Gamma scanning of nuclear fuel

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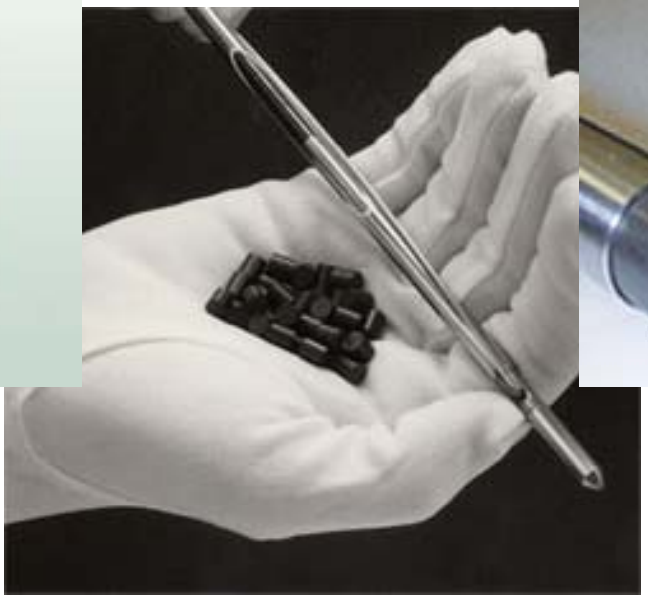
Short walk through of presentation

- What is a nuclear fuel rod?
- Which nuclides are relevant?
- Gamma scanning instrumentation and rig set up

- Scan types:
  - The state of the fuel rod in 2D
  - Relative activity profile
  - Activity determination

Nuclear fuel rod:
Zircaloy tube with Uranium oxide pellets



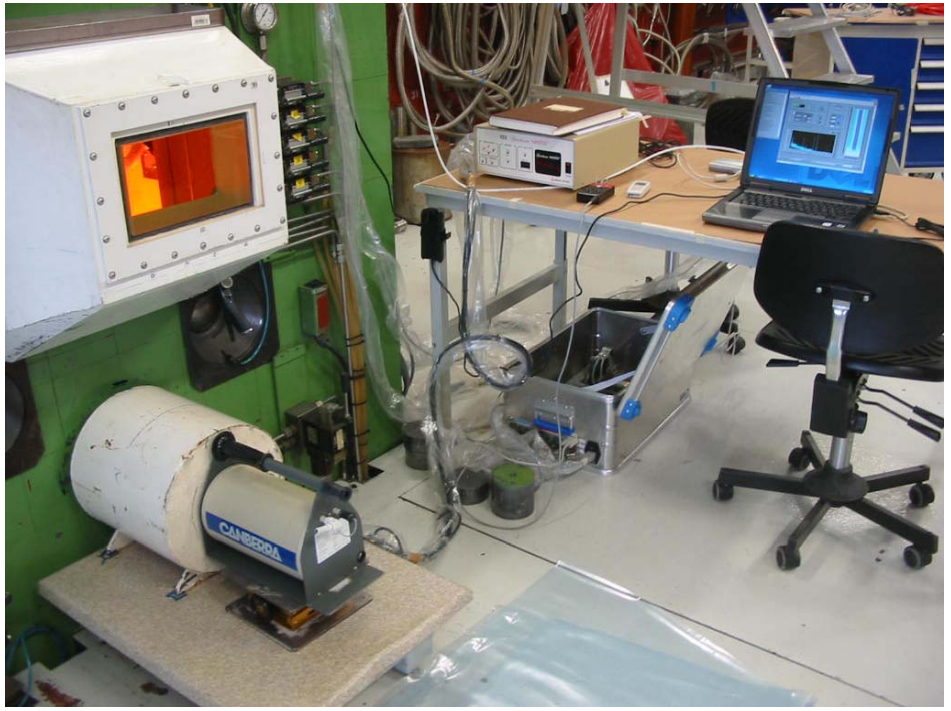
The spent fuel rod contains a variaty of actinides, fission- and activation products

- Nuclides of interest are typically:
  Cs-137, Cs-134, Ru-103, I-131

- Activity of Cs-137 in the order of GBq/mm
  No problem finding that Cs-137!

Instrument and rig set up

- Rig installed in hot cell
- Portable Canberra Ge detector and Ortec MCA
- Computer with software developed at HRP



Challange:

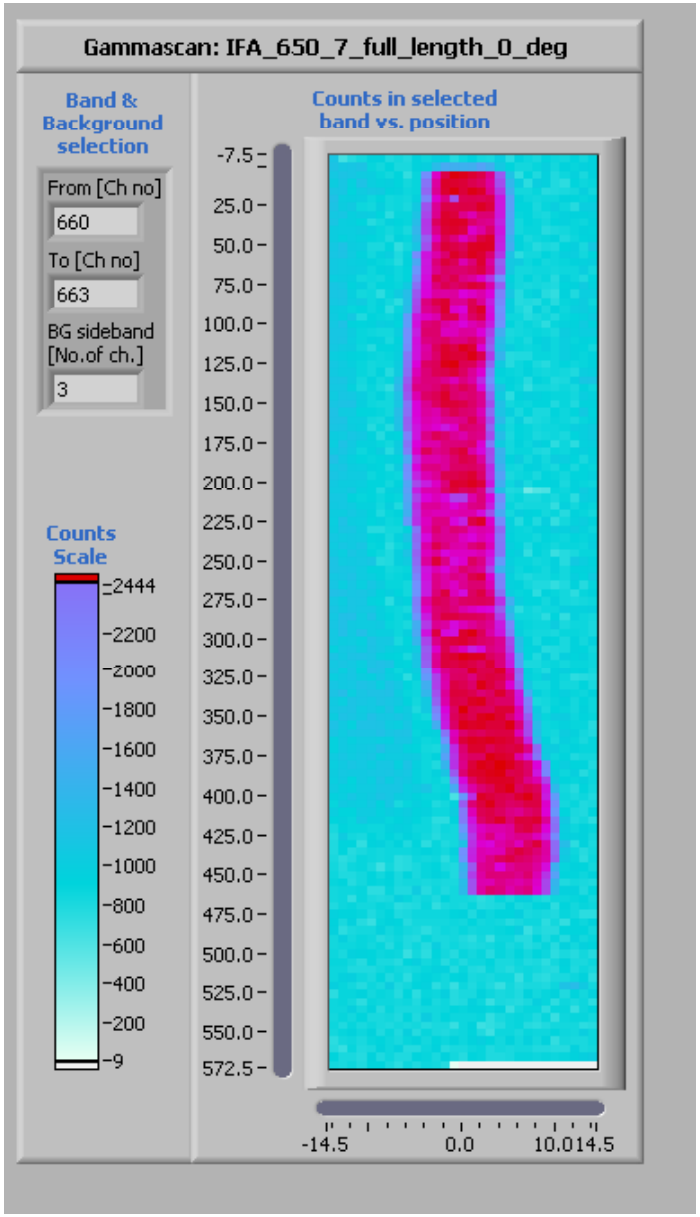
Suppress gamma flux to reduce detector dead time

- Variable fuel-detector distance
- Wide selection of collimator apertures;
  0.1 to 0.5 mm slice or 1.5 mm circle

- If nothing else will do it:
  Aluminium shielding plugs

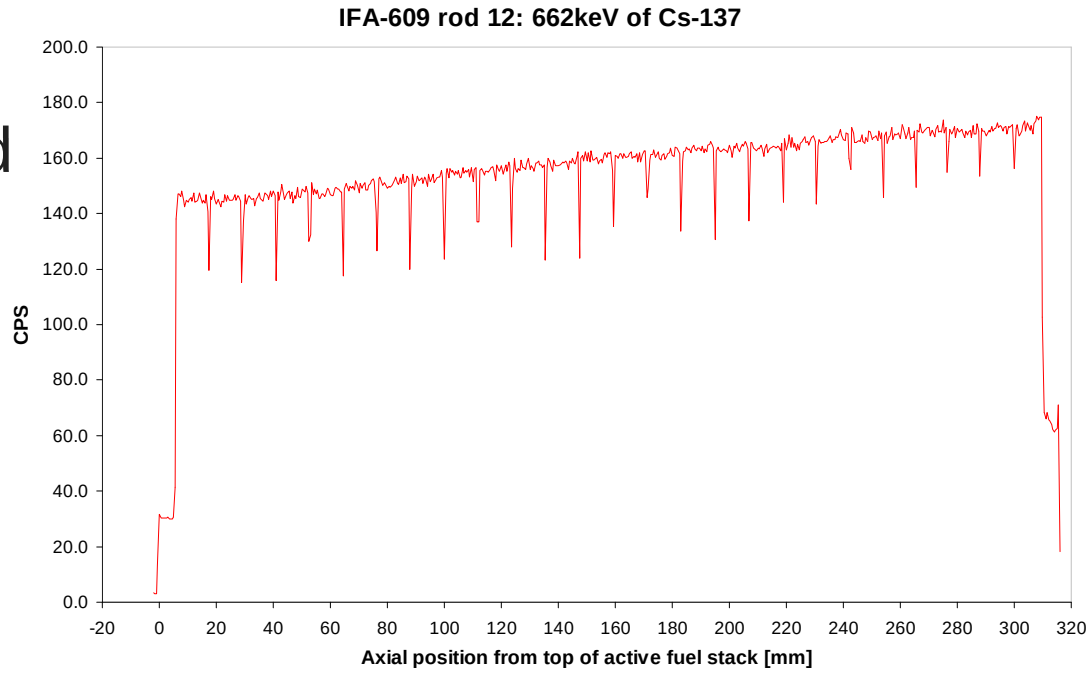
The state of the fuel rod: 2D image scans

- Rod within sealed pressure flask
- Rod has been exposed to LOCA conditions
- ”Point” scanning:
  1.5 mm circle collimator
- 3-5000 measurement steps in a x-y grid system



Fuel rod activity profile

- ”Slice scanning”: slit collimator wider than rod diameter
- Axial steps at selectable intervals:
  - Simple activity profile or …
  - Identify individual fuel pellets?
- The full energy spectrum is recorded



Activity determination

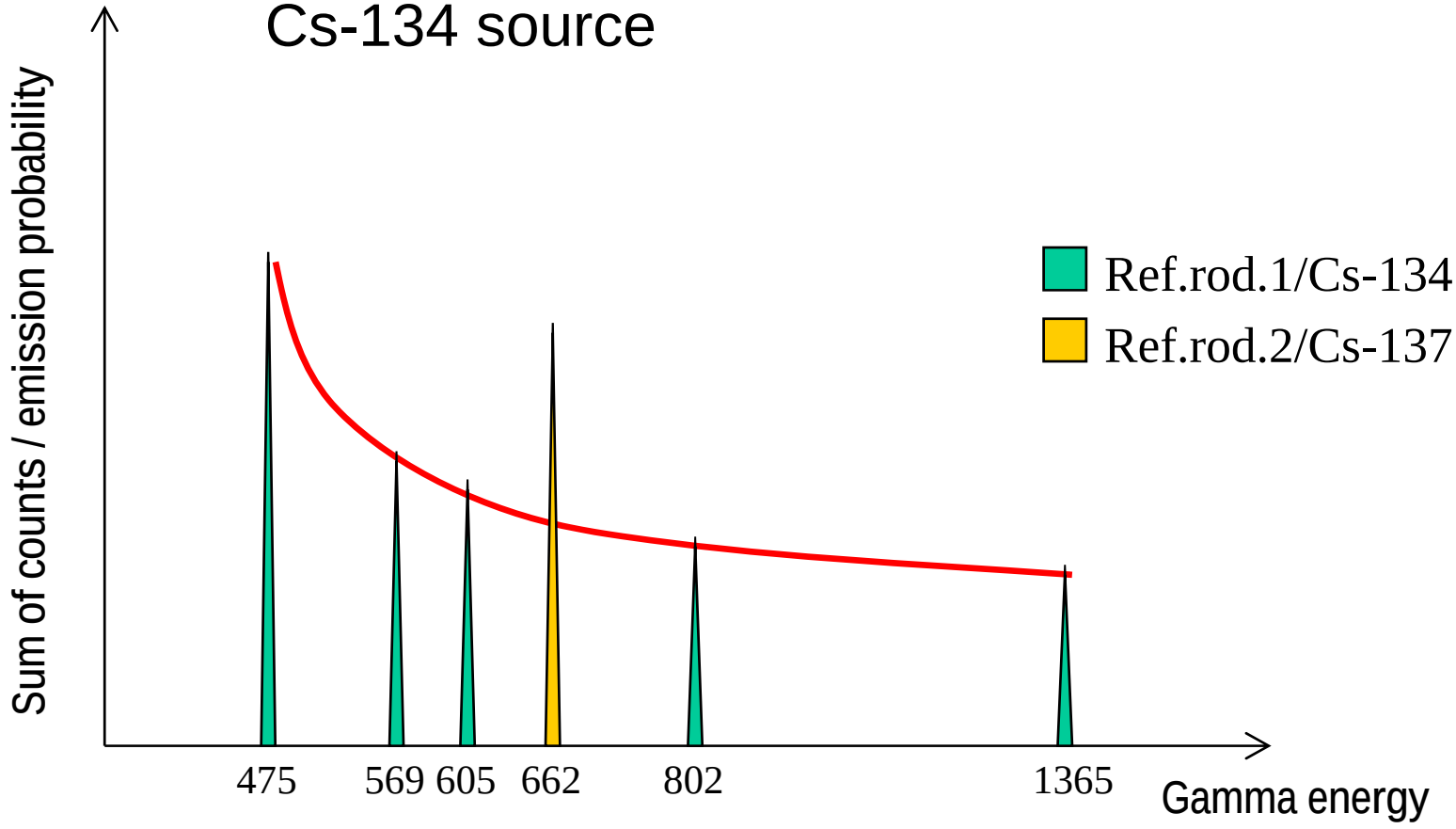
- Need the Counting efficiency factor, Ec, relevant for
  - the source geometry
  - the rod-detector distance and collimator aperture
  - the energy in question

$$A = \frac{C_r}{E_C \cdot I}$$

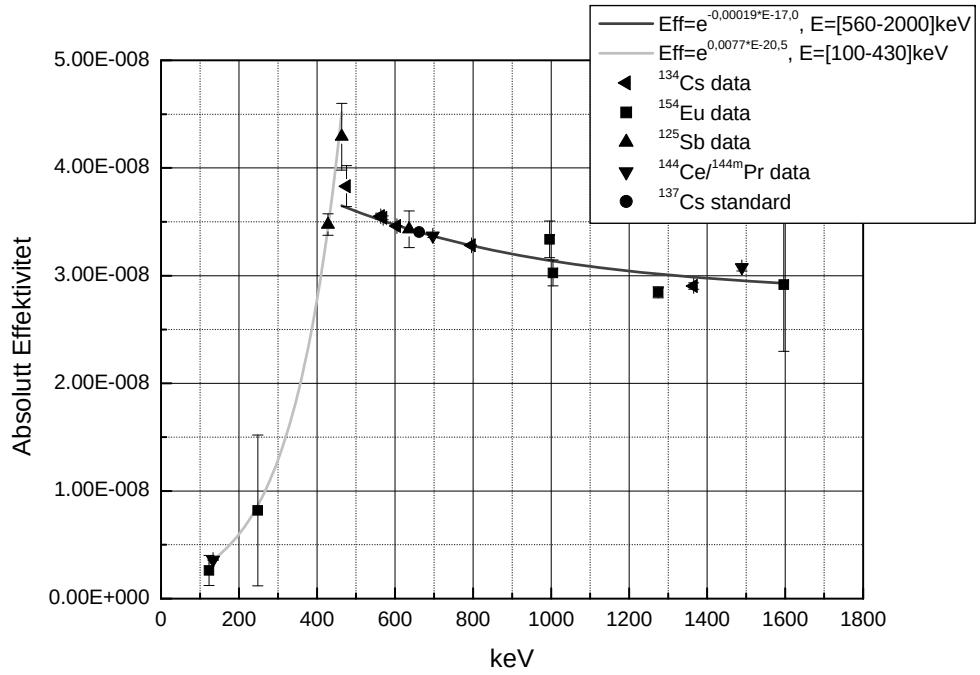
A = Nuclide activity
Cr = Count rate
Ec = Counting efficiency
I = Emission probability

Principle of generating the counting efficiency

- A standard Cs-137 rod source is used to produce a reference Cs-134 source



- **With the help of additional nuclides, the counting efficiency is determined for a wide range of energies**



- **The total rod activity is determined by applying the counting efficiency factor to the activity profile**

Gamma scanning is a useful tool in order to examine the fuel rod without inflicting damage

Thank you for your attention!