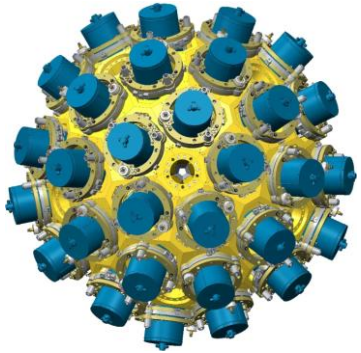
The GRIT-AGATA-VAMOS campaign at GANIL in 2029-2030

Emmanuel Clément
M. Assié, D. Ramos

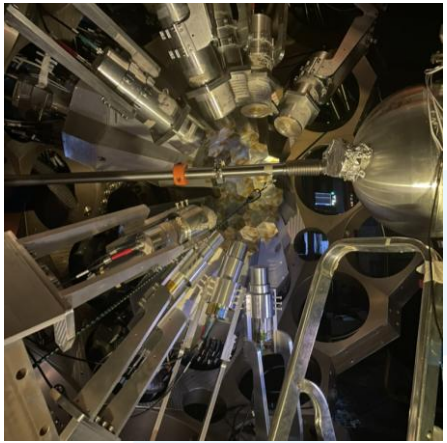
2026 Colloque du GANIL

The AGATA project : THE ultimate spectrometer

www.agata.org

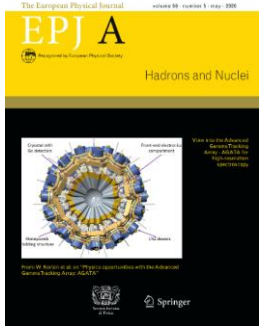


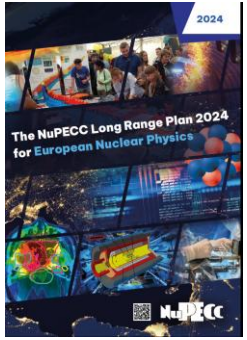
- 180 (60 triple-clusters) crystals
- Mass of Germanium: 362 kg
- Solid Angle: 82 %
- Acquisition rate >50 kHz
- Efficiency: 43% (M_γ=1) , 28% (M_γ=30)
- Angular resolution: ~1º



agata@lnl 2026

S. Akkoyun *et al.*, Nucl. Instrum. Methods Phys. Res., Sect. A 668, 26 (2012).





AGATA White Book : W. Korten et al, Eur. Phys. J. A (2020) 56:137

Topical Issue EPJA (2023) :
https://epja.epj.org/component/toc/?task=topic&id=1878
The European Physical Journal A
AGATA: Advancements in Science and Technology
Editors : Nicolas Alamanos, Maria Jose Garcia Borge, Angela Bracco, Emmanuel Clement, Andres Gadea, Wolfram Korten, Silvia Leoni and John Simpson

The AGATA project : THE ultimate spectrometer

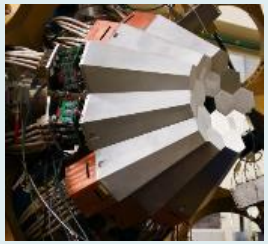
1st AGATA Steering Committee and Management Board (2002)

MoU Phase 1 + Addendum

March 2022

MoU Phase 2

2010-2012
Legnaro, Italy
Intense stable beams
15 detectors



AGATA Demonstrator + PRISMA at LNL

2012-2014
GSI, Germany
Fast fragmentation beams
25 detectors

AGATA at GSI

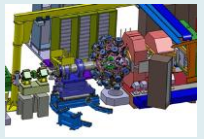
2014- 2021
GANIL, France
ISOL and stable beams
approaching 1π (45)

AGATA at GANIL

2021- 2028
LNL, Italy
Stable beams
EXOTIC beams

LNL 2.0

2028- 2030(+1 ?)
GANIL, France
ISOL beams from
SPIRAL1



GANIL 2.0

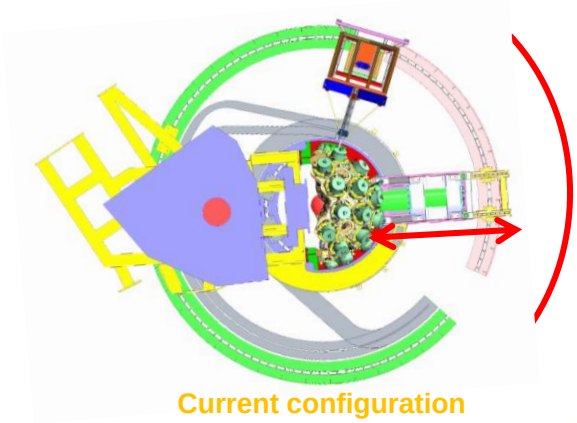
2031 –
LNL, SPES, Italy
FAIR, Germany
ISOLDE, CERN

AGATA @ LNL: 2021 - 2028

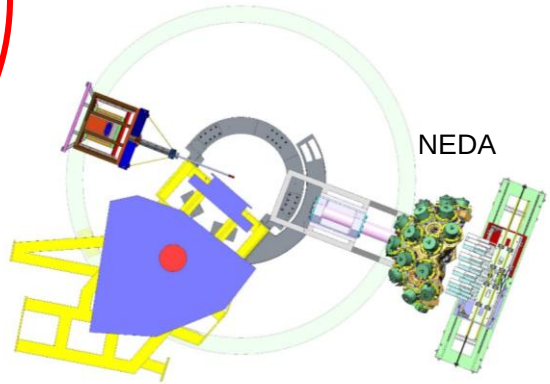
Since April 2022, 58 experiments have been performed at LNL with AGATA

Two configurations:
- 2021 – July 2026: AGATA coupled to PRISMA
- July-2026 – mid-2028: AGATA at “zero-degree”

AGATA coupled with PRISMA



Current configuration



AGATA zero degrees

EXOTIC beams succesfully delivered to AGATA

- Intensities up to 10^5 pps at the AGATA target position
- Three experiments performed using TANDEM primary beams

^{238}U beam delivered on AGATA

- Isospin symmetry
- Nuclear collectivity in N~Z from A=19 to A=92
- Collectivity in light Ba-Te in the vicinity of ^{100}Sn
- High spin states in Z = [60-80]
- Fundamental symmetries in light nuclei
- Spectroscopy for astrophysics

Towards a new campaign at GANIL

AGATA at GANIL 2

Wednesday May 22, 2024, 11:00 AM → 6:30 PM Europe/Paris

Maison d'Hotes (GANIL)

Description The goal of this one day meeting organized at GANIL (GuestHouse) is to construct the physics case of the second AGATA campaign at GANIL by the end of the present decade.

The participar
the physics ob

GRIT AGATA VAMOS 2029-2030 Campaign

Jun 11, 2025, 2:00 PM → Jun 13, 2025, 12:30 PM Europe/Paris

GuestHouse (GANIL)

Description The AGATA European Tracking array will be hosted at the GANIL Facility in 2029 and 2030 with a possible extension in 2031. The primary objective is an experimental campaign using a 2\pi AGATA coupled to GRIT, a 4\pi silicon array for light charged particle spectroscopy, and the high acceptance VAMOS magnetic spectrometer.

The present meeting aims at defining more precisely the physics objectives with the goal of editing a white book to prepare the campaign. The worshop will also include technical aspects with discussion on the detection systems geometries, constrains, front end electronic and softwares. The management of the campaign will be also introduced.

The campaign will benefit of the existing SPIRAL1 beams but developpment of new beams will be encouraged.

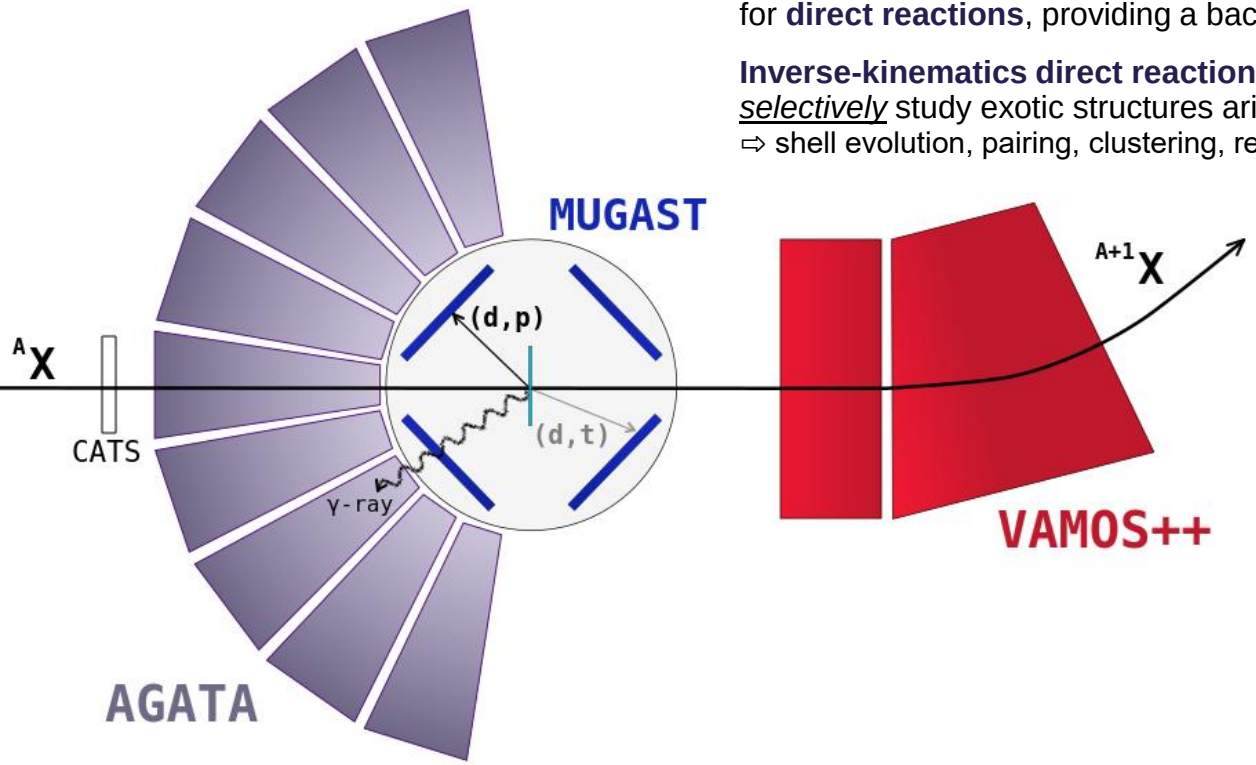
- Exploit high-quality beams available at GANIL: RIBs from SPIRAL1 and high-intensity stable beams from CSS complex
- Exploit state-of-the-art existing instrumentation, such as the VAMOS++ spectrometer
- Collaborate with groups working on particle detectors (MUGAST/GRIT) and active and cryogenic targets (ATRACT)

… for a large number of proposed topics.

The MUGAST-AGATA-VAMOS campaign (2019-2021)

MUGAST-AGATA-VAMOS combination⇨ extremely complete and versatile setup for **direct reactions**, providing a background-free, high-resolution performance.

Inverse-kinematics direct reactions with RIBs from SPIRAL1 allowed to *selectively* study exotic structures arising away from stability.
⇨ shell evolution, pairing, clustering, reactions of interest for nuclear astrophysics…



VAMOS++: (0° configuration)
detection of heavy beam-like recoil.
⇨ rejection of parasitic reactions

MUGAST:
identification, energy, angle meas. of the light ejectile of the reaction.
⇨ E_x reconstruction, β_{recoil} for Doppler correction via 2-body kinematics

AGATA:
high-resolution γ-ray spectroscopy, with tracking algorithms, high efficiency.
⇨ high resolving power, E_x-E_γ corr.

M. Assié *et al*., Nucl. Instrum. Methods Phys. Res. **A 1014** (2021) 165743

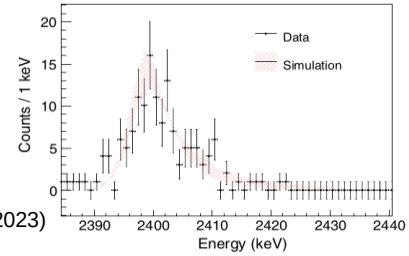
Highlights from MUGAST-AGATA-VAMOS

Testing 3N interactions via lifetime measurements in ^{20}O

Lifetime measurement of 2^+_2 and 3^+_1 states as a sensitive probe of the 3N-force contribution in *ab-initio* models.

^{19}O(*d*,*p*)^{20}O at 8 *A*MeV (SPIRAL1 beam on CD_2+Au)
VAMOS @0° ⇨ beam-like recoil detection
MUGAST ⇨ bw-emitted proton detection ⇨ E_x
AGATA ⇨ high-res. γ-ray spectroscopy of ^{20}O

The entry point constrained and initial velocity distrib. for each state measured ⇨ **Improved lifetime meas.** in the fs scale via DSAM challenges the performance of *ab-initio* models.



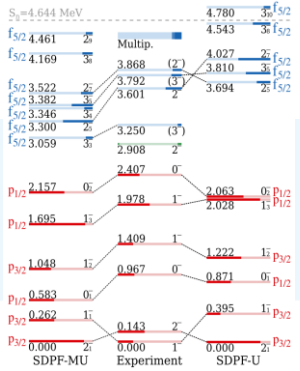
I. Zanon *et al.*, Phys. Rev. Lett. **131**, 262501 (2023)

Direct transfer to ^{46,48}K as a survey of the $\pi(s1/2)$-$\nu(sdpf)$ interaction

Single-neutron transfer on ^{47}K exploits its unusual gs configuration to probe πsd–νfp cross-shell interactions, key to describe nuclear structure around N=28.

New benchmark for $\pi s_{1/2}$–νsdfp interaction in theoretical models over 4 harmonic oscillator shell

p-γ coincidence crucial to resolve doublets.
Nine new bound states identified and spectroscopic factors deduced.



C. J. Paxman *et al.*, Phys. Rev. Lett. **134**, 162504 (2025)
C. J. Paxman et al. Phys. Rev. C - Accepted 14 July, 2026

Additional analysis by C. J Paxman (Talk on Wednesday)

Probing proton occupancies and charge depletion in ^{46}Ar via the (^{3}He,d) reaction

Daniele Brugnara [ORCIDa,b], Andrea Gottardo [ORCIDb], Marlene Assiè[c], Carlo Barbieri [ORCIDd,e], Daniele Mengoni [ORCIDa,f], Didier Beaumel[c], Stefano Brolli [ORCIDd,e], Simone Bottoni [ORCIDd,e], Emmanuel Clement[g], Gianluca Colò [ORCIDd,e],

Using a ^{3}He Cryogenic Target – submitted to PLB

By-product l analysis by S. Pigliapoco (Talk on Wednesday)

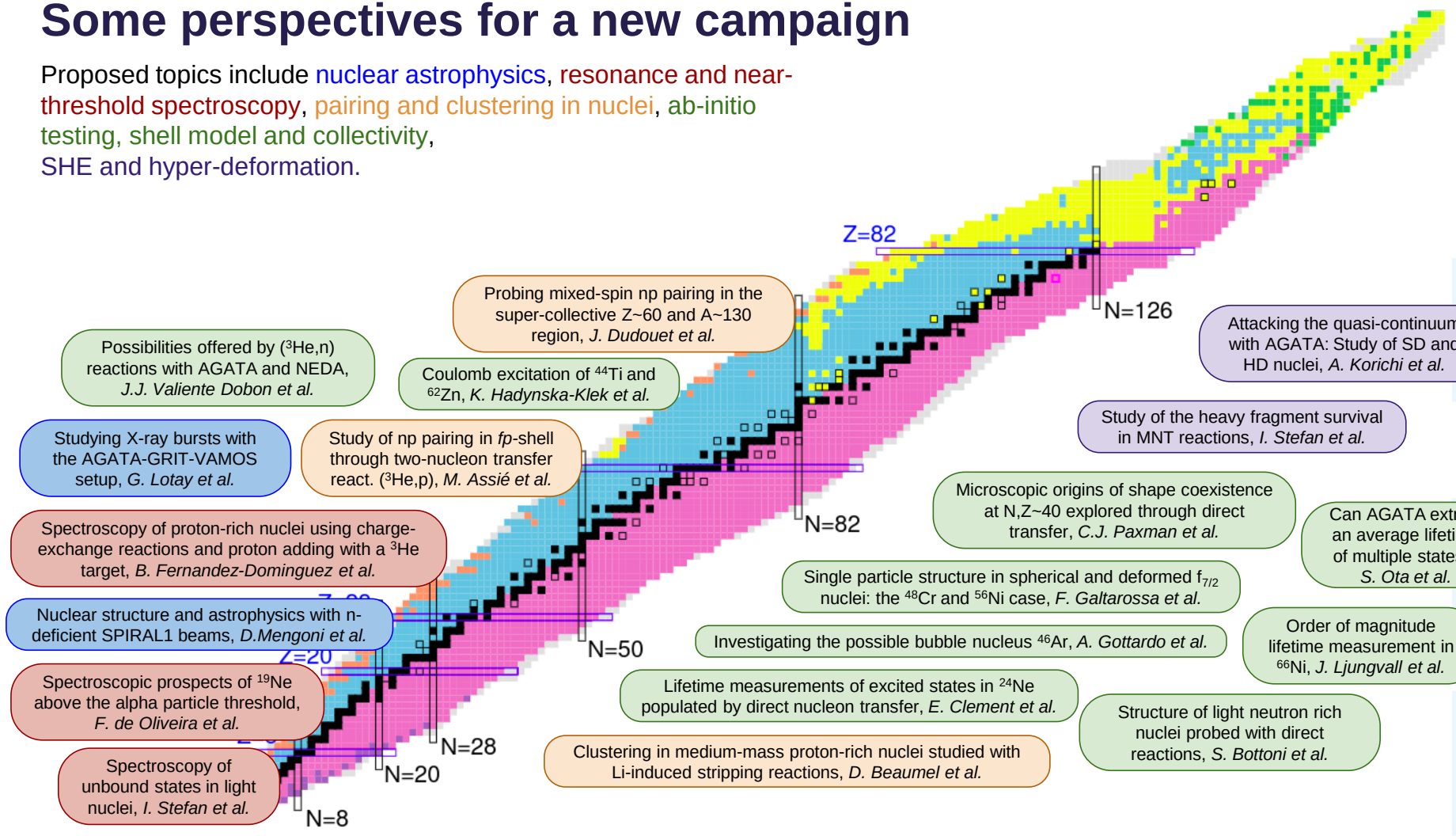
Measurement of the ^{15}O(α,γ)^{19}Ne X-ray burst trigger reaction through first α particle-transfer reaction onto an exotic ion beam

J.S. Rojo,[1,2] N. de Séréville,[3] P. Adsley,[4,5] C.Aa. Diget,[1] A. M. Laird,[1] M. Assié,[3] E. Clément,[6] A. Lemasson,[6] D. Ramos,[6] F. Galtarossa,[7] A. Matta,[8] V. Girard-Alcindor,[6,3] J. José,[9] M. L. Avila,[10] D. Barrientos,[11] B. Bastin,[6] D. Beaumel,[3] M. A. Bentley,[1] G. Benzoni,[12] Y. Blumenfeld,[3] A. Bracco,[12,13] S. Brambilla,[12] W. Catford,[14] B. Cederwall,[15] S. Chen,[1] M. Ciemala,[16] F. Delaunay,[8] F. Didierjean,[17] G. Duchêne,[17] J. Dudouet,[17] J. Eberth,[18] F. Flavigny,[8] C. Fougères,[6] G. de France,[6] S. Franchoo,[3] A. Gadea,[19] J. Gibelin,[8] A. Gillibert,[20] V. González,[21] A. Gottardo,[7] F. Hammache,[3] L. J. Harkness,[22] H. Hess,[18] A. Jungclaus,[23] N. Jovancevic,[3] M. Labiche,[24] L. Lalanne,[3] S. Leblond,[6] S. M. Lenzi,[25,26] S. Leoni,[12,13] J. Ljungvall,[3] A. Lohstroh,[27] A. Lopez-Martens,[3] A. Maj,[16] R. Menegazzo,[25] D. Mengoni,[26,25] B. Million,[12] D. R. Napoli,[7] J. Nyberg,[28] F. de Oliveira-Santos,[6] Zs. Podolyak,[14] A. Pullia,[12,13] B. Quintana,[29] D. Ralet,[6] C. Reardon,[1] F. Recchia,[25,26] P. Reiter,[18] K. Rezynkina,[7,17] M. D. Salsac,[20] E. Sanchis,[21] M. Şenyiğit,[30] M. Siciliano,[7,20,31] J. Simpson,[24] D. Sohler,[32] I. Stefan,[3] O. Stezowski,[33] J. J. Valiente-Dobón,[19,7] D. Verney,[3] and M. Zielińska[20]

Using α-transfer – submitted to PRL

Some perspectives for a new campaign

Proposed topics include nuclear astrophysics, resonance and near-threshold spectroscopy, pairing and clustering in nuclei, ab-initio testing, shell model and collectivity, SHE and hyper-deformation.



The VAMOS-GRIT-AGATA campaign (2029-2030)

2024 - Approval of a zero-degree campaign of VAMOS-GRIT-AGATA using SPIRAL1 beams for 2029-2030.
Formal decision on location after 2030 to be taken in 2027 by the AGATA Steering Committee.

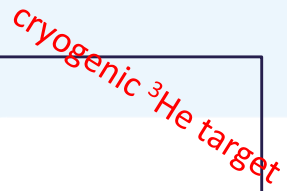
Commitment of the GANIL management to allocate:
- ➢ at least 50% of CYCLO beam time (subject to PAC approval and rules for non-commercial users)
  ⇨ ~100 UT per year, i.e. ~2500 hours of beam on target.

SPIRAL1 beams:

- Availability of already operational gas beams (He, N, O, F, Ne, Ar, Kr) up to ~20*A*MeV covers most of the LoI
- Improving the intensity of most of them opens opportunities
- **Open discussion on the required beam R&D:**
  ^{55}Co, ^{57}Ni, ^{44}Ti technically feasible, the latter possibly in batch mode.

VAMOS-GRIT-AGATA combined setup:

- **AGATA:**
  2π configuration at 23cm from target.
  Provides high resolution and peak-to-total ratio, high resolving power.
  High efficiency (13% with tracking for 1.3MeV-^{60}Co with P/T=42%)
- **GRIT Phase0:**
  BW configuration, compact assembly ensuring minimal gaps, γ-transparency.
  High granularity for good Doppler correction via 2-body kinematics and for an improved E_x resolution. PSA implementation for particle identification.
- **VAMOS++:**
  Full background rejection with heavy recoil detection.
  Different focal plane configurations optimized for light/heavy ion detection.



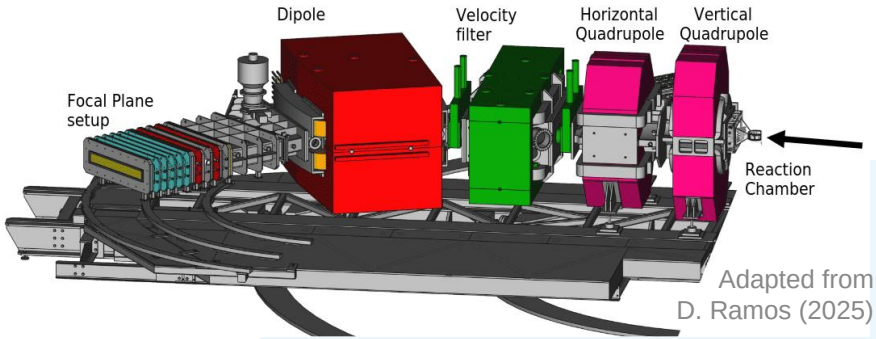
The setup: VAMOS++ spectrometer

Resp. : D. Ramos

A. Lemasson *et al.*, NIM A **1054** (2023) 168407
M. Rejmund *et al.*, NIM A **1076** (2025) 170445

The large-acceptance magnetic spectrometer **VAMOS++** provides reaction-product detection and identification.

Multiple technical and software developments since 2021 improved the performance opening a range of possibilities.



Adapted from D. Ramos (2025)

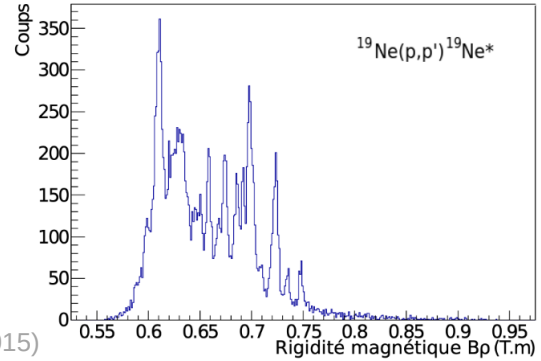
Different experiments may have different requirements,

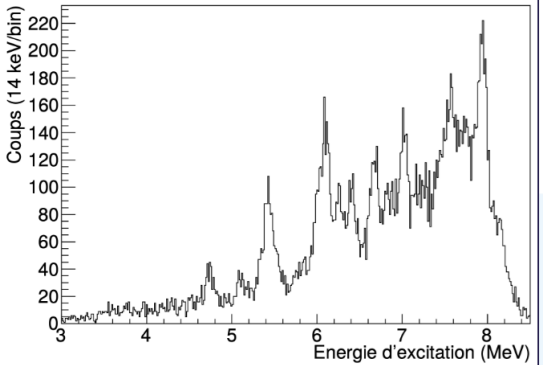
a. Heavy recoil **detection** (ToF coincidence) for spurious reaction rejection ⇨ higher intensities reached.
b. Heavy fragment **identification**, e.g. for unbound states decaying through different open channels.
   FP configuration to be properly adapted to the (Z,A).
c. Light recoil detection in inverse-kinematics inelastic scattering reactions, e.g. *(p,p').*

Further details can be found here and here.

inelastic scattering experiment ^{19}Ne(*p,p'*)^{19}Ne*, followed by *p*, *α* or *γ* decay.

VAMOS detects the *p'*, while the *p*, *α* from the decay were detected by a Si telescope.
The excitation energy of ^{19}Ne has been reconstructed from the magnetic rigidity in VAMOS.





F. Boulay, PhD thesis (2015)

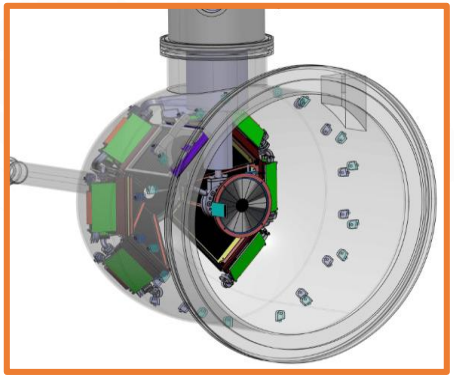
Last AGATA Week

https://indico.in2p3.fr/event/37746/

121 participants discussing experimental results from the current LNL campaign, R&D on detectors and software's, status of the project and prospectives.

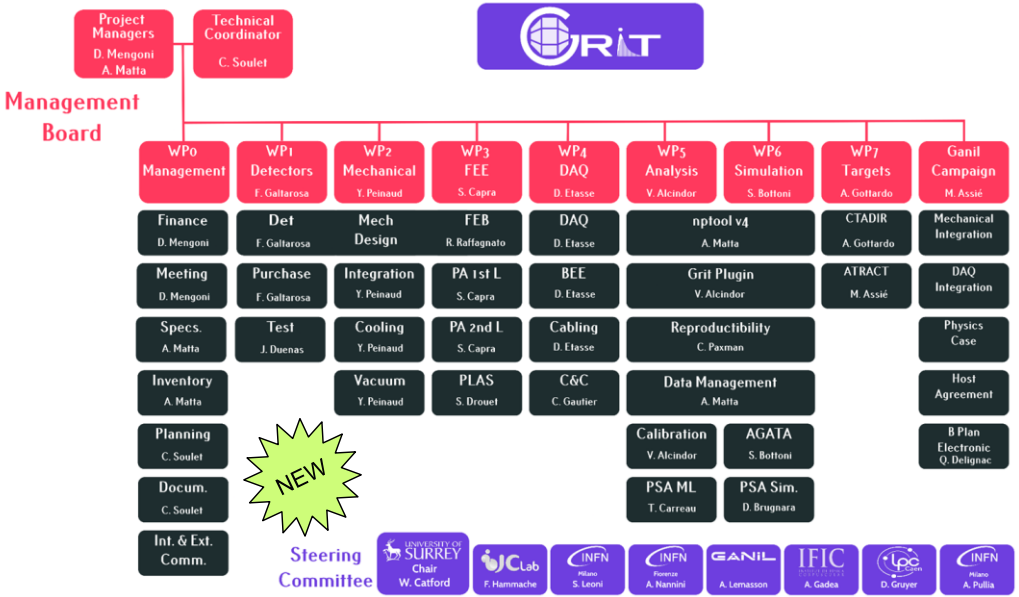
Steering comittee chair : M. Zielinska (CEA)
Collaboration Council chair : J. J. Valiente-Dobon (IFIC)
Project Manager : E.C

Campaign Spoke : S. Bottoni (Uni-Milano, INFN)
Local PM : C. Ciampi



2026-2031 : MoU II : A. Matta & D. Mengoni

- New organisation, mirror of AGATA
- France, Italy, UK, Spain, Croatia
- Community Council (GCC) coming up
  - Grit Spokesperson to be elected
  - Scientific Animation



Funding:

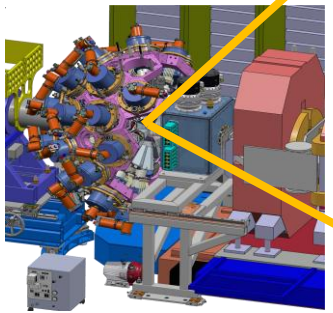
- IN2P3 & INFN through MoU
- Grants: LPC, GANIL, IFIC, STFC, CROATIA

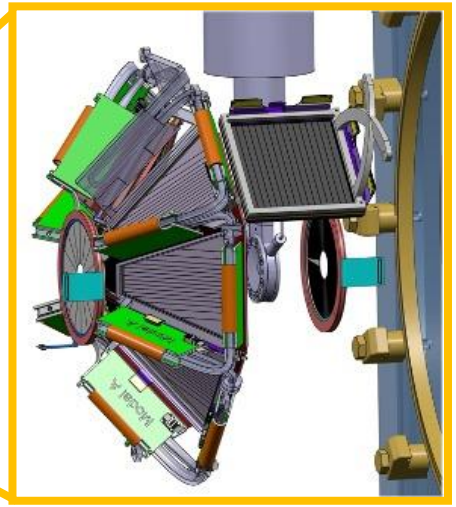
Physics Programs:

- Structure&Astro w/ **transfer reaction**
- GANIL (2028-2031) : Spiral 1+
- SPES (2032-20xx) : Fission Frag.

Courtesy A. Matta (LPC)

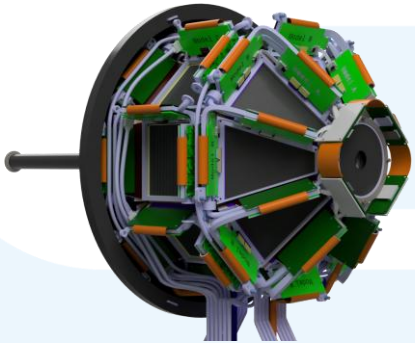
GRIT_Phase0





- Backward detection:
  - 6 two-stage trapezoidal telescopes
  - 1 single-stage annular detector
- 90 degrees (for normalization purpose):
  - 1 two-stage square detector
- Forward detection:
  - 1 two/single-stage annular detector

GRANULARITY	RESOLUTION	IDENTIFICATION	TRANSPARENCY
7056	E&T	nTD	4%
Individuals Stripes	**~40 keV** energy resolution	Silicon wafer for **PSA** enable identification	**Abs. 1 MeV**
26 telescopes of 2 Layers	**~500ps** TOF resolution	Integrated Digital Elec. with **ASICs**	AGATA integration
4Pi det. with Trapezoide, Square and Annular		Add. **E-TOF & E-DE** PID	



Courtesy A. Matta (LPC)

Construction Timeline

Delivering Phase 0 at GANIL in 2028

2024

BEE design
Cables design
ASICs design
Software

2025

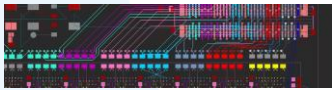
Square det.
BEE design
ASICs design

2026

BEE prod.
Cables
Annular det.

2027

ASICs
FEE
Mechanics



2028

Phase 0 installation at GANIL

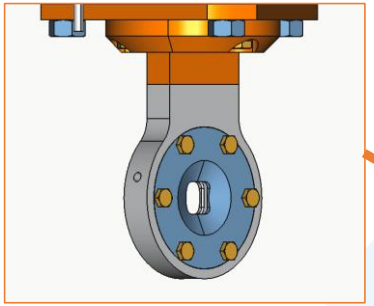
Courtesy A. Matta (LPC)

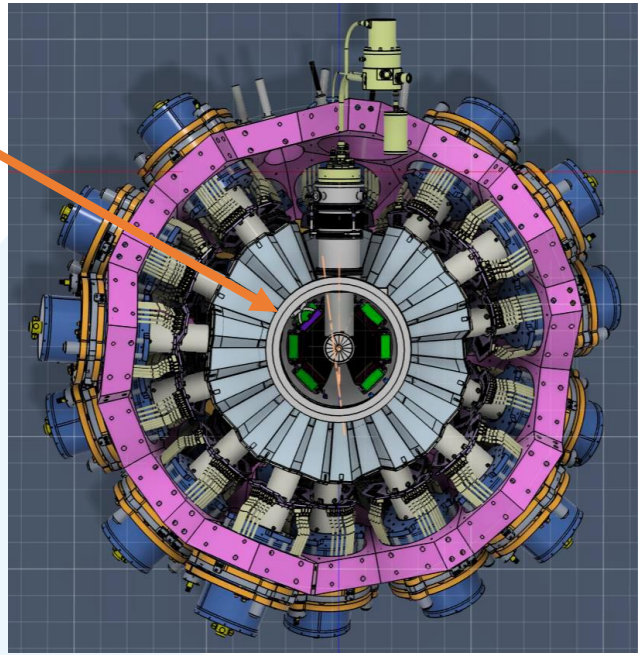
atract.in2p3.fr

ATRACT : a new cryogenic ^{3}He target

- Based on cryocooler
- **R&D on new material for target windows:**
- De-icing protocol
- **Integration into AGATA-GRIT-VAMOS**

M. Assié, M. Pierens, *S. Blivet,* ***M. Le Bihan,***
A. Barrière (IJCLAB) talk last Monday





Courtesy of M. Assié and A. Barrière

<u>The availability of a new ^{3}He target is highly strategic for the campaign</u>

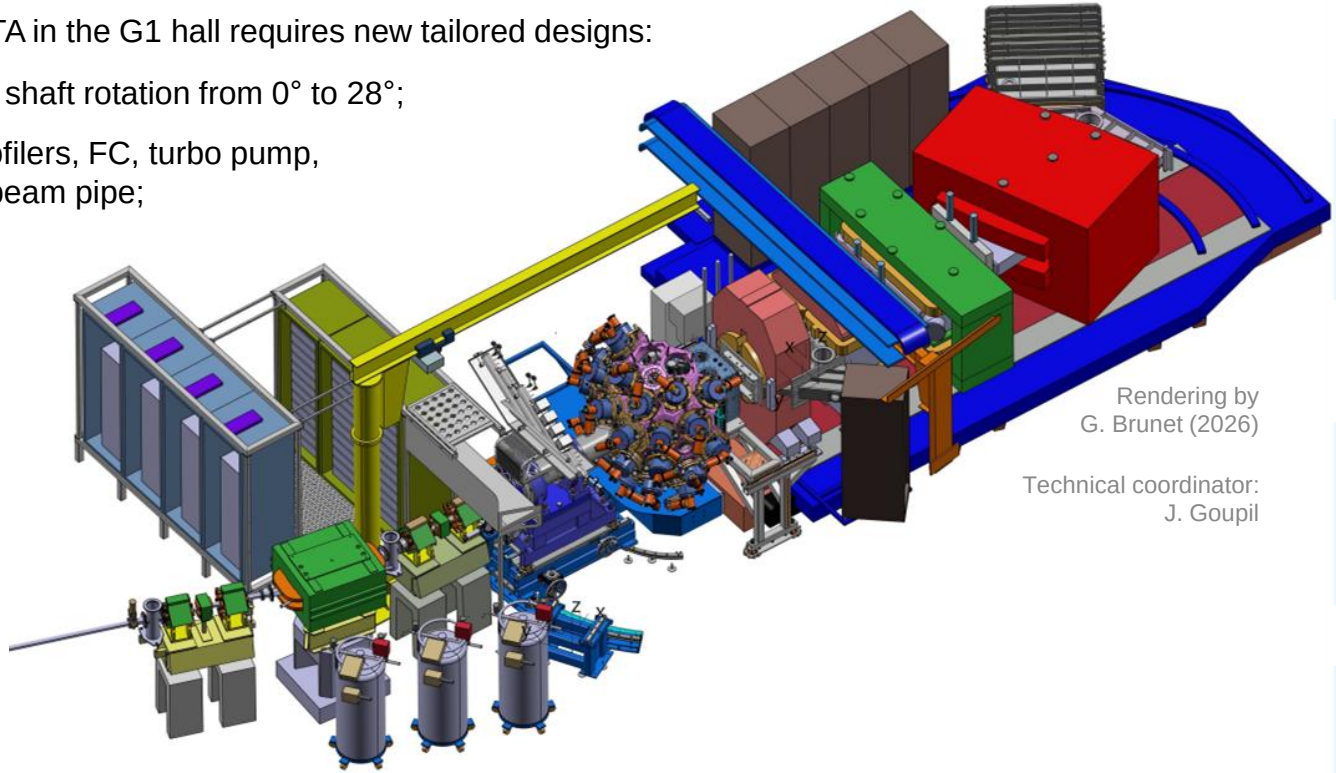
In a limited capability for SPIRAL1 R&D, ^{3}He target offers a huge potential with existing beams (basically all the physics of the neutron shells studied by (d,p) can be revisited by studying the proton shells)

→See talk by Antoine on Monday evening

VAMOS-GRIT-AGATA: integration

The integration of VAMOS-GRIT-AGATA in the G1 hall requires new tailored designs:

- Installation of two rails for AGATA shaft rotation from 0° to 28°;
- New diagnostic box (including profilers, FC, turbo pump, flange for tracking detector) and beam pipe;
- Cable management and LN_2 manifold structure;
- Redesigned rack platform placement in G1;
- Integration of cryogenic ^{3}He target;



Rendering by
G. Brunet (2026)

Technical coordinator:
J. Goupil

The campaign: Host Laboratory Agreement

Draft of the Host Laboratory Agreement for the VAMOS-GRIT-AGATA campaign at GANIL.

- Definition of the budget sharing among collaborations, including the allocation of the GANIL Hosting Lab installation funds for both AGATA and GRIT, as well as of the respective operational costs
- Beam time:
- Common VAMOS-GRIT-AGATA Data Management Plan drafted

⇨ Draft of the Host Agreement currently discussed, Common DMP available on ATRIUM

ATRIUM-1036258

Roadmap to the 2029 campaign

An overall timeline until the start of the campaign:

- Mechanical designs are complete and are being validated. Manufacturing by the end of 2027.
- Last G1 experiments in spring 2028, followed by installation starting in June-July 2028.
- Commissioning of the setup is planned for late 2028 / early 2029
- The campaign is expected to start in 2029

Pre-PAC meeting to be organized in 2027 after the GANIL SC for a more detailed preparation of the campaign.
Local teams are available for further information and discussions on possible technical adjustments to fulfill the experimental requirements.

VGA implementation	**2026**				**2027**				**2028**				**2029**				…
	1 trim.	2 trim.	3 trim.	4 trim.	1 trim.	2 trim.	3 trim.	4 trim.	1 trim.	2 trim.	3 trim.	4 trim.	1 trim.	2 trim.	3 trim.	4 trim.	
Design + manufacture																	
Preparation																	
Installation																	
Exploitation																	


GANIL