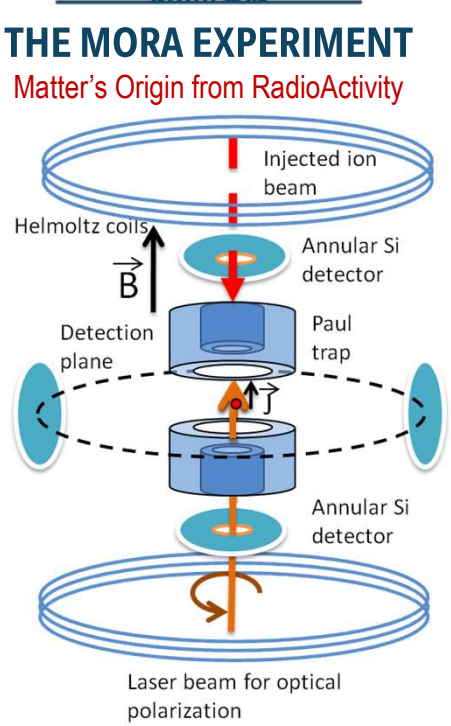
ENTRETIEN ANNUEL PROJET MORA

MORA: sonder l'origine de l'asymétrie matière antimatière par la mesure de la corrélation *D* dans la désintégration d'ions $^{23}Mg^{+}$ et $^{39}Ca^{+}$ piégés et polarisés



Corrélation $D\dfrac{\vec{J}\cdot(\vec{p_e}\times\vec{p_\nu})}{J(E_eE_\nu)}$

T impaire → via CPT → Recherche de violation de CP

Techniques de pointes

- Production de faisceaux radioactifs intenses à GANIL
- Refroidissement et piégeage d'ions développés au LPC CAEN
- Polarisation laser **innovante**

Projet financé **pour la partie équipement** par la Région Normandie **et pour les thèses, postdocs** par l'ANR + ANR ACCLAIM

RÉGION NORMANDIE

anr agence nationale de la recherche AU SERVICE DE LA SCIENCE

X2!

2022-2028: Tests de principe de la polarisation laser à JYFL et première mesure de *D* à JYFL, avec une intensité de ^{23}Mg réduite

2029-…: data taking à DESIR

ENTRETIEN ANNUEL PROJET MORA

Organisation du projet redéfinie dans le cadre du nouveau projet ANR « AdvanCed CaLcium radioActive Isotope Manipulation for MORA »

Data taking à Jyväskylä, analyse, production, lasers et supervision projet

Porteur du projet: GANIL — Coordinateur: P. Delahaye

Design et construction du cooler buncher pour DESIR

Partenaire français: LPC CAEN — Coordinateur partenaire : L. Hayen

Partenaires étrangers

Soutien de la campagne à Jyväskylä, développement d'un stacking trap for ACCLAIM

Hôte du projet MORA pour 2020-2028 — Coordinateur partenaire : T. Eronen

Experts en polarization laser, soutien technique pour le stacking trap

KU LEUVEN NUCLEAR AND RADIATION PHYSICS — Coordinateur partenaire : R. De Groote

Experts français théorie EFT — IJCLab Irène Joliot-Curie Laboratoire de Physique des 2 Infinis — Contact A. Falkowski

Projet MORA - ANR
Équipes concernées 2020 - 2025

m*m
2020-2025

Période 2020 – 2025 (Oct) ANR MORA

110 m*m

Dont 36 PhD, 6+2+2 postdoc

165 m*m

Dont 70 PhD, 24 postdoc

30 m*m

Dont 18 postdoc

Financements Région, ANR et Université

Période 2025 (Oct) – 2029 ANR ACCLAIM MORA - prévisionnel

32 m*m

163 m*m

Dont 72 PhD, 24 postdoc

1 m*m

+ partenaires étrangers

10 m*m (+ 18 PhD?)

20 m*m

+Financements Région et Université

PUBLICATIONS

DEPUIS 4 ANS	ANNÉE 2022	ANNÉE 2023	ANNÉE 2024	ANNÉE 2025
Nombre de publications: 4 (+2 en 2021 +3 en 2019 +1 en 2020)	1	1	1	1+1
Nombre de communications: 14 (+5 en 2021 +5 en 2020 +4 en 2019 + 1 en 2020)	5	3	2	5
Nombre de thèses soutenues: 2	-	2	-	-

Nishu Goyal et Sacha Daumas-Tschopp

Articles

- A. Falkowski, M. González-Alonso, A. Palavrić, A. Rodríguez-Sánchez, Constraints on subleading interactions in beta decay Lagrangian, arXiv:2112.07688 https://doi.org/10.48550/arXiv.2112.07688 JHEP 02 (2024) 091
- A. Falkowski, A. Rodríguez-Sánchez, On the sensitivity of the D parameter to new physics, arXiv:2207.02161, https://doi.org/10.48550/arXiv.2207.02161
- N. Goyal et al., detection of recoil ion in the beta decay of laser oriented trapped radioactive isotopes for the MORA project, J. Phys:Conf. Ser. 2586 012142 (INPC 2022) https://doi.org/10.1088/1742-6596/2586/1/012142
- N. Goyal, A. Singh, S. Daumas-Tschopp et al., *Performance of the MORA apparatus for testing time-reversal invariance in nuclear beta decay,* Eur. Phys. J. A (2025) 61: 221, https://doi.org/10.1140/epja/s10050-025-01694-3
- Paper under review for the Oxford Research Encyclopedia of Physics, P. Delahaye and L. M. Motilla Martinez, *Matter's Origin from the RadioActivity of trapped and laser oriented ions (status and perspectives)*

• Communications – latest 2022/2025

- L. M. Motilla: INPC 2025 – EuNPC 2025 - Platan 2024 – Ganil colloquium 2023 – PhyNuBE 2023 Aussois
- P. Delahaye (invitations): Mazurian Lake conf. 25 – ESNT Saclay 25 - EURORIB 2024 - Les Houches CP2023 - JYFL colloquium 2022
- S. Daumas-Tschopp: ISOL France 2022, Poster @ ARIS 2023
- N. Goyal – TCP2022 (& INPC), GDR InF annual meeting 2022
- A. Singh EMIS2022

anr agence nationale de la recherche

RÉGION NORMANDIE

+Workshops

- 2-5 Mai 2022: JYFL

International MORA workshop – 40 participants
https://indico.in2p3.fr/event/25986/

Faits marquants 2021 - 2022

Off-line commissioning in LPC Caen
September 2021

^{23}Na trapped ions from alkali source

Shipping incident – trap chamber to be repaired - October 2021

Installation in JYFL
November 2021 – injection line

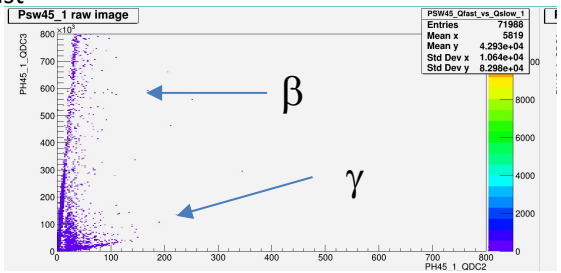
Installation in JYFL
January 2021 – trap and detectors

Commissioning in JYFL
Mid February – off-line

^{23}Na trapped ions from cooler buncher

Commissioning in JYFL
18th - 20th February – on-line
27-31 May 2022 – on-line

Q_{fast}



Q_{slow}

First ^{23}Mg β activity is recorded

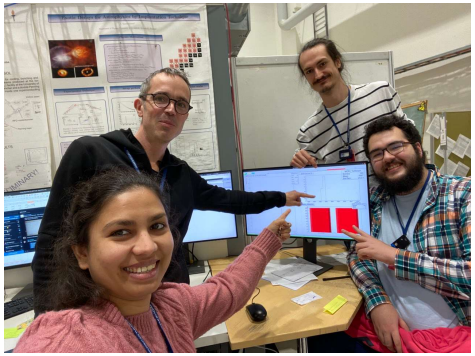
Large involvement of LPC Caen technical resources

Faits marquants 2023 - 2024

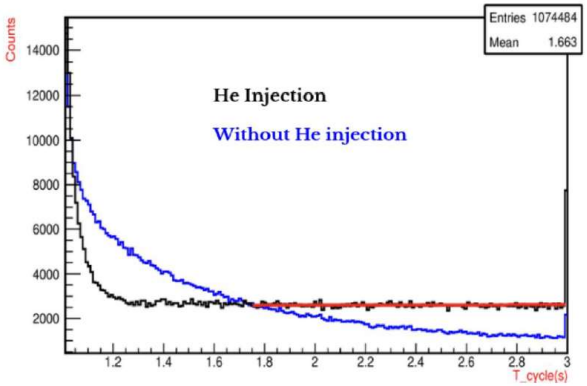
Contamination rend la mesure de polarisation difficile

^{23}Na:$^{23}Mg \gtrsim 1000$

Piégeage des ions ^{23}Na ions pendant 11s



Evaporation des ions ^{23}Na piégés sur détecteurs d'ions de recul



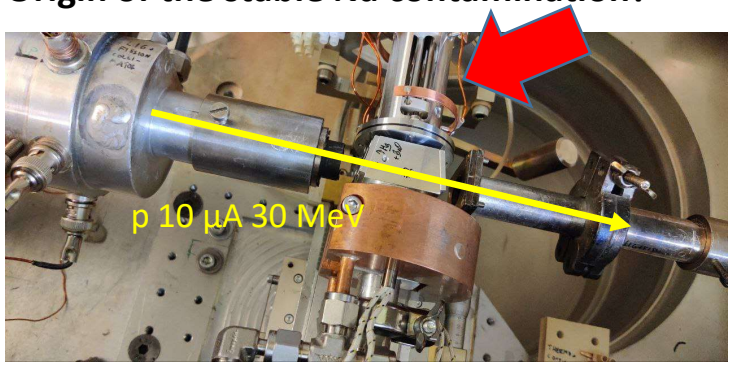
Temps de piégeage~4min

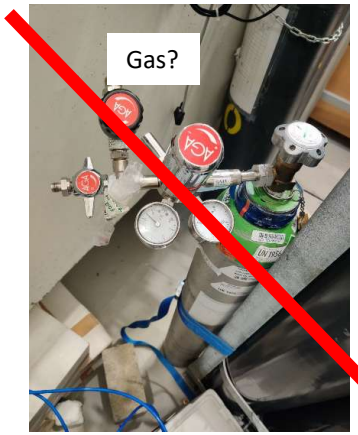
Happy students at Les Houches School

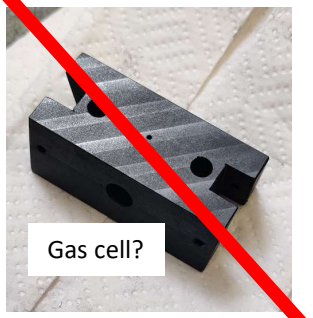
+ Platan24, EMIS23, TCP22

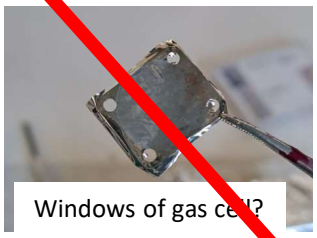
Struggling with contamination 2023 – 2024

Origin of the stable Na contamination?









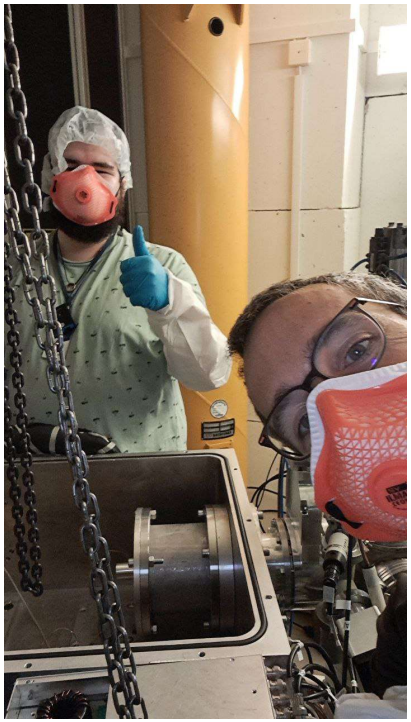
Culprit: The SextuPole Ion Guide! SPIG

Sputtering of electrodes by ionized He

Explains that:

- The gas purity matters
- The Na+ can be trapped in the SPIG
- The Na+ only comes when p beam on
- …

SPIG deionized water cleaning and refurbishing - 2025



Experimental breakthrough

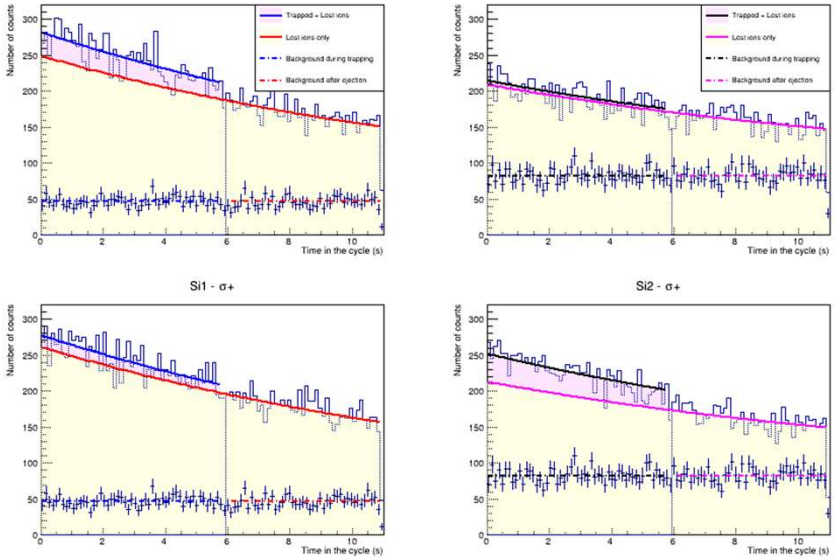
March 25

Si detectors to measure the polarisation

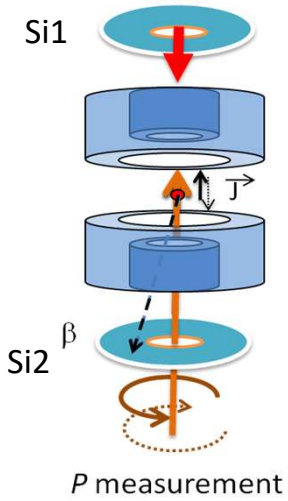
Si1 Si2

σ−

σ+



Polarisation measurement



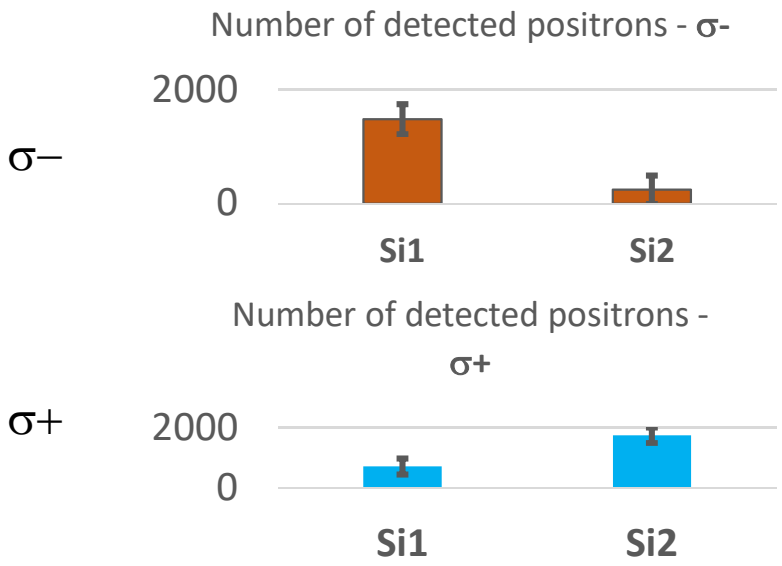
First polarization measurement

- Polarization σ- : $A^- = \frac{nSi_1 - nSi_2}{nSi_1 + nSi_2} = 0.72 \pm 0.25$
- Polarization σ+ : $A^+ = -0.42 \pm 0.16$
- Full polarization of the cloud (from simulations): $A^- = -A^+ = 0.51 \pm 0.01$

Experimental breakthrough

March 25

Si detectors to measure the polarisation



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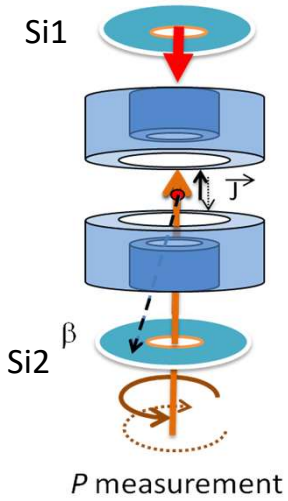

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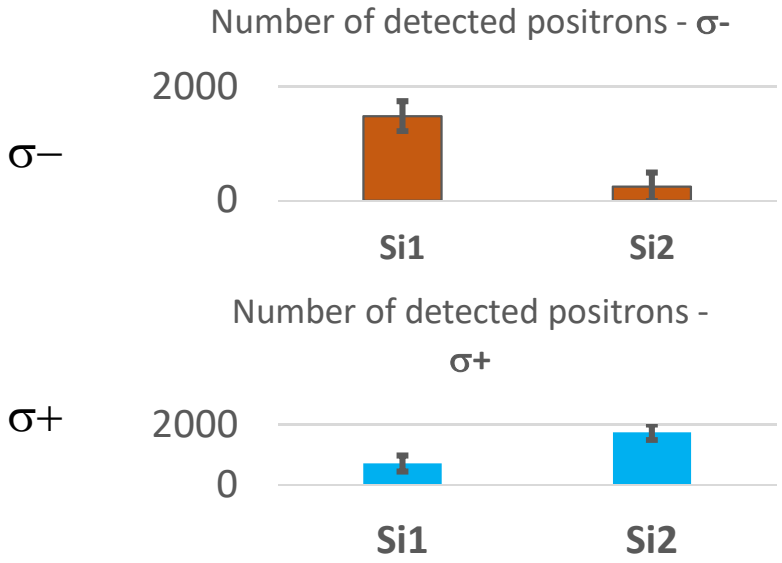

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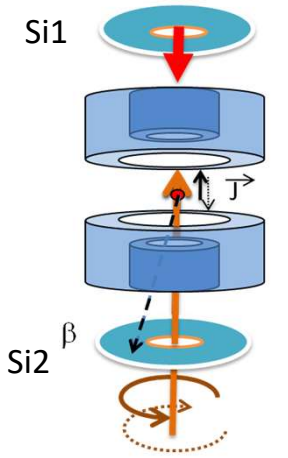

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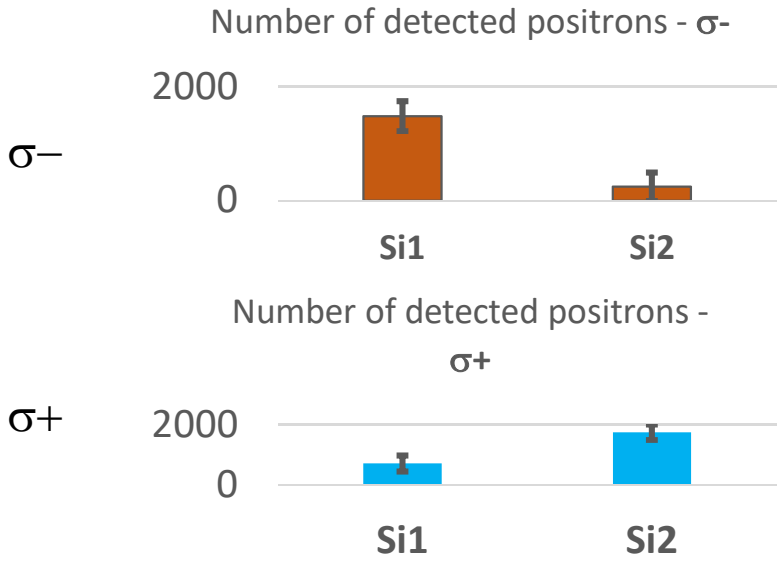
$$|A| = 0.51 \pm 0.14$$

➡ **55%<P<100% at 90% C.L.**

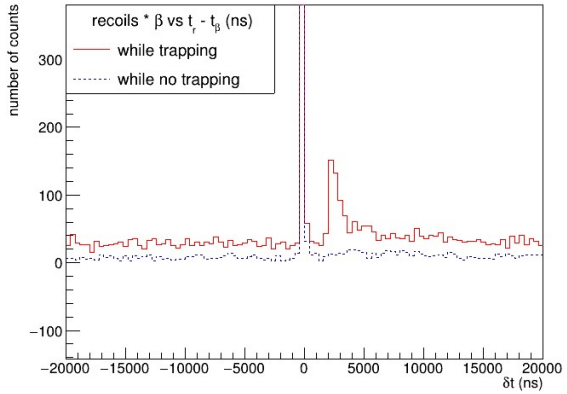
Experimental breakthrough

March 25

Si detectors to measure the polarisation



First β-recoil coincidences



Trapped ions/cycle
90±9 from Si detectors
145±55 from coincidences

First polarization measurement

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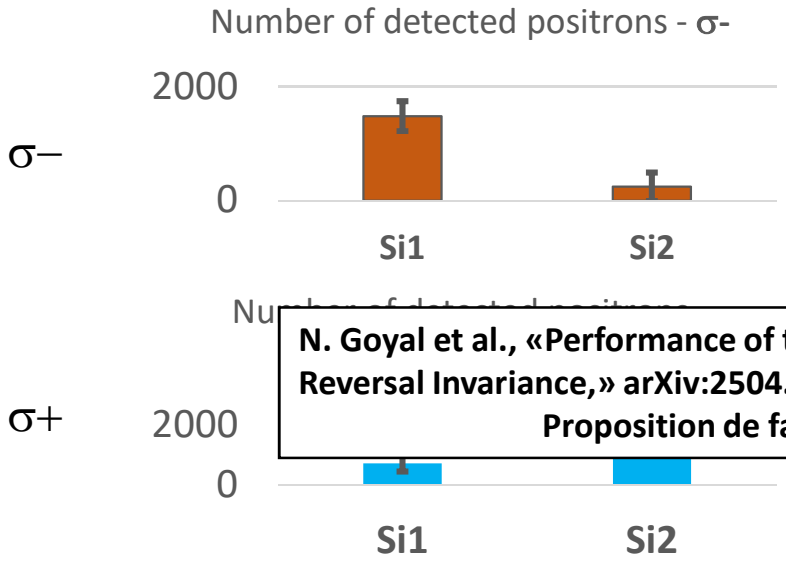
Experimental breakthrough

Si detectors to measure the polarisation

March 25



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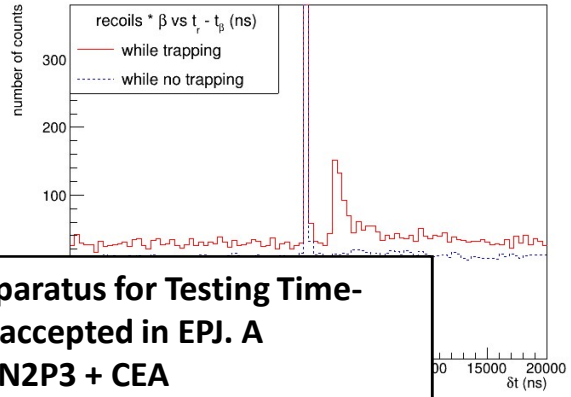

N. Goyal et al., «Performance of the MORA Apparatus for Testing Time-Reversal Invariance,» arXiv:2504.16957, 2025, accepted in EPJ. A

Proposition de fait marquant IN2P3 + CEA

Trapped ions/cycle

90±9 from Si detectors

145±55 from coincidences

First polarization measurement

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➡ **55%<P<100% at 90% C.L.**

Summary

- **MORA permits looking for new interactions violating CP in nuclear β decay**
- **The innovative technique of polarisation has been demonstrated**
  - **55%<P<100% at 90 C.L.**
  - More data from July is being analysed
- **The beam purity issue at IGISOL is being tackled**
  - the *D* correlation measurement requires 10^4 $^{23}Mg^+$ ions in the trap
    - In March still 2 orders of magnitude of contamination to fight against
    - In June less than 1 order of magnitude missing
      - baked and cleaned Nb rods for the SPIG
      - MR-ToF-MS to measure precisely the ^{23}Na:^{23}Mg ratio
    - **July 7th – 14th: ^{23}Na:^{23}Mg finally down to 2**
      - Trapped ions was limited to 1000 because of failing optics, but **projections give >10^4**
    - **We are now ready to measure the *D* correlation in $^{23}Mg^+$ decay**
- **Investigating the case of $^{39}Ca^+$ isotopes for future measurements**
  - **New ANR project granted -** AvanCed CaLcium radioActive Isotopes Manipulation for MORA - **ACCLAIM MORA**
    - At JYU/IGISOL
      - Production and purity test just happened, for preparing data taking
        - Test beam time for ^{39}Ca was difficult for different technical reasons
        - Yield of ^{39}Ca is sufficient.
      - A stacking trap will be developed for cleaning beams with the MR-ToF-MS
    - At GANIL/SPIRAL1
      - Beam development of $^{39}Ca^+$ will be undertaken within a PhD thesis

Baking SPIG and gas cell components

Outlook

Towards a ~10^{-5} measurement of *D* at DESIR (2028-…)

- High Resolution Separator (>20,000 Resolving power demonstrated!)
  - Other purification tools: PIPERADE, MR ToF MS
- **$^{23}Mg^{+}$ at required rate** > 10^{8} pps from SPIRAL1 at GANIL
- **$^{39}Ca^{+}$ beam development to reach >10^{7} pps** - part of the ACCLAIM project
  - Bunching scheme developped at LPC Caen

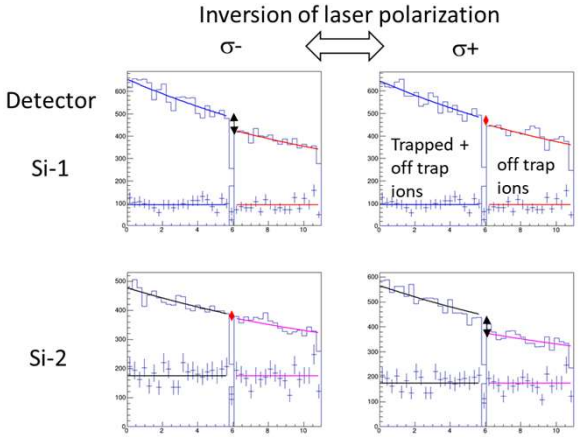
Photos: courtesy B. Blank

Delivery: 5th of Sept!

Cf. talk of F. Farget

NEWS

Démonstration de la polarisation laser dans le piège de MORA
Demonstration of the laser polarisation in the trap of MORA

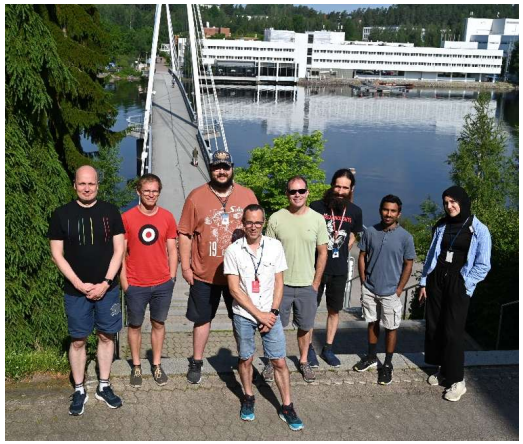


Le degré de polarisation des ions $^{23}Mg^{+}$ dans le piège de MORA a été mesuré à IGISOL en Finlande. C'est une première expérimentale pour cette technique innovante. Les premières estimations montrent qu'il est supérieur à 55% avec un intervalle de confiance de 90%.

The degree of polarization of 23Mg+ ions in the MORA trap has been measured at IGISOL in Finland. This is an experimental first for this innovative technique. Initial estimates show that it is greater than 55%, with a confidence interval of 90%.

NEWS

MORA a le vent en poupe!
MORA has the wind in its sails!



Un jalon clé pour MORA : à IGISOL (Finlande), la contamination du faisceau de ^{23}Mg par ^{23}Na a été réduite de trois ordres de grandeur, atteignant une pureté suffisante pour la mesure du coefficient *D*. Par ailleurs, l'ANR a confirmé le financement du projet ACCLAIM_MORA, qui étendra les mesures à l'isotope $^{39}Ca^{+}$, d'abord à IGISOL puis à DESIR.

A key milestone for MORA: at IGISOL (Finland), ^{23}Na contamination in the ^{23}Mg beam was reduced by three orders of magnitude, achieving the purity required for measuring the *D* coefficient. ANR has also confirmed funding for the ACCLAIM_MORA project, which will extend the measurements to the $^{39}Ca^{+}$ isotope, first at IGISOL and later at DESIR.

JALONS

ACCLAIM MORA Gantt chart

Year	1 (starting fall 2025)				2				3				4			
Task \ Trimester	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Project management				M1.1				M1.1				M1.1				**D1.1**
Dissemination			M1.2				M1.2				M1.2				M1.2	
Production of Ca beams at SPIRAL 1			M2.1.1					M2.1.2				M2.1.3				**D2.1**
Ca target for IGISOL				**D2.2**												
High intensity buncher for SPIRAL1 beams		M3.1.1						M3.1.2				M3.1.3				**D3.1**
Stacking trap for purified beams at IGISOL				M3.2.1				M3.2.2				M3.2.3				**D3.2**
Control of polarisation		M4.1.1						M4.1.2			**D4.1**					
Analysis of Data						M4.2.1						M4.2.2				**D4.2**
Theoretical corrections								M4.3								

Preparation

Ongoing task

Operation

28/29 Moving to DESIR

Utilisation budget année N

Dotation : Région Avril 2018 – Juillet 2020

315k€ (GANIL) + 317k€ (LPC Caen): 632 k€

Dotation : ANR Janvier 2020 – Juin 2024

149k€ (GANIL) + 169k€ (LPC Caen) + 120k€(IJCLab Orsay): 439 k€

Dotation : ANR Octobre 2025 – Sept 2029

419k€ (GANIL) + 267k€ (LPC Caen) : 686 k€

	Production	Purification	Bunching	Polarisation	Analyse
GANIL	**1 PhD à SPIRAL 1** Design et test d'1 ECS dédié			**Optique** de polarisation transverse **(50 k€)**	**Postdoc 24m** pour la réduction des effets systématiques
LPC CAEN		**Buffer trap (150k€)** pour séparation par tof à Jyväskylä	**Section buncher** sur le RFQ MORA à DESIR **(70k€)**		
JYVÄSKYLÄN YLIOPISTO UNIVERSITY OF JYVÄSKYLÄ		Participe au design et à la construction*			
KU LEUVEN NUCLEAR AND RADIATION PHYSICS				Participe au design	

(*:étudiants + atelier mécanique)

+40k€ missions GANIL + LPC CAEN

Budget pluri-annuel

2025: Budget fonctionnement 10k€

- Fourniture Nb + mécanique pour SPIG: 7.7 k€
- Optique laser Ca: 1.7k€
- FALCO amplifier RF coupleur RF 0.8 k€
- Ecran Phosphore 0.7 k€

	2025	**2026**	**2027**	**2028**
Investissement	-	-	-	-
Fonctionnement	10 (10 GANIL)	10 (10 GANIL)	10 (10 GANIL)	10 (10 GANIL)
Missions	11,5 (10 GANIL)	10 (10 GANIL)	10 (10 GANIL)	10 (10 GANIL)

10k€/ans demandés pour la détection/ électronique et maintenance du setup pendant la période à JYFL (fait partie du **PSG GANIL**)

10 k€/ans demandés pour missions à JYFL au GANIL

- Missions **ANR 25 k€ GANIL 15 k€ LPC Caen** - **complément accord bilatéral ACCLAB/GANIL à renouveler avec la nouvelle direction**
- Luis Miguel en cotutelle à l'université Jyväskylä
  - Sous contrat Université de Caen jusqu'en 2025 → missions couvertes par GANIL
  - 2025-2026 maintenant sous contrat université de Jyväskylä

2029: retour au GANIL/DESIR 10k€ transport + 10k€ installation

Recommendations

● The scientific council recommends the team to evaluate carefully the possible show-stoppers and to clarify the breakdown structure and plan of the project at the University of Jyväskylä.

- Thanks to the progressive and **nearly complete removal of contamination in 2025** the **showstoppers** for the measurement of the polarization degree and *D* correlation **are now being retired**, at least for ^{23}Mg. The main source of contamination (sputtering of stable traces of Na in the sextupole ion guide – SPIG - of IGISOL) has been identified and is cured by association of techniques (new SPIG in Nb, specific beam optics settings).

- As an important milestone **the polarisation proof-of-principle has been achieved** in March 25 and published in EPJ A (review article on the MORA apparatus):
  - Performance of the MORA apparatus for testing time-reversal invariance in nuclear beta decay
    - https://link.springer.com/article/10.1140/epja/s10050-025-01694-3
  - **We want to present this achievement as a Fait Marquant CNRS/CEA**

- **The AdvanCed CaLcium radioActive Isotope Manipulation for MORA (ACCLAIM MORA) ANR project** accepted this year (686 k€) consolidates the cases of ^{23}Mg and ^{39}Ca at Jyväskylä with a detailed plan for these two isotopes for the next 3 years.
  - ACCLAIM MORA provides funds for developping **a universal cleaning methods of beams using the Multi-Reflexion Time-of-Flight Mass Spectrometer** at IGISOL (stacking trap for fast cleaning cycles, 150 k€)
  - A **second addendum has been submitted in Sept. 2025** for proposing an organization of the remaining time at Jyväskylä to do high impact measurements during 2026-2028/29.
    - It will be complemented by a last addendum in Sept. 2026
    - The addendums include beam time for testing the purification technique and other objectives specific to ACCLAIM MORA (transverse polarisation control thanks to dedicated laser optics).

● Regarding the next step at DESIR, namely the measurement for ^{39}Ca, the scientific council recommends the realization of a detailed study in a timely manner of the various requirements including the financial aspects, and in coordination with the management of IN2P3.

- The **ACCLAIM MORA project prepares the MORA campaigns at GANIL**, especially with ^{39}Ca
  - ACCLAIM provides funds for a **PhD thesis dedicated to the ^{39}Ca beam development** using a novel utilisation of the TULIP target ion source with fragmented beams over the next 4 years
  - ACCLAIM provides funds (70k€) for the developpement of a **high intensity buncher integrated in the RFQ cooler** being developped by LPC Caen using funds from DESIR for the installation of MORA at DESIR

- **ACCLAIM does not fund the laser system** that will be necessary at DESIR (~ 500 k€) **for MORA but other possibilities are explored within IN2P3**
  - The laser system has been suggested by the Physics Division of GANIL and DESIR management as a part to be funded by the FAIR-SPIRAL 2 agreement
  - As this laser system is redundant with other projects (Louis Lalanne, Laser spectroscopy at DESIR) complementary sources of support could come from ANR/ERC

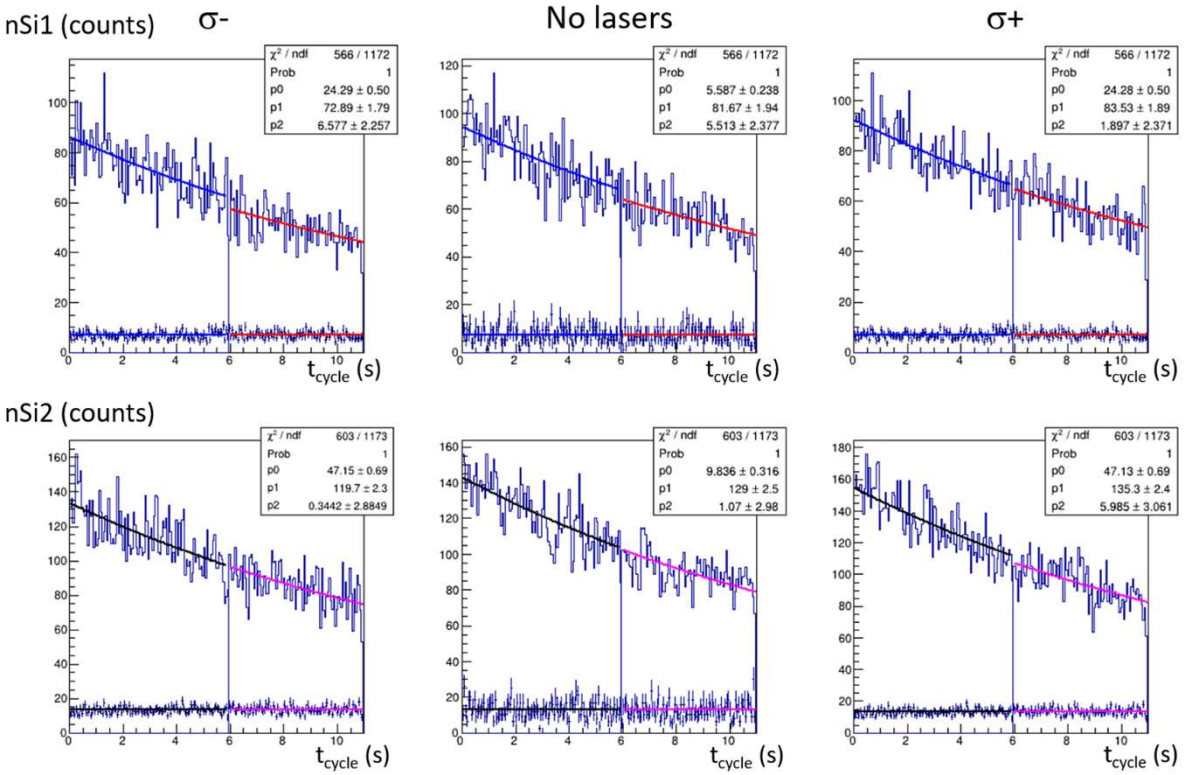
SUMMARY

- the plans for MORA are getting clearer at Jyväskylä because of the recent success with reducing the contamination of ^{23}Mg to its lowest level.
- We achieved an important milestone with the proof-of-principle of the Laser polarization (fait marquant proposé)
- The ACCLAIM MORA project consolidates plans for ^{39}Ca at DESIR by providing resources to a solid international consortium gathered around clear objectives
- Some work remains to identify resources for the lasers at DESIR (Accord FAIR - SPIRAL 2 or other sources)

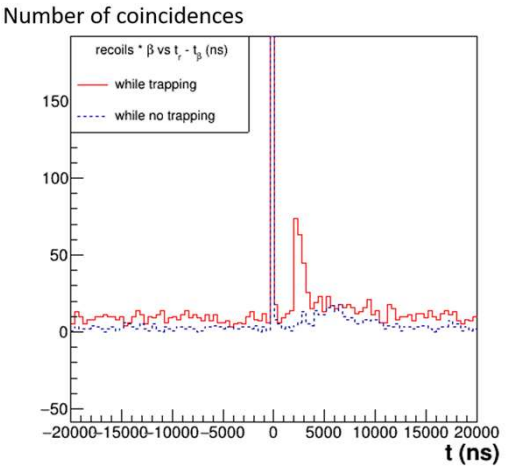
BACKUP

Previous year's Experimental breakthrough

Si detectors to measure the polarisation



β-recoil coincidences



Trapped ions/cycle

166±66 from Si detectors

182±31 from coïncidences

First indication of polarization

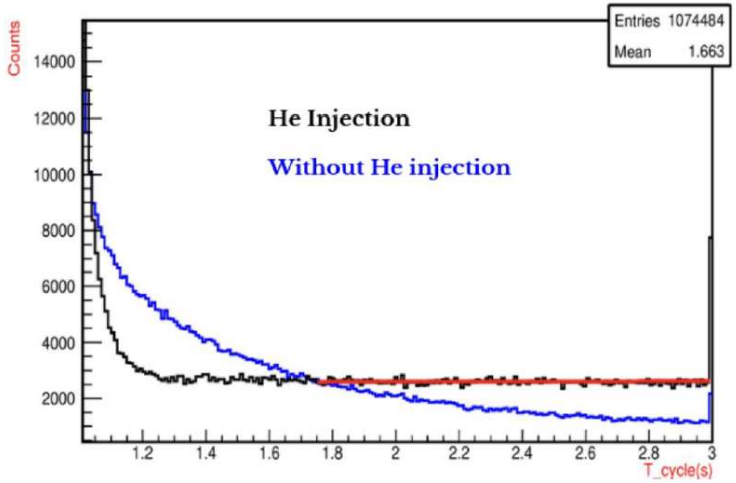
- Polarization σ- : $A^- = \frac{nSi_1 - nSi_2}{nSi_1 + nSi_2} = 0.90 \pm 0.79$
- Polarization σ+ : $A^+ = -0.52 \pm 0.49$
- Full polarization of the cloud (from simulations): $A^- = -A^+ = 0.51 \pm 0.01$

$\boldsymbol{A^- - A^+} = 1.42 \pm 0.93 > 0.51$

➡ We have reverted the polarization at 84%CL

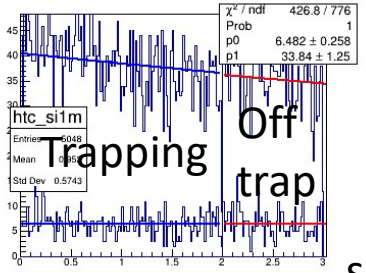
Previous results (Nov. 2022)

Evaporation des ions piégés sur détecteurs d'ions de recul (RIDE)

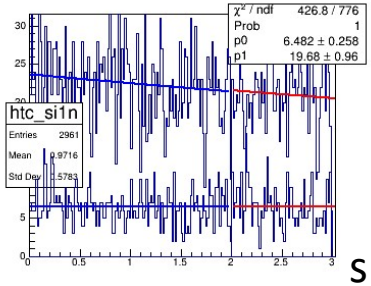


Trapping half-life~4min

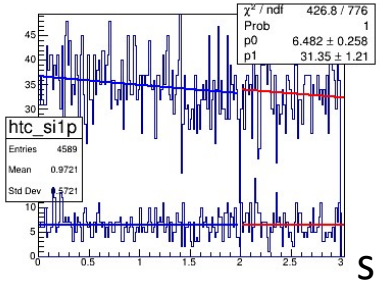
Si 1 σ-



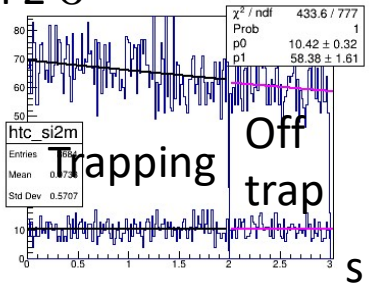
Si 1 laser off



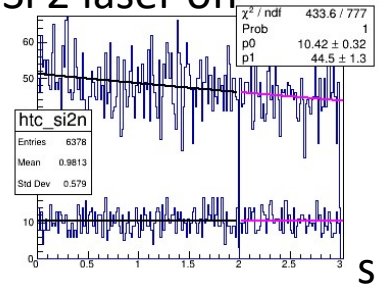
Si 1 σ+



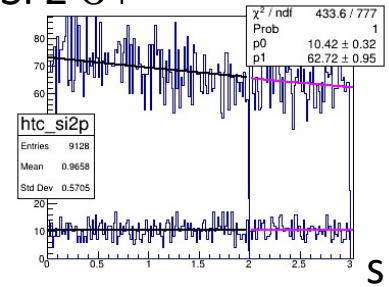
Si 2 σ-



Si 2 laser off



Si 2 σ+



Décroissances hors piège dominent le signal

Moins de 20 ions $^{23}Mg^{+}$ piégés par bunch (90%CL)

Pas de mesures d'asymétrie significatives

Projet ACCLAIM_MORA

AdvanCed CaLcium radioActive Isotope Manipulation for MORA

- **Défis à relever pour $^{39}Ca^{+}$**
  - **Polarisation plus complexe que $^{23}Mg^{+}$**
    - 2 lasers IR + Visible pour $^{39}Ca^{+}$ vs 1 laser UV pour $^{23}Mg^{+}$
  - **Pureté du faisceau à améliorer à Jyväskylä**
    - Situation uniquement éclaircie avec $^{23}Mg^{+}$, rapport $^{39}K^{+}$:$^{39}Ca^{+}$ >1000
  - **Production à ~10^{7} pps sur SPIRAL 1 pour DESIR est complexe**
    - Faisceau réactif et court temps de vie – aucun Ca extrait des cibles actuelles
    - Bunching des ions 10^{7}/paquet en moins d'1 µs est aussi un défi - nécessite une étude
  - **Contrôle accru des effets systématiques pour $^{39}Ca^{+}$**
    - **Polarisation transverse** comme source principale d'effets systématiques

PI: Pierre Delahaye

L. Hayen

T. Eronen

R. De Groote

Techniques avancées de manipulation des ions proposées dans ACCLAIM

	Production	Purification	Bunching	Polarisation	Analyse
GANIL	**1 PhD à SPIRAL 1** Design et test d'1 ECS dédié			**Optique** de polarisation transverse **(50 k€)**	**Postdoc 24m** pour la réduction des effets systématiques
LPC CAEN		**Buffer trap (150k€)** pour séparation par tof à Jyväskylä	**Section buncher** sur le RFQ MORA à DESIR **(70k€)**		
JYVÄSKYLÄN YLIOPISTO UNIVERSITY OF JYVÄSKYLÄ		Participe au design et à la construction*			
KU LEUVEN NUCLEAR AND RADIATION PHYSICS		(*:étudiants + atelier mécanique)		Participe au design	

+40k€ missions GANIL + LPC CAEN

Search for new physics via the *D* correlation measurement

A non-zero *D* can arise from CP violation

$$D\,\frac{\langle \vec{J} \rangle}{J} \cdot \left(\frac{\overrightarrow{p_e}}{E_e} \times \frac{\overrightarrow{p_\nu}}{E_\nu} \right)$$

T reversal odd

$$D \equiv \sin(\varphi_{AV}) \cdot \underbrace{\frac{2\rho}{1+\rho^2} \cdot \left(\frac{J}{J+1} \right)^{1/2}}_{F(X)} \qquad \rho \sim \frac{C_A M_{GT}}{C_V M_F}$$

Best measurement so far: $D_n = (-0.94 \pm 1.89 \pm 0.97) \cdot 10^{-4}$ *emiT collaboration, PRL 107, 102301 (2011),*

$D_{^{19}Ne} = (1 \pm 6) \cdot 10^{-4}$ *Calaprice, Hyp. Int. 22(1985)83*

$\varphi_{AV} = 180.013° \pm 0.028°$ (68% CL)

Search for New Physics

- **Direct constraints** on CP-violating Wilson coefficients in the nucleon-level EFT
- Specific New Physics models
  - via **the L-R symmetric model:**
    - M. J. Ramsey-Musolf et J. C. Vasquez, «Left-right symmetry and electric dipole moments. A global analysis,» arXiv:2012.02799 [hep-ph], 2020.
  - via **the LQ model**
    - Thorough investigation undertaken at IJClab by Adam Falkowski and Antonio Rodriguez-Sanchez
      - «On the sensitivity of the D parameter to new physics » , Eur. Phys. J. C (2022) **82**: 1134
      - Presentation at MORA workshop https://indico.in2p3.fr/event/25986/
    - Severe constraints for CP violating terms from EDM, pion decay and high energy searches
    - But D is also sensitive **to exotic non-CP violating terms via recoil-order corrections**

➡ Interest for ~10^{-4} measurement

➡ Interest for ~10^{-5} measurement

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Below 10^{-4}, measurement of Final State Interactions

Recoil order effect due to the weak magnetism (allowed in SM)

$$D_{FSI}\sim Z\alpha\,\frac{E_e}{M}\cdot A(\mu_f-\mu_i)$$ Callan and Treiman, Phys. Rev. 162(1967)1494.

Never accessed by a direct measurement in *D*

Search for new physics via the *D* correlation measurement

A non-zero *D* can arise from CP violation

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A measurement of *D* to the 10^{-5} level: looking for New Physics and accessing for the first time FSI

Edoardo Alviani and Adam Falkowski: ***On the Coulomb corrections in nuclear beta decay*** arXiv:2412.17702 [hep-ph]

MORA in a nutshell

THE MORA PROJECT

THE MORA EXPERIMENT
Matter's Origin from RadioActivity

D **correlation measurement in ^{23}Mg, ^{39}Ca decays to the 10^{-5} level with some beam, laser and trapping R&D**

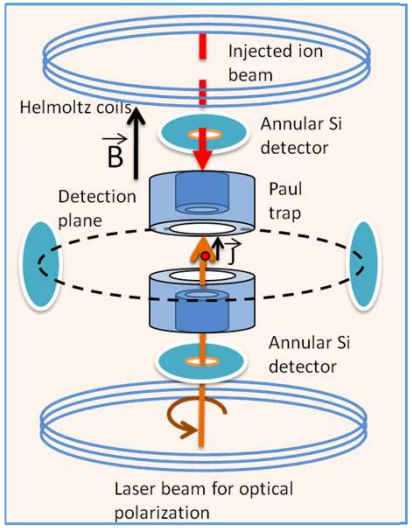
State of the art techniques from ISOL facilities

- **Ion cooling and trapping originally developped for**

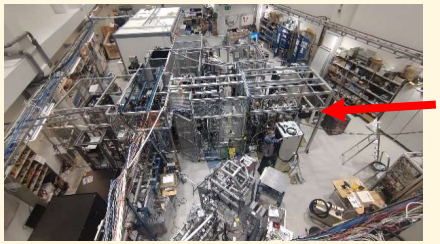
New trap and new detection setup:
off-line commissioning at LPC Caen and GANIL

Completed in automn 2021

- **Theoretical studies with state-of-the-art EFTs**



- **Innovative laser polarisation techniques at**



MORA installation at JYU/IGISOL (completed!)

Proof of principle of polarization
First *D* measurement ~10^{-4}

Started in Feb 2022

With experts from: ISOLDE, KU LEUVEN NUCLEAR AND RADIATION PHYSICS, MANCHESTER 1824 The University of Manchester

Back to GANIL /DESIR, making use of the intense and purified ISOL beams from SPIRAL 1/ S3-LEB: **2028**