**Applications of Liquid Scintillation Spectrometry (LSC) for NORM measurements**

**- training course programme**

|  |  |  |  |
| --- | --- | --- | --- |
| **Title/Topics** | | **hours** | **Lecture/**  **Exercise** |
| **I** | **Introduction to LSC and its application to NORM measurements** | **7** |  |
| 1 | General information about NORM: definitions and terminology, natural radionuclides importance and sources of NORM, sequential decay and disequilibrium in natural decay series | 2 | L/Bogusław Michalik |
| 2 | General information about LSC: background, history, applications | 1 | L/Stanisław Chałupnik |
| 3 | Liquid scintillation spectrometry principle: an overview of different counters, construction and technical solution applied, background limitation, quenching phenomenon, PSA adjustment, Cerenkov radiation counting, criteria for scintillation cocktail choice. | 3 | L/Stanisław Chałupnik |
| 4 | Practical Comparison of counters available in the lab | 1 | E/Stanisław Chalupnik |
| **II** | **Basics of radiochemistry: analytical method used in separation of natural radionuclides** | **3** |  |
| 1 | Sample digestion and dissolution | 1 | L/Izabela Chmielewska |
| 2 | Ion exchange procedure and extraction chromatography used in radiochemistry | 1 | L/Izabela Chmielewska |
| 3 | Coprecipitation techniques with different carriers. Methods employed in radioactive sources preparation. | 1 | L/Izabela Chmielewska |
| **III** | **Radiochemical procedure of radium isotopes separation and test sample preparation for LSC** | **20** |  |
| 1 | Radium in environmental samples - procedure | 2 | L/Izabela Chmielewska |
| 2 | Radium in environmental samples - chemical separation, practical exercises | 16 | E/Izabela Chmielewska |
| 3 | Radium source preparation for LS counting, practical exercises | 2 | E/Izabela Chmielewska |
| **IV** | **Radium determination by means of LSC** | **10** |  |
| 1 | Special set up of LS spectrometer Wallac Quantulus for radium determination: anticoincidence guard, alpha/beta discrimination, PSA optimization, counter calibration, double window method | 3 | L/Stanisław Chałupnik |
| 2 | Radium spectra analysis, correction coefficients quantification, quenching correction | 3 | E/Stanisław Chałupnik |
| 3 | Calculation: radium isotopes concentration, uncertainty budget, detection limit | 3 | E/Stanisław Chałupnik |
| 4 | Method validation, summary | 1 | L/Stanislaw Chalupnik |
| **V** | **Application of LSC for radon and thoron progeny** | **14** |  |
| 1 | Determination of radon in water by LSC - counter set up, calibration | 2 | L/Stanisław Chałupnik |
| 2 | Sample preparation for radon in water measurement | 2 | E/Izabela Chmielewska |
| 3 | In-situ LSC measurements: radon and thoron and progeny | 2 | E/Stanisław Chałupnik |
| 4 | PEAC measurements | 4 | E/Stanisław Chałupnik |
| 5 | Interpretation of the obtained results: calculations, detection limit | 4 | E/Stanisław Chałupnik |
| **VI** | **Principle of quality management system. Organization of radiochemical and LSC laboratory** | **6** |  |
| 1 | Norm ISO 17025, accreditation, participation in PT/ILC | 2 | L/Michał Bonczyk |
| 2 | Usage of CRM, standard solutions, | 1 | L/Michał Bonczyk |
| 3 | Equipment necessary in radiochemical labs selection of fit for purpose equipment. | 2 | L/E/  Stanisław Chałupnik/ Izabela Chmielewska |
| 4 | Discussion and summary | 1 | L/E/Bogusław Michalik |
|  | **in total** | **60** |  |