T 71: Neutrino Astronomy 3

Time: Wednesday 16:15–18:30 Location: T-H30

T 71.1 Wed 16:15 T-H30

Up-going high energy showers with the fluorescence detector of the Pierre Auger Observatory — Ioana Alexandra Caracas and •Karl-Heinz Kampert for the Pierre Auger-Collaboration — Bergische University Wuppertal, Gaußstr. 20, Wuppertal, Germany

The ANITA observations of two steeply up-going cosmic ray like showers with energies above 10^{17} eV remain unexplained. The Fluorescence Detector (FD) of the Pierre Auger Observatory is also sensitive to such phenomena, given its wide field of view and substantial operation time. Using 14 years of available FD data, the post-selection exposure to up-going induced showers exceeds the one of ANITA by a factor of at least 10, as indicated from dedicated studies. Therefore a search for up-going induced air showers with the FD can be used to either refute or confirm the occurrence of such intriguing events.

We have conducted a generic search for upward cosmic ray like induced air showers using the FD of the Pierre Auger Observatory. Dedicated Monte Carlo simulations of both signal and expected background, together with the usage of a 10% burn data sample, have been used in order to apply selection criteria and calculate the resulting FD exposure. The unblinding of the data indicates no excess found above background expectations. As a result, preliminary upper limits are set on the flux of up-going cosmic ray like induced air showers.

**Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)*

T 71.2 Wed 16:30 T-H30

Constraining BSM scenarios producing up-going τ induced air showers with the Pierre Auger Observatory* — •Ioana Alexandra Caracas for the Pierre Auger-Collaboration — Bergische University Wuppertal, Gaußstr. 20, Wuppertal, Germany

High energy steeply up-going air showers as observed by ANITA can't be explained by Standard Model (SM) physics and require Beyond Standard Model (BSM) scenarios. τ-leptons decaying in the atmosphere represent the main primary candidates for such showers.

The Pierre Auger Observatory has set strict upper limits on the flux of up-going cosmic ray like air showers. The generic search is recast here in terms of BSM particles producing up-going τ-leptons. In any such BSM scenario a significantly reduced cross section of the hypothetical particle with matter is required, allowing them to propagate through the Earth with sufficiently low interaction probability. Interactions close to the surface could result in the creation of τ-leptons that escape into the atmosphere to induce up-going showers. The optimum BSM cross section for this to happen is found to be $\sigma_{\mathrm{BSM}} \approx 10^{-2}\sigma_\nu$.

Using both the Surface Detector and the Fluorescence Detector data, combined upper limits are set on particles creating up-going τ-leptons for different BSM scenarios.

**Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)*

T 71.3 Wed 16:45 T-H30

Search for a high energy neutrino flux from Gamma Ray Bursts using the Pierre Auger Observatory* — •Tobias Heibges for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstraße 20 42119 Wuppertal, Germany

Gamma Ray Bursts (GRBs) are among the most violent explosions known in the Universe. A characteristic feature is a very high flux of gamma rays produced in these explosions which can be observed and located by satellites, such as the Swift and Fermi satellites.

A high energy gamma ray flux can be interpreted as an indication for the acceleration of charged particles up to the highest energies. Therefore, Gamma Ray Bursts are among the prime candidates to be sources of ultra high energy cosmic rays (UHECRs). High energy neutrinos are commonly regarded as a smoking gun indicator of UHECR acceleration and as they are not deflected by magnetic fields they can be easily traced back to their source and thereby contribute to unraveling the mystery about the origin of UHECRs.

The Pierre Auger Observatory is sensitive to high energy neutrinos with energies beyond $\sim 10^{17}$ eV. In this talk the non-observation of any high energy neutrino events is used to set an upper limit on the high energy neutrino flux seen on earth, produced by GRBs.

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T 71.4 Wed 17:00 T-H30

Event selection for new triggers used for neutrino detection at the Pierre Auger Observatory* — •Srijan Sehgal for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

The Pierre Auger Observatory with its large array of Surface Detector (SD) stations can be used to detect highly inclined neutrino-induced extensive air showers. Two new SD triggers, time-over-threshold-deconvolved (ToTd) and multiplicity of positive steps (MoPS), installed in 2014 were shown to vastly increase the detection capability for the neutrino-induced air showers in the lower energy (E $< 10^{19}$eV) regime with a little to no change in background events.

This talk analyzes the event selection procedure on data and neutrino-induced showers simulated with CORSIKA both reconstructed using the Auger software framework. Events in the zenith angle range of $60^o < \theta < 75^o$ and energies below 10^{19}eV are selected to investigate the low-energy performance of the new triggers. The main point of focus is the effect of the new triggers on efficiency and purity of an improved neutrino selection.

**Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A20PX1)*

T 71.5 Wed 17:15 T-H30

Reconstruction performance using RNO-G — •Sjoerd Bouma for the RNO-G Collaboration-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Erwin-Rommel-Str. 1, D-91058 Erlangen

RNO-G is an in-ice radio detector in Greenland which aims to detect Extremely High Energy (EHE) neutrinos through the Askaryan effect. Deployment started in Summer 2021, with the first 3 out of a planned 35 detector stations now built and taking data. As the first production-scale in-ice radio neutrino detector, RNO-G both complements as well as helps to inform the design of the planned radio extension of IceCube-Gen2.

One important aspect of RNO-G and potential future radio neutrino detectors, aside from their effective volume, is the ability to reconstruct the properties of detected (neutrino-induced) radio shower signals. An accurate reconstruction of the neutrino direction is crucial in order to identify potential sources of EHE neutrinos. We will present a brief overview of the current state of reconstruction performance using algorithms developed for the open-source NuRadioMC software package by the RNO-G collaboration, and provide an outlook for future improvements.

T 71.6 Wed 17:30 T-H30

Data reduction for the Radio Neutrino Observatory Greenland — •Zachary Meyers for the RNO-G Collaboration-Collaboration — DESY, Platanenallee 6, 15738 Zeuthen, Germany — Erlangen Center for Astroparticle Physics (ECAP), Friedrich-Alexander-University Erlangen-Nuremberg, 91058 Erlangen, Germany

Continuing the search for utra-high energy neutrinos ($>$ 10 PeV) beyond the range of optical detection methods, the Radio Neutrino Observatory Greenland (RNO-G) is now online after a successful first season of deployment. Total data taken during the shortened 2021 campaign from the three operational stations amounts to nearly ten million recorded events, requiring more than 330GB of storage. While this could be considered a manageable sum, next year another 7 stations are planned to come online, while the complete array will consist of 35 total. And for future experiments, requiring hundreds of similar stations, the data volumes rapidly increase to a level where it is no longer feasible to run direction and energy reconstruction algorithms on the entire dataset. Low level cuts must be made early in the data processing stages (or even onboard the detector itself in real time) in order to be computationally efficient. In an attempt to discriminate between thermal noise fluctuations, anthropogenic noise and neutrino-like signal, we show the potential effectiveness of deep learning approaches, specifically convolutional neural networks (CNNs), in both the time and frequency domains. When compared and combined with more traditional methods such as matched filtering, a comprehensive strategy for post trigger filtering can be established.

T 71.7 Wed 17:45 T-H30

Cosmic ray detection efficiency and implications for in-ice radio detectors for high-energy neutrinos — •Lilly Pyras for the RNO-G Collaboration-Collaboration — DESY, Platanenallee 6, 15738 Zeuthen, Germany — Erlangen Center for Astroparticle Physics (ECAP), Friedrich-Alexander-University Erlangen-Nuremberg, 91058 Erlangen, Germany

A promising technique to measure neutrinos above 10 PeV is the detection of radio signals generated by the Askaryan effect. The emission is caused by neutrino-induced particle cascades in dense media e.g. ice. Since 2021 the Radio Neutrino Observatory Greenland (RNO-G) is being deployed, consisting of in-ice strings of antennas down to 100 m and antennas closer at the surface. One of the main challenges of the data analysis is distinguishing between background stemming from cosmic rays e.g. high energy muons and a real neutrino event. By building the detector with surface antennas we can use the established method of radio detection of air showers to identify incoming muons and use these signals as veto mechanism in the neutrino detection. An efficient veto trigger will lend higher confidence in identifying neutrinos and prevent the false positive neutrino detections caused by muons. This report presents the development of tagging incoming air showers as veto and analyses its performance.

T 71.8 Wed 18:00 T-H30

Search for periodic low energy neutrino sources — •Maximilian Eff for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, Friedrich-Alexander Universität Erlangen-Nürnberg (FAU), Erlangen, Germany

Pulsars are rotating neutron stars that emit beams of electromagnetic radiation. Neutrino emission from pulsars has been the subject of phenomenological models during the last decades. So far, experimental data has not shown any significant neutrino emission at high energies. This contribution reports about the development of a novel approach that aims at identifying low-energy neutrinos from periodic sources with a neutrino telescope. This is done by applying a Fast Fourier Transformation to the PMT counting rate time series.

T 71.9 Wed 18:15 T-H30

PLEnuM: A world-wide monitoring system of high-energy astrophysical neutrinos — •Lisa Schumacher[1], Matteo Agostini[2], Mauricio Bustamante[3], Foteini Oikonomou[4], and Elisa Resconi[1] — [1]ECP, TU Munich, GER — [2]UCL, London, UK — [3]NBI, Copenhagen, DEN — [4]NTNU, Trondheim, NOR

The discovery of high-energy astrophysical neutrinos by IceCube has shaped neutrino astronomy in the recent years. However, the observation rate of astrophysical neutrinos in the TeV-PeV energy range remains small, such that various questions about high-energy neutrinos and their astrophysical origin remain open. This situation will improve when new neutrino telescopes will come online in the next years: KM3NeT, Baikal-GVD and P-ONE in the Northern Hemisphere, as well as IceCube-Gen2 as extension of IceCube in the Southern Hemisphere. In order to answer our open questions, we propose the Planetary Neutrino Monitoring System (PLEnuM), a concept for a combined repository of world-wide high-energy neutrino observations. PLEnuM can reach more than four times the exposure available today by combining the exposures of the current and future neutrino telescopes distributed around the world. Depending on the declination, spectral index, and flavor, PLEnuM will improve the sensitivity to astrophysical neutrinos by up to two orders of magnitude. We present first estimates on the capability of PLEnuM to discover Galactic and extragalactic sources of astrophysical neutrinos and to characterize the diffuse flux of high-energy neutrinos in unprecedented detail.