PARIS & AGATA LOIs al LNL with Stable beams

Franco Camera

University of Milano Statale, Department of Physics
INFN section of Milano

Timescale:

- AGATA will probably move from GANIL to LNL during 2021
- Commissioning: end of 2021 beginning of 2022
- AGATA could be available in LNL with Stable Beams in 2022

Nominal and compact positon position (-10 cm) at 1,3 MeV considering a reaction chamber of Al 4 mm.

Start of the camapign with 20TC. By the end of the campaign with 30TC.

Configuration	Nominal position	Compact position
20TC	8.8%	13.9%
30TC	13.6%	19.0%

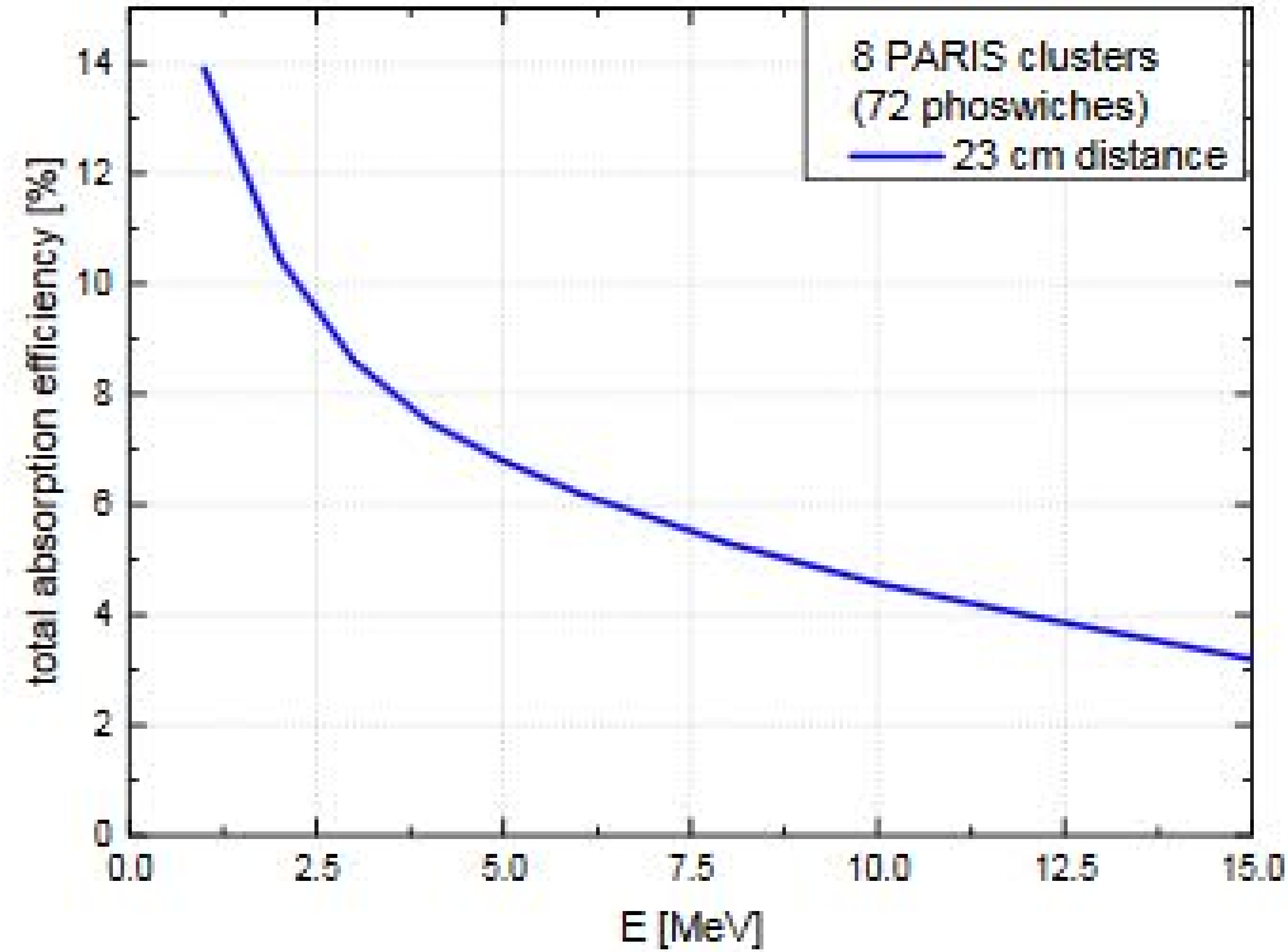
AGATA – Array of HPGe

- 20-30 triple Clusters
- Angular distribution and 'imaging' capability
- FEP efficiency (at 1.3 MeV) = 9 – 19%

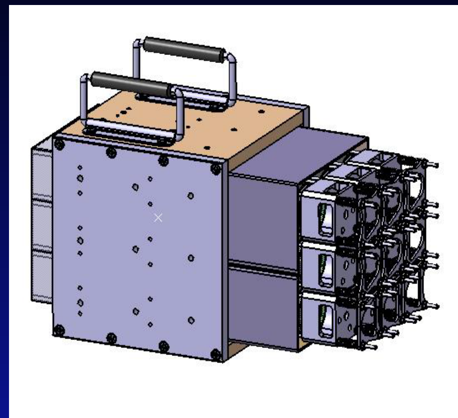
PARIS – Array of Phoswiches (1 cluster => 9 phoswiches)

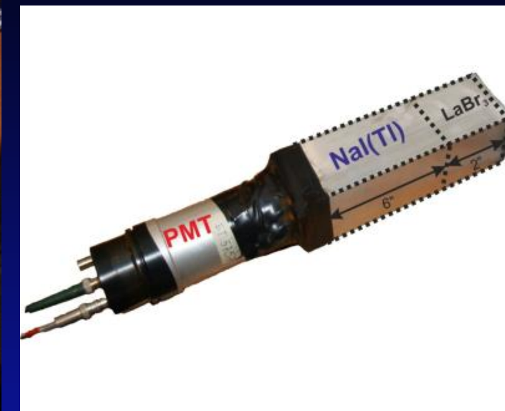
- in 2022 eigth clusters are expected to be ready
  - 8 clusters -> 72 phoswiches
  - 72 phoswiches -> 72 rectangular LaBr3:Ce / $CeBr_3$ 2"x2"x2" +
    72 rectangular NaI 2"x2"x6"

- 72 crystals of $LaBr_3$:Ce/$CeBr_3$ are expected to be available
  - this mean a 'multiplicity filter' with 72 elements
- A volume of ≈ 28 L of NaI is expected to be available
  - this mean high efficiency for high energy γ-rays


8 PARIS clusters
(72 phoswiches)
23 cm distance
total absorption efficiency [%]
E [MeV]
0
2
4
6
8
10
12
14
0.0
2.5
5.0
7.5
10.0
12.5
15.0

PARIS





PARIS is a detector array which which can

- provide time resolution (better than HPGe, namely AGATA)
- provide the multiplicity information from frontal $LaBr_3$ or $CeBr_3$ in addition to Agata unsuppressend fold
- provide large efficiency for high energy γ-rays

LOI Lists (there are 9 LOIs + …)

LOI n. 3 - M. Krzysiek et al.
Study on the single particle structure of Pygmy Dipole Resonance

LOI n 10 - M.Kmiecik et al.
The search for Jacobi shape transition in hot rotating nuclei from the Mo-Ba region

LOI n. 17 - P.Bednarczyk et al.
Investigation of a high spin distribution structure in the vicinity of 44Ti via discrete and continuum gamma spectroscopy with AGATA+EUCLIDES+RFD and PARIS detectors

LOI n. 19 - M.Ciemala et al.
Lifetime measurement of excited states in neutron-rich C isotopes: a test of the three body forces

LOI n. 24 - F.Crespi et al.
Gamma and Particle Decay of Giant Resonances Excited by Inelatic scattering of 17O ions at 20MeV/A

LOI n. 28 - G.Gosta el al.
Measurement of Isospin Mixing

LOI n. 29 - G.Benzoni et al.
GDR feeding of SD states: a LOI for AGATA@LNL

LOI n. 39 - K. Handynska et al.
Coulomb Excitation of the Super-Deformed structures in A~40 mass Region

LOI n. 46 - M. Vanderbrouck et al.
Study of the Isovector Giant Dipole Resonance in hot superheavy nuclei

LOI Physics Cases – TOPICS

Hot and Cold GR

PDR

Nuclear Structure

Physics Case 1

LOI n 10 - M.Kmiecik et al.
The search for Jacobi shape transition in hot rotating nuclei from the Mo-Ba region

LOI n. 28 - G.Gosta el al.
Measurement of Isospin Mixing

LOI n. 29 - G.Benzoni et al.
GDR feeding of SD states: a LOI for AGATA@LNL

LOI n. 46 - M. Vanderbrouck et al.
Study of the Isovector Giant Dipole Resonance in hot superheavy nuclei
(PRISMA Spectrometer is required)

Measurement of high energy γ-rays
γ decay of the Giant Dipole Resonance in hot nuclei

The IsoVector GIANT DIPOLE RESONANCE is used as a probe for the measurement of the nuclei properties, in particular

- Jacobi Shape $\Rightarrow$ LOI by M. Kmiecik (Mo-Ba mass region)
- Feeding of SD states $\Rightarrow$ LOI by G.Benzoni (Eu or Pb isotopes)
- Isospin Mixing $\Rightarrow$ LOI by G.Gosta (N=Z medium-light nuclei)

- Superheavy $\Rightarrow$ LOI by M. Vanderbrouck (Super-Heavy nuclei)

  - The two fission fragments will be detected in coincidence using the large acceptance magnetic spectrometer PRISMA and its second arm.

  - The identification will allow to study the influence of the fission process (symmetric vs asymmetric) in IVGDR gamma decay.

AGATA

measurements of low-medium energy γ rays

PARIS array

measurement of high-energy γ rays. → Measurements of GR

→ Multiplicity filter

PRISMA spectrometer → Gating Conditions

Array of large volume 3”x3” **CLYC detectors**

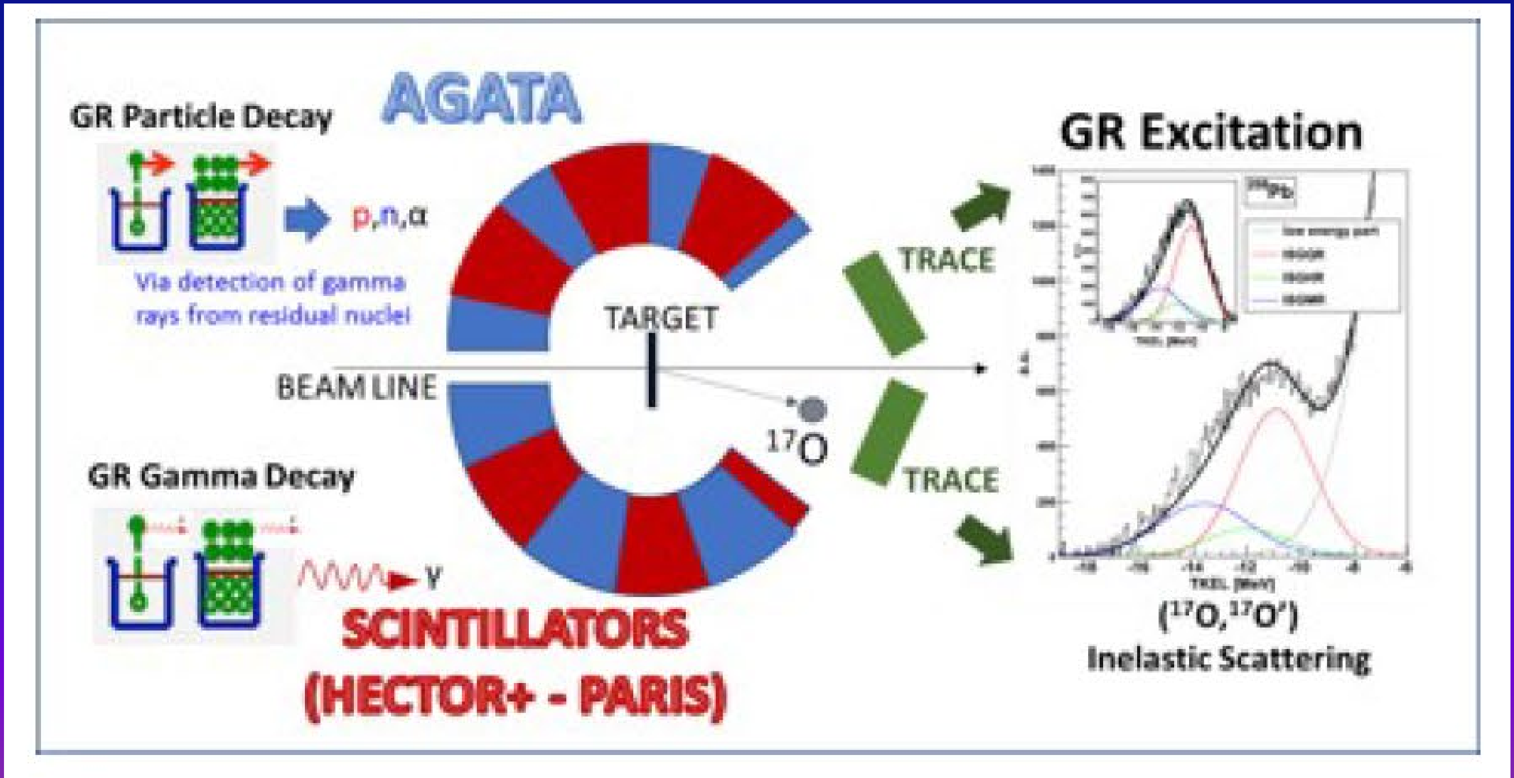
for the measurement of high-energy γ rays and neutrons.

Test for the possible use with radioactive beams

Physics Case 2

LOI n. 24 - F.Crespi et al.
Gamma and Particle Decay of Giant Resonances Excited by Inelatic scattering of ^{17}O ions at 20MeV/A

LOI n. xx – J. Isaak et al.
Gamma strength functions and decay pattern of dipole excitations
Measurement of γSF in Te isotopes



Inelastic scattering to excite GR on ^{40}Ca,^{24}Mg or Ni isotopes

Gamma decay to the Ground State + 2 step gamma decay

- Scintillators => GR ground state decay in ^{40}Ca,^{24}Mg or Ni isotopes
- Trace => ^{17}O measurement

- Energy lost from beam = Gamma ray energy measured in scintillators

Particle decay

- AGATA/Scintillators => Measurement of gamma rays from resudual nuclei
  => Measurement of entry point
  => Example ^{17}O(20 MeV/A) + ^{40}Ca -> $^{17}0$ + $^{40}Ca^*$ -> $^{17}0$ + p + γ + ^{39}K
- Trace => selection of excitation energy range of ^{40}Ca

- Energy lost from beam > γ-ray energy measured in AGATA/scintillators

It is critical a very high γ FEP efficiency for low energy gamma rays to avoid systematic errors

Physics Cases 3
4 LOIs

LOI n. 3 - M. Krzysiek et al.
Study on the single particle structure of Pygmy Dipole Resonance

PDR decay in Ba isotopes
PDR γ-decay to the ground state measured with AGATA
"PARIS + AGATA will ensure efficiency for the γ–γ coincidence measurement"
" By gating on the first excited states measured with PARIS one would precisely identify the decay branching with AGATA."

LOI n. 17 - P.Bednarczyk et al.
Investigation of a high spin distribution structure in the vicinity of ^{44}Ti via discrete and continuum gamma spectroscopy with AGATA+EUCLIDES+RFD and PARIS detectors

Fusion-Evaporation reaction to produce ^{44}Ti or ^{42}Ca
Extension of level scheme for spin higher than 12-16 hbar
Problem: SD band will come from spin alignement or molecular structure
"The PARIS scintillation array will be applied for simultaneous detection of high energy gamma rays possibly feeding the SD bands"

Physics Case 3
4 LOIs

LOI n. 19 - M.Ciemala et al.
Lifetime measurement of excited states in neutron-rich C isotopes: a test of the three body forces
(PRISMA Spectrometer is required)
(Differential plunger is required)

Multi Nucleon Transfer reaction induced by a ^{18}O beam on a ^{188}Pt target
The main focus of experiment are $^{16\text{-}18}C$ isotopes
The aim is the measurement of:

i) the lifetime of the second 2^+ state (DSAM technique)
ii) the decay branch from the second 2^+ state to the ground state or to the first + state
(this will be achieved by employing the very efficient PARIS scintillators)
iii) …………

LOI n. 39 – K. Handynska et al.
Coulomb Excitation of the Super-Deformed structures in A~40 mass Region

Safe Energy Coulomb Excitation campaign mass region ^{28}Si-^{56}Ni
The aim is to perform a study of the SD structures in nuclei, the measurement, in a model independent way, the deformation of the yrast and SD bands
The γ-rays in the energy range between 0.3 to 6 MeV will be measured by AGATA + PARIS in coincidence with the SPIDER array

What is needed

One or Two Mechanical Frames

- For the LOI where Prisma is required
- For the LOI where Prisma is not required

Electronics to couple PARIS with AGATA DAQ

- At least 72 channel of digitizers (a minimum of 5 digitizers are needed)
- Trigger logic

Conclusion

The physics cases of

- HOT GDR, PDR, Nuclear Structure

requires the measurement of

- High and low energy γ-rays
- The multiplicity of the gamma radiation (in addition to AGATA information)
- good time resolution

Some of the LOI Requires the additional use of

- TRACE, RFD and Prisma

It is an excellent opportunity to prepare an AGATA+PARIS campaign

There will be a non negligible mechanical and electronics work to couple the two arrays during this campaign .

Thank you for the attention