Determination of the $B(E3, 0^+ \rightarrow 3^-)$ strength in the octupole correlated nuclei ^{142,144}Ba using Coulomb excitation

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Local contact: Liam P. Gaffney

Status report

INTC Meeting

November 2nd 2016

Octupole collectivity in nuclei

Microscopic

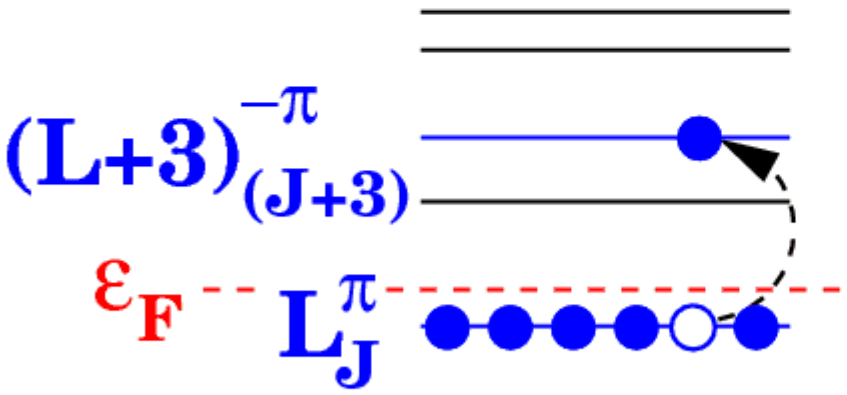
Nuclear shell structure

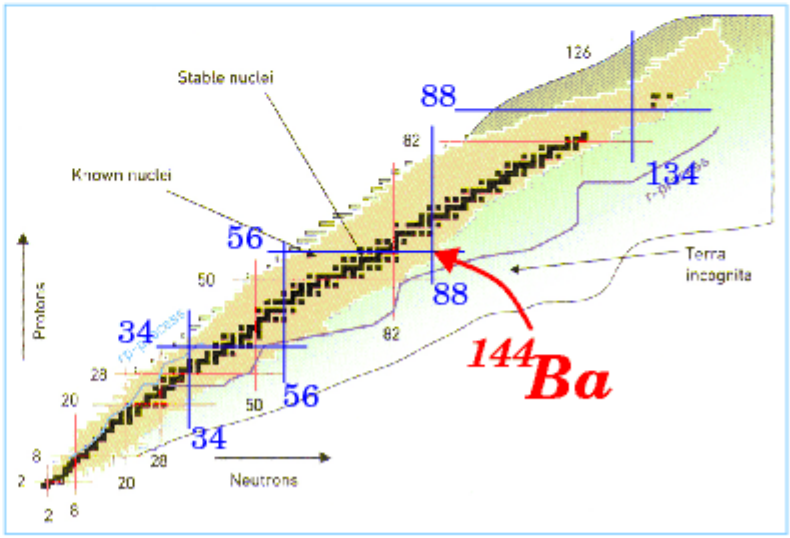
$E((L+3)(J+3))-E(LJ) \ll$

$E(LJ) < \varepsilon_F < E((L+3)(J+3))$

→

Strong octupole correlation

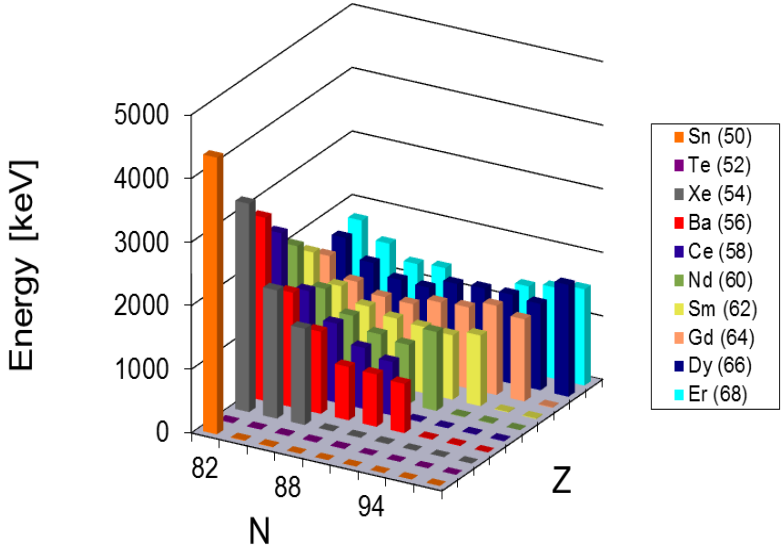


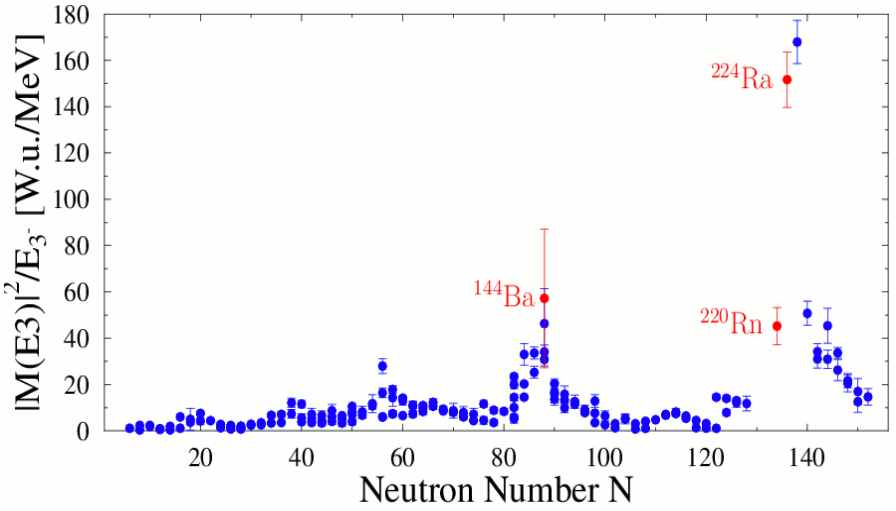


Experimental observables – Status

3^- excitation energies

B(E3) strength

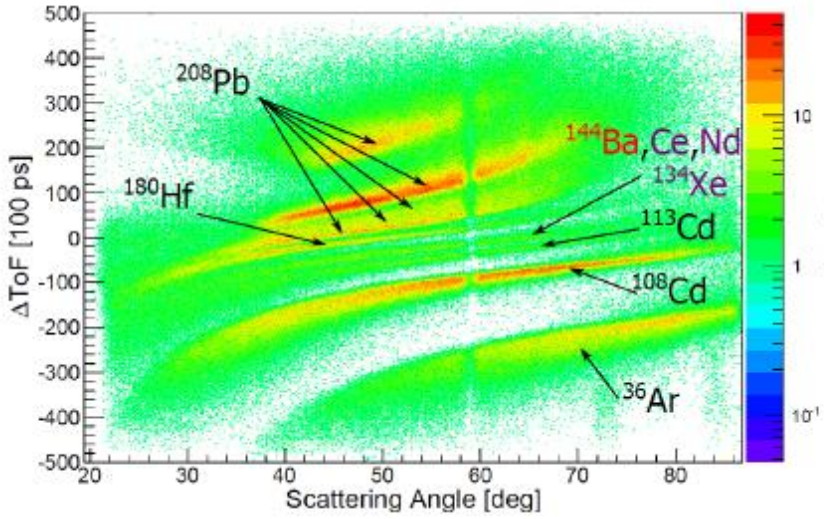




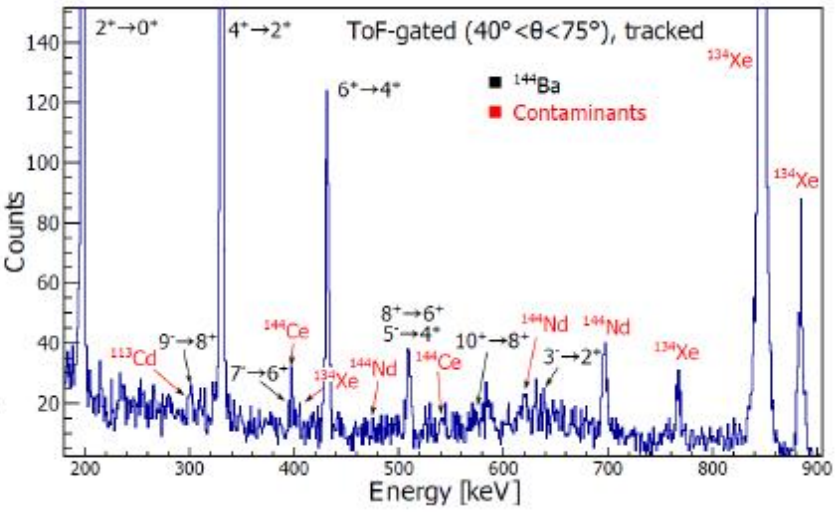
^{144}Ba Coulex on ^{208}Pb
Argonne National laboratory (CARIBU)

B.Bucher et al., PRL 116, 112503 (2016)

Particle ID plot



γ-ray spectrum



Beam intensity:
8×10^3/s

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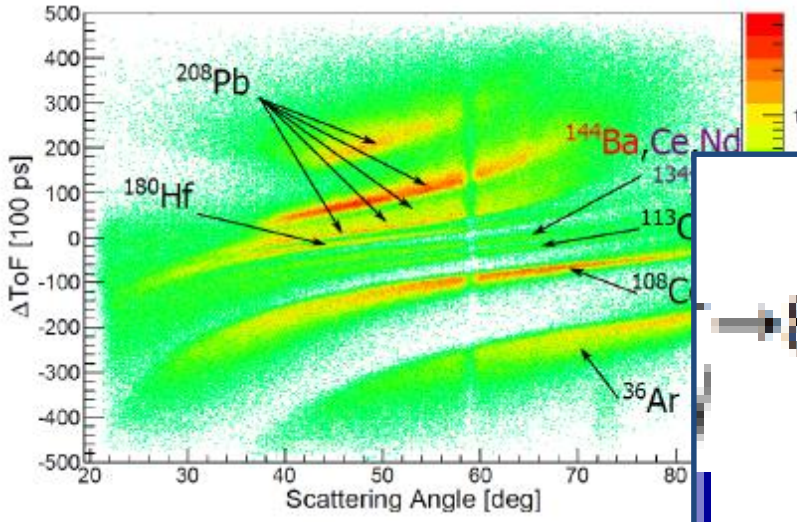
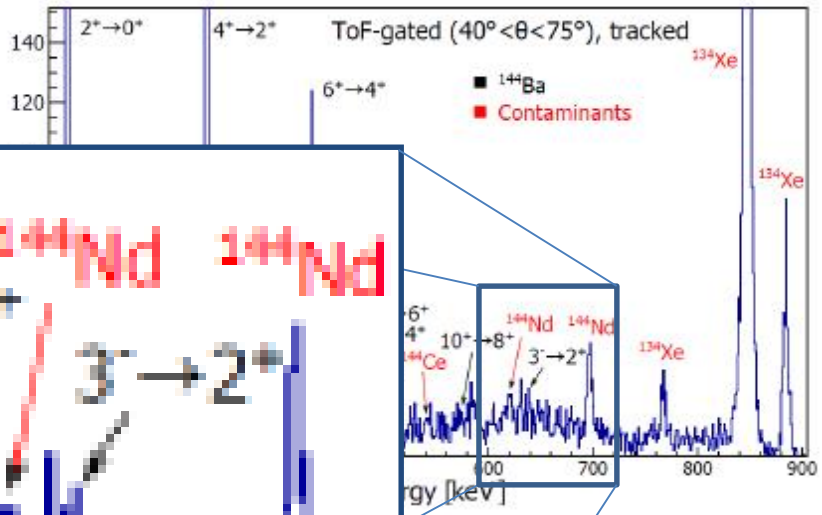
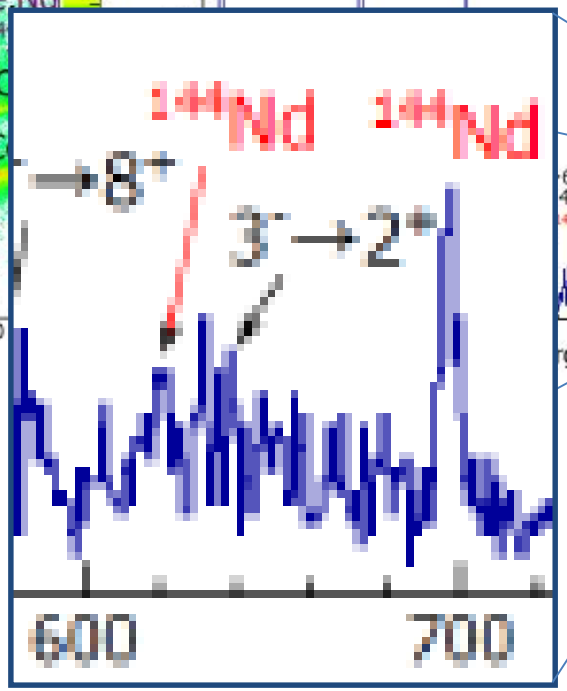
Particle ID plot



γ-ray spectrum





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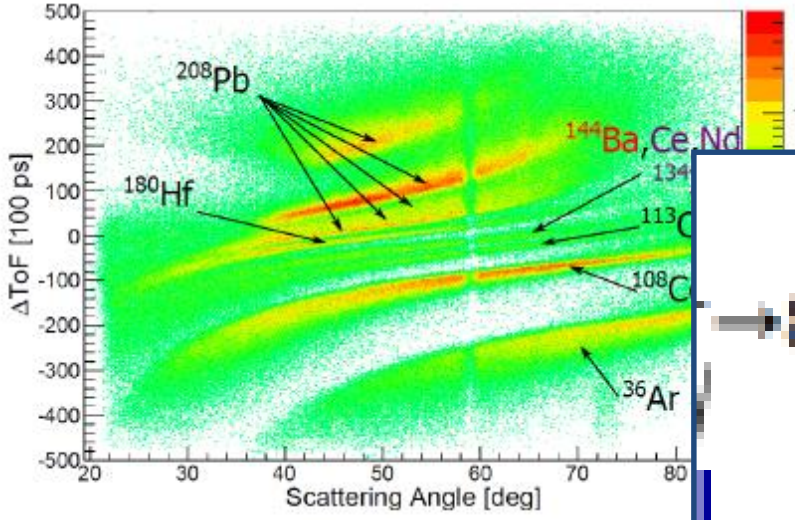
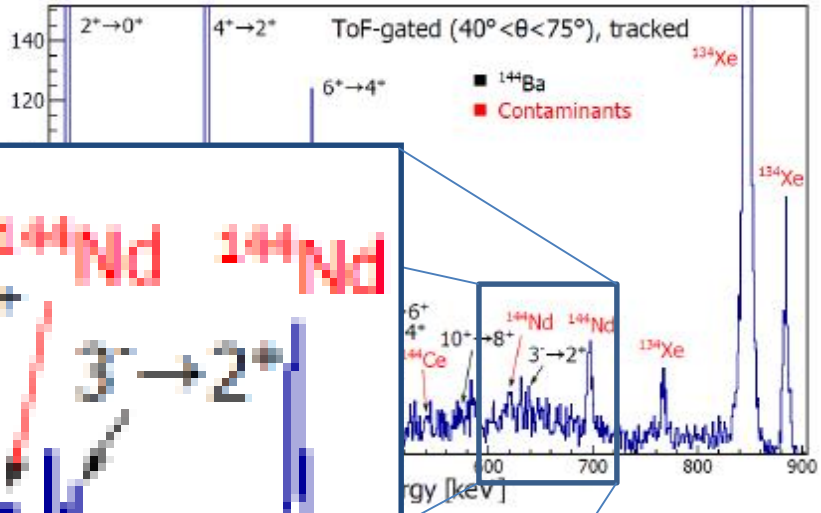
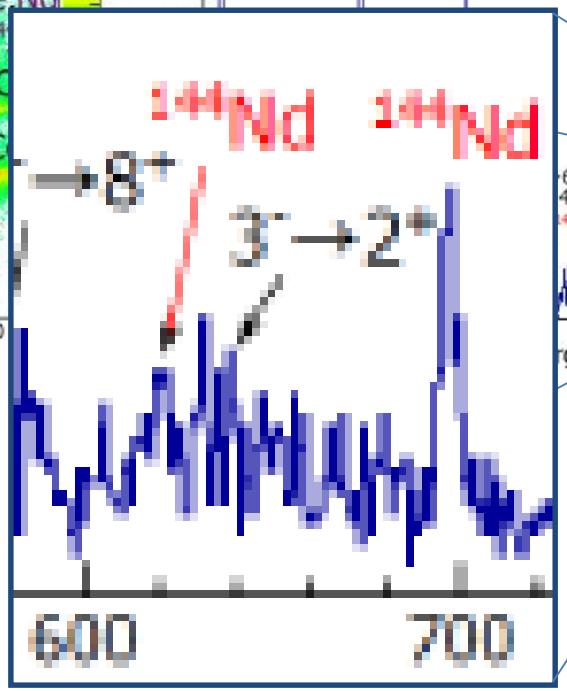


γ-ray spectrum





Beam intensity:
8×10^3/s

$$B(E3, 3^- \rightarrow 0^+) = 48^{+25}_{-34}\ W.u.$$

^{144}Ba Coulex on ^{208}Pb
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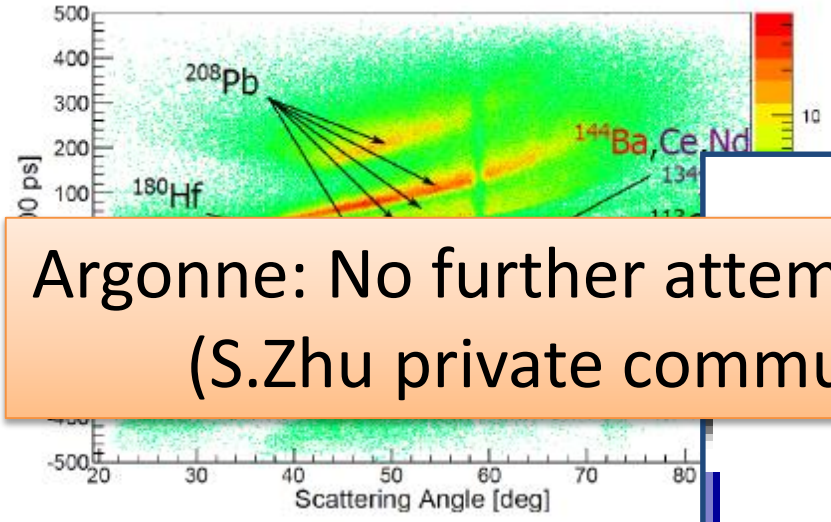
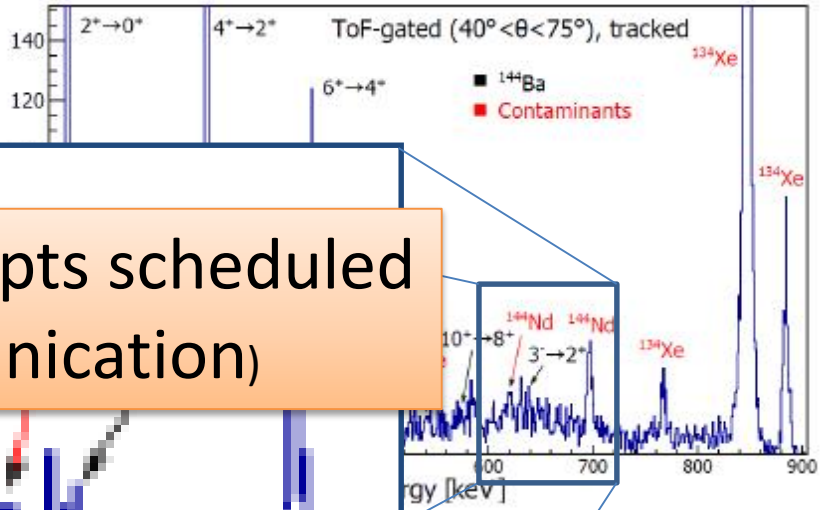
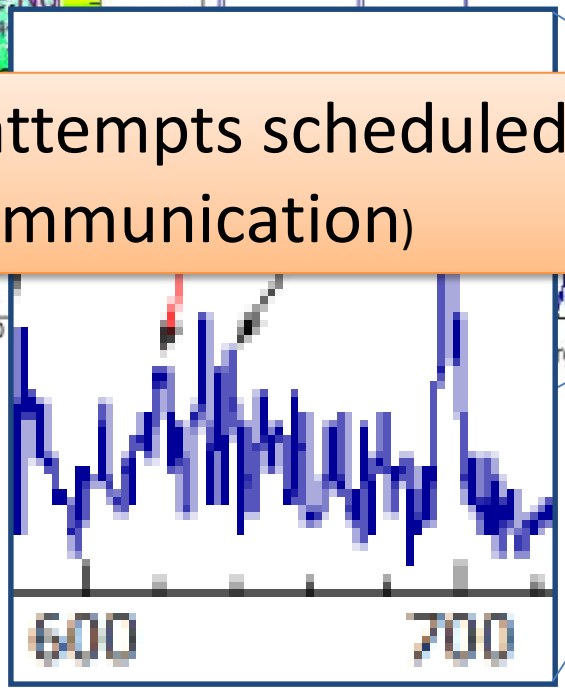
Particle ID plot



γ-ray spectrum



Argonne: No further attempts scheduled
(S.Zhu private communication)



Beam intensity:
8×10^3/s

$B(E3, 3^- \rightarrow 0^+) = 48^{+25}_{-34}\ W.u.$

ISOLDE production yields & experimental setup

Nucleus	**Half-life** [s]	**Target Material**	**Ip** [μA]	**PSB or SC**	**ISOLDE Production Yield** [Ions/μC]	**Yield at Coulex target** [Ions/s]
^{142}Ba	642	UCx	1.5	SC	*1.1x10^{8}	**2.2x10^{6}
^{144}Ba	11.5	UCx	1.5	SC	*1.0x10^{7}	**2.0x10^{5}

** Assumption: 2% transmission through HIE-ISOLDE

Setup: RILIS, Miniball & TRex

* http://isolde.web.cern.ch/ISOLDE/

γ–ray yields ^{142}Ba

Assumption: $B(E3, J^{+} \rightarrow J^{-}) = 10$ W.u.

Target	Time [h]	Transition	Eγ [keV]	Counts
^{58}Ni	16	$2^+ \rightarrow 0^+$	359.6	513470
	(40-65°)	$4^+ \rightarrow 2^+$	475.2	30140
		$3^- \rightarrow 2^+$	966.9	350
		$1^- \rightarrow 0^+$	1326.5	<10
^{208}Pb	24	$2^+ \rightarrow 0^+$	359.6	248430
	(40-70°)	$4^+ \rightarrow 2^+$	475.2	79270
		$3^- \rightarrow 2^+$	966.9	400
		$1^- \rightarrow 0^+$	1326.5	<10

γ–ray yields ^{144}Ba

Assumption: $B(E3, J^{+} \rightarrow J^{-}) = 15$ W.u.

Target	Time [h]	Transition	Eγ [keV]	Counts
^{58}Ni	80	$2^+ \rightarrow 0^+$	199.3	204350
	(33-70°)	$4^+ \rightarrow 2^+$	330.9	13000
		$3^- \rightarrow 2^+$	639.0	300
		$1^- \rightarrow 0^+$	759.0	230
^{208}Pb	120	$2^+ \rightarrow 0^+$	199.3	305170
	(40-70°)	$4^+ \rightarrow 2^+$	330.9	77900
		$3^- \rightarrow 2^+$	639.0	280
		$1^- \rightarrow 0^+$	759.0	240

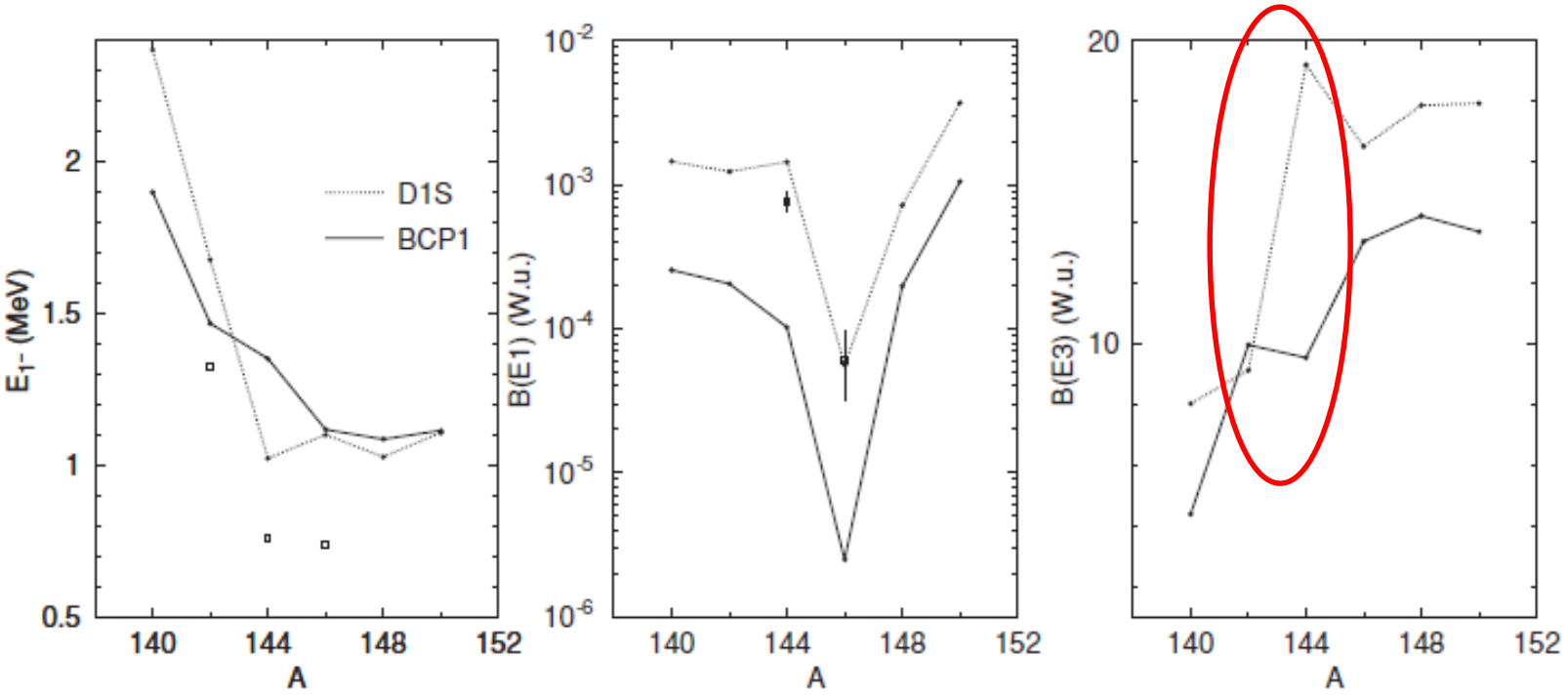
Requested beam time

Laser ionisation ~10–15%
50% Laser ON & 50% Laser OFF

…Meanwhile:
Increased to >25%

$^{142}Ba \rightarrow {}^{58}Ni$:	2 shifts
$^{142}Ba \rightarrow {}^{208}Pb$:	3 shifts
$^{144}Ba \rightarrow {}^{58}Ni$:	10 shifts
$^{144}Ba \rightarrow {}^{208}Pb$:	15 shifts
Setup&Tune HIE–ISOLDE:	3 shifts
Total:	**33 shifts**

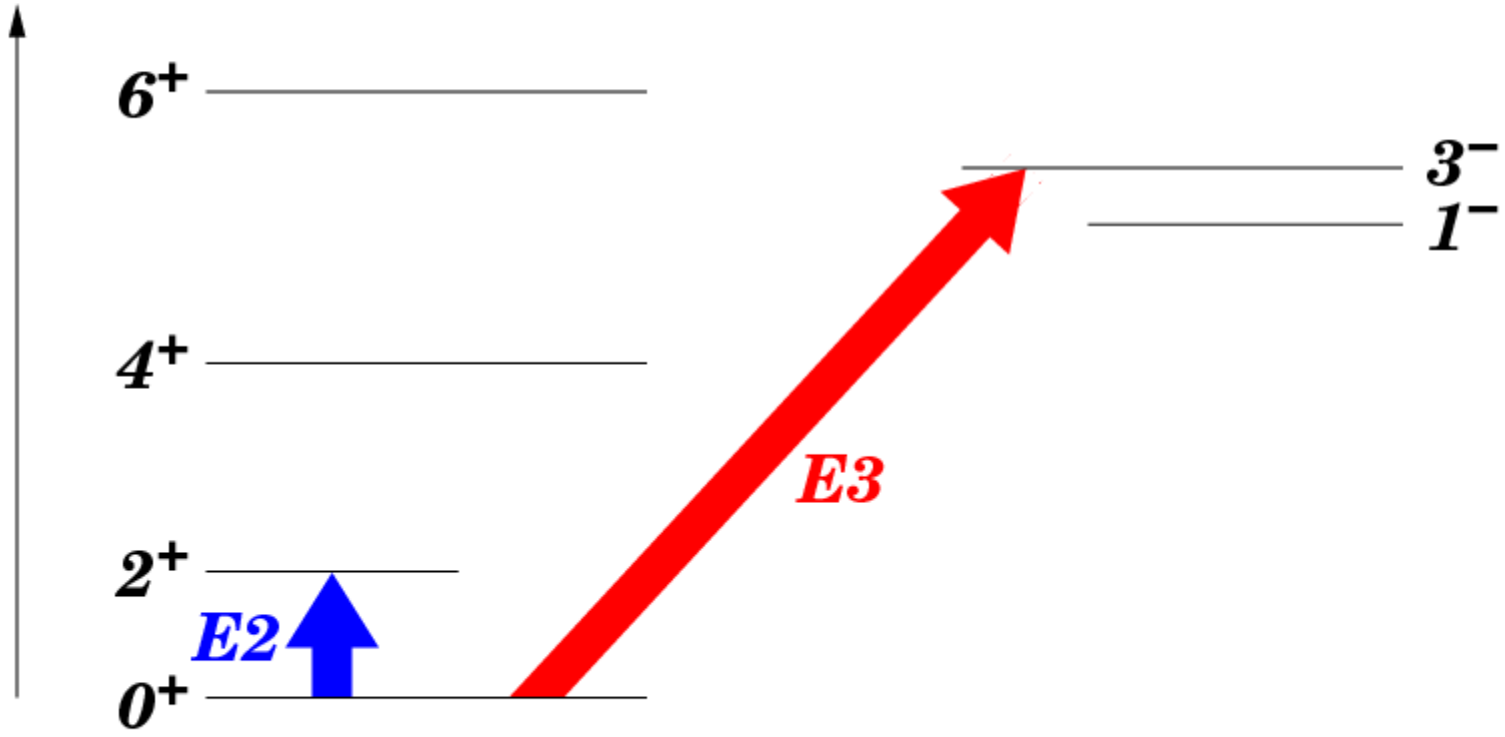
Octupole collectivity in the Barium isotopic chain? Predictions by theory



L.M.Robledo et al., Phys.Rev.C 81 (2010) 034315

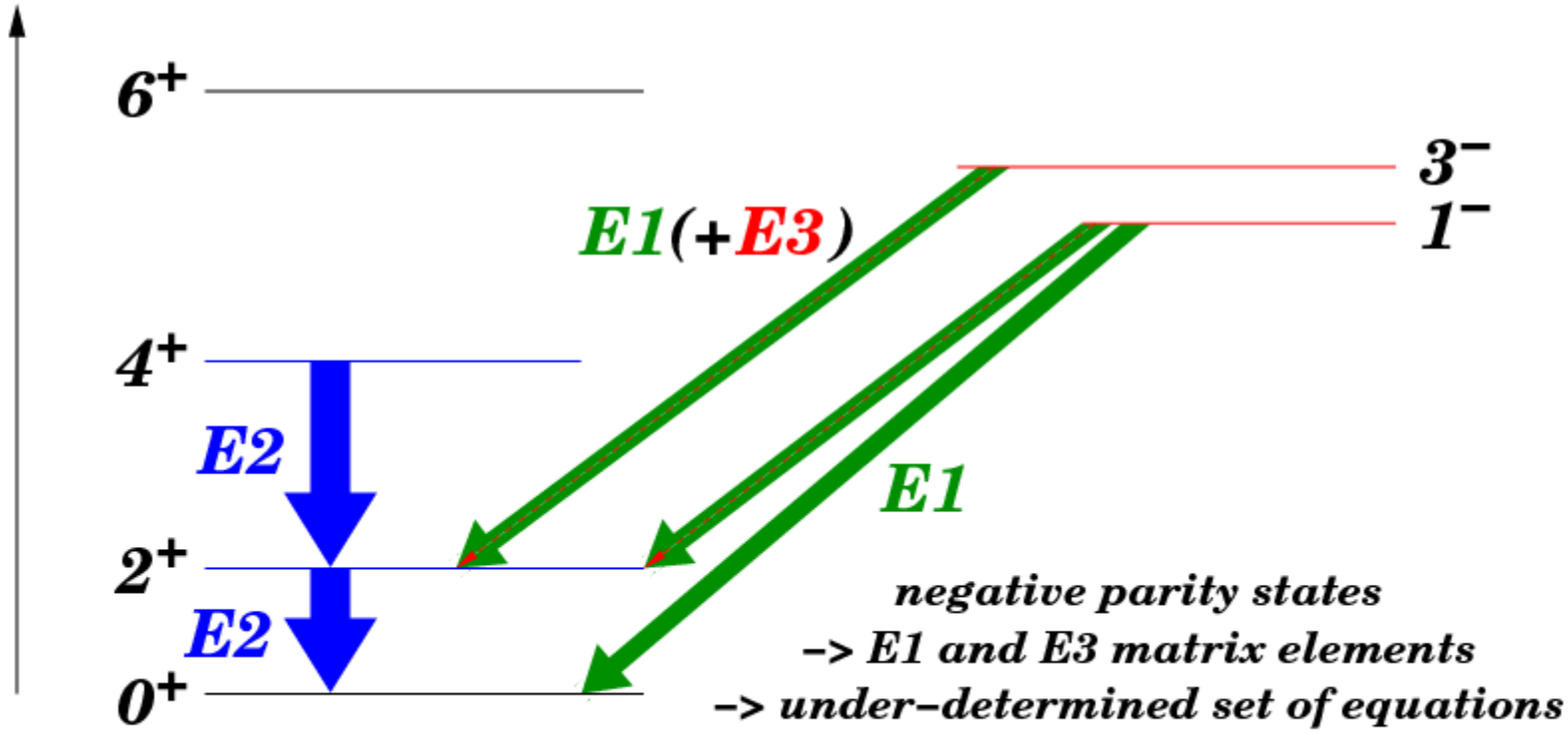
Coulomb excitation of ^{144}Ba

First order process



Coulomb excitation of ^{144}Ba

de–excitation: γ–decay



Solution: Change Z of target –> change excitation paths