

Paper ID: 157

Title: **Tracking Electrons Produced by Compton Scatter within a Prompt Gamma Imaging Device**

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Reviewer comments in black

Author response in red

**Reviewer 1 Comments** [pdf file: NPRP157-Reviewer\_Comments1.pdf]

Page 1

- Abstract: election circled
  - o Changed election to electron

Page 2

- Introduction (first line): [3-6] circled with comment brief
  - o Changed line: There are a number of ways to detect these prompt gammas [3-6], but this work concentrates on a device called a Compton camera.
  - o To: There are a number of ways to detect these prompt gammas, using both physically and electronically collimated devices [3-6], but this work concentrates on a device called a Compton camera.
- Introduction (end of 2<sup>nd</sup> paragraph): “does not make sense. Is not a sentence.”
  - o Changed line: A major factor in this uncertainty is the electron produced during the Compton interaction.
  - o To: A primary source of position uncertainty has to do with the recorded position of electron produced during the Compton interaction.
- Introduction (end of 3<sup>rd</sup> paragraph): “Compare to SPECT collimator system, prompt gammas are singular, without spatial correlation, eg. PET.”
  - o A great comment, but ignored due to space constraints, was partially addressed in comment above regarding different types of prompt gamma detection.
  - o No changes made
- Section 2.1.1 (1<sup>st</sup> paragraph): “formatting”
  - o Justified text
- Section 2.1.1 (2<sup>nd</sup> paragraph): “but 2<sup>nd</sup> is photoelectric. (ignoring binding energy)”
  - o Changed line: during the two Compton interactions.
  - o To: during the Compton and photoelectric interactions.

Page 3

- Figure 1 Caption: “formatting”
  - o Reduced size of Figure 1 slightly so Figure 1 caption looked better.
- Section 2.1.2: “formatting”
  - o Justified text

Page 4

- Section 2.1.3 (1<sup>st</sup> paragraph): “Why is this the standard? Ref standard? Discuss standard.”
  - o No space to describe, but added reference to previous work discussing the setup

- Section 2.2: circle 4.44 MeV with comment “discuss”
  - Sentence added: The 4.44 MeV source was used to replicate one of the primary prompt gammas produced during proton irradiation.
- Section 2.2: circle 0.01 mm with question mark
  - Clarification statement added: (equivalent to an energy threshold of 44.4 keV)
- Figure 4: “total below scatter 1?”
  - Sentence added to Figure 4 caption: Total is the average electron range for all scatters.
- Figure 4: “Uncertainties? What are the ‘lines’?”
  - Uncertainties were calculated, but the error bars were smaller than the symbols and were not included. The lines merely connected the points to indicate the trends.
  - No changes made
- Figure 5: “What is the ‘total’? Shouldn’t that be the sum of all S1 + S2 + S3?”
  - Yes, sentence added to Figure 5 caption: Total is the sum of all scatters.
- Section 3.1: “fundamental physics behind this CS is primary angle. Angular distribution? And then energy changes, so angle changes.”
  - Good point. Sentence added: The scatter angle of the Compton interaction will also impact the electron energy and range, but due to the geometry of the infinite detectors, the range of scatter angles for each scatter remains approximately the same, and thus will only have a smaller contribution on the electron range than the incident gamma energy.

## Page 5

- Figure 6: “Fig 6 not a defined cut-off for electrons as expected as photon induced so some photons (exp attenuated) make it to back surface, thus electrons escape, even at depth.”
  - Yes, I think so.
  - No changes made
- Figure 6: “Uncertainties? What is the line? Exp for photon attenuation”
  - Uncertainties were calculated, but the error bars were smaller than the symbols and were not included. The lines merely connected the points to indicate the trends. Interesting comment about attenuation, that is certainly a primary factor in the decrease.
- Figure 7: “What is the ‘total’ sum of E1 + E2 + E3 = 4.44 MeV?”
  - Yes, sentence added to Figure 5 caption: Total is the average of all scatters.
- Section 3.2: circled 0.2 MeV & 0.26 MeV with comment “difference in significance. Why is this? Binding energy? How is the expected calculated?”
  - The expected value is the energy lost by the gammas, statement changed from: (0.26 MeV from the first scatter)
  - To: (energy lost by the Compton gammas)
- Section 3.3 (1<sup>st</sup> paragraph): “due to geometry, you force energy distribution to be what it is by geom and coincidence requirements”
  - Feel like comment addressed with statement at end of first paragraph in Section 3.3  
-> Because of the Polaris J detector geometry, a successful triple scatter interaction will have a very narrow angular window and due to the angular dependence of the Compton equation, will, consequently, have a very narrow energy acceptance window, resulting in the 1.5 MeV energy bump.
  - No changes made

- Section 3.3 (2<sup>nd</sup> paragraph): circled “half of the simulated electron range” with comment “assuming a linear track for the electron, so this is an overestimate”
  - True, added statement regarding overestimation.
- Section 3.3 (2<sup>nd</sup> paragraph): circled “assumes that the detector ... use the middle of the track as its position.” With comment “depends ... normally kinematics give end of track.”
  - This is likely a naïve view and need to follow up with the manufacturers of the detector.
  - No changes made
- Section 3.3 (2<sup>nd</sup> paragraph): circled “0.2 MeV” with comment “systematic, which could be calibrated, not an uncertainty.”
  - Changed wording from uncertainty to deviation in measured value.

#### Page 6

- Figure 8: “y-axis labels”
  - Sentence added to Figure 8 caption: The y-axis is the number of gammas and Total is the sum of all scatters.
- Conclusion: “prefer conclusion here – formatting again” with arrow
  - Done.

#### **Reviewer 2 Comments** [pdf file: SAIP\_2016-157-Peterson-v2\_yacoob.pdf]

#### Page 2

- Section 2.1.1: “is the gamma absorbed?”
  - Changed line: during the two Compton interactions.
  - To: during the Compton and photoelectric interactions.

#### Page 5

- Conclusion: “where do I see this?”
  - Section 3.4 was added to better summarize the results before the conclusion.