



Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO



THE GAMMA COLLABORATION

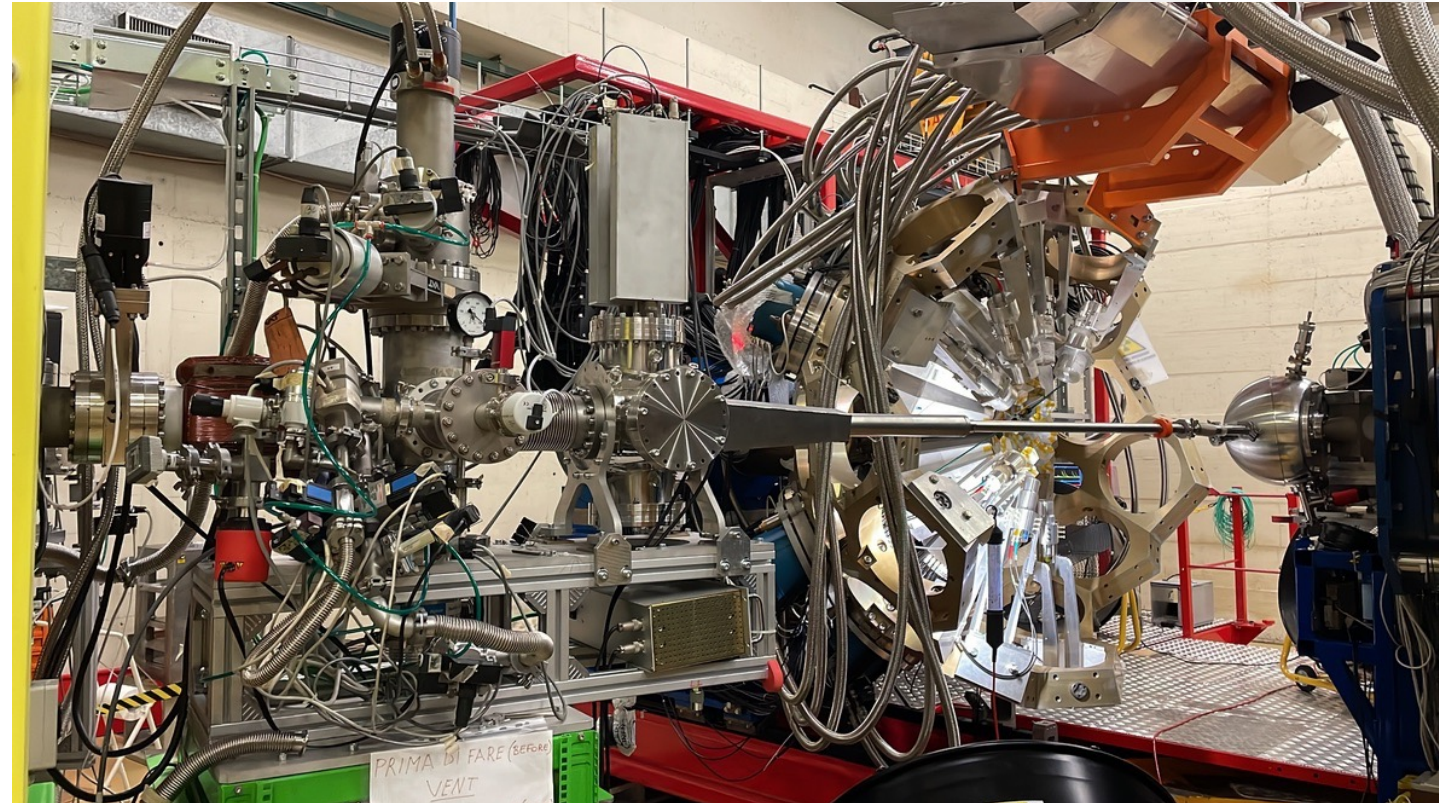
ALAIN GOASDUFF – INFN LNL



THE NATIONAL COLLABORATION



- Researchers
46.22 FTE (61 people)
- Technologists
5.25 FTE (12 people)
- 5 sections
Perugia, Firenze, Milano, Padova, LNL
- Consuntivi 2023:
 - 94 Publications
 - 128 Talks
 - 31 Thesis
- National coordinators:
Andrea Gottardo (LNL), Silvia Leoni (MI)



GAMMA @ LNL

- Researchers:

11.25 FTE (16 people including 6 PhDs)

- Technologists:

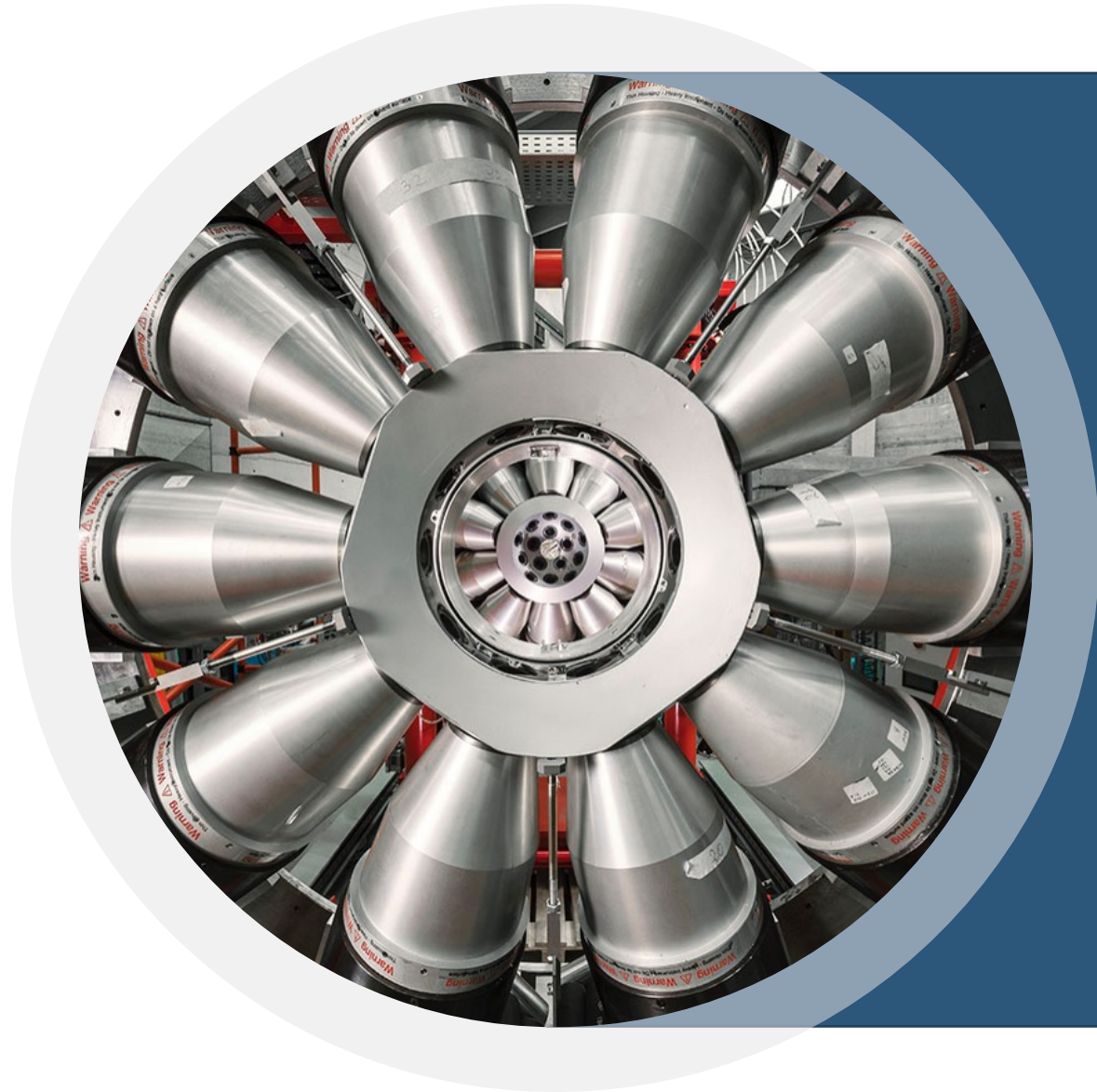
2.15 FTE (8 people)

- Local coordinator:

Alain Goasduff

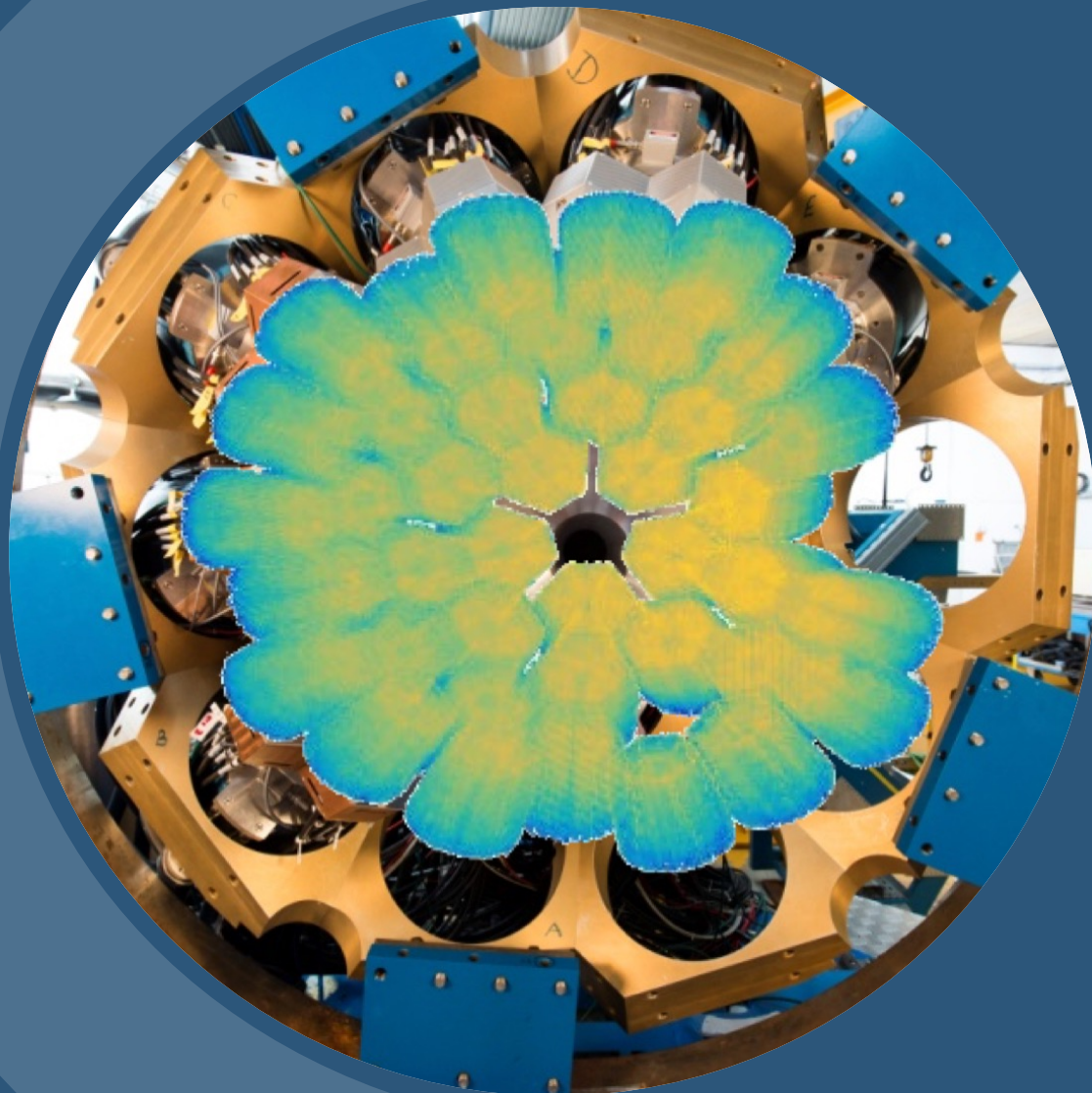
- Projects:

- **GALILEO** – Resident HPGe array at LNL
- **AGATA** – Segmented HPGe detectors
- **NEDA** – High efficiency neutron multiplicity
- **GRIT** – Segmented Si detectors
- **PARIS** – High efficiency phoswich detectors
- **CTADIR** – Cryogenic Target –PRIN2017-2022
- **B-DS** – b-decay station for SPES
- **SLICES** – Electron spectroscopy for SPES





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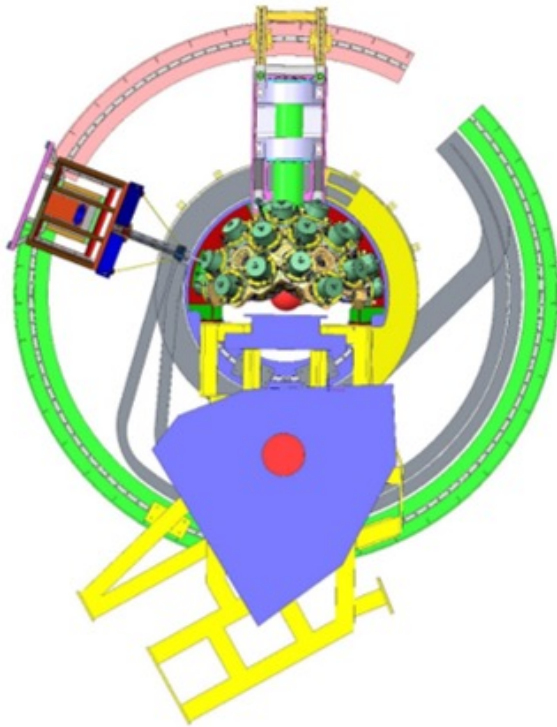


AGATA @ LNL

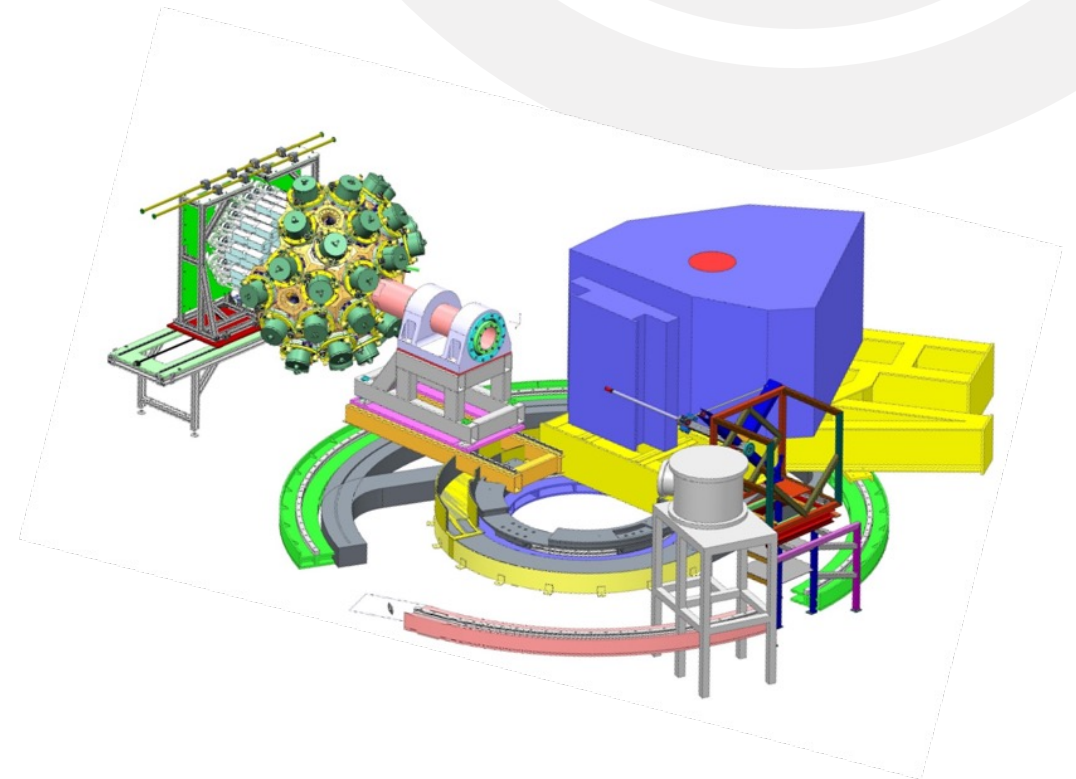


AGATA CAMPAIGN @ LNL

Coupled to PRISMA
(since 2022)



Configuration at “Zero-degrees”
(from 2025)



Exploring the nuclear chart

Search for octupole structures in the light U Th and Pa isotopes via
Multinucleon transfer reactions
(A. Goasduff G. De Angelis)

Understanding the nature of 0^+ states in ^{110}Sn and ^{112}Sn and ^{108}Cd
(N. Marginean, M.Ciemala, F.Crespi)

Probing Multiple Shape Coexistence in ^{110}Cd with Coulomb Excitation
(M.Zielinska, K.Wrzosek Lipska, A.Nannini, P.Garrett)

Pathway to nuclear structure in heavy neutron rich nuclei in the vicinity of N=126 and nuclei northwest of ^{132}Sn via multinucleon transfer reactions
(P.Reiter)

Search for a Josephson like effect in the $^{116}\text{Sn}+^{60}\text{Ni}$ system
(L. Corradi, S. Szilner)

Coexisting Shapes in ^{96}Zr
(D. Doherty, N. Marchini, M. Zielinska)

Shape Coexistence Coulex of ^{74}Se
(W.Korten, K.Wrzosek Lipska, E.Clement)

Study of shape coexistence in ^{60}Fe via lifetime measurement of excited 0^+ states
(G.Pasqualato/J.Ljungvall)

Test of the CKM unitarity and the existence of Fierz interference through the measurement of superallowed beta decay of light nuclei
(J.Ha/F.Recchia)

Lifetimes in the ^{196}Os region populated with multinucleon transfer reactions
(D. Brugnara, M. Sedlak, J. Pellumaj)

Probing nucleon nucleon correlations in the $^{48}\text{Ca}+^{208}\text{Pb}$ system below the Coulomb barrier
(T. Mijatovic L. Corradi)

Fusion fission for gamma ray spectroscopy of neutron rich nuclei around N=50
(A. Gottardo, M. Caamano, D. Ramos, JJVD)

Nuclear structure in the vicinity of the Z=28 neutron rich isotopes with AGATA and PRISMA
(R.M.PerezVidal/S.Bottoni/E.Sahin/A.Illana)

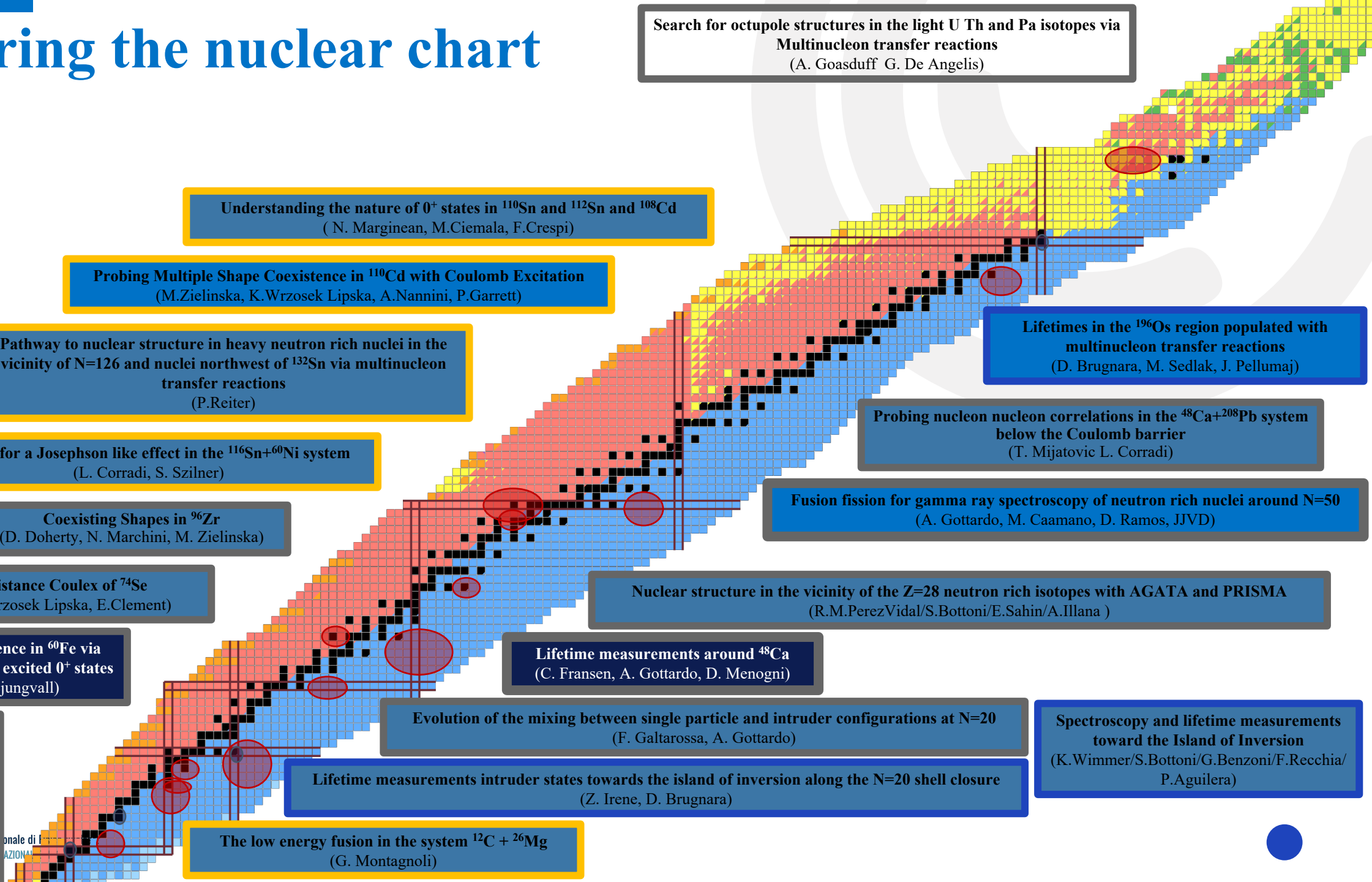
Lifetime measurements around ^{48}Ca
(C. Fransen, A. Gottardo, D. Menogni)

Evolution of the mixing between single particle and intruder configurations at N=20
(F. Galtarossa, A. Gottardo)

Spectroscopy and lifetime measurements toward the Island of Inversion
(K. Wimmer/S.Bottoni/G.Benzoni/F.Recchia/P.Aguilera)

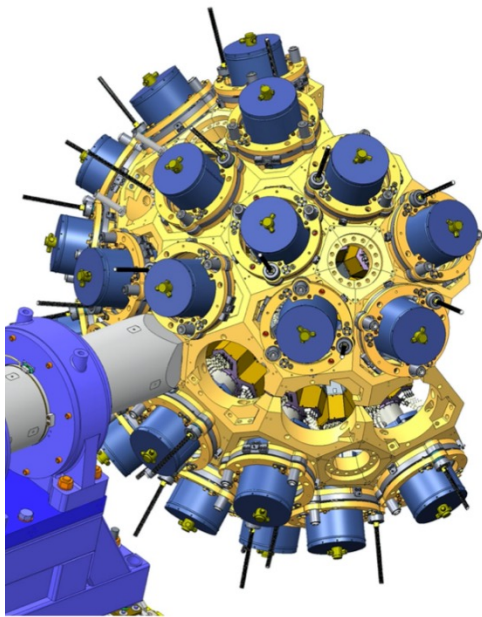
Lifetime measurements intruder states towards the island of inversion along the N=20 shell closure
(Z. Irene, D. Brugnara)

The low energy fusion in the system $^{12}\text{C} + ^{26}\text{Mg}$
(G. Montagnoli)

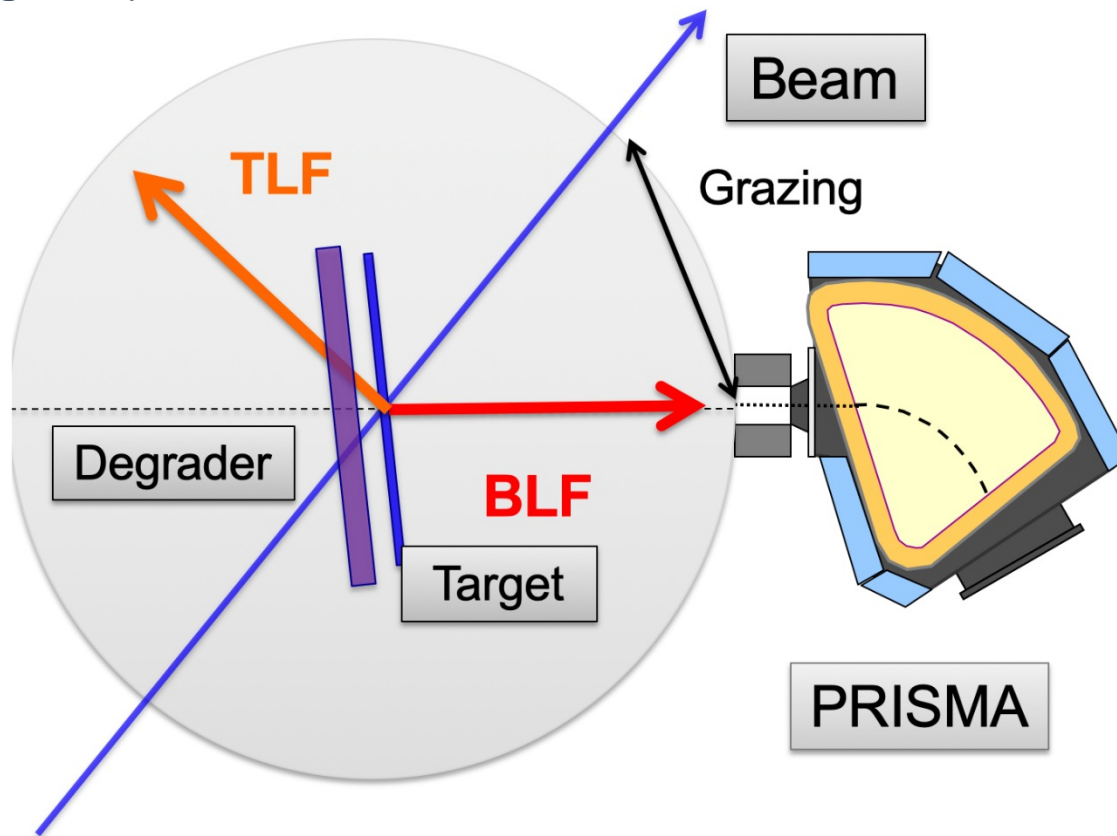


LIFETIME MEASUREMENT IN HEAVY PARTNER

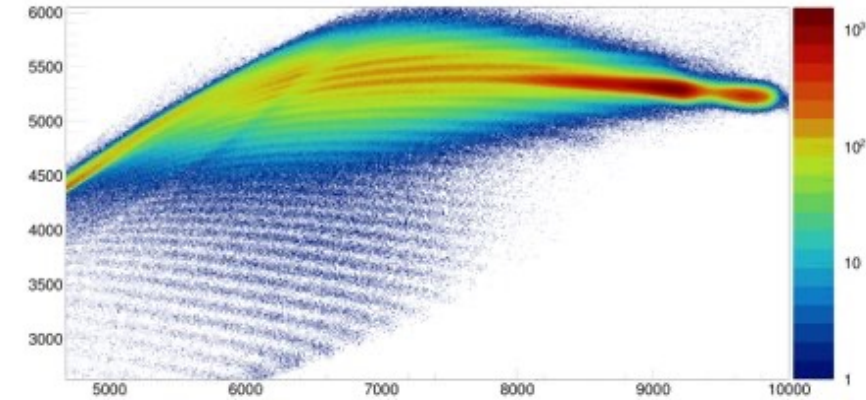
$^{136}\text{Xe} + ^{198}\text{Pt}$ (1.4 mg/cm²) at 1.13 GeV



AGATA

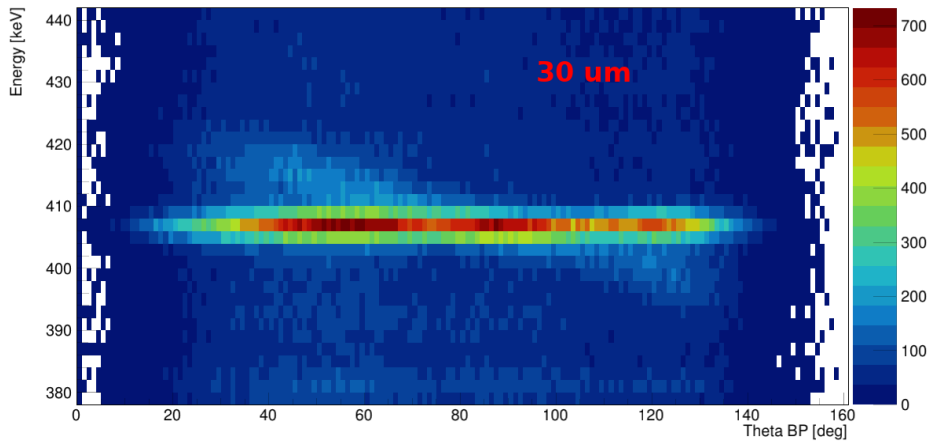


Z identification in PRISMA

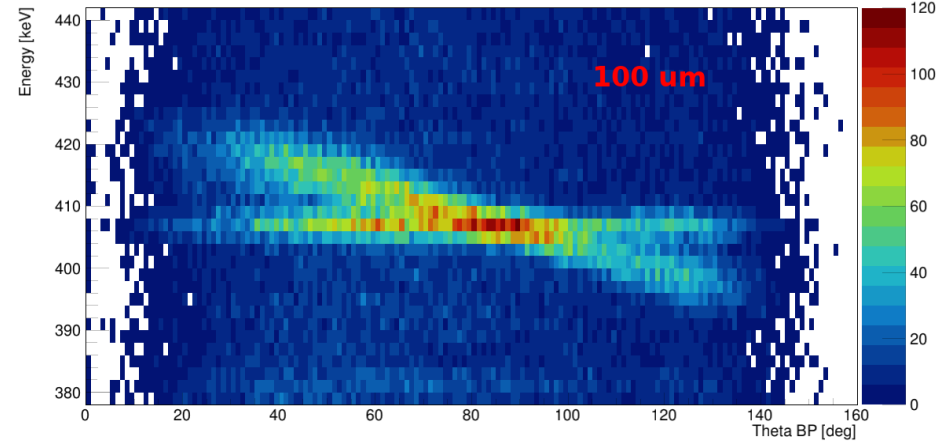


LIFETIME MEASUREMENT IN HEAVY PARTNER

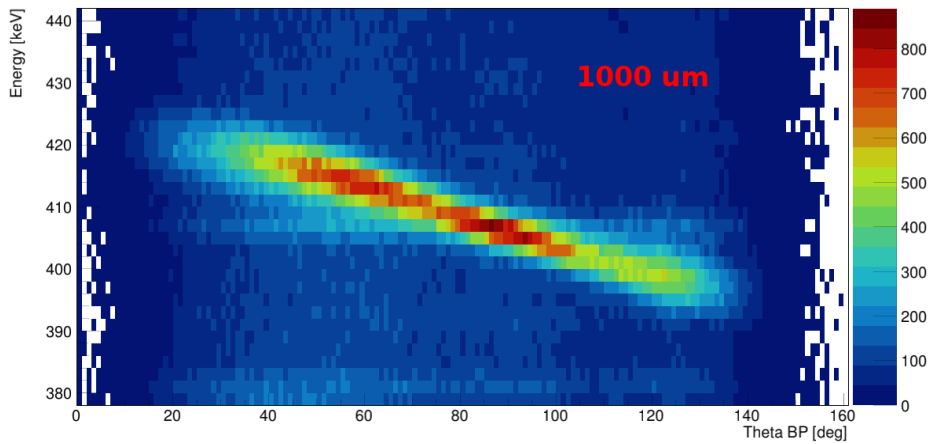
Non-DC gamma energy vs theta of binary partner adback spectrum with cut a136_z54



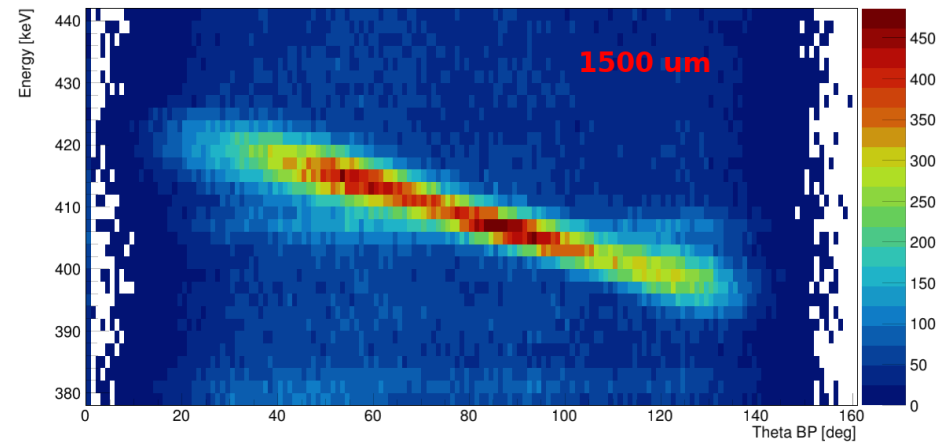
Non-DC gamma energy vs theta of binary partner adback spectrum with cut a136_z54



Non-DC gamma energy vs theta of binary partner adback spectrum with cut a136_z54



Non-DC gamma energy vs theta of binary partner adback spectrum with cut a136_z54



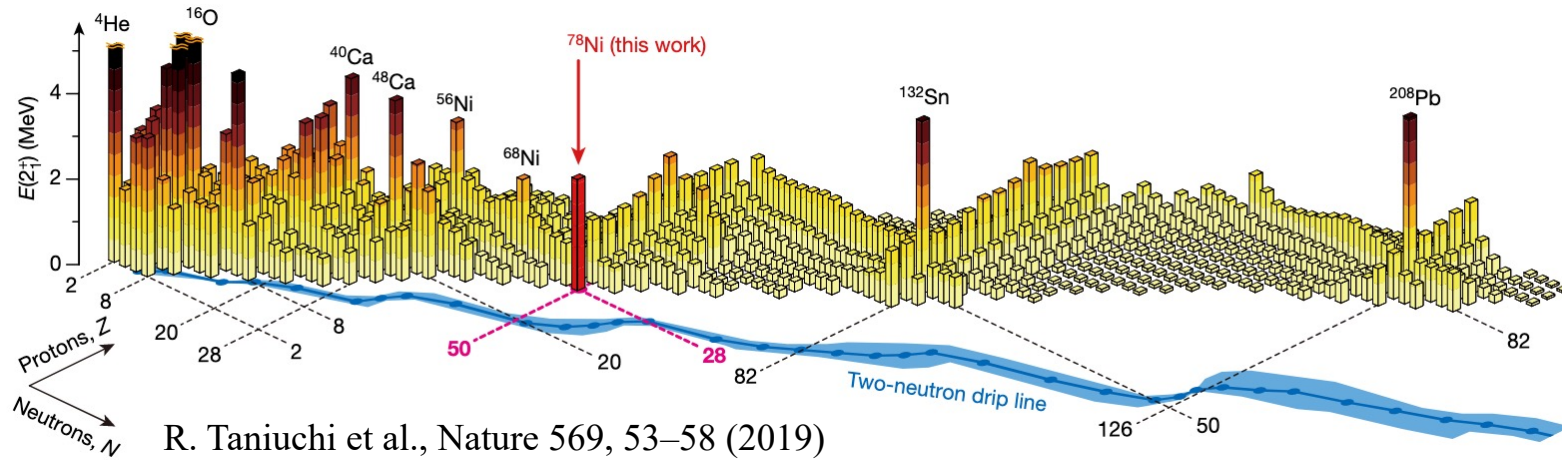
^{198}Pt
 $E(2^+) = 407 \text{ keV}$
 $t_{1/2} = 22 \text{ ps}$

Fusion-fission for $N=50$ studies

(A. Gottardo, M. Caamaño, J. J. Valiente-Dobón, D. Ramos)



The N=50 closure in neutron rich nuclei

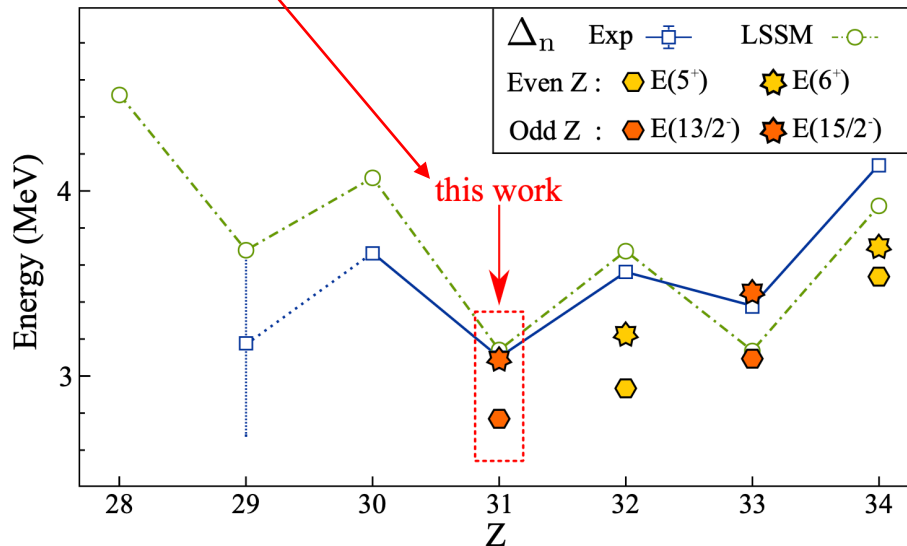


Proton knockout technique: **low spin** levels, **proton s.p.** wave function
 Prediction (and observation?) of a well deformed 4p-4h intruder structure

R. Taniuchi et al., Nature 569, 53–58 (2019)

F. Nowacki et al., Phys. Rev. Lett. 117, 272501 (2016)

J. Dudouet et al. PRC 100, 011301(R) (2019)



Energy gap reduction in N=50 isotones towards ⁷⁸Ni.

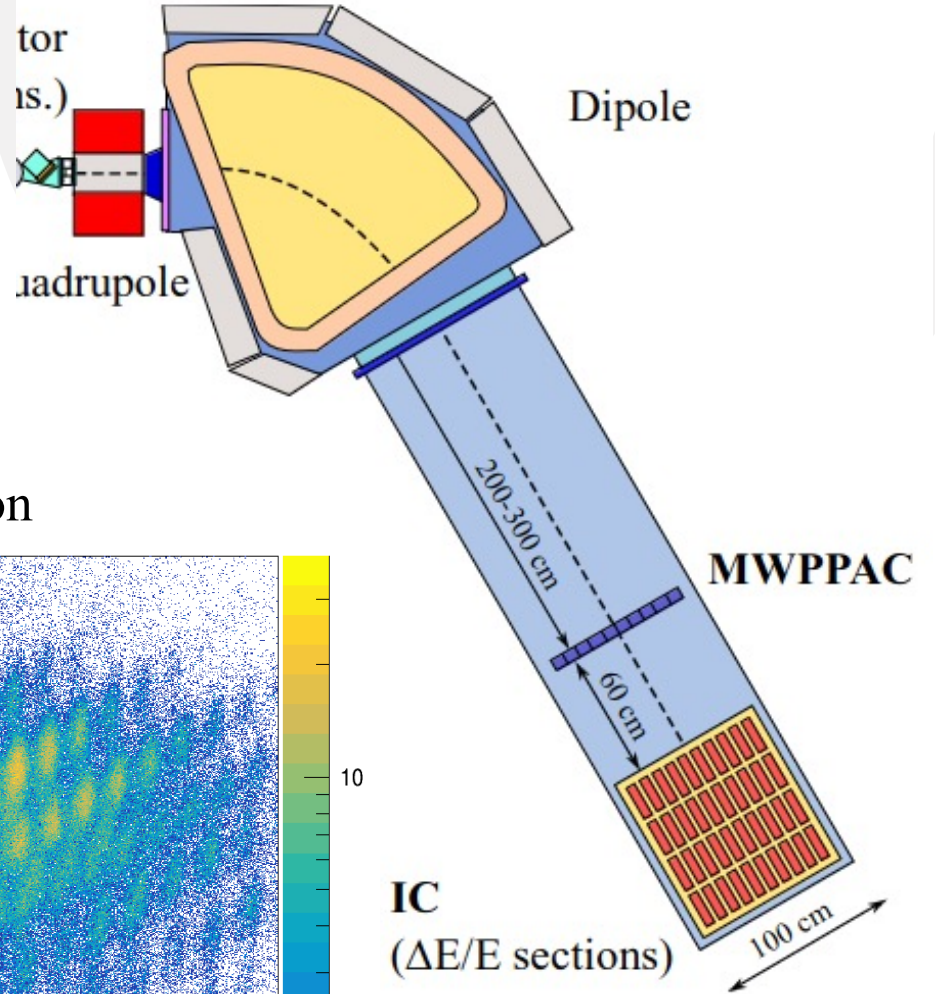
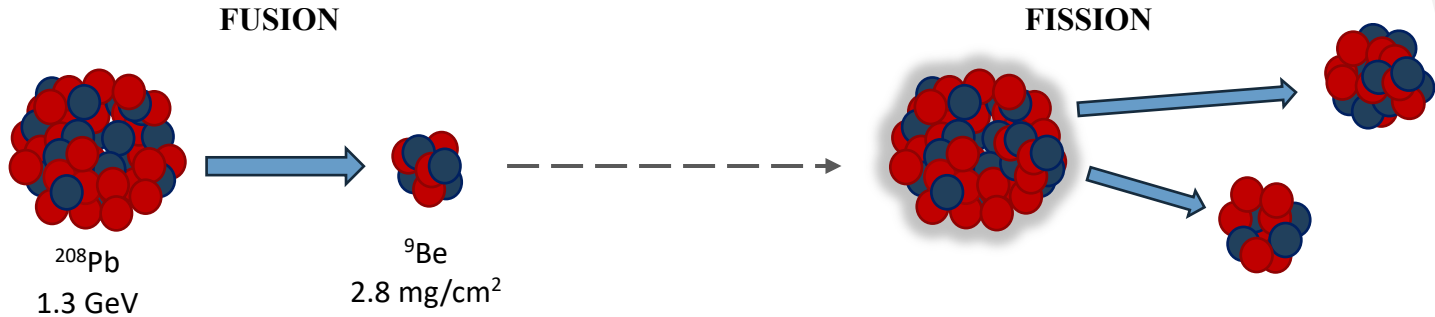
Increase in ⁸⁰Zn from mass measurements.

5⁺, 6⁺ states in even-even nuclei come from core excitations and provide a measurement of the gap.

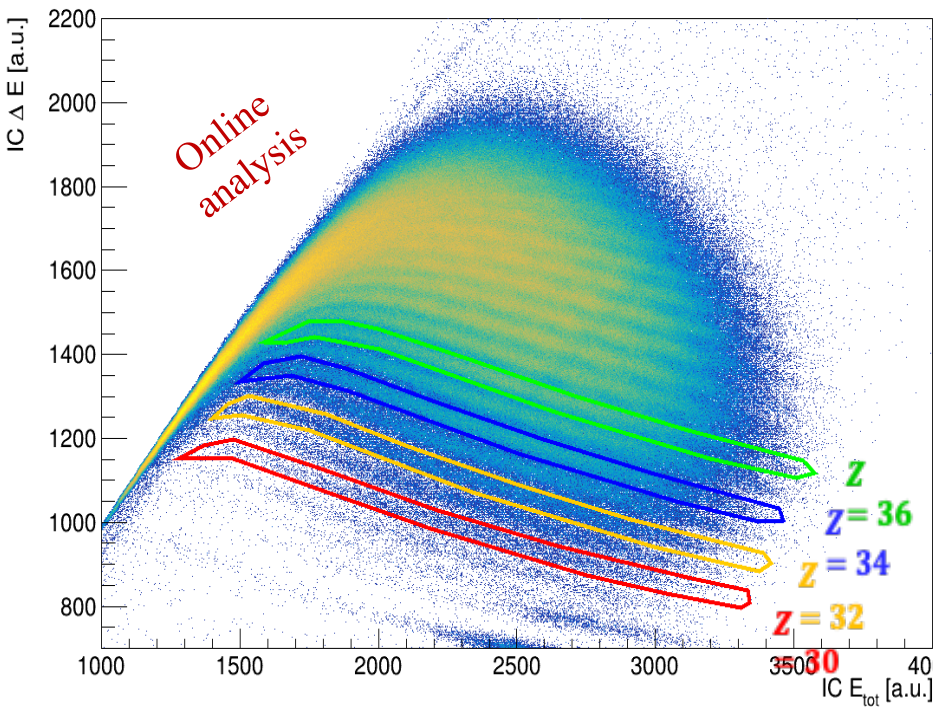
Yrast states in ⁸⁰Zn, ⁷⁹Cu



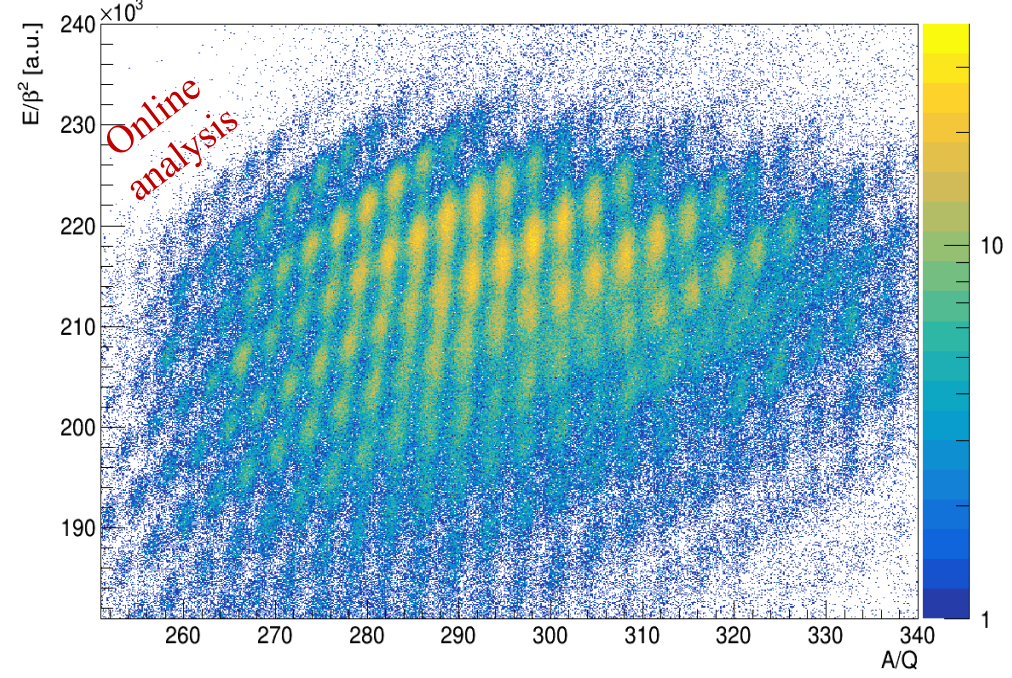
Fusion-fission for N=50 studies



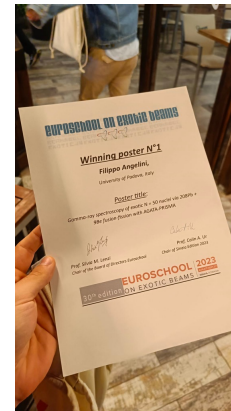
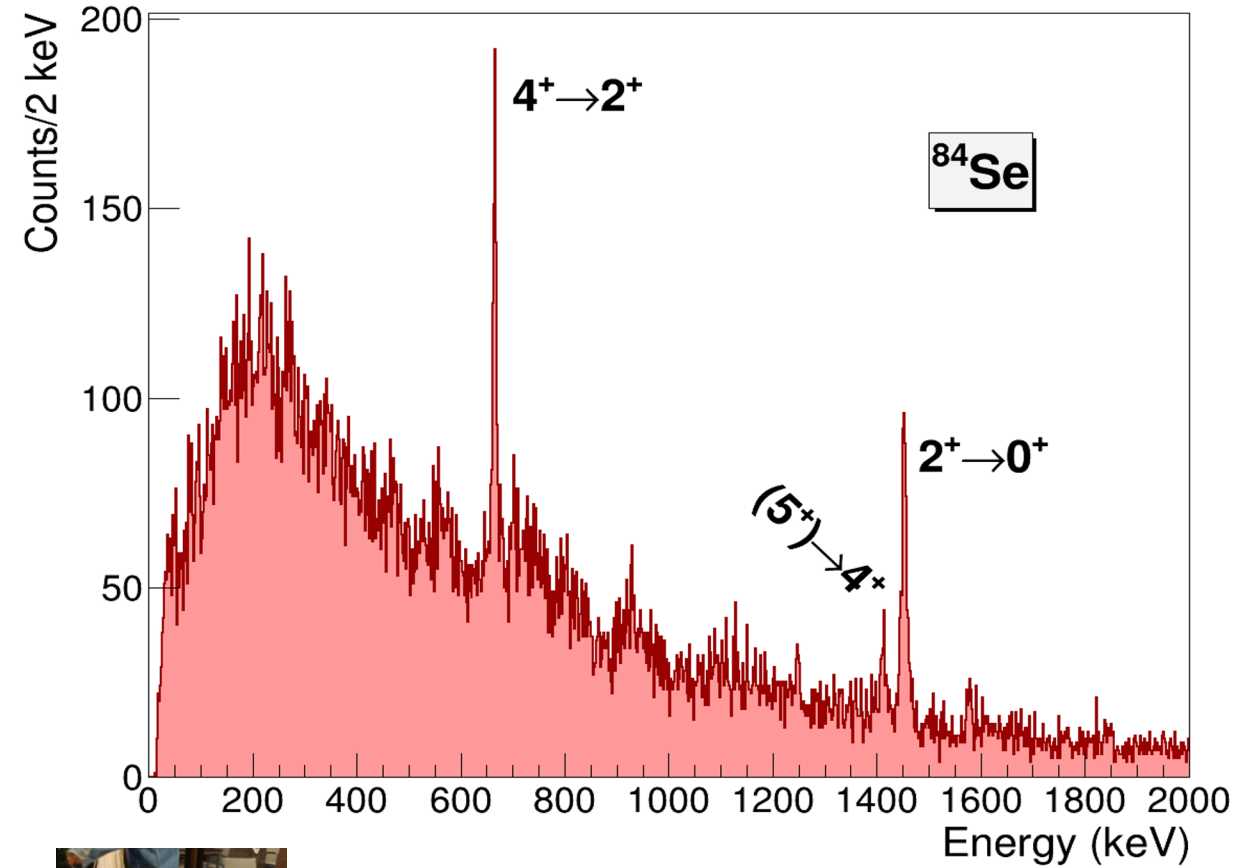
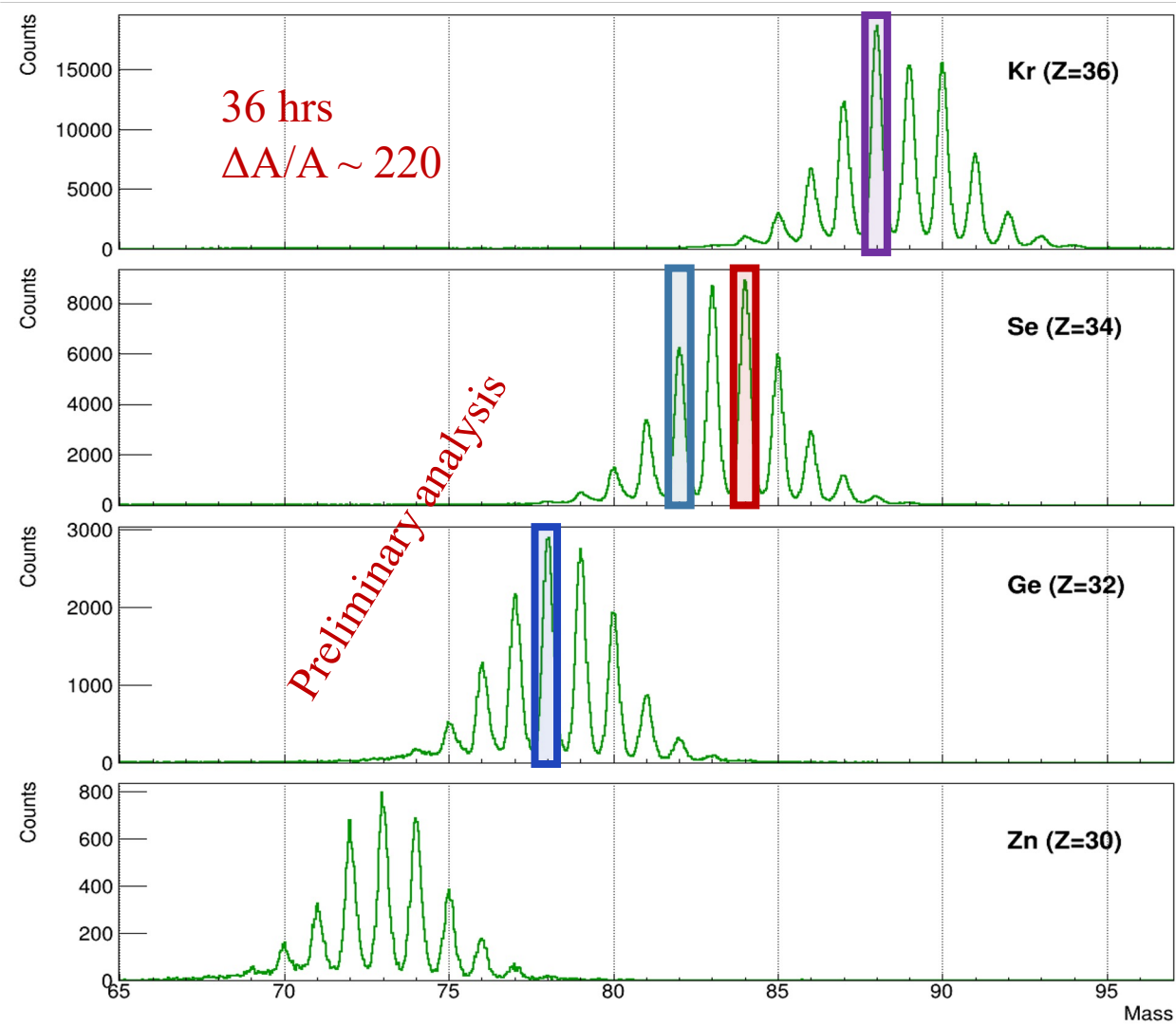
Z identification



A/Q identification



Preliminary data



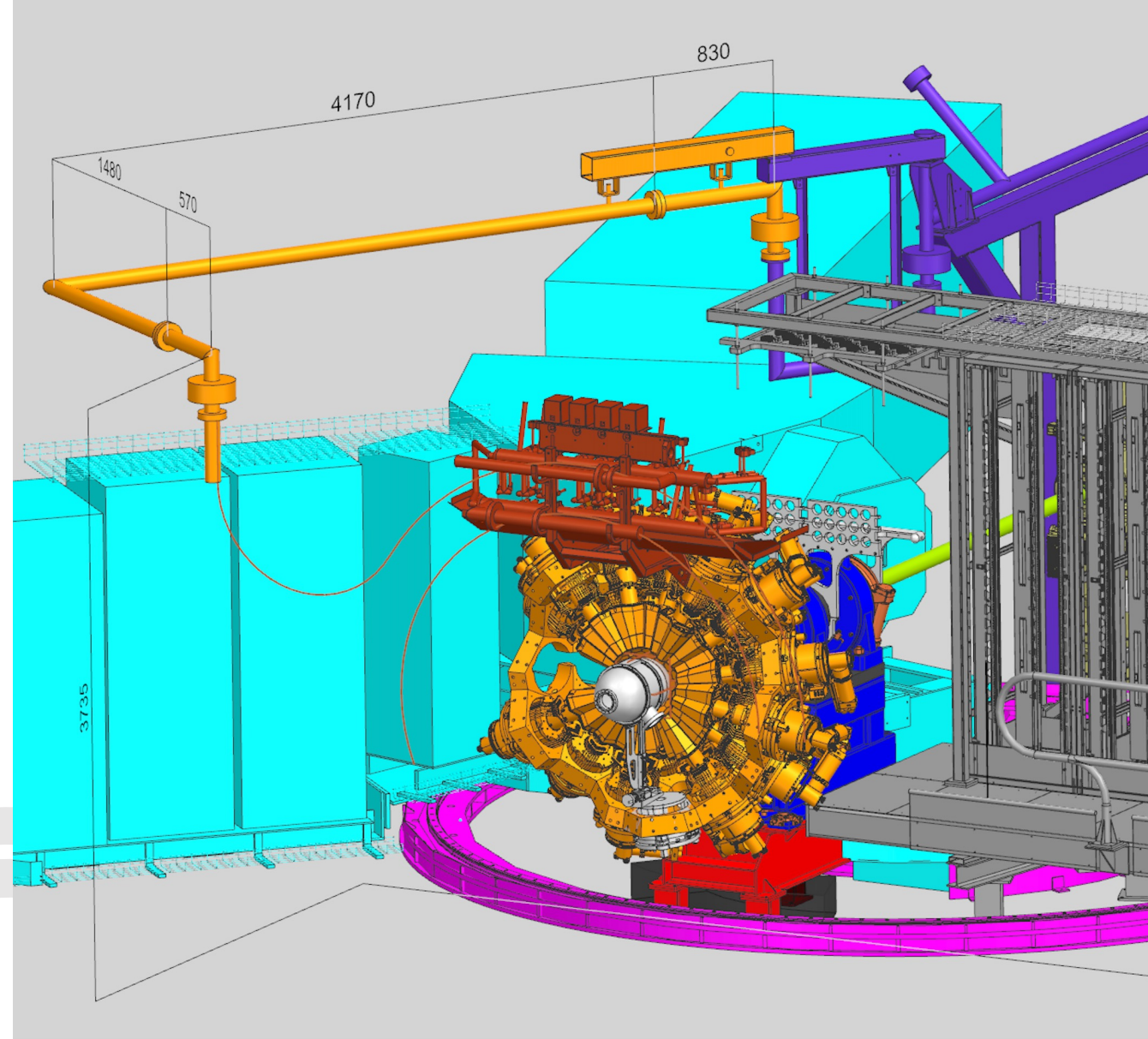
PhD Thesis of F. Angelini (University of Padova)

AGATA ZERO DEGREES

AGATA at zero-degrees

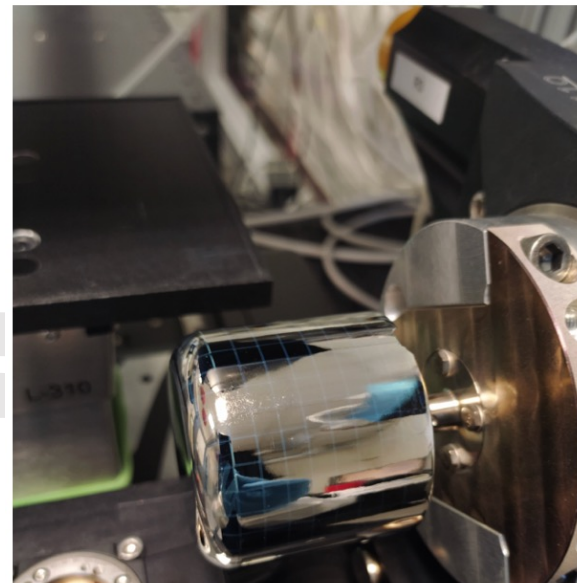
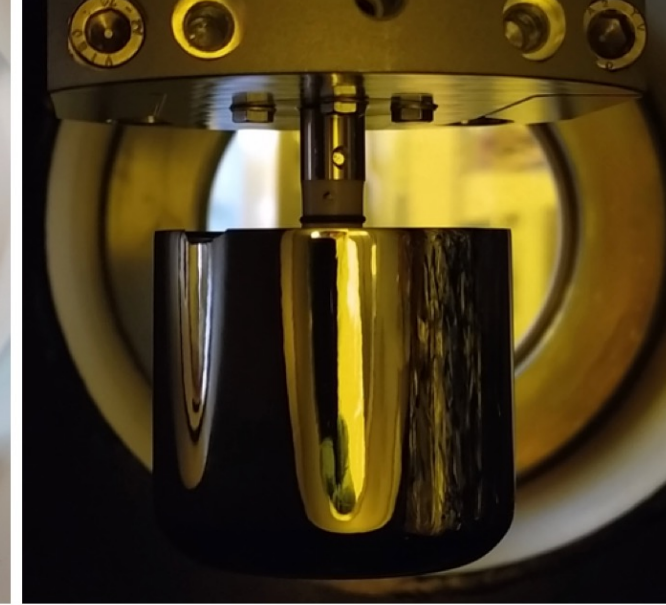
- Hot rotating nuclei, GDR, super deformation, high spin states
- Isospin symmetry, proton-neutron pairing and spectroscopy of $N \sim Z$ nuclei
- Direct reactions, Coulex and lifetime measurements, near-threshold states
- Reactions relevant for astrophysics, structure of ^{12}C , three-body force

Complementary instrumentation:
NEDA, PARIS, EUCLIDES, TRACE, ...



N₃G – HPGE DETECTOR DEVELOPMENT

- Development of front-end electronic
- New coating method for p-type segmented coaxial HPGe crystal
- Technology extensively tested under n-fluxes from the CN up to $4 \cdot 10^9$ neutrons/cm²
- Research Agreement between the LNL-N3G team and MIRION Technology (CANBERRA) is highly relevant





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GALILEO @ LNL



COLLABORATION WITH PANDORA

- New high rates pre-amplifier for GALILEO detectors (A. Pullia, S. Capra)
- First tests at LNL, production done
- Refurbishment of the 16 detectors in progress
- DAQ developed at LNL

Design study of a HPGe detector array for β -decay investigation in laboratory ECR plasmas

Eugenia Naselli^{1*}, Domenico Santonocito¹, Simone Amaducci¹, Luigi Celona¹, Alessio Galatà², Alain Goasduff², Giorgio Sebastiano Mauro¹, Maria Mazzaglia¹, Bharat Mishra¹, Daniel R. Napoli², Angelo Pidotella¹, Giuseppe Torrisi¹ and David Mascali¹

frontiers | Frontiers in Physics

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A high resolution γ -ray array for the pandora plasma trap

A. Goasduff¹, D. Santonocito^{2*}, R. Menegazzo³, S. Capra^{4,5}, A. Pullia^{4,5}, W. Raniero¹, D. Rosso¹, N. Toniolo¹, L. Zago^{1,6}, E. Naselli² and D. R. Napoli¹

¹Laboratori Nazionali di Legnaro, INFN, Legnaro, Italy, ²Laboratori Nazionali del Sud, INFN, Catania, Italy, ³Sezione di Padova, INFN, Padova, Italy, ⁴Dipartimento di Fisica, Università degli Studi di Milano, Milano, Italy, ⁵Sezione di Milano, INFN, Milano, Italy, ⁶Dipartimento di Fisica e Astronomia, Università degli Studi di Padova, Padova, Italy

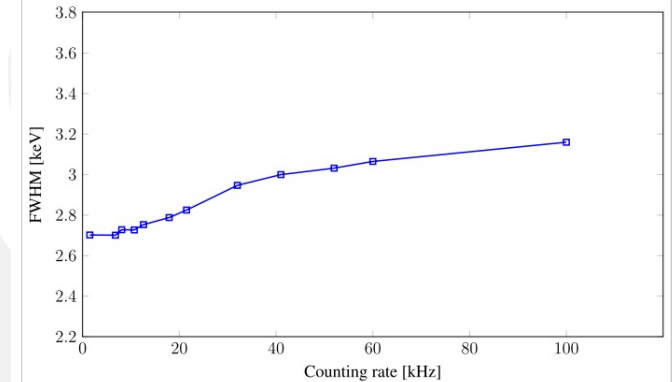


FIGURE 6

Measured FWHM of a GALILEO HPGe single crystal as a function of the counting rate using the V1725 CAEN digitizer. The HPGe detector was equipped with the new pre-amplifier. A 150 kBq ⁶⁰Co source placed at 10 cm from the detector, generating a fixed counting rate of 1.5 kHz. A stack of sources, composed of ²⁴¹Am, ¹³³Ba and ¹³⁷Cs, was placed on a movable vertical plate in order to simulate different low energy background counting rates. All the measurements were taken over 10 min runs.

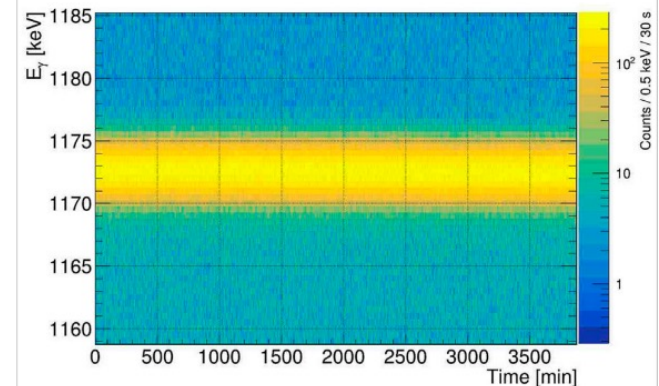
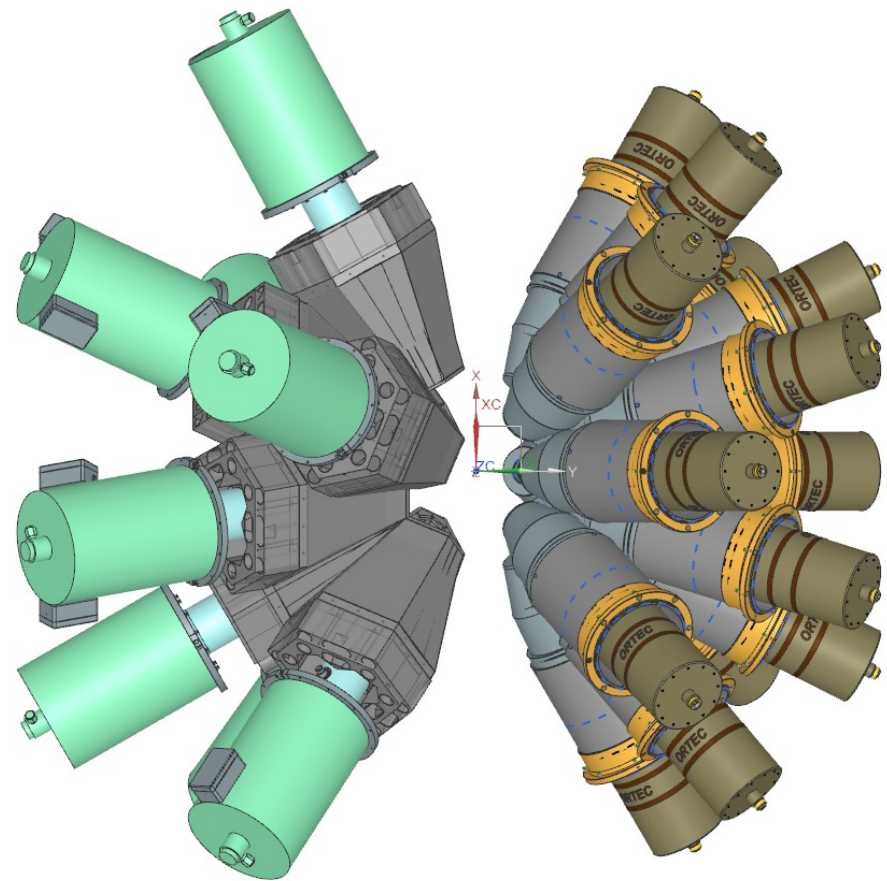


FIGURE 8

Energy vs. Time measured of 60 h using the multi-source with a total rate of 50 kHz. The energy axis has been zoomed on the 1172-keV transition coming from the ⁶⁰Co source.

GALILEO PHASE III

- Discussion within the GAMMA collaboration started to prepare the phase III of the GALILEO array
- Short term:
 - refurbishment of the pre-amplifier for high rates capabilities for high intensity stable beams
- Long term:
 - Increasing the detection efficiency
 - Increased flexibility of the geometry
 - Stable / radioactive beams
 - Measurement with PRISMA / standalone





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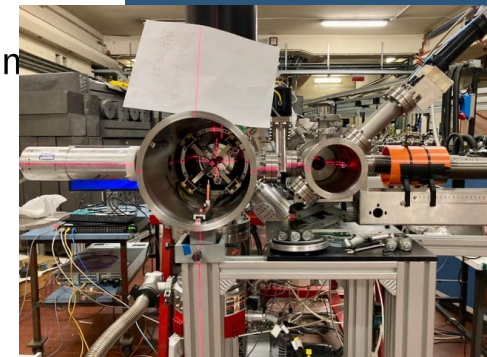
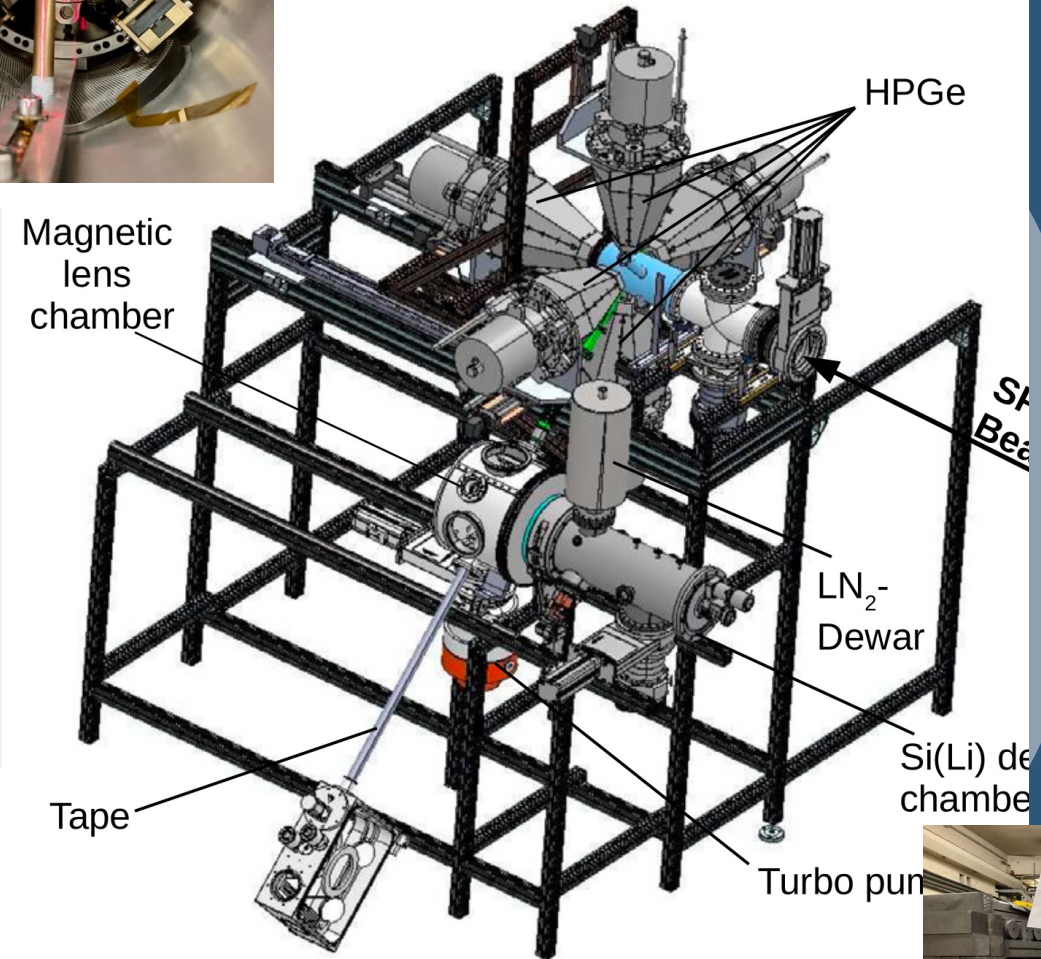
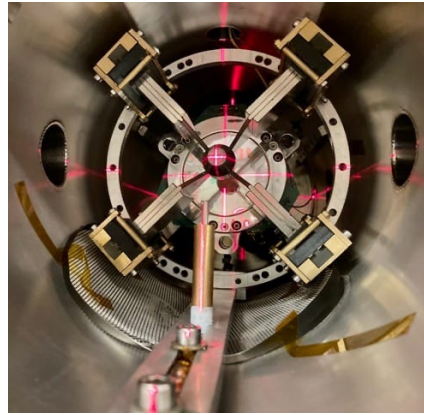


SPES 1⁺ BEAMS

DECAY STUDIES

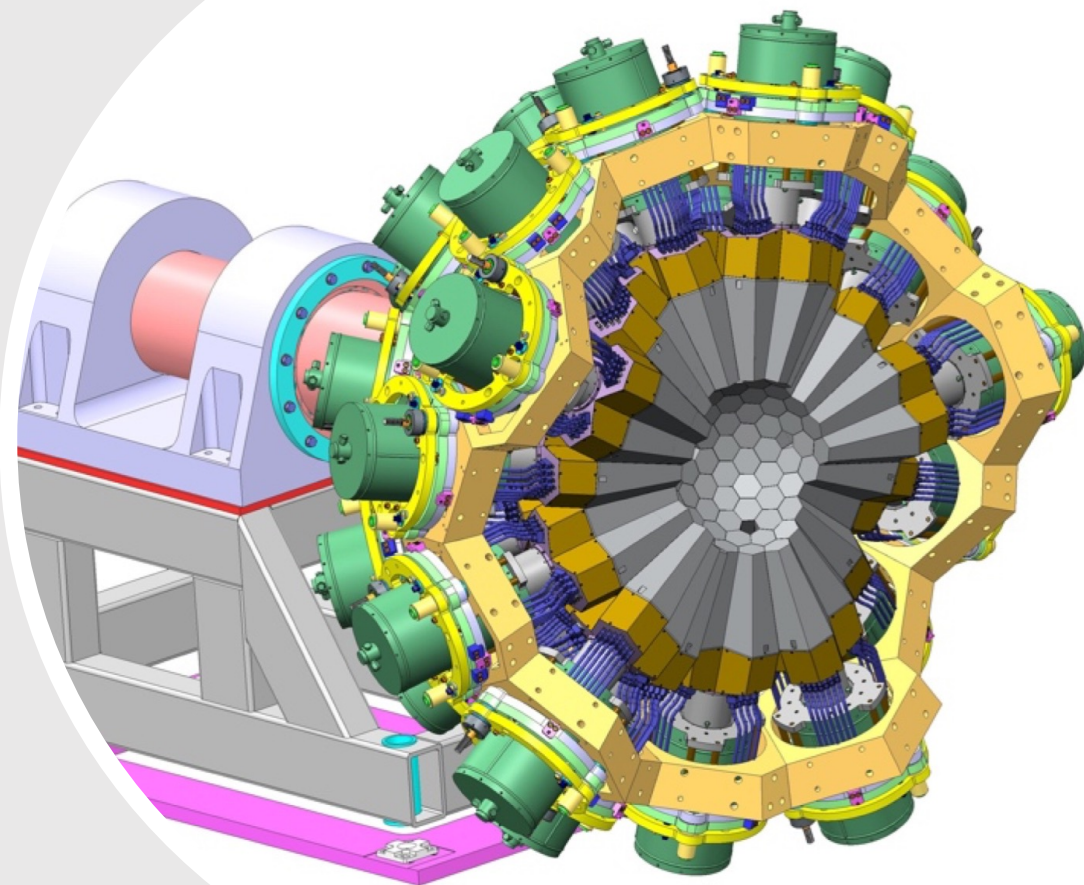
SPES LOW ENERGY

- Two measurement points:
 - Beta-decay:
 - 5 GALILEO Triple Cluster + Anti-Compton
 - New plastic for $4\pi\beta$ tagging
 - Delayed electron spectroscopy:
 - Segmented silicon 7 mm-thick detector
 - β -tagging
 - Tested at CN and available for experiments (ICE118Sn)





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THANK YOU



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[HTTP://GAMMA.LNL.INFN.IT](http://gamma.lnl.infn.it)