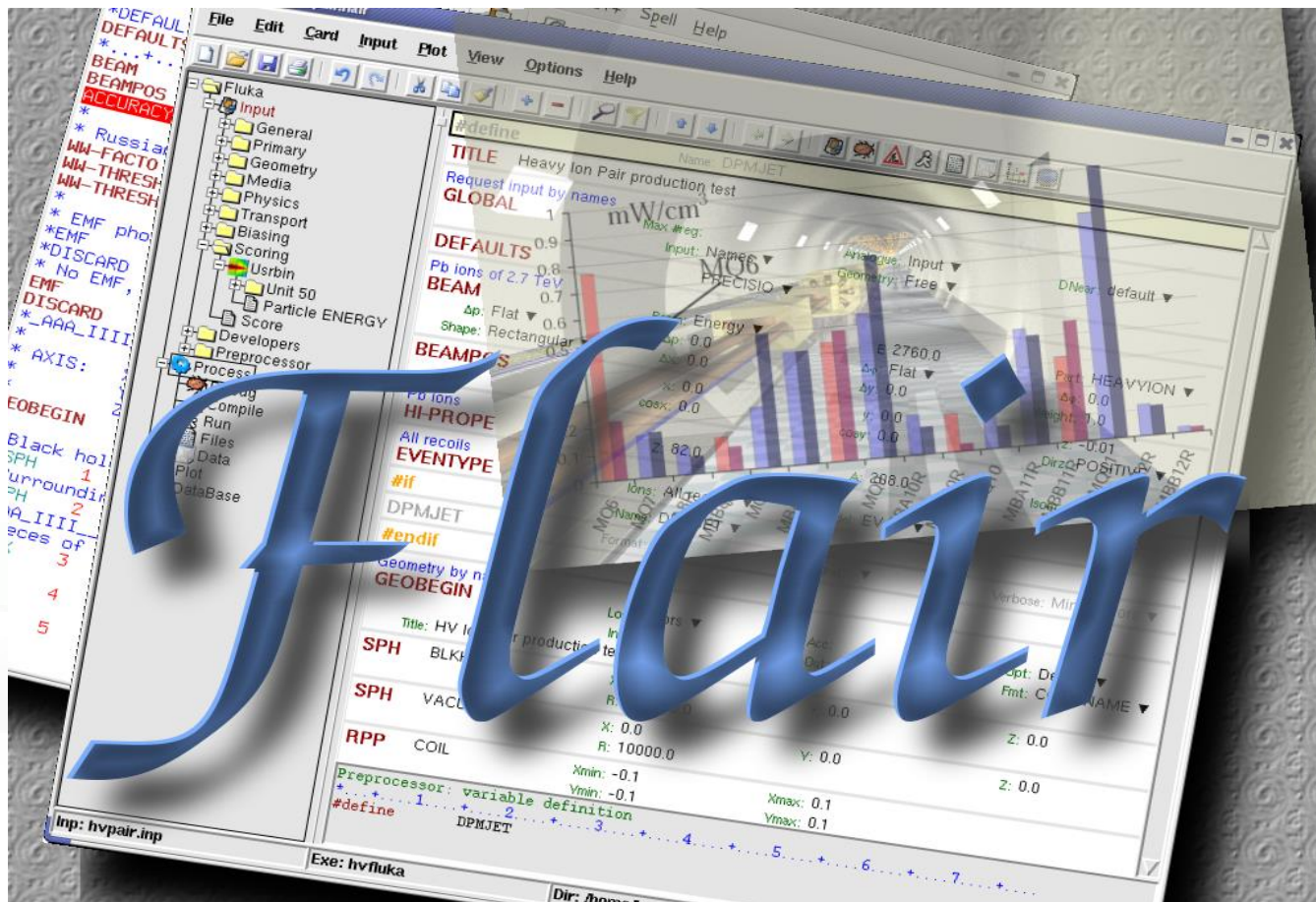




Flair Advanced Features

Advanced FLUKA 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 [1/2]

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 (tomorrows talk);
- **Compilation** of the FLUKA Executable;
- **Running** and **monitoring** of the status of a/many run(s)

What is flair [2/2]

Back-End interface:

- Inspection of the output files (core dumps and directories)
- Output file(s) viewer dividing into 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
- Nuclear wallet cards
- Library of materials
- DICOM images conversion to VOXEL geometries
- PET automatic geometry creator
- Programming python **API**
- Everything is accessible with keyboard shortcuts

Concepts: Flair Project

- Store in a **single text 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 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 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!

Command line options

Usage: flair [options] <filename | filename.flair | filename.inp>

Options:

- -d/D Activate/Deactivate the beta-development features
- -e exe Use exe as fluka executable
- -i inputfile Fluka input file (w/o the .inp extension)
- **-r** Load most recent project
- -R # Load recent project (number 1..10 or filename)
- **-l** List recent projects
- **-1** Load the first flair file in the folder

Interface

Tabs drag to rearrange or to undock

The screenshot displays the Flair software interface. At the top, a menu bar includes File, Edit, Card, Filter, and View. Below it is a toolbar with icons for Cut, Copy, Paste, Show, Comment, Refresh, Move Up, Move Down, Preprocessor, Material, Add, Change, Clone, and a search bar. The main window is titled 'Input' and contains a text editor with the following content:

```
#define jng 0
#define test2
#define test3 1
TITLE n_TOF lead target
GLOBAL Max #reg: Input: Names Analogue: DNear:
NEW-DEFAULT Energy
E: 0.3 Part: PROTON
Δφ: Gauss Δφ: 1.7
Shape(Y): Rectangular Δy:
y: -0.5 z: -10.0
Type: POSITIVE
cosx: 0.17364818 cosy:
Acc: Opt:
Inp: Out: Fmt: COMBNAME
```

Below the text editor is a table of parameters. The bottom of the window shows a 2D histogram plot with a color scale from 1 to 100. The status bar at the bottom indicates 'Inp: nt0f33.inp', 'Card:1', 'Displayed:80', and 'Total:82'. A green notification box in the bottom right corner reads: 'Loaded project', 'Project: nt0f33.flair', 'Input: nt0f33', 'Dir: /home/bnv/prg/physics/fluka/flair/examples'.

Program tabs

Dynamic Tab

Ribbon

Program page

Program page

Notification

Status bar

Quick access

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

Interface - Multi docking

The screenshot displays the ntof33.flair - flair software interface, which is designed for multi-docking. The main window is divided into several panels:

- Input Panel:** Contains a tree view on the left with categories like General, Primary, Geometry, Media, Physics, Transport, Biasing, Scoring, Flair, and Preprocessor. The main area shows a list of input parameters and their values, including:
 - #define 2 : 10
 - #define 3 : 1
 - #define 4 : 2
 - #define 5 : 1
 - GLOBAL Max #reg: Analogue: DNear: Input: Names Geometry: Free
 - DEFAULTS NEW-DEFAULT
 - BEAM Beam: Energy E: 0.3 Part: P
 - BEAMPOS x: 2.2632 y: -0.5 z: -
 - GEOBEGIN Log: Acc: Opt: Inp: Out: Fmt: C
 - Black body
 - SPH BLKBODY x: 0.0 y: 0.0 z: 0
 - \$start translat dx: =5*2 dy: 3.0 dz: 2
 - Void sphere
 - SPH VOID x: 0.0 y: 0.0 z: 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
 - RPP LEADTARGET Xmin: 40.0 Ymin: 40.0
 - *...1...2...3...4...5...#define ang 10
- Run Panel:** Contains a table with columns Run, Spawn, and Usrxxx. The table lists various detectors and their parameters, including:

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
- Output Panel:** Contains a table with columns Type, Process, and Status. The table lists various processes and their status, including:

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

The interface also includes a toolbar at the top with icons for Cut, Copy, Paste, Run, Files, Data, Add, Delete, Move Up, Move Down, Clone, Loop, Rename, Scan, Add, Remove, Refresh, Rules, Clean, and Process. The status bar at the bottom shows "Input: ntof33.inp" and "Files: 45".



Interface

Keyboard:

Almost everything is possible with the keyboard see manual for shortcuts

Ctrl-Enter: Execute most important action

Ins/Del: Add or Delete

Mouse:

right-click anywhere to get a popup menu

Listboxes:

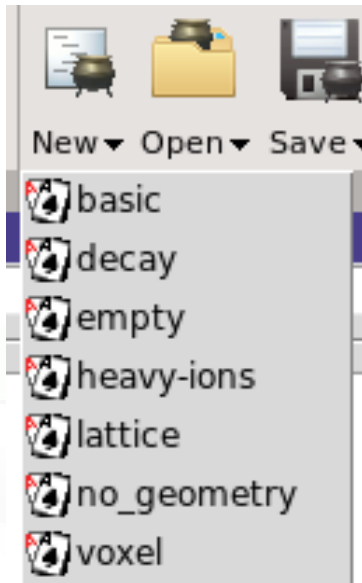
all listboxes are searchable. Typing only the characters (A-Z) and numbers (0-9) all other are ignored

LabelFrames:

can be collapsed/expanded by clicking on the label

Input Templates

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




Default template: **basic.inp**

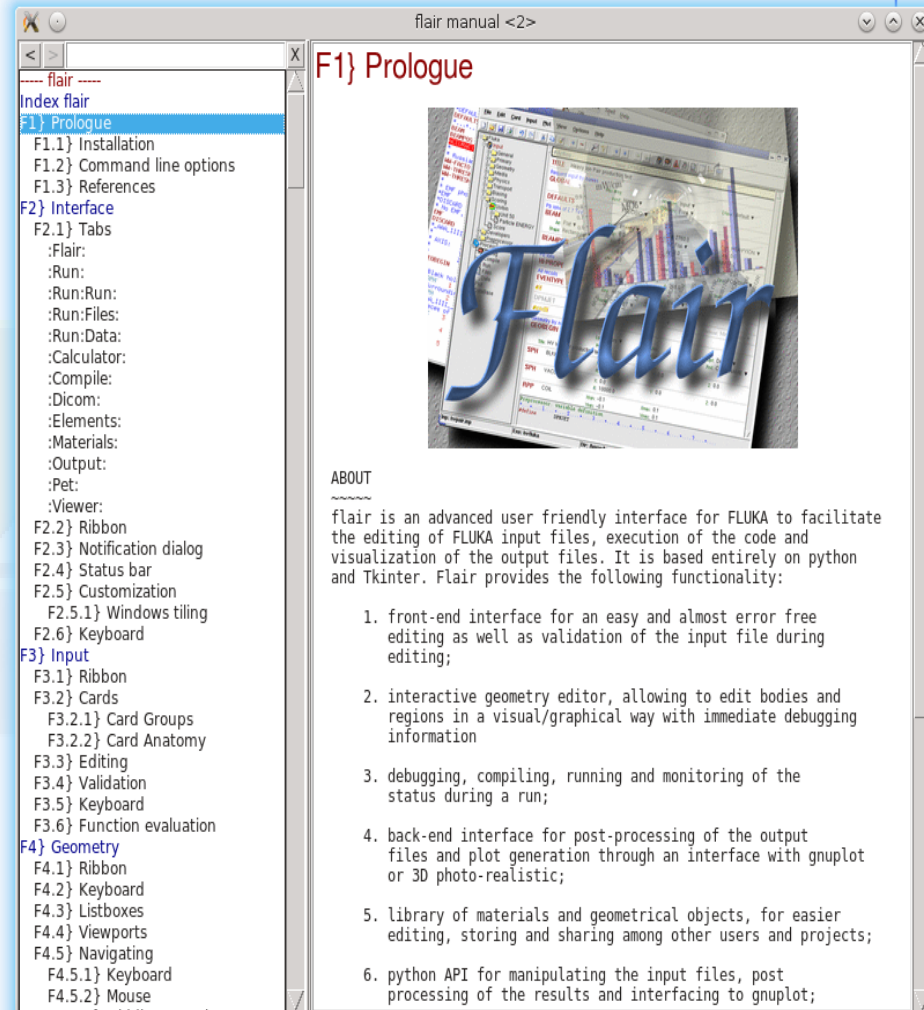
```

TITLE
GLOBAL                                1.0      1.0
DEFAULTS
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 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
    
```

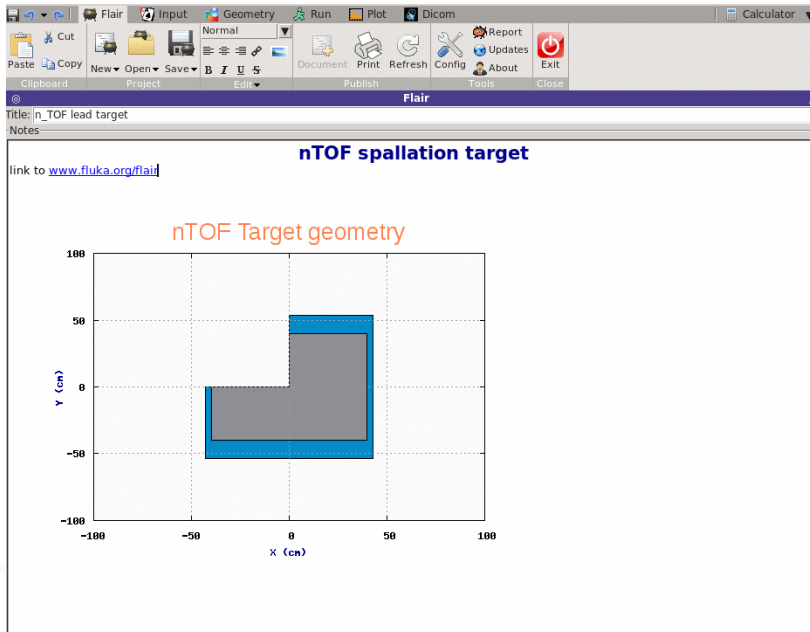
The user can create his own set of input templates. They are normal FLUKA input files and they have to be placed in the directory `~/.flair/templates` (create the directory if not existing)

Help

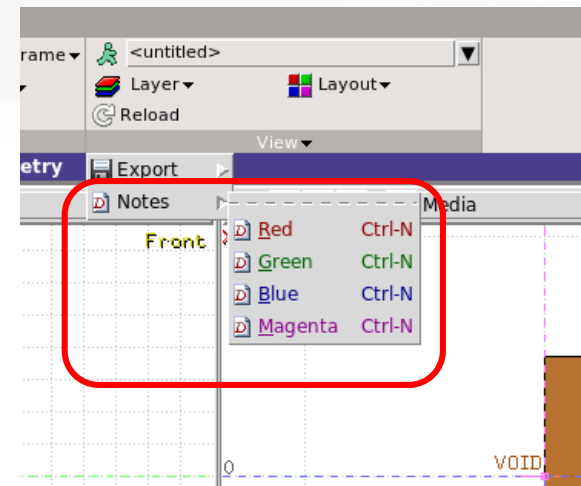
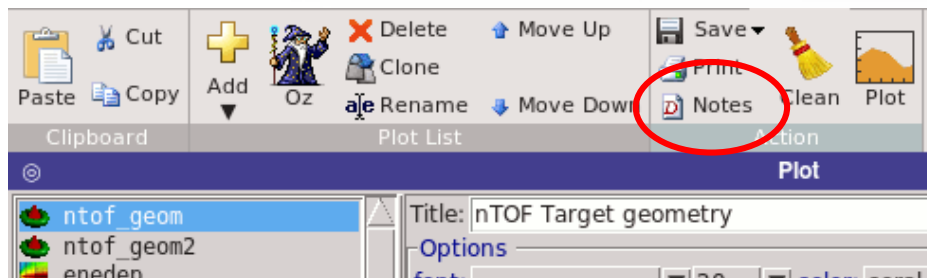
- [F1] or the help icon 
- Displays both the flair and the installed fluka manual
- Searchable:
 - **Filter** pages only with specific keywords (keeps history of keywords)
 - Type searching in the listbox
 - **Ctrl-F** to search for a keyword inside the displayed page



Page: Flair



- Notes, like a simple word processor. Accepts basic formatting, images and URLs to external documents.
- Any plot or geometry viewport can be inserted as an image inside the notes



Input

Display Active Cards of A Run Configuration

Material Database

Variables for parametric runs

Hide Card Interpretation

Manual Editing

Input Editor – 2: Import / Export

Importing

- **Input:** merge parts or entire input file with the current
- **Mcnp:** import mcnp geometry into FLUKA. (experimental)
- **Gdml:** import gdml geometries into FLUKA. Use of parenthesis on Macro bodies (e.g. polycone, xrtu...) which can lead to complicated geometry for FLUKA to handle. (experimental)

Exporting

- **Gnuplot:** save active plot to a gnuplot script
- **Makefile:** create a makefile for compiling the executable
- **Mcnp:** save input in MCNP format: Geometry, Materials, Importances
- **Povray:** save geometry into povray 3D format

Input Editor - 3

- Drag'n'drop from the TAG of the cards
- Double click on card TAG to select all similar cards
- Editing multiple cards: select cards and modifying the value in one card will propagate the change to all similar selected cards
- Ctrl-Double-Click Show/Hide selected cards
- #if..#endif, \$transform, \$translat or \$expand flair will enclose the selected cards with the #if #endif, or \$start_xxx, \$end_xxx transformation cards
- Popup Balloon tooltip displays short help:
 - for every option on every card
 - body description in the REGION expression
- Right-click: shows popup-menu
 - Quick filtering by REGION, MATERIAL, scoring etc...
- Easter Eggs: AWARI by Double-Right-Click on dialog showing the card representation as text at the bottom of the screen

Input Editor – 4

- Automatic indentation of nested **#if..#endif** and **\$start..\$end** directives.
- To refresh the display press **Ctrl-R**
- Each **REGION** can be split into many cards if needed to be used with preprocessor commands.
- Use as a name "&"

Void around

REGION VOID

Neigh: 5

Volume:

Expr: +void -target

#if BIAS ▼

REGION &

cont: -bias

#endif

Input Editor – 5: Function Evaluation

- Using functions (starting with the **=** “equal” symbol like in Excel) as arguments to the cards can make the input easier (or more complex) to read and manipulate
- Check manual “**F3.6 Function Evaluation**” for all possible functions/constants
- **Examples:**
 - **Units:** =10*MeV, =5*inch, =10*um, =2*hour, =5*cm*fwhm
 - **Physics:** =p2E(10*MeV, Mp), =X0(Z,A), dE2dp(E,dE,m)
 - **Card reference:** =w(1)+5.0*cm, =b(TARGET,2), =C(BEAM,1,1)
 - **Vector operations:** =cross({1.,0.,0}, {0.,1.,0.})
 - All mathematical functions are accepted

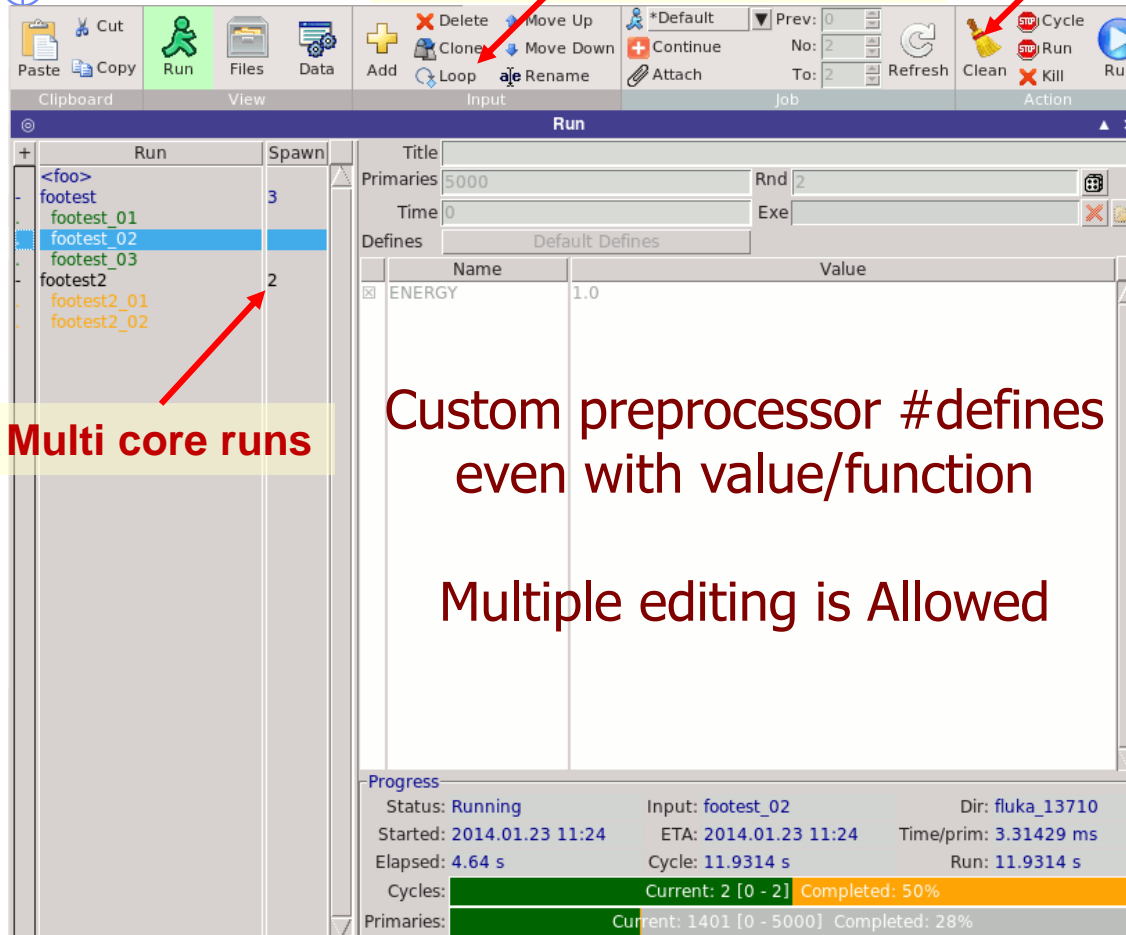
WARNING:

1. Functions are evaluated by flair and a FLUKA compatible input will be written.
2. If you modify with an external editor the input you need to reload it in flair make a change and save it.
3. The function evaluation is different than the **\$variable** from FLUKA
4. Python evaluation: $1/2=0$ $1.0/2 = 0.5$

Running

Run loops over a variable

Clean all run generated files



<inputname> refers to the input file AS IT IS in the input editor.

Create additional runs based on the same input file by overriding:

- Title
- Preprocessor definitions
- Random number seed
- Starting particles
- Execution timeout
- Executable

- Monitors the status of the run by inspecting the FLUKA output files. If **timeout** occurs try to re-**Attach** to the running process.
- The timeout is user-definable in the **Preferences** dialog

Running: How to use multicore CPU's

- Create clones of the current input e.g. **test.inp** named: test**1**.inp, test**2**.inp, test**3**.inp ...
- Assign a **different random number seed** on each run (Rnd entry). Incremental from the parent run.
- Select all in the listbox and click Run
- Check "**Preferences**" for changing the naming format

Multiple Selection:

- To modify **many runs** at the same time, select them in the listbox
- The options will be "*disabled*"
- **Right-click** on the options you want to **enable** and modify them
- Modify the filters in Data processing for summing up all cycles from all runs (see later)

Output Files

USBIN to ASCII format

Files pattern

The screenshot shows the FLUKA GUI. The 'Run' window is active, displaying a list of runs and cycles. The 'Files' panel is also visible, showing a list of files generated by the runs. A red arrow points from the 'USBIN to ASCII format' text to the 'Filter' input field in the Files panel. Another red arrow points from the 'Files pattern' text to the same 'Filter' input field.

Run	Spawn	Cycles	File	Type	Size	Date
<foo>		001	footest_02001_fort.22	22	2514	2014.01.23 11:
footest	3	002	ranfootest_02001	-file-	1651	2014.01.10 14:
footest_01		003	footest_02001.err	Error	6930	2014.01.23 11:
footest_02		compile	footest_02001_fort.21	21	160238	2014.01.23 11:
footest_03		data	footest_02001.log	Log	9519	2014.01.23 11:
footest2	2	fluka_19879	footest_02001.out	Output	99326	2014.01.23 11:
footest2_01		input	footest_02.out	Output	1129	2014.01.23 11:
footest2_02		plot				
		temporary				

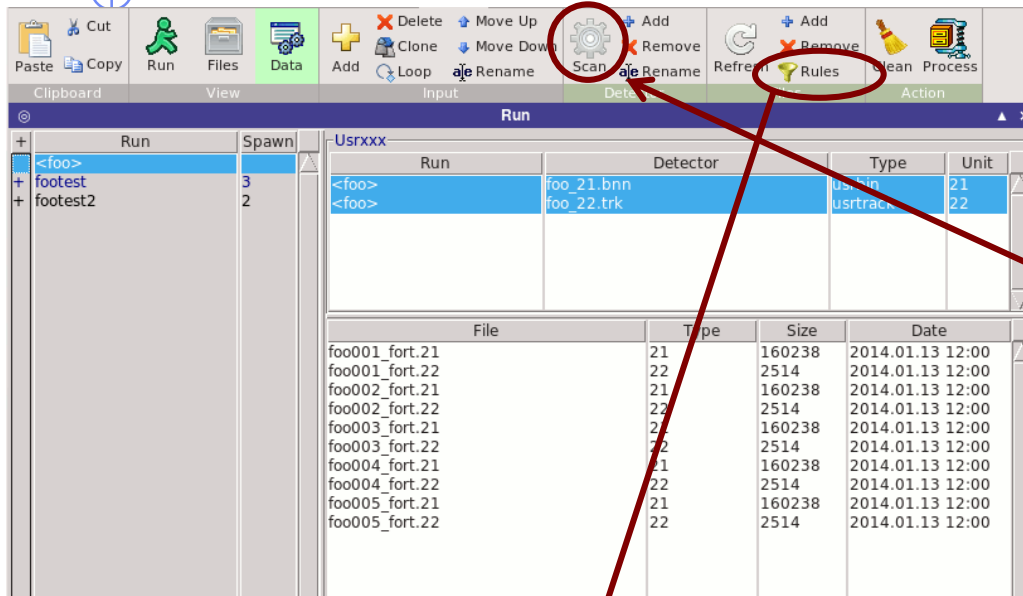
Inspect Output files generated by FLUKA classified per: **Run/Cycle**

As well special output files from **compilation data processing plotting and temporary**

Double clicking opens:

- Files in the file Viewer
- coredumps in debugger

Data Processing



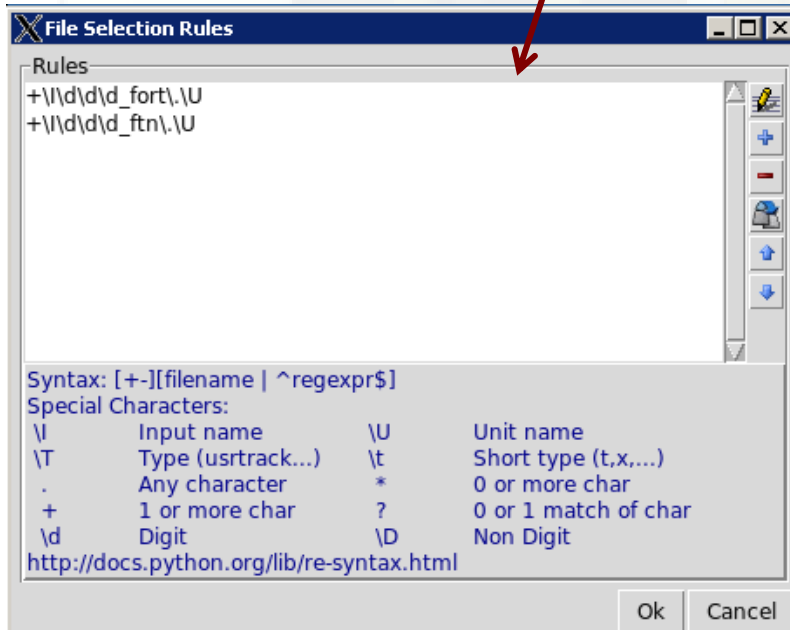
Process all scoring BINARY output files for each Run.

Name rules are defined in Preferences

Automatically scan input for scoring cards

+/- Modify file list by adding / removing items

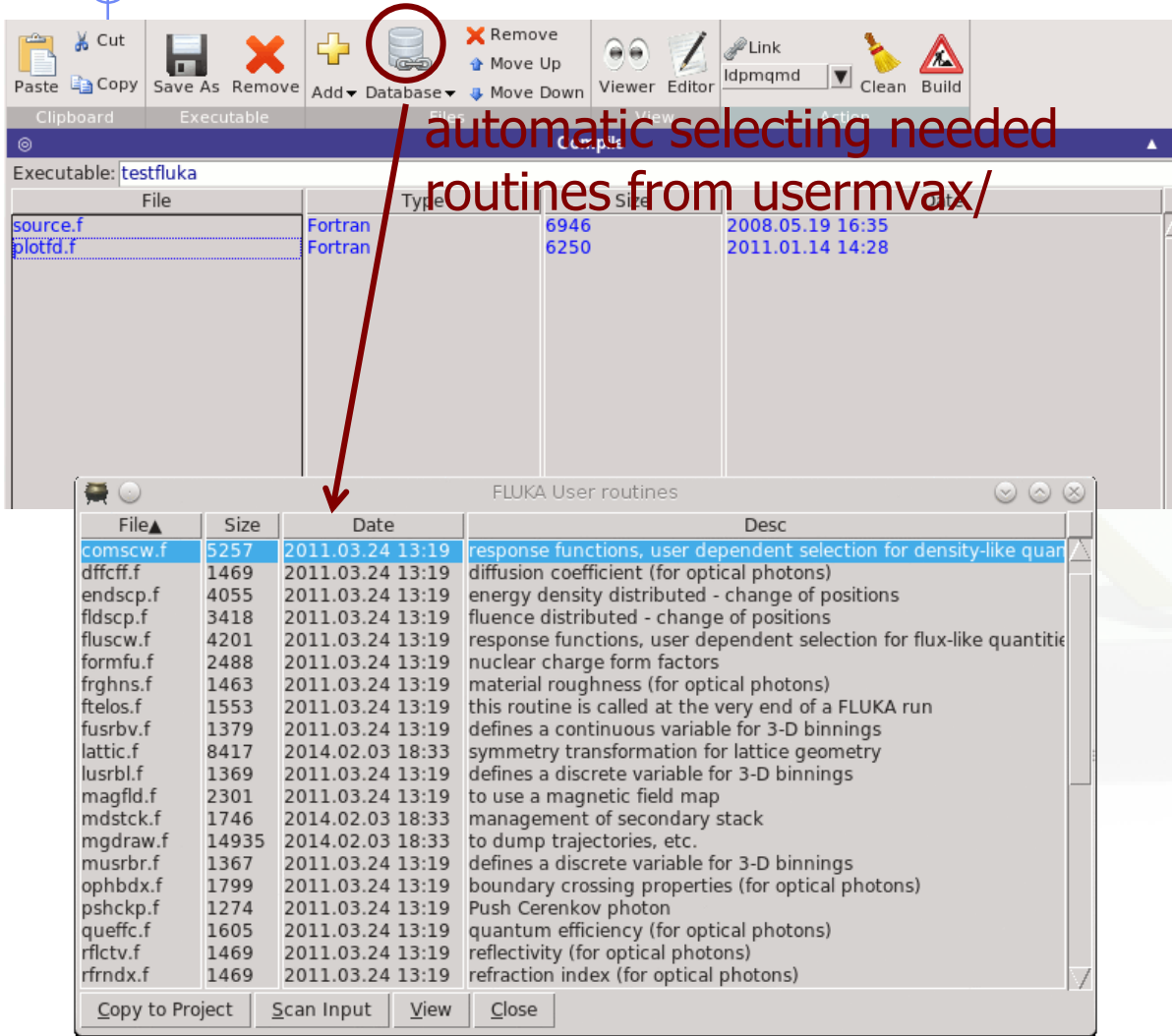
Dialog for editing scanning rules for files.



💡 To modify the rules for multiple scoring cards, select all Usrxxx before

💡 The default rules can be modified in the **Preferences Dialog**

Compiling



Filetypes accepted:

- Fortran: .f, .F, .for, .FOR
- C/C++: .c, .cpp, .cxx, .cc
- Libraries: .a, .so

Automatic scanning of necessary user routines and copying them to project folder.

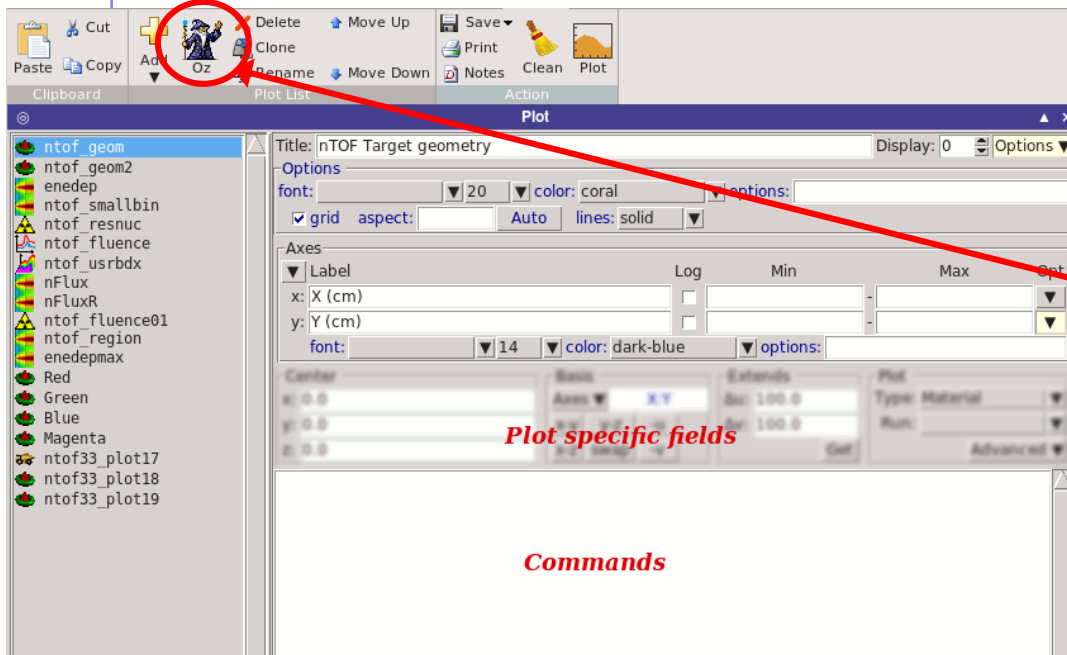
Build: behaves like a "makefile" compiles based on files timestamp when are newer

Compile: Forces compile of the selected files

Clean: cleanup of all produced files

When you are unsure, click on "Clean" before "Build"

Plots



It is important to set a **unique** filename for each plot. This filename will be used for every auxiliary file that the plot needs (the extension will change)

The **Wizard** button creates automatically one plot for each processed unit (From the default input file)

Multiple plots can be selected and modified. All changes on enabled fields will be propagated on selected plots

Right-click on disabled items to enable/disable the field during multiple editing

All plots share the same header and footer

Commands: allows to enter gnuplot commands for further customization

Plot Types

- **Geometry** For geometry plots
- **USRBIN** For plotting the output of USRBIN
- **USR-1D** To plot single differential quantities from cards **USRBDX, USRTRACK, USRCOLL, USRYIELD**
- **USR-2D** To plot double differential from **USRBDX**
- **RESNUCLE** To plot 1d or 2d distributions of **RESNUCLEi**
- **USERDUMP** To plot the output of USERDUMP. Useful for visualizing the source distribution (ToDo)

General Tips

- In the Configuration Dialog you can set global commands to execute before or after any plot
- The **output page** displays all the commands that are sent to gnuplot. As well as the errors. In case of problem always consult the output window!
- Multiple displays can be used to compare plots
- Advanced options are displayed by clicking the **"Options"/"Advanced"** buttons
- Additional axes can be found in the **"Axes"** button
- In the **Gnuplot commands** you can fully customize the plot by adding manually gnuplot commands:
- Special commands:
 - **plot, splot** with no options, defines the order where flair should insert the plot or splot command.
 - **replot <plot-cmd>** append extra plots to the one generated by flair

USRBIN Plots

Normalization could be plotted:

- 2D projection, 1D projection
- Trace of the maximum
- Full width at half maximum

The screenshot shows the 'Binning Detector' window. Red arrows point to the following elements:

- Usrbin file:** Points to the 'File' field containing 'ntof33_usrbin_50'.
- Detector:** Points to the 'Det' dropdown menu showing '1 EneDep'.
- Rebinning:** Points to the 'X' and 'Y' axis rebinning controls, which are set to 1.
- Swap axes:** Points to the 'swap' checkbox, which is currently unchecked.
- Get limits from gnuplot using right-mouse:** Points to the 'Get' button.
- Draw errors:** Points to the 'errors' checkbox, which is currently unchecked.
- Norm:** Points to the 'Norm' field, which is empty.

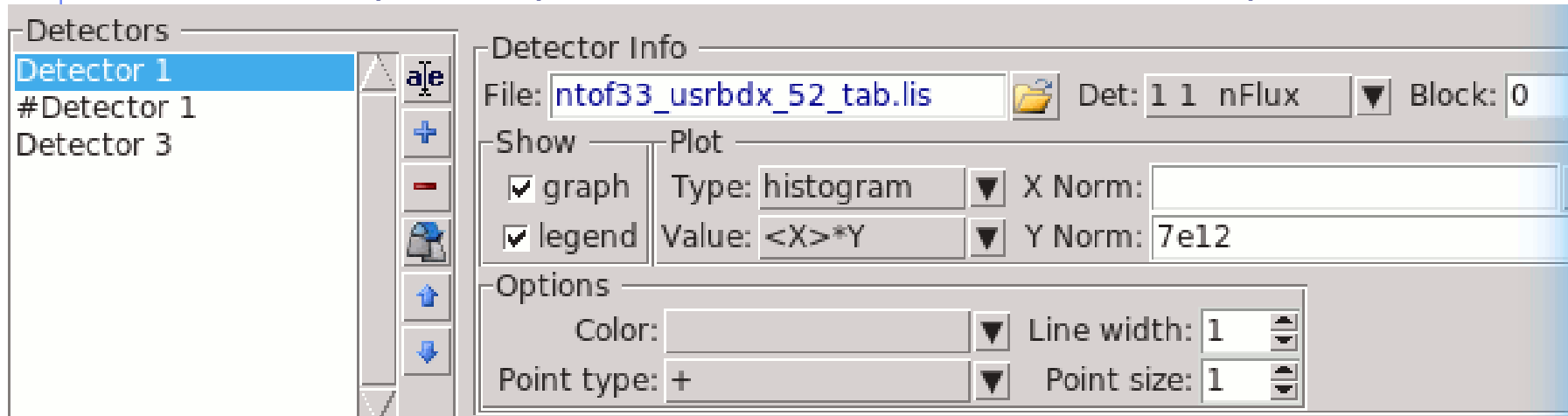
Other visible fields include 'Title: n_TOF lead target', 'Cycles: 4', 'Primaries: 2432', 'Weight: 2432.0', 'Time: *****', 'Sum file: *****', 'Min: 6.93416879E-10', 'Max: 0.204449102', 'Int: 6.18527894', 'Type: 2D Projection', 'Geometry Use: -Auto-', 'Pos: -15', and 'Axes: Auto'.

Normalization could be used as:
 number or expression evaluating in a number $65e-3/2.7$
 function with x as variable. e.g $E2T(x*65e-3/2.7)-293$
 with the function defined in the Gnuplot commands
 $E2T(x) = ((3.00629e-08*x-0.000108436)*x+1.01097)*x+311.839$

Draw errors. (combined with log)
 Correct only if one slice is used

USR-1D

- Multiple 1D plots can be displayed: USRBDX, USRTRACK, USRYIELD as well the “plot” output from USRBIN, RESNUCLEI,... or experimental data



- Detectors:** listbox to add graphs
- File:** detector file name (`_tab.lis` or `.dat`)
- Det:** Detector name or index
- Block:** multi-dimensional information, splitted into blocks
- Type:** drawing type (histogram, histerrors, lines,...)
- Value:** Y , $\langle X \rangle * Y$, $Dx * Y$
- X Norm:** to change units ($1/\text{eV}$,...)
- Y Norm:** normalization function like in USRBIN

Materials Database

Materials Database Interface:

Search:

Group: Biological, Elements, General, ICRU, Implantation, Liquids / Gases, Metal Alloys, Plastics / Polymers, Targets, User

Material List:

Material	Density	Stoichiometry
Mercury	13.546	Hg
728 Cyclohexanone	0.9478	H-10, C-6, O-1
Lead	11.35	Pb
Thallium	11.72	Tl
Cyclobutane	0.00125	H-8, C-4
1-Chlorobutane	0.8862	H-9, C-4, Cl-1
Sodium nitrate Na_N_O3	2.261	N-16.5, O-56.5, Na-27
Thulium	9.321	Tm
478 Hexene	0.673	C-6, H-12
Butane C4_H10	0.0024934	H-17.3, C-82.7

Material Properties: Title: Cyclobutane

Notes: Chemical Formula: C₄H₈

Names: Cyclobutane

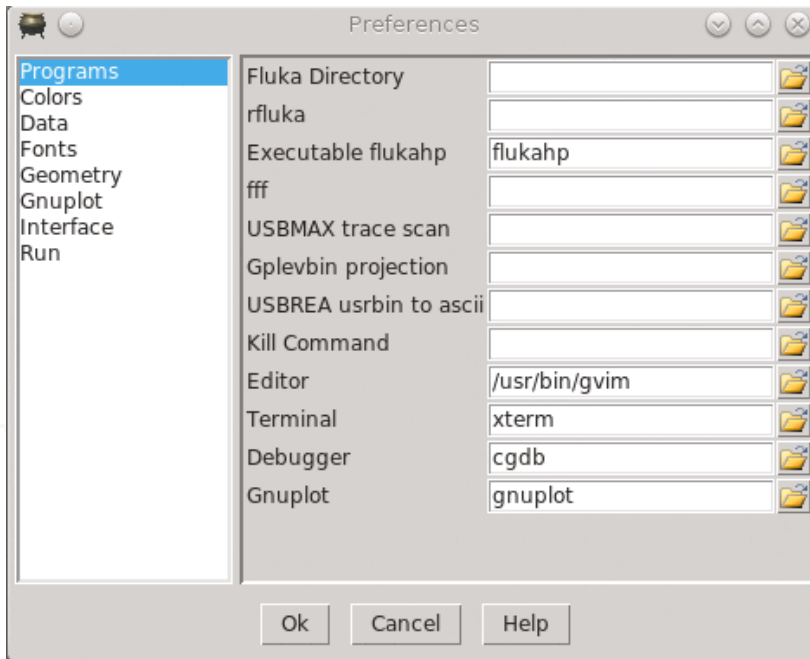
Edit the material database

- search database
- insert material to input
- add/del material edit material
- Grab materials from input
- Modify Stoichiometry and properties of material

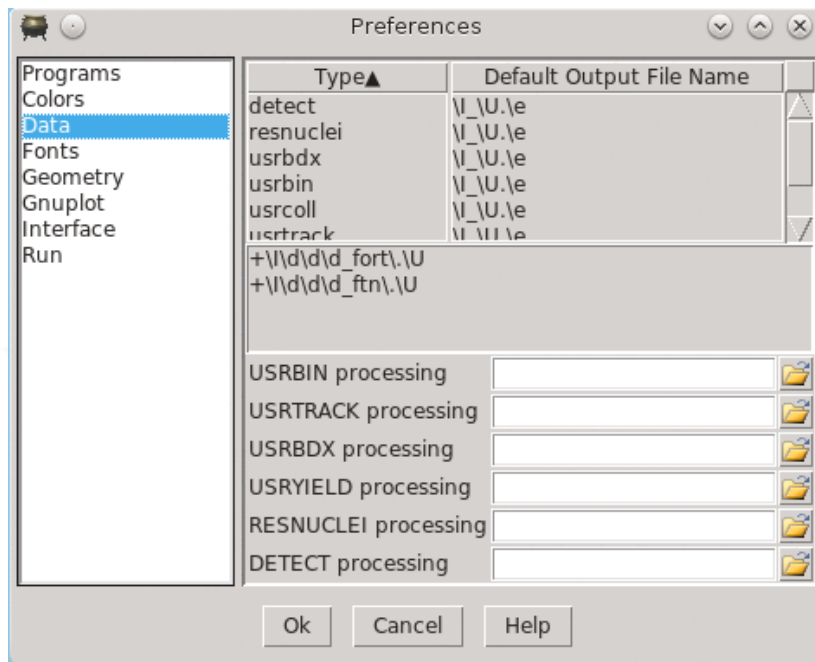
WARNING: When modifying the database a local copy will be created in ~/.flair folder, with the user changes

Configuration Dialog: Programs

- Set FLUKA directory
- Override default programs to use
- Processing programs are in the "Data" section



Configuration Dialog: Data



- Define how to generate the automatic filenames

\I will be replaced by input

\T by card name

\t by card character

usrbdx x

usrbin b

usrcoll c

usrtrack t

usryield y

resnuclei r

\U the abs(unit-number)

Configuration Dialog: Geometry

Laptop Mode:

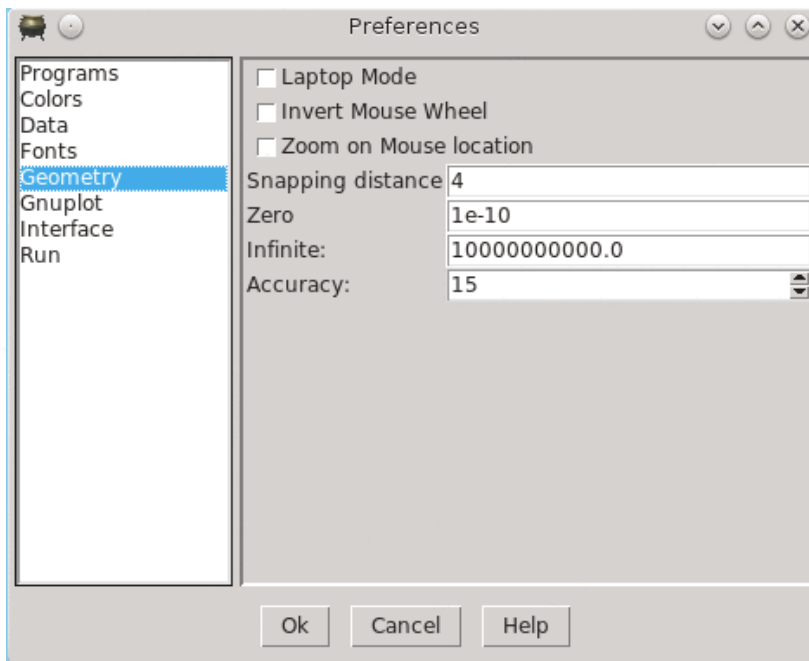
check to swap middle with right mouse buttons. Middle button is used in GeometryEditor for panning, zooming, rotating etc...

Zero:

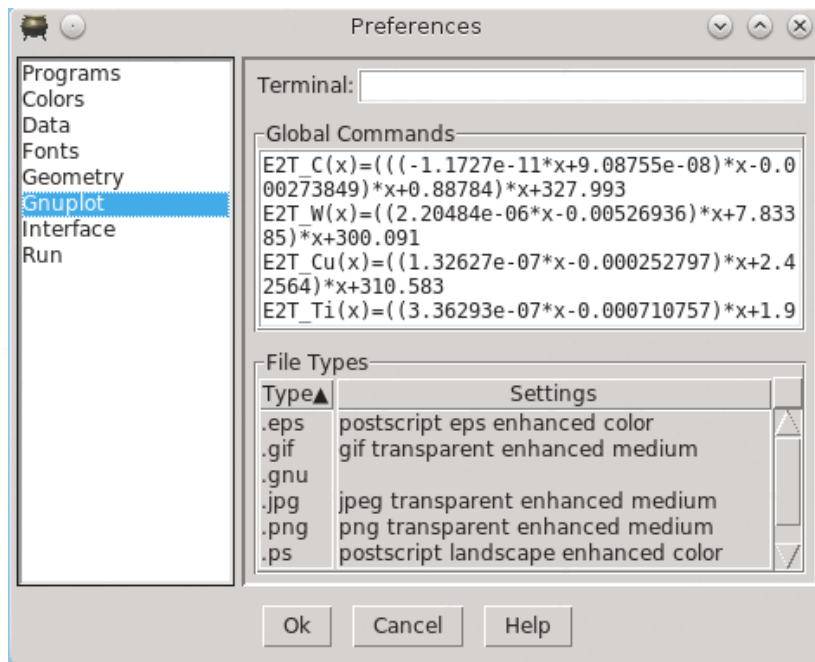
Infinite:

Accuracy:

same as in the Bodies Transformation dialog



Configuration Dialog: Gnuplot



Terminal:

additional options to supply to default terminal

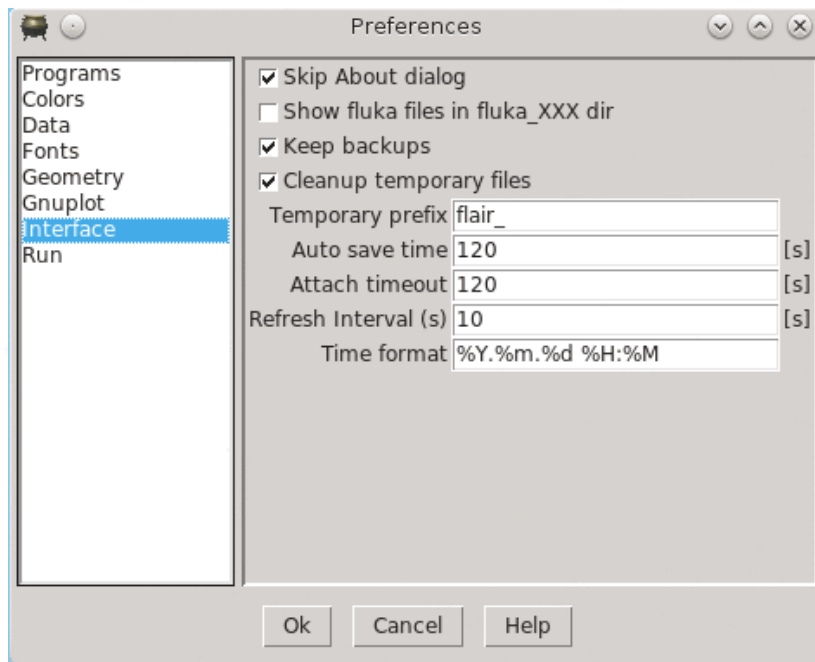
Global Commands:

gnuplot commands to be executed before any plot

File Types:

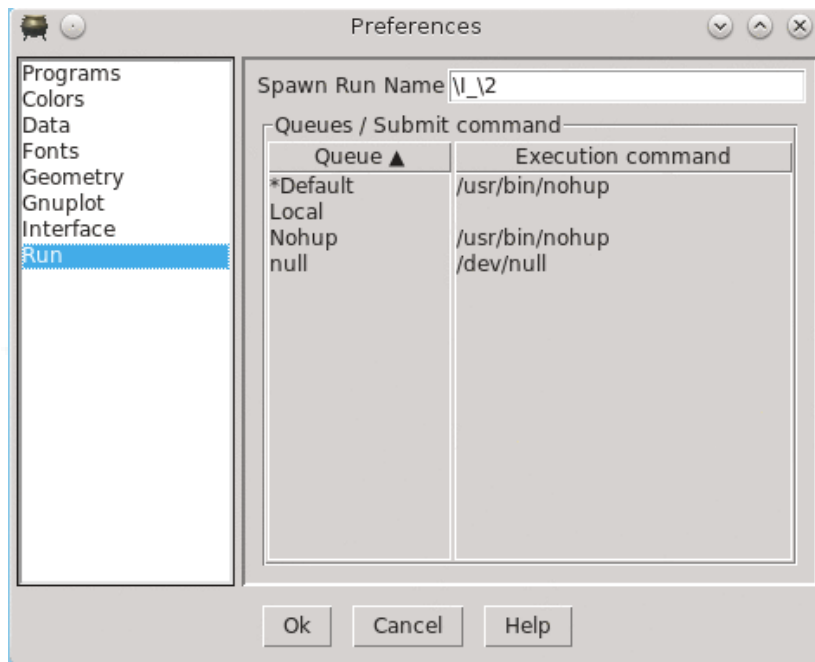
Right-click: to Add/Delete/Modify file types.

Configuration Dialog: Interface



- General interface settings
- Keep backups when files are saved as (file~)
- Automatically Cleanup temporary files. Disable only if you want to inspect files after Debug or Plot when an error occurs
- Key time to reset the type-in search in listboxes
- Balloon delay time
- Time format for files (follows python&C syntax)
- Time out to attach to a running simulation
- Automatic refresh interval of information

Configuration Dialog: Run



- Define rules for "spawn"ed named generation

Default: \I\A

\I input name

\A aa,ab,ac..

\A AA, AB, AC...

\n 1,2,3,...

\2 01, 02, 03, ...

\3 001, 002, 003...

\4 0001, 0002, 0003,...

e.g. To run in a subdirectory each job **\2/\I**

- Custom queues can be added in the list box (**Right-click** to add/remove a queue)
- Example qfluka.sh to submit on pbs/torque cluster system can be found on the flair web site

Programming Interface: API

There is work presently going on to decouple the functionality from the interface, some of the basic classes can be used to input processing

file: **Input.py** - to manipulate input files

```
import Input
```

`Input.init([database])` to initialize the database of cards

Most commonly used classes:

Card containing the description of each card

Input manipulating the FLUKA input file

file: **Project.py** - to manipulate project files

API: class Card

Constructor: `Input.Card(tag, what [,comment [,extra]])`
what is a list starting with `what[0]=sdum`

Important Methods:

<code>setWhat(n, value)</code>	set value to <code>what#n</code>
<code>nwhats()</code>	return number of whats
<code>what(n)</code>	return value of <code>what#n</code>
<code>numWhat(n)</code>	return numeric value of <code>what#n</code>
<code>intWhat(n)</code>	return integer value of <code>what#n</code>
<code>clone()</code>	return a copy of the card
<code>setEnabled(e)</code>	enable/disable card

API: class Input

Constructor: `Input.Input()`

initialize the structure to hold an input file

Important Variables:

cardlist

a list with pointers to cards

cards

a dictionary with pointers to cards grouped per tag

Important Methods:

`read(filename)`

read input from file

`write(filename)`

write input to filename

`addCard(card,pos)`

add card to position pos (or end of file)

`delCard(pos)`

delete card from position pos

`preprocess()`

preprocess input to check for active cards

`setEnabled(e)`

enable/disable card

API: class Project

Constructor: `Project.Project()`
initialize the structure to hold a project file

Important Methods:

<code>clear()</code>	to re-initialize project
<code>load(filename)</code>	load project from file filename
<code>save([filename])</code>	save project to filename
<code>runCmd(run)</code>	create run command

API: example

Read an input file and modify the random number seed

```
import Input
inp = Input.Input()
inp.read("test.inp")
try:
    rndcard = self.cards["RANDOMIZ"][0]
    rndcard.setWhat(2,5723)
except:
    print "No RANDOMIZE card found"
    sys.exit(0)
inp.write("test2.inp")
```


API: .flair file structure

comments

Variable: Value

Notes:

multi-line values are terminated with
Ctrl-L

Run: name

...

Block of Run related information

Data:

...

... Including Data processing information

EndData

EndRun

Plot: name

...

Plot related informations

EndPlot