# cartesianDETECT2

Diksha Sharma and Aldo Badano

Center for Devices and Radiological Health
U.S. Food and Drug Administration

diksha.sharma@fda.hhs.gov

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## 1. Introduction

cartesianDETECT2 is a dedicated Monte Carlo optical transport code for modeling pixelated scintillator structures. It is based on DETECT2 (the optical transport code for MANTIS) but has been specifically tailored for use with pixelated detector structures.

The main developer of cartesianDETECT2 is **Diksha Sharma**, at the U.S. Food and Drug Administration. The source code is free and open software in the public domain, as explained in the Disclaimer section below. The reference to be used for citing this work is

D. Sharma, C. Sze, H. Bhandari, V. Nagarakar and A. Badano. Depth-of-interaction estimates in pixelated scintillator sensors using Monte Carlo techniques, submitted to Medical Physics, 2013.

This code is still under development; please report to the author any issue or bug that you may encounter. Feel free to suggest any improvements in the code too.

## 2. Disclaimer

This software and documentation (the "Software") were developed at the Food and Drug Administration (FDA) by employees of the Federal Government in the course of their official duties. Pursuant to Title 17,

## 3. Code input and output

`cartesianDETECT2` requires 18 command line arguments which specify the optical transport simulation parameters. They are (in order):

- X, Y detector dimensions (µm)
- Side and thickness of column (µm)
- Intercolumnar gap (µm)
- Refractive index of column and intercolumnar space
- Top surface absorption
- Bulk absorption (µm ^-1)
- Surface roughness coefficient
- Lower x, y PRF (Point Response Function) bounds (µm) for the image
- Upper x, y PRF bounds (µm)
- Pixel pitch (µm)
- Seed input for RNG
- Scintillation events file name (input)
- PRF file name (output)

- Radial response file name (output)

Apart from this, `cartesianDETECT2` also uses one input file to supply the information required to generate optical photons, and produces two output files.

Input file contains the energy deposition event information in terms of location in the detector (x, y, z) in µm and energy deposited (E) in eV. The number of optical photons are sampled using a Poisson distribution with a mean equal to the ratio of the energy deposited at each interaction location and the mean energy required to generate an optical photon in the CsI detector. Any available package can be used for doing the x-ray and electron transport, as long as it can give these energy deposition events. For the examples included, we used `PENELOPE 2006` with some modifications to `penEasy` main program to return the required energy deposition information per interaction event.

Output files: PRF (point response function) data and radial response on the PRF data.

Radial response on the PRF is calculated by aggregating the detected optical photons at the sensor plane in radial bins of 10 µm. To account for the change in the bin area moving outward, each bin is normalized by its area.