TRIUMF

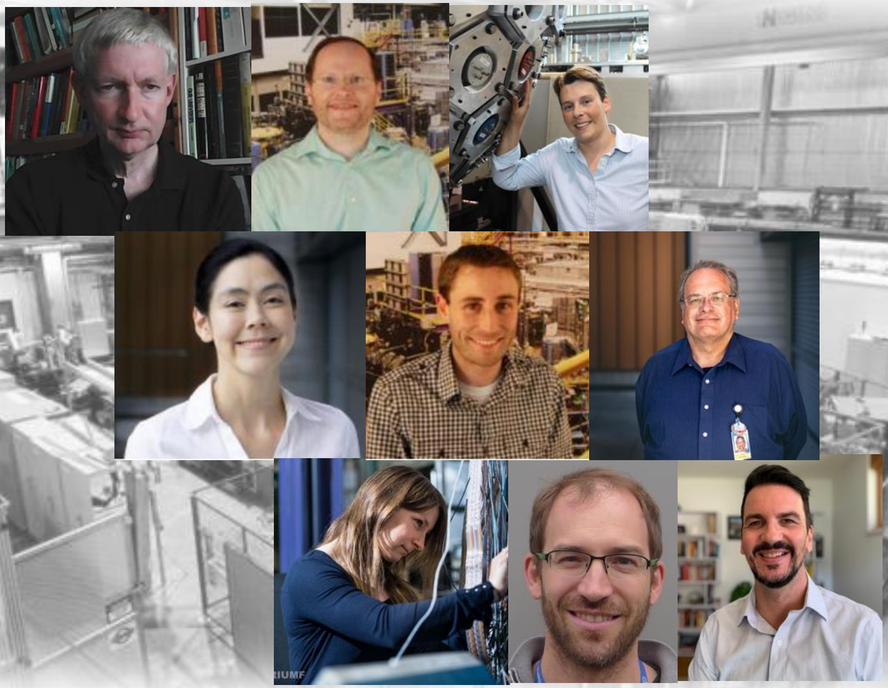
ARIEL Experiments Overview

Adam Garnsworthy (he/him)
TRIUMF Senior Scientist
ARIEL Principal Scientist

ARIEL Science workshop 2026

Discovery, accelerated

Nuclear Physics Department



Left to right:
J. Behr, B. Davids, I. Dillmann,
A. Kwiatkowski, A. Garnsworthy, G. Hackman,
A. Lennarz, S. Malbrunot-Ettenauer, C. Ruiz (Department Head)

Operate:
- Facility Coordinators and system experts of experimental equipment in ISAC
- Secure operational funding for experimental equipment (NSERC)

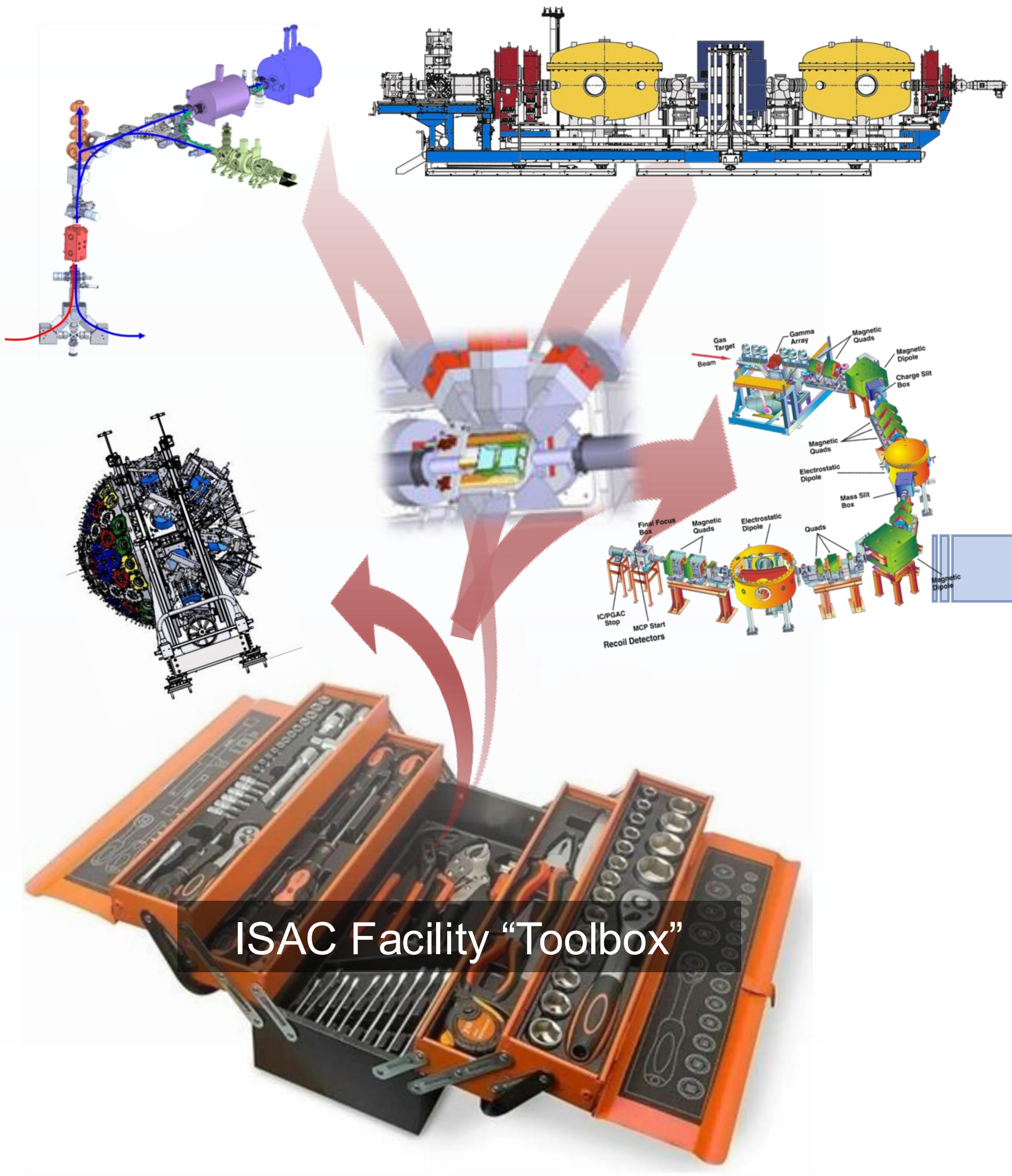
Supervise:
- 10-25 postdocs
- 20-30 grad students
- 20-30 undergraduate students

Host:
- Hundreds of scientific visitors per year

ARIEL Experiments Operations Department

- Martin Alcorta, Department Head
- 3 Expert Technicians: Shaun Georges, Mel Good, Peter Machule
- Operations specialist: Mahdiar Khosravi
- Support existing facilities, new installations and visiting detectors

The ISAC experimental toolkit



Nuclear ground state & decay properties via decay spectroscopy

Charged-particle-induced reaction cross section measurement

Decay spectroscopy of reaction-induced excited states in exotic systems

Ground state mass measurement

Precise decay spectral shapes

Preparation & measurement of quantum states via lasers / traps

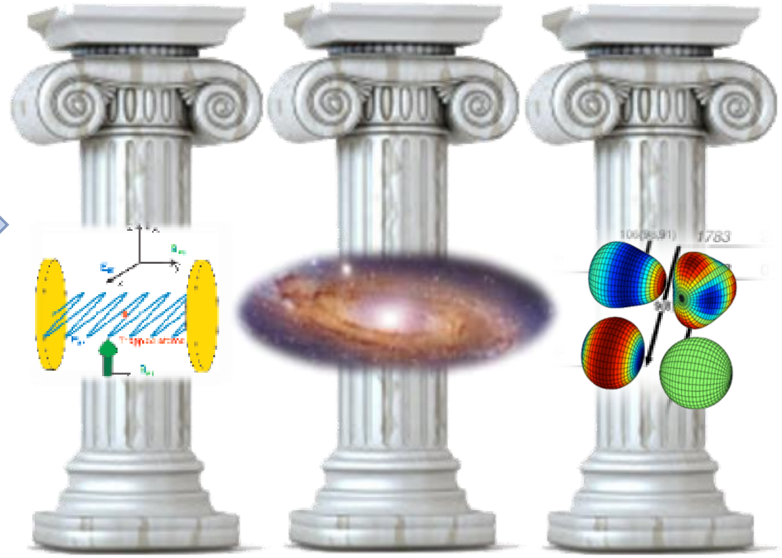
Neutron-induced reaction cross section measurement

Radioactive molecule production

Precise Tests of Fundamental Interactions

Nuclear Astrophysics

Nuclear Structure



Research Themes

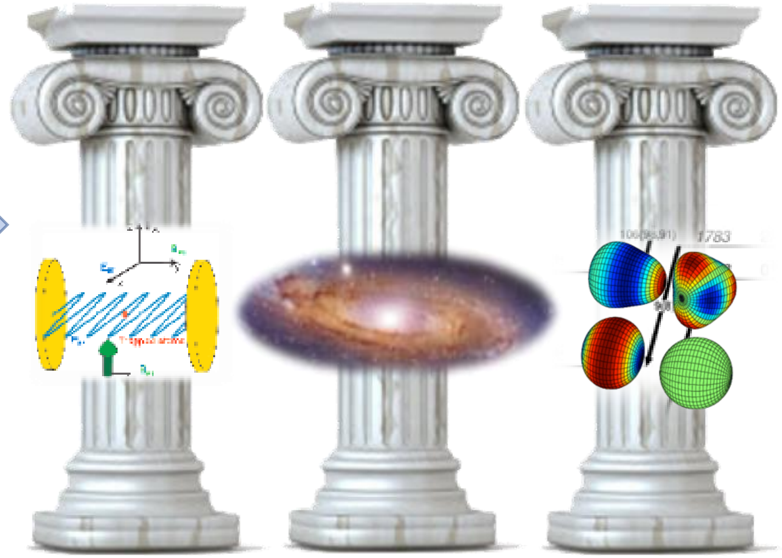
TRINAT	Precise, kinematically-complete measurements of beta-decay and associated parameters. Sensitive to time-reversal symmetry violation.
TITAN	Multi-instrument ion trap facility for masses & decay spectroscopy: MRTOF, MPET, EBIT: precision or coverage
FRANCIUM	Laser prepared Francium atoms probed towards Atomic Parity Violating signal
GRIFFIN / DESCANT	Decay spectrometer for gammas, betas, conversion electrons, neutrons
Polarizer / Laser-spec	Collinear laser spectroscopy for charge radii and nuclear moments. production of spin polarized isotopes for beta decay asymmetry experiments
DRAGON	Direct measurement of radiative proton & alpha capture reactions on exotic or stable isotopes
SONIK	Elastic scattering of radioactive nuclei → low energy scattering phase shifts
TUDA	Versatile direct & indirect charged particle reaction facility based around silicon arrays
DSL	Doppler-shift lifetimes facility for determination of excited state lifetimes
IRIS	Solid hydrogen or deuterium target scattering facility using CsI & Silicon arrays → extracting structure information from reactions using weak exotic beams
TIGRESS	In-Flight Gamma-Ray Spectroscopy following reactions induced on accelerated beams
EMMA	Recoil Spectrometer for detection & analysis of exotic reaction residues

- Nuclear ground state & decay properties via decay spectroscopy
- Charged-particle-induced reaction cross section measurement
- Decay spectroscopy of reaction-induced excited states in exotic systems
- Ground state mass measurement
- Precise decay spectral shapes
- Preparation & measurement of quantum states via lasers / traps
- Neutron-induced reaction cross section measurement
- Radioactive molecule production

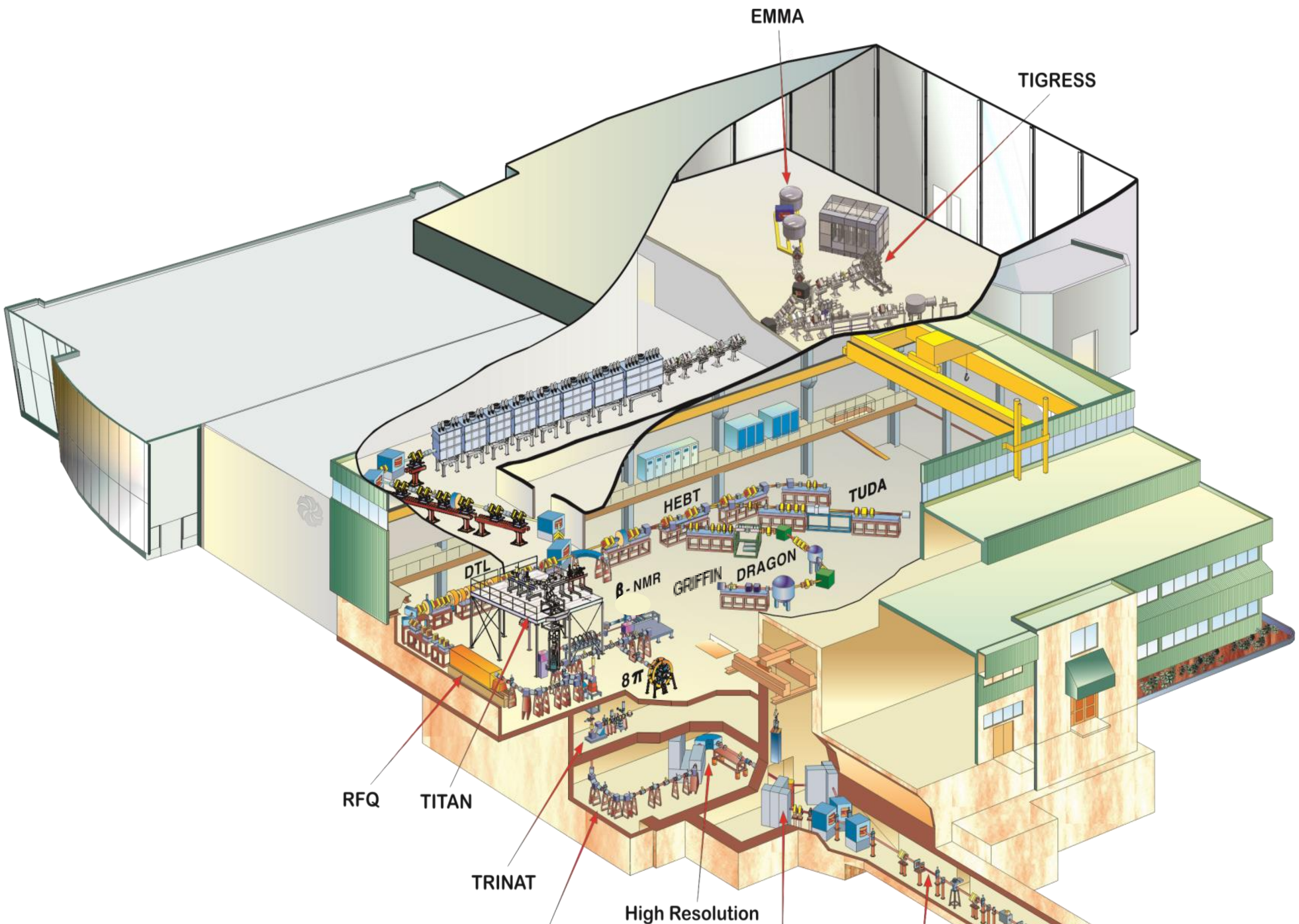
Precise Tests of Fundamental Interactions

Nuclear Astrophysics

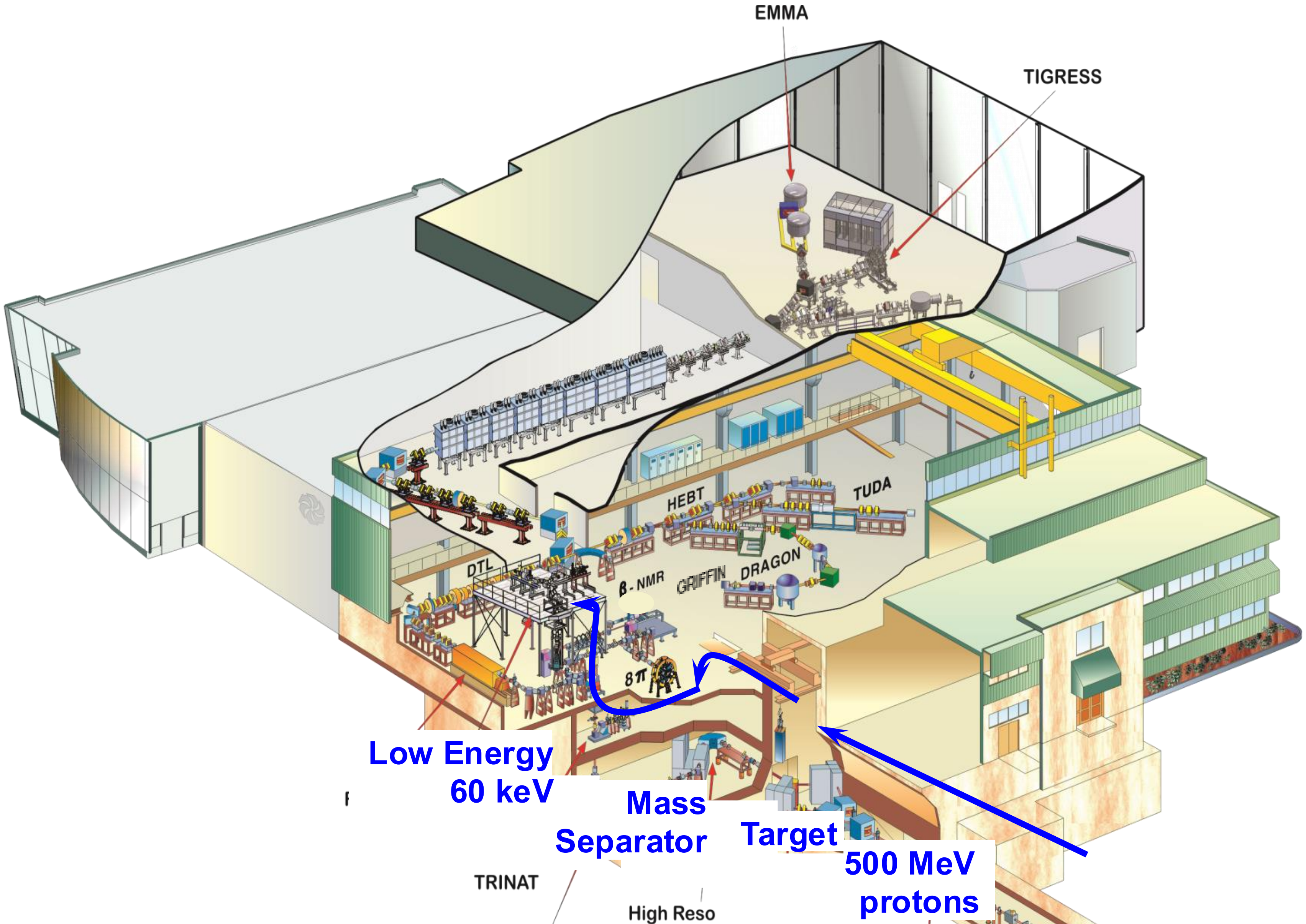
Nuclear Structure



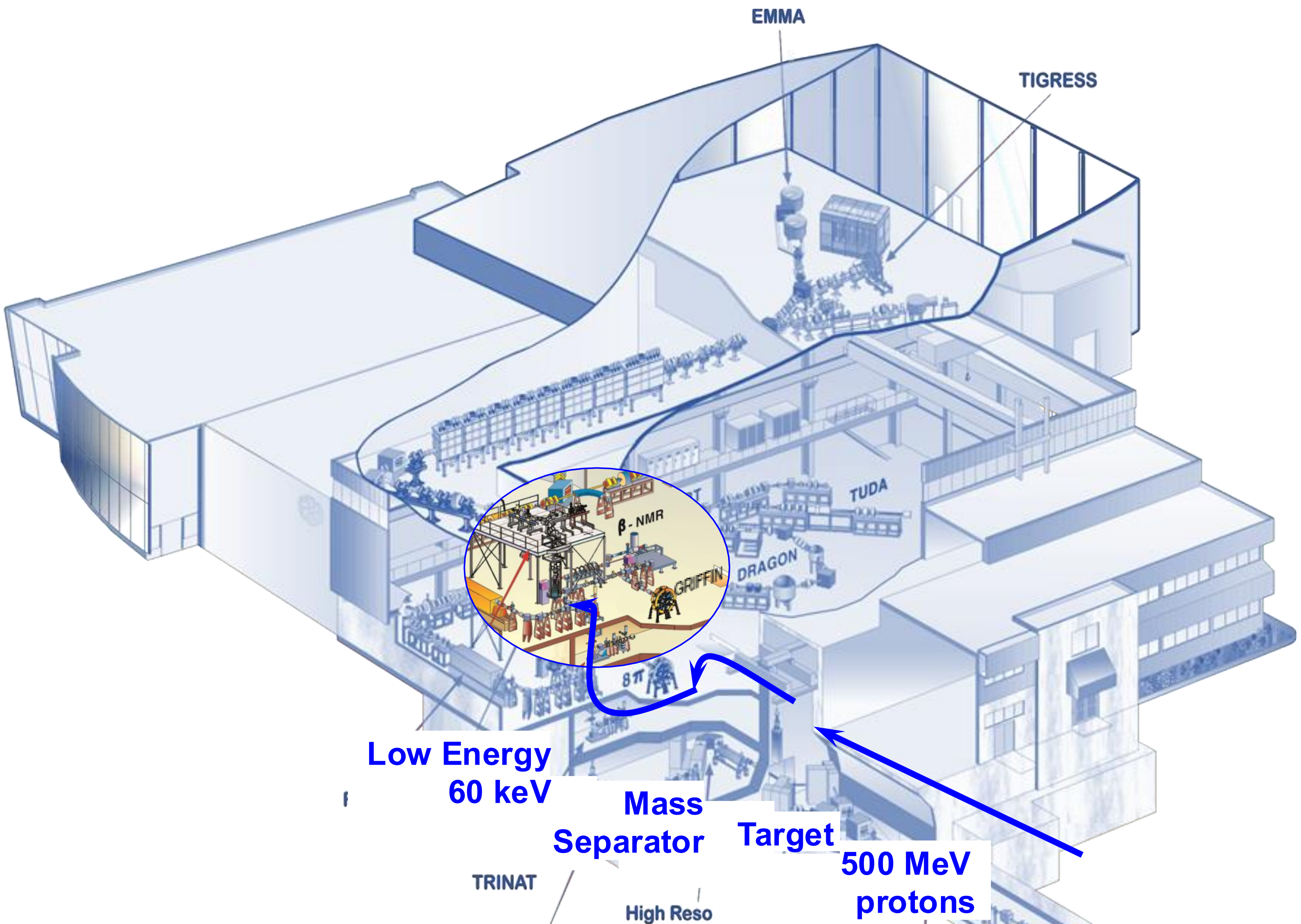
ISAC-TRIUMF ISOL facility for rare isotope beams



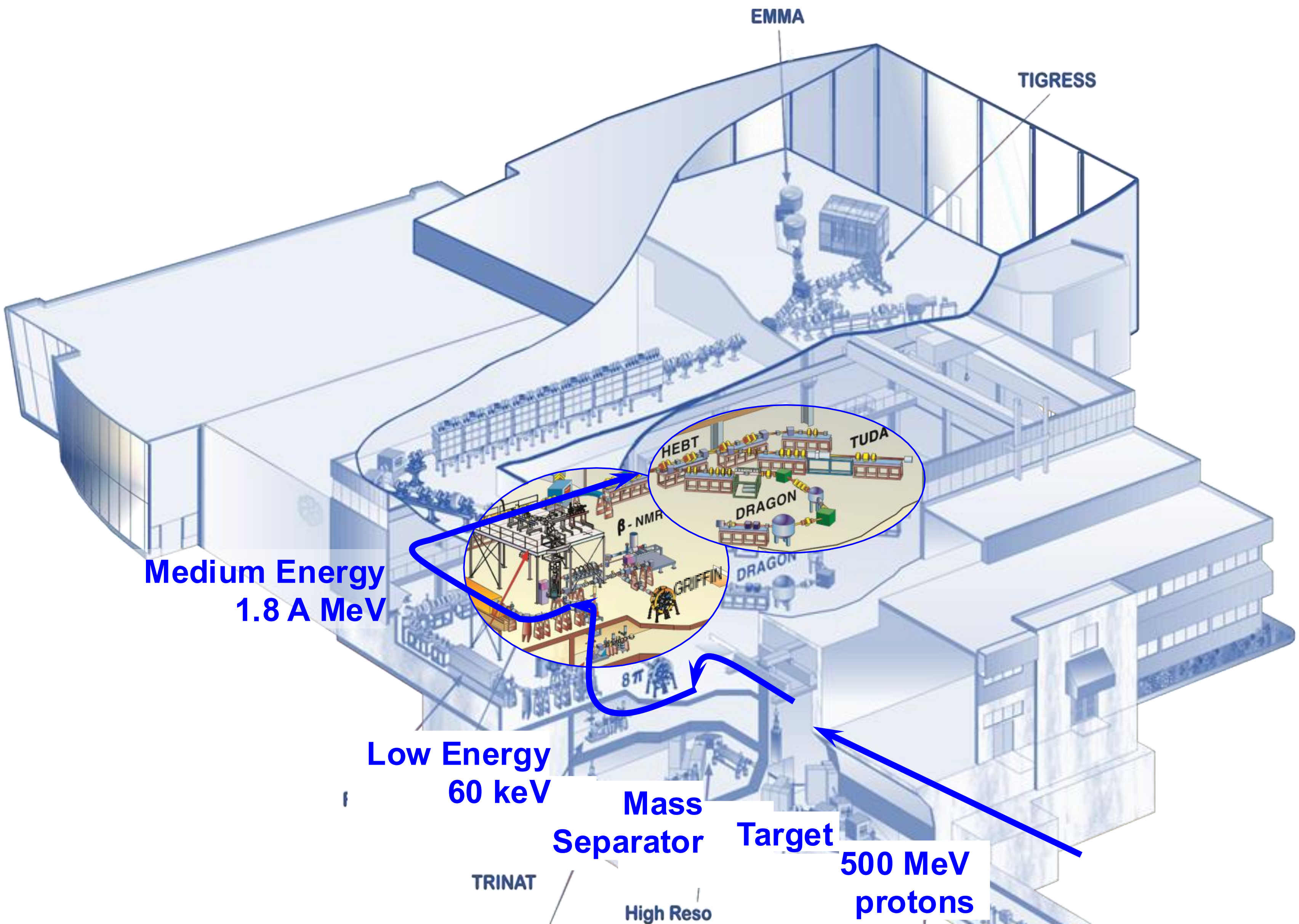
ISAC-TRIUMF ISOL facility for rare isotope beams



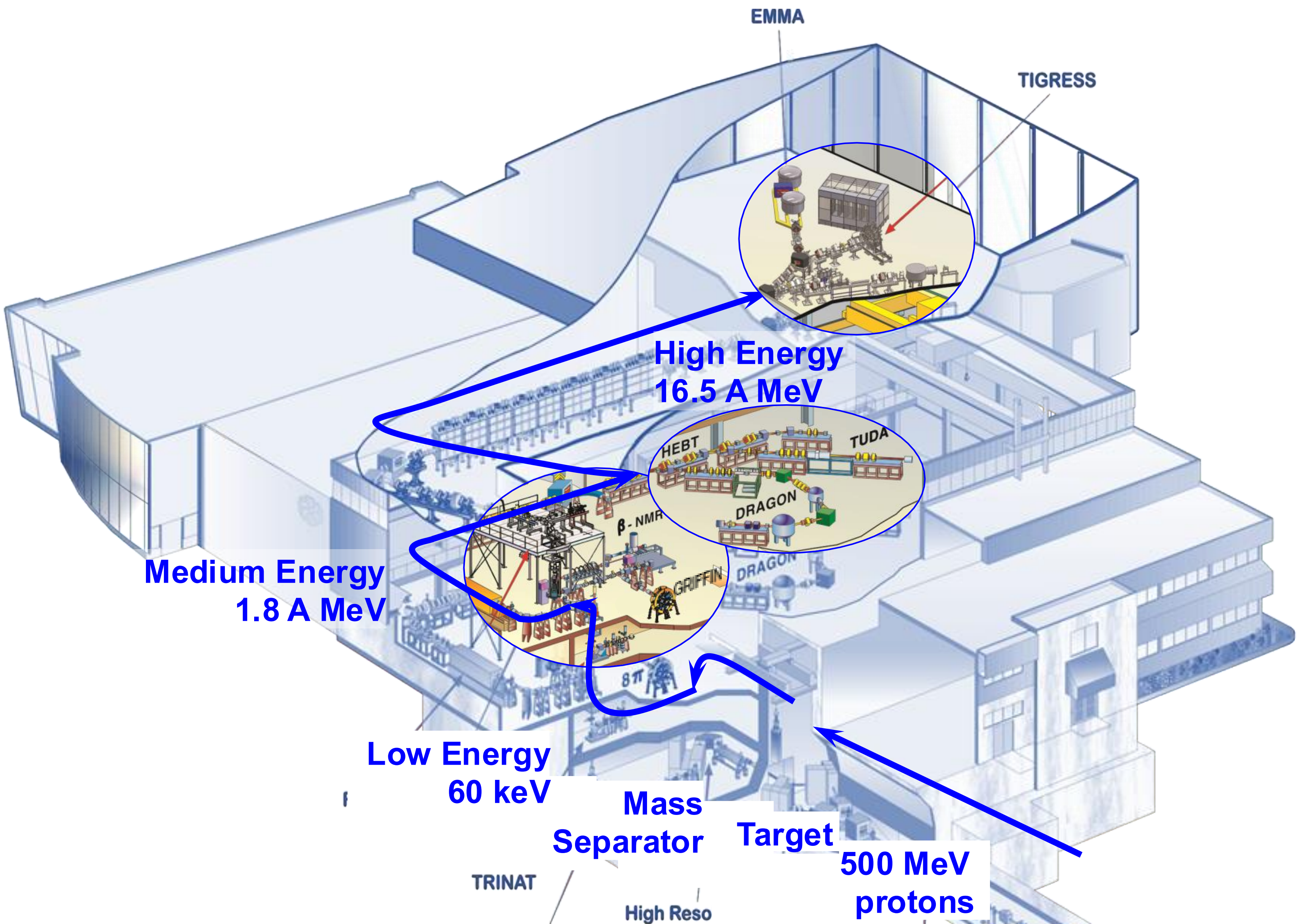
ISAC-TRIUMF ISOL facility for rare isotope beams



ISAC-TRIUMF ISOL facility for rare isotope beams



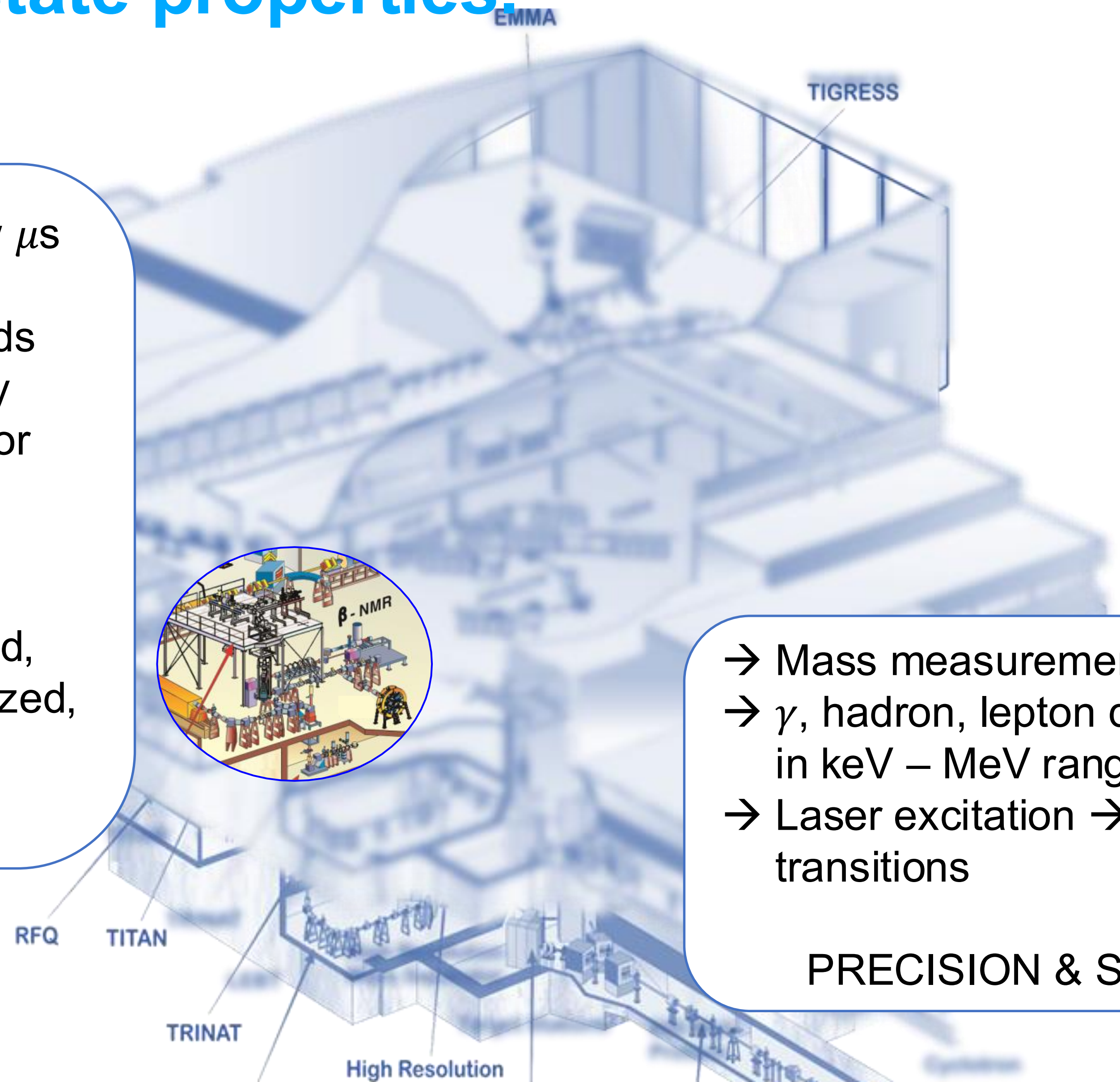
ISAC-TRIUMF ISOL facility for rare isotope beams



Low-energy RIB experiments (≤60 keV) access ground-state properties.

- Slow beams travelling for few μs per meter
→ Stop after nanometers in solids
→ Decelerate to a stop relatively easily with modest DC fields or using gas RFQ

- **Stopped Beams** that can be manipulated, shunted, trapped, re-ionized, neutralized, polarized, allowed to decay



→ Mass measurements
→ γ, hadron, lepton decay products in keV – MeV range
→ Laser excitation → atomic transitions

PRECISION & SENSITIVITY

Medium-energy RIB experiments:
tuned for astrophysics (0.15-1.8 A MeV)

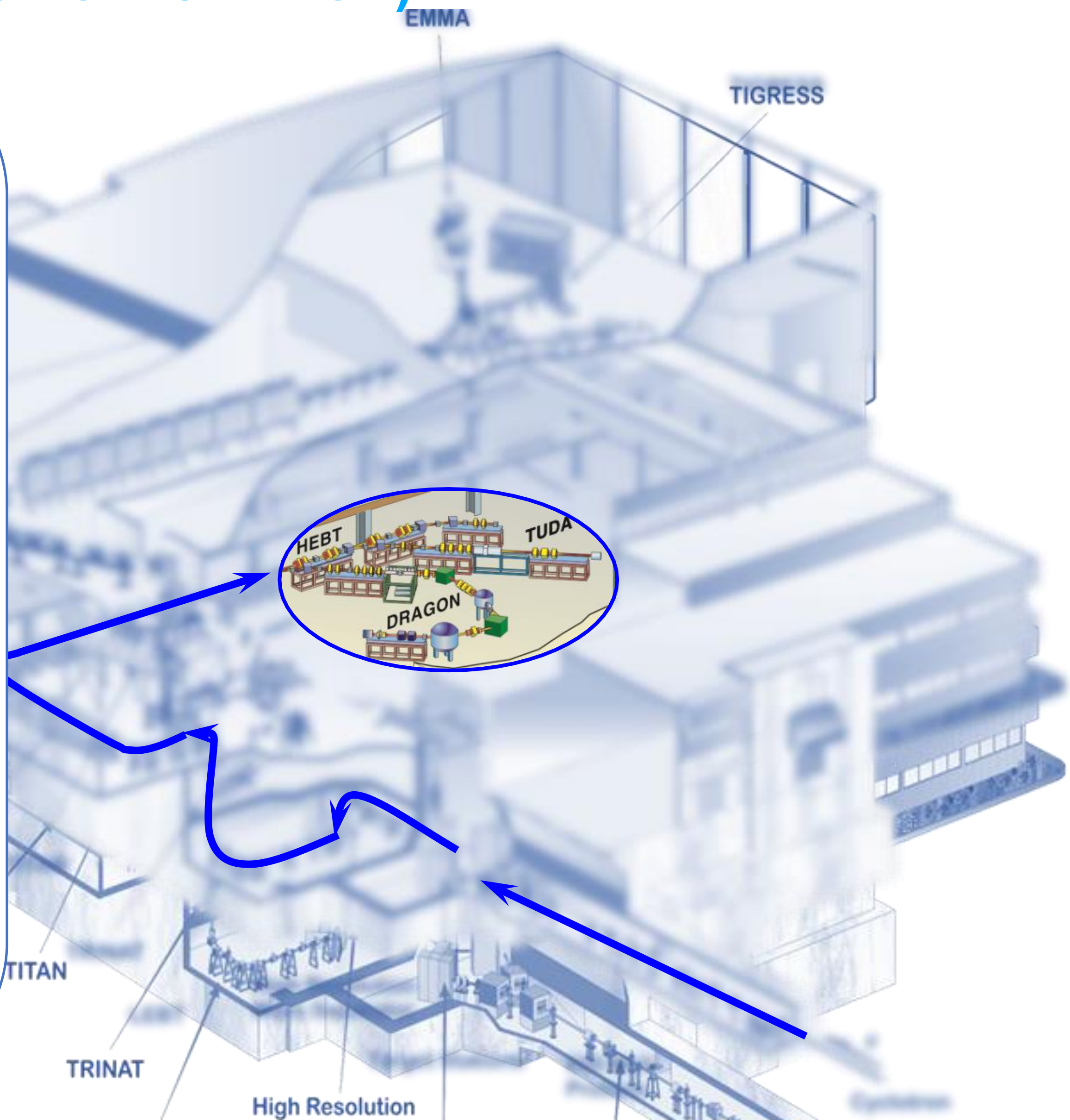
v=0.01*c* beams

→ Sub Coulomb Barrier fusion reactions
Compound Nucleus and Direct mechanisms
Nuclear Resonances

Tuned to stellar energies for range of scenarios, from AGB stars to X-ray bursters to supernovae
+ tests of *ab initio* via scattering

→ Largest beam intensities needed

PIONEERING DIRECT and INDIRECT MEASUREMENTS

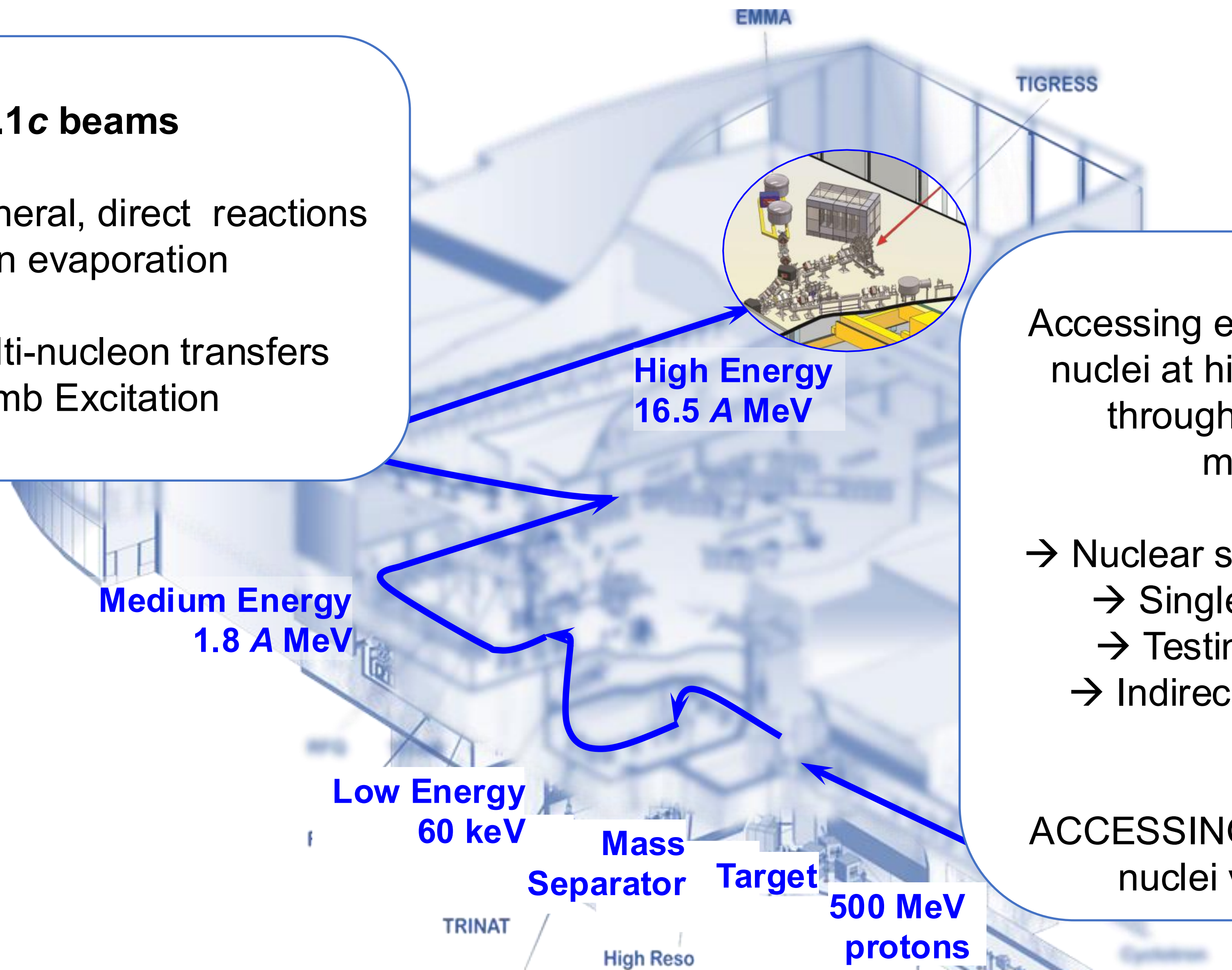


High-energy RIB Experiments (10-16.5 A MeV)

v=0.1c beams

→ Highly peripheral, direct reactions
+ fusion evaporation

Single or multi-nucleon transfers
Coulomb Excitation



Accessing excited states of exotic nuclei at higher energies, spins through specific reaction mechanisms.

→ Nuclear shapes & deformations
→ Single particle structure
→ Testing nuclear models
→ Indirect measurements for astrophysics

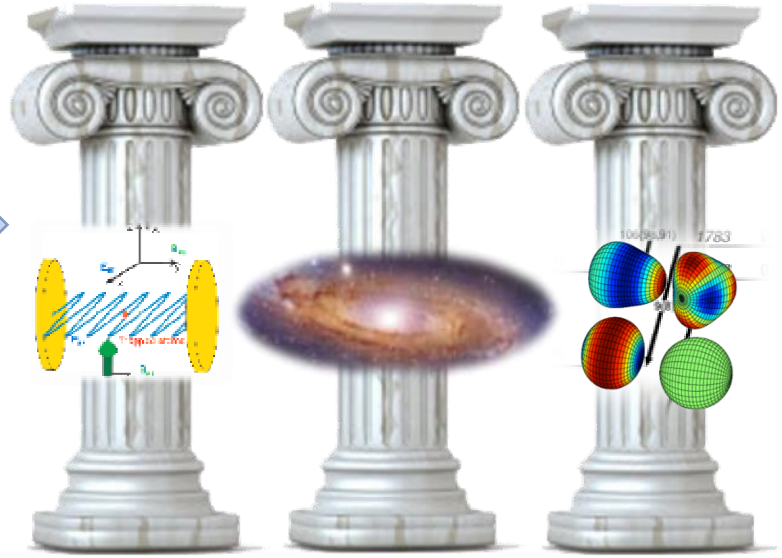
ACCESSING properties of exotic nuclei via *REACTIONS*

Research Themes

TRINAT	Precise, kinematically-complete measurements of beta-decay and associated parameters. Sensitive to time-reversal symmetry violation.
TITAN	Multi-instrument ion trap facility for masses & decay spectroscopy: MRTOF, MPET, EBIT: precision or coverage
FRANCIUM	Laser prepared Francium atoms probed towards Atomic Parity Violating signal
GRIFFIN / DESCANT	Decay spectrometer for gammas, betas, conversion electrons, neutrons
Polarizer / Laser-spec	Collinear laser spectroscopy for charge radii and nuclear moments. production of spin polarized isotopes for beta decay asymmetry experiments
DRAGON	Direct measurement of radiative proton & alpha capture reactions on exotic or stable isotopes
SONIK	Elastic scattering of radioactive nuclei → low energy scattering phase shifts
TUDA	Versatile direct & indirect charged particle reaction facility based around silicon arrays
DSL	Doppler-shift lifetimes facility for determination of excited state lifetimes
IRIS	Solid hydrogen or deuterium target scattering facility using CsI & Silicon arrays → extracting structure information from reactions using weak exotic beams
TIGRESS	In-Flight Gamma-Ray Spectroscopy following reactions induced on accelerated beams
EMMA	Recoil Spectrometer for detection & analysis of exotic reaction residues

- Nuclear ground state & decay properties via decay spectroscopy
- Charged-particle-induced reaction cross section measurement
- Decay spectroscopy of reaction-induced excited states in exotic systems
- Ground state mass measurement
- Precise decay spectral shapes
- Preparation & measurement of quantum states via lasers / traps
- Neutron-induced reaction cross section measurement
- Radioactive molecule production

Precise Tests of Fundamental Interactions | Nuclear Astrophysics | Nuclear Structure

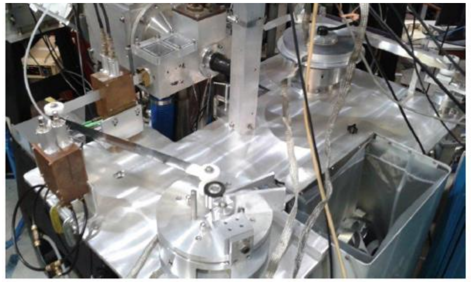


Precise Tests of Fundamental Interactions

GRIFFIN

Gamma & Electron spectrometer

(decay spectroscopy, superallowed decays)

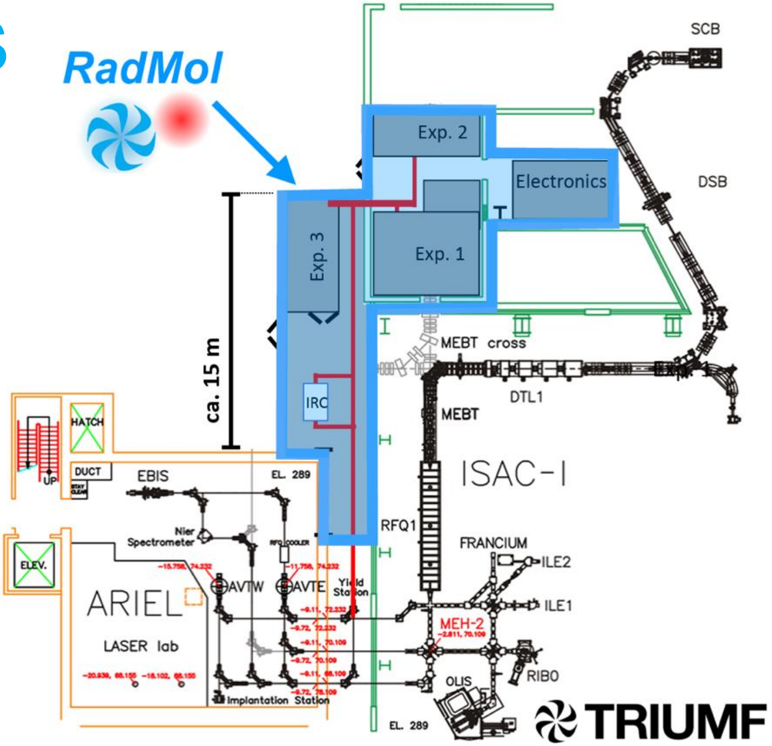


4π gas counter

(precision half lives of superallowed decays)

Radioactive Molecules

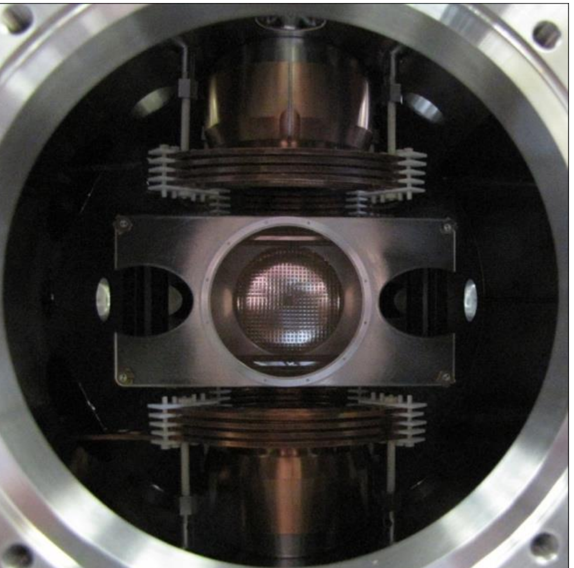
(Schiff moment, EDM, Cp)

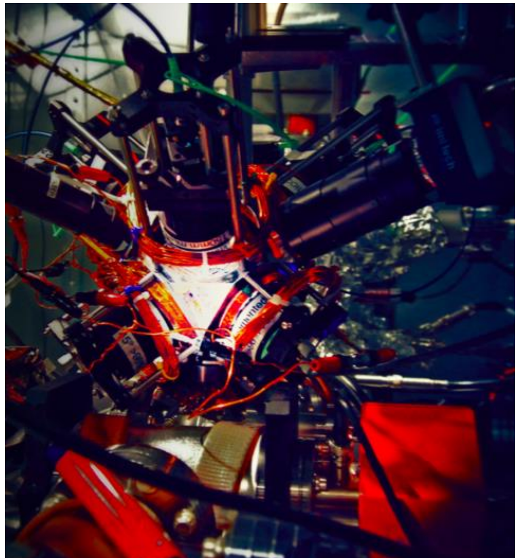


TRINAT

Neutral Atom Trap

(βν-neutrino correlations)





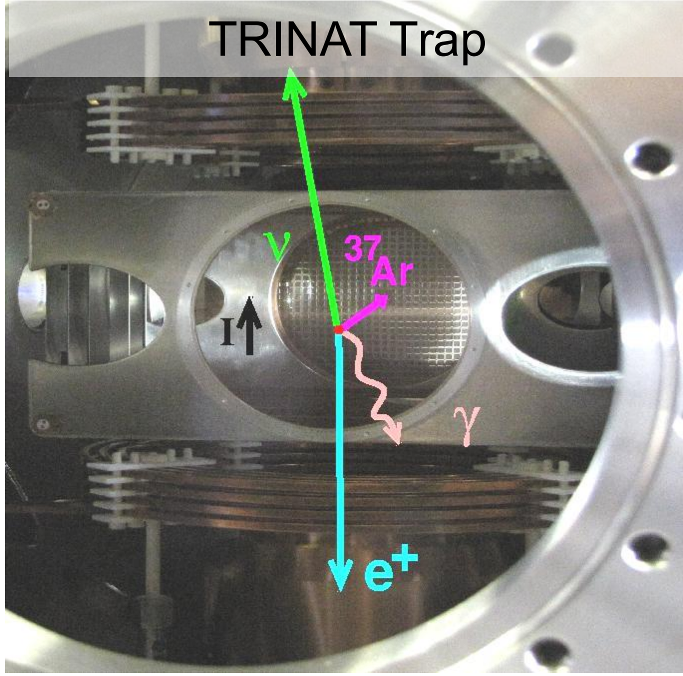
FRANCIUM MOT

(PNC, anapole moment)

Precision measurements with Atom Traps

TRINAT: TRIUMF neutral atom trap for β decay

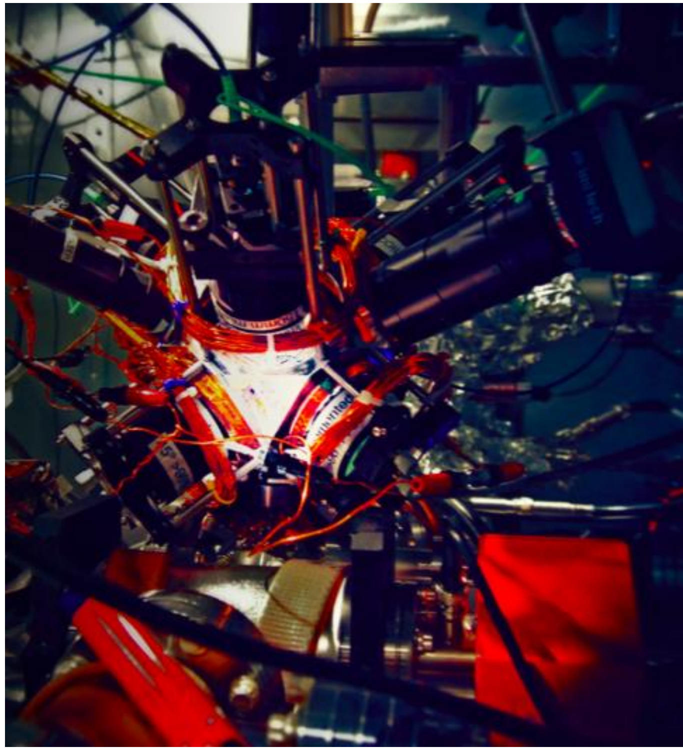
- Traps K, Rb isotopes with 10^{-3} efficiency, Spin-polarized 99.1(1)%
- Momenta of all decay products → neutrino momentum
  - +GAGG scintillators for β-recoil-γ correlations: time-reversal and isospin breaking
- Precision angular distributions → tests the extreme handedness predictions (i.e. extreme parity breaking) of the Standard Model weak interaction



FRANCIUM Atomic Parity Non-Conservation Experiment

- 10^6 trapped Francium atoms → < 1% PNC stats in < 1 day
- Fr = Heaviest alkali atom, atomic calculations to high accuracy to interpret parity-breaking effects
- Goals: **Measurement of atomic PNC in ^{211}Fr**
  - **complementary to ^{133}Cs atomic PNC's** best measurement of weak neutral interaction at low momentum transfer → sensitive to 5-8 TeV Z', and/or ~MeV Z'
  - $^{207\text{-}211,220\text{-}226}$Fr PNC sensitive to new physics depending on neutron number.
  - Nuclear anapole moments: collective weak N-N physics

FRANCIUM-PNC



First Direct Measurement of the Spatial Extent of a Neutrino Wavepacket

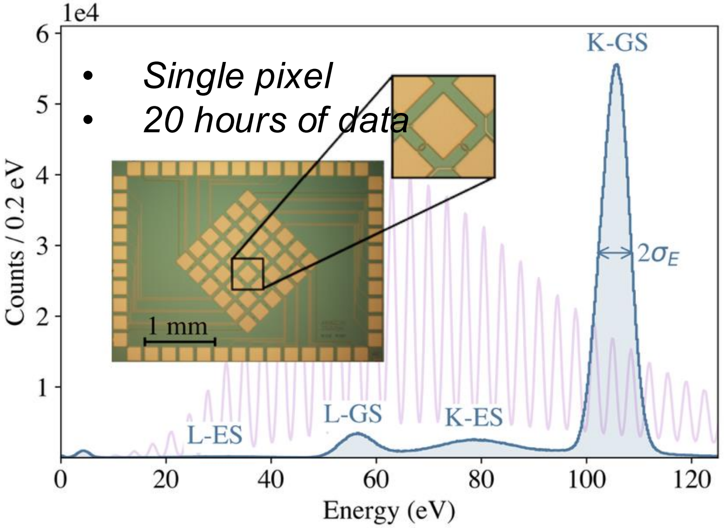
The BeEST experiment ^{7}Be beam time continues to reap rewards…

- New concept to probe quantum properties of fundamental particles: **Highly localized rare isotopes in superconductors at low temperature**
- All data from BeEST Phase-III from **a single ISAC beam shift** (^{7}Be)

Direct Experimental Constraints on the Spatial Extent of a Neutrino Wavepacket

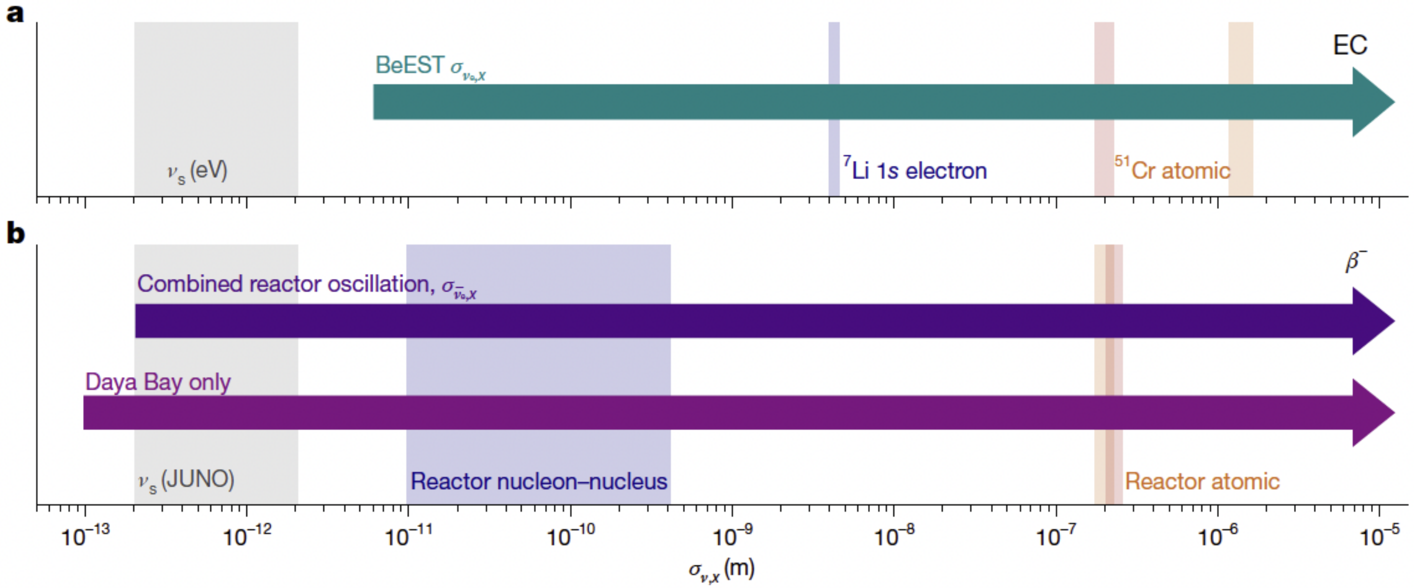
Joseph Smolsky[1*], Kyle G Leach[1,2*], Ryan Abells[3], Pedro Amaro[4], Adrien Andoche[5], Keith Borbridge[1], Connor Bray[1,6], Robin Cantor[7], David Diercks[8], Spencer Fretwell[1], Stephan Friedrich[6], Abigail Gillespie[1], Mauro Guerra[4], Ad Hall[7], Cameron N Harris[1], Jackson T Harris[9], Calvin Hinkle[1], Amii Lamm[1], Leendert M Hayen[10], Paul-Antoine Hervieux[5], Geon-Bo Kim[6], Inwook Kim[6], Annika Lennarz[3,11], Vincenzo Lordi[6], Jorge Machado[4], Andrew Marino[1], David McKeen[3], Xavier Mougeot[12], Francisco Ponce[13], Chris Ruiz[3], Amit Samanta[6], José Paulo Santos[4], Caitlyn Stone-Whitehead[1], John Taylor[1], Joseph Templet[1], Sriteja Upadhyayula[3], Louis Wagner[3], William K Warburton[9]

[1]Department of Physics, Colorado School of Mines, 1500 Illinois St, Golden, 80401, Colorado, USA.
[2]Facility for Rare Isotope Beams, Michigan State University, 640 S Shaw Lane, East Lansing, 48824, MI, USA.
[3]TRIUMF, 4004 Wesbrook Mall, Vancouver, BC V6T 2A3, Canada.



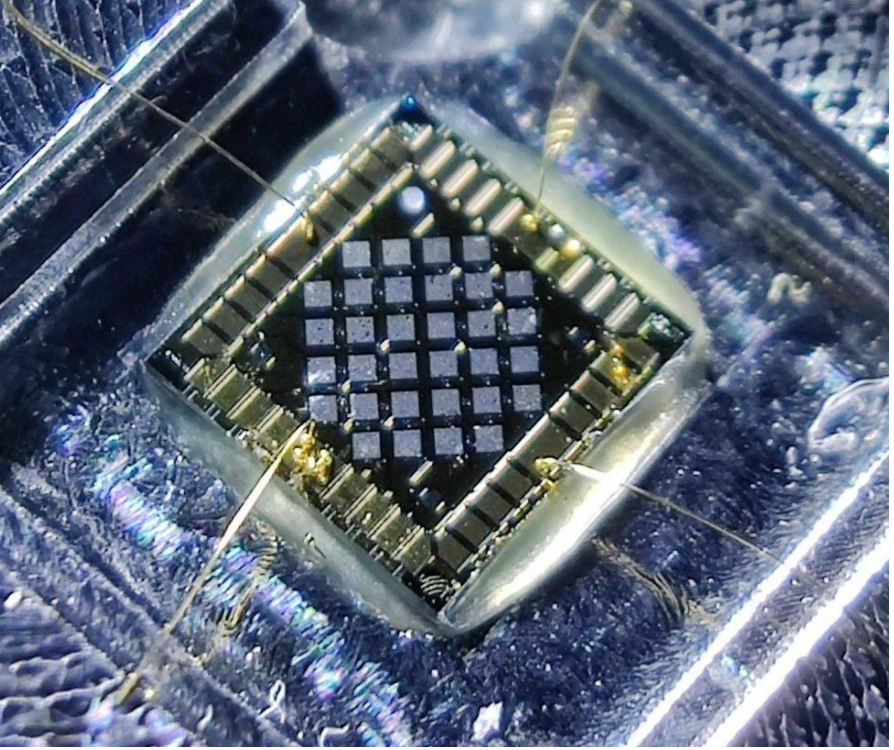
$$\sigma_x \sigma_p \geq \hbar/2$$

- Measurement of recoil energy width is direct probe of localization scale of daughter
- Used to directly extract limit on spatial width of wavepacket
- Improves on all combined reactor oscillation data



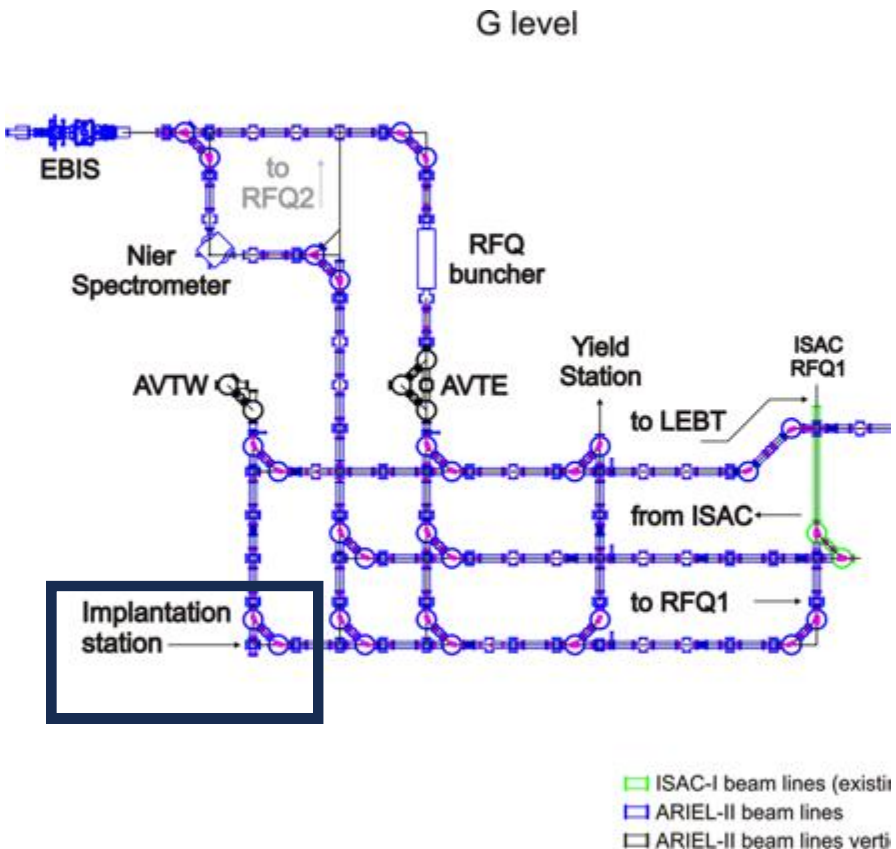
J. Smolsky, K.G. Leach et al. (BeEST Collab), Nature 638, 640 (2025), arXiv: 2404.03102 (2024)

Courtesy of Kyle Leach

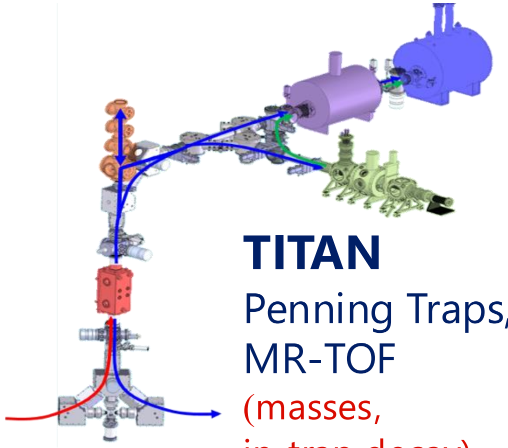


Next phases of BeEST experiment require:

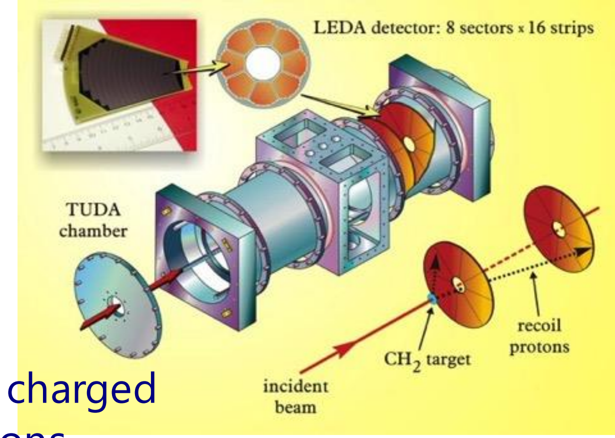
- Superior suppression of 7Li in beam ← CANREB HRS
- Greater availability of 7Be ← greater ARIEL RIB hrs
- Easily accessible implantation station ← CANREB ground floor



Nuclear Astrophysics



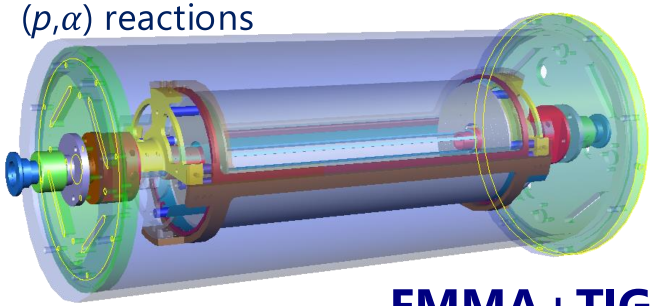
TITAN
Penning Traps, MR-TOF
(masses, in-trap decay)



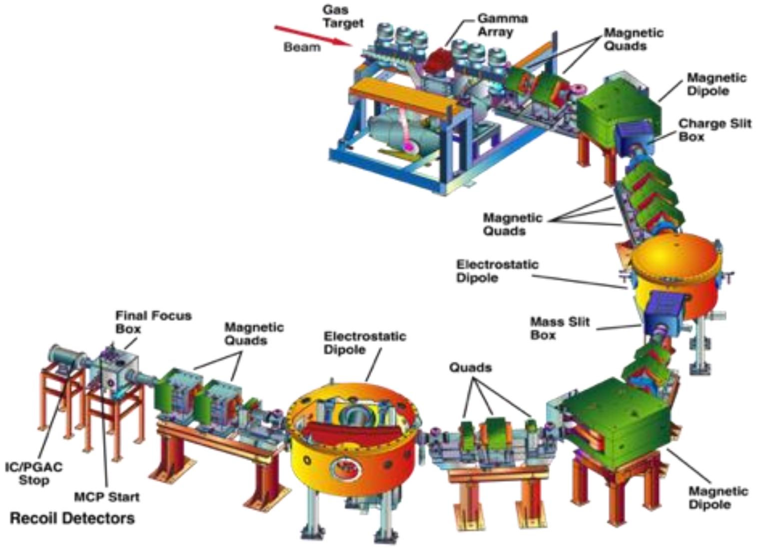
TUDA
Astrophysical charged particle reactions

GRIFFIN
Gamma & Electron spectrometer
(decay properties)

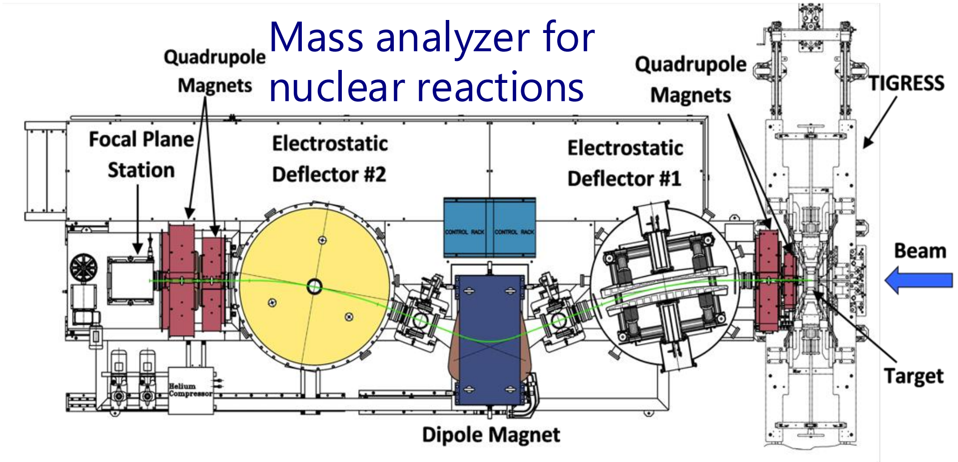
TACTIC: annular TPC for direct measurement of weakest (α,p) (p,α) reactions

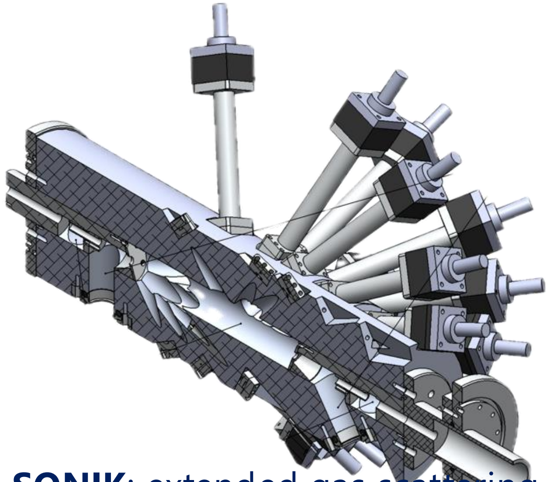


DRAGON
Astrophysical capture reactions



EMMA+TIGRESS
Mass analyzer for nuclear reactions



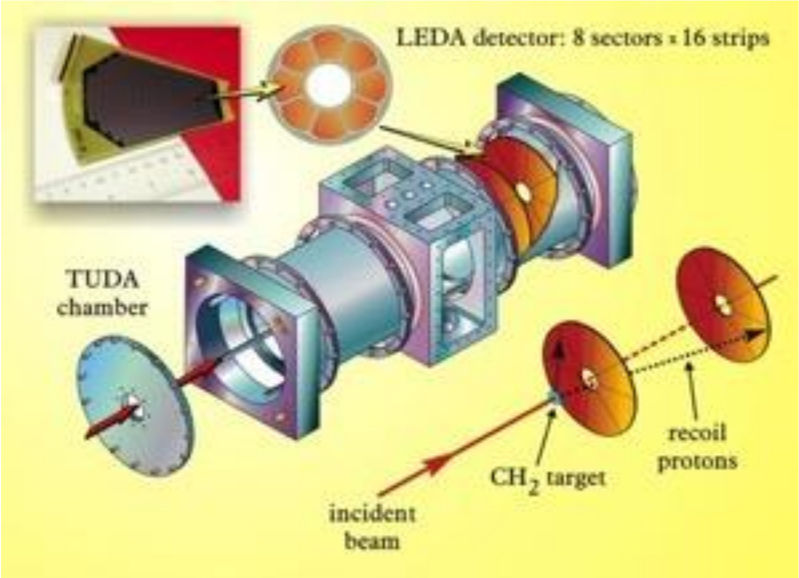


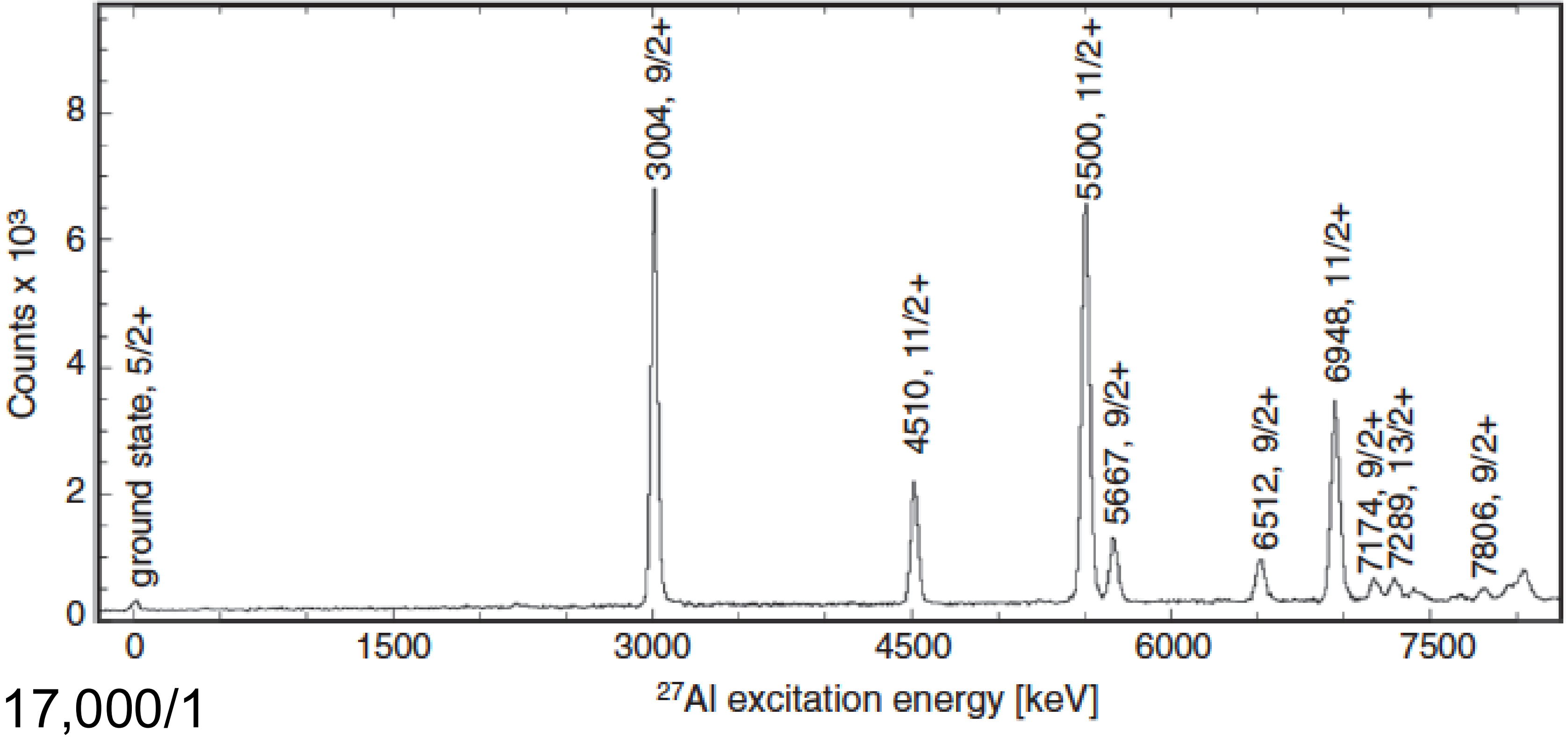
SONIK: extended gas scattering detector (precision low E elastic phaseshifts)

TUDA: $^{26g}Al(d,p)^{27}Al$

PRL 115, 062701 (2015) PHYSICAL REVIEW LETTERS week ending 7 AUGUST 2015

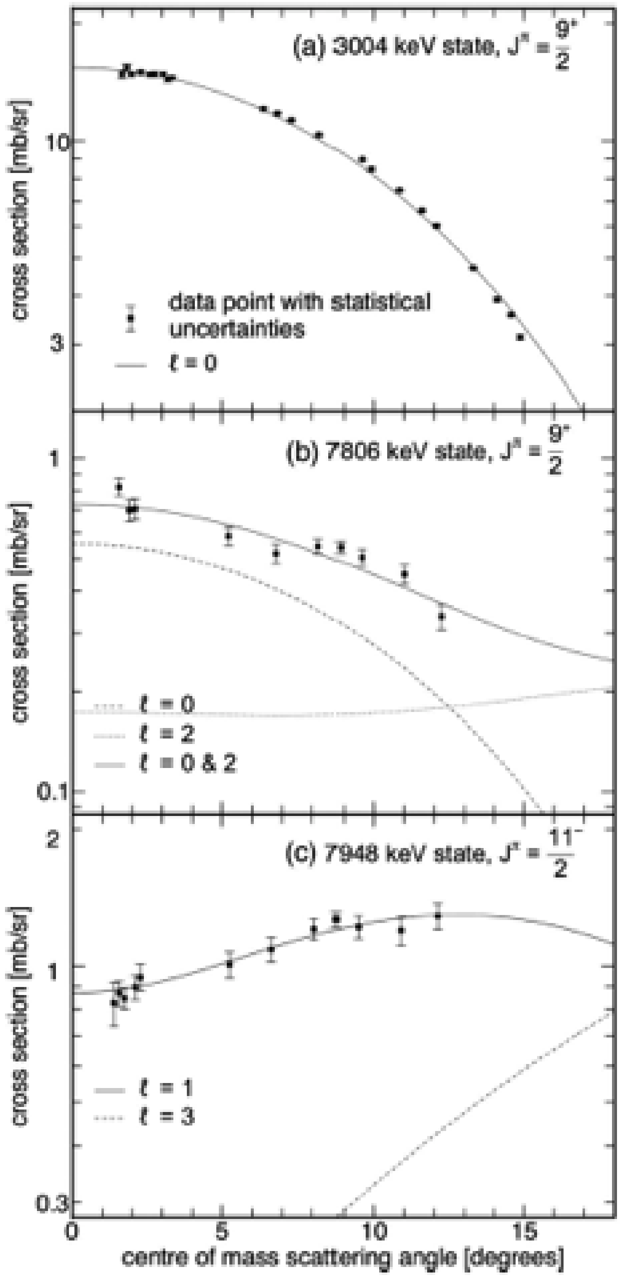
Inverse Kinematic Study of the $^{26g}Al(d,p)^{27}Al$ Reaction and Implications for Destruction of ^{26}Al in Wolf-Rayet and Asymptotic Giant Branch Stars

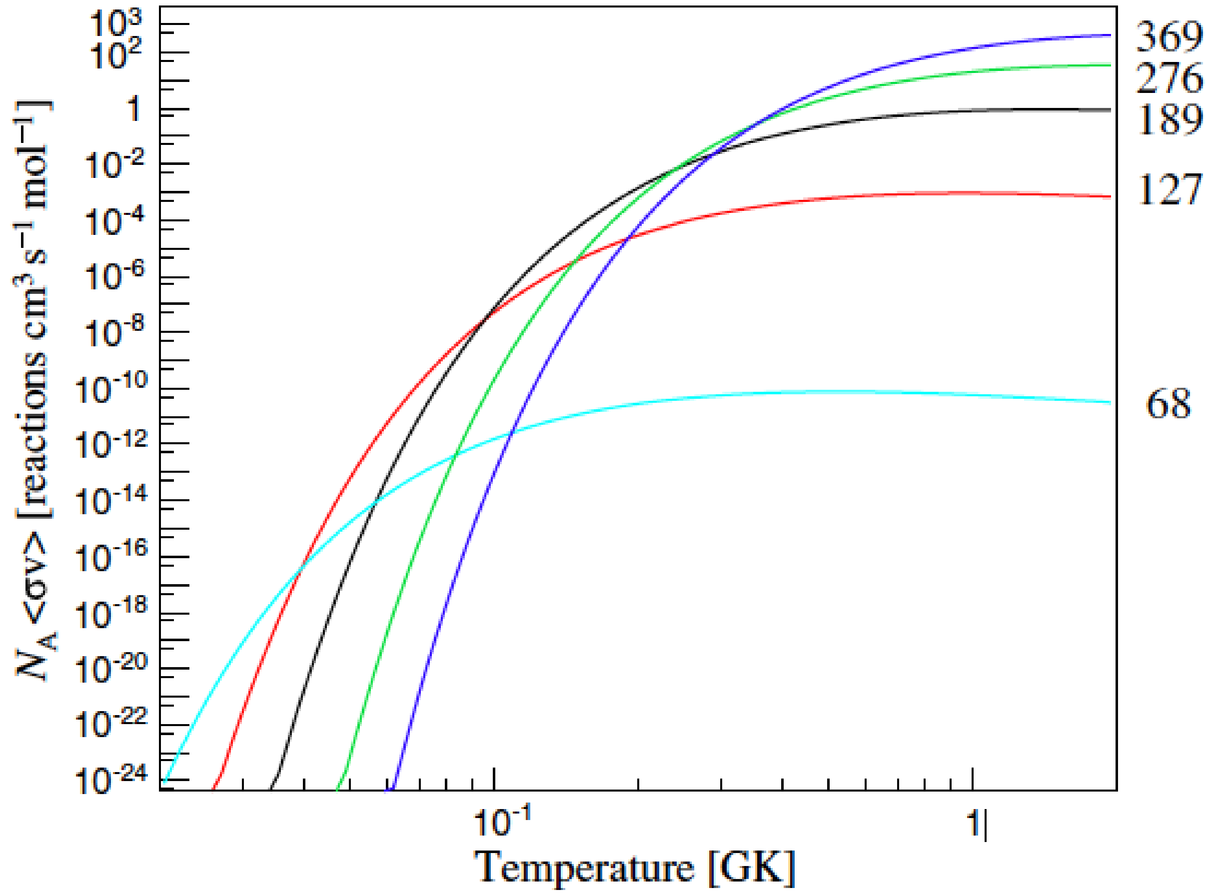




TUDA array
1pnA ^{26}Al at 6 AMeV with GS/IS=17,000/1
~50 μg=cm^2 thick CD_2 target
~40keV FWHM

TUDA: $^{26g}Al(d,p)^{27}Al$





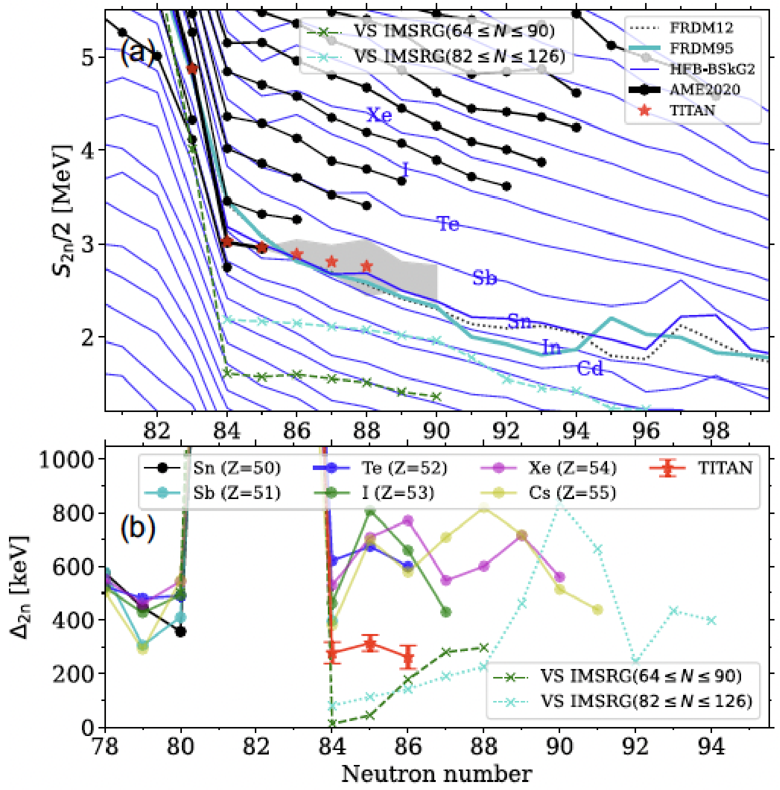
127 keV resonance in ^{27}Si determines the entire $^{26g}Al(p,\gamma)^{27}Si$ reaction rate over almost the complete temperature range of Wolf-Rayet stars and AGB stars.

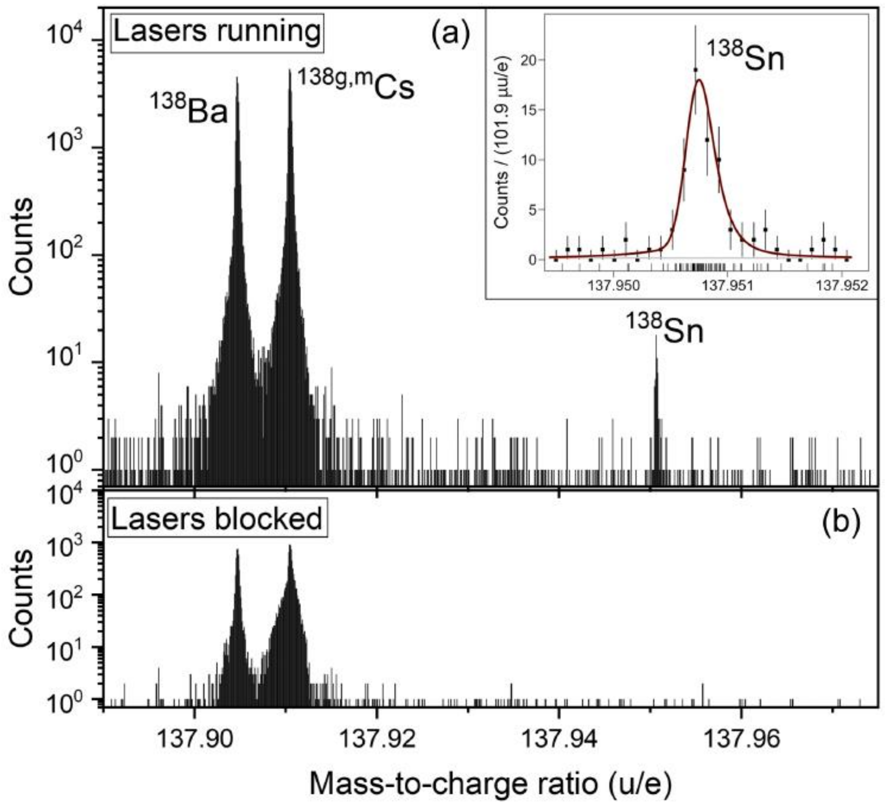
V. Margerin, G. Lotay *et al.*, PRL 115, 062701 (2015).

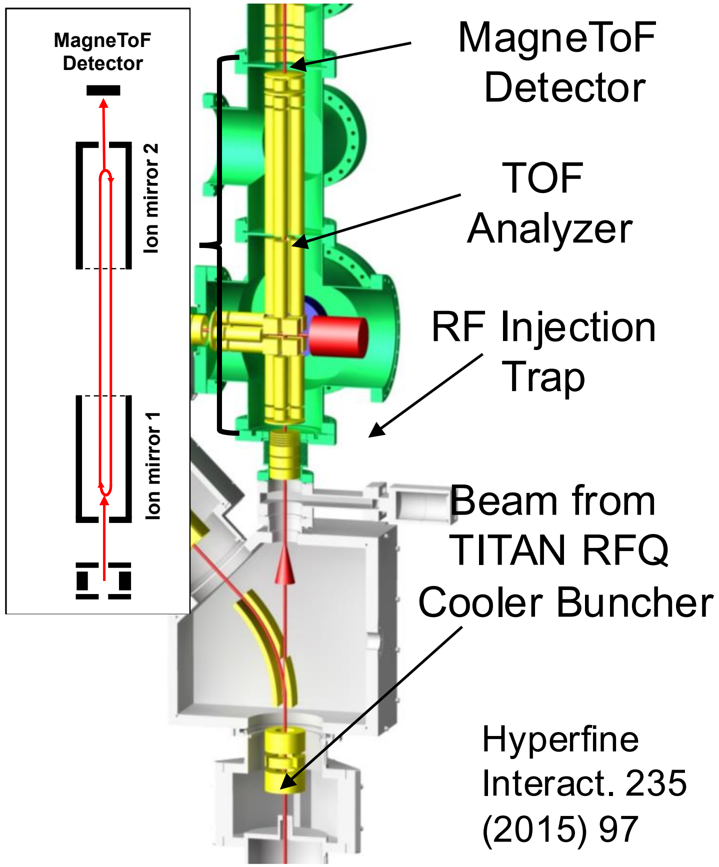
PHYSICAL REVIEW LETTERS 134, 232701 (2025)

Precision Mass Measurements Reveal Low Neutron Pairing in Tin beyond $N = 82$ and Its Impact on Stellar Nucleosynthesis

A. Mollaebrahimi,[1,2,3,*] C. Walls,[4,2] T. Dickel,[3,1] T. Miyagi,[5,6,7,8] A. Sieverding,[9,10] C. Andreoiu,[11] J. Ash,[2] B. Ashrafkhani,[12,2] I. Belosevic,[2] J. Bergman,[1] C. Brown,[13] T. Brunner,[14] J. Cardona,[4,2] L. Egoriti,[2] G. Gelinas,[12,2] G. Gwinner,[4] Z. Hockenbery,[14,2] J. D. Holt,[2,14] A. Jacobs,[15,2] S. Kakkar,[4,2] B. Kootte,[4,2] J. Lassen,[2] E. M. Lykiardopoulou,[15,2] S. Malbrunot-Ettenauer,[2,16] G. Martínez-Pinedo,[3,5,17] S. F. Paul,[2] W. R. Plaß,[3,1] M. P. Reiter,[13] A. Ridley,[2] C. Scheidenberger,[3,1,18] R. I. Thompson,[12] Y. Wang,[15,2] M. E. Wieser,[12] and A. A. Kwiatkowski[19,2]







Hyperfine Interact. 235 (2015) 97

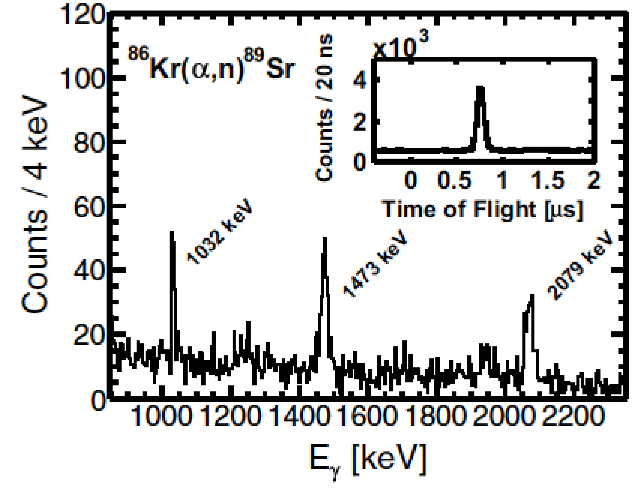
Technique:
Multi-reflection Time-of-Flight mass spectrometry using TITAN MR-ToF-MS with achievable precision of better than 100 ppb

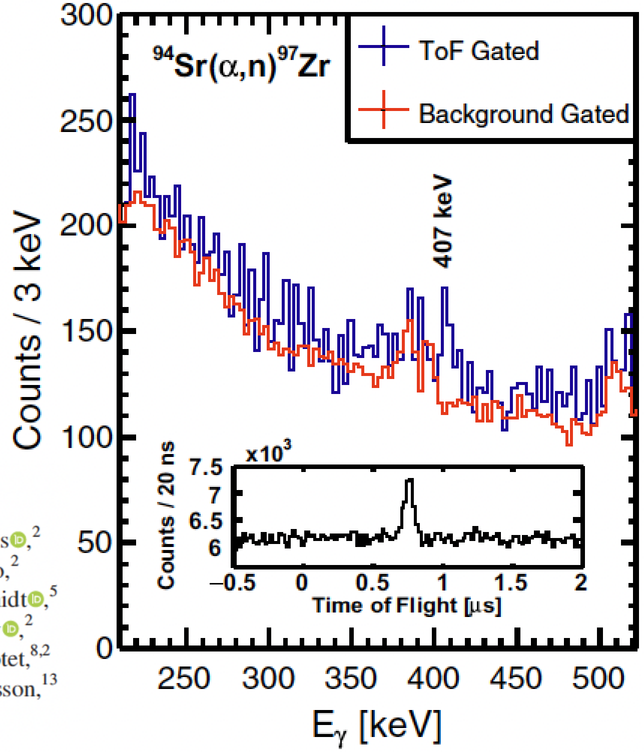
- Evidence for notably decreased empirical pairing gap beyond *N*=82.
- S_{2n} trend is flatter than in heavier elements.
- Significantly improved uncertainty for inputs to abundance calculations

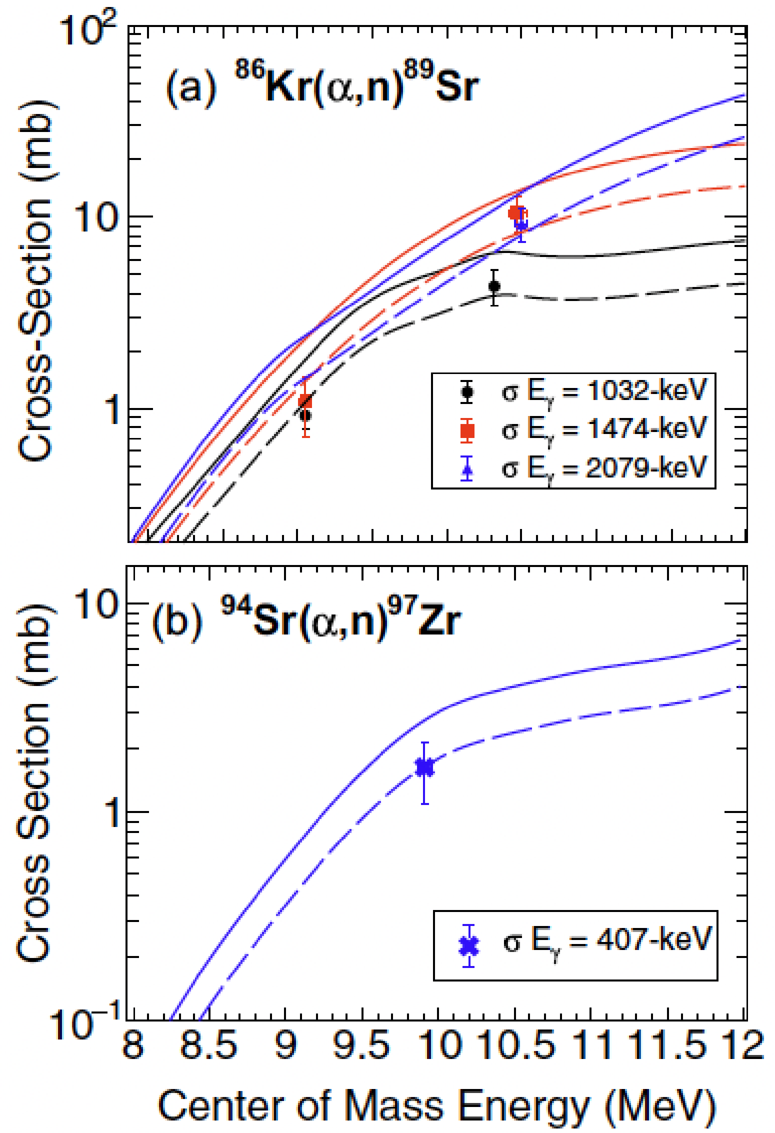
First Measurement of a weak r-process reaction on a radioactive nucleus

$^{86}Kr(\alpha,n)^{89}Sr$ & $^{94}Sr(\alpha,n)^{97}Zr$ reactions with EMMA & TIGRESS

- Received 86Kr & 94Sr beam at EMMA & TIGRESS
  - → Identify recoils with EMMA, γ-rays with TIGRESS to tag excited states
- Used a novel type of He-containing target (sputtered in Helium atmosphere – large density of He trapped in microscopic voids)
- Partial cross sections for production of gamma rays determined for lowest energy ^{86}Kr experiment
- First measurement of a Weak r-process reaction on a radioactive nucleus





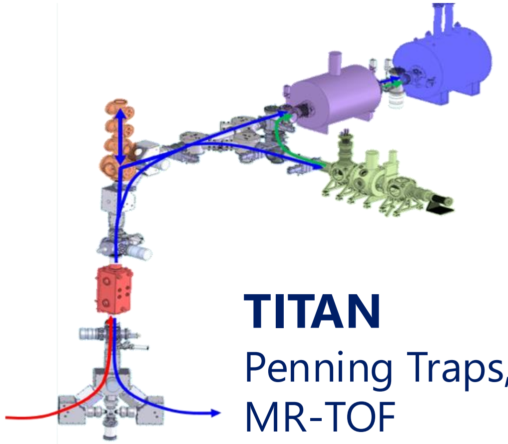


PHYSICAL REVIEW LETTERS **134**, 112701 (2025)

Editors' Suggestion

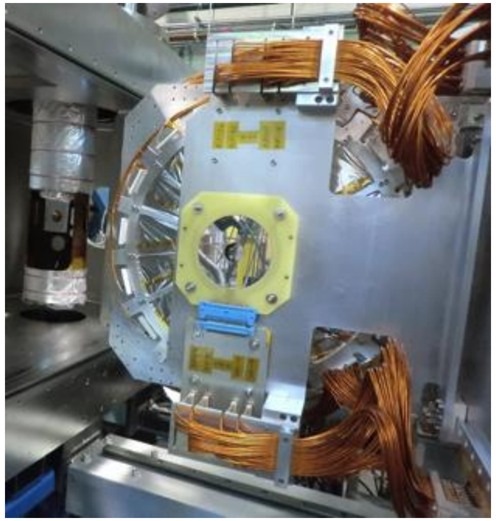
First Measurement of a Weak *r*-Process Reaction on a Radioactive Nucleus

M. Williams,[1,*] C. Angus,[2,3] A. M. Laird,[3,2] B. Davids,[2,4] C. Aa. Diget,[3,2] A. Fernandez,[5] E. J. Williams,[2] A. N. Andreyev,[3] H. Asch,[4] A. A. Avaa,[2] G. Bartram,[1] S. Chakraborty,[2,3] I. Dillmann,[2] K. Directo,[2] D. T. Doherty,[1] E. Geerlof,[2] C. J. Griffin,[2] A. Grimes,[2] G. Hackman,[2] J. Henderson,[1] K. Hudson,[4,2] D. Hufschmidt,[5] J. Jeong,[6,2] M. C. Jiménez de Haro,[5] V. Karayonchev,[2,†] A. Katrusiak,[2] A. Lennarz,[2,7] G. Lotay,[1] B. Marlow,[2] M. S. Martin,[4,‡] S. Molló,[8,2] F. Montes,[9] J. R. Murias,[2] J. O'Neill,[1] K. Pak,[6,2] C. Paxman,[1,§] L. Pedro-Botet,[8,2] A. Psaltis,[10] E. Raleigh-Smith,[2,∥] D. Rhodes,[2] J. S. Rojo,[2] M. Satrazani,[11] T. Sauvage,[12] C. Shenton,[1,2] C. E. Svensson,[13] D. Tam,[4] L. Wagner,[2] and D. Yates[2,14]

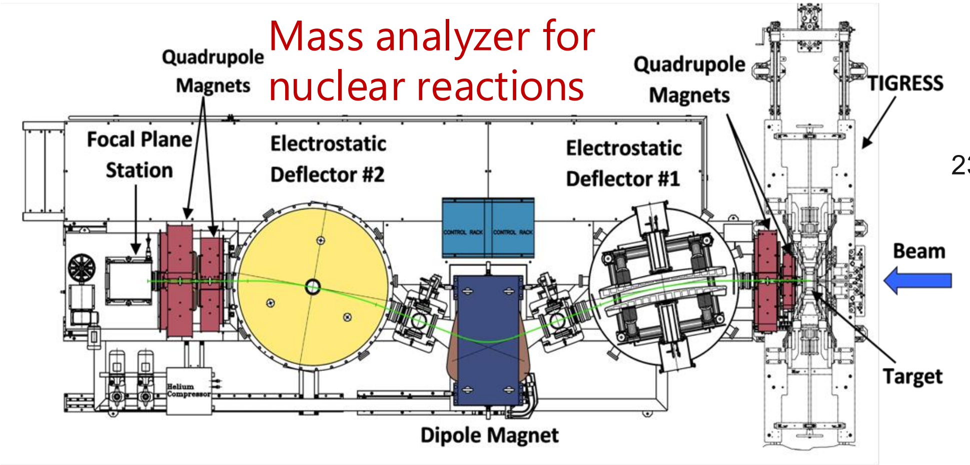


TITAN
Penning Traps,
MR-TOF
(masses,
in-trap decay)

IRIS
Solid hydrogen
target for direct
reactions



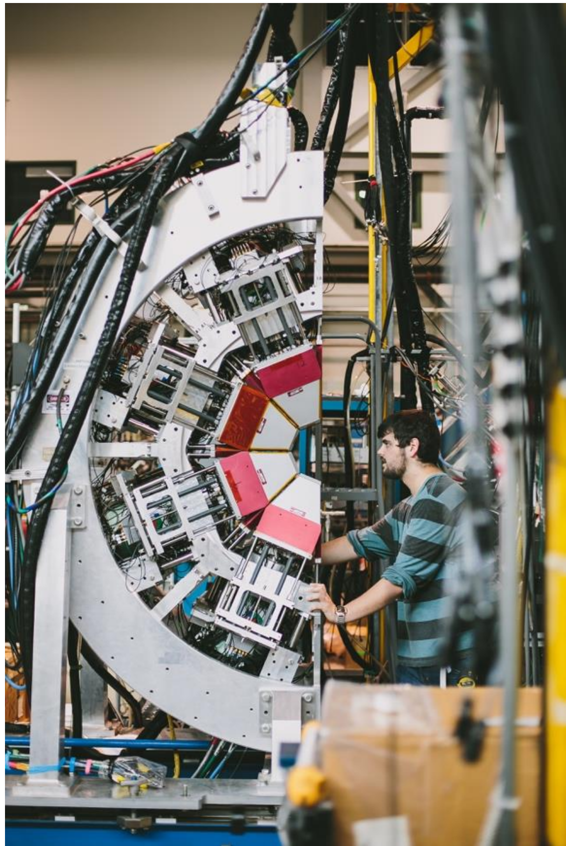
EMMA+TIGRESS
Mass analyzer for
nuclear reactions



Nuclear Structure

GRIFFIN
Gamma & Electron
spectrometer
(decay properties)

Polarizer beamline
Co-linear Laser spectroscopy



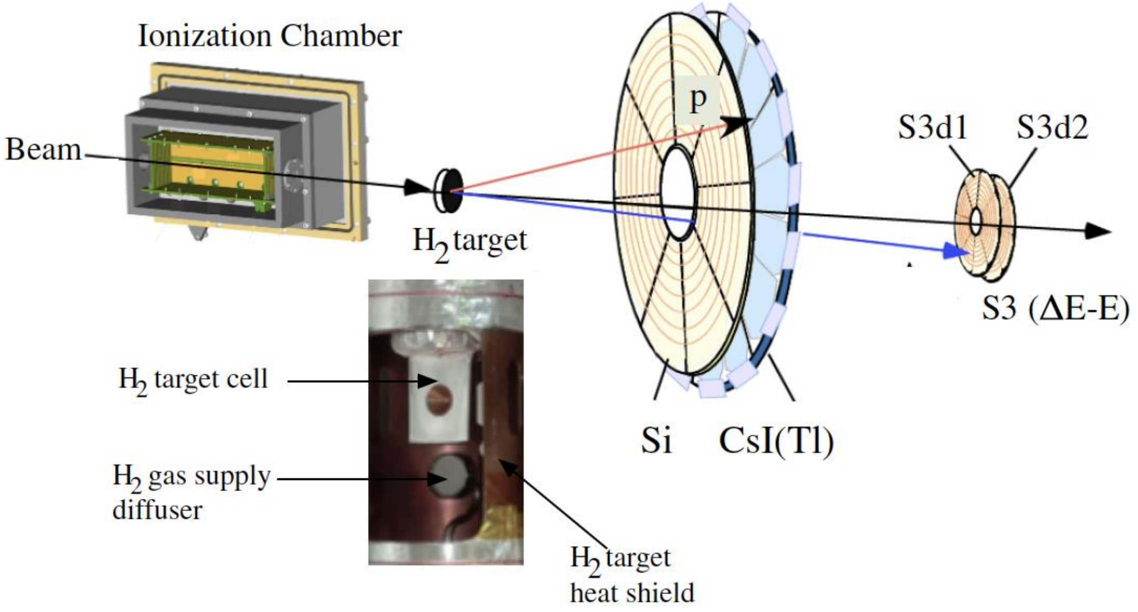
TIGRESS
In-beam γ-ray spectroscopy

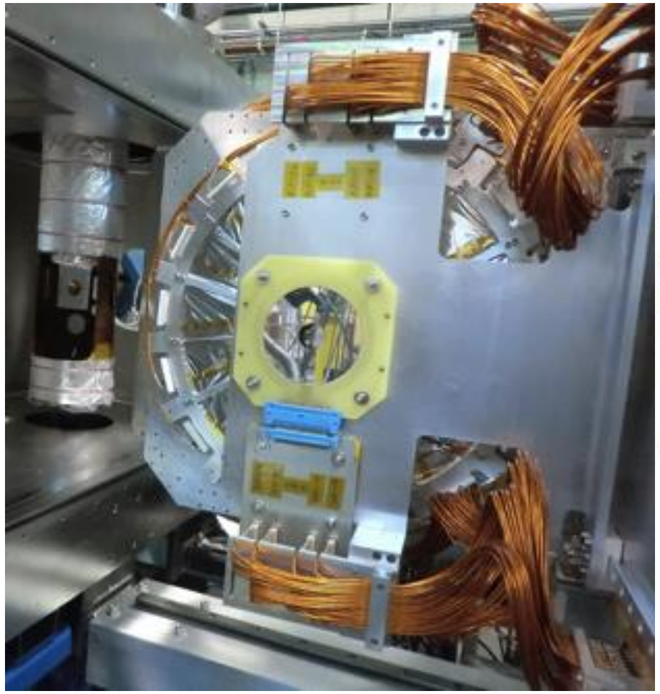
IRIS + theory determine magnitude of 3N forces.

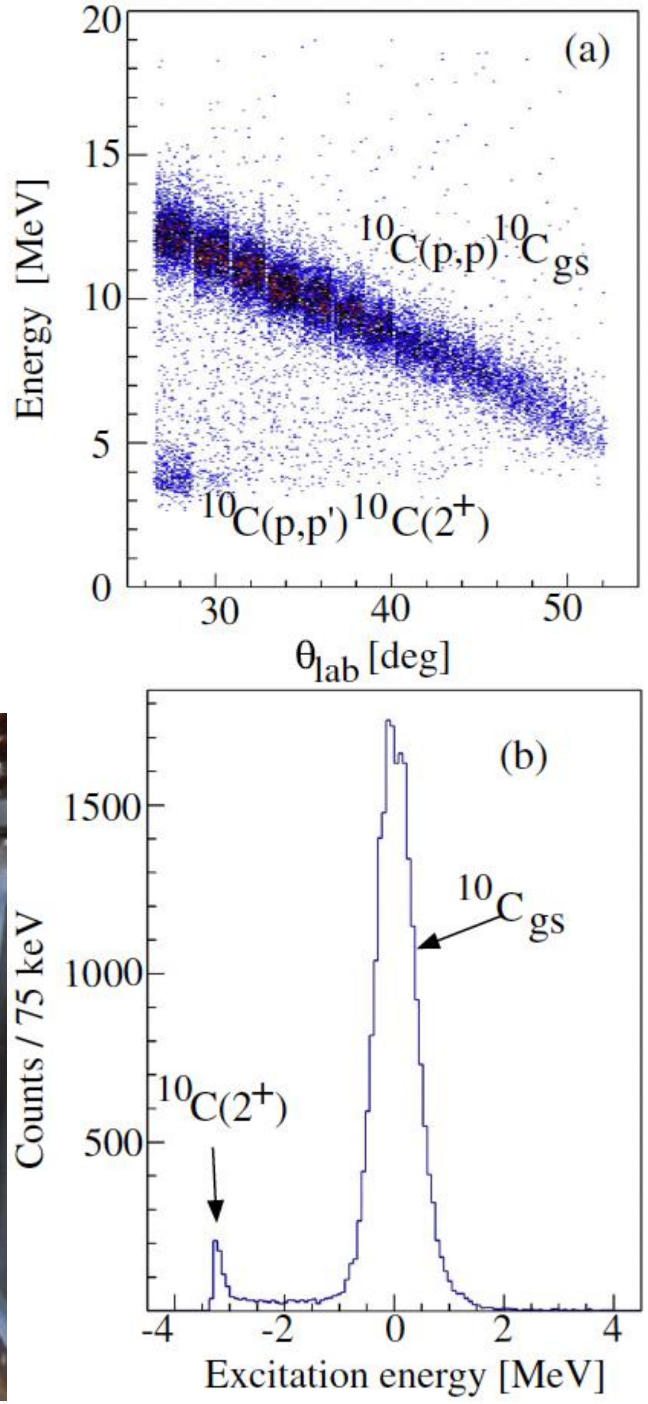
Selected for a Viewpoint in *Physics*
PRL **118,** 262502 (2017) PHYSICAL REVIEW LETTERS week ending 30 JUNE 2017

Nuclear Force Imprints Revealed on the Elastic Scattering of Protons with ^{10}C

A. Kumar,[1] R. Kanungo,[1*] A. Calci,[2] P. Navrátil,[2†] A. Sanetullaev,[1,2] M. Alcorta,[2] V. Bildstein,[3] G. Christian,[2] B. Davids,[2] J. Dohet-Eraly,[2,4] J. Fallis,[2] A. T. Gallant,[2] G. Hackman,[2] B. Hadinia,[3] G. Hupin,[5,6] S. Ishimoto,[7] R. Krücken,[2,8] A. T. Laffoley,[3] J. Lighthall,[2] D. Miller,[2] S. Quaglioni,[9] J. S. Randhawa,[1] E. T. Rand,[3] A. Rojas,[2] R. Roth,[10] A. Shotter,[11] J. Tanaka,[12] I. Tanihata,[12,13] and C. Unsworth[2]





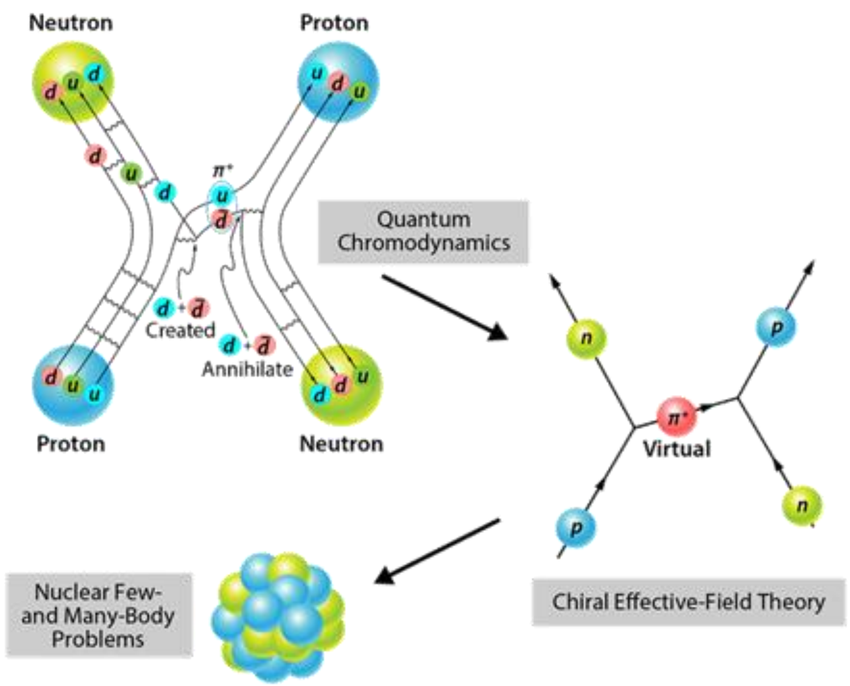


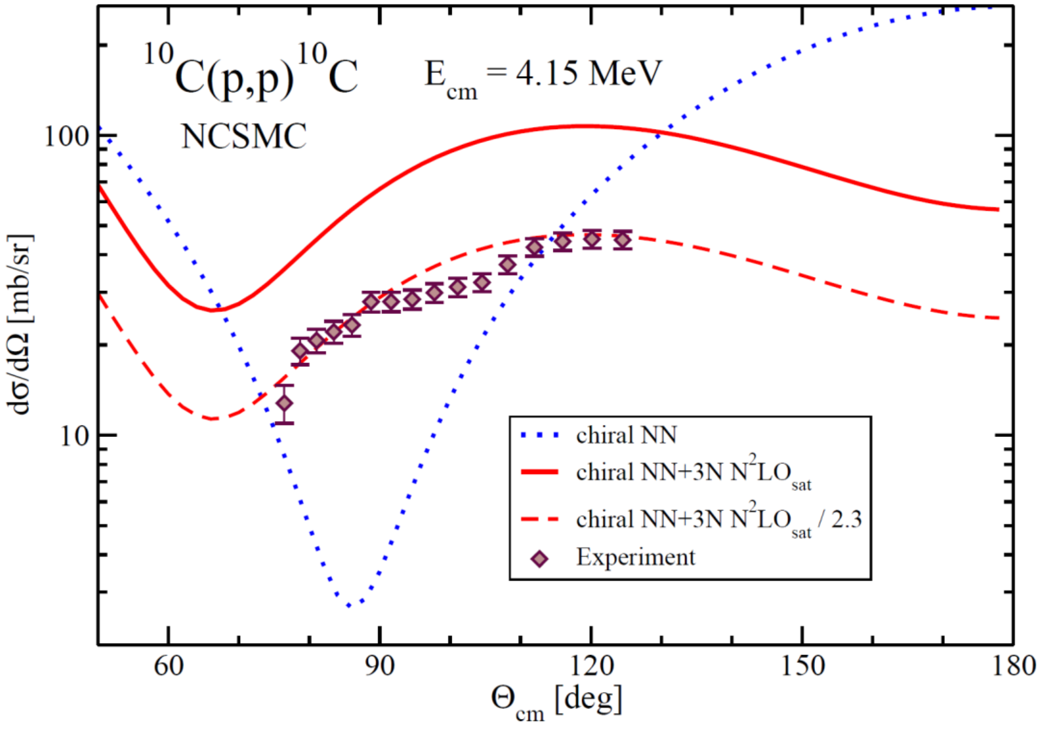
IRIS + theory determine magnitude of 3N forces.

Selected for a Viewpoint in *Physics*
PRL **118,** 262502 (2017) PHYSICAL REVIEW LETTERS week ending 30 JUNE 2017

Nuclear Force Imprints Revealed on the Elastic Scattering of Protons with ^{10}C

A. Kumar,[1] R. Kanungo,[1*] A. Calci,[2] P. Navrátil,[2†] A. Sanetullaev,[1,2] M. Alcorta,[2] V. Bildstein,[3] G. Christian,[2] B. Davids,[2] J. Dohet-Eraly,[2,4] J. Fallis,[2] A. T. Gallant,[2] G. Hackman,[2] B. Hadinia,[3] G. Hupin,[5,6] S. Ishimoto,[7] R. Krücken,[2,8] A. T. Laffoley,[3] J. Lighthall,[2] D. Miller,[2] S. Quaglioni,[9] J. S. Randhawa,[1] E. T. Rand,[3] A. Rojas,[2] R. Roth,[10] A. Shotter,[11] J. Tanaka,[12] I. Tanihata,[12,13] and C. Unsworth[2]



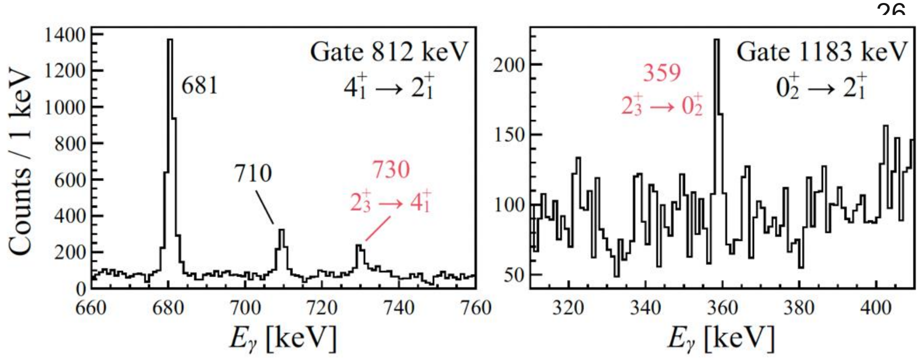


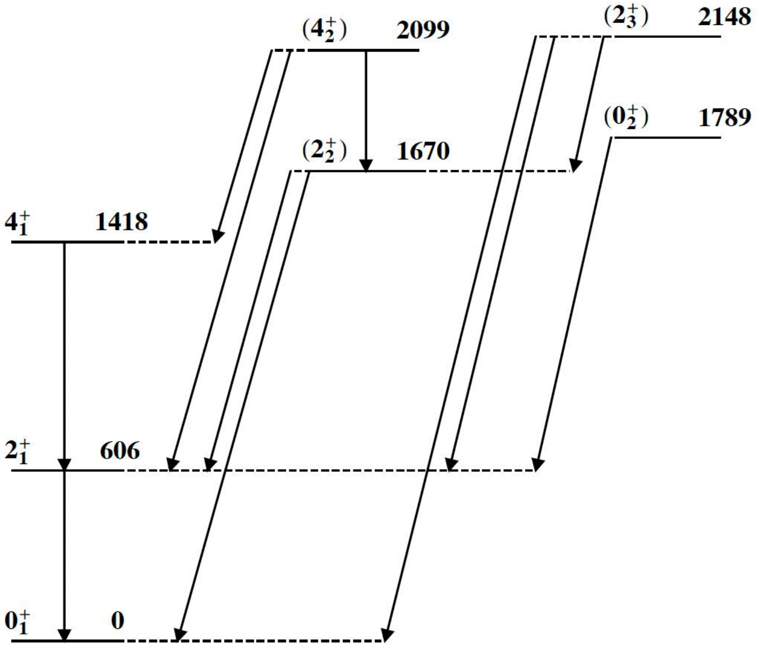
- 2000 pps ^{10}C beam scattered on solid hydrogen target at 4.54 and 4.82 A MeV.
- Scientific highlight: 3-body forces achieve qualitative agreement and correct order of magnitude.

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

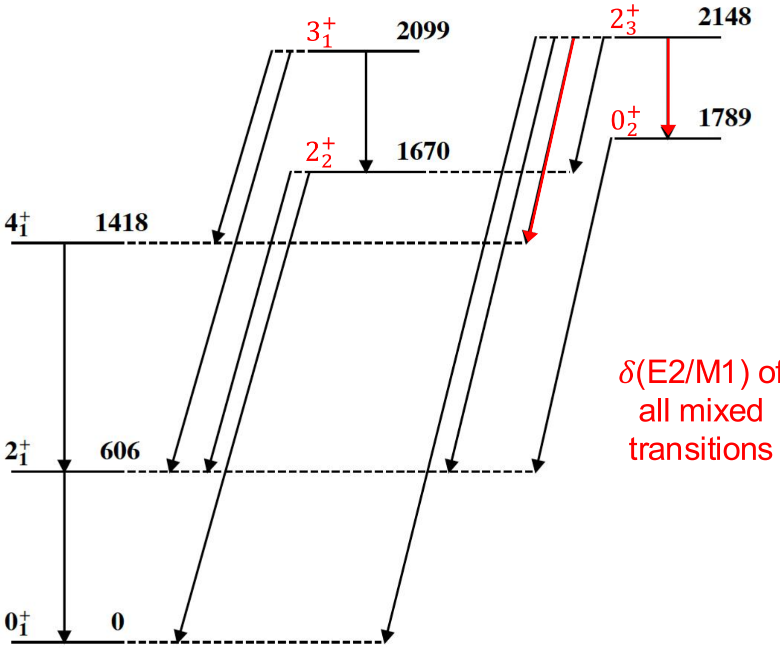
M. Rocchini *et al.*, Phys. Rev. Lett. 130, 122502 (2023).

- ^{74}Zn investigated at GRIFFIN following ^{74}Cu β decay (~1,700 pps for 40 hrs)
- γ-γ angular correlation analysis ⟹ Firm spin assignments for 2_2^+, 3_1^+, 0_2^+, 2_3^+ states.
- Two new transitions observed ⟹ $2_3^+ \longrightarrow 0_2^+$ and $2_3^+ \longrightarrow 4_1^+$

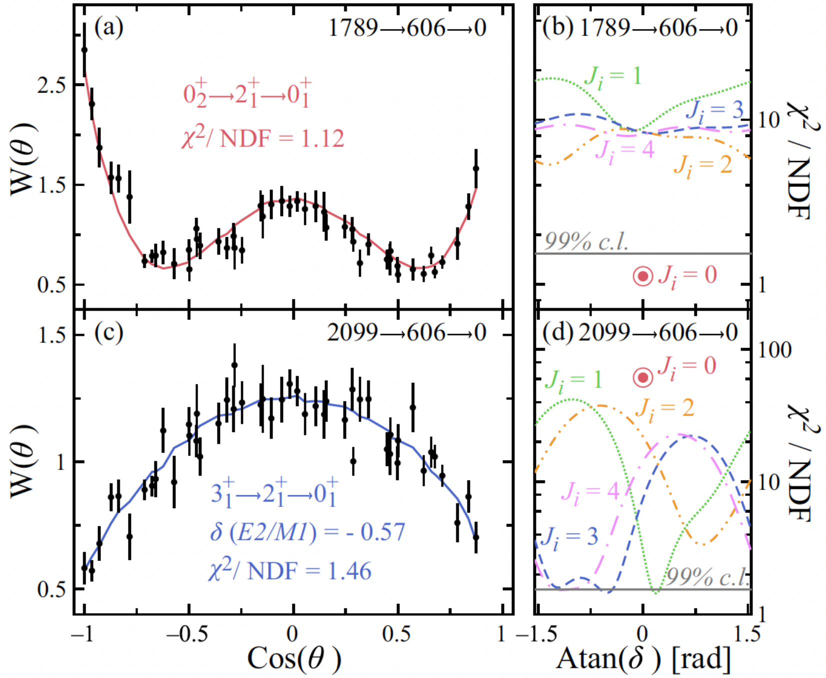




^{74}Cu β-decay @ORNL
J.L.Tracy Jr. et al., PRC 98, 034309 (2018)



δ(E2/M1) of all mixed transitions



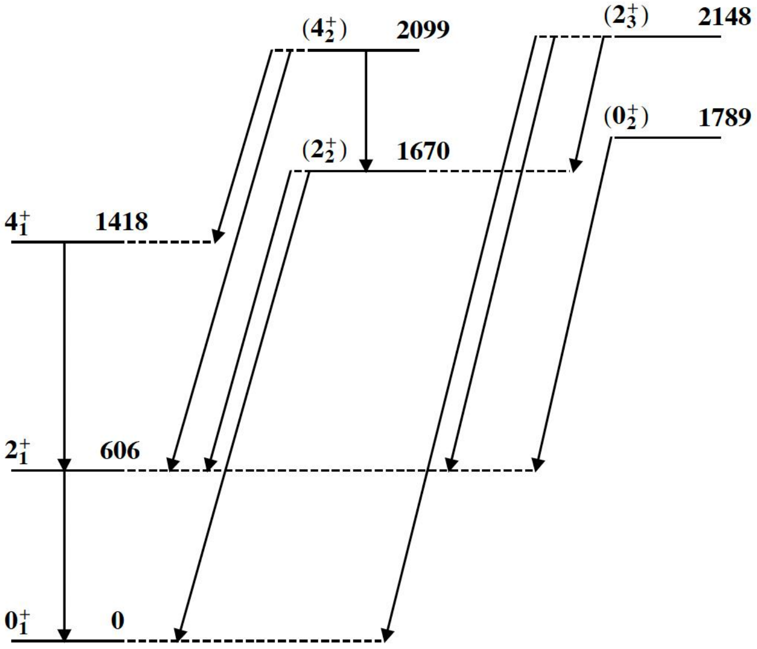
^{74}Cu ***β*****-decay @GRIFFIN**
M. Rocchini *et al.*, PRL 130, 122502 (2023).

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

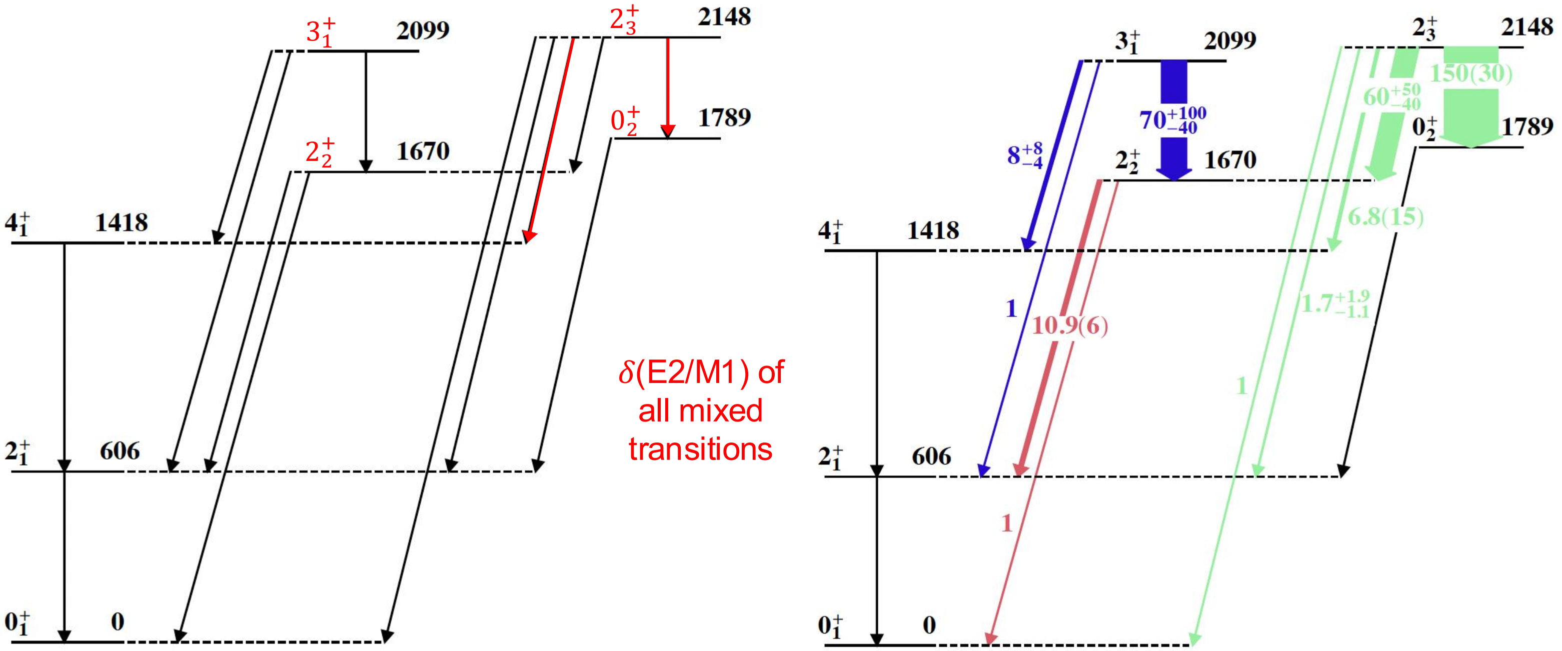
M. Rocchini *et al.*, Phys. Rev. Lett. 130, 122502 (2023).

- ^{74}Zn investigated at GRIFFIN following ^{74}Cu β decay (~1,700 pps for 40 hrs)
- γ-γ angular correlation analysis ⟹ Firm spin assignments for 2_2^+, 3_1^+, 0_2^+, 2_3^+ states.
- Two new transitions observed ⟹ $2_3^+ \longrightarrow 0_2^+$ and $2_3^+ \longrightarrow 4_1^+$
- From measured γ-ray branching and *E2/M1* mixing ratios for transitions de-exciting the 2_2^+, 3_1^+, 2_3^+ states ⟹ Relative B(*E2*) values

New spectroscopic data corrects the level scheme and allows assessment of relative transition strengths.



^{74}Cu β-decay @ORNL
J.L.Tracy Jr. et al., PRC 98, 034309 (2018)

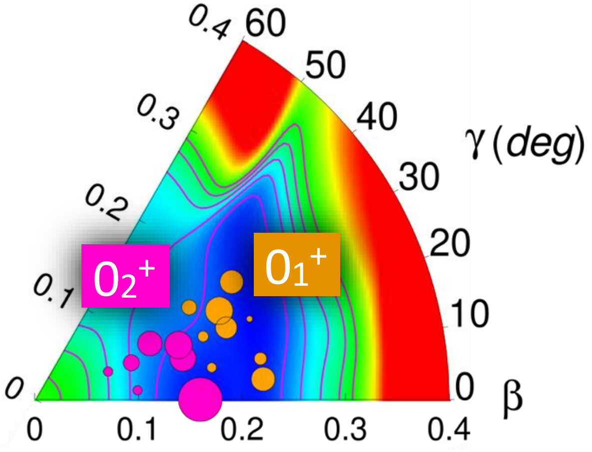


^{74}Cu ***β***-decay @GRIFFIN
M. Rocchini *et al.*, PRL 130, 122502 (2023).

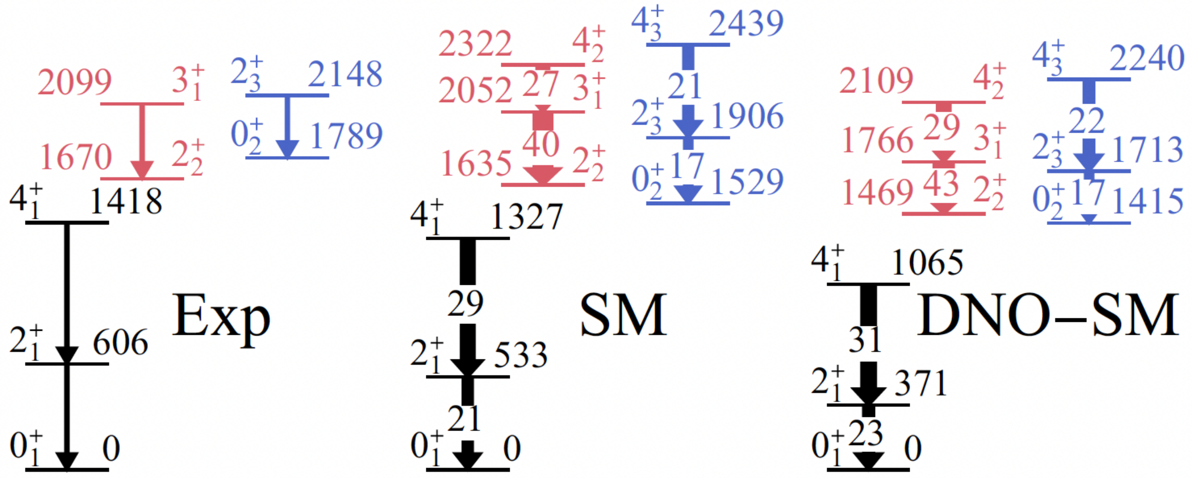
First Evidence of Axial Shape Asymmetry and Configuration Coexistence in ^{74}Zn: Suggestion for a Northern Extension of the N = 40 Island of Inversion

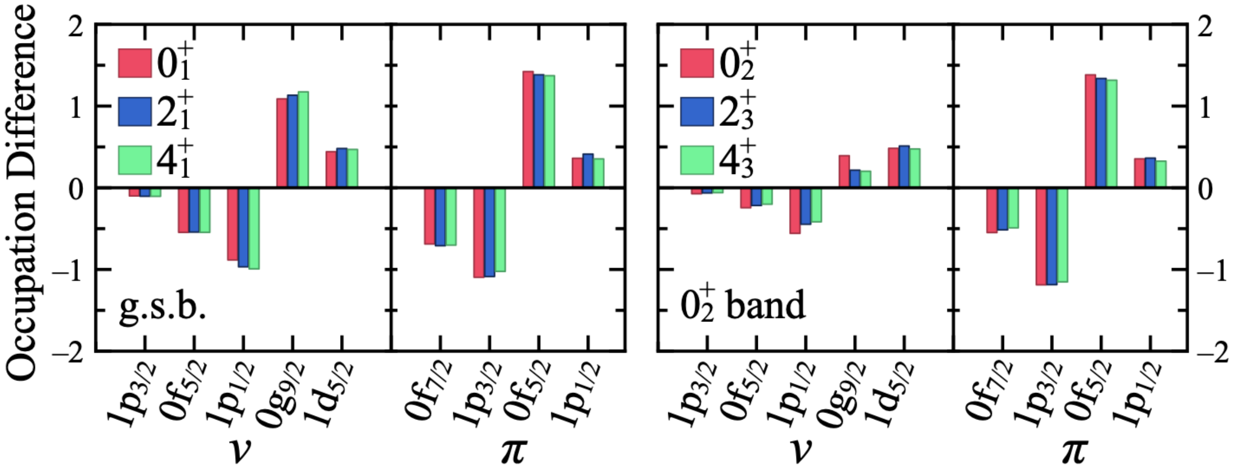
M. Rocchini *et al.*, Phys. Rev. Lett. 130, 122502 (2023).

- A rotational-like structure appears at low energy in ^{74}Zn
- New microscopic Large-Scale Shell-Model calculations
- Shapes of individual states and Wave-function compositions
- The ground state is found to have enhanced axial shape asymmetry (triaxiality)
- Configuration-coexisting 0_2^+ state

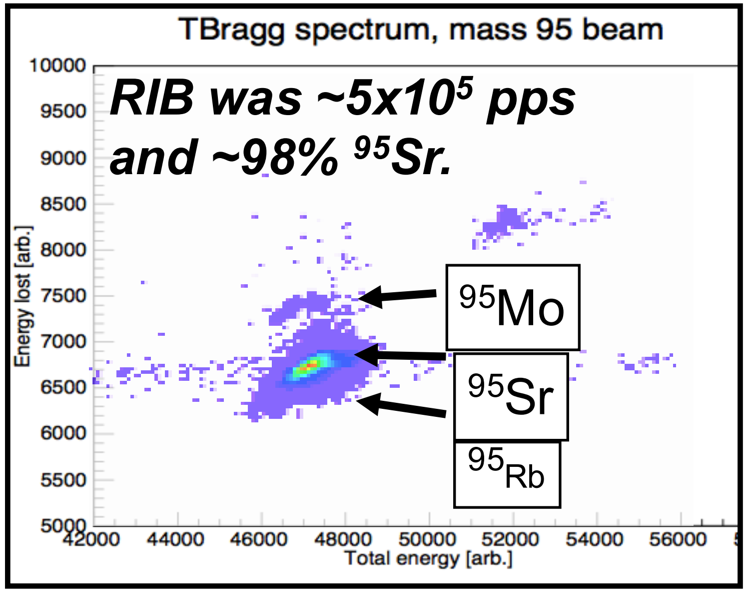


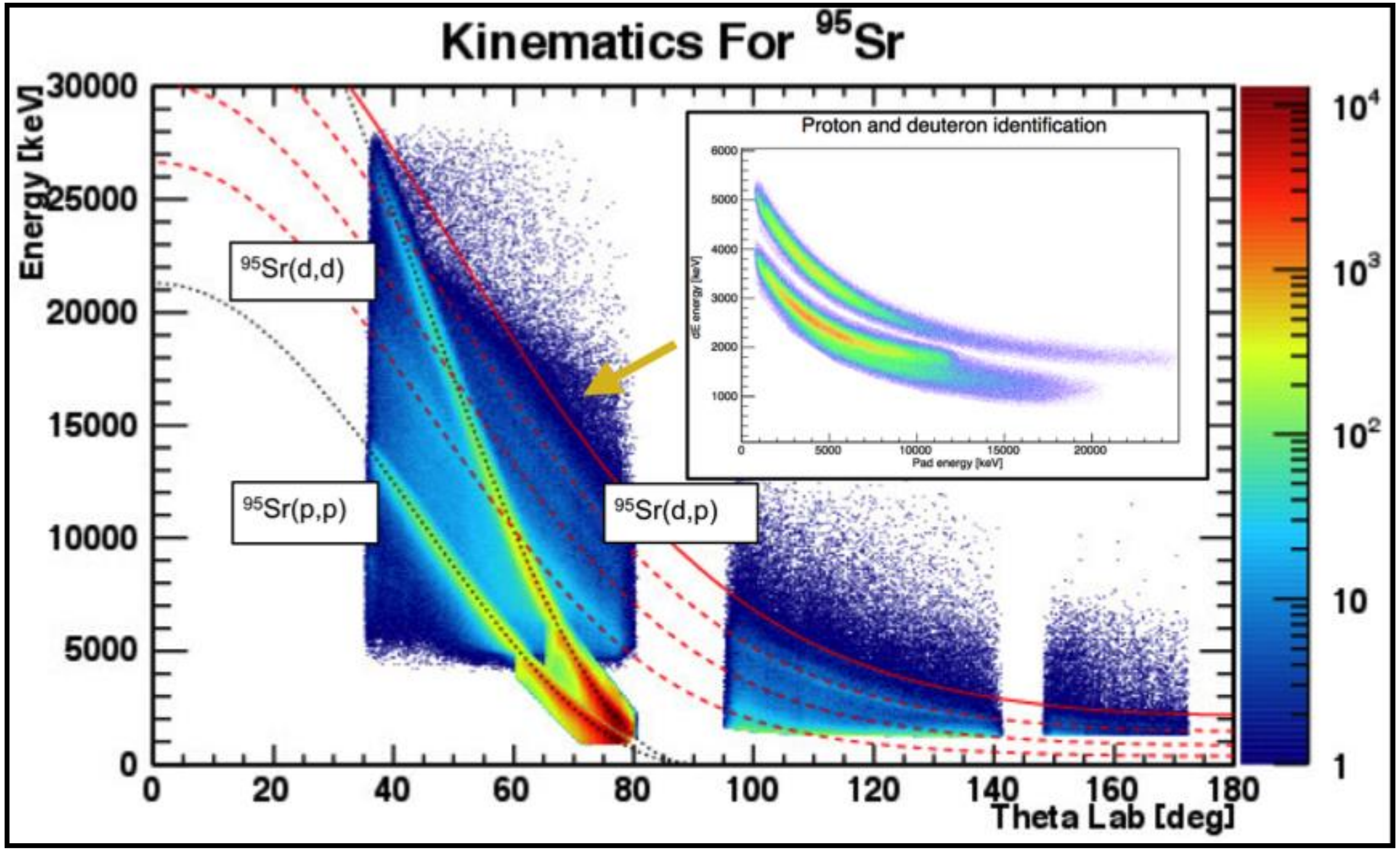
The influence of the *N* = 40 “island of inversion” appears to manifest above *Z* = 26, previously thought as its northern limit in the chart of the nuclides

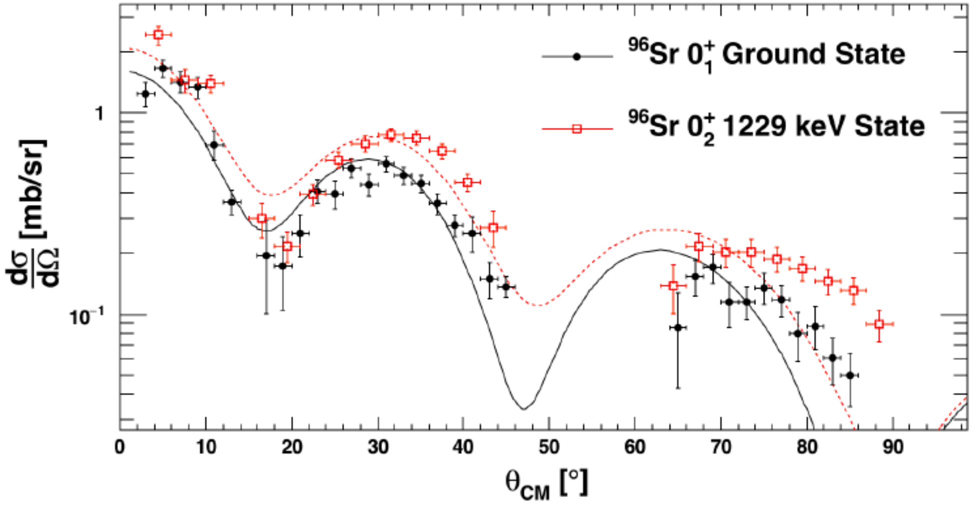




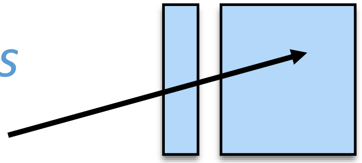
SHARC Data





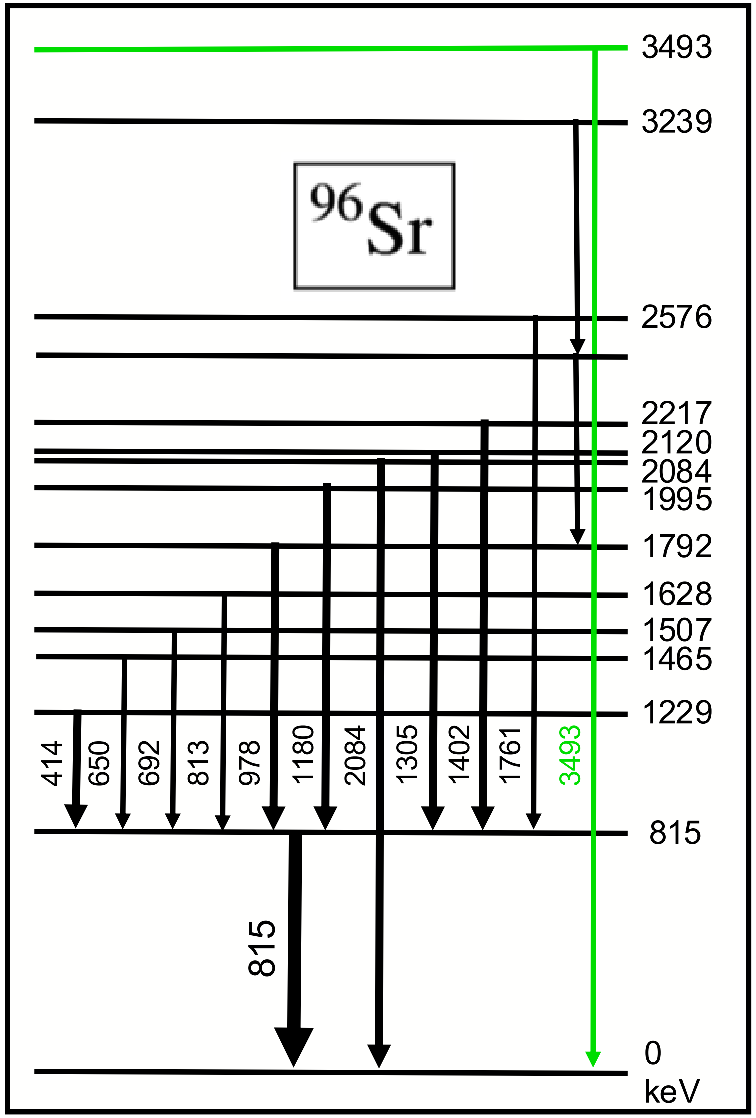


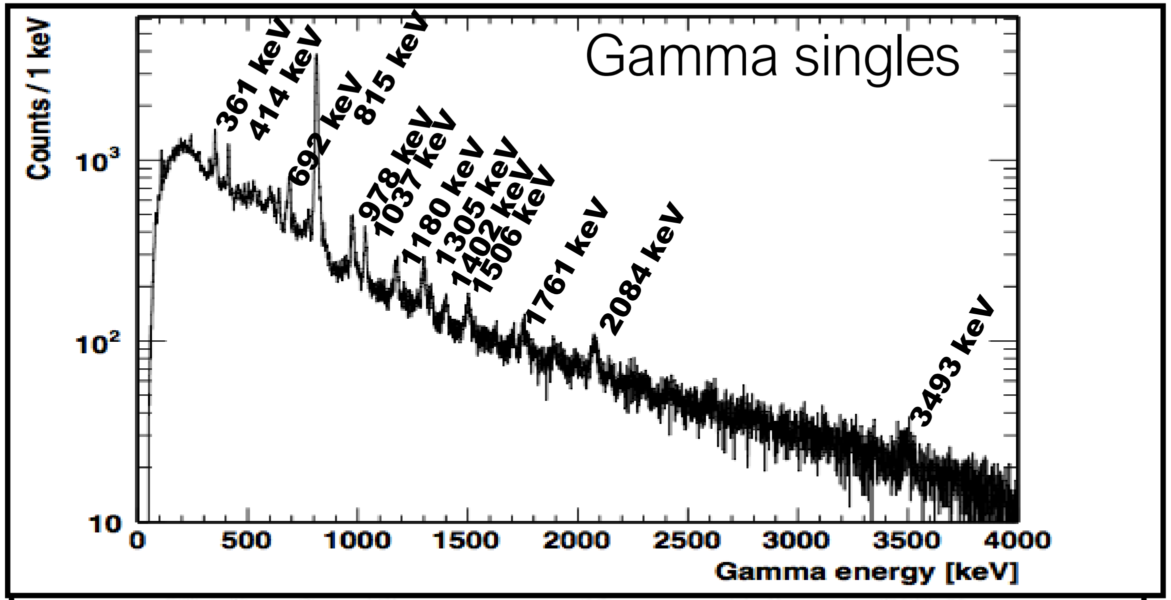
Particle ID from dE-E detectors

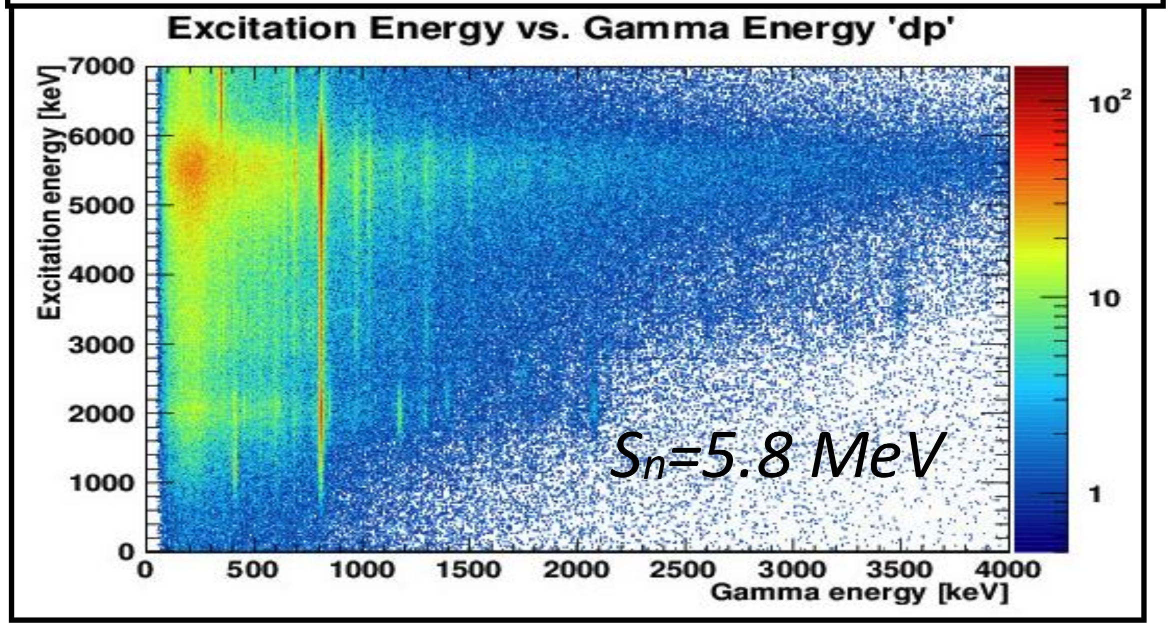


S. Cruz *et al*., Phys. Letts. B 786, 94 (2018); Phys. Rev. C **100**, 054321 (2019)

TIGRESS Data



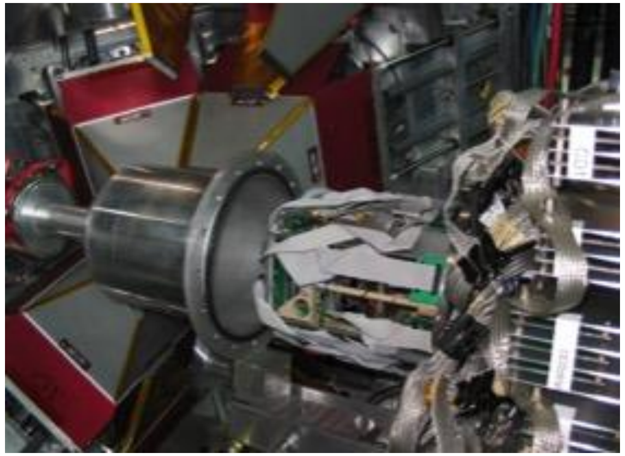


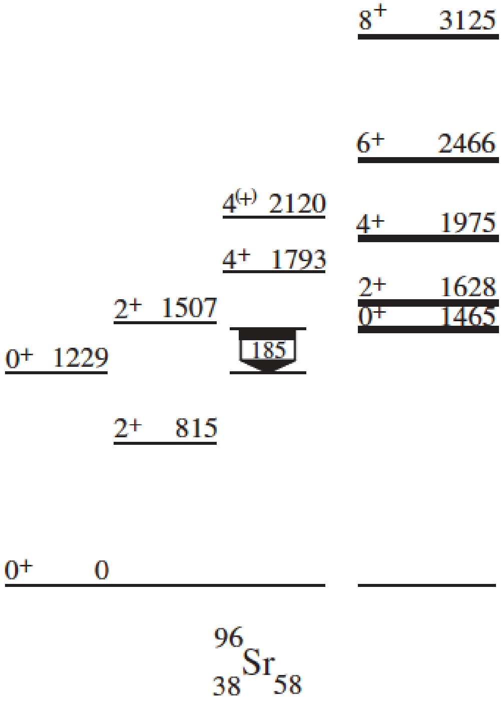


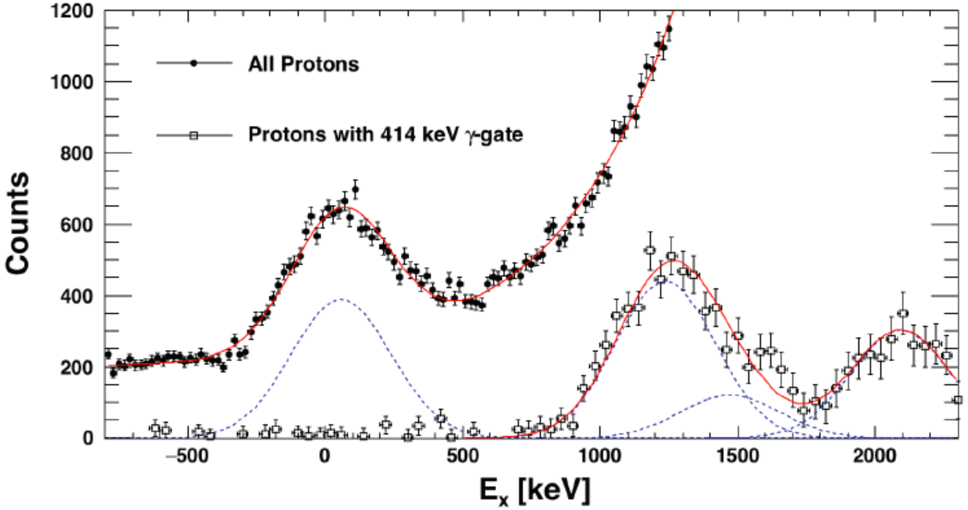
S. Cruz *et al*., Phys. Letts. B 786, 94 (2018); Phys. Rev. C **100**, 054321 (2019)

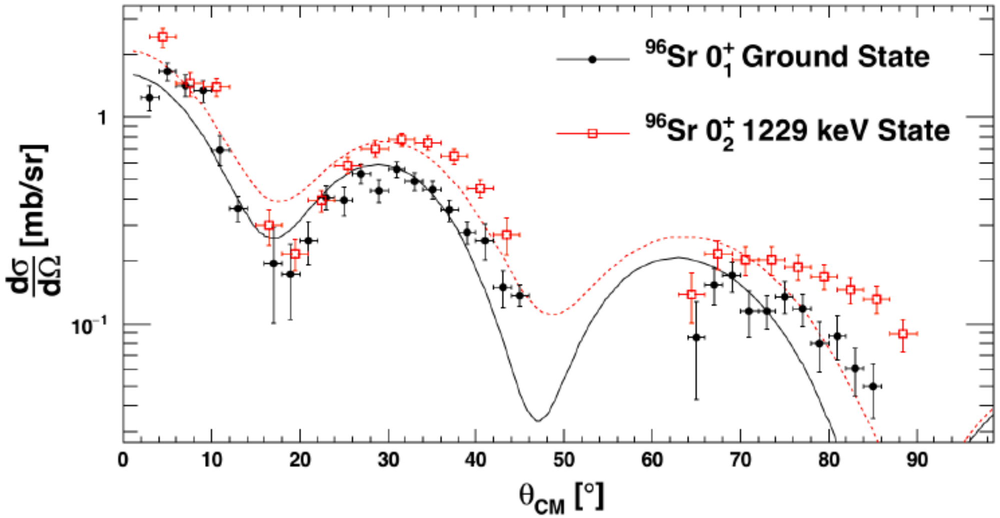
^{96}Sr $0_{1,2}^{+}$ States

- ^{95}Sr ground state is well described as a $\nu s_{1/2}$ spherical state
- spectroscopic factors of C^2S = 0.19(3), 0.22(3), and 0.33(12) for the 0^+_1 , 0^+_2 , and 0^+_3 states
- ^{96}Sr may exhibit triple shape coexistence, with a weakly deformed ground state, and two excited 0^+ configurations – a deformed and a spherical one – which undergo strong mixing.









S. Cruz *et al*., Phys. Letts. B 786, 94 (2018); Phys. Rev. C **100**, 054321 (2019)

New opportunities in the ARIEL era

- Greater reliability from the ARIEL target stations/modules and an independent driver

- Photo-fission
  - Cleaner neutron-rich beams, lying on or approaching *i*- and *r*-process paths

- Multiple RIB delivery
  - More capacity for experiments
  - More capacity for beam development of new species, higher intensities or cleanliness
  - Opportunity to schedule longer beamtimes

- Longer beamtimes
  - Precision experiments lasting weeks to 1 month+ become feasible e.g. FRANCIUM PNC (more precisely “Francium on Tap”), DRAGON & TUDA “complete” direct measurements, BeEST Sterile neutrino experiment “SuperBeEST Phase” etc
  - Opens opportunity for more accelerated beam experiments: DRAGON/TUDA, EMMA, TIGRESS, IRIS, + *External Users*

TRIUMF

Thank you
Merci

www.triumf.ca

Follow us **@TRIUMFLab**

Discovery, accelerated