FLUKA
Standard Output and Plotting

Beginners' FLUKA 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 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…

File Edit View

- ex3001.out
  - License/version
  - Input Echo
  - Nuclear Data
  - Mulmix Output
  - Requested Products/D
  - Neutron Data
  - dp/dx
  - Blank Common
  - Media Parameters
  - EMF-FLUKA
  - Fluka Particles
  - Beam Properties
  - Particle Thresholds
  - Termination Condition:
  - Mult. Coulomb Scatteri
  - EM Showers
  - Particle Importances
  - Scoring
  - Material Properties
  - Regions Summary
  - Initialization Time
  - Output During Transpc
  - Events by Region
  - Scattering Statistics
  - Run Summary

```
*----------    ..+....1....+....2....+....3....+....4....+....5....+....6....+....7...          ----------*

***** 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*

FileViewer: ex3001.out

File Edit View

- ex3001.out
  - License/version
  - Input Echo
    - Body data
    - Region data
    - Body echo
    - Region echo
  - Nuclear Data
  - Mulmix Output
  - Requested Products/Dec
  - Neutron Data
  - dp/dx
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```
Interpreted body echo


Body n.         1  SPH  BLK        Rot.      0
        0.000000                 0.000000          0.000000          10000.00
Body n.         2  RPP  VOI        Rot.      0
       -1000.000                 1000.000          -1000.000         1000.000          -1000.000         1000.000
Body n.         3  ZCC  TARG       Rot.      0
        2.718000                 0.000000          25.00000          25.00000
Body n.         4  XYP  ZTlow      Rot.      0
        3.140000
Body n.         5  XYP  ZThigh     Rot.      0
        13.14000
Body n.         6  XYP  T1seg      Rot.      0
        4.140000
Body n.         7  XYP  T2seg      Rot.      0
        5.140000
```

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

FileViewer: ex3001.out

File Edit View

- ex3001.out
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  - Input Echo
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    - Region data
    - Body echo
    - Region echo
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  - Mulmix Output
  - Requested Products/Dec
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```
Interpreted region echo


Region n.         1 BLKHOLE
                  1       -2
Region n.         2 TARGS1
                  3       -4        6
Region n.         3 TARGS2
                  3       -6        7
Region n.         4 TARGS3
                  3       -7        5
Region n.         5 INAIR
          OR      2       -3
          OR      2        4
          OR      2       -5
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
 *----------------                                                  ----------------*
 *----------------    switch on to debug this geometry              ----------------*
```

Nuclear data [1/3]

FileViewer: ex4001.out

File Edit View

- ex4001.out
  - License/version
  - Input Echo
  - Nuclear Data
  - Mulmix Output
  - Requested Products/Decay
  - Neutron Data
  - dp/dx
  - Blank Common
  - Media Parameters
  - EMF-FLUKA
  - Fluka Particles
  - Beam Properties
  - Particle Thresholds
  - Termination Conditions
  - Mult. Coulomb Scattering
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```
 *** 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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```
**** 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

Nuclear data [3/3]

FileViewer: ex4001.out

File Edit View

- ex4001.out
  - License/version
  - Input Echo
  - Nuclear Data
  - Mulmix Output
  - Requested Products/Decay
  - Neutron Data
  - dp/dx
  - Blank Common
  - Media Parameters
  - EMF-FLUKA
  - Fluka Particles
  - Beam Properties
  - Particle Thresholds
  - Termination Conditions
  - Mult. Coulomb Scattering
  - EM Showers
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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 fromm  ***
*** 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

Material properties

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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, BLCCRA=    7.78788E+00    2.51981E+00    1.08102E-02

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

 ZTILDE, AE103, BLCCRE=    6.63158E+00    2.51981E+00    1.07635E-02
 BLCC, XCC, TFFLU0, XR0FLU=    6.33212E+03    7.58200E-04    1.05734E-03    4.27023E-05
 BLCCE, XCCE, TFEMF0, XR0EMF=    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
```

Material properties, multiple scattering parameters

This warning is normal!

Radiation Decay

FileViewer: ex4001.out

File Edit View

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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

FileViewer: ex4001.out

File Edit View

- 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      ( 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

Material Parameters – *dp/dx*

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File Edit View

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  - License/version
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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 bremmstrahlung    ****


*****   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               *****
        eimer density effect parameters:                                                 *****
        0.1708, X1 =   3.0127, C =  -4.2395, A =   0.0802 m =   3.6345 D0 =   0.1200 *****

        cted energy loss tabulated in     54 intervals *****
        ray production activated above  1.0000E-03 GeV *****

        fluctuations activated for this medium, level  1 *****
        o 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 bremss. threshold (DELTARAY,PAIRBREM)

Material parameters – *Transport thresholds*

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File Edit View

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  - License/version
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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
      Rho
      Ae
      Ap
      dE
      be
     (up
```

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

upper limit for $e^{\pm}$ in MeV

zoom

```
 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)
```

same for photons

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 c

 Starting location in bla
 Last location in blank c

 Starting location in bla
 Last location in blank c
1
```

transport threshold for e± (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      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
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     -0.100000000      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

Input interpreted summary – *Thresholds*

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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: 1000000000000000000.00 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

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Complete description of each requested estimator

```
******* "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 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
[illegible]	[illegible]	[illegible]	[illegible] 000	0.1000E+31	0.1000E+31	0.1000E+31	0.1000E+31
[illegible]	[illegible]	[illegible]	[illegible] 000	0.1000E+31	0.1000E+31	0.1000E+31	0.1000E+31
[illegible]	[illegible]	[illegible]	[illegible]3370E-04	0.7040E+06	0.1418E+07	0.7532E+06	0.8508E+09
[illegible]	[illegible]	[illegible]	[illegible]1660E-03	0.3506E+06	0.6310E+07	0.5682E+06	0.6024E+34
[illegible]	[illegible]	[illegible]	[illegible] 848	39.41	77.65	35.28	17.26
[illegible]	[illegible]	[illegible]	[illegible] 000	39.52	110.5	21.35	18.23
[illegible]	[illegible]	[illegible]	[illegible]1170E-02	0.7054E+05	0.1872E+06	0.3247E+05	0.3319E+05
[illegible]	[illegible]	[illegible]	[illegible]1330E-02	0.6438E+05	0.1624E+06	0.2574E+05	0.3013E+05
9 MAGNESIU	12.00	24.30	[illegible] 740	55.31	117.7	14.39	26.58
[illegible]	[illegible]	[illegible]	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	[illegible]	[illegible]	[illegible]
23 TUNGSTEN	74.00	183.8	19.30	9.055	[illegible]	[illegible]	[illegible]
24 TITANIUM	22.00	47.87	4.540	25.79	[illegible]	[illegible]	[illegible]
25 NICKEL	28.00	58.69	8.902	13.87	[illegible]	[illegible]	[illegible]
26 WATER	3.333	6.005	1.000	81.49	[illegible]	[illegible]	[illegible]

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

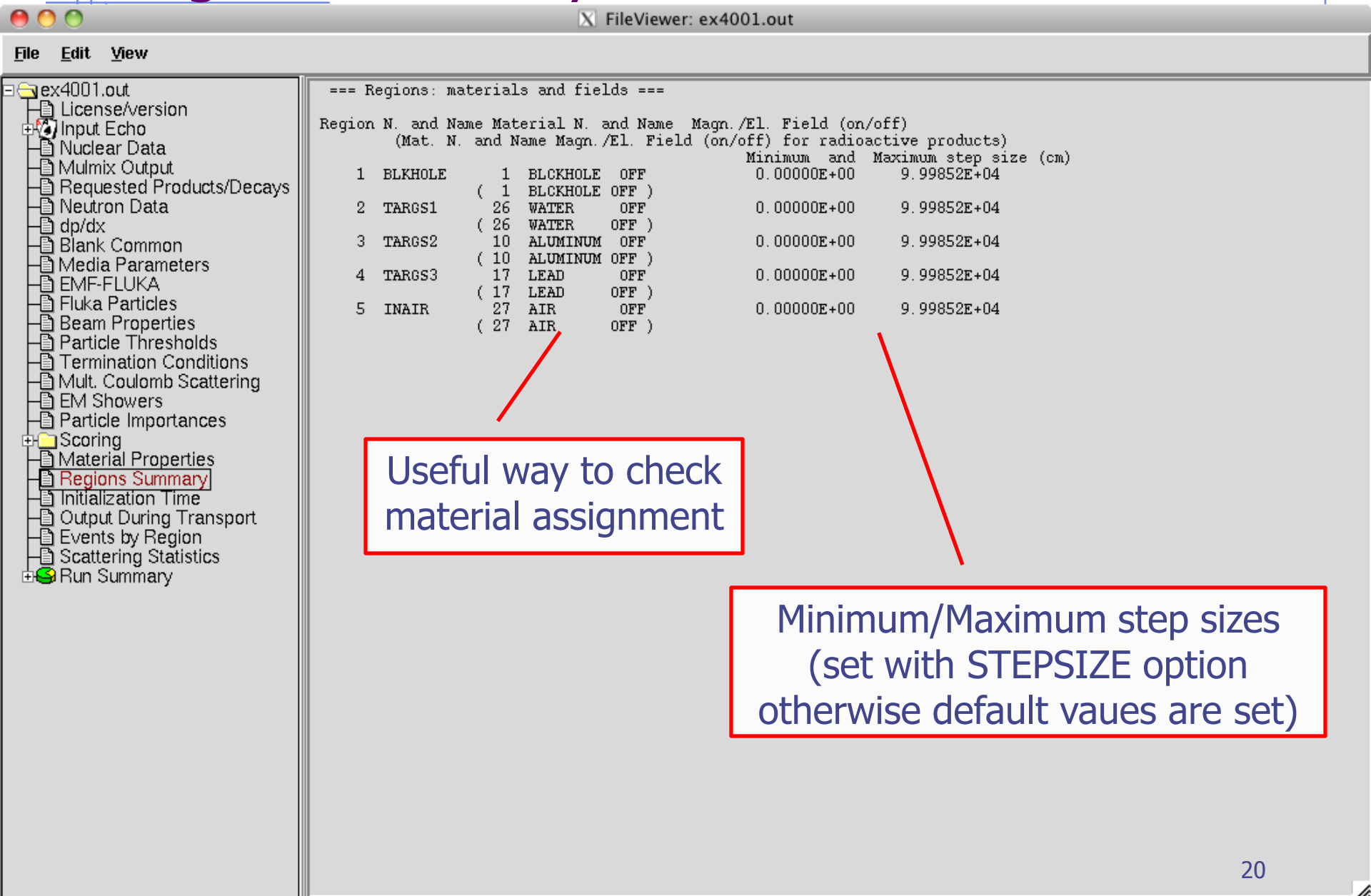
27 AIR	7.262	14.55	0.1205E-02	0.6931E+05	0.1810E+06	0.3039E+05	0.3262E+05

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

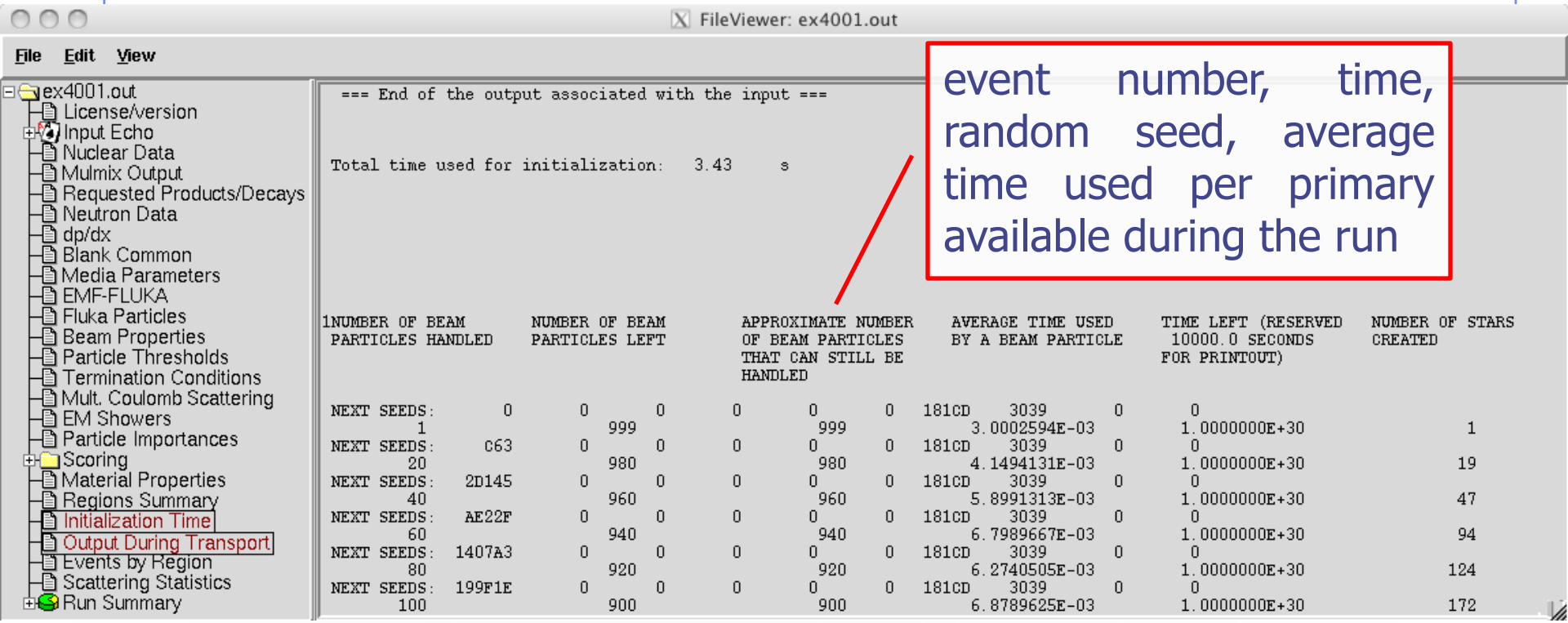
Data related to the beam particle type specified in the BEAM card

Compound interpreted composition

Regions summary



Initialization time / Run informations



Results – *Scoring*

Results of SCORE options for all region:
very useful for debugging and for cross-check with estimators

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1Region #	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 Density GeV/cm**3 /one beam particle	EM-ENRGY Density GeV/cm**3 /one beam particle
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 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*

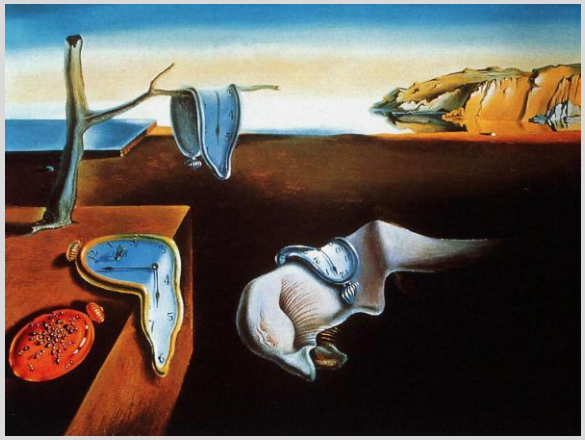
FileViewer: ex4001.out

File Edit View

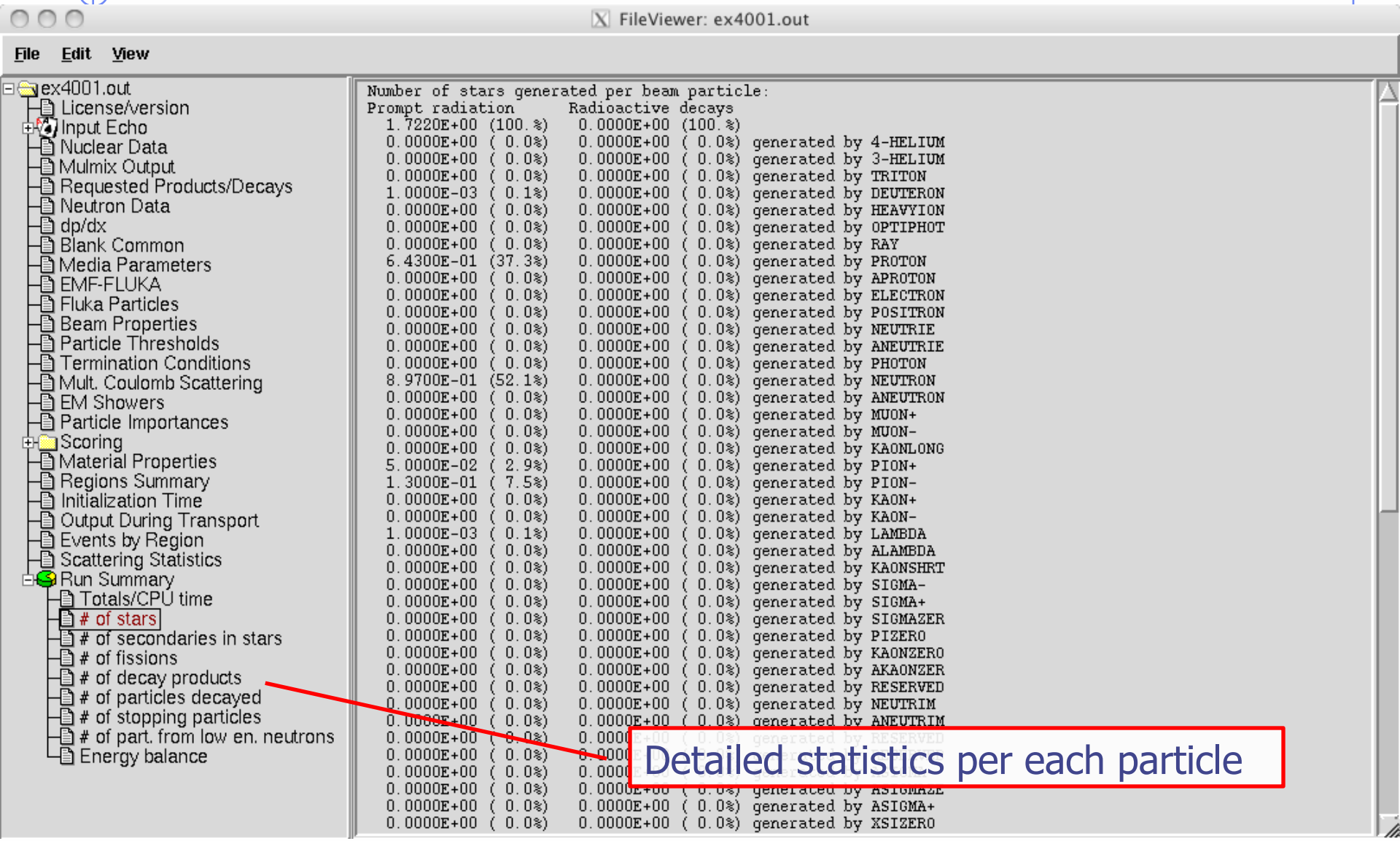
- ex4001.out
  - License/version
  - Input Echo
  - Nuclear Data
  - Mulmix Output
  - Requested Products/Decays
  - Neutron Data
  - dp/dx
  - Blank Common
  - Media Parameters
  - EMF-FLUKA
  - Fluka Particles
  - Beam Properties
  - Particle Thresholds
  - Termination Conditions
  - Mult. Coulomb 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

```
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*



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
Prompt radiation      Radioactive decays
  2.9309E-01  ( 8.4%)   0.0000E+00 ( 0.0%) GeV hadron and muon dE/dx
  1.1665E-01  ( 3.3%)   0.0000E+00 ( 0.0%) GeV electro-magnetic showers
  8.8952E-03  ( 0.3%)   0.0000E+00 ( 0.0%) GeV nuclear recoils and heavy fragments
  0.0000E+00  ( 0.0%)   0.0000E+00 ( 0.0%) GeV particles below threshold
  0.0000E+00  ( 0.0%)   0.0000E+00 ( 0.0%) GeV residual excitation energy
  1.1821E-03  ( 0.0%)   0.0000E+00 ( 0.0%) GeV low energy neutrons
  2.9282E+00  (83.7%)   0.0000E+00 ( 0.0%) GeV particles escaping the system
  1.6105E-02  ( 0.5%)   0.0000E+00 ( 0.0%) GeV particles discarded
  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;
- $e^{\pm}/\gamma$ (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

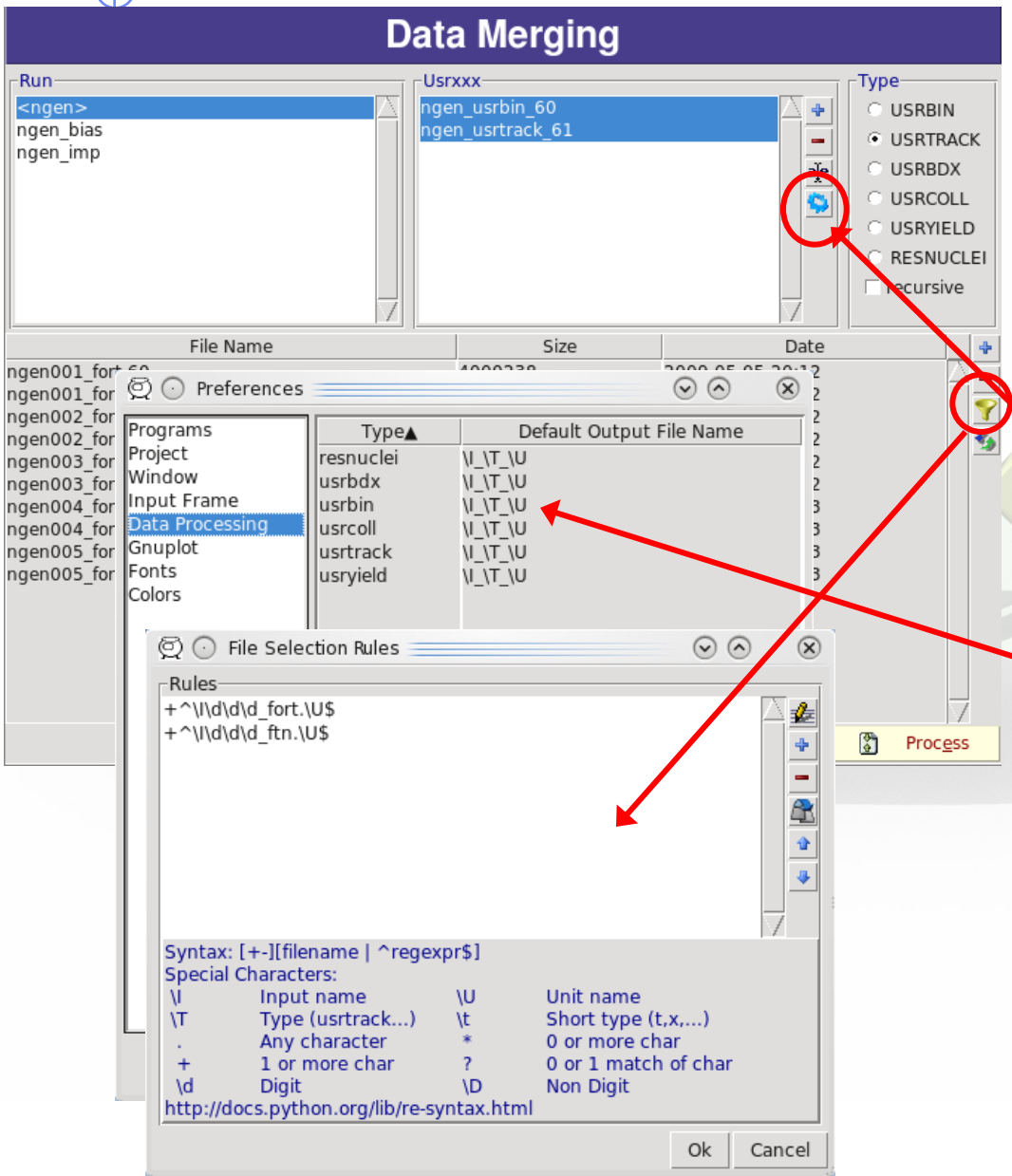
FileViewer: fluka_11407/ex4001.out

File Edit View

- fluka_11407/ex4001.c
  - License/version
  - Input Echo
  - Scoring
  - Run Summary
  - ERROR

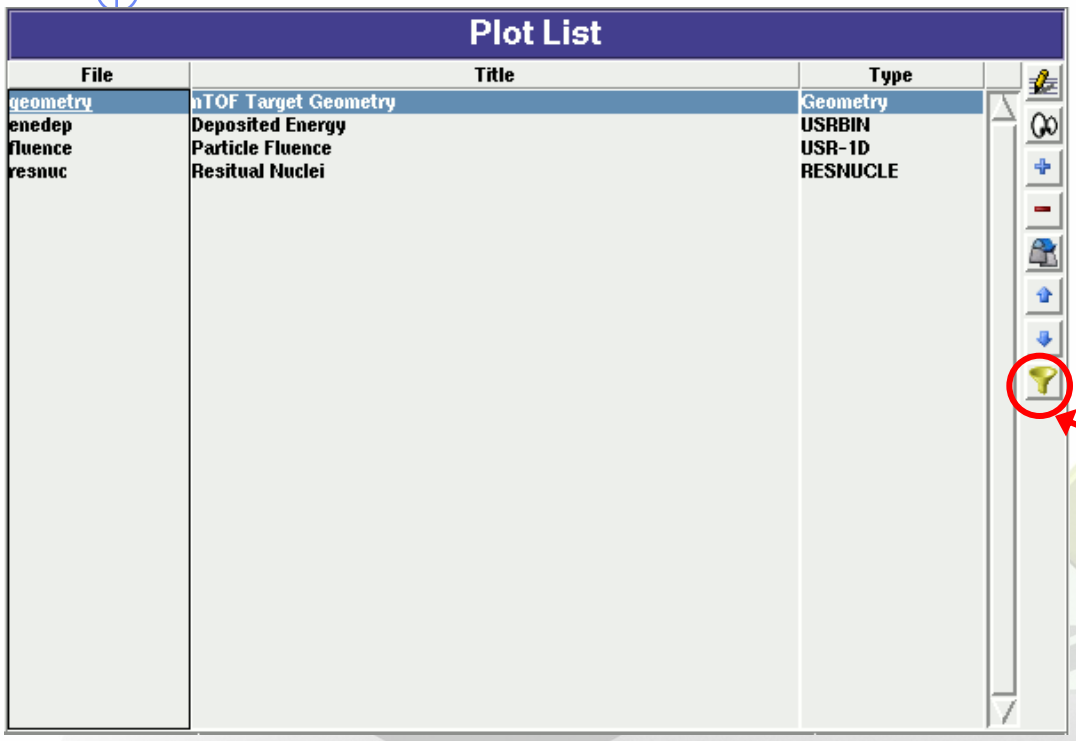
```
***** Next control card *****   USRBDX     10.00      1.0000E-03   40.00      0.000      0.000      0.000      &

***** 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      &

***** 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      &

***** 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 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 generated 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

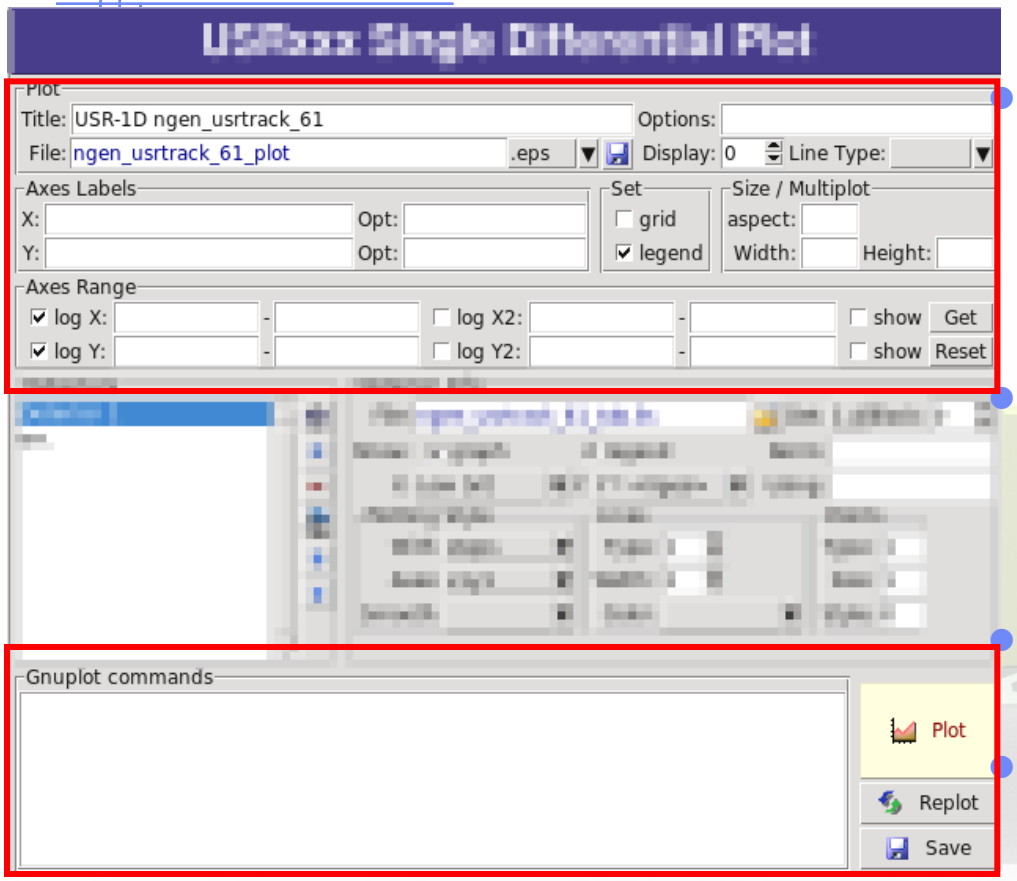


- Plots can be created in the "Plot" list frame. Either Add new plots or Clone from existing ones.
- It is important to set a unique filename for each plot. This filename will be used for every auxiliary file that the plot needs (changing the extension)
- The Filter button creates automatically one plot 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



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.

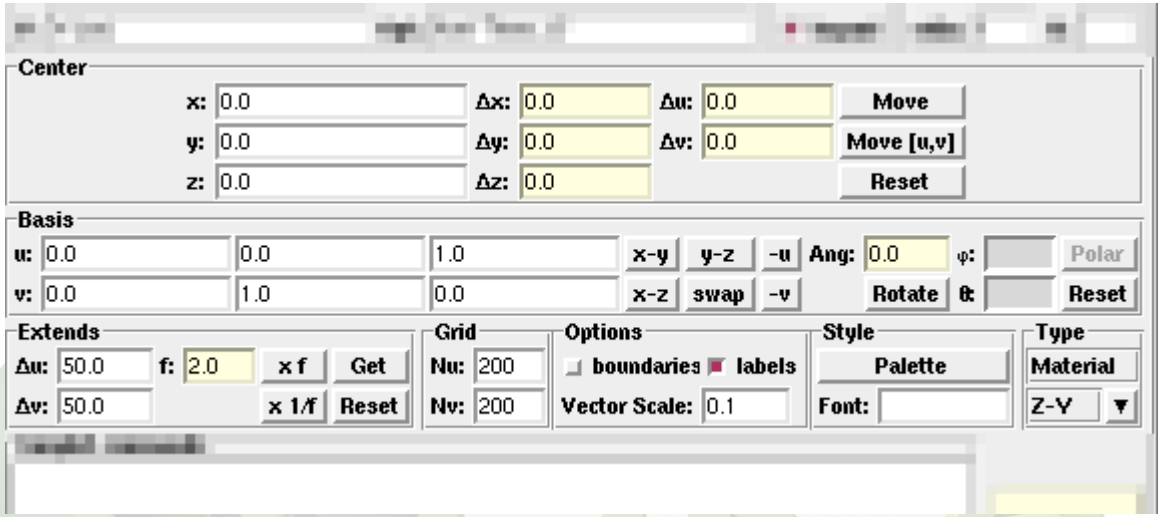
Re-Plot will force the creation of all files regardless their state

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 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



- 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, …)

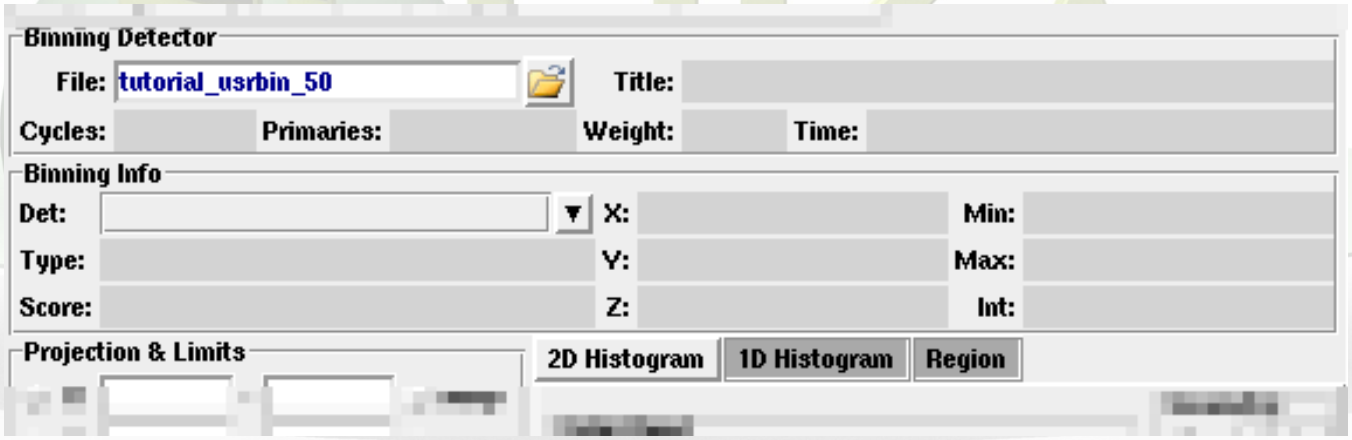
Geometry Plotting

- 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

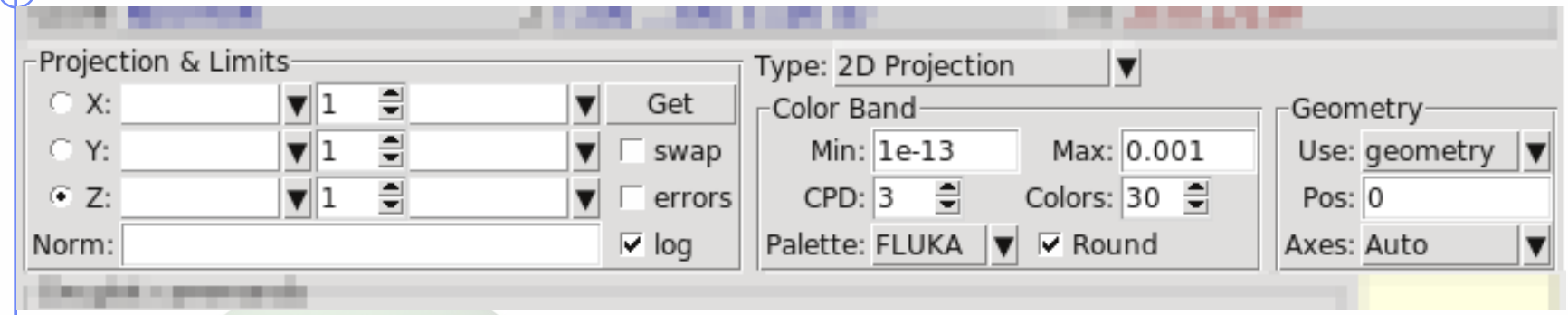
- With the USRBIN plotting frame you can perform:
  - 2D projection or region/lattice plot
  - 1D projection or region/lattice plot
  - 1D maximum trace
  - 1D trace scan

  of the data or errors from USRBIN data.



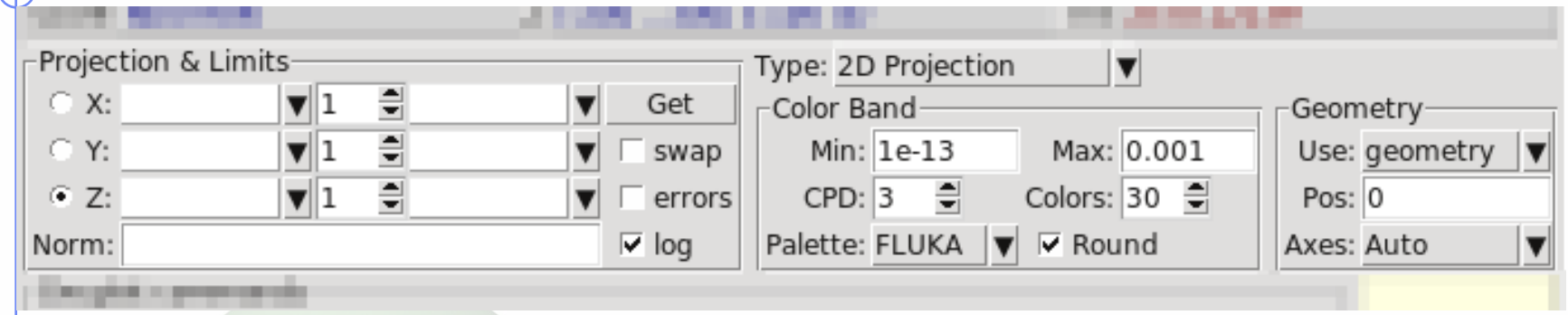
- Set the usrbin summary file in the File: field
- Select from Det: the detector to use.
- All the available detector information will be displayed
- The information Mininum, Maximum and Integral will be filled after the plot! *WARNING: it is always the projection min/max*

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.

$$\log10(\mathrm{Max}) = \log10(\mathrm{Min}) + \mathrm{Colors}/\mathrm{CPD}$$

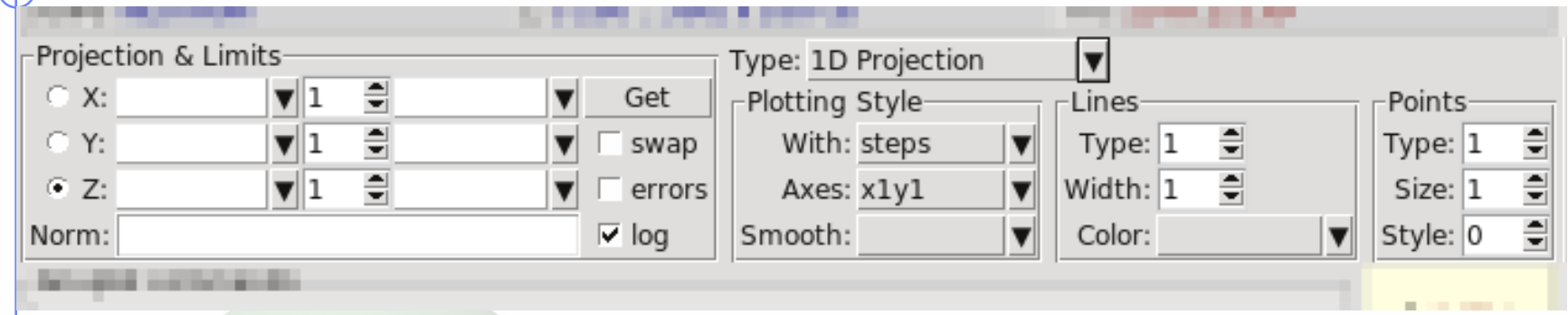
- Once the value is changed in one field, the Max will be calculated accordingly
- Palette: offers a possibility to the user to choose from various predefined palettes. The user can define his own palette using the "set palette" command from the "Gnuplot commands" text box

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 do 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

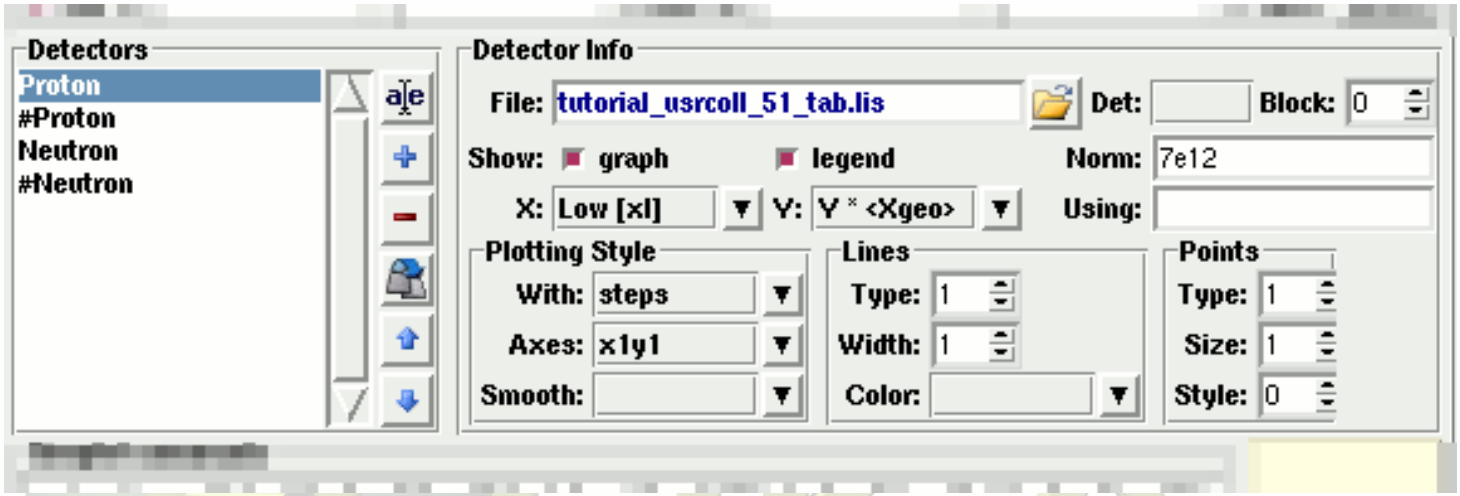
- Same as the 1D Projection, but displays only the maximum value on each slice. (eg. on a Z-projection, it will display the maximum on each X-Y slice)

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 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*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 × <X> — Y-bin value multiplied by the mean X value of the bin (Isolethargic)
  - Y × <Xgeo> — Y-bin value multiplied by the geometrical X-mean of the bin (Isolethargic)
  - Y × Xl — -//- with the X-low value of the bin
  - Y × Xh — -//- with the X-high value of the bin
  - Y × 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 × < Xgeo or X>, for isolethargic 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 superimposed 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