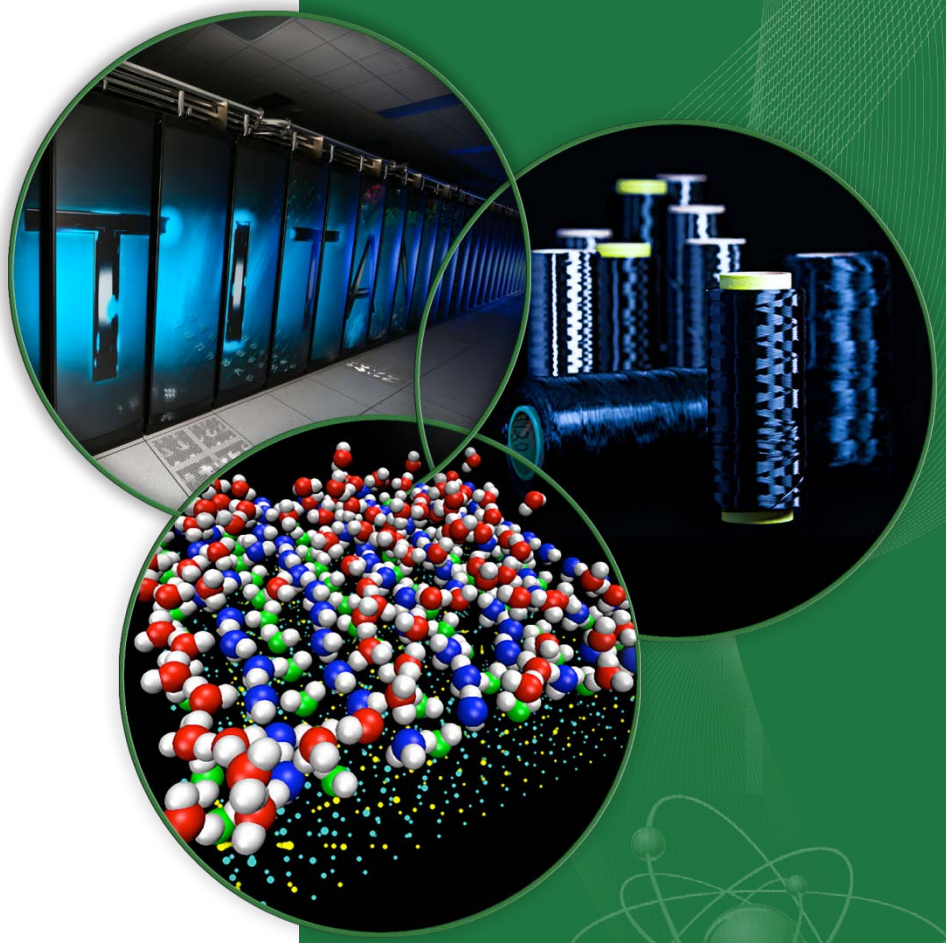
Hybrid K-Edge Densitometer Measurements at ORNL

HKED Calibration and Quality Control Standards



20 July 2014

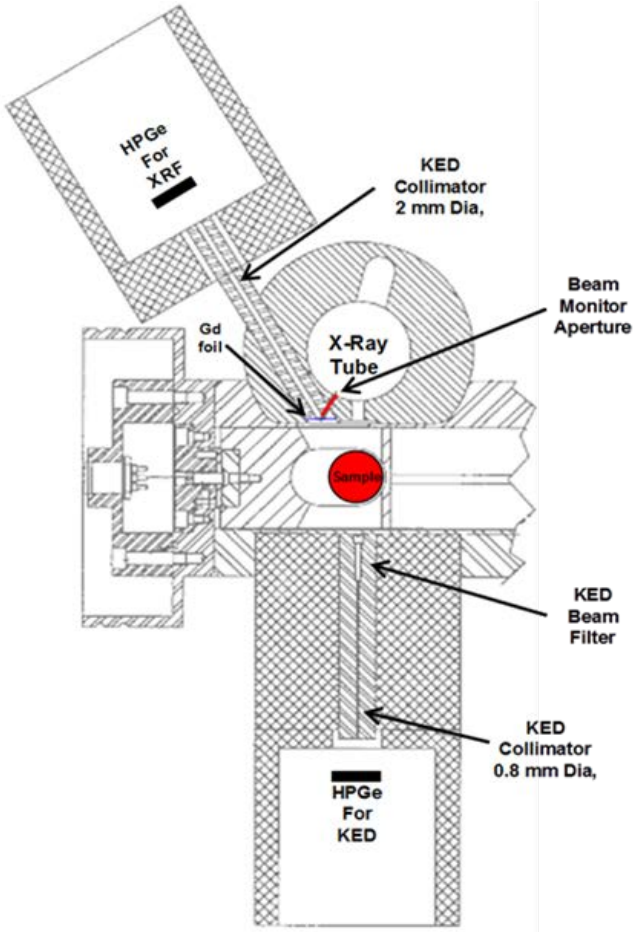
NDA User's Group Meeting

ORNL is managed by UT-Battelle
for the US Department of Energy

OAK RIDGE National Laboratory

HKED System

- K-edge densitometry (KED) and relative X-ray fluorescence (XRF) measurement techniques



HKED Measurements

- Calibration with nitric acid solution standards
  - XRF (U001, U005, U015, U045)
  - KED (U045, U100, U150, U200, U250, U300)
  - Hybrid (UPu100, UPu150, UPu250 [U/Pu 100:1])
  - Reference (U000)
- KCl salt slurry
  - Test rotational symmetry
- Epoxy resin stability
  - Quality control
- XRF backscatter tests
  - Aid fitting of new spectra from pryoprocessing

Aqueous Solution Standard Degradation

- Short working life
  - Evaporation
  - Leaking
  - Radiolysis
  - Solution absorption
  - Glass dissolution
- Direct experience
  - ORNL
  - Canberra Industries
- Need for stable alternative

G. C. Lowenthal and H. A. Wyllie, “The Storage of Radioactive Solutions with Standardised Disintegration Rates”, Nuclear Instruments and Methods, 112 (1973) 367-371.
W. B. Mann, A. Rytz, and A. Spernol, “Radioactivity Measurements Principles and Practice”, International Journal of Radiation Applications and Instrumentation Part A, Volume 39 No. 8, 1988.

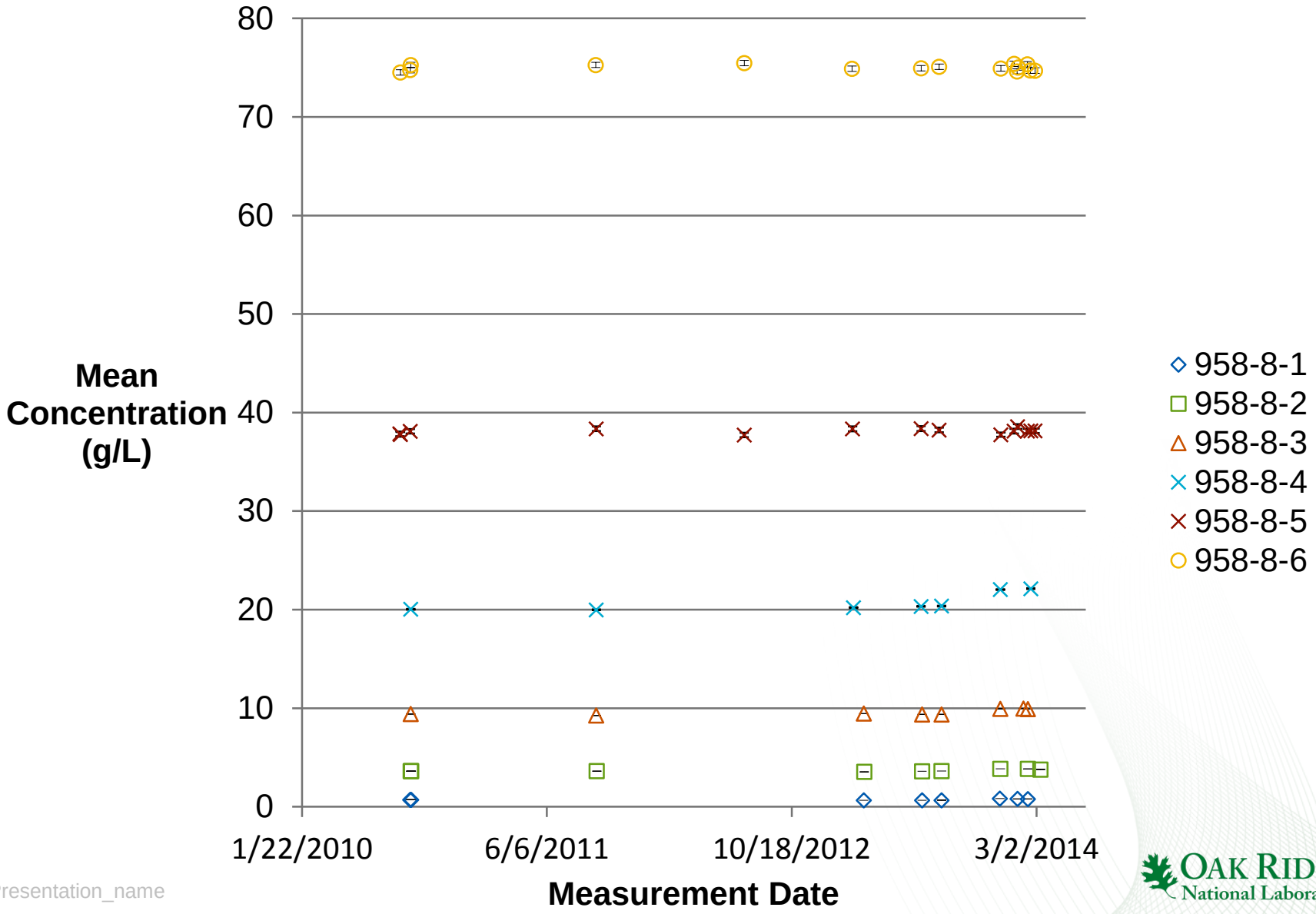
Alternative Stable Reference Standards

- Glass
  - UK Support Program to the IAEA
  - NIST CRM 610 Trace Elements in Glass
- Metal foil
  - U and Pu
- Fuel pellet
  - MOX
- Epoxy resin

Epoxy Resin

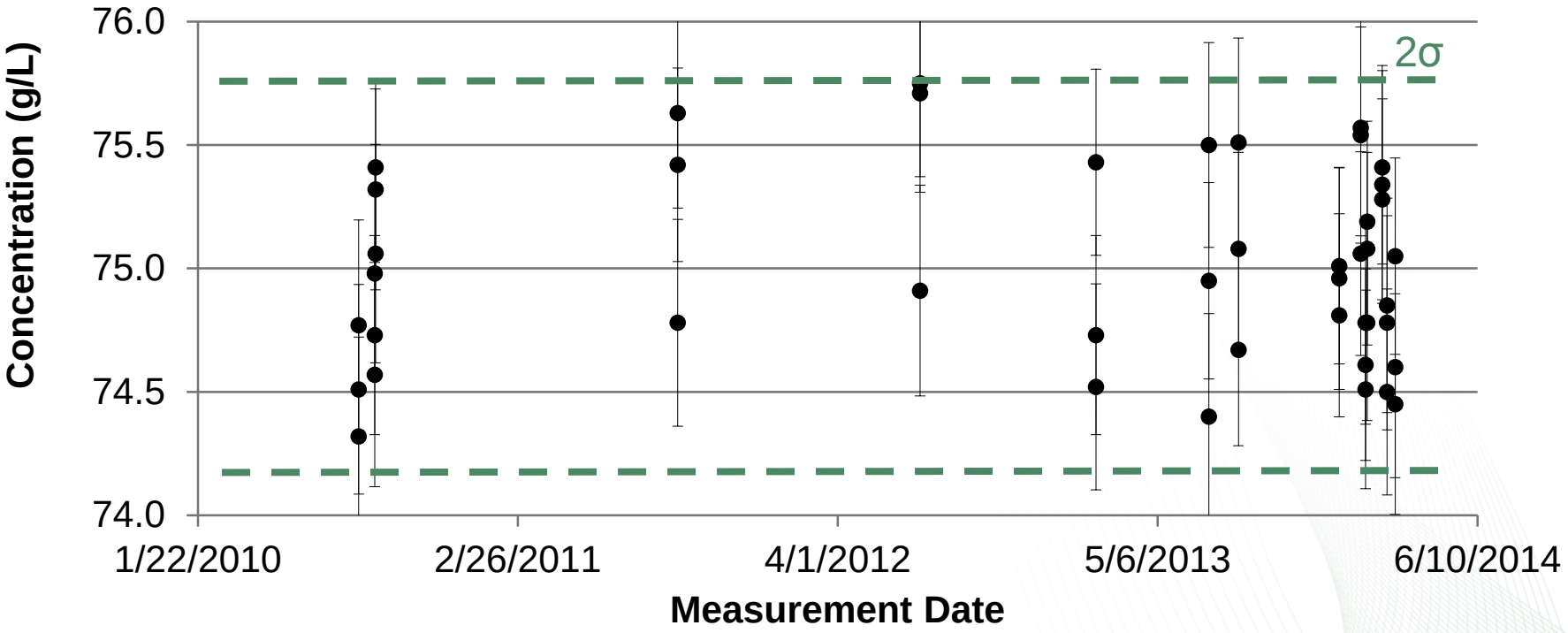
- Uranium oxide suspended in epoxy resin
  - From Canberra Industries
- Repeated XRF and KED measurements for over 3 years
- Nominal concentration range 1 to 76 g/L U
- Determined stable within expected precision of system

Stability of Epoxy Standards



Stability of Single Standard (KED)

- Single replicate measurements of nominal 75.9 g/L U standard
- 75.00 g/L mean with 0.52% standard deviation



Conclusion

- Wide range of HKED measurements conducted at ORNL
- Epoxy standards stable within expected precision of system
  - New deployment could be tested with epoxy certified reference material
  - Suitable for international round-robin exercise