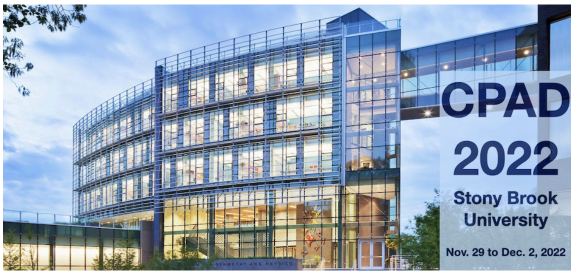

Contribution ID: **117** Type: **Contribution Talk**

A TOPAS Simulation of Low-Dose High-Resolution Low-Z-Medium Whole-Body TOF-PET

Tuesday, 29 November 2022 17:00 (20 minutes)

We have used the TOPAS Geant4-based package to write a parametric simulation of the pattern recognition and image reconstruction of a whole-body TOF-PET camera employing a liquid scintillator with low atomic number (Z) as the active medium rather than conventional high-Z crystals, and with large-area MCP-based photodetectors for determination of Time-of-Flight. For 511 keV gamma rays Compton scattering dominates the photo-electric effect by a factor of 10^4, resulting in a chain of successive scatterings with decreasing energy. Each scatter in the detector medium produces a recoil Compton electron that deposits ionization energy along its track.

The kinematic constraints of Compton scattering and the recorded energies and positions in the chain of scatters are used to time-order the scattering events, which are typically separated by at least several centimeters. The first interaction of each gamma ray in the detector medium is chosen from the most probable ordering. A Line-of-Response (LOR) is then constructed between the first interaction points of the two gamma rays. The LOR is parameterized by a transverse Gaussian resolution determined by the detector medium and the optical system viewing the medium, and a longitudinal resolution determined by the time-of-flight (TOF) measured by large-area fast photodetectors.

The TOPAS package was used to simulate a detector consisting of a 30 cm thick, 200-cm long, cylinder surrounding a 45 cm diameter bore. The active medium is assumed to be linear alkylbenzine (LAB),doped with a (yet-to-be-determined) photoswitchable fluorescent dye, capable of many cycles of excitation to fluorescence after being activated by the ionization of the Compton electrons.

Two phantoms were simulated using ^{18}F as the radioactive tracer: the Derenzo geometric phantom, and the human brain of the XCAT voxelized whole-body phantom with an added 2 cm diameter tumor. We present statistics on signal reconstruction efficiencies, misidentifications and signal-to-noise. We show reconstructed images with current nominal activities, and with the activities reduced by factors of 10^2, 10^3, and 10^4.

Primary authors: DOMURAT-SOUSA, Kepler (student@uchicago.edu;alum@uchicago.edu;member@uchicago.edu); FRISCH, Henry (faculty@uchicago.edu;staff@uchicago.edu;member@uchicago.edu); LA RIVIERE, Patrick (University of Chicago); POE, Cameron (student@uchicago.edu;member@uchicago.edu;staff@uchicago.edu); SHIDA, João (MIT); SPIEGLAN, Eric (University of Chicago); SQUIRES, Allison (University of Chicago)

Presenter: DOMURAT-SOUSA, Kepler (student@uchicago.edu;alum@uchicago.edu;member@uchicago.edu)

Session Classification: WG2: Calorimetry

Track Classification: WG2: Calorimetry