Onset of Deformation in Neutron-Rich Yttrium Isotopes Studied by the Coulomb Excitation Tagged by the β-decay

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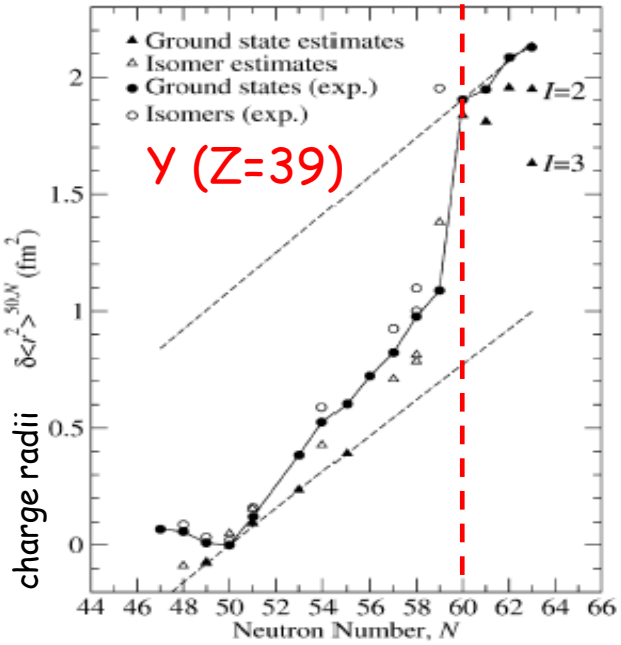
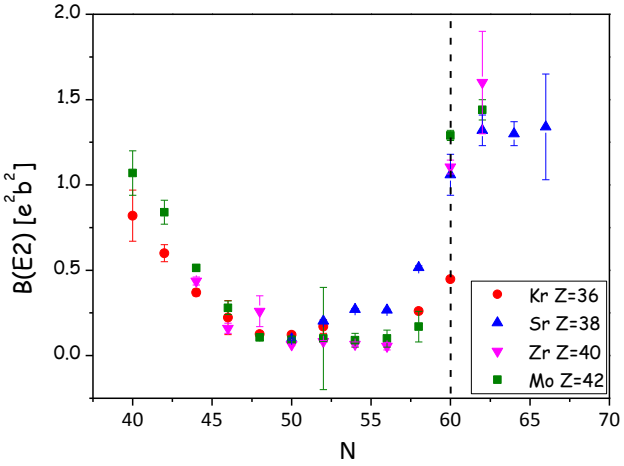
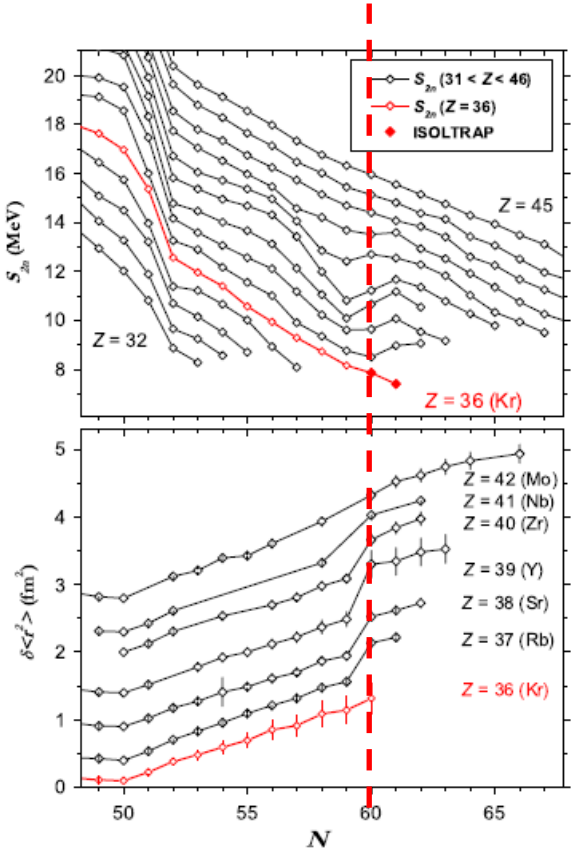
Menu:

1. Introduction: shape coexistence in Z>36
2. Y isotopic chain
3. ^{98}Y
4. Experimental setup
5. Beam rates and feasibility
6. Conclusions

Apart from Kr isotopic chain all nuclei with Z≥ 36 exhibit a sudden onset of deformation at N≈60
Recent B(E2) measurement in ^{94,96}Kr seem to also point to a smooth onset of deformation







Yttrium isotopic chain is interesting in many ways:

- Sharpest change in deformation
- Possible shape coexistence in many isotopes
- Presence of long-living isomeric states

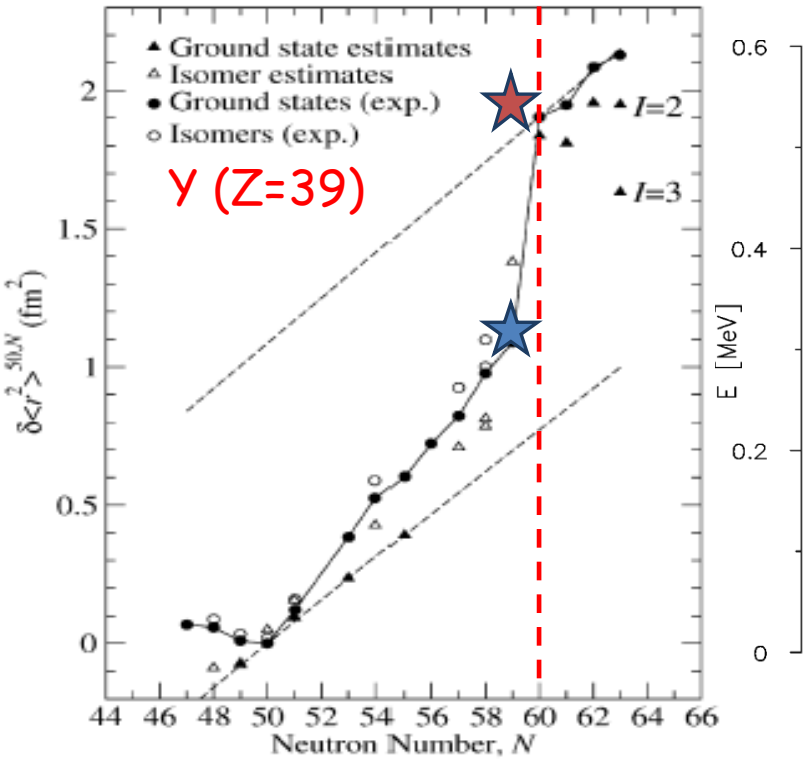
B.Cheal, PLB 645 (2007) 133
H.Mach, NPA 523 (1991) 197
M.Albers, PRL 108 (2012) 062701
S.Naimi, PRL 105 (2010) 032502

Studies performed using: isotope-shift measurements; β decay; γ spectroscopy of fission fragments;
Production: ISOL beams, n-induced fission;

Yttrium isotopic chain Spherical N=56 subshell closure effective up to ^{97}Y
^{99}Y has strongly deformed g.s.

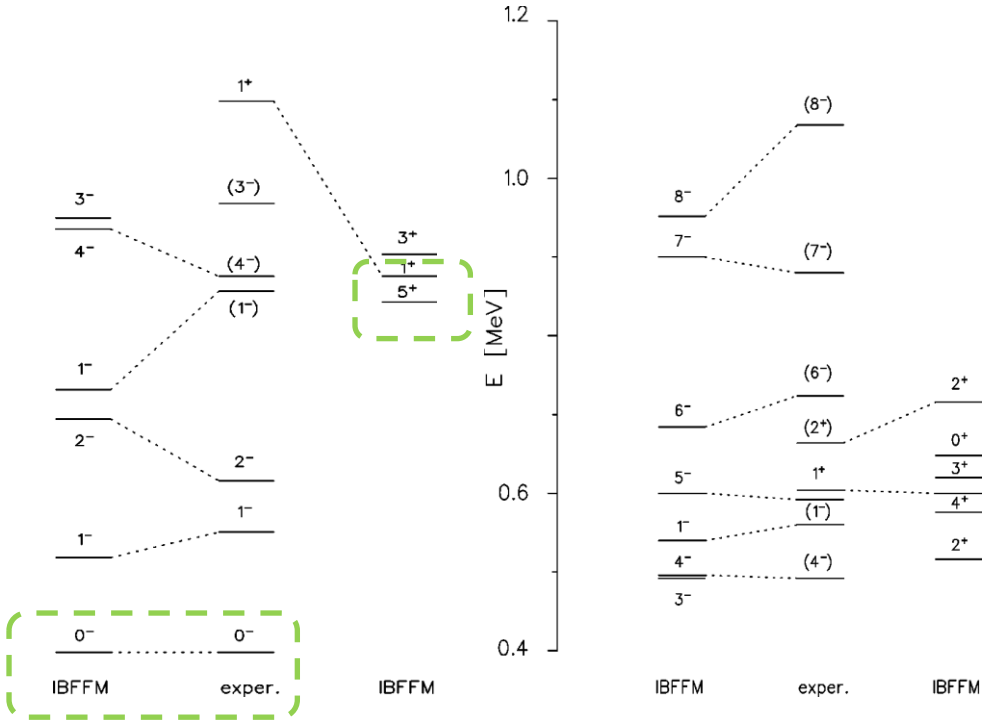
^{98}Y: g.s is spherical. Deformation of isomeric state is debated

Recent exp. result



B.Cheal, PLB 645 (2007) 133

Recent IBFFM calculation

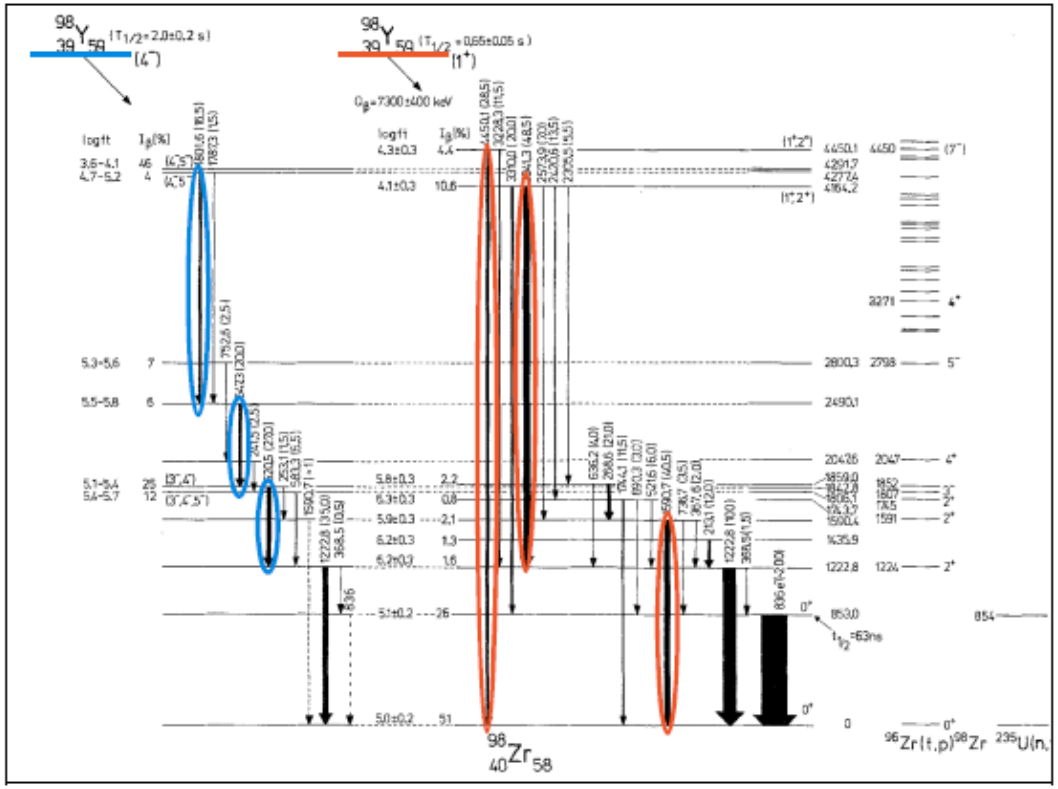


Spherical states Deformed states

S.Brant, PRC 69 (2004) 034327

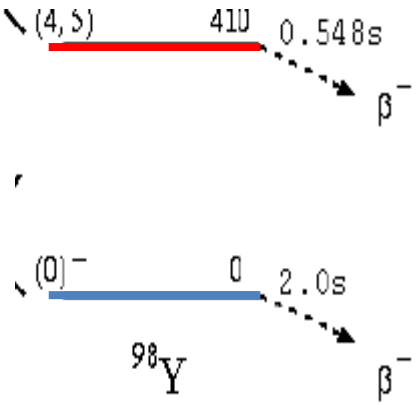
Structure of ^{98}Y is not well defined

g.s. confirmed as 0^-;
J^π of isomeric state is $I \geq 4$, $I=4$ or $I=5$, parity non defined



K. Sistemich et al., Z. Physik A 281, 169 (1977)

Different decay chains following β decay of isomer and g.s



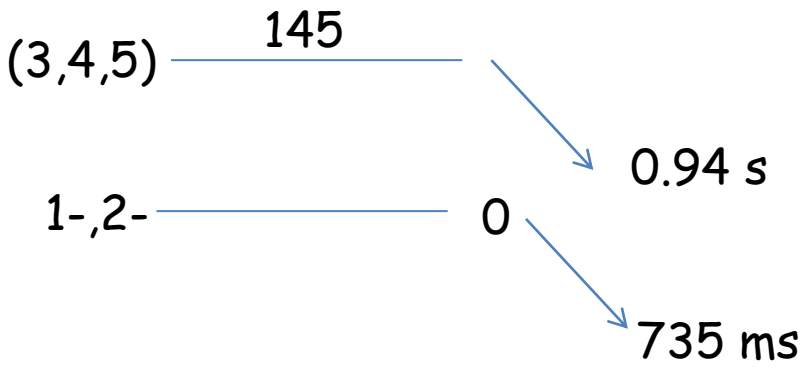
β-delayed γ from isomer:
854 (41%)
1223 (100%)
1590 (41%)
1744 (15%)
2420 (16%)
2941 (46%)
3310 (20%)

β-delayed γ from g.s.:
620.5 (27.6%)
647.6 (23%)
1223 (35%)
4292 (17%)

CoulEx on both ground and isomeric state
Distinction based on β-delayed γ cascades

Such β-decaying isomeric states are present also in $^{100\text{-}102}$Y

^{100}Y



The 735-ms activity with Jπ=1-,2- is arbitrarily assigned to the g.s. and 0.94-s activity with J=(3,4,5) to an isomer at 145 keV. No experimental results exist as yet which can definitely confirm the association of measured half-lives and adopted Jπ's with the two states.

^{102}Y

^{102}Y: low/high spin β-decaying isomers

Again it will be possible to study the structural properties of two different isomeric states observing their β decay

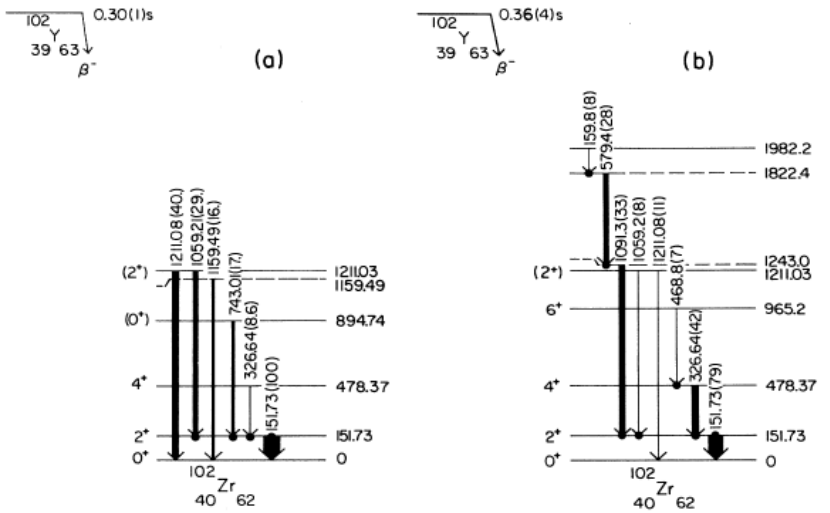
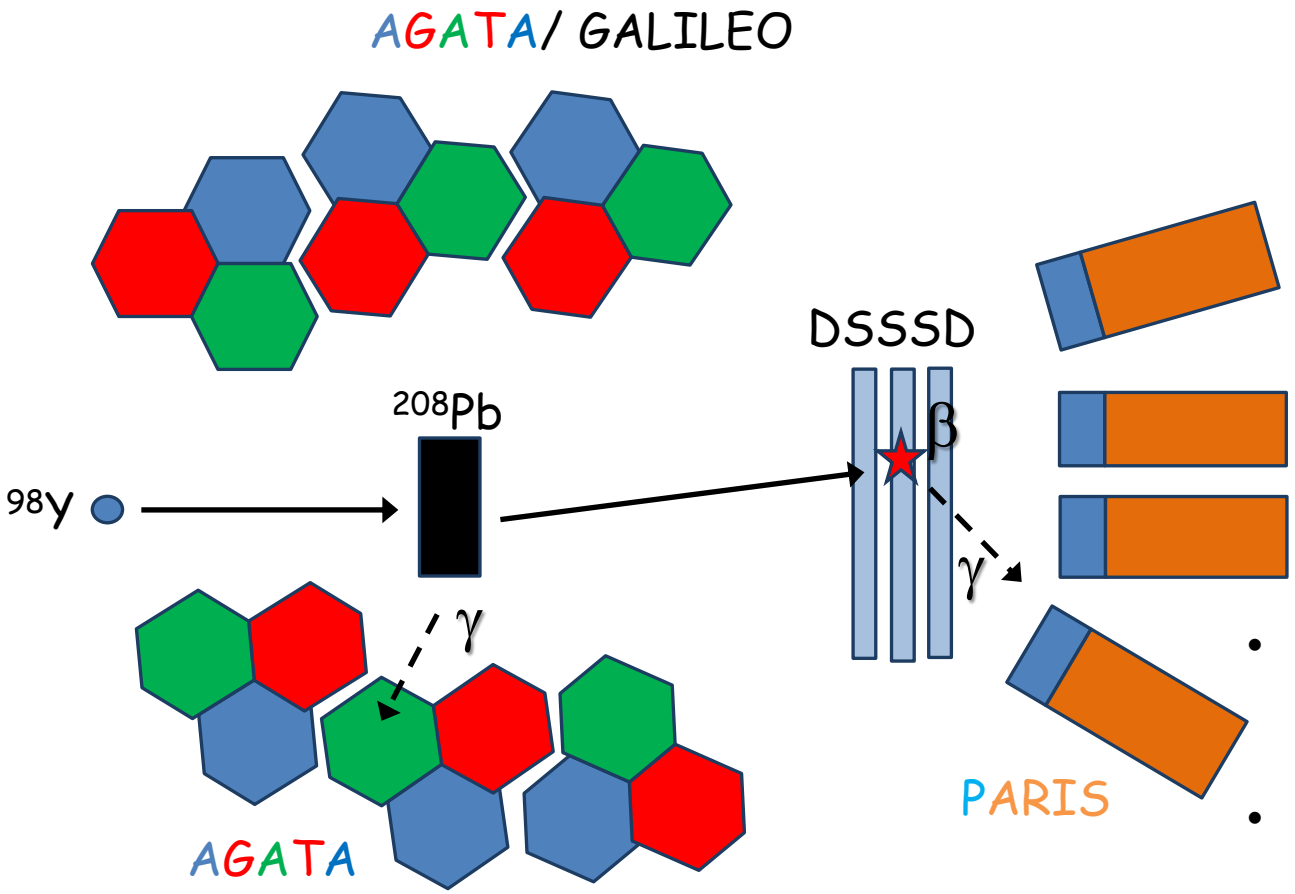


FIG. 4. Decay scheme for (a) low-spin and (b) high-spin isomers of ^{102}Y with energies in keV. The intensities in (a) and (b) are from the TRISTAN and high-spin columns, respectively, in Table I.

Experimental array:

^{98}Y ≤10.4AMeV
v/c = 14.8 %
^{208}Pb 0.5 mg/cm^2
Si thickness* = 115 μm
$T_{1/2}$(g.s) = 2.0 s
$T_{1/2}$(isomer) = 0.54 s



PARIS

- Good resolution and high efficiency for β-delayed γ detection
- Good timing performances for lifetime determination in daughter nuclei
- modularity

AGATA

Tracking capabilities for CoulEx
High β ➔ need for Doppler correction

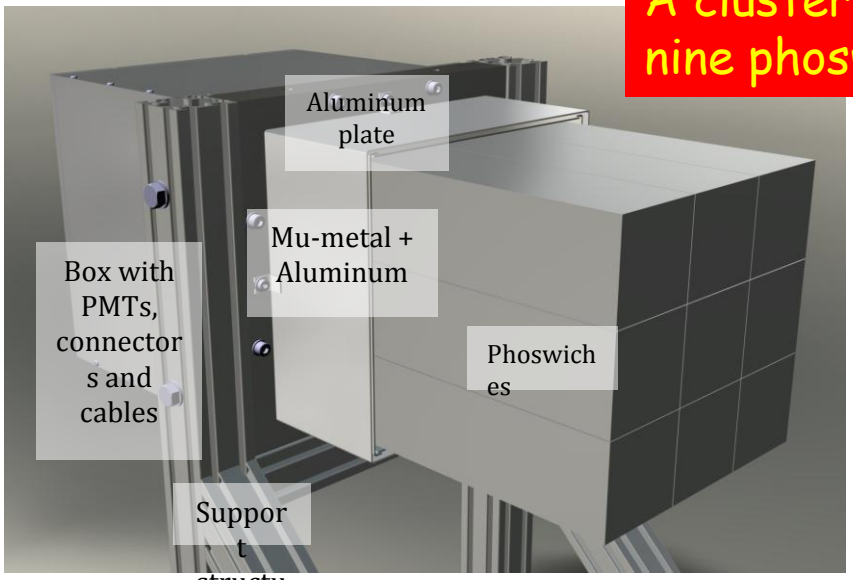
* Required to stop ions

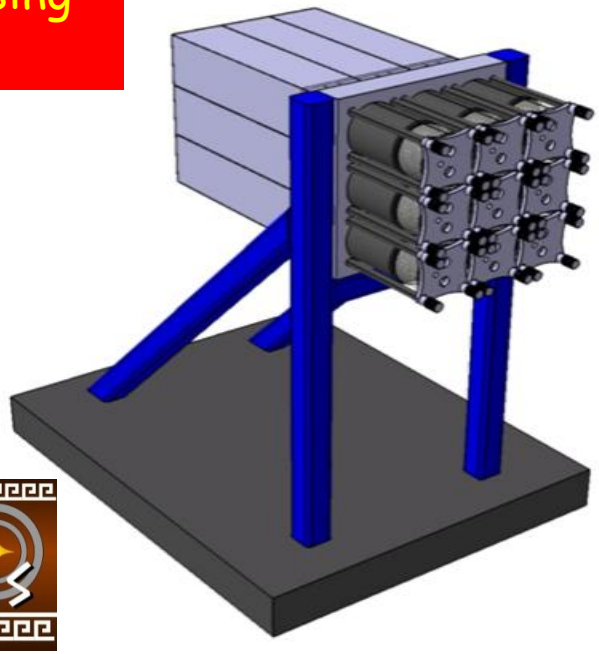
Basic element: a phoswich LaBr3+NaI

LaBr3 2"x2"x2"	NaI (2"x2"x6")	PMT

5 prototypes were ordered from Saint Gobain:
1 to Orsay, 1 to Strasbourg, 3 to Krakow

A cluster module comprising nine phoswich detectors



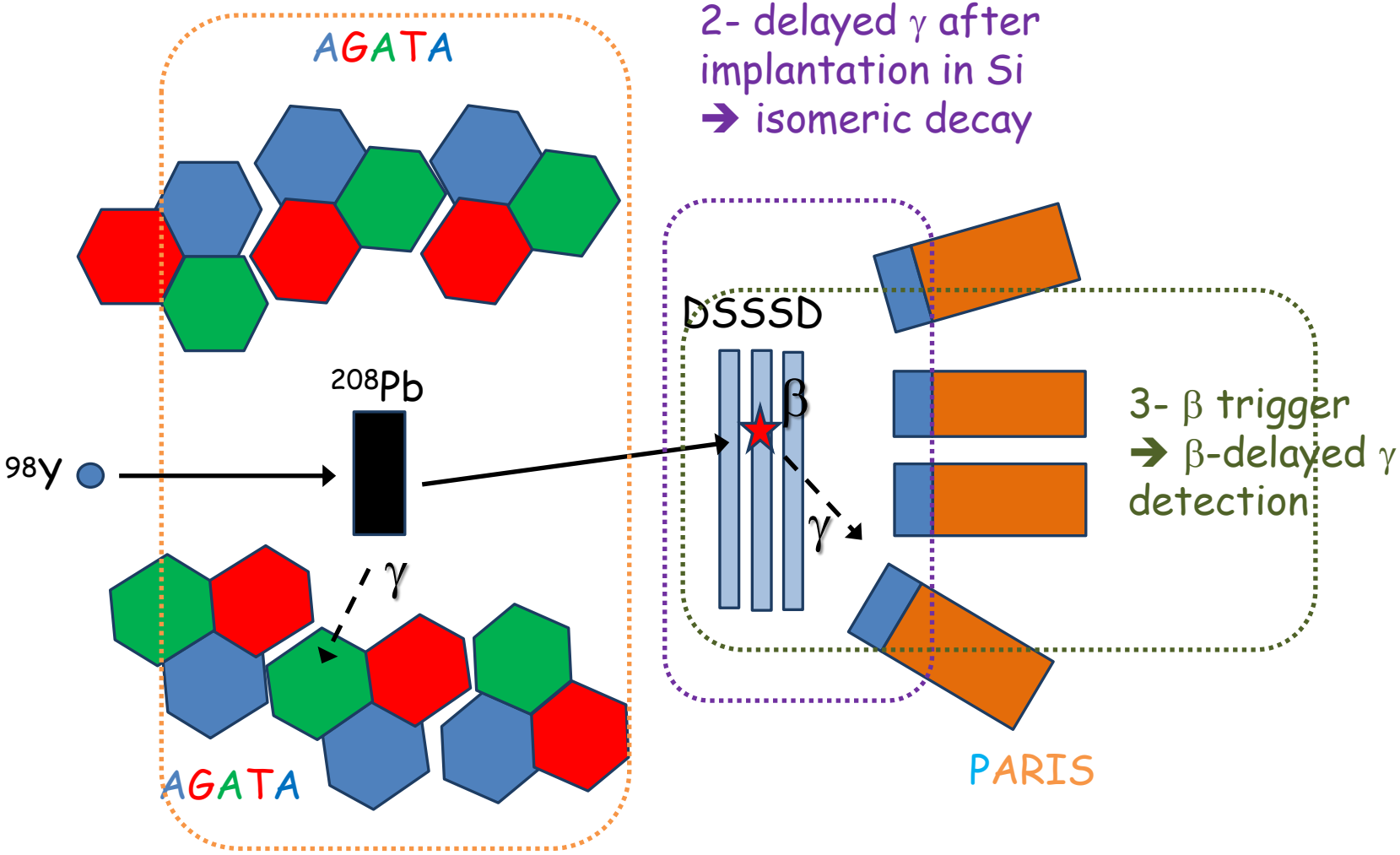


PARIS

3 different triggers

1- prompt γ detection at target related with implantation in Si
➔ CoulEx deexcitation

2- delayed γ after implantation in Si
➔ isomeric decay



3- β trigger
➔ β-delayed γ detection

Discrimination implants/betas ???

Beam intensities estimates

Element	A	Z	N	T1/2 s	RIBs at 260KeV 1+	Re-accelerated RIBs C.B. eff=3- 4 % Linac tr.=50% particles/s	q+	Max E/A	Comments * target different from UCx. To be developed @SPES SIS= surface ion source LIS= laser ion source FEBIAD= plasma source x = easy, xxxx= difficult
Sr	98	38	60	6.53E-01	6,16E+05	1,23E+04	14	9,9	
Sr	99	38	61	2.69E-01	2,80E+04				
Sr	100	38	62	2.02E-01	2,30E+03				
Y	88	39	49	9.21E+06	4,46E+05	8,92E+03	15	11	LIS source xxxx
Y	90	39	51	2.30E+05	5,11E+07	1,02E+06	15	11	
Y	91	39	52	5.06E+06	2,73E+08	5,46E+06	15	10,8	
Y	92	39	53	1.27E+04	1,05E+09	2,10E+07	15	10,8	
Y	93	39	54	3.66E+04	2,92E+09	5,84E+07	15	10,7	
Y	94	39	55	1.12E+03	5,39E+09	1,08E+08	15	10.7	
Y	95	39	56	6.18E+02	7,29E+09	1,46E+08	15	10,6	
Y	96	39	57	5.34E+00	4,47E+08	8,94E+06	15	10,6	
Y	97	39	58	3.75E-00	2,44E+08	4,89E+06	15	10,4	
Y	98	39	59	5.48E-01	2,12E+07	4,24E+05	15	10,4	
Y	99	39	60	1.47E+00	2,69E+07	5,38E+05	15	10,4	
Y	100	39	61	7.35E-01	5,52E+06	1,10E+05	15	10,2	
Y	101	39	62	4.50E-01	1,19E+06	2,39E+04	15	10,2	
Y	102	39	63	3.60E-01	2,76E+05	5,52E+03	15	10,2	
Y	103	39	64	2.30E-01	4,10E+04				
Y	104	39	65	2.36E-01	5,14E+03				

Possible campaign:
Study of feasibility with ^{96}Y and ^{98}Y (10^6-10^5 pps)
Study of structure of ^{100}Y (10^5pps)

Difficult to estimate efficiency of the array

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