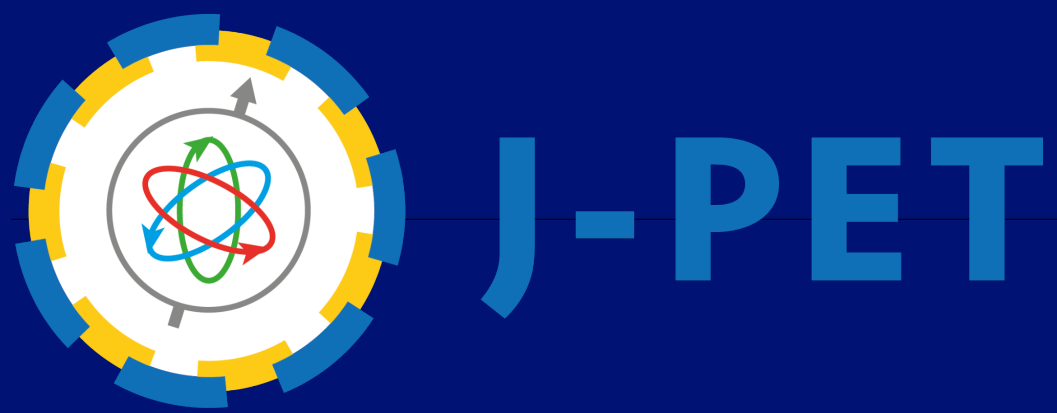


Study of Total-Body J-PET sensitivity as a function of the ring number



Sharareh Jalali^{*1}, Martin Rädler², Keyvan Tayefi Ardebili³, Pawel Moskal⁴

^{1, 2, 3, 4} Faculty of Physics, Astronomy, and Applied Computer Science, Jagiellonian University



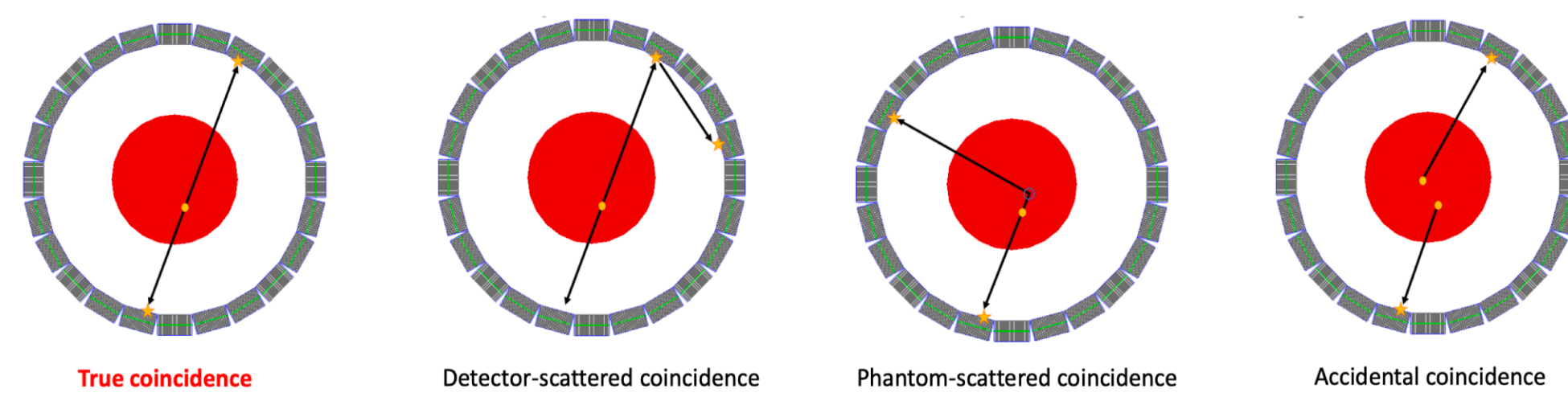
Abstract

Positron Emission Tomography (PET) is a key molecular imaging technique in nuclear medicine. The Total-Body PET scanner, due to its extended detection area, offers significantly higher sensitivity, which is a key factor in overall tomographic performance [1]. The J-PET collaboration is currently developing a novel Total-Body PET prototype with an Axial Field Of View (AFOV) exceeding 250 cm, enabling low-dose imaging, reduced scan times, and dynamic imaging capabilities. A distinguishing feature of this design is the use of cost-effective plastic scintillators, which have the potential to make large-FOV PET scanners more widely accessible [2]. One of the key performance metrics in PET is sensitivity, defined as the rate of true coincidence events detected per second per unit source strength [3]. This study employs GATE simulations [4] to evaluate and compare the sensitivity of the Total Body J-PET and plastic-based brain PET scanner. Additionally, it investigates the combined sensitivity of brain PET integrated with the Total-Body J-PET system.

Method

Sensitivity:

The sensitivity of PET is expressed of the rate in count per second that sure coincidence event are detected for a given source strength.



Simulation

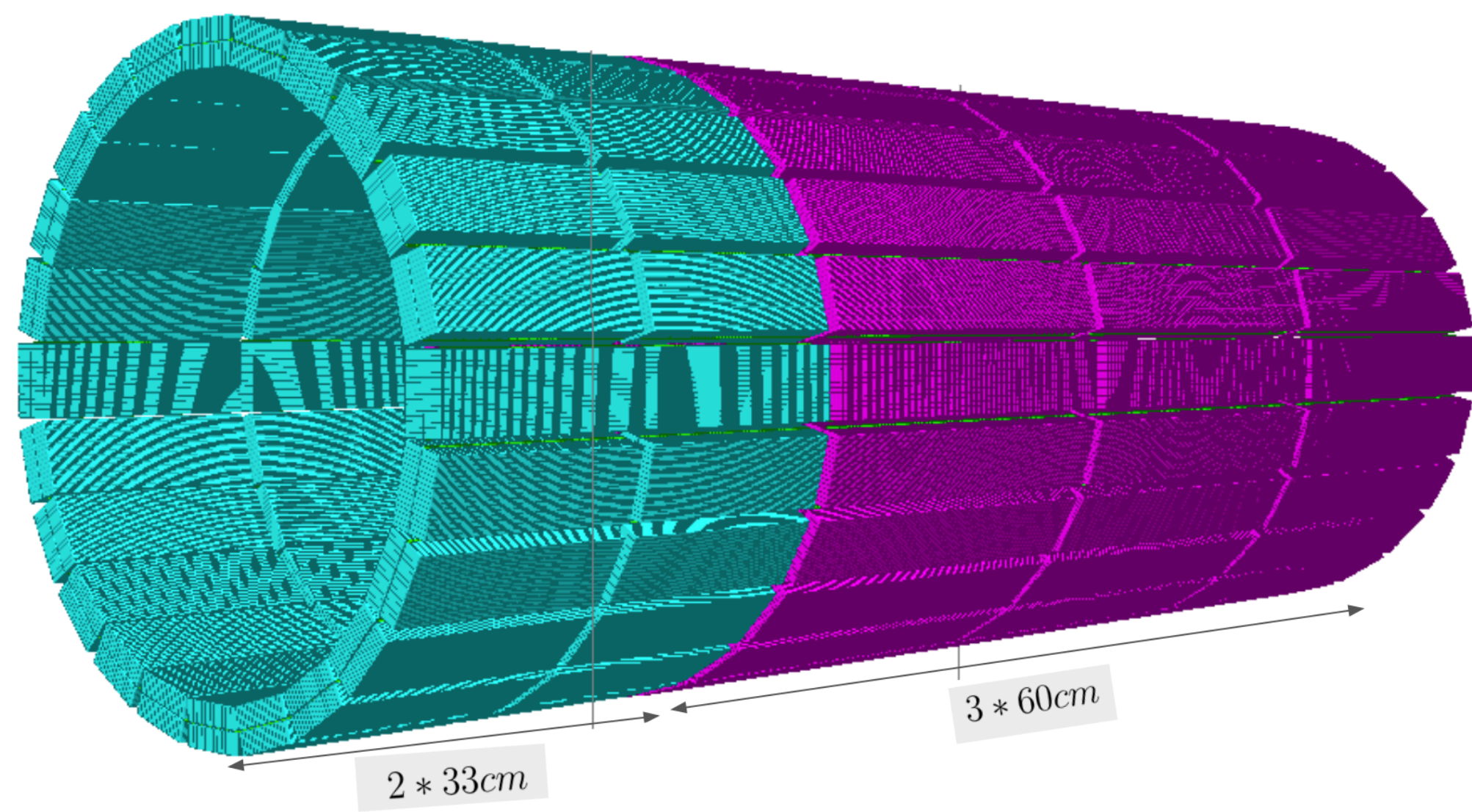
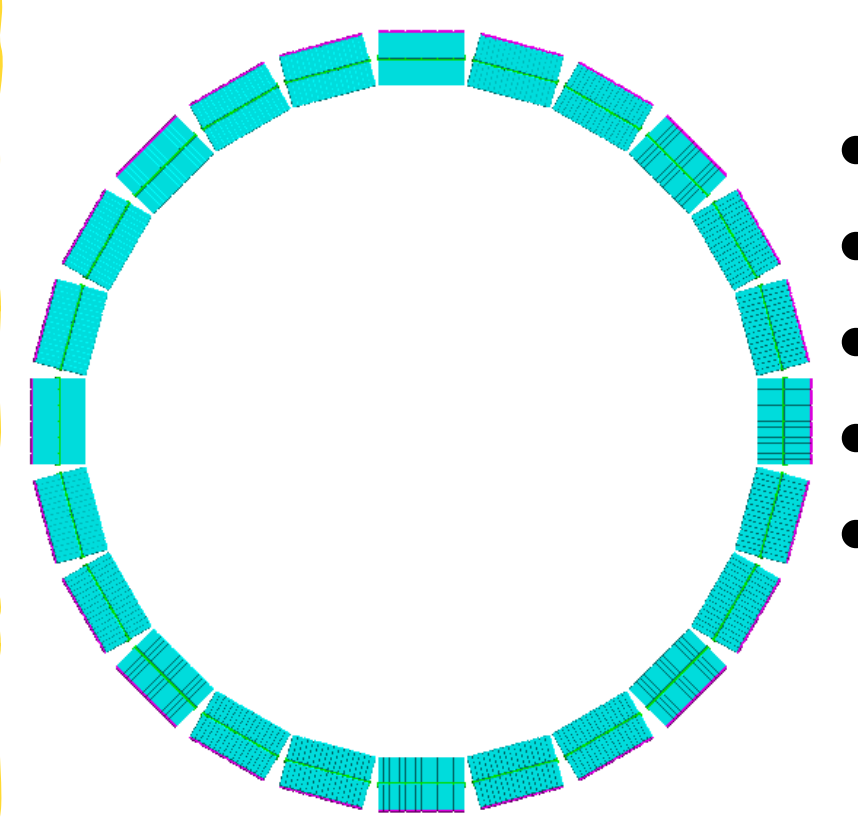


Figure 1: Schematic view of simulated Total-Body J-PET.



- Radius source: 0.5 mm
- Source type: Gamma back to back
- Simulation time: 5s
- Source activity: 1MBq
- Source length: 261cm

Figure 2: The front view of the scanner consisting of 24 modules.

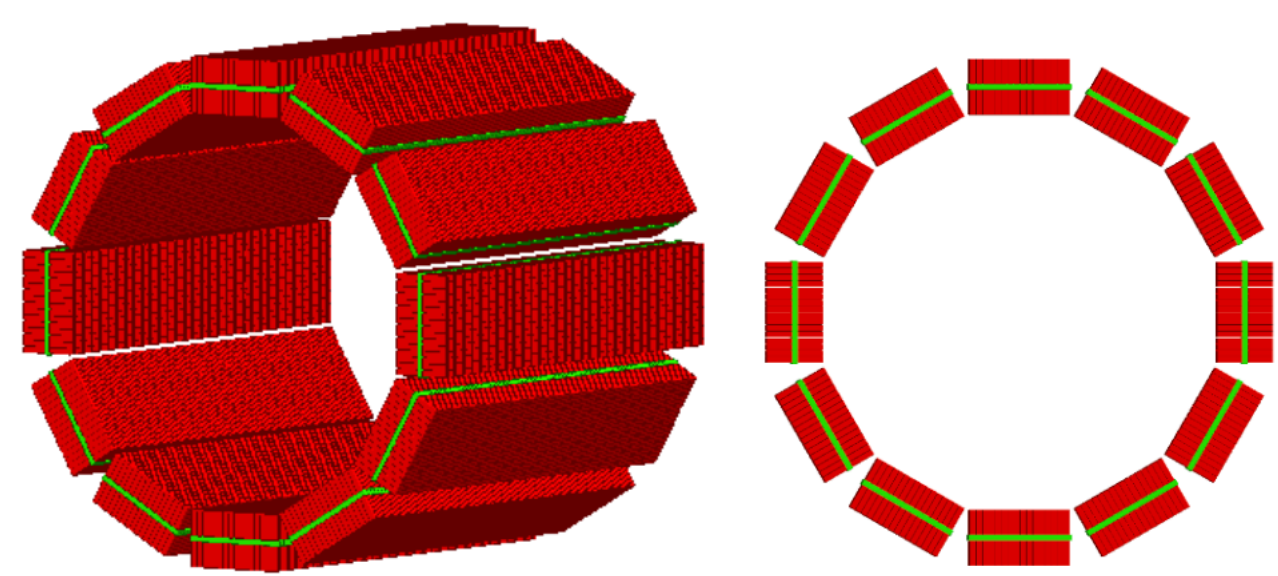


Figure 3: The front view of the Brain_PET scanner, consisting of 12 modules.



- Radius source: 0.5 mm
- Source type: Gamma back to back
- Simulation time: 5s
- Source activity: 1MBq
- Source length: 261cm

Acknowledgment

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Result

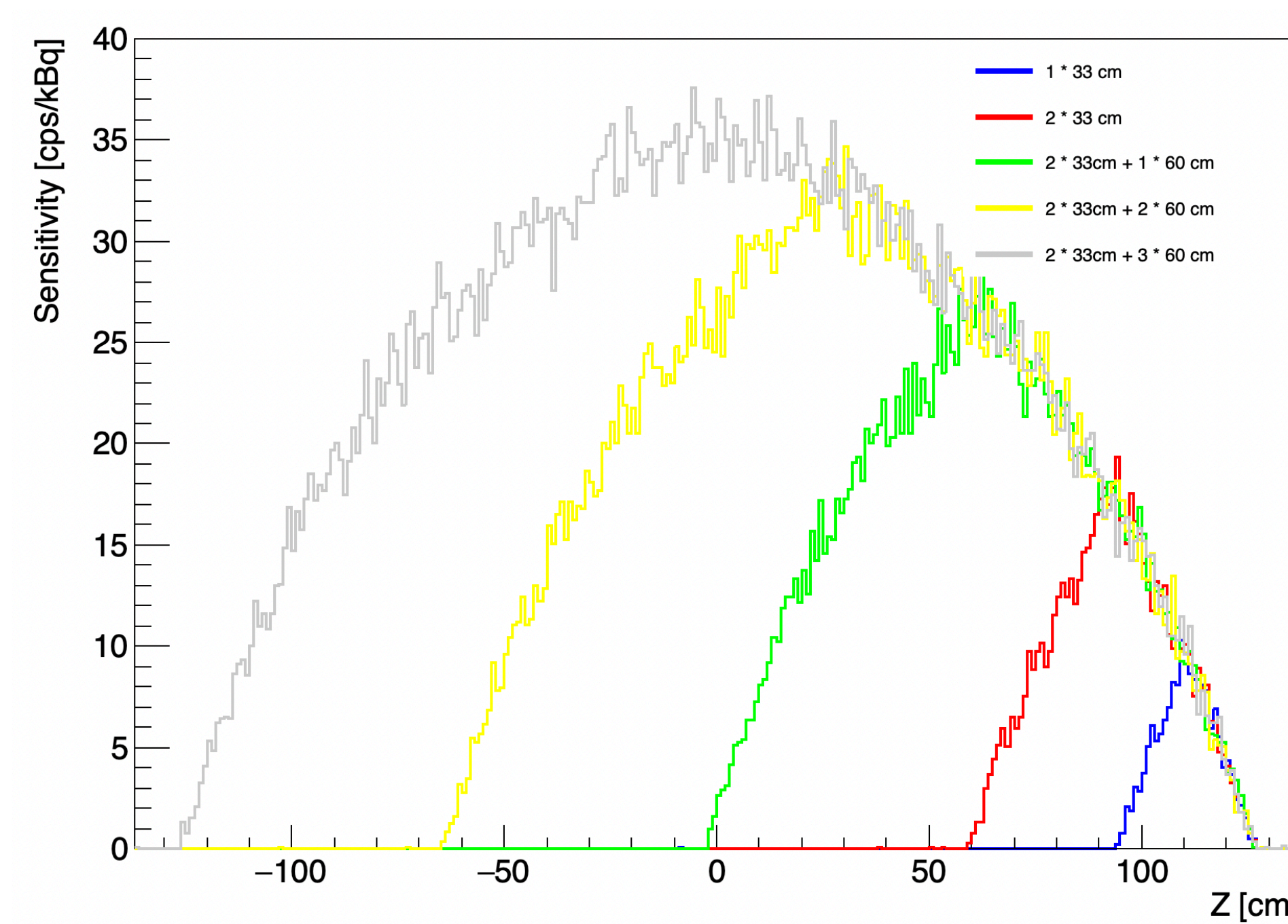


Figure 4: Preliminary results of the axial sensitivity profile for the Total Body J-PET. The X-axis represents the Z-coordinate of the annihilation position, While the Y-axis presents the count rate in count per second per kBq of source activity.

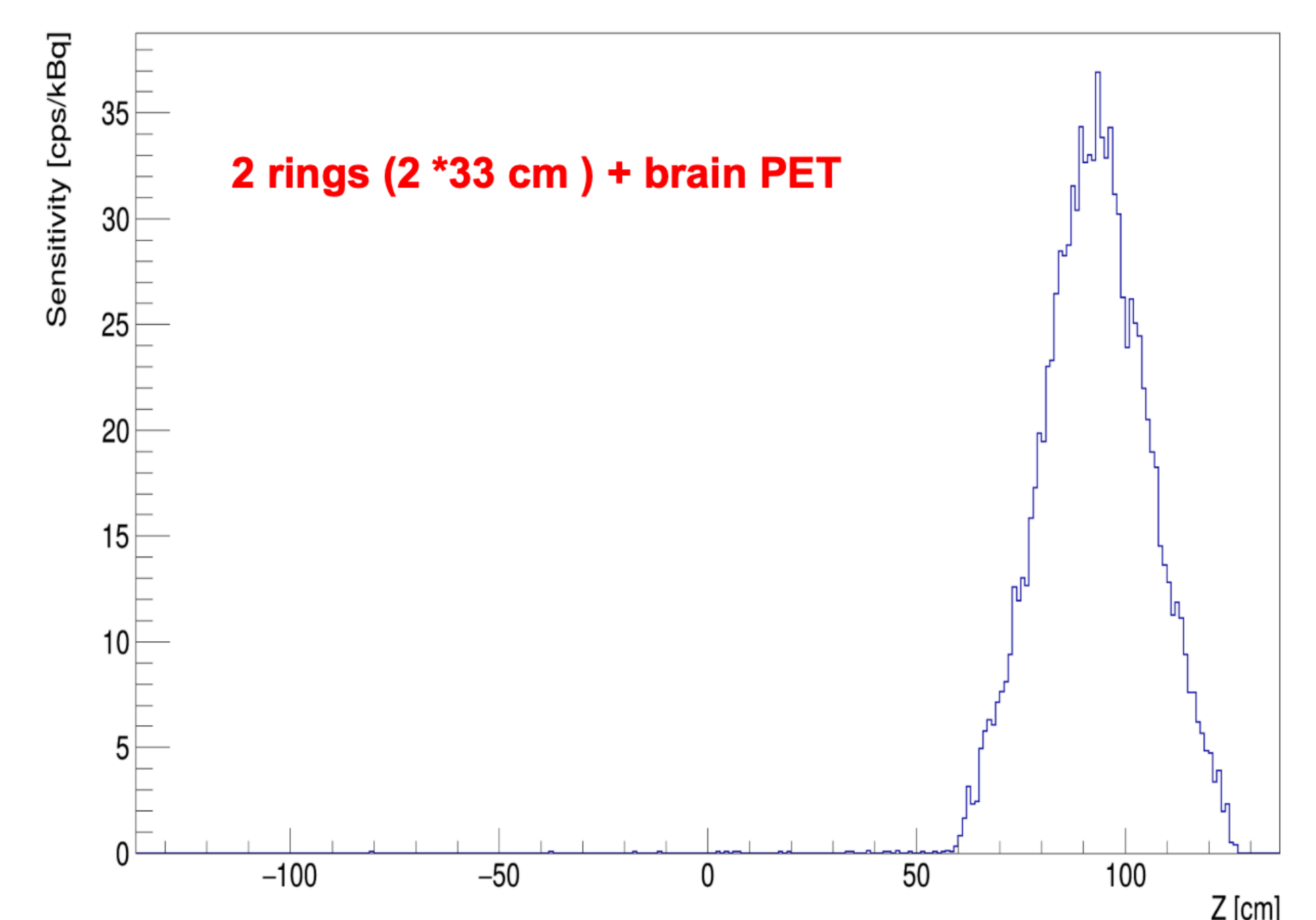
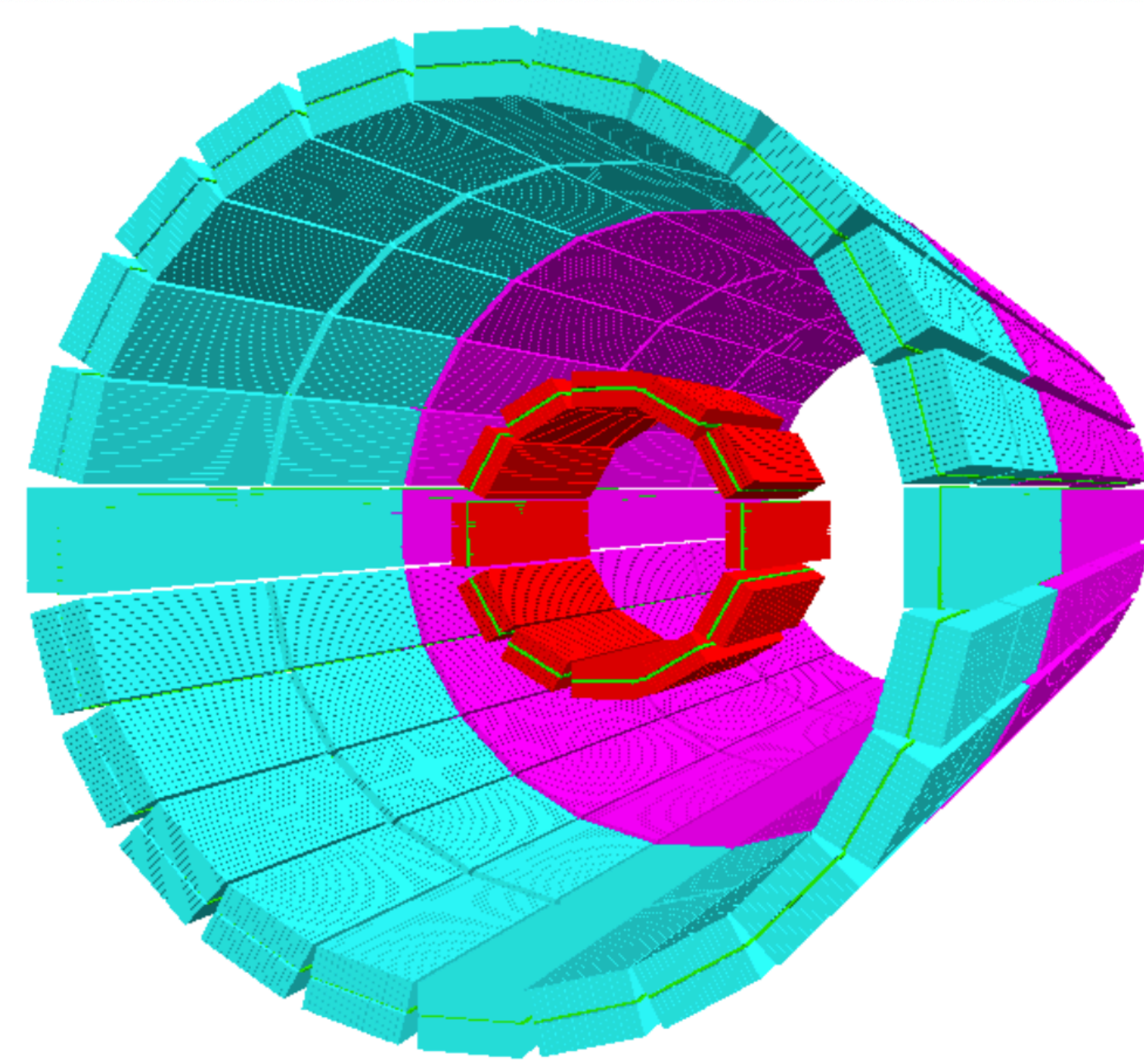


Figure 5: (left) Schematic view of simulated Brain PET inside the Total-Body J-PET (between the two rings with the length of 33 cm). (Right) Sensitivity Profile of Brain PET inside the two rings with the length of 33 cm.

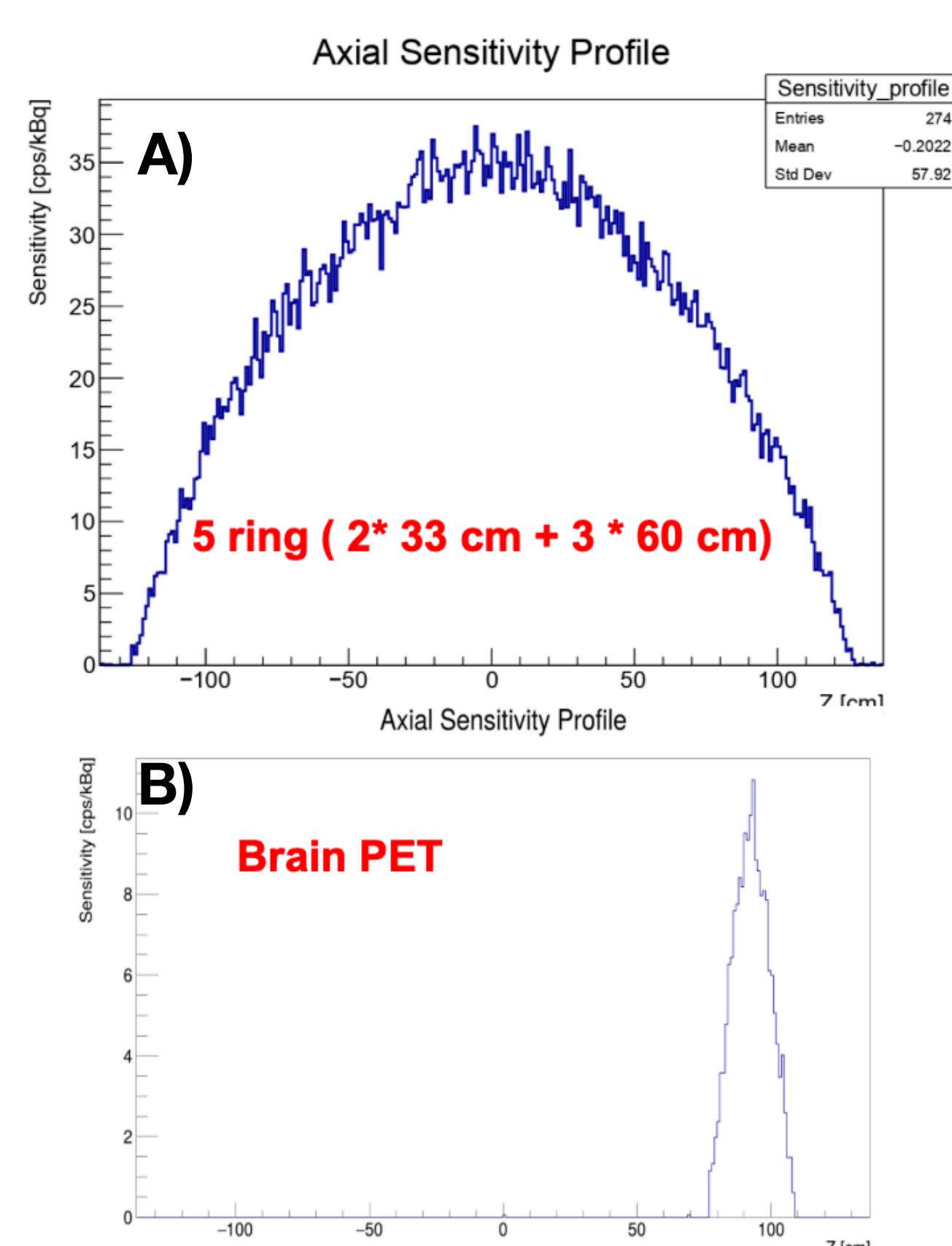
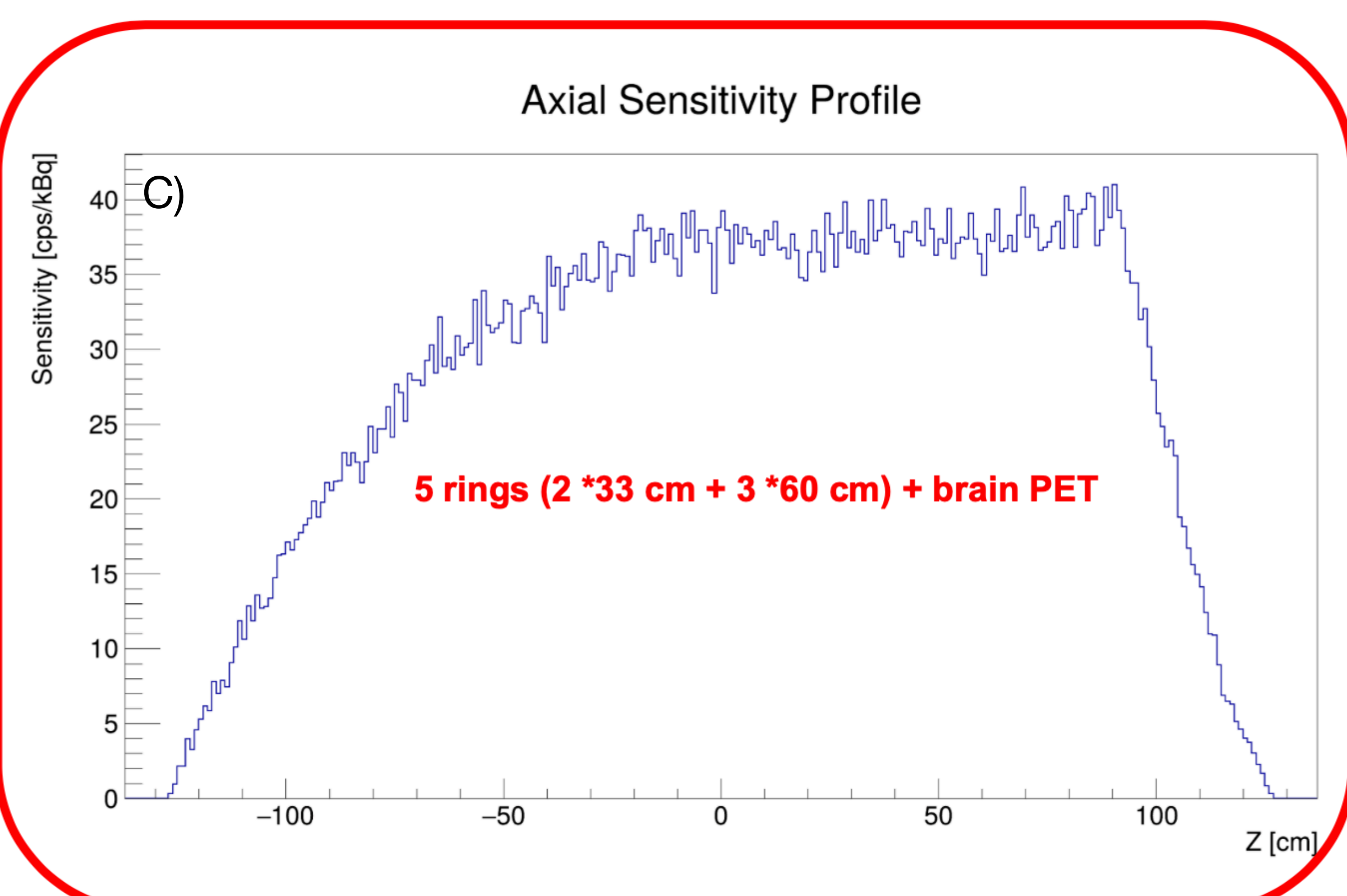


Figure 6: A) Sensitivity Profile of Total body J-PET scanner. B) Sensitivity Profile of Brain PET. C) Sensitivity Profile of Brain PET inside the Total Body J-PET.



Conclusion

- Brain-PET integrated into total-body J-PET was simulated.
- Sensitivity was quantified versus number of rings (Fig. 4).
- Result: More rings → higher sensitivity.

References

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