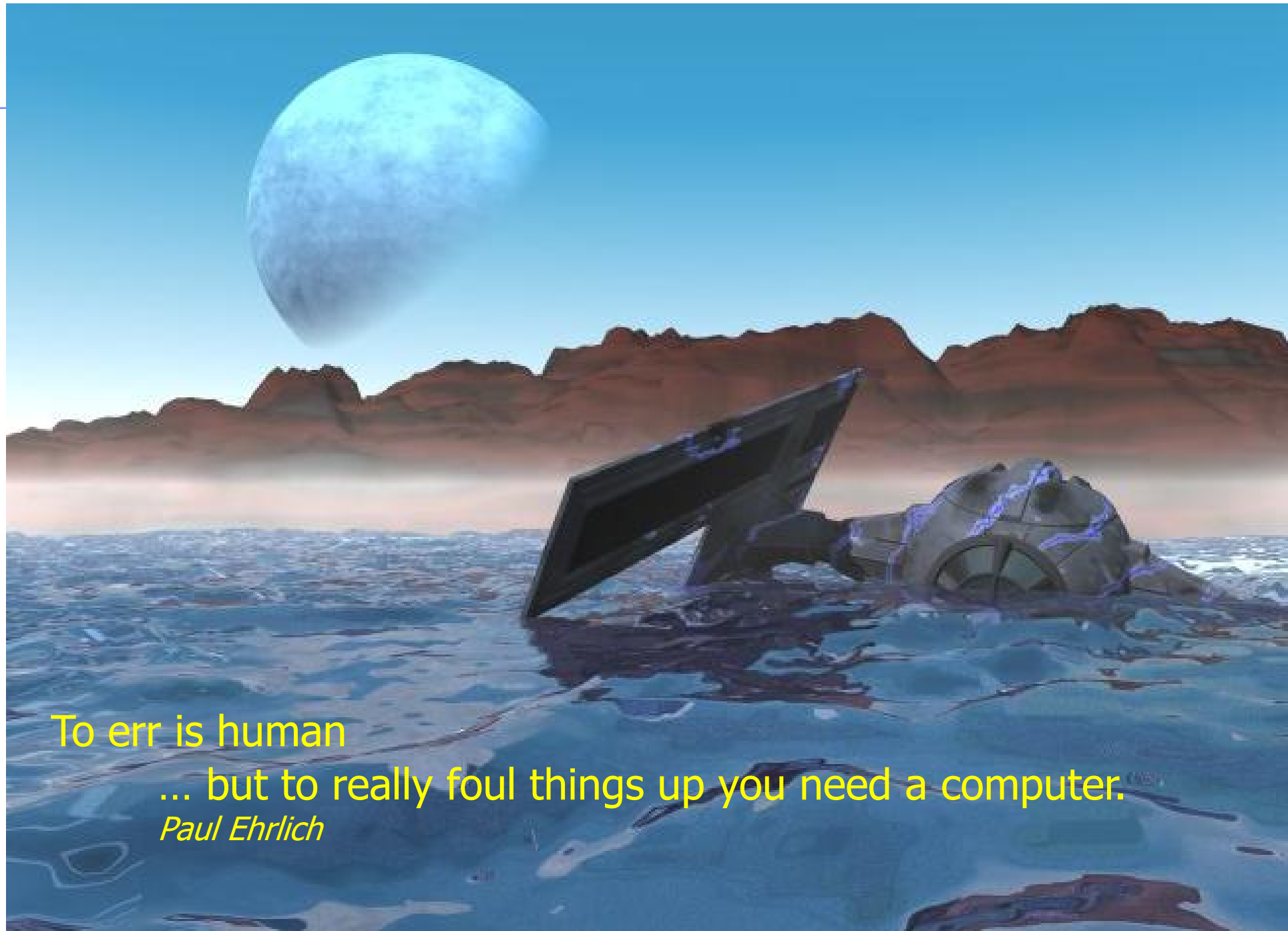


The slide features a decorative layout with blue lines and corner ornaments. A vertical line on the left and a horizontal line at the top intersect at a small blue circle in the top-left corner. Another horizontal line is positioned below the main title. A vertical line on the right and a horizontal line at the bottom intersect at a small blue circle in the bottom-right corner.

Handling of Errors and Crashes

21st FLUKA Beginners' Course
ALBA Synchrotron (Spain)
April 8-12, 2019



To err is human

... but to really foul things up you need a computer.

Paul Ehrlich



DON'T PANIC

Overview

Sometimes the users get crashes...

Sometimes results look weird...

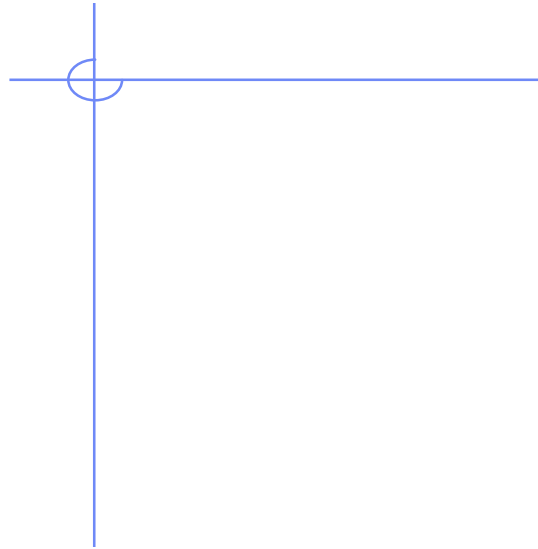
- Often, these are simple problems the users can address and solve on their own: the first purpose of this lecture is to help you to identify this type of errors.
- In few other cases, a real FLUKA problem is found: the second purpose of this lecture is to help you to spot these types of errors
- Other error cases mainly deal with the sensibleness of the results and the best approach to simulations

Overview

Typical errors:

- Installation problems
- Crashes at run initialization, usually due to mistyping / wrong setting of cards in the input file
- Crashes while tracking particles (typically due to geometry)
- Problems found after the end of the simulation, usually due to subtle errors in the input file

NB: non-trivial crashes at runtime which are not explicitly related to geometry issues typically require the use of gdb...



Installation problems

Installation problems

- Nothing happens, or “executable not found” message in FLAIR
 - Check you have the proper version of FLUKA for your platform and you have all packages needed for compiling and executing Fortran programs

For LINUX distributions, you generally need:

g77 , compat-gcc-34-g77 or gfortran, libg2c

(check the supported versions on the RELEASE-NOTES file included in the distribution)

- Verify your **\$FLUPRO** environment variable is properly set (in .bashrc, .tcshrc, .cshrc...). Check also the preferences panel (config) in FLAIR.

Installation problems

- In the .out file you get a message like this:

```
**** This version is obsolete and is      ****
**** going expire in few days.           ****
**** Please contact the FLUKA list       ****
**** or look for an updated version      ****
**** at http://www.fluka.org          ****
```

- update your version of FLUKA
- “make” again
- re-link your executable

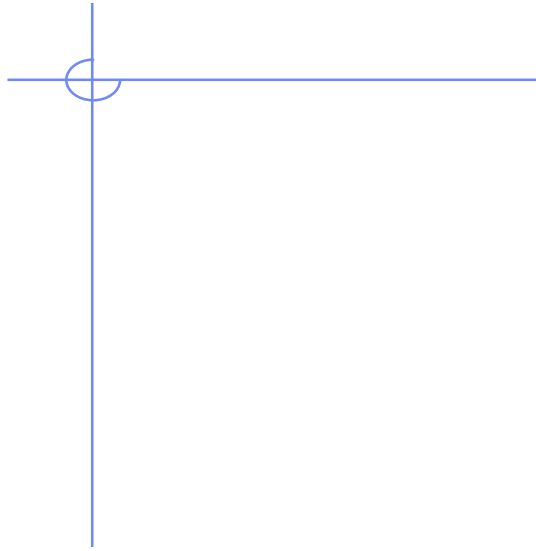
Starting a run

If you see a message a la:

ERROR: Running in the FLUKA folder XXXX is a very bad idea

.... it means you are running a FLUKA run in \$FLUPRO. This is not a good idea....

DO NOT RUN inside the FLUKA folder!!



Crashes at run initialization

Crashes at run initialization: general

The following message appears on the terminal (or in the *inpname.out* file then using Flair) and no results are produced:

```
Removing links  
Removing temporary files  
Saving output and random number seed  
No ranexample16_2002 generated!
```

Look at the BEGINNING of the .log and at the END of the *.out/.err* files and check for Messages. These files can be located in:

- your working directory
- temporary subdir *fluka_#####*
- Output Files window in FLAIR

The *.err file: not only errors

The *.err file will report errors, but also a lot of warning messages which have a meaning mostly for the developers.

For instance: the following messages are not errors!

```
*** Frmbrk: we are dealing with a bag of 8 164.306992
*** Frmbrk: we are dealing with a bag of 7 186.47261
*** Frmbrk: a bag of 10 identical nucleons, cannot be managed ***
```

Additional useful information is written to the .err file:

```
NEXT SEEDS:171B5708      1      0      0      0      0 33B49B1      0      0      0
220000      780000      780000      1.6305137E-02      1.0000000E+30      2853
NEXT SEEDS:1E5C731D      1      0      0      0      0 33B49B1      0      0      0
*** EVENTD: IJ,IBAR(IJ),ICH(IJ),IBTAR,ICHTAR,PPERNU -6 4 2 12 6 67.0629729
ECKDPM,PXKDPM,PYKDPM,PZKDPM -2.61119861 0.000579929462 -0.0154642238
-2.52471092
KP,IBRSNC(KP),ICRSNC(KP),TVRSNC(KP),ANRSNC(KP),EKRSNC(KP) 1 9 5 0.0885864878
8.39331037 0.00395470202
```

**No. of events
simulated so far**

**No. of events
remaining to be simulated**

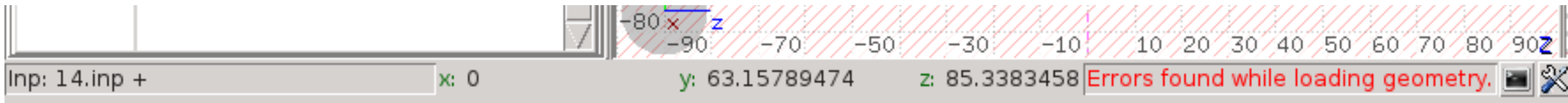
Formatting errors in the .inp file

This type of error was very common before the development of FLAIR


- FLUKA echoes all the parsed lines of the *.inp file in the *.out file
In case of problems, the echo stops at the last card correctly interpreted
WARNING: FLUKA reads the input file in many passages, therefore, the order of the echoed cards does not necessarily correspond to the order in the .inp file!
- In case the problem is located in the geometry declaration, please have a look also at the fort.16 file in the fluka_##### temporary subdirectory
- Some non visible control characters (e.g. tab, \t, \n, ^M) may inadvertently be present in the input file. You can clean your input using text editors, perl or "dos2unix" Linux command. TIP: some mail clients can show these characters
- Remember to *always* check the first cycle you requested (e.g. *_001.out)
- Remember that the total length of a line in FREE format is 132 characters

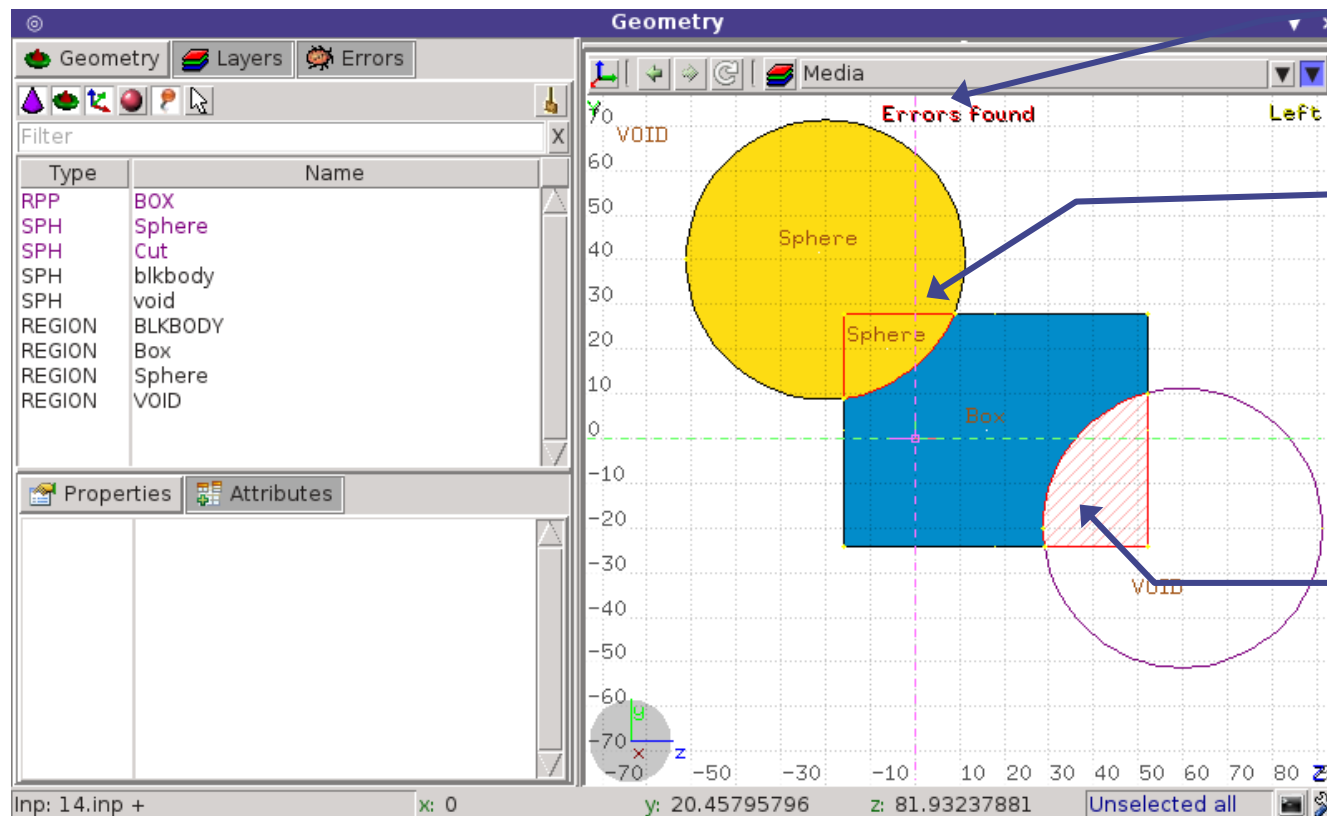
Geometry Errors

- The Geometry Editor allows to spot geometry errors when the .inp file is parsed/updated (recall dedicated lecture!)
- A warning message in the Geometry status bar notifies the user about the presence of geometry errors
- A warning is also issued for not strictly geometrical errors (e.g.: missing material assignment to a region, unknown card...)



Geometry Errors

- Affected areas are surrounded by red lines:
 - Areas filled with a full color correspond to overlapping regions
 - Areas filled with red lines correspond to a missing region definition
- Clicking the  Errors icon displays the dialog box with the errors
- Touching surfaces are checked against 10 significant digits

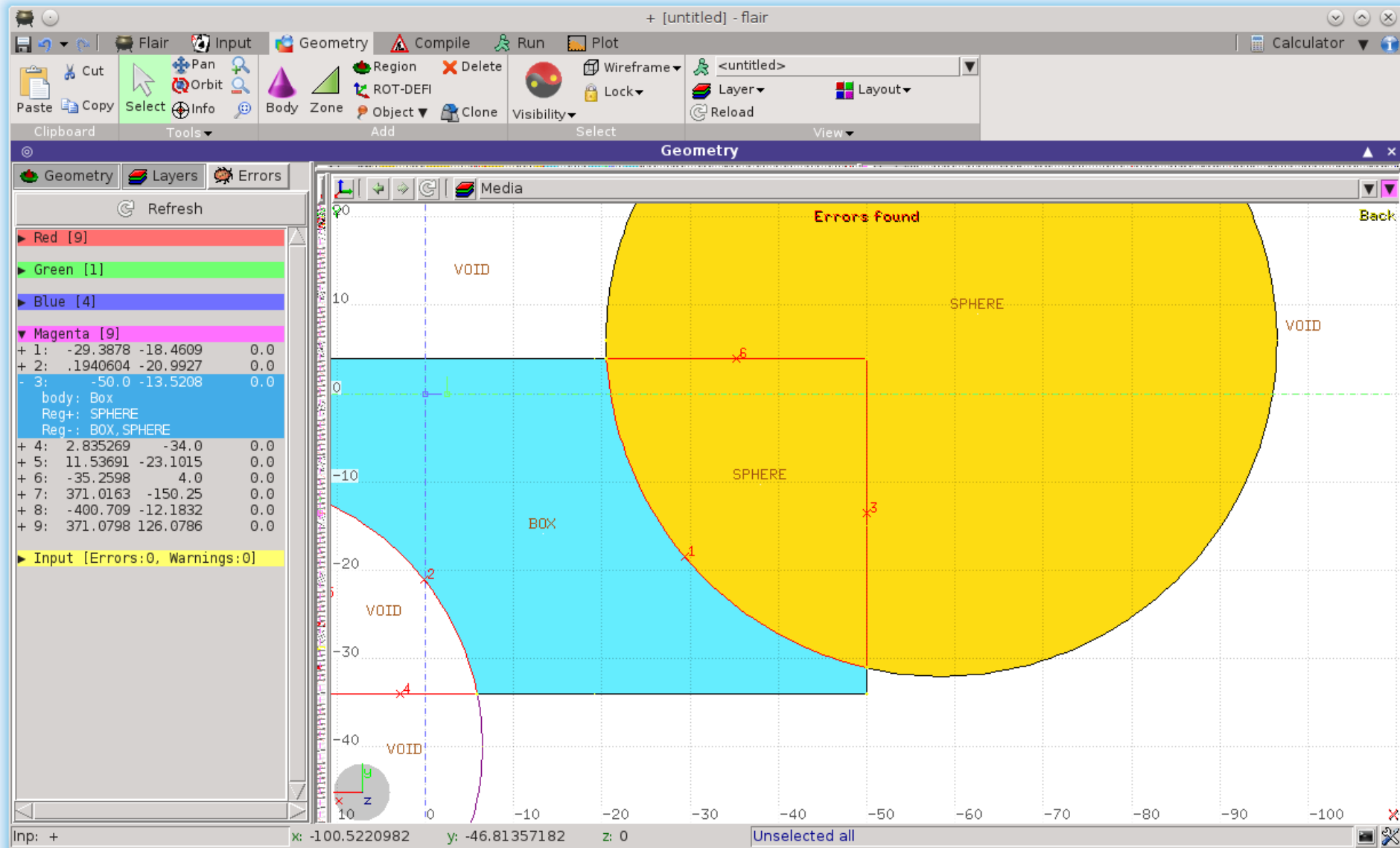


Presence of errors

Overlapping regions

Missing region definition

Geometry Errors



Geometry: parentheses expansion

At the initialization of the geometry, you may get this kind of message in the first line of `.log` file:

```
Subscript out of range on file line 56, procedure rpnorm.f/rpnorm
Attempt to access the 114705-th element of variable tx
```

You have exceeded the maximum expansion limit for parenthesis, set to 100000

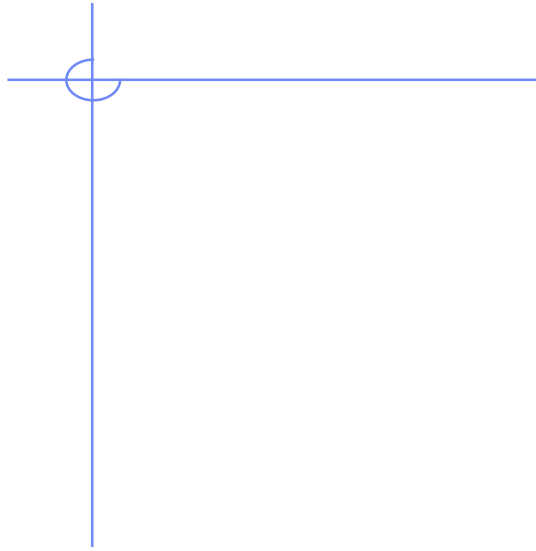
WARNING even with a simple region expression this limit can be reached, especially if you are using infinite bodies!

Re-write the geometry in such a way to diminish the Number of parenthesis e.g. using the OR (pipe) to make the union of different zones



Frequent input-file errors**

**A few common mistakes are in spare slides 42-44
More details/warnings will be given throughout the week



Crashes during tracking

Crashes during tracking: geometry

- Typical message due to errors in geometry

Abort called from FLKAG1 reason TOO MANY ERRORS IN GEOMETRY Run stopped!
STOP TOO MANY ERRORS IN GEOMETRY

Did you debug your geometry?????????

- Look in the .err/.out files to better direct your debugging
- Consider also the use of the **RAY** particle to trace and analyze your geometry. **WARNING**: this is an advanced topic not covered in this course (see the Manual chapter 14)

Crashes during tracking: geometry

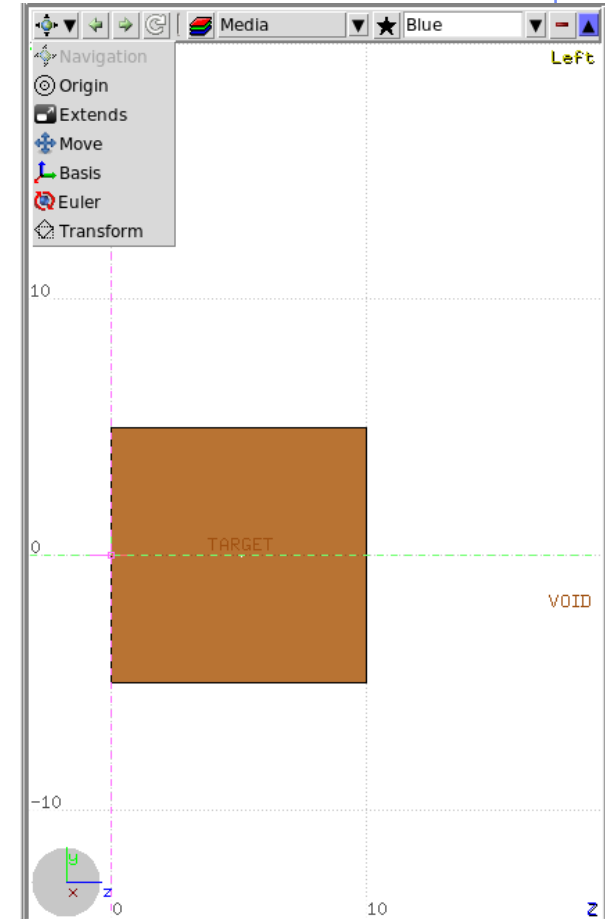
```
Geofar: Particle in region 3 (cell # 0) in position
1.000000000E+00 0.000000000E+00 1.000000000E+00 is now causing
trouble, requesting a step of 6.258867675E-07 cm to direction -
2.285059979E-01 -9.412338141E-01 2.487245789E-01, error count:
0 [...skipped...] Particle index 3 total energy 5.189748600E-04
GeV Nsurf 0 We succeeded in saving the particle: current region
is n. 2 (cell # 0)
```

- GEOFAR errors (.out/.err file) during tracking, point to:
 - errors in the geometry
 - numerical precision errors
- The problematic point is given by $\text{position} + \text{step} * \text{direction}$
- (LATTICES are VERY sensitive to numerical precision: use as many digits as possible to ensure a proper description of the lattice, the related transformation and the prototype)

Tip: To find the position in the geometry viewer

- Either you do the math: $\text{position} + \text{step} * \text{direction}$
.... and navigate to that position in Flair
- Alternatively, in Flair's geometry editor:
 - Open the projection dialog [O]
 - Origin: Enter the X,Y,Z coordinates of the position
 - Basis: Enter as U vector the directory
 - Move: enter as +U: the step

And you will end up in the error location



It runs, but...

...something seems wrong...

...you do not understand the results

LOOK in the output file!

what?

everything, of course!

a few examples follow, you'll find out more on your own

RANDOMIZ card

- You run several cycles and the statistical errors appears to be **ZERO**
Most probably you are starting the same histories on every cycle

This is a typical error if the **RANDOMIZe** card does not exist!

Verify the existence of **RANDOMIZe** card and that **WHAT(1)=1.0**

- You get the following message in the *.out file

```
**** No Random file available !!!!! ****
```

```
Abort called from FLRM64 reason NO RANDOM FILE Run stopped!
```

```
STOP NO RANDOM FILE
```

Most probably the error occurred during the previous cycle which didn't generate random number seed for the current cycle, whereupon the program halts.

Cards defining the beam

The total/partial energy balance does not meet expectations:

- Remember that for HEAVY IONS the kinetic Energy or Momentum in the **BEAM** card is given **PER NUCLEON**, while in all other cards the energy is the total kinetic one: check the numbers in the beam section of the .out file
- Check if you selected Energy or Momentum in BEAM
- Verify that your primary source **BEAMPOS** is **NOT defined on a surface boundary**, but always inside a region

MATERIAL / COMPOUND cards

The total/partial energy balance does not meet your expectations or particle fluences show discontinuities

Check:

- the **density** is defined for all MATERIALS
- **Z** and **A** are given in case of a **specific isotope**
- mixing **fractions** (and signs!) in COMPOUND cards
- Check syntax using Flair

Geometry induced weird results

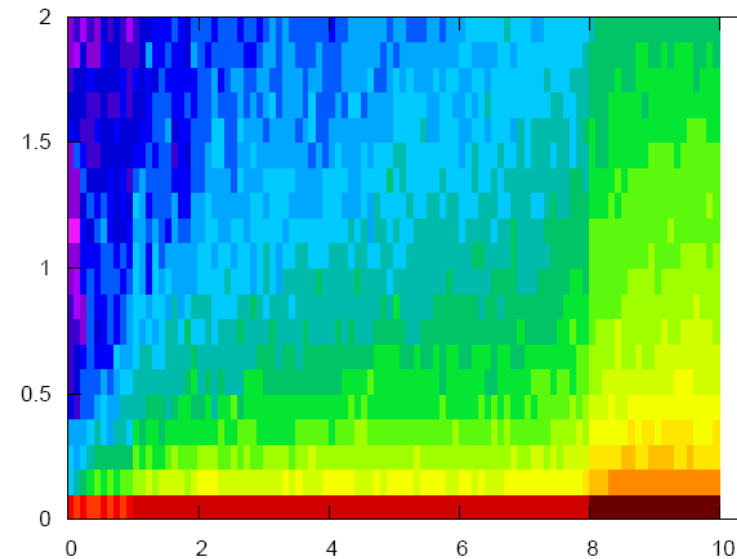
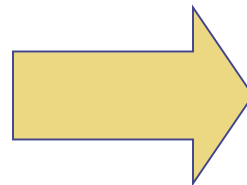
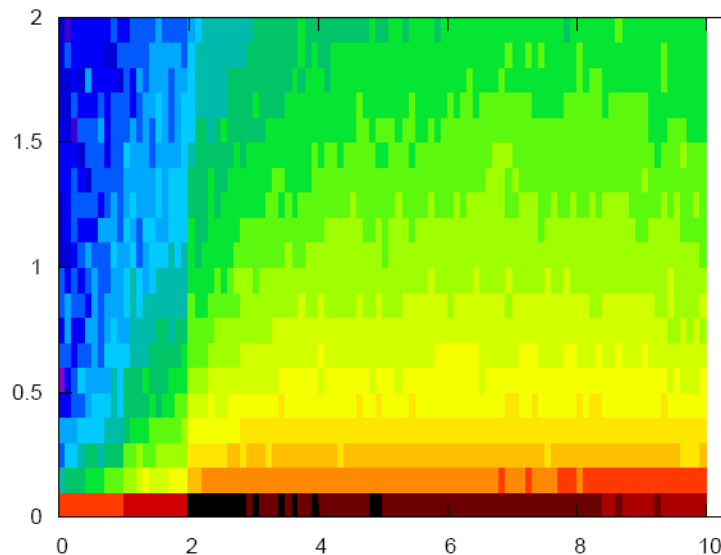
Possible symptoms:

- the energy/fluence among different regions is not as expected
- problems with boundary-crossing estimators (low fluences, empty data...)

Did you debug your geometry????????

Overlapping regions are **NOT** detected by FLUKA at initialization, and do **NOT** cause run-time errors.

Example: in ex12 target, make targs2 overlap with targs3



Preprocessor

Preprocessor directives (see basic input lecture) are very powerful, but pay attention to nesting:

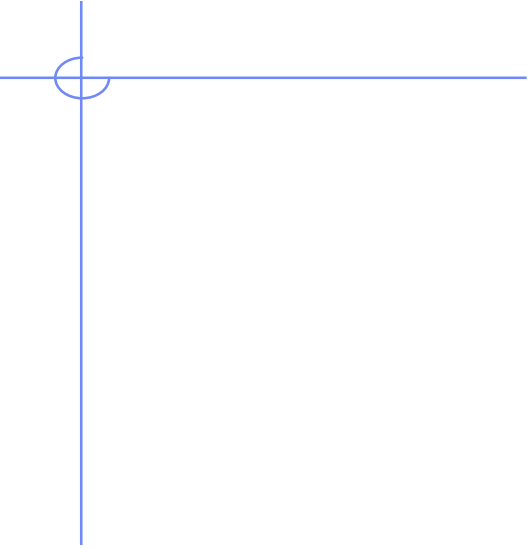
- every **#if** directive must have its closing **#endif** directive;
- Up to 10 nested levels are allowed;
- Up to 40 variables can be defined;

Merging cycles from different jobs

- Verify that you merge cycles for which the .inp files differ only by the RANDOMIZ card
- It is a good habit to remove the files before starting a run:
 - Flair offers this possibility to “Clean” the generated files from each process: Hit the button “Clean” before a run
 - It’s good to develop the habit to remove the output files **from test runs**

FLUKA users and the manual

The identification of the solution to all the problems shown so far, imply that a FLUKA user lives **symbiotically** with the Manual....



Now PANIC

Run time errors with exceptions

You get a message on terminal like:

```
===== Running FLUKA for cycle # 1 =====  
/disk3/flukanew/flutil/rfluka: line 309: 30048 Aborted (core dumped) $!EXE} <$INPF 2>$LOGF >$LOGF
```

The temporary fluka_##### subdirs remain, with the *.log, *.out, *.err files, a core.* file and the last random seed

The last random seed allows to restart the run from the configuration occurring at maximum 5 minutes of CPU-time before the error!

Run time errors with exceptions

Suggestions:

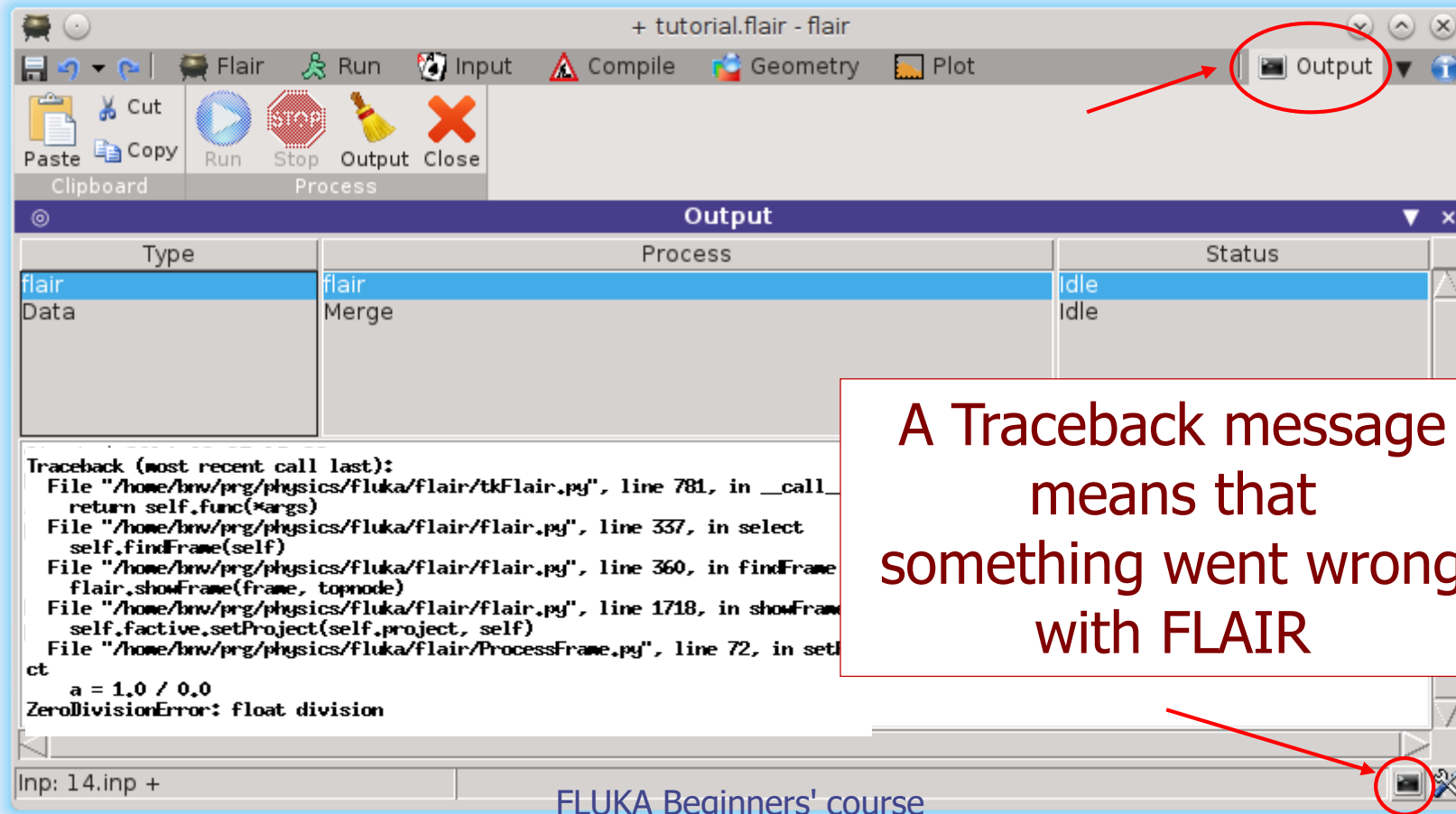
1. Check the end of *.out / *.err files or the beginning of the *.log file:
 - they may contain important information for you or for the experts
 - the code has many internal checks, and some error conditions are recorded
2. Maybe there is a very well hidden geometry problem

Reading errors

- On Unit 14: your nuclear.bin file might be corrupted or missing (check all your binary files in \$FLUPRO) or doesn't match the FLUKA distribution
- On Unit 1: leads to a problem with the random seed.
It typically happens when you start the simulation with a **rfluka** command with option **-N n** with $n > 0$: check for the existence of **ran***n** in the directory where you issue **rfluka**!

Flair output window

- The output window of FLAIR contains all messages from FLAIR, FLUKA, processing, and plotting tools
- Always consult it in case of problem or doubts



Flair Error Report

- In case of Traceback, when closing the program or after too many messages, FLAIR will propose to send the Traceback message to the authors for further investigation

Please send this report unless you know the reason for the problem, e.g. opening a problematic .inp, non existing directory etc...

It will be good to provide also a small description on how to reproduce the problem

The text box can be edited



gdb: How To

How to run it:

- from terminal:

```
cd fluka_####
```

```
gdb $FLUPRO/flukahp core.*
```

- from FLAIR:

double click on the core file from the "Output Files" Frame;

Advanced Topic:

The GNU debugger (gdb) can help in spotting the problem

```
GNU gdb Red Hat Linux (6.0post-0.20040223.19rh)
Copyright 2004 Free Software Foundation, Inc.
GDB is free software, covered by the GNU General Public License, and you are
welcome to change it and/or distribute copies of it under certain conditions.
Type "show copying" to see the conditions.
There is absolutely no warranty for GDB.  Type "show warranty" for details.
This GDB was configured as "i386-redhat-linux-gnu"...Using host libthread_db library "/lib/tls/libthread_db.so.1".
```

```
Core was generated by `/home/battist/flukacourse/Pavia/examples/errors/flukamy'.
Program terminated with signal 6, Aborted.
Reading symbols from /usr/lib/libg2c.so.0...done.
Loaded symbols for /usr/lib/libg2c.so.0
Reading symbols from /lib/tls/libm.so.6...done.
Loaded symbols for /lib/tls/libm.so.6
Reading symbols from /lib/libgcc_s.so.1...done.
Loaded symbols for /lib/libgcc_s.so.1
Reading symbols from /lib/tls/libc.so.6...done.
Loaded symbols for /lib/tls/libc.so.6
Reading symbols from /lib/ld-linux.so.2...done.
Loaded symbols for /lib/ld-linux.so.2
#0  0x009c37a2 in _dl_sysinfo_int80 () from /lib/ld-linux.so.2
```

gdb: How To

Basic commands:

- **bt**, to list the functions which led to the current one and the crash
- **f**, to switch to a given frame (i.e. interrupted function)
- **p**, to print the value of a given variable

```
(gdb) bt
#0 0x009c37a2 in _dl_sysinfo_int80 () from /lib/ld-linux.so.2
#1 0x00a02e59 in raise () from /lib/tls/libc.so.6
#2 0x00a04882 in abort () from /lib/tls/libc.so.6
#3 0x005f0baf in sig_die () from /usr/lib/libg2c.so.0
#4 0x005f0c4b in f_setarg () from /usr/lib/libg2c.so.0
#5 <signal handler called>
#6 0x080496f4 in source_ (nomore=0x1) at source.f:123
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
#7 0x0806cb04 in feeder_ (kendcn=0x91520e4) at feeder.FOR:186
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
BFD: BFD 20040223 20040223 assertion fail /usr/src/build/392707-i386/BUILD/gdb+dejagnum-20040223/bfd/libbfd.c:551
#8 0x0804d2cb in flukam_ (iflgeo=0x864e948) at flukam.FOR:3228
#9 0x080492f2 in MAIN__ () at fluka.FOR:278
#10 0x0864e836 in main ()
```

Here it is!
frame #6 in source.f
at line 123

FLUKA bug?

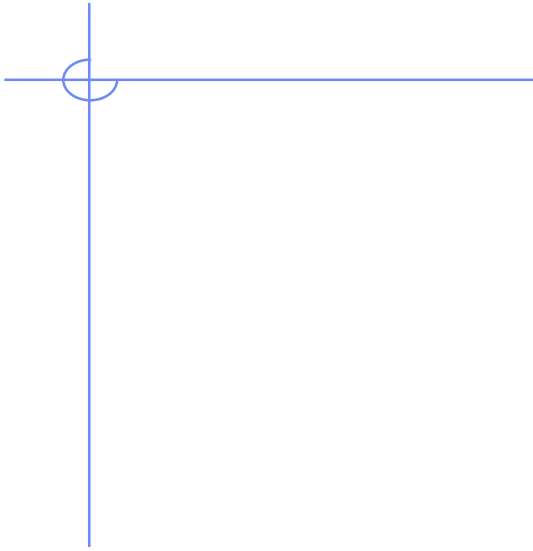
If your crash does not fall in any of the previous categories, and you do not understand what happens, prepare a report and send it to fluka-discuss@fluka.org together with a tar file containing:

- .inp, .out, .log, .err files
- additional auxiliary files (if any)
- last random seed (ran* file in fluka_####)
- and any other possible useful information

Advanced users may also add the gdb results

Summary

- In case of technical problems, your best allies are:
 1. the FLUKA **manual**
 2. error messages at the end of **.out/.err files**, and beginning of **.log file**
- In case of doubts on the results:
 1. read the **FAQ** of FLUKA:
<http://www.fluka.org/fluka.php?id=faq&mm2=3>
 2. search for a similar problem in the FLUKA **discussion list**
 3. if you really cannot understand the issue, or if you need to ask about physics related problems, write to:
fluka-discuss@fluka.org



SPARES

Low-energy neutron cross section not found

- Low-energy neutrons in FLUKA are discussed at length tomorrow, but we anticipate a typical error and its solution.
- FLUKA associates low-energy neutron cross section on a MATERIAL name basis.

→ Open manual, table 10.4.1.2

- Should your material name be different from the material name in the table, the association fails and an error is issued:

```
*** (n,p)  proton production activated for Xsec mat. #    3 ***  
**** Low energy neutron xsec not found for some media 12 13 ****  
POTASS
```

Keep an open eye for tomorrow's lecture and in particular the slides on the LOW-MAT card! See also in the manual.

Heavy Ions

- The binary (flukahp) obtained with the default linking script (lfluka) does not include the interaction generators for heavy ions above 100-150 MeV/n.
- To include them, a dedicated binary has to be linked with **ldpmqmd**
- You can verify whether the relevant event generators are linked by looking for initialization message like “initializing **RQMD**” and “initializing **DPMJET**” in the .out file.

The FUDGEM parameter

In EMFCUT with SDUM=PROD-CUT, WHAT(3) accounts for the fraction of atomic electrons contributing to MCS.

In Rutherford xs: $Z^2 \rightarrow Z(Z+f)$ $f=WHAT(3)$

A value of 10^{-5} is fine for low delta-ray production thresholds: the contribution of atomic electrons is accounted for via ionization losses. Low means much lower than typical atomic shell binding energies (several 10s of keV).

For higher delta-ray production thresholds, if $WHAT(3) \ll 1$, there would be a fraction of atomic electrons not contributing to scattering. WHAT(3) should be set to 1.

```
* ..+....1.....+....2.....+....3.....+....4.....+....5.....+....6.....+....7..
EMFCUT      ElePosiTh  WHAT(2)  WHAT(3)  Mat1      Mat2      StepPROD-CUT
```

A finite value should be entered for WHAT(3), otherwise:

*** Atomic electron contribution to MCS for material Set to zero.

Are you sure?****

USRBIN/EVENTBIN scoring definitions errors

- USRBIN scoring method:
 - **WHAT(1) ≥ 10** Track-length quantities, i.e. they can be distributed along a track (fluence, energy deposition...)
 - **WHAT(1) < 10** Point-wise quantities, i.e. they have to be scored on a point, or in the middle of the step (activity, fission, neutron balance...)

*** Activity/fission/neutron balance binnings cannot be track-length!!!

- Badly defined USRBIN scoring:

```
***** Fluka stopped in Usrbin: "usr/eventbin" n.      1 *****  
***** with zero width  0.000      for axis  R  *****
```

- Output units:

- Never use unit# <20 (reserved for FLUKA internal use) or >99 (Fortran77 limitation)
- Never mix the output of different scoring cards in the same unit

Flair fully satisfies all these requirements!

LOW-MAT errors

```
*** (n,p)  proton production activated for Xsec mat. #    3 ***
**** Low energy neutron xsec not found for some media 12 13 ****
POTASS
```

The name of a material breaks the correspondence with the low energy neutron cross section library available in FLUKA (see manual chapter 10)

In the given example **POTASS** is specified in the SDUM of the **LOW-MAT** card, instead of **POTASSIU**

Check the use of **LOW-MAT** cards in the manual, particularly material names and parameters

NB: Do you really need **LOW-MAT**?

This card is necessary only in a limited amount of cases, and can be easily misinterpreted by non expert user

Again: read the manual! Chapter 10, table 10.4.1.2

Formatting errors: Examples

```
*** Unknown control code: ROT-DEF , ignored ***
```

```
***** Next control card ***** ROT-DEF 0.000 0.000 0.000 0.000 0.000 0.000 0.000 NEW-DEFA
```

```
**** Unknown Input card !!!!!!!!!!! ****
```

Mistyped ROT-DEFI card: ROT-DEF

```
*** Unable to resolve name element BLCKHOL in card ***
```

```
ASSIGNMA BLCKHOLE BLKHOLE
```

```
*** run stopped_***
```

.inp file in fixed format: misalignment in the BLCKHOLE word (the final "E" is lost)

```
***** Next control card ***** BEAM -3.500 -8.2425E-02 -1.700 0.000 0.000 1.000 PROTON
```

```
Abort called from FLUKAM reason UNKNOWN PROJECTILE OR "OLD" HEAVY ION OPTION (NO LONGER SUPPORTED) Run stopped!
```

```
STOP UNKNOWN PROJECTILE OR "OLD" HEAVY ION OPTION (NO LONGER SUPPORTED)
```

.inp file in fixed format: the SDUM identifying the particle is not properly aligned

Formatting errors: Examples

```
*** The 3th field      -50  of the following input card ***
USRBDX      99.0      218.0      -50      TARGETS1      TARGETS2      78.5398 Sp1ChH
*** does not contain a valid formatted fortran real number!!! ***
*** It is ambiguous and it could be read differently on different compilers ***
*** depending whether it defaults or not to the blank=0 formatted input rule ***
```

WHAT(3) has no decimal point

Remember that FLUKA requires ALL numbers to be
in floating point representation, **integers included**

```
*** The 1th field -.9256E-3  of the following input card ***
COMPOUND  -.9256E-3  NITROGEN-.2837E-03  OXYGEN-.01572E-3  ARGON AIR
*** does not contain a valid formatted fortran real number!!! ***
*** It is ambiguous and it could be read differently on different compilers ***
*** depending whether it defaults or not to the blank=0 formatted input rule ***
```

WHAT(1) must be aligned to the right, being in exponential format

LOW-MAT errors

```
*** (n,p)  proton production activated for Xsec mat. #    3 ***
**** Low energy neutron xsec not found for some media 12 13 ****
POTASS
      -
```

- **WARNING:** the default temperature has changed with respect to older FLUKA distributions:
 - New library with 260 groups: **296 K**
 - Old library with 72 groups: **293 K**
- When an error is printed, FLUKA reports the SDUM of the LOW-MAT card concerned
If the SDUM is empty, you will see nothing in the output