Track Etch Detectors (TED)

Main features:
passive, integrating detectors of charged particles (A,Z ≥ 1),
insensitive to X-rays, gamma, electrons

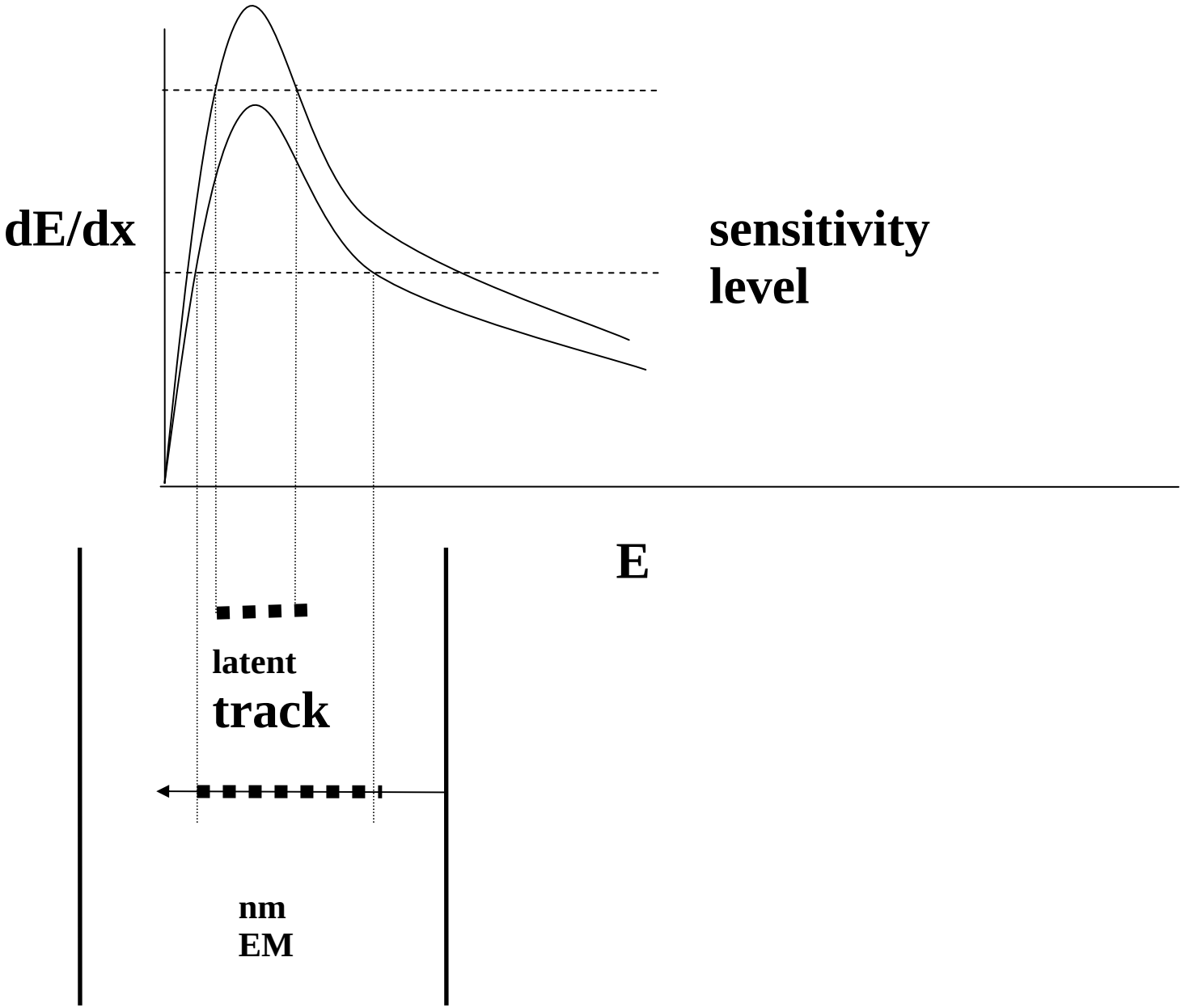
Principle:

1) radiation induced damage in dielectrics
2) magnification => visualisation = track formation
3) evaluation = track counting, analysing =>

=> information about particles, exposure,

detector characteristics ...

1) radiation induced damage



untreated detector

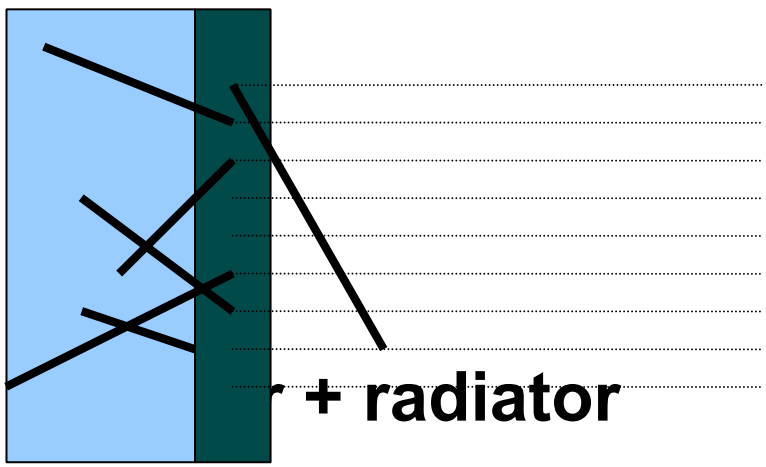
Detecting materials:	**Detected particles:**
inorganics	
glass, mica, minerals	heavy ions, fission fragments
organics	
polymers (PADC, CN, PC, ...)	protons, D, T, α, light ions, ...

Indirectly detected particles

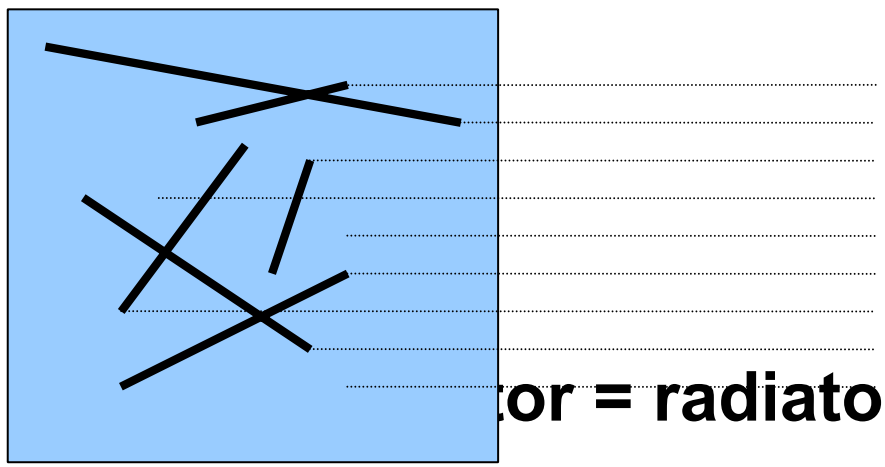
neutrons, relativistic ions

via transformation in radiators

Radiators:	Reaction:
polyethylene	(n,n), (n,n') - recoil protons, C
Li, B_{nat}, B_{enr}	(n,α)
U, Th, Bi	(n,f)
detector itself	(n,p), scattered recoils of C,
N, O	



r + radiator



tor = radiator

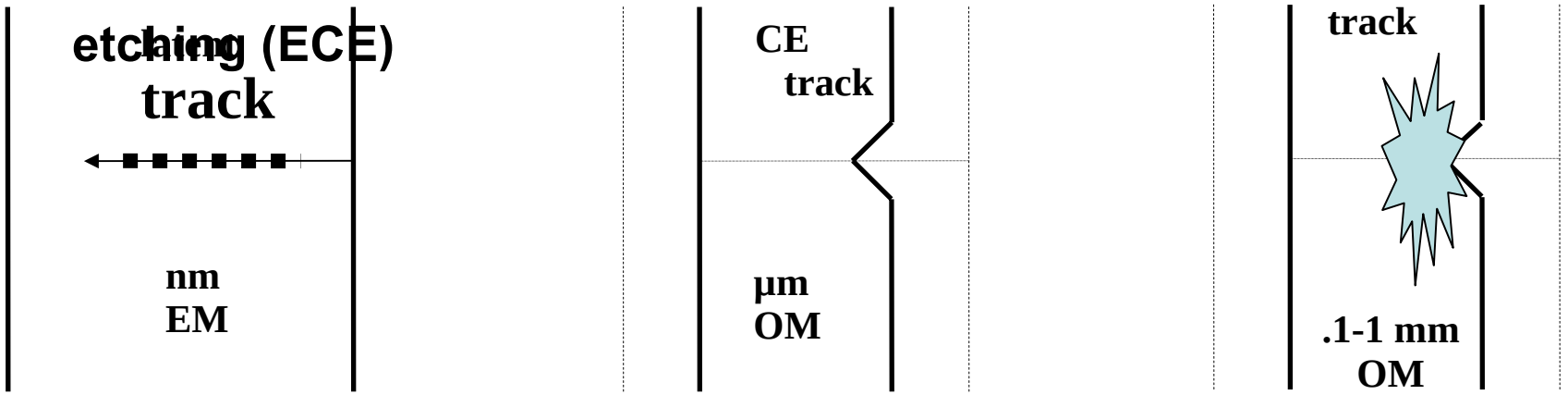
2) magnification => visualisation

processing

chemical etching (CE)

electrochemical

etching (ECE)

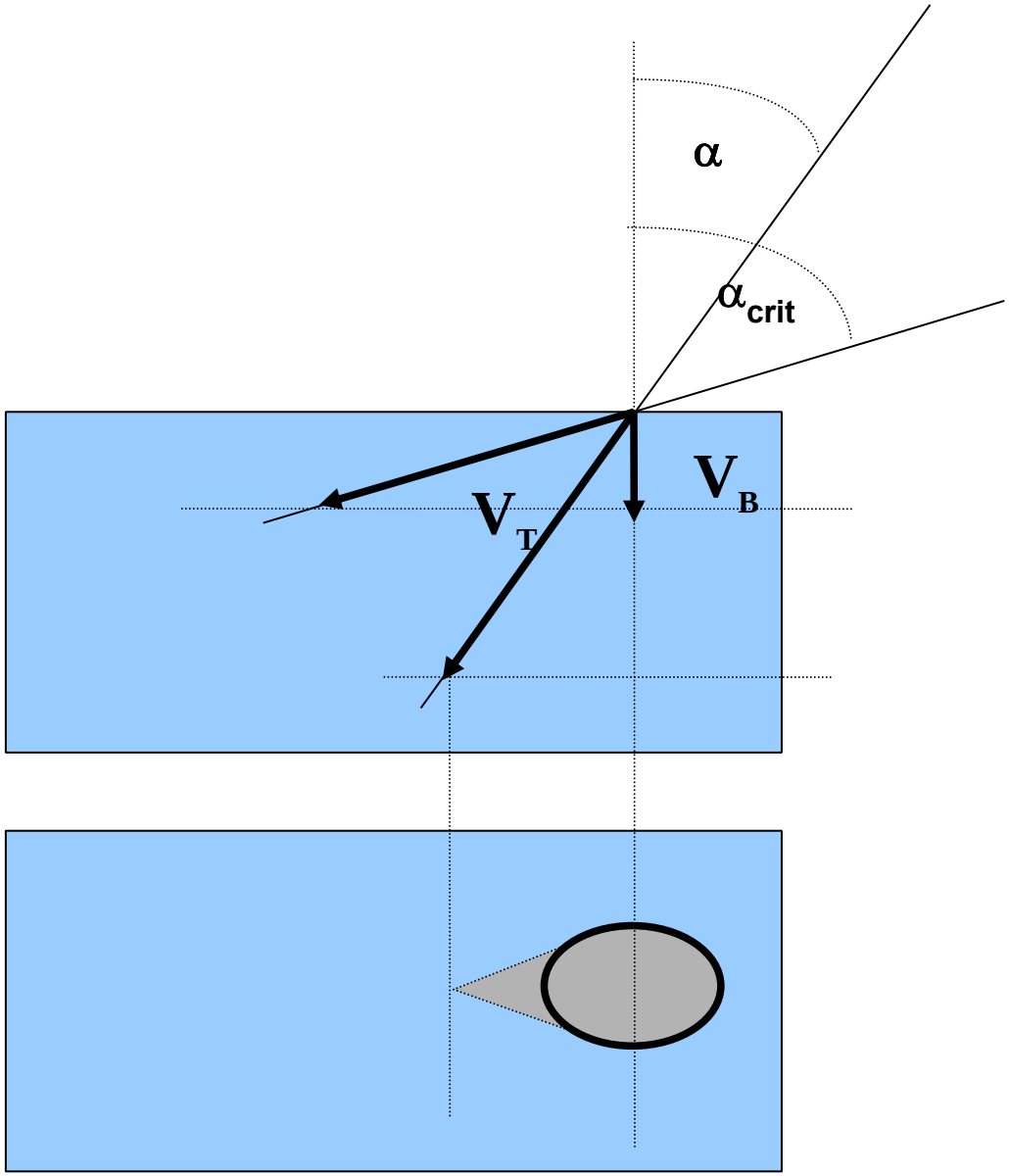


etching in caustic solutions

dtto

(NaOH, KOH in water)

+ HV/HF



$$V_T/V_B > 1,\ \alpha < \alpha_{crit}$$

$$V_B = V_T * \cos\alpha_{crit}$$

Pretahnout obrazek No.2 z lonske prezentace
ECE detektor, detaily ECE a CE stop

? foto of ECE-device ?

3) evaluation

CE tracks

track density **- visual counting (optical microscope, 200 - 500x), JSC, image analysers**

track analysis **- visually (particular tasks), image analysers**

ECE tracks

track density **- visual counting (projective microscope, 100 - 200x, microfiche reader), image analysers**

Applications:

- study of nuclear reactions
- nuclear filters production
- dating (minerals, meteorites)
- neutron dosimetry
- cosmic rays studies
- radon measurements
- autoradiography
- plasma physics

...

Previous and recent studies

a. Study of optimal detector treatment (PADC, partially PC, CN, glass) and characteristics (PADC, energy dependence of neutron registration)

b. Determination of critical angle and angular dependence of registration efficiency for various particles in PADC

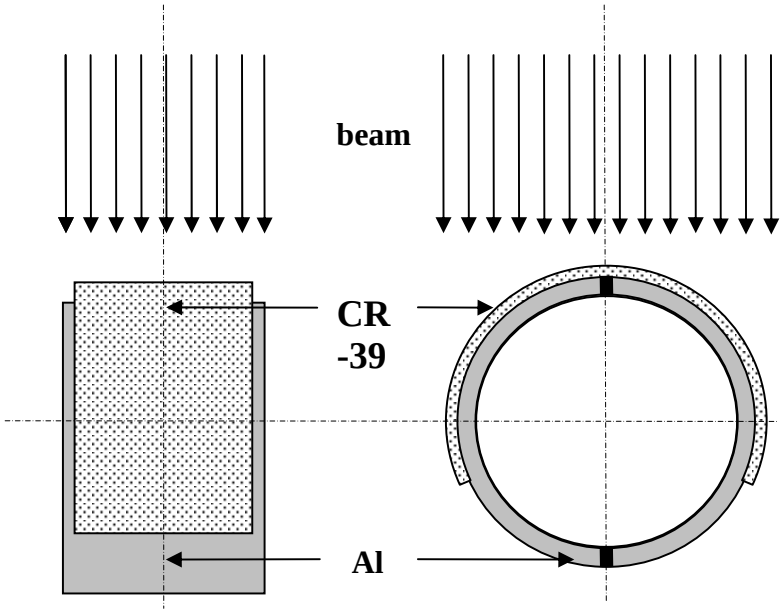
c. Measurement of LET spectra around nuclear facilities and at high altitudes (mountains, planes, spacecrafts)

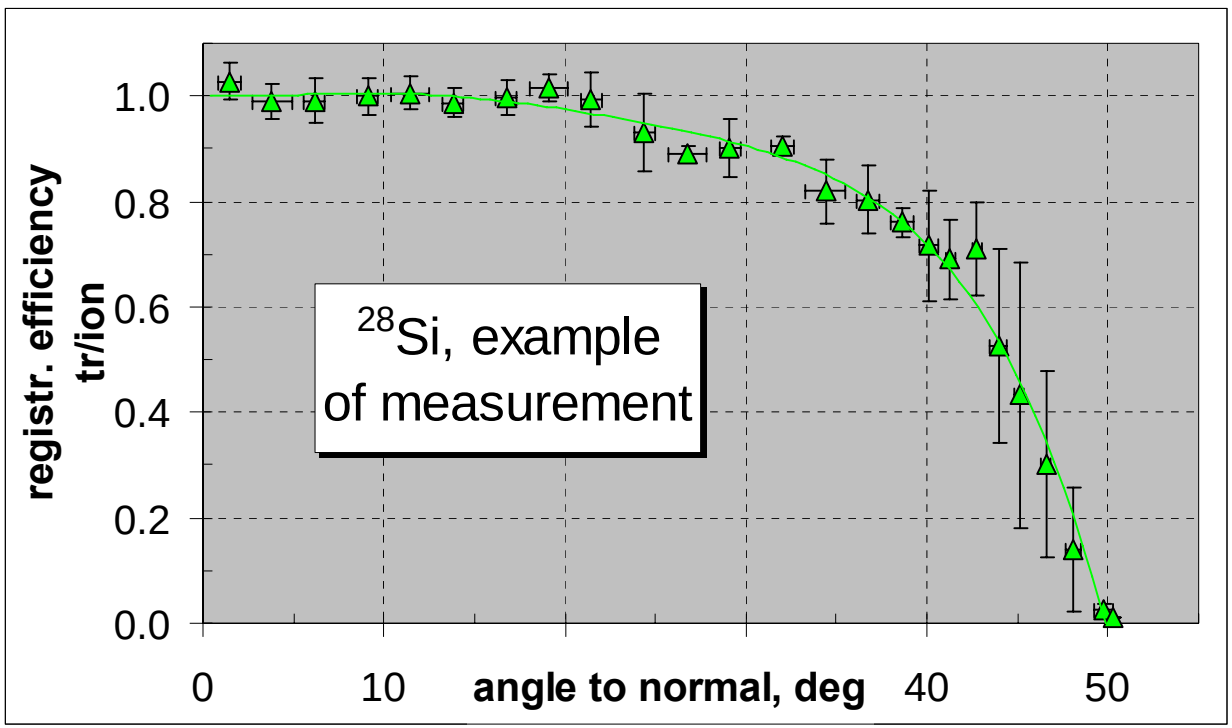
d. Measurement of neutron dose induced by cosmic rays at different altitudes. Collaboration NPI/INRNE

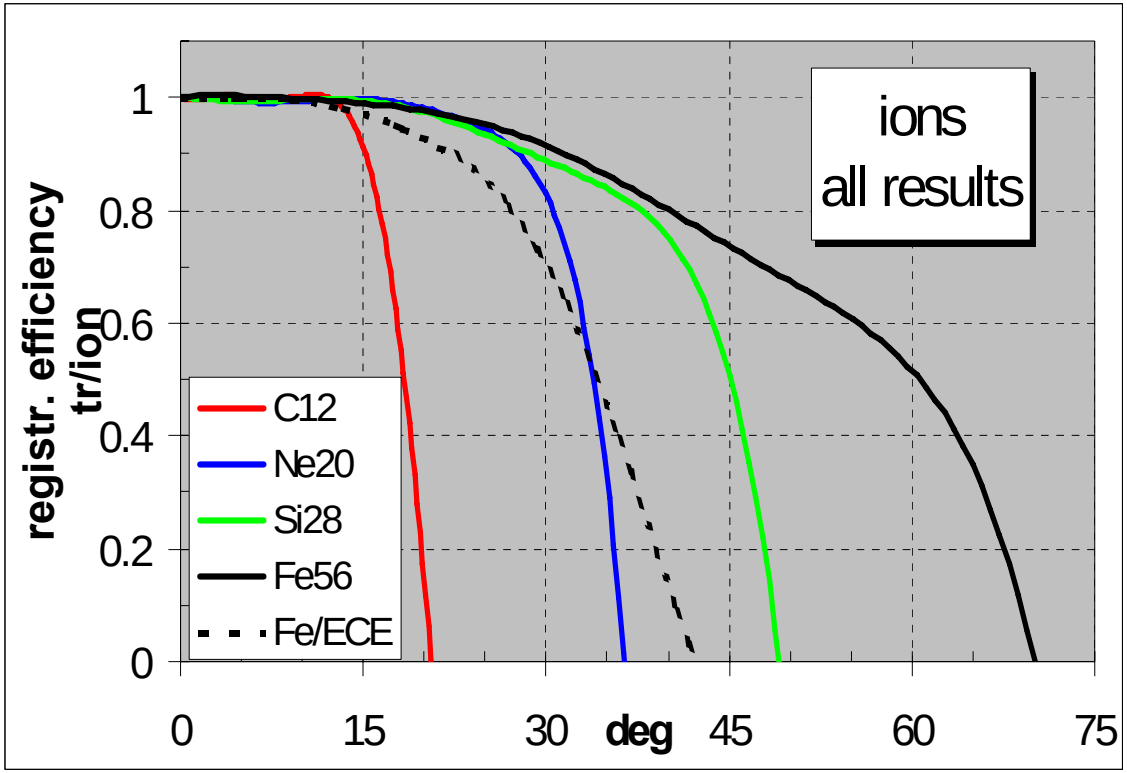
e. Measurement of neutron dose around high-energy X-ray radiotherapy machines

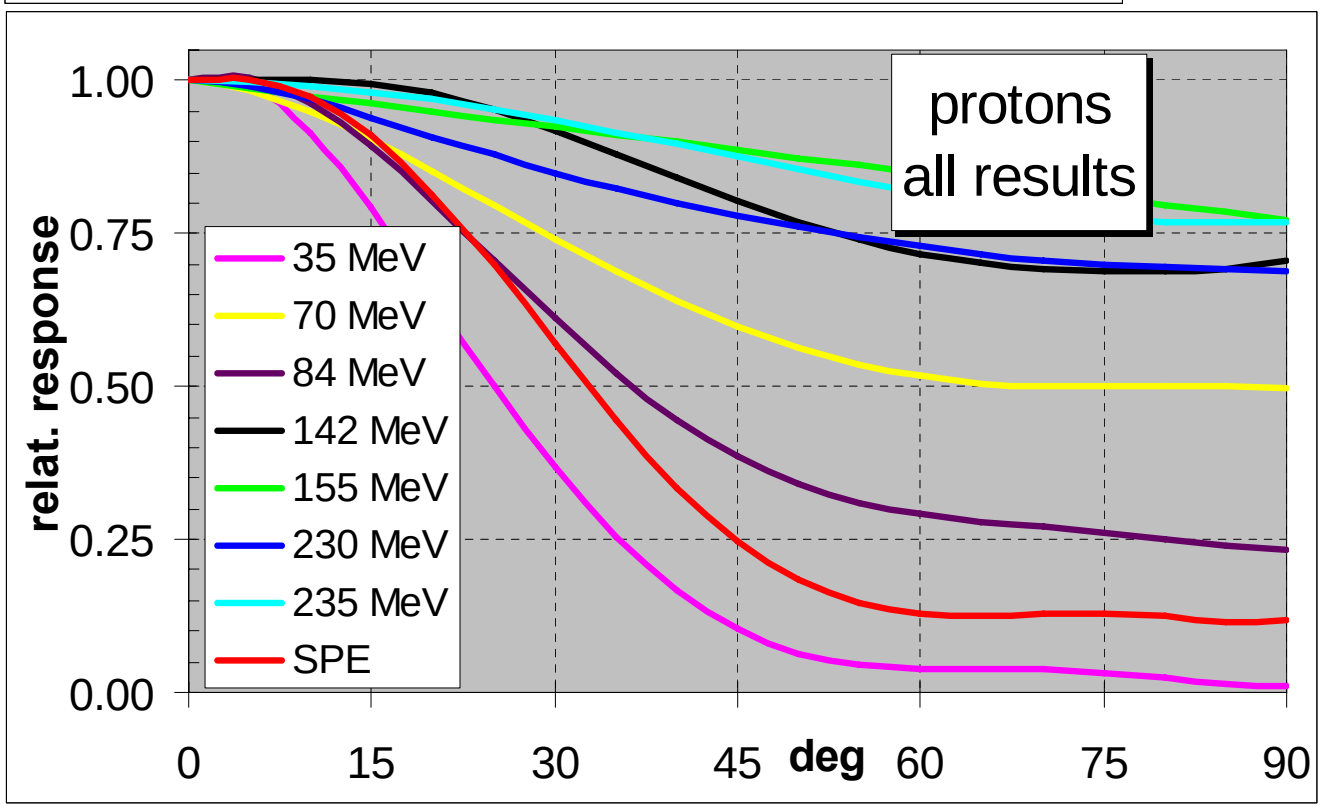
f. Soil gas radon concentration measurements. Collaboration NPI/INRNE

b. Determination of critical angle and angular dependence of registration efficiency for various particles in PADC









Ions, directly detected

^{12}C, E = 400

MeV/nucleon

^{20}Ne, E = 400

MeV/nucleon

^{28}Si, E = 490

MeV/nucleon

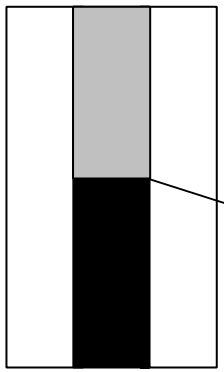
^{56}Fe, E = 500

MeV/nucleon

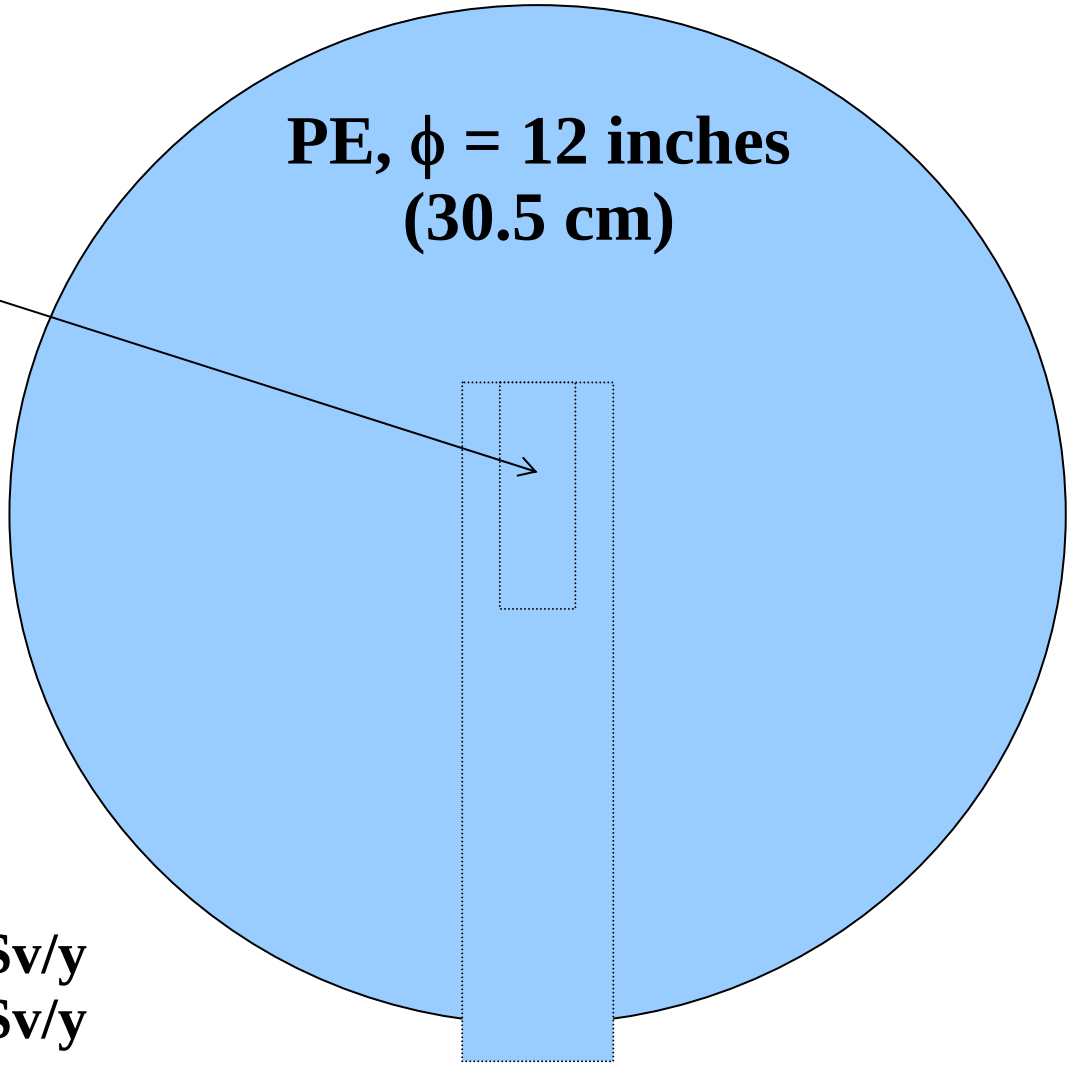
Protons (E_p > 30 MeV)

indirectly detected

d. Neutron dose induced by cosmic rays at different altitudes



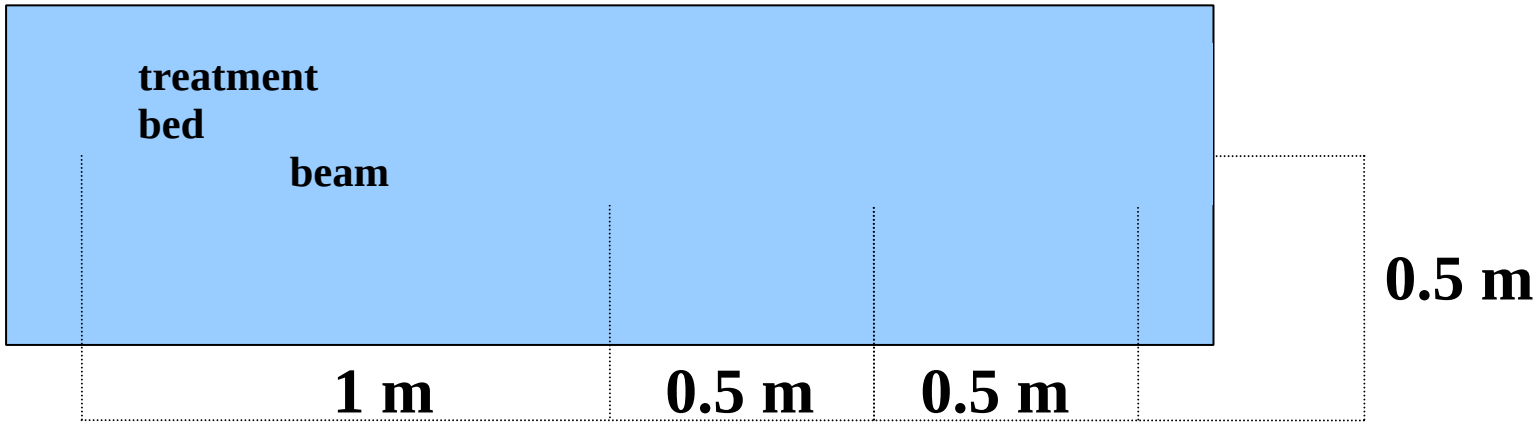
det+B_{enr}+det
<= (n,α) =>



Prague, 300 m: **~ 50 uSv/y**
Klet, 1070 m: **~ 70 uSv/y**
Lomn.St., 2630 m: **~ 300 uSv/y**
Musala, 2925 m: **~ 300 uSv/y**

e. Measurement of neutron dose around high-energy X-ray radiotherapy machines

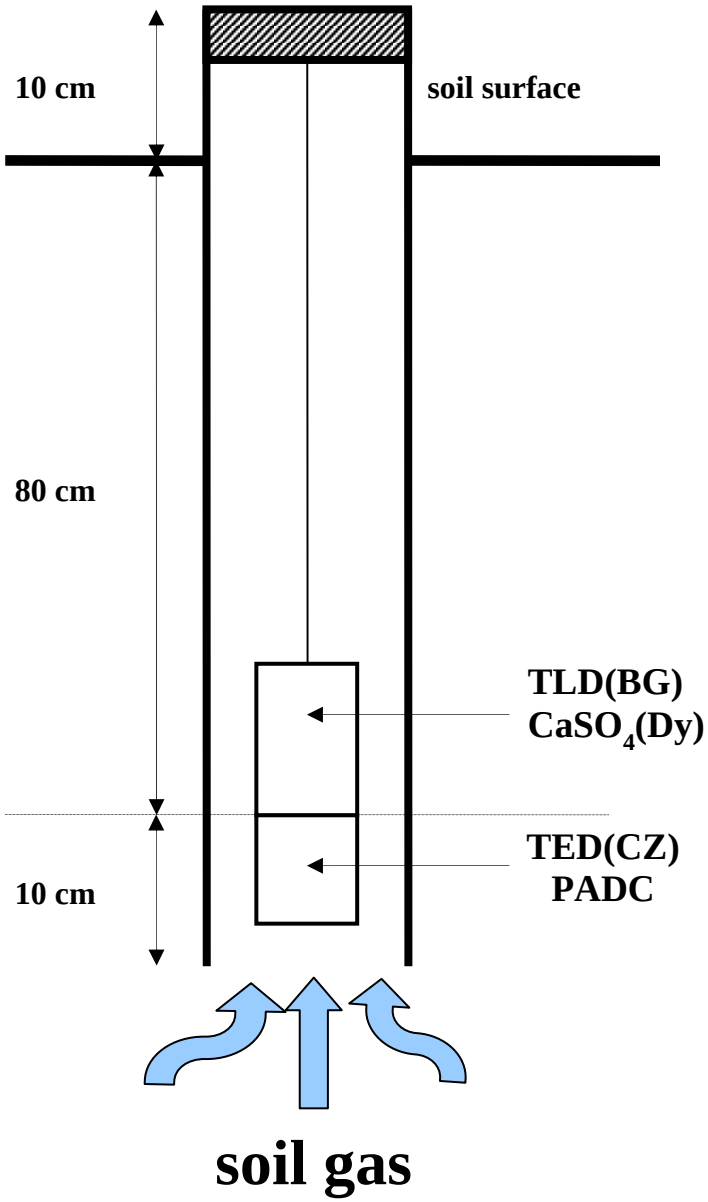
E_e > 10 MeV, (e,e'n), (γ,n)
Varian Clinac 2100C (15 MeV), 13 Bonner spheres, ϕ = 2, 2.5, 3, 3.5, 4, 4.5,
5, 6, 7, 8, 10, 12 and 15 inches, response matrix, deconvolution code, spectra unfolding

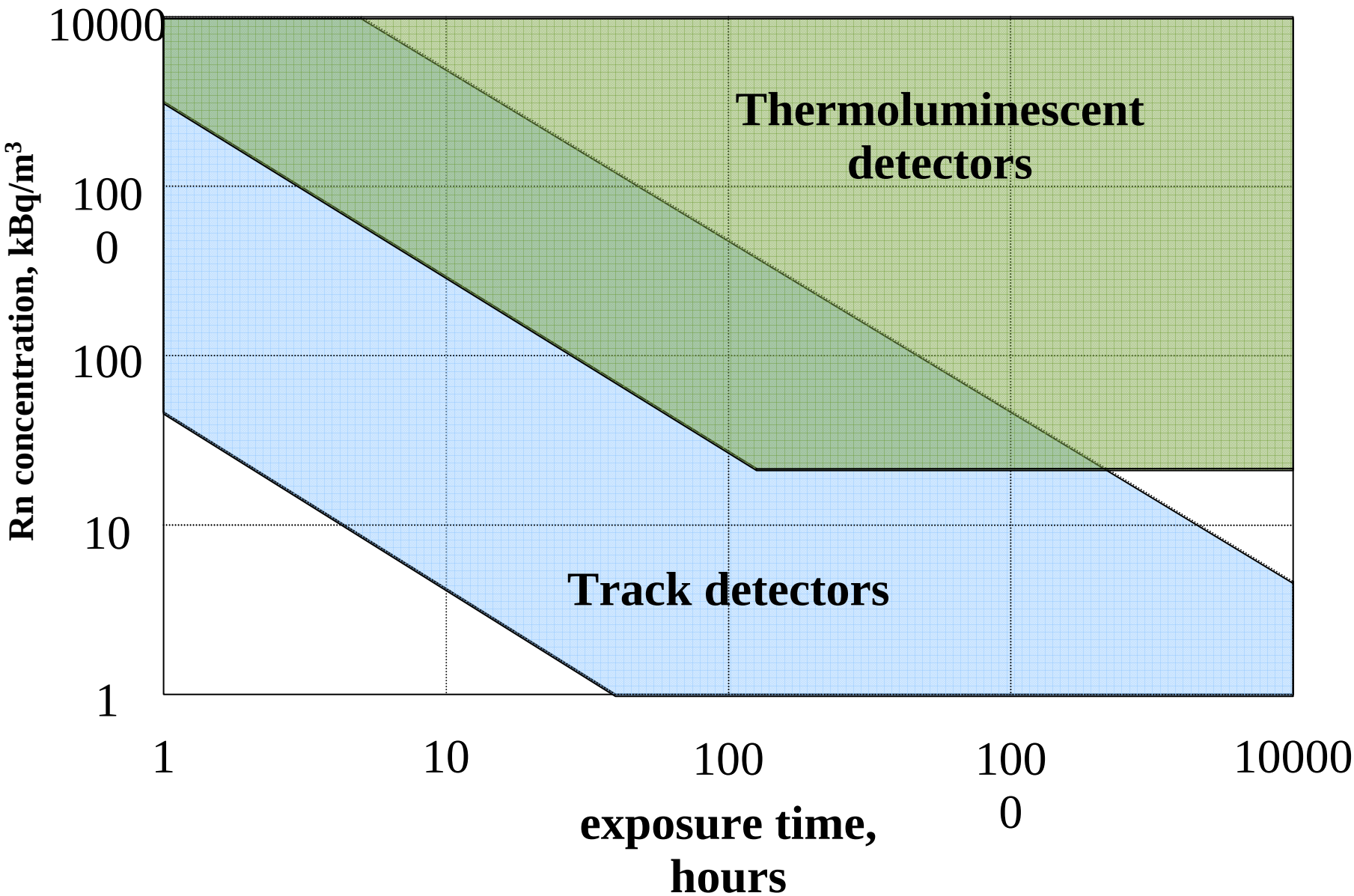


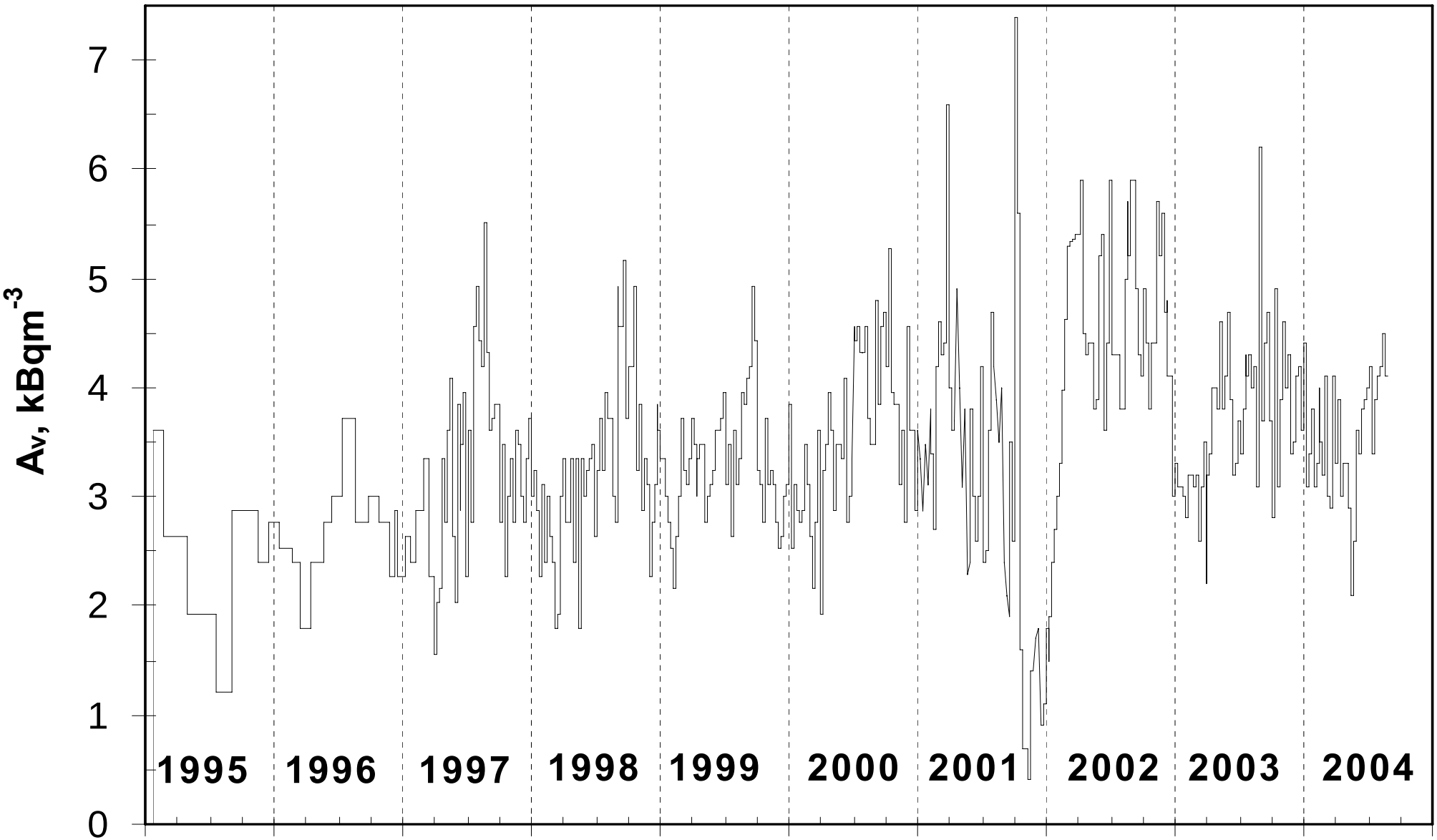
Position 1
2 **3**

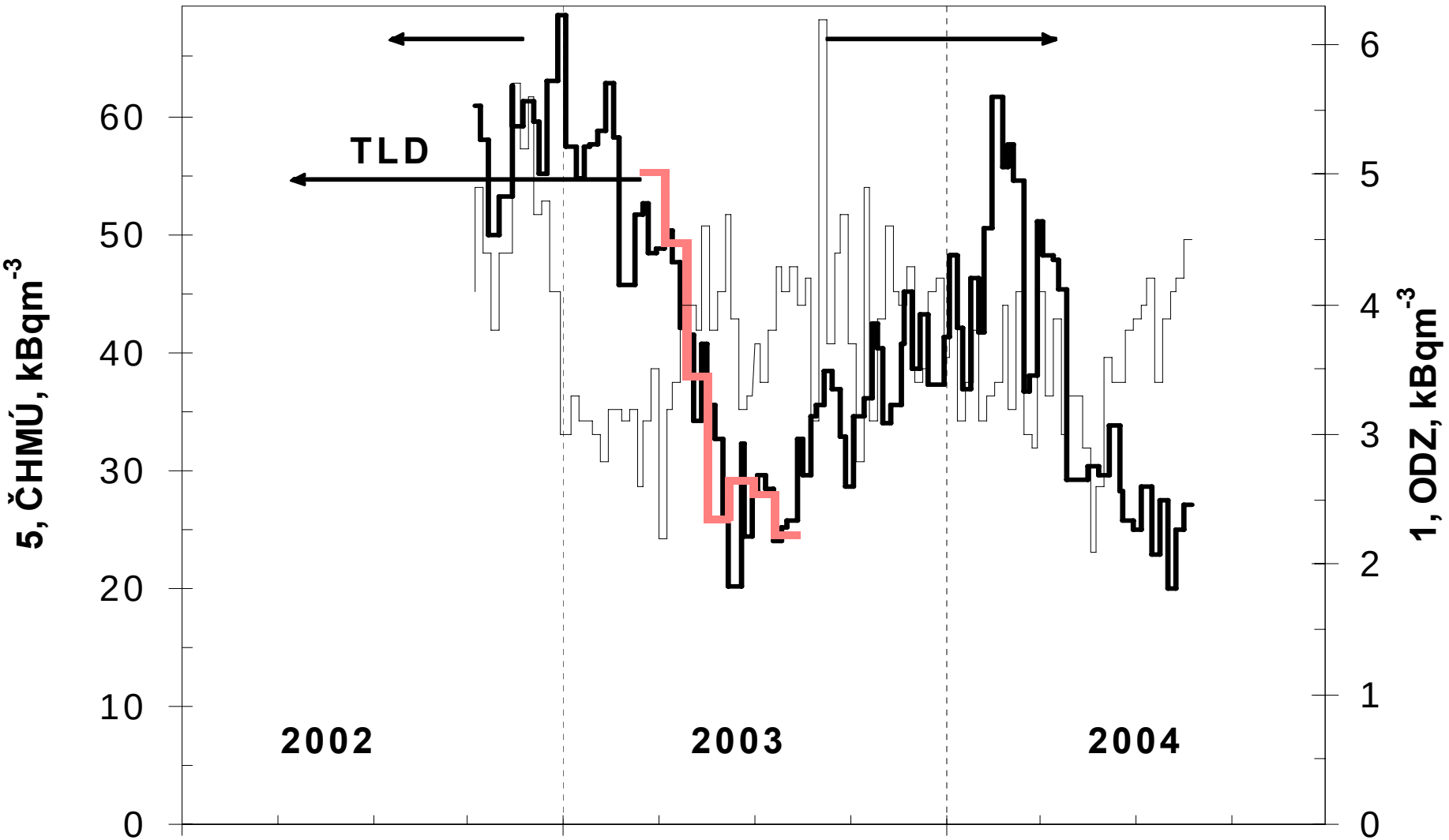
Position	H*(10)/D [uSv/Gy]	Total (at treatment dose ~40 Gy)
1	154.6	~ 0.62 mSv
2	214.2	~ 0.82 mSv
3	276.3	~ 1.11 mSv

f. Soil gas radon concentration measurements




10000
100
0
100
10
1
Rn concentration, kBq/m3
Thermoluminescent detectors
Track detectors
1
10
100
100
0
10000
exposure time, hours


A_v, kBqm^{-3}
0
1
2
3
4
5
6
7
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004


TLD
5, ČHMÚ, kBqm-3
1, ODZ, kBqm-3
0
10
20
30
40
50
60
0
1
2
3
4
5
6
2002
2003
2004

Nearest tasks:

- ECE-device in operational use in INRNE
- Development of SW treatment of direct binary picture (digital camera, scanner) without microscope. Introducing into routine, NPI/INRNE.
- Continuation of field measurement (radon, cosmic rays) using TED and TLD, NPI/INRNE.