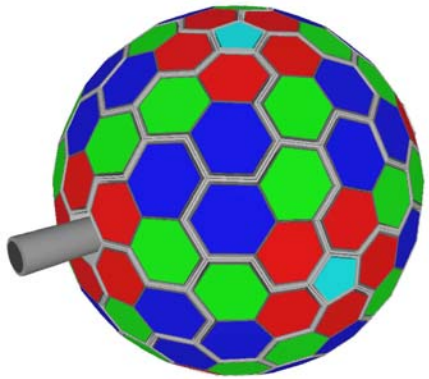
AGATA status



John Simpson
Nuclear Physics Group

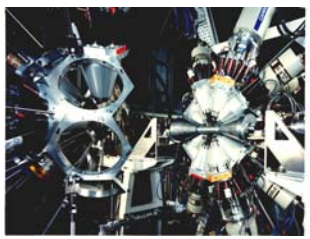
CCLRC
Daresbury Laboratory

AGATA Week, Legnaro
15-19 September 2003

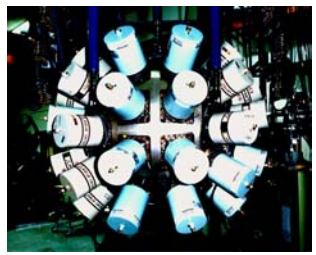
Arrays from TESSA0 to AGATA

TESSA

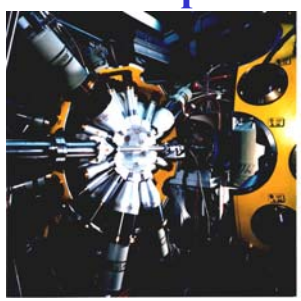
ESS30



EUROGAM

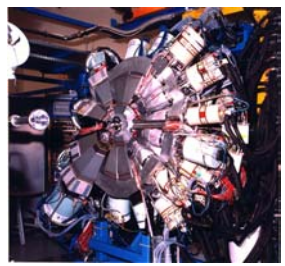


GaSp



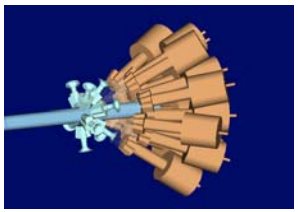
EUROBALL III

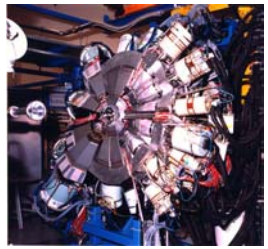
EUROBALL IV



AGATA

Future Developments in Spectroscopy Instrumentation in Europe





RISING, GSI

Euroball

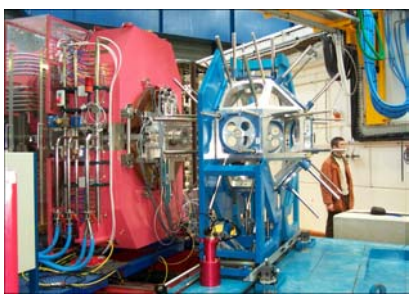
JUROGAM GREAT, JYFL

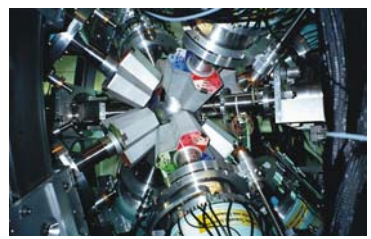
PRISMA, LNL

Radioactive beam spectroscopy

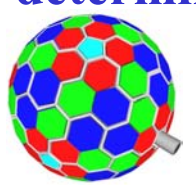
EXOGAM, SPIRAL, Ganil

MINIBALL, RexIsolde





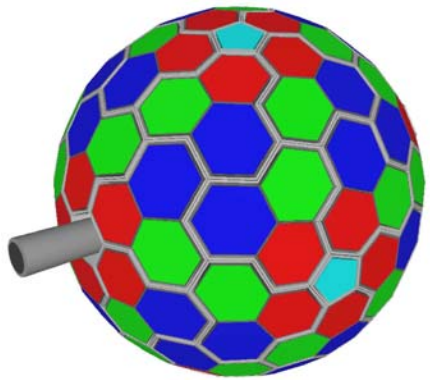
Segmentation
Encapsulation
Position determination, pulse shape analysis



•Gamma-ray tracking
TMR EU collaboration
AGATA

AGATA
The Advanced Gamma Ray Tracking Array

AGATA the ultimate gamma-ray spectrometer!



Next generation spectrometer based on gamma-ray tracking
Based on years of worldwide R&D on gamma-ray tracking
No suppression shields
4π array
Very high efficiency and spectrum quality
Stable, radioactive beams, low-high velocities

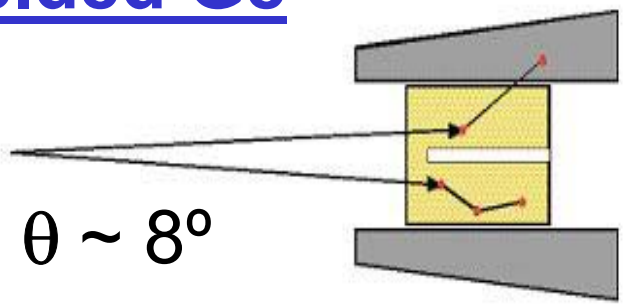
Idea of γ-ray tracking

Compton Shielded Ge

ε_{ph} ~ 10%

N_{det} ~ 100

Ω ~40%

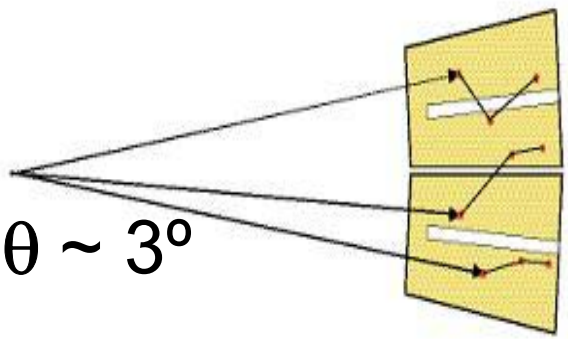


large opening angle means poor energy resolution at high recoil velocity

Ge Sphere

ε_{ph} ~ 50%

N_{det} ~ 1000



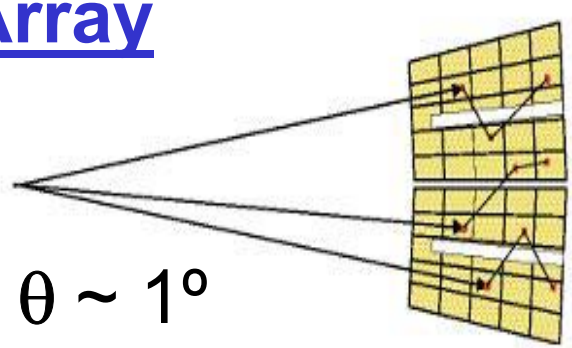
too many detectors are needed to avoid summing effects

Ge Tracking Array

ε_{ph} ~ 50%

N_{det} ~ 100

Ω ~80%



Combination of:

- segmented detectors
- digital electronics
- pulse processing
- tracking the γ-rays

Tracking requires:

Good position determination from
Digital pulse processing

Previous/current projects:

EU Vth Framework TMR `Development of γ-ray tracking detectors' (6 EU countries)

UK Instrumentation grant 'Digital Pulse Processing and γ-ray tracking (Liverpool, Surrey, Daresbury)

Miniball and Exogam (European collaborations)

Mars, Italy

GRETA, USA

Proved that position resolution can be achieved, tracking algorithms developed,
Highly segmented detectors developed

Next step

Build a sub array of few highly segmented detectors, prove tracking in real situations
Scale up to full array, fund full array

GRETA U.S.A. Funded for development modules, Request for GRETINA, 40 crystals

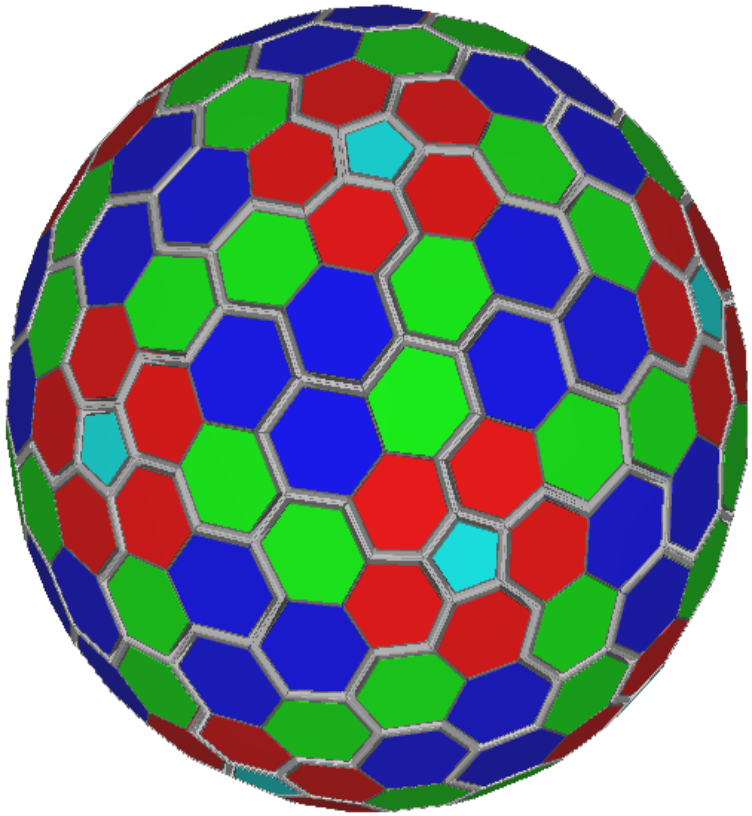
AGATA Europe (10 countries, 42 laboratories) Research and Development Phase

Funding approved in France, Germany, Italy, other countries bidding.

AGATA

(Advanced Gamma Tracking Array)

4π γ-array based on 192 highly segmented germanium detectors



180 hexagonal crystals in 60 triple-clusters
12 pentagonal crystals individually canned
Inner Radius 22 cm
230 kg of germanium
solid angle coverage 80 %
6780 segments

Efficiency: 40% (M_γ=1) 25% (M_γ=30)
Peak/Total: 65% (M_γ=1) 50% (M_γ=30)
FWHM(1 MeV) ~2 keV

Angular resolution of detected γ-rays ~1°
➔ FWHM(1 MeV, v/c=50%) ~ 6 keV !!!
(compared with ~40 keV of present arrays)

Construction ~8 years Cost ~40 M € Effort ~150 MY

AGATA proposal by: D.Bazzacco (Padova), B.Cederwall (Stockholm), G.Duchêne (Strasbourg), J.Eberth (Köln), W.Gast (Jülich), J.Gerl (GSI), W.Korten (Saclay), I.Lazarus (Daresbury), R.M.Lieder (Jülich), J.Simpson (Daresbury)

The AGATA Collaboration
Memorandum of Understanding
2003 Research and Development

Bulgaria:	**Univ. Sofia**
Denmark:	**NBI Copenhagen**
Finland:	**Univ. Jyvaskyla**
France:	**GANIL Caen, IPN Lyon, CSNSM Orsay, IPN Orsay, CEA-DSM-DAPNIA Saclay, IreS Strasbourg**
Germany:	**HMI Berlin, Univ. Bonn, GSI Darmstadt, TU Darmstadt, FZ Jülich, Univ. zu Köln, LMU München, TU München**
Italy:	**INFN and Univ. Firenze, INFN and Univ. Genova, INFN Legnaro, INFN and Univ. Napoli, INFN and Univ. Padova, INFN and Univ. Milano, INFN Perugia and Univ. Camerino**
Poland:	**NINP and IFJ Krakow, SINS Swierk, HIL & IEP Warsaw**
Romania:	**NIPNE & PU Bucharest**
Sweden:	**Chalmers Univ. of Technology Göteborg, Lund Univ., Royal Institute of Technology Stockholm, Uppsala Univ.**
UK:	**Univ. Brighton, CLRC Daresbury, Univ. Keele, Univ. Liverpool, Univ. Manchester, Univ. Paisley, Univ. Surrey, Univ. York**

Position resolution of 5 mm achieved (UK, Greta, Miniball,Mars)

Tracking algorithms and simulations of pulse shapes being developed

The AGATA RESEARCH and DEVELOPMENT PHASE

- **Develop 36 fold segmented encapsulated detector of right shape**
- **Develop cryostat for groups "clusters" of these detectors**
- **Develop digital electronics (700 channels)**
- **Finalise signal algorithms for energy, position and time**
- **Develop tracking algorithms**
- **Write technical proposal for full array**

Build demonstration unit to prove tracking in real situations

AGATA Organisation

AGATA Steering Committee
Chairperson M.Pignanelli, Vice Chairperson J.Gerl
G.deAngelis, W.Gelletly, J.Gerl, D.Guerreau, J.Jolie, N.Alamanos, D.Balabanski, B. Cederwall, J. Kownaski, P.J.Nolan, D.Bucurescu, B.Cederwall, R.Julin, G.Sletten

AGATA Managing Board
J.Simpson (Project Manager)
D.Bazzacco, G.Duchêne, J.Eberth, A.Gadea, W.Korten, R.Krücken, J.Nyberg

AGATA Working Groups

J.Eberth	R.Krücken	D.Bazzacco	G.Duchêne	A.Gadea	J.Nyberg	W.Korten
Detector Module	Local Level Processing	Conceptual Design and Global Level Processing	Design & Infrastructure	Ancillary Detectors and Ancillary Detector Integration	Data Analysis	EU Contact

AGATA Teams

- Preamplifiers
- Detector and Cryostat
- Digitisation
- Pre-process. algorithms
- Pre-process. hardware
- PSA
- Detector Characterisation
- Conceptual design
- Gamma-ray Tracking
- Data acquisition hardware
- Data acquisition software
- Global clock and trigger
- Mechanical design
- Infrastructure
- R & D other detectors
- Detectors and devices
- Elec. and data acq.
- Devices for key experiments
- Experiment simulation
- Data base
- Data processing

The Remit of the Working Groups

Detector Module Group

This group is responsible for the design and construction of the germanium detector capsules and the associated cryostats including the preamplifiers.

Design and Infrastructure Group

This group is responsible for mechanical design for the sub array of detectors and all associated infrastructure items. It is also responsible for the conceptual mechanical design of the full array. In particular, the group has to ensure that all aspects of the spectrometer integrate together. The Group is also responsible for the co-ordination of other germanium detector developments that could be used for tracking or part of an AGATA experimental set-up.

Local Level Processing Group

This group is responsible for the hardware and software required for the pulse processing to provide energy, time and position information from the germanium detectors. The group also has the responsibility for the detector characterisation and pulse shape analysis.

Conceptual Design and Global Level Processing Group

This group is responsible for the simulations of the performance of the array. It is also responsible for the collection and processing of the data from all the detectors and associated local level processing. This includes tracking and all aspects of data acquisition, data storage and online analysis.

Ancillary Detector and Ancillary Detector Integration Group

This group is responsible for co-ordination of all ancillary detectors and their developments and their integration with AGATA. Integration includes all aspects of mechanics, infrastructure, electronics and data acquisition.

Data Analysis Group

This group is responsible for all aspects of data analysis, data storage and data bases. It is also responsible for defining generic experiments to test the performance of the AGATA sub-module and the full AGATA.

EU Group

This group is to co-ordinate the EU AGATA JRP for the I3NS.

AGATA TEAMS and TEAM LEADERS

Detector Module Working Group. Chairperson Juergen Eberth.

Detector module and cryostat	leader D. Weisshaar
Preamplifier	leader A. Pullia

Local level Processing. Chairperson Reiner Krucken.

Pulse shape analysis team	leader T. Kroll
Detector characterisation team	leader A. Boston
Digitisation	leader P.Medina
Pre-processing algorithms	leader W. Gast
Pre-processing hardware	leader I.Lazarus

Conceptual Design and Global level Processing. Chairperson D.Bazzacco

Global clock and trigger	leader M.Bellato
Data acquisition	leader G.Maron
Conceptual design	leader E. Farnea,
Gamma-ray tracking	leader W.Lopez-Martens
GUI, system control ?	leader ?

Ancillary detectors and ancillary detector integration. Chairperson A.Gadea.

Ancillary detector impact on AGATA performances	
Electronics and data acquisition integration	leader Ch.Theisen
Mechanical integration of ancillary detectors and devices in AGATA	
Ancillary devices for the key experiments	
Other team leaders are to be identified.	

Design and Infrastructure. Chairperson G.Duchêne.

Mechanical design	Team leaders are to be identified
Infrastructure	
R&D on other Ge detectors.	

Data Analysis Working Group. Chairperson Johan Nyberg.

Physics and event simulation of key experiments	leader E. Farnea
Detector data base parameters	leader to be decided
Data processing (online/offline analysis, etc.)	leader O.Stezowski

Project Specification and Project Handbook

Copies available

Project Specification

Description of project and aim for this Research and Development Phase
Tasks of the working groups and teams
Deliverables
Milestones
Timescales

Project handbook

Project management
Documentation
Risk, Quality, Safety
Mailing lists

AGATA SPECS

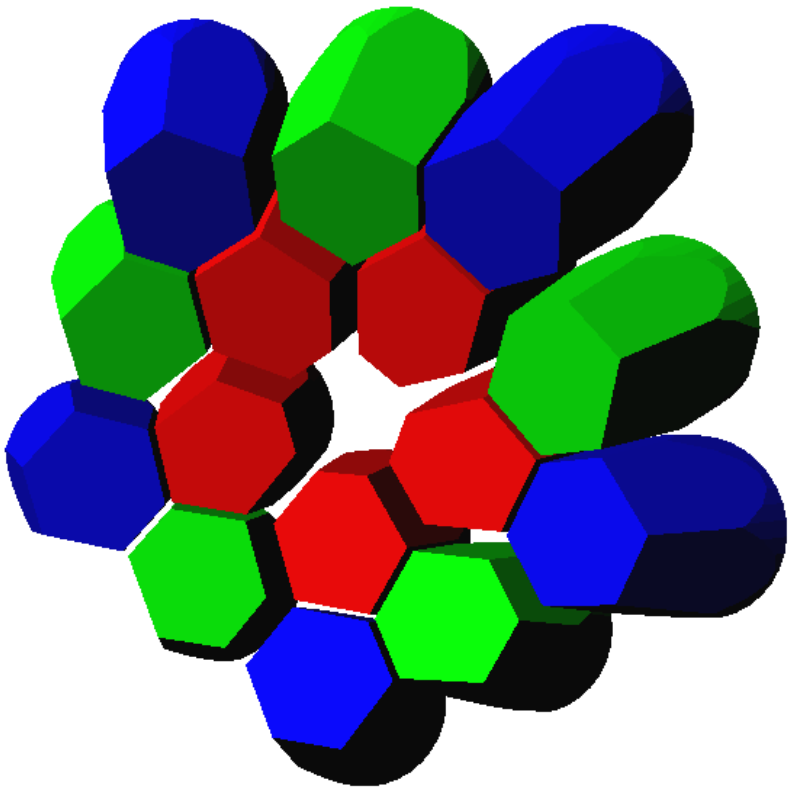
Quantity	Specified for	Target Value
Photo-peak efficiency (ε_{ph})	E_γ = 1 MeV, M_γ = 1, $\beta < 0.5$ E_γ = 1 MeV, M_γ = 30, $\beta < 0.5$ E_γ = 10 MeV, M_γ = 1	40 % 25 % 10 %
Peak-to-total ratio (P/T)	E_γ = 1 MeV, M_γ = 1 E_γ = 1 MeV, M_γ = 30	60 - 70 % 40 - 50 %
Angular resolution ($\Delta\theta_\gamma$)	$\Delta E/E < 1\%$	better than 1°
Maximum event rates	M_γ = 1 M_γ = 30	3 MHz 300 kHz
Inner free space (R_i)		170 mm

Detector requirements:

efficiency, energy resolution, dynamic range, angular resolution, timing, counting rate, modularity, angular coverage, inner space

The First Step:
The AGATA Demonstrator

Objective of the final R&D phase 2003-2007



1 symmetric triple-cluster

5 asymmetric triple-clusters

36-fold segmented crystals

540 segments

555 digital-channels

Eff. 3 – 8 % @ $M_\gamma = 1$

Eff. 2 – 4 % @ $M_\gamma = 30$

Full ACQ

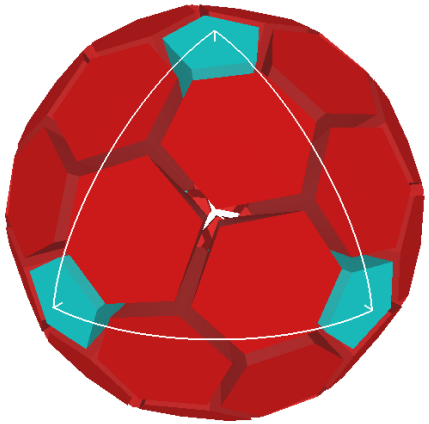
with on line PSA and γ-ray tracking

Test Sites:

GANIL, GSI, Jyväskylä, Köln, LNL

Cost ~ 7 M €

Geodesic Tiling of Sphere using 60–240 hexagons and 12 pentagons



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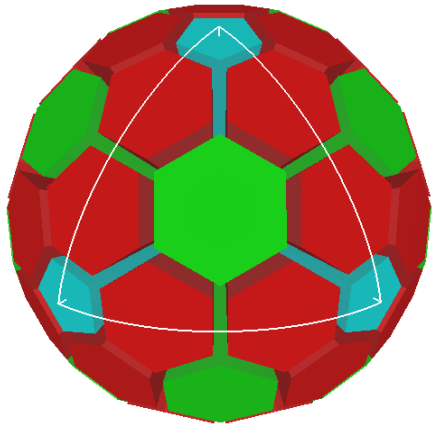

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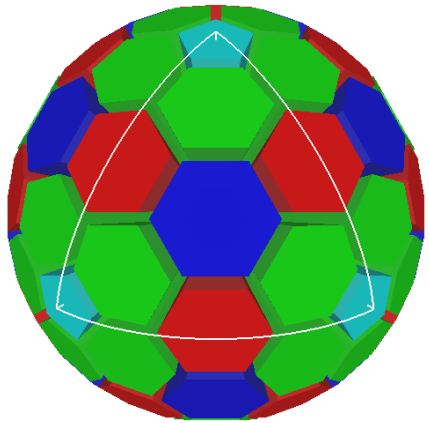

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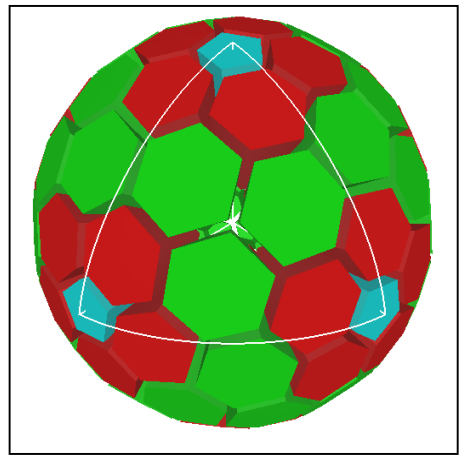
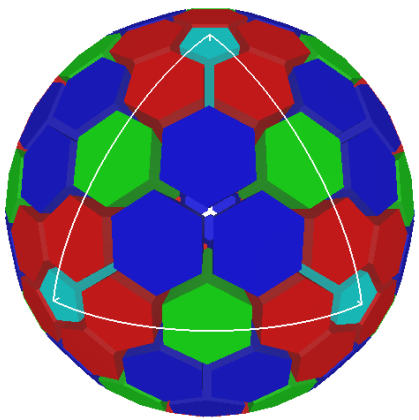


120



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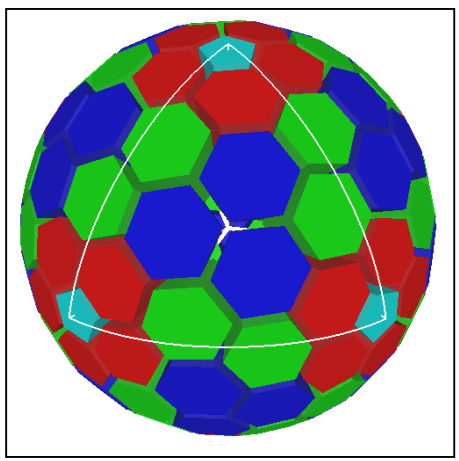

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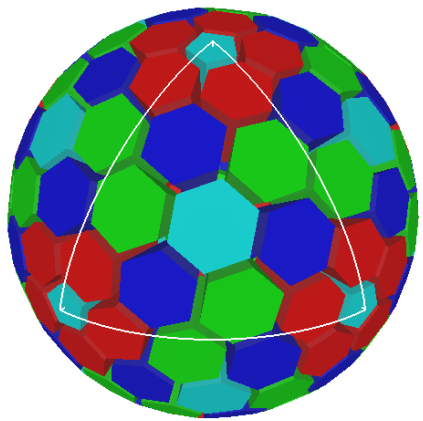

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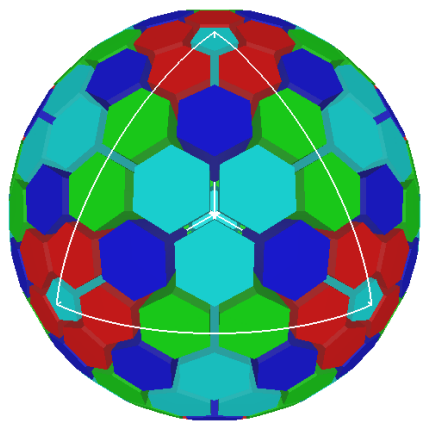
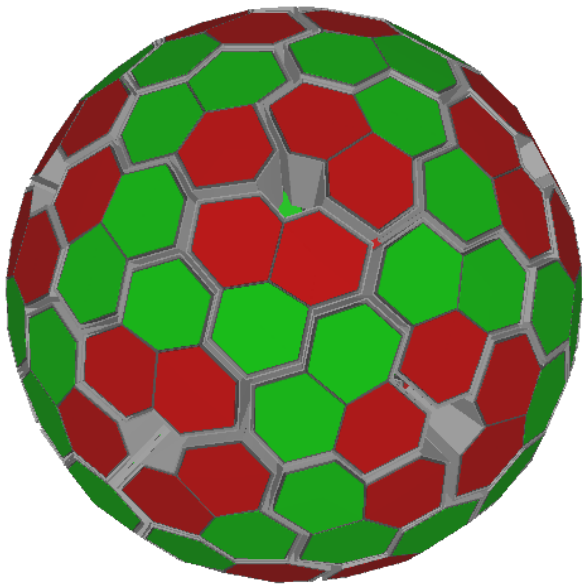
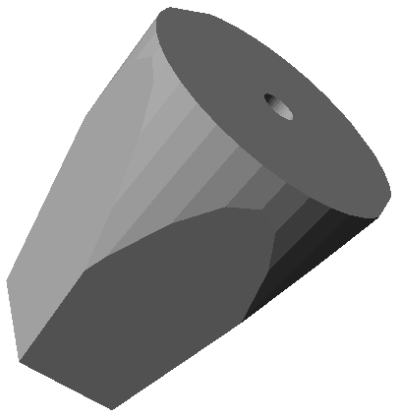


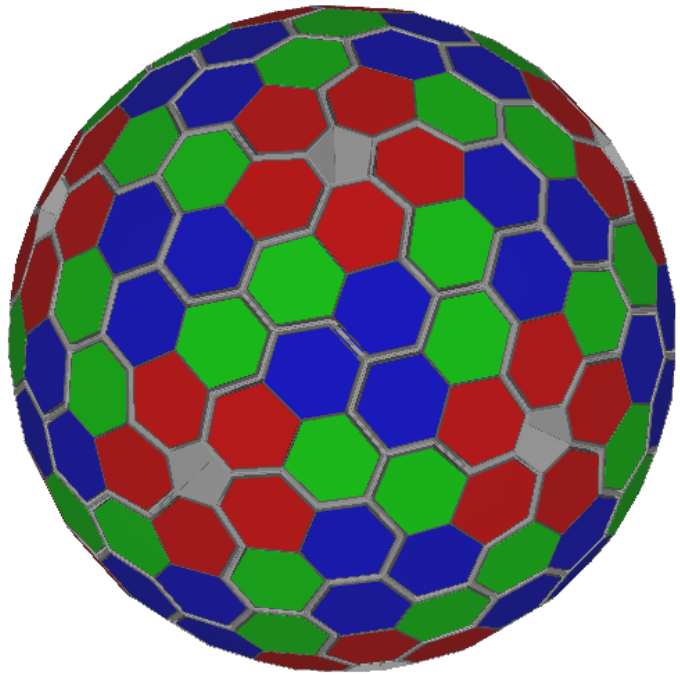
240

Two candidate configurations



Ge crystals size:
length 90 mm
diameter 80 mm





120 hexagonal crystals	2 shapes
40 triple-clusters	2 shapes
Inner radius (Ge)	17 cm
Amount of germanium	220 kg
Solid angle coverage	74 %
Singles rate	~70 kHz

4320 segments 4440 electronics channels

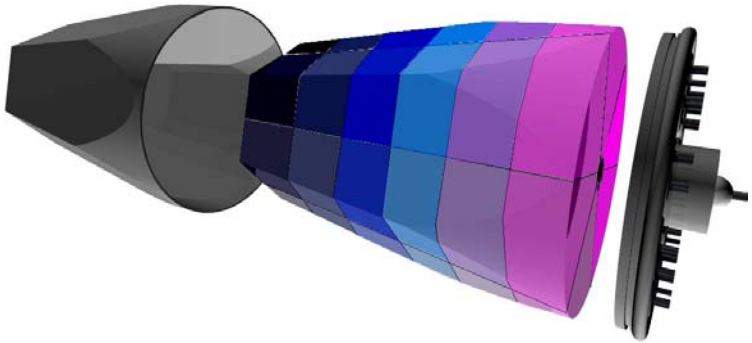
Efficiency: 38% (M_γ=1) 21% (M_γ=30)
Peak/Total: 63% (M_γ=1) 47% (M_γ=30)

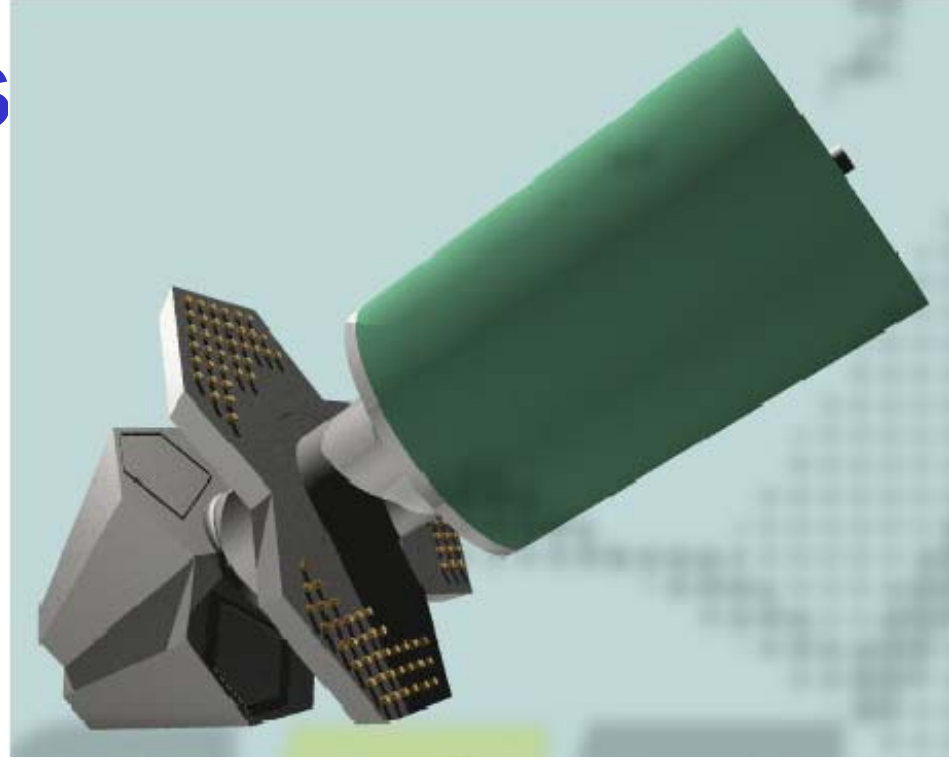
180 hexagonal crystals	3 shapes
60 triple-clusters	all equal
Inner radius (Ge)	22 cm
Amount of germanium	310 kg
Solid angle coverage	80 %
Singles rate	~50 kHz

6480 segments 6660 electronics channels

Efficiency: 40% (M_γ=1) 25% (M_γ=30)
Peak/Total: 65% (M_γ=1) 50% (M_γ=30)

AGATA Detectors



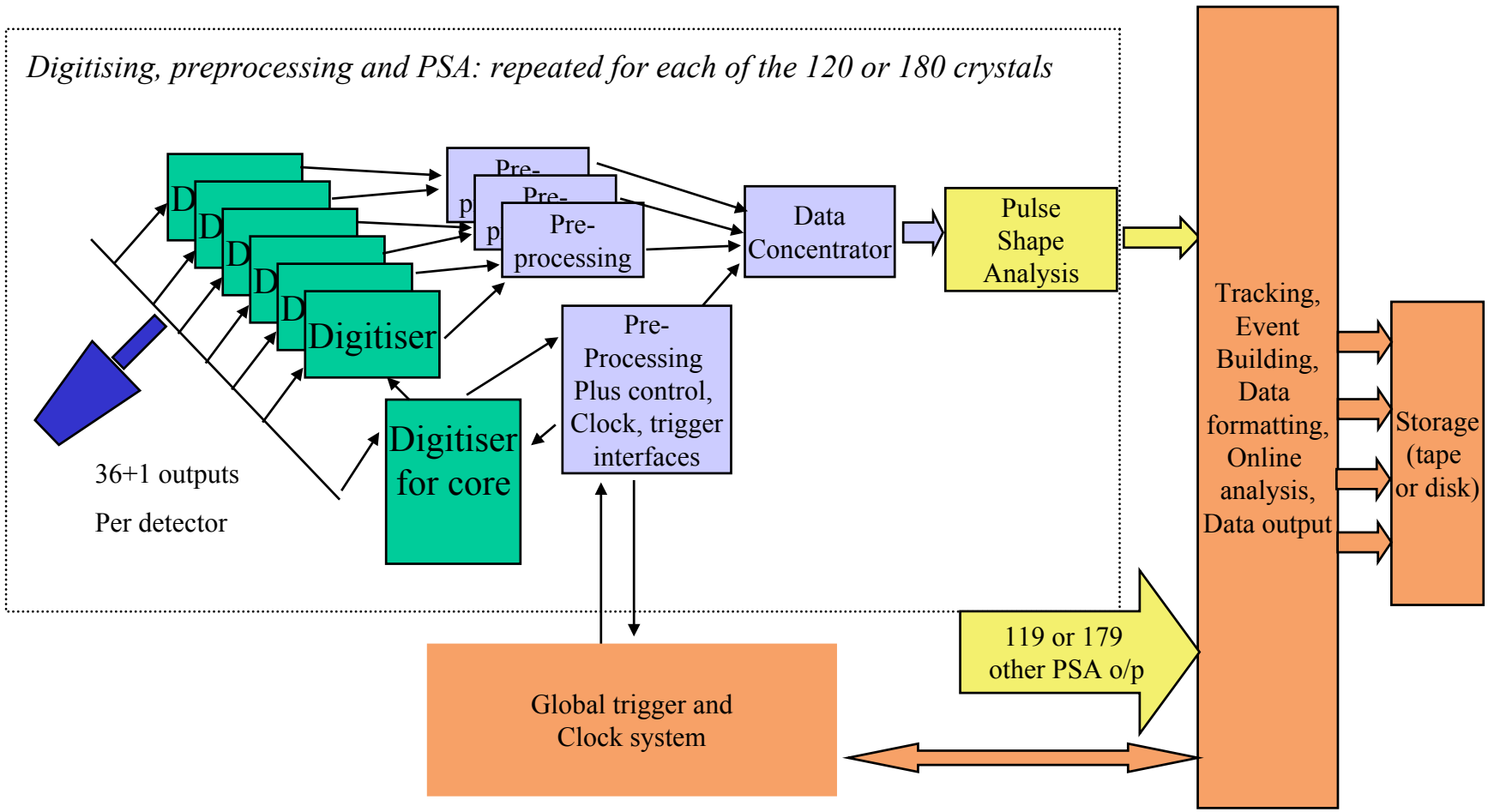


Hexaconical Ge crystals
90 mm long
80 mm max diameter
36 segments
Al encapsulation
    0.6 mm spacing
    0.8 mm thickness
37 vacuum feedthroughs

3 encapsulated crystals
111 preamplifiers with cold FET
~230 vacuum feedthroughs
LN_2 dewar, 3 liter, cooling power ~8 watts

Germany & Italy ordered 3 symmetric encapsulated crystals.
Cryostat will be built by CTT in collaboration with IKP-Köln
Cluster ready by end 2004

Schematic System Diagram



Segment level processing: energy, time
Detector level processing: trigger, time, PSA
Global level processing: event building, tracking, software trigger, data storage

Funding

Bids and promised bids for capital

Denmark	**173**
Finland	**200**
France	**1269**
Germany	**1293**
Italy	**1250**
Poland	**100**
Sweden	**500**
UK	**1021**
EU	**1120**
Total	**6926**

Obtained (in principle) funding from France, Germany and Italy ~3.6M

Cost estimate?

To do
Initial guesstimate

Detectors	**4.7**
LLP	**0.8**
GLP	**0.4**
D&I	**0.2**
Ancill	**0.6**
DA	**0.2**
Total	**6.9M**

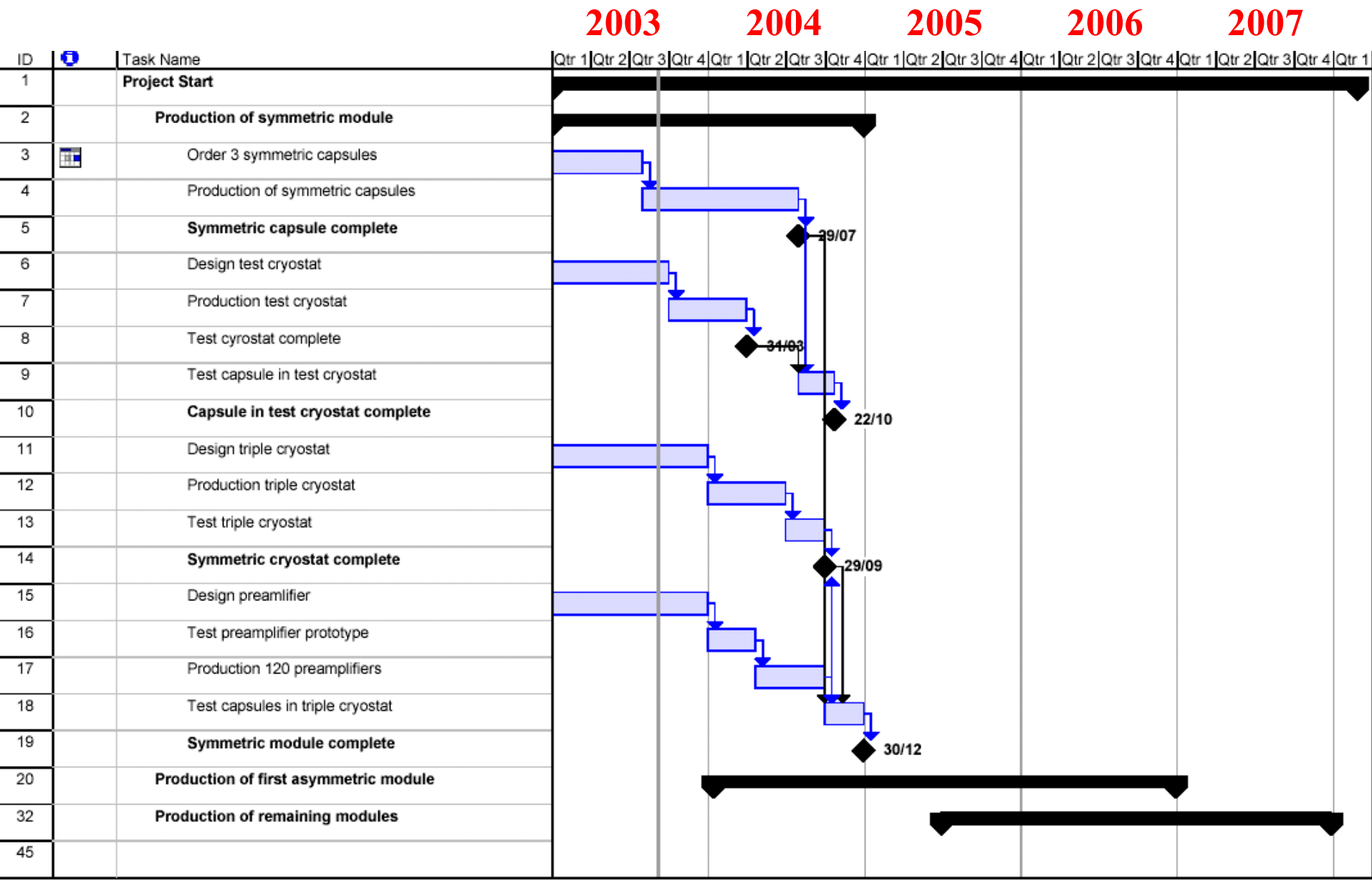
Ge detectors
Cost for asymmetric capsules not clear and increasing
LLP and GLP
Specification not fixed, costing to do

Timescale

Five year research and development phase of AGATA
Start January 2003 End December 2007
Aim to have sufficiently large enough array to test tracking and performance with sources and in beam
Timescales drive by detector deliveries.

Global timescale estimates:

First three symmetric capsules expected mid 2004
Test individual as 3-unit module by end 2004
Start ordering asymmetric capsules in 2004
depends on geometry and deliveries of first symmetric capsules
First asymmetric cluster in 2005
Test first crystals/ modules with "existing electronics"
Electronics for demonstrator array required end 2005/ start 2006
Time for R&D, GUI, algorithms PSA, tracking…
Test sub array 2006/2007


2003
2004
2005
2006
2007
Qtr 1 Qtr 2 Qtr 3 Qtr 4 Qtr 1 Qtr 2 Qtr 3 Qtr 4 Qtr 1 Qtr 2 Qtr 3 Qtr 4 Qtr 1 Qtr 2 Qtr 3 Qtr 4 Qtr 1 Qtr 2 Qtr 3 Qtr 4 Qtr 1
ID
Task Name
1 Project Start
2 Production of symmetric module
3 Order 3 symmetric capsules
4 Production of symmetric capsules
5 Symmetric capsule complete
6 Design test cryostat
7 Production test cryostat
8 Test cyrostat complete
9 Test capsule in test cryostat
10 Capsule in test cryostat complete
11 Design triple cryostat
12 Production triple cryostat
13 Test triple cryostat
14 Symmetric cryostat complete
15 Design preamlifier
16 Test preamplifier prototype
17 Production 120 preamplifiers
18 Test capsules in triple cryostat
19 Symmetric module complete
20 Production of first asymmetric module
32 Production of remaining modules
45
29/07
31/03
22/10
29/09
30/12

AGATA WEEK

ALL AGATA team to meet
ALL to be present throughout the week
Travel, information exchange, overlap of tasks between groups
Specifications to be agreed (e.g. LLP, GLP)

Programme
Tuesday 16th September
Introduction followed by
Plenary session organised by R.Krucken and D Bazzacco
Teams:
Pre-amplifiers, digitisation, pre-processing hardware, data acquisition, clock and trigger,
Pre-processing alogrithms,

Wednesday 17th September
Plenary session organised by J.Eberth and G.Duchêne
Teams:
Detector module and cryostat, design and MC simulations,
mechanical design, detector characterisation, pulse shape analysis, gamma-ray tracking

Thursday 18th September
Plenary session organised by A.Gadea, J.Nyberg and G.Duchêne
Teams:
Ancillaries, R&D other detectors, Infrastructure,Detector data base, data processing
Late afternoon status of working groups by chairpersons
Rooms available Friday 19th September

LOGO competition
Entries received by 8th September
Winner and presentation on Thursday