Background problems when measuring NORMs

17.09.2009

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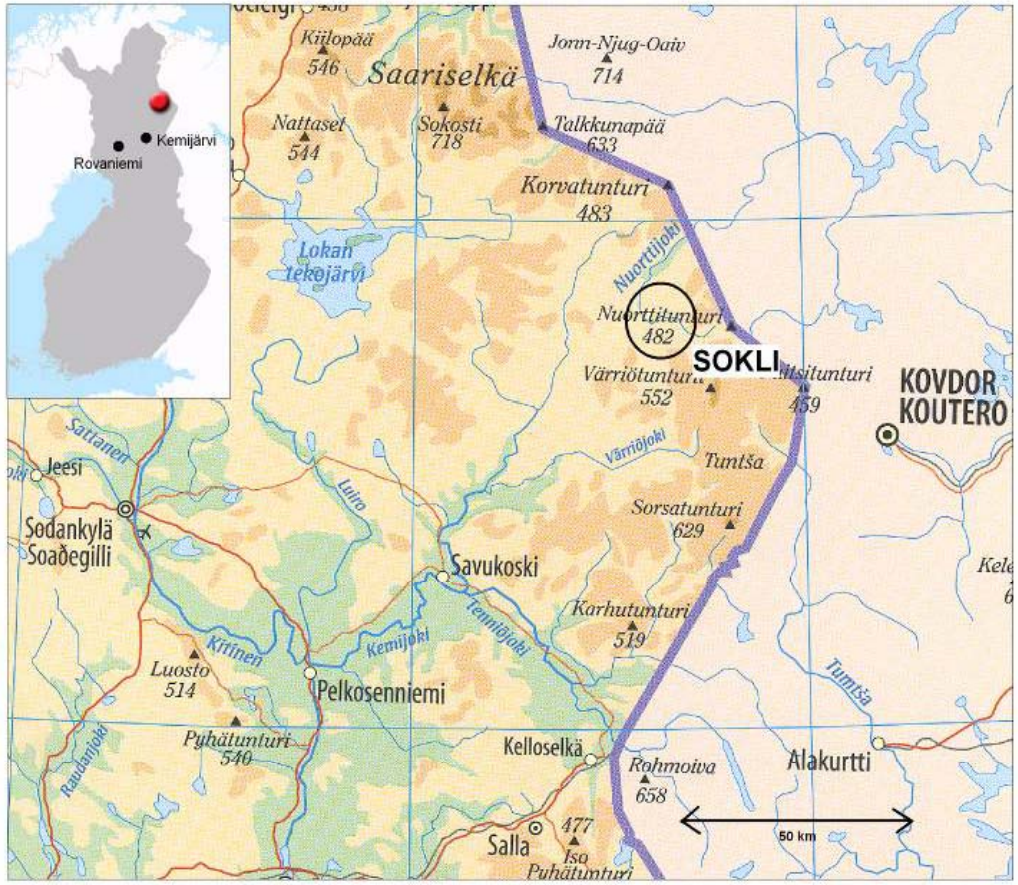
Sokli Mine

Located in one of the last wilderness areas in Europe.
Surrounded by delicate and vulnerable environment

The phosphate ore is rich in radium and thorium



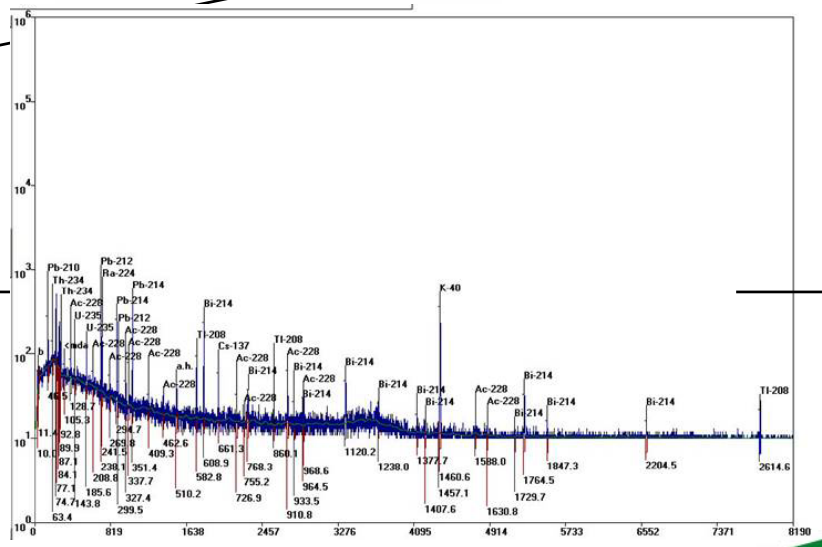
The need for determining low levels of NORMs (Normally Occurring Radioactive Material) rose when public was concerned about opening of Sokli phosphate mine.

Some background...

- The public was concerned that process waters and dust from the mine will contaminate the environment
- Yara Finland decided to order baseline study

⟶ Need to measure NORM's in berries, sediment, riverwaters, reindeer meat etc.

Example of a sample chain



Tulokset:

-Ra-226 Bq/kg

--Ra-228 Bq/kg

-Th-228 Bq/kg

-Th-232 Bq/kg

NORM measurement in STUK

- Samples will be put in vacuum sealed bags to prevent Rn-222 (noble gas) from escaping -> calculations assume stability
- The samples will be ”aged” for 3 weeks in order to have stability (production=decay)
- Directly from the spectrum can be observed Pb-210, Th-234 Bi-214, Pb-214, Ac-228, Pb-214, Tl-208, U-235, Pa-234 ja K-40
- Amounts of Uranium (238), radium (226, 228) and thorium (228 ja 232) must be calculated from their daughter activities.

→

- Problem: When determining NORM’s background caused by Rn-daughters the background turns into contamination !!

Background formulas

Where does background come into importance ?

Activity = peak area - assumed background

Minimum detectable amount (MDA)

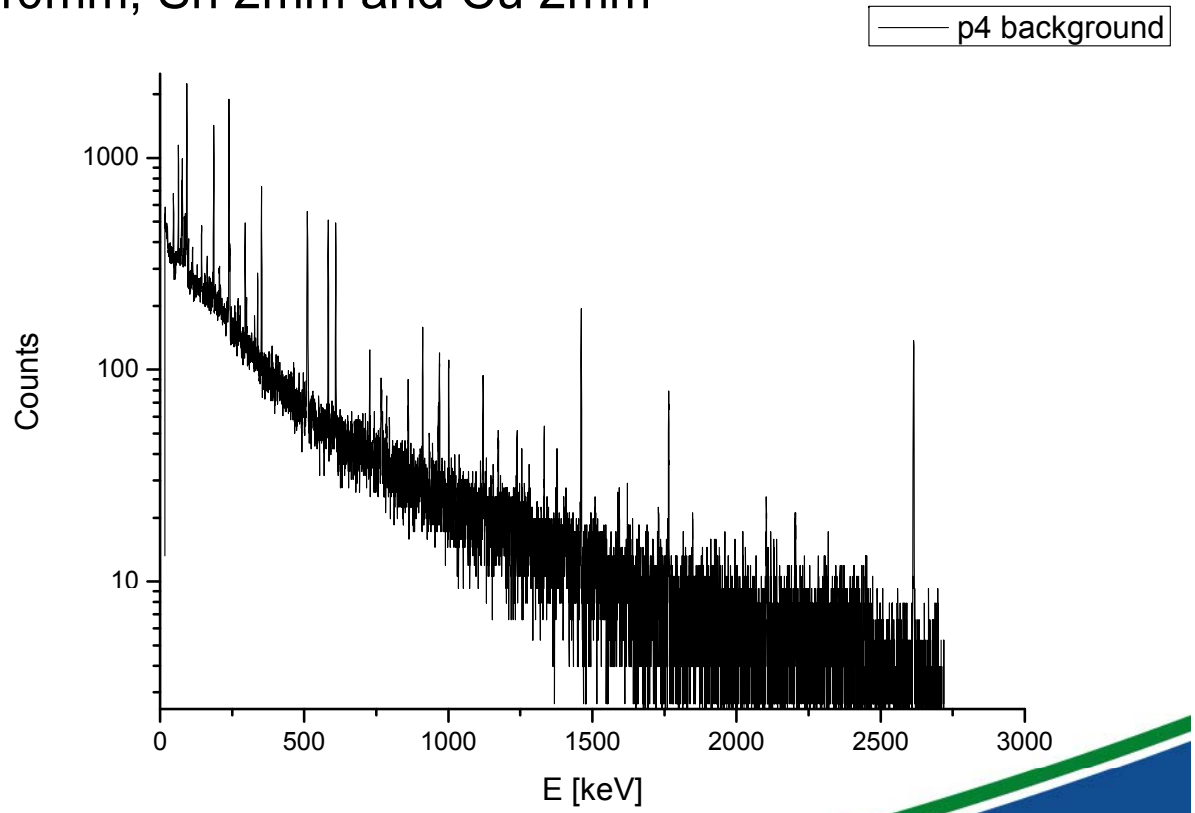
⟶

- $L_c = (2B)^{½}$ Curie critical limit
- $L_D = L_C + k'(2B)^{½}$ Curie detection limit

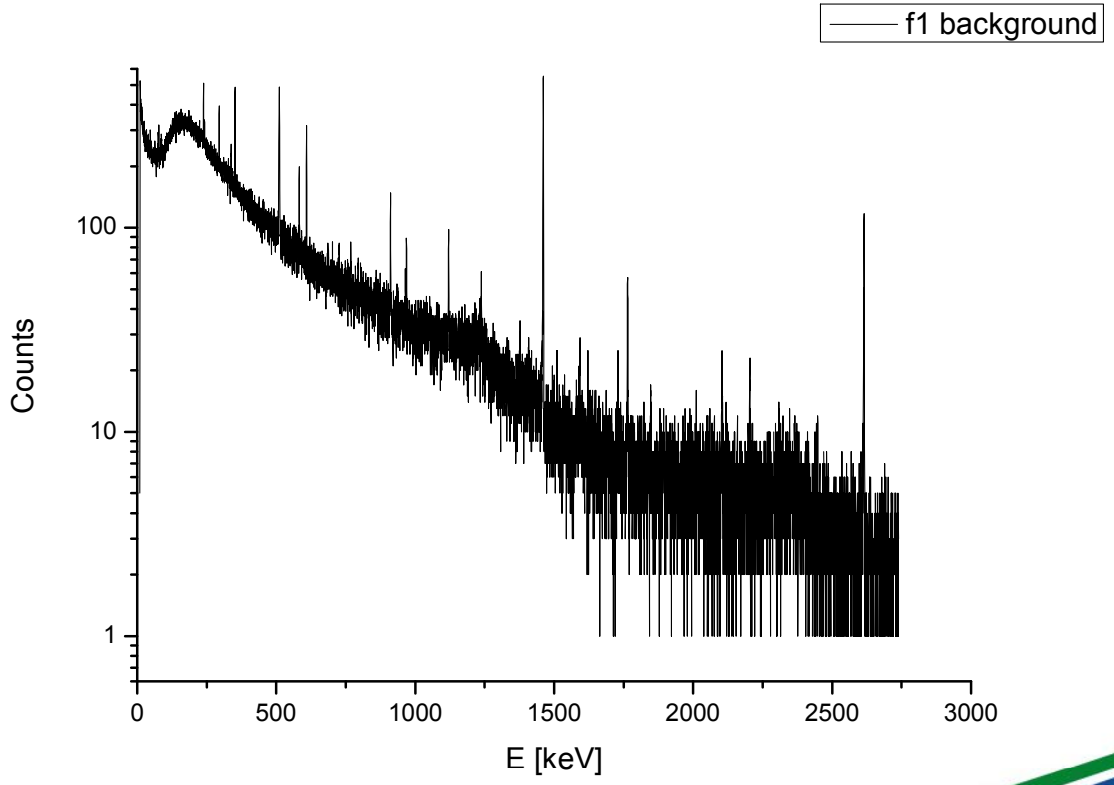
If background is doubled then MDA goes up by ~50 %

Background properties of detector systems

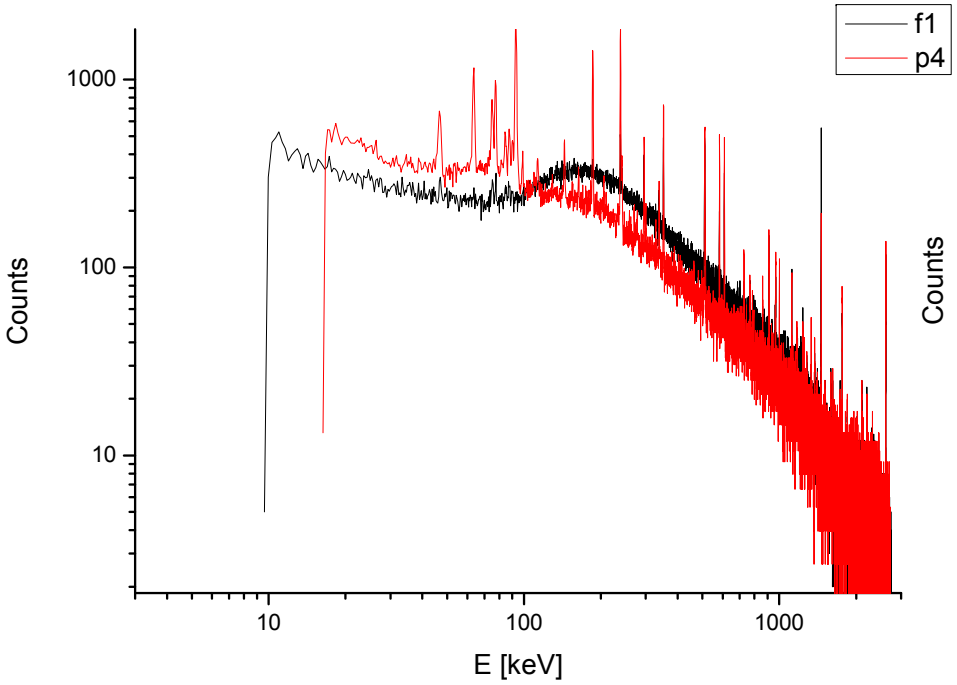
- P-type HPGe, 30 % relative efficiency (53x 57mm) in lead shield made by Viishanke from bulk materials
- Background shield chamber size 360x360mm
- layers SS 6mm, Pb 140mm, Sn 2mm and Cu 2mm

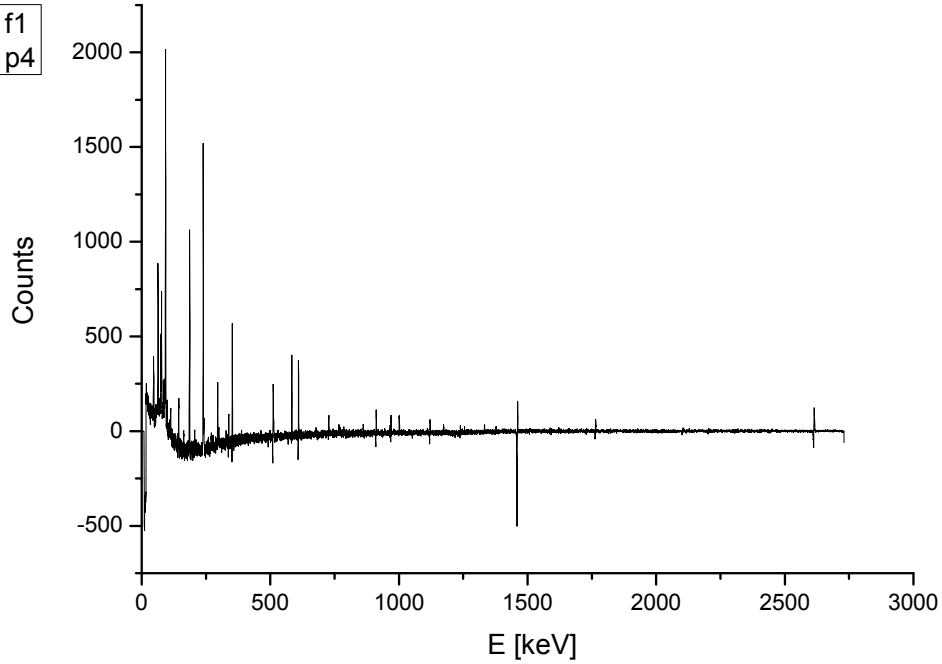


- P-type Orctec FX-series HPGe detector with 50% relative efficiency, crystal size 85x 33mm
- Placed in Canberra Ultra-low background shield
- Chamber size 229x356mm
- layers SS 9,5mm, Pb 150mm, Sn 1mm and Cu 1,6mm



- Comparing background...



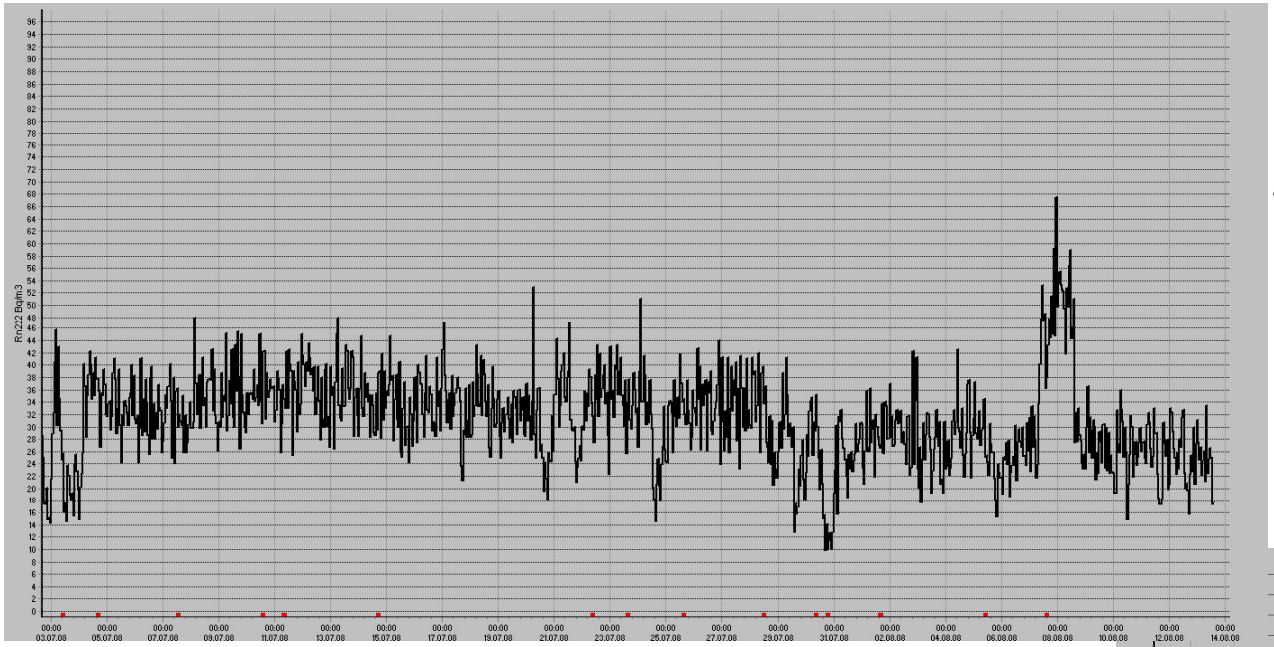


Lesson learned: Bulk materials are not fit for low level environmental radioactivity measurements

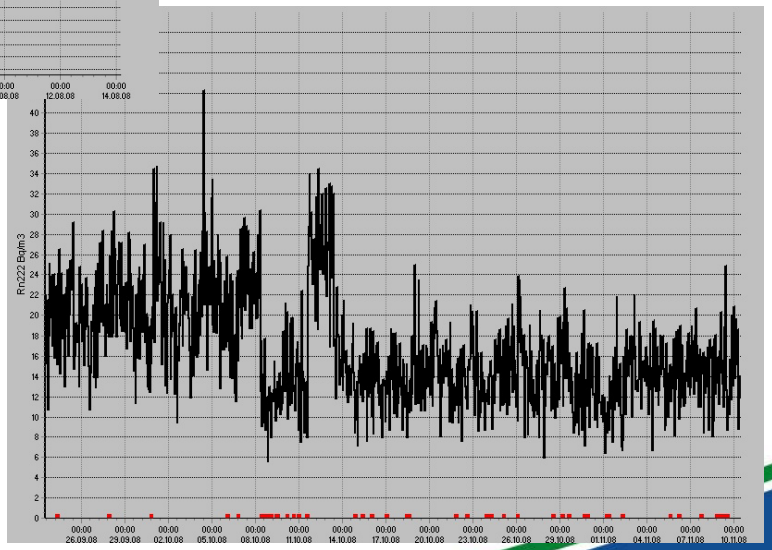
Rn-222 in laboratory air

- Important background source
- Quite often not stable
- Ventilation plays the key role, quite often ventilation is automated allowing significant changes in Rn concentration
- Genitron AlphaGuard was used to monitor Rn concentration in laboratory air

Rn-222 measurements in the laboratory

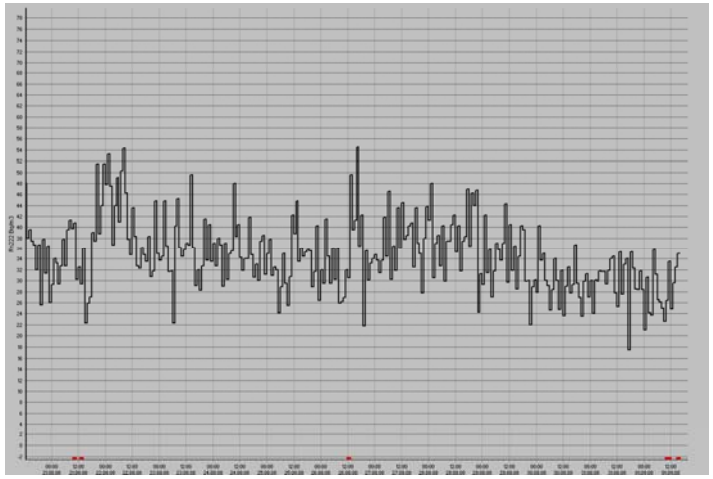


Rn-222 background
2.7.-14.8.08



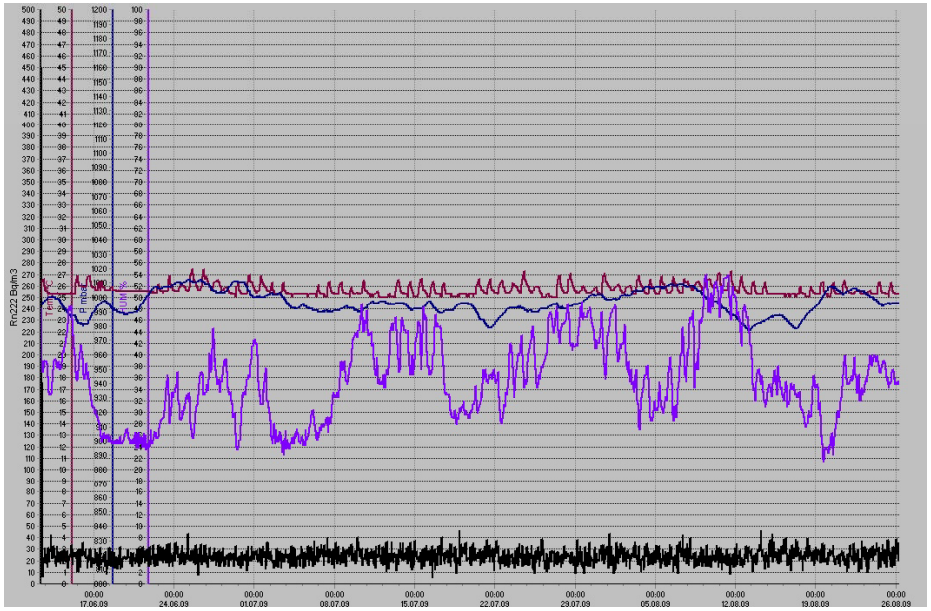
Rn-222 background 25.9.-
11.11.08

Continues...



August 2008

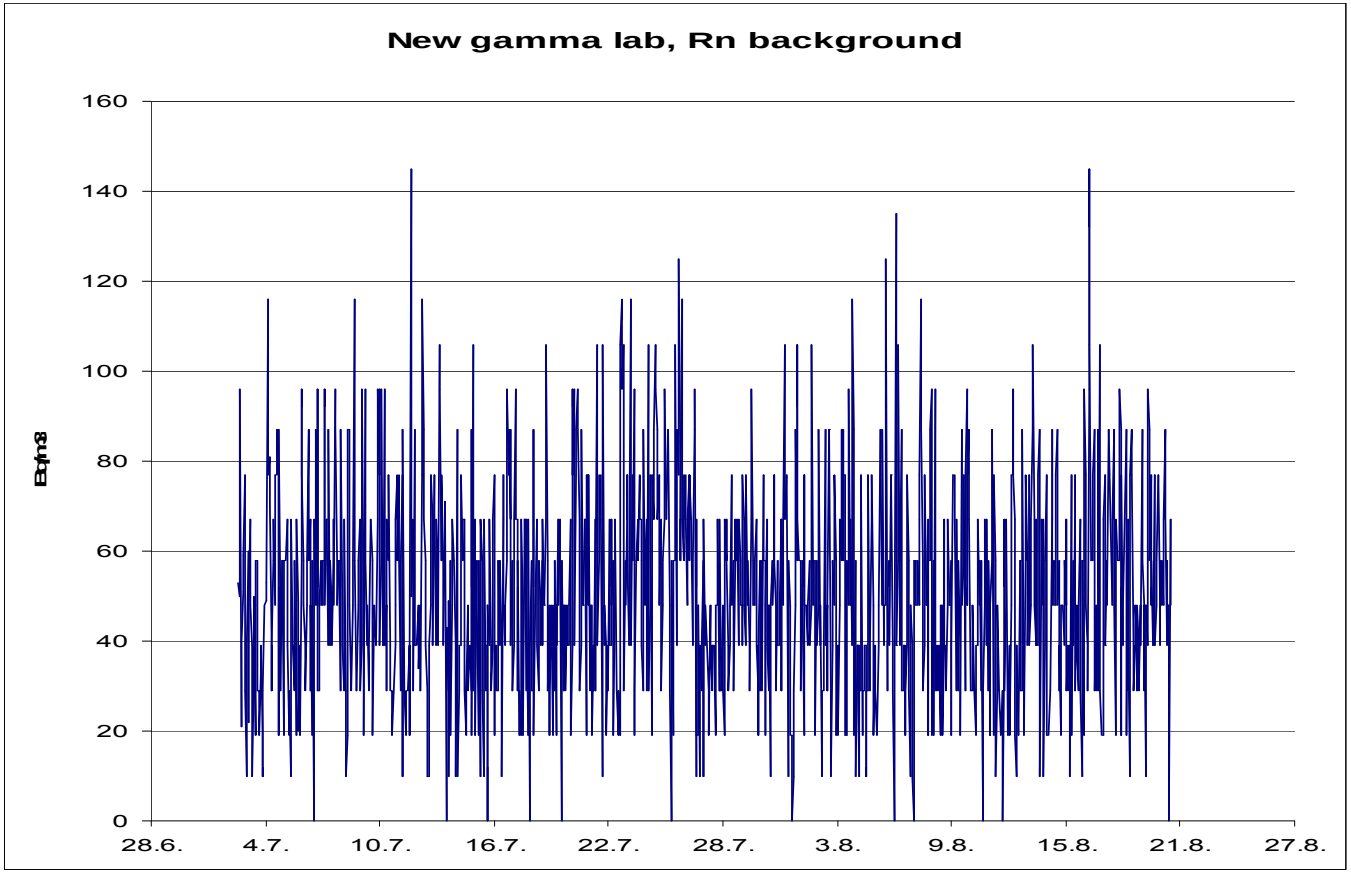
Shows decreasing trend as air outside gets cooler !



Summer 2009

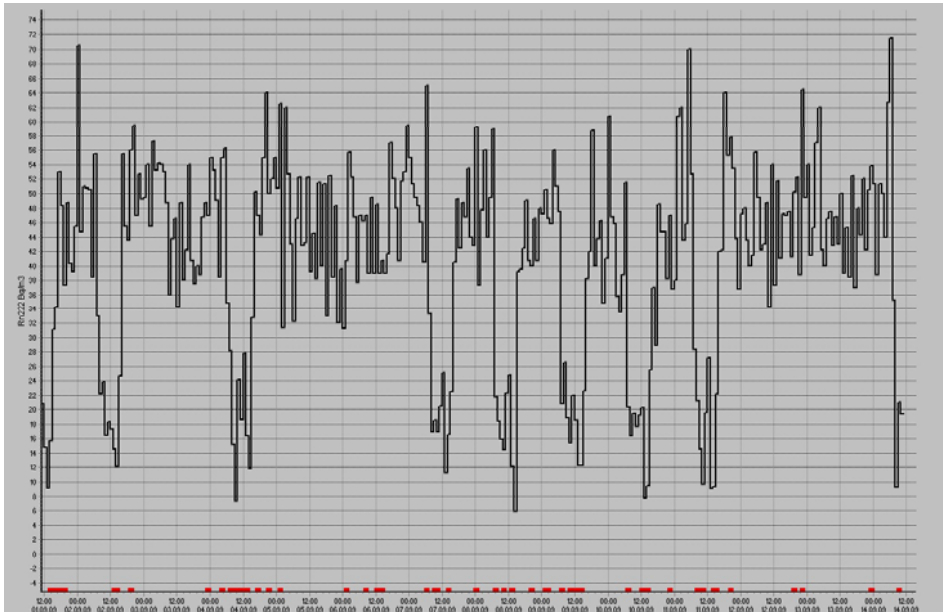
steady behaviour and low values of Rn, approx. 20-30 Bq/m3

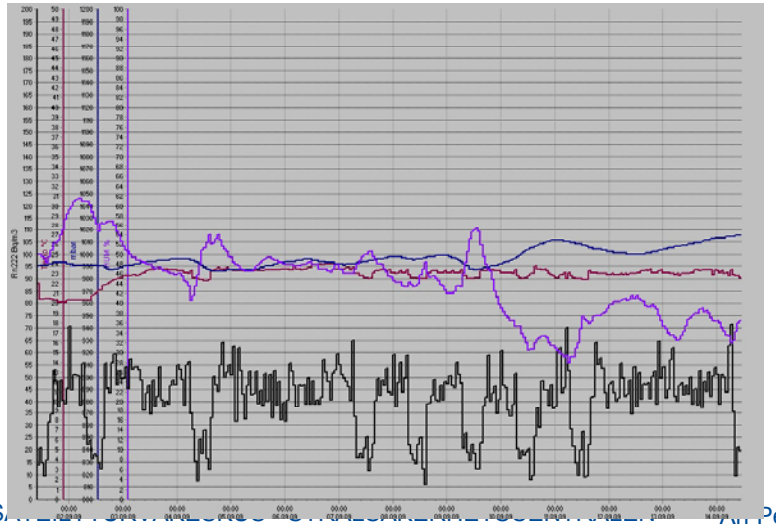
New laboratory facilities at Finnish Geological Survey



- High background from Rn, not acceptable for low level gamma radiation measurements
- Repairs where done, mainly sealing

After sealing of floors and doors, improving ventilation etc...





- High ventilation during working hours, low ventilation during night time and weekends
- low values 10-15 Bq/m3, high values 50-60 Bq/m3

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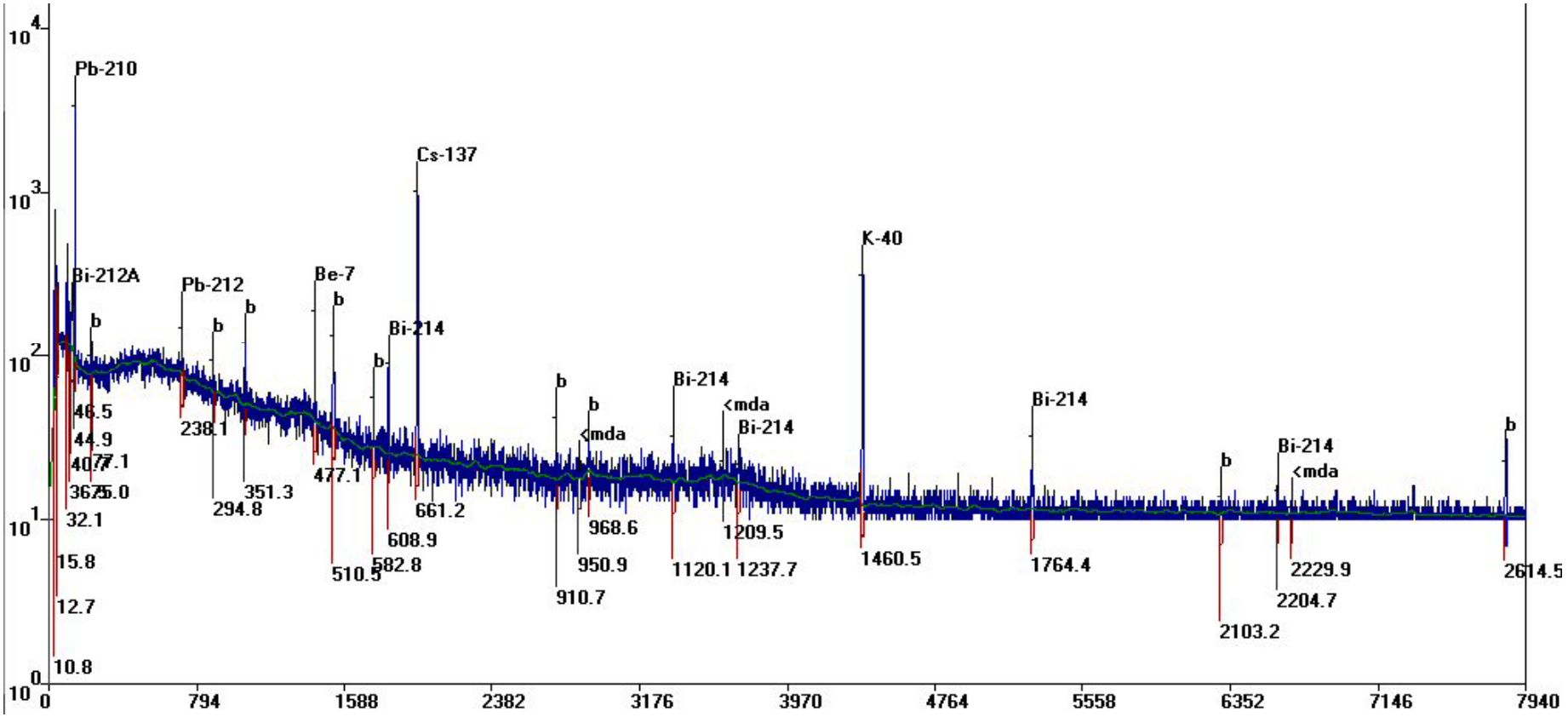
Ventilation must be changed into 24/7 mode !!

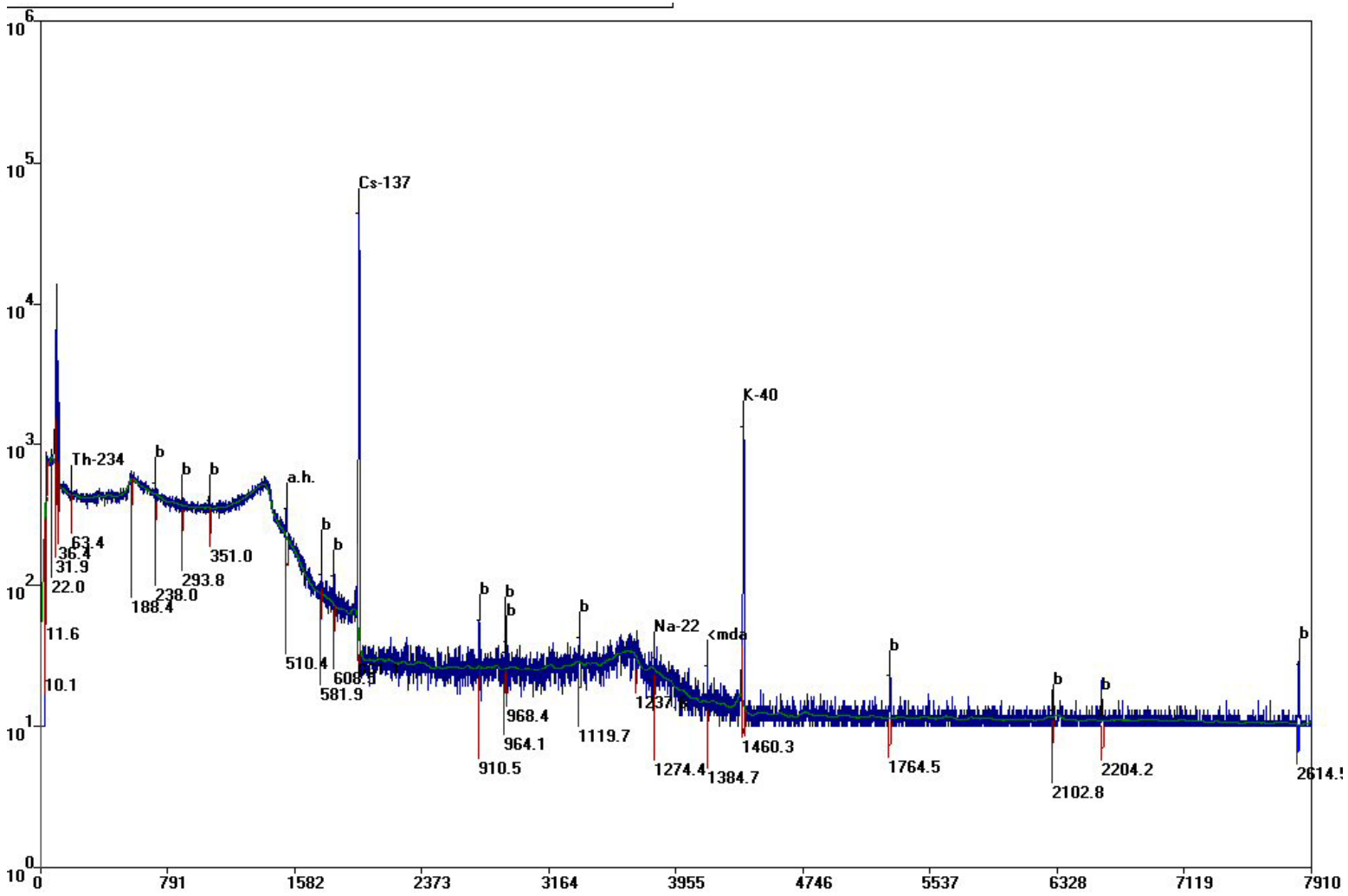
Different types of problems with different types of samples

Lichens (Usnea)



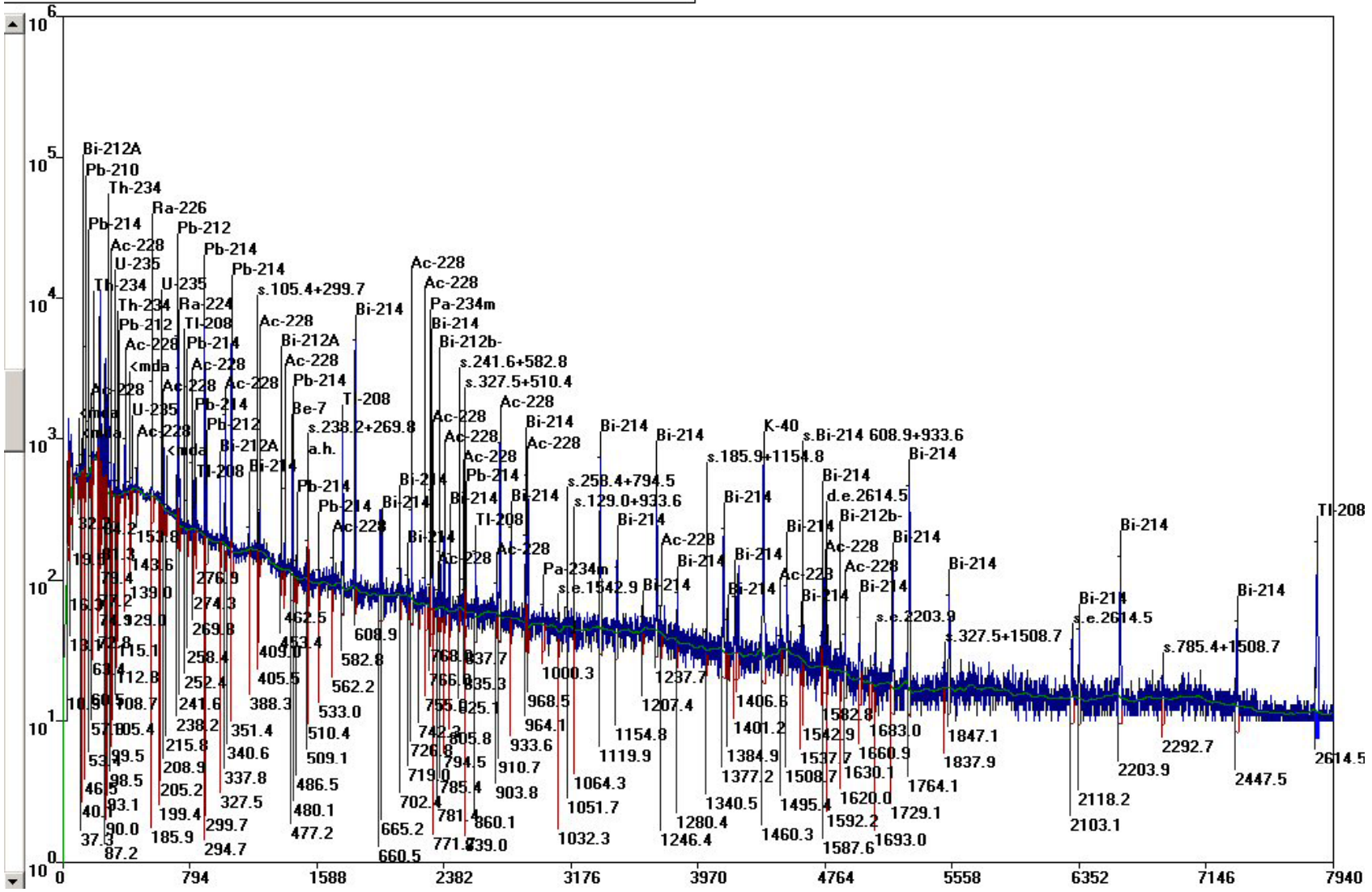
Main problem: How to prove something is zero ?

Reindeer meat



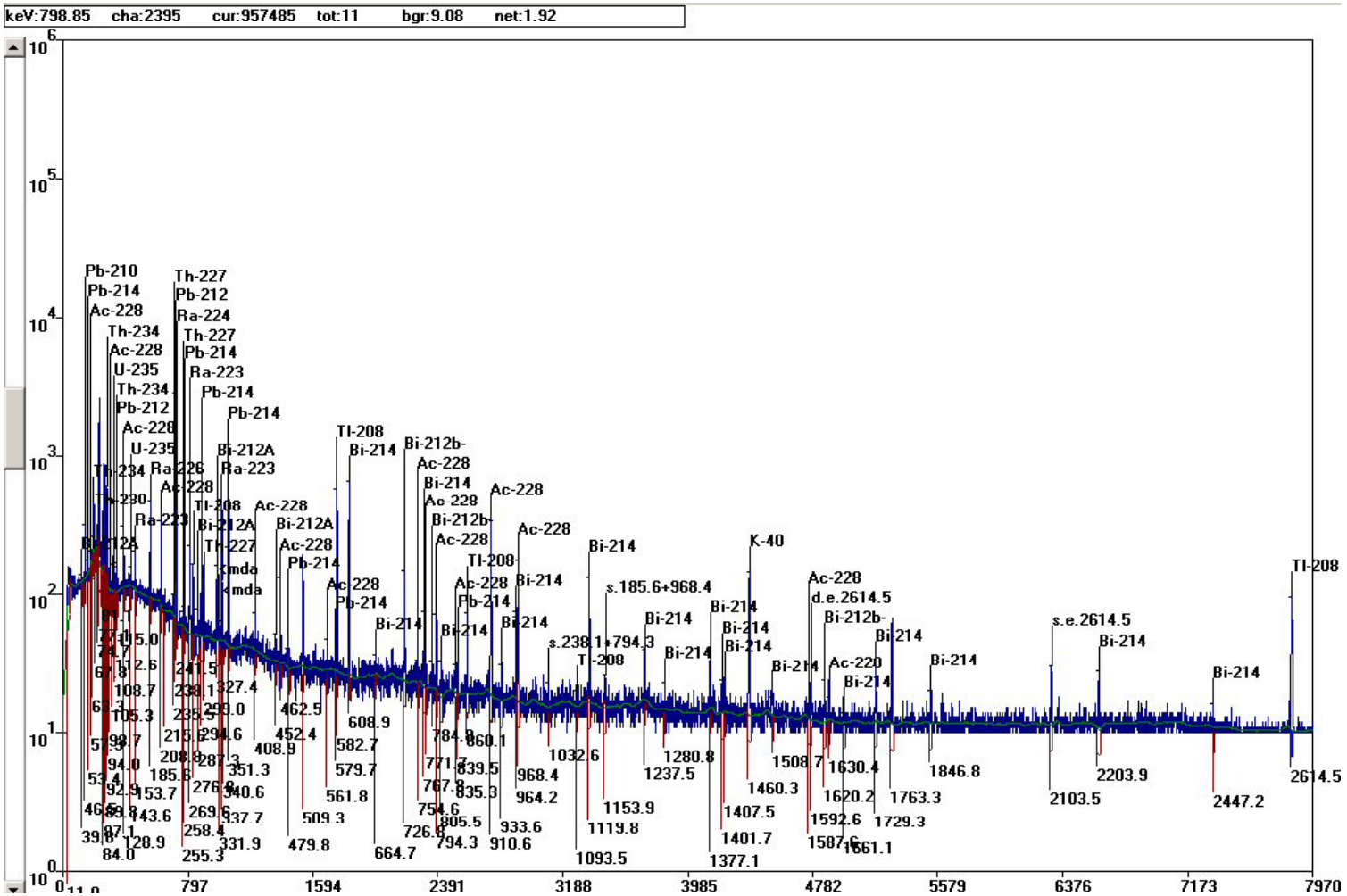
Main problem: Compton scattering kills low activity NORM peaks

Water plants (Fontinalis)



No problem, nice and easy !

Niobium/Phosphate ore



Too high activity and close geometry causes overflow in the analysis program matrices and pile up. Measurement time must be short.

Improvements

- Compton suppression, reduces interfering Compton from peaks with higher energy (reindeer meat)
- Nitrogen flush, in the initial test improvement roughly only about 10%. Expensive.
- Rn-daughters deposited inside lead chamber. Cleaning with alcohol, is it effective enough ?
- Flushing with Rn free air....still an idea under development

Kiitoksia !
Tack så mycket !
Takk skal du ha !
Mange tak !
Takk fyrir !
Thank you !