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Ultra-high energy neutrino simulations

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Appendix A

Implementation of ANTARES in ANIS

On input the program ANIS uses a steering file which contains all run specific information. Below is an example of such a file for the ANTARES telescope which is situated at depth $D = 2196.849$ meters. In this example $N = 10000$ upward-going muon neutrinos and anti-neutrinos (50% each) are generated between 10 GeV and 10^{12} GeV assuming an energy spectrum $F(E) = E^{-1} \text{GeV}^{-1} \text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$. cross sections are evaluated in the framework of pQCD using the CTEQ5 parton distribution functions (PDFs). The chosen size of the neutrino interaction volume (Final Volume) has been set equal to a cylinder with a radius of $R = 600$ meters, an upper (detector region) and a lower (target region) heights both equal to $\text{HAheight} = \text{HBheight} = 600$ meters. This Final Volume encompasses the ANTARES Can ($R = 266.11$ meters, $\text{HAheight} = 278.15$ meters and $\text{HBheight} = 341.47$ meters) for every events in the energy range of interest. It therefore allows to generate all the events which can produce detectable secondaries in the ANTARES telescope, without missing any. To optimize the geometry of the Final Volume, its size is adjusted for each event to the maximum muon range at the considered energy. A detailed description of the various parameters can be found in [74].

```
#####  
# Steering file for running ANIS with the ANTARES telescope      #  
#####  
#  
# The flux information:  
f p 1. 10 1e12 -1. 0. 14  
#  
# The geometry information  
g c 600 600 600 2196.849 1  
# The run information  
r 10000 2 1 1234  
#
```

Implementation of ANTARES in ANIS

```
# the data directory
d /anis.v1.8.2/data
#
# The cross section processes and data.
# Do not change unless you know what you are doing.
s CC cteq5/cteq5_cc_nu.data cteq5/final_cteq5_cc_nu.data 101010 110
s CC cteq5/cteq5_cc_nubar.data cteq5/final_cteq5_cc_nubar.data 10101 110
s NC cteq5/cteq5_nc_nu.data cteq5/final_cteq5_nc_nu.data 101010 110
s NC cteq5/cteq5_nc_nubar.data cteq5/final_cteq5_nc_nubar.data 10101 110
s GR dummy dummy 10000 1
```

The generated events can be re-weighted to any relevant power-law spectrum such as diffuse AGN-like or other ultra-high-energy (UHE) neutrino (and anti-neutrino) flux predictions.

The second value that follows the “r” run parameter in the steering file stands for the output format to be used by ANIS. The AMANDA/IceCube f2000 ASCII format is used for ANTARES as the lepton propagator MMC which is interfaced with ANIS is using this specific format.