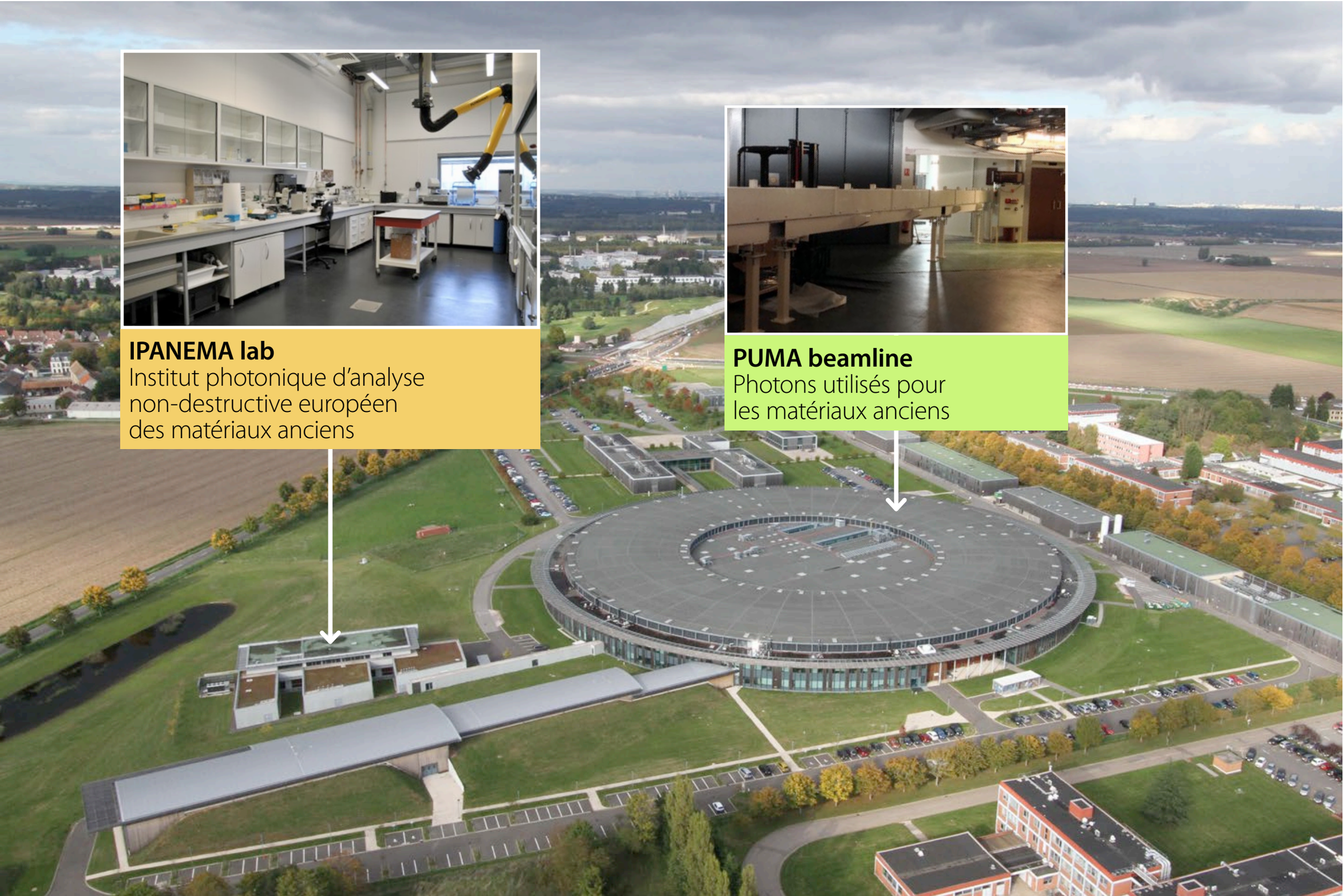
IPANEMA | ARCHAEOLOGY CONSERVATION SCIENCES PALAEONTOLOGY PALAEO-ENVIRONMENTS | ANCIENT MATERIALS RESEARCH PLATFORM

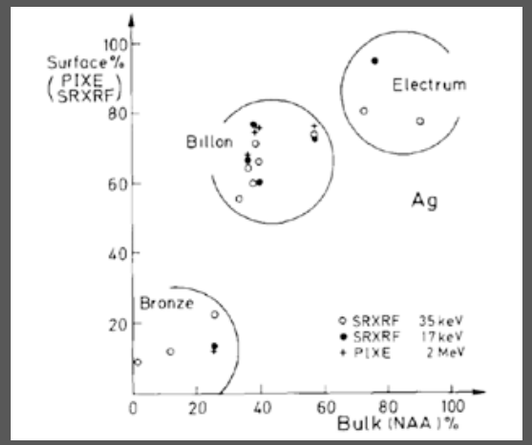
African projects at the IPANEMA research platform for ancient materials
Perspective within the *European research infrastructure for Heritage science*

Loïc Bertrand
IPANEMA, CNRS, ministère de la Culture et de la Communication
Université Paris–Saclay, France
Co-coordinator **ERIHS-FR**

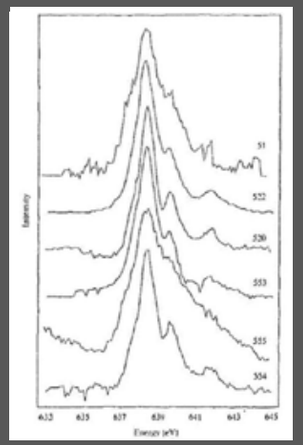
IPANEMA | ARCHAEOLOGY CONSERVATION SCIENCES PALAEONTOLOGY PALAEO-ENVIRONMENTS | ANCIENT MATERIALS RESEARCH PLATFORM

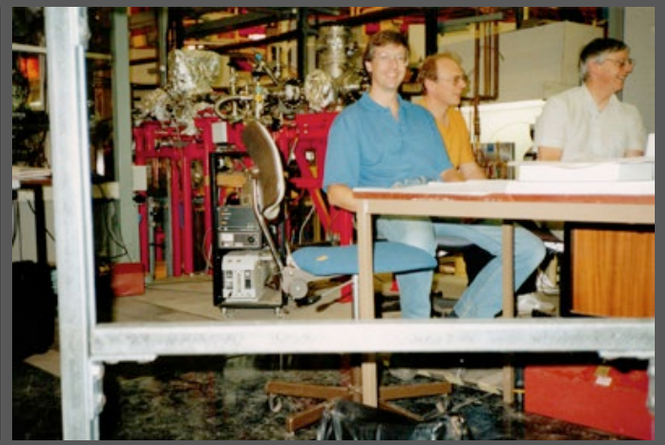

Louvre
Versailles
Orly
SOLEIL
0
2,5
5 km


IPANEMA lab
Institut photonique d'analyse non-destructive européen des matériaux anciens
PUMA beamline
Photons utilisés pour les matériaux anciens

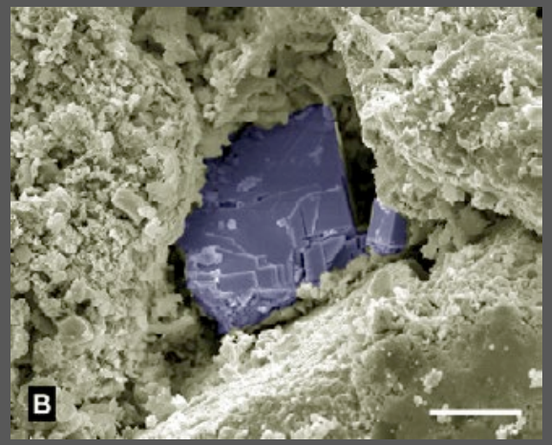


1989 P. Chevallier (LURE, Orsay) *et al.* show that synchrotron XRF discriminates ancient Gaullish coins from their composition

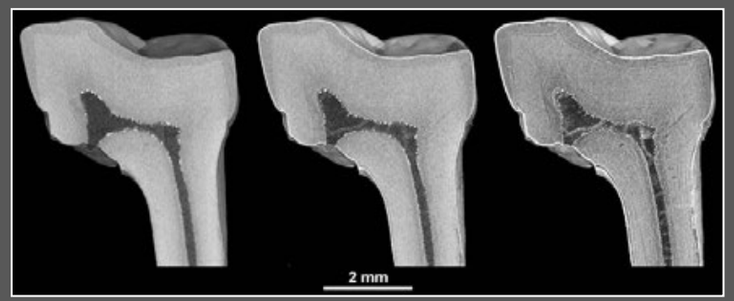




1995 P. Schofield (London NHM) *et al.* study the colour of ancient glasses by performing Fe and Mn X-ray speciation

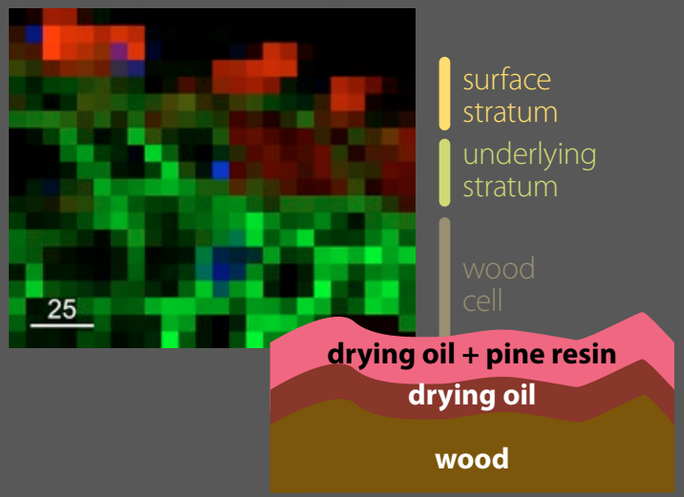


1999 Ph. Walter (C2RMF, Paris) *et al.* demonstrate that Egyptians mastered lead chemistry to synthesise cosmetics



2006 P. Tafforeau (ESRF, Grenoble) *et al.* demonstrate the power of phase-contrast µCT to image palaeontological fossils

2008 J. Dik (TU Delft) *et al.* visualise a lost Van Gogh painting by scanning a canvas painting



2010 J.-P. Échard (Musée de la Musique, Paris) *et al.* identify the process used by A. Stradivari to finish his musical instruments

South African rock art

St. Hoerlé, S. Mguni, D. Pearce, C. Sandt, L. Jacobson, L. Bertrand…

McGregor museum

AHRI

Materials microanalysis & dating for rock art studies

Clanwilliam, 28 Sept. – 05 oct. 2008

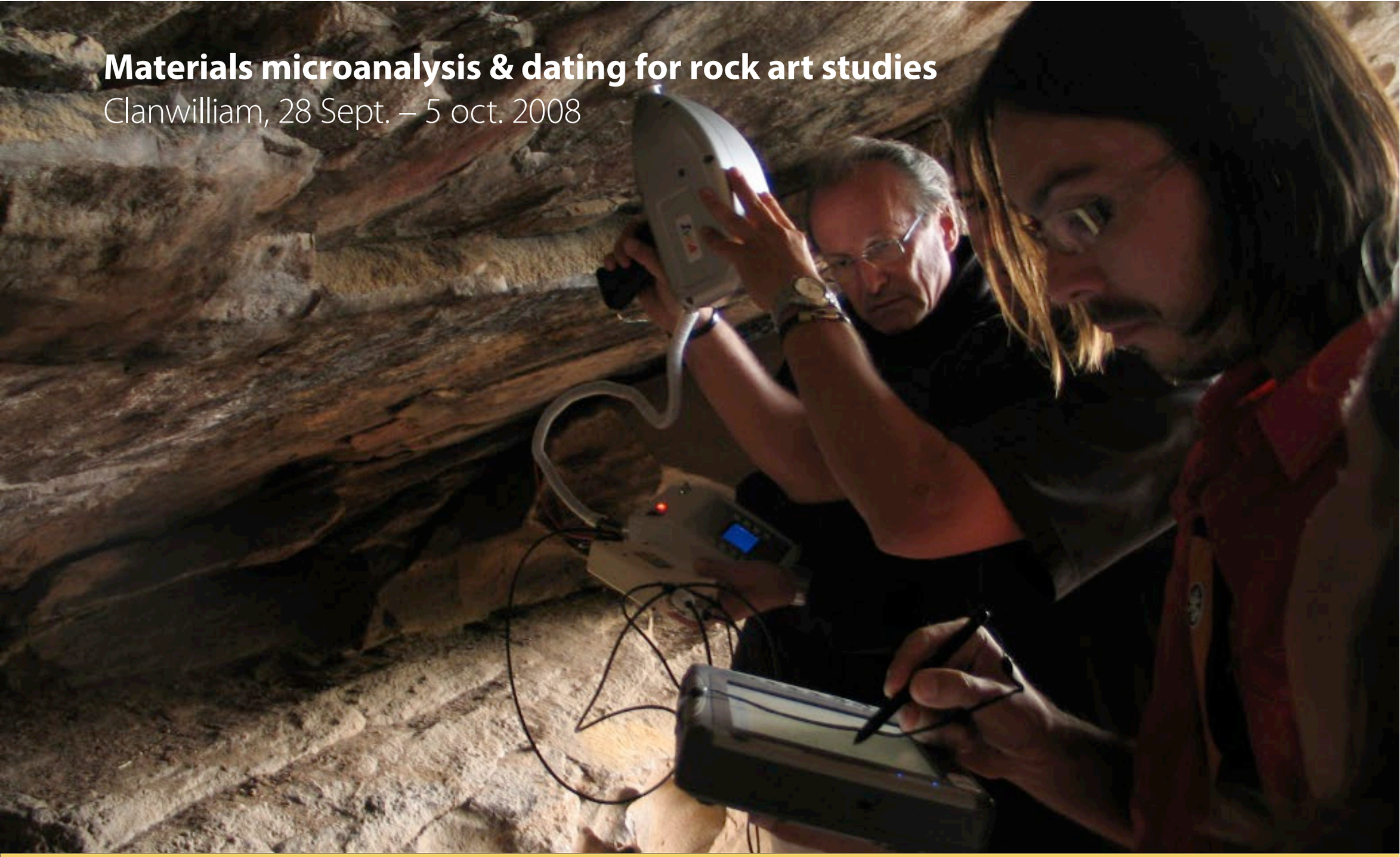
African Light Source Conference

Loïc Bertrand 17 November 2015

IPANEMA ARCHAEOLOGY CONSERVATION SCIENCES PALAEONTOLOGY PALAEO-ENVIRONMENTS | ANCIENT MATERIALS RESEARCH PLATFORM

Materials microanalysis & dating for rock art studies

Clanwilliam, 28 Sept. – 5 oct. 2008



African Light Source Conference

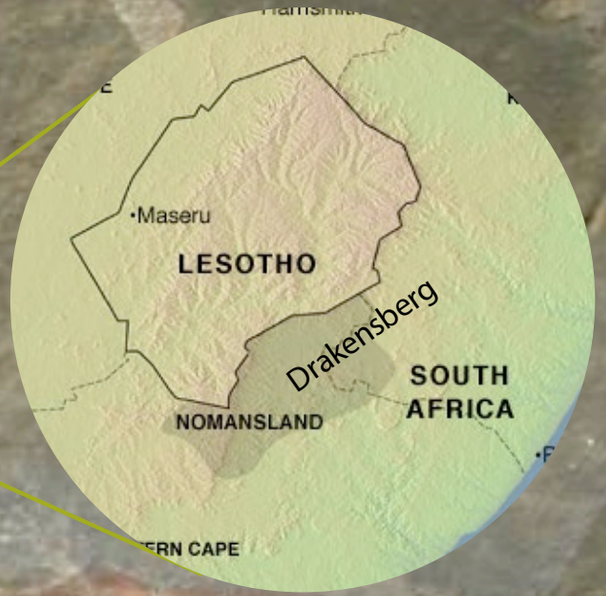
Loïc Bertrand 17 November 2015

IPANEMA ARCHAEOLOGY CONSERVATION SCIENCES PALAEONTOLOGY PALAEO-ENVIRONMENTS | ANCIENT MATERIALS RESEARCH PLATFORM

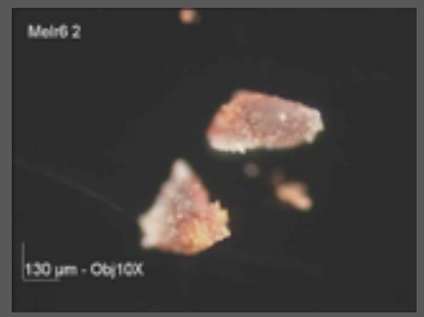
San rock art

St. Hoerlé, D. Pearce, L. Bertrand

collaboration: SOLEIL, PACEA, Wits/RARI, C2RMF, IPANEMA



1000 BC ??? - 1920's



exfoliated flakes from Nomansland
microsamples embedded in polyester resin

origins centre

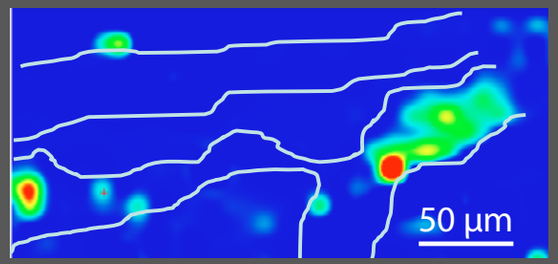
stereomicroscopy

light microscopy (visible, UV)

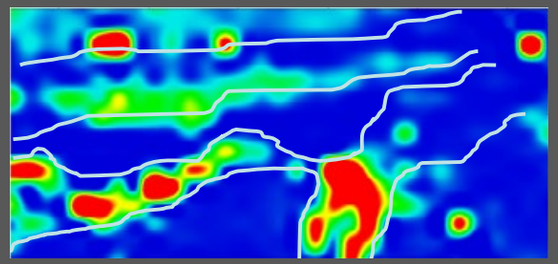
Raman spectrosc.

SEM-EDX

laboratory and synchrotron FT-IR



gypsum

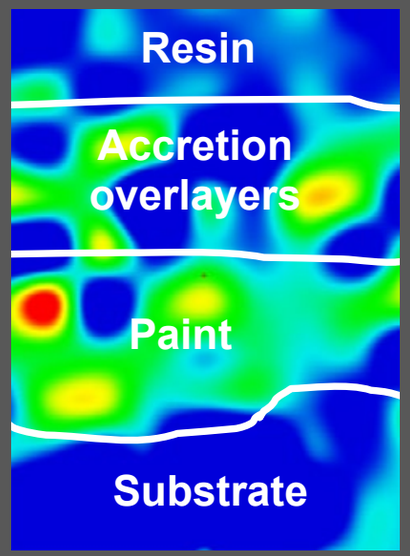


Ca oxalate

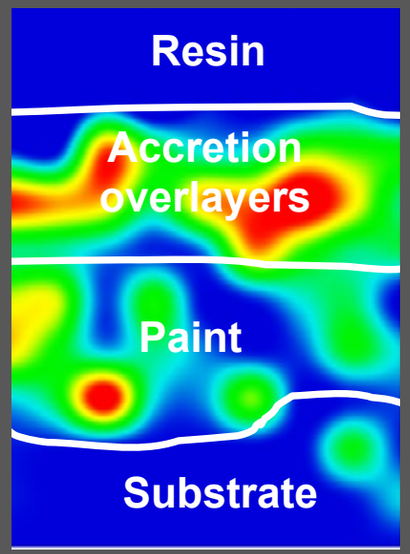
20 µm

SOLEIL SYNCHROTRON

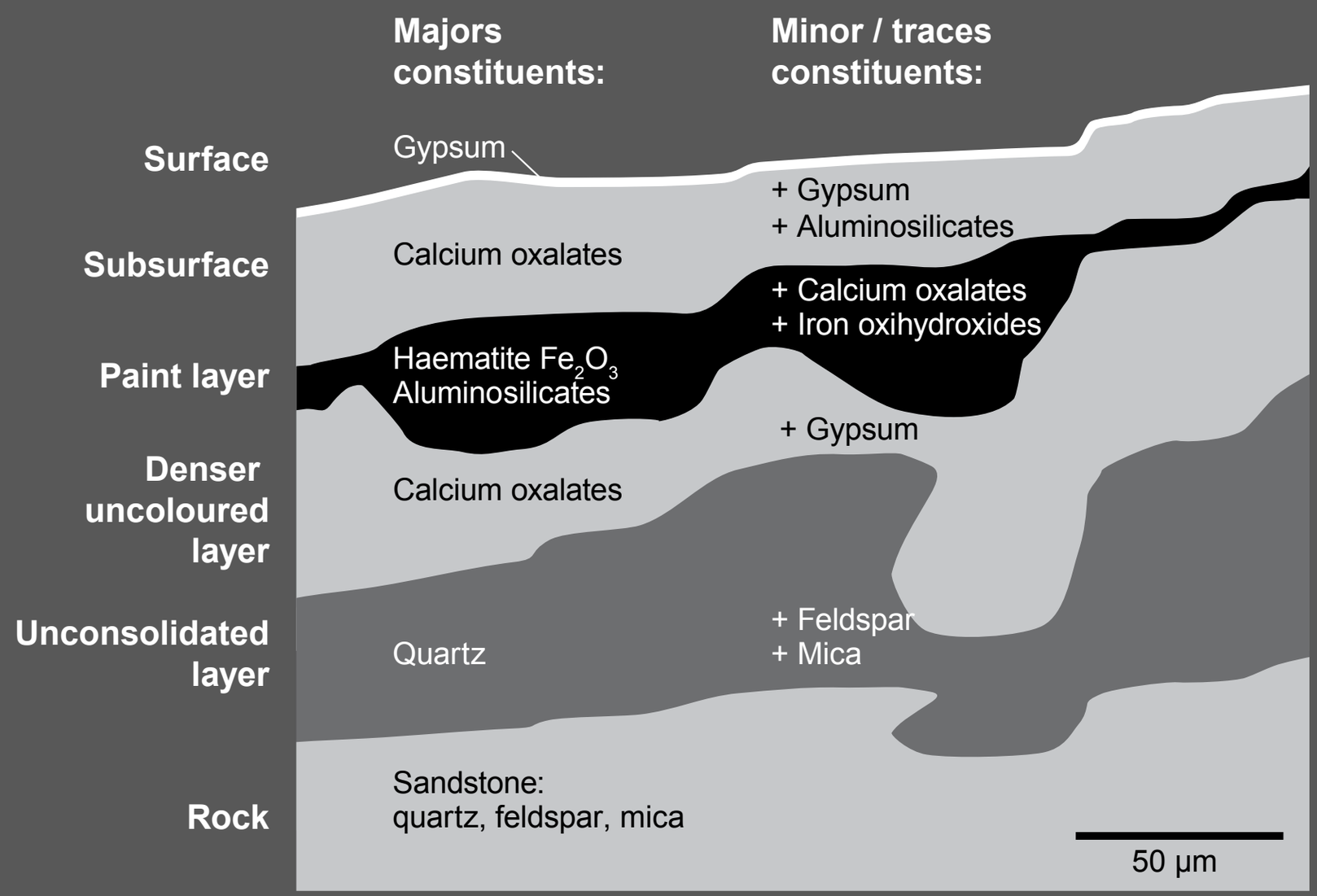
SMIS
µFTIR refl., 128 sc, 4 cm^{-1}
$(12\ \mu m)^2$ - step 10 µm



Fe oxihydroxydes



Ca oxalate



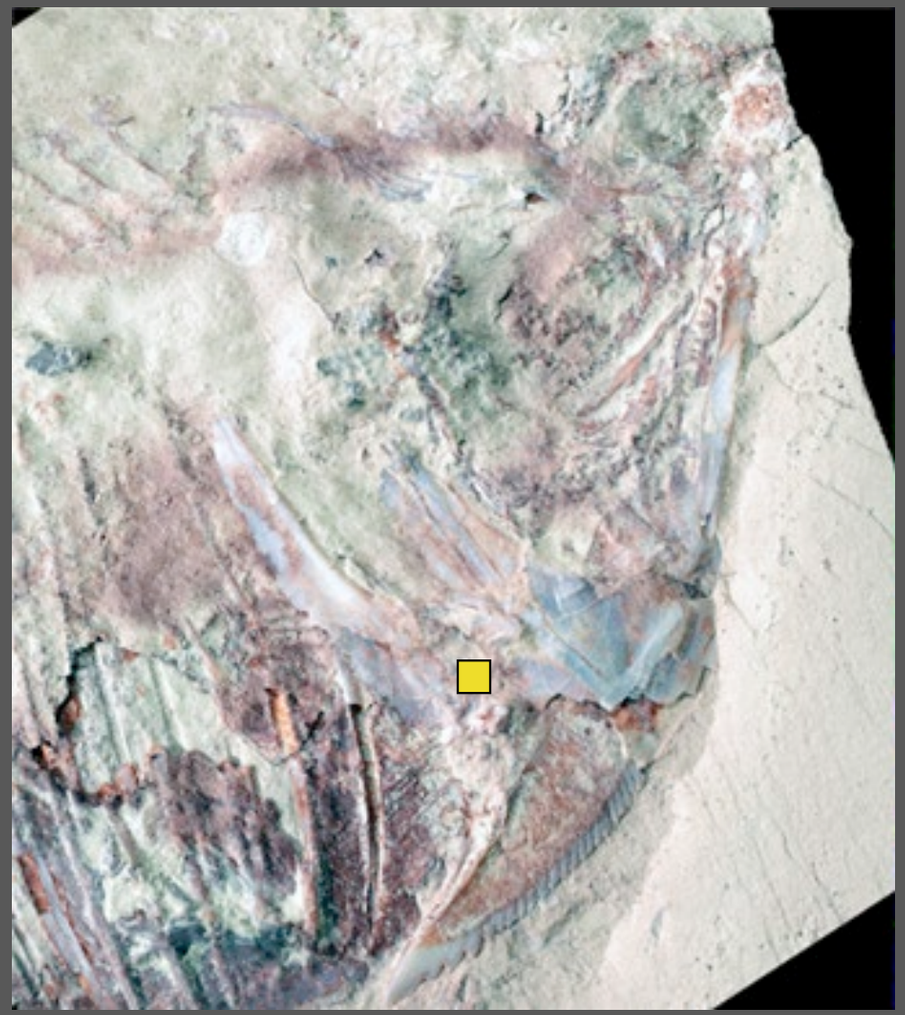
- S. Hoerlé et al. South Afr. Archaeol. Bull., 65(192):221–224, 2010.
- S. Hoerlé et al., *Imaging the layered fabric of paints from Nomansland rock art (South Africa)*, Archaeometry, in press.

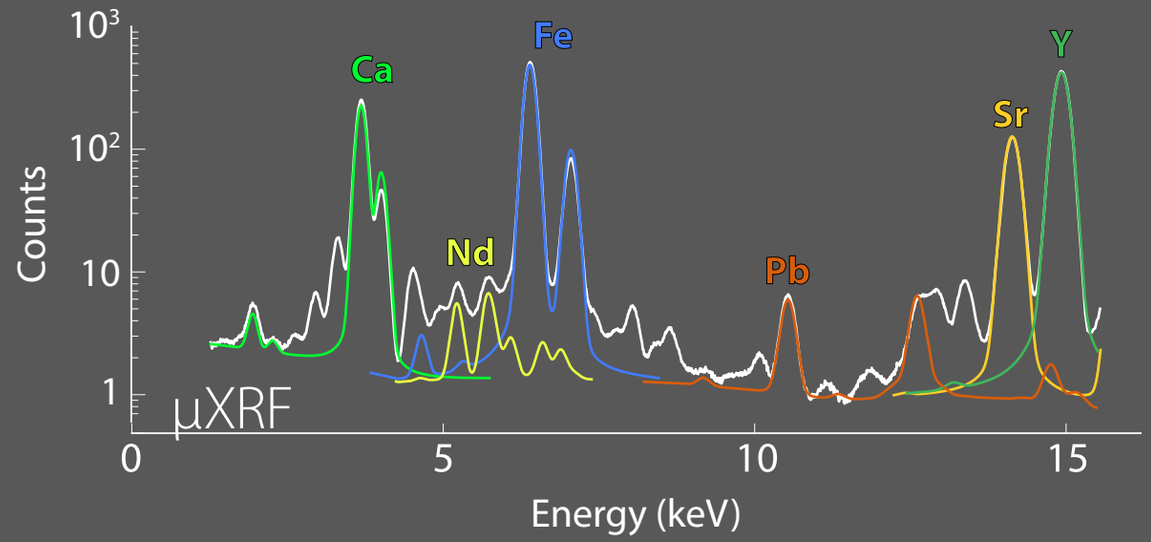
Morphology, exceptional preservation and taxonomy of Cretaceous fossils from Morocco

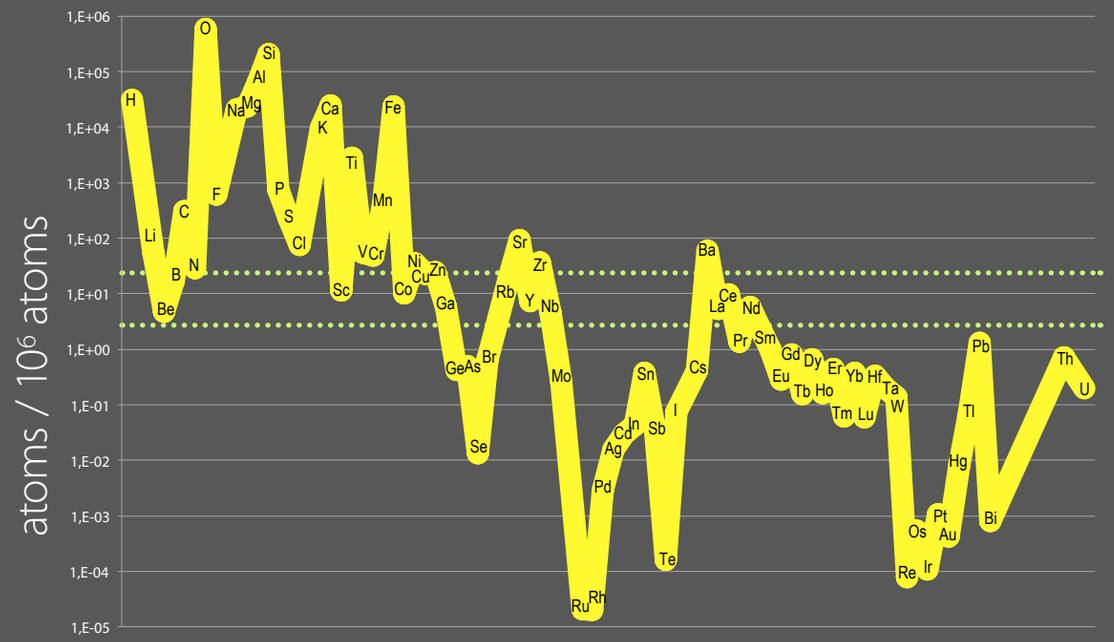
P. Gueriau, C. Mocuta, L. Bertrand
collaboration: MNHN Paris, IPANEMA, SOLEIL, DOT, SLAC Stanford

Fossils from Djebel Oum Tkout
Southern Morocco
Konservat-Lagerstätten
Upper Cretaceous (c. 100 Ma)

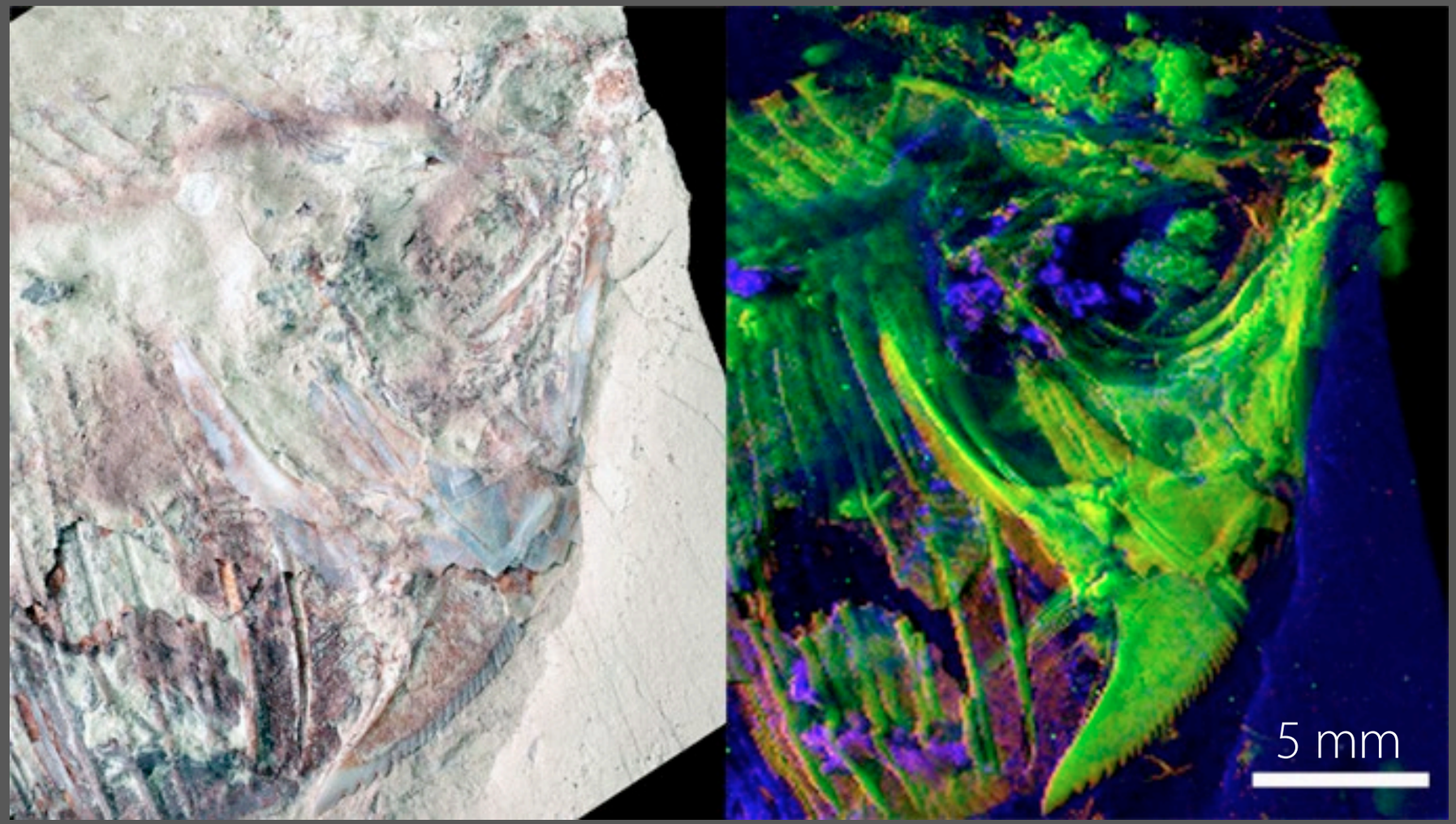
Members of the field campaign team: Nour-Eddine Jalil (BioDecos, Department of Earth Sciences, Cadi Ayyad University, Marrakesh, Morocco; CR2P), Abdelilah Tourani, Fatima Khaldoune (BioDecos), Paulo M. Brito, Bouziane Khalloufi (Departamento de Zoologia, Universidade do Estado do Rio de Janeiro, Brazil) and Hélène Bourget (Museum of Natural History of Marrakesh, Cadi Ayyad University, Marrakesh, Morocco).

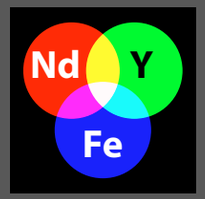






adapted from "Abundance of elements in crustal rocks", Chemistry of the Elements, N. N. Greenwood, A. Earnshaw, 1998





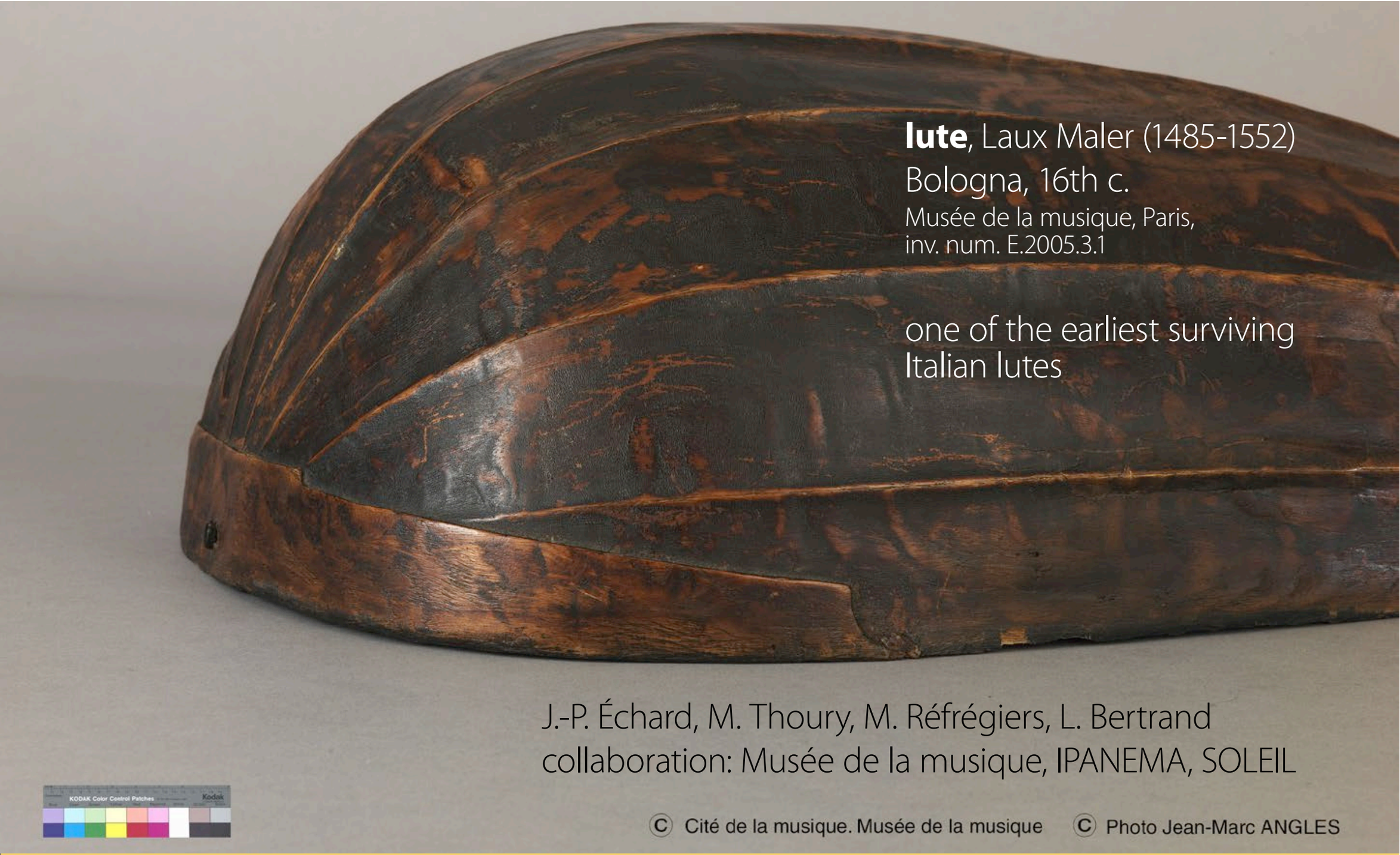
- P. Gueriau *et al.* PLoS ONE, **9**(1):e86946, 2014.
- P. Gueriau, L. Bertrand. Microsc. Today, **23**(3):2–6, 2015.
- P. Gueriau *et al.* Anal. Chem., **87**(17):8827--8836, 2015.

Le Monde

Paléontologie

Des terres rares pour mieux voir les fossiles

Des chercheurs français (Muséum national d'histoire naturelle, université Pierre-et-Marie-Curie, CNRS) ont mis au point une nouvelle technique d'imagerie



lute, Laux Maler (1485-1552)
Bologna, 16th c.
Musée de la musique, Paris,
inv. num. E.2005.3.1

one of the earliest surviving
Italian lutes

J.-P. Échard, M. Thoury, M. Réfrégiers, L. Bertrand
collaboration: Musée de la musique, IPANEMA, SOLEIL

Paris, early 18th c.

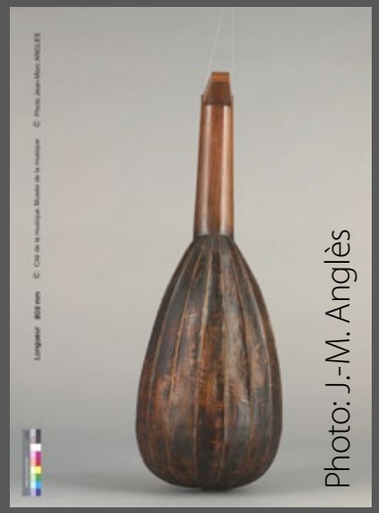
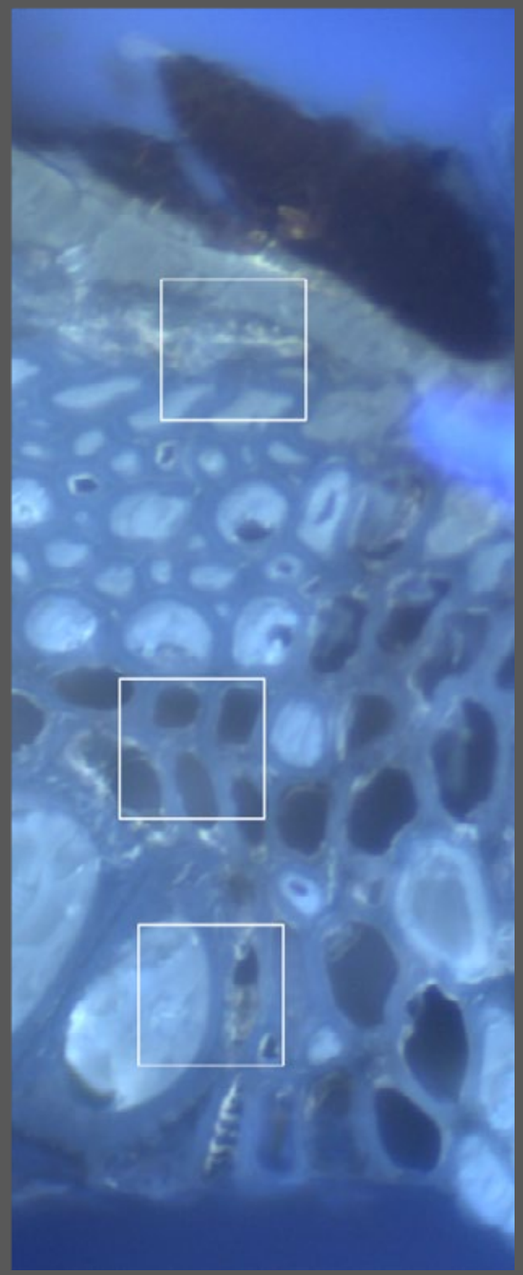
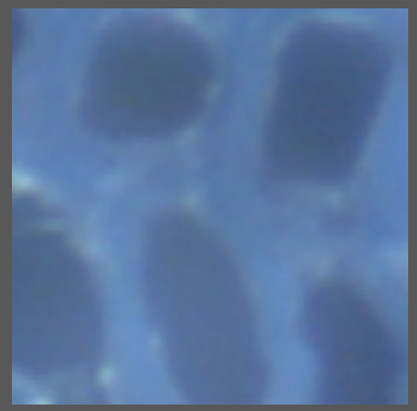
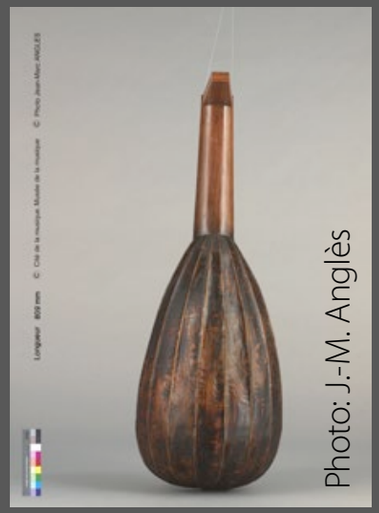


Photo: J.-M. Anglès

epiluminescence
365 nm exc. (Hg)







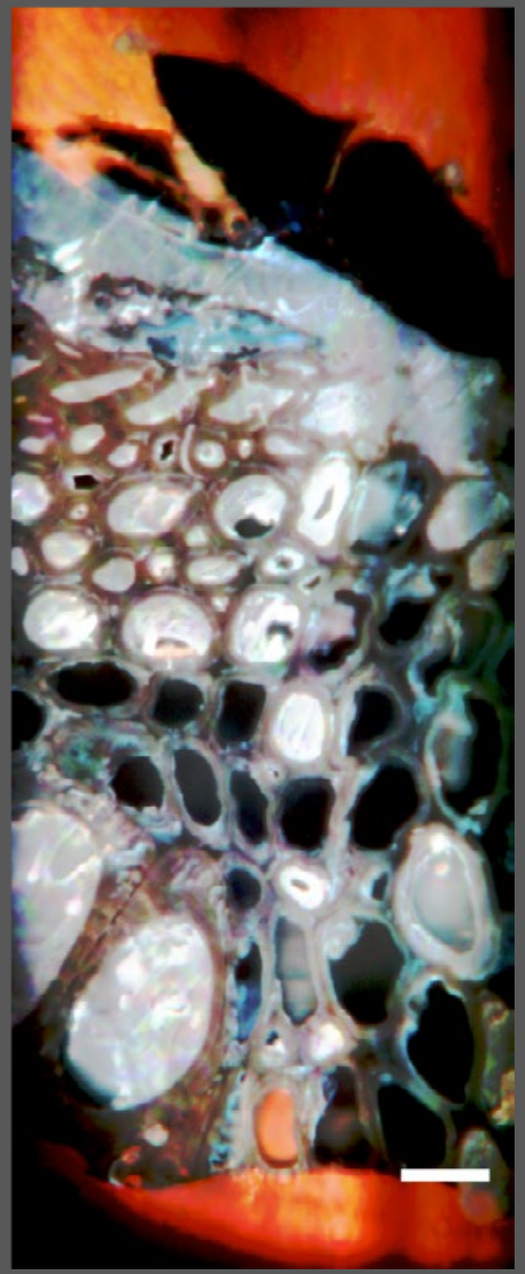
light microscopy, Py-GC/MS:

upper layer: drying oil + diterpenic Pinaceae resin

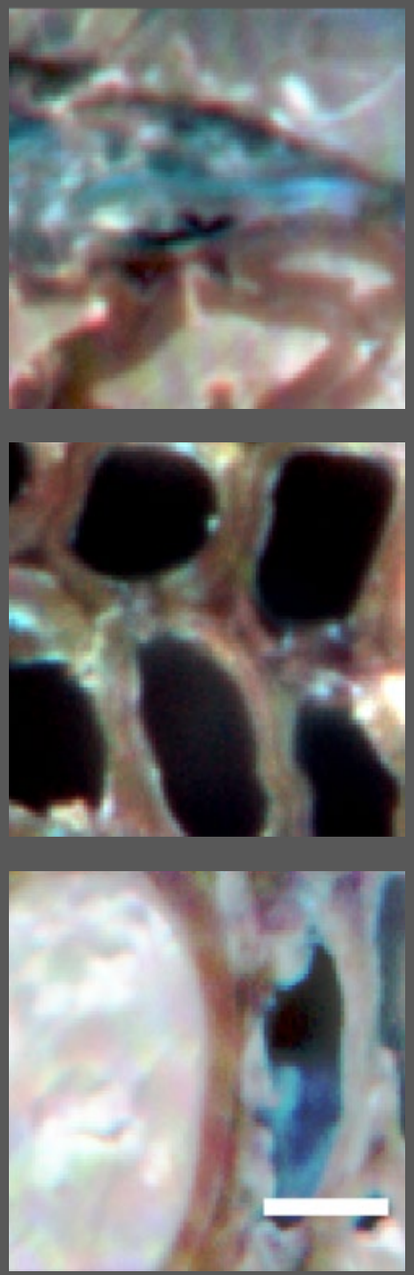
lower layer: drying oil

ash wood (*Fraxinus* sp.)

UV full-field luminescence imaging
@ SOLEIL DISCO Telemos
275 nm exc. / 380, 465, 500 nm em.
313 nm proj. pixel size



40 µm



20 µm

▶ J.-P. Échard *et al*, Analyst, **140**(15):5344–5353, 2015.

Historical archive documents from South Africa and Timbuktu

K. Dzinavatonga, M. Thoury, L. Bertrand

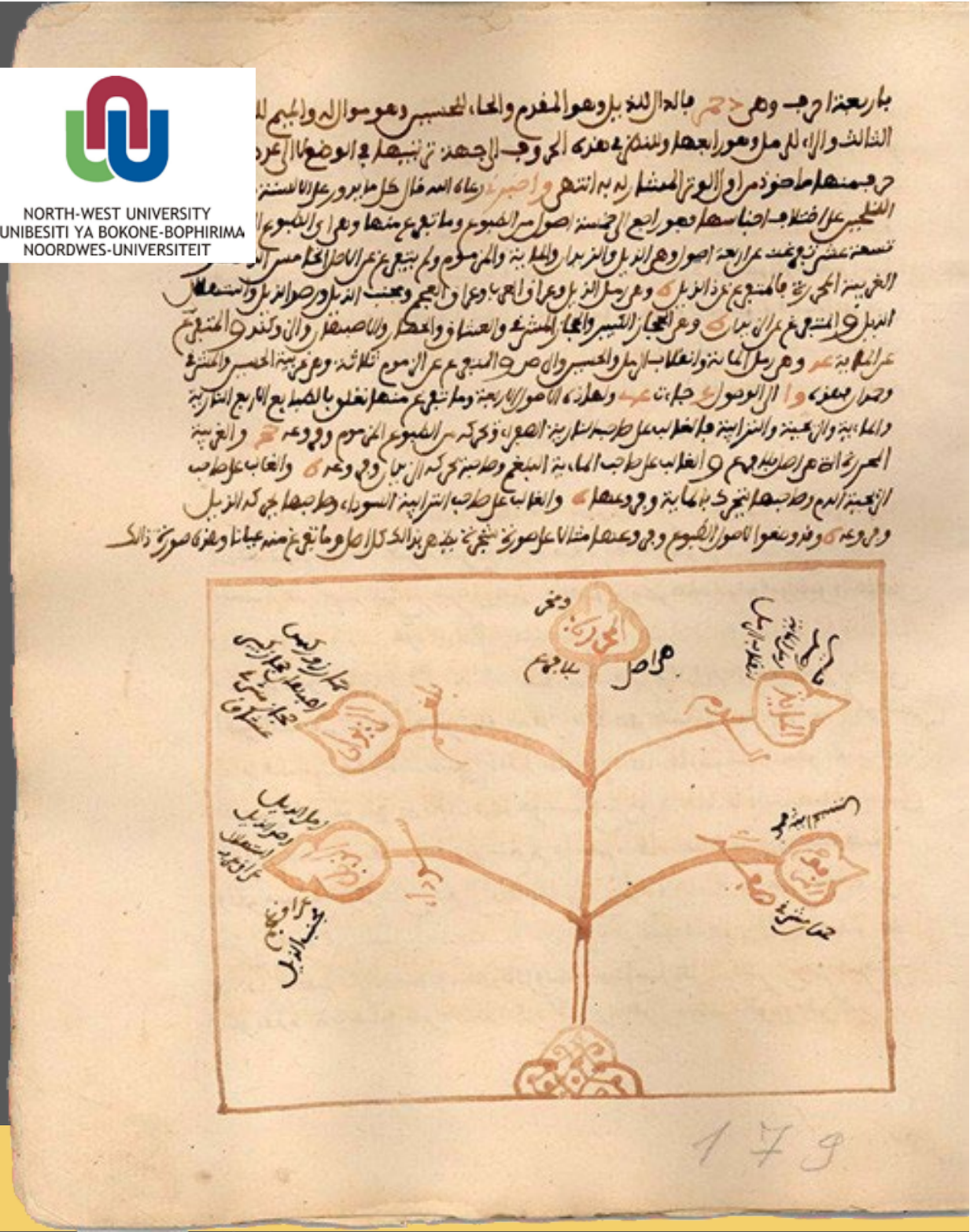
collaboration: North-West Univ., Ntl Library of South Africa, IPANEMA

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Part of the Material Science Innovation and Modeling research focus area

Microscopic and spectroscopic techniques to analyse historical documents

Collaboration with the Preservation unit of the National Library of South Africa

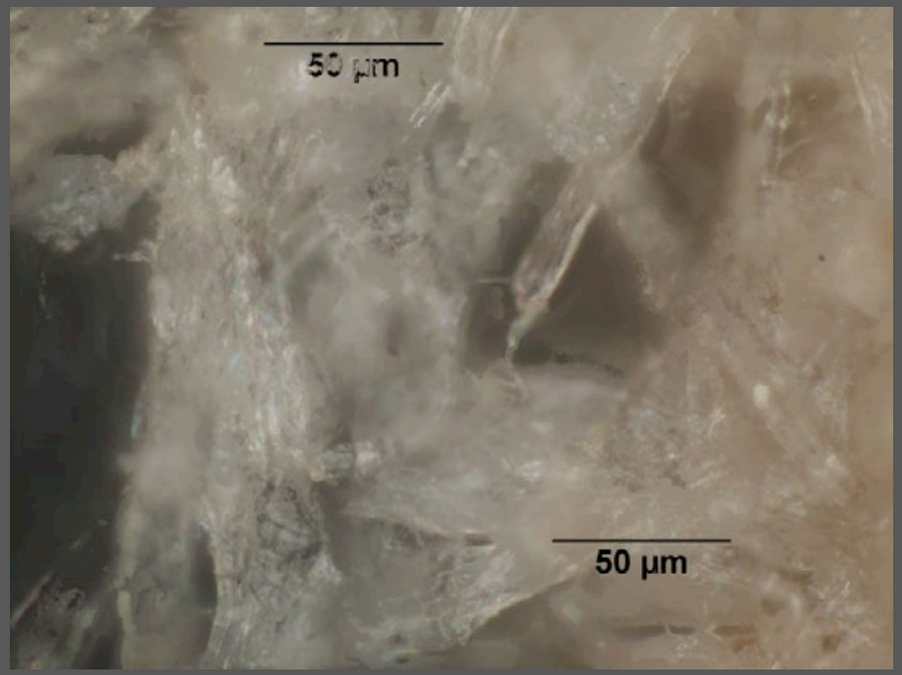


Investigation of the **manufacturing technologies** used to produce historical documents in the southern African region

Chemical composition and degradation pathways of African historical documents

Ink, fibre and sizing analysis of African historical documents

Collaboration with institutions that deal with archaeological objects for resource sharing



Research stay of Kaitano Dzinavatonga to work on proposals, start preparing samples and perform preliminary tests

European Commission's support to Heritage sciences

Through FP5, FP6 and FP7 more than 70 projects dedicated to tangible heritage have been funded

A strong and lively transdisciplinary infrastructure is being created since 1999: LabS-TECH, EU-ARTECH, CHARISMA, IPERION CH

… towards a dedicated European legal entity

ERIHS – European research infrastructure on Heritage science

"the CERN of ancient materials"

Access to European resources

Methodological research

ERIHS-EU

ARCHLAB

Scientific archives

MOLAB

Mobile units

FIXLAB

Synchrotron
Ion beam
Neutron
Lasers
Dating

DATAPOLE

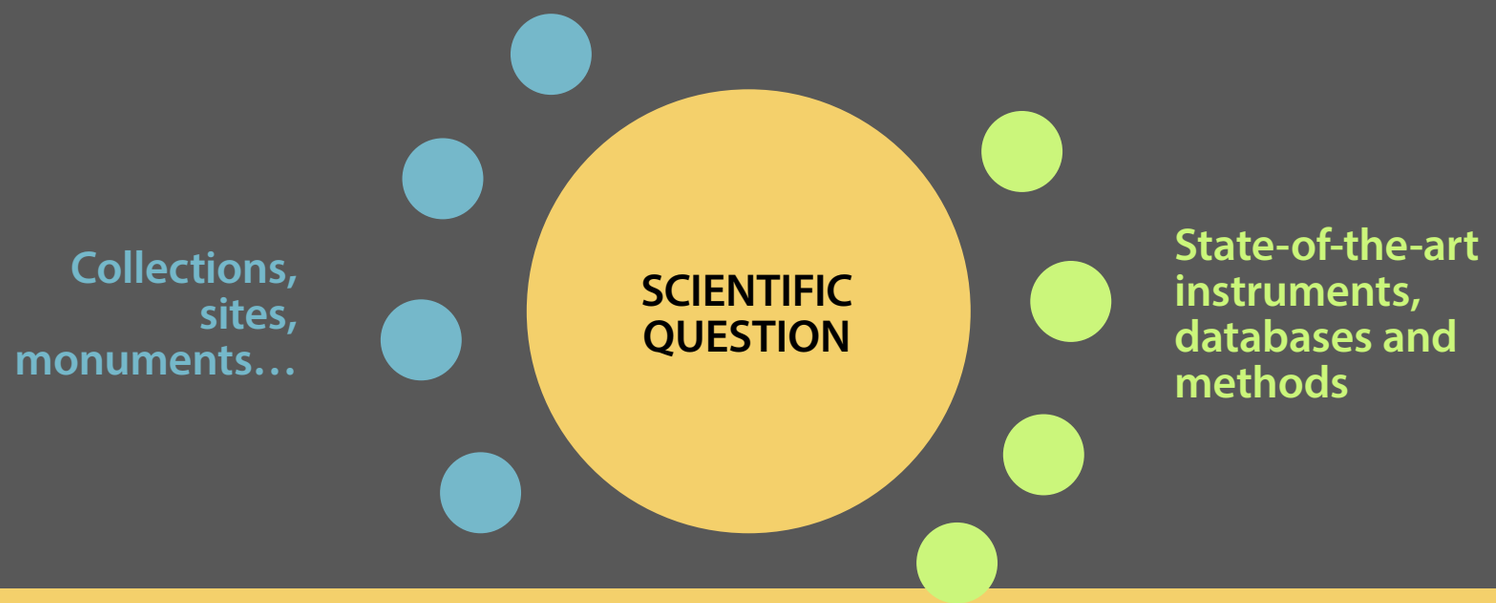
DARIAH-EU
Digital Research Infrastructure for the Arts and Humanities

European Commission

Collaborative revolution around the artefact

ERIHS-EU

Access of *ad hoc* **interdisciplinary teams** constituted of specialists from **ancient materials** (archæology, art history, conservation, curation, palæontology, history), **instrumentation and material sciences** (physics, physico-chemistry, chemistry, biology, environment) and **data** (signal processing, statistics, representation)



ERIHS-EU

Focus on **medium-term** international projects

Increased **access** and **support**

Simplified access
e.g. online directory, submission portal

Interoperability of resources

Optimized **data** handling and sharing

Quality assessment from user feedbacks

Sustainability

ERIHS-EU

Focus on **medium-term** international projects

Increased **access** and **support**

Simplified access
e.g. online directory, submission portal

Interoperability of resources

Optimized **data** handling and sharing

Quality assessment from user feedbacks

Sustainability

Significant **methodological development**

From a European to a Global Research Infrastructure

12 European Member States

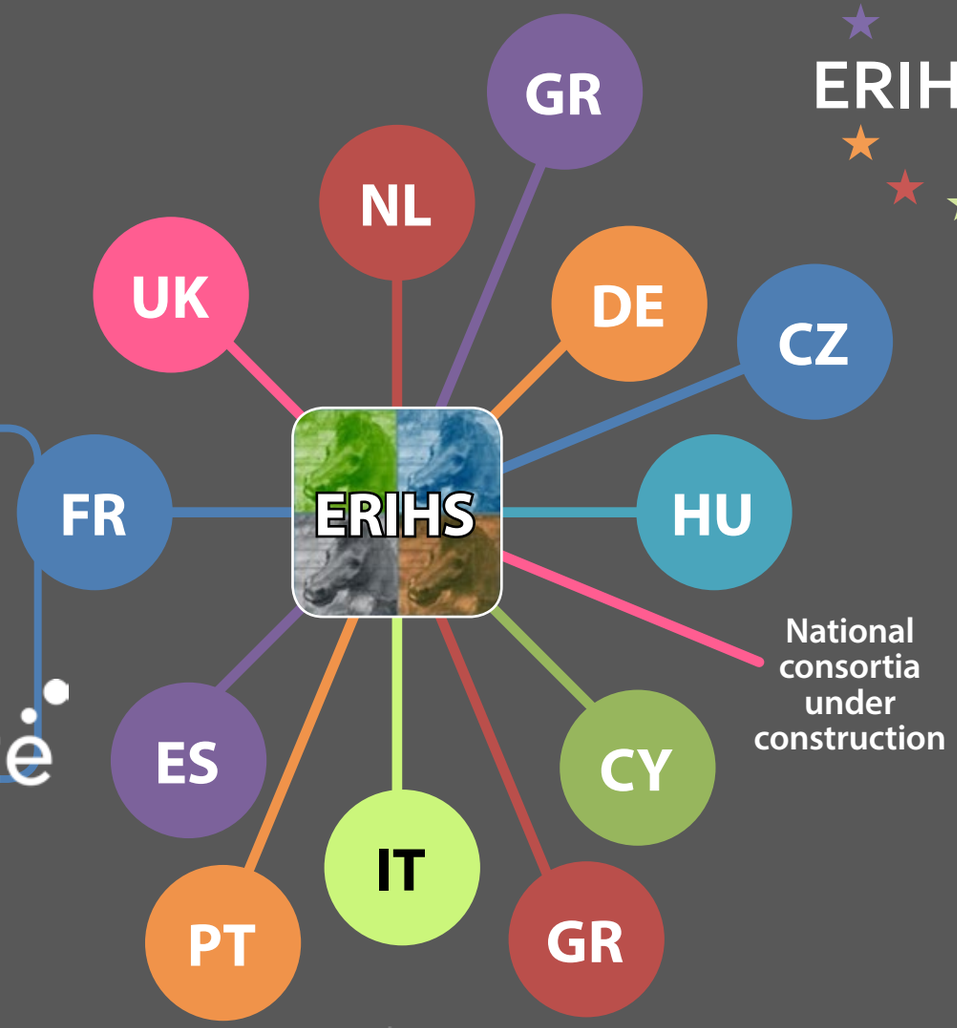
G8 – GSO

ERIHS-EU

Paris & Paris-East
Portable instrumentation
Ion beam analysis
Laser
Archives

Saclay
Synchrotron
Data processing
Humanities

université PARIS-SACLAY



ICCROM

IPANEMA ARCHAEOLOGY CONSERVATION SCIENCES PALAEONTOLOGY PALAEO-ENVIRONMENTS | ANCIENT MATERIALS RESEARCH PLATFORM

European (and international) access programme is already open!

IPERION CH

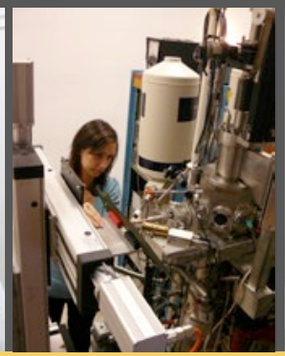
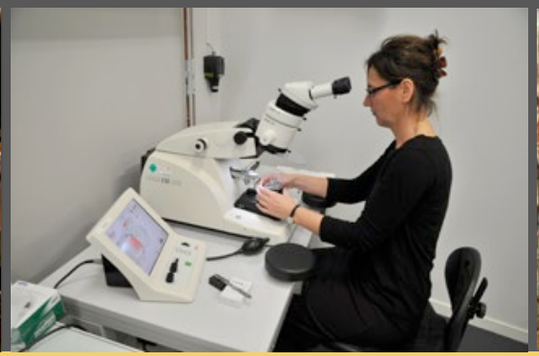
4 **large-scale** facilities
- ion beam facilities (AGLAE, Atomki)
- synchrotron (SOLEIL)
- neutron (BNC)

1 **mobile** laboratory

10 scientific **archive** centres

2 calls per year (September and February)

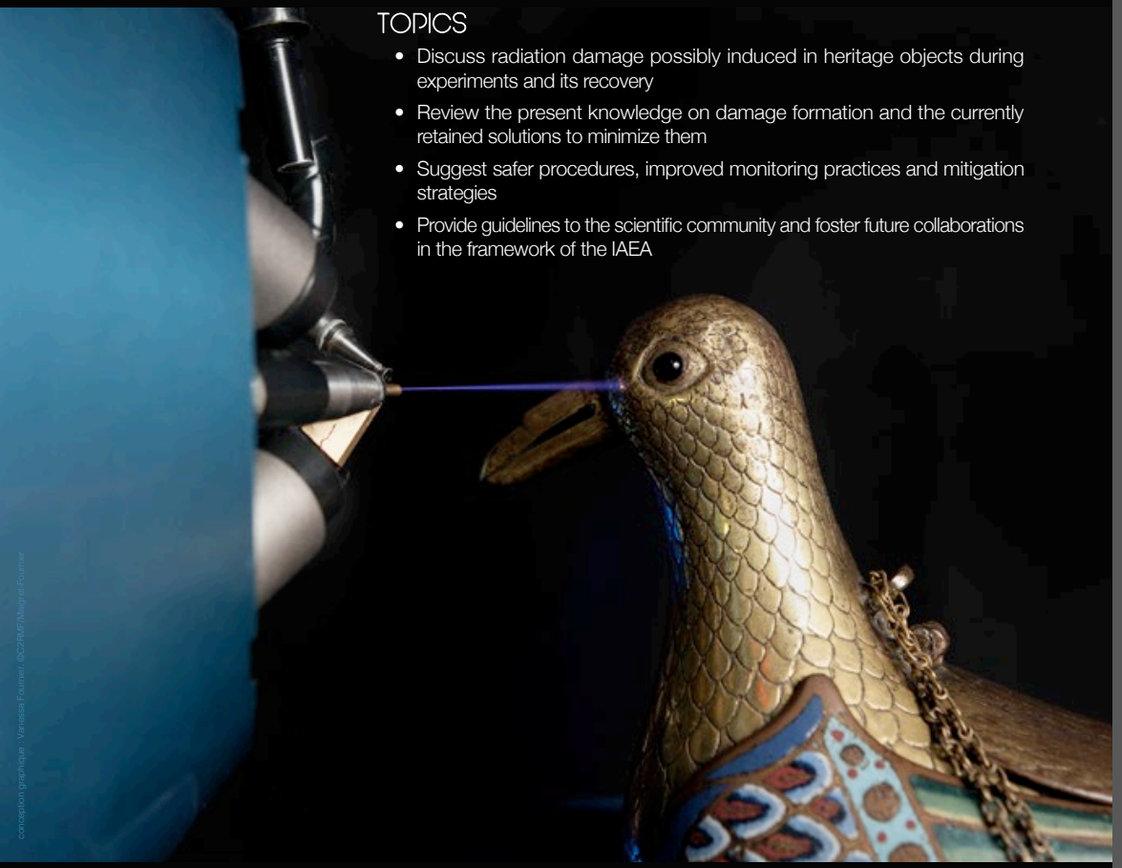
Users are invited to contact the facilities at
http://www.iperionch.eu

IAEA Technical meeting

INVESTIGATING HERITAGE MATERIALS WITH SAFER ION AND PHOTON BEAM EXPERIMENTS

7 - 10 December 2015
C2RMF, Palais du Louvre, Paris, France



TOPICS

- Discuss radiation damage possibly induced in heritage objects during experiments and its recovery
- Review the present knowledge on damage formation and the currently retained solutions to minimize them
- Suggest safer procedures, improved monitoring practices and mitigation strategies
- Provide guidelines to the scientific community and foster future collaborations in the framework of the IAEA

IAEA International Atomic Energy Agency

CENTRE DE RECHERCHE ET DE RESTAURATION DES MUSÉES DE FRANCE

IPANEMA

further information:
iaea.org
c2rmf.fr
ipanema.cnrs.fr

contact:
aliz.simon@iaea.org
thomas.calligaro@culture.gouv.fr
loic.bertrand@synchrotron-soleil.fr

Investigating heritage materials with safer ion and photon beam experiments

International Technical Meeting
7-10 Dec 2015, C2RMF
Palais du Louvre, Paris

radiation damage
physical response of materials
damage mitigation
monitoring and procedures
guidelines

IAEA
International Atomic Energy Agency

CENTRE DE RECHERCHE ET DE RESTAURATION DES MUSÉES DE FRANCE

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IPERION CH

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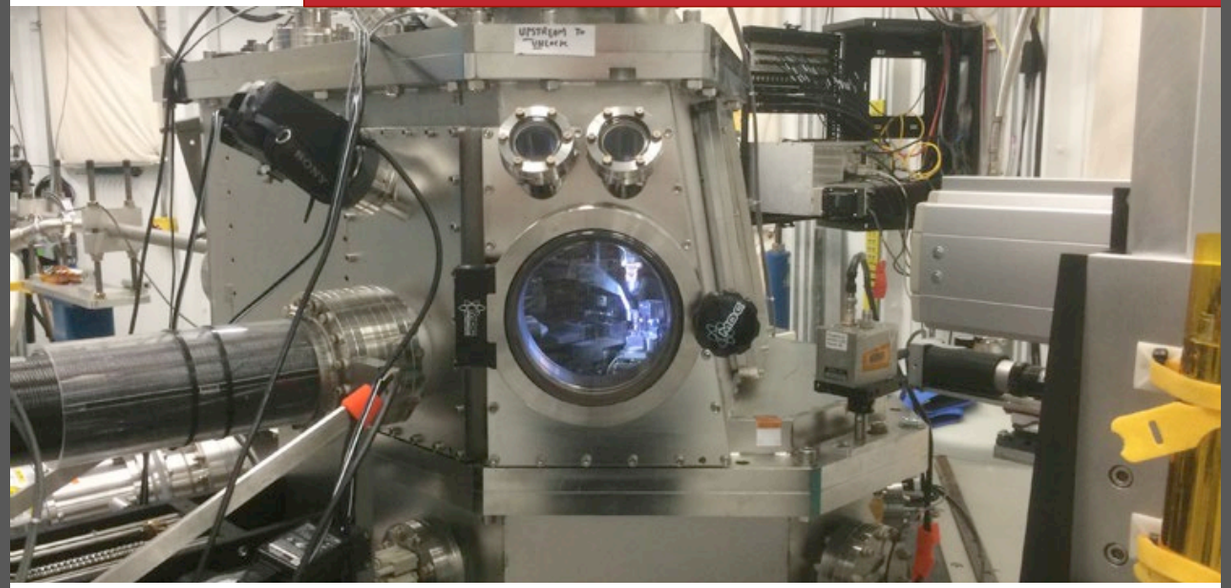
SR2A Chicago 2016

Synchrotron Radiation and Neutrons in Art and Archaeology



Save the Date: **September 6-9, 2016**

Art Institute of Chicago, Millennium Room, 111 S Michigan Ave, Chicago

Hosted by the Northwestern University /Art Institute of Chicago
Center for Scientific Studies in the Arts (NU-ACCESS)

Preliminary Deadlines:
Online Early Registration: February 1, 2016
Abstract Submission: April 1, 2016
Notification of Abstract Acceptance: June 1, 2016

We welcome paper submissions from archaeological scientists, conservation scientists, geochemists, paleontologists, material scientists, and researchers from all disciplines with experience applying analytical techniques in large-scale research facilities to address questions about our cultural heritage.

For more details, visit: http://sites.northwestern.edu/sr2a/

ART INSTITUTE CHICAGO · NU ACCESS · Argonne NATIONAL LABORATORY · The Field Museum · THE ORIENTAL INSTITUTE · INDIANAPOLIS MUSEUM OF ART IMA · DIA DETROIT INSTITUTE OF ARTS · NEMA · ARCHAEOLOGY CONSERVATION SCIENCES PALAEONTOLOGY PALAEO-ENVIRONMENTS · ANCIENT MATERIALS RESEARCH PLATFORM

M. Thoury, S. X. Cohen, P. Gueriau, S. Hœrlé*, S. Schöder – IPANEMA

All international collaborators mentioned along the presentation

C. Sandt, P. Dumas – SMIS beamline, SOLEIL
M. Réfrégiers, F. Jamme – DISCO beamline, SOLEIL
C. Mocuta, D. Thiaudière, S. Réguer – DIFFABS beamline, SOLEIL

IPANEMA is a member of the PATRIMA regional network (Agence nationale de la recherche) and of the IPERION CH infrastructure consortium of the European Commission (Horizon2020)

THANK YOU FOR YOUR ATTENTION!

INTERNATIONAL YEAR OF LIGHT 2015