Responses to Reviewers' comments (id: 406)

Dear Editor,

We have made changes as suggested by the Referees. Our responses to the Referees' comments are in italics text and listed below each comment, along with descriptions of changes made.

In order to meet the 6-page limit, we have removed Fig.7 from the revised manuscript as it was not very informative. On the other hand, we have added two plots (Figs.1 and 2) as the Referee 1 have requested. We have shortened a few paragraphs and included a few numbered equations in the main text to save space.

We sincerely hope the paper now meets all publication criteria of the SAIP 2016 proceedings.

Kind regards,
J.K. Thomas, R. Moharana and S. Razzaque

Review 1: Comments (Referee 1)

This paper summarizes results of VHE neutrino predictions for IceCube-Gen2 based on afterglow modeling of a set of 17 nearby GRBs. The work is definitely of interest to the community, but unfortunately, it is rather poorly written, both in terms of language and in terms of completeness and clarity. I urge the authors to consult with a native English speaker to improve the language, and take into account my specific comments below before re-submitting.

<u>Response:</u> *We thank the Referee for a positive report. We have now improved presentation and English in the revised manuscript. Our replies to the specific comments and changes made in the manuscript are below.*

1) Most importantly, it is unclear how the electron-synchrotron GRB afterglow modeling constrains the CR proton spectra. This modeling only constrains the electron spectra and the target synchrotron photon fields, but it remains completely unclear what assumptions have been made concerning the proton spectra and their normalization. Please clarify.

<u>Response:</u> *The cosmic-ray spectrum (n(E_p) or dN/dE) is a power-law of energy with index -2, assumed to originate from Fermi acceleration. The normalization is done by integrating the differential spectrum E(dN/dE) over the minimum and maximum energy range of protons and equating it to the total kinetic energy (dominated by protons) of the GRB blast wave. We have added a brief description in the text now. A more detailed description is in Ref. [1].*

2) In order to assess to what extent the fits (and fit parameters) are constrained, I suggest to include a plot of at least one or two examples of the afterglow modeling (SEDs and light curves).

<u>Response:</u> *We have now included SED and light curve of GRB 130831A in Fig. 1 and Fig. 2,*

respectively, in the revised manuscript.

3) Equations 3 and 4, and the text around it: I find the nomenclature here very confusing and misleading (for example, one would naturally expect E_{ph} to be a photon energy...). Please specify that all the energies in those equations are proton energies. I presume that the break proton energies are those that correspond to the pion production threshold for the given photon energies, right? I suggest to include explicit expressions for these energies in the text. Also, please define nu_m and nu_c. E_{ps} is defined, but never used. More importantly (see point 1): How is it constrained, and what are typical values?

<u>Response:</u> *We have improved text around eqs. 3 and 4 and explained various terms more clearly. The E_{pl} and E_{ph} are actually proton-break energies corresponding to break energies in synchrotron spectrum. In particular, E_{pl} corresponds to h\nu_m and E_{ph} corresponds to h\nu_c. Here \nu_m and \nu_c are synchrotron frequencies for electrons with minimum energy and cooling energy, respectively. A detailed description can be found in Refs. [1] and [9] with typical values of these proton energies and photon frequencies, which we obviously cannot elaborate on due to page limit.*

The values of photon break frequencies such as \nu_m and \nu_c are constrained from fitting GRB afterglow data, an example of which is now shown in Figs.1 and 2 of the revised manuscript.

We have removed E_{ps} as it was indeed not used.

4) Please correct Equation (7), and define the f-factor.

<u>Response:</u> *We have Corrected equation (7).*

5) Equation 8 is, again, quite confusing: E_p appears to be a proton energy, but then n(E_p) is a photon number density - obviously as a function of *photon energy* ... Please clarify.

<u>Response:</u> *Indeed E_p is the proton energy but n(E_p) is the differential number density of protons, not photons.*

Review 1: Comments (Referee 2)

The paper models and predicts the neutrino emission during the afterglow of 17 gamma-ray bursts (GRBs). The predicted neutrino flux is compared to the sensitivity of the future IceCube2 detector.

Apparently (this is not completely clear from the paper) these GRBs cannot be detected with the future IceCube2 detector. This result can serve only as an estimate of the future potential of IceCube2, as the discussed GRBs are in the past and cannot be observed with IceCube2. It would have been interesting to see the results obtained with the current IceCube detector.

<u>Response:</u> *There have been studies in the past by other authors, for upper limit for neutrino*

flux from GRBs by IceCube. We have cited some of these results now in the text.

Section 2 discusses the modelling of the synchrotron emission of the GRBs. No details are given, a brief description of the model would have been nice. Tables 1 and 2 summarise a lot of parameters, but the influence of these parameters are not clear. The parameters p and v_8 are not explained.

Response: *We have now added a short description of modeling synchrotron emission from GRB blast wave. Essentially, a population of electrons with a power-law distribution in energy is injected in the shocked region of the blast wave (assuming a Fermi shock-acceleration mechanism). These electrons then lose energy by radiating synchrotron photons in the magnetic field created (assuming some plasma instability) in the shock region as well. Various breaks in the energy spectrum of the electrons (synchrotron-self-absorption, minimum injection energy, synchrotron cooling) translates to breaks in the synchrotron spectrum. This model successfully describes various observed properties of GRB afterglow.*

The parameters p and v_8 are now defined.

Section 3 discusses the estimation of the neutrino flux. The neutrino fluxes after T_90 and 100x T_90 are shown in plots for all GRBs and two different scenarios. Figures 3 and 4 are not referenced in the text. Right before equation (1) the blast wave of GRB130427A is mentioned, but the discussed neutrino production process should be vaild for all GRBs. Figures 5, 6 and 7 are wrongly referenced as 7, 8 and 9 in the text.

Response: *We have now added references to Figures 3 and 4 in the text, and corrected the figure numbers. Indeed the neutrino production process is valid for all GRBs. We have removed specific reference to GRB 130427A.*

Part of the presented work was the calculation of the number of neutrinos to be detected with IceCube2. These numbers are not reported, but should be shown in the paper. Further on, the expected and observed numbers of neutrinos in the current IceCube detector would be interesting as well.

Response: *These numbers are quite small. Instead of the numbers we report the upper limits on the neutrino fluence in Figs.7 and 8. A rough estimate of the number of neutrinos can be inferred from the ratio of the model to the upper limits.*

If my understanding of the results is correct, these neutrinos cannot be detected with IceCube2. The question is how large the detector needs to be made to allow for a detection.

Response: *The understanding of the Referee is correct that neutrinos from the GRBs we have modeled cannot be detected with IceCube-2. On the hand it is difficult to answer how large the detector needs to be to allow for a detection. In addition to the physical size of a detector, its detection technology is also important. From the ratios of the upper limits and models in Figs.7 and 8 it can be estimated that at least a few orders of magnitude increase in sensitivity would be required to detect our modeled neutrino flux.*

Review 0: Comments

Corrections:
1. The spacing between the abstract and the author names and affiliations is not correct.

Response: *We removed an extra space between the abstract and the author names and affiliations.*