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A 2-D localization of a lightly shielded radiation source using a network of small form factor CZT sensors

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INTRODUCTION

Illicit trafficking of radioactive substances and the risk of their use in radiological bombs (dirty bombs) is a problem that the research community has been experiencing in recent years. Their localization is particularly difficult and from time to time a variety of detection methods have been proposed, particularly in areas with relatively defined inputs / outputs e.g. in ports and airports. However, their identification in open spaces e.g. squares, stadiums have a greater degree of difficulty. Below is a method of detecting radioactive substances in open spaces, which was studied by our team.

DETECTION APPARATUS

We used solid-state CZT spectroscopic detectors, of the type shown in Figure 1 below. These detectors are of small size but very sensitive and record the energy spectrum of the radiation emitted by radioactive materials (X, γ radiation).

***Figure 1:** Solid state spectroscopic CZT detectors.*

A system of five such detectors in cruciform topology (Figure 2) records the gamma-ray spectrum in real time. The data are transmitted to a central computer station for processing. A ^{137}Cs radiation gel source of about 7MBq embedded in a Pb cylinder of 1cm width was used to test the performance of the source localization algorithms.

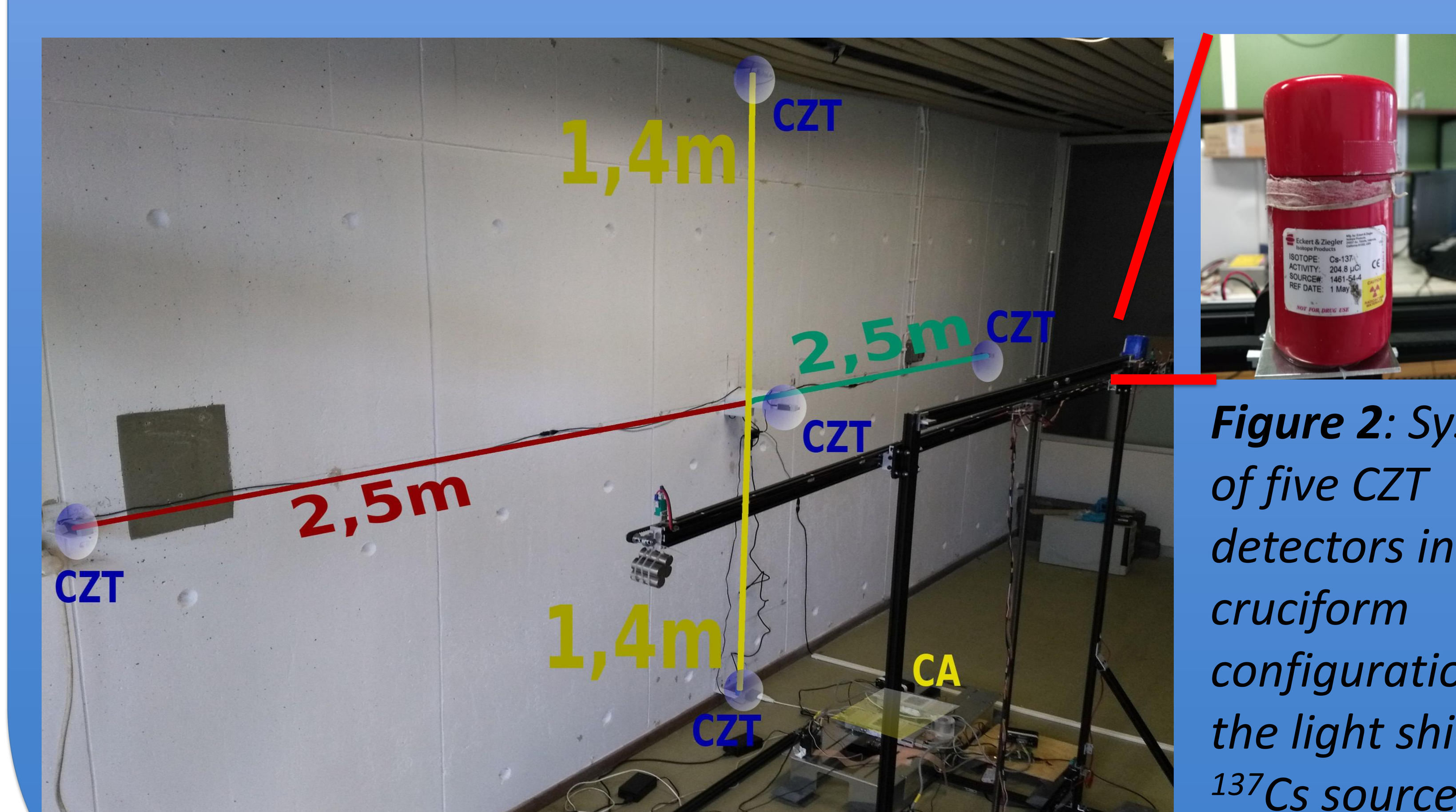

***Figure 2**: System of five CZT detectors in cruciform configuration and the light shielded ^{137}Cs source.*

SPECTRAL RESPONSE

The spectral response of the system for a ^{137}Cs light shielded radioactive source located in an arbitrary point inside a monitoring area of 500 × 280 × 200 cm^3 is shown in Figure 3.

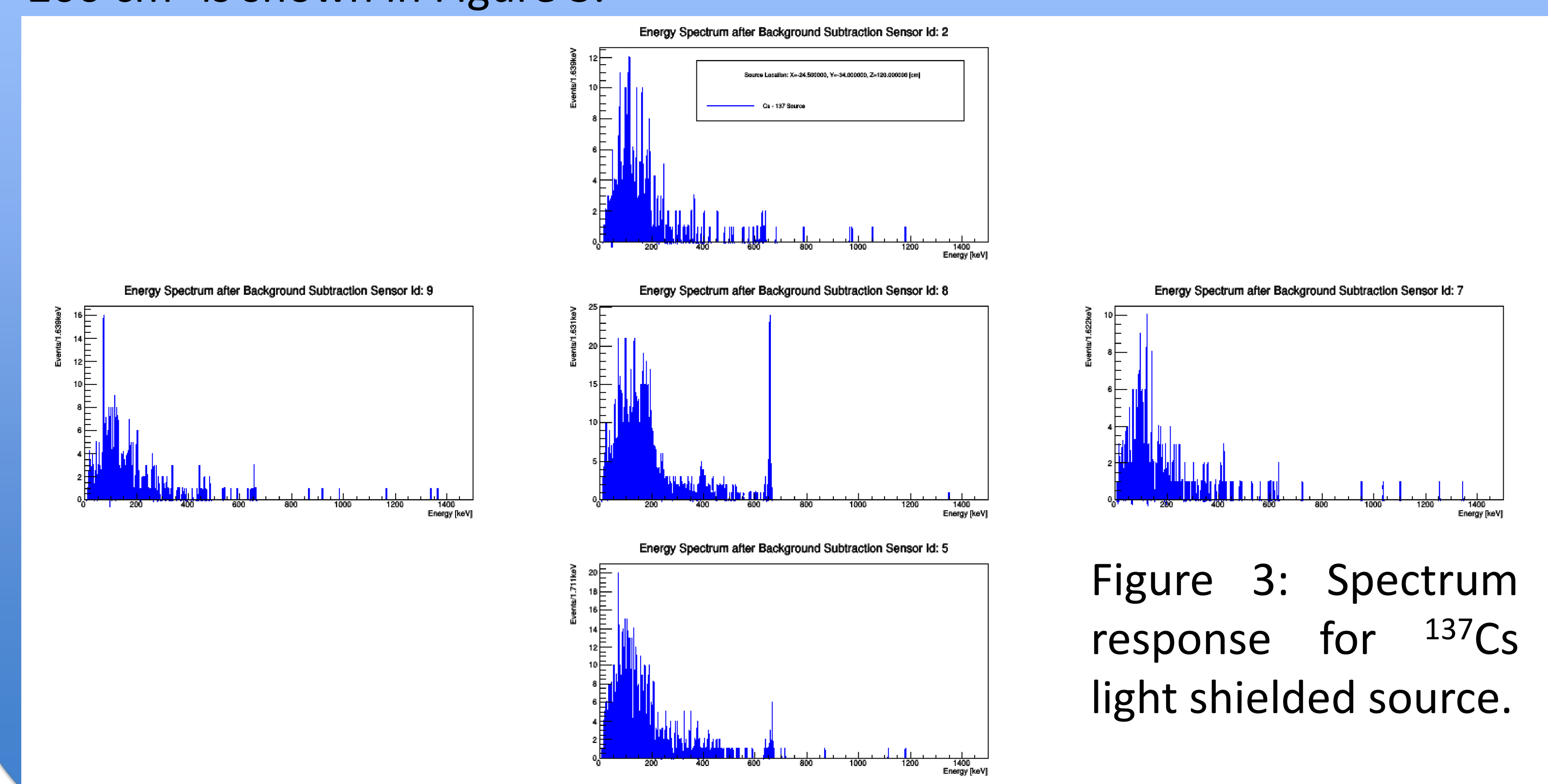

Figure 3: Spectrum response for ^{137}Cs light shielded source.

ALGORITHMS - SYSTEM RESPONCE

After processing the spectra in the central computing station using analytical algorithms and machine learning techniques, the location of the radioactive material can be estimated with a resolution better than 20 cm in horizontal and vertical directions for an exposure time of at least 40sec (Figure 4).

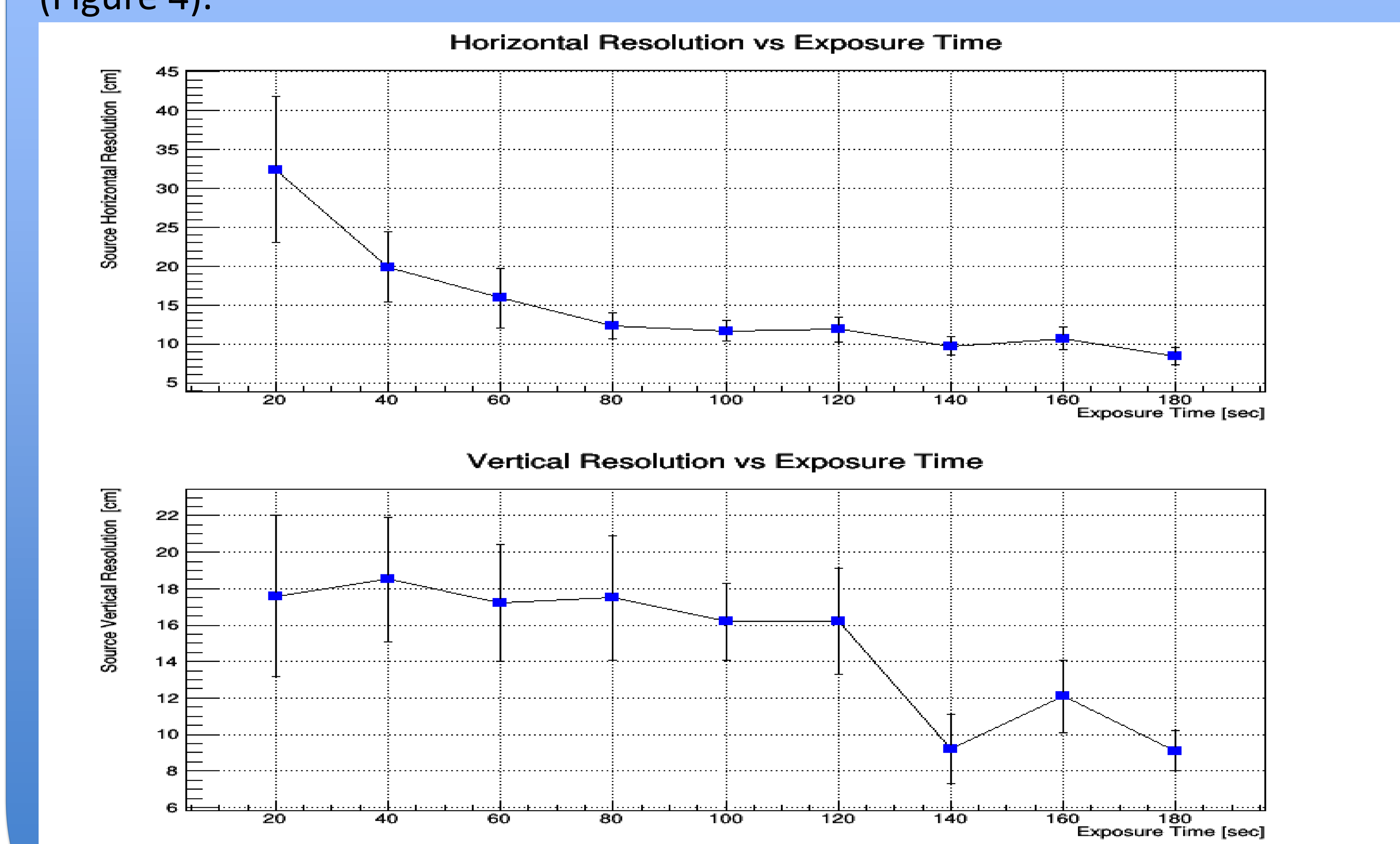

***Figure 4:** .Horizontal (up) and vertical (down) position resolution of the light shielded ^{137}Cs radioactive source.*

CONCLUSIONS

A network of five small form factor solid state CZT detectors in cruciform topology was used for a 2-D localization of lightly shielded radiation sources. Both analytical algorithms and machine learning techniques, show that the location of the radioactive material can be estimated with a resolution better than 20 cm in horizontal and vertical directions for an exposure time of at least 40sec.

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