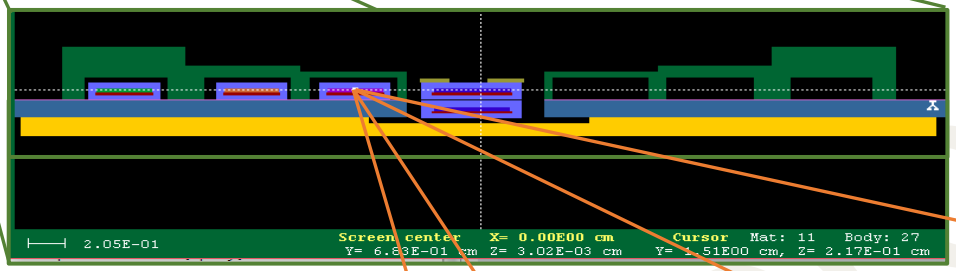
Monte Carlo Simulations for X-ray sensor development at RTI

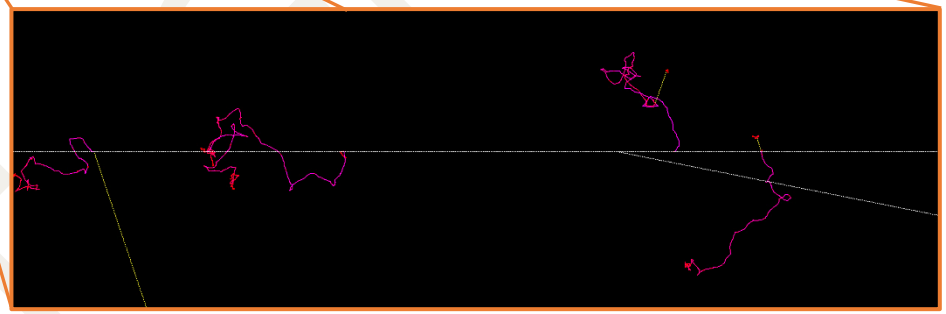
Any detector-layout and measurement setup may be expressed in terms of geometrical structures or voxels as obtained from 3D-CAD.

In a Monte Carlo simulation, interaction probabilities are used to predict the response of a detector upon irradiation with x-rays. All interactions depend on particle energy and medium.



An unknown x-ray spectrum is simply simulated when electrons with kV_p are accelerated towards an anode. Every medium described by physical properties and probability distributions for involved mechanisms.

Every γ-interaction (Photoelectric effect, Compton and Rayleigh scattering) deposits energy until particle is fully absorbed. Ionization of a semiconductor creates electron-hole-pairs that migrate through the substrate until collected at the electrodes. This generates a current that is proportional to the incoming radiation and subsequent deposition of energy.



Comparisons of measured and simulated currents are made for the Cobia geometry and W-spectra with 3mmAl total filtration and energies ranging from 40 to 140 kV_p.

The simulation assumes an ideal lattice structure and geometric efficiency. Diodes as used for the Cobia, have a decreased efficiency due to edge effects and lattice defects. These account for a 30% decrease in comparison to simulation. However, a collimator removes this factor as is shown by the central diode (chip#3).

Conclusively, simulated signal ratios are a powerful and reliable tool for the development of future x-ray sensors and measurement methods.