

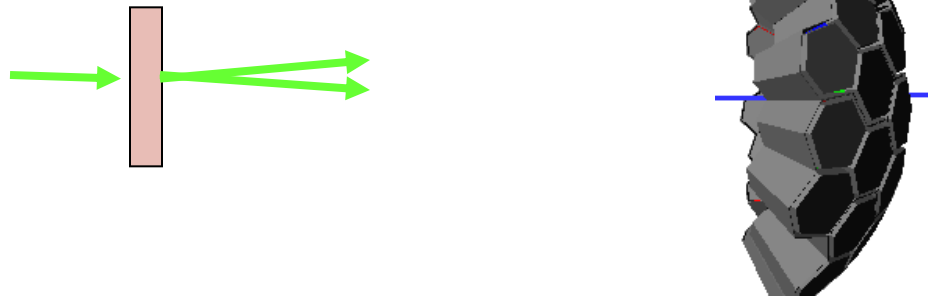
Agata simulations (WP3): Building tools for the GSI phase

by

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The University of York

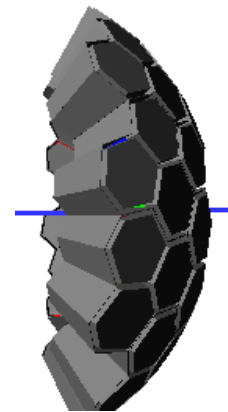
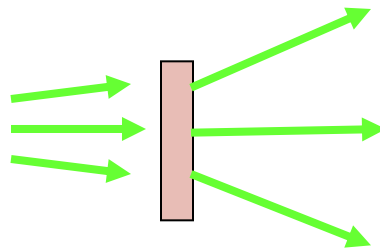
Typical simulation set-up for Legnaro:

- *A sharp beam spot.*
- *Beam angle well defined : along the z axis.*
- *Recoil's energy and angular spread is small.*
- *Recoil's v/c ~few % (non relativistic treatment).*



Additional challenges for GSI:

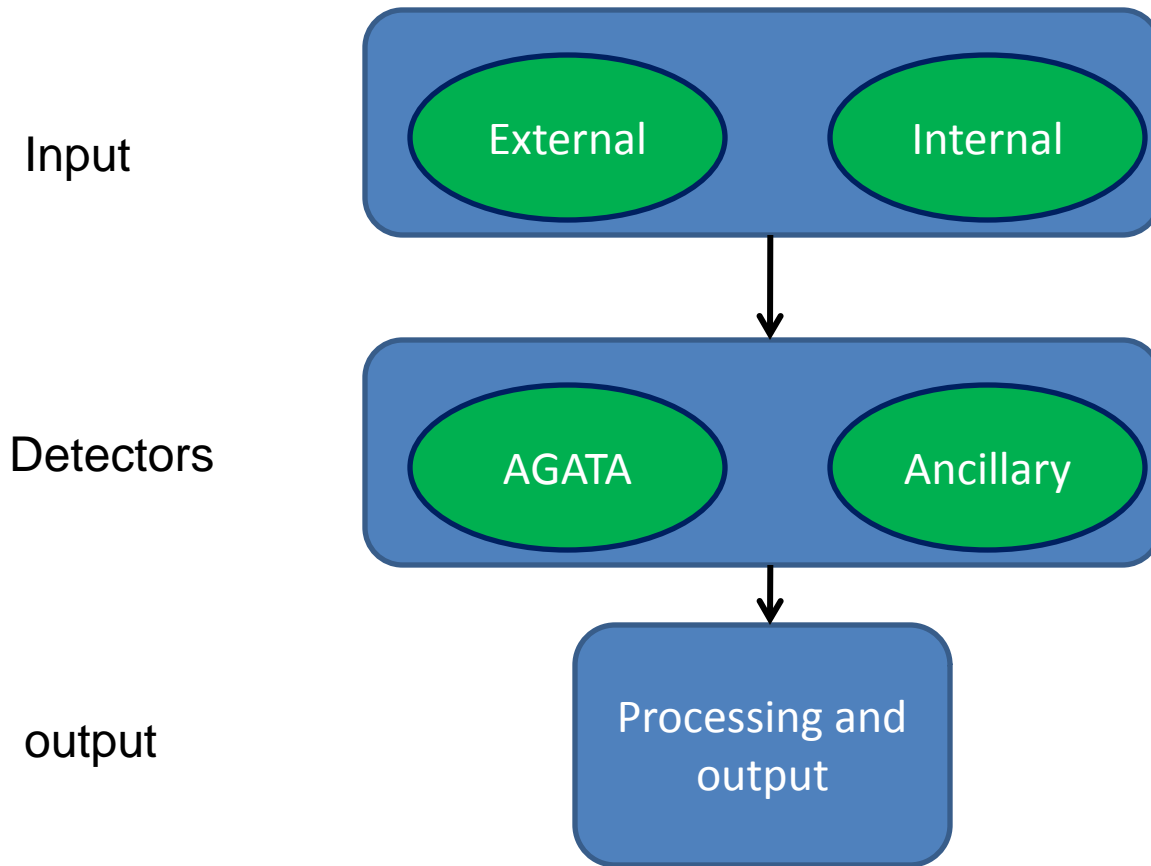
- *Beam spot is several cm big.*
- *Beam has larger divergence (emittance).*
- *$v/c \sim 40\text{-}50\%$. (Relativistic Doppler shift and Lorentz Boost)*



to meet these new challenges:

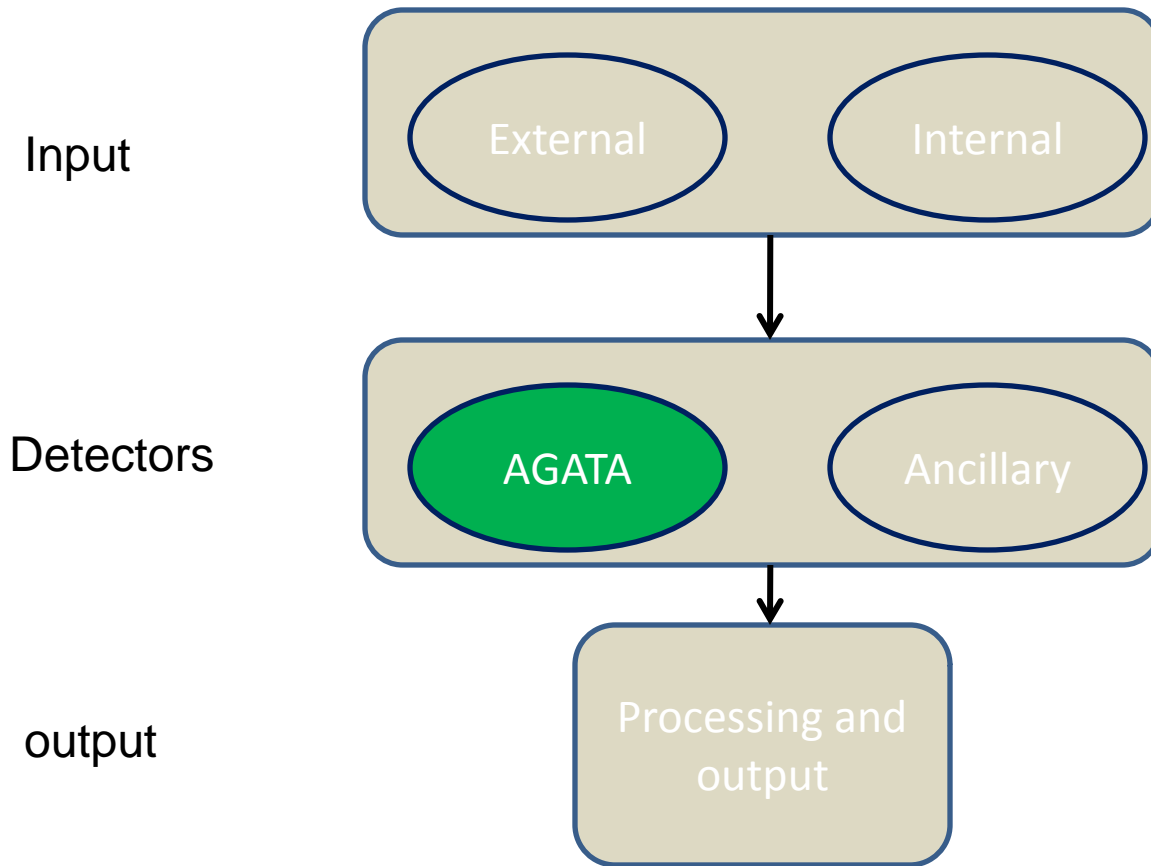
1. New geometry at forward angles (Lorentz Boost)
2. track the fragments : New tracking ancillary (LYCCA)
3. New event generator : fragmentation + gamma cascades
4. Analysis codes

Simulation code's structure



Building block model of Agata code. Blocks can be modified or new blocks can be added.

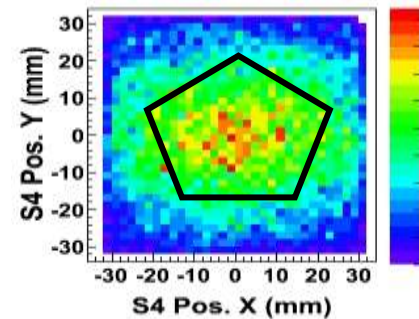
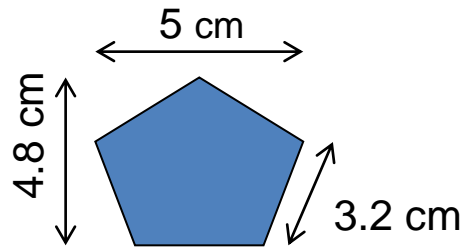
(1) Geometry :



Building block model of Agata code. Blocks can be modified or new blocks can be added.

(1) Geometry : beam size constraints

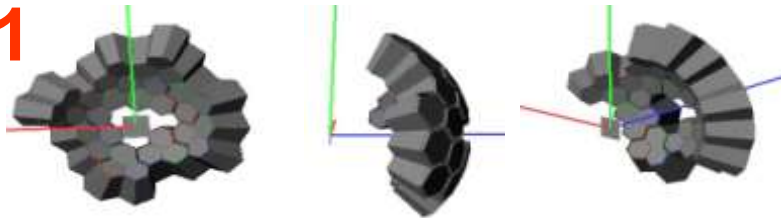
Beam spot at S4 is much bigger than the pentagon hole available in the current AGATA geometry.



(1) Geometry : comparison of shell geometries

Shell geometries

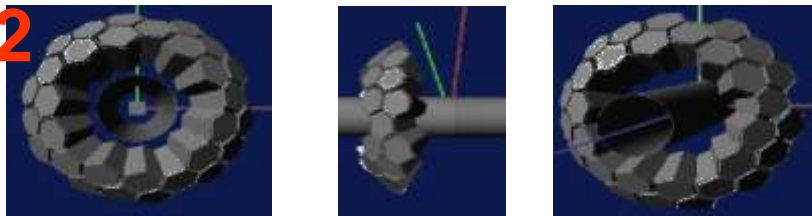
S1



10 Clusters (Hole 1 Cluster)

Hole small (appx. 7 cm)

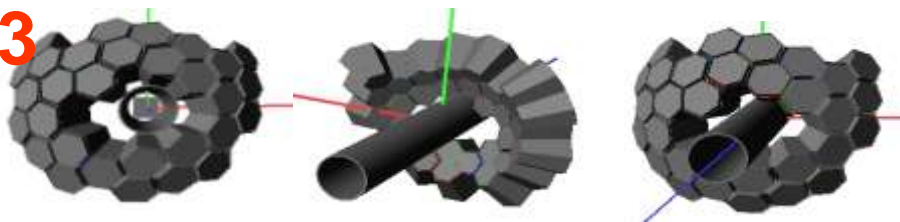
S2



10 Clusters (Hole 5 Clusters)

Hole (22.8 cm) beam-pipe 16 cm

S3



10 Clusters (Hole 2 Clusters)

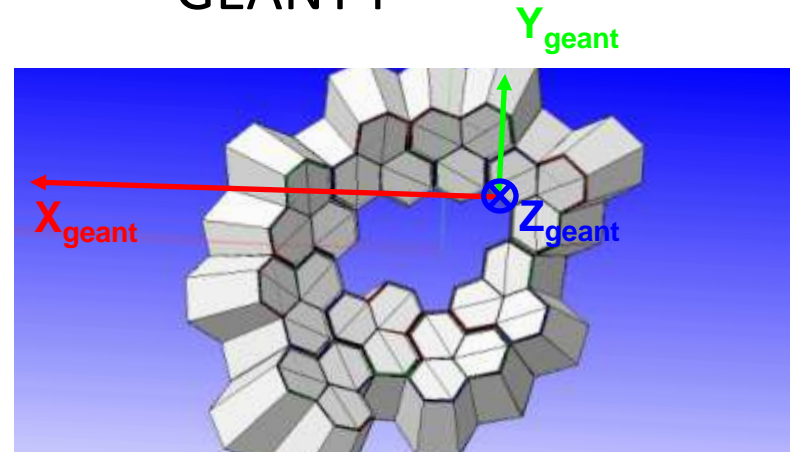
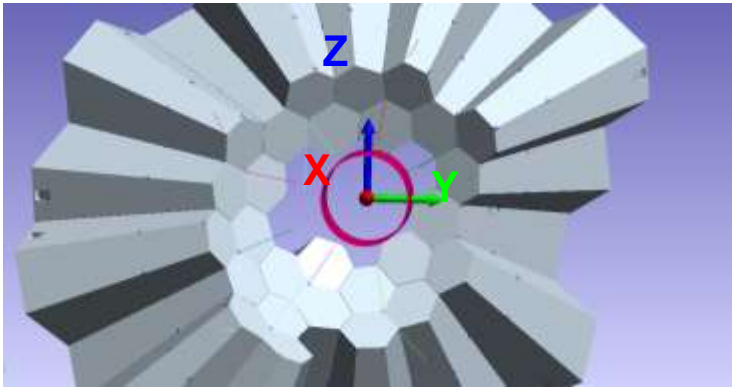
Hole (11.5 cm) beam-pipe 11 cm

(1) Geometry : from CAD to Geant4

CAD

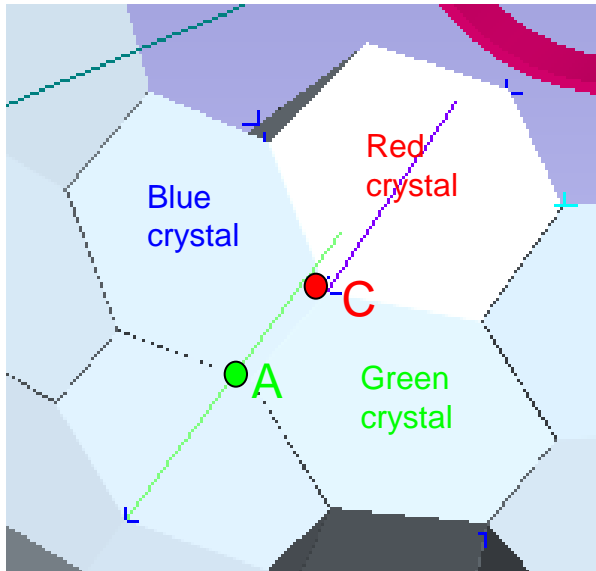


GEANT4



- Different coordinate systems currently used in CAD and AGATA geant4 code
 - Same target coordinates (0,0,0), but different axis.
 - CAD can easily provides:
 - positions of the centre of each cluster front face.
 - AGATA code requires:
 - positions of each cluster barycentre,
 - polar and azimuthal angles (Θ, Φ),
 - cluster orientation (Ψ).
- Interface developed to easily pass from one coordinate system to another

(1) Geometry : Shell's performance

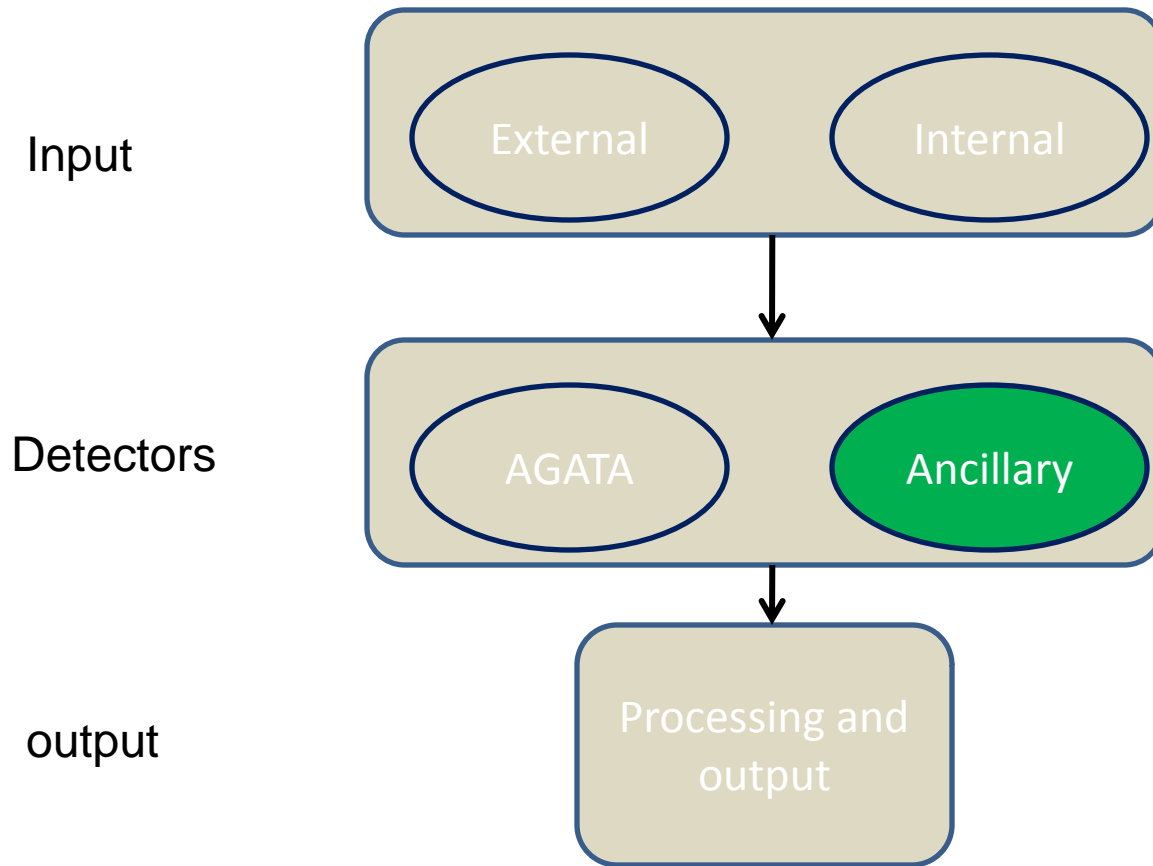


Simulation results:

- Simulation input:
 - $E_\gamma = 1 \text{ MeV}$, $M_\gamma = 1$
 - $v/c = 43\%$
 - Distance target-Clusters: 23 cm
 - Target/Source position: (0,0,0)
- Results (mgt tracking code):
 - Photopeak efficiency: 8.5 %
 - P/T: 45%
 - Resolution (FWHM): 7 keV

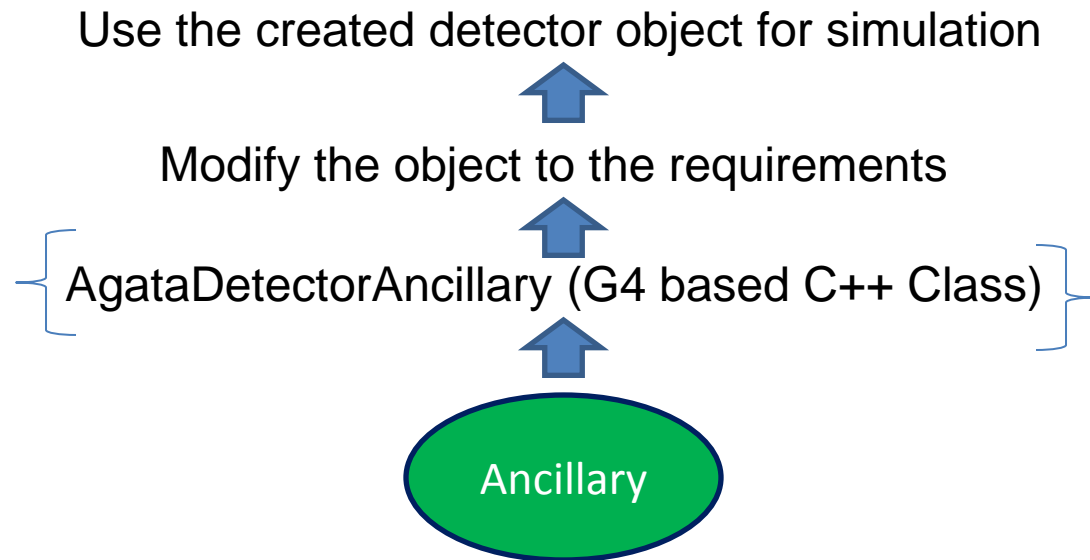
(2) Tracking fragments : adding ancillary LYCCA

LYCCA=Lund-York-Cologne CALorimeter

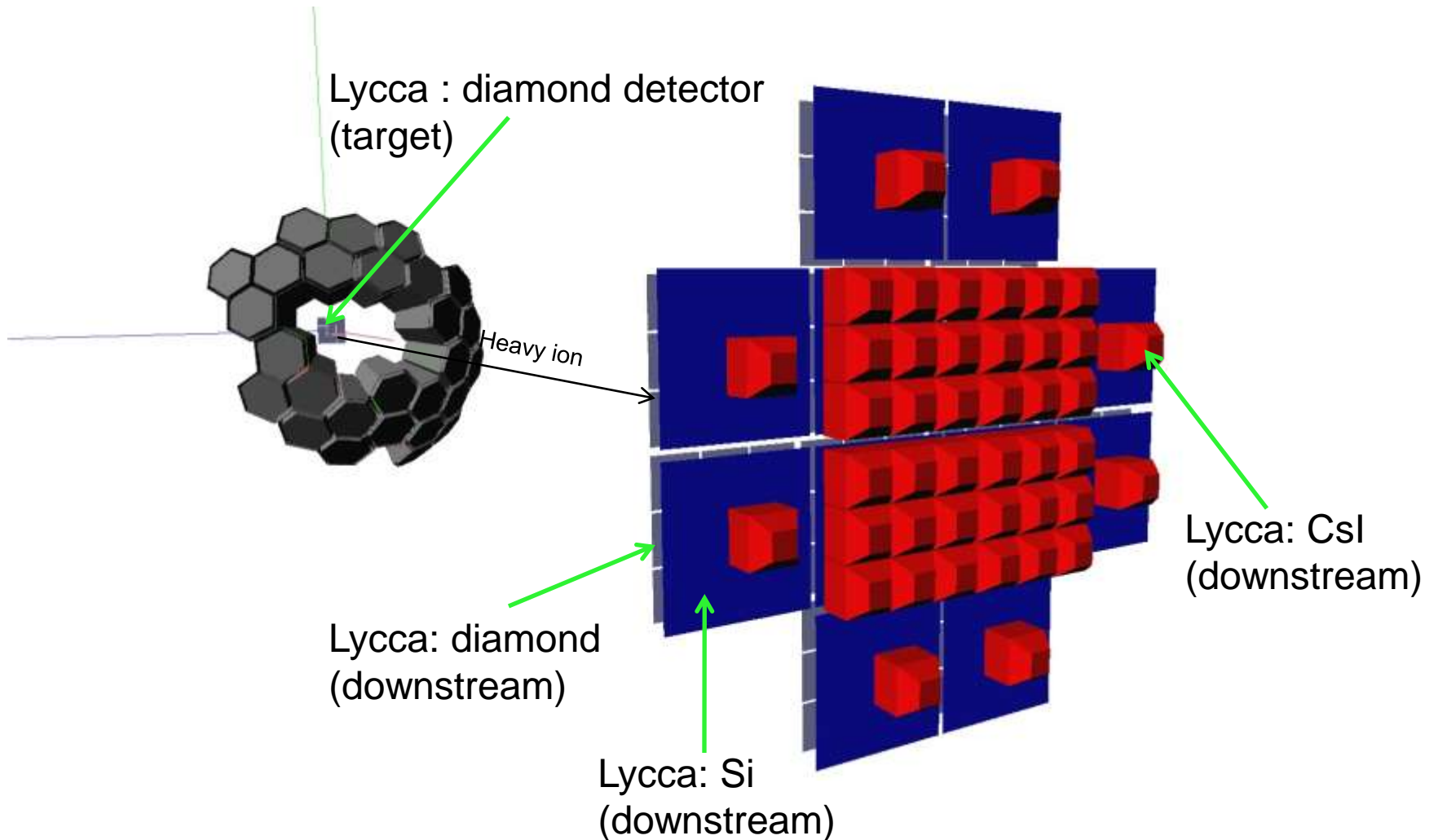


Building block model of Agata code. Blocks can be modified or new blocks can be added.

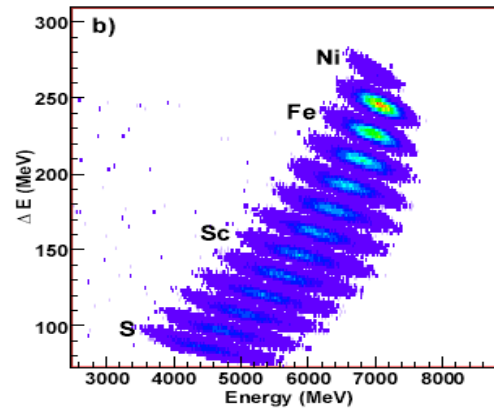
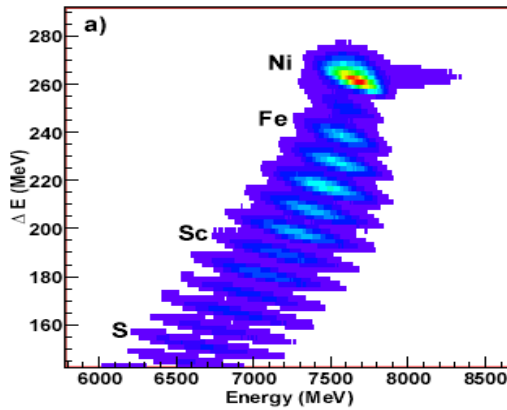
(2) Tracking fragments : adding ancillary LYCCA



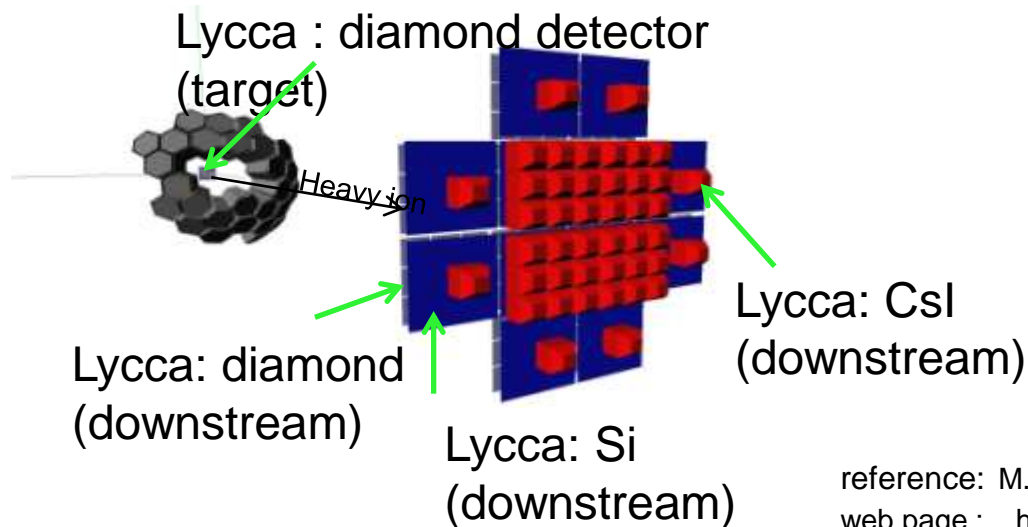
(2) Tracking fragments : LYCCA



(2) Tracking fragments : LYCCA

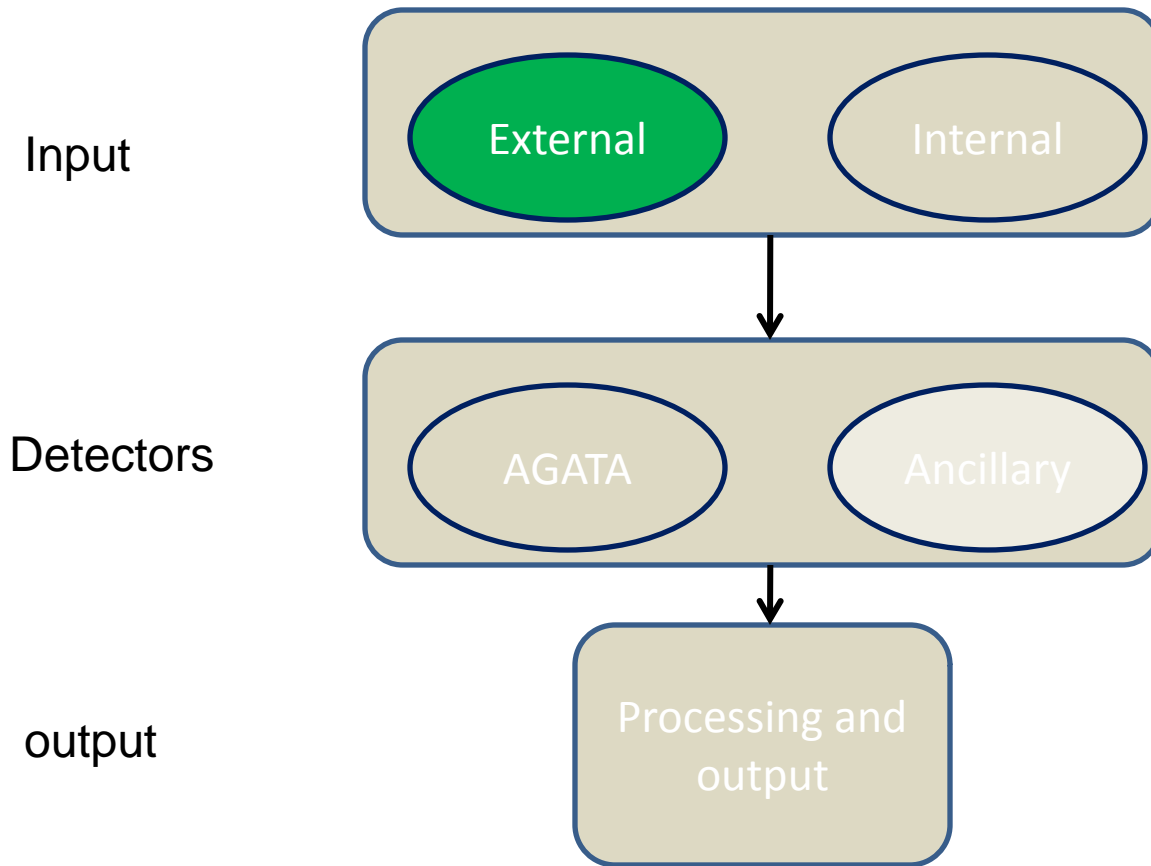


Result of simulation
using CATE and comparison
with simulations.
NIM. A606, 589 (2009)



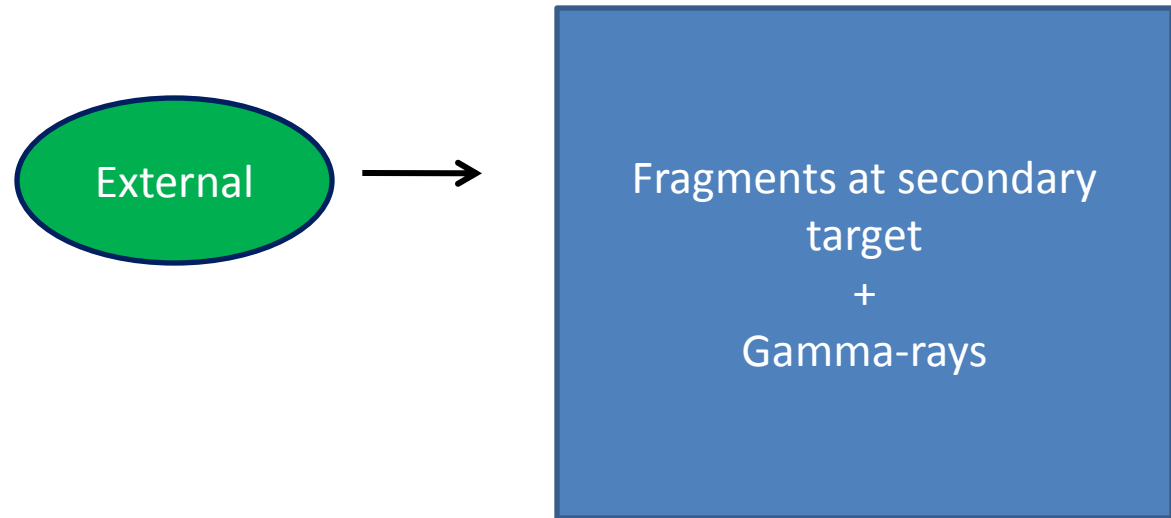
reference: M.J. Taylor *et al.*, NIM. A606, 589 (2009)
web page : <http://wwwnsg.nuclear.lu.se/lycca/>

(3) Event generation :



Building block model of Agata code. Blocks can be modified or new blocks can be added.

(3) Event generation : fragments + gamma-rays



(3) Event generation : fragment

Ion transport code MOCADI has been used for generation of fragments.

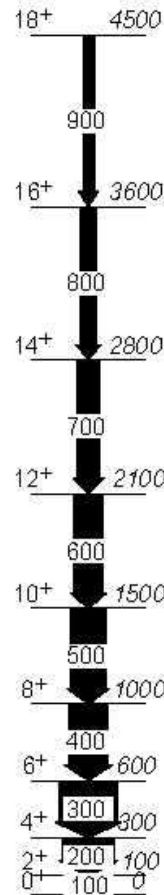
The fragments are generated with a given energy and angular spread at the secondary target just before AGATA and then tracked by LYCCA which measures the energy, angle, and TOF of the fragments.

The package “*lyccasim*” can apply cross-sections to the MOCADI output. Its is available at website <http://wwwnsg.nuclear.lu.se/lycca/>

(3) Event generation : gamma rays

Gammaware :

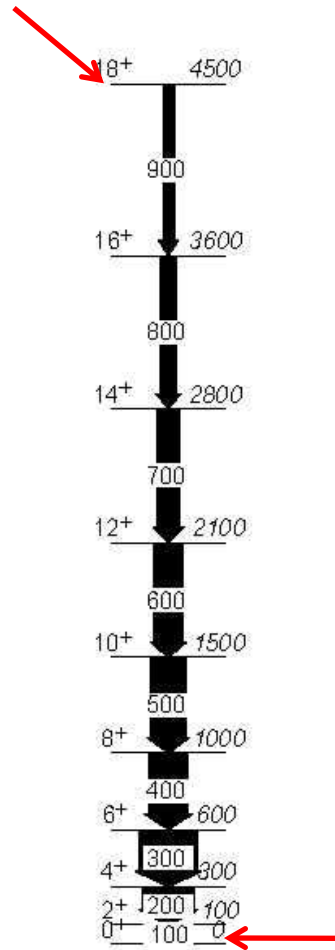
- uses first principle of Monte-Carlo.
- integration is sometimes problematic.
- Can work with complex level schemes. (not at GSI)
- not fast.



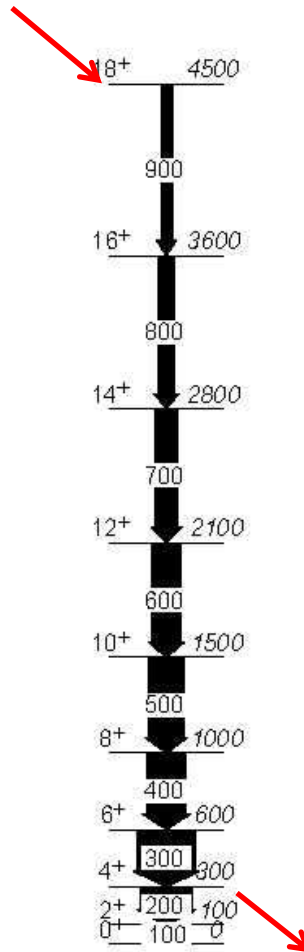
Advance Cascade Generation (ACG):

- possible cascades are generated in advance with production probability
- integration is simple (40 lines of code)
- does not work yet with complex level schemes (GSI)
- faster

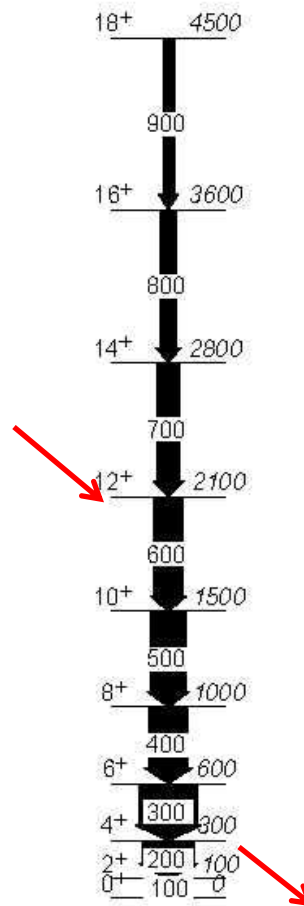
(3) Event generation : gamma rays :



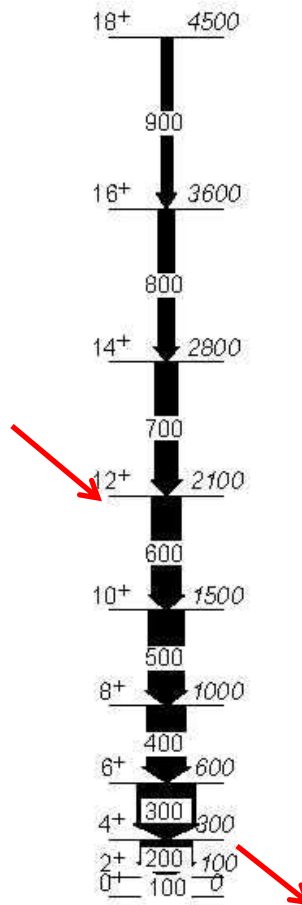
(3) Event generation : gamma rays



(3) Event generation : gamma rays



(3) Event generation : gamma rays : Gammaware

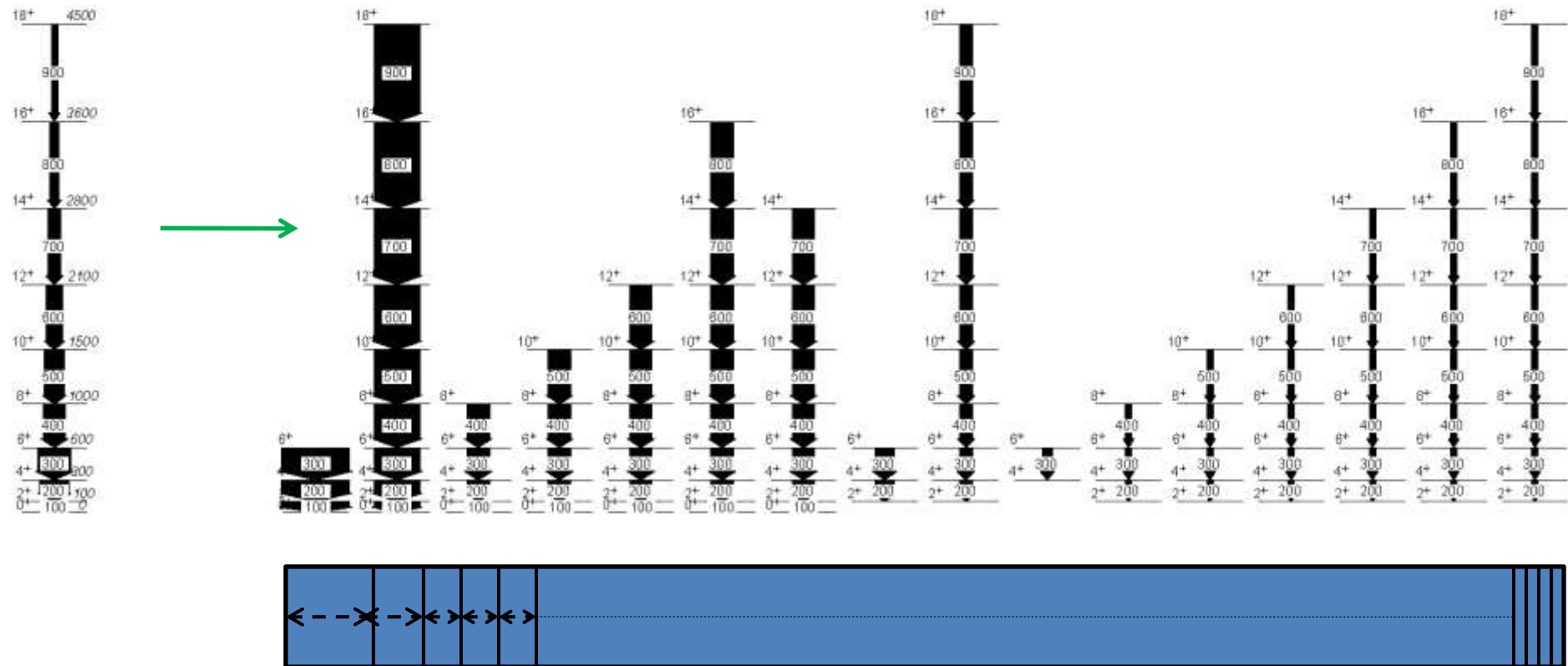


Gammaware : Brute force technique

- (i) First one random will find out where band is fed in.
- (ii) Next a series of random numbers, one for each level will trace if the level decays in or out of the band

So... Large number of random numbers need to be generated for every event.

(3) Event generation : gamma rays : ACG



one random number is required for every event

summary:

- new AGATA geometry from CAD tools has been imported into the AGATA code. (S2 type geometry 10 TC)
- Tracking array LYCCA has been incorporated into the AGATA code.
- Event generation part is also worked out : MOCADI (fragments) along with ACG (gammas) is used to generate events.
- Analysis codes to analyse the output of simulation are being written (UK and GSI working together).

collaborators

This work is being carried out by York and Daresbury together and working very closely with the GSI simulation team led by Cesar Domingo Pardo