Outline: RISING - active stopper 2006

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web-page: <u>https://web-docs.gsi.de/~wolle/</u> and click on



- 1. measurements with double-sided Si-strip detector
- 2. mesytec and multichannel systems electronics
- 3. ²⁴¹Am and ²⁰⁷Bi source
- 4. implantation detector for RISING
- 5. experimental results



Active catcher for implantation-decay correlations Implantation-decay correlations with large background[<] (half lifes similar to the implantation rate):

✓ implantation-decay time correlation: active catcher
✓ implantation-decay position correlation: granularity
✓ implantation of several ions: thickness and area
✓ energy of the implanted ion and the emitted β

- 3 double-sided silicon-strip detectors
 - surface 5x5 cm²
 - thickness 1 mm
 - 2 x 16 3.125 mm strips
 - manufactured by MICRON









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grounding



experimental set-up

Rakesh Kumar, P. Doornenbal, I. Kojouharov, W. Prokopowicz, H. Schaffner, H.J. Wollersheim NIM A 598 (2009) 754



Measurements with a double-sided Si-strip detector 2006



Price: 2200 €



Measurements with a double-sided Si-strip detector 2006

grounding





Output signal of the MPR-32 preamplifier for a 207 Bi β -source (pulse-height 200mV, decay time 30 μ s)



Energy resolution with ²⁴¹Am source measurement in vacuum







Low energy peak from gap events at about ½ the full pulse height

C.Wrede et al. NIM B204 (2003), 619

MICRON	#2215-17
Voltage:	200V
C	
²⁴¹ Am	$E_q = 5.486 \text{ MeV}$
range	~28 μm



Strip multiplicity with ²⁴¹Am source





Two dimensional position spectra



²⁴¹Am source centered



²⁴¹Am source left



²⁴¹Am source centered, strip-multiplicity=1



²⁴¹Am source left, strip-multiplicity=1

MICRON #2243-5 Voltage: 40V, measurement in vacuum



Energy resolution with ²⁰⁷Bi source measurement in vacuum





experimental set-up



MICRON #2512-17

Voltage: 200V

²⁰⁷ Bi	E=482, 976 keV
range	$0.94, 2.31 \text{ mm} (e^-e^- \text{ interaction})$



Energy resolution with ²⁰⁷Bi source measurement in vacuum





experimental set-up



MICRON #2512-17 Voltage: 200V

²⁰⁷ Bi	E=482, 976 keV
range	0.94, 2.31 mm (e ⁻ e ⁻ interaction)



Energy resolution with ²⁰⁷Bi source measurement in vacuum





GSİ

experimental set-up

Energy resolution with ²⁰⁷Bi source measurement in vacuum and dry N₂







<u>conclusion</u>: measurement in dry N_2

²⁰⁷ Bi	E=482, 976 keV
range	0.94, 2.31 mm (e ⁻ e ⁻ interaction)



Energy resolution of the DSSSD

MICRON	∆E (²⁴¹ Am) vacuum	∆E(²⁰⁷ Bi) vacuum	∆E(²⁰⁷ Bi) dry nitrogen
#2243-5	<mark>N:</mark> 31.3 keV	N: 16.2 keV P: 33.3 keV	N: 16.0 keV P: 32.5 keV
#2243-4	<mark>N</mark> : 30.2 keV	<mark>N</mark> : 18.5 keV	
#2243-3	<mark>N</mark> : 34.0 keV	<mark>N</mark> : 18.2 keV	
#2243-2	N: 35.7 keV	N: 14.5 keV P: 27.0 keV	
#2512-17	N: 27.4 keV P: 29.7 keV	N: 14.8 keV P: 18.8 keV	



experimental set-up









γ-energy [keV]	e ⁻ -energy
569.6	481.7 [K]
	553.8-556.7 [L]
	565.8-567.2 [M]
1063.7	975.7 [K]
	1047.8-1050.6 [L]
	1059.8-1061.2 [M]

²⁰⁷Bi emits gamma rays and electrons

Energy threshold of the DSSSD







Measurements with a double-sided Si-strip detector 2006



Total cost 27,250.- €(discriminator not included)



Energy resolution with ²⁰⁷Bi source measurement with Mesytec and Multichannel Systems





experimental set-up



MICRON #2243-5 Voltage: 200V measurement in vacuum

ORTEC 572

shaping time 0.5 μ s $\Delta E=122 \text{ keV}$ 1.0 μ s $\Delta E=112 \text{ keV}$ 2.0 μ s $\Delta E=103 \text{ keV}$



Energy resolution with ²⁰⁷Bi source measurement with Multichannel Systems









MICRON #2243-5

Voltage: 200V measurement in vacuum



experimental set-up



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Double-sided silicon-strip detector DSSSD

- surface 5x5 cm²
- thickness 1 mm
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- ✓ thickness sufficient for HI-implantation
- \checkmark but range of β -particles larger than 1mm
- \checkmark therefore part of the kinetic energy is measured





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Monte-Carlo simulation with GEANT4





Simulated energy spectrum of β -particles emitted from fragments implanted uniformly (solid line) and exactly in the centre (dashed line) in the middle of a DSSSD.

Calculated β-detection efficiency as a function of the DSSSD threshold for the two considered implantation scenarios Detection threshold should be less than 100 keV



Rare ISotope INvestigation at GSI spectroscopy of stopped beams





Chamber for active stopper measurement with dry N₂



<u>result:</u> 6mm Pertinax ≈ 2mm Al 2mm Pertinax for active stopper chamber



Pertinax

phenolic-formaldehyd cellulose-paper PF CP 2061



Stopped RISING array @ GSI: 15x7 element Cluster with DSSD





Chamber for active stopper measurement with dry N₂



Thin black Pocalon C foil $20 \mu m$





Chamber for active stopper









Count rate limitations with active stopper

- $3 \times 16 \times 16 = 3 \times 256 = 768$ total pixels.
 - Assume upper limit for β -half-life of ~30 seconds
 - Each pixel hit every 5 half-lives (150 s)
- Max. rate of $\sim 768/150 = 5$ per sec (= 50 per 10s spill).
- Rate increases directly with decreasing half-life
- (e.g., $T_{1/2} = 10$ seconds $\rightarrow 150$ per 10 s spill cycle)
- Dual gain pre-amps on DSSSD to get energies of
- implanted ion and β -particle
- All events time stamped with MHz clock.



Fragment separator FRS





Implantation range

Estimated implanted isotopes for a setting centered on ^{192}W in 1 mm thickness silicon with a monoenergetic degrader at S2





Estimated implanted isotopes for a setting centered on ¹⁹²W in 1mm thickness silicon with a monoenergetic degrader at S2





Experimental results conversion electrons





Experimental results beta decay



