ISOLDE News

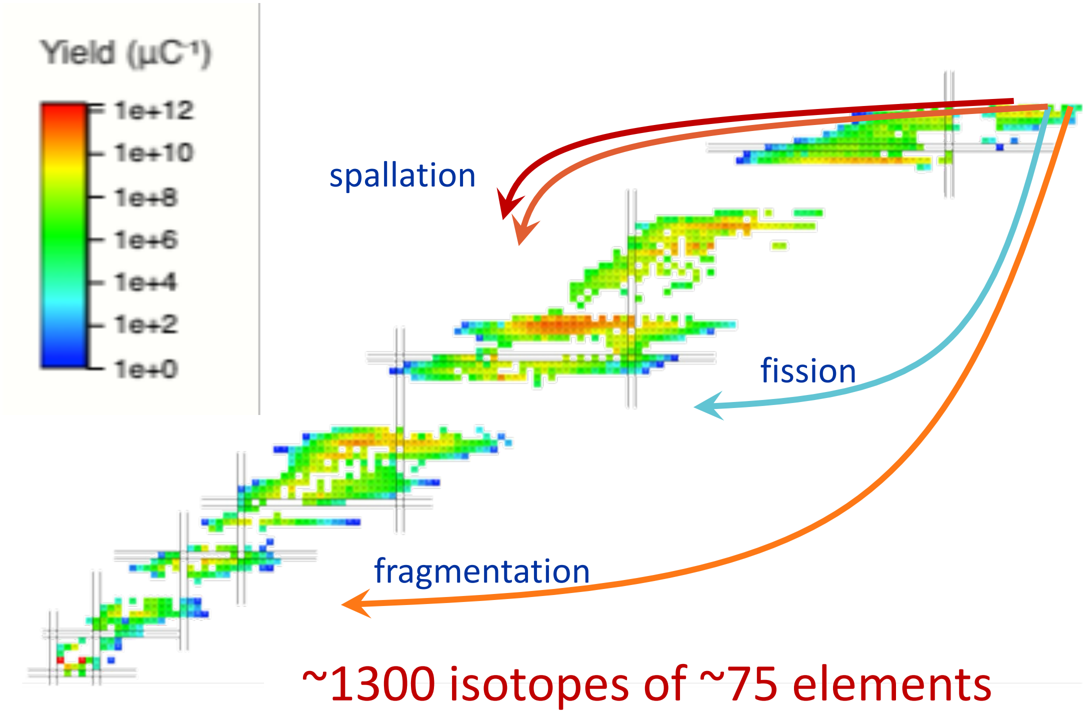
Luis Mario FRAILE
EP-SME-IS
ISOLDE Collaboration Spokesperson

ISOLDE Flagship European ISOL Radioactive Ion Beam Facility

The only radioactive ion beam facility using **GeV protons**, giving access fission, spallation, fragmentation for RIB production. *Impact from **p** energy and intensity*.

Diverse within the diversity: large user community and more than *15* state-of-the-art instruments: advanced laser spectroscopy, mass traps, detector arrays, spectrometers, reactions at the few MeV/u regime.

- Nuclear structure by **decay** and **reactions**
- Properties off stability, **shapes**, particle emission
- Nuclear **astrophysics** studies
- Interfacing atomic and nuclear physics
- Fundamental **interactions**, physics BSM
- **Masses** for fundamental properties, astrophysics
- Fission studies by reactions
- Condensed-matter physics and **material** science
- Radioisotopes for **medical** applications
- Life sciences and **biophysics**



ISOLDE and n_TOF Experiments Committee (INTC)

The ISOLDE PAC. The committee recommendations are transmitted by the Chairperson to the CERN **Research Board**, which takes final decisions on approval of experiments.

The INTC will review the ISOLDE (and n_TOF) programme, emphasis on the RUN3.
Prof. Marek Pfützner (Chair) has scheduled an open session on **11 February 2026**, followed by a closed session.

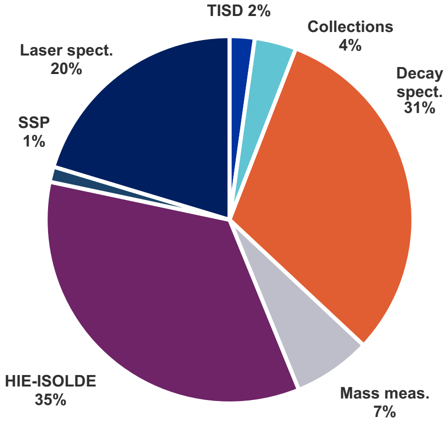
All shifts for experiments at ISOLDE will be zeroed.
The INTC will begin an in-depth assessment of the physics programme(s) during the CERN Long Shutdown 3 (LS3).

Prof. Silvia Leoni (University of Milan and INFN) has been appointed and will take over as a chair. Calls for proposals will follow.

https://committees.web.cern.ch/intc

The ISOLDE user community & the ISOLDE Collaboration

\# **621 active users** listed in the human resources database as of **30 November 2025**
\# And **983 users** appear in the CERN **Greybook**. https://greybook.cern.ch/
\# Users of >49 nationalities from >27 countries have come to ISOLDE in 2025



Expected about 450 shifts = 150 days **delivered** for experiments in 2025

Out of them 1/3 to HIE-ISOLDE

50 experiments served (12 HIE)

ISOLDE Collaboration: 17 members

ISOLDE Collaboration Spokesperson / EP-SME-IS July 2025

Chairperson of the ISCC since July 2025
Janne Pakarinen from the **University of Jyväskylä**

ISOLDE thesis award

An average of 14 PhD theses defended every year with work linked to ISOLDE

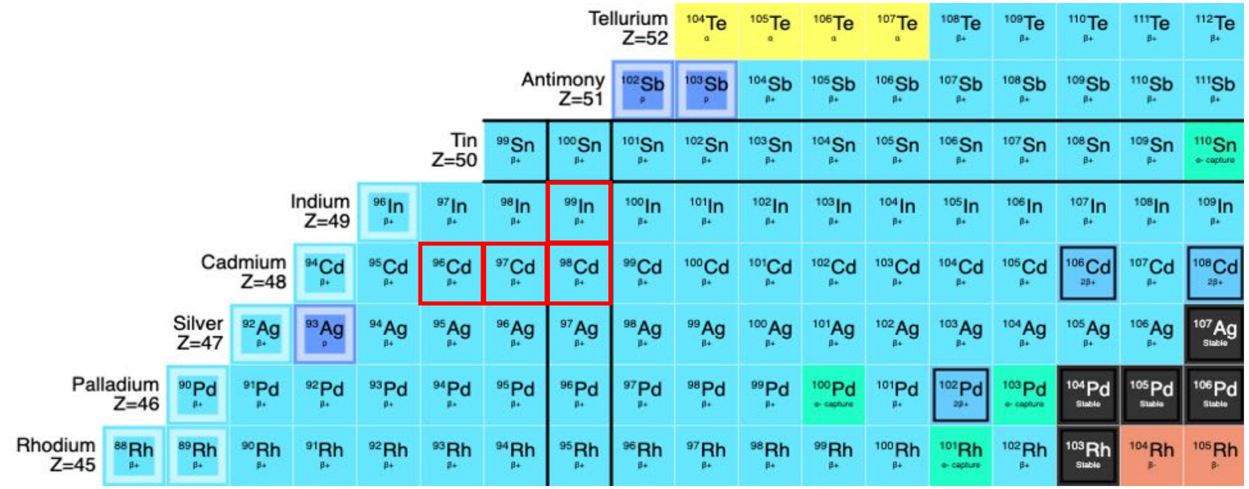
The **ISOLDE thesis award** will be granted by the ISOLDE collaboration to young scientists from institutions in ISCC members in recognition of outstanding research achievements connected to ISOLDE and associated with their PhD studies.

Selection committee:
Kara Lynch, Wilfried Nörtershäuser, Marek Pfützner and G. Georgiev

First call in **2026**, be prepared!
Details of the procedure will be announced later.

Highlights: expanding the limits of the nuclear chart

The most neutron-deficient nuclides in the ^{100}Sn region, at and *across* N=50



Nuclear structure at the edge

^{100}Sn is the heaviest self-conjugate doubly-magic nucleus stable with respect to particle emission

Close to proton dripline

Enhanced neutron-proton correlations when same orbitals are occupied, symmetries

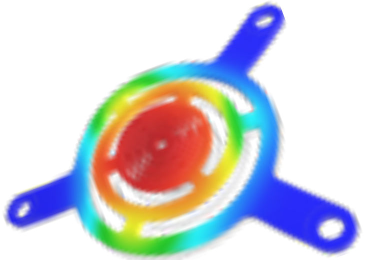
Astrophysical rp-process

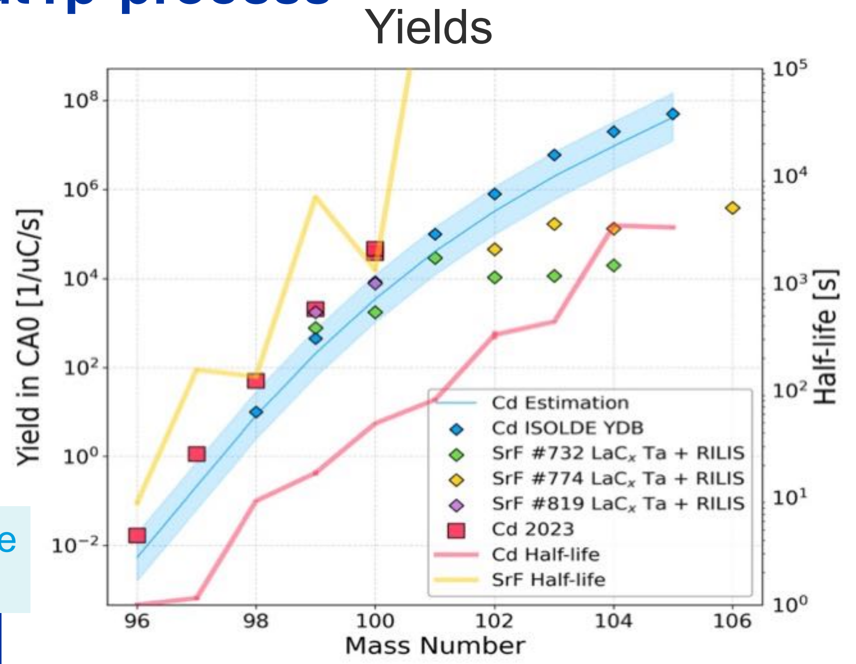
ISOLDE technical improvements since 2023

Prototype **LaC_x target** with improved heat-shielding and spider-web ion source

Benefit from exception to get **2.5 μA** proton **intensity**

Science in this area of the Nuclear Chart will benefit from the PSB 2.0-GeV (and intensity) upgrade



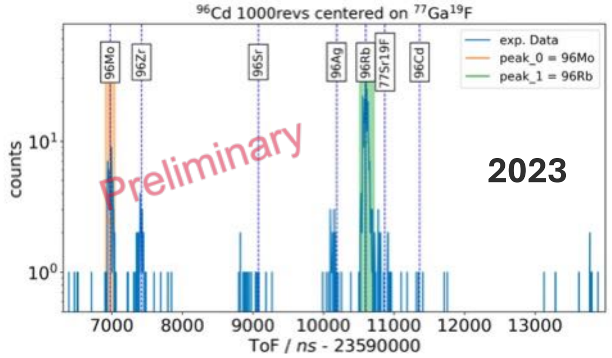


Mass measurements feasible with 0.01 ions per second!

Neutron-deficient Cd in 2025: masses & charge radii

ISOLTRAP: first mass measurement of ^{96}Cd and consolidated data for ^{98}Cd and ^{97g,m}Cd

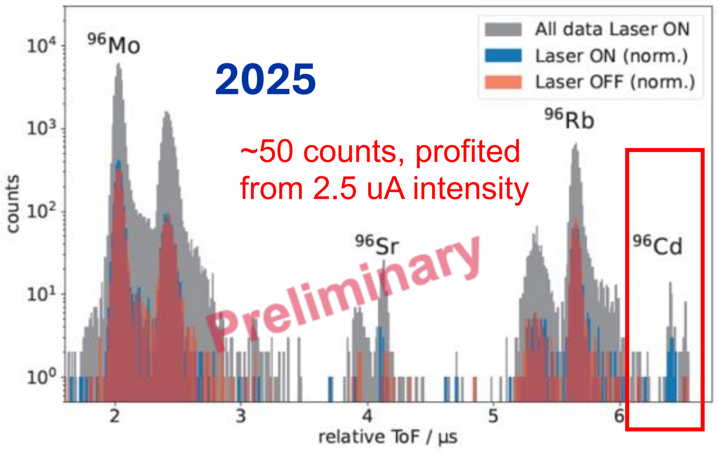
Ch. Schweiger *et al.*

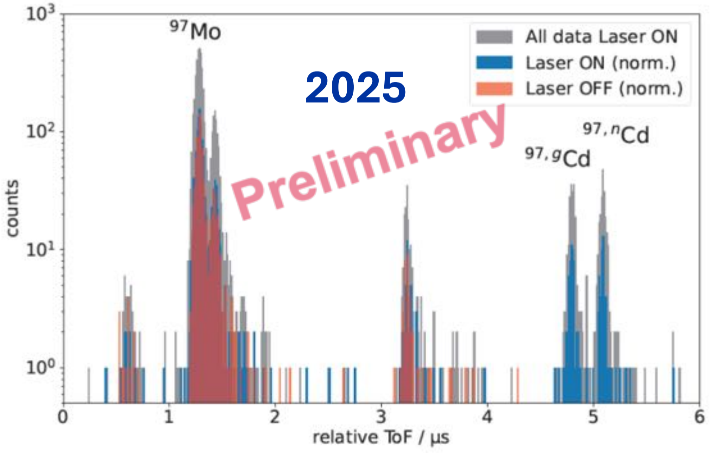


Lange, D. et al., in preparation

Efficiency improved in ISOLTRAP

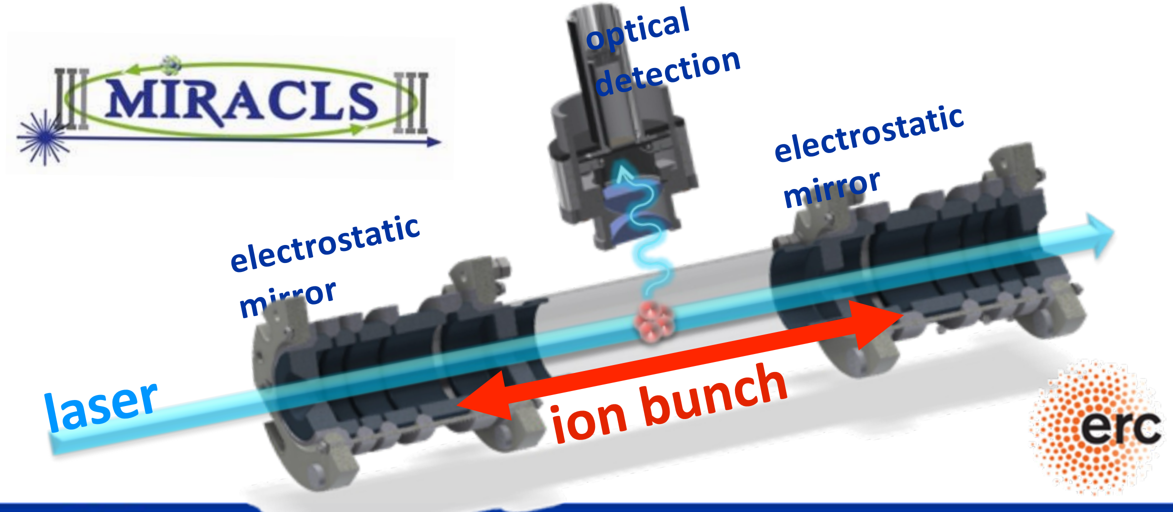
Experiment **IS745**
M. Mougeot et al.



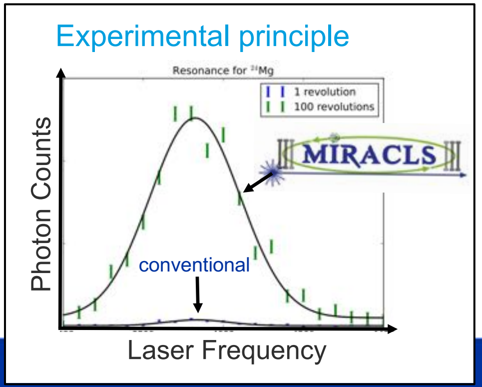


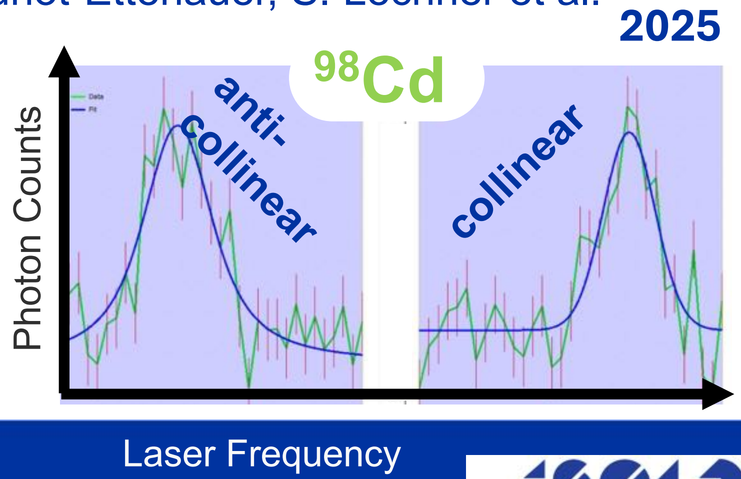
MIRACLS: first laser spectroscopy of ^{98}Cd

S. Malbrunot-Ettenauer *et al.*

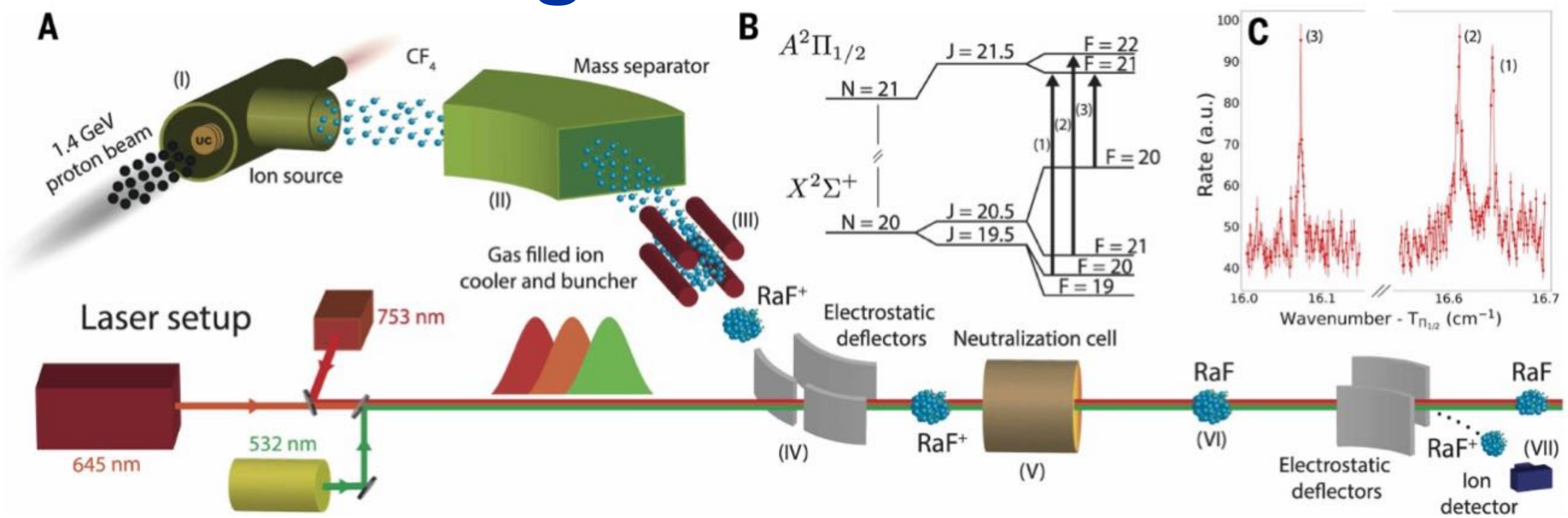


Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy
Experiment **IS775**, S. Malbrunot-Ettenauer, S. Lechner et al.





Nuclear magnetization in molecules



Science 390, 6771 Oct 2025

RESEARCH ARTICLES

NUCLEAR PHYSICS

Observation of the distribution of nuclear magnetization in a molecule

S. G. Wilkins[1]*†, S. M. Udrescu[1]*†, M. Athanasakis-Kaklamanakis[2,3], R. F. Garcia Ruiz[1]*, M. Au[4,5], I. Belošević[6], R. Berger[7], M. L. Bissell[8], A. A. Breier[9], A. J. Brinson[1], K. Chrysalidis[4], T. E. Cocolios[3], R. P. de Groote[3], A. Dorne[3], K. T. Flanagan[8,10], S. Franchoo[11], K. Gaul[7], S. Geldhof[3], T. F. Giesen[9], D. Hanstorp[12], R. Heinke[4], T. Isaev[13], Á. Koszorús[2], S. Kujanpää[14], L. Lalanne[3], G. Neyens[3], M. Nichols[12], H. A. Perrett[8], J. R. Reilly[8], L. V. Skripnikov[13], S. Rothe[4], B. van den Borne[3], Q. Wang[15], J. Wessolek[8], X. F. Yang[16], C. Zülch[7]

Laser spectroscopy and CP-violation sensitivity of actinium monofluoride, arXiv:2507.05224

nature communications

Article

https://doi.org/10.1038/s41467-025-55977-w

Electron correlation and relativistic effects in the excited states of radium monofluoride

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Check for updates

M. Athanasakis-Kaklamanakis[1,2,3], S. G. Wilkins[4,5], L. V. Skripnikov[25], Á. Koszorús[1,2], A. A. Breier[6,7], O. Ahmad[2], M. Au[8,9], S. W. Bai[10], I. Belošević[11], J. Berbalk[2], R. Berger[12], C. Bernerd[8], M. L. Bissell[13], A. Borschevsky[14], A. Brinson[4], K. Chrysalidis[8], T. E. Cocolios[2], R. P. de Groote[2], A. Dorne[2], C. M. Fajardo-Zambrano[2], R. W. Field[15], K. T. Flanagan[13,16], S. Franchoo[17,18], R. F. Garcia Ruiz[4,5], K. Gaul[12], S. Geldhof[2], T. F. Giesen[7], D. Hanstorp[19], R. Heinke[8], P. Imgram[2], T. A. Isaev[25], A. A. Kyuberis[14], S. Kujanpää[20], L. Lalanne[1,2], P. Lassègues[2], J. Lim[3], Y. C. Liu[10], K. M. Lynch[13], A. McGlone[13], W. C. Mei[10], G. Neyens[2], M. Nichols[19], L. Nies[1], L. F. Pašteka[14,21], H. A. Perrett[13], A. Raggio[20], J. R. Reilly[13], S. Rothe[8], E. Smets[2], S.-M. Udrescu[4], B. van den Borne[2], Q. Wang[22], J. Warbinek[23,24], J. Wessolek[8,13], X. F. Yang[10] & C. Zülch[12]

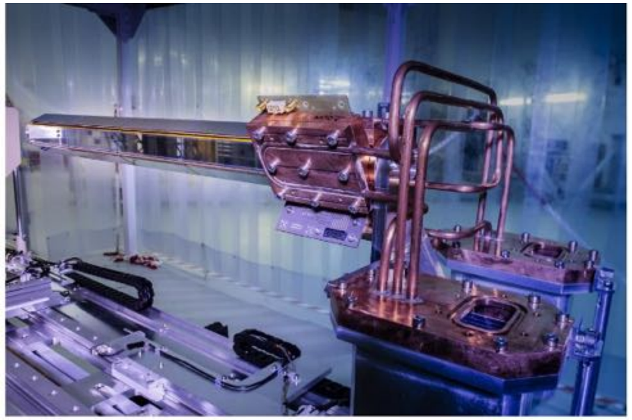
Fundamental symmetries

Symmetry violation via precision molecular spectroscopy of molecules containing heavy radioactive nuclei at **ISOLDE**

Hyperfine structure of **^{225}RaF** and calculations to test magnetization distribution within the radium nucleus.

Results pave the way for sensitive tests of fundamental symmetries using short-range electron-nucleus interaction

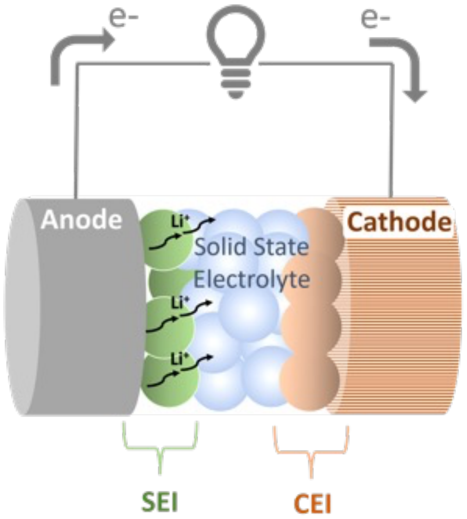
Many highlights to be presented in the workshop



IS739 Study of fission properties of neutron-rich nuclei for r-process nucleosynthesis using inverse-kinematics (d,p) transfer at ISS.

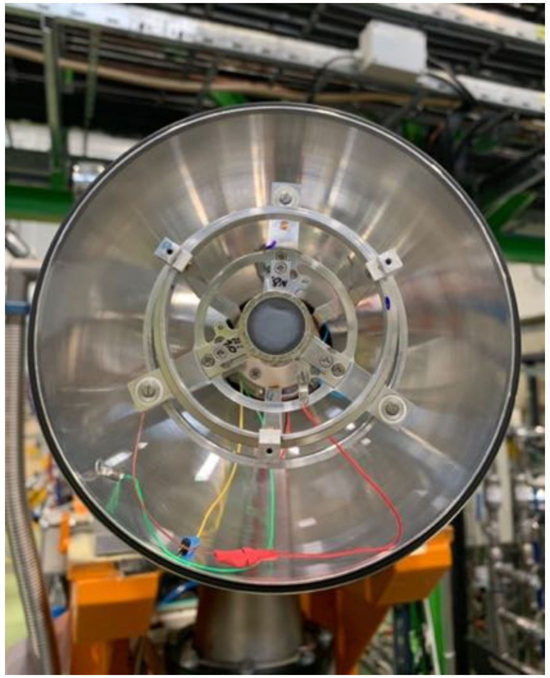
IS709 Shape coexistence in n-rich Sr isotopes via 0^+ states and E0 transitions from Rb β decay using γ–γ angular correlations and SPEDE internal conversion spectroscopy.

IS764 Investigation of bulk and interfacial diffusion of ^{8}Li and Li$^+$ ion dynamics in solid-state Li battery materials using β-NMR with polarized beams



IS702 Study of the evolution of quadrupole collectivity near the N = 82 shell closure by measuring Q moments and B(E3) values via Coulomb excitation.

IS676, IS761 & **IS774** Recoil distance Doppler-shift method together with Miniball for excited-state lifetimes (plunger campaign)



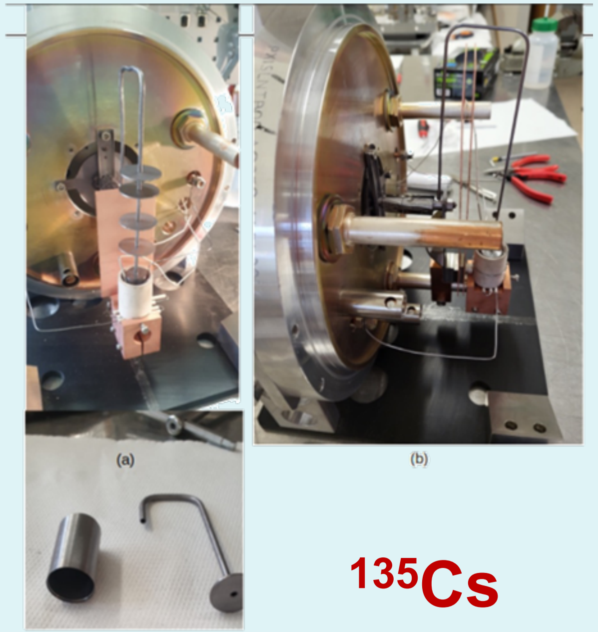
ISOLDE synergies

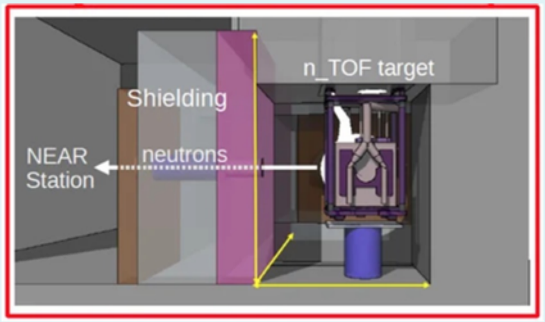
n_TOF

(n,gamma) reactions on unstable isotopes relevant to s- and i- processes of stellar nucleosynthesis

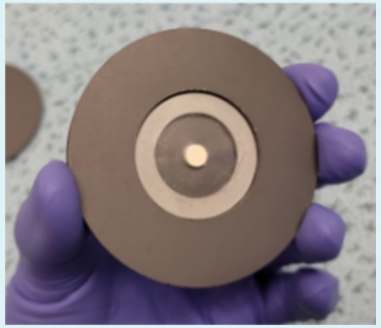
Targets produced at ISOLDE (**IS721** for Cs)

Measure MACS at n_TOF (NEAR)





^{135}Cs



Among the **21 key s-nuclei** listed in Kaeppeler, *Rev. Mod. Phys* 83, 157 (2011)

AD PUMA

Annihilation of antiprotons with short-lived exotic nuclei to probe surface proton–neutron densities and reveal features such as neutron skins or nuclear halos.

Heavy ion collisions

Nuclear **shapes** are studied at ISOLDE by combining high-resolution decay spectroscopy with selective reaction techniques such as Coulomb excitation. They provide sensitive, model-independent constraints on deformation and shape coexistence.

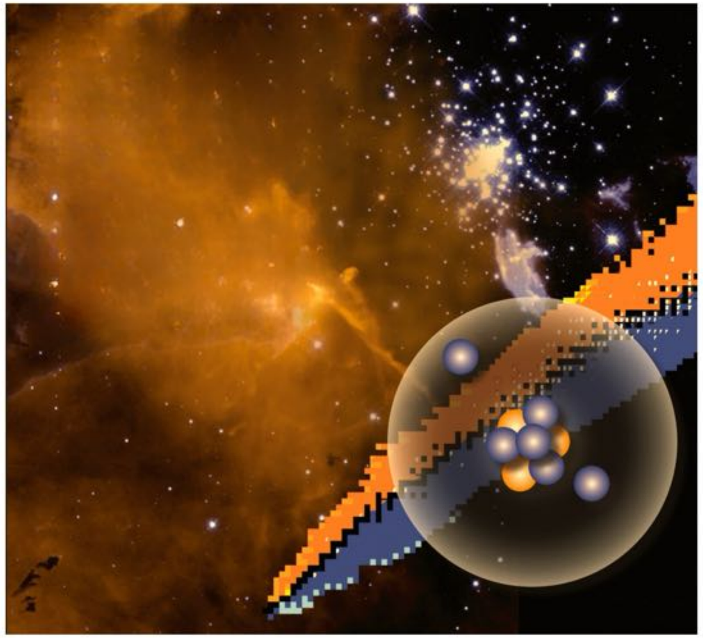
Science communication and public engagement

CERN EP Newsletter https://ep-news.web.cern.ch/
CERN *homepage* updates
Featured pieces of news on **CERN webpage**

ISOLDE visits in 2025:
202 visits, 2109 visitors, 198 groups

Decoding r-Process Nucleosynthesis: Precision Studies of Exotic Indium Isotopes at ISOLDE

James Cubiss (University of Edinburgh), Robert Grzywacz (University of Tennessee Knoxville) 24th Jun 2025



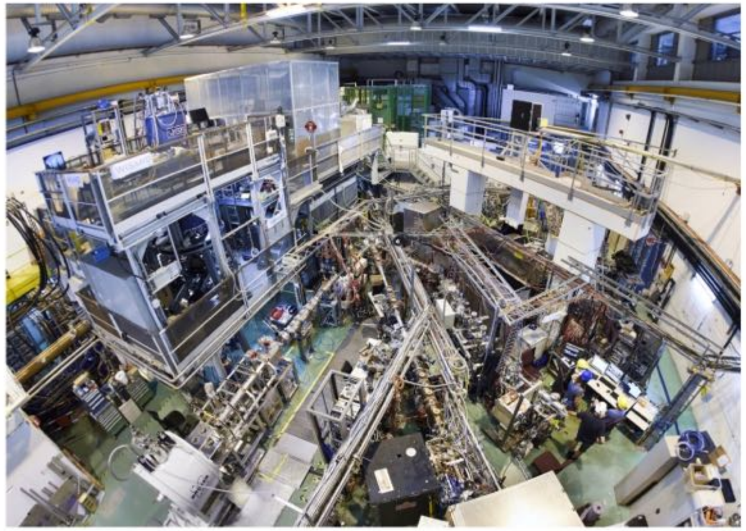
ISOLDE

How are the chemical elements synthesised in stellar environments? Which processes lead to their creation? What impact does nuclear physics have on their production? Describing the origins of the chemical elements and their observed abundances remains one of the most significant challenges in modern physics [1]. In particular, modelling the production of elements heavier than iron has proven difficult, with the heaviest elements such as gold, lead, and uranium thought to be produced in the exotic "rapid neutron capture" or "r-process" [2]. This process is currently poorly understood, with the first observational evidence for it having only recently been reported [3], following the GW170817 neutron-star merger [4]. It is now thought that these cataclysmic events are one of the primary sources of r-process nucleosynthesis, with each event producing masses of gold roughly equal to that of our own planet.

EP Newsletter of the EP department

ISOLDE charts the shores of the islands of inversion

Panos Charitos 1st Oct 2025

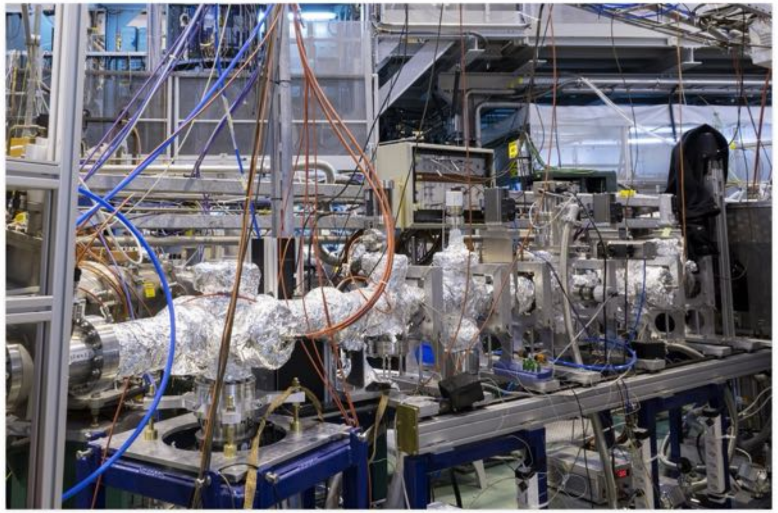


For decades, CERN's ISOLDE (Isotope Separator On-Line Device) facility has been a global leader in exploring the behaviour of exotic nuclei far from stability. By delivering beams of short-lived isotopes and enabling their study with advanced spectroscopic techniques, ISOLDE has expanded our view on nuclear structure and reshaped our understanding of how protons and neutrons organise themselves inside the nucleus.

Molecules of pear-shaped atomic nuclei bear fruit

A new ISOLDE study of molecules containing pear-shaped atomic nuclei helps shape future research aimed at testing fundamental symmetries of nature

23 OCTOBER, 2025 | By Ana Lopes

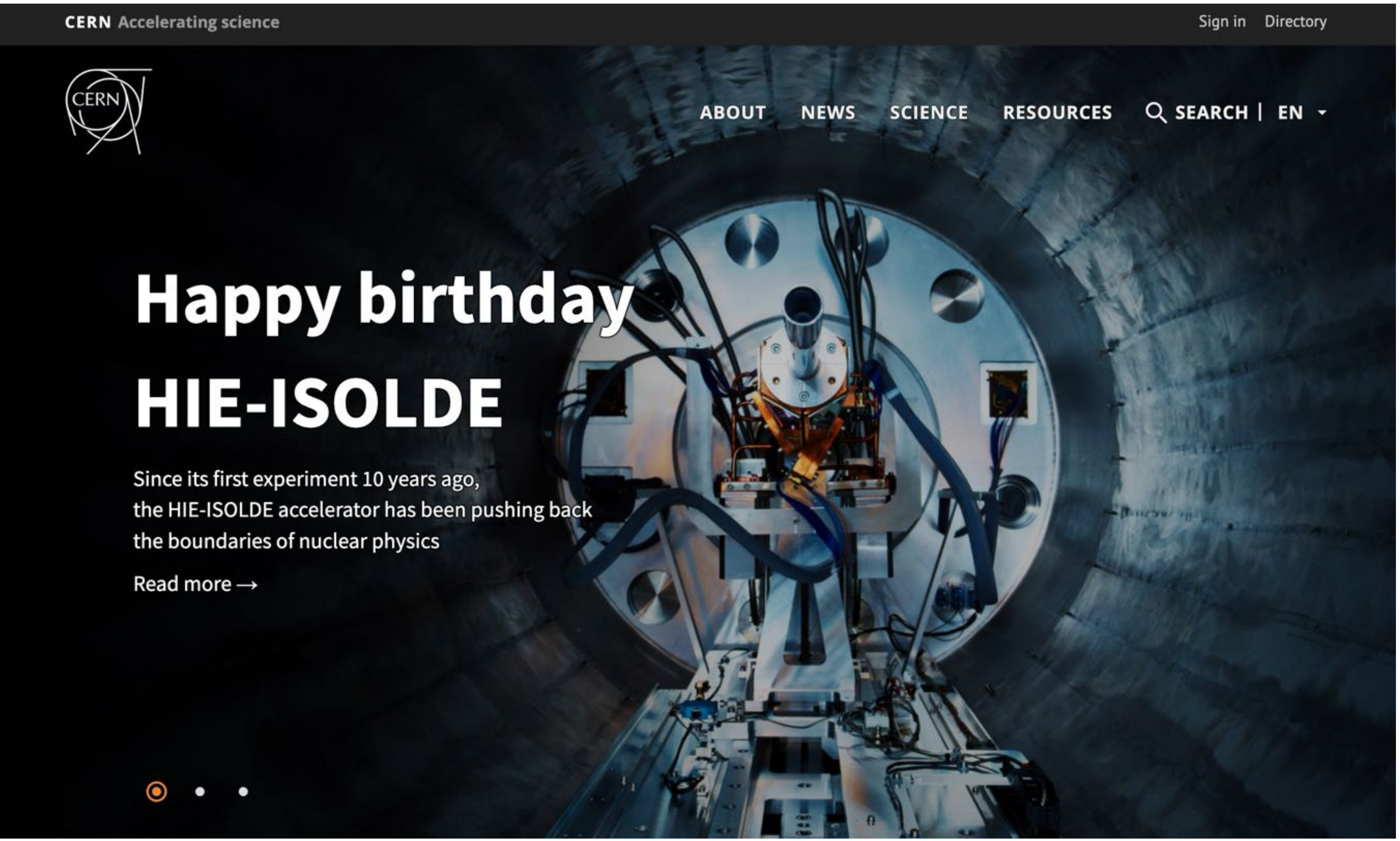


The collinear resonance ionisation spectroscopy (CRIS) apparatus at the ISOLDE facility. (Image: CERN)

Most atomic nuclei are round or the shape of a rugby ball. But some have been found to have a more exotic pear shape, with more mass at one end than the other.

Writing in the journal *Science*, an international team of researchers describes how a combination of theoretical calculations and measurements of a molecule containing a pear-shaped nucleus, radium monofluoride ($^{225}Ra^{19}F$), has borne fruit.

Ter



HIE-ISOLDE: 10 years, 10 highlights

Since its first experiment in 2015, HIE-ISOLDE has been pushing back the boundaries of nuclear physics

The Isotope Separator On-Line facility (ISOLDE) directs a proton beam from the Proton Synchrotron Booster (PSB) onto specially developed thick targets, producing low-energy beams of radioactive nuclei – those with too many or too few neutrons to be stable. These beams can be further accelerated to energies of up to 10 MeV per nucleon using the HIE-ISOLDE linear

5

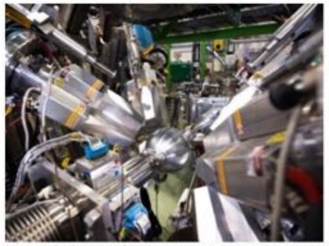
accelerator, enabling a wide range of studies. The HIE-ISOLDE beams are sent to three experimental stations: the Miniball array of high-purity germanium gamma-ray detectors, the ISOLDE solenoid spectrometer (ISS), which repurposed a former MRI magnet, and the scattering experimental chamber (SEC), used for a broad variety of physics experiments. Since its first experiment in October 2015, HIE-ISOLDE has been pushing back the boundaries of nuclear physics. To celebrate its 10th anniversary, we look back at ten key achievements that have defined its first decade.

The HIE-ISOLDE accelerator in 2016. (Image: CERN)

The first HIE-ISOLDE experiment

The first experiment at HIE-ISOLDE, conducted in October 2015, accelerated a radioactive beam of neutron-rich zinc nuclei to 4 MeV per nucleon, using the new superconducting linear accelerator, and delivered it to the Miniball station. The beam's higher energy compared to that of REX-ISOLDE, the predecessor to HIE-ISOLDE, allowed researchers to study high-energy states of these nuclei in unprecedented detail and to compare the results with state-of-the-art theoretical models.

and searching for physics beyond the Standard Model. In 2019, researchers reported a study using HIE-ISOLDE beams of ^{224}Rn and ^{226}Rn at Miniball that revealed that, unlike ^{224}Ra, which was studied at the earlier accelerator REX-ISOLDE, these radon nuclei do not maintain static pear shapes in their ground states. Instead, they vibrate between a pear shape and its mirror image, offering less sensitivity in searching for new physics than ^{224}Ra.



The Miniball array of high-purity germanium gamma-ray detectors in 2025. (Image: CERN)

The ISS magnet: from MRI to nuclear physics

In 2016, a decommissioned MRI magnet travelled across the seas from Australia to CERN for a second life as the heart of the ISOLDE Solenoidal Spectrometer (ISS). ISS received its first beams in 2018 and was fully commissioned in 2021. Since then, it has studied 20 different nuclear species, from heavy nuclei like ^{212}Rn to light ones such as ^{11}Be, showcasing the wide range of nuclei available at ISOLDE.

HIE-ISOLDE: 10 years, 10 highlights

https://phys.org/news/2025-12-hie-isolde-ten-years-highlights.html

Since its first experiment in 2015, the HIE-ISOLDE accelerator has been pushing back the boundaries of nuclear physics

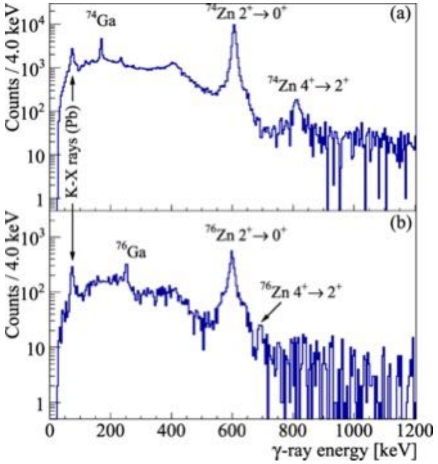
27 November, 2025

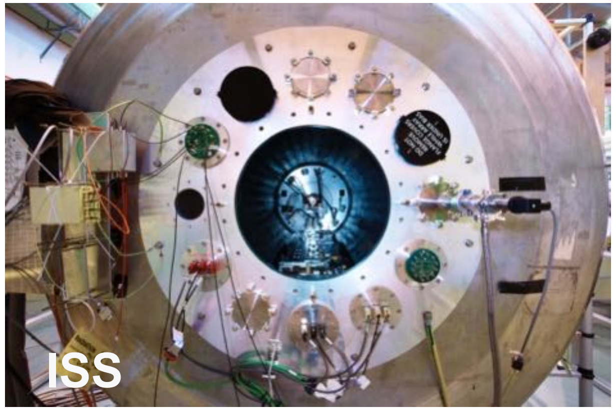
https://home.cern/news/news/accelerators/hie-isolde-10-years-10-highlights

10 years of the first HIE-ISOLDE experiment

October 2015: **Coulomb excitation of ^{74,76}Zn**, A. Illana, M. Zielińska, M. Huyse *et al.*

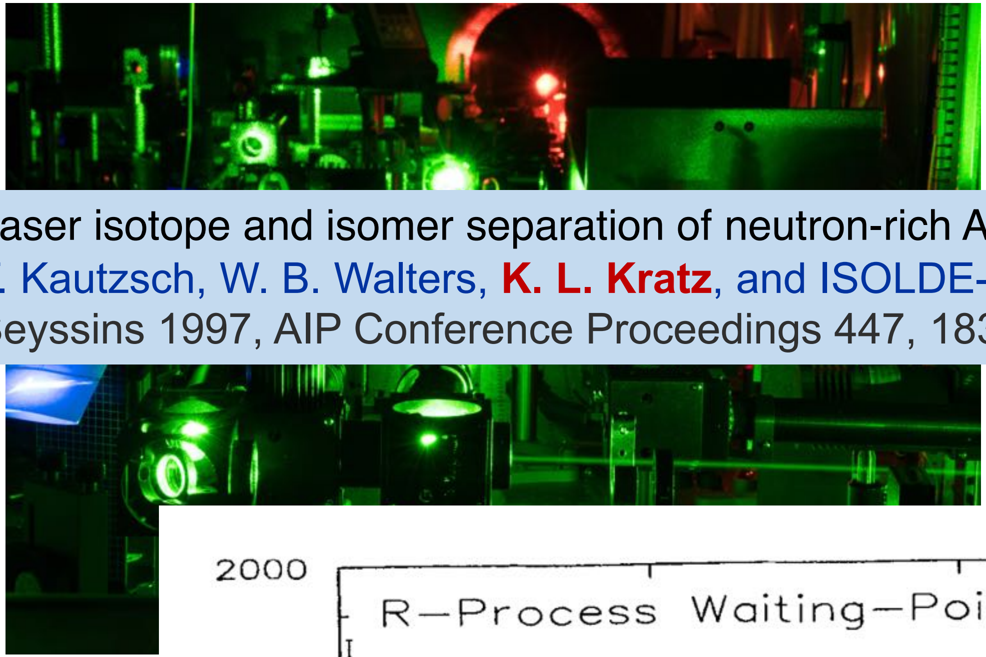
4 MeV/u with 1 cryomodule, Miniball





Consolidation during LS3

RILIS: HFS



Laser isotope and isomer separation of neutron-rich Ag-isotopes

T. Kautzsch, W. B. Walters, **K. L. Kratz**, and ISOLDE-IS333-Collaboration

Seyssins 1997, AIP Conference Proceedings 447, 183 (1998)

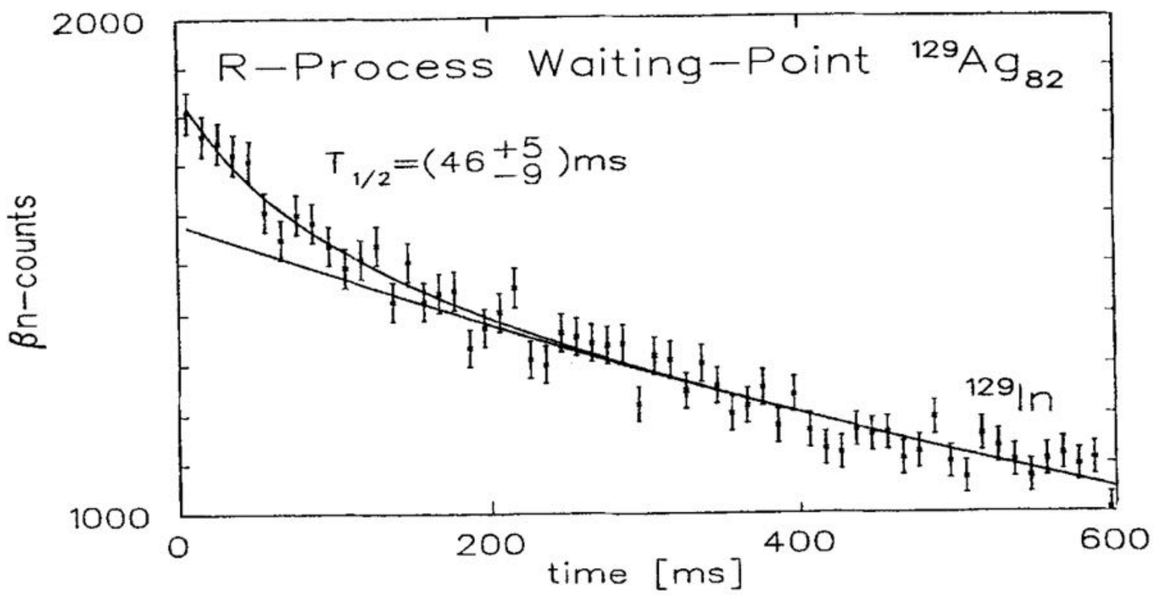
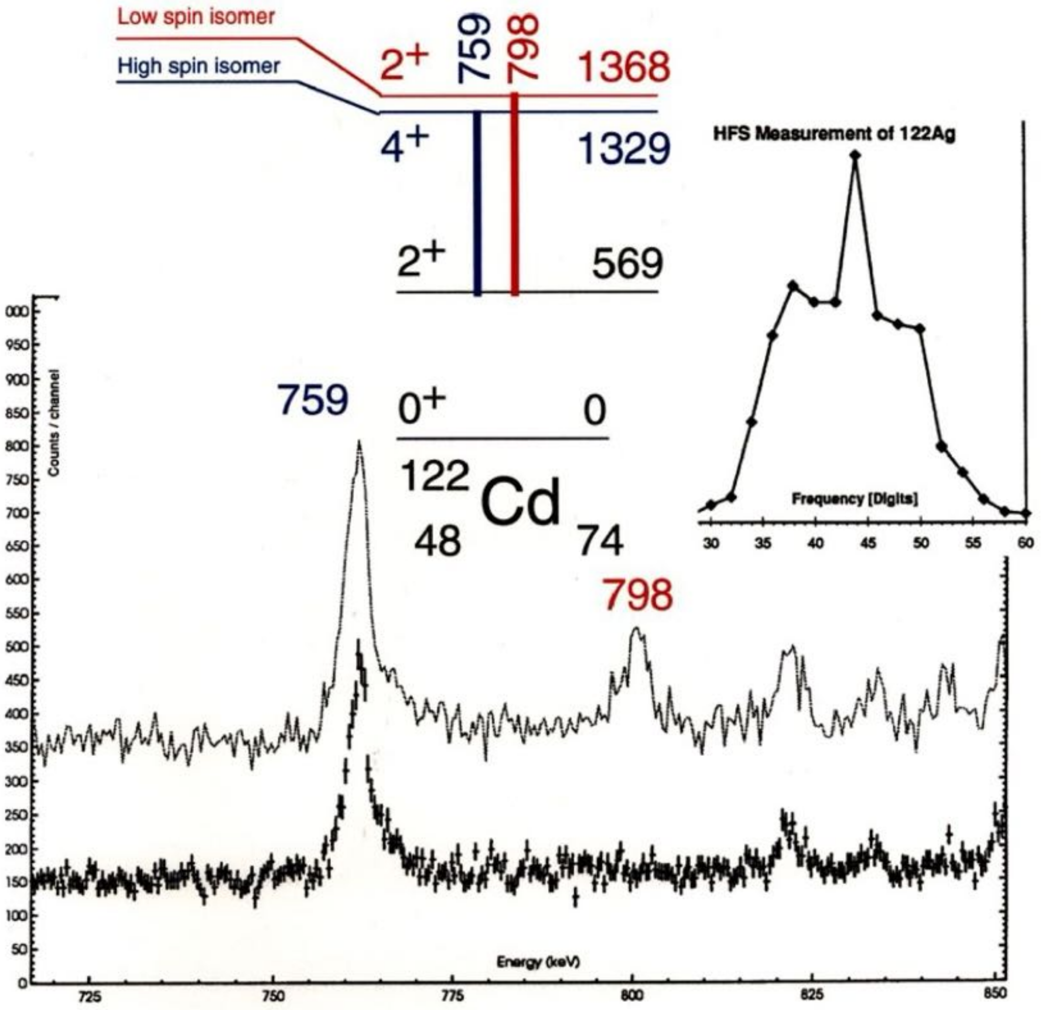


Figure 5: Beta delayed neutrons from the decay of ^{129}Ag

Part of the γ-ray spectrum of the decay of Ag-122 isomers.

The upper spectrum was taken with the laser frequency set at 44 and may be compared with the lower spectrum which was taken with the laser set at 36. The gamma ray at 798.4 keV is attributed to the decay of the 2_2^+ level to 2_1^+ level whereas the line at 759 keV is attributed to the decay of the 4_1^+ level to 2_1^+ level.



Remembering **Karl-Ludwig Kratz**

German nuclear chemist and astrophysicist (23 April 1941 – 23 March 2025)

- Pioneered methods connecting the structure of exotic nuclei to the cosmic abundances of elements, focusing on **r-process** nucleosynthesis in stellar explosions.
- Led developments of **laser ionization techniques** at ISOLDE, enabling some of the first experiments with r-process nuclei.
- His work laid the foundation for modern r-process research at radioactive beam facilities worldwide.

Honored with the **Glenn T. Seaborg Award** (1999) and the **Hans A. Bethe Prize** (2014) for contributions to nuclear chemistry and nuclear astrophysics.

https://www.jinaweb.org/news/karl-ludwig-kratz-1941-2025

Thanks to Bill Walters!

LS3, offline activities and the ISOLDE improvements programme

LS3 for ISOLDE starts 8 December 2025

Window of opportunity for **offline** and **standalone** operation of experiments Feb to Aug 2026 **continue physics programme** with long-lived sources (ILL, MEDICIS…)

Many other activities going on in the ISOLDE hall, requires coordination

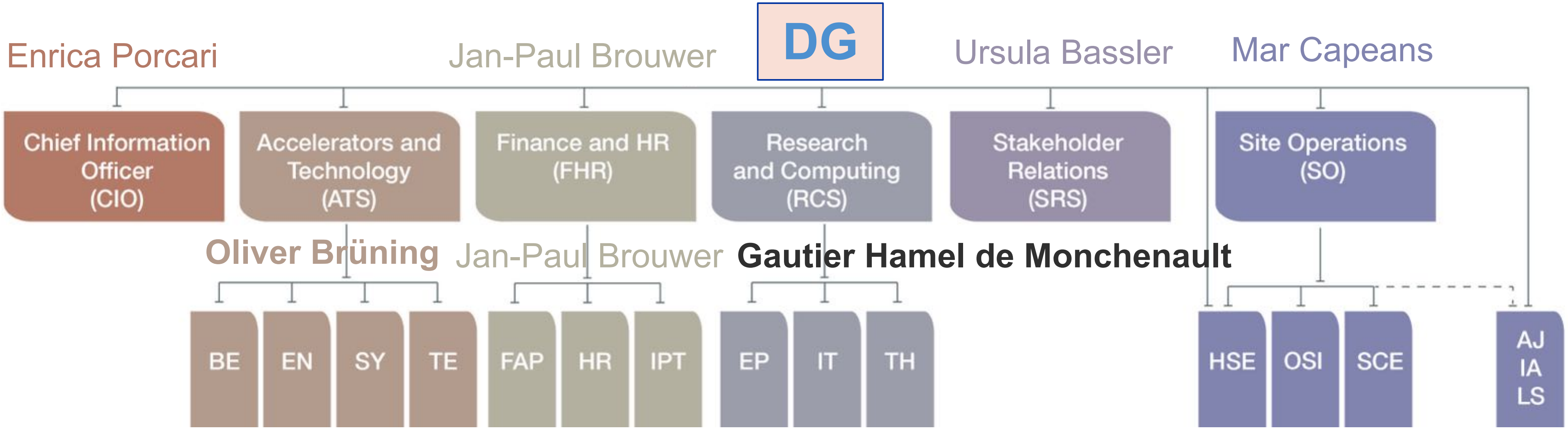
ISOLDE improvements programme

Funding secured via mid-term plans and consolidatio
ISOLDE collaboration contributions

- **ISOLDE beam dump replacement project**
- Upgrade of BTY line to 2 GeV
- Mass separators and low and low energy transfer lines
- Superconducting HIE LINAC, including manpower (urgent, impacting science)
- REX LINAC and preparation traps (mostly not funded but essential)
- Beam development and manipulation

CERN management structure for 2026–2030

Mark Thomson, Director-General Designate:
"CERN's main scientific priorities for 2026–2030 will be Completing the High Luminosity LHC (HL-LHC) and the timely completion of the upgrades of the ATLAS and CMS experiments… …. …. ….. …. Developing a long-term vision and roadmap to exploit the **CERN injector complex**, in order to deliver an exciting, **diverse programme of experiments for Physics Beyond Colliders**."



Malika Meddahi will lead Beams (BE)
Said Atieh will lead Engineering (EN)
Roberto Losito will lead Accelerator Systems (SY)
Rhodri Jones will lead Technology (TE)

Giovanna Lehmann will lead Experimental Physics (EP)
Simone Campana will lead Information Technology (IT)
Urs Wiedemann will lead Theoretical Physics (TH)

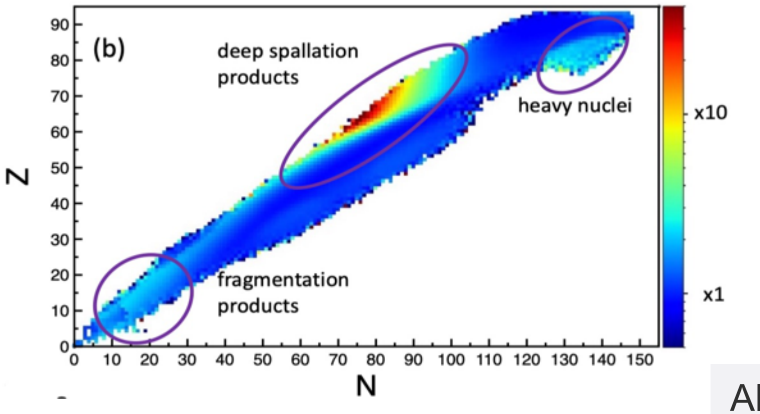
Group leaders also appointed

ISOLDE prospects and challenges

New beam dumps: **2 GeV**, **6 μA** as <u>design</u> aim

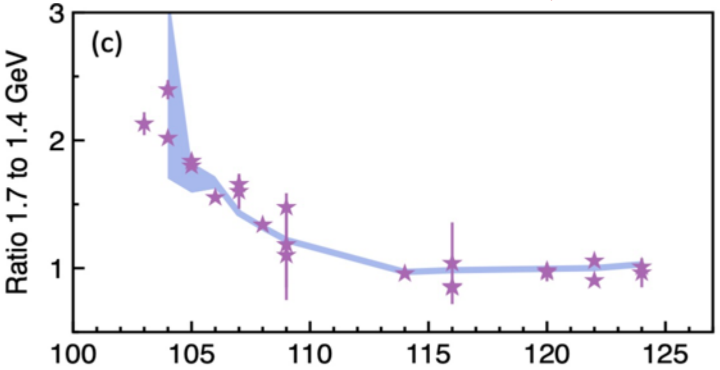
Profit from energy increase for certain production mechanisms, proven @ 1.7 GeV

Profit from intensity increase to extend reach to exotic nuclei (proven by 2.5 μA)



1.4-GeV to 2-GeV increases:

- fragmentation products x2 to x5.
- exotic spallation products **>x6**.
- heavier nuclei x2 to x5.
- minor increase for fission fragments.



Already with PSB x2 in intensity, across all isotopes, new beam dumps (targets, FEs) this makes an order of magnitude jump for exotic cases: new reach, **discovery potential**

Challenges:

Get **HIE-ISOLDE** fully operational, complete upgrades (i.e. front-ends during LS4)

Limited space constrains the development and expansion of physics programme

Operational and scheduling flexibility, increased **capacity** (i.e. beam switching)

Proton availability: ISOLDE most potentially impacted by SHiP, studies ongoing

Continue world-leading nuclear-physics programmes unique to CERN **post LHC**

Future Science with RIBs @CERN

Broad Science Programme

Continue research on key topics and emerging Science

Highlighted and endorsed by NuPECC **Long-range plan 2024**

Unique opportunities for more than 10 years

Potential for much longer science programmes

Precision ground-state and decay properties of **very exotic nuclei**: structure, astrophysics, isotopes, neutrinos

Polarized beams: nuclear spins, β-NMR, protein folding in biological fluids, diffusion in solids

Radioactive molecules for fundamental physics searches

Opportunities with precision **mass measurements** for **fundamental symmetries**

Increase capabilities by increased yields of most exotic; isotope purity and yields; **TISD**; consistent running

New **instruments**, i.e. HISTARS, ISRS at HIE/ISOLDE

Physics cases for a **RIB storage ring** remain valid

Synergies with other programmes: **AD** (PUMA), **n_TOF**

Still very competitive across the nuclear chart for >10 years vs. other facilities (i.e. the *projected* FRIB reaccelerated beams at 400 kW in the 2030s).

EPJ+ **Focus issue on ISOLDE**

The ISOLDE programme
Original papers, including reviews, research articles, technical papers…
Future plans and upgrades can be included

Editors-in-Chief: Beatrice Fraboni (Bologna), Gastón García López (CMAM Madrid)
Managing Editors: Anders Kastberg (Nice), Eugenio Nappi (Bari), …
Guest editors: LM Fraile, **Marek Pfützner**, **Janne Pakarinen**, **Klaus Blaum**

Online, with hybrid publishing model. Option for printout.
Guest editors to handle manuscripts and take editorial decisions.
Open very soon! Final submission date **September 2026**

ISOLDE Workshop and Users meeting 2025
Dec 3 – 5, 2025
CERN, Room **222/R-001**
https://indico.cern.ch/event/1576520/

Prizes, donated by CAEN, will be awarded for the best young speakers and the best posters presented at the workshop poster session.

Welcome!