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**FLUKA**  
**Standard Output and Plotting**

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Beginners' FLUKA Course

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# The FLUKA Standard Output

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

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

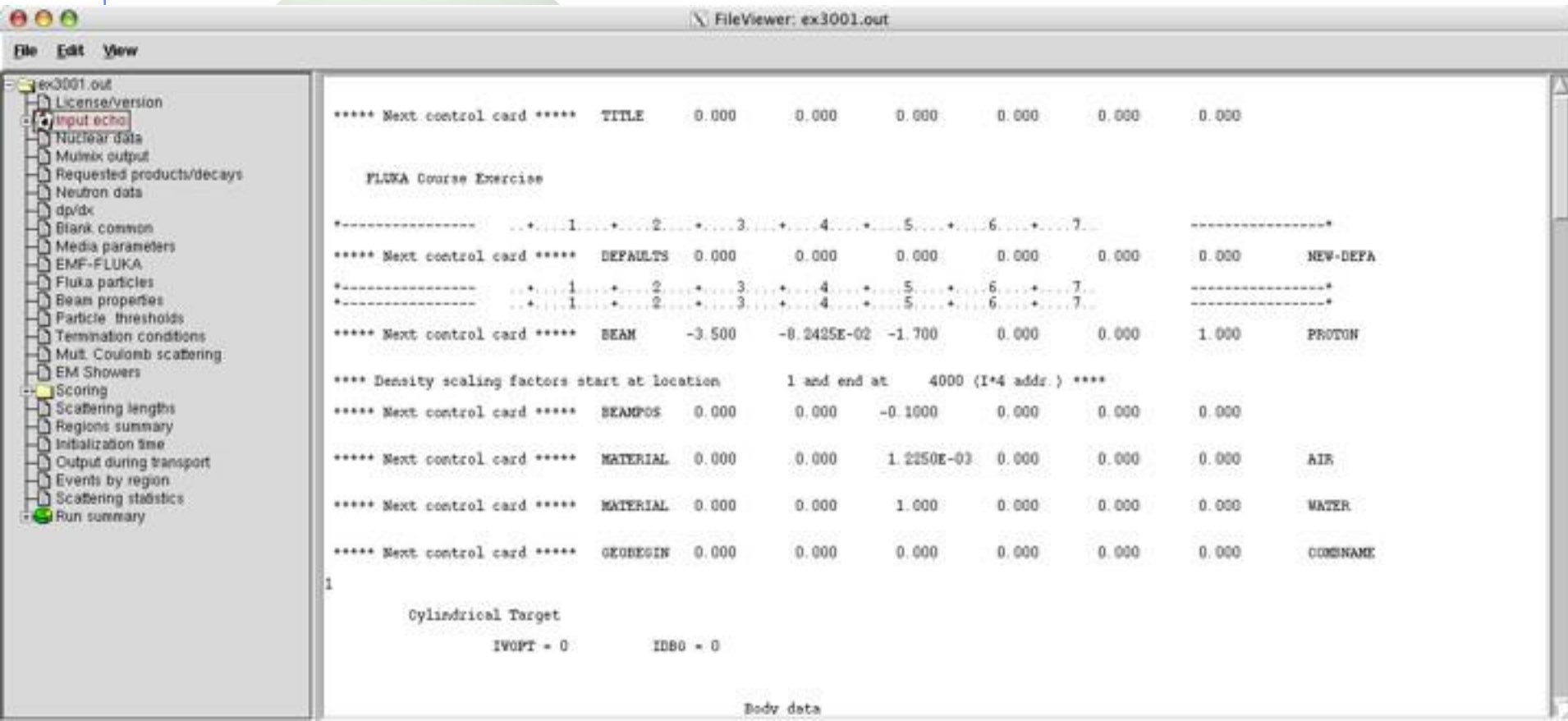
- **It must be checked at least once when setting up a simulation and always in case of doubts/crashes (together with *inp###.err* and *inp###.log* files)**

- Let's have a look to *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...
- For instance: TITLE is the first to appear, then all comment cards are listed together, followed by the beam related cards, etc. etc.



```
FileViewer: ex3001.out
File Edit View
ex3001.out
  License/version
  Input echo
  Nuclear data
  Muxix 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
  Scoring
  Scattering lengths
  Regions summary
  Initialization time
  Output during transport
  Events by region
  Scattering statistics
  Run summary

***** Next control card ***** TITLE 0.000 0.000 0.000 0.000 0.000 0.000

      FLUKA Course Exercise

-----+-----
      + 1 + 2 + 3 + 4 + 5 + 6 + 7
***** Next control card ***** DEFAULTS 0.000 0.000 0.000 0.000 0.000 0.000 0.000 NEW-DEPA
-----+-----
      + 1 + 2 + 3 + 4 + 5 + 6 + 7
***** 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 ***** SEAMPOS 0.000 0.000 -0.1000 0.000 0.000 0.000

***** Next control card ***** MATERIAL 0.000 0.000 1.2250E-03 0.000 0.000 0.000 AIR

***** Next control card ***** MATERIAL 0.000 0.000 1.000 0.000 0.000 0.000 WATER

***** Next control card ***** GEOBEGIN 0.000 0.000 0.000 0.000 0.000 0.000 COBNAME

1

      Cylindrical Target
      IVOPT = 0 IDBO = 0

      Body data
```

# Input echo – *Geometry output*

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

The image shows two side-by-side screenshots of a FileViewer window displaying the output of a simulation. The left window shows the 'Interpreted body echo' and the right window shows the 'Interpreted region echo'. Both windows have a file explorer on the left and a main text area on the right.

**Interpreted body echo (Left Window):**

Body n.	1	SPH	BLK		0.000000
	0.000000				0.000000
	10000.00				
Body n.	2	RPP	VOI		1000.000
	-1000.000				1000.000
	1000.000				-1000.000
Body n.	3	SCC	TARO		0.000000
	0.000000				0.000000
	25.00000				
Body n.	4	XYP	zmin		0.000000
	0.000000				
Body n.	5	XYP	zMax		10.00000
	10.00000				
Body n.	6	XYP	z1cm		1.000000
	1.000000				
Body n.	7	XYP	z2cm		2.000000
	2.000000				

**Interpreted region echo (Right Window):**

Region n.	1	BLKHOLE			
	1	-2			
Region n.	2	VAC			
	2	4			
	OR	2	5	-4	-3
	OR	2	-5		
Region n.	3	WATtar			
	3	6	-4		
Region n.	4	ALTar			
	3	7	-6		
Region n.	5	PBTar			
	3	5	-7		

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

	VOLUMES (CM**3)				
1 REG	1	2	3	4	5
VOLUME	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00
+00					

# Nuclear data

File Edit View

ex3003.out

- License/version
- Input echo
  - Body data
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  - Body echo
  - Region echo
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- Neutron data
- dp/dx
- Blank common
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- Fluka particles
- Beam properties
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```
*** Reading evaporation and nuclear data from unit: 14
*** Evaporation: using NNDC (1996) data ***

Starting location in blank common of LVL data: 4490
Last location in blank common of LVL data: 586959

Starting location in blank common of gamma data: 586960
Last location in blank common of gamma data: 689387

:
:
:
**** Atomic mass for 56-Fe : 52.1030807 GeV ****
**** Nuclear mass for 56-Fe : 52.0898265 GeV ****
**** Excess mass for 107-Ag: -0.088405259 GeV ****
**** Cameron E. m. for 107-Ag: -0.0891378522 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
LNUNOK, LNUNOK, LNUNOK
P T T
Neutrino
DATE: 4/22/ 8, TIME: 15: 3:2

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

Information about the basic nuclear data file used in the program

some memory allocation details...

active options for the nuclear model



# Material properties

FileViewer: ex3003.out

File Edit View

ex3003.out

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```

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

Number of elements = 3. Density= 1.225000E-03 (g/cm**3)
0 I Z Pa F_i Rho_i
Index Atomic Atomic Proportion Proportion
Number Weight by Number by weight

1 7.00000 14.0067 0.784754 9.255849E-04
2 8.00000 15.9994 0.210573 2.836954E-04
3 18.0000 39.9480 4.673085E-03 1.571974E-05

ZTILDE, AE103, BLCRA= 7.56380E+00 2.51981E+00 9.97355E-03

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

ZTILDE, AE103, BLCRE= 6.53935E+00 2.51981E+00 1.04506E-02
BLC, XCC, TPFLUO, XROFLU= 7.83319E+00 2.65738E-05 8.54719E-01 4.25526E-05
BLCCE, XCC, TPEMP, XROEMP= 8.91162E+00 2.83218E-02 2.24469E+00 9.00128E-02
Particle n.: 1 Ecuta (prim. & sec.) = 0.9583 GeV 0.9583 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 2 Ecuta (prim. & sec.) = 0.9583 GeV 0.9583 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 3 Ecuta (prim. & sec.) = 2.0511E-02 GeV 2.0511E-02 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 4 Ecuta (prim. & sec.) = 2.0511E-02 GeV 2.0511E-02 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 10 Ecuta (prim. & sec.) = 0.1257 GeV 0.1257 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 11 Ecuta (prim. & sec.) = 0.1257 GeV 0.1257 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 13 Ecuta (prim. & sec.) = 0.1596 GeV 0.1596 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 14 Ecuta (prim. & sec.) = 0.1596 GeV 0.1596 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 15 Ecuta (prim. & sec.) = 0.5136 GeV 0.5136 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 16 Ecuta (prim. & sec.) = 0.5136 GeV 0.5136 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 20 Ecuta (prim. & sec.) = 1.217 GeV 1.217 GeV, Hthasz = 1.0000E+3
0 GeV
Particle n.: 21 Ecuta (prim. & sec.) = 1.209 GeV 1.209 GeV, Hthasz = 1.0000E+3
0 GeV

```

Material properties, multiple scattering parameters

the warning is normal!

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# Radiation Decay

FileViewer: ex3003.out

File Edit View

- ex3003.out
  - License/version
  - Input echo
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    - Body echo
    - Region echo
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  - Mulmix output
  - Requested products/decays**
  - Neutron data
  - dp/dx
  - Blank common
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  - EMF-FLUKA
  - Fluka particles
  - Beam properties
  - Particle thresholds
  - Termination conditions
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```
**** Isotope tabulation data start      at location 1080685 and end at 1097830 (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 decay radiation options

Radiation biasing

# Neutron data

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File Edit View

ex3003.out

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  - Region data
  - Body echo
  - Region echo
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- dp/dx
- Blank common
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- Fluka particles
- Beam properties
- Particle thresholds
- Termination conditions
- Mult. Coulomb scattering
- EM Showers
- Scoring
  - Scattering lengths
  - 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

```
*** Recoil proton production activated for Xsec mat. # 1 ***
*** (n,p) proton production activated for Xsec mat. # 2 ***
Group cross sections storage starts at 1
Last location used for group xsecs 1244497

**** THE FOLLOWING VALUES ARE FROM
Panini Xsec
0 Number of primary groups (Ngrpn) 72
Number of primary downscatters (Nds) 72
Number of secondary groups (Ngrpg) 22
Number of secondary downscatters (Ndsg) 22
Number of prim+sec groups (Ingp) 94
Table length (Itbl) 97
Loc of within group (sig gg) (Isgg) 4
Number of media (Nxsmed) 129
Number of coefficients (Ncoef) 6
Number of angles (Nansct) 3
1
*** Fluka to low en. xsec material correspondence: printed atomic densities are meaningless when
used in a compound ***
```

Fluka medium number	Name	Xsec medium number	atomic density ( at/(cm barn) )	Id. 1	Id. 2	Id. 3
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	293
7	NITROGEN	2	0.0000E+00	7	-2	293
8	OXYGEN	3	0.0000E+00	8	16	293
10	ALUMINUM	4	6.0240E-02	13	-2	293
17	LEAD	6	3.2988E-02	82	-2	293
20	ARGON	5	0.0000E+00	18	-2	293

Low-energy neutron info, material correspondence

More info on low-neut cross sections if requested **LOW-NEUT**



# Material Parameters – $dp/dx$

FileViewer: ex3003.out

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    - Region echo
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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
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```
*** dp/dx tab. generated up to 11.74 GeV/c/n ***

**** Nuclear form factor 'a la Kelner' selected ****
**** Standard Coulomb correction selected ****
**** for charged hadron and muon bremsstrahlung ****

***** dp/dx : material number 26 "AIR" *****

***** Gas: actual (Fluka) pressure : 1.0000E+00 atm. *****

***** Average excitation energy : 8.5667E+01 eV, weighted Z *****
***** Sternheimer density effect parameters: *****
***** X0 = 1.8000, X1 = 4.0000, C = -10.5787, A = 0.2 *****

***** 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 27 "WATER" *****

***** Average excitation energy : 7.5319E+01 eV, weighted Z/A : 5.5508E-01 *****
***** Sternheimer density effect parameters: *****
***** X0 = 0.2000, X1 = 2.0000, C = -3.5102, A = 0.4440 n = 3.0000 D0 = 0.0000 *****

***** Restricted energy loss tabulated in 54 intervals *****
***** Delta ray product

***** dE/dx fluctuation
***** (up to 2I di

***** Restricted pair p
***** Exp. pair production activated above 0.0000E+00 GeV *****
```

Material-dependent parameters for ionization energy losses

Check  $\delta$ -ray and bremsstrahlung threshold (DELTA RAY, PAIR BREM)

# Material parameters – *Transport thresholds*

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File Edit View

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- # of stars
- # of secondaries in stars
- # of fissions
- # of decay products
- # of particles decayed

1 Quantities/Biasing associated with each media:

**AIR**

Rho =	1.225000E-03	g/cm**3	Rlc=	29890.6	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)

**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

below the threshold for explicit secondary electron production

**Annotations:**

- Upper limit for  $e^\pm$  in MeV (green text, pointing to Ue = 11737.8 MeV)
- Same for photons (blue text, pointing to Ap = 0.333333 MeV)
- Production threshold for  $e^\pm$  in MeV (Total energy, not just kinetic) (red text, pointing to Ae = 1.51100 MeV)

# Material parameters – *EMF-FLUKA*

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- dp/dx
- Blank common
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- Mult Coulomb scattering
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  - Initialization time
  - Output during transport
  - Events by region
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- Run summary
  - Totals/CPU time
  - # of stars
  - # of secondaries in stars
  - # of fissions
  - # of decay products
  - # of particles decayed

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

Region	EMF	FLUKA			
1	0 VACUUM	1 BLACKHOLE			
Ecut =	0.0000E+00 MeV,	Pcut =	0.0000E+00 MeV,	BIAS =	P, Ray. = F, S(q, Z) = T,
Pz(q, Z) =	F				
2	1 AIR	26 AIR			
Ecut =	1.5110E+00 MeV,	Pcut =	3.3333E-01 MeV,	BIAS =	P, Ray. = F, S(q, Z) = T,
Pz(q, Z) =	F				
3	2 WATER	27 WATER			
Ecut =	1.5110E+00 MeV,	Pcut =	3.3333E-01 MeV,	BIAS =	P, Ray. = F, S(q, Z) = T,
Pz(q, Z) =	F				
4	3 ALUMINUM	10 ALUMINUM			
Ecut =	1.5110E+00 MeV,	Pcut =	3.3333E-01 MeV,	BIAS =	P, Ray. = F, S(q, Z) = T,
Pz(q, Z) =	F				
5	4 LEAD	17 LEAD			
Ecut =	1.5110E+00 MeV,	Pcut =	3.3333E-01 MeV,	BIAS =	P, Ray. = F, S(q, Z) = T,
Pz(q, Z) =	F				

1

**Transport threshold for  $e^\pm$  and photons in MeV (Total energy, not just kinetic)**

# FLUKA Particles

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  - # of secondaries in stars
  - # of fissions
  - # of decay products
  - # of particles decayed

```
=== Output before the actual run - Particle properties: ===  
  
=== Transportable Fluka particles: ===  
  
Particle Number      Mass      Mean Life  Charge  Baryon Discard  Decay  PDG id  
                (GeV/c**2)      (s)                number Flag(=1)  Flag  
  
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  
  
...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&SPI+-          207  
---
```

...continues on your screen!



# Input interpreted summary – *Beam*

FileViewer: ex3003.out

File Edit View

ex3003.out

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  - # of stopping particles
  - # of part. from low en. neutrons
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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 (rectangular): 0.0824250 (GeV/c)
Beam hit position: 0.00000000 0.00000000 -0.1000000000 ca
Beam direction cosines: 0.00000000 0.00000000 1.00000000
Beam spot FWHM X-width (Rectangular): 0.0000 ca
Beam spot FWHM Y-width (Rectangular): 0.0000 ca
Beam FWHM angular divergence (Gaussian): 1.7000 (mrad)
The nominal beam position belongs to region: 2(VAC), lattice cell: 0( )
```

Check the starting region



# Input interpreted summary – *Thresholds*

FileViewer: ex3003.out

File Edit View

ex3003.out

- License/version
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  - # of stopping particles
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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 PROTON transport: 1.000E-02 GeV

Cut-off kinetic energy for APRON transport: 1.000E-02 GeV

Cut-off kinetic energy for ELECTRON transport defined in the Eafcut card

Cut-off kinetic energy for POSITRON transport defined in the Eafcut card

Cut-off kinetic energy for NEUTRINE transport: 0.000E+00 GeV

Cut-off kinetic energy for ANEUTRINE transport: 0.000E+00 GeV

Cut-off kinetic energy for PHOTON transport defined in the Eafcut card

Cut-off kinetic energy for NEUTRON transport: 1.960E-02 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

Cut-off kinetic energy for ALAMBDA transport: 1.000E-02 GeV

Cut-off kinetic energy for KAONSHRT transport: 1.000E-02 GeV

Cut-off kinetic energy for STON transport: 1.000E-02 GeV

# Input interpreted summary – *TC, MCS, EM*

FileViewer: ex3003.out

File Edit View

ex3003.out

- License/version
- Input echo
  - Body data
  - Region data
  - Body echo
  - Region echo
- Nuclear data
- Mulmb 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
- Scoring
- Scattering lengths
- 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

```
=== Termination conditions: ===
Minimum cpu-time reserved for output:          80.00 sec
Maximum number of beam particles to be followed: 10
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.Passo',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

none in ex3, check ex5 output

```
FileViewer: /home/lsarchia/FLUKA0608/ex5/ex5001.out

File Edit View

/home/lsarchia/FLUKA0608/ex5/
├── 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
├── Scoring
│   ├── USRBIN
│   ├── USRBDX
│   ├── USRTRACK
│   ├── USRCOLL
│   ├── USRYIELD
│   ├── RESNUCLE
│   └── DETECT
├── Scattering lengths
├── Regions summary
├── Initialization time
├── Output during transport
├── Events by region
├── Scattering statistics
└── Run summary

***** "usrbin" option:

Region   binning n.   1 "Target1"  , generalized particle n.  208
      3 bins corresponding to the region sets:
from region   3 to region   5 in step of   1 regions, or
from region   0 to region   0 in step of   1 regions, or
from region   0 to region   0 in step of   1 regions
data will be printed on unit   41 (unformatted if < 0)
normalized (per unit volume) data will be printed at the end of the run

***** "USRBDX" option:

Bdrx n.   1 "Al2PbF"  , generalized particle n.  213, from region n.   4 to region n.   5
detector area: 1.0000E+00 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  -51 (unformatted if < 0)

Bdrx n.   2 "Al2PbI"  , generalized particle n.  213, from region n.   4 to region n.   5
detector area: 1.0000E+00 cm**2
this is a one way only estimator
this is a current 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  -52 (unformatted if < 0)

***** "USRTRACK" option:

No user track-length estimator defined

***** "USRCOLL" option:

No user collision density estimator defined

***** "Usryield" option:

No user yield estimator defined
```

Complete description of each estimator requested

# Materials – *Scattering lengths*

FileViewer: /home/lsarchia/FLUKA0608/ex5/ex5001.out

File Edit View

\*\*\* Material compositions: \*\*\*


Material Number&Name	Atomic Number	Atomic Weight	Density	Inelastic Scattering Length for PROTON at Beam energy	Elastic Scattering Length for PROTON at Beam energy	Radiation Length	Inelastic Scattering Length for neutrons at Threshold Momentum
			g/cm**3	cm	cm	cm	cm
1 BLOCKBOLE	0.000	0.000	0.000	0.1000E+31	0.1000E+31	0.1000E+31	0.1000E+31
2 VACUUM	0.000	0.000	0.000	0.1000E+31	0.1000E+31	0.1000E+31	0.1000E+31
3 HYDROGEN	1.000	1.008	0.8370E-04	0.7040E+06	4.418E+07	0.7532E+06	0.6496E+09
4 HELIUM	2.000	4.003	0.1660E-03	0.3506E+06	3.310E+07	0.5602E+06	0.6024E+34
5 BERYLLIUM	4.000	9.012	1.848	19.41	65	16.98	17.02
6 CARBON	6.000	12.0	14.0				
7 NITROGEN	7.000	14.0					
8 OXYGEN	8.000	16.0					
9 MAGNESIUM	12.00	24.3					
10 ALUMINUM	13.00	26.9					
11 IRON	26.00	55.8					
12 COPPER	29.00	63.5					
13 SILVER	47.00	107.					
14 SILICON	14.00	28.09	2.329	43.04	86.94	9.370	20.21
15 GOLD	79.00	197.0	19.32	9.239	13.14	0.3344	7.014
16 MERCURY	80.00	200.6	13.55	13.25	18.79	0.4752	9.847
17 LEAD	82.00	207.2	11.35	15.97	22.54	0.5612	12.05
18 TANTALUM	73.00	180.9	16.65	10.44	15.03	0.4094	7.382
19 SODIUM	11.00	22.99	0.9710	97.58	212.4	28.56	47.49
20 ARGON	18.00	39.95	0.1660E-02	0.6692E+05	0.1186E+06	0.1178E+05	0.3734E+05
21 CALCIUM	20.00	40.08	1.550	71.72	127.0	10.42	36.21
22 TIN	50.00	118.7	7.310	20.90	31.44	1.206	14.35
23 TUNGSTEN	74.00	183.8	19.30	9.055	13.00	0.3504	6.169
24 TITANIUM	22.00	47.87	4.540	25.79	43.52	3.560	15.05
25 NICKEL	28.00	58.69	8.902	13.87	22.83	1.424	8.396
26 AIR	7.323	14.55	0.1225E-02	0.6817E+05	0.1780E+06	0.2989E+05	0.3174E+05

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

Material	Number	Atom content	Partial Densities
NITROGEN	7	0.78475	0.92558E-03
OXYGEN	8	0.21057	0.28370E-03
ARGON	20	0.46731E-02	0.15720E-04
27 WATER	3.333	6.005	1.000
28 AIR	7.323	14.55	0.1225E-02

Compounds interpreted composition

Material	Number	Atom content	Partial Densities
HYDROGEN	3	0.66667	0.11190
OXYGEN	8	0.33333	0.89810





# Regions summary

FileViewer: /home/lsarchia/FLUKA0608/ex5/ex5001.out

File Edit View

/home/lsarchia/FLUKA06

- License/version
- Input echo
- Nuclear data
- Mulmix output
- Requested products/di
- Neutron data
- dp/dx
- Blank common
- Media parameters
- EMF-FLUKA
- Fluka particles
- Beam properties
- Particle thresholds
- Termination conditions
- Mult. Coulomb scatteri
- EM Showers
- Scoring
  - Scattering lengths
  - Regions summary**
  - Initialization time
  - Output during transpor
  - Events by region
  - Scattering statistics
- Run summary

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

Useful way to check material assignment

Minimum step size set with STEPSIZE option

...maximum step size not yet implemented



# Runtime Info – *Output associated with the run*

FileViewer: /home/lsarchia/FLUKA0608/ex5/ex5001.out

File Edit View

/home/lsarchia/FLUKA0608/ex5/ex501

\*\*\* End of the output associated with the input \*\*\*

Total time used for initialization: 5.72 s

Periodic echo of:  
event number, time, random seed

Initialization time

FileViewer: /home/lsarchia/FLUKA0608/ex5/ex5001.out

File Edit View

	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	0	0	
1	9999	0	9999	3.1994820E-02	1.0000000E+30	5
NEXT SEEDS: E4F7	0	0	0	0	0	
200	9800	0	9800	9.4485593E-03	1.0000000E+30	363
NEXT SEEDS: 358D09	0	0	0	0	0	
400	9600	0	9600	9.6310341E-03	1.0000000E+30	733
NEXT SEEDS: 6D5E63	0	0	0	0	0	
600	9400	0	9400	9.4968883E-03	1.0000000E+30	1040
NEXT SEEDS: A24DB0	0	0	0	0	0	
800	9200	0	9200	9.5422989E-03	1.0000000E+30	1327
NEXT SEEDS: DA74CD	0	0	0	0	0	
1000	9000	0	9000	9.5565476E-03	1.0000000E+30	1692
NEXT SEEDS: 110259A	0	0	0	0	0	
1200	8800	0	8800	9.8909954E-03	1.0000000E+30	2070
NEXT SEEDS: 15285B2	0	0	0	0	0	
1400	8600	0	8600	1.0159884E-02	1.0000000E+30	2460
NEXT SEEDS: 1959EFF	0	0	0	0	0	
1600	8400	0	8400	1.0267189E-02	1.0000000E+30	2799
NEXT SEEDS: 1D5A948	0	0	0	0	0	
1800	8200	0	8200	1.0121794E-02	1.0000000E+30	3140
NEXT SEEDS: 208385B	0	0	0	0	0	
2000	8000	0	8000	1.0115952E-02	1.0000000E+30	3479
NEXT SEEDS: 241A206	0	0	0	0	0	
2200	7800	0	7800	1.0115280E-02	1.0000000E+30	3805

Output during transport

# Results – *Scoring*

Results of SCORE options for all region:


**very useful** for debugging and for cross-check with estimators

iRegion #	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	2.952010062E+00		5.917832799E-02	
2	INAIR	1.000000000E+00	7.110000000E-02	8.400000000E-03	8.810405276E-03		1.656213307E-03	
3	TARGS1	1.000000000E+00	1.820000000E-02	1.200000000E-02	3.402603794E-03		2.095980620E-04	
4	TARGS2	1.000000000E+00	4.680000000E-02	2.700000000E-02	8.117056983E-03		8.733151927E-04	
5	TARGS3	1.000000000E+00	1.542600000E+00	3.834000000E-01	3.883824258E-01		1.237258076E-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*



The screenshot shows a FileViewer window titled "FileViewer: /home/lsarchia/FLUKA0608/ex5/ex5001.out". The window has a menu bar with "File", "Edit", and "View". On the left, a file tree shows the directory structure, with "Scattering statistics" selected. The main area displays the following text:

```
**** Total number of not-performed scatterings in FLUKA:      9134
**** Total number of scatterings with no LDA in FLUKA:      122127
**** Ratio of rejected/accepted samplings from the Moliere's distribution in FLUKA:      0.0000
**** ( Total multiple scatterings: 9.1518E+05; Total single scatterings: 0.0000E+00 )

**** Total number of not-performed scatterings in EMF :      1448
**** Total number of scatterings with no LDA in EMF :      8570
**** Ratio of rejected/accepted samplings from the Moliere's distribution in EMF :      0.0000
**** ( Total multiple scatterings: 3.9907E+06; Total single scatterings: 0.0000E+00 )
```

# Results – *Statistics of the run*

FileViewer: /home/lsarchia/FLUKA0608/ex5/ex5001.out

File Edit View

/home/lsarchia/FLUKA0608/ex5/ex5001.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
- Scoring
  - Scattering lengths
  - 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

```
Total number of primaries run:          10000 for a weight of: 1.000000E+04
!!! Please remember that all results are normalized per unit weight !!!
The main stack maximum occupancy was    86 out of    40000 available

Total number of inelastic interactions (stars):          16787
Total weight of the inelastic interactions (stars): 1.678700E+04

Total number of low energy neutron interactions:          183327
Total weight of the low energy neutron interactions: 1.833582E+05

Total CPU time used to follow all primary particles: 9.750E+01 seconds of:
Average CPU time used to follow a primary particle: 9.750E-03 seconds of:
Maximum CPU time used to follow a primary particle: 9.499E-02 seconds of:
Residual CPU time left: 1.000E+30 seconds of:
```



**CPU time is not real time!**



# Run summary: *detailed statistics*

FileViewer: ex3003.out

File Edit View

ex3003.out

- License/version
- input echo
  - Body data
  - Region data
  - Body echo
  - Region 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
- Scoring
  - Scattering lengths
  - 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

Number of stars generated per beam particle:

Prompt radiation		Radioactive decays		
1.8000E+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
0.0000E+00	(0.0%)	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 RAY
8.0000E-01	(44.4%)	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 NEUTRINE
0.0000E+00	(0.0%)	0.0000E+00	(0.0%)	generated by ANEUTRINE
0.0000E+00	(0.0%)	0.0000E+00	(0.0%)	generated by PHOTON
6.0000E-01	(33.3%)	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
0.0000E+00	(0.0%)	0.0000E+00	(0.0%)	generated by PION+
4.0000E-01	(22.2%)	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-
0.0000E+00	(0.0%)	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 ASIGMA-
0.0000E+00	(0.0%)	0.0000E+00	(0.0%)	generated by ASIGMAZE
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 for each particle type



# Energy Balance

FileViewer: ex3003.out

File Edit View

ex3003.out

- License/version
- Input echo
  - Body data
  - Region data
  - Body echo
  - Region 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
- Scoring
  - Scattering lengths
  - 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				
2.2985E-01 (6.6%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV hadron and muon dE/dx
2.0173E-01 (5.8%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV electro-magnetic showers
2.9934E-02 (0.9%)	0.0000E+00 (0.0%)	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%)	0.0000E+00 (0.0%)	GeV particles below threshold
0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV residual excitation energy
1.2287E-03 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV low energy neutrons
2.8904E+00 (82.6%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	0.0000E+00 (0.0%)	GeV particles escaping the system
3.0979E-02 (0.9%)	0.0000E+00 (0.0%)	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%)	0.0000E+00 (0.0%)	GeV particles out of time limit
1.1584E-01 (3.3%)				GeV missing

- Hadrons and muons below thr. are ranged out, unless thresholds exceed 100 MeV
- electrons, positrons and photons not included (electro-magnetic showers)

going in the black-hole

Neutrinos are discarded by default

Calculated by difference: in pure e-m problems it should be 0, while in hadronic problems it is the energy spent in endothermic nuclear reactions ( $\approx 8$  MeV/n), or gained in exothermic (i.e., mostly neutron capture): it is  $-\text{total } Q$

# Error message

FileViewer: ex\_3001.out

File Edit View

ex\_3001.out

- License/Version
- Input echo
- Scoring
- Run summary
- ERROR

```
GEOEND      6.0      0.0      11.0     -6.0      0.0      -6.0DEBUG
GEOEND     120.0      1.0      170.0
**** Geometry debugging requested and activated ****
    from X=-6.000000000E+00 to X= 6.000000000E+00 in step dx= 1.000000000E-01
    from Y= 0.000000000E+00 to Y= 0.000000000E+00 in step dy= 0.000000000E+00
    from Z=-6.000000000E+00 to Z= 1.100000000E+01 in step dz= 1.000000000E-01

Total time used for geometry initialization:  5.999E-02 s

***** Next control card *****
0.000      WATER      MATERIAL  0.000      0.000      1.000      0.000      0.000

***** Next control card *****
0.000      AIR      MATERIAL  0.000      0.000      1.2250E-03  0.000      0.000

***** Next control card *****
0.000      WATER      COMPOUND  2.000      3.000      1.000      8.000      0.000

***** Next control card *****
20.00     AIR      COMPOUND -0.9256     7.000     -0.2837     8.000     -1.5720E-02

***** Next control card *****
0.000      RANDOMIZ  1.000      0.000      0.000      0.000      0.000

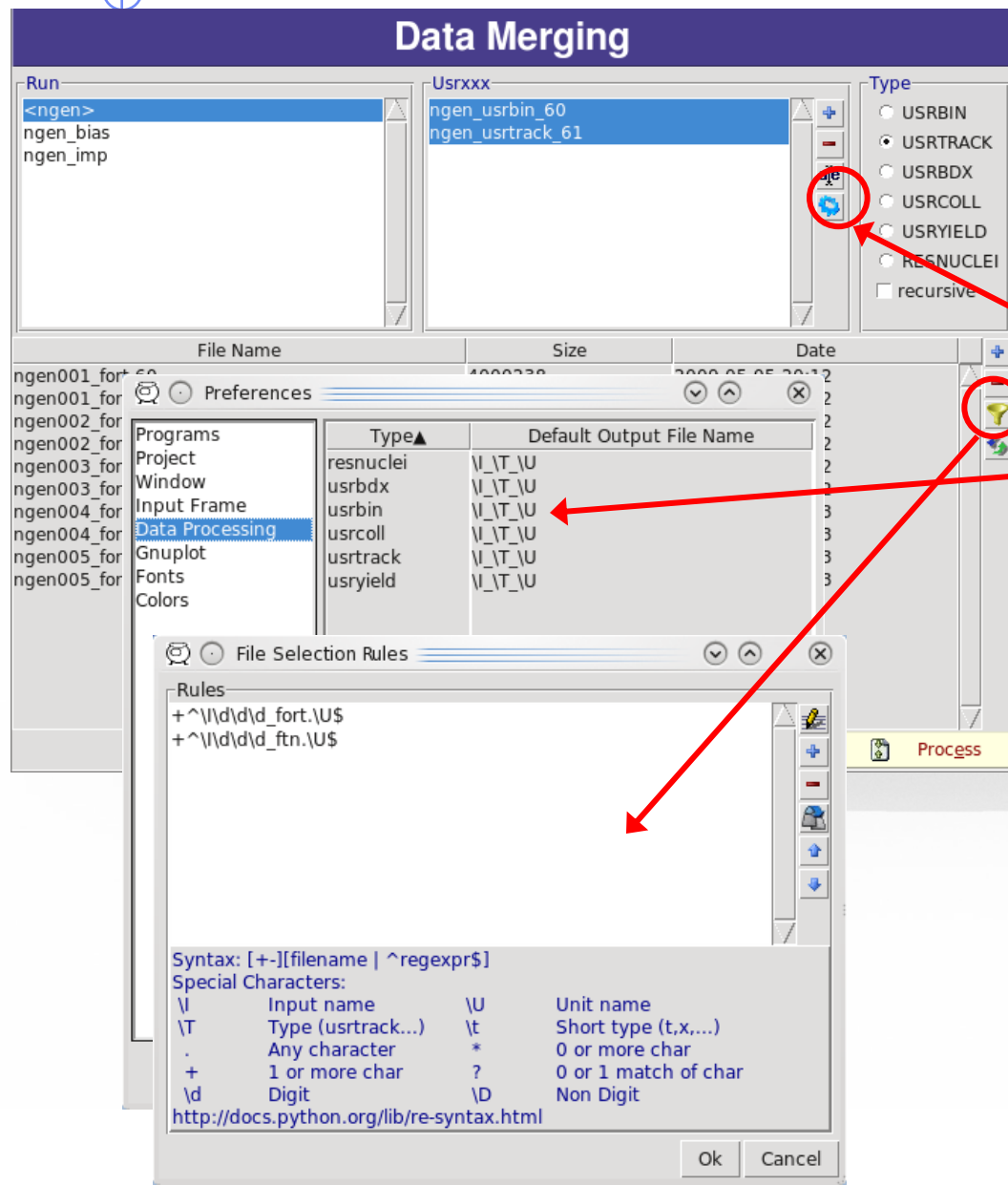
RM64 INITIALIZED:      98765      12345      0      0

***** Next control card *****
0.000      ASSIGNMA  1.000      1.000      0.000      0.000      0.000

***** Next control card *****
0.000      ASSIGNMA  26.00     2.000      0.000      0.000      0.000

*** Unable to resolve name element FLORIAN in card ***
ASSIGNMA      FLORIAN      TARGS2
*** run stopped ***
```

# flair: Data Processing



- Flair the **first time** 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 generate by the rules specified in the preference dialog
- The automatic rules could 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 (changing the extension)
- 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:

Y: Opt:

Set

grid

legend

Size / Multiplot

aspect: Width: Height:

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 that are sent to gnuplot. As well as the errors. In case of 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

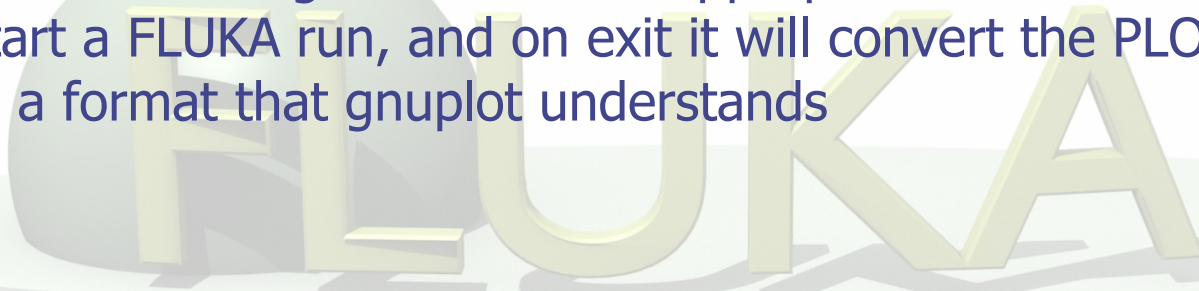
The screenshot shows a software interface for geometry plotting with the following sections:

- 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, 0.0, 1.0 and v: 0.0, 1.0, 0.0. Buttons: x-y, y-z, -u, x-z, swap, -v. Ang: 0.0, φ: [field], Rotate, Polar, Reset.
- Extends:** Δu: 50.0, Δv: 50.0, f: 2.0. Buttons: x f, Get, x 1/f, Reset.
- Grid:** Nu: 200, Nv: 200.
- Options:**  boundaries,  labels, Vector Scale: 0.1.
- Style:** Palette, Font: [field].
- Type:** Material, Z-Y [dropdown].

- 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

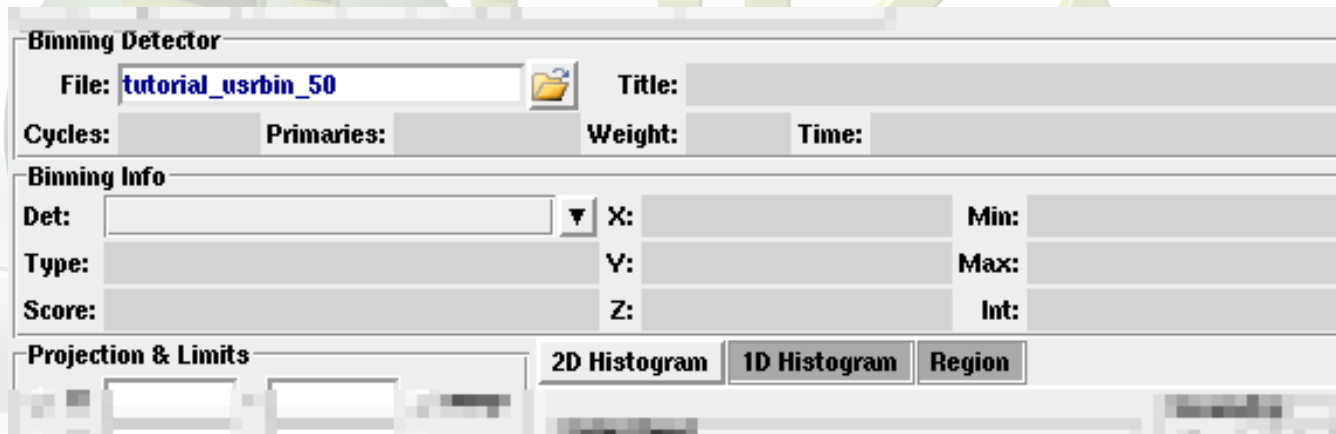


FLUKA



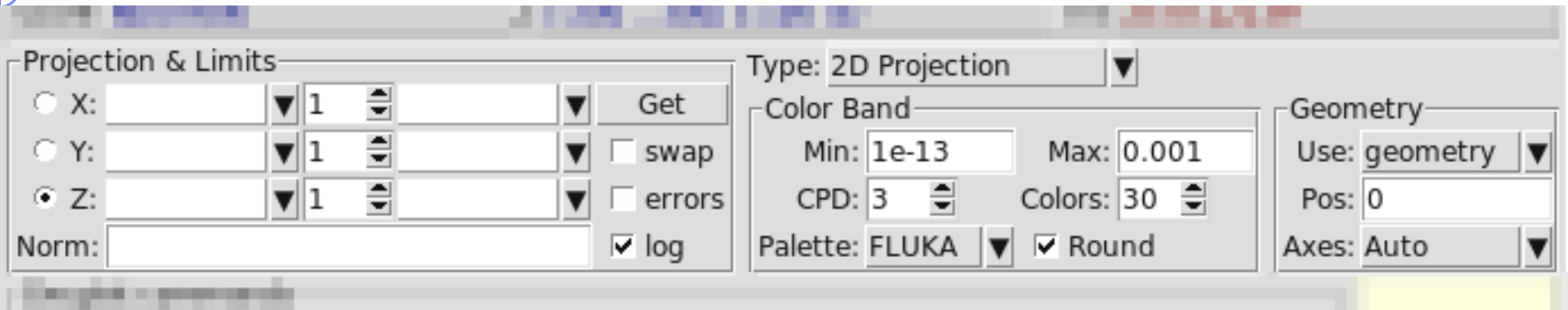
# USRBIN

- 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 scan
- of the data or errors from USRBIN data.



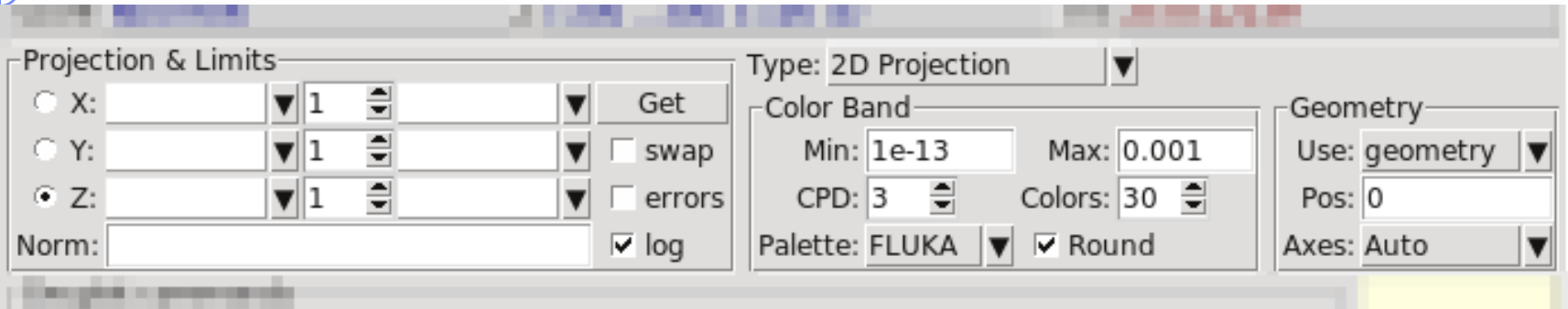
- Set the usrbn summary file in the File: field
- Select from Det: the detector to use.
- All the available detector information will be displayed
- The information **Minimum**, **Maximum** and **Integral** will be filled after the plot! *WARNING is always the projection min/max*

# 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

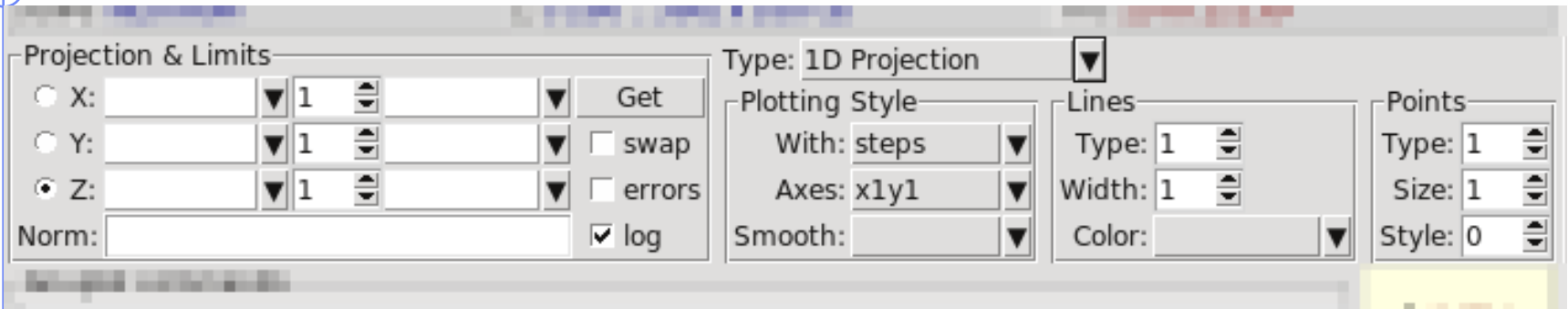
# USRBIN (2D plot) cont..

Superimpose 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 usrbn file do not contain the absolute coordinates
- The color palette is predefined in flair, but the user can modify it with the **"set palette"** gnuplot command. See gnuplot help page for more info.



# 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 to 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:  
[**xl**, **xh** refer to the limits of each individual bin of the histogram]
  - GeoMean [ $\sqrt{xl \cdot xh}$ ] Geometrical mean. Should be used if X is **scored** as a log-histogram
  - Mean [ $(xl+xh)/2$ ] Normal mean. For **linear** scoring
  - Low [xl] Low value of the bin
  - High [xh] 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)
  - $Y \times Xl$  -//- with the **X-low** value of the bin
  - $Y \times Xh$  -//- 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:  **$Y \times \langle X_{\text{geo}} \text{ or } X \rangle$** , 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 a histogram with the errorbars 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

