„Lifetime measurement of high-lying short-lived states in ^{69}As”

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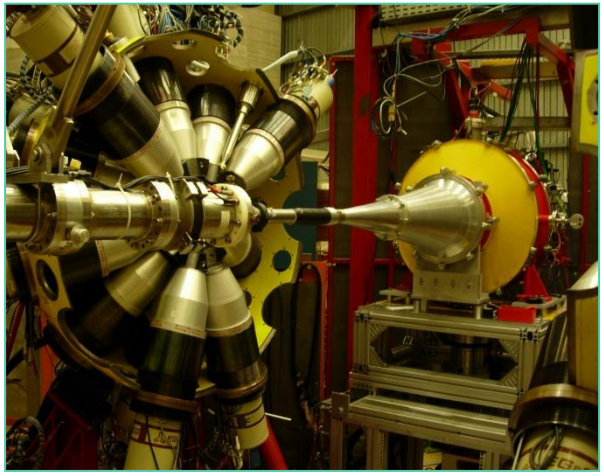
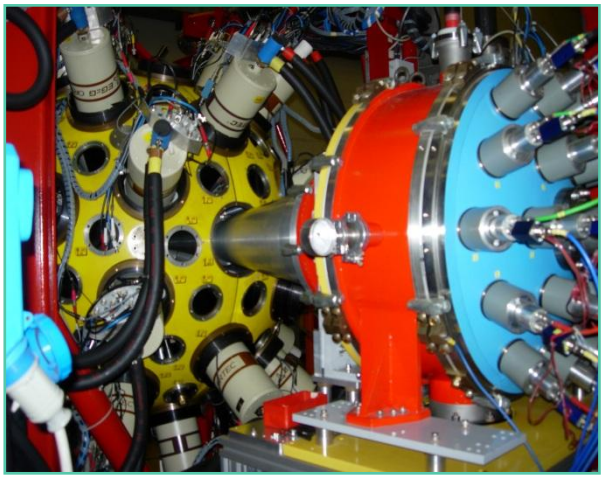
EGAN 2012 Workshop, 25-28 June

Experiment: GASP + RFD setup





- Reaction: ^{32}S (95MeV) + ^{40}Ca (0.8mg/cm^2)
- Tandem XTU at LNL , pulsing 400ns
- November 2009

  - Measured: recoils in coincidence with γ-rays
  - Evaporation residues:

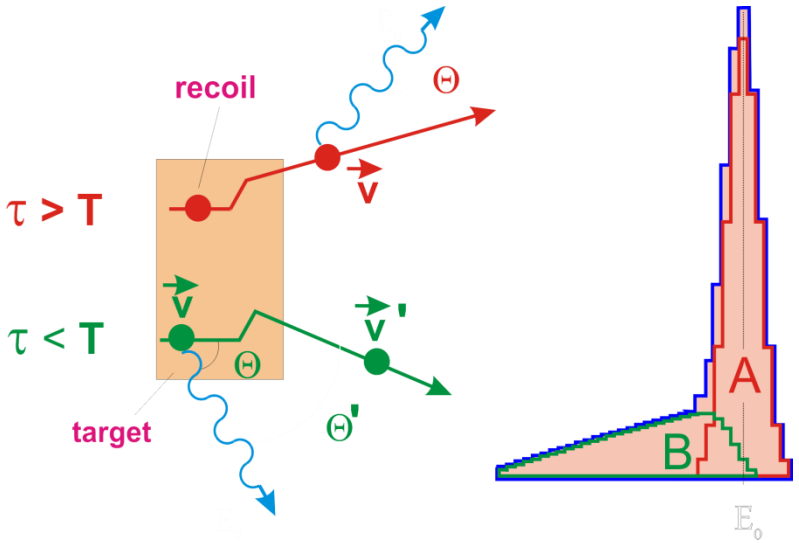
    $^{67,69}As$, $^{66,68}Ge$, $^{69,70}Se$, $^{63,65}Ga$

Goal:

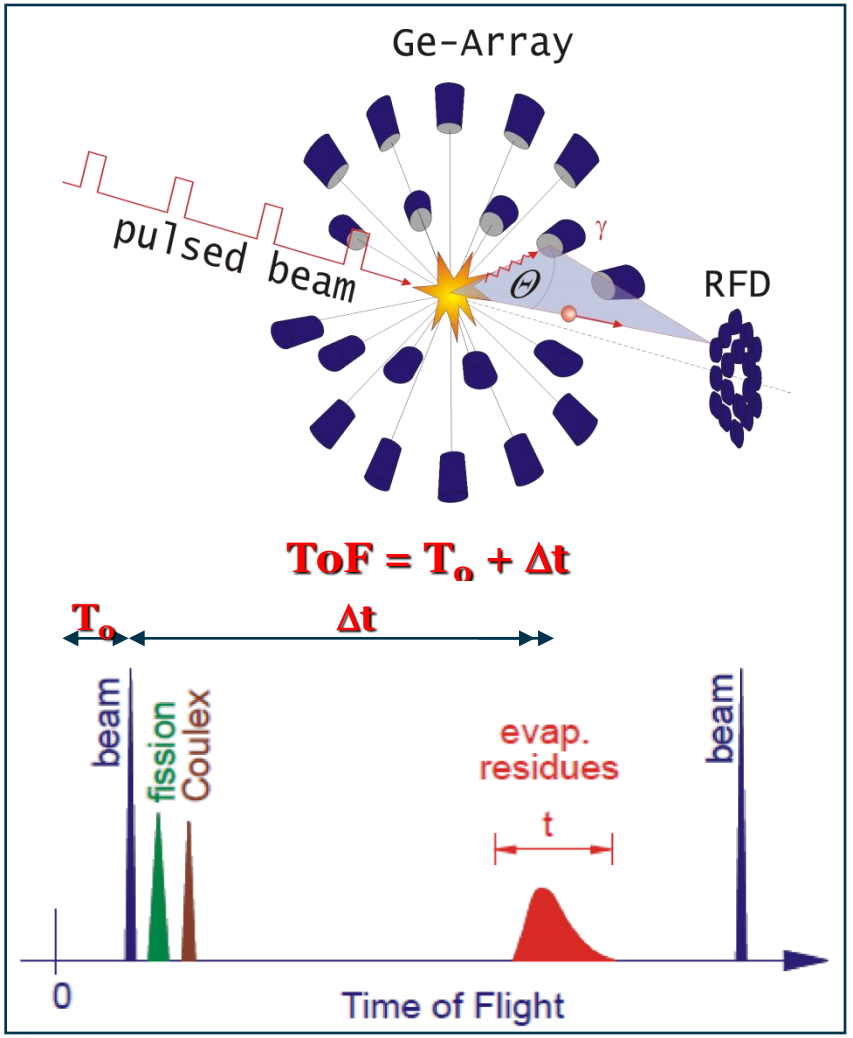
- measure the lifetimes of excited states in the vicinity of A~70
- verify predictions of various theoretical models

Measurement technique

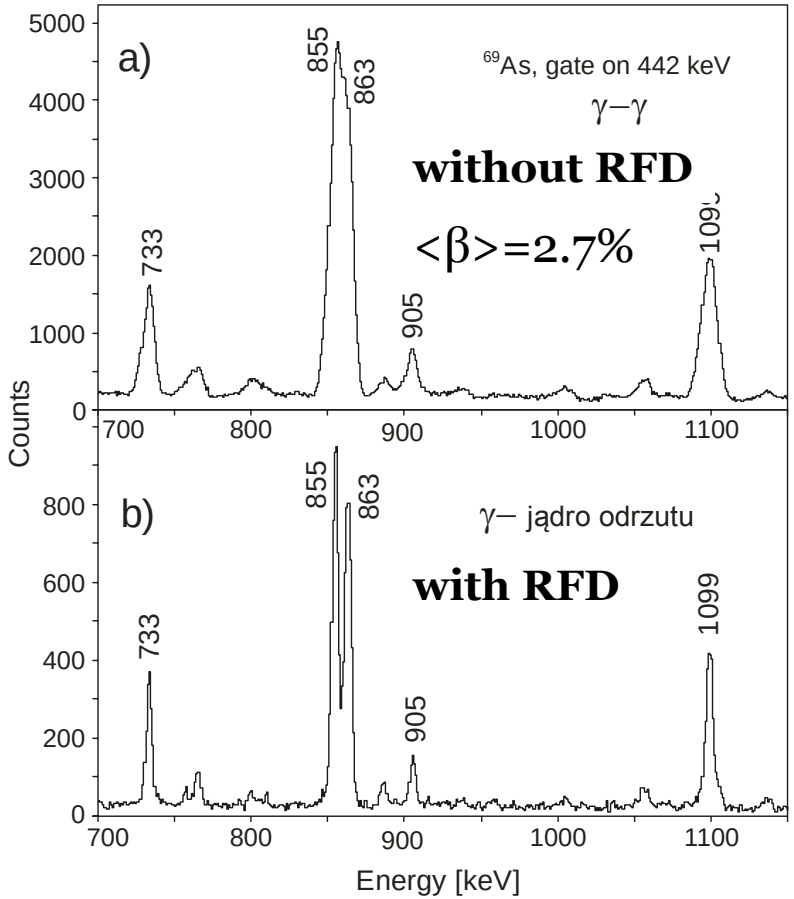
Lifetime estimation based on the recoil velocity measurement



$$R = \frac{A}{A+B} \rightarrow \tau$$

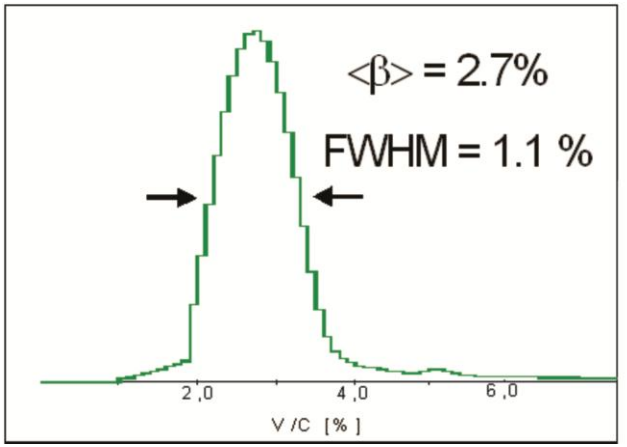


Experimental spectra



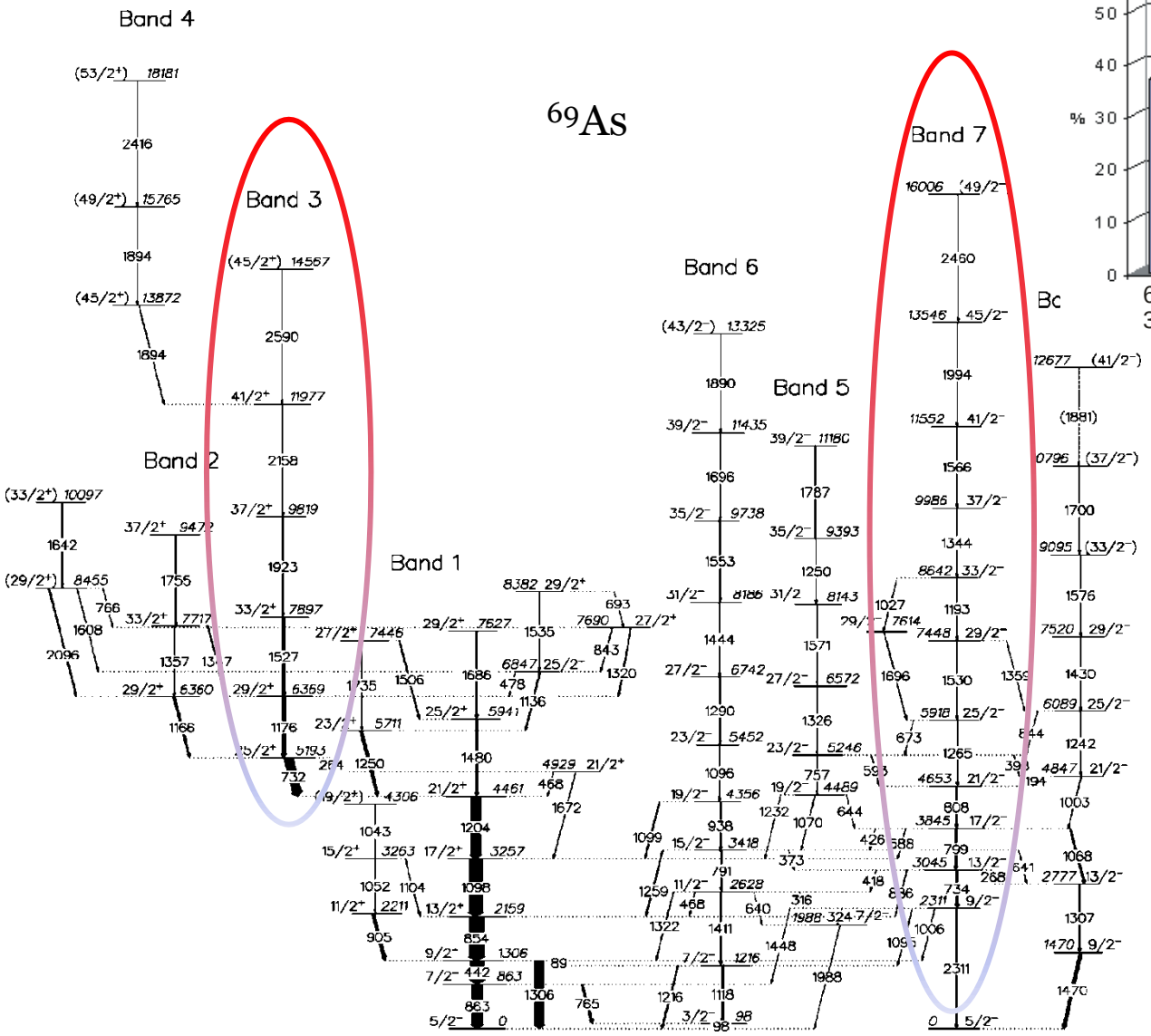
Upper panel: average correction
Lower one: event-by-event correction

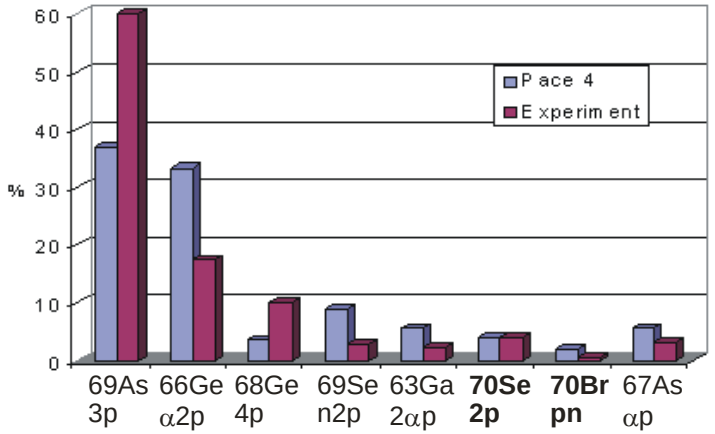
Exp. recoil velocity spectrum - wide



Only by measuring recoil velocity -
Energy resolution – gain by factor 2!

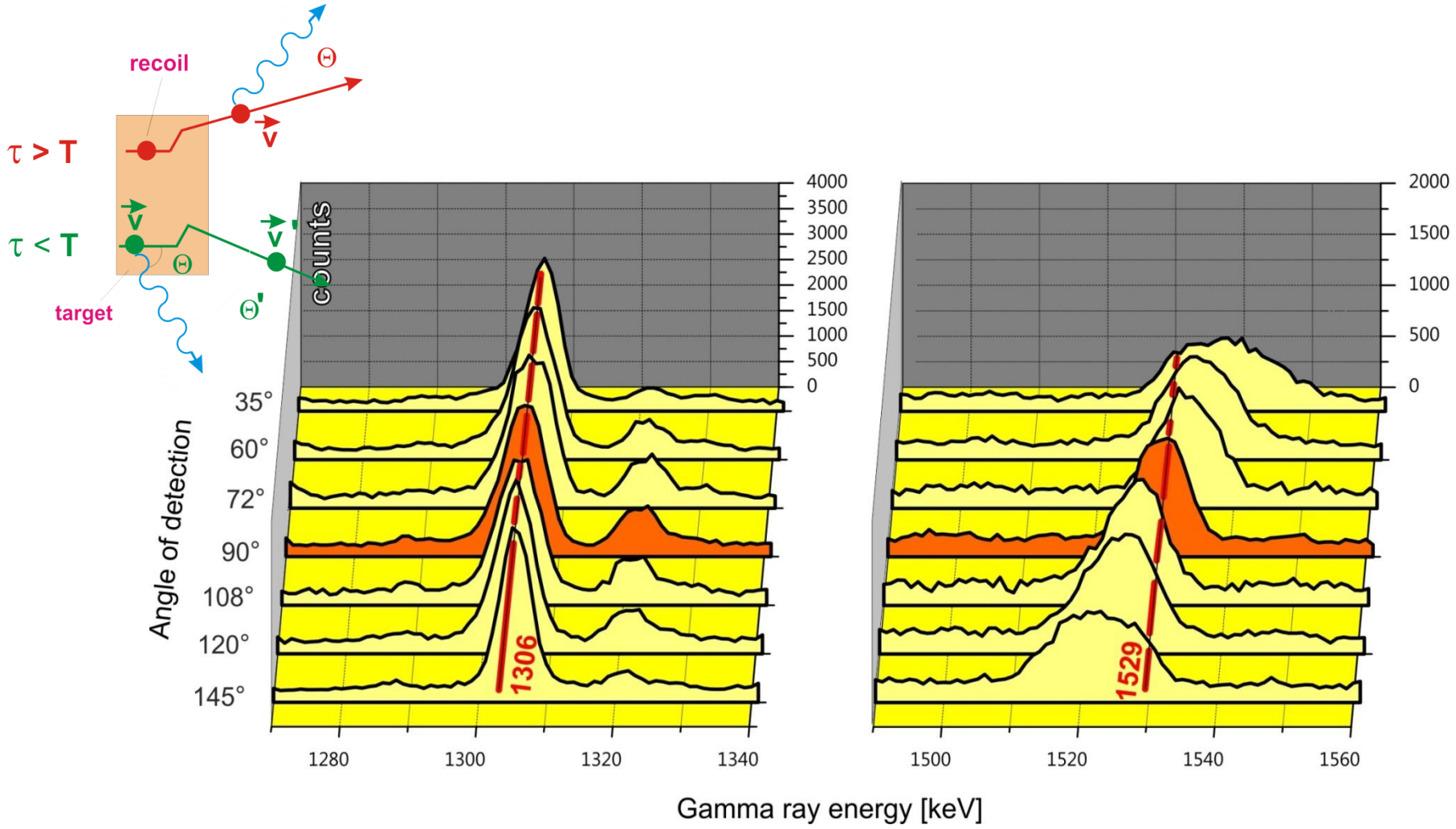
The nuclei of interest



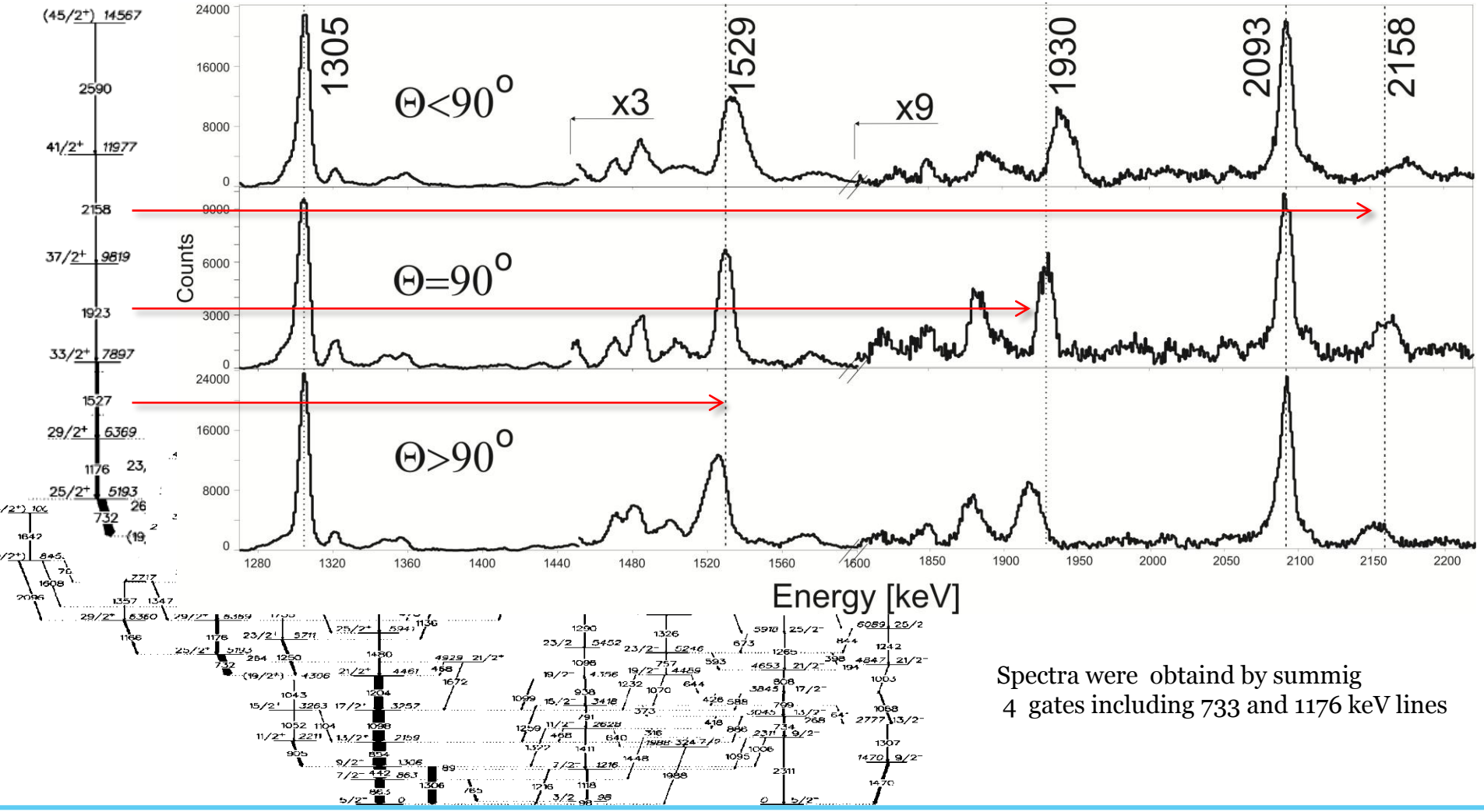


Stefanescu et al., Phys. Rev. C 70, 044304 (2004)

Lifetime effect

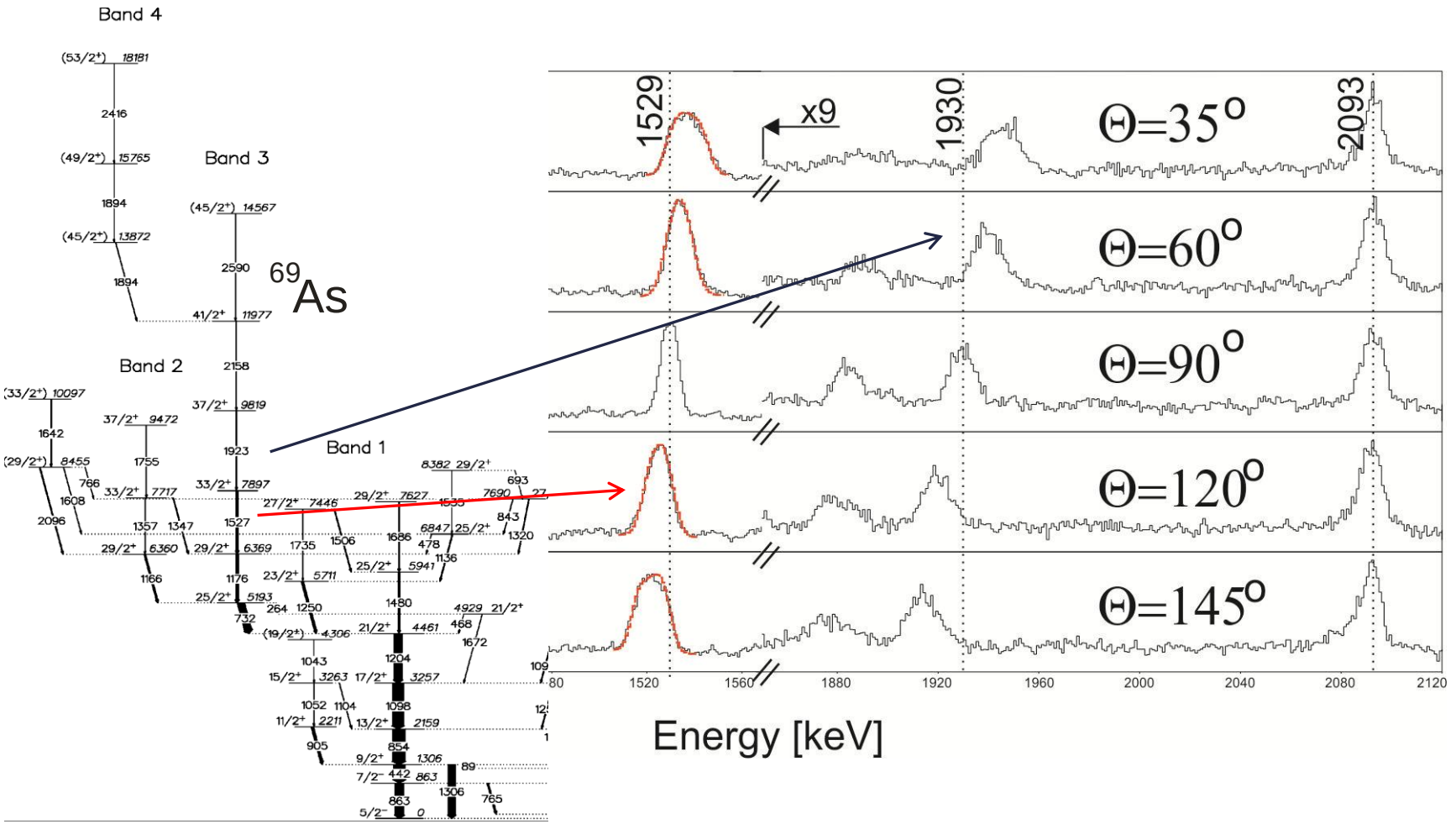


Short lifetimes for all lines in band „3”



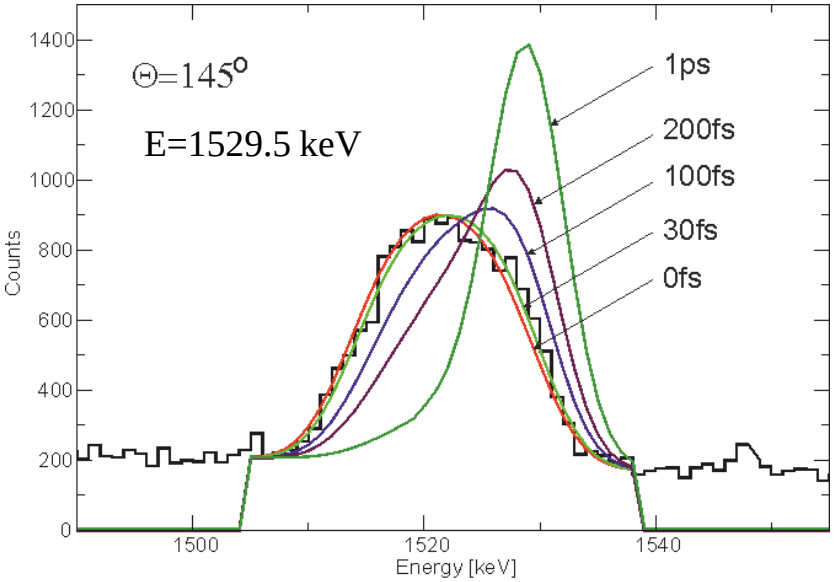
Spectra were obtaind by summig
4 gates including 733 and 1176 keV lines

Short lifetimes in band „3”



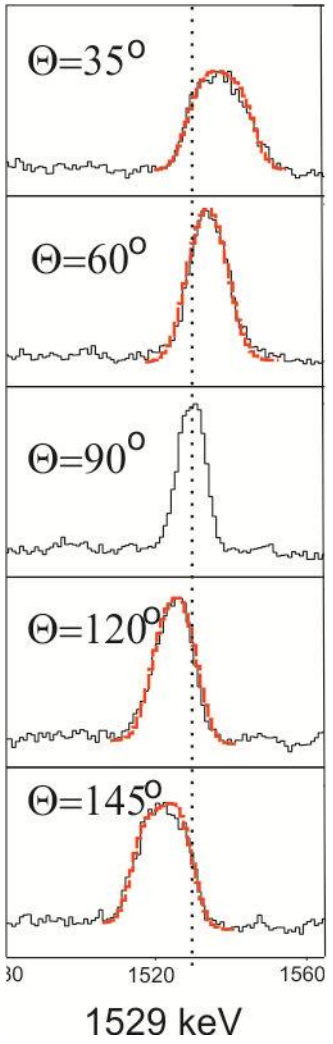
Lifetime estimation for 1529 keV line

Calculated line shapes



Taking into account all spectra we get:

E=1529.5 keV ➡ τ=20 (-20, +30)fs



1529 keV

Lifeteime vs deformation

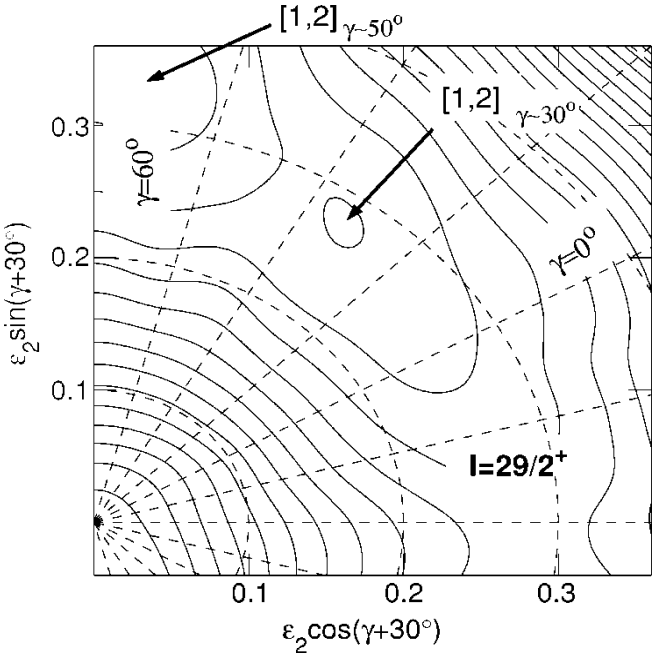
$$B(E2) = \frac{8.196 \cdot 10^{-10}}{E^5[MeV] \cdot \tau[s]}[e^2 fm^4] \rightarrow \beta_2$$

Experimental B(E2) and $\beta_2$values

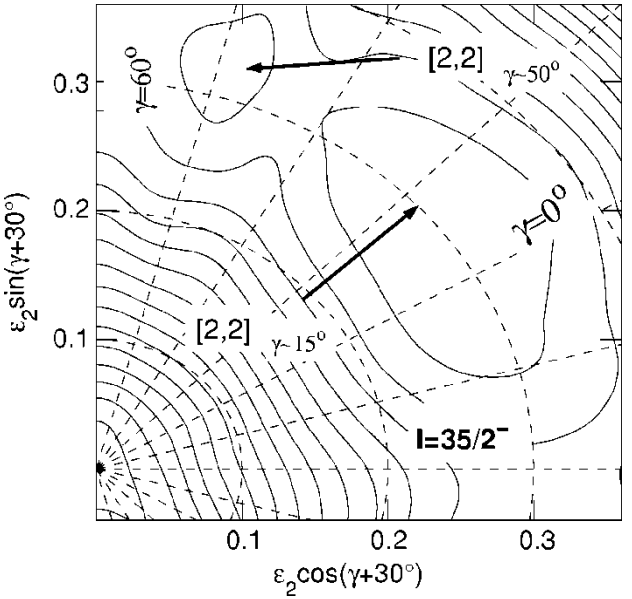
- E=1529.5 keV, τ<50 fas
  - ✓ **B(E2)> 1958 e²fm⁴ (115 W.u.)**
  - ✓ Qs > 108 fm²
  - ✓ Qo > 236 fm²
  - ✓ $\beta_2 > 0.5$
- E=1930 keV, τ<40 fas
  - ✓ **B(E2)> 1015 e²fm⁴ (60 W.u.)**
  - ✓ Qs > 78 fm²
  - ✓ Qo > 169 fm²
  - ✓ **$\beta_2 > 0.4$**

Theoretical predictions for ^{69}As - CNS cal.

I. Stefanescu et al., Phys. Rev. C 70, 044304 (2004)

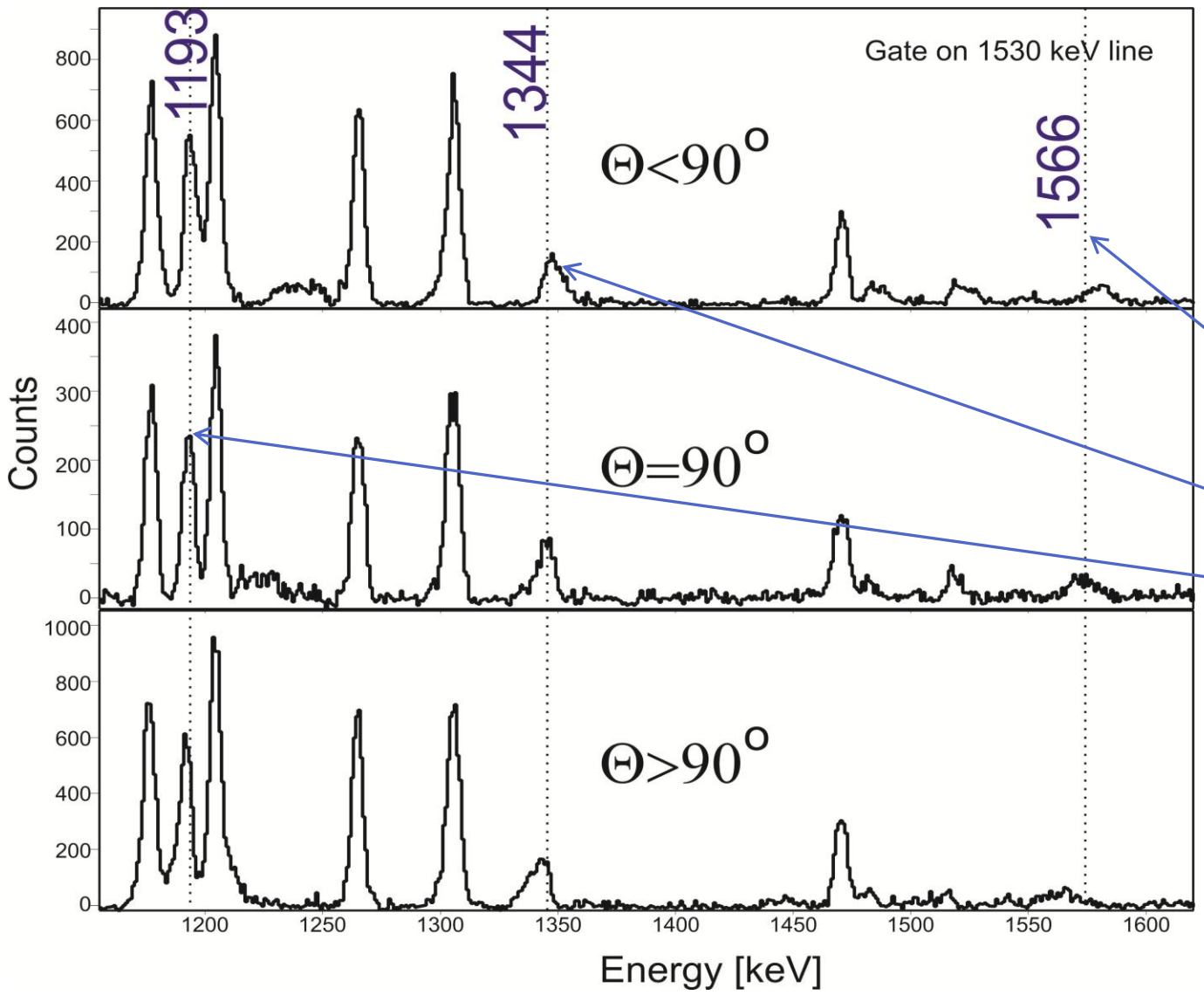


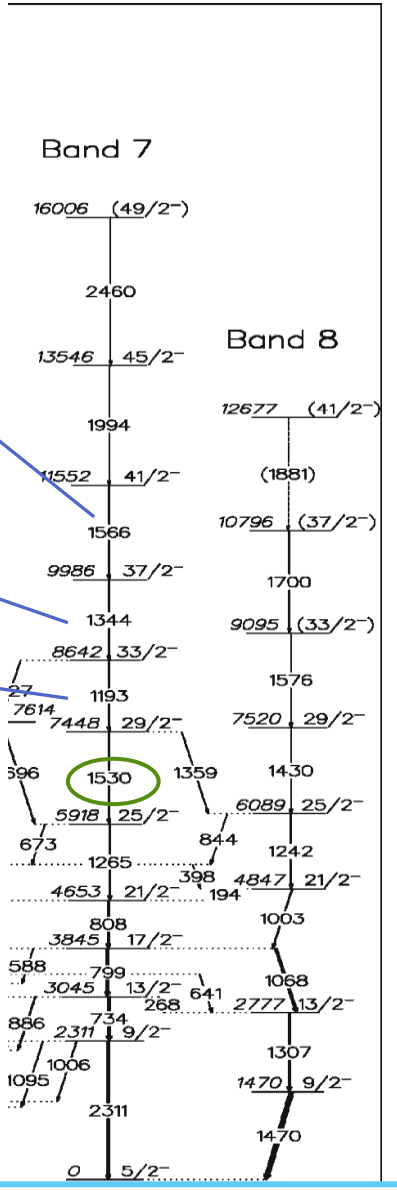
$\beta_2 \approx 0.28, \gamma \approx 30^o$ – band „3"



$\beta_2 \approx 0.3, \gamma \approx 15^o$ – band „7"

Band „7”


Gate on 1530 keV line
1193
1344
1566
Θ<90°
Θ=90°
Θ>90°
Counts
Energy [keV]


Band 7
Band 8
16006 (49/2⁻)
2460
13546 45/2⁻
1994
11552 41/2⁻
1566
9986 37/2⁻
1344
8642 33/2⁻
1193
7614
7448 29/2⁻
1530
5918 25/2⁻
1265
4653 21/2⁻
808
3845 17/2⁻
799
3045 13/2⁻
734
2311 9/2⁻
2311
0 5/2⁻
12677 (41/2⁻)
(1881)
10796 (37/2⁻)
1700
9095 (33/2⁻)
1576
7520 29/2⁻
1430
6089 25/2⁻
1242
4847 21/2⁻
1003
2777 13/2⁻
1068
1307
1470 9/2⁻
1470

Summary

- This experiment shows that very interesting physical problems can be investigated with that type of setup
- Measurement of very short excited states lifetimes is possible when using Ge array with RFD
- Our results offer unique opportunity for testing various micro- and macroscopic theoretical models that are used to interpret the variety of collective bands known in the ^{69}As nucleus

Collaboration

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