



Investigation of the nuclear structure of ^{33}Al to probe the island of inversion

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2018 CAP Congress

Outline

Shell evolution and mapping the island of inversion

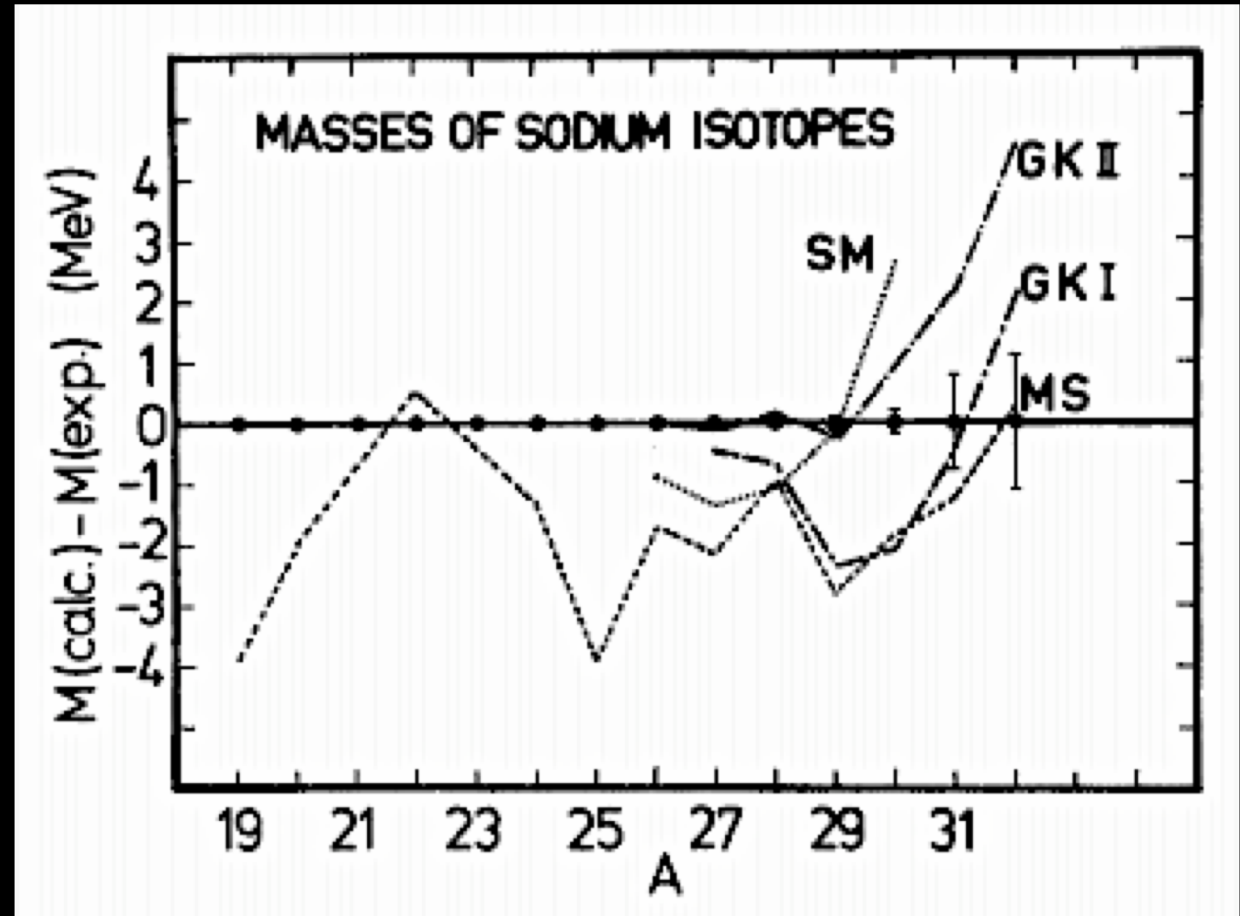
Motivation for investigating ^{33}Al

Experiment S1367: TRIUMF laboratory and GRIFFIN

Data analysis to determine half-lives and level scheme

Evolution of the shell structure

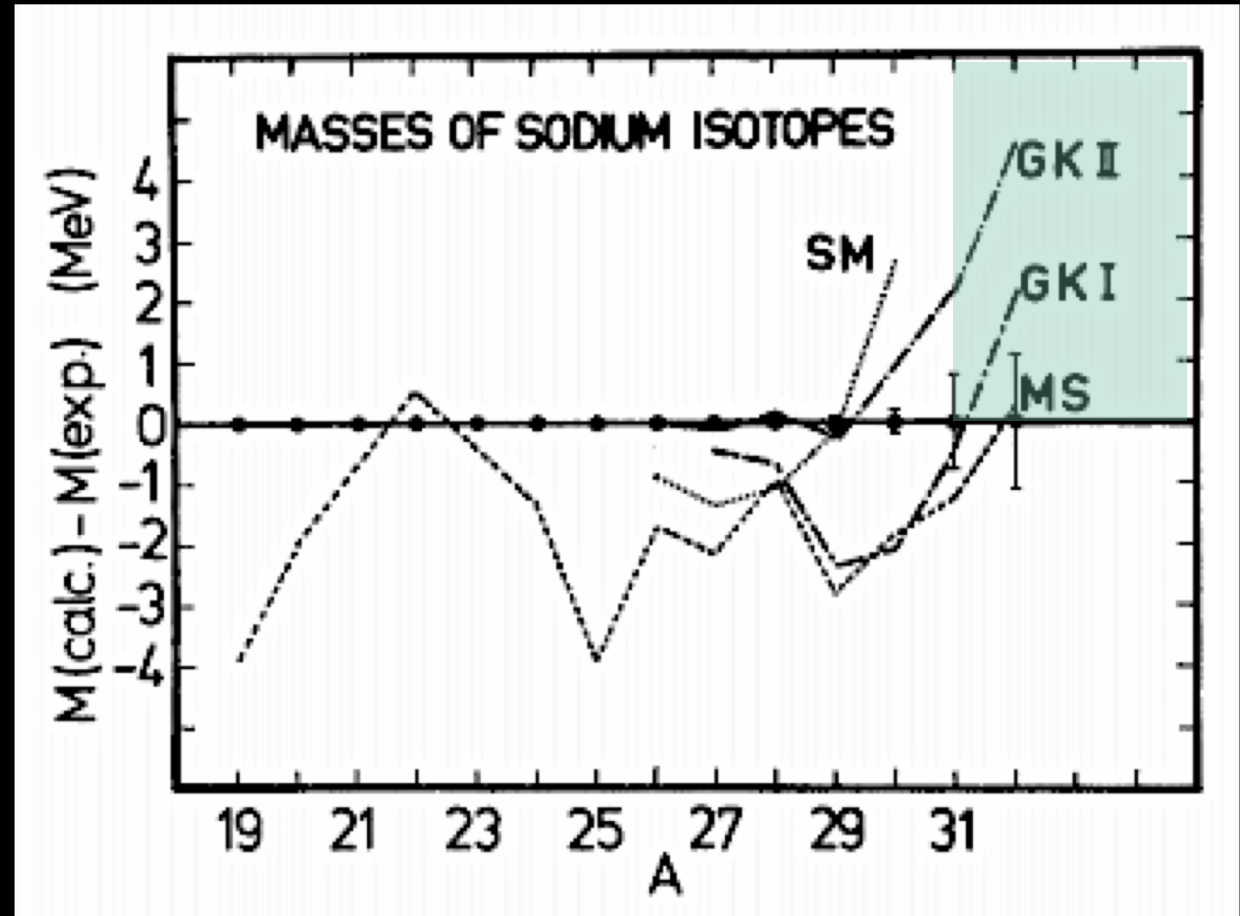
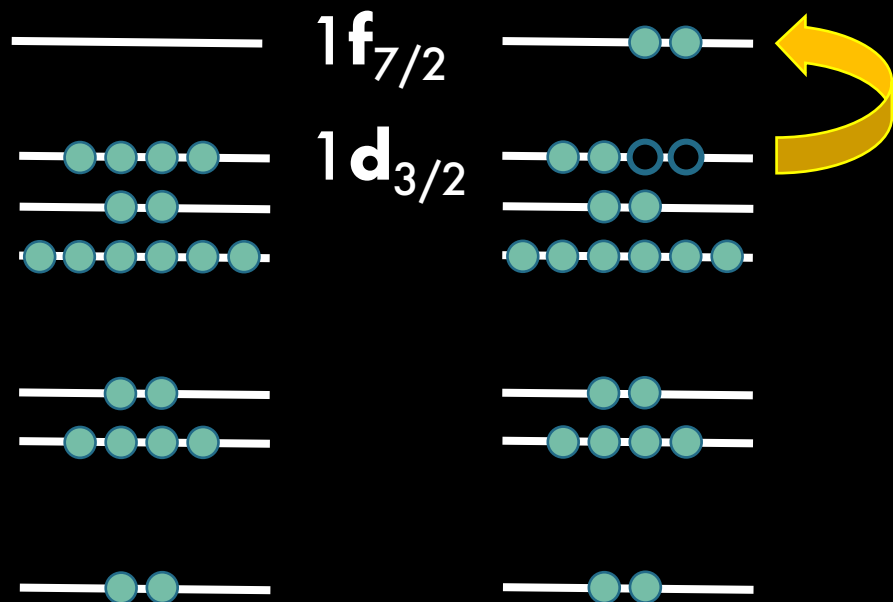
The spherical magic number at $N = 20$ disappears in neutron-rich nuclei



C. Thibault, et al., Phys. Rev. C **12**, 644 (1975)

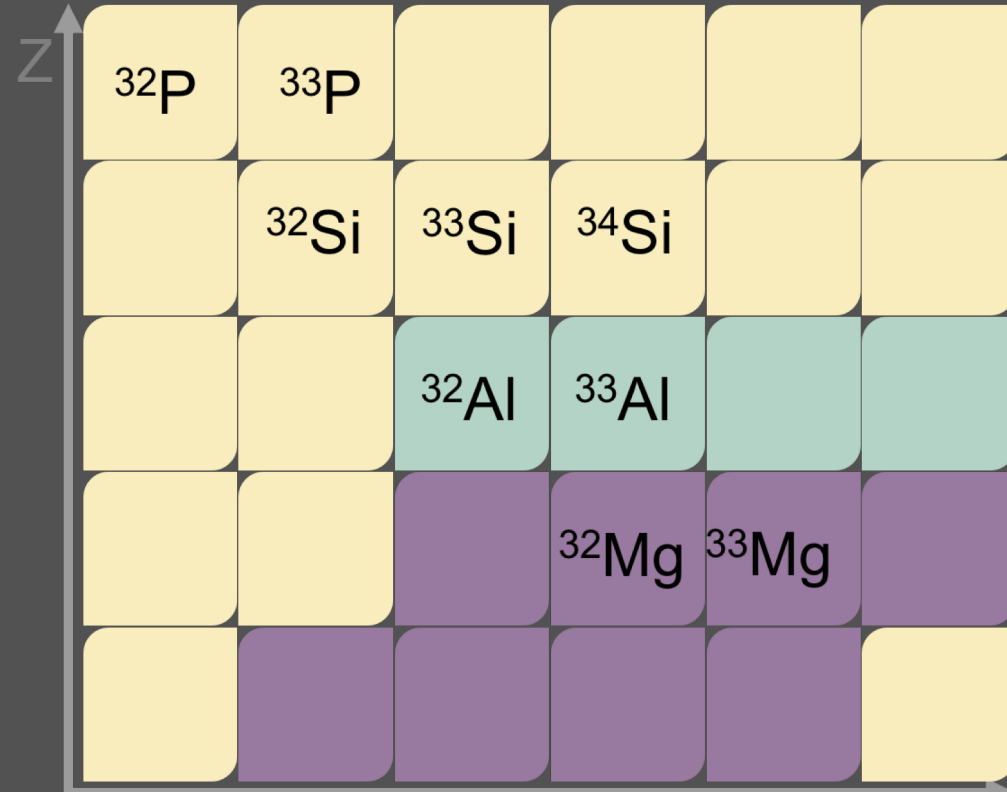
Evolution of the shell structure

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The island of inversion



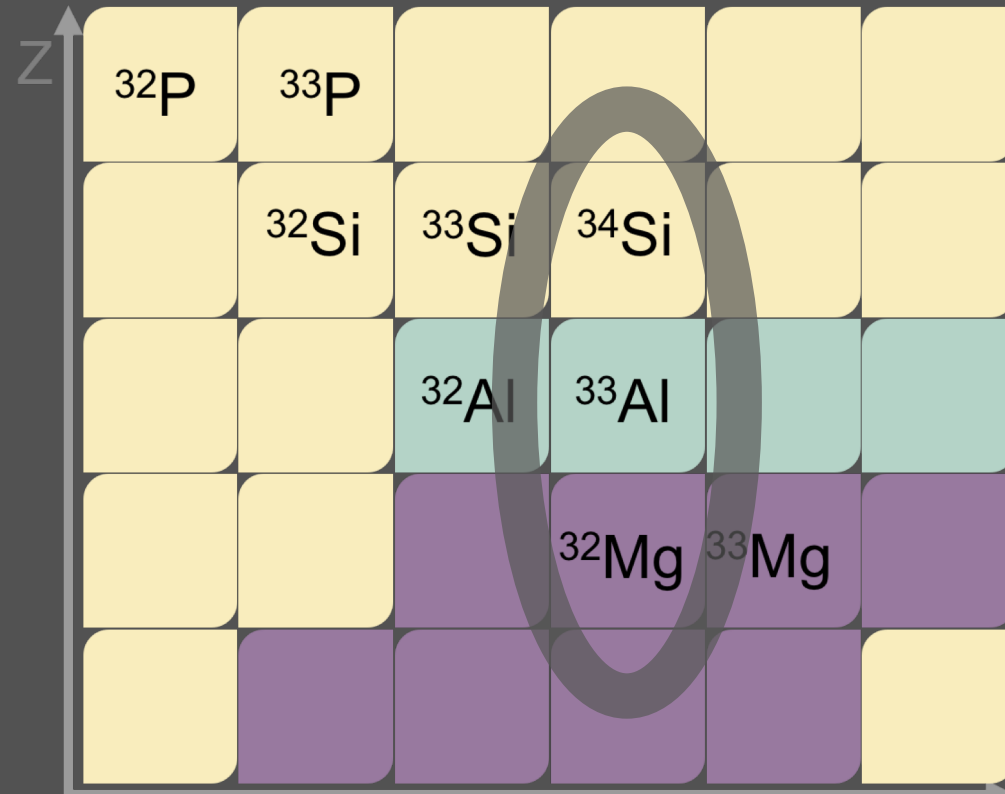
UNKNOWN CONFIGURATION N

INTRUDER CONFIGURATION

NORMAL CONFIGURATION

P. Himpe et al., Physics Letters B 643 (2006) 257–262

The island of inversion



UNKNOWN CONFIGURATION N

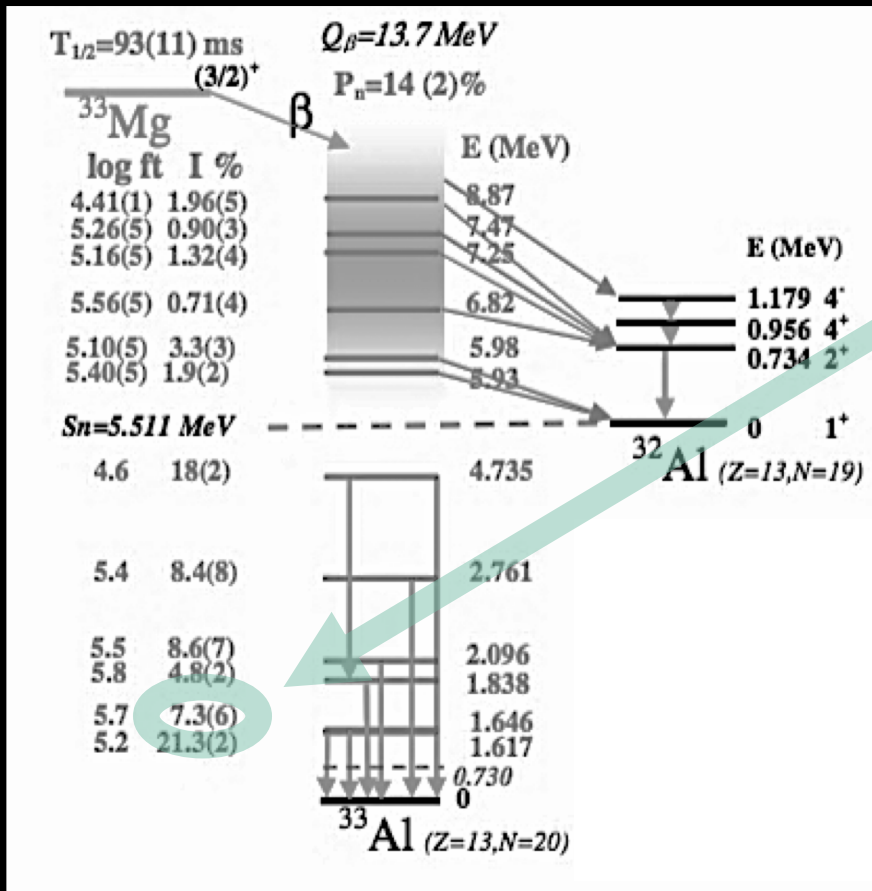
INTRUDER CONFIGURATION

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^{33}Al : conflicting results

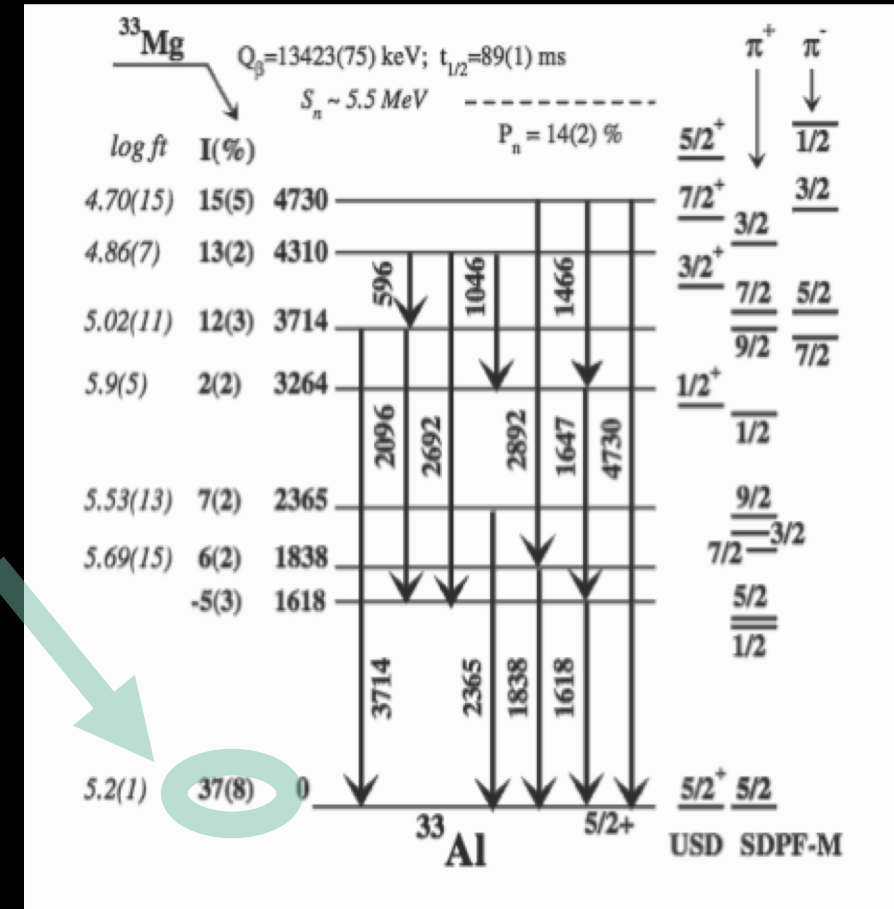
(ground state of ^{33}Al is $5/2^+$)



Disagreement

1. strong feeding of 1647 keV level

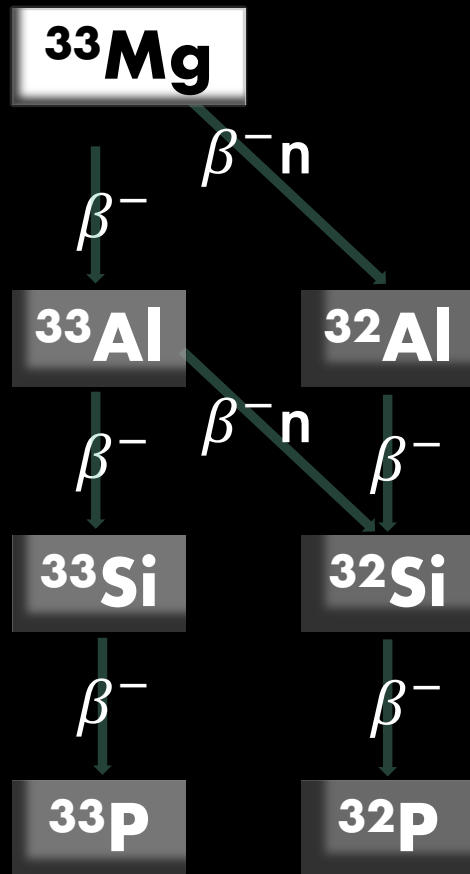
2. intensity attributed to large g.s. feeding, leading to negative parity assignment



J. C. Angélique et al., AIP Conf. Proc. 831, 134 (2006)

V. Tripathi et al., Phys. Rev. Lett. 101, 142504 (2008)

Purpose of experiment



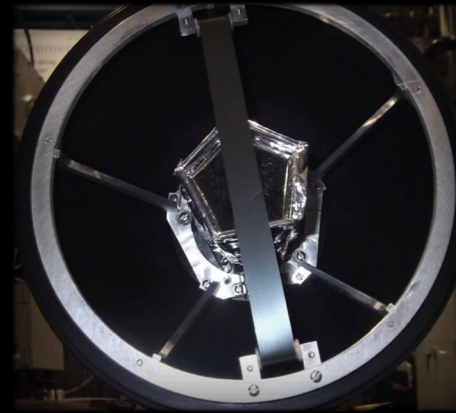
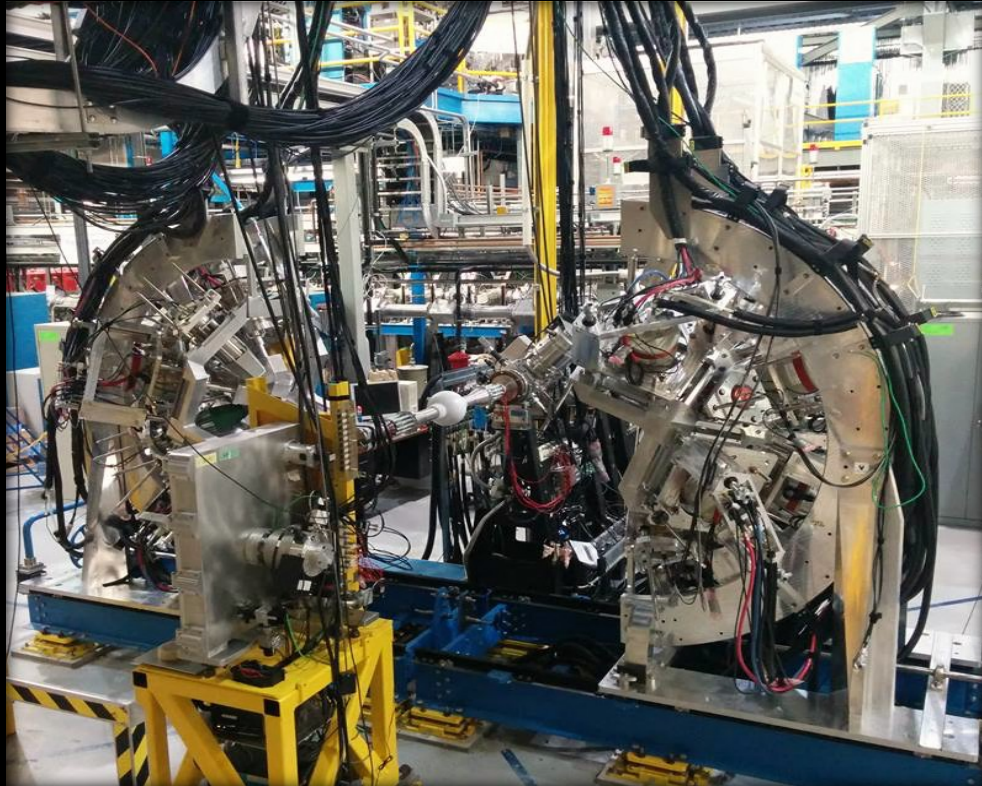
Data analysis goal	Contribution to understanding of nuclear structure
Level scheme for daughter/granddaughter: ($^{32}, ^{33}\text{Al}$ and $^{32}, ^{33}\text{Si}$)	Determine configuration (deformed/not/mixed)
Detailed branching ratios	Clarification of ground state properties of ^{33}Al
Mg, Al and Si half-lives	Verify accuracy of accepted values

Experiment: S1367



Part of larger experiment
with ^{34}Mg and ^{35}Mg

Rate: at times $\sim 10^4$ pps

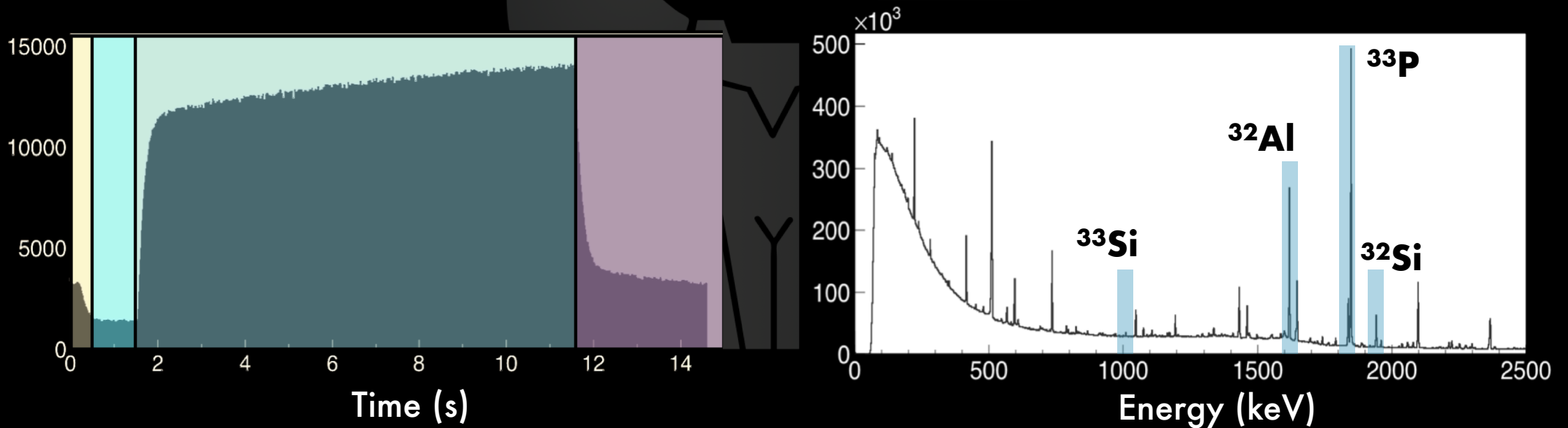


GRIFFIN,
SCEPTAR and
DESCANT



γ -ray spectroscopy data

All good cycles summed γ -ray counts

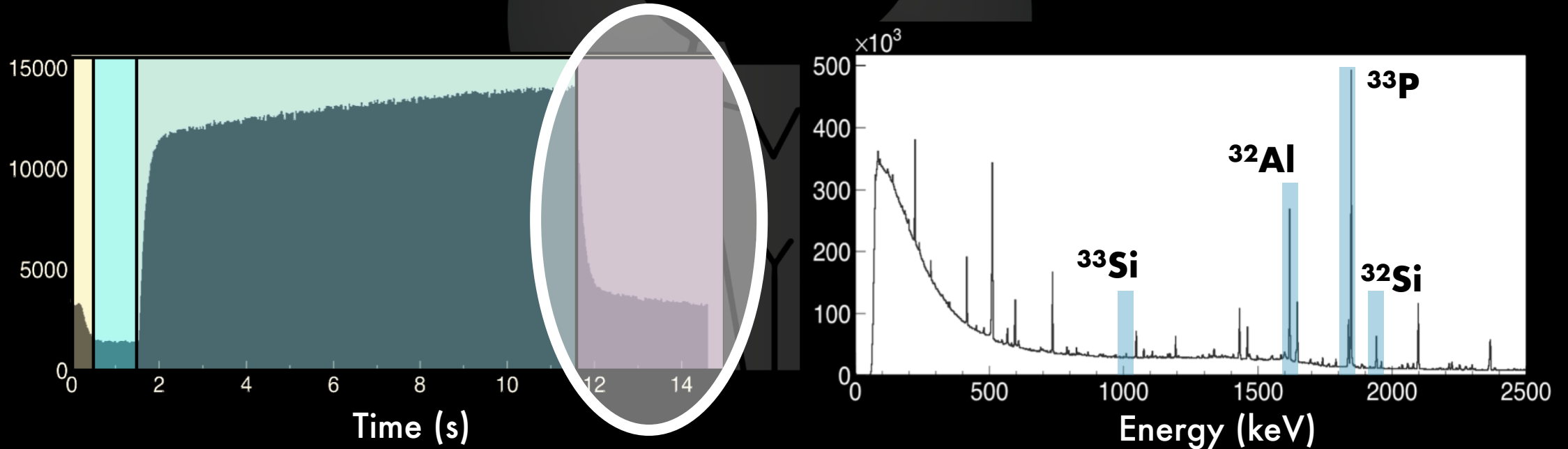


- Tape move
- Background
- Beam on
- Beam off

Some of the γ peaks of species in this decay that have been used for analysis

γ -ray spectroscopy data

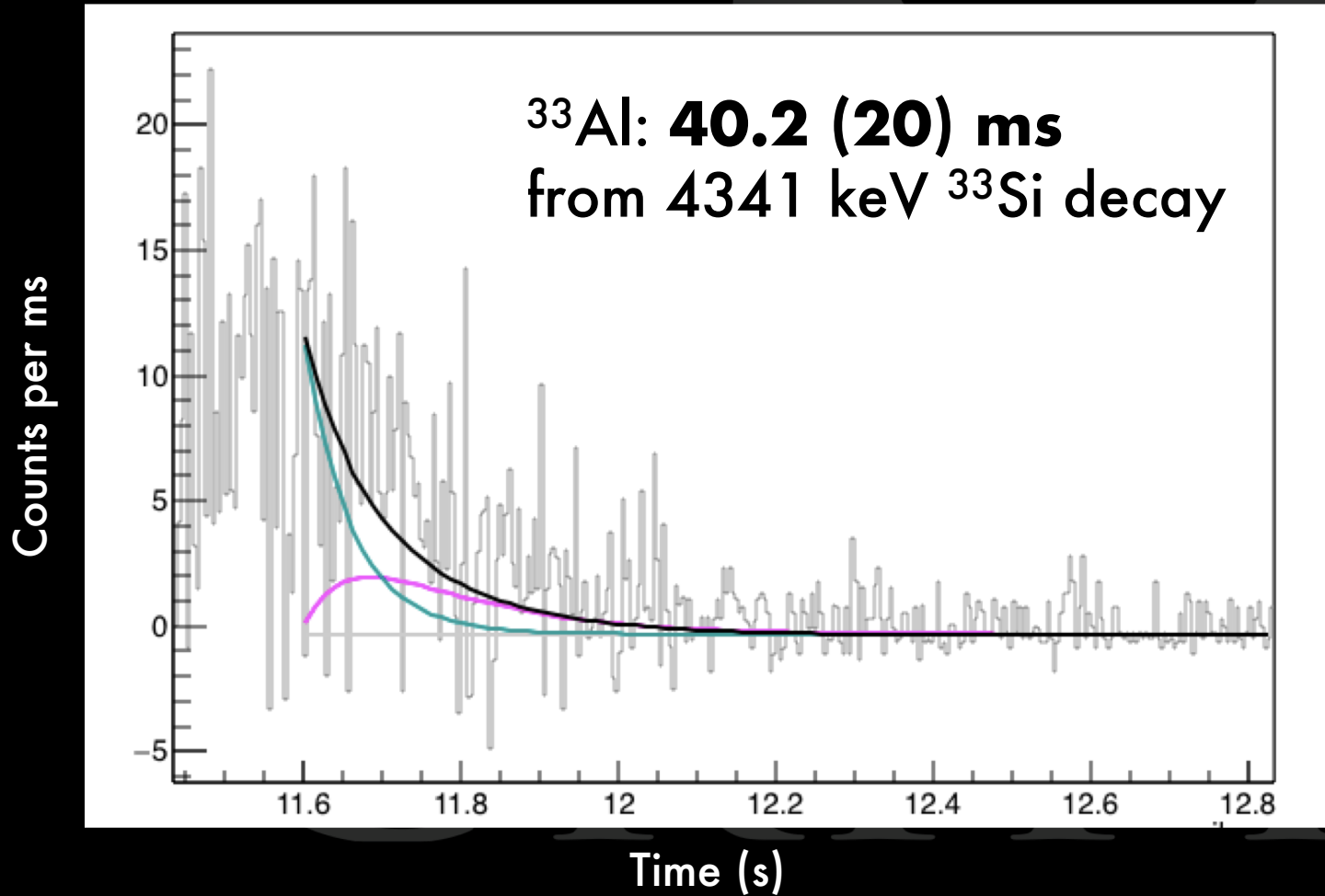
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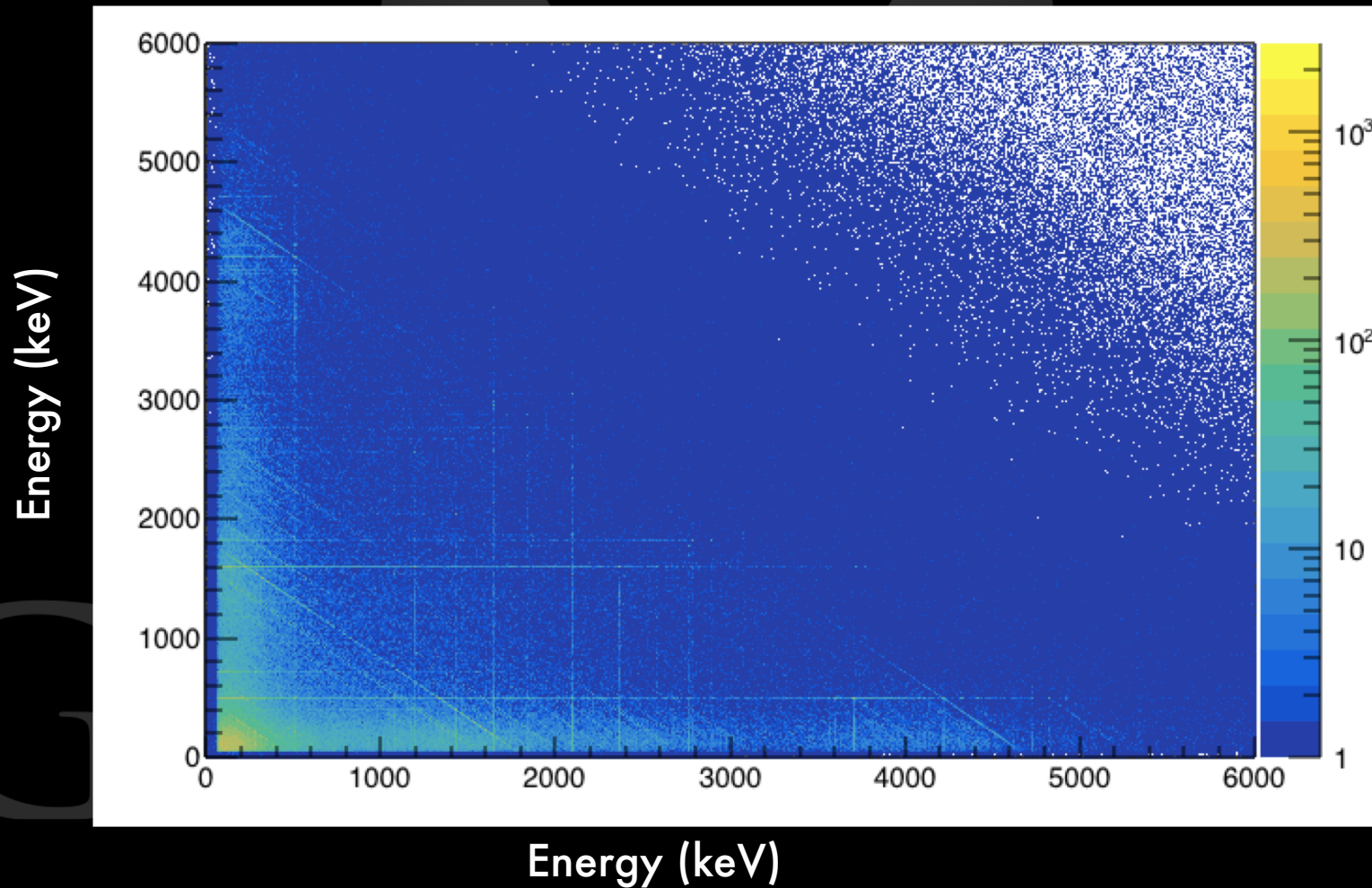
Analysis: Half-lives



Isotope	$T_{1/2}$
^{33}Mg	93.4 (24) ms
^{33}Al	40.2 (20) ms
^{32}Al	25.9 (30) ms
^{33}Si	6.2 (11) s

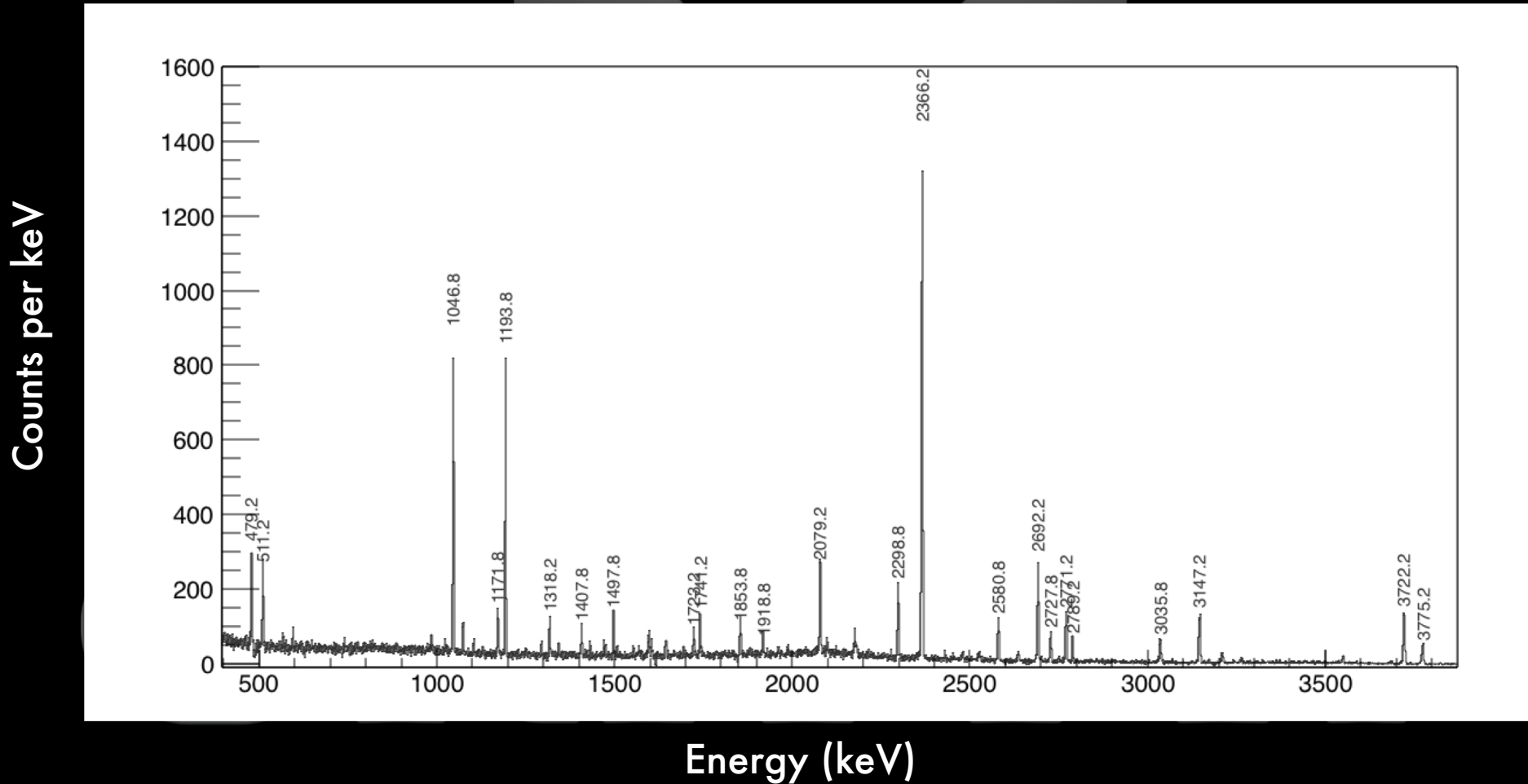
Analysis: Coincidence building

β tagged $\gamma - \gamma$



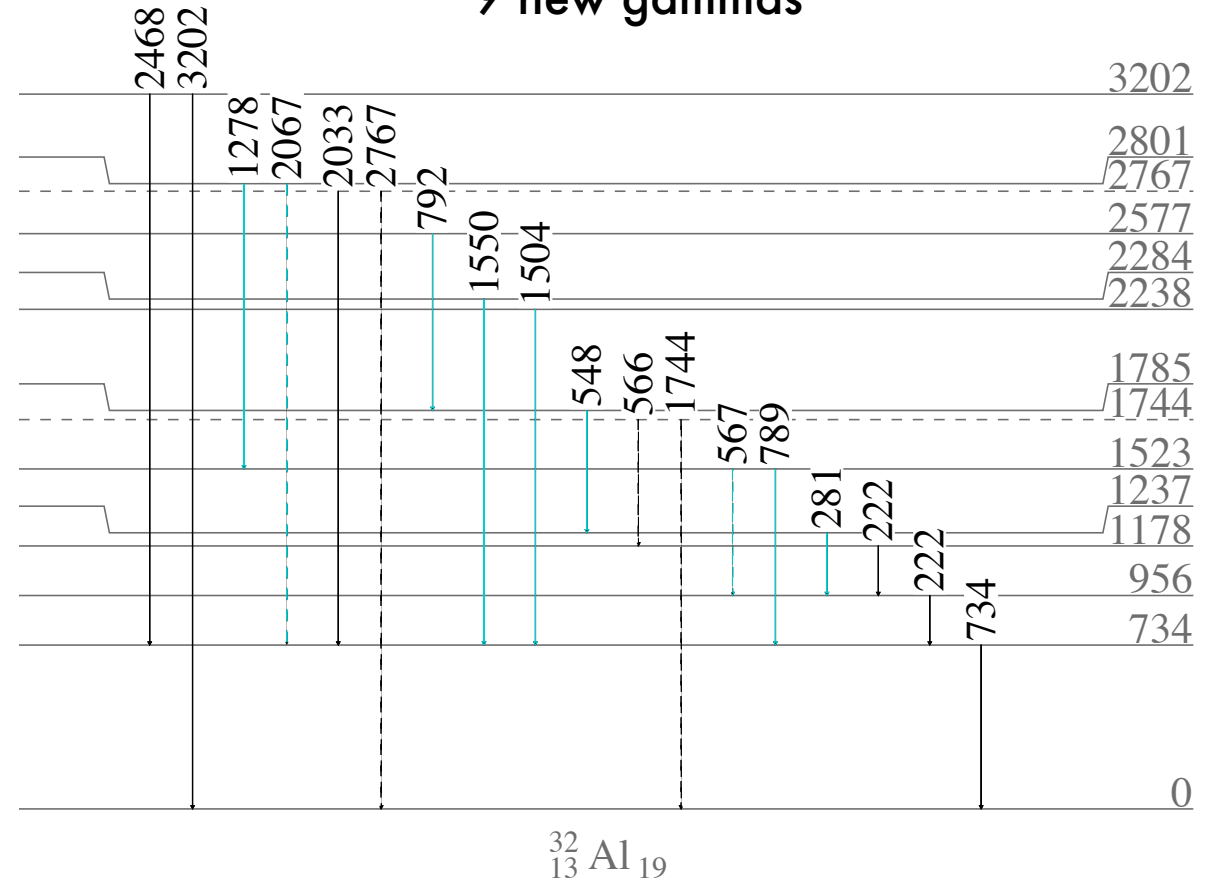
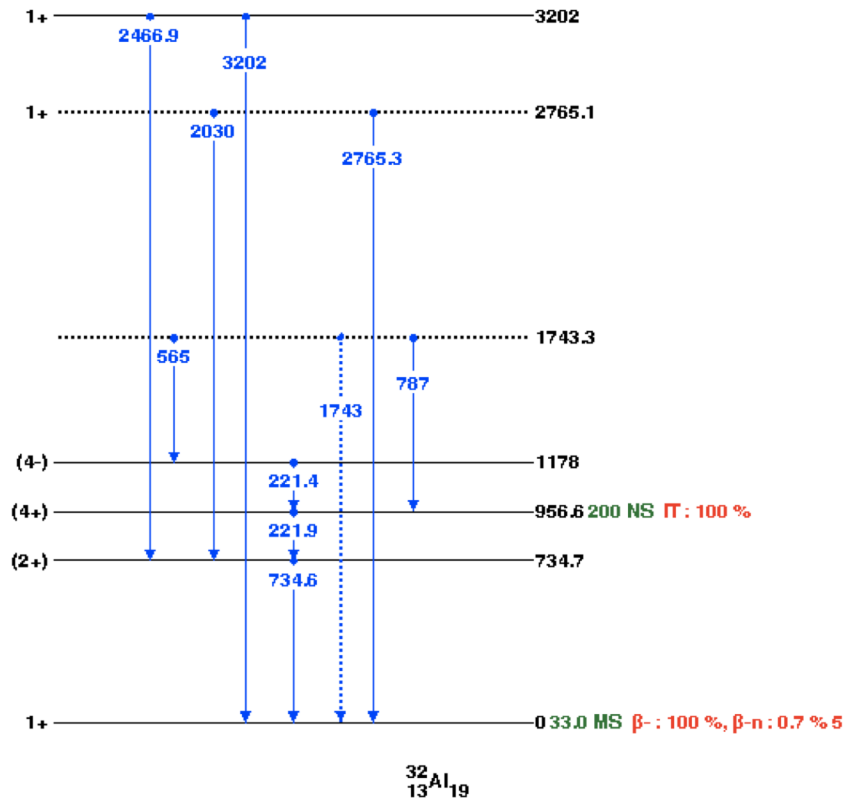
Analysis: Coincidence building

1618 keV gate from ^{33}Al



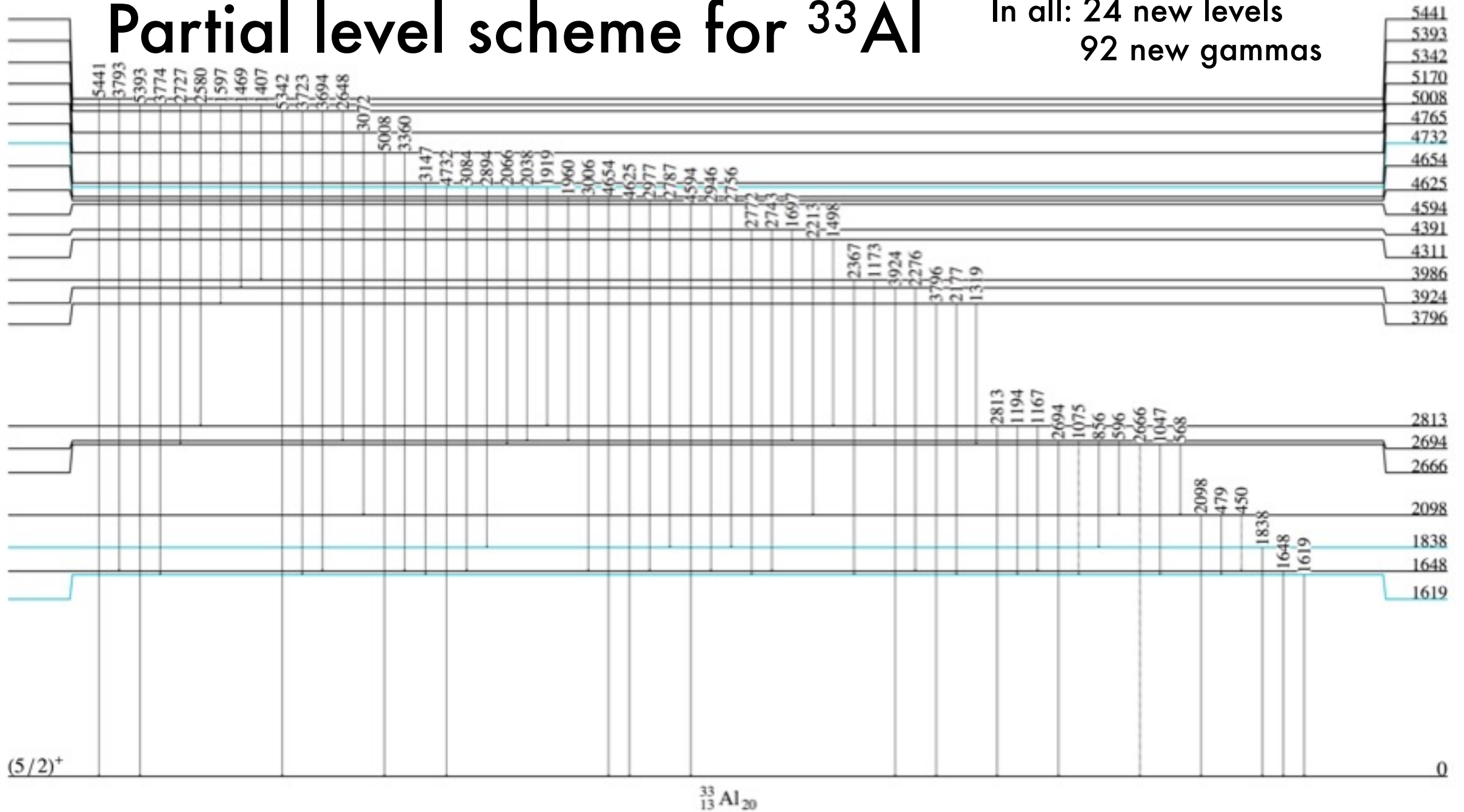
Level scheme of ^{32}Al

8 new levels
9 new gammas



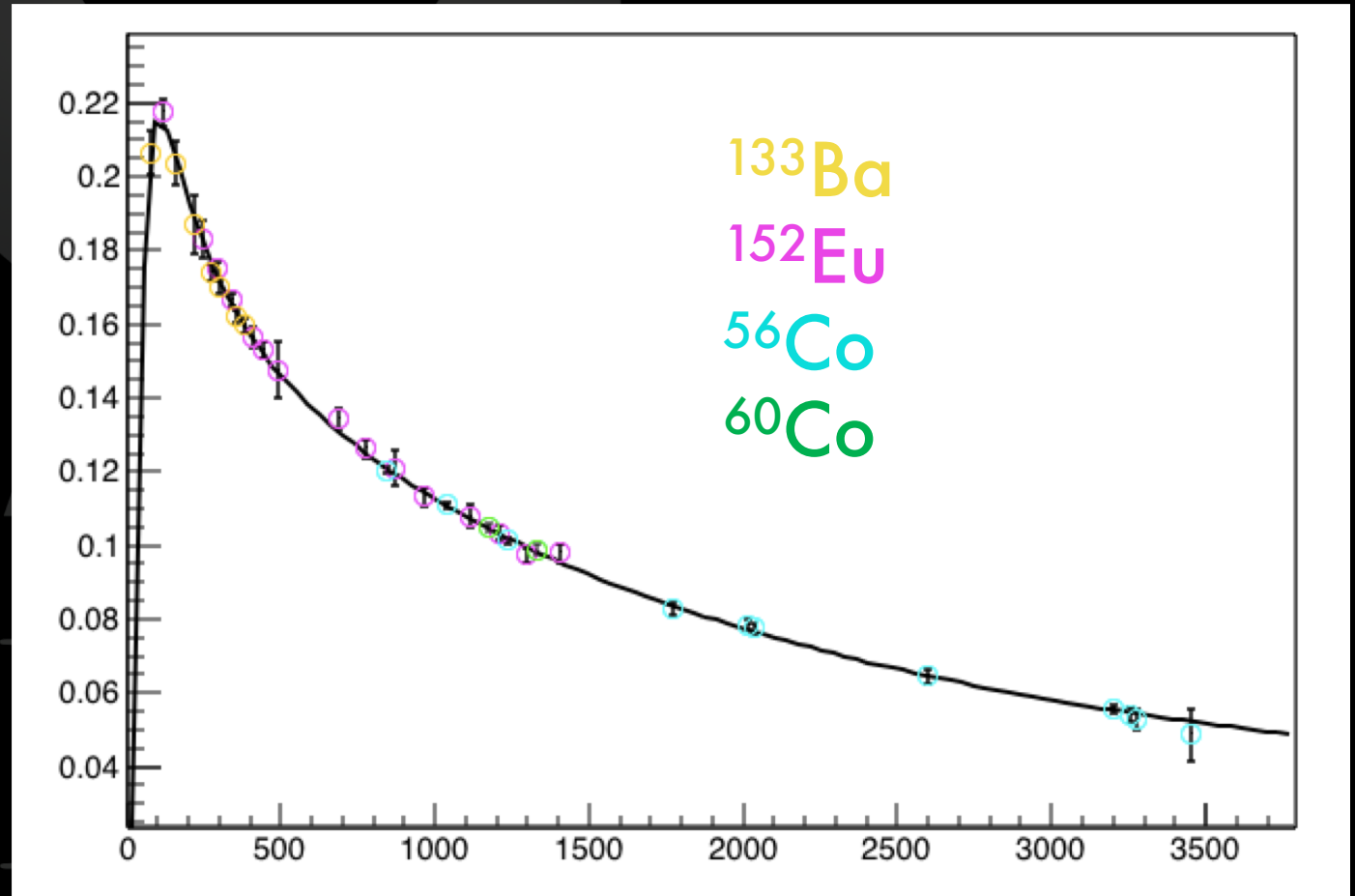
Partial level scheme for ^{33}Al

In all: 24 new levels
92 new gammas



Efficiency of GRIFFIN

- 20mm delrin; addback by clover; 12 detectors
- Needed for current step of calculating branching ratios



GR

In conclusion

Half-lives determined for ^{33}Mg , ^{33}Al , ^{33}Si and ^{32}Al

Expanded level scheme agrees more closely with earlier experiment (GANIL, 2006)

Branching ratio calculations in progress

GRIFFIN

Thank you! Merci!

UNIVERSITY
of GUELPH

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