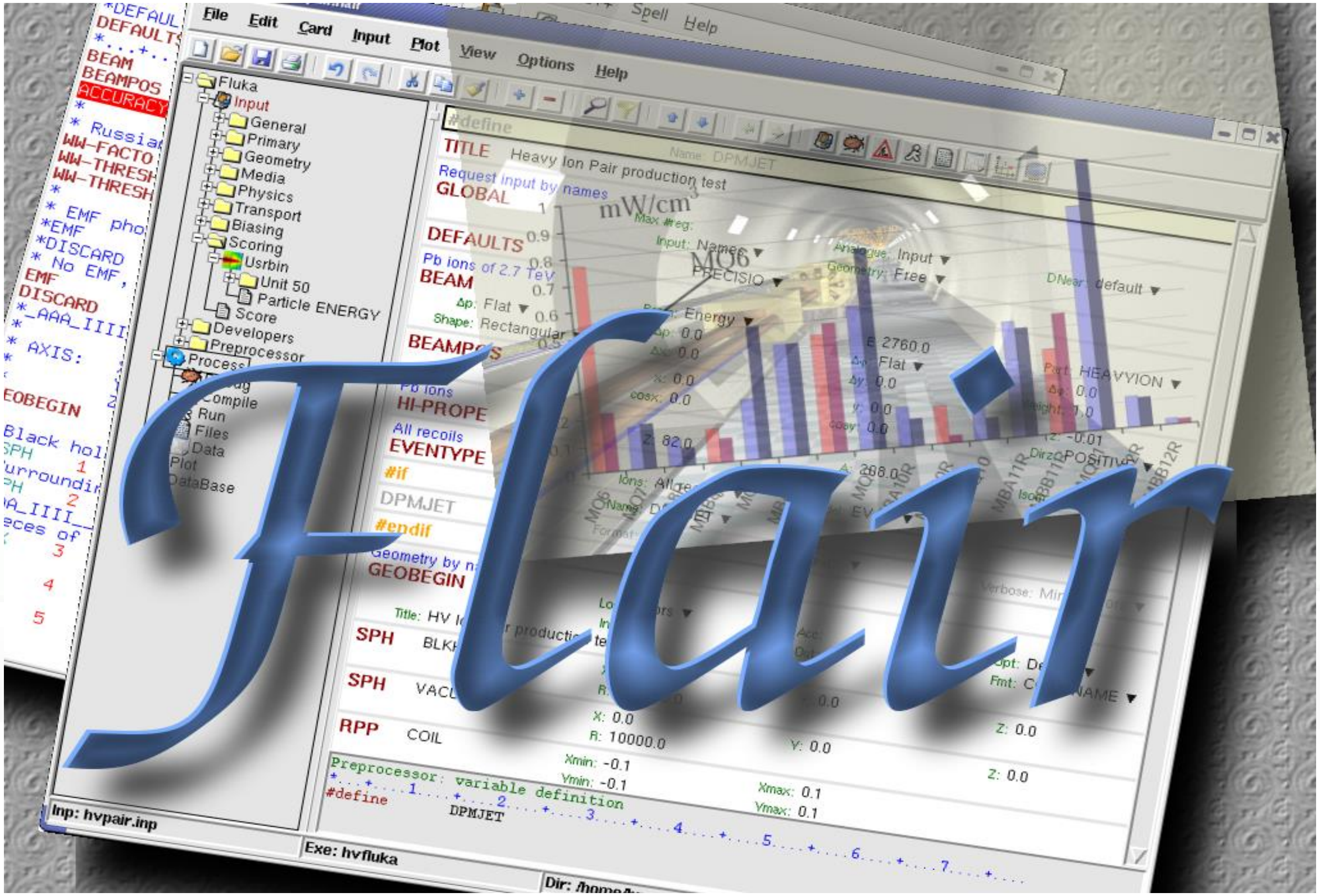
Introduction to Flair

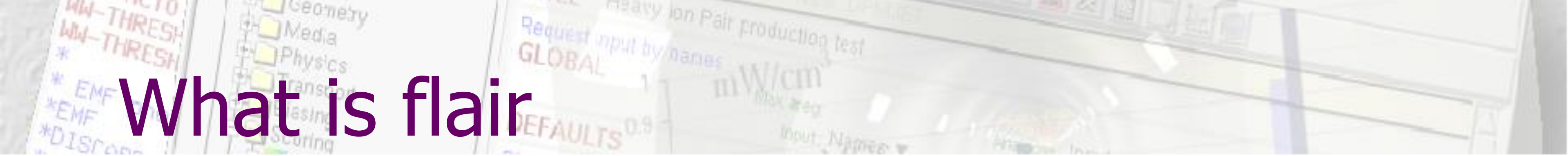
FLUKA Beginner’s Course

About



/fleə(r)/ n [U,C] natural or instinctive ability (to do something well, to select or recognize what is best, more useful, etc.

[*Oxford Advanced Dictionary of Current English*]



What is flair

FLUKA Advanced Interface [http://www.fluka.org/flair]

- **All-in-one** User friendly graphical Interface
- Minimum requirements on additional software
- Working in an intermediate level
  Not hiding the inner functionality of FLUKA

Front-End interface:

- Fully featured **Input file Editor**
  - Mini-dialogs for each card, allows easy and almost error free editing
  - Uniform treatment of all FLUKA cards
  - Card grouping in categories and card filtering
  - Error checking and validation of the input file during editing
- **Geometry:** interactive visualization editing, transformation, optimizations and debugging (see Geometry Editor talk)
- **Compilation** of the FLUKA Executable
- **Running** and **monitoring** of the status of a/many run(s)

What is flair

Back-End interface:

- Inspection of the output files (core dumps and directories)
- Output file(s) viewer divided in sections
- Post processing (merging) the output data files
- Plot generation through an interface with gnuplot

Other Goodies:

- Access to FLUKA manual as hyper text
- Checking for release updates of FLUKA and flair
- Import export to various formats: MCNP/X, GDML, Povray…
- Nuclear wallet cards
- Library of materials
- Database of geometrical objects (Not yet completed)
- Programming python **API**
- Everything is accessible with keyboard shortcuts

Concepts: Flair Project

- Store in a single file all relevant information:
  - Project notes
  - Links to needed files: input file, source routines, output files …
  - Multiple runs from the same input file, as well as running status
  - Procedures on how to run the code
  - Rules on how to perform data merging
  - Information on how to post process and create plots of the results
- You can consider Flair as an editor for the project files.
- Can handle any FLUKA input format (reading & writing), but internally it works using the names format for the input, free format with names for the geometry (Recommended way of working)
- The format is plain ASCII file with extension: .flair

Note: If you want to copy a project you need to copy also all linked files especially the input and source routines!

Installation

- Flair web site to download code and documentation

  http://www.fluka.org/flair

- Installation procedures:
  - RPM/DEB method (Linux): strongly recommended! on systems that support the RPM/DEB. The package will create all file association, menu items and keep track of updates and files installed.
    The package will install the program to: /usr/local/flair
    and will create the following launcher programs:

◆ /usr/local/bin/flair	flair program
◆ /usr/local/bin/fm	FLUKA manual
◆ /usr/local/bin/pt	Periodic Table
◆ /usr/local/bin/fless	FLUKA output viewer

  - tar.gz method (MacOS, MS-Windows). Please follow the instructions on:
    http://www.fluka.org/flair/download.html
    and for special instruction on the FAQ:
    http://www.fluka.org/flair/faq.html

Starting flair

Programs Menu (Linux)

- Click the icon of Flair from the programs menu;
- Flair is registered under the Science/Physics category but depending your Linux distribution and window manager it might appear in different sub-menus (i.e. Applications, Education, Science or Others).

Window Manager (Linux, only via RPM or DEB installation)

- Flair makes an association of the following extensions:

***.flair** ***.fluka *.inp**

Console

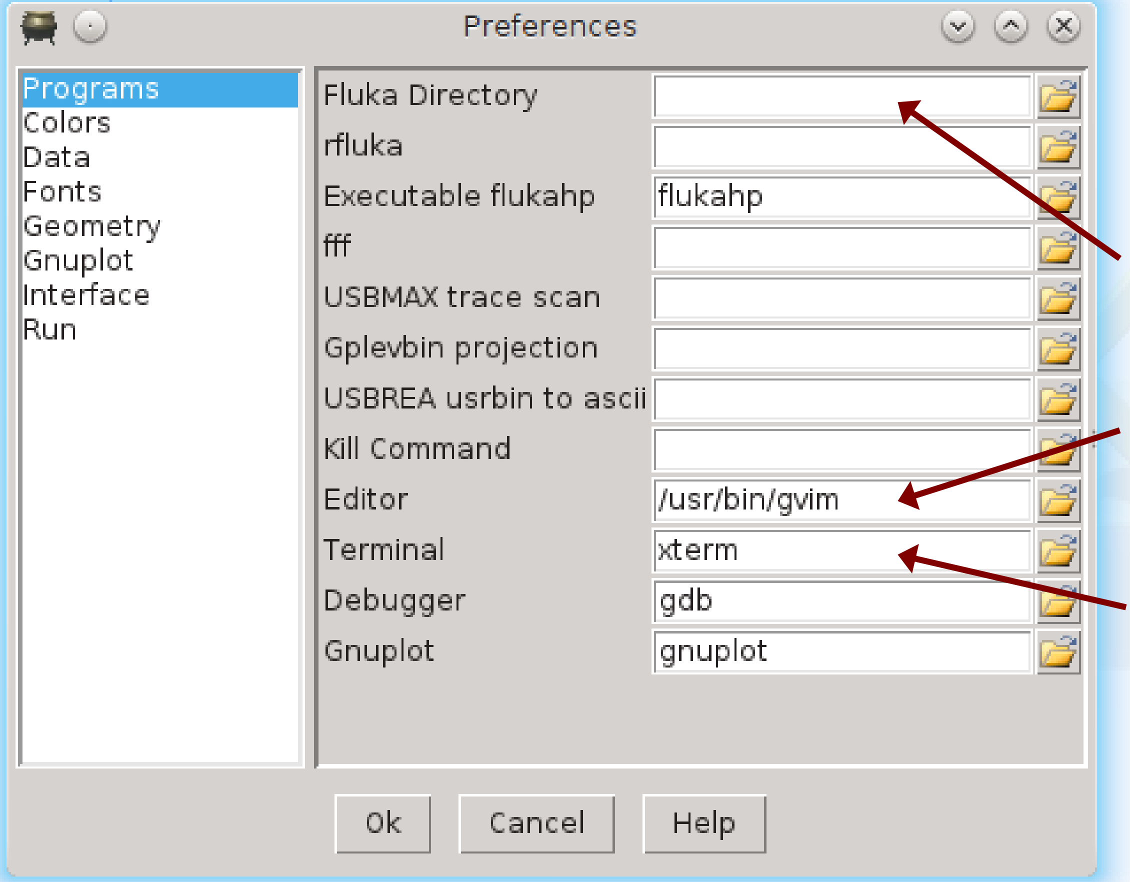
- Type the command flair. Remember to add to your **`$PATH`** the directory where flair is installed!

Startup

Unless you specify any option during startup flair will perform the following operation:

- Check for the existence of a FLUKA installation (FLUPRO environment variable), and if not found will open the Preferences dialog to set explicitly the FLUKA path;
  WARNING: Window managers (GNOME, KDE…), as well command shells (bash, tcsh, ash…) have a different configuration file where they expect the environment variable.
- Open the “Check for Updates” dialog (every 30 days interval).

Basic Preferences



Fluka Directory
rfluka
Executable flukahp: flukahp
fff
USBMAX trace scan
Gplevbin projection
USBREA usrbin to ascii
Kill Command
Editor: /usr/bin/gvim
Terminal: xterm
Debugger: gdb
Gnuplot: gnuplot

The program tab of preferences allows the user to set the default programs and directories

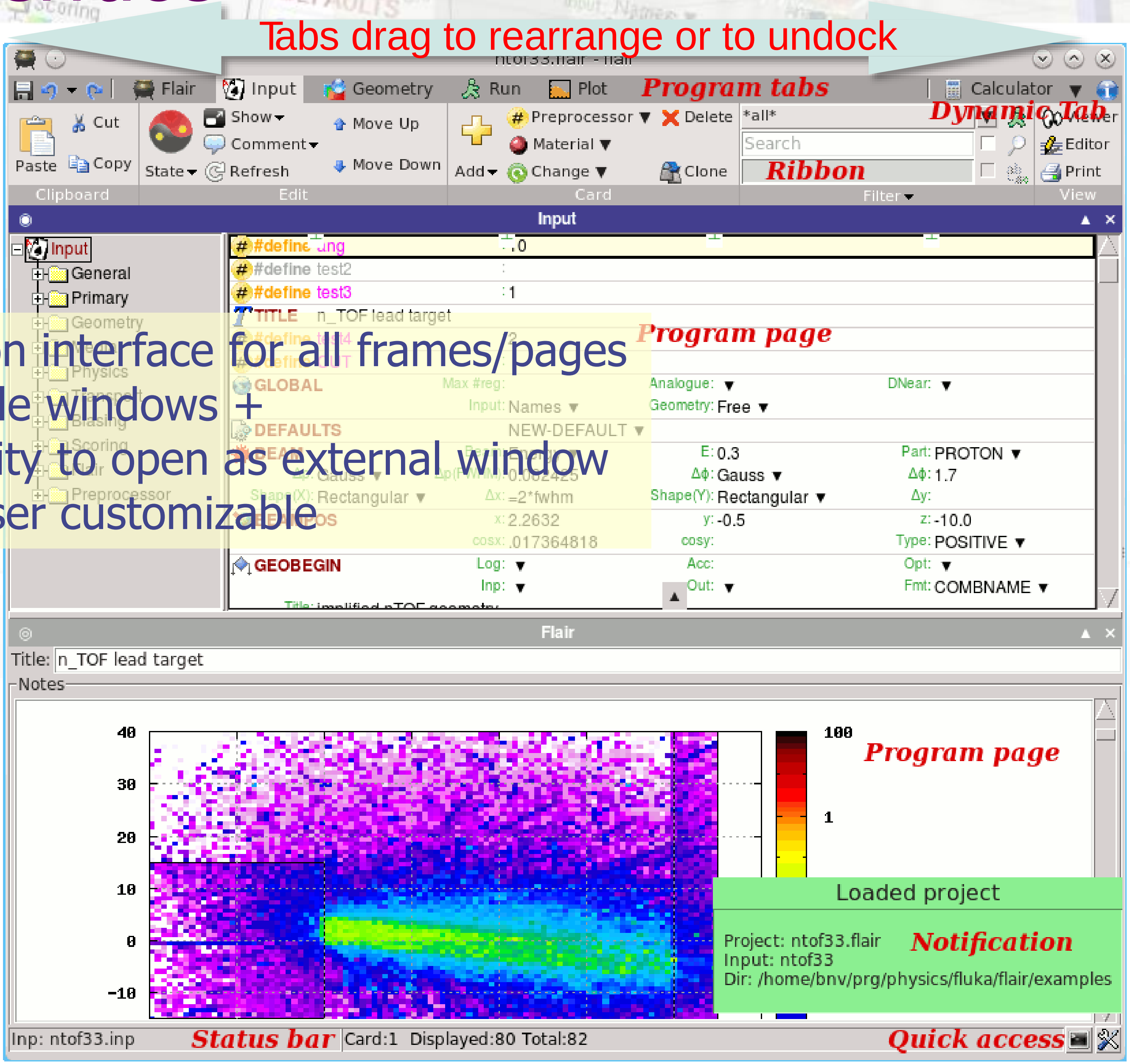
Set your FLUKA directory, to override $FLUPRO

Set your favorite editor

Set your favorite console program (xterm, nxterm, kconsole…)

Interface

- Common interface for all frames/pages
- Dockable windows + Possibility to open as external window
- Fully User customizable



```
#define ang          0
#define test2
#define test3        1
TITLE     n_TOF lead target
#define test4        2
GLOBAL        Max #reg:        Analogue: ▼        DNear: ▼
              Input: Names ▼   Geometry: Free ▼
DEFAULTS      NEW-DEFAULT ▼
BEAM          Beam: Energy ▼   E: 0.3             Part: PROTON ▼
              Δp: Gauss ▼      Δp(FWHM): 0.082425    Δϕ: Gauss ▼   Δϕ: 1.7
              Shape(X): Rectangular ▼   Δx: =2*fwhm   Shape(Y): Rectangular ▼   Δy:
BEAMPOS       x: 2.2632        y: -0.5            z: -10.0
              cosx: .017364818 cosy:              Type: POSITIVE ▼
GEOBEGIN      Log: ▼           Acc:               Opt: ▼
              Inp: ▼           Out: ▼             Fmt: COMBNAME ▼
              Title: implified nTOF geometry
```

Flair

Title: n_TOF lead target

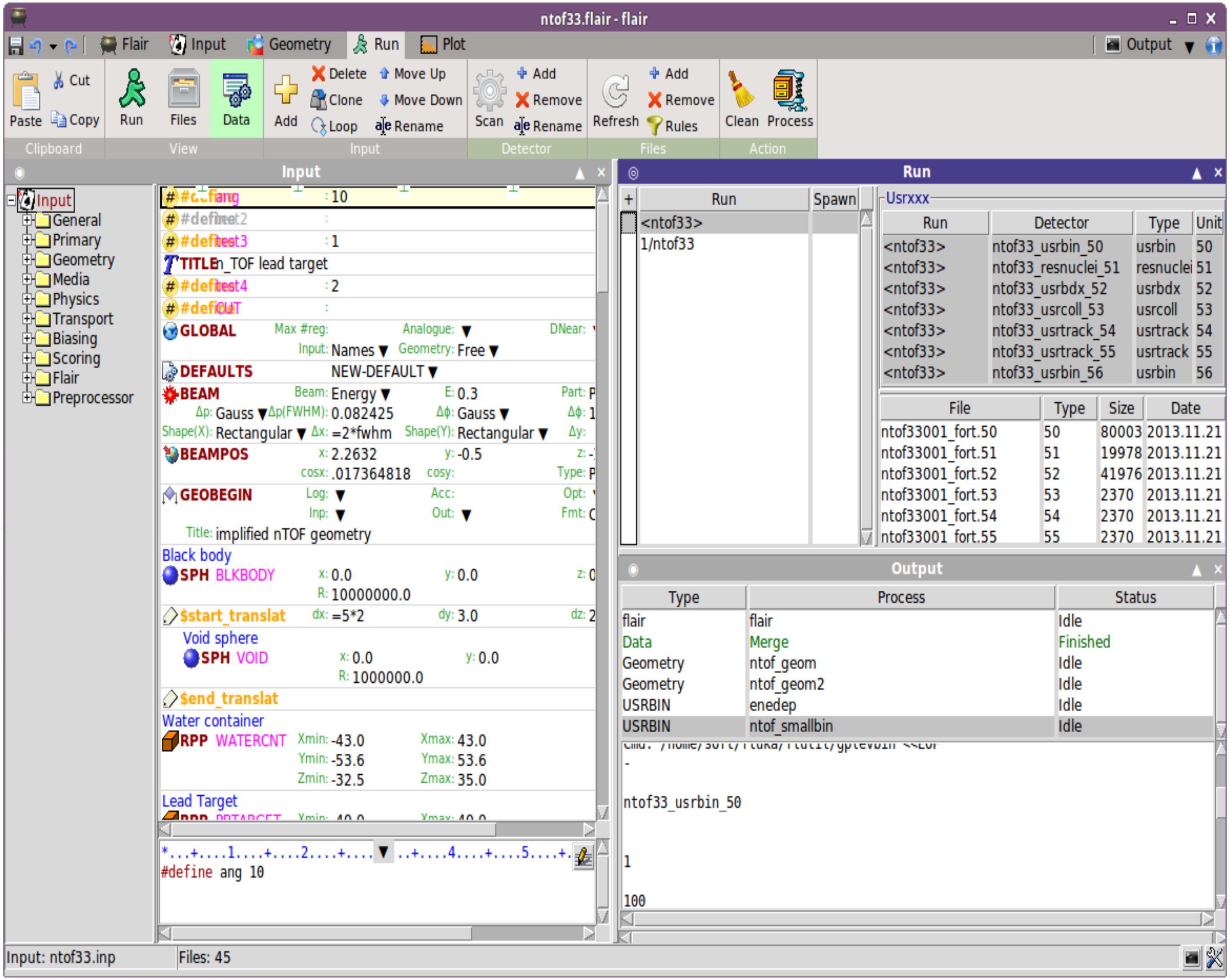
Notes

Loaded project

Project: ntof33.flair
Input: ntof33
Dir: /home/bnv/prg/physics/fluka/flair/examples

Inp: ntof33.inp Card:1 Displayed:80 Total:82

Interface - Multi docking



Input
- General
- Primary
- Geometry
- Media
- Physics
- Transport
- Biasing
- Scoring
- Flair
- Preprocessor

#define ang : 10
#define test2 :
#define test3 : 1
TITLE n_TOF lead target
#define test4 : 2
#define CUT :
GLOBAL Max #reg: Analogue: ▼ DNear:
Input: Names ▼ Geometry: Free ▼
DEFAULTS NEW-DEFAULT ▼
BEAM Beam: Energy ▼ E: 0.3 Part:
Δp: Gauss ▼ Δp(FWHM): 0.082425 Δϕ: Gauss ▼ Δϕ:
Shape(X): Rectangular ▼ Δx: =2*fwhm Shape(Y): Rectangular ▼ Δy:
BEAMPOS x: 2.2632 y: -0.5 z:
cosx: .017364818 cosy: Type:
GEOBEGIN Log: ▼ Acc: Opt:
Inp: ▼ Out: ▼ Fmt:
Title: implified nTOF geometry
Black body
SPH BLKBODY x: 0.0 y: 0.0 z:
R: 10000000.0
$start_translat dx: =5*2 dy: 3.0 dz:
Void sphere
SPH VOID x: 0.0 y: 0.0
R: 1000000.0
$end_translat
Water container
RPP WATERCNT Xmin: -43.0 Xmax: 43.0
Ymin: -53.6 Ymax: 53.6
Zmin: -32.5 Zmax: 35.0
Lead Target

```
*...+....1....+....2....+.... ..+....4....+....5....+.
#define ang 10
```

Run	Spawn
<ntof33>	
1/ntof33	

Usrxxx

Run	Detector	Type	Unit
<ntof33>	ntof33_usrbin_50	usrbin	50
<ntof33>	ntof33_resnuclei_51	resnuclei	51
<ntof33>	ntof33_usrbdx_52	usrbdx	52
<ntof33>	ntof33_usrcoll_53	usrcoll	53
<ntof33>	ntof33_usrtrack_54	usrtrack	54
<ntof33>	ntof33_usrtrack_55	usrtrack	55
<ntof33>	ntof33_usrbin_56	usrbin	56

File	Type	Size	Date
ntof33001_fort.50	50	80003	2013.11.21
ntof33001_fort.51	51	19978	2013.11.21
ntof33001_fort.52	52	41976	2013.11.21
ntof33001_fort.53	53	2370	2013.11.21
ntof33001_fort.54	54	2370	2013.11.21
ntof33001_fort.55	55	2370	2013.11.21

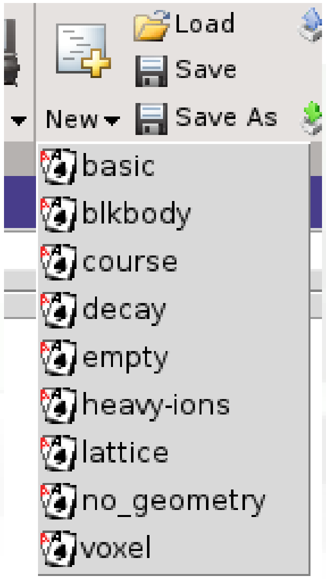
Type	Process	Status
flair	flair	Idle
Data	Merge	Finished
Geometry	ntof_geom	Idle
Geometry	ntof_geom2	Idle
USRBIN	enedep	Idle
USRBIN	ntof_smallbin	Idle

```
Cmd: /home/sofi/fluka/flutil/gplevbin <<EOF
-

ntof33_usrbin_50


1

100
```

Input: ntof33.inp Files: 45

Input Templates

- When requesting a new input or a new project flair will prompt to select an input template:



Default template: basic.inp

```
TITLE

GLOBAL                                         1.0       1.0
DEFAULTS                                                              NEW-DEFA
BEAM
BEAMPOS
GEOBEGIN                                                              COMBNAME
    0    0
* Black body
SPH blkbody    0.0 0.0 0.0 10000000.0
* Void sphere
SPH void       0.0 0.0 0.0 1000000.0
* Cylindrical target
RCC target     0.0 0.0 0.0 0.0 0.0 10.0 5.0
END
* Black hole
BLKBODY      5  +blkbody -void
* Void around
VOID         5  +void -target
* Target
TARGET       5  +target
END
GEOEND
* ..+....1....+....2....+....3....+....4....+....5....+....6....+....7..
ASSIGNMA    BLCKHOLE   BLKBODY
ASSIGNMA      VACUUM      VOID
ASSIGNMA      COPPER    TARGET
RANDOMIZ         1.0
START
STOP
```

The user can create his own set of input templates. They are normal FLUKA input files and they have to be placed in the directory ~/.flair/templates (create the directory if not existing)

Input Editor

- With the input editor the user can manipulate the input cards:
  - Add card to input
  - Edit existing ones
  - Copy & Paste
  - Clone (Duplicate)
  - Import from other input files
  - Validate the correctness of the cards
  - Error filtering
  - Rearrange order
- The editor will try to rearrange the input cards (if needed) to create a valid FLUKA input file
  e.g. body cards outside the GEOBEGIN/GEOEND parts will be moved inside

Note: Automatic rearranging of cards cannot work if "**#include**" cards are present. The user have to do it manually

Card Categories

For easier access, cards are grouped in the following categories:

General	General purpose (TITLE, DEFAULTS, GLOBAL…)
Primary	Definition of the primary starting particles
Geometry	Cards related to the definition of the geometry bodies/regions/lattices plotting and rotations/translations
Bodies	Subcategory containing only the bodies definition
Transformations	Subcategory containing only the geometrical directives
Media	Definition and assignment of materials
Physics	Setting physics properties of the simulation
Transport	Modify the way particles are transported in FLUKA
Biasing	Cards for importance biasing definition
Scoring	Cards related to scoring
Flair	flair special cards
Preprocessor	Definitions for creating conditional input files

Concepts: Extended Cards

- Flair is treating the input file as a list of extended cards;
- Each extended card contains:
  - Comment: All commented lines preceding the card(s) as well the inline comments
  - Tag: The 8 character word identifying the card. All tags not recognized by flair will be converted to #error
  - WHATs: Multiple number of WHATs (0=sdum, 1-6 first line, 7-12 continuation line...)
  - Extra: multi line string of extra information for special cards like REGION, TITLE, PLOTGEOM etc.
  - State (Enable/Disable)
- Flair recognize automatically (and separates them from the comments) all the disabled valid FLUKA cards

Concepts: Extended Cards

- The region definition in the in geometry is emphasized by the presence of a card named “REGION”
- All COMPOUND cards related to one material are joined in one card
- Cards are edited with the flair editor through the use of the mini-dialogs, forcing the user to enter a *proper* information
- The user gets full control of the card using the Edit dialog (See button at *lower right corner)*
- Flair will try to find the best floating point representation of each number, to ensure the maximum accuracy; number of digits that fits in the specific width (10 for the fixed format, 22 for the free format)
- Function evaluation: a field value starting with **=** will force flair to evaluate its content as a function e.g.

  BEAMPOS x: =2*10+length

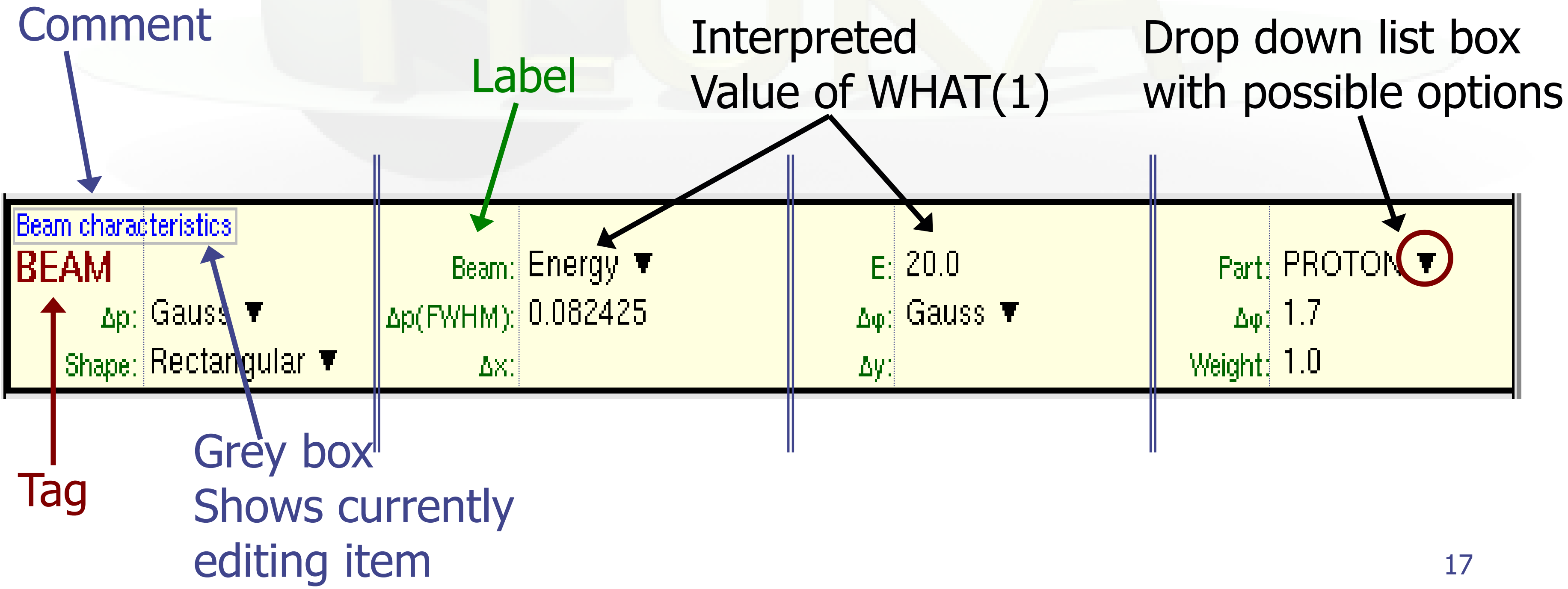
  Flair will create a valid fluka input containing the evaluation of the formula and keep the formula inside the comments as

  *@what.1 =2*10+length

Anatomy of a card mini-dialog

- For each extended card flair has a mini dialog (currently in 4 columns), interpreting all information stored in the card

```
* Beam characteristics
BEAM           -20.0 -0.082425      -1.7                           1.0PROTON
```



Beam characteristics
BEAM
Beam: Energy ▼ | E: 20.0 | Part: PROTON ▼
Δp: Gauss ▼ | Δp(FWHM): 0.082425 | Δφ: Gauss ▼ | Δφ: 1.7
Shape: Rectangular ▼ | Δx: | Δy: | Weight: 1.0

Comment

Label

Interpreted Value of WHAT(1)

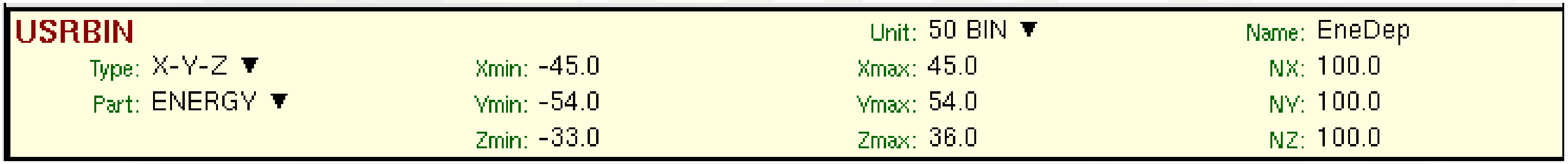
Drop down list box with possible options

Tag

Grey box Shows currently editing item

Anatomy of a card mini-dialog

```
* Energy deposition in 3D binning
USRBIN          10.0    ENERGY     -50.0      45.0      54.0      36.0EneDep
USRBIN         -45.0     -54.0     -33.0     100.0     100.0     100.0&
```



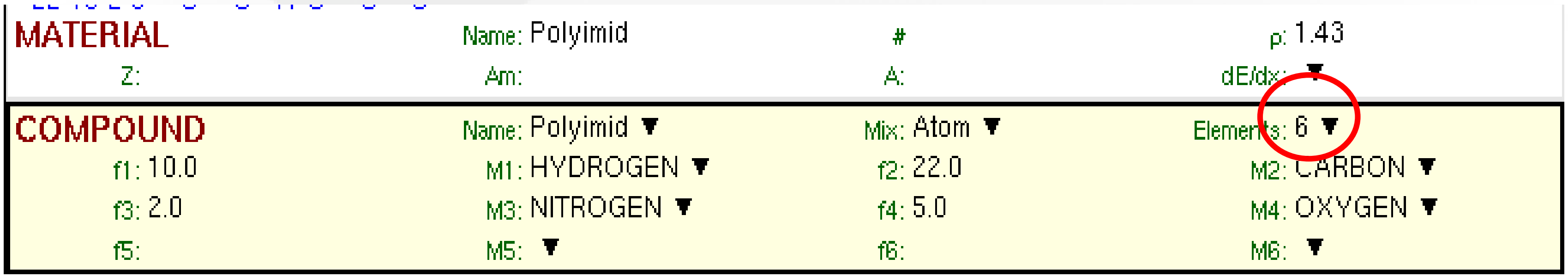
USRBIN

		Unit: 50 BIN ▼	Name: EneDep
Type: X-Y-Z ▼	Xmin: -45.0	Xmax: 45.0	NX: 100.0
Part: ENERGY ▼	Ymin: -54.0	Ymax: 54.0	NY: 100.0
	Zmin: -33.0	Zmax: 36.0	NZ: 100.0

Anatomy of a card mini-dialog

```
* Polypyromellitimide Polyimide, Kapton
* Chemical       O = C   H-C   C = O
* Formula           / \  // \ / \      H-C - C-H        H-C - C-H
*                  /   \C    C   \    //     \\        //     \\
*            ---- N     |    ||   N - C        C - O - C        C ----
*                  \   /C    C   /     \     /          \     /
*  C  H  N O        \ /  \\ / \ /      H-C = C-H        H-C = C-H
*   22 10 2 5    O = C   H-C    C = O
```

```
MATERIAL                            1.43                              Polyimid
COMPOUND        10.0  HYDROGEN      22.0   CARBON        2.0  NITROGENPolyimid
COMPOUND         5.0    OXYGEN                                        Polyimid
```



MATERIAL Name: Polyimid # ρ: 1.43
Z: Am: A: dE/dx:

COMPOUND Name: Polyimid Mix: Atom Elements: 6
f1: 10.0 M1: HYDROGEN f2: 22.0 M2: CARBON
f3: 2.0 M3: NITROGEN f4: 5.0 M4: OXYGEN
f5: M5: f6: M6:

Editing Cards

While in input editor you can work in two modes:

1. Card mode: manipulate the cards as a unit (e.g. to copy, paste, delete, change order of cards)
2. Edit mode: manipulate the contents of the card

Edit mode is activated immediately after adding a new Card, by hitting Enter or with the mouse click

To leave edit mode click the Esc or with the mouse click somewhere else

The active item (what) is highlighted with a grey rectangle and highlighted also in the card viewer below the editor

A range of cards can be selected with:

- Shift + Mouse
- Shift + Up/Down arrows

Validating input and Error correction

- Flair validates the input file while loading and each card during editing
- Errors are highlighted in **red**
- For the moment only syntactical errors are checked, and a few logical errors
- Popup-menu option “Show errors” displays a short message on what is expected as correct value
- Menu item “Input / Filter Invalid” shows only the invalid cards from the last filtered view

Material Database

- Flair contains an internal database of ~500 predefined materials and/or compounds
- Some (~300) with the Sternheimer parameters

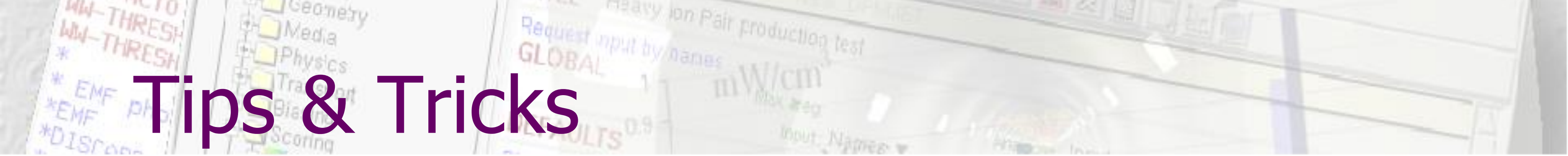
Please use these data as Reference only!

- Validate **always** the correctness of the data
- If errors found please contact the author

- The database can be edited, and populated with your own materials. In this case a local copy of the database will be made in ~/.flair directory

Starting a Run

- Flair can start a simulation (single run) based on the input file
- Multiple runs can be started by overriding some options, like #defines, title, random number seed and number of starting particles (primaries)
- Flair will try to "attach" to a run. Using only the information from the output files generated by FLUKA, flair will try to identify the directory where the run takes place and monitor the progress of the selected run
- During the execution of the run the user can view the output files in the "Files Frame" under the "Run Tab"



Tips & Tricks

- Mouse
  - right-click — opens the popup-menu with the most important actions
- Keyboard — Check the accelerators on the menus
  - Ctlr-Enter — Performs the default action in every frame.

    e.g. Add a card in the Input Editor

    start a run in the Run Frame
  - Ctrl-Space — Access popup-menu (like right-clicking)
  - Listboxes — All listboxes in flair are searchable and case insensitive. Type the first characters of the string you are searching and the closest match will be highlighted

    Ctrl-G repeats the search. Space selects/deselect item
  - +, -, Ins — While editing the REGION expression shows a list of all available bodies

Known Bugs / Limitations

- Unicode / International characters do not work well and should be avoided
- Gnuplot:
  - <4.2 has a bug in the number of palette colors, and on the cblabel for the wxt terminal
  - 4.4.3 has a non linear behavior on the palette colors for the xterm terminal
- Inline comments, and comments inside REGION definition are treated as one comment preceding the input card

- **REMEMBER** always that the .flair and .inp are different thing

  Do not save the project as .inp or the input file as .flair

Other goodies

Flair has a lot of functionalities that are not shown in this tutorial

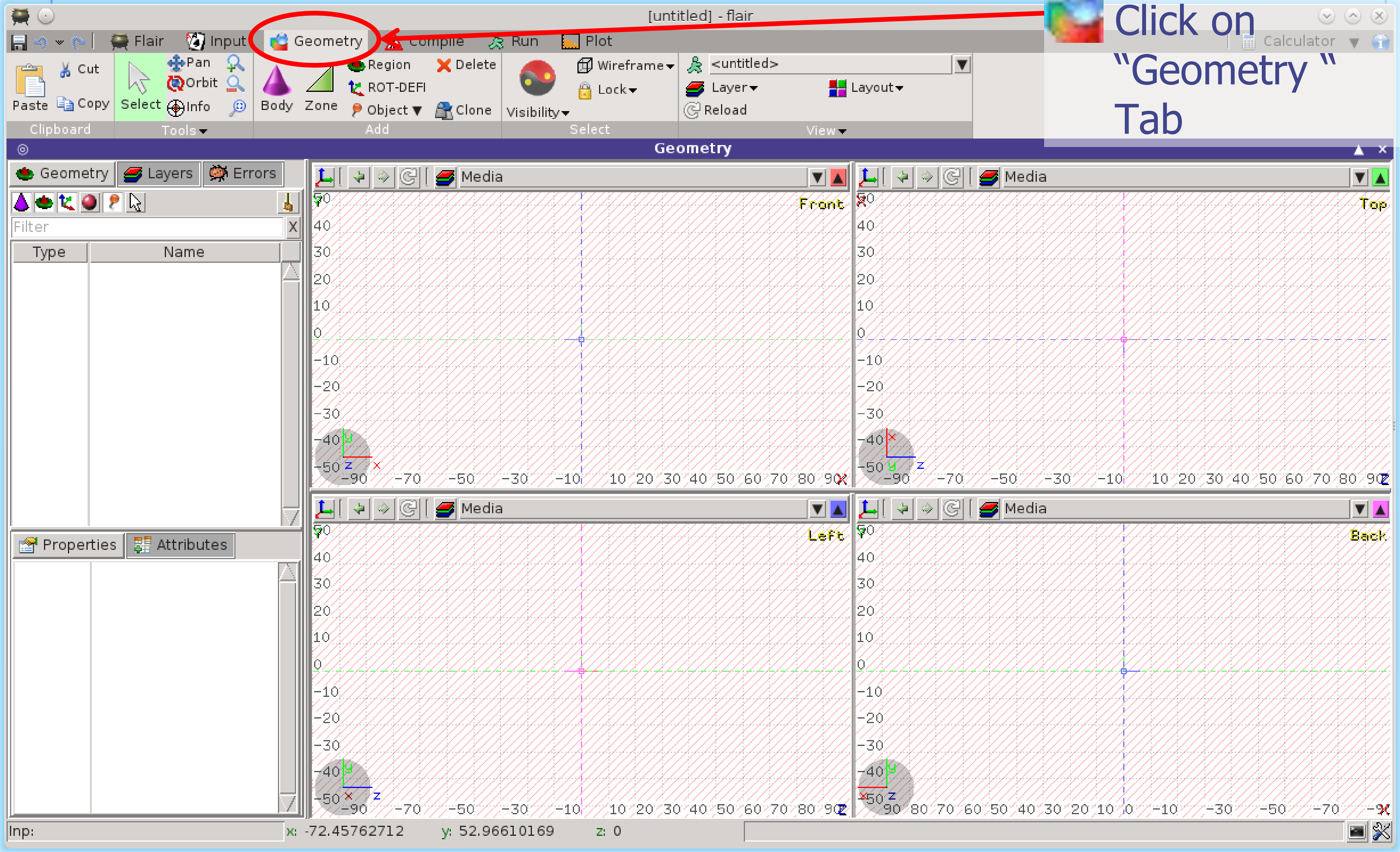
Most of these will be shown during the exercises of the course

We would advice the users to go through the various menus and help page and try it out

Flair – Geometry Editor – Part I

Beginners' FLUKA Course

Starting the Geometry Editor



Click on "Geometry " Tab

Geometry editor

- Working on 2D cross sections of the geometry;
- Interactive visual editing of the geometry in 2D;
- Debugging bodies/regions in a graphical way;
- Fast 3D rendering of the geometry;

Pros

- Fast display of complex geometries;
- Many user-customizable layers;
- Graphical editing of the bodies with snapping mechanism to generate accurate coordinates;
- Visual selection and editing of zones w/o the need to know the orientation of bodies;
- Use real curve of bodies with no conversion to vertices/edges;
- Interactive debugging with information of problematic bodies, regions and/or zones;

Cons

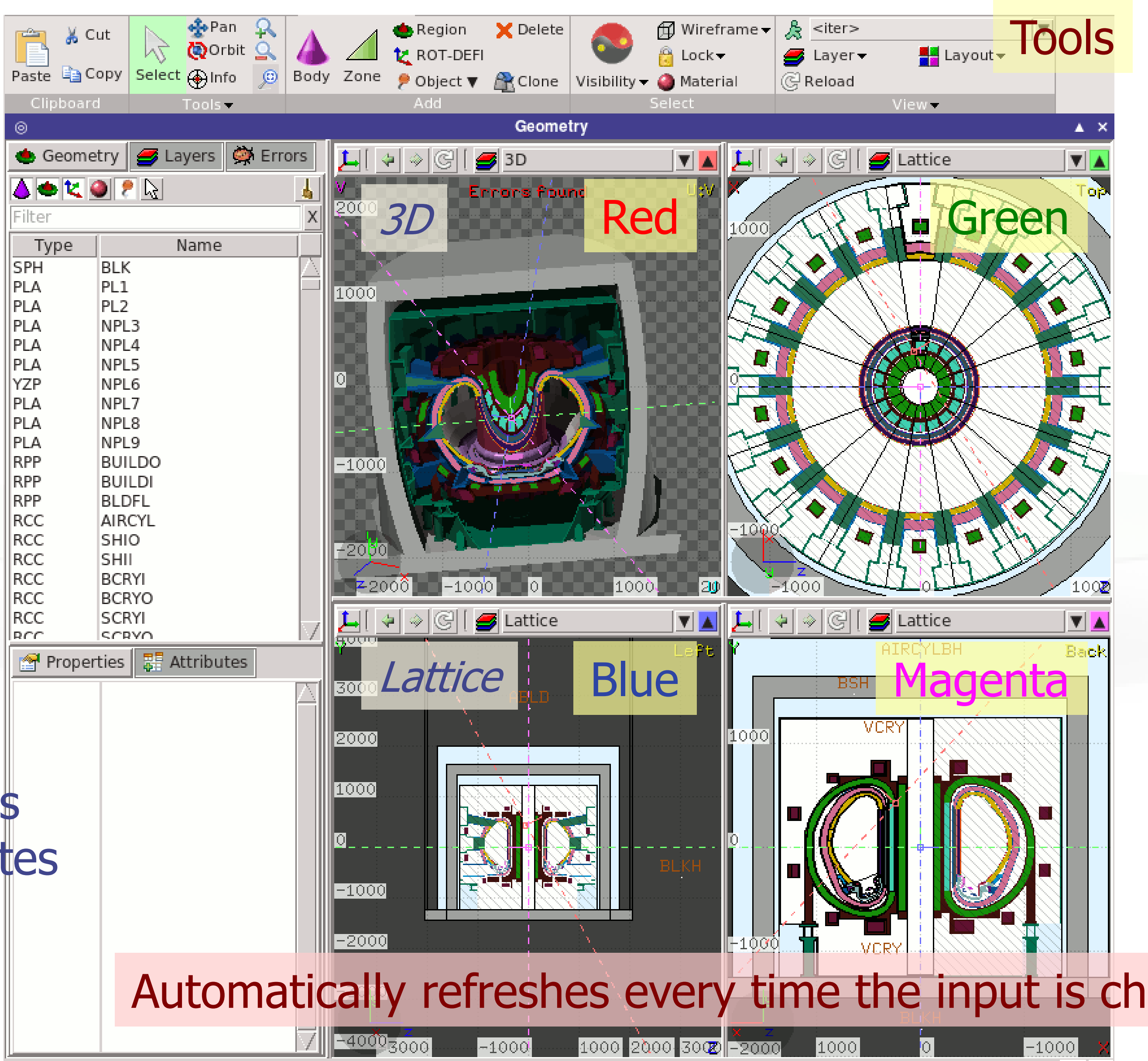
- Tricky to orientate in an unknown geometry;
- Difficult to find region using the expression;

Geometry Editor: Interface

Filter

Filtered Objects

Properties & Attributes



Tools

3D

Red

Green

Lattice

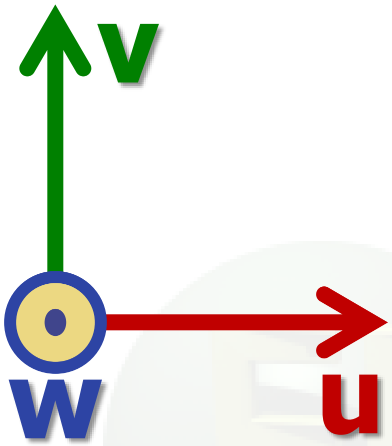
Blue

Magenta

Type	Name
SPH	BLK
PLA	PL1
PLA	PL2
PLA	NPL3
PLA	NPL4
PLA	NPL5
YZP	NPL6
PLA	NPL7
PLA	NPL8
PLA	NPL9
RPP	BUILDO
RPP	BUILDI
RPP	BLDFL
RCC	AIRCYL
RCC	SHIO
RCC	SHII
RCC	BCRYI
RCC	BCRYO
RCC	SCRYI
RCC	SCRYO

Automatically refreshes every time the input is changed

Viewport axes System

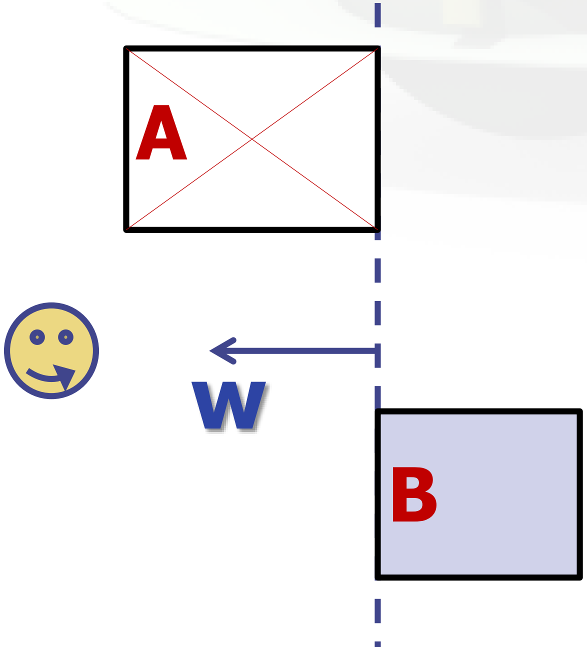


Each viewport is defined by:

- Origin center of viewport
- Basis relative axes system u, v, w.
  w is coming out of the screen towards the user
- Extends zooming

Note:

- Each viewport is facing towards negative **–w**
- If bodies A, B are touching the viewport like on the plot.
- Only body B will be visible



Navigation - Keyboard

[*arrows*]	pan viewport
Ctrl + [*arrows*]	orbit viewport around **u,v** axes
+ [Shift]	rotates by 90º
Page Up/ Page Down	pan viewport front/back
Ctrl + PgUp/PgDn	rotate viewport around **w** axis
= / -	zoom in / zoom out
o	open projection dialog to set the **o**rigin/basis/save/recall etc…
0 (zero)	Center to origin
1, 2	**front [X:Y] / back [-X:Y]**
3, 4	**left [Z:Y] / right [-Z:Y]**
5, 6	**top [Z:X] / bottom [-Z:X]**

Assuming: Z = direction of the beam (horizontal)

X = horizontal

Y = vertical

Navigation – Mouse [1/2]

With the left mouse button:

1. Select the appropriate action pan/orbit/zoom with:
   I. Menu → Tools
   II. Toolbar
   III. Keyboard shortcut
2. Click and drag the desired viewport

	function	key	description
✥	Pan	x	Pan viewport
↻	Orbit	t	Orbit viewport using a virtual **t**rackball
🔍	Zoom	z	Drag area to **z**oom In ([**Ctrl**] to zoom out)
		Shift-Z	Zoom viewport on selected items
⇦		Alt-Left	Go to previous in history projection
⇨		Alt-Right	Go to next in history projection

Navigation – Mouse [2/2]

- With the middle mouse button

alone	Pan/Move viewport
Ctrl	orbit projection using a virtual trackball
Ctrl-Middle-Shift	orbit projection using a virtual trackball with steps of 15 degrees
Shift	select rectangle region and zoom into
Shift-Middle-Ctrl	select rectangle region and zoom out

- Wheel (if any) zoom in/zoom out

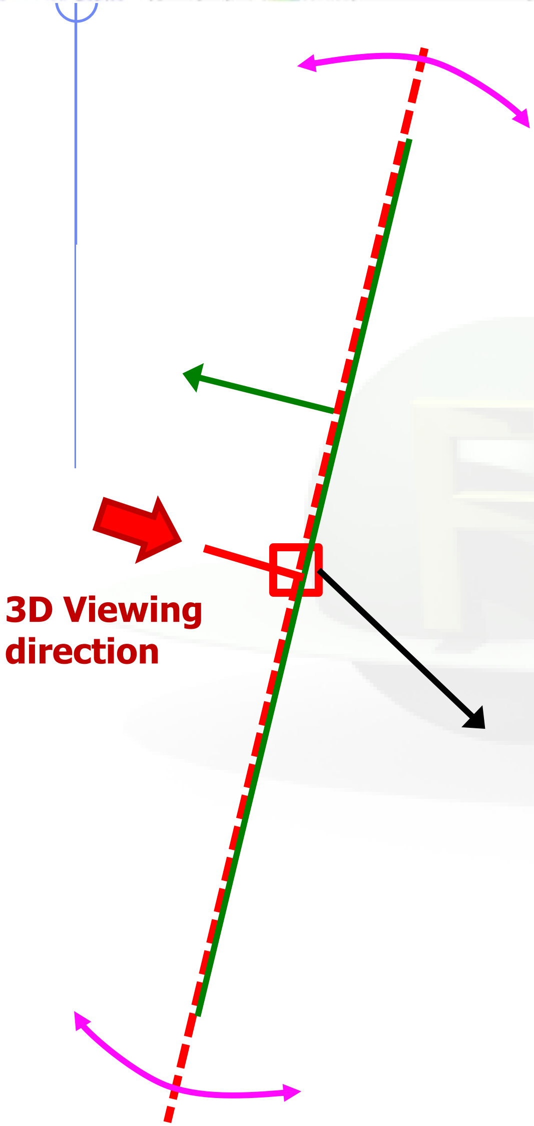
Ctrl-Wheel	pan/move forward or backward
Ctrl-Shift-Wheel	smoother pan/move forward/backward

- With the right mouse button

alone	opens popup menu
Shift	pan/move viewport
Ctrl	orbit projection using a virtual trackball

When laptop mode is enabled in the Preferences/Geometry then the middle and right buttons are swapped

Navigation – Viewport lines [1/2]



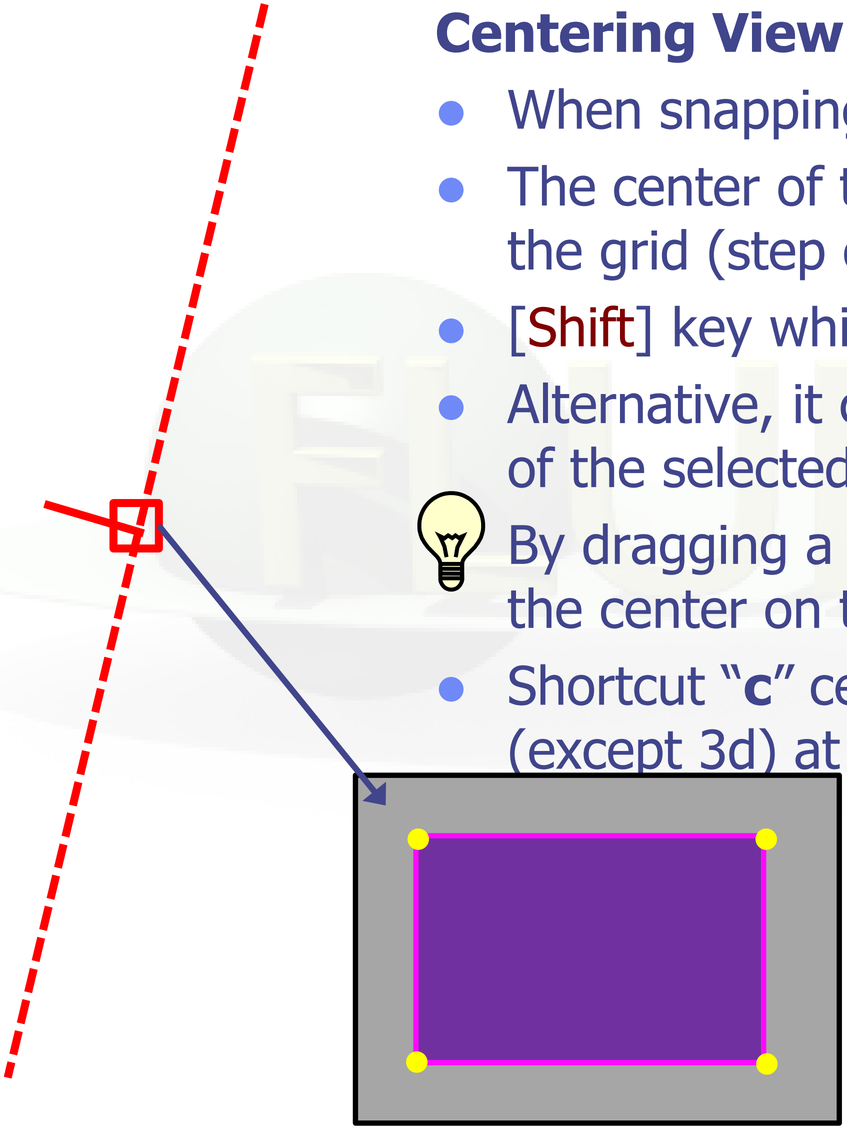
Description:

- Dashed lines represent other viewports (the intersection of other viewports with the current one);
- The center is represented with a square;
- Viewing direction **w** is indicated by a short line;
- When another viewport is outside the view window, the viewport-line will be displayed on the closest edge;

Actions: Select ↖ + left mouse button

- Drag the center square to reposition the viewport
- Drag the line close to the center to reposition the viewport along the vertical **w** axis
- Drag the extremities to rotate it

Navigation – Viewport lines [2/2]

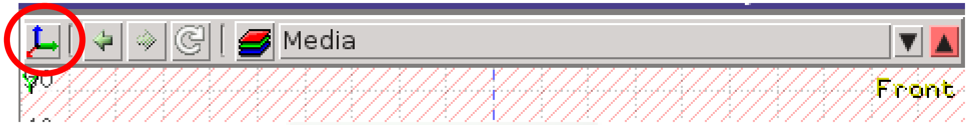


Centering Viewports

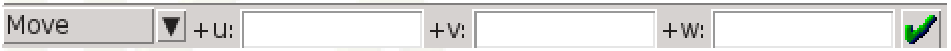
- When snapping to grid is activated
- The center of the viewport will be aligned to the grid (step of 1/10 of the main grid)
- [Shift] key while toggle the snapping action;
- Alternative, it can be centered on the vertices of the selected bodies;
- By dragging a viewport center it always moves the center on the current viewing plane.
- Shortcut "**c**" centers all other viewports (except 3d) at the mouse pointer

Navigation – Projection dialog

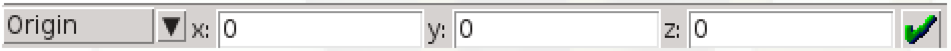
With the projection [**o**] button you can change, move, shift, rotate, save and reload the projection of a viewport



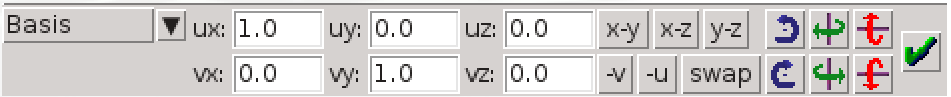
Shift the coordinate system


Move ▼ +u: +v: +w: ✓

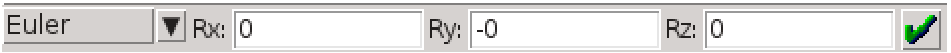
Set the **o**rigin of the viewport


Origin ▼ x: 0 y: 0 z: 0 ✓

Change the reference axis

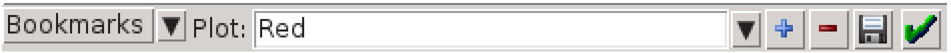

Basis ▼ ux: 1.0 uy: 0.0 uz: 0.0 x-y x-z y-z
vx: 0.0 vy: 1.0 vz: 0.0 -v -u swap ✓

Rotate around the Cartesian axis

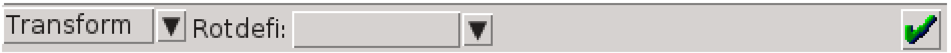

Euler ▼ Rx: 0 Ry: -0 Rz: 0 ✓

Shortcut: Ctrl + (1-6)

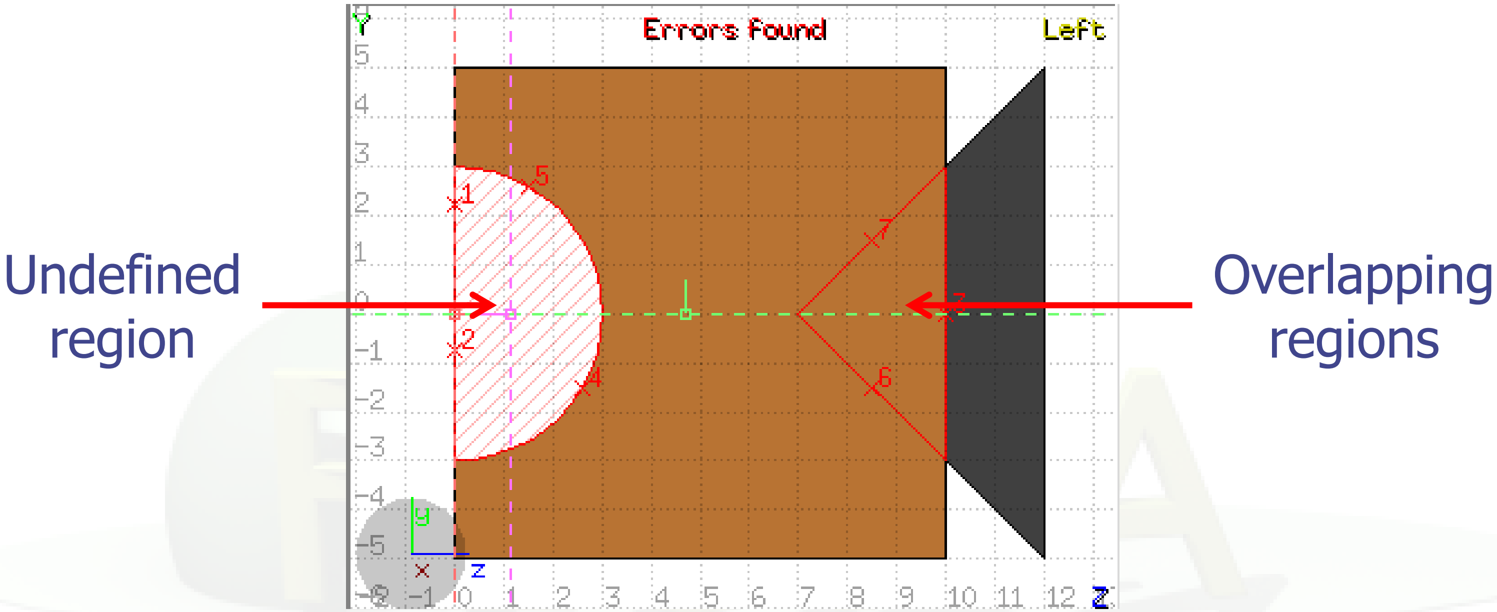
Add and Select Bookmark


Bookmarks ▼ Plot: Red ▼ ✓

Select Transformation


Transform ▼ Rotdefi: ▼ ✓

Debugging Geometry Errors



Undefined region

Overlapping regions

Errors found notifies that are errors in the geometry (on the current projection):

- The areas affected by the errors are outlined with a **Red** stroke:
  - Areas filled with a full color correspond to overlapping regions;
  - Areas filled with red lines correspond to a missing region definition;
  - Body segments that are involved in the errors are numbered;
- Clicking the Errors tab (on the left) displays the dialog with the errors.
- Touching surfaces are checked against **10** significant digits
- Non-strictly geometrical errors (i.e. missing Material Assignment to a region, non recognized cards) are also notified;