# MA-XRF scanner using a handheld spectrometer

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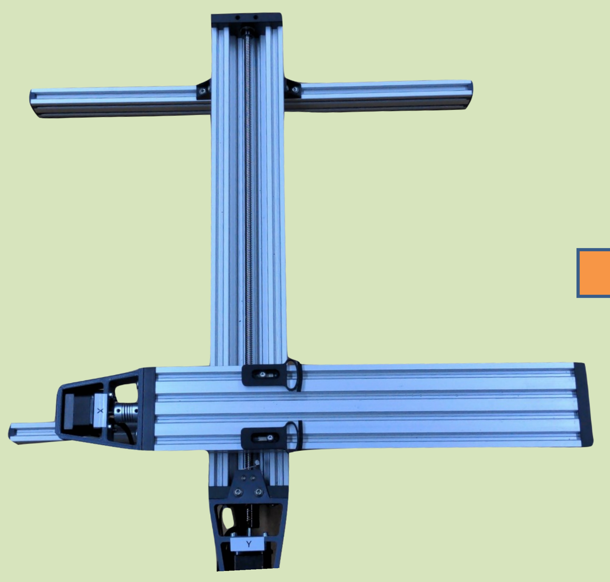
## *Introduction*

Single point XRF analysis proved to be exceptionally useful for materials characterization. Recent advancements in instrumentation allowed in situ analysis with the use of handheld XRF spectrometers. However, no matter how widespread and useful handheld spectrometers have proven to be, their limitations compared to MA – XRF scanning is obvious [1]. In the current work, we developed a way to produce elemental distribution maps using a handheld spectrometer by building a low–cost XY positioning stage that enables sample movement. The system utilizes a microcontroller board and two linear motion stages. The communication with both the spectrometer and the positioning stage is accomplished by a Python script and using industry-standard G-code instructions. An open-source web interface allows for remote monitoring of the progress of the scan. The spectrometer is mounted above the scanning area on a tripod.

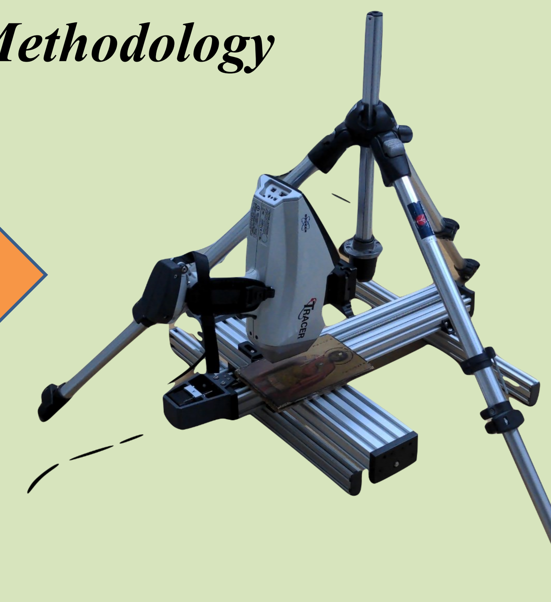
MA–XRF setups are commercially available, but they come at a high cost and even though they are considered portable, the mobility of the system described above is unparalleled. This setup can be used in the analysis of inhomogeneous areas, that elemental mapping is of high importance, such as paintings and other artifacts of cultural heritage [2], geological samples (core samples) [3], or even can be used as a multi measurement tool by spreading on the positional stage multiple samples.

## *Methodology*

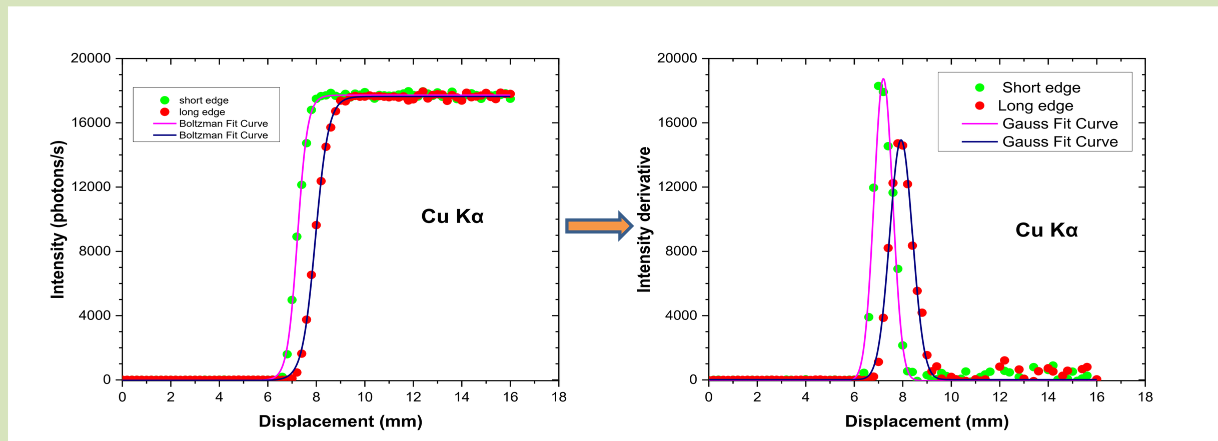


The x-y stage that was built by combining two low-cost linear stages, the is handled by using an ESP 32 controller. The minimum step that can be achieved is 100 μm on each direction.


The handled spectrometer (Tracer 5i, Bruker) and the original aluminum collimators (3mm and 8mm spot sizes – 2mm and 4.5mm bore size) that accompany the instrument. On top a modified collimator, where a brass thread was drilled to achieve 1 mm beam spot



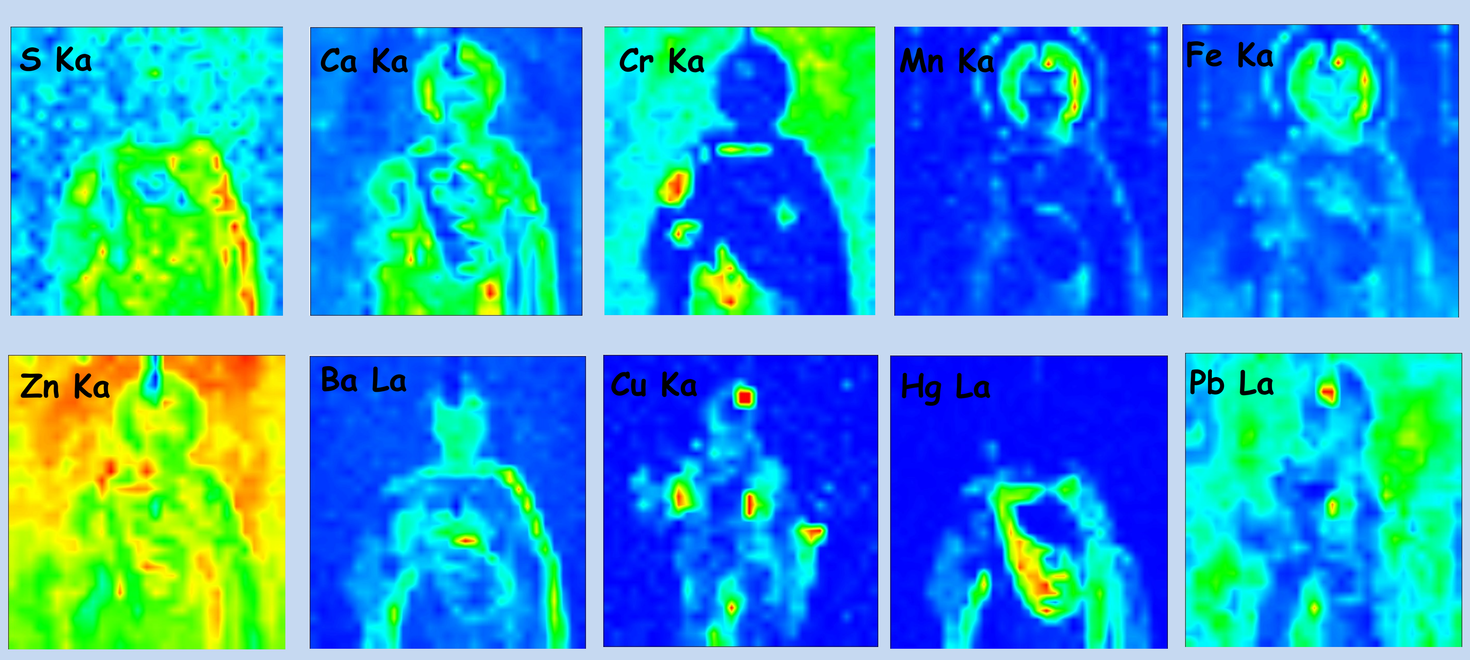
The spectrometer mounted on a tripod during scanning of a panel painting



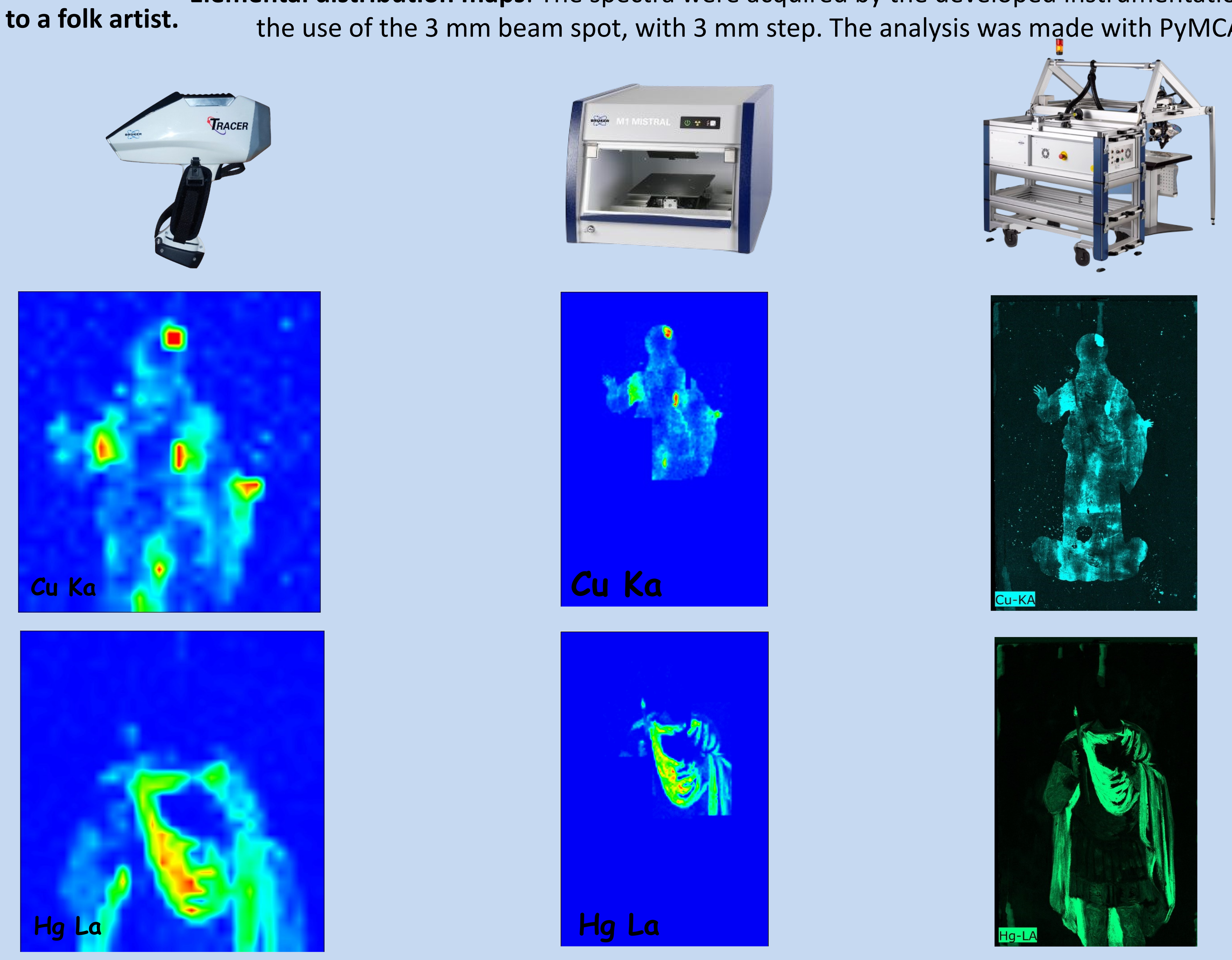

Measurement of the 1mm (custom made collimator) beam spot. The sample is 1 mm away from the nominal sample position. The beam spot was found equal to 1.1 mm for the long edge and 0.9 mm for the short edge.

## *Panel painting*

**The examined panel painting (11.5 x 17.5 cm²) depicts Saint Fanourios and is attributed to a folk artist.**

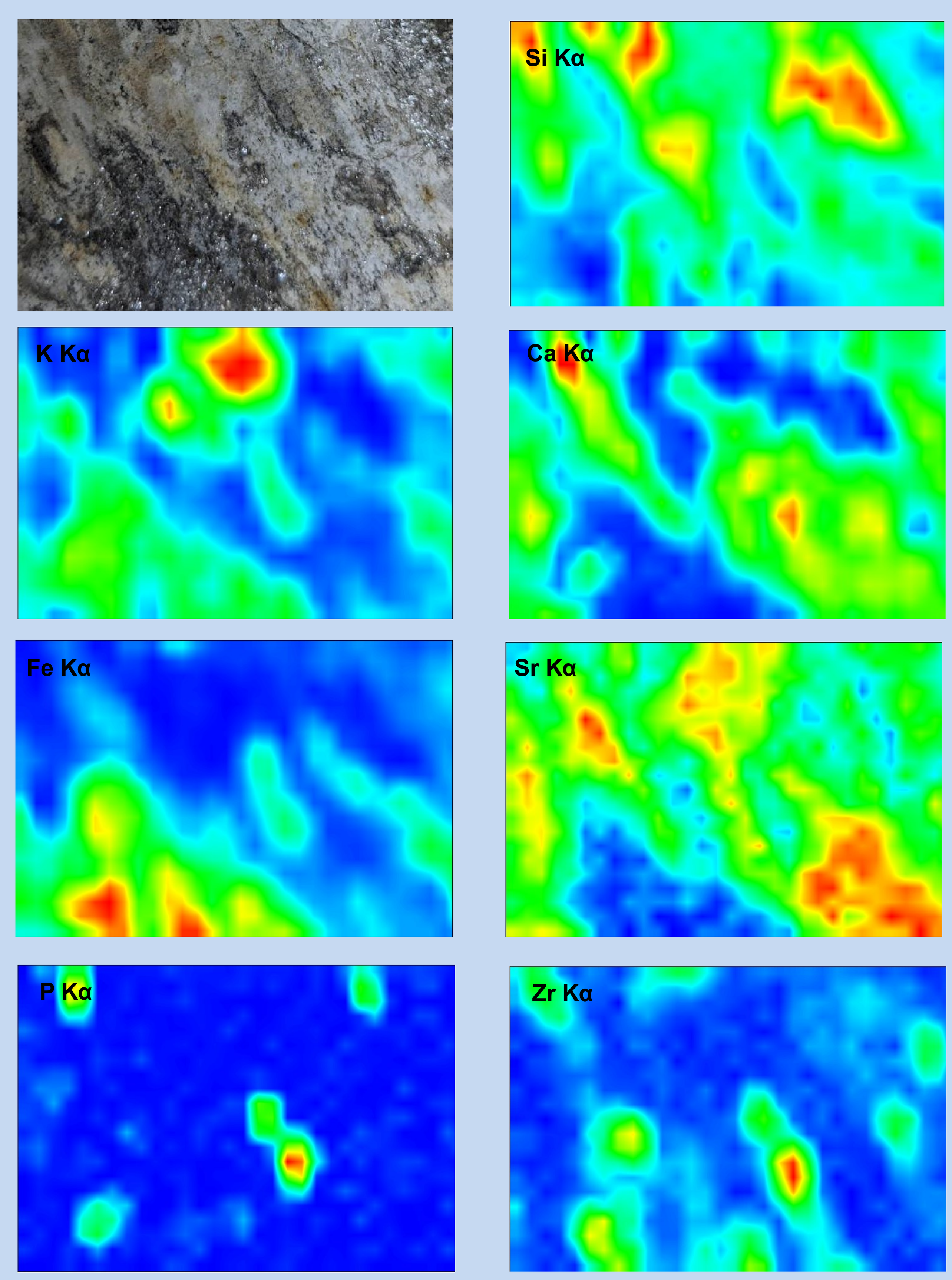



**Elemental distribution maps**: The spectra were acquired by the developed instrumentation with the use of the 3 mm beam spot, with 3 mm step. The analysis was made with PyMCA




**Comparison of three different scannings: With the developed instrumentation (left), with a tabletop micro-XRF spectrometer M1- Mistral (middle) and state of the art MA-XRF spectrometer M6 Jetstream (right)**

## *Rock sample*




Elemental distribution maps of a **2x3 cm²** rock sample that originates from Karistos (Evia, Greece).
1 mm beam spot and 1 mm step was used for the measurement.
The analysis was made with PyMCA

## Conclusions

In the current work we developed a way of producing elemental distribution maps, by combining a handheld spectrometer with a low-cost x-y stage. Even though the suggested instrumentation lacks in spatial resolution, the mobility of the system is of great importance and can be used in- situ as a means of preliminary examination. Also, the sensitivity of the instrument to the low–Z elements makes the presented implementation an excellent tool for qualitive analysis.

## References

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