Decay spectroscopy of neutron-rich nuclei around ^{37,38}Al

Nuclear Structure 2012

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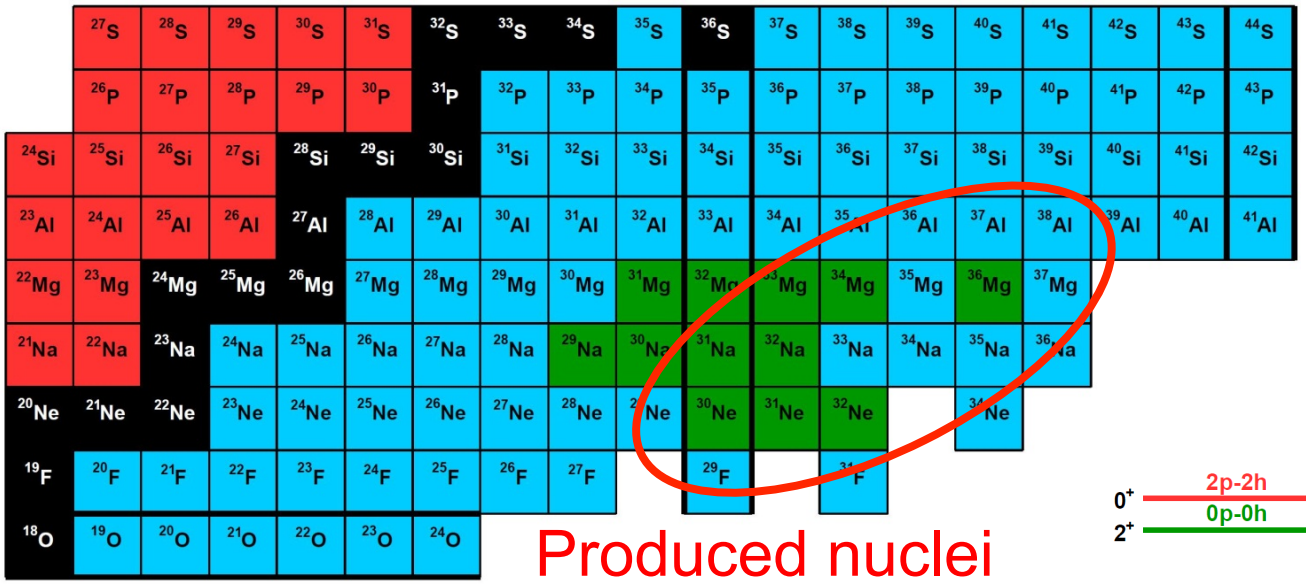
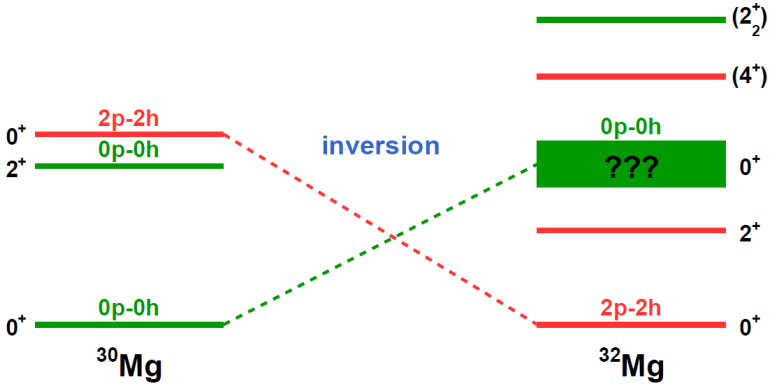
Motivation

Nuclear structure of nuclei around the area around the "island of inversion" via decay spectroscopy

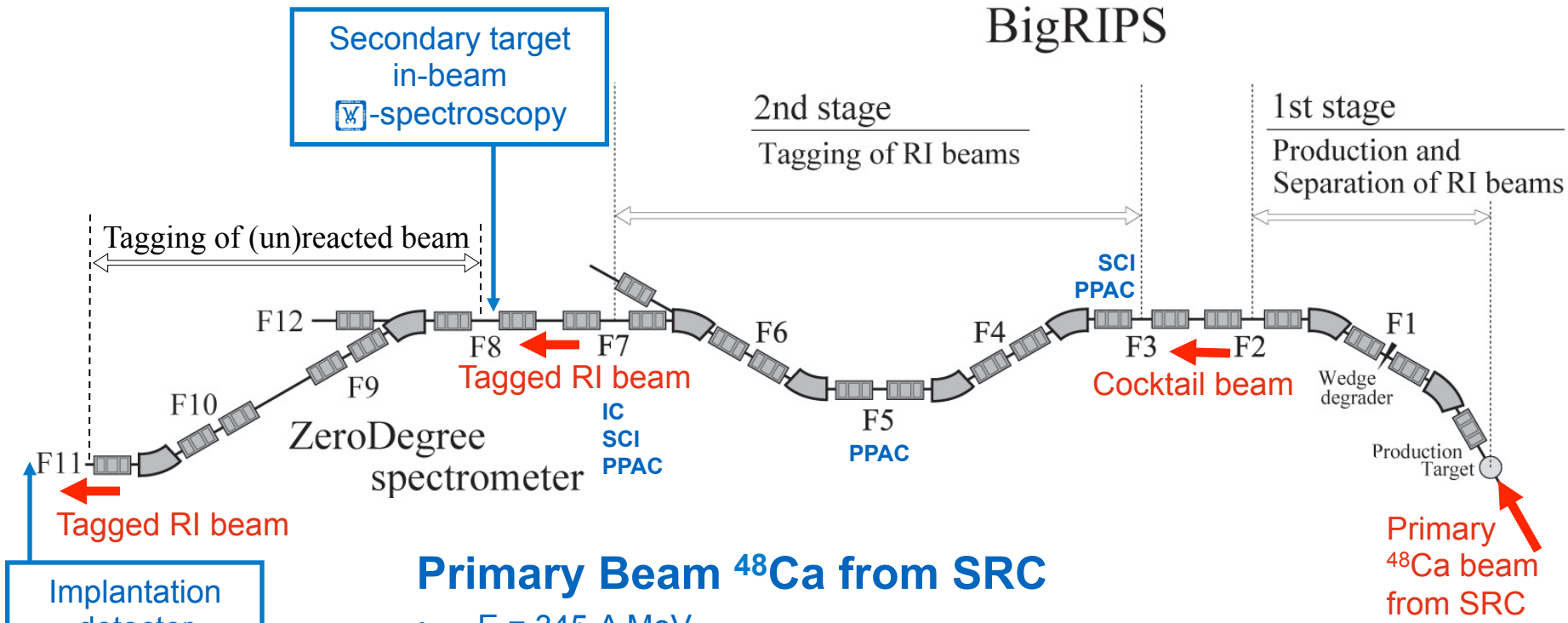
- β-half-lives
- Level schemes of daughter nuclei (β-delayed γ-rays)





K. Wimmer, Dissertation, TUM, 2010
K. Wimmer et al. Phys. Rev. Lett. 105 (2010) 252501

Beam



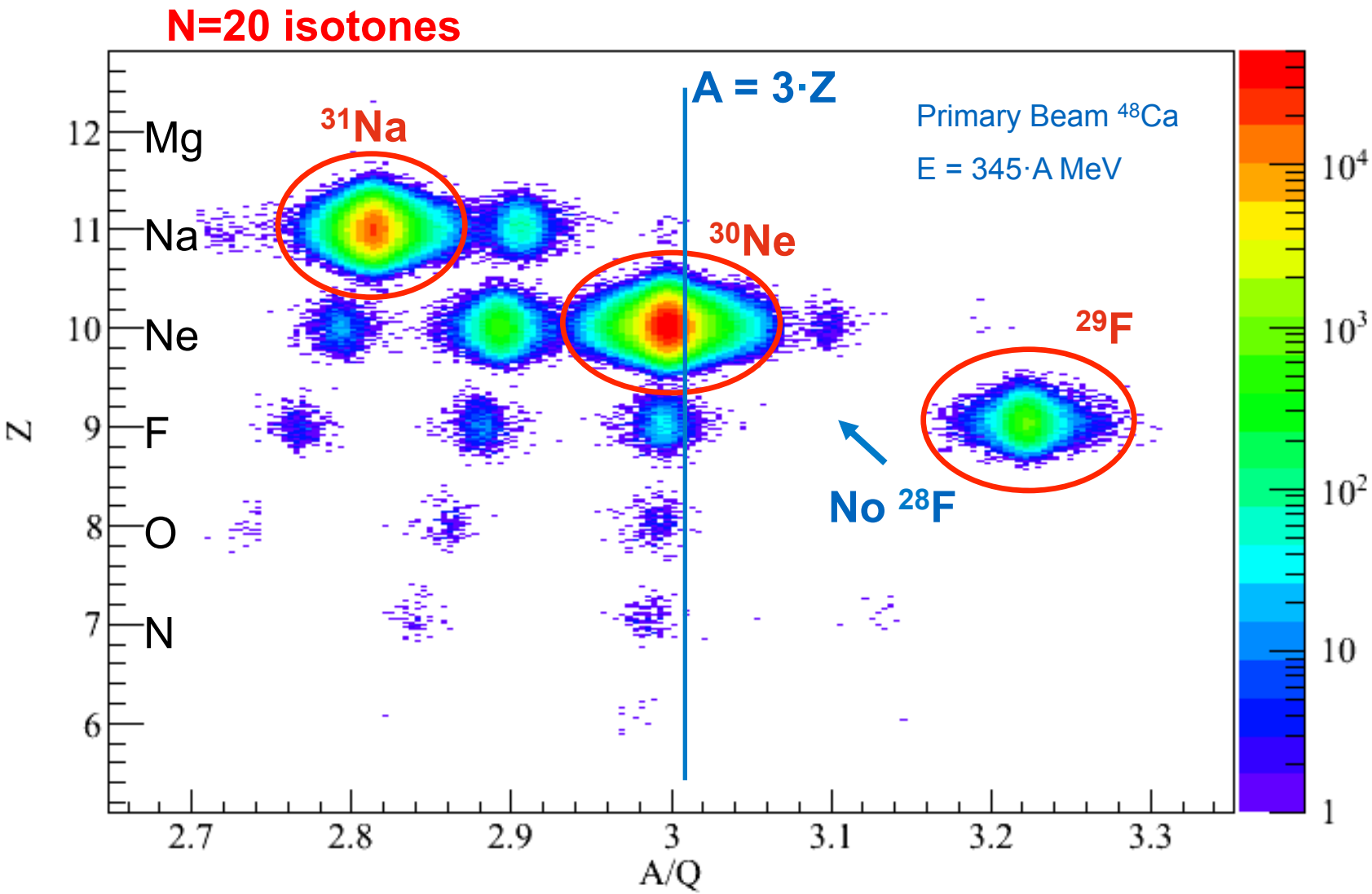
Primary Beam ^{48}Ca from SRC

- E = 345·A MeV
- Average I = 70 pnA = $4.4 \cdot 10^{11}$ pps
- Fragmentation (Target: 2.8g/cm^2 ^{9}Be)

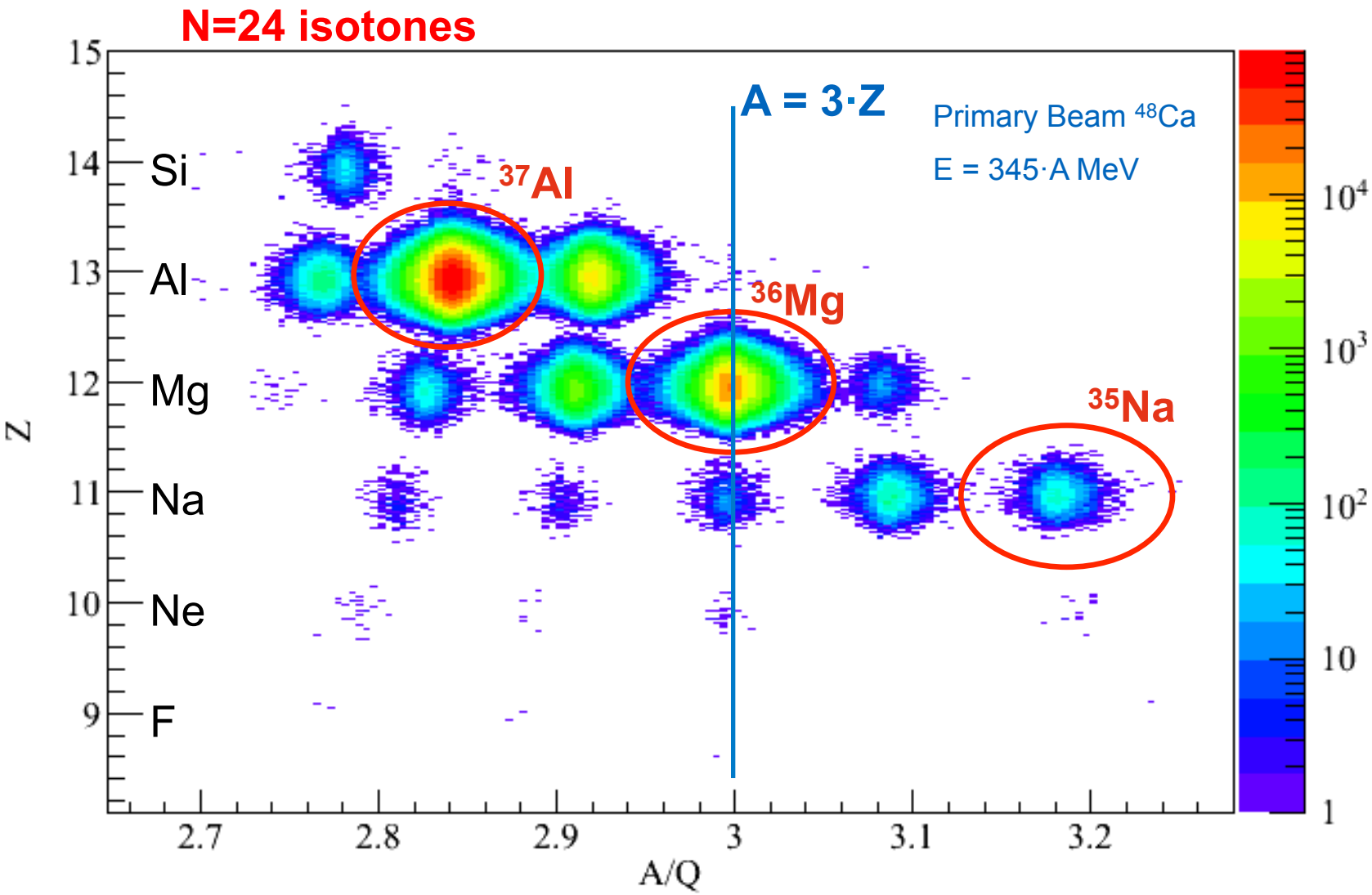
Identification F3-F7 and F8-F11

- Ionization chambers (F7): ΔE → **Z**
- Plastic scintillators (F3,F7): TOF → β
- PPACs (Beam position, F3,F5,F7): Bρ = β γ **A/q** m_0c

Particle identification – ^{30}Ne setting



Particle identification – ^{36}Mg setting

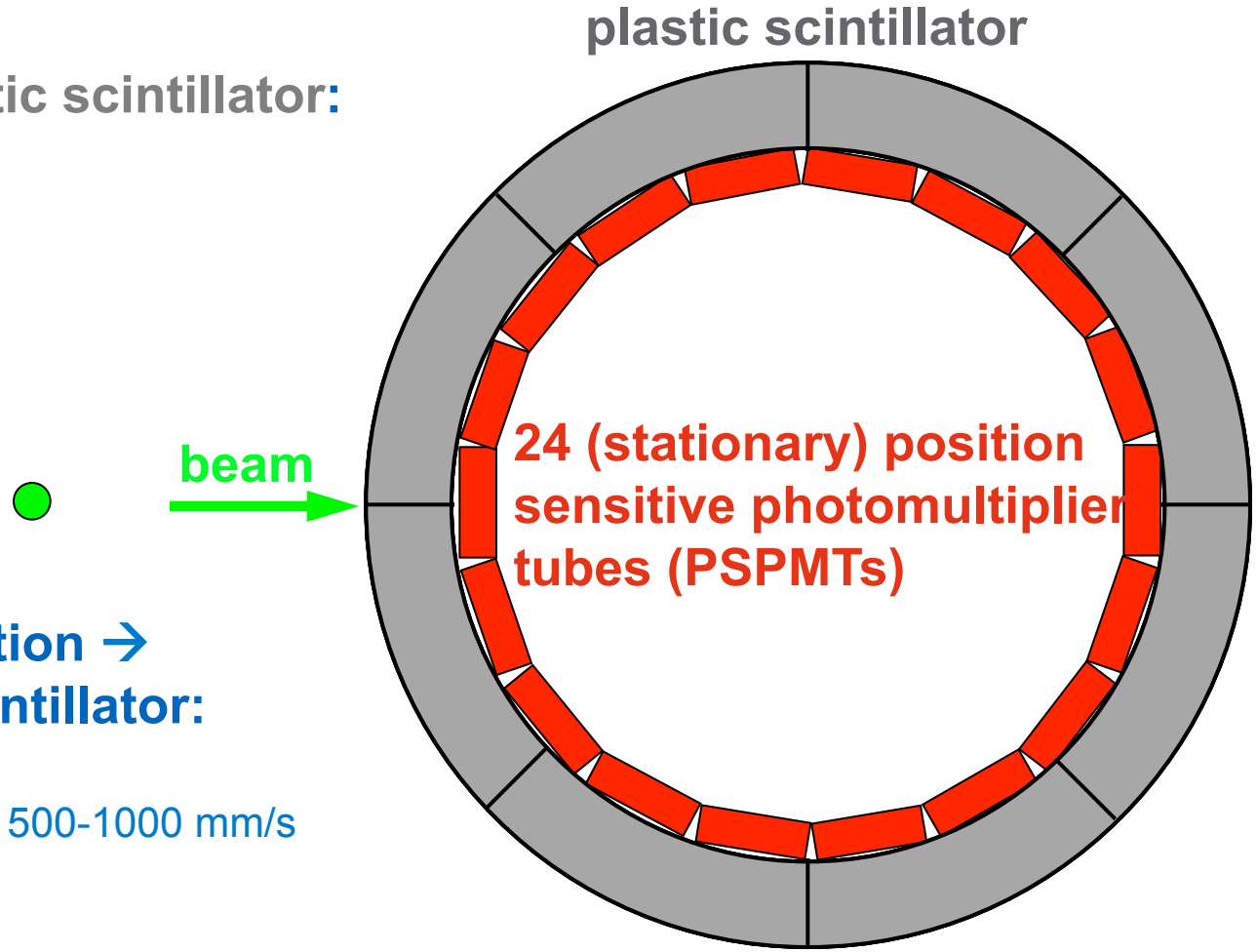


CAITEN: Implantation & β-detection

CAITEN - Cylindrical Active Implantation Target for Efficient Nuclear-decay study

Implantation in plastic scintillator:

- Each pixel 6 x 6 mm^2
- Thickness 20 mm
- $4 \cdot 10^4$ pixels
- Height 100 cm
- Diameter 50 cm



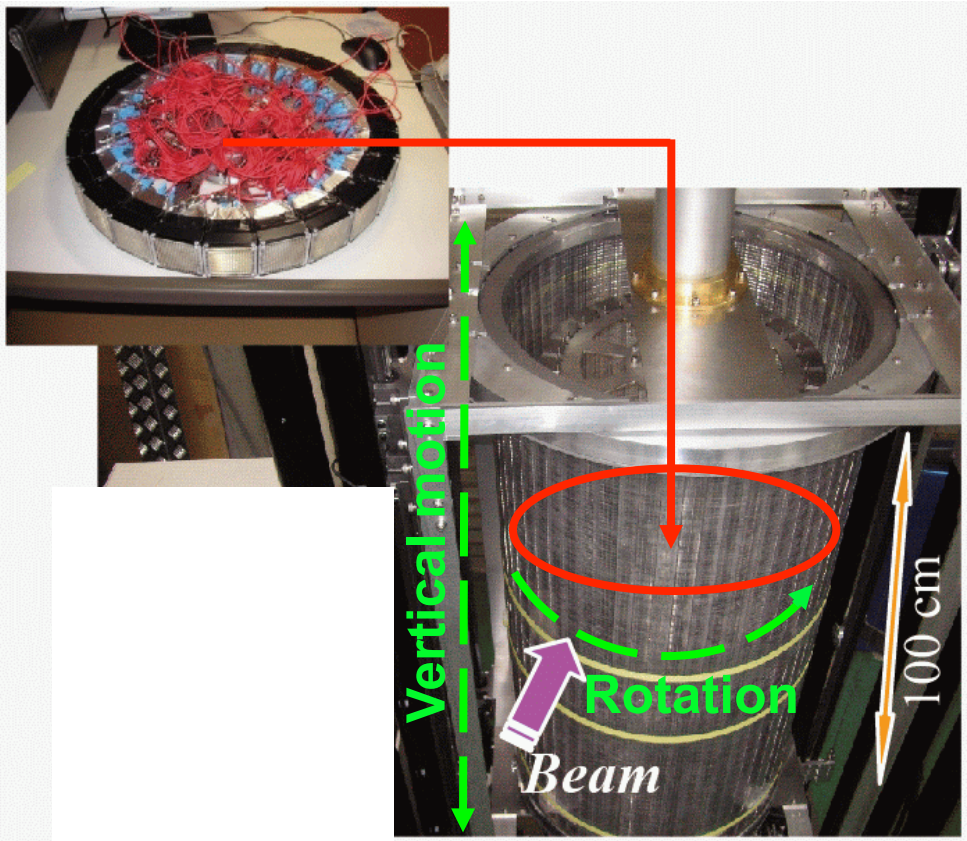
Similar to a tape station → Motion of plastic scintillator:

- Rotation: 20-40 rpm ≙ 500-1000 mm/s
- Vertical Motion 2 mm/s

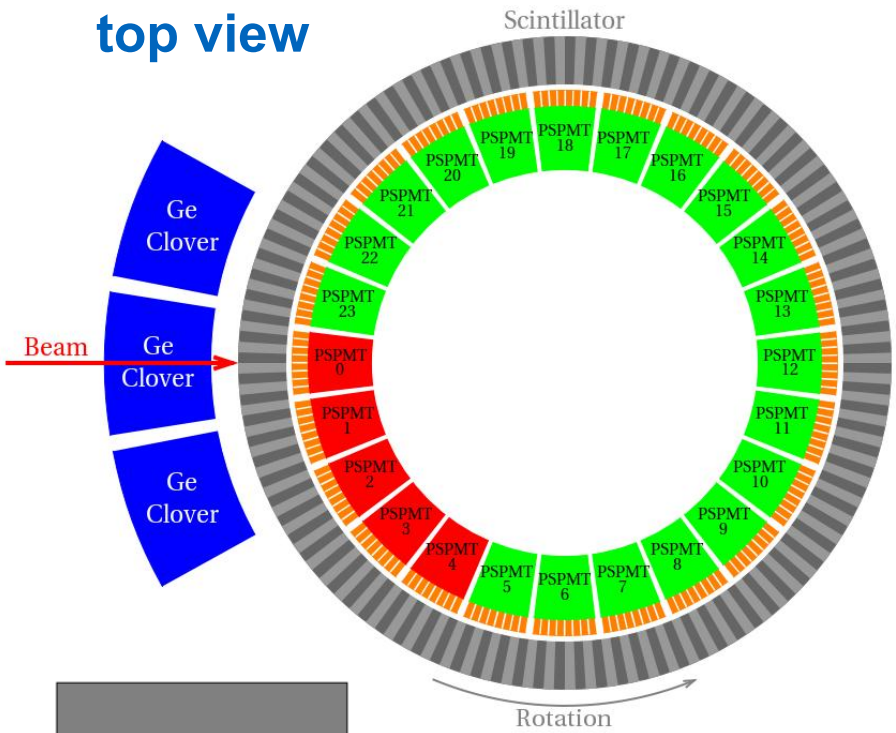
PSPMTs

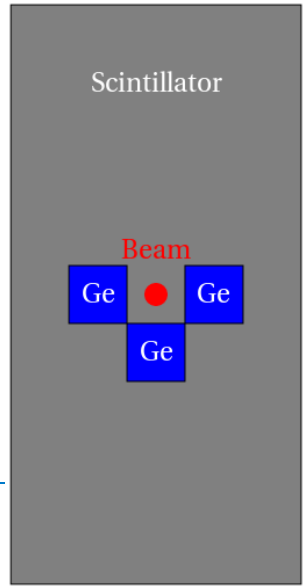
view from the top

CAITEN: Implantation & β-detection



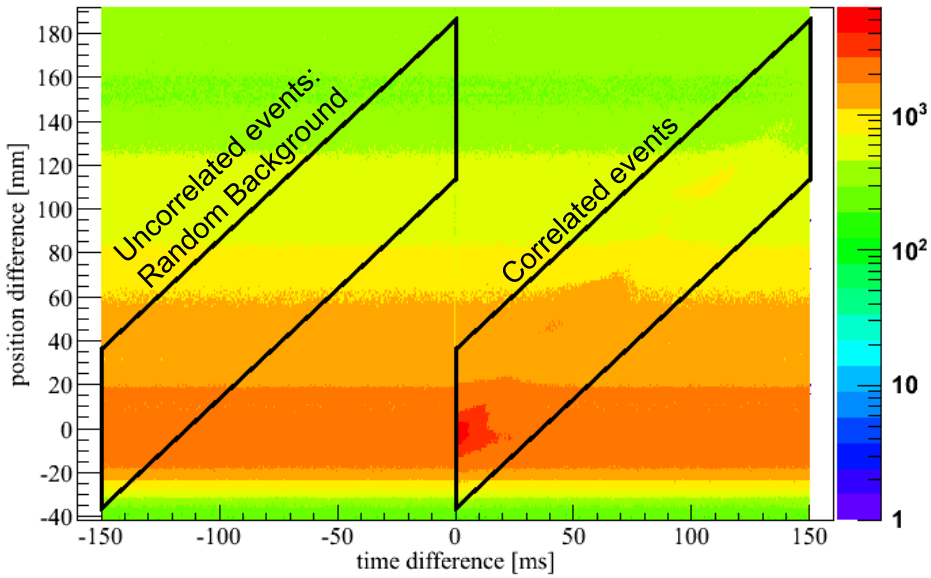
top view

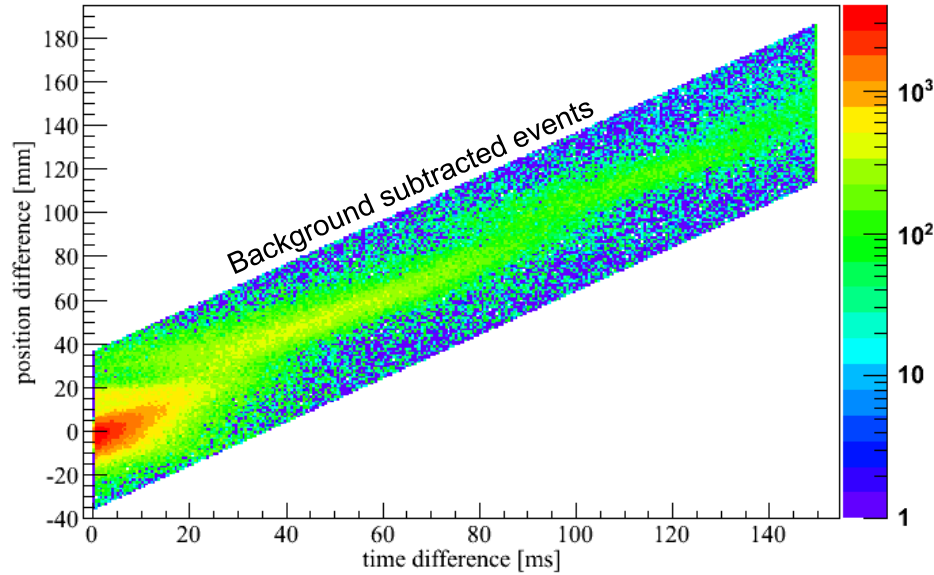




front view

Correlation → Half-life measurement

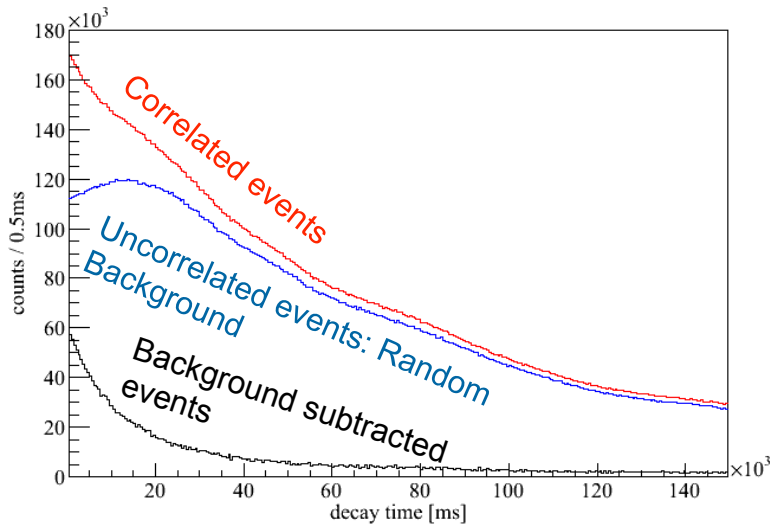




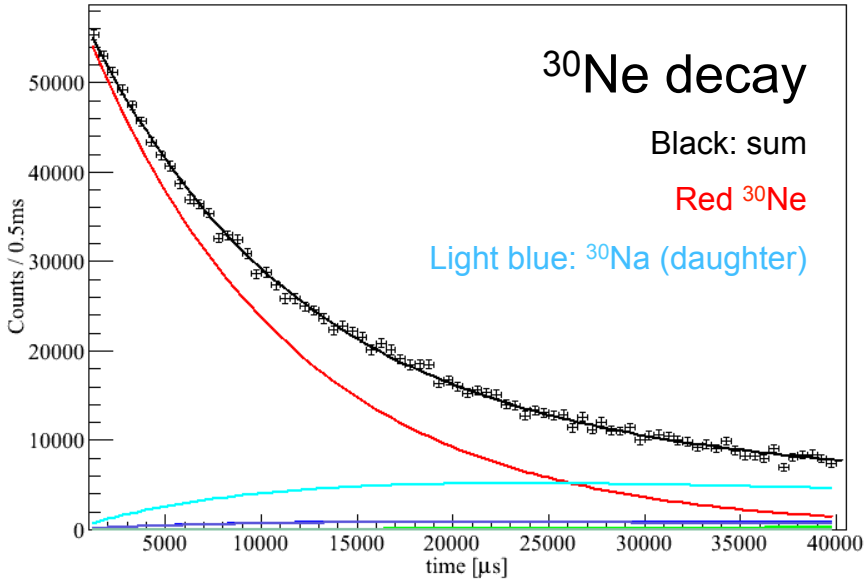
Implantation rate: ~ 200Hz

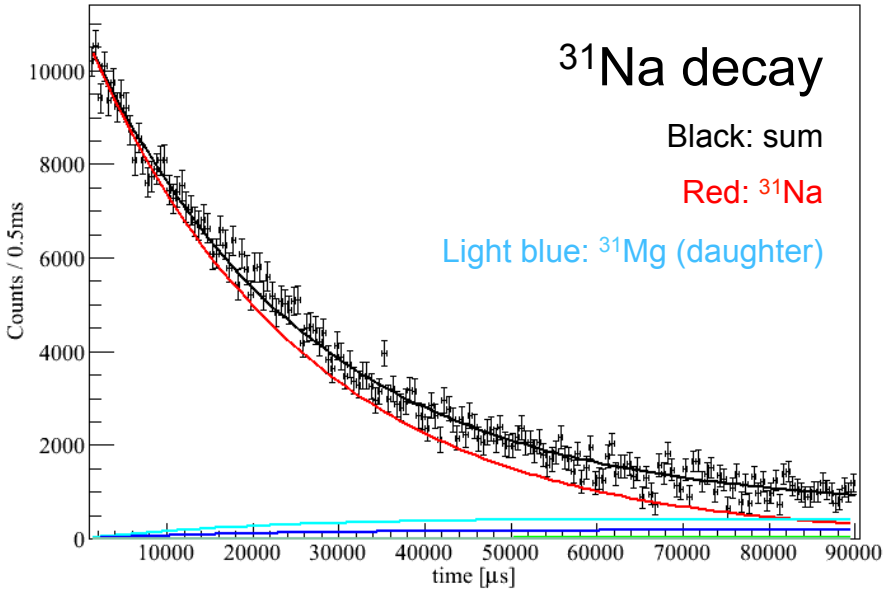
Background subtraction necessary

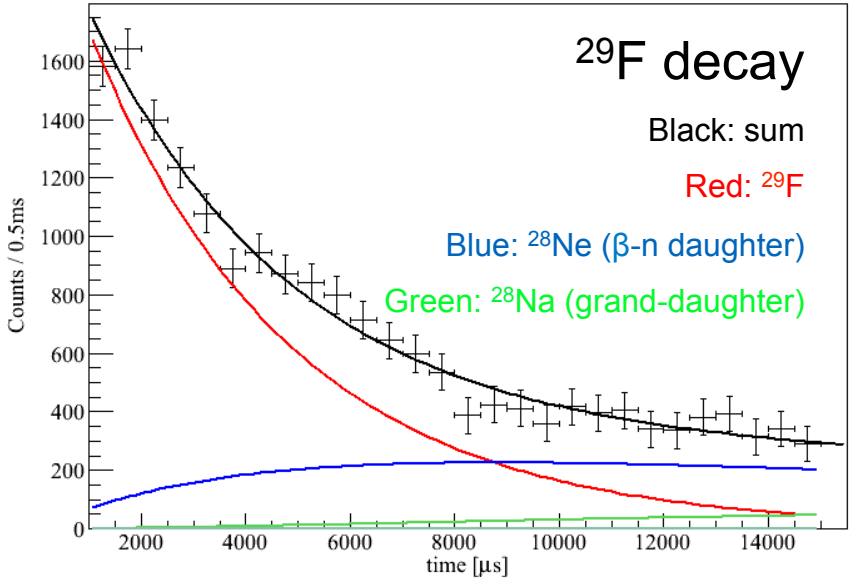
Gated on implantations of ^{30}Ne



β-half-lives of N=20 nuclei







Only fit parameter: $T_{1/2}$ of Parent nucleus

Input parameters: $T_{1/2}$ of (grand-)daughter nuclei, P(n) & P(2n)

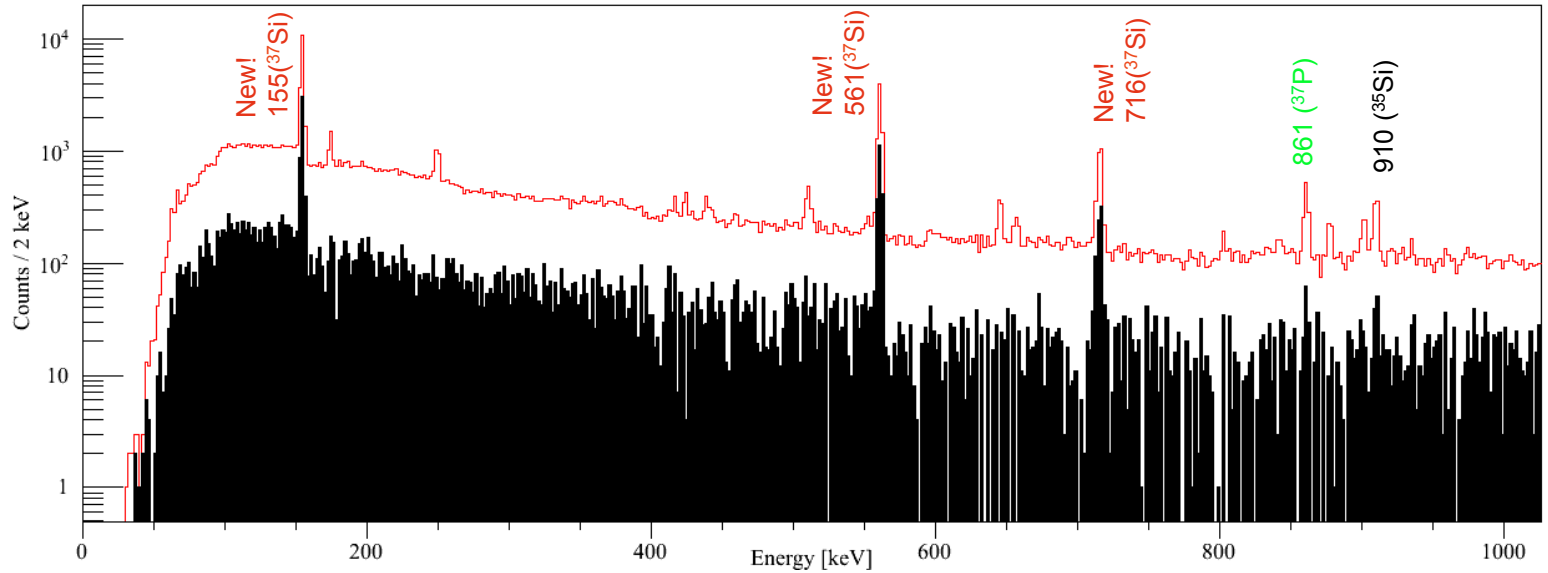
Systematic error: Error of $T_{1/2}$ of (grand-)daughter nuclei, P(n) & P(2n)

	Fitted $T_{1/2}$ (fit err) (sys err)	Literature $T_{1/2}$
^{30}Ne	7.40 (4) (7) ms	7.3(3) ms [1]
^{31}Na	17.53 (18) (22) ms	17.0(4) ms [2]
^{29}F	2.67 (10) (16) ms	2.4(4) ms [3], 2.6(4)ms [4]

Preliminary!

[1] V. Tripathi et al., Phys. Rev. C 76, 021301 (2007) [2] D. Guillemaud-Mueller et al. Nuclear Physics A 426(1) (1984) 37 – 76
[3] Z. Dlouhy et al Journal of Physics G: Nuclear and Particle Physics 25(4) (1999) 859
[4] M. Notani et al. RIKEN Accel. Prog. Rep. 31(1998) 71

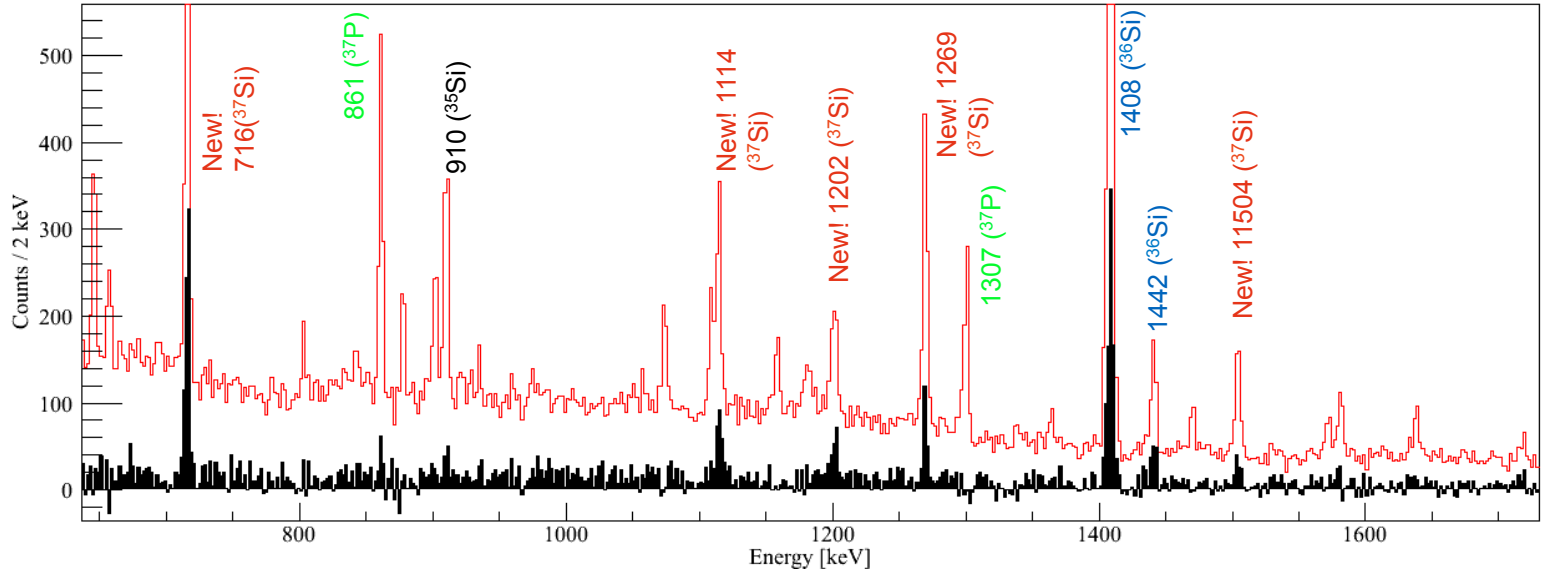
β-delayed γ-rays of ^{37}Al implants



Transitions in:

- ^{37}Si (daughter)
- ^{37}P (granddaughter)
- ^{36}Si (β-n daughter)

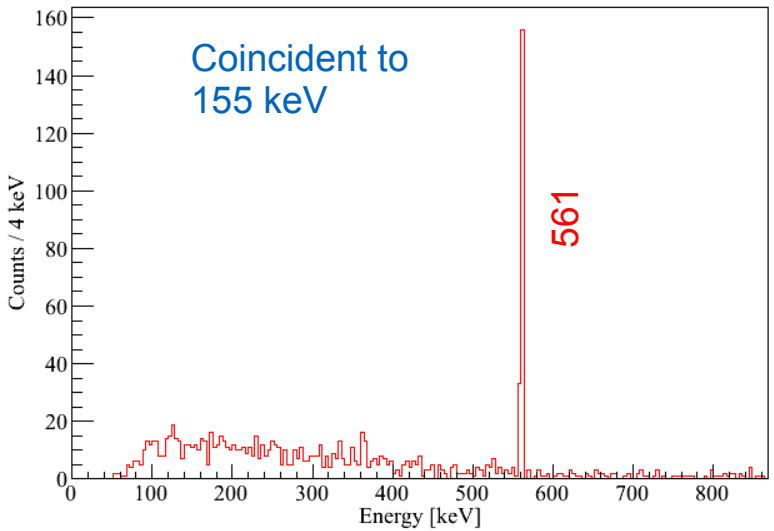
γ-spectrum after β-decay of ^{37}Al, all correlated events within 10 ms after implantation

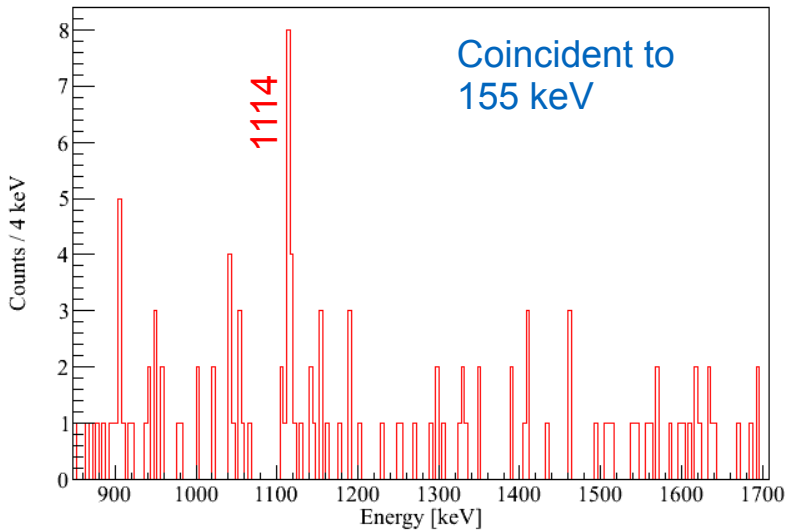


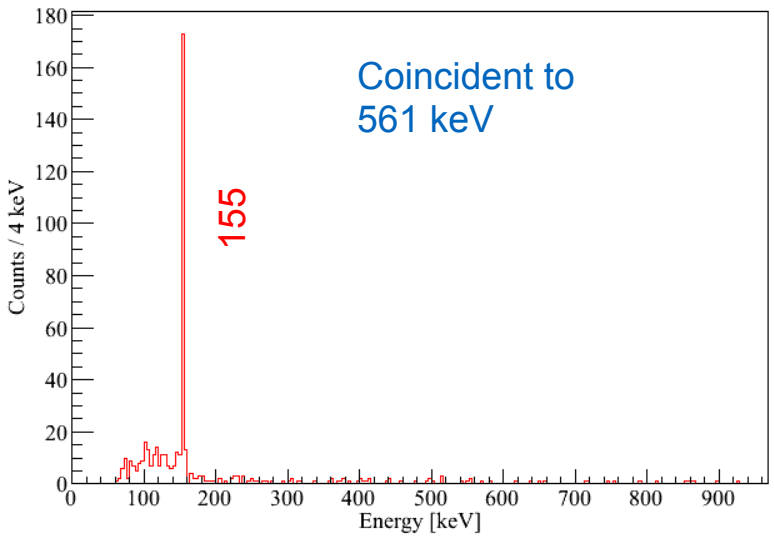
Red: Raw spectrum

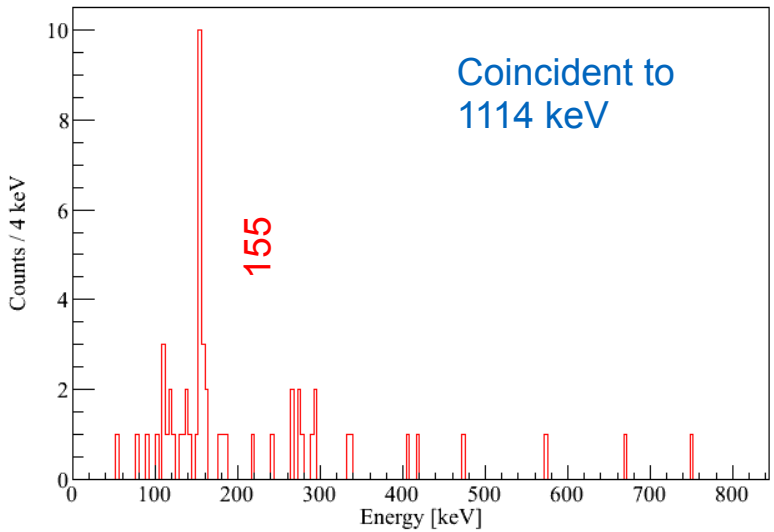
Black: Background subtracted spectrum

^{37}Al decay – β-γ-γ coincidences

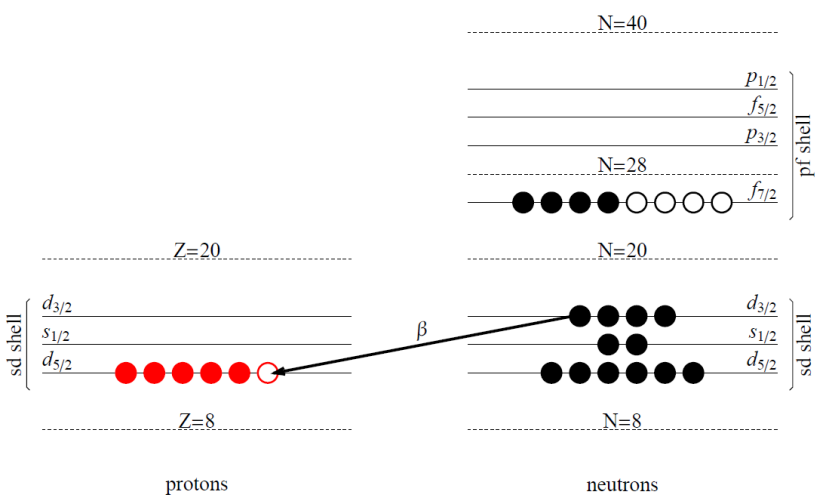


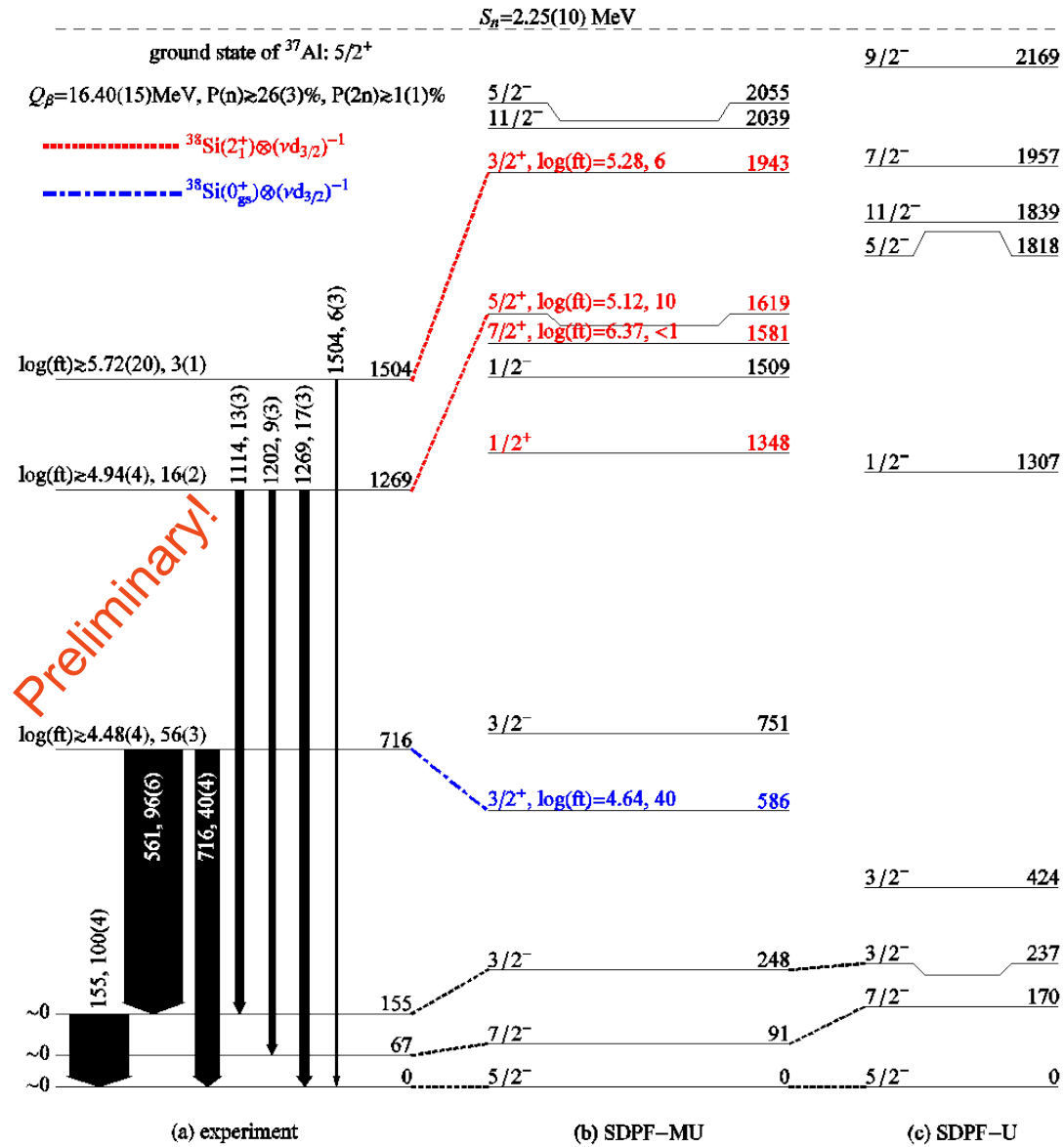






First experimental level scheme of ^{37}Si





Comparison of the experimental level scheme of ^{37}Si with shell model calculations

SDPF-MU: Y. Utsuno, T. Otsuka, B. A. Brown, M. Honma, T. Mizusaki, and N. Shimizu, arXiv/1201.4077v1

SDPF-U: F. Nowacki and A. Poves, Phys. Rev. C 79(1) (2009) 014310

Summary

- First experimental observation of β-delayed γ-rays in ^{37}Si and β-γ-γ coincidences

→ First level scheme

→ Comparison with shell model calculations

- Half-lives of N=20 isotones with smaller errors

Thank you for your attention!

CAITEN Collaboration:

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[3] TRIUMF, Vancouver, Canada
[4] Tokyo University of Science, Japan

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