

# MA-XRF data evaluation

Matthias Alfeld, Geert van der Snickt  
ICXOM Satellite Workshop CH MA-XRF  
Trieste, 24.09.17

# Curriculum Vitae

Name	Matthias Alfeld
2003-2008	Diplom Chemiker (University of Hamburg, DE)
2008-2013	Dr. rer. nat. / Doctor in de wetenschappen Universities of Hamburg (DE) and Antwerp (BE) <i>Development of Scanning macroXRF for the Investigation of Historical Paintings</i>
2013-2015	Post Doc and Beamline Scientist at the Deutsches Elektronen Synchrotron (DESY) in Hamburg (DE)
2015-2018	<b>Junior Chair</b> at the Laboratoire d'Archéologie Moléculaire et Structurale (LAMS) , CNRS, UMR 8220, Sorbonne Universités, UPMC Univ Paris 06

# My PhD at the UA: Mobile scanners for paintings

Instrument A (2009)



Instrument B (2010)



Instrument C (2010)



Instrument D (2011)



# My PhD at the UA: Mobile scanners for paintings

Instrument A (2009)



Instrument B (2010)



Bruker M6 Jetstream (2012)



Instrument D (2011)



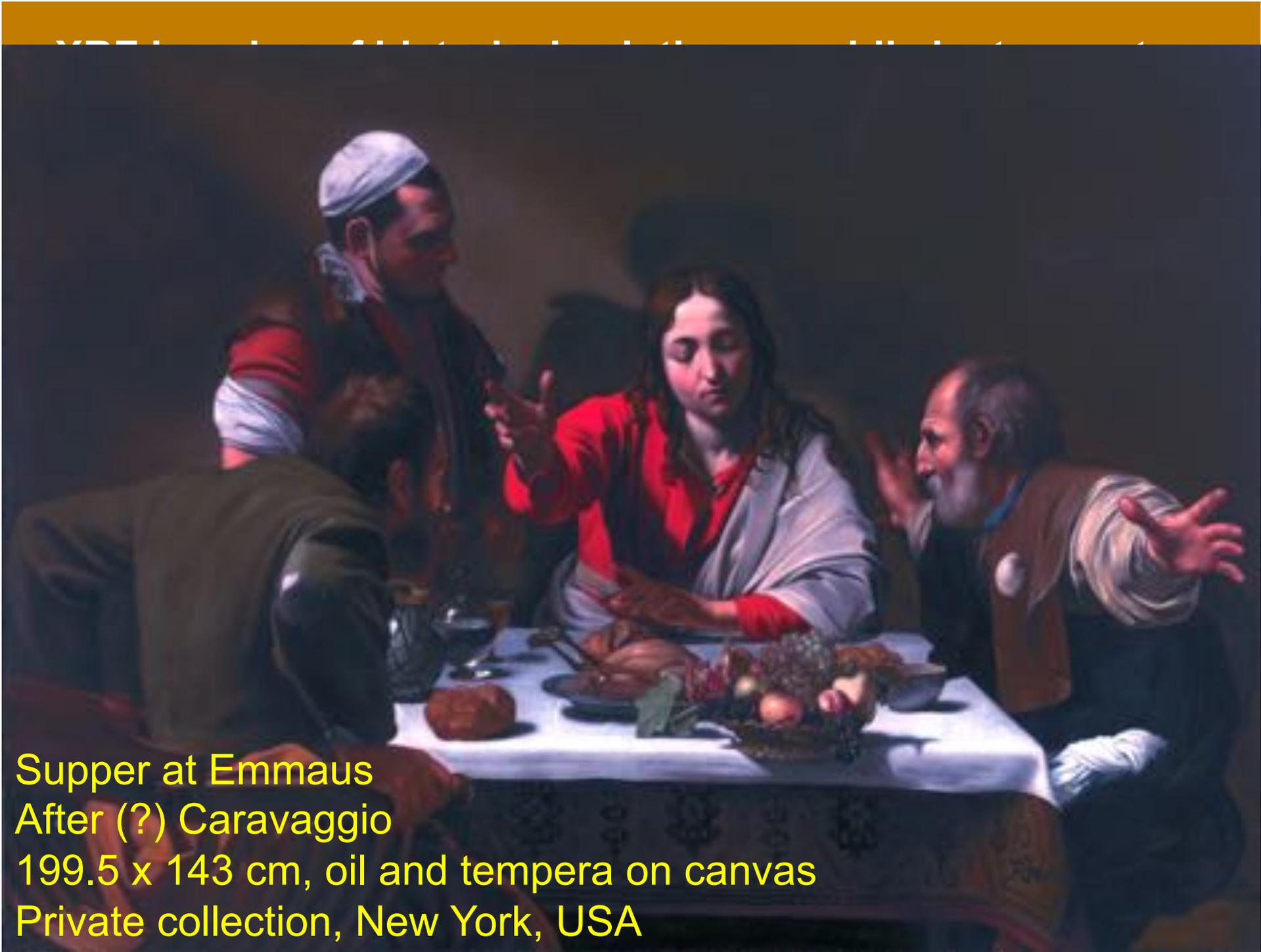
Universiteit  
Antwerpen

# Besprochene Gemälde



# Preliminary Notes

- > This tutorial explains my personal workflow to develop MA-XRF imaging data of historical paintings.
- > This needs two software packages: PyMCA and datamuncher.
- > PyMCA:
  - I am not the developer
  - I will only explain the features we need (there are much more)
  - One reason to learn it: It is instrument independent, so you can take the knowledge with you.
- > Datamuncher is my work and can be found:
  - <http://sourceforge.net/projects/datamuncher/>

A dramatic oil and tempera painting on canvas depicting the biblical story of the Supper at Emmaus. The scene is set in a dark, dimly lit room. In the center, a woman with long dark hair, wearing a red tunic and a grey shawl, sits at a table covered with a white cloth. She has her eyes closed and her hands are raised in a gesture of prayer or surprise. To her right, an older man with a white beard and a brown vest over a dark tunic sits at the table, also with his hands raised and a look of awe on his face. In the foreground, the back of a man's head and shoulders is visible, looking towards the central figures. The table is set with various dishes, including bread, a bowl, and a basket of fruit. The lighting is focused on the central figures, creating a strong contrast with the dark background.

Supper at Emmaus  
After (?) Caravaggio  
199.5 x 143 cm, oil and tempera on canvas  
Private collection, New York, USA



(For a Long Time)

World's Largest Object Entirely Mapped with XRF

Composed of 12 individual scans with Instrument D

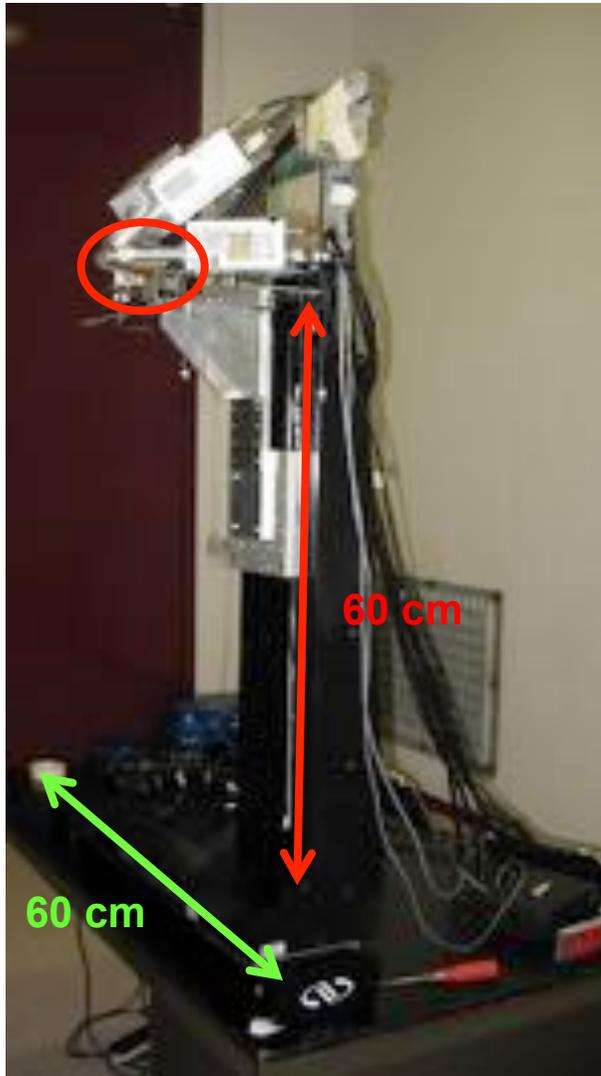
2032 x 1456 pixel

1 mm step size

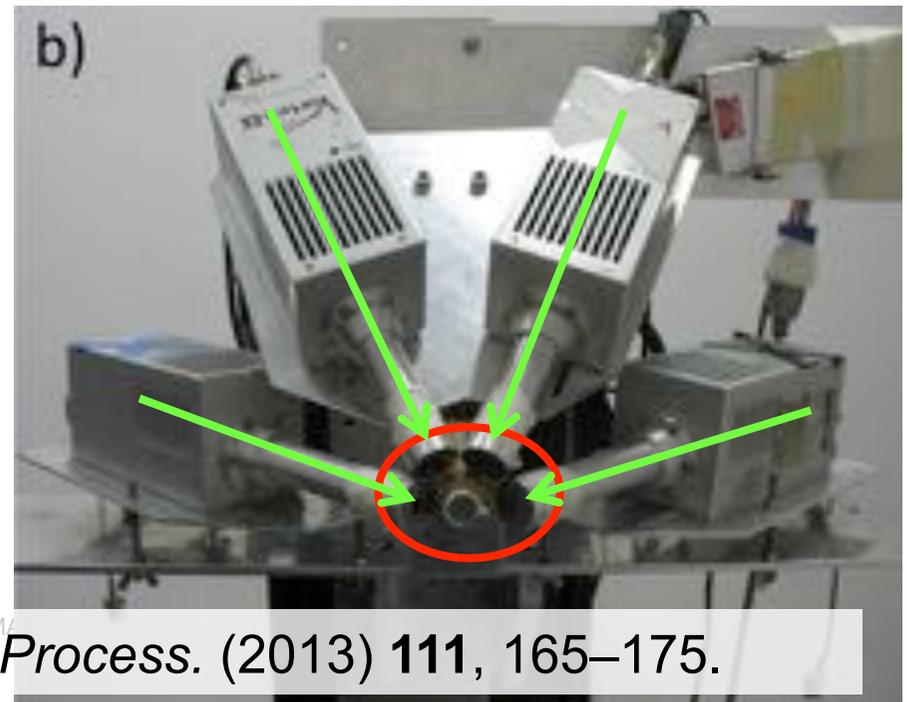
~0.4 s/pixel

=> 16 days

# XRF imaging of historical paintings: mobile instruments



Name: Instrument D (University of Antwerp)  
Source: 10 W Rh X-ray tube  
Optic: 0.5 or 0.8 mm Pb pinhole  
Detectors: 4 SDDs  
Range: 60 x 60 cm<sup>2</sup>



M. Alfeld, et al., *Appl. Phys. A: Mater. Sci. Process.* (2013) **111**, 165–175.



Identification of minor components

Fe: Earth pigments



Mn: Earth pigments



Identification of minor components

Hg-L: Vermilion (HgS)



Pb-L: Lead white



Cu: Green and blue pigments



# Smalt



- Smalt is a ground Co-rich K based glass, used as a blue pigment in the 17<sup>th</sup> century.
- Its minor components next to Co and K are: Fe, Ni, As and Bi.
- Different kinds of smalt are known to be used.

K. Janssens, G. Van Der Snickt, M. Alfeld, P. Noble, A. van Loon, J.K. Delaney, et al., Rembrandt's "Saul and David" (c. 1652): Use of multiple types of smalt evidenced by means of non-destructive imaging, *Microchem. J.* 126 (2016) 515–523. doi:10.1016/j.microc.2016.01.013.

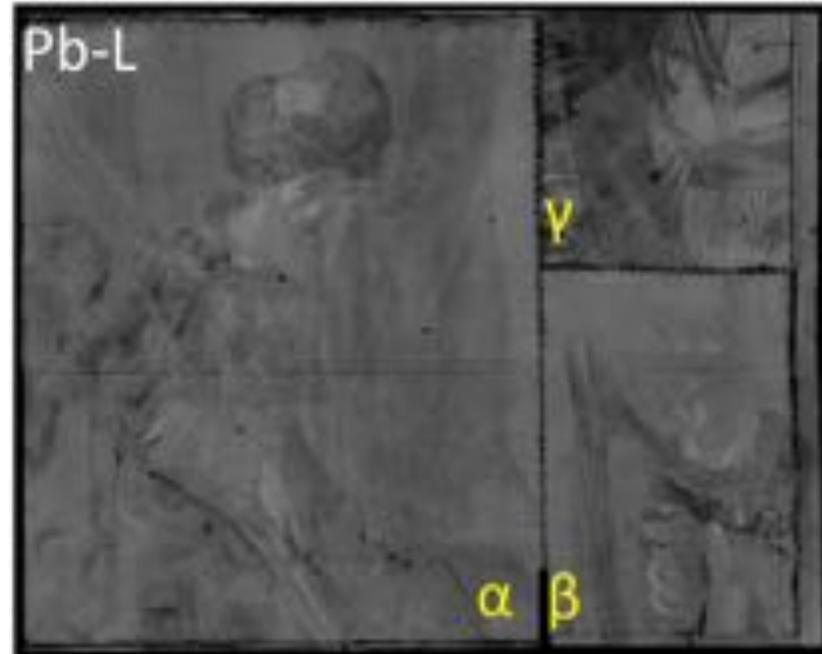
# Saul and David



Rembrandt, Saul and David, c. 1652  
126 x 158 cm, Mauritshuis Museum  
inv. no. MH621, Bredius no. 526  
oil on canvas

K. Janssens, G. Van Der Snickt, M. Alfeld, P. Noble, A. van Loon, J.K. Delaney, et al., Rembrandt's "Saul and David" (c. 1652): Use of multiple types of smalt evidenced by means of non-destructive imaging, *Microchem. J.* 126 (2016) 515–523. doi:10.1016/j.microc.2016.01.013.

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# Saul and David



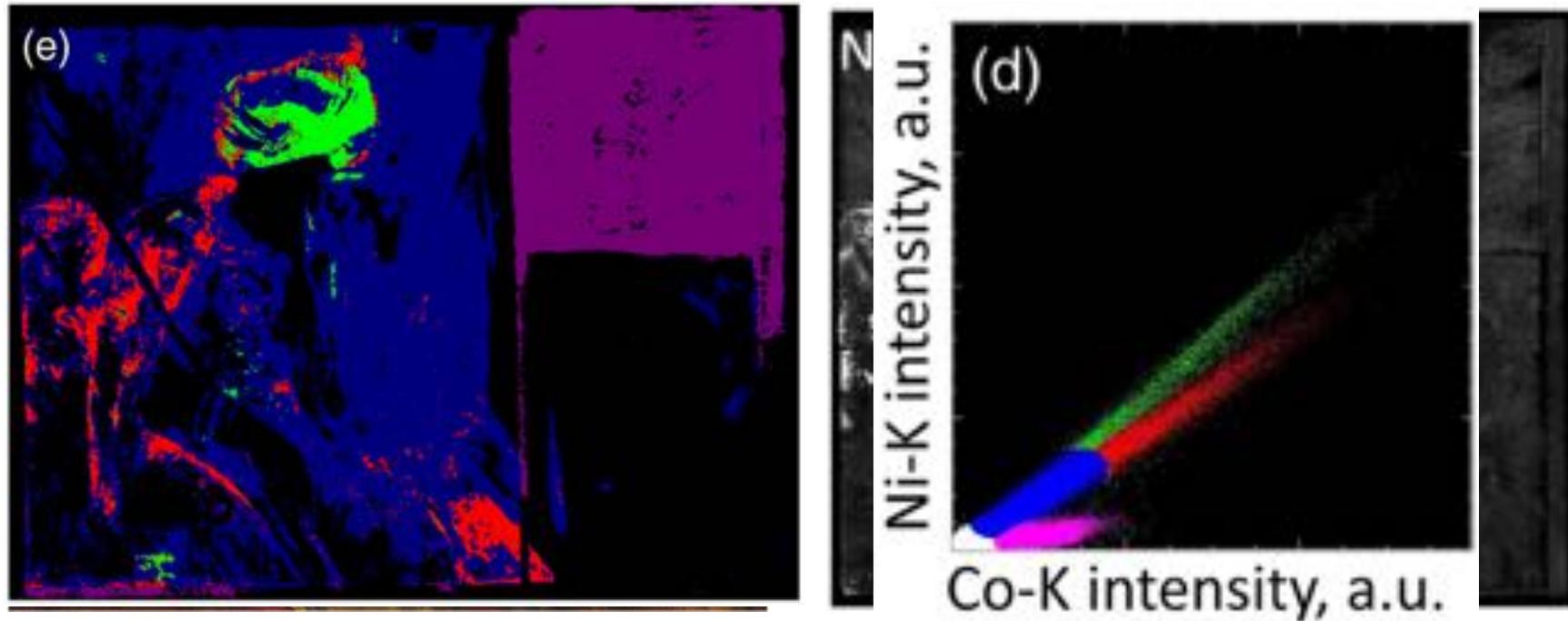
K. Janssens, G. Van Der Snickt, M. Alfeld, P. Noble, A. van Loon, J.K. Delaney, et al., Rembrandt's "Saul and David" (c. 1652): Use of multiple types of smalt evidenced by means of non-destructive imaging, *Microchem. J.* 126 (2016) 515–523. doi:10.1016/j.microc.2016.01.013.

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K. Janssens, G. Van Der Snickt, M. Alfeld, P. Noble, A. van Loon, J.K. Delaney, et al., Rembrandt's "Saul and David" (c. 1652): Use of multiple types of smalt evidenced by means of non-destructive imaging, *Microchem. J.* 126 (2016) 515–523. doi:10.1016/j.microc.2016.01.013.



Portrait of a man, unknown artist,  
private collection  
88.5 x 74 cm<sup>2</sup>, oil on canvas

controversial attribution:  
Portrait of Michelangelo(?)  
1520 Sebastiano del Piombo

Barbieri, C. 'Chompare e amicho karissimo: A portrai  
of Michelangelo by his friend Sebastiona.' *Artibus et  
Historiae*. Vol. 28, nr. 56, 2007, pp.107-120.

# References

## > My data evaluation workflow has been published:

- M. Alfeld, K. Janssens, "Strategies for processing mega-pixel X-ray fluorescence hyperspectral data: a case study on a version of Caravaggio's painting Supper at Emmaus", *J. Anal. At. Spectrom.* 2015, **30**, 777-789. doi: 10.1039/C4JA00387J
- <http://sourceforge.net/projects/datamuncher/>
- [www.youtube.com/channel/UCTUlnhE6gO6nteTNfCkuseA/playlists](http://www.youtube.com/channel/UCTUlnhE6gO6nteTNfCkuseA/playlists) (linked on sourceforge)

## > If you are interested in the development of MA-XRF you can look up (and cite) my review papers:

- 2012-2017:  
M. Alfeld, L. de Viguerie, "Recent developments in spectroscopic imaging techniques for historical paintings – A Review", *Spectrochim. Acta, Part B*, 2017, **136**, 81-105. doi: 10.1016/j.sab.2017.08.003
- -2012:  
M. Alfeld, J.A.C. Broekaert, "Mobile depth profiling and sub-surface imaging techniques for historical paintings - A Review", *Spectrochim. Acta, Part B* 2013, **88**, 211-230. doi: 10.1016/j.sab.2013.07.009

## > Proper references to PyMCA are:

- M. Cotte, T. Fabris, G. Agostini, D. Motta Meira, L. De Viguerie, V.A. Solé, Watching Kinetic Studies as Chemical Maps Using Open-Source Software, *Anal. Chem.* 88 (2016) 6154–6160. doi:10.1021/acs.analchem.5b04819.
- V.A. Solé, E. Papillon, M. Cotte, P. Walter, J. Susini, A multiplatform code for the analysis of energy-dispersive X-ray fluorescence spectra, *Spectrochim. Acta Part B.* 62 (2007) 63–68. doi:10.1016/j.sab.2006.12.002.
- <http://pymca.sourceforge.net>