Contribution ID: **76** Type: **oral**

Selection techniques of neutrino-induced cascades in the Baikal-GVD neutrino telescope

Monday, 25 July 2022 14:30 (15 minutes)

The main aim of the Baikal-GVD (Gigaton Volume Detector) neutrino telescope is to detect high energy astrophysical neutrinos and to identify their sources on the sky. The Baikal-GVD is located at a depth of 1366 metres in Lake Baikal. Currently (year 2022), it is composed of 10 functionally independent units, referred to as clusters, that comprise 2880 optical modules (OMs) in total. OMs are designed to register Cherenkov light originating from secondary particles produced in neutrino interactions.

Charged-current interactions of electron neutrino and neutral-current interactions of all three neutrino flavours produce a Cherenkov light signature of a single cascade in the telescope. Muons originating from the muon neutrino charged current interactions in the water induce track events.
Although, cascade topologies can also be created by discrete stochastic energy losses along the tracks from the atmospheric muon bundles. These muons represent the most abundant background in the search of astrophysical neutrinos via cascade channel. In result, different kinds of data analysis techniques for the selection of neutrino induced cascade events have been developed and optimized.

The techniques are based on the time and charge information of signals detected at the OMs (called hits). For instance, one of the technique searches the maximal number of track hits amongst cascade hits, which are present in the muon bundle event. Other techniques investigate the distributions of hits charges and positions of hit OMs associated with cascade events. All the presented selection tools were developed, tested, and optimized by means of the Monte Carlo simulations.

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Session Classification: Parallel 2

Track Classification: NU