STIR-GATE-Connection v1.0

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What is GATE?

"GATE is an advanced opensource software developed by the international OpenGATE collaboration and dedicated to numerical simulations in medical imaging and radiotherapy."*

Based upon the GEANT4** simulation toolkit's well-validated high energy physics models.

Advanced emission tomography tools allow for the construction of scanners and insertion of positron emission sources and attenuation voxelised phantoms.
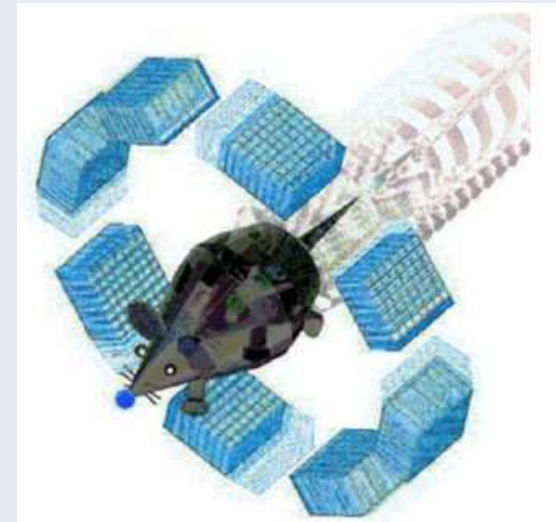
Geant4 Application for Emission Tomography
a simulation toolkit for PET and SPECT*

*http://www.opengatecollaboration.org/
**https://geant4.web.cern.ch/

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How to use the STIR-GATE-Connection

1. [Optional] Create a Voxelised Phantom from a parameter file using STIR functionality

2. Setup and run GATE simulations in cluster array jobs

3. Combine and Unlist ROOT files

4. Compute Data Corrections for Reconstruction using STIR

https://github.com/UCL/STIR-GATE-Connection
https://github.com/UCL/STIR-GATE-Connection/blob/master/VoxelisedSimulation/ExampleSTIR-GATE.sh

SetupSimulation.sh

PrepareScannerFiles.sh:
Currently two example scanners
- Siemens mMR
- GE Discovery 690

GenerateSTIRGATEImages.sh:
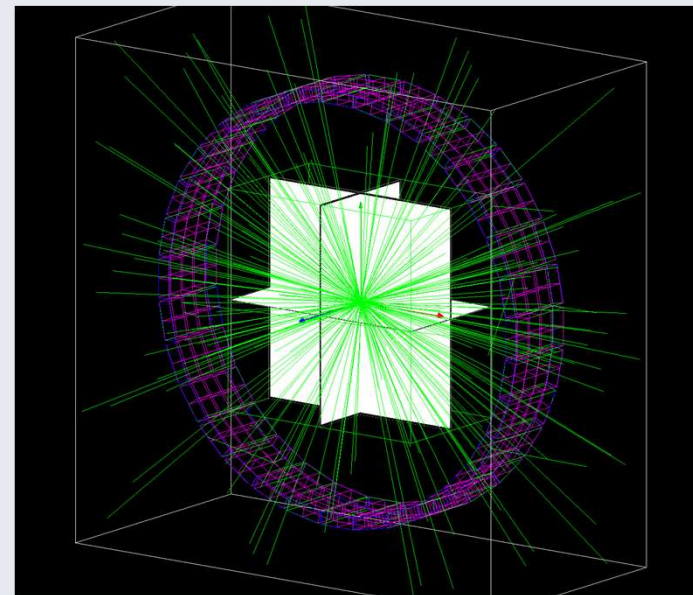- Create using STIR and *.par files
- Modifies attenuation to type int.

Gate SetupDmap.mac
- Creates density
  map

https://github.com/UCL/STIR-GATE-Connection/blob/master/VoxelisedSimulation/SetupSimulation.sh   4

CheckGeometry.sh

Gate –qt to visualize:

- Scanner geometry

  (crystals, blocks, buckets)

- Phantom *(check position)*

- Emission photons

Emission profile of a point source at the center for the scanner

RunGATE.sh

Computes many GATE variables from interfile headers

Sets the central voxel of the activity and attenuation volumes to the center of the scanner

Sets correct voxel sizes

Sets correct number of voxels

AUTOMATICALLY FROM THE HEADERS

Simulations run with a unique *${TASK_ID}*

https://github.com/UCL/STIR-GATE-Connection/blob/master/VoxelisedSimulation/RunGATE.sh

Automatic Centring
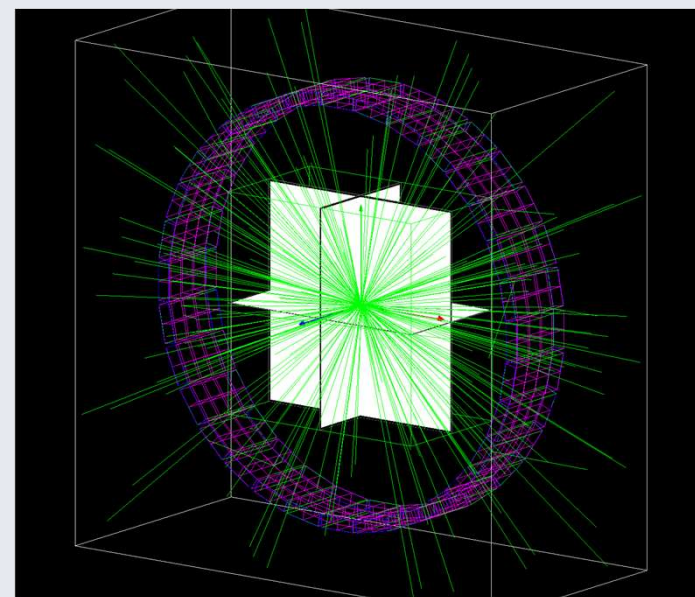
SourceSingleCentralVoxel.par

```
1   generate_image Parameters :=
2   output filename:=activity
3
4   X output image size (in pixels):=110
5   Y output image size (in pixels):=110
6   Z output image size (in pixels):=65
7   X voxel size (in mm):= 4
8   Y voxel size (in mm):= 4
9   Z voxel size (in mm):= 4.0625
10
11     Z number of samples to take per voxel := 1
12     Y number of samples to take per voxel := 1
13     X number of samples to take per voxel := 1
14
15  shape type:= ellipsoid
16  Ellipsoid Parameters:=
17     radius-x (in mm):=2
18     radius-y (in mm):=2
19     radius-z (in mm):=2
20     origin (in mm):={130,0,0}
21     END:=
22  value :=10000
23
24  END:=
```

sourcePosX.mean
= -0.0015 mm

sourcePosY.mean
= -0.057 mm

sourcePosZ.mean
= -0.013 mm

Emission profile of a point source at the center for the scanner

https://github.com/UCL/STIR-GATE-Connection/blob/master/ExamplePhantoms/STIRparFiles/SourceSingleCentralVoxel.par

UnlistRoot.sh

Two sets of ROOT file output: Coincidences and Delayed

lm_to_projdata: Unlists ROOT file into sinograms using template *.hroot* and *.hs* files

Two methods of unlisting the output of cluster array jobs

1. Combine *.root* files and unlist   2 . Unlist in job, sum sinograms

Users choice!

https://github.com/UCL/STIR-GATE-Connection/blob/master/VoxelisedSimulation/SubScripts/UnlistRoot.sh

Data Corrections

EstimateGATESTIRNorm.sh: Script is used to compute the Geometric/Efficiency Normalisation Factors between GATE and STIR.

EstimateRandomsFromDelayed.sh: Estimates the contribution of Random Coincidences from GATE Delayed Coincidences.

EstimateScatter.sh: Estimates the contribution of Scatter Coincidences. *(PR)*

Each of these use STIR utilities.

https://github.com/UCL/STIR-GATE-Connection/blob/master/VoxelisedSimulation/SubScripts/EstimateGATESTIRNorm.sh
https://github.com/UCL/STIR-GATE-Connection/blob/master/VoxelisedSimulation/SubScripts/EstimateRandomsFromDelayed.sh
https://github.com/UCL/STIR-GATE-Connection/pull/50

Future work

- Validation methods
  - Point source
  - Oblique plane

- More scanner geometries

- Automatic creation of GATE scanner geometries from STIR interfile headers

- Improve documentation

Contributions, Comments and Feedback are Encouraged!

Any Questions?

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