Coulomb Excitation measurements of Radioactive Ions

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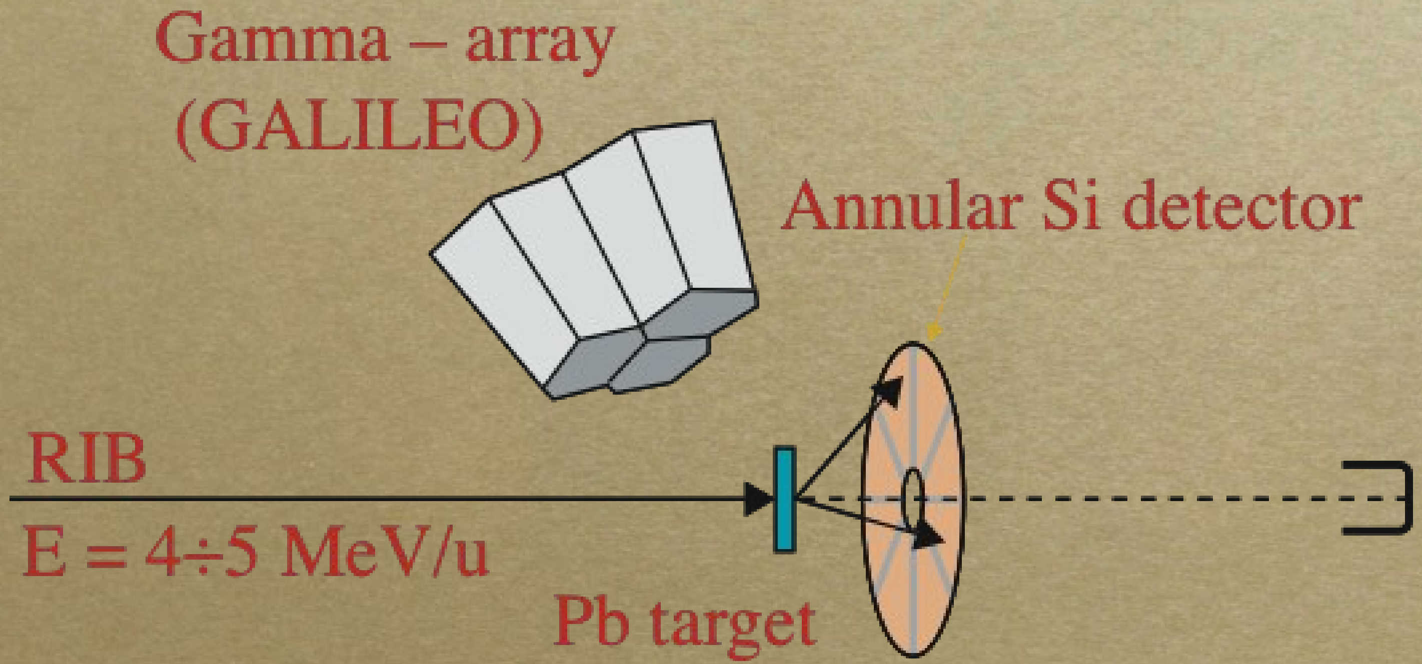
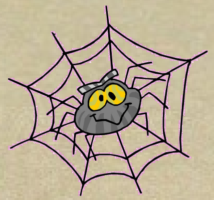
CoulEx measurements with RIBs

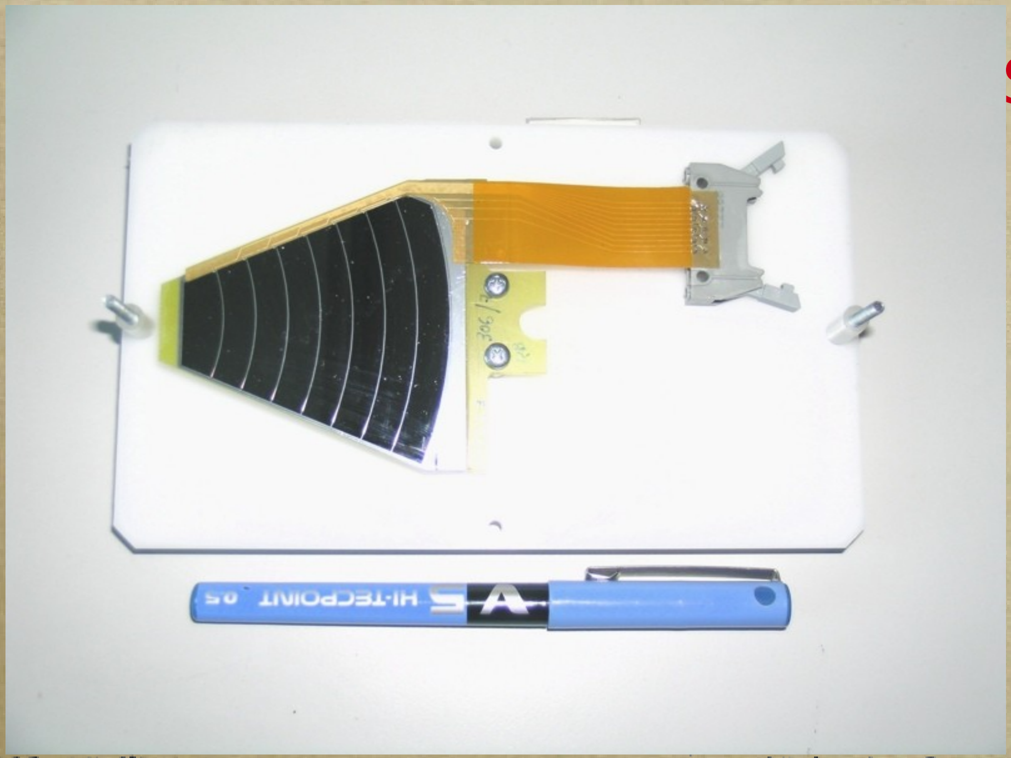
Coulomb excitation measurements in inverse kinematics : projectile nuclei are scattered on a heavy target and detected at forward angles to provide a clean trigger for selecting gamma rays



SPIDER (Silicon PIe DetectoR) an apparatus for particle detection



- **a pie of 8 sectors of Si Strip detectors**
- **the reaction chamber housing the target and the Si Strip Detector**
- **dedicated electronics**



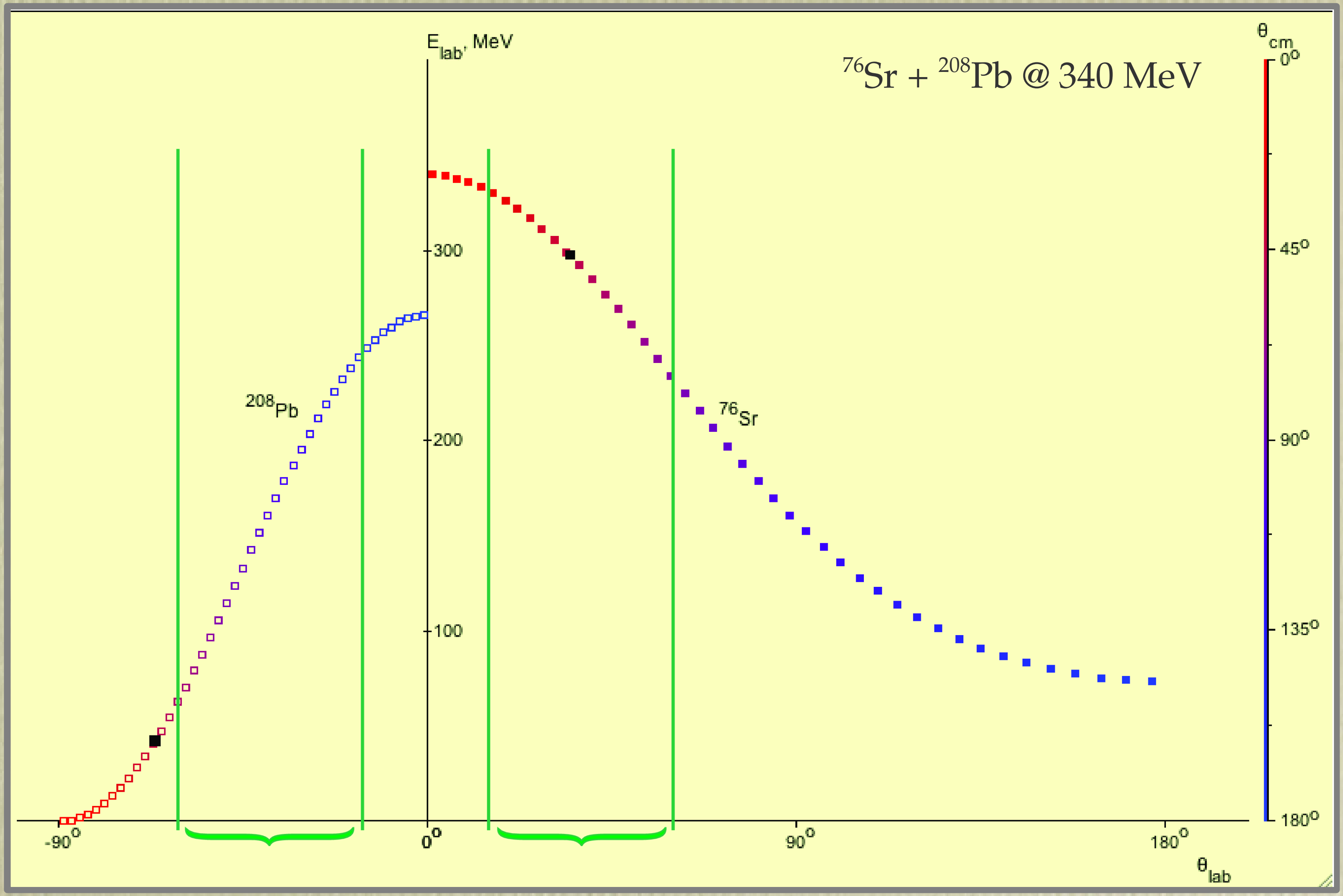
SPIDER: Silicon PIe DEtectoR

- 8 Si detectors of trapezoid shape arranged to form an annular disc.
- Each sector is segmented into eight independent annular strips on the front surface (junction side).
- The rear surface (ohmic side) consists of a unique electrode
- The thickness of the Si detector is around 300μm with a 50nm dead layer

Strip no.	Inner radius (mm)	Outer radius (mm)	θ_{min} (deg)	θ_{max} (deg)
1	76.7	85.0	56.9	59.5
2	68.1	76.4	53.7	56.7
3	59.5	67.9	50.0	53.6
4	50.9	59.3	45.5	49.9
5	42.4	50.7	40.3	45.4
6	33.8	42.1	34.1	40.1
7	25.2	33.6	26.7	33.9
8	16.6	25.0	18.4	26.6

When the detector is mounted at 5 cm distance from the target the coverage of the polar angle θ is about 42 degrees (from 18 to 60 degrees)

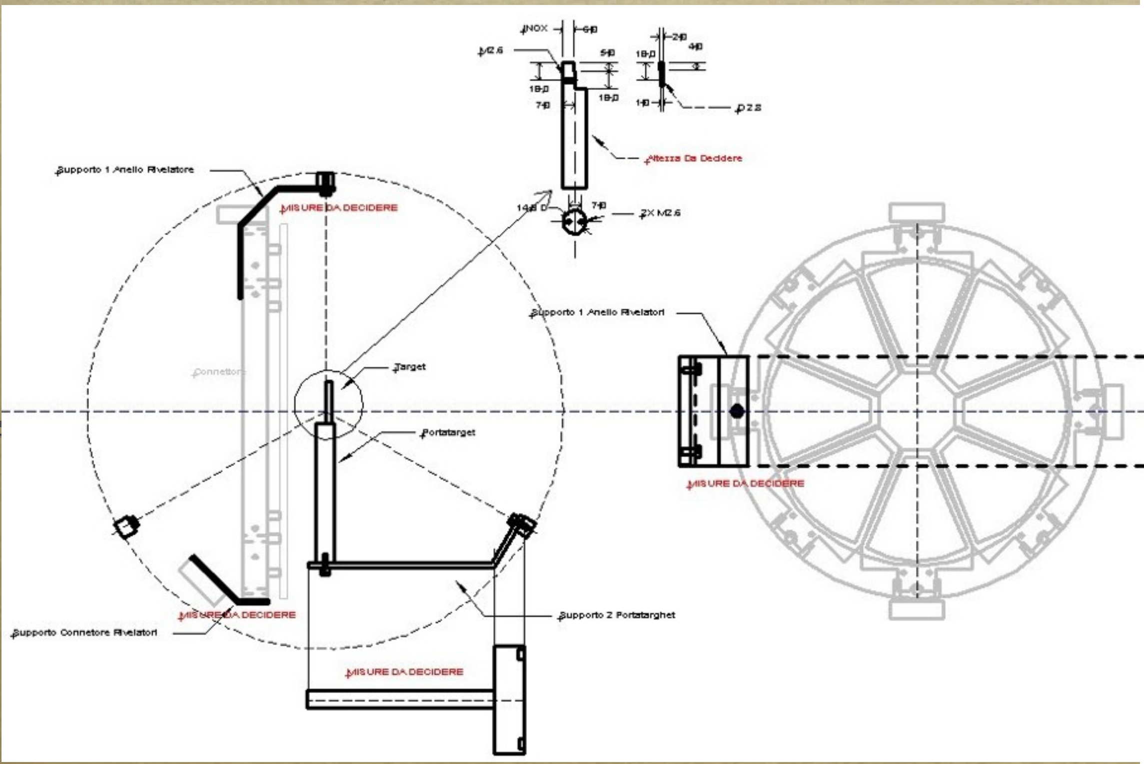
Example of the kinematics



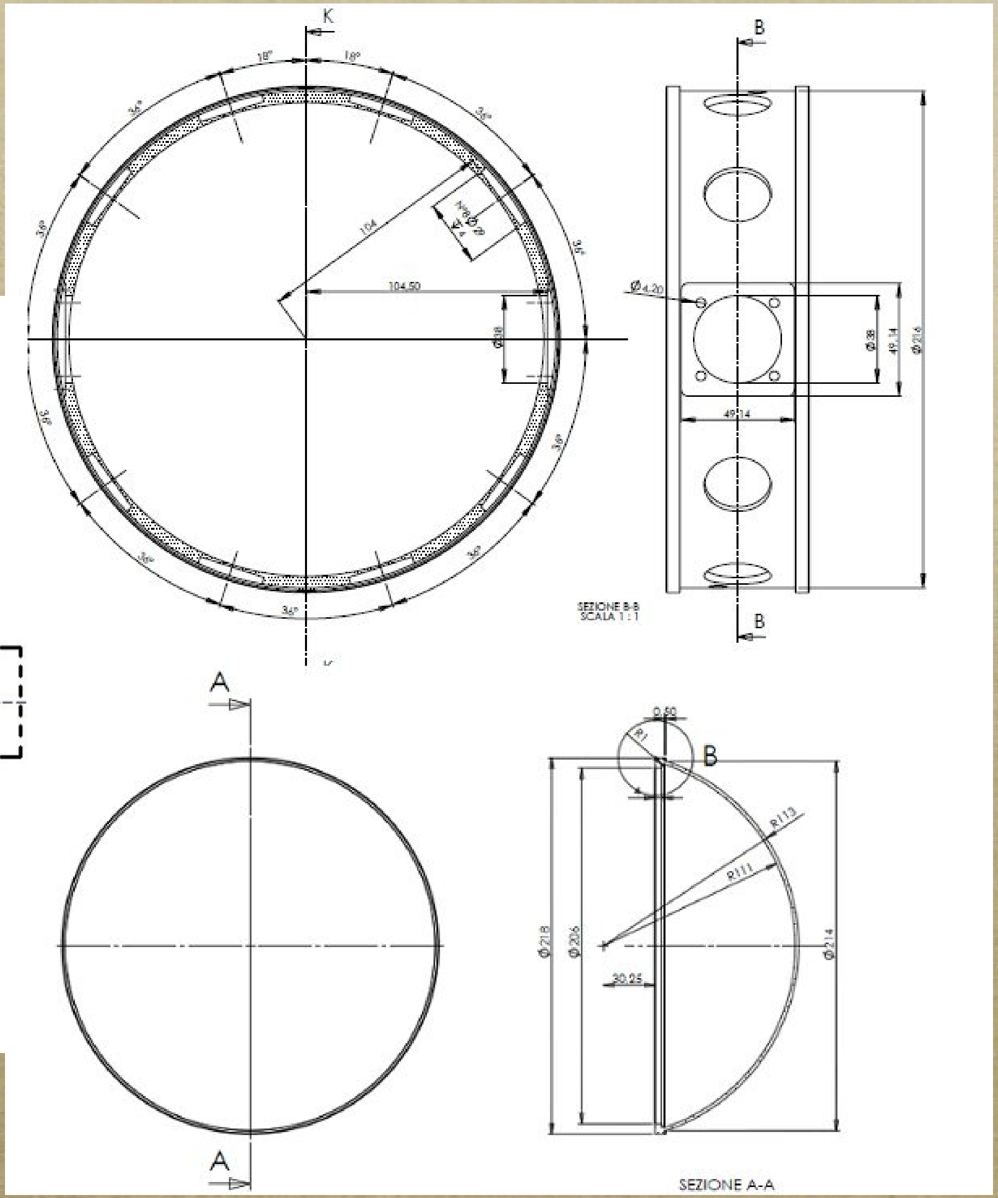
With the Si detector mounted at 5 cm distance from the target

θ coverage: → 18 to 60 degrees

The reaction chamber



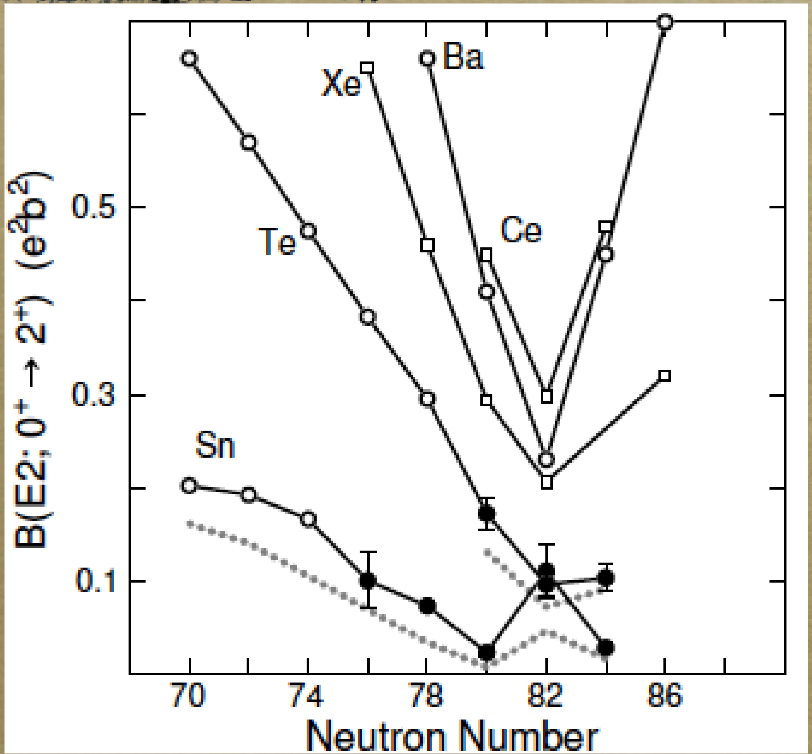
Courtesy of M. Ottanelli



Constructed by ECOVIDE

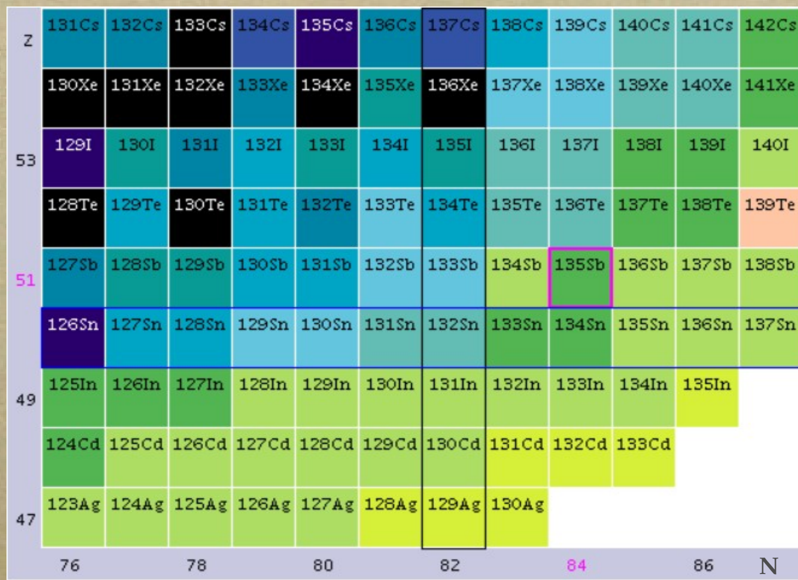
The north east region of Z=50 and N=82

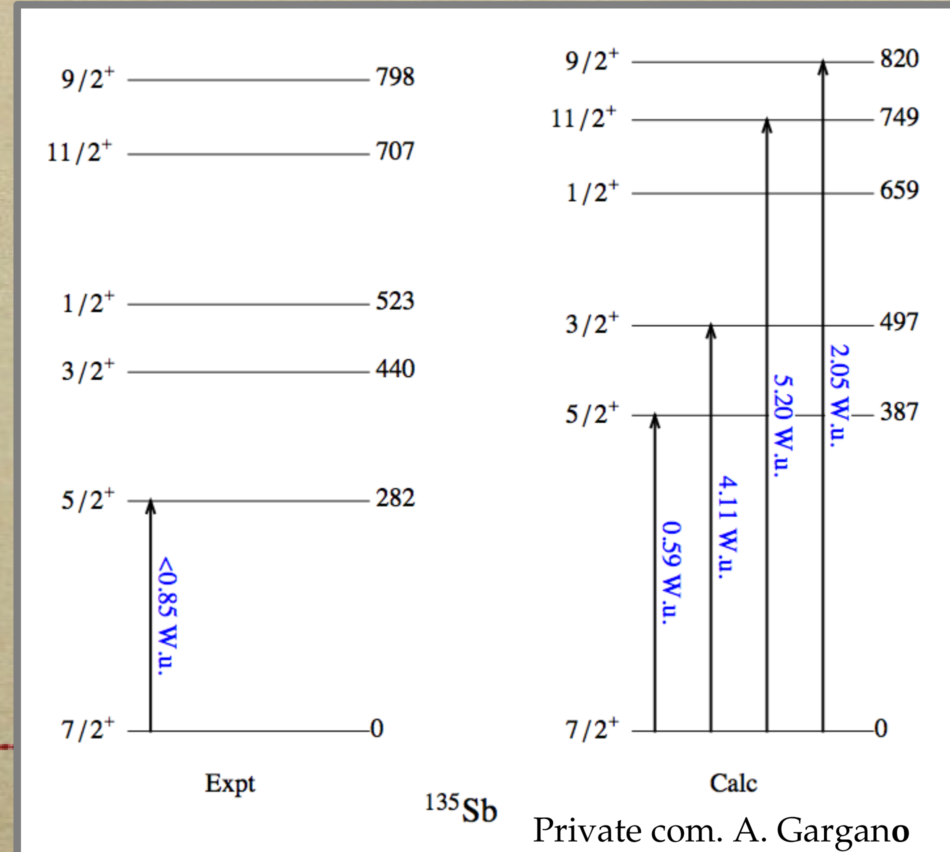
The study of exotic nuclei in the regions of shell closures is drawing much attention.
The advent of SPES neutron-rich radioactive beam facility opens the possibility for a wide range of experimental investigations of nuclei in the region around N=82 and Z=50 shell closure, whose properties are still little known.



D.C. Radford, Eur. Phys. J A 25, s01,383-387 (2005)

CoulEx of ^{135}Sb





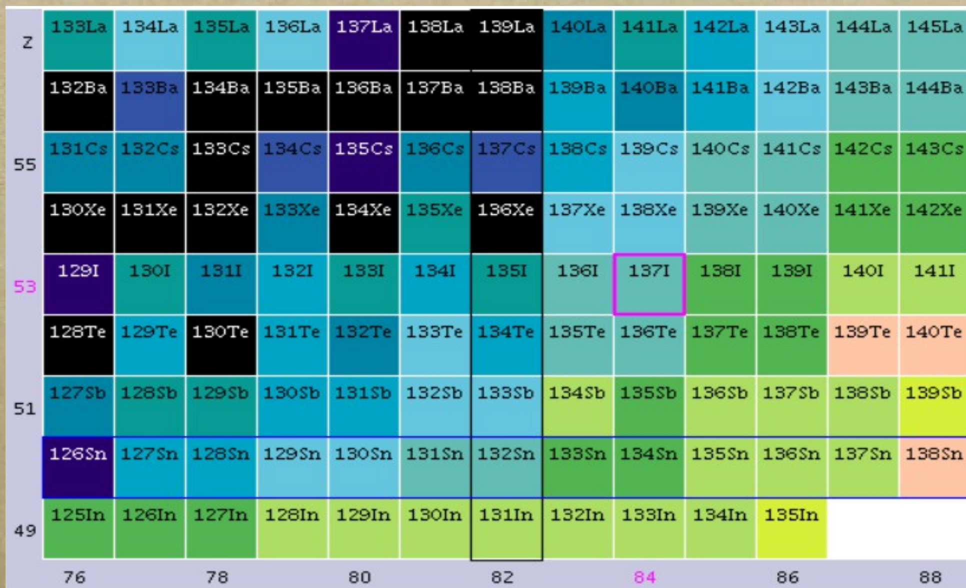
	Target	Yield (p/s)
^{135}Sb	UCx	$2.88 \cdot 10^5$

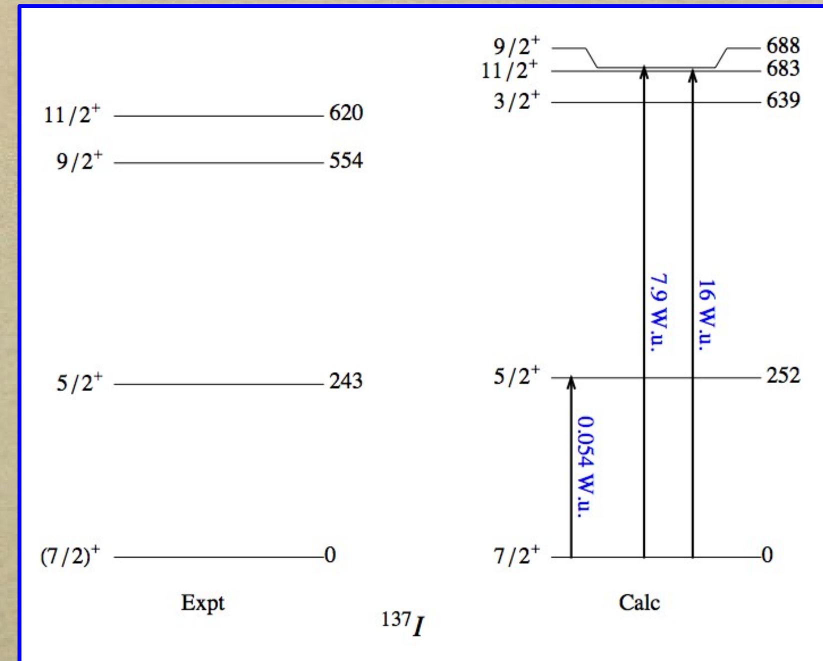
output of GOSIA for ^{135}Sb:

^{135}Sb	Energy [keV]	Y [mb•mg/cm²/sr]	counts/day
11/2+→ 7/2+	707	33	140
3/2+→ 7/2+	440	31	130

beam intensity: $2.88 \cdot 10^5$ ion/sec
beam energy:540 MeV

CoulEx of ^{137}I





Private com. A. Gargano

	Target	Yield (p/s)
^{137}I	CeS	$2.18 \cdot 10^9$

output of GOSIA for ^{137}I:

^{137}I	Energy [keV]	Y [mb•mg/cm^2/sr]	counts/day
11/2+→7/2+	683	93	300
9/2+ →7/2+	688	11	30

Investigation of critical point symmetries in neutron rich nuclei

D. Tonev, G. de Angelis, P. Petkov, N. Goutev, M.S. Yavahchova, A. Dewald, I. Deloncle, D. Bazzacco, S. Brant, E. Farnea, A. Gadea, C. He, S. Lenzi, S. Lunardi, R. Menegazzo, B. Melon, D. Mengoni, A. Nannini, D. R. Napoli, H. Penttila, A Pipidis, F. Recchia, E. Sahin, C.A. Ur, J.Valiente Dobon, and Q. Zhong

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The X(5) model

X(5): (Quasi-) Symmetry at the critical point of the phase/shape transition from spherical to axial deformed (Vibrator- rigid Rotor)

The E(5) model

E(5): Symmetry at the critical point of the phase/shape transition from spherical to triaxial γ-soft deformed (Vibrator- γ-soft)

2001 the approximate solution of the Bohr Hamiltonian

$H_B = T_{vib} + T_{rot} + V(\gamma,\beta)$

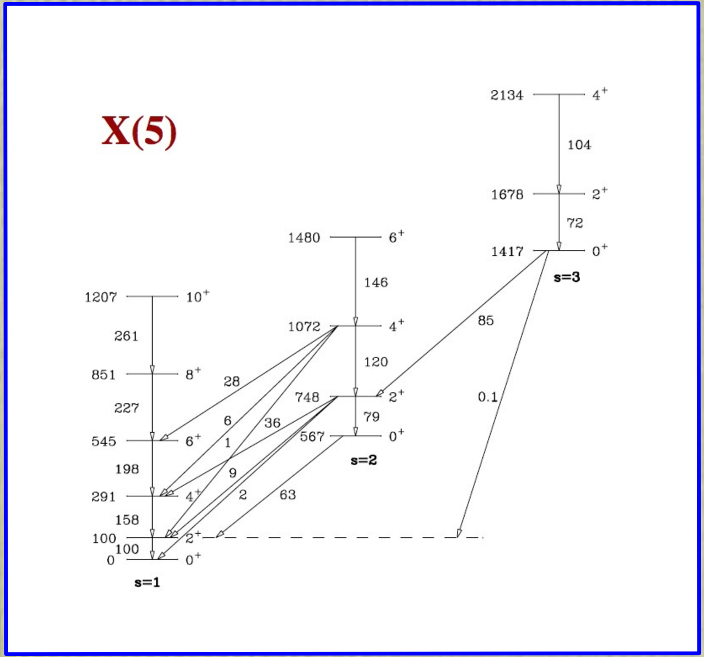
proposed by Iachello, with

$V(\gamma,\beta) = V(\gamma) + V(\beta)$

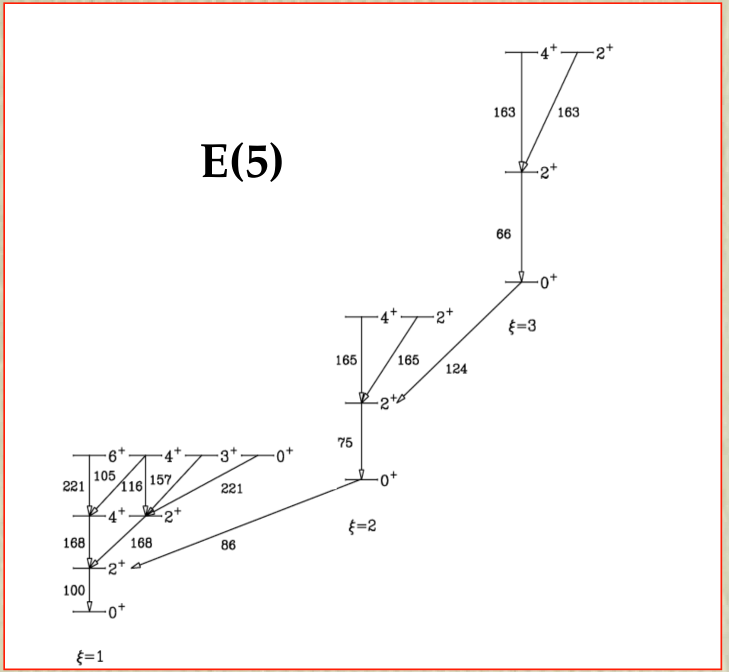
$V(\gamma)$ harmonic oscillator in γ

$V(\beta)$ square well in β

$V(\beta)$ square well in β



F.Iachello, Phys.Rev.Lett. 87 (2001) 052502

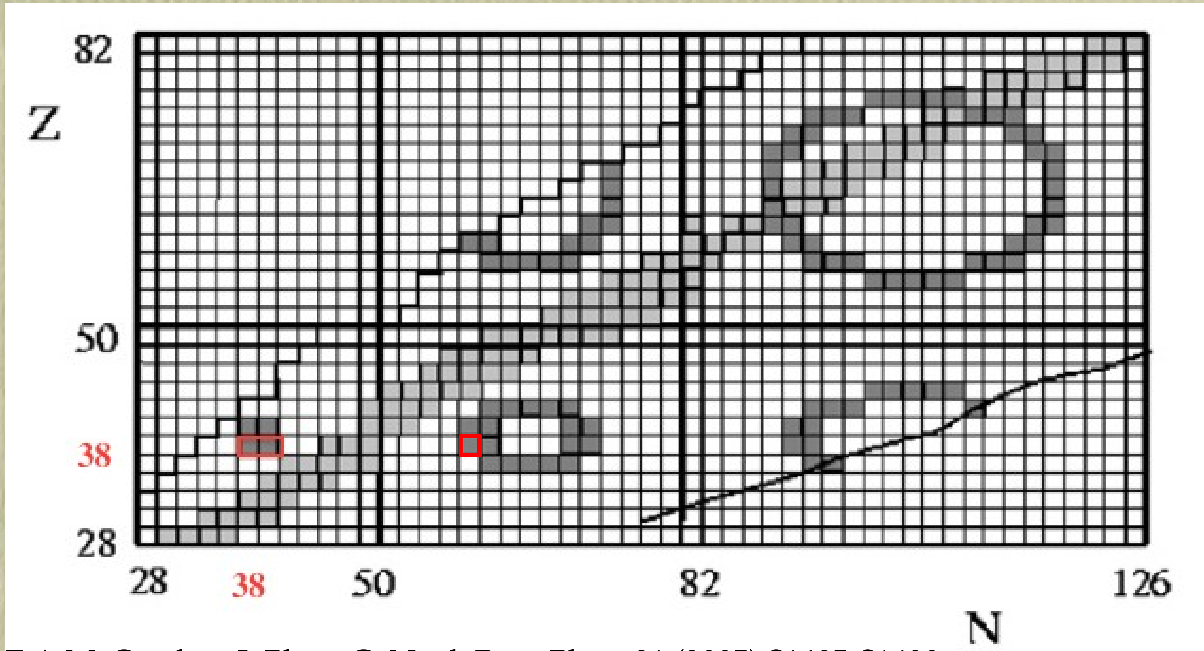


Iachello, Phys.Rev.Lett. 85 (2000) 3580

Parameter free model

Only two scaling factors for the comparison with experimental data

X(5) critical point symmetry candidates



E.A.McCutchan,J. Phys. G: Nucl. Part. Phys. 31 (2005) S1485-S1490

A ~ 80

^{76}Sr, ^{78}Sr

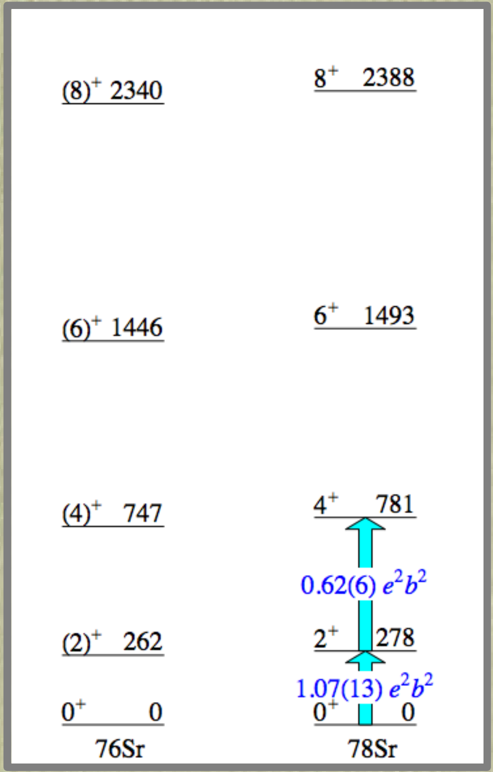
	Target	Yield (p/s)
^{76}Sr	ZrC	$7.2 \cdot 10^{5}$
^{78}Sr	ZrC	??

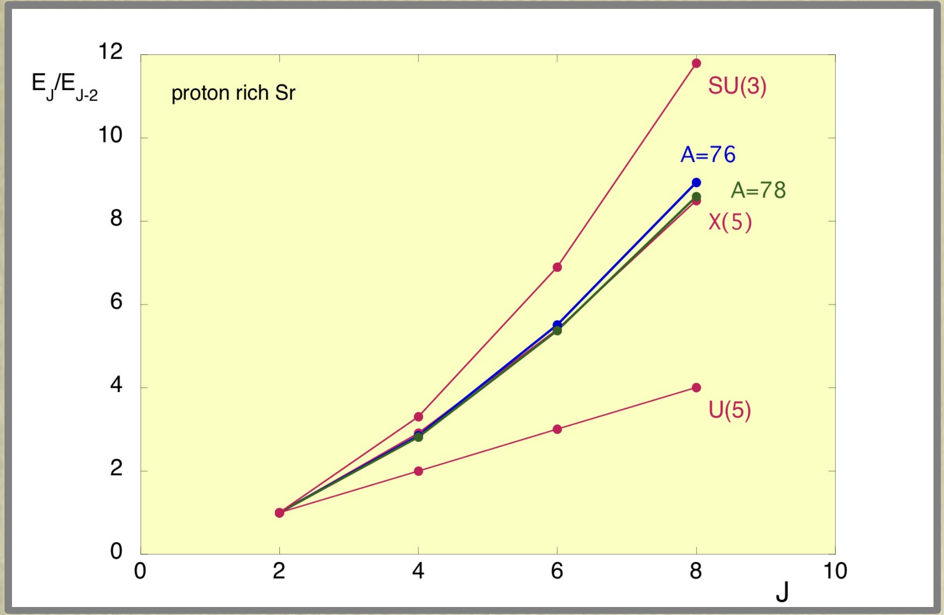
A ~ 100

^{98}Sr

	Target	Yield (p/s)
^{98}Sr	UCx	$1.2 \cdot 10^{4}$

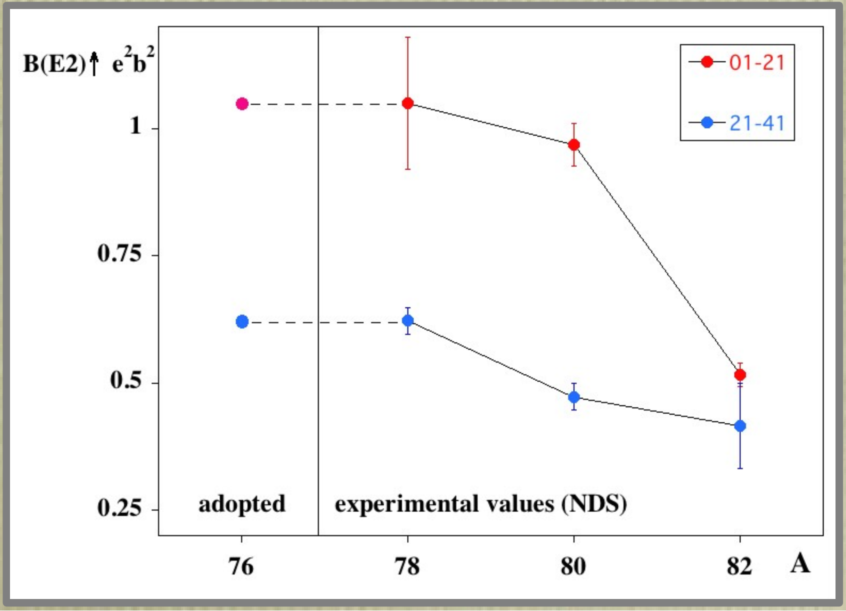
CoulEx of ^{76}Sr





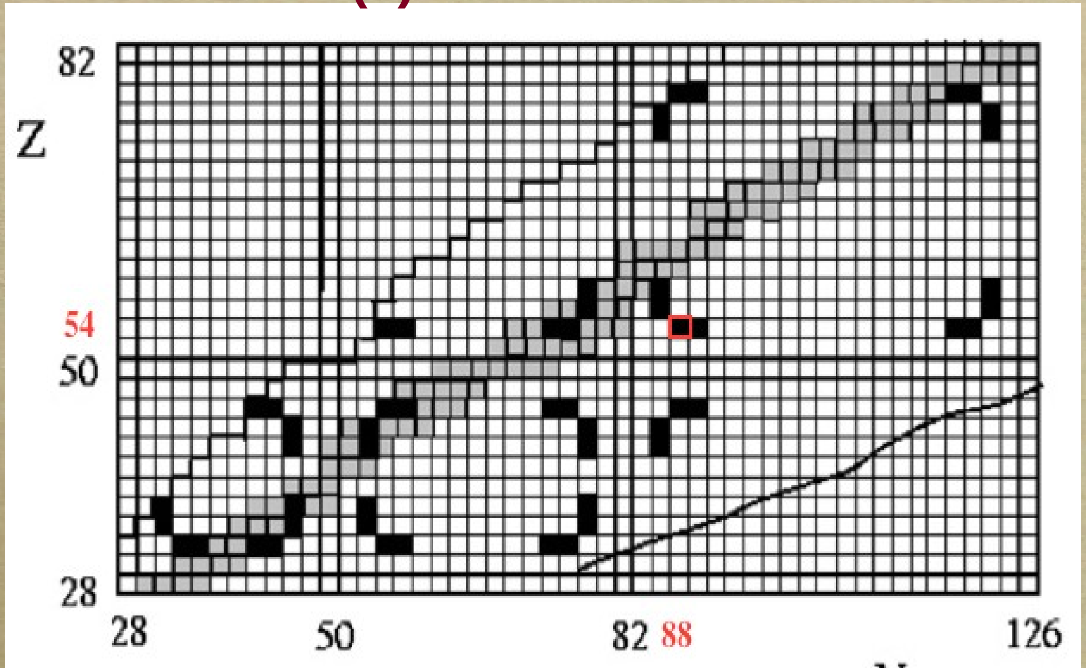
output of GOSIA:

	σ[mb/sr mg/cm²]	counts / day
$2_1 \rightarrow 0_1$	914	350
$4_1 \rightarrow 2_1$	72	40



We have performed a calculation with the GOSIA code for a 340MeV ^{76}Sr beam impinging on a 1mg/cm2 thick ^{208}Pb target, assuming a beam intensity of 8000 ion/sec.

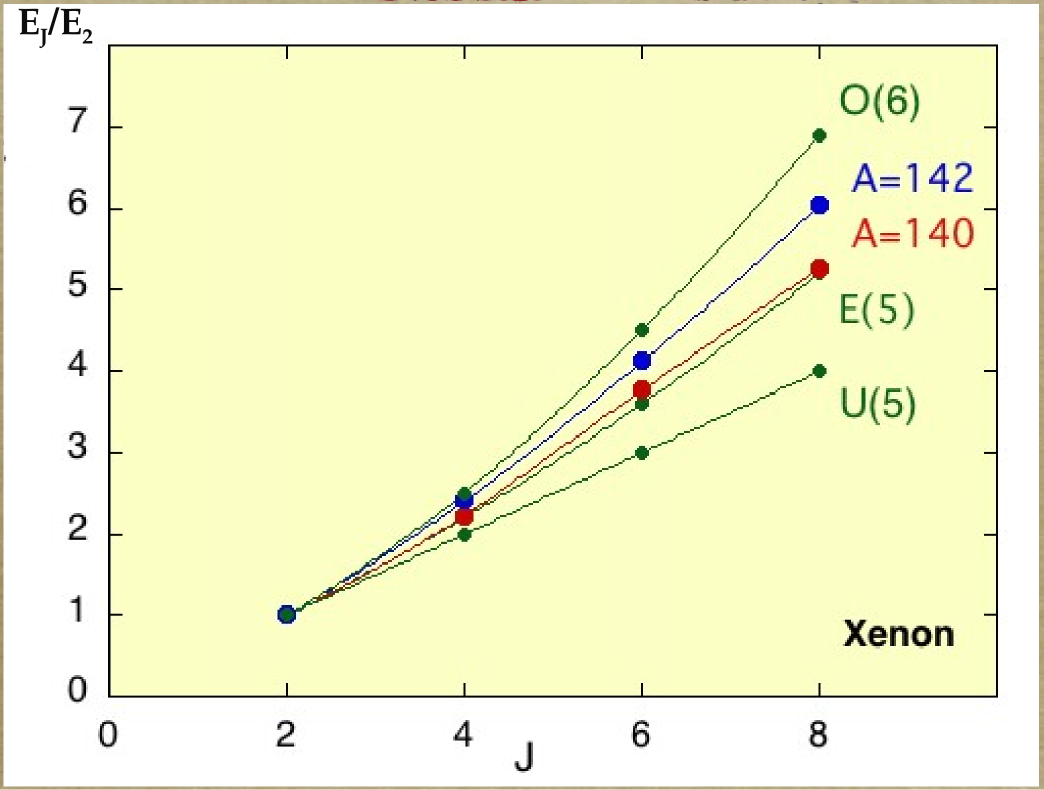
E(5) candidates



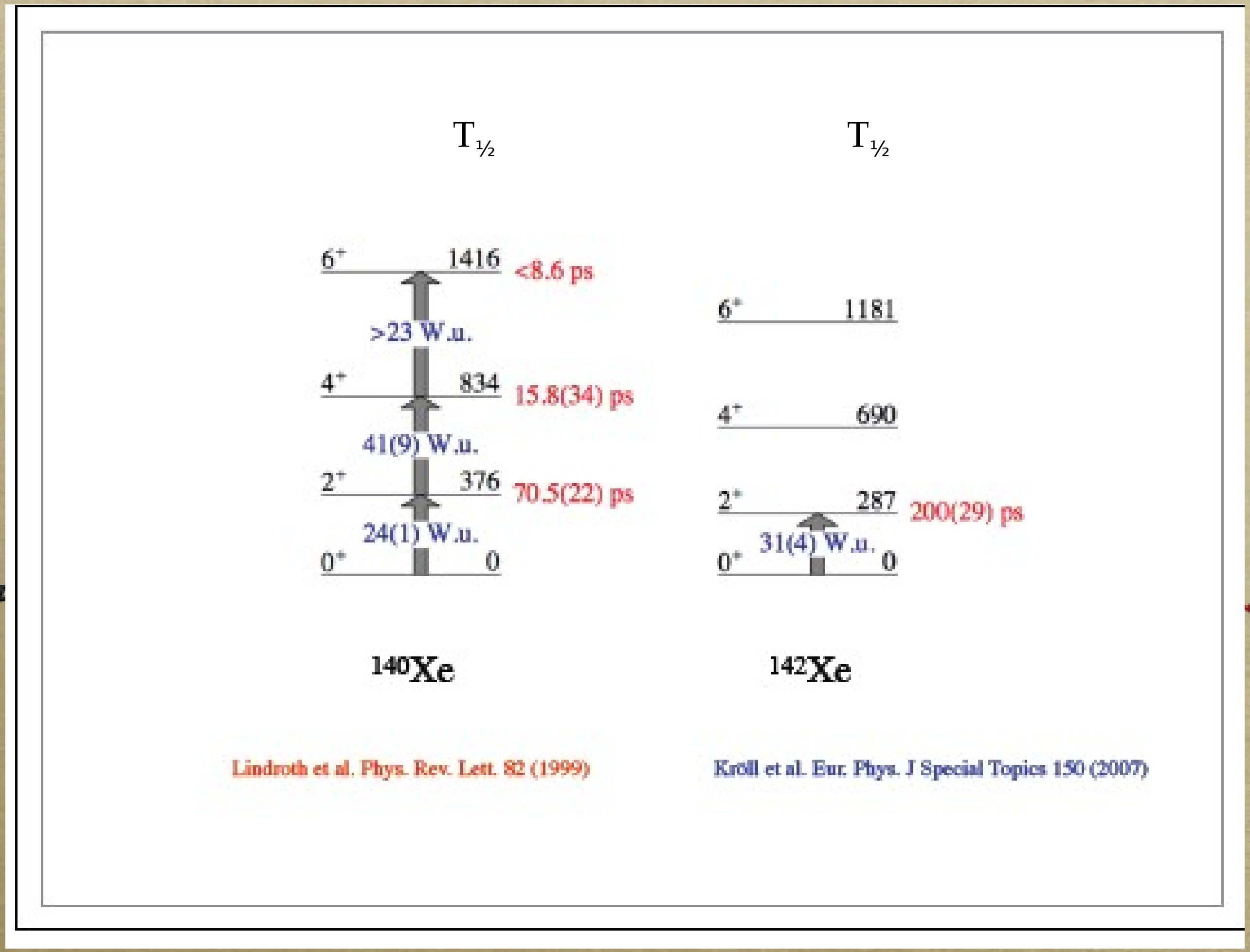
McCutchan,J. Phys. G: Nucl. Part. Phys. 31 (2005) S1485-S1490

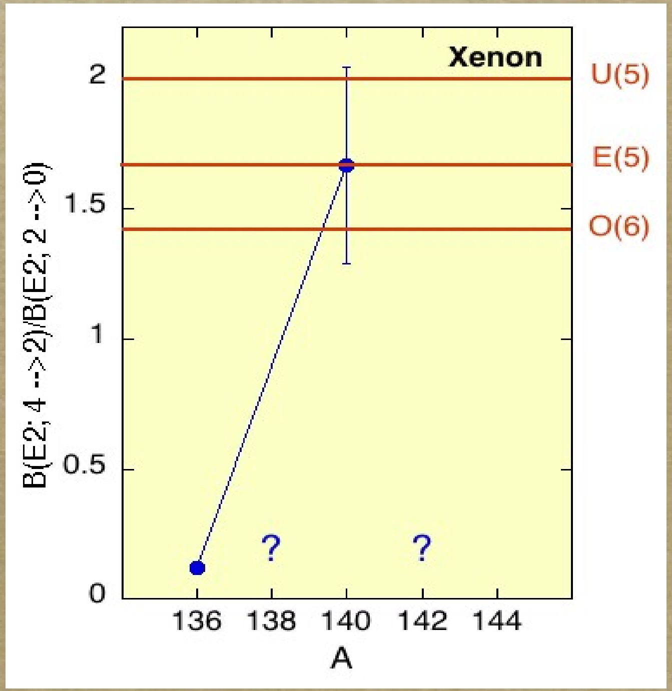
CoulEx of $^{140,142}Xe$

	Target	Yield (p/s)
^{140}Xe	UCx	$1.34 \cdot 10^{7}$
^{142}Xe	UCx	$7.49 \cdot 10^{5}$



^{140,142}Xe isotopes: what is known





The available information does not allow to draw a definite conclusion

output of GOSIA for $^{140,142}Xe$:

beam intensity: $1.3 \cdot 10^7$ ion/sec
beam energy: 580 MeV

^{140}Xe	Energy [keV]	Y [mb•mg/cm^2/sr]	counts/hour
$2_1 \rightarrow 0_1$	376	567	6333
$4_1 \rightarrow 2_1$	458	160	1787
$6_1 \rightarrow 4_1$	582	23	257

beam intensity: $7.5 \cdot 10^5$ ion/sec
beam energy: 600 MeV

^{142}Xe	Energy [keV]	Y [mb•mg/cm^2/sr]	counts/hour
$2_1 \rightarrow 0_1$	287	735	459
$4_1 \rightarrow 2_1$	403	138	86
$6_1 \rightarrow 4_1$	490	23	14

Conclusions

- We are setting up an apparatus for detection of radioactive ions.
  It can be coupled to a Gamma array (Galileo, Agata)

- As an example we report CoulEx of ^{135}Sb, ^{137}I, ^{76,78,98}Sr and ^{140,142}Xe

- We presents the results of GOSIA calculations for ^{135}Sb, ^{137}I, ^{76}Sr and ^{140,142}Xe

Proton-rich beams for SPES-α

Development of target materials for proton-rich beams, will increase the experimental possibilities at SPES toward the next call for LOI's in 2012.