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Interactive comment on "Percent-level production of ^{40}Ar by an overlooked mode of ^{40}K decay" *by* Jack Carter et al.

Anonymous Referee #2

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I find this to be a valuable manuscript for geochronologists that provides evidence for the existence of a branch of the 40K decay system that has been questioned in the geochronology literature. Although the first referee indicates that the branch is not questioned in the nuclear physics community, this is not the case in the geochronology community, which in my opinion reasonably motivates the manuscript.

As a geochronologist, it is difficult for me to assess the validity of large sections of the paper (particularly section 4). Although the first referee states that parts of that section include 'textbook knowledge in nuclear physics', I find them valuable particularly given the submission of the manuscript to a geochronology-focused journal.

Specific Comments:

Line 70, Figure 1: In (for example) McDougall and Harrison (1999), the positron decay of 40K to 40Ar is shown as also involving a gamma ray at 1.02 MeV. However, Figure 1 shows the positron decay as direct to the ground state of 40Ar. Please address this discrepancy.

Line ∼100: I'll preface this by noting that I'm not a physicist, but why doesn't the energy involved in the gamma ray come into account here? Why is it only the electron capture energy (and not the gamma) that matters? The total energy of the electron capture plus gamma would seem to be sufficient to couple with the positron decay. Also, given the note above (Line 70, Figure 1), is this argument affected by whether the positron decay goes directly to ground state or has an associated gamma?

Line 106: For readers who are not nuclear physicists, a brief explanation of quantum selection rules would make this more readable.

Figure 2 caption: Perhaps note that uncertainties were either not estimated or are smaller than the symbols? This is stated in the text but would be ideal to have in the caption as well.

Line 287 (and throughout): The use of 'flux monitor' is a common error – should be 'fluence monitor', as they are measuring the total neutron fluence (flux over time) affecting samples over the entire irradiation, rather than monitoring the neutron flux at one specific time.

Line 303: Based on Figure 5, I calculate a different percent decrease for K-Ar ages at 1 Ga (2.5%, for ca. 25 Ma at 1 Ga, rather 1.3%). The value 0.7% at 4.5 Ga seems accurate, and the 1.6% at 1 Ma is not identifiable (due to scaling of graph) in the figure. It would be helpful to have an expanded Figure 5, with multiple scales (or just expand this scale down to 1 Ma) to highlight different parts of the geologic timescale. It would also be helpful to show results in relative values as well as absolute values. Finally, the K-Ar line seems to have structure (e.g. around 10ˆ8 a) that should be explained.

Line 306: I'm struggling to understand the use of a fluence monitor at 23.2 Ma. I realize this is (may be?) a theoretical monitor, but it's in a paragraph with clear reference to Fish Canyon sanidine and I've spent some time wondering if '23.2' was a typo for '28.2 Ma'. Actually, I'm still not sure – is this a typo? If not, perhaps just note that it's a theoretical monitor of arbitrarily chosen age (if that's indeed what it is), to prevent others from wondering the same.

Technical Corrections:

Line 97: "They are linked because both processes have the same initial and final nuclear states." It's not clear what 'they' refers to – likely electron capture and positron, but perhaps beta?

Line 124: The symbol is missing from the pdf for type of emission

Line 148: Is Emax defined somewhere?

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