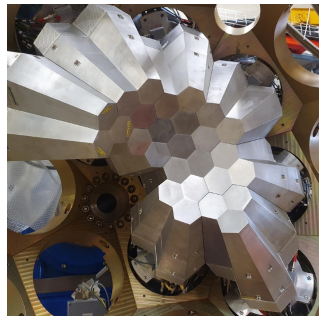
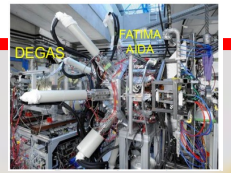
GAMMA @ CSN3:
studi di struttura nucleare con tecniche di spettroscopia GAMMA

RL: G.Benzoni

RN: S.Leoni e A.Gottardo

CAMPAGNE SPERIMENTALI COMPLEMENTARI
FASCI (stabili, instabili, neutroni) e APPARATI allo stato dell'arte, …





AGATA
ADVANCED GAMMA TRACKING ARRAY

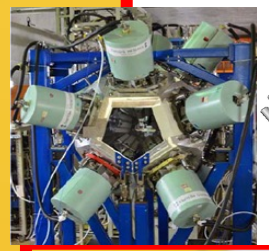
FAIR

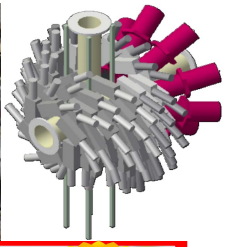
Oslo

JYFL

Separator

DUBNA





Krakow

GANIL

GSI

Orsay

Legnaro

ISOLDE
CERN

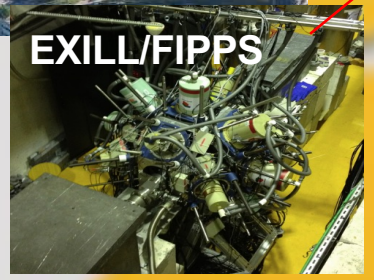
ILL

EURICA

SUNFLOWER COLLABORATION

OSAKA
RIKEN

NEUTRONS FOR SCIENCE



Bucharest

LNS

MICHIGAN STATE UNIVERSITY

Argonne NATIONAL LABORATORY

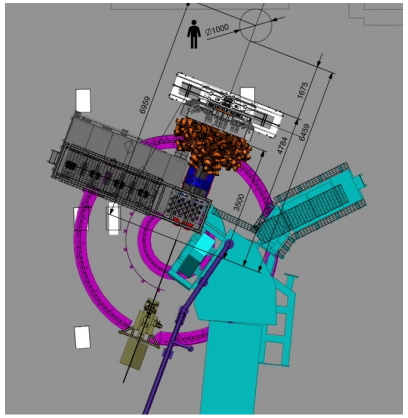
GALILEO Array at LNL
Working horse for

SPES
exotic beams for science

AGATA: Advanced Gamma Tracking Array based on segmented detectors

Campagna di Fisica @ LNL 2021 ➔ 2026 + …

AGATA accoppiata a spettrometro PRISMA



4 campagne di fisica concluse Apr2022 ➔ Lug 2024
Richiesta e uso di ~80% tempo di fascio @ LNL
PAC luglio 2024 per prossima campagna

- Impegni nel 2024: supporto per campagna di presa dati
- Presentazione e realizzazione di Proposal a spokes di UniMi e INFN-MI
- Md.S.R.Laskar, assegno di ricercar su AGATA finisce attivita' luglio 2024

2024: Spostamento verso nuova configurazione "stand-alone"

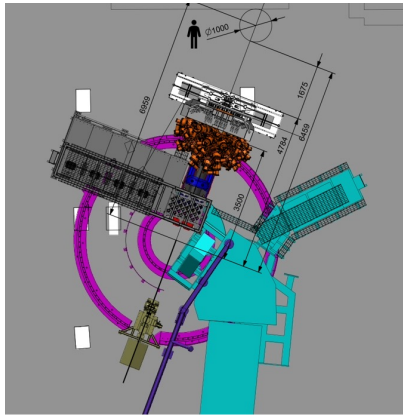
- Progettazione camera di scattering + linea di fascio: ufficio progettazione @INFN-MI, GB
- Nuovo read-out scheme per rivelatori ancillari: S.Brambilla, C.Boiano, S.Capra
- Integrazione con target criogenici: F.Crespi
- Integrazione con Scintillatori: F.Camera e A. Giaz

Attivita' sulla nuova configurazione prosegue nel 2025 con pre-installazione
Attivita' di disegno e realizzazione supporti per ancillaries
Test in-beam del nuovo readout system

AGATA: Advanced Gamma Tracking Array based on segmented detectors

Campagna di Fisica @ LNL 2021 ➔ 2026 + …

AGATA accoppiata a spettrometro PRISMA



4 campagne di fisica concluse Apr2022 ➔ Lug 2024
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- Impegni nel 2024: suppo…
- Presentazione e r… …kes di UniMi e INFN-MI
- Md.S.R.I.a… …GATA finisce attivita' luglio 2024

MOU attivo fino a 2030
Richiesta per 2025: 521 k€ (IVA incl.)
OC 2025: 136 k€ (IVA incl.)

2024: Spostamento … …urazione "stand-alone"

- Progettazione camera di scatteri… …l fascio: ufficio progettazione @INFN-MI
- Nuovo read-out scheme per rivel… …ancillari: S.Brambilla, C.Boiano, S.Capra
- Integrazione con target criogenici: F.Crespi
- Integrazione con Scintillatori: F.Camera e A. Giaz

Attivita' sulla nuova configurazione prosegue nel 2025 con pre-installazione
Attivita' di disegno e realizzazione supporti per ancillaries
Test in-beam del nuovo readout system

AGATA Management Board and Teams

https://prezi.com/view/6wEXBwIno5QKyLJrBd8H/ **Phase 2**

Project Manager / AMB Chairperson

Working Group Chairpersons, ASC Chairperson (A. Bracco) ACC Chairperson (S. Leoni).

LPM-LNL, LPM-GSI, LPM-GANIL J.Nyberg (Dissemination),

AMB Chairperson
Project Manager
E. Clément

Resource Manager
B. Million

Environmental Officer
R. Perez Vidal

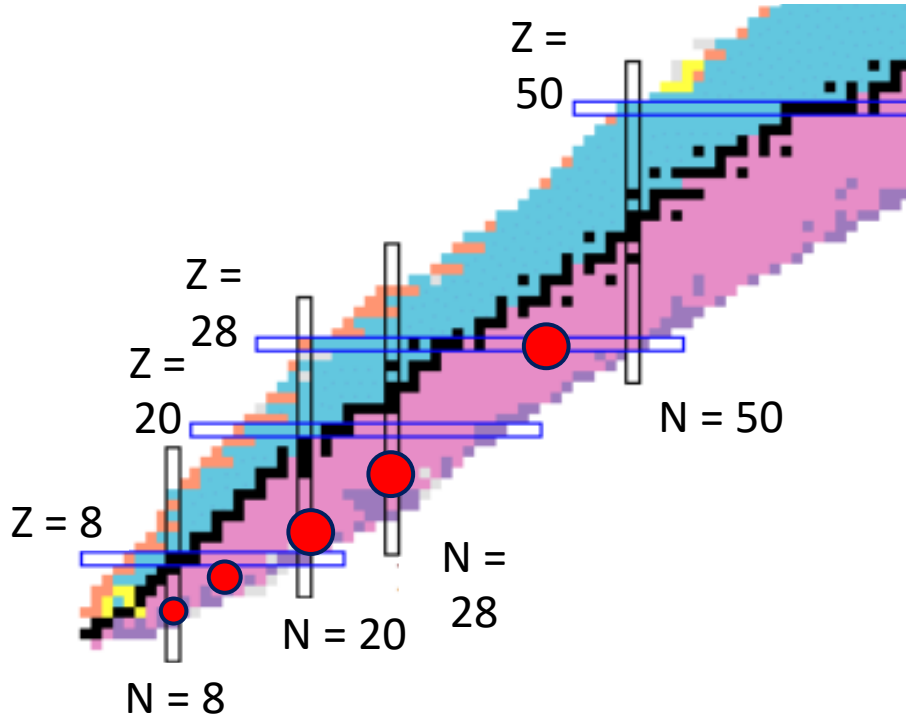
AGATA Working Groups	AGATA Teams			
Detector Module H. Hess	Detector & Cryostat M. Zielinska M.H. Sigward	Detector CAT &Testing H. Boston	R & D on gamma Detectors & Applications D. Judson	
Front-end Electronics A.Gadea	Pre-Amplifier Digitizer A. Pullia	Pre-processing I. Lazarus	Global Trigger & Synchronization GANIL	Coupling To Ancillaries A. Goasduff
Data Processing O. Stézowski	DAQ Infrastructure IJCLab-LNL	Online/offline Interoperability G. Baulieu	DAQ Processing E. Legay	Reprocessing & analysis Data Manager J. Dudouet
Infrastructure B. Million	Detector array Infrastructure R. Menegazzo	Mechanical Infrastructure R. Smith	AGATA Array Database C. Aufranc	
PSA & Tracking R&D A. Boston	PSA Algorithm Development F. Holloway	Detector Characterisation A. Boston	Tracking Development A. Lopez-Martens	
Performance and Simulation M. Labiche	AGATA Performance R. Perez Vidal	AGATA Commissioning F. Crespi	AGATA Simulation M. Labiche	

Local Project Managers (LPM)

INFN-LNL	FAIR	GANIL-SPIRAL2
Legnaro	Darmstadt	Caen
J.J. Valiente-Dobon	K. Wimmer	E. Clément

Towards the Island of Inversion at N=20

Simone Bottoni



Eur. Phys. J. Plus (2023) 138:709
https://doi.org/10.1140/epjp/s13360-023-04249-x
THE EUROPEAN PHYSICAL JOURNAL PLUS
Regular Article

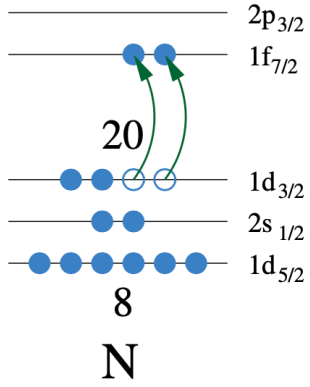
Nuclear physics midterm plan at Legnaro National Laboratories (LNL)

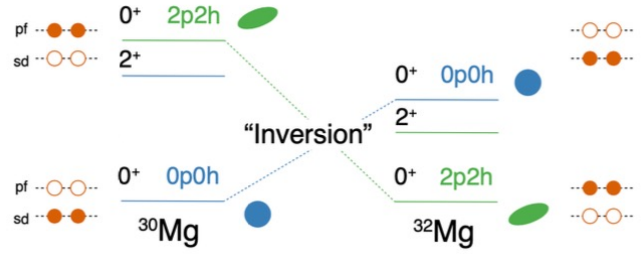
Experimental campaign discussed in the LNL Mid Term Plan (Phase A)

Working group: Light to medium mass exotic nuclei
Convener: S. Bottoni

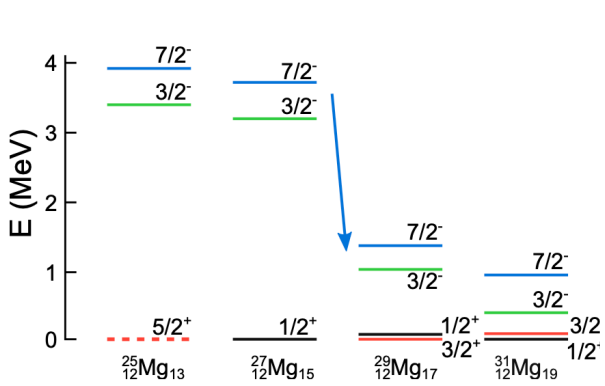
Island of Inversion

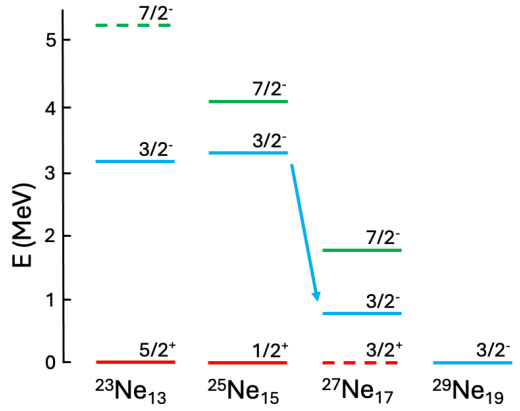
reduction of the N=20 shell gap





K. Wimmer et al., Phys. Rev. Lett. 105, 252501 (2010)



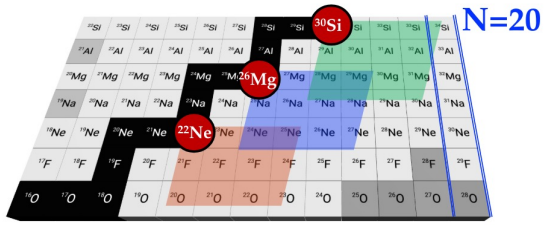


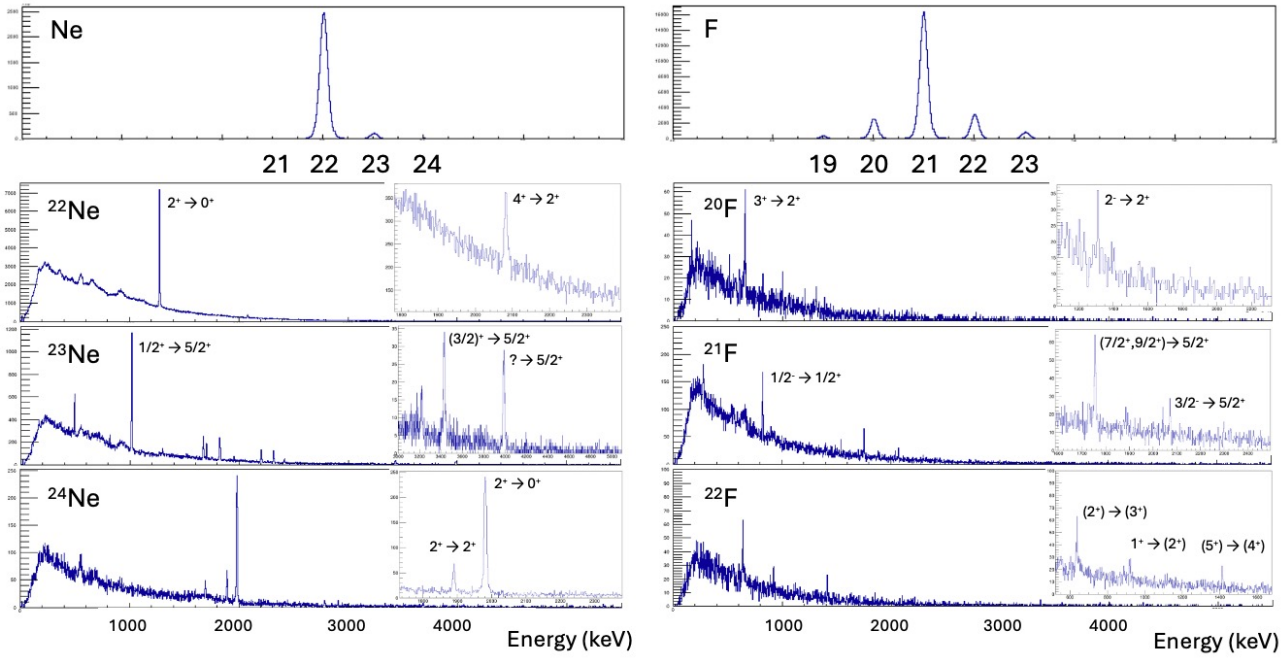
Towards the Island of Inversion at N=20

Simone Bottoni

Multi-nucleon transfer reactions

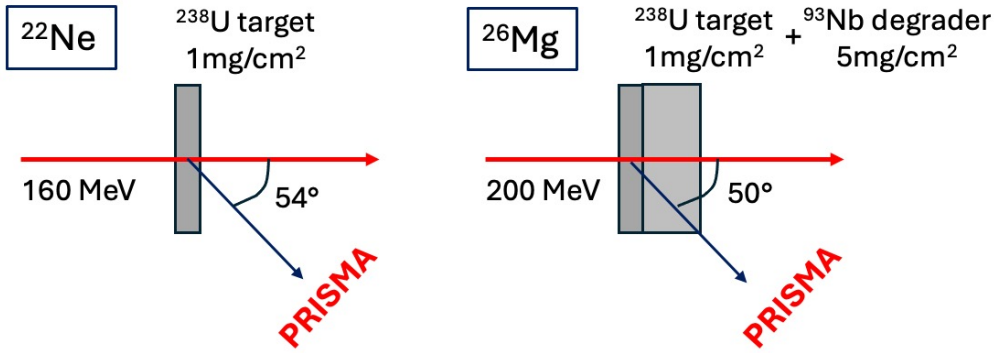
light beams and ^{235}U target

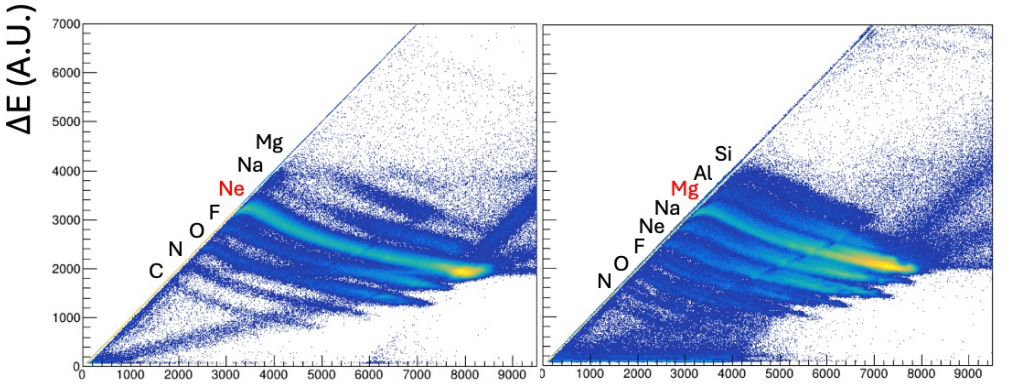




2 experiments perfomed

K. Wimmer, S. Bottoni, G. Benzoni, P. Aguilera, F. Recchia





Apr. 2023

June 2024

AGATA-PRISMA coincidences

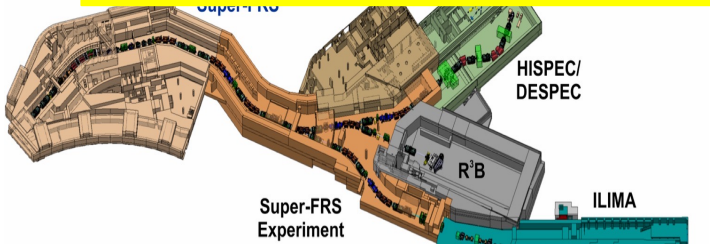
mass reconstruction and Doppler correction

Analysis by F. Drent (GSI), P. Aguilera (UNIPD), **D. Genna (UNIMI)**

HIGHLIGHTS GAMMA 2023: Campaigns at International Labs.

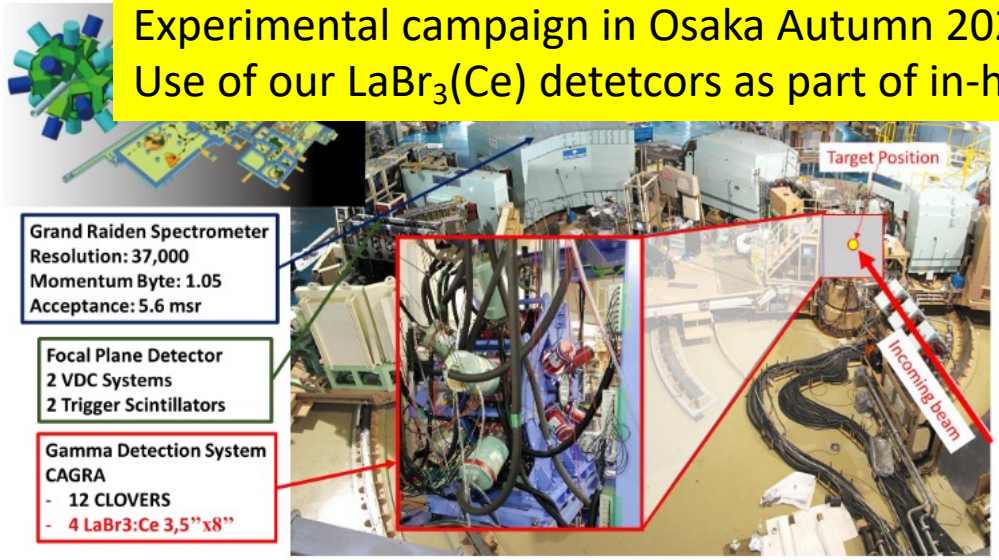
Phase-0 Campaign @GSI started in 2020 (3 exps./year)

- 3 experiments Italian leadership (PhD projects):
  - 1 exp. Run by Italian Gamma Coll. in 2024

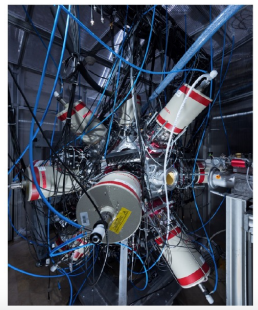


Experimental campaign in Osaka Autumn 2023-24-25

Use of our $LaBr_3(Ce)$ detetcors as part of in-house array



FIPPS
8 Clovers (ILL)
8 Clovers (IFIN-HH)



Studies of (n,g) or fission fragments at ILL
Several isotopic chains
83Se studies using target developed with CUPID coll. (CSN2)
Program on-going in 2024-25

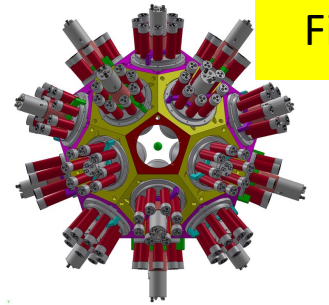
LOHENGRIN ^{131}Sb

PHYSICAL REVIEW C **107**, 014322 (2023)

Testing the predictive power of realistic shell model calculations via lifetime measurement of the $11/2^+$ state in ^{131}Sb

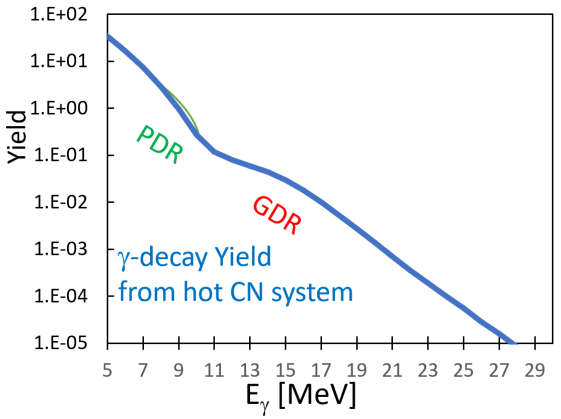
S. Bottoni,[1,2,*] E. R. Gamba,[1,2] G. De Gregorio,[3,4] A. Gargano,[4] S. Leoni,[1,2] B. Fornal,[5] N. Brancadori,[1] G. Ciconali,[1,2] F. C. L. Crespi,[1,2] N. Cieplicka-Oryńczak,[5] Ł. W. Iskra,[5] G. Colombi,[1,2,6] Y. H. Kim,[6,†] U. Köster,[6] C. Michelagnoli,[6] F. Dunkel,[7] A. Esmaylzadeh,[7] L. Gerhard,[7] J. Jolie,[7] L. Knafla,[7] M. Ley,[7] J.-M. Régis,[7] K. Schomaker,[7] and M. Sferrazza[8]

Studies of Pygmy Resonance states built on hot compound nucleus:
First ever experimental measurement



ELIFANT-GG@IFIN Bucharest
11 3x3 inch $LaBr_3$:Ce
10 3x3 inch $CeBr_3$

$^{3x}S+^{2x}Mg \rightarrow ^{xy}Ni^* \rightarrow \gamma,n,p,\alpha,\ldots+$



Extended experimental program on Shape coexistence and Shape

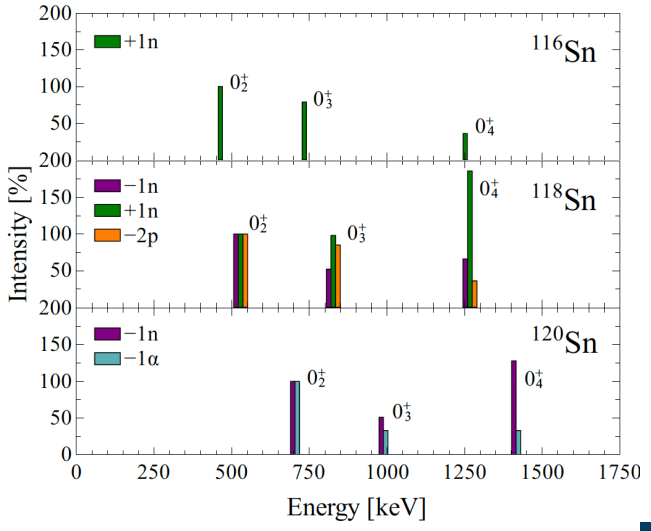
complementary experiments at LNL, IFIN-HH, ILL

Analysis ongoing in Ni A=60 Region:

(n,γ) at ILL: ^{62,64}Ni
1n, 2n, 1p transfer at IFIN-HH with ROSPHERE: ^{62,64,66}Ni

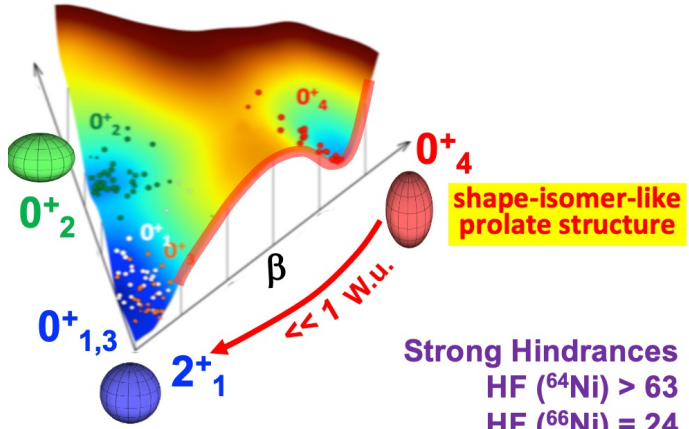
Performed/planned experiments in Ca and Sn A=100 Region:

^{18}O+ ^{112}Sn →^{114}Sn: lifetime (DSAM and Plunger), ROSPHERE (2022)
^{32}S+ ^{110}Cd → ^{112}Sn: lifetime (Plunger), AGATA+PRISMA (2022)
1n, 2n, 2p, (alpha) transfer → $^{114,116,118.120}$Sn: DSAM, ROSPHERE (2023)
1n transfer → $^{114,116,118.120}$Sn: lifetime (Plunger), ROSPHERE (2024)

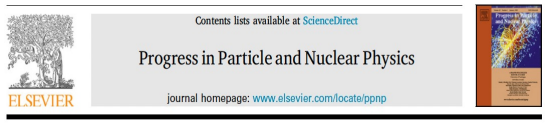


G. Corbari PhD Thesis (Sn Region)
M. Luciani PhD Thesis (Ca Region)

High Potential Energy Barrier



Strong Hindrances
HF (^{64}Ni) > 63
HF (^{66}Ni) = 24



Review

Multifaceted character of shape coexistence phenomena in atomic nuclei

S. Leoni [a,b,*], B. Fornal [c], A. Bracco [a,b], Y. Tsunoda [d], T. Otsuka [e,f]

[a] Dipartimento di Fisica dell'Università degli Studi di Milano, Italy
[b] INFN, Sezione di Milano, Italy
[c] Institute of Nuclear Physics PAN, Krakow, Poland
[d] Center for Nuclear Study, The University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan
[e] Department of Physics, The University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan
[f] RIKEN Nishina Center, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan

review paper in print

ARTICLE INFO

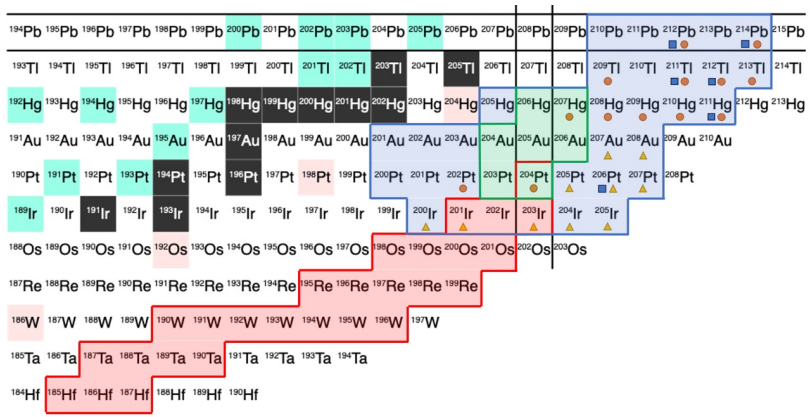
Keywords:
Nuclear structure
Shape coexistence
Shape isomers
Superdeformed bands

ABSTRACT

This article is devoted to a review of decay properties of excited 0⁺ states in regions of the nuclear chart well known for shape coexistence phenomena. Even–even isotopes around the Z=20 (Ca), 28 (Ni), 50 (Sn), 82 (Pb) proton shell closures and along the Z=36 (Kr), Z=38 (Sr) and Z=40 (Zr) isotopic chains are mainly discussed. The aim is to identify examples of *extreme shape coexistence*, namely highly deformed structures, well localized in the Potential Energy Surface in the deformation space, which could lead to γ decays substantially hindered. This is in analogy to the 0⁺ fission shape isomers in the actinides region and to the superdeformed (SD) states at the decay-out spin in medium/heavy mass systems. In this survey, the Hindrance Factor (HF) of the E2 transitions de-exciting 0⁺ states or SD decay-out states is a primary quantity which is used to differentiate between types of shape coexistence. The 0⁺ states, examined with the help of the hindrance factor, reveal a multifaceted scenario of shape coexistence. A limited number of 0⁺ excitations (in the Ni, Sr, Zr and Cd regions) exhibit large HF values (>10), some of which are associated with the clear separation of coexisting wave functions, while in most cases the decay is not hindered, due to the mixing between different configurations. Comparisons with theory predictions based on various models are also presented, some of which shed light on the microscopic structure of the considered states and the origin of the observed hindrances. The impact of shape ensembles at finite temperature on the decay properties of highly-excited states (Giant Dipole Resonances) is also discussed. This research area offers a complementary approach for identifying regions where extreme shape coexistence phenomena may appear.

Approaching r-process path around N=126

Marta Polettini



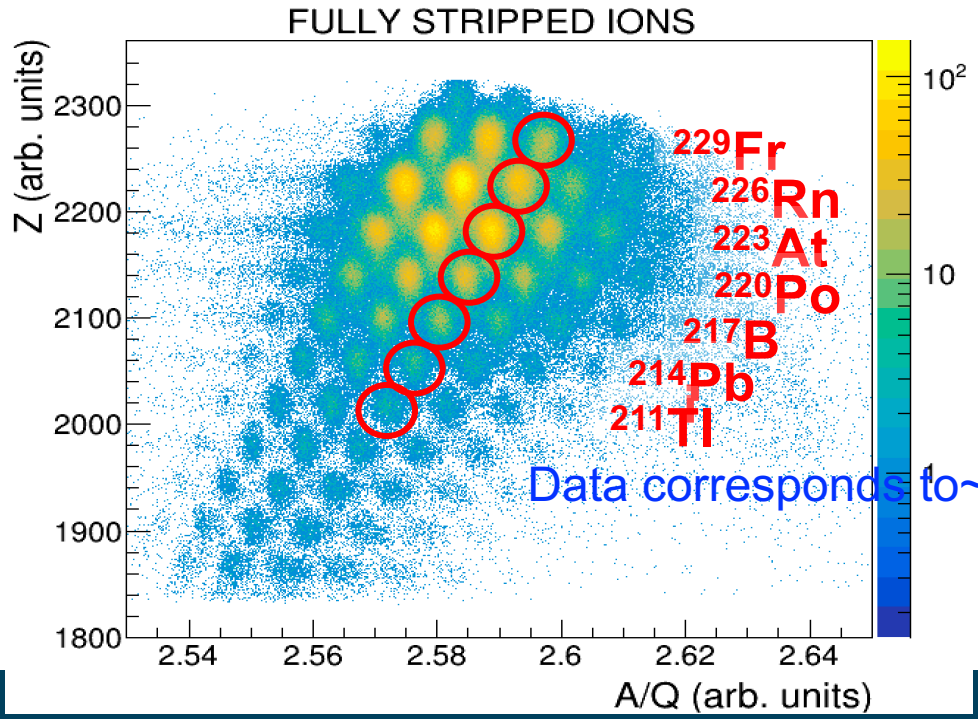
Main goals:

⇒ Obtain nuclear properties used as inputs into r-process network calculations

⇒ Provide new data to test nuclear models

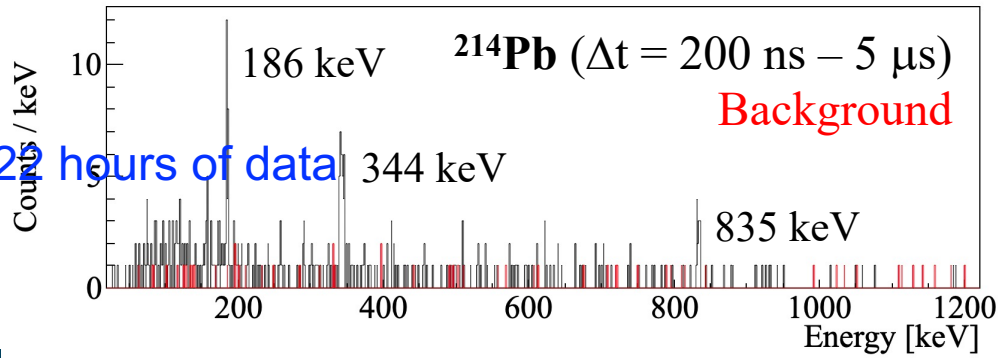
Focus on the Pt isotopic chain:

- Trace the evolution of **decay schemes** between N=122 and N=129
- Search for a **seniority isomer** in ^{206}Pt
- New **β-decay half-lives** measurements in ^{205,206,207}Pt and ^{207,208}Au

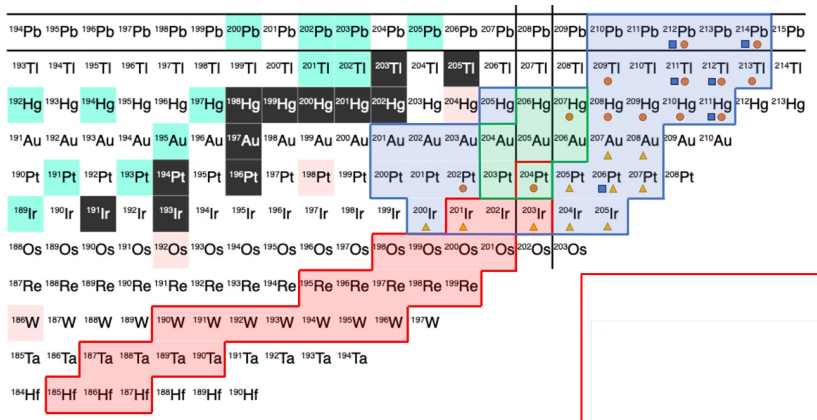


Experiment performed mid-June 2024

Data analysis to be started



Approaching r-process path around N=126



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Focus on the Pt isotopic chain:

- [illegible]tween N=122 and N=129
- ^{205,206,207}Pt and ^{207,208}Au

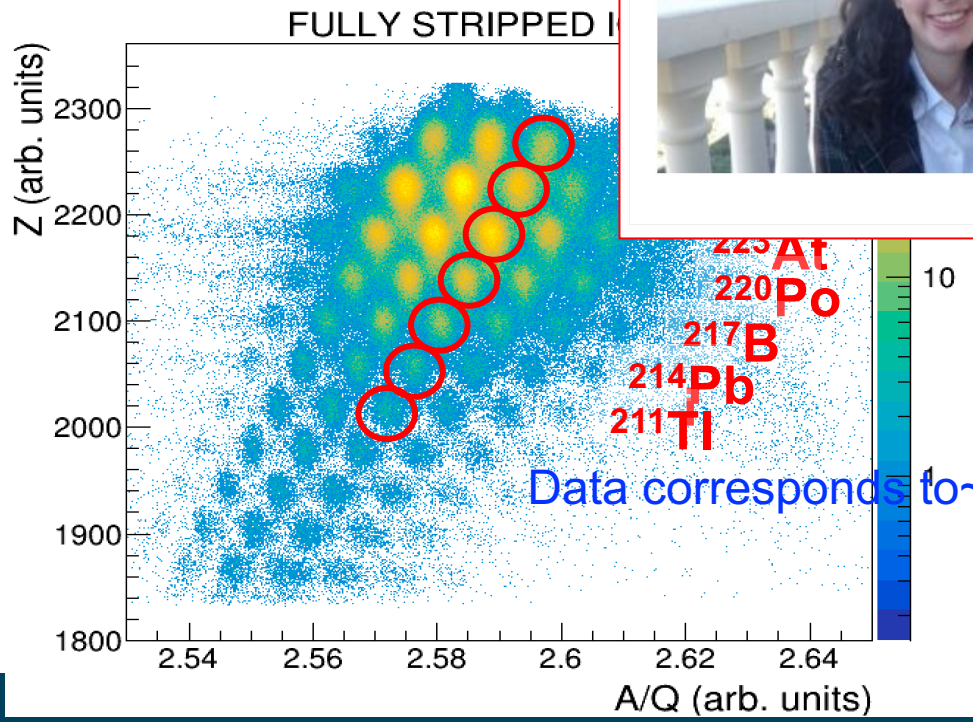
Marta Polettini ha vinto il Premio Villi per la migliore tesi di dottorato in fisica...

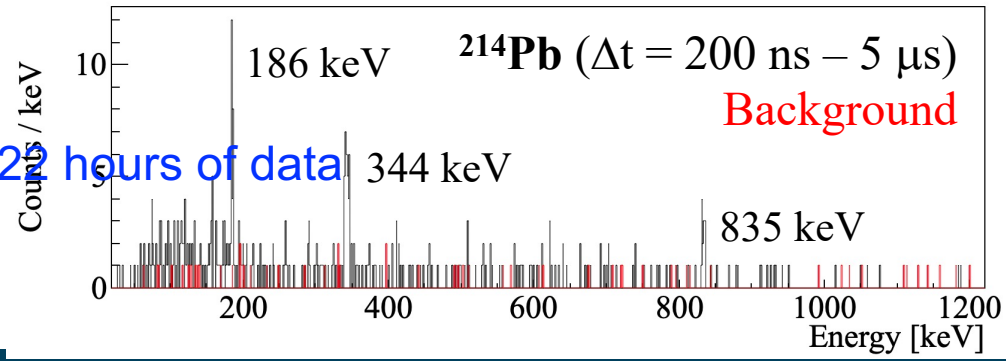
Domenica, 21 Aprile 2024

La nostra studentessa Marta Polettini e' stata selezionata come vincitrice del Premio Villi, assegnato annualmente dalla CSN3 dell'INFN, per la migliore tesi

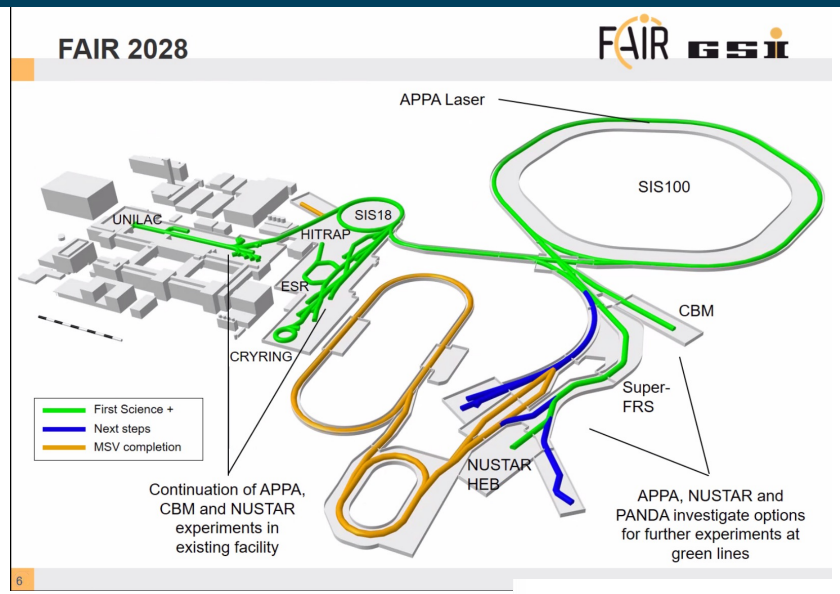
1 2 **3** 4 5

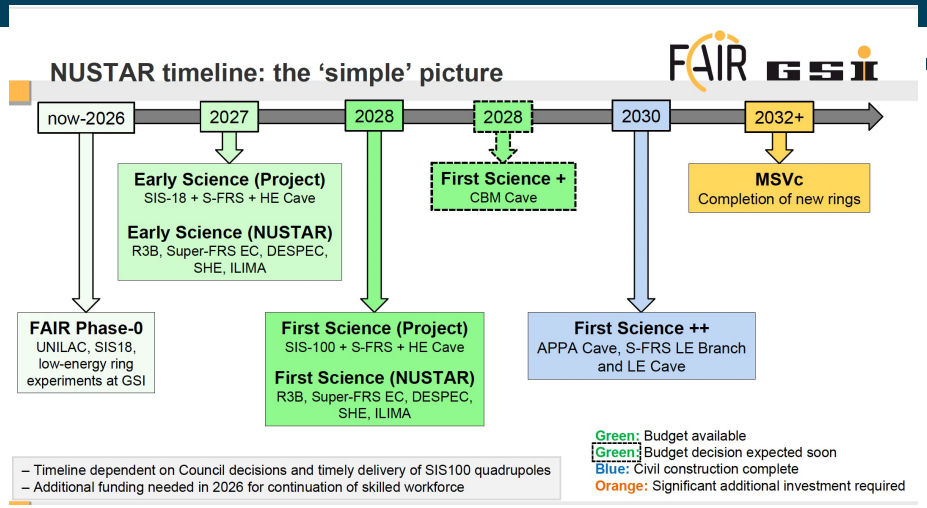
2024





Activity at GSI-FAIR





- **HISPEC/DESPEC (High-Resolution in-flight Spectroscopy/Decay Spectroscopy)**
- **R^{3}B (Reactions with Relativistic Radioactive Beams)**
- **MATS (Precision Measurements of very short-lived nuclei using an Advanced Trapping System)**
- **LaSpec (Laser Spectroscopy)**
- **ILIMA (Isomeric Beams, Lifetimes and Masses)**
- AIC
- **ELISe (Electron-Ion Scattering in a Storage Ring)**
- **EXL (Exotic nuclei studied in light-ion induced reactions at the NESR storage ring)**
- **Super-FRS Experiments**
- **SHE (Super-Heavy Element Research)**

C-MOU:

- final version to be released end of June
- Already got approval from INFN legal office ➔INFN ready to sign
- 31 Senior members from 6 divisions (Mi-Pd-LNL-Ct-LNS-Na)
- Covering years 2025-2028

  Total 207 kE ➔ **annual FEE of 51.75 kE**

HISPEC-DESPEC Collaboration Agreement:

- Signed by INFN on 06/06/2024
- 26 Senior Members from 3 divisions (Mi-Pd-LNL)
- **Yearly Fee of 14.4 kE**

https://fair-center.eu/for-users/experiments/nustar/experiments.html

Activity on Pygmy and Giant Resonances

- Pygmy states: oscillation of neutron excess against core
- Importanto to follow at increasing N/Z
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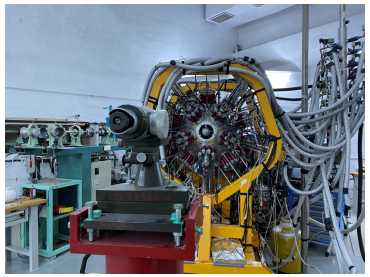
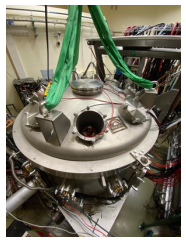
- **Comparison of data-sets at 2 locations**

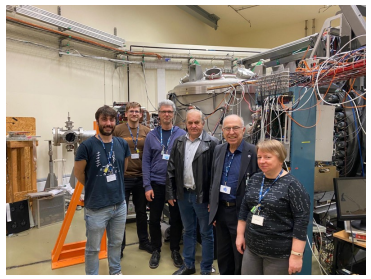
Spokespersons:
O.Wieland & **A.Giaz,** F.Crespi, F.Camera

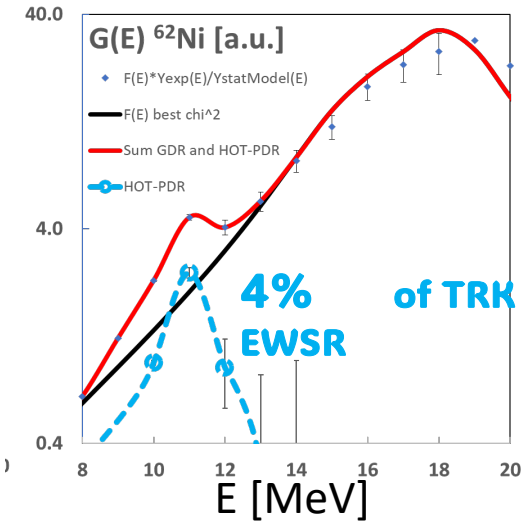
ELIGANT @ IFIN-HH (T>0)

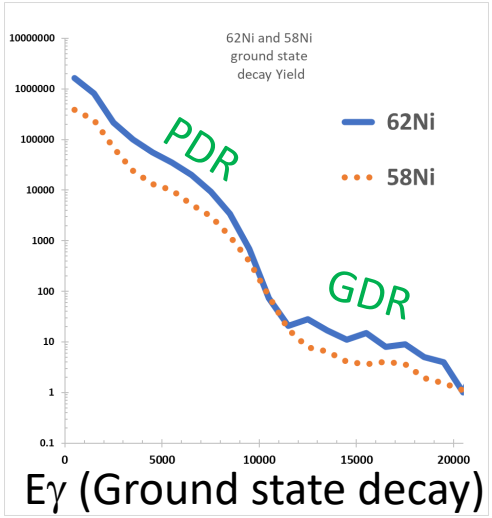


KRATTA+PARIS+LABr3@Cracovia









Activity on Pygmy and Giant Resonances

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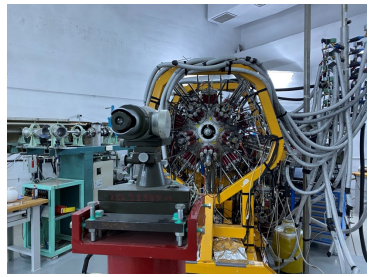
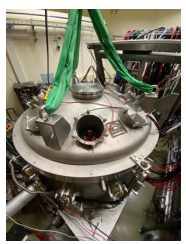
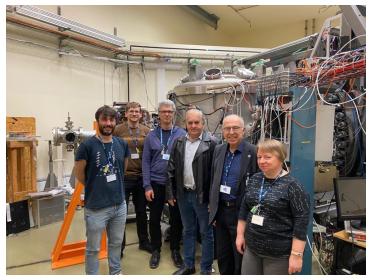
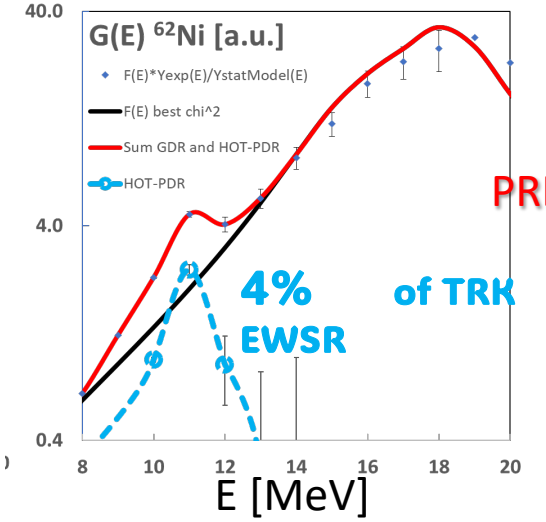


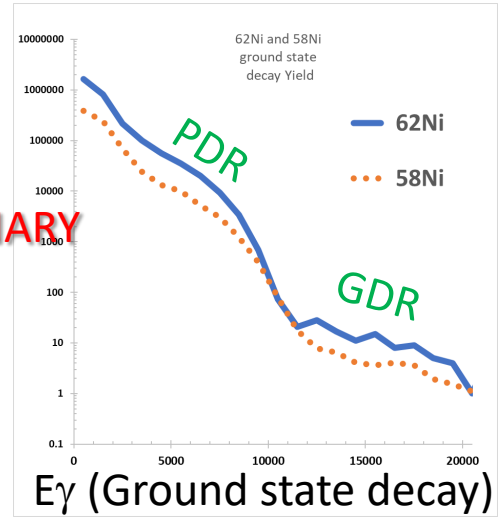
KRATTA+PARIS+LABr3@Cracovia







PRELIMINARY



Spokespersons:

O.Wieland & **A.Giaz,** F.Crespi, F.Camera

PANDORA

Photo-Absorption of Nuclei and Decay Observation for Reactions in Astrophysics

Photo-**A**bsorption of **N**uclei and **D**ecay **O**bservations for **R**eaction in **A**strophysics

~ Extragalactic propagation of ultra-high energy cosmic rays (UHECRs)

~ Nuclear Structure

= electric dipole strength distribution: PDR, GDR, EDP

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Oliver Wieland

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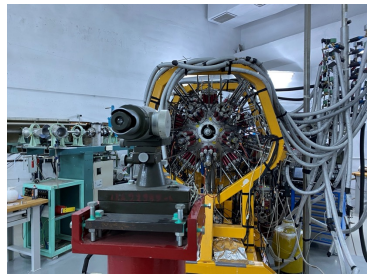
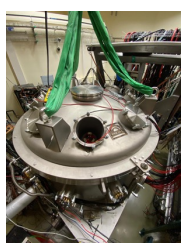
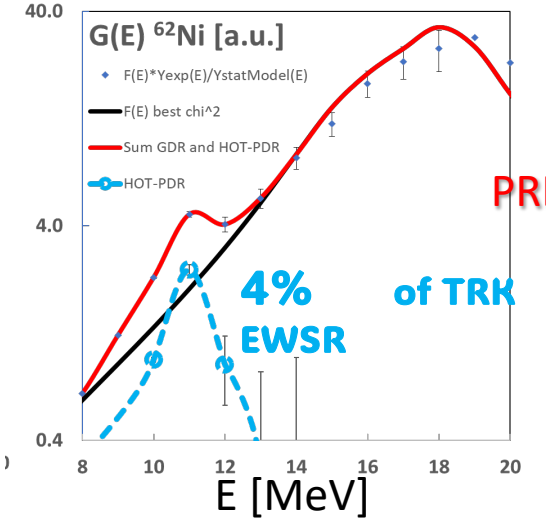


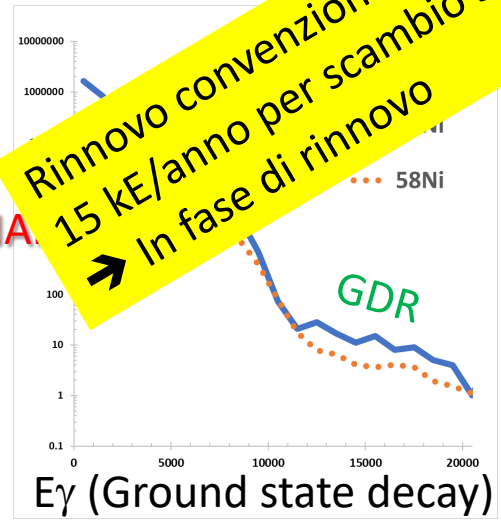
KRATTA+PARIS+LABr3@Cracovia



Rinnovo convenzione Italia-Polonia –POLITA-
15 kE/anno per scambio scientifico su tutta Italia
➔ In fase di rinnovo



PRELIMINA



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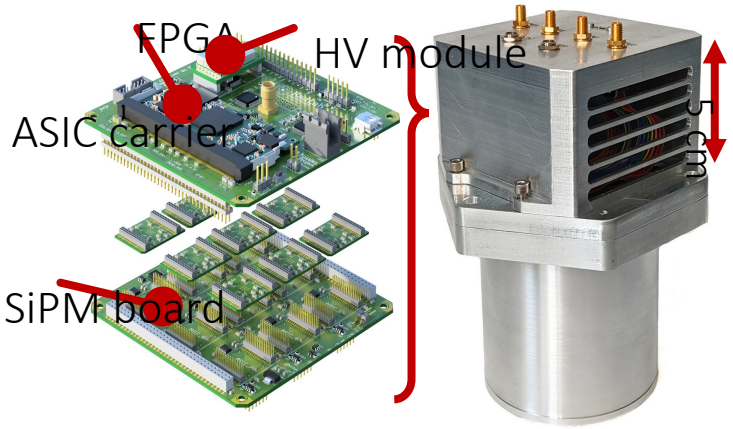
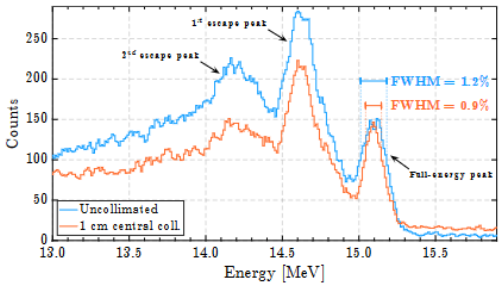
Attivita' di R&D di rivelatori / readout / DAQ

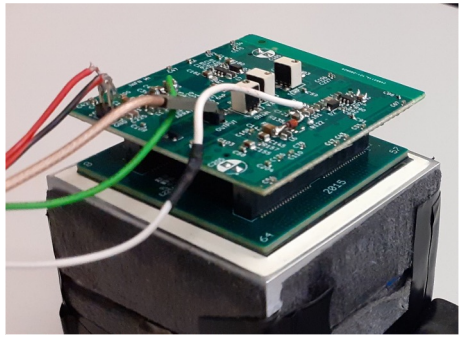
Test sotto fascio per scintillatore $LaBr_3$:Ce:Sr letto da SiPM

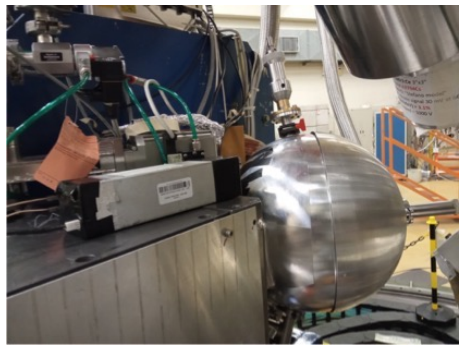




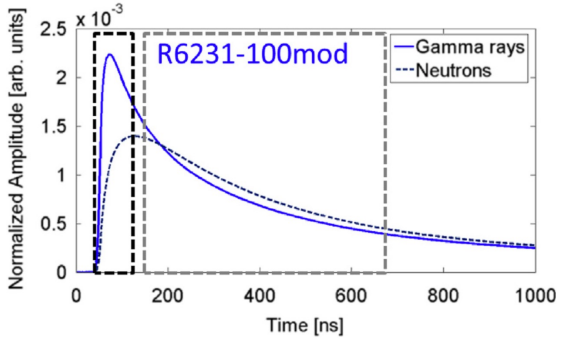
SiPM readout for PARIS phoswich det.
➔ test sotto fascio @ AGATA

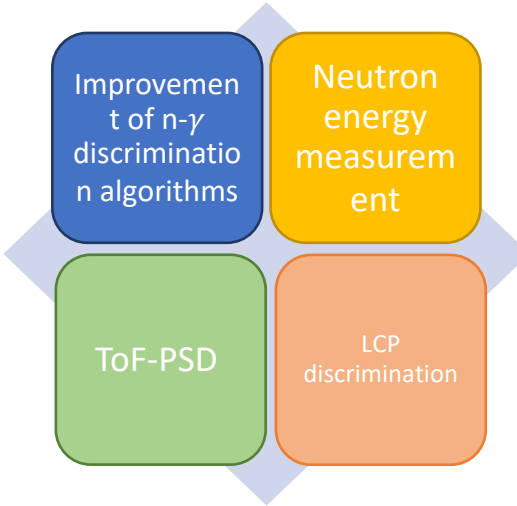
- **2″x2″x2″ $LaBr_3$** (first part of the crystal)
- 2 inch **sensL** matrix, signal as a sum of 64 SiPM (6x6 mm)
- Thermal compensation
- Dedicated electronics
- First in-beam test





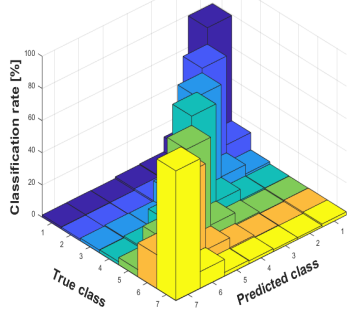
New activity on ClyC detectors for g-n discrimination





ML algorithms to derive position sensitivity

Confusion matrix (1D)

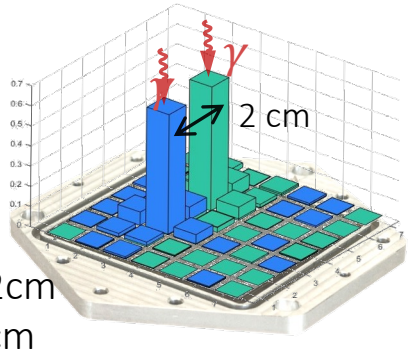


Decision Tree

- Mean error: 0.47cm
- RMS error: 1.08cm

Neural Network

- Mean error: 0.42cm
- RMS error: 1.02cm



Consuntivi 2023:

Budget : **1276.50 KE**
Researchers: **46.22 FTE (61 people)**
Technologists: **5.25 FTE (12 people)**
5 INFN divisions (MI-Pd-LNL-Fi-Pg)

MI**: 27 persone / 19.4 FTE**
➔ aumento in 2024 per N3G
Budget Mi**: 796 (+25 SJ) KE**

96 publications (DOI indexed)
31 Thesis (BT/MT/PhD)
~130 talks to Conferences

Consuntivi attivita' 2023:

ITALIA
Budget : **1276.50 KE**
Researchers: **46.22 FTE (61 people)**
Technologists: **5.25 FTE (12 people)**
5 INFN divisions (MI-Pd-LNL-Fi-Pg)

MILANO
27 persone / 19.4 FTE
➔ aumento in 2024 per N3G
Budget Mi**: 821 KE**

96 publications (DOI indexed)
31 Thesis (BT/MT/PhD)
~130 talks to Conferences

Richieste economiche 2025:

Consumo	45 k€	di cui	7 k€	s.j.	
Trasporti	0 k€	di cui	0 k€	s.j.	
Inventariabile	14.5 k€	di cui	0 k€	s.j.	
SPServizi	151 k €	di cui	0 k€	s.j.	
Apparati**	649 k€	di cui	20 k€	s.j.	
Riparazioni/licenze	5 k€	di cui	0 k€	s.j.	
Σ		**864.5 k€**	**di cui**	**7 k€**	**s.j.**
Missioni	**125 k€**				

*** su APPARATI Milano: PARIS MoU (48 k€), GRIT MoU (30 k€), AGATA MoU (551 k€) 3π configuration in 10 years (total investment: 5.5 M€))*

Richieste di Servizi:
- Officina meccanica: 10 mesi/uomo
- Servizio Progettazione: 12 mesi/uomo
- Elettronica: 12 mesi/uomo (C.Boiano)