

## PANDA – Particles And Non-Destructive Analysis

*PANDA is a sensitive measurement device for non-destructive sample analysis. In PANDA many techniques and instruments used in basic research are applied to the analysis of environmental and safeguards samples. Besides being a fully operational measurement device PANDA is also a platform for the development of new techniques and measurement tools.*

### Features

- Sensitive sample analysis using non-destructive analysis techniques
- Particle localization
- Pu isotope ratio determination

### Technical characteristics

- Two measurement positions operating inside a vacuum chamber
- Separate vacuum chamber for loading and changing samples
- Measurement position 1 hosts a position sensitive double sided silicon strip detector (DSSSD) for the detection of alpha particles and an HPGe detector for gamma- and X-rays
- Possibility to make coincidence studies ( $\alpha$ - $\gamma$ ,  $\gamma$ - $\alpha$  etc.)
- Event-mode data acquisition
- Data stored in LINSSI database
- SPANDA software for data processing
- Measurement position 2 hosts a prototype silicon drift detector that is currently being tested
- Data collected with VASIKKA and stored in LINSSI database



Fig. 1. Photograph of the PANDA device.

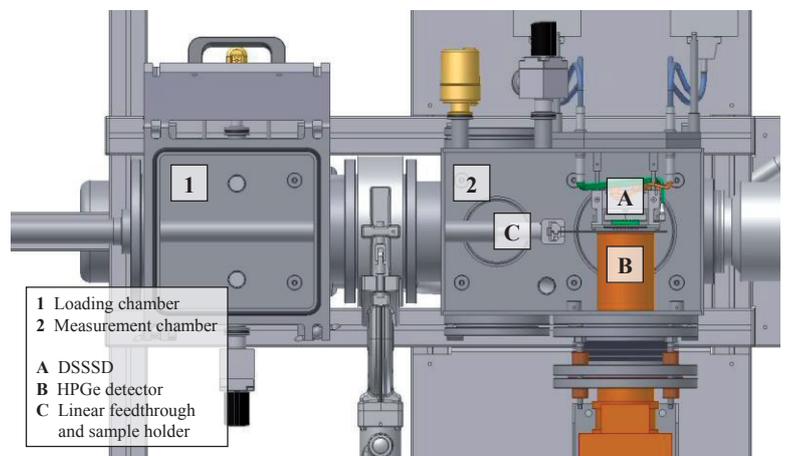
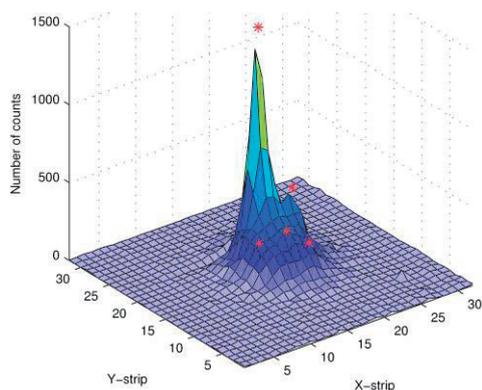


Fig. 2. CAD drawing of the inside of PANDA's loading and measurement chambers.

## Applications

### Locating particles

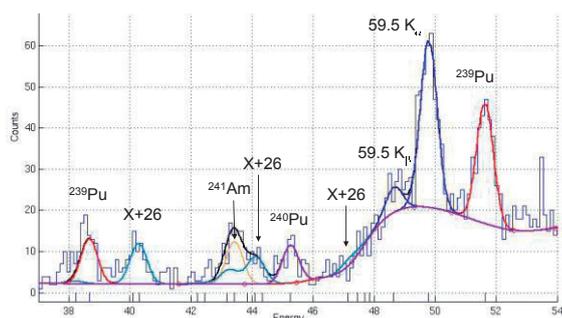
PANDA's position sensitive alpha detector can be used to detect particles from large-area samples such as swipes or filters and perform a preliminary particle analysis for them (Fig. 3).



**Fig. 3.** Hitmap measured with the DSSSD. The locations of the fitted particles are marked as red asterisks.

### Coincidence gating ( $\alpha$ - $\gamma$ , $\gamma$ - $\alpha$ etc.)

PANDA's DSSSD and HPGe detectors can be used to make various coincidence studies. For example an alpha-gated gamma spectrum can have nearly zero background. This greatly improves the detection of many hard-to-detect nuclides such as  $^{239,240}\text{Pu}$  (Fig. 4).



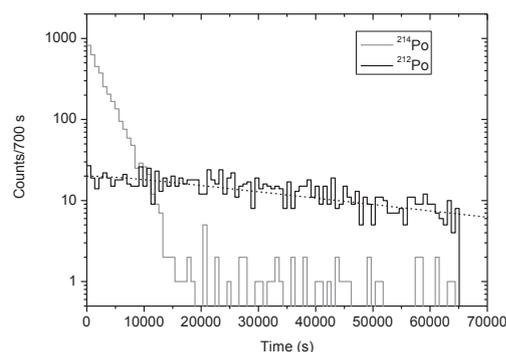
**Fig. 4.** Part of a fitted alpha-gated gamma spectrum of a particle sample originating from a nuclear bomb and containing  $^{239,240}\text{Pu}$  and  $^{241}\text{Am}$ .

### Further reading

- Turunen J, Peräjärvi K, Pöllänen R, Toivonen H. PANDA – A novel instrument for non-destructive sample analysis. Nuclear Instruments and Methods in Physics Research A 2010; 613: 177–183.
- Turunen J, Ihantola S, Peräjärvi K, Pöllänen R, Toivonen H. Novel spectrometric approach to non-destructive characterization of safeguards samples. ESARDA Bulletin 45, December 2010. p. 23–28.
- Peräjärvi KA, Ihantola S, Pöllänen RC, Toivonen HI, Turunen JA. Determination of  $^{235}\text{U}$ ,  $^{239}\text{Pu}$ ,  $^{240}\text{Pu}$ , and  $^{241}\text{Am}$  in a nuclear bomb particle using a position-sensitive  $\alpha$ - $\gamma$  coincidence technique. Environmental Science and Technology 2011; 45 (4): 1528–1533.
- Turunen J, Ihantola S, Peräjärvi K, Toivonen H. Comprehensive radioassays of samples using the PANDA device. Nuclear Instruments and Methods in Physics Research A 2012; 678: 78–82.

### Time stamped event data

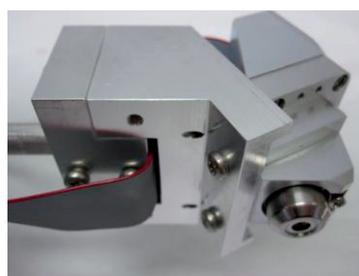
PANDA's data are collected in event-mode. Events are time stamped. This storage format allows the generation of final spectra for the analysis even after the measurement. The event time stamping enables various time behavior studies (Fig. 5).



**Fig. 5.** Time behavior of  $^{212}\text{Po}$  and  $^{214}\text{Po}$  alpha particle counts in a sample measured with the DSSSD detector.

### Conversion electron spectroscopy

The samples can be transported between PANDA's two measurement positions. If a sample screening in measurement position 1 reveals an interesting particle the measurements can be continued in measurement position 2. The prototype silicon drift detector (SD<sup>3</sup>) in PANDA's measurement position 2 can also be used for the detection of conversion electrons (Fig. 6).



**Fig. 6.** The silicon drift detector in PANDA's measurement position 2.

## Technology Readiness Level 5

STUK-TTL-FLYER-2011-009, 17 Oct 2012

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