



Standard output and plotting

FLUKA Beginner's Course

The FLUKA Standard Output

- FLUKA provides a standard output file that contains plenty of useful information:

(fortran unit 11, *inp###.out* from rfluka)

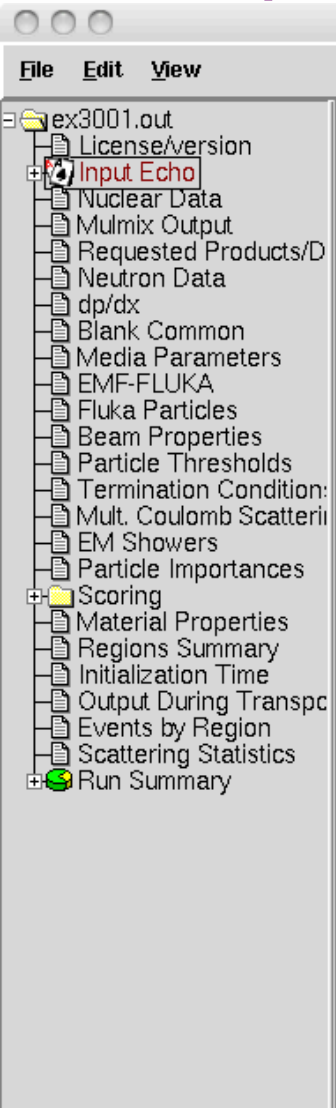
- **It must be checked at least once when setting up a simulation and always in case of doubts/crashes (together with *inp###.err* and *inp###.log* files)**

- Let's have a look at *ex_3001.out* (editor or flair output viewer:

Process – Files – select *ex_3001.out* , or
fless *ex_3001.out*)

Input echo

The data cards are parsed in groups, and do not appear in same order as they are inserted in the input file...



```
***** Next control card ***** TITLE 0.000 0.000 0.000 0.000 0.000 0.000
FLUKA Course Exercise
*-----
* use names everywhere and free format for geometry
*-----
***** Next control card ***** DEFAULTS 0.000 0.000 0.000 0.000 0.000 0.000 NEW-DEFA
*-----
* beam definitions
*-----
* Geometry
*-----
* Materials definition
*-----
***** Next control card ***** BEAM -3.500 -8.2425E-02 -1.700 0.000 0.000 1.000 PROTON
**** Density scaling factors start at location 1 and end at 4000 (I*4 addr.) ****
***** Next control card ***** BEAMPOS 0.000 0.000 -0.1000 0.000 0.000 0.000
***** Next control card ***** GEOBEGIN 0.000 0.000 0.000 0.000 0.000 0.000 COMBNAME
1
```

TITLE is the first to appear, then all comment cards are listed together, followed by the beam related cards, etc...

Input echo – *Geometry output*

The image shows two screenshots of a FileViewer window displaying the output of a simulation. The top screenshot shows the 'Interpreted body echo' section, which lists body data for seven bodies. The bottom screenshot shows the 'Interpreted region echo' section, which lists region data for five regions and includes volume calculations.

Interpreted body echo

Body n.	Material	Rot.	Volume	Center X	Center Y	Center Z
1	SPH BLK	0.000000	10000.00	0.000000	0.000000	0.000000
2	RPP VOI	0.000000	1000.000	-1000.000	1000.000	-1000.000
3	ZCC TARG	0.000000	25.00000	2.718000	25.00000	25.00000
4	XYP ZTlow	0.000000	3.140000	13.14000	4.140000	5.140000
5	XYP ZThigh	0.000000	13.14000	4.140000	5.140000	5.140000
6	XYP Tlseg	0.000000	4.140000	5.140000	5.140000	5.140000
7	XYP T2seg	0.000000	5.140000	5.140000	5.140000	5.140000

Interpreted region echo

Region n.	Material	Volume
1	BLKHOLE	-2
2	TARGS1	-4
3	TARGS2	-6
3	TARGS3	-7
4	TARGS3	-7
5	INAIR	-5

1 OPTION 0 WAS USED IN CALCULATING VOLUMES, FOR 5 REGIONS
 3: INPUT VOLUMES, ANYTHING ELSE: VOLUMES = 1.0

REG	1	2	3	4	5
VOLUME	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

----- switch on to debug this geometry -----

Followed by the geometry output, if not redirected (see **GEOBEGIN** card). Echo of the commands is presented together with interpretation and correspondence between numbers and names

Nuclear data [1/3]

FileViewer: ex4001.out

File Edit View

ex4001.out

- License/version
- Input Echo
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- Mulmix Output
- Requested Products/Decay
- Neutron Data
- dp/dx
- Blank Common
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- Fluka Particles
- Beam Properties
- Particle Thresholds
- Termination Conditions
- Mult. Coulomb Scattering
- EM Showers
- Particle Importances
- Scoring
- Material Properties
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- Initialization Time
- Output During Transport
- Events by Region
- Scattering Statistics
- Run Summary

```
*** Reading evaporation and nuclear data from unit: 14
**** Nuclear data file for Fluka9x-20xy ****
File version: 2011.1
Copyright (C) 1990-2011 by Alfredo Ferrari & Paola Sala
*** Evaporation: using NNDC (1996) data ***
Starting location in blank common of LVL data: 4522
Last location in blank common of LVL data: 9634777
Starting location in blank common of CE data: 9634778
Last location in blank common of CE data: 9685549
Starting location in blank common of alpha data: 9685550
Last location in blank common of alpha data: 9688309
Starting location in blank common of gamma data: 9688310
Last location in blank common of gamma data: 9819257
Starting location in blank common of beta data: 9819258
Last location in blank common of beta data: 9861545
Starting location in blank common of GDR data: 9861546
Last location in blank common of GDR data: 9916600
Starting location in blank common of (g,x) data: 9916601
Last location in blank common of (g,x) data: 10219521
**** RIPL2/Ign. self-cons. T=0 N,Z-dep. level density used ****
**** RIPL-2 / Ignyatuk level density en. dep. used ****
**** with Moller, Nix self-cons set of parameters for T=oo ****
**** Original Gilbert/Cameron pairing energy used ****
**** Maximum Fermi momentum : 0.268371314 GeV/c ****
**** Maximum Fermi energy : 0.0376013778 GeV ****
**** Average Fermi energy : 0.022676846 GeV ****
**** Average binding energy : 0.00768006314 GeV ****
**** Nuclear well depth : 0.04528144 GeV ****
**** Excess mass for 11-B : 0.00866803993 GeV ****
```

information about the basic nuclear data file used

Some memory allocation details

Nuclear data [2/3]

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File Edit View

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```
**** Atomic mass for 40-Ca : 37.224926 GeV ****
**** Nuclear mass for 40-Ca : 37.2147255 GeV ****
**** Excess mass for 55-Fe : -0.0574751087 GeV ****
**** Cameron E. m. for 55-Fe : -0.0595041849 GeV ****
**** Cam.El. E. m. for 55-Fe : -0.0580860823 GeV ****
**** My.&Sw. E. m. for 55-Fe : -0.0575032495 GeV ****
**** Atomic mass for 55-Fe : 51.1747131 GeV ****
**** Nuclear mass for 55-Fe : 51.1614609 GeV ****
**** Excess mass for 56-Fe : -0.0606013089 GeV ****
**** Cameron E. m. for 56-Fe : -0.0623576604 GeV ****
**** Cam.El. E. m. for 56-Fe : -0.0608849637 GeV ****
**** My.&Sw. E. m. for 56-Fe : -0.0604862086 GeV ****
**** Atomic mass for 56-Fe : 52.1030807 GeV ****
**** Nuclear mass for 56-Fe : 52.0898285 GeV ****
**** Excess mass for 107-Ag: -0.088405259 GeV ****
**** Cameron E. m. for 107-Ag: -0.0891378522 GeV ****
**** Cam.El. E. m. for 107-Ag: -0.0886852369 GeV ****
**** My.&Sw. E. m. for 107-Ag: -0.0882571116 GeV ****
**** Atomic mass for 107-Ag: 99.5814896 GeV ****
**** Nuclear mass for 107-Ag: 99.5576096 GeV ****
**** Excess mass for 132-Xe: -0.0892794058 GeV ****
**** Cameron E. m. for 132-Xe: -0.0898088515 GeV ****
**** Cam.El. E. m. for 132-Xe: -0.0892864987 GeV ****
**** My.&Sw. E. m. for 132-Xe: -0.0894251093 GeV ****
```

Nuclear data used in the program

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Nuclear data [3/3]

FileViewer: ex4001.out

File Edit View

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```
**** My.&Sw. E. m. for 235-U : 0.0413222089 GeV ****
**** Atomic mass for 235-U : 218.942078 GeV ****
**** Nuclear mass for 235-U : 218.895767 GeV ****
**** Excess mass for 238-U : 0.0473045185 GeV ****
**** Cameron E. m. for 238-U : 0.0524553321 GeV ****
**** Cam.El. E. m. for 238-U : 0.0481762439 GeV ****
**** My.&Sw. E. m. for 238-U : 0.0473943055 GeV ****
**** Atomic mass for 238-U : 221.74295 GeV ****
**** Nuclear mass for 238-U : 221.696655 GeV ****

**** Evaporation from residual nucleus activated ****
**** Deexcitation gamma production activated ****
**** Evaporated "heavies" transport activated ****
**** High Energy fission requested & activated ****
**** Fermi Break Up requested & activated ****

**** Neutrino generators initialized F T T ****

*** Neutrino xsec file header: Neutrino Xsec file from ***
*** Neutrino xsec file generated on: DATE: 9/10/ 8, TIME: 19:48:1 ***

Minimum kinetic energy for BME : 1.0000E-03 (GeV/n)
Overall minimum kinetic energy for ion nuclear interactions: 1.0000E-03 (GeV/n)

*** Material WATER (# 26 automatically guessed by FLUKA, please check its correctness ***

*** Material AIR (# 27 automatically guessed by FLUKA, please check its correctness ***

**** Fluorescence data successfully retrieved from unit 13 ****
```

active options for the nuclear model

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Material properties

FileViewer: ex4001.out

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```
**** Subroutine Mulmix: medium n. 26 ****

Number of elements = 2, Density= 1.000000 (g/cm**3)
0 I Z Pa F_i Rho_i
Index Atomic Atomic Proportion Proportion
Number Weight by Number by weight

1 1.00000 1.00794 0.666667 0.111898
2 8.00000 15.9994 0.333333 0.888102

ZTILDE, AE103, BLCGRA= 7.78788E+00 2.51981E+00 1.08102E-02
```

Material properties,
multiple scattering
parameters

```
**** Warning!!! Least square fit for blccre failed to keep max. rel. Blcce err. below 1% ****
**** Max. error is 1.1 %, for beta2 = 0.00358 ****
```

This warning is normal!

```
ZTILDE, AE103, BLCRE= 6.63158E+00 2.51981E+00 1.07635E-02
BLCC, XCC, TFFLUO, XROFLU= 6.33212E+03 7.58200E-04 1.05734E-03 4.27023E-05
BLCCE, XCCE, TFEMF0, XROEMF= 7.52263E+03 8.13614E-01 2.65915E-03 8.90013E-02
Particle n.: -6 Ecutm (prim. & sec.) = 3.747 GeV 3.747 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: -5 Ecutm (prim. & sec.) = 2.828 GeV 2.828 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: -4 Ecutm (prim. & sec.) = 2.829 GeV 2.829 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: -3 Ecutm (prim. & sec.) = 1.896 GeV 1.896 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 1 Ecutm (prim. & sec.) = 0.9583 GeV 0.9583 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 2 Ecutm (prim. & sec.) = 0.9583 GeV 0.9583 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 3 Ecutm (prim. & sec.) = 2.0511E-02 GeV 2.0511E-02 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 4 Ecutm (prim. & sec.) = 2.0511E-02 GeV 2.0511E-02 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 10 Ecutm (prim. & sec.) = 0.1257 GeV 0.1257 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 11 Ecutm (prim. & sec.) = 0.1257 GeV 0.1257 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 13 Ecutm (prim. & sec.) = 0.1596 GeV 0.1596 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 14 Ecutm (prim. & sec.) = 0.1596 GeV 0.1596 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 15 Ecutm (prim. & sec.) = 0.5136 GeV 0.5136 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 16 Ecutm (prim. & sec.) = 0.5136 GeV 0.5136 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 20 Ecutm (prim. & sec.) = 1.217 GeV 1.217 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 21 Ecutm (prim. & sec.) = 1.209 GeV 1.209 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 31 Ecutm (prim. & sec.) = 1.209 GeV 1.209 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 33 Ecutm (prim. & sec.) = 1.217 GeV 1.217 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 36 Ecutm (prim. & sec.) = 1.341 GeV 1.341 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 37 Ecutm (prim. & sec.) = 1.341 GeV 1.341 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 38 Ecutm (prim. & sec.) = 1.692 GeV 1.692 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 39 Ecutm (prim. & sec.) = 1.692 GeV 1.692 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 41 Ecutm (prim. & sec.) = 1.797 GeV 1.797 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 42 Ecutm (prim. & sec.) = 1.797 GeV 1.797 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 45 Ecutm (prim. & sec.) = 1.889 GeV 1.889 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 46 Ecutm (prim. & sec.) = 1.889 GeV 1.889 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 49 Ecutm (prim. & sec.) = 1.988 GeV 1.988 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 50 Ecutm (prim. & sec.) = 1.988 GeV 1.988 GeV, Hthnsz = 1.0000E+30 GeV
Particle n.: 51 Ecutm (prim. & sec.) = 2.305 GeV 2.305 GeV, Hthnsz = 1.0000E+30 GeV
```



Radiation Decay

File Edit View

ex4001.out

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```
**** Isotope tabulation data start      at location 10219522 and end at 10242872 (I*4 addr.) ****

No radioactive products/decays requested

Flags for applying biasing to prompt and/or decay radiation:
      Hadr/muon      EM      Low en. Neut.
      Prompt/Decay  Prompt/Decay  Prompt/Decay
Inter./decay length:   T   F       T   F       T   F
Leading Particle   :   T   F       T   F       T   F
Importance and WW  :   T   F       T   F       T   F

EM transport threshold multipliers:      prompt      decay
                                          1.00E+00    1.00E+00
```

info on the decay radiation options

Radiation biasing

Neutron data

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ex4001.out

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```
Group cross sections storage starts at 10352413
Last location used for group xsecs 11784019

*** Values read from the cross section file ***
Panini independent Xsec
Number of primary groups          260
Number of primary downscatters   260
Number of primary upscatters     30
Number of secondary groups       42
Number of secondary downscatters 42
Number of neutron+gamma groups   302
Total xsec table length          335
Loc. of within group (g->g) xsec 34
Number of media read             269
Number of Leg. coefficients       6
Number of discrete angles        3

1
*** Fluka low energy group transport threshold: 261
    corresponding to an energy threshold of: 1.00001E-14 GeV

1
*** Fluka to low en. xsec material correspondence: printed atomic densities are meaningless when used in a compo
und ***

Fluka medium      Name      Xsec medium  atomic density      Id. 1      Id. 2      Id. 3
number            number          number      ( at/(cm barn) )

    1      BLCKHOLE      0      0.0000E+00      0      0      0
    2      VACUUM      1000     0.0000E+00      0      0      0
    3      HYDROGEN     1      0.0000E+00      1     -2     296
    6      CARBON       2      0.0000E+00      6     -2     296
    7      NITROGEN     3      0.0000E+00      7     -2     296
    8      OXYGEN       4      0.0000E+00      8     16     296
   10      ALUMINUM     5      6.0240E-02     13     27     296
   17      LEAD         7      3.2988E-02     82     -2     296
   20      ARGON        6      0.0000E+00     18     -2     296
```

Low-energy neutron info, material correspondence.. More info on low energy neutron cross section if the **LOW-NEUT** card is specified

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Material Parameters – dp/dx

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```
*** dp/dx tab. generated up to      11.74 GeV/c/n ***
*** Barkas Z^3 corrections accounted for ***
*** Bloch Z^4 corrections accounted for ***
*** Mott Z - e corrections accounted for ***
*** Nuclear stopping power accounted for ***
**** Nuclear form factor 'a la Kelner' selected      ****
**** Standard Coulomb correction selected            ****
****   for charged hadron and muon bremsstrahlung    ****

***** dp/dx : material number 26 "WATER"          *****
**** Average excitation energy : 7.5000E+01 eV, weighted Z/A : 5.5508E-01      ****
**** Sternheimer density effect parameters:          ****
**** X0 = 0.2400, X1 = 2.8004, C = -3.5017, A = 0.0912 m = 3.4773 D0 = 0.0000 ****
**** Restricted energy loss tabulated in 54 intervals ****
**** Delta ray production activated above 1.0000E-03 GeV ****
**** dE/dx fluctuations activated for this medium, level 1 ****
**** (up to 2I discrete levels, up to 2 K-edges) ****
**** Restricted pair production energy loss added ****
**** Exp. pair production activated above 0.0000E+00 GeV ****
**** Restricted bremsstrahlung energy loss added ****
**** Exp. bremsstrahlung activated above 1.0000E-03 GeV ****

***** dp/dx : material number 10 "ALUMINUM" *****
**** Average excitation energy : 1.6600E+02 eV, weighted Z/A : 4.8181E-01      ****
**** Sternheimer density effect parameters:          ****
**** X0 = 0.1708, X1 = 3.0127, C = -4.2395, A = 0.0802 m = 3.6345 D0 = 0.1200 ****
**** Restricted energy loss tabulated in 54 intervals ****
**** Delta ray production activated above 1.0000E-03 GeV ****
**** dE/dx fluctuations activated for this medium, level 1 ****
**** (up to 2I discrete levels, up to 2 K-edges) ****
**** Restricted pair production energy loss added ****
```

Material-dependent parameters for ionization energy losses

Check δ -ray and brems. threshold (DELTARAY, PAIRBREM)

Material parameters – *Transport thresholds*

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1 Quantities/Biasing associated with each media:

WATER

Rho =	1.00000	g/cm**3	Rlc=	36.0830	cm
Ae =	1.51100	MeV	Ue =	11737.8	MeV
Ap =	0.333333	MeV	Up =	11737.3	MeV

dE/dx fluctuations activated for this medium, level 1
below the threshold for explicit secondary electron production
(up to 2I discrete levels, up to 2 K-edges)

ALUMINUM

Rho =	2.69900	g/cm**3	Rlc=	8.89633	cm
Ae =	1.51100	MeV	Ue =	11737.8	MeV
Ap =	0.333333	MeV	Up =	11737.3	MeV

dE/dx fluctuations activated for this medium, level 1
below the threshold for explicit secondary electron production
(up to 2I discrete levels, up to 2 K-edges)

LEAD

Rho =	11.3500	g/cm**3	Rlc=	0.561207	cm
Ae =	1.51100	MeV	Ue =	11737.8	MeV
Ap =	0.333333	MeV	Up =	11737.3	MeV

dE/dx fluctuations activated for this medium, level 1
below the threshold for explicit secondary electron production
(up to 2I discrete levels, up to 2 K-edges)

AIR

ALUMINUM

Rho =	2.69900	g/cm**3	Rlc=	8.89633	cm
Ae =	1.51100	MeV	Ue =	11737.8	MeV
Ap =	0.333333	MeV	Up =	11737.3	MeV

dE/dx fluctuations activated for this medium, level 1
below the threshold for explicit secondary electron production
(up to 2I discrete levels, up to 2 K-edges)

production threshold for e^\pm in MeV (total energy, not only kinetic)

upper limit for e^\pm in MeV

same for photons

zoom

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Material parameters – EMF-FLUKA

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1 Correspondence of regions and EMF-FLUKA material numbers and names:

Region	EMF	FLUKA
1	0 VACUUM	1 BLCKHOLE
2	1 WATER	26 WATER
Ecut = 1.5110E+00 MeV, Pcut = 3.3333E-01 MeV,		BIAS = F, Ray. = F, S(q, Z) = T, Pz(q, Z) = F
3	2 ALUMINUM	10 ALUMINUM
Ecut = 1.5110E+00 MeV, Pcut = 3.3333E-01 MeV,		BIAS = F, Ray. = F, S(q, Z) = T, Pz(q, Z) = F
4	3 LEAD	17 LEAD
Ecut = 1.5110E+00 MeV, Pcut = 3.3333E-01 MeV,		BIAS = F, Ray. = F, S(q, Z) = T, Pz(q, Z) = F
5	4 AIR	27 AIR
Ecut = 1.5110E+00 MeV, Pcut = 3.3333E-01 MeV,		BIAS = F, Ray. = F, S(q, Z) = T, Pz(q, Z) = F

Starting location in blank common of binning data:12075833
Last location in blank common of binning data: 12195835

Starting location in blank common of bdrx data:12195837
Last location in blank common of bdrx data: 12196319

Starting location in blank common of track/coll data:12196321
Last location in blank common of track/coll data: 12196321

Starting location in blank common of ...
Last location in blank common of ...

Starting location in blank common of ...
Last location in blank common of ...

1

transport threshold for e^\pm (Ecut) and photons (Pcut) in MeV (total energy, not only kinetic)

FLUKA Particles

exhaustive list of **FLUKA** particles

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=== Output before the actual run - Particle properties: ===

=== Transportable Fluka particles: ===

Particle	Number	Mass (GeV/c**2)	Mean Life (s)	Charge	Baryon number	Discard Flag(=1)	Decay Flag	PDG id
4-HELIUM	-6	3.7273803	1.000E+18	2	4	0	1	9999
3-HELIUM	-5	2.8083922	1.000E+18	2	3	0	1	9999
TRITON	-4	2.8089218	1.000E+18	1	3	0	1	9999
DEUTERON	-3	1.8756134	1.000E+18	1	2	0	1	9999
HEAVYION	-2	0.0000000	1.000E+18	0	0	0	1	9999
OPTIPHOT	-1	0.0000000	1.000E+18	0	0	0	1	9999
RAY	0	0.0000000	0.00	0	0	0	1	9999
PROTON	1	0.9382723	1.000E+18	1	1	0	1	2212
APROTON	2	0.9382723	1.000E+18	-1	-1	0	1	-2212
ELECTRON	3	0.0005110	1.000E+18	-1	0	0	1	11
POSITRON	4	0.0005110	1.000E+18	1	0	0	1	-11
NEUTRIE	5	0.0000000	1.000E+18	0	0	1	1	12
ANEUTRIE	6	0.0000000	1.000E+18	0	0	1	1	-12
PHOTON	7	0.0000000	1.000E+18	0	0	0	1	22
NEUTRON	8	0.9395656	889.	0	1	0	1	2112
ANEUTRON	9	0.9395656	889.	0	-1	0	1	-2112
MUON+	10	0.1056584	2.197E-06	1	0	0	1	-13
MUON-	11	0.1056584	2.197E-06	-1	0	0	1	13

...and many more

=== Generalised particles (201-233) (for scoring): ===

Generalised particle	Number
ALL-PART	201
ALL-CHAR	202
ALL-NEUT	203
ALL-NEGA	204
ALL-POSI	205
NUCLEONS	206
NUC&PI+-	207
ENERGY	208
PIONS+-	209
BEAMPART	210
EM-ENRGY	211
MUONS	212
E+&E-	213
AP&AN	214

...continues on your screen!

Input interpreted summary – *Beam*

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```
=== Output before the actual run - Beam properties ===

Fluka incident beam properties:

Beam particle: PROTON   Id:   1 (Fluka)  2212 (PDG)  Charge:   1 Baryon n.:   1
                Mass: 0.9383      (GeV/c^2)  Mean life: 1.0000E+18 (s)  Weight:   1.000
Average beam momentum      :                4.337961 (GeV/c)
Average beam kinetic energy:                3.500000 (GeV)
Momentum deviation at FWHM (gaussian):      0.0824250 (GeV/c)
Beam hit position          :   0.00000000      0.00000000      -0.10000000      cm
Beam direction cosines:    0.00000000      0.00000000      1.00000000
Beam spot FWHM X-width (Rectangular) :      0.0000      cm
Beam spot FWHM Y-width (Rectangular) :      0.0000      cm
Beam FWHM angular divergence (Gaussian)   :                1.7000 (mrad)
(Spatial distribution, polarization, and angular direction and distribution
are given in the beam frame of reference)

Beam reference frame (world coordinates):
Beam X axis:   1.00000000      0.00000000      0.00000000
Beam Y axis:   0.00000000      1.00000000      0.00000000
Beam Z axis:   0.00000000      0.00000000      1.00000000

The nominal beam position belongs to region:   5(INAIR  ),
lattice cell:   0(      )
```

Check where the beam is starting

15

Input interpreted summary – *Thresholds*

FileViewer: ex4001.out

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```
=== Particle transport thresholds:  
Global cut-off kinetic energy for particle transport: 1.000E-02 GeV  
The cut-off kinetic energy is superseded by individual particle thresholds if set  
  
Cut-off kinetic energy for 4-HELIUM transport: 1.000E-02 GeV  
Cut-off kinetic energy for 3-HELIUM transport: 1.000E-02 GeV  
Cut-off kinetic energy for TRITON transport: 1.000E-02 GeV  
Cut-off kinetic energy for DEUTERON transport: 1.000E-02 GeV  
Cut-off kinetic energy for PROTON transport: 1.000E-02 GeV  
Cut-off kinetic energy for APROTON transport: 1.000E-02 GeV  
Cut-off kinetic energy for ELECTRON transport defined in the Emfcut card  
Cut-off kinetic energy for POSITRON transport defined in the Emfcut card  
Cut-off kinetic energy for NEUTRIE transport: 0.000E+00 GeV  
Cut-off kinetic energy for ANEUTRIE transport: 0.000E+00 GeV  
Cut-off kinetic energy for PHOTON transport defined in the Emfcut card  
Cut-off kinetic energy for NEUTRON transport: 1.000E-14 GeV  
Cut-off kinetic energy for ANEUTRON transport: 1.000E-05 GeV  
Cut-off kinetic energy for MUON+ transport: 1.000E-02 GeV  
Cut-off kinetic energy for MUON- transport: 1.000E-02 GeV  
Cut-off kinetic energy for KAONLONG transport: 1.000E-02 GeV  
Cut-off kinetic energy for PION+ transport: 1.000E-02 GeV  
Cut-off kinetic energy for PION- transport: 1.000E-02 GeV  
Cut-off kinetic energy for KAON+ transport: 1.000E-02 GeV  
Cut-off kinetic energy for KAON- transport: 1.000E-02 GeV  
Cut-off kinetic energy for LAMBDA transport: 1.000E-02 GeV
```


Input interpreted summary – TC, MCS, EM

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```
=== Termination conditions: ===
Maximum cpu-time allocated for this run: 100000000000000000.00 sec
Minimum cpu-time reserved for output: 10000.00 sec
Maximum number of beam particles to be followed: 1000
Maximum number of stars to be generated: infinite

=== Multiple Coulomb scattering: ===
Moliere Coulomb scattering for primaries: T
Moliere Coulomb scattering for secondaries: T

Hadrons/muons:
Flag for MCS check with boundary normals: F
Flag for Coulomb single scattering(s) at boundaries: F
(# of Coulomb single scattering(s) at boundaries: 1)
Flag for single scatterings below min. (Moliere) energy: F

=== Electromagnetic Showers: ===
EM showers are treated by the EMF (A.Fasso`,A.Ferrari,P.R.Sala) code

Electrons/positrons:
Flag for MCS check with boundary normals: F
Flag for Coulomb single scattering(s) at boundaries: F
(# of Coulomb single scattering(s) at boundaries: 1)
Flag for single scatterings below min. (Moliere) energy: F

1
```

Scoring

FileViewer: ex4001.out

Complete description of
each requested estimator

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```
***** "usrbin" option:

R - Z   binning n.   1 "TargEne   ", generalized particle n.   208
R coordinate: from 0.0000E+00 to 1.0000E+01 cm,   100 bins ( 1.0000E-01 cm wide)
Z coordinate: from -5.0000E+00 to 1.5000E+01 cm,   200 bins ( 1.0000E-01 cm wide)
axis coordinates: X = 0.0000E+00, Y = 0.0000E+00 cm
data will be printed on unit  -40 (unformatted if < 0)
accurate deposition along the tracks requested
normalized (per unit volume) data will be printed at the end of the run

R - Z   binning n.   2 "TargChH   ", generalized particle n.   218
R coordinate: from 0.0000E+00 to 1.0000E+01 cm,   100 bins ( 1.0000E-01 cm wide)
Z coordinate: from -5.0000E+00 to 1.5000E+01 cm,   200 bins ( 1.0000E-01 cm wide)
axis coordinates: X = 0.0000E+00, Y = 0.0000E+00 cm
data will be printed on unit  -40 (unformatted if < 0)
accurate deposition along the tracks requested
normalized (per unit volume) data will be printed at the end of the run
this is a track-length binning

R - Z   binning n.   3 "TargN     ", generalized particle n.     8
R coordinate: from 0.0000E+00 to 1.0000E+01 cm,   100 bins ( 1.0000E-01 cm wide)
Z coordinate: from -5.0000E+00 to 1.5000E+01 cm,   200 bins ( 1.0000E-01 cm wide)
axis coordinates: X = 0.0000E+00, Y = 0.0000E+00 cm
data will be printed on unit  -40 (unformatted if < 0)
accurate deposition along the tracks requested
normalized (per unit volume) data will be printed at the end of the run
this is a track-length binning

***** "USRBDX" option:

Bdrx n.   1 "Sp1ChH   ", generalized particle n.   218, from region n.     2 to region n.     3
detector area: 7.8540E+01 cm**2
this is a one way only estimator
this is a fluence like estimator
logar. energy binning from 1.0000E-03 to 1.0000E+01 GeV,   40 bins (ratio : 1.2589E+00)
linear angular binning from 0.0000E+00 to 6.2832E+00 sr ,    1 bins ( 6.2832E+00 sr wide )
data will be printed on unit  -50 (unformatted if < 0)

Bdrx n.   2 "Sp2ChH   ", generalized particle n.   218, from region n.     3 to region n.     4
detector area: 7.8540E+01 cm**2
this is a one way only estimator
this is a fluence like estimator
logar. energy binning from 1.0000E-03 to 1.0000E+01 GeV,   40 bins (ratio : 1.2589E+00)
linear angular binning from 0.0000E+00 to 6.2832E+00 sr ,    1 bins ( 6.2832E+00 sr wide )
data will be printed on unit  -50 (unformatted if < 0)

Bdrx n.   3 "Sp3ChH   ", generalized particle n.   218, from region n.     4 to region n.     5
```

Materials – Scattering lengths

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```


=== Material compositions: ===
Material      Atomic      Atomic      Density      Inelastic      Elastic      Radiation      Inelastic
Number&Name  Number      Weight      g/cm**3      Scattering     Scattering    Length         Scattering
                                     cm           Length for    Length for    for neutrons at
                                     cm           PROTON at    PROTON at    Threshold
                                     cm           Beam energy  Beam energy  Momentum
                                     cm           cm           cm           cm

```

Data related to the beam particle type specified in the BEAM card

Material Number&Name	Atomic Number	Atomic Weight	Density g/cm**3	Inelastic Scattering Length for PROTON at Beam energy cm	Elastic Scattering Length for PROTON at Beam energy cm	Radiation Length cm	Inelastic Scattering Length for neutrons at Threshold Momentum cm
10 ALUMINUM	13.00	26.98	2.699	36.71	75.04	8.896	17.24
11 IRON	26.00	55.84	7.874	15.55	25.41	1.757	9.128
12 COPPER	29.00	63.55	8.960	13.97	23.26	1.436	8.423
13 SILVER	47.00	107.9	10.50	14.12	21.47	0.8543	10.59
14 SILICON	14.00	28.09	2.329	43.04	86.54	9.370	20.38
15 GOLD	79.00	197.0	19.32	9.239	13.14	0.3344	7.012
16 MERCURY	80.00	200.6	13.55	13.25	18.79	0.4752	9.852
17 LEAD	82.00	207.2	11.35	15.97	22.54	0.5612	12.03
18 TANTALUM	73.00	180.9	16.65	10.44	15.03	0.4094	7.390
19 SODIUM	11.00	22.99	0.9710	97.58	212.4	28.56	47.77
20 ARGON	18.00	39.95	0.1660E-02	0.6692E+05	0.1186E+06	0.1178E+05	0.3754E+05
21 CALCIUM	20.00	40.08	1.550	71.73	127.1	10.42	36.39
22 TIN	50.00	118.7	7.310	20.91	31.45	1.506	14.37
23 TUNGSTEN	74.00	183.8	19.30	9.055	13.04	0.374	6.104
24 TITANIUM	22.00	47.87	4.540	25.79	41.00	1.404	11.00
25 NICKEL	28.00	58.69	8.902	13.87	22.83	1.404	11.00
26 WATER	3.333	6.005	1.000	81.49	127.1	10.42	36.39
27 AIR	7.262	14.55	0.1205E-02	0.6931E+05	0.1810E+06	0.3039E+05	0.3262E+05

Compound interpreted composition



```

Material      Number      Atom content      Partial Densities
HYDROGEN      3            0.66667           0.11190
OXYGEN        8            0.33333           0.88810

```

```

Material      Number      Atom content      Partial Densities
CARBON        6            0.15019E-03       0.14939E-06
NITROGEN      7            0.78443           0.90994E-03
OXYGEN        8            0.21075           0.27925E-03
ARGON         20           0.46712E-02       0.15454E-04

```

Regions summary

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```
=== Regions: materials and fields ===
Region N. and Name Material N. and Name Magn./El. Field (on/off)
      (Mat. N. and Name Magn./El. Field (on/off) for radioactive products)
      Minimum and Maximum step size (cm)
1  BLKHOLE      1  BLCKHOLE  OFF      0.00000E+00  9.99852E+04
   (  1  BLCKHOLE  OFF )
2  TARGS1      26  WATER    OFF      0.00000E+00  9.99852E+04
   ( 26  WATER    OFF )
3  TARGS2     10  ALUMINUM OFF      0.00000E+00  9.99852E+04
   ( 10  ALUMINUM OFF )
4  TARGS3     17  LEAD     OFF      0.00000E+00  9.99852E+04
   ( 17  LEAD     OFF )
5  INAIR      27  AIR      OFF      0.00000E+00  9.99852E+04
   ( 27  AIR      OFF )
```

Useful way to check material assignment

Minimum/Maximum step sizes
(set with STEPSIZE option
otherwise default values are set)

Initialization time / Run informations

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=== End of the output associated with the input ===

Total time used for initialization: 3.43 s

NUMBER OF BEAM PARTICLES HANDLED	NUMBER OF BEAM PARTICLES LEFT	APPROXIMATE NUMBER OF BEAM PARTICLES THAT CAN STILL BE HANDLED	AVERAGE TIME USED BY A BEAM PARTICLE	TIME LEFT (RESERVED 10000.0 SECONDS FOR PRINTOUT)	NUMBER OF STARS CREATED
NEXT SEEDS: 0	0	0	181CD 3039	0	
1	999	999	3.0002594E-03	1.0000000E+30	1
NEXT SEEDS: 063	0	0	181CD 3039	0	
20	980	980	4.1494131E-03	1.0000000E+30	19
NEXT SEEDS: 2D145	0	0	181CD 3039	0	
40	960	960	5.8991313E-03	1.0000000E+30	47
NEXT SEEDS: AE22F	0	0	181CD 3039	0	
60	940	940	6.7989667E-03	1.0000000E+30	94
NEXT SEEDS: 1407A3	0	0	181CD 3039	0	
80	920	920	6.2740505E-03	1.0000000E+30	124
NEXT SEEDS: 199F1E	0	0	181CD 3039	0	
100	900	900	6.8789625E-03	1.0000000E+30	172

event number, time, random seed, average time used per primary available during the run

Results – *Scoring*

Results of SCORE options for all region:

very useful for debugging and for cross-check with estimators

Region #	name	volume in cubic cm	ALL-PART Star Density Stars/cm**3 /one beam particle	BEAMPART Star Density Stars/cm**3 /one beam particle	ENERGY GeV/cm**3 /one beam particle	Density	EM-ENERGY GeV/cm**3 /one beam particle	Density
1	BLKHOLE	1.000000000E+00	0.000000000E+00	0.000000000E+00	2.928199323E+00		4.557256612E-02	
2	TARGS1	1.000000000E+00	1.700000000E-02	8.000000000E-03	3.488408038E-03		1.713414203E-04	
3	TARGS2	1.000000000E+00	5.700000000E-02	3.100000000E-02	8.922057690E-03		7.317583684E-04	
4	TARGS3	1.000000000E+00	1.563000000E+00	3.820000000E-01	3.983831246E-01		1.144531387E-01	
5	INAIR	1.000000000E+00	8.500000000E-02	1.000000000E-02	9.016724646E-03		1.290495432E-03	
Total (integrated over volume):			1.722000000E+00	4.310000000E-01	3.348009638E+00		1.622193000E-01	
**** Next control card ****			STOP	0.000	0.000	0.000	0.000	0.000

inelastic interactions of primary particles

The volume is not automatically evaluated, you have to specify it in the geom. description

Results – *Statistics of Coulomb scattering*

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```
**** Total number of not-performed scatterings in FLUKA:      888
**** Total number of scatterings with no LDA in FLUKA:    12251
**** Ratio of rejected/accepted samplings from the Moliere's distribution in FLUKA:  0.0000
**** ( Total multiple scatterings: 9.5186E+04: Total single scatterings: 0.0000E+00 )

**** Total number of not-performed scatterings in EMF :      123
**** Total number of scatterings with no LDA in EMF :      666
**** Ratio of rejected/accepted samplings from the Moliere's distribution in EMF :  0.0000
**** ( Total multiple scatterings: 3.6342E+05: Total single scatterings: 0.0000E+00 )
```

Results – *Statistics of the run*

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 - Totals/CPU time**
 - # of stars
 - # of secondaries in stars
 - # of fissions
 - # of decay products
 - # of particles decayed
 - # of stopping particles
 - # of part. from low en. neutrons
 - Energy balance

```
Total number of primaries run:          1000 for a weight of: 1.000000E+03
!!! Please remember that all results are normalized per unit weight !!!
The main stack maximum occupancy was      81 out of      40000 available

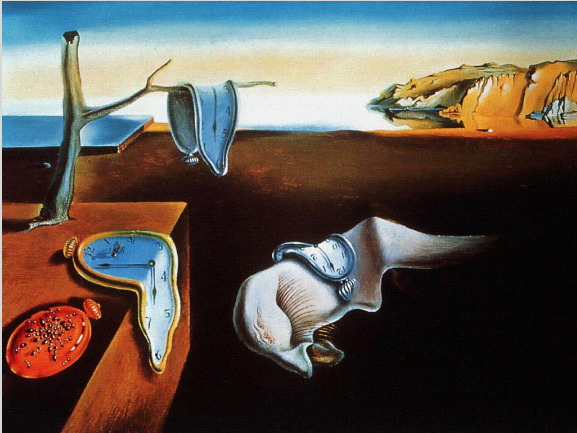
Total number of inelastic interactions (stars):          1722
Total weight of the inelastic interactions (stars):  1.722000E+03

Total number of elastic interactions:          1582
Total weight of the elastic interactions:  1.582000E+03

Total number of low energy neutron interactions:          20821
Total weight of the low energy neutron interactions:  2.082621E+04

Total CPU time used to follow all primary particles:  6.843E+00 seconds of:
Average CPU time used to follow a primary particle:  6.843E-03 seconds of:
Maximum CPU time used to follow a primary particle:  4.699E-02 seconds of:
Residual CPU time left:          1.000E+30 seconds of:
```

CPU time is not real time!



Run summary: *detailed statistics*

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 - # of stars
 - # of secondaries in stars
 - # of fissions
 - # of decay products
 - # of particles decayed
 - # of stopping particles
 - # of part. from low en. neutrons
 - Energy balance

Number of stars generated per beam particle:

Prompt radiation	Radioactive decays	
1.7220E+00 (100.%)	0.0000E+00 (0.0%)	
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by 4-HELIUM
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by 3-HELIUM
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by TRITON
1.0000E-03 (0.1%)	0.0000E+00 (0.0%)	generated by DEUTERON
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by HEAVYION
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by OPTIPHOT
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by RAY
6.4300E-01 (37.3%)	0.0000E+00 (0.0%)	generated by PROTON
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by APROTON
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by ELECTRON
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by POSITRON
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by NEUTRIE
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by ANEUTRIE
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by PHOTON
8.9700E-01 (52.1%)	0.0000E+00 (0.0%)	generated by NEUTRON
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by ANEUTRON
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by MUON+
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by MUON-
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by KAONLONG
5.0000E-02 (2.9%)	0.0000E+00 (0.0%)	generated by PION+
1.3000E-01 (7.5%)	0.0000E+00 (0.0%)	generated by PION-
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by KAON+
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by KAON-
1.0000E-03 (0.1%)	0.0000E+00 (0.0%)	generated by LAMBDA
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by ALAMBDA
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by KAONSHRT
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by SIGMA-
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by SIGMA+
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by SIGMAZER
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by PIZERO
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by KAONZERO
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by AKAONZER
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by RESERVED
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by NEUTRIM
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by ANEUTRIM
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by RESERVED
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by RESERVED
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by ASIGMAZER
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by ASIGMA+
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	generated by XSIZERO

Detailed statistics per each particle

Energy Balance

FileViewer: ex4001.out

File Edit View

ex4001.out

- License/version
- Input Echo
- Nuclear Data
- Mulmix Output
- Requested Products/Decays
- Neutron Data
- dp/dx
- Blank Common
- Media Parameters
- EMF-FLUKA
- Fluka Particles
- Beam Properties
- Particle Thresholds
- Termination Conditions
- Mult. Coulomb Scattering
- EM Showers
- Particle Importances
- Scoring
 - Material Properties
 - Regions Summary
 - Initialization Time
 - Output During Transport
 - Events by Region
 - Scattering Statistics
- Run Summary
 - Totals/CPU time
 - # of stars
 - # of secondaries in stars
 - # of fissions
 - # of decay products
 - # of particles decayed
 - # of stopping particles
 - # of part. from low en. neutrons
 - Energy balance

3.5000E+00 (100.%) GeV available per beam particle divided into		Radioactive decays		
Prompt radiation	2.9309E-01 (8.4%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV hadron and muon dE/dx
	1.1665E-01 (3.3%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV electro-magnetic showers
	8.8952E-03 (0.3%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV nuclear recoils and heavy fragments
	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV particles below threshold
	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV residual excitation energy
	1.1821E-03 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV low energy neutrons
	2.9282E+00 (83.7%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV particles escaping the system
	1.6105E-02 (0.5%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV particles discarded
	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV particles out of time limit
	1.3589E-01 (3.9%)			GeV missing

Particles below threshold:

- Hadrons and muons below threshold are ranged out unless the threshold >100 MeV;
- e^\pm/γ (EM- showers are not included).

Escaping the system: going to *blackholes*.

Discarded particle (i.e. neutrinos).

Missing Energy: Calculated by difference:

- pure EM problems it should be 0;
- in hadronic problems it is the energy spent in endothermic nuclear reactions (≈ 8 MeV/n), or gained in exothermic (i.e. mostly neutron capture): it is $-total Q$.

Error message

FileViewer: fluka_11407/ex4001.out

File Edit View

fluka_11407/ex4001.c

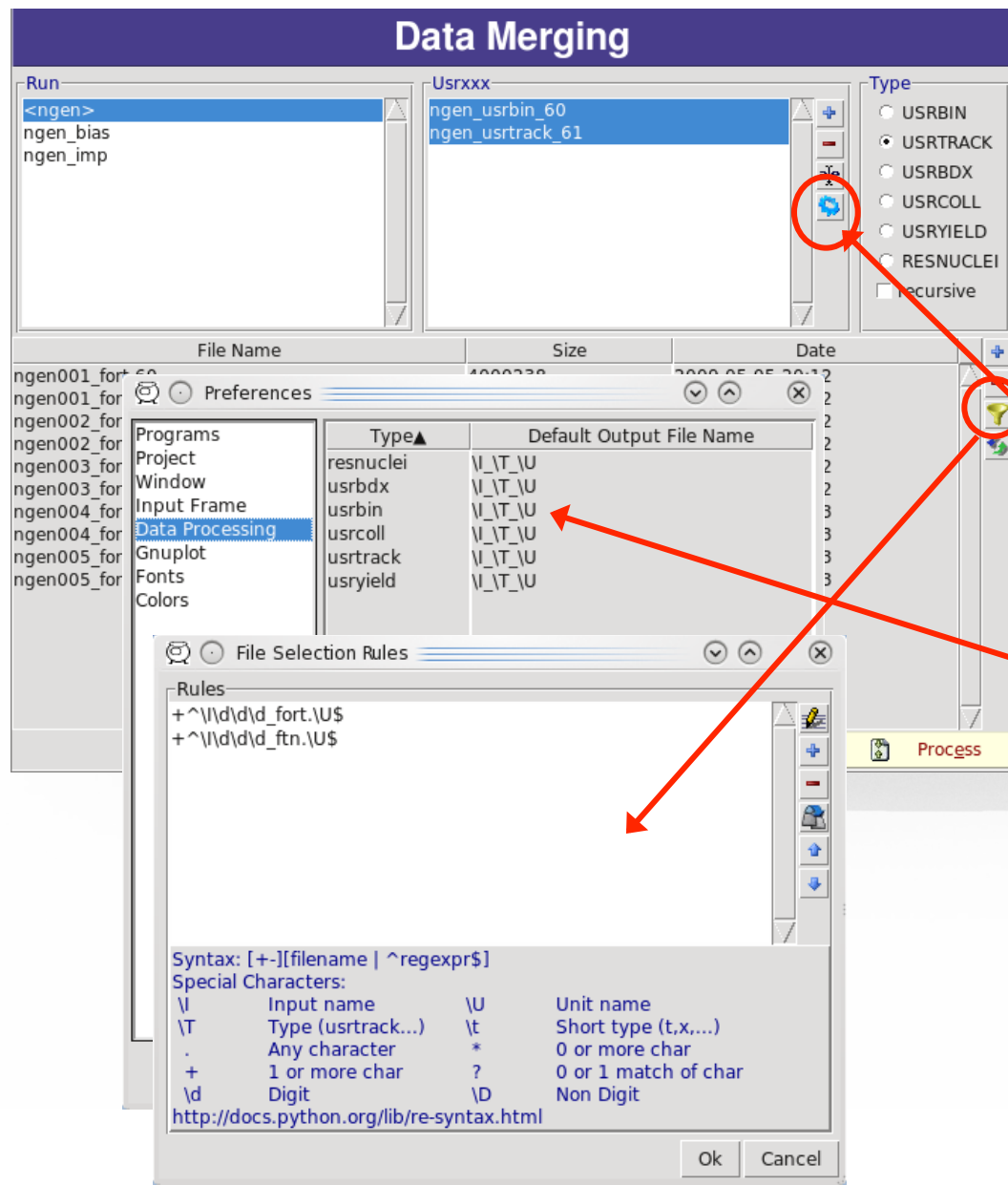
- License/version
- Input Echo
- Scoring
- Run Summary
- ERROR

```
***** Next control card ***** USRBDX 10.00 1.0000E-03 40.00 0.000 0.000 0.000 0.000 &
***** Next control card ***** USRBDX 99.00 218.0 -50.00 4.000 5.000 329.9 Sp3ChH
***** Next control card ***** USRBDX 10.00 1.0000E-03 40.00 0.000 0.000 0.000 0.000 &
***** Next control card ***** USRBDX 99.00 218.0 -54.00 3.000 4.000 78.54 Sp2ChHA
***** Next control card ***** USRBDX 10.00 1.0000E-03 40.00 0.000 0.000 3.000 &
***** Next control card ***** USRTRACK -1.000 218.0 -55.00 4.000 628.3 40.00 TrChH
***** Next control card ***** USRTRACK 10.00 1.0000E-03 0.000 0.000 0.000 0.000 0.000 &
***** Next control card ***** USRYIELD 124.0 209.0 -57.00 4.000 5.000 1.000 YieAng
***** Next control card ***** USRYIELD 180.0 0.000 18.00 10.00 0.000 3.000 &
***** Next control card ***** RESNUCLE 3.000 -60.00 0.000 0.000 4.000 0.000 activ
***** Next control card ***** START 1000. 0.000 0.000 0.000 0.000 0.000

Total time used for input reading: 4.999E-03 s

**** Region n. 4 (TARGS3 ) has no assigned material, run stopped ****
Abort called from PRCHCK reason NO MATERIAL ASSIGNED TO A REGION Run stopped!
STOP NO MATERIAL ASSIGNED TO A REGION
```

Flair: Data Processing



- Flair **initially** scans the input for possible unformatted output data for each scoring card. It **creates automatic rules for processing (merging)**.
- If in the mean time you have modified the input click the **"automatic" scan**
- The **default names** are generated by the rules specified in the preference dialog
- The automatic rules can be modified by manually adding or removing files or by advanced pattern matching with the filter dialog

Plot List

Plot List		
File	Title	Type
geometry	nTOF Target Geometry	Geometry
enedep	Deposited Energy	USRBIN
Fluence	Particle Fluence	USR-1D
resnuc	Residual Nuclei	RESNUCLE

- Plots can be created in the “Plot” list frame. Either Add new plots or Clone from existing ones.
- It is important to set a unique filename for each plot. This filename will be used for every auxiliary file that the plot needs (with different extensions)
- The Filter button creates automatically one plot for each processed unit
- Double click on a plot, or hit Enter or click the Edit icon to display the plotting dialog



- The list box is editable with a “Slow Double Click”
- Right-click brings a popup menu with all options

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)

Plotting Frames

USRxxx: Single Differential Plot

Plot

Title: USR-1D ngen_usrtrack_61 Options:

File: ngen_usrtrack_61_plot .eps Display: 0 Line Type:

Axes Labels

X: Opt: Set grid Size / Multiplot aspect: Width: Height:

Y: Opt: legend

Axes Range

log X: - log X2: show Get

log Y: - log Y2: show Reset

Gnuplot commands

Plot

Replot

Save

- All plot types share some common fields: Title + options, Filename, Axis Labels, Legends (Keys) and Gnuplot Commands.
- **Plot** button (Ctrl-Enter) will generate all the necessary files to display the plot, **ONLY** if they do not exist.
- **Re-Plot** will force the creation of all files regardless their state
- Check the gnuplot manual to provide additional customization commands: e.g. To change the title font to Times size=20, add in the Opt: field the command: `font 'Times,20'`

General Tips

- To set some default parameters for gnuplot, create a file called `~/.gnuplot`
- The output window displays all the commands sent to gnuplot as well as the errors. In case of a problem always consult the output window!
- In the **Gnuplot commands** you can fully customize the plot by adding manually commands. Please consult the gnuplot manual for available commands
- All buttons and fields have tool tips. Move the cursor on top of a field to get a short description

Geometry Plotting

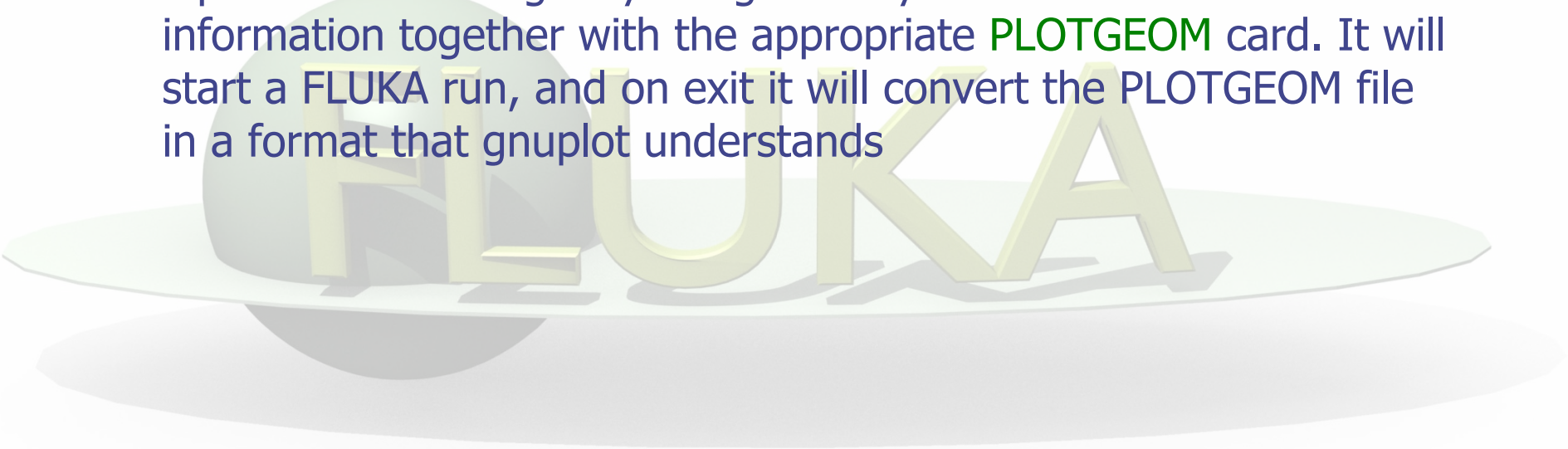
The screenshot shows a software interface for geometry plotting with the following sections:

- Center:** Fields for x: 0.0, y: 0.0, z: 0.0. Corresponding delta fields: Δx: 0.0, Δy: 0.0, Δz: 0.0. Buttons: Move, Move [u,v], Reset.
- Basis:** Fields for u: 0.0, v: 0.0. Buttons: x-y, y-z, -u, x-z, swap, -v, Rotate, Polar, Reset.
- Extends:** Fields for Δu: 50.0, Δv: 50.0, f: 2.0. Buttons: x f, Get, x 1/f, Reset.
- Grid:** Fields for Nu: 200, Nv: 200.
- Options:** Checkboxes for boundaries (unchecked) and labels (checked). Field for Vector Scale: 0.1.
- Style:** Button for Palette, Field for Font.
- Type:** Field for Material, Dropdown menu for Z-Y.

- For geometry plotting the following information is needed (Fields with white background):
 - Center (x,y,z) point defining the center of your plot
 - Basis (U,V): Two perpendicular axis vectors defining the new system
 - Extends (DU, DV) of the plot. The total width/height will be **twice** the extends
 - Scanning grid (NU, NV): how many points to scan
 - Plotting type (Only borders, Regions, Materials, ...)

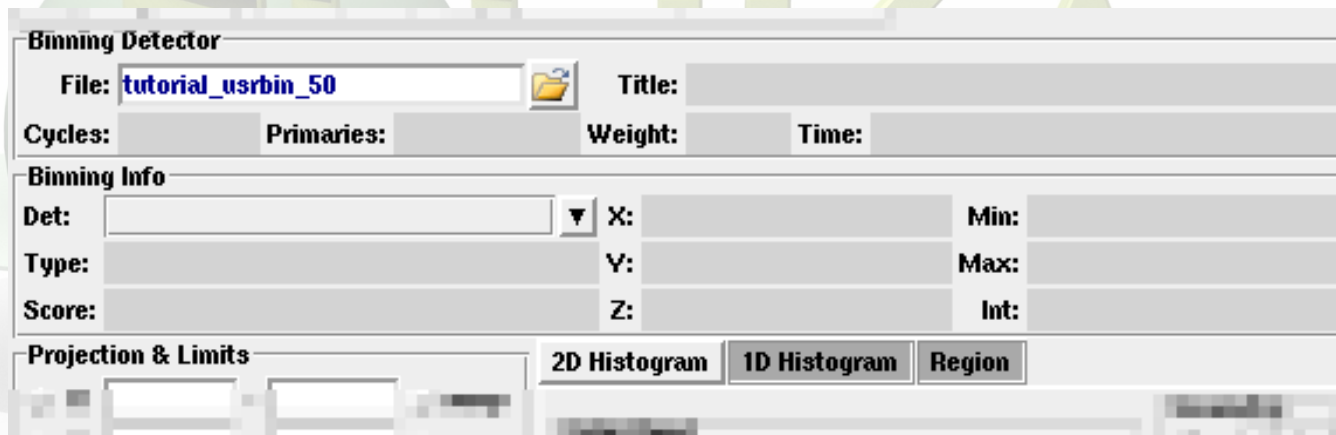
Geometry Plotting

- All input fields with **light-yellow** background are used to perform operations on the previous fields. e.g. to rotate the basis-vectors
- When the **"Plot"** button is pressed, flair will create a temporary input file containing only the geometry and the related information together with the appropriate **PLOTGEOM** card. It will start a FLUKA run, and on exit it will convert the PLOTGEOM file in a format that gnuplot understands



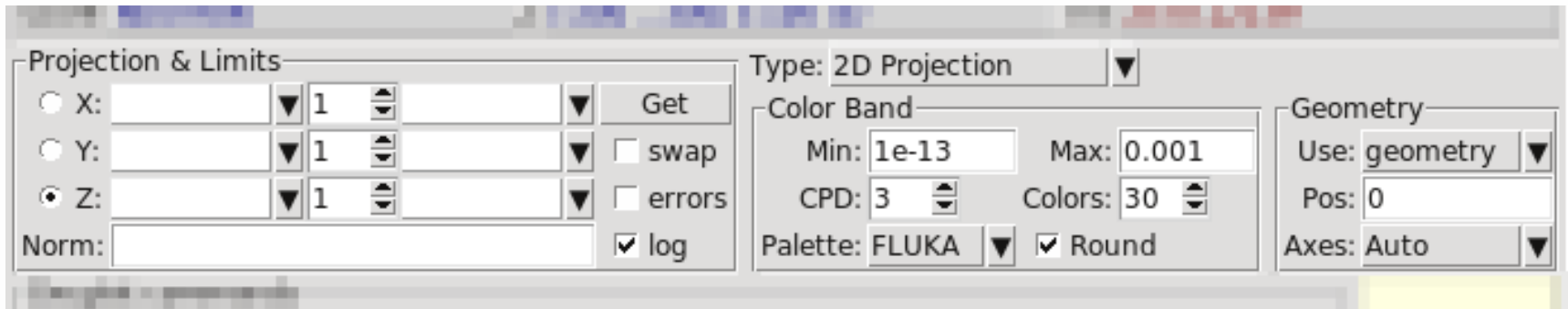
USRBIN

- With the USRBIN plotting frame you can perform:
 - 2D projection or region/lattice plot
 - 1D projection or region/lattice plot
 - 1D maximum trace
 - 1D trace scanof the data or errors from USRBIN data.



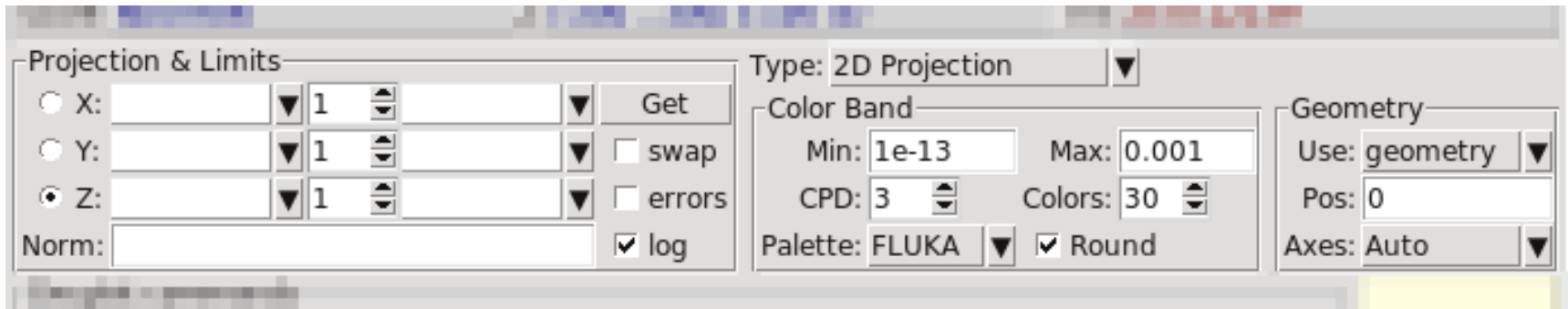
- Set the usrbn summary file in the File: field
- Select from Det: the detector to use.
- All the available detector information will be displayed
- The information **Minimum**, **Maximum** and **Integral** will be filled after the plot! *WARNING: it is always the projection min/max*

USRBIN (2D plot)



- Select the "2D Projection" type
- Select the **projection axis, limits, and rebinning**
- swap: will exchange the plotting X and Y axis
- errors: will plot the (uncorrelated) error values as color plot
- **Get**: will get the projection limits from the gnuplot window
- Norm: is the **normalization value or expression**. You can even define a function to use as normalization using as argument x:
e.g. $5*x**2+4*x$
- log: select linear or log in the color bar axis

USRBIN (2D plot) cont.



- The **Minimum**, **Maximum**, **Colors** and **CPD** (Colors Per Decade) are interconnected.

$$\log_{10}(\text{Max}) = \log_{10}(\text{Min}) + \text{Colors}/\text{CPD}$$

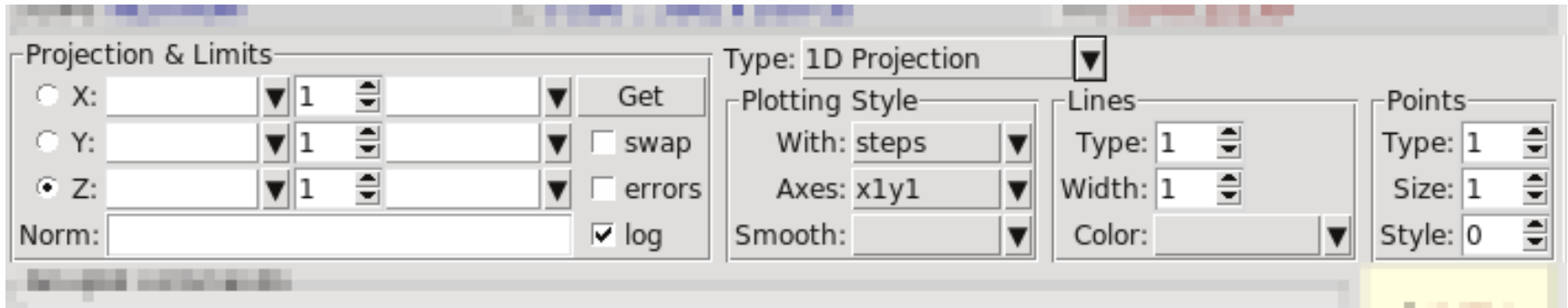
- Once the value is changed in one field, the **Max** will be calculated accordingly
- **Palette:** offers a possibility to the user to choose from various predefined palettes. The user can define his own palette using the "set palette" command from the "Gnuplot commands" text box

USRBIN (2D plot) cont..

Superimposing the geometry can be done either automatically or manually

- **Auto:** Select **-Auto-** in the Use: field of the Geometry and the program will try to draw the geometry at the middle of the limits on the projection axis. To change the position modify the Pos: value
- **Manual:** The dropdown listbox will display also a list of all geometry plots in the flair project. Select the one you prefer and the plotting axis. The manual mode can be used in special cases when the **usrbin** file does not contain the absolute coordinates

USRBIN (1D-plots)



1D Projection

- Select the projection axis from "Projection & Limits" as before
WARNING: When making projections the error is typically underestimated.

1D Max

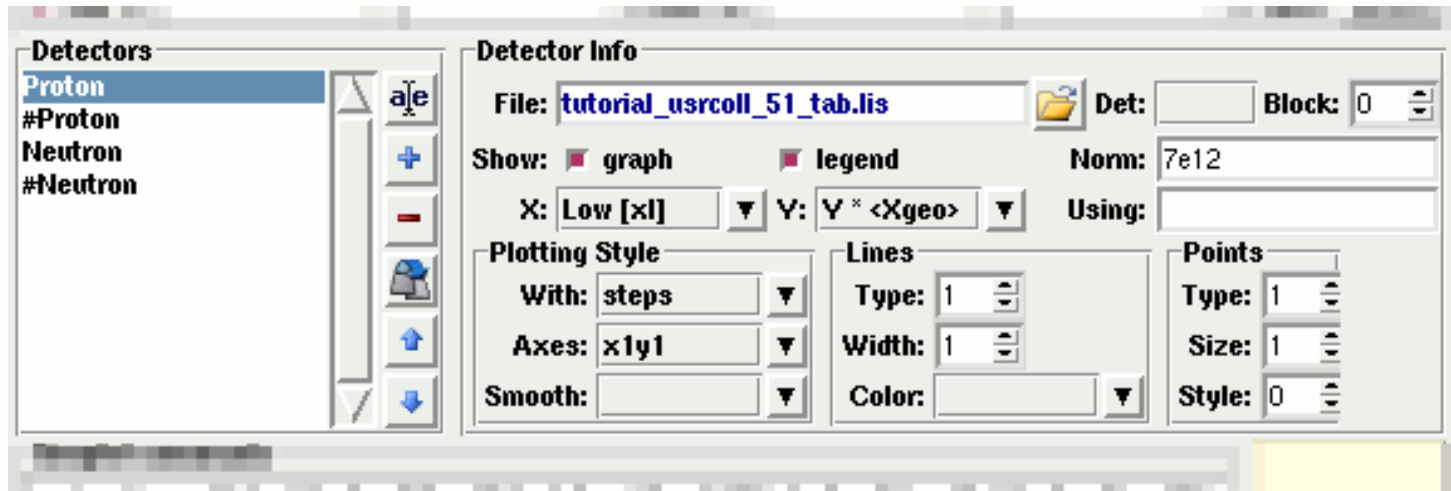
- Same as the 1D Projection, but displays only the maximum value on each slice. (eg. on a Z-projection, it will display the maximum on each X-Y slice)

1D Trace H or V

- Displays the position of the maximum and also the FWHM on either the horizontal or vertical plane (requires the **usbmax.c** prg)

Plotting Style: (see USR-1D)

USR-1D Single Differential Plot



- USR-1D is able to plot the 1D single differential information from the **USRBDX**, **USRCOLL**, **USRTRACK** and **USRYIELD** cards (The 2D information is not handled).
- The file type in use should have the extension **_tab.lis** and are generated by the FLUKA data merging tools (See Data Frame)
- You can superimpose many scoring output in a single plot.

USR-1D Single Differential Plot

The basic steps to create a plot are:

- Add or Clone a `_tab.lis` file, in the Detectors listbox.
- Select the detector to be used from the Det: dropdown listbox
- Set a name in the Name: field. Names starting with `#` will not be displayed as keys in the plot
- Select the X: and Y: information to plot as well the Style: X,Y,Style have different values.

Note: Different combination will be interpreted in different way from gnuplot, resulting in maybe unwanted results

- You have the possibility to select:
 - Plotting axes
 - Smoothing of the plot
 - Color, line type, width, point sizes etc.
(Enter the command "test" in the **gnuplot** command and hit "Plot" you will get a plot of all possible types)
 - Predefined styles

USR-1D Plots

- X: choices:
[x_l , x_h refer to the limits of each individual bin of the histogram]
 - GeoMean [$\sqrt{x_l \cdot x_h}$] Geometrical mean. Should be used if X is **scored** as a log-histogram
 - Mean [$(x_l + x_h) / 2$] Normal mean. For **linear** scoring
 - Low [x_l] Low value of the bin
 - High [x_h] High value of the bin
- Y: choices:
 - Y Y-bin value as given by FLUKA
 - $Y \times \langle X \rangle$ Y-bin value multiplied by the **mean X value** of the bin (Isolethargic)
 - $Y \times \langle X_{geo} \rangle$ Y-bin value multiplied by the **geometrical X-mean** of the bin (Isolethargic)
 - $Y \times X_l$ -//- with the **X-low** value of the bin
 - $Y \times X_h$ -//- with the **X-high** value of the bin
 - $Y \times DX$ -//- with the **width** of the bin

USR-1D Plots

- **Style:** has a huge list of choices as given by gnuplot. You can consult gnuplot manual for the description of the options. Some suggested settings are the following:
 - To make a **line/scatter plot with or without errors**
 - X: **GeoMean** (if scored in log), **Mean** (if scored in linear)
 - Y: **$Y \times < X_{\text{geo}} \text{ or } X >$** , for isoethargic plotting
 - Style: **lines, linespoints, dots, errorbars, yerrorbars, errorlines...**
 - To make a histogram
 - X: **Xlow [xl]**
 - Y: **what ever choice you want to plot**
 - Style: **steps**
 - or
 - X: **Xhigh [xh]**
 - Style: **histeps**

USR-1D Plots

- You have the possibility to superimpose plots. Useful if you want to show histograms with error bars superimposed.
- You can selected angular slices from **USRBDX** data using the **"Block"** option
- You can superimpose experimental data or any other data file and override all options using the **"Using:"** input field