Gammaspectroscopy at the Loviisa NPP

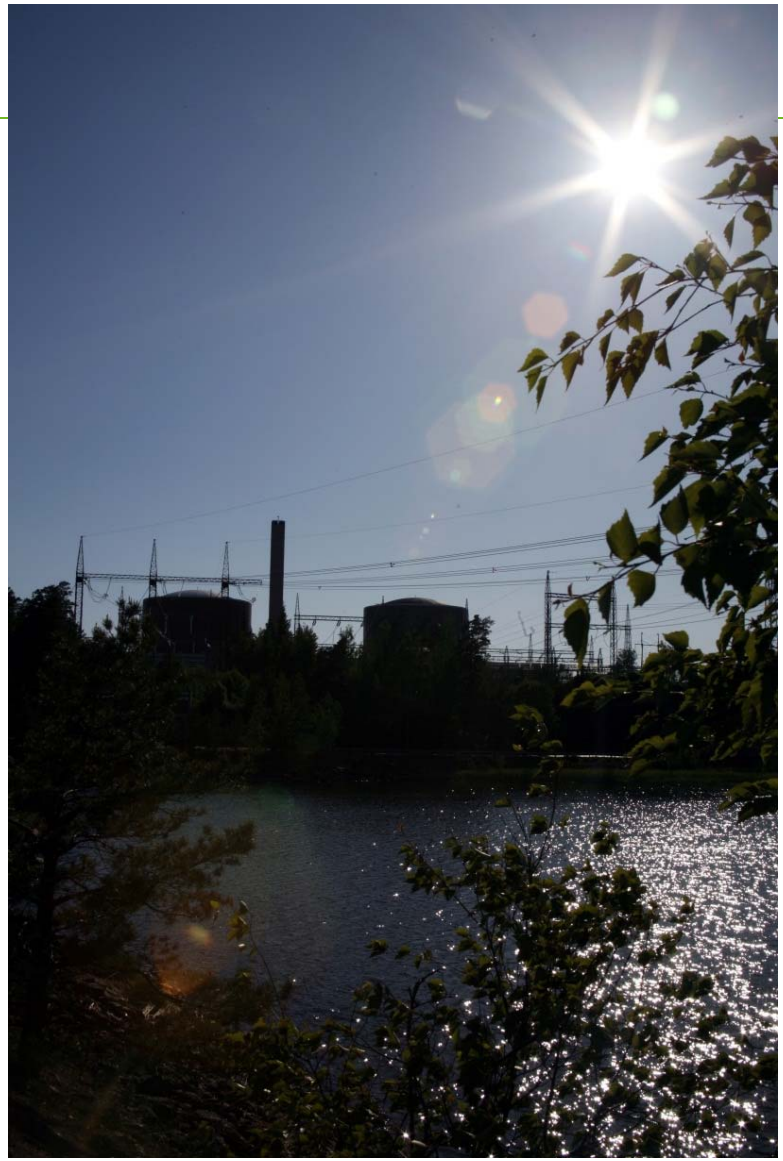
Laura Togneri, 7.10.2014

Personnel

- The Radiochemistry section is part of the Operation Unit at Loviisa NPP.
  - Belongs to the Operation Chemistry Group with the Chemistry laboratory and the Process Chemistry sections.
  - Co-operation with the Radiation Safety Group is extensive

- Radiochemistry
  - Laura Togneri (Manager of Radiochemistry)
  - Miia Lampén (Radiochemist)
  - Riku Savila (Laboratory analyst)
  - Minna Ollas (Laboratory technician)
  - Jarno Saarela (Laboratory assistant)

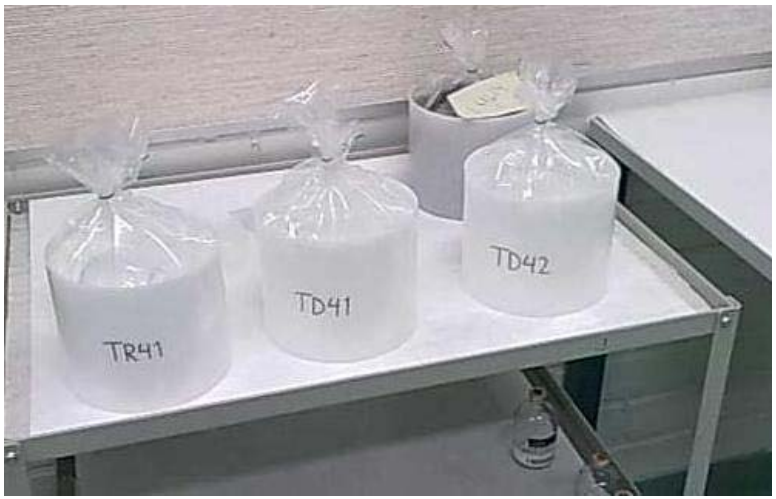
- Senior advisor
  - Roger Kvarnström



Responsibilities

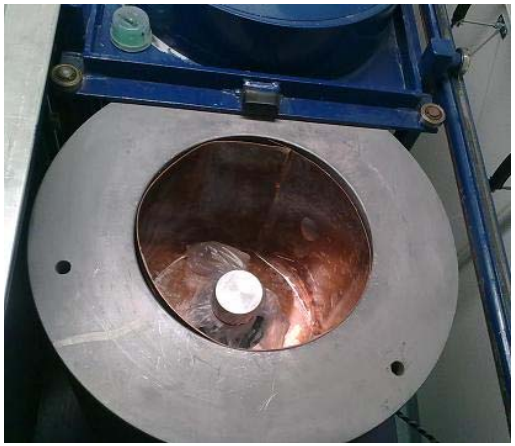
- Process monitoring
  - To follow activities in the primary circuit and in other systems
  - Condition monitoring of cladding tubes
  - To search for fuel leakages
  - Condition monitoring of the purification systems
  - To identify foreign substances
  - To evaluate corrosion in primary circuit

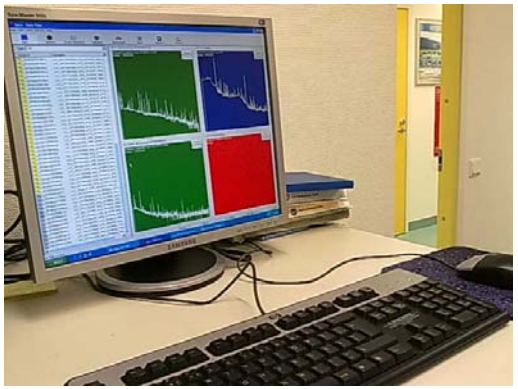
- Radioactive release monitoring
  - Water from collection tanks before release
  - Stack monitoring
    - Aerosols
    - Iodines
    - Noble gases



Gamma spectroscopy

- Close to 10 000 measurements/year
- Measuring the majority of the most significant nuclides
- Four liquid nitrogen cooled HPGe detectors (Canberra)
  - Two 20-25%, active samples, GC-type
  - Two 60%, release samples, GC and GX-type
  - 10 cm lead shield to reduce background radiation interference
  - Characterised detectors, LabSOCS
- Canberra's APEX Lab Productivity Suite v. 1.3
  - Genie 2000 (S500 v. 3.2.1, S501 v. 3.2.3)
- ONLINE detectors in both plants (PAMS + Genie2000)
  - Measurements every hour (can be reconfigured)
  - Used for trend surveillance of the primary coolant
- One detector in the emergency laboratory
  - 10%, extended energy range, CryoCycle cooled, GX-type





- The electronics for the four laboratory detectors are situated in a separately cooled room

- Digital NIM modules are used, to be able to control e.g. the high voltage and the linear amplilfier from the computer

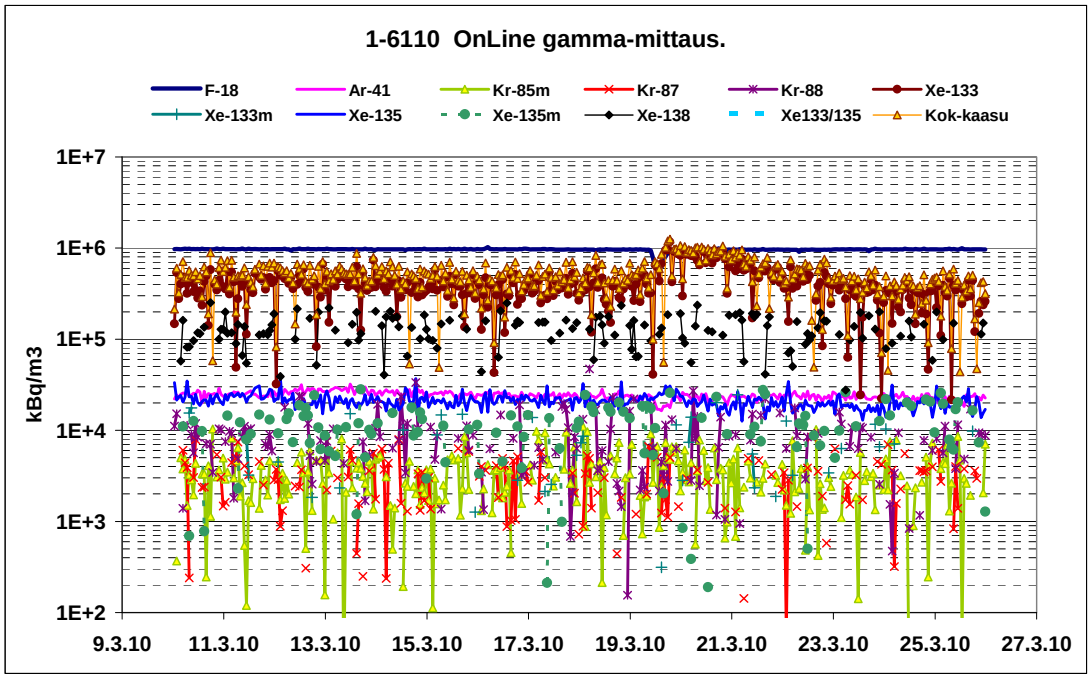
- Electronics for one 25% and one 60% are located in one BIN rack => we will not loose both 60% detectors at once

- All measurement equipment in the laboratory is behind UPS electricity

- A vast supply of analog modules is available in case of failure of the digital ones

ONLINE-gamma measurements

- Continuous electrically cooled gamma spectrometers (15%) on both sites, Canberra (GC-type) in Lo1 and Ortec (POP-TOP-type) in Lo2
- Nuclide specific results are obtained from the primary circuit every hour
- Gives a trend that can be used to track changes in the primary coolant and to plan more detailed laboratory measurements
  - Not an official measurement, decisions and evaluations are always based on laboratory results



Emergency preparedness

- One CryoCycle cooled gamma detector (10%) is located in the emergency laboratory
- Possibility to flush the detector chamber with pressurised air during measurement
  - minimising the effect of raised background during accident situations
- The range is from 20 keV to 3000 keV
- Can also be used for long measurements of release samples

Gammaspectroscopy at an NPP

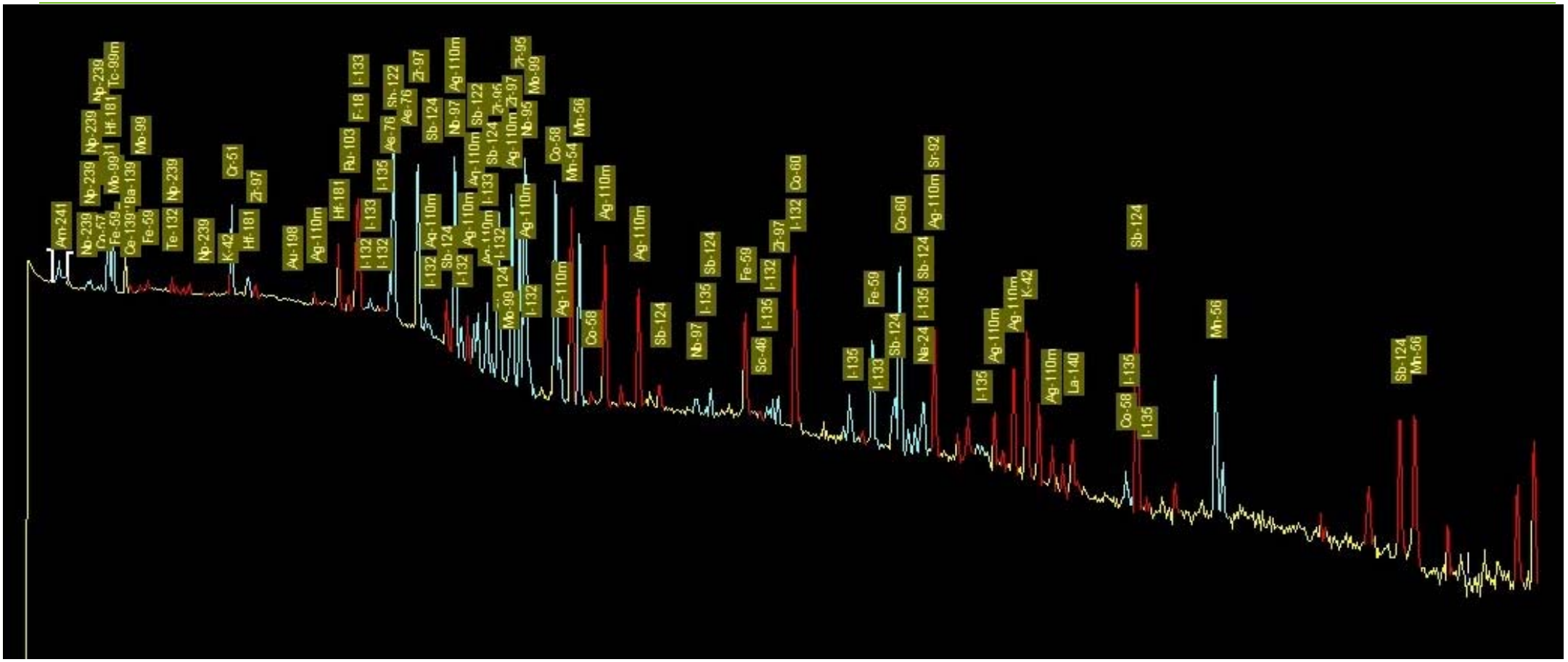
- Two main purposes for the same equipment
  1. To measure all release samples reliably (water and air)
  2. To evaluate changes in different systems at the plant (fuel leak, leaks between systems)
  - ➢ Activities ranging between ~ 1E-4 – 1E8 Bq/L are measured with the same equipment
  - ➢ Risk for: raised background and cross contamination
  - ➢ A lot of optimising is needed to be able to use the same equipment for such different purposes

- The main challenge is to learn ”what is normal” i.e. what it means if a certain nuclide is present in a certain sample.
  - Constant training of the laboratory staff is required
  - ”What is normal” changes due to e.g. process changes and fuel leakages
    - Constant learning for the whole Radiochemistry staff
  - For NPP system-monitoring: more ”trending” than ”absolute” results
  - For release monitoring: reliable and conservative results

Spectrum analysis

- Geometries are chosen to provide a spectrum that is readable
  - Distance to detector is increased or the sample amount decreased to gain a smaller dead time for the measurement = less summing.
  - Distance is also used to minimise the effect of coincidence
- The spectrum is analysed with a standard analysis sequence
  - There are analysis sequences for different purposes
    - For active samples, the challange of interfering peaks
    - To specifically ”dig out” a result for I-134 (bkg result needed for fuel leak evaluation)
    - For release samples, to get the required MDA
- The nuclide libraries used have extensive nuclide lists
  - Some nuclide results are preferred over the other – I-134 vs. Mn-56 (847 keV)
  - The analyser needs to understand what is ”logical” and what is not and also what the result is used for
    - Constant training
- The aim is, that the time used to go through peaks is kept to a minimum
  - Analysis sequence should be good enough to find the essential nuclides.

LO2 particulate matter 3.10.2014



- **133 peaks** are found, 38 of them are identified as SUM or ESC peaks
- Peaks for 37 nuclides are initially identified, after interference correction and daugther/parent evaluation, results for **34 nuclides** are given.