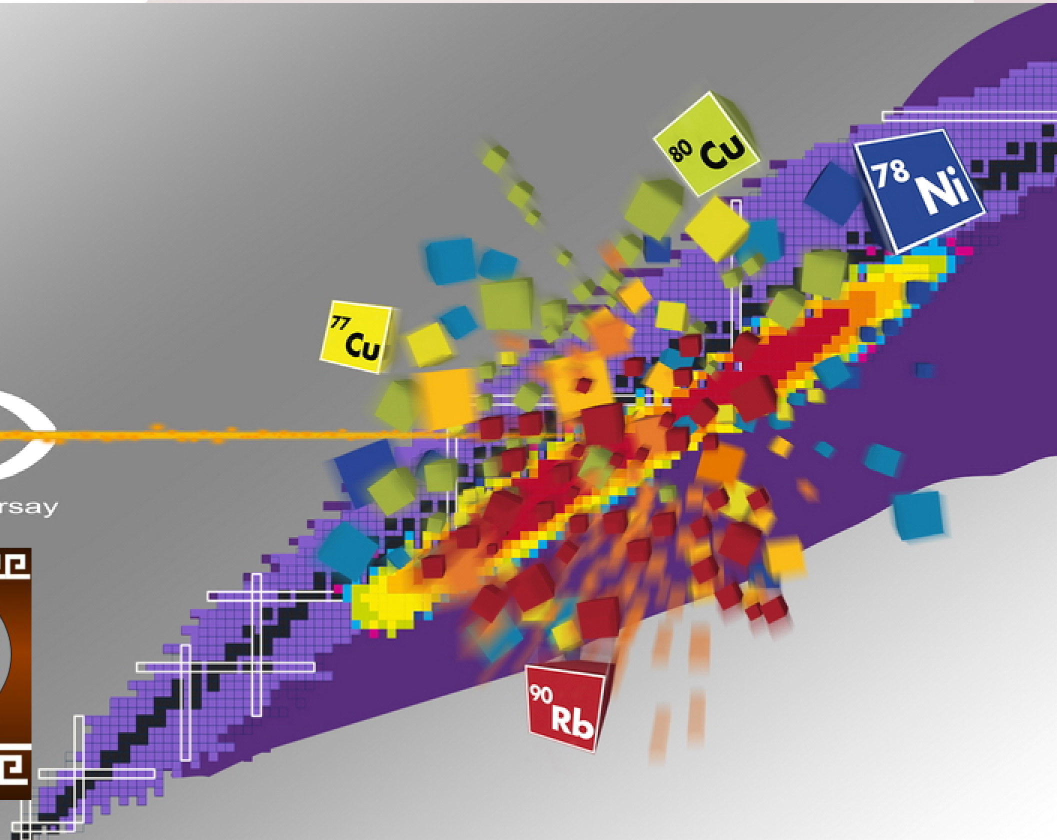
INSTITUT DE PHYSIQUE NUCLÉAIRE
ORSAY

Opportunities for PARIS at ALTO facility

ALTO
Accélérateur Linéaire et Tandem à Orsay

PARIS



ALTO Facility (for PARIS …)

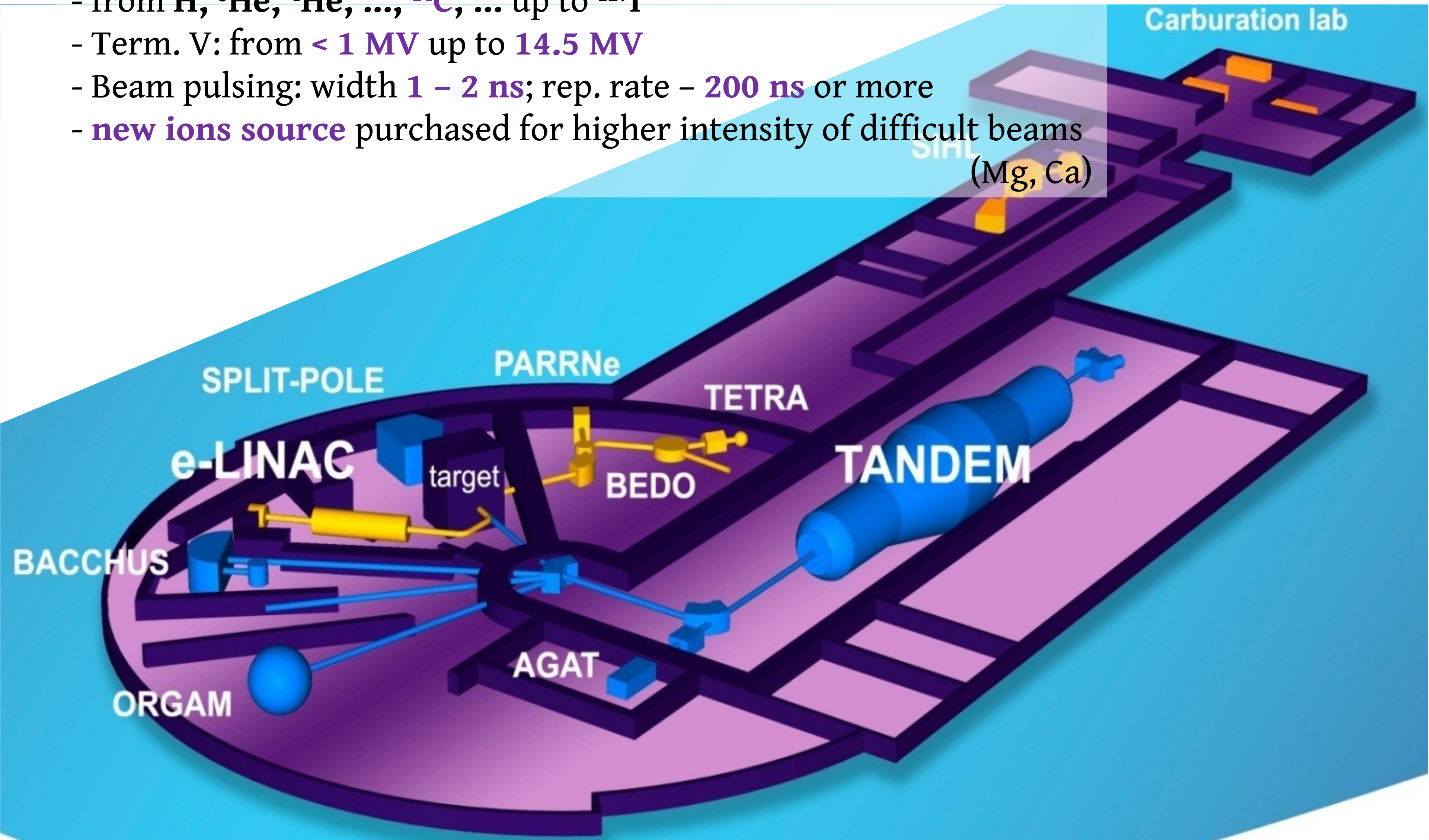
and

PDR and beta-decay

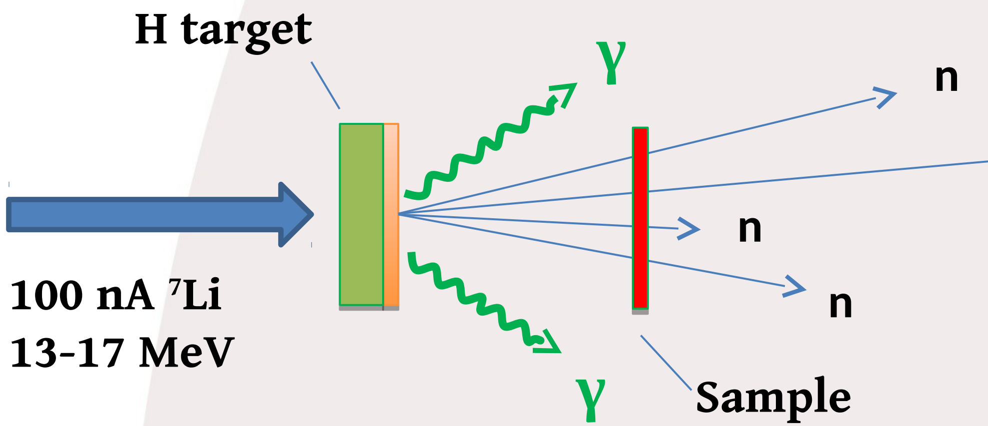
ALTO FACILITY: STABLE IONS BEAMS

Standard Tandem beams

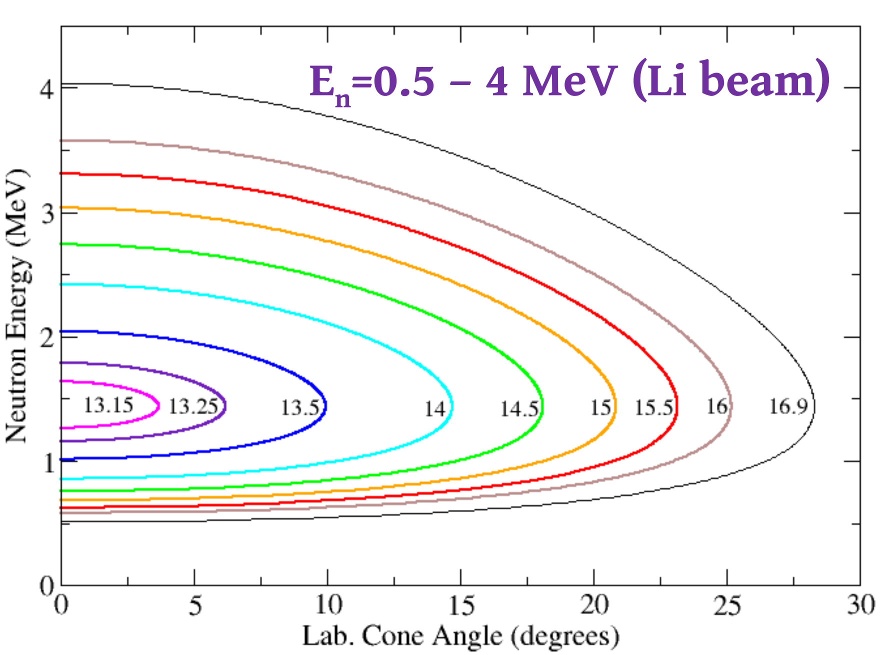
- from **H, ^{3}He, ^{4}He, …, ^{14}C, … up to ^{127}I**
- Term. V: from **< 1 MV** up to **14.5 MV**
- Beam pulsing: width **1 – 2 ns**; rep. rate – **200 ns** or more
- **new ions source** purchased for higher intensity of difficult beams (Mg, Ca)

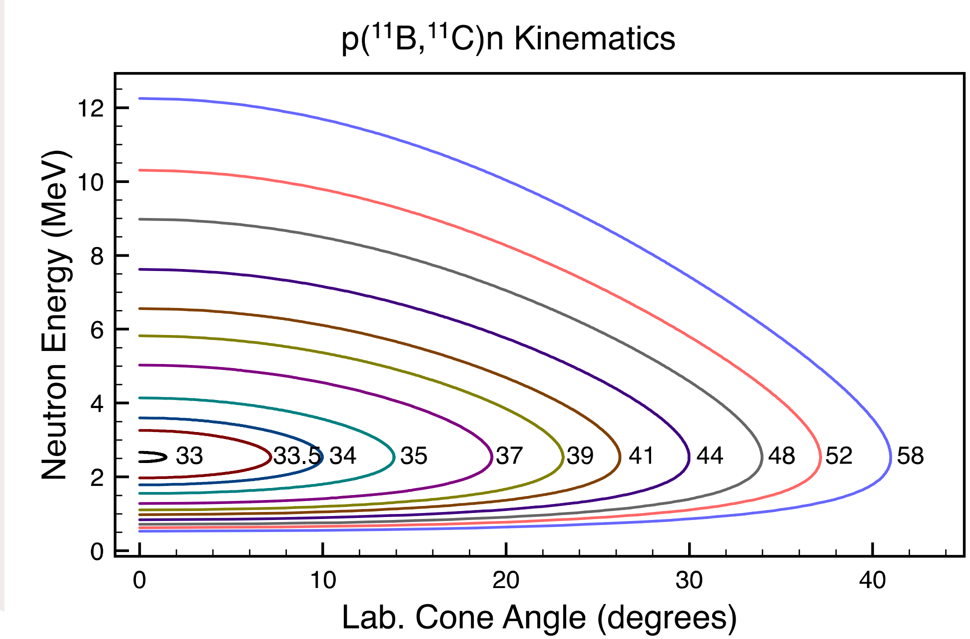


Lithium (*Boron*) Inverse Cinematiques ORsay Neutron source



Intensely forward focused mono-energetic neutron source:
10^7 n/s/steradian





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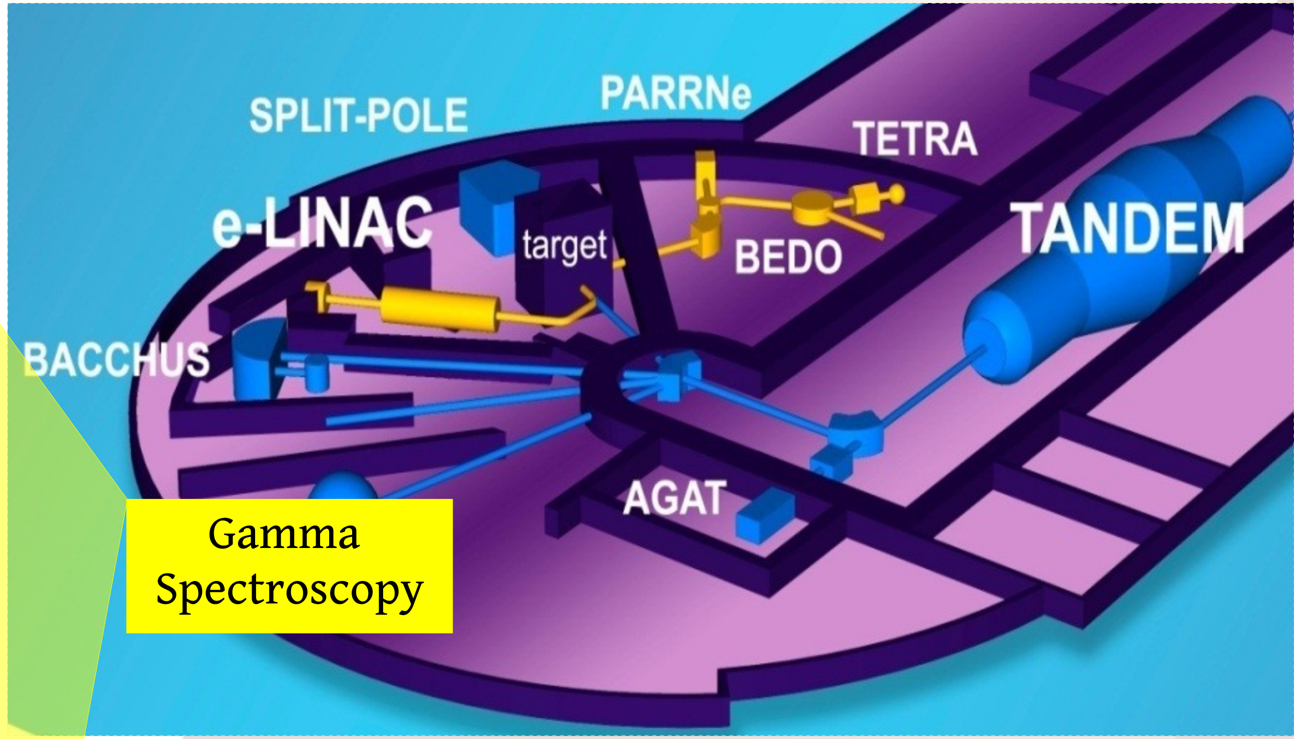


Year:
2010
2014
2015
2017
2018

γ-spectroscopy

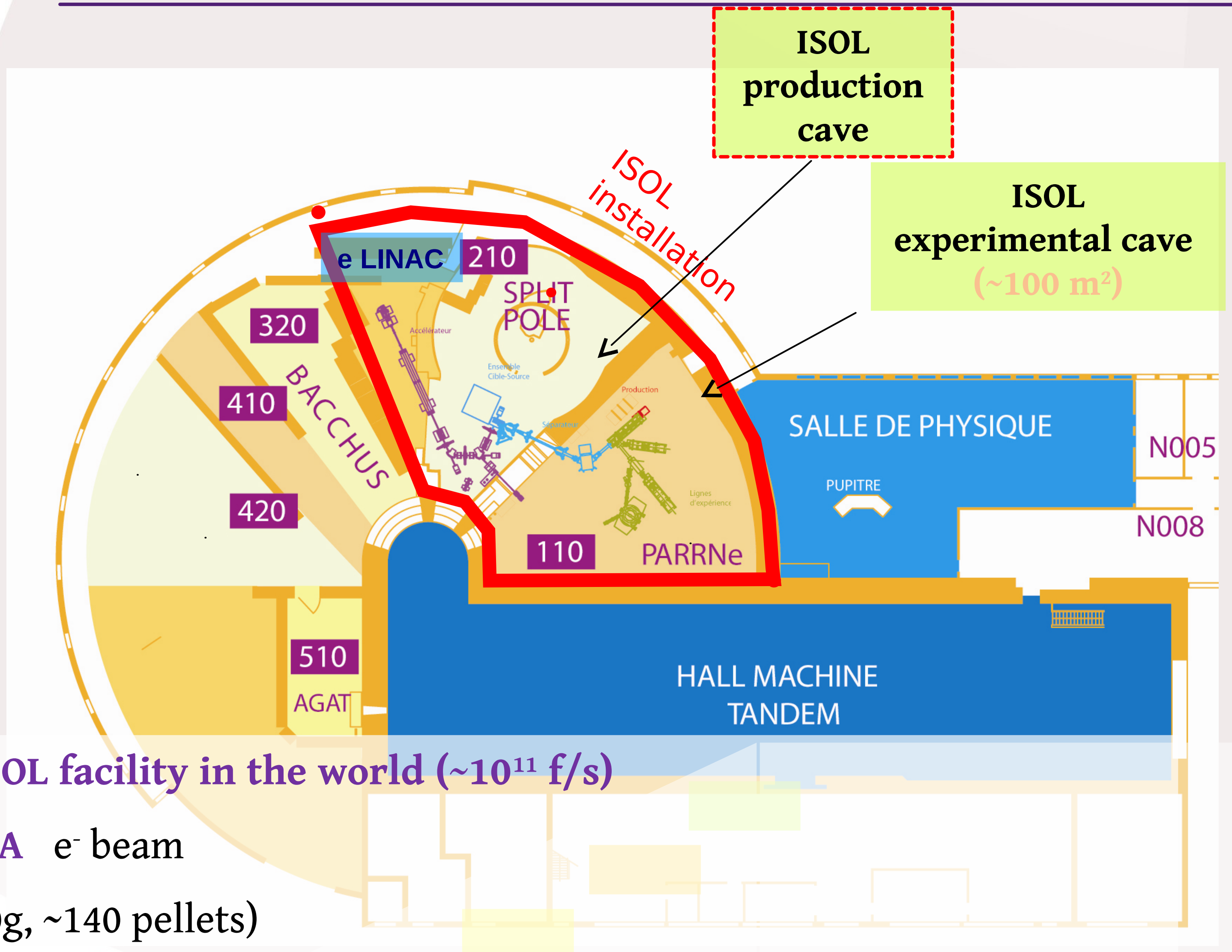
PARIS

nu – ball

PARIS experiments:
(performed)
- *(High energy gamma response of PARIS)*
- Neutron response of PARIS (M. Ciemala)
- Prompt g and n emission for 238U/239Pu fast induced fission (L. Qi)
- Prompt g-rays as a probe for nuclear dynamics (I. Harca)

(to be performed)
- Feeding of low-energy structures in ^{188}Pt of different deformations by the GDR decay (M. Kmiecik)
- Coulomb excitation of super-deformed band in 40Ca (P. Napiorkowski)

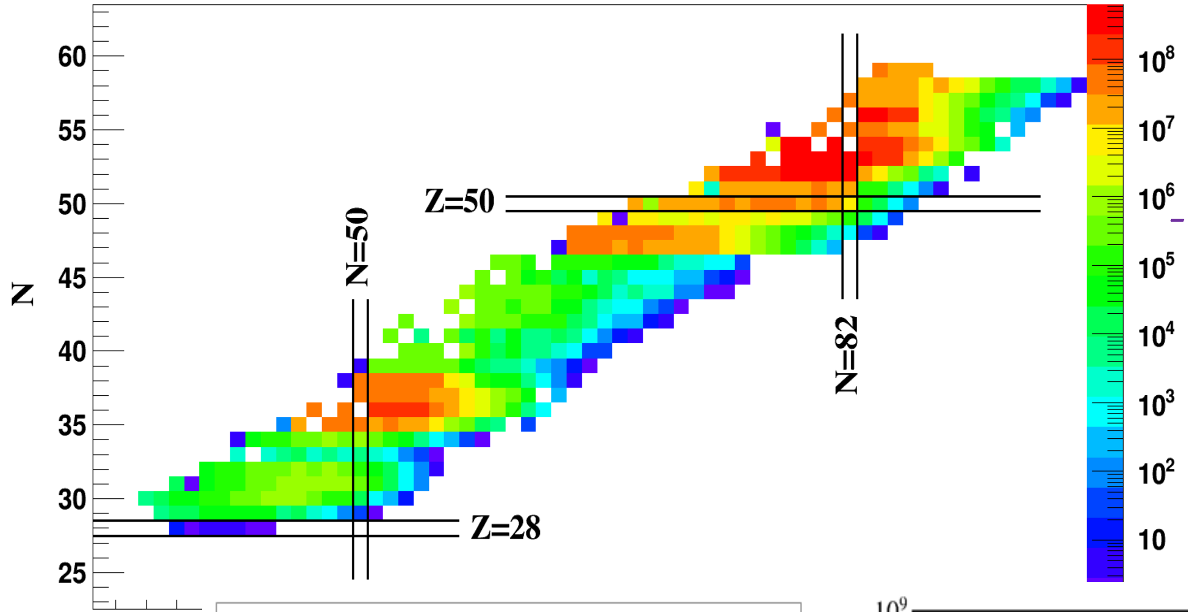
THE ALTO FACILITY: RADIOACTIVE IONS BEAMS



First photofission ISOL facility in the world (~10^{11} f/s)

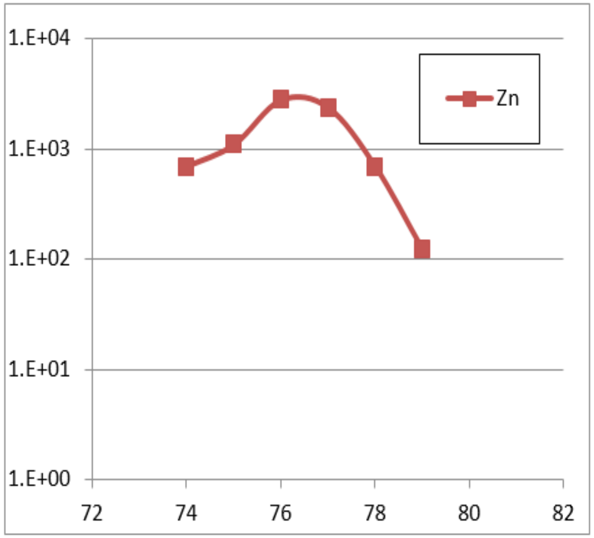
- **50 MeV** & **10 μA** e^- beam
- UCx target (~70g, ~140 pellets)
- Z selection with : **Surface/LASER ion source**
- Mass Selection with PARRNe magnet -> mono-isotopic achievable

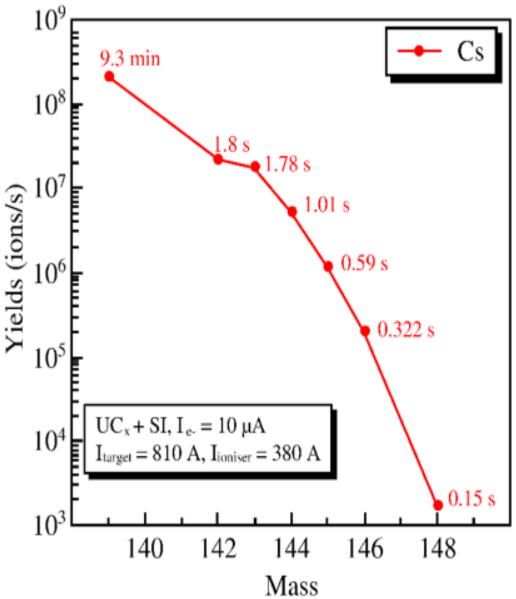
Production yields projections for an universal FEBIAD source

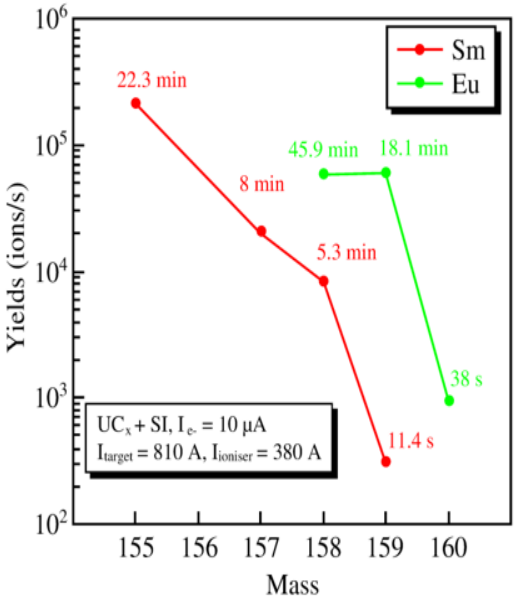


- fission rate : 10^{11} fission/sec
- order of magnitude close to reality

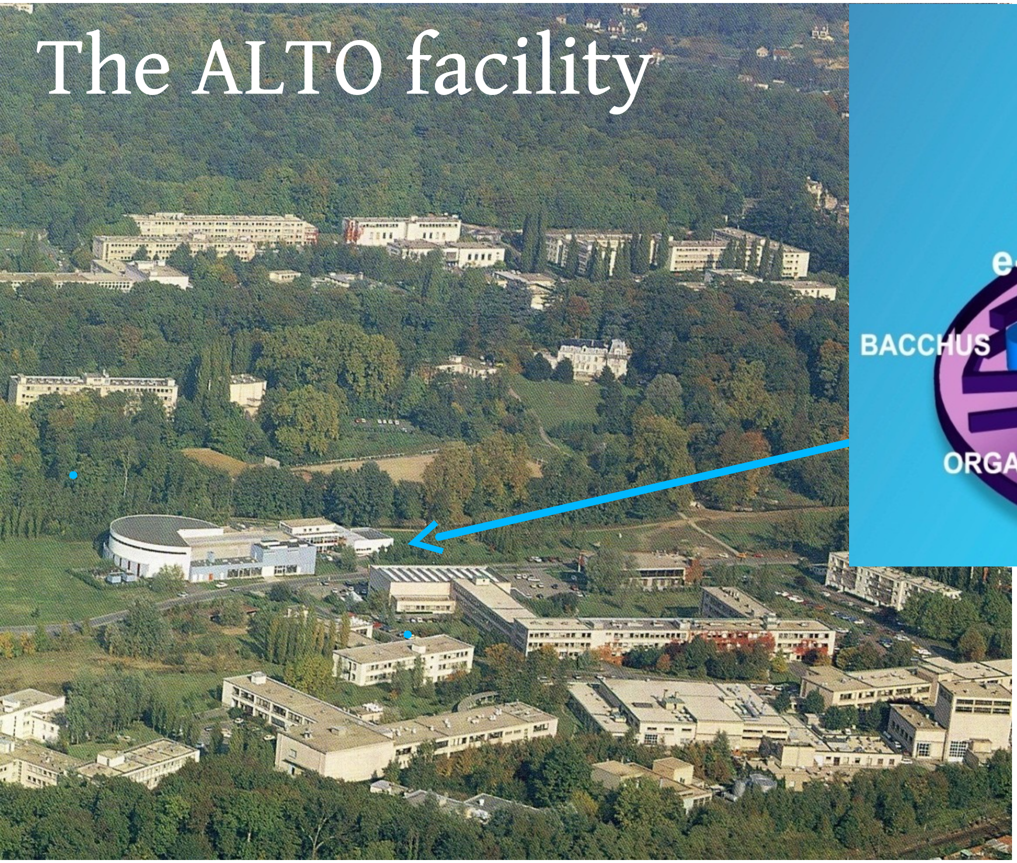
Measured yields

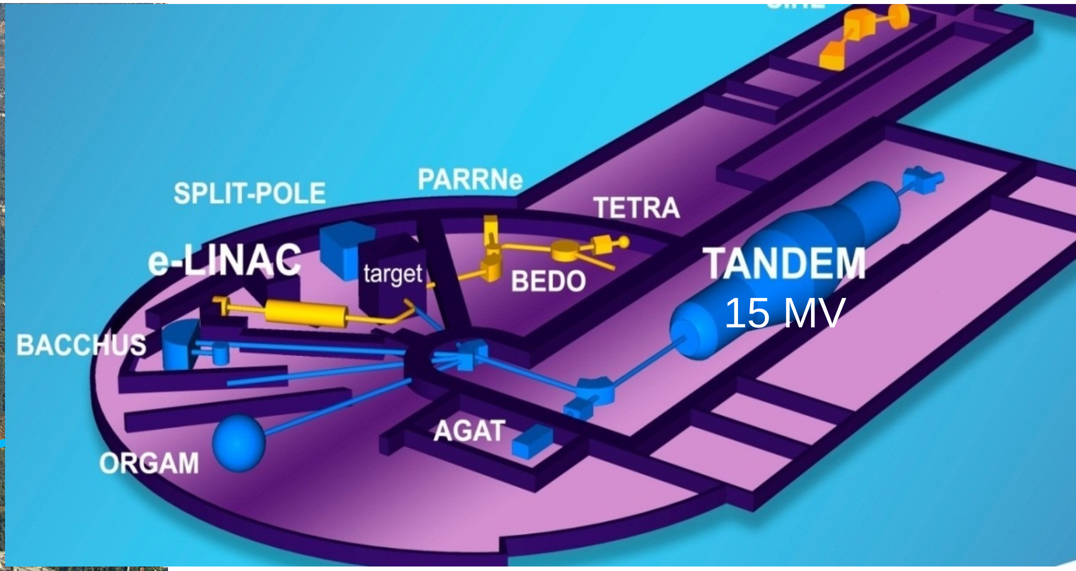






The ALTO facility





	2014	2015	2016
Users	135	246	200
Beam-time	2232 h	3816 h	2544 h
	279 UT	477 UT	318 UT

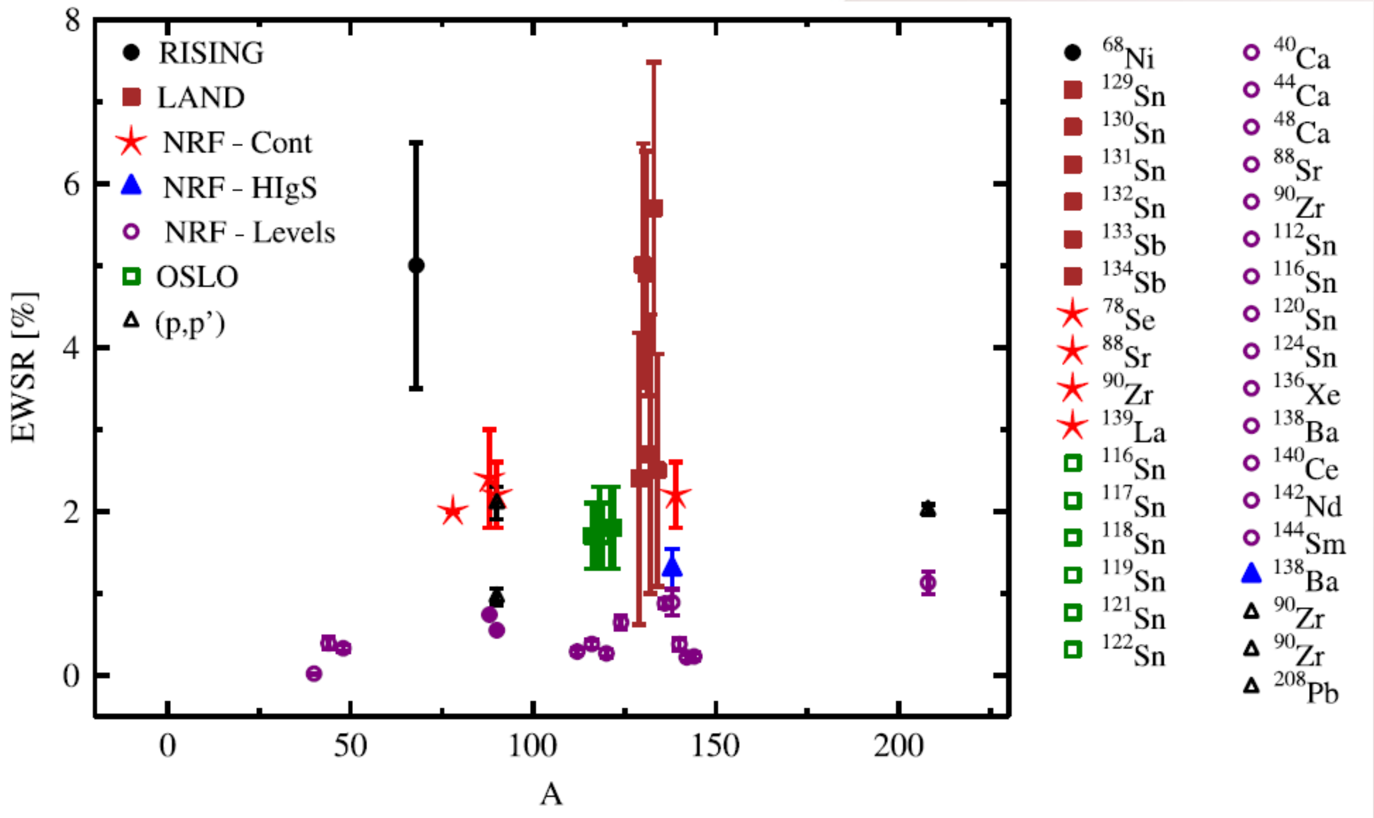
ALTO Facility (for PARIS ...)

and

PDR and beta-decay

Experimental and theoretical PDR work :
concentrated around proton closed shells : Z=20, 28, 50, 82

(recent review: D. Savran et al. / PPNP 70 (2013) 210–245)



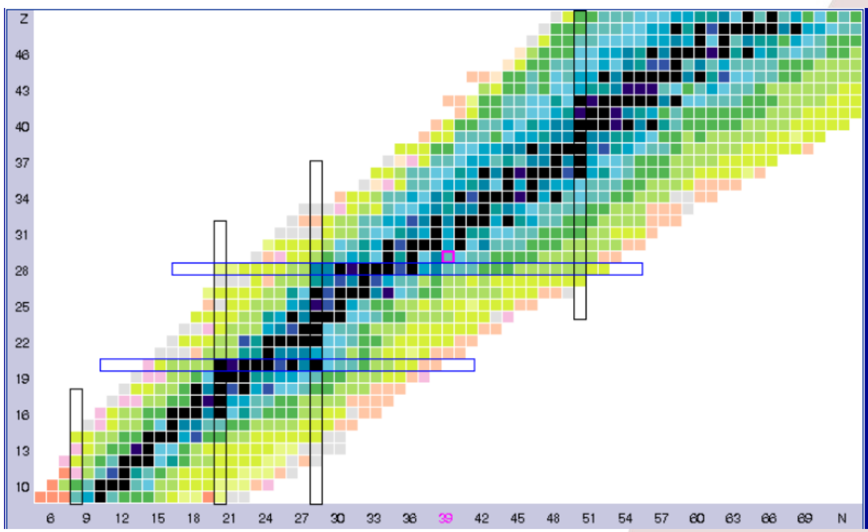
Different (complementary) experimental techniques : NRF, relat COULEX, hadron scattering, ion induced reactions (probing also the PDR structure)

What about PDR studies along closed neutron shell isotonic chains ?

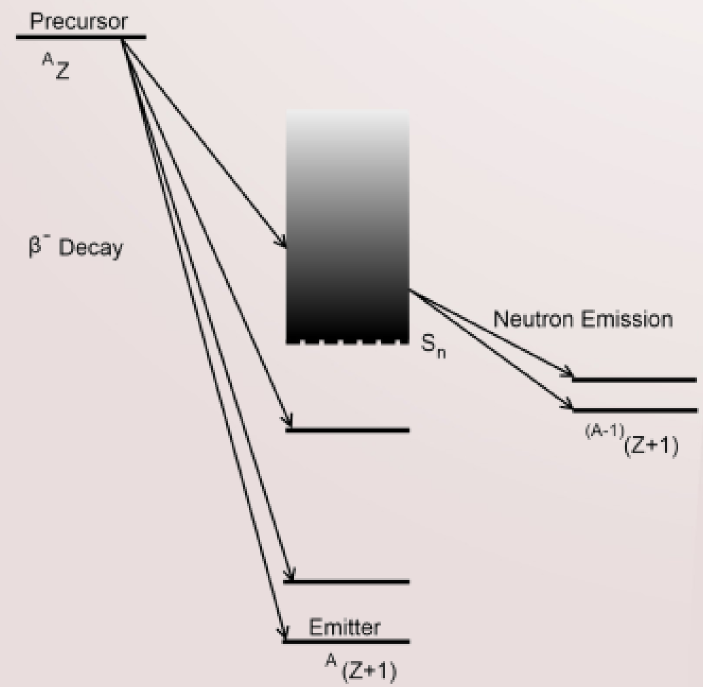
Limited to stable nuclei !

N=50 : R. Schwengner et al, PRC87 (2013)
N = 82 : D. Savran et al, PRC84 (2011)
Theoretical calculations: N. Tsoneva et al, Journal of Physics G: Nuc. Part. Phys. 35 (2008)
...

Remark :
along an isotonic chain you become faster exotic that along an isotopic chain
→ experimentally challenging ...



But this also opens the Q-beta window and lowers the Sn !

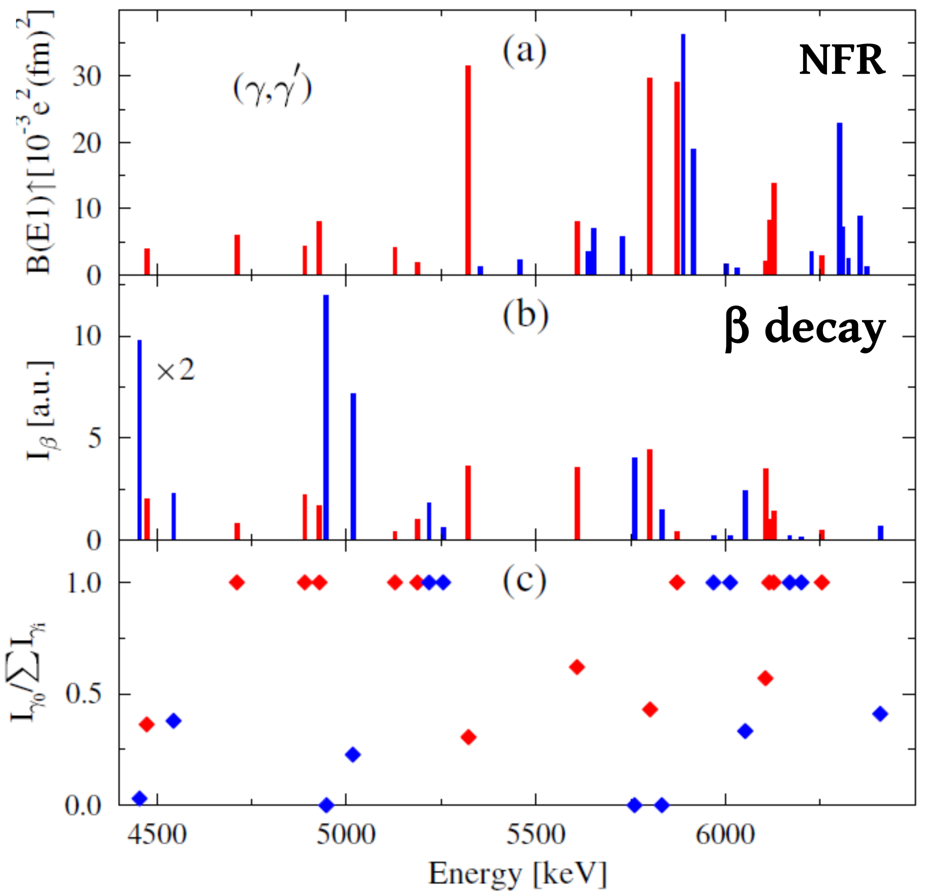


Result: high energy exited states are populated (PDR region ~ 7-10 MeV) and some high energy γ transitions compete with n-decay (signature of E1 type)

Mother	J^π	Daughter	S_n [keV]	Q_β [keV]	$P_{\beta n}$ [%]
^{48}K	(2^-)	^{48}Ca	9945	12090	1.1
^{50}K	$(0^-, 1^-, 2^-)$	^{50}Ca	6353	14220	22.5
^{84}Ga	(0^-)	^{84}Ge	5243	12900	42.5
^{86}Br	(1^-)	^{86}Kr	9857	7626	
^{96}Y	0^-	^{96}Zr	7856	7096	
^{98}Y	$(0)^-$	^{98}Zr	6415	8824	0.33
^{130}In	$1^{(-)}$	^{130}Sn	7596	10249	0.92
^{136}I	(1^-)	^{136}Xe	8084	6930	
^{140}Cs	1^-	^{140}Ba	6428	6220	
^{142}Cs	0^-	^{142}Ba	6181	7325	0.09
^{144}Cs	$1^{(-)}$	^{144}Ba	5901	8500	2.9
^{146}Cs	1^-	^{146}Ba	5495	9370	12.4

Example 1: ^{136}I $\rightarrow$ ^{136}Xe(stable), N=82

(Scheck et al, PRL116 (2016)



Red – transitions seen in both

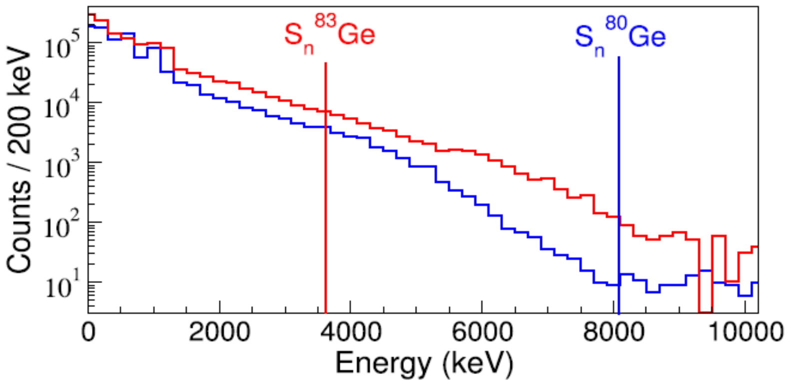
<u>Ingredients</u>:

- High Qbeta window
- Daughter Sn in the Qbeta window
- J^π selection rules should allow for GT decay to states connected by E1 to GS (matching B(GT) - B(E1) ...)

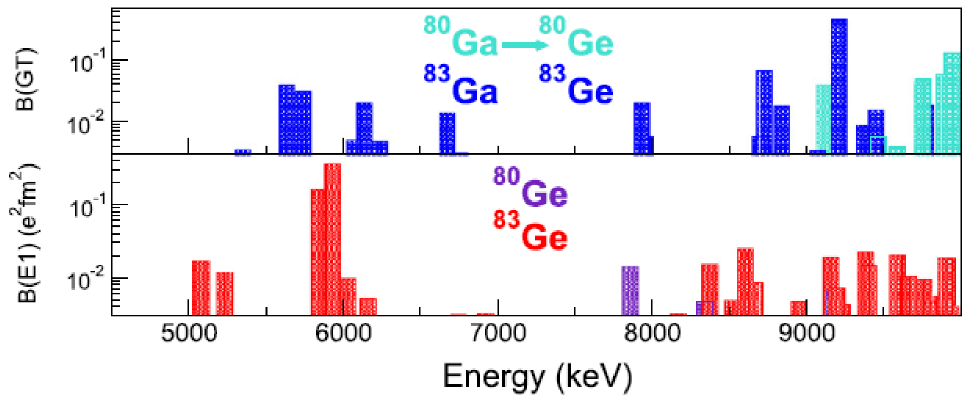
Example 2 : ALTO-RIB experiment
^{83}Ga: can GT trigger low-lying nuclear dipole oscillations ?

Measurement (1 single LaBr3 2x2x4):
^{80}Ga → ^{80}Ge and ^{83}Ga → ^{83}Ge

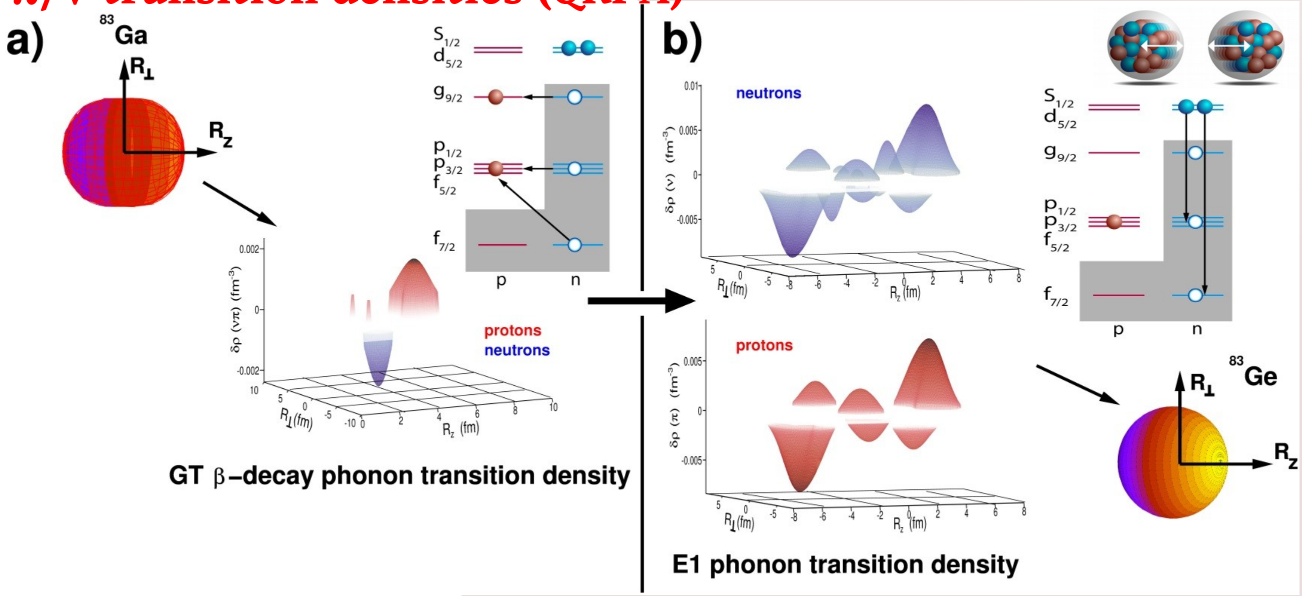
A.Gottardo et al., PLB772 (2017)



Model:



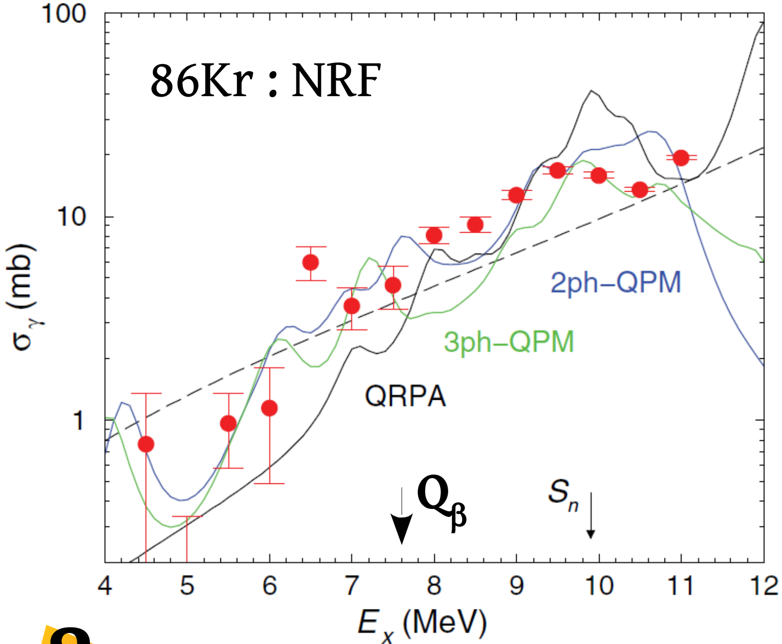
π/ν transition densities (QRPA)

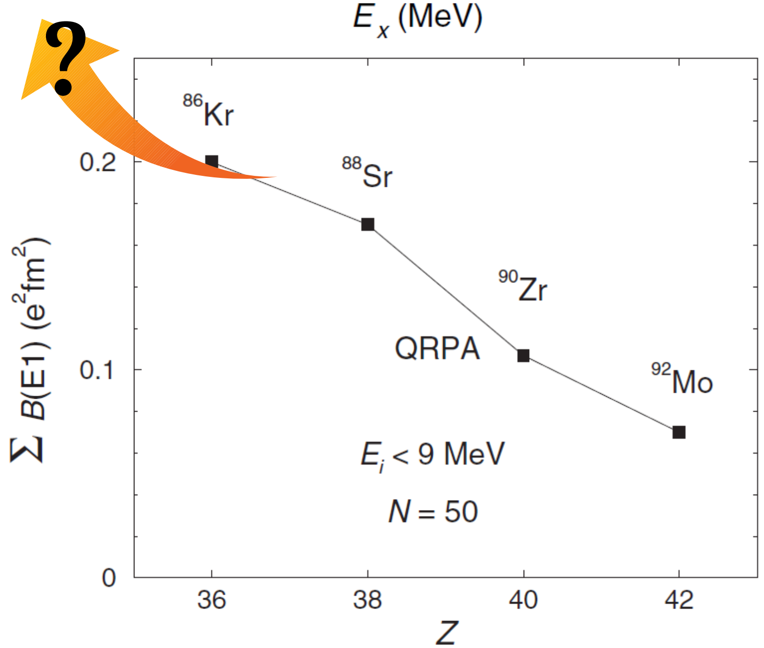


a) GT decay create a depletion of neutron density in the core

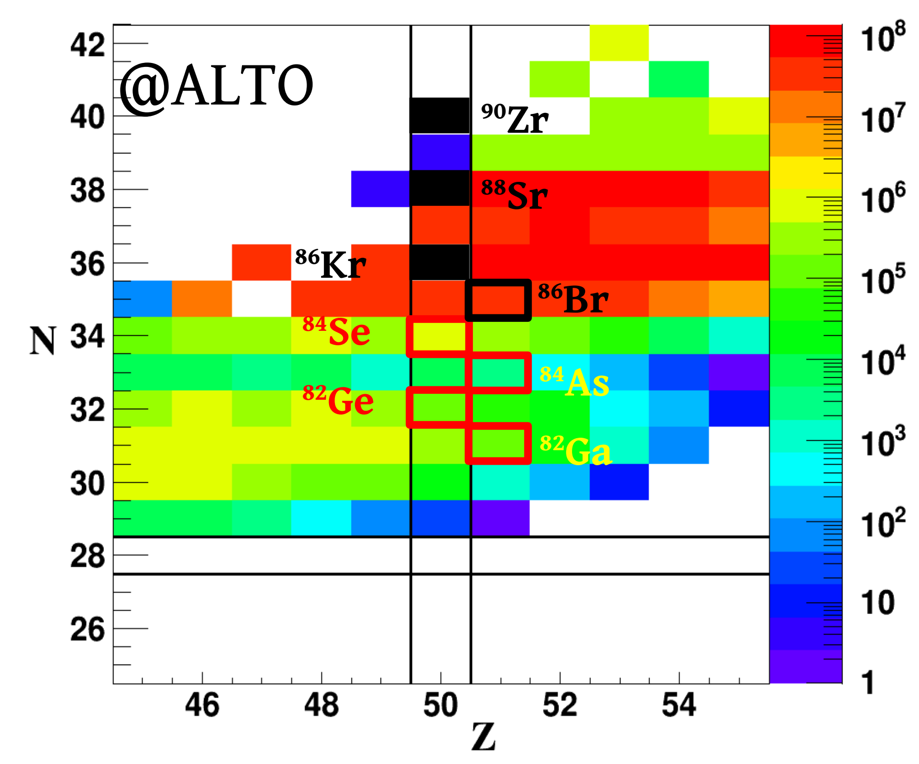
b) The excited ^{83}Ge states can then decay via E1 γ emission with a «PDR-like» transition density

N = 50 : dipole strength distribution studies towards neutron rich isotopes





(Schwengner et al, PRC87 (2013))



Keep in mind :

Beta decay alone can't answer to the question : "PDR or not PDR ?" ...

Need to populate the PDR states by other mechanisms (near to far future ...)

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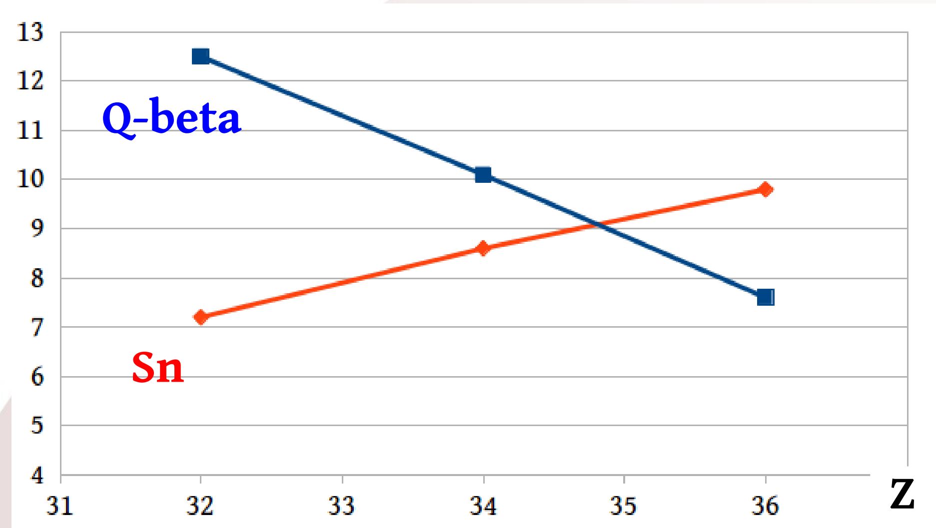
SETUP @ ALTO:

- Tape implantation
- Beta detection : plastic
- 3 PARIS clusters
- 3 high volume Ge + 1 Clover



82Ga (1$^-$)→ 82Ge

84As (3$^-$) → 84Se

86Br (1$^-$)→ 86Kr