Solid Earth Discuss.,
doi:10.5194/se-2016-35-AC1, 2016

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

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Received and published: 17 June 2016

Many thanks for this helpfull review, which not only offered a chance to improve the contents, but also the language.

We would like to respond now to your comments:

1. "...the comments about SPECT perhaps need a bit more clarification" In our view the main advantage of SPECT is the larger choice of available tracer nuclides. Also, when the sample is small enough and the radiation energy high enough (with an upper limit at the pair-production threshold), the effect of attenuation and scattering could be acceptable. These effects could be mitigated by due modelling based on the density distribution of the sample. Boutchko et al. have shown the feasibility of the method. However, we feel that the state of the art is less advanced than with PET. We indeed

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forgot the reference to Boutchko et al. in this section, who successfully conducted flow experiments in glass beads with PET and SPECT observation. We therefore added one more sentence.

2. "...quite detailed treatment of decay correction..." You are probably right, the decay correction is rather straight-forward. We experienced problems with large frame lengths compared to the decay time, which probably could occur elsewhere, but this is easily solvable. Our point in this introductory section is the direct calculation of concentration from the count rate. This is rather trivial with respect to physics, but the geoscientific-oriented reader probably is not aware of that. We switched to the decay constant, because you are right with the clumsiness of the half-life (which we – even worse – denominated "decay time").

3. "..the authors imply that randoms correction is achieved by varying the size of the coincidence timing window .." We wanted to avoid a lengthy discussion and did not go into the details, which probably considers our scanner as a special case. In the first instant we are recording single-event LMFs. We than use some type of "software delay line" or we do some computations with varying coincidence window sizes. Both methods have basically the same effect, but the latter one is more stable. We tried to say it more precisely.

4. "..the authors should make it clear that the limitation on the shortest frames of 60s is speciïňĄc to their particular scanner Actually, even with our rotating gantry frame rates of about 10 s are possible. Our typical frame rates are considerably longer than 60 s, in order to acquire sufficient events. This is the more stringent condition. We fixed this and shortly discussed the optimum frame rate in relation with your comment 9..

5. "it is theoretically possible to include other effects (such as scatter) within the probability" and 6".. it is also possible to model it during the reconstruction process" We feel that some type of model based image reconstruction, or even inversion based on Monte-Carlo simulations, could considerable improve image quality and physical sig-

nificance of the results. We added a sentence about inversion and made clear, that this is the solution implemented in STIR. Of course, there is a large number of publications and algorithms available. We believe that the reader might start with the rather basic papers by Zaidi and by Basu et al.

7. With respect to error analysis: It may be better just to refer to some of the classic articles on the subject, such as Barrett et al:.." Our intention is to show that the error range is acceptable and somewhere in the range the variation that are expected in geological materials. In order to show that it is feasible to conduct a proper error analysis, we did this rather simplistic error estimation. The paper of Barrett et al. provides a sound basis to do it more rigorously, but without straightforward practical applicability. This paper, among others, is also cited in the more recent one of Kirov et al., which is included in our references. We therefore think that an interested reader – who likes to bother himself with this subject – would find the necessary information. On the other hand, we admit that the book chapter of Prekeges is not too profound, but possibly just right for non-specialists. Frankly, the error propagation from the corrections of attenuation and scatter to the final image should be considered more profoundly. Frequently, these corrections appear to be almost as significant as the actual measured PET data for the result – which is different to medical applications. It should be done in future. We feel that a more involved analysis goes beyond scope of this paper.

8. "..The detection threshold may be affected by intrinsic radiation in scanners that use Lutetium based scintillators, such as LSO and LYSO. . ." We did not go so far into the detail. The Lu-component of the detector crystals is part of the background radiation, together with the local radiation level. Currently, we moved into another laboratory with a lower background level and we can now infer that the background radiation in the lab has the larger effect than the intrinsic detector radioactivity. The example is a synthetic one, which also included a random background and Lu-activity as sources of noise. We shortly included this in the section about MC-simulations – it appears less relevant in this geoscientific context.

9. "...should clarify whether the detection threshold of 10 Bq/voxel depends on the length of the frames" We referred to the activity concentration as the relevant outcome. We think that the crucial parameter is the SNR (quotient of trues rate and background level). This ratio is independent of the frame length. However, the background noise level (deduced from blank measurements) is in the order of the detection threshold that we found. Apparently the number of counts projected to one voxel was the limiting parameter. Therefore, an increase of the frame length would proportionally lower the detection threshold as far as the count rate is higher than the background. The calculations were primarily conducted on the count-number level and can be scaled quite simply to count-numbers. Therefore we need about 50 counts in bins that are projected to the reconstructed source volume. We restructured this section, which also had some redundancy and incoherencies, and added a note with respect to the optimum frame rate. We are aware, that the sound definition and quantification requires further attention. It is a considerable complication, when PET measurements are compared to geoscientific process simulations on the pore scale.

The typographical and grammatical mistakes were eliminated.

Actual version as pdf-supplement

Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/se-2016-35/se-2016-35-AC1-supplement.pdf

Interactive comment on Solid Earth Discuss., doi:10.5194/se-2016-35, 2016.

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