

# Background in low radiation level laboratory

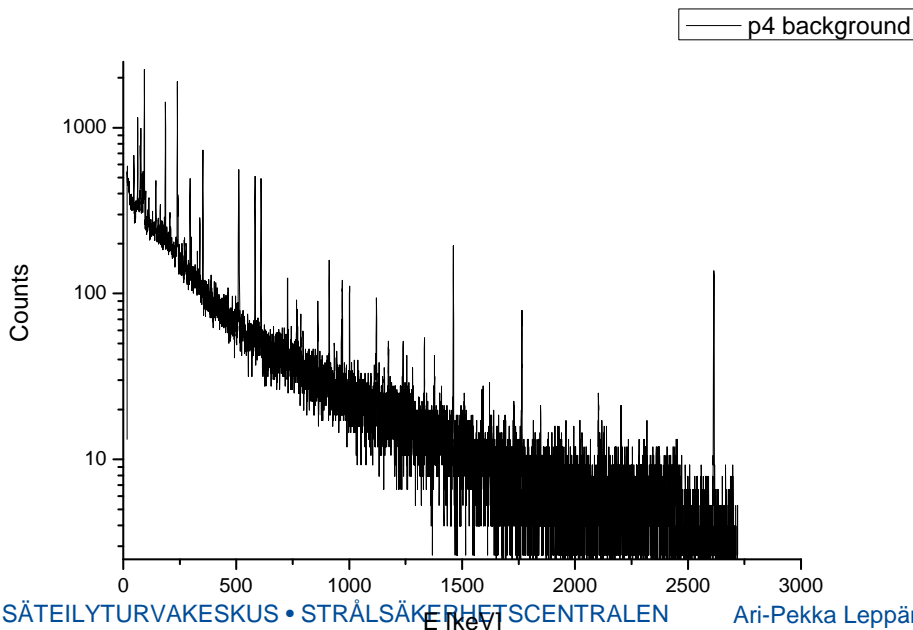
28.09.2010

NKS GammaSem

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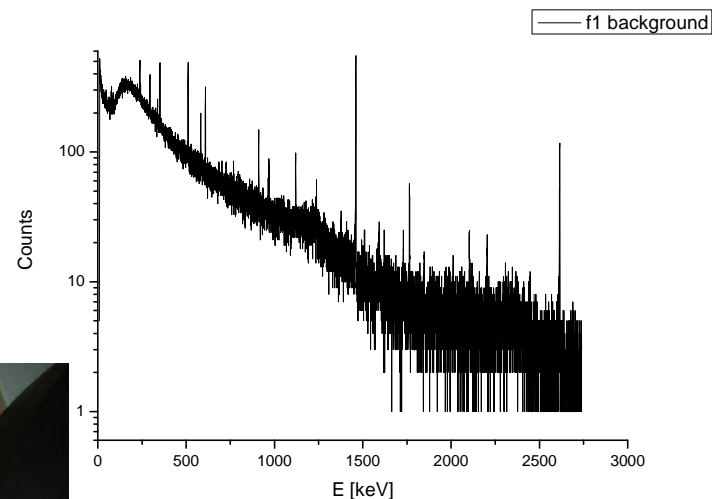
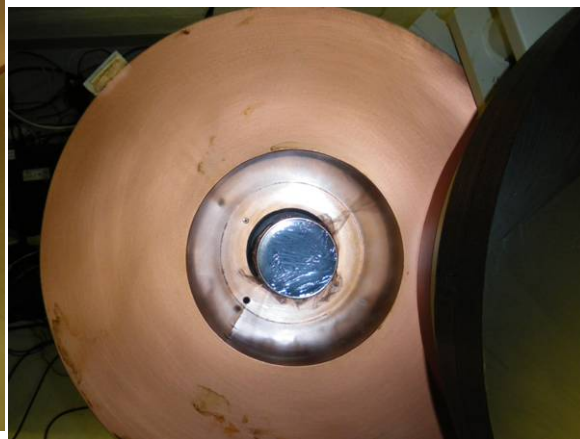
# Background

- STUK's laboratory moved from under ground to ground level facilities -> need to test what has changed in the gamma background
- In NORM measurements in swipe samples and in airborne radioactivity monitoring background plays an important role -> background must be as low as possible
- Aspects effecting the total background must be known before background can be reduced efficiently. (K-40, Rn-level, cosmic ray induced reactions, NORMs)



# Test set-up

- 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



- Series on background measurements was done by varying the set up.
- The background measurement time was fixed exactly to 48 hours.
- The ventilation of the lab was kept at constant, thus eliminating the variations caused by fluctuation in Rn-background. The average Rn-concentration was 20-25 Bq/m<sup>3</sup>
- Total of 7 background measurements was done.
- One background measurement in old laboratory was taken for comparison. Old laboratory facility was about 20 m underground.

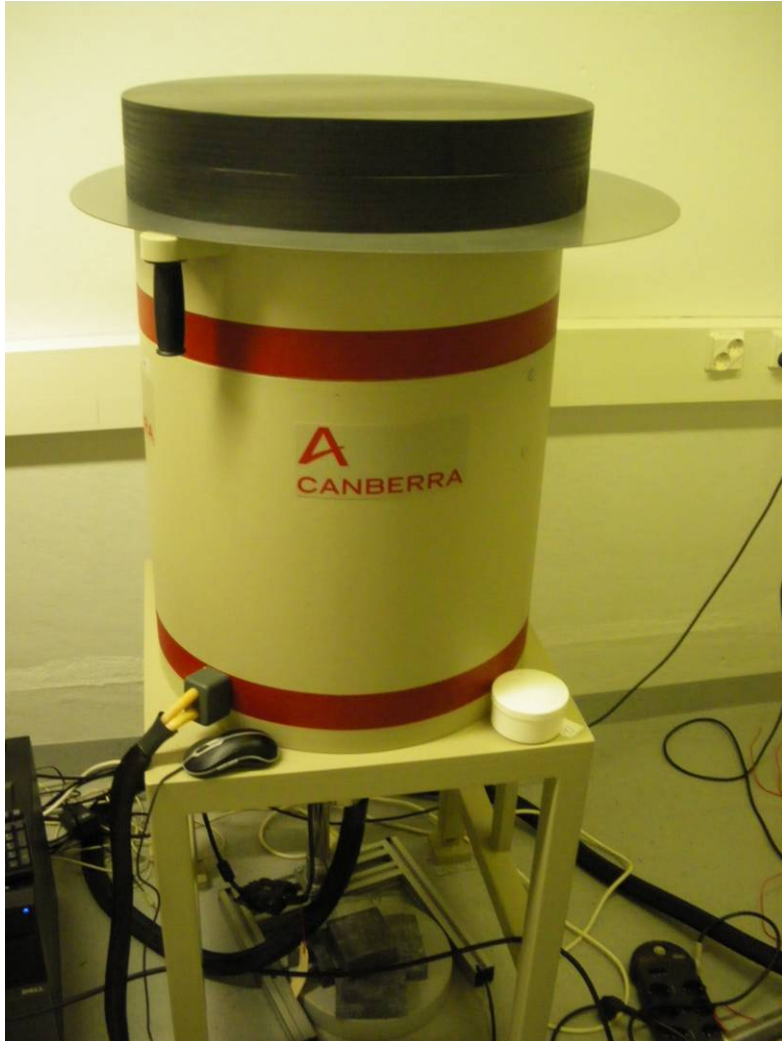
# 1. Measurement



Shield closed, lead bricks on the floor, plastic covers on top.

The idea of plastic disks was to slow down cosmic neutrons.

## 2. measurement



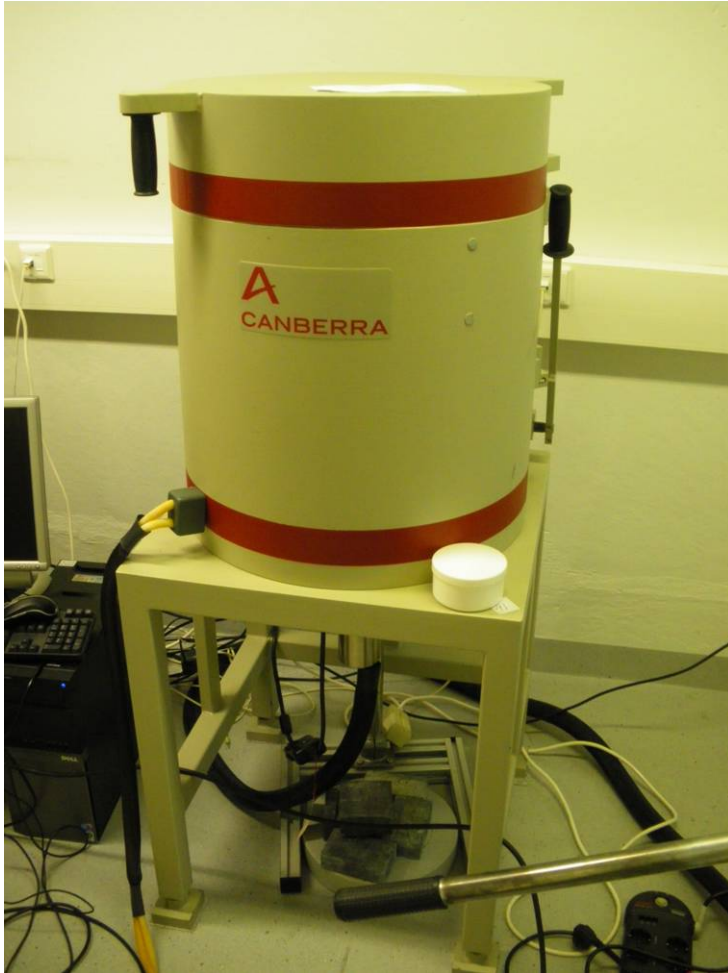
Same as previous but metal plate containing boron was added on top of shield.

The idea was to capture the cosmic neutrons with boron in the steel plate.

Cd would work much better but in low budget testing free materials work much better.



### 3. measurement



Plastics and metal plate from top of the shield was removed.

Idea was to study the effects of plastic disks and metal plate

## 4. measurement

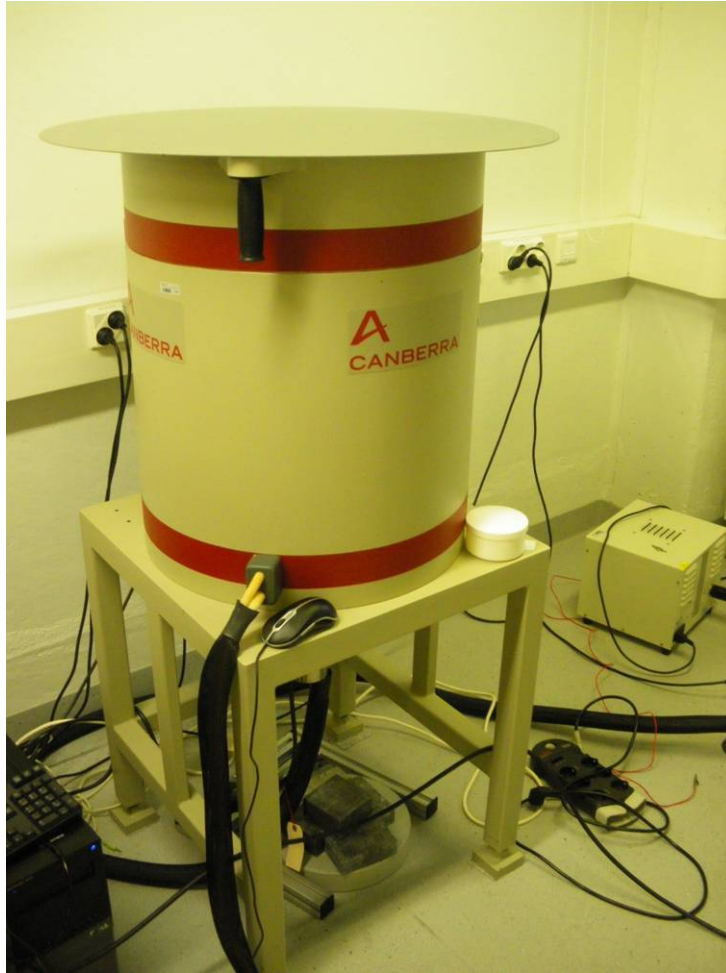


Metal plate and lead bricks beneath the lead castle were removed.

Idea was to study the effect of lead bricks on the floor which prevent the detector from "seeing" the floor.



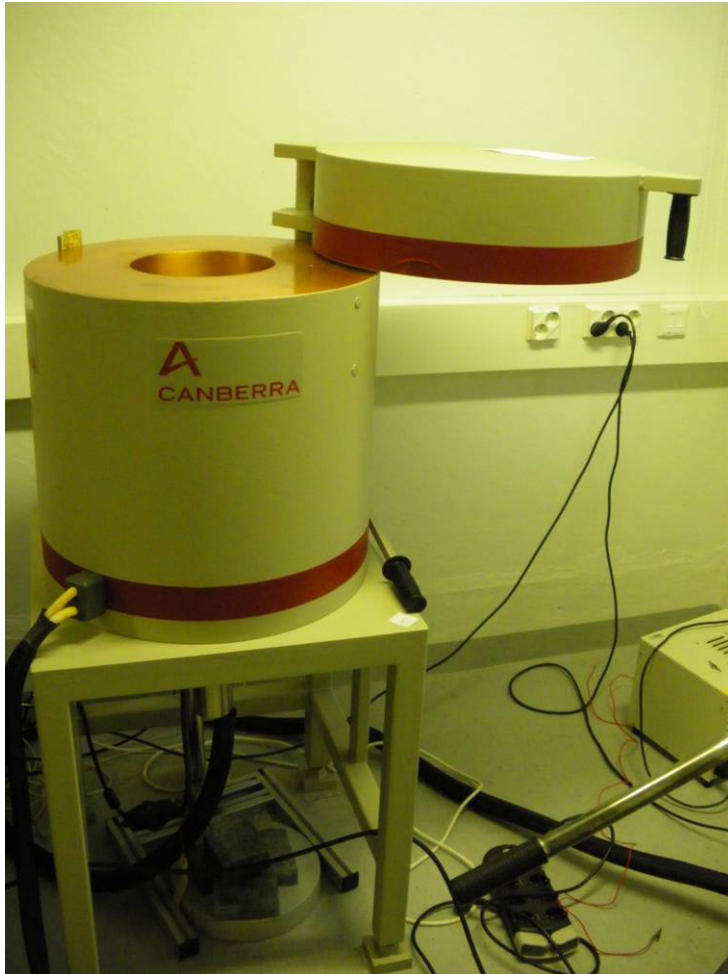
## 5. measurement



Plastic covers were removed.  
Lead bricks and metal plate  
was put back on.

Initially there were some  
indications that the metal  
plate contained NORM's  
and the effect of the plate  
was questionable.

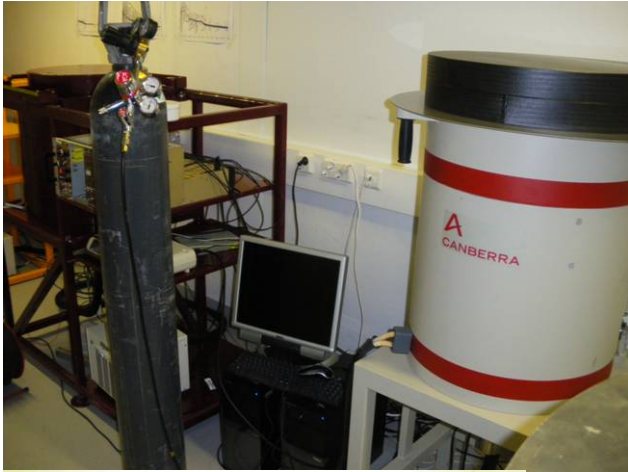
## 6. measurement



The top of the lead castle was opened.

The idea was to test the effect of the castle, comparable to in-situ measurement.

# 7. measurement



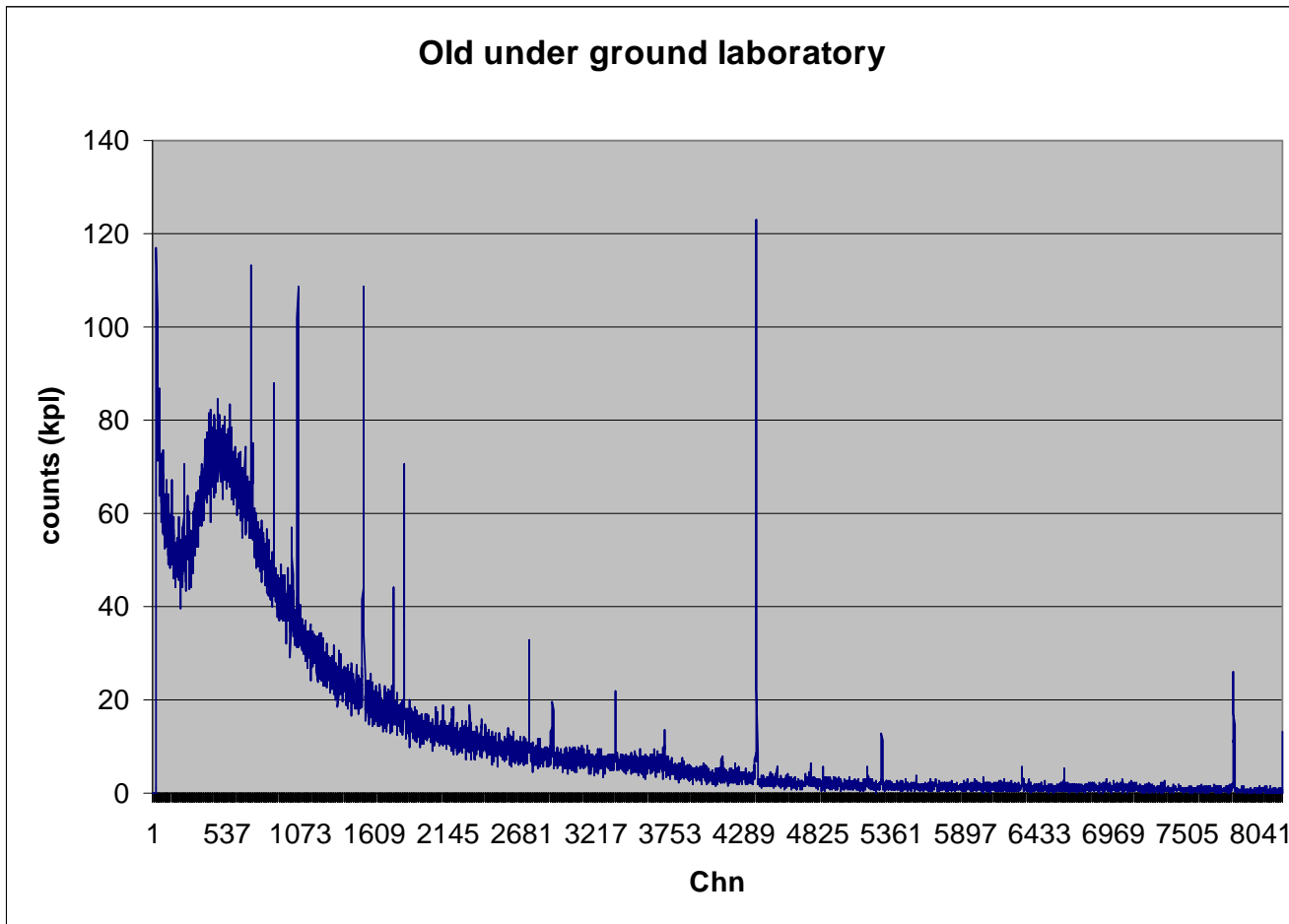
Same as case #1. but nitrogen gas was purged into detector chamber.

The idea was to eliminate Rn and Rn-daughters from the detector chamber



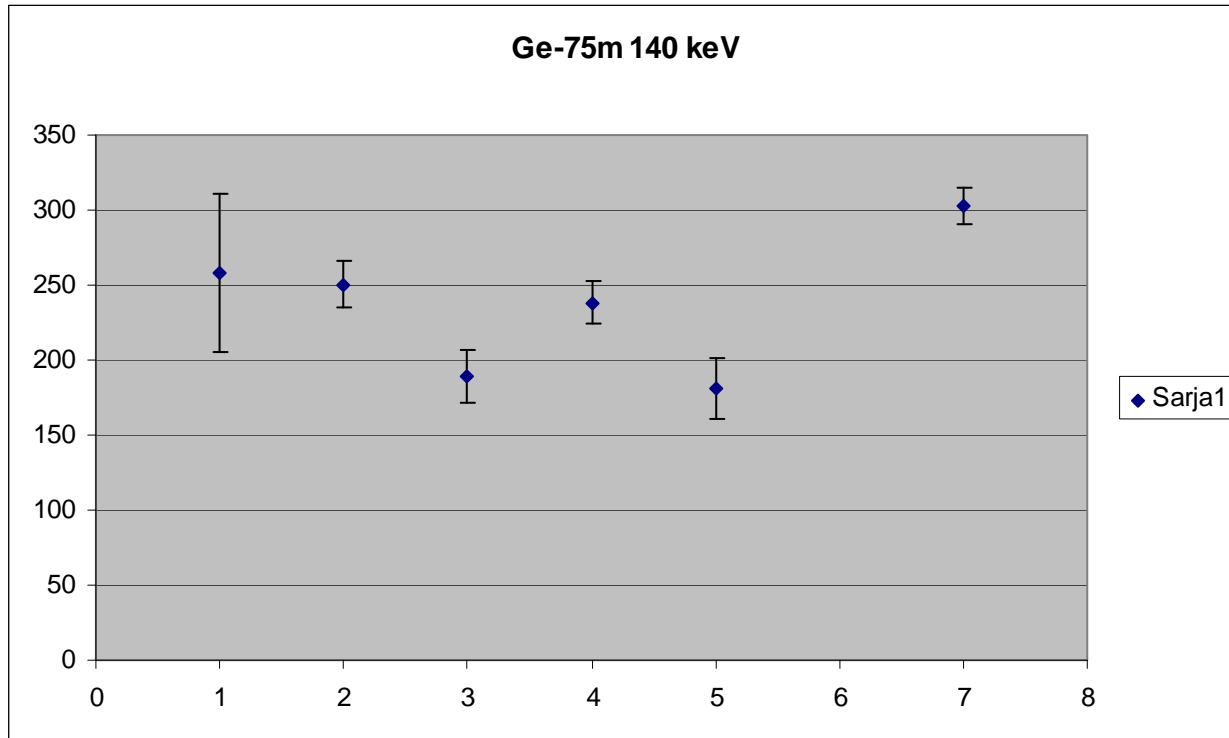
# 8. measurement

Old background measurement in under ground lab was taken for comparison



# Results of selected peaks and energies

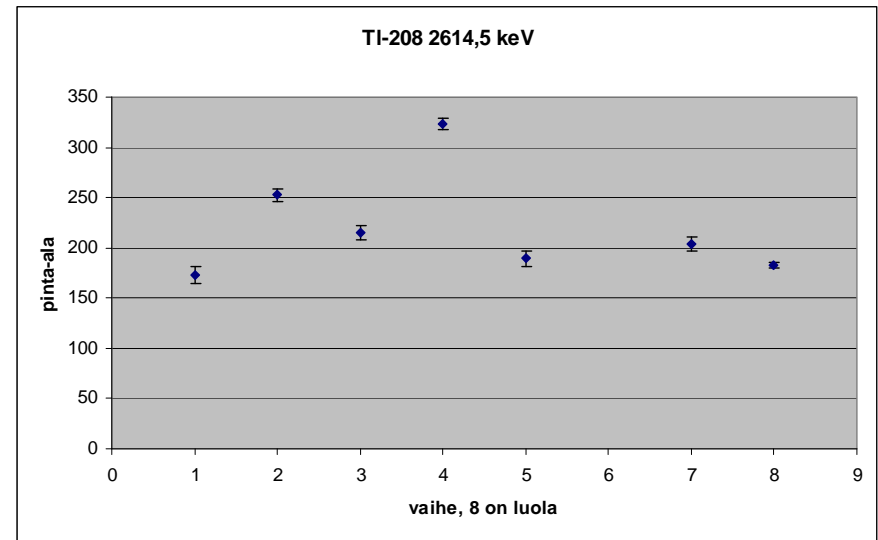
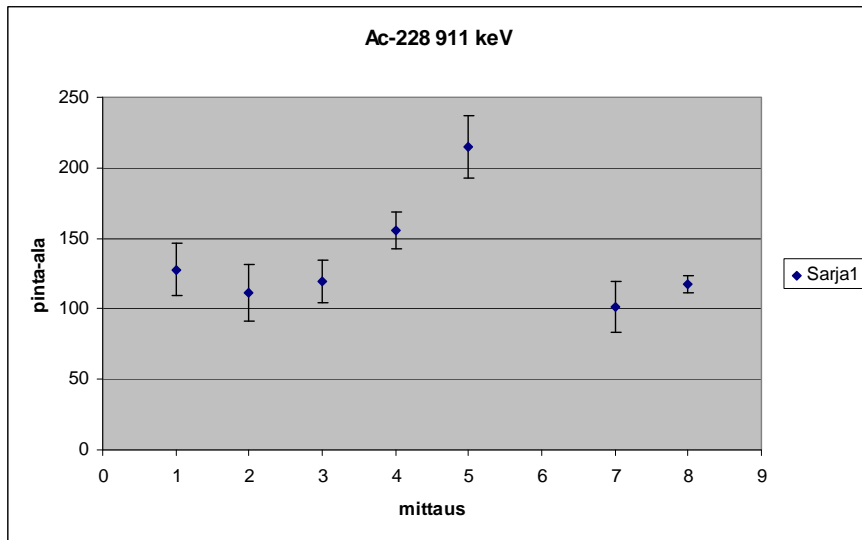
Cosmic ray induced Ge-75m peak at 140 keV



The neutrons obey  $1/v$  law !

The plastic disks slowed down the neutron but without effective absorption there is no point.

# Typical peaks used to calculate NORMs



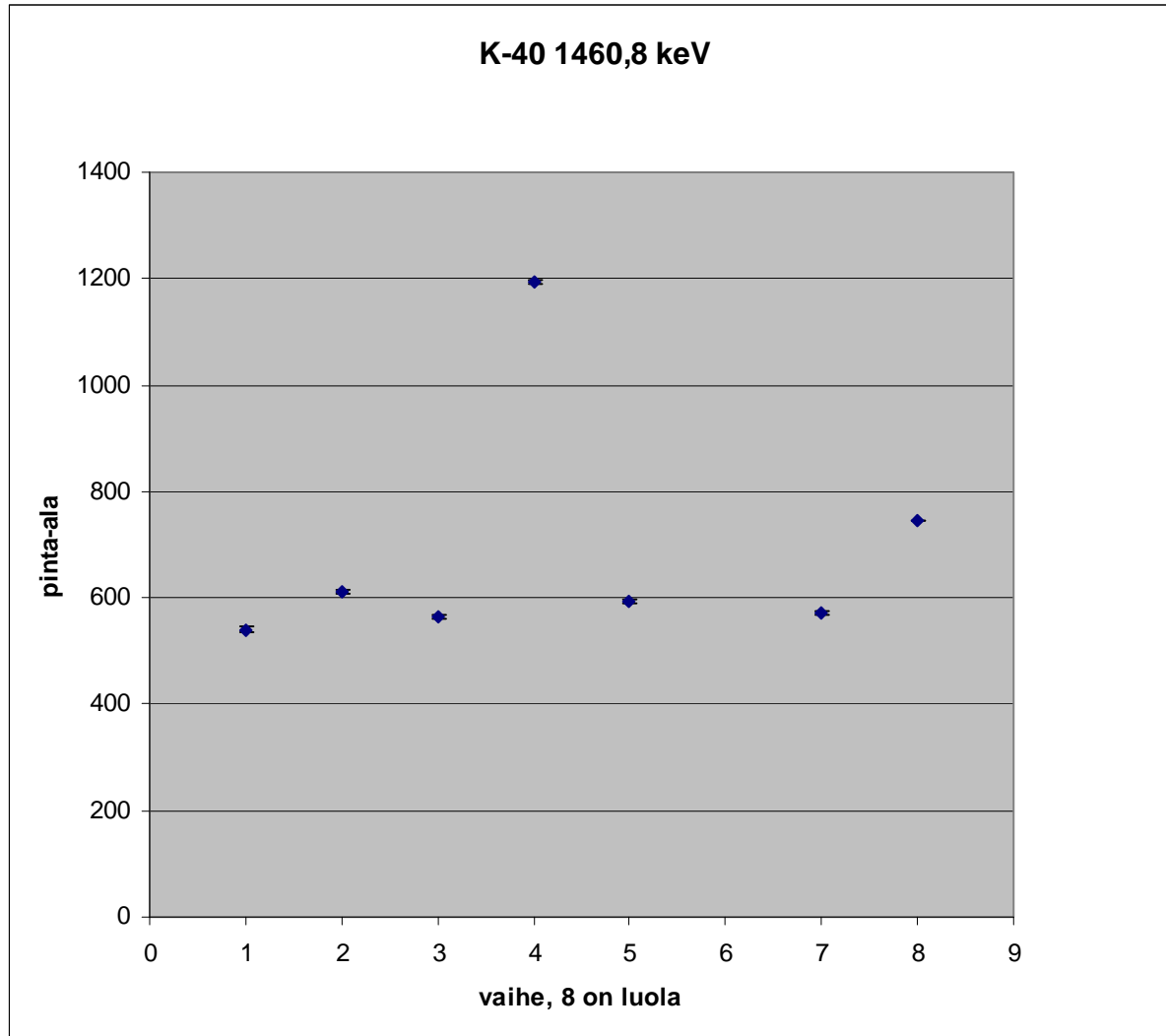
No clear and obvious patterns. Need to do re-measurements.

Problems in measurement room ventilation ?



# K-40 1461 keV peak

K-40 from walls, roof, floor....

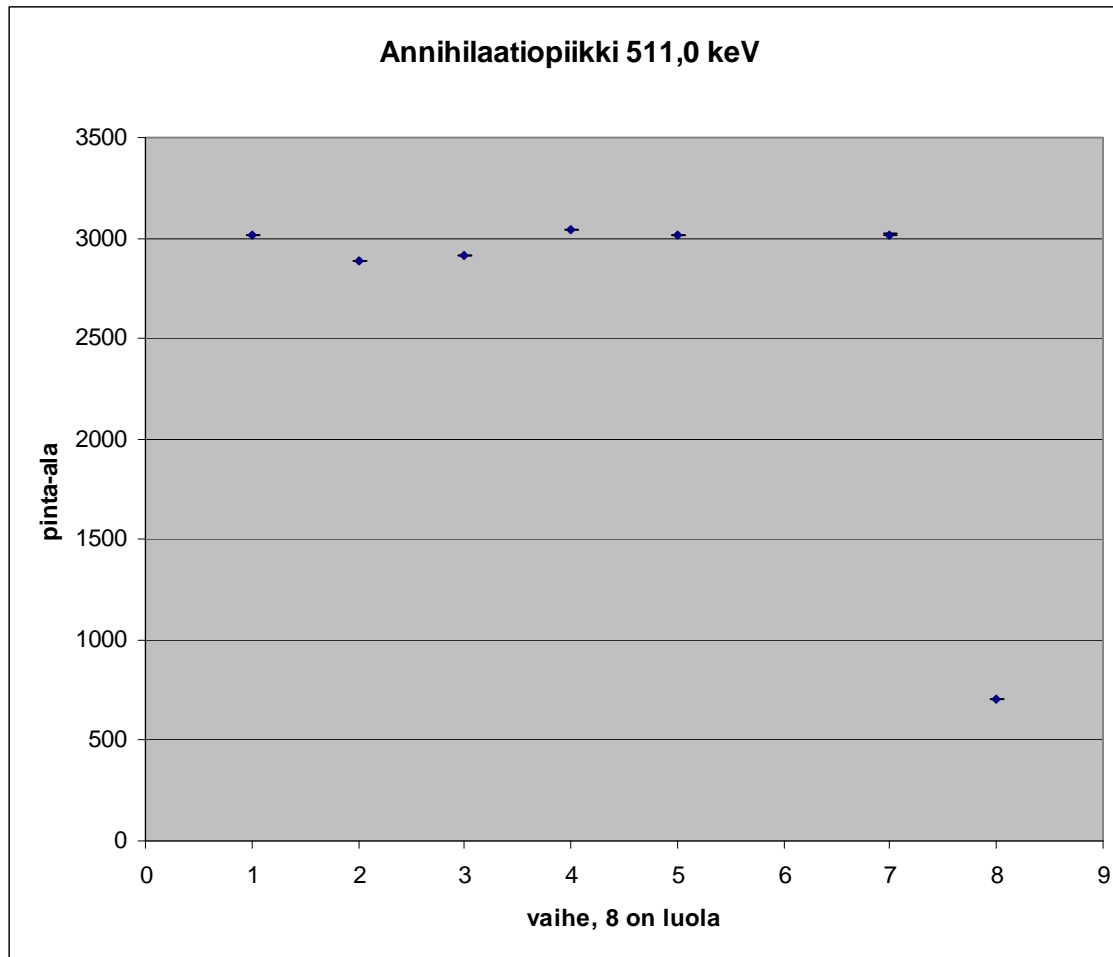


metal plate contained K-40

K-40 lead bricks on the floor reduce K-40 background significantly

Underground facility had higher K-40 background

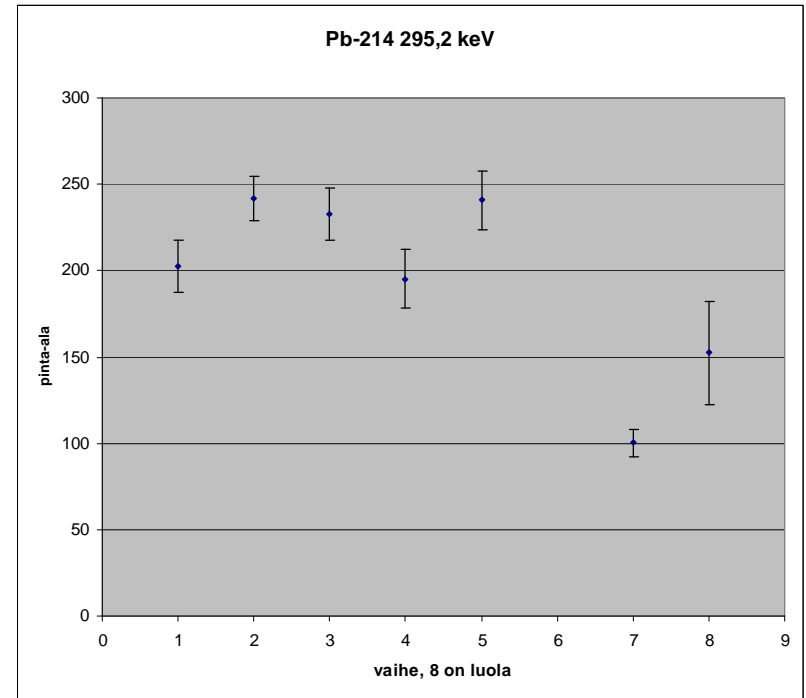
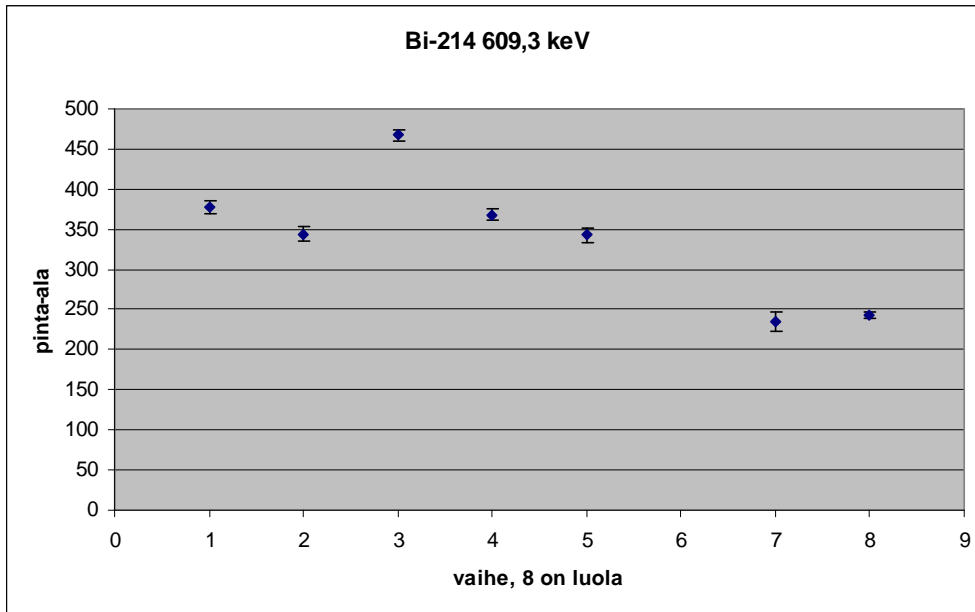
# 511 keV annihilation peak



minor effect from  
borated plate

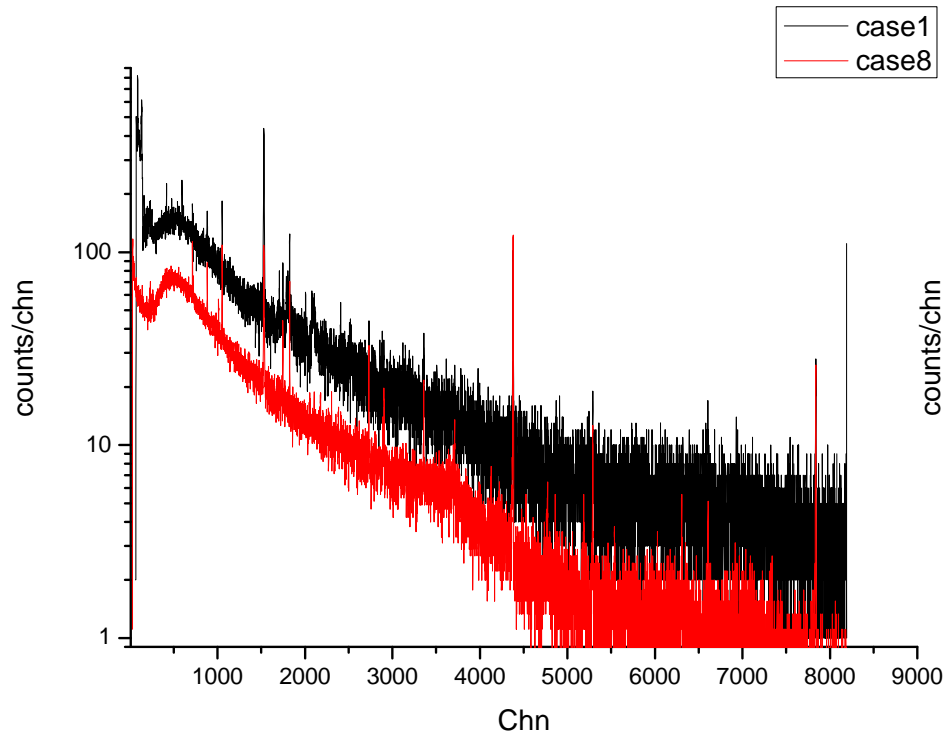
Large effect from  
underground facility

# Rn-daughters

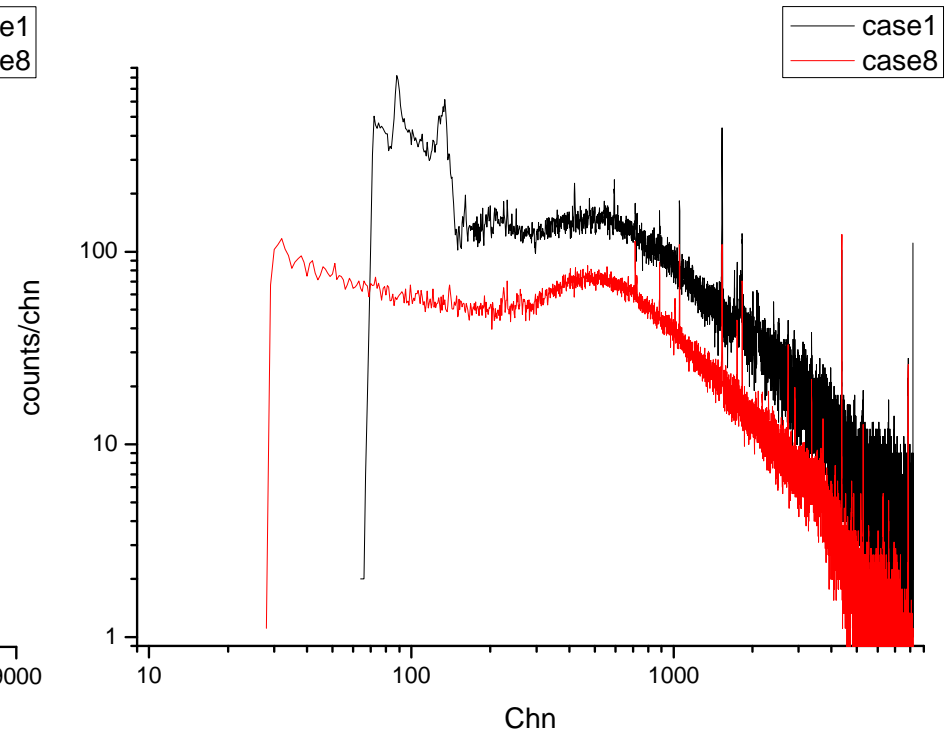


# 7 measurement demonstrates the effect of N<sub>2</sub> flush

# Changes in myon induced flux



underground vs. ground level



low energy part

Which one would you like to have ?

# Summary

- Different methods was tested in order to reduce background in low level gamma spectroscopy
- plastic discs do reduce the effect of cosmic neutron although they need to be accompanied by absorber
- borated stainless steel is not a very good absorber due to low concentration of boron and "high" concentration of NORMs
- Lead bricks on the floor prevents the detector from seeing the floor
- N<sub>2</sub> flush reduces Rn-daughters inside the detector chamber
- from background point of view underground facilities are significantly better than ground level ones.



A scenic view of a cable-stayed bridge over a river. In the foreground, a large tree with vibrant yellow autumn leaves stands on a grassy bank. The bridge has a tall, slender pylon and several stay cables. The water reflects the bridge and the surrounding landscape. The sky is a pale, overcast blue.

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