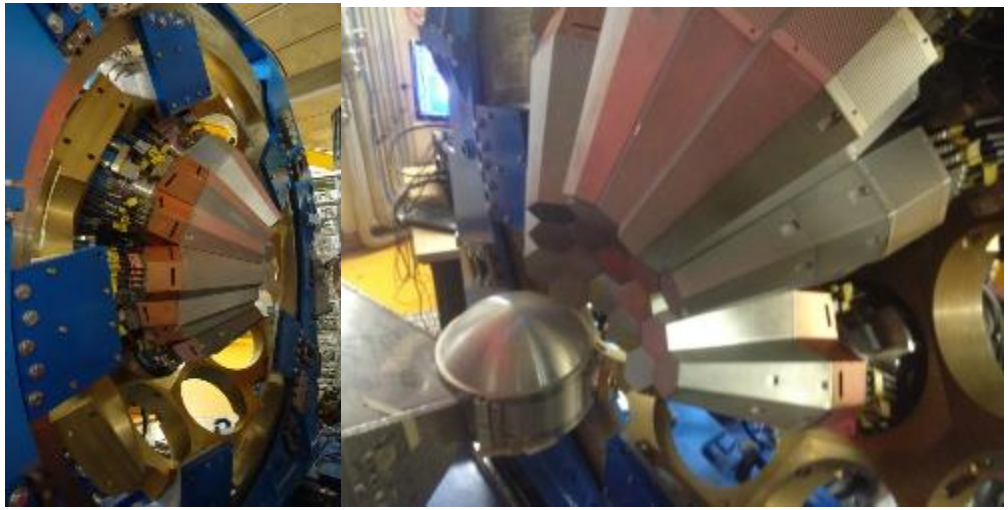
Introduction to the AGATA Week: Status of the AGATA Project

Andres Gadea (IFIC-CSIC, Spain)
on behalf the AGATA Management Board and Teams



21st AGATA Week, February-March, 2021

IFIC INSTITUT DE FÍSICA CORPUSCULAR

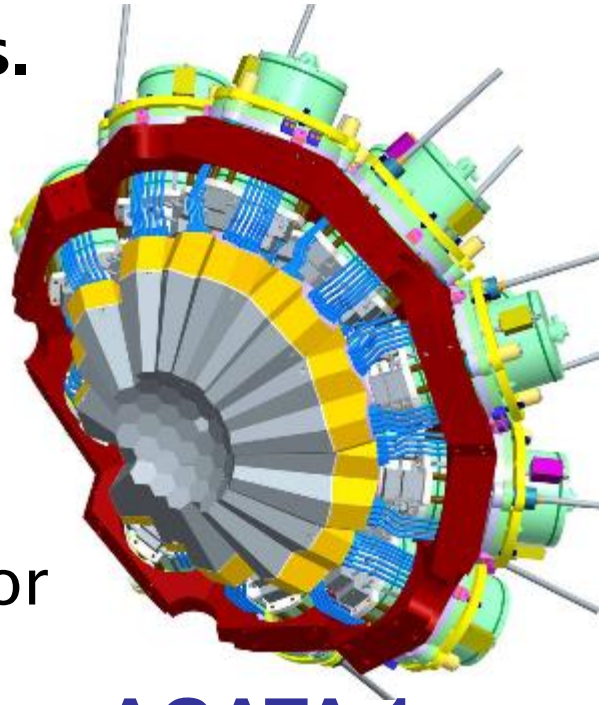
CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

AGATA ADVANCED GAMMA TRACKING ARRAY

AGATA from Phase 1 to Phase 2

2009-2020(2021) → (2021)-2030

- **Phase 1 of AGATA (>1π)→ 60 crystals. MoU Extended for 2021, ~95 % achieved**
- **57 crystal set-up at LNL in 2022**
- **AGATA Phase 2 (3π / 4π): Project Definition Completed and presented to the International Review Panel.**
- Improving mobility and compatibility for the host labs: FAIR, GANIL/SPIRAL, LNL/SPES, HIE-ISOLDE, JYFL,



AGATA 1π

- Sustainable growth of the AGATA subsystems from 60 to 180 Detectors.
- Achieving full Tracking Performance and optimizing the Position sensitivity.
- Improving performance of subsystems FEBEE, DAQ, etc…

AGATA Management Board for Phase 1

A. Gadea (Project Manager)

A. Boston, B. Million, A. Korichi, F. Recchia, H.Hess, J.Simpson (ASC) and S.Leoni (ACC).
J. Gerl (LCM-GSI), E. Clement (LCM-GANIL), J.J.Valiente-Dobón (LCM-LNL)

AMB Chairman
Project Manager
A.Gadea

Resource
Manager
B.Million

AGATA Working Groups	AGATA Teams			
Detector Module H.Hess	Detector & Cryostat (tbd)	Detector CAT &Testing H. Boston	R & D on gamma Detectors & Applications	
Front-end Electronics A. Gadea	Pre-Amplifier Digitizer A. Pullia	Global Trigger & Synchronization M. Bellato	Pre-processing I. Lazarus	
Data Processing A.Korichi	Hard/Software DAQ Support G. Lalaire	Slow Control & FEE Monitoring E. Legay	Data Analysis & Tracking O. Stezowski A. Lopez-Martens	Data distribution and re-processing F.Crespi J.Dudouet
PSA & Characterization A.Boston	PSA Algorithm Development L. J. Harkness	Detector Characterisation J.Simpson		
Infrastructure. Comp. Det. B.Million	Detector array Infrastructure R.Menegazzo	Complementary Detectors A.Goasduff	Mechanical Infrastructure R.Smith	
Performance and Simulation F.Recchia	AGATA Performance J.Ljungvall C.Michelagnoli	AGATA Commissioning P.R. John	AGATA Physics & exp. Simulation M. Labiche	
Technical Coordinator Engineering Advi.	Compatibility EMC, Interfacing	Specification control	Quality Control	Documentation

Local Campaign Managers (LCM)

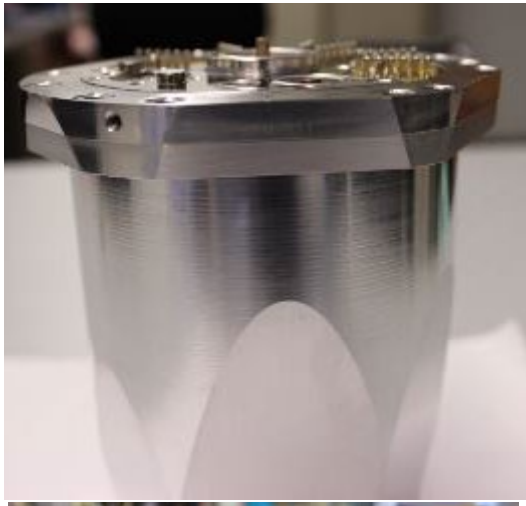
INFN-LNL	GSI	GANIL-SPIRAL2
Legnaro	Darmstadt	Caen
J.J.Valiente-Dobón	J.Gerl	E.Clement

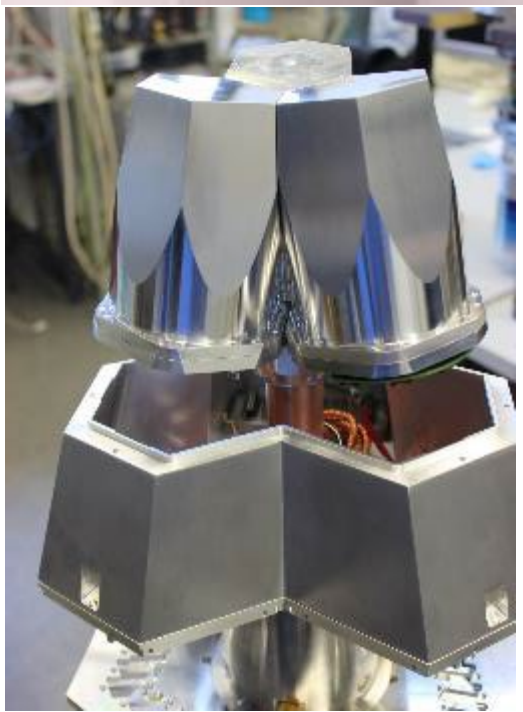
Detector Module Developments

- New encapsulation technique with reusable capsule (IKP-Cologne and Mirion Technologies)
  - Already in use at the end of Phase 1
  - Fully compatible with previous ones
  - Faster and safer mounting of crystal in capsule
  - Reduced repair cost (~ 40%)

- Improving the reliability of the cryostats:
  - New feedthroughs: gold-plated contact pins on aluminium-oxide ceramic
  - Improved vacuum getter material in a flexible housing on the cooling finger
  - Long term development: Digital Pre-amplifier with cool ASIC

- Annealing now performed at Mirion: capsule vacuum pumped, improved performance recovery
- Detector contact & passivation technologies being developed at INFN-LNL and Uni. Padova





IKP-Uni.Köln, IRFU-Saclay, Uni.Liverpool, IPHC, INFN-LNL, Uni. Padova

AGATA Detectors & Cryostats

50 AGATA capsules procured
47 available

A001 – A016 Delivered,

B001 – B017 Delivered, B005, B010 on repairing

C001 – C017 Delivered, C001 repairing

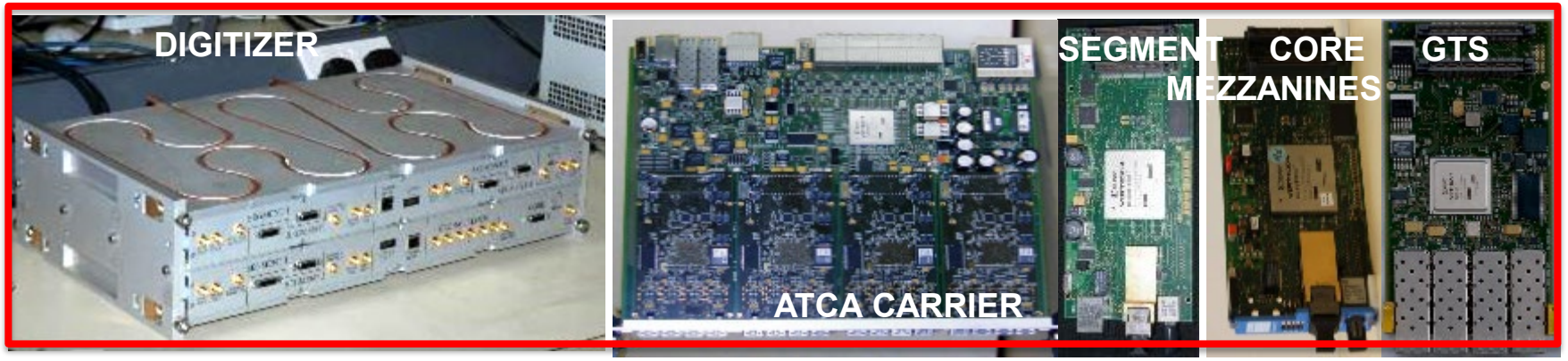
Repair Schedule: C001 February 2021, B010 and B005 April 2021

- **39 capsules setup for the 2021 experimental campaign**
- **13 Triple Clusters**
- **Maintenance performed by IKP, IRFU, GANIL and IPHC**
- **CAT performed at IKP, Uni.Liverpool, IRFU and IPHC**
- **Completed maintenance of ATC1,3,4 and 5. ATC7 under maintenance and ATC15 newly delivered**

- **4 New Capsules Ordered by U.K.**
- **3 New Capsules Ordered by Hungary**
- **2 Triple Cryostat ordered by Italy & Hungary.**

Note:1 ATC from DEGAS: A501 repairing Scheduled for February 2021

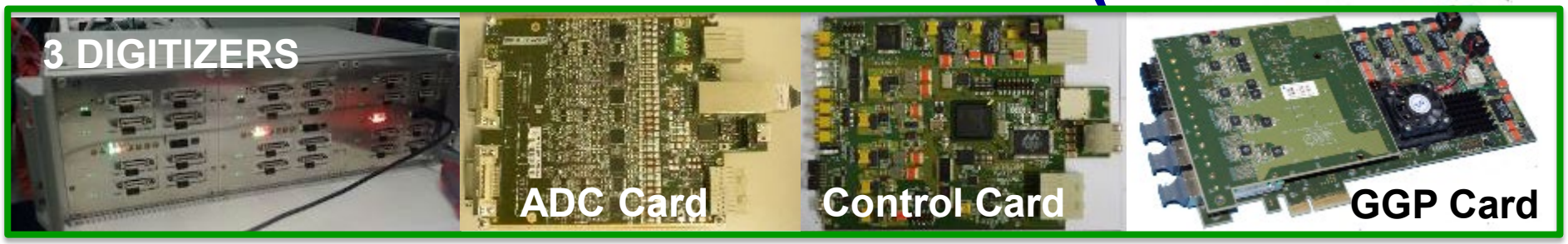
AGATA Electronics Phase 0 (2005-2011)



20 channels available and working: obsolescence

Transceiver Synchronization issues in 9 Core DIGITIZER cards

AGATA Electronics Phase 1 (2011-2017)



1st production batch (14) only 9 GGP (4 GALILEO) & 13 Digitizers available

2nd production batch (14) 13 GGP and 14 Digitizers (3 GGP with issues)

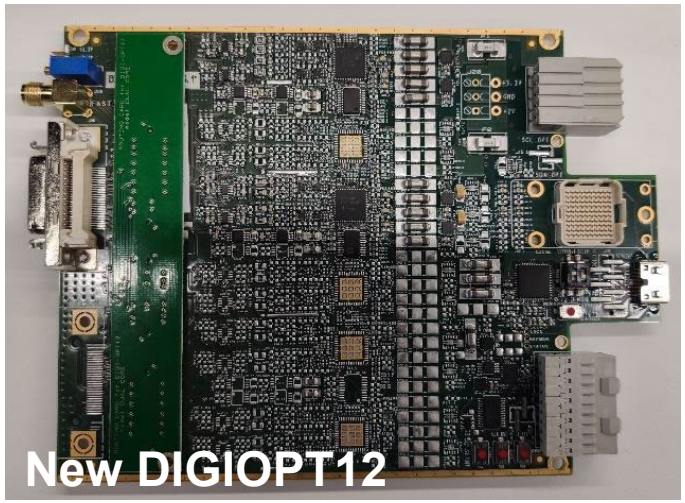
GGP Motherboard production for maintenance (11) 3 GGP sent to GANIL.

TOTAL 19 Channels working + 3 to be installed

IPHC Strasbourg Uni.Liverpool STFC Daresbury IPNO, CSNSM-Orsay INFN-Padova

INFN-Milano INFN-Padova INFN-LNL IFIC-Valencia ETSE-Uni-Valencia

Phase 2 Electronics



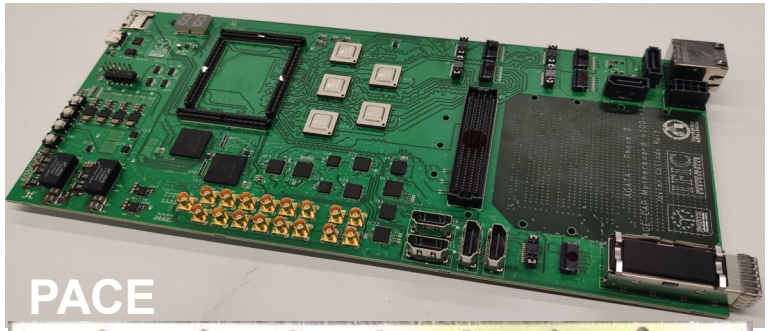
Digitizer Board Upgraded for Phase 2

- New analogue signal conditioning: lower noise larger bandwidth
- Dealing with DNL using Sliding Scale corrections
- Copper connection to the neighbouring pre-processing board
- 33 Segment and 11 Core boards already delivered

Designed by INFN-Milano. Produced by EOS S.r.l.

Pre-Processing Board for Phase 2

- Data pre-processing and Ethernet boards designed with SoM commercial Mezzanines
- ADC input using the time-multiplexing concept
- Ethernet: read-out, monitoring & control
- Hardware being validated
- Firmware under development (mostly completed)



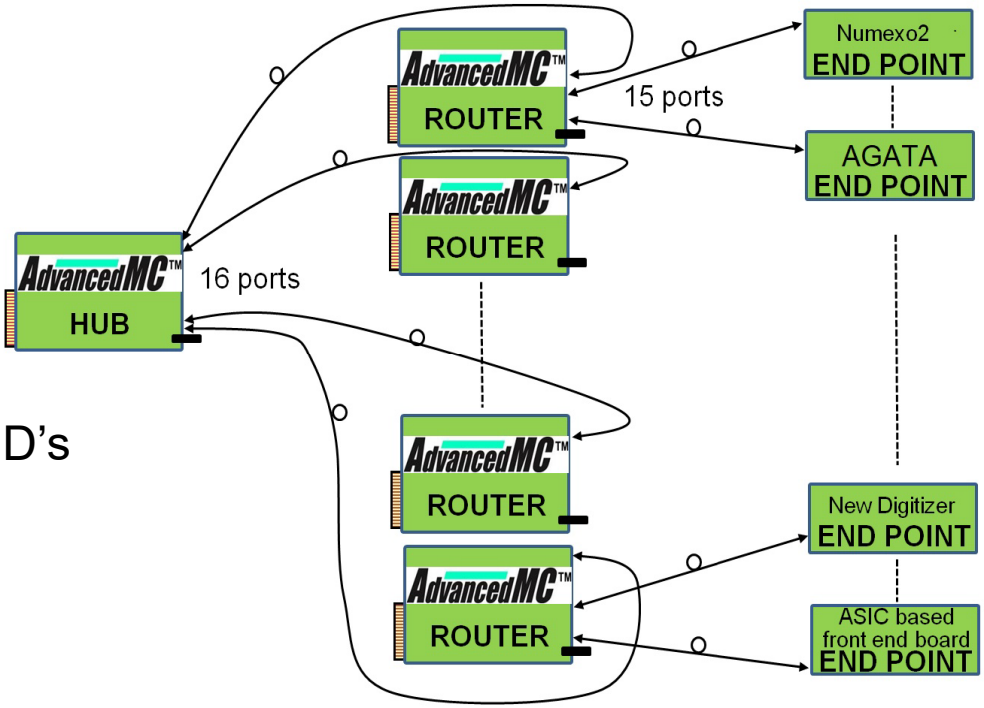
Ethernet board & Firmware: IJCLab-Orsay
Pre-processing board IFIC & ETSE-Valencia
Pre-processing Firmware: IPHC-Strasbourg, STFC-Daresbury
Monitoring, Read-out & Control: IPHC-Strasbourg, IJCLab-Orsay, STFC-Daresbury

Global Trigger & Synchronization: SMART

To be implemented in 2024

- AGATA GTS system broadly used
- New (hardware compatible) SMART system designed by GANIL (G. Wittwer et al.)
- Increased number of Trigger Request ID's
- Adapted to AGATA + Complementary Instruments.
- Larger logic equation capabilities and flexibility in the trigger partitions
- First prototypes produced

-HUB +Trigg. Proc.
-ROUTER



Responsibility of GANIL GAP

Phase 1 AGATA Data Flow DCOD at GANIL

Hardware:

- Replacement of fundamental service servers & switches Completed in October 2020
- Installation of 3 GGP on servers ongoing.
- Replacement for the older HP servers (10 years) ongoing. The new ones will be used with Phase 2 electronics
- CEPH Disk: updated with CEPH Luminous 12.2.13 which should help to avoid observed errors

DAQ Software:

- Working stable. Including AGATASpy.

Installation at LNL:

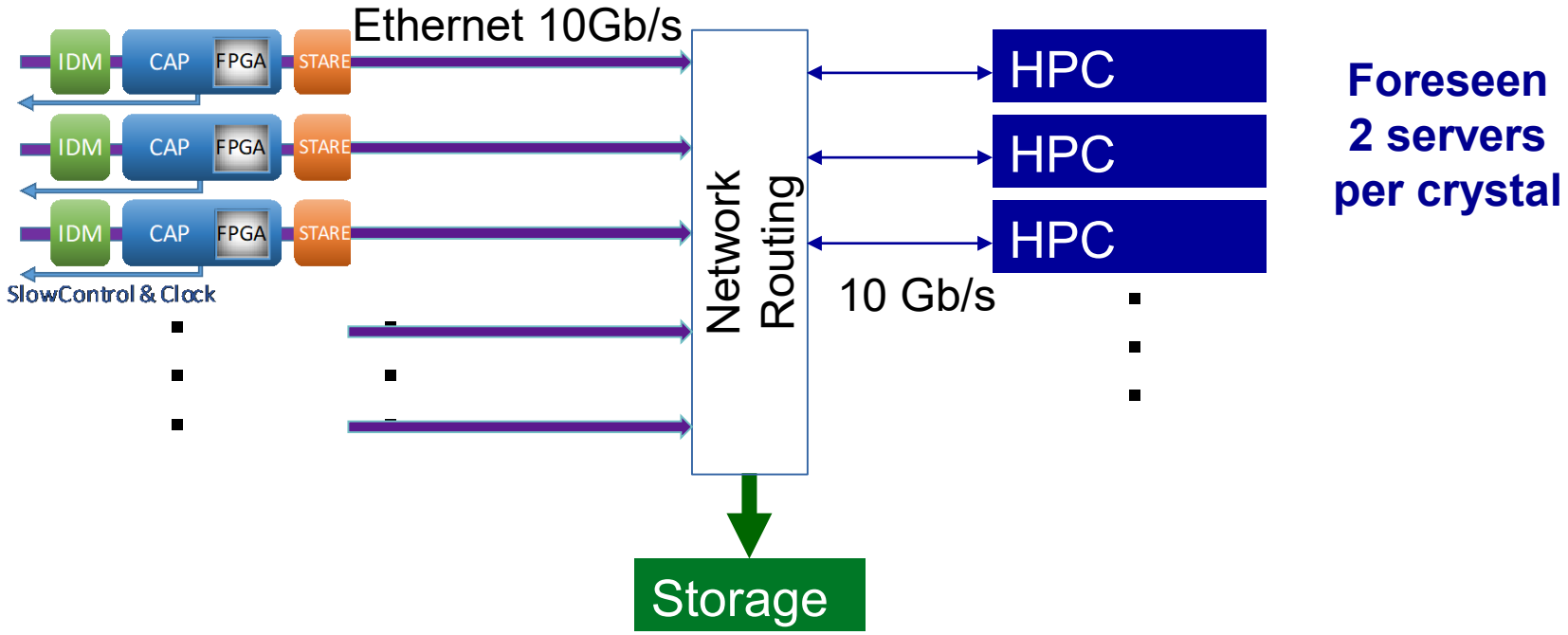
Prepared an image of DCOD to test the coupling with the LNL instrumentation. The test is being performed with two GGP at LNL.

CSNSM-Orsay, GANIL, IPN-Lyon, IPN-Orsay, INFN-LNL, IFJ-PAN-Crakow,

AGATA Data Flow (DCOD)

Project Definition AGATA Data Flow and Data Processing Section

Phase 2 electronics based on Ethernet, no point to point links beyond 2025



Foreseen 2 servers per crystal

Task Managed by IJCLab-Orsay

CPU distributed over High Performance Computer farms (HPC)

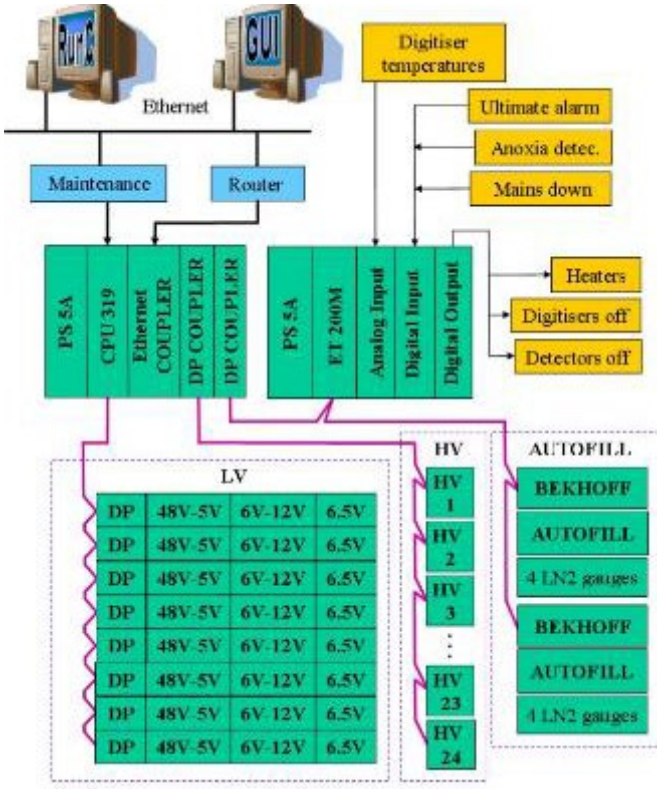
DCOD (NARVAL+ Posix Memory Handler (PMH) + Common Transport Layer (CTL))

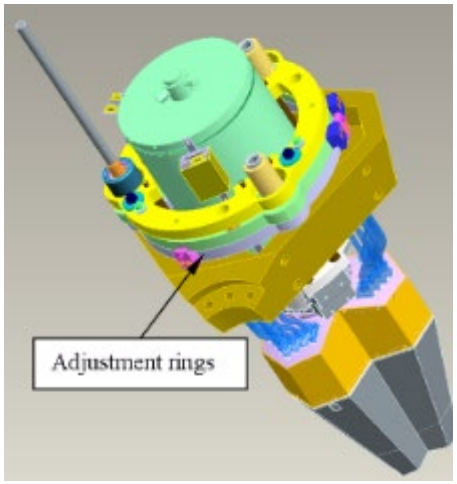
IJCLab-Orsay, GANIL, IP2I-Lyon

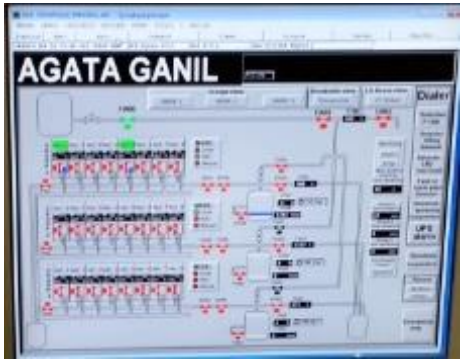
Infrastructure: Detector Support & Mechanical

LVPS**, **Patch boxes**, **HV System, Autofill system,
Data and Power Supply Cabling,** **Mechanics etc

Ready for the 45 detector system (1π)







- Maintenance of the existing LVPS crates completed
- New LVPS units to complete Phase1 and for Phase 2 first production ongoing

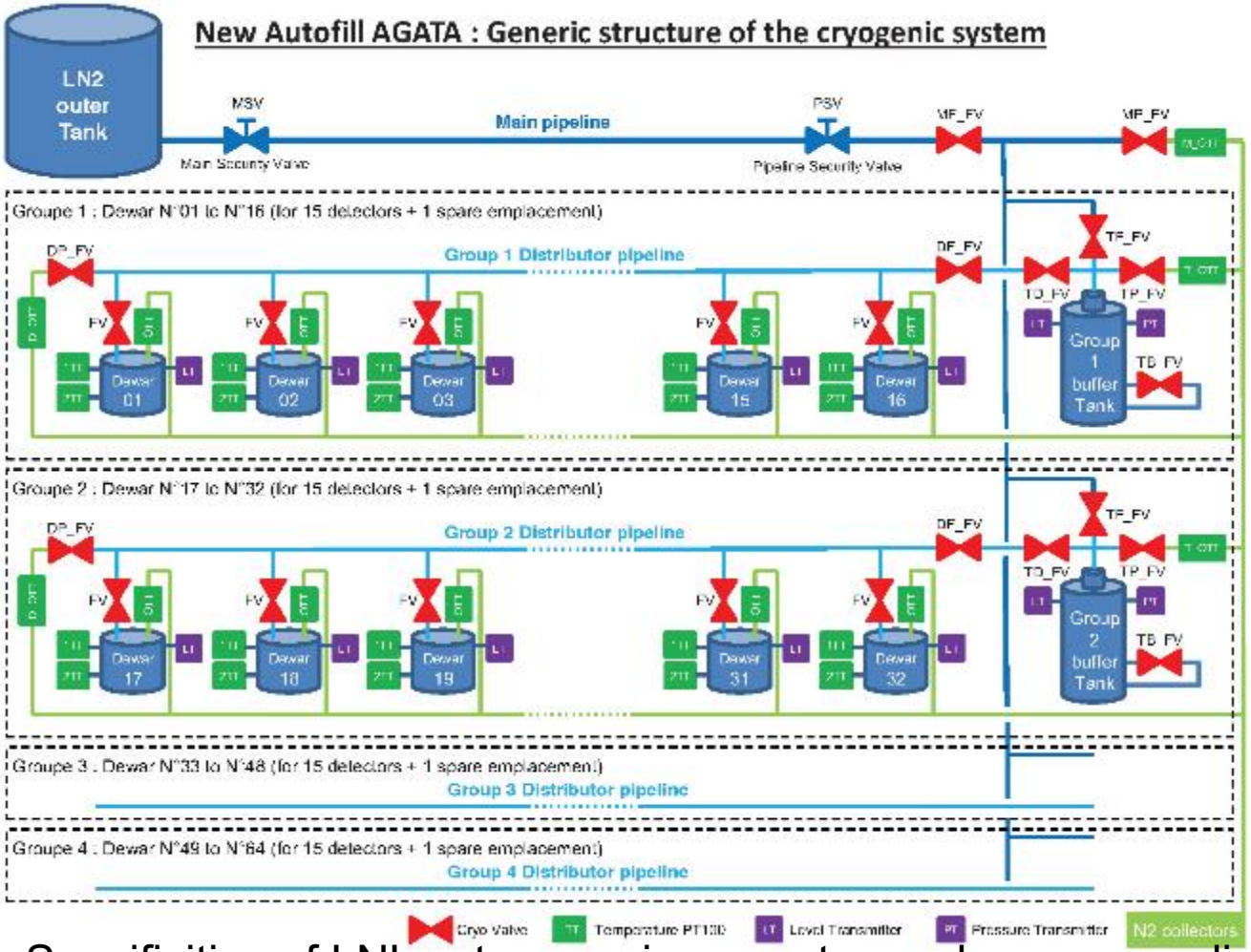
CEA Saclay, INFN-Padova, INFN-Milano, GSI, CSNSM-Orsay
STFC-Daresbury, IPHC-Strasbourg, GANIL, INFN-LNL, JYFL-Jyvaskyla,

Detector Infrastructure: DSS Subsystems

- **Autofill upgrade.**
  - Extendable to manage 60 ATCs. Produced by IRFU, France
  - Based on a state-of-the-art PLC
  - New GUI will be based on EPICS
- **LVPS**
  - 8 ATC (Phase 2 LVPS) developed by AXIS for IRFU/CEA Saclay
  - More compact, dimensioned to the phase 2 needs, lower cost
- **Cabling**
  - Mainly unchanged
  - Avoiding (60-120 m) long optical fibers in the front-end Electronics
- **HV**
  - Commercial CAEN SY4527 mainframe + A1560H boards or ISEG crate + EHS8260P boards

IRFU/CEA Saclay, INFN-Padova, INFN-Milano, GSI, IJCLab-Orsay
STFC-Daresbury, IPHC-Strasbourg, GANIL, INFN-LNL, JYFL-Jyvaskyla,

Phase2 Detector Infrastructure: DSS Subsystems



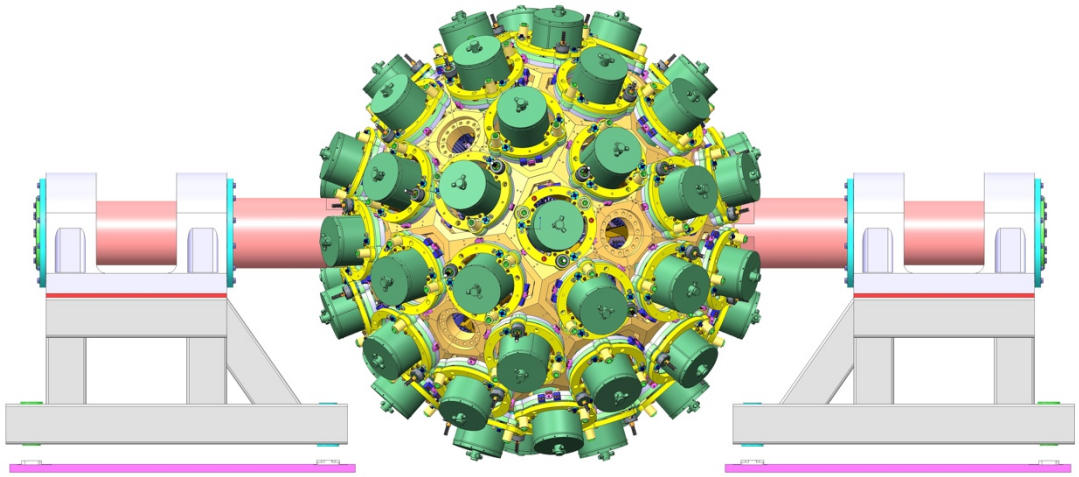
- Specificities of LNL setup require an extra work corresponding to 4 men months and the personnel is not available. Discussing how to coordinate or add efforts to deliver on time for the beginning of the LNL campaign
- Autofill components procurement delayed to 2021

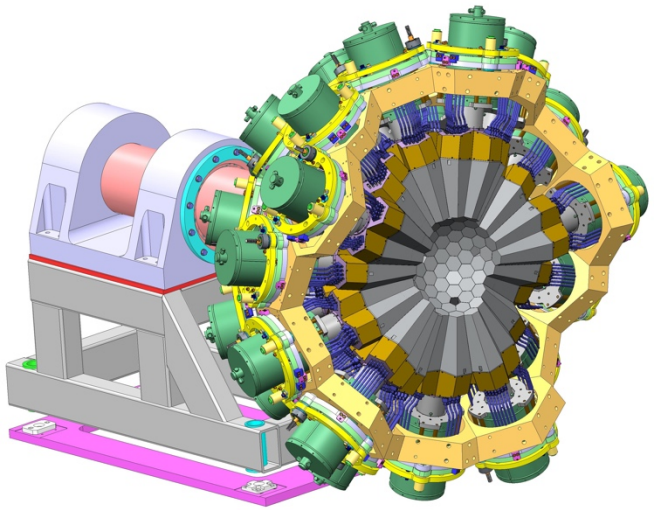
IRFU/CEA Saclay, INFN-Padova, INFN-Milano, GSI, CSNSM-Orsay
STFC-Daresbury, IPHC-Strasbourg, GANIL, INFN-LNL, JYFL-Jyvaskyla,

Mechanical Infrastructures

Phase 2 (already for the LNL campaign)

- New Mechanics compatible with all host laboratories
- A mainframe will hold 2π array, 2 mainframes for 4π
- Rotates $\pm$ 90° for detector mounting
- New alignment and positioning procedure





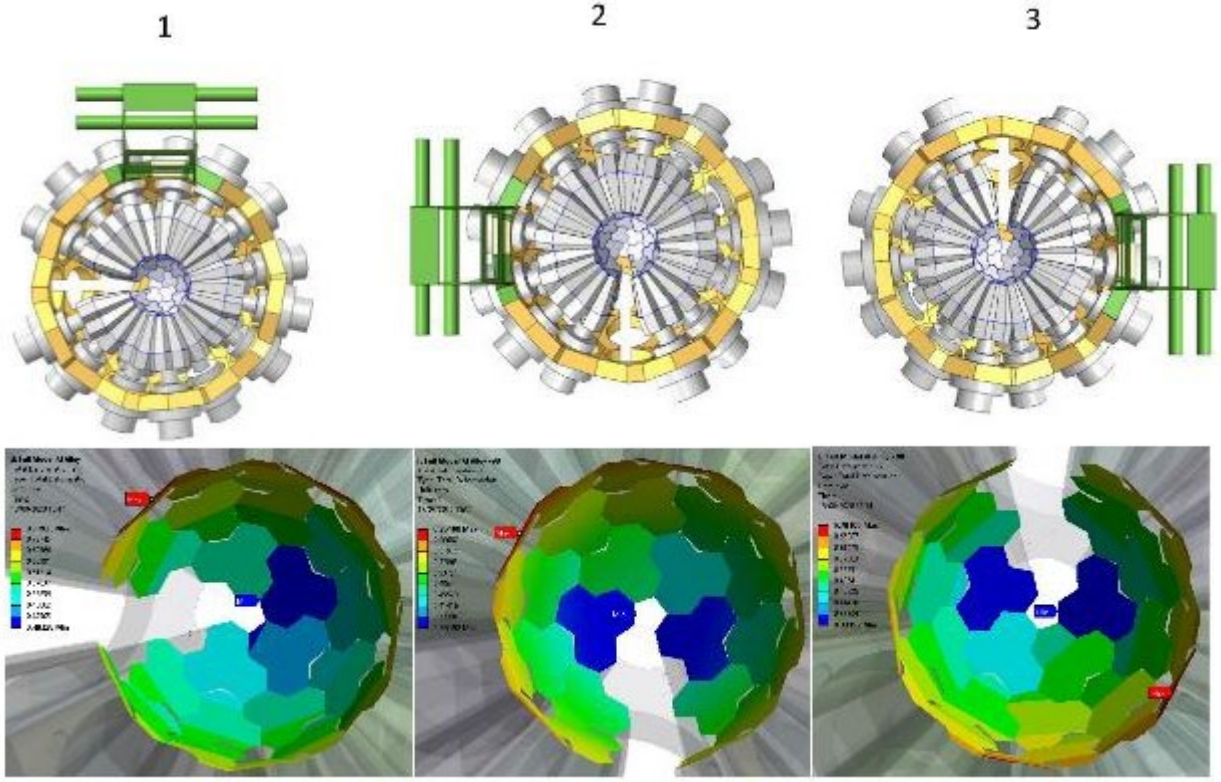
Managed by STFC-Daresbury

STFC-Daresbury, GANIL, INFN-Milano, INFN-Padova

STFC-Daresbury

Mechanical Infrastructures

- Personnel in the team: A. Grant and I. Burrows retired.
- Mechanical project for the LNL campaign completed
- Flanges under production at INFN-Padova and INFN-LNL
- Work done on the Flange leading screws, mounting procedure and patch box mounting.
- A relevant milestone after summer was the completion of the FEA analysis for the LNL setup, that includes the LNL manifold attached to the flange honeycomb.



Characterization Status and Upgrades

- In collaboration with GRETA to study the contribution to the PSA of: charge mobility temperature dependence, realistic charge cloud size crystal dead layers, n-damage and Electronics signal chain

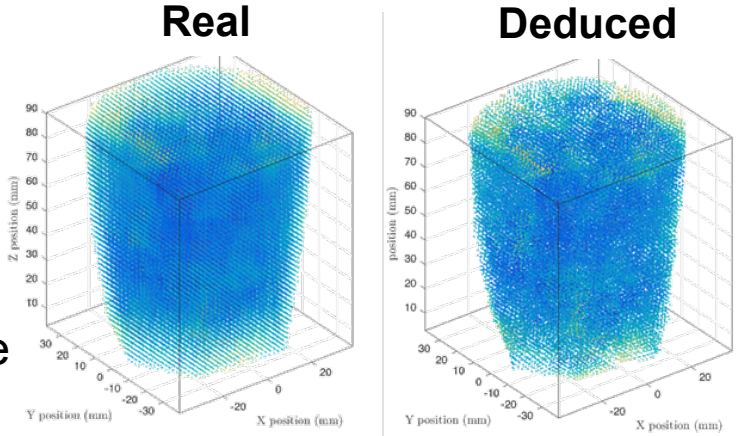
- Uni. Liverpool Scanning table :
  - A005 characterisation measurements in mid-May.
  - Heavily neutron damage A009 characterization completed late October
    (will be redone after Mirion annealed the capsule)
  - C017 characterization now ongoing
- IPHC Scanning table:
  - Now upgraded
  - scaned a MIRION detector late July (2D and possibly 3D),
  - Scanned the surface of a LNL prototype
  - As soon as it can be delivered, A005 will be scanned for a comparison of Liverpool and IPHC scanning tables

- The analysis of the A005 scanning data (Liverpool scanning table) is proceeding at Uni. Liverpool, IPHC and IPN-Lyon. The data is available for all the collaboration.

Uni.Liverpool, STFC-Daresbury, IPHC-Strabourg, IJCLab, GSI, Uni.Salamanca, IPN-Lyon

PSA Status and Upgrades

- Improve the computation performance of the AGS algorithm. Ready for the INFN-LNL campaign
- Handle multiple interactions for segments or use Machine Learning algorithms are key deliverables going forward
- Determination of PSA position uncertainties for the tracking algorithm.
- OASIS ANR contributing in several areas of the PSA developments



Early Attempts with Neural Networks
(F. Holloway, Uni Liverpool)

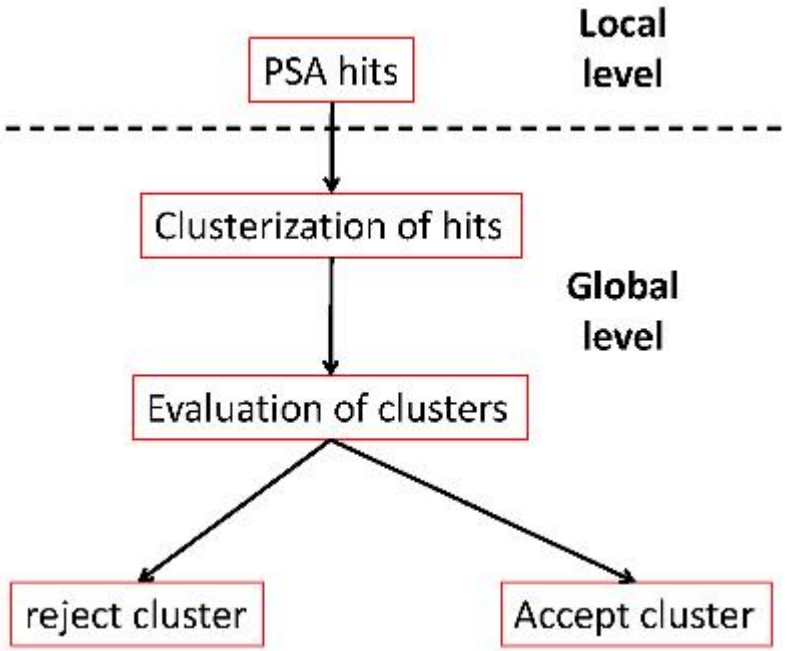
Implications on Data Flow and PSA Infrastructures

- Optimise to run on highly parallel, multi-core nodes
- Optimise to allow flexibility in platform, basis format, PSA outputs, and pre-processing options
- Explore performance in massively multi-core processors vectorization and multi-threading

Uni. Liverpool Uni. York GANIL-Caen IJCLAB-Orsay IRFU/CEA-Saclay IPHC-Strasbourg GSI-Darmstadt IKP-Uni. Cologne TU-Darmstadt Uni. Salamanca

Tracking

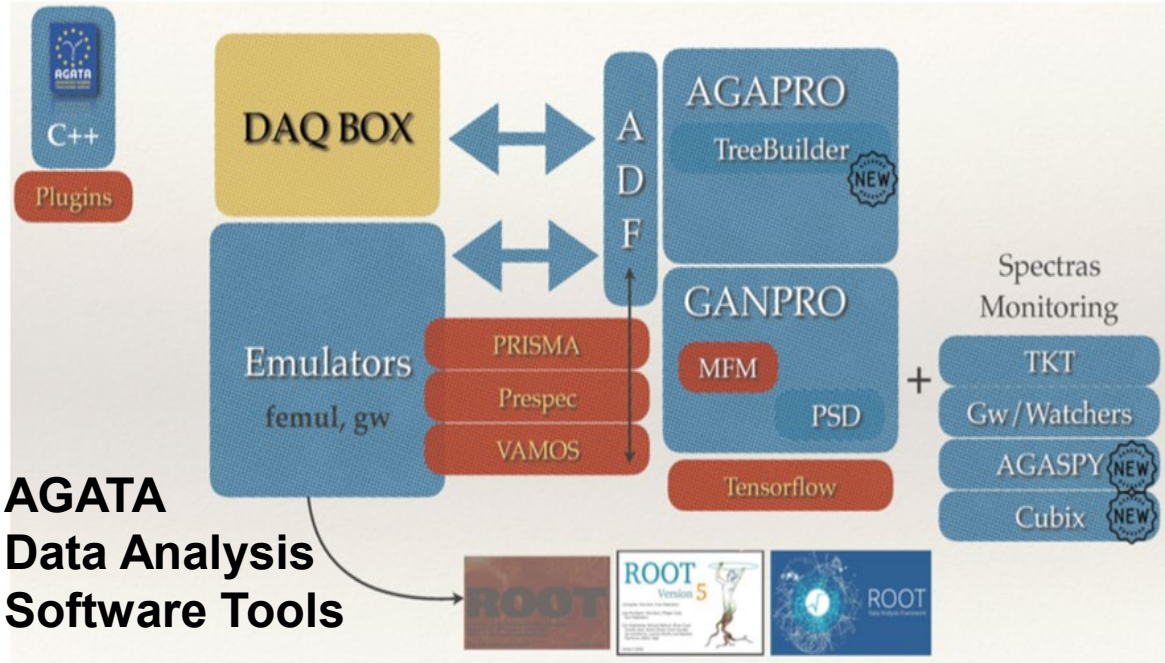
- Provide uncertainties on the interaction position (PSA)
- Deconvolute Multiple Interactions per segment (PSA)
- New procedure to validate single interaction points on the basis of ranges in Ge (like in GRETA)
- Machine learning algorithms for cluster recognition
- Comparing clusters, containing common interaction points
- Correlations between clusterisation & cluster validation



IJCLAB Orsay, TU-Darmstadt

AGATA Data Analysis & Storage

- New data analysis software "CUBIX" on GammaWare
- Expected improvements: faster/automatic way to perform parts of the data treatment
- Response functions for Tracking arrays



- Techniques from AGATA-GRETINA/GRETA collaboration
- New AGASpy package, needed after the upgrade to DCOD
- Coordination on Data Analysis efforts: hands-on workshops and blog with documentation server

IP2I Lyon, IJCLAB Orsay, INFN-Milano, GANIL-Caen, INFN-Padova, IRFU-Saclay

AGATA Simulations & Performance

Simulations

- The AGATA Code (AC) maintained and available at: http://npg.dl.ac.uk/svn/agata
- The most relevant activity of the simulations team during the last year:
  - Support to prepare the performance section of the AGATA Physics Case: updated simulations of the efficiency & P/T of the 4pi array in calorimeter mode, tracking mode and core mode
  - Support and revision of performance for few physics cases
  - Integration of PRISMA in the AGATA Geant4 code

Performance

- Publication: performance figures of the early AGATA set-up at GANIL.
- New performance source measurements: low energy and response functions.
- Determination of the response function using monoenergetic radioactive sources.
- Long term goal: Response fuctions for the different capabilities of the array: Angular ditributions, correlations, polarization, intensities…

STFC-Daresbury, GANIL, INFN-Padova…

Summary of key matters

- The emergency situation had consequences on the number of detectors in the set-up and in the maintenance programme.
- Electronics for Phase 2 progressing. Some delay due to the difficulties caused by the emergency, within contingency time. Goal: Full Integration tests at GANIL in June 2021.
- Difficulties with the production of the LN2 Autofill to be used in the LNL campaign. Delays foreseen due to missing personnel. Solutions being evaluated.
- Mechanical design for the LNL campaign (on the Phase 2 context) completed. Production on Schedule.
- Delays on Phase 2 MoU signature may have consequences on the LNL installation plans and early Phase 2 2021 productions.

Thanks' to all the AGATA Collaborators

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Una manera de hacer Europa

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