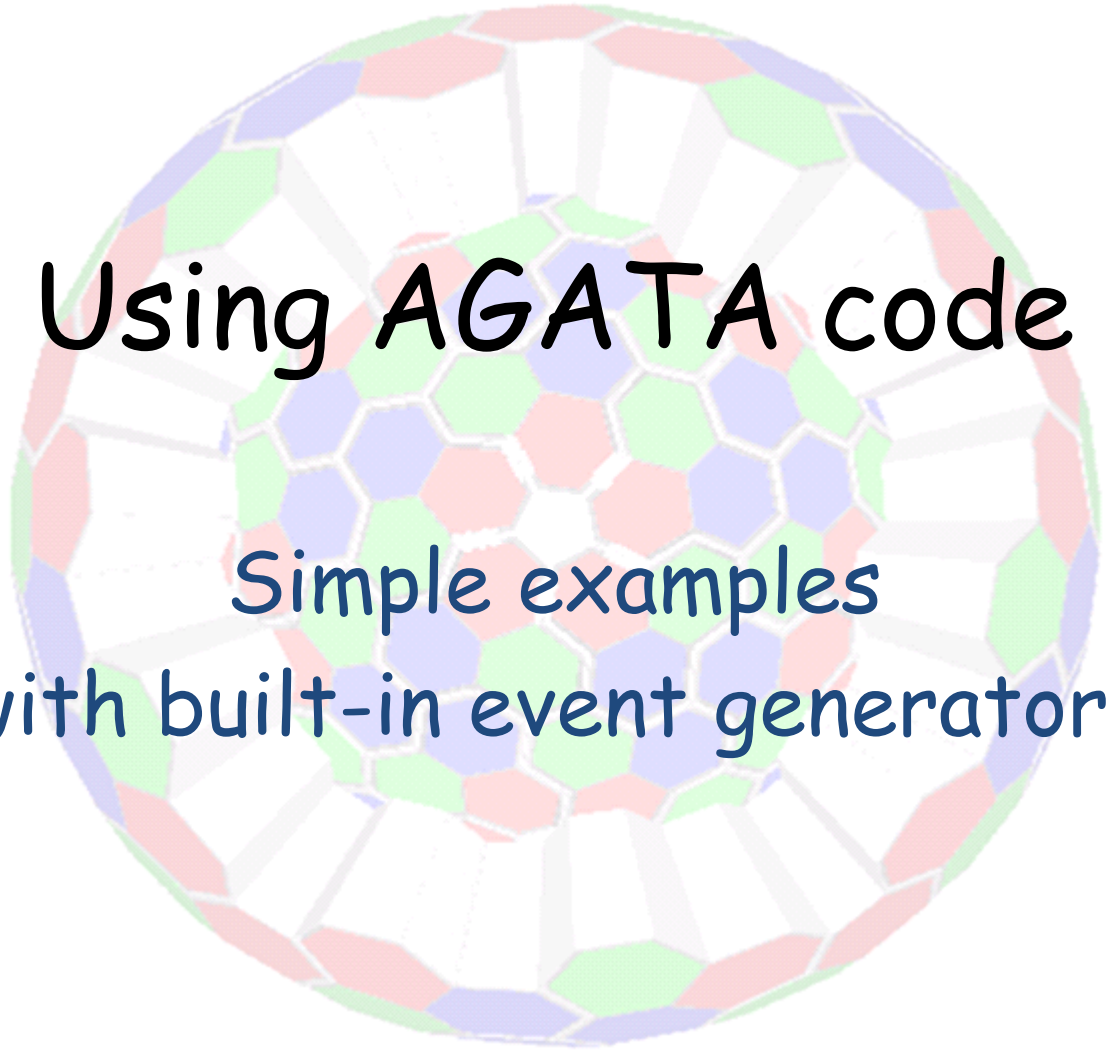
Science & Technology Facilities Council



Using AGATA code

Simple examples
with built-in event generators

The options

>$G4WORKDIR/bin/Linux-g++/Agata -h (or ./build/Agata -h)

-g index select geometry (0=AGATA, 1=SHELL, 2=Simple, 3=Geom for test of Physics 4=Orgam (eurogam))
-a N_anc n_1 ... n_N select ancillary devices
-n use also neutrons, protons, ...
-noLE use the standard treatment of the interactions for gamma/e-/e+
-noLowH use the standard treatment of the interactions for hadrons
-p consider the linear polarization of the photons
-Vol enables the use of geantinos for volume and solid angle calculation
-Ext reads the event sequence from file
-Gen uses user-supplied event generation
-Test Event generator using geant4 gun commands
-b file.mac runs in batch mode executing file.mac
-Path <dir> sets base directory to <dir>
-seed uses current time as seed for random number engine
-run r sets first run number to r
-SN Use G4ScreenedNuclear instead of multiplescattering for Generic Ions
-decay zZZ.aAAA make radioactive decayfiles
-AddOn library_name Add some kind of det. via shared lib
-h help, print this list

Example #1 – Running in Interactive Mode (IM)

>$G4WORKDIR/bin/Linux-g++/Agata (or ./build/Agata)

Idle> ls → List of all interactive commands (IC)

Idle> ls /Agata/ → List of Agata/ exclusive IC

Idle> ls /Agata/generator/

Idle> ls /Agata/generator/gamma/

Idle> /control/execute macros/geom180-demo.mac → Execute the macro Geom180-demo.mac

Idle> /Agata/generator/gamma/energy 1332.5

Idle> /Agata/run/beamOn 100

Idle> /Agata/file/enableLM → Save the output in an ASCII file

Idle> /Agata/run/beamOn 100000

The macros: geom180-Demo.mac

```
#
# Macro file to set the geometry to the A=15 polyhedron
#
/Agata/detector/solidFile ./A180/A180solid.list
/Agata/detector/angleFile ./A180/A180eulerDemo.list
/Agata/detector/wallsFile ./A180/A180walls.list
/Agata/detector/clustFile ./A180/A180clust.list
/Agata/detector/sliceFile ./A180/A180slice.list
/Agata/detector/enableCapsules
/Agata/detector/update
```

- For more crystals, you can substitute the file A180eulerDemo.list by other A180euler$_{xxx}$.list files available in A180/

- Ex: A180euler.list for the full AGATA array

The output file GammaEvent.0000

- The header output

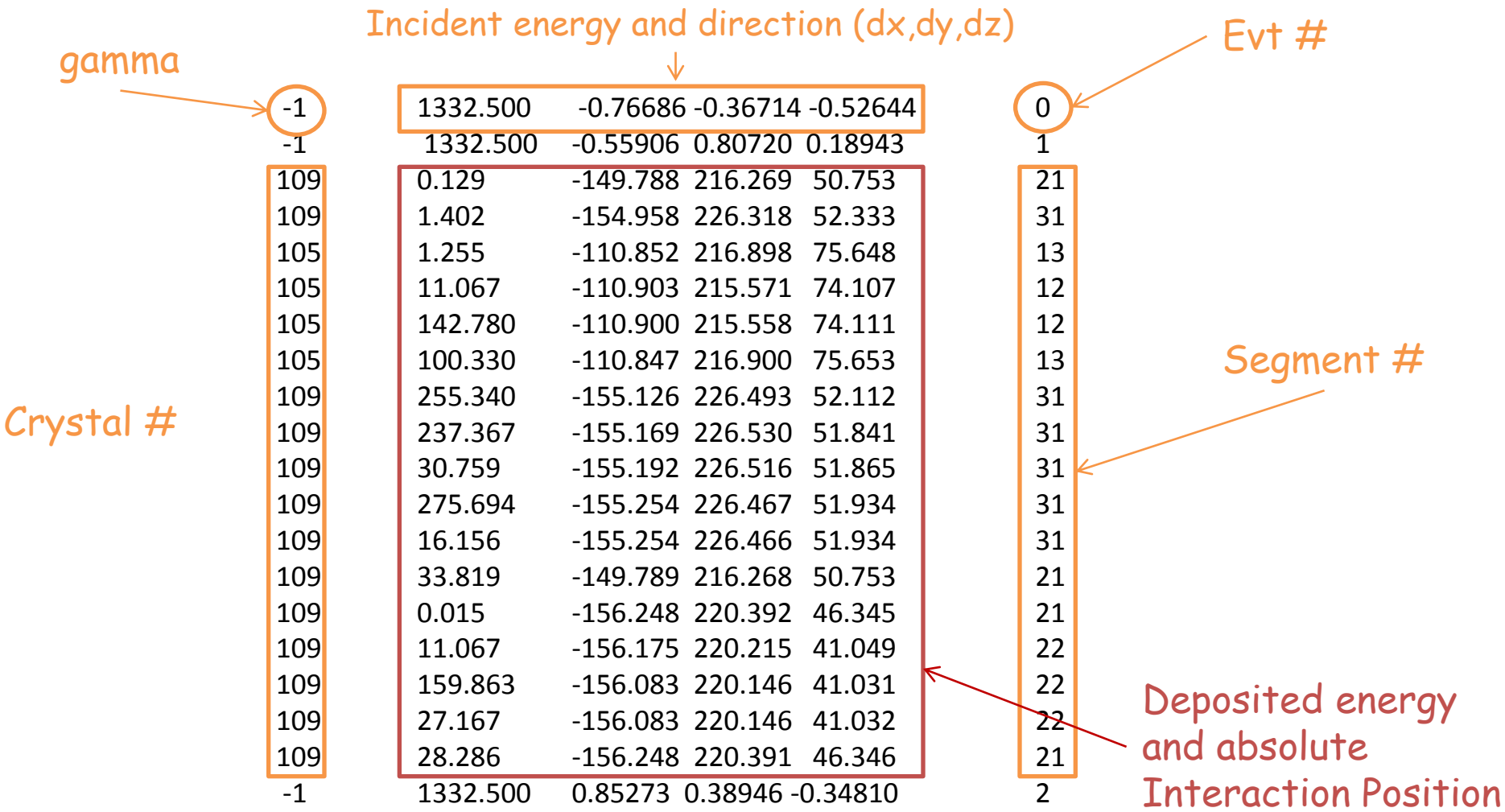
Read Out settings,
Geometry description,
Evt generator description,
Beginning of event,

See doc. for more details

```
AGATA 7.3.0
OUTPUT_MASK 11100100
# nDet Energy AbsolutePosition(x y z) RelativePosition(x' y' z')
# RelativePosition for mgs (x'' y'' z'') nSeg time interaction
# 0--> disabled; 1--> enabled
DISTFACTOR 1
ENERFACTOR 1
G4TRACKING 0
DATE Thu Nov 14 09:11:53 2013
GEOMETRY
AGATA
SUMMARY 235.008  329.202  180  3 6 6 6 6 6 6
TRANSFORMATION   0.000   0.000   0.000   0.000   0.000   0.000
PASSIVE 1
CAPSULES 1
ENDGEOMETRY
GENERATOR 0
ENDGENERATOR
GAMMA 1
1332.5000
RECOIL   0.0000  0.0000  0.0000  0.0000  1.0000  0.0000
SOURCE       0      0    0.0000    0.0000    0.0000
$
```

The output file GammaEvent.0000

- The output events



Running the tracking codes

1. Using mgt:

```
> cd analysis/mgt
> pwd
> setenv MGTDIR /path/to/mgt
> ./mgt –h
> ./mgt –f ../../GammaEvent.0000
```

- By default, the output file spec.dat is generated (or overwritten) and can be open directly with xtrackn (GASPWare)

- You can also open this file with ROOT as follow:

```
> cd rootana
> root –l
> .x AgataAna.C
```

  The output file tracking.root is generated (or overwritten)

  The doppler corrected energy spectrum after tracking (hist #30) is plotted automatically.

- You can also create an ASCII output file for the hist #30 with the command:

```
> ./mgt –oa 30 30  –f ../../GammaEvent.0000
```

  The output file is then spec30.asc

Useful things to know about mgt

1. **Histogram list:**
   the list is available at the top of the mgt.c and now also in the README file
   (you will get it if you update your agata distribution with the command: svn update)

2. **Handling Agata Double Cluster !!!!**

   mgt doesn't yet handle double cluster automatically !

   When double clusters are used in the AGATA geometry, the line "SUMMARY" in the output file GammaEvent.xxxx has to be modified so that the number of crystals is 3 times the number of clusters (even though some clusters have only 2 crystals).

   Ex: if your geometry has 3ATC + 2ADC (=25 crystals), the simulation output files will have a SUMMARY line:

   SUMMARY 25 …

   This has to be replaced by:

   SUMMARY 30 …

   Before running mgt.

Running the tracking codes

1. **Using oft:**

There are 2 options whether you ran simulations with a built-in or external event generator

a) **Built-in**

> cd analysis/oft/built-in

> bash

> ulimit –s 65536 (or ulimit –s 32768)

You may need to edit the forward_n.c file and change parameters appropriately and (re)compile:

> gcc forward_n.c –lm –o forward

>./forward

The ascii output file "spectrum" is generated (or overwritten).

You can also use root to open it, as follow:

> root –l

.x OFTana.C

Running the tracking codes

1. **Using oft:**

There 2 options whether you ran simulations with a built-in or external event generator

a) **Built-in**
b) **External**

> cd analysis/oft/external

> bash

> ulimit –s 65536 (or ulimit –s 32768)

You may need to edit the forward_n.c file and change parameters appropriately and (re)compile:

> gcc forward_external.c –lm –o forward

>./forward

The ascii output file "spectrum" is generated (or overwritten).

You can also use root to open it, as follow:

> root –l

.x OFTana.C

Example #2 – visualisation in IM

>$G4WORKDIR/bin/Linux-g++/Agata (or ./build/Agata)

Idle> /control/execute macros/geom180-demo.mac
Idle> /control/execute macros/visGL.mac
Idle> / control/execute macros/visVRML.mac
Idle> exit

Hint: with VRML, to open the visu. window automatically, define the environment variable:

setenv G4VRMLFILE_VIEWER vrmlview

Example #3 – beam velocity in IM

>$G4WORKDIR/bin/Linux-g++/Agata (or ./build/Agata)

Idle> /Agata/file/enableLM

Idle> /control/execute macros/geom180-demo.mac

Idle> /Agata/generator/gamma/energy 1332.5

Idle> ls /Agatagenerator/recoil/

Idle> /Agata/generator/recoil/beta 5

Idle> /Agata/run/beamOn 1000

Example #4 - γ + particles in IM

>$G4WORKDIR/bin/Linux-g++/Agata -n (or ./build/Agata -n)

Idle> /Agata/file/enableLM

Idle> /control/execute macros/geom180-Demo.mac

Idle> /Agata/generator/gamma/energy 1332.5

Idle> ls /Agata/generator/

Idle> ls /Agata/generator/neutron

Idle> /Agata/generator/neutron/energy 1000

Idle> /Agata/run/beamOn 1000

Example #5 - basic rotational band

>$G4WORKDIR/bin/Linux-g++/Agata (or ./build/Agata)

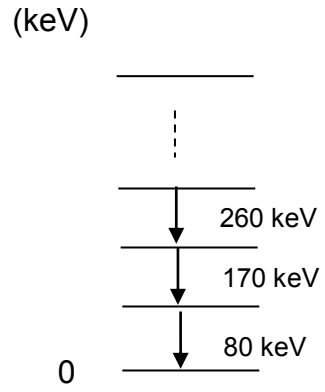
Idle> /Agata/file/enableLM

Idle> /control/execute macros/geom180-Demo.mac

Idle>/Agata/generator/recoil/beta 5

Idle> /Agata/generator/gamma/band 80 90 30 ⟶ (lowest E, Eg, Mg)

Idle> /Agata/run/beamOn 10000



Example #6 - using ancillaries

>$G4WORKDIR/bin/Linux-g++/Agata -a 1 9

(or ./build/Agata -a 1 9)

Idle> /Agata/detector/enableAncillary

Idle> /Agata/detector/rotateArray 180. 0. 0.

Idle> /control/execute macros/geom180-Demo.mac

Idle>/control/execute macros/visVRML.mac

Ancillary list

Ancillaries	Index	Sensitive Det. instances	Offset
Koeln Si det.*	1	1	1000
Shell (default)	2	1	2000
DANTE*	3	1	3000
EUCLIDES *	4	2	4000,5000
Brick (PRISMA "dipole")	6	0	6000
N-Wall *	7	1	7000
DIAMANT *	8	1	8000
EXOGAM	9	1	9000
HELENA *	10	1	10000
RFD *	11	1	11000
TRACE ?	12	2	12000,13000
CUP ?	14	1	14000
GASPARD ?	15	1	15000
Cassandra*	16	1	16000
AIDA*	17	1	17000
FATIMA*	18	1	18000

*Geometry defined but analysis code not provided (yet).

Example #7 – Running in Batch Mode (BM)

All Interactive commands can be put in a macro file which is called when launchin the agata code with the option **–b file.mac**

Ex: Agata+EXOGAM macro with visualisation:

>./Agata -a 1 9 –b macros_ganil/vis/agata5D5T_exogam.mac

(or ./build_agata/Agata –a 1 9 –b …)

AGATA+EXOGAM macro without visualisation:

>./Agata -a 1 9 –b macros_ganil/mc/agata5D5T_exogam.mac

(or ./build_agata/Agata –a 1 9 –b …)

Example #8: analysing EXOGAM simulation -1-

- You can create your own analysis code for EXOGAM data by inspecting the output file GammaEvent.xxxx
- Using mgt ? Possibly with –anc and –ang options: ! To be checked !
- Using oft – (see Joa)

- Use the basic analysis code built in AgataAnalysis.cc class, using the command: /Agata/analysis/enable.
  - It is basic because: Doppler correction not implemented , and only valid for 8 clovers.
  - How to:
    - Copy macros_ganil/mcagata5D5T_exogam.mac to agata5D5T_exogam_ana.mac and edit the latter.
    - Add the following command: /Agata/analysis/enable
    - Comment the line: /Agata/generator/recoil/beta 5
    - And Run the code in batch mode :

      > Agata –a 1 9 –b macros_ganil/mc/agata5D5T_exogam_ana.mac

    ➢ 8 binary files called G00.0000, G01.0000, … G07.0000 are then produced.

Example #8: analysing EXOGAM simulation -2-

- G00.0000 = sum energy spectrum for AGATA+EXOGAM
- G01.0000 = spectrum of each AGATA crystals
- G02.0000 = spectrum of each AGATA clusters
- G03.0000 = sum energy spectrum of AGATA crystals
- G04.0000 = EXOGAM only
- G05.0000 = same as above but vetoed by Anti Compton shield
- G06.0000 = as above + AGATA
- G07.0000 = AGATA only

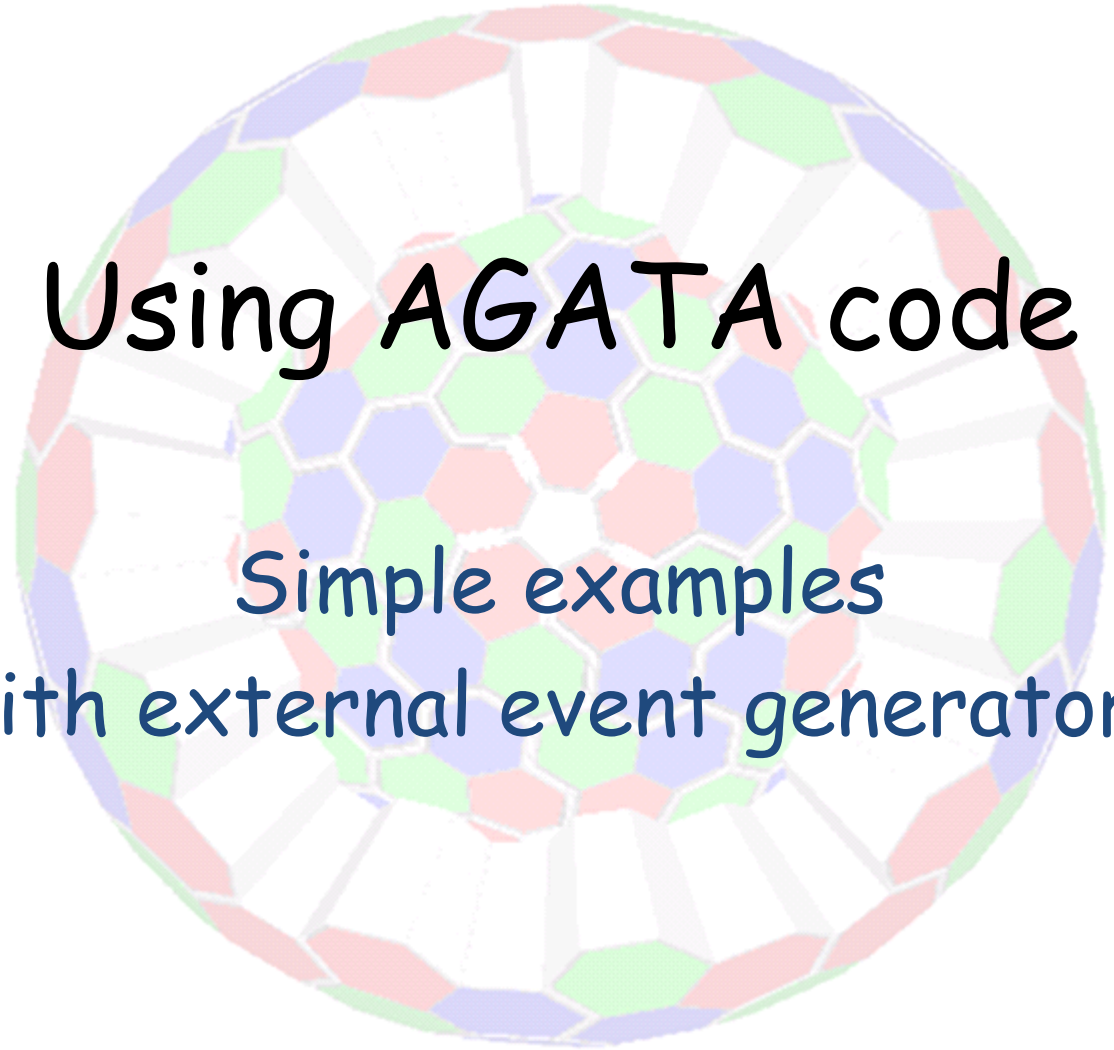
- To visualize the spectra, run the root macros AgataAnaG0X.C in analysis/exogam/:

  > cd analysis/exogam
  >root –l
  >.x AgataAnaG0X.C

Example #8: analysing EXOGAM simulation -3-

- 8 root output files are created and appear in the ROOT browser window
  - G00.0000 → All_Output.root (1 histo.)
  - G01.0000 → AGATACrystals_Output (1 histo. per crystals)
  - G02.0000 → AGATAClusters_Output (1 histo. Per clusters)
  - G03.0000 → AGATA_Sum_Crystals_Output (1 histo)
  - G04.0000 → EXOGAM_Output.root (1histo)
  - G05.0000 → EXOGAM_CS_Output.root (1histo)
  - G06.0000 → AGATA_EXOGAM_CS_Output.root (1histo)
  - G07.0000 → AGATA_Only_Output.root (1histo)

- To visualize the spectra via the root Browser, click on the file name and click on the spectrum



Using AGATA code

Simple examples
with external event generators

Using an external event generators

- AGATA code accepts ASCII file of events as input.

- You can create your own event generator to produce this event file or you can use:
  - GammaWare (.ags files)
  - ext_generators/ (distributed with the AGATA code)

Format of the event input file

Example: Events00 file in Agata/events/:

```
FORMAT 0 0                          = Emitter info , Emitted info
#                                   (Level of detailed information: 0 to 4)
#
REACTION 6 12 16 32 88.0            = Z_beam, A_beam, Z_target, A_Target, E_beam
#                                             (Default= 1, 1, 6, 12, 0)
#
EMITTED 2 1 4                       = N_total, Type_i=0, …, Type_i-N
#
$                                   = Beginning of event
-101 12 26 44. 0. 0. 1. 0.  0.  0.  = Emitter: z, A, E, x_Dir, y_Dir ,z_Dir, x_S, y_S ,z_S
 1 3000. 0. 1. 0. 0. 0. 0.  0.  0.      = 1st emitted: E, x_Dir, y_Dir ,z_Dir, x_S, y_S ,z_S, [t, P]
 4 5000. 1. 0. 0. 0. 0. 0.  0.5 1   = 2nd emitted: E, x_Dir, y_Dir ,z_Dir, x_S, y_S ,z_S, [t, P]
```

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

Command:

```
$G4BIN/agata –Ext
Idle>/control/execute macros/geom180.mac
Idle>/Agata/generator/emitter/eventFile  /Path/to/Eventfile/EventfileName
```

The “ Format X X “ line

Emitter line

EmitterType	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

EmittedType	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 [t P]

Example #1: 60CoEvents

1. Have a look at the 60CoEvents file

2. Run the agata code:

```
> $G4WORKDIR/…/Agata  -Ext
Idle>/Agata/file/enableLM
Idle>/control/execute  macros/geom180-Demo.mac
Idle>/Agata/generator/emitter/eventFile  events/60CoEvents44
Idle> /Agata/runbeamOn 3000
```

3. Then run mgt or oft to read GammaEvent.0000 and produce the energy spectrum

Producing event input files with GammaWare

- Install GammaWare (with cmake)
- source Gw-env.csh (or Gw-env.sh)
- Download a .*ags* file from http://radware.phy.ornl.gov/agsdir1.html

- cd PathTo/gammaware/demos/gem directory and run:
  root –l
  .L ToGeant.C
  toGEANT1("PathTo/yourfile.ags", 1000, "YourOutputfile")
  .q

> YourOutputfile.event (ascii) and YourOutputfile.root files are created !

Producing event input files ext_generators/

- The executable *Event_generator* provides an event output file with Format 0 0

- To compile it, you'll need gsl installed
  - Then run: make

- To run it:

  >./event_generator yourSetupFile FutputFileName

- Several example of setup files are given for different reactions:
  - Example.setup (typical plunger setup)
  - exampleInelastic.Setup
  - exampleTransfer.Setup

example.setup (1)

```
NumberProjectiles: 21000

########################################
# definition of a target layer:
########################################
# Layer: A Z density(in g/cm^3)   thickness(in um)  relative_excitation_probability angular_straggling(in mrad/um) reaction_type
# all length in micometers
# A = Z = 1 and density = 0 means vacuum
# available reaction types: C   inverse coulex  ( do nothing : ejectile flys with velocity of projectile )
#                           k   knock out (or fragmentation) : Relative change of velocity (Borrel et al.)
#                           f   fusion evaporation: ejectile flys with center of mass velocity
########################################
Layer: 197 79  19.3            208.0          90.0  0.0  C
Layer:   1      1   0           500.0           0.0   0.0  C
Layer: 197 79  19.3            208.0          90.0  0.0  C

########################################
# characteristics of projectile and beam
########################################
Ap:  85                    # projectile mass
Zp:  35                    # projectile charge number

E0: 201.7                  # initial projectile energy (in MeV/A)
deltaE: 0.005              # variance of initial projectile energy (in MeV/A)

x0: 0.0                                # primary beam position and variance in x-direction (in um)
deltax: 25000
y0: 0.0                                # primary beam position and variance in y-direction (in um)
deltay: 17000
```

example.setup (2)

```
##########################################
# characteristics of ejectile
##########################################
Ae:  85                 # ejectile mass
Ze:  35                 # ejectile charge number
Bn:   8.0   # binding energy in MeV/u

decay_filename: example.decay
```

example.decay

level: ground_state 0.0

level: excited_state1 373.8 6.71
    decay: ground_state 100 1

level: exciter 100000 0.1
    decay: excited_state1 100 10000

Example #2

1- Run:

>./event_generator example.setup output.dat

2- Run:

>./Agata –Ext

Idle>/Agata/file/enableLM

Idle>/control/execute macros/geom180-Demo.mac

Idle>/Agata/generator/emitter/eventFile /path/to/output.dat

Idle>/Agata/rrun/beamOn 21000

3- Run mgt or oft

exampleInelastic.Setup (1)

```
NumberProjectiles: 10000
#
########################################
# definition of a target layer:
########################################
# Layer: A Z density(in g/cm^3)   thickness(in um)  relative_excitation_probability angular_straggling(in mrad/um) reaction_type
# all length in micometers
# A = Z = 1 and density = 0 means vacuum
# available reaction types: C   inverse coulex  ( do nothing : ejectile flys with velocity of projectile )
#                           k   knock out (or fragmentation) : Relative change of velocity (Borrel et al.)
#                           f   fusion evaporation                  : ejectile flys with center of mass velocity
#                           T   Elastic/Inelastic scattering and n-transfer in inverse kinematics
########################################
Layer: 1 1  0.001                50.0              90.0  0.0  T
########################################
# characteristics of projectile and beam
########################################
Ap:  114                         # projectile mass
Zp:   54                         # projectile charge number
Xsp: -67.18                      # Mass excess [MeV]

E0:                              50.     # initial projectile energy (in MeV/A)
deltaE:          0.005 # variance of initial projectile energy (in MeV/A)

x0: 0.0                                  # primary beam position and variance in x-direction (in um)
deltax: 25000
y0: 0.0                                  # primary beam position and variance in y-direction (in um)
deltay: 17000
#
```

exampleInelastic.Setup (2)

```
########################################
# characteristics of target nucleus
# (note: target layer could be different that the target nucleus of interest: CD2 layer - d=target nucleus)
########################################
Atg:            1                       # target ejectile mass
Ztg:            1                       # target z
Xstg:           7.289                   # Mass excess [MeV]

########################################
# characteristics of heavy ejectile
########################################
Ae:  114                    # ejectile mass
Ze:   54                    # ejectile charge number
Bn:   8.0                   # binding energy in MeV/u
Xse:  -67.18                # Mass excess [MeV]
Ex:   12.888                # Excited state [MeV] populated after reaction (Ex used only for the kinematics,
            # the decay cascade should be described in the decay_filename below)
#
# gamma decay file
decay_filename: 114Xe.decay
#
# Cross section file for transfer or elastic/Inelastic scattering (cross section vs thetaCM)
Xsec_filename: CrossSection/flat.txt
#Xsec_filename: CrossSection/sn132dp_gs_10AMeV.txt
#
########################################
# characteristics of light ejectile (for transfer reaction)
########################################
Ale: 1                                  # light ejectile mass
Zle: 1                                  # light ejectile z
Xsle:           7.289                   # Mass excess [MeV]
```

Example #3

1- Run:

>./event_generator exampleInelastic.setup output.dat

2- Run:

>./Agata –Ext

Idle>/Agata/file/enableLM

Idle>/control/execute macros/geom180-Demo.mac

Idle>/Agata/generator/emitter/eventFile /path/to/output.dat

Idle>/Agata/rrun/beamOn 10000

3- Run mgt or oft