

# Check File Structure

## General discussion

This check file contains all kinds of information depending on the print command used in the optns file. The general syntax is

```
print name number
```

which writes output from the module “name” using print level “number”. The higher the number the more detailed is the output. This is essentially a tool for developers. However, the command

```
print * 2
```

may be useful for the “normal user”. Here one produces several lists of particles (including their parent-children relations), at different stages of the simulation. The structure of the file is as follows

```
##### start event number 1 #####
.....
##### list before fragmentation #####
...
##### list after fragmentation #####
...
##### final decay #####
...
##### list after bjinta #####
...
##### start event number 2 #####
.....
```

where “...” refers to the particle list at that stage. A particle list contains the particles with one line per particle, with several columns, the most important ones being (these are actually the first 12 columns):

```
ior    - index of first parent of particle i
jor    - index of last parent of particle i
i      - index of particle
ifir1  - index of first child
ifir2  - index of last child
id     - particle id (EPOS code)
ist    - particle status
ity    - particle type of origin
pt     - particle transverse momentum
m      - particle mass
E      - particle energy
y      - particle rapidity
```

Concerning the particle id, we have

```
1 to 6      - quarks
-6 to -1   - antiquarks
9          - gluons
3 digits    - mesons
4 digits    - baryons
```

The file **src/KWt/idt.dt** contains the EPOS particle id codes.

Concerning the particle status ist, we have

```
20,21      - parton
29         - string
0          - last generation hadron
1          - other hadron
```

A complete list of particle status values can be found in the file **src/KWt/istat.dt**.

## Example 1 (electron-positron)

In the following we show an example for electron-positron annihilation. For simplicity we only show the first 9 columns.

The first table (before fragmentation) shows the initial particles (electron, id=12 and positron, id=-12), the photon (id=10) produced from  $e^+ + e^- \rightarrow \gamma$ , and then the produced chain of partons from  $\gamma \rightarrow s + \bar{s} \rightarrow s + g + g + \bar{s}$  with a strange quark (id=3) and a strange antiquark (id=-3) as well as two gluons (id=9).

```
#####
##### list before fragmentation #####
#####
ior jor i ifr1 ifr2 id ist ity pt
-----
0 0 1 0 0 12 1 0 0.000E+00
0 0 2 0 0 -12 1 0 0.000E+00
1 2 3 4 7 10 1 0 0.000E+00
3 3 4 0 0 3 20 30 0.109E+01
3 3 5 0 0 9 20 30 0.778E+00
3 3 6 0 0 9 20 30 0.446E+00
3 -3 7 0 0 -3 20 30 0.000E+00
```

Next we look at the list after fragmentation. In our example, the chain of 4 partons  $s - g - g - \bar{s}$  represents a kinky string, which decays into hadrons. In the list, one first maps the chain of partons to a string, with i=8, and with status ist=29 (=string). The string entry is only for bookkeeping, the properties of the string are known via the parent indices ior and jor, which allow to trace back to the partons which constitute the string.

```
#####
##### list after fragmentation #####
#####
ior jor i ifr1 ifr2 id ist ity pt
-----
4 7 8 9 22 800100010 29 30 0.225E-03
8 0 9 0 0 -130 0 30 0.213E+00
8 0 10 0 0 110 0 30 0.116E+00
8 0 11 0 0 110 0 30 0.874E+00
8 0 12 0 0 111 0 30 0.730E+00
8 0 13 0 0 121 0 30 0.687E+00
8 0 14 0 0 111 0 30 0.519E+00
8 0 15 0 0 231 0 30 0.370E+00
8 0 16 0 0 -231 0 30 0.210E-01
8 0 17 0 0 2130 0 30 0.780E+00
8 0 18 0 0 -1231 0 30 0.635E+00
8 0 19 0 0 -120 0 30 0.162E+00
8 0 20 0 0 120 0 30 0.215E+00
8 0 21 0 0 230 0 30 0.672E+00
8 0 22 0 0 330 0 30 0.389E+00
```

Directly following the string i=8, we see the string decay products, with i from 9 to 22. All these particles have mother index 8 (the string) and status 0, because they are (at this moment) last generation. The resonances did not decay yet.

In the list, we see several resonances, which will finally decay:

```
i=12, id=111, name=rho0
i=13, id=121, name=rho+
i=14, id=111, name=rho0
i=15, id=231, name=K*0
i=16, id=-231, name=K*0b
i=17, id=2130, name=Lambda
i=18, id=-1231, name=Sigma*0
i=21, id=230, name=K0
i=22, id=330, name=eta'
```

The decay products will be seen in the following list, where the father index ior (the leftmost number) allows to identify the decaying particle.

```
#####
##### final decay #####
#####
12 0 23 0 0 -120 0 30 0.880E+00
12 0 24 0 0 120 0 30 0.337E+00
13 0 25 0 0 120 0 30 0.328E+00
13 0 26 0 0 110 0 30 0.447E+00
14 0 27 0 0 -120 0 30 0.359E+00
14 0 28 0 0 120 0 30 0.334E+00
15 0 29 0 0 -120 0 30 0.193E+00
15 0 30 0 0 130 0 30 0.508E+00
16 0 31 0 0 120 0 30 0.268E+00
16 0 32 0 0 -130 0 30 0.284E+00
17 0 33 0 0 -120 0 30 0.231E+00
17 0 34 0 0 1120 0 30 0.552E+00
18 0 35 0 0 -2130 0 30 0.391E+00
18 0 36 0 0 110 0 30 0.264E+00
21 0 37 0 0 -20 0 30 0.672E+00
22 0 38 0 0 -120 0 30 0.108E+00
22 0 39 0 0 120 0 30 0.118E+00
22 0 40 0 0 220 0 30 0.205E+00
35 0 41 0 0 120 0 30 0.562E-01
35 0 42 0 0 -1120 0 30 0.399E+00
```

We also see a decay of a decay product: particles 41 and 42 are decay products of 35, which is already decay product of 18. In principle we are done, particle production is finished, but it is nevertheless useful to consider one more list, namely the full list at the end with the complete parent-children relations for all particles. This is provided in the following list.

```
#####
##### list after bjinta #####
#####
ior jor i ifr1 ifr2 id ist ity pt
-----
0 0 1 0 0 12 1 0 0.000E+00
0 0 2 0 0 -12 1 0 0.000E+00
1 2 3 4 7 10 1 0 0.000E+00
3 3 4 8 0 3 21 30 0.109E+01
3 3 5 8 0 9 21 30 0.779E+00
3 3 6 8 0 9 21 30 0.446E+00
3 -3 7 8 0 -3 21 30 0.247E-04
4 7 8 9 22 800100010 29 30 0.225E-03
8 0 9 0 0 -130 0 30 0.213E+00
8 0 10 0 0 110 0 30 0.116E+00
8 0 11 0 0 110 0 30 0.874E+00
8 0 12 23 24 111 1 30 0.730E+00
8 0 13 25 26 121 1 30 0.687E+00
8 0 14 27 28 111 1 30 0.519E+00
8 0 15 29 30 231 1 30 0.370E+00
8 0 16 31 32 -231 1 30 0.210E-01
8 0 17 33 34 2130 1 30 0.780E+00
8 0 18 35 36 -1231 1 30 0.635E+00
8 0 19 0 0 -120 0 30 0.162E+00
8 0 20 0 0 120 0 30 0.215E+00
8 0 21 37 37 230 1 30 0.672E+00
8 0 22 38 40 330 1 30 0.389E+00
12 0 23 0 0 -120 0 30 0.880E+00
12 0 24 0 0 120 0 30 0.337E+00
13 0 25 0 0 120 0 30 0.328E+00
13 0 26 0 0 110 0 30 0.447E+00
14 0 27 0 0 -120 0 30 0.359E+00
14 0 28 0 0 120 0 30 0.334E+00
15 0 29 0 0 -120 0 30 0.193E+00
15 0 30 0 0 130 0 30 0.508E+00
16 0 31 0 0 120 0 30 0.268E+00
16 0 32 0 0 -130 0 30 0.284E+00
17 0 33 0 0 -120 0 30 0.231E+00
17 0 34 0 0 1120 0 30 0.552E+00
```

18	0	35	41	42	-2130	1	30	0.391E+00
18	0	36	0	0	110	0	30	0.264E+00
21	0	37	0	0	-20	0	30	0.672E+00
22	0	38	0	0	-120	0	30	0.108E+00
22	0	39	0	0	120	0	30	0.118E+00
22	0	40	0	0	220	0	30	0.205E+00
35	0	41	0	0	120	0	30	0.562E-01
35	0	42	0	0	-1120	0	30	0.399E+00

## Example 2 (proton-proton)

In the following, we show an example for proton-proton scattering. For simplicity we only show the first 9 columns.

The first table (before fragmentation) shows the initial particles (protons, id=1120), then an invalid Pomeron (ist=32), not considered, insufficient energy, then a valid Pomeron (ist=31), which decays into objects with indices 126 to 136. The latter are chains of final state timelike (TL) partons (as explained earlier in the electron-positron example). The partons carry ist=20, in the final list shown later they have ist=21. All partons point back (via ior) to the Pomeron they are originating from. Just before the chains of partons one finds two entries with ist=25, referring to the first two partons directly produced from the Born process. The ist=25 partons are put into the list as additional information, however without parent/children relations.

Finally we see in the list the projectile and target remnant (ist=41), each one "decaying" into a string, given in terms of a parton chain composed of two soft partons.

We do not show the complete list, "... " refers to entries not being printed.

```
#####
##### list before fragmentation #####
#####
ior   jor   i   ifr1  ifr2   id ist ity   pt
-----
-1    0     1    0     0     1120 1  0  0.000E+00
-1    0     2    0     0     1120 1  0  0.000E+00
 1    2     3    0     0    -1000099 32 20  0.000E+00
 1    2    16   126   136   3111199 31 31  0.136E+01
...
 0    1    124   0     0      9 25 30  0.357E+01
 0    1    125   0     0      9 25 30  0.301E+01
16    8    126   0     0     -2 20 30  0.113E+01
16    9    127   1     0      9 20 39  0.223E+01
16    7    128   0     0      1 20 30  0.231E+01
16    8    129   0     0      3 20 30  0.525E+00
16   -9    130   12    0      9 20 31  0.229E+01
16   -9    131   12    0      9 20 31  0.107E+01
16   -9    132   11    0     -1 20 31  0.837E+00
16    7    133   0     0     -1 20 30  0.301E+01
16   -9    134   11    0      9 20 31  0.337E+00
16   -9    135   11    0      9 20 31  0.830E-01
16   -9    136   11    0      1 20 31  0.210E+01
 1    0    137   139   140   112099 41 40  0.307E+01
 2    0    138   141   142   112099 41 50  0.109E+01
137   0    139   0     0     1100 20 42  0.321E+01
137   0    140   0     0      2 20 42  0.181E+00
138   0    141   0     0     1200 20 52  0.941E+00
138   0    142   0     0      1 20 52  0.245E+00
```

Attention: The values for jor and ifr1 for partons (ist=20) have a special meaning, mainly information for the developers, just ignore them.

Next we look at the list after fragmentation.

One first maps the chain of partons to a string, with status `ist=29` (=string). The string entry is only for bookkeeping, the properties of the string are known via the parent indices `ior` and `jor`, which allow to trace back to the partons which constitute the string.

```
#####
##### list after fragmentation #####
#####
ior   jor   i   ifr1  ifr2   id ist ity   pt
-----
 126  128  379   380   395 810000100 29 31  0.353E+01
 379   0   380    0    0   120 0 31  0.663E+00
 379   0   381    0    0   110 0 31  0.342E+00
 379   0   382    0    0   221 0 31  0.170E+00
 379   0   383    0    0  -120 0 31  0.260E+00
 379   0   384    0    0   120 0 31  0.581E+00
 379   0   385    0    0  -121 0 31  0.257E+00
 379   0   386    0    0   221 0 31  0.189E+00
 379   0   387    0    0  -231 0 31  0.457E+00
 379   0   388    0    0   231 0 31  0.533E+00
 379   0   389    0    0   120 0 31  0.235E+00
 379   0   390    0    0  -1121 0 31  0.948E+00
 379   0   391    0    0   1120 0 31  0.107E+01
 379   0   392    0    0   110 0 31  0.515E+00
 379   0   393    0    0  -1220 0 31  0.292E+00
 379   0   394    0    0  2223 0 31  0.149E+01
 379   0   395    0    0   120 0 31  0.127E+01
 129  132  396   397   405 800101000 29 30  0.316E+01
 396   0   397    0    0  -130 0 30  0.460E+00
 396   0   398    0    0   121 0 30  0.116E+01
 396   0   399    0    0   221 0 30  0.685E+00
 396   0   400    0    0  -120 0 30  0.362E+00
 396   0   401    0    0   111 0 30  0.111E+01
 396   0   402    0    0   121 0 30  0.812E+00
 396   0   403    0    0  -121 0 30  0.239E+00
 396   0   404    0    0   120 0 30  0.345E+00
 396   0   405    0    0  -120 0 30  0.790E+00
 133  136  406   407   410 810001000 29 30  0.367E+01
 406   0   407    0    0  -130 0 30  0.233E+01
 406   0   408    0    0  -1135 0 30  0.961E+00
 406   0   409    0    0   2115 0 30  0.178E+01
 406   0   410    0    0   121 0 30  0.557E+00
 139  140  411   412   415 821000000 29 42  0.307E+01
 411   0   412    0    0   2115 0 42  0.219E+01
 411   0   413    0    0   120 0 42  0.584E+00
 411   0   414    0    0   111 0 42  0.567E+00
 411   0   415    0    0  -120 0 42  0.376E+00
 141  142  416   417   422 821000000 29 52  0.109E+01
 416   0   417    0    0   1120 0 52  0.884E-01
 416   0   418    0    0   110 0 52  0.585E+00
 416   0   419    0    0  -120 0 52  0.623E+00
 416   0   420    0    0   220 0 52  0.100E+01
 416   0   421    0    0   111 0 52  0.675E+00
 416   0   422    0    0   120 0 52  0.128E+00
```

Directly following the string (`i=379` for the first one considered), we see the string decay products.

All these particles have mother index 379 (the string) and status 0, because they are (at this moment) last generation hadrons. The resonances did not decay yet.

In the previous list, we have seen several resonances, which will finally decay.

The decay products are shown in the following list, where the father index ior (the leftmost number) allows to identify the decaying particle.

```
#####
##### final decay #####
#####
ior   jor   i   ifr1  ifr2   id ist ity   pt
-----
382   0   680   0     0    -120  0 31  0.390E+00
382   0   681   0     0     120  0 31  0.224E+00
385   0   682   0     0    -120  0 31  0.386E+00
385   0   683   0     0     110  0 31  0.405E+00
386   0   684   0     0    -120  0 31  0.155E+00
386   0   685   0     0     110  0 31  0.203E-01
386   0   686   0     0     120  0 31  0.340E+00
387   0   687   0     0    -230  0 31  0.338E+00
387   0   688   0     0     110  0 31  0.353E+00
388   0   689   0     0     230  0 31  0.495E+00
388   0   690   0     0     110  0 31  0.150E+00
390   0   691   0     0    -1220  0 31  0.988E+00
390   0   692   0     0    -120  0 31  0.126E+00
394   0   693   0     0    2221  0 31  0.154E+01
394   0   694   0     0     110  0 31  0.642E-01
398   0   695   0     0     120  0 30  0.328E+00
398   0   696   0     0     110  0 30  0.838E+00
399   0   697   0     0    -120  0 30  0.750E-01
399   0   698   0     0     110  0 30  0.221E+00
399   0   699   0     0     120  0 30  0.429E+00
401   0   700   0     0    -120  0 30  0.101E+01
401   0   701   0     0     120  0 30  0.193E+00
402   0   702   0     0     120  0 30  0.775E+00
402   0   703   0     0     110  0 30  0.276E+00
403   0   704   0     0    -120  0 30  0.121E+00
403   0   705   0     0     110  0 30  0.182E+00
408   0   706   0     0    -1234  0 30  0.996E+00
408   0   707   0     0    -120  0 30  0.144E+00
409   0   708   0     0     121  0 30  0.119E+01
409   0   709   0     0    1220  0 30  0.654E+00
410   0   710   0     0     120  0 30  0.517E+00
410   0   711   0     0     110  0 30  0.347E+00
412   0   712   0     0     121  0 42  0.929E+00
412   0   713   0     0    1220  0 42  0.131E+01
414   0   714   0     0    -120  0 42  0.159E+00
414   0   715   0     0     120  0 42  0.610E+00
420   0   716   0     0     10  0 52  0.859E+00
420   0   717   0     0     10  0 52  0.142E+00
421   0   718   0     0    -120  0 52  0.147E+00
421   0   719   0     0     120  0 52  0.628E+00
...

```

The list is not complete, there are also decays of decay products. In principle we are done, particle production is finished. It is nevertheless useful to consider one more list, namely the full final list at the end with the complete parent-children relations for all particles. This is provided in the following list.

```
#####
##### list after bjinta #####
#####
ior   jor   i   ifr1  ifr2   id ist ity   pt
-----
-1    0    1    0     0    1120  1  0  0.000E+00
-1    0    2    0     0    1120  1  0  0.000E+00
 1    2    3    0     0 -1000099 32 20  0.000E+00
...
 1    2    16  126   136  3111199 31 31  0.136E+01
...

```



In case of pseudosoft Pomerons, a given Pomeron may split into several sub-Pomerons, as shown in the following example.

```
#####
##### list after bjinta #####
#####
ior   jor   i   ifr1  ifr2   id ist ity   pt
-----
-1    0    1    0     0    1120  1  0  0.000E+00
-1    0    2    0     0    1120  1  0  0.000E+00
 1    2    3    0     0   -1000099 32 20 0.000E+00
...
 1    2    4    19    37   3111199 31 30 0.138E+01
...
 0    0   17     0     0     9 25 30 0.373E+01
 0    0   18     0     0     9 25 30 0.103E+01
 4    8   19   143     0    -2 21 30 0.352E+01
 4   -9   20   143     0     9 21 31 0.566E+00
 4   -9   21   143     0     9 21 31 0.155E+01
 4   -9   22   143     0     9 21 31 0.253E+01
 4   -9   23   143     0     9 21 31 0.108E+01
 4    7   24   143     0     2 21 30 0.202E+01
 4    8   25   155     0     1 21 30 0.710E+00
 4    7   26   155     0    -2 21 30 0.243E+01
 0    0   27     0     0     9 25 30 0.952E+00
 0    0   28     0     0     9 25 30 0.731E+01
 4    7   29   160     0    -2 21 30 0.114E+01
 4   -9   30   160     0     1 21 31 0.557E+01
 4    7   31   168     0     2 21 30 0.242E+01
 4   -9   32   168     0     9 21 31 0.860E+00
 4   -9   33   168     0     9 21 31 0.627E+00
 4   -9   34   168     0     9 21 31 0.478E+00
 4    8   35   168     0    -3 21 30 0.232E+01
 4    8   36   178     0     3 21 30 0.176E+01
 4   -9   37   178     0    -1 21 31 0.127E+01
```

There is only one Pomeron entry (here  $i=4$ ), but there are two pairs of  $ist=25$  partons ( $i=17-18$  and  $i=27-28$ ), followed in each case by a list of  $ist=21$  partons. So one has two sub-Pomerons.