# Portable thyroid monitors for detection of $^{131}$I in emergency situations

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**Abstract**: The need for assessing internal radiation doses in emergency situations is evident. Studies done in Ukraine, Belarussia and the southern parts of Russia after the Chernobyl accident have shown an unexpected increase of thyroid cancers in children and young people. Direct measurements give both individual results and results for groups. In the past two years, Radiation and nuclear safety authority - STUK has obtained 35 monitors for thyroid measurements in the field conditions. The monitors work as spectrometers, which makes it possible to do real time spectrum analysis in the field.

## Introduction

The aim of this work is to improve the preparedness for thyroid monitoring in emergency situations. The need for assessing internal radiation doses in emergency situations have been demonstrated after accidents in Brasil, Ukraine and other countries. Studies done in Ukraine, Belarussia and the southern parts of Russia after the Chernobyl accident have shown an unexpected increase of thyroid cancers in children and young people. Direct measurements, which should be done as soon as possible after an alert to give support for decision making, give both individual results and results for groups.

## Results and discussion

In the recent years, Radiation and nuclear safety authority - STUK has obtained 25 Atomtex RKG-AT1320 monitors and ten Canberra InSpector 1000 monitors for thyroid measurements in the field conditions. The AT1320 thyroid monitor consists of a detector with 1”x1” NaI(Tl) crystal, control unit and lead collimator (Figure 1, left). The construction of the InSpector 1000 thyroid monitor is similar apart from the size of the NaI(Tl) crystals which is 2”x2” (Figure 1, right). The energy resolutions of the crystals are better than 8 %. The monitors work as spectrometers making it possible to do real time spectrum analysis in the field. The collected spectrum is shown on the display of the control unit. It is possible to store spectra in the detection unit, from where they can be later on transferred to a PC. The energy stabilization is done before starting measurements using a $^{137}$Cs source. Likewise the background control and sensitivity check (also with $^{137}$Cs source) are carried out before measurements.


**Figure 1.** Left: RKG-AT1320 thyroid monitor: NaI(Tl) detector, control unit, charger, $^{137}$Cs control source and cables. Right: InSpector 1000 thyroid monitor: In addition to spectrum acquisition mode the Inspector monitor can be used in dose rate mode or in nuclide identification mode.

The aim of thyroid monitoring is to determine the $^{131}$I activity in the thyroid with minimal interference from activity in the rest of the body. This is achieved by placing a shielded or a collimated detector near the neck at the position of the thyroid. However, both RKG-AT1320 and InSpector 1000 thyroid monitors are planned to be movable and easy to carry. During measurement the RKG-AT1320 detection unit planned to be held in hand, although it can also be placed to a stand. Thus, the weight of the detection unit can not be more than a couple of kilograms. The collimator used in the present RKG-AT1320 measurement set-up is made of 5 mm thick lead and it weights about 1 kg (Figure 2, left). Assessment of the contribution to the detector response from radioiodine in blood and in surrounding measurement area can be made by placing the detector over a different area in of the body (e.g. thigh) [1]. For thyroid measurements, InSpector 1000 monitor is positioned into a table-top lead shield of 12.5 kg weight (Figure 2, right).

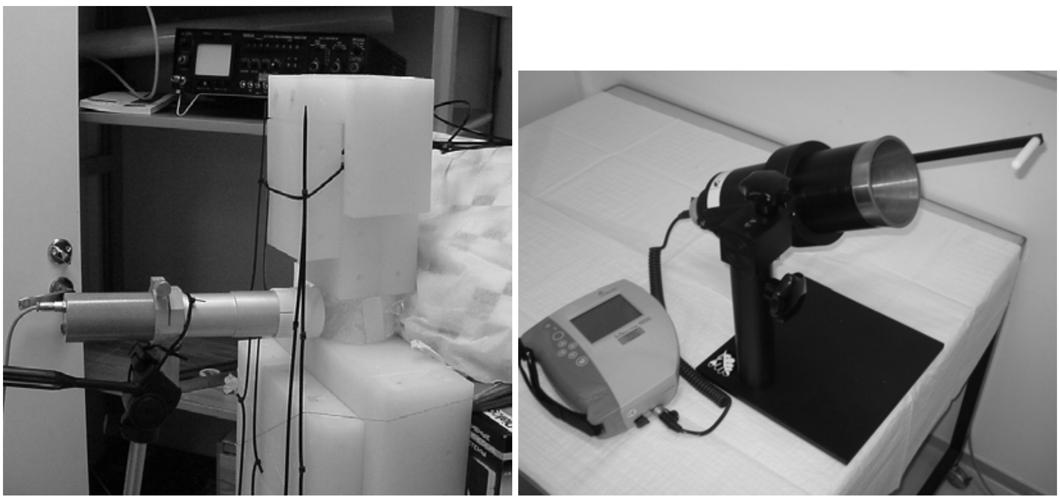

**Figure 2**. Left: RKG-AT1320 thyroid monitor in a 5 mm lead collimator and an adult phantom in measurement distance of 7 cm. Right: InSpector 1000 thyroid monitor in a table-top lead shield.

The detection efficiency depends greatly on the distance between the detector and thyroid. To get good statistics in a short time the detector should be placed as close to the neck as possible. The exact position of the thyroid must be known in order to get right results in the close geometry. If the detection distance is longer, is not so crucial to place the detector exactly on the thyroid. Two measurement distances were used in the calibration of the RKG-AT1320 thyroid monitors, 7 cm and 20 cm. Three calibrations were done for both distances: adult, teenager (14 years old) and child (6 years old). The St. Petersburg thyroid phantom and whole body phantom with $^{40}$K rods were used in the calibration. Two capsules filled with $^{131}$I solution were placed in the thyroid phantom. The minimum detectable activities (MDAs) when using the measurement time of 100 s in normal conditions are about 2000 Bq and 330 Bq for 20 cm and 7 cm detection distances, respectively. If longer time of 600s is chosen, the MDAs are significantly lower: 760Bq and 120 Bq for 20 cm and 7 cm distances, respectively. The set-up with 7 cm detection distance is about six times more efficient than that with 20 cm distance.

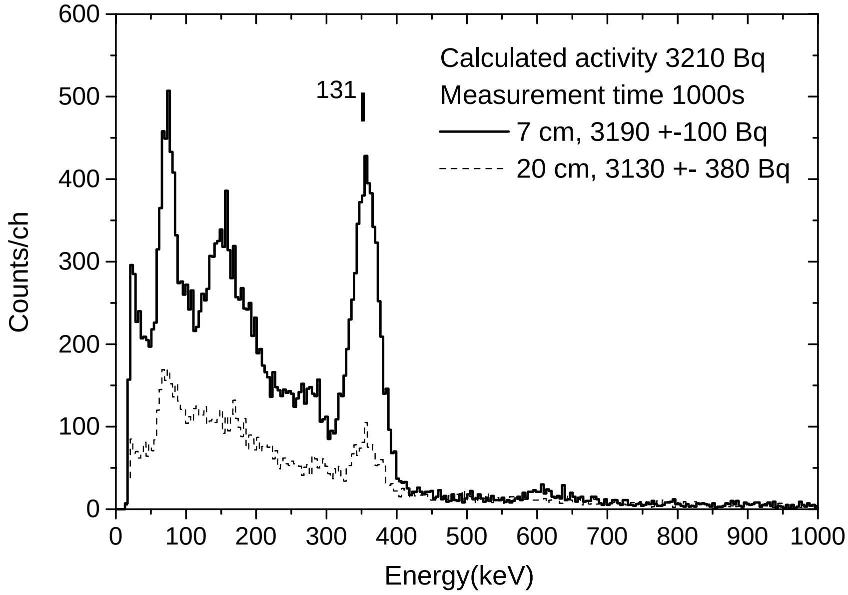


**Figure 4.** Gamma-ray energy spectra collected from a $^{131}$I thyroid phantom (distances 7cm and 20 cm).

The use of a lead collimator - even though the thickness of the collimator is only a few millimetres - reduces significantly the low-energy background resulting from scattered γ-rays. This is illustrated in Figure 5, where a γ-ray energy spectra collected from a $^{131}$I thyroid phantom with and without the 5 mm lead collimator is shown. A $^{137}$Cs source has been placed in the vicinity of the thyroid monitor to demonstrate the background radiation from surroundings in a fallout situation. These tests have also been carried out using RKG-AT1320 thyroid monitor. InSpector 1000 monitors will be calibrated and similar tests will be done during summer 2005.

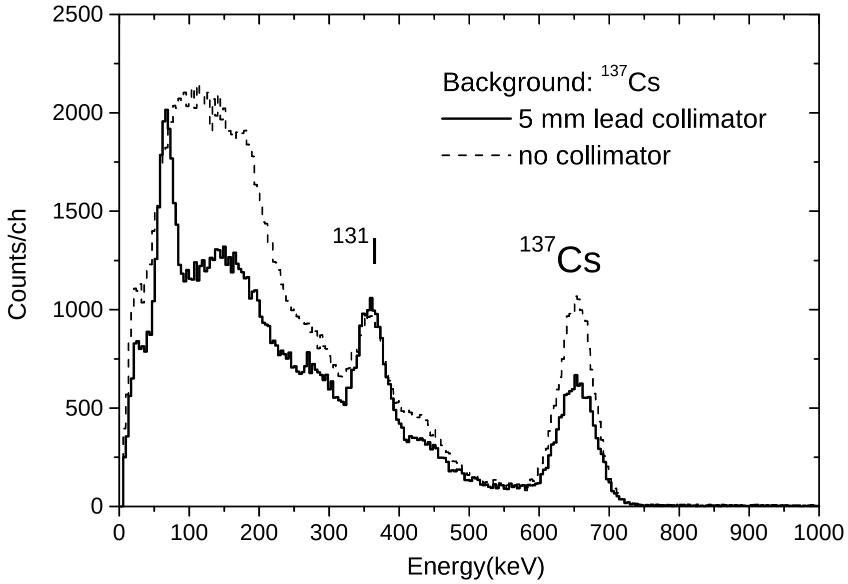


**Figure 5.** Gamma-ray energy spectra collected from a $^{131}I$ thyroid phantom with and without the 5 mm lead collimator.

## References

[1] Direct Determination of the Body Content of Radionuclides. ICRU Report 69, Journal of the ICRU, Volume 3 No 1 2003.