AGATA Location from 2027: Possible campaign at LNL

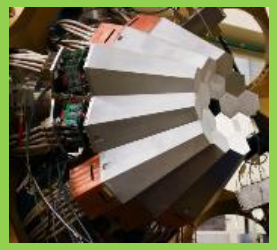
Jose Javier Valiente Dobón LNL (INFN)
on behalf of
Faïçal Azaiez (INFN LNL Director)

The AGATA time line

MoU Phase 1 + Addendum

MoU Phase 2

2010-2012
Legnaro, Italy
Intense stable beams
15 detectors

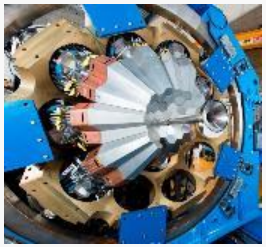


AGATA Demonstrator + PRISMA at LNL

2012-2014
GSI, Germany
Fast fragmentation beams
25 detectors

AGATA at GSI

2014- 2021
GANIL, France
ISOL and stable beams
approaching 1π (45)



AGATA at GANIL

2021—
LNL, Italy
Stable beams
SPES radioactive beams

AGATA at LNL 2.0

Two different configurations

LNL: new data centre, new targets ^{9}Be, ^{232}Th, ^{238}U and new ^{238}U beam

Nuclear Inst. and Methods in Physics Research, A 1049 (2023) 168040

Contents lists available at ScienceDirect

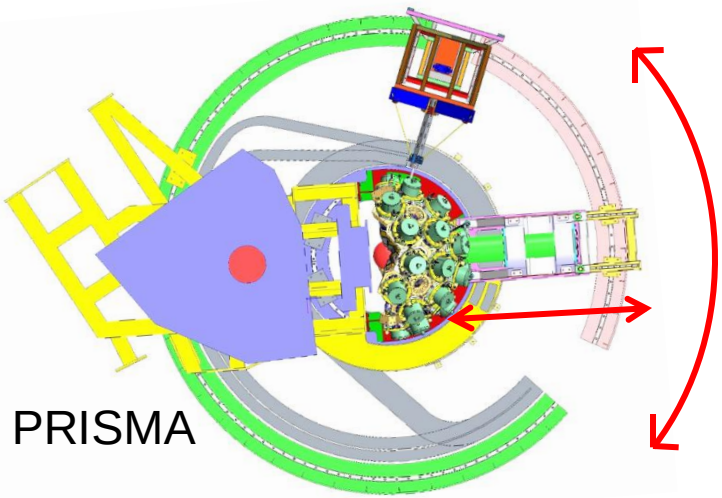
Nuclear Inst. and Methods in Physics Research, A

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

Full Length Article

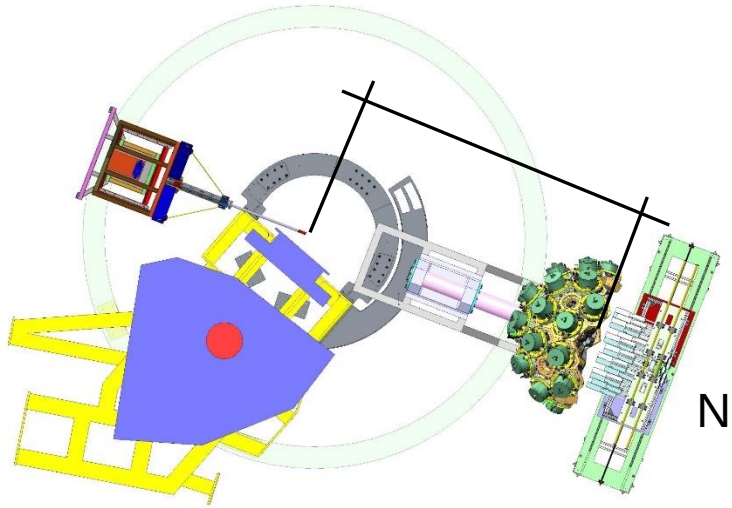
Conceptual design of the AGATA 2π array at LNL

AGATA coupled with PRISMA

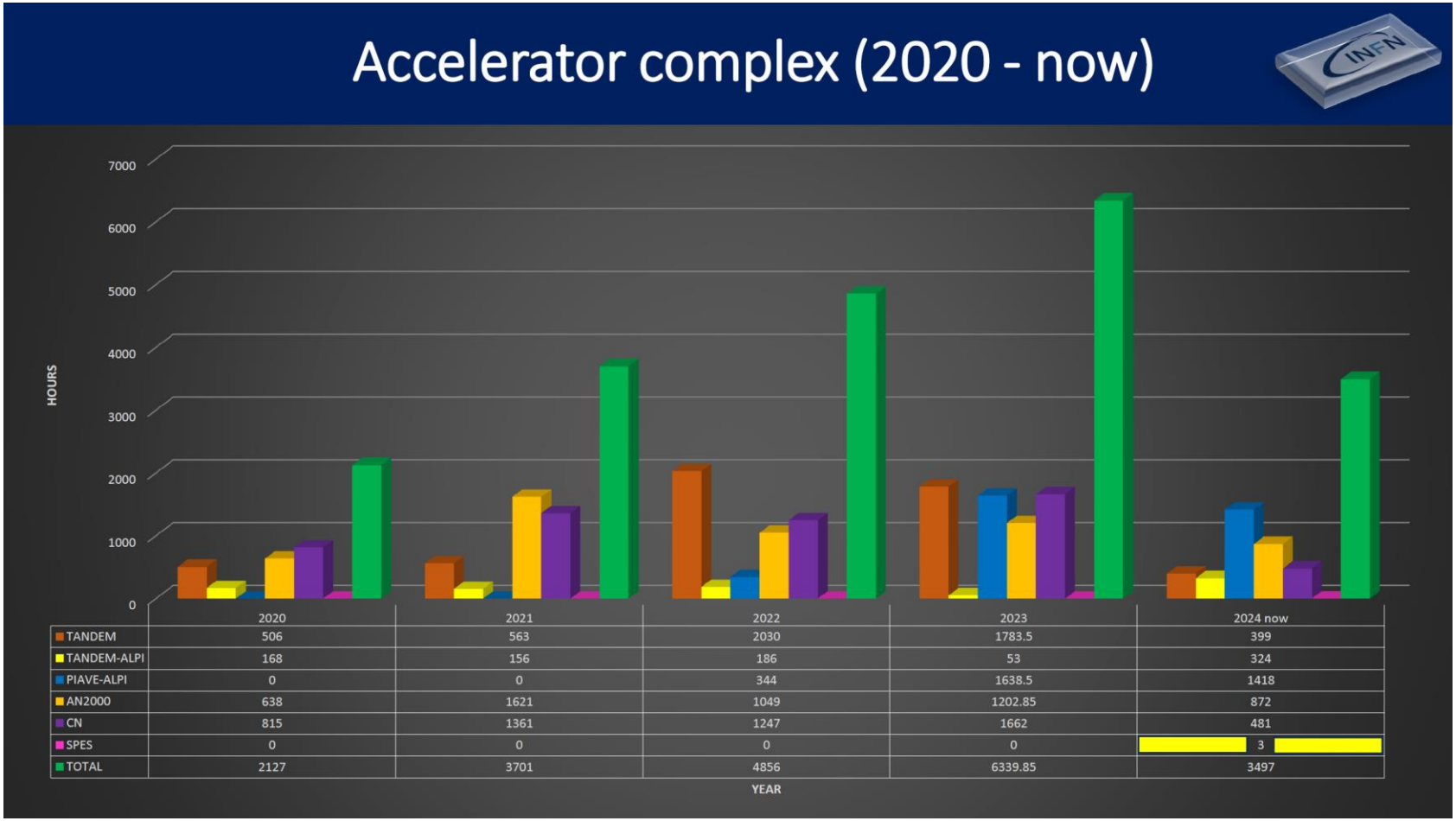


Current configuration

AGATA zero degrees

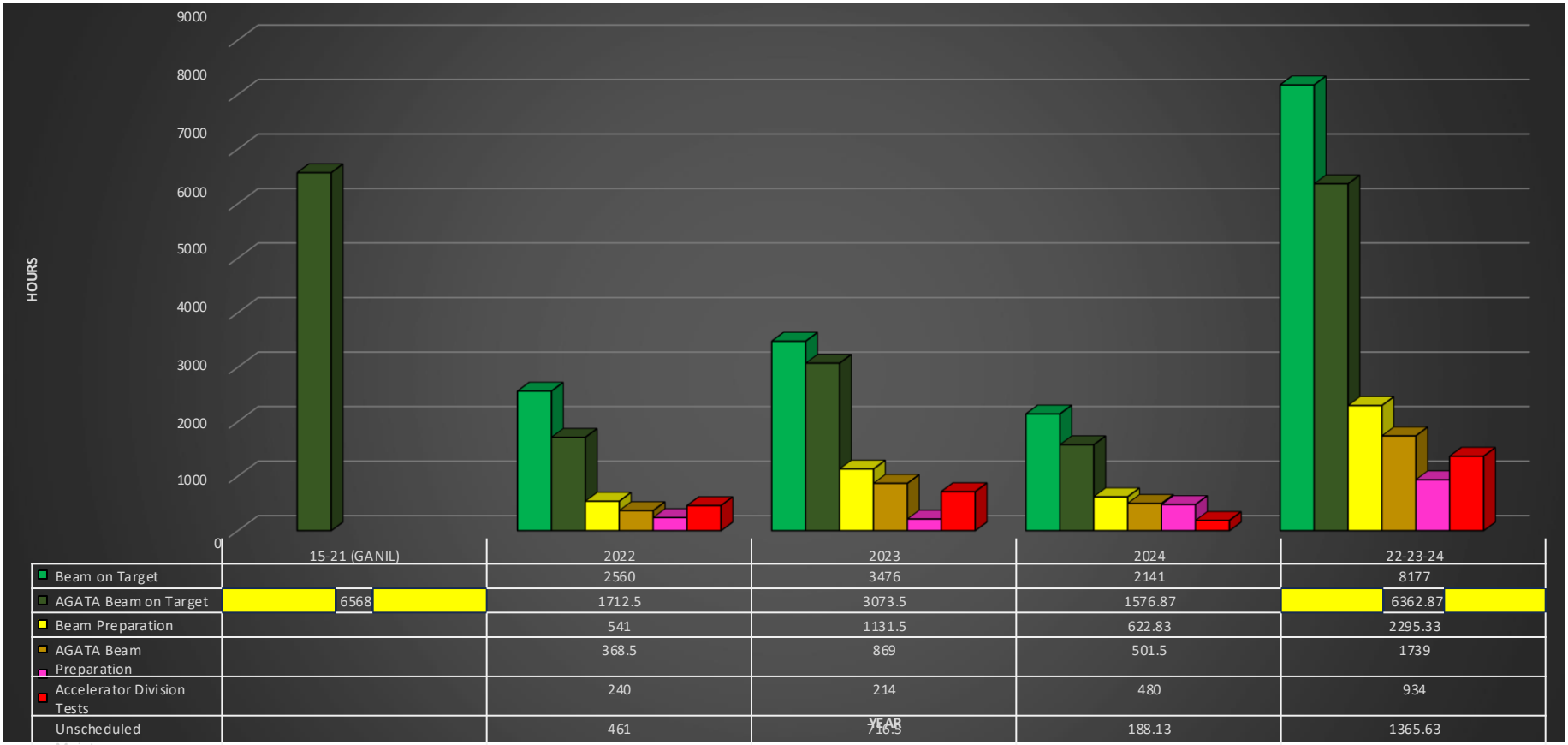


LNL Beam Time



	2020	2021	2022	2023	2024 now
TANDEM	506	563	2030	1783.5	399
TANDEM-ALPI	168	156	186	53	324
PIAVE-ALPI	0	0	344	1638.5	1418
AN2000	638	1621	1049	1202.85	872
CN	815	1361	1247	1662	481
SPES	0	0	0	0	3
TOTAL	2127	3701	4856	6339.85	3497

AGATA BT experiments (2022 - now)



	15-21 (GANIL)	2022	2023	2024	22-23-24
Beam on Target		2560	3476	2141	8177
AGATA Beam on Target	6568	1712.5	3073.5	1576.87	6362.87
Beam Preparation		541	1131.5	622.83	2295.33
AGATA Beam Preparation		368.5	869	501.5	1739
Accelerator Division Tests		240	214	480	934
Unscheduled Maintenance		461	716.5	188.13	1365.63

AGATA physics campaign

Priority A: 31

Priority B: 23

~Two year of almost continuus data taking!! (commissionig April 2022)

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

Octupole correlations in the neutron deficient plutonium isotopes
(J.F.Smith, D.Mengoni)

Accessing neutron-rich nuclei close to ^{208}Pb via multi-nucleon transfer reactions (F. Galtarossa, T. Mijatovic)

Decay-out of the oblate, triaxial and highly-deformed bands in ^{136,137}Nd (C. Petrache/O. Stezowski)

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}Sn+^{60}Ni system
(L. Corradi, S. Szilner)

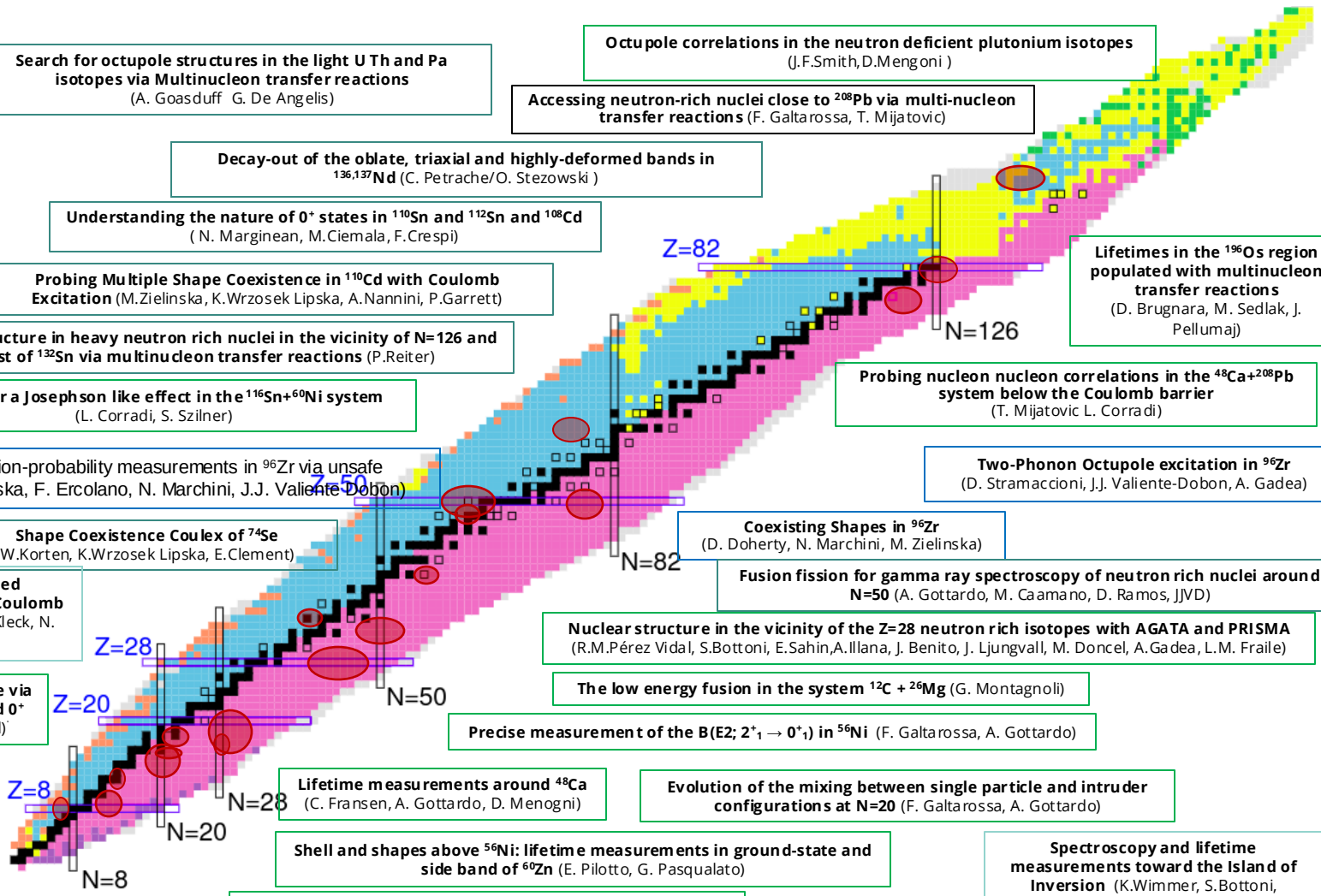
Combined lifetime and transition-probability measurements in ^{96}Zr via unsafe Coulomb excitation (M. Zielinska, F. Ercolano, N. Marchini, J.J. Valiente-Dobon)

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

The emergence of enhanced collectivity near magic nuclei: Coulomb excitation of ^{60}Ni (K. HadinskaKleck, N. Marchini, M. Rocchini,)

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}Ca+^{208}Pb system below the Coulomb barrier
(T. Mijatovic L. Corradi)

Two-Phonon Octupole excitation in ^{96}Zr
(D. Stramaccioni, J.J. Valiente-Dobon, A. Gadea)

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

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.Pérez Vidal, S.Bottoni, E.Sahin,A.Illana, J. Benito, J. Ljungvall, M. Doncel, A.Gadea, L.M. Fraile)

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

Precise measurement of the B(E2; $2^+_1 \rightarrow 0^+_1$) in ^{56}Ni (F. Galtarossa, A. Gottardo)

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)

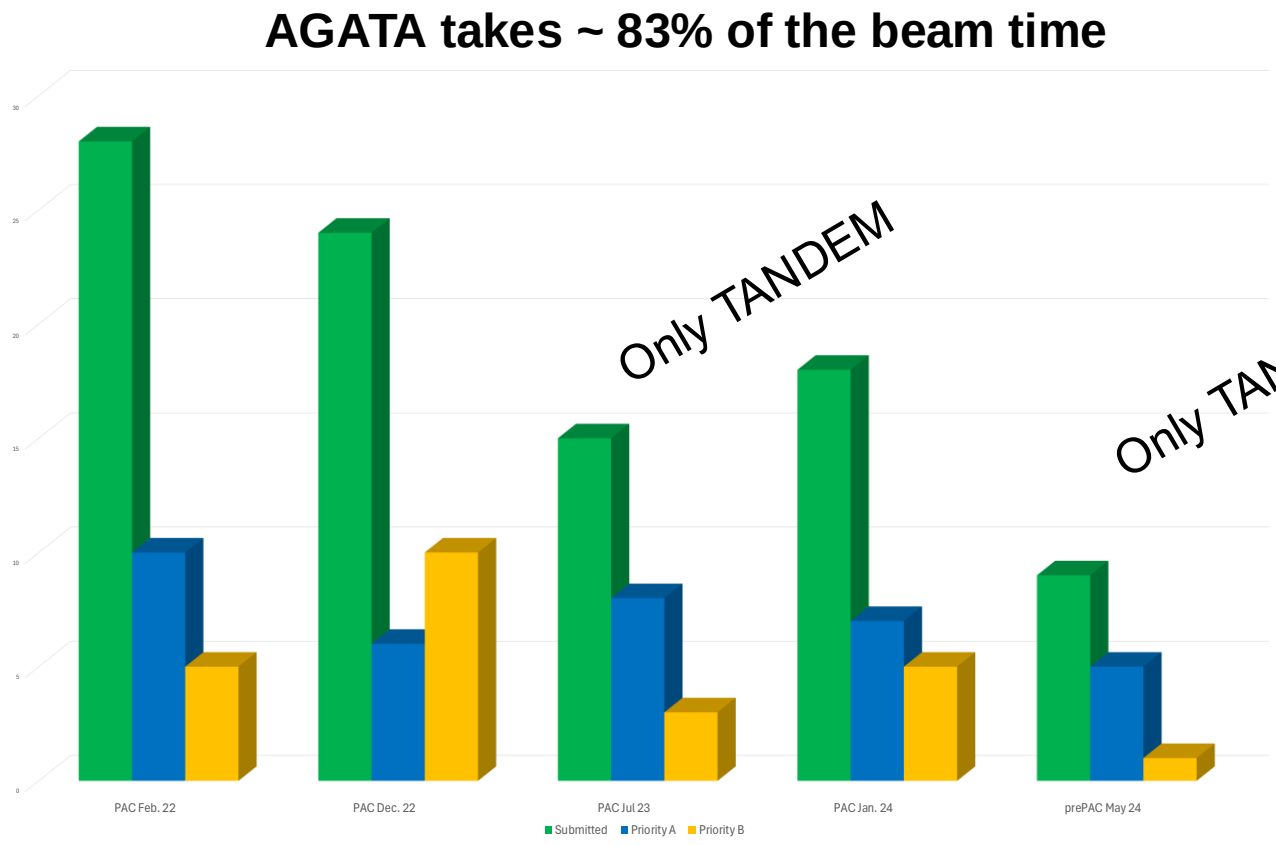
Shell and shapes above ^{56}Ni: lifetime measurements in ground-state and side band of ^{60}Zn (E. Pilotto, G. Pasqualato)

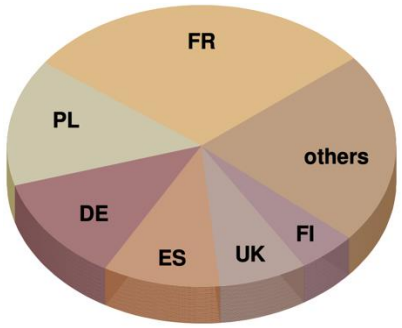
Spectroscopy and lifetime measurements toward the Island of Inversion (K.Wimmer, S.Bottoni, G.Benzoni, F.Recchia, P.Aguilera)

Lifetime of the 6793 keV state in ^{15}O (J.Skowronski, E. Pilotto)

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

Summary AGATA physics campaigns





non-italian spokersons institution nationality

29 + 3 experiments performed and 1 exp. high energy γ.
Starting middle of October next campaign

AGATA ACC physics campaign

Investigating shape coexistence in Z≈N A≈70 nuclei using Coulomb excitation of selenium-74 — *Robin Kjus*
Milano 11:30 - 11:45

Report on AGATA@LNL experiment E22.41 "Probing Multiple Shape Coexistence in 110Cd with Coulomb Excitation"
Iwona Piętka

12:00

Report on experiment EXP_009 (22.23) — *Filippo Angelini*
Milano 12:00 - 12:15

Report on the AGATA@Legnaro experiment EXP 22.04 — *Rainer Abels*
Milano 12:15 - 12:30

Analysis of EXP-017 and EXP-022: Challenges, Solutions, and Future Directions — *Conor Sullivan*
Milano 12:30 - 12:45

Report on the data analysis of the experiment 23.015 devoted to the search for the decay-out of the oblate, triaxial and …
Costel Petrache

13:00

Report on the AGATA EXP_013 (22.85) — *Hamid Ayatollahzadeh*
Milano 13:00 - 13:15

Concluding remarks — *Magdalena Zielinska et al.*
Milano 13:15 - 13:30

09:00

Lifetime measurement of astrophysically relevant 6.793 MeV state of 15O — *Elia Pilotto*
Milano 09:00 - 09:15

Spectroscopy and lifetime measurements toward the Island of Inversion with the AGATA-PRISMA setup — *Davide Genna*
Milano 09:15 - 09:30

Lifetime measurements for the study of intruder states towards the island of inversion along the N = 20 shell closure
Raquel Nicolás Del Álamo

Report on AGATA experiment 001 phase 2 (LNL PAC: 22.07) — *Luca Zago*
Milano 09:45 - 10:00

10:00

Report on the AGATA experiment number 011 — *Giuseppe Andreetta*
Milano 10:00 - 10:15

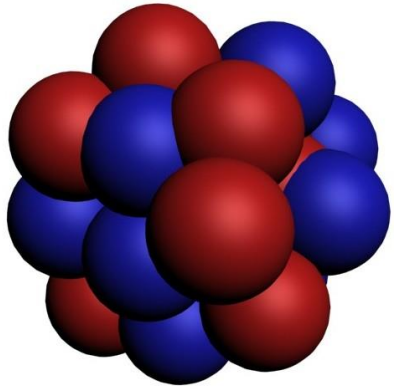
Report on the AGATA experiment number 22.18 — *Robin Kjus*
Milano 10:15 - 10:30

Two-Phonon Octupole excitation in 96Zr — *Damiano Stramaccioni*
Milano 10:30 - 10:45

Report on the AGATA experiment number 23.061 (Combined lifetime and transition-probability measurements in 96Zr vi…
Zarin Ahmed

Lifetime measurement of heavy systems

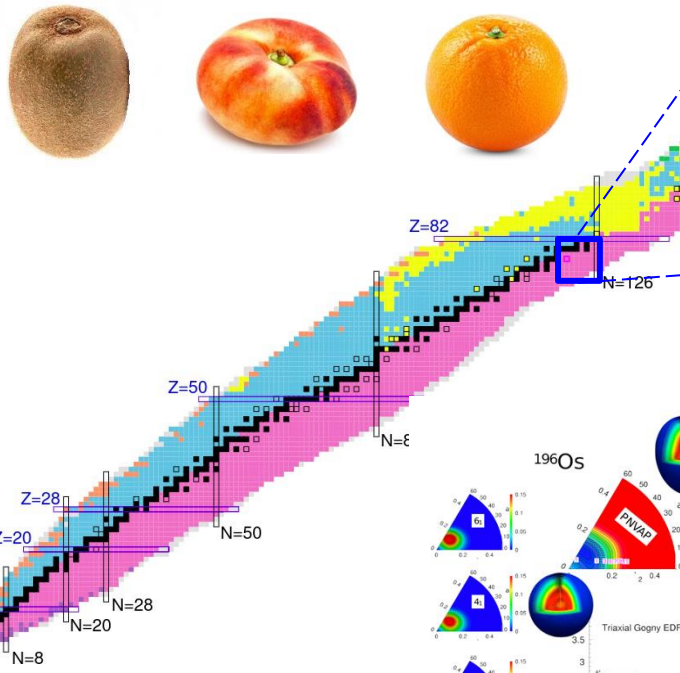
^{196}Os

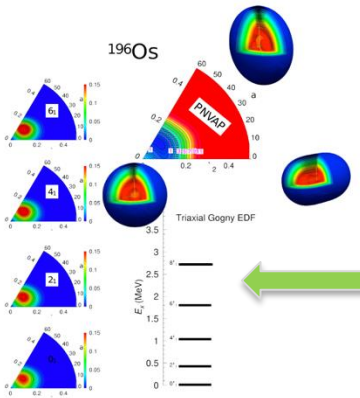


Shape transition in Os isotopes

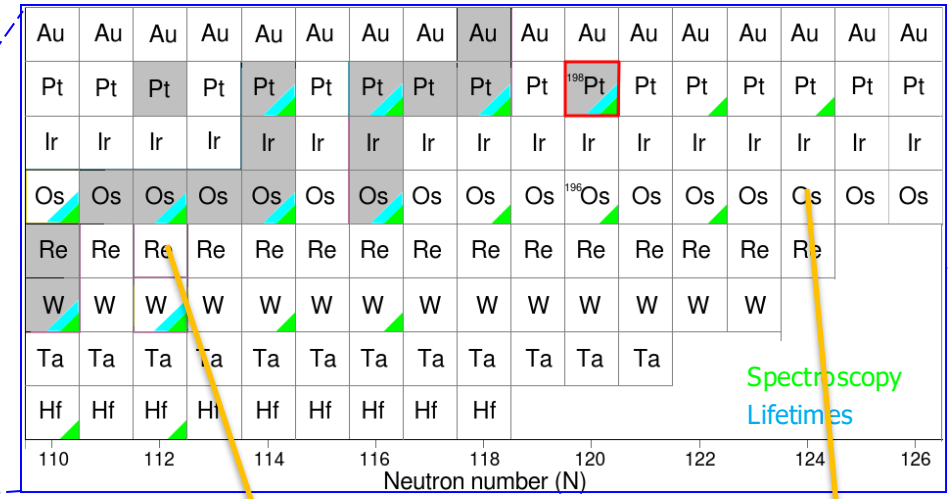
Spokepersons: D. Brugnara, M. Sedlak, J. Pellumaj

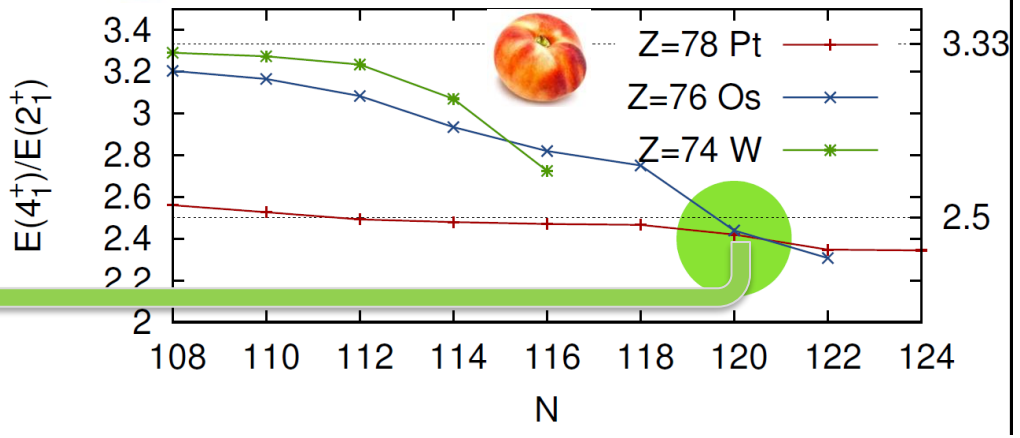
Shape transitions from prolate to oblate and spherical at N=126





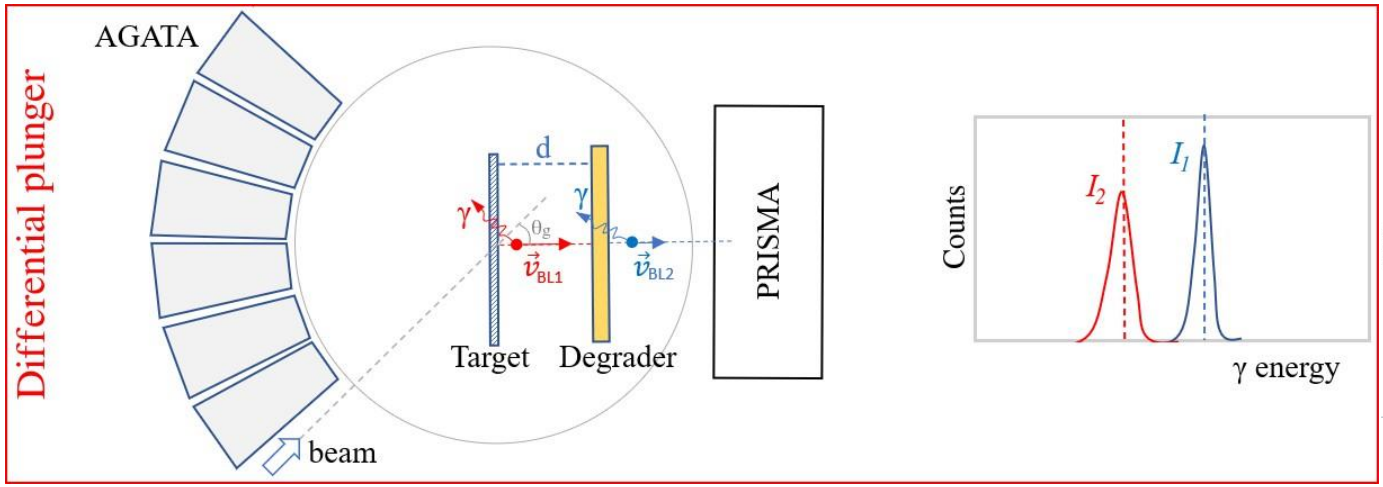
gamma soft

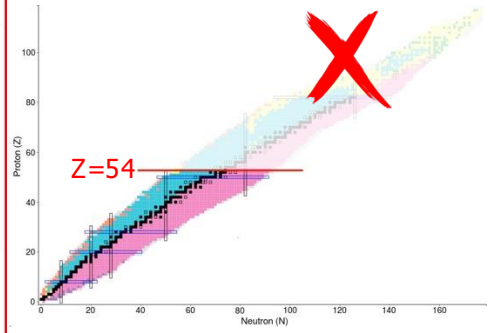


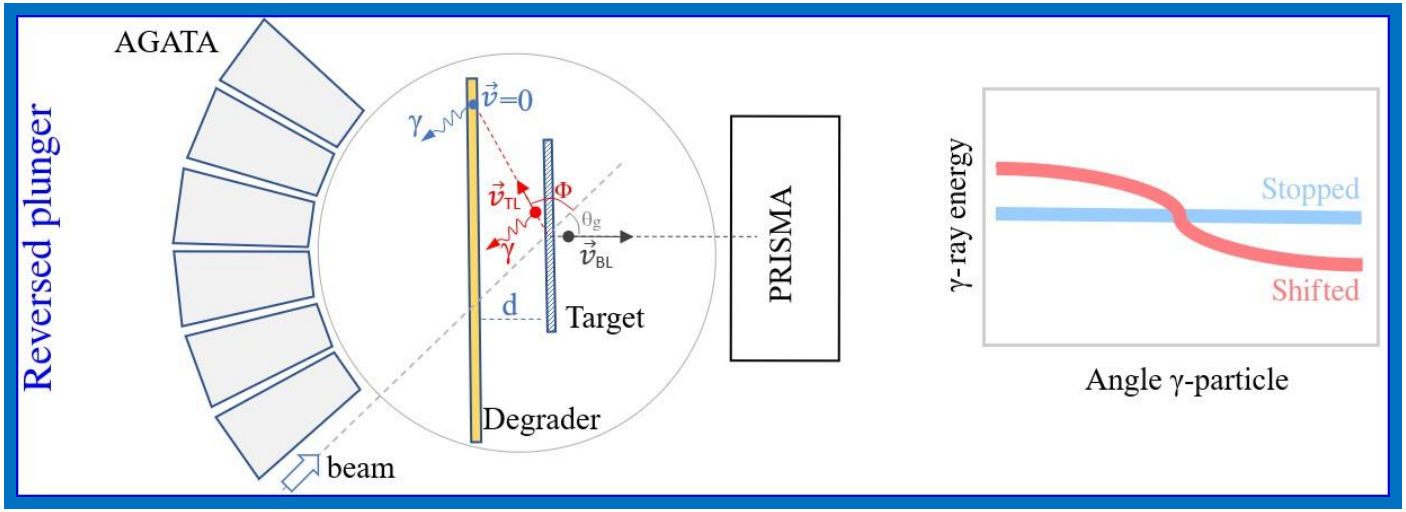


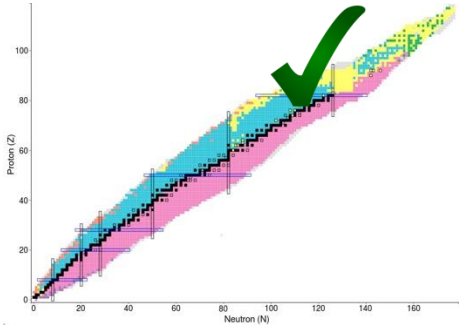
New technique for lifetime measurements

$$\tau^{-1} \sim B(E2: J_i \rightarrow J_f) = 1/(2J_i + 1)\langle \psi_f \,||\mathbf{E2}||\, \psi_i \rangle^2$$





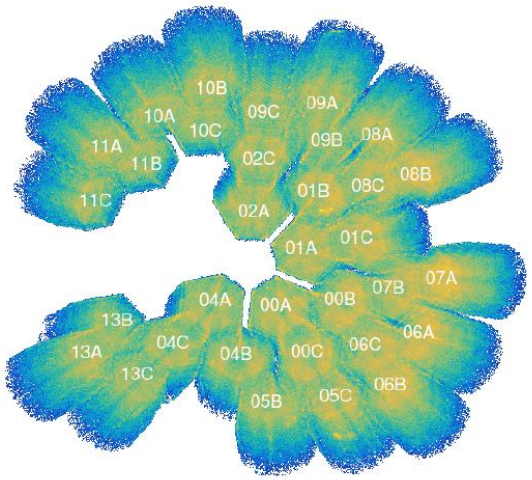


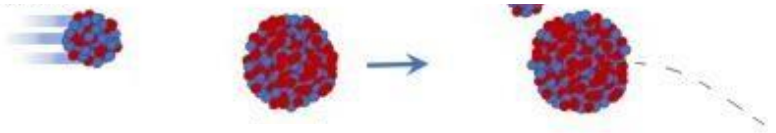


Newly developed to take advantage of the continuus angular range

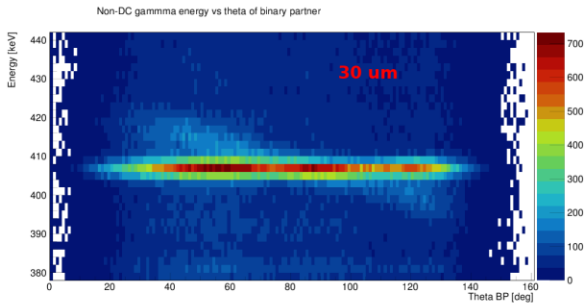
Shape transitions in Os isotopes

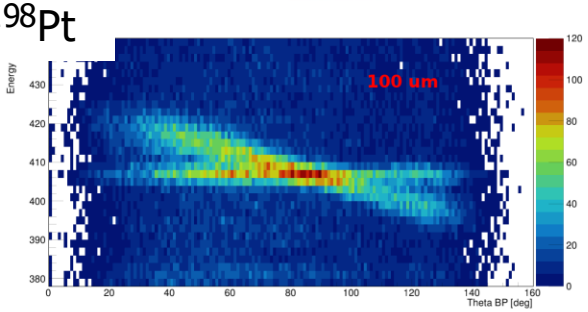
Degrader: ^{93}Nb PRISMA set at 39°
Plunger distances: 30, 40, 50 and 120 μm ^{136}Xe @1134 MeV ^{198}Pt target

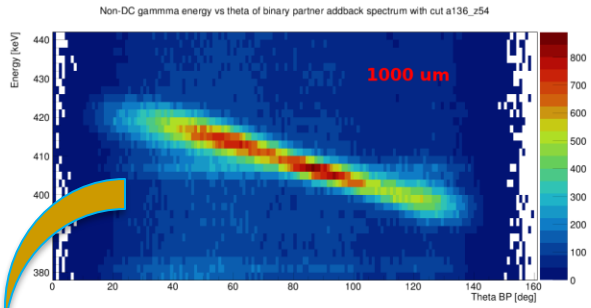


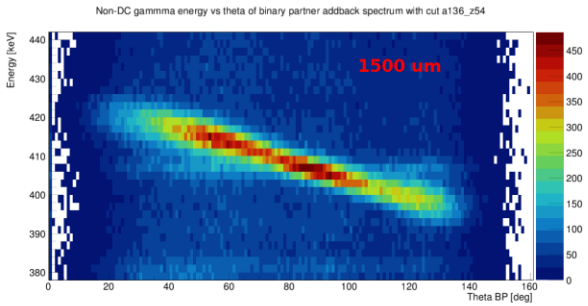


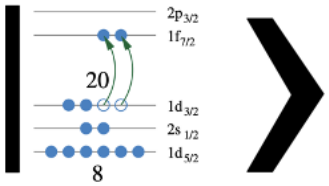
^{198}Pt









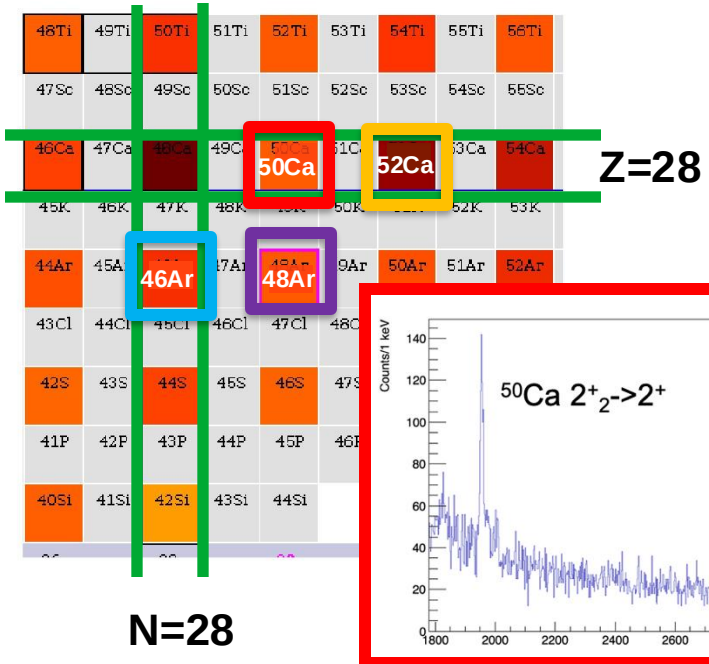


APCAD—Analysis program for the continuous-angle DSAM ☆

Shell evolution around ^{48}Ca

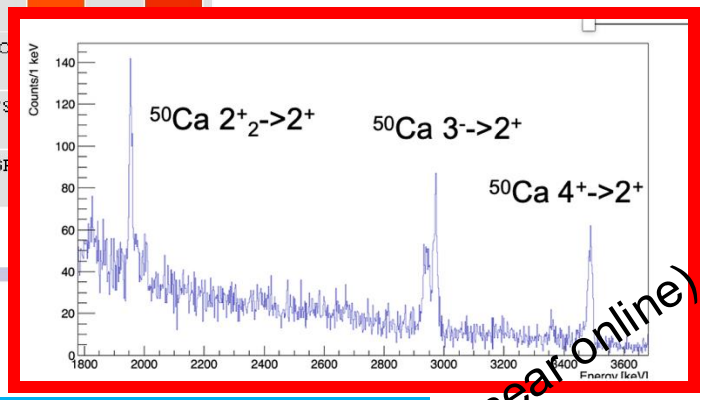
^{48}Ca @ 520 MeV onto ^{238}U

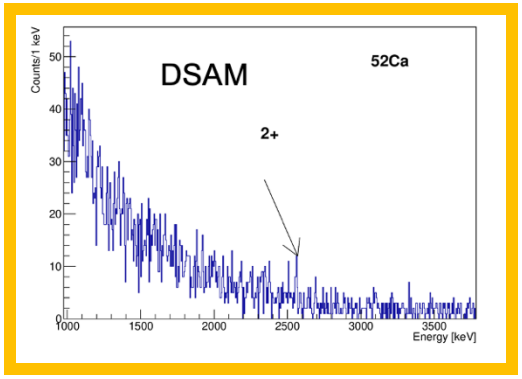
Spokepersons: A. Gottardo, D. Mengoni, C. Fransen

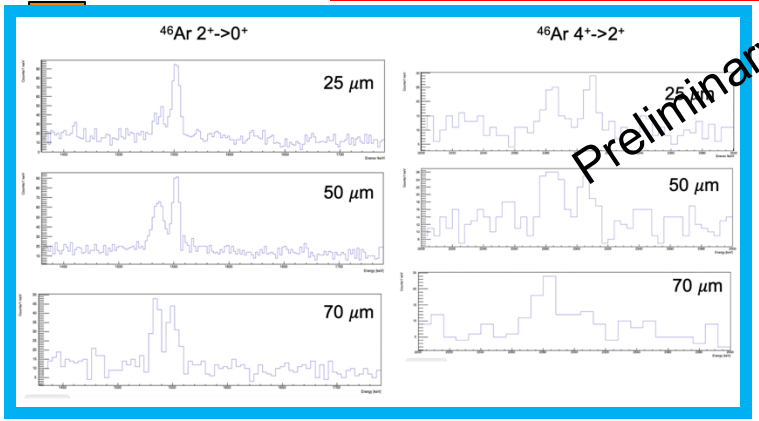


Investigation of **$^{50\text{-}52}$Ca**
→ large charge and matter radii observed
→ also hints for subshell closures
N=32 ($vp_{3/2}$), N=34 ($vp_{1/2}$); mass measurements

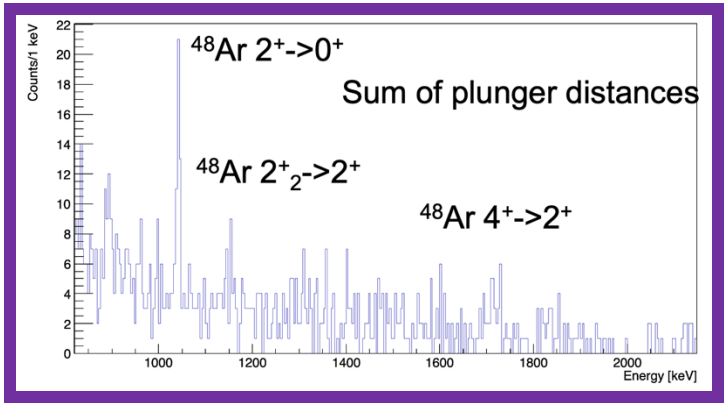
Investigation of **$^{46\text{-}48}$Ar**
→ Weakening of N=28 shell closure in ^{46}Ar
→ explanation from shell structure:
depletion of $\pi s_{1/2}$?







Preliminary (near online)



Workshop zero degrees

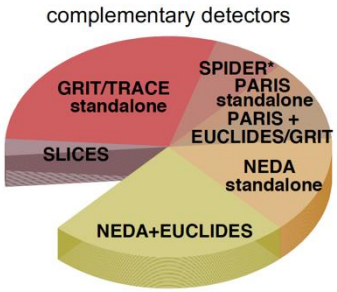
AGATA Campaign at LNL

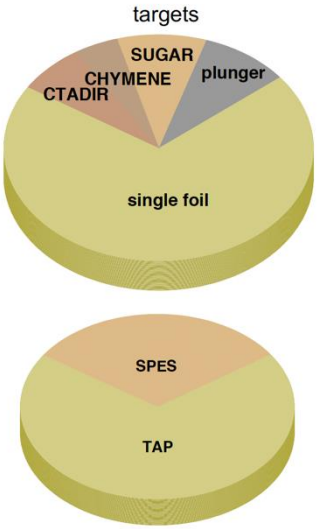
Third Pre-PAC Workshop and

Zero-Degree Campaign Workshop

LNL, April 19th-21st, 2023

Large Variety of compleme





- 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

ng response from the community

- 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** (13 for SPES)

Spokespersons:

18 France
13 Poland
6 Spain
3 UK
2 Germany
10 Others

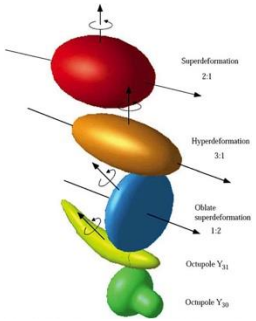
large majority (33) with at least one Italian spokesperson; percentage of Italian co-spokesperson consistent with earlier AGATA Pre-PACs at LNL

particularly strong representation of France and Poland

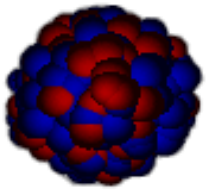
co-spokespersons from outside the AGATA collaboration: Mexico, US, Korea, Brazil

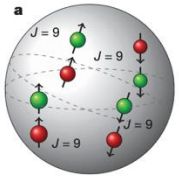
Enough requests for at least 1.5 more year of AGATA operation at LNL (stable beams)

Physics addressed Zero degrees conf.

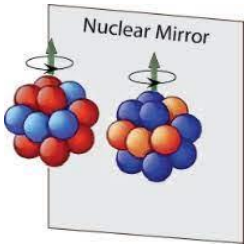


Hot rotating nuclei, GDR, superdeformation, high-spin states…

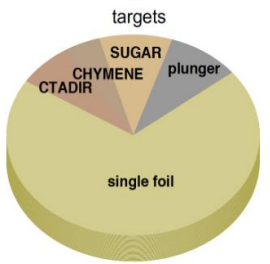




Isospin symmetry, proton neutron pairing and spectroscopy of N~Z nuclei



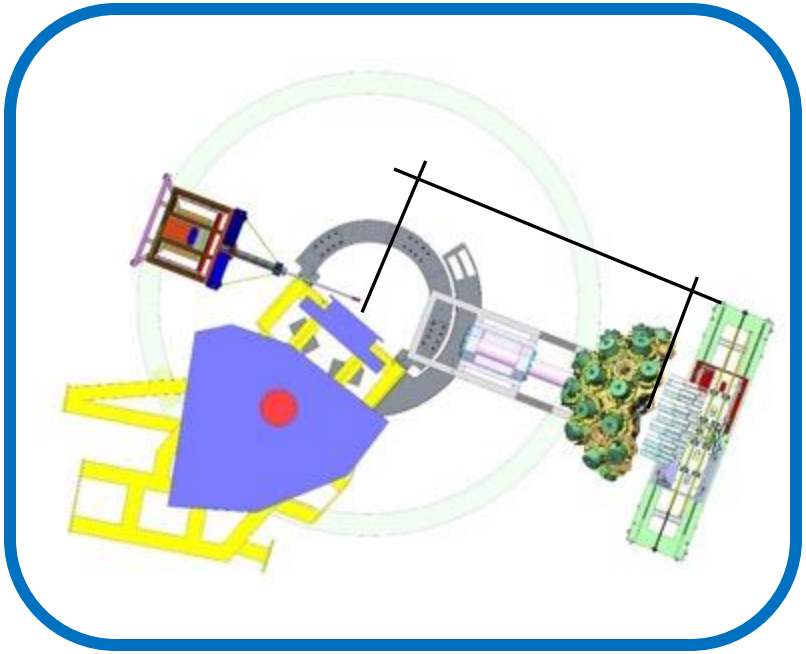
More than 30 LoIs sent



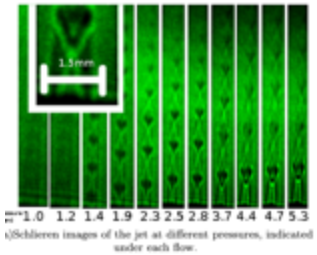
Reactions relevant for astrophysics, structure of ^{12}C, three-body force ^{16}C

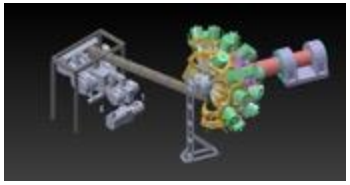
Complementary detectors 0 degrees

AGATA zero degrees



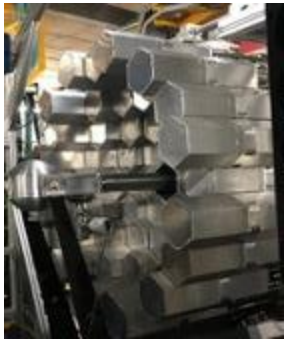
Targets: CTADIR + SUGAR



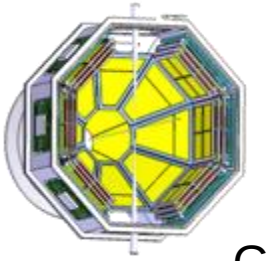


PARIS

SLICES
CHYMENE
TRACE



NEDA



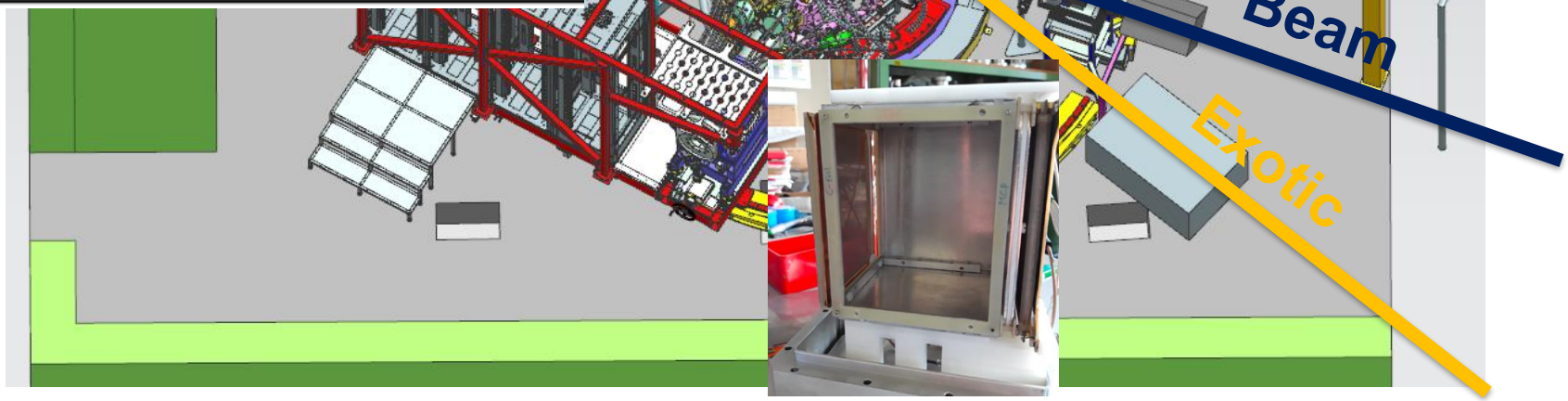
GRIT

Exotic beams (endorsed by PAC)

Last two tests within this year

RIB	Intensity (pps)	E_{max} (MeV)
$^{8}Li^{3+}$	5×10^{4}	21.7
$^{7}Be^{4+}$	5×10^{5}	44.2
$^{8}B^{5+}$	4×10^{2}	45.5
$^{10}C^{6+}$	2×10^{3}	51.8
$^{11}C^{6+}$	10^{5}	54.2
$^{15}O^{8+}$	2×10^{4}	70.6
$^{17}F^{9+}$	4×10^{4}	79.6
$^{18}Ne^{10+}$	2×10^{3}	78.1

Possibility to connect the facility EXOTIC for the In-Flight production of light Radioactive Ion Beams to the gamma-ray Spectrometer AGATA



LNL request

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Legnaro
Il Direttore

Legnaro, May 28, 2024

Dear Angela, dear ASC members,

the Legnaro National Laboratory devoted about 6150 hours of beam time for AGATA from April 2022 to May 2024, providing stable beams from 1H to 208Pb with the TANDEM-PIAVE-ALPI accelerator complex. The fraction of beam time devoted to AGATA was about 83%. The program is to deliver a similar amount of beam time to AGATA in the coming years. From autumn 2025, the 238U beam will also become available as the authorization from the safety authorities has been granted recently. First available beam energy will be 6.4 MeV/u.

The Legnaro National Laboratories hence expresses its interest in continuing to host the AGATA array from 2027 until 2031.

The Laboratory engages to provide stable beams from the Tandem-PIAVE-ALPI complex and move to the new ALPI injector ADIGE which will be available to provide intense stable beams. Accelerated ions range from 1H to 238U, with energies and intensities according to the table in:
https://www.lnl.infn.it/wp-content/uploads/Fasci_TAP.pdf

The LNL will guarantee at least 3000 hours of beam per year, with a minimum of 80% devoted to AGATA.

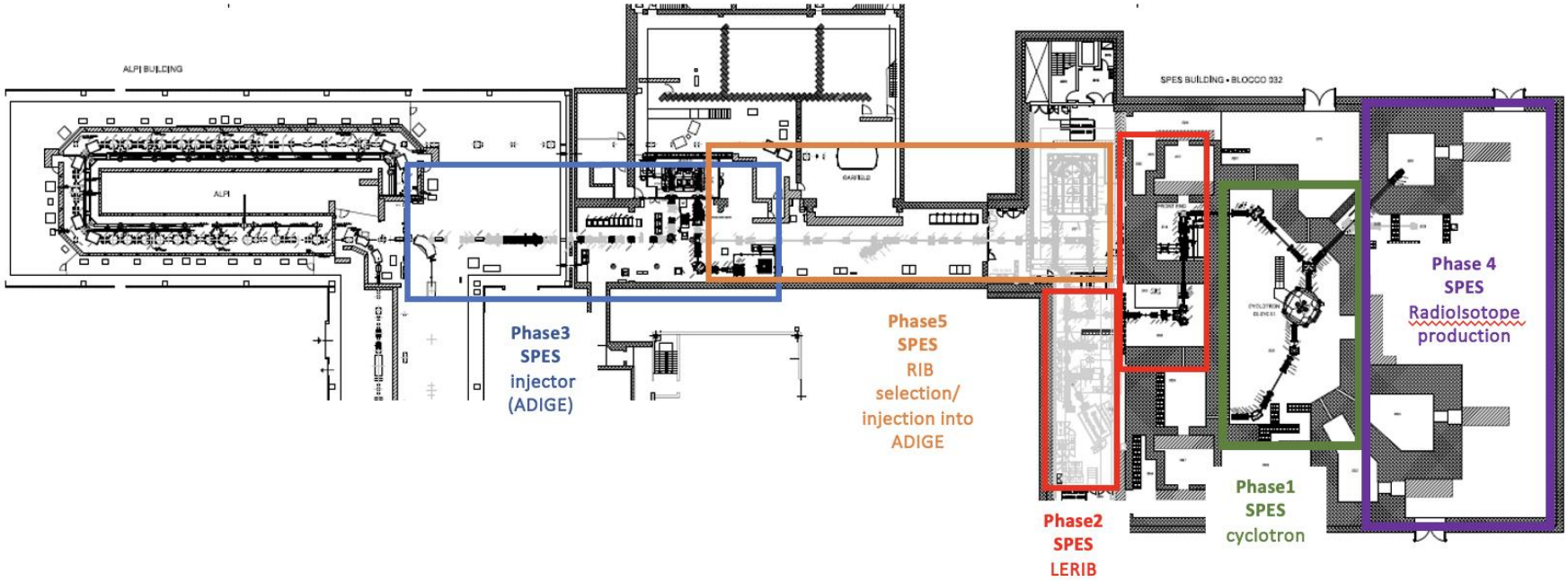
The new phased approach and organization of the SPES project planned a restart and commissioning of the SPES driver cyclotron which delivered this week its first beam for a first experiment of 67Cu radioisotopes cross-section measurement. The SPES phase of production of ISOL low energy radioactive beam and the operation of the new injector (ADIGE) is planned for the end of 2025. The LNL foresees the availability from 2028 of the SPES unstable beams post-accelerated by the ADIGE-ALPI complex up to 10 MeV/u.

LNL together with the Italian community of AGATA is fully committed to provide all means for the success of the AGATA experimental campaigns for the proposed period.

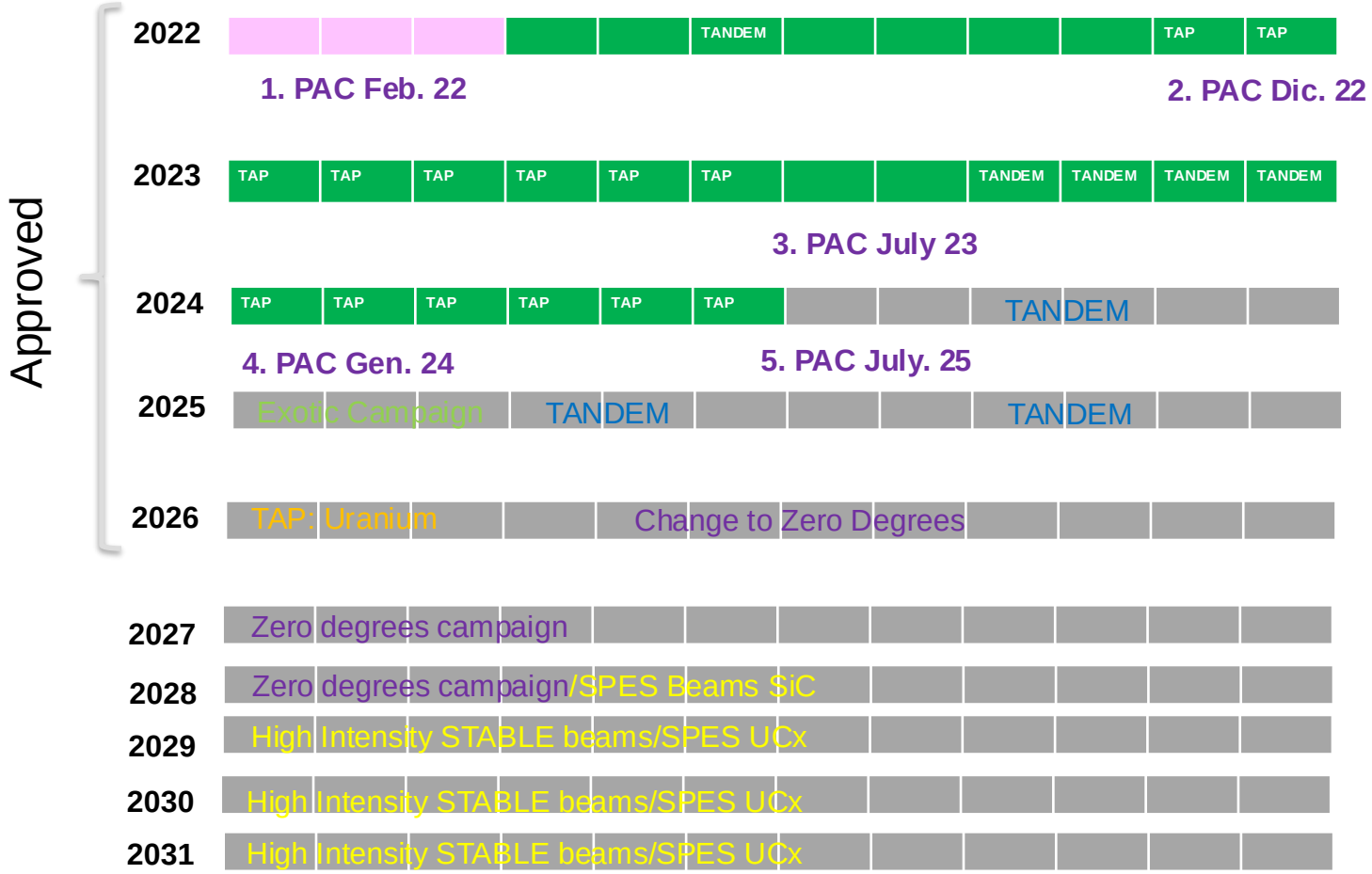
Firmato da
Faical Azaiez
IT
in data
28-05-2024

Summary of SPES project status and future plans

- Phase 1: Operation of the SPES cyclotron April 2024 and first experiment May 2024
- Phase 2: Commissioning of the ISOL low-energy radioactive beams: end 2024
- Phase 3: Complete the ADIGE new injector and RFQ for ALPI (SPES post-accelerator): end 2025/early 2026
- Phase 4: Radioisotope production facility : end 2026
- Phase 5: Commissioning of post-accelerated radioactive beams (SiC target): end 2027



Physics campaign



Summary

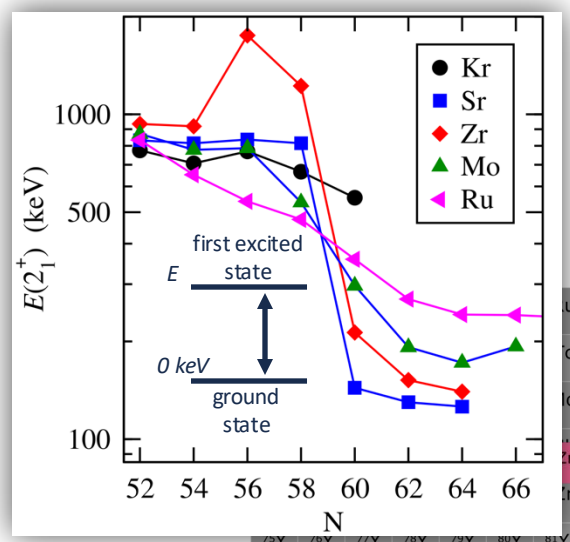
- Rich experimental campaign thanks to an overwhelming response from the community. So far 29 experiments performed.
- AGATA has been requested to stay at LNL from 2027 to 2031 and continue the experimental campaign.
- Full support of the INFN management, of the laboratory and many INFN sections and Universities to make possible this physics campaign

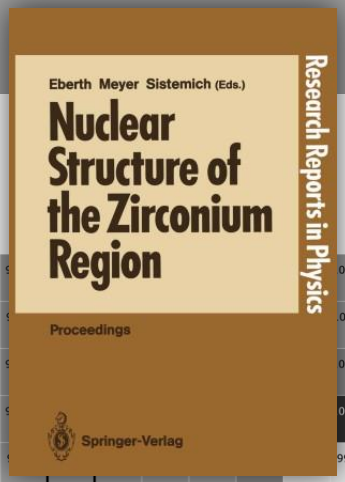
Stay tuned: exciting results from the performed experiments to come!

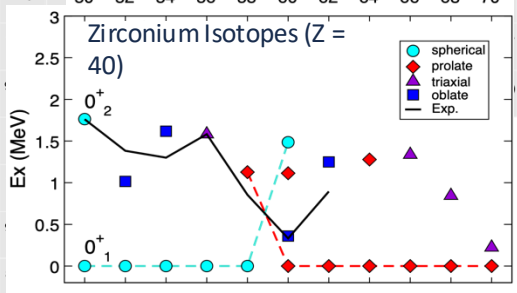
AGATA 4π Biennale Venezia style

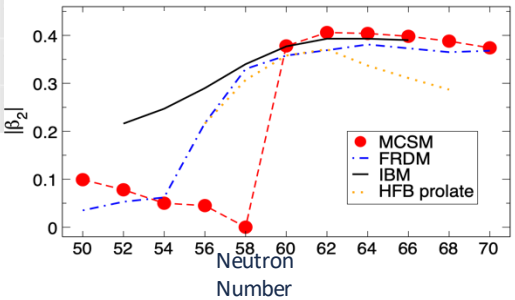
END

The Zr isotopes









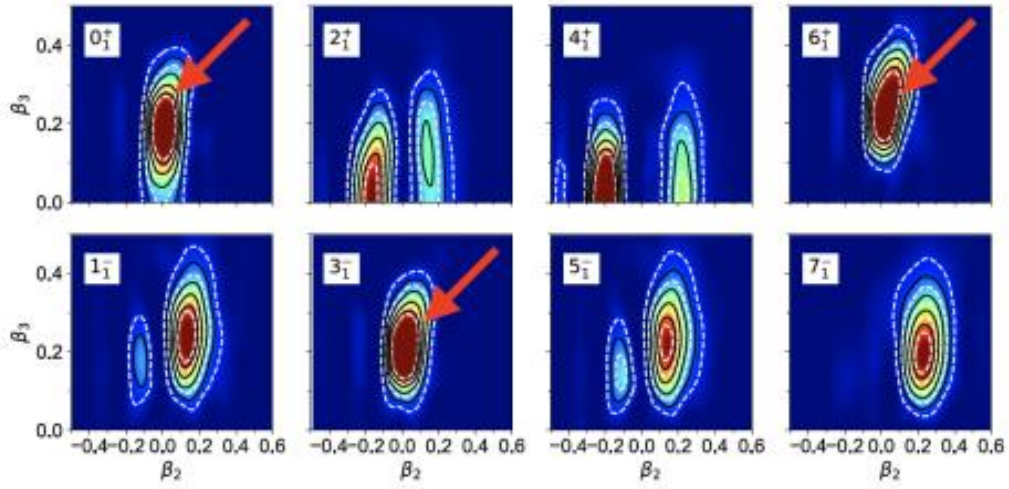
PRL 117, 172502 (2016) PHYSICAL REVIEW LETTERS week ending 21 OCTOBER 2016

Quantum Phase Transition in the Shape of Zr isotopes

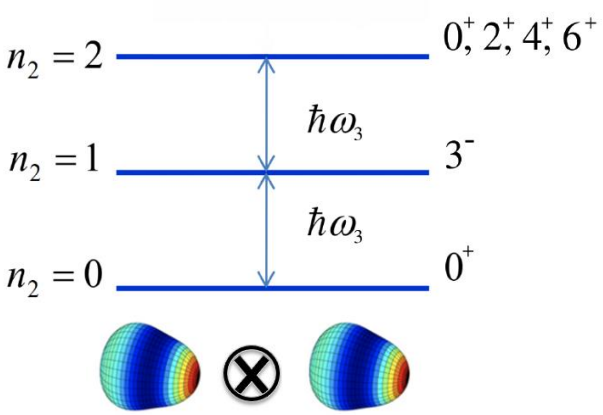
Tomoaki Togashi,[1] Yusuke Tsunoda,[1] Takaharu Otsuka,[1,2,3,4] and Noritaka Shimizu[1]

Two-Phonon Octupole excitation

T. Rodriguez (private communication)



Two-Phonon excitation



Gogny EDF calculations show strong **octupole deformation** for 0_1^+, 3_1^- and 6_1^+ **collective wf**, which present very similar features

Is the **6^+** state a **two-octupole phonon** excitation?

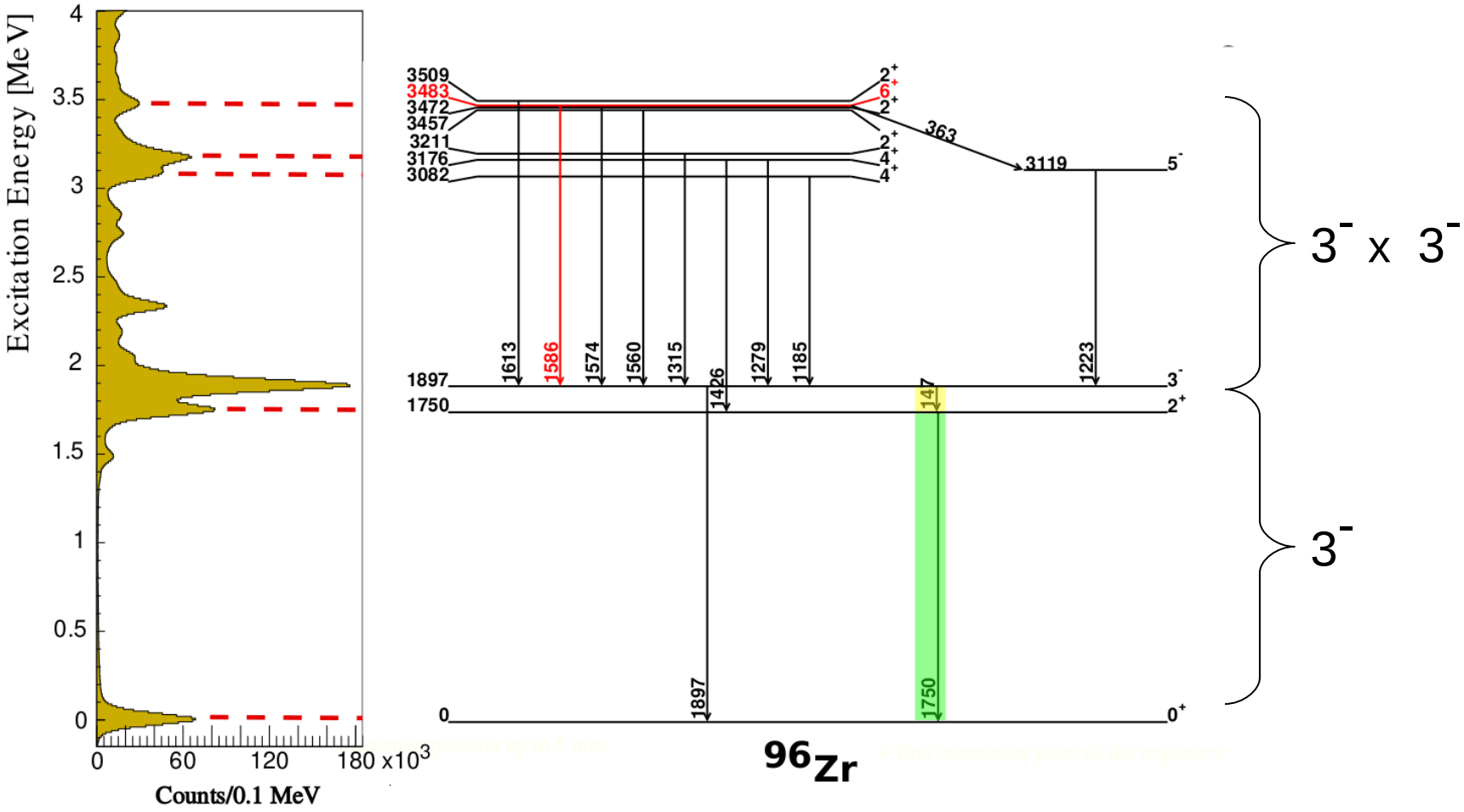
Lifetime of the 6_1^+ state is known: **$T_{1/2}(6_1^+) = 25(9)$ ps**

Measuring its **γ-rays BR** we can get the **$B(E3; 6_1^+ \rightarrow 3_1^-)$**

Two-Phonon Octupole excitation

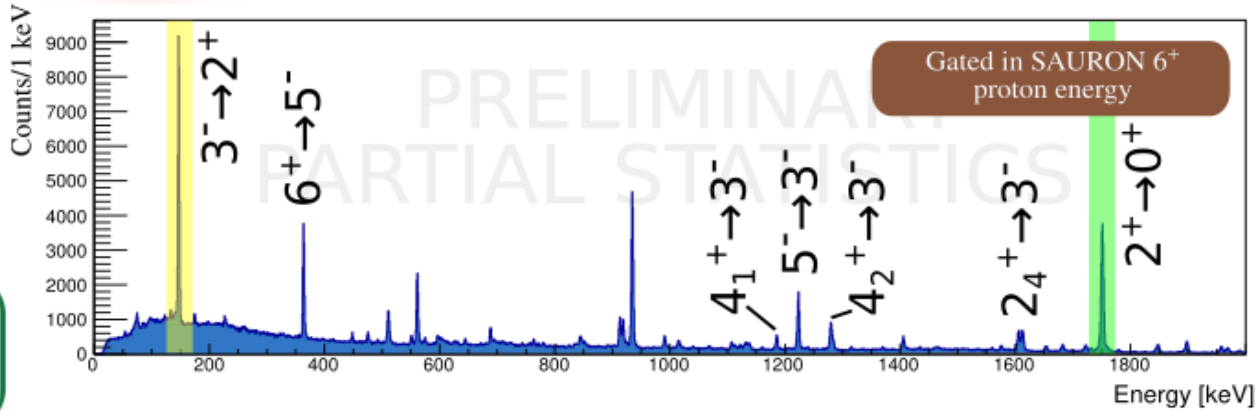
^{96}Zr(p,p') ^{96}Zr reaction to populate the double octupole phonon

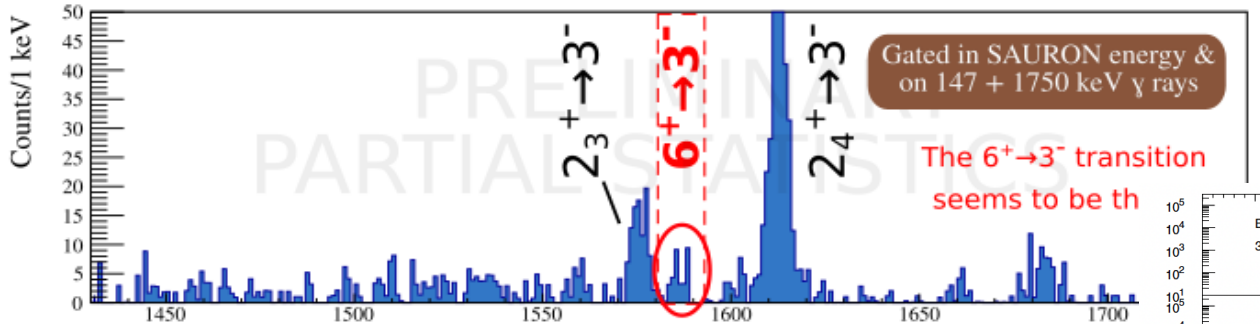
The reconstructed **^{96}Zr excitation energy** spectrum shows that the **6^+ state**, along with a few candidates for the other **two-phonon multiplet members**, was strongly populated



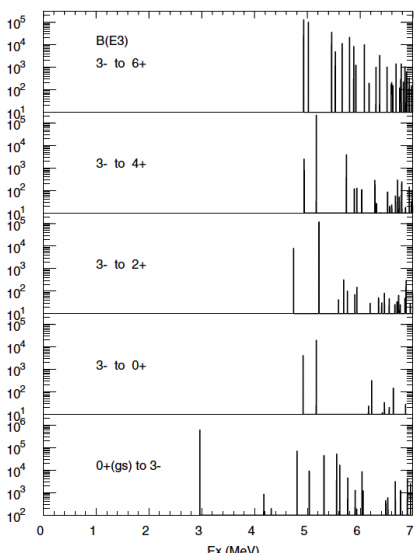
Two-Phonon Octupole excitation

147 keV + 1750 keV sum gates





^{208}Pb



What about the other members (0^+, 2^+, 4^+ of the double octupole phonon?