A Recoil-Beta Tagging Study of N=Z Nucleus ^{66}As

THE UNIVERSITY of York

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JYFL

Outline

- Introduction
- Recoil-Beta-Tagging
- Isomeric states in ^{66}As
- In-beam gamma-ray spectroscopy of ^{66}As
- Summary

Introduction

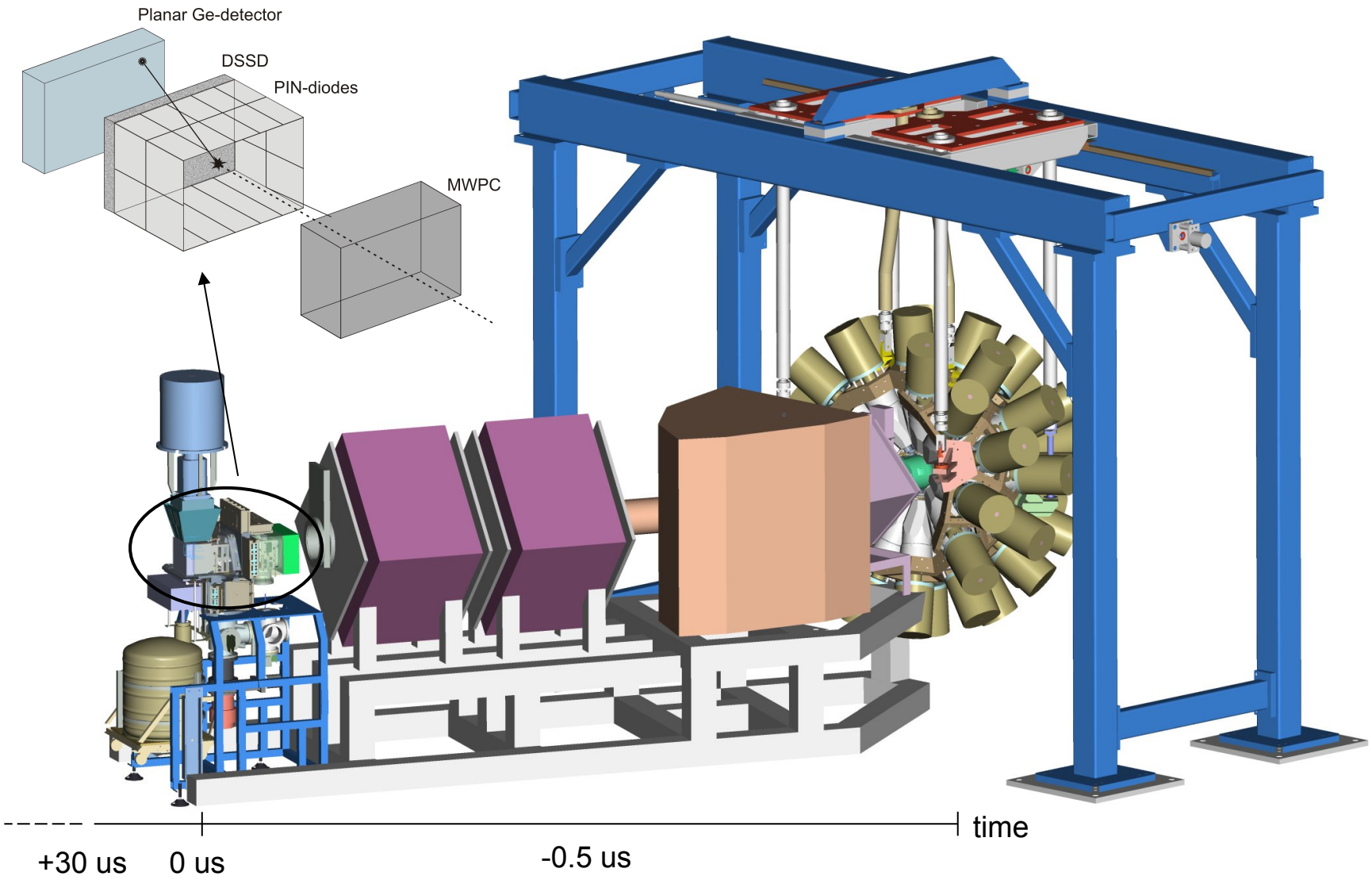
- The proton rich nuclei around A~70 mass region constitute a rich landscape for nuclear structure studies where a wide range of different phenomena are manifested.

- Especially in the case of N=Z nuclei these are the proton-neutron pairing, shape coexistence, changes in the CEDs.

- In addition, the information gained for excited states in the neutron deficient A~70 mass region, adds to our understanding of the astrophysical rp-process.

- Studying these nuclei is an experimental challenge. The recoil-beta tagging developed at JYFL has extented the possibilities of nuclear structure studies to more neutron deficient nuclei in this mass region.

Recoil-Beta-Tagging



Recoil-Beta-Tagging

- Goal is to tag prompt and delayed gamma-rays with beta-particles
- To succesfully do this, high beta-endpoint energy and a short half-life is needed
- Typical endpoint energies and half-lives around A~70 mass region are 2-6MeV and 1s-1h.
- Certain exotic isotopes decay by Fermi superallowed beta-decay, then Q_{EC}~10MeV and $t_{1/2}$~10ms. These nuclei can be studied with RBT.

Recoil-Beta-Tagging

Reaction: $^{28}S + ^{40}Ca \longrightarrow {}^{66}As + pn$ E_b=75MeV and 83MeV

$^{65}Ga + 3p$

$^{66}Ge + 2p$

$^{65}Ge + 2pn$

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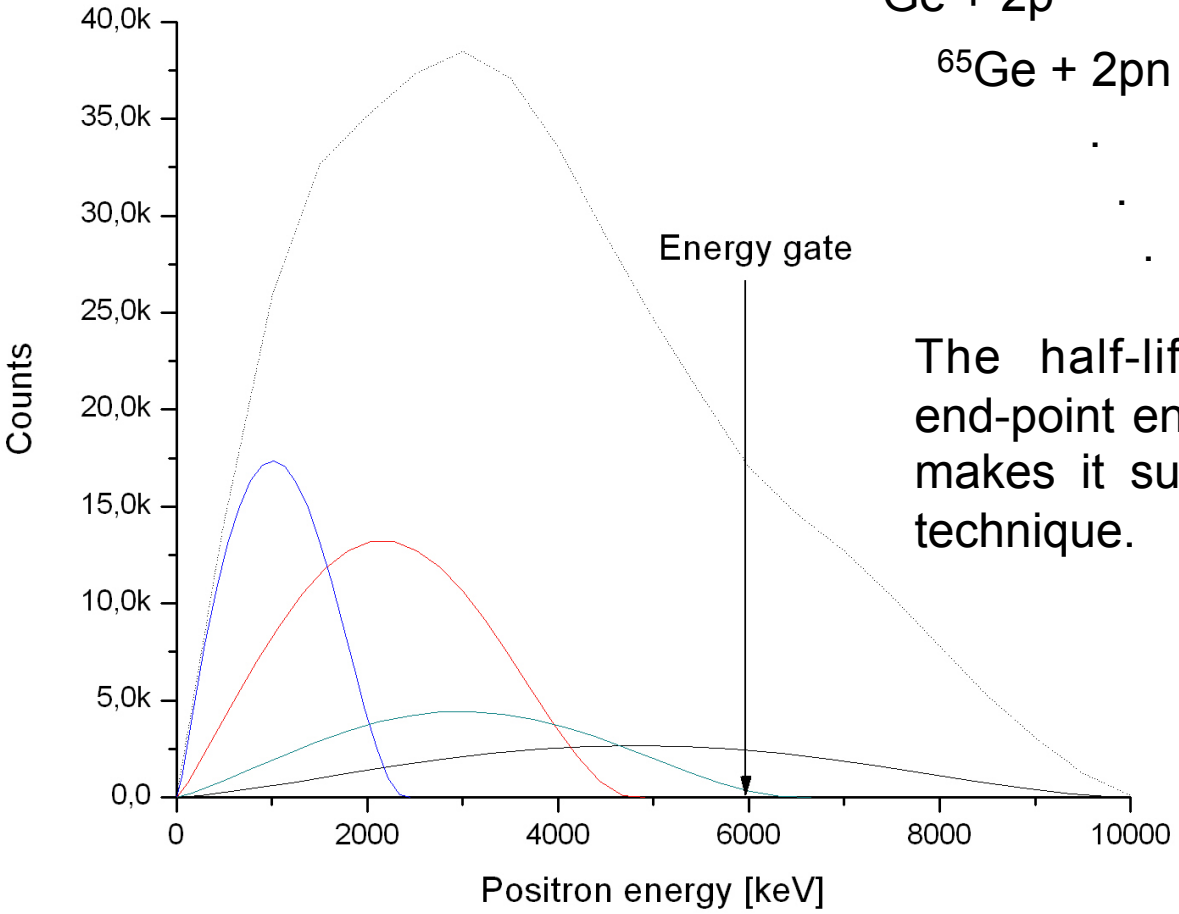
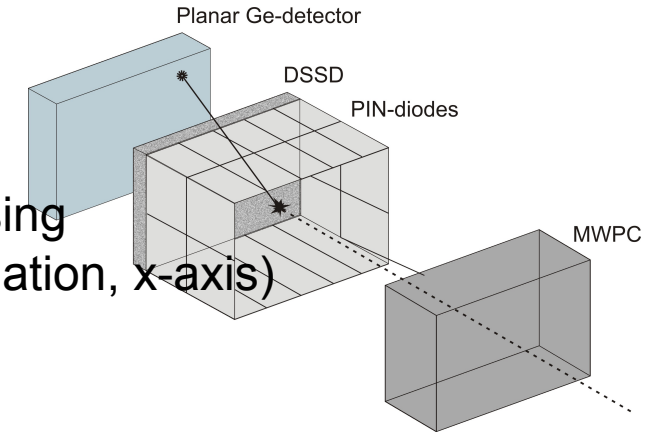
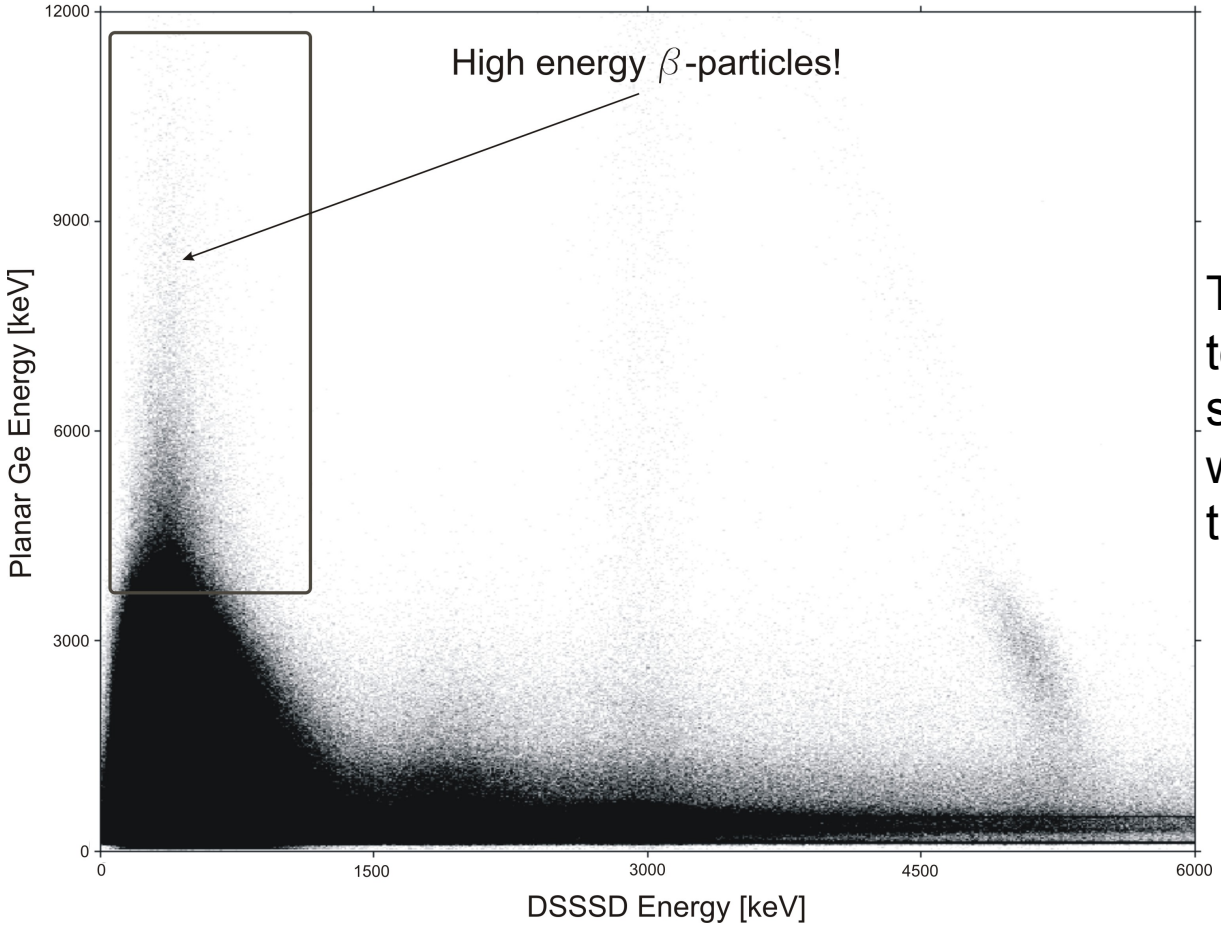


The half-life ($t_{1/2}$=96ms) and the end-point energy (Q=9.6MeV) of **^{66}As** makes it suitable to study with RBT technique.

Recoil-Beta-Tagging



High energy beta-particle identification is carried out by using coincidences between the silicon strip detector (DE information, x-axis) and the planar ge-detector (full E information, y-axis).

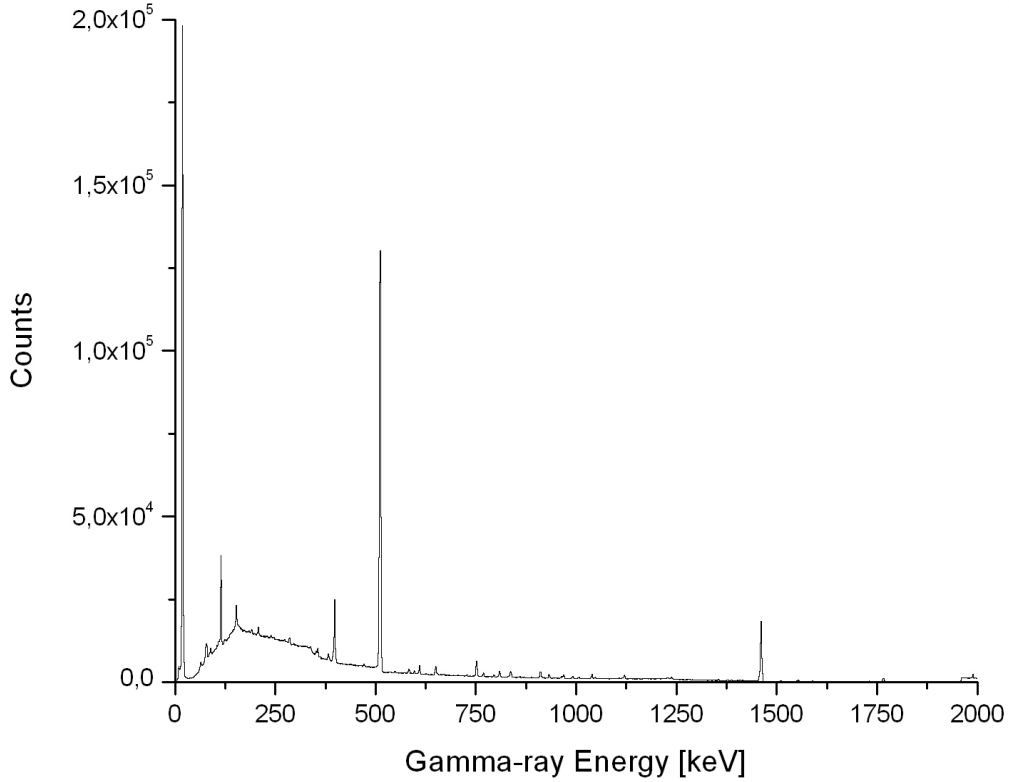


These events are correlated to a recoils that occured in the same pixel of the DSSD within a maximum correlation time of **300ms** (~3x$t_{1/2}$(^{66}As))**.**

Isomeric states in ^{66}As

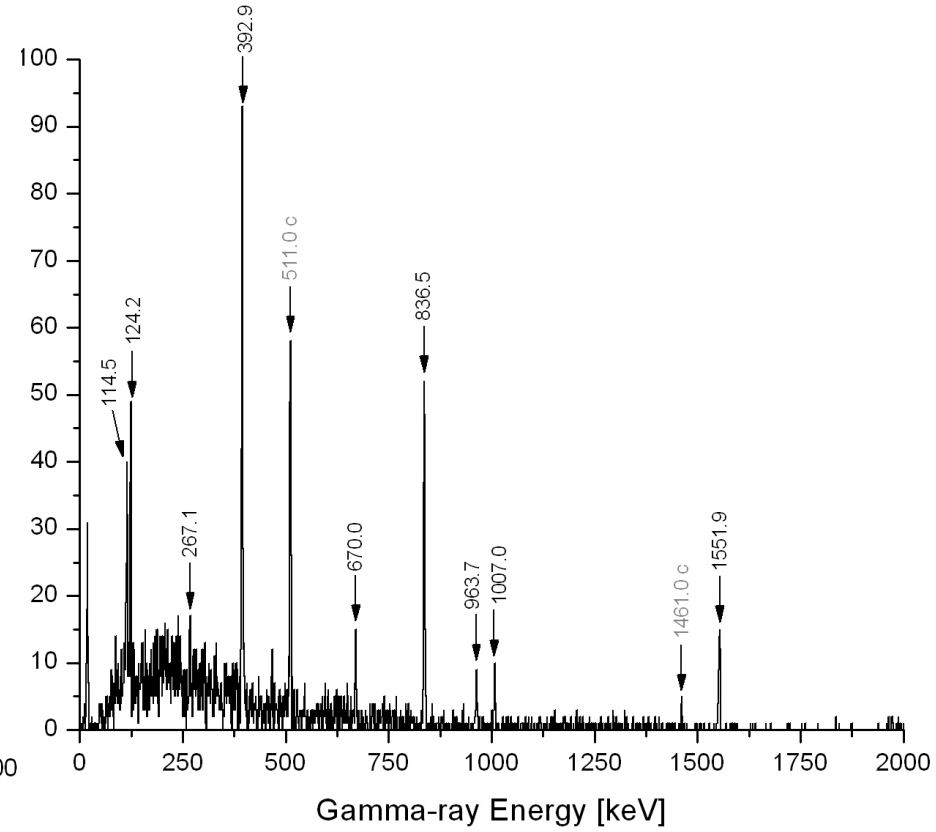
Focal plane Clover spectra

Recoil gated delayed gammas



~10x10^6 events

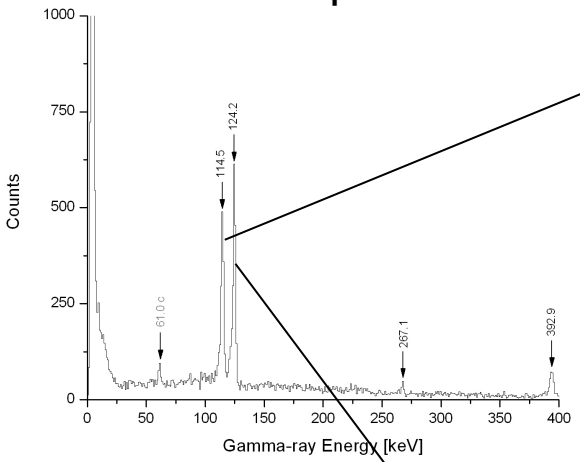
^{66}As tagged delayed gammas



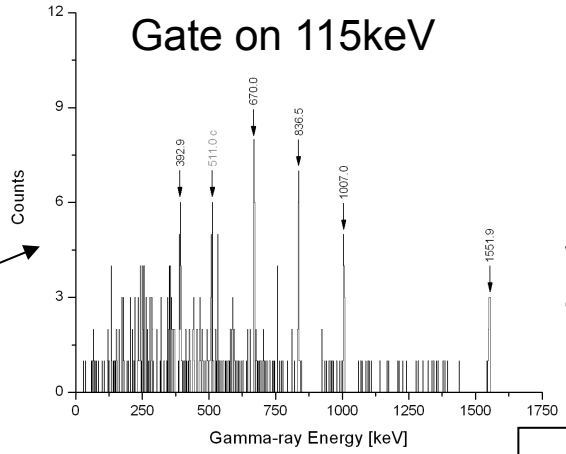
~1x10^3 events

Isomeric states in ^{66}As

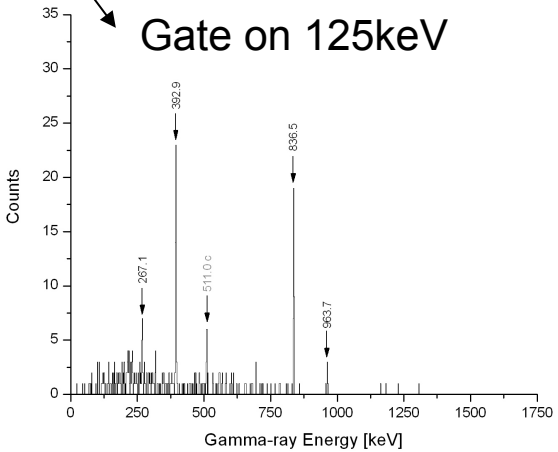
Planar spectrum



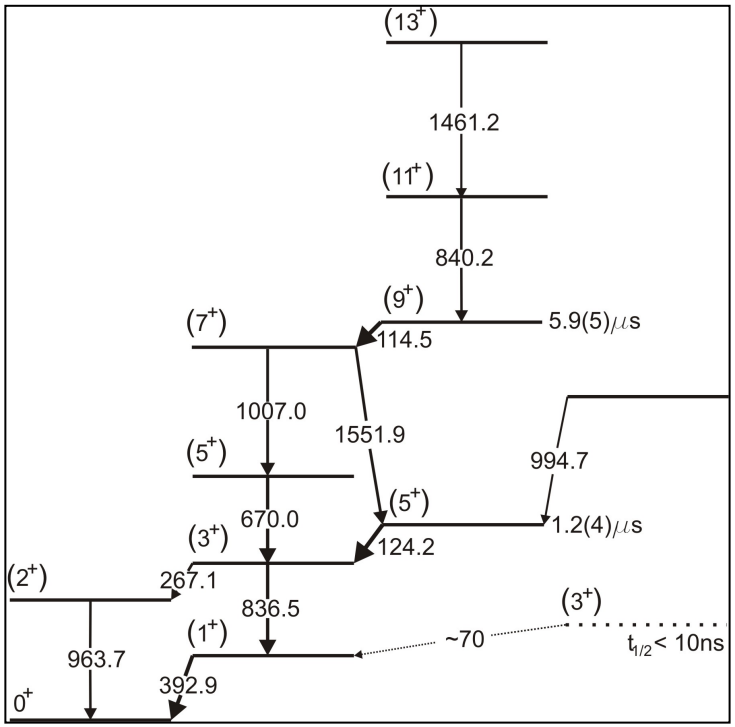
Gate on 115keV



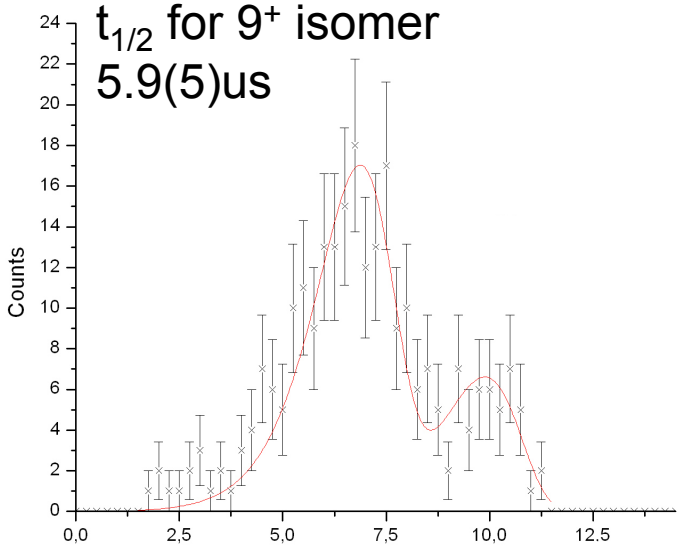
Gate on 125keV

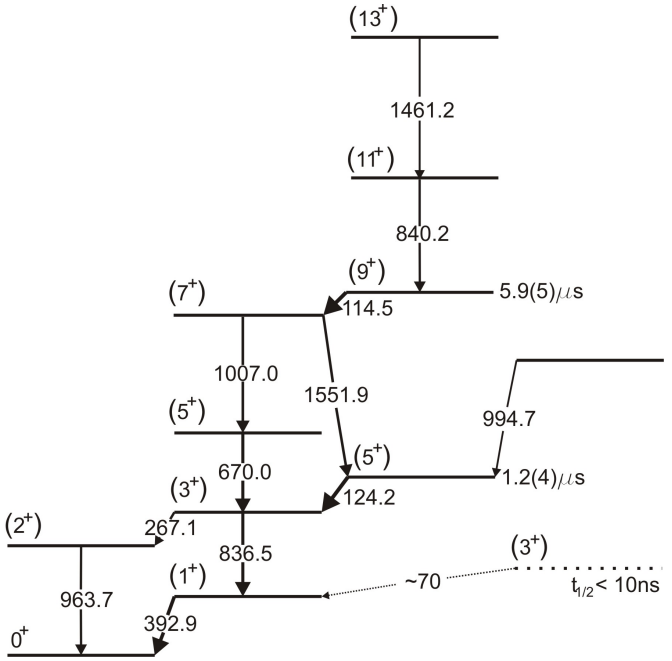


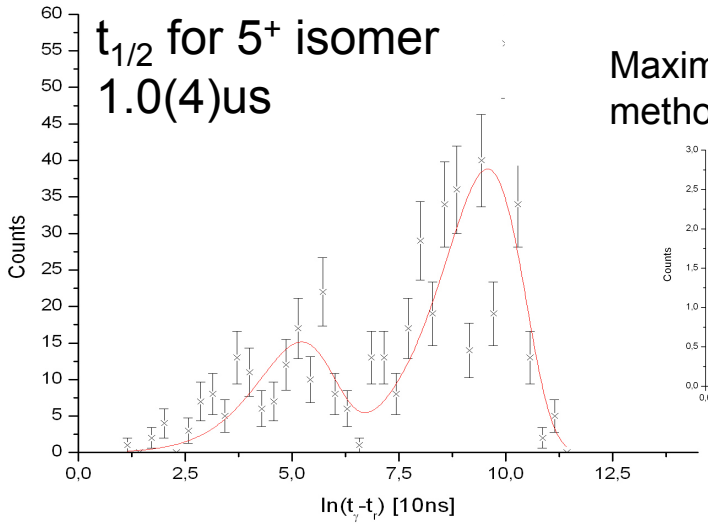
Ordering of the isomeric states was established by comparing the time stamps of 115keV and 125keV gamma transitions.



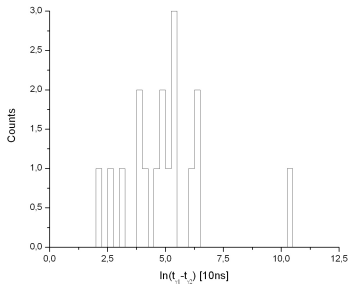
Isomeric states in ^{66}As







Maximum likelihood method gives: $t_{1/2}=1.3^{+0.5}_{-0.3}$ us



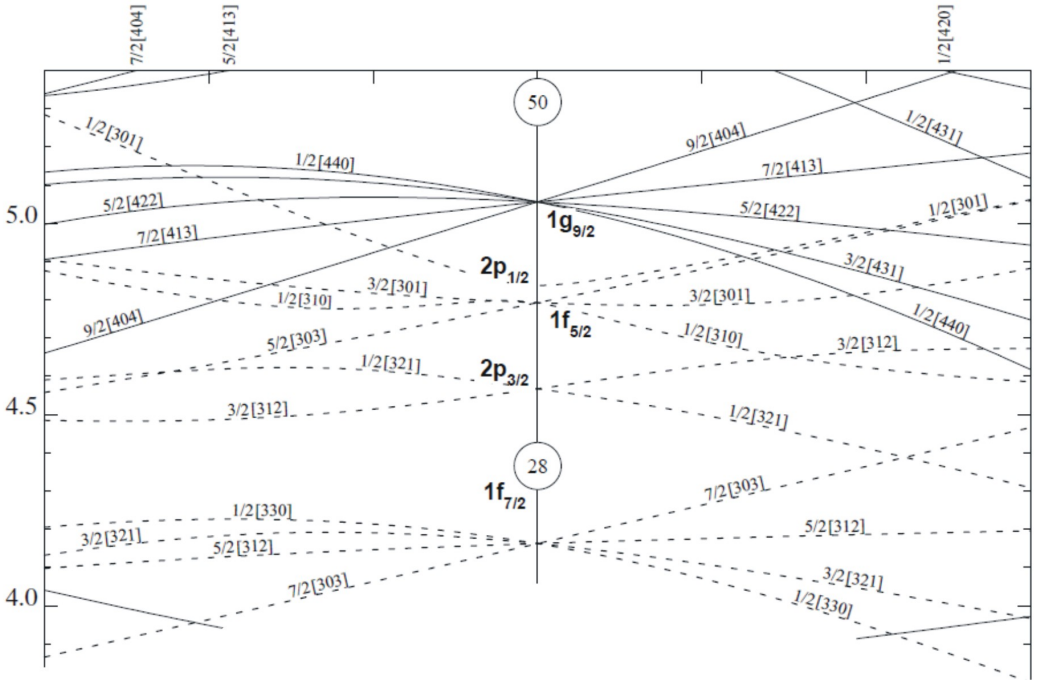
Experimental B(E2) values:

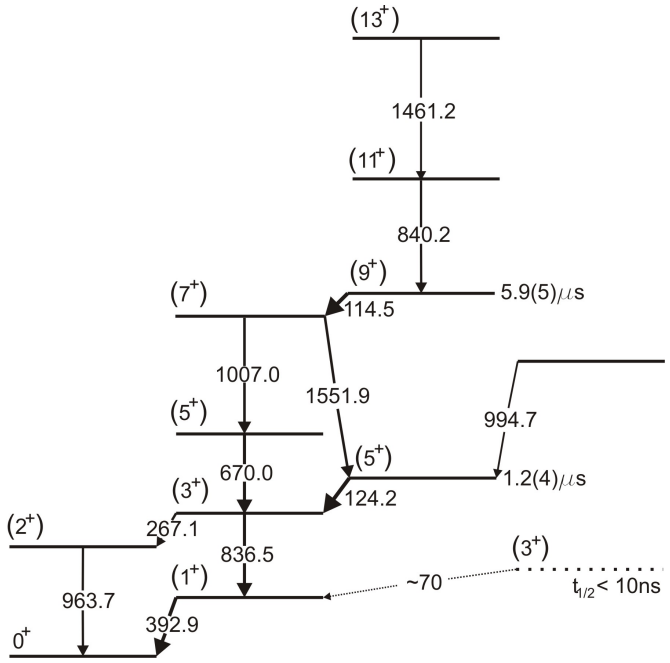
B(E2, $9^+ \rightarrow 7^+$) = 0.20 W.u
B(E2, $5^+ \rightarrow 3^+$) = 0.87 W.u.

Isomeric states in ^{66}As

Configurations:

The configuration of the isomeric states are two fully aligned $g_{9/2}$ and $f_{7/2}$ nucleons for the 9^+ and 5^+ respectively. According to the experimental B(E2) values of the gamma-rays depopulating the isomeric states, the transitions are not significantly hindered. The long half-life can be attributed ,in part, to the low transition energy, 115keV and 125keV.

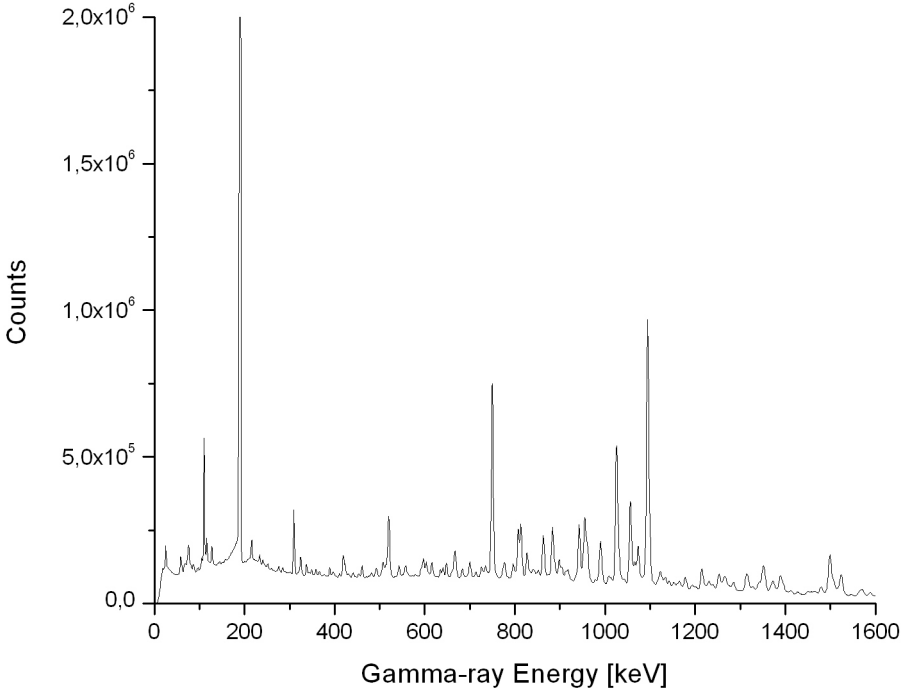




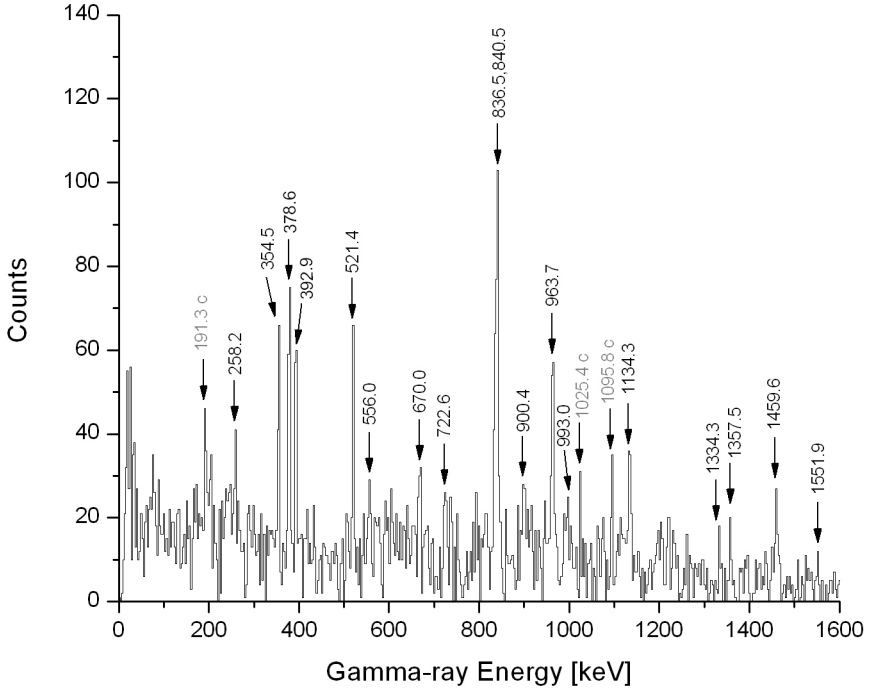
In-beam gamma-ray spectroscopy of ^{66}As

Jurogam II spectra

Recoil gated prompt gammas



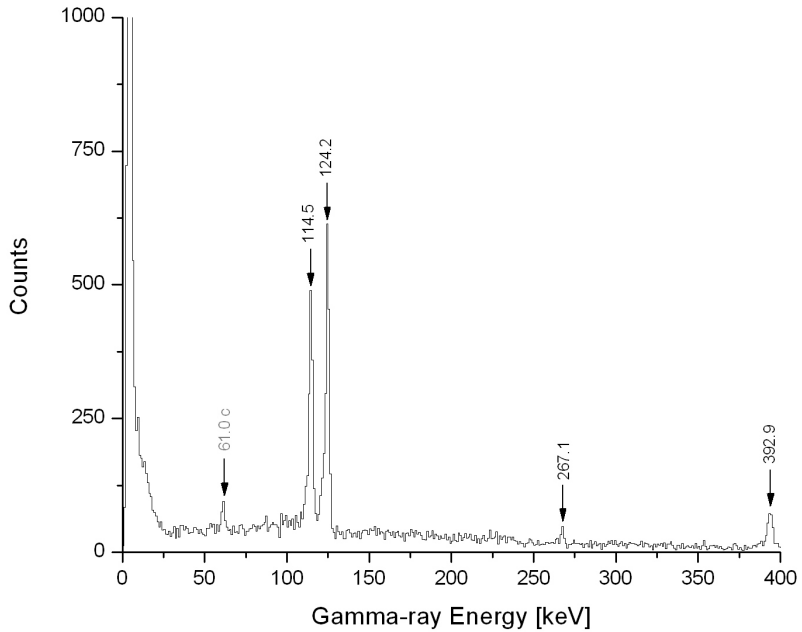
^{66}As tagged prompt gammas



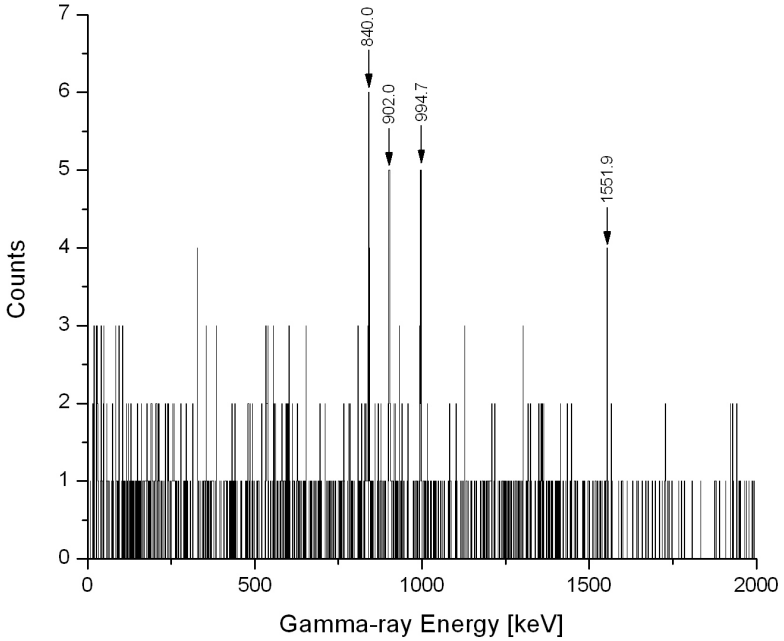
Prompt gamma-radiation by ^{66}As

The isomer decay tagging is also possible way to study prompt gammas!

Delayed gammas in Planar ge-detector



Prompt gammas in Jurogam II



Summary

- RBT-method can be succesfully utilized to study medium mass nuclei, in this case the ^{66}As, the lightest nucleus ever studied at RITU
- Half-lives of two isomeric states have been measured, 5.9(5)us for 9^+ and 1.2(4)us for 5^+ state (literature values 8.2(5)us and 1.1(1)us by Grzywacz et. al.)
- Several new prompt gamma transitions originating from the ^{66}As have been observed
- Work is still in progress. Combining RBT and RIT, a better understanding of the low lying structures in 66As will be achieved