KM3NeT/ARCA Expectations for a Diffuse Neutrino Flux from Starbursts Galaxies

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ABSTRACT:

We present the expectations of ARCA detector for starburst galaxies (SBGs) observation, as a diffuse signal. To describe the diffuse flux, we make use of a recent theoretical model which implemented a "blending" of spectral indexes for high-energy spectral energy distributions. For the analysis, we provide the 5−year differential sensitivity for two ARCA building blocks, considering both track and shower events, in the range of 100 GeV - 10 PeV. We found that ARCA has the potential to constrain the selected phenomenological scenarios, showing the minimum of the sensitivity where the theoretical spectral energy distributions are expected to peak. A significant neutrino detection would provide a compelling evidence of the link between star-forming processes and hadronic emissions.

ANALYSIS:

*To calculate the probability for the ARCA detector to observe a diffuse signal SBG:*

• All flavours Monte Carlo simulation of 1 building block (BB).
• We considered the energy range [100 GeV - 10 PeV] that we divided in 11 bins.
• Using the binned method and frequentist statistics [2] we calculated for each energy bin the model rejection factor (MRF):

$$MRF = \mu_{90}/\mu_s$$

where μ_{90} is the average upper limit at 90 % C.L., and μ_s is the expected number of signal.

• A selection for track-like events was performed considering upgoing events and using an multivariate analysis with machine learning (a boosted decision tree, BDT).

• A selection for shower-like events was performed considering quality (likelihood selection) and containment cuts, and also using an appropriate BDT.

SELECTED EVENT DISTRIBUTIONS:
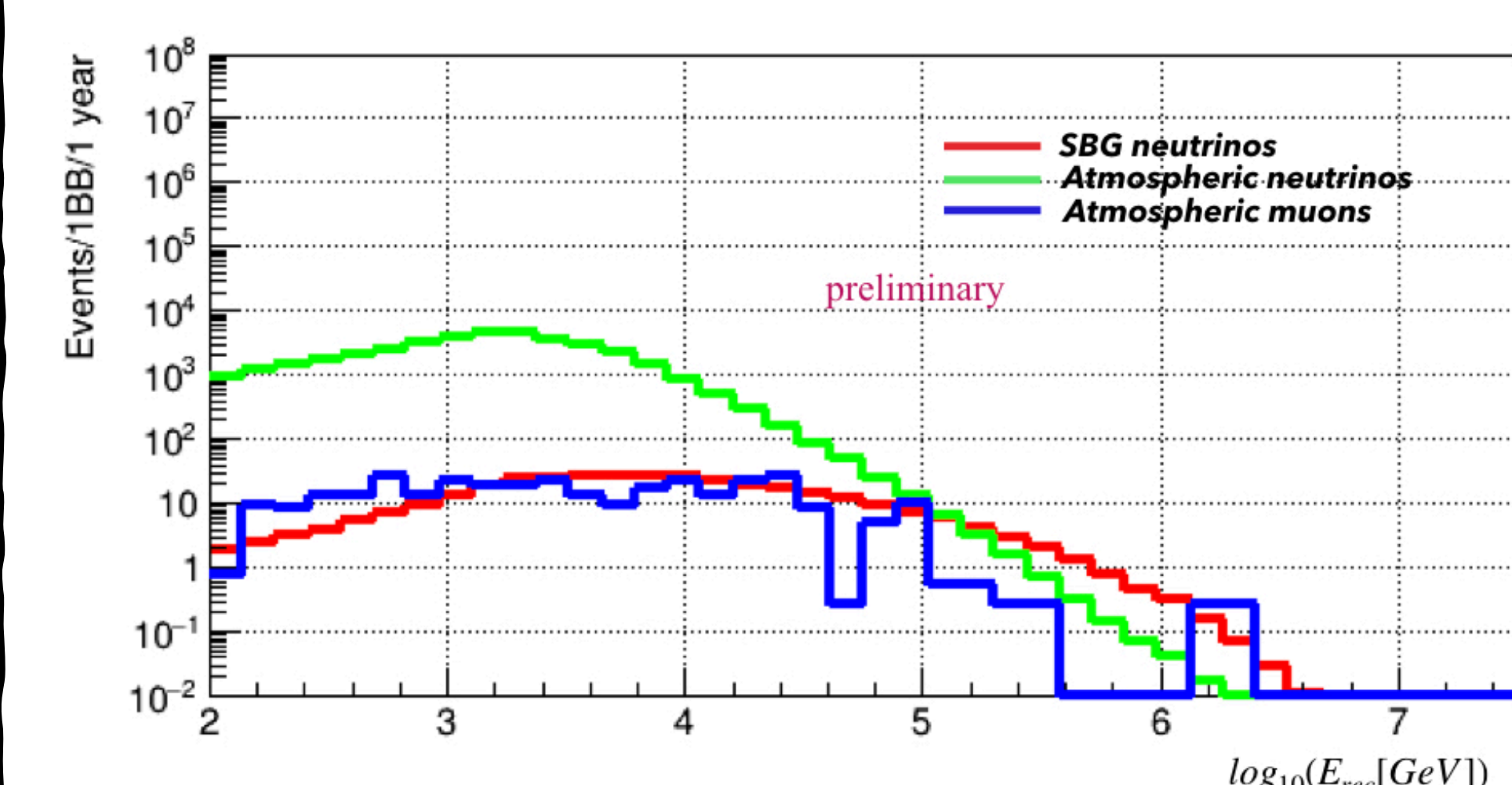
Distribution of the track-like sample for background (blue and green lines/histograms) and signal (red line/histogram) as a function of the reconstructed energy after upgoing and BDT selection.

INTRODUCTION:

A recent multi-messenger study [1] has shown that Starburst Galaxies may well explain up to 40% of the IceCube's HESE data (see plot below). This study implements a blending of spectral indexes, capturing the variability of this parameter along the source class.

• The theoretical SED peaks at hundred of TeVs, thereby compatible with a observation by ARCA after a few years of data taking.
• For this model a proton energy cut-off of the order of tens of PeVs is preferred
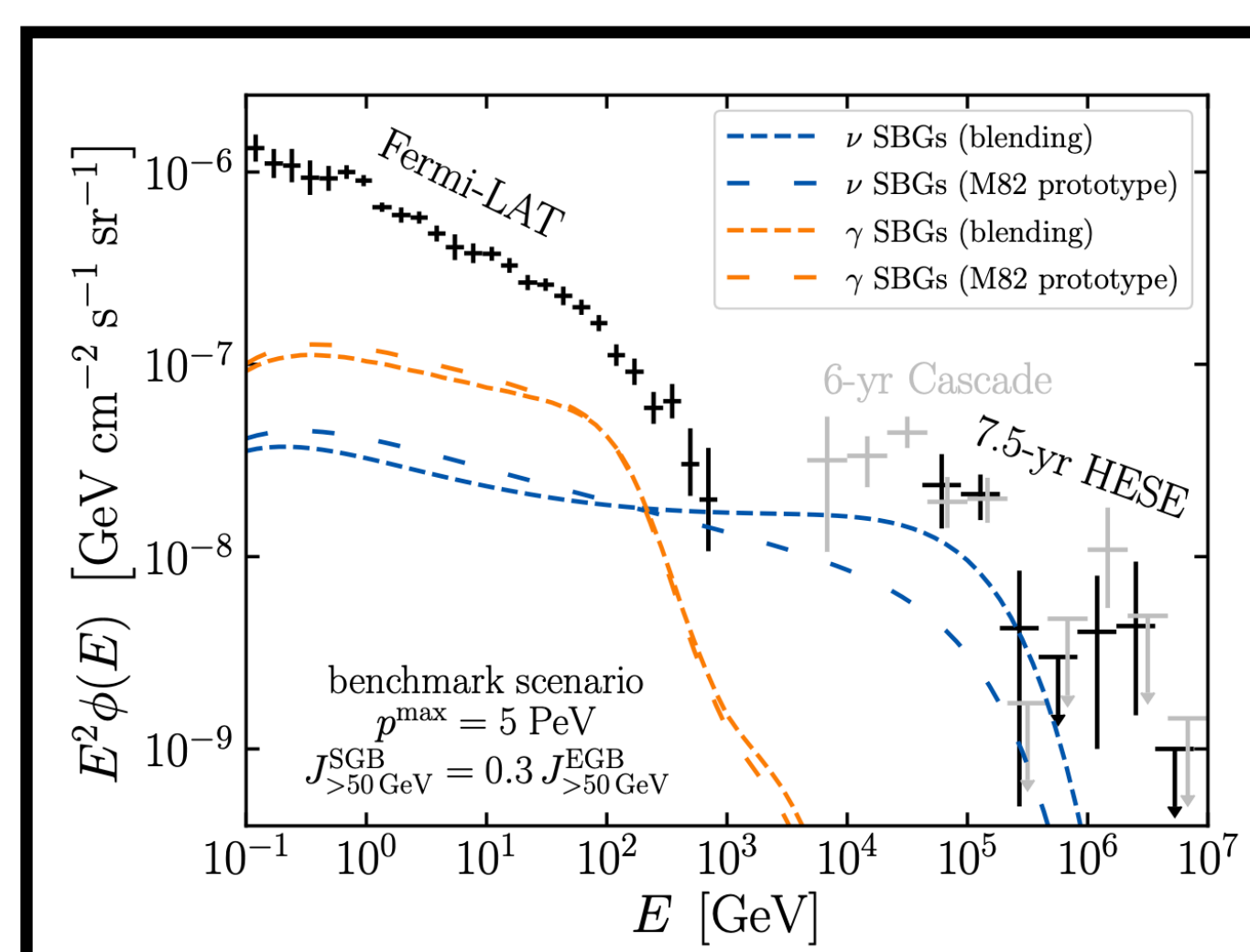
The point of this analysis is to quantitatively scrutinise if the upcoming ARCA detector will be able to test such a scenario.

RESULTS:
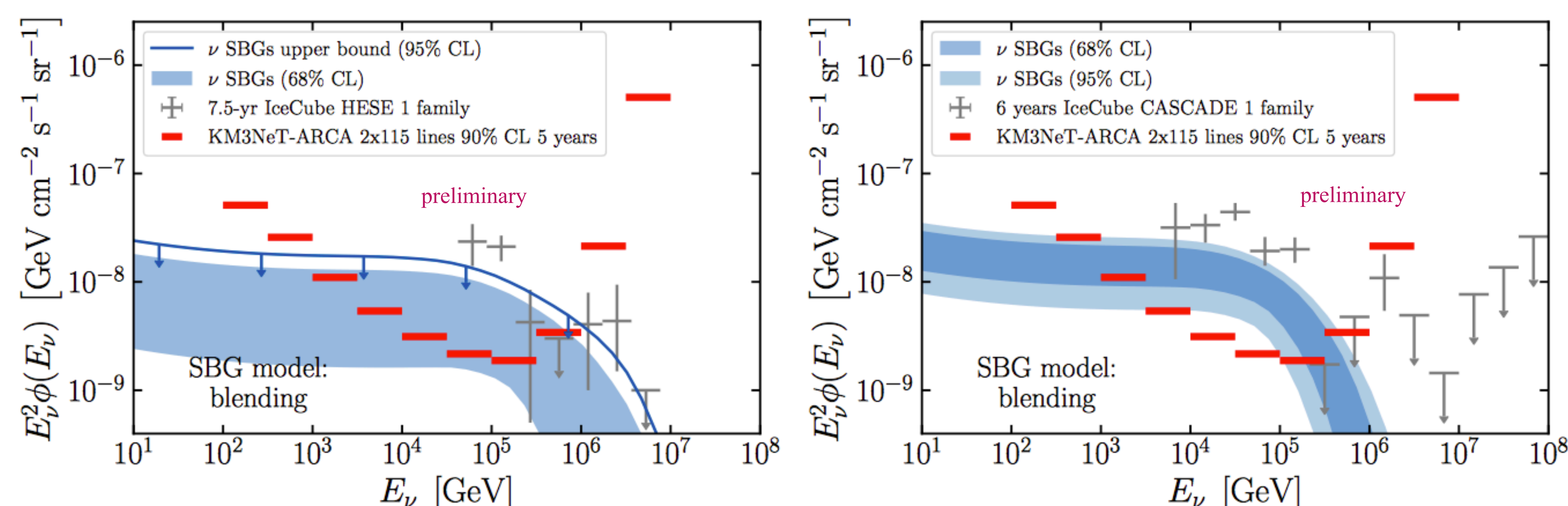
The differential sensitivity of ARCA (2 building blocks) for the diffuse SBGs neutrino signal is calculated in the energy range of 100 GeV - 10 PeV considering an observative time of 5 years.

Expected signal from two different scenarios compared with the computed sensitivity: on the left scenario HESE and Fermi-LAT EGB are taken into account, otherwise on the right CASCADE and Fermi-LAT EGB.

CONCLUSIONS:

In this contribution we study the possibility to observe the SBGs diffuse neutrino signal. Furthermore we provide the calculation of the differential sensitivity in the energy range 100 GeV - 10 PeV. We can summarize our results obtained: in 5 years of ARCA observations the expected diffuse signal from SBGs can be constrained. This would imply a important step forward for the multicomponent description of the astrophysical neutrino flux measured up to now.

REFERENCES:

[1] Ambrosone et al. MNRAS, V. 503, May 2021, p. 4032-4049

[2] J. Neyman, Phil. Trans. Roy. Soc. A, 236, p. 333, 1937