

- Available for laboratory use or as an input solution instrument.
- Latest (2009) version of PC-Based Los Alamos Advanced HKED software.
- Turnkey-complete HKED system packages available.
- Retrofits available for ALL other HKED systems.
- Custom configurations available to match HKED equipment to existing hot cell with suitable failsafe sample handling methods.
- Physics and Engineering consulting design support available.
- Flexible choice of standards for calibration purposes, including ability to use suites of standards with different enrichment factors.
- Superior attenuation correction algorithm permits good calibrations with small numbers of calibration standards.
- Measurement range from 100 mg/L to 100's of g/L for six Actinides (U, Pu, Th, Np, Am, Cm), with ratios of major to minor to 100's.
- Ease of sample preparation, especially when compared to destructive methods.



In a K-edge densitometer (KED), a continuous-energy beam of photons from a tungsten-anode x-ray tube is transmitted through a liquid sample. Photon transmission through the sample is measured at two photon energies which closely bracket the K-absorption edge energy of the element of interest. The concentration (grams per liter) of the measured element is a simple function of the photon transmission below and above the absorption edge, and the path length of x-rays through the sample.

KED can be extremely accurate, and is typically applied to concentrated solutions (>10 g/L). For samples in a 2-cm path length vial, the best KED precision (0.15%) is obtained for samples with a concentration of about 200 g/L.

In a hybrid K-edge/x-ray fluorescence densitometer (HKED), KED is augmented by a simultaneous x-ray fluorescence (XRF) measurement of the specimen. The concentration of the most-abundant actinide is determined by KED, and the XRF detector measures fluoresced x-rays emitted from sample face. Concentrations of other actinides are derived from attenuation-corrected ratios of XRF peak areas.

This combined technique (thus the term "Hybrid") allows measurement of dissolver solutions in reprocessing plants having typical U concentrations of 150–250 g/L and Pu concentrations of 1–3 g/L. In this case, U is measured by K-edge densitometry, and the Pu/U ratio is measured by XRF.

K-edge densitometry (or hybrid K-edge densitometry, HKED) is applicable to all U, Th and Pu materials and to mixed U-Th or U-Pu (MOX) samples containing at least 0.2 g/L of the analyte. A precision and accuracy of about 0.2% for uranium and 0.75% for Pu may be achieved when the concentration of the analyte ranges from 50 to 150 g/L in a typical measurement time of 1000 seconds.

A typical schematic view of an HKED is shown in figure 2.

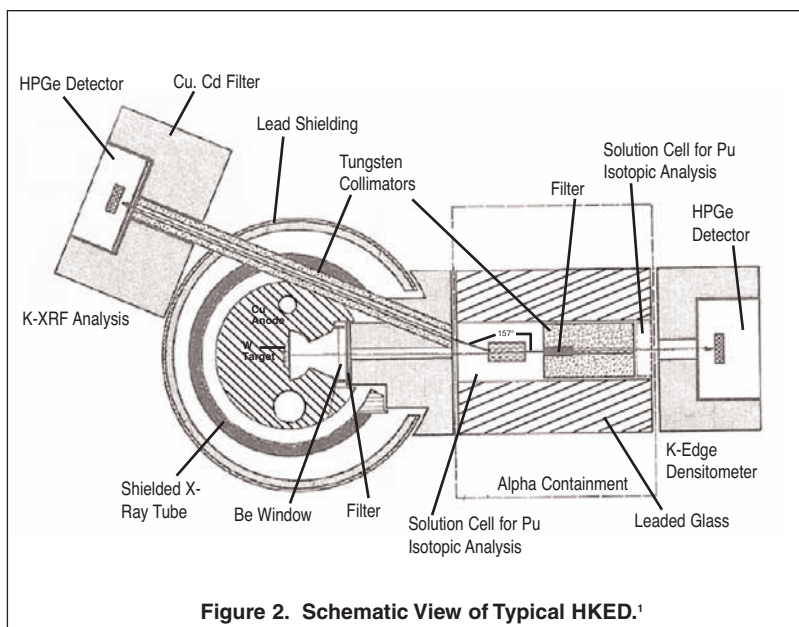


Figure 2. Schematic View of Typical HKED.¹

¹Reilly D., Ensslin N., Smith H., Kreiner S., Passive Nondestructive Assay of Nuclear Materials LA-UR-90-732 P302.

Hybrid K-Edge Densitometer (HKED)

LATEST GENERATION (2009)

The ORTEC HKED

The latest ORTEC implementation of this instrument is based upon the LANL Hybrid K-Edge Densitometer (HKED) version 2007 software, licensed from Los Alamos, coupled to the latest HPGe detectors and digital spectroscopy software from ORTEC.

The most recent version LANL HKED software is available from ORTEC either as a turn-key system based on ORTEC HPGe detectors and electronic hardware or as part of an upgrade package, available for all existing HKED systems regardless of the original supplier.

LANL HKED Software Summary

The LANL HKED software is the most advanced HKED analytical software in existence. ORTEC is the original tech-transfer partner of LANL HKED technology and software. The LANL HKED software was the first in the industry to be PC-based and can perform analyses on a standard laptop, even without HKED hardware attached, which in itself offers huge potential benefits in a training environment.

Software Features

- Control of every hardware component of every system in which previously deployed; x-ray generator, multichannel analyzers, sample changer (if present), and temperature sensor (if present).
- “Dynamic current adjustment” maximizes throughput in the acquisition system by automatically optimizing the production rate of x-rays in order to improve the counting statistics.
- Software operates with Windows XP or Vista.
- Analysis of spectra from disk if no HKED hardware present (training/reanalysis mode).
- Extensive use of graphics improves ease of use feedback to operator and thus result quality: real-time color graphs of analytical data, drop-down lists, grids for tabular data, etc.
- Outputs reports in text format, customizable via user-editable templates.
- HTML reports with spectrum plots and other graphs embedded as JPG files.
- Easy to calibrate; KED standards are not required to have only one enrichment value.
- Analysis parameters from simple to edit text files.
- Does not require a passive spectrum for dissolver solution samples, thereby increasing sample throughput.
- Can operate in KED-only mode, for existing K-edge densitometer systems that do not incorporate an XRF detector (non-HKED).

Figure 3 shows the operator screen during an assay. An almost identical screen is presented when a previous data set or “dossier” is recalled for reanalysis. The left hand spectrum shows the KED channel while the right hand spectrum shows the XRF channel.

The reanalysis input screen is shown in figure 4.

Figure 5 shows the setup of the K-edge fitting.

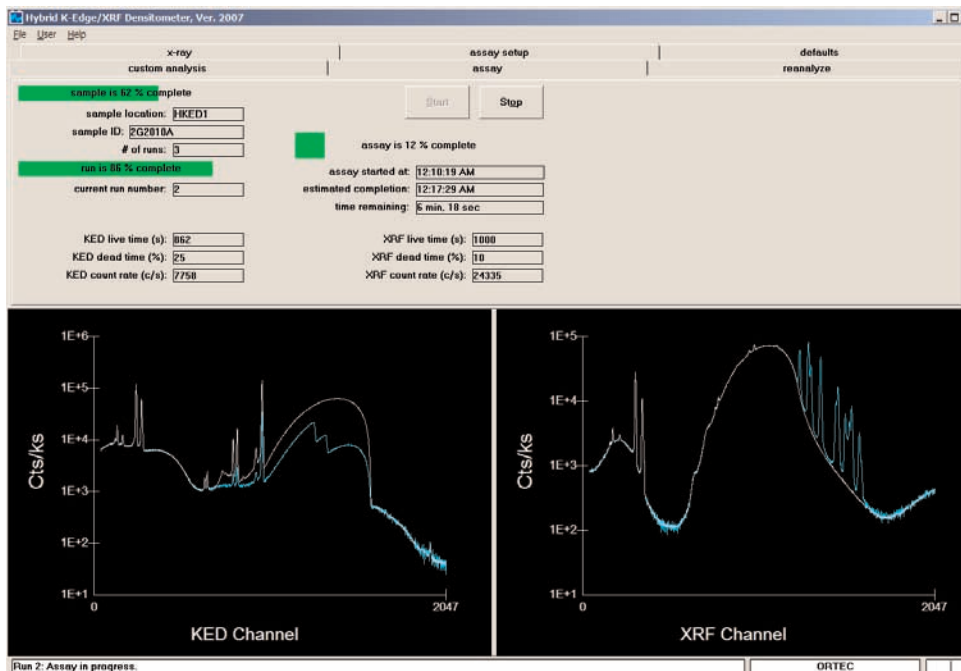


Figure 3. Assay in Progress.

Hybrid K-Edge Densitometer (HKED)

LATEST GENERATION (2009)

Hardware Summary

A complete HKED system will contain the following components.

Measurement Chamber For hot cell and glovebox based systems, the measurement chamber is located outside the hot cell or glovebox. This includes a positioning method for the sample(s), and radioactive containment of the sample(s). Coupled with shielding for the x-ray tube, the measurement chamber contains the “x-ray optics” of the system.

Sample Transportation The sample(s) must be transported between the loading area (inside the glovebox or hot cell) and the measurement position. This is preferably accomplished with an automatic sample changer that allows multiple samples to be loaded into a sample tray. It is also possible to move a sample manually using a cable or other manipulator.

X-Ray Generator The x-ray generator is an OEM component of the HKED system. The x-ray generator typically consists of an x-ray tube, a high-voltage cable, a cathode generator base unit, operator console, and remote control option. A system for cooling the x-ray tube is a crucial component of the x-ray generator system. ORTEC currently recommends the GE Inspection System ISOVOLT Titan 160, but equivalent generators may be used.

High-Purity Germanium Detectors Two low-energy planar HPGe detectors are needed, one for the KED subsystem, the other for the XRF subsystem. These systems also require cooling, typically with LN₂; mechanical coolers optional. See <http://www.ortec-online.com/detectors/photon/detectors.htm>

Multichannel Analyzers Two multichannel analyzers are needed, one each for KED and XRF subsystems. ORTEC recommends high throughput digital spectrometers, such as the current DSPEC Pro. See <http://www.ortec-online.com/electronics/mca/mca.htm>

Monitoring Devices (optional) LANL recommends devices for monitoring the system’s state of health. An automatic sample temperature sensor is useful for density correction, and can be integrated into the LANL HKED software. Temperature and flow sensors for x-ray generator cooling water are also helpful.

Computer A Windows XP or Vista compatible PC, preferably with LCD color monitor, keyboard, and mouse; loaded with LANL HKED analytical software.

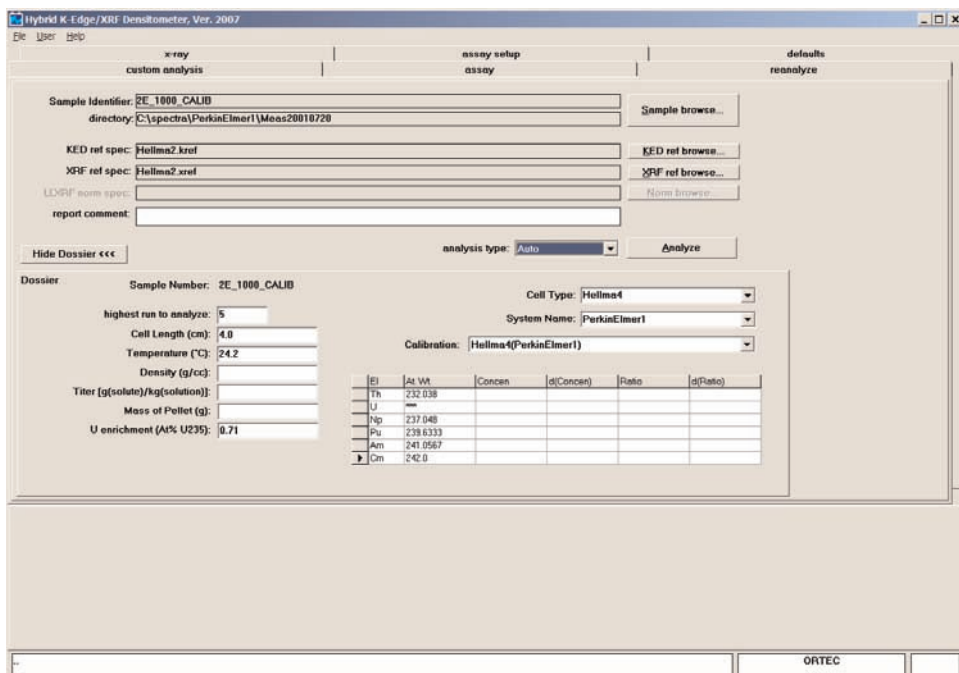


Figure 4. Reanalysis Input Screen.

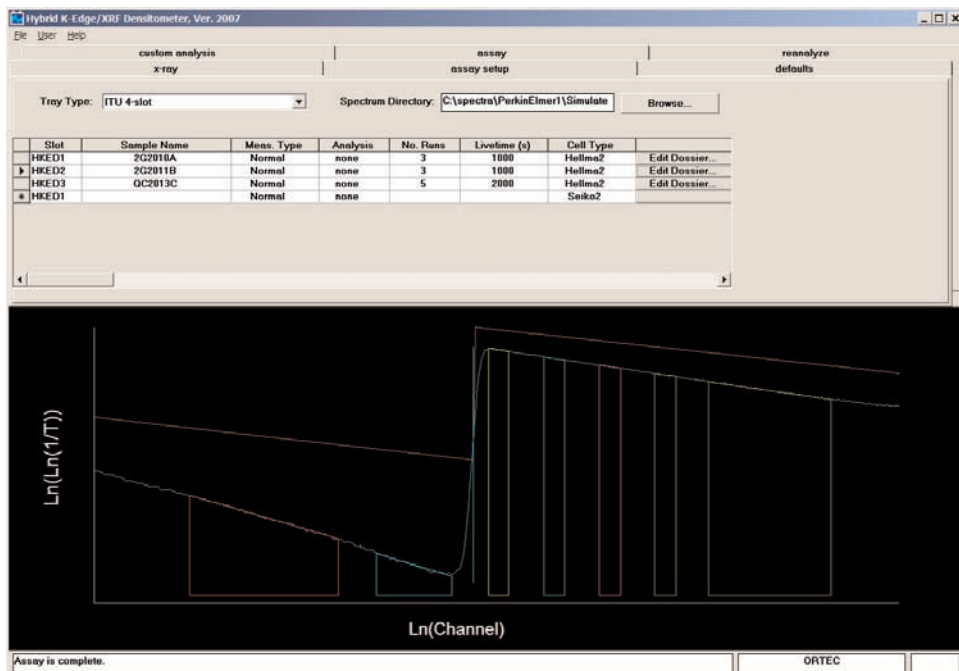


Figure 5. Assay Setup: Fitting of K-Edge.

Hybrid K-Edge Densitometer (HKED)

LATEST GENERATION (2009)

ORDERING INFORMATION

HKED systems incorporating the latest ORTEC hardware and LANL software are available commercially from ORTEC as “turn-key” systems. Additionally, existing systems may be upgraded to the latest specifications and performance regardless of the original supplier. For further information, contact your local representative or go to www.ortec-online.com and click on “Contact Us.”

ORTEC Products Group

ORTEC has more than 40 years of experience in the design and manufacture of highly sensitive radiation detectors used by government and industrial laboratories, nuclear facilities, medical research and in nuclear safeguards. We manufacture over 1600 products used for nuclear power plant and government nuclear facility operations, special nuclear materials safeguards, search and identification of radioactive materials, and chemical weapons detection.

Founded in 1960 by scientists from Oak Ridge National Laboratory, ORTEC first developed the technology for silicon based radiation detectors. Today, it is a leading manufacturer of high-purity germanium, high-resolution radiation detectors and instruments and systems which exploit this technology. We have been growing our own HPGe crystals since the 1970's.

ORTEC is a business unit of AMETEK Advanced Measurement Technology (AMT), a division of AMETEK, Inc. (NYSE listed, ticker symbol: AME). Headquartered in suburban Philadelphia, AMETEK is a leading global manufacturer of electronic instruments and electromechanical devices with nearly 10,000 colleagues worldwide. It operates 40 manufacturing facilities and a dozen direct sales and service centers in the United States and has 24 plants and more than 50 direct sales and service operations in over 30 other countries around the world. Annualized sales for AMETEK are over \$1.5 billion.

Specifications subject to change
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www.ortec-online.com

Tel. (865) 482-4411 • Fax (865) 483-0396 • ortec.info@ametek.com
801 South Illinois Ave., Oak Ridge, TN 37831-0895 U.S.A.
For International Office Locations, Visit Our Website

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