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)

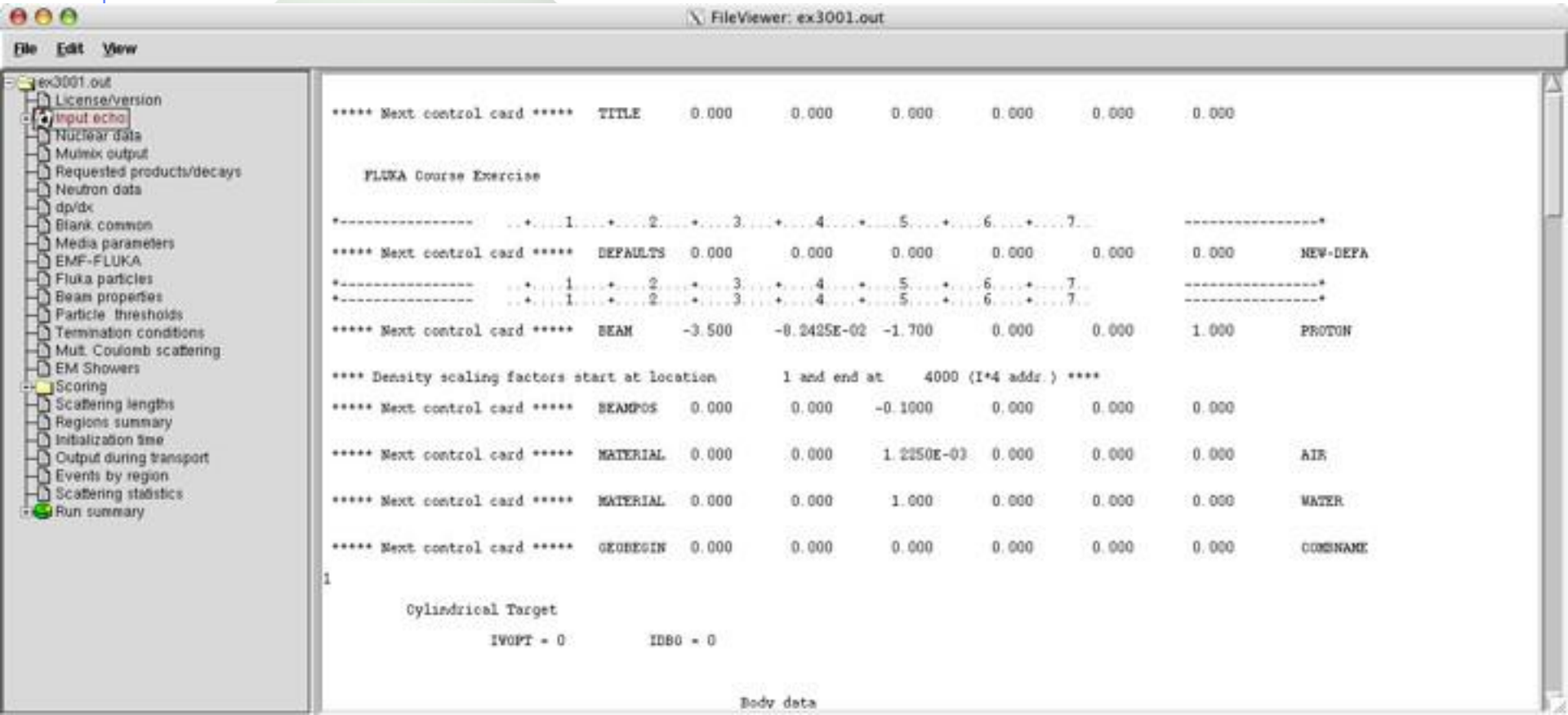
- Let's have a look to ex_3001.out (editor or flair output viewer:

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

  fless *ex_3001.out*)

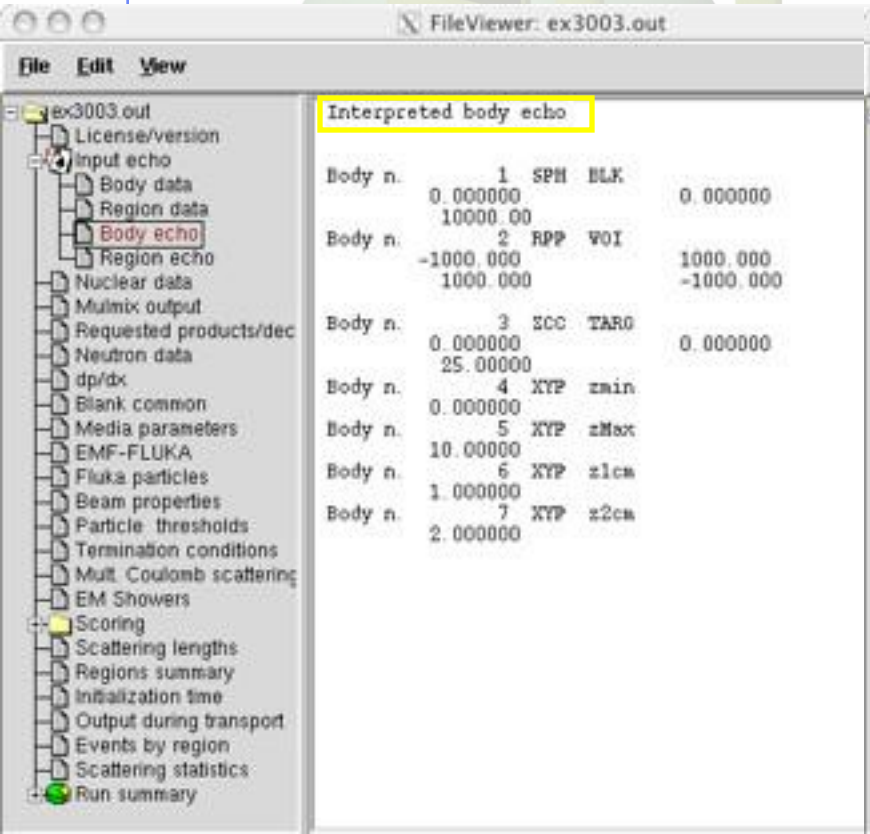
Input echo

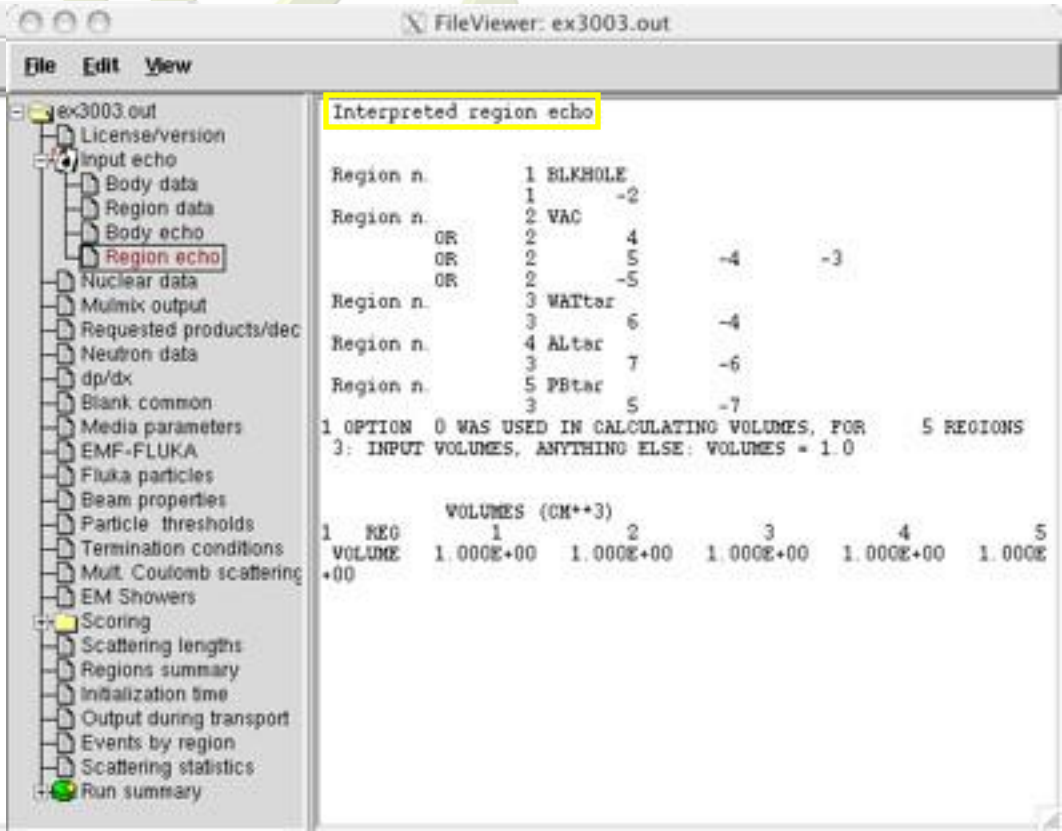
- The data cards are parsed in groups, and do not appear in same order as they are inserted in the input file…
- For instance: TITLE is the first to appear, then all comment cards are listed together, followed by the beam related cards, etc. etc.



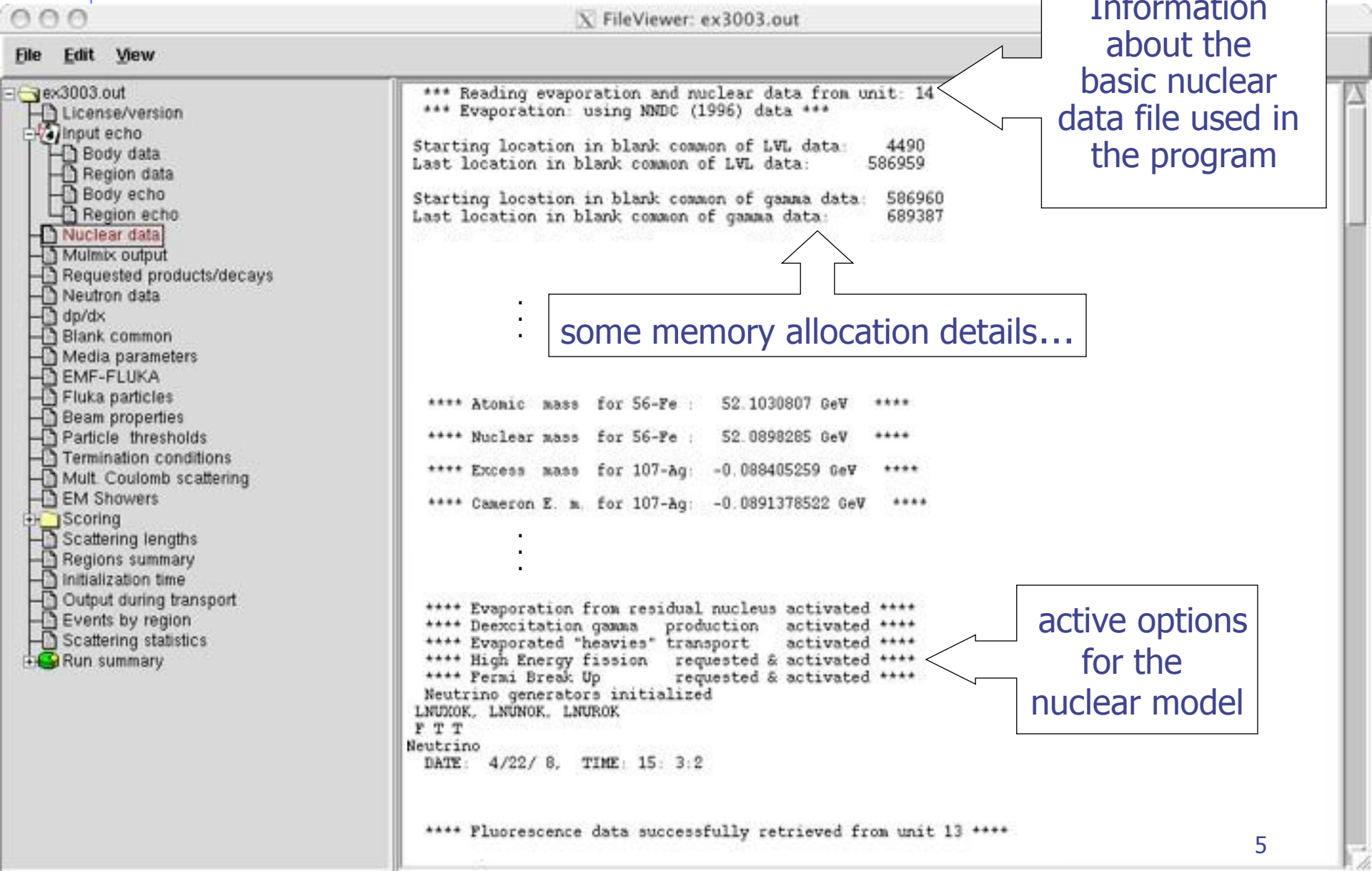
Input echo – *Geometry output*

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





Nuclear data

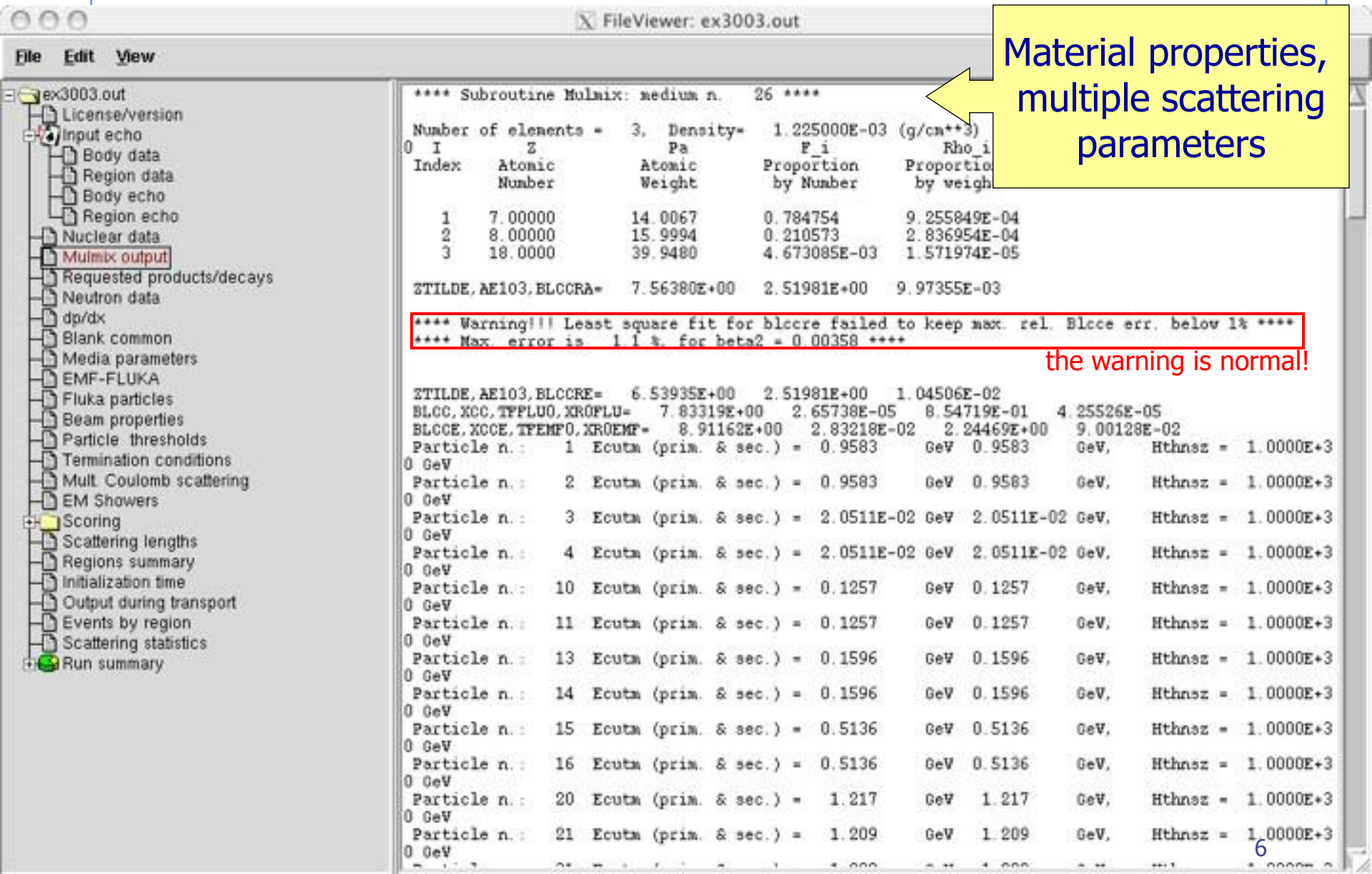


Information about the basic nuclear data file used in the program

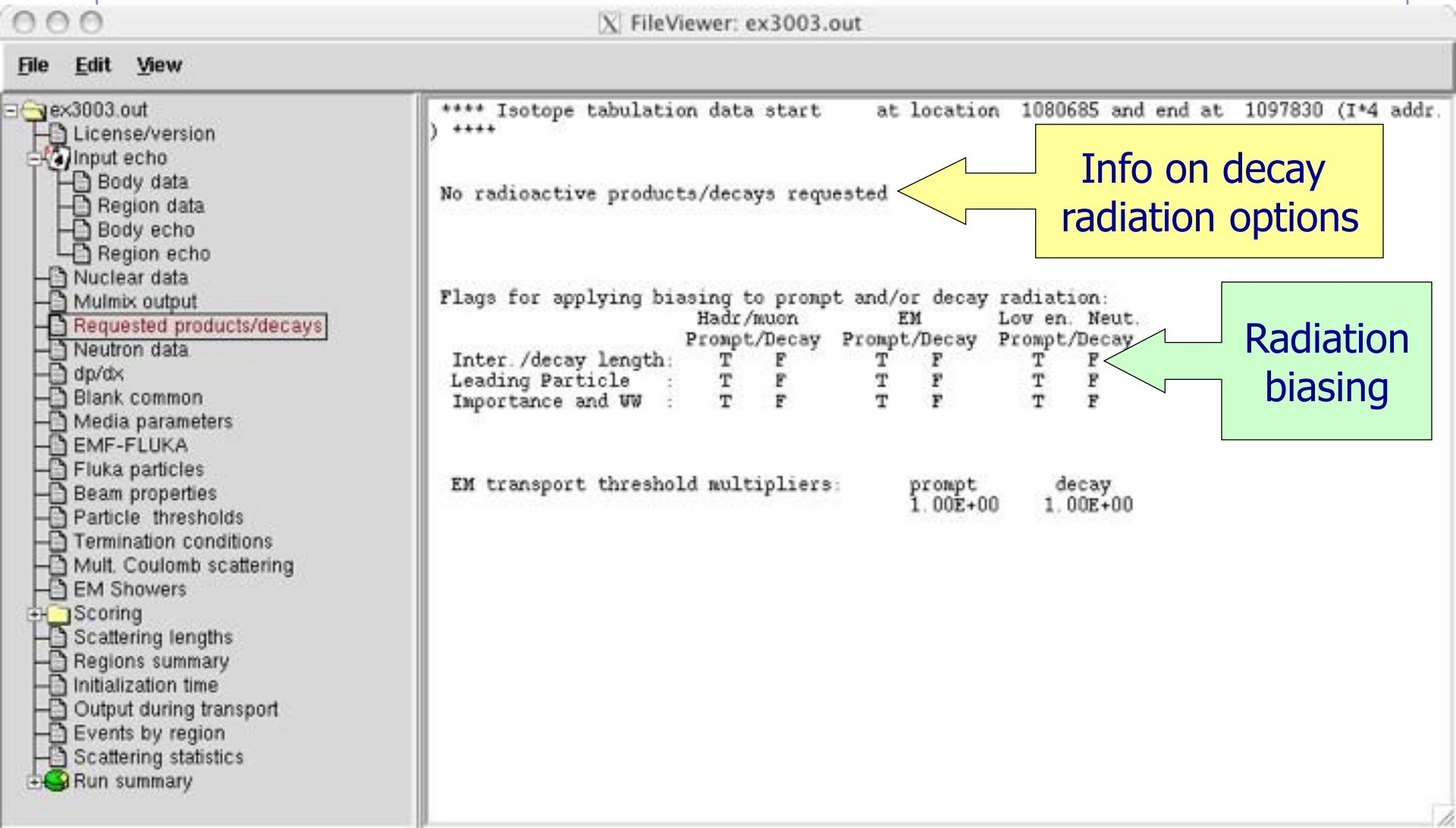
some memory allocation details…

active options for the nuclear model

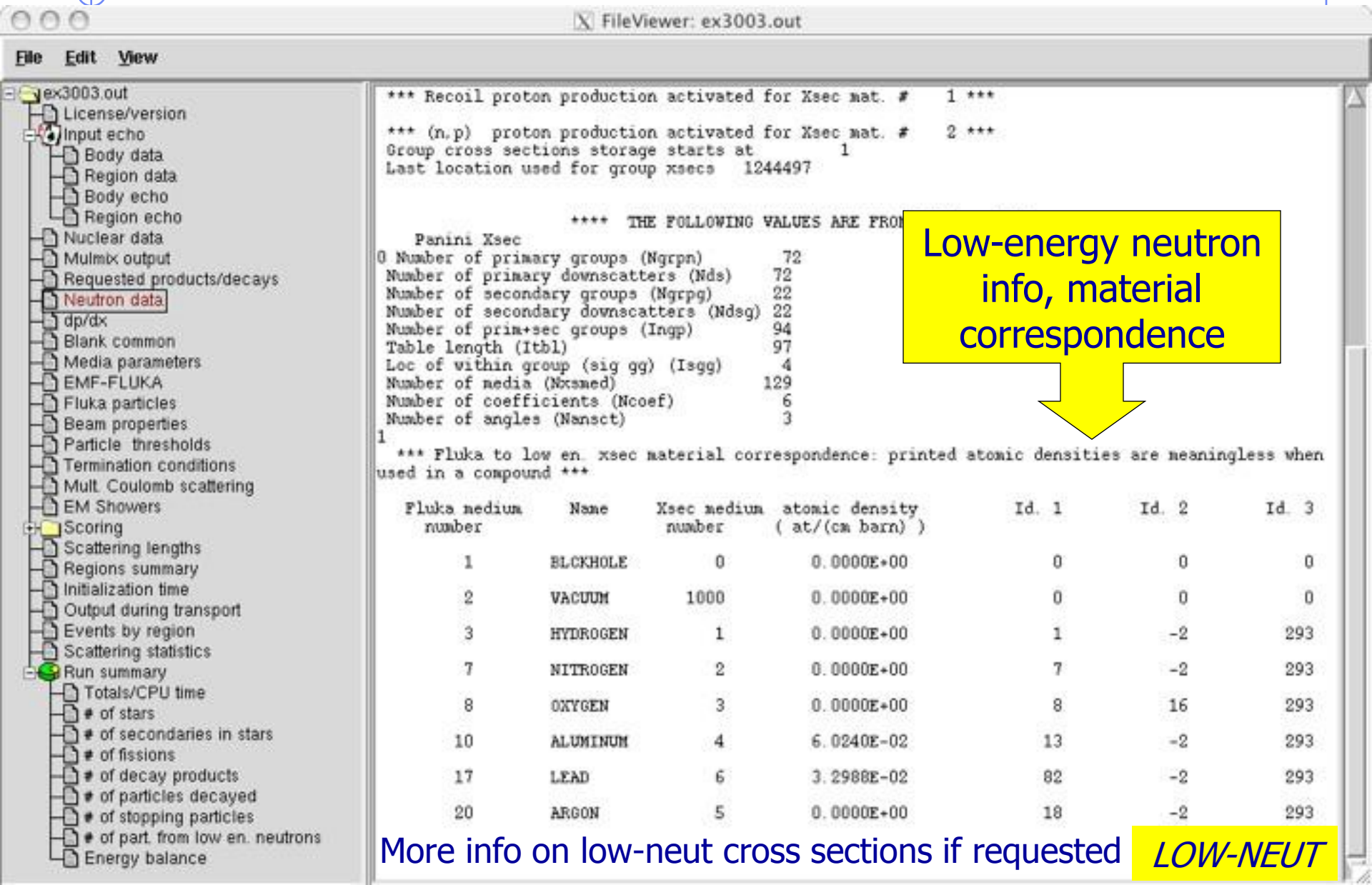
Material properties



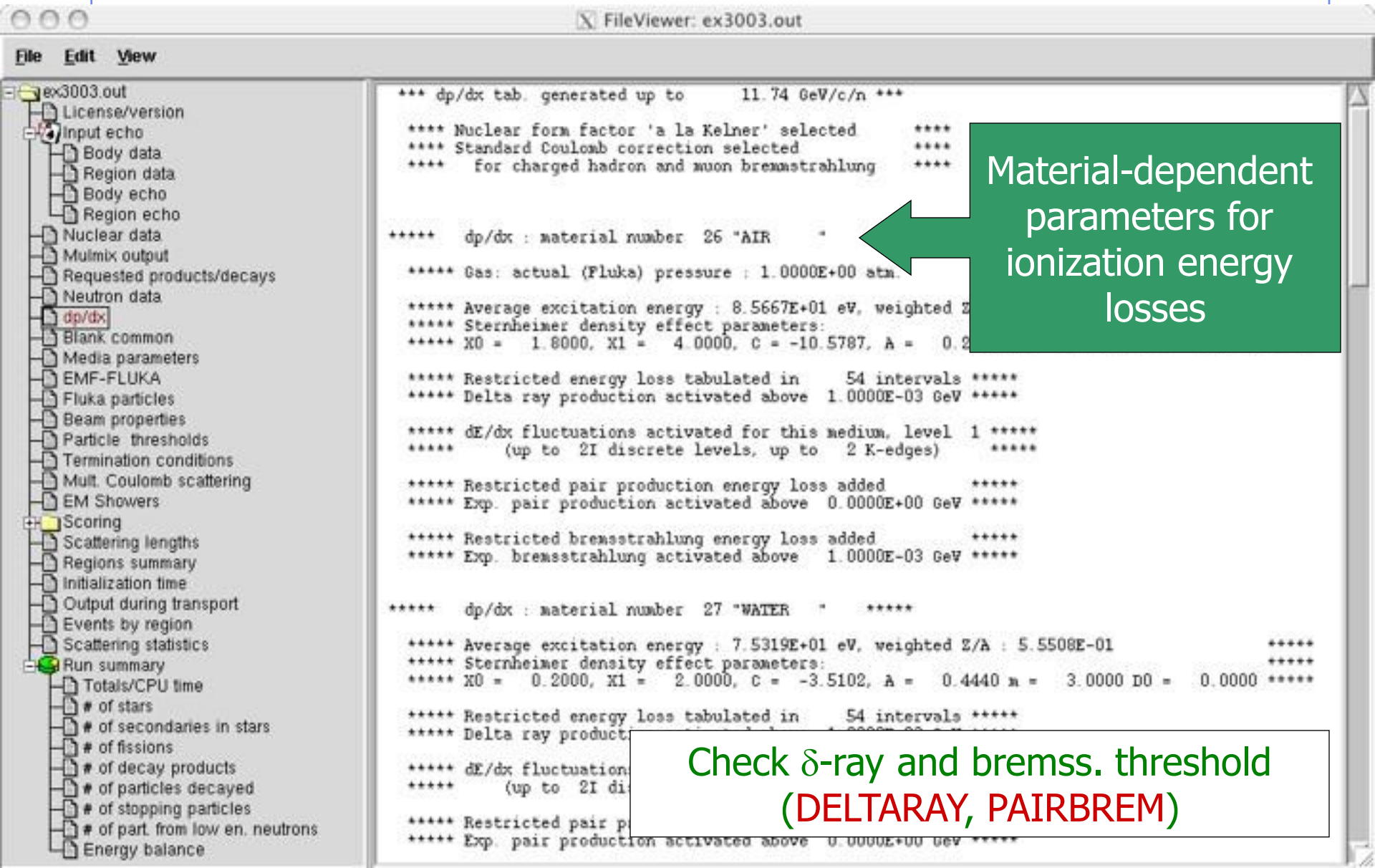
Radiation Decay



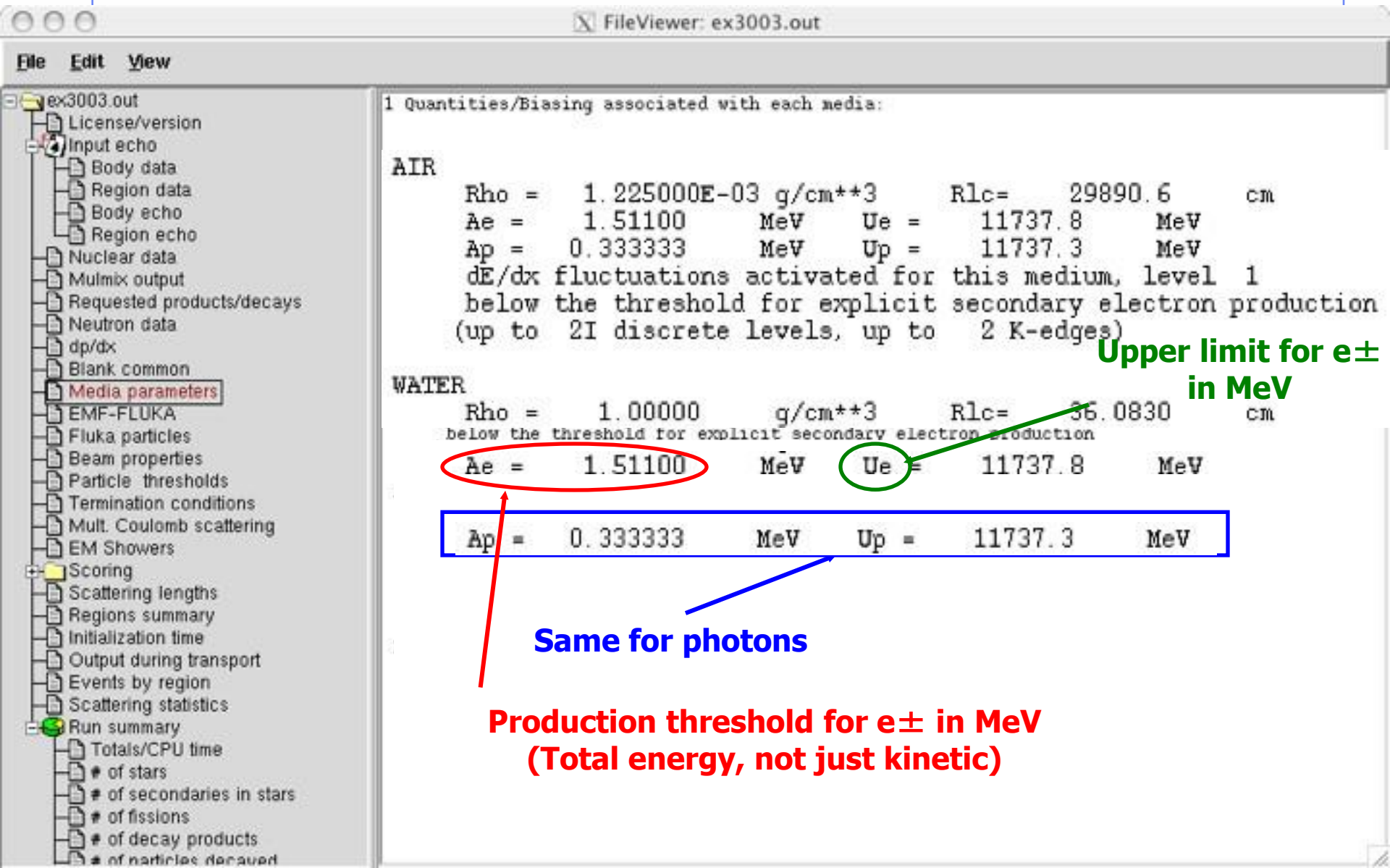
Neutron data



Material Parameters – *dp/dx*



Material parameters – *Transport thresholds*



Material parameters – *EMF-FLUKA*

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

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

            1            0   VACUUM                   1  BLCKHOLE
     Ecut =  0.0000E+00 MeV,     Pcut =  0.0000E+00 MeV,     BIAS = F,    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 = F,    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 = F,    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 = F,    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 = F,    Ray. = F,    S(q,Z) = T,
Pz(q,Z) = F
1
```

Transport threshold for e± and photons in MeV
(Total energy, not just kinetic)

FLUKA Particles

FileViewer: ex3003.out

File Edit View

- ex3003.out
  - License/version
  - Input echo
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    - 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
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    - # of decay products
    - # of particles decayed

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

exhaustive list of FLUKA particles

```
 === 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&PI+-                 207
```

...continues on your screen!

Input interpreted summary – *Beam*

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

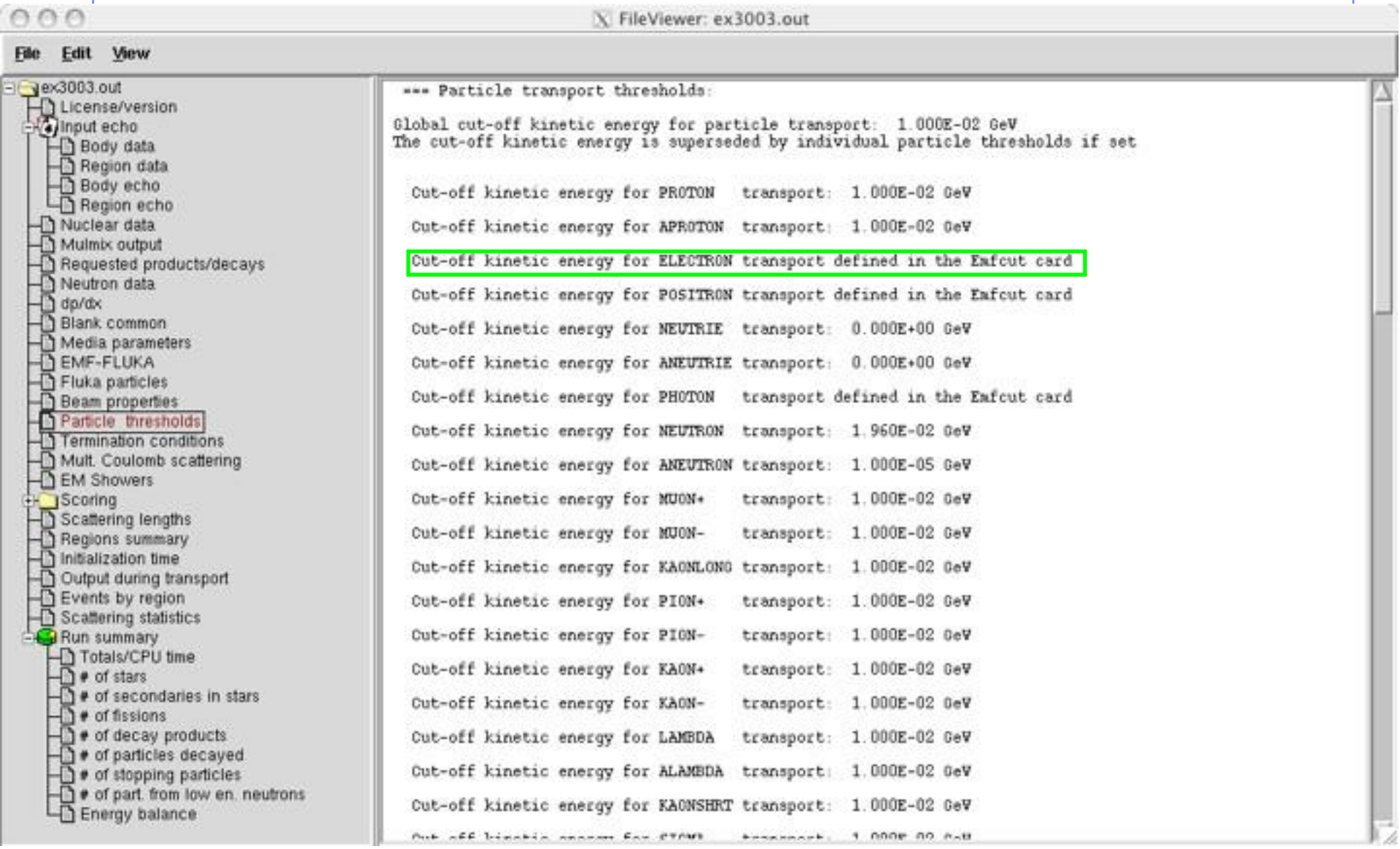
```
*** Output before the actual run - Beam properties ***


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     -0.100000000      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)
  The nominal beam position belongs to region:       2(VAC     ), lattice cell:       0(        )
```

Check the starting region

Input interpreted summary – *Thresholds*



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
  - Mulmix output
  - Requested products/decays
  - Neutron data
  - dp/dx
  - Blank common
  - Media parameters
  - EMF-FLUKA
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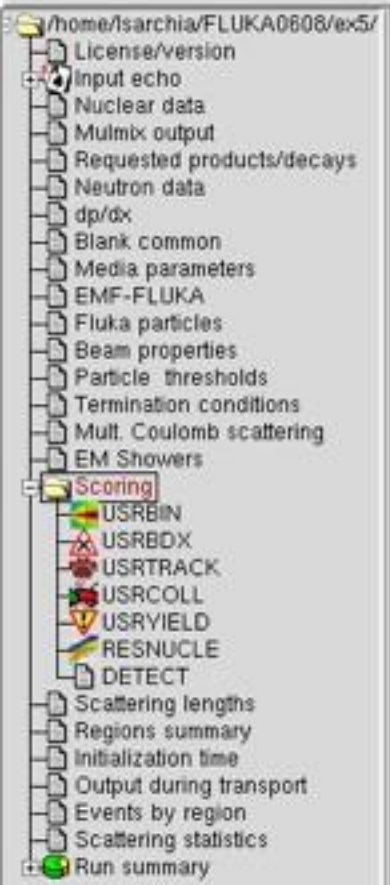
  - Scattering statistics
  - Run summary
    - Totals/CPU time
    - # of stars
    - # of secondaries in stars
    - # of fissions
    - # of decay products
    - # of particles decayed
    - # of stopping particles
    - # of part. from low en. neutrons
    - Energy balance

```
 *** 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.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 none in ex3, check ex5 output

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

File Edit View




```
******* "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:
```

Complete description of each estimator requested

Materials – *Scattering lengths*

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

File Edit View

/home/lsarchia/FLUKA0608/ex5/ex5001.(
- 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

=== 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 BLCKHOLE	0.000	0.000	0.000	0.1000E+31	[illegible]E+31	0.1000E+31	0.1000E+31
2 VACUUM	0.000	0.000	0.000	0.1000E+31	[illegible]000E+31	0.1000E+31	0.1000E+31
3 HYDROGEN	1.000	1.008	0.8370E-04	0.7040E+06	[illegible]418E+07	0.7532E+06	0.6496E+09
4 HELIUM	2.000	4.003	0.1660E-03	0.3506E+06	[illegible]310E+07	0.5602E+06	0.6024E+34
5 BERYLLIU	4.000	9.012	1.848	39.41	[illegible].65	35.28	17.00
6 CARBON	6.000	12.0[illegible]					
7 NITROGEN	7.000	14.0[illegible]					
8 OXYGEN	8.000	16.0[illegible]					
9 MAGNESIU	12.00	24.3[illegible]					
10 ALUMINUM	13.00	26.9[illegible]					
11 IRON	26.00	55.8[illegible]					
12 COPPER	29.00	63.5[illegible]					
13 SILVER	47.00	107.[illegible]					
14 SILICON	14.00	28.09	2.329	43.04	66.54	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	7.262	14.55	0.1225E-02	0.6817E+05	0.1780E+06	0.2989E+05	0.3174E+05

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

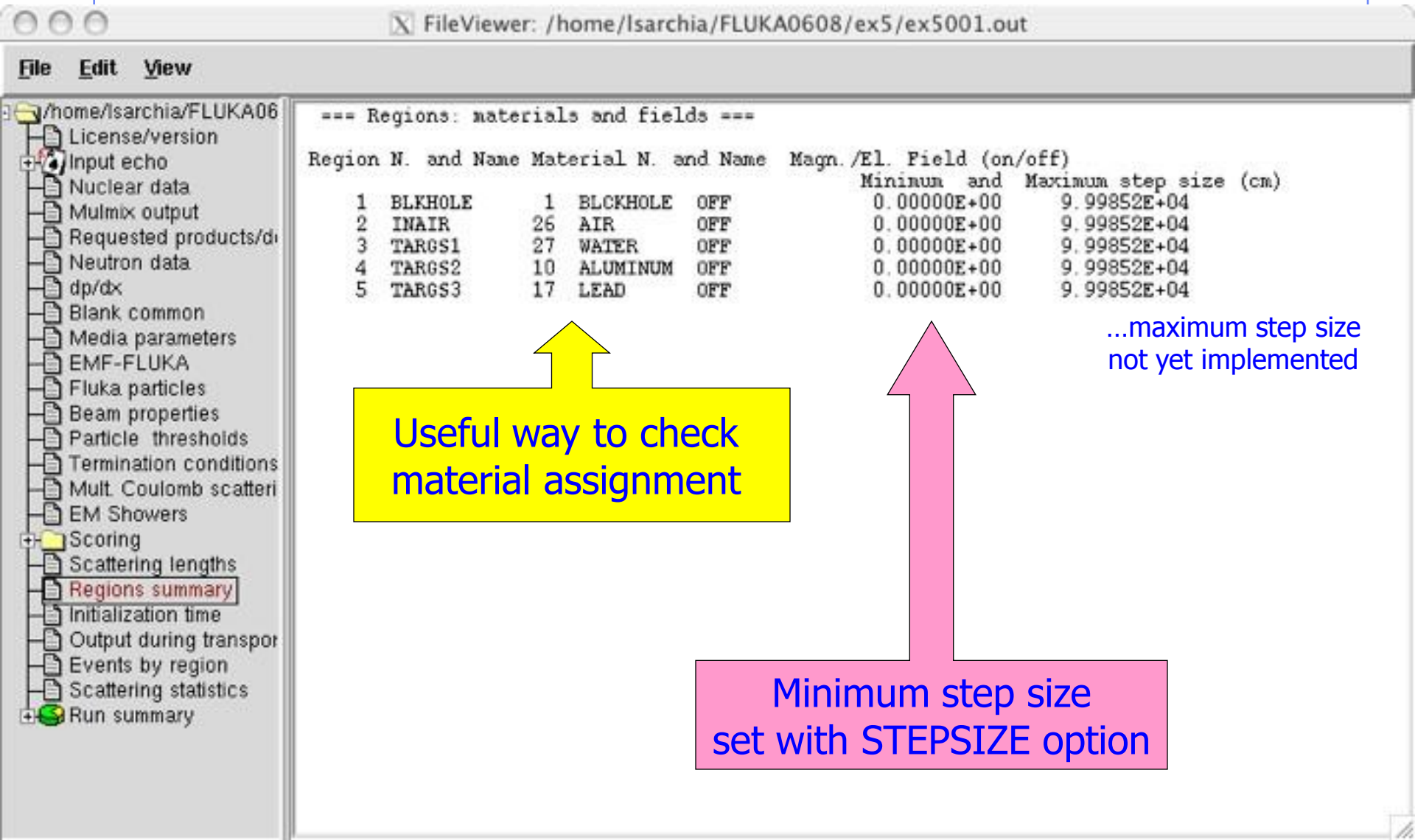
27 WATER	3.333	6.005	1.000	81.49

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

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

Compounds interpreted composition

Regions summary



Runtime Info – *Output associated with the run*

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

File Edit View

/home/lsarchia/FLUKA0608/ex5/ex50
- License/version
- Input echo
- Nuclear data
- Mulmix output
- Requested products/decays
- Neutron data
- dp/dx
- Blank common
- Media parameters
- EMF-FLUKA
- Fluka particles
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- Output during transport

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


Total time used for initialization:    5.72      s
```

Periodic echo of:

event number, time, random seed

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

File Edit View

/home/lsarchia/FLUKA0608/ex5/ex50
- License/version
- Input echo
- Nuclear data
- Mulmix output
- Requested products/decays
- Neutron data
- dp/dx
- Blank common
- Media parameters
- EMF-FLUKA
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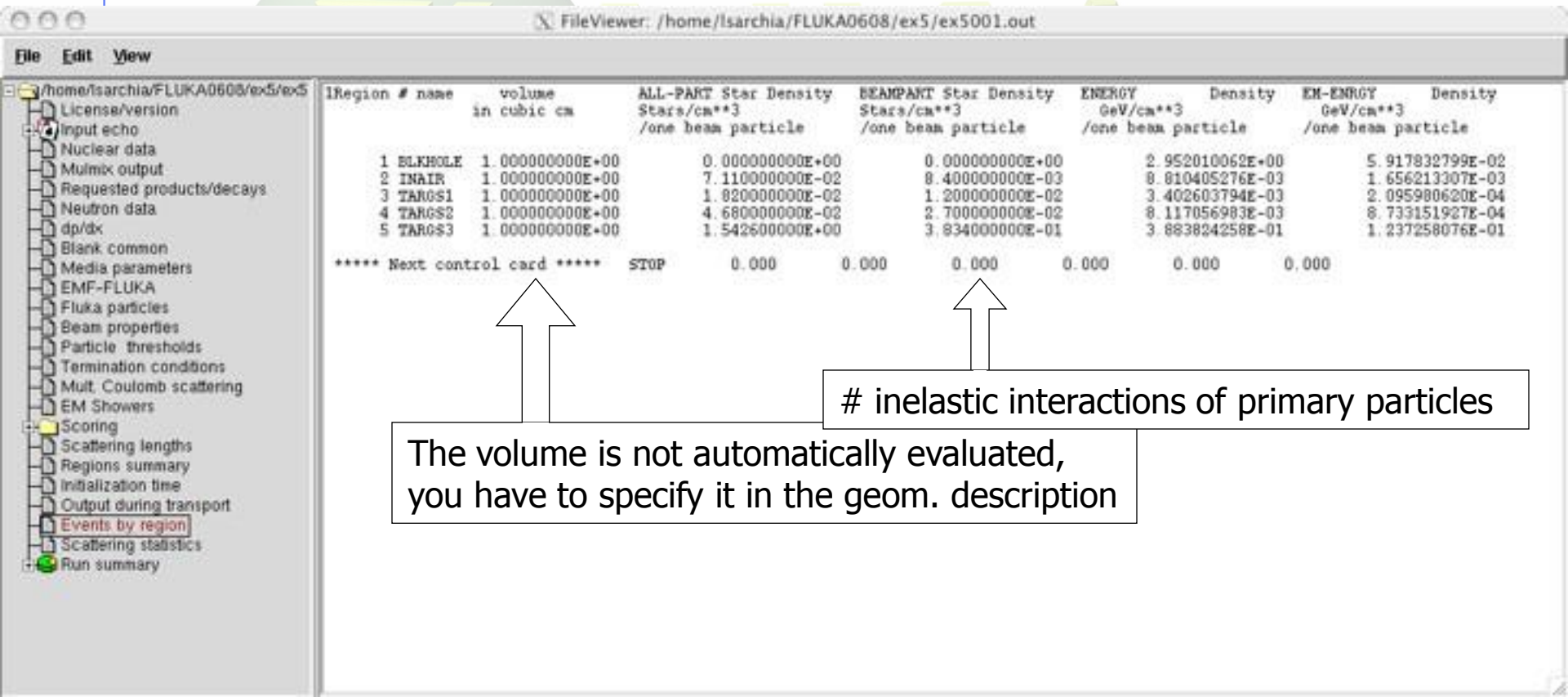
NUMBER OF BEAM PARTICLES HANDLED		NUMBER OF BEAM PARTICLES LEFT		APPROXIMATE NUMBER OF BEAM PARTICLES THAT CAN STILL BE HANDLED		AVERAGE TIME USED BY A BEAM PARTICLE		TIME LEFT (RESERVED 10000.0 SECONDS FOR PRINTOUT)	NUMBER OF STARS CREATED
NEXT SEEDS	0	0	0	0	0	181CD 3039	0	0	
1		9999		9999		3.1994820E-02		1.0000000E+30	5
NEXT SEEDS	E4F7	0	0	0	0	181CD 3039	0	0	
200		9800		9800		9.4485593E-03		1.0000000E+30	363
NEXT SEEDS	358D09	0	0	0	0	181CD 3039	0	0	
400		9600		9600		9.6310341E-03		1.0000000E+30	733
NEXT SEEDS	6D5E63	0	0	0	0	181CD 3039	0	0	
600		9400		9400		9.4968883E-03		1.0000000E+30	1040
NEXT SEEDS	A24DB0	0	0	0	0	181CD 3039	0	0	
800		9200		9200		9.5422989E-03		1.0000000E+30	1327
NEXT SEEDS	DA74CD	0	0	0	0	181CD 3039	0	0	
1000		9000		9000		9.5565476E-03		1.0000000E+30	1692
NEXT SEEDS	110259A	0	0	0	0	181CD 3039	0	0	
1200		8800		8800		9.8909954E-03		1.0000000E+30	2070
NEXT SEEDS	1528SB2	0	0	0	0	181CD 3039	0	0	
1400		8600		8600		1.0159084E-02		1.0000000E+30	2460
NEXT SEEDS	1959EFF	0	0	0	0	181CD 3039	0	0	
1600		8400		8400		1.0267189E-02		1.0000000E+30	2799
NEXT SEEDS	1D5A948	0	0	0	0	181CD 3039	0	0	
1800		8200		8200		1.0121794E-02		1.0000000E+30	3140
NEXT SEEDS	208385B	0	0	0	0	181CD 3039	0	0	
2000		8000		8000		1.0115962E-02		1.0000000E+30	3479
NEXT SEEDS	241AE06	0	0	0	0	181CD 3039	0	0	
2200		7800		7800		1.0115280E-02		1.0000000E+30	3805

Results – *Scoring*

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



Results – *Statistics of Coulomb scattering*

Results – *Statistics of the run*

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

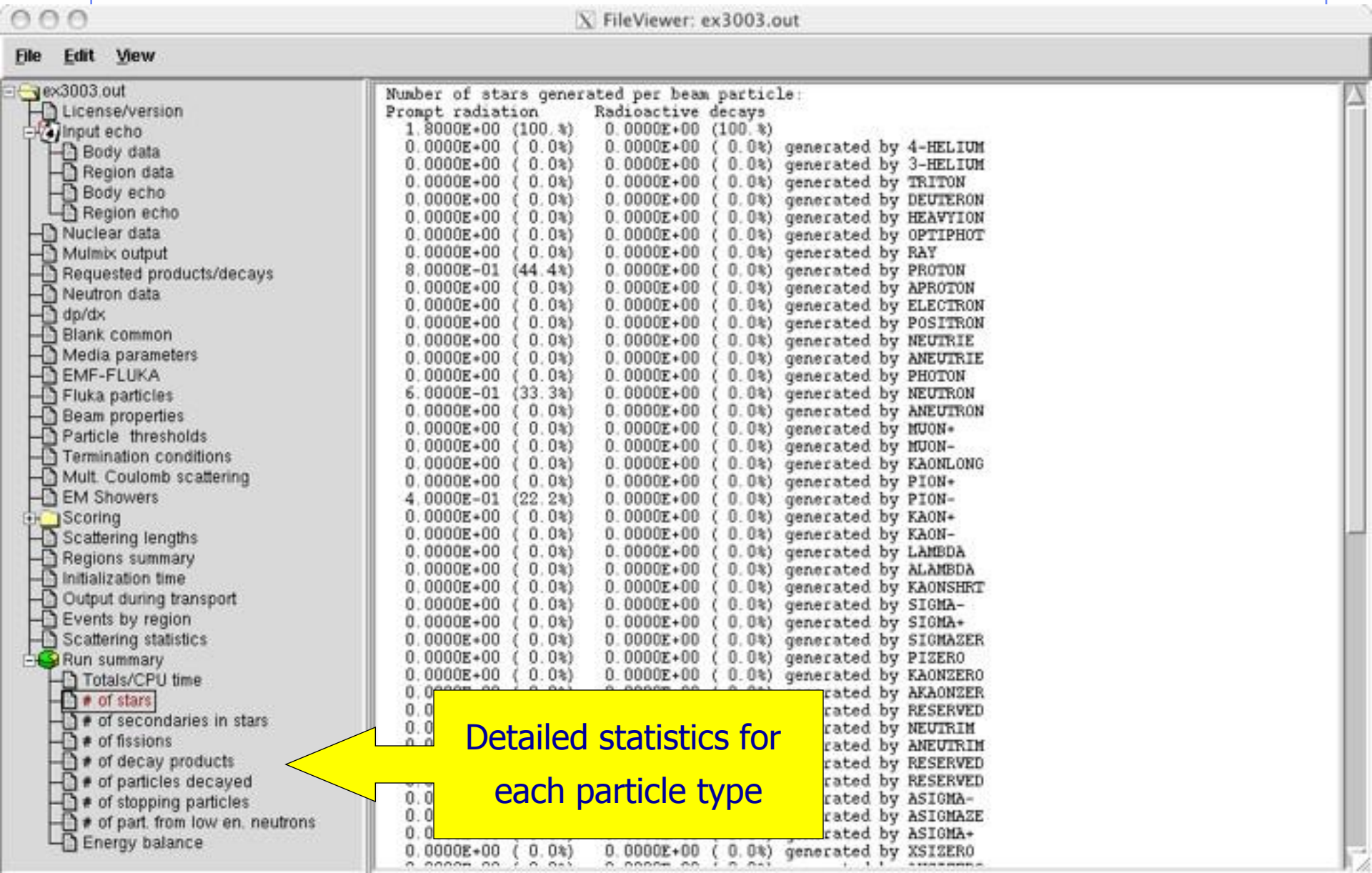
File Edit View

- /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*



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
Prompt radiation      Radioactive decays
  2.2985E-01  ( 6.6%)   0.0000E+00 ( 0.0%) GeV hadron and muon dE/dx
  2.0173E-01  ( 5.8%)   0.0000E+00 ( 0.0%) GeV electro-magnetic showers
  2.9934E-02  ( 0.9%)   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
  1.2287E-03  ( 0.0%)   0.0000E+00 ( 0.0%) GeV low energy neutrons
  2.8904E+00  (82.6%)   0.0000E+00 ( 0.0%) GeV particles escaping the system
  3.0979E-02  ( 0.9%)   0.0000E+00 ( 0.0%) GeV particles discarded
  0.0000E+00  ( 0.0%)   0.0000E+00 ( 0.0%) GeV particles out of time limit
  1.1584E-01  ( 3.3%)                       GeV missing
```

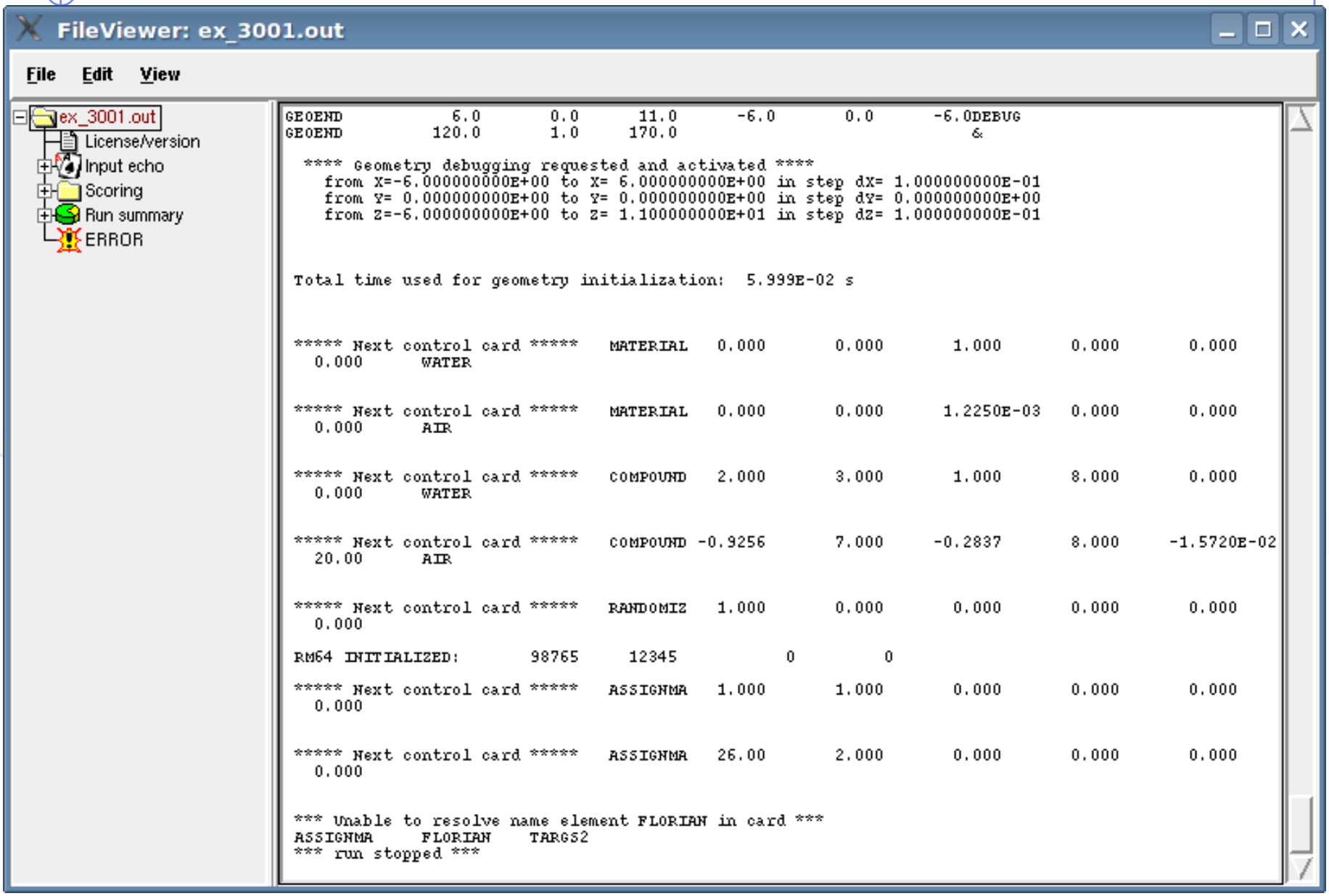
- Hadrons and muons below thr. are ranged out, unless thresholds exceed 100 MeV
- electrons, positrons and photons not included (electro-magnetic showers)

going in the black-hole

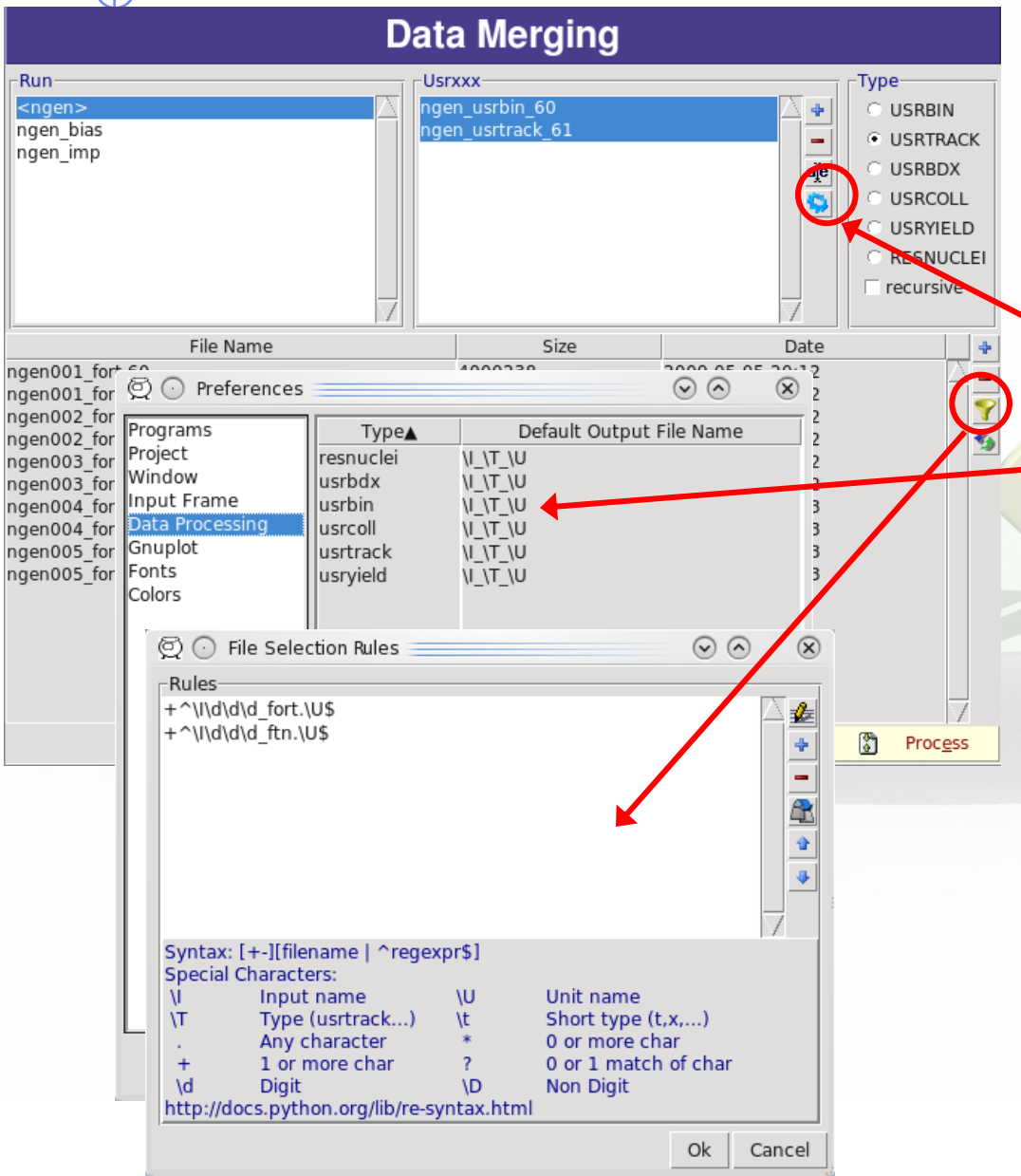
Neutrinos are discarded by default

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 (≈ 8 MeV/n) , or gained in exothermic (i.e., mostly neutron capture): it is –total Q

Error message

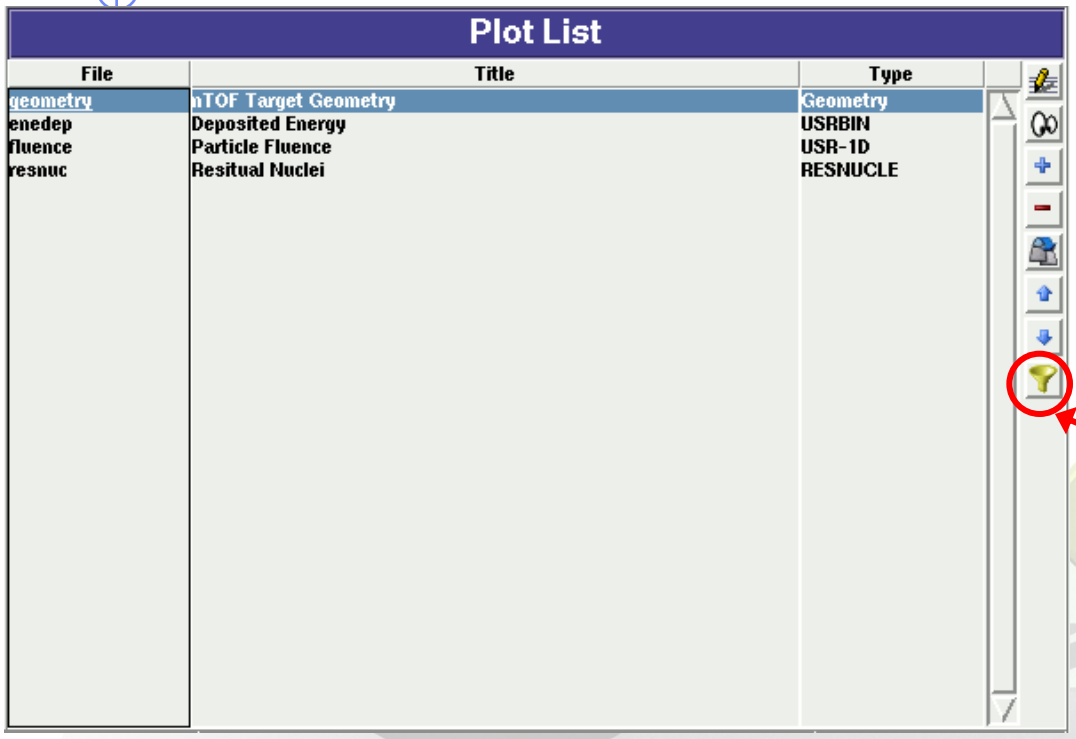


flair: Data Processing



- 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

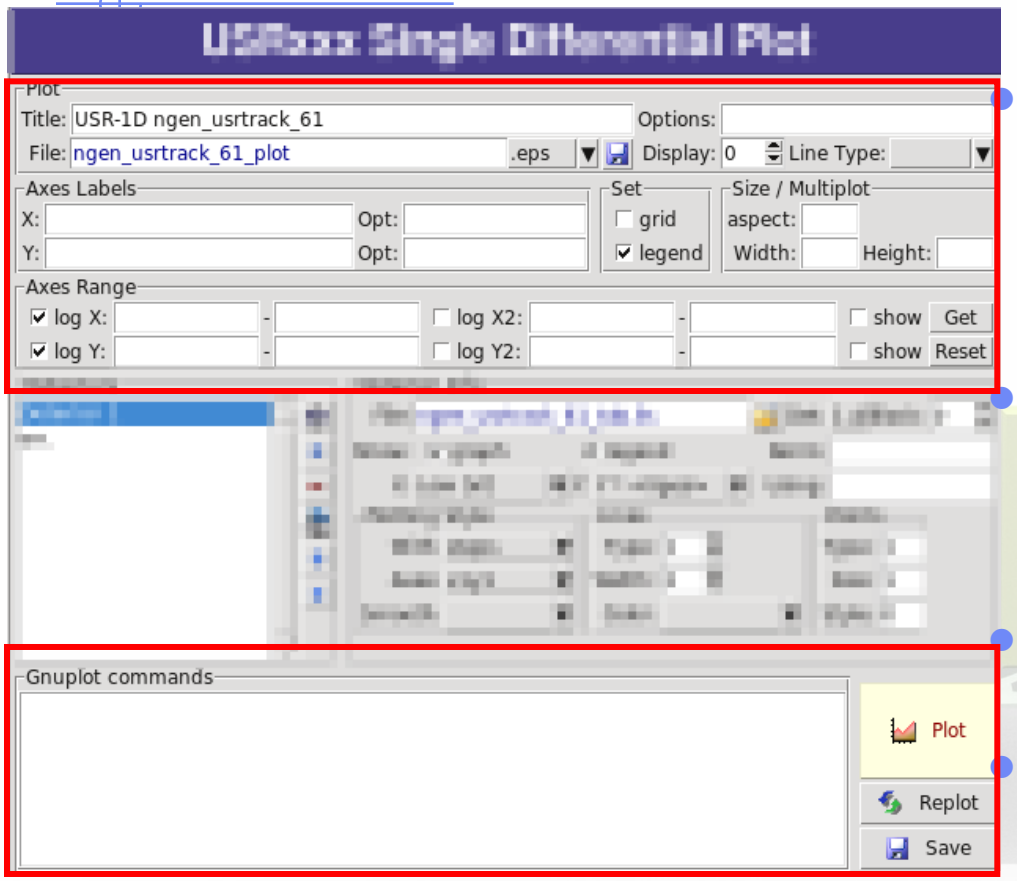


- Plots can be created in the "Plot" list frame. Either Add new plots or Clone from existing ones.
- It is important to set a unique filename for each plot. This filename will be used for every auxiliary file that the plot needs (changing the extension)
- The Filter button creates automatically one plot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

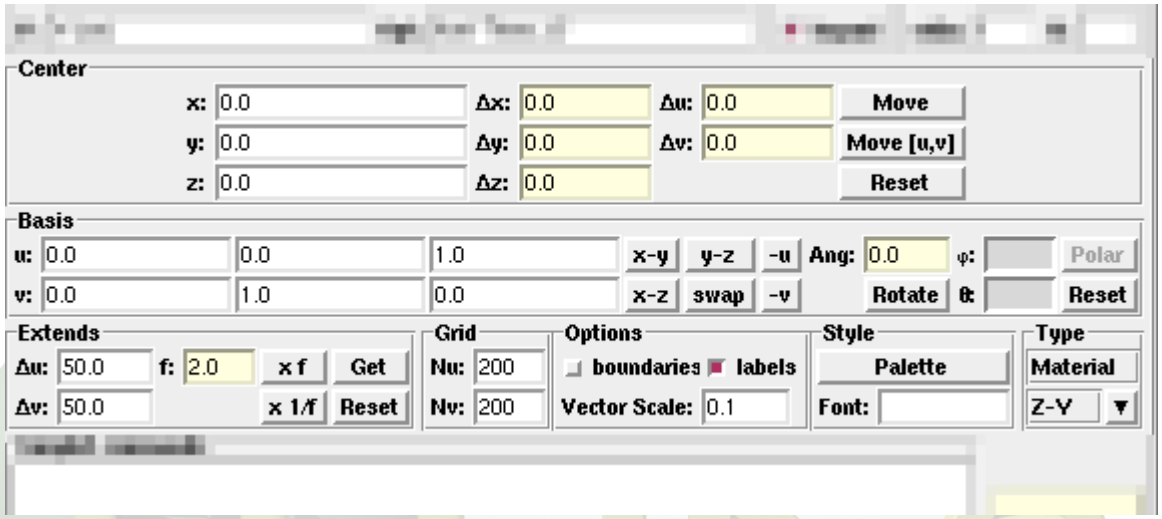


- All plot types share some common fields:
  Title + options, Filename, Axis Labels, Legends (Keys) and Gnuplot Commands.
- Plot button (Ctrl-Enter) will generate all the necessary files to display the plot, ONLY if they do not exist.
- Re-Plot will force the creation of all files regardless their state
- 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 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



- 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, …)

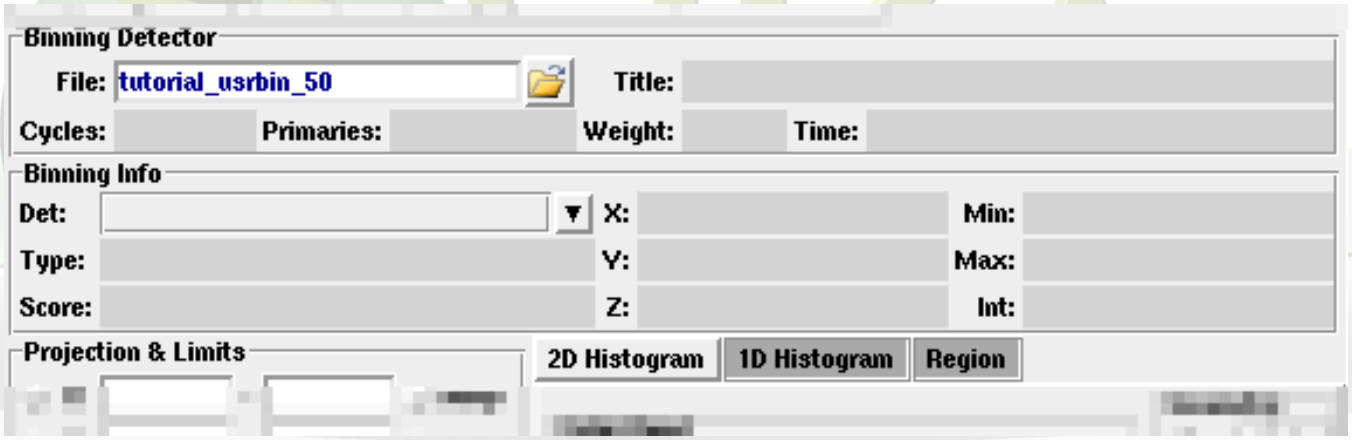
Geometry plotting

- 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

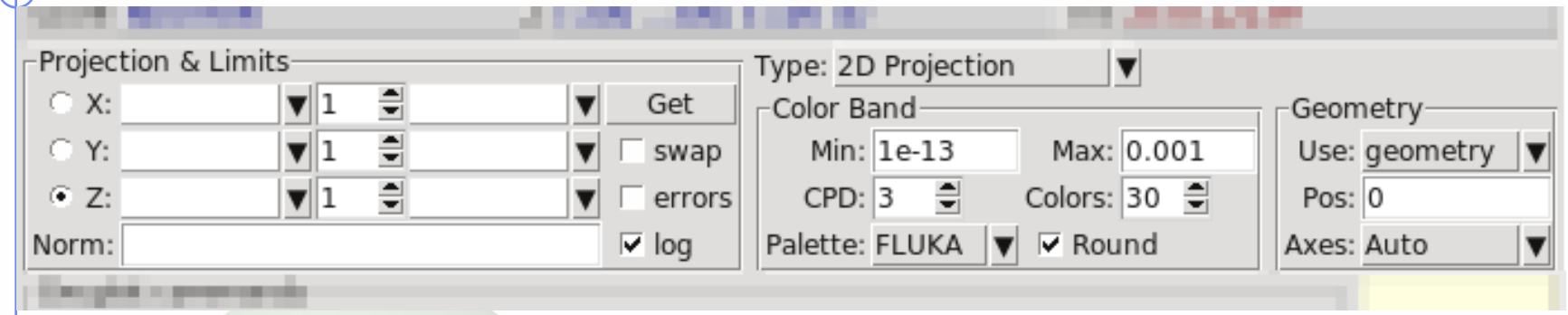
- With the USRBIN plotting frame you can perform:
  - 2D projection or region/lattice plot
  - 1D projection or region/lattice plot
  - 1D maximum trace
  - 1D trace scan

  of the data or errors from USRBIN data.



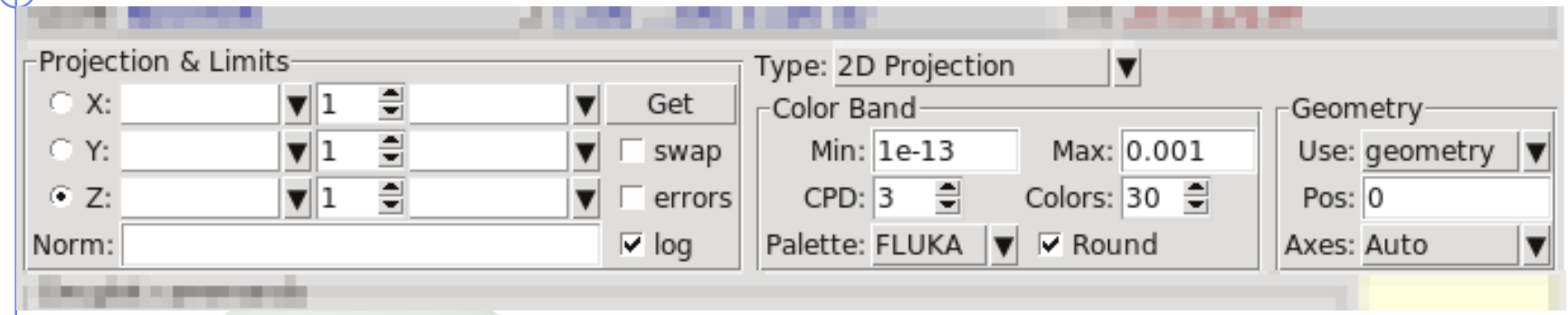
- Set the usrbin summary file in the File: field
- Select from Det: the detector to use.
- All the available detector information will be displayed
- The information Mininum, Maximum and Integral will be filled after the plot! *WARNING is always the projection min/max*

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.

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

- 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

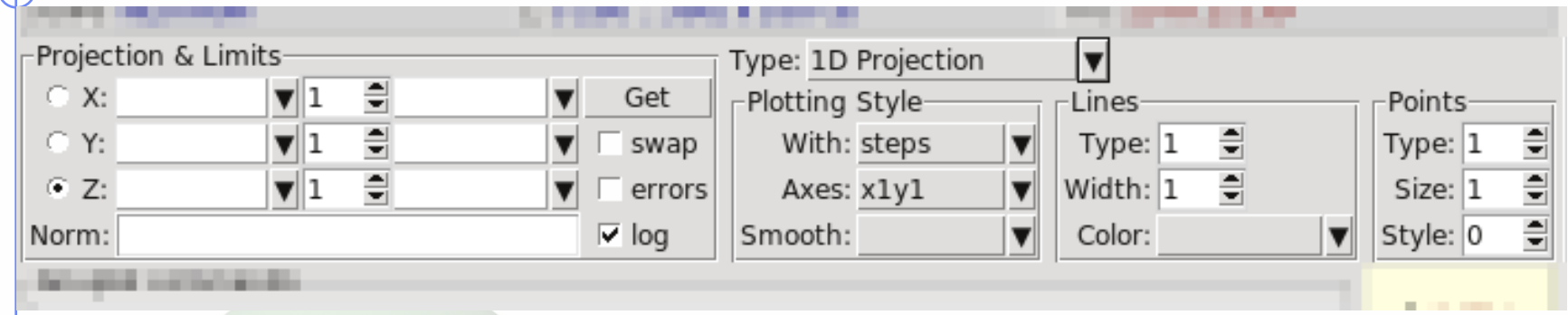
USRBIN (2D plot) cont..

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 usrbin 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

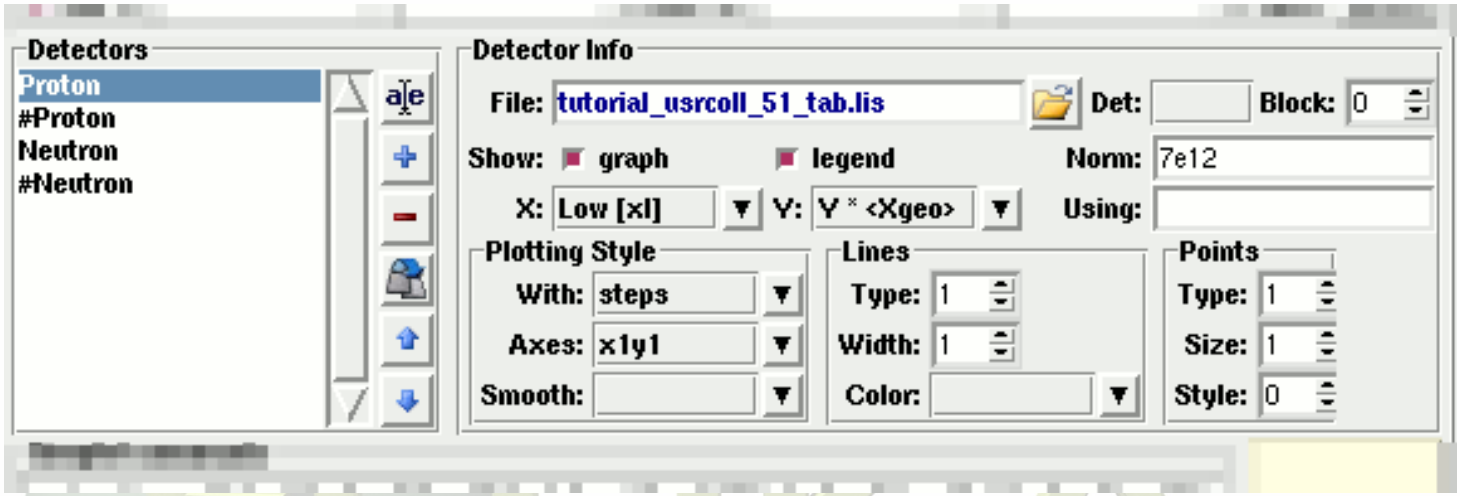
- Same as the 1D Projection, but displays only the maximum value on each slice. (eg. on a Z-projection, it will display the maximum on each X-Y slice)

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*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 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