Marco Rocchini
INFN - Istituto Nazionale di Fisica Nucleare
FIRENZE DIVISION

Gamma-Ray Spectroscopy Following Beta-Decay of ISOL Beams: Present at TRIUMF and Future at SPES

TRIUMF Laboratories

TRIUMF Laboratories

TRIUMF Laboratories

TRIUMF Labs

GRIFFIN γ-Ray Spectrometer

γ-γ Angular Correlations with GRIFFIN

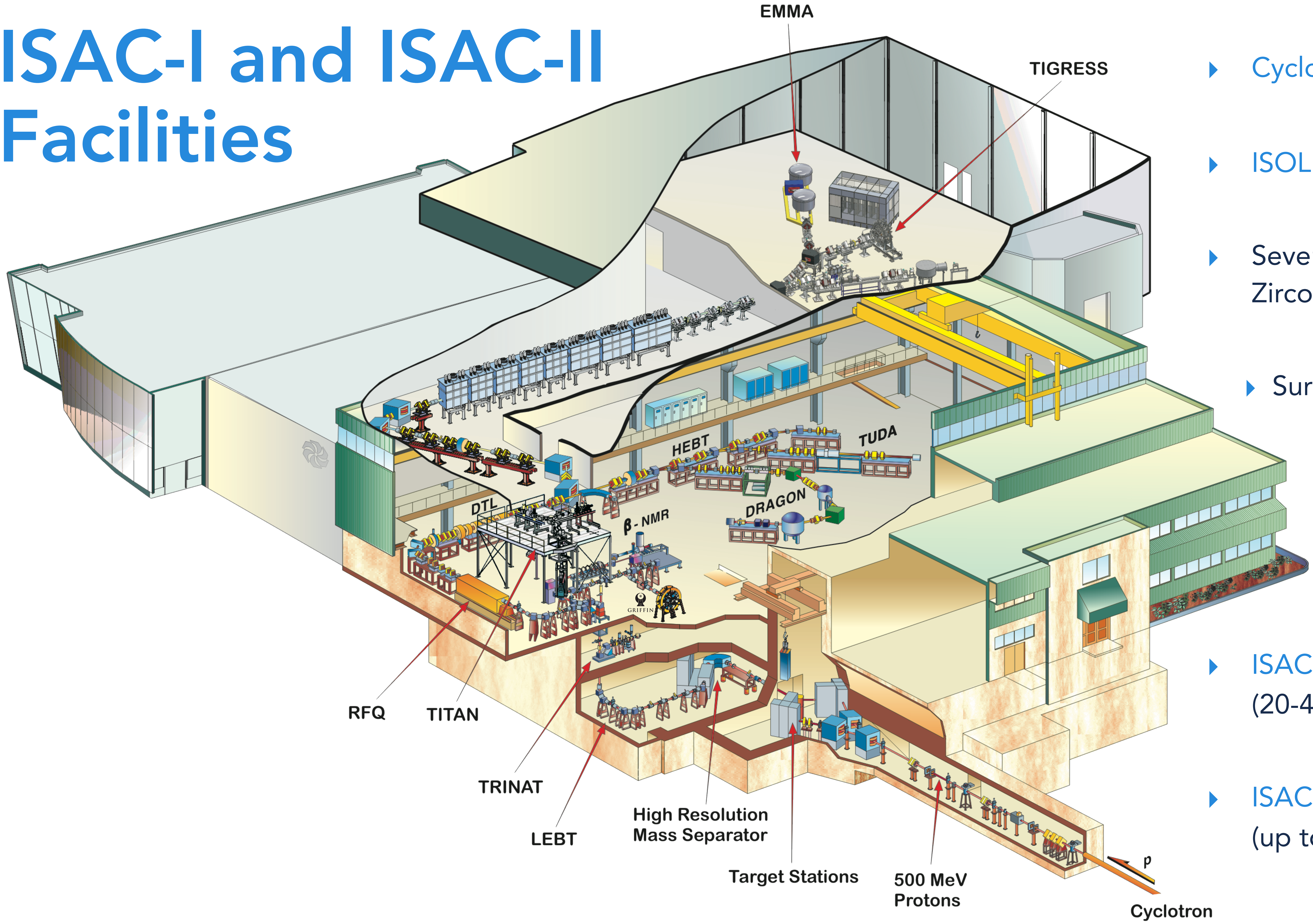
GAMMA & GRIFFIN

^{74}Zn: Iols & r-Process

SPES

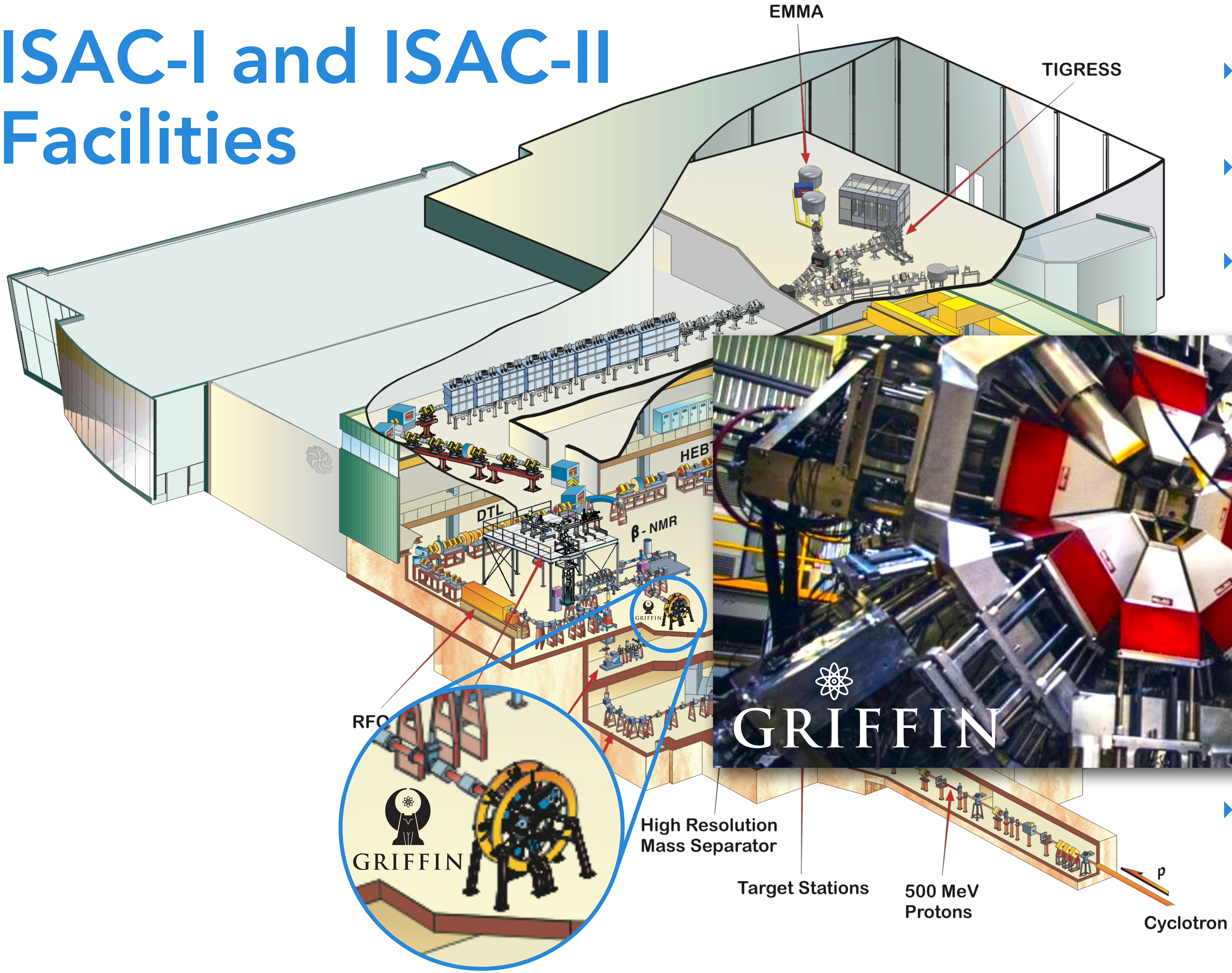
SPES β-Decay Station

ISAC-I and ISAC-II Facilities

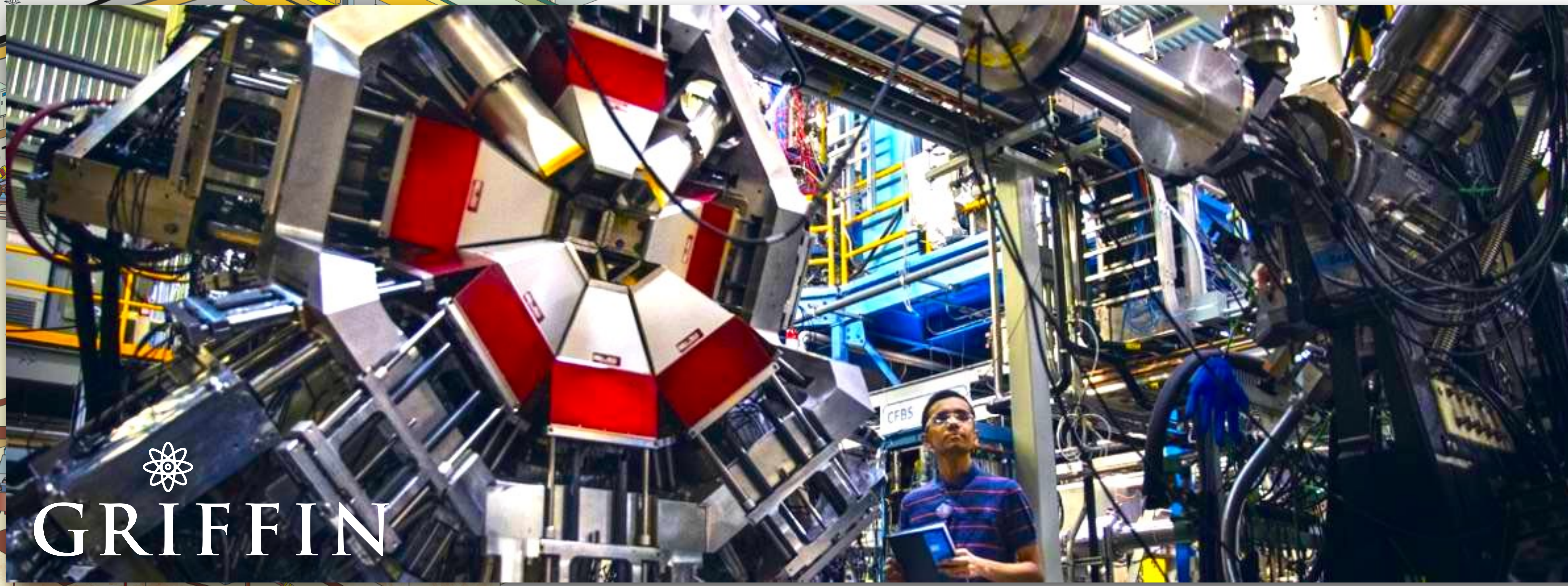


- Cyclotron ⟹ 500-MeV protons
- ISOL (Isotope Separation On-Line) method
- Several primary targets (Uranium, Tantalum, Zirconium, ...)
  - Surface and laser ion sources
    - High-resolution mass separator
    - Several experimental setups
- ISAC-I ⟹ Non-reaccelerated beams (20-40 keV)
- ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A)

ISAC-I and ISAC-II Facilities



- Cyclotron ⟹ 500-MeV protons
- ISOL (Isotope Separation On-Line) method
- Several primary targets (Uranium, Tantalum, Zirconium, …)

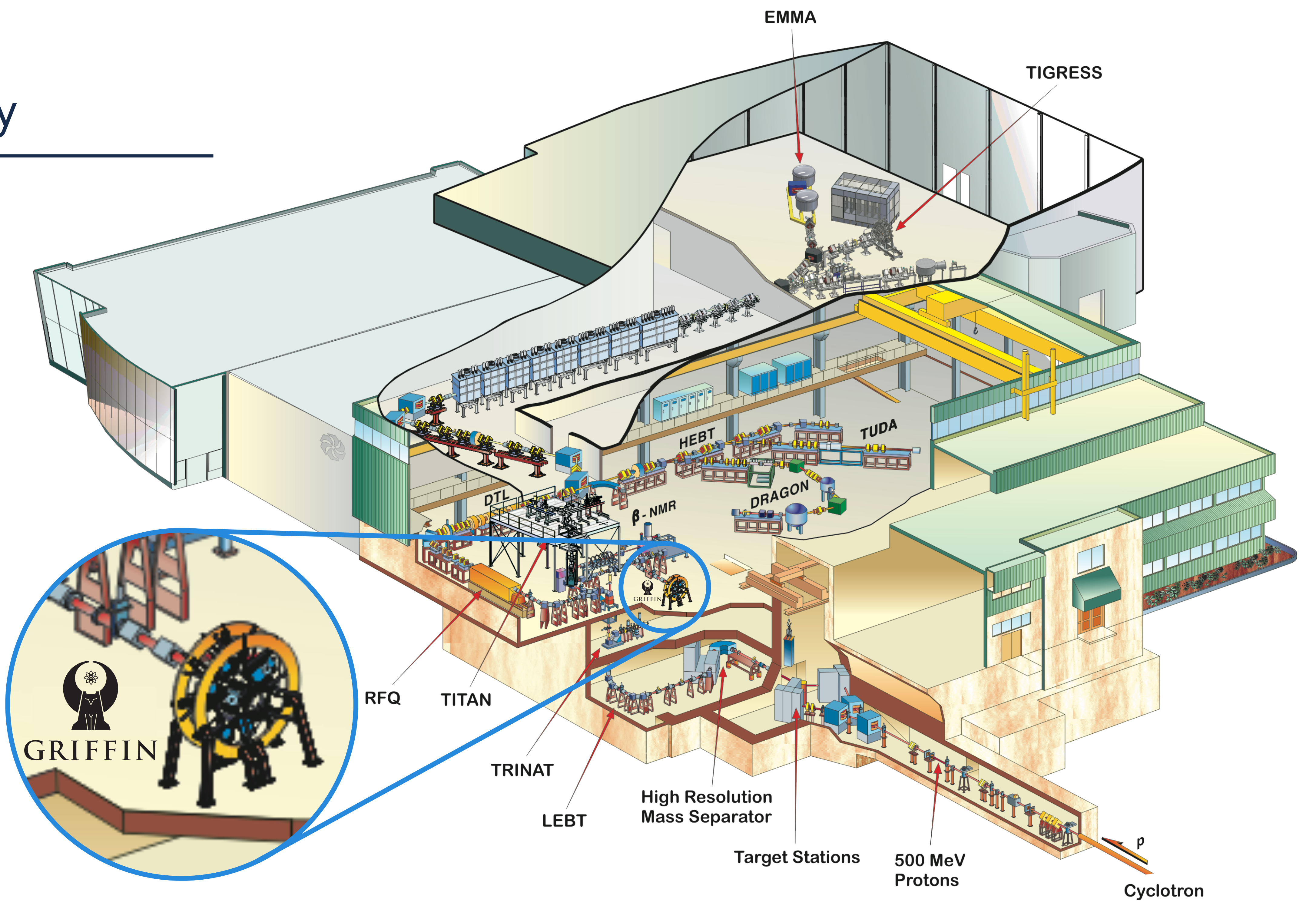


- ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A)

Gamma-ray spectroscopy following beta-decay

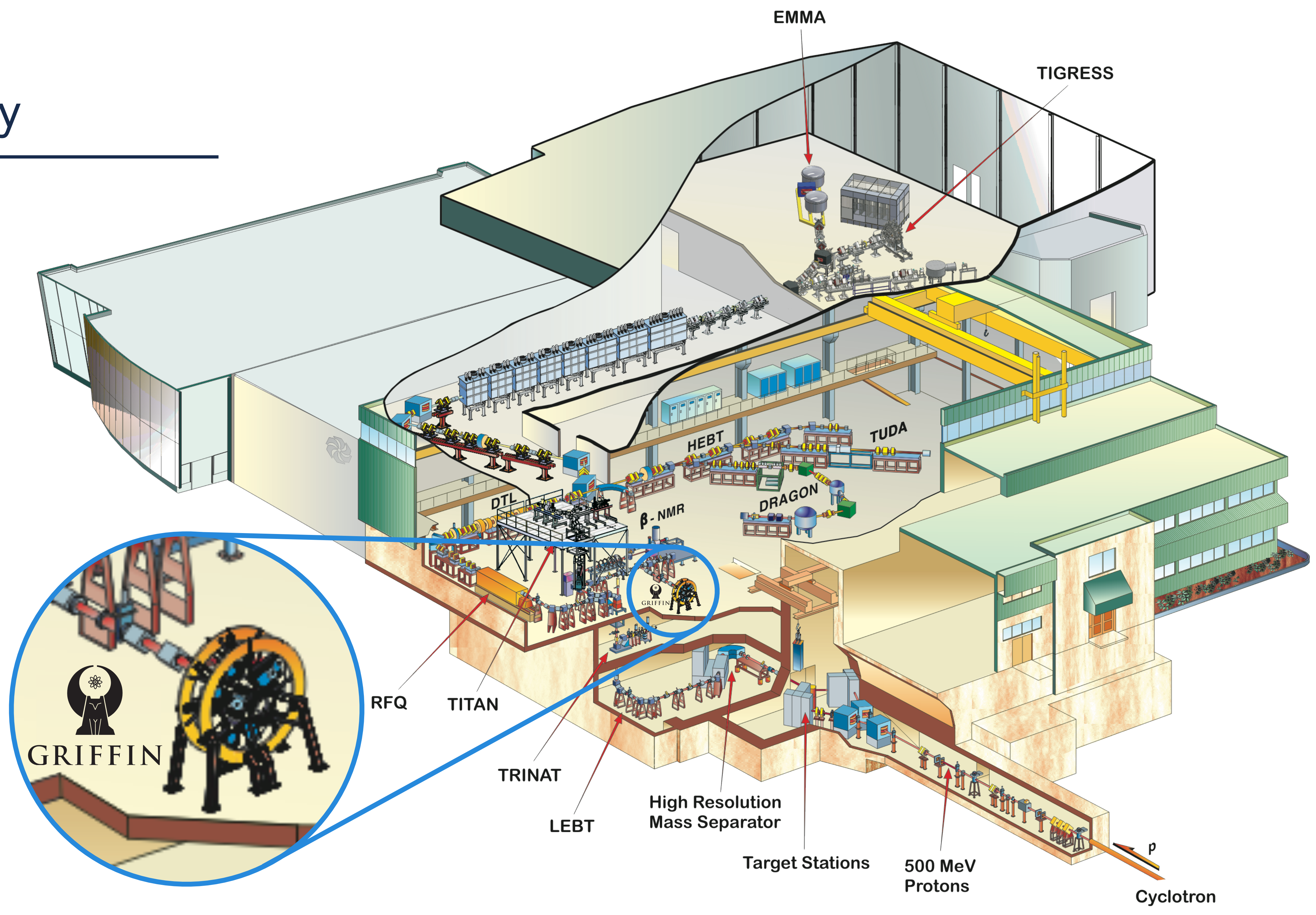
GRIFFIN @TRIUMF

- ISAC facility: Radioactive Ion Beam production using the ISOL technique
  - ISAC-I ⟹ Non-reaccelerated beams (20-40 keV) ⟹ GRIFFIN
  - ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A) ⟹ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices



Gamma-ray spectroscopy following beta-decay

GRIFFIN @TRIUMF

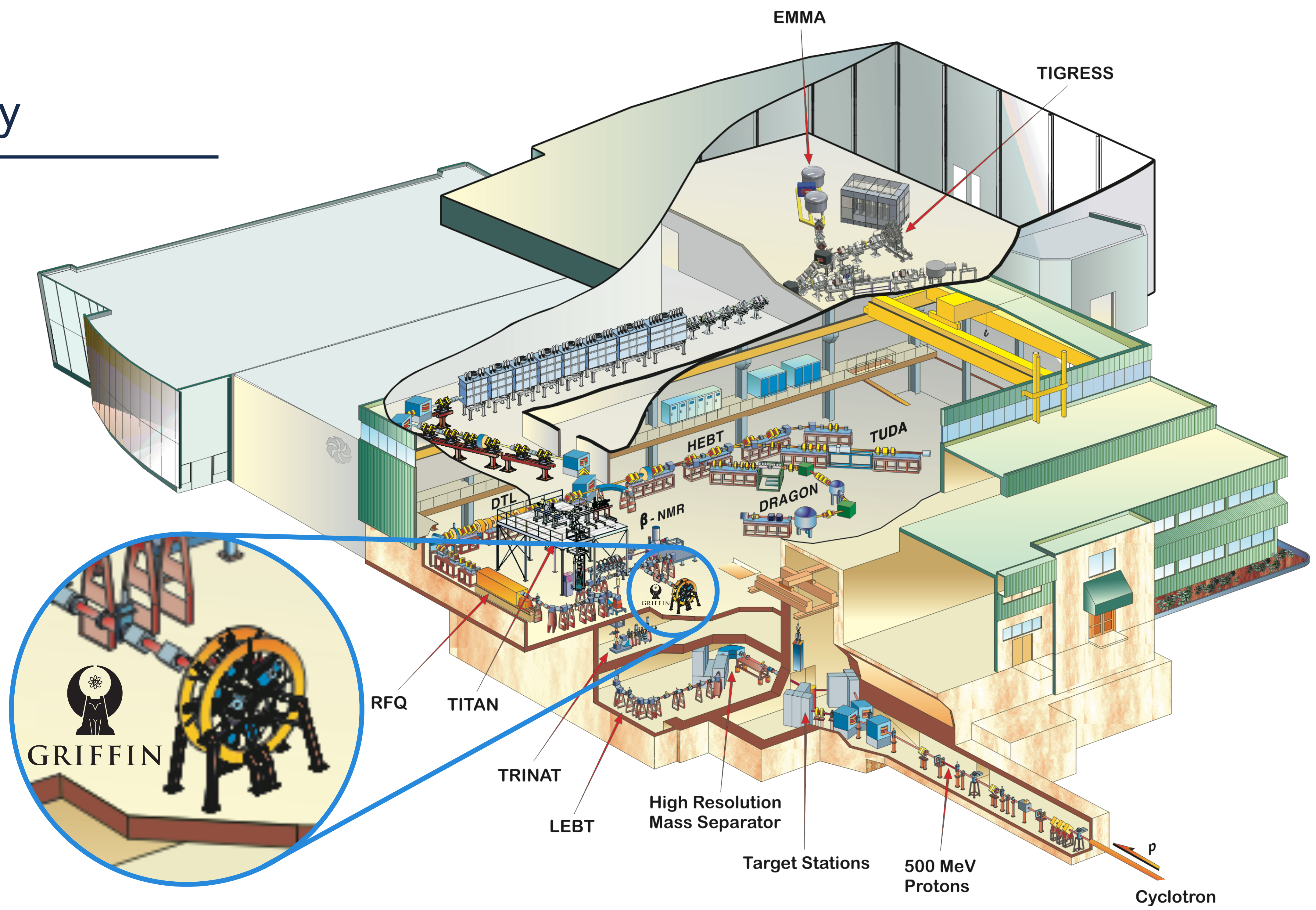


- ISAC facility: Radioactive Ion Beam production using the ISOL technique
  - ISAC-I ⟹ Non-reaccelerated beams (20-40 keV) ⟹ GRIFFIN
  - ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A) ⟹ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices

A.B. Garnsworthy et al., NIMA 918, 9 (2019)

Gamma-ray spectroscopy following beta-decay

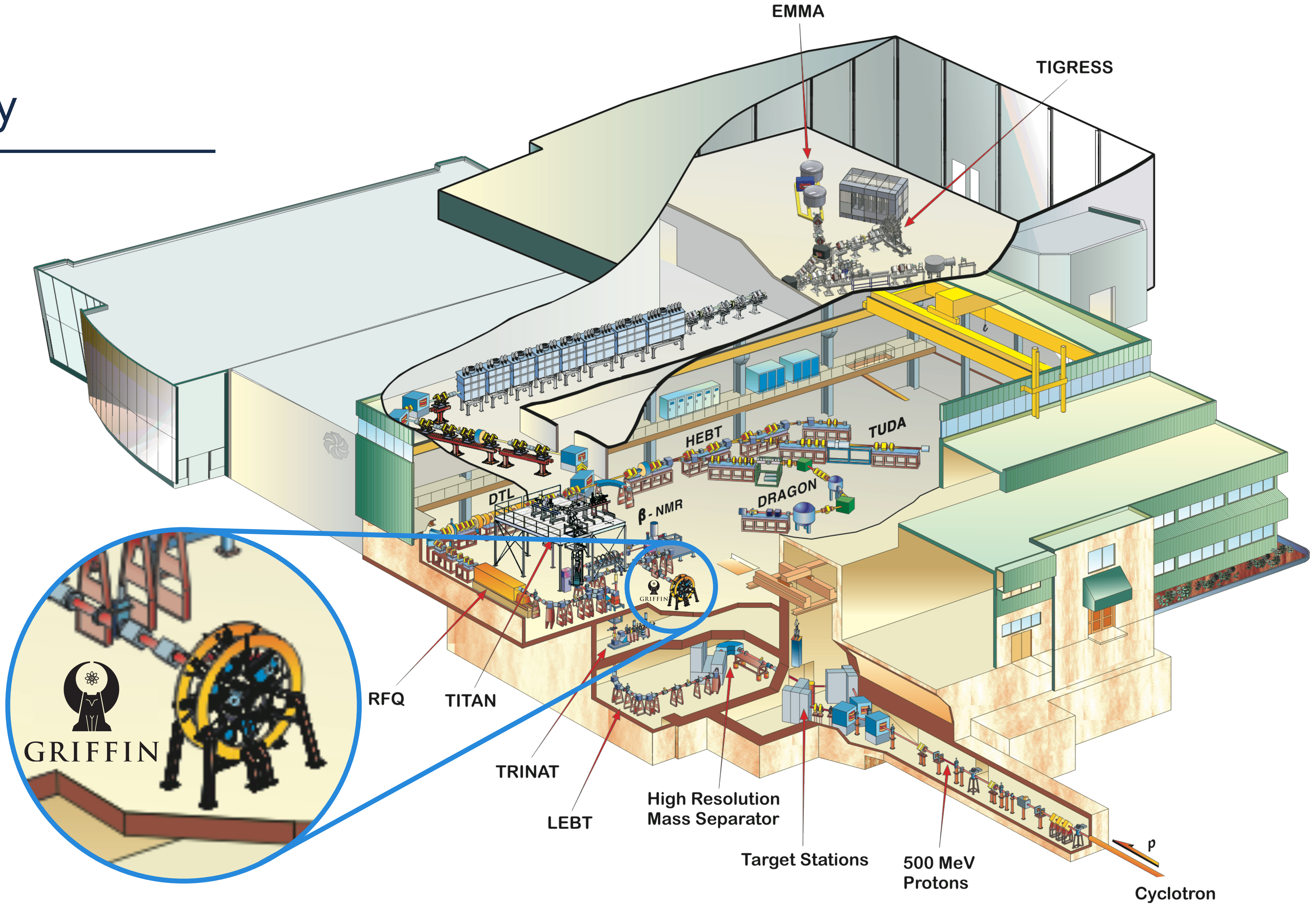
GRIFFIN @TRIUMF



- ISAC facility: Radioactive Ion Beam production using the ISOL technique
  - ISAC-I ⟹ Non-reaccelerated beams (20-40 keV) ⟹ GRIFFIN
  - ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A) ⟹ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices

A.B. Garnsworthy et al., NIMA 918, 9 (2019)

GRIFFIN @TRIUMF



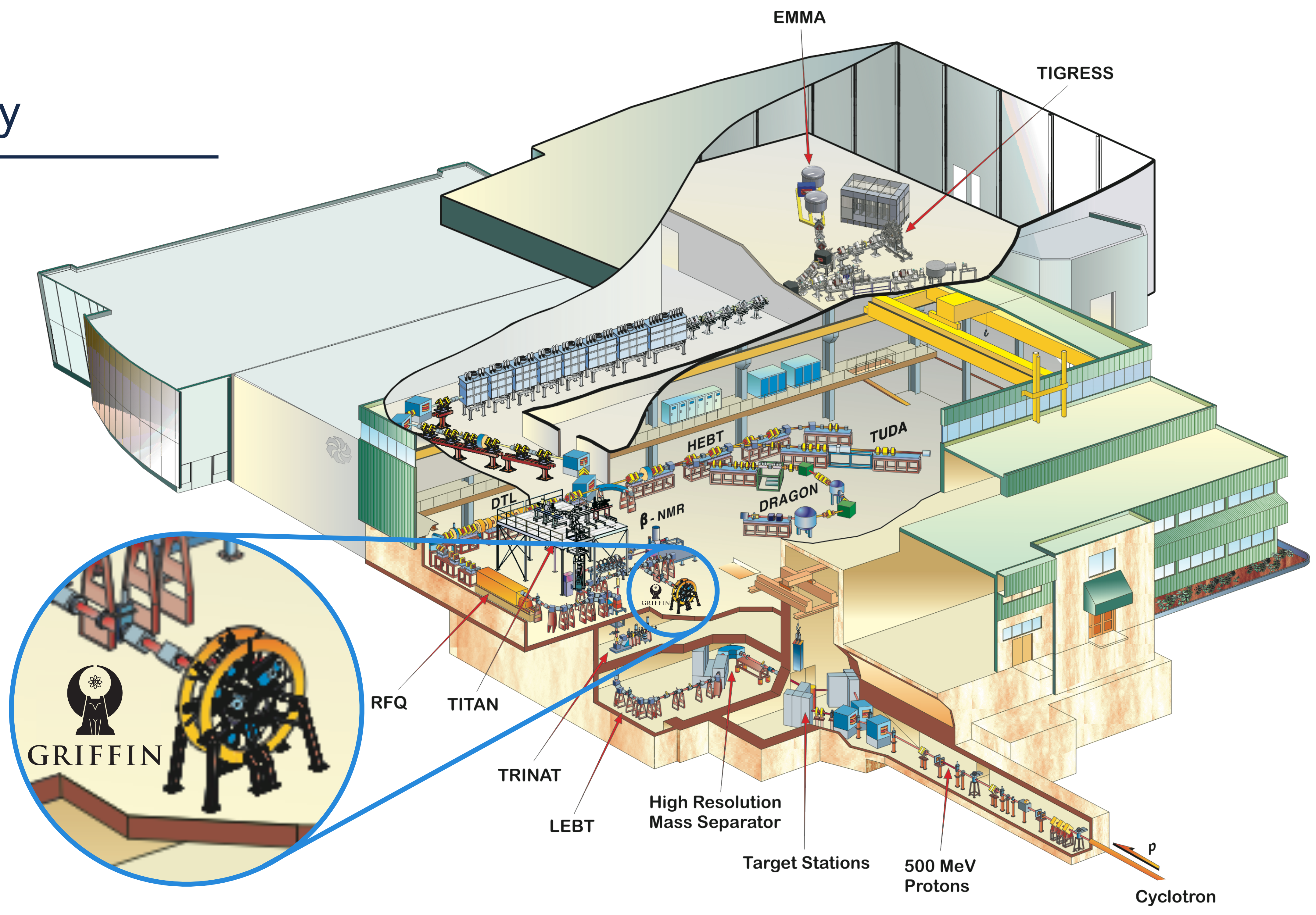
- ISAC facility: Radioactive Ion Beam production using the ISOL technique
  - ISAC-I ⟹ Non-reaccelerated beams (20-40 keV) ⟹ GRIFFIN
  - ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A) ⟹ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices

A.B. Garnsworthy et al., NIMA 918, 9 (2019)

Gamma-ray spectroscopy following beta-decay

GRIFFIN @TRIUMF

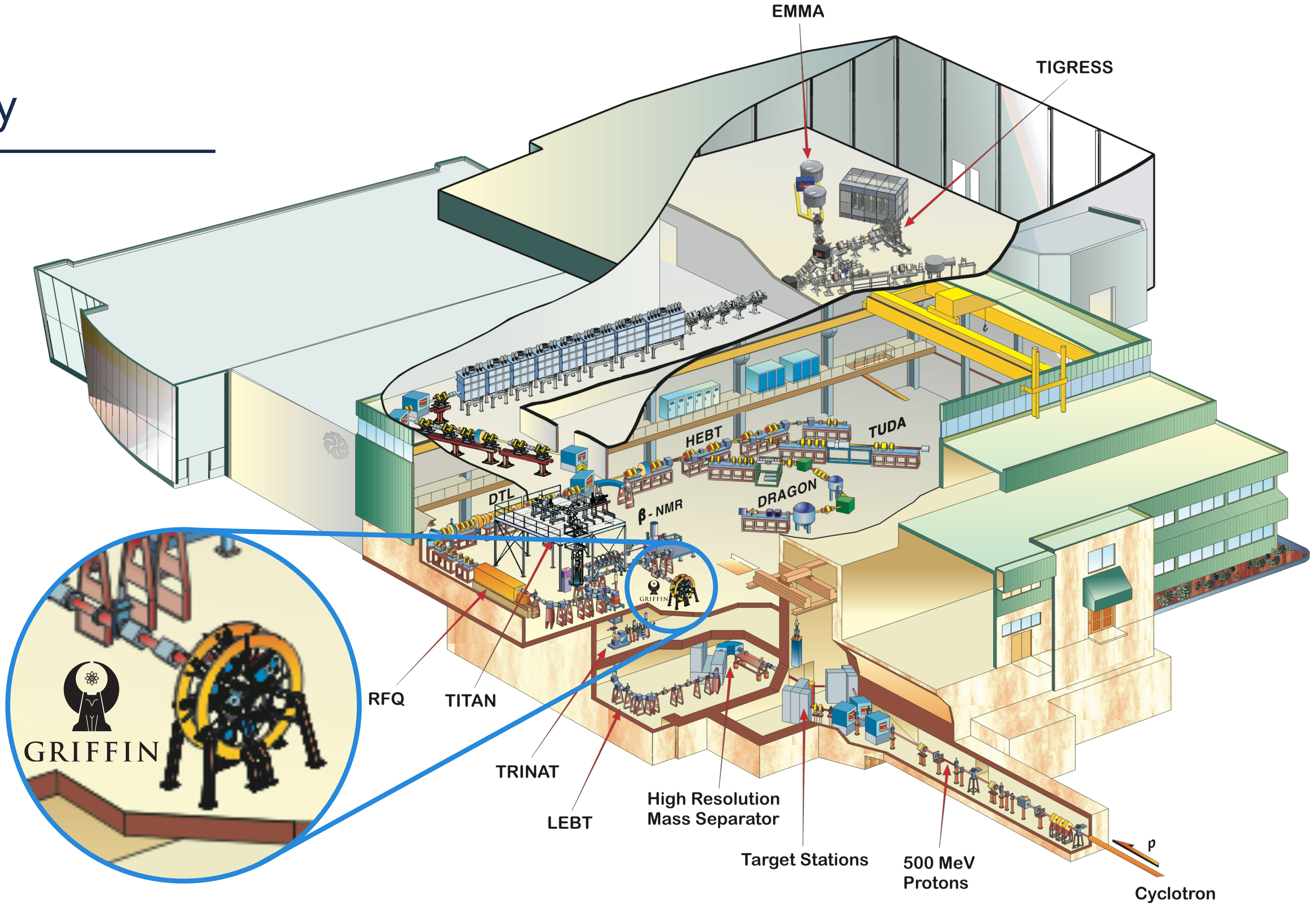
- ISAC facility: Radioactive Ion Beam production using the ISOL technique
  - ISAC-I ⟹ Non-reaccelerated beams (20-40 keV) ⟹ GRIFFIN
  - ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A) ⟹ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices



A.B. Garnsworthy et al., NIMA 918, 9 (2019)

Gamma-ray spectroscopy following beta-decay

GRIFFIN @TRIUMF



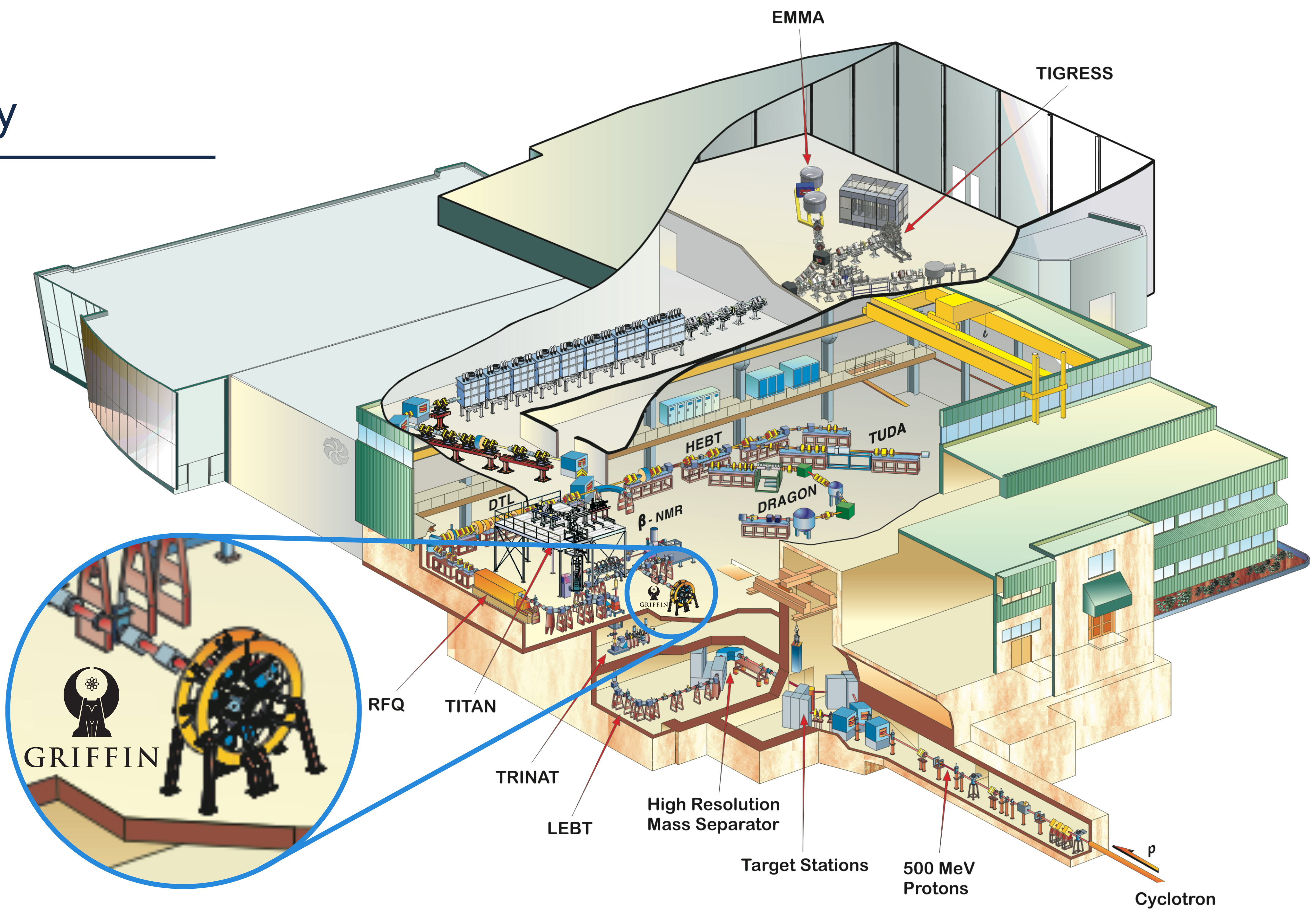
- ISAC facility: Radioactive Ion Beam production using the ISOL technique
  - ISAC-I ⟹ Non-reaccelerated beams (20-40 keV) ⟹ GRIFFIN
  - ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A) ⟹ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices

A.B. Garnsworthy et al., NIMA 918, 9 (2019)

Gamma-ray spectroscopy following beta-decay

GRIFFIN @TRIUMF

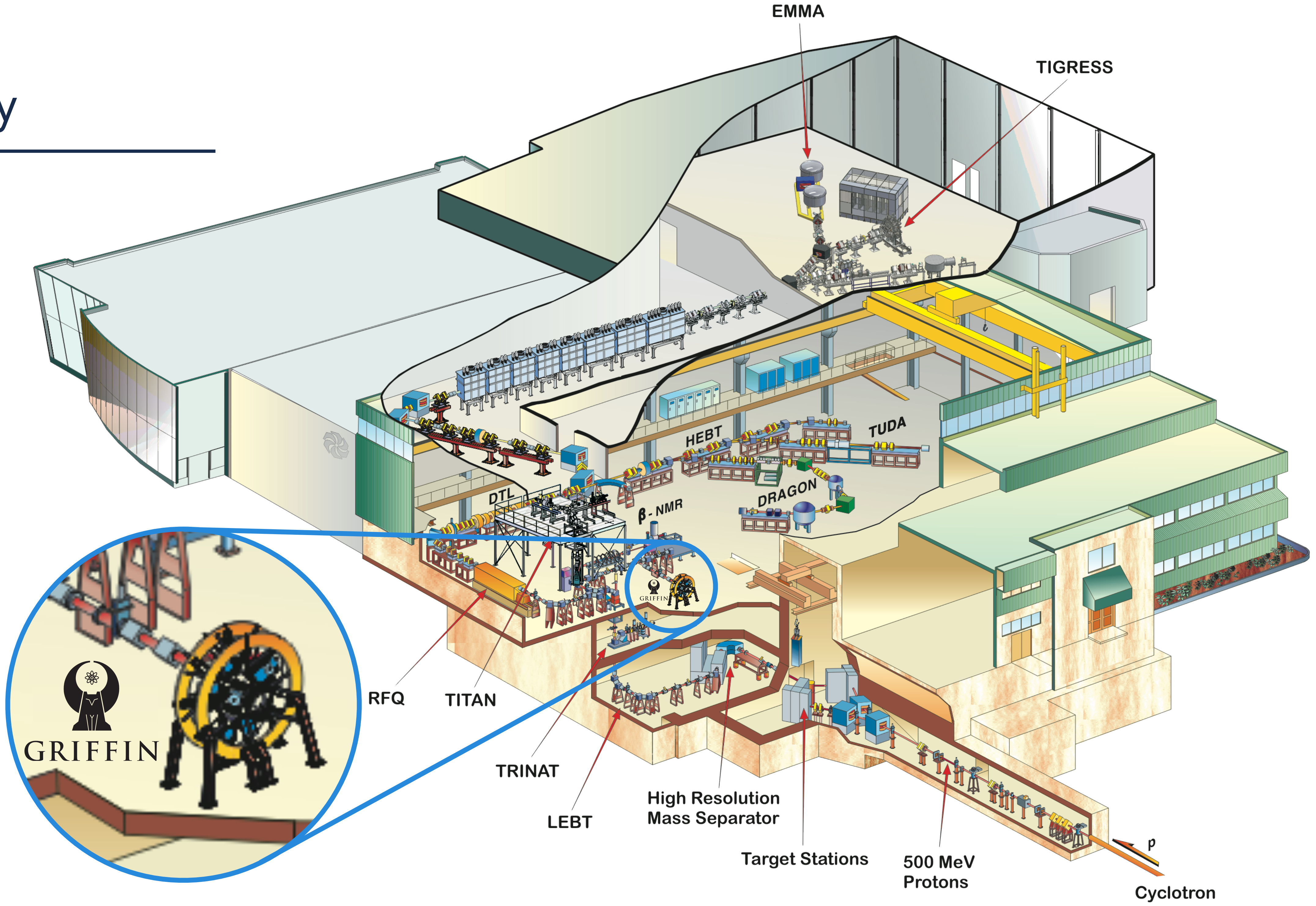
- ISAC facility: Radioactive Ion Beam production using the ISOL technique
  - ISAC-I $\Longrightarrow$ Non-reaccelerated beams (20-40 keV) $\Longrightarrow$ GRIFFIN
  - ISAC-II $\Longrightarrow$ Post-accelerated beams (up to ~10 MeV/A) $\Longrightarrow$ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices



A.B. Garnsworthy et al., NIMA 918, 9 (2019)

Gamma-ray spectroscopy following beta-decay

GRIFFIN @TRIUMF



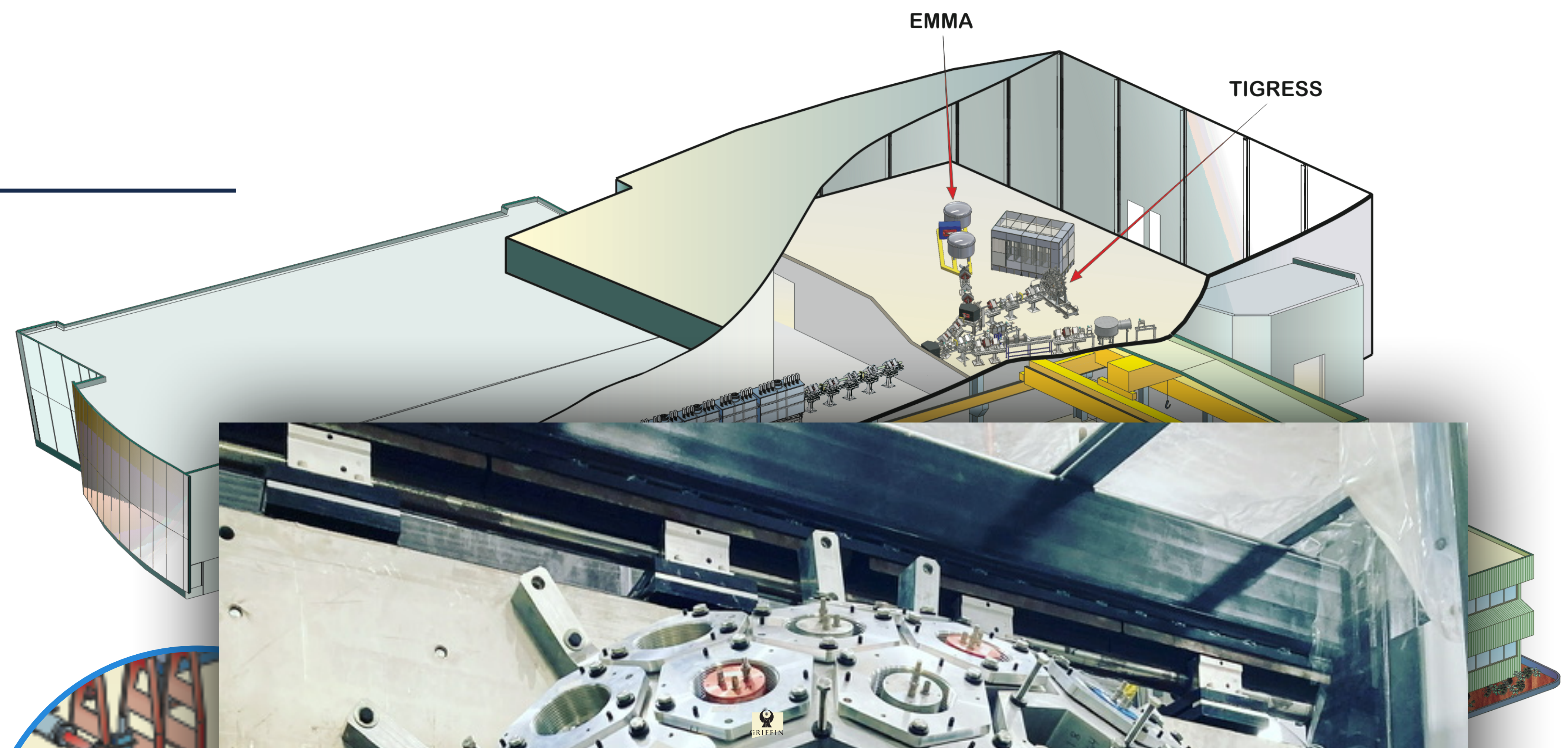
- ISAC facility: Radioactive Ion Beam production using the ISOL technique
  - ISAC-I ⟹ Non-reaccelerated beams (20-40 keV) ⟹ GRIFFIN
  - ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A) ⟹ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices

A.B. Garnsworthy et al., NIMA 918, 9 (2019)

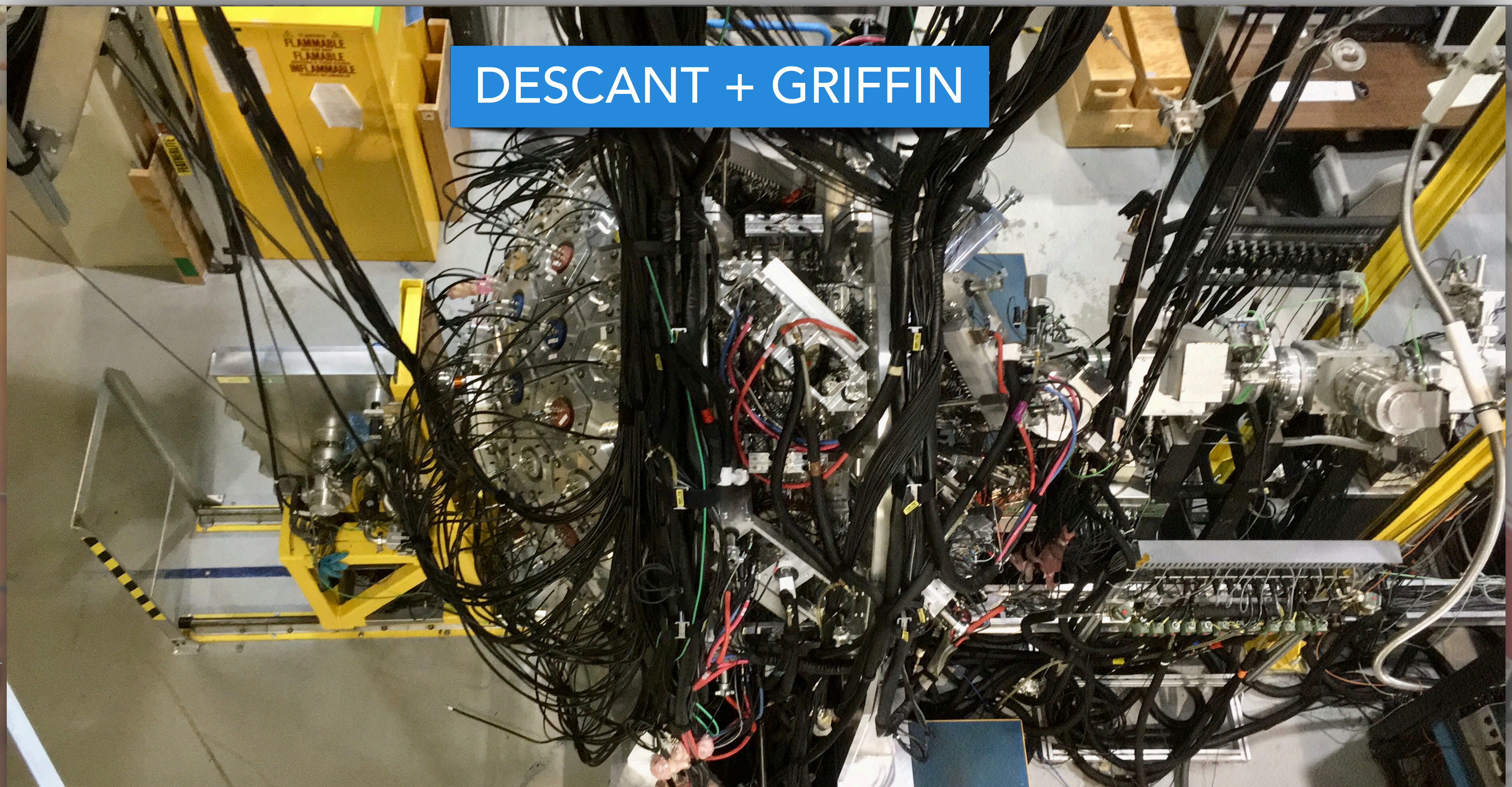
INFN

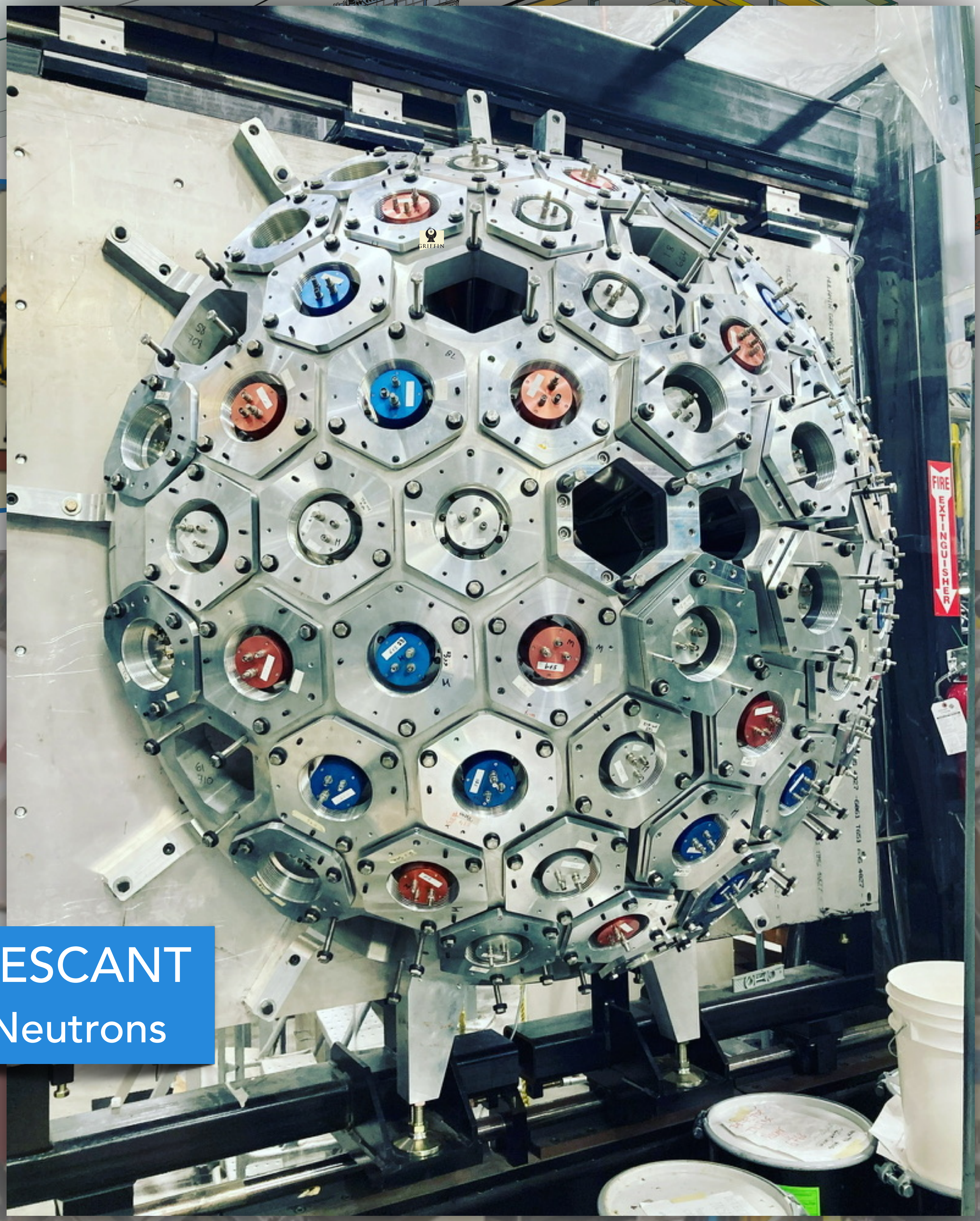
Gamma-ray spectroscopy following beta-decay

GRIFFIN @TRIUMF

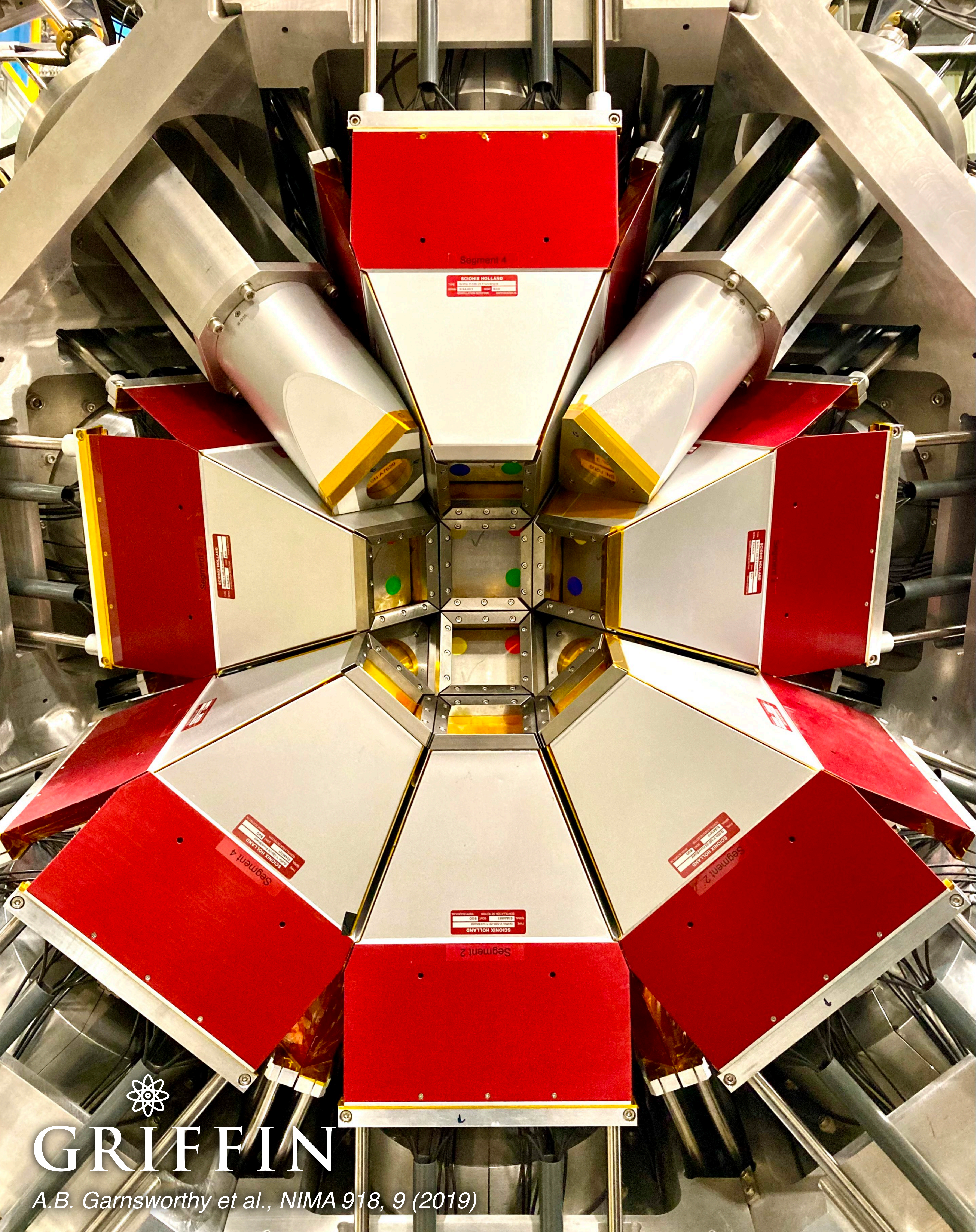


- ISAC facility: Radioactive Ion Beam production using the ISOL technique
    - ISAC-I ⟹ Non-reaccelerated beams (20-40 keV) ⟹ GRIFFIN
    - ISAC-II ⟹ Post-accelerated beams (up to ~10 MeV/A) ⟹ TIGRESS
- GRIFFIN (Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei): High-efficiency γ-ray spectrometer equipped with many ancillary devices





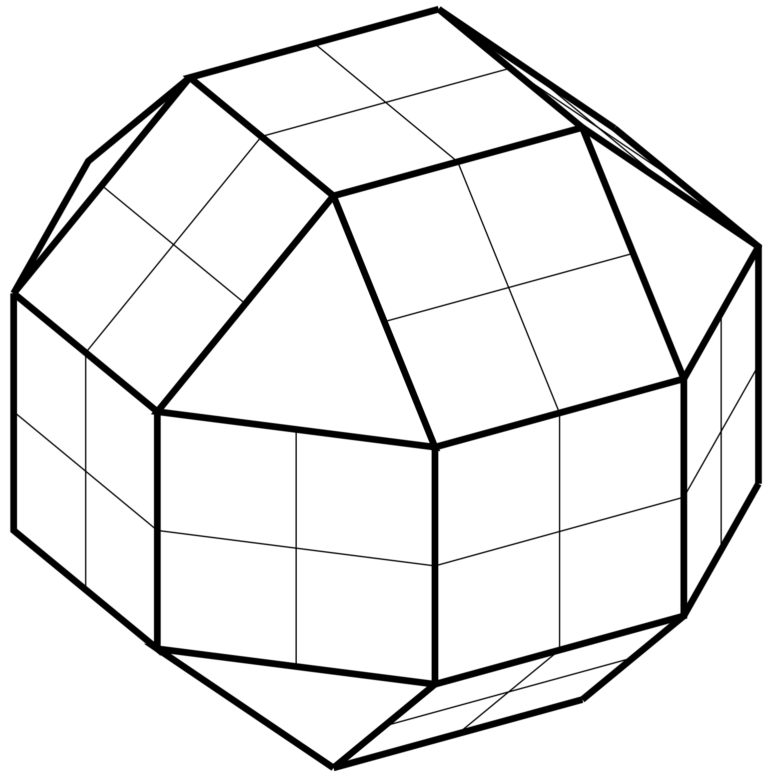
G
A.B.



A.B. Garnsworthy et al., NIMA 918, 9 (2019)

γ-γ Angular Correlations

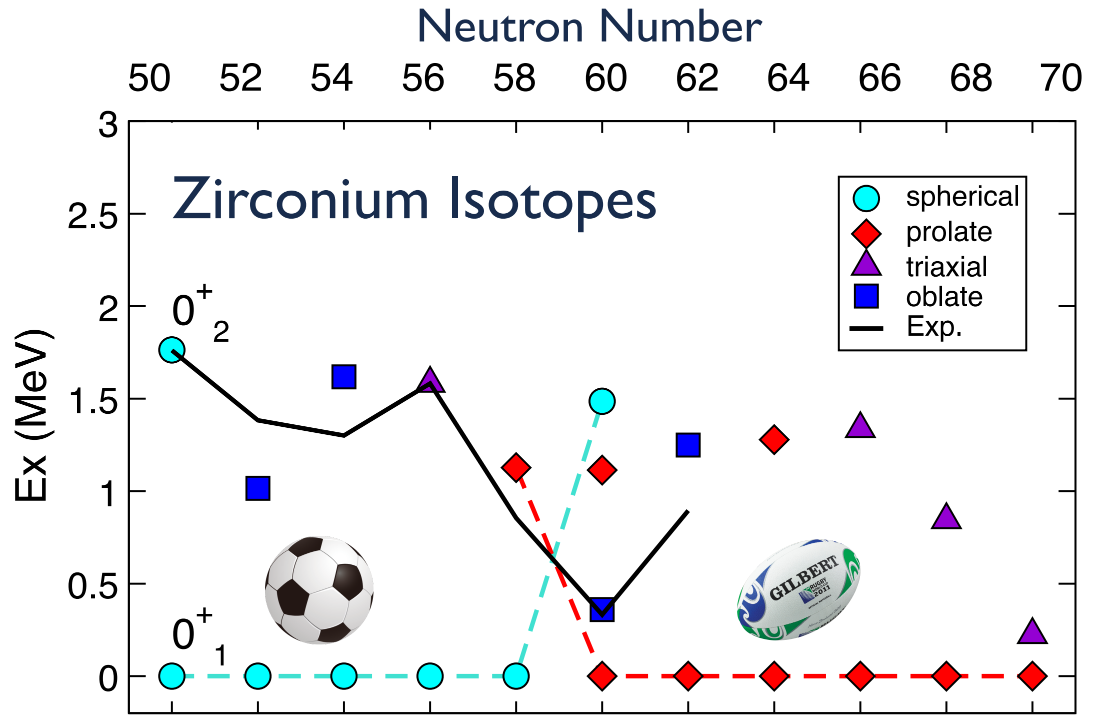
- γ-γ Angular Correlations with GRIFFIN:
  J.K. Smith et al., NIMA 922, 47 (2019)
  - Rhombicuboctahedron geometry ⇒ Up to 52 opening angles



  - Event mixing technique ⇒ No need to know # of pairs for each opening angle and relative efficiencies of the detectors
  - Finite sizes of the detectors ⇒ Detailed GEANT4 simulations
  - Definitive spin assignments at the 99% CL

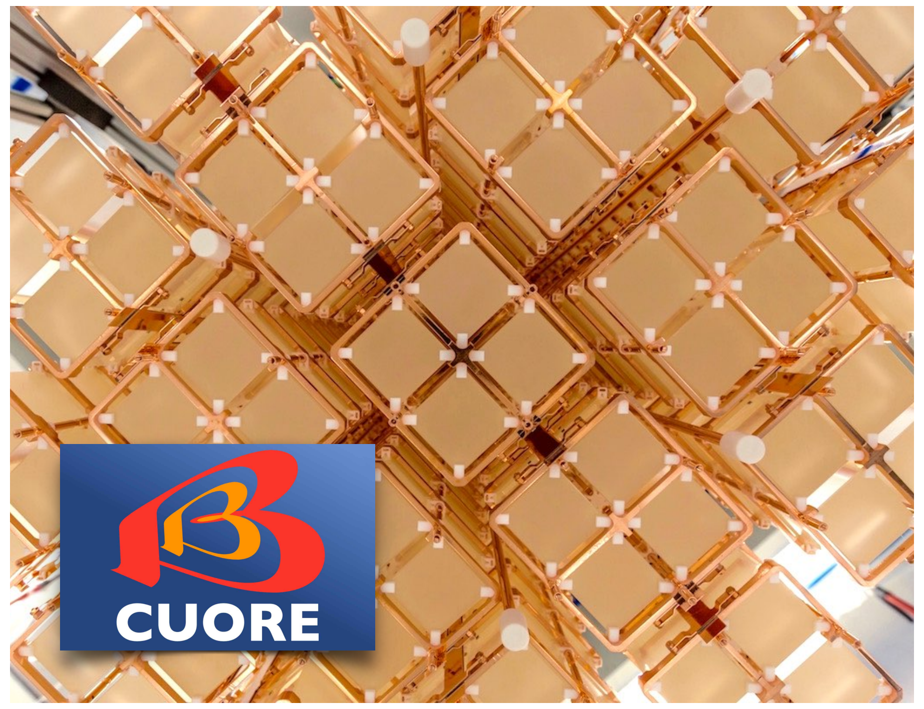
Florence Activities with GRIFFIN

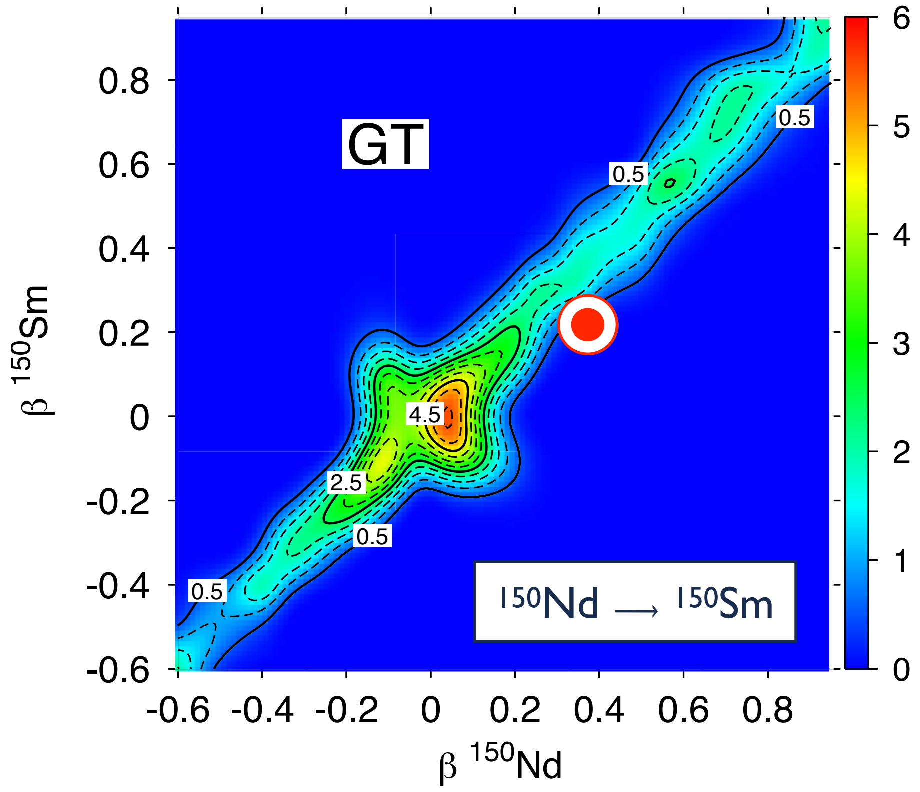
1 Quantum-phase transition in the Zr isotopes



T. Togashi et al., Phys. Rev. Lett. 117 (2016) 172502

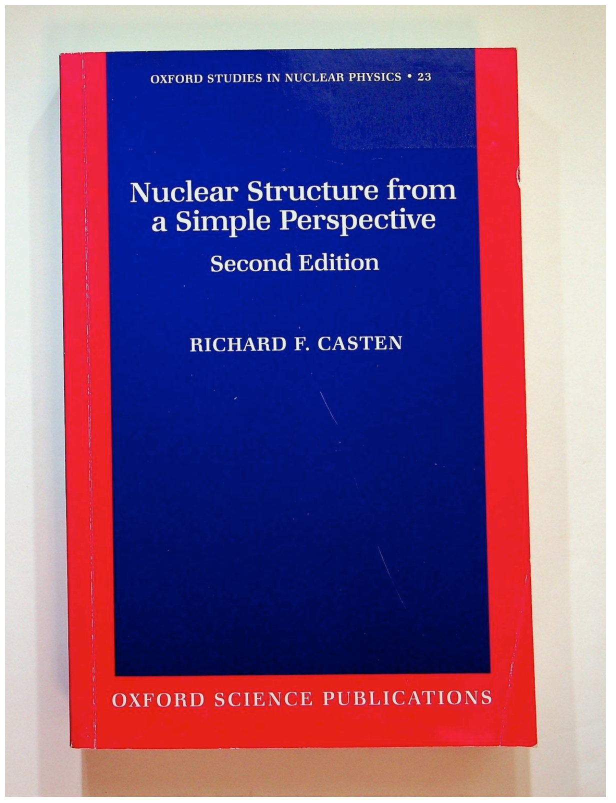
2 Influence of the nuclear shape on 0νββ decay

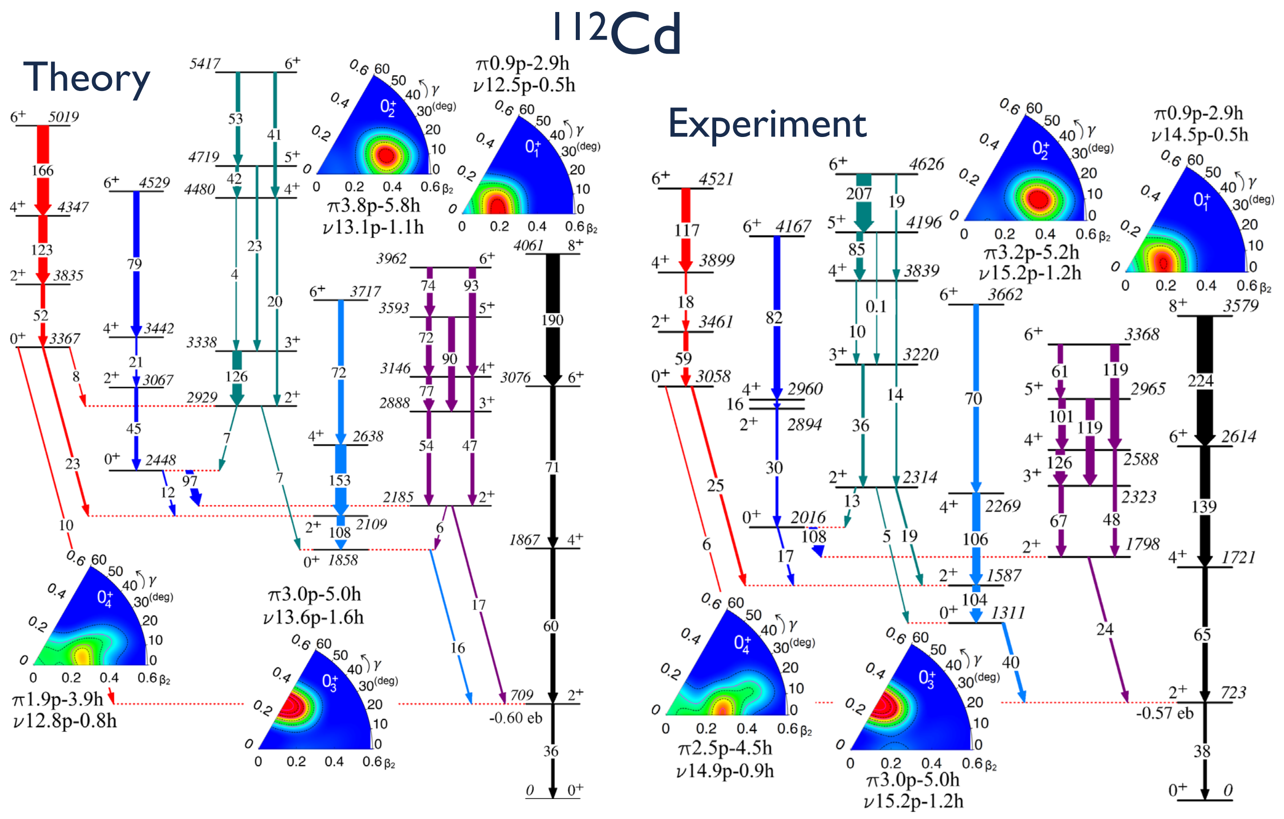




T.R. Rodríguez and G. Martínez-Pinedo, Phys. Rev. Lett. 105, 252503 (2010)

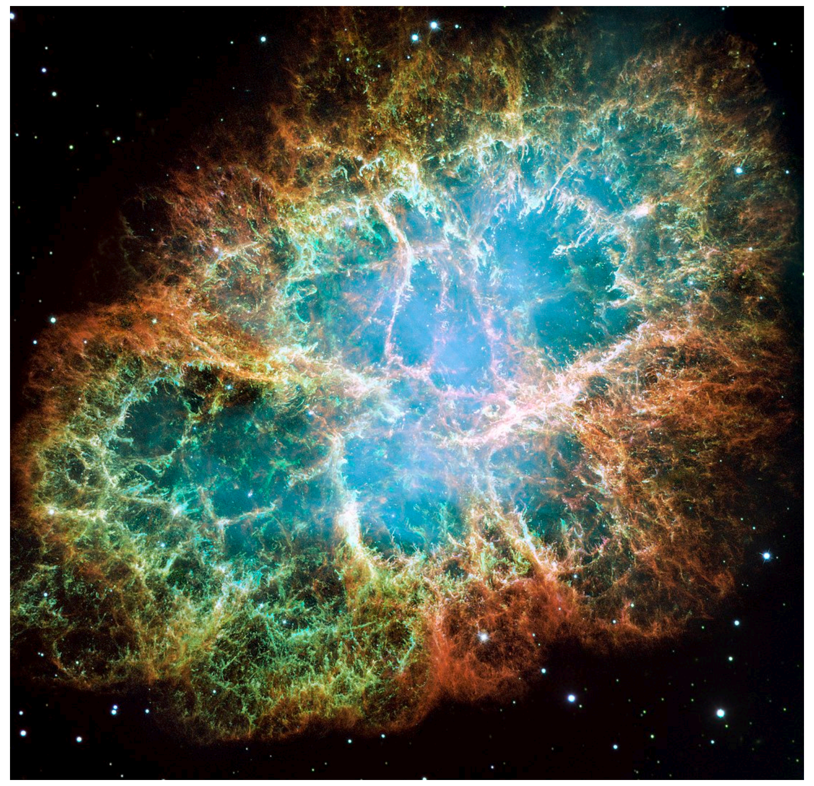
3 The downfall of low-energy vibrations in nuclei



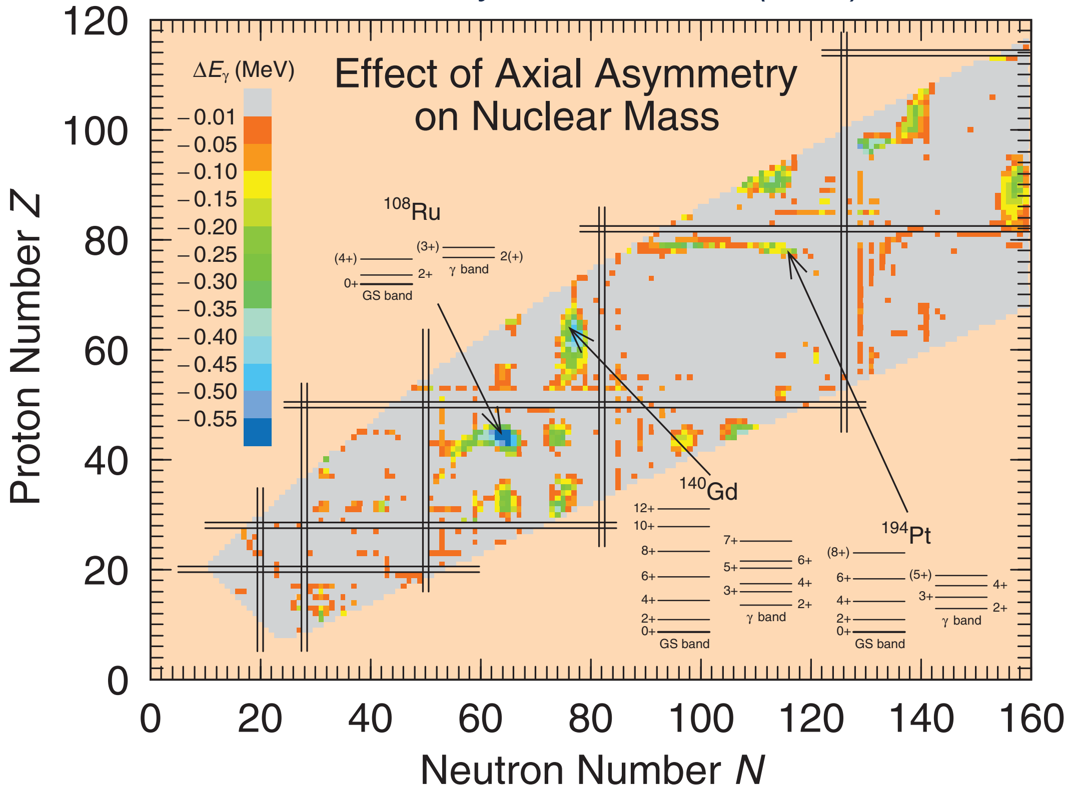


P.E. Garrett et al., Phys. Rev. Lett. 123 (2019) 142502

4 Triaxiality in radioactive nuclei & the r-process



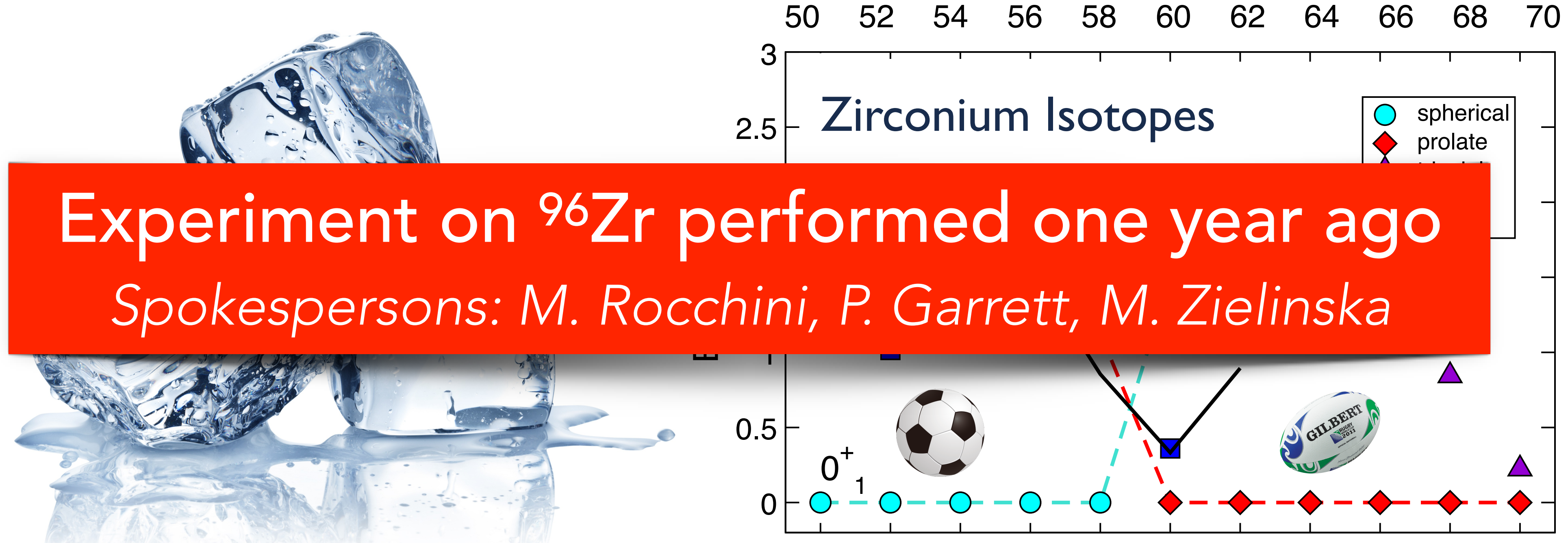
P. Möller et al., Phys. Rev. Lett. 97 (2006) 162502



Florence Activities with GRIFFIN

- TRIUMF Labs
- GRIFFIN γ-Ray Spectrometer
- γ-γ Angular Correlations with GRIFFIN
- GAMMA & GRIFFIN
- ^{74}Zn: Iols & r-Process
- SPES
- SPES β-Decay Station

1 Quantum-phase transition in the Zr isotopes

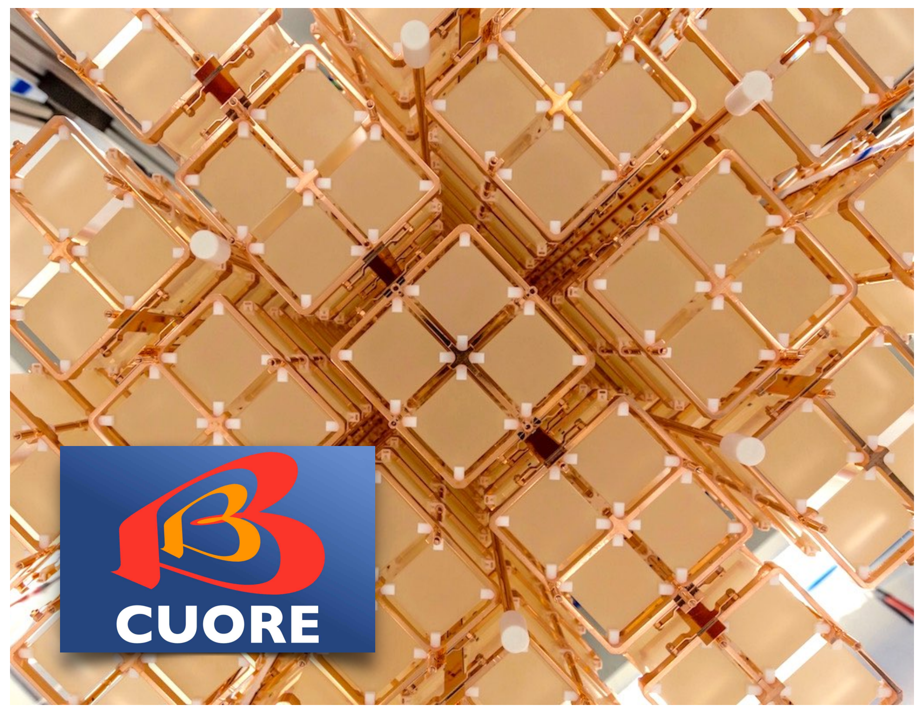


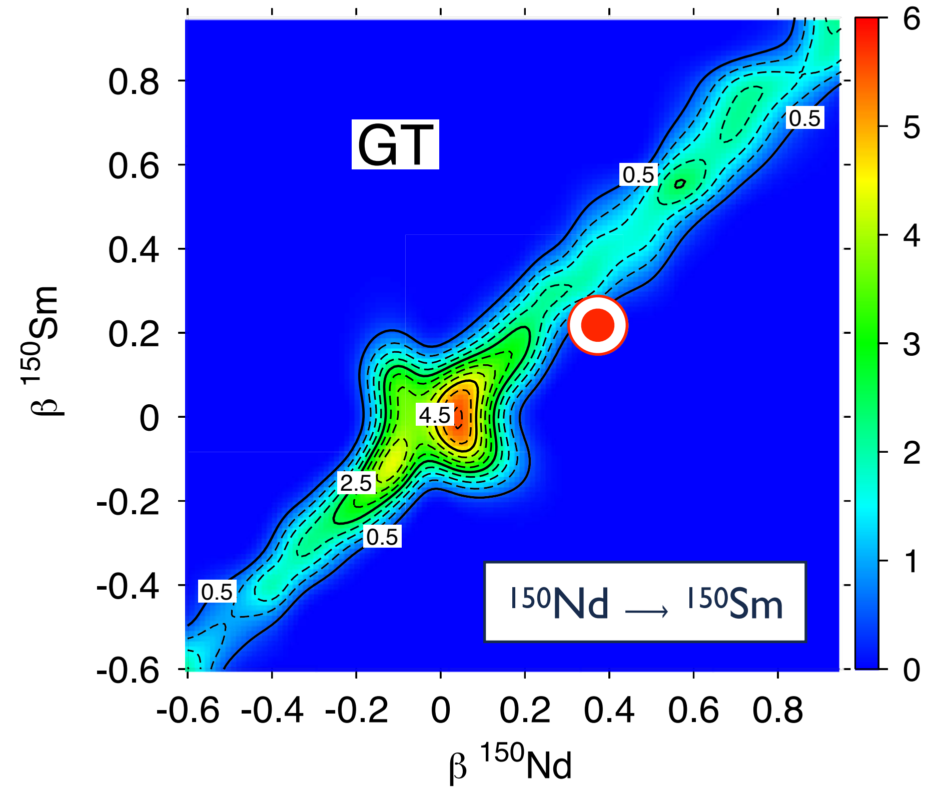
Experiment on ^{96}Zr performed one year ago

Spokespersons: M. Rocchini, P. Garrett, M. Zielinska

T. Togashi et al., Phys. Rev. Lett. 117 (2016) 172502

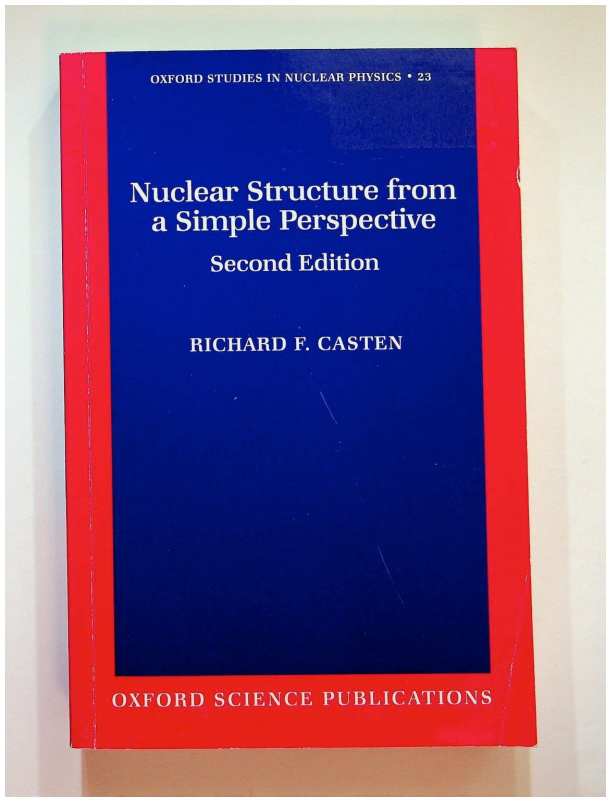
2 Influence of the nuclear shape on 0νββ decay

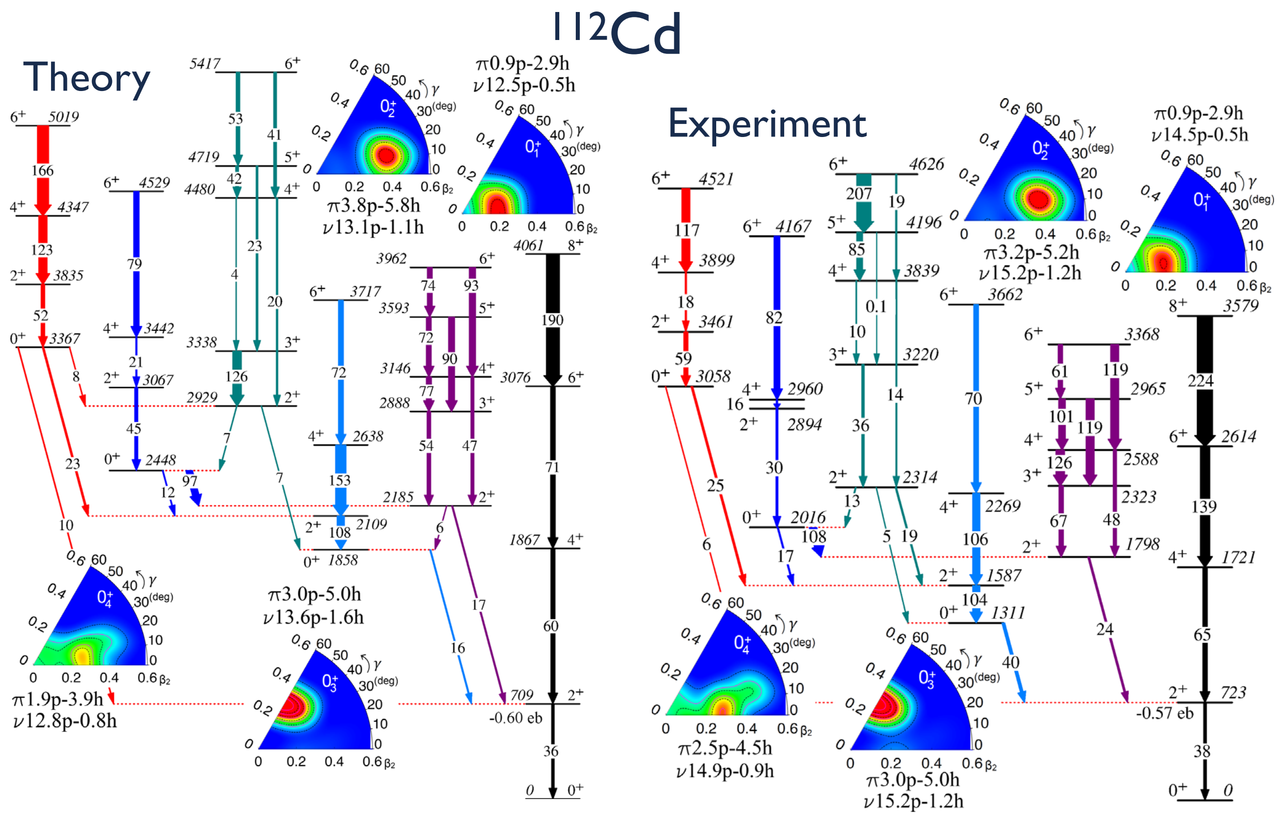




T.R. Rodríguez and G. Martínez-Pinedo, Phys. Rev. Lett. 105, 252503 (2010)

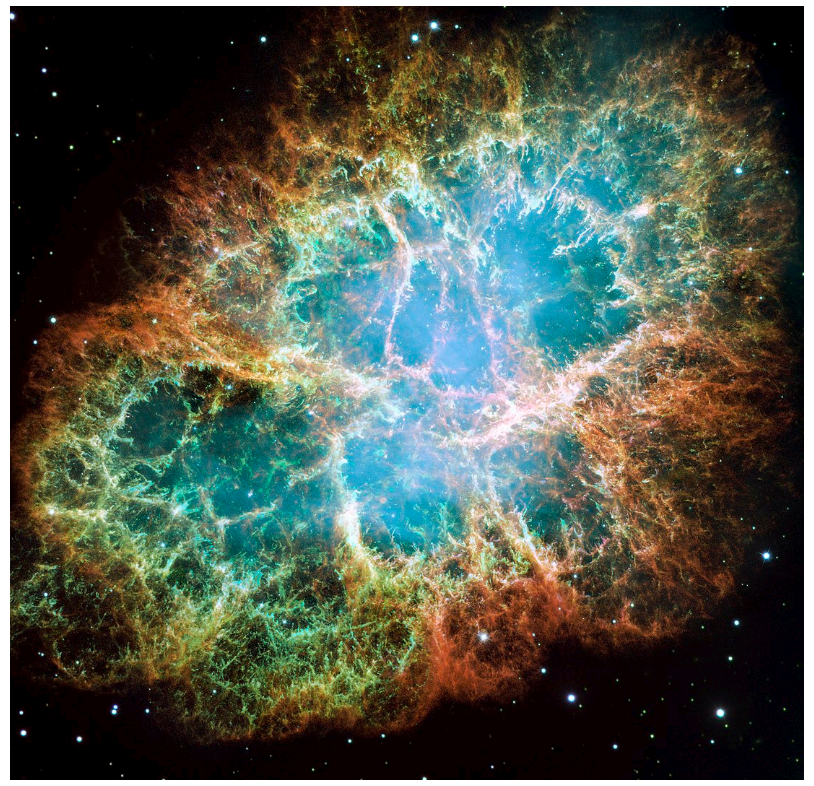
3 The downfall of low-energy vibrations in nuclei



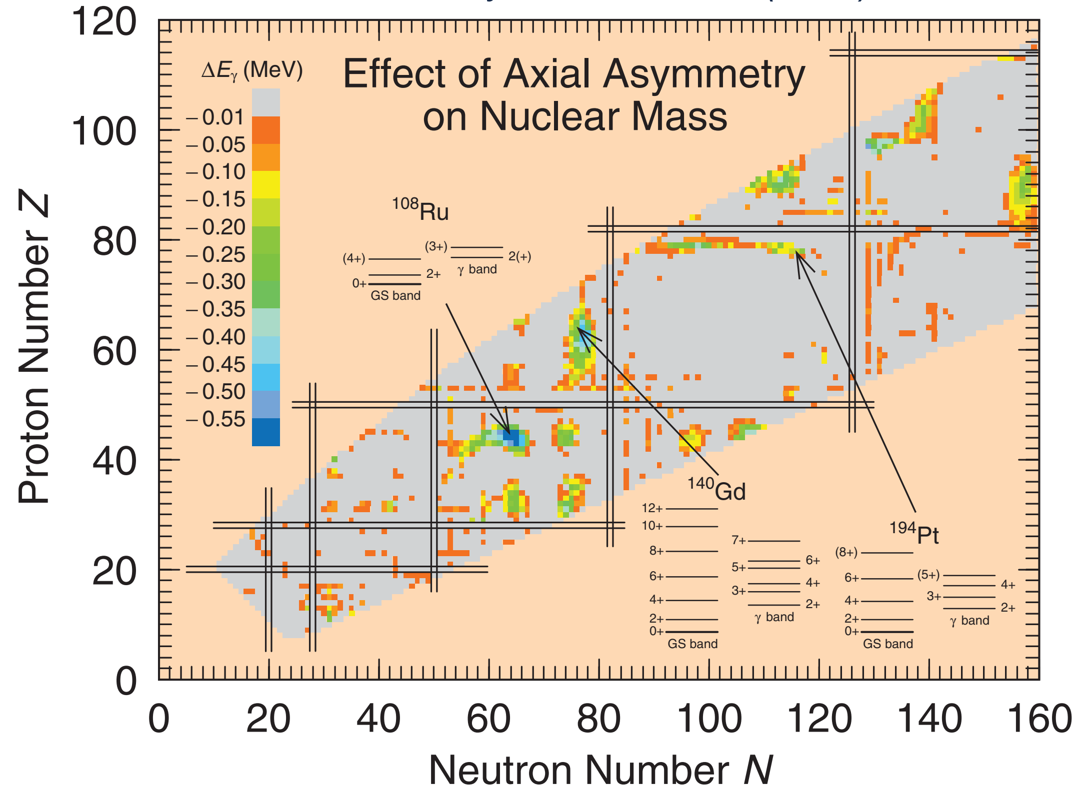


P.E. Garrett et al., Phys. Rev. Lett. 123 (2019) 142502

4 Triaxiality in radioactive nuclei & the r-process



P. Möller et al., Phys. Rev. Lett. 97 (2006) 162502



Florence Activities with GRIFFIN

- TRIUMF Labs
- GRIFFIN γ-Ray Spectrometer
- γ-γ Angular Correlations with GRIFFIN
- GAMMA & GRIFFIN
- ^{74}Zn: IoIs & r-Process
- SPES
- SPES β-Decay Station

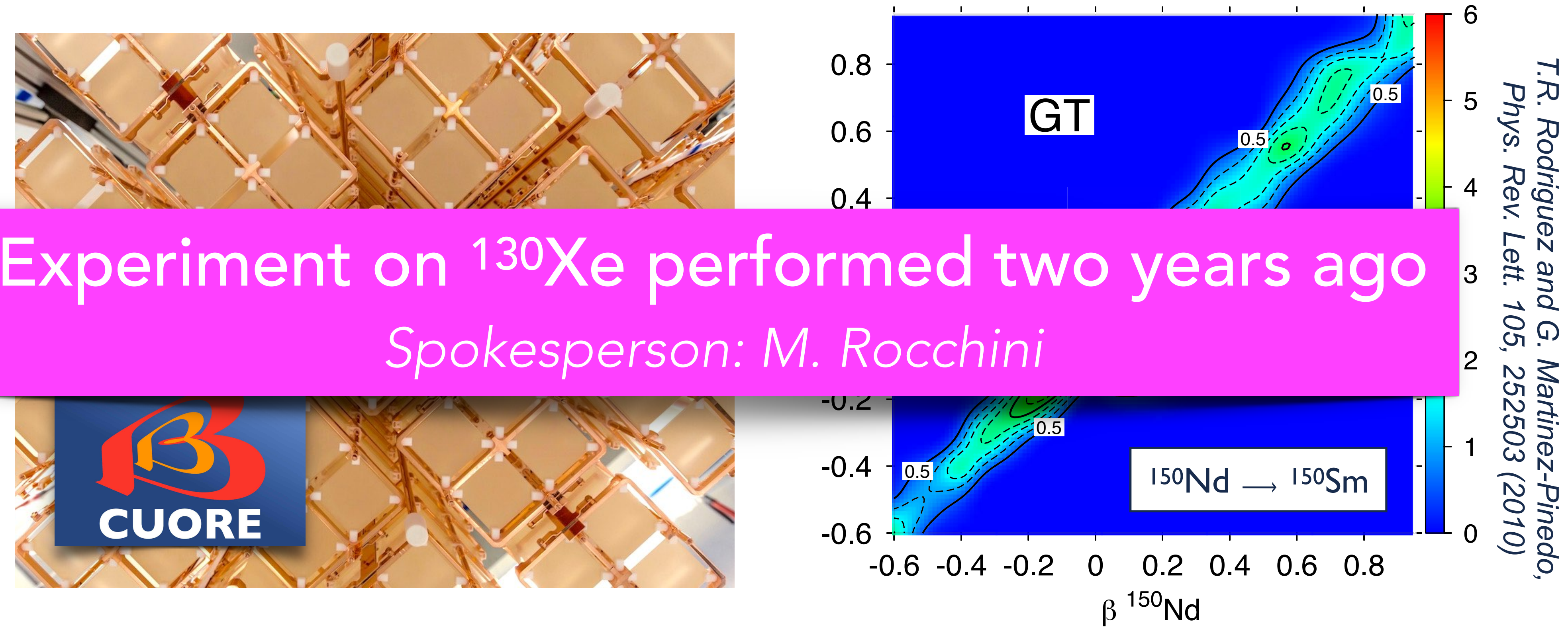
1 Quantum-phase transition in the Zr isotopes

T. Togashi et al., Phys. Rev. Lett. 117 (2016) 172502

Experiment on ^{96}Zr performed one year ago

Spokespersons: M. Rocchini, P. Garrett, M. Zielinska

2 Influence of the nuclear shape on 0νββ decay

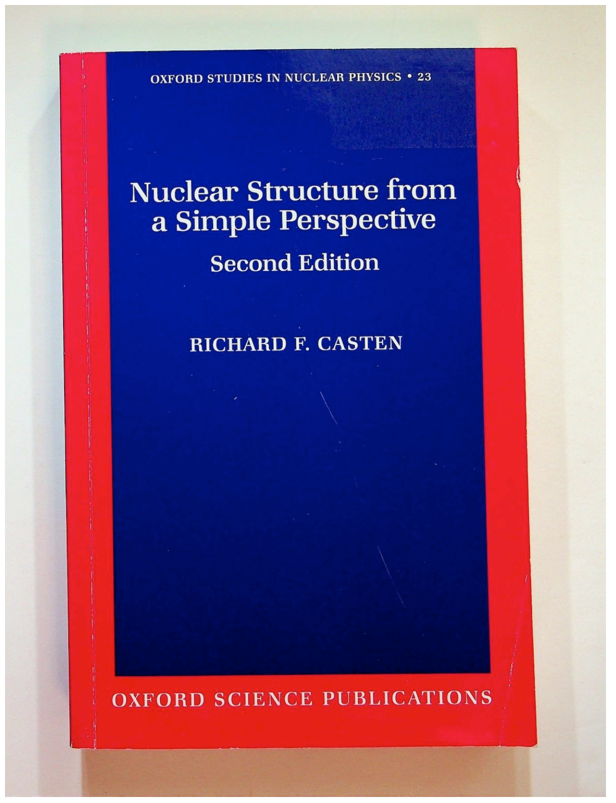


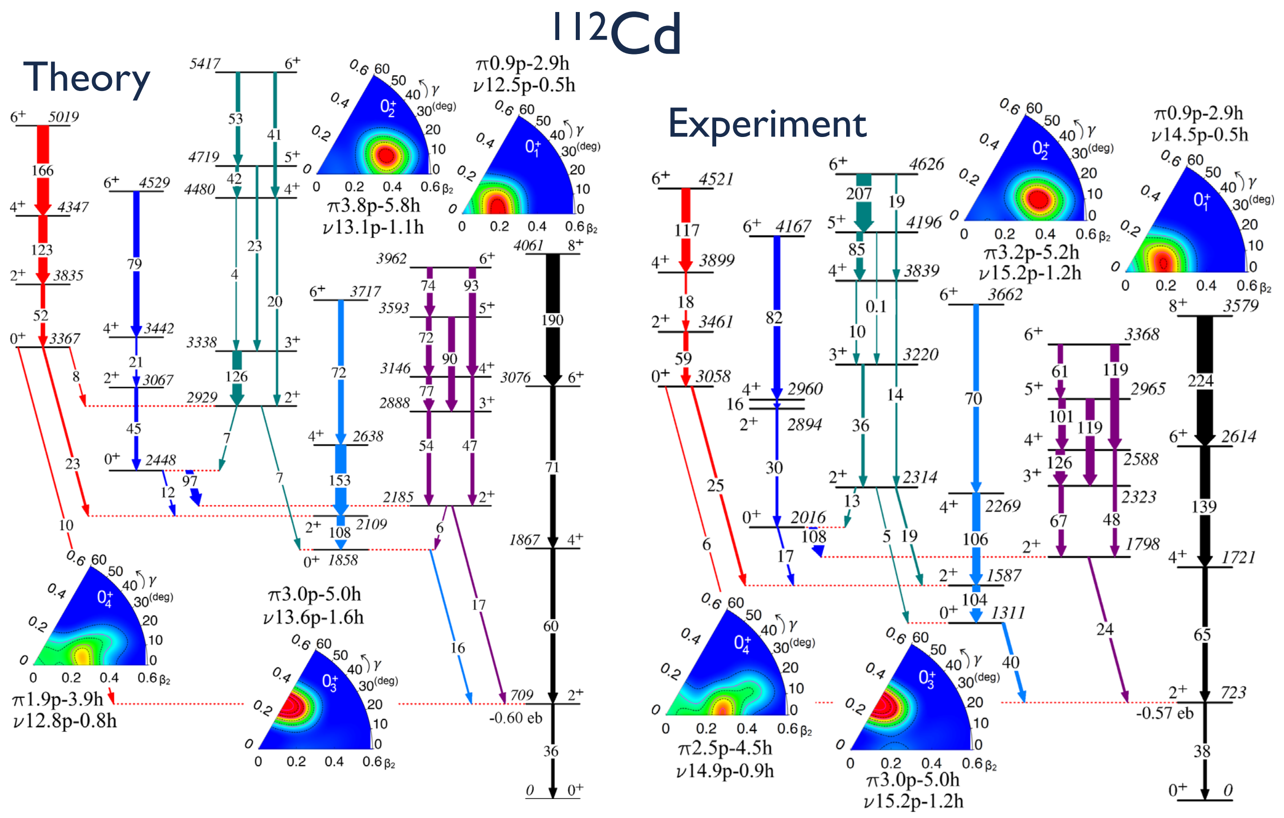
T.R. Rodríguez and G. Martínez-Pinedo, Phys. Rev. Lett. 105, 252503 (2010)

Experiment on ^{130}Xe performed two years ago

Spokesperson: M. Rocchini

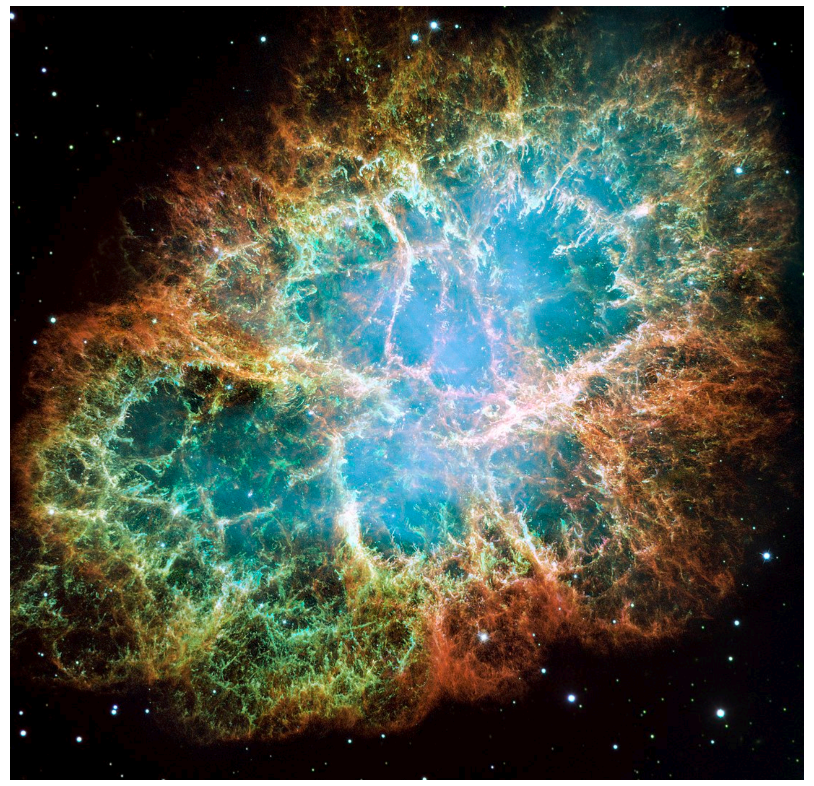
3 The downfall of low-energy vibrations in nuclei

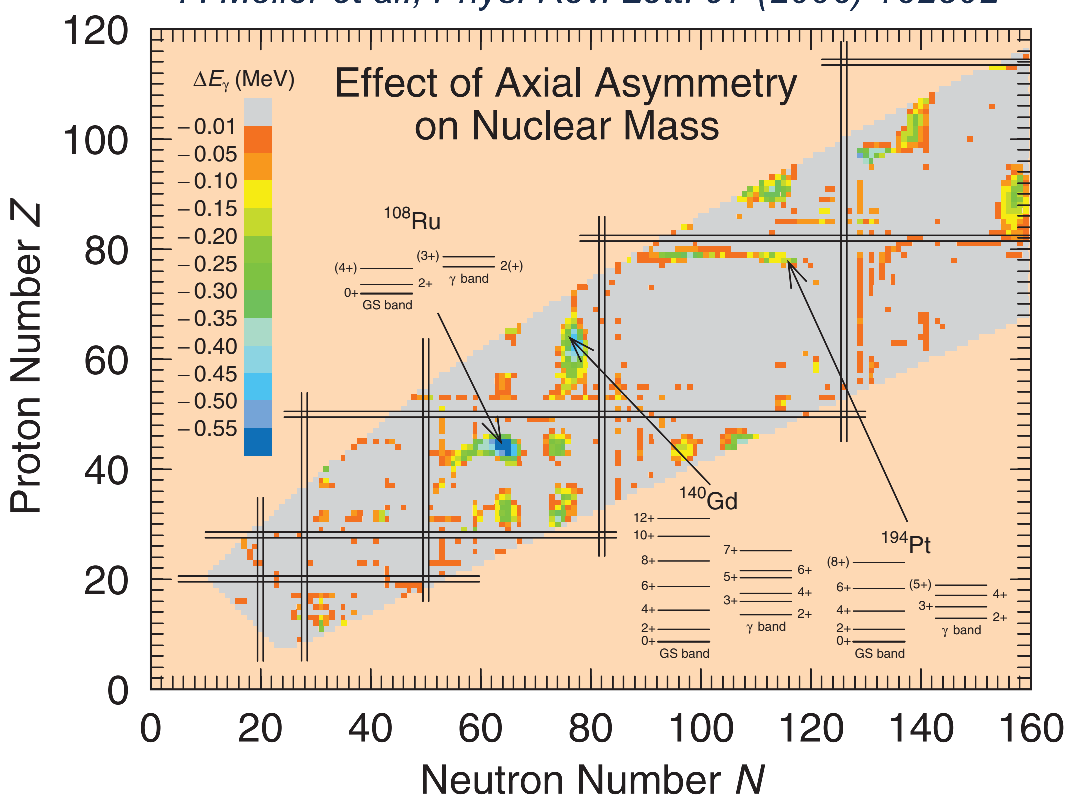




P.E. Garrett et al., Phys. Rev. Lett. 123 (2019) 142502

4 Triaxiality in radioactive nuclei & the r-process





P. Möller et al., Phys. Rev. Lett. 97 (2006) 162502

Florence Activities with GRIFFIN

- TRIUMF Labs
- GRIFFIN γ-Ray Spectrometer
- γ-γ Angular Correlations with GRIFFIN
- GAMMA & GRIFFIN
- ^{74}Zn: Iols & r-Process
- SPES
- SPES β-Decay Station

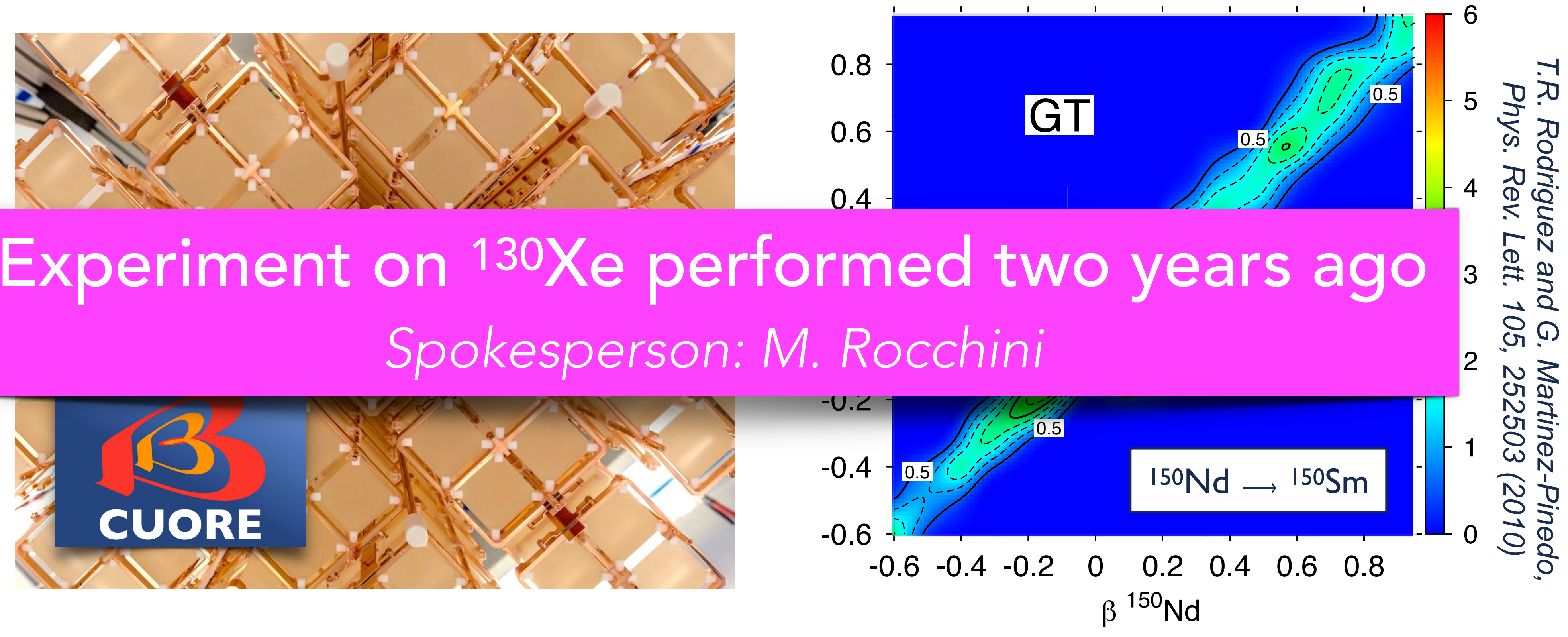
1 Quantum-phase transition in the Zr isotopes

Experiment on ^{96}Zr performed one year ago

Spokespersons: M. Rocchini, P. Garrett, M. Zielinska

T. Togashi et al., Phys. Rev. Lett. 117 (2016) 172502

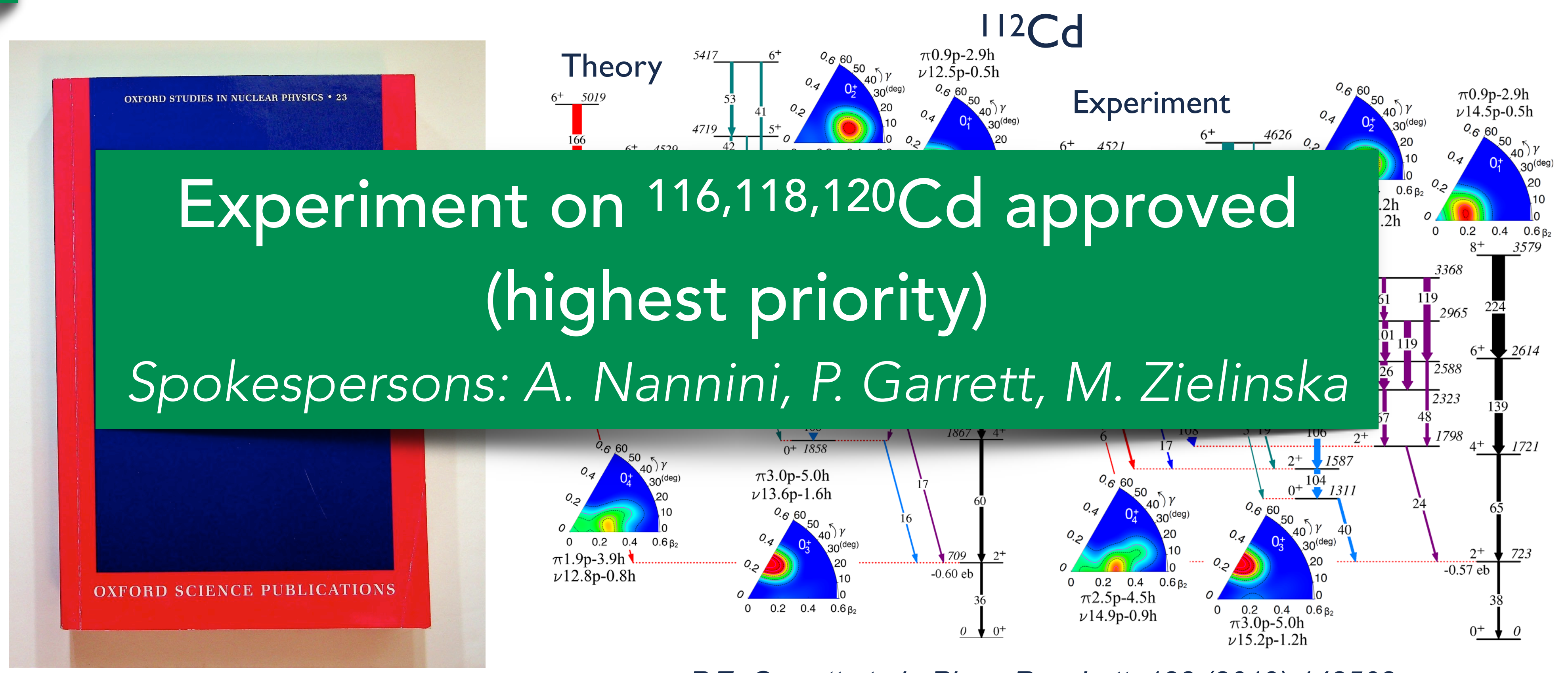
2 Influence of the nuclear shape on 0νββ decay



Experiment on ^{130}Xe performed two years ago

Spokesperson: M. Rocchini

3 The downfall of low-energy vibrations in nuclei

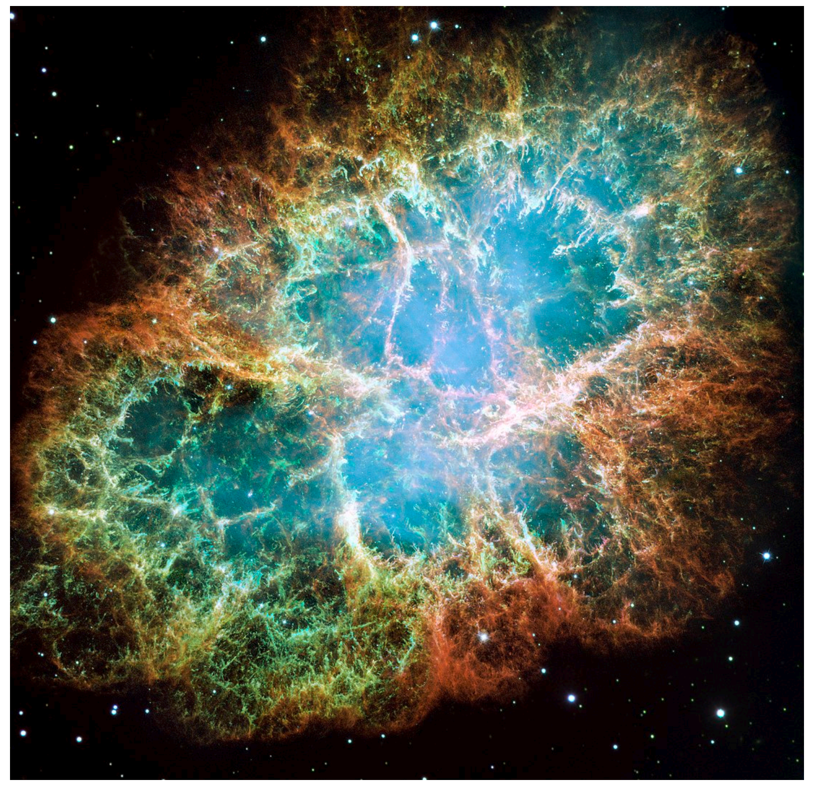


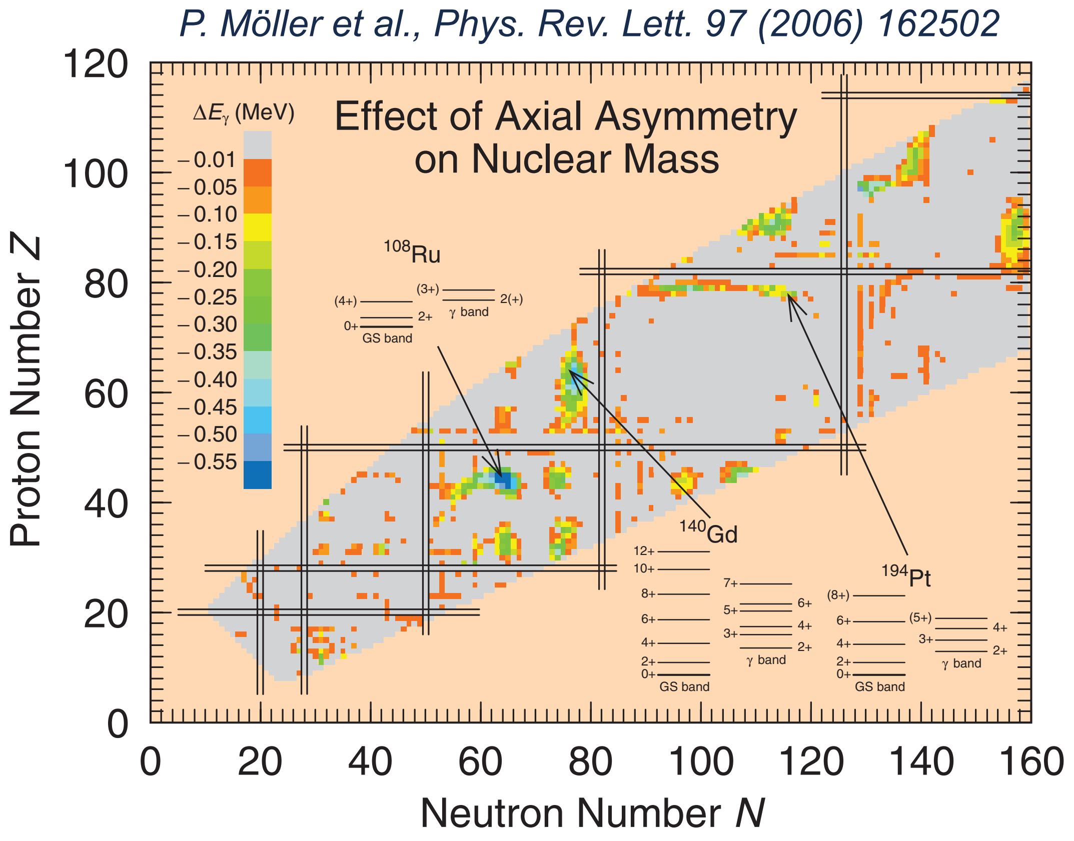
Experiment on $^{116,118,120}Cd$ approved (highest priority)

Spokespersons: A. Nannini, P. Garrett, M. Zielinska

P.E. Garrett et al., Phys. Rev. Lett. 123 (2019) 142502

4 Triaxiality in radioactive nuclei & the r-process





Florence Activities with GRIFFIN

- TRIUMF Labs
- GRIFFIN γ-Ray Spectrometer
- γ-γ Angular Correlations with GRIFFIN
- GAMMA & GRIFFIN
- ^{74}Zn: IoIs & r-Process
- SPES
- SPES β-Decay Station

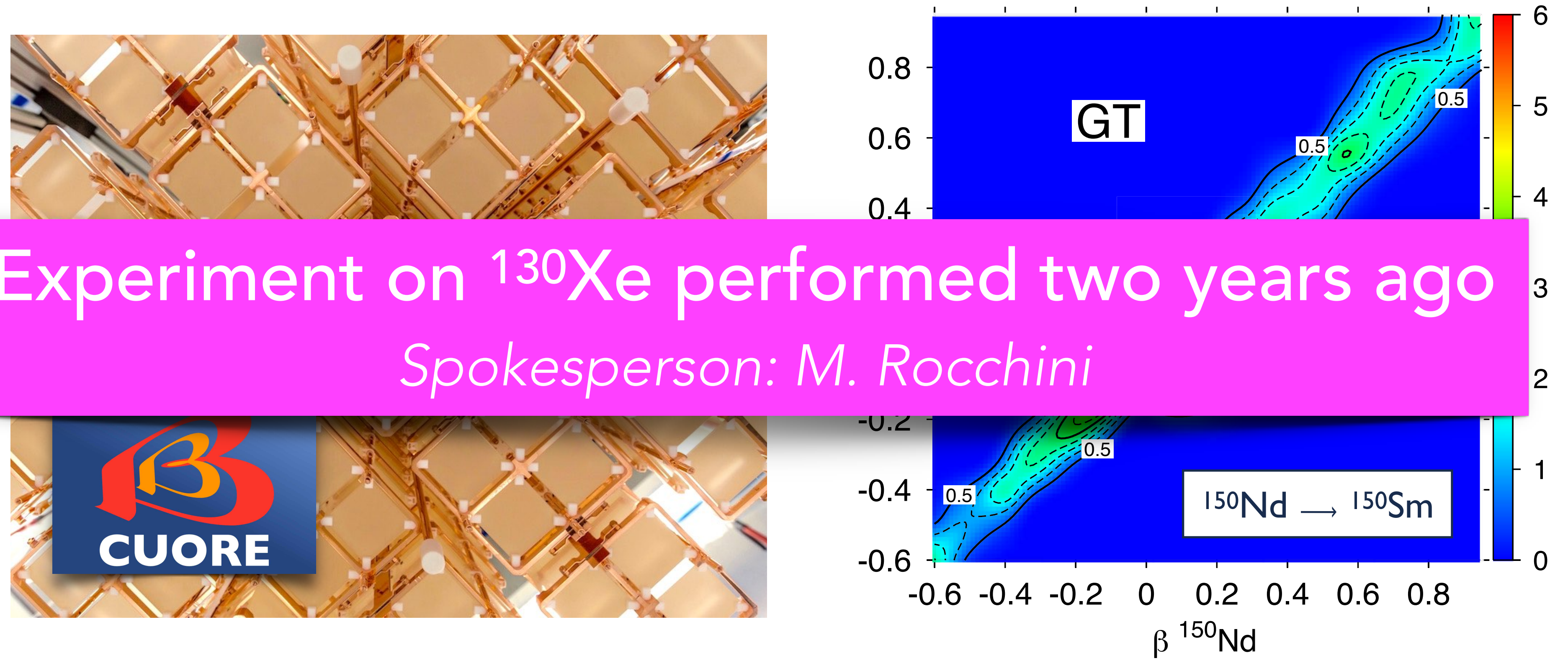
1 Quantum-phase transition in the Zr isotopes

T. Togashi et al., Phys. Rev. Lett. 117 (2016) 172502

Experiment on ^{96}Zr performed one year ago

Spokespersons: M. Rocchini, P. Garrett, M. Zielinska

2 Influence of the nuclear shape on 0νββ decay

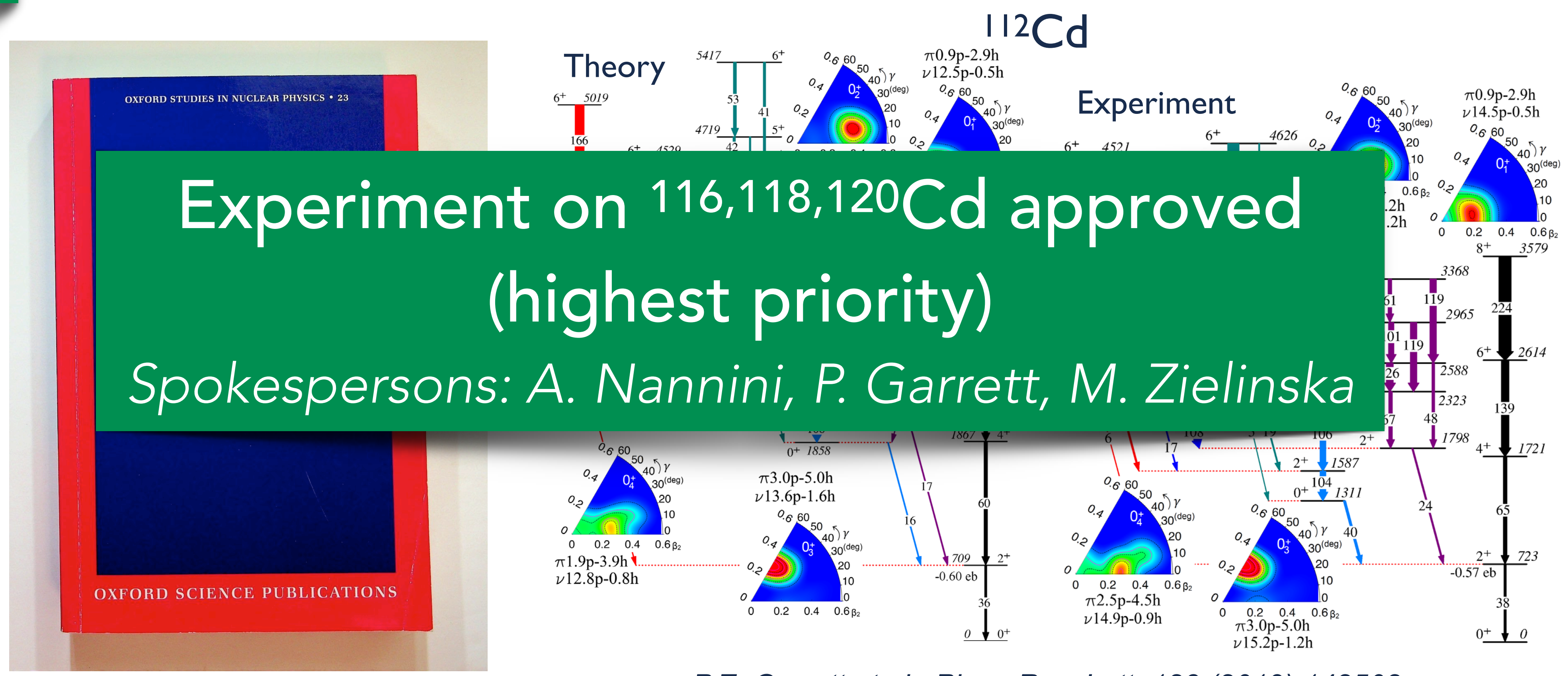


T.R. Rodríguez and G. Martínez-Pinedo, Phys. Rev. Lett. 105, 252503 (2010)

Experiment on ^{130}Xe performed two years ago

Spokesperson: M. Rocchini

3 The downfall of low-energy vibrations in nuclei

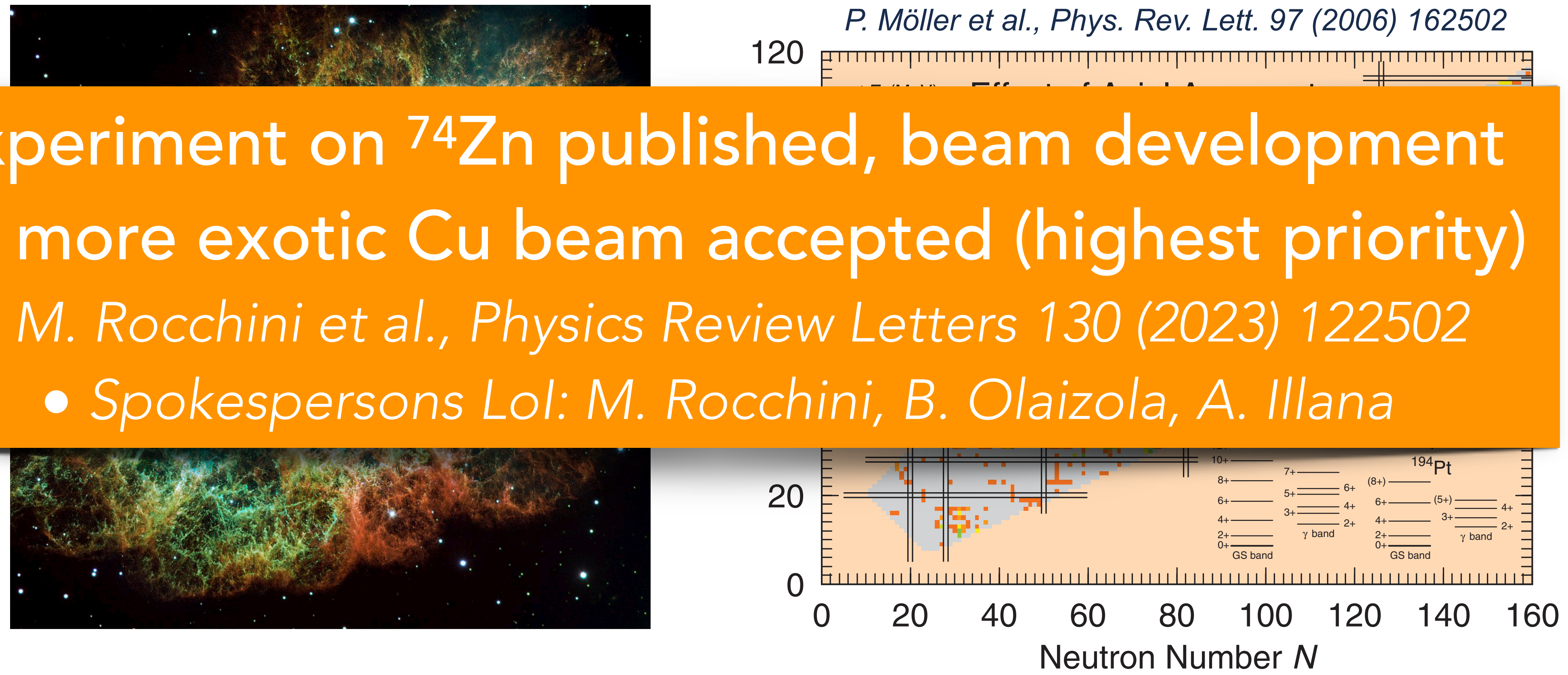


P.E. Garrett et al., Phys. Rev. Lett. 123 (2019) 142502

Experiment on ^{116,118,120}Cd approved (highest priority)

Spokespersons: A. Nannini, P. Garrett, M. Zielinska

4 Triaxiality in radioactive nuclei & the r-process

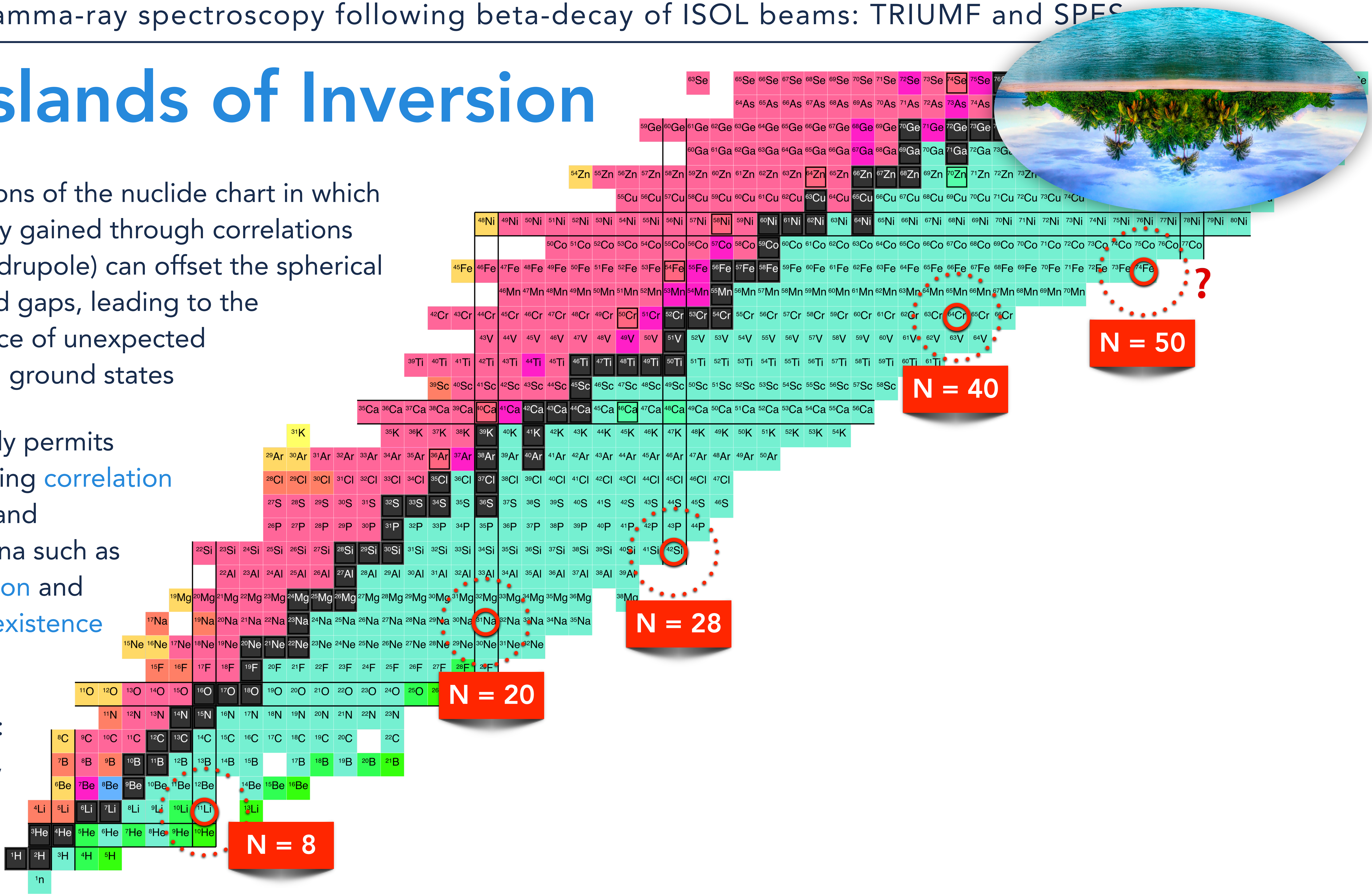


Experiment on ^{74}Zn published, beam development for more exotic Cu beam accepted (highest priority)

- *M. Rocchini et al., Physics Review Letters 130 (2023) 122502*
- *Spokespersons LoI: M. Rocchini, B. Olaizola, A. Illana*

Islands of Inversion

- IoIs: Regions of the nuclide chart in which the energy gained through correlations (*e.g.*, quadrupole) can offset the spherical mean-field gaps, leading to the appearance of unexpected deformed ground states
- Their study permits investigating correlation energies and phenomena such as deformation and shape coexistence
- 4 IoIs identified: N = 8, 20, 28, 40



Islands of Inversion

TRIUMF Labs

GRIFFIN γ-Ray Spectrometer

γ-γ Angular Correlations with GRIFFIN

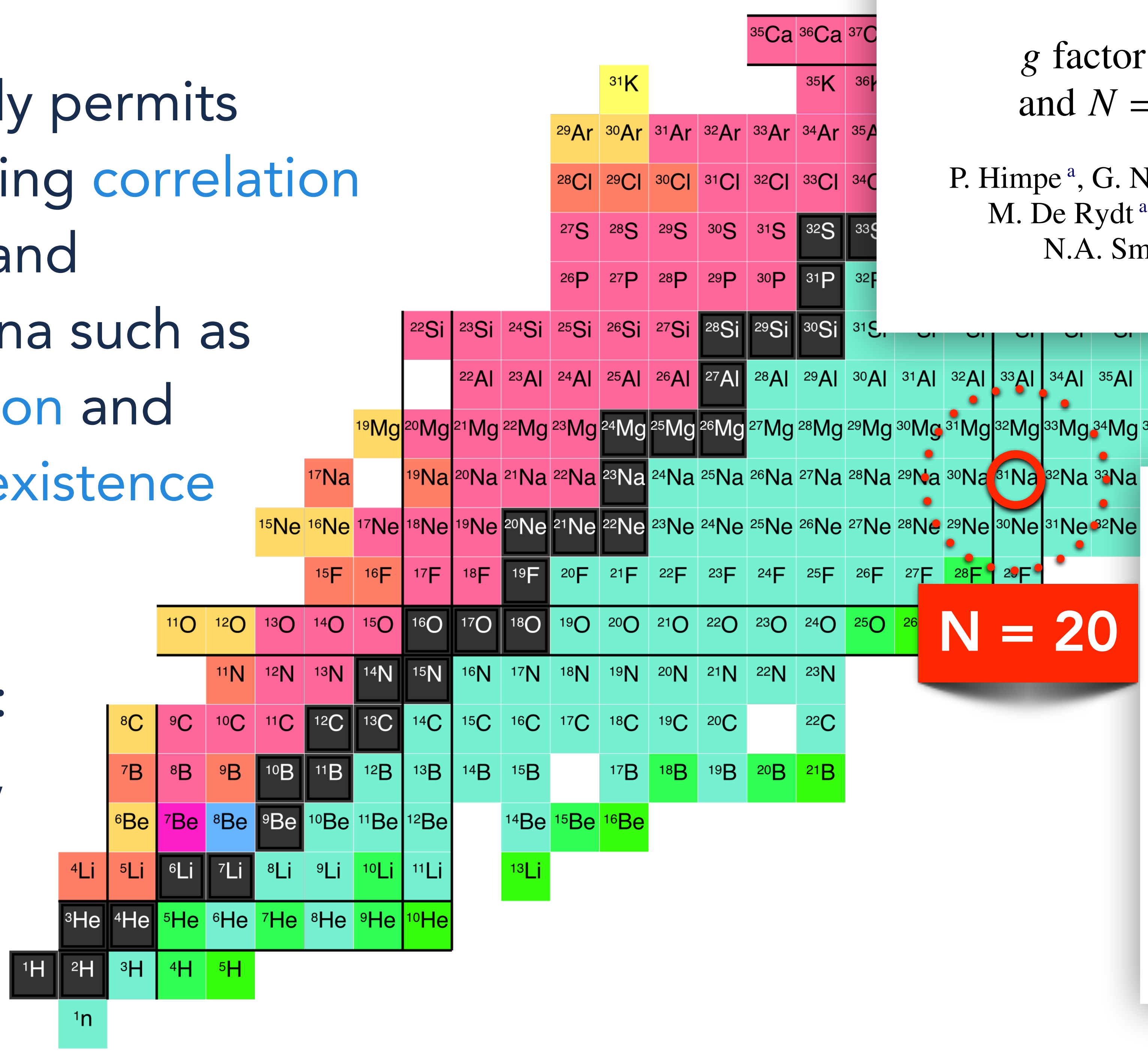
GAMMA & GRIFFIN

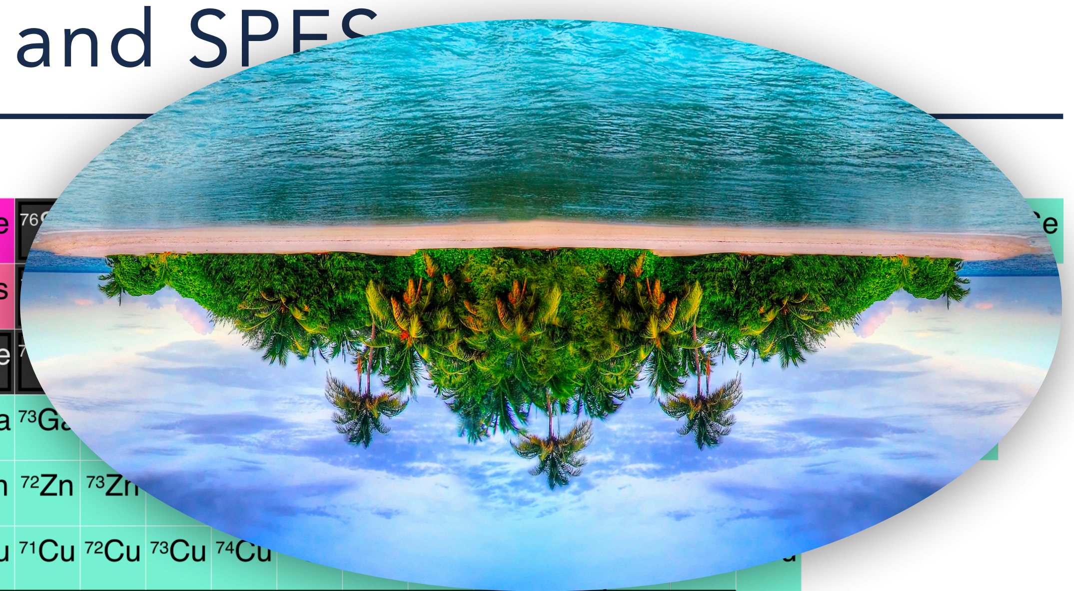
^{74}Zn: IoIs & r-Process

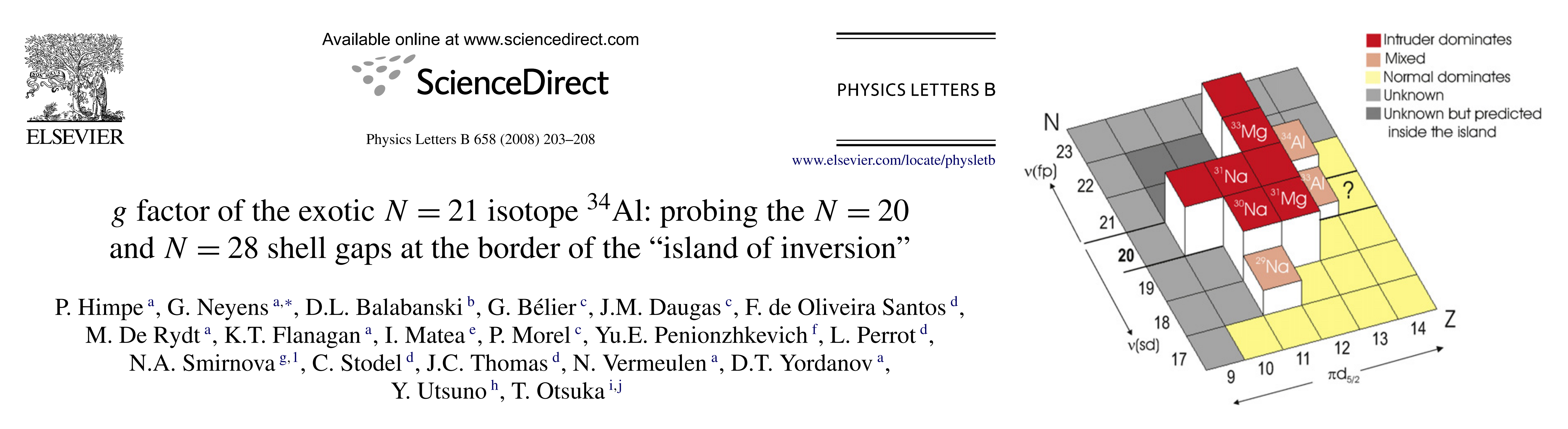
SPES

SPES β-Decay Station

- IoIs: Regions of the nuclide chart in which the energy gained through correlations (*e.g.*, quadrupole) can offset the spherical mean-field gaps, leading to the appearance of unexpected deformed ground states
- Their study permits investigating correlation energies and phenomena such as deformation and shape coexistence
- 4 IoIs identified: N = 8, 20, 28, 40



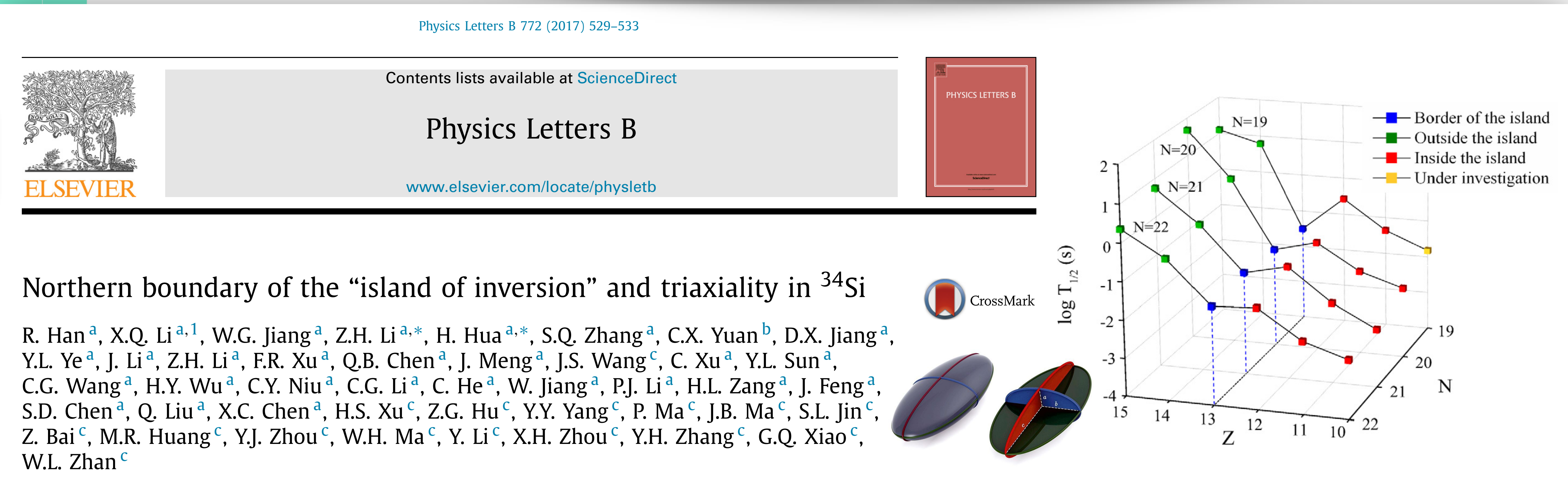



Available online at www.sciencedirect.com
ScienceDirect
PHYSICS LETTERS B
Physics Letters B 658 (2008) 203–208
www.elsevier.com/locate/physletb

g factor of the exotic *N* = 21 isotope ^{34}Al: probing the *N* = 20 and *N* = 28 shell gaps at the border of the "island of inversion"

P. Himpe[a], G. Neyens[a,*], D.L. Balabanski[b], G. Bélier[c], J.M. Daugas[c], F. de Oliveira Santos[d], M. De Rydt[a], K.T. Flanagan[a], I. Matea[e], P. Morel[c], Yu.E. Penionzhkevich[f], L. Perrot[d], N.A. Smirnova[g,1], C. Stodel[d], J.C. Thomas[d], N. Vermeulen[a], D.T. Yordanov[a], Y. Utsuno[h], T. Otsuka[i,j]

The search for the boundaries of the IoIs


Physics Letters B 772 (2017) 529–533
Contents lists available at ScienceDirect
Physics Letters B
www.elsevier.com/locate/physletb

Northern boundary of the "island of inversion" and triaxiality in ^{34}Si

R. Han[a], X.Q. Li[a,1], W.G. Jiang[a], Z.H. Li[a,*], H. Hua[a,*], S.Q. Zhang[a], C.X. Yuan[b], D.X. Jiang[a], Y.L. Ye[a], J. Li[a], Z.H. Li[a], F.R. Xu[a], Q.B. Chen[a], J. Meng[a], J.S. Wang[c], C. Xu[a], Y.L. Sun[a], C.G. Wang[a], H.Y. Wu[a], C.Y. Niu[a], C.G. Li[a], C. He[a], W. Jiang[a], P.J. Li[a], H.L. Zang[a], J. Feng[a], S.D. Chen[a], Q. Liu[a], X.C. Chen[a], H.S. Xu[c], Z.G. Hu[c], Y.Y. Yang[c], P. Ma[c], J.B. Ma[c], S.L. Jin[c], Z. Bai[c], M.R. Huang[c], Y.J. Zhou[c], W.H. Ma[c], Y. Li[c], X.H. Zhou[c], Y.H. Zhang[c], G.Q. Xiao[c], W.L. Zhan[c]

Islands of Inversion

TRIUMF Labs

GRIFFIN γ-Ray Spectrometer

γ-γ Angular Correlations with GRIFFIN

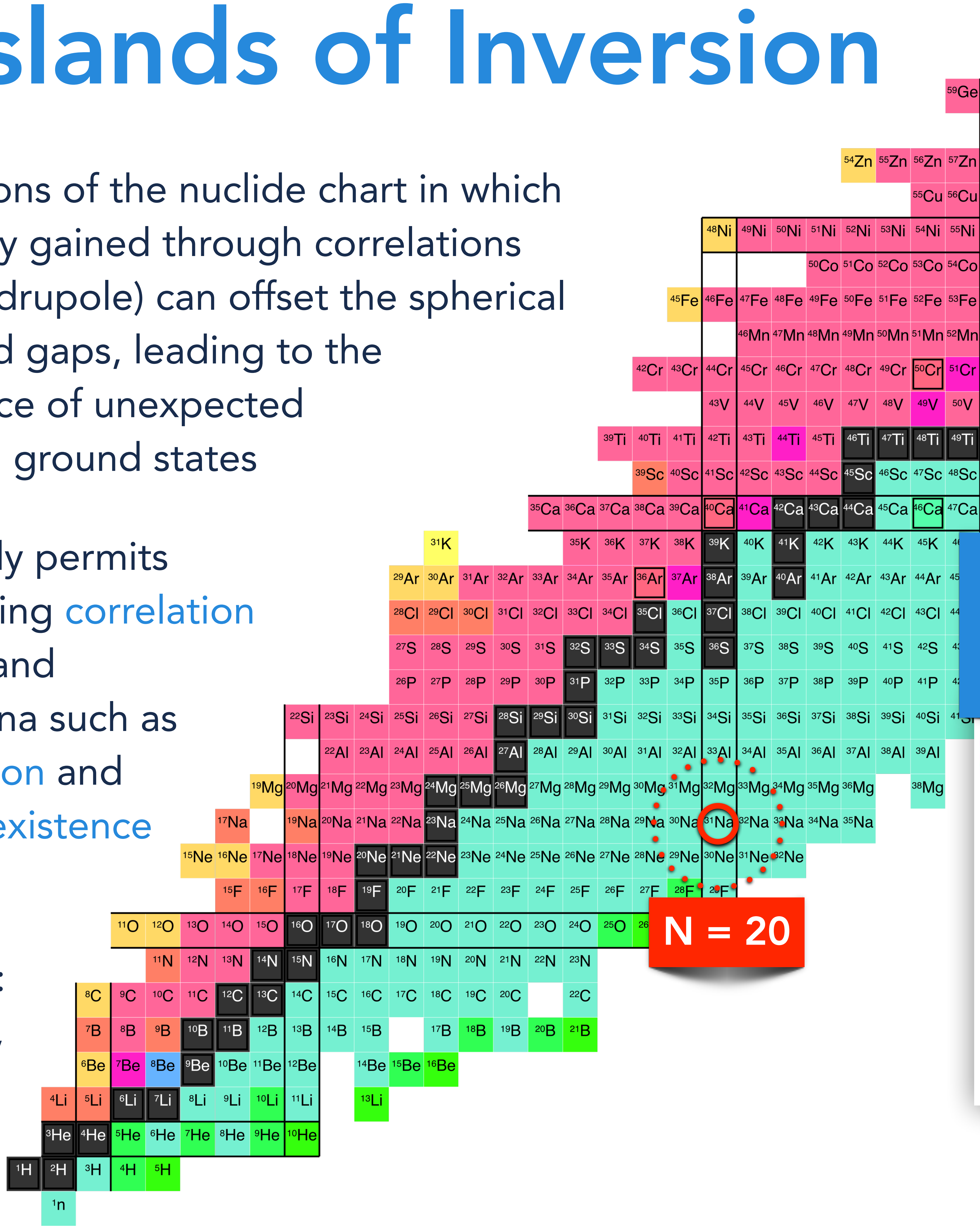
GAMMA & GRIFFIN

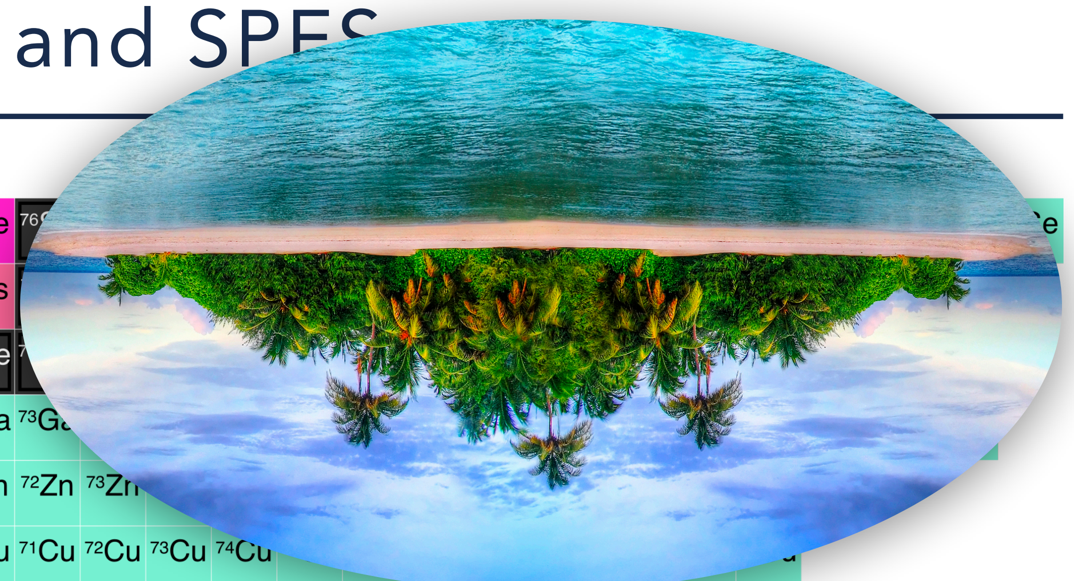
^{74}Zn: IoIs & r-Process

SPES

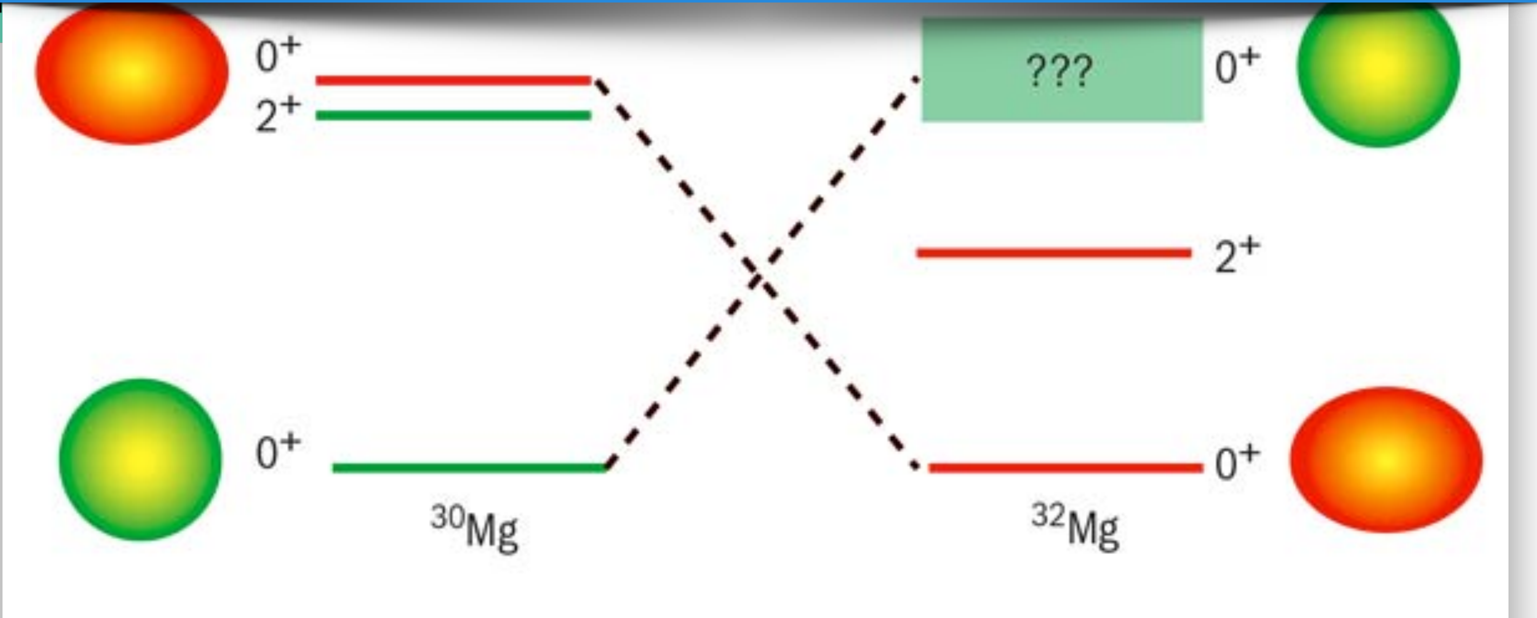
SPES β-Decay Station

- IoIs: Regions of the nuclide chart in which the energy gained through correlations (*e.g.*, quadrupole) can offset the spherical mean-field gaps, leading to the appearance of unexpected deformed ground states
- Their study permits investigating correlation energies and phenomena such as deformation and shape coexistence
- 4 IoIs identified: N = 8, 20, 28, 40





Shape Coexistence is often observed at the borders of the IoIs, with inversions of "normal" and intruder configurations



T. Kröll and K. Wimmer, CERN Courier - Strong Interactions (Feature), ISOLDE explores the Island of Inversion

Islands of Inversion

TRIUMF Labs

GRIFFIN γ-Ray Spectrometer

γ-γ Angular Correlations with GRIFFIN

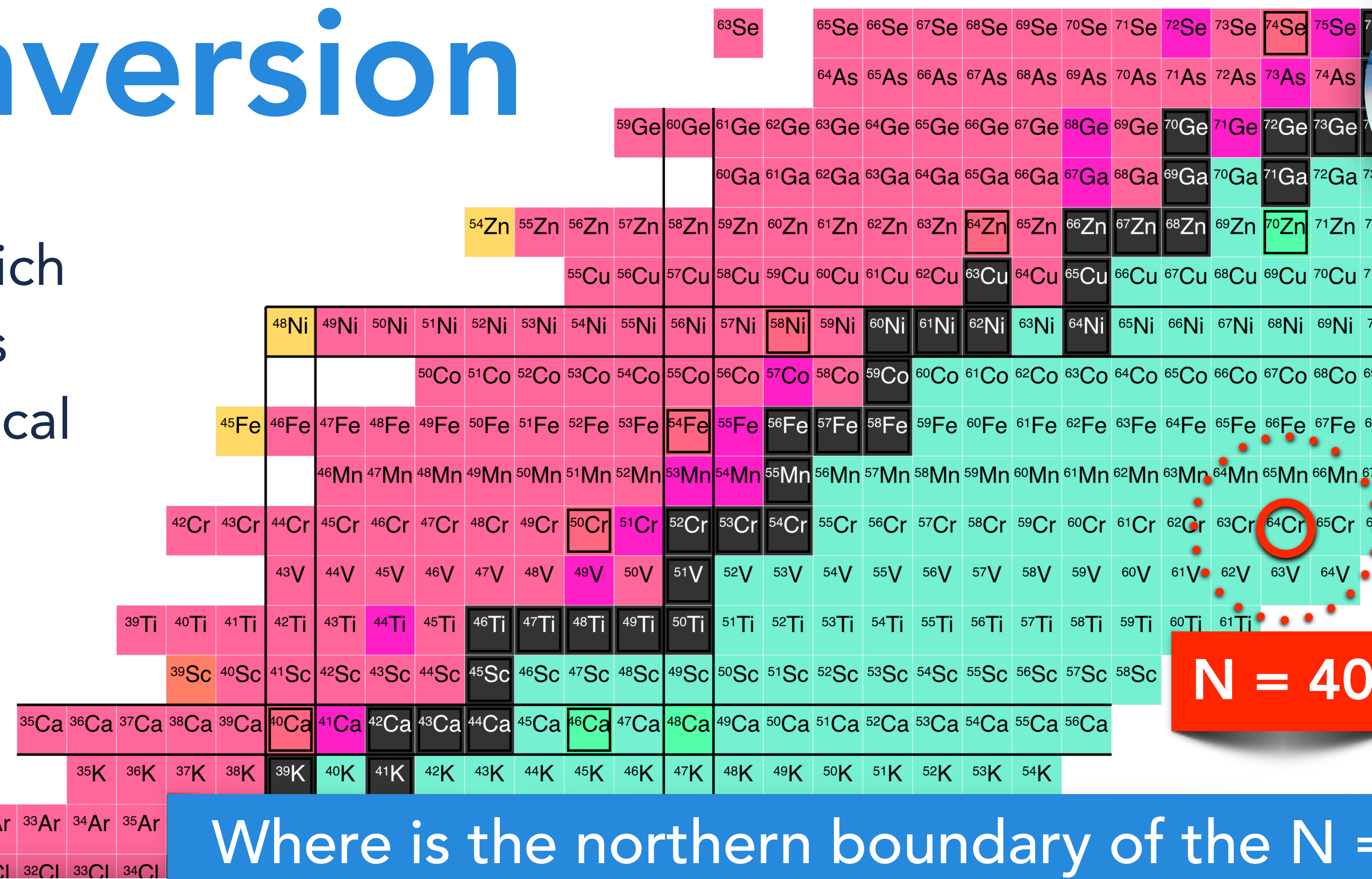
GAMMA & GRIFFIN

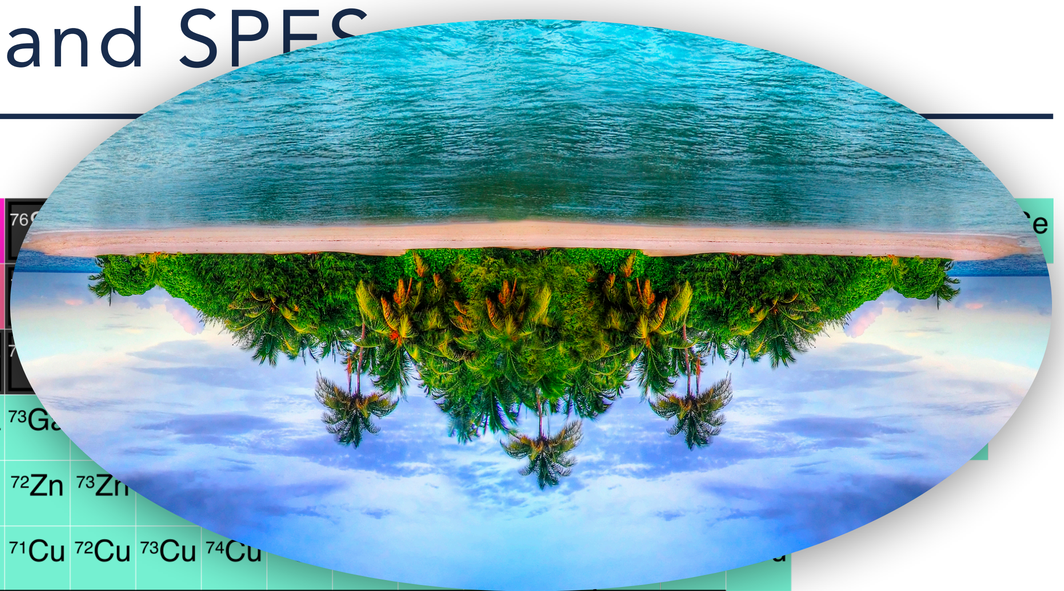
^{74}Zn: IoIs & r-Process

SPES

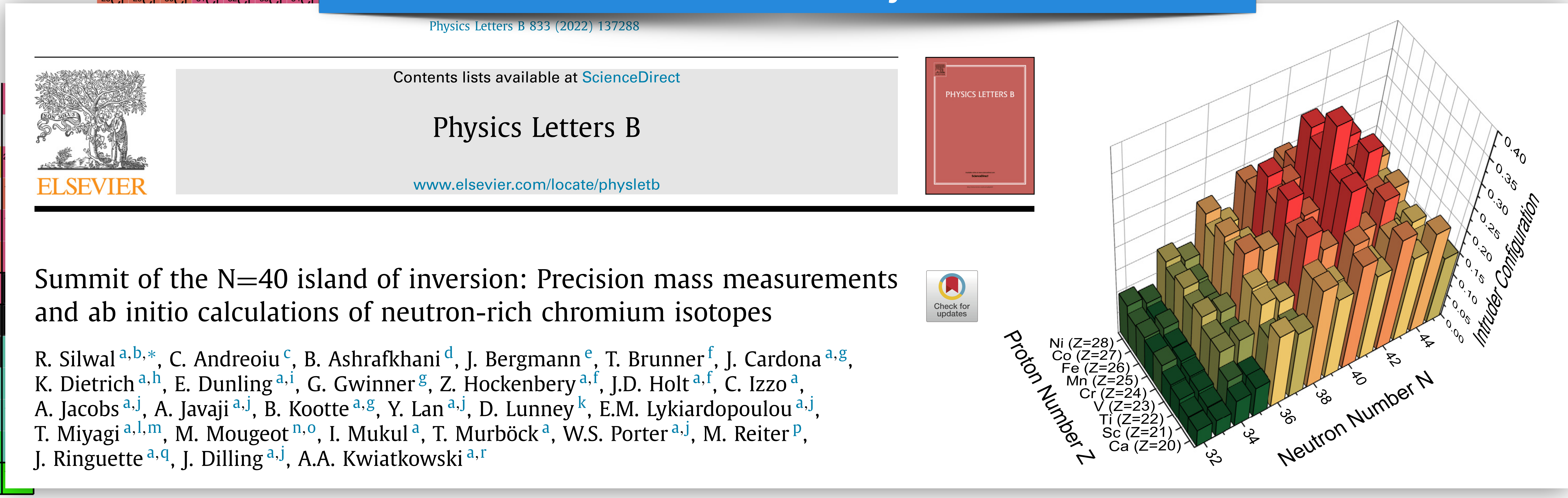
SPES β-Decay Station

- IoIs: Regions of the nuclide chart in which the energy gained through correlations (*e.g.*, quadrupole) can offset the spherical mean-field gaps, leading to the appearance of unexpected deformed ground states
- Their study permits investigating correlation energies and phenomena such as deformation and shape coexistence
- 4 IoIs identified: N = 8, 20, 28, 40





Where is the northern boundary of the N = 40 IoI?


Physics Letters B 833 (2022) 137288

Contents lists available at ScienceDirect

Physics Letters B

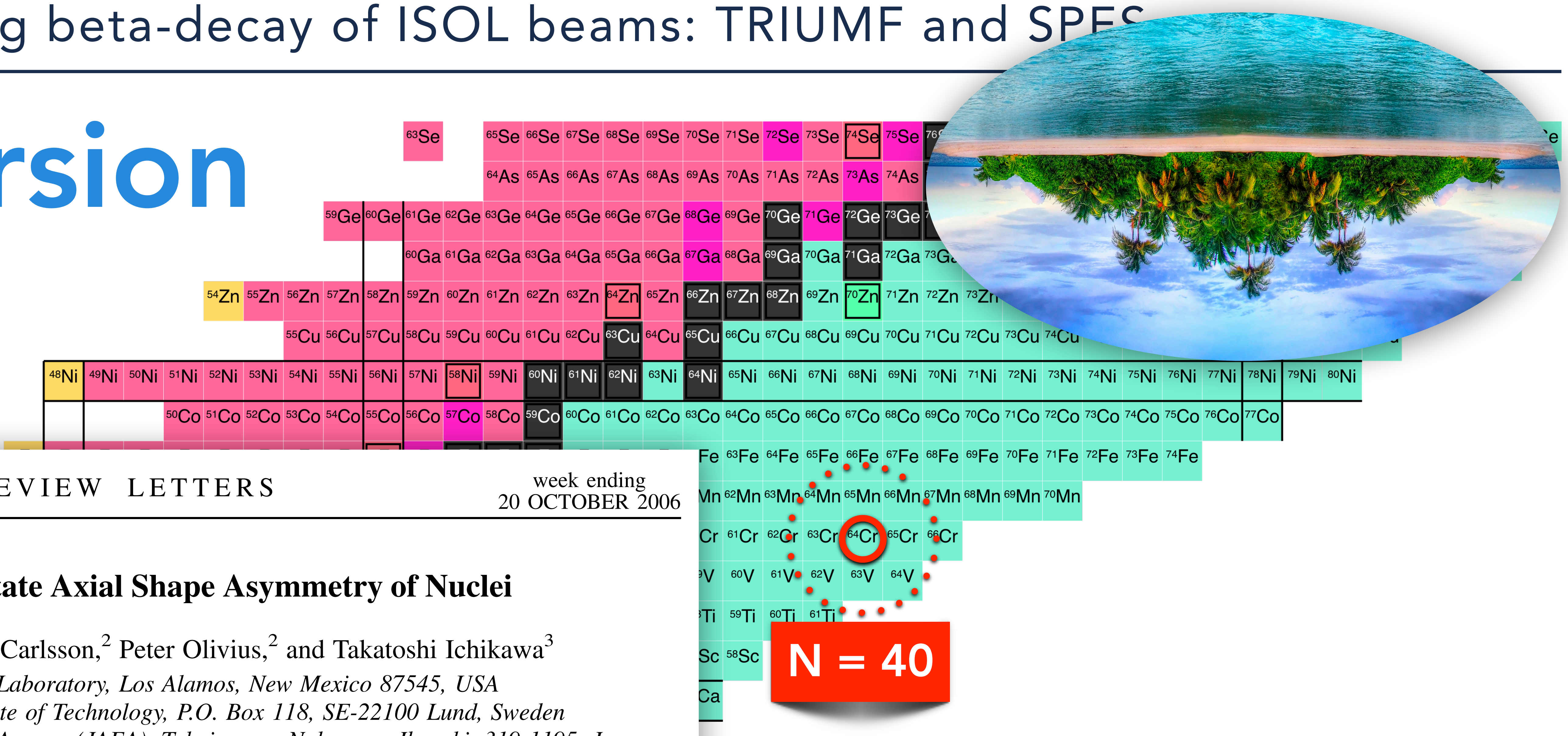
www.elsevier.com/locate/physletb

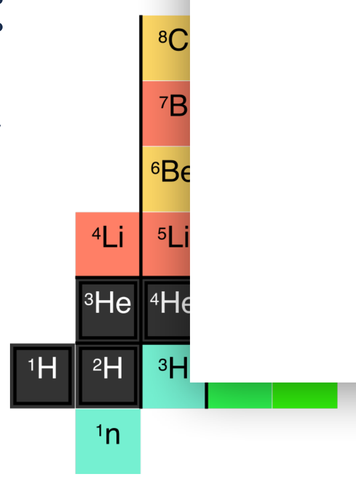
Summit of the N=40 island of inversion: Precision mass measurements and ab initio calculations of neutron-rich chromium isotopes

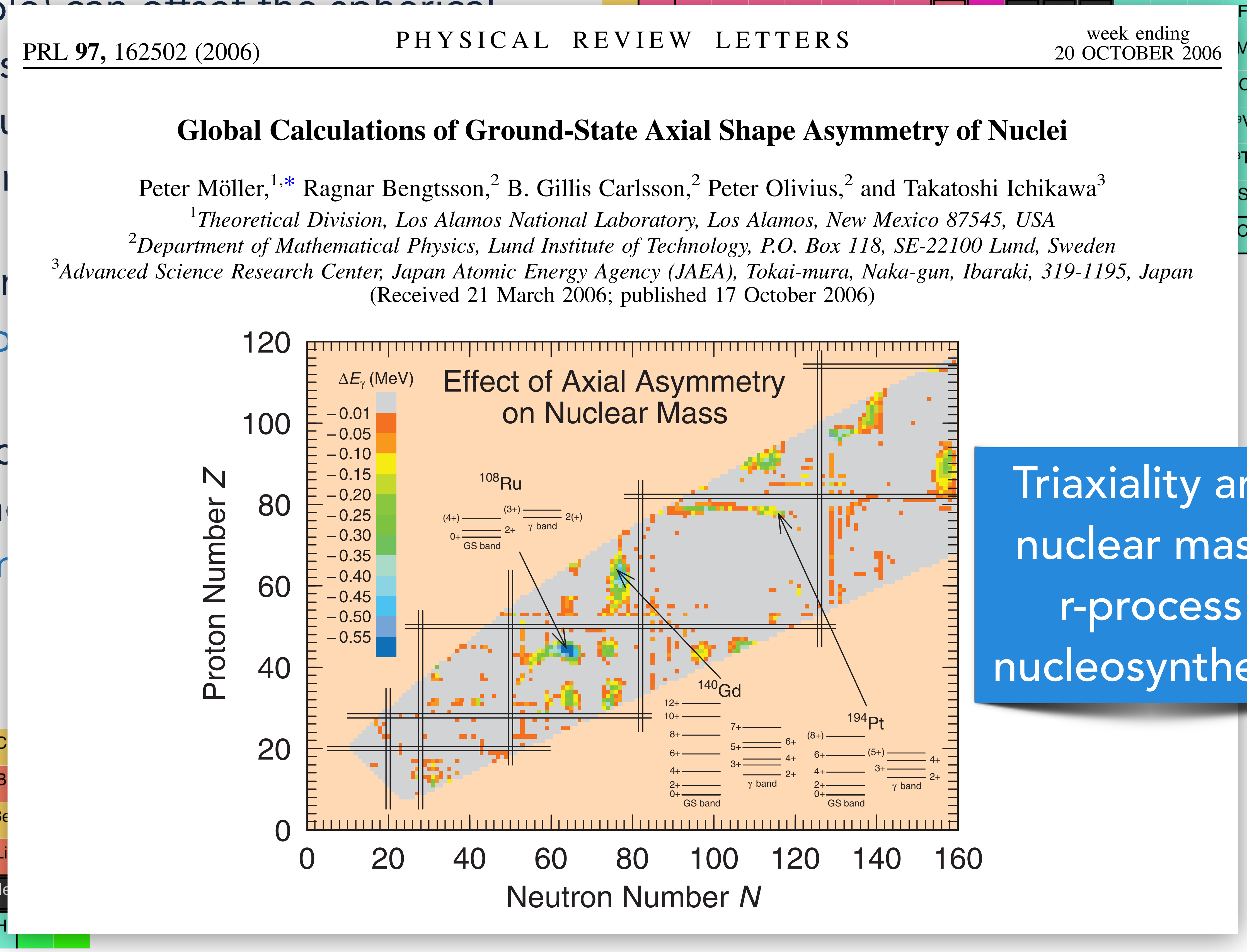
R. Silwal[a,b,*], C. Andreoiu[c], B. Ashrafkhani[d], J. Bergmann[e], T. Brunner[f], J. Cardona[a,g], K. Dietrich[a,h], E. Dunling[a,i], G. Gwinner[g], Z. Hockenbery[a,f], J.D. Holt[a,f], C. Izzo[a], A. Jacobs[a,j], A. Javaji[a,j], B. Kootte[a,g], Y. Lan[a,j], D. Lunney[k], E.M. Lykiardopoulou[a,j], T. Miyagi[a,l,m], M. Mougeot[n,o], I. Mukul[a], T. Murböck[a], W.S. Porter[a,j], M. Reiter[p], J. Ringuette[a,q], J. Dilling[a,j], A.A. Kwiatkowski[a,r]

Islands of Inversion

- IoIs: Regions of the nuclide chart in which the energy gained through correlations (e.g., quadrupo… mean-field gaps… appearance of … deformed grou…
- Their study per… investigating c… energies and phenomena su… deformation an… shape coexiste…
- 4 IoIs identified: N = 8, 20, 28, 40



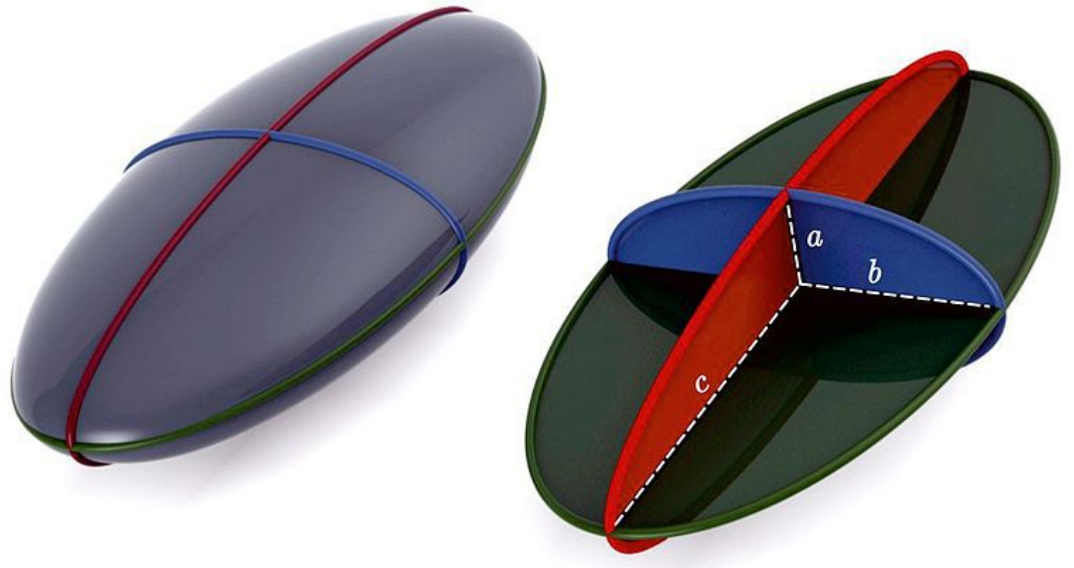



PRL 97, 162502 (2006) PHYSICAL REVIEW LETTERS week ending 20 OCTOBER 2006

Global Calculations of Ground-State Axial Shape Asymmetry of Nuclei

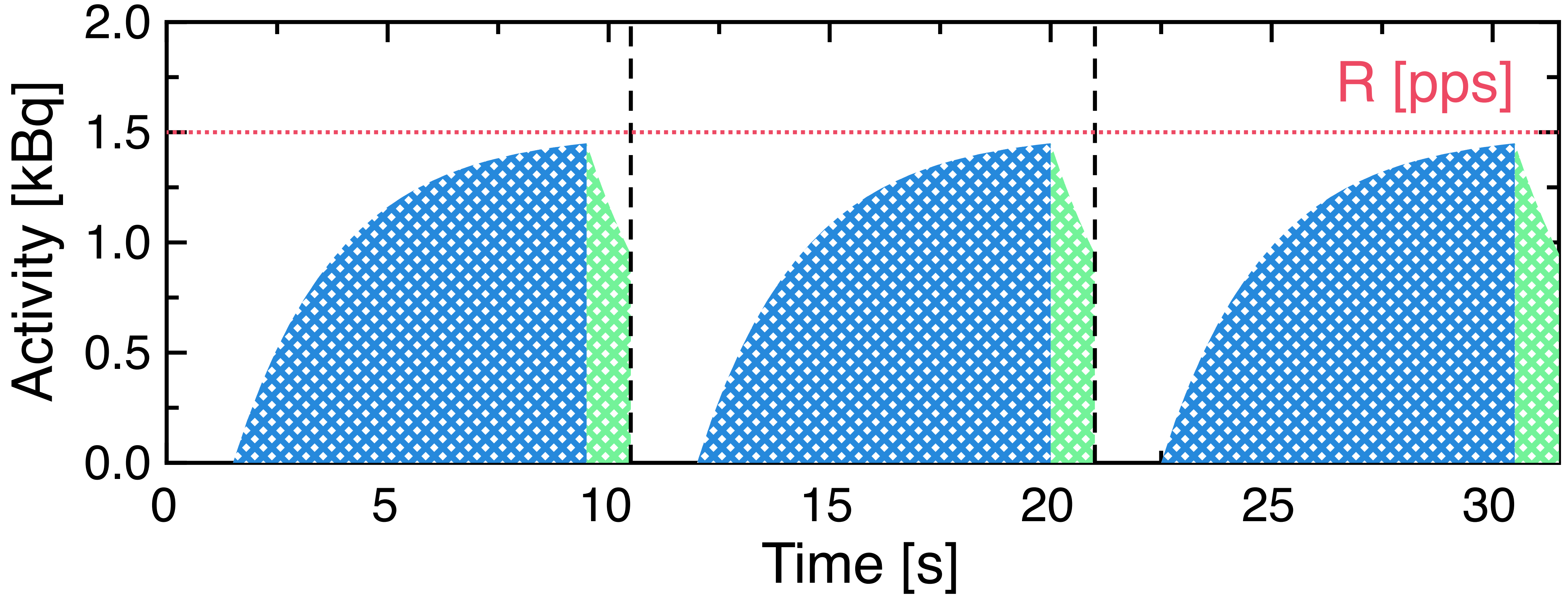
Peter Möller,[1,*] Ragnar Bengtsson,[2] B. Gillis Carlsson,[2] Peter Olivius,[2] and Takatoshi Ichikawa[3]
[1]*Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545, USA*
[2]*Department of Mathematical Physics, Lund Institute of Technology, P.O. Box 118, SE-22100 Lund, Sweden*
[3]*Advanced Science Research Center, Japan Atomic Energy Agency (JAEA), Tokai-mura, Naka-gun, Ibaraki, 319-1195, Japan*
(Received 21 March 2006; published 17 October 2006)

Triaxiality and nuclear mass: r-process nucleosynthesis



Our Experiment on ^{74}Zn with GRIFFIN

- ^{74}Zn via ^{74}Cu β-decay [$T_{1/2}$ = 1.63(5) s], Beam intensity ≈ $1.5 \cdot 10^3$ pps
- GRIFFIN: 12 of 16 available clovers at 14.5 cm from the target
  - ε_γ(1332.5 keV) = 7.8%, ε_γ(300 keV) = 16.6%
  - P/T (addback + BGO suppressors) = 45.5%
- Tape cycle: 5 $T_{1/2}$ on, 1 s off, 0.5 s background, 1 s tape movement



γ-γ Angular Correlations: the (0_2^+)

TRIUMF Labs

GRIFFIN γ-Ray Spectrometer

γ-γ Angular Correlations with GRIFFIN

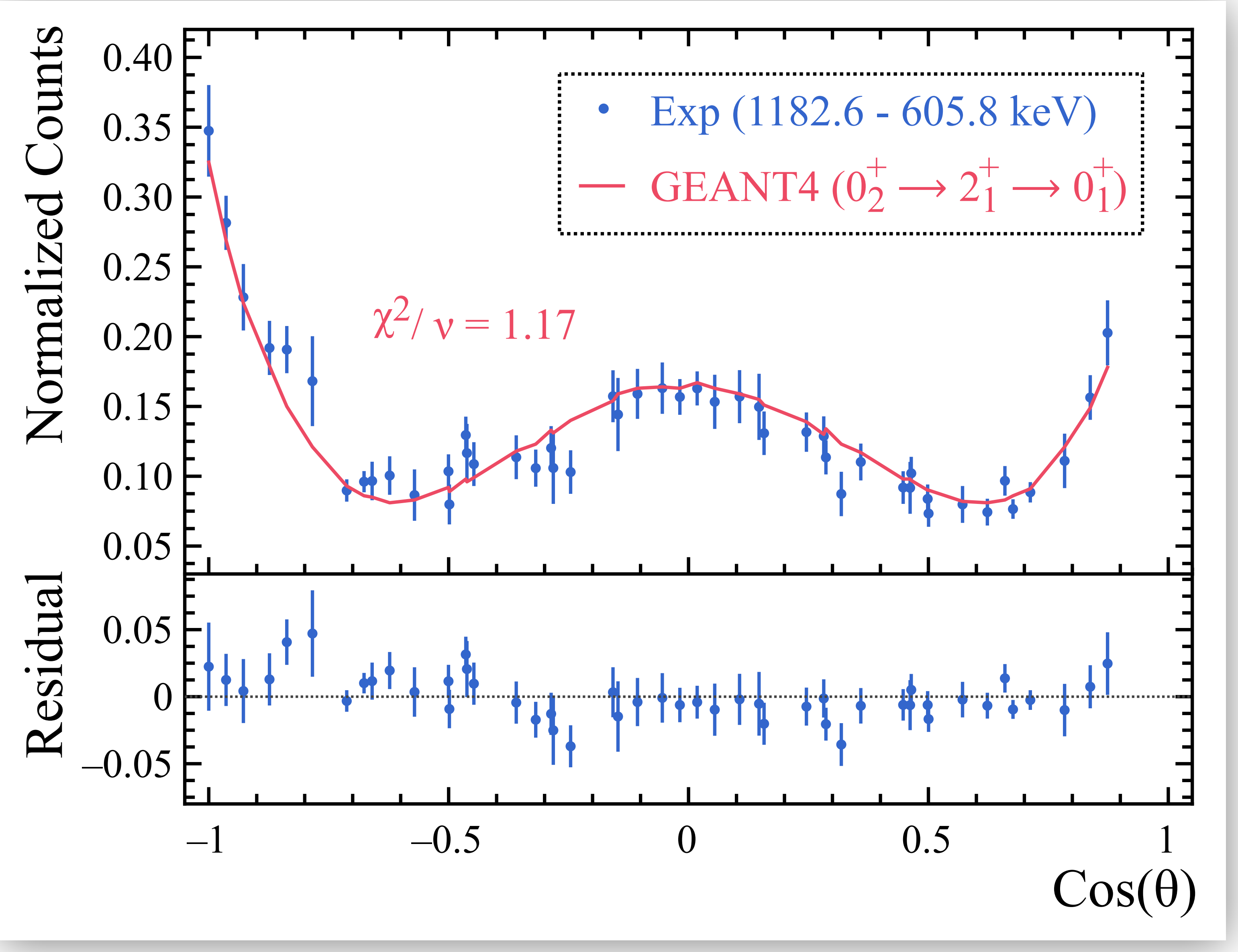
GAMMA & GRIFFIN

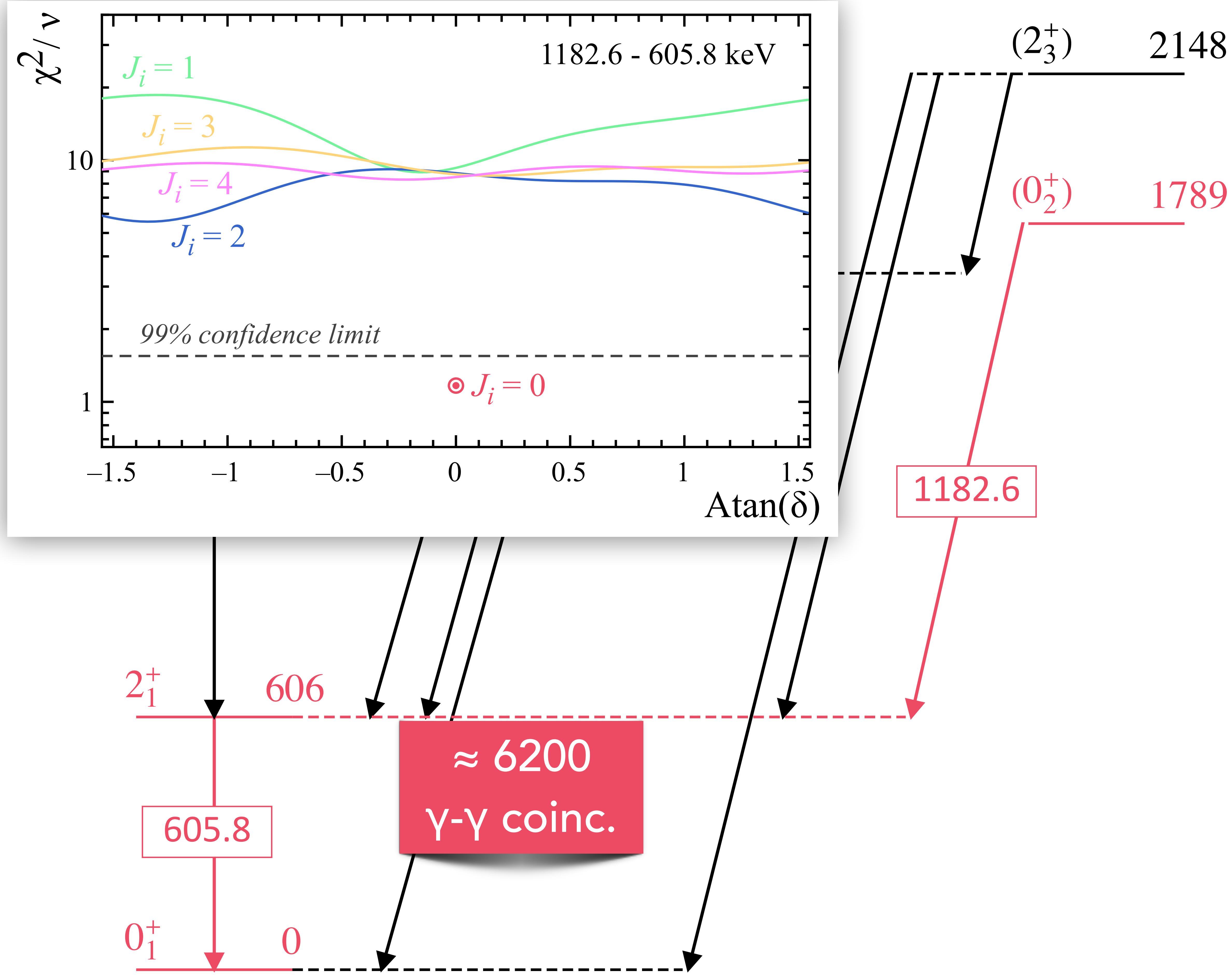
^{74}Zn: Iols & r-Process

SPES

SPES β-Decay Station

- The state at 1789 keV is firmly established as the first excited 0^+ state

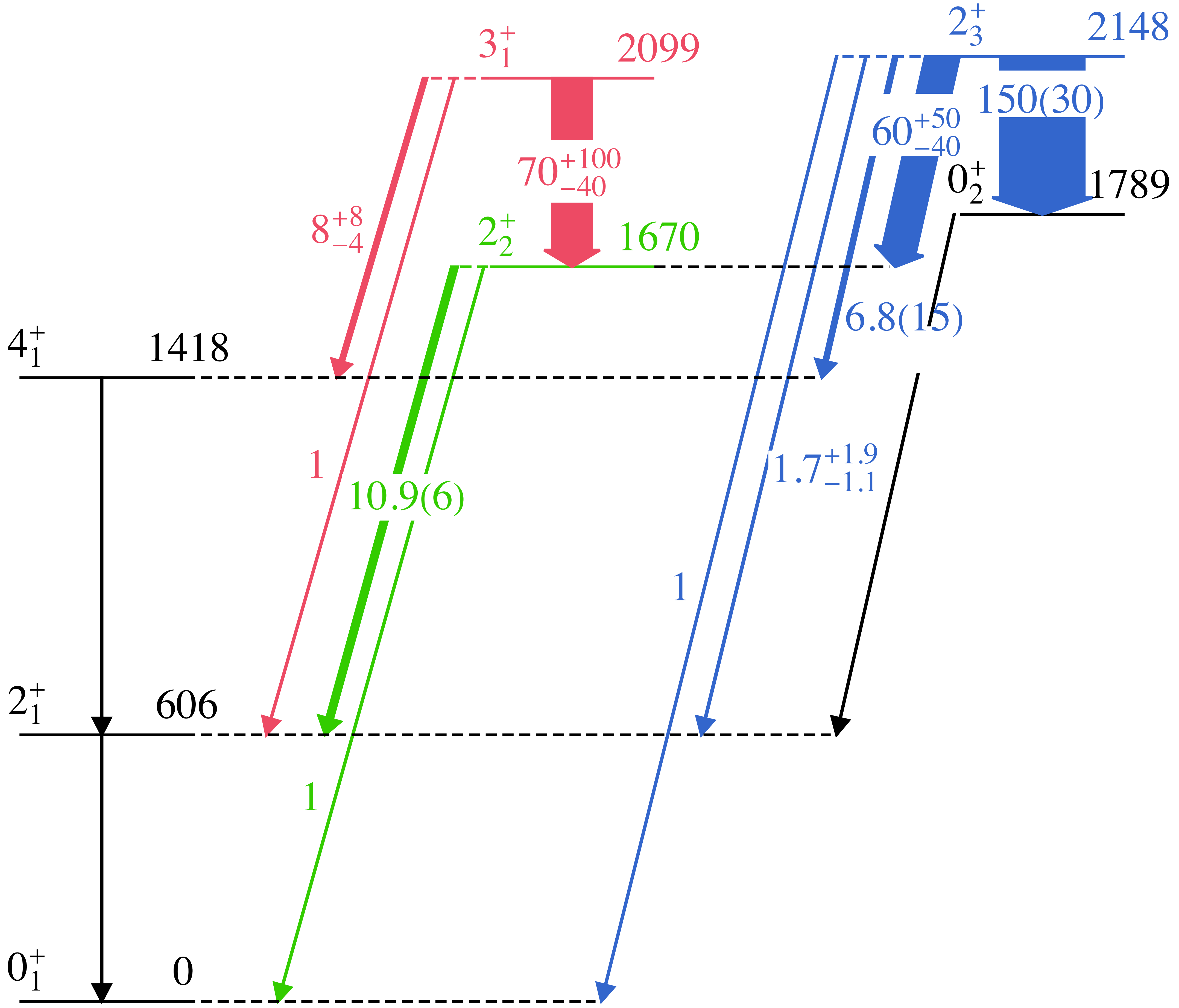




Experimental Results in a Nutshell

- New, definitive spin assignment for:
  - 2_2^+, 0_2^+, 3_1^+, 2_3^+ states
- Two new transitions:
  - $2_3^+ \longrightarrow 4_1^+$ and $2_3^+ \longrightarrow 0_2^+$
- From measured branching ratios and δ(E2/M1) mixing ratios ⇒ Relative B(E2) values

Strong transitions observed, indicative of band structures at low-spin in ^{74}Zn



Calculated Shapes from Shell Model

TRIUMF Labs

GRIFFIN γ-Ray Spectrometer

γ-γ Angular Correlations with GRIFFIN

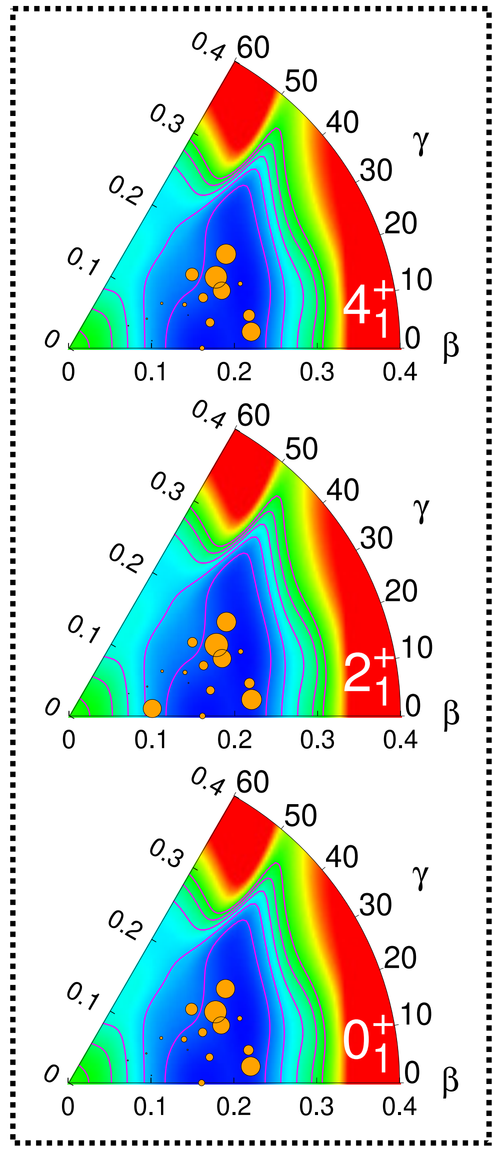
GAMMA & GRIFFIN

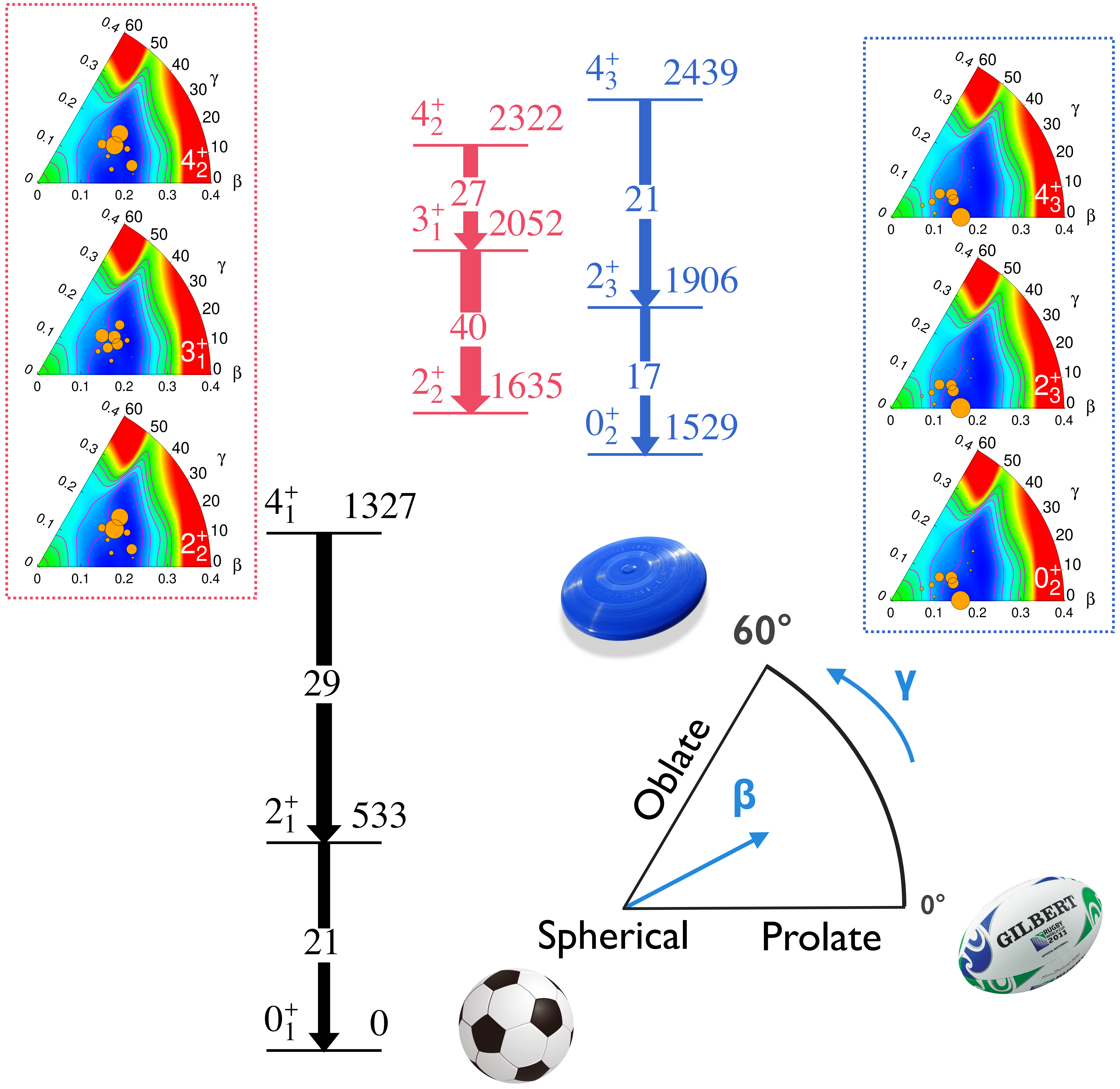
^{74}Zn: Iols & r-Process

SPES

SPES β-Decay Station

- The experimental results triggered new developments in state-of-the-art shell model calculations (LSSM, Large-Scale Shell Model by Silvia Lenzi, Frédéric Nowacki, Duc D. Dao)
- The calculations reproduce well the results
- For the first time with this approach, shapes of ground and excited states have been extracted





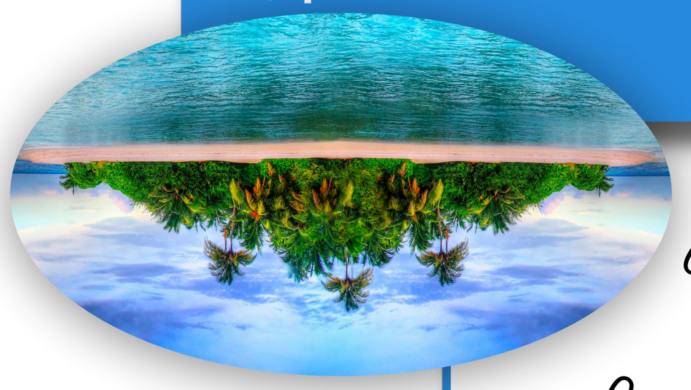
Calculated Shapes from Shell Model

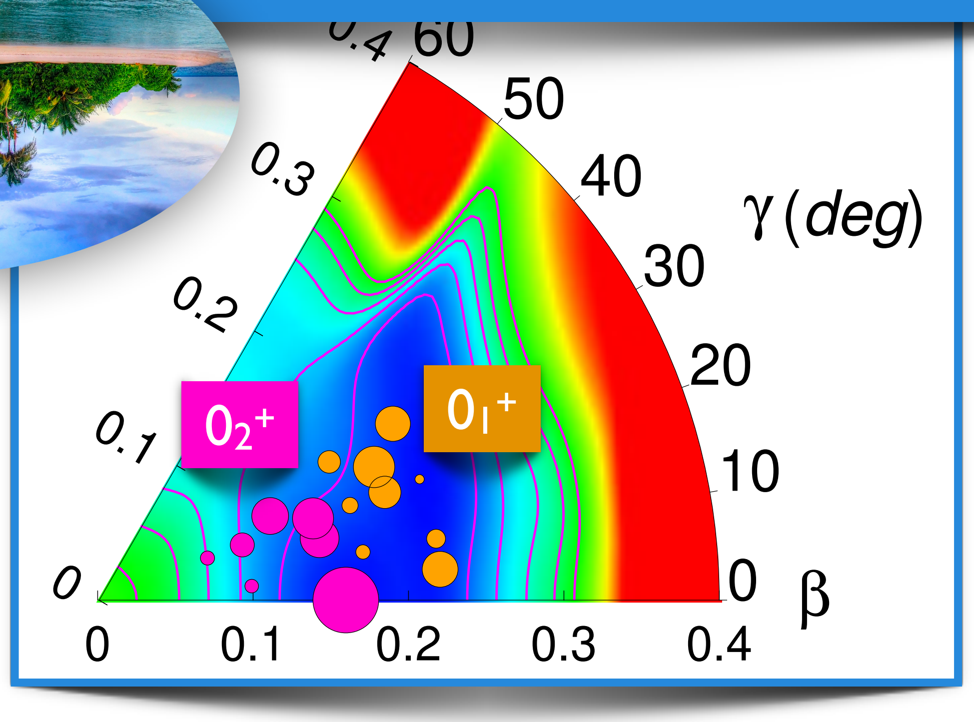
- The experimental results triggered new developments in state-of-the-art shell model calculations (LSSM, Large-Scale Shell Model by Silvia Lenzi, Frédéric Nowacki, Duc D. Dao)
- The calculations reproduce well the results
- Fo … ground an …

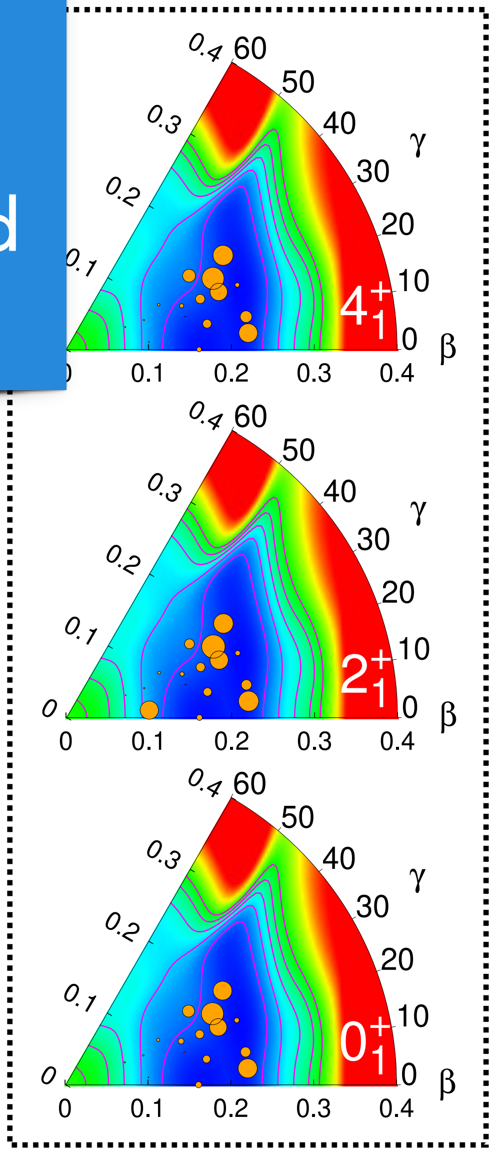
The 0_2^+ state is less deformed than the ground state

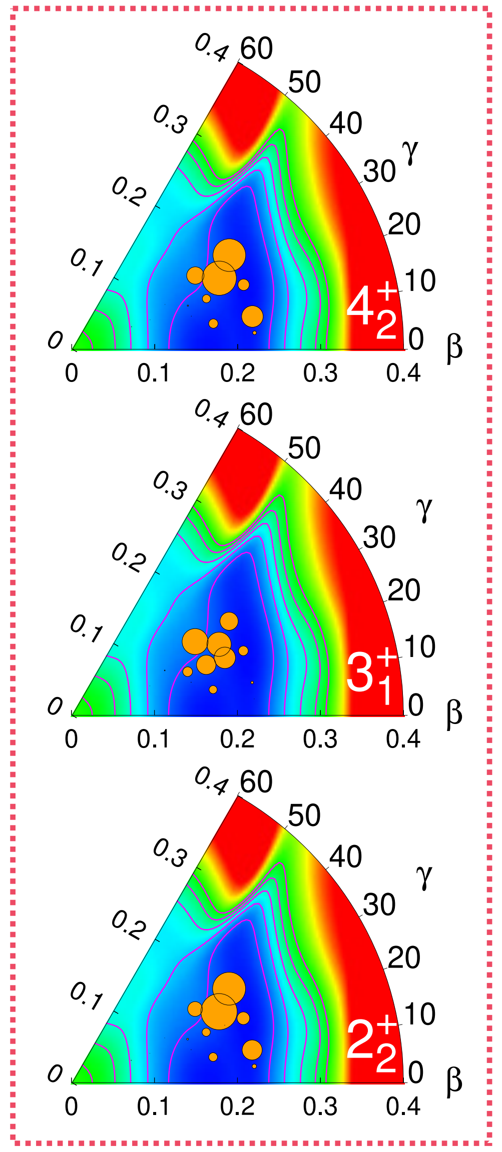
⬇

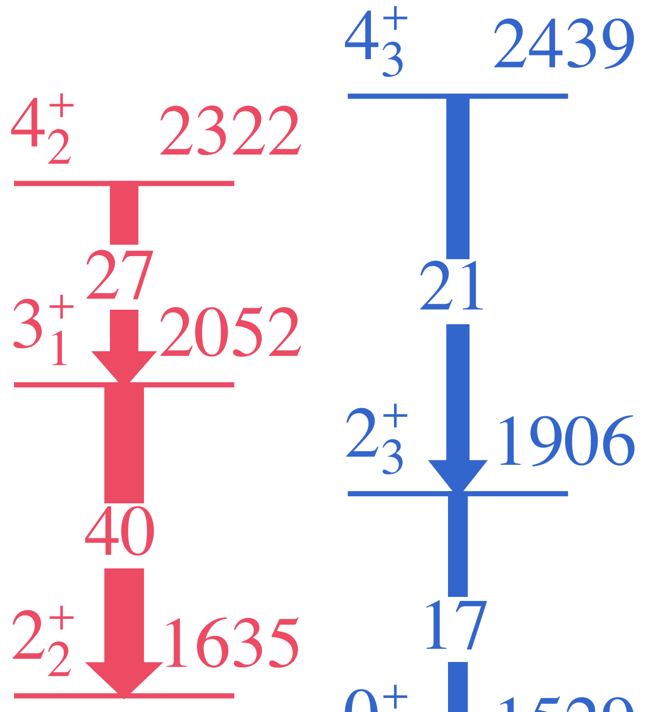
Typical behaviour of a nucleus in an Island of Inversion

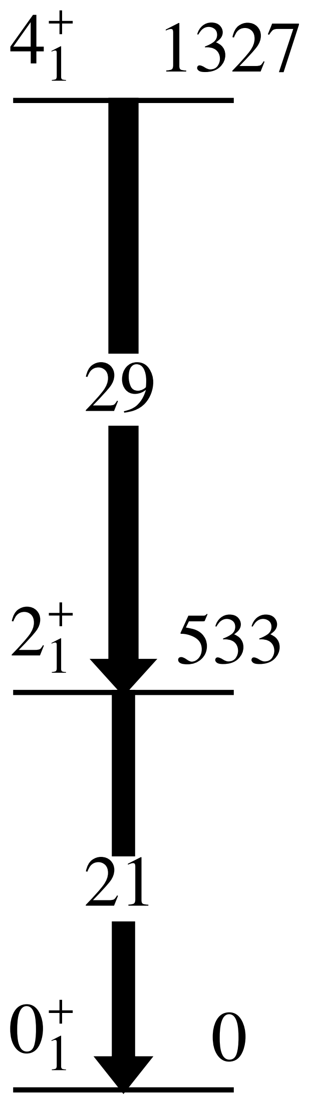


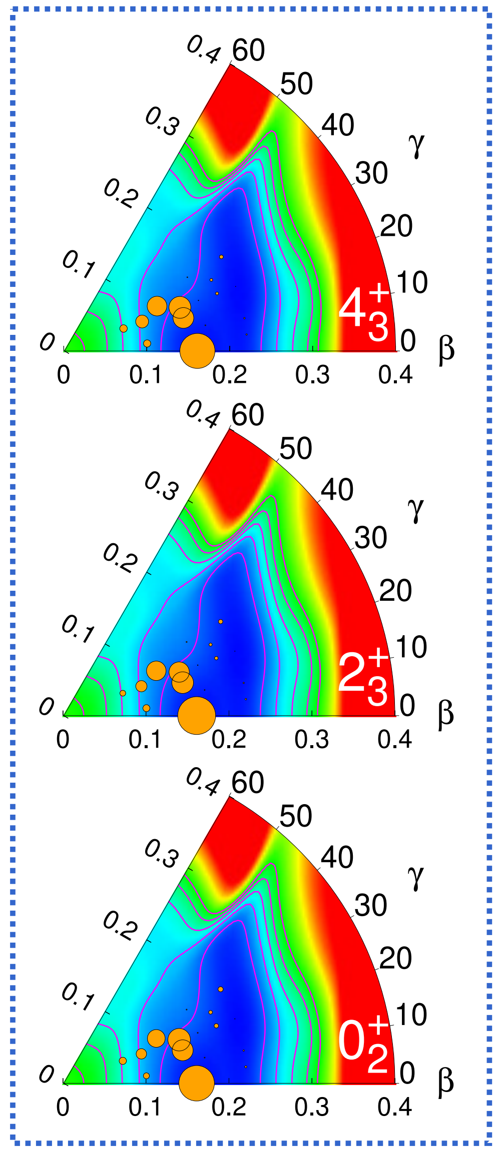


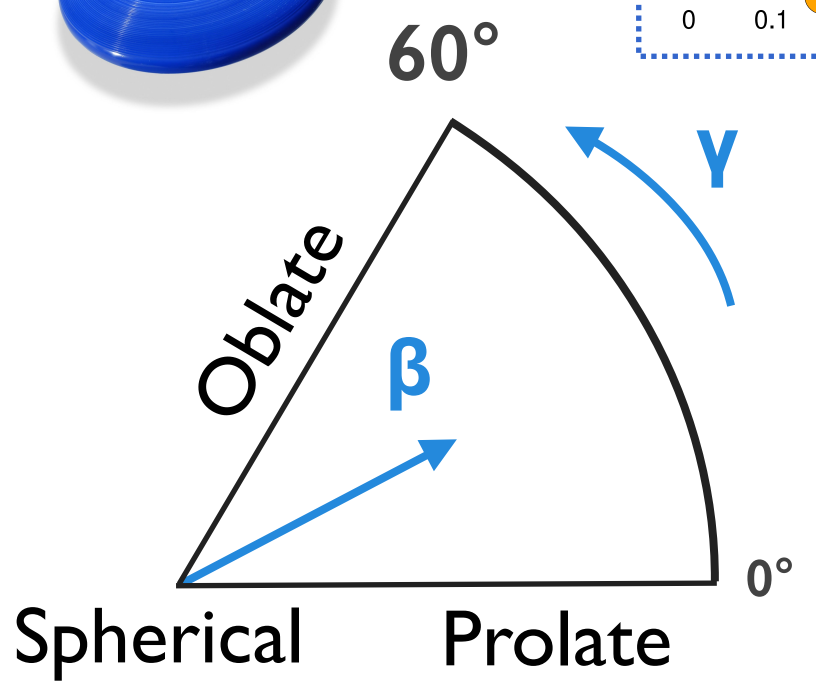












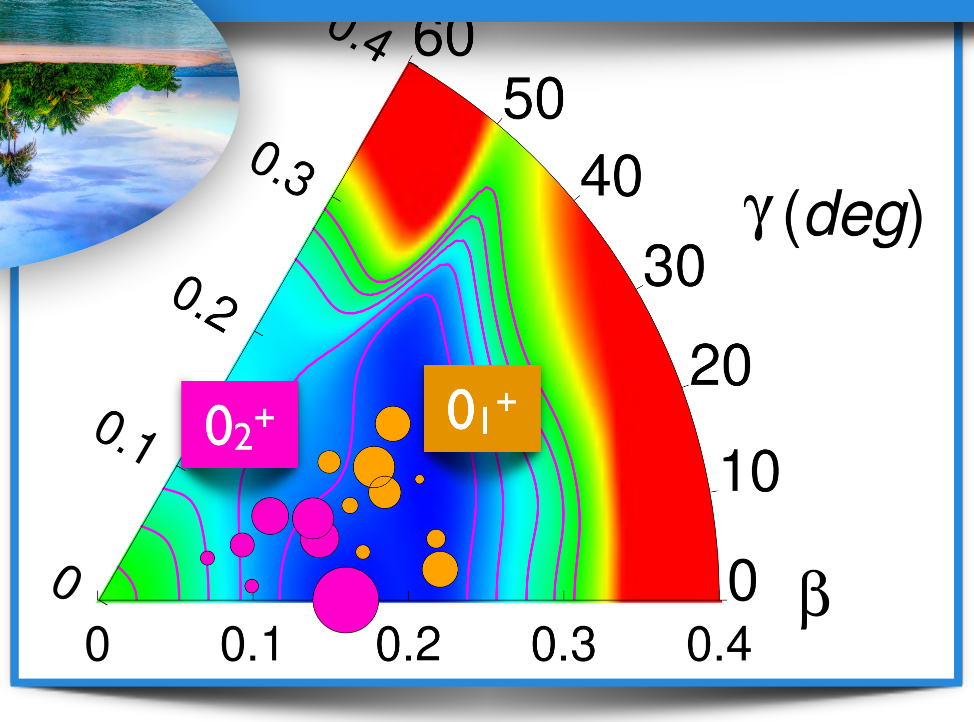
Calculated Shapes from Shell Model

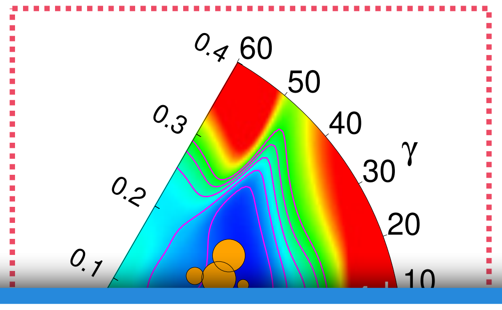
- The experimental results triggered new developments in state-of-the-art shell model calculations (LSSM, Large-Scale Shell Model by Silvia Lenzi, Frédéric Nowacki, D. D. Dao)
- The calculations reproduce well the results
- Fo… an… groun…

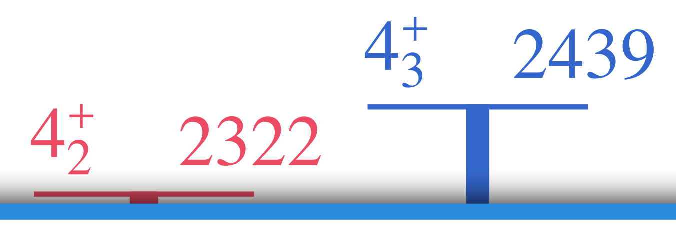
The 0_2^+ state is less deformed than the ground state

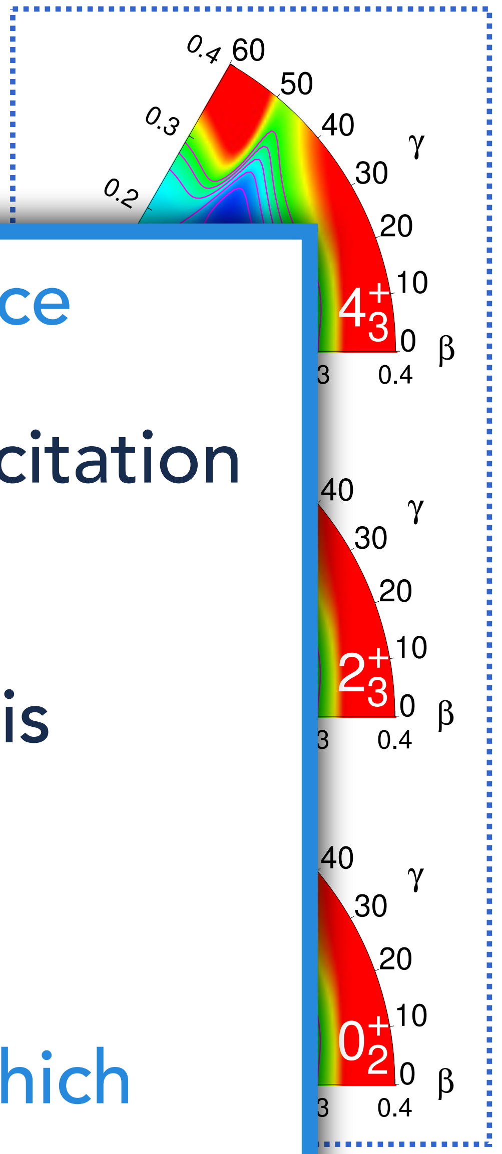
⬇

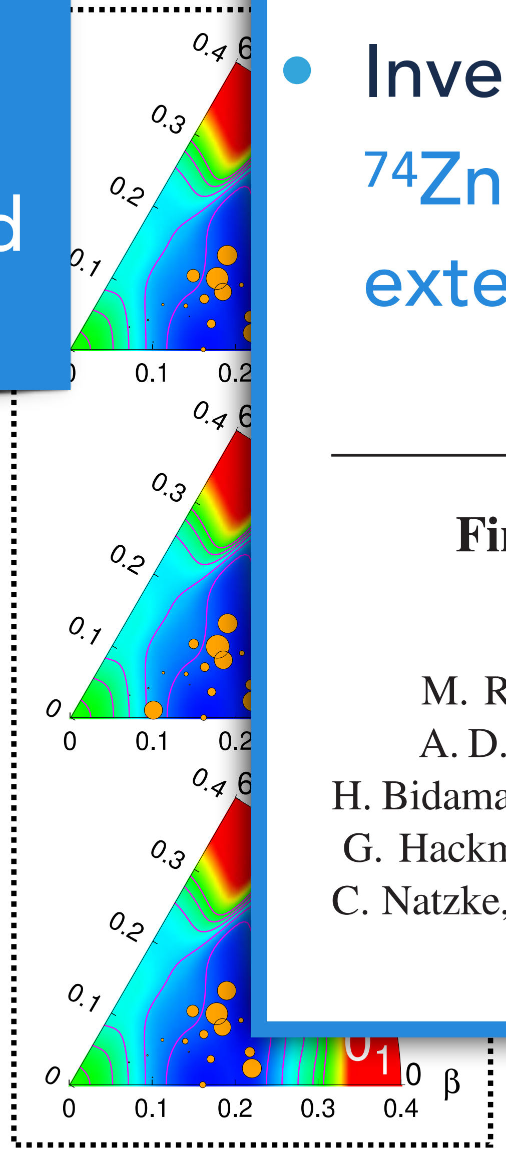
Typical behaviour of a nucleus in an Island of Inversion









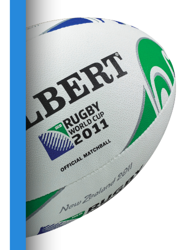


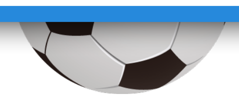
- Strong $2_3^+ \longrightarrow 0_2^+ \Longrightarrow$ Hint of Configuration Coexistence
- Strong $3_1^+ \longrightarrow 2_2^+ \Longrightarrow$ Hint of a quasi γ-band at low excitation energy and Triaxiality
- New Large-Scale Shell-Model calculations support this interpretation
- Inversion of "normal" and intruder configurations $\Longrightarrow$ ^{74}Zn seems to be in the N = 40 Island of Inversion, which extends further north in the chart of the nuclides

PHYSICAL REVIEW LETTERS 130, 122502 (2023)

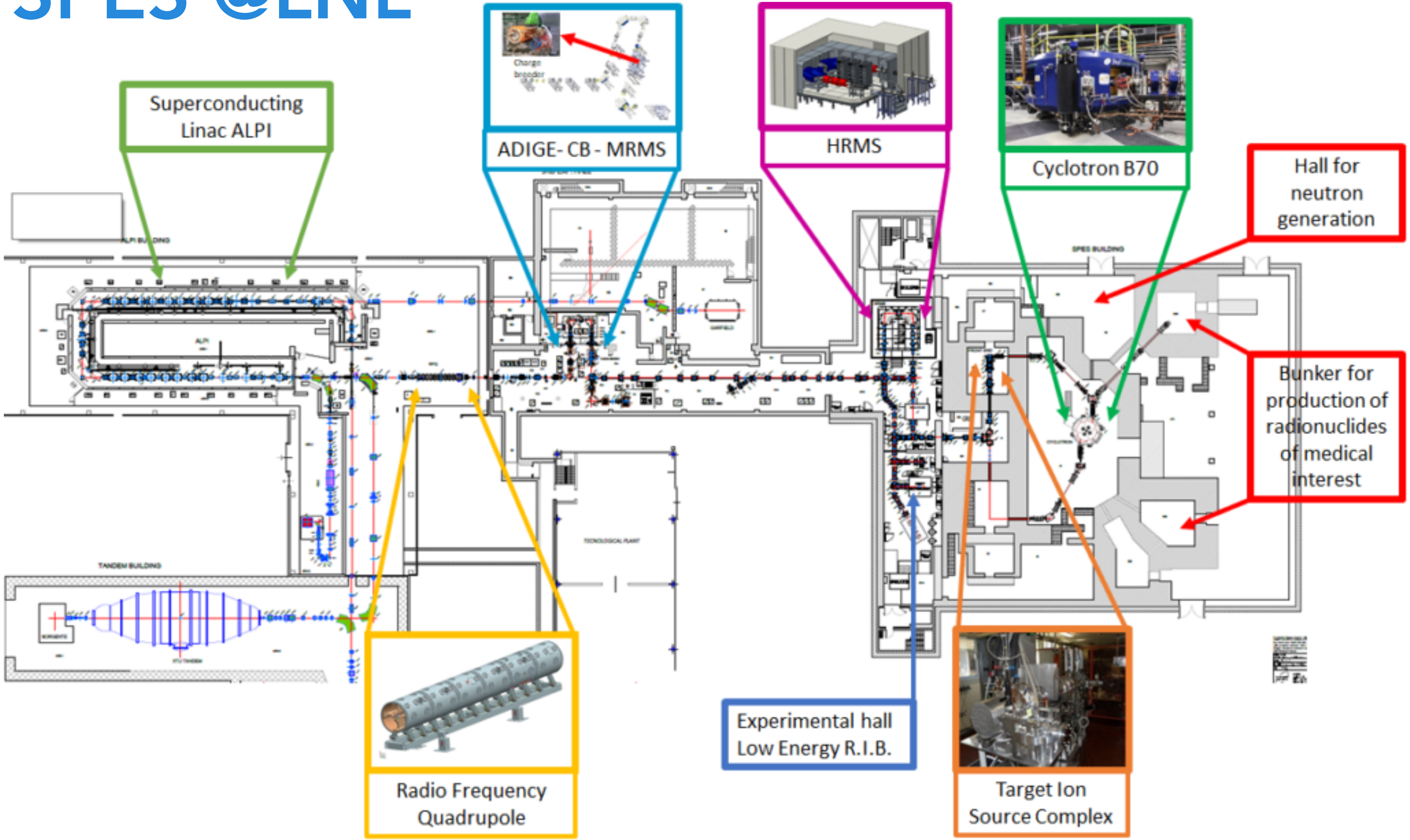
First Evidence of Axial Shape Asymmetry and Configuration Coexistence in ^{74}Zn: Suggestion for a Northern Extension of the $N = 40$ Island of Inversion

M. Rocchini[1,*] P. E. Garrett[1] M. Zielińska[2] S. M. Lenzi[3,4] D. D. Dao[5] F. Nowacki[5] V. Bildstein[1] A. D. MacLean[1] B. Olaizola[6,†] Z. T. Ahmed[1] C. Andreoiu[7] A. Babu[6] G. C. Ball[6] S. S. Bhattacharjee[6,‡] H. Bidaman[1] C. Cheng[6] R. Coleman[1] I. Dillmann[6,8] A. B. Garnsworthy[6] S. Gillespie[6] C. J. Griffin[6] G. F. Grinyer[9] G. Hackman[6] M. Hanley[10] A. Illana[11] S. Jones[12] A. T. Laffoley[1] K. G. Leach[10] R. S. Lubna[6,§] J. McAfee[6,13] C. Natzke[6,10] S. Pannu[1] C. Paxman[6,13] C. Porzio[6,14,15,∥] A. J. Radich[1] M. M. Rajabali[16] F. Sarazin[10] K. Schwarz[6] S. Shadrick[10] S. Sharma[9] J. Suh[9] C. E. Svensson[1] D. Yates[6,17] and T. Zidar[1]

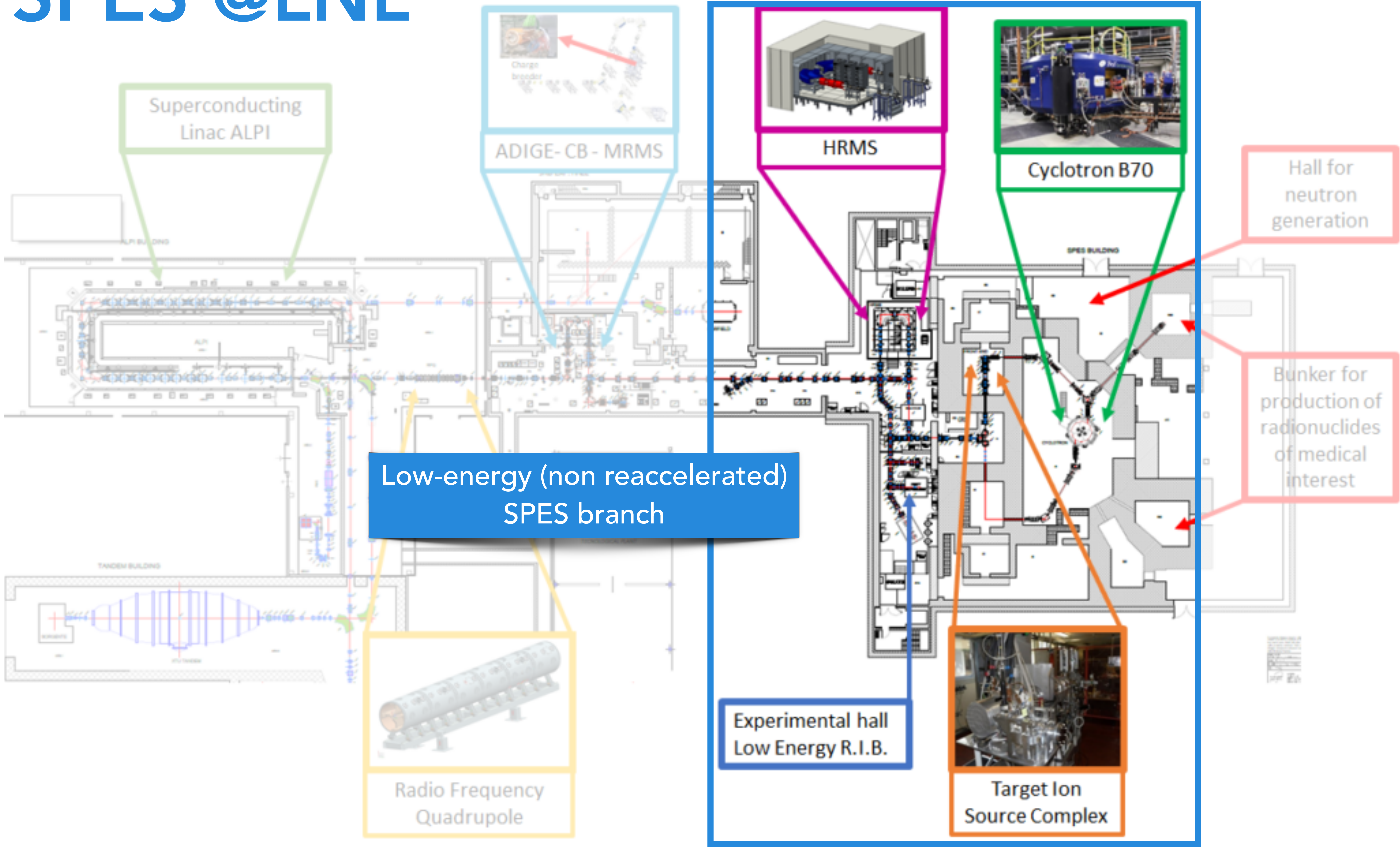




SPES @LNL

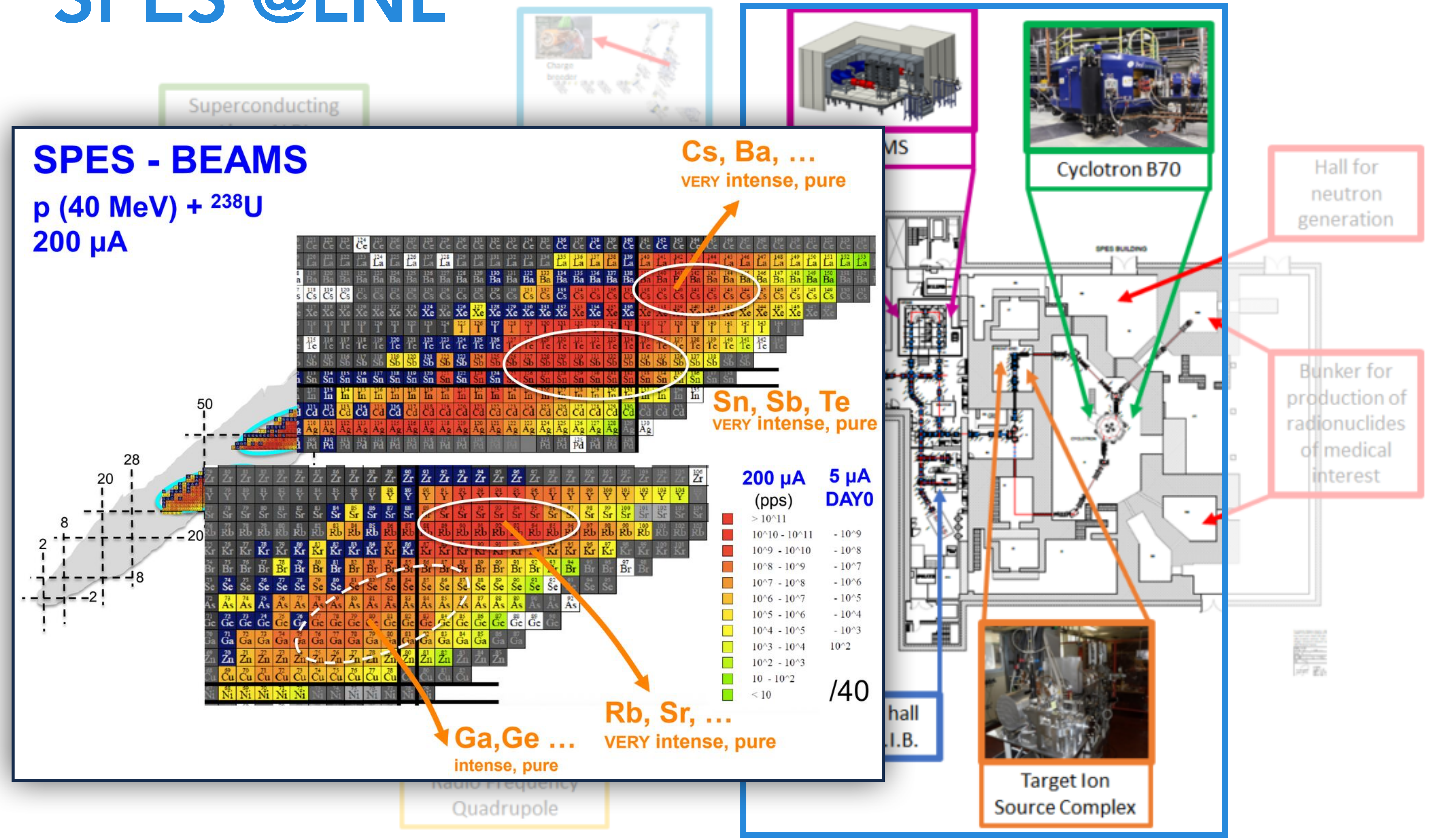

Superconducting Linac ALPI
ADIGE- CB - MRMS
HRMS
Cyclotron B70
Hall for neutron generation
Bunker for production of radionuclides of medical interest
Radio Frequency Quadrupole
Experimental hall Low Energy R.I.B.
Target Ion Source Complex

SPES @LNL

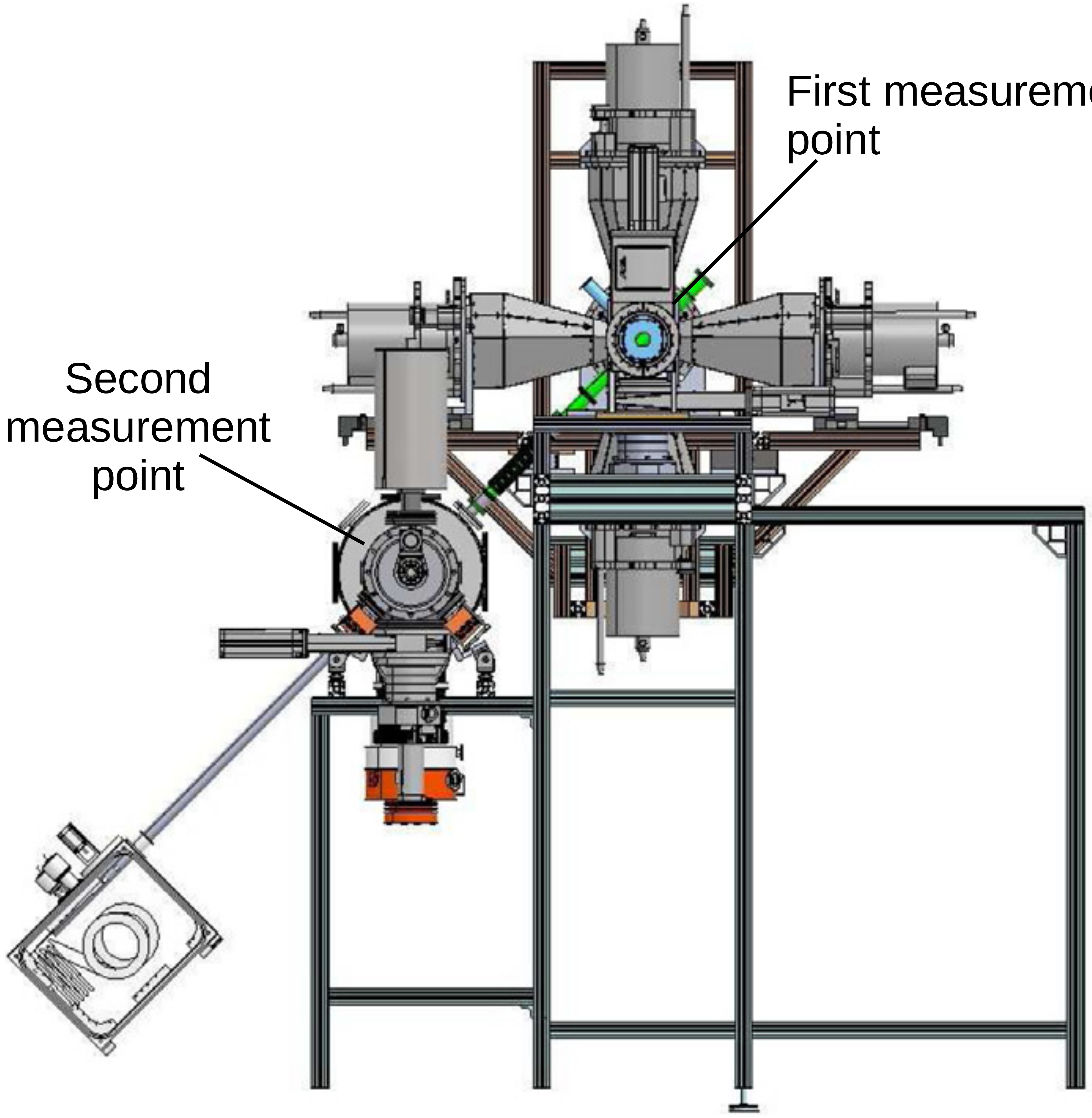


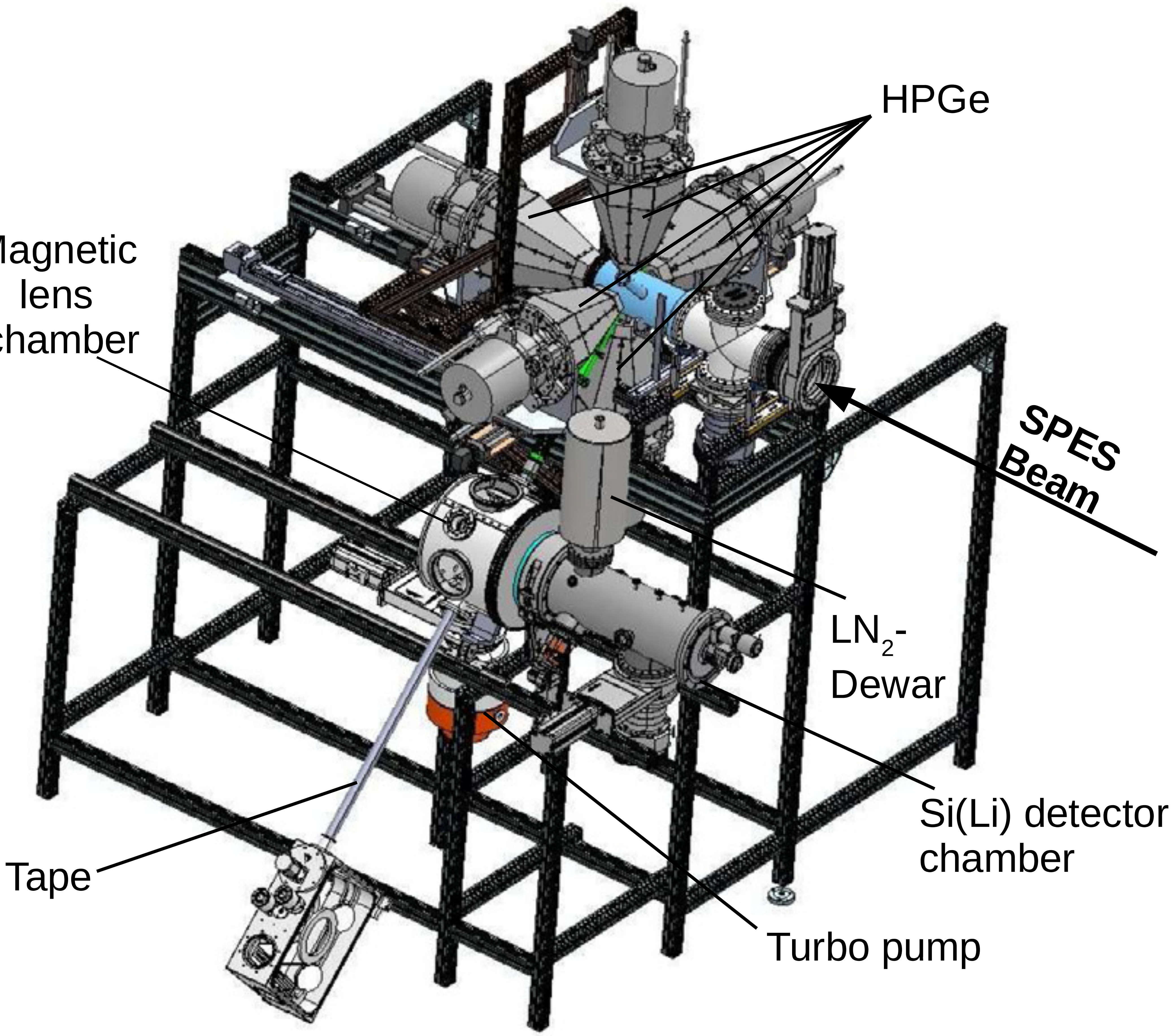
Superconducting Linac ALPI
ADIGE- CB - MRMS
HRMS
Cyclotron B70
Hall for neutron generation
Bunker for production of radionuclides of medical interest
Low-energy (non reaccelerated) SPES branch
Experimental hall Low Energy R.I.B.
Target Ion Source Complex
Radio Frequency Quadrupole

SPES @LNL

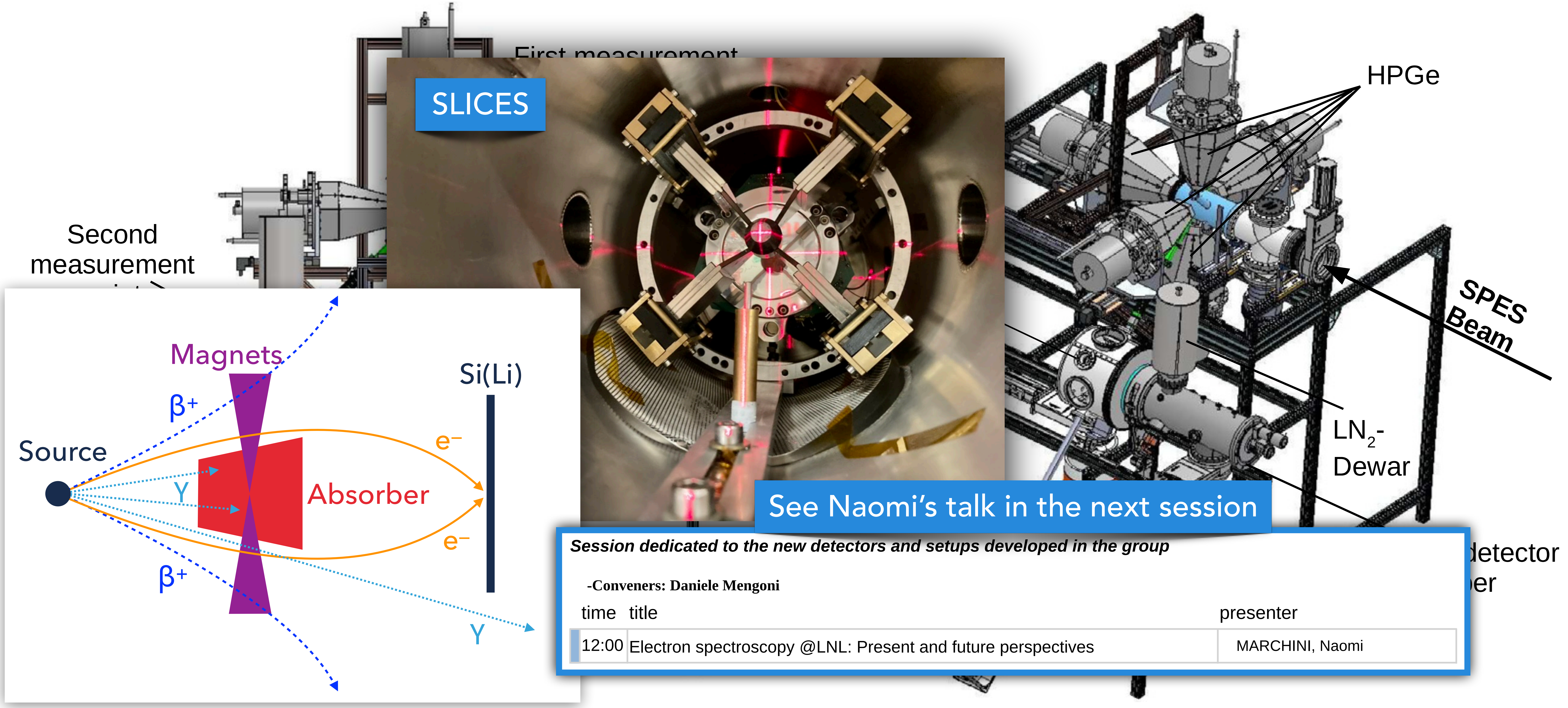

SPES - BEAMS
p (40 MeV) + 238U
200 µA
Cs, Ba, …
VERY intense, pure
Sn, Sb, Te
VERY intense, pure
Rb, Sr, …
VERY intense, pure
Ga,Ge …
intense, pure
200 µA
(pps)
5 µA
DAY0
/40
50
28
20
8
2
Cyclotron B70
Hall for neutron generation
Bunker for production of radionuclides of medical interest
Target Ion Source Complex
Superconducting
Quadrupole
hall

β-Decay Station @ SPES





β-Decay Station @ SPES



Session dedicated to the new detectors and setups developed in the group

-Conveners: Daniele Mengoni

time	title	presenter
12:00	Electron spectroscopy @LNL: Present and future perspectives	MARCHINI, Naomi

N. Marchini, A. Nannini at al., Nuclear Inst. and Methods in Physics Research, A 1020 (2021) 165860

Marco Rocchini
INFN - Istituto Nazionale di Fisica Nucleare
FIRENZE DIVISION

Thank you for the attention

GOSIA

Next GOSIA school in Florence (tentatively scheduled at the end of January 2025)