Event-Mode Data Acquisition for Non-Destructive Laboratory Analysis

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OUTLINE

1. Introduction
2. Feasibility study 2007
3. PANDA equipment
4. Discussion

NDA - Non-Destructive Analysis

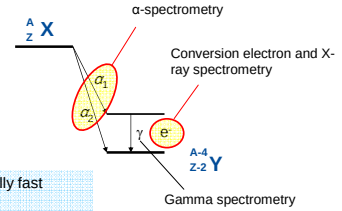
1. Sampling
2. Mesurement: $\alpha\beta\gamma Xe^{-}$
3. Analysis and Data Management

1. Introduction

- Combining the results of different methods provides results that are not available using individual methods.

$1 + 1 \geq 2$

Decay/emission processes and spectrometric analysis techniques



Emission processes are usually fast (typical time scales 10^{-15} s)

Where is the beef ?

Software-based coincidence

Event-mode data acquisition
(List mode)

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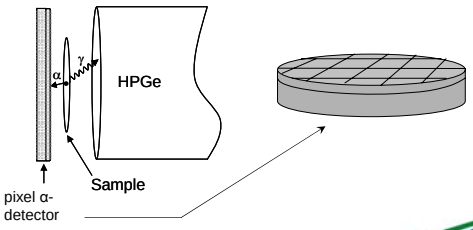
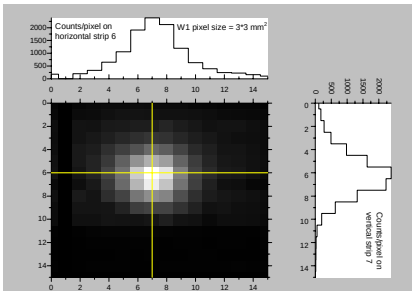
2. Feasibility study

- Accelerator Laboratory of the University of Jyväskylä.
- A particle from a nuclear bomb (Thule) was measured using a HPGe detector and an α-detector with 16x16 pixels.



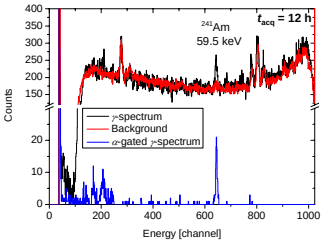
Locating radioactive particles

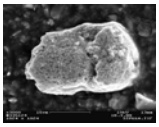
Radioactive particles present in the sample are visible as "white" spots (here the Thule particle)



α-gated γ-spectrum

Only those photons are registered which are in coincidence with alpha particles.





Improved signal-to-noise ratio

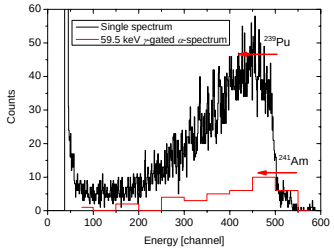
Peak area smaller by a factor of 2-4.

Background reduced by factor of 1000.

Another example of "software coincidence"

γ-gated α-spectrum

Only those alphas (red histogram) are registered which are in coincidence with 59.5-keV photons.



Shape of the ^{241}Am α-peak can be justified from the measurement.

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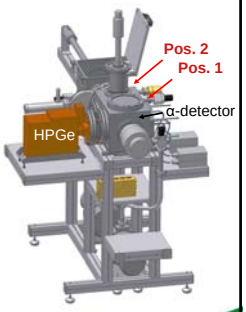
3. PANDA - Particles And Non-Destructive Analysis

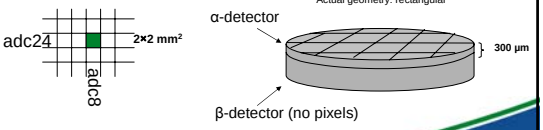
- Platform for different types of radiation detection systems.
- First results at the end of 2008.
- 2 measurement positions, 2 different detectors available in each position.
- Several detector types with different setups are possible.
- Samples: electrodeposited plates, air filters, swipes, individual particles ...

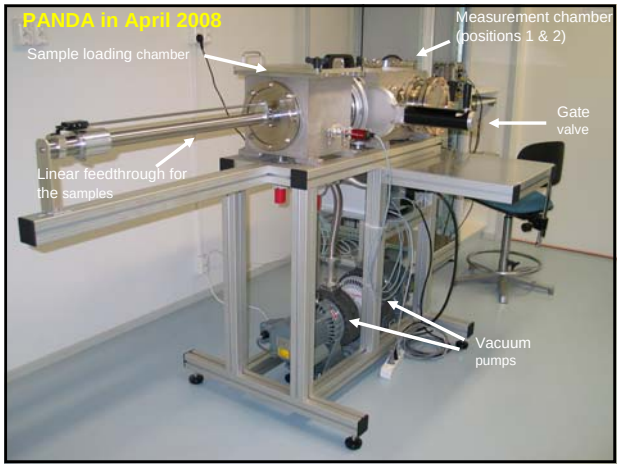


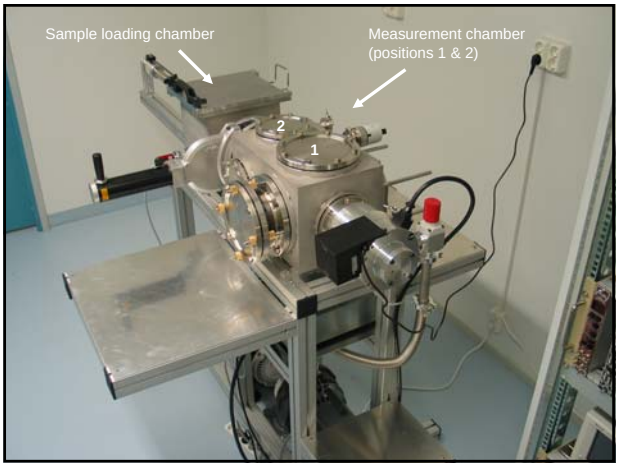
- Sample screening is done in measurement position 1, whereas position 2 is for detailed analyses of a specified particle.
- All measurements (including γ-ray spectrometry) can be done in vacuum (10^{-7} mBar) → αβγXe^{-} measurements are possible.
- Linear feedthroughs enables accurate movement and positioning of the detectors and the sample (~10 µm).

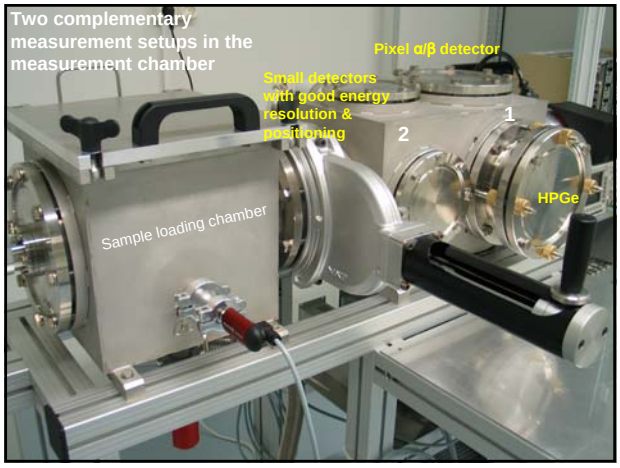
Position-sensitive detector and time stamps

- PANDA's α-detector has 1024 pixels, each of them acts like an individual spectrometer → position signal from the strips.
- Coincidence window will be about 1 µs wide in time.





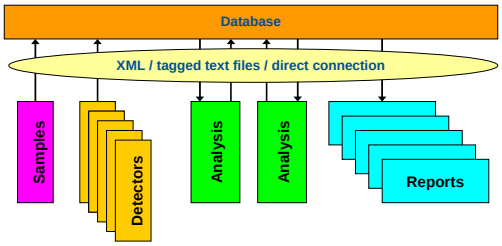




Data Management

- XML format for data structures
- Database designed for event-mode data
- Use of LINSSI database - I/O tables (LINux System for Spectral Information) intended for MySQL platform.
- Database attached to a www server; data visualization and other application scripts written in PHP.

LINSSI database



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- PANDA - comprehensive characterization of radioactive materials
- Low detection limits - event-mode data acquisition
- Several spectra, $\alpha\beta\gamma Xe$ measurements, from one measurement
- Applications - safeguard analysis, environmental...

4. Discussion

- Some samples could be analyzed completely with PANDA.
  OR
  PANDA could operate as a sophisticated screening device for locating particles of interest for further studies.
- PANDA finds particles with Pu-mass of the order of 10^{-12} g in 24 h.

→ ^{239,240}Pu particles with mass of 10^{-9} g (activity ~3 Bq, diameter ~6 µm) can be identified in a few min.