Hybrid SEDs for neutrino events integrated in the *SEDBuilder* tool of the ASI-SSDC MWL environment

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Abstract

The quest for the electromagnetic counterparts of the TeV-PeV neutrino events observed by the current neutrino detectors is one of the hottest topic in modern astrophysics.

Public online tools integrated in a multi-wavelength environment, like the SSDC ***SkyExplorer*** and the ***SEDBuilder*** tools, are of great utility to identify the possible neutrino source candidates, allowing to restrict the search around the neutrino source position uncertainty region (in average of the order of 1 deg in radius), and to derive the electromagnetic spectral energy distribution (SED) of the source candidates.

In this work, we present the SSDC catalog of candidate astrophysical neutrinos, based on the public events announced by the IceCube detector, that has been recently included in the ***SkyExplorer*** tool, and a new feature of the ***SEDBuilder*** tool which allow the construction of the hybrid photon–neutrino SED of the neutrino source candidates.

The ***hybrid SED***, used in conjunction with the ***SkyExplorer*** tool, will help the users to identify the best neutrino source candidates according to their classification and SED characteristics.

The SSDC web tools for MWL studies

https://www.ssdc.asi.it

The ASI-SSDC multi-wavelength (MWL) environment and its online web services (the ***Multi-Mission Interactive Archive***, the ***SkyExplorer,*** and the ***SEDBuilder*** tools) allows science users to explore and download data and data products from several space-based missions; to perform cross-catalog searches between resident and external catalogs; to extract spectral energy distributions and perform modelization of sources.

The new *HYBRID SEDs* for multi-messenger studies

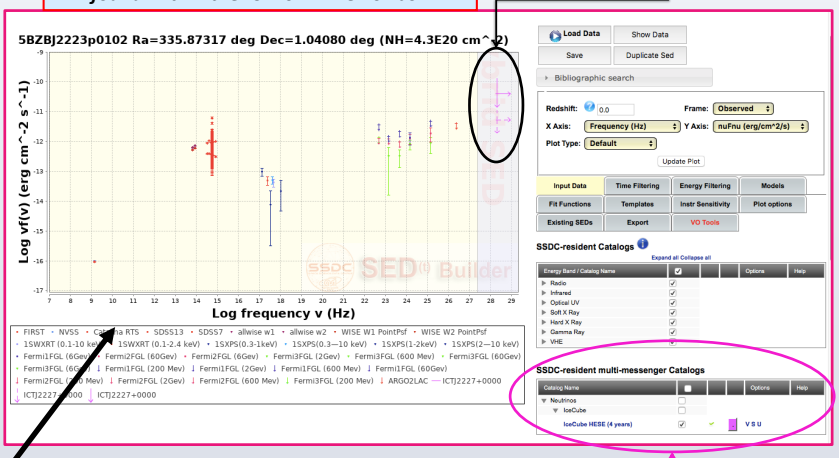
A new SSDC catalog of candidate astrophysical neutrinos has been built based on the single-track neutrino events (HESE) observed by the IceCube detector during the first 4 years of observations (2010-2014) [1,2,3]. For each neutrino event in this catalog, we derived an upper bound on the neutrino spectral energy flux density (shown as a downward arrow within the purple TeV-PeV energy band in the SED example on the right).

To estimate the neutrino flux from one neutrino event, we assumed:

- a power-law spectral emission shape with index=2.0;
- a period during which the source is emitting neutrinos equals to the whole 4-years IceCube livetime (1347 days) or equal to 0.5 years, corresponding to the duration of a gamma-ray flare as in the case of the TXS 0506+056 neutrino flare [4].
- the IceCube all-sky effective area for muon neutrino tracks [5]
- the neutrino-induced muon deposited energy as a lower limit of the true neutrino energy.

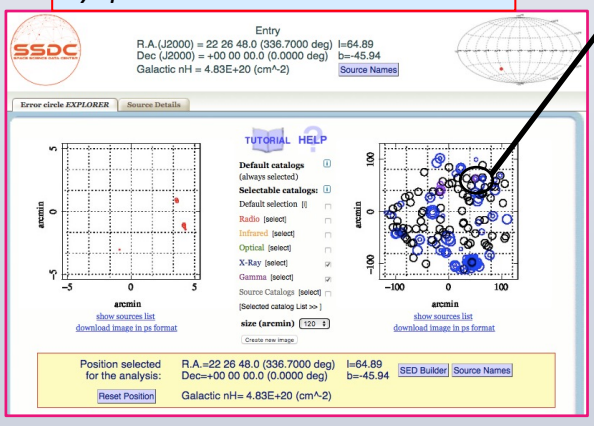
Hybrid SED for a R-X-G source found within the IC140114A error box

4-yrs (dashed line) neutrino flux upper bound
0.5-yrs (solid line) neutrino flux upper bound



The new SSDC-resident multi-messenger (MM) catalog window, showing the IC4HESE Catalog. This MM Catalogs window appears as input data to the *SEDBuilder* only when the queried input source position lays within the HESE neutrino track uncertainty region.

SkyExplorer around the neutrino event IC140114A



References

[1] IceCube Collaboration, Phys. Rev. Lett. 113, 101101 (2014)
[2] IceCube Collaboration, Proceedings of Science (ICRC2015) 1081
[3] IceCube 4-yrs HESE Catalog: https://icecube.wisc.edu/science/data/HE-nu-2010-2014
[4] IceCube Collaboration et al., Science 361, eaat1378 (2018)
[5] Available at this URL: https://icecube.wisc.edu/science/data/HE-nu-2010-2012

Acknowledgements and contacts

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