

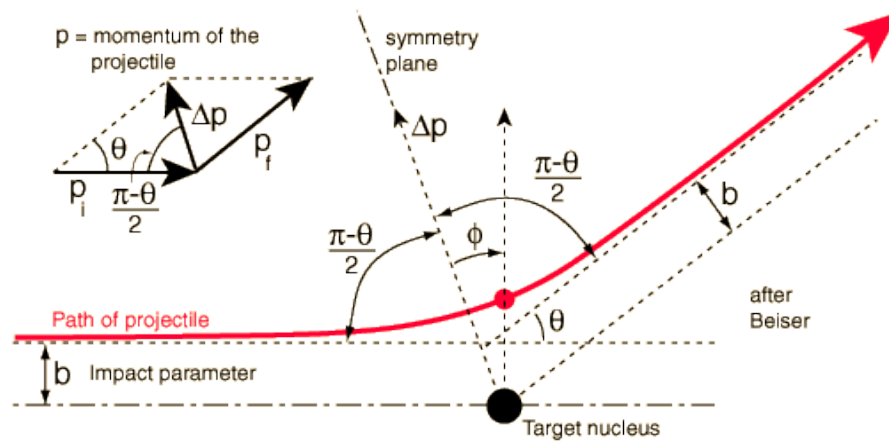
OPORTUNITIES in EXPERIMENTAL NUCLEAR PHYSICS (in SPAIN)

Alejandro Algora
IFIC (CSIC-Univ. Valencia)

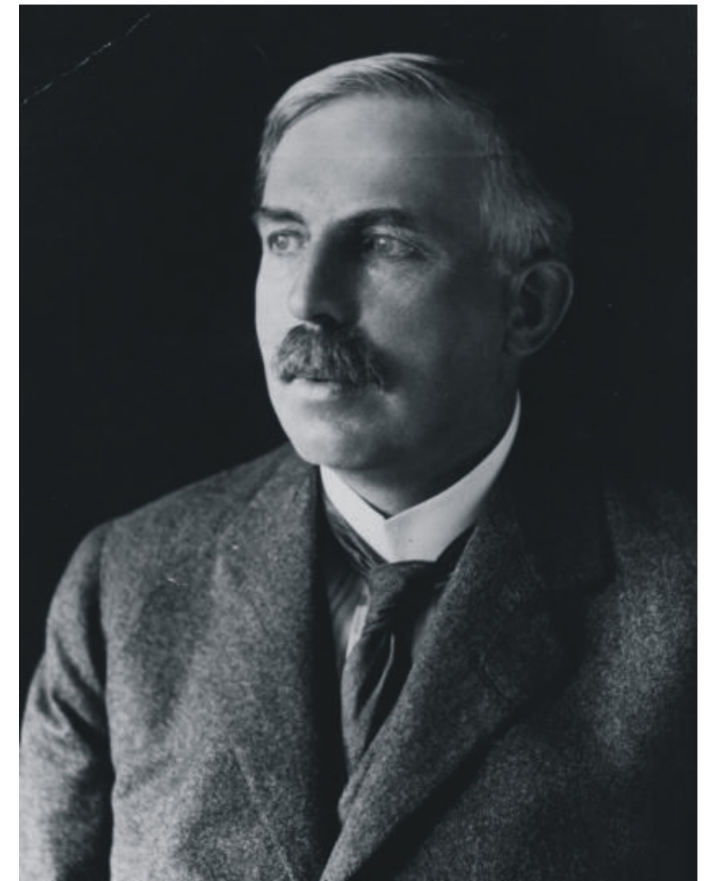


III CPAN DAYS, 2-4 November 2011

A little history ...



This year we celebrate the 100th birthday of nuclear physics. You might think that nuclear physics is already an old science and all questions have been answered but ...



E. Rutherford

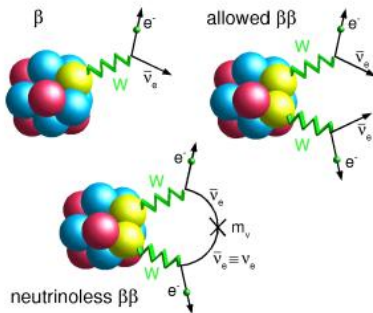
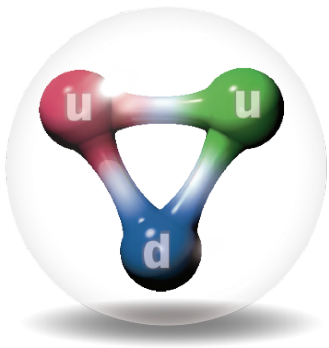
Main questions in current Nuclear Structure Research

- What are the limits of nuclear existence? What is the heaviest element we can make and where does the neutron-dripline lie?
- Do new forms of collective motion occur far from the valley of nuclear stability?
- Are there new forms of nuclear matter in very loosely bound nuclear systems?
- How does the ordering of quantum states, with all of its consequent implications for nuclear structure and reactions, alter in highly dilute or neutron-rich matter?
- Do symmetries seen in near-stable nuclei also appear far from stability and do we observe new symmetries?
- How are the elements and isotopes found in the Universe formed?
- Where are the sites of the r-process(es) of nucleosynthesis?
- What is the nuclear equation of state for neutron stars?
- etc, etc.

Taken from NUPECC long range plans

Why Nuclear Physics is still special?

- Quantum system of variable number of particles ($1 \leq A \leq 300$)
- Playground of the strong, electromagnetic and weak interaction
- The states of these quantum systems can be excited more or less flexibly (by means reactions and beta decay, constrained by nature laws)
- Test ground of many-body approaches
- Explain many things related also to the macroscopic World (nuclear astrophysics, the internal heat of our planet, etc.)
- Multiple applications in our lives (nuclear energy, medical diagnostics, cancer therapy, non-proliferation control, monitor climate change, material analysis, etc.).



Main activities and used facilities

Main Experimental Research Activities

- Nuclear structure and dynamics
- Nuclear astrophysics
- Fundamental interactions
- Nuclear physics tools and applications

Main Research Facilities

- GSI (Germany)
- ISOLDE (CERN)
- n_TOFF (CERN)
- Univ. of Jyväskylä (Finland)
- GANIL (France)
- INFN-LNL (Italy)
- ...also installations overseas (TRIUMF, RIKEN, etc.)



The local map: main experimental groups

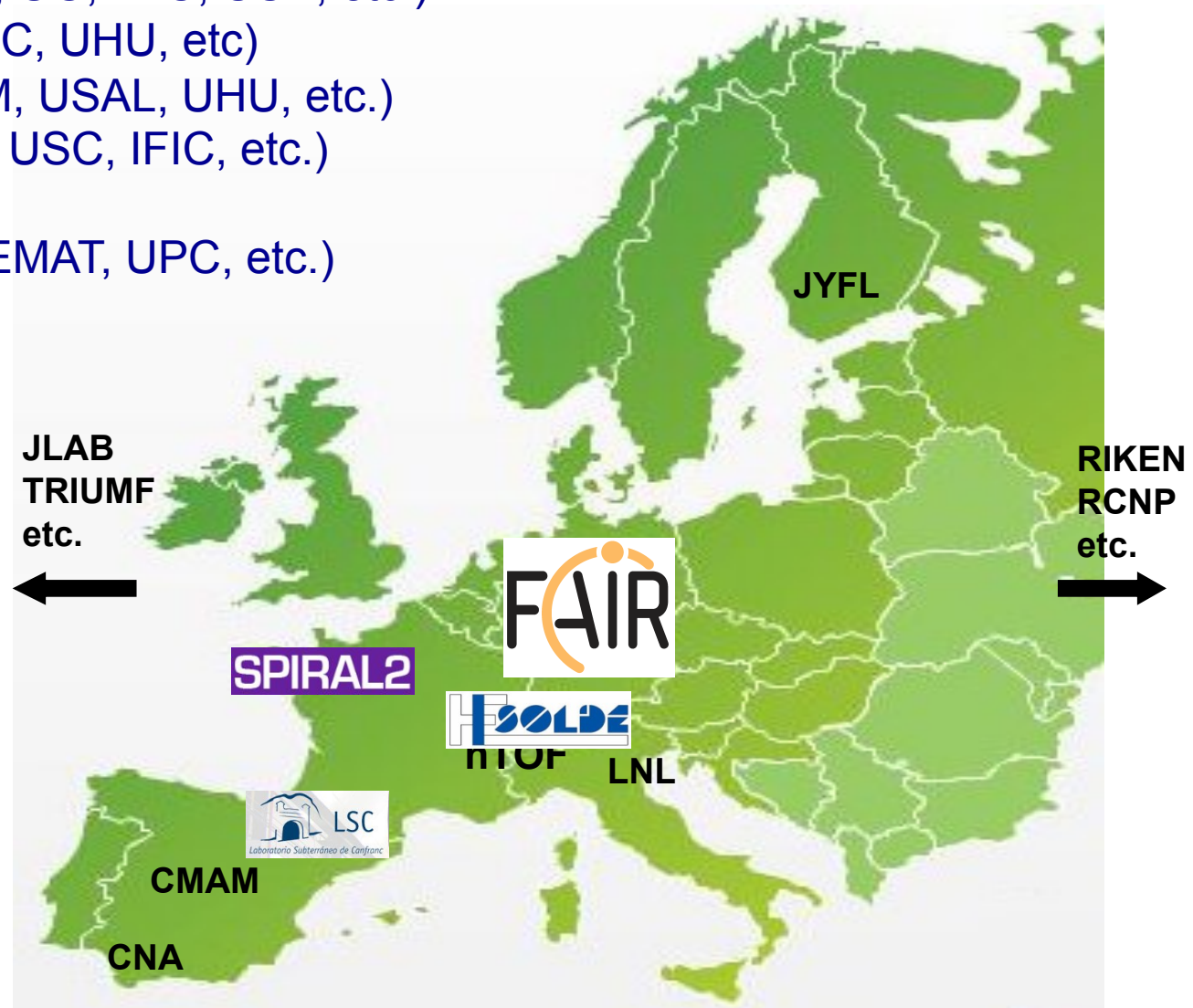


Experimental Groups

- Nuclear Innovation Group (CIEMAT, Madrid)
- Exp. Nucl. Phys. Group (IEM-CSIC, Madrid)
- Nuclear Phys. Group (U. Complutense, Madrid)
- Nat. Accelerator Centre (Sevilla)
- Gamma Spec. Group (IFIC-CSIC, Valencia)
- Struc. of Matter Group (Univ. Huelva)
- Nuclear Eng. Section (Univ. Pol. Cataluña)
- Exp. Group of Nuclei and Particles (Univ. Santiago Compostela)
- Univ. Vigo (Vigo)
- Nucl. Phys. Group (Univ. Granada, Granada)

Map of Infrastructures used by the Spanish researchers

GSI (USC, IEM, IFIC, UG, CIEMAT, UPC, UVI, UC, USE, etc.)
ISOLDE (IEM, UC, UG, IFIC, USE, etc.)
GANIL (USC, IFIC, UHU, etc.)
Legnaro (IFIC, IEM, USAL, UHU, etc.)
nTOF (CIEMAT, USC, IFIC, etc.)
JLAB (UC)
Jyväskylä (IFIC, CIEMAT, UPC, etc.)
and many others



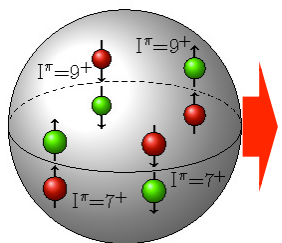
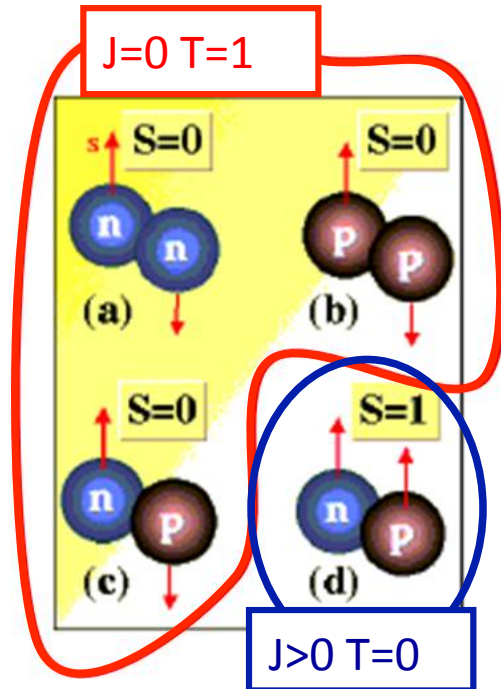
Some highlights of the last period (2010-2011)

- Nuclear force (T=0 pairing)
- Collectivity in nuclei
- Structure of nucleons
- Reactions with exotic (halo) nuclei
- Extending the limits of nuclear chart
- Mass measurements
- Cross section measurements
- Beta decay studies

These highlights reflect the kind of work the groups perform, but do not cover the full spectrum of activities.

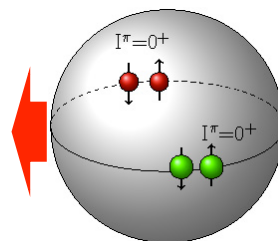
Isoscalar (T=0) proton neutron pairing

The Spin-Isospin symmetry family



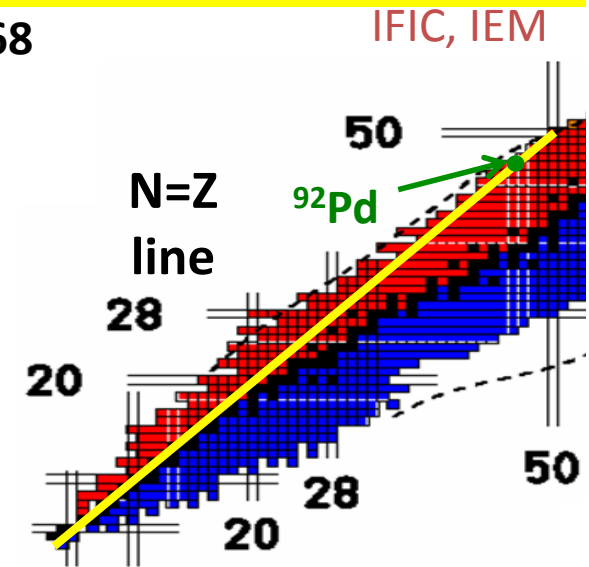
T=0 pair
Condensate

T=1 pair
Condensate



B. Cederwall et al., Nature 469 (2011) 68

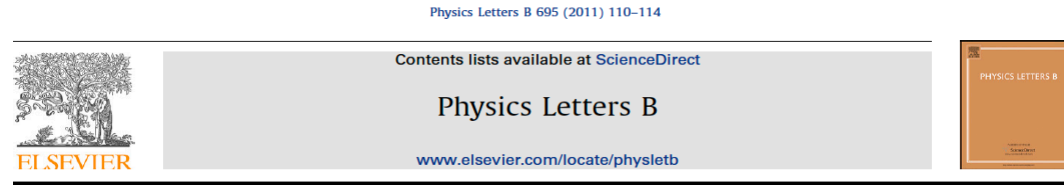
Pairing is an important ingredient of the effective nuclear forces and it is essential for understanding the structure of nuclei. Since long heavy N=Z nuclei have been seen as candidates to study phenomena related with the T=0 pairing.



Effects of p-n pairing in Structure: T=0 needed in SM

T=0+T=1					T=1	
8 ⁺ 3127					8 ⁺ 2636	8 ⁺ 2530
(6 ⁺) 2536	6 ⁺ 2466	8 ⁺ 2600	6 ⁺ 2749	6 ⁺ 2633	6 ⁺ 2224	6 ⁺ 2099
		6 ⁺ 2110	4 ⁺ 2079	4 ⁺ 2212		
(4 ⁺) 1786	4 ⁺ 1708	4 ⁺ 1518		2 ⁺ 1417	2 ⁺ 1460	2 ⁺ 1415
			2 ⁺ 1171			
(2 ⁺) 874	2 ⁺ 878	2 ⁺ 797				
0 ⁺ 0	0 ⁺ 0	0 ⁺ 0	0 ⁺ 0	0 ⁺ 0	0 ⁺ 0	0 ⁺ 0
⁹² Pd exp	⁹² Pd SM	⁹² Pd T=0	⁹² Pd T=1	⁹² Pd no np	⁹⁶ Pd SM	⁹⁶ Pd exp

Evidence for reduced collectivity around neutron mid-shell



Evidence for reduced collectivity around the neutron mid-shell in the stable even-mass Sn isotopes from new lifetime measurements

A. Jungclaus^{a,*}, J. Walker^{a,b}, J. Leske^c, K.-H. Speidel^d, A.E. Stuchbery^e, M. East^e, P. Boutachkov^f, J. Cederkäll^g, P. Doornenbal^h, J.L. Egido^b, A. Ekström^g, J. Gerl^f, R. Gernhäuserⁱ, N. Goel^f, M. Górska^f, I. Kojouharov^f, P. Maier-Komorⁱ, V. Modamio^{a,b}, F. Naqvi^{j,f}, N. Pietralla^c, S. Pietri^{k,f}, W. Prokopowicz^f, H. Schaffner^f, R. Schwengner^l, H.-J. Wollersheim^f

^a Instituto de Estructura de la Materia, CSIC, E-28006 Madrid, Spain

^b Departamento de Física Teórica, Universidad Autónoma de Madrid, E-28049 Madrid, Spain

^c Institut für Kernphysik, Technische Universität Darmstadt, D-64289 Darmstadt, Germany

^d Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, D-53115 Bonn, Germany

^e Department of Nuclear Physics, Australian National University, Canberra ACT 0200, Australia

^f Gesellschaft für Schwerionenforschung (GSI), D-64291 Darmstadt, Germany

^g Department of Physics, Lund University, S-22100 Lund, Sweden

^h RIKEN Nishina Center, Wako, Saitama 351-0198, Japan

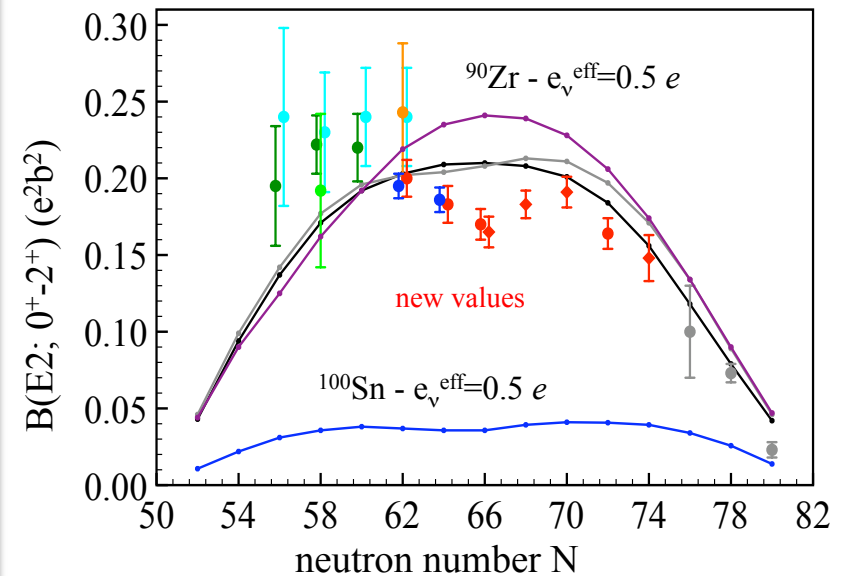
ⁱ Physik Department E12, Technische Universität München, D-85748 Garching, Germany

^j Institut für Kernphysik, Universität zu Köln, D-50937 Köln, Germany

^k Department of Physics, University of Surrey, Guildford, GU2 7XH, United Kingdom

^l Institut für Strahlenphysik, FZ Dresden-Rossendorf, D-01314 Dresden, Germany

IEM



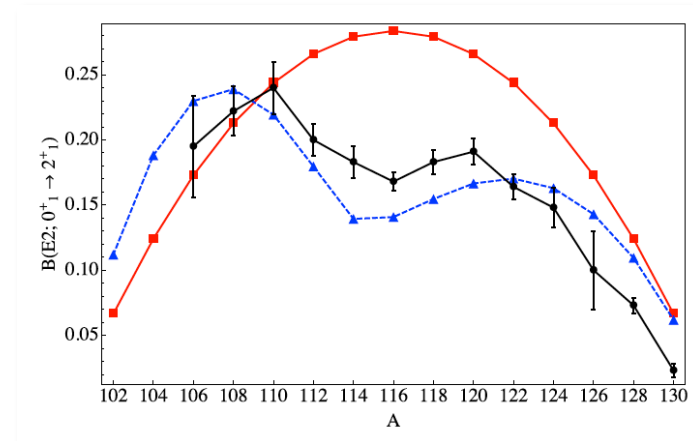
Shell model: Proton core excitations responsible for most of the observed E2 strengths !



Should be reflected by the $g(2^+)$ values !

J. Walter, A. Jungclaus, et al. PRC 84(2011) 014319 and J. Walter PhD thesis, UAM, 2011

Theoretical “reply”:



I.O. Morales, P. Van Isacker, I. Talmi, PLB 703 (2011) 606 “Generalized seniority and E2 transitions in the tin isotopes”

Mass measurements for astrophysics

Selected for a Viewpoint in *Physics*

PRL 106, 122501 (2011)

PHYSICAL REVIEW LETTERS

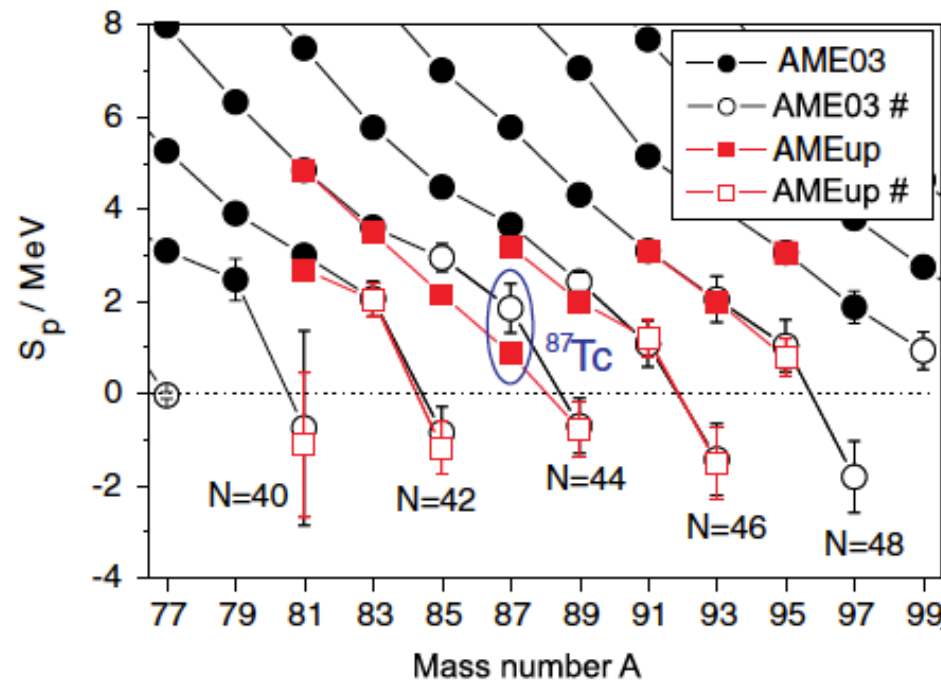
week ending
25 MARCH 2011

UG

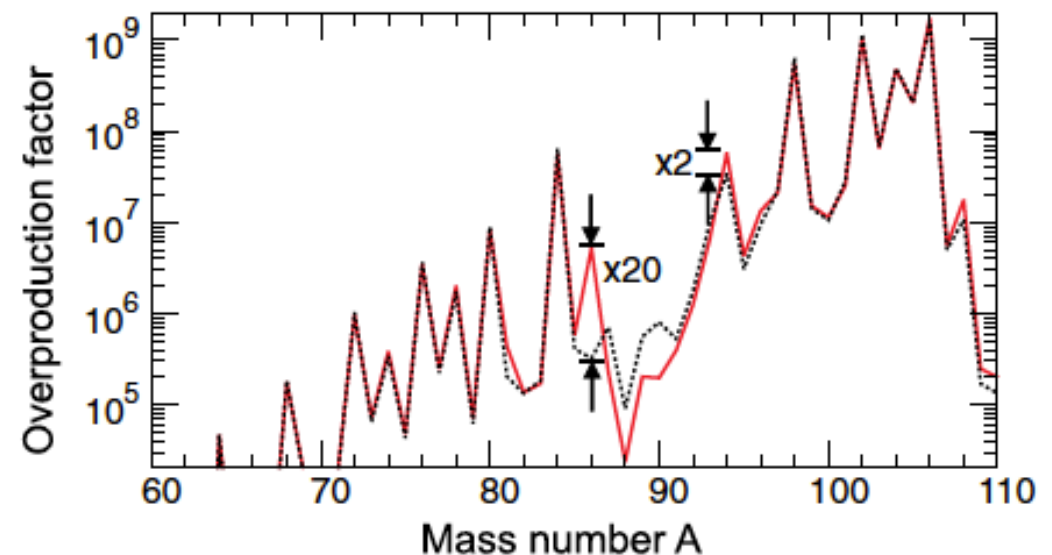
Mass Measurements of Very Neutron-Deficient Mo and Tc Isotopes and Their Impact on rp Process Nucleosynthesis

E. Haettner,^{1,2,*} D. Ackermann,² G. Audi,³ K. Blaum,⁴ M. Block,² S. Eliseev,^{2,†} T. Fleckenstein,¹ F. Herfurth,²
F. P. Heßberger,² S. Hofmann,² J. Ketelaer,^{5,‡} J. Ketter,⁴ H.-J. Kluge,² G. Marx,⁶ M. Mazzocco,⁷ Yu. N. Novikov,^{2,8}
W. R. Plaß,^{1,2} S. Rahaman,^{9,‡} T. Rauscher,¹⁰ D. Rodríguez,¹¹ H. Schatz,¹² C. Scheidenberger,^{1,2} L. Schweikhard,⁶
B. Sun,^{1,13} P. G. Thirolf,¹⁴ G. Vorobjev,^{2,8} M. Wang,¹⁵ and C. Weber^{9,§}

Mass measurement of 10 proton-rich nuclei
of astrophysical interest using SHIPTRAP



Change in the abundance of the ashes of
astrophysical x-ray bursts for $A=86, 94$



Electron scattering of nuclei

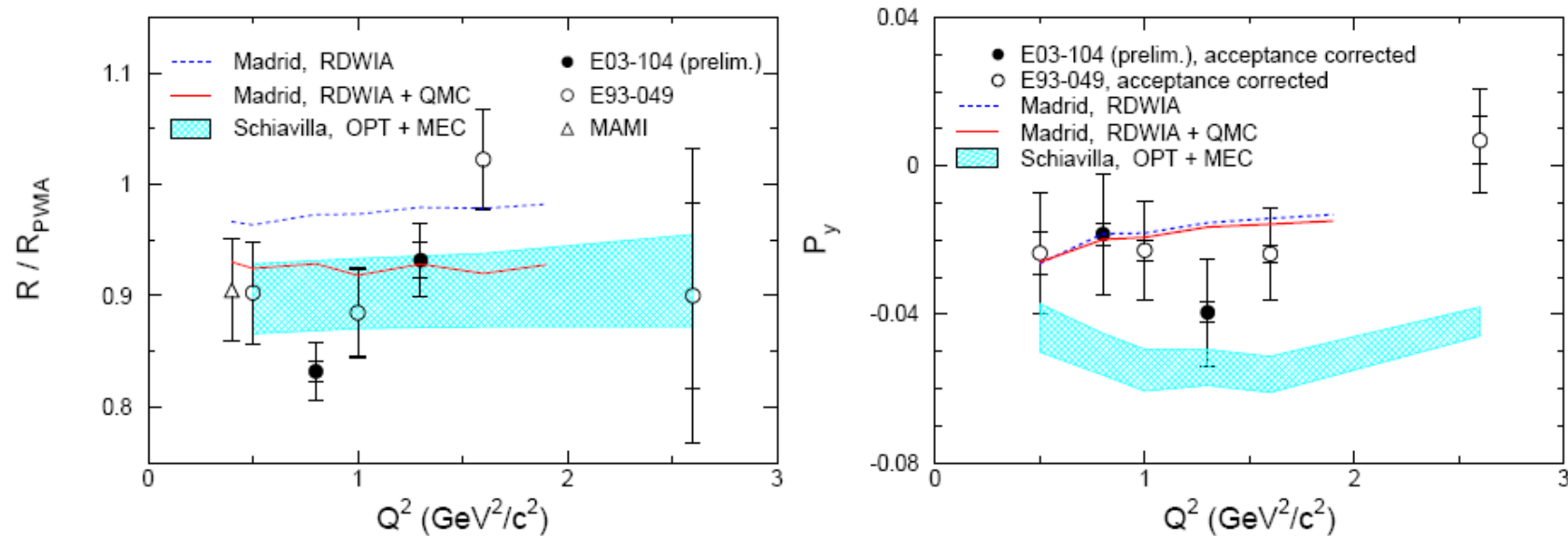
UC

Experimental study performed at JLAB

Goal: Tests of nuclear structure, Coulomb Sum Rule experiment

(e,e'p) experiments: high precision spectroscopic factors and correlations in oxygen and lead

ratio of G_E/G_M form factors in bound nucleons (PhysRevLett.105.262302,2010)

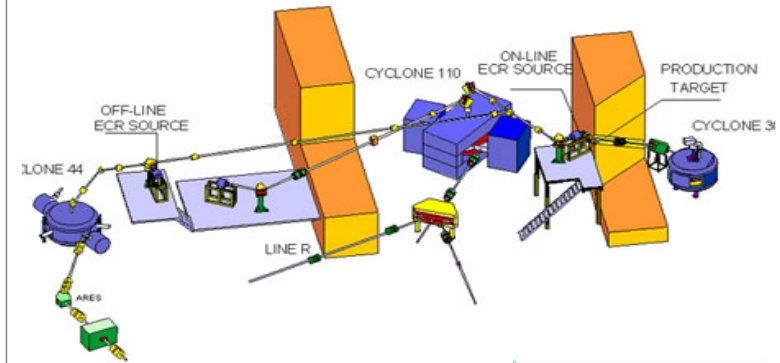
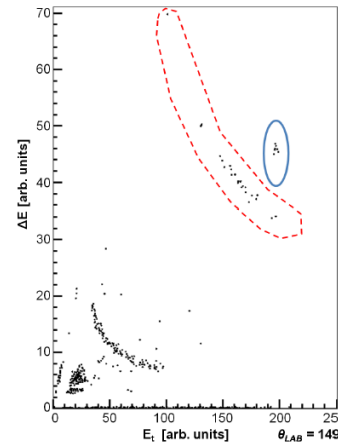
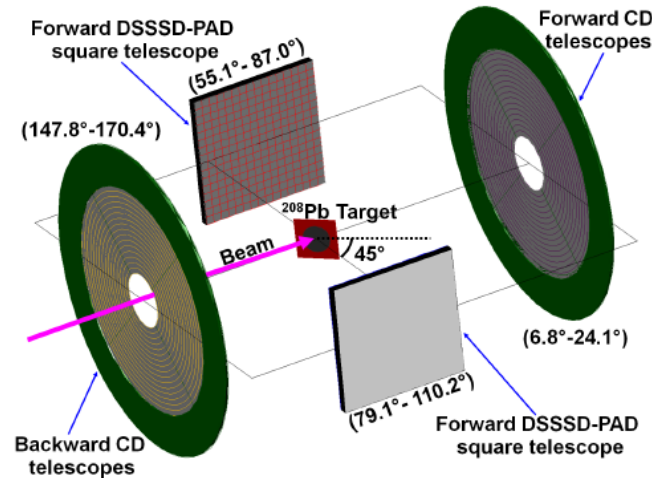


Data suggests the presence of mild medium modifications of the form factors, like the ones implied in Quark Meson Coupling model. Alternative (nonrelativistic) modeling (cyan area) is not compatible with data for induced (P_y) polarization

Polarization transfer and induced polarization in the $^4\text{He}((e,e'p)^3\text{H})$ reaction PhysRevLett.106.052501 (2011) , PhysRevLett.105.072001 (2010)

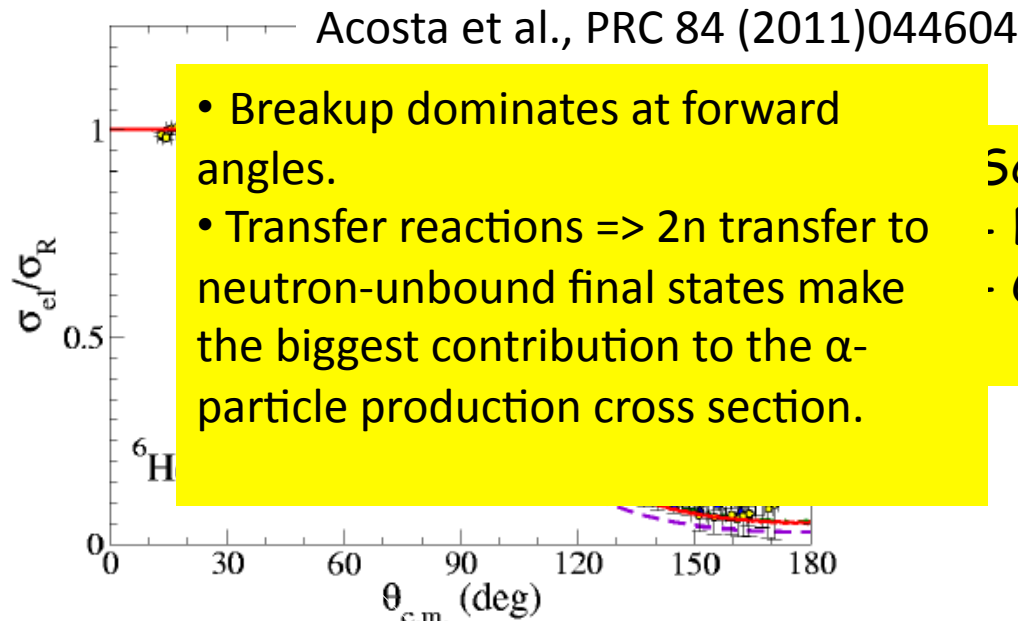
^6He on ^{208}Pb @ Louvain-la-Neuve

UHU, USE, IEM



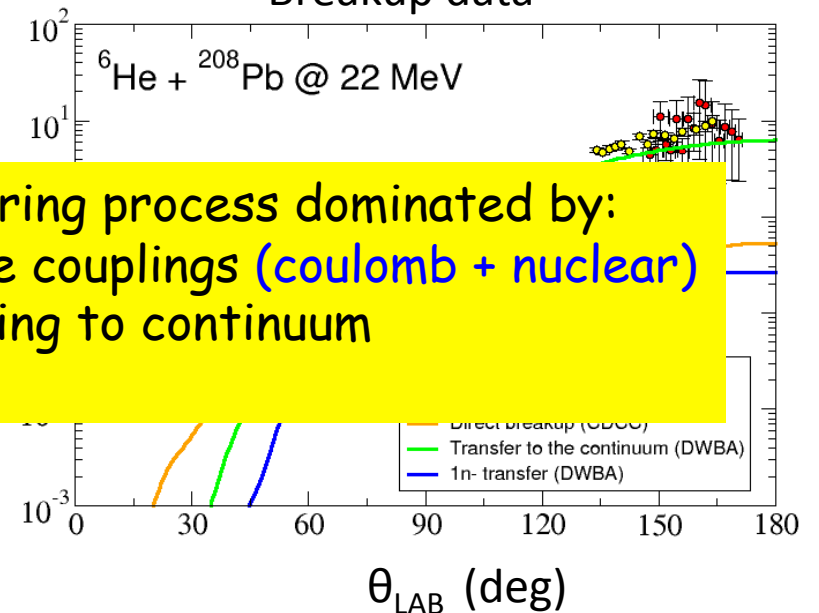
CRC

Breakup data



Scattering process dominated by:

- Dipole couplings (coulomb + nuclear)
- Coupling to continuum

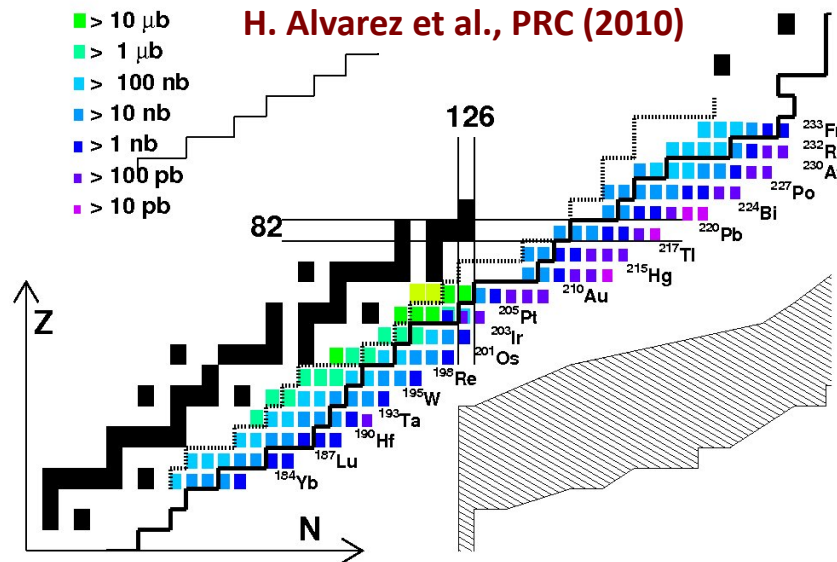


CDCC calculations: K. Rusek et al., PRC 72, 037603 (2005).
 Full CDCC (red) No continuum (magenta) Dipole coupling (green)

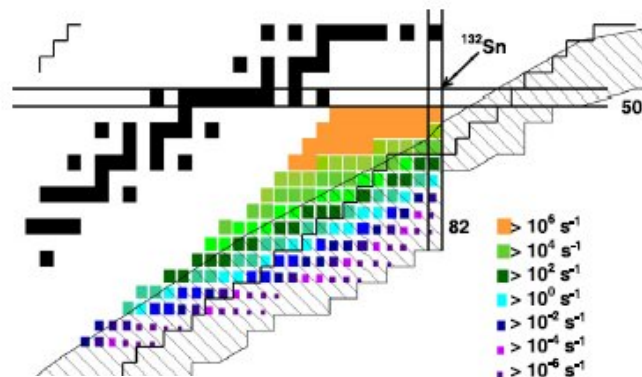
Fernández-García et al. Nuc. Phys. A 840 (2010)19
 Fernández-García et al. Phys. Rev. B 693 (2010) 310

Extending the present limits of the chart of nuclides

Production of heavy neutron-rich nuclei
in cold-fragmentation reactions



Production of medium-mass neutron-rich nuclei
by fragmenting fission residues

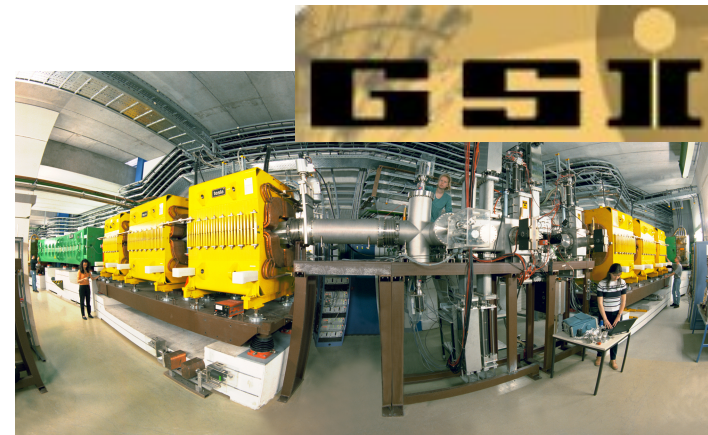
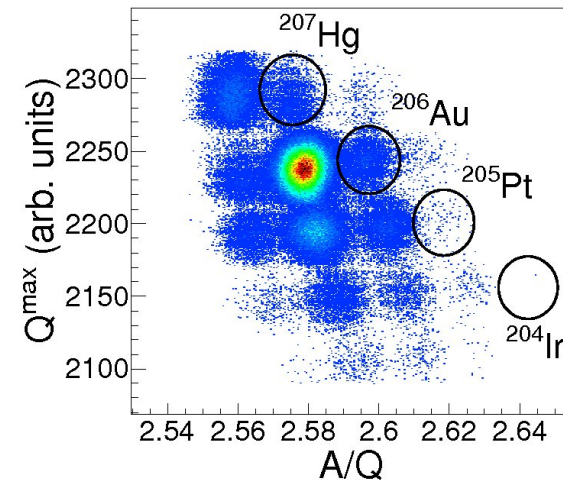


D. Perez et al., PLB (2011)

USC

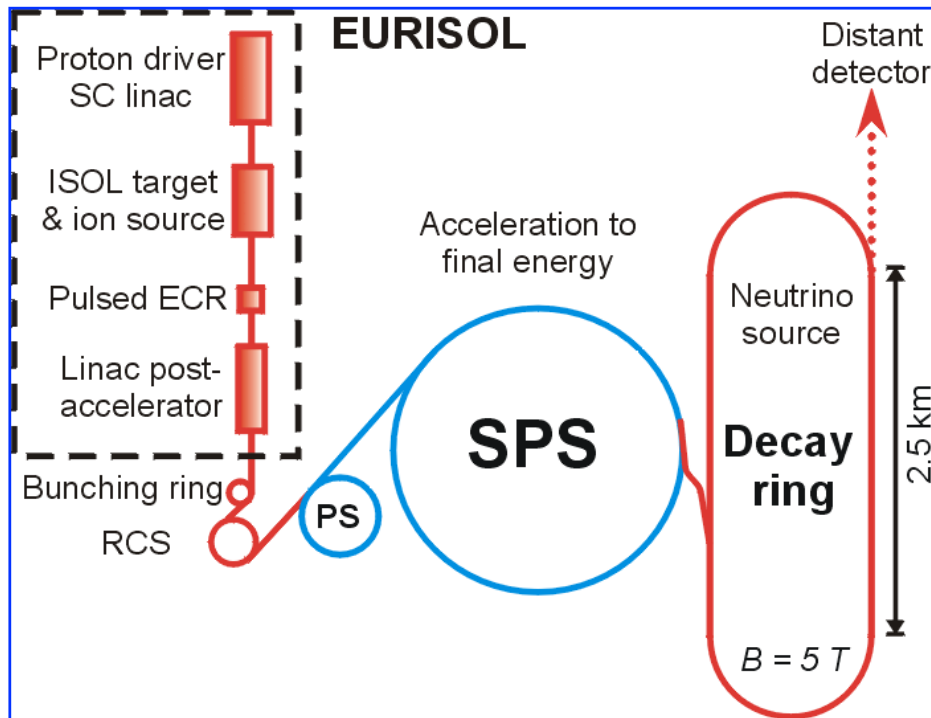
Production of heavy neutron-rich nuclei
in charge-exchange reactions

A.I. Morales et al., PRC (2011)



Possible neutrino physics application

IFIC, IEM, CIEMAT



BETA BEAMS

${}^6\text{He}$, ${}^{18}\text{Ne}$

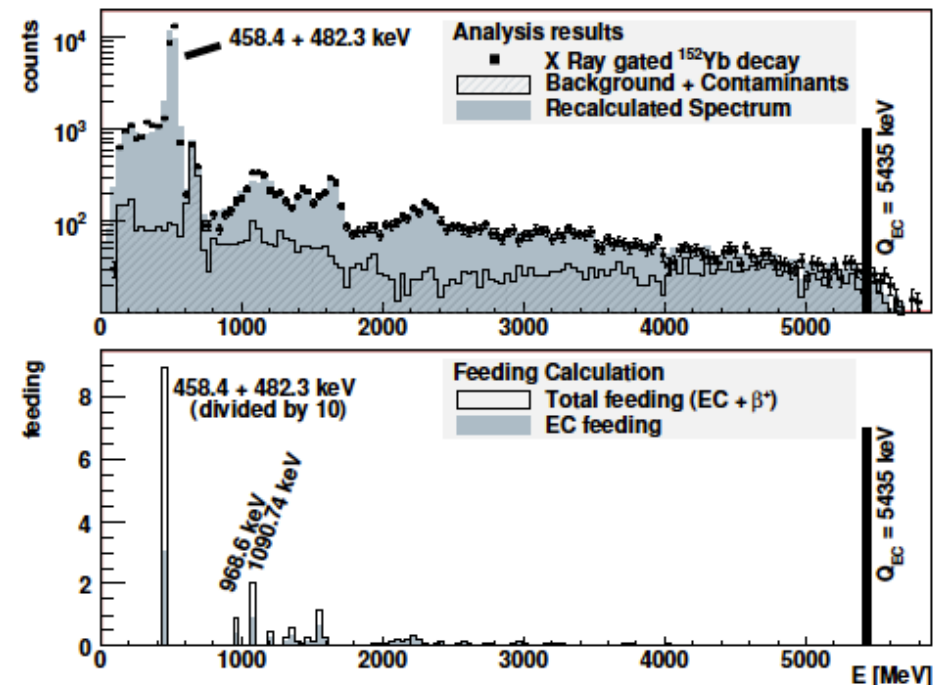
P. Zucchelli
Phys. Let. B532
(2002) 166

Elementary Particles

	I			II			III			Force Carriers
	Quarks	Leptons	Force Carriers	Quarks	Leptons	Force Carriers	Quarks	Leptons	Force Carriers	
Quarks	u up	d down	c charm	s strange	t top	b bottom	γ photon	g gluon		
Leptons	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	e electron	μ muon	τ tau	Z Z boson	W W boson		

E. Estevez *et al.*, PRC 84, 034304 (2011)

Study of the beta decay of ${}^{150}\text{Er}$, ${}^{152}\text{Yb}$ and ${}^{156}\text{Yb}$ as possible candidates for a mono-energetic neutrino beam facility based on electron capture beta decay using the TAS. Following the idea of Bernabeu *et al.* JHEP 12 (2005) 014

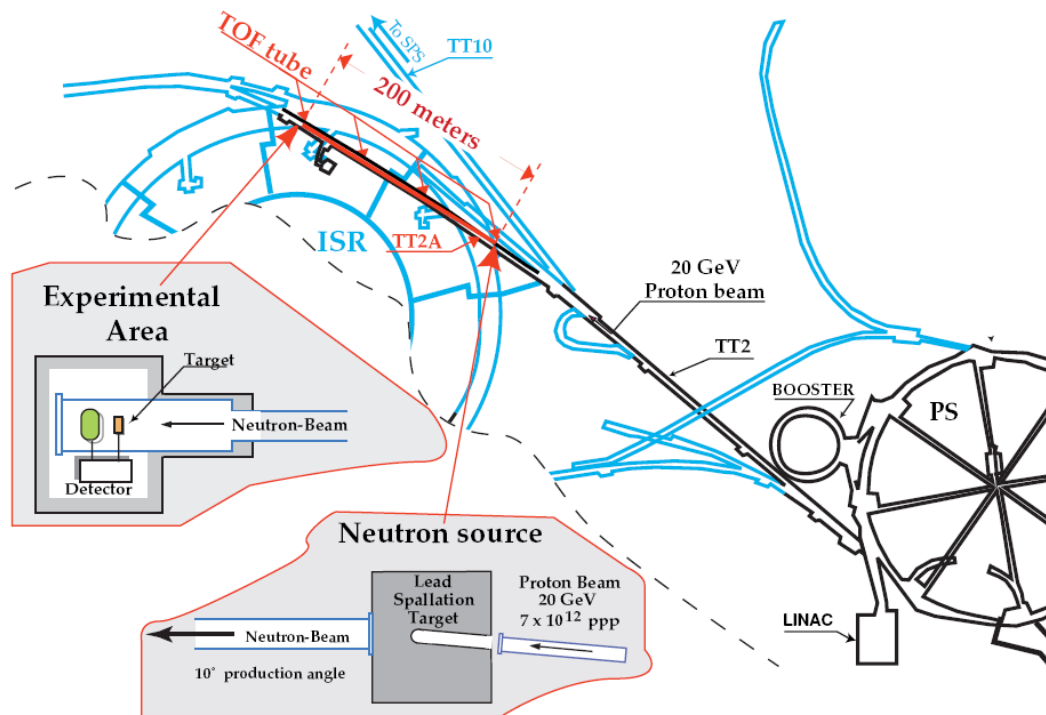


(n,γ) cross section measurement of fissile isotopes

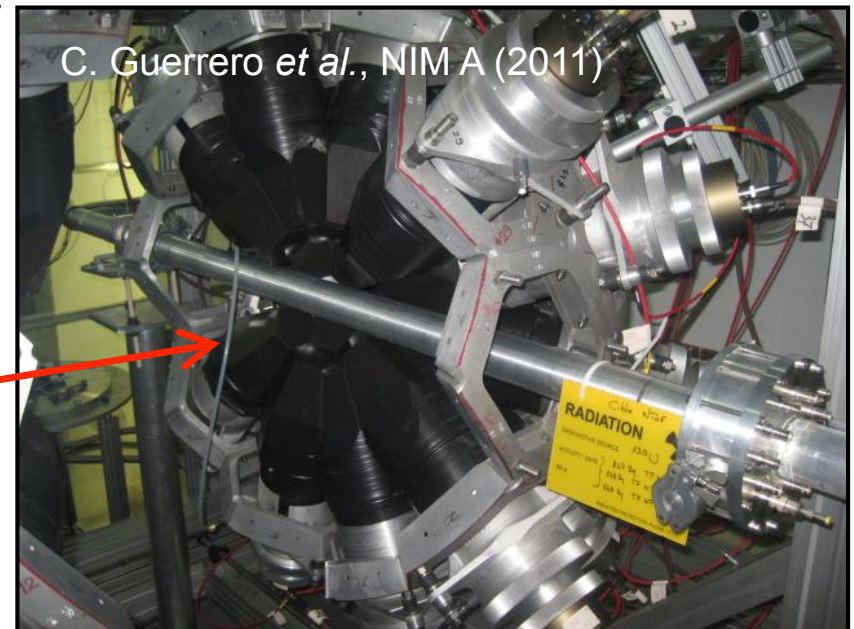
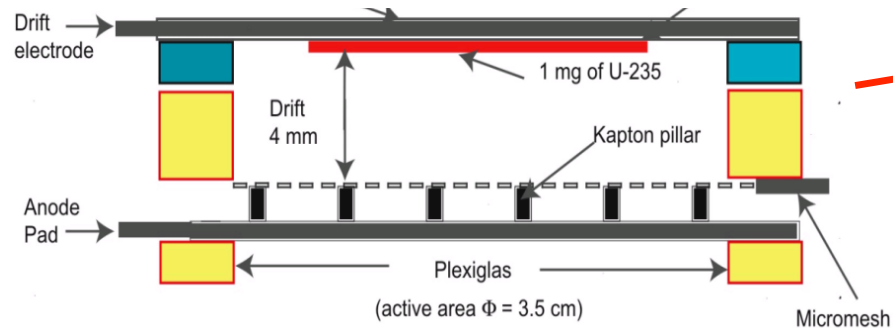
CIEMAT, IFIC, USC, UPC, USE

Fission γ -ray **background 5 times** larger than the capture γ -ray signal

- Total Absorption calorimeter for γ -ray detection
- Micromegas detectors for fission detection.



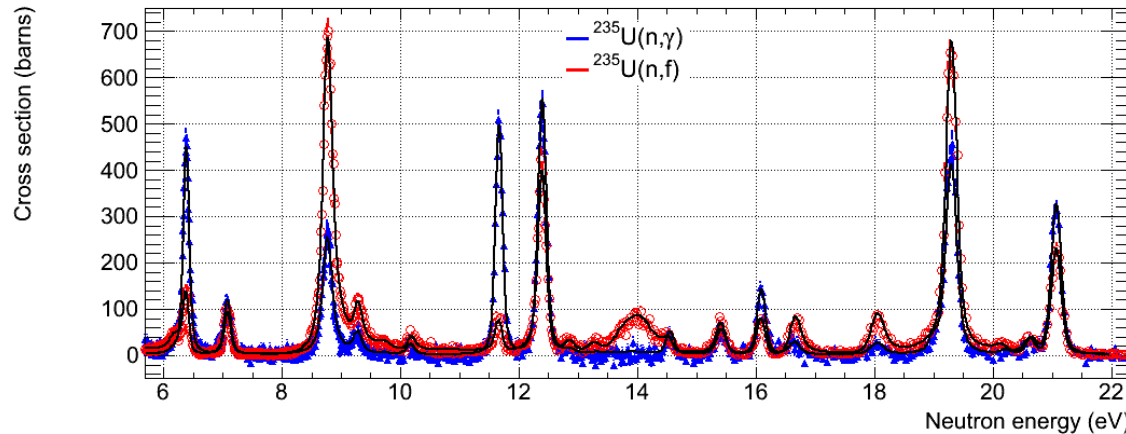
Micromegas detector loaded with 3 mg of ^{235}U



C. Guerrero *et al.*, NIM A (2011)

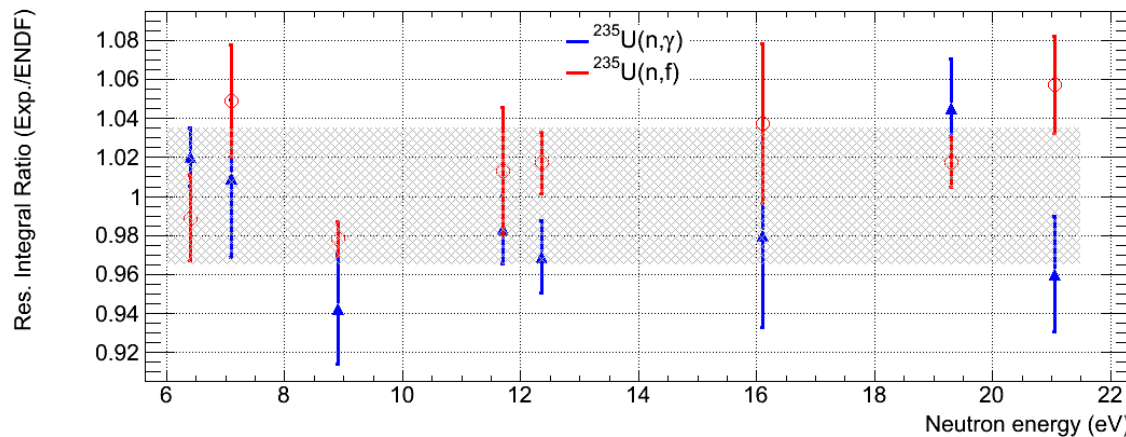
(n, γ) cross section measurement of fissile isotopes: ^{235}U

CIEMAT, IFIC, USC, UPC, USE



Fission spectra tagged with the micromegas detector

Measurements important for the design of new reactors.



Successful test experiment for ^{235}U : standard deviation of the residuals is 3.5%.

New proposal submitted to INTC. Spokespersons: C. Guerrero, D. Cano-Ott

Increasing visibility/role of our community

Future PRESPEC fast beam campaign at GSI (using AGATA)

31 LOI (9 Spanish LOI)

Recent EURICA campaign (Cluster detectors at RIBF, Riken, Japan)

19 proposals were presented (4 Spanish proposals)

Many proposals at GSI, ISOLDE, n_TOF, LNL, Univ. of Jyväskylä, TRIUMF, GANIL, etc.

(by USC, CIEMAT, UC, IFIC, UPC, US, IEM, IFIC, etc.)

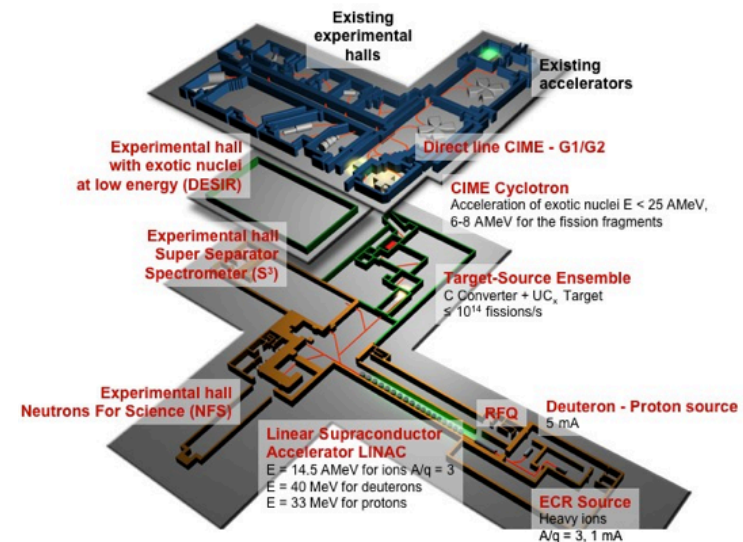
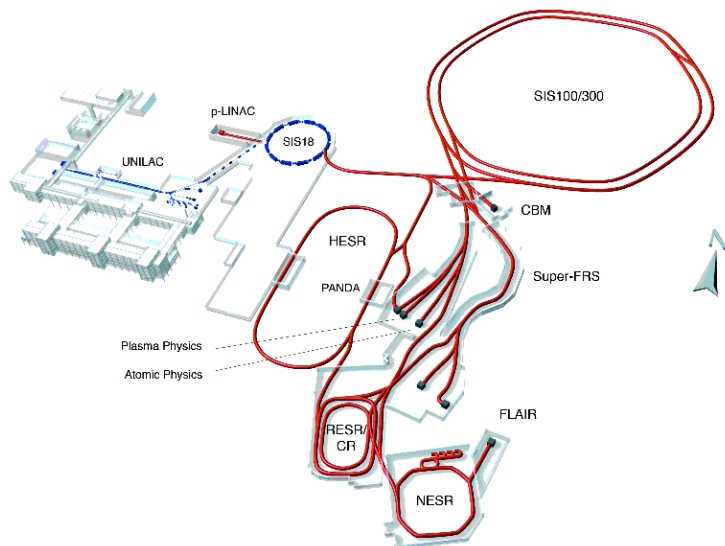
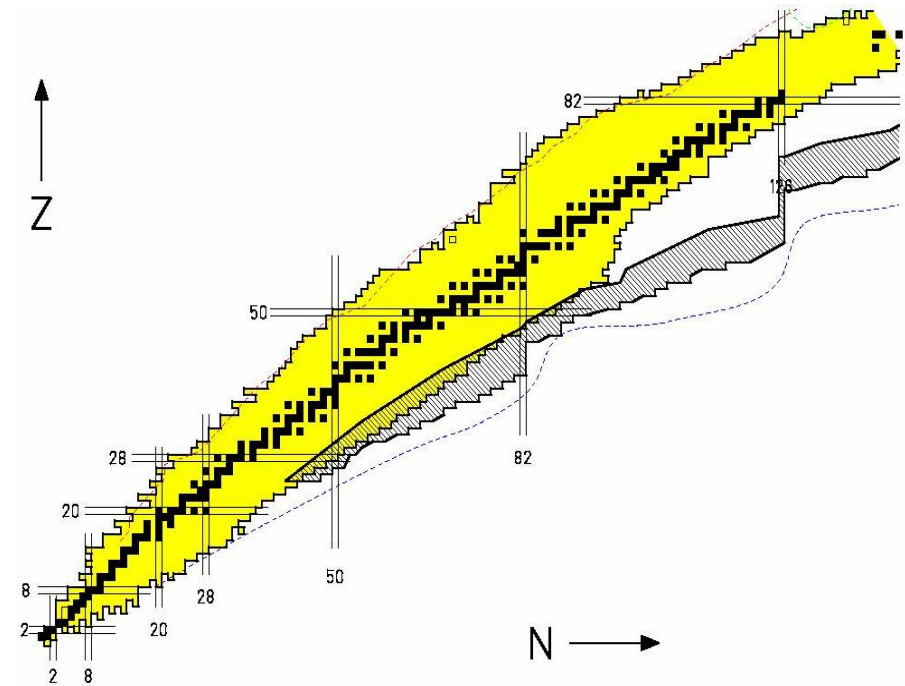
Participation in international committees and leading role in international collaborations and experiments (FAIR, ISOLDE, AGATA, PRESPEC, n_TOF, etc.)

Instrumentation developments

The advent of the first generation of RIBF facilities has already opened up a new era in probing nuclei beyond the limits of stability.

But there is still a large amount of work to be done. Presently we only know approximately 3000 nuclei from the 8000 that are assumed to exist.

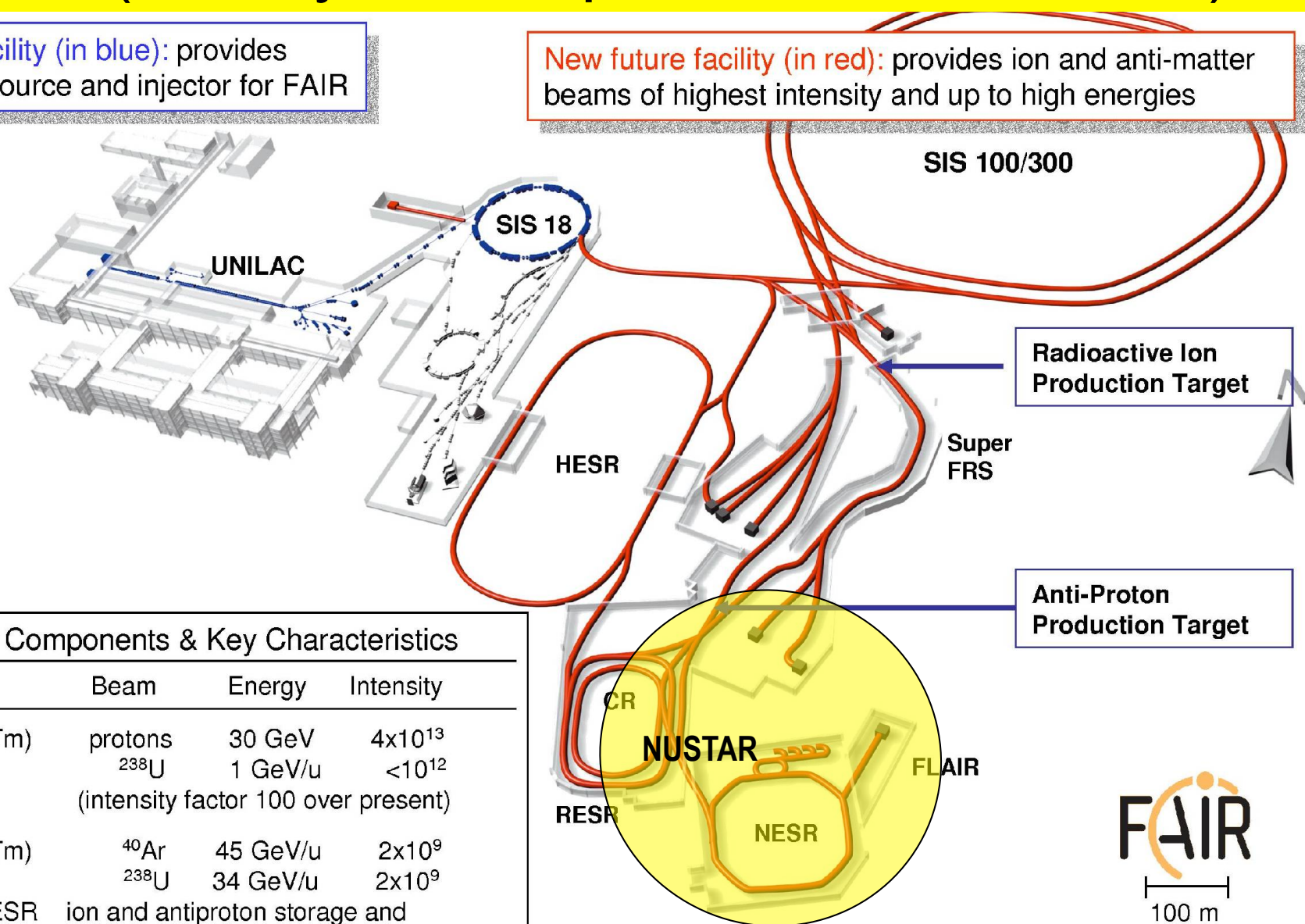
Their study will open new frontiers in our knowledge.



FAIR (Facility for Antiproton Ion Research)

Existing facility (in blue): provides ion-beam source and injector for FAIR

New future facility (in red): provides ion and anti-matter beams of highest intensity and up to high energies



Accelerator Components & Key Characteristics

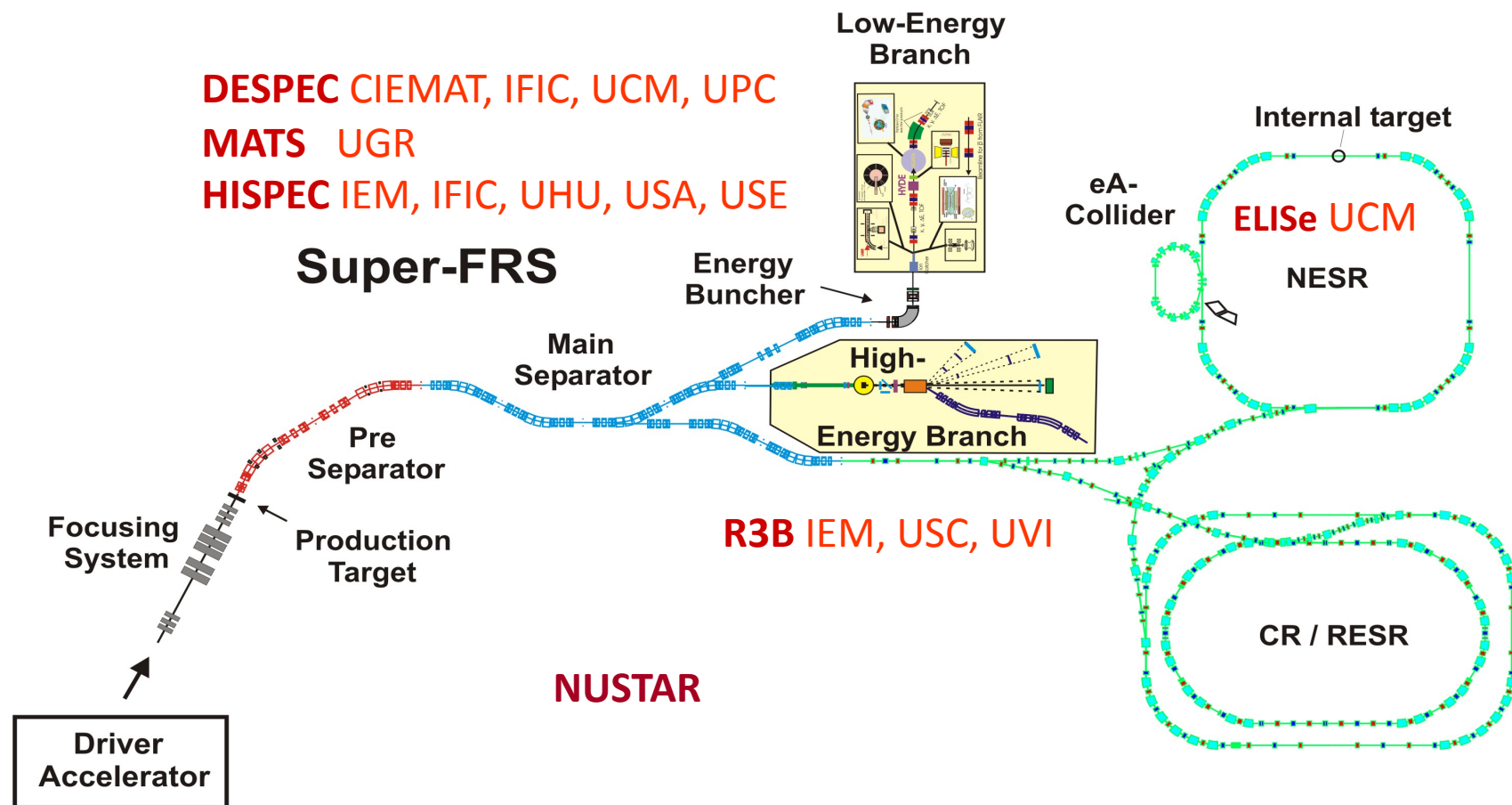
Ring/Device	Beam	Energy	Intensity
SIS100 (100Tm)	protons	30 GeV	4×10^{13}
	^{238}U	1 GeV/u	$< 10^{12}$
(intensity factor 100 over present)			
SIS300 (300Tm)	^{40}Ar	45 GeV/u	2×10^9
	^{238}U	34 GeV/u	2×10^9
CR/RESR/NESR	ion and antiproton storage and experiment rings		
HESR	antiprotons	14 GeV	$\sim 10^{11}$
SuperFRS	rare-isotope beams	1 GeV/u	$< 10^9$



Spanish participation in FAIR

NUclear STructure Astrophysics and Reactions (NUSTAR collaboration)

8 experiments: DESPEC, ELISe, EXL, HISPEC, ILIMA, LASPEC, R3B, MATS

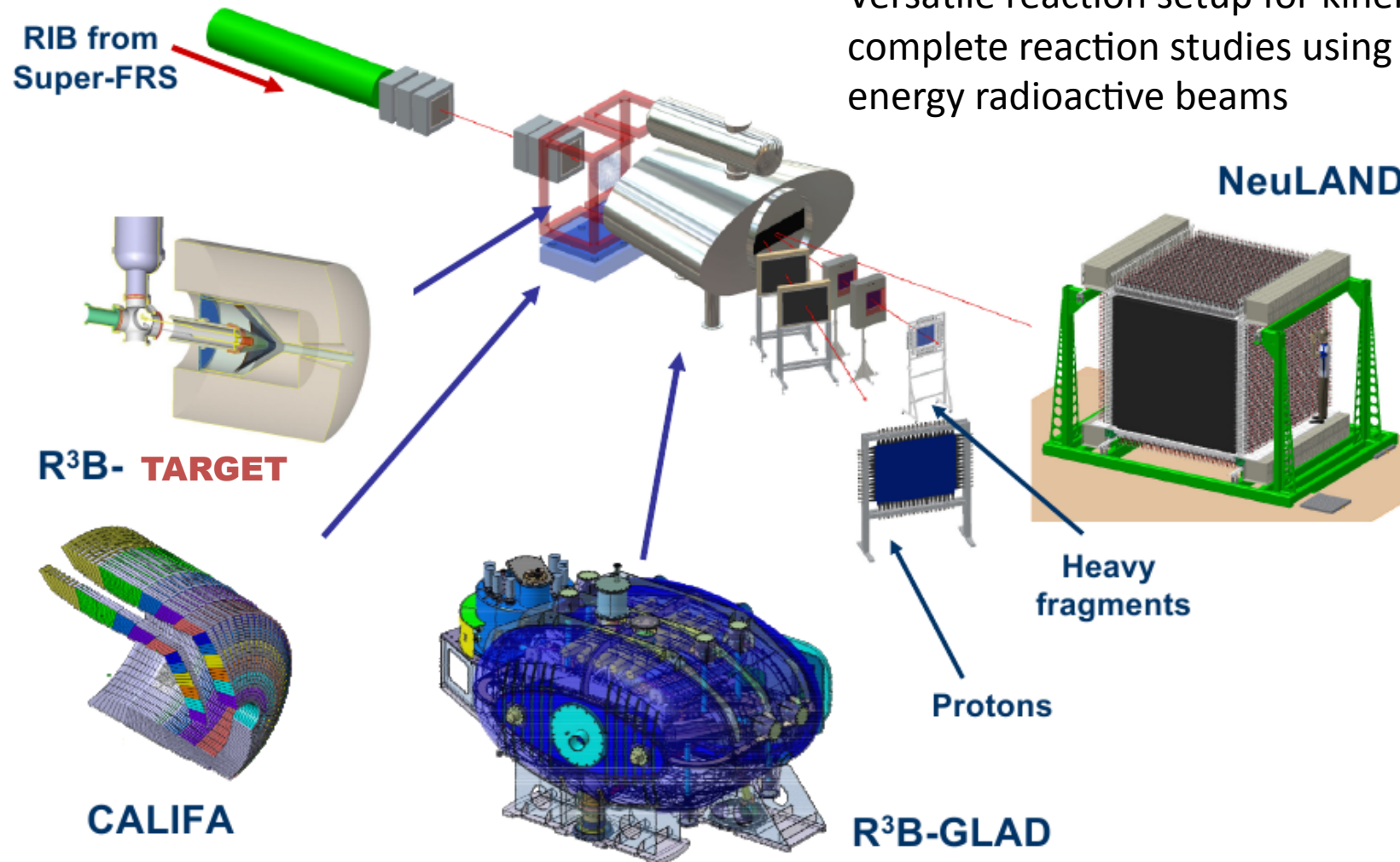


Reactions with Relativistic Radioactive Beams R3B

USC, IEM, UVI

- nuclear structure and astrophysics: direct reactions
- reaction mechanisms: fission, fragmentation
- equation of state for asymmetric matter

Versatile reaction setup for kinematical complete reaction studies using high energy radioactive beams



CALIFA: The R3B CALorimeter for In Flight detection of γ -rays and high energy charged pArticles

Califa coordinator: D. Cortina
iTOF coordinator: C. Paradela

Purpose : detection of γ -rays (100 keV-30 MeV)
light charged particles (p up to 300 MeV)

Working modes:

high-resolution spectrometer
 γ and p calorimeter
hybrid detector: calorimeter and spectrometer

Challenges:

Wide dynamic range
Energy resolution ($\Delta E/E < 6\%$ 1MeV γ
 ~ 1 300 MeV p)

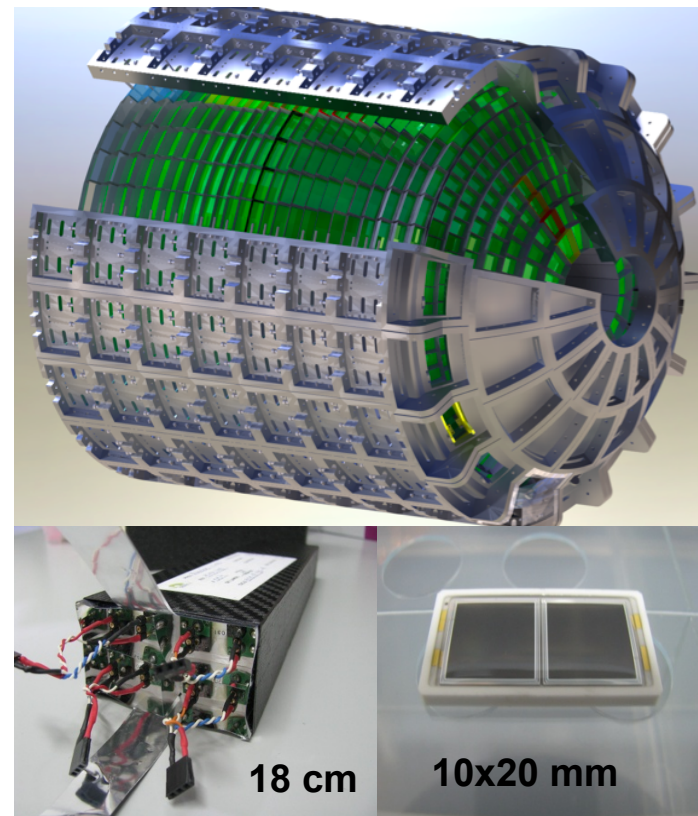
High granularity (~ 3000 crystals)

Technical choice for the detection system

Backward angles: CsI(Tl) +LAAPD
Forward angles: Phoswich detectors +LAAPD

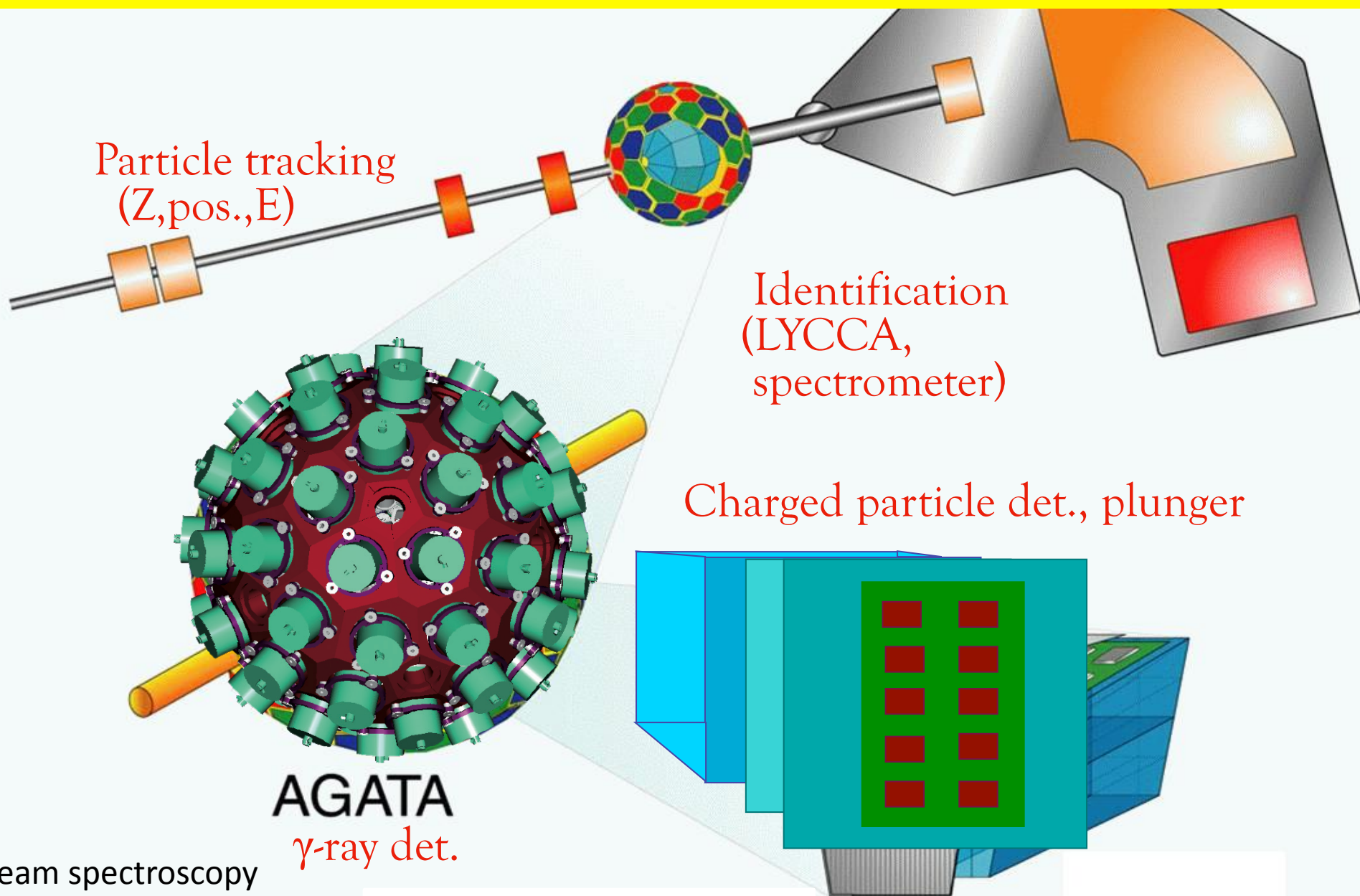
Design optimised for reactions at relativistic energies

Dimensions	120x80x80 cm
Volume	0.5 m ³
N of crystals	3296
weight	1800 kg



TDR of Backward angles submitted
R&D for the Forward angles on going

High-resolution In-flight SPECTroscopy (HISPEC)



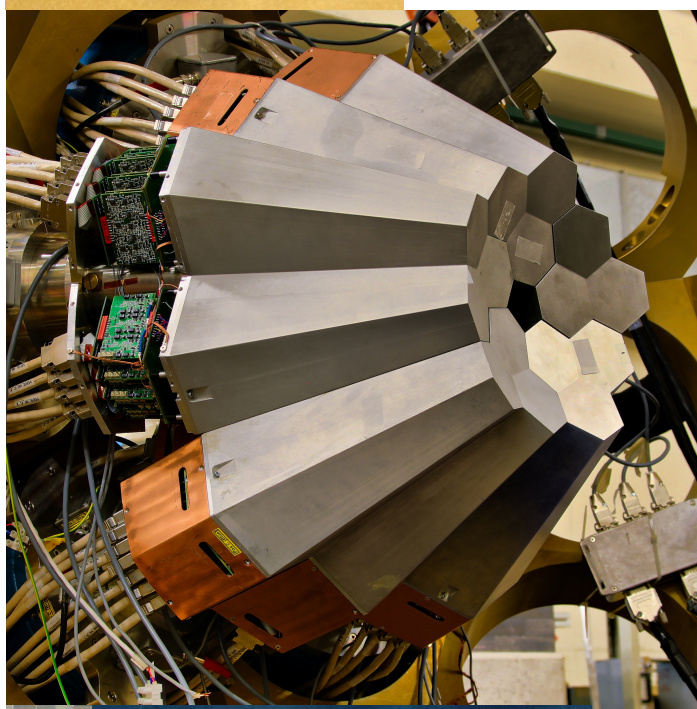
In-beam spectroscopy
using radioactive beams
at low and intermediate E

AGATA: the first European γ -tracking Array

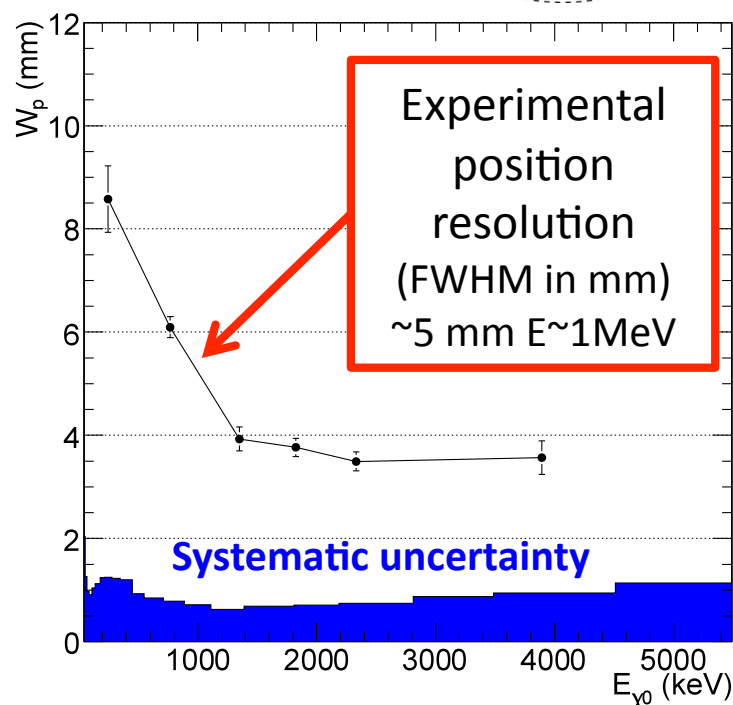
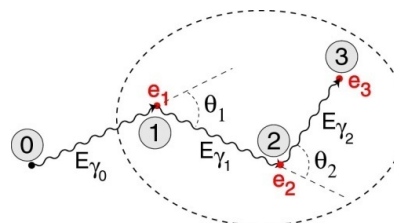


Highly Segmented Ge-detector encapsulated with the EUROBALL technique

Pulse Shape Analysis and TRACKING in position sensitive mode to maximize efficiency and sensibility.

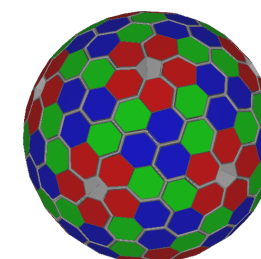
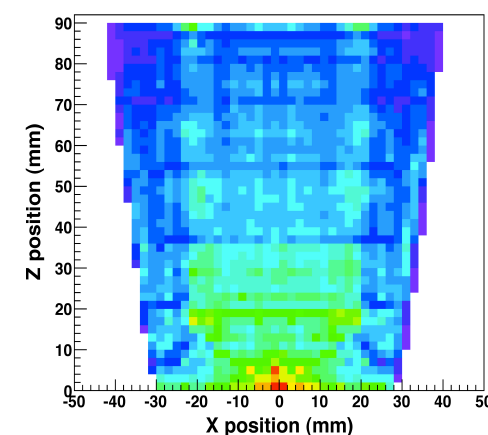
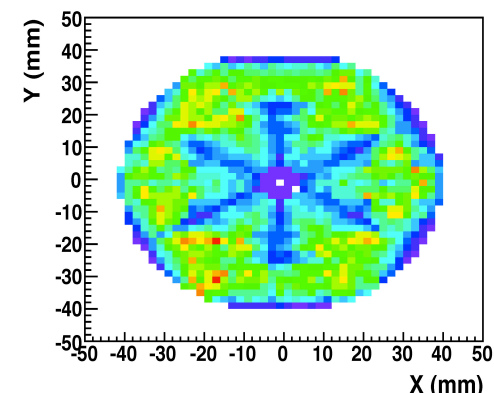


Compton Tracking



IFIC, IEM, USAL

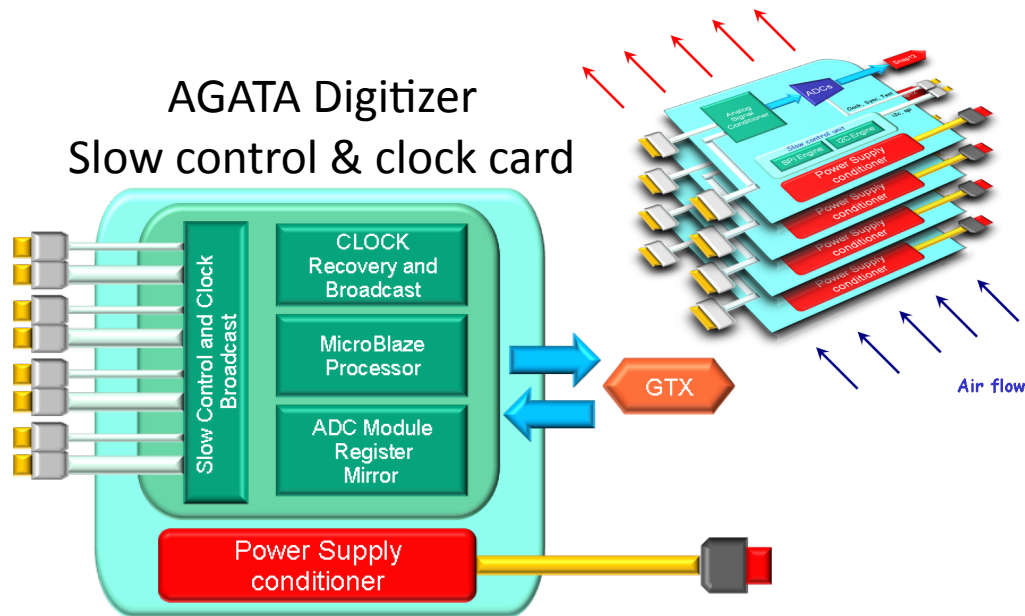
Proj. Manag.: A. Gadea



4π array

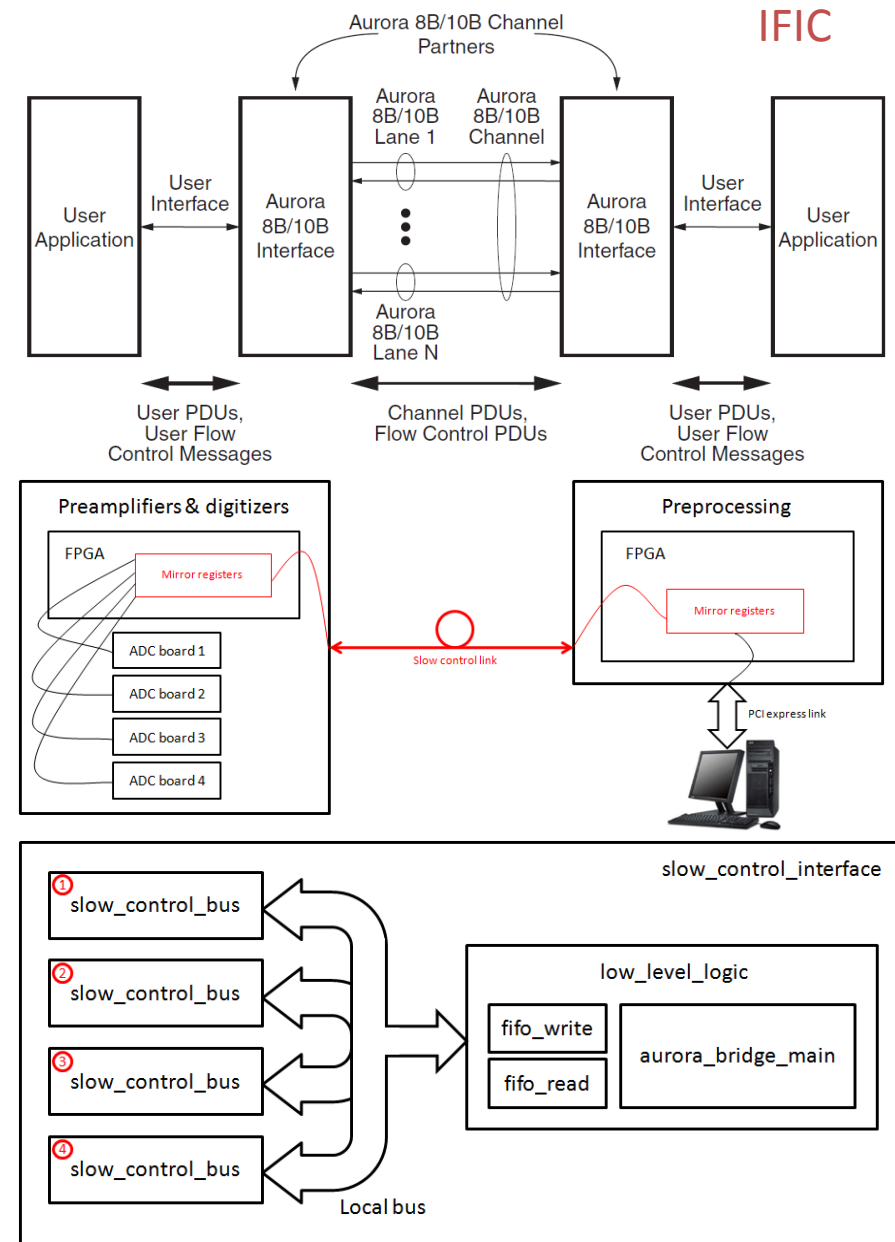


Future AGATA Digitizer Slow control interface with Mirror registers



- Remote control of devices by a high-speed optical serial link
- Multiple bus synchronization using the Aurora protocol
- Hardware and software
- Testbench development

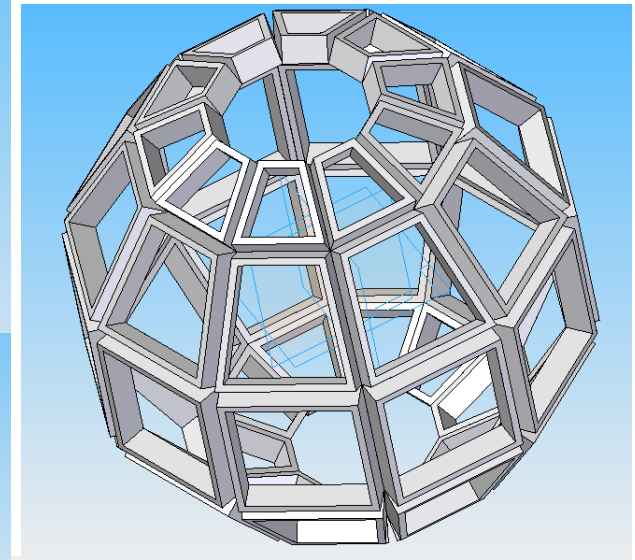
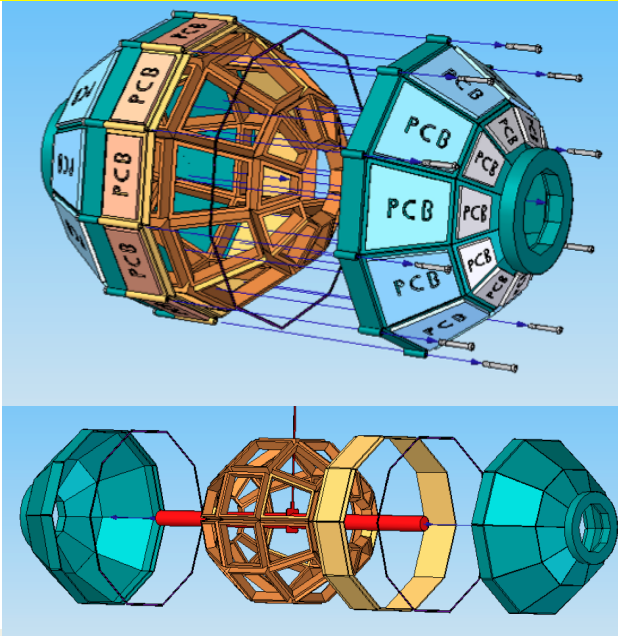
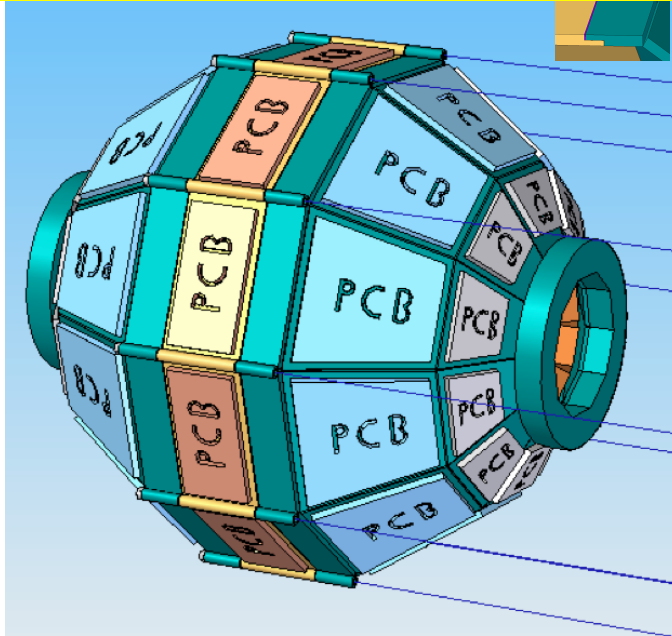
Diego Barrientos CPAN TS fellow



Mechanical design of HYDE

Univ. Huelva

Coordinator: I. Martel



Characteristics:

- ~ 4 PI ARRAY
- Detection of charged particles.
- Particle ID using PSA , DE/E and TOF.
- Energy & angular resolution ($< 150 \text{ keV}$, $1^\circ/0.1^\circ$).
- Large multiplicity (> 3)

Design constraints:

- Subsystem of AGATA array
- Use at other RIB facilities (SPIRAL2, HIE-SOLAR, LEGNARO-SPES)
- Modularity and portability

Construction:

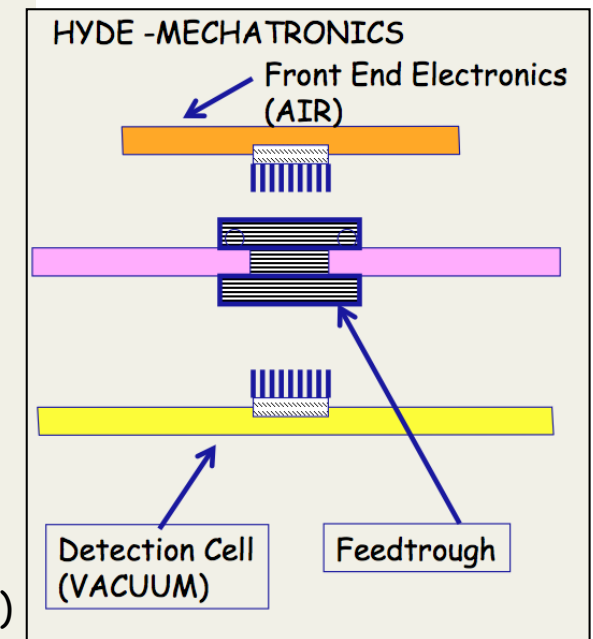
- Chamber $< 380 \text{ mm}$ diameter
- 49 DETECTOR CELLS
- 3 different shapes: square + 2 trapezoids fitting 4" wafer.
- Cylindrical symmetry/10 sides

Mechatronics

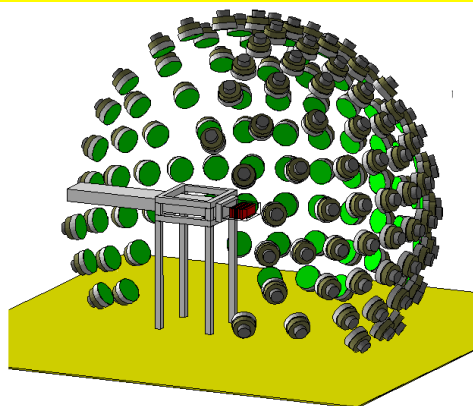
- FFE on air
- 31.360 channels
- High density feedthroughs
- Multiplexing.

Detector cell (Silicon)

- 4 inches, NTD silicon wafers
- Strip size 0,4 mm, Multilayer (5 layer)

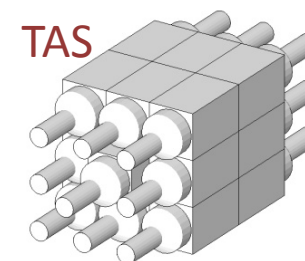
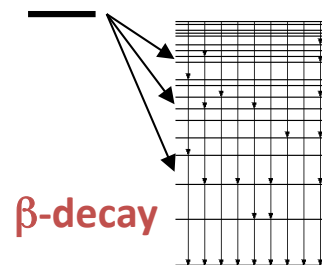
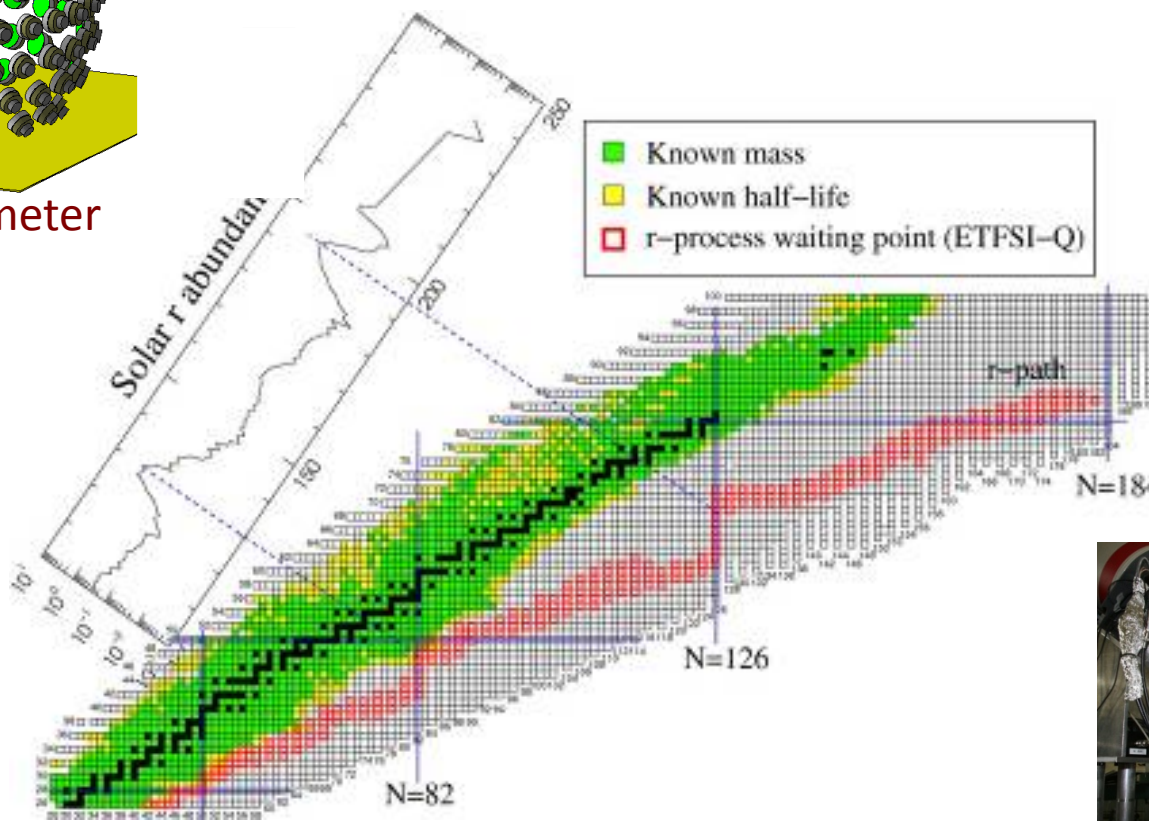
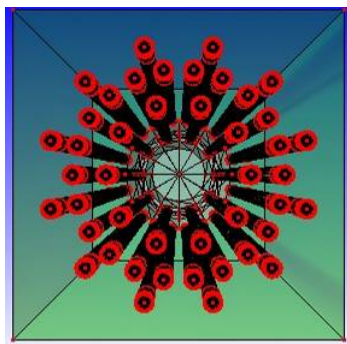


DEcay SPECtroscopy

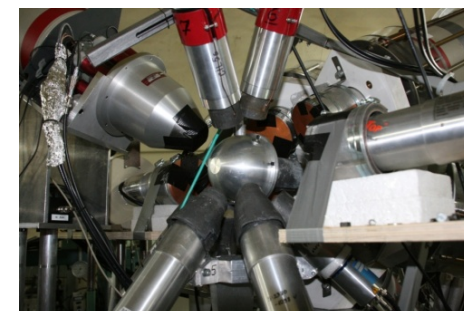


Neutron spectrometer
with AIDA

Beta delayed
neutron detector



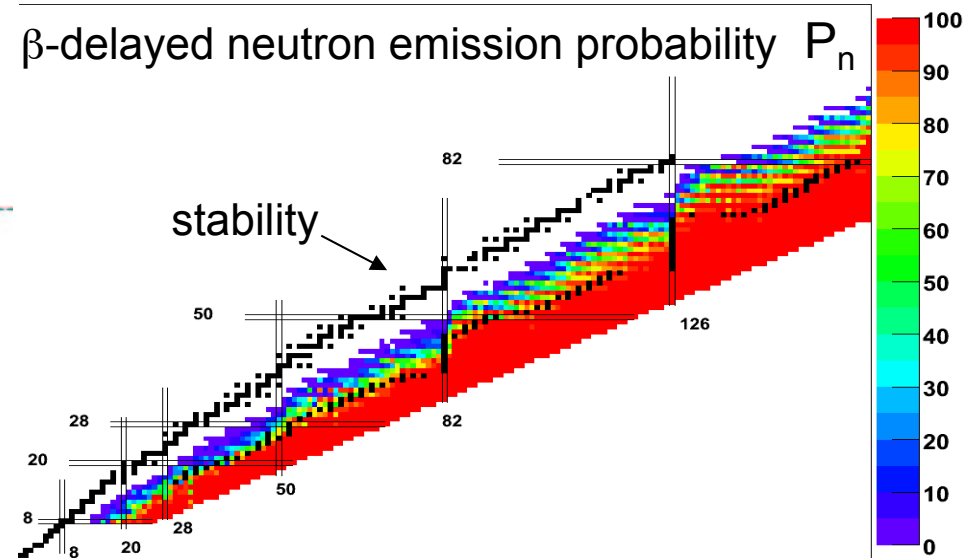
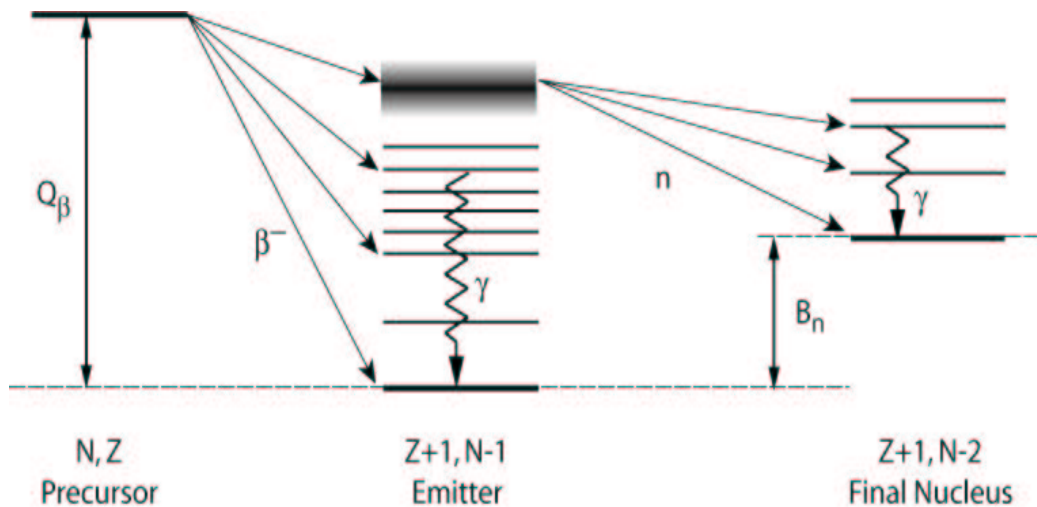
Fast timing
array



β , n , γ -decay of exotic (neutron-rich) nuclei...
DESPEC requires different types of equipment to
study the multiple aspects of the problem

The MODular Neutron SpectromeTER (MONSTER)

Coordinator: D. Cano



CIEMAT coordinates the **international collaboration** responsible of the construction of **MONSTER** and the NUSTAR collaboration neutron detector working group (900 researchers, 150 institutions)

CIEMAT (Spain)

Instituto de Física Corpuscular, Universidad Politécnica de Cataluña (Spain)

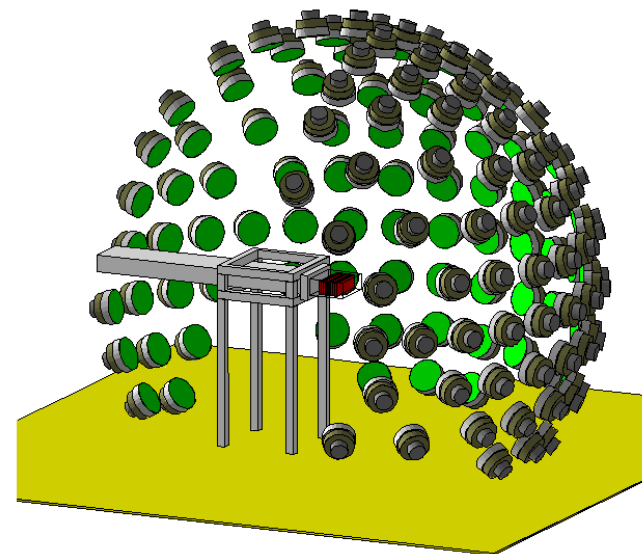
LPC – Caen (France)

University of Jyväskylä (Finland)

Laboratori Nazionali di Legnaro (Italy) – NEDA project

University of Uppsala (Sweden) – NEDA project

VECC – India



150 – 200 cells of BC501A liquid scintillator for β -decay studies



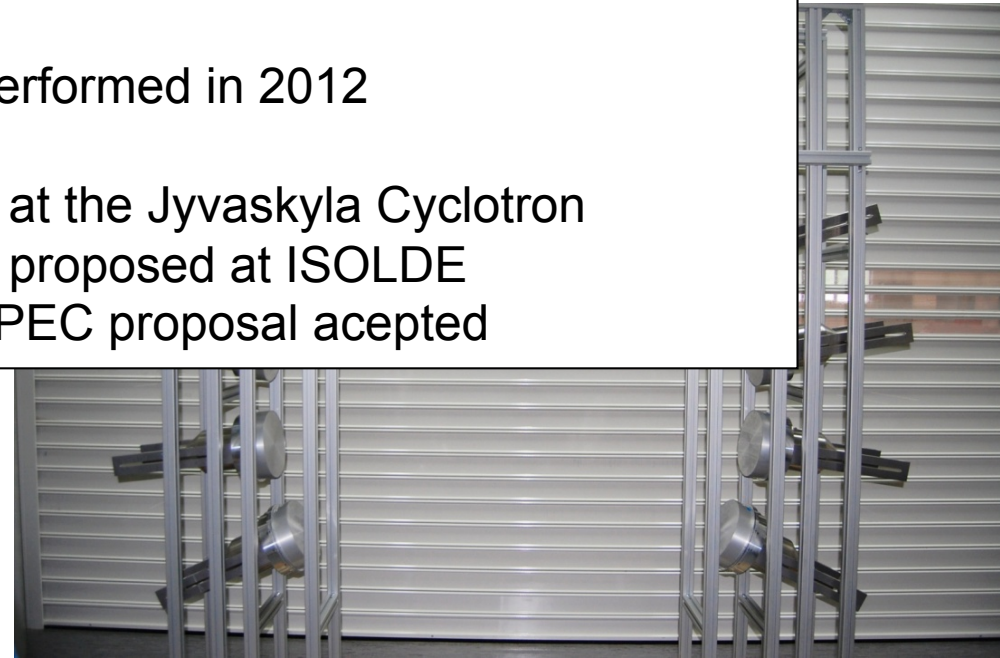
Construction of the MONSTER demonstrator

- First 30 BC501A cells have been delivered.
- 30 Hamamatsu R4144 PMTs have arrived.
- The mechanical structure is well advanced.

Funding for additional 10 cells has been obtained

1st tests will be performed in 2012

- Test experiment at the Jyvaskyla Cyclotron
- Test experiment proposed at ISOLDE
- Umbrella PRESPEC proposal accepted



Neutron counters: BELEN

Design of the prototype of the Beta Delayed Neutron detector with Monte Carlo simulations MCNPX and GEANT4. Different versions:

- BELEN-20 at 20 atms for JYFL. Used in experiments
- BELEN-30; 20 @ 20 atm, 10 @ 10 atm for GSI. Used in exp.
- BELEN-90 for FAIR. Under design. TDR in progress.

Experiment at JYFLTRAP (Finland) to measure β delayed neutron emission of fission fragments (in collaboration between UPC, IFIC and CIEMAT):

- Nov 2009: ^{95}Rb , ^{88}Br , ^{94}Rb , ^{138}I . (cal. and nucl. Structure)
- Jul 2010 : ^{95}Rb , ^{88}Br , ^{85}As , ^{86}As , ^{85}Ge , ^{91}Br , ^{137}I . (decay heat and testing models)

Background measurements at GSI and Canfranc underground laboratory.

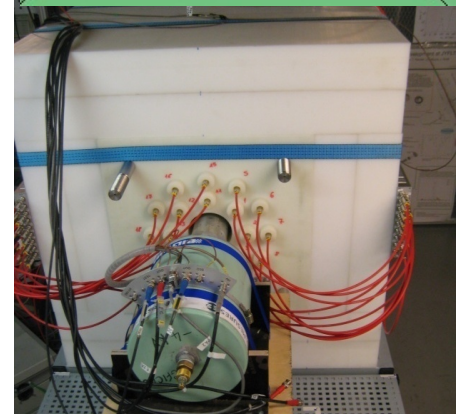
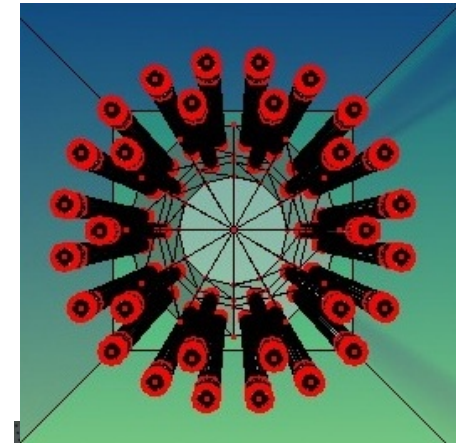
Experiment at GSI with BELEN-30 & SIMBA September 2011, nuclei of astrophysical interest:

- S323: ^{127}Pd , ^{126}Pd , ^{128}Ag
- S410: ^{215}Tl , ^{211}Hg

Coordinator: M.B. Gomez

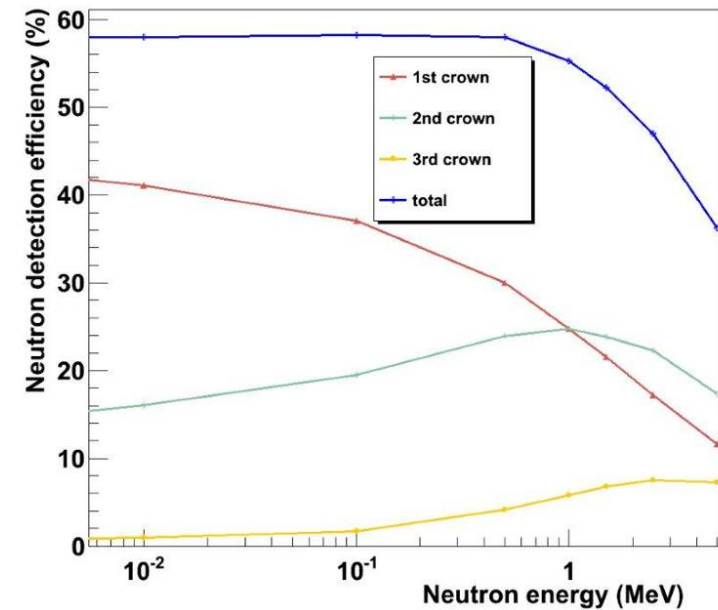
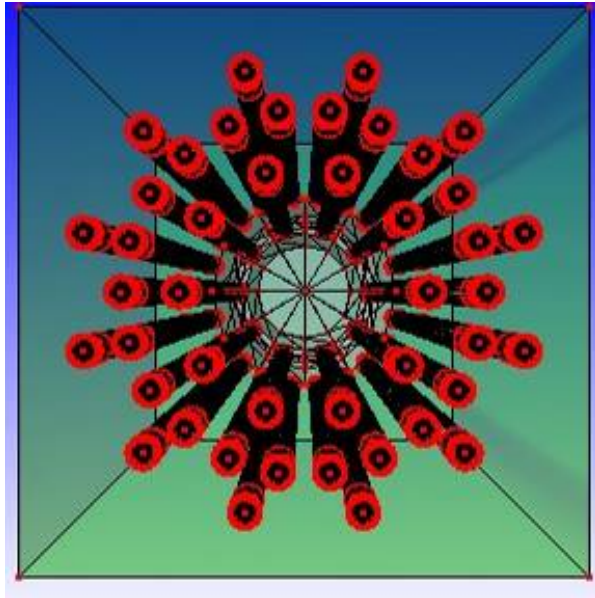


$$P_N = \frac{N_n}{N_\beta}$$



Towards BELEN for FAIR

- Initial plans were for 44 ^3He counters. Now collaboration with GSI & JINR => New design with 90 counters



COUNTERS FOR BEta deLayEd Neutron detector

- ✓ 40 count @ 10 atm UPC (refurbishment)
- ✓ 10 count @ 10 atm GSI
- ✓ 40 count @ 4 atm JINR

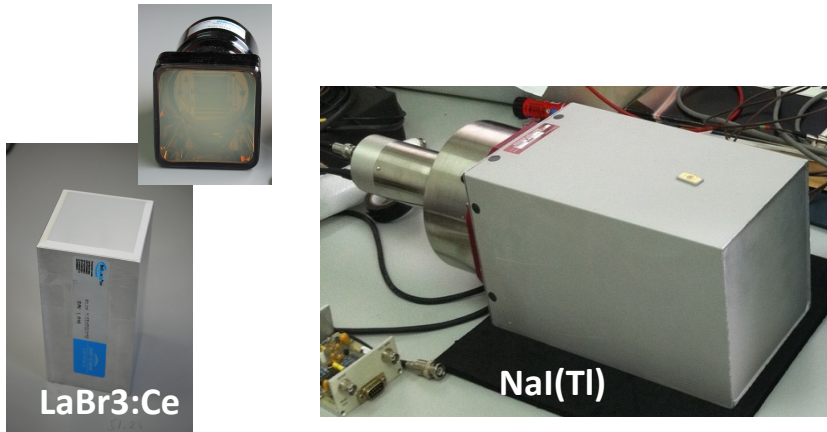
Further simulations to be performed,
redesign detector with 90 counters
Achieve high and flat efficiency.
TDR in progress



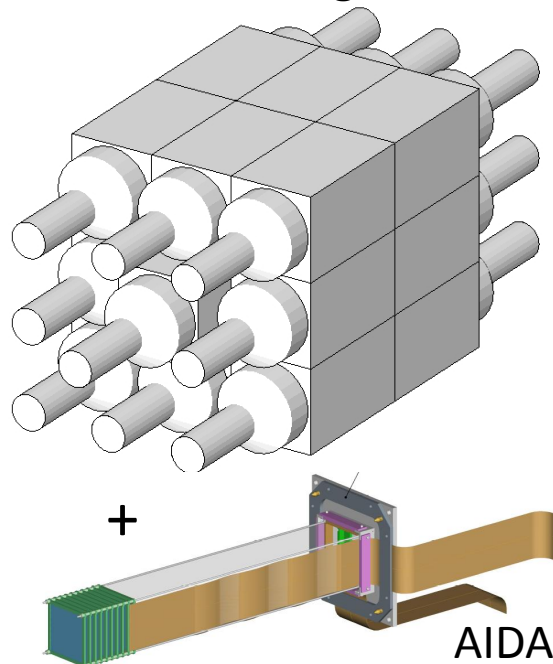
Total Absorption γ -Ray Spectrometer for DESPEC-NUSTAR experiment

IFIC, CIEMAT

Coordinator: J. L. Tain

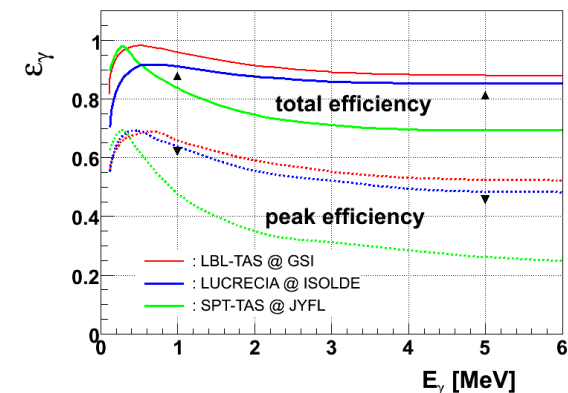
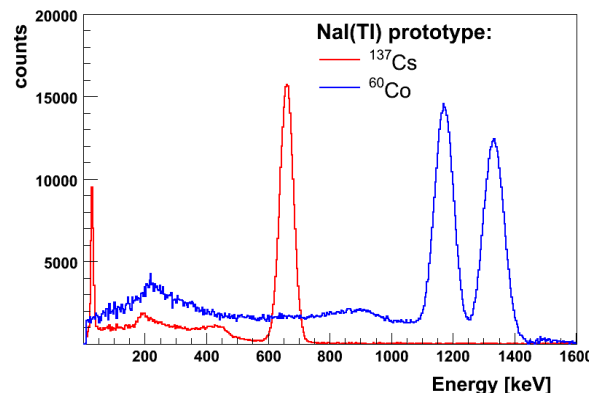


Final design:



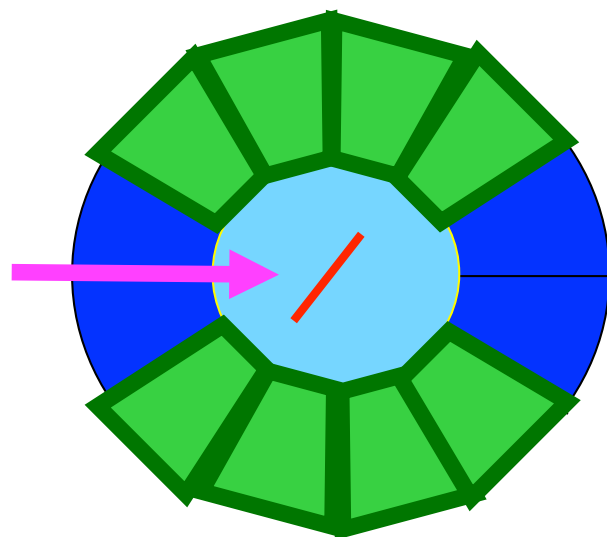
17× NaI(Tl)
15×15×25cm³
Ø5" PMT

- Accurate measurement of β -strength distribution of exotic nuclei for nuclear structure and astrophysics
- Design and prototyping work finished
- In beam tests during 2012
- TDR completed and under revision by the collaboration
- Additional modules under construction
- Electronics: improved preamplifier modules under development
- Data acquisition: new digital DACQ is being tested



FATIMA (FAst TIMing Array) @ DESPEC

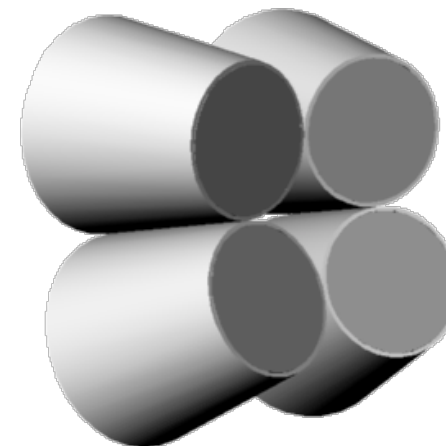
UC



- 48 $\text{LaBr}_3(\text{Ce})$ detectors
- arranged in 4 rings around the target
 - using 9-12 clusters of 4 individually-shielded crystals

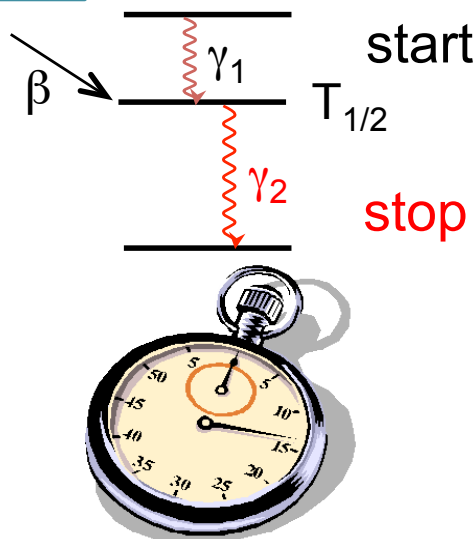
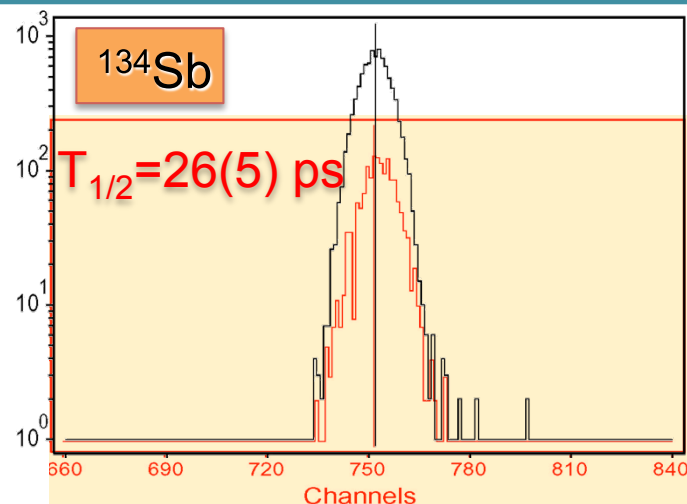


Coordinator: L. M. Fraile



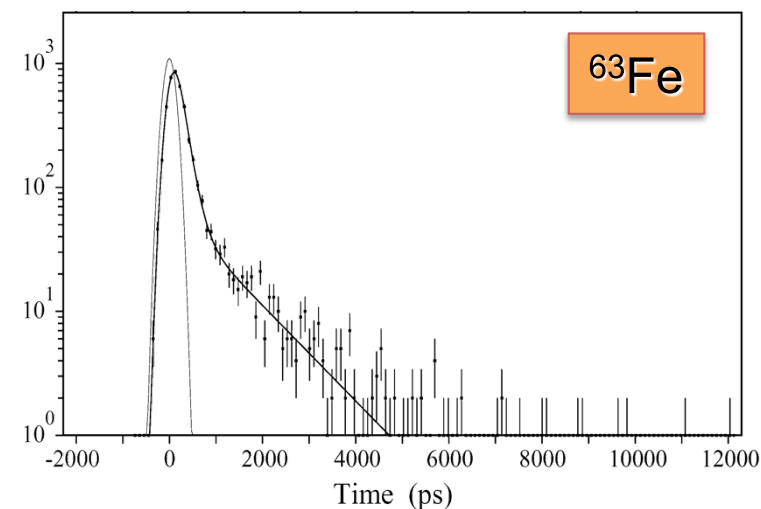
Time distribution Centroid shift (τ)

Range: down to 5-10 ps



De-convolution of slope ($T_{1/2}$)

Range: 30 ps to 30 ns (or longer)

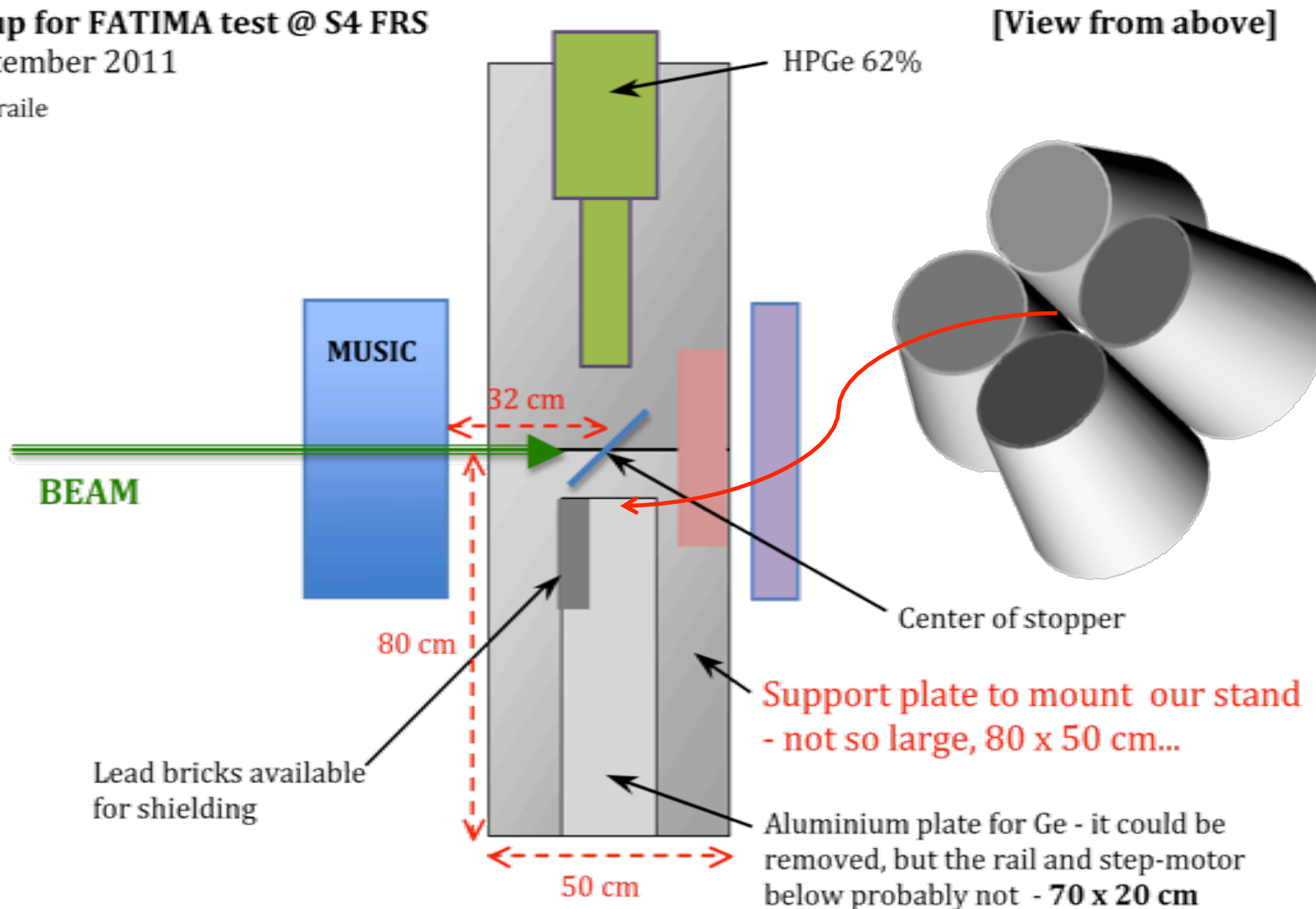


FATIMA test GSI 2011

Setup for FATIMA test @ S4 FRS

September 2011

LM Fraile



Experimental developments in Granada (2011)

UG

1) High-Performance Mass Spectrometry Using a Quantum Sensor

“Starting Grant” form the European Research Council ERC-2011-StG call

Starting date of the project: 01/11/2011

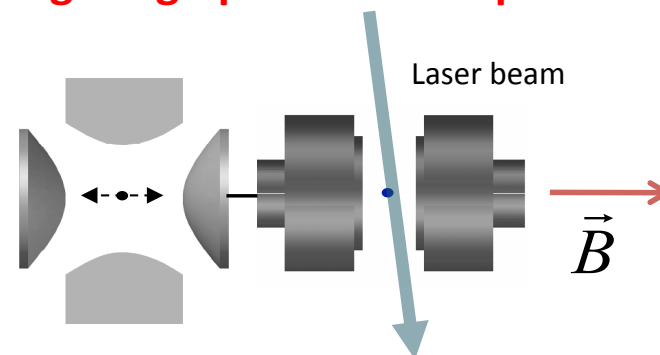
D. Rodríguez, Applied Physics B: Optics and Lasers, accepted



European
Research
Council

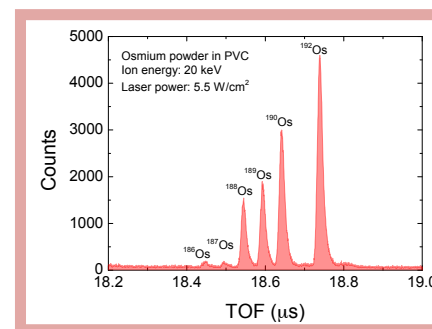
MATS spokesperson: D. Rodriguez

- The quantum sensor (principle)
Weighting up nuclei with photons



2) Laser ion source for tests in operation

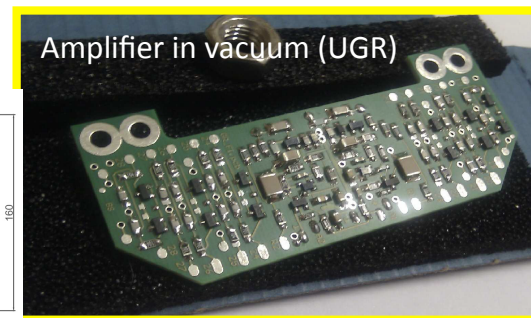
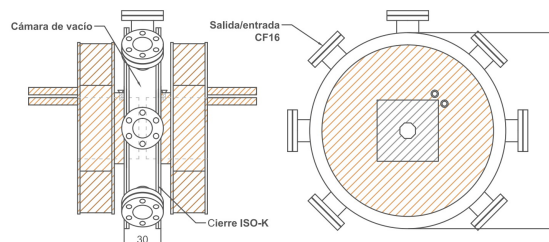
Production of osmium and rhenium ions
(To be published)



3) Detection of induced image current for MATS (FAIR) and SHIPTRAP

Electromagnet system built up and tested (see applications talk)

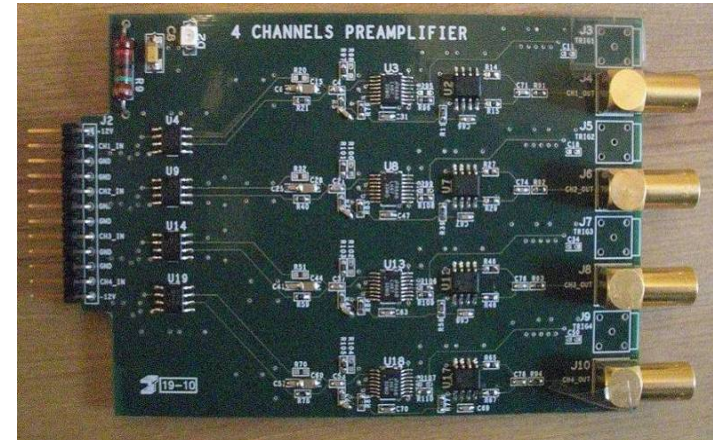
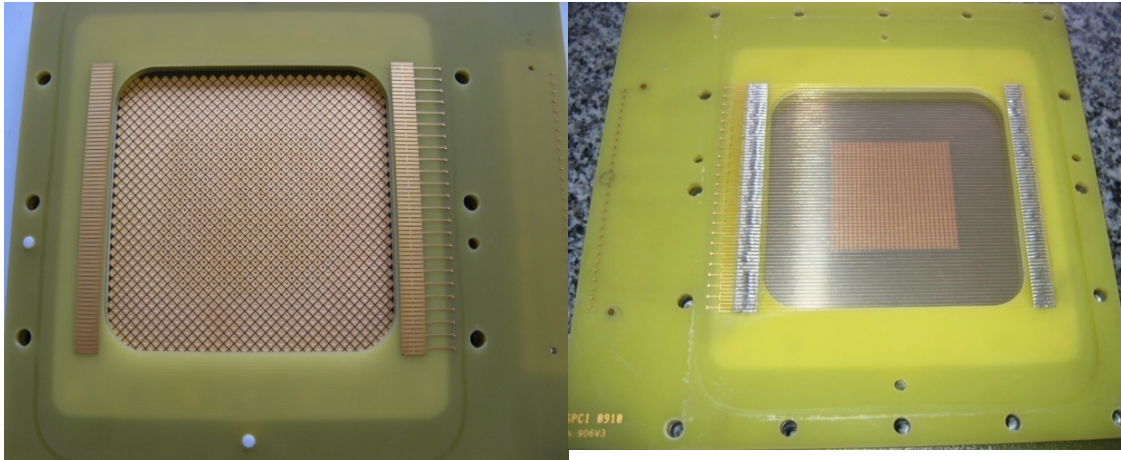
J. M. Cornejo, Master thesis (2011)



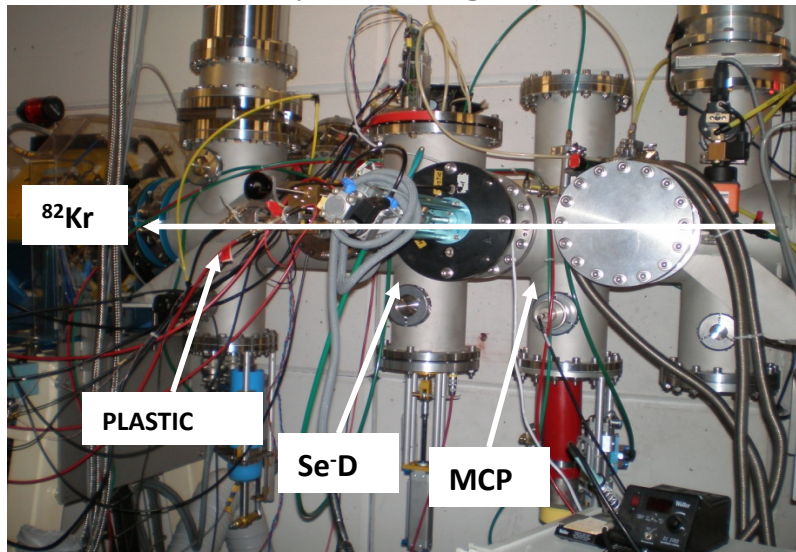
CNA: Low pressure gas detectors for beam tracking

Collaboration CEA-Saclay, GANIL, U.Sevilla, CNA, IMSE

USe, CNA

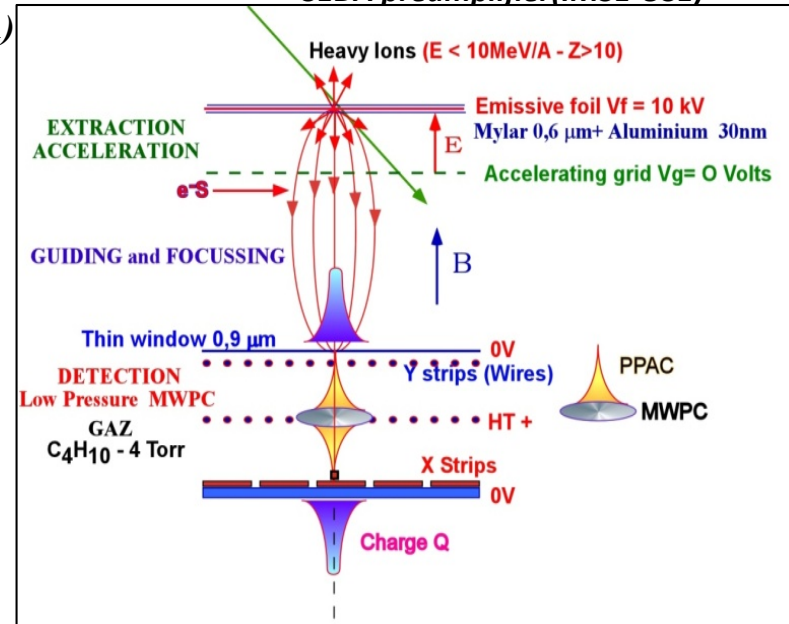


Detectors mini-SeD 2D y micromegas (CEA-GANIL-USE-CNA)



Beam test at GANIL

SEDA preamplifier(IMSE-USE)



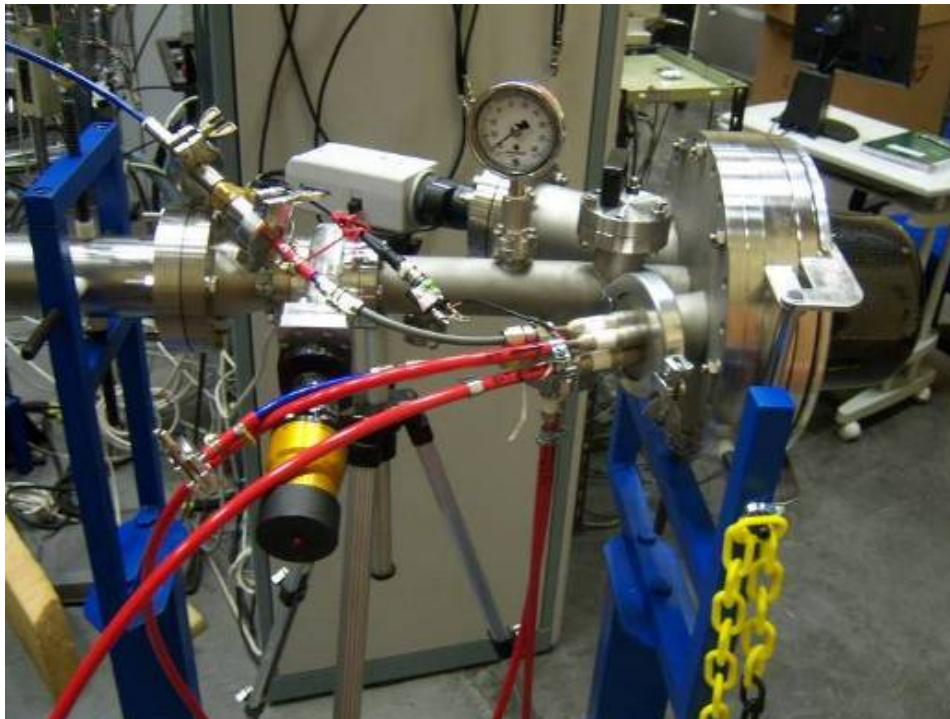
Principle of the SeD beam detectors

Tandem-Neutron line at CNA

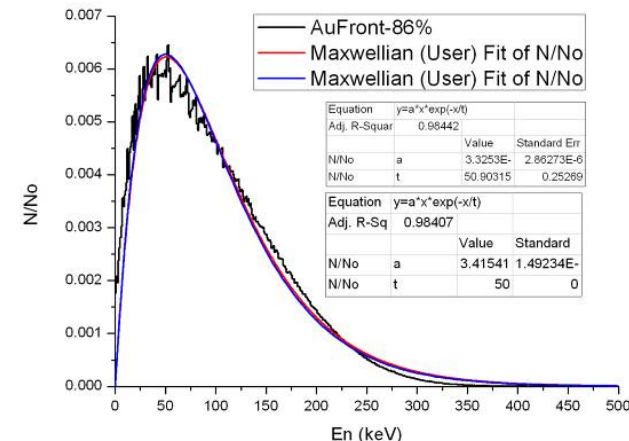
CNA, USev

Neutron beam line developed at LNL Legnaro and adapted to CNA

We performed two different activations that should correspond to measure the *Maxwellian Average Cross Section* of ^{181}Ta at $kT=30$ keV and $kT=55$ keV (Au as reference).



Javier Praena, PostDoc; CPAN contract



MACS $^{181}\text{Ta}(n,\gamma)$ (mb)	
	30 keV
THIS WORK	843 ± 71
Kadonis (TOF)	766 ± 15
Beer & Käppeler (Activation)	$894 \pm (50)$
Macklin (TOF)	703 ± 35
M. Tepe, thesis (Activation)	788 ± 33
Xia <i>et al</i> (Activation)	828 ± 51
ENDF/B-VII.0	793.4
JEFF-3.1	752.8
JENDL-4.0	750.6

MACS $^{181}\text{Ta}(n,\gamma)$ (mb)	
	55 keV
THIS WORK	462 ± 43
Kadonis (TOF)	557
ENDF/B-VII.0	555.8
JEFF-3.1	551.9
JENDL-4.0	550.4

In case of 55 keV we can not compare with other activation experiments since this is the first one.

Summary

- The Spanish nuclear physics community has a consolidated international role and visibility
- The upgrade of existing and the construction of new radioactive beam facilities brings unique opportunities to the field
- Several Spanish groups play an important/leading role in the development of instrumentation for the second generation radioactive beam facilities
- CPAN has played also an important role in last years as a source of financial support
- We should not allow the “crisis” to cut our wings



Thank you for your attention

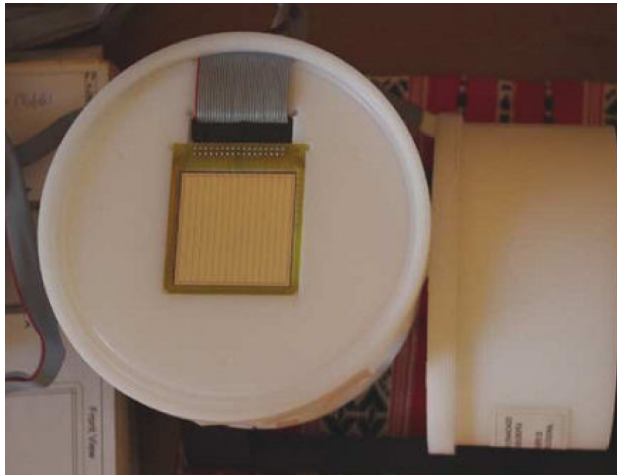
NGC 6960: The Witch's Broom Nebula

Contributions from A. Jungclaus, J. Gomez Camacho, D. Rodriguez, J. L. Tain, D. Cano, I. Martel, J. Benlliure, I. Duran, M. Belen Gomez, D. Cortina, J. M. Quesada, B. Quintana, A. Gadea, M. J. Garcia-Borge, J. M. Udias, L. M. Fraile, C. Paradela

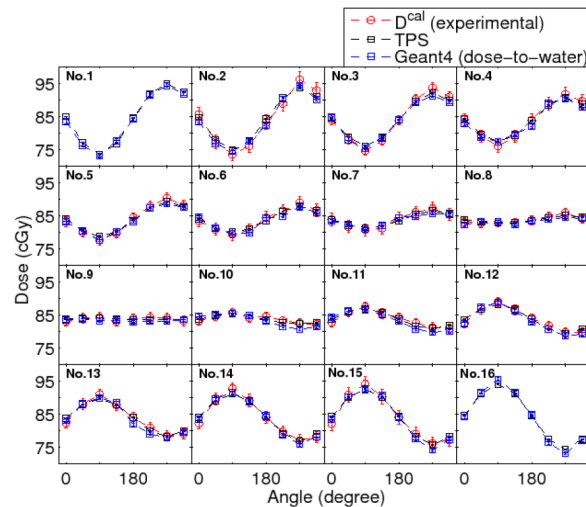
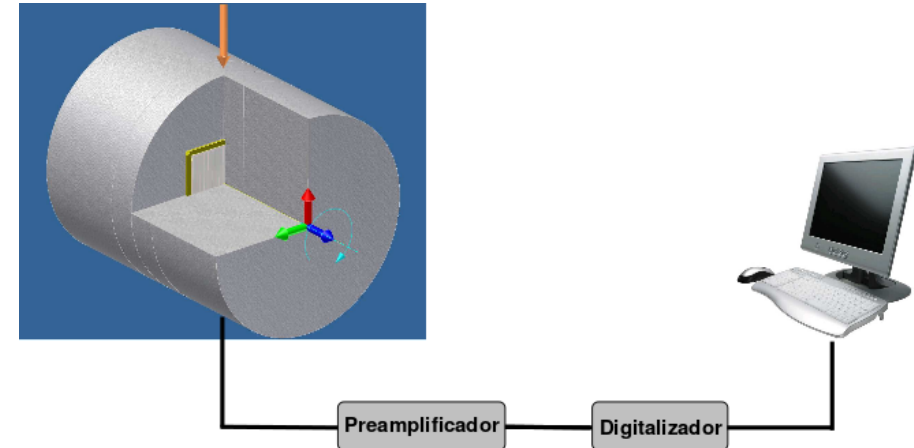
SPARE SLIDES

Characterization of a strip Si detector for Radiotherapy dosis measurements

U.Sevilla-CNA-INABENSA-HUVM-ESII M. Overejo: Contrato CPAN



Si strip detector inside a cilindrical phantom



Dose measured in the different strips vs simulations



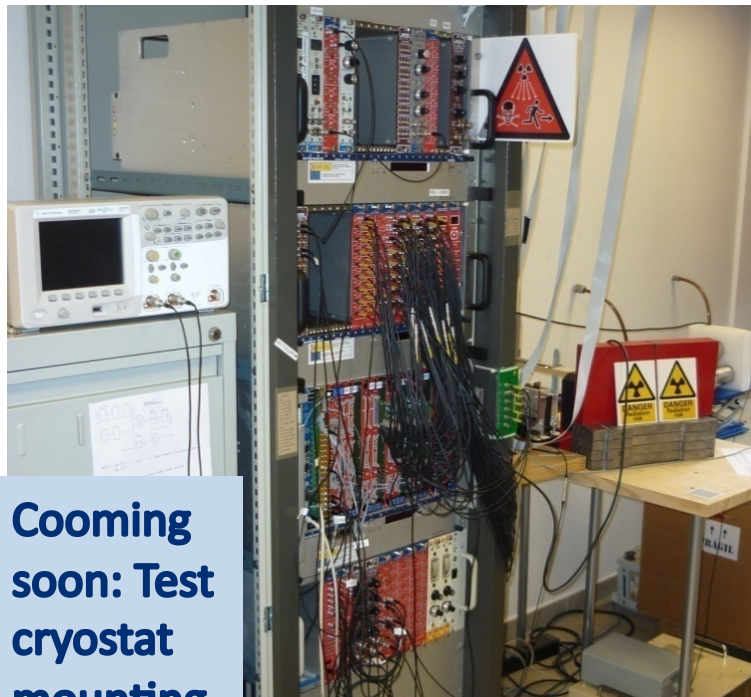
Measurement with a clinical electron accelerator

Patent application submitted

Salamanca Lyso-based Scanning Array SALSA

PURPOSE: To associate interaction position in the Ge crystal to the electrical signal shapes

CRITICAL ISSUE
the position resolution



Coming soon: Test cryostat mounting



VNIVERSIDAD
D SALAMANCA

“Towards a deep characterization of a 64-fold-pixelated Position Sensitive Detector for a new Gamma-Scanning System of HPGe segmented detectors”. Oral contribution to ANNIMA 2011 and IEEE-Valencia

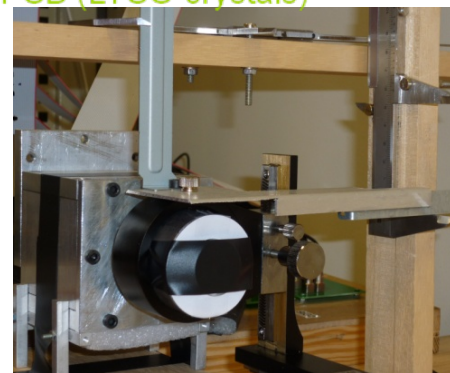
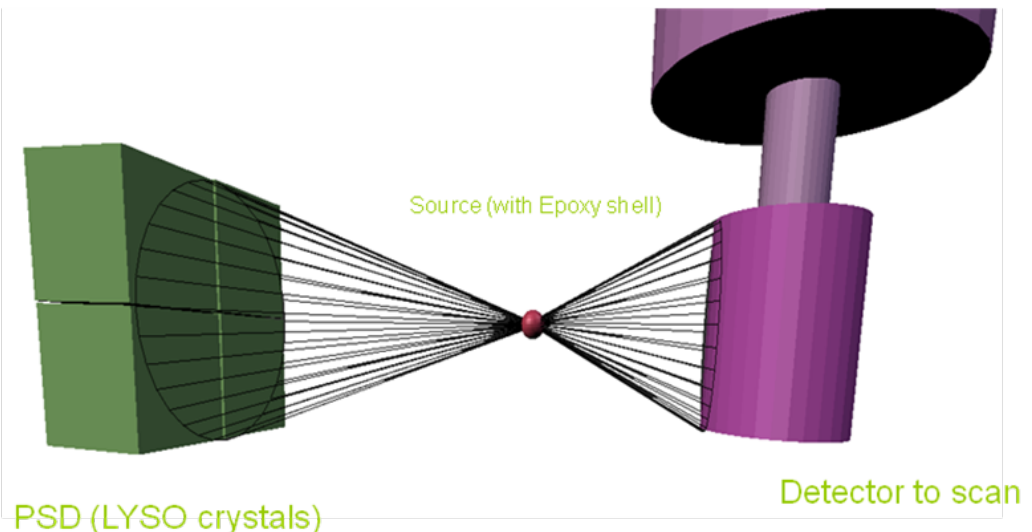


Figure. Scanning System CAD Design

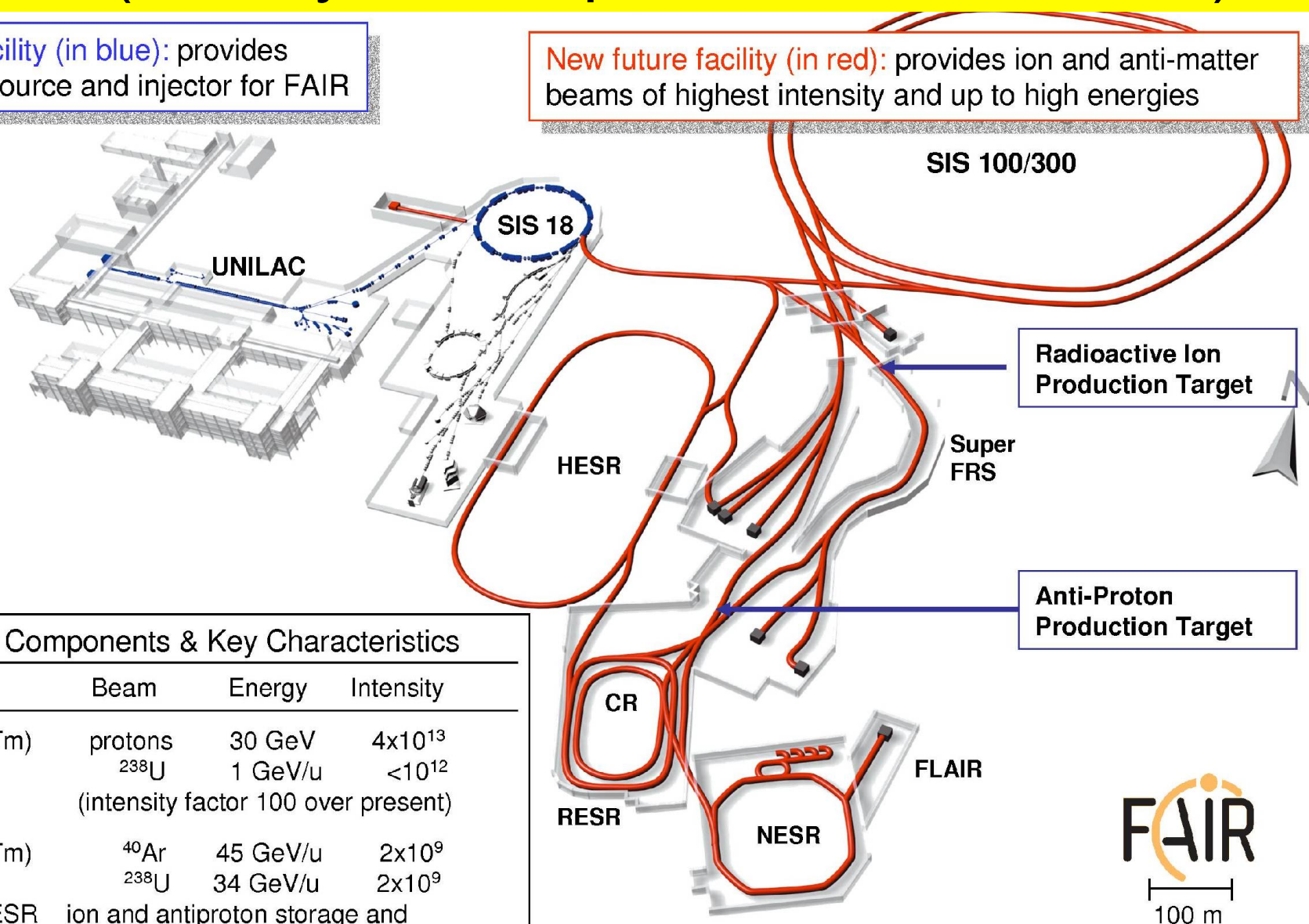
Ge characterization method based on the comparison of Ge signals by F. Crespi NIMA 593 (2008)

Total	213250 €
FPA2008	206800 €

FAIR (Facility for Antiproton Ion Research)

Existing facility (in blue): provides ion-beam source and injector for FAIR

New future facility (in red): provides ion and anti-matter beams of highest intensity and up to high energies



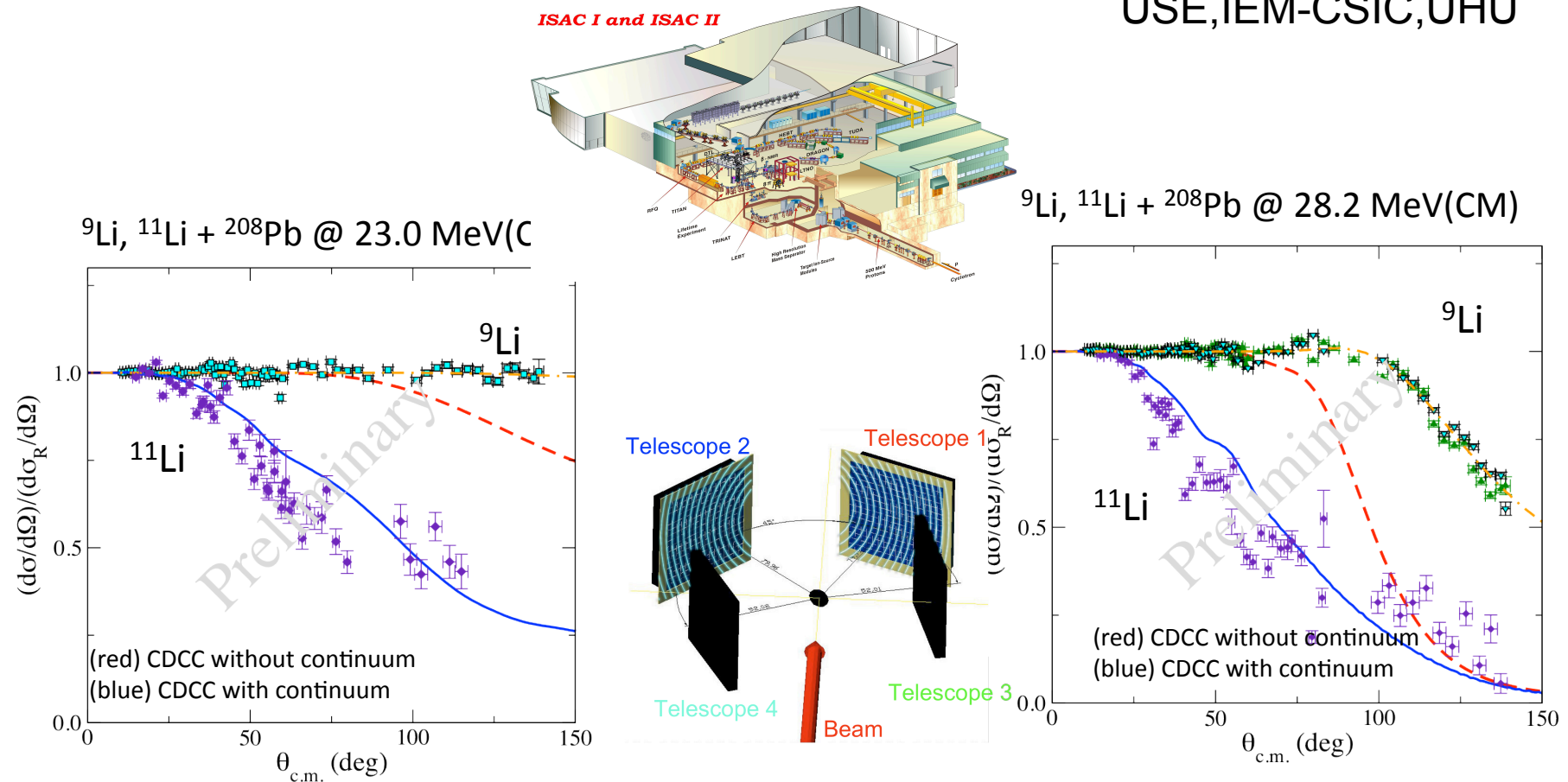
Accelerator Components & Key Characteristics

Ring/Device	Beam	Energy	Intensity
SIS100 (100Tm)	protons	30 GeV	4×10^{13}
	^{238}U	1 GeV/u	$< 10^{12}$
	(intensity factor 100 over present)		
SIS300 (300Tm)	^{40}Ar	45 GeV/u	2×10^9
	^{238}U	34 GeV/u	2×10^9
CR/RESR/NESR	ion and antiproton storage and experiment rings		
HESR	antiprotons	14 GeV	$\sim 10^{11}$
SuperFRS	rare-isotope beams	1 GeV/u	$< 10^9$



First measurement of the elastic scattering of the halo nucleus ^{11}Li and its core ^9Li on ^{208}Pb at energies below and around the Coulomb barrier @ TRIUMF

USE, IEM-CSIC, UHU



The $^9\text{Li} + ^{208}\text{Pb}$ scattering data behave as expected.

- The strong reduction of the $^{11}\text{Li} + ^{208}\text{Pb}$ elastic cross section observed both below and around the Coulomb barrier, along with the corresponding increase in the break-up cross section, depends strongly on the Coulomb dipole coupling of the ground state to low energy continuum states in ^{11}Li .