AGATA PHYSICS CAMPAIGNS IN 2022-2025

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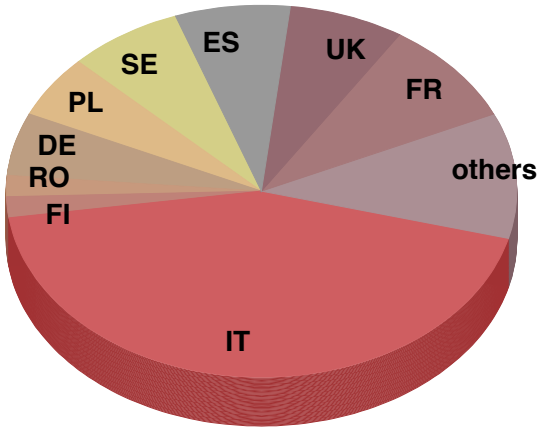
Lyon, June 21-23, 2023

EXPERIMENTAL CONSTRAINTS FOR THE 2022-2023 CAMPAIGN

- stable beams from the Tandem-ALPI-PIAVE complex
- ancillaries compatible with PRISMA
- ready to run in 2022-2023 (excludes projects that need long-term beam development or detectors used elsewhere, e.g. PARIS)

- **first Pre-PAC Workshop** (November 8-10, 2021) : 34 LoIs presented



- large majority (24) with at least one Italian spokesperson
- 9 out of 13 countries of the AGATA collaboration represented by LoI spokespersons
- co-spokespersons from Croatia, Belgium, Norway, US, Australia; 56 persons from 14 countries act as spokespersons

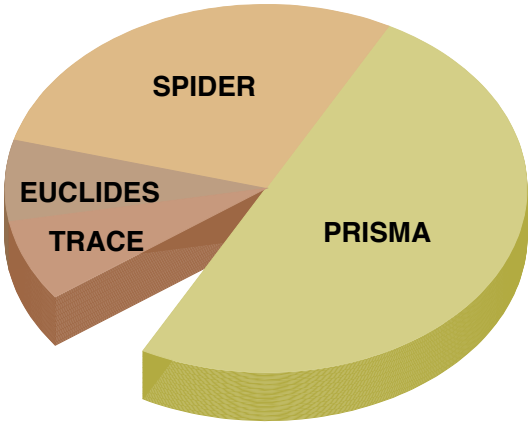
AFTER THE PRE-PAC MEETING

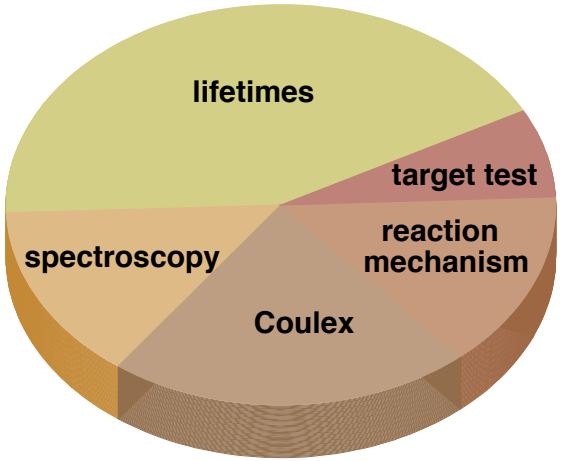
- call for proposals, December 11, 2021 – only TANDEM beams available before autumn 2022

⇒ we decided to authorise submission of proposals for AGATA with TANDEM beams, which have not been discussed at the Pre-PAC

- 27 AGATA projects + commissioning proposed to the PAC, for a total of 227 days (151 TANDEM only, 137 involving ALPI and/or PIAVE)
- PAC meeting February 21 – 24, 2022:
  10 measurements with AGATA accepted with priority A
  (7 complete experiments, 2 feasibility tests, 1 extended commissioning)
  5 more with priority B (one of them scheduled in 2022)
- TANDEM only: 45 days + 9, need for ALPI and/or PIAVE: 38 days + 11

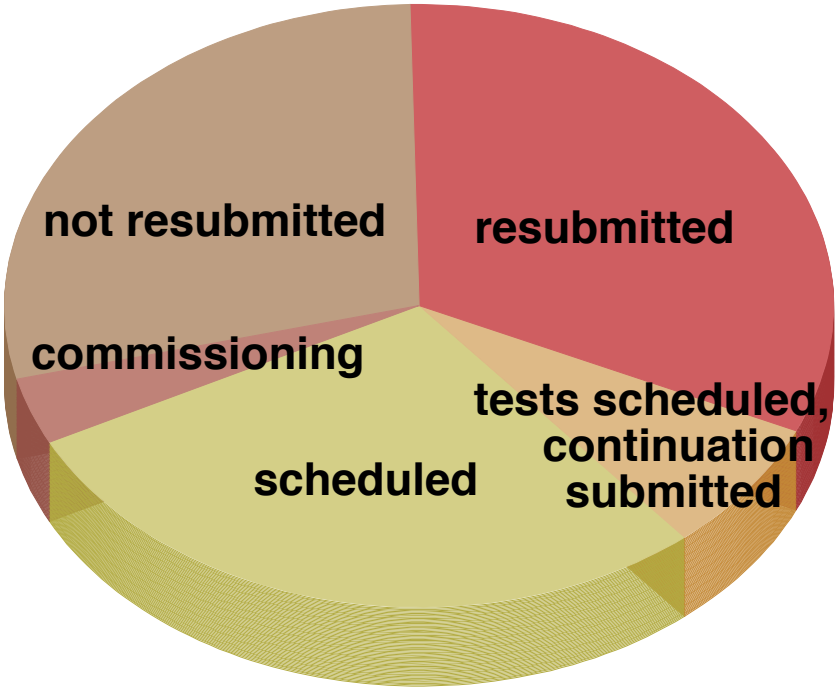
ACCEPTED PROPOSALS - STATISTICS





- 7 projects out of 14 required PRISMA
- lifetime measurements (RDDS, DSAM) dominated, with a fair share of other types of measurements

PROJECTS DISCUSSED AT FEBRUARY 2022 PAC



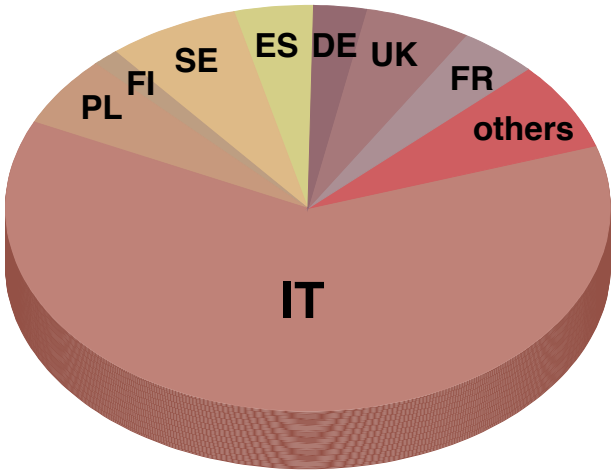
8 physics projects scheduled
(7 priority A + 1 priority B)
+ one priority B experiment scheduled after the Pre-PAC

2 proof-of-principle tests scheduled – physics projects on their basis submitted to the 2nd pre-PAC

9 proposals resubmitted to the current Pre-PAC, some with important modifications (-1)

8 proposals not resubmitted

SECOND PRE-PAC - STATISTICS

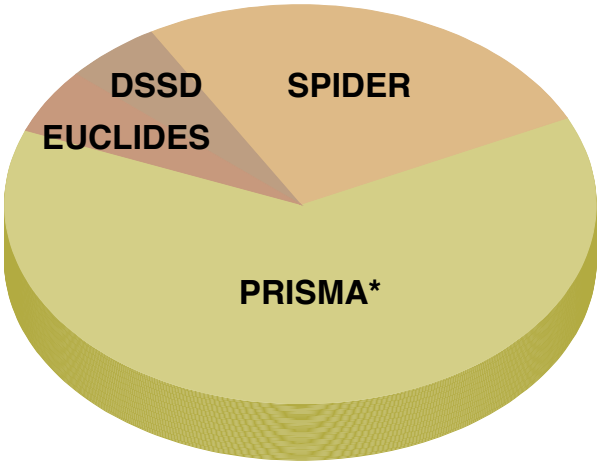


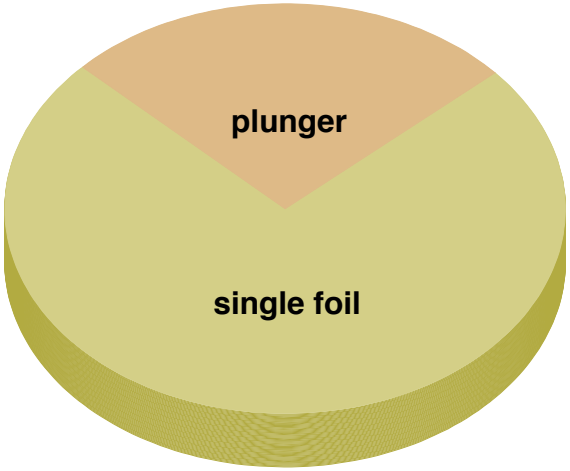
- 28 LoIs submitted, including 9 new ones
- projects prepared in closer collaboration with local experts: considerably fewer technical challenges, more refined rate estimates and simulations
- emerging vast collaborations around certain physics themes (e.g. lifetimes around ^{68}Ni)

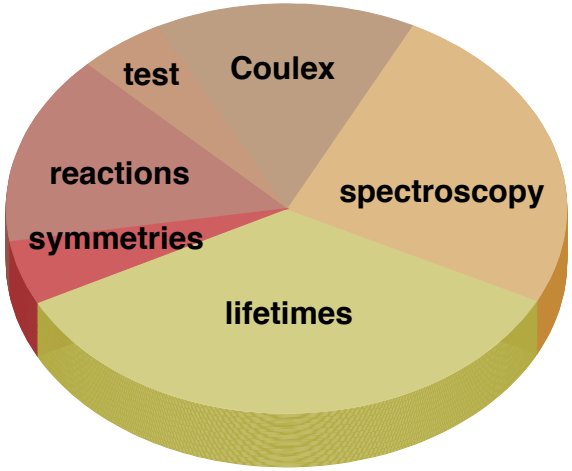
- large majority of Italian spokespersons; other 7 countries of the AGATA collaboration also represented
- 50 persons from 13 countries act as spokespersons

About 270 days of beamtime requested – minor decrease compared to last year

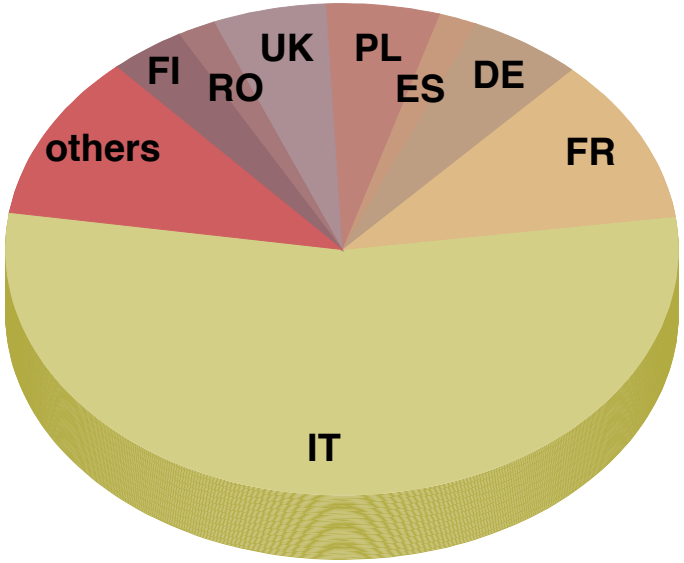
ACCEPTED PROPOSALS (PRIORITY A + SCHEDULED PRIORITY B)







- Experiments involving PRISMA dominate (plot includes those that use DANTE or LaBr together with PRISMA)
- Good balance between spectroscopy, lifetime measurements (plunger and DSAM), and Coulomb excitation; reaction mechanism studies important
- Good representation of most countries of the AGATA collaboration among the spokespersons, with a fair participation of countries outside the collaboration

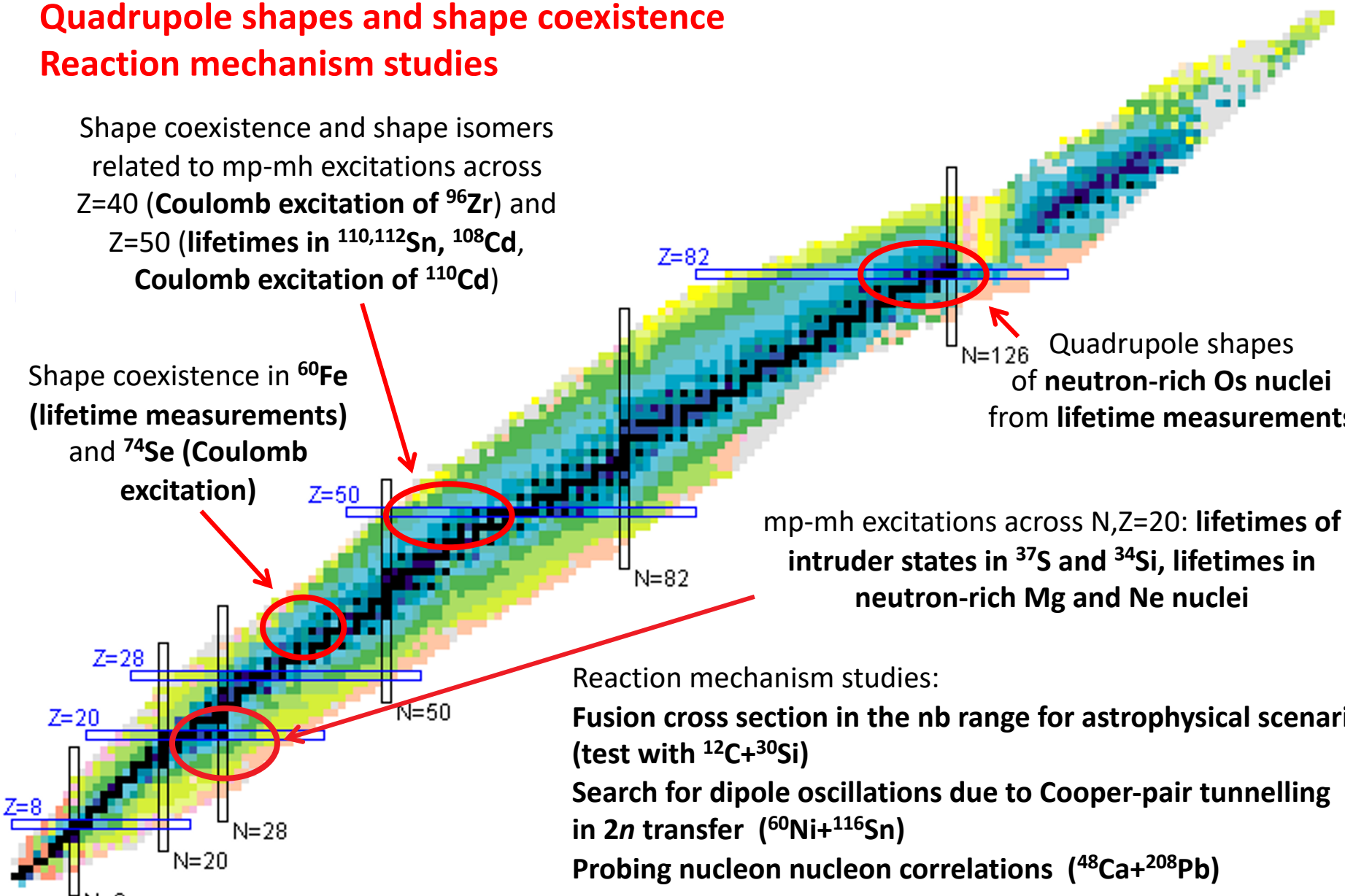


PHYSICS CASES – ACCEPTED PROJECTS

Quadrupole shapes and shape coexistence
Reaction mechanism studies

Shape coexistence and shape isomers related to mp-mh excitations across Z=40 (**Coulomb excitation of ^{96}Zr**) and Z=50 (**lifetimes in ^{110,112}Sn, ^{108}Cd, Coulomb excitation of ^{110}Cd**)

Shape coexistence in ^{60}Fe **(lifetime measurements)** and ^{74}Se **(Coulomb excitation)**



Quadrupole shapes of **neutron-rich Os nuclei** from **lifetime measurements**

mp-mh excitations across N,Z=20: **lifetimes of intruder states in ^{37}S and ^{34}Si, lifetimes in neutron-rich Mg and Ne nuclei**

Reaction mechanism studies:

Fusion cross section in the nb range for astrophysical scenarios (test with ^{12}C+^{30}Si)

Search for dipole oscillations due to Cooper-pair tunnelling in 2*n* transfer (^{60}Ni+^{116}Sn)

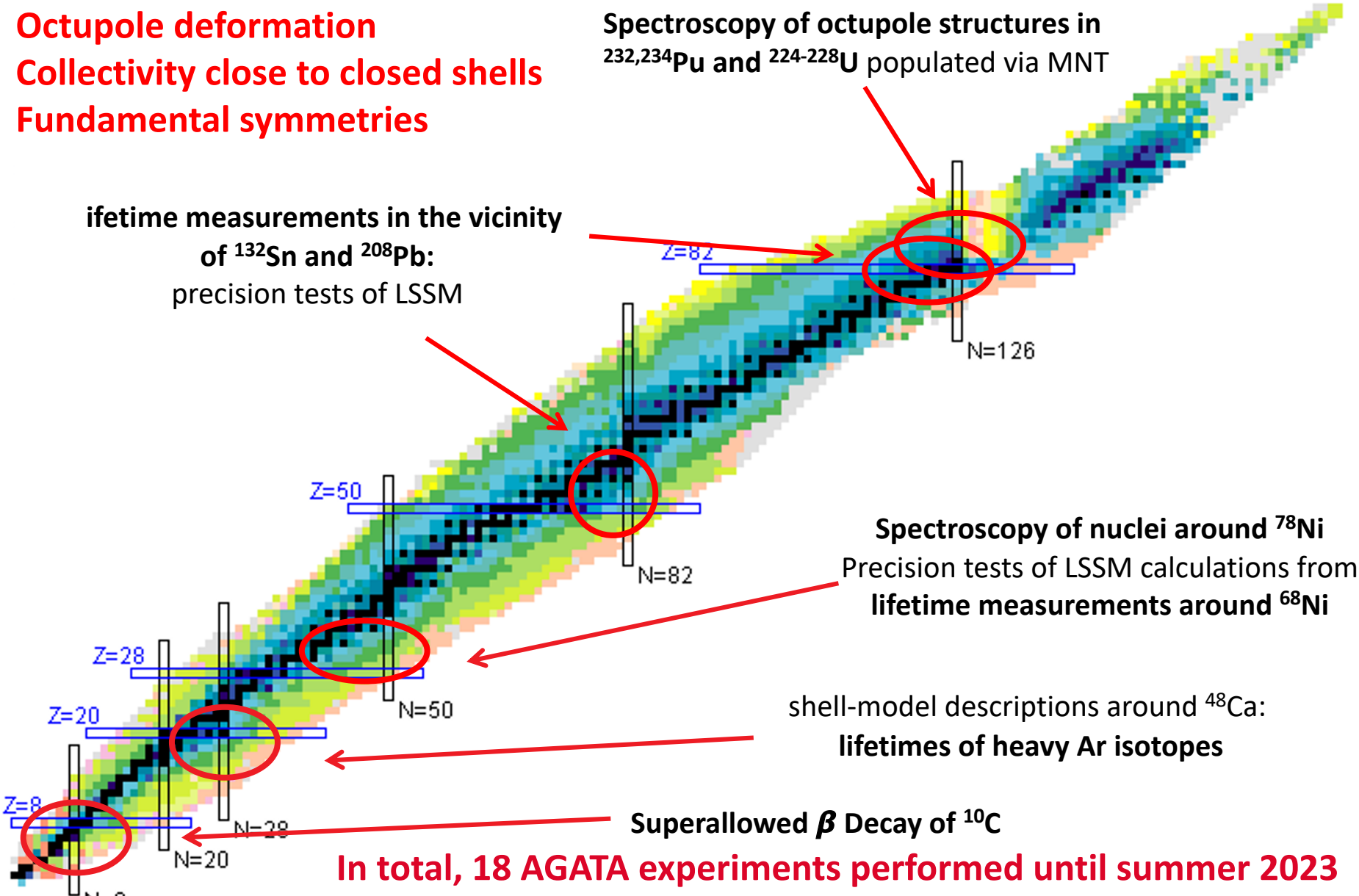
Probing nucleon nucleon correlations (^{48}Ca+^{208}Pb)

PHYSICS CASES – ACCEPTED PROJECTS

Octupole deformation
Collectivity close to closed shells
Fundamental symmetries

Spectroscopy of octupole structures in ^{232,234}Pu and $^{224\text{-}228}$U populated via MNT

ifetime measurements in the vicinity of ^{132}Sn and ^{208}Pb:
precision tests of LSSM



Spectroscopy of nuclei around ^{78}Ni
Precision tests of LSSM calculations from **lifetime measurements around ^{68}Ni**

shell-model descriptions around ^{48}Ca:
lifetimes of heavy Ar isotopes

Superallowed β Decay of ^{10}C

In total, 18 AGATA experiments performed until summer 2023

THIRD PRE-PAC (APRIL 2023)

- stable beams from Tandem
- complementary detectors compatible with PRISMA
- experiments ready to run before end of 2023

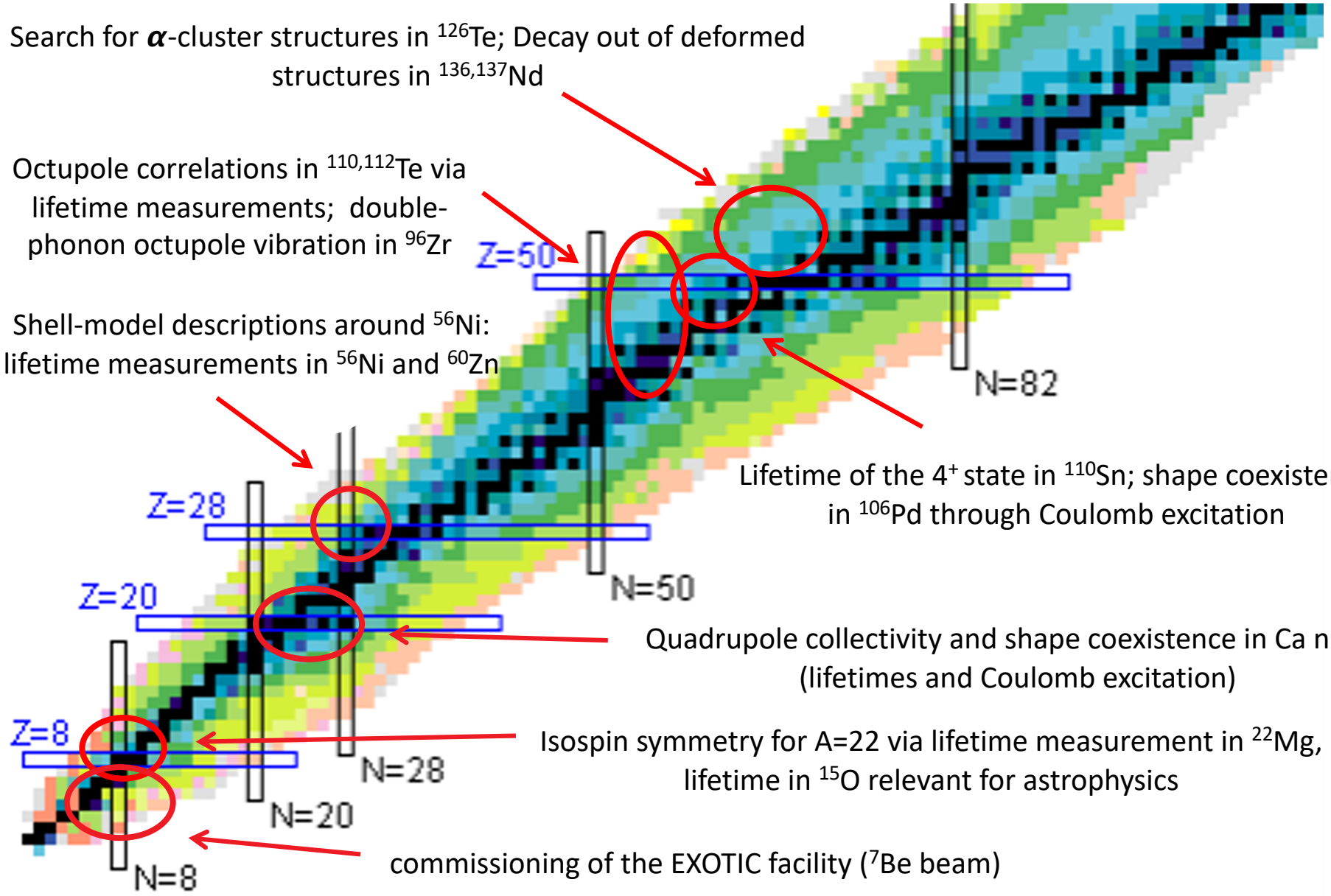
- These are strong constraints! While there is a large decrease of the number of LoIs compared to the previous two Pre-PACs, we should rather compare it to the number of AGATA proposals for the February 2022 PAC (”emergency” call for Tandem projects to be performed before summer 2022)
  - February 2022 PAC: 12 Tandem proposals for a total of 76 days (commissionning not included)
  - Third Pre-PAC: 11 new projects + two resubmitted ones, for a total of 80 days (+ two projects that did not provide a beamtime estimate)

PHYSICS CASES - 3RD PRE-PAC

Search for α-cluster structures in ^{126}Te; Decay out of deformed structures in ^{136,137}Nd

Octupole correlations in ^{110,112}Te via lifetime measurements; double-phonon octupole vibration in ^{96}Zr

Shell-model descriptions around ^{56}Ni: lifetime measurements in ^{56}Ni and ^{60}Zn



Lifetime of the 4^+ state in ^{110}Sn; shape coexistence in ^{106}Pd through Coulomb excitation

Quadrupole collectivity and shape coexistence in Ca nuclei (lifetimes and Coulomb excitation)

Isospin symmetry for A=22 via lifetime measurement in ^{22}Mg, lifetime in ^{15}O relevant for astrophysics

commissioning of the EXOTIC facility (^{7}Be beam)

Two different configurations

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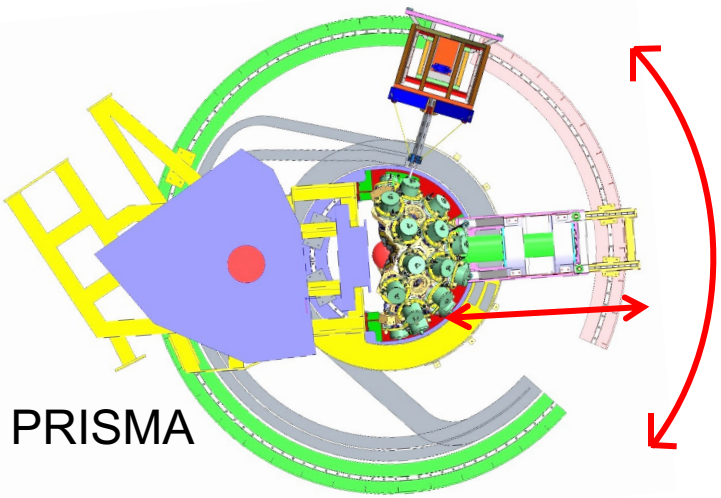
journal homepage: www.elsevier.com/locate/nima

Full Length Article

Conceptual design of the AGATA 2π array at LNL

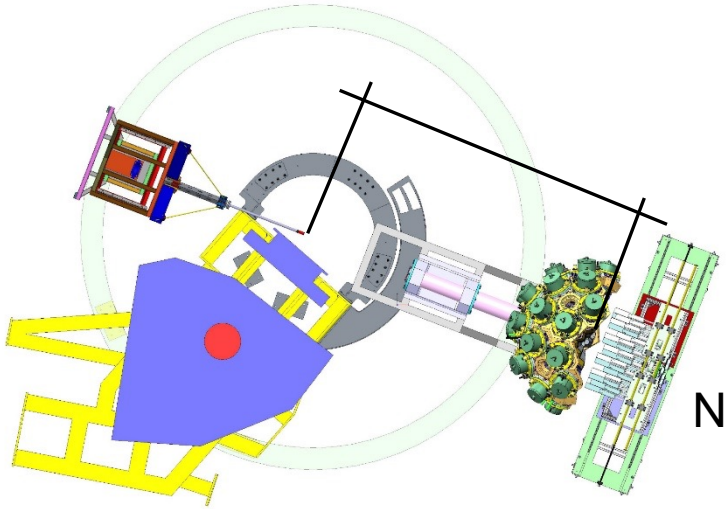
AGATA coupled with PRISMA



Current configuration

Commissioning 26/4/2022

AGATA zero degrees (2025)



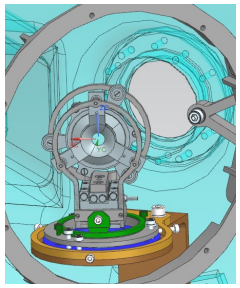
TANDEM + PIAVE + ALPI beams
SPES beams

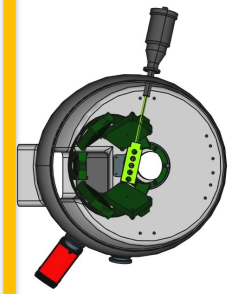
Complementary detectors

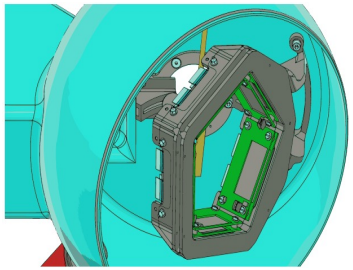
First PACs

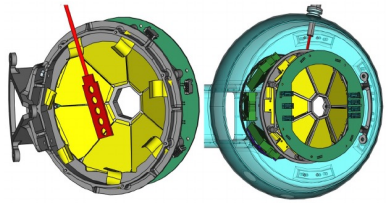
commissioned

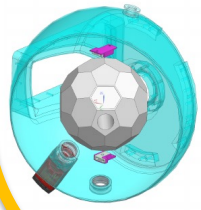
- PRISMA : L. Corradi, F. Galtarossa
- GAL-TRACE : S. Capra, G. Zhang
- EUCLIDES: J. Pellumaj, D. Brugnara
- SPIDER: M. Rocchini, M. Balogh
- DANTE: K. Rezynkina
- Gamma-ray scintillators: E. Gamba, S. Pigliapoco
- Plunger: I. Zanon J. Benito

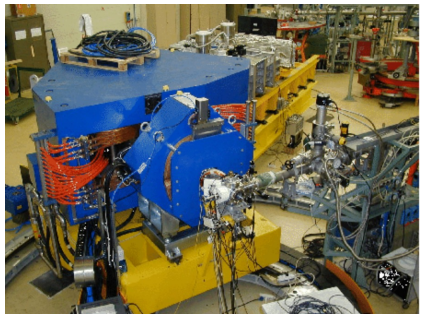


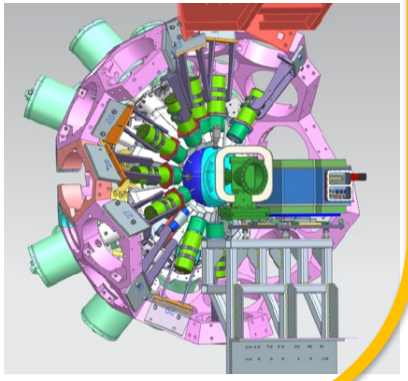




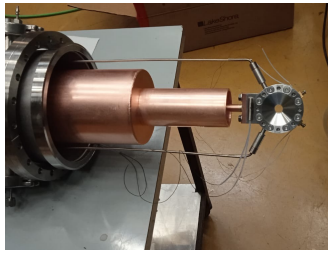


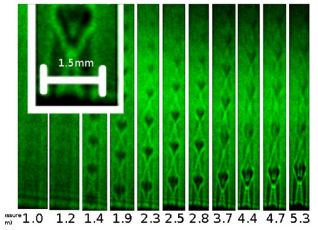






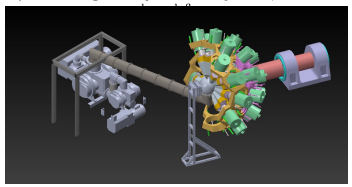
Targets: CTADIR + SUGAR

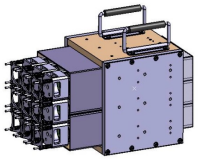




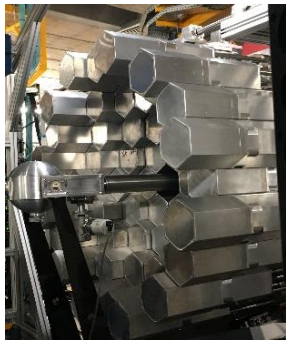
i)Schlieren images of the jet at different pressures, indicated

PARIS

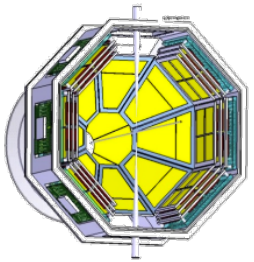




SLICES
CHYMENE
TRACE



NEDA



GRIT

AGATA Campaign at LNL

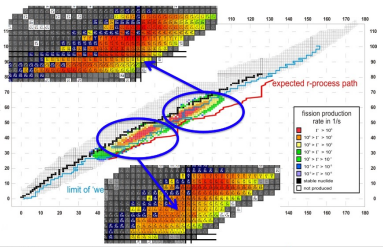
Third Pre-PAC Workshop and

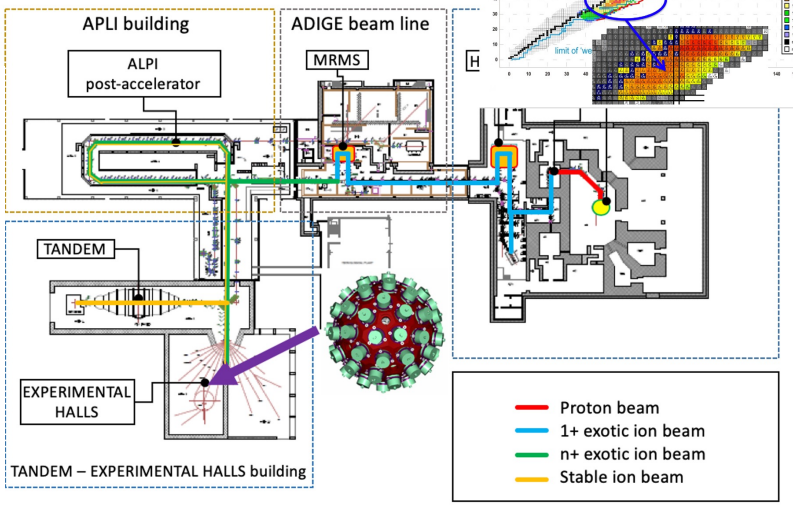
Zero-Degree Campaign Workshop

LNL, April 19th-21st, 2023

Meeting devoted to the discussion of the future campaign involving AGATA at zero degrees → preliminary information about **DayOne SPES beams**

40 MeV - 200 μA of protons → production of re-accelerated neutron-rich exotic beams **10^{13} fission/s in-target production, and re-acceleration at 10*A MeV (A=132)**





List of possible first SPES beams:

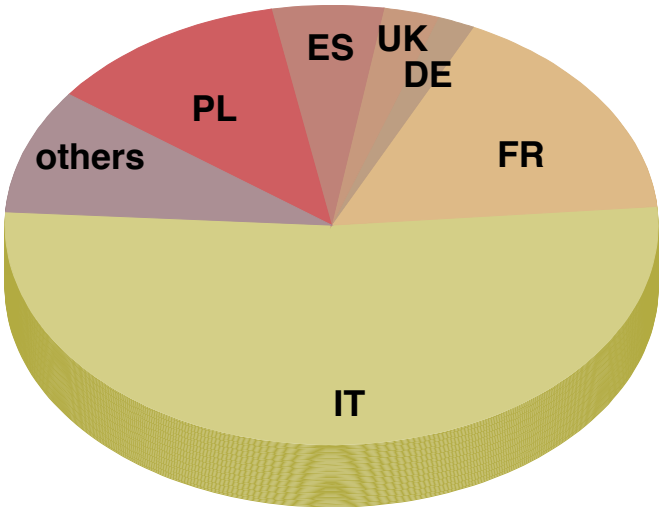
Primary target	Beam	Intensity (pps)	Max energy (MeV/A)
TiC	43Sc	2,40E+07	10
TiC	44Sc	2,25E+08	10
TiC	42K	3,70E+07	10
UCx	130Sn	3,95E+06	10
UCx	132Sn	7,70E+05	10
UCx	132Te	2,11E+07	10
UCx	132Sb	9,50E+05	10
UCx	134Te	1,50E+04	10
UCx	94Rb	6,80E+06	10
UCx	75Ga	1,10E+05	10

The intensities are to be considered at the target position.

DETAILS OF THE CALL FOR LOIS

- stable beams from the Tandem-ALPI-PIAVE complex or first SPES beams
- complementary set-ups compatible with AGATA at zero degrees: NEDA, PARIS, GRIT, TRACE, gas/cryogenic targets (SUGAR, CTADIR, CHYMENE) but also some that are used in the present campaign: EUCLIDES, SPIDER, DANTE

- overwhelming response from the community:
  42 "physics" LoIs + 4 umbrella proposals



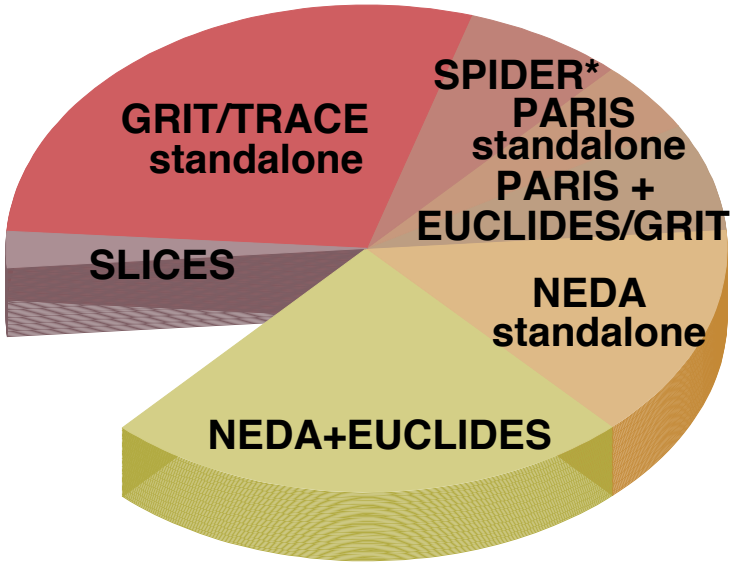
- large majority (33) with at least one Italian spokesperson; percentage of Italian co-spokesperson consistent with earlier AGATA Pre-PACs at LNL

- particularly strong representation of France and Poland

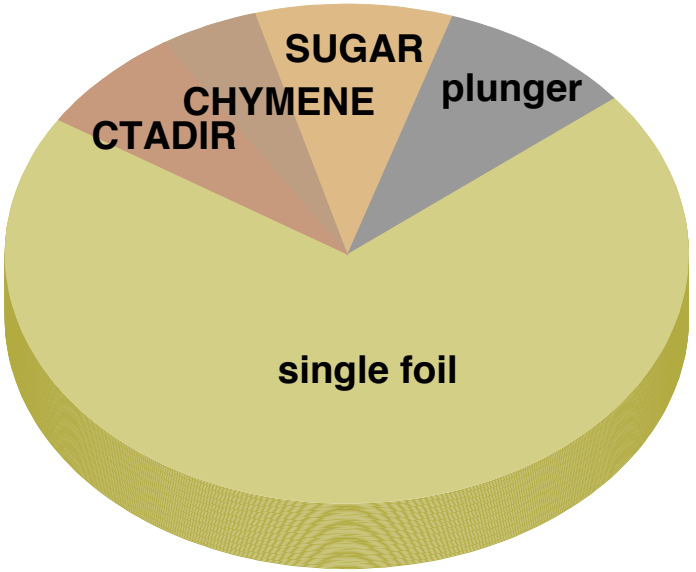
- co-spokespersons from outside the AGATA collaboration: Mexico, US, Korea, Brazil

LoIs - STATISTICS

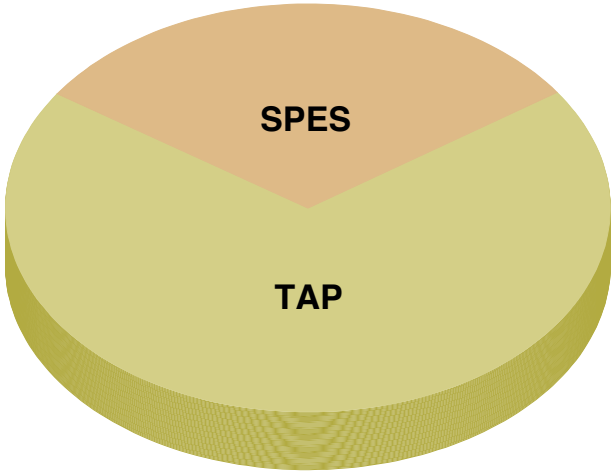
complementary detectors



targets

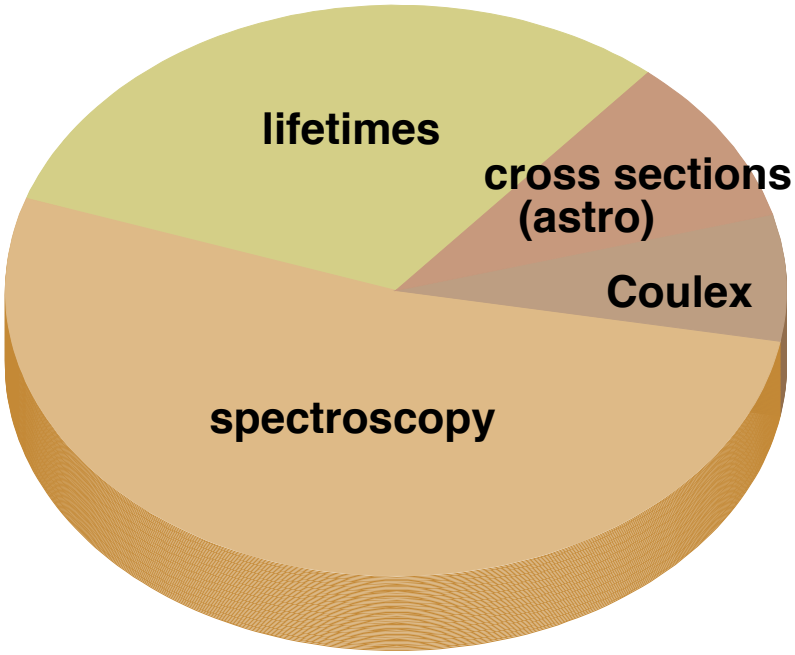


- there is no “preferred” set-up (in contrast to the PRISMA campaign)
- fewer plunger measurements, fair interest in studies using gas/cryogenic targets
- enthusiastic reception of SPES beams

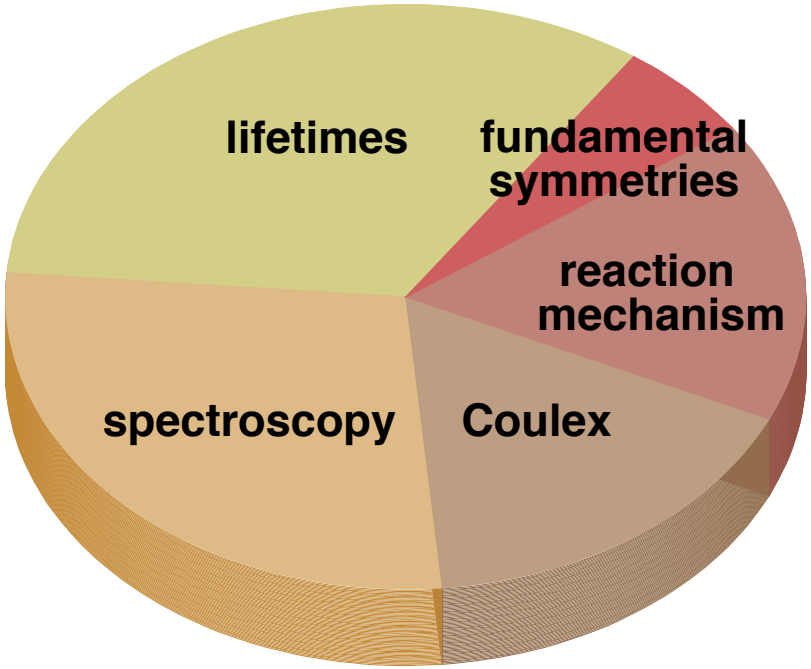


LoIs - STATISTICS

ZD LoIs

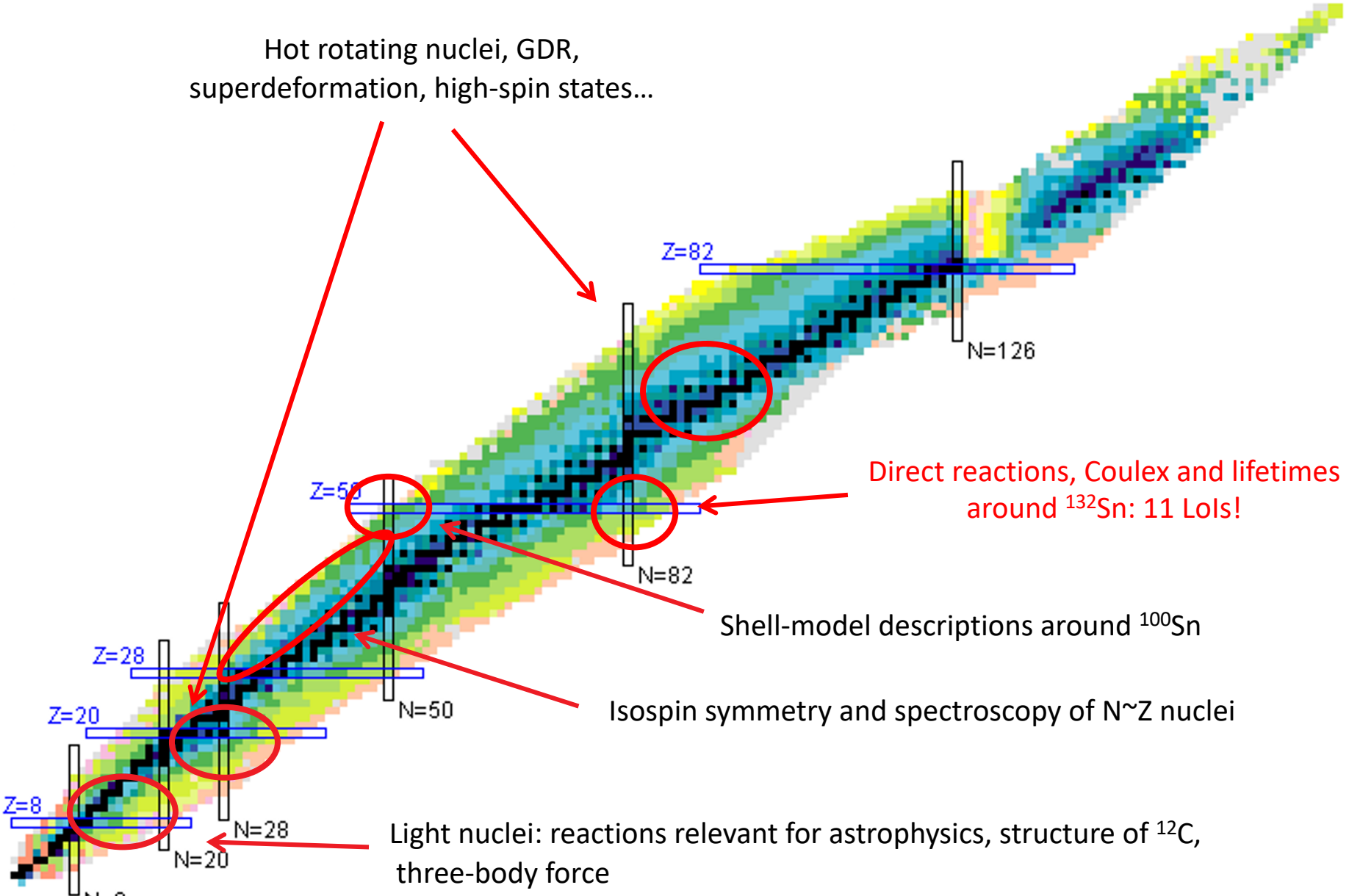


Priority A + scheduled B

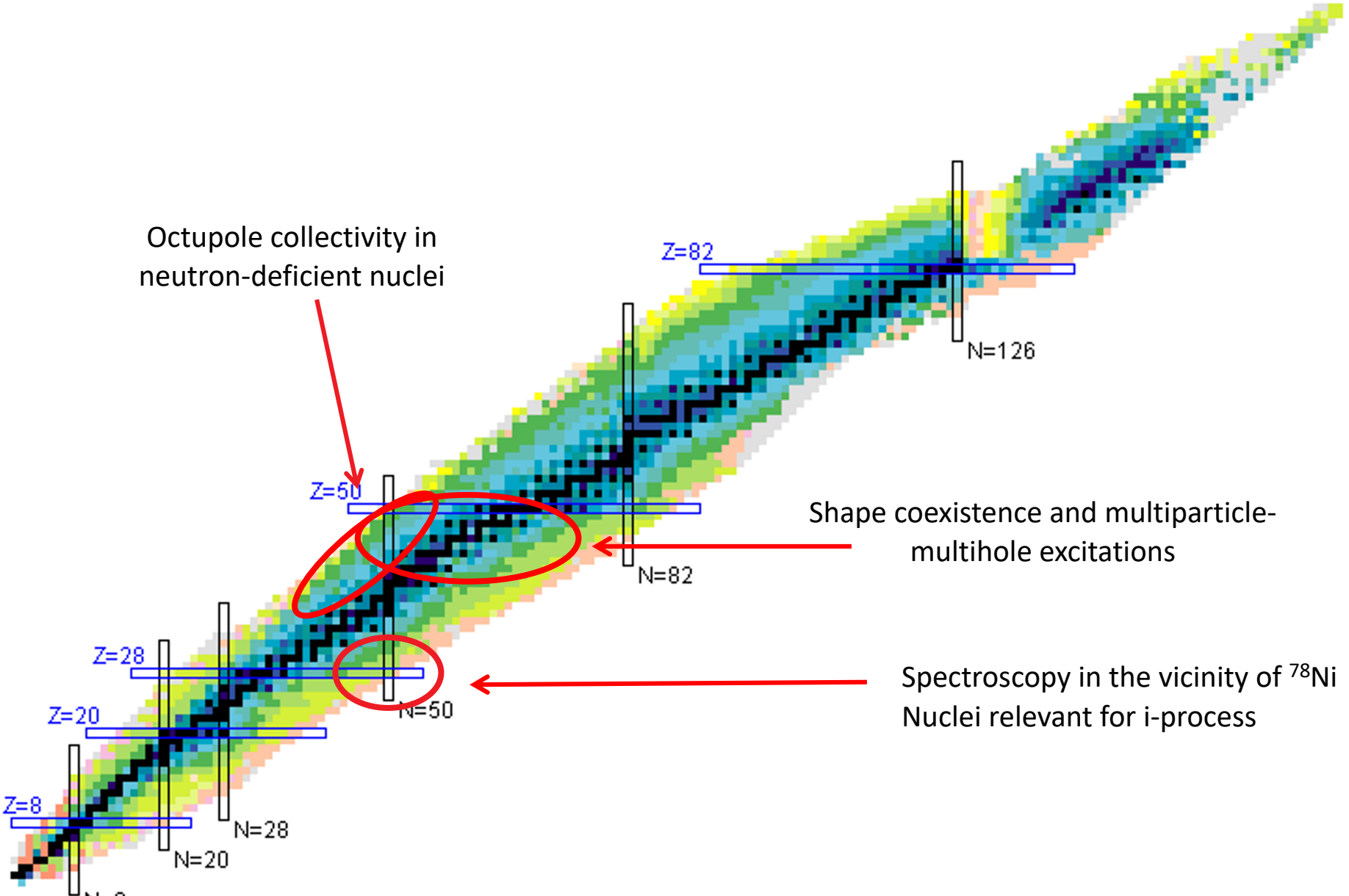


- more spectroscopy, fewer transition probabilities and reaction mechanism studies
- return of high-spin physics
- renewed interest in reactions relevant for astrophysics

PHYSICS CASES FOR THE ZD CAMPAIGN



PHYSICS CASES FOR THE ZD CAMPAIGN



FRENCH INVOLVEMENT IN THE ZD LOIS

- *DSAM measurement in ^{132}Sn using direct reaction* (E. Clément, M. Assié, F. Flavigny, A. Matta, I. Zanon)
- *Investigation of the microscopic structure of Pygmy Dipole Resonances in ^{132}Sn using transfer reactions* (D. Beaumel)
- *Nuclear structure studies around ^{132}Sn with a tritium target* (S. Bottoni, F. Galtarossa, M. Assié)
- *Excitation energy, spin and parity determination in identical superdeformed bands via the search and placement of linking transitions. The case of the identical bands of ^{151}Tb and ^{152}Dy* (G. Duchêne)
- *Structure of neutron-rich Ge isotopes in vicinity of the double-magic ^{78}Ni nucleus* (F. Didierjean, G. Duchêne, A. Gottardo, M. Moukaddam, D. Verney)
- *Spectroscopy in ^{102,103}Sn and lifetime measurements in ^{103}Sn to investigate nuclear structure toward ^{100}Sn* (G. Pasqualato, A. Gottardo)
- *Octupole and non-Yrast states in ^{80}Zr* (A. Gadea, R. Perez Vidal, G. de France)

+ umbrella proposals:

- *Study of direct reactions using the CHyMENE target* (I. Zanon, A. Gillibert, A. Gottardo, A. Corsi)
- *Umbrella LoI for GRIT* (D. Beaumel, D. Mengoni)
- *High-spin studies with AGATA – a physics campaign* (G. Duchêne)
- *Coupling PARIS with AGATA* (A. Maj, F. Camera, M. Lewitowicz)

OUTLOOK

- **Strong interest from the community in the zero-degree campaign**
- Multitude of new set-ups and experimental techniques, notably:
  - Studies of neutron-deficient nuclei with NEDA + EUCLIDES
  - MNT with radioactive beams (3 LoIs)
  - Direct reactions with gas/cryogenic targets
  - Electron spectroscopy with SLICES
  - Renewal of interest in high-spin physics

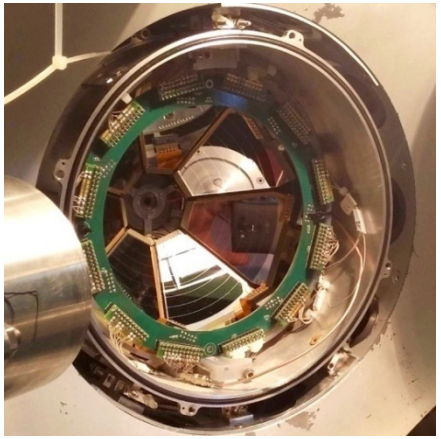
Current campaign planning:

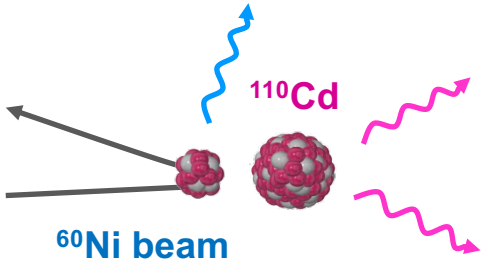
- One more PAC for Tandem-ALPI-PIAVE experiments with AGATA + PRISMA (end of 2023, evaluating experiments to run in early 2024)
- Change to the zero-degree configuration (6 months, to be completed by early 2025)
- 2025: campaign with SPES beams, NEDA, PARIS…

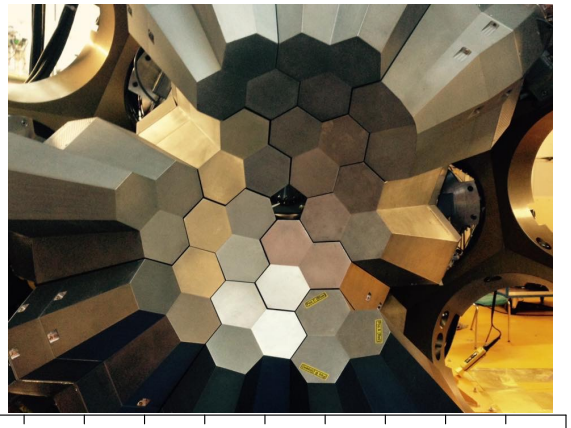
MULTIPLE SHAPE COEXISTENCE IN ^{110}CD

K. WRZOSEK-LIPSKA, P. GARRETT, A. NANNINI, M. ROCCHINI, MZ

Coulomb excitation of ^{110}Cd with AGATA + SPIDER

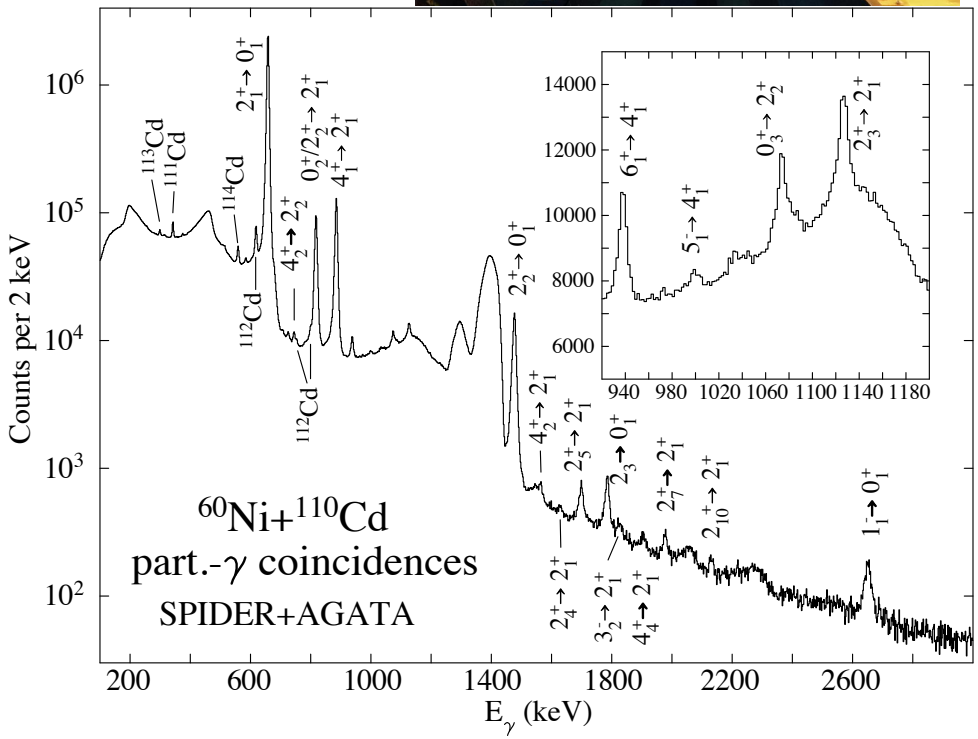






Measurement complementary to studies with lighter beams (^{32}S, ^{14}N) performed with EAGLE at HIL Warsaw

Data taking: June 3-5, 2022 + October 18-21, 2022



PRIORITY A EXPERIMENTS WITH AGATA

- 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) – 7 days
- Evolution of the mixing between single-particle and intruder configuratios approaching the island of inversion at $N = 20$ (F. Galtarossa, A. Gottardo) – 6 days
- Coexisting shapes and precision tests of Monte-Carlo Shell-Model calculations in ^{96}Zr (N. Marchini, D.T. Doherty, M. Zielińska) – 4 days
- Fusion-fission for γ-ray spectroscopy of neutron-rich nuclei around $N = 50$ (A. Gottardo, M. Caamaño, D. Ramos, J.J. Valiente-Dobón) – 14 days
- Search for a Josephson-like effect in the ^{116}Sn + ^{60}Ni system (L. Corradi, S. Szilner) – 14 days
- Probing multiple shape coexistence in ^{110}Cd with Coulomb excitation (M. Zielińska, K. Wrzosek-Lipska, A. Nannini, M. Rocchini, P. Garrett) – 5 days
- Understanding the nature of 0^+ states in ^{110,112}Sn and ^{108}Cd (N. Marginean, M. Ciemała, F. Crespi) – 12 days

PRIORITY A EXPERIMENTS WITH AGATA - TESTS AND COMMISSIONING

- Test of particle-γ coincidences with Agata+Euclides for studies of light-ion fusion at astrophysical energies (G. Montagnoli, A.M. Stefanini) – 3 days
- Test of the ^{70}Zn-^{64}Ni alloy target for nuclear structure studies in the vicinity of Z=28 neutron-rich isotopes with AGATA and PRISMA (R.M. Perez Vidal, S. Bottoni, E. Sahin, A. Illana, J. Benito, J. Ljungvall) – 3 days
- Commissioning of AGATA and complementary detectors at LNL (F. Crespi, F. Galtarossa, J. Pellumaj, M. Rocchini, M. Sedlak) – 15 days (split over 3 runs)
    - AGATA + PRISMA + DANTE
    - AGATA + SPIDER + DANTE
    - reverse Plunger

blue – TANDEM only (45 days + 9), red – need for ALPI and/or PIAVE (38 days + 11)

PRIORITY B EXPERIMENTS WITH AGATA

- Delineating the island of shape coexistence in $N \sim Z$ nuclei around A=70 through Coulomb excitation of ^{74}Se (W. Korten, K. Wrzosek-Lipska, E. Clément) – 5 days

- Establishing the properties of ^{19}Ne cluster states important for X-ray bursts (C. Wheldon, T. Kokalova) – 7 days

- Investigating the nature of the low-lying states of 196Os via lifetime measurements (D. Brugnara, J. Pellumaj, M. Sedlak) – 11 days

- Lifetime measurements for intruder states towards the island of inversion along the N=20 shell closure (I. Zanon, D. Brugnara) – 8 days

- Isospin mixing in the N=Z=36 ^{72}Kr: Lifetime measurement of the E1 isospin forbidden transitions (G. de Angelis, B. Rubio) – 12 days