Considerations on the adequacy of Nordic capabilities for early detection of emergencies

Radiation and Nuclear Safety Authority
(STUK)

Kaj Vesterbacka

What is detectable?

- Measuring radiation is not straight forward. Concentration of radioactivity or the dose rate can vary by factor 10^{12}.. One instrument is not enough.

- Detection level depends on measuring instrument, measuring time, concentration or flux of radiation

- Different levels and types of radioactivity require different types of equipment.

Concentration of I-131	Method	
1500 Bq/m^3	GM detector, 10 min	0,1 µSv/h
1 µBq/m^3	Air sampler, few days	

10^6 Bq/m^3 of I-131 causes dose rate of 60 µSv/h

What is early ?

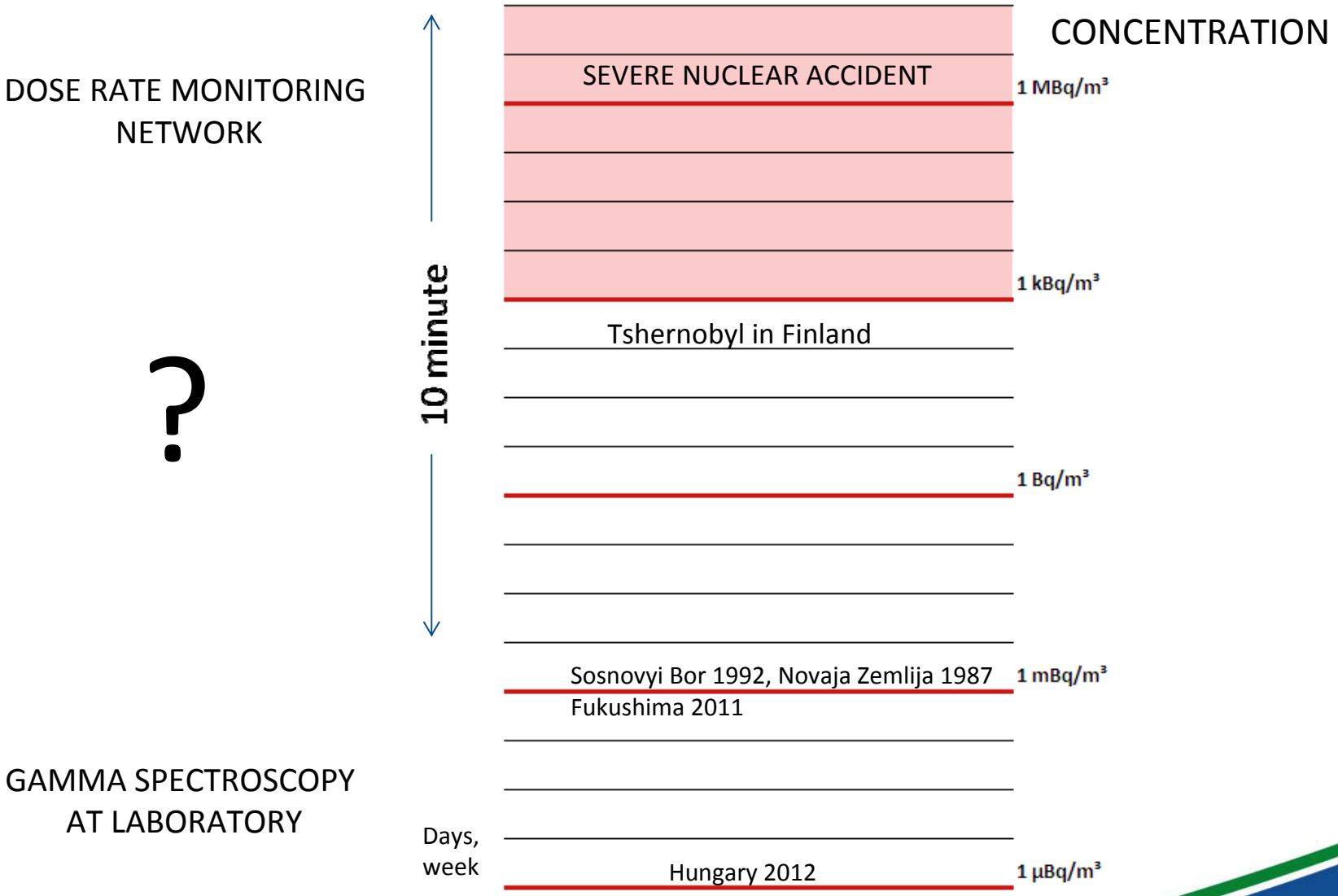
- Detecting radioactivity in the air at levels of µBq/m^3 after several days is early

- Detecting radioactivity in the air at levels of 1 kBq/m^3 with air sample in a normal situation is not early

- Detecting radioactivity in the air at levels of kBq/m^3 with GM-detector in 10 minute is early

→ To react and detect different levels and types of radioactivity as early as possible require different types of equipment.

Detection and equipment vs. time and radioactivity

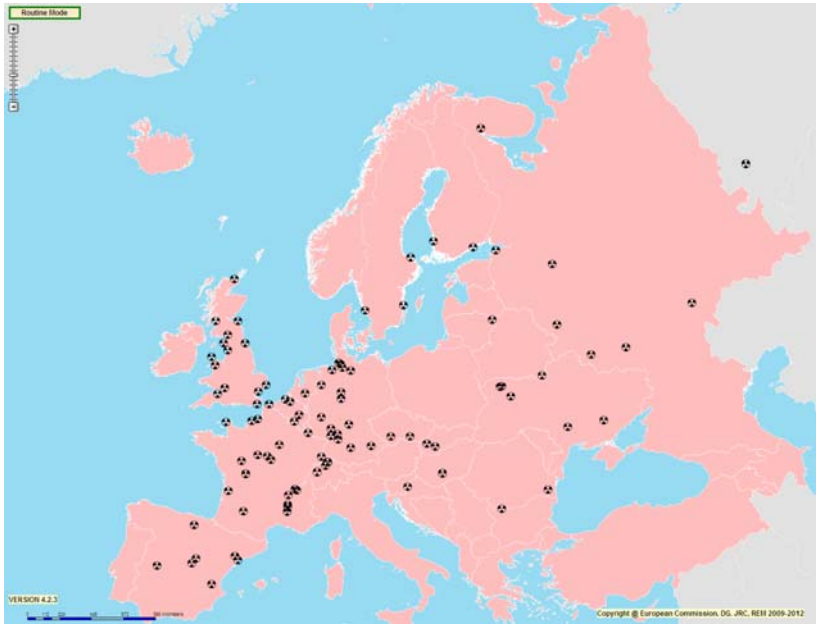


The threats

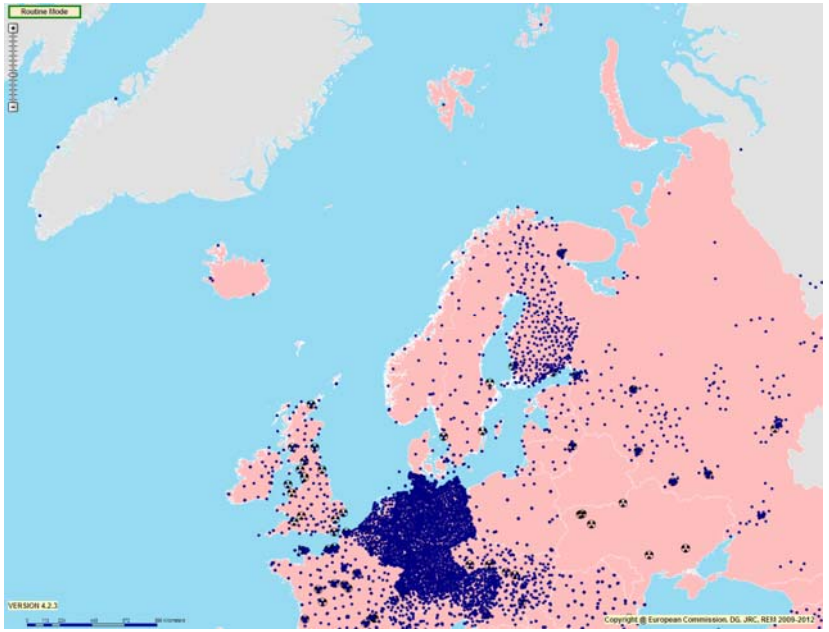
- The accident in Fukushima showed that accidents do happened and authorities must be prepared for them
- The affects of nuclear accidents are global, authorities around world must be able to respond
- There are also other types of nuclear threats like related to spent fuel, malicious acts of radioactivity etc. in which authorities must be prepared for
- The geographical vicinity of threats or the probability of the threat should define the scale of preparedness and detection (monitoring networks around nuclear installations)

Active nuclear power plants and dose rate monitoring networks in Europe

Nuclear power plants



Dose rate monitoring networks



Current means of detection (1/3)

1. Dose rate monitoring networks

- All European including Nordic countries have monitoring networks for external dose rate. The number of stations and their locations are selected by countries

- Usually they have two main functions: Make alarm and provide radiation awareness

- Dose rate monitoring networks are normally equipped with quite insensitive robust detectors like GM-tubes, proportional counters etc.

- In many countries external dose rate monitoring networks were built after Chernobyl accident and have now been renewed

Current means of detection (2/3)

2. Monitoring the radioactivity in the air

- The most sensitive method for detecting increased levels of radioactivity is monitoring the radioactivity in the air (detection levels typically 1 µBq/m$^{3)}$
- This method provides detailed nuclide information of the composition of the radiation
- The downside is the time from the sampling to the result. In normal situation this can easily be several days on even more

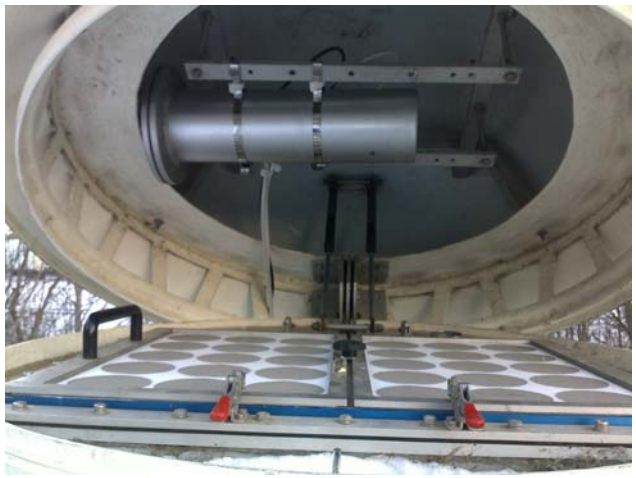
Current means of detection (3/3)

3. Cooperation

- Cooperation between Nordic countries increases the ability to respond threats: one detects, all knows
- Different type of knowledge and equipments benefits all
- Nordic countries have mutual agreements of exchanging of data and information
- Exchanging information lower the level of detection

Improving the level of detection

- Adding spectrometers:
  - to the dose rate monitoring stations
  - field teams
  - air samplers
- Changing communication to real time
- Increasing the level of automation in data handling



$LaBr_3$ spectrometer fasten to the lid of the air sampler

The detection levels of $LaBr_3$ spectrometers

In-situ

- The detection limit for I-131 at dose rate monitoring with 10 minute measuring is around 30-40 Bq/m^3. This corresponds to the increase of dose rate around 2 nSv/h

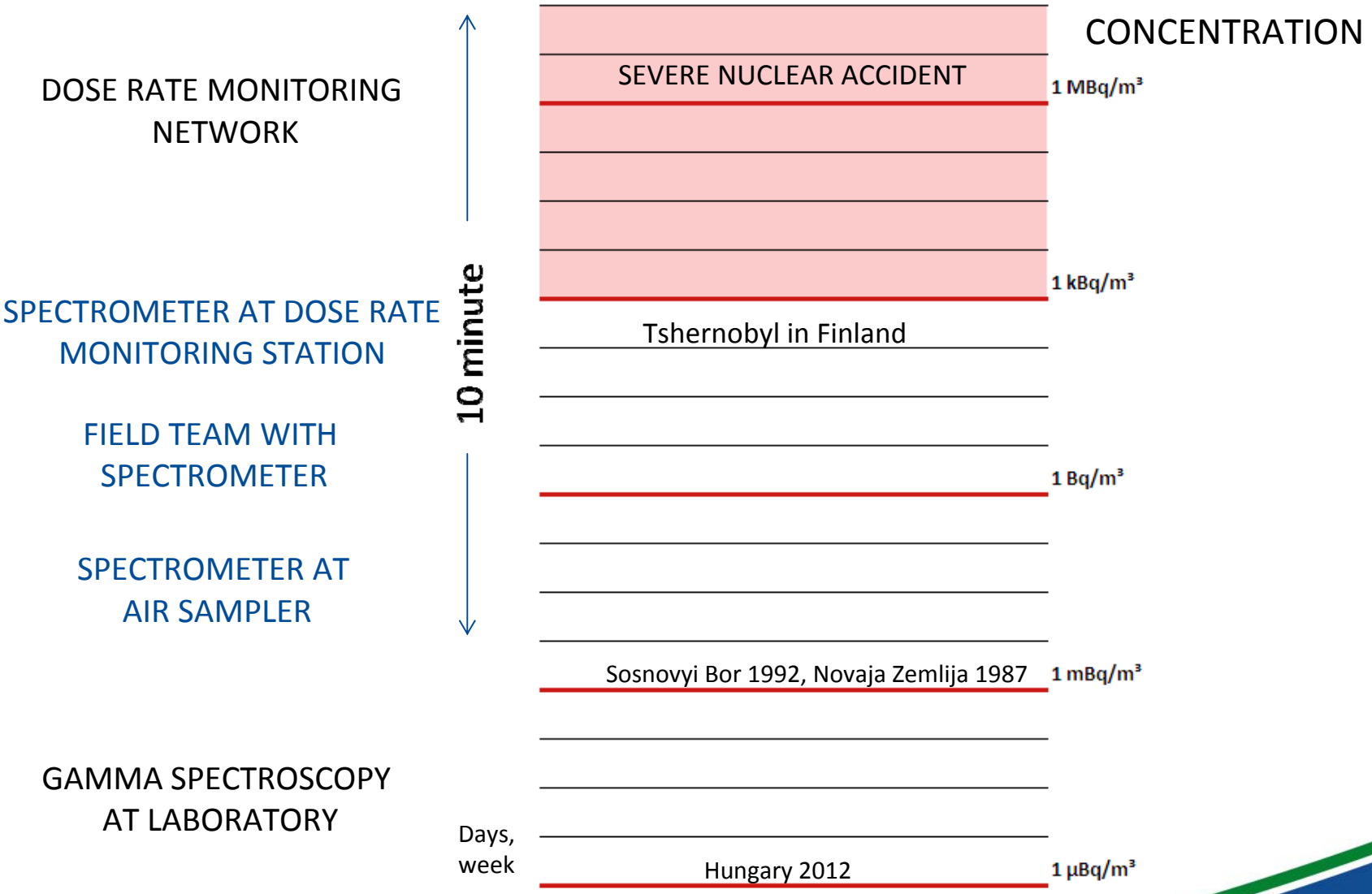
Sampler

- The detection levels at air samplers depend on the amount of the air sampled, but after 6 hours (500 m^3/h) detection level for I-131 is around 50 mBq/m^3

- For example, installing $LaBr_3$ or NaI spectrometer to dose rate monitoring station, increases overall sensitivity by factor 20-100

→$LaBr_3$ or better spectrometer gives nuclide specific information about radiation.

Detection and equipment vs. time and radioactivity



Data management

- Data management level should be as high as possible in all levels

- System should minimize the possibility of making false alarms of false judgement

- It is practically impossible to buy these kind of data management systems from software companies:
  - They do not have out-of-box solutions for suitable for everyone
  - All need tailoring
  - It is not good to have emergency system which is depends on software company
  - Usually very expensive to buy and maintain

  → Import parts in these data management systems like data structures must be done in-house

Conclusions

- Nordic countries have adequate capabilities for early detecting of radioactivity

- Nordic countries have arrangements for exchanging information: one detects, all knows

- Improvements:
  - More spectrometric measurements
  - Increasing automation in data handling
  - Real time data availability
  - Joint exercises (DEMOEX, REFOX, GAMMASEM etc)
  - Data format for exchanging gamma spectrometric information should be developed