Jacobs Challenging today. Reinventing tomorrow.

MCBEND and VisualWorkshop Developments

Jacobs

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MCBEND Overview

- MCBEND is a general purpose radiation transport code for neutron, gamma-ray and electron transport.
  - It is supplied and maintained by the ANSWERS® software service.
- MCBEND has been used in the UK and internationally for over 45 years
- Applications Include:
  - Reactor operations, Fuel transport, Storage facilities, Reprocessing plant
  - Personnel dose uptake, Medical Dosimetry, Product Sterilisation
  - Oil Well logging predictions, Incident detection systems
  - Materials degradation, Detector modelling

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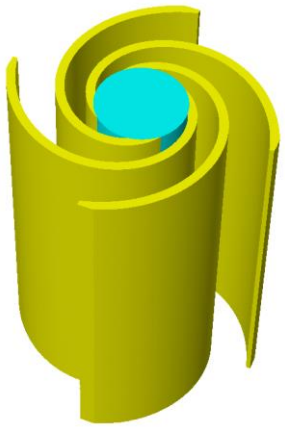
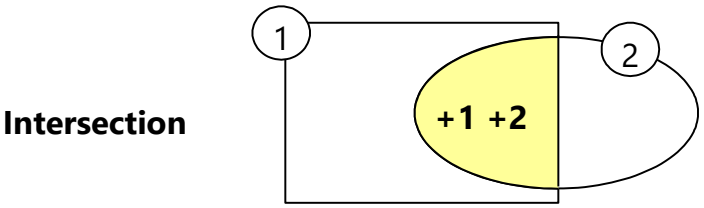
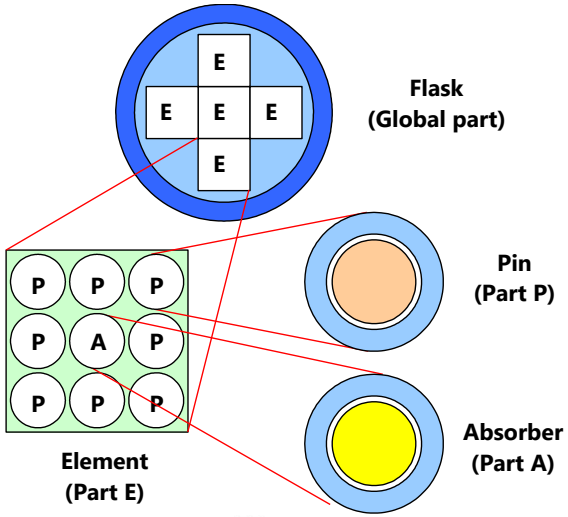
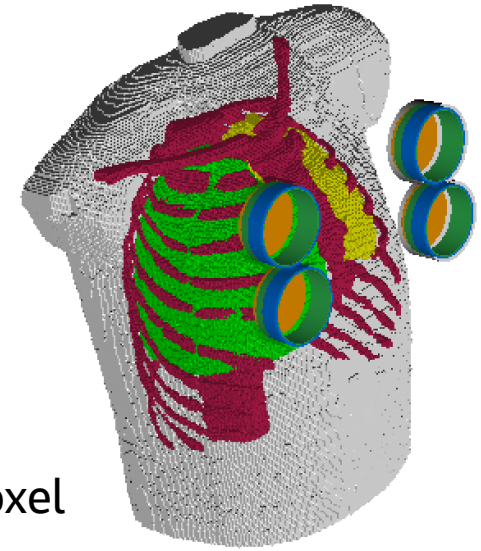
MCBEND Overview

- MCBEND has a powerful and flexible geometry modelling package that allows exact representation of any geometry.
  - Hierarchical combinatorial geometry
  - Range of specialised delta-tracking geometries
  - Optimised functions are available to treat imported tetrahedral mesh, polygon surface and voxel geometry types
  - Import models from IGES, OBJ, STL, MSH format CAD files

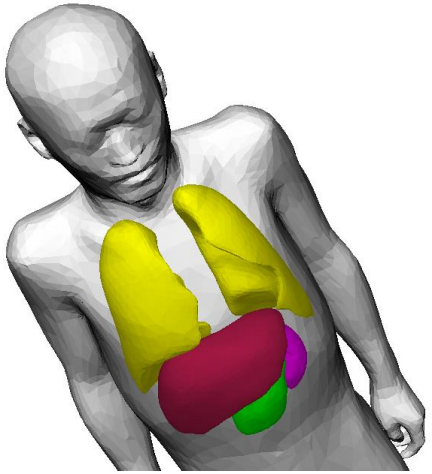








Voxel



Polygon

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MCBEND Scored Quantities

Quantity	Definition
Scalar fluxes	$\phi_g = \int_{E_{g-1}}^{E_g} \int_{4\pi} N(E, \underline{\Omega}) d\underline{\Omega} dE$
Responses	$R = \int_0^\infty \phi(E)\rho(E)dE$
Sensitivities	$\frac{\sigma}{R}\frac{\partial R}{\partial \sigma}$ or $\frac{\sigma}{\phi_g}\frac{\partial \phi_g}{\partial \sigma}$

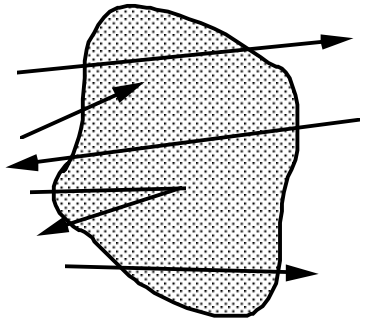
(Sensitivities are not available for charged particles)

Track Length Estimation

Quantity required: The mean flux ($\overline{\Phi}$) in a scoring region of volume v

The physical situation:

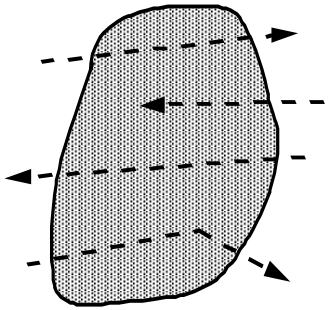
Real particles, continually threading the region



$$\overline{\Phi} = \frac{Total\ path\ length\ per\ sec}{V}$$

The MCBEND Model:

Simulated particles, all here assumed to have weight 1.0



Total source strength = S

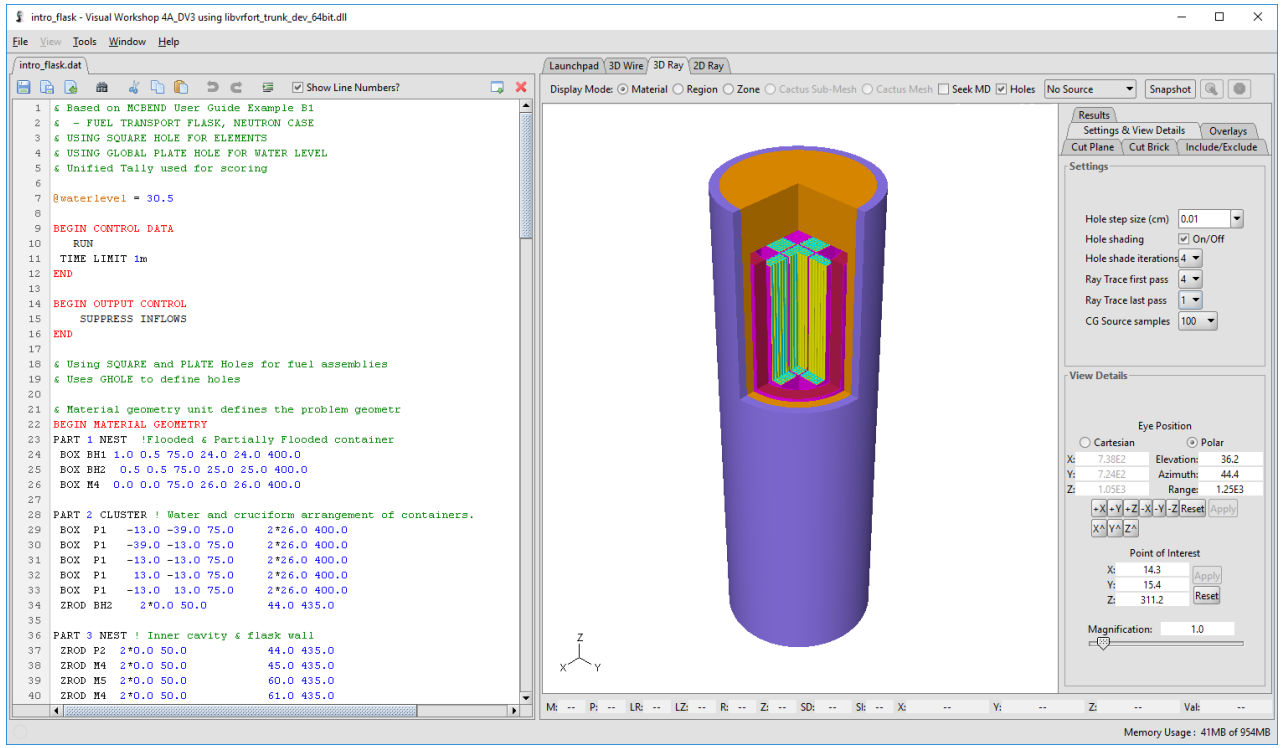
Particles started = P

Let the i^{th} simulated particle have track length in the scoring region X_i. Then:

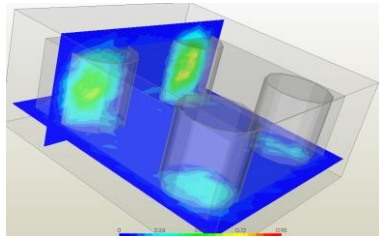
$$Estimate\ of\ \overline{\Phi} = \frac{S\ \sum X_i}{P\ V}$$

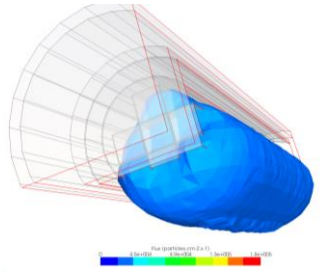
Visual Workshop Overview

- A tool for creating, viewing, verifying, running and analysing results from MCBEND calculations.



- Interactive real time 2D & 3D ray trace using the particle tracking routines from MCBEND
- Interactive Wire Frame display
- Graphing of results
- 2D and 3D contour and cell plots or results overlaid on the model





- Options for customising how a calculation utilises parallel hardware, including submission to HPC systems.
- Tools for optimisation, goal seeking and uncertainty analysis – among others

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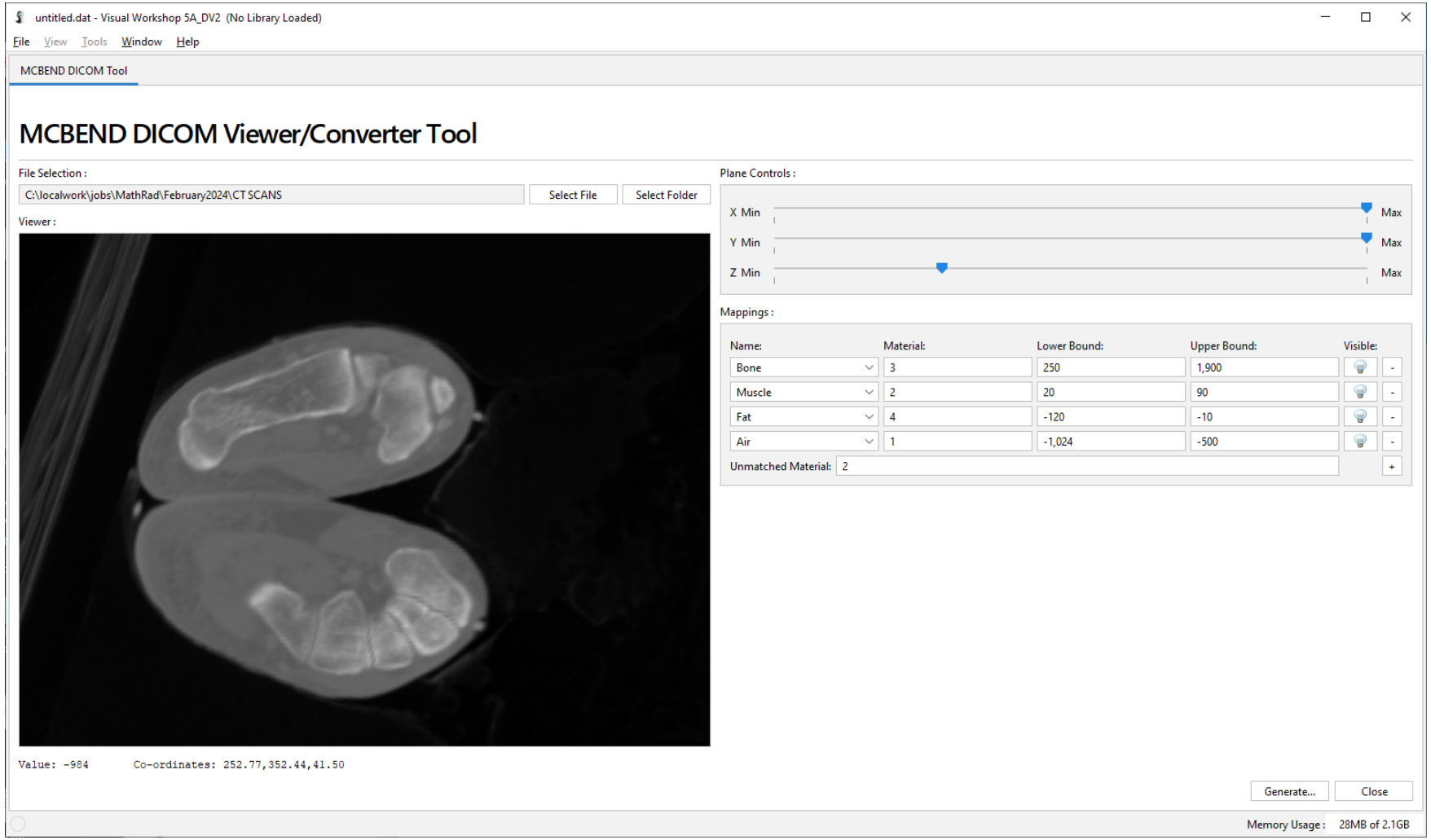
Visual Workshop DICOM Viewer/Converter

- View X, Y Z slices though a 3D DICOM dataset.
- Customise Hounsfield units.
- Highlight voxels selected by current Hounsfield values.
- Generate a MCBEND geometry.



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MCBEND Developments: Bortfeld Method

- A new MCBEND input section (unit) 'BORTFELD DATA'.
  - Specify a start point, direction and distance for each proton beam
  - Other parameters can be added easily

- Processed after the input is read and before the monte-carlo calculation.
  - Uses the MCBEND geometry and material compositions
  - Produces a table of values for each beam

Possible Future Development Work

- Visual Workshop
  - Load/ Save sets of Hounsfield values.
  - Automatic generation of MCBEND material compositions.
  - View the Proton Beams.
  - View the results from the Bortfeld model.

- MCBEND
  - Include Bortfeld model parameters for a wider range of materials.
  - Input for model parameters.
  - Input for beam energy.

Thank You

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