

MATS (precise Measurements on very short-lived nuclei using an Advanced Trapping System)

Daniel Rodríguez
Departamento de Física Atómica Molecular y Nuclear
Universidad de Granada

For the MATS collaboration
NUSTAR week 2014
(IFIC-CSIC) Valencia, September 2014



European Research Council
Established by the European Commission



Bundesministerium
für Bildung
und Forschung



Helmholtz-Institut Mainz



MAX-PLANCK-INSTITUT FÜR KERNPHYSIK

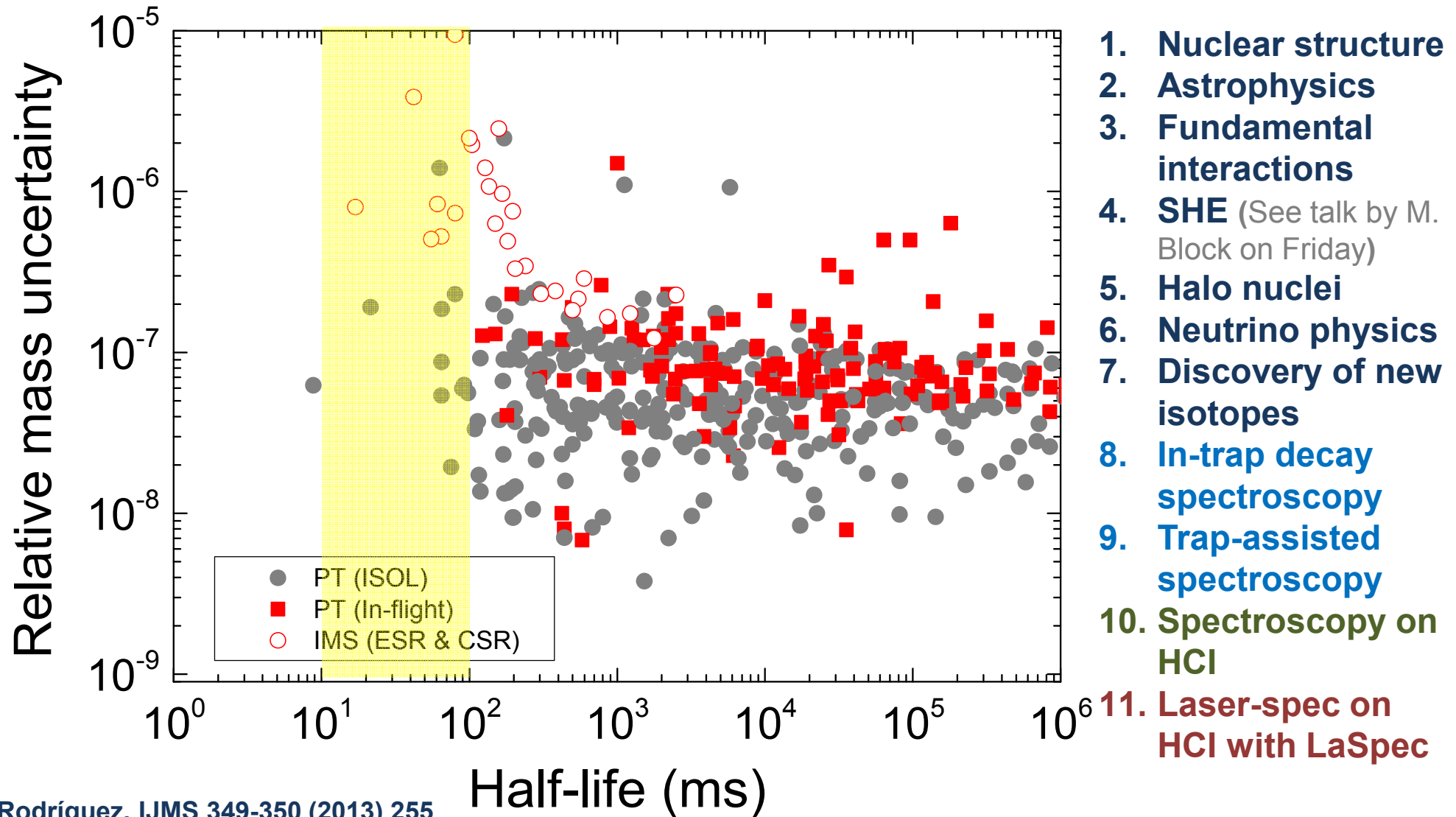


Outline

- Motivation
- The collaboration and the facility
- On-going developments with prospects for MATS
- Summary & outlook

Motivation for MATS at FAIR

Precise mass measurements on short-lived isotopes





Motivation for MATS at FAIR

Complementarity of MATS with other Penning traps

Type of Reacion	ISOL TRAP	CPT	SHIP TRAP	JYFL TRAP	LEBIT	TITAN	TRIGA TRAP	CARIBU	MLL TRAP	MATS
ISOL	X					X			X	
Fusion		X	X							
IGISOL				X						
Fragm.					X					X
Neutron induced fission							X			
Spontaneous fission								X		
HCI						X				X

The MATS collaboration

11 countries, 32 institutes, ~ 90 members

Belgium		Universite Bruxelles, KUL
Canada		TRIUMF
Finland		JYFL
France		CSNSM-IN2P3, CNRS, CENBG
Germany		EMAU, FAIR, FAU, GSI, TUD, JGU, MPIK, JLU, LMU, PTB
India		VECC, RGC
Russia		PNPI, PSU
Spain		UHU, UGR, IFIC
Sweden		SU, UU
Switzerland		ISOLDE/CERN
USA		LLNL, MSU, LSU

<http://www.fair-center.eu/for-users/experiments/nustar/experiments/mats.html>

The MATS facility

Contributions

Dipole magnet
(Jyväskylä)

RFQ buncher
(Jyväskylä)

MR-TOF-MS
(Giessen)

LaSpec facility
(see talk by Simon Kaufmann)

MATS Penning traps
(LMU, Granada, GSI, Mainz,
MPIK, Sweden, VECC)

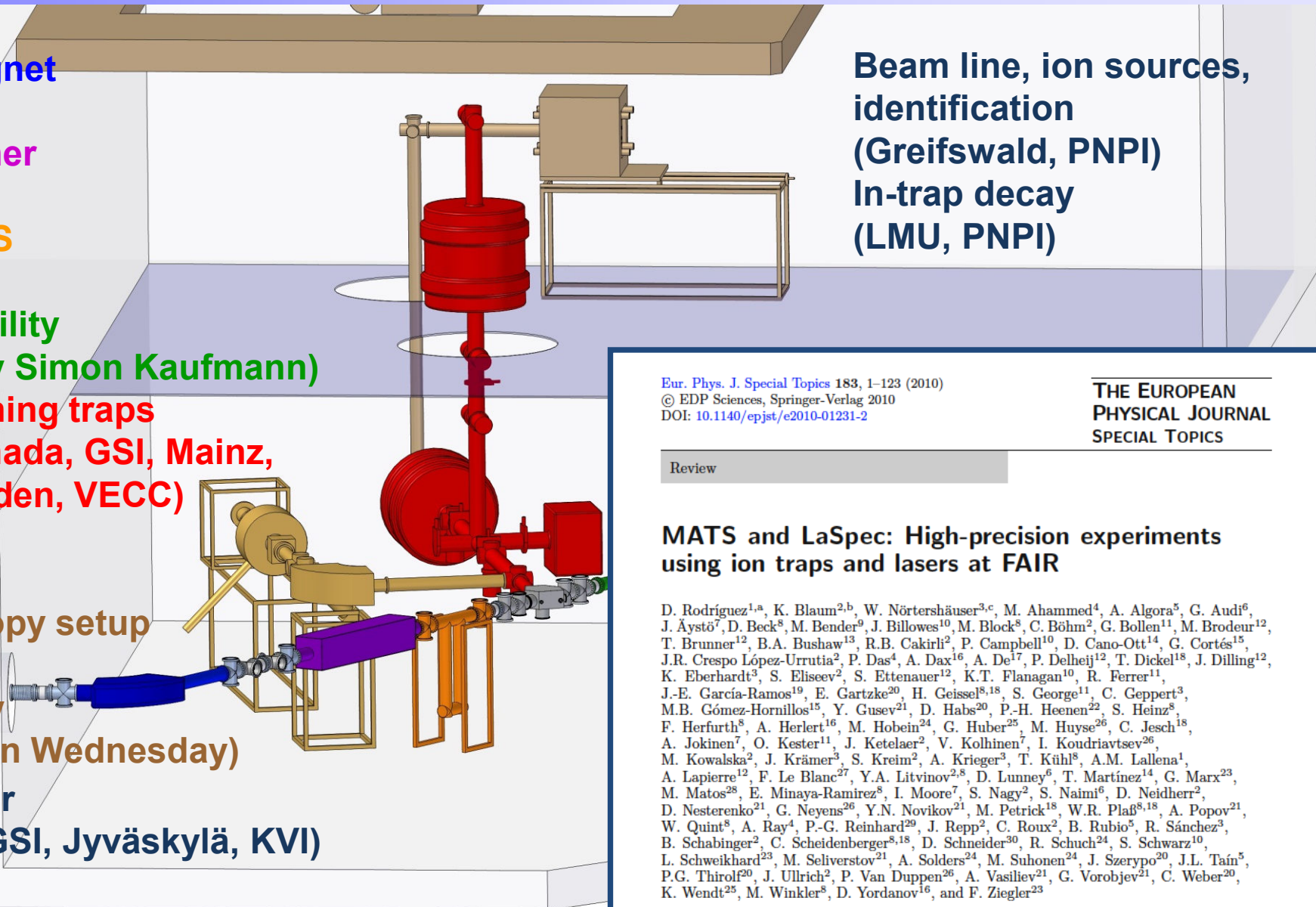
EBIT
(MPIK)

Spectroscopy setup
(IFIC, UPC)

(see talk by
A. Algora on Wednesday)

Gas catcher
(Giessen, GSI, Jyväskylä, KVI)

Beam line, ion sources,
identification
(Greifswald, PNPI)
In-trap decay
(LMU, PNPI)



Eur. Phys. J. Special Topics 183, 1–123 (2010)
© EDP Sciences, Springer-Verlag 2010
DOI: 10.1140/epjst/e2010-01231-2

THE EUROPEAN
PHYSICAL JOURNAL
SPECIAL TOPICS

Review

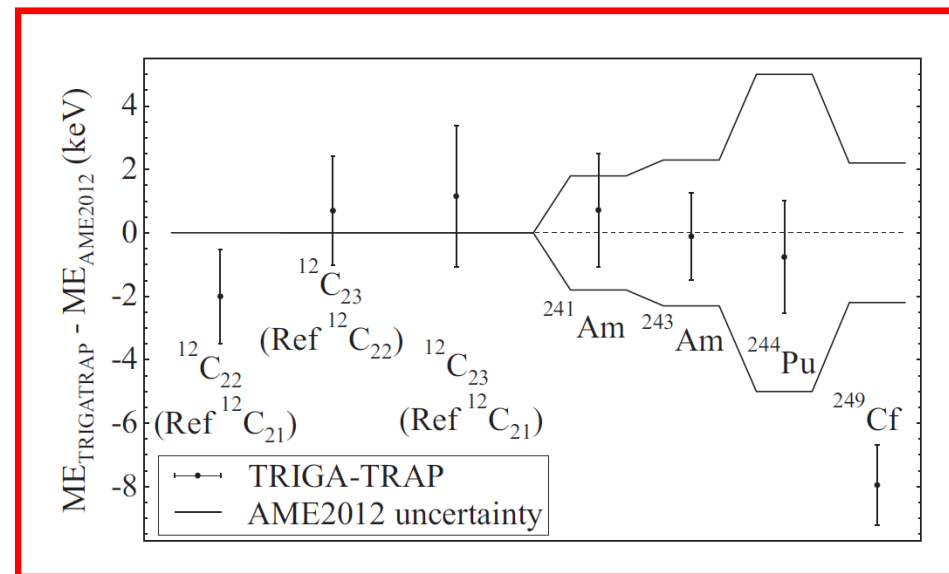
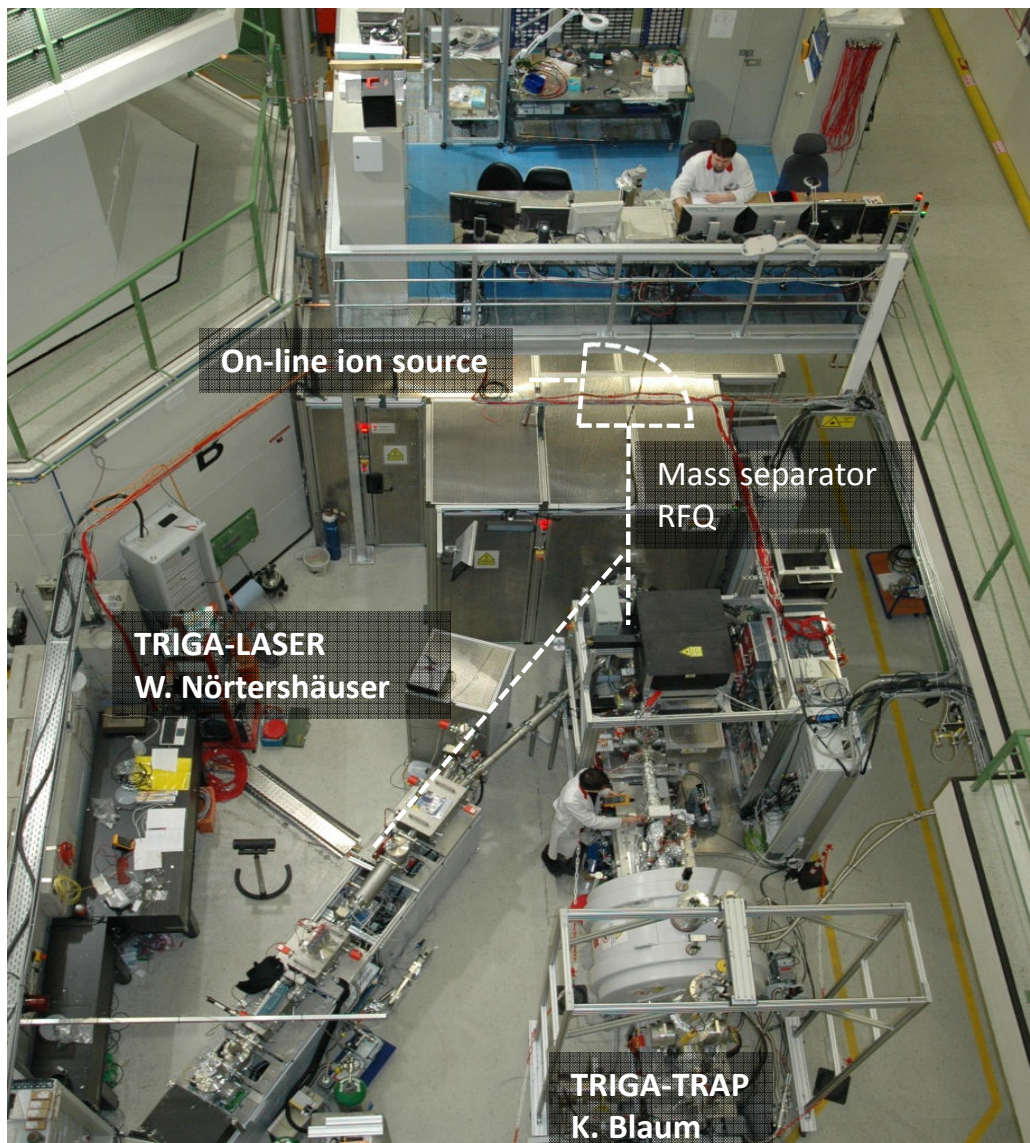
MATS and LaSpec: High-precision experiments using ion traps and lasers at FAIR

D. Rodríguez^{1,a}, K. Blaum^{2,b}, W. Nörtershäuser^{3,c}, M. Ahammed⁴, A. Algora⁵, G. Audi⁶, J. Äystö⁷, D. Beck⁸, M. Bender⁹, J. Billowes¹⁰, M. Block⁸, C. Böhm², G. Bollen¹¹, M. Brodeur¹², T. Brunner¹², B.A. Bushaw¹³, R.B. Cakirli², P. Campbell¹⁰, D. Cano-Ott¹⁴, G. Cortés¹⁵, J.R. Crespo López-Urrutia², P. Das⁴, A. Dax¹⁶, A. De¹⁷, P. Delheij¹², T. Dickel¹⁸, J. Dilling¹², K. Eberhardt³, S. Eliseev², S. Ettenauer¹², K.T. Flanagan¹⁰, R. Ferrer¹¹, J.-E. García-Ramos¹⁹, E. Gartzke²⁰, H. Geissel^{8,18}, S. George¹¹, C. Geppert³, M.B. Gómez-Hornillos¹⁵, Y. Gusev²¹, D. Habs²⁰, P.-H. Heenen²², S. Heinz⁸, F. Herfurth⁸, A. Herlert¹⁶, M. Hobein²⁴, G. Huber²⁵, M. Huyse²⁶, C. Jesch¹⁸, A. Jokinen⁷, O. Kester¹¹, J. Ketelaer², V. Kolhinen⁷, I. Koudriavtsev²⁶, M. Kowalska², J. Krämer²⁷, S. Kreim², A. Krieger³, T. Kühl⁸, A.M. Lallena¹, A. Lapiere¹², F. Le Blanc²⁷, Y.A. Litvinov^{2,8}, D. Lumey⁶, T. Martínez¹⁴, G. Marx²³, M. Matos²⁸, E. Minaya-Ramirez⁸, I. Moore⁷, S. Nagy², S. Naimi⁶, D. Neidherr², D. Nesterenko²¹, G. Neyens²⁶, Y.N. Novikov²¹, M. Petrick¹⁸, W.R. Plaß^{8,18}, A. Popov²¹, W. Quint⁸, A. Ray⁴, P.-G. Reinhard²⁹, J. Repp², C. Roux², B. Rubio⁵, R. Sánchez³, B. Schabinger², C. Scheidenberger^{8,18}, D. Schneider³⁰, R. Schuch²⁴, S. Schwarz¹⁰, L. Schweikhard²³, M. Seliverstov²¹, A. Solders²⁴, M. Suhonen²⁴, J. Szerypo²⁰, J.L. Tain⁵, P.G. Thirolf²⁰, J. Ullrich², P. Van Duppen²⁶, A. Vasiliev²¹, G. Vorobjev²¹, C. Weber²⁰, K. Wendt²⁵, M. Winkler⁸, D. Yordanov¹⁶, and F. Ziegler²³

On-going developments with prospects for MATS

The first stage (TRIGA-TRAP)

Already in operation



M. Eibach *et al.*, Phys. Rev. C 89 (2014) 064318

On-going developments with prospects for MATS

I. The ion-gas catcher and MR-TOF device

- On-line test with ^{238}U projectile fragments produced at 1 GeV/u at the FRS in October 2011 and July/August 2012.
- Another beamtime takes place at present at GSI.

Giessen, GSI, Jyväskylä, KVI
W.R. Plass *et al.*, *NIMB*, 317 (2013) 457

II. The new PI-ICR (Phase-Imaging Ion-Cyclotron-Resonance) technique

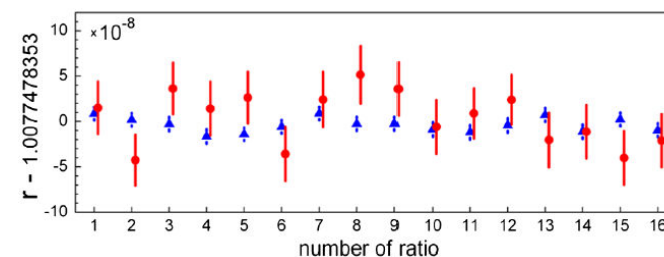
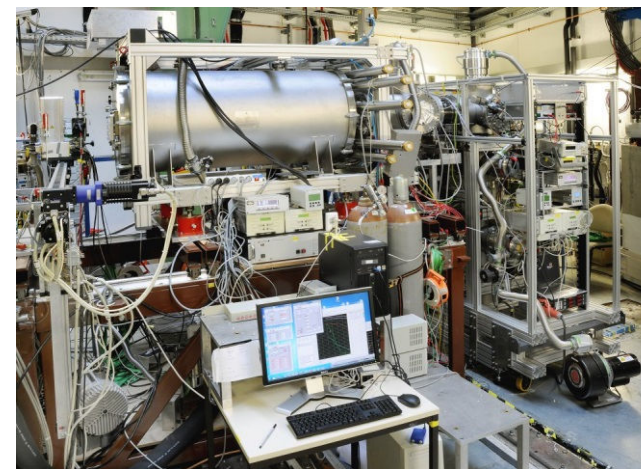
- This method is 25 times faster and provides a 40-fold increase in resolving power with respect to the Ramsey technique.
- The mass measurement requires less ions.

MPIK/GSI/Greifswald → See talk by E. Minaya on Friday
S. Eliseev *et al.*, *Phys. Rev. Lett.* 110 (2013) 082501

III. The construction of the trap comprised of detectors for in-trap decay studies

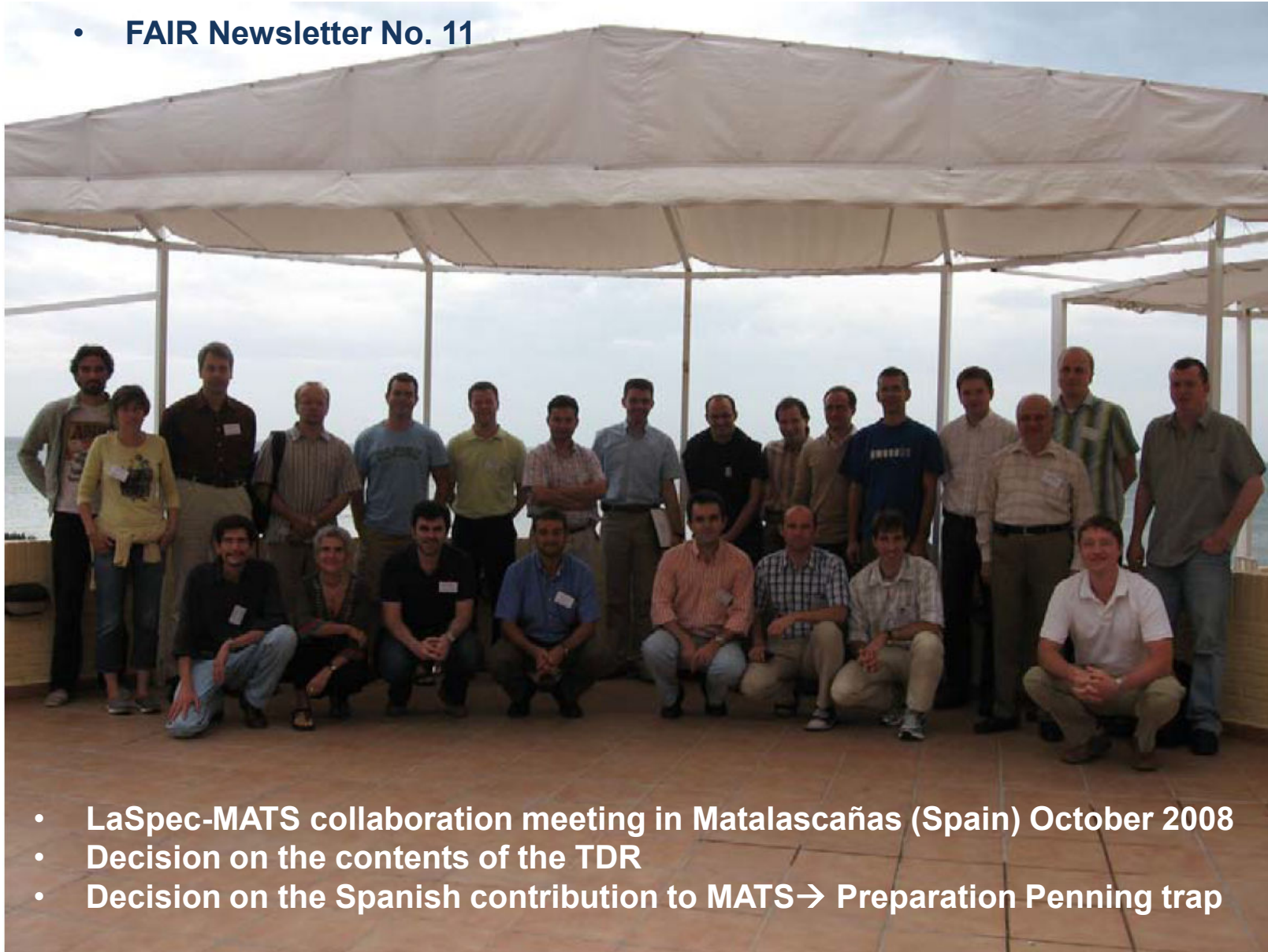
- Customized detectors have been developed for the cryogenic & UHV-conditions requested for MATS
- Extensive characterization have been performed.

LMU → See talk by C. Weber on Thursday
C. Weber *et al.*, *NIMB* 317 (2013) 532



On-going developments with prospects for MATS Spain

- FAIR Newsletter No. 11



- LaSpec-MATS collaboration meeting in Matalascañas (Spain) October 2008
- Decision on the contents of the TDR
- Decision on the Spanish contribution to MATS→ Preparation Penning trap

On-going developments with prospects for MATS Spain

I. The preparation Penning trap

- A Penning trap has been built and is under commissioning in the framework of the project TRAPSENSOR.

J.M. Cornejo, P. Escobedo, D. Rodríguez, *Hyperfine Interact.* 227, (2014) 223



European Research Council
Established by the European Commission



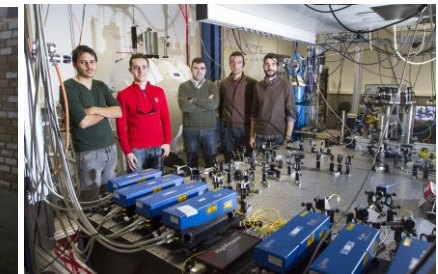
II. Improving sensitivity to reach single-ion detection

- A cold-head system (4 K) has been built and it is ready for the construction and commissioning of a Fourier- Transform Ion-Cyclotron-Resonance (FT-ICR) system.

This contribution has been considered as secured money from the Spanish Ministry

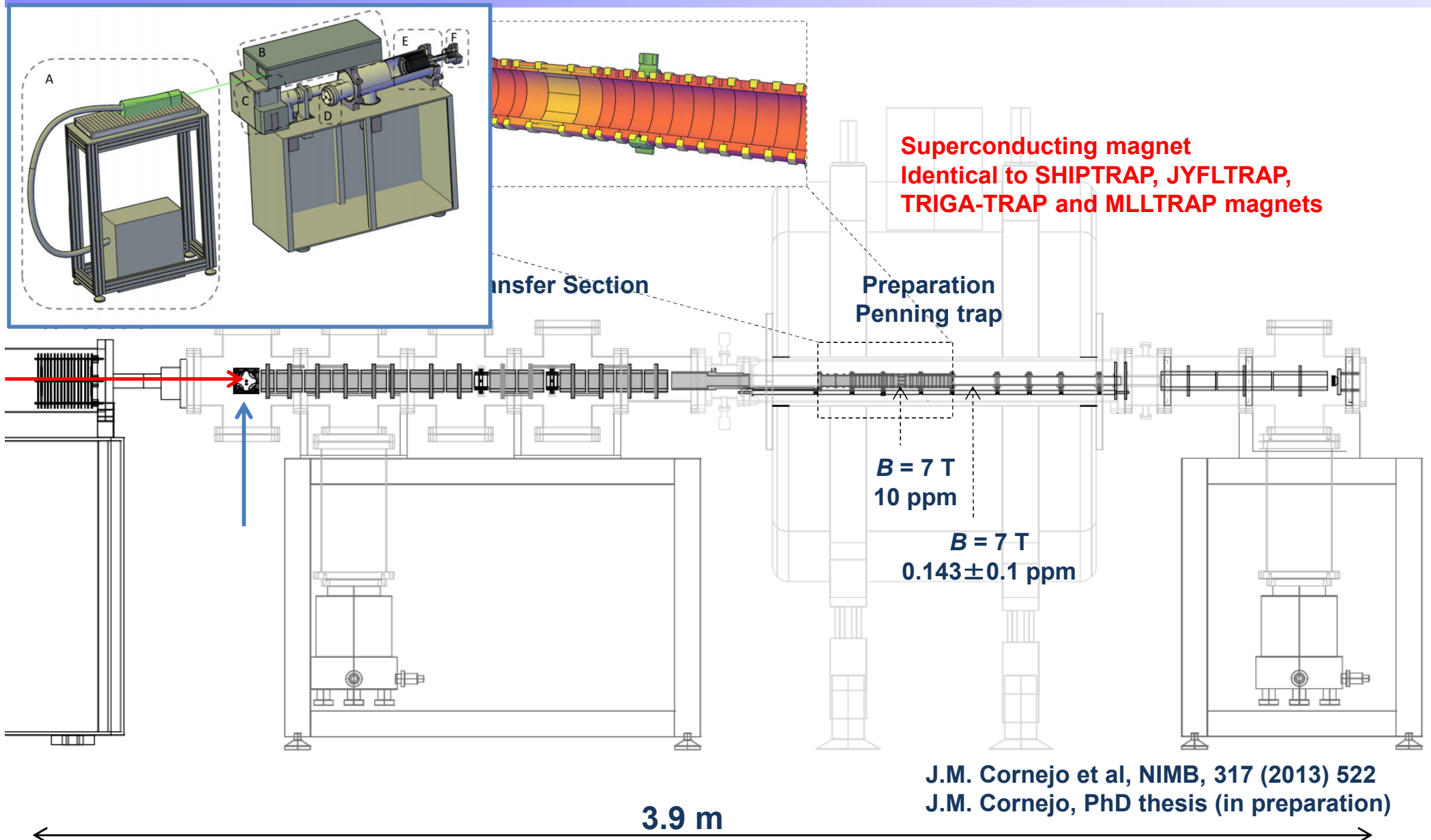


III. The infrastructure in Granada is available to carry out these developments



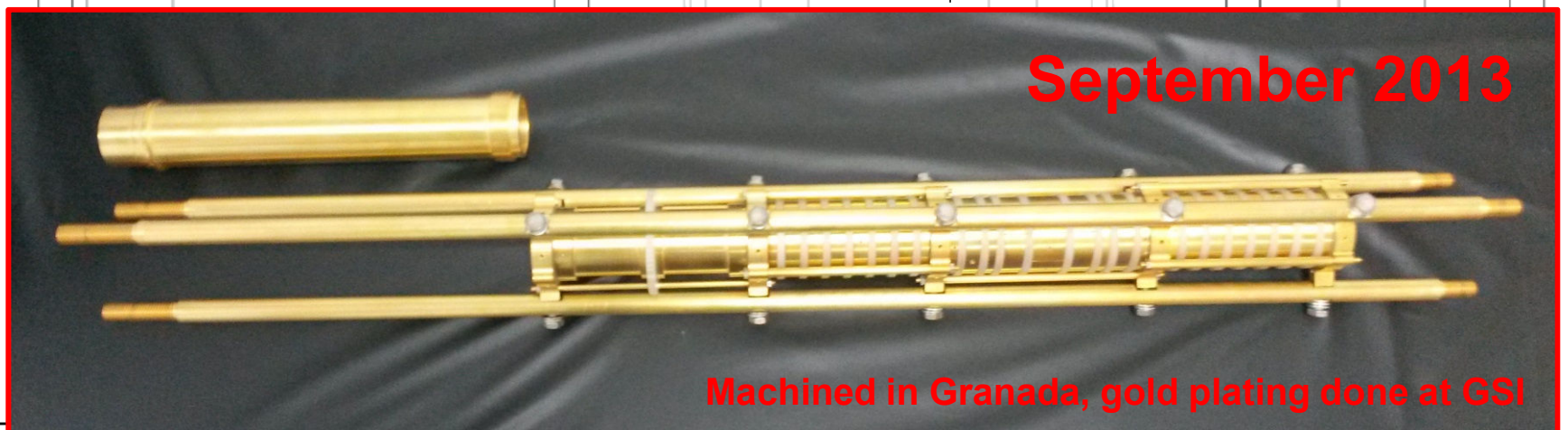
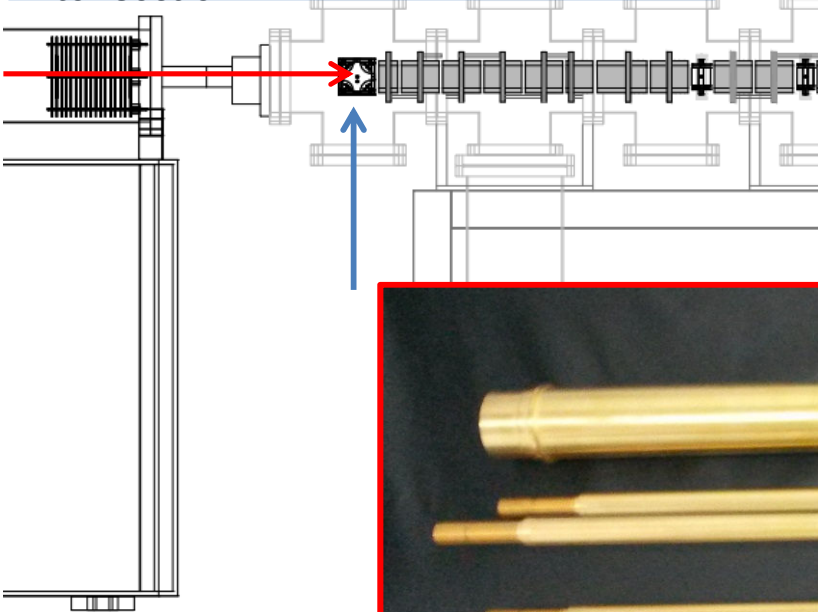
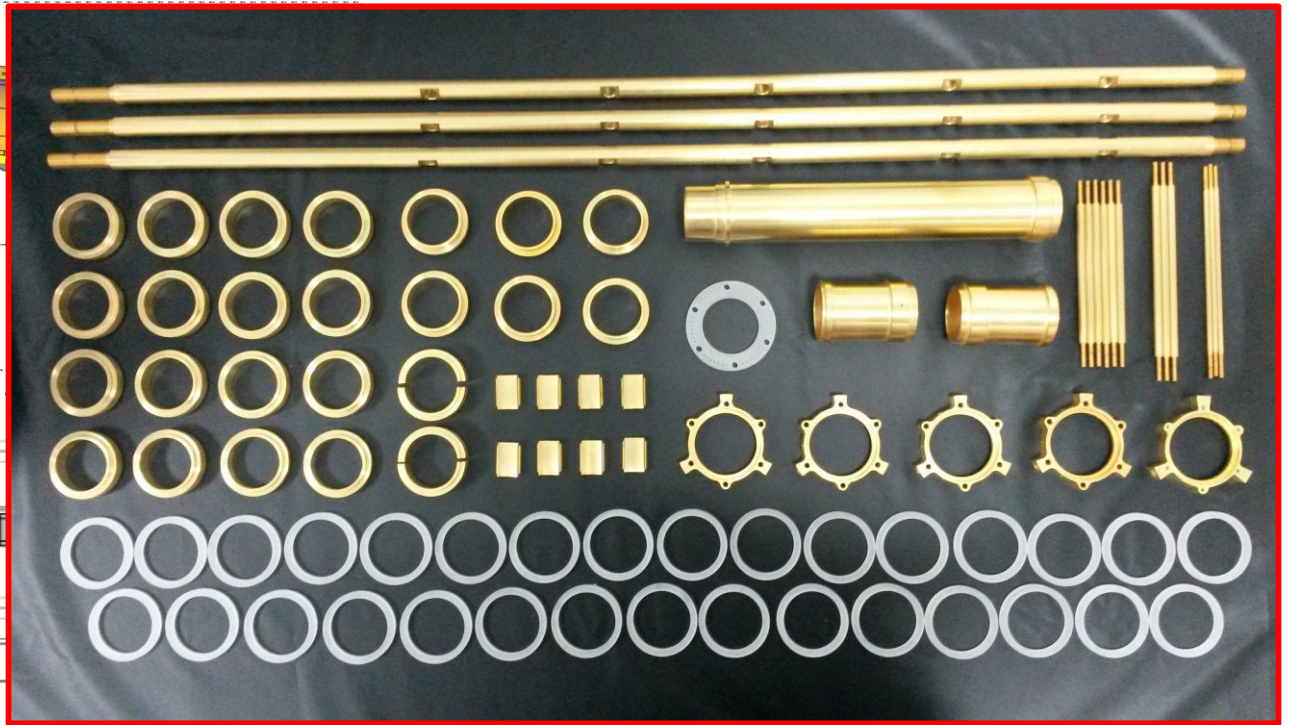
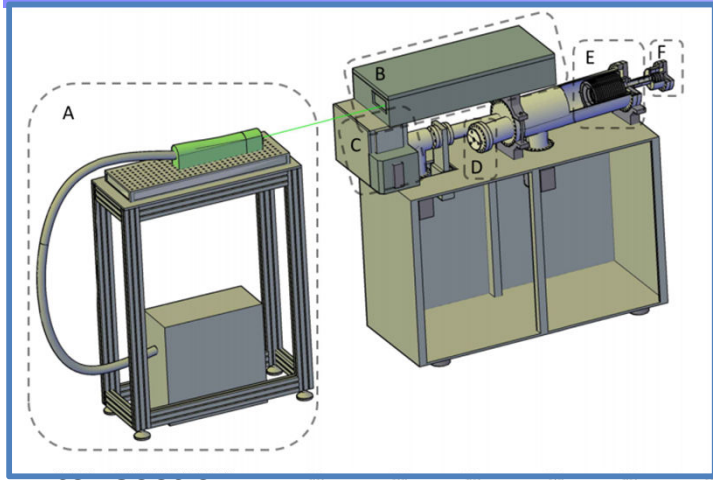
On-going developments with prospects for MATS

The Preparation Penning trap



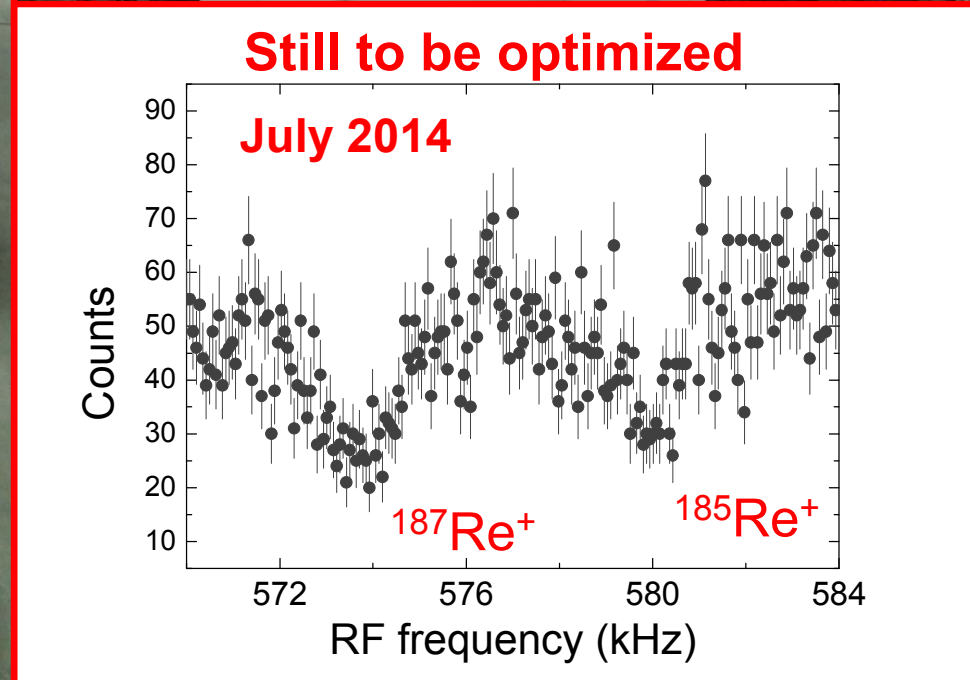
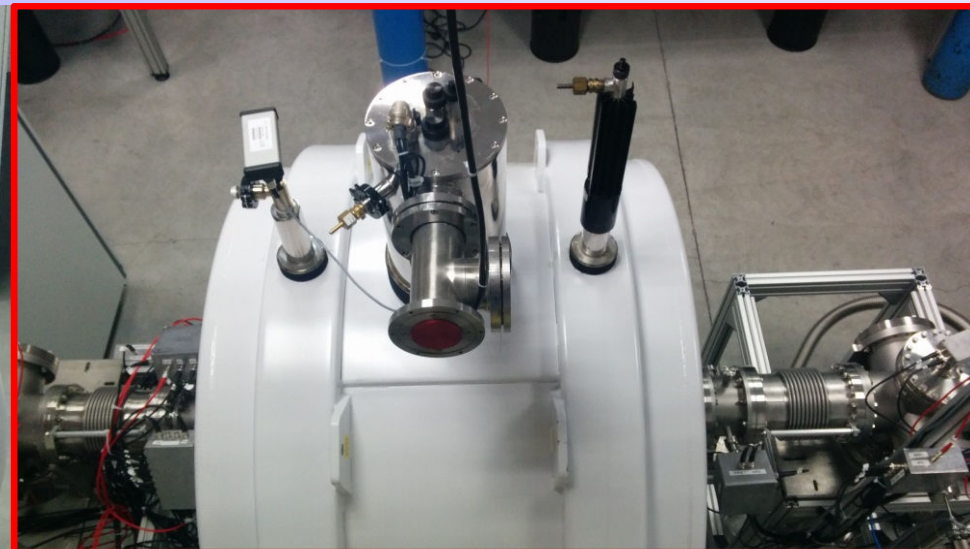
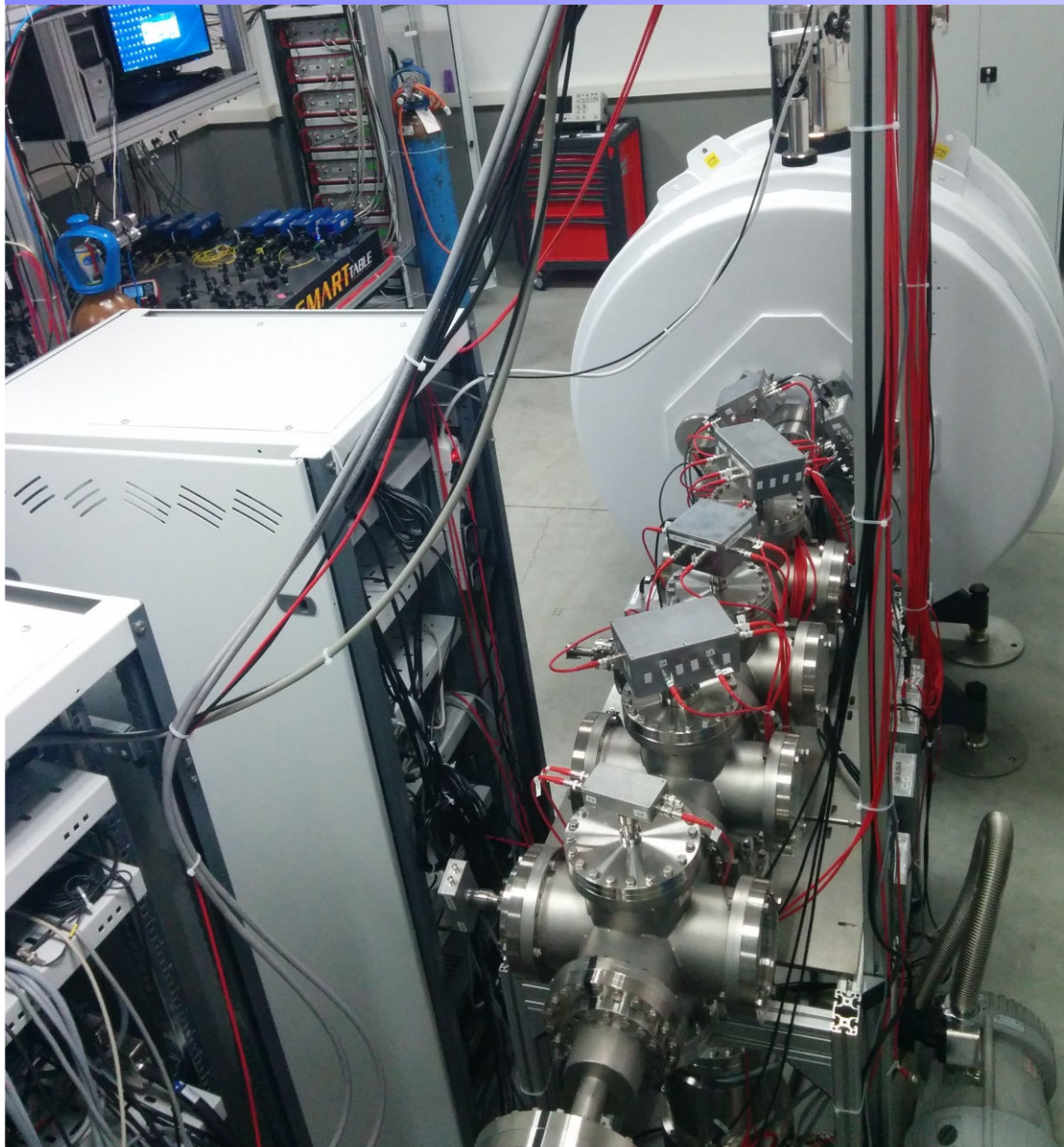
On-going developments with prospects for MATS

The Preparation Penning trap



On-going developments with prospects for MATS

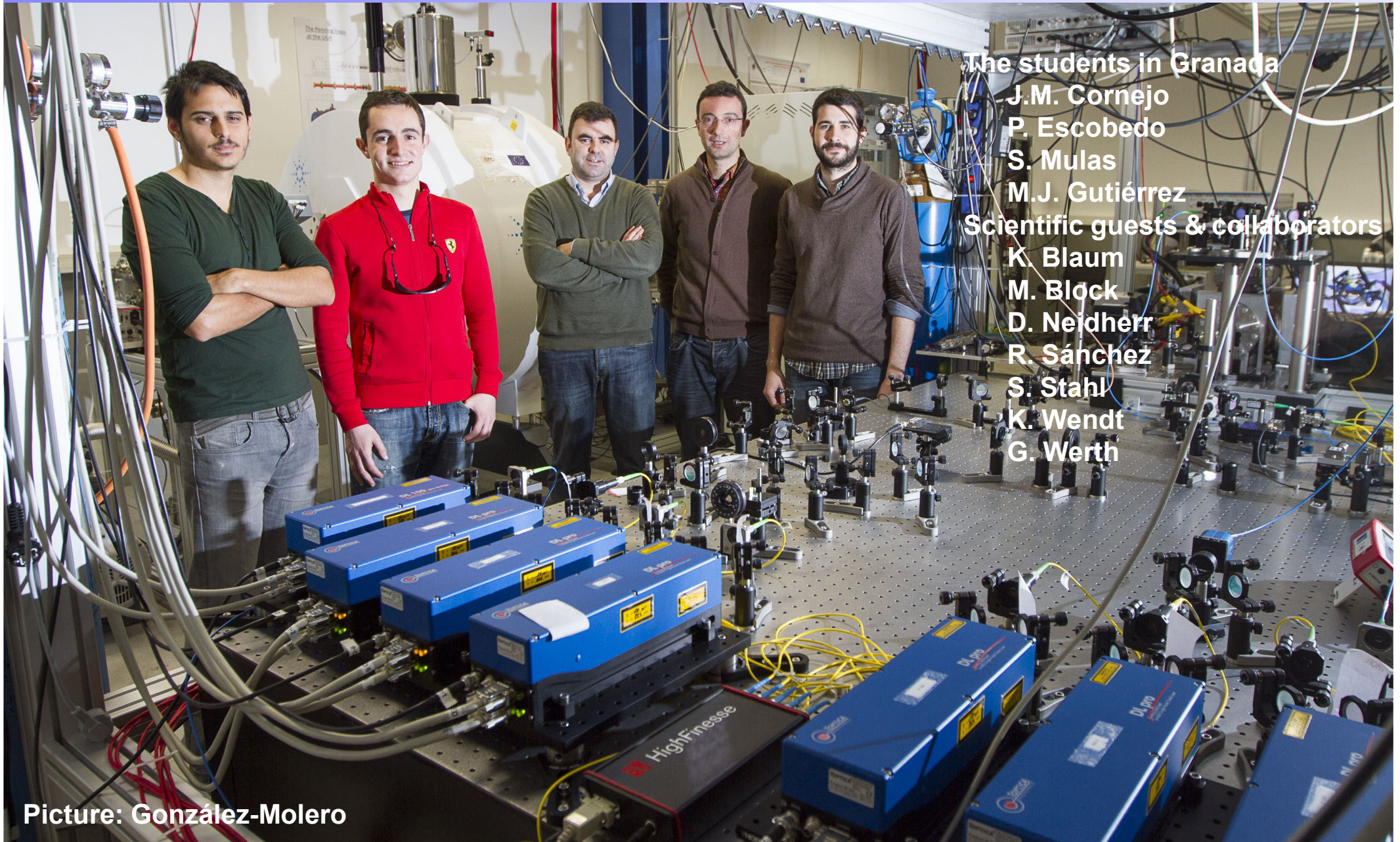
The Preparation Penning trap



Summary & Outlook

- The Spanish contribution to MATS is very active.
- There are two contributions included in the cost matrix:
 1. The construction of the preparation Penning trap
 2. The Implementation of an FT-ICR system
- An ion-trap (and laser) laboratory has been built at the University of Granada, which allows for the commissioning of devices to be developed for MATS.
- A Penning trap has been built with the specifications of the MATS preparation Penning trap.
- A cold-head system (4 K) is now in operation to carry out FT-ICR developments to reach single ion sensitivity.

Thank you very much for your attention!!



The students in Granada
J.M. Cornejo
P. Escobedo
S. Mulas
M.J. Gutiérrez
Scientific guests & collaborators
K. Blaum
M. Block
D. Neidherr
R. Sánchez
S. Stahl
K. Wendt
G. Werth

Picture: González-Molero