Recent RTD activities on gamma-ray spectrometry in STUK

NKS – GammaRay 2018 Seminar

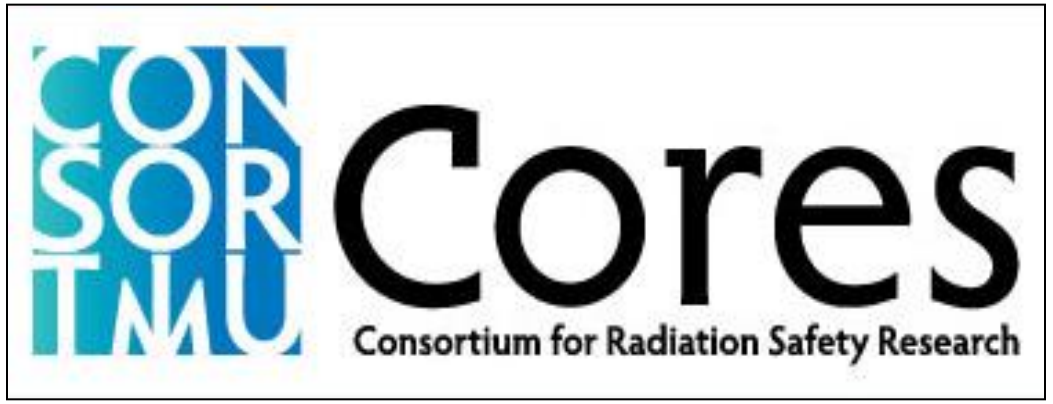
Iceland, Reykjavik 25-26.9.2018

Roy Pöllänen

1. Introduction

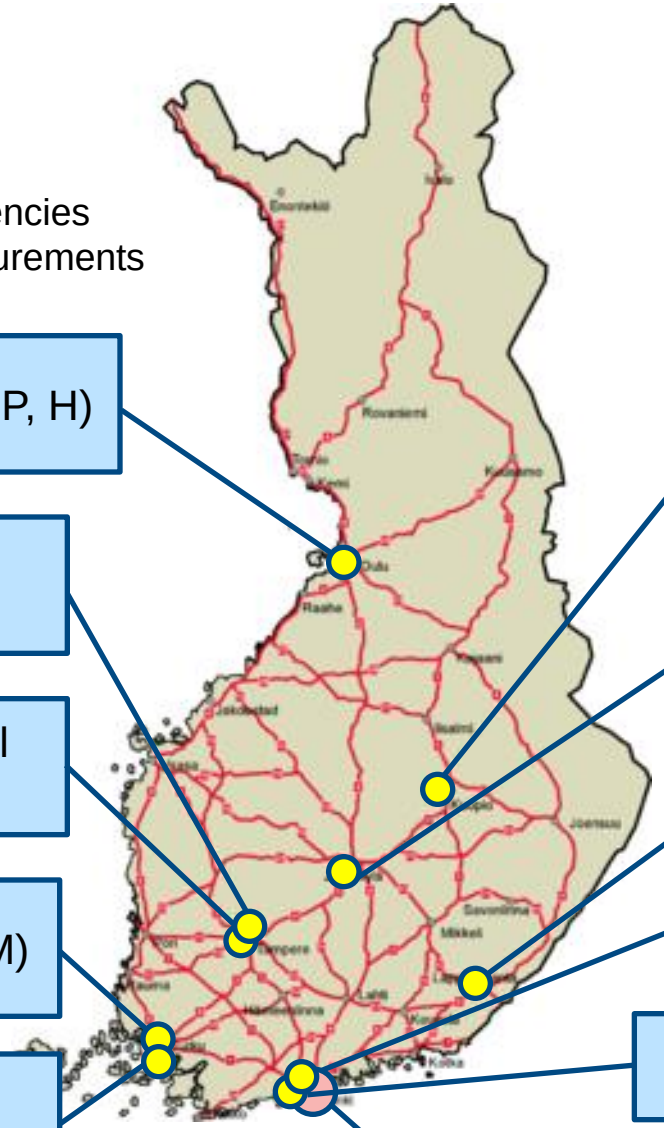
- Notable budget cut (initiated by the Finnish government) mainly in 2015 led to considerable decrease of RTD activities.
- Nowadays STUK's economic picture is more bright → possibilities to activate RTD efforts again.

National programme and Consortium for radiation safety research
www.cores.fi



The purpose of Cores is to coordinate and strengthen radiation safety research in Finland.

H = Health
M = Medical
E = Environment
P = Prepareness for emergencies
T = Technologies and measurements



University of Oulu (E, T, P, H)

University of Tampere (H, M)

Tampere Technological University (T)

University of Turku (H, M)

Åbo Akademi (H, M)

University of Eastern Finland (H, M, E, T)

University of Jyväskylä (T, E)

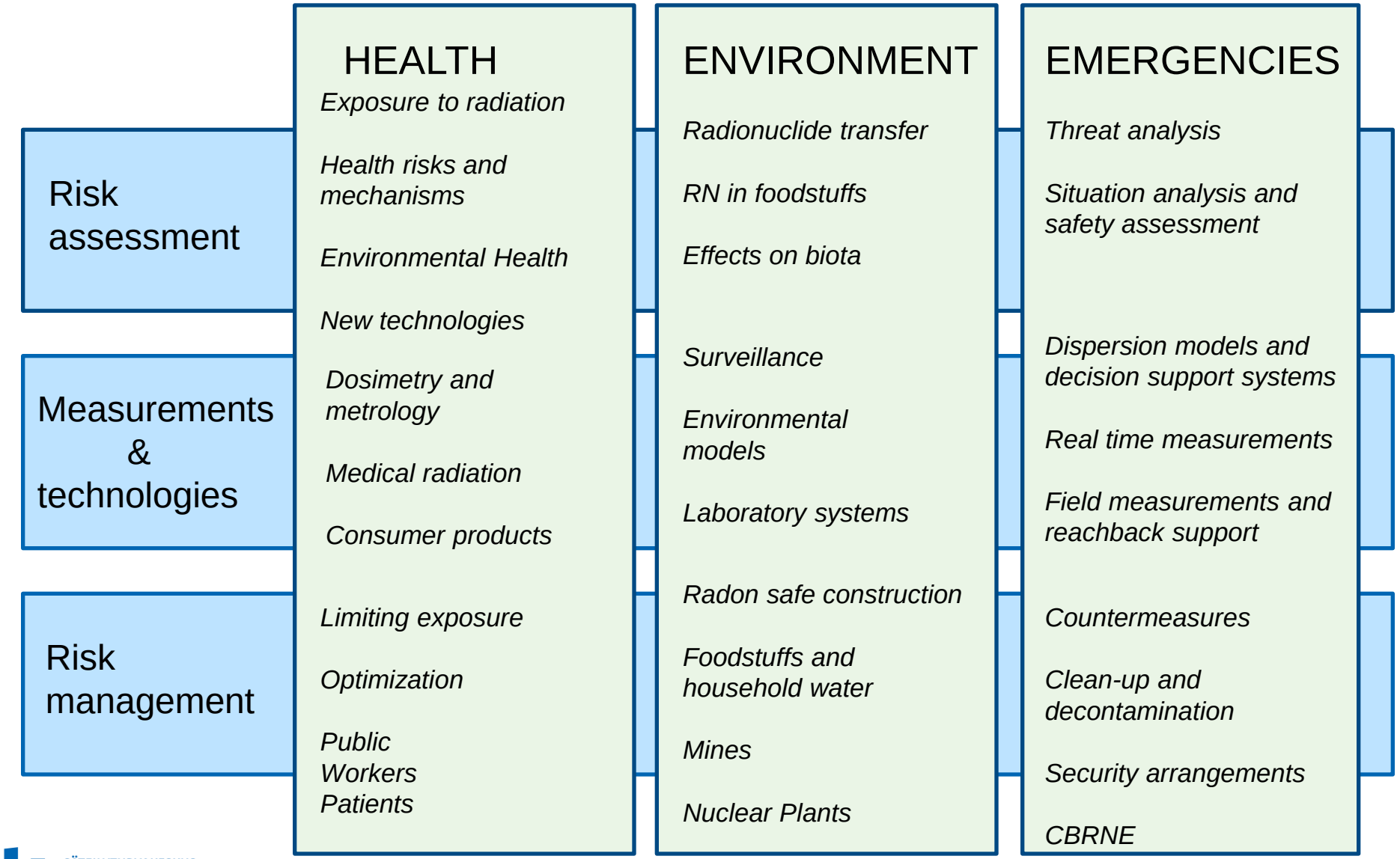
Lappeenranta University of Technology (T, P)

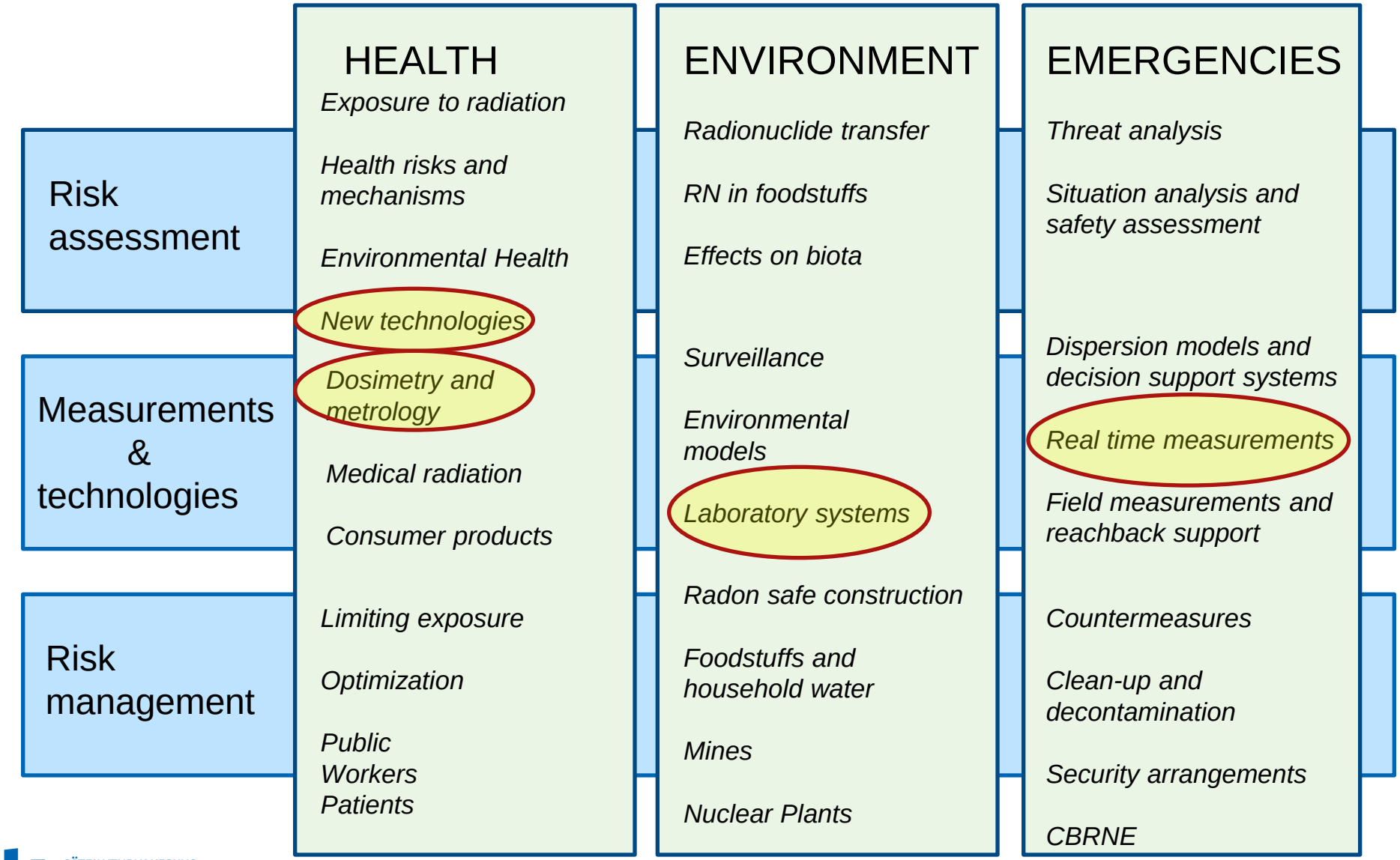
University of Helsinki (T, E, P, M)

Aalto University (T)

STUK, Helsinki (P, T, M, E, H)

Cores framework




HEALTH
Exposure to radiation
Health risks and mechanisms
Environmental Health
New technologies
Dosimetry and metrology
Medical radiation
Consumer products
Limiting exposure
Optimization
Public
Workers
Patients
ENVIRONMENT
Radionuclide transfer
RN in foodstuffs
Effects on biota
Surveillance
Environmental models
Laboratory systems
Radon safe construction
Foodstuffs and household water
Mines
Nuclear Plants
EMERGENCIES
Threat analysis
Situation analysis and safety assessment
Dispersion models and decision support systems
Real time measurements
Field measurements and reachback support
Countermeasures
Clean-up and decontamination
Security arrangements
CBRNE
Risk assessment
Measurements & technologies
Risk management

2. STUK's γ-ray lab

- 16 HPGe spectrometers (7 Ortec, 9 Canberra).
- 4 electrically cooled, others are LN_2-cooled (5 Möbius, 7 Cryo-Cycle).
- Digital MCAs (different DSPEC generations).
- 3000 – 4000 analyses per year.

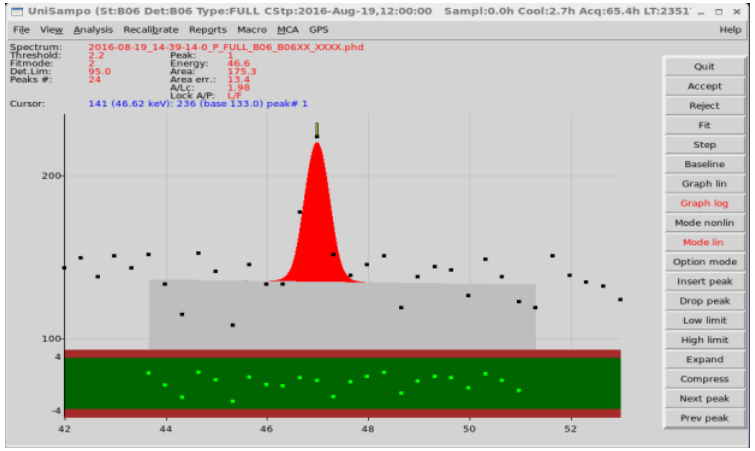

γ1

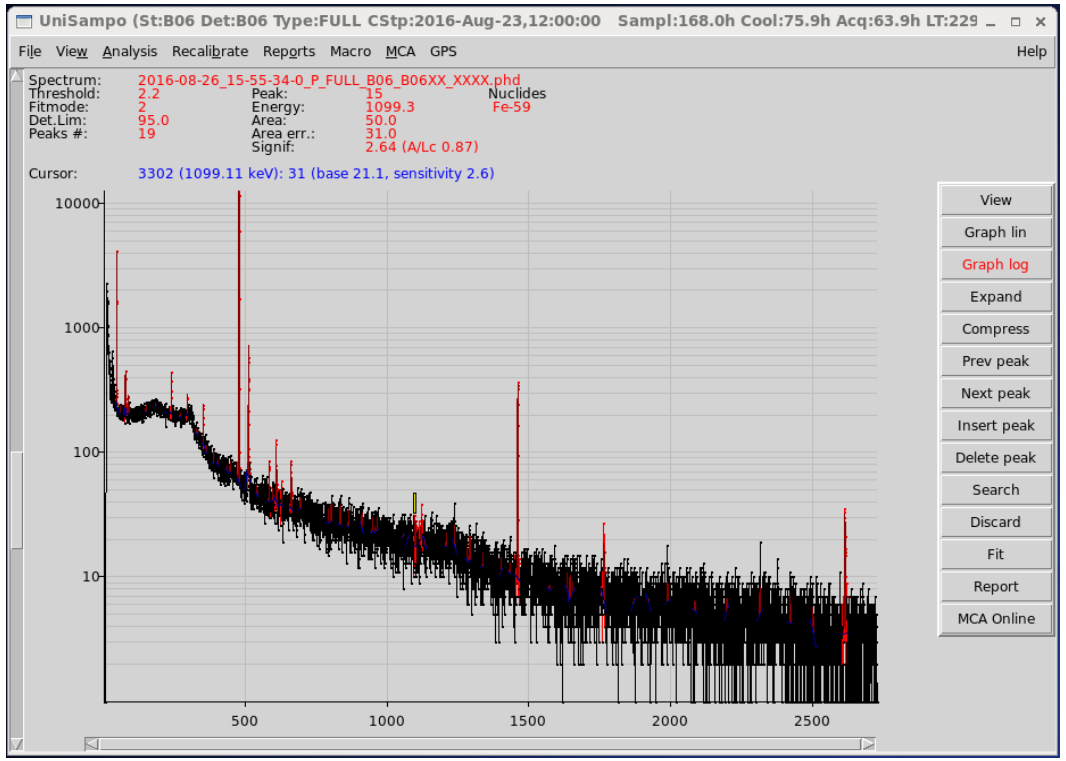
γ2

UniSampo-Shaman spectrum analysis software

- UniSampo: peak search, baseline & peak fitting, peak areas
- Shaman: rule-based peak identification and activity calculation, mimics human analyst

Interactive fitting





Measurement geometries

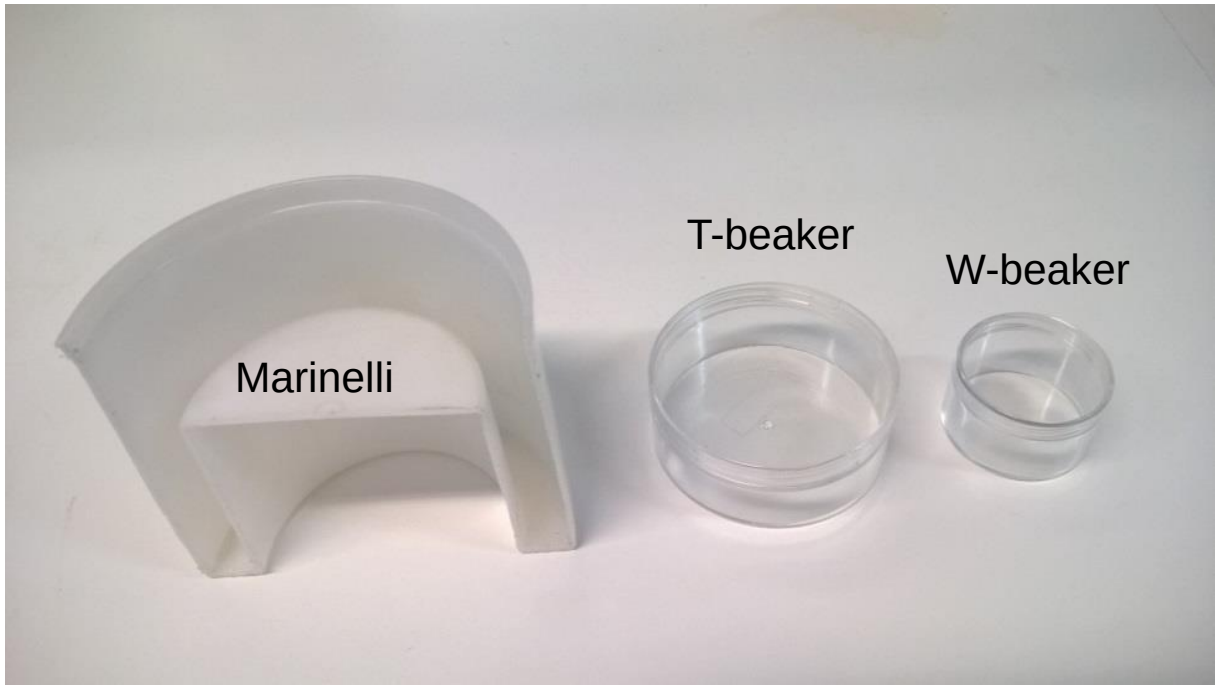
Simple cylindrical:

- 0-30 mL, free sample height
- 0-100 mL, free sample height

Marinelli:

- 0.5 L, fixed sample height

Some special geometries, too



3. RTD activities in γ-ray spectrometry

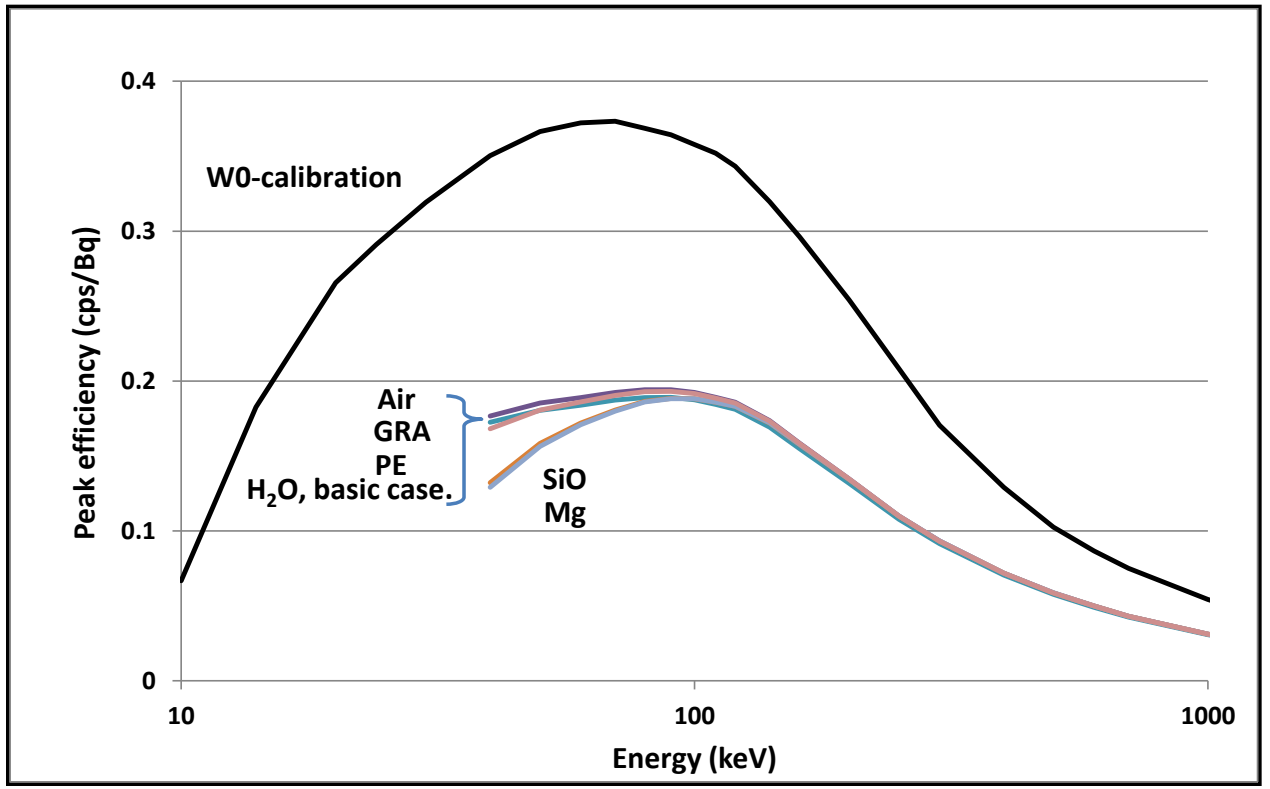
a) Routine sample analysis with the aid of efficiency transfer software
b) List mode data acquisition with Compton Suppression device
c) List mode data acquisition and α/β-γ coincidences (MiniPanda device)
d) Renewal of external dose rate monitoring network
e) Gamma-ray spectrometry in borders
f) Development of remote expert support (reachback)
g) Gamma-ray spectrometry in the field

a) Introducing EFFTRAN for routine sample analyses

- Present way to perform sample thickness & density correction was found to be non-optimal and there is no good traceability for the uncertainties.
- Elemental composition of the samples should be accounted for.
- (M)(W)EFFTRAN is under investigation for the analyses.

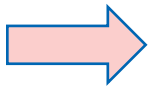
⇨ MSc. thesis is in preparation

The influence of the elemental composition to the peak efficiency, sample height 26 mm.



b) List mode data acquisition with Compton Suppression device

c) List mode data acquisition and α/β-γ coincidences (MiniPanda device)

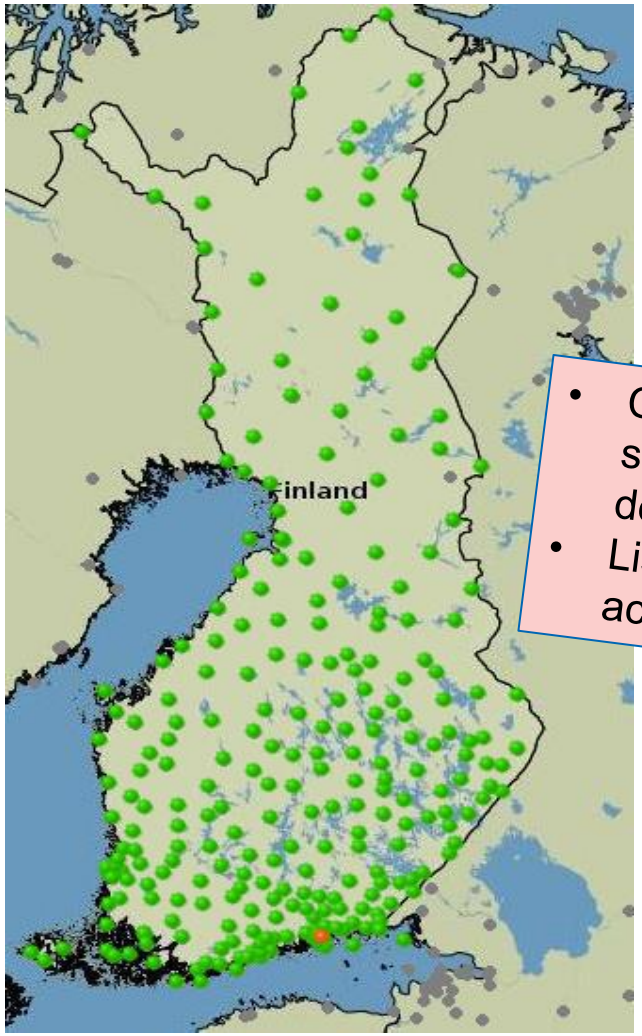


See next presentation

d) Novel sensor for the Finnish early warning network

Goals/Design Basis/Features:

- Reseach project with duration of 4 years.
- Radionuclide identification.
- Dose rate determination.
- Differentiation between airborne radionuclides and ground contamination.
- Determination of the altitude of the plume passing the measurement station.
- Fully automatic and reliable data collection and processing.
- Compact, low power, cost-effective, robust.



- Combination of scintillation detectors
- List mode data acquisition

e) Gamma-ray spectrometry in borders (or other purposes)

Research version GeGI characteristics:

- Compton and collimator-based imaging
- γ-ray energies up to 12 MeV.
- 90 mm × 11 mm Ge detector.
- Energy resolution <0.3% @ 662 keV.
- List mode raw data.

Germanium Gamma Ray Imaging Spectrometer (GeGI)

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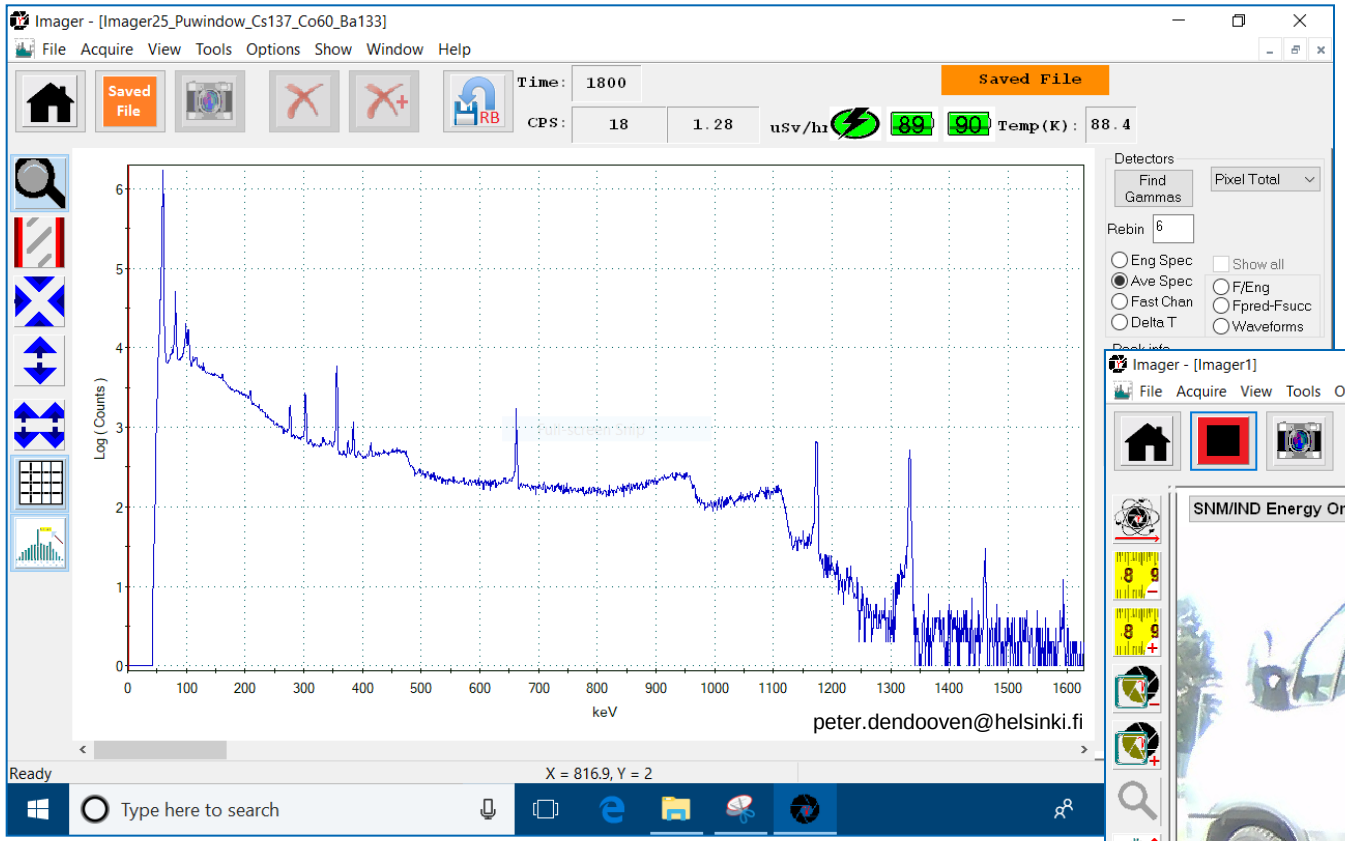
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Saved File
Time: 1800
CPS: 18 1.28
uSv/hr 89 90 Temp(K): 88.4
Detectors
Find Gammas
Pixel Total
Rebin 6
Eng Spec
Ave Spec
Fast Chan
Delta T
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F/Eng
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Waveforms
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keV
peter.dendooven@helsinki.fi
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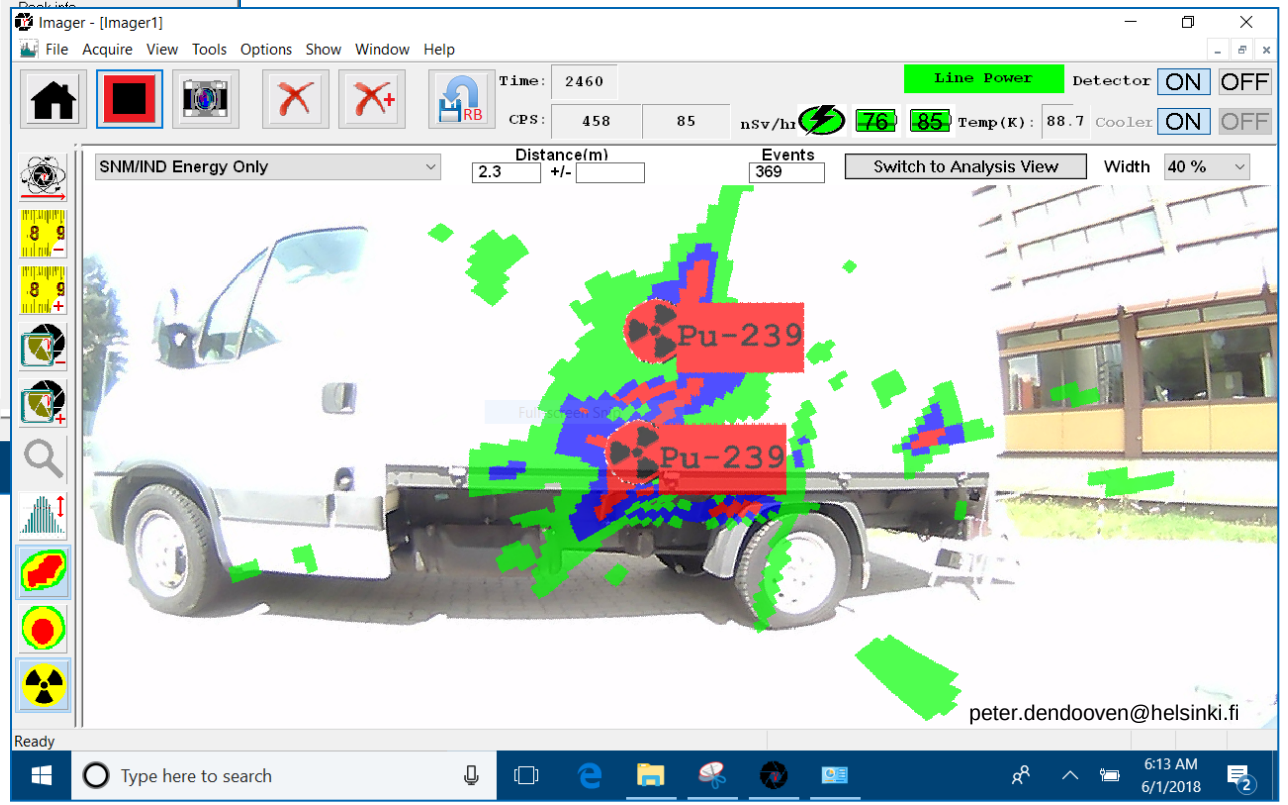
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CPS: 458 85
nSv/hr 76 85 Temp(K): 88.7
Line Power
Detector ON OFF
Cooler ON OFF
SNM/IND Energy Only
Distance(m) 2.3 +/-
Events 369
Switch to Analysis View
Width 40 %
Pu-239
Pu-239
peter.dendooven@helsinki.fi
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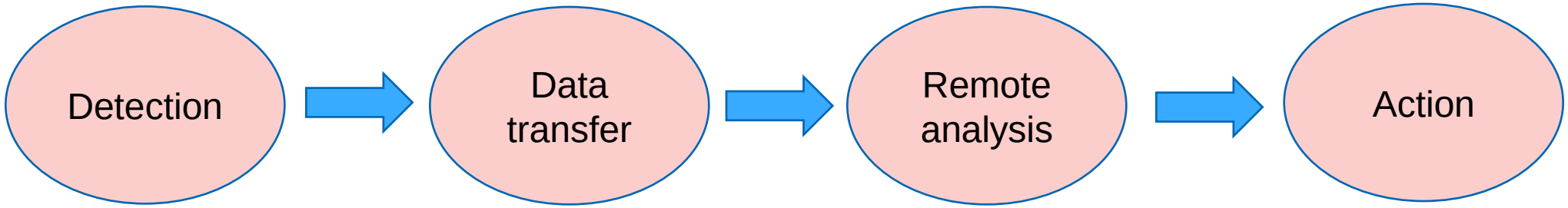
6/1/2018

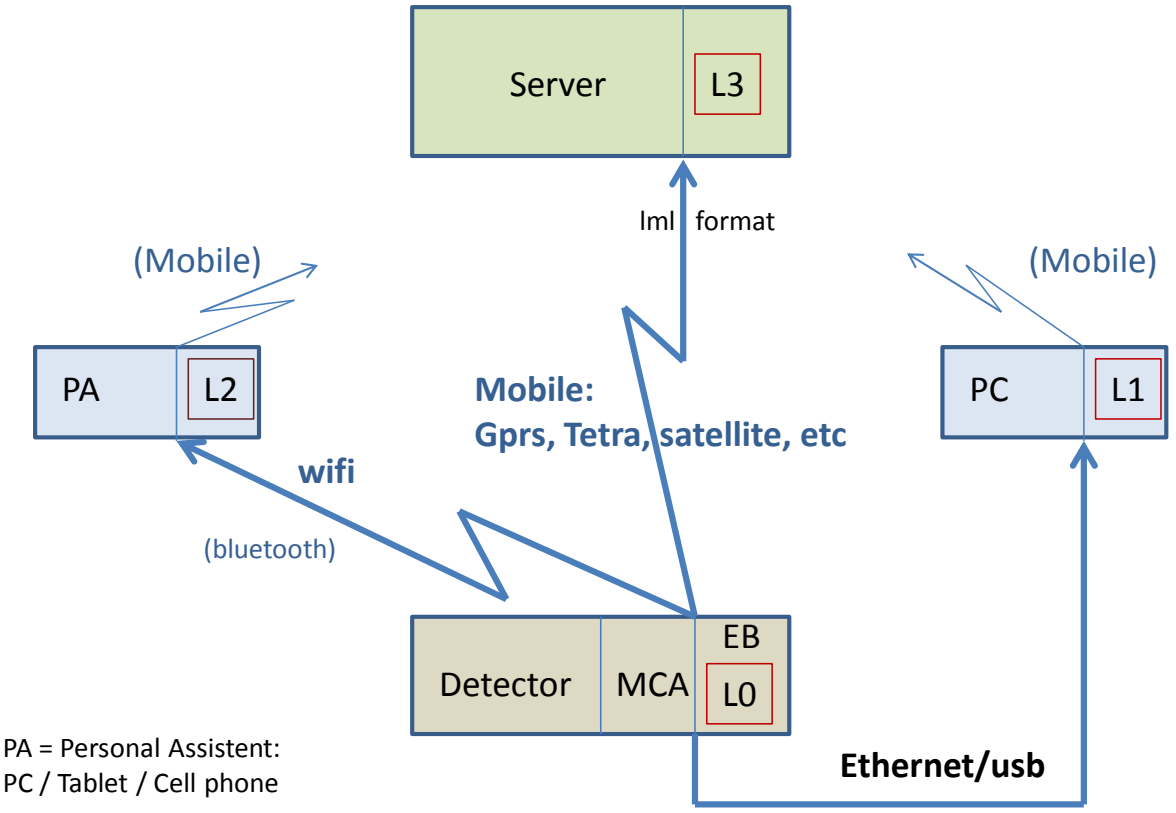
f) Development of remote expert support (reachback)

Remote expert support is a concept especially for in-field measurements

- The detection architecture was developed by STUK in cooperation with other Finnish security authorities.
- The concept is already viable and has been used in STUK for several years.
- Development and especially raising the awareness of the methodology is needed.



Detection system, including LINSSI databases (L0-L3)



PA = Personal Assistent:
PC / Tablet / Cell phone

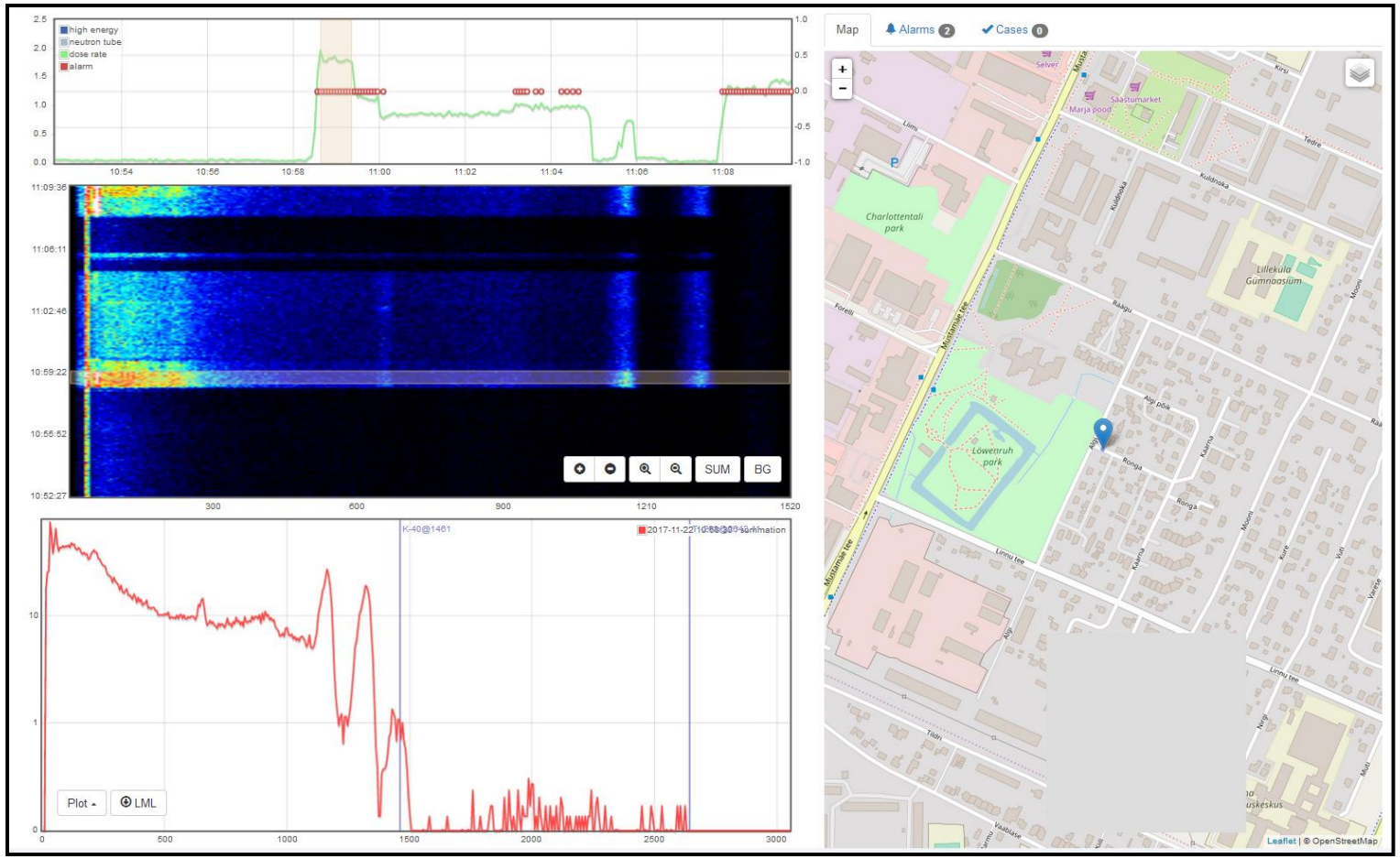
EB = Embedded computer

1. Relocatable detectors
2. Hand-held detectors
3. Backpacks
4. Car, ship, UAS
5. Other

Technology demonstration:

STUK's team (located in Helsinki) is helping Estonian Rescue Board for spectrum analysis and other scientific support

Kari Peräjärvi and Philip Holm in action



Tarja Ilander, STUK

g) Gamma-ray spectrometry in the field

- Gamma-ray spectrometer mounted in a UAV.
- Cooperation between University of Oulu, STUK and Finnish Defence Forces
- Test measurements were done in August 2018

Kromek GR1 (~9000 €)
- CdZnTe, volume 1 cm^3
- Power needed 250 mW
- Mass 60 g
- 25 x 25 x 63 mm^3
- Functioning up to 100 µSv/h!

[redacted]