**EASYPET-EDUGATE SIMULATION TOOLKIT – INSTRUCTIONS**

**1. Install the EasyPET-EduGate Simulation Toolkit**

**Step 1.** Download **EasyPET-EduGate Simulation Toolkit codes** from Github

https://github.com/pmcorreia/easyPET-EduGate

Click on ‘Clone or download’ button on the right. Choose ‘Download ZIP’ (you can also download the codes using Git or SVN).

Make a working directory named ‘EasyPETSim’

Extract the ‘easyPET-EduGate-master.zip’ into the working directory.

Open a new terminal (Ctr+Alt+T), go to the master directory and compile the codes:

* cd EasyPETSim/easyPET-EduGate-master
* sh dependencies.sh

**Step 2. Install Anacoda and set environment**

Go to /tmp directory and install Anacoda following the instruction here

<https://www.digitalocean.com/community/tutorials/how-to-install-anaconda-on-ubuntu-18-04-quickstart>

After installing Anaconda, configure conda:

* conda create -n easyPET-simulations-environment python=3.5 pyqt=4 numpy scipy matplotlib scikit-image scikit-learn

Set environment (this step should be done each time you open a new terminal):

* conda activate easyPET-simulations-environment

**2. Running simulation and analysing data**

To start the EasyPET-EduGate Simulation Toolkit, you should go to the easyPET-EduGate-master directory and call the SimulationGUI:

* cd easyPET-EduGate-master
* python SimulationGUI.py

There are two menus in the GUI, Simulation and Data analysis as shown in Figures 1 and 3.

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Figure 1. Simulation menu on the EasyPET Simulation GUI

**Running simulation**

**Step 1: Select the output folder**

Click on the ‘Select simulation output’ button to choose an output folder.

Good practice: The output directory should be outside the ‘easyPET-EduGate-master’ folder for easily upgrading the codes in the future.

**Step 2: Select source**

Click on the ‘Select source file’ button and choose the necessary source file.

For examples, the source file ‘250um\_diameter\_10uCi\_1cmAcrylicNa22Source\_fast.py’ means there is a Na-22 source (10uCi, disk diameter of 250 um) placed in an acrylic holder (diameter of 1 cm). The simmulation starts with anihilation gammas (511 keV) instead of positrons from Na-22 for fast simulation.

**Step 3: Choose a source position**

Change the three coordinate position (x,y,z mm) next to the selected file name. The coordinate origin is at the center of the EasyPET machine as shown in Figure 3.

Example: (5, 0, 0) means the source is at the position (x = 5 mm, y = 0 mm, z = 0 mm)

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| SP5700 photo  (A) | |
| (B)  Fan rotation axis  Axial rotation axis | **Detector 1**  **Detector 2**  (C) |

Figure 2. (A) EasyPET kit, (B) Rotation axes, (C) Ratation angles [1].

**Step 4: Choose EasyPET angle parameters**

**Step top:** the angular increments in the fan rotation of Detector 1 (9°)

**Top scan range:** the angular arc covered by the rotation of Detector 1 (45°)

**Step bottom:** the angular increments in the axial rotation of Detector 2 (9°)

**Time per LOR:** simulation time for each LOR in ns (10 ms)

**Number of turn:** the number of turns of Detector 2

**Step 5: Run simulation**

Click on the ‘Start Simulation’ button, and check the error files in the output folder.

It takes time to finish the simulation (30 minutes or more depends on the configuration of the virtual machine)

When the simulation finishes, there is no message either on the GUI or the terminal. You should compare the time of the ‘easyPETSimulationGate.out’ file with the time of the machine. If the ‘easyPETSimulationGate.out’ file keeps updating, the simulation is running.

When the simulation stops, the ‘easyPETSimulationGate.out’ will end with the line, ‘Visualization Manager deleting ...’. The simulation data are stored in ‘easyPET.root’ file.

**Analysing Data**

**Step 1: Open the root file from the simulation**

Click ‘Select results file’ and looking for the simulation root file ‘easyPET.root’

**Step 2: Choose parameters for image reconstruction.**

**Filter type:** the filter for image processing. It could be None/ramp/shepp-logan/cosine/hamming/hann

**Interpolation:** the algorithm to interpolate data for image reconstruction, linear/nearest/cubic.

**Pixel size (mm):** 0.1/0.25/0.5/1/2

**Gauss filter:** the parameter for a Gauss filter in FBP

**Colormap:** color maps for visualization (sinogram and reconstructed image)

**Coincidence window (ns):** the time window to select coincidence events

**Energy window (keV):** the energy window of selected events

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Figure 3. Data Analysis Menu

**Step 3: Data analysis and image reconstruction**

Click on the ‘Start Analysis’ to run the analysis program.

A sinogram and the reconstructed image will be shown on the left pad, and the energy spectrums of the annihilation gammas are shown on the right pad.

**References**

1. CAEN 2018 SP5700 EasyPET Guide, <https://www.caen.it/products/sp5700/>

2. Correia, Pedro Manuel Mendes, et al. "An EDUGATE simulation toolkit based on the educational easyPET." *Biomedical Physics & Engineering Express* 5.2 (2019): 025009.