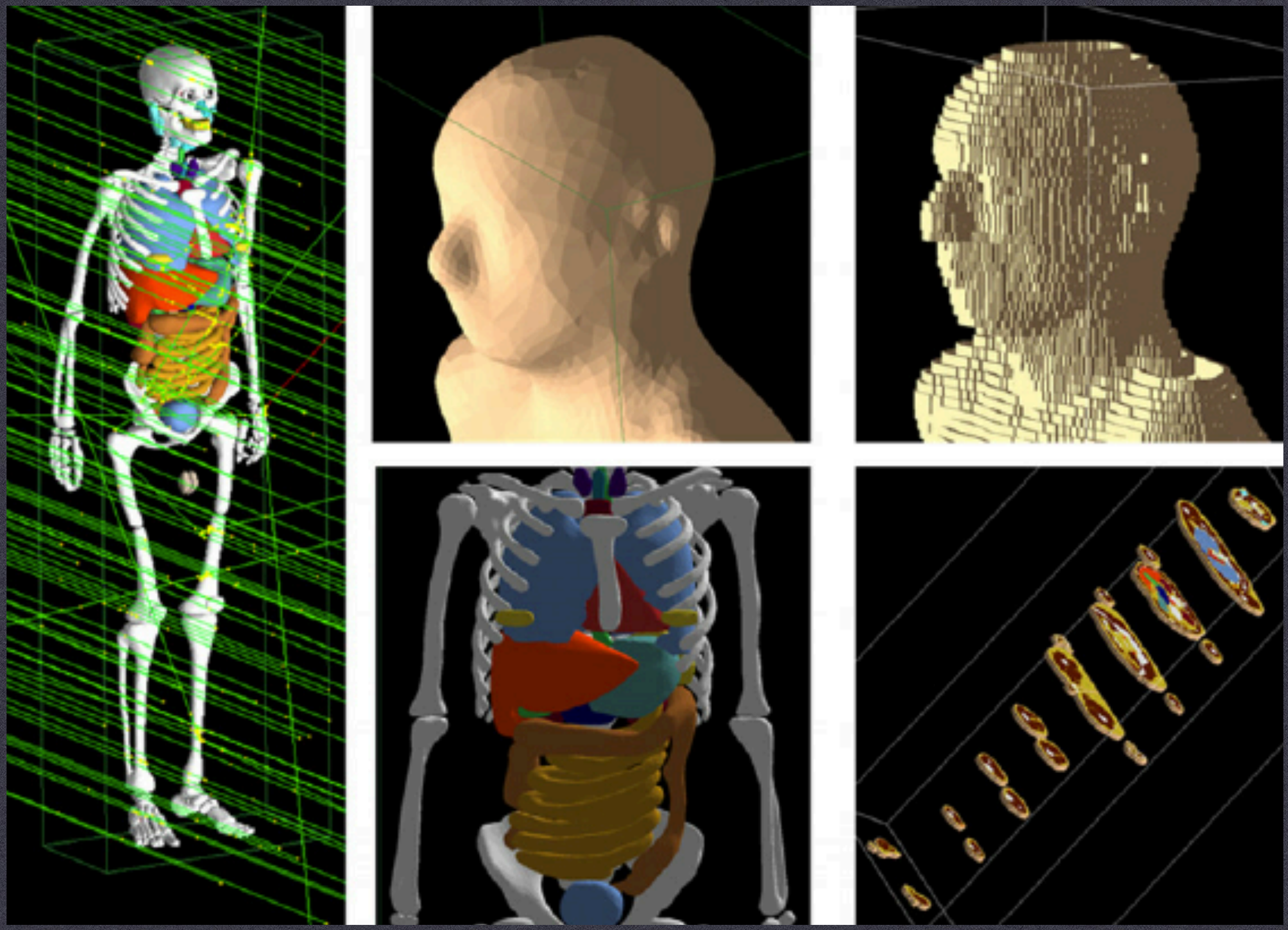


GEANT4

HUMAN PHANTOM EXAMPLE

Overview

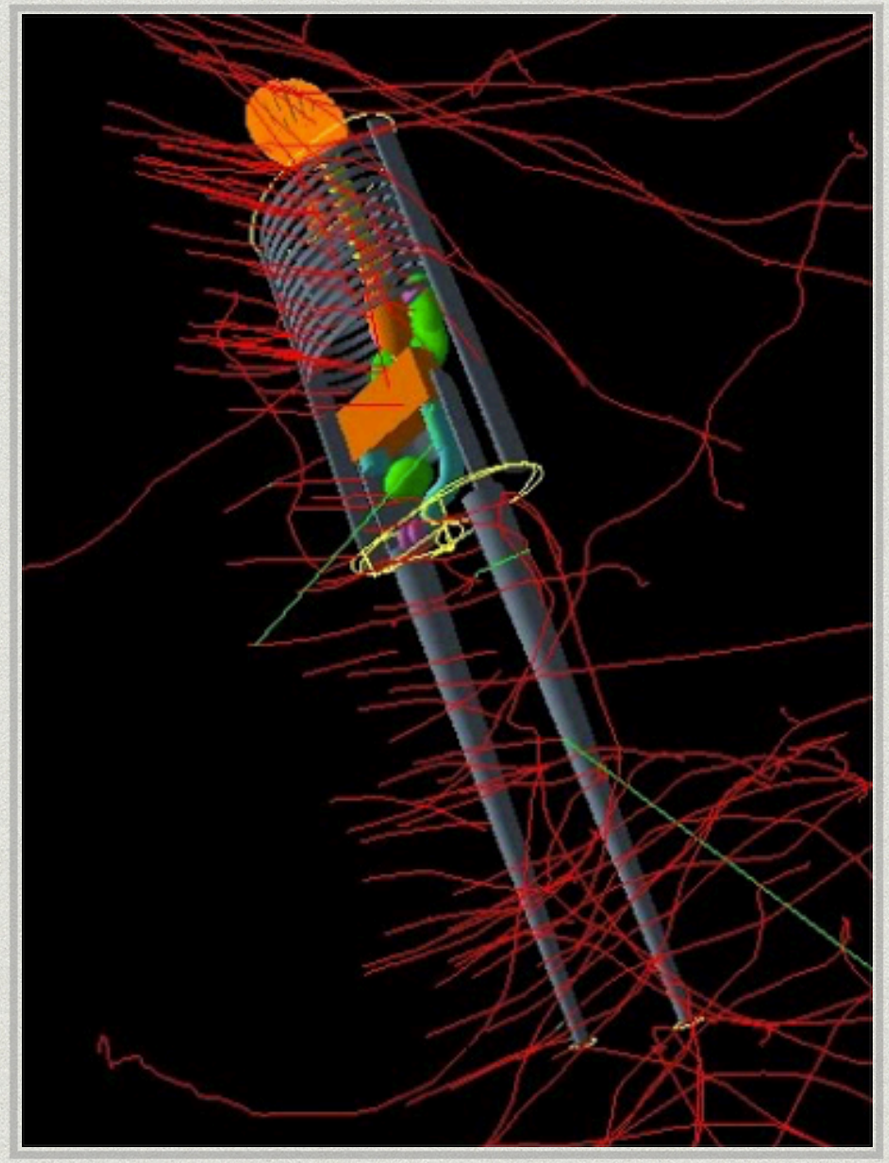
- Human organs simulated using a simplified geometry
- Male and female phantoms available
- Placed inside a radiation field
- Can be used to estimate the dose in each organ
- Study the use of a shielding volume (e.g. SS, Pb) to protect the phantom and check reduction in dose

Steps to run the simulation

- Get the zipped file from here, unzip it and copy the folder to the ~/docker/geant4 folder
- Open a terminal, go to the geant4 folder and start the docker container:
  - **`cd ~/docker/geant4`**
  - **`source setup_docker.sh`**
  - **`source run_docker.sh`**
- You are now inside the docker container. Go to the simulation folder:
  - **`cd /usershared`**
  - **`source config.sh`**
  - **`cd human_phantom`**
- Compile and run the simulation
  - **`make`**
  - **`phantom`**

Running the simulation

- The macro **default.mac** controls the simulation in interactive mode
- Try the various phantoms available (the ORNL ones will not work)
- **primary.mac** is were the primary particles are defined
- Default is a field of 1 MeV electrons
- Run a few events with **/run/beamOn 100**



Analysis

- When exiting the simulation, information about the amount of energy deposited in each organ is printed out
- There is also a root file which we can use for analysis: **human_phantom.root**
- We need statistics to do a proper analysis. There is a **batch.mac** macro to run the simulation without visualisation
- Run the simulation with 1M events
- Open root and run the macro.C script:
  - **root -l**
  - **.x macro.C**

Exercise 1

- Run the simulation with a field of gammas instead of electrons, compare the results
  - Both in terms of total absorbed energy and organs affected

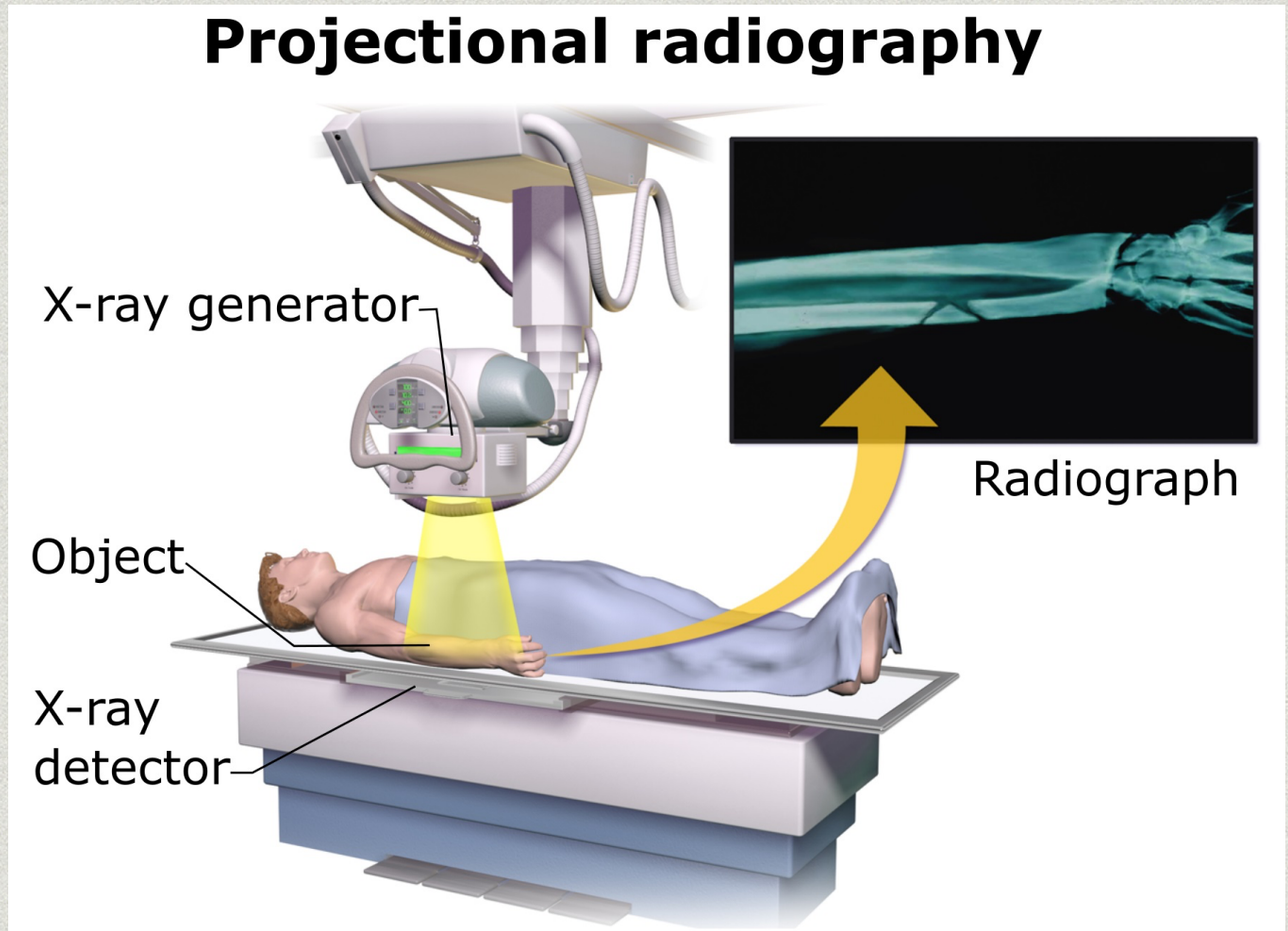
Exercise 2

- Now we will place a Stainless Steel shield above the phantom
- Edit file **G4HumanPhantomConstruction.cc** inside the **src** folder (line 237) to use stainless steel (**SS)** as the material for the shield
- Recompile the simulation (**make**)
- Note that the default shield is only 1 mm thick
- Repeat the study from Exercise 1, compare the effect of the shield for both electrons and gammas. What can you conclude?
- Improve the shield to make it more efficient for gammas:
  - make it thicker (e.g. 3 cm)
  - user a denser material (Lead, Tungsten)

Exercise 3

- Modify the analysis script to show dose instead of deposited energy
- Hint: the mass of each organ is printed at the start of the simulation
  - To save you some time I've already copied them to the file organs.txt

Exercise 4



- Let's try to simulate a full body X-ray
- Modify the geometry so that the shield is placed behind the phantom (1 mm, use air as material) — this will be our detector
- Modify the source definition: use a field of X-rays (we can try different energies and check what's best — 100, 250, 500 keV)
- We need to "hack" the simulation, and modify the SteppingAction to store information about the X-rays that reach the "detector"