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# *Interactive comment on* "Geoscientific process monitoring with positron emission tomography (GeoPET)" *by* Johannes Kulenkampff et al.

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In this manuscript the authors give an overview of the potential applications of Positron Emission Tomography (PET) in the field of geosciences. The manuscript is well written and thought provoking. There are a number of typographical and grammatical errors (detailed below) and I also have a few minor questions and points that the authors may wish to consider.

Minor Comments:

1. Page 3 line 29: I think you mean "interference" rather than "inferences" but the comments about SPECT perhaps need a bit more clarification. While it is true that most SPECT studies use tracers that gamma rays with energies lower than 511 keV that doesn't have to be the case and SPECT could be used with higher energy tracers



that would mitigate some of the problems that you've attributed to the technique. Also, in theory, SPECT doesn't have the same limit on resolution (due to positron range) as PET.

2. On page 5 there is quite a detailed treatment of radioactive decay, but in practice most scanners will incorporate a decay correction, so this factor is often ignored when dealing with PET data. It's worth pointing out that this approach may not be valid when dealing with very long frames but maybe this section could be reduced in length without loss of clarity. Also, using half-life rather than the decay constant makes the equations rather clumsy. It may be better to use the decay constant in the equations and simply state the relationship between decay constant and half-life.

3. On page 6 the authors imply that randoms correction is achieved by varying the size of the coincidence timing window. In fact randoms rates are either estimated from the singles rates of the detectors or using a "delay line".

4. On page 8 the authors should make it clear that the limitation on the shortest frames of 60s is specific to their particular scanner and that scanners with fixed rings can acquire shorter frames.

5. At the bottom of page 8 the concept of a "geometrical probability" is introduced and the probability is broken down into three factors. While this notation is correct for the methods used by the authors it is theoretically possible to include other effects (such as scatter) within the probability.

6. Similarly, on page 10, the authors claim that scatter "must be subtracted from the measured projections". While this is one option, the authors should point out that it is also possible to model it during the reconstruction process.

7. The discussion of image variance on page 11 is somewhat simplistic. As the authors are no doubt aware the variance within images reconstructed using iterative reconstruction methods (such as OSEM) had been the subject of much study. It may be

better just to refer to some of the classic articles on the subject, such as: H H Barrett, D W Wilson and B M W Tsui “Noise properties of the EM algorithm. I. Theory” Phys. Med. Biol. 39[5], 883, 1994

8. The detection threshold may be affected by intrinsic radiation in scanners that use Lutetium based scintillators, such as LSO and LYSO. The authors should mention this fact on pages 11 and 12 and also indicate whether the Monte Carlo simulations that were used to determine the detection threshold included simulation of this intrinsic radiation.

9. The authors should clarify whether the detection threshold of 10 Bq/voxel depends on the length of the frames i.e. if the object were scanned for longer could a lower activity be detected.

Typographical/Grammatical Errors:

1. Page 2 lines 4-5 should read “treat the material as a black box”

2. Page 2 line 13 should read “takes advantage of the simple”

3. Page 2 lines 14-15 should read “We have striven, successfully, to broaden the scope of PET applications to geoscientific and technical use for more than 15 years”

4. Page 2 line 24 should read “now allow for the characterization of the structure”

5. Page 4 line 1 should read “PET can serve as a gold-standard”

6. Page 4 line 3 should read “brings a great increase in the understanding of”

7. Page 5 line 6 should read “isotope is applied as a radiotracer”

8. Page 5 equation 1: The right hand side is that standard exponential decay equation, but I’m not sure what the middle section means. Why, for example, is there a subscript of 2 on T ?

9. Page 5 lines 18-9 should read “only a small fraction of these nuclides can be pro-



duced with acceptable expenditure”

10. Page 5 line 23 should read “photon pair produced by the annihilation”

11. Page 5 line 27 should read “Because of the poor energy resolution”

12. Page 6 line 29 the term NA (Avagadro’s number) should be defined

13. Page 7 lines 19-20 should read “Short lived PET-tracers”

14. Page 9 line 12 should read “are accumulated in low sensitivity”

15. Page 10 line 21 should read “PET images reflect the concentration of the”

16. Page 10 line 28 should read “is a complicated subjective mapping method”

17. Page 14 line 5 should read “As an example”

18. Page 14 line 7 should read “was calculated from the backprojection”

19. Page 14 line 8 should read £estimated from the backprojection”

20. Page 14 line 10 should read “which is includes as the backprojection coefficient”

21. Page 14 line 28, although the use of “a” to denote years is a common convention it would be clearer just to use “y” (or years) here.

22. Page 15 lines 6-7 should read “regard to material effects make it an outstanding option for quantitative tomography of tracer transport”

23. Page 15 lines 24-25 should read “process tomography in laboratory studies, as it is for functional studies in biomedical research and”

24. Page 22, the caption for figure 2 should read “One typical sinogram”

25. Page 24, the caption for figure 5 should read “of the four point sources in Figure 4 as a function of the total activity”

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