



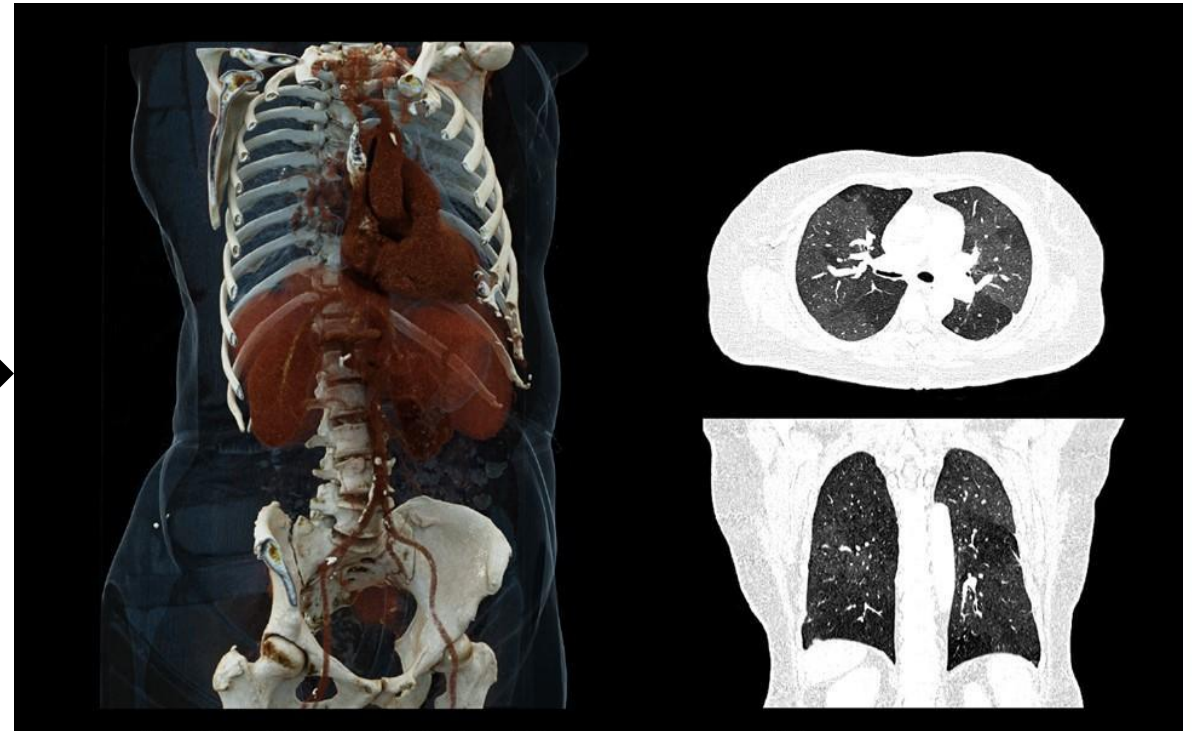
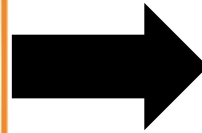
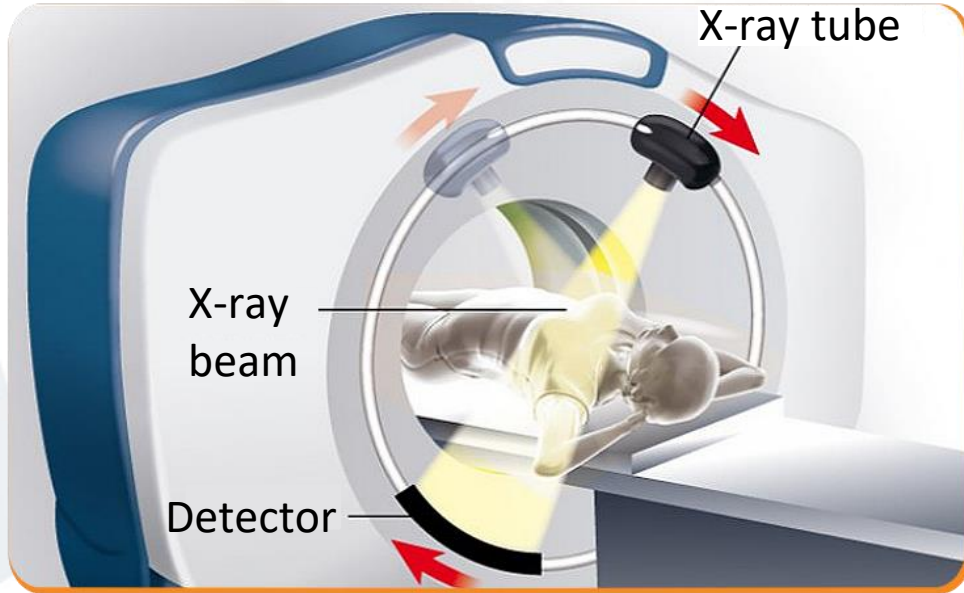
Simulation of a clinical CT scanner using GATE 10



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CT scanners basics



[NAEOTOM Alpha - Applications pulmonaires](#)

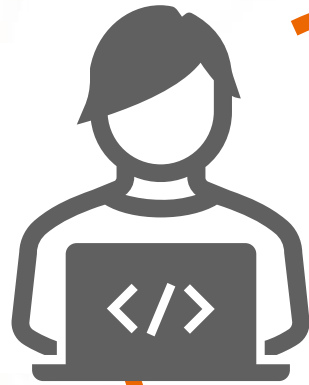
[- Siemens Healthineers France \(siemens-healthineers.com\)](#)

[Votre scanner | Société d'Imagerie Médicale Bois-Bernard \(ramsaysante.fr\)](#)

Objectives with Monte Carlo tool

Monte Carlo CT scanner simulation with new GATE 10

- Python
- Many libraries (Numpy, Matplotlib...)
- One script



Real CT scanner

- Dosimetry
- Image reconstruction



Protocols optimisation

Geometry example: QC phantom

```
CTDI_ph = sim.add_volume("Tubs", "CTDI_ph")  
CTDI_ph.mother = "vol_rot"  
CTDI_ph.rmin = 0 * cm  
CTDI_ph.rmax = 16 * cm  
CTDI_ph.dz = 7.25 * cm  
CTDI_ph.material = "IEC_PLASTIC"
```



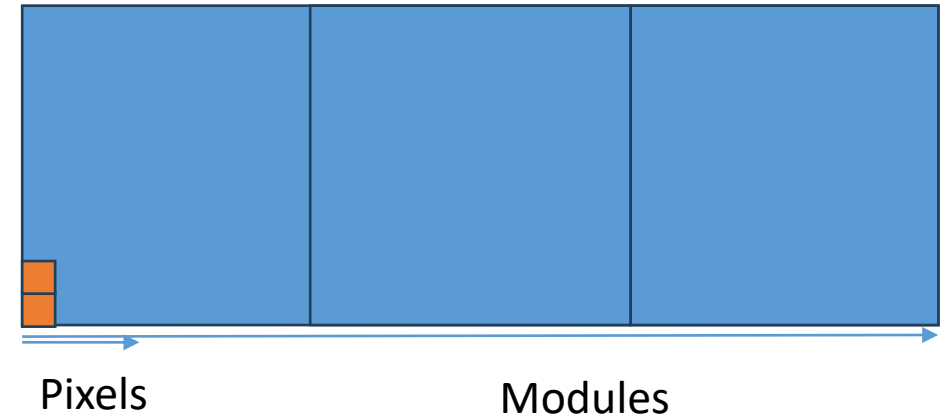
CTDI phantoms

Geometry example: EID's detector

```
pixel = sim.add_volume("Box", "pixel")  
pixel.mother = module.name  
pixel.size = [1 * mm, 1 * mm, 1 * mm]  
pixel.translation = None  
pixel.rotation = None  
pixel.material = "UFC"
```

```
pixel_tr = gate.geometry.utility.get_grid_repetition(  
[20,1,32], spacing=[1 * mm, 1 * mm, 1 * mm]  
)
```

```
pixel.translation = pixel_tr
```



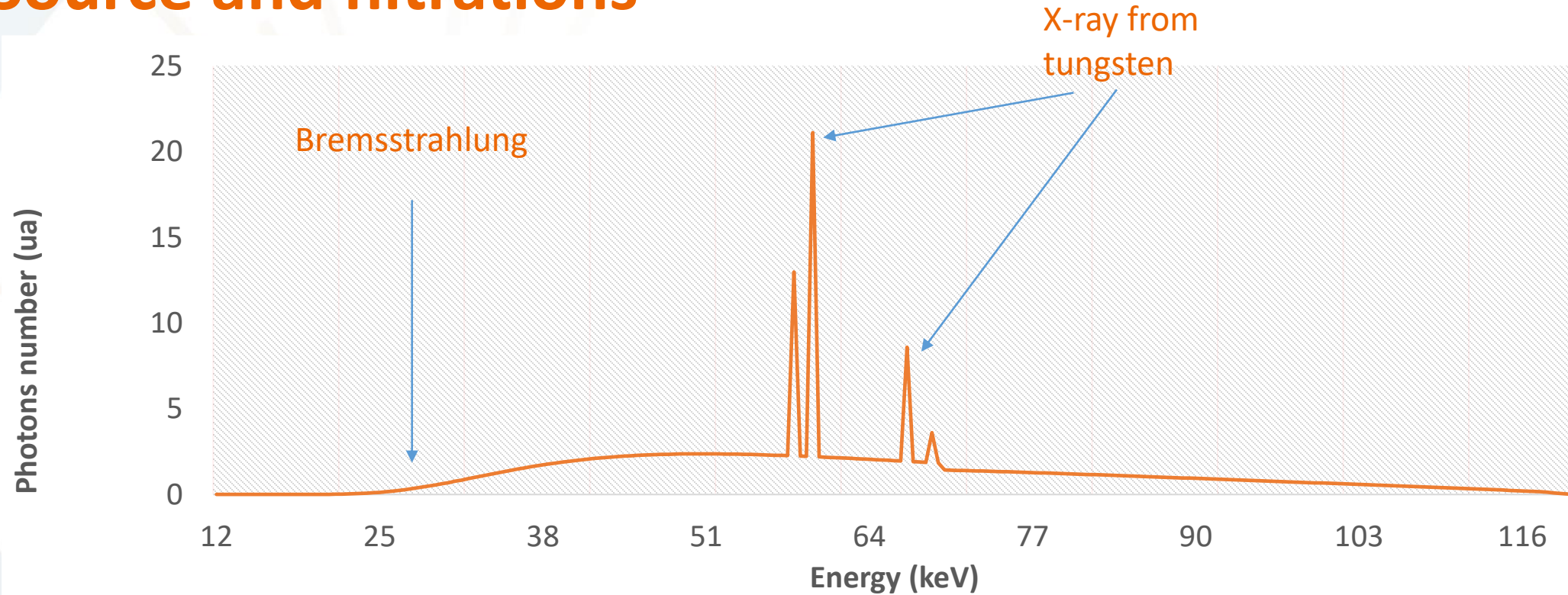
Physics

```
sim.physics_manager.physics_list_name = "G4EmStandardPhysics_option"
```

```
sim.physics_manager.set_production_cut("CTDI_ph", "gamma", 10 * um)
```

```
sim.physics_manager.set_production_cut("CTDI_ph", "electron", 10 * um)
```

Source and filtrations



Input Gate 10: SpekPy^{1,2,3}

Technical data

Compton diffusion measurements

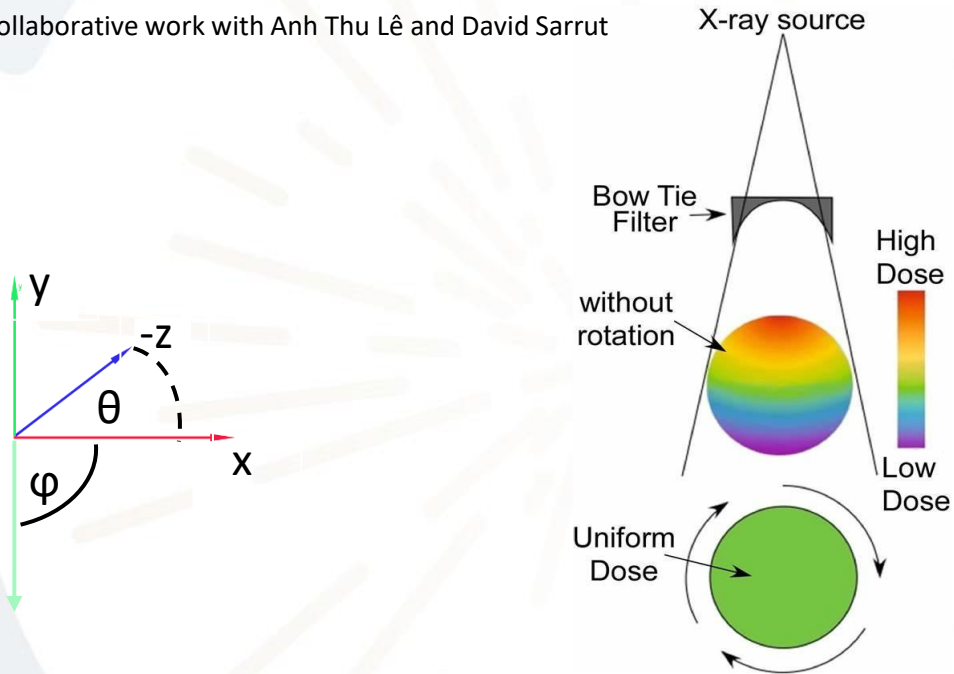
[1] Med Phys. 2007 34(6):2164-74

[2] Med Phys. 2007 34(6):2175-86

[3] Phys Med Biol. 2009 54(19):433-38

Bow Tie filter / angular distribution feature

Collaborative work with Anh Thu Lê and David Sarrut



```
source.direction.type = "histogram"
```

```
source.direction.histogram_phi_weight = [0, 0.3, 0.5, 1, 0.5, 0.3 ...]
```

```
source.direction.histogram_phi_angle = [60 * deg, 70 * deg, 80 * deg ... ]
```


Actor

Edep and Dose

Dose inside CTDI phantom, organs for anthropomorphic phantoms...

Digitizer

Hits and single to store energy deposition inside voxels...

Statistiques

Informations concerning the simulation

Motion actor

...

Analysis

Dose

Dose inside CTDI phantom, organs for anthropomorphic phantom

Image reconstruction

Projections → Numpy, Pandas

Images → RTK etc..



...

Conclusion and demo

- Bow Tie filter effect modelisation in GATE 10
- Python workflow for CT scanner Monte Carlo simulation and analysis