Combining rotational and translational MA-XRF fast scanning for a real-time elemental imaging of 3D painted artworks

F.P. Romano[1], C. Caliri[2], P. Nicotra[3], S. Di Martino[3]

(1) IBAM-CNR, Via Biblioteca 4, 95124 Catania, Italy
(2) INFN-LNS, Via Santa Sofia 62, 95123, Catania, Italy
(3) SIATEL Srl, Via Santa Sofia 62, 95123, Tremestieri Etneo, Italy

LANDIS-X is a novel mobile X-ray scanner integrating MA-XRF, µXRF and confocal-XRF for performing a real-time elemental imaging of paintings. The instrument is based on a modular X-ray source (Rh- and Cr-targets) focused with a polycapillary and two SDD detectors operated simultaneously in TLIST event-mode. The scanner is based on a three-axis system presenting a $110 \times 70 \times 20$ cm^3 range. A rotational scanning option has been recently introduced in the scanner with the aim of performing the XRF elemental imaging of 3D painted artworks. A combination of a stet-by-step rotation with a continuous translation along Y and Z directions (the latter guided with a laser sensor operated in a real-time), allows obtaining high-resolution images over a scanning range of 360 degrees.

LANDIS-X allows performing different X-ray based techniques. MA-XRF is carried out by positioning samples out of the polycapillary focus with the primary beam presenting a spot size of some hundreds of microns. The full area is covered in 4.3 h with a pixel size of 500 µm and 5 ms dwell time (i.e., 100 mm/sec scanning speed). A lateral resolution of 25 µm can be achieved at the focus positon, allowing the use of the scanner for a high resolution micro-XRF mapping of pigment materials. Finally, a conical polycapillary equips an ancillary SDD detector easily enabling a confocal-XRF set-up. A depth profile of the pictorial layer can be performed with 15-20 µm resolution.

X-ray pixel spectra are processed on the fly with a real-time least square fitting procedure, and elemental images are elaborated in a live mode during the scanning. A number of processing functions are applied to the forming images by using a robust software included in LANDIS-X. Among the analytical capabilities: mathematical, logical and geometrical operations; RGB and LUT correlation maps; Local, maximum pixel and sum X-ray spectra analysis; PCA and ICA analysis; ROI imaging spectroscopy; Scatter Plots are included in the software.

Elemental distribution correlation maps of Fe and Ca in a painted attic pottery obtained by combining rotational and translational MA-XRF scanning