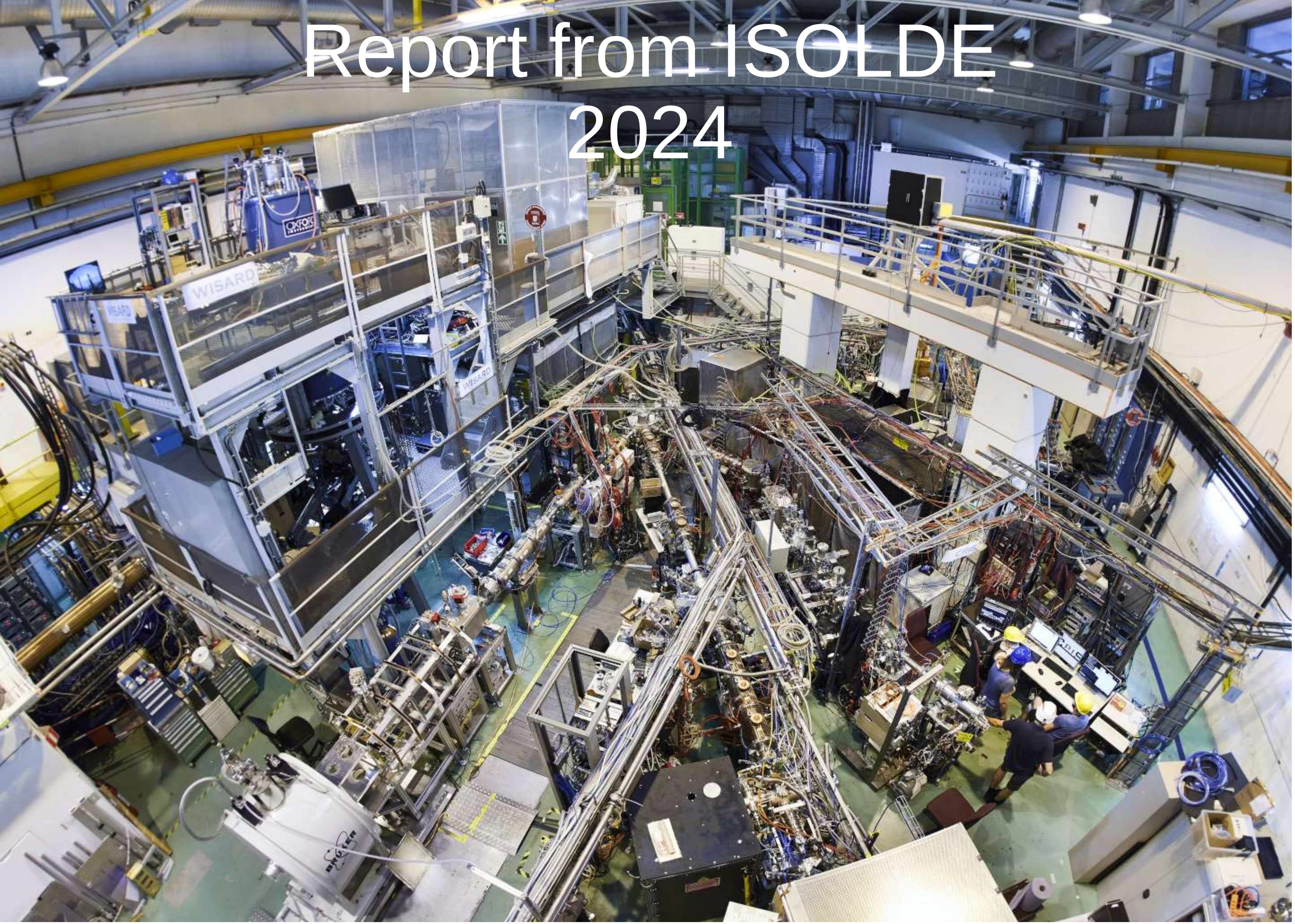
Report from ISOLDE 2024



W. Nörtershäuser

TECHNISCHE
UNIVERSITÄT
DARMSTADT

Thanks to

T. Lellinger

T. Kröll

N. Pietralla
H. Mayr, T. Stetz

P. Reiter

L. Schweikhard
C. Schweiger

A. Obertelli
F. Wienholtz
L. Niess

ISOLDE 2024

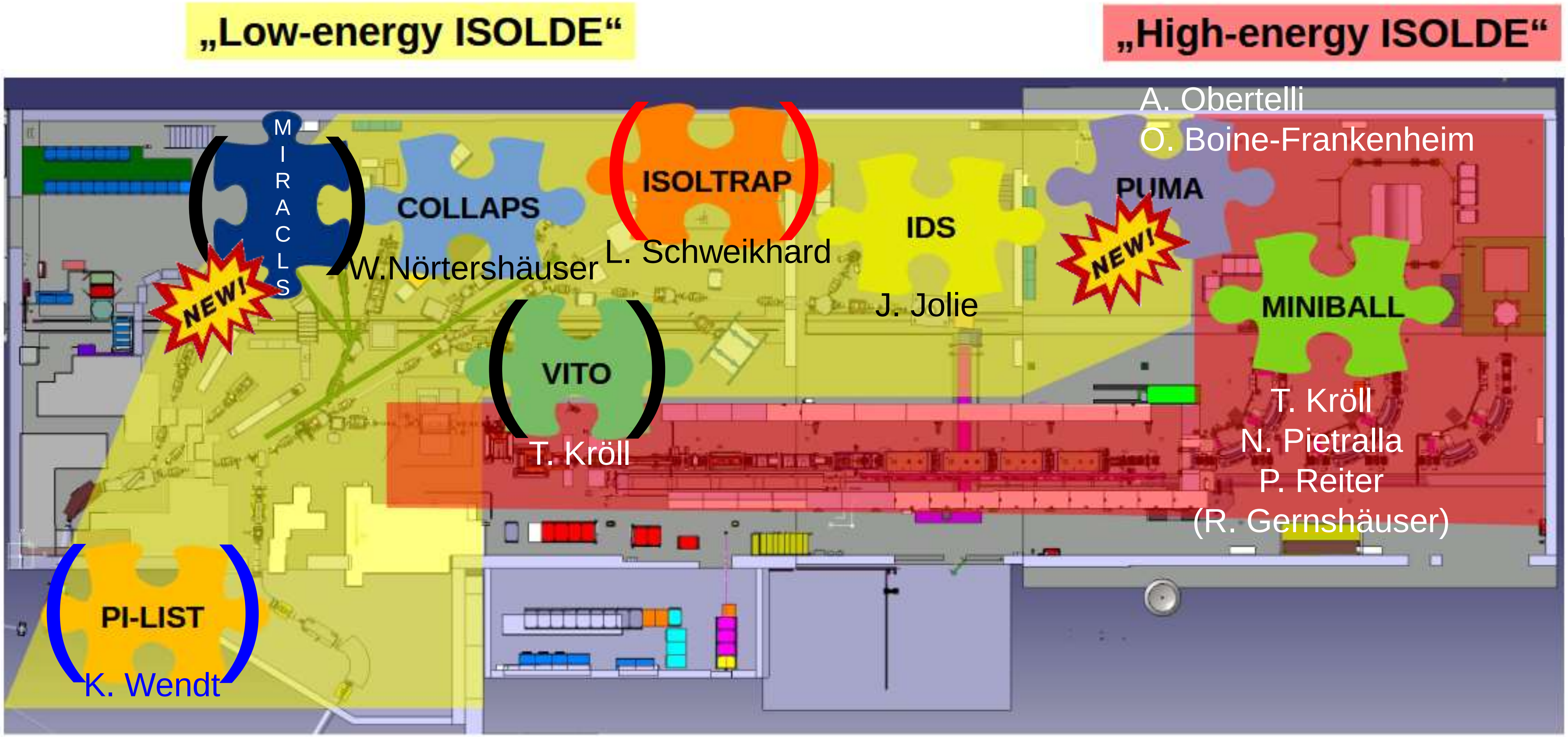
- Delivered beams to around 50 INTC Proposals and Letters of Intent, including 9 HIE-ISOLDE experiments.
- More than 420 shifts for physics and machine development.
- Plenty of interesting science…

1716 visitors toured with 231 guides

YEARS / ANS CERN
1954-2024

ISOLDE – German Participation and BMBF Funding

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung



TECHNISCHE UNIVERSITÄT DARMSTADT

UNIVERSITÄT ZU KÖLN

UNIVERSITÄT GREIFSWALD Wissen lockt. Seit 1456

JG|U JOHANNES GUTENBERG UNIVERSITÄT MAINZ

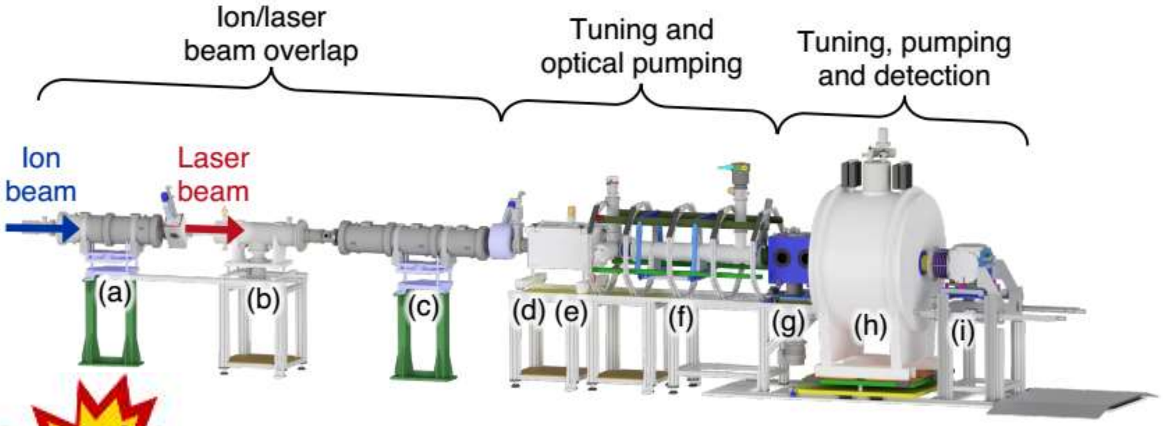
TUM

( ) Retired

( ) No Application for Funding

( ) No BMBF Funding in 2024-2027

VITO β-NMR beam line at ISOLDE



NEW!

Implementation of new digital DAQ

Magnetic moment of ^{47}K

$$\boxed{\mu_I(^{47}\mathrm{K}) = 1.936\,182(19)\mu_\mathrm{N}}$$

- two orders of improvement in precision
- hyperfine anomaly (Bohr-Weisskopf effect)
- ... to be published

NEW!

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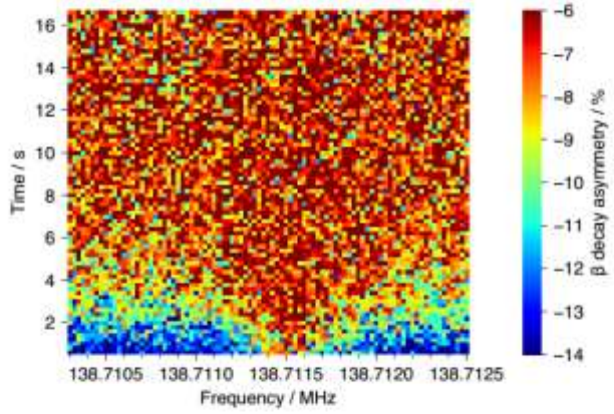
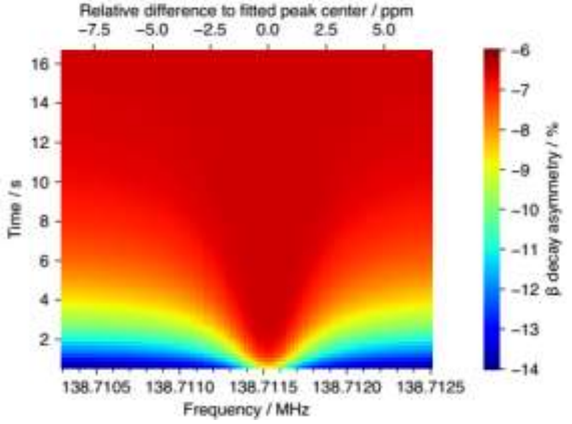
Two-dimensional analysis and fit of time-resolved β-decay asymmetry (radioactive ^{47}K implanted in ionic liquid)

data



fit



M. Jankowski, Doctoral Thesis (TU Darmstadt, 2024)
M. Jankowski, M. Kowalska et al., *Fully upgraded β-NMR setup at ISOLDE for high-precision high-field studies;* submitted to *Physica Scripta*

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Bundesministerium für Bildung und Forschung

Deutsches Technisches Doktorandenprogramm am CERN (Wolfgang-Gentner-Stipendien)

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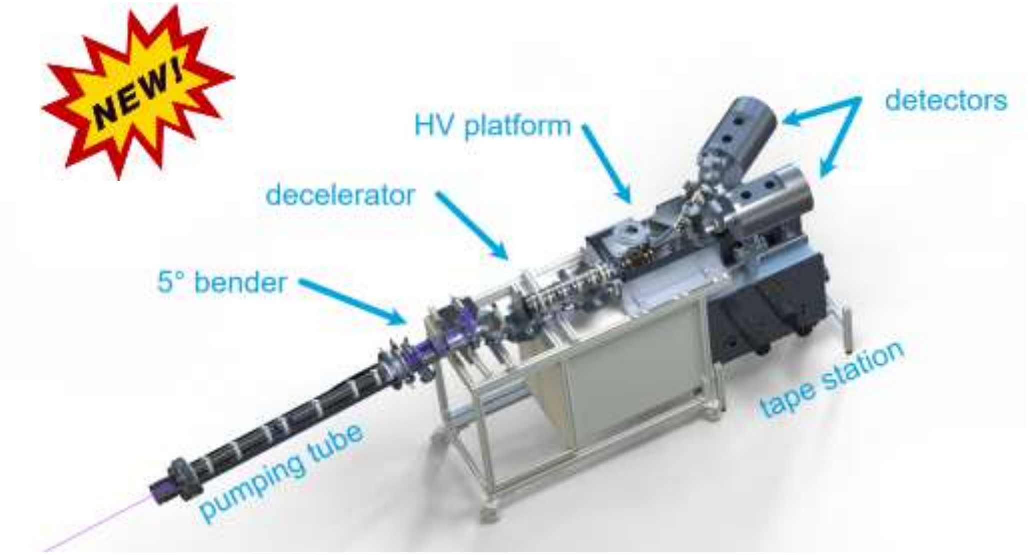
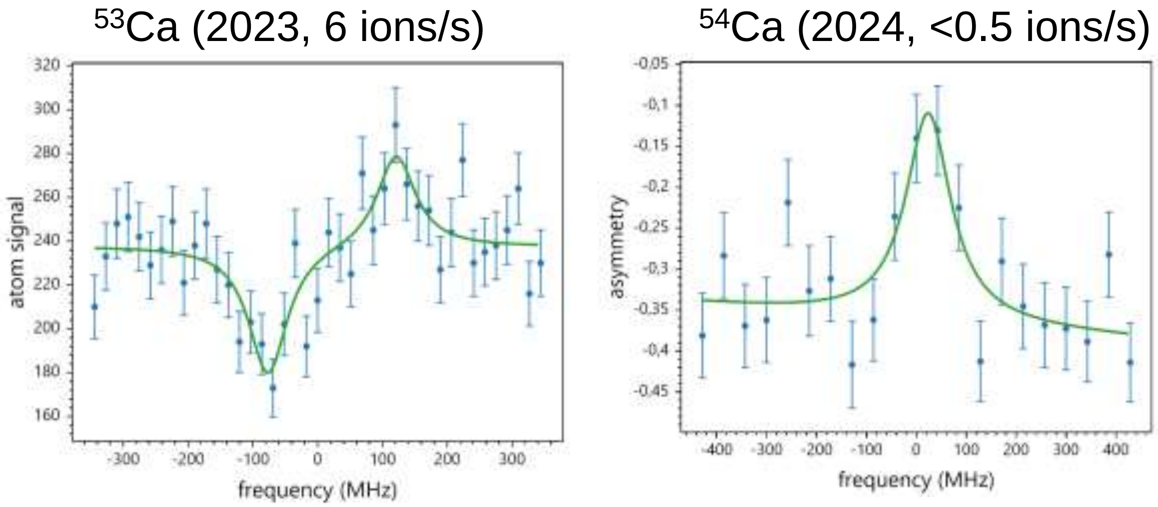
Newly implemented ROC setup at COLLAPS



- new beamline
- new tape stations
- new DAQ

+ new test stand for “offline“ trouble shooting

➔ Sensitivity record for collinear laser spectroscopy!



- extracted magnetic dipole moment and charge radii
- clear indications of N = 32 subshell closure

T. Lellinger, Doctoral Thesis (TU Darmstadt, 2024)
Publication in preparation…

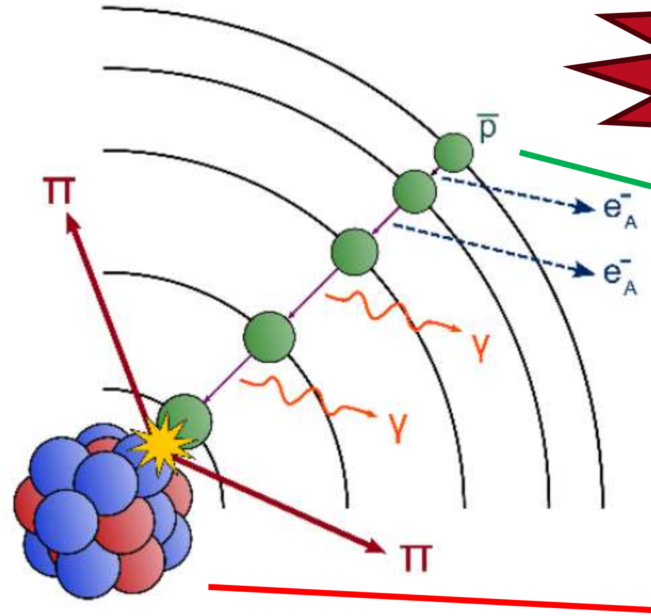
Wolfgang-Gentner-Stipends currently suspended
Very successful program that needs to be revived!

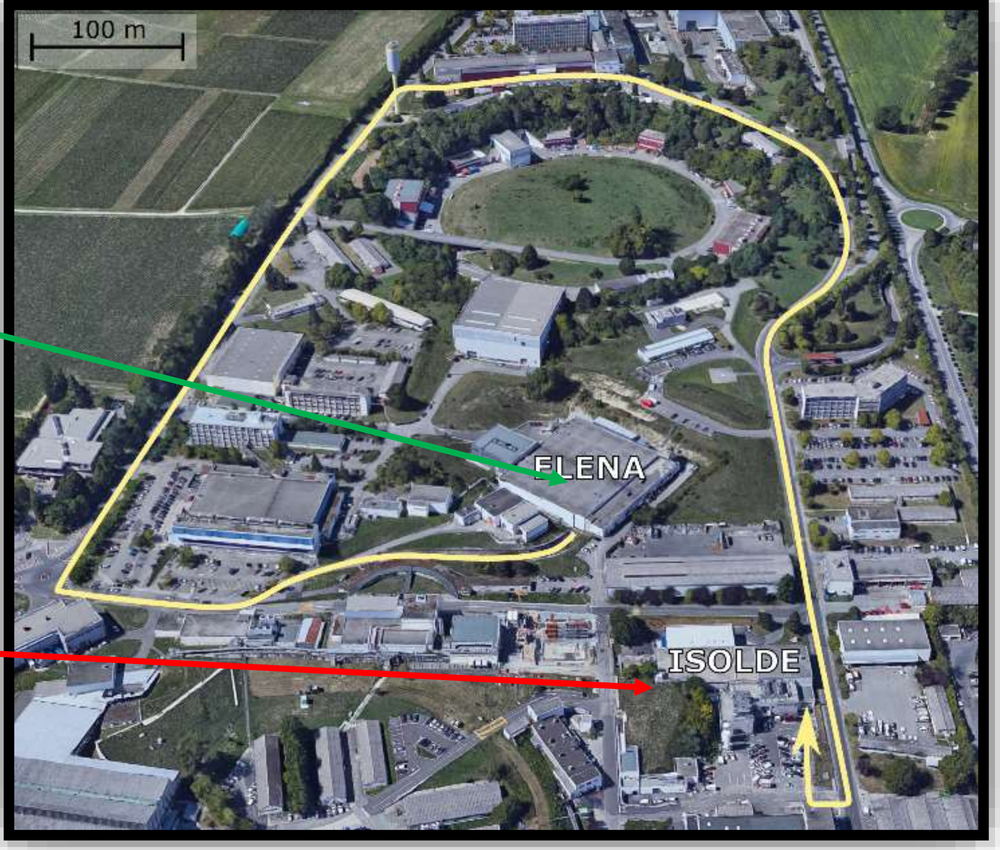
COLLAPS TECHNISCHE UNIVERSITÄT DARMSTADT UNIVERSITY OF LIVERPOOL KU LEUVEN EURO-LABS

antiProton Unstable Matter Annihilation (PUMA)

Technique: Low-energy antiprotons as a probe

New kid
in town !





<u>PUMA aims to:</u>

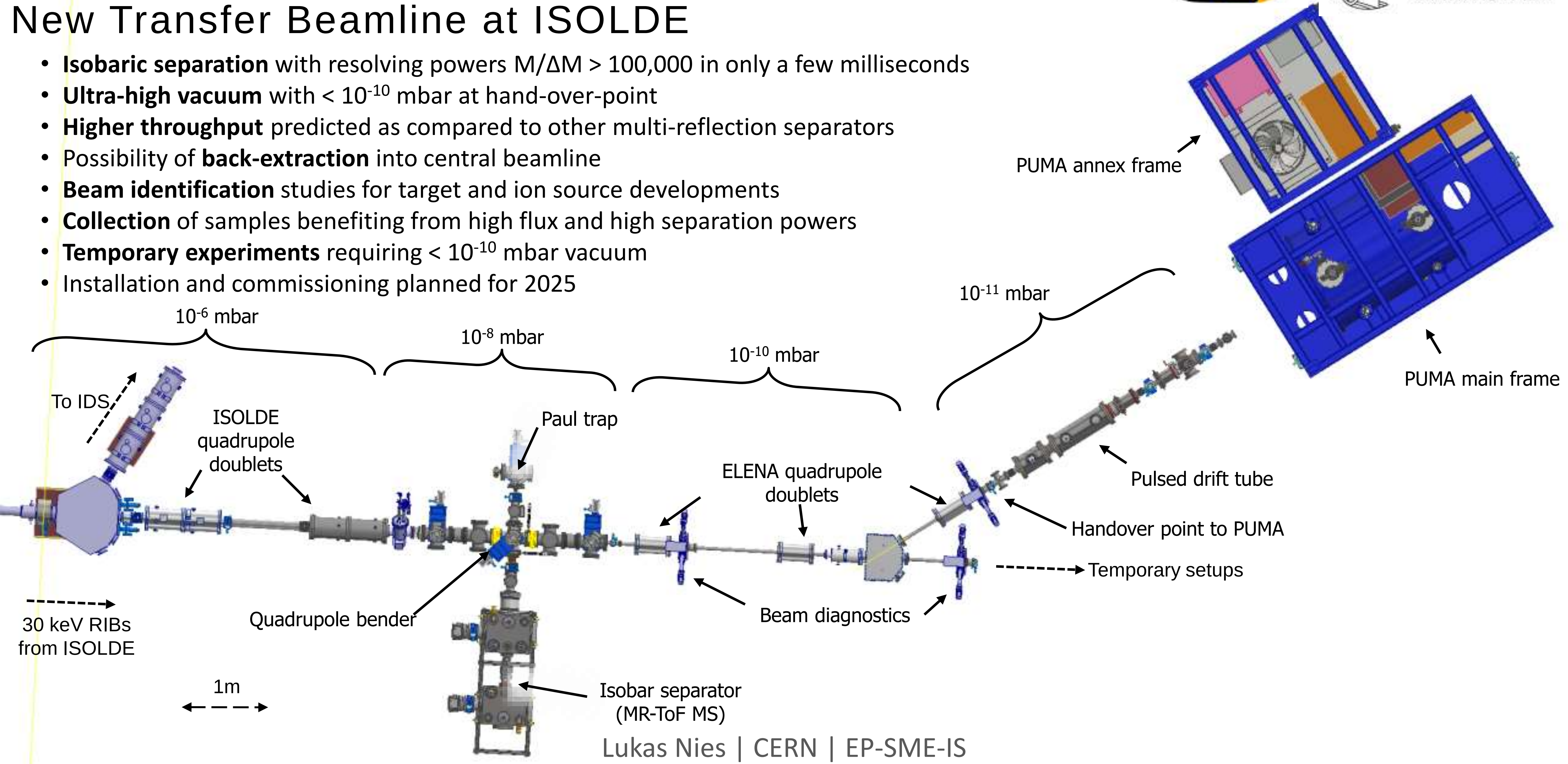
1. Provide new nuclear observable *R*
2. Characterize nuclear density tails (skins, halos, …)
3. Find new p and n halos
4. Understand development of n-skins

IJCLab Irène Joliot-Curie
LKB
IPHC
TRIUMF
erc
Alexander von HUMBOLDT STIFTUNG
TECHNISCHE UNIVERSITÄT DARMSTADT

antiProton Unstable Matter Annihilation (PUMA)

New Transfer Beamline at ISOLDE

- **Isobaric separation** with resolving powers M/ΔM > 100,000 in only a few milliseconds
- **Ultra-high vacuum** with < 10^{-10} mbar at hand-over-point
- **Higher throughput** predicted as compared to other multi-reflection separators
- Possibility of **back-extraction** into central beamline
- **Beam identification** studies for target and ion source developments
- **Collection** of samples benefiting from high flux and high separation powers
- **Temporary experiments** requiring < 10^{-10} mbar vacuum
- Installation and commissioning planned for 2025



Nuclear Physics Studies through Mass Spectrometry

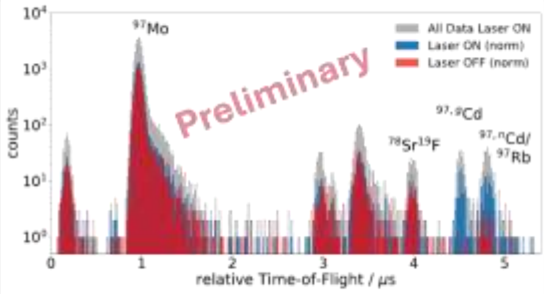
Highlights of 2023/2024

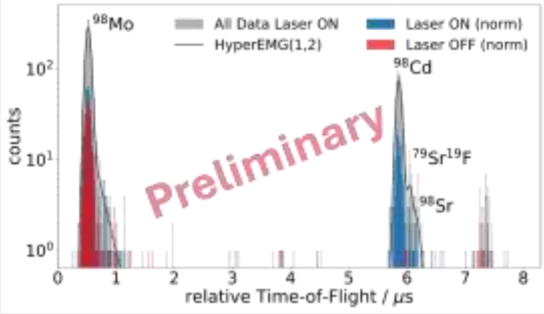
D. Lange (MPI Kernphysik)
P.F. Giesel (U Greifswald)
Ch. Schweiger (MPI Kernphysik)
L. Schweikhard (U Greifswald)
K. Blaum (MPI Kernphysik)
for the **ISOLTRAP collaboration**

Closing in on ^{100}Sn: Investigation of shell evolution near doubly-magic nuclei

- First direct measurement of ^{97gs,n}Cd and high-statistics measurement of ^{98}Cd
- yields new data point for single-neutron binding energy at N=50

D. Lange et al., in preparation





L. Nies et al., submitted to PRC (2024)

Actinide Studies with LISA

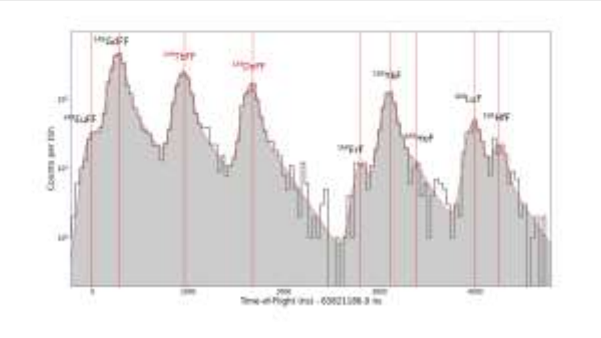
- Production and extraction of ^{225}AcFF for medical applications

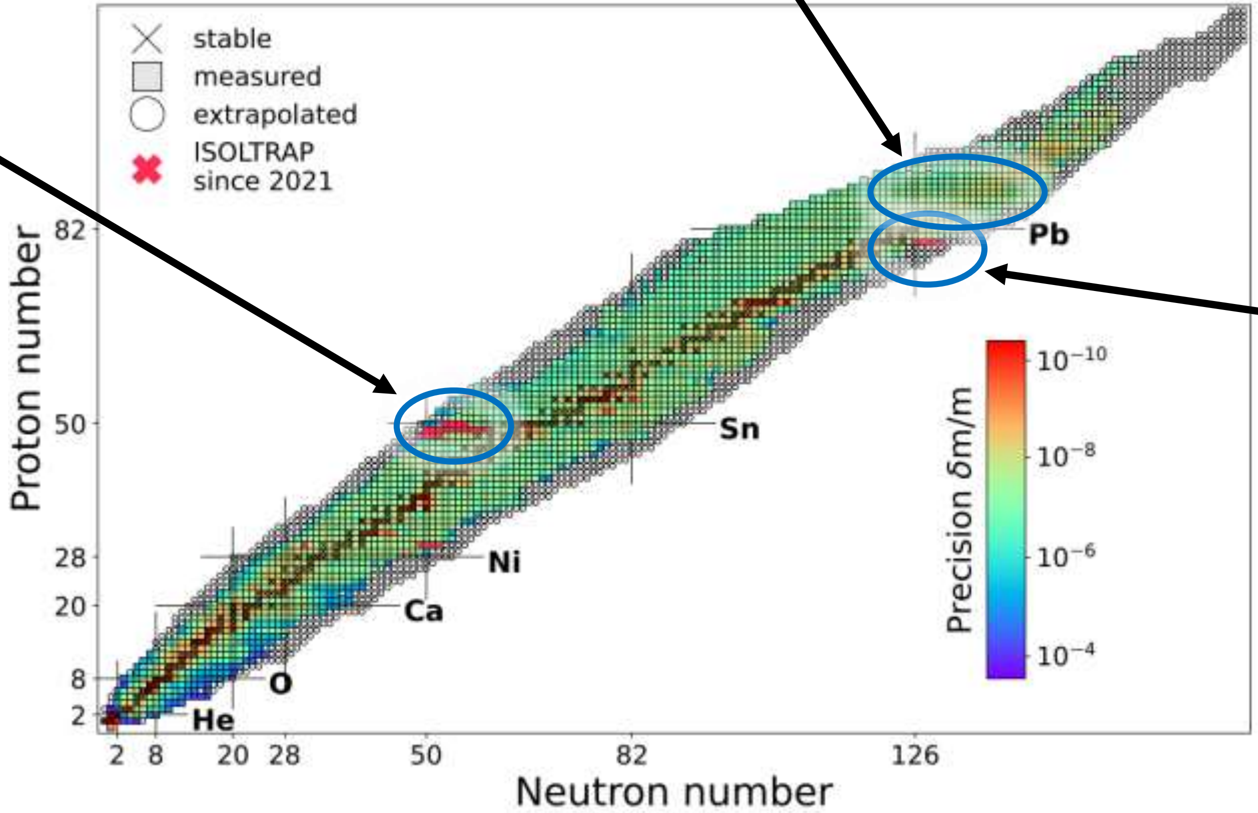
M. Au et al., J. Radioanal. Nucl. Chem. https://doi.org/10.1007/s10967-024-09811-0 (2024)

Molecular beams of lanthanides

- Production and extraction of ^{149,152,155}TbFF for medical applications - co-collection of the parent (Dy) and easier to manage/handle contaminants

Wojtaczka, W. et al., in preparation

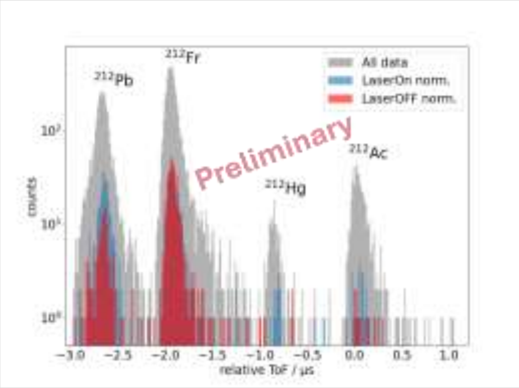




First ever mass measurements of n-rich mercury isotopes

^{209}Hg, ^{210}Hg, ^{212}Hg for investigation of the average p-n interaction (δV_{pn}) close to doubly-magic ^{208}Pb

D. Lange et al., in preparation



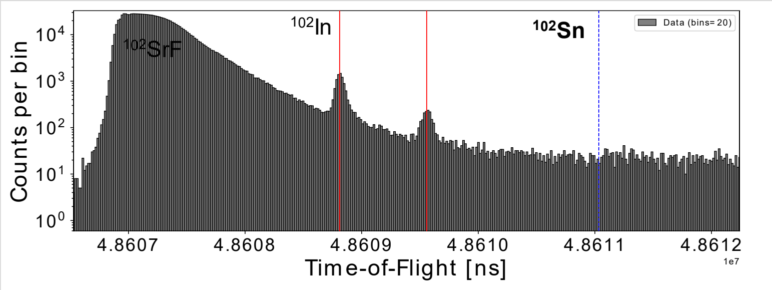
Nuclear Physics Studies through Mass Spectrometry

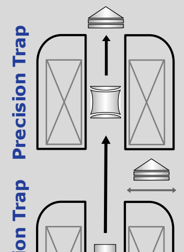
Developments in 2024/2025

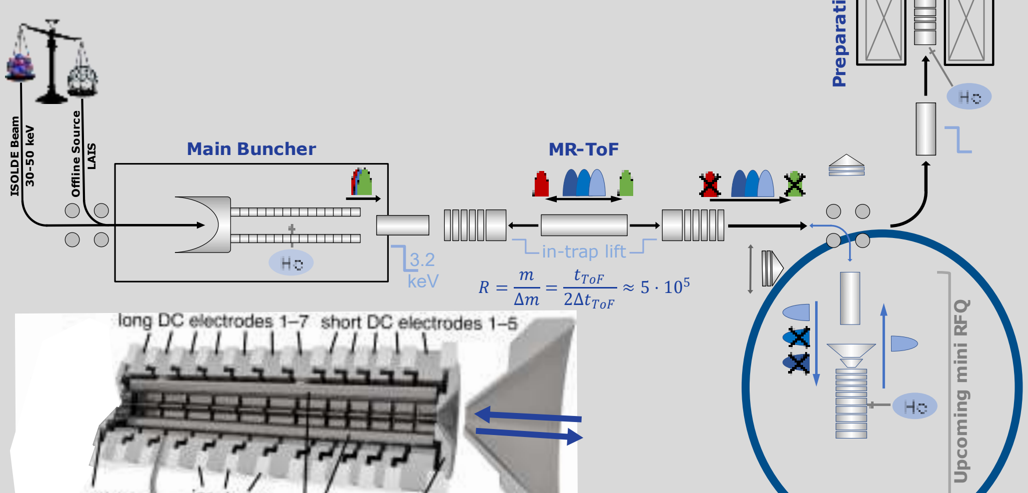
D. Lange (MPI Kernphysik)
P.F. Giesel (U Greifswald)
Ch. Schweiger (MPI Kernphysik)
L. Schweikhard (U Greifswald)
K. Blaum (MPI Kernphysik)
for the **ISOLTRAP collaboration**

Mass selective retrapping

- Measurement in the ^{100}Sn region have shown strong contamination (e.g. SrF)
- New miniRFQ allows mass-selective retrapping and background suppression [1]







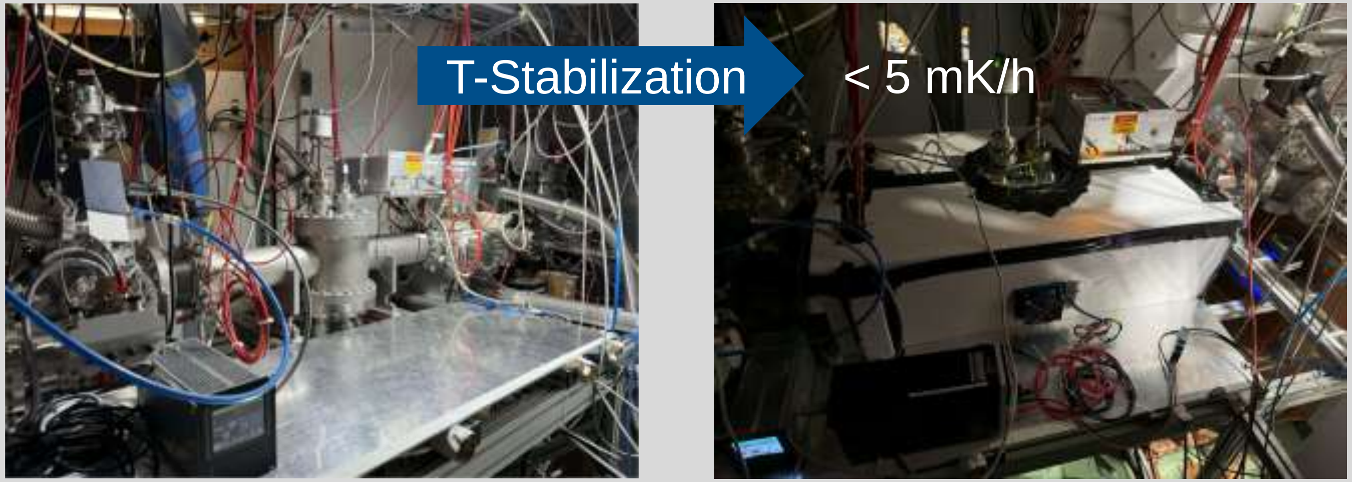
D. Lange, currently being commissioned

Mass Spectrom. **28**, 1079-1090 (2017)

Temperature stabilization of the MR-ToF device

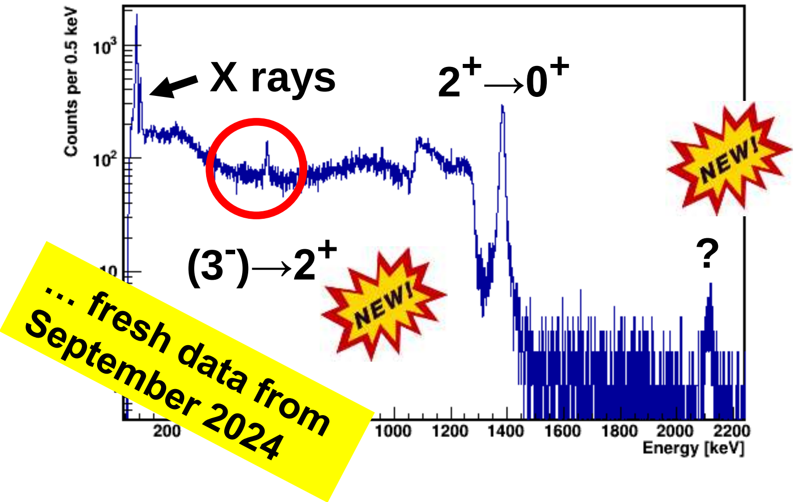
- Drift of the ToFs of the ions is observed which is correlated with changes of the temperature in the surrounding laboratory
- Stability crucial for the identification of ions and for low-yield cases where to ToF cannot be corrected
- Development of a temperature stabilization system for the vacuum chamber (see picture below) and for the active voltage stabilization system [2] based on Peltier elements and a PID loop

F. Mehlhorn, BSc thesis,
publication in preparation

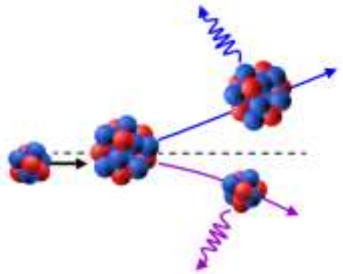


Exploring the octupole 🍐 collectivity of nuclei with Miniball

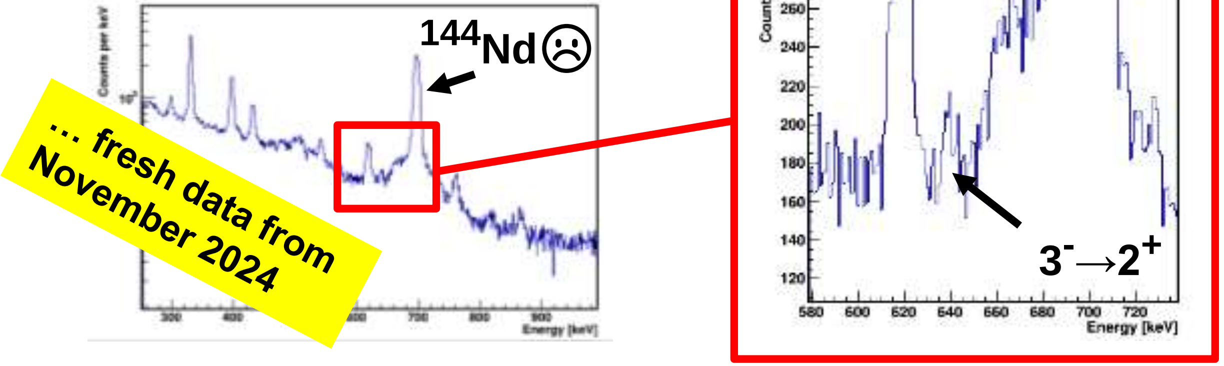
^{214}**Ra** on ^{120}Sn @ 4.5 MeV/u



- most of the beams are unique to ISOLDE
- post-acceleration by HIE-ISOLDE
- „safe“ Coulomb excitation sensitive to collective degrees of freedom



^{144}**Ba** on ^{208}Pb @ 4.2 MeV/u



- high-resolution γ-ray spectroscopy with Miniball (refurbished and equipped with new DAQ in 2022)

Coulomb excitation @HIE-ISOLDE

Gamma-ray spectroscopy with Miniball

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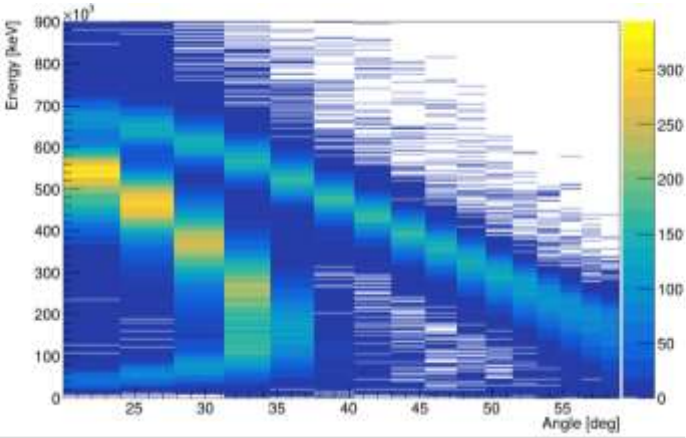


CoulEx of ^{142}Sm

Shell stabilization in $N = 80$ isotones for $Z \leq 58$

G. Rainovski *et al.*, Phys. Rev. Lett. 96, 122501 (2006)

$\rightarrow$ search for $2^+_{1,\mathrm{ms}}$ for Z > 58

^{142}Sm accessible through CoulEx

only with radioactive ion beam

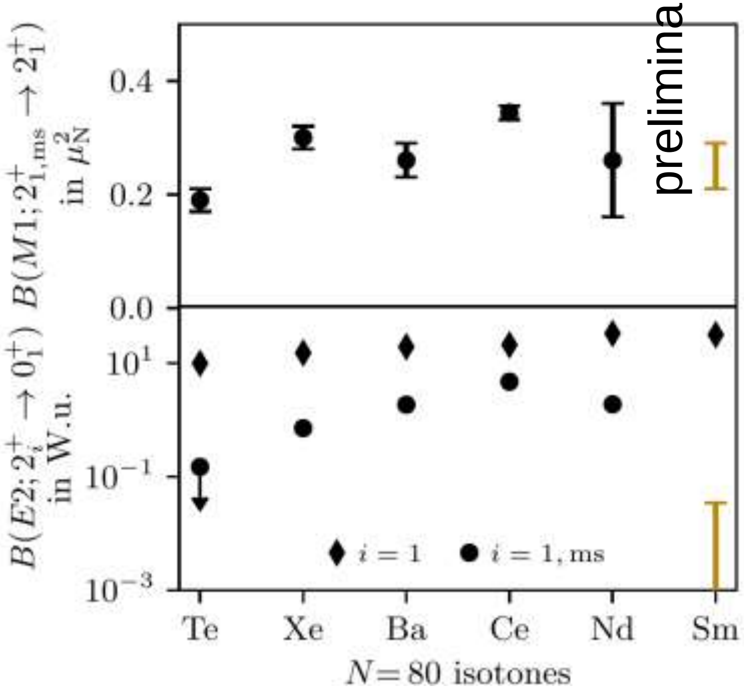
$\rightarrow$ ISOLDE

2^+_3 identified as $2^+_{1,\mathrm{ms}}$ through

$\boldsymbol{B(M1) \approx 0.25\ \mu_N^2}$

Preliminary

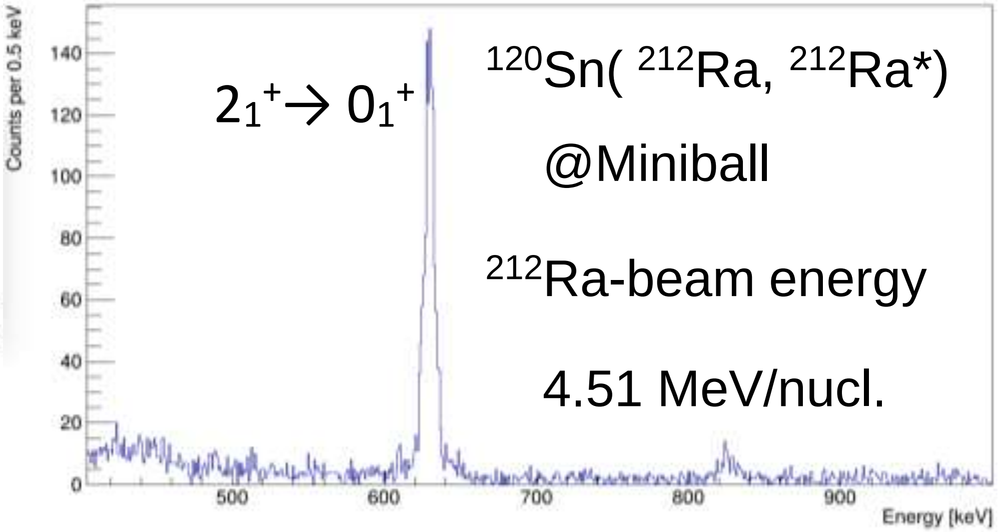
Submission in preparation by T.Stetz



preliminary

CoulEx of ^{212}Ra

- Active research, beam time 09/24
- Goal: Obtain unknown $B(E2; 2^+_1 \rightarrow 0^+_1)$
- Validation of seniority scheme in N=124



$2_1^+ \rightarrow 0_1^+$

^{120}Sn(^{212}Ra, ^{212}Ra*)

@Miniball

^{212}Ra-beam energy

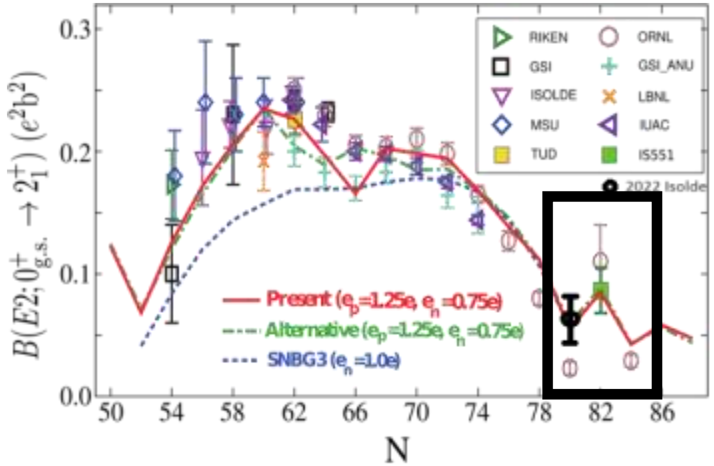
4.51 MeV/nucl.

Coulomb excitation of ^{130}Sn with Miniball at ISOLDE

UNIVERSITÄT ZU KÖLN

ISOLDE

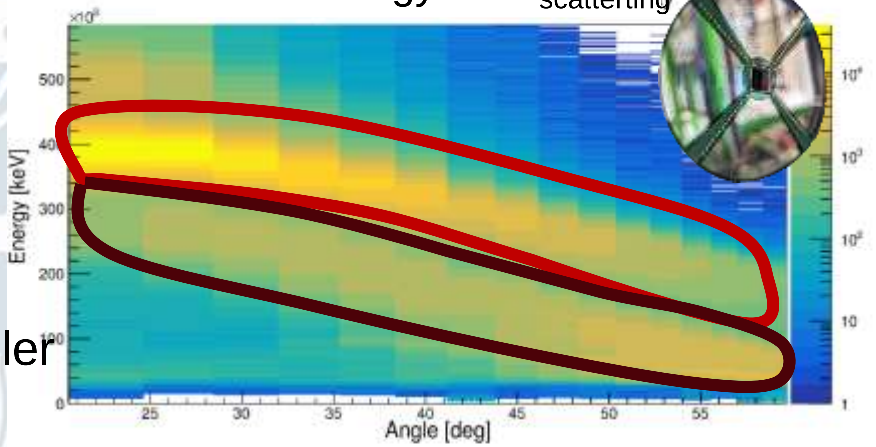
MINIBALL



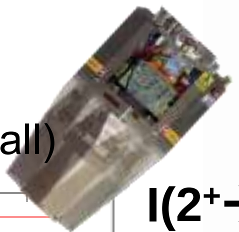
Doubly-magic character of ^{132}Sn confirmed by Cologne group of D. Rosiak, *et al.* [1]

Discrepancy around double magic ^{132}Sn unresolved [2]

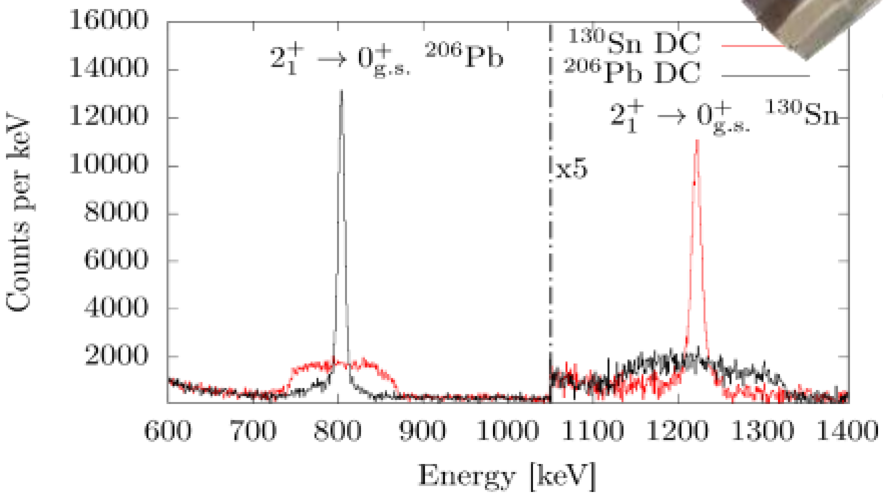
Particle energy vs. $\theta_{scatterting}$



Particle gate allows for Doppler correction of γ rays



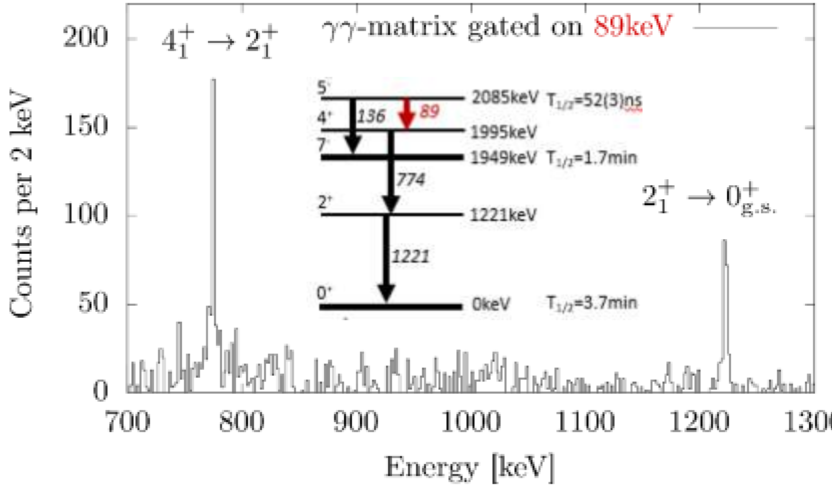
Doppler-corrected γ ray spectra (Miniball)



I($2^+ \to 0^+$)$_{130Sn}$ = 31500 counts

→ Accurate experimental shell-structure information of 2^+ state

Coulomb excitation of 7^- isomer from second ^{130}Sn beam component observed for the first time in RIB experiment



[1] ^{132}Sn value by D. Rosiak, P. Reiter *et. al*.; Phys. Rev. Lett. 121, 252501 (2018)

[2] T. Togashi; Y. Tsunoda; T. Otsuka; N. Shimizu; M. Honma; Phys. Rev. Lett. 121, 062501 (2018)

Supported by BMBF Projects 05P21PKCI1, 05P24PKCI1, 05P21RDCI2

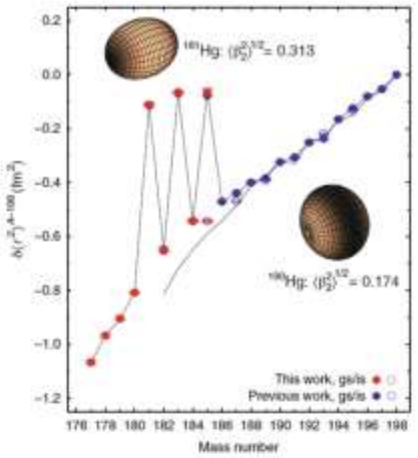
This project has received funding from the European Union's Horizon Research and Innovation programme under Grant Agreement No. 101057511

Bundesministerium für Bildung und Forschung

EURO-LABS
EUROPEAN LABORATORIES FOR ACCELERATOR BASED SCIENCES

Couloumb excitation of ^{185g,m}Hg with Miniball at ISOLDE

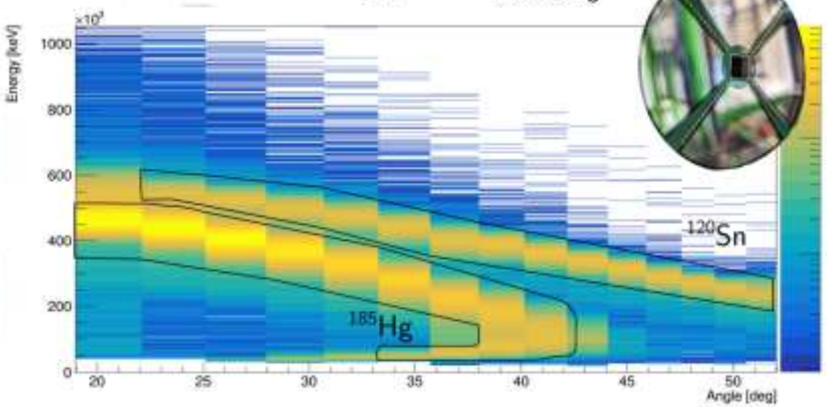
UNIVERSITÄT ZU KÖLN

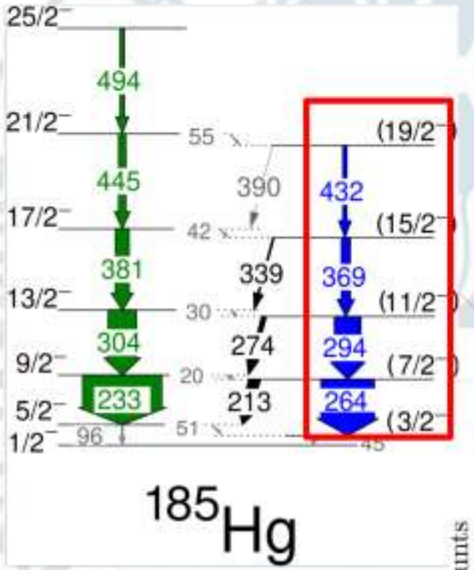


Staggering effect from charge radii measurements between even and odd mass Hg nuclei [1]
→ shape coexistence in Hg isotopes

Coulomb excitation of isomeric ^{185m}Hg and ground state ^{185g}Hg beam individually

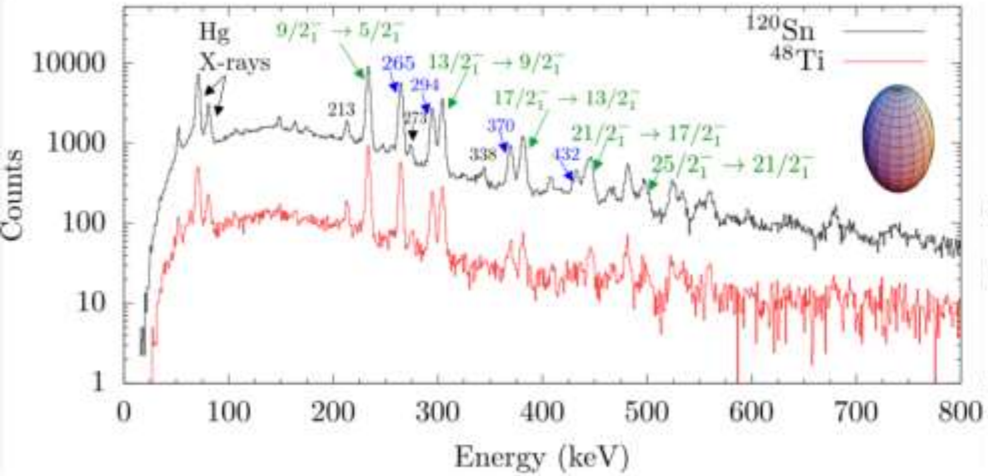
Particle energy vs. $\theta_{scatterting}$

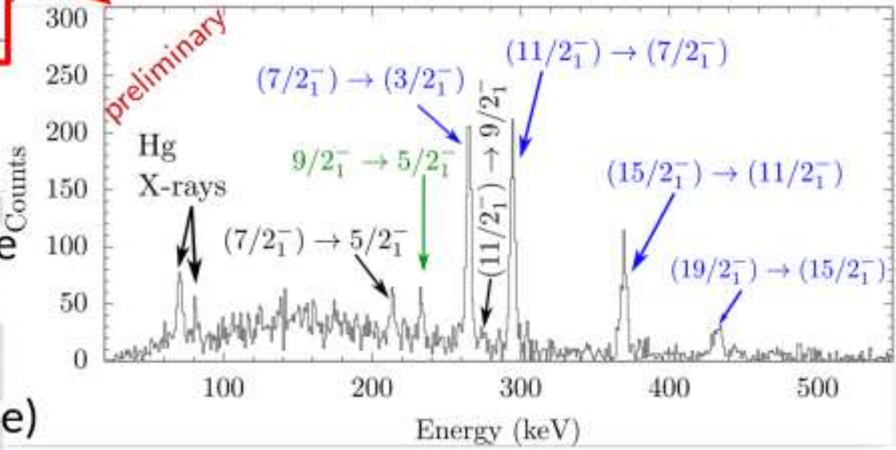




Sum of coincidence gates in 3/2⁻ band

Doppler-corrected γ ray spectra of ^{185g}Hg (Miniball)





Ground state band up to 25/2⁻ state (green) as in Hannachi *et al.* [2]

New rotational band observed (blue)
→ connected to ground state band

[1] B. Marsh *et al.* Nature Physics, 14(12):1163-1167 (2018)
[2] F. Hannachi *et al.* Z. Phys. A, 330:15-22 (1988)

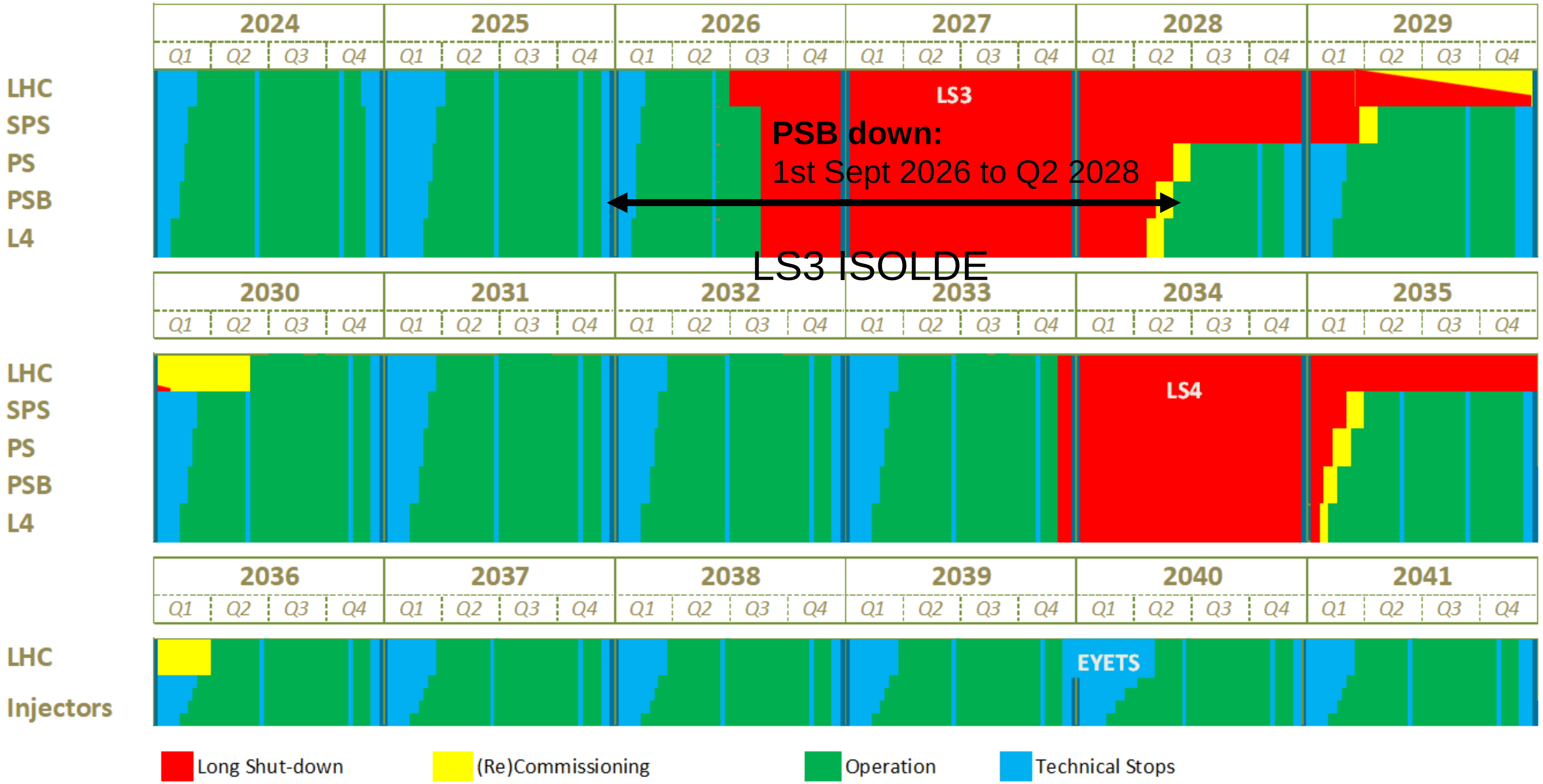
Supported by BMBF Projects 05P21PKCI1, 05P24PKCI1
This project has received funding from the European Union's Horizon Research and Innovation programme under Grant Agreement No. 101057511

Bundesministerium für Bildung und Forschung

EURO-LABS EUROPEAN LABORATORIES FOR ACCELERATOR BASED SCIENCES

Long-term schedule for accelerator complex

(version 5th Nov 2024- still needs final approval)



LS3
ISOLDE
Upgrade

Beam Dump Replacement (24M ↔ 19 M PSB)
Begin of upgrade for 2 GeV operation
Planning of RILIS laboratory upgrade
Central beam line pulsing and beam gates
ISCOOL Improvements

REXTRAP Improvements
REX-ISOLDE Power Amplifiers Replacement
Repair of 9GP RF Structure
Cryo Module 1 Refurbishment

Thank you

W. Nörtershäuser

TECHNISCHE UNIVERSITÄT DARMSTADT

Thanks to

T. Lellinger

T. Kröll

N. Pietralla
H. Mayr, T. Stetz

P. Reiter

L. Schweikhard
C. Schweiger

A. Obertelli
F. Wienholtz
L. Niess