

# Using the $\text{LaBr}_3:\text{Ce}$ scintillation detector for mobile $\gamma$ -spectrometry

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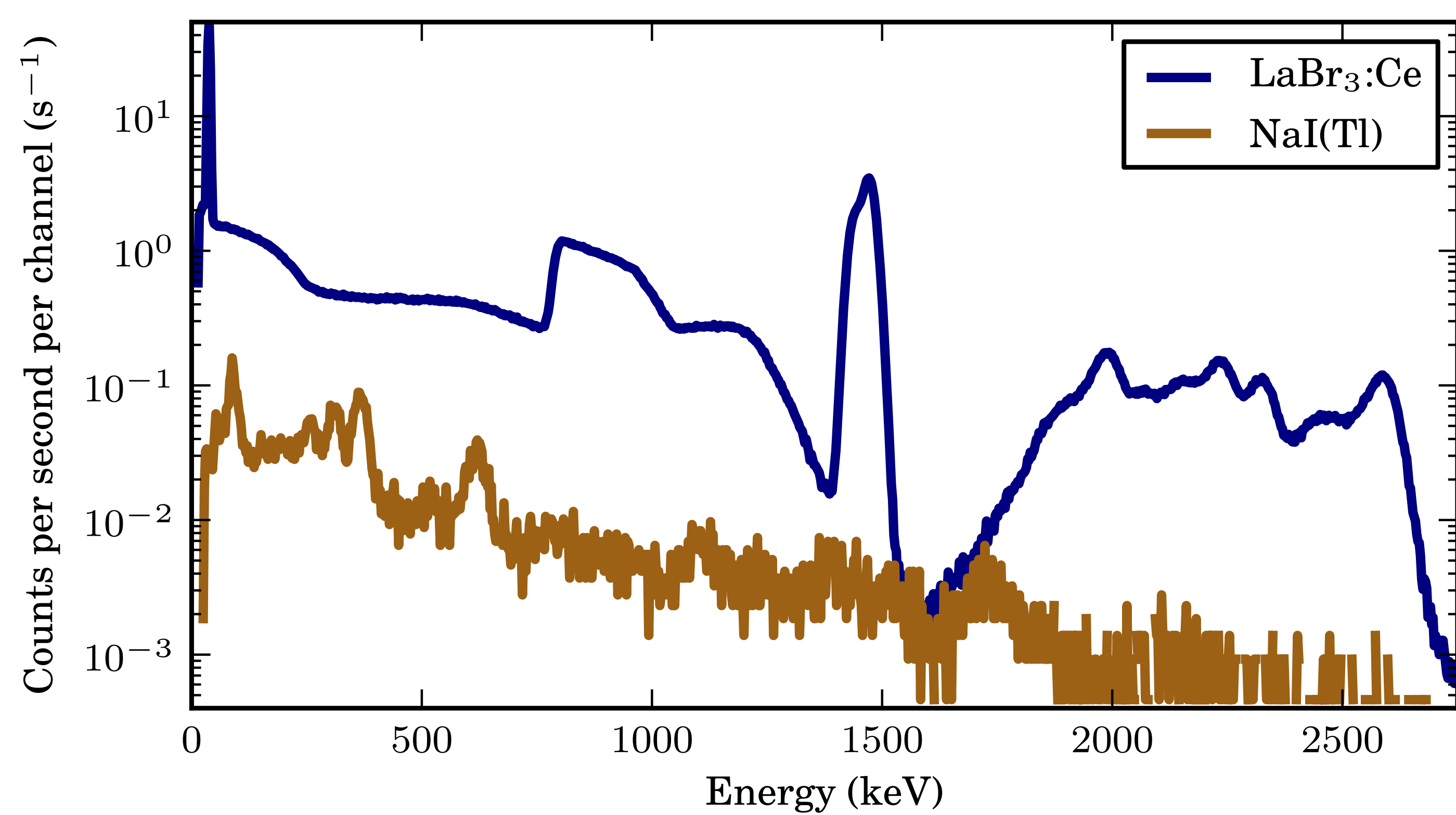
## Introduction

Although HPGe-detectors have almost completely replaced scintillation detectors such as NaI(Tl) in the laboratory, NaI(Tl)-detectors are still the detector of choice when it comes to mobile  $\gamma$ -spectrometry because of their low maintenance and the possibility to make large NaI(Tl)-crystals.

A scintillation material that improves upon the energy resolution and the photon cross section of the NaI(Tl)-detector has only relatively recently appeared in the form of  $\text{LaBr}_3:\text{Ce}$  [1].  $\text{LaBr}_3:\text{Ce}$  sports a better energy resolution, a higher density and a shorter decay time of the scintillation pulse than a NaI(Tl)-scintillator. The drawback of a  $\text{LaBr}_3:\text{Ce}$ -scintillator is that it is internally contaminated with  $^{138}\text{La}$  and  $^{227}\text{Ac}$ .

The work on which this poster is based, was done to decide if a 3" x 3"  $\text{LaBr}_3:\text{Ce}$ -detector could replace a similar or bigger sized NaI(Tl)-detector in mobile  $\gamma$ -spectrometry.

## Internal contamination



The figure is showing a background measurement made in a very low pulse rate environment with the  $\text{LaBr}_3:\text{Ce}$ -detector used in this study and a 3" x 3" NaI(Tl)-detector.

The pulse rate was found to be 3 to 4 cps when measuring with the NaI(Tl)-detector and  $\approx 500$  cps when measuring with the  $\text{LaBr}_3:\text{Ce}$ -detector.

## References

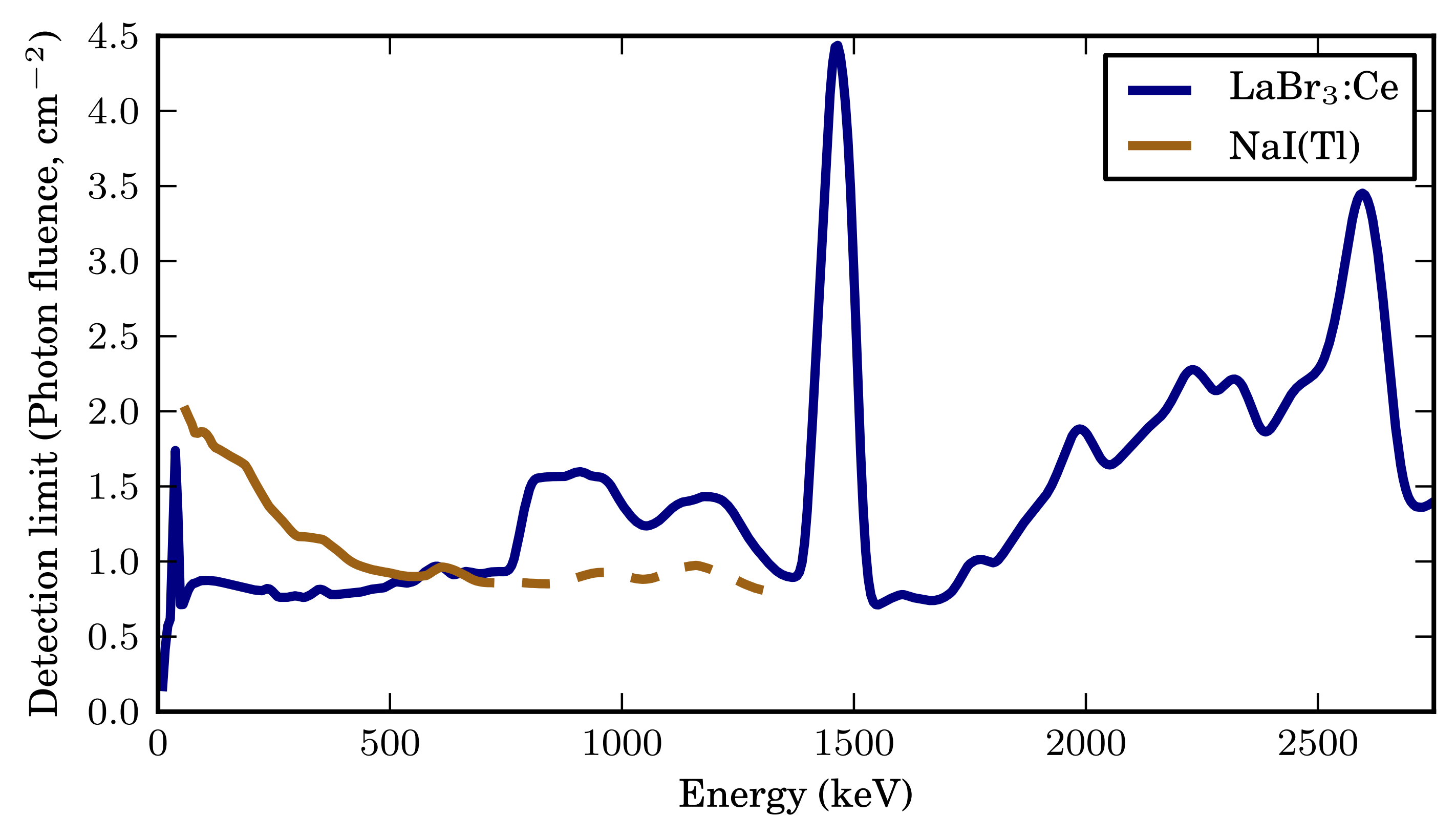
- [1] M. Moszyński, "Inorganic scintillation detectors in  $\gamma$ -ray spectrometry," *Nucl. Instr. and Meth. in Phys. Res., A*, vol. 505, no. 1-2, pp. 101–110, 2003.
- [2] L. Currie, "Limits for qualitative detection and quantitative determination. application to radiochemistry," *Analytical Chem.*, vol. 40, no. 3, pp. 586–593, 1968.
- [3] B. D. Milbrath, B. J. Choate, J. E. Fast, W. K. Hensley, R. T. Kouzes, and J. E. Schweppe, "Comparison of  $\text{LaBr}_3:\text{Ce}$  and NaI(Tl) scintillators for radio-isotope identification devices," *Nucl. Instr. and Meth. A*, vol. 572, pp. 774–784, Jan 2007.
- [4] M. Moszyński, J. Zalipska, M. Balcerzyk, M. Kapusta, W. Mengesha, and J. D. Valentine, "Intrinsic energy resolution of nai(tl)," *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, vol. 484, no. 1-3, pp. 259 – 269, 2002.
- [5] P. Kock, R. R. Finck, J. M. C. Nilsson, K. Östlund, and C. Samuelsson, "A deviation display method for visualising data in mobile gamma-ray spectrometry," *Appl. Radiation and Isotopes*, vol. 68, pp. 1832–1838, May 2010.

## Detection limit

To find the photon fluence needed to decide whether or not a  $\gamma$ -source is present in a specific set of measurement conditions, a framework developed by Currie [2] was used.

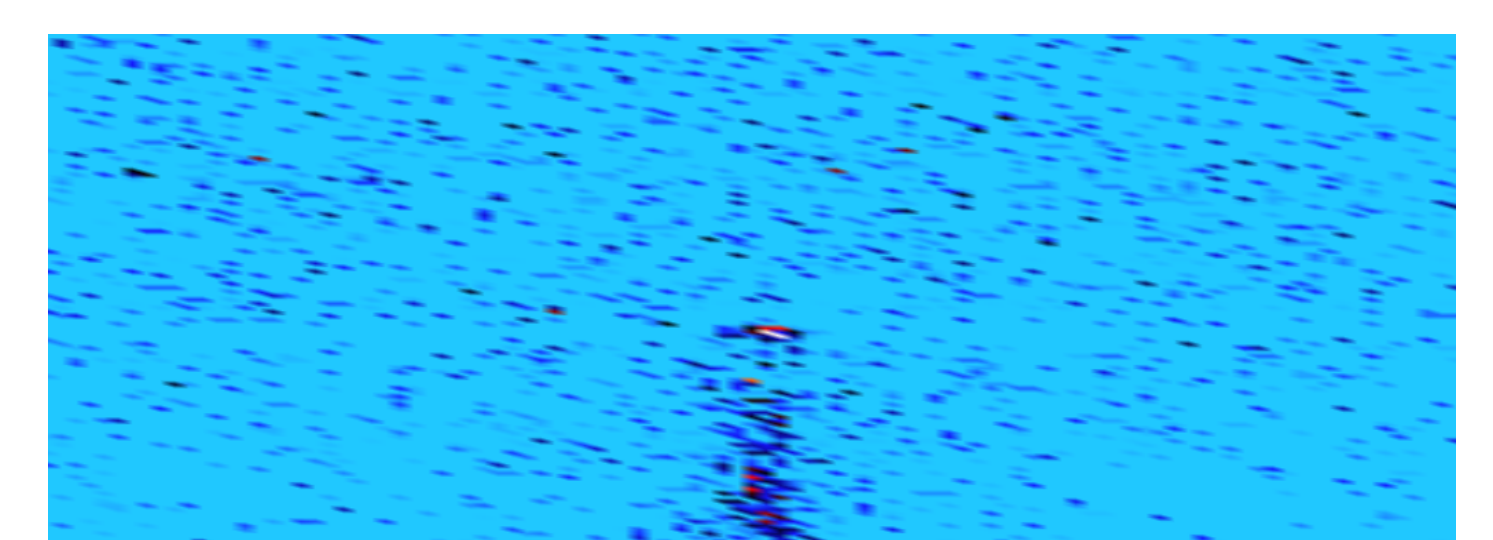
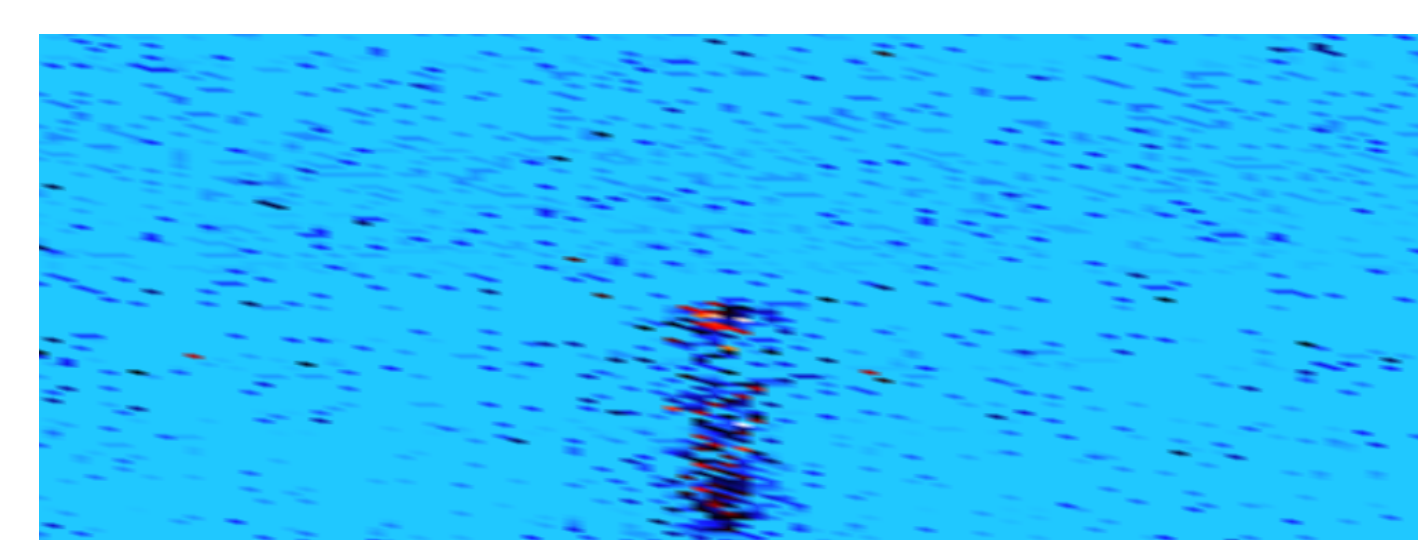
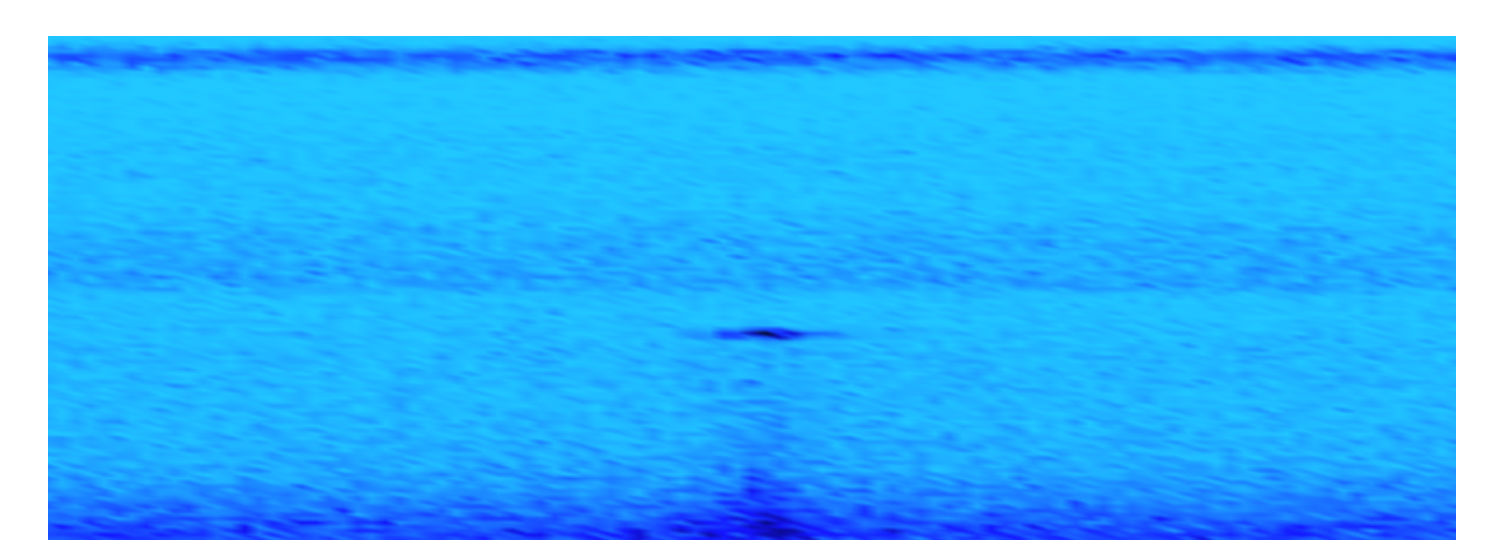
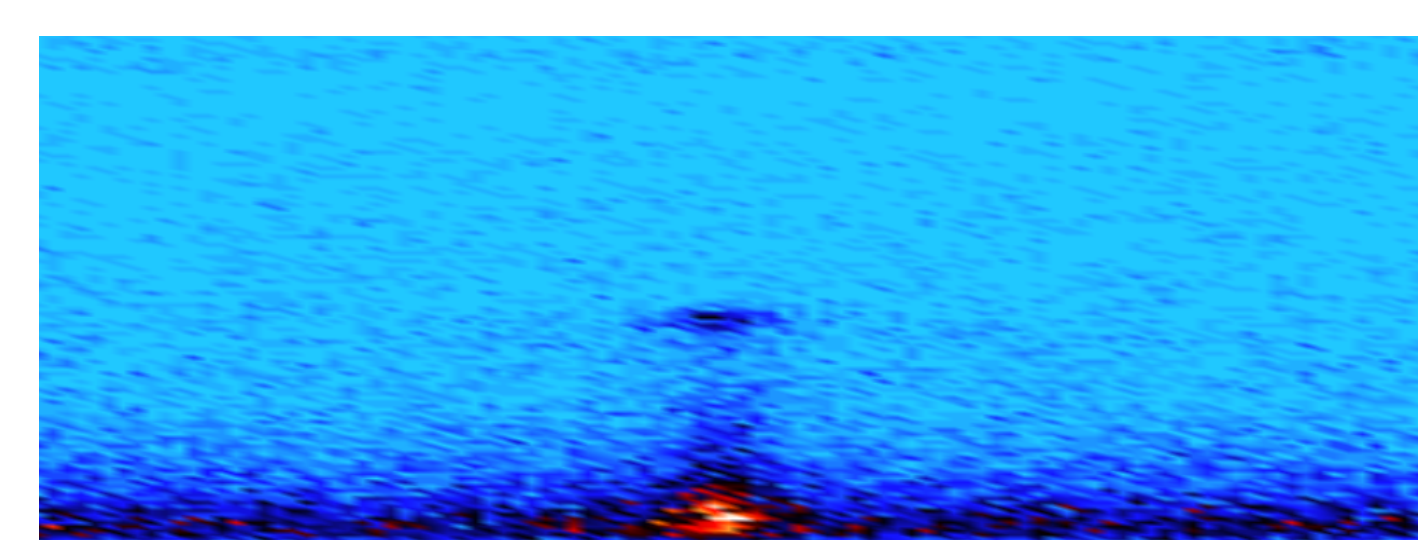
The background used to calculate the detection limit resulted in  $\approx 350$  cps when measured with a 3" x 3" NaI(Tl)-detector. The detection limit was calculated to correctly identify the presence of a source in 95 % of the cases.

For comparison, the detection limit was also calculated for a NaI(Tl)-detector. Values for the energy resolution of the NaI(Tl)-detector were obtained from Milbrath *et al.* [3] and Moszyński *et al.* [4].



## Using the deviation display

To simplify the interpretation of the relatively complex pulse height distribution from a  $\text{LaBr}_3:\text{Ce}$ -detector when doing mobile  $\gamma$ -spectrometry, the deviation display [5] is used instead of the regular waterfall display.



A qualitative test of a modification of the deviation display was done. The  $\text{LaBr}_3:\text{Ce}$ -detector and a 3" x 3" NaI(Tl)-detector was placed in a vehicle driving  $\approx 30$  km/h down a road with a  $\approx 37$  MBq  $^{137}\text{Cs}$  source placed 15 meters away from the road.

## Conclusion

Although the deviation display was used successfully to limit the effect of the internal contamination when doing mobile  $\gamma$ -spectrometry, the conclusion drawn is that the increase in detector efficiency and resolution is not enough for the  $\text{LaBr}_3:\text{Ce}$ -detector to replace the NaI(Tl)-detector. Despite this, the  $\text{LaBr}_3:\text{Ce}$ -detector has its uses and could prove valuable when mapping radiation fields in a medium to high pulse rate environment.

## Thanks to

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