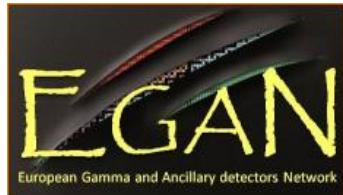
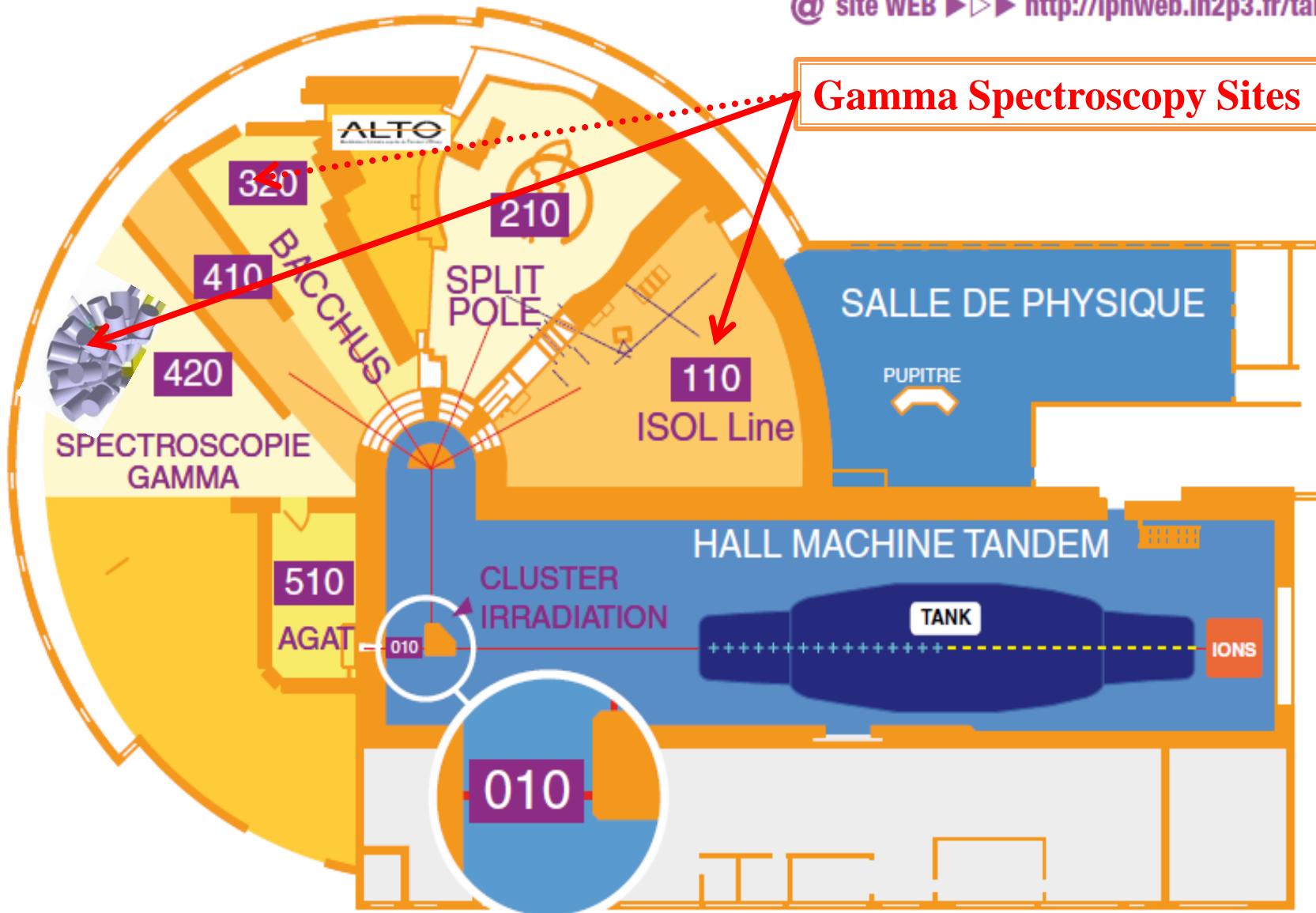


Gamma Spectroscopy with Stable Beams at the Orsay Tandem

Iolanda Matea, IPN, Orsay, France

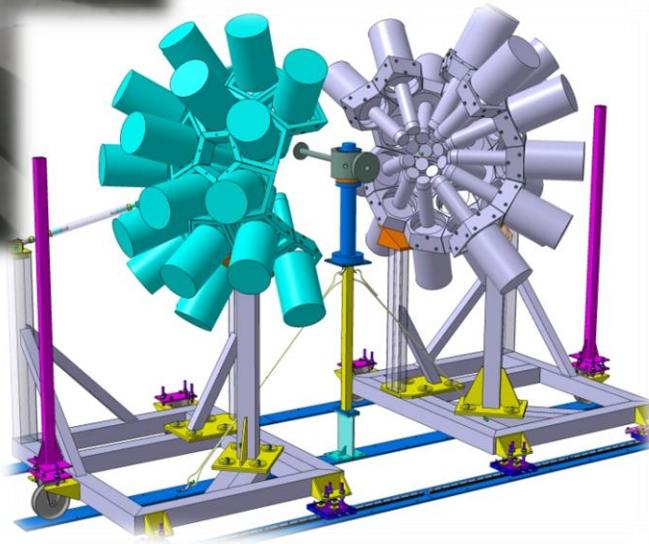
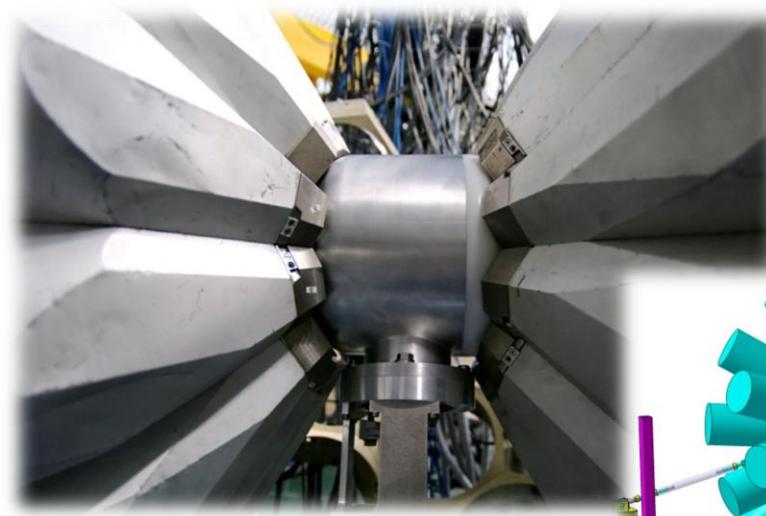


23-26 June, GSI, Darmstadt, Germany



ORGAM

Present Status



45 Eurogam mechanical cells

Distance to target : 180 mm

Efficiency/Ge : 0.1 % @ 1MeV

IPN: homebase of the LoanPool

GammaPool loan until end 2015



Since 2011: 1-2 campaigns of 4-5 experiments per year

—The Orsay Gamma Array Campaigns—

ORGAM

2012

- Only LoanPool resources
- 13 BGO + 13 EUROGAM Phase 1 Ge

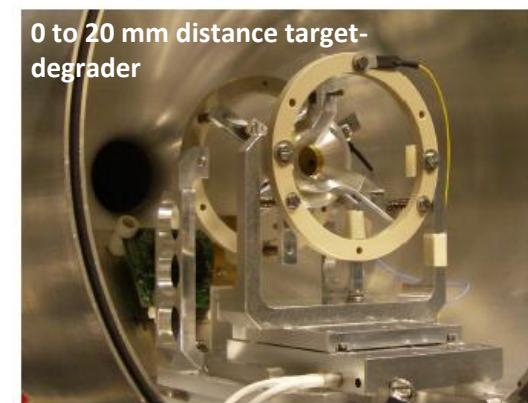


November 2013 to January 2014 campaign
18 Ge+BGO detectors (GP+ LP resources)
Clover detectors

Ancillaries:

none

OUPS Plunger



N-SI-52 : "Toward the excitation and de-excitation of nuclear isomers in plasma"
(SP: F. Hannachi, CENBG, Bordeaux, France)

N-SI-48 : "Development of the Time Dependent Recoil In Vacuum technique
for *radioactive-beam geometry*"
(SP: G. Georgiev, CSNSM, Orsay, France)

N-SI-50 : "Probing the boundary of shape coexistence south of Z=82: Lifetime
measurements of excited states in ^{170}Os using the RDDS method"
(SP: J. Ijungvall, CSNSM, Orsay, France)

N-SI-44 : "Search for X(5) symmetry in ^{168}W nucleus"
(SP: K. Gladnishki, Dept of Atomic Phys, Faculty of Physics, Sofia, Bulgaria)

N-SI-49 : "Study of Superdeformed Shell Structure and Beyond in $A \sim 40$
Nuclei"
(SP: E. Ideguchi, CNS, Univ of Tokyo, Japan)

Silicon Ball

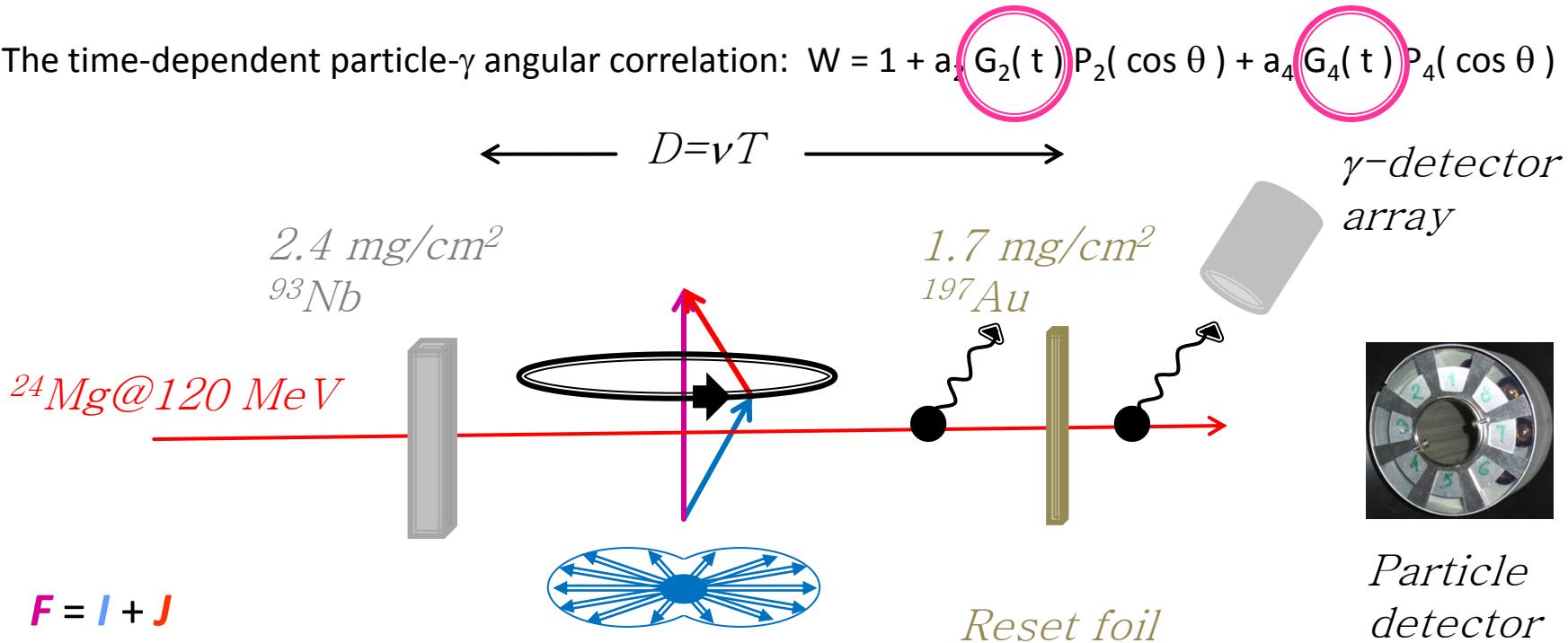
continued in November 2013



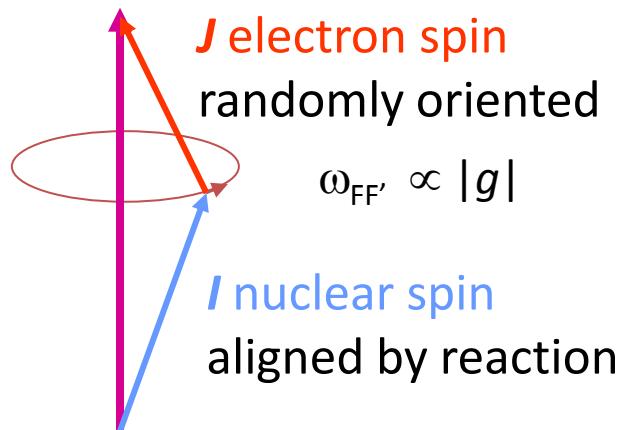
Recoil in Vacuum: H-like Mg ions

Time-Differential Recoil-in-Vacuum (Plunger) Method

The time-dependent particle- γ angular correlation: $W = 1 + a_2 G_2(t) P_2(\cos \theta) + a_4 G_4(t) P_4(\cos \theta)$



$$\mathbf{F} = \mathbf{I} + \mathbf{J}$$



J electron spin

randomly oriented

$$\omega_{FF'} \propto |g|$$

I nuclear spin

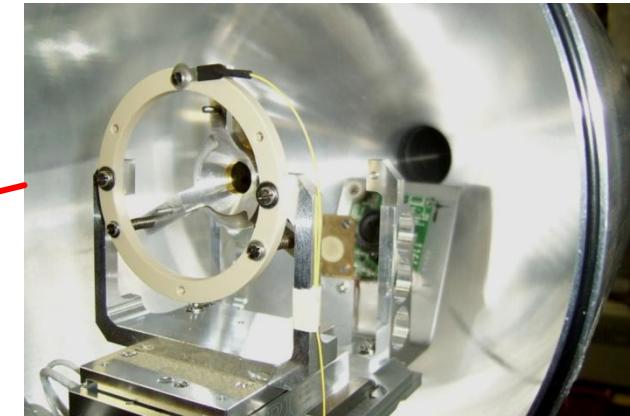
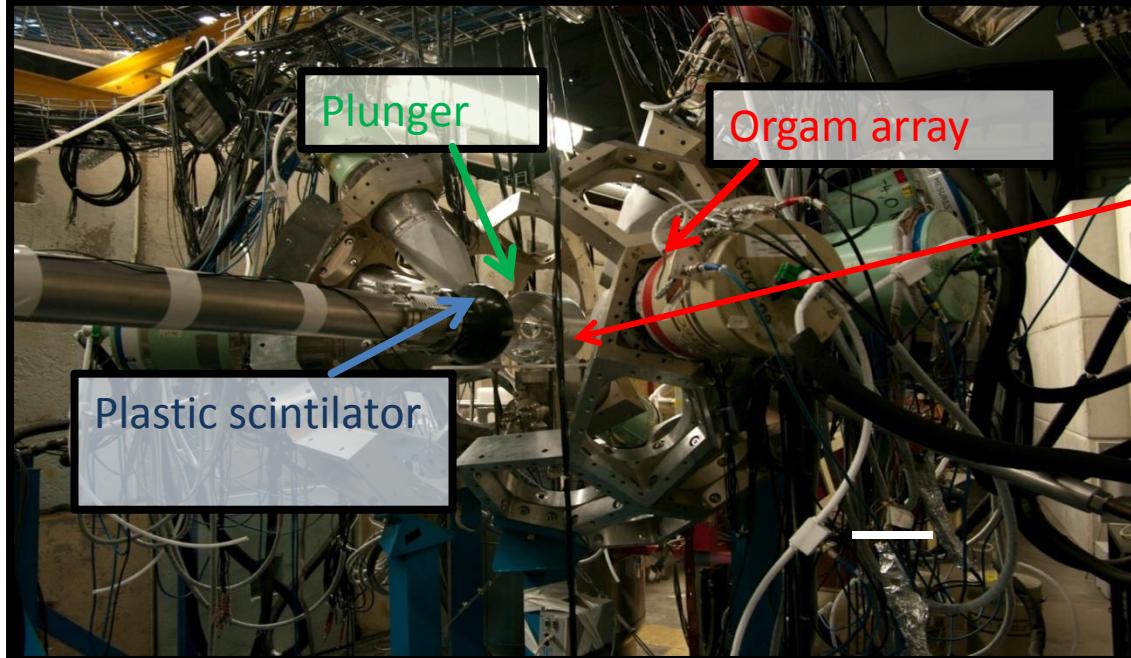
aligned by reaction

More than 40% of ions are H-like, i.e.
single 1s electron:

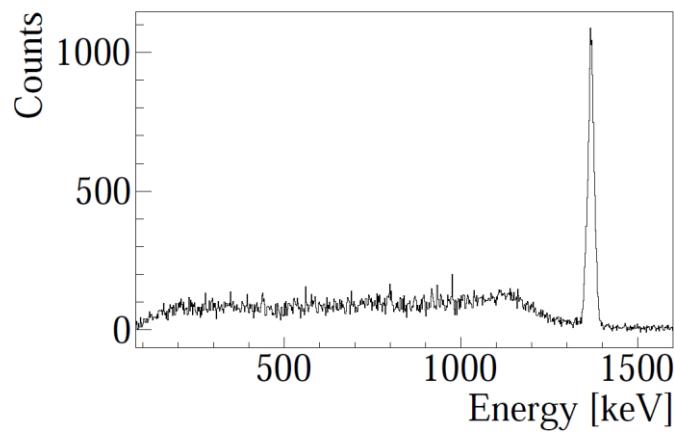
$$B(0) = 16.7Z^3 \text{ tesla}$$



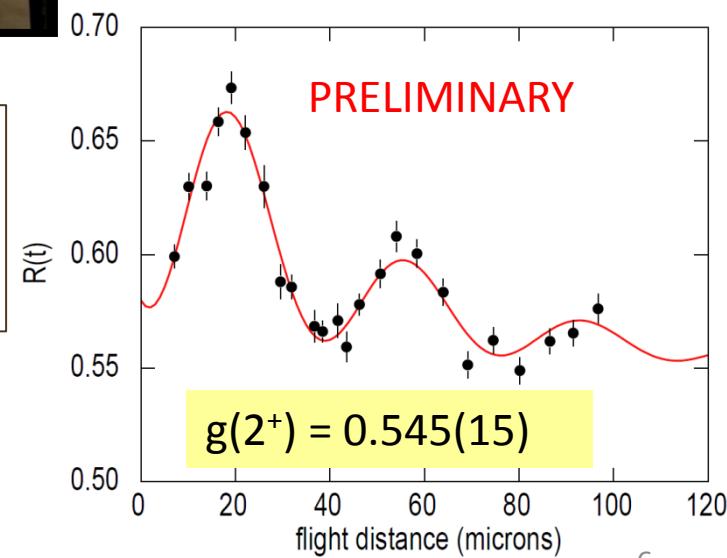
High precision g-factor measurement



Plunger "O U P S"

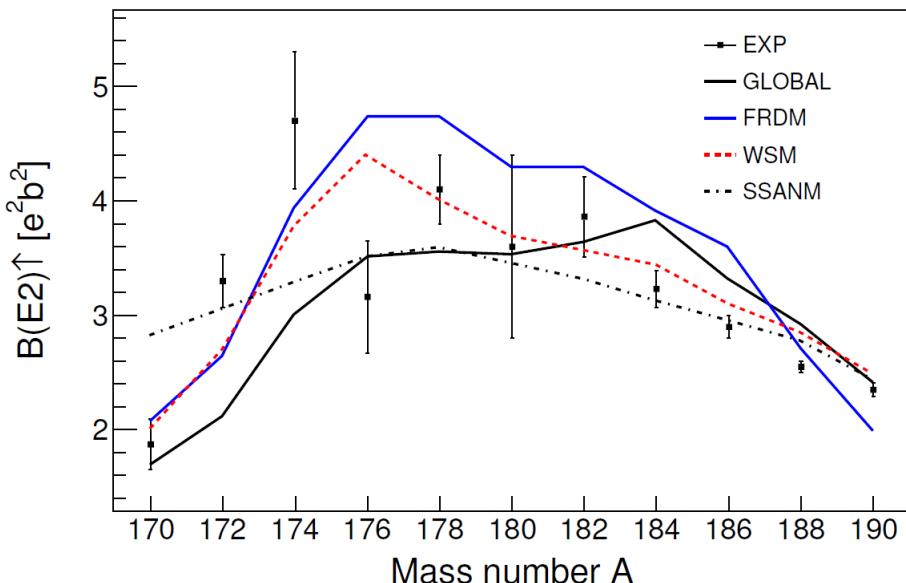
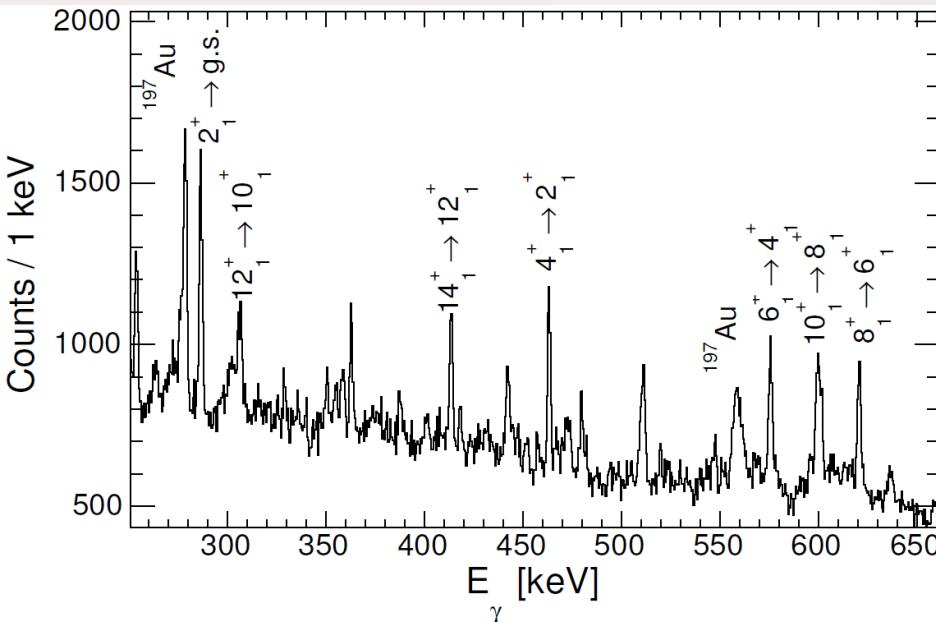
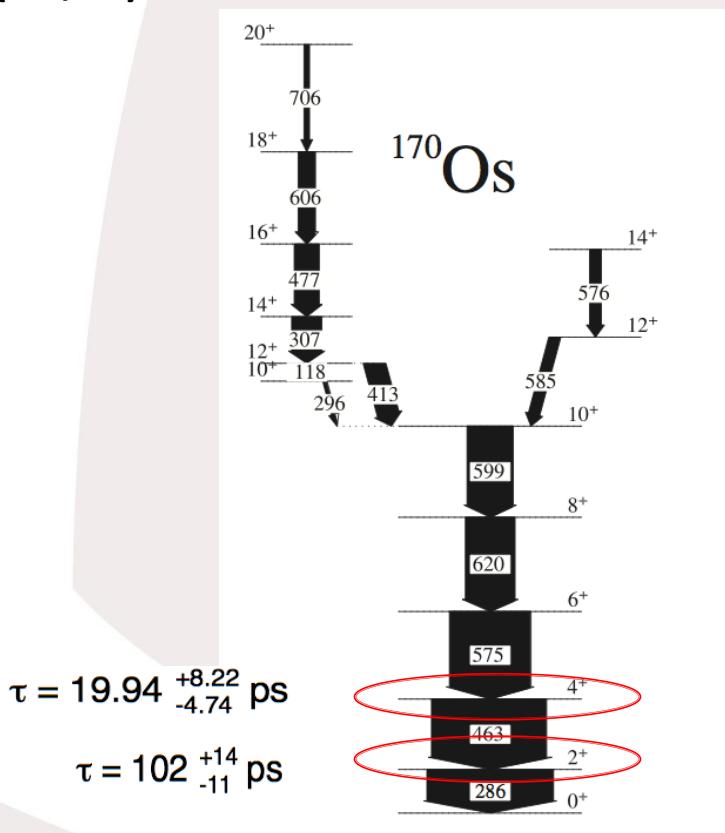


^{24}Mg 2^+ state
USD shell model:
 $g(2^+) = 0.5465$



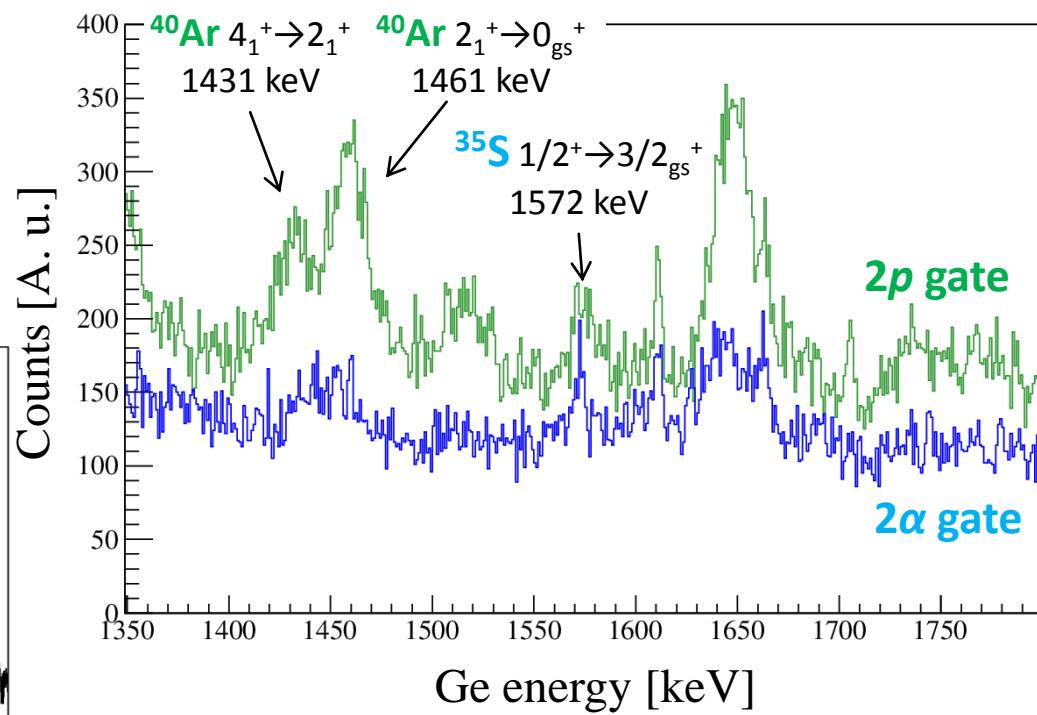
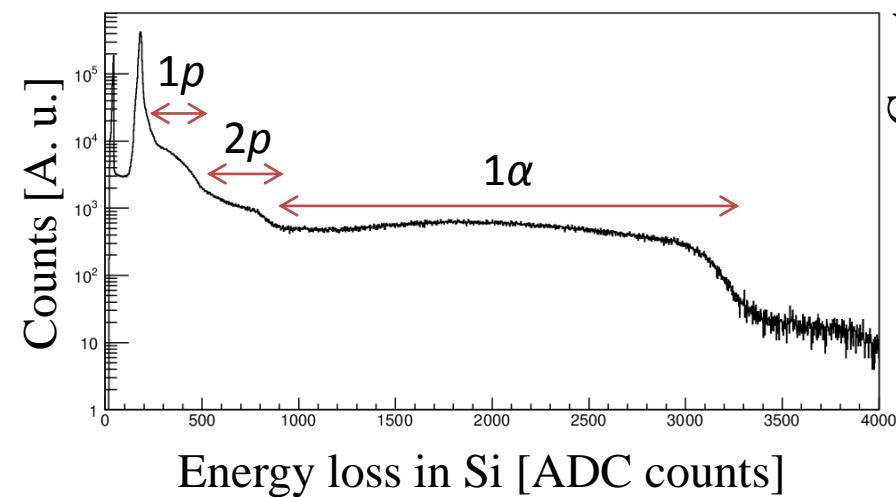
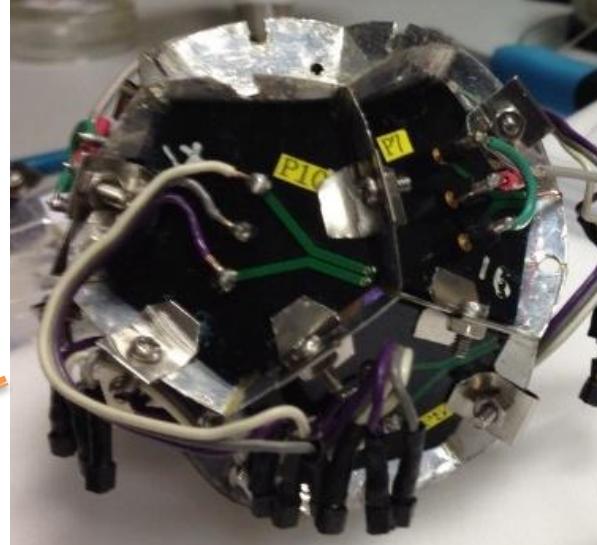
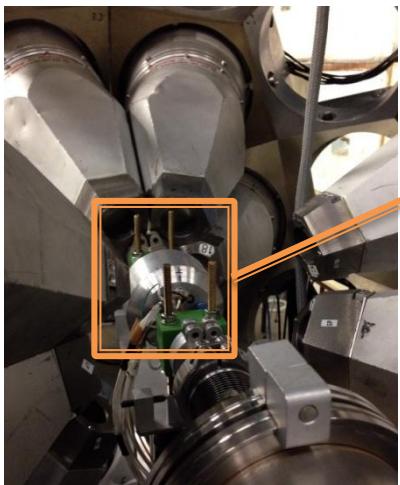
Probing the boundary of shape coexistence south of Z=82

- Probe the boundary of shape coexistence south of Z=82
- Investigating the change of structure in the Z=76 region : ^{170}Os shape coexistence ?
- $^{142}\text{Nd}(\text{d},\text{n})^{170}\text{Os}$



ORGAM-SiBall campaign

- Coordinators:
I. Matea (IPN) and E. Ideguchi (RCNP, Osaka Univ.)
- Vol. 1: N-SI-49 (E. Ideguchi, D. Verney) in Jan. 21 – 27, 2013
 - Super-deformation in $^{35,36}\text{S}$, ^{40}Ar via $^{18}\text{O} + ^{26}\text{Mg} \rightarrow ^{44}\text{Ca}^*$



2013-2014 ORGAM campaign

Ancillaries:

“Study of alpha clustering in sd shell nuclei”

(SP: D. Suzuki, IPN Orsay, France)

Silicon Ball

“Nuclear moments and nuclear orientation from incomplete fusion and transfer reactions”

(SP: G. Georgiev, CSNSM, Orsay, France)

“Time dependent recoil in vacuum for Na-like 56Fe ions”

(SP: A. Stuchbery, ANU Canberra, Australia)

OUPS Plunger

“Lifetime measurements using the RDDS method after incomplete fusion”

(SP: A. Goasduff, CSNSM, France)

“Octupole collectivity in 156Gd: lifetime measurements of the first 4- and 6- states in 156Gd”

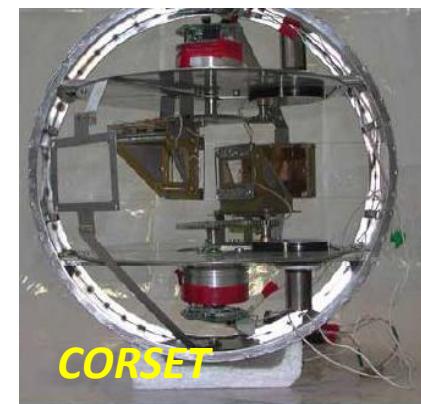
(SP: L. Sengele, IPHC, Strasbourg, France)

“Investigations of shell effects in fusion-fission and quasifission processes in the reaction $^{160}\text{O}+^{204}\text{Pb}$ and $^{34}\text{S}+^{186}\text{W}$ ”

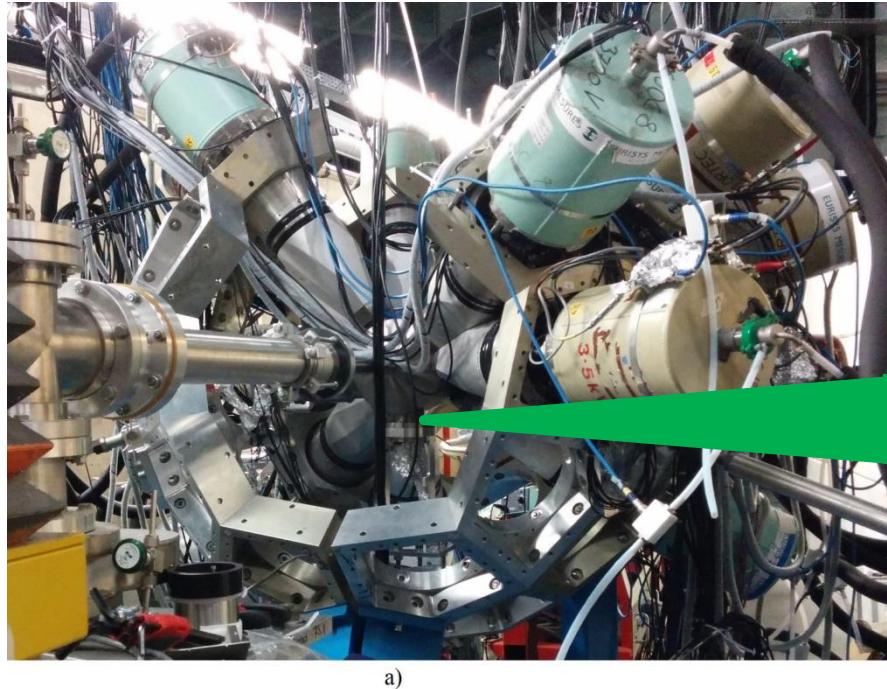
(SP: E. Kozulin, JINR, Dubna, Russia)

“Use of the LICORNE facility to test the feasibility of gamma-ray spectroscopy far from stability via a new method: fast-neutron induced fission and selection by isomer tagging”

(SP: J. Wilson, IPN, Orsay, France)



First CORSET + ORGAM coupling



- Time resolution δt 150 ps
- Mass resolution δM ± 1.5 amu
- Angular resolution $\delta\Theta, \delta\varphi$ $\pm 0.3^\circ$
- Solid angle of each arm 100 msr
- Range of measured angles: 16°



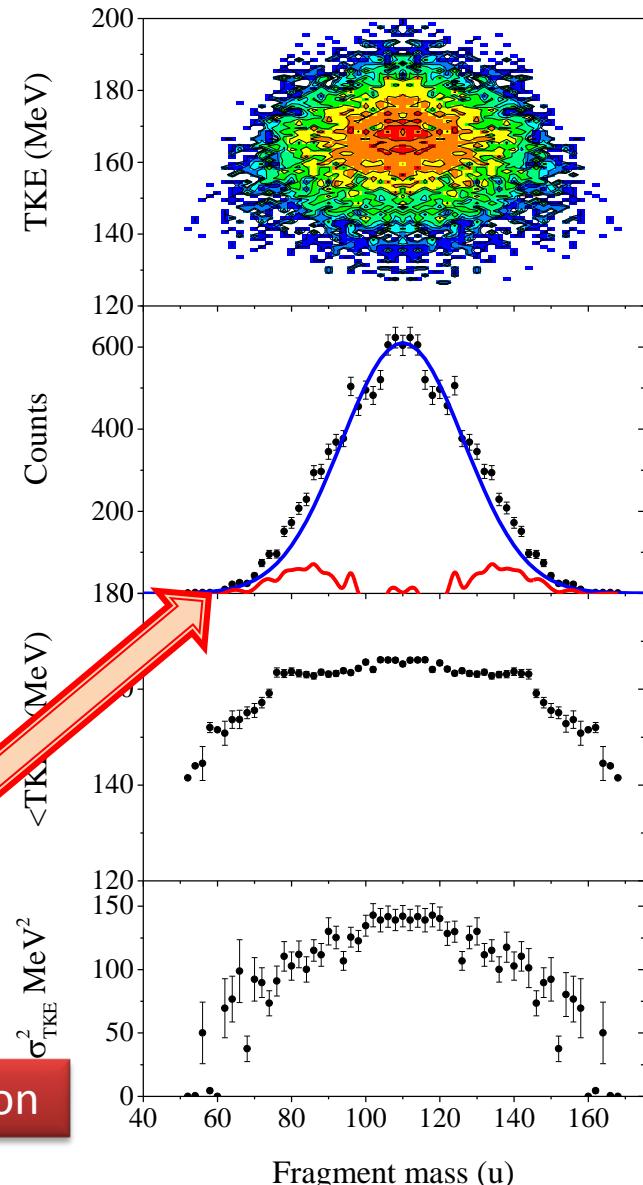
Results: CORSET data

Parameter	value
The Coulomb barrier (in lab sys.)	160.5 MeV
Cross section	
Irradiation time	~3 days
Beam current	~10 nA
Collected statistics for fission fragments	14500
Excitation energy of CN	48 MeV

The multimodal fission: The contribution of asymmetric fission is about 7.7%



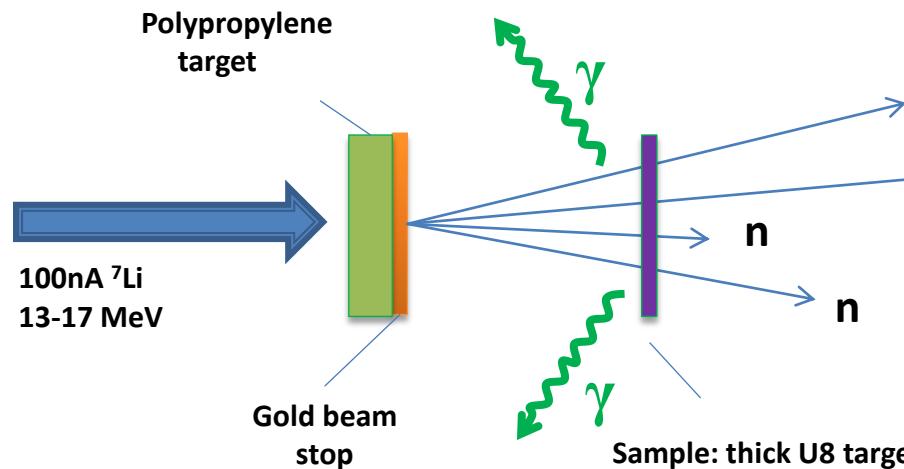
Very low statistics for coincident gamma detection



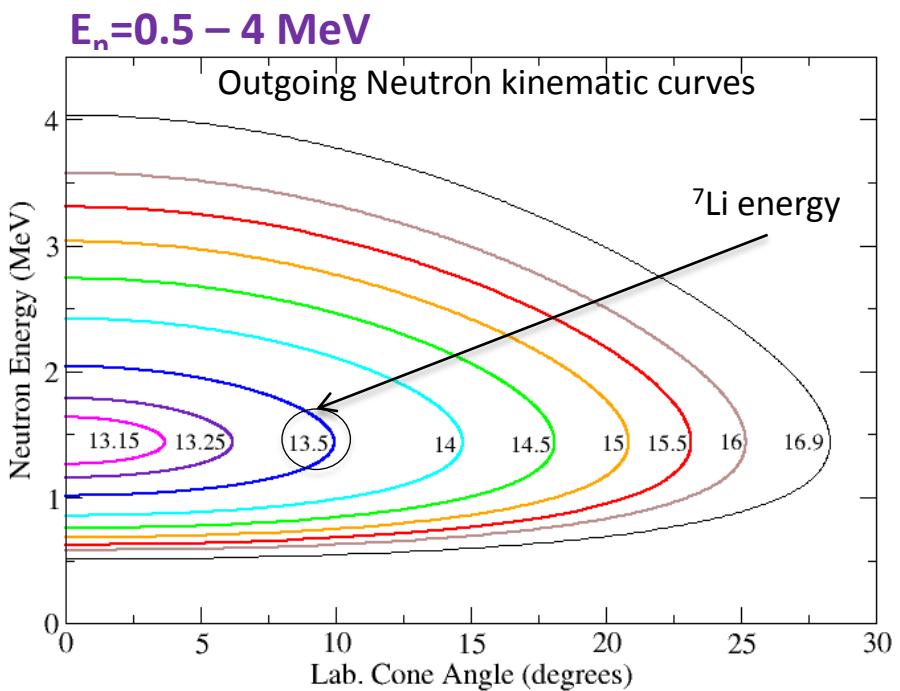
—LICORNE—

Campaign Managers: M. Lebois, J. Wilson

Lithium Inverse Cinematiques ORsay Neutron source

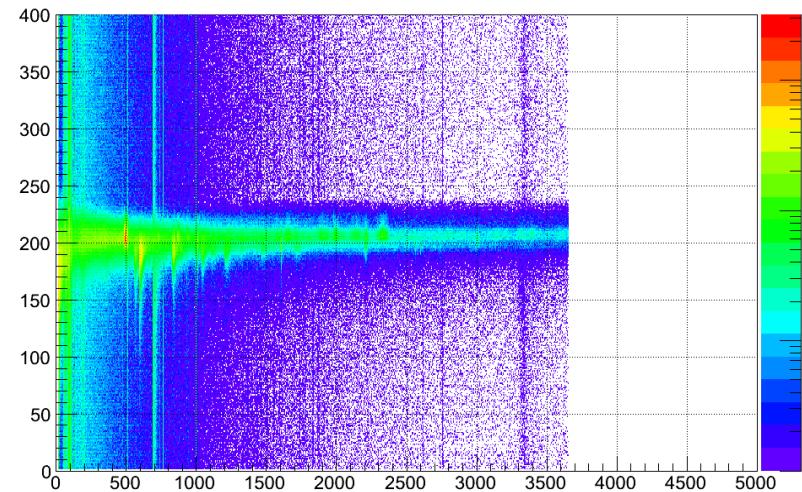


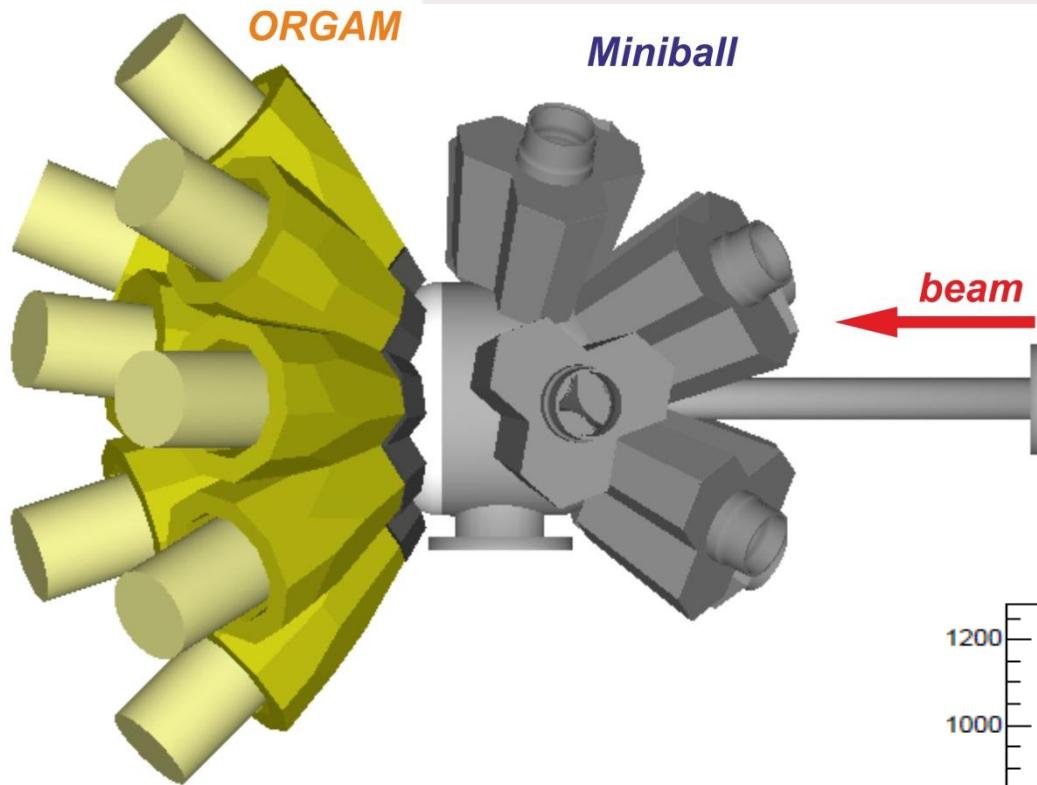
Intense focused monoenergetic neutron source:
 $10^7 \text{ n/s/steradian}$



First LICORNE – ORGAM coupling:
January 2014

- Isomer tagging of fission partners
- too many FE reactions on Carbone
- need H₂ gas target for neutrons
- MINORCA accepted experiment



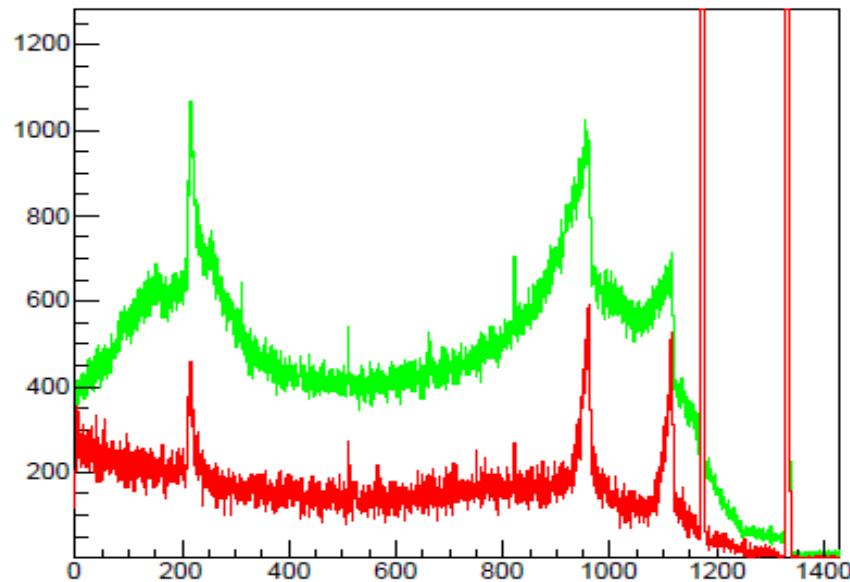


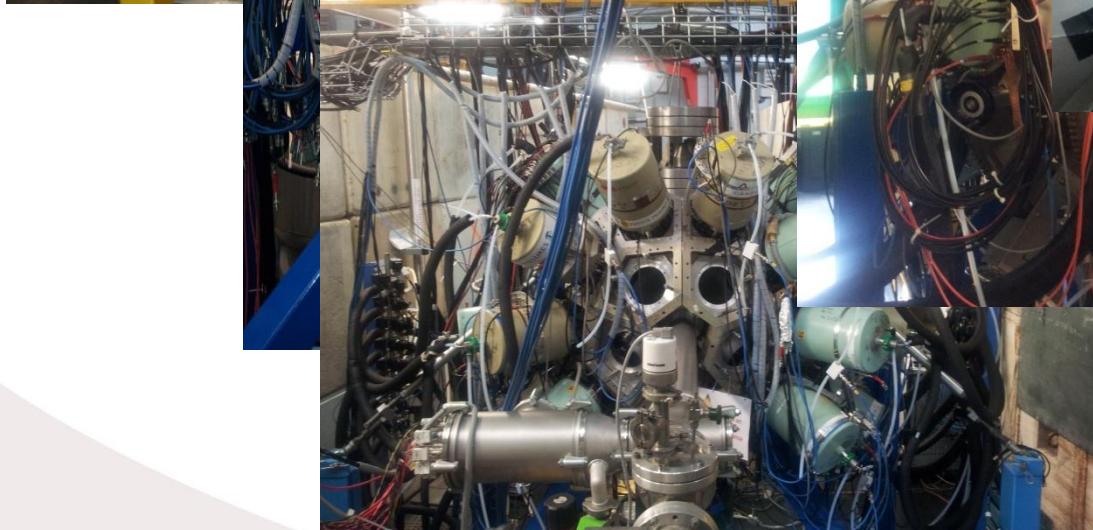
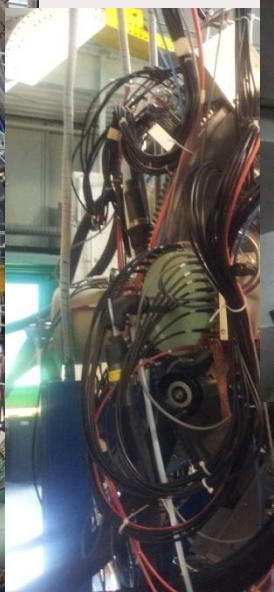
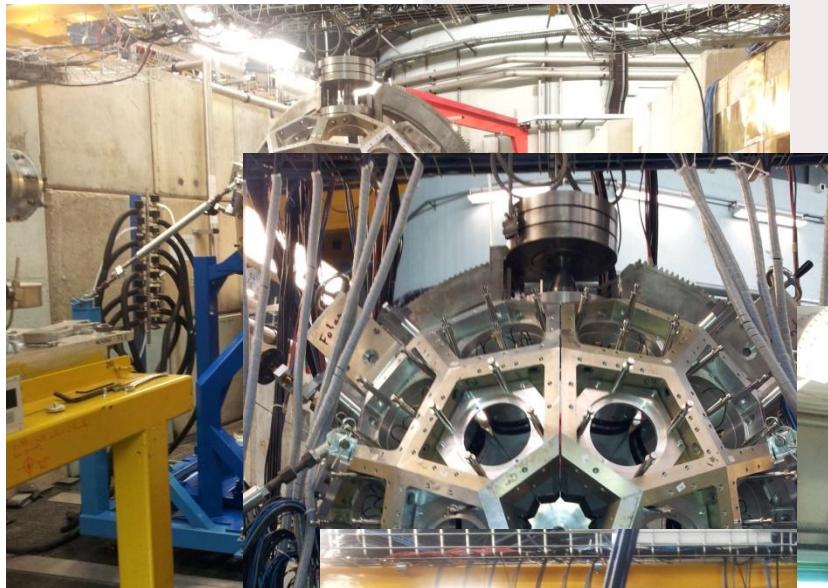
Efficiency at 1332 keV:
6.3% - Miniball
1.8% - 15 ORGAM Ge's
TOTAL → 8.1%

15 ORGAM ***anti-Compton shielded***
 Ge detectors x 0.1%

8 Miniball triple cluster detectors
 at @ 14 cm from target ***with addback***

MiniballClusterAddback





12 ORGAM AC HPGe x 0.1%
8 Miniball triple cluster at ~14 cm from target
7.3% efficiency @ 1.33 MeV

MINORCA Accepted Proposals

Total number of MINORCA requested UTs: **232** (about 80 days)

1. Single-particle structure in the second minimum. Search for high-K bands above fission isomers. (G. Georgiev - CSNSM) → **45 UTs**
2. *g* factor measurements of short-lived states in the Mg isotopes towards the Island of Inversion: ^{26}Mg and ^{28}Mg (G. Georgiev - CSNSM) → **18 UTs**
3. Shape coexistence in ^{74}Se studied through complete low-spin spectroscopy after Coulomb excitation (M. ZIELINSKA - SPhN) → **21 UTs**
4. Measurement of octupole collectivity in Nd, Sm and Gd nuclei using Coulomb excitation (P.A. Butler - Univ. of Liverpool) → **21 UTs**
5. Spectroscopy of the neutron-rich fission fragments produced in the $^{238}\text{U}(\text{n},\text{f})$ reaction (J. Wilson - IPN) → **45 UTs**
6. Evaluation of the Angular Momentum Dependence of the ^{96}Mo γ Strength Function (B. Goldblum - Univ of California) → **22 UTs**
7. Search for X(5) symmetry in ^{78}Sr nucleus (K. Gladnishki - Univ of Sofia) - **21 UTs**
8. Lifetime Measurement of ^{100}Ru : A possible candidate for the E(5) critical point symmetry (T. Konstantinopoulos - CSNSM) - **18 UTs**
9. Lifetime measurements in ^{113}Te : Determining Optimal effective charges approaching the N=Z=50 doubly-magic shell closure. (D.M. Cullen - Univ of Manchester) - **21 UTs**

MINORCA commissioning May 2014

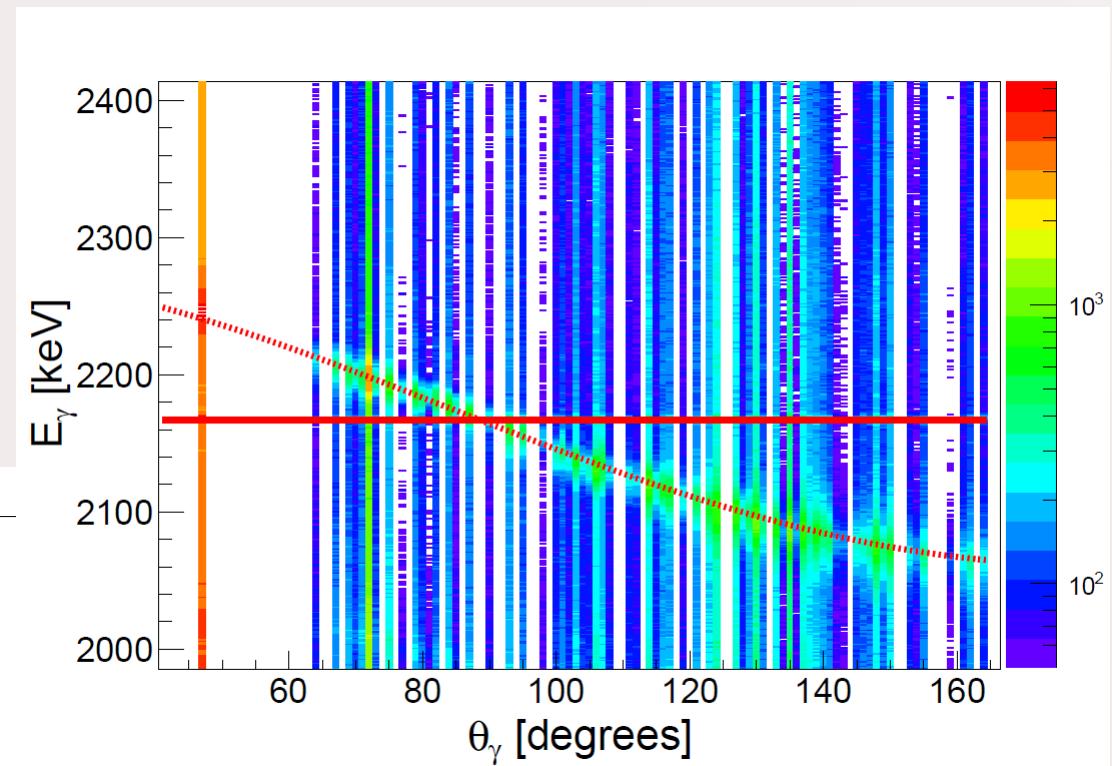
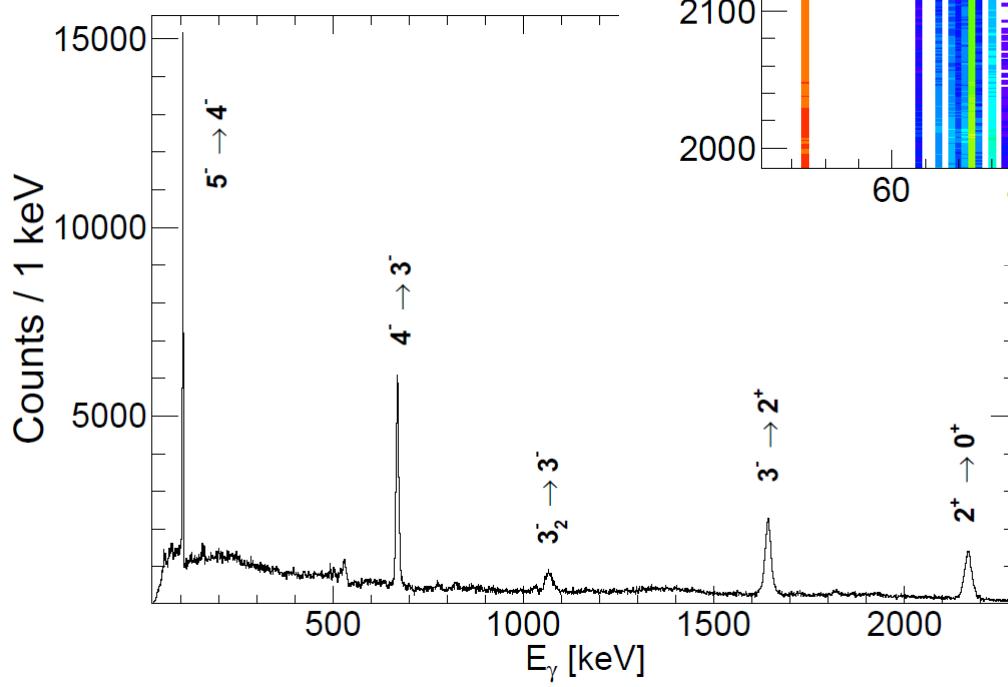
^{37}Cl @ 120 MeV

Target: 1.9 mg/cm² CD2

Reaction: d(^{37}Cl ,n) ^{38}Ar

v/c ~ 5%

Energy lost in target: ~40 MeV



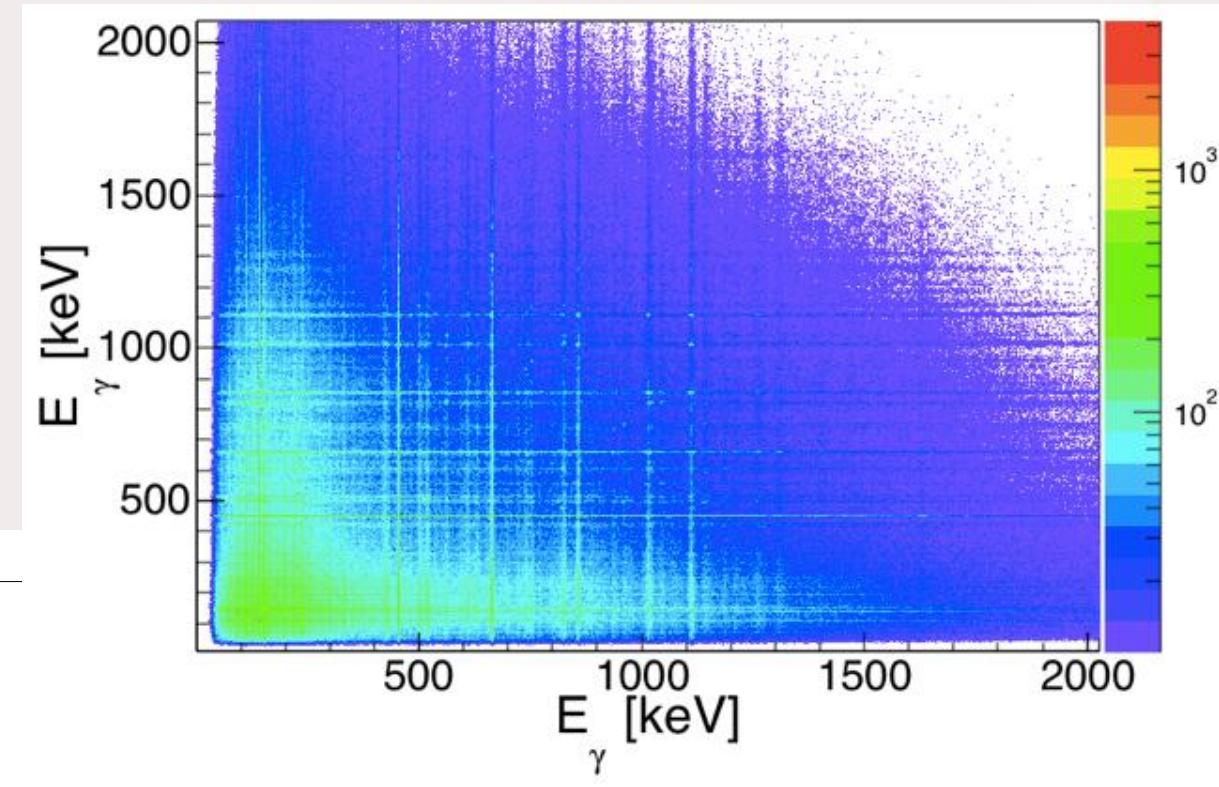
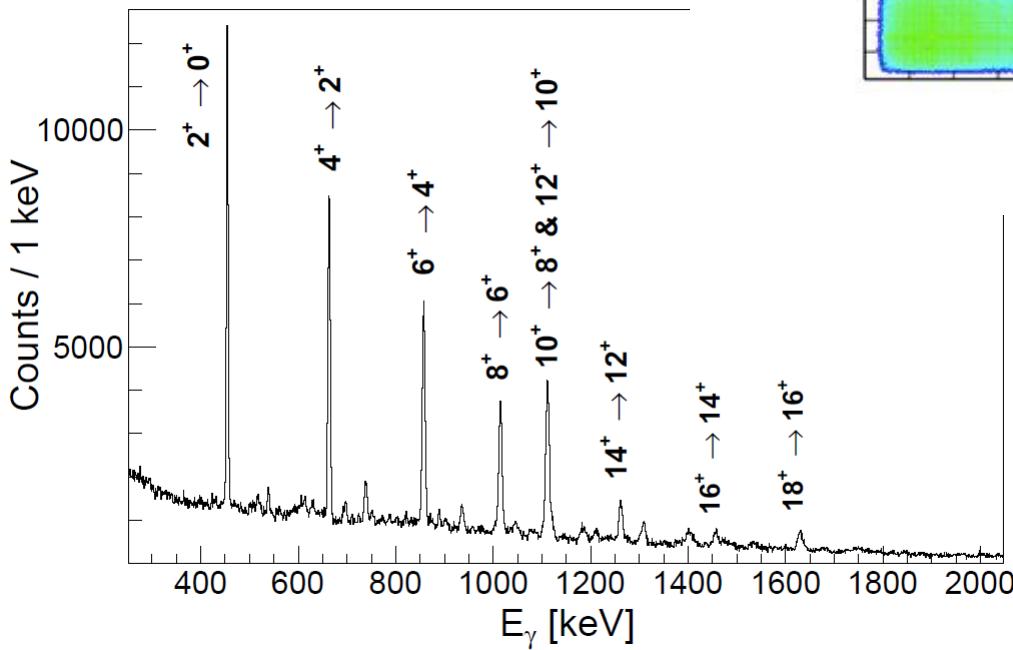
MINORCA commissioning May 2014

37Cl @ 120 MeV

Target: 1.1mg/cm² 45Sc

Reaction: 45Sc(³⁷Cl,a2n)⁷⁸Kr

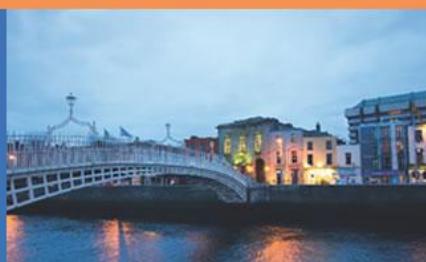
v/c ~ 2.1 %



IOP Institute of Physics

Physics with Large Arrays of Novel Scintillators

15–16 January 2014, Jury's Custom House, Dublin, Ireland



Proposal for a PARIS@IPNO campaign

Prompt γ -rays as a probe of nuclear dynamics with PARIS@IPNO

C. Schmitt¹, I. Matea², J.N. Wilson², O. Dorvaux³, O. Stézowski⁴

¹GANIL, CNRS/IN2P3-CEA/DAM, Boulevard Bécquerel, 14000 Caen

²IPNO, Bât.100, Rue Clemenceau, 91406 Orsay

³IPHC, UDS/CNRS/IN2P3, Rue du Loess, Strasbourg

⁴IPNL, UCBL/CNRS/IN2P3, Rue Fermi, Lyon

HPGe detectors also available for high resolution gamma measurement in complement to PARIS

2 days Workshop at IPN in Autumn with call for Lols in preparation

Campaign possible in the second half of 2015

Many Thanks to:

- IPN, FR :** D. Verney, J. Wilson, M. Lebois, G. Mavilla, P. Rosier, A. Gottardo, M. Josselin, D. Suzuki ...
- CSNSM, FR :** G. Georgiev, J. Ljungval, A. Goasduff, T. Konstantinopoulos, S. Cabaret ...
- JINR, RU :** E. Kozulin
- IKP, DE :** N. Warr, H. Hess, B. Siebeck ...
- ANU, AU :** A. Stuchbery
- Istanbul University, TR :** A. Kusoglu
- CNS, JP :** E. Ideguchi, S. Go

and many others ...

Incomplete Fusion Reactions (ICF) for Gamma Spectroscopy



Nuclear Spin Orientation in ICF reactions

