

## Whole gamma imaging: PET combined with Compton imaging

*Saturday, 9 October 2021 11:30 (20 minutes)*

Whole gamma imaging (WGI) is a novel concept of combined PET with Compton imaging. An additional detector ring, which is used as the scatterer, is inserted in a conventional PET ring so that single gamma rays can be detected by the Compton imaging method. In addition to a conventional PET mode, Compton imaging (single-gamma mode) is possible. Further large impact can be expected for triple gamma emitters such as  $^{44}\text{Sc}$  (about 4 h half-life), that emits a positron and a 1157 keV gamma ray almost at the same time (triple-gamma mode). In principle, only a few decays would be enough to localize the source position by calculating intersection points of a 511 keV line-of-response with a 1157 keV Compton cone. We developed a prototype of the WGI system [1][2]. All interaction events were recorded as list-mode data, and event selection such as coincidence detection was done in software. We measured a  $^{137}\text{Cs}$  point source in the single-gamma mode and a  $^{22}\text{Na}$  point source with conventional coincidence detection. The  $^{22}\text{Na}$  point source was also used to demonstrate the triple gamma mode as it emits a 1275 keV gamma ray after a positron decay. In the single-gamma mode, spatial resolution for the  $^{137}\text{Cs}$  point source obtained by 3D list-mode OSEM was 4.4 mm FWHM (8 cm off-center) - 13.1 mm FWHM (center). Spatial resolution values for the  $^{22}\text{Na}$  point source, obtained by the absorber-absorber coincidence and the scatterer-scatterer coincidence, were almost the same (below 2 mm). In the triple gamma mode, where only simple backprojection was applied and no image reconstruction algorithm was applied, spatial resolution for the  $^{22}\text{Na}$  point source was 4.8 mm FWHM (8 cm off-center) - 5.7 mm FWHM (center). WGI with  $^{44}\text{Sc}$  can be also used to measure positronium lifetime [3], which may enable a new field of “quantum PET (Q-PET)”. One possible application of Q-PET is hypoxia imaging of tumor patients [4].

### References

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