# Answers to the JCAP-Referee (JCAP_027P_0507)

22-Aug-07

*The authors appreciate very much the recommendations of the referee, and have agreed to improve the document to allow for rapid publication. Please find below the text of the modifications where it is reminded also the referee comments/questions.*

1) page 6 middle: ”In order to be sensitive to DUV scintillation, ....” The referee does not know what is DUV. Some explanation might be useful to the readers.

*The acronym DUV means Deep Ultra Violet light .with wavelength < 300nm, as it has been written explicitly.*

2) page 8, 7th line from the end of Section 2: ”...., and the and the ...” should be ”..., and the ...”

*This typo has been corrected.*

3) page 12, 8-9th lines: ”Up to a factor of two improvement in efficiency is expected for models like p− > $e^+$ g and p− > $\mu^+$ g, ...” The referee does not understand why ”up to a factor of two improvement in efficiency” can be possible in liquid Argon. For example, the referee refers G.Blewitt et al., PRL 55, 2114 (1985). In this report, the authors discussed that the efficiency for $e^+$g in a water Cherenkov detector was 66%. One cannot expect a factor two of improvement in efficiency in any detector.

*The authors agreed that the sentence "up to a factor two" was misleading. To be more precise the channel efficiencies are explicitly introduced in the text.*
*“Thanks to the clean photon identification and separation from $\pi^0$, it is expected an efficiency of $98\%$ for both the channels $p\rightarrow e^+\gamma$ and $p\rightarrow \mu^+\gamma$ which constitute an improvement of $35\%$ and $92\%$ respectively compared to Super-Kamiokande present result.”*

4) page 15 middle: ”For MEMPHYS one should rely on the detection of the decay products of the $K^+$ since its momentum (360MeV) is below the water Cherenkov threshold of 570MeV: a 256MeV/c muon and its .....” The referee noticed that some numbers might be wrong: 360MeV -> 340MeV/c, 570MeV -> 570MeV/c (there must be ”/c”) 256MeV/c -> 236MeV/c.

*The mistakes have been corrected.*

5) page 17: middle: ”IBD” is not defined.

*The acronym was defined in the Table 6 but now is also defined in the core part of the text (Inverse Beta Decay).*

6) page 20, Table 7: This is a question from the referee: Is it really true that the "Earth effect" affects both the nu$_e$ and nu$_e$ − bar signal even for $\sin^2\mu_{13} < 10^{-5}$ ? It seems there is no mention of this effect in the text. Ifthis is true, this should be discussed in the text, including the reason for sucheffect.

*To clarify the document we have add at the beginning of the paragraph discussing the Earth effect, the following sentence:*
*(After "..modulation of the p(E).."*

*"Under the assumption of a definite mass hierarchy (either normal or inverted), the calculation of neutrino conversion probability in Earth can be reduced to a 2 nu problem, so that in Table 5 and Eq. (2), one can substitute cos^2 \theta_12 -->1-P_E and sin^2 \theta_12-->P_E, where P_E=P(\nu_e \to nu_2) in the Earth. Analytical expression for P_E can be given for particularly simple (or approximated) situations of Earth matter crossing [1].*

*New reference added:*
*[1] Supernova neutrino oscillations: A Simple analytical approach.*
*G.L. Fogli, E. Lisi , D. Montanino , A. Palazzo . Phys.Rev.D65:073008,2002,*
*Erratum-ibid.D66:039901,2002.*

7) page 21, Fig.8: What are "LL", "KRJ" and "TBP" ?

*The acronyms were taken from Ref 40 and now implemented in the caption of Figure 8:*
*"The DSN neutrino rates are shown for different models of core-collaps supernova simulation performed by the Lawrence Livermore (LL) , Keil, Raffelt and Janka (KRJ) and Thompson, Burrows and Pinto (TBP) groups."*
*The reader is also invited to look at reference [40] as the figure is a reprint of this article.*

8) page 23, around 14th line from the bottom: The authors discuss the possible detection of pep neutrinos. However, people understood that the detector of pep neutrinos might not be easy if the detector is not located in very deep underground. The referee recommends discussing the possible background at the candidate site.

*The authors agreed to introduce a discussion of the background as followed. In page 24, the first sentence in the LENA paragraph has to be changed:*

*"For the proposed location of LENA in Pyh\'asalmi ($\sim$4000~m.w.e.), the cosmogenic background will produce $^{11}$C which contribute to the CNO and pep neutrino measurements. At the Pyh\"almi site, the signal to background ratio is estimated to be $\sim1$~[1]. Event by event, background rejection can be achieved by registration of the neutron capture which follows $^{11}$C production by spallation processes induced by cosmic muons. This technique has been successfully demonstrated in the Counting Test Facility for Borexino (CTF)~[2].*

*New references added:*
*[1] T. Hagner, R. v.Hentig, B. Heisinger, L. Oberauer, S. Schönert, F. v.Feilitzsch, E. Nolte, "Muon induced Production of Radioactive Isotopes in*

*Scintillation Detectors", Astroparticle Physics 14, 33 (2000)*

*[2] Borexino collaboration, "CNO and pep neutrino spectroscopy in Borexino: Measurement of the deep underground production of cosmogenic 11C in organic liquid scintillator", Phys. Rev. C 74 045805 (2006)*

9) page 24: 4th line: ".... a reduction factor of 3 ¤ $10^{-4}$) [102]." ! ")"
after $10^{-4}$ must be eliminated ?

*This typo has been corrected.*

10) page 24, Eq.(4): $N_{Abs-GT}$ and $N_{Abs-F}$ are not defined.

*The exponent acronyms were coming from Table 9, but the notation is now explicitly introduced in the text.*

11) page 28, last para. and page 29 Table 10: The referee does not understand the way to calculate the statistical significance. As an example, the referee would like to discuss the numbers in the first row in table 10: The Top and Bottom events are 223 and 266, respectively. For simplicity the referee assumes that there is no systematic error. In this case, one can estimate the statistical significance of the Bottom event excess by; (266-223)/sqrt(266)= 2.6 sigma. This is the most optimistic case. However, the authors estimate the significance of 3.1 sigma. The referee urges the authors to check the significance again. If what the authors claim is correct, it is recommended to write the statistical method employed in this paper.

*Thanks to the referee, the authors have revisited the quoted numbers. The authors estimate that the results are correct and to clarify the statistical treatment method used, the authors have replaced the sentence "$P_\beta$ is the Poisson probability for the measured excess of upward going events to be due to a statistical fluctuation as a function of the exposure" by the new paragraph:*
*"We use a suitable discriminant variable to enhance the signal to background ratio of the analyses. After cuts, two sets of events are built: $n_b$ (the number of expected downward going background) and $n_t = n_b + n_s$ (the number of expected upward going events, where $n_s$ is the number of taus). A statistical treatment of the data is performed by building two Poissonian probability density functions:*
*\begin{equation}*
*f_b(r) \equiv \frac{e^{-n_b} n_b^r}{r!}*
*\end{equation}*
*with mean $n_b$ and*
*\begin{equation}*
*f_t(r) \equiv \frac{e^{-n_t} n_t^r}{r!}     \end{equation}*
*with mean $n_t$.*
*The statistical significance of the expected $n_s$ excess is evaluated following two procedures:*
*\begin{itemize}*
*\item The pdf $f_b$ and $f_t$ are integrated over the whole spectrum of possible measured $r$ values and the overlap between the two is computed:*

*$P_\alpha \equiv \int_0^\infty min(f_b(r), \ f_t(r)) dr$.*
*The smaller the overlap integrated probability ($P_\alpha$) the larger the significance of the expected excess.*
*\item We compute the probability $P_\beta*
*\equiv \int_{n_t}^\infty \frac{e^{-n_b} n_b^r}{r!} dr$ that, due to a statistical fluctuation of the unoscillated data, we measure $n_t$ events or more when $n_b$ are expected.*
*\end{itemize}* »

12) page 30, 2nd para.: ”In MEMPHYS, one expect 10 times more geo-neutrino events ....” The referee does not understand why only ”10 times more”. If one compares the number of protons in the KamLAND and MEMPHYS detectors, the difference must be about 1000. The author should explain why ”10 times more” rather than ”1000 times more”. In addition, the referee feels that this paragraph should be improved significantly. Otherwise, the reader might feel that the authors are simply dreaming. At least it is recommended refering the SNO trigger threshold rather than the Super-Kamiokande threshold, since SNO had much careful selection of the detector materials and achieved the lower threshold than Super-Kamiokande.

*The referee is totally correct. The authors recognize that at the present time, there is no solid basis to emphasize the possibility to trigger at sufficiently low threshold to make sense the analysis of Geo-neutrino with MEMPHYS like detector. So, the authors rather prefer to cancel the small paragraph and regret to have made confusion.*

13) page 32, 4-5th lines from the bottom: ”.... The significant deficit, interpreted in terms of neutrino oscillations enables a measurement of $\mu_{12}$...” The referee thinks that this sentence is slightly misleading, since the $\mu_{12}$parameter is essentially determined by the solar neutrino experiments.

*The authors agree to reformulate the sentence as followed:*
*“The significant deficit combined with the solar experiment results, interpreted in terms of neutrino oscillations, enables a measurement …”*

14) Figs.22 and 26: It seems that the definition for the CP violation seems different between the two figures. In Fig.26, the excluded regions covers delta = +/- pi. However, in Fig.22, the excluded region does not extend to delta = 0 or 2pi. These 2 figures should use the same definition for the ”CP violation sensitivity”. In addition, the referee feels that the readers might not show much interest in seeing the CP sensitivity for the already excluded ¢$m^2_{12}$regions (Fig.26).

*After discussion with the authors of the papers [37,134] (partly authors of the present JCAP submission) we came quickly to the following conclusion. In reference [37] (Fig. 22), the definition of sensitivity to CP violation requires Delta chi^2 > 9 for the CP conserving values delta = 0 and delta = pi. In contrast for reference [134] (Fig. 26), it is considered as CP conserving value only delta = 0 and not delta = pi. This explains the difference between the two graphs.*

*The authors agree to make clearer the caption of the two figures, but as it was agreed by the authors to use already published graphs, there is no possibility to update the fig. 26 even if the authors recognize the relevant comment of the referee and take note of an update graph for a future publication.*