Hands-On on physics

« microbeam »

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microbeam

- This example is a specific application demonstrating how to simulate a cellular irradiation beam line
  - This is a real life setup, available at the Centre d'Etudes Nucléaires de Bordeaux-Gradignan, in France

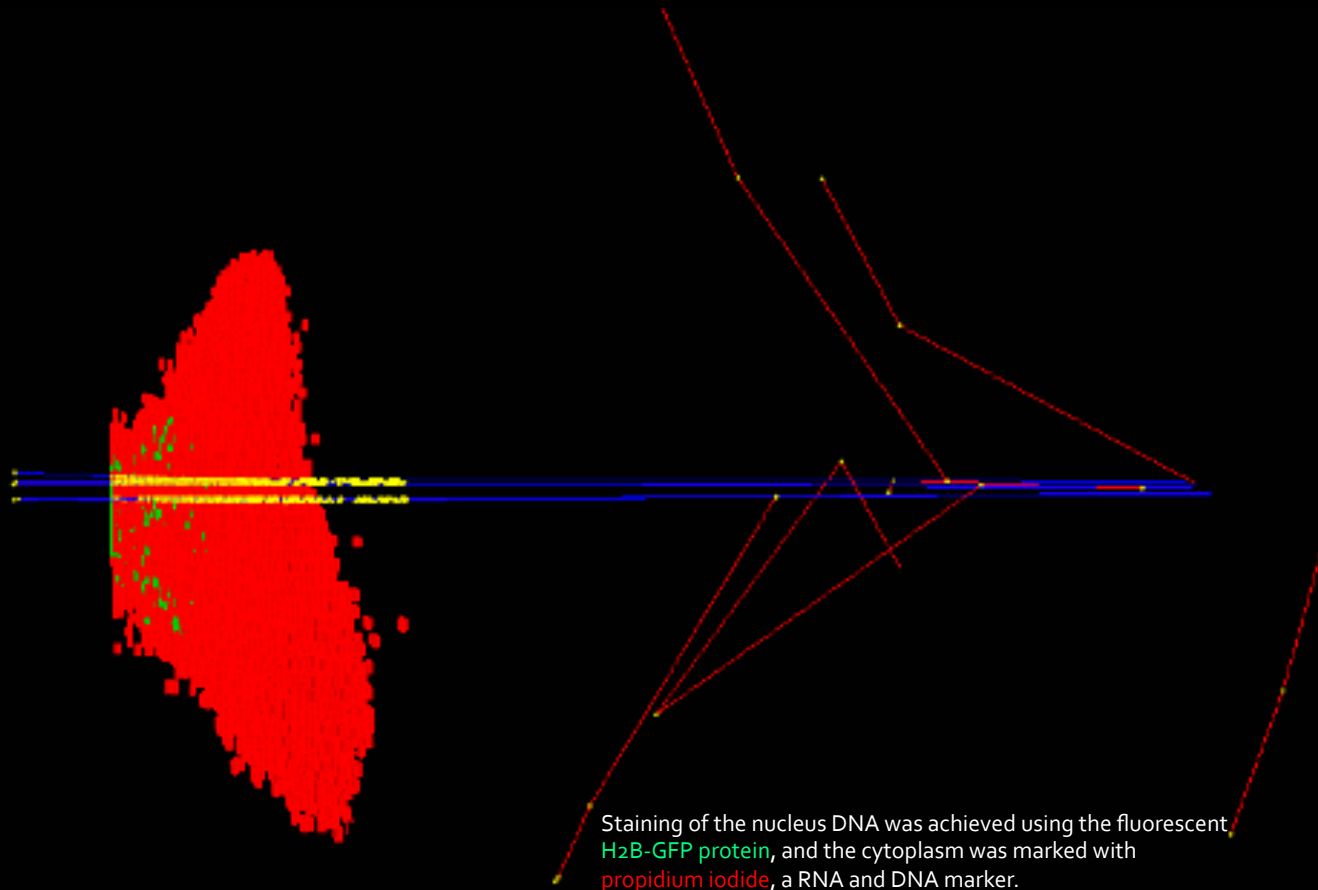- This is an advanced example and it is located in $G4INSTALL/examples/advanced

Experimental setup

Schematic view of the CENBG five AIFIRA beam lines

View of the CENBG microbeam line
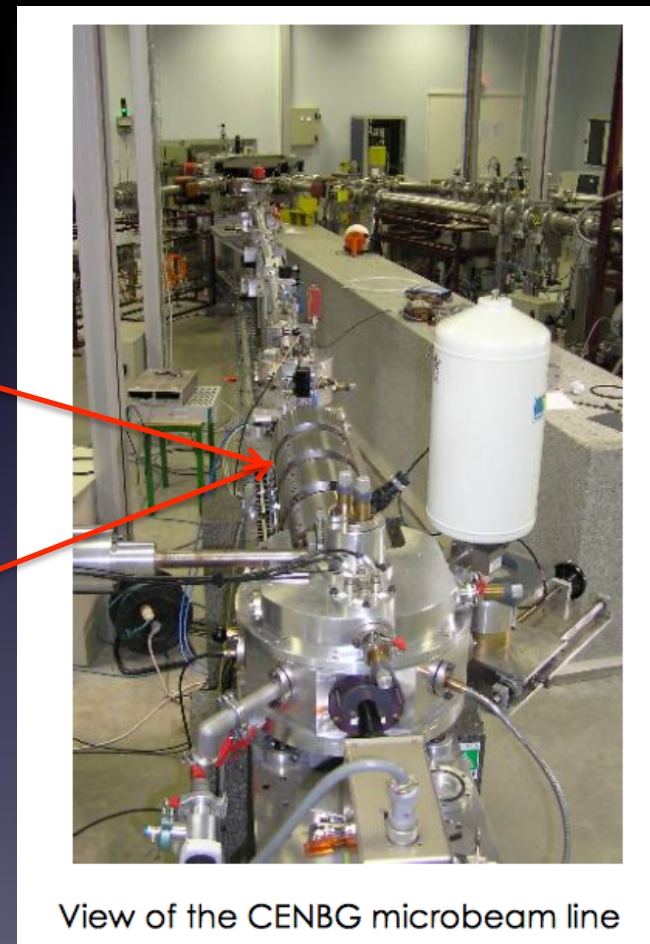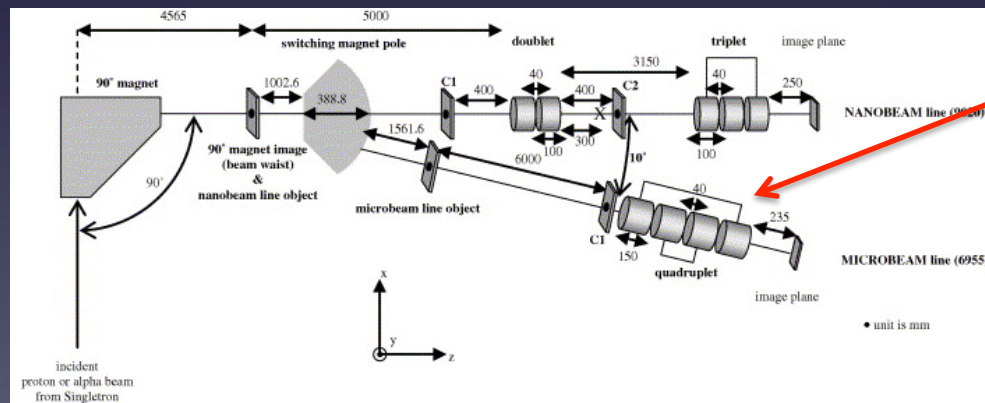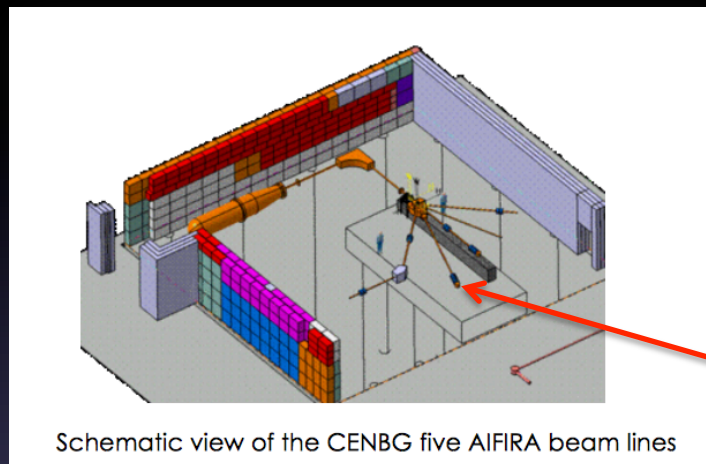
microbeam

- This example is not specific to Geant4-DNA but demonstrates features in link to radiobiology:

  – How to implement a realistic beam line
    - A switching dipole magnet with fringing field, to deflect by 10° the 3 MeV alpha beam generated by the electrostatic accelerator into the microbeam line, oriented at 10 degrees from the main beam direction;
    - A circular object collimator, defining the incident beam size at the microbeam line entrance; the collimator has been simulated from realistic electron microscopy images;
    - A quadrupole based magnetic symmetric focusing system allowing equal transverse demagnifications of 10. Fringe fields are calculated from Enge's model.
    - A dedicated cellular irradiation chamber setup, taking into account all the elements encountered by the incident beam (diaphragm, gas detector, isobutane, beam extraction window, air, culture foil, culture medium, cell dish...) ;
    - A set of horizontal and vertical electrostatic deflecting plates which can be turned on or off to deflect the beam on target;

  – How to implement a realsitic 3D cellular phantom: a realistic human keratinocyte voxellized cellular phantom observed from confocal microscopy and taking into account realistic nucleus and cytoplasm chemical compositions. The phantom uses the G4PVParameterised class.

  – How to calculate energy deposition in the cell.

A HaCat cell in Geant4

Staining of the nucleus DNA was achieved using the fluorescent H2B-GFP protein, and the cytoplasm was marked with propidium iodide, a RNA and DNA marker.

Voxel size: 180 x 180 x 160 nm^3

microbeam

- Copy the microbeam advanced example to your local directory, create your build directory and compile

  ```
  cd
  cp —R $G4EXAMPLES/examples/advanced/microbeam .
  mkdir build-microbeam
  cd build-microbeam
  cmake ../microbeam
  make
  ```

- Run microbeam (microbeam.mac is read by default)

  ```
  ./microbeam
  ```

  - 10 alpha particles of 3 MeV are shot
  - Low energy EM physics for alphas, electrons, photons
  - Hadronic elastic and inelastic processes for alphas
  - Results are saved in microbeam_t*.root files

- Results can be analyzed using ROOT

  ```
  root plot.C
  ```

(for visualization, replace 'OGL' by 'OGLI' in vis.mac)   6

Output of microbeam