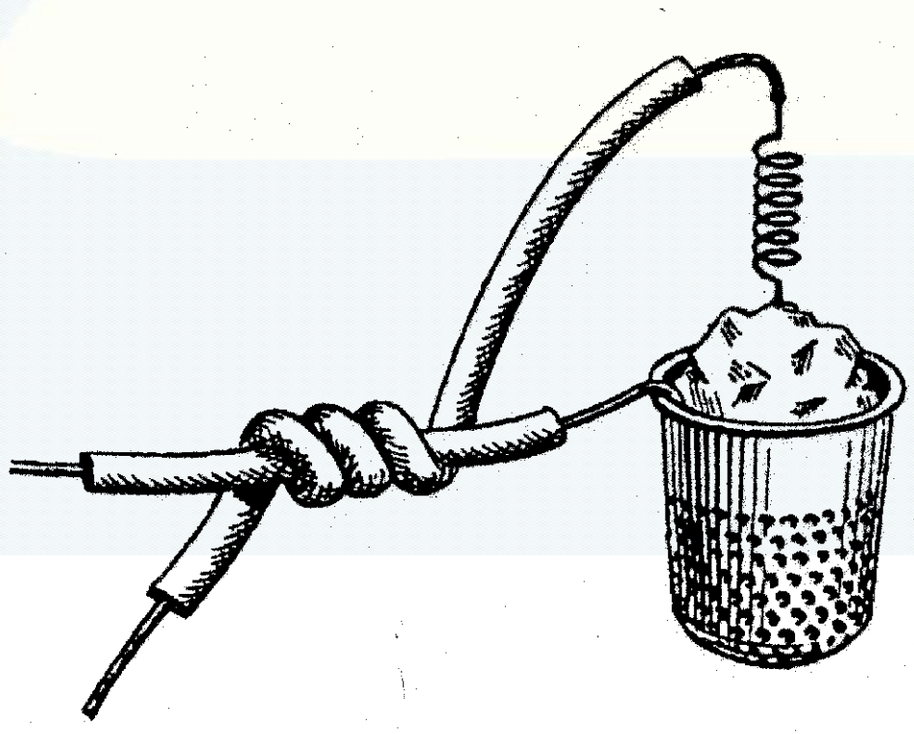
ELECTRONICS
Design Division

Measurement system for indoor climate



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Outline

- Introduction of task
- Properties of Radon
- Detection of ionised particles
- Measurement system for radon
- Measurement system for indoor climate
- Project task

Introduction, task

- The instrument should measure;
  - Temperature
  - Humidity
  - Radon (Alpha particles)
  - Carbon dioxide
  - TVOC (Total Volatile Organic Compounds, gases which has 6 to 16 carbon atoms)
- The platform is the mbed system.
- Interface electronics are built by the group members.
- Sensors are customized to the mbed system

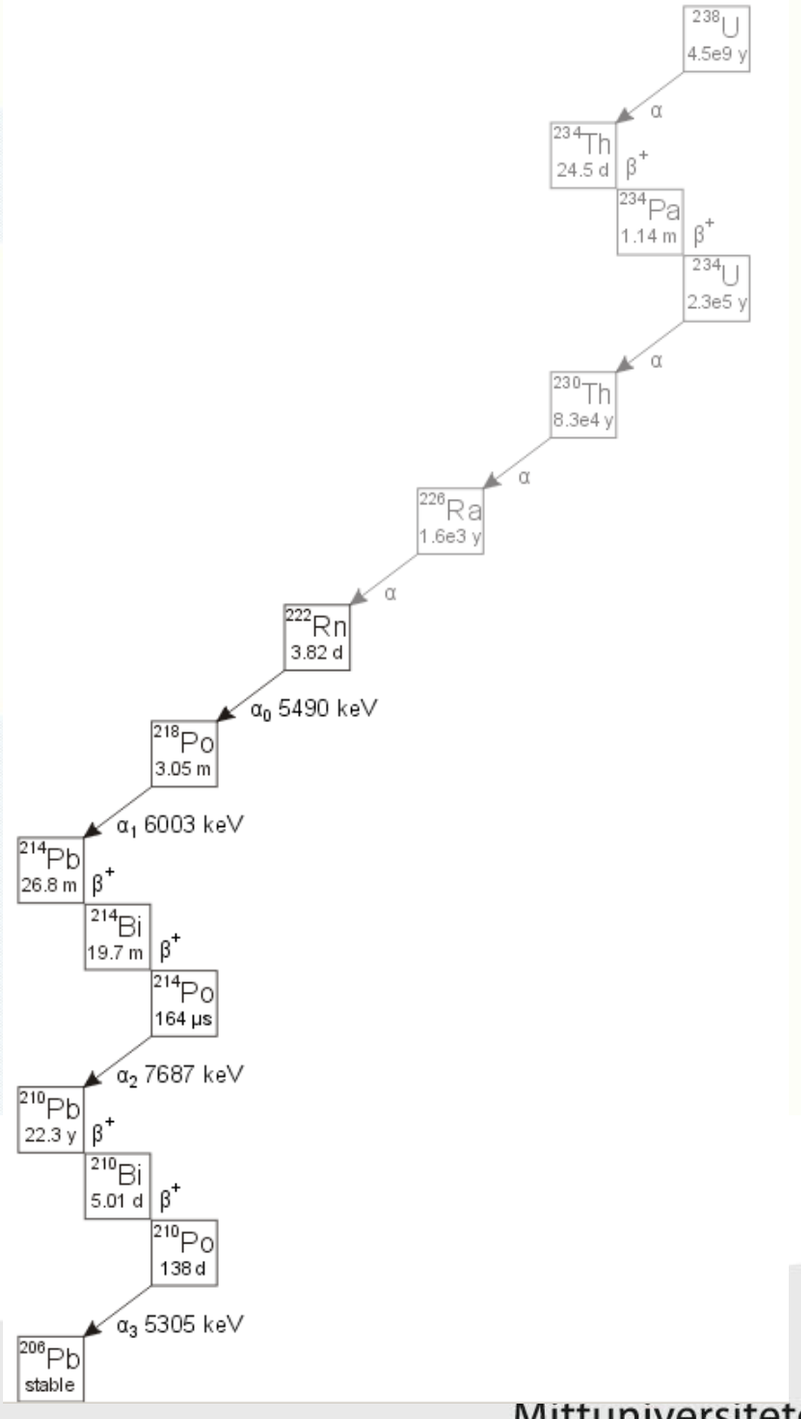
Properties of Radon

- Radon is a gaseous isotope (^{222}Rn) with a half-life of ~4 days
- Its relative long decay time makes it possible to be released from the ground and contaminate the air in houses.
- Radon can also be released from building material, i.e. blue light concrete or gas concrete made of alum shale
- Inhaled Radon in lungs decomposes into ^{218}Po and ^{214}Po, which decay products, can cause lung-cancer. It is especially dangerous for smoker since radioactive particles can be stuck to particles in the smoke.
- Highest allowed concentration of Radon in buildings is 200 Bq/m^3 (Sweden). WHO have suggested a decreased value to 100 Bq/m^3 from the international standard of 1000 Bq/m^3

Bq= one decay/s

Properties of Radon

^{222}Rn (not charged)	⟶	5.49 MeV
^{218}Po (charged)	⟶	6.003MeV
^{214}Po (charged)	⟶	7.686MeV



Properties of Radon

Bq/m^3	Occurrence example
1	Radon concentration at the shores of large oceans is typically 1 Bq/m^3. Radon trace concentration above oceans or in Antarctica can be lower than 0.1 Bq/m^3.
10	Mean continental concentration in the open air : 10 to 30 Bq/m^3. Based on a series of surveys, the global mean indoor radon concentration is estimated to be 39 Bq/m^3.
100	Typical indoor domestic exposure. Most countries have adopted a radon concentration of 200–400 Bq/m^3 for indoor air as an Action or Reference Level. If testing shows levels less than 4 picocuries radon per liter of air (160 Bq/m^3), then no action is necessary. A cumulated exposure of 230 Bq/m^3 of radon gas concentration during a period of 1 year corresponds to 1 WLM.
1,000	Very high radon concentrations (>1000 Bq/m^3) have been found in countries where houses are built on soils with a high uranium content and/or high permeability of the ground. For levels are 20 picocuries radon per liter of air (800 Bq/m^3) or higher, the home owner should consider some type of procedure to decrease indoor radon levels.
10,000	The "Working Level" in uranium mines corresponds to a 7000 Bq/m^3 concentration. The concentration in the air at the (unventilated) Gastein Healing Gallery averages 43 kBq/m^3 (about 1.2 nCi/L) with maximal value of 160 kBq/m^3 (about 4.3 nCi/L).[49]
100,000	About 100,000 Bq/m^3 (2.7 nCi/L) was found in Stanley Watras's basement.
1,000,000	Expositions reaching 1,000,000 Bq/m^3 can be found in unventilated uranium mines.

Correspond to 135 packs of cigarettes a day

Properties of Radon

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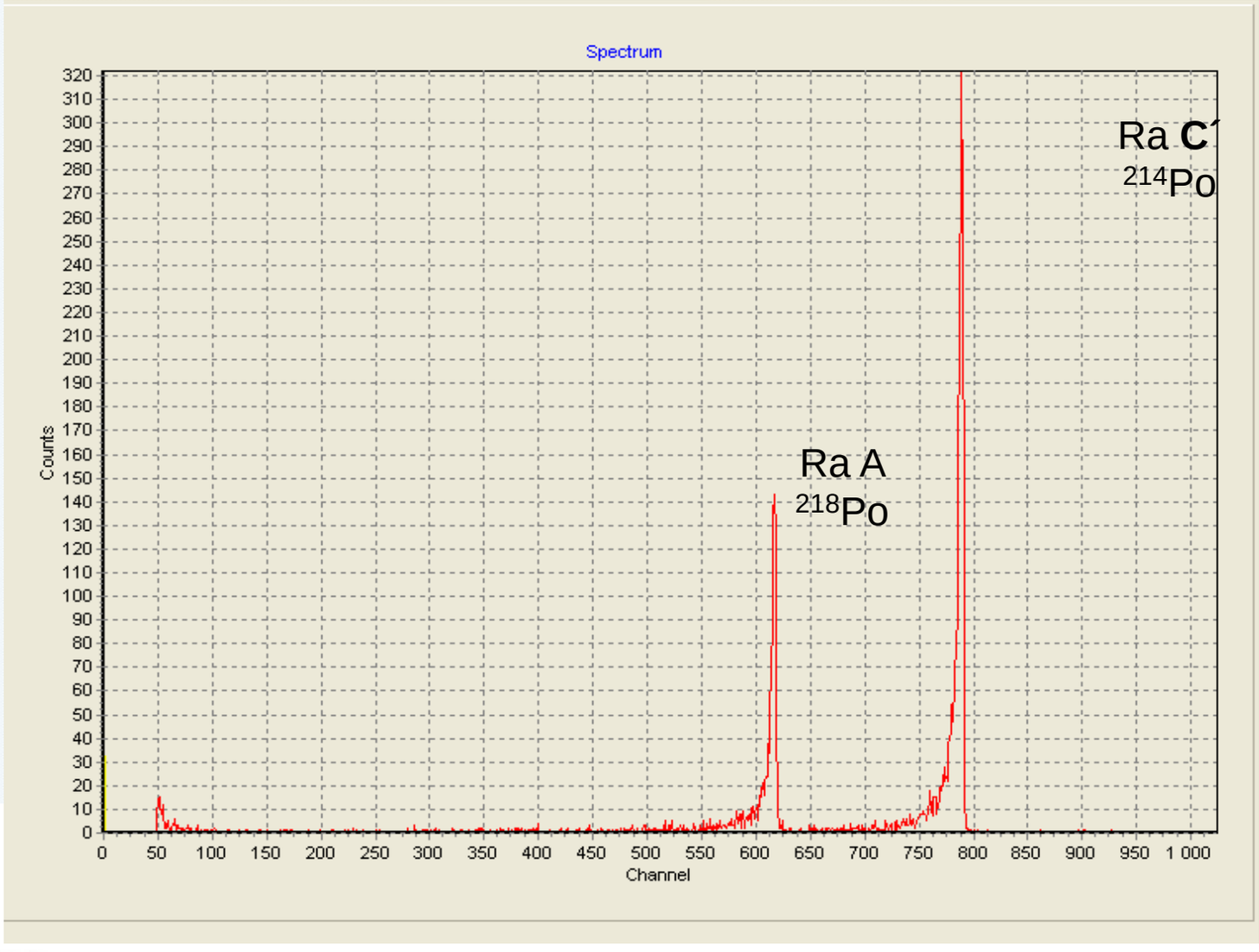
Properties of Radon



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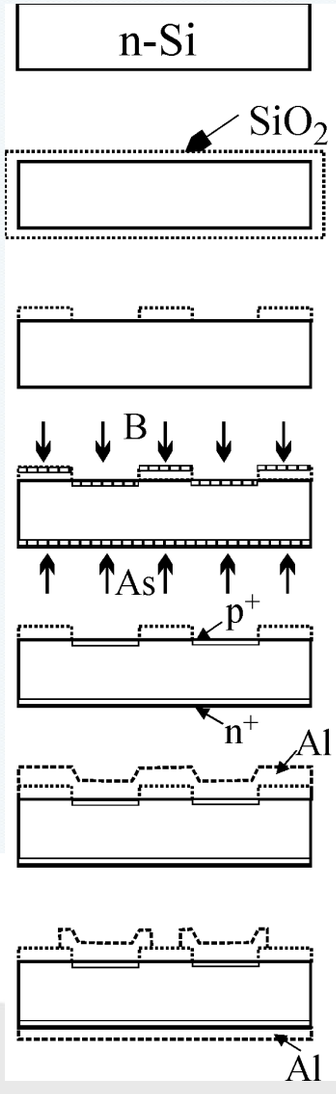
Detection of ionised particles



n-Si Wafer

Oxide passivation

Opening of windows

Doping by ion implantation
B 15 keV $5x10^{14}$ cm^{-2}
As 30 keV $5x10^{15}$ cm^{-2}

Annealing at $600^{o}C$, 30 min

Al metallisation

Al pattering at the front

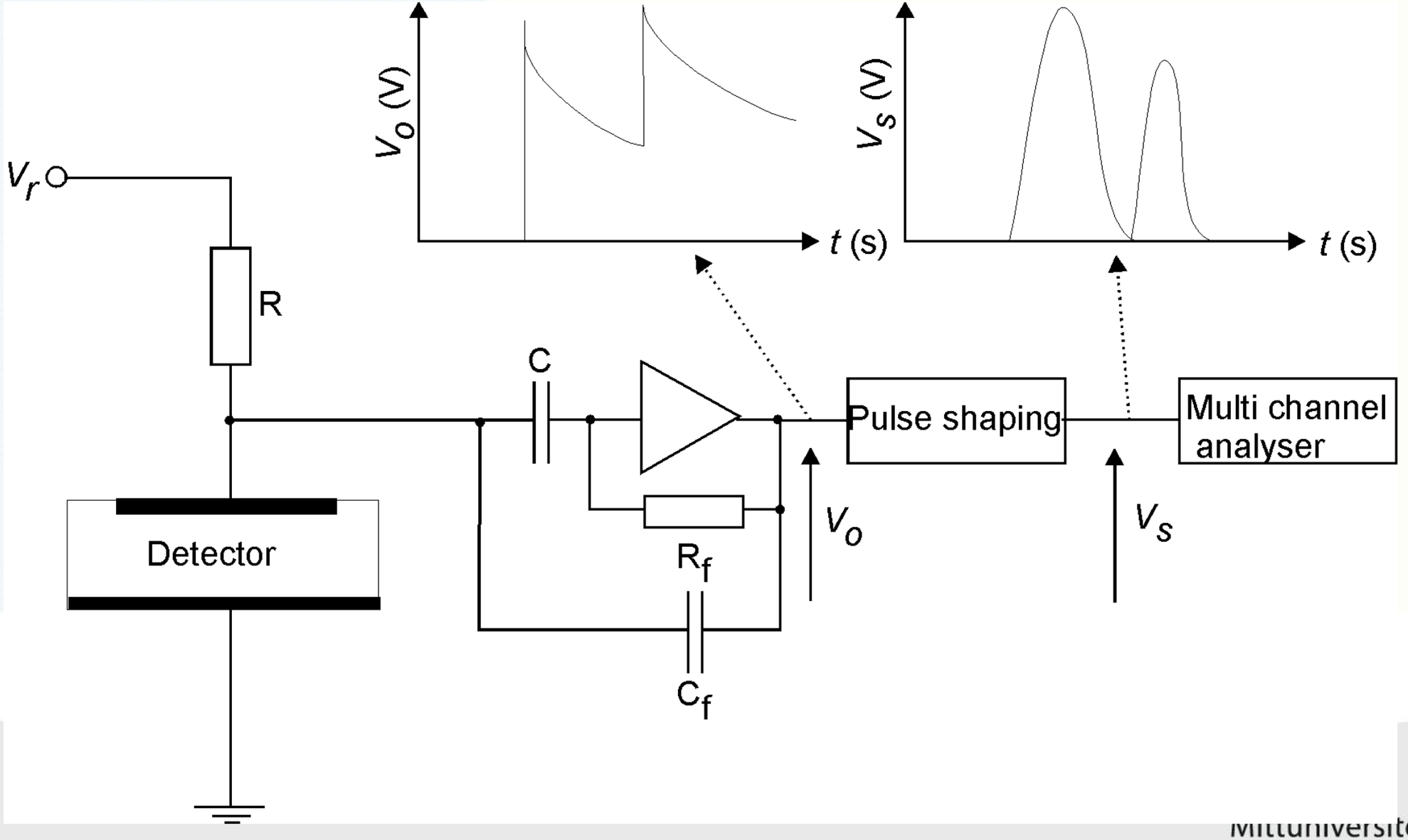
Al-rear contact

Planar processing of detectors

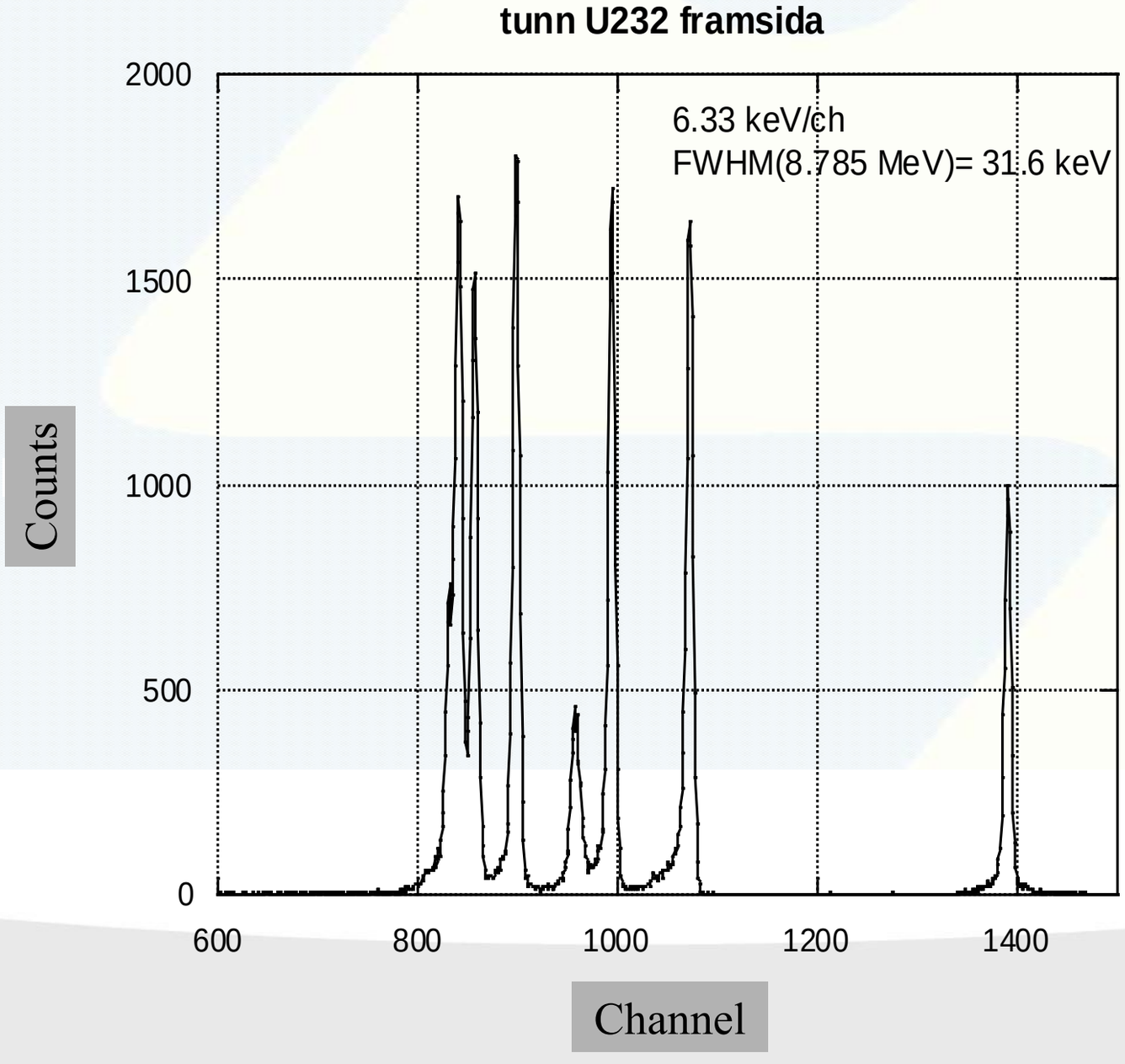
- Passivated, silicon planar diode detector
- Almost operated with reverse bias voltage, (except photodiodes normally operated with zero bias voltage)

•J. Kemmer, Nucl. Instr. and Meth. **226**, 45, (1984)

Detection of ionised particles



Detection of ionised particles



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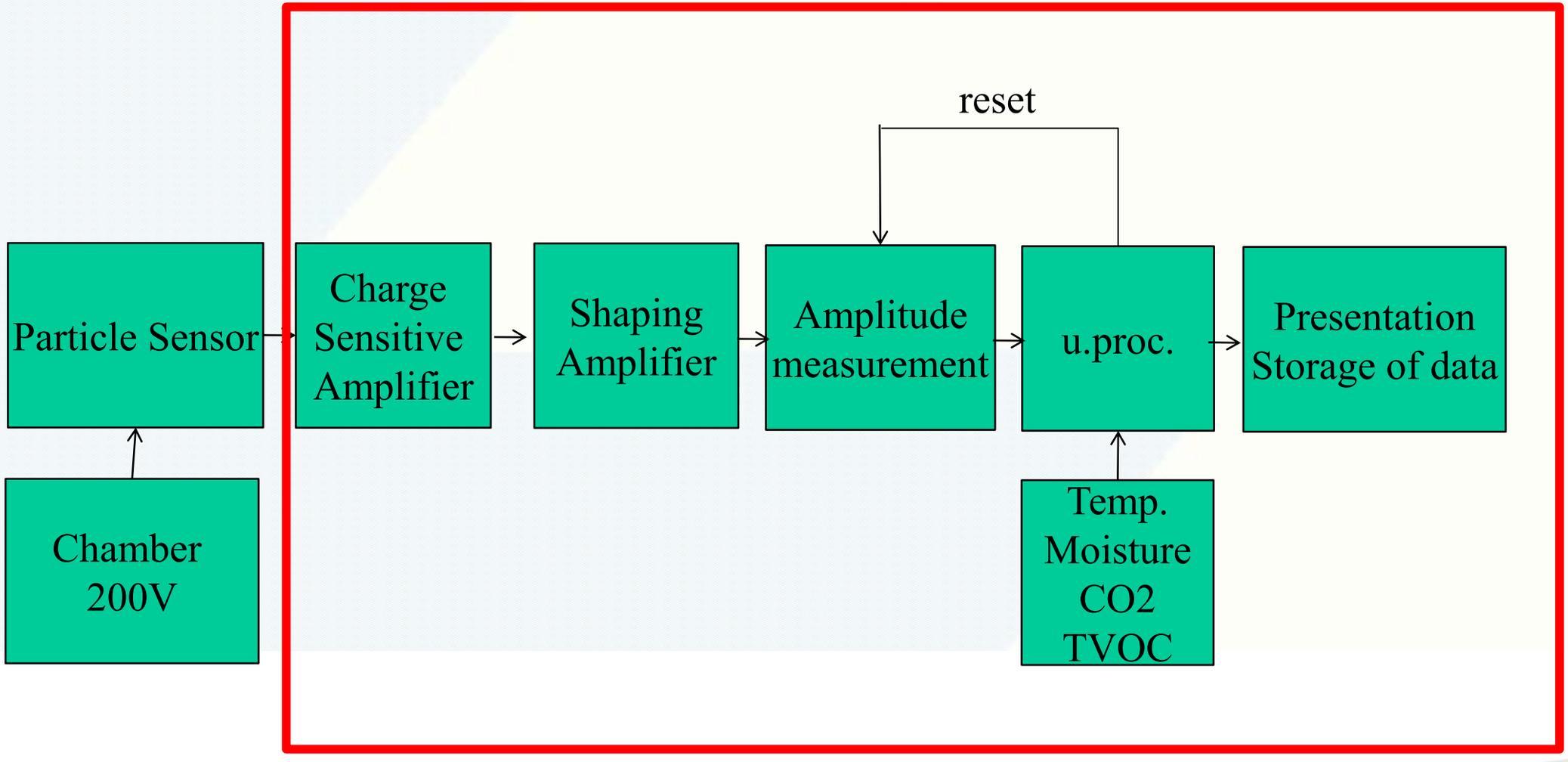
Measurement system for radon



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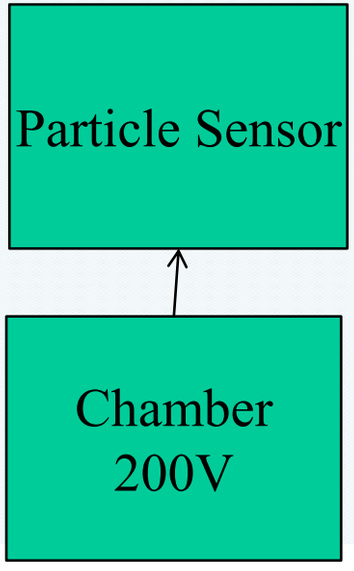
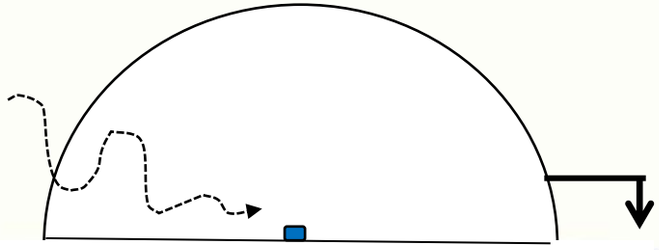
Measurement system for radon





Only radon is passing through the filter
Radon daughters are charged (positive), which attracted them to the negative potential of the detector

Measurement system for radon

Charge Sensitive Amplifier

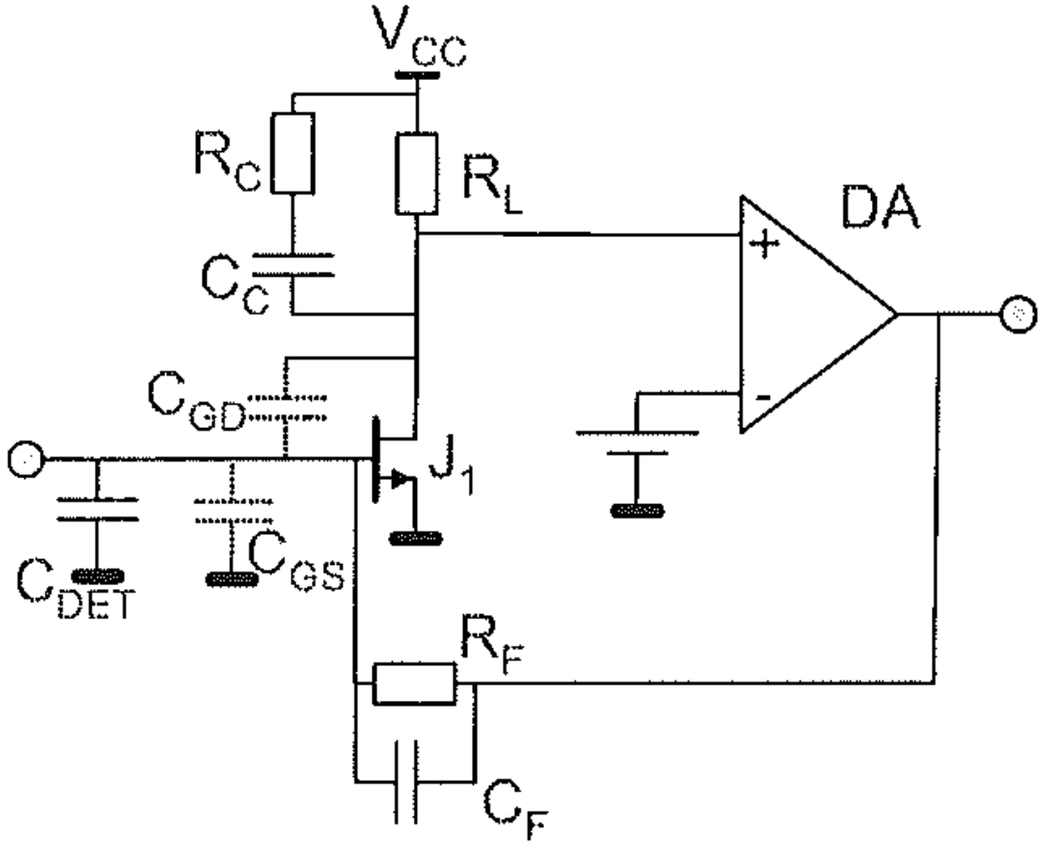
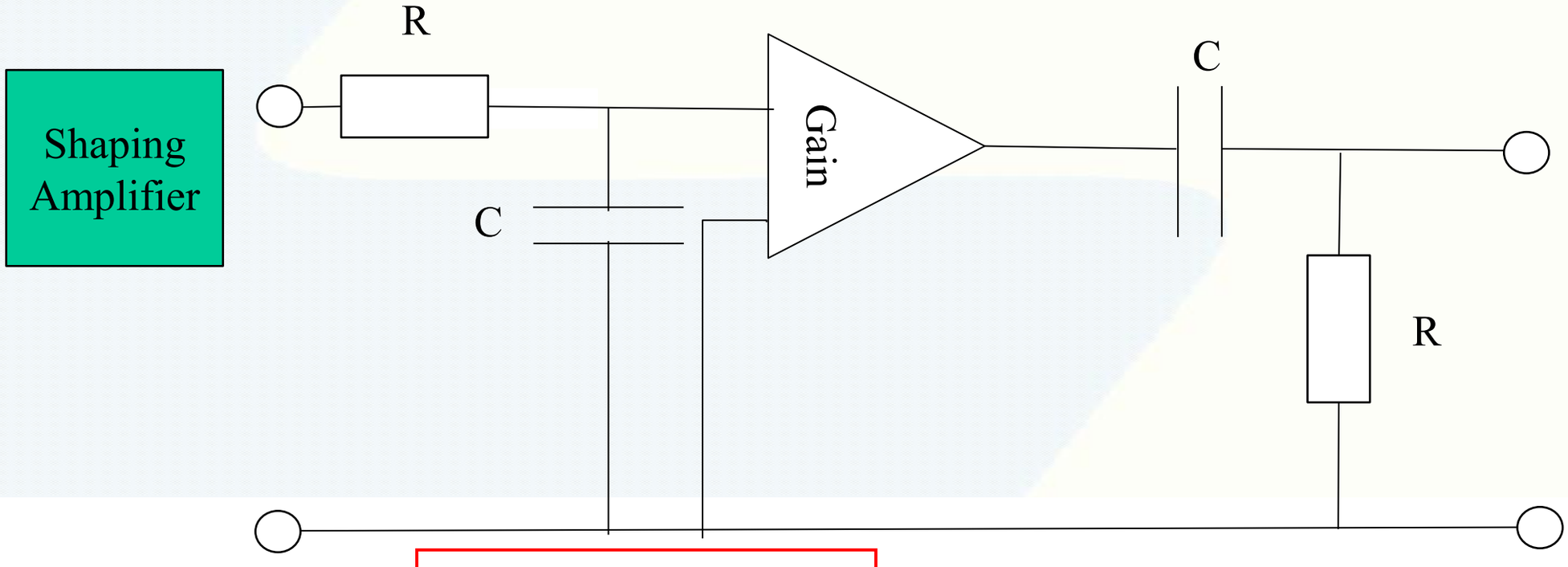


Fig. 2: Schematic diagram of the two stage CSP.

Measurement system for radon



More information in Article

Measurement system for radon

Amplitude measurement

- Fast AD converter
- Peak detector (A particle of 5 MeV should give a signal of 1V)
  - Reset function must be included, ”discharge the capacitor C2”
  - The reset is done by the u-proc.

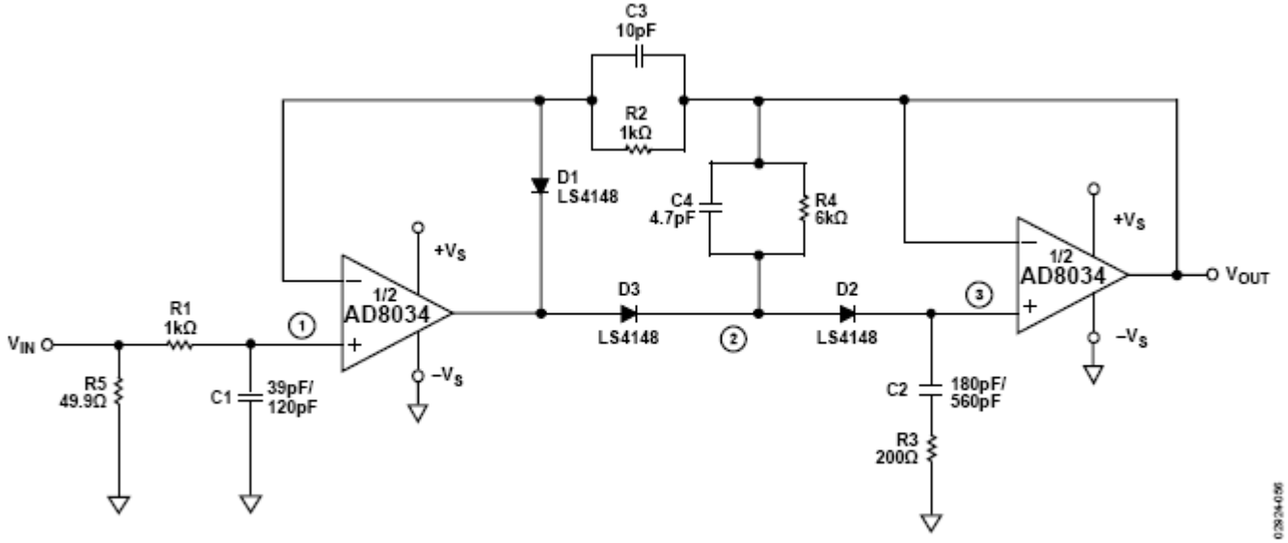


Figure 55. High Speed, Unity Gain Peak Detector Using AD8034

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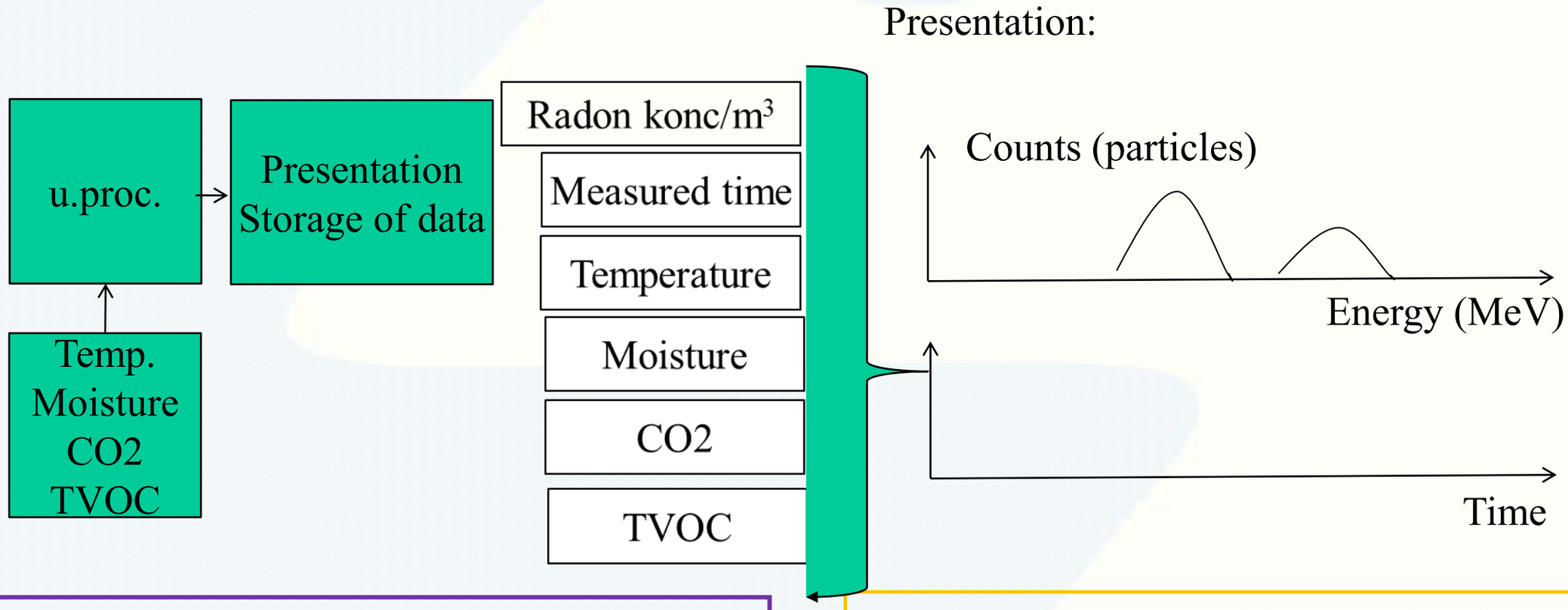
Measurement system for indoor climate



File should contain:
particle number, energy, time, temp, moisture, CO2, TVOC.

- The communication with PC is done by using USB or wireless interface
- The program language used is optional

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Project task

- 4? groups, regular meeting, one/ week
  - Documented meetings, what to do, what have been done, progress
  - All members should have a defined task to be responsible for.
  - Simulation of peak detector
  - Group report regarding PC-program, and testing/reporting of full operated prototype.
  - Demonstration and oral presentation of the project

Project task (4-5 members/group)

1. Temp and moisture sensor
   - Connection of sensor to digital input
   - Programming to read temp and moisture from sensor

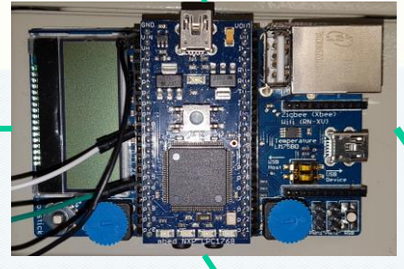
   CO2 and TVOC
   - Connection of sensor to digital input
   - Programming to read data
   - Verification of measurements
2. Calculation and presentation of data from mbed system to PC
   - Calculation of radon content based on pulses/ time unit
   - Presentation of data on LCD-display (mbed)
   - Logging and presentation of data on PC as fkn of time
3. Construction and building of peak detector (amplitude measurement) with reset fkn for detection of radon, charge sensitive amplifier and shaping amplifier.

Project task

Radon

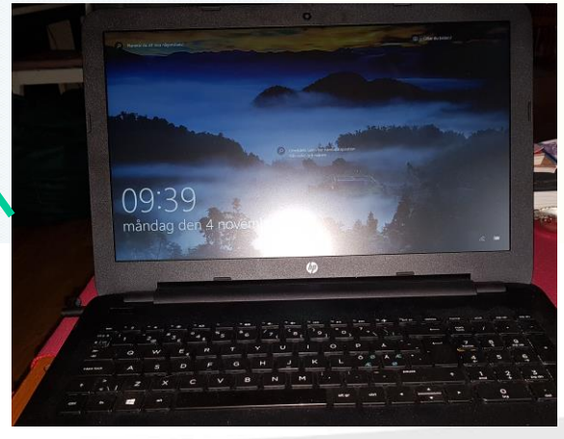
Interface

mbed



T/H

PC



CO2
TVOC

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Measurement system for indoor climate

http://apachepersonal.miun.se/~gorthu/ASS/