



Dicom processing in flair

Vasilis.Vlachoudis@cern.ch

Dicom importing to FLUKA

Flair has been enhanced to perform through a user friendly interface:

- Dicom file conversion to enhanced FLUKA voxel format
 - The conversion is done using the python **pydicom** library
 - The user has to provide:
 - Dicom set identified by the *Series UID*
 - List of predefined materials and compounds
 - Hounsfield ranges to material conversion
 - Hounsfield ranges to density and dE/dx correction scaling
 - The enhanced FLUKA voxel format contains in a single voxel file all the information: Voxel data, material assignments, material and compound definitions and correction factors
- Dicom file conversion to FLUKA USRBIN format
 - Gives the possibility to import the output of the TP systems in flair, where the user can visualize and compare with FLUKA predictions through the standard fluka/flair tools.

Dicom selection

The screenshot shows the 'testvoxel.flair - flair' application window. The interface is divided into several sections:

- Left Panel:** A tree view showing the project structure under 'Fluka', including folders like 'Input', 'Process', 'Database', and 'Tools'. The 'Dicom' tool is selected.
- Top Panel:** A menu bar with 'File', 'Edit', 'Card', 'Input', 'View', 'Tools', and 'Help'. Below it is a toolbar with various icons.
- Right Panel:** The 'DICOM process' window, which is currently showing the '2. Voxel' tab. It displays the directory path: `/home/bnv/prg/physics/fluka/flair/dicom/DICOM/lung_petct`.

The 'DICOM process' window contains two main data tables:

Dicom sets

Series Instance UID	Date	Patient	Institution	Study
1.2.840.113619.2.218.40400356.14199.1	2009.04.10 11:30	AM	IEOMilano	PET CT 4D RPM
1.2.840.113619.2.218.40400356.14199.1	2009.04.10 11:30	AM	IEOMilano	PET CT 4D RPM
1.2.840.113619.2.218.40400356.14199.1	2009.04.10 11:30	AM	IEOMilano	PET CT 4D RPM
1.2.840.113619.2.218.40400356.14199.1	2009.04.10 11:30	AM	IEOMilano	PET CT 4D RPM
1.2.840.113619.2.218.40400356.14199.1	2009.04.10 11:30	AM	IEOMilano	PET CT 4D RPM
1.2.840.113619.2.131.4178195915.12393	2009.04.10 1457	AM	IEOMilano	PET CT 4D RPM
1.2.840.113619.2.218.40400356.14199.1	2009.04.10 11:30	AM	IEOMilano	PET CT 4D RPM

Slices

File	Type	Size	Date
T66001_CT001.dcm	dcm	527782	2012.10.25 14:58
T66001_CT002.dcm	dcm	527782	2012.10.25 14:58
T66001_CT003.dcm	dcm	527782	2012.10.25 14:58
T66001_CT004.dcm	dcm	527778	2012.10.25 14:58
T66001_CT005.dcm	dcm	527778	2012.10.25 14:58
T66001_CT006.dcm	dcm	527778	2012.10.25 14:58
T66001_CT007.dcm	dcm	527778	2012.10.25 14:58
T66001_CT008.dcm	dcm	527778	2012.10.25 14:58
T66001_CT009.dcm	dcm	527778	2012.10.25 14:58

Header

```
(0008, 0000) Group Length          UL: 624
(0008, 0005) Specific Character Set  CS: 'ISO_IR 100'
(0008, 0008) Image Type              CS: ['ORIGINAL', 'PRIMARY', 'AXIAL']
(0008, 0012) Instance Creation Date  DA: '20090409'
(0008, 0013) Instance Creation Time  TM: '114108'
(0008, 0016) SOP Class UID           UI: CT Image Storage
(0008, 0018) SOP Instance UID        UI: 1.2.840.113619.2.218.40400356.14199.1239363052.997
(0008, 0020) Study Date              DA: '20090410'
(0008, 0021) Series Date             DA: '20090409'
(0008, 0022) Acquisition Date        DA: '20090409'
(0008, 0023) Content Date            DA: '20090409'
(0008, 0030) Study Time              TM: '113621'
(0008, 0031) Series Time             TM: '113750'
(0008, 0032) Acquisition Time        TM: '114014'
(0008, 0033) Content Time            TM: '114108'
```

At the bottom of the window, the status bar shows: `Inp: testvoxel.inp`, `Exe:`, and `Dir: /home/bnv/prg/physics/fluka/flair/dicom`.

Voxel Generation

The screenshot shows the 'testvoxel.flair - flair' application window. The interface includes a menu bar (File, Edit, Card, Input, View, Tools, Help), a toolbar, and a left-hand tree view with categories like Fluka, Input, Process, Plot, Database, Material, Elements, Tools, and Output. The 'DICOM process' panel is active, displaying various parameters and a table of Hounsfield unit conversions.

DICOM process

1. DICOM 2. Voxel

UID: 1.2.840.113619.2.218.40400356.14199.1239363052.739

Patient Name: AM Date/Time: 2009.04.10 11:36

Institution: IEOmilano Study: PET CT 4D RPM

slices: 64 # voxels [Nx x Ny x Nz]: 512 x 512 x 64

Voxel size [dx x dy x dz]: 0.976562 x 0.976562 x 2.5 mm³ Dimensions [Dx x Dy x Dz]: 500 x 500 x 160 mm³

Rescale: 1 * val + -1024 Unit range [Min..Max]: -3024 .. 3071

Unique Units [Regions]: 3719 # materials: 43

Materials: material.inp

Unit to Material : body.mat

< Unit	Material	Cr[min]	Cr[max]	Cr*[dedx_min]	Cr*[dedx_max]
-1021	AIR	0.6825432	1.3174568	1.0	1.0
-1016	HU<-1015	0.720281108	1.27971895	1.0	1.0
-1011	HU<-1010	0.835391418	1.16460858	1.0	1.0
-1001	HU<-1000	0.733656625	1.16949124	1.0	1.0
-996	HU<-995	0.909584201	1.05424948	1.0	1.0
-989	HU<-988	0.909502356	1.09049764	1.0	1.0
-975	HU<-974	0.85108832	1.14891168	1.0	1.0
-963	HU<-962	0.902912681	1.09708732	1.0	1.0
-951	HU<-950	0.919883508	1.08011649	1.0	1.0
-926	HU<-925	0.862306423	1.13769358	1.0	1.0
-901	HU<-900	0.893000468	1.10699951	1.0	1.0
-831	HU<-830	0.783902333	1.21609767	1.0	1.0
-701	HU<-700	0.75158871	1.24841129	1.0	1.0
-501	HU<-500	0.765689411	1.23431059	1.0	1.0
-121	HU<-120	0.734835247	1.26516475	1.0	1.0
-84	HU<-83	0.980501545	1.01835909	1.0	1.0
-54	HU<-53	0.98600717	1.01305997	1.0	1.0
-24	HU<-23	0.986384099	1.01270032	1.0	1.0
6	HU<7	0.98674495	1.01236373	1.0	1.0
14	HU<18	0.995655766	1.00173225	1.0	1.0
79	HU<80	0.972407965	1.03421835	1.0	1.0
100	HU<120	0.980146255	1.00104493	1.0	1.0
119	HU<120	0.962511989	0.973311932245	1.0	1.0
199	HU<200	0.973911929092	1.02131168	1.0	1.0

Create VOXEL file: test.vxl **VOXEL**

Create USRBIN file: dicom.bnn **USRBIN**

Dicom information

Materials file

Hounsfield unit
Conversion to
Material and
Density correction

FLUKA simulation

Voxel 2D projection
Overlaid with a
300MeV p+ beam
Simulation from FLUKA

Flair has the possibility
to make also 3D plots
of voxels

