Abstract ID: 16867 Title: Electric Field and Ionization Signal Simulation in Liquid Xenon Detectors for PET

Purpose: A liquid xenon (LXe) detector prototype was developed to assess the performance of LXe for use in positron emission tomography. In this prototype, the measurement of ionization signals was achieved by using a time projection chamber (TPC), and scintillation light was measured by large area avalanche photodiodes. This work is aimed to simulate the electric field and readout signals in the LXe TPC.

Methods: The electric field inside a single sector of the prototype detector was calculated through the finite element method using the software of Opera-3d, with focus given to determining the uniformity of the field. The simulation model consists of a cathode, an anode, and field cage strips, which were immersed in a liquid xenon volume. With the electric field map obtained by Opera-3d, the signals simulation were implemented in the Garfield package. The detector responses, including the primary ionization, generation of electron clouds, electron drift, diffusion, induced current signals on induction wires, and collection signals on anodes, were simulated. Comparison of simulation signals and measurement signals was made.

Results: Three-dimensional simulation results for the prototype detector showed that the field was nearly uniform in the center, with electron drifts deviating by less than 1 mm between the cathode and anode. The region of dead space constitutes 2.9% of the total volume in this sector. The simulation signals were in a good agreement with measurements.

Conclusions: The good uniformity inside the chamber guaranteed 3-D sub-millimeter position resolution across the entire field of view. Based on the 3D electric field map, we can assign correction factors to correct the non-uniformity in the whole sector. We also correctly simulated the signals of the TPC.