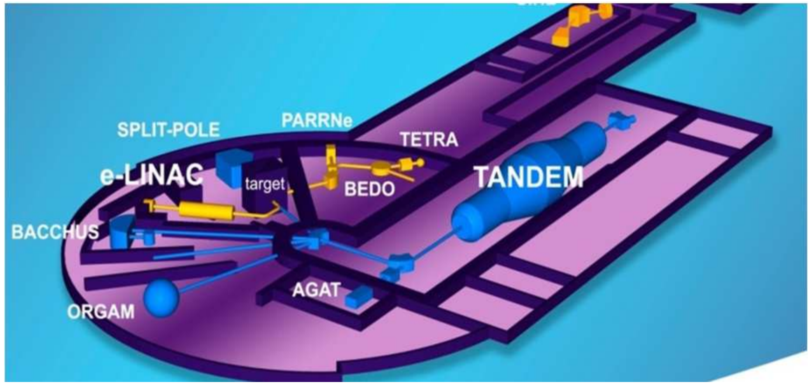
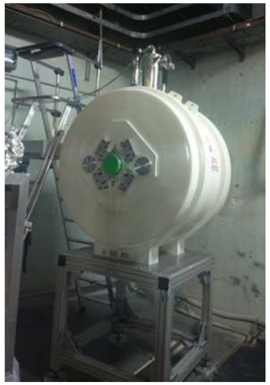
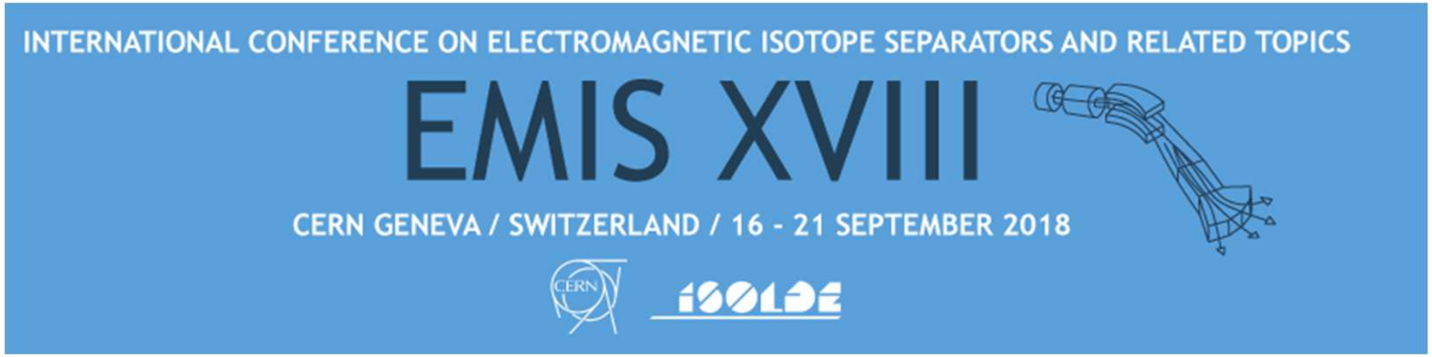
New program for measuring masses of silver isotopes near the *N*=82 shell closure with MLLTRAP at ALTO





Enrique Minaya Ramirez
Institut de Physique Nucléaire d'Orsay



MLLTRAP project in Germany

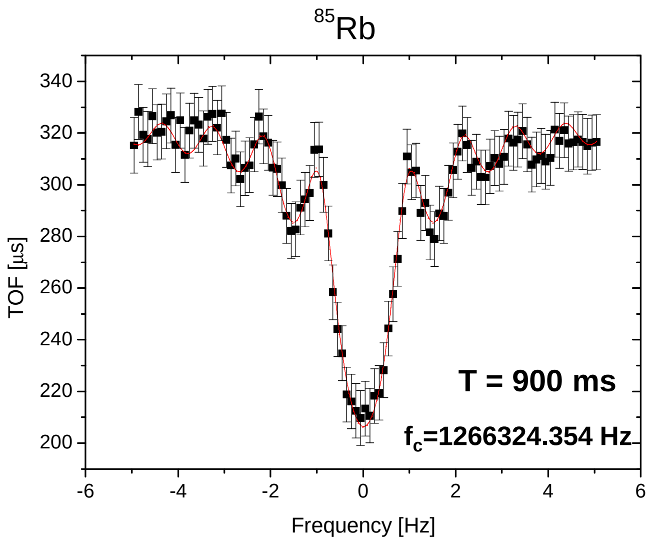
MLLTRAP

- ❑ **Penning trap mass spectrometer**
- ❑ **High-precision mass measurements**

Peter G. Thirolf , Christine Weber et al.

Maier-Leibnitz-Laboratorium für Kern-, Teilchen- & Beschleunigerphysik

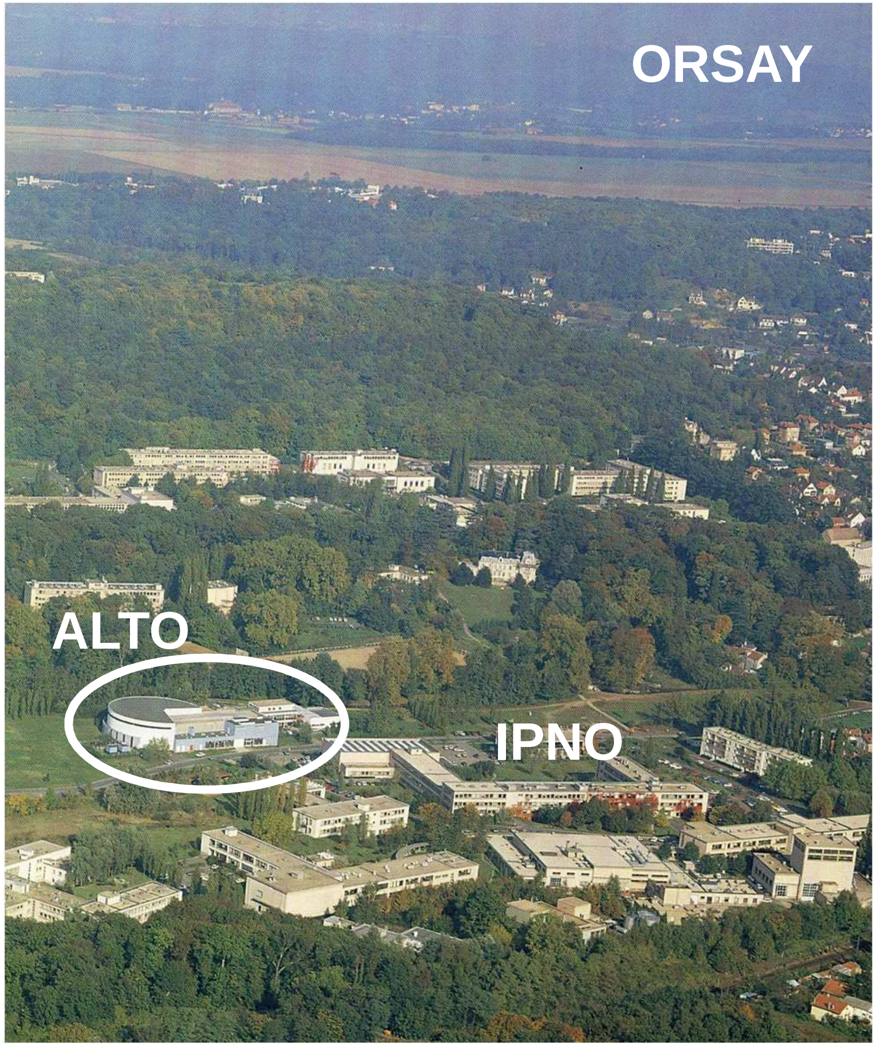
LMU



2009 → Off-line commissioning

V.S. Kolhinen, et al., Nucl. Instrum. Methods Phys. Res., Sect. A 600 (2009) 391

MLLTRAP project in France



IPN INSTITUT DE PHYSIQUE NUCLÉAIRE ORSAY

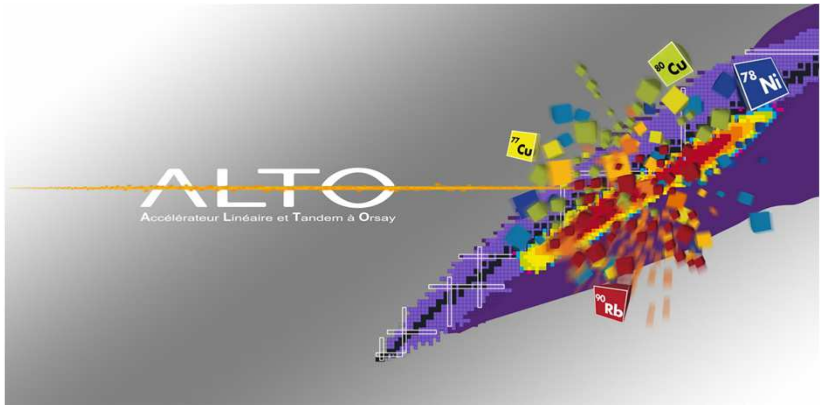
CNRS IN2P3 Les deux infinis

UNIVERSITÉ PARIS SUD

CHANDA

ENSAR

ENSAR2

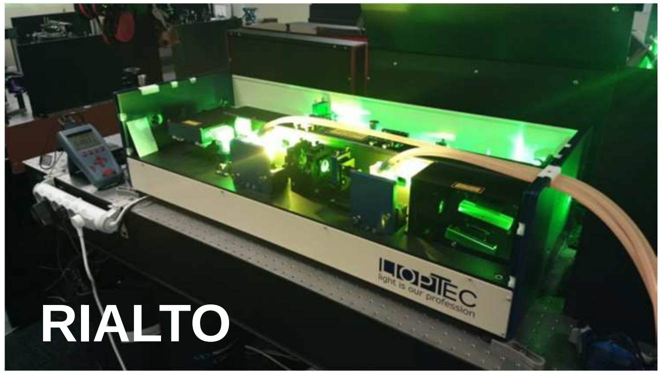


***A**ccélérateur **L**inéaire auprès du **T**andem d'**O**rsay*

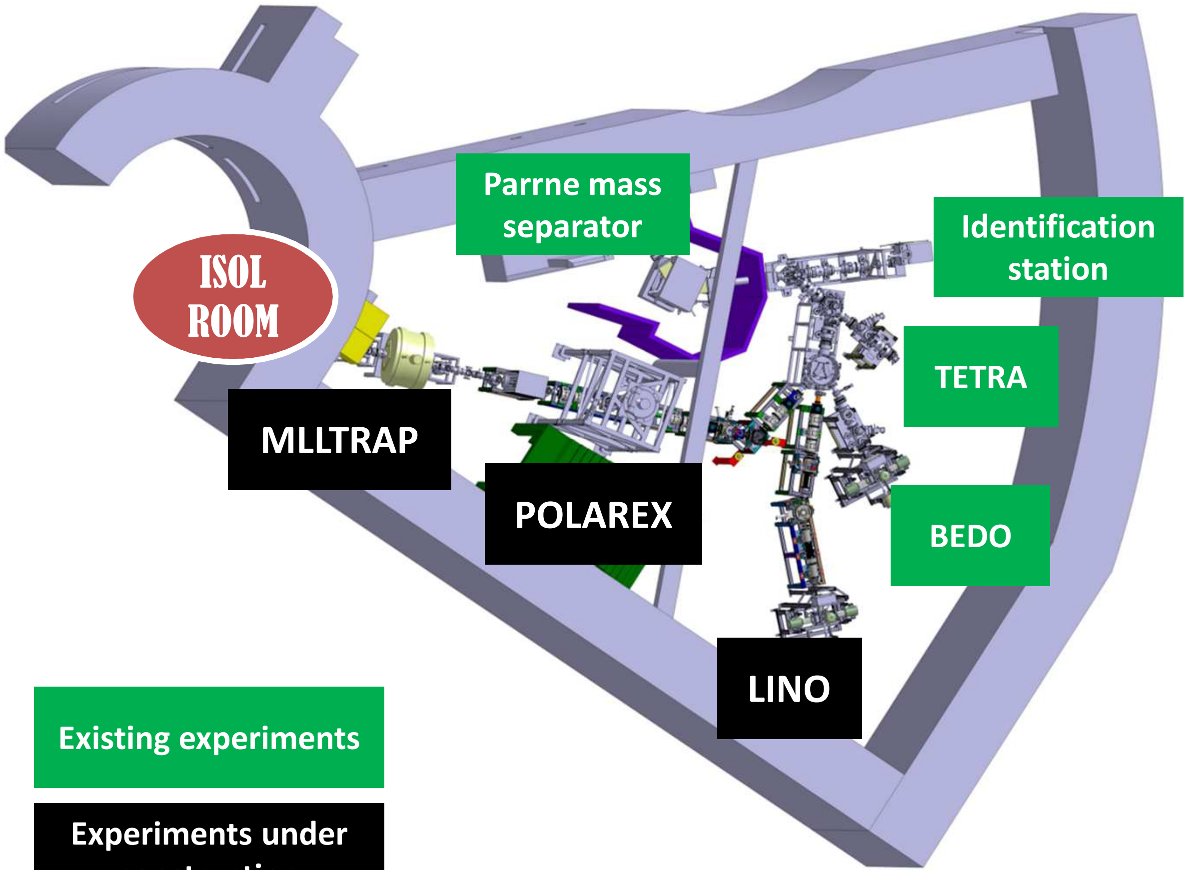
MLLTRAP project in France

First operational RIB facility based on photo-fission →populating the GDR of ^{238}U

- **30-kV platform**
- **mass separator (A/ΔA = 1500)**
- **10 µA, 50 MeV e- beam**
- **10^{11} – 4 x10^{11} fissions/s**



MLLTRAP @ ALTO



Existing experiments

Experiments under construction

2016

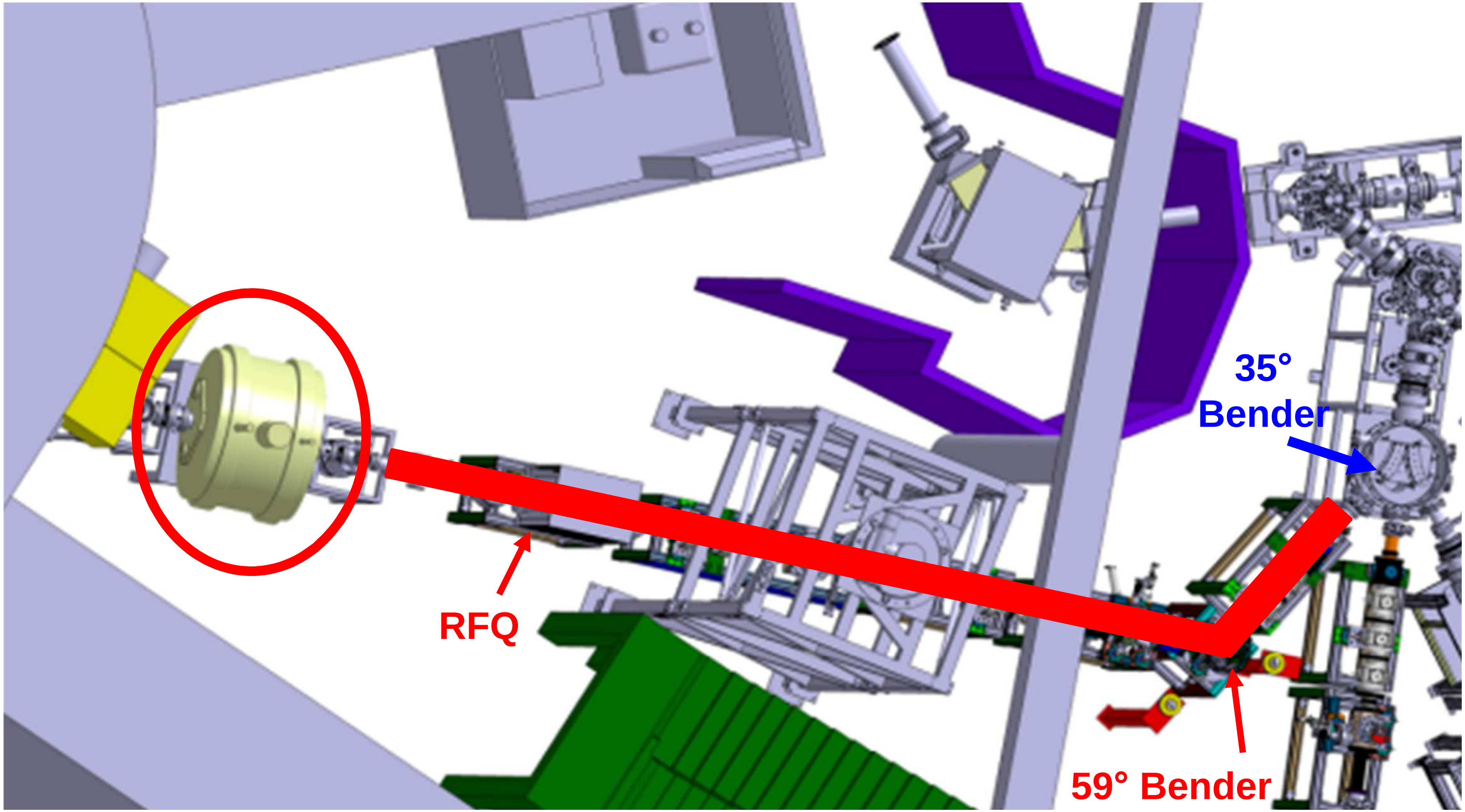
"Charting Terra Incognita of Exotic Nuclei"

2017

SESAME

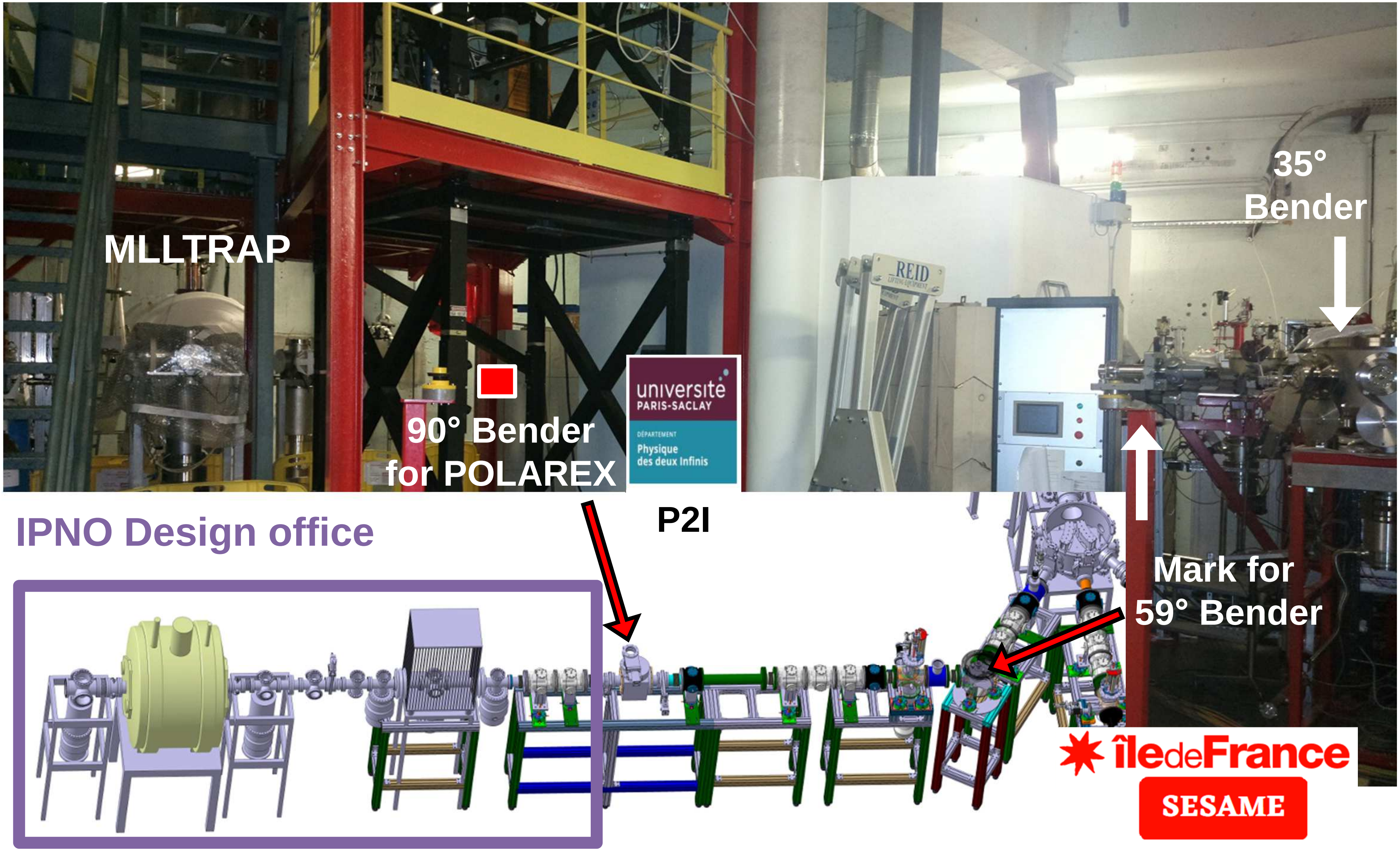
"Reaching Terra Incognita of Exotic Nuclei"

Status of MLLTRAP@ALTO



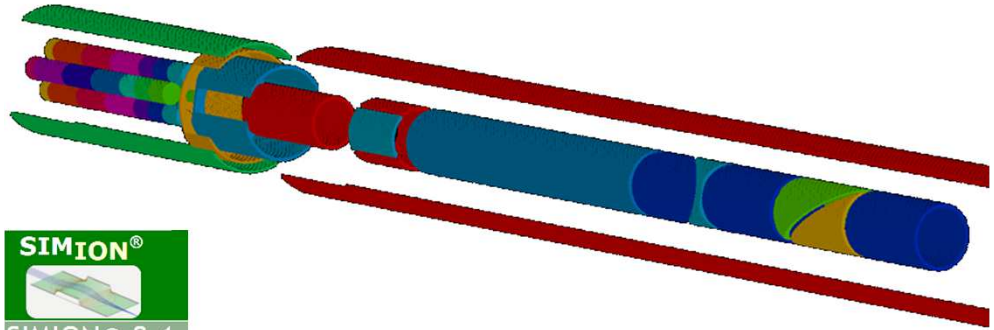
- ❑ **New area rehabilitated**
- ❑ **7 T superconducting magnet with 2 homogenous regions**
- → **Energized in November 2017**

Status of MLLTRAP@ALTO

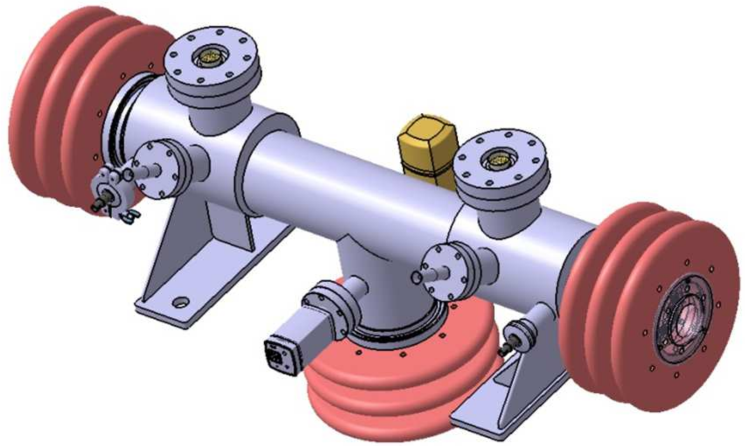


Status of MLLTRAP@ALTO

RFQ cooler and buncher



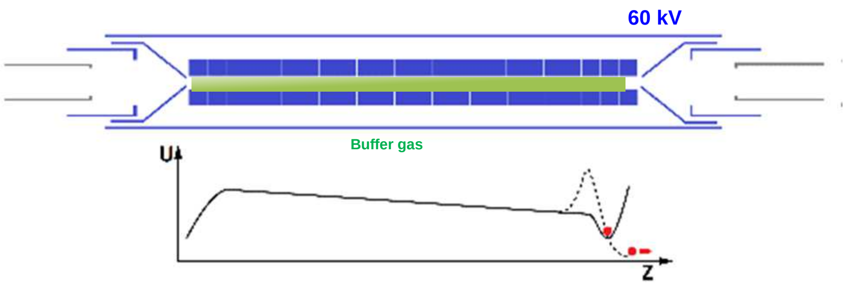
SIMION®
SIMION® 8.1



$2r_0$ = 14 mm
L = 503.5 mm (15 segments)

Transverse emittance : ~ 20 π.mm.mrad @ 1 keV

Longitudinal emittance : ~ 10 eV.μs

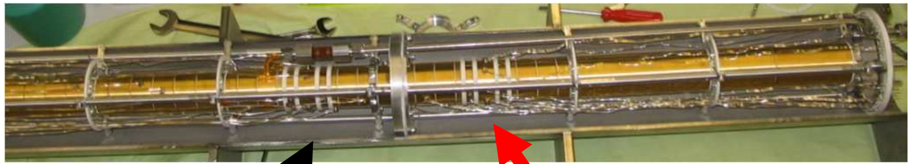


RFQ COLETTE @ 30 keV

T. Beyer et al., Appl. Phys. B 114 (2014) 129

MLLTRAP setup ALTO

High-precision mass measurements

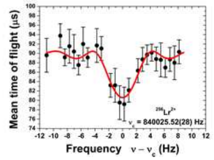


Purification Trap

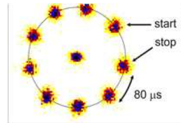
Measurement Trap

MCP delay line

TOF-ICR

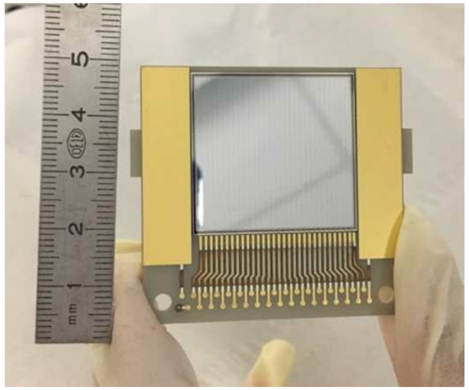


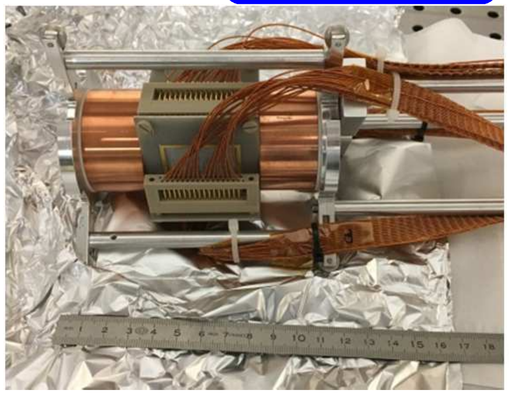
PI-ICR



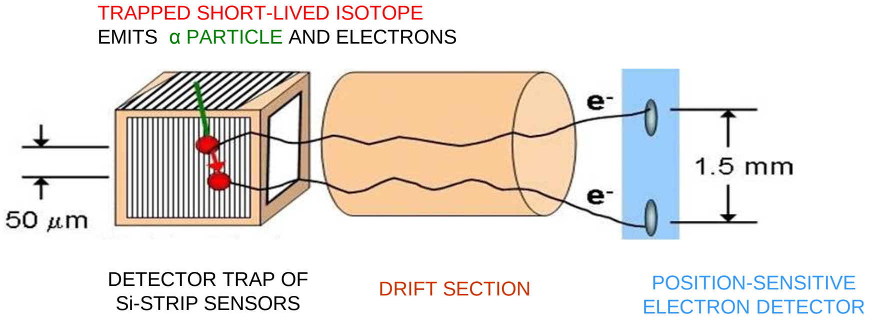
In-trap decay spectroscopy

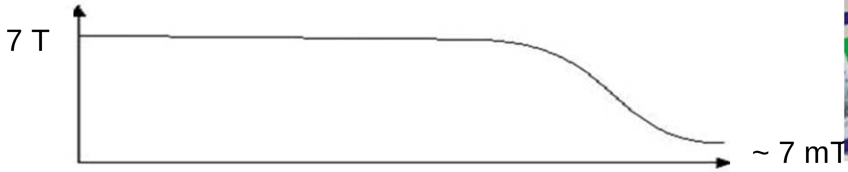
Detector Trap





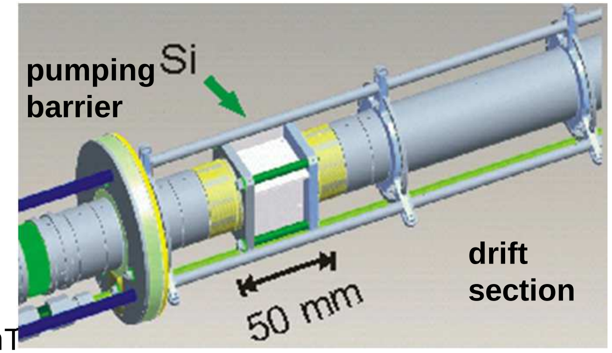
In-trap decay spectroscopy for MLLTRAP



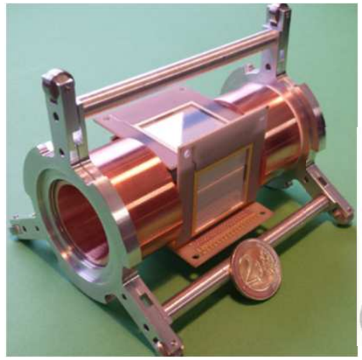


MAGNETIC FIELD STRENGTH ALONG THE TRAP AXIS

C. Weber et al., Int. J. Mass Spectrom. 349-350, 270 (2013)
C. Weber et al., Nucl. Instr. Meth. B 317, 532 (2013)



Conceptual layout



Detector trap

- ‘detector trap’: α-detectors act as trap electrodes
- customized α detectors were developed and characterized for the cryogenic and UHV-conditions (single-sided Si-strip detector, active area 30x30 mm², 30 strips, α-energy resolution ~ 20 keV)

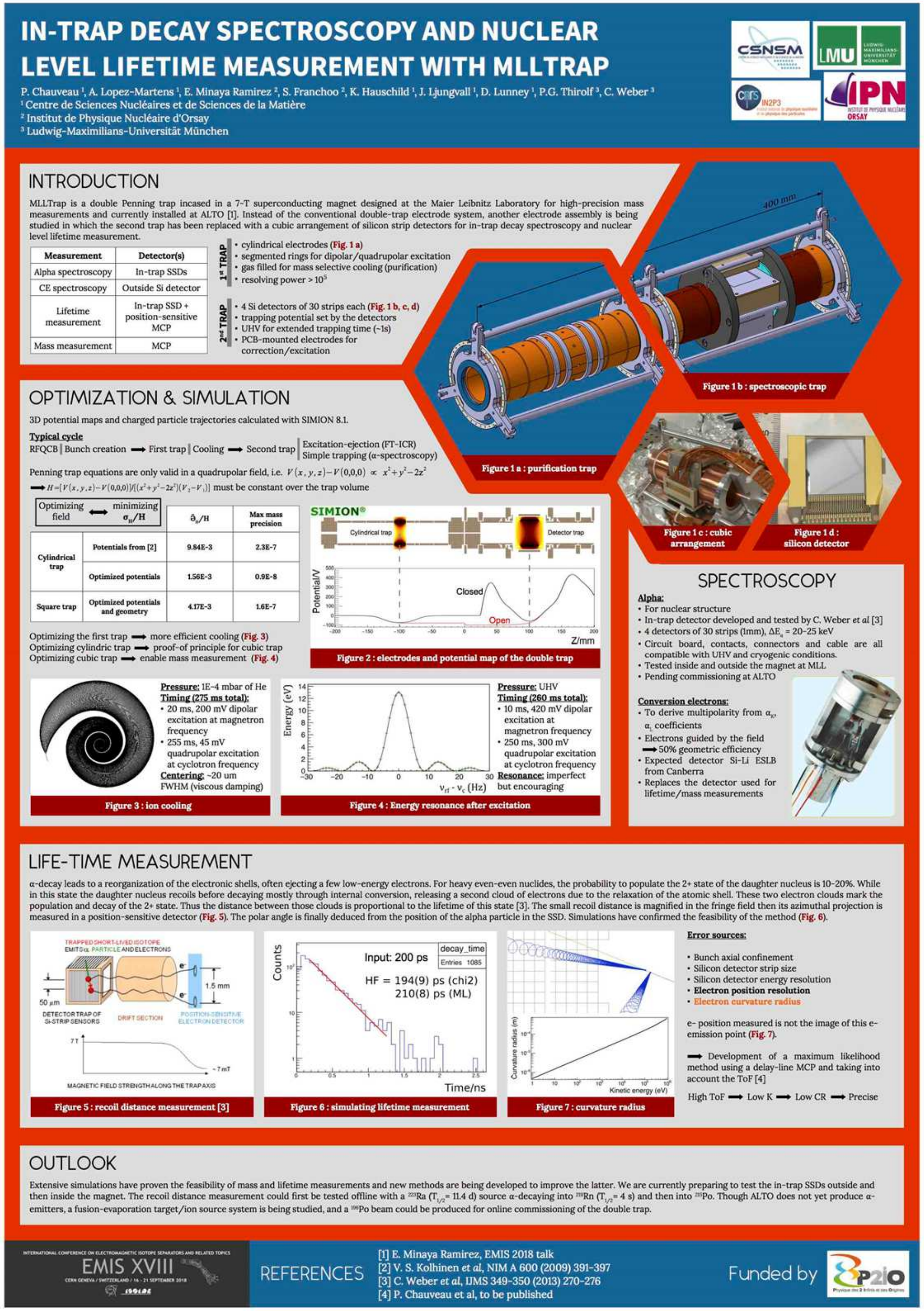
Advantages:

- Decay experiments with carrier-free particles stored in a Penning trap enable studies on ideal ion samples.
- The improved energy resolution can be exploited for high-resolution α- and electron-decay spectroscopy.

Physics Goals :

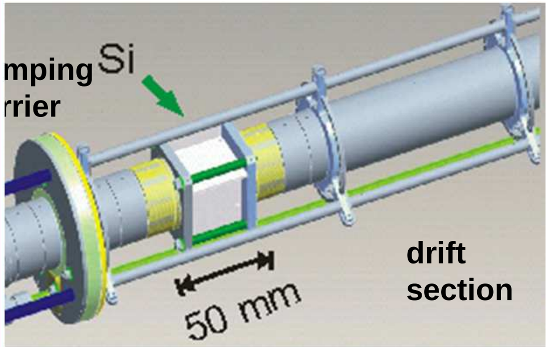
- From lifetime measurements of the first excited 2^+ states in heavy nuclei, nuclear quadrupole moments Q_0 can be derived
- Similar experiments on 0^+ states allow for a determination of E0 decay strengths r^2 (E0)
- Shape coexistence of 0^+ configurations as present in mid-shell regions around magic proton numbers

In-trap decay spectroscopy for MLLTRAP

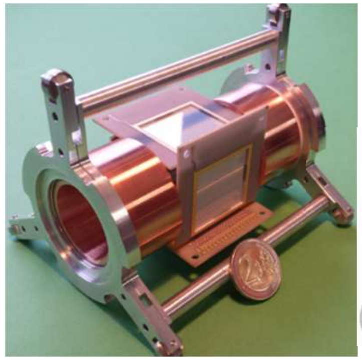


Weber et al., Int. J. Mass Spectrom. 349-350, 270 (2013)

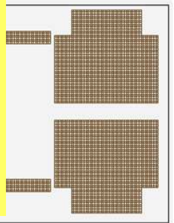
Weber et al., Nucl. Instr. Meth. B 317, 532 (2013)



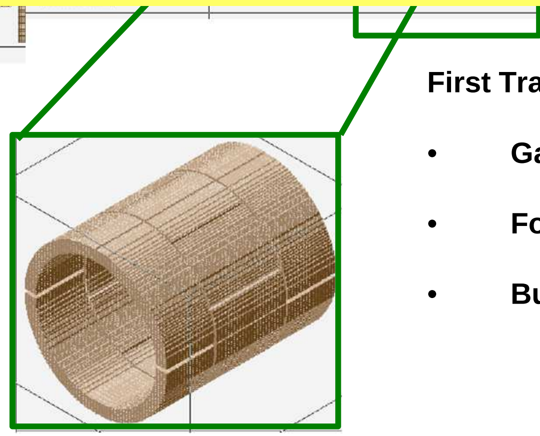
Conceptual layout



Detector trap



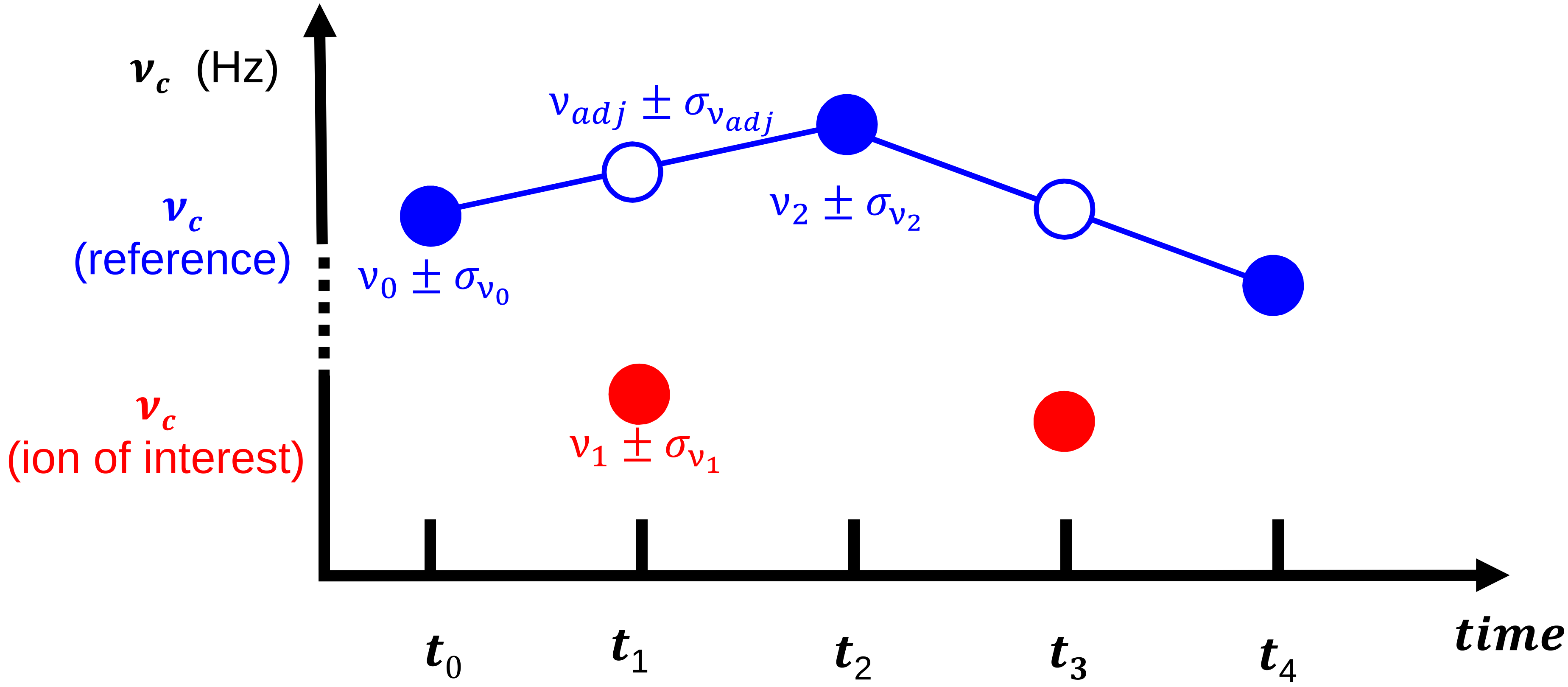
See poster #28 by Pierre Chauveau



First Trap:

- Gas filed
- For mass-selective cooling
- Built

Magnetic field calibration



→ **keep track of magnetic field variations during on-line measurements**

→ **Probe developed by Caylar (company nearby Orsay)**

→ **Measurements performed during the last months**

CAYLAR
INSTRUMENTATION SCIENTIFIQUE

îledeFrance
SESAME

High-precision mass measurements at ALTO

ALTO

Letter of Intent for Day 1
MLLTRAP experiments

PAC session : March 2017	EXP # (Do not fill in):

Title: **High-precision mass measurement of silver isotopes (*A*=113 – 129) towards the *N*=82 shell closure with MLLTRAP at ALTO**

Is it a follow up experiment? [Yes/No]: **No** If yes, experiment number:

Spokespersons (if several, please use capital letters to indicate the name of the contact person):

Enrique Minaya Ramirez

Address of the contact person:

Institut de Physique Nucléaire 15 rue Georges Clémenceau 91406 Orsay

Other Participants or Organisations:

P. Ascher[1], B. Blank[1], P. Chauveau[2], P. Delahaye[3], S. Franchoo[4], M. Gerbaux[1], S. Grévy[1], J. Ljungvall[2], A. Lopez-Martens[2], D. Lunney[2], M. MacCormick[4], A. De Roubin[5], P. Thirolf[6], J.-C. Thomas[3], D. T. Yordanov[4]

[1]*Centre d'Etudes Nucléaires de Bordeaux-Gradignan, France*

[2]*Centre de Sciences Nucléaires et de Sciences de la Matière, Orsay, France*

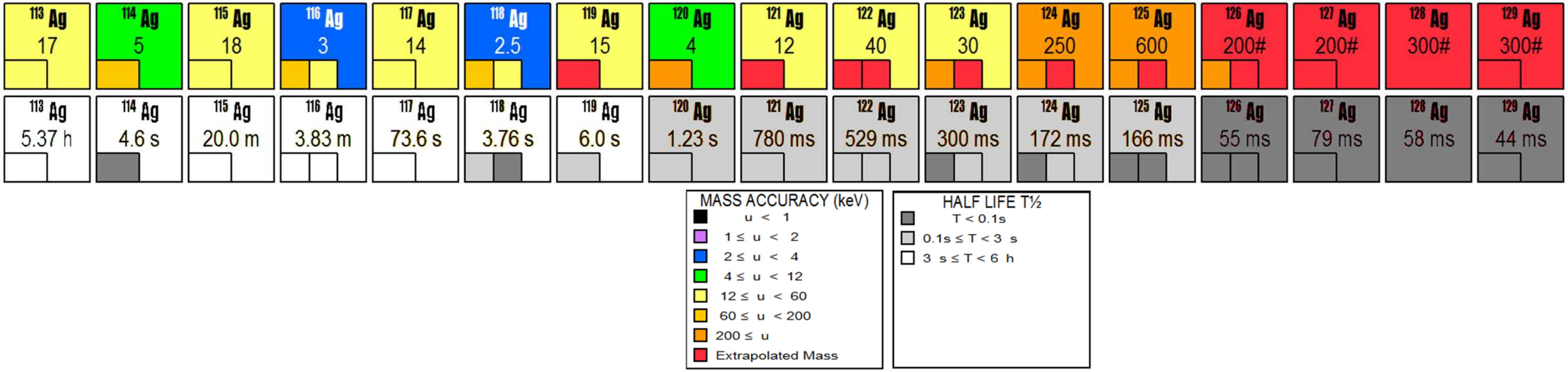
[3]*Grand Accélérateur National d'Ions Lourds, Caen, France*

[4]*Institut de Physique Nucléaire d'Orsay, France*

[5]*University of Jyvaskyla, Department of Physics, Finland*

[6]*Ludwig-Maximilians-Universität München, Garching, Germany*

High precision mass measurements of silver isotopes

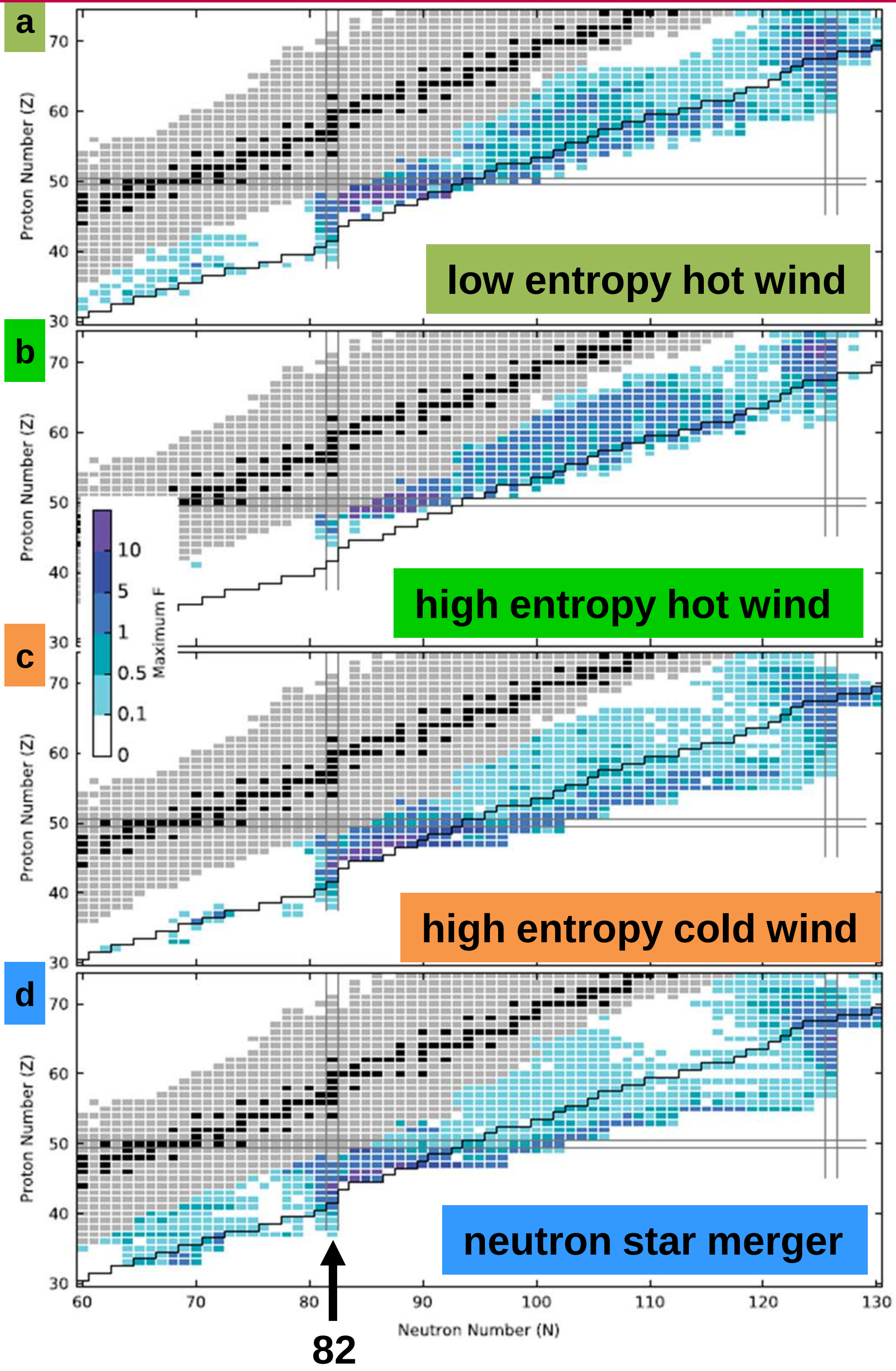


^{113,115,118}Ag : Characterize the performance of the full detection system

$^{123\text{-}125}$Ag : Sensitivity of MLLTRAP to ions with short half-lives and low statistics

^{126}Ag and above : evolution of the shell gap at *N*= 82 (PI-ICR)

Masses for nuclear astrophysics studies



Important nuclei from sensitivity studies

Nuclear mass (silver isotopes)

mass	a	b	c	d
126	0.05	*	0.15	1.28
127	0.11	0.02	0.22	1.68
128	**2.22**	**3.51**	1.23	**2.89**
129	1.92	0.71	1.18	**2.90**
130	**12.54**	0.04	0.68	**3.03**

M.R. Mumpower et al., PPNP86 (2016) 86

Thank you for your attention!