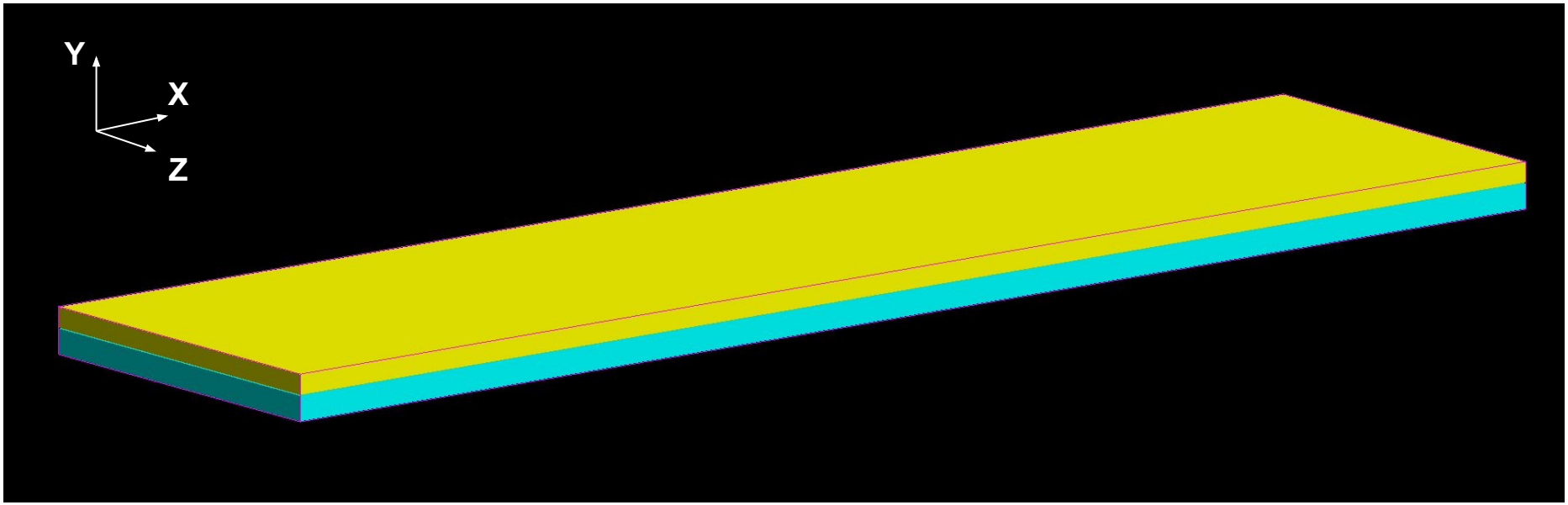
GATE simulation

LYSO-200um_Plastic-250um

Scintillator tiles

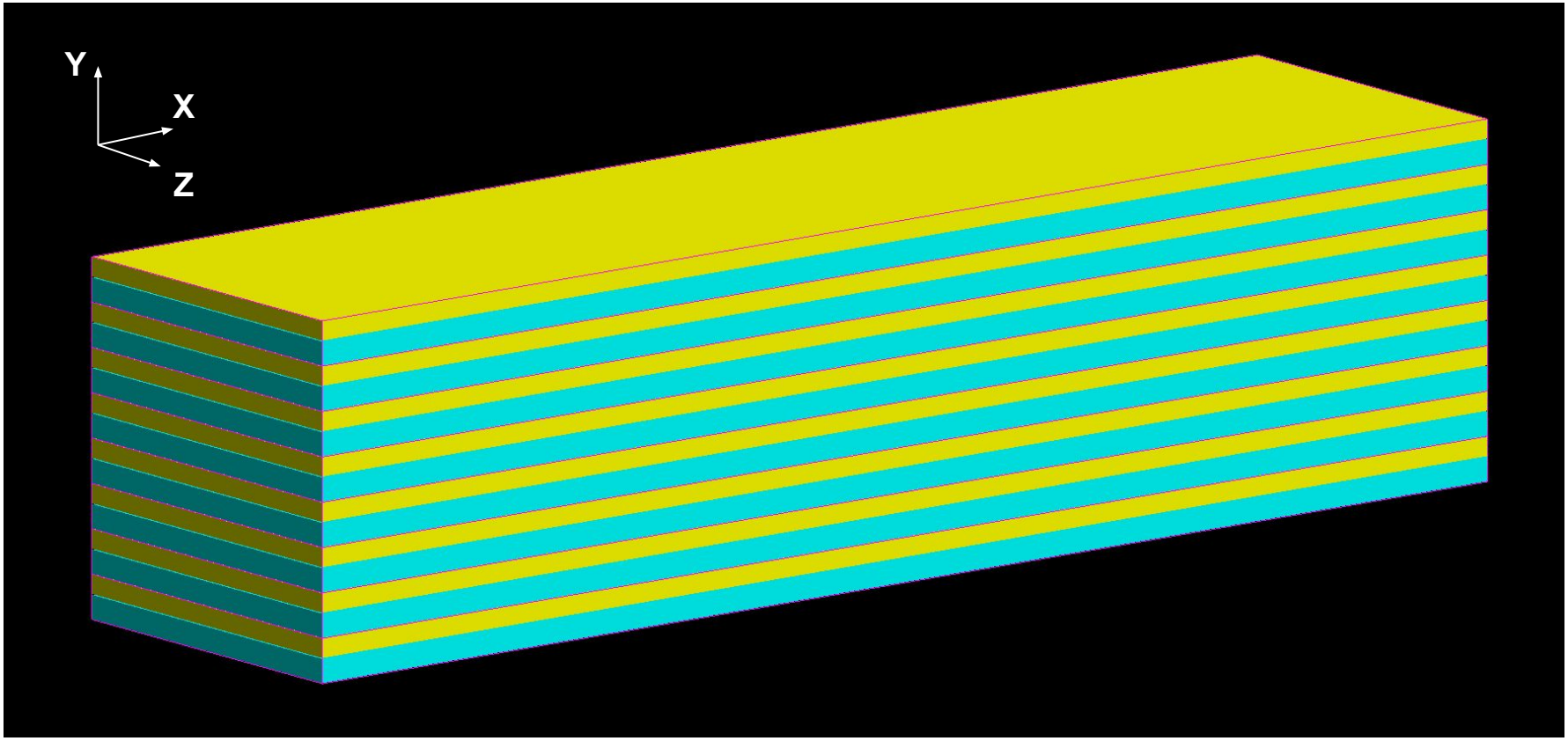
- **LYSO (yellow):**
  - 15 mm x 0.20 mm x 3.75 mm
  - d = 7.1 g/cm3
  - GATE “layer 0”
- **Plastic (cyan):**
  - 15 mm x 0.25 mm x 3.75 mm
  - d = 1.18 g/cm3
  - GATE “layer 1”

Stacking



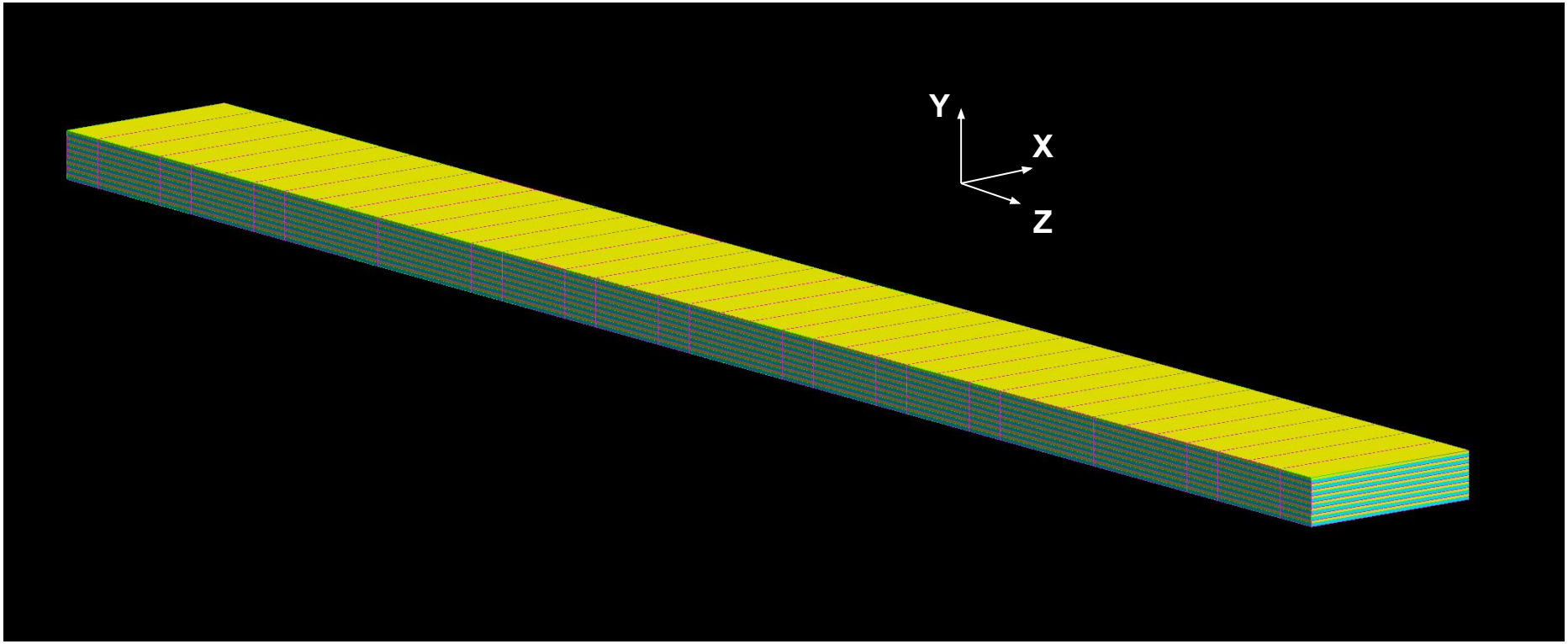
- 1 Plastic and 1 LYSO volume stacked together
  - 10 microns gap (air) between volumes
  - In GATE, these two together define a “crystal” (magenta)

A pixel



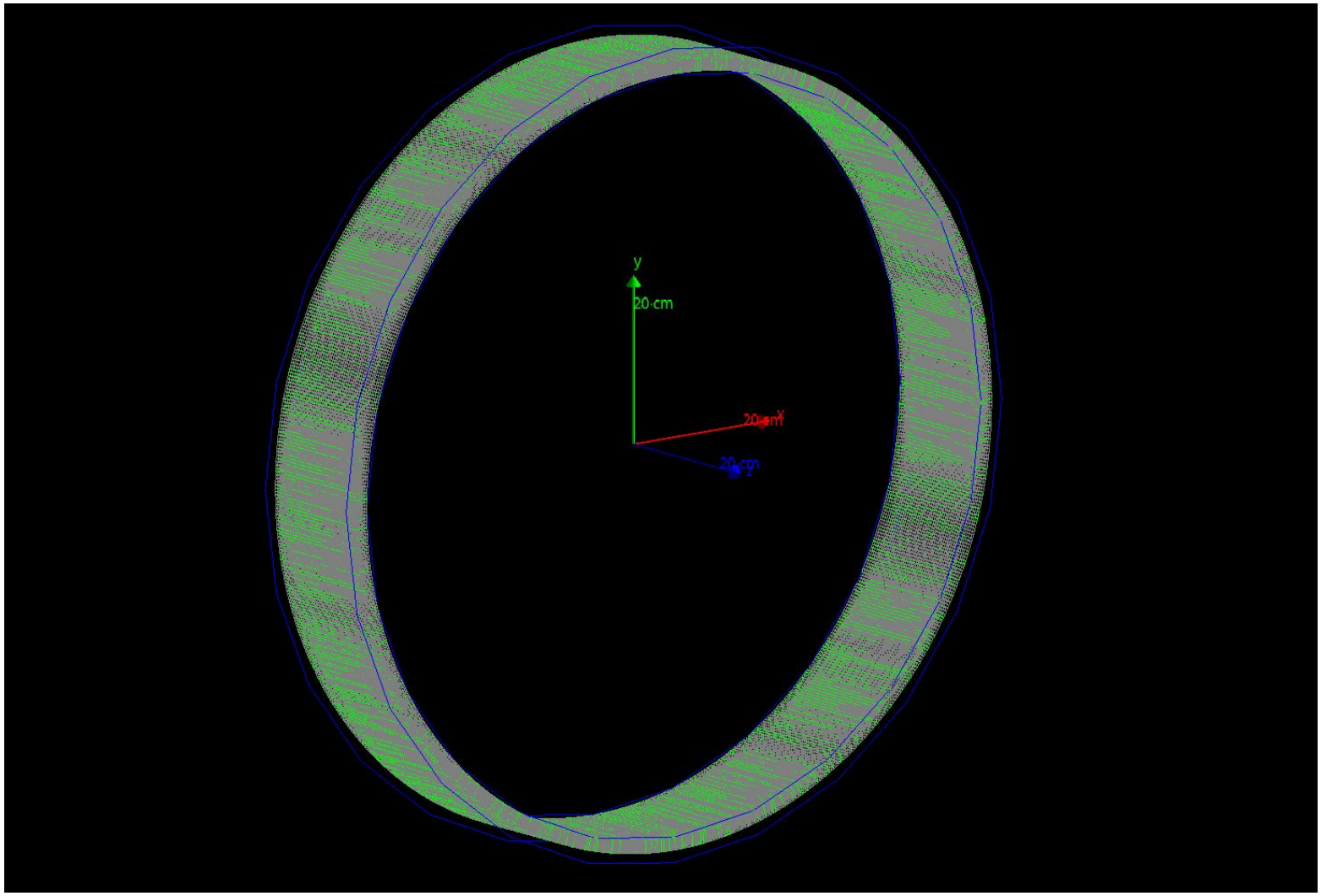
- A repetition of 8 “GATE crystals” in y direction
  - Gap of 10 microns between “GATE crystals”
  - Total volume 15 mm x 3.76 mm x 3.76 mm
  - In GATE, this is a “module”
  - The **digitizer adder** is set to the module depth (setDepth 2)

rsector



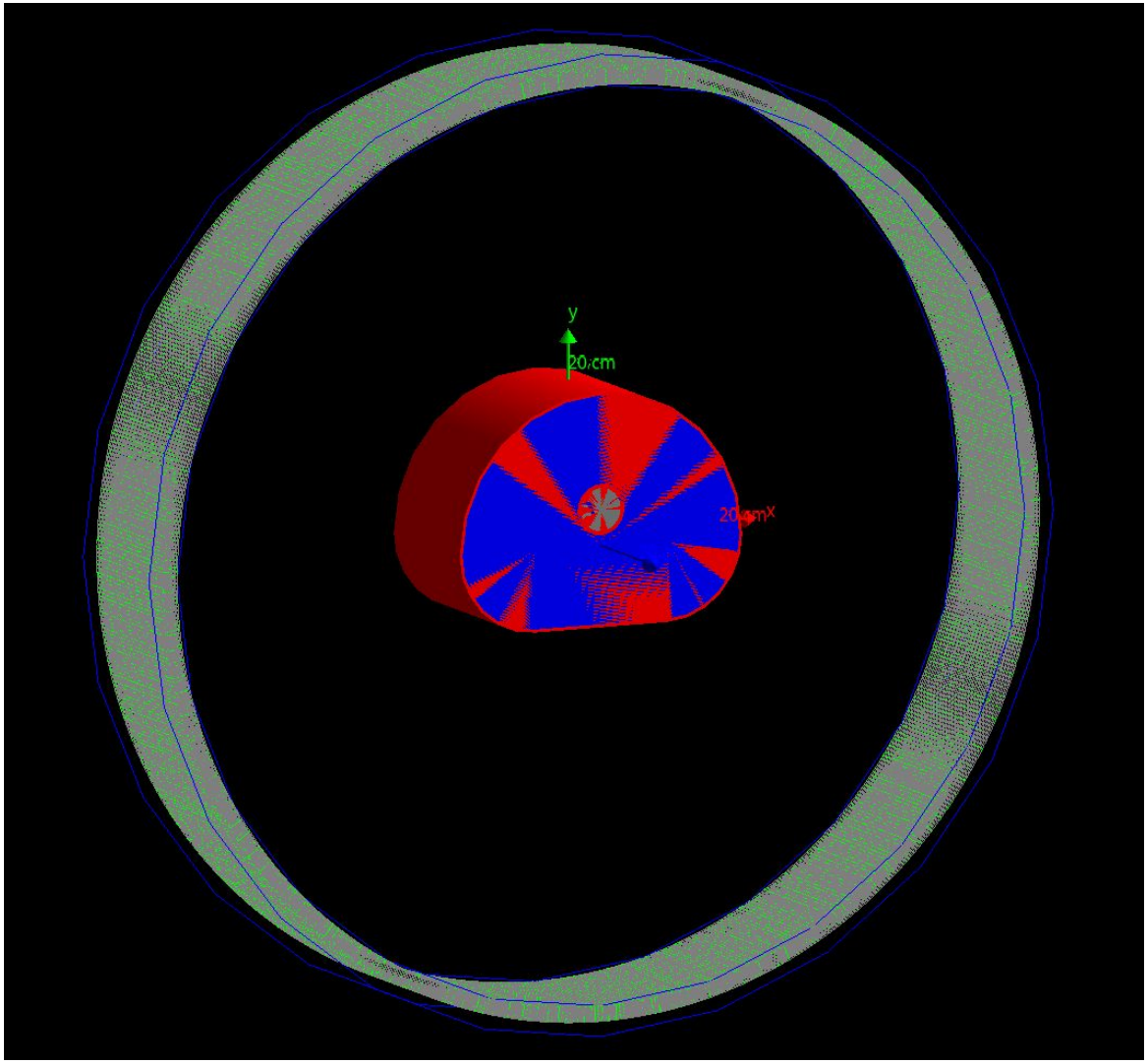
- A repetition of 40 “GATE modules” in z direction
  - Gap of 10 microns between “GATE modules”
  - Total volume 15 mm x 3.76 mm x 150.4 mm

Scanner



- Ring of 751 rsectors, rmin 45 cm

Scanner + source



- NEMA IQ phantom (provided by Nikos)

Physics and cuts

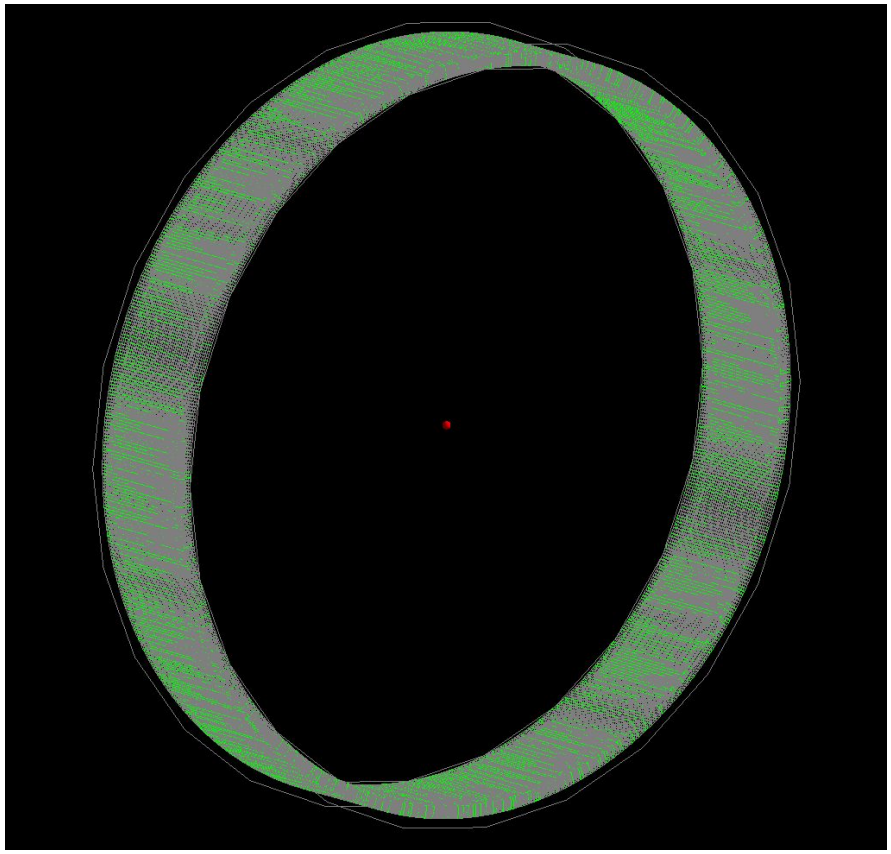
```
/gate/physics/addPhysicsList emstandard_opt3
# /gate/physics/addProcess DecayPhysics
/gate/physics/addProcess PositronAnnihilation  e+
/gate/physics/addProcess RadioactiveDecay

/gate/physics/processList Enabled
/gate/physics/processList Initialized

#
#      C U T S
#
# Cuts for particles
/gate/physics/Gamma/SetCutInRegion      world {cut} um
/gate/physics/Electron/SetCutInRegion   world {cut} um
/gate/physics/Positron/SetCutInRegion   world {cut} um
```

- Short production cuts allow sharing of energy between tiles
- Cuts can be defined at run time with command line parameter (see instructions on github)

Test for cuts and energy sharing



- “Phantom” = Plastic sphere, 5 mm radius
- Placed in center of FOV
- Source = sphere, 1 mm radius, center of “phantom”
- 43 MBq ^{18}F e^{+} iso source

Production cuts

Production cut [μm]	Coincidences (en. > 400 keV)	Fast events [%]	Disk space [GB]	Total CPU time [h]
	For ~2 GATE seconds			
1000	73789	0.689	2.2	8.9
100	64408	15.72	15.2	23.5
75	64780	16.04	16.5	23.5
50	64410	16.15	18	22.7
25	63980	16.81	19	25
10	64075	16.91	20	27.1
5	64533	17.42	20.5	29.5
1	64401	17.08	43	110.1

- Quick test on lxplus (200 jobs x cut)
- Analysis on GATE **Hits:**
  - Coincidence = same eventID, more than 400 KeV in 2 “GATE modules” (our crystals)
  - Fast events = both crystals with > 10 keV deposited in the Plastic material
- Results are ok for cuts < **25-10** micron

Fast and slow coincidences

- Fixing production cuts at 25 microns

- Definitions:
  - Fastest = > 10 keV deposited in Plastic in both crystals involved in coincidence
  - Fast = > 10 keV deposited in Plastic in just 1 crystal involved
  - Standard = < 10 keV deposited in Plastic in both crystals involved in coincidence

- Percentages:
  - Fastest = 16.81%
  - Fast = 48.34%
  - Standard = 34.85%

Digitizer

```
/gate/digitizer/Singles/insert adder
/gate/digitizer/Singles/insert readout
/gate/digitizer/Singles/readout/setPolicy TakeEnergyWinner
/gate/digitizer/Singles/readout/setDepth 2

/gate/digitizer/Singles/insert thresholder
/gate/digitizer/Singles/thresholder/setThreshold 300. keV
/gate/digitizer/Singles/insert upholder
/gate/digitizer/Singles/upholder/setUphold 700. keV

/gate/digitizer/name Coincidences
/gate/digitizer/insert coincidenceSorter
/gate/digitizer/Coincidences/setWindow 0.1 ns
/gate/digitizer/Coincidences/minSectorDifference 1

/gate/digitizer/Coincidences/MultiplesPolicy takeAllGoods
```

- Readout depth defined at module level (it’s out crystal element)
- What is a suitable coincidence window?