2nd Topical Workshop in Low Radioactivity Techniques
October 1 - 4, 2006 - Aussois

Radon reduction facility and Radon measurements at the Modane Underground Laboratory

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and
the NEMO Collaboration

CENBG

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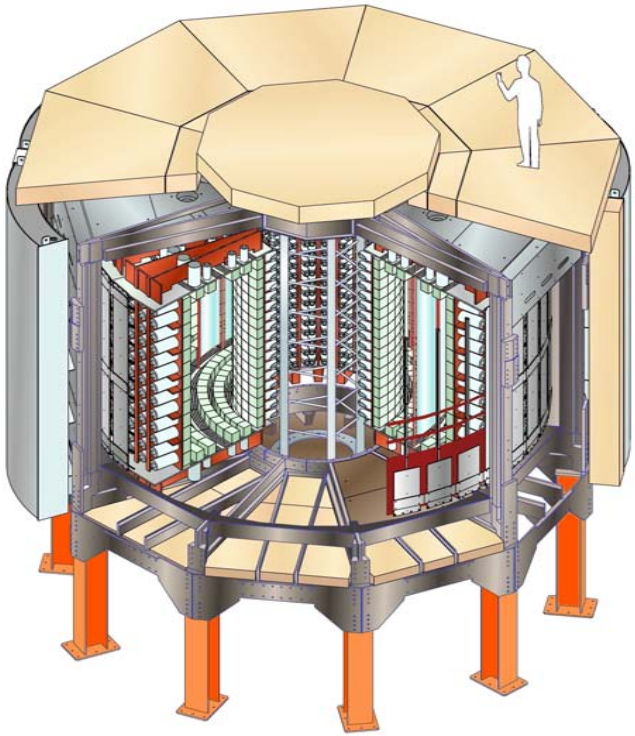
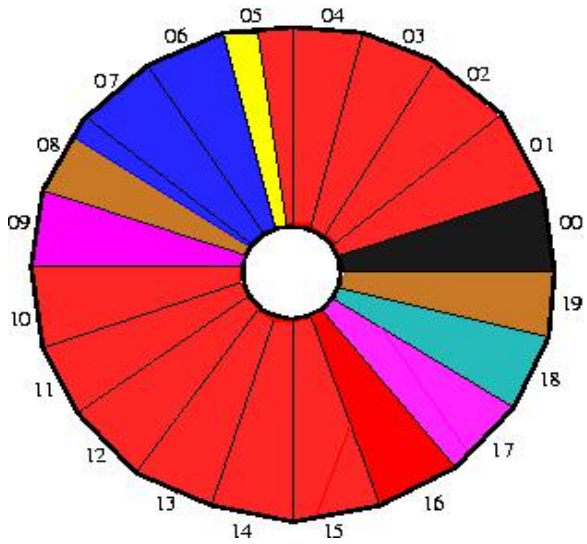
NEMO3 Detector

The NEMO3 (Neutrino Ettore Majorana Observatory) experiment investigates neutrinoless double beta decay ($2\beta0\nu$).

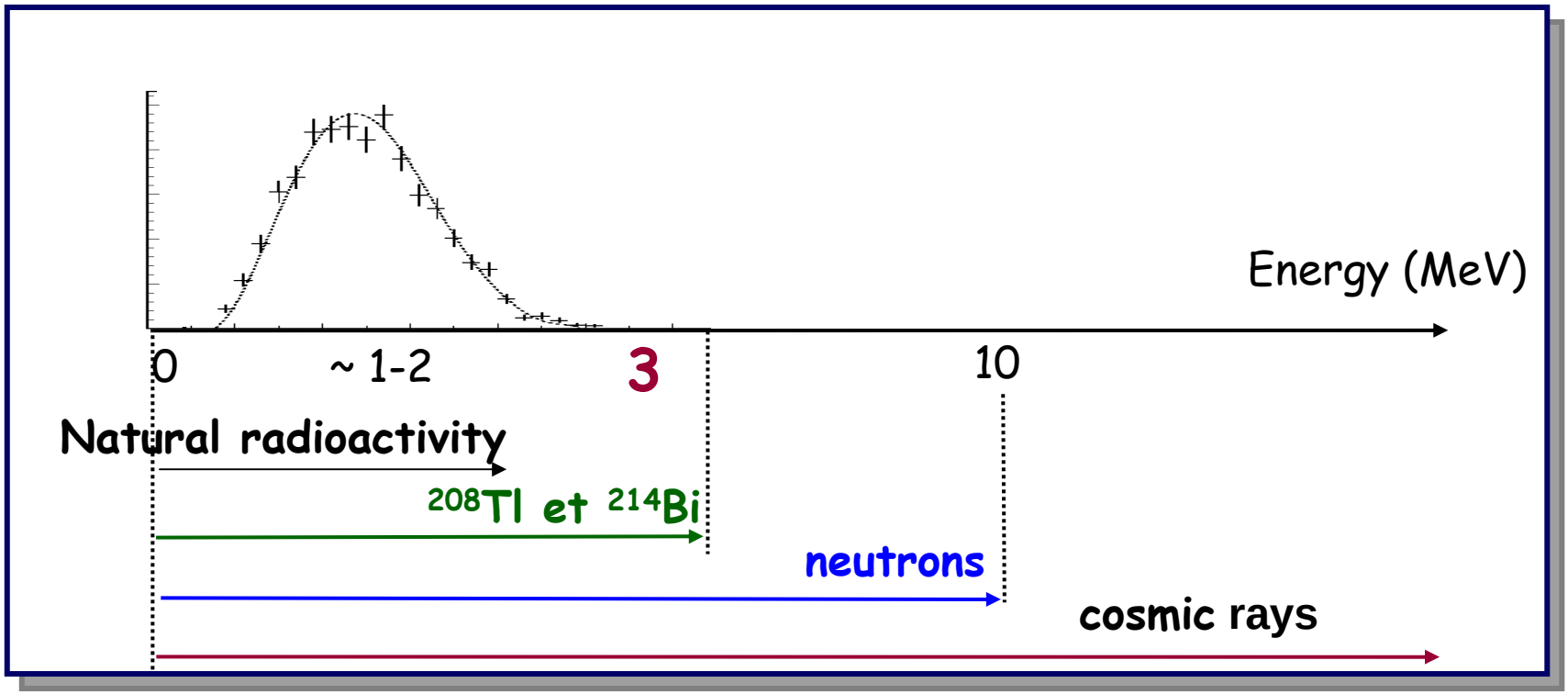


7 kg Mo^{100}
1 kg Se^{82}
0,4 kg Cd^{116}
1 kg Te^{130}
50 g Nd^{150}
20 g Zr^{96}
7 g Ca^{48}
1 kg Te^{nat}
0,6 kg Cu



NEMO3 is now running in the (LSM). It is a very low radioactive background detector.

Origin of the background in NEMO3



Cosmic rays → Underground lab (1700 m of rocks)
10.000.000 muons/m^2/day (>200 MeV)
LSM : 4 muons/m^2/day !!

Neutrons coming from rock and materials surrounding the detector :
Shielding: water, wood, paraffin …

Natural radioactivity ^{208}Tl , ^{214}Bi

All construction materials are selected according their radio-purity ⚠ Rn

Radon level in NEMO 3

- In the LSM the level of radon activity is about 16 Bq/m^3
- First data have shown inside NEMO3 a level of Rn around 15 mBq/m^3
- This level gives 8 events/year in the ^{100}Mo (7 kg) $\beta\beta0\nu$ energy bin
- Need to be reduced by at least a factor of 10
- The origin of this Rn was suspected to be air leaks between the sectors

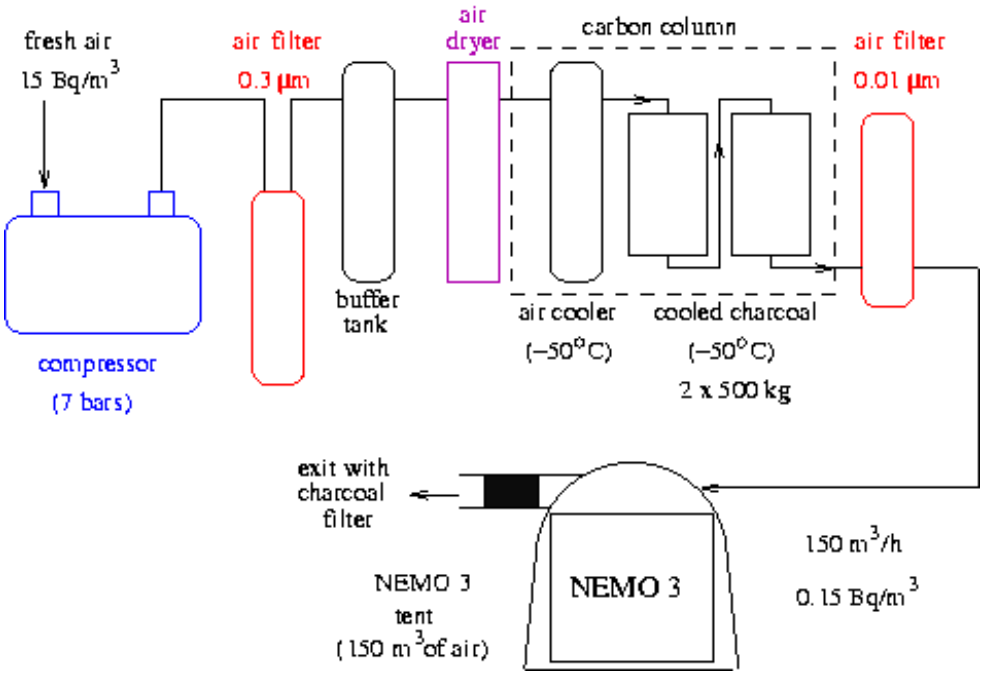
In 2004 :the detector has been surrounded by an airtight plastic tent.

The radon value inside the tent went down from 16 Bq/m^3 to 5 Bq/m^3

Not enough

Free-Radon air factory

Principe:
Air circulation (150 m³/h) trough a column of charcoal cooled down at -50°C



The specifications of the radon trapping facility are :

- Compressor (7 bars)
- filtration with oil separator (0.03 µm) and dust separator (0.1 µm)
- Air Dryer with a dew point -70°C for 8.5 bars -30°C at maximum value
- Cooling unit
- Two adsorption columns, with internal diameter of 600 mm and 3 m high
- Charcoal: activated carbon 2x500 kg

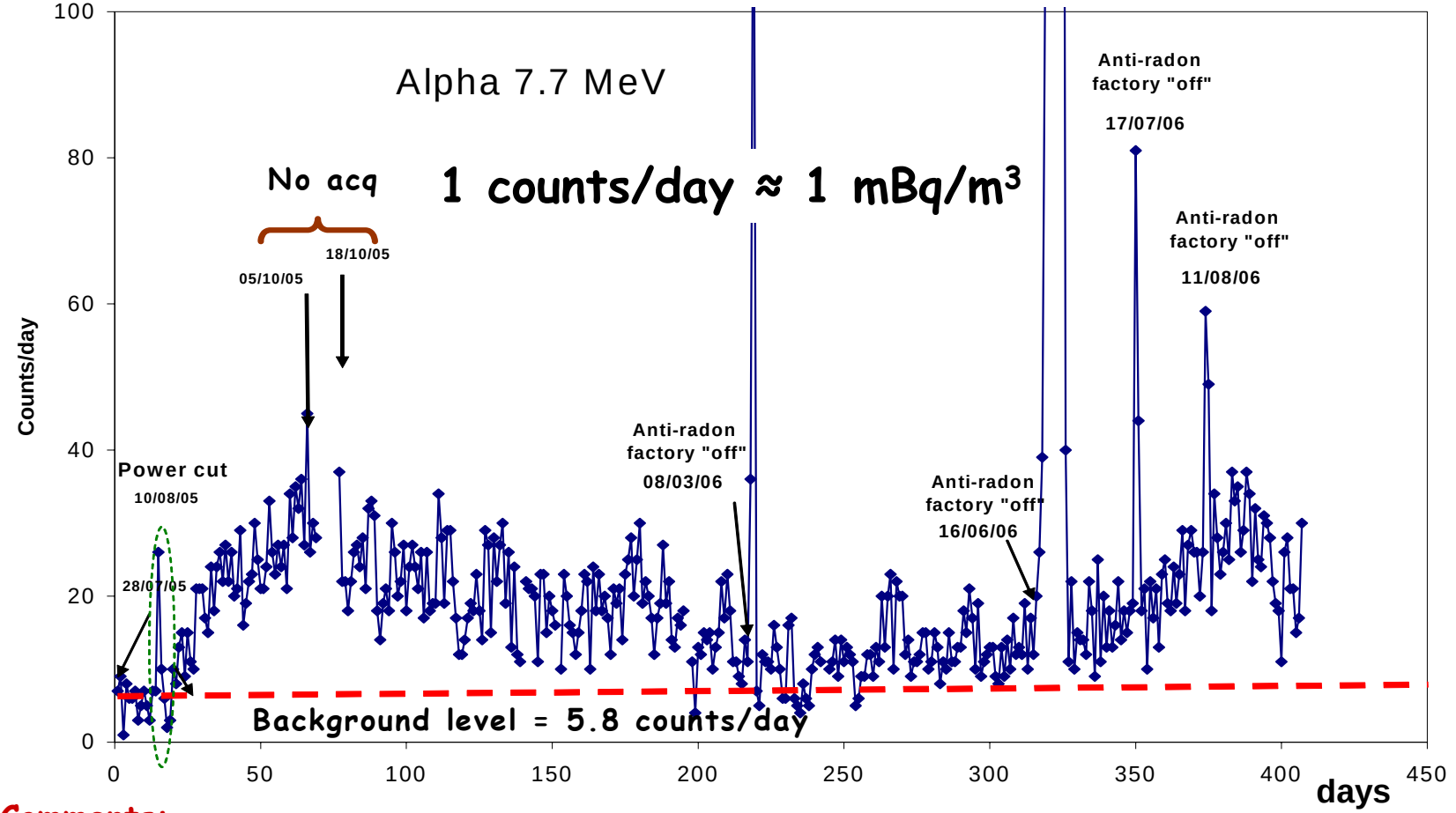
The Rn level at exit of the column: 18 mBq/m³ ⟹ air sent into the tent


NEMO 3
Radon
Trapping
Facility

Rn control at the exit of the anti-radon factory

(from 28/07/05 to 13/09/06)

Evolution of the radon activity at the exit of the free-radon air factory between the 28 July 2005 to 13 September 2006. One point corresponds to 24h measurement. The average activity in this period (~ 1 year) is around 18 mBq/m^3.



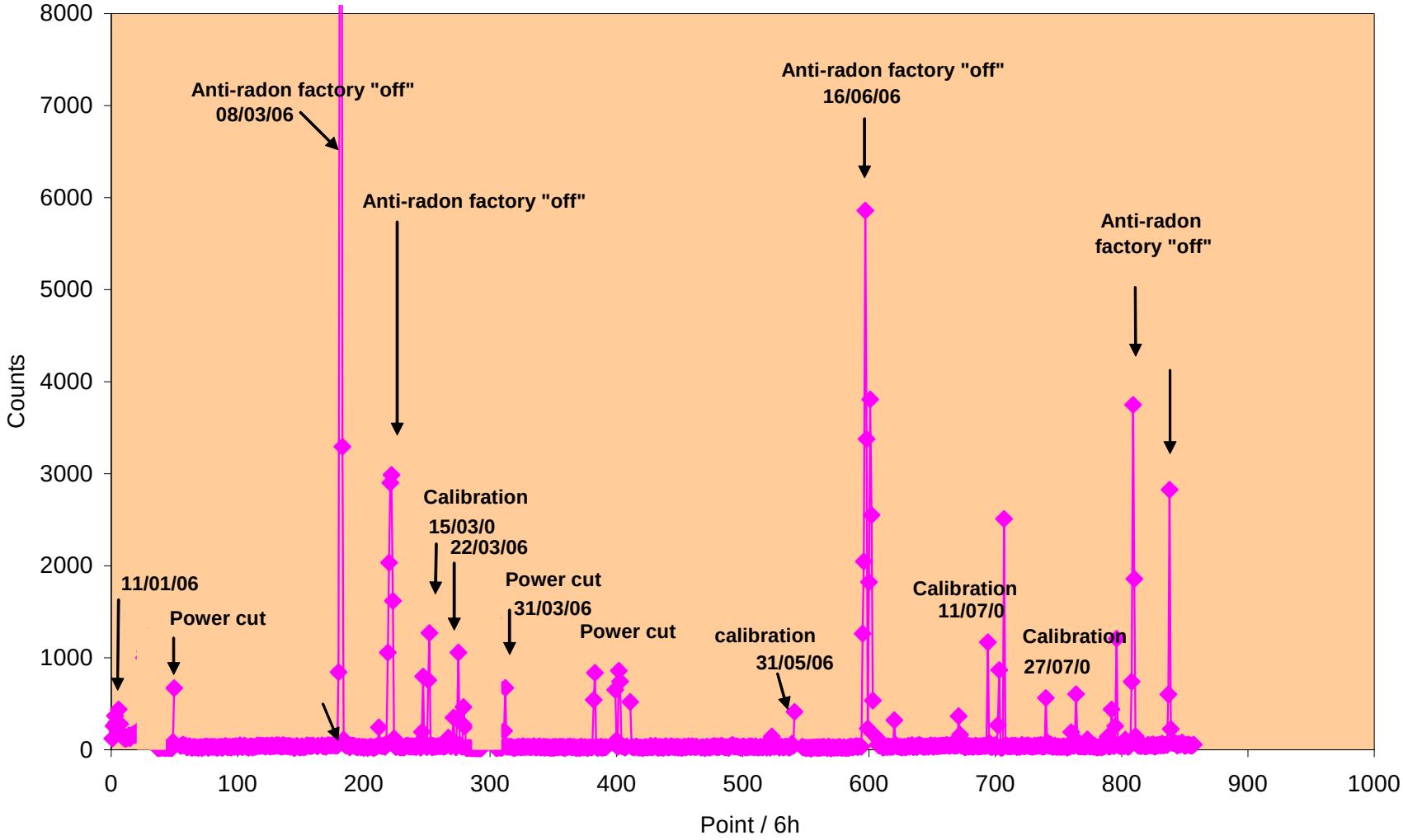
Comments:

- Natural variations of the radon level in the LSM
- Temperature variation of the charcoal column

1 measurement / day

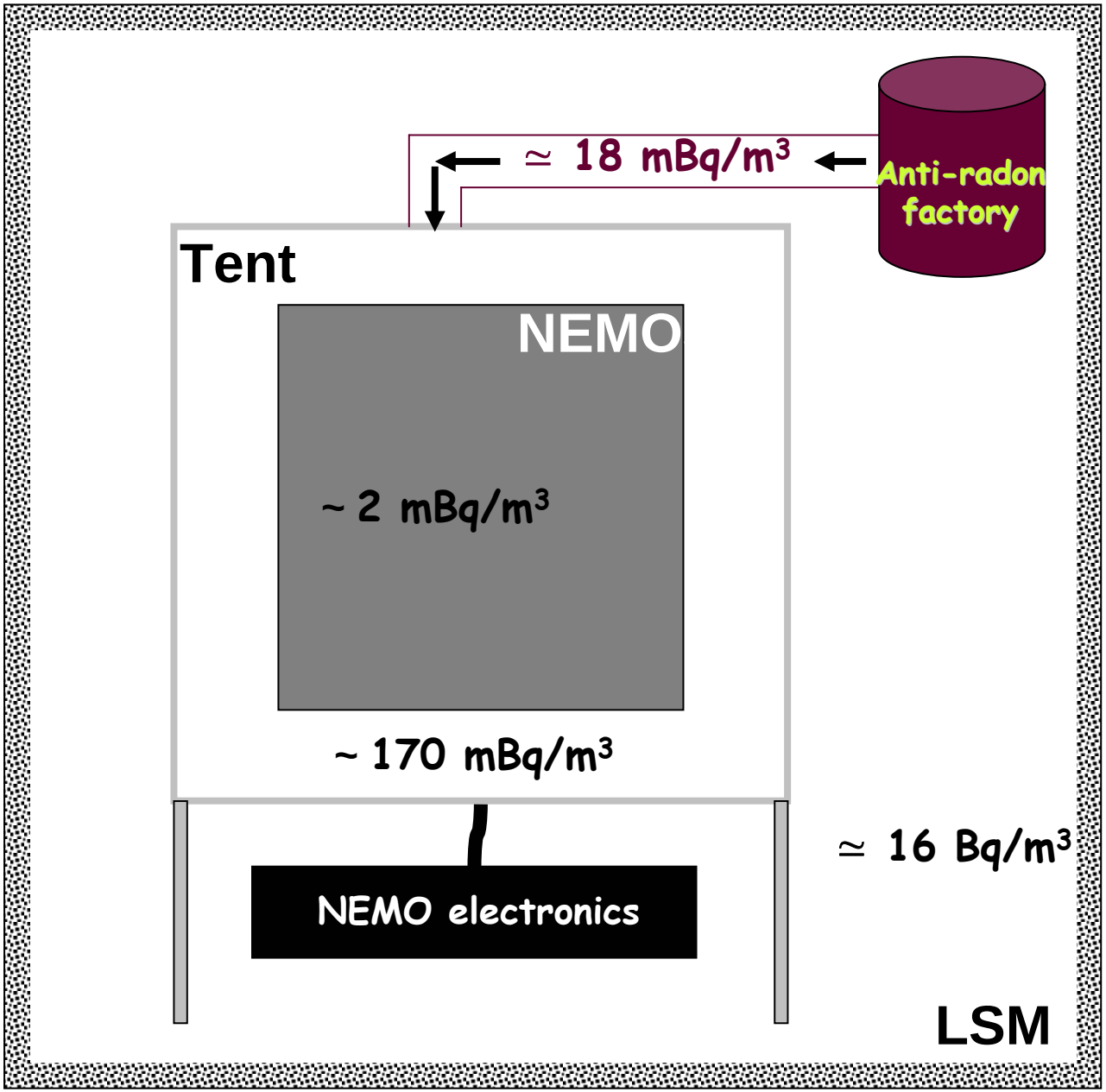
Rn control in the NEMO tent (11/01/06 to 13/09/06)

Evolution of the radon activity inside the airtight tent with the radon detector between the 11 January 2005 to 13 September 2006. One point corresponds to 6h measurement.



- The average activity in this period is around 170 mBq/m^3.
- Several accidents due to different events (energy calibration, power cuts, …)
- Note that after each accident we come back to the low Rn level within ~1 day .

Current situation for NEMO3



The difference between the activity injected and measured inside the tent due to:

- ❖ air leaks in the tent
- ❖ degassing of the NEMO electronics

We suspect some ^{220}Rn (Thoron) in NEMO3 ?!

We planned to study this component with a new radon detector

High Sensitivity Radon Detectors

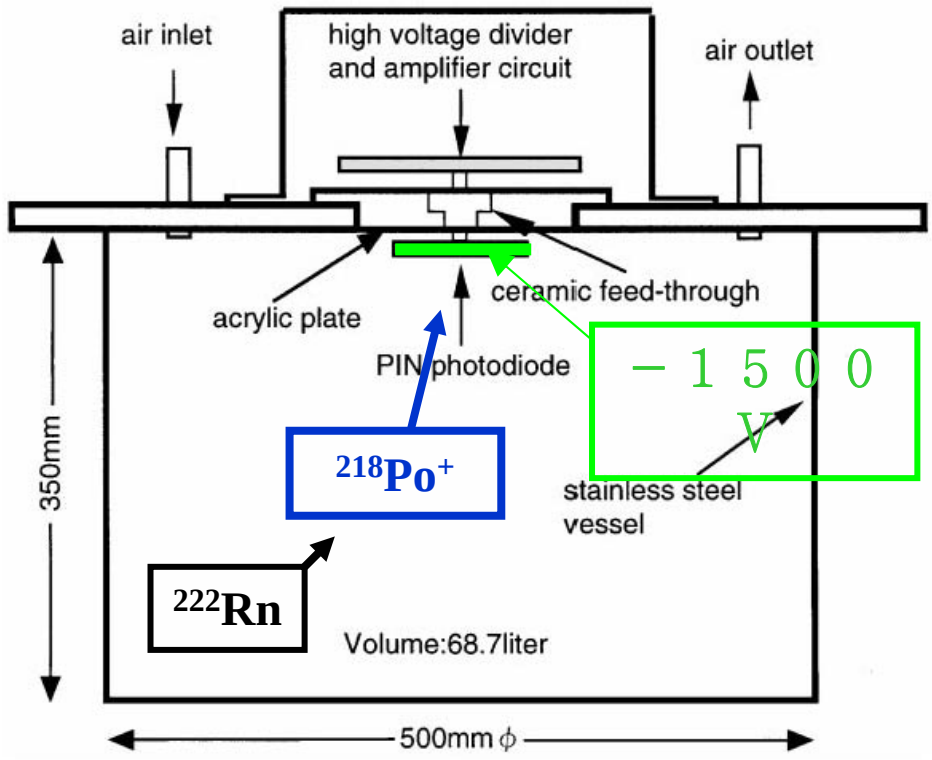
Built by H.Ohsumi, Saga University, Japan

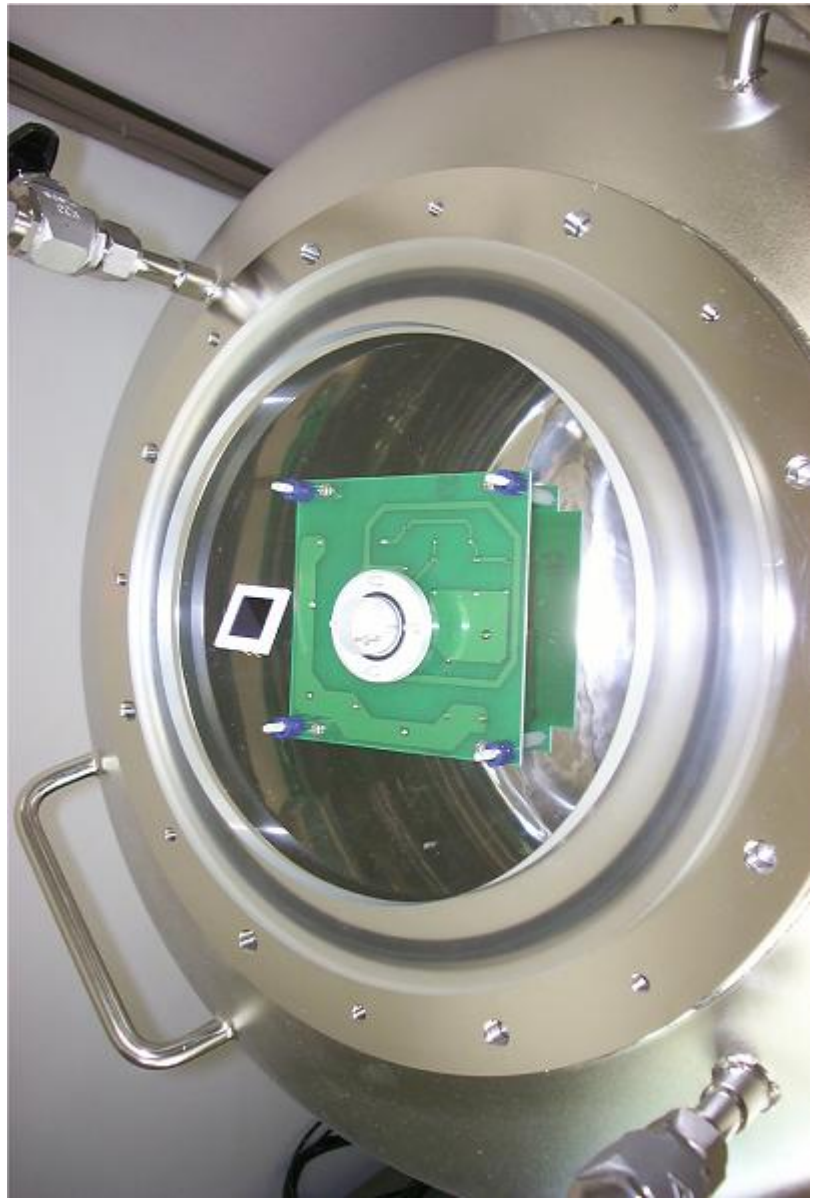
- Electrostatic collection of the ^{222}Rn daughter (-1500 V)
- Energy measurement of the alpha decay on the PIN photodiode
- Large (70 l) and clean vessel to get high sensitivity

Typical sensitivity

~1mBq/m^3

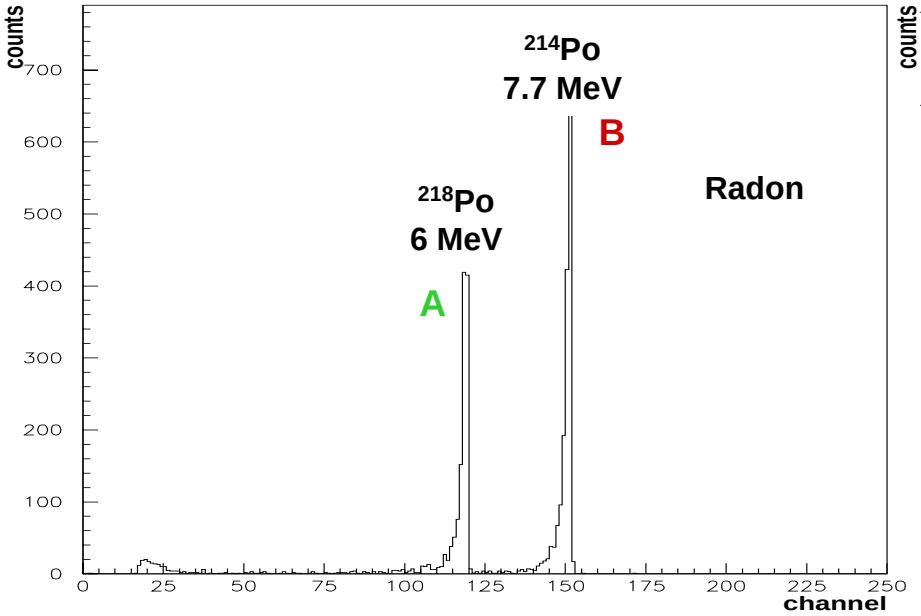
1 α detected in 24h

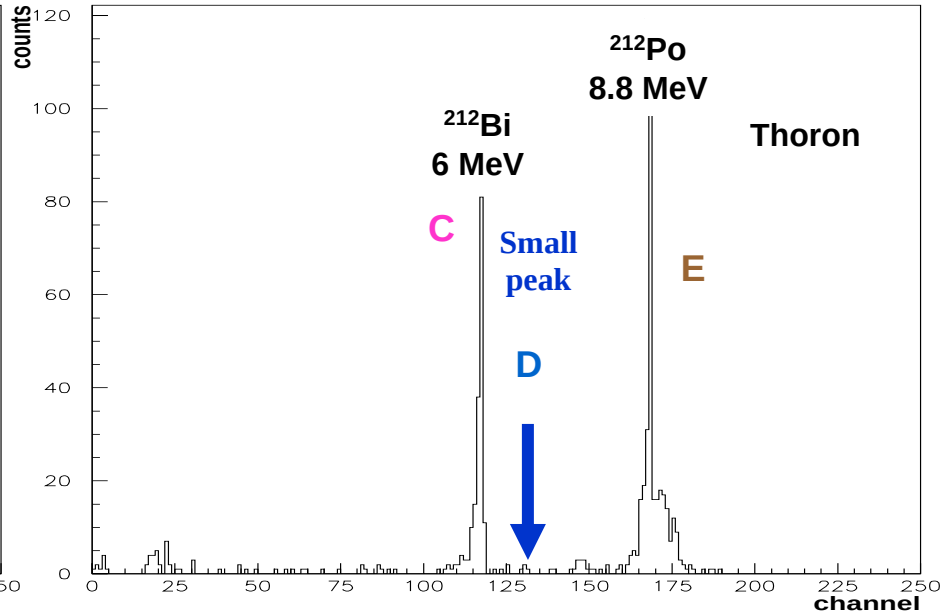


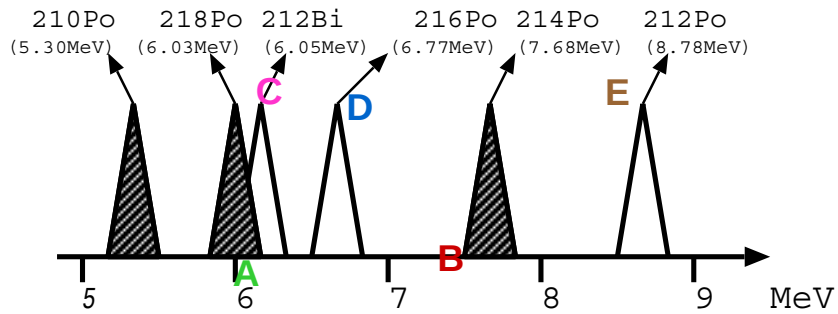


Typical α spectra

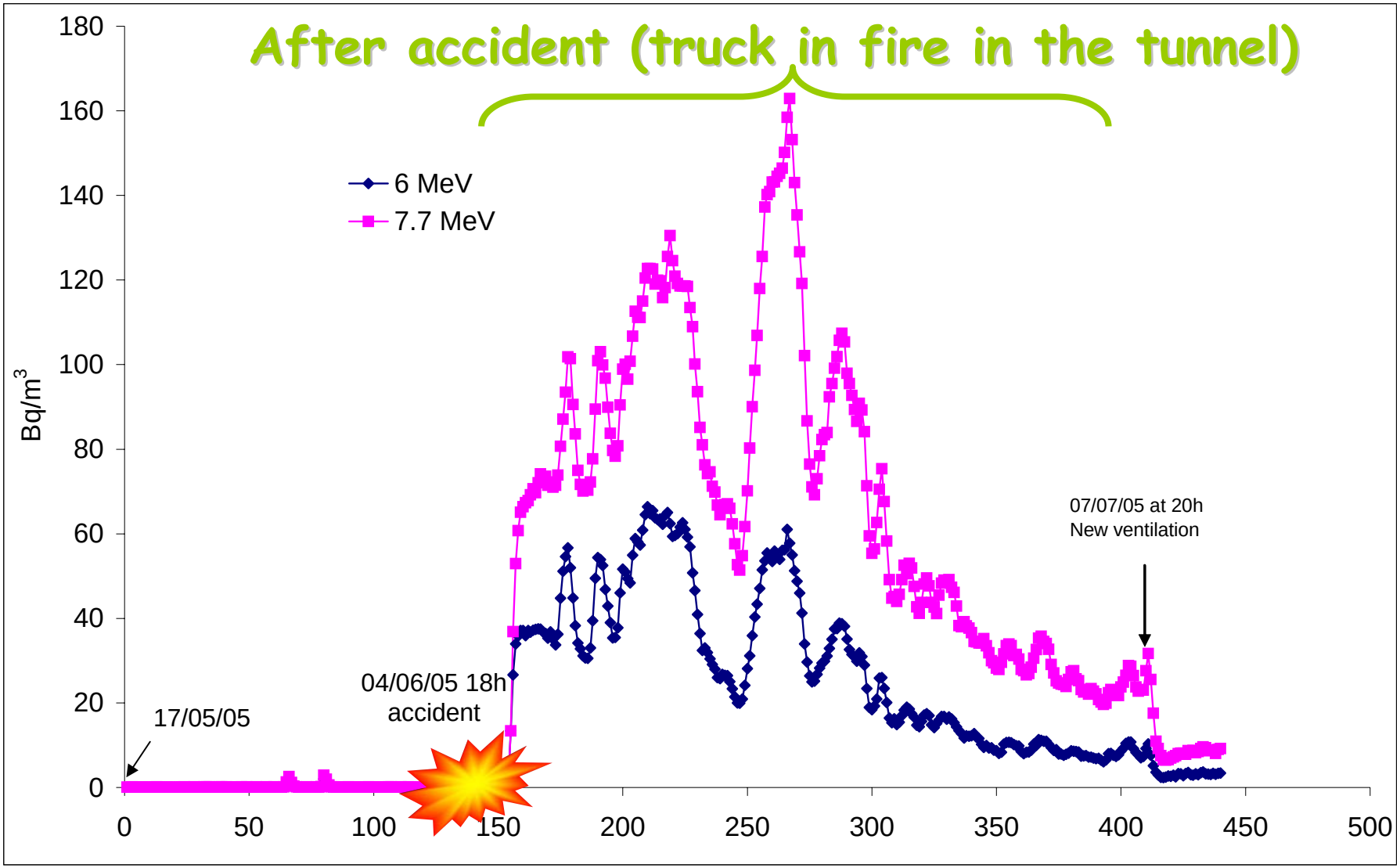
The decays of ^{218}Po, ^{214}Po, ^{210}Po (daughter of ^{222}Rn in the U-series), and ^{212}Po (daughter of ^{220}Rn in the Th-series) are distinguished by monoenergetic peaks in the energy spectrum. (7.7 MeV and 8.8 MeV)







Example of Rn monitoring in the NEMO tent



After the accident in the tunnel, ventilation and compressor went off