

# RESPONSE TO: REPORT OF REFEREE 1 AND 2

## 1 Report of referee 1 – response

**The authors have responded to all questions/comments raised in our previous report. The new version of the paper is substantially improved. We support the publication of the paper as it stands. However, we would like to suggest few minor changes, as it follows.**

We gratefully appreciate all the useful comments that were put forth by both reviewers for the paper. They were extremely helpful and we agree that with the input from the reviewers, the paper is substantially improved.

**Page 11, Section 3.3, 5th paragraph. Please correct Exp11 to Exp1. It would be better to change the term “efficiency”, which is used in the text, by the term “estimated efficiency”.**

DONE. Correction implemented. The text has been updated to: "Having large variations in the  $\text{Exp}_1$  component will in turn cause large variation in the individual DOMs estimated efficiencies. "

**Page 13, Table 1 and Page 14 Section 4.1. We still believe that a discussion on the statistical correlation between the estimated parameters will add to the clarity of the paper. Despite the title of Section 4.1 such a discussion does not appear in the text.**

DONE. The section aims to describe the correlation between the fitted parameter values and the DOMs hardware characteristics. The mentioned correlation between the fitted parameters themselves is certainly also interesting, but would be hard to interpret as we do not have a good expectation of the interaction between the processes that lead to the different components. We thus choose not to elaborate on this aspect in this paper.

**Page 17, paragraph “dim source measurement”. Please change the subscript 0.25 to 0.23.**

DONE. Thanks.

**Page 18, Section 4.3.1 and Table 2. No all differences are in “sub-percent” level. Better use in “few percent” level. Please correct the header of the last column in Table 2.**

DONE. Suggestion implemented. The last column was removed from the table, since it was not discussed in the text. The largest difference observed is found to be 0.5%, so the "sub-percent level" terminology remains in place.

## 2 Report of referee 2 – response

We thank the authors for a substantially improved version of the paper. We have reviewed the revised manuscript. The content flow, the presentation of the studies, and the discussion of the results are largely improved over the previous version. We support the publication of the paper. We also believe that a few additional improvements would be beneficial for the clarity of the presentation. A few suggestions are listed below.

DONE. Thank you very much once again.

**p.5, 5 lines from the bottom: ->"in units of PEs, or photoelectrons". Then, replace PE with PEs wherever appropriate in the following.**

DONE. Text changed to: "in units of PEs, or photoelectrons." The unit of charge, tailing a number, has been left as PE rather than PEs.

**p.9, sec.3.2: zero charge ->small charge values.**

DONE. Implemented.

**10, last paragraph: it would be clearer to rephrase it to ->found to have SNR=57,9 and SNR=0,69x10<sup>5</sup>, in the bin with the lowest SNR value and for the full distribution, respectively.**

DONE. Thanks for the suggestion, it was introduced.

**p.11: 5th paragraph ->an efficiency.**

DONE. Thanks.

**p.11, last paragraph: "withing"**

DONE. Thanks.

**p.12, 3rd paragraph: may want to use the greek symbol for  $\chi^2$ , as in Fig.6.**

DONE. Thanks.

**Fig. 6, legend: symbol appears twice for "event dataset".**

DONE. Thanks.

**Fig.6, caption: what are N, mu, sigma? please add explanation in the caption. "is the 2PE contamination". If so, what is the expected "PE contribution? perhaps it can be quantified.**

DONE. The caption now states: "The definitions of the fitted values in the annotation can be found in the description of Eq. 2." We've added the description there for N as well. In the description of Eq. 2, it now states: "We will subsequently refer to the probability of a photoelectron contributing to the Gaussian component as  $N = 1 - P_{e1} - P_{e2}$ ." The PE contribution is the SPE curve.

**Table 1: "NQE"? does it refer to "Standard QE"? 2nd column: is this "P e2" instead? in the column titles, it would be OK to simply refer to the names of the variables, as in Eq.2.1**

DONE. Apologies, "NQE" was an earlier term for "Std. QE". It has since been updated. The 2nd column should have been Pe2. We've also removed the descriptive column header for the variables, and added this text to the caption: "The definitions of each fitted variable can be found in the description of Eq. ??."

**p.13, 2nd paragraph: 15,85%. I find 16.1% (by comparing numbers in the 2nd column, 1st and 2nd lines, in Table1).**

DONE. It is actually simply due to rounding in the Table. The full values are 0.21138549573511975 and 0.24489732831971175, giving a difference of 15.85%. However, to avoid this confusion, the values now reported in the text will be those referenced from the rounded values in the table. The text has been updated. There was also an issue with the reported errors of percentage comparisons. These numbers and have since been updated.

**p.13, 2nd paragraph: "Gaussian norm". If you are referring to a value in Table1/Eq.2.1, please clarify what is the term and how that is defined.**

DONE. The text should have said Gaussian probability (N) rather than Gaussian norm, as described in the description of Eq. 2.

**p.13, 2nd paragraph: 3,177: I find 3,4% by comparing the SDs (1st and 2nd lines). Also: Is the difference significant? It is small and compatible with the uncertainties.**

DONE. Accounting for the rounding, we get  $3.178 \pm 0.005\%$  (with the updated figure). This change is simple to account for in the simulation by changing the HQE DOM efficiency by the same amount. It would be a small effect on analysis if we did not change this though.

**p.13, 4th paragraph: Standard QE DOMs: add "(NQE in Table 1)".**

DONE. NQE notation has been removed.

**Fig.8: Values/colors/legend seems to be inconsistent with text. HQE red (in the text) is it with the Old Toroid (in the legend)? Also, Standard QE is blue (in the text) w/ New Toroid (in the legend). Please verify.**

DONE. Thanks. This was a typo in the text. The figure compares the Std. QE DOMs instrumented with the different toroids. The text has been updated.

**Fig.8, caption: There is no mention of HQE in the caption, whereas the text refers to HQE. Please clarify.**

DONE. This figure is only for the std. QE DOMs. The text has been updated.

**Fig.9: Please clarify what are the vertical dashed lines, in the caption/legend. The white line (solid, dashed, dotted) is not in the legend. Suggest choosing different colors and make the symbols consistent in the Fig. and in the legend.**

DONE. We've removed the vertical lines to simplify the figure. They were at 0.13PE, 0.23PE, and 1.00PE to guide the eye.  
 The colors have been changed such that we can describe them correctly in the legend.

**p.16, 1st paragraph: Greater ->More.**

DONE. Implemented.

**Fig.10, caption: Not clear what is the dependence on the year or IceCube season. Please define Delta P/Delta t. Does it refer to the change of the individual parameters (P) over time (t)? Please clarify in the caption.**

DONE. It's essentially the slope of how each parameter changes throughout the IceCube seasons considered. The caption has been updated to: "The change in the individual DOM fitted parameters,  $\Delta P$ , over time (IceCube season IC86.2011 to IC86.2016),  $\Delta t$ ."

**Is there a seasonal effect, ie. winters vs summers, that may also be relevant? Please clarify.**

It was found that there doesn't appear to be a significant deviation observables at the level of statistics that we have. The figures below show the result of the fit for the Gaussian mean throughout the 2012 season. You can ignore the FADC line, this is a low resolution digitizer used in IceCube. It should also be noted that the temperature in-ice is extremely stable throughout the season.

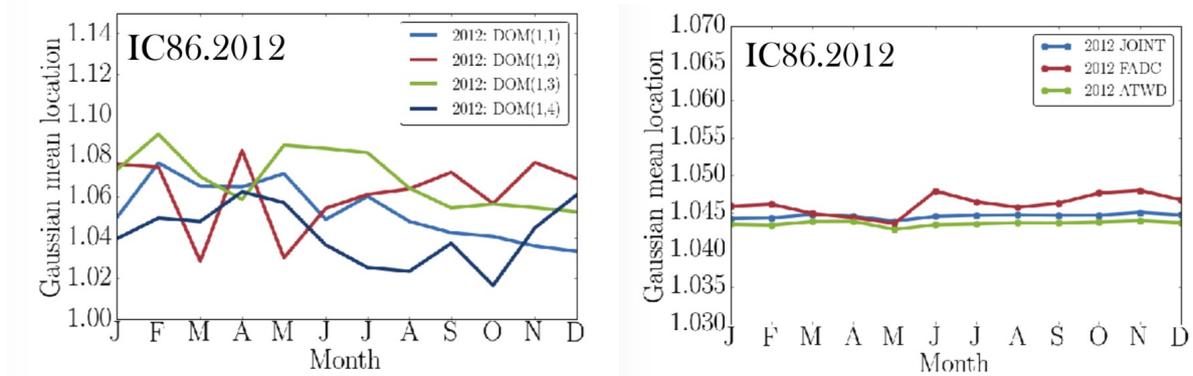


Figure 1: The change in the fitted location of the Gaussian mean throughout the course of an entire season. The paper describes the fitting procedure for the ATWD, feel free to ignore the FADC line. It's also worth noting that since these are seasonal fits, the statistics used is 1/12th that of every year. Left is the result of four DOMs throughout IC86.2012, Right is the average over the full detector.

**Suggestion: in many places, the correct term "laboratory" could be used in place of jargon "lab".**

DONE. Updated, thanks.

**p.17, 2nd paragraph from the bottom: suggest replacing: peak position ->peak charge.**

DONE. Sounds good.

**p.18, sec. 4.3.1, 1st paragraph: Q 0, Q 013, Q 023 are defined as bright, semi-bright, and dim. Suggest removing the term "bright-to-dim" as the ratios are defined as they are. Sometimes they refer to bright-to-semi-bright. Twice in the text and once in the caption.**

DONE. The term bright-to-dim ratio has been replaced by: "the dim, semi-bright, and bright source measurement ratios".

**p.18, last line: ->DOMs.**

DONE. Updated.

**p.19, Sec.4.5, 2nd paragraph: chain to ->chain as for**

DONE. Updated.

**Fig.11, caption: in the text it is not referred to as "neutrino event". Perhaps better use "for upward-going muons". Please make it consistent.**

DONE. The term neutrino event in the caption was changed to "event."

**Fig.11, legend: data symbol appears twice in left and right plots.**

Fixed.

**p.20, Conclusions: Please define "Gaussian component". What is it? It is not clear as it is.**

DONE. We've replace "Gaussian component" with "Gaussian standard deviation".

**p.20, Conclusions: add quotes around "total charge per DOM" and "total charge over the number of channels". Alternatively, use symbols and define those.**

DONE. Added the quotes. Thanks.