AGATA : Organisation of the campaign and technical aspect
From 2008 to 2015, the AGATA collaboration foreseen to construct and exploit a $1\pi$ array with 15 fully equipped Triple Cluster

→ 3 facilities

- LNL/SPES (Legnaro, Italy) 2010-2012 with 5 cluster
- GSI/FAIR (Darmstadt, Germany) 2012-2013 8-10 cluster
- GANIL/SPIRAL2 (Caen, France) 2014-2015 10-15 cluster
2010 → 2011
LNL: 5TC

2012 → GSI/FRS
5TC+5 DC

2014 → GANIL/SPIRAL2
15TC

AGATA D.+PRISMA
Total Eff $^{\text{Nominal}} \sim 2.6\%$

AGATA @ FRS
Total Eff. ($\beta=0.5$) $\sim 10\%$

AGATA + VAMOS
+ (EXOGAM2)

AGATA Eff $^{\text{Nominal}} \sim 8\%$ to
14% in close configuration
AGATA at the FRS focal plane

2012: 1\textsuperscript{st} campaign: 4 weeks of data taking
2013: GSI shut down

- HpGe capsules maintenance
- Software/hardware upgrades
- Topology Manager/Electronic Control Core
- Data Analysis

2014: 2\textsuperscript{nd} campaign from March to May
<table>
<thead>
<tr>
<th>Session</th>
<th>Collaborators</th>
<th>Duration</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>S424:</td>
<td>Korten/Gerl</td>
<td>(4 days, 9/2012)</td>
<td>Performance commissioning (PreSPEC-AGATA- LYCCA)</td>
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<tr>
<td>S429:</td>
<td>Rudolph / Podolyák / Gerl</td>
<td>(6 days, 10/2012)</td>
<td>Quadratic evolution of collectivity around $^{208}$Pb</td>
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<tr>
<td>S430:</td>
<td>Wieland / Gorská</td>
<td>(5/7 days, 10/2012)</td>
<td>Pygmy Dipole Resonance in $^{64}$Fe and the properties of neutron skin</td>
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<tr>
<td>S426:</td>
<td>Pietralla / Rainovski / Gerl</td>
<td>(1/8 days, 2014)</td>
<td>Relativistic M1-Coulomb excitation of $^{85}$Br</td>
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<td>S433:</td>
<td>Gadea / Gorská</td>
<td>(5 days, 10/2012)</td>
<td>Coulomb excitation of the band-terminating $12^+$ yrast trap in $^{52}$Fe</td>
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<tr>
<td>S431:</td>
<td>Boutachkov / Korten</td>
<td>(4 days, 11/2012)</td>
<td>Proton hole states in $^{132}$Sn and $N=82$ shell structure</td>
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<tr>
<td>S428:</td>
<td>Pietri</td>
<td>(4 days, 11/2012)</td>
<td>Shape evolution in neutron-rich Zr</td>
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<tr>
<td>S427:</td>
<td>Sahin / de Angelis</td>
<td>(5 days, 2014)</td>
<td>Study of the Tz=-1 nucleus $^{70}$Kr (isospin symmetry A=70)</td>
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<tr>
<td>S434:</td>
<td>Recchia / Bentley</td>
<td>(5 days, 2014)</td>
<td>Transition rates and mirror energy differences in isobaric multiplets</td>
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</tbody>
</table>
Status of AGATA: the array

GSI Beam time
- 19/20 crystals running
- 21 channel fully instrumented

Summer 2013
- 35 capsules have been produced (3 Sym- 32 Asym)
- 3 under production
- 27 Asym are operational
- 5 to be fixed after failure
- 23 integrated in Cryostat with 4 “spears”

<table>
<thead>
<tr>
<th>ATC1</th>
<th>ATC2</th>
<th>ATC3</th>
<th>ATC4</th>
<th>ATC5</th>
<th>ATC6</th>
<th>ADC1</th>
<th>ADC2</th>
<th>ADC3</th>
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<tr>
<td>A008</td>
<td>A003</td>
<td>A002</td>
<td>A007</td>
<td>A004</td>
<td>A001</td>
<td>-</td>
<td>-</td>
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<td>B003</td>
<td>B010</td>
<td>B007</td>
<td>B002</td>
<td>B004</td>
<td>B008</td>
<td>B012</td>
<td>B011</td>
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<tr>
<td>C003</td>
<td>C005</td>
<td>C001</td>
<td>C007</td>
<td>C009</td>
<td>C006</td>
<td>C010</td>
<td>C008</td>
<td></td>
</tr>
</tbody>
</table>

→ 25 fully equipped electronic chain

Advanced project definition 2013-2015

New electronic to equip the next 20 capsules (1π)
Padova and Orsay designs evaluated by 7 international experts
Padova electronic choosen in Autumn 2012; Commissionning in 2014
The AGATA steering committee agreed on one year prolongation of the campaign at GANIL until end of 2016.

1st workshop on the 18th - 20th of February organized at GANIL, dedicated to the physics of the GANIL Campaign using stable and radioactive beams (SPIRAL1) based on LoI sent in February. See previous talk.

The first campaign will be AGATA + VAMOS std. + EXOGAM2 (+ Plunger)

Proposals using these setups will be submitted to the next PAC meeting (foreseen in June 2014).
Preliminary Planning:

January - March 2014: Beam time at GANIL with the Cyclotrons

March → 7th of May 2014: GSI beam time; Data taking

April–May at GANIL:
Infrastructure and mechanical installation

AGATA is moving to GANIL by end of May

Mechanical installation completed by end of June

FEE-DAQ installation completed by end of July

Autofill installation, detectors installation and cabling completed by end of July

Detector cooling after summer break

Source Test in September—November

December 2014: 1 month of beam at the cyclotrons  In-beam Commissioning

2015 – Physics campaign
Commissioning runs

We proposed to use the reaction $^{238}$U+$^{64}$Ni in DIC

Large counting rate with important background
Less demanding for the fragment identification
Can be directly compared to EXOGAM+VAMOS data
2 set of data: pure spectroscopy followed by a plunger measurement
The AGATA Simulation team

Core team:
Marc Labiche (convener)
Cesar Domingo-Pardo,
Joa Ljungvall,
Johan Nyberg,

Extra support:
- At GANIL: Marcin Palacz (N-Wall-NEDA),
  Grzegorz Jaworski (EXOGAM),
  Bart Bruyneel (FATIMA)
- At GSI: Dan Bloor (LYCCA+AGATA),
  M. Reese (evt generator for plunger),
- At Legnaro: Dino Bazzacco, …

Develop:
- Code general improvement
- Addition of Ancillary detector
- Event generators - Background
- Preliminary analysis codes

Assist:
- Installation
- Running
- Bug fixing

Maintain:
- Compatibility with GEANT4 distributions

Perform simulations:
- Of general interests (Source or Commissioning runs)
- Of experiment proposals, Occasionally

- A tagged version is available on-line with AGATA, EXOGAM, NWALL, FATIMA, DIAMANT detectors and an event generator
  http://npg.dl.ac.uk/svn/agata

- A detailed User Manual is available

- VC with spokesperson organized on the 18th September

- A one day training to prepare the collaboration meeting has been proposed
$^{76}\text{Ge}$

100 $\mu$m

$2^+ \rightarrow 0^+$

$2^+_2 \rightarrow 2^+_1$

200 $\mu$m

1000 $\mu$m

counts

counts

counts

$E$ [keV]

$E$ [keV]

$E$ [keV]

simulated

experim.

feeding:

$\sim 30\%$

$\sim 70\%$

$t_{1/2} = 8$ ps

$t_{1/2} = 18.2$ ps

C. Louchart (exp), C. Michelagnoli (sim)

E. Clément
Simulated configurations

Three configurations

- **AGATA nominal**: source in the focal point of AGATA, 235 mm from the front face of the crystals.
- **AGATA compact**: AGATA moved 100 mm towards the source (along the $z$ axis) compared to the nominal position.
- **AGATA nominal + 8 EXOGAM Clover detectors**.

Three different sizes of AGATA

- **5ATC**: 15 HPGe crystals, LNL (2011).
- **5ATC+5ADC**: 25 HPGe crystals, GSI (2013).
- **15ATC (1π)**: 45 HPGe crystals, GANIL (2015?).

ATC = AGATA Triple Cluster detector
ADC = AGATA Double Cluster detector
Efficiency versus number of HPGe crystals

Source: $^{60}\text{Co}$, tracked energies (mgt), $10^6$ events

- AGATA nominal
- AGATA compact
- AGATA nominal + 8 EXOGAM Clovers

$E_{\gamma}=1332$ keV

Using:
- GEANT4.9.6p01
- The GEANT4 decay of $^{60}\text{Co}$

~30 AGATA crystals at 130 mm to target is equivalent to 30 AGATA crystals at nominal distance + 8 EXOGAM clovers at 90° (source at rest)

J. Ljungvall for the AGATA collaboration
Validation of GEANT4 and tracking codes

Comparison of experimental and simulated peak efficiency at 1332.5 keV and Peak-to-Total (P/T) using a $^{60}$Co source.

8 EXOGAM Clovers with add-back and BGO veto

<table>
<thead>
<tr>
<th>Exp/Sim</th>
<th>Efficiency</th>
<th>P/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>4.8%</td>
<td>50%</td>
</tr>
<tr>
<td>Simulation</td>
<td>4.7%</td>
<td>56%</td>
</tr>
</tbody>
</table>

Data and simulation from LNL. Courtesy of D. Bazzacco

Derived from $^{60}$Co; values given in % at 1332.5 keV

<table>
<thead>
<tr>
<th></th>
<th>Before tracking Efficiency</th>
<th>P/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Spectrum Experimental</td>
<td>1.70</td>
<td>19.5</td>
</tr>
<tr>
<td>Simulated</td>
<td>1.84</td>
<td>22.9</td>
</tr>
<tr>
<td>Sum Spectrum Experimental</td>
<td>2.33</td>
<td>33.0</td>
</tr>
<tr>
<td>Simulated</td>
<td>2.73</td>
<td>44.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>After tracking Efficiency</th>
<th>P/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Spectrum Experimental</td>
<td>1.77</td>
<td>41.5</td>
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<tr>
<td>Simulated</td>
<td>2.41</td>
<td>58.7</td>
</tr>
<tr>
<td>Sum Spectrum Experimental</td>
<td>1.86</td>
<td>44.5</td>
</tr>
<tr>
<td>Simulated</td>
<td>2.56</td>
<td>60.0</td>
</tr>
</tbody>
</table>

GSI source measurement by end of 2013
Sensitivity versus gamma-ray energy

\[
\text{Sensitivity} = \frac{\epsilon_{\text{abs}} \cdot (P/T)}{\text{FWHM}}
\]

\(M_Y=6, \beta = 0.12,\) AGATA nominal, tracked energies (oft), 167000 events

AGATA 1π compact at 1000 keV: sensitivity = 0.018 (mgt).
Comparison of FWHM

\[ M_\gamma = 6, \ \beta = 12\% , \text{AGATA nominal, tracked energies (oft), 167000 events} \]

\[ AGATA\ 1\pi\ \text{compact at 1000 keV: FWHM = 3.29 keV (mgt)} \]
Conclusions

Sensitivity at $\beta = 12\%$ is much larger for AGATA compact than EXOGAM.

Not easy to add AGATA and EXOGAM data for when $\beta > 0$.

8 EXOGAM Clovers at 90$^\circ$ is useful if $\beta$ is less than a few percent and for measurements of angular correlations and linear polarisation.

AGATA compact: potential problems with count rates. Solid angle increase of crystals in backward positions increase by almost 3.
FATIMA included in Agata simulation code

- Agata Simulation with 5ATC + 5ADC at nominal distance (23.5cm)
- Fatima: 8 x 4 clusters (in Exogam frame) 1.5’ x 2’ LaBr3 crystals inner radius = 15.6 cm (arrows)
- Fatima includes lead shield (yellow in picture)
- P/T will be underestimated: magnets not included (give low energy backscattering)

Can be replaced by PARIS clusters

Courtesy of B. Bruyneel
The local AGATA group provides the needed specific items in order to host the AGATA array in the experimental vault, coordinate the installation and the exploitation of the array during the campaign.

The responsibility for the installation and maintenance of these sub-systems is with the AGATA collaboration through the AGATA Teams and the AMB. They will guarantee as well that the full AGATA setup itself will be in operational conditions.

In summary:
- IKP Cologne is responsible for the detectors
- Infrastructure responsibilities are shared between CEA-Saclay, INFN-Milano, GSI and IPHC-Strasbourg
- Mechanic design and construction are shared between IPHC-Strasbourg, STFC-Daresbury and GANIL
- The Front-end Electronics responsibilities are shared between INFN-Padova, INFN-LNL, INFN-Milano, STFC-Daresbury and CSNSM
- DAQ responsibilities are shared between CSNSM, IPNO and GANIL

- The GANIL local team provides the local support on the detectors including the survey of the cooling.
- It acts as a link with the responsible of the AGATA detector working group.
- The GANIL Data Acquisition team provides a 1st level support on data acquisition and associated electronics and acts as a link with the AGATA DAQ working group.

It is the responsibility of GANIL to make these site-dependent items available for the AGATA array, according to the physics requirements and the technical specifications of the various sub-systems.
On-going:
- All detailed studies completed
- The most important calls for tenders have been sent (LN2, water cooling on-going)
- Several purchase orders placed (Optical link, mechanic, preprocessing, electricity, air conditioning)

Budget validated for 2013-2014

15th April 2013: Project review at GANIL
- Organisation
- PBS/WBS
- 2013-2014 Budget
- Ressource plan
- Planning
- Detectors support design done by STFC Daresbury in collaboration with GANIL.
- Design by STFC completed and cross checked by GANIL in December.
- Plans produced by STFC and cross checked by GANIL in July.
- IPHC workshop takes in charge the construction of the detectors support with IN2P3-AP funds **
- GANIL designs the additional platform and takes in charge the integration work, motors, beam line and target chamber. It insures the compatibility for gas-filled, rotating target, plunger, fragile target and standard spectroscopy. Plans validated in July.
- Both at IPHC and GANIL, the construction has started.

I. Burrows (STFC), M. Ozille, P. Gangnant (GANIL), G. Gaudiot (IPHC)
Integration work

- Optical link (GANIL) Delivered
- Water distribution, Electricity (GANIL) Delivery April-May 2014
- Platform (GANIL) Delivery T1-2014
- Detector support (IPHC) Delivery April 2014
- Target Loader+beam pipe (GANIL) Delivery T1-2014
- EXOGAM2
Integration: case of the optical links

220 optical links from GSI will be re-used
GANIL provides 110 additional new wires
This covers 15 TC with 25 capsules using the 1st digitizers and 20 capsules with the new one
with 20% spears

JL. Foucher, L. Ménager, P. Gangnant

Optical links delivered at GANIL last Wednesday
Several meetings have clarified the needs and the topology of the full system.

Transfer of knowledge at GSI
- 1st full week last June
- Beam time in 2014
**DIAMANT:**
* Sufficient numbers of CsI detectors for replacement if needed.
* The VXI system must be replaced
* Spear NUMEXO2 modules for the EXOGAM -NEDA/NWALL arrays cover DIAMANT needs
* No funding could be yet raised for the Digital signal processing (1 year of work)
* New DIAMANT chamber needed. The IPN-Lyon has expressed its wish to do the design.

**NEDA-NWALL:**
* The collaboration plans to build up around 45 detectors of NEDA. Designs are now ready
* Test at the beginning of next year for the first prototype
* Electronics is going in parallel with EXOGAM2 and the production will start in October.
* Full board ready to be tested by the beginning of 2014 in Valencia.
* Coordination with the GALILEO project at LNL end of 2015

During this campaign at LNL, the NWALL array will be equipped with the new electronics.
VAMOS-Gas-filled: (see Ch. Theisen’s talk on Monday)
*The French funding agencies ranked the gas-filled mode project with a B priority
*Less performing but less expensive version (B plan) was evaluated (GANIL / Saclay).
*The next funding request dead-line for 2014 grants is October 23th
*If green light is obtained in 2013, it is not excluded to be ready with the B plan mid-2015.

The timetable for the two campaigns using the NEDA or VAMOS-gas-filled setups will be organized on the basis of the progress on the development of the instruments in 2015

Commissioning beginning of 2016.

To complete the propose physics goals, an additional 1 year of beam time at GANIL might be necessary
The involvement of French laboratories is already substantial, first inside the collaboration and in the preparation of the GANIL campaign.

IPHC laboratory at Strasbourg has significantly contributed to the funding of the mechanics (41 k€) and has taken the responsibility of the construction the support of the detectors.

The electronics control and data flow are designed and supported by the CSNSM and IPNO. The Run Control is written under a CSNSM-IPNO-GANIL collaboration. CSNSM develops the PSA and Tracking algorithms and ensure the maintenance of the pre-processing.

IPNL is developing and providing support for the data format and the AGATA data analysis package.

CSNSM is responsible for the plunger device to be used during the campaign and also provides major contributions in the simulation AGATA working group.

The CEA-Saclay is responsible for the Autofill programming and power supply of the very-front end, ensures daily support and maintenance of the HPGe capsules.

The feedback from the French community to the LoI is the most important:

45% of the LoI are lead by French spokesperson
Pre-processing: BAE019

- Host the preprocessing and pc farm
- Important refurbishment
- Contract signed; Civil work will start in 2013
AGATA Configurations at GANIL

EXOGAM, LaBr3, BaF2 …

2.30mm Distance TC from the target

100mm

without EXOGAM

331–343
Pure efficiency

Resolving power

Which combinaison of detector?
Target loader and beam line

- **GANIL** is in charge of the beam section and target chamber design for most of the experiment.

- **Target loader**: Detailed design on going by GANIL.
  We insure the compatibility for gas-filled, rotating target, plunger, fragile target, and standard spectroscopy.

- **Design of the DIAMANT chamber** under discussion with IPNL.

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**Diagram**

- **DIAMANT Solo**: 2; 3%
- **MUST2**: 1; 1%
- **AGATA Solo**: 1; 1%
- **VAMOS (disp)**: 20; 29%
- **VAMOS (gfm)**: 15; 21%
- **VAMOS (foc)**: 2; 3%
- **NWALL**: 18; 26%
- **DSSD**: 11; 16%