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Referee report

1 General Comments

I found this article very interesting, well-written, and highly recommend its publication, after addressing some minor comments and questions, that I hope can contribute to clarify some points.

1.1 Section 2: Experimental setup

page 4, Figure 1 From the Figure, its caption, and the paper text, it is not clear what is the layout of the detector pairs and how they are isolated from each other. I imagine that each detector pair would be isolated from the other 2 pairs, at least in what regards the scintillation light. If that's the case it would be good to indicate that. Also, is there some lead separation between the pairs, to prevent "cross-detector contamination", i.e. a small fraction of gammas from one source being detected in a non-corresponding detector? Maybe an additional schematic of the layout inside box A would help, or at least some extra explanation of that layout and what measures are taken to prevent that possible contamination.

page 5, decay rate calculation You mention how you calculate the decay rate ("integrating the photopeak and dividing by the livetime"). However, since you want to measure half-lives (as you say at the end of page 15) and not just decay rates, you need a good precision in the knowledge of the absolute activity of the various sources used. The paper would benefit from having some discussion about the expected precision of the sources, and if you plan to do some cross-check, like using the same source in more than one setup.

page 5, muon veto You mention that you will have a muon veto to tag events caused by muons. How much bigger will the veto be w/r to the detectors' size? Crossing muons can cause activation of the surrounding materials, producing neutrons that may reach the NaI(Tl) scintillators. Did you consider these neutrons as a possible source of background? The energy of the neutron-induced events might be different than that of the source decays, but still, it is known that the cosmic muon flux has seasonal modulations due to atmospheric temperature. Do you expect you will need to reject the data for some time following a muon trigger, in order to also veto events due to muon-induced neutrons? In this case, there would be some dead time, possibly large since the muon rate is large at surface. Still, if you expect neutrons not to be a problem, maybe because of a clearly distinct energy pattern, it would be good to indicate that in the paper.

1.2 Section 3: DAQ and data handling

In this section I have three comments about Figure 5:

- Is the choice of binning deliberate? It appears that 1.6 μs line falls right in the middle of a bin, in fact causing it to have 1/2 of the counts of other bins close by. If the binning was such that 1.6 μs would match a bin edge, that bin would not appear downward shifted.
- Is there an empty bin, centered at a x=90? If so, why?
- The x axis legend units could be changed to [Number of 20 ns bins]

1.3 Section 4: Slow control and slow monitoring

In this section I have three comments about temperature control:

- In the caption of Fig. 1b), a "bracket" is mentioned, not a "frame". Is the frame the blue/green piece below the PMTs? If so, it should be made explicit somewhere, wither with an arrow or in the caption.

- About the fact that the Monte Carlo model does not reproduce exactly the measured effect of thermal expansion/contraction. One possibility is the fact that you consider only the aluminum frame. The metal parts of the PMTs will possibly also expand/contract (with a different coefficient), making the actual source/scintillator distance variation more complicated to predict that if a single material is considered.

- At what energy was the MC simulation done? From Figure 11, the same MC value is presented for all the energies. Since the data show a larger change for higher energies (where the detection efficiency is lower), I wonder if the same effect was not seen in MC?

1.4 Section 5: Limits on systematic uncertainties

In this section I have three comments about the magnetic field:

- Is any kind of mu-metal magnetic shielding used?

- The Earth's magnetic field is quite different in the 4 sites, especially in Brazil, given the South American anomaly. This could be the source of systematic differences between the sites.

- About the monitoring of the magnetic field, the paper mentions only the monitoring of the field's magnitude, not the direction (that the sensor measures). In addition to the magnitude of the field, possible systematics induced by the field are dependent on the relative orientation of the PMTs and the field direction. Will the positioning of the PMTs be made taking into account the field direction at each site? If not will the relative direction be monitored?

2 Typo, minor edits

page 7, mid of 3rd paragraph You write "(3) not be within $\sim$ the NaI(Tl) decay time (1.6 μs) in order ...". It's not clear with respect to what is this time considered. From the context, it's presumably w/r to a previous trigger, but that should be explicit.

page 7, end of section 3.1 You say that the threshold voltage is set to be $\sim$ 100 keV. You should either quote an actual voltage, or use some wording like "the equivalent of $\sim$ 100 keV".

page 8, line 5 Where you write "1.8 μs", you probably mean "1.6 μs".

page 14, penultimate line "of of 36 mG"

page 16, ref. 2 "Leibzig" $\rightarrow$ "Leipzig".

page 16, ref. 10 missing space before "Earth".