

X-ray Microscopy Focussed Interest Group - or the 'X-ray FIG' for short

Contributed by a few members of the X-ray FIG

X-rays have played a major part in the field of microscopy for many years, indeed their role in society was more or less instantly sealed when Roentgen imaged his wife's hand, creating that truly iconic first X-ray image. Within the Royal Microscopy Society however X-rays have, up until now, not featured prominently. True, many of our members use X-rays in some form or other as part of their work but only a select few focus their efforts solely on using X-rays to enable scientific discovery. As a result the X-ray microscopy community has been represented within the RMS via the Electron Microscopy Section Committee with a significant number of X-ray microscopy technique users scattered across other sections particularly within the Engineering and Physical Sciences community. However over the last few years the profile of X-ray microscopy has increased significantly in part due to the increasing popularity of X-ray imaging particularly as it has become easier to collect high quality data without having to leave the home laboratory. Given this it seemed a perfect opportunity for the RMS to explore whether there is sufficient interest within the society to merit a section dedicated to X-ray microscopy and thus the X-ray Microscopy Focussed Interest Group or X-ray FIG was formed.

The X-ray FIG are a group of scientists covering an incredibly broad range of topics but with one thing in common – we all use x-rays in some way, shape or form and of course we are all convinced that X-ray microscopy has a key role to play in science. To give you a flavour of who we are and what we do a few of us have put together brief outlines of who we are and what we do.

We'd love to have more join us. All are welcome – whether you are already an avid user of X-ray microscopy techniques or are wanting to find out more about how X-rays could potentially revolutionise your research! You can find out more on the RMS website.

Below some of our group introduce themselves:



What I like doing when I'm not X-ray-ing things: When I'm not in the (wet or dry) lab you can find me practising some outdoor sports like hiking, climbing, scuba diving or cycle touring, cooking meals with friends, or brewing cider.

Name: Timothy Burnett

Affiliation: The University of Manchester, NXCT

X-ray interests: I am Director of the National lab X-ray computed tomography facility (nxct.ac.uk) which is a national research facility set up by EPSRC as partnership between Manchester, Southampton,

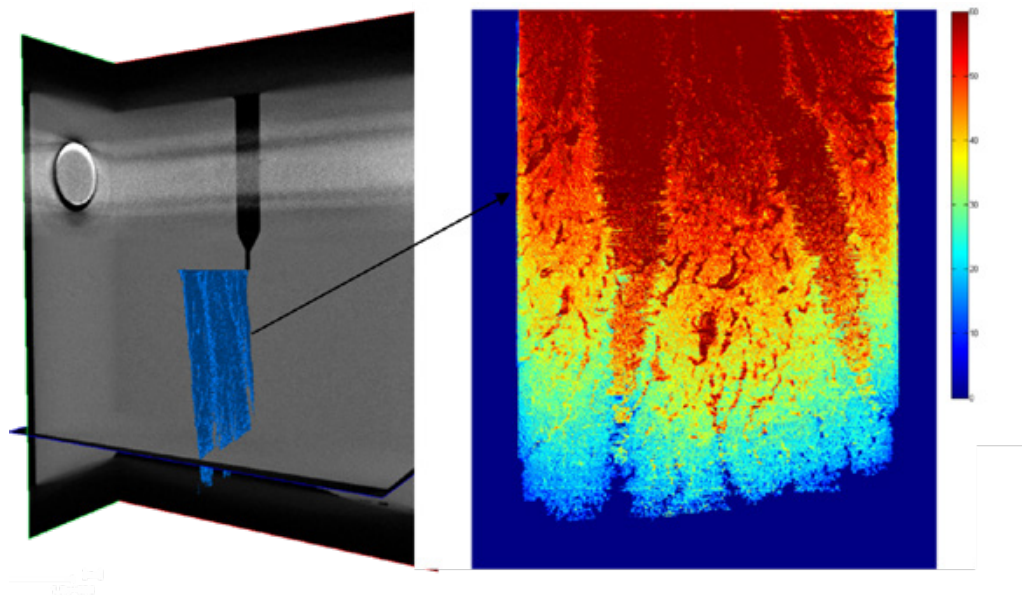
Name: Carles Bosch Piñol

Affiliation: The Francis Crick Institute

X-ray interests: I am a neuroscientist at the Francis Crick Institute (London) specialising in multimodal, correlative imaging of neural circuits. By combining an array of imaging techniques, I have developed a strategy to target specific regions in the brain to be explored with ultrastructural precision while keeping the big picture that provides context. These techniques involve light, X-ray and electron microscopy. X-ray imaging of soft tissue samples can provide volumetric information non-destructively along with a resolving power that reaches interesting both multi- and sub-cellular features of interest. Accordingly, it plays a crucial role in bridging the mm with the μm scales in this correlative workflow. Using this approach enables studying the structure and function of the same neural circuit, and it gets us a bit closer to understanding how mammalian brains work.

My current research addresses the structure and logic of the neural circuits for smell. My background includes a BSc in Biotechnology (UAB, Barcelona), a MSc in Neuroscience and a PhD in Biomedicine (UB, Barcelona). Furthermore, I am interested in facilitating scientific discovery and multidisciplinary collaboration. I participate in diverse outreach initiatives, and have organised science-focussed events tailored to both specialised and broad audiences.





Environmentally assisted cracking of high strength (7xxx) aluminium. Showing the compact tension specimen with crack and the measurement of the crack opening according the micron colour bar

UCL and Warwick Universities and Diamond Light Source. It is our mission to provide access and support to UK researchers to enable them to take advantage of X-ray imaging from first time users to expert users conducting novel experiments. We are also exploring how we can support the visualisation and analysis of the very largest 3D and 4D images to help our users.

My area of expertise is in materials science and I have a focus on developing time-lapse and in-situ X-ray imaging and in particular using this as a starting point for correlative imaging investigations. Watching how materials behave as they are tested gives amazing insight to understand their performance but often further detailed investigations are needed. For example it is often vital to confirm the chemistry or crystal structure of the material at the point of failure. By using focused ion beam (FIB) and electron imaging techniques I have been able to target regions of interest for further forensic investigation. I am particularly interested in the environmentally assisted cracking of aluminium alloys where the combination of an applied stress, a humid atmosphere and a susceptible microstructure is

enough to cause failure well below the expected strength of the material. It is a fascinating synergy combining the effects of stress and corrosion reactions with the material at a very subtle level that has meant this phenomenon is still not well understood after over 50 years of research!

What I like doing when I'm not X-ray-ing things: Mountain biking, running, going on days out with my family.

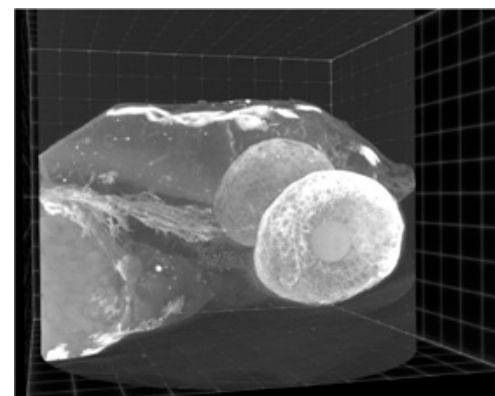
Name: Lucy Collinson

Affiliation: Francis Crick Institute

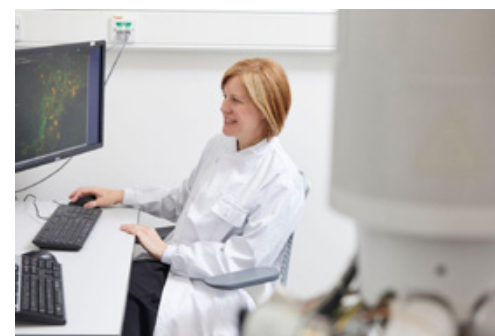
X-ray interests: I run the Electron Microscopy Science Technology Platform at the Crick, but that is a bit of a misnomer, since nowadays our work depends on light, X-rays and electrons. This is because most of our samples contain a region of interest - a cell or a structure inside the tissue - which needs to be located and trimmed to the limited size that can be imaged at high resolution with EM. Identification of the region of interest is normally done using a fluorescent protein imaged with fluorescence microscopy techniques,



False-coloured *Drosophila melanogaster* (fruit fly) imaged with a Zeiss Versa 510 X-ray Microscope (Dr Anne Weston, Francis Crick Institute)



Zebrafish hindbrain infected with *Toxoplasma gondii* imaged on a Zeiss Versa 510 X-ray microscope (MC Domart, Francis Crick Institute, Yoshida et al., 2020)



or by shape and density using X-ray microscopy techniques. Sometimes we even use fluorescence microscopy followed by X-ray microscopy followed by electron microscopy in multimodal correlative imaging workflows.

My first adventures in imaging biological samples with X-rays started when Liz Duke approached me at Microscience (the forerunner of mmc) back in 2010, after which we developed workflows together for preparing and imaging vitrified cells by soft X-ray microscopy at synchrotron beamlines at BESSY, ALBA and Diamond. At the other end of the scale,

Anne Weston in my lab was imaging much larger tissue samples in a Skyscan benchtop hard X-ray microscope in around 2008 with collaborators at UCL and later with Rosy Manser at Zeiss, and in 2016 we installed our own Zeiss Versa 510 system for nano-anatomy and correlative imaging.

The field is incredibly exciting and growing exponentially, with Eva Periero and Maria Harkiolaki's teams at ALBA and Diamond pushing the limits of correlative cryo-soft X-ray techniques, and Alexandra Pacureanu's work at ESRF imaging tissues, Thomas Schneider's work imaging hundreds of biological samples per day at Petra III, and Peter Lee's work imaging whole human organs at ESRF pushing the envelope of resolution, throughput and sample size respectively.

What I like doing when I'm not X-ray-ing things: Cooking, sewing, surfing (not very well).

Name: Liz Duke

Affiliation: EMBL Hamburg, Germany.

X-ray Interests: Liz Duke has just moved to the EMBL Hamburg Outstation on the DESY site where she is setting up a group to establish X-ray Imaging of biological samples within EMBL. Prior to her move to Germany Liz was based in the UK, working at Diamond Light Source, the UK synchrotron facility for over 15 years.

Liz has spent her entire career working at synchrotrons where she has focussed on developing X-ray methods for Life Science Research. After working for many years in the field of macromolecular crystallography she saw the light and moved into X-ray microscopy with a particular focus on X-ray imaging. The amazing structural details revealed using cryo soft X-ray tomography had her instantly hooked on imaging. Using soft X-rays to image individual cells is amazing but when she saw the potential of using hard X-rays to image bulk soft tissue samples she could help herself and leapt at the opportunity.

Because hard X-rays have penetration power they

are perfect for imaging samples bulkier than single cells. However the challenge is to generate the contrast so that useful images can be collected. Thankfully the sample preparation techniques used in volume electron microscopy (heavy metal staining) work perfectly with X-rays as well. So using the P14 beamline on the PETRA III synchrotron at DESY we can collect a 3D data set on a marine organism such as *platynereis dumerilii* in less than 5 minutes.



One of the last rides I had on Indi before leaving for Germany

But Liz doesn't spend her entire time hidden away in the control cabin of an X-ray beamline! When she's not on the beamline she's quite likely to be found in the kitchen cooking dishes by her favourite chefs which she then shares with guests or, if none are around, with her cat ("Furry Lucy"). Or she will be down at the stables looking after her very hairy horse ("Indi") - or she will be once Indi makes the move to Germany.

Name: Marco Endrizzi

Affiliation: University College London, NXCT

X-ray interests: I was trained as an experimental physicist and joined the X-ray imaging field during my PhD. My contributions include a method for performing X-ray dark-field imaging with incoherent illumination, hence suitable for implementation using standard X-ray tubes in laboratory settings. I am co-Director of the National Research Facility for lab-based X-ray Computed Tomography (NXCT,



A tropical coral reef about 250 million years ago, today these (46.293, 11.837) are my favourite mountains

<https://nxct.ac.uk/>). At UCL we have the first X-ray phase-contrast imaging systems available to users outside a synchrotron. My interests are focussed on developing instrumentation, as a means to empower the research community with new tools.

What I like doing when I'm not X-ray-ing things: being outdoors, taking photos and spending long hours in a darkroom (sometimes!)

Name: Llion Evans

Affiliation: Swansea University, UK Atomic Energy Authority (UKAEA)

X-ray interests:

Dr Llion Marc Evans holds an EPSRC Manufacturing Research Fellowship (2018-2023) at the Zienkiewicz Centre for Computational Engineering, Swansea University. He is also Director of the Centre of



Llion Evans

Excellence in Advanced Data-Driven Engineering Design (ADDED), Chair of the annual 'Image-Based Simulation for Industry' event and an Exec Member of the Collaborative Computational Project in Tomographic Imaging. His main research interests are image-based simulation using the finite element method (IBSim) and its application in high-value manufacturing (HVM).

What I like doing when I'm not X-ray-ing things:

With a young family at home, any time not at work is spent creating memories with them as they grow up. One of my other passions in recent years has been photography (which fits in well with family life), and a by-product of spending so much time performing X-ray imaging has been a better appreciation of the 'exposure triangle'. Just like not having enough time to analyse my X-ray images, I have years' worth of photos waiting to be edited.

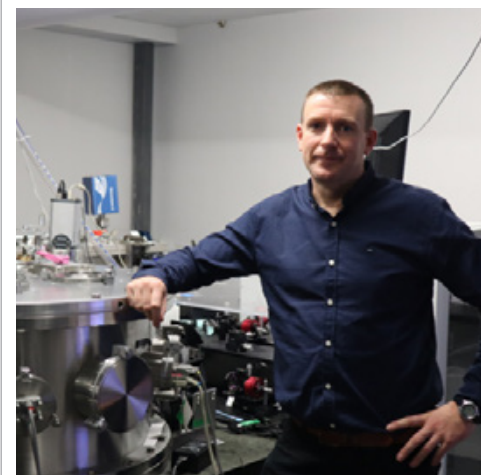
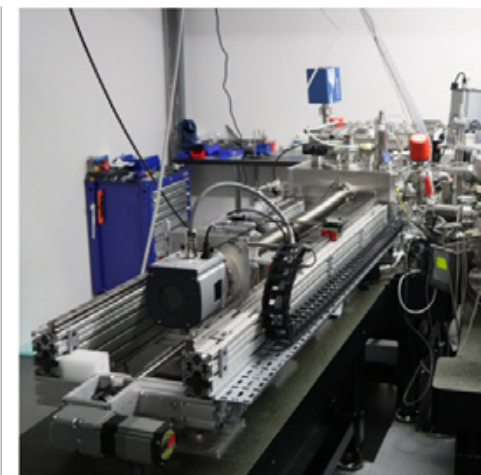
Name: Kenneth Fahy

Affiliation: SiriusXT

X-ray interests:

I am trained as an experimental physicist, and during my PhD and postdoc at University College Dublin I began working with extreme ultraviolet and soft X-ray plasma-based light sources for imaging and metrology applications. I subsequently co-founded SiriusXT to develop and commercialise a lab-scale soft X-ray microscope for biological imaging in the 'water window', a region of the EM spectrum in which water is transparent to these wavelengths but organic molecules are absorbing. My job is focused on developing the instrumentation as well as exploring the many applications of soft X-ray microscopy, including the development of correlative techniques to help answer biological questions across a broad range of length scales and complexities.

What I like doing when I'm not X-ray-ing things: Running, hiking, keen interest in most sports, spending time with my young family.



Kenneth in the SiriusXT lab with the soft X-ray microscope

Name: Vincent Fernandez

Affiliation: Natural History Museum, London UK

X-ray interests: Vincent is the manager of the X-ray CT laboratory at the Natural History Museum (NHM), London, UK. He is a palaeontologist by training and likes imaging fossils, but founds interest on all types of objects he can X-ray.

Vincent did his PhD at the European Synchrotron Radiation Facility (ESRF, Grenoble, France) where he studied fossilised eggs, using X-ray CT to image vertebrate embryos preserved in them. His skills on the virtual extraction of fossils lead him to the Evolutionary Studies Institute at the University of the Witwatersrand (Johannesburg, South Africa) where he spent two years as a postdoctoral fellow looking at fossils of mammal-like reptiles preserved



Vincent Fernandez (right) at the Florida Museum of Natural History with one of his mammal-like reptile friends (left)

in fossilised burrow casts. In 2013, he returned to the ESRF, first as a post-doctoral fellow and then as a junior scientist. During this time, Vincent developed more interest in the imaging process, trying to help users with all sorts of samples, but started to be interested in programming to improve image quality. In 2018, he moved to the NHM, helping users with their experiments and data analysis.

What I like doing when I'm not X-ray-ing things: Vincent likes imaging in his private life as well, taking photographs of the places he visits (he has also tried doing some image processing to improve his holiday photos but realised it was a bit too much like work). He also likes video games, reading manga, going to the cinema and eating chocolate while watching series in the evening.

Name: Amin Gabout

Affiliation: University of Manchester

X-Ray interests: Amin completed his PhD at Aarhus University in Denmark focusing on the use of X-ray Computed Tomography imaging to visualise and quantify soil structure. He then moved to the UK and after three years as postdoc at the University of Nottingham, he joined the Natural History Museum to work at the X-ray Imaging facility. He has been involved and contributed in numerous project in palaeontology, archaeology and curation. Some of those projects featured in a high impact TV program with Sir David Attenborough. He is now working



Amin Gabout

at the Henry Moseley X-ray Imaging facility (The University of Manchester) as Senior Experimental officer where he collaborates with industry and develops open AI and image analysis methods for material science.

Name: Roland Kröger

Affiliation: University of York

X-ray interests: I am working on Nano- and Biomaterials using electron microscopy (TEM, SEM), Raman Spectroscopy and X-ray based characterisation tools such as SAXS, WAXS, STXM, XRF in a collaboration with Julia Parker at the Diamond Light Source. My interest covers a wide range of nanomaterial systems but in particular biominerals such as nacre, muscles, corals, bones and teeth. I see X-ray tools as complementary to electron microscopy and other imaging and spectroscopic methods where a lot of questions that e.g. TEM and SEM are not able to provide answers to X-ray often can - and vice versa. One of my foci lies on the understanding of the dynamics of mineralisation in e.g. collagen (a process central to bone and tooth formation) using dedicated *in situ* sample stages. Such tools are invaluable for the study of the growth and dissolution of biomineralising systems. A central goal is to comprehensively cover the different length scales which are accessible by electron and X-ray based imaging and spectroscopic methods. This will allow us to address exciting research questions such as:

how do phase transformations affect the formation of hydroxyapatite from an amorphous calcium phosphate compound? There is clearly a broad scope and fantastic potential here.

What I like doing when I'm not X-ray-ing things: Reading (in particular non-science literature), creating good food from non-pre-processed ingredients, being idle.

Name: Satyam Ladva

Affiliation: Quantum Design UK and Ireland Ltd.

X-ray interests: I am the Technical Product Manager at Quantum Design UK and Ireland, in charge of managing our X-ray and optics product lines, on behalf of our suppliers Sigray Inc. and Moxtek



Satyam Ladva, and punting on the River Cam!

Inc. Sigray Inc. focus on the production of large scale X-ray systems including 3D X-ray Microscopy both NanoXRM and MicroXRM. Moxtek Inc. focus on providing a range of X-ray sources, optics and detectors for a variety of handheld and table top systems. We are also representatives of Raptor Photonics, who manufacture X-ray Cameras. My own background in X-ray techniques includes the use of X-ray Diffraction and X-ray Photoelectron Spectroscopy, as well as EDX in SEM, during my Engineering Doctorate project at UCL on carbon nitride and other related materials. Further X-ray industry knowledge I enhanced during my time at Thermo Fisher Scientific.

What I like doing when I'm not X-ray-ing things: Hiking in Nature, implementing ways to live more sustainably, Reading, Cooking, listening to world music, Japanese-related activities - trying new things :)

Name: Dr. Rosy Manser

Affiliation: Life Science Marketing Team, Carl ZEISS Microscopy

X-Ray interests: I was first introduced to X-ray imaging in 2015 when I looked after the X-ray Microscopy business for ZEISS in the UK. Prior to this my microscopy experience was very much seated in the visible light world with fluorescence imaging forming the bulk of my day to day thinking. When I moved into X-ray imaging the first thing



Dr Rosy Manser

that struck me was the vast range of specimens that can be explored. Having seen incredible datasets captured from samples as diverse as bones, explosives, soft tissues, composites and rocks, it is the diversity of addressable scientific questions that continues to drive my keen interest in X-ray imaging today.

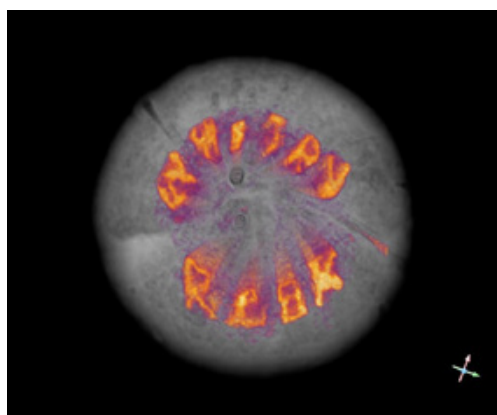
The opportunities for bringing X-ray imaging into multi-modal workflows encompassing other imaging techniques is also a big area of interest for me. Whether the question to hand is about exploring samples at different length-scales or with different modalities such as fluorescence and contrast, there are many unexplored possibilities and this is an exciting time for X-ray imaging in general.

Aside from my microscopy interests, I love spending time in the great outdoors, be this tinkering in the garden or hiking with my border collie. It never ceases to amaze me how quickly time passes when out exploring in the elements!

Name: Dr Ria L Mitchell

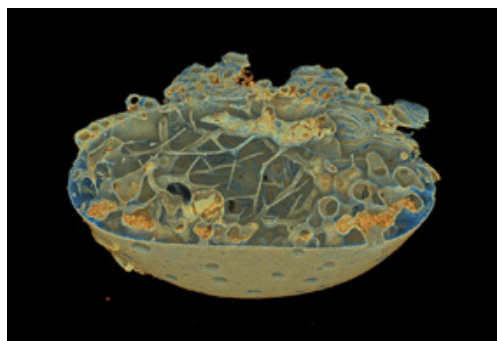
Affiliation: The University of Sheffield

X-ray interests: I am the Experimental Officer in X-ray Computed Tomography in the Sheffield Tomography Centre - we have a Zeiss Xradia 620 Versa system and numerous Deben rigs, allowing in-situ compression/tension/heating/cooling/electrochemical experiments on various sample types. I have wide ranging X-ray interests: one aspect is using correlative microscopy/imaging to correlate data across dimensions (2D-3D-4D), scales (centimetres - to - nanometres) and modes (including CT/X-ray Microscopy, FIB-SEM, OM, and SEM), which provides a more holistic interpretation of scientific questions. My specific research interests include the methods by which ancient terrestrial life lived on/within their substrates to promote organism-substrate interactions, weathering, soil development, and biogeochemical cycling. I study rocks for physical, chemical, and biological indications of these interactions and weathering deep in the

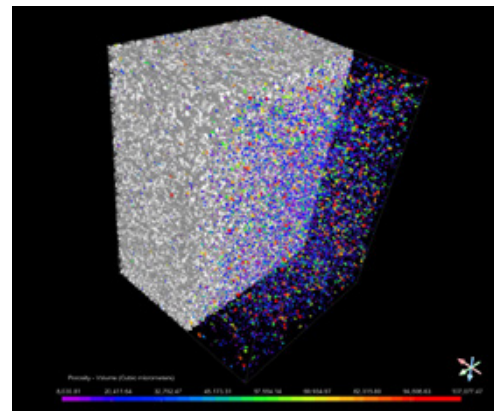


Dr Ria Mitchell (left), and XRM of a stick of rock from Whitby, with which Ria was recently runner up in the Video category of the RMS Scientific Imaging Competition 2021

geologic past, but also study modern day analogues - primordial landscapes such as cryptogamic ground covers from Iceland and New Zealand. I



3D rendering of borings (likely by a mixture of polychaete worms and sponges) in a beach pebble. Imaged on a Nikon XTH 225 (Swansea University)



Porosity variations in a 3D printed additively manufactured part. Imaged on a Zeiss Xradia Versa 620 (The University of Sheffield)

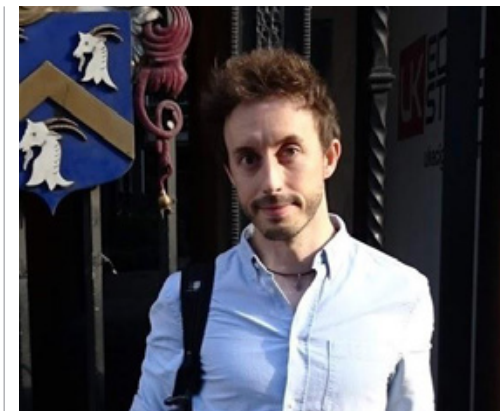
employ numerous techniques to better understand these processes: tomography (e.g. 3D/4D imaging), microscopy (e.g. SEM, OM, FIB-SEM), chemistry (e.g. ICP-AES, XRD, SEM-EDS), and combinations of the above through correlative microscopy. Specific time periods of interest include the evolution of the first terrestrial plants and biologically-mediated soils in the Early Palaeozoic, and the initial colonisation of land surfaces by microbial crusts in the Proterozoic. I am also interested in palaeobotany and palaeosols (fossil soils).

What I like doing when I'm not X-ray-ing things: Hiking, the outdoors and nature, going to the theatre to see musicals, singing along to said musicals in my car, travelling (in non-COVID times!)

Name: Dan O'Flynn

Affiliation: British Museum

X-ray interests: I am the British Museum's X-ray Imaging Scientist, with responsibility for running the large-scale X-radiography and CT scanning laboratory located deep underneath the galleries. I study material from across the world and throughout history - to learn about ancient cultures, and their interactions with the world around them. A particular research interest is the application of X-ray CT scanning to ancient organic material and faunal remains. Before working in the cultural heritage sector, I completed a PhD in experimental physics at the University of Warwick



Dan O'Flynn



Dan in the British Museum X-ray imaging lab, with the Townley Discobolus

and worked as a Postdoctoral Research Associate in the Department of Medical Physics and Biomedical Engineering, University College London.

What I like doing when I'm not X-ray-ing things: Rock climbing whenever possible, hiking, guitar and photography.

Name: Charlie Wood

Affiliation: University of Portsmouth

X-ray interests: Charlie is a senior X-ray microscopist at the University of Portsmouth. His interests involve lab-based X-ray technique and technology development, utilising his background in mathematics and physics. This spans source and detector development, the interaction of X-ray photons with matter, the design of custom X-ray systems, image reconstruction, and quantitative



Charlie investigating the microstructure of mild steel in a traditional mid 19th century manually-operated smithy

post-processing. Charlie's research experience has crossed different characterisation modalities, which fuels his desire to explore correlative workflows, leading him to establish the Correlative Microscopy Network (CoMic). Charlie also investigates the link between material microstructure and macroscopic function for a range of materials and processes.

What I like doing when I'm not X-ray-ing things:

Charlie is passionate about self-sufficiency and off-grid living, once spending nearly two years living in a yurt. Charlie keeps bees, grows fruit and vegetables, and practises traditional craft skills, including blacksmithing. Charlie also enjoys playing guitar and piano.

Contacting the Royal Microscopical Society

The offices of the Royal Microscopical Society are at:
37/38 St Clements, Oxford, OX4 1AJ, UK
Tel: +44 (0) 1865 254760

For general enquiries email info@rms.org.uk
For information about meetings and courses email events@rms.org.uk
For membership enquiries email membership@rms.org.uk

www.rms.org.uk

Labtech

... innovative and practical tools
for electron microscopists

The little things make a big difference



- Unsurpassed range of holders and adaptors for EM
- Tools for SEM, FIB, TEM applications
- High quality vacuum grade components
- Available in the UK and IE from Labtech-em

www.labtech-em.com/em/em-home Tel: 01435 517000