I/O AGATA ROOT trees

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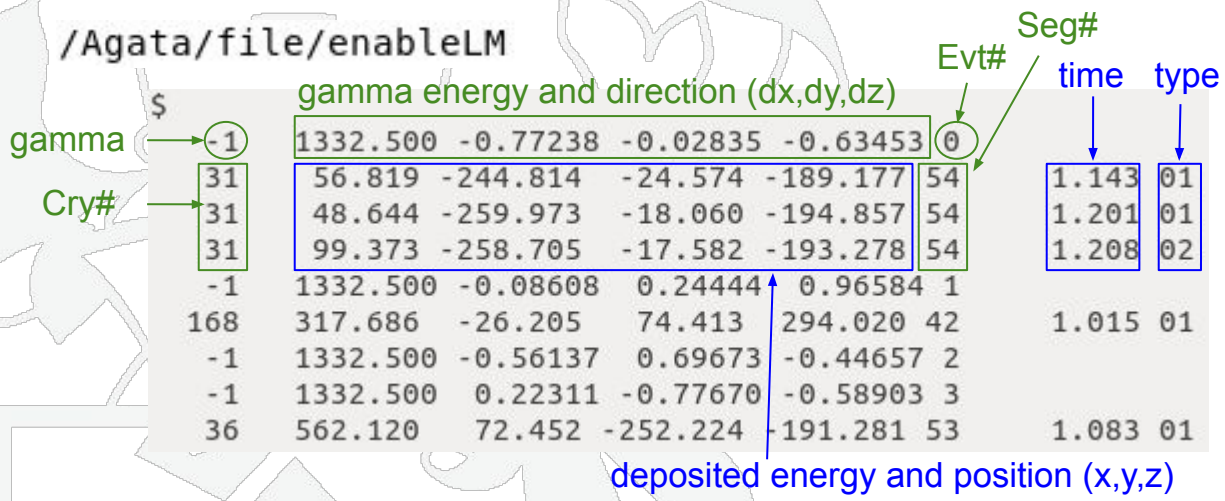
Tree output



mac file:

```
/Agata/file/enableROOT
/Agata/file/InterOnly
/Agata/file/info/outputMask 11100111
/Agata/file/verbose 3
/control/execute macros/geom180.mac
/Agata/generator/gamma/energy 1332.5
/Agata/tracking/method 1
/Agata/run/beamOn 10000
```

output rootfile:

```
TFile**         GammaEvents_0000.root
 TFile*         GammaEvents_0000.root
  KEY: TObjString       header0;1
  KEY: TTree    htree;1 RunSummary
  KEY: TTree    gtree;1 events
root [2] htree->Show(0)
======> EVENT:0
 outputMask      = 111001110
 unitLength_mm   = 1
 unitEnergy_keV  = 1
 nevent          = 10000
```

Tree output

```
/Agata/file/enableLM
$
-1    1332.500 -0.77238 -0.02835 -0.63453 0
31     56.819 -244.814   -24.574 -189.177 54     1.143 01
31     48.644 -259.973   -18.060 -194.857 54     1.201 01
31     99.373 -258.705   -17.582 -193.278 54     1.208 02
-1    1332.500 -0.08608  0.24444  0.96584 1
168    317.686  -26.205   74.413  294.020 42     1.015 01
-1    1332.500 -0.56137  0.69673 -0.44657 2
-1    1332.500  0.22311 -0.77670 -0.58903 3
36    562.120   72.452 -252.224 -191.281 53     1.083 01
```

gamma

Cry#

gamma energy and direction (dx,dy,dz)

Evt#

Seg#

time

type

deposited energy and position (x,y,z)

mac file:

```
/Agata/file/enableROOT
/Agata/file/InterOnly
/Agata/file/info/outputMask 11100111
/Agata/file/verbose 3
/control/execute macros/geom180.mac
/Agata/generator/gamma/energy 1332.5
/Agata/tracking/method 1
/Agata/run/beamOn 10000
```

tree structure:

```
root [1] gtree->Show(0)
======> EVENT:0
 ievent          = 0
 Beta_recoil     = 0
 vx_recoil       = 0
 vy_recoil       = 0
 vz_recoil       = 1
 px_recoil       = 0
 py_recoil       = 0
 pz_recoil       = 0
 Tdecay_recoil = 0
 partType        = -1
 e_part          = 1332.5
 vx_part         = -0.772377
 vy_part         = -0.0283463
 vz_part         = -0.634532
 ipart           = 0
 nhits           = 3
 ndet            = 31, 31, 31
 edep            = 56.8188, 48.6444, 99.3729
 x_lab           = -244.814, -259.973, -258.705
 y_lab           = -24.574, -18.0598, -17.5822
 z_lab           = -189.177, -194.857, -193.278
 nseg            = 54, 54, 54
 time            = 1.14265, 1.20086, 1.20779
 inter           = 1, 1, 2
```

emitter info

gamma info

External eventFile

AgataExternalEmission.cc **ASCII** file:

```
FORMAT 0 0
REACTION  1  1  6  12  1
EMITTED 1 1
```

header

```
$
-101 81 215 125183.99 -0.000862 0.000313 1.000000 -0.220272 0.500425 3.160559
1 583.398 0.007769 0.007230 0.999944 -0.220272 0.500425 3.160559
1 1466.578 0.655244 -0.529772 0.538515 -0.223522 0.501604 6.929110
$
-101 81 215 125142.46 0.000116 -0.000073 1.000000 0.128411 -0.443071 1.473071
1 188.256 0.715495 -0.546059 0.435760 0.128411 -0.443071 1.473071
1 3839.792 0.080789 0.119571 0.989533 0.128494 -0.443122 2.180282
$
-101 81 215 124925.77 -0.000574 -0.000445 1.000000 0.704242 -0.713115 1.592475
1 346.629 0.323809 -0.478142 0.816412 0.704242 -0.713115 1.592475
1 3142.643 0.031291 -0.372263 0.927600 0.703145 -0.713966 3.505422
```

event

FORMAT Emitter Emitted

Emitter	Line
0	-101 zEmi aEmi eEmi Dx Dy Dz Sx Sy Sz
1	-101 zEmi aEmi eEmi Dx Dy Dz
2	-101 zEmi aEmi eEmi
3	-101 zEmi aEmi
4	-101

Emitted	Line
0	type Elab Dx Dy Dz Sx Sy Sz [t P]
1	type ECM D'x D'y D'z Sx Sy Sz [t P]
2	type Elab Dx Dy Dz [t P]
3	type ECM D'x D'y D'z [t P]
4	type ECM

index	Type
1	gamma
2	neutron
3	proton
4	deuterium
5	triton
6	3He
7	alpha
8	Generic ion
97	Electron
98	Positron
99	Geantino

External eventFile

AgataExternalEmissionR.cc **ROOT** file:

input rootfile:

```
TFile**         AGATASimInput00.root
 TFile*         AGATASimInput00.root
  KEY: TTree    htree;1 header tree
  KEY: TTree    gtree;1 events tree
root [2] htree->Show(0)
======> EVENT:0
 emitterType     = 0
 emittedType     = 0
 zBeam           = 1
 aBeam           = 1
 zTarg           = 6
 aTarg           = 12
 eBeam           = 1
 nTypes          = 1
 Types           = 1
```

one emitted particle ⇔ one tree entry

```
root [1] gtree->Show(0)
======> EVENT:0
ievent          = 0                  // event ID
z_react         = -1.01434
t_decay         = 84.7916
newemitter      = 1                  // new emitter flag
Z_emitter       = 81                 // emitter info:
A_emitter       = 215
E_emitter       = 582.251            // Energy, MeV/u
px_emitter      = -2.20272           // emitter position, mm
py_emitter      = 5.00425
pz_emitter      = 31.6056
vx_emitter      = -0.000862334       // emitter direction
vy_emitter      = 0.000312797
vz_emitter      = 1
type            = 1                  // emitted type
px_emitted      = -2.20272           // emitted position, mm
py_emitted      = 5.00425
pz_emitted      = 31.6056
theta_emitted_CM = 0.0321418         // emitted direction, CM
phi_emitted_CM  = -2.118
theta_emitted_part = 0.0110612
E_emitted_CM    = 200.8              // emitted energy, CM
vx_emitted_CM   = -0.0167205
vy_emitted_CM   = -0.0274438
vz_emitted_CM   = 0.999483
E_emitted       = 583.398            // emitted energy, lab
vx_emitted      = 0.00776881         // emitted direction, lab
vy_emitted      = 0.00723011
vz_emitted      = 0.999944
```

External eventFile

AgataExternalEmissionR.cc **ROOT** file:

input rootfile:

```
TFile**         AGATASimInput00.root
 TFile*         AGATASimInput00.root
  KEY: TTree    htree;1 header tree
  KEY: TTree    gtree;1 events tree
root [2] htree->Show(0)
======> EVENT:0
 emitterType     = 0
 emittedType     = 0
 zBeam           = 1
 aBeam           = 1
 zTarg           = 6
 aTarg           = 12
 eBeam           = 1
 nTypes          = 1
 Types           = 1
```

one emitted particle ⇔ one tree entry

```
root [2] gtree->Show(1)
======> EVENT:1
ievent          = 0                  // event ID
z_react         = -1.01434
t_decay         = 98.1337
newemitter      = 0                  // new emitter flag
Z_emitter       = 81                 // emitter info:
A_emitter       = 215
E_emitter       = 582.251            // Energy, MeV/u
px_emitter      = -2.23522           // emitter position, mm
py_emitter      = 5.01604
pz_emitter      = 69.2911
vx_emitter      = -0.000862334       // emitter direction
vy_emitter      = 0.000312797
vz_emitter      = 1
type            = 1                  // emitted type
px_emitted      = -2.23522           // emitted position, mm
py_emitted      = 5.01604
pz_emitted      = 69.2911
theta_emitted_CM = 2.02057           // emitted direction, CM
phi_emitted_CM  = 2.80985
theta_emitted_part = 1.00299
E_emitted_CM    = 1373               // emitted energy, CM
vx_emitted_CM   = -0.851442
vy_emitted_CM   = 0.293302
vz_emitted_CM   = -0.434764
E_emitted       = 1466.58            // emitted energy, lab
vx_emitted      = 0.655244           // emitted direction, lab
vy_emitted      = -0.529772
vz_emitted      = 0.538515
```

External eventFile

AgataExternalEmissionR.cc **ROOT** file:

input rootfile:

```
TFile**         AGATASimInput00.root
 TFile*         AGATASimInput00.root
  KEY: TTree    htree;1 header tree
  KEY: TTree    gtree;1 events tree
root [2] htree->Show(0)
======> EVENT:0
 emitterType     = 0
 emittedType     = 0
 zBeam           = 1
 aBeam           = 1
 zTarg           = 6
 aTarg           = 12
 eBeam           = 1
 nTypes          = 1
 Types           = 1
```

one emitted particle ⇔ one tree entry

```
root [3] gtree->Show(2)
======> EVENT:2
ievent          = 1                  // event ID
z_react         = -1.20746
t_decay         = 41.3407
newemitter      = 1                  // new emitter flag
Z_emitter       = 81                 // emitter info:
A_emitter       = 215
E_emitter       = 582.058            // Energy, MeV/u
px_emitter      = 1.28411            // emitter position, mm
py_emitter      = -4.43071
pz_emitter      = 14.7307
vx_emitter      = 0.00011638         // emitter direction
vy_emitter      = -7.25568e-05
vz_emitter      = 1
type            = 1                  // emitted type
px_emitted      = 1.28411            // emitted position, mm
py_emitted      = -4.43071
pz_emitted      = 14.7307
theta_emitted_CM = 2.1373            // emitted direction, CM
phi_emitted_CM  = -0.0944136
theta_emitted_part = 1.11978
E_emitted_CM    = 200.8              // emitted energy, CM
vx_emitted_CM   = 0.840024
vy_emitted_CM   = -0.0795461
vz_emitted_CM   = -0.536687
E_emitted       = 188.256            // emitted energy, lab
vx_emitted      = 0.715495           // emitted direction, lab
vy_emitted      = -0.546059
vz_emitted      = 0.43576
```

External eventFile

mac file, ASCII input:

```
/Agata/file/enableROOT
/Agata/file/InterOnly
/Agata/file/info/outputMask 11100111
/Agata/file/verbose 0
/control/execute macros/geom180.mac
/Agata/generator/emitter/eventFile ./Events0000
/Agata/tracking/method 1
/Agata/run/beamOn 1000
```

```
agata$ ./build/Agata -Ext -b simExt.mac
```

mac file, ROOT input:

```
/Agata/file/enableROOT
/Agata/file/InterOnly
/Agata/file/info/outputMask 11100111
/Agata/file/verbose 0
/control/execute macros/geom180.mac
/Agata/generator/emitter/eventFile ./AGATASimInput00.root
/Agata/tracking/method 1
/Agata/run/beamOn 1000
```

```
agata$ ./build/Agata -Ext -R -b simExt.mac
```

External event generator

FAIREvtGen:

```
ATIMA             exampleCH2.setup  exampleLH2.setup  include   README
example2.decay    example.decay     example.setup     Makefile  src
example2.setup    exampleDeg.setup  FAIREvtGen.C      MOCADI    SuperFRS.in
```

- adapte from the EvtGen
- calculate energy loss in material using ATIMA
- deal with compound material
- accept MOCADI output file as input

Example 1:

***example_CH2.setup*:**

```
NumberProjectiles:    1000
decay_filename:       example.decay
ROOTFileName:         AGATASimInputCH2_0.root

########################################
# characteristics of projectile and beam
########################################
Ap:      216     # projectile mass
Zp:       82     # projectile charge number
Xsp:    7.51     # Mass excess [MeV]

E0:      628.    # initial projectile energy (in MeV/A)
deltaE:    1.    # variance of initial projectile energy (in MeV/A)

x0:      0.0     # beam position and variance in x-direction (in mm)
deltax:  5.
y0:      0.0     # beam position and variance in y-direction (in mm)
deltay:  5.

#####################################
# definition of a target layer:
#####################################
Layer:  CT   H4C2    2  0  0   0.    930.   5.00   1
             1.008   1  4
            12.011   6  2

#####################################
# definition of reaction:
#####################################
Reaction:    K       200.

#####################################
# characteristics of heavy ejectile
#####################################
Ae:    215             # ejectile mass
Ze:     81             # ejectile charge number
Bn:      7.73          # binding energy in MeV/u
Xse:    10             # Mass excess [MeV]
Ex:      0.0           # excitation energy in MeV
```

 # ^{216}Pb beam

 # CH2 target 930 mg/cm^3 5 mm

 # knockout reaction
200 MeV/c momentum transfer

 # ^{215}Tl fragment

***example.decay*:**

```
level: ground_state 0.0

level: excited_state2 1373. 67.1
        decay: ground_state 100 1

level: excited_state1 1573.8 67.1
        decay:  excited_state2 100 1

level: exciter 100000 0.1
        decay: excited_state1 100 10000
```

Example 2:

***example_Deg.setup*:**

```
NumberProjectiles:    100000
Mocadi_filename:      SuperFRS.root
decay_filename:       example.decay
ROOTFileName:         AGATASimInputDeg_0.root

########################################
# output options:
ROOTFileBeamFrag:      1
EnergyDeposit:         1

########################################
# characteristics of projectile and beam
########################################
MocadiBeamIndex:           0

########################################
# definition of a target layer:
########################################
Layer:  T    9.012   4  0  0   0.   1850.   3.78   1
Layer:  D  180.95   73  0  0  10.  16601.   1.     0
Layer:  D  180.95   73  0  0  20.  16601.   1.     0

########################################
# definition of reaction:
########################################
Reaction:    K       200.

########################################
# characteristics of heavy ejectile
########################################
MocadiFragIndex:           1

Bn:      7.73          # binding energy in MeV/u
```

save beam and frag info

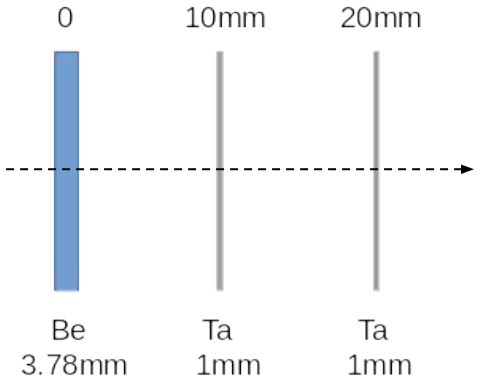
save energy deposit in material

read beam info from MOCADI tree

reaction probability

read frag mass, Z from MOCADI tree, simulate reaction, Eloss and scattering

```
TFile**         SuperFRS.root
 TFile*         SuperFRS.root
  KEY: TTree    T    a tree with the data from MOCADI
root [2] T->Show(0)
======> EVENT:0
 n        = 2
 x        = -0.68709,      -0.687054
 a        = -0.474812,     -0.357727
 y        = -0.00735409, -0.00722417
 b        = 2.44371,       3.3292
 energy = 634.291,       588.547
 time     = 0.839729,      0.839745
 mass   = 216.007,       215.009
 z        = 82,            81
 elnum  = 0,             0
 tof      = 0.839729,      0.839745
 de       = 527.672,       10040.1
 brho     = 11.0589,       10.6356
 weight  = 3.66249e-16, 7.49084e-20
 range    = -1000
 tpos     = -0.274789
```



Example 2:

***example_Deg.setup*:**

```
NumberProjectiles:    100000
Mocadi_filename:      SuperFRS.root
decay_filename:       example.decay
ROOTFileName:         AGATASimInputDeg_0.root

########################################
# output options:
ROOTFileBeamFrag:      1
EnergyDeposit:         1

########################################
# characteristics of projectile and beam
########################################
MocadiBeamIndex:         0

########################################
# definition of a target layer:
########################################
Layer:  T    9.012    4  0  0   0.    1850.    3.78    1
Layer:  D  180.95    73  0  0  10.   16601.    1.      0
Layer:  D  180.95    73  0  0  20.   16601.    1.      0

########################################
# definition of reaction:
########################################
Reaction:    K       200.

########################################
# characteristics of heavy ejectile
########################################
MocadiFragIndex:         1

Bn:      7.73          # binding energy in MeV/u
```

beam and frag info

energy deposit in material

reaction pos. decay time

```
root [2] gtree->Show(0)
======> EVENT:0
 ievent          = 0
 beam_x          = -0.68709
 beam_a          = -0.474812
 beam_y          = -0.00735409
 beam_b          = 2.44371
 beam_z          = -1.89
 beam_beta       = 0.803796
 frag_x          = -0.65642
 frag_a          = 5.27621
 frag_y          = 0.0486688
 frag_b          = 5.91786
 frag_z          = 20.5001
 frag_beta       = 0.724993
 NLayers         = 6
 ELayer          = 10241.8,
                   0, 17414.9, 0, 18164.2, 0
 z_react         = 1.88902
 t_decay         = 84.7916
 newemitter      = 1
 Z_emitter       = 81
 A_emitter       = 215
 E_emitter       = 420.936
 px_emitter      = -0.600053
 py_emitter      = 0.11189
 pz_emitter      = 31.1831
 vx_emitter      = 0.0052761
 vy_emitter      = 0.00591774
 vz_emitter      = 0.999969
 type            = 1
 px_emitted      = -0.600053
 py_emitted      = 0.11189
```

Example 2:

example_Deg.setup:

```
NumberProjectiles:    100000
Mocadi_filename:      SuperFRS.root
decay_filename:       example.decay
ROOTFileName:         AGATASimInputDeg_0.root

########################################
# output options:
ROOTFileBeamFrag:      1
EnergyDeposit:         1

########################################
# characteristics of projectile and beam
########################################
MocadiBeamIndex:         0

########################################
# definition of a target layer:
########################################
Layer:  T    9.012    4  0  0   0.    1850.    3.78    1
Layer:  D  180.95    73  0  0  10.   16601.    1.      0
Layer:  D  180.95    73  0  0  20.   16601.    1.      0

########################################
# definition of reaction:
########################################
Reaction:    K       200.

########################################
# characteristics of heavy ejectile
########################################
MocadiFragIndex:         1

Bn:      7.73          # binding energy in MeV/u
```

OFT tracking, Doppler corrected Energy