



Khalifa University's Radioanalysis Laboratory Capabilities

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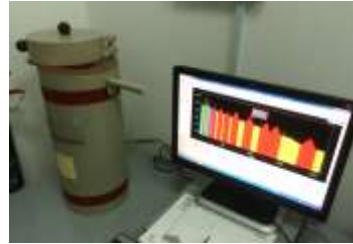
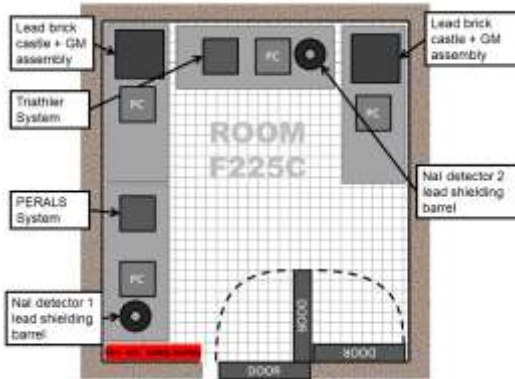
KHALIFA
UNIVERSITY

Khalifa University Background

- Established on 13 February 2007 by **His Highness Sheikh Khalifa bin Zayed Al Nahyan**, the President of the UAE
- Current main focus areas of the Nuclear Engineering Department are:
 - Developing human capital
 - Research related to BNPP site
 - Environmental measurements
 - Nuclear safety
 - Nuclear security



Radiation Stability Measurements Laboratory



NaI(Tl) LED Temperature-Stabilized Scintillation Detector :

- CANBERRA's NAIS-2x2 NaI(Tl) LED In combination with the Osprey – CANBERRA's all-in-one HVPS, preamplifier, and digital MCA
- Laminar shield provides shielding from the external radiation sources while minimizing internally generated X-rays



PERALS Spectrometer :

- Liquid scintillation counter for alpha measurements
- 99.95% electron and photon rejection capability to allow for counting of alpha particles in a mixed radiation environment



Triathler System :

- Liquid scintillation counter for alpha and beta measurements
- Internal MCA allows for spectral measurements and analysis



Safeguards Laboratory



HPGe Micro-Detective-HX :

- Sterling cooler allows for a light weight liquid nitrogen free HPGe detector
- Internal GM-tube provides dose-rate information in high-radiation fields
- Internal He-3 tube allows for advanced plutonium detection
- Internal GPS



CZT nanoRaider :

- 3 CZT crystals for advanced energy resolution
- He-3 neutron detection
- Internal GPS



NaI(Tl) Enrichment Measurement System:

- 2" 10 stage Photomultiplier Tube (PMT) mated to a 2" X 2" NaI(Tl) cylindrical scintillation crystal
- Designed for measurements of uranium enrichment using the simple comparator method or enrichment meter technique



Environmental Radiation Laboratory



Gamma Spectroscopy System (HPGe Detector) with Automatic Sample Changer:

- ORTEC GEM40P4
- Detection Efficiency: 40%
- Energy resolution: 1.85 keV for 1.33 MeV peak of ^{60}Co



Low Background Alpha and Beta Counter:

- Protean Instruments WPC 1050
- Ultra low background detection: 0.1 cpm for Alpha, 0.9cpm for Beta
- Detection efficiency: 40% for ^{210}Po / ^{231}Am / ^{230}Th / ^{137}Cs , 35% for ^{99}Tc and 55% for ^{90}Sr / ^{90}Y



Liquid Scintillation Counter:

- Perkin Elmer LSC-Tri-Carb 3110 TR
- Detection efficiency: 60% for ^3H , 95% for ^{14}C



HPGe Detectors from FANR:

- ORTEC: 60% detection efficiency
- CANBERRA: 40% detection efficiency



Preparation Room:

- Oven, rotor mill and vibratory sieve shaker
- Fume hood, emergency shower and eye wash



Radiation Science Laboratory



Geiger-Müller (GM) Tube:

- Spectrum Techniques ST360
- RSS5: Set of five sources, Alpha, Beta, Gamma.
- RAS20: Set of 20 calibrated absorbers.



NaI(Tl) Scintillation Detector:

- Radiation Sensors 6S6P1.5VD
- 1.5" 10 stage Photomultiplier Tube (PMT) mated to a 1.5" X 1.5" NaI(Tl) cylindrical scintillation crystal



Silicon Detectors for Alpha / Beta:

- ORTEC Silicon Charged-Particle Detectors
- With vacuum chamber, NIM-bin, and oscilloscope



Cloud Chamber :

- Allows students to see radiation interactions
- Different types of radiation are visually distinguishable



NaI(Tl) Mobile measurement system :

- 2x2 NaI(Tl) with the Osprey
- Mobile system allows for shielded in-filed measurements of radioactive materials



Multi-purpose Handheld Contamination Meter :

- Thermo Scientific's RadEye B20
- Pancake GM-tube detector for alpha, beta, gamma and X-ray radiation



Radioactive Isotope Identifier :

- SAM 940 from Berkeley Nuclearcs Corporation
- 2' x 2' Sodium Iodide (NaI) detector
- Ethernet connections
- Allows third party hardware such as GPS



Calibration Radioactive Sources

The List of *check sources*, *liquid sources*, and *Marinelli sources* used for calibrations at Khalifa University

Isotope	Activity [μCi]
Na-22	0.4 – 0.9
K-40	0.1 – 0.6
Mn-54	0.1 – 23
Co-57	0.1 - 1.4
Co-60	0.1 – 6.8
Sr-90	0.1 – 2.7
Cd-109	0.2 – 0.4
I-129	0.1
Ba-133	0.8 – 1.6
Cs-137	0.1 – 24.1
Eu-152	15.9
Tl-204	0.1 – 2.2
Cm-244	0.1 – 0.2
Am-241	0.1 – 5.1
Th ore	Small
U ore	Small

Isotope	Activity [μCi]
H-3	0.1 – 1.7
C-14	0.1 – 0.8
Ra-226	0.1

Item	Isotopes
Marinelli - old	^{60}Co , ^{109}Cd , ^{137}Cs , ^{241}Am
Marinelli - new	^{57}Co , ^{60}Co , ^{85}Sr , ^{88}Y , ^{109}Cd , ^{113}Sn , ^{137}Cs , ^{139}Ce , ^{203}Hg , ^{241}Am



Multi-laboratory Comparison Radioactive Sources

The List of *IAEA reference samples* and a *U.S. DOE / Mixed Analyte Performance Evaluation Program (MAPEP) sample* used for benchmarking at Khalifa University

Sample	Quantity	Description	Contained Radionuclides
IAEA – 321	1	Milk Powder, 250g	^{40}K , ^{90}Sr , ^{134}Cs , ^{137}Cs
IAEA – 444	2	Soil, 200g	^{54}Mn , ^{60}Co , ^{65}Zn , ^{109}Cd , ^{134}Cs , ^{137}Cs , ^{210}Pb , ^{241}Am
IAEA – 312	3	Soil, 50g	^{226}Ra , Th, U
IAEA – 434	2	Phosphogypsum, 250g	^{210}Pb , ^{226}Ra , ^{230}Th , ^{234}U , ^{238}U
IAEA – 447	2	Moss Soil	^{137}Cs , ^{208}Tl , ^{210}Pb , ^{210}Po , ^{212}Pb , ^{214}Pb , ^{214}Bi , ^{226}Ra , ^{228}Ac , ^{234}Th , ^{234}U , ^{238}U , ^{238}Pu , $^{239+240}\text{Pu}$, ^{241}Am
IAEA – 385	2	Radionuclides in Irish Sea Sediment	^{40}K , ^{137}Cs , ^{226}Ra , ^{228}Ra , ^{230}Th , ^{232}Th , ^{234}U , ^{238}U , ^{238}Pu , $^{239+240}\text{Pu}$, ^{241}Am
IAEA – 414	2	Radionuclides in Sea Fish	^{40}K , ^{137}Cs , ^{232}Th , ^{234}U , ^{235}U , ^{238}U , ^{238}Pu , $^{239+240}\text{Pu}$, ^{241}Am
IAEA – 372	2	Radionuclides in Grass	^{40}K , ^{137}Cs
MAPEP – 11 – Ra226/U238	1	Soil, 800g	^{226}Ra , ^{238}U



Future Plans

- Setup teaching HPGe
- Setup teaching Liquid Scintillator
- Develop real-time mobile radiation detection capabilities
 - Large volume (4L) NaI crystal
- Expand neutron detection capabilities
 - Neutron detectors
 - BF₃ straws
 - ³He gas
 - CLYC detector
 - Neutron sources
 - ²⁵²Cf
 - Am-Li
 - Am-Be
- Acquire uranium standards
 - DU, Nat. LEU, HEU, metal, oxide...



Conclusions

- Khalifa University has created and continuously develops advanced capabilities in radiation detection and environmental radiation analysis
- There are four dedicated radiation detection laboratories with a variety of instruments and purposes at Khalifa University

