Methods for the suppression of background cascades produced along atmospheric muon tracks in Baikal-GVD

Zuzana Bardačová
on behalf of the Baikal-GVD Collaboration

Comenius University in Bratislava, Slovakia

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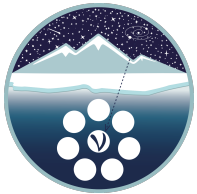
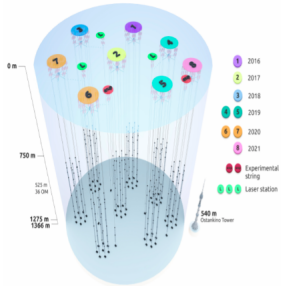
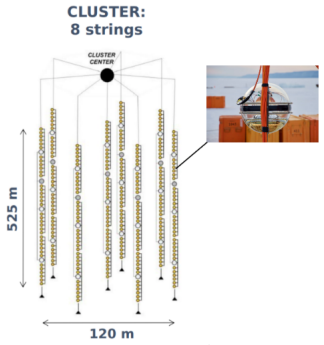


Baikal GVD

- The Baikal Gigaton Volume Detector (GVD) is placed 1366 meters deep in Lake Baikal
- Currently (year 2021) the Baikal GVD consists of 8 clusters (instrumented volume $\approx 0.4\ \mathrm{km}^3$)
- The cluster comprises 288 Optical Modules (OMs) arranged on 8 strings $\rightarrow$ in total 2304 OMs





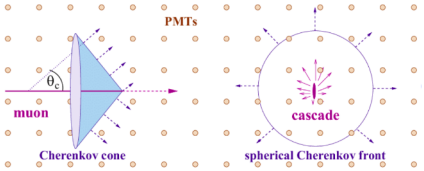
Background Cascades

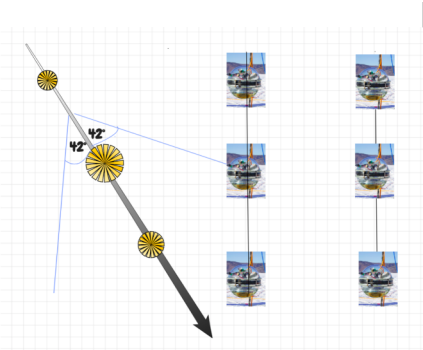
Neutrino interactions

- $\nu_\mu(CC) \rightarrow$ track
- ν_e, low energy ν_τ (CC) $\rightarrow$ cascade
- all flavors (NC) $\rightarrow$ cascade

Background cascades

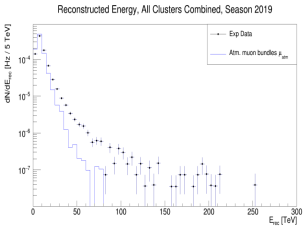
- $\mu_{\mathrm{atm}} \rightarrow$ muon bundles
- Bkg cascades:
- Stochastic energy losses along μ_{atm} tracks

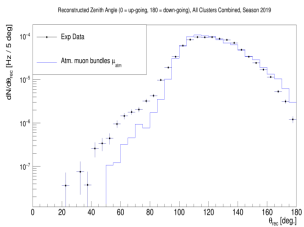


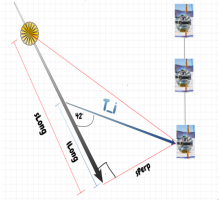


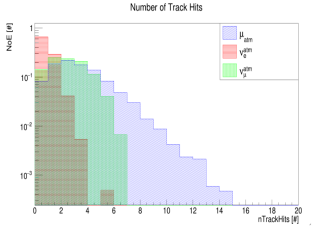
Suppression Methods for Background Cascades

- These events create abundant background in the search of the neutrino cascades
- Suppression methods are based on search of track hits from muon
- nTrackHitsFilter - how many track hits is present in the event
- $T_i = t_{\mathrm{recoCascade}} + (\mathrm{sLong} - \mathrm{lLong}) \cdot \frac{1}{\mathrm{c}} + \sqrt{\mathrm{sPerp}^2 + \mathrm{lLong}^2} \cdot \frac{1}{\mathrm{c_w}}$
- BranchRatio, CloseHits, QEarly (inspired by ANTARES), trackCharge, $\chi^2_{\mathrm{recoPos}}$, z coordinate





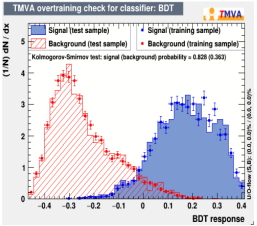


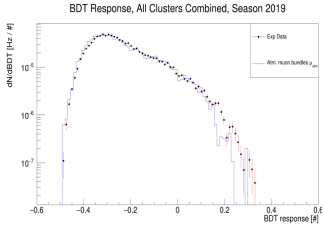


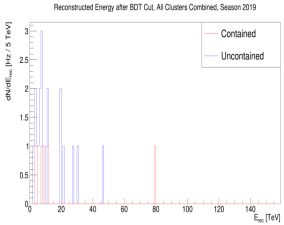
Boosted Decision Trees

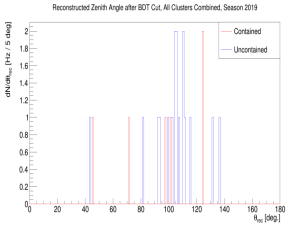
- BDTs (TMVA ROOT package) were used to take the most discriminating power of many variables
- To find signal cascade → BDT cut applied
- 25 events remained

Cl	E_{rec} [TeV]	θ [°]	ϕ [°]	ρ [m]	L	Q [p.e.]	nHits	nRecoHits	nTrackHits
0	79.7	71.30	4.96	47.65	1.05	1665.01	106	49	0
4	46.6	43.11	247.31	61.55	1.25	3804.82	69	23	0









Thank you for your attention!