Self-contained Simulation Tools – X-ray Source Sim.

Figure 1: The Geant4 detector geometry for the X-ray source simulation. Electron gun and target parameters are fully parameterized and accessible through macro text files as a target material selection.

Figure 2: Geant4 simulation of the X-ray source setup for target materials Ag, Au, Cu, Mo, and Ag, and Au consisting of 20 million primary electrons at 50keV. The target angle was set to 18°. Please adjust to 18°.

Self-contained Simulation Tools – 2D Pixel Detectors

Figure 3: Conversion efficiency of incident X-rays into primary electrons for Bremsstrahlung X-rays depending on target material.

Estimates for incident electrons at energies of 20 keV, 50 keV and 100 keV and elements C (Z=6), Al (Z=13), Cu (Z=29), Mo (Z=42), Ag (Z=47) and Au (Z=79) are shown.

Each simulation consisted of 40 million primary electrons and the target angle was set to 18°.

Figure 4: Geant4-based quantum efficiency simulations for the three large 2D pixel detectors with 8μm readout capable at European XFEL. From left to right: the AGIPD, LPO and DSSC are shown. The individual absorption eddy current simulations by the respective detector生产商s’ companies are visible. Each detector simulation was simulated at different incidence angles: 0°, 20°, 30°, 45°, and 60°. Additional simulations were made to verify that the energy-dependent variation of efficiency is due to back scattering (reduction for large angles at small energies) and geometric length (enhancement for large angles at high energies).

X-ray Camera Simulation Toolkit: X-CSIT

As a result of our work on the European XFEL with University College London, we have developed the X-ray camera simulation toolkit X-CSIT (X-ray Camera Simulation Toolkit) which can simulate a complete X-ray camera system. X-CSIT is designed as a modular toolkit rather than a complete simulation, which will allow it to be used as a serial tool to be used in a wide variety of pixel detector and swap out modules for improved simulations if they become available.

Figure 6: Quantum efficiency and absorption graphs with 1000 photons per energy bracket. The positions of charge deposition, which was extracted from Geant4, passed back to the framework, then on to a python based and displayed using a matplotlib script. The plots are an example, demonstrating the simulation and data framework is working correctly.

X-CSIT: Current Status and Preliminary Results

Thus far, the framework for X-CSIT has been written and is undergoing testing. In addition, Geant4 has been integrated into the particle simulation framework and is communicating data back and forth.

As a further proof of concept the framework has been linked to the python interpreter and can pass data to it. The plots below were made with matplotlib, a python plotting library.

X-CSIT: Outlook

X-CSIT is still very early development and prototyping. Features still to be added include: a charge carrier simulation including charge spreading and noise effects, electronics simulation toolkit, an expanded Geant4 simulation toolkit that includes detector models and other libraries for setting libraries for visualization and analysis.

Lastly there are plans to validate X-CSIT using data taken by an early prototype of LPD, which took test data at the SLAC and PETRA II facilities early in 2013.

References