth crossing probability - Trunk genhen has this corrected, re-production ongoing, GENHEN Glashow resonance takes nucleon density, not electron density in the weight., weight x2 the "correct" one.

Status of GENHEN

Luigi Antonio Fusco¹, Ofelia Pisanti²

¹ Laboratoire APC,

² Universita di Napoli

Genhen trunk (v8 candidate), so basically we had: Branch of v7r6 with tau regeneration properly done; Trunk developing from v7r7 with tau interaction cured as in v7r6; Ofelia merged the two; Final checks ongoing by myself and Ofelia, seems that pretty much everything is in place right now: taus interaction volumes looks fine, anue NC Pearth properly computed and treated. Cross sections. NLO used with LO parton distribution functions (which is wrong) – CC only for Earth propagation if EAPROP is switched off: not correct. MUSIC not implemented in the tau regeneration version; Taus from Glashow resonant interactions in anue Earth propagation are not considered. Some additional nue/numu might come from them.

MC comparisons

Luigi Antonio Fusco

Laboratoire APC

In **v2** and **v3** we usually observed a deficit of 20/25% with respect to Bartol, a bit more wrt Honda – the Honda flux we are using is lower than Bartol’s. This was dependent on the event selection e.g. 20% for PS cuts (Bartol 2004, outdated/wrong/overestimated flux); 27% for the atmospheric neutrino spectrum (Bartol 2006); 25% for diffuse cuts (Honda 2007 + Enberg 2008); This is more or less still observed, the dependency seems to be a bit less flat in “event quality” (how much?) and more flat in “event energy” (is it?). There might be an effective underestimation of low-energy events - to be checked by doing areas/acceptances comparisons. The zenith distribution yet does not contain that much information. Whatever is done using MUPAGE should be handled with care...

ANTARES Data Production

A. Enzenhöfer

CPPM

All jobs for ANTARES data of the first six months of 2018 were processed once, a number of jobs (< 5%) failed due to computing issues and will be reprocessed - only a small number of jobs permanently fails. Subset of data from 2017 (2000 jobs) was used to test singularity solution at CC-Lyon on a larger scale - processing via Singularity on CentOS7, SeaTray release 18-07-00; Storage /in2p3/SeaTray/prod_singularity-test_2019_01_01/Line12/sea/ - processing went smooth, no obvious delay due to execution of singularity, performance analysis ongoing, dedicated ELOG entry in preparation.

A KM3NeT look at Antares (Monte Carlo) data

M. de Jong

KM3NeT reconstruction software is versatile it can be applied as-is to Antares Monte Carlo data. KM3NeT reconstruction software is performant •improvement of angular resolution compared to best-ever Antares algorithm; Antares science output can (always) be augmented a) prepare for legacy (open data, open software), b) consider global re-run of data analysis (better results, new publications).

Status of Calibration

M. Circella

HW and threshold tuning of the apparatus done recently; 10 OMs recovered back to nominal operation. Previous schemes useful in various respect - to understand how the various activities are inter-correlated, to study how to optimize all efforts, to recognize the contributions from all

people involved (note in particular the latest changes: Massimiliano has taken over from Ilenia for K40; Giulia has taken over from Javier for time calibration; Agustín has taken over from Heide for updating the calibration table in the DB). As they say here in Georgia: ("Strength is in Unity")...

ANTARES K40 calibration

Massimiliano Lincetto

CPPM

Variations of OM efficiencies last vs second-to-last period of Ilenia's calibration (201712-5 - 201712-4); First period of my calibration vs last period of Ilenia's (201801-1 -201712-5). The ANTARES K40 calibration procedure is stable and efficient. Relatively quick follow up of the production of quality tables is in place. I have limited time for proactive quality control, but I am willing to do a one-time work to provide standard benchmarks plot according to requirements.

The Sun shadow observation with the ANTARES neutrino telescope

Andrey Romanov, master student at Moscow State University

In collaboration with T.Chiarusi, V.Kulikovskiy, M.Sanguineti and F.Versari

One of the methods to estimate the angular resolution is based on the Sun shadow. This analysis has been adapted from Moon shadow analysis. In order to find the best quality cuts which maximize the significance of MC sample test hypothesis approach was used. New approach for the determination of significance (test hypothesis approach) has been performed and it shows the significance 2.9σ for MC sample. For the new set of cuts MC/data comparison has been done. The slope in 1d muon distribution in the region far from the Sun center has been investigated. The possible explanation of the slope is strong angular non-uniformity in the atmospheric muon flux. Increasing statistics for MC sample has been started using "fake Sun" approach. It is promising and more fake Suns (with 8, 12 and 16 hours shift) should be added to MC sample.

Search for neutrino counterparts of cataloged GW events from run O2 with ANTARES

Marta Colomer Molla

IFIC

Prompt emission search over ± 500 s. Bg rate computed from data using the run including the GW event, excluding this time window. Bg rate scale to (90% CL area/half/sky area)*(1000s/run duration). Assumption – uniform rate over the run and over the sky. Optimization on the significance at 3σ level First time showers are included full sky in a GW analysis. 1st detected by Swift. 1st GRB observed by Cherenkov gamma-ray telescope. No counterpart seen by IC. Downgoing transient localized event (GW170817 like). Apply same analysis as for GWHEN as starting point.

DU ANALYSIS INTRODUCTION

R. Coniglione and J. Hofstaedt

Currently ORCA-DU1 and ARCA1 in commissioning phase, ARCA1 will finish the commissioning phase at end of February and ORCA-DU1 the 20th of March. Currently checks on data are on-going ... Paper of depth dependence on the hand of editorial board after the PC review. New K40 calibration procedure under check. Analysis on the search for neutrinos in ORCA2 and ARCA2 is still on going. Atmospheric neutrinos detected with the first KM3NeT detection units ORCA and ARCA - comparison of the measured atmospheric muon flux with Monte Carlo simulations (Simulation and DU Analysis WGs). MC-data comparison at low level (number of hit, number of DOMs, triggers...) Depth intensity relation analysis with new K40 calibration - test KM3Sim detx i.e. gdm1 converter (almost ready) in RBR production; A user friendly code that can easily look at the DataBase info for each operating DOM/DU.

Updates on muon depth dependence with timeslice data

Massimiliano Lincetto

Muon depth-intensity relation (DIR) can be probed by studying coincidence rates on KM3NeT DOMs. No reconstruction, every DOM is treated as independent. Original study for ARCA2 has been refined and extended to ORCA1. A combined depth dependence can be evaluated but we are still missing a few steps to perform a flux measurement. The time window has been extended from 10 to 15 ns, as this was allowed for the selected ORCA runs (after #2867) + minimum rate threshold of 1 kHz; The ARCA simulation has been found to have wrong PMT parameters in the simulation, resulting in lower efficiency – this solved many problems in our understanding; The muon ux model was improper, and has now been corrected; Updated PMT efficiency calibration is now in place. Since we rely on simulations only with the purpose of relative calibration, the depth dependence is independent on the parametrisation used for the Monte Carlo... this is both an advantage and a limit: we have not 100% confidence that the proportionality between muon and coincidence rate is the same at all depths.

Data-MC analysis for ARCA2 Search for Neutrino Candidates

Anna Sinopoulou
NCSR “Demokritos”

This analysis focuses on: cuts optimization for selecting well reconstructed events and selection criteria to identify neutrino event candidates. Distance of Cherenkov photons emission point < 120m, angle between photon direction and PMT direction < 90 deg, Δt between expected and measured hit time < 30ns, i.e. 5 DOMs under the Cherenkov hypothesis to be consistent with the reconstructed track. Calculation of the angle difference (diffangle) between the best track and every other track solution from the reconstruction for each event. Investigation of the minimum diffangle and the maximum diffangle between the solutions for reco, well reco and really badly reco events. Still there are things to investigate: investigation of a new cut (instead

of the MinMax), cut on the ratio of hits on up/down hemispheres of DOMs, possible optimizations when the new MC is available.

ORCA DU-2 analysis: Q/ndf, Cherenkov conditions cuts & max ToT cut

Dmitry Zaborov
ITEP

Neutrino candidate rate visibly higher than expectation; contamination by atmospheric muons Suspected. Data-MC agreement far from perfect. For cut optimization we want identical conditions for muons and neutrinos: same software version, same settings, same detector, same noise level, ... RBR MC is used to estimate the atmospheric muon background in the final analysis. Many of the previously good neutrino candidates will not survive the Q/ndf cut, i.e. a way to suppress possible contamination by atmospheric muons... lik/ndf cut provides some useful redundancy. The “Cherenkov conditions” cut provides a mild improvement; A more reliable anti-sparking cut implemented. Analysis approaching a final state; Looking forward to more neutrinos with DU-1.

First Experience from ORCA-DU1

Jannik Hofstadt
ECAP

ORCA-DU1 data looks very good, every DOM working, every PMT working, no sparks,... Seven noisy PMTs with too low threshold, i.e. many short ToT (~few ns). Noisy PMTs are not peculiar, a likely they can be recovered, by adjusting threshold. Noisy PMTs show strange oscillation with ~0.1Hz. Humidity in DOMs much more homogenous than in ORCA-DU2 (there are likely correlations between sparks and low humidity). Similar reco zenith distributions for DU1 & DU2 a DU1 works as expect.

FIRST LOOK AT ARCA1 DATA

R. Coniglione and S. Biagi

Applying reconstruction algorithm to a subsample of ARCA1 data after run number 6000 was discovered that only few events are reconstructed. After investigating the full DAQ chain (detector/t0 files, CU +JPP) and feedback from analysis, a power cycle of the DU-backbone was performed, to reboot all CLBs. The correct synchronism was recovered. ARCA1 good quality data after more than three years since deployment - all PMTs working, HV tuning recovered PMTs with low ToTs, NO DOMs lost (NO need of power cycle), a new timing issue found in the CLBs. Data-MC comparison in line with ARCA2.

WIMP searches from the Galactic Centre, ANTARES and combined ANTARES/IceCube

Rebecca Gozzini

IFIC

IceCube collaborators at ULB: Nadège Iovine, Sebastian Baur, Juanan Aguilar
CSIC

Data proc 2018 01, MC v4, switched to Honda conventional weight 9260 CC ν_μ tracks 3054.4 days lifetime, 19272 runs. Here cuts are $\Lambda < -5.2$, $\beta < 1^\circ$, $\cos\beta > 0$. Differences between data and MC contain a 0.9 factor $\text{GetWeightHonda}/\text{GetWeightW3}$, and ~ 0.95 lifetime scaling factor. We observe a small decrease in effective area using MC v4. ANTARES sensitivity is successfully reproduced with IceCube method, both in number of events (i.e. indep. of acceptance) and in annihilation cross-section. In fact we carried on a check of our PPPC4 spectra against PYTHIA used by IceCube. The ν channel was not properly simulated for IceCube, so even here the differences went unnoticed. This analysis would like to go to ICRC.

ANTARES: Dark Matter searches towards the Sun (Update)

A. Nuñez-Castiñeyra

CPPM

Supervisor V. Bertin

Expected flux of muon (anti-)neutrino from WIMP annihilations in the [Sun](#) at Earth. Wimpsim includes neutrino oscillations and absorption/regeneration in the Sun. PPPC 4 DMID also includes radiative corrections. Taking only MC events that are in a possible position from the Sun in the (θ, ϕ) plane. Needed to build the Point spread function. Next steps - extend analysis for low energy track events, compare sensitivities with BBfit and GridFit reconstructions with full data set; Extend analysis with shower events for ν_e/ν_τ CC signal events (+ NC events) with full data set; Compare the sensitivities coming from pppc spectra with the ones from wimpsim.

First steps and plans to constrain the azimuth angle in BBFit single line events in Antares

Chiara Poire

UPV, PhD student

Search for Dark Matter from the Sun - BBFit single line strategy (Best strategy), low energy region ($< 200\text{GeV}$), neutrinos μ , antineutrinos μ , CC events. Try to constrain the Azimuth in BBFit single line, studying the distribution of hits. Reconstruction techniques and machine learning algorithms will be studied and compared. The Idea (1): Use the information of the Hits, like the position and calculate the azimuth angle (φ) through the function atan2 . Another Idea (2) -fix/impose the position of OMs (next slide), i.e. due to the different position/orientation of every line is necessary to do line per line, calculate the average of the position, weighed with the number of hits corresponding to the OM (Evaluate the value of φ , compare with φ MC). To do -idea(1): add the line position to correct OMs pos and idea (2): implementing the code.

Nuclearites analysis

Y. TAYALATI

Mohamed V University

Faculty of Sciences

Rabat

0 runs from 2009 - Silver run “quality criteria”, DQ=4; Directional trigger (3N) - 5 L1 hits correlated in space and time; Cluster trigger (T3) - two clusters of two L1 hits in adjacent and next-to-adjacent storeys, within a $2.2 \mu\text{s}$ window; Nuclearite Masse: $3 \cdot 10^{13}$ to 10^{17} GeV (100 events/each run - slow massive particles, 10^{-3} , RBR – V4. In progress and to do - DATA %MC (Scale factor); Fit the charge barycenter distributions; Optimise the selection cuts : "dt" and "V",...

Magnetic Monopole Search with ANTARES

J. Boumaaza¹, J. Brunner², I. El Bojaddaini³, A. Moussa³, Y. Tayalati¹

¹ Mohammed V University, Rabat, Morocco

² Centre de Physique des Particules de Marseille

³ Mohammed I University, Oujda, Morocco

The new production includes magnetic monopoles, atmospheric muons and neutrinos (latest MC production); Magnetic monopole production relies on a new simulation of delta-rays based on KYG model of cross section; A collection of data up to 2017 is considered (~ 1928 days); All productions are based on RBRV4 taking in to account the degradation of OM efficiency; Each production undergoes two reconstructions, corresponding to β free and $\beta=1$, these slides will consider only the case for $\beta=1$. Number of Cherenkov photons emitted per cm in the sea water. The new simulation of MM relies on KYG model for the emission of delta-rays giving a higher amount of light. To obtain the best sensitivity we optimize the Model Rejection Factor for each velocity interval, by playing on α and N hit cuts. Finally - reconstruction of atm. Muons and neutrinos using Bbfit with β free (latest production); Simulation of the remaining β ranges for Magnetic monopole (KYG always); Perform the extrapolation and redo the optimization.

First Steps in Sun DM Searches with ORCA

Daniel Lopez-Coto

University of Granada

Full ORCA - 115 strings, 23 m horizontal spacing, 9 m vertical spacing. Bartol flux model for atmospheric neutrinos used. Check of reconstructed quantities (Energy and Zenith angle) - event reconstruction efficiency computation; Calculation of the angular and energy resolution; Effective Area calculation for atmospheric neutrinos; Dark Matter spectra from WimpSim 4.1.1.; Signal and Background PSF generation. Ongoing - signal and Background PSF; Want to run new WimpSim production on Lyon with 106 annihilations and extend the Wimp Mass range (help needed!!). Next Steps - sensitivity calculation for the selected cuts, best cut parameters searching.

See Science

Technique and first results of small-scale 3D temperature sensor mooring array in weakly stratified deep Mediterranean waters

Hans van Haren

NIOZ, Royal Netherlands Institute for Sea Research

What does turbulence affect in the ocean? - transport of matter (marine geology), without turbulence no life (marine biology), large-scale ocean stratification (marine chemistry).

Purpose: resolve all energetic internal waves, Large turbulent overturns to study their 3D development. Construction: self-unrolling lines on compacted multi-array, 45 lines, 120 m long (vertical), 9.5 m apart (horizontal), 3000 high-resolution synchronized T-sensors, sampling rate 0.5Hz, endurance >2y.

KM3NeT Electronics Status

Status of FMCv3:

Diego Real Máñez (IFIC-UV)

Giuliano Pellegrini (INFN –Sezione di Bologna)

FMCv1 mounted on all deployed base containers ORCA and ARCA since. Electronics Phase II: PBv3 i.e. 20 units received from a pre-production batch. All of them functionally tested. 2 sent to INFN Genova and 2 to Nikhef for further tests. Development of new firmware to test EDFA, Laser Beacon and C.U. from CLB through FMCv3. Firmware modification to Include the number of elements in the super time FIFOs. This shows the FIFOs are no tempt yat the beginning of the run. The system starts before optics configuration (OOS). Software modification in the state machine is needed. This will fix the OOS problem.

Introduction to the DAQ/Readout session

Tommaso Chiarusi

Sezione di Bologna

The OOS issue is not due to an hardware issue (i.e. VHDL developments). The OOS is due to stochastic delays in the State Machine transitions between the CLB subsystems. Quick action - modified Control Unit to grant a prefixed ordering in the transition of the CLB subsystems. Under test @ BCI; Final action (a.s.a.p.) - re-design of how the CLB emb-s/w handles the state-transitions to forbid misalignments inside the CLB subsystems; Immediate action - use the OOS-patch.

MONITORING CHANNEL ANALYSIS IN ARCA

ALBA DOMI

INFN, CPPM

Two separate tools, running online and in parallel: udpAnalyser.py and udpRates.py. The analysis shows a correlation between the OOS issue and the variable TDC_SUPERTIME_FIFO.

In particular, when TDC_SUPERTIME_FIFO != 0, its value is shows directly the TimeSlice (TS) shift of that particular DOM wrt the others due to the OOS. This result was confirmed by Federico's analysis made with JTurbot2D. Apparently the TS shift is typically <= 3, but for few runs it is quite big (ex. value = 8,9,10,11). The change in the TDC_SUPERTIME_VALUES has been observed also by Federico with JTurbot2D: RUN 6332, udpAnalyser i.e. initial value = 8, final value = 11 for DOM 9, JTurbot2D. This analysis, combined with the one made by Federico with JTurbot2D, shows that there is correlation between the TS shift due to the OOS and the variable TDC_SUPERTIME_FIFO. I have also looked at the variable AES_SUPERTIME_FIFO (connected to the acoustic) but it is always 0. TO DO - make the new versions of the codes available and apply the same analysis also to ORCA.

OUT OF THE SINC TEST SETUP & OUT OF SINC ISSUE

V. van Beveren

R. Bruijn

P. Jansweijer

The CLB embedded software implements a state machine having 6 states, including the initial 'undefined' state. Furthermore it consist of five subsystems, all implementing this state machine (DOM version): System, Network, Optics, Acoustics, Instrumentation. All subsystemscan be controlled at once, or separately - in the initial investigation for OOS the assumption was they are moved at once, using the wildcard expression event; However CU controls all subsystems completely separate, and delays in order of hundreds of milliseconds *may* occur between subsystems on the same CLB. In case of KM3NeT a complete DU must be available for tests such that new hardware, software or firmware can be thoroughly tested before deployment and unforeseen future issues can be reproduced, traced down and solved.

Dual DHCP boot with Redundant White Rabbit Switches

Antonio F. Díaz, Sergio Navas (UGR-Spain)

Diego Real, David Calvo (IFIC-Spain)

WRS Redundant configuration in Phase-II -- off-shore (2 White Rabbit Switches), on-shore links through port 1 (wri1). Each WRS interface (eth0, wri1) should be assigned to different subnets to avoid tricky configurations. DHCP servers cannot process different subnets in the same interface. We assign an IP to each MACVLAN at the DHCP server. It can response to both subnet requests. We can use isc-dhcp-server to configure DHCP Failover.

CONTROL UNIT & DATABASE NEWS

C. Bozza

University of Salerno & INFN Gruppo Collegato di Salerno

ARCA Commissioning started with Release Candidate 1 (SVN 11377) and completed with RC9 (SVN 11549). Some features have been left for testing at BCI to ensure that ARCA leaves the commissioning stage quickly. Position Calibration needs some work on the DB and specific efforts for development both on KM3Web and in the DBI. A few upgrades for general services,

most work on QA/QC forms. QA/QC forms now follow the paradigm of TB_OPERATIONS, with a DECISIONID tored when each form is closed (it was only in TB_QAQC_REPORT_PARAMS before this bunch of upgrades).

Computing and Software Working Group

Kay Graf
ECAP

Software updates - continuous improvements on all central software projects (new algorithms, additional functionality, documentation), Jpp branch v10.3, v11rc, Aanet v2rc, KM3pipe v8.9.2; Computing updates - extensive use of CC-IN2P3, CNAF and NCBJ-CIS resources available; IT services - DB updates, transition to GIT and GITlabCI/CD. Software Update Strategy (Jpp, Aanet) - Jppup to (including) v10.3 developed in SVN; From v11 on in GIT. Benchmark files should be created to test each release/development against including standard distributions. Due to high commitments in commissioning phase of ARCA/ORCA, several tasks „dormant“ - t0 and detector geometry handling via calibration groups in the DB; Software maintainence strategy; Software review; Scalability of computing environment for extending detectors; Automatic offline processing of data (including all steps from calibration to reconstruction and data quality); Service tasks (see before).

Git CI/CD via GitLab CI KM3Pipe

Tamas Gal
ECAP, FAU

Our Git server (GitLab v11.8.0) (Login with your KM3NeT Google Account, Authenticate using SSH keys) <https://git.km3net.de>. Continuous Integration (CI) and Continuous Delivery (CD). [Integrating your project with just three lines!](#) Configure it with a single file called .gitlab-ci.yml **Build, script, make**. This will automatically trigger the CI on every push to Git; It will run per default on our base image (CentOS 7); You can use whatever image you like and install hatever you want. docker.km3net.de/base/centos-full:7 includes all the required build tools and compiles and is a good starting point for your C/C++/Fortran projects. [Automatic Docker Image Build and Publishing](#). Python Project Template contains everything a Python package developer needs - pip-compliant package structure, unit testing infrastructure, documentation including auto-API, full GitLab CI support (building using multiple Python versions), code style check.

Aanet: (selection of) Developments and plans

Aart heijboer

Included slalib+ wrapper that works in C++ and Python for almost all slalibfunctionality. Specialized class for astronomical coordinates - based on Seatray::Astro i.e. checked routines from ANTARES, includes proper dealing with UTM coordinates (meridian convergence angle), and J2000 convention. Aanetis the data format used for offline. Hope is it offers easy way to

analyse data - many simple examples, e-mails for help, trac, gitissues are dealt with fast, new version ready for use (branch v2_rc for now), use inside JPP being tested in CI. Numpy is a python library for working with C-arrays. A Janet supports python through PyROOT and offers speed by using same objects in C++. Slalib still standard library for positional astronomy - written in fortran; A Janet: C++ wrappers automatically generated for ~all slalib functions; Support ROOT dictionary i.e. easy and unified use in both C++ and python. Classes designed with 3 usagemodes in mind: compiled C++, interpreted CINT/Python (pyroot) (new: use with numpy/numba, Jupyter Notebook); TTree Draw tuple-like analysis (Extremely quick throw-away analysis on a single file). All three can be mixed!

Modelling of PMT analogue signal

(JPMT Analogue Signal Processor)

M. de Jong

offshore signal processing - new model has less parameters than old model: QE; gain; gain spread; rise time; TTS; threshold; offset; slope; curvature; and saturation); I/O of model parameters backward compatible (PMT efficiency file); QE; gain; gain spread; rise time; TTS and threshold; Some parameters of new model should have different values (threshold ~0.3pe, rise time ~8.5ns). ARCA2 data were taken with too low HVs on various PMTs - causes a deficiency, most notably culprit(s) in analysis of depth dependence of atmospheric muons. To measure gain [and gain spread] of PMT, one needs to model time-over-threshold distribution - new model seems to reliably work for any gain, can be applied to L0 as well as L1 data.

JRunAnalyzer

Rodrigo G. Ruiz

Each JDAQ Summary slice contains JDAQ Summaryframe objects, each of them containing information for a DOM. The methods JDAQ Summary frame getDAQ Frame Status and JDAQ Summary frame getRate allow to retrieve the CLB header information for a given DOM at a given time slice, as well as the rates for each PMT in the DOM. JRunAnalyzer monitors this information and produces the histograms shown in sections. Concerning the CLB header, the high rate veto (HRV) activations, the TDC FIFO buffers, and the UDP packets are monitored. For each summary slice and for each DOM, JRunAnalyzer checks how many PMTs entered the HRV regime. Events are triggered by different algorithms that search for groups of hits satisfying certain clustering conditions or triggers. Their values can be tuned for different detector geometries or data taking conditions as part of the run setup.

DOM orientation & position in Jpp

Feifei Huang

IPHC

Implement in Jpp the calculation of DOM orientations (i.e. quaternions) from AHRS data and calibration. Do interpolations of the quaternions (vs. time), so that DOM orientations can be

obtained at times when AHRS data is missing. Produce detector file where DOM (PMT) orientations & positions are modified according to the interpolated quaternions or DOM positions at any given time. Finally – 1D polynomial interpolation on quaternions works well, even when raw data points are noisy or have possibly malfunctioning data points. Produce new detector file with interpolated quaternions at some time T (T within run time range).

Online reconstruction system

(Software session)

Giuliano Maggi

CPPM

In a multi messenger context, an online reconstruction system is needed (see also my presentation in the multi-messenger data). A proposal for an online reconstruction system has been implemented for KM3NeT (this is based on C++, BOOST, python; several JPP tools (latest trunk), to use socket connection reconstruction algorithms); Currently it is taking data for ORCA DU-1 km3net@marcorcadaq at CPPM. A first phase for an online reconstruction system has been developed and currently is working for ORCA DU-1. This is based in C++ (and BOOST), python, and several JPP tools. This online Software package is located in my KM3NeT svn-sandbox (is public for KM3, *but* this is been moving to git.km3net). TO DO - run the recos in antorcaoff1.in2p3.fr, online event viewer and get data from ARCA. Currently running in km3net@marorcadaq at CPPM - reconstruction processes are ran in this machine; A Jligier also is running here which receives the result of the reconstructions.

Simulation overview

Vladimir Kulikovskiy

INFN Sezionedi Genova

Some of our software is currently only compliable with SL5(g77) environment - GENHEN, propa. They are also dependent on CERNLIB. Last weeks Lyon removed sl5 cernlib compilation. Sl6 cernlib seems to be still OK (g77) but sl7 is gfortran compiled and not anymore compatible. Expansion to the new computing resources (GRID) requires full chain of software installation. Base OS can be incompatible with our requirements (missing libraries, different compilersetc). Cross sections in GenHen: Parton Distribution Functions are LO, NLO improvement. Earth attenuation in the weights,when no full propagation in Earth is activated, is calculated with only CC cross section. Alternative calculation by using some external package. MUSIC not implemented in the nuxversion of nu_tau regeneration. nu_tau from Glashow resonance interaction of anu_e in Earth are not fully simulated: the ir regeneration would give other nu_e/nu_mu.

It is about your stories - science communication in KM3NeT

G. De Wasseige, P. Coyle, E. de Wolf et al

APC, CNRS, France

Storylines (let's talk about us) - "KM3NeT: The next generation": scientific and technical innovations; "KM3NeT at work": sea campaigns/our workshops/events: advertise what we are doing; "Meet our Collaboration": for everyone!; "Heroes of KM3NeT": highlight hardware/software/production work, sea operation crews, grants/funding/awards, ... Draw me a neutrino... Who? 3 groups: group νe : pre-school/primary school, group $\nu \mu$ - secondary school, group $\nu \tau$: adult... When? October 2019...

KM3Sim maintenance news

Jerzy Mańczak
IFIC

GDML is application independent format designed to define detector geometry. KM3Sim parses GDML format into Geant4 geometry (standard Geant4 utility). So far, the KM3Sim input file had to be prepared by hand – the idea was to automate that process. Hierarchy of the Geant4 geometry has to be chosen (output will depend on it). Shifts and rotations of the DOMs should be taken into account. Different coordinate systems in GDML and detx. Hierarchy of the Geant4 geometry has to be chosen (output will depend on it). Shifts and rotations of the DOMs should be taken into account. Different coordinate systems in GDML and detx. Introducing visualization in Geant4 application is rather easy. So far HepRep and VRML (obsolete) support is being tested.

MC and data comparisons

Piotr Kalaczyński
SWIERK

CORSIKA/data agreement improved - still some non-understood deviations for ORCA: vertical muons (mupage vs CORSIKA) and pos_z outliers); RADD optimization: default propa setting was not optimal and reprocessing from can level needed. Statistics now (full production 10^8 μ bundles): 61.6 % of full production (sea lvl), 4.6 % (can lvl, ARCA2) 99K 13 times less and 0.3 % (reco lvl, ARCA2) 99K 15 times less. Storage: latest production: 0.8 TB, sps user quota: 2 TB, CIS user quota: 100 TB (containerisation required). Investigate propa: check the code itself (will need help FORTRAN ...) and increasing RADD, we waste events. μ are considered collectively: x; y; z pos and dir averaged over all μ in a bundle and E summed over all μ in a bundle. Reasons: computational efficiency - at reco level bundles _tted as single μ anyway and others did it too, so it's better for comparing. No multiplicity correction applied to mupage

Self-veto studies based on CORSIKA simulations

Rafat WojcZYnski
NCBJ, Warsaw

Downgoing atmospheric neutrino events can be vetoed by accompanying μ 's from the same shower. Cosmic ν 's does not have muon companions. DONE: model approximations agree with CORSIKA simulations at can level; Most effective veto for: high energies, vertical events ($E > 10$ TeV, $\Theta < 60^\circ$ Veto > 99%); Passing fraction heat map for range of E and $\cos\Theta$. TO DO: support

CORSIKA simulation chain work with Piotr Kalaczyński (increase statistics at can level);
Perform simulations at reco level, use ARCA/ORCA DATA.

ORCA HE: New simulations for 7 and 115 lines

Luigi Antonio Fusco et al

Software involved: **ORCA115** (Gogita + Rezo) - gSeaGen (up to 5 TeV) and genhen (up to 1 PeV); 3 energy ranges: [50 GeV, 5 TeV], [5 TeV, 50 TeV], [50 TeV, 1 PeV] – E^{-2} ; 1 energy range: [50 GeV, 5 TeV] – E^{-2} ; `/sps/km3net/users/gogita/Prod. ORCA115->7` (Giuliano) – genhen [50 GeV - 5 TeV] (from Gogita, 115l); JSirene with Steffen's 7l detector file; `/sps/km3net/users/gmaggi/data/orca_KM3NeT_ORCA_7_23m_9m/nu_mu/`. ORCA7 (Nhan, Marta, Luigi, Gwen) – gSeaGen ; 3 energy ranges [30 GeV, 70 GeV], [180, 220 GeV], [800GeV-1220GeV], E^{-1} ; KM3Sim, KM3, JSirene; KM3Sim: `/sps/km3net/users/mcolomer/ORCAprodHE/ mc/atm_neutrino/orca_7strings_av23min20mhorizontal_18OMs_alt9mver_cal_v2_mod_moved/v5`; KM3: `/sps/km3net/users/gdewasse/ORCA-produc_on/data_processing/trunk/ mc/atm_neutrino/orca_7strings_av23min20mhorizontal_18OMs_alt9mver_cal/v5`; JSirene: `/sps/km3net/users/nchau/ORCA_test`. Finally - 3 simulation productions; Different software/energy range/spectral index used; Discrepancies between the groups/software; ≠ efficiency, ≠ computational time, origin? Need to coordinate for testing! Once solved, comparison at trigger/reco levels; Documentation of simulation production and tests to be done on the eLog and wiki.

ORCA Neutrino Oscillations

J. Brunner

Mass productions - 7L production (Steffen): summary generation chain over the next weeks; Single muon score parameter derived from pre-training; 20m production (Bruno): PID finished around Christmas; Analysis with ParamNMH & Swim ongoing; 23m reprocessing (new analysis tools); Dusj finished; JGandalf energy correction pending; PID & summary pending.

NMH sensitivity – Draft publication exists: first round of corrections received from Bruno, Liam producing new version, to be distributed in WG; Upgrades using 20m production ongoing; ParamNMH (Mathieu); Swim (Christine); NIKHEF Tool (Bruno). Attempts to use more dimensions beyond E, θ : studies ongoing, several PID bins, Bjorken-y. Few new systematic (skews) agreed on at Valencia: to be included into Swim and ParamNMH (Mathieu, Christine). Exotic oscillation signals – Progress on various subjects: NSI (Nafis & Tarak); Neutrino decays (Tarak); Sterile (Alba, Tarak); Quantum decoherence (ECAP, Thomas). Make analyses coherent with NMH analysis. Comparison with world data whenever possible.

Low-energy Monte Carlo productions for ORCA

S. Hallmann

ECAP

All productions have Dusj shower-reco and JGandalf track-reco (reco-LNS, JShowerFit).
[Variables included in the summaries](#) -1) Monte Carlo / reconstruction parameters, 2) Dusj

energy correction, 3) tau-decay information variables (leptonic e,mu /hadronic decays not stored in .evt. info inferred from tau-decay particles), 4) Number of runs per flavour / generated events for Monte Carlo /reconstruction parameters contained in the full PID sample, 5) derived variables: 3d/4d distances / angles between recos, 6) upward-downward deltaChi2 variables for JShowerFit/JGandalf, 7) Geometric Coverage variables, 8) Usual “first guess” event-selection (containment variables adjusted to have same margin around instrumented volume (R=130m (23m)→ R=110m (20m))). Hit/No-Hit PDFs calculated for nue-CC and numu-CC events with respect to Dusj reconstruction position/direction. Calculated track/shower likelihood difference features for hits around reco vertex and tested different setups. Containment variables have been adjusted to have same margin around the detector. Gain in PID performance seems small.

P2SO: Protvino-to-SuperORCA Swim Sensitivity Updates with the 20m Production

Christine Nielsen

Energy scale skew between interaction types - Covers uncertainties in hadron shower light yields using a single parameter that can be used to calculate correlated effects on different channels; 6% prior uncertainty on underlying parameter Extra flux normalization; Depends on $\cos \theta_{\text{Zenith}}$; To cover various flux-related uncertainties; Prior of 2%, from Barr paper. Multiple systematic effects studied, and several have been implemented for sensitivity studies going forward - Cross-section systematics shown to have small effect for now; New flux and energy scale systematics implemented; Still investigating that it's all correct; Shows large improvement in sensitivity for both NH and IH; LLR fits in progress – slower but less conservative.

Sensitivity of ORCA to quantum decoherence effects

M. Fahn, M. Bruchner, J. Hofstadt, Th. Eberl

ECAP, FAU

Standard decoherence effect expected due to wave-packet separation, Non-standard decoherence effects due to interaction of the (open) quantum system with its environment. Transition from pure into mixed states. Investigated sensitivity of ORCA to state-of-the-art phenomenological model of decoherence - Compared to existing upper bounds by KamLAND, Minos, IceCube and DeepCore for most conservative regions in parameter space; ORCA found to be competitive for E-n cases, normal and inverted ordering similar; Weak dependence on true θ_{23} ; ARCA expected to be competitive for En cases.

Breaking Degeneracies

Jannik Hofstadt

ECAP

P2SO allows high precision measurement of leptonic CP-violating Dirac phase δ_{CP} , competitive and complementary to other planned experiments (DUNE/T2HKK). What is Super-ORCA? densified version of ORCA, 10x denser than ORCA-LoI9m: ‘optimised’ for measuring δ_{CP} with

atmospheric neutrinos, which requires good detector performance for $E_\nu = 0.5 - 2$ GeV. Super-ORCA with atm. ν presented at PANE2018 and Neutrino2018. P2SO - Protvino beam to Super-ORCA. Using $\nu + \bar{\nu}$ beam helps resolve $\delta_{CP}-\theta_{23}$ degeneracy ($\nu/\bar{\nu}$ beam a positive/negative horn polarity). T2HKK focuses on second osci max, where P_{osci} are different. For $\delta=0^\circ \& 180^\circ$: $\delta_{CP}-\theta_{23}-\theta_{13}$ degeneracy limits δ_{CP} resolution, and this more present than in DUNE due to worse E resolution & PID. For $\delta=90^\circ \& 270^\circ$: less systematics limited and much higher event statistics helps P2SO. Finally - P2SO is important part of 'P2O Letter of Interest' arXiv:1902.06083 [physics.ins-det]; P2SO is competitive & complementary to DUNE/T2HKK. δ_{CP} resolution for $\delta_{CP}=0^\circ$ limited by $\delta_{CP}-\theta_{23}(-\theta_{13})$ degeneracy; Using $\nu + \bar{\nu}$ beam helps to reduce degeneracy.

Sterile Neutrinos with ANTARES & ORCA

J. Brunner

Oscillation probability - vacuum, no matter effects; $P(\alpha \rightarrow \alpha)$ depends only on absolute values of matrix elements; Only one line involved; Valid for any number of generations; $N=4 : 3$ independent $|U_{\alpha i}|^2$, $3\Delta m_{ij}^2$; ν_{τ} neutrinos, vacuum, first family decoupled and 2 flavour oscillations. $3+1$ neutrinos, Δ_{41} averaged out, $\sin^2\theta_{24} = 0.1$; Matter effects, various parameter combinations: 1) $\sin^2\theta_{24}=0.10$, $\sin^2\theta_{34}=0.00$; 2) $\sin^2\theta_{24}=0.00$, $\sin^2\theta_{34}=0.10$; 3) $\sin^2\theta_{24}=0.05$, $\sin^2\theta_{34}=0.05$. Matter effects, various parameter combinations, SK approx: 1) $\sin^2\theta_{24}=0.10$, $\sin^2\theta_{34}=0.00$; 2) $\sin^2\theta_{24}=0.00$, $\sin^2\theta_{34}=0.10$; 3) $\sin^2\theta_{24}=0.05$, $\sin^2\theta_{34}=0.05$. For $\delta_{24}=0^\circ, 90^\circ, 180^\circ, 270^\circ$ - Effect visible if both θ_{24} and θ_{34} non-zero. Finally - OscProb reproduces IC, SK, MINOS when same approximations are used; Neglecting δ_{24} is ok for $P(\mu \rightarrow \mu)$ in vacuum (MINOS); Neglecting δ_{24} is incorrect in matter; Oscprob allows for full 4×4 treatment without approximations; ANTARES / ORCA should produce results: phase fixed + other approx to compare with IC, SK and phase fitted, full 4×4 treatment.

JPP SHOWER RECONSTRUCTION AND STERILE NEUTRINOS ANALYSIS

ALBA DOMI
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The energy reconstruction is worse with the PARAM PDF. I correct it with a linear function of Reco Energy. BJORKEN Y RECONSTRUCTION - (1) use 4D MC PDFs: $PDF(D, \delta_c, \theta_{PMT}, \phi_{PMT})$ and (2) use 5D MC PDFs: $PDF(E, D, \delta_c, \theta_{PMT}, \phi_{PMT})$. For 4D PDFS - both made with MC data by using JHistHDG. For 5D PDFS - both made with MC data by using a modified version of JHistHDE (to take into account all the hadrons). COMPARISON BETWEEN 4D AND 5D APPROACH - improve the Energy Correction of JShowerFit with PARAM PDF (by correcting with the hadronic energy dependence formula); Improve the Bjorken Y Reconstruction (4D case); Improve position reconstruction; Run JShowerFit into the MC ORCA masked for 1 DU with the goal to run it with ORCA DU1 DATA. Update of oscillation

parameters (NuFit v. 3.2); Consider also a prior of 3% on global Energy scale (Realistic case!). Start in the first and in the second octant of θ_{23} and select the minimum for each bin. TO DO - complete the tests on the impact of CP24 phase (with Jürgen and João) i.e. new study which has not been done by other atmospheric neutrino experiments! Complete the mass-dependent analysis for ORCA (with all priors etc) with Tarak; Since the mass-dependent analysis code is ready i.e. extend the analysis also to ORCA HE and ARCA. Salvador is already helping with this: he extended the energy range of the atmospheric flux into Swim up to 5 TeV.

NSI Sensitivities at KM3NeT-ORCA

N. R. Khan Chowdhury, Tarak Thakore
IFIC, CSIC

Determination of atmospheric oscillation parameters - normal Ordering assumed, data generated with standard oscillation(*), no priors on NSI. The sensitivity to $\epsilon_{\mu\tau}$ does not vary “much” with the track vs shower cut. NSI sensitivities for ORCA looks competitive to current Super-K and IceCube limits- impact of NSI on the NMO sensitivity is studied, effect of NSI on determination of atmospheric oscillation parameters is estimated, wiki page (link) is under construction and the analysis would like to go to ICRC. Using the SWIM package to simulate the detector response. Osc. parameter values are taken from NuFit v3.2. NMO sensitivity affected by Eps_em, Eps_et.

Sterile Neutrino Sensitivity with ORCA + (Other topics in the backup)

Tarak Thakore
IFIC

An advantage for ORCA : Can constrain all three mixing elements ($U_{\alpha 4}$) simultaneously, because the atmospheric flux contain both ν_{μ} and ν_e components, unlike the accelerator /reactor oscillation experiments, which can typically only constrain one of the mixing elements at a time. This indirectly helps to resolve the appearance-disappearance tension in the sterile global fits. There are many theoretical motivations for sterile neutrinos at low m_{41} scale. However, ORCA has access to longer baselines(10,000 km) than MINOS (735 km), larger matter effects, which results in enhanced sensitivities for ORCA. Both sterile neutrino and NSI analyses are computationally intensive, because the oscillation probability calculation are more demanding than the std. 3F oscillations. Moreover, there is a larger parameter space in the fits. We have a lot of interesting physics material for sterile neutrinos and NSI sensitivity at ORCA. This would be a follow up paper to the mass hierarchy sensitivity paper. A new reweighting package for GENIE v3 was released, around Christmas. In this version, the reweighting machinery is working correctly. With GENIE v3, a variety of model tunes are available, more can be created. What model tune will be optimal for ORCA? Perhaps we should create a new tuning of models that perform well at energy relevance for ORCA MH determination. To

answer such questions, we need to better understand both the reweighting machinery and the underlying neutrino interaction physics.

NMH Oscillation parameter measurement with ORCA7

Nhan Chau

To determine the sensitivity of ORCA7 to Δm_{31} and θ_{23} follow up the analysis of Bruno. Using Swim for Asymmetry plot of $(E, \cos \theta)$ histogram and perform a log likelihood fit. Data taking time is set to 1 year. Seem to be overestimate the contribution of shower and middle sample in comparison with NNMO - in contact with Bruno & Tarak for detail crosschecking settings and plots; Include the effect of systematics, background. Construct CL contour in parameter space. Optimize the PID cut and classification.

HE WG - INTRODUCTION

R. Coniglione

Mass production ready (except nu_tau), Wiki on MCv5 production now completed - study of the sensitivity of the KM3NeT-ARCA detector to extragalactic sources (M. Sanguineti, G. Ferrara); Observation of Glashow resonance (J. Manczak, G. Illuminati); Looking to the Milky Way diffuse high-energy neutrinos with KM3NeT/ARCA (A. Marinelli). Most of these analyses are on going (Results expected at the next collaboration meeting). How to proceed for analysis on point-like in steady mode or/and for transient with the MCv5 simulation? Analysis “a la KM3NeT” or analysis “a la ANTARES”? Agreed with Damien to use at moment an analysis “a la ANTARES”: at moment no time or hour angle present for each simulated event in point-like mode in the final stages of the MC simulation.

Blazar neutrino fluxes with shower in ARCA

Matteo Sanguineti

INFN Genova, LNS, INAF Brera

This analysis is based on the previous Monte Carlo production Results from different reconstruction algorithms are taken in account in the selection criteria optimization: JGandalf, strategy and Aashowerfit. The input from the different reconstruction algorithms are exploited to find the best cut using RDF approach. Example of correlation matrix between all the variable included in the RDF training nueCC channel. Distributions of the RDF value for atmospheric muons (blue) and cosmic neutrinos (red). The blazar flux estimations provided by the INAF group has been used to estimate the KM3NeT ARCA sensitivity for cascade channel. For the most promising source we can obtain a 5σ significance in 8 years (3σ in 3 years). Plan for the future - update the analysis to the new MC (fruitful discussions with Rosa, Vladimir, Giovanna..) and new (wo)manpower: Natalia Briukhanova (MSU).

Sensitivity of ARCA for Glashow resonance detection

Jerzy Mańczak

IFIC

Significance after 1 year with 2 blocks of ARCA – BDT classification applied - 1.0σ (Old formula) and 0.74σ (New formula). Time necessary to reach 3σ significance with full ARCA - 9 years (Old formula) and 16.6 years (New formula). This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 713673. The research leading to these results has received funding from "la Caixa" Foundation.

KM3NeT and IceCube effective area comparison

Gwen, Marta, Rosa, Julien, Luigi

APC, CNRS, France

Comparison between our effective areas at trigger level and comparison with IceCube point source and GFU for upgoing/downgoing events at a time t . Parameters for ARCA 1bb and IceCube correspondingly - height: 700 and 1000, diameter: 1km and 1 km, medium: water and ice, number of DOMs: 2070 and 5160, photocathode area: 292 m² and 284 m², sky coverage in upgoing: part of Northern (and Southern hemispheres) and Northern sky, depth (bottom): 3500 m and 2450 m. Focus of on interactions $N(x) = N_0 (1 - e^{-x/\lambda})$. On paper - we should have more events, from simulation - we have similar number of events or less.

ARCA Expectations for the low latitudes Fermi Bubbles

Antonio Marinelli

INFN. Pisa

In coll. with Ankur Sharma

Possibility that the low latitude Fermi Bubbles have a different behavior with a harder SED for $E > 100$ GeV. The possibility to have a harder SED for the low latitude Bubbles can reconcile the Fermi-LAT and HAWC data with the inferred neutrino SED for the HESE catalog.

The Fermi-LAT data in the region of the low latitude Bubbles ($|b| < 10^\circ$) can be explained through diffuse Galactic component just up to hundred of GeVs. The gamma-ray hardening at low latitude Bubbles ($|b| < 10^\circ$) need to be understood. If this hardening in the gamma-ray SED is really due to the low latitude Bubbles and not just unresolved sources, give more chances to observe correlated ν events. Considering the favorable position of the low latitudes Bubbles ARCA will obtain a good discovery potential in only 1 year assuming a cutoff at 100 TeV. Finally - At the low latitudes Fermi Bubbles, $|l| < 15^\circ$ and $|b| < 10^\circ$, a hard gamma-ray spectrum without low energy cutoff seems present; Very soon a Fermi-LAT dedicated paper; ARCA has the potential to observe the possible presence of protons in the initial wind of the Bubbles in only one year.

Studying the Neutrino Sky at 3500 N.A.P.

Karel Melis

One probability function for all event signatures $P(\text{ev} | \chi)$ contains two members, from which first probability to observe first hit on PMT, but second member probability that nothing is detected on PMT. Catalogue of event likelihood landscapes. User defines his/hers flux to test...

ANTARES search for high-energy neutrinos from TeV emitting blazars Markarian 421 and 501, in coincidence with HAWC gamma-ray flares

Mukharbek Organokov

Institut Pluridisciplinaire Hubert Curien (CNRS)

Université de Strasbourg

Determine the relative contribution of each component, **S** and **B**, at a given point in the sky at a given time. Calculate the probability to have a **S** above a given **B** model. improves the analysis by reduce of background; improves the discovery potential over a time integrated search. **LC** can be used as a time probability distribution function. Bayesian analysis helps to identify changes between flux state via finding change points at transition from one flux state to the next. Different flare states amplitudes used - the current analysis involve the raw-data LCs with 1 TeV as a threshold, and flare blocks obtained w.r.t. that; the spectral fit parameters are not similar as well; The last analysis presumed the Bayesian blocks have already been done, but for that the initial LCs had other thresholds than 1 TeV, e.g., 2 TeV and 3 TeV for Mrk 421 and Mrk 501 respectively. Different optimized λ cuts have impact on sensitivity fluxes $S^{90\%CL_{\text{Median}}}$ - for Mrk 501, ~18% difference in used fluxes give roughly worsening by factor proportional to ratio 1.1 (longer time) / 1.18 (worse flux) ≈ 0.9 , which is roughly ≈ 1.1 worsening that we observe; For Mrk 421, we use ≈ 2.2 longer duration, but sensitivities better by factor ≈ 1.8 . Hence, using same idea, if assume e.g. $\approx 20\%$ differences, we obtain $2.2/1.2 \approx 1.8$, exactly what we observe. different data/mc set with new reprocessed data and new mc might cause some affect.

Multi-messenger real-time analysis with the ANTARES neutrino telescope

D. Dornic (CPPM)

D. Turpin (CPPM/IRAP), M. Ageron, V. Bertin, J. Brunner, A. Mathieu (CPPM), F. Schüssler, B. Vallage (CEA/IRFU), S. Basa (LAM), A. Coleiro (APC/IFIC)

on behalf the ANTARES, TAROT, MASTER, ZADKO, Swift, M.W.A., H.E.S.S., INTEGRAL Collaborations

Statistics of the sent neutrino alerts (07/2009-31/12/2018): 292 alerts sent to robotic telescopes [84 DIR + 208 HE], 17 sent to Swift, 15 sent to Integral (3 followed), ≈ 20 to MWA (3 followed), - 2 to HESS. ANTARES neutrino alert classification in 4 categories: Rank 1 is sent to MASTER, TAROT robotic telescopes, MWA radio telescope, INTEGRAL, Swift/XRT telescope and HESS gamma-ray telescope (Fermi is done offline); Rank 2 is sent to robotic telescopes + MWA + INTEGRAL; Rank 3 is sent to only robotic telescopes and Rank.4 is sent to only MASTER telescopes. ANTARES alert system - very performant & efficient alert sending system: able

sending in ~ 5 s with a precision of $\sim 0.3-0.4\sigma$ (3 muon-neutrino triggers), be careful to the extended tail; Full multi-wavelength follow-up covering the whole EM spectrum; No more agreement with HESS, new proposal by S. Croft/ C. James with MWA; Extensive effort of MASTER for the optical follow-up, need papers asap; 3 papers in the pipeline (ANT150901, early and long-term follow-up). ANTARES real-time analysis - All GRB in the ANTARES horizon is analyzed (binned analysis), so far no coincidence; Follow-up of IC alerts; Preparation for the analysis of the GW alerts of run o3; AMON ANTARES / Fermi-LAT running in real-time (extension to HAWC ?)

Combined Search For High Energy Neutrino And Subthreshold Gravitational Waves From O2 Ligo-Virgo Run

B. Baret, T. Pradier

News with respect to O1, O2 raw data got public yesterday. Reconstruction codes get public - Model dependant pipelines available (not useful here) and Model independant pipelines (what we want). Coherent Wave Burst - should get public in « near future ». Equivalent python pipeline being devolped by APC Virgo group. Optimisation based on the maximisation of detectable common source while controlling the false detection rate, Sensitivity equivalent to IC (2009-2010) with point source cuts. O1 like selection of candidates almost ready (weeks). Time permitting - possibility of optimisation using GW data (months); Include showers ?

Ending remarks

Aart Heijboer

Thank you for your attendance!

We should evaluate the new meeting schedule

Start on Tuesday

Parallel technical Sessions

Please don't hesitate to give feedback

Many thanks to our Hosts!

Excellent food, meeting rooms, tech. Support

See you in Nantes

Expect analyses of 5 working DUs