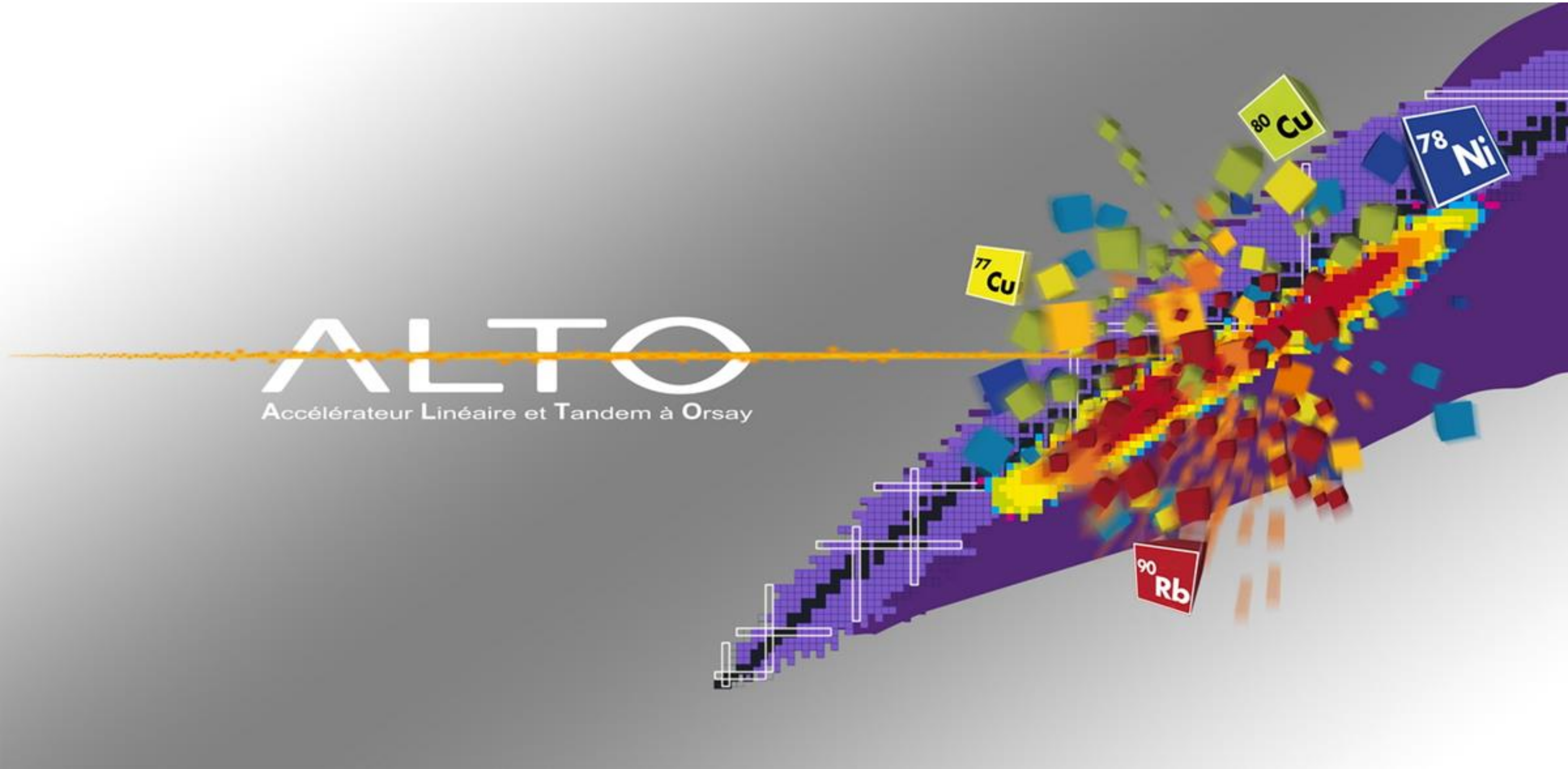
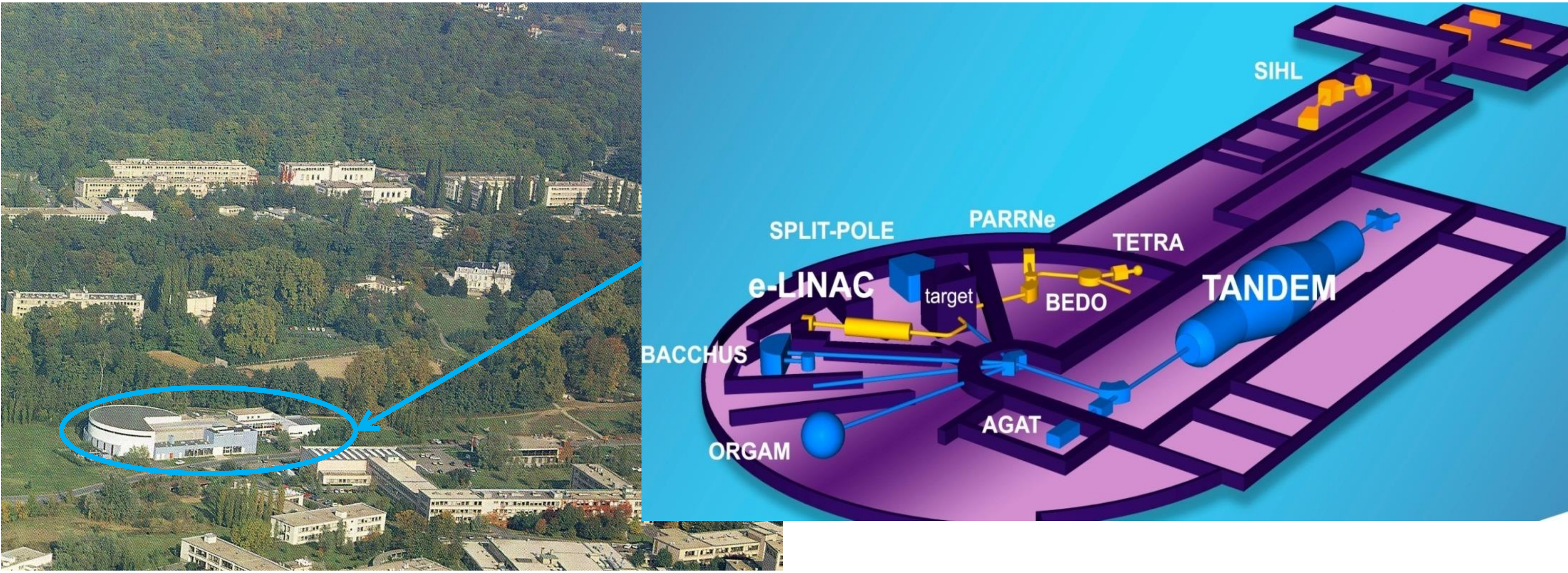
ALTO - status, recent results and near-future plans

Georgi Georgiev,
CSNSM, Orsay, France



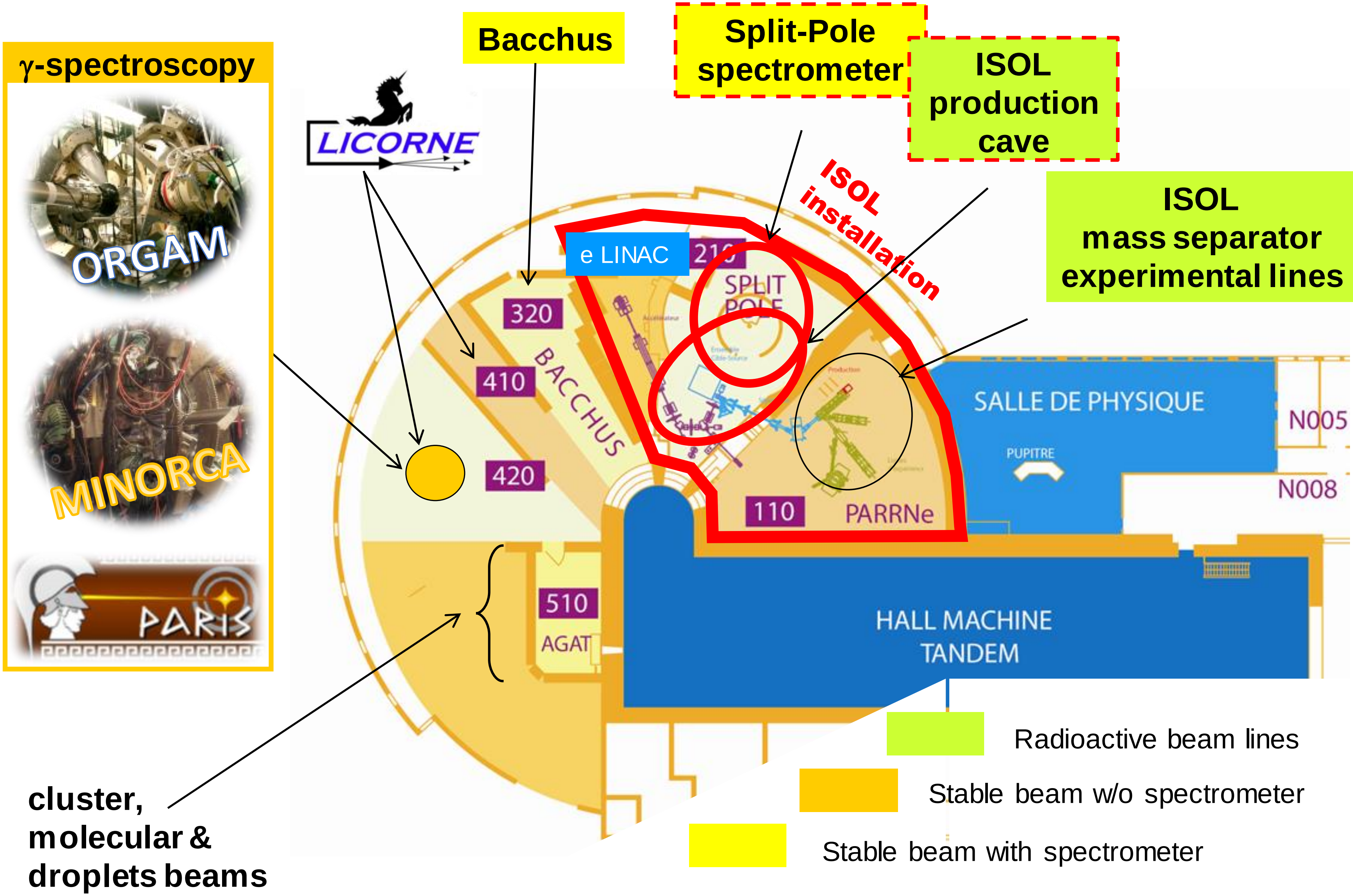
The ALTO facility



	2013	2014	2015*
Users	200	135	+150
Beam-time	2983 h	2297 h	+3000 h
	373 UT	287 UT	+375 UT

ALTO TNA within ENSAR and ENSAR2

Experimental areas

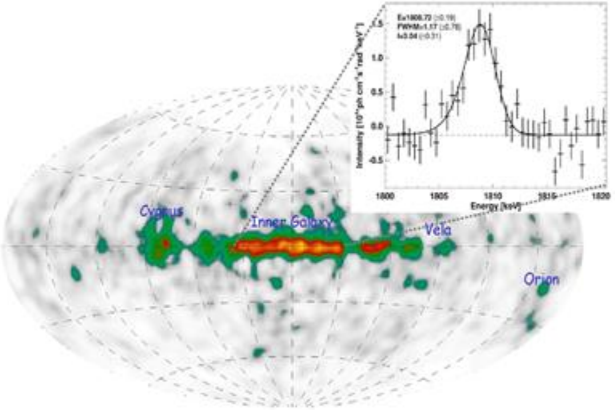


^{26}Al nucleosynthesis in massive stars

N. de Séréville & A. M. Laird N-SI-36

Astrophysical motivation:

- Gamma-ray emission associated with ^{26}Al observed in our galaxy.
- ^{26}Mg coming from ^{26}Al decay observed in presolar grains
- ^{26}Al yields depends strongly on reactions ^{26}Al(n,p)^{26}Mg and ^{26}Al(n,α)^{23}Na
- Need for better ^{27}Al spectroscopy (E_R, Jπ, Γ_p, Γ_α) above neutron threshold (S_n = 13 MeV)

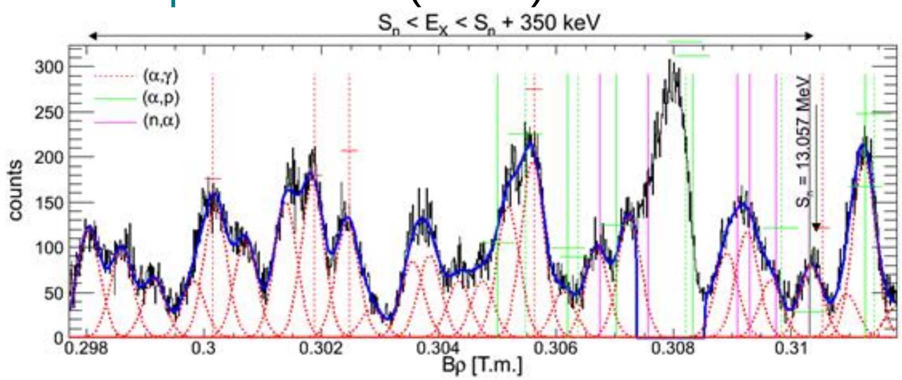


Credit: MPE Garching / R. Diehl

^{26}Al(n,p)^{26}Mg and ^{26}Al(n,α)^{23}Na in massive star

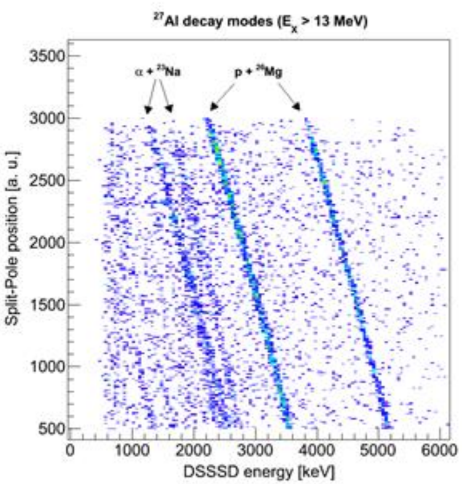
→ Populating resonances with the ^{27}Al(p,p')^{27}Al* reaction

Split-Pole spectrometer (ALTO) + DSSSDs in reaction chamber



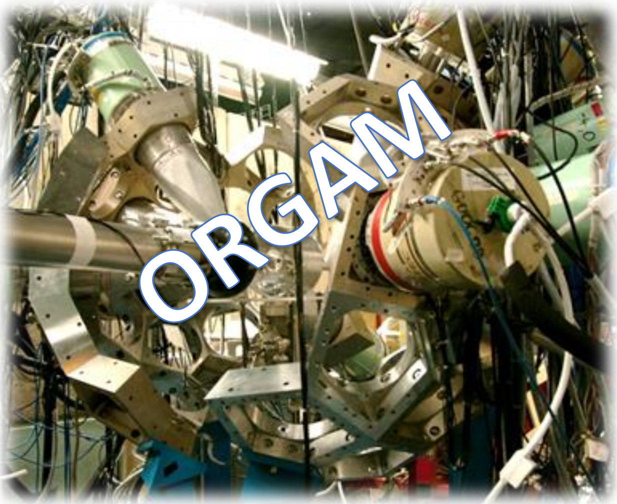
30 new states above neutron threshold in ^{27}Al

S. Benamara, N. de Séréville et al, PRC 89, 065805 (2014)

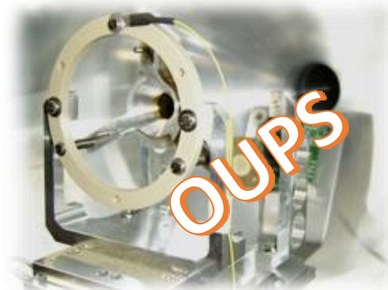


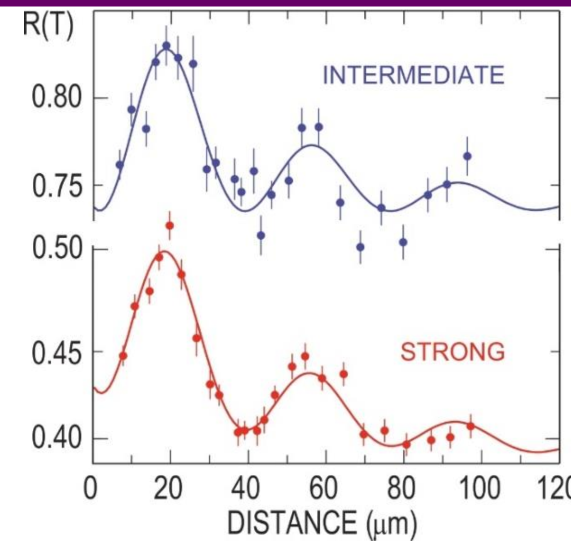
Adsley et al. to be submitted

TDRIV on H-like ions: ^{24}Mg



beam: ^{24}Mg @120 MeV (5 MeV/u)
target: 2.4 mg/cm^2 ^{93}Nb
reset Foil: 1.7 mg/cm^2 ^{197}Au

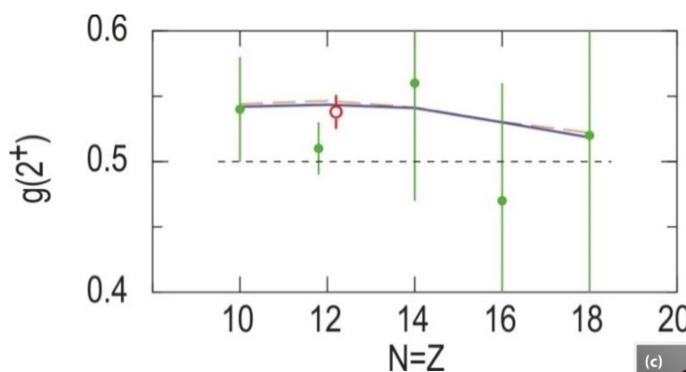




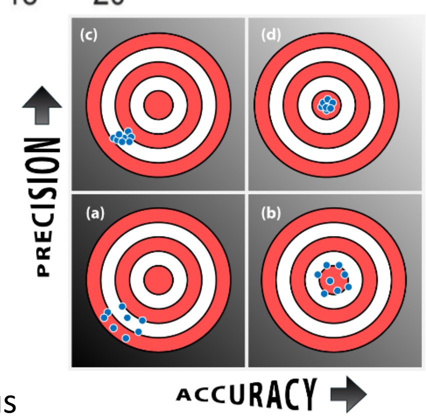
Previous measurement:
$|g(2^+)| = 0.51$ (2)
R.F. Horstman et al., NPA 248, 291 (1975)

Our result:
$|g(2^+)| = 0.538$ (13)

A. Kusoglu et al. PRL 114, 062501 (2015)

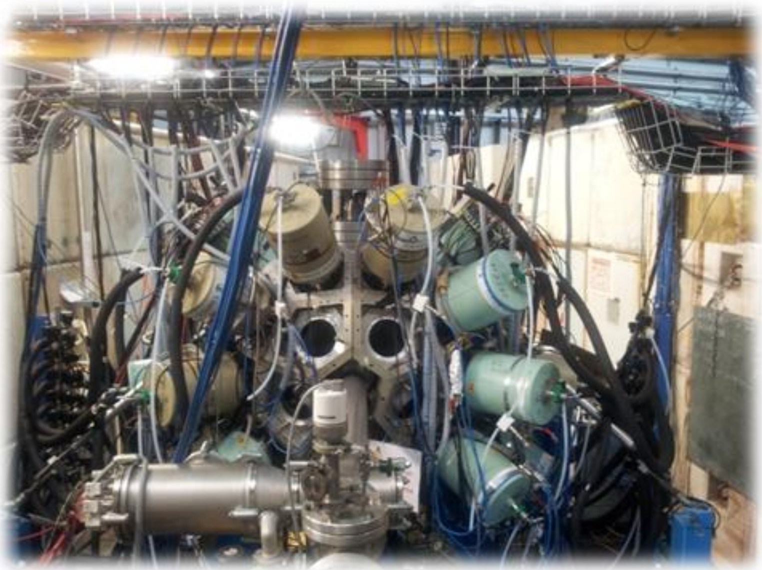


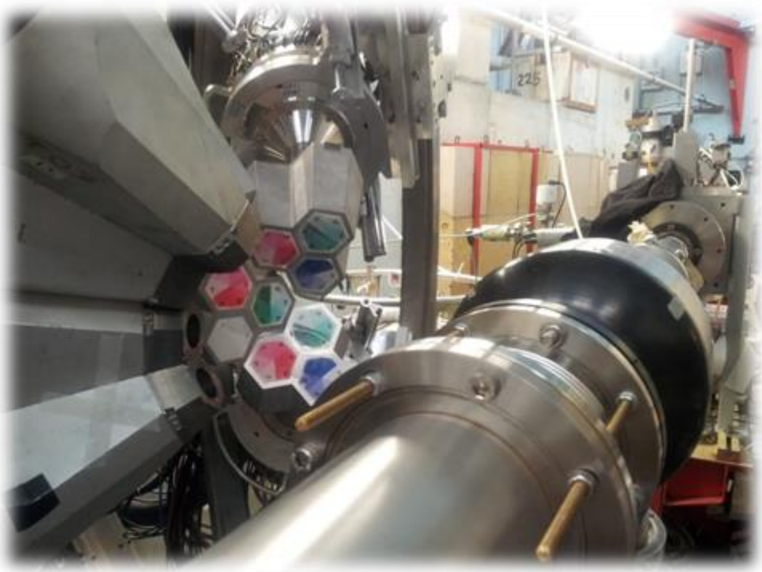
High-accuracy g-factor measurements are essential for constraining the theories!



Minorca in Orsay?

MINORCA in Orsay (June 2014 – March 2015)





12 ORGAM *CS* HPGe x 0.1%

8 Miniball TC at ~14 cm from target

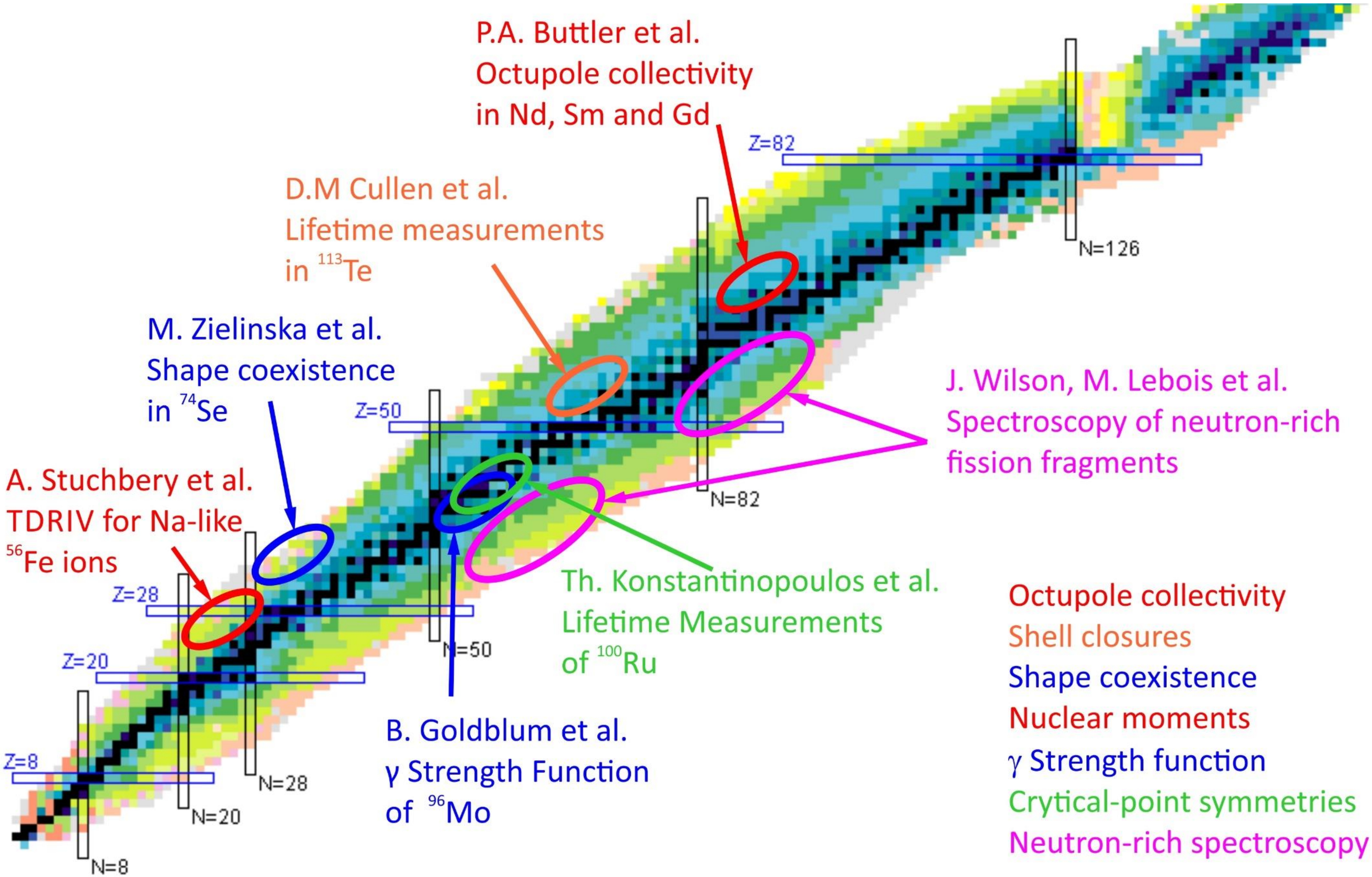
7.3% efficiency @ 1.33 MeV

ancillary detectors:

- **Orsay plunger (OUPS)**
- **particle detector**
- **DSSD**

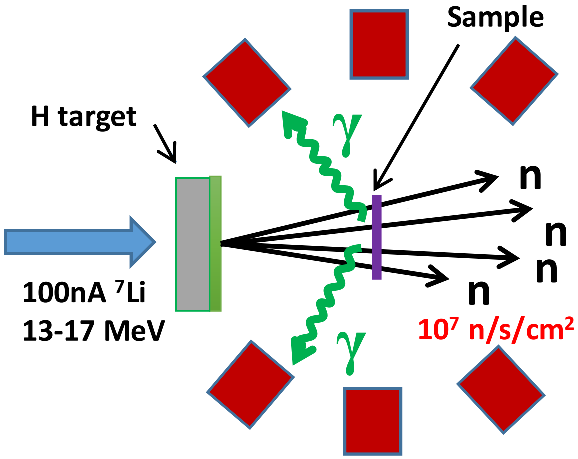
Campaign managers: I. Matea and G.G.

MINORCA physics cases



Campaign managers: I. Matea and G.G.

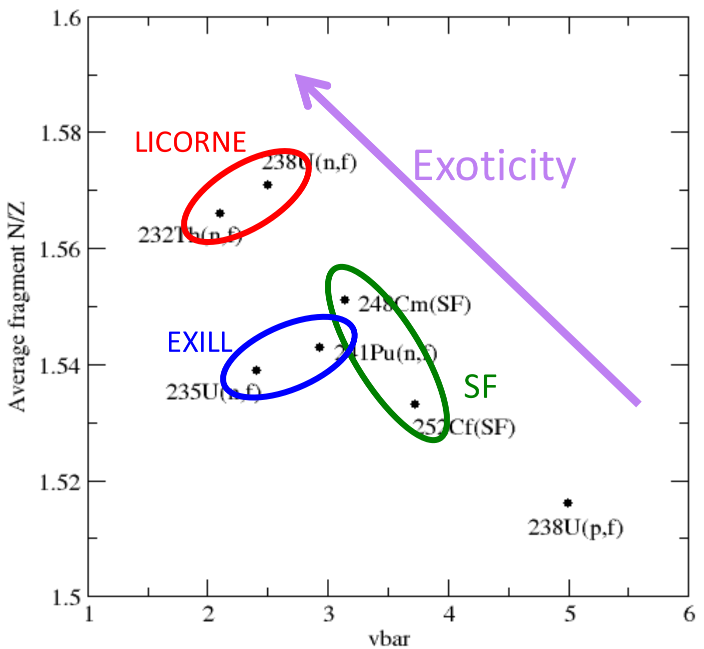
Lithium Inverse Cinematics ORsay NEutron source

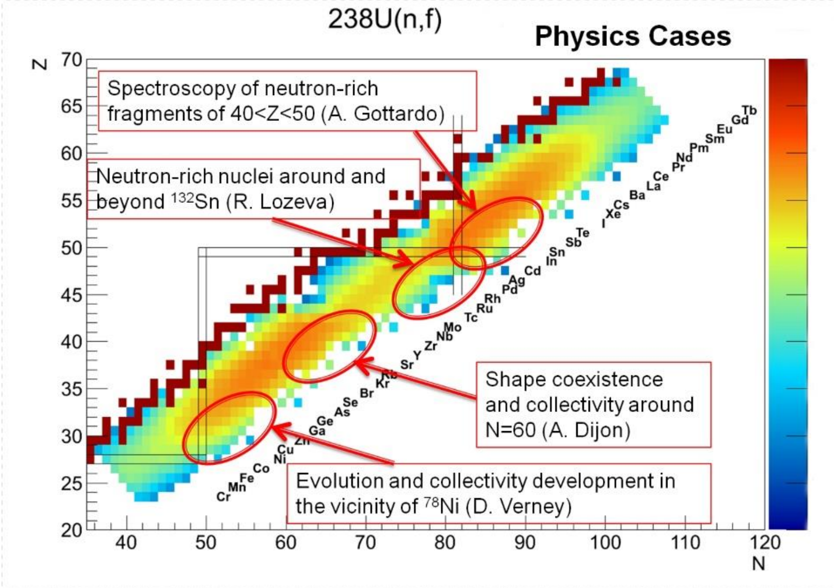


LICORNE +MINORCA

n-induced fission of ^{238}U

TIPS – tagging of isomer partners

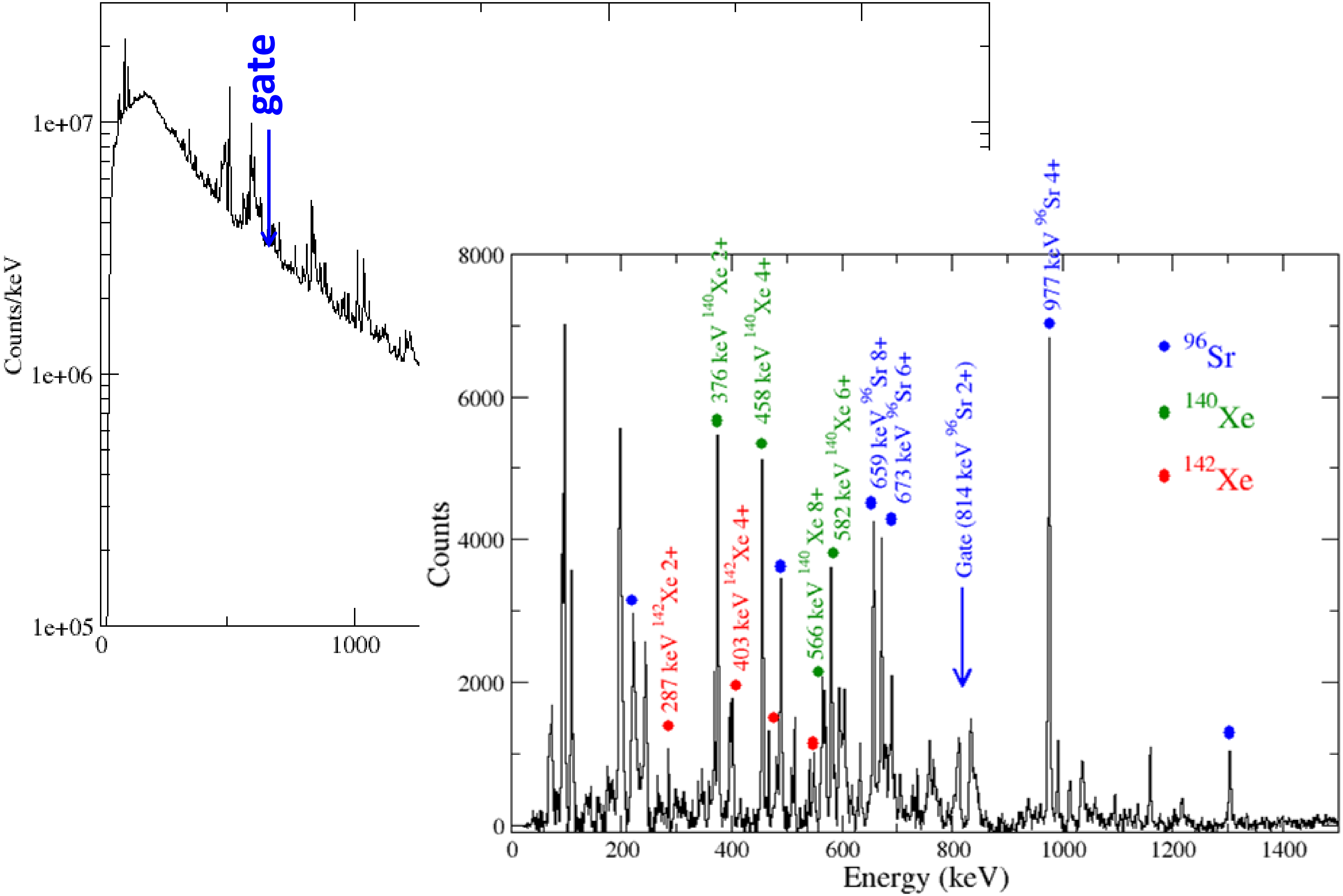




J. Wilson, M. Lebois *et al.*

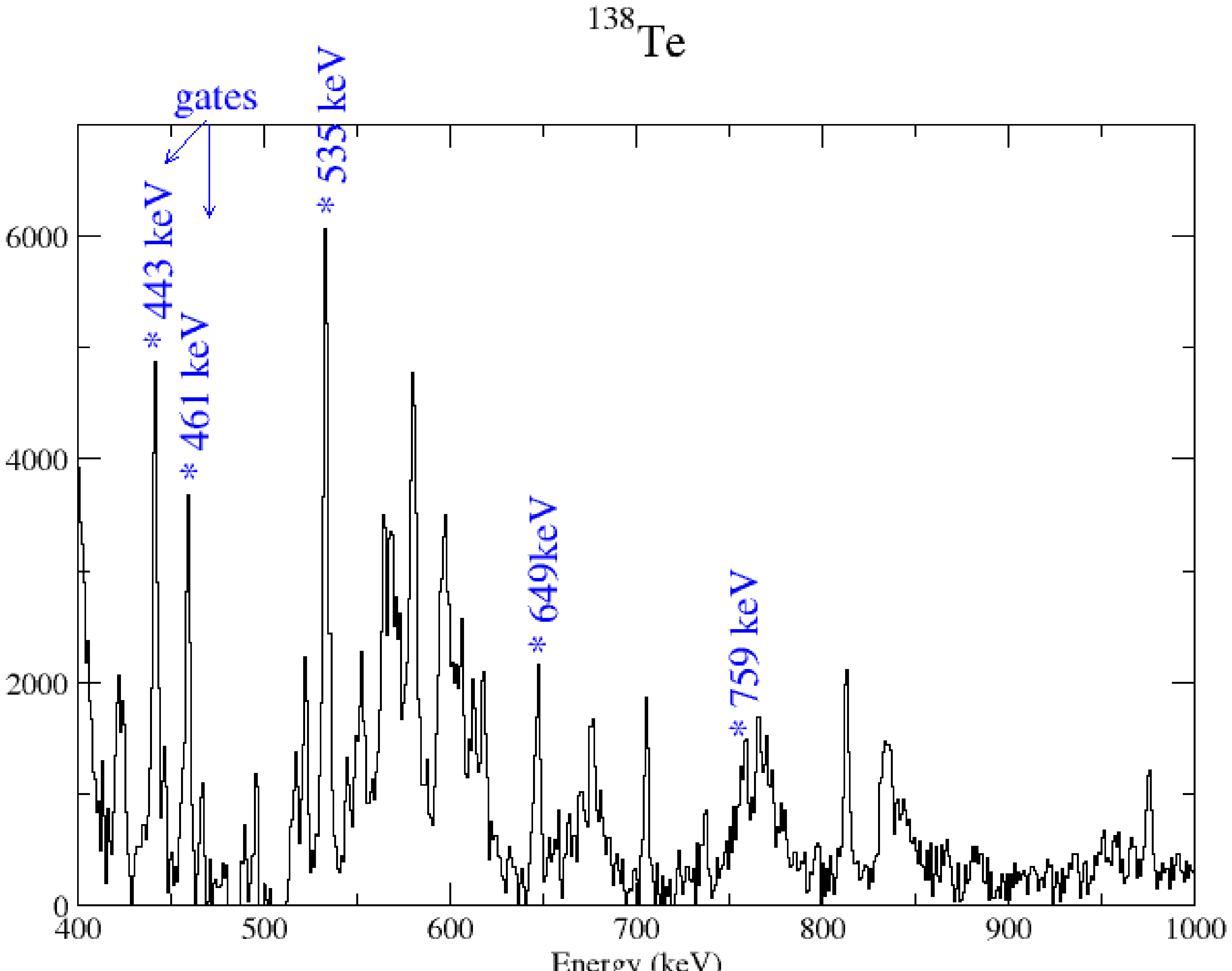
Testing ground for NFS@SPIRAL2

Does it work?



gate
Counts/keV
1e+07
1e+06
1e+05
0
1000
Counts
Energy (keV)
287 keV 142Xe 2+
376 keV 140Xe 2+
403 keV 142Xe 4+
458 keV 140Xe 4+
566 keV 140Xe 8+
582 keV 140Xe 6+
659 keV 96Sr 8+
673 keV 96Sr 6+
Gate (814 keV 96Sr 2+)
977 keV 96Sr 4+
96Sr
140Xe
142Xe

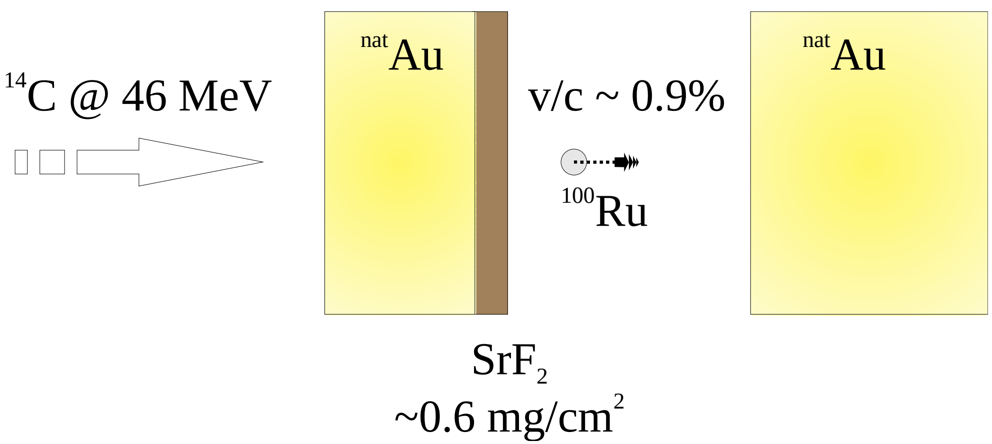
The most exotic (so far)



Is ^{100}Ru an E(5) nucleus?

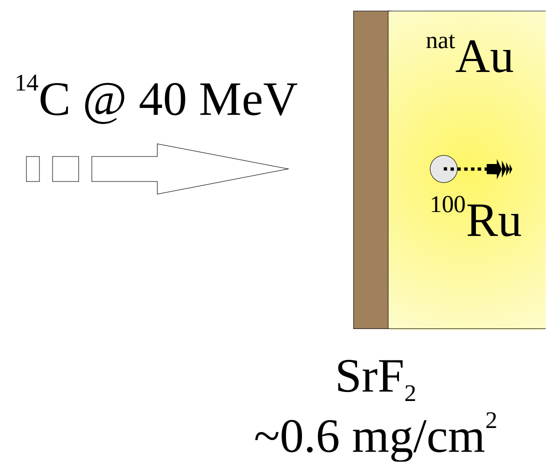
- ^{88}Sr(^{14}C, 2n)^{100}Ru : 200 mbarn @ 42 MeV
- ^{14}C beam @ <1.5 pnA
- MINORCA array

Recoil Distance Doppler Shift measurement:



* 12 plunger distances from 1 um to 1 mm

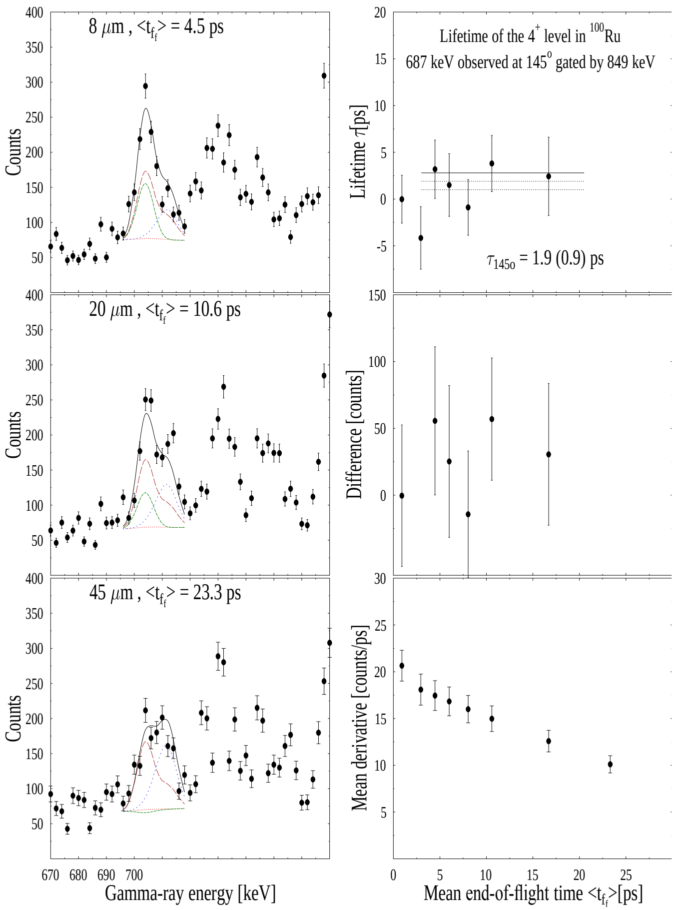
Doppler Shift Attenuation measurement:

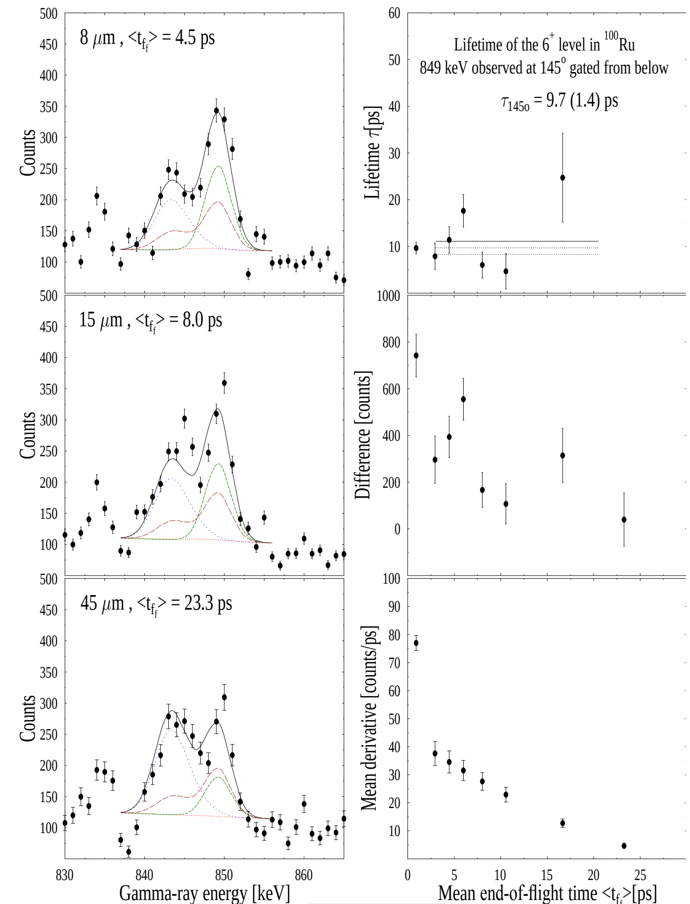


6.5*10^8 γ–γ coincidences collected

T. Konstantinopoulos *et al.*

RDDS: 4^+ and 6^+





$\tau(4^+)$ = 3.4 (10) ps

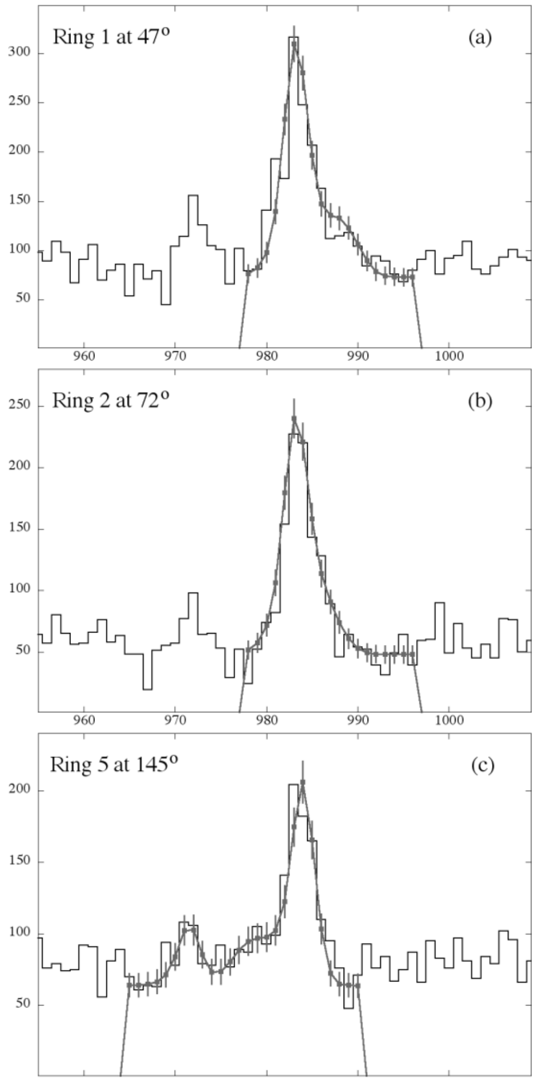
$T(6^+)$ = 9.4 (15) ps

*Monte Carlo simulation performed to fit the lineshapes

T. Konstantinopoulos *et al.*

DSAM for the 8^+

Fit with DSAM code for
3 different detector angles



I_i^π	E_x (keV)	τ (ps)	$I_i^\pi \rightarrow I_f^\pi$	E_γ (keV)	B(E2) (W.u.)
2_1^+	539.510	18.1 (2)	$2_1^+ \rightarrow 0_1^+$	539.509	35.6 (5)
4_1^+	1226.465	[illegible]	$4_1^+ \rightarrow 2_1^+$	686.972	[illegible]
6_1^+	2075.674	[illegible]	$6_1^+ \rightarrow 4_1^+$	849.20	[illegible]
8_1^+	3060.068	[illegible]	$8_1^+ \rightarrow 6_1^+$	984.45	[illegible]

Preliminary!

T. Konstantinopoulos *et al.*

ALTO – radioactive beams from photofission

ALTO – RIB production

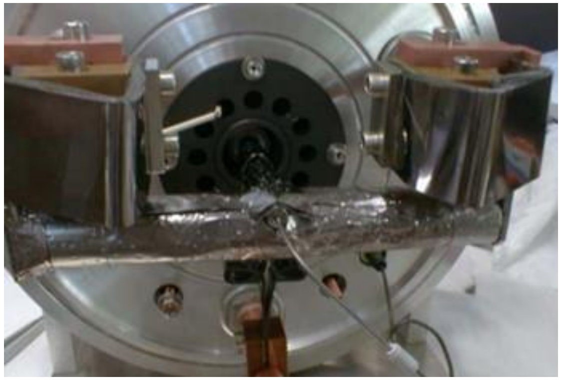
First operational RIB facility based on photo-fission

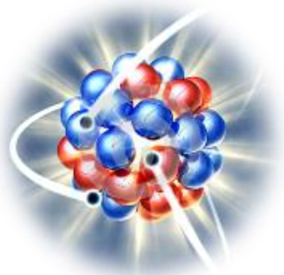
→populating the GDR of ^{238}U

standard ISOLDE target

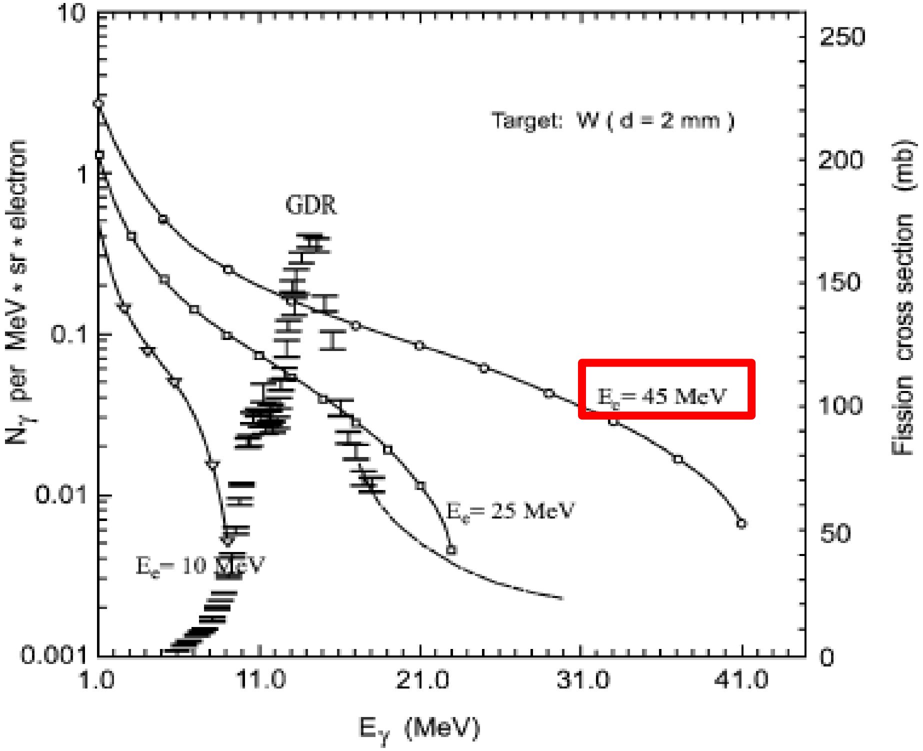
∅ = 14 mm; L = 140 mm

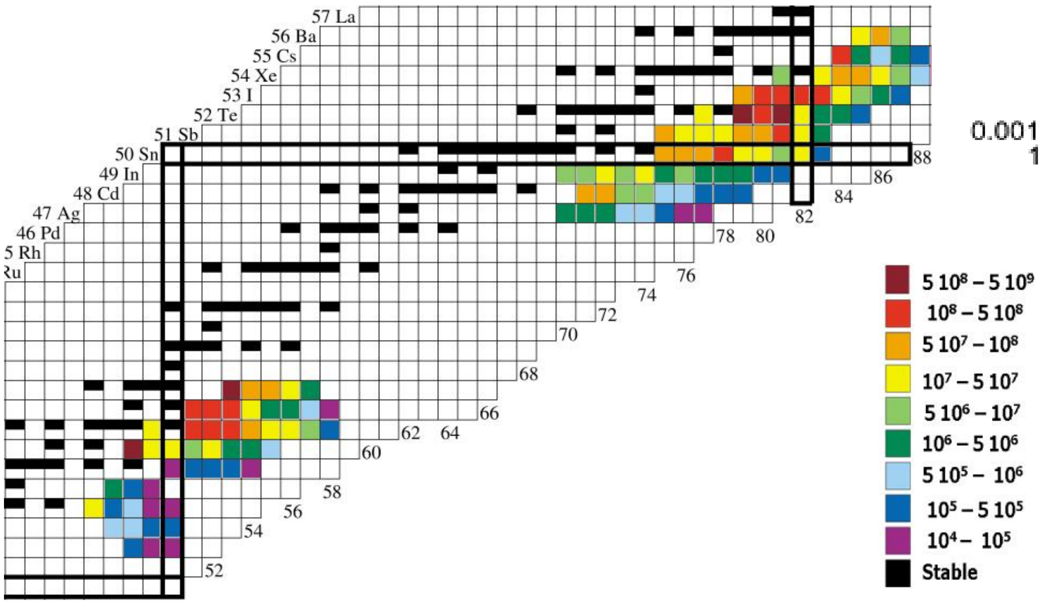
ρ = 3.2 g/cm^3; T ≤ 2100° C





Y. Oganessian *et al.*, NPA 701 (2002) 87c





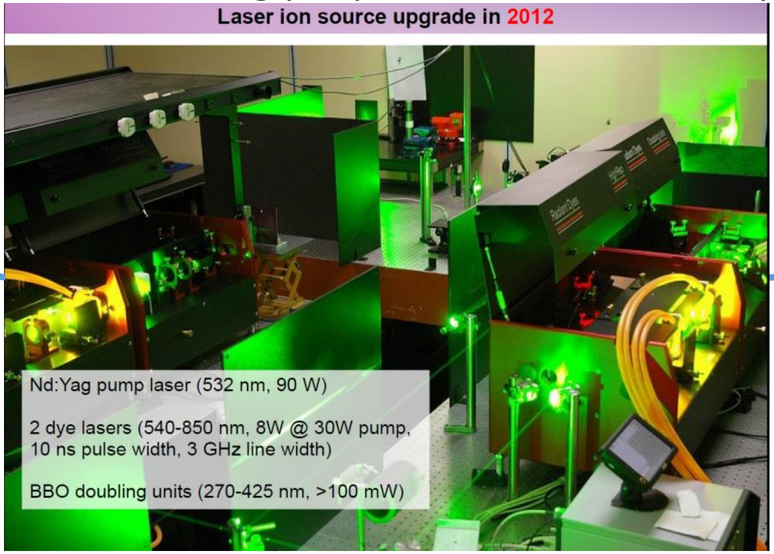
→ Yields for 10 μA, 50 MeV e^- beam

Rialto: Resonant laser ionisation for beam selectivity

S. Franchoo et al.

The variety of the physics program at ALTO strongly depends on RIB availability, intensity and purity

LASER ION SOURCE

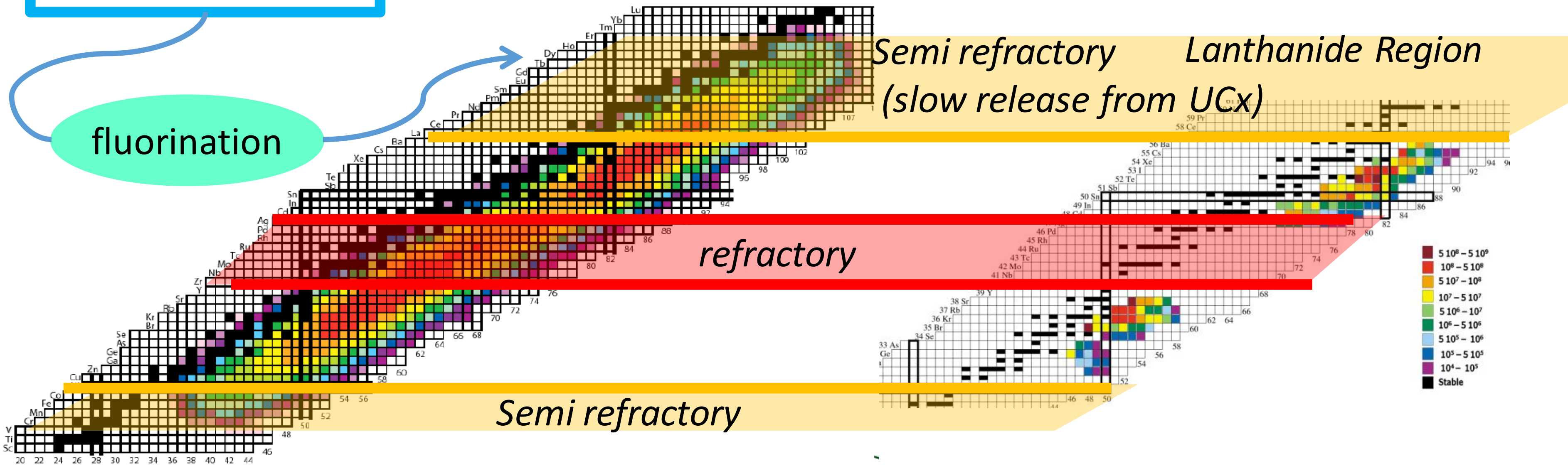


efficiency, Z-selectivity improvement

first successfully laser ionized beam Phys. Rev. C 88, 047301 (2013)

IN-TIS CHIMISTRY

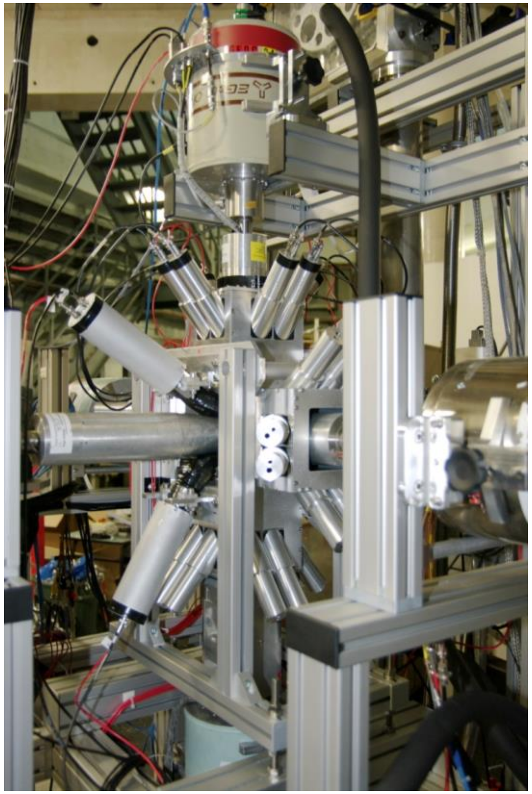
fluorination



Nuclear structure in β-decay

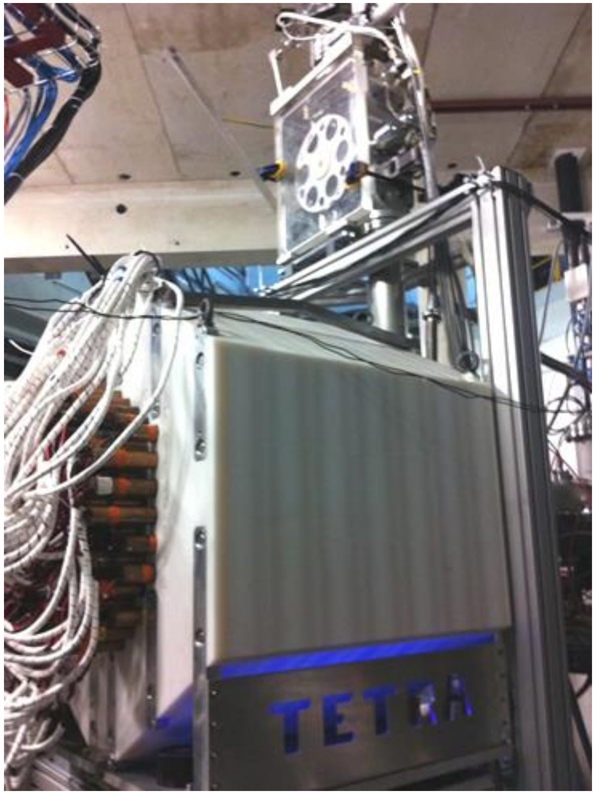
D. Verney et al.

BEDO setup



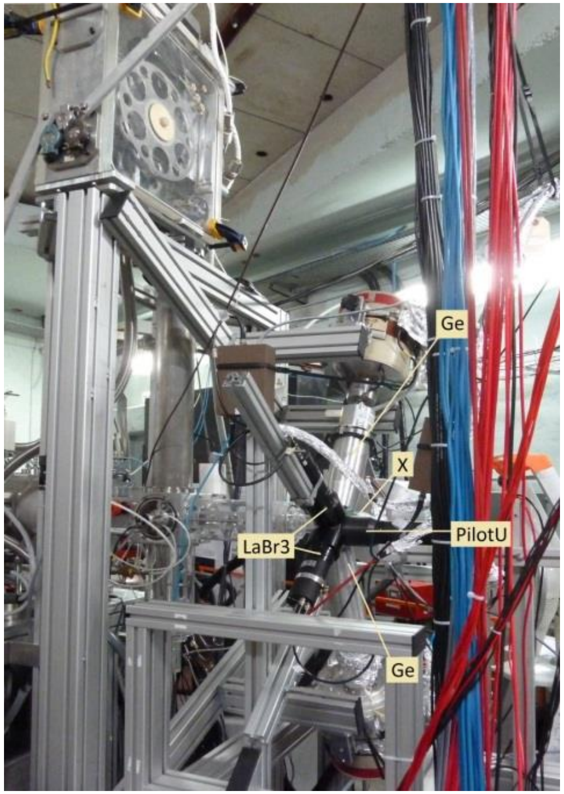
up to 5 Ge detectors (ε = 5-6%)
4π β trigger

neutron detection
TETRA



80 ^{3}He tubes $\varepsilon(^{252}\mathrm{Cf}) = 53\%$
borated polyethylene shielding

fast timing
LaBr3

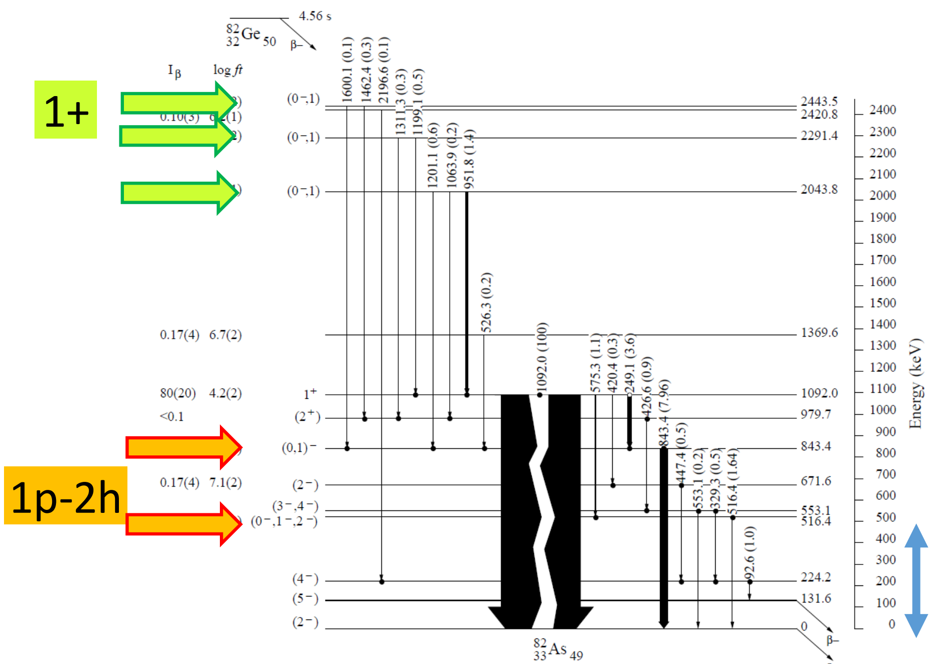


Fast-timing studies using $LaBr_3$ detectors

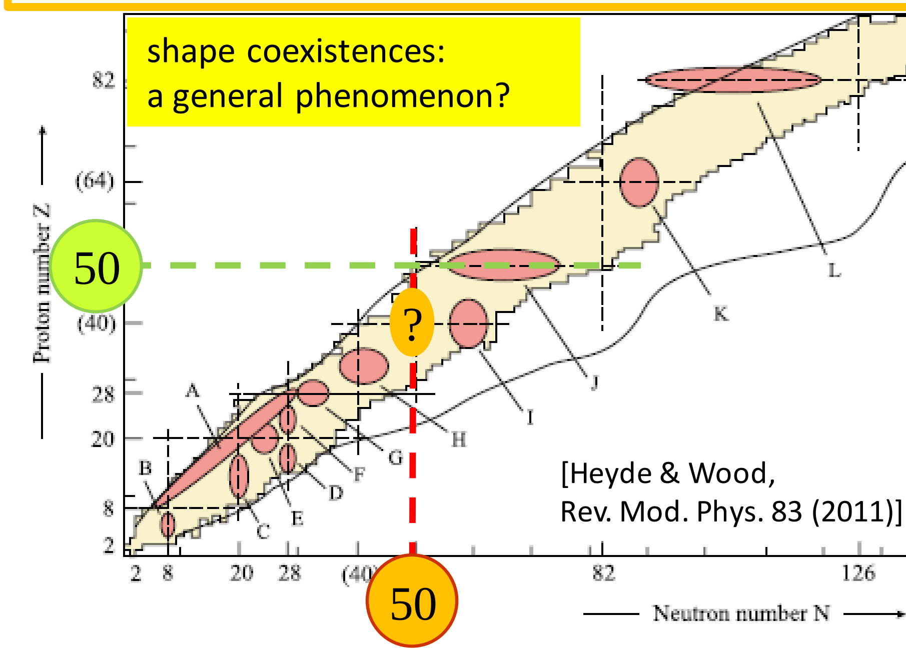
Results from BEDO in β-delayed γ-spectroscopy mode

$^{82}Ge \rightarrow {}^{82}_{33}As_{49}$

(1) problem of the spectral distribution of 1^+ states in the N=50 region
(→ responsible for the half-life of the mother nucleus, possible consequences on the r-process)
interpreted by the theoretical work of Severyukhin… Giai *et al. (influence of couplings to 2p-2h and tensor interaction)*

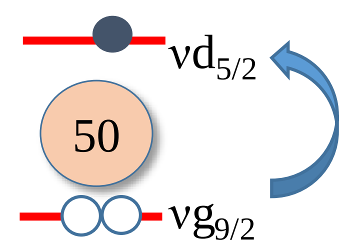


(2) ubiquitous presence of intruder states of the type 1p-2h
→ signature of **shape *coexistence***



Though this phenomenon seems to concern all shell-closure regions: not a single study at N=50 <u>for more than 3 decades</u>! (Z=50 a textbook case)

conclusion: an «island of inversion» is « missed » at N=50 by 0.5 MeV only !

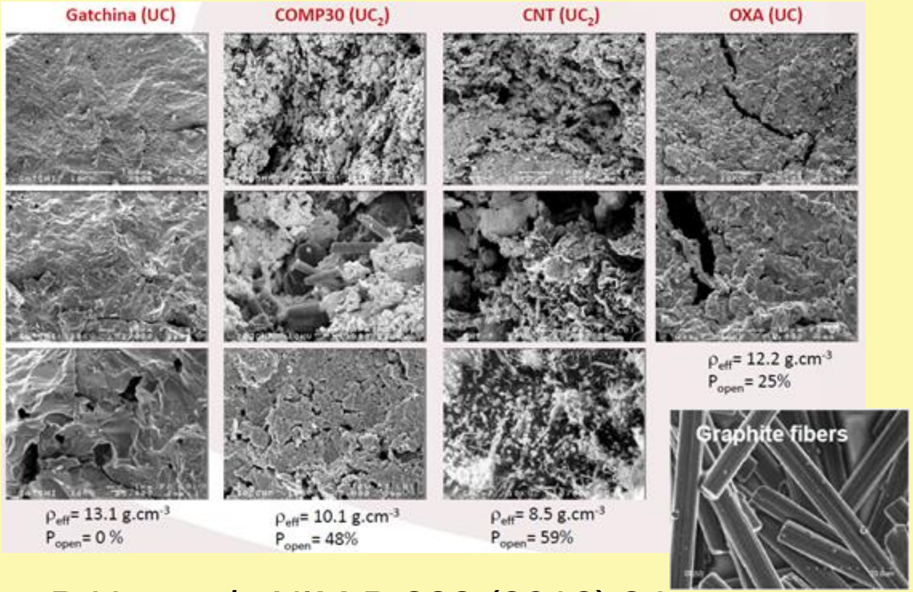


A. Etilé *et al.*, Phys. Rev. C 91, 064317 (2015)

Target and ion source developments

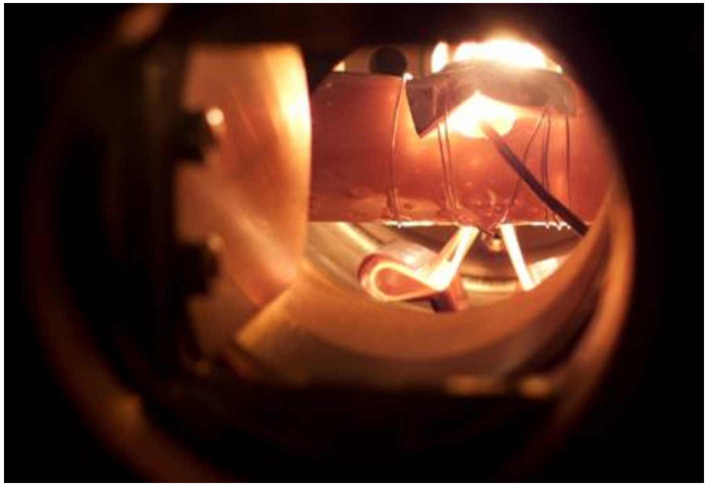
M. Cheikh *et al.*

Control porosity
Reduce pellet thickness



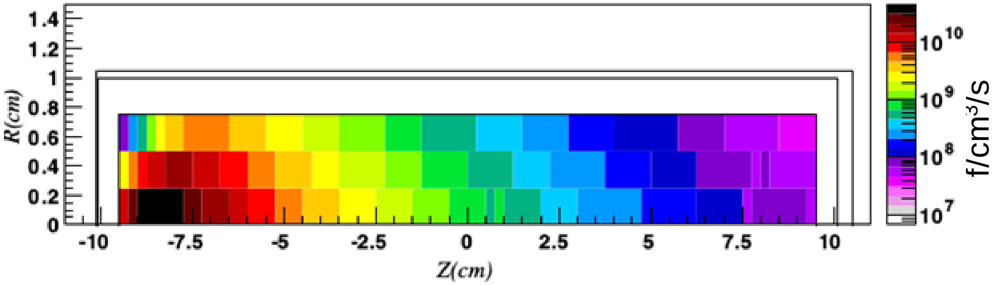
B Hy *et al.*, NIM B 288 (2012) 34
Ensar Actilab:
IPN, Cern, CMMO, Ganil, INFN, Univ Rennes

Accelerate release using molecules:
fluorinated molecular beams



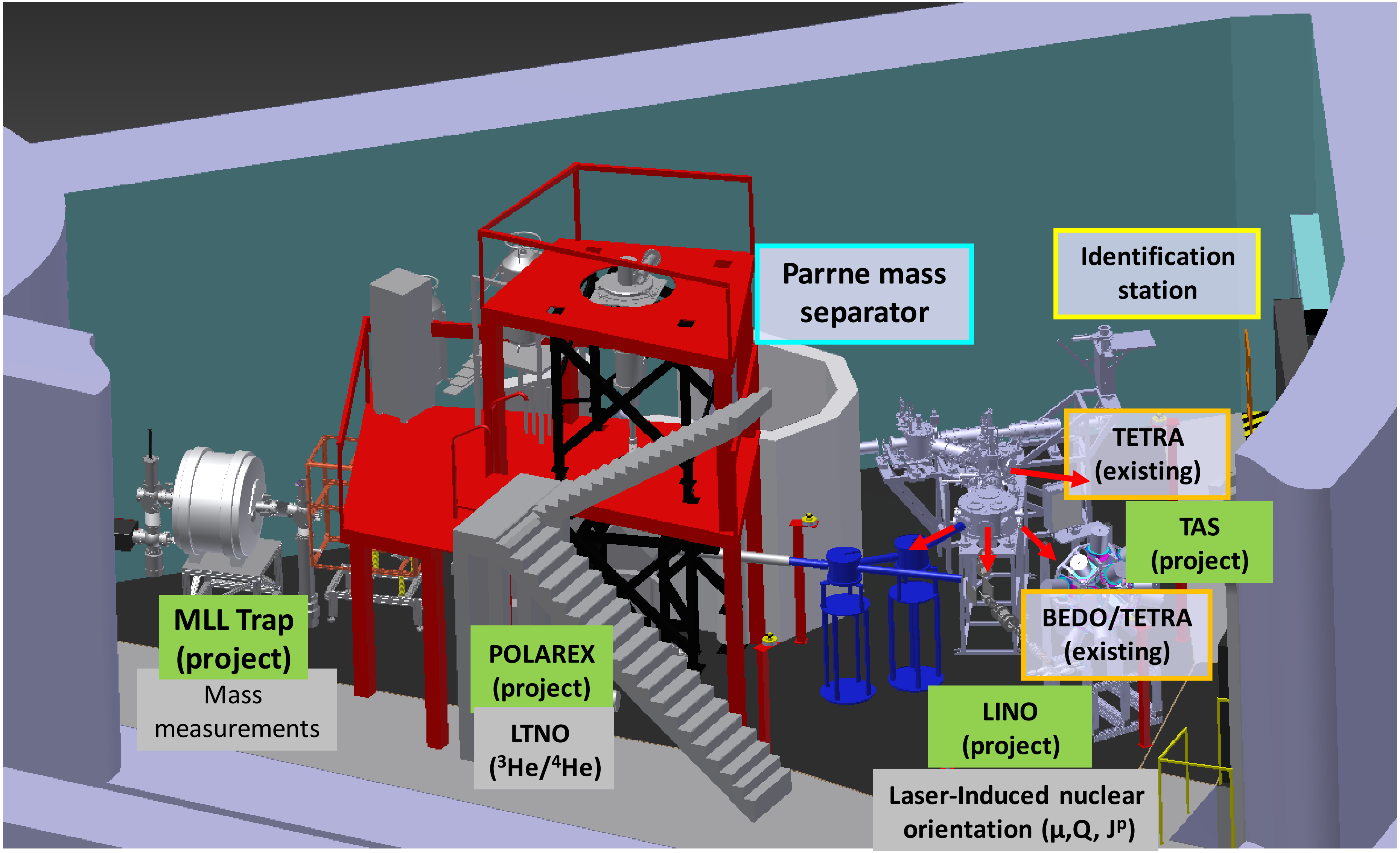
B Roussière *et al.*
IPN, CSNSM, INRNE-Sofia, Tandar-Buenos Aires

target size optimisation →
e- energy deposit in the first 2.65 cm



Fluka fission rate in 3.2 g/cm^3 UC_x target
M Cheikh *et al.*, NIM B 266 (2008)

Present setups and near-future projects



Conclusions

- ALTO – a small-scale facility for stable AND radioactive beams that provides physics results with considerable impact
- Low-energy RIB facility based on photo-fission (first in the word!)
- The R&D and the physics program at ALTO a step towards a next-generation ISOL RIB facility:
  - initiate physics cases, train ISOL physicists, develop instruments and methodologies

- The collaboration is the key towards the success!

Thank you!