WARWICK
THE UNIVERSITY OF WARWICK

Research Technology Platforms

What are the Research Technology Platforms?

The University of Warwick's Research Technology Platforms (RTPs) provide an integrated network of world-class facilities and expertise that enable researchers to perform outstanding science.

We aim to enhance local, regional and international research outcomes by providing researchers with access to a network of cutting-edge technology platforms, operated with world-best expertise and leadership principles, to enable innovative research of the very highest quality.

A key feature of the RTP programme is that access is open to researchers across all disciplines within the University, as well as external partners from academia and industry. Equally, the RTP programme acts as an access point for industry to make use of a wider range of experimental techniques and the ability to talk directly to the technical experts who can provide bespoke analysis.

Each RTP has a dedicated support team who are devoted to the smooth running of their facility, with maximum available usage time, and to helping researchers optimise the benefits from using the RTP.

As experts in their techniques, they can provide specialised training and advice on data analysis; often they will be pioneering new methodologies from which users subsequently benefit.

The RTP programme, overseen by myself as the Deputy Pro-Vice-Chancellor (Research), enables Warwick to take a coordinated approach to its key research technologies and ensure they remain at the state-of-the-art. By listening to the needs of our multidisciplinary user base, we determine the strategic future direction of each RTP and identify new areas that can be supported in this expanding programme.

I hope that this brochure provides you with some ideas of the range of opportunities available within the RTPs and that we will soon be able to help with your research and/or address your technical challenges.

Professor David Leadley
Deputy Pro-Vice Chancellor (Research)

OUR STAFF

This brochure highlights the cutting-edge technologies that the RTPs provide access to. However, without our knowledgeable technical professionals the RTPs simply could not operate. We are extremely fortunate to have dedicated and approachable experts in their fields to underpin both the research at Warwick as well as helping solve challenges brought to us by industry and other institutions. Our staff add great value to the investment that we have made and deserve recognition for the work they do.

If you are publishing work that has benefitted from the support our staff have provided, please do check out our fair attribution policy and help us ensure the correct level of visibility and recognition for the contribution they have made **warwick.ac.uk/research/technicians/fairattribution**

Use from
200+
research groups

40
Academic
and Technical

Staff
700+
external contracts

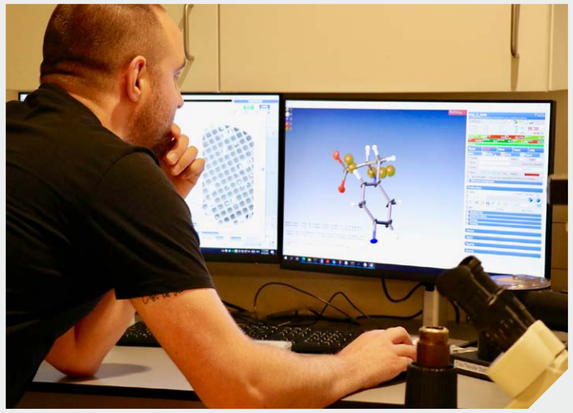
+£20m
Investment in capital

Electron Diffraction

In partnership with the University of Southampton and the National Crystallography Service (NCS), Warwick houses the first dedicated electron diffractometer in the UK for structural solution.

The unique Rigaku Synergy ED instrument allows us to use electron diffraction to study and solve the structure of nanomaterials (< 1μm crystals) that are typically too small, or too difficult to crystallise, to be solved using conventional X-ray diffraction techniques., including syncrotron radiation. Typical materials include MOFS, Pharmaceuticals, Catalysts and battery materials. Measurements are also possible in non-ambient conditions including cryo-plunging down to 100 K. It is complementary to a number of other techniques, including X-ray diffraction, TEM imaging and NMR crystallography.

The two instruments, at Warwick and Southampton, form the £3M EPSRC funded National Electron Diffraction Facility (NEDF, https://www.ncs.ac.uk/nedf/), which offers a full structural solution service to our external academic users who can apply for time via the NCS. We also operate on a commercial basis with competative rates. Please contact us for more details.



Dr David Walker

How Do I Access the RTPs?

USERS AT WARWICK

Each RTP has a Manager, listed below, who will be best positioned to indicate what training or services are available and the timeframe for gaining access. They will also be able to provide the latest internal costing for accessing the RTP if applicable. Once trained, many of the RTPs run online booking systems to provide users with the most convenient access possible.

RTP	Contact details	Page
Advanced Bioimaging	s.bakker@warwick.ac.uk – **Dr Saskia Bakker**	06
Advanced Mass Spectrometry	meng.li.1@warwick.ac.uk – **Dr Meng Li**	08
Bioinformatics	r.stark@warwick.ac.uk – **Dr Richard Stark**	10
Biological Services Unit	biotech4@warwick.ac.uk – **BSU Manager**	32
Micro-focus X-ray Computed Tomography	a.attridge@warwick.ac.uk – **Dr Alex Attridge**	12
Electron Microscopy	s.j.york@warwick.ac.uk – **Mr Stephen York**	14
Polymer Synthesis and Characterisation	d.lester@warwick.ac.uk – **Dr Daniel Lester**	16
Proteomics	proteomics@warwick.ac.uk – **Dr Andrew Bottrill**	18
Scientific Computing	miguel-afonso.oliveira@warwick.ac.uk – **Dr Miguel Alfonso Oliveira**	20
Research Computing	matthew.ismail@warwick.ac.uk – **Dr Matthew Ismail**	22
Spectroscopy	b.breeze.1@warwick.ac.uk – **Dr Ben Breeze**	24
Photoemission	m.walker@warwick.ac.uk – **Dr Marc Walker**	26
X-ray Diffraction	d.walker.2@warwick.ac.uk – **Dr David Walker**	28
WCUS	jack.woolley@warwick.ac.uk – **Dr Jack Woolley**	30

EXTERNAL USAGE

Warwick Scientific Services	c.gerard@warwick.ac.uk – **Claire Gerard**	35

Advanced Bioimaging

Find out more

Imaging temperature down to **-176˚C**

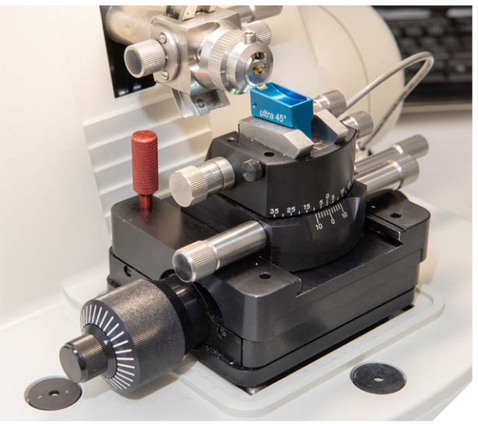
£2m worth externally funded equipment

70nm slice thickness

The Advanced Bioimaging RTP was established in 2015. It supports the investigation of complex biological problems by researchers at Warwick and externally, through the application of cutting-edge imaging technologies. The RTP specialises in transmission electron microscopy (TEM).

The RTP houses two transmission electron microscopes. The JEOL2200FS (2016) is equipped with a field emission gun electron source, an in-column energy filter, and a Gatan K2 Direct electron detector. The JEOL2100Plus (2018) is fitted with a LaB6 filament and a Gatan OneView IS CMOS camera. Additionally, the suite boasts a Leica GP2 plunge-freezer, an RMS cryo-ultramicrotome, and other supporting equipment such as a glow discharger and a carbon coater.

External users can be trained to use the equipment or imaging can be carried out as a service.



www.warwick.ac.uk/go/bioimaging

Dr Corinne Smith Advanced Bioimaging RTP Director
corinne.smith@warwick.ac.uk | 02476 522461

Dr Saskia Bakker Advanced Bioimaging RTP Manager
s.bakker@warwick.ac.uk | 02476 574095

"It's a really professional setup. We've never had any issues and we've always been able to access the kit when we need it. Everything happens smoothly and it's a really easy relationship."

Xerion Healthcare

CAPABILITIES

Thin section TEM

Room-temperature TEM of thin sections of embedded cells or tissues can give information about cell morphology and changes in cellular ultrastructure in samples after genetic mutations or drug treatments. By using immunogold labelling techniques, certain protein locations can be identified. Tomography can give a 3D view of smaller cellular structures.

Negative stain TEM

Negative stain TEM is a quick and cheap way of looking at purified samples such as nanoparticles, proteins, and viruses. The sample is surrounded by a heavy-metal containing stain and dried, which provides contrast in the electron beam. Negative stain TEM is a good method to answer questions about particle morphology, sample homogeneity and particle size.

Cryo-TEM

Cryo-TEM provides information on the interior structure of samples including nanoparticles, soft materials including polymers, lipid vesicles, purified protein, protein complexes and viruses. The sample is flash-frozen and imaged at liquid nitrogen temperatures. This frozen-hydrated method provides a more native-like environment for biological samples and allows for imaging of self-assembling polymer samples that are unsuitable for dry-state TEM. By collecting a large amount of data and processing the images, 3D structures can be obtained for suitably homogenous purified proteins. 3D structures can also be obtained by cryo-tomography.

Mass Photometer

Our Refeyn MP2 Mass Photometer can be used to measure the mass of proteins and protein complexes in solution, within a range of 40 kDa to 5 MDa. This can give useful complementary information to traditional techniques such as native PAGE or gel filtration.

Sample preparation

The Advanced Bioimaging RTP can also help with the preparation of biological samples for other techniques, e.g., scanning electron microscopy or computed tomography. We frequently collaborate with other RTPs to access these techniques.

Advanced Mass Spectrometry

Find out more

12T & 15T instruments

20 ionization, dissociation and separation methods

In-house data analysis software

The Advanced Mass Spectrometry (AMS) RTP specialised in high resolution, high mass accuracy, and advanced tandem mass spectrometry, primarily using Fourier transform ion cyclotron resonance (FTICR) mass spectrometry.

In addition to acquiring a wide variety of types of mass spectrometry data, we specialise in helping users with sample preparation, acquisition, and data analysis so that we are confident in the data quality going out the door. Our goal is to complement traditional mass spectrometry approaches; if other mass spectrometry approaches won't work, then come talk to us and we'll likely find a way."

The AMS-RTP has a newly installed 15T FTICR equipped with the widest range of ionisation and fragmentation techniques, making us capable of studying molecules from almost every class of chemical or biochemical compound – regardless of solubility, hydrophobicity/hydrophilicity, or molecular weight issued. Complex mixtures are our expertise! Additionally, we can generate trapped ion mobility separations (TIMS) results which lets us filter ions according to their collision cross-section (CCS) which can be combined with most of our other fragmentation techniques giving us additional dimensionalities to the datasets that can be produced. Finally, we have a number of sample preparation and chromatographic approaches available, so please contact us.

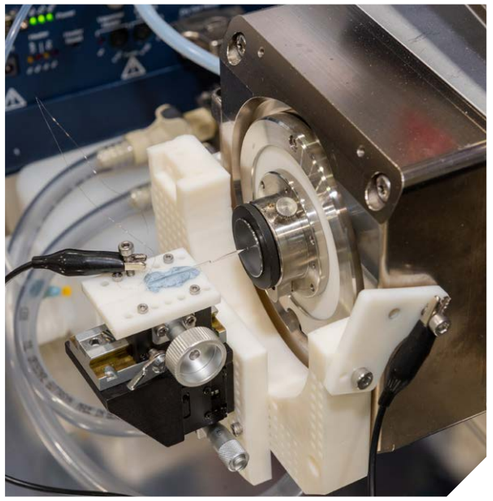
Example project areas include top-down proteomics, post-translational modification analysis on proteins, polymer molecular structure and sequencing analysis, DNA/RNA sequencing and epigenetic analysis, glycan structures, lipid differentiation and structures, metabolomics, petroleomics (and related complex mixture areas in biofuels, natural products, and environmental samples). Generally, if it has a molecular structure and it can be ionised, we likely have a way to measure it.

www.warwick.ac.uk/research/rtp/ams

Prof Peter O'Connor Advanced Mass Spectrometry RTP Director
p.oconnor@warwick.ac.uk | 02476151008

Dr Meng Li Advanced Mass Spectrometry RTP Manager
meng.li.1@warwick.ac.uk | 02476151304

> "The Warwick AMS-RTP has the UK's greatest mass resolving power, and the expertise to make the most of it. A great team to collaborate with."
>
> **Prof. Jackie Mosely, University of York**



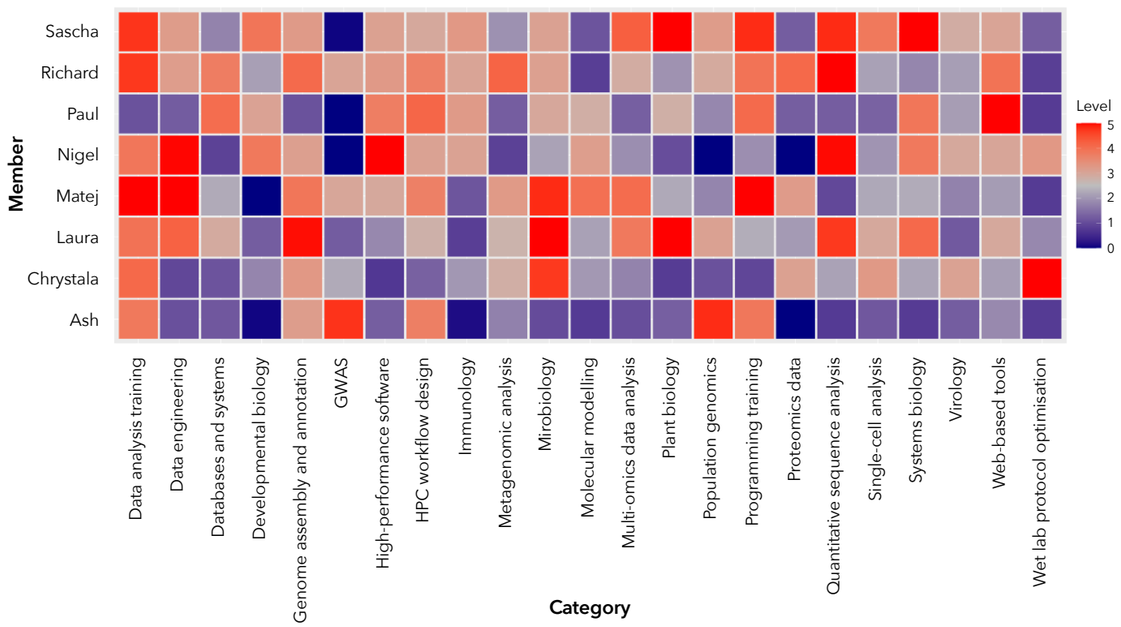
Bioinformatics

Find out more

www.warwick.ac.uk/go/bioinformatics

Professor Sascha Ott Bioinformatics RTP Director
s.ott@warwick.ac.uk | 024 7615 0258

Richard Stark Bioinformatics RTP Manager
r.stark@warwick.ac.uk | 024 7657 4266



CAPABILITIES

Our services include

- Planning of experimental and computational workflows to enhance data processing and interpretation.
- Collaboration on complex bioinformatics analysis challenges.
- Adaptable computing cluster technologies to meet your needs.
- Strengthening of grant applications with a range of bioinformatics input.
- Support generating figures and submitting data to repositories.
- Bioinformatics training and clinics for one-to-one advice.
- Provision of bioinformatics tools on the web or as mobile phone apps.

Computing hardware

The Bioinformatics RTP has access to several HPC cluster systems. Some we manage ourselves, and some are managed for us by the Scientific Computing RTP. These provide computational power far beyond that available on a desktop machine in terms of both CPU core count and available RAM. You can apply for accounts on these machines, or RTP staff are able to run analyses on your behalf.

List of Instruments /techniques

Our team provides assistance in bioinformatics across a broad range of data types and platforms and at all stages of the experimental procedure; from experimental design, through analysis and interpretation, to delivering results as figures and as interactive web tools. Techniques on which we regularly work with researchers include (meta)genomics, transcriptomics and proteomics, single-cell sequencing technologies, sequence assembly and regulatory sequence analysis. This is not a comprehensive list of the everevolving techniques with which our team has expertise and our experience can prove useful in other fields, so please contact us to discuss how we can help with your research.

> The Bioinformatics RTP have been invaluable in the installation and setup up of a new database system which will help us manage and distribute our seed resources. Their expertise and flexible, professional approach has been key to enabling the timely installation, and I very much look forward to working with them on other projects."
>
> **Dr Charlotte Allender,**
> **Warwick Genetic Resources Unit**

Micro-focus X-ray Computed Tomography

Find out more

Access to **5** instruments

50+ internal and external clients

25 days of instrument use each month (300 per year)

X-ray Computed Tomography (CT) is an established 3D imaging technique, well known for its medical applications, that is becoming an increasingly valuable method for the non-destructive characterisation of micro structures, material samples and components across a broad range of industrial and cultural sectors.

The CT scanning systems collect a large number of 2D radiographs, which with a 360° rotation of the sample are then reconstructed to create 3D volumetric models, using algorithms such as Filtered Back Projection (FBP). The resulting data set can be visualised and/or analysed in a variety of ways; including images, slice-through videos, geometric quantification, porosity analysis etc.

Whilst CT systems have limitations in terms of the size and density of objects that can be scanned, and resolutions that can be achieved, the Micro-focus CT RTP at the University of Warwick has a suite of systems with the ability to scan and image a broad range of samples, from grains of rice through to automotive engine blocks.

The Micro-focus CT RTP provides high-resolution X-ray CT scanning capabilities to enable the 3D imaging of a wide range of materials and geometries. Located within the Centre for Imaging, Metrology and Additive Technologies (CiMAT) at WMG, our nationally-leading facility currently has five CT scanners, ranging from a high power/ high penetration system capable of scanning large metallic objects such as automotive engines, gearboxes and electric drive units, through to a lab grade ultra-high resolution system, capable of achieving resolutions of just a few hundred nanometres for material samples of a few millimetres in size. We also have a high speed CT system capable of 4D imaging of samples in dynamic states (e.g. under load in compression rigs).

www.warwick.ac.uk/research/rtp/ct

Professor Mark Williams Micro-focus CT RTP Director
m.a.williams.1@warwick.ac.uk | 02476 575361 | 07824 540945

Alex Attridge Micro-focus CT RTP Manager
a.attridge@warwick.ac.uk | 02476 575420

We have a dedicated team of researchers and scientists who provide scanning and imaging services, as well as more complex data analysis, visualisation and reporting, to both external and internal customers, including automotive, aerospace, bio medical engineering, police forensics, heritage and archaeology. We have a Measurement Management System and are aligned to ISO10012 for data capture, handling and analysis, and can provide a range of services including basic scanning and imaging, data analysis and consultancy, and research.

Mix of high resolution, power and speed scanners and dedicated image processing equipment with secure storage

Sectors worked with:

- Wide range of applications including automotive, aerospace, forensics and historical artefacts

University departments worked with to date:

- Engineering, Physics, Maths and Statistics, Chemistry, Life Sciences and Warwick Medical School

CAPABILITIES LIST OF INSTRUMENTS /TECHNIQUES

Zeiss Versa 620
– High resolution system

- 160 kV source
- 170 nm – 25 µm voxel size
- Maximum object diameter = 45 mm (90 mm in wide field mode)
- Phase contrast and local tomography

Waygate V|tome|x M300
– Metrology system

- 300 kV source
- 2 µm minimum voxel size
- Ultra-high resolution 4k detector
- Maximum object diameter of 420 mm
- Stated MPE 3.8 µm + L/100 based on VDI 2630

Zeiss METROTOM 1500
– Metrology system

- 225 Kv source
- High resolution 3k detector
- Large cabinet for samples up to 1.5 m tall
- Stated MPE 4.5 µm + L/50 based on VDI 2630

TESCAN UniTom XL
– High speed system

- 180 Kv max
- 1.5 µm minimum voxel size
- High resolution 2.8k detector
- High frame rate detector – scans possible in as little as 10 seconds
- Large source-detector distance for propagation phase contrast

Nikon XT H 450RT
– High power system

- 450 kV / 450 W source with rotating target
- 80 – 113 µm voxel size (Micro-focus)
- 3D and 2D detectors (flat panel and CLDA)
- Can penetrate ~30 mm Steel, ~120 mm Aluminium
- Large cabinet, max object diameter ~600 mm

> "The Micro CT facility at Warwick has provided invaluable scanning support for our Homicide investigations and has provided vital evidence for a large number of high profile cases. Our partnership is seen as a national model for academic partnership with law enforcement."
>
> **Detective Chief Superintendent**
> **Mark Payne Head of Force Cid, West Midlands Police**

Electron Microscopy

Find out more

Access to **8** instruments

22 external clients

1000+ hours of instrument use each month

The Electron Microscopy RTP is a central facility for the University of Warwick and is one of the leading centres in the UK.

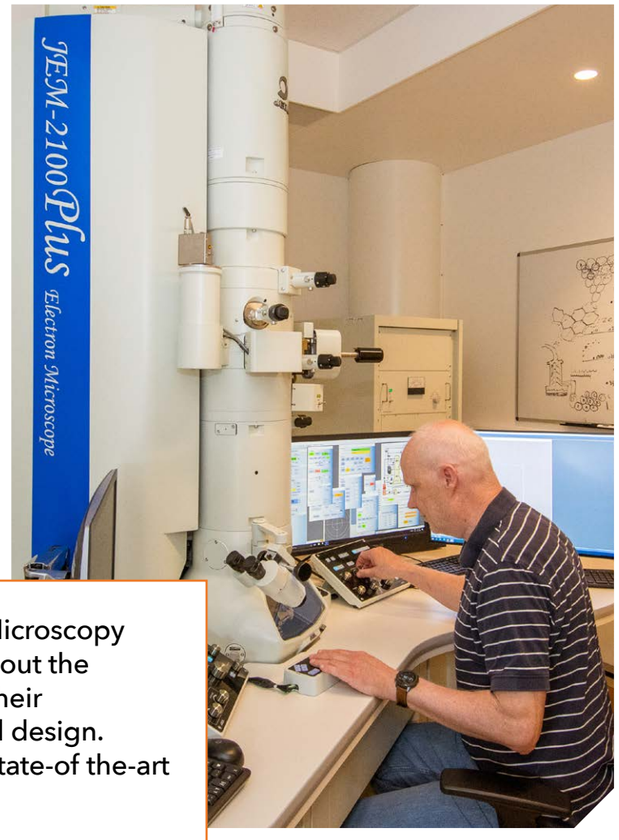
It contains a wide range of microscopes in a purpose-built suite, including: high resolution scanning electron microscopes (SEM); focused ion beam (FIB); several transmission electron microscopes, from simple imaging to atomic resolution; and state of the art scanning probe microscope (SPM/AFM). There are currently more than 200 registered users of the microscopes, both within the University as well as external commercial and academic users.

Work can be performed by highly experienced RTP staff. We also provide training and offer self-use of equipment.

www.warwick.ac.uk/research/rtp/em

Dr Richard Beanland Electron Microscopy RTP Director
r.beanland@warwick.ac.uk | 02476 573884

Steve York Electron Microscopy RTP Manager
s.j.york@warwick.ac.uk | 02476 523391



"The technical staff in the Electron Microscopy RTP have been excellent at carrying out the measurements we need and using their experience to input on experimental design. They help fulfil the potential of the state-of the-art equipment they provide access to."

BYK Additives

CAPABILITIES LIST OF INSTRUMENTS /TECHNIQUES

Scanning electron microscopy (SEM); energy-dispersive X-ray (EDX) analysis; cathodoluminescence (CL); focused ion beam (FIB) microscopy; transmission electron microscopy (TEM); electron energy loss spectroscopy (EELS); scanning probe microscopy (SPM); atomic force microscopy (AFM); optical microscopy; specimen preparation

TEM

The Jeol 2100 TEM can be used in scanning mode. Bright field and annular dark field images can be collected simultaneously and has an energy-dispersive X-ray detector to provide information on the chemical composition of a sample.

The Jeol ARM200F is a high-resolution aberration-corrected transmission electron microscope. This allows atomic resolution imaging both in STEM and TEM modes. The microscope has an electron energy loss spectrometer to allow detection and quantification of the elemental composition down to the atomic level. The microscope also has a energy-dispersive X-ray detector. This also yields composition maps with atomic resolution; both EDX and EELS spectra can be collected simultaneously.

SEM

Two scanning electron microscopes are able to image surfaces and handle a wide variety of samples, from conducting and semiconducting materials, beam sensitive or non-conducting samples. It has a secondary electron, backscattered and in-lens imaging modes. There is an energy-dispersive X-ray (EDX) spectrometer that allows elemental composition analysis and a Cat hodoluminescence (CL) system used to characterise the optical properties of a sample at the nanoscale in the SEM. A STEM detector and multi-TEM-sample holder is also available.

FIBSEM

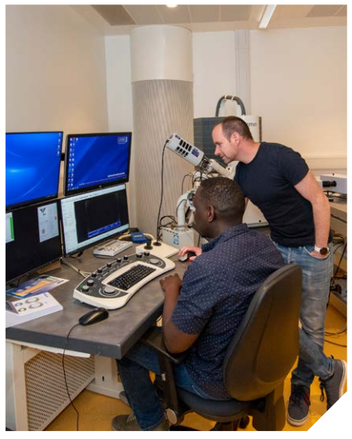
The FIBSEM has two columns; a column used in taking scanning electron microscopy images (SEM), and a ion column to allow focused ion beam (FIB) cutting. The FIB allows for very precise cutting of samples, with the SEM able to image the process in real time. A micromanipulator is also available to allow the user to pick up small objects. This opens up many possibilities, including picking up individual particles a few micrometers in size, making a TEM specimen from a specific site with nm precision.

ATOMIC FORCE MICROSCOPY

The atomic force microscope is suitable for use with a wide range of samples and features a vast array of modes. The AFM is able to image conductive, semiconducting and insulating samples in both air and liquid environments. The head can be adjusted to fit a wide range of sample sizes. A heating stage (30 to 250 Celsius) is also available with the ability to image under a constant flow of N2.

SPECIMEN PREP

Cutting; Polishing; Ion beaming for TEM samples.



Polymer Synthesis and Characterisation

Find out more

40 instruments

100+ internal and external clients

~2000 hours of instrument use each month

The University of Warwick is a globally-recognised centre of excellence in polymer research, which is underpinned by the state-of-the-art Polymer Characterisation RTP.

The RTP houses a world class size exclusion chromatography (SEC) suite, a wide range of thermal analysis equipment, particle sizing from nanometre to micrometre scales, materials analysis, such as rheology and mechanical testing, and contact angle measurement. On top of this we have access to more general analytical techniques such as, GC, IR and HPLC.

In addition to experiments using the analytical techniques above, external users can take advantage of formulation development and analysis, plus bespoke project design to meet your requirements.

www.warwick.ac.uk/research/rtp/polymercharacterisation/

Professor David Haddleton Polymer Characterisation RTP Director
d.m.haddleton@warwick.ac.uk | 02476 5 23256

Dr. Daniel Lester Polymer Characterisation RTP Manager
d.lester@warwick.ac.uk | 02476 574147

> "WSS / The Polymer RTP have provided us with an outstanding service, delivering leading edge science to help advance our research."
>
> Dr. David Bell, Unilever

CAPABILITIES

Gel Permeation Chromotography (GPC) / Size Exclusion Chromotography (SEC)

GPC/SEC separate on the basis of size, allowing for the accurate measurement of molecular weight averages and distributions. With advanced detectors (LS/VS), properties such as molecular size (R_g and R_h) and true molecular weight can also be measured. The Polymer Characterisation RTP is one of the few facilities world-wide that can offer SEC/GPC for a range of organic solvents (DMF, THF and $CHCl_3$ – but expandable to solvents such as DMAc), in addition to specialist aqueous and high temperature measurements. This includes a new BioSEC instrument for size separating and analysing biomaterials (such as proteins).

Thermal Analysis

The Polymer Characterisation RTP has three techniques for thermal analysis: thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA).

The three TGAs (including a TGA/MS) can be used to determine the thermodynamics and kinetics of processes involving weight loss, such as corrosion or oxidation. The three DSCs provide quantitative measurement of phase transitions used to determine composition and properties of materials, and can also perform photo DSC. The two DMAs allows the study of the viscoelastic behaviour of polymers from temperature/frequency sweeps or dynamic stress-strain testing. DMA also allows analysis of polymers analogous to DSC but with greater sensitivity.

Materials Testing

The Polymer RTP has a universal testing rig for characterising the mechanical properties of materials. This is tailored towards polymer materials, having a relative small load cell (500N). Typical measurements are tension, compression and peel, allowing determination of properties such as upper tensile strength, Young's modulus and elasticity.

The facility also has a rheometer with parallel plates in various diameters, which compliments the DMA and mechanical testing, allowing determination of properties such as elasticity and viscosity. This instrument also has a tribology geometry for determining lubrication properties, and also a photo-rheology plate.

Particle Size Determination

The particle size determination equipment in the Polymer Characterisation RTP is able to size materials from 0.6 nm to 500 µm *via* dynamic light scattering (DLS) or laser diffraction (LD). This provides an adaptable platform for a wide range of samples in a multitude of dispersants. We have 3 instruments available for this including two brand new instruments.

Drop Shape Analysis

The RTP has a drop shape analyser (DSA) that allows for the measurement of static and dynamic contact angles of liquids on surfaces, interfacial and surface tension of liquids and surface energies of solids.

Infra-Red Spectroscopy

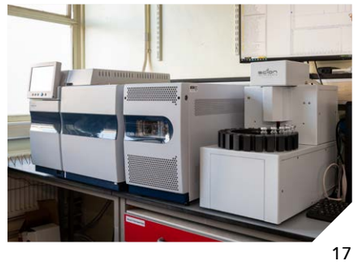
IR (sometimes FTIR) is a ubiquitous but under used technique that can give insight into chemical composition by analysis of bending and stretching modes of certain functional groups. This technique is suitable for solid state and can be applied to almost any analytical challenge.

GCFID/GCMS

The facility has four GC instruments with different detectors, allowing the gas phase separation and analysis of high-volatility analytes. These can be used for concentration determination of analytes via FID (flame ionisation detection) or chemical identification via MS (mass spectrometry). More over, one of these instruments has a headspace injector allowing for analysis of very volatile materials.

HPLC

The facility has 4 HPLC instruments, 1 with PDA, 1 preparative HPLC, an instrument with fluorescence, UV and DRi detectors, and a brand new LCMS.



Proteomics

Find out more

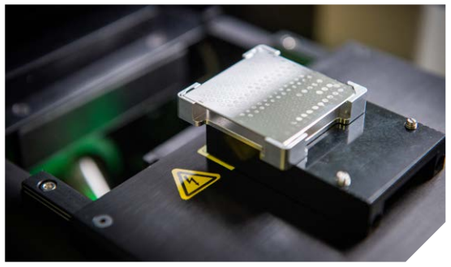
3 instruments

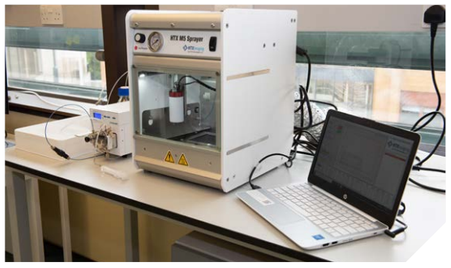
126 users from **65** different research groups

Deep proteome analysis

The Proteomics RTP provides services and support to academic and commercial researchers seeking to identify and quantify proteins and their modifications.

The analysis of protein mixtures from gel slices, co-IPs or enrichments is routine and we can identify several thousand proteins in complex samples such as, cell lysates and tissue extracts. Analysis of intact proteins, ion mobility mass spectrometry and Mass Spectrometry Imaging are also areas of particular expertise. You will find support from an enthusiastic proteomics team to help with scientific discussion, experimental design, sample preparation, analysis of data and provision of training.





www.warwick.ac.uk/research/rtp/proteomics

Dr Andrew R. Bottrill Proteomics Facility RTP Director
proteomics@warwick.ac.uk | 02476 574182

CAPABILITIES

Experimental Design and Sample Preparation

The Proteomics RTP provides detailed advice on selecting the most appropriate experiment to investigate the full proteome, cell fraction proteomes, protein immune precipitations, peptide enrichment and PTM experiments. And, we are open to new ideas!

Sample quality is critical to obtain outstanding mass spectrometry results. We provide a broad range of standardised protocols, guides and tutorials allowing deep proteome analysis and maximising the quality of your results.

List of Instruments /Techniques

The Proteomics RTP has a number of advanced LC-MS/MS capable instrument platforms. The correct type of chromatographic separation and mass spectrometry are adapted for your requirements. Particular instrument features are:

- timsTOF Pro
- Ion Mobility mass spectrometry and ultra-fast LC-MS/MS.
- Identify and Quantify unknowns from complex mixtures

Ion mobility allows separation of ions based on their collisional cross-section. This facilitates separation of isomers, such as phosphopeptides or proteins folded in different ways. Ion mobility can also be used to separate based on charge-state which is effective for pulling out cross-linked peptides. This is a sophisticated platform for all quantitative proteomics and metabolite investigations.

Orbitrap Fusion

- Outstanding mass accuracy and resolution.
- Wide range of fragmentation modes
- MALDI Mass Spectrometry Imaging (MALDI-MSI)

MALDI-MSI is a label-free technique which provides comprehensive and unbiased spatially resolved characterisation of biological surfaces, such as tissues or bacterial biofilms. A thin freshly-frozen or fixed sample section is mounted on a metal-coated glass slide and evenly coated with an organic matrix. Spatially localised data is acquired by firing a laser at the surface of the tissue, where the energy is absorbed by the matrix molecules, which are ionised along with co-crystalised biomolecules and measured using the Orbitrap Fusion.

Quantiva Triple Quadrupole

- Validate targets generated from analysis of complex mixtures

Targeted quantification of known compounds (peptides or metabolites) with high accuracy and sensitivity using selected reaction monitoring (SRM). A range of chromatographic options are available including nano-LC (as Orbitrap above) and high flow rate analytical UPLC for ultrafast identification with high accuracy and sensitivity.

Data Analysis

The Proteomics RTP utilises powerful workstations to interrogate databases for protein identification and quantitation. A range of search tools are provided including MaxQuant, Mascot and Sequest. Label free, SILAC and TMT quantification is possible at protein/peptide and post-translational modification site level.

Data return to users is provided via Scaffold software for basic needs and via Perseus where detailed statistical analysis is required. Skyline is utilised for targeted experiments.

We support many standard types of statistical testing, including principal component analysis (PCA), sample correlation test, heat map hierarchical clustering, gene ontology category enrichment analysis and kinase motif analysis. Additional synergy is provided by close support from the Bioinformatics RTP.

Scientific Computing

Find out more

270 managed Linux

Used by **50+** research groups

3 HPC clusters

Scientific Computing is the discipline of solving science and engineering problems on computers.

The Scientific Computing RTP provides solutions and infrastructure to help achieve this goal.

Currently we manage a Linux research computing environment deployed to hundreds of user PCs, workstations, and servers and accessible via several remote desktop technologies. The RTP hosts Warwick's High Performance Computing (HPC) clusters for batch processing of computationally intensive workflows, such as large-scale simulations, high throughput parameter searches, and analysis of large datasets.

Our Research Software Engineering (RSE) team provide training and consultancy as well as more direct support via secondment to research projects.

www.warwick.ac.uk/research/rtp/sc

Professor David Quigley Scientific Computing RTP Director
d.quigley@warwick.ac.uk | 024 7657 4100

Dr Miguel Afonso Oliveira
Scientific Computing RTP Facilities Manager
miguel-afonso.oliveira@warwick.ac.uk

Systems Team - scrtp-facilities@warwick.ac.uk

Abhishek Kamble, Senior HPC Infrastructure Engineer
abhishek.kamble@warwick.ac.uk

Phillip Harvey-Smith, HPC Administrator
p.harvey-smith@warwick.ac.uk

Magnus Lewis-Smith, Senior Linux System Administrator
m.lewis-smith@warwick.ac.uk

Jaroslaw Zachwieja, Senior Linux System Administrator
grok@warwick.ac.uk

Arkadiy Davidov, Research Software Specialist
arkadiy.davydov@warwick.ac.uk

RSE Team - rse@warwick.ac.uk

Dr Chris Brady, Senior Research Software Engineer
c.s.brady@warwick.ac.uk

Dr Heather Ratcliffe, Senior Research Software Engineer
h.ratcliffe@warwick.ac.uk

Dr Philip Grylls, Senior Research Software Engineer
pip.grylls@warwick.ac.uk

CAPABILITIES LIST OF INSTRUMENTS /TECHNIQUES

List of facilities

- Managed Linux research computing environment coupled to high capacity user and group network storage.
- Shared "taskfarm" servers for batch computing jobs.
- Two large HPC clusters for large-scale parallel computing workloads.
- The Sulis tier 2 HPC service operated on behalf of HPC Midlands+
- Research Software Engineering (RSE) team providing training and consultancy to users of the RTP facilities, and longer-term software engineering support via secondment to research projects

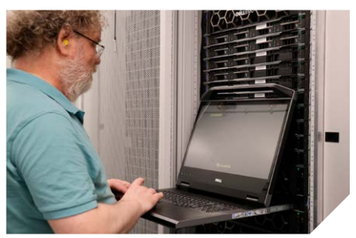
Managed Linux Desktop Computing Environment

Users registered with the RTP have access to our systems via several remote desktop technologies, or by deploying our managed Linux configuration onto local desktop hardware. Each user has access to networked data storage, software development tools including the GNU and Intel compiler suites plus a library of standard Python packages for simulation, analytics and machine learning, numerical libraries and a managed scientific software stack.

Commercial scientific packages (Matlab, Maple, Mathematica) licensed centrally by the university are also available. We deliver a large (currently 7 Petabyte) group storage system to these desktops, suitable for large datasets shared by multiple users.

Avon

HPC cluster with 180 compute nodes, each with 2 x Intel Xeon Platinum 8268 (Cascade Lake) 2.9 GHz 24-core processors and 192GB DDR4 memory per node. The nodes are linked by Mellanox HDR100 (100 Gbit/s) InfiniBand allowing all 8640 compute cores to operate as a single parallel computer. Avon also contains 16 nodes equipped with 3 x NVIDIA RTX 6000 Graphics Processing Units (GPUs) per node for GPU-accelerated applications such as machine learning, molecular dynamics, image processing etc. 4 additional nodes contain 1.5TB of memory for applications requiring large amounts of RAM. All Avon nodes are connected to a high speed parallel file system of 1PB storage. Access to a 200TB scratch space based on high performance SSDs is also available.



Sulis

Sulis is a national tier 2 HPC service focussed on high throughput and ensemble computing, funded by a £3M "World Class Labs" award from UKRI. It is available to Warwick researchers via an internal application mechanism. The system consist of 167 dual processor compute nodes with AMD EPYC processors (128 cores per node) and 512GB of RAM. An additional 30 nodes are equipped with 3x NVIDIA A100 GPUs per node. See sulis.ac.uk for details.

> "The RSEs are an extremely useful knowledge resource, teaching new PhD starters to optimising previously written code for our research."
>
> **Professor Sandra Chapman, Department of Physics**

Research Computing

Find out more

RESEARCH COMPUTING

Research Computing is a new initiative within Warwick, with a mission to create an enhanced, broader and more strategic research computing provision.

Encompassing digital research infrastructure and the associated people and expertise, research computing aims to enable computationally-driven, data-centric and digital research on a university-wide basis.

Research Computing works across, within and beyond the RTPs, with close links to Scientific Computing and Bioinformatics, the Research Software Engineering community, IDG and the library.

Current research infrastructure projects include improving provision for archiving large-scale research datasets; easier access to cloud computing for researchers and enhancing data transfer to, from and within campus.

www.warwick.ac.uk/research/rtp/rc

research-computing@warwick.ac.uk

Dr Matthew Ismail
Technical Director of Research Computing
matthew.ismail@warwick.ac.uk

Matt oversees the university's research computing provision, providing technical leadership across teams delivering High Performance Computing (HPC), bioinformatics, research software engineering and research data storage. Two key aspects of Matt's role are in shaping and delivering the university's research computing technical strategy, and in supporting and collaborating with the academic community to ensure researchers have access to the research technologies they need. Matt's background is in experimental and computational chemistry then technical roles within HPC.

"I look forward to working with both the academic community and IDG to further the research computing provision available across campus. I am eager to collaborate with researchers to explore new and exciting advanced technologies which could help to achieve their research goals."

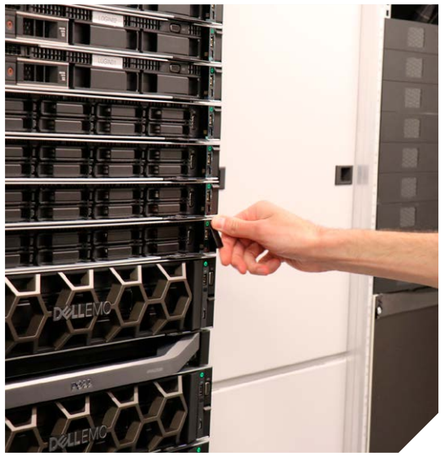
Dr Matthew Ismail,
Technical Director of Research Computing

RESEARCH SOFTWARE ENGINEERING

Formerly the IDG Technology for Research team, Godwin Yeboah, James Tripp and Steve Ranford joined Research Computing within the RTPs this year, as Senior Research Software Engineers.

The RSE team has expertise in areas such as use of R and Python in data analysis, visualisation and machine learning, web development relevant to the digital humanities and use of Linux environments in research infrastructure.

The team can provide RSE support through the research lifecycle, from supporting the grant application stage, to collaborating with research groups, and publishing, archiving and communicating research outputs in line with open research methods and practices.



Dr Godwin Yeboah Senior Research Software Engineer
g.yeboah@warwick.ac.uk

Godwin has interdisciplinary RSE expertise spanning Geographic Information Science/Systems and advanced geospatial applications; geocomputation in social science research; geoinformatics and photogrammetry; and geomatic/geodetic engineering. He has worked as a researcher at both PhD and postdoctoral level, leading the development of geospatial research methods. Prior to joining Warwick, he held several positions in Europe and West Africa working in both academia and industry.

Dr James Tripp Senior Research Software Engineer
james.tripp@warwick.ac.uk

James is a research technology expert with a background in experimental and computational psychology, cognitive science and information integration. He has applied frequentist statistics and Bayesian modelling to problems in data science, and led teaching and laboratory activities in computational methods in psychology. James joined the RSE team from Warwick's Centre for Interdisciplinary Methodologies (CIM), where he built a Linux-based research infrastructure and supported research software development across a number of disciplines.

Steve Ranford Senior Research Software Engineer
steve.a.ranford@warwick.ac.uk

Steve has extensive experience in digital humanities, having helped researchers in the Faculty of Arts realise numerous projects over many years. His wide-ranging experience includes collaborating with research teams on projects such as the British Black and Asian Shakespeare Database, and the cinematic Projection Project, with a particular focus on exploitation of web technologies. Steve is particularly passionate about the creative side of technical projects, especially to help researchers use digital tools to communicate their research outputs more effectively.

Spectroscopy

Find out more

16 instruments

100+ Active users in the last 6 months

Used by **6** departments

The Spectroscopy RTP enables access to leading facilities and tailored training for researchers requiring the spectroscopic data that supports Warwick's world-class scientific research.

The range of complementary techniques available at the RTP enables non-destructive investigation and characterisation of liquid, solid and gaseous samples.

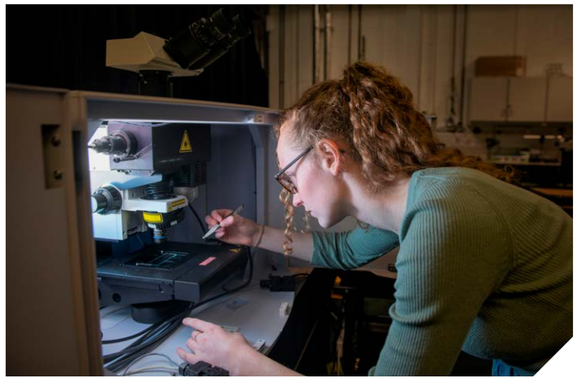
Services include Raman, photoluminescence and optical absorption spectroscopy and microscopy, and electron paramagnetic resonance. The RTP has access to specialised data analysis software and databases of reference spectra to aid material characterisation. The spectroscopy team can provide full training for researchers or run data on their behalf. The spectroscopy RTP is an accredited bronze LEAF laboratory, and the facility has been awarded BSi 45001.

> "As materials characterisation experts, our work benefits of outputs from the spectroscopy RTP facility. This facility provides state of the art equipment, and the Spectroscopy team can provide support and training that is second to none. Our work benefits of outputs from such a fantastic facility."
>
> **Tara Schiller, WMG**

www.warwick.ac.uk/research/rtp/spectroscopy
spectroscopy@warwick.ac.uk

Dr Ben Green Spectroscopy RTP Director
B.Green@warwick.ac.uk

Dr Ben Breeze Spectroscopy RTP Manager
B.Breeze.1@warwick.ac.uk | 02476 572865 | 07384 231344



CAPABILITIES

Raman Spectroscopy and Microscopy

Raman spectroscopy measures inelastically scattered light from a sample. Laser light focused onto a sample interacts with molecular vibrations or phonons with the lattice and is scattered with a lower energy (Stokes) or higher energy (anti-Stokes). The Raman spectrum gives insight into the structural properties of a material and each material provides a unique fingerprint.

Combining Raman spectroscopy with a microscope allows a precise point on a surface to be analysed and maps of samples to be built up. The RTP equipment can perform Raman measurements and hyperspectral maps using different excitation wavelengths ranging from UV to NIR.

Fluorescence Spectroscopy, Microscopy, and Lifetimes

Fluorescence Spectroscopy is a non-destructive technique that focuses monochromatic light onto a sample, exciting electrons which absorb this light into a higher-energy state; these electrons subsequently relax to ground states, emitting light that is collected and measured. It can be used to characterise the electronic properties of a material and has applications diverse as quantum dots, solar cells, amino acids, and such as the band gap or defects present in semiconductors.

The RTP is able to measure fluorescence with excitation energy and detection from the UV to NIR. Our spectrometers are capable of steady state fluorescence measurements on bulk material in solid, liquid, and powder forms, as well as being able to produce hyperspectral spatial maps of samples. In addition, we can also perform time-resolved measurements gaining information about photoluminescence and phosphorescence lifetimes from nanoseconds to seconds.

FT-IR Spectroscopy and Microscopy

FT-IR Absorbance spectroscopy can be used for both qualitative and in some cases quantitative investigations. The Infrared absorption spectrum is produced from the light interacting with chemical bonds at vibrational and rotational frequencies allowing identification materials and defects. Samples can be characterised in bulk or spatial maps can be built up using a Microscope in both transmission and reflection. It is also possible to monitor reactions as they happen in real time building up time resolved maps from micro-seconds to hours. The facility offers measurements in both the MIR and NIR spectral range on liquids, solids, and powders.

UV Vis Optical Absorption Spectroscopy

The absorption equipment available at the RTP allows investigation of the optical properties of materials using monochromatic light of wavelengths in the UV and visible regions. UV-VIS Absorbance spectroscopy can characterise a material's electronic structure, but is most often used to determine concentrations using the Beer-Lambert Law.

Electron Paramagnetic Resonance (EPR)

EPR is used for study and quantification of chemical species that have one or more unpaired electron, such as organic and inorganic free radicals or inorganic complexes possessing a transition metal ion. EPR spectroscopy is used in various branches of science, such as chemistry and physics, for the detection and identification of free-radicals and paramagnetic centres. EPR is a sensitive, specific method for studying both radicals formed in chemical reactions and the reactions themselves in real time.

The RTP offers continuous wave, pulsed and Rapid Scan EPR to provide identification, characterisation, and quantification of paramagnetic species in samples, as well as monitor dynamic process in-situ on time scaling ranging from sub micro-seconds to hours.

Additional Equipment

The facility has a range of in-situ perturbations to samples to help probe and characterise samples. These include: Variable temperature from 4 to 1700 K; Optical excitation from UV to NIR; and in-situ hydrostatic and uniaxial pressure. In addition, the spectroscopy team have significant expertise in collaborating with our users to building custom in-situ experiments tailored to researcher's particular needs.

Photoemission

Find out more

2 instruments

50+ Active users per year

1000+ samples per year

The Photoemission RTP was first established as the Warwick Photoemission Facility in 2012 before becoming a RTP in 2021 and thus has many years of experience in dealing with both academic and industrial surface characterisation projects across the full spectrum of the sciences.

The research undertaken in the RTP is broadly divided into two categories, routine surface analysis and more fundamental surface science. The RTP hosts two modern instruments, both capable of performing surface characterisation experiments with X-ray photoelectron spectroscopy (XPS) and ultraviolet photoelectron spectroscopy (UPS).

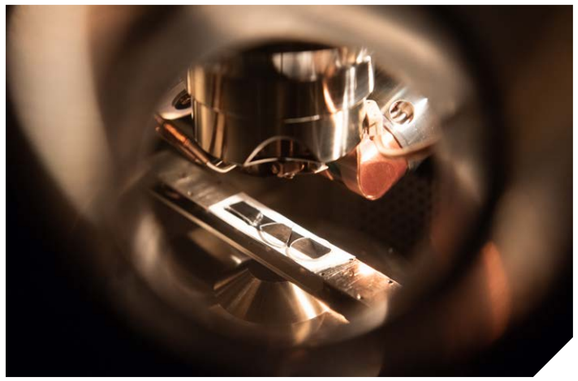
The Kratos Axis Ultra DLD spectrometer is a high throughput instrument with automated sample positioning and data acquisition for XPS and UPS. The instrument is also capable of XPS-imaging of surfaces to a resolution of 3 µm, depth profiling of surfaces and annealing to 600 °C. Samples can be loaded via an inert transfer vessel from a suitable N_2 or Ar glovebox.

The Omicron Multiprobe spectrometer also provides routine XPS and UPS, in addition to depth profiling, annealing to 850 °C in vacuum, examining the periodicity of crystalline surfaces with low energy electron diffraction (LEED) and transfer from compatible vacuum systems using a vacuum suitcase. The preparation chamber also houses a thermal gas cracker and a port for user deposition sources.

Users can be trained to use the equipment and carry out data analysis, or this can be provided as an all-inclusive service.

www.warwick.ac.uk/research/rtp/xps/

Dr Marc Walker RTP Manager
M.Walker@warwick.ac.uk | 02476 151776



CAPABILITIES

X-ray Photoelectron Spectroscopy

X-ray photoelectron spectroscopy (XPS) is uniquely placed as a quantitative surface analysis technique which can provide elemental composition as well as the chemical and electronic state of the top ~10 nm of a solid material. Both conducting and insulating samples can be studied as the instruments are equipped with charge neutralisation. Wafers, solid samples and powders can be loaded directly in to the instrument, while solutions can be drop-cast or spin-coated on to an appropriate substrate and dried before being loaded in to the vacuum. The valence band and core energy levels are accessible with our Al Kαx-ray sources.

Ultraviolet Photoelectron Spectroscopy

Ultraviolet photoelectron spectroscopy employs He I and He II photon emission to study the electronic structure of the most loosely bound electrons at the surface. UPS can be used to determine the work function of a material, as well as locating the valence band maximum energy with respect to the Fermi level. Samples generally need to be conductive or consist of thin films on conductive substrates.

Complementary Techniques

The spatial distribution of elements on the surface can be mapped in imaging XPS. The sampling depth of the XPS experiments can be reduced to improve surface specificity via variation of the take-off angle, while a composition profile deeper in to the sample can be extracted from a depth profiling experiment using the in-situ ion guns. The periodicity of crystalline surfaces can be studied using LEED.

Additional Capabilities

In-situ surface modification is possible via gas dosing, ion bombardment to remove material, annealing of the sample, or by depositing organic and inorganic material on to the surface using a user-supplied deposition source. Samples which are sensitive to air can be transferred from a glovebox under nitrogen or argon to the Kratos instrument, or under vacuum to the Omicron instrument from a compatible system.

> "Warwick's facilities have been indispensable to our R&D at Oxford PV. Their state-of-the-art equipment and expert data analysis have helped us to achieve world-record solar PV efficiencies and to move our technology towards industrial production."
>
> Oxford Photovoltaics

X-ray Diffraction

Find out more

5 metre long **SAXS**

650+ publications since 2008

Measurements from **-261°C** to **1200°C**

The X-ray Diffraction (XRD) RTP has a wide range of X-ray technologies and expertise in data analysis.

A dedicated team of four members of staff can help train you, provide access to state-of-the-art equipment or carry out experiments on your behalf. The RTP houses 6 powder diffractometers, 2 single crystal diffractometers, 2 high resolution diffractometers, a wavelength dispersive x-ray fluorescence (WD-XRF) instrument, a small angle X-ray scattering (SAXS) system and electron diffractometer.

> "The training and data analysis help we have had on the SAXS has really helped us push the boundaries of our research. In particular, Steve has been excellent at supporting our exploration of a new technique."
>
> Professor Sebastien Perrier, Department of Chemistry

www.warwick.ac.uk/research/rtp/xrd/

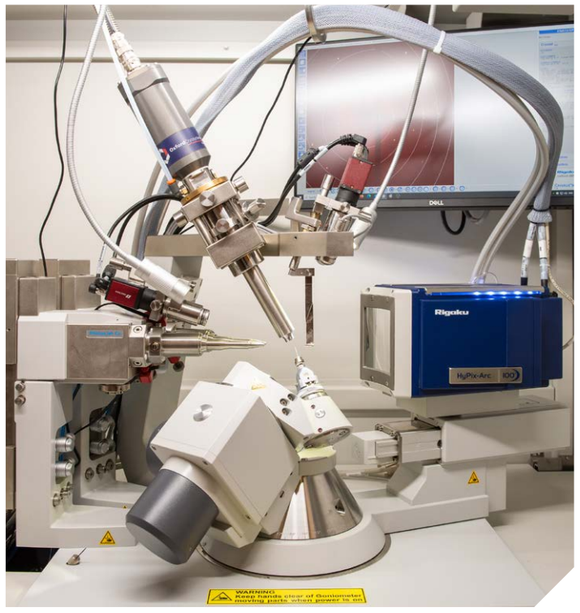
Professor Richard Walton XRD RTP Director
r.i.walton@warwick.ac.uk | 02476 523241

Dr David Walker XRD RTP Manager
d.walker.2@warwick.ac.uk | 02476 151299

Dr Steven Huband SAXS Specialist
s.huband@warwick.ac.uk | 02476 151782

Dr Jere Tidey Electron Diffraction Specialist
Jere.Tidey@warwick.ac.uk

Dr Jie Liu Powder Diffraction Specialist
jie.liu.3@warwick.ac.uk



CAPABILITIES

The XRD RTP has a range of X-ray centric techniques. Typical measurements include phase identification, structural determination, Rietveld refinement; determination of phase contamination and sample purity; layer thickness, composition and roughness; stress and texture measurements. Advanced functional materials such as battery materials, power electronics, coatings, solar cells, catalysts steels and energy storage materials are a particular focus, but we have growing experience in the study of soft matter such as polymers and organic materials.

X-ray Diffraction

XRD is a powerful non-destructive technique for characterizing crystalline materials. At Warwick we have powder, single crystal and high resolution diffraction capabilities.

Powder XRD relies on diffraction from randomly orientated grains to produce a semi-unique 1D pattern, which can be matched against a database of known structures or to refine a structural model (Rietveld refinement) for atomic level crystal structure information. Warwick has 6 diffractometers covering different energies (Cu, Co and Mo sources), high-throughput, high-resolution, high-temperature (up to 1200 °C), low-temperature (down to 12 K) and *in-situ* reactions.

Single crystal diffraction is a powerful X-ray technique for the solution of crystal structures, providing key information on symmetry and atomic positions. Usage spans from routine structural work on organic and metal-organic small molecules to highly detailed investigations of heavy metal oxides. Warwick is equipped with two powerful single-crystal diffractometers, including a Rigaku Oxford Diffraction Synergy S with an ARC 100 hybrid phton counting detector and a SuperNova equipped with an Oxford Cryosystems N-Helix cryo cooling system for data collection down to 25 K.

High-resolution XRD uses highly monochromatic X-rays to study individual Bragg peaks of bulk single-crystal and thin-film materials, allowing precise measurement of layer thicknesses, composition analysis and diffuse scatter measurements. Typical routine applications of high-resolution XRD include reflectivity, rocking curves and reciprocal space mapping, stress and texture measurements. A high temperature stage (up to 1100 °C) is available.

Small angle X-ray scattering

SAXS is an X-ray technique for non-destructive investigation of nanoscale particle size, distribution and morphology. Typical measurements include particle size, distribution and morphology determination, tensile strain and temperature variation measurements.

Applications include polymers, nanocomposites, magnetic nanoparticles, powders, fibres, pastes, gels, liquid dispersed particles and thin-films (Grazing-Incidence SAXS).

The Xenocs Xeuss 2.0 SAXS system is equipped with dual microfocus sources; Cu for standard measurements and Mo for more absorbing samples. It has a *q* range of 0.025 to 30 nm-1, giving a maximum measurable particle diameter up to roughly 250 nm. We have Linkam HFSX350, TS700 and TST250V stages for measurements as a function of temperature (-196 to 700 °C) and/or strain (-196 to 250 °C).

X-ray Fluorescence

A full-size Rigaku Primus IV WD-XRF is available for the determination of elemental composition from B to U with a focus on light-element sensitivity. Samples can be in solid form, pellets, fused beads or powders.

Warwick Centre for Ultrafast Spectroscopy

Find out more

Wide range of working **wavelengths** from **200-20000 nm** and **0.5-3 THz**

£20M worth externally funded equipment

40 femtosecond time resolution

The Warwick Centre for Ultrafast Spectroscopy was established in 2017 and became an RTP in 2021. The use of cutting-edge ultrafast (femtosecond = 10^{-15} s) lasers allows for the observation of atomic and charge carrier motion.

This is used to investigate novel materials and molecules from semiconductors to new sunscreen filters.

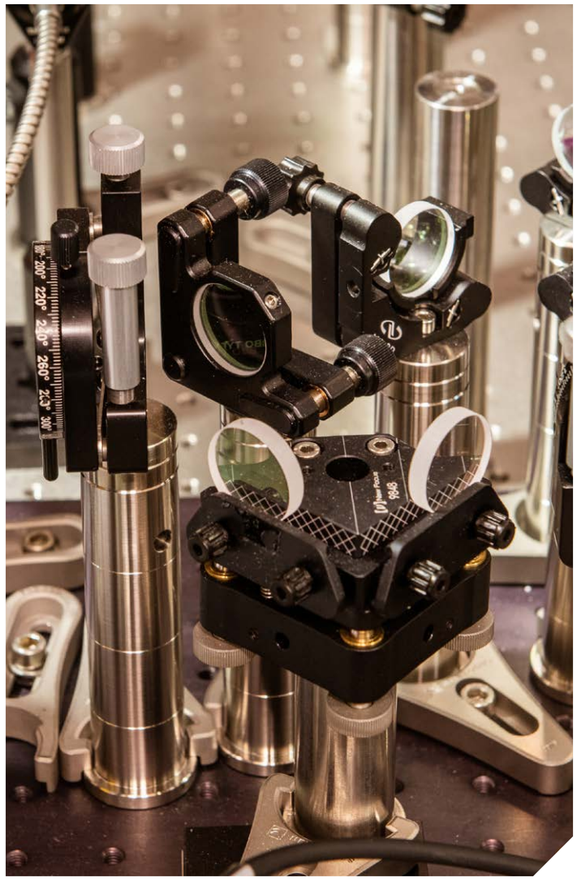
The RTP houses an ultrafast Ti:sapphire laser system (Newport Spectra-Physics Spitfire PA Pro) with four independently-compressible beam outputs. Through use of several optical parametric amplifiers (TOPAS, Light Conversion) the 800 nm fundamental of the Spitfire can be converted into any wavelength from the UV (235 nm) to the mid-infrared (20 microns), while we use custom non-linear effects to produce far-infrared (terahertz) pulses (75 to 600 microns). These sources serve four major beamlines in the facility: Transient Electronic Absorption, Transient Vibrational Absorption, Optical Pump/Terahertz Probe and High Field Terahertz Spectroscopy. Additionally, the facility has a Cary60 UV-Vis absorption spectrometer, a Bruker 70V Fourier Transform IR spectrometer and a Horiba Fluorolog 3 fluorescence spectrometer, which performs time-resolved fluorescence measurements down to 1 ns time resolution over the 300nm to 1700nm wavelength range. We can run experiments in a number of environments, including air, dry N2 atmosphere and vacuum, and have a number of cryostats available to test samples from 77 to 300 K.

External users can be trained to use some of the simpler equipment (UV-Vis/FTIR/Fluorolog) for occasional use, or on the ultrafast system if they require long-term use. Measurements can be carried out as a service.

www.warwick.ac.uk/research/rtp/wcus

Dr James Lloyd-Hughes Ultrafast Spectroscopy RTP Director
J.Lloyd-Hughes@warwick.ac.uk | 02476 522043

Dr Jack Woolley Ultrafast Spectroscopy RTP Manager
jack.woolley@warwick.ac.uk



CAPABILITIES

Transient Electronic Absorption Spectroscopy

Using a tunable excitation laser ranging between 200-2500 nm, and a broadband white light probe laser which spans 320-720 nm with every laser shot, the population of excited electronic states can be probed with femtosecond time resolution. We use this technique to develop new sunscreens and solar cell materials while also trying to understand the photophysics of fluorophores and photocatalysts.

Transient Infrared Absorption Spectroscopy

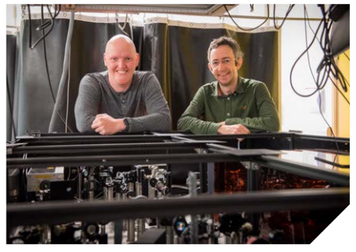
Similar to transient electronic absorption, a tunable excitation laser, this time from 200 nm down to 9000 nm IR excitation, pumps the system. IR light from 2500-20000 nm then measures the transient IR spectra, giving a picture of the changes in vibrational energy over time. This allows us to observe structural changes, vibrational dynamics and low-energy electronic states within such systems as diamond defects, carbon nanotubes, and much solution phase photochemistry.

Optical Pump Terahertz Probe Spectroscopy

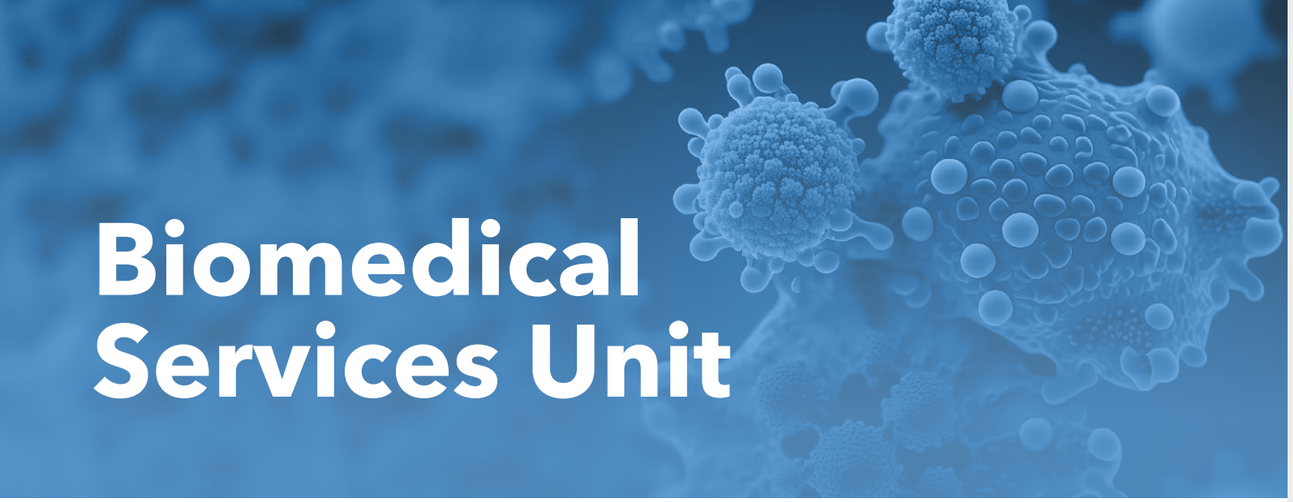
A pump beam of between 200 and 9000 nm photoexcites the sample which is probed by far IR terahertz light. Through this technique we can observe very low energy vibrational states, photoconductivity, and charge carrier dynamics after excitation with light. We have used this technique to study such systems as carbon nanotubes, semiconductor materials, and novel halide perovskites of interest in optoelectronics and energy applications.

High Field Terahertz Spectroscopy

By passing 800 nm light through a lithium niobate crystal, we generate terahertz pulses with strong electric fields (1MV/cm). By using this to drive the system under study, we can observe unique photophysics as free charges or terahertz vibrational modes are pushed far from equilibrium, and then recover. Synchronised terahertz or visible pulses can be used to probe the relaxation dynamics.



> "We used the ultrafast transient absorption instruments at WCUS and had a great experience. The staff were incredibly helpful in arranging the visit and helped us ensure our samples were ready run from the minute we arrived, absolutely maximising the time we had booked. They were hugely supportive of the student making the measurements, and even showed some examples of data processing. I couldn't recommend this more if you're in need of some ultrafast data!"
>
> Dr Joseph Beames
> University of Birmingham.



Biomedical Services Unit

Research involving animals has made, and continues to make, a vital contribution to understanding, treating and curing many major health problems.

Whilst new methods have enabled scientists and medical researchers to reduce and replace experiments involving animals, some animal studies must continue for further progress in science and medicine to be made.

Cognisant of the many ethical and legal issues surrounding the use of animals in biomedical research, the University of Warwick Biomedical Services Unit (BSU) contributes to the advancement of biomedical research through the supply of high quality research animals and allied professional services.

To see how we can help you, contact

biotech4@warwick.ac.uk

CAPABILITIES

- Compliance with UK and EU legislation concerning the breeding and use of animals for research
- Transgenic service licences to enable breeding and supply of genetically altered animals (mice and fish) for research
- Antibody service licence: custom antibodies can be generated in mice
- Transportation and ordering of animals arranged on your behalf
- Breeding of animals and maintaining of colonies to meet your experimental requirements
- Licenced and competent staff to assist with procedures
- Procedure and surgical rooms available for general use.
- Containment level 2 holding facility and procedure room.

140
individually ventilated rat cages with a total holding capacity of 420 rats

1150
individually ventilated mice cages with a total holding capacity of 3500 mice

15000
zebra fish capacity in our recirculating aquatic system

Elemental Analysis and Chemical Composition

We have several complimentary techniques available in the RTPs, which can provide a wealth of chemical and elemental information across a wide range of samples:

X-ray Fluorescence (XRF)

Based in the XRD RTP, we have a powerful Rigaku Primus IV Wavelength Dispersive X-Ray Fluorescence Spectrometer (WD-XRF) equipped with a 4 kW tube - analyser crystals provide the energy resolution, enabling a high sensitivity and reducing the line overlaps which are commonly seen in Energy Dispersive instruments (ED-XRF).

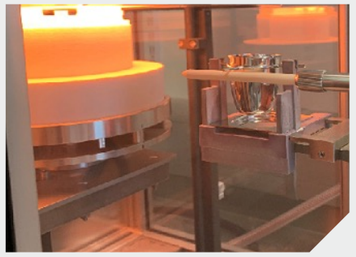
We are able to measure elemental compositions down to .ppm levels from Boron to Uranium for solids, powers, liquids, thin films and alloys. Our instrument is also equipped with small-spot mapping system, which allows for a particular area of a sample (as small as ⌀0.5 mm) to be identified using a camera, and then analysed.

Image: Rigaku ZSX Primus IV XRF Instrument

The Electron Microscopy RTP also has Energy Dispersive (EDX) spectrometers attached to many of their instruments, allowing both imaging and elemental analysis to be conducted at the same time.

XRF Sample Preparation

We also have sample preparation capability and can produce pressed-pellets and fused beads using our Fluxana Vitreox fusion machine, allowing for sample homogenization and more accurate results. Two complement this, we have two Fluxana calibration standard sets for highly accurate analysis of cements and raw materials.



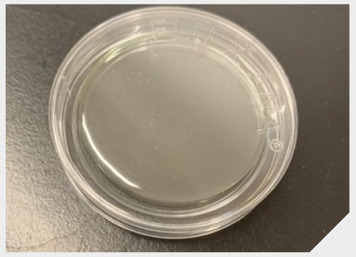


Image: Fused Bead Preparation

X-Ray Photoelectron Spectroscopy (XPS)

The Photoemission RTP houses two photoelectron spectrometers which can be used for routine, high-throughput analysis of solid materials – including powders, polymers, metals, thin-films etc. With this technique we can probe the surface of the material (top ~10 nm) to provide both quantitative elemental and chemical compositional information (i.e, oxidation states, functional groups/ bonding environments). Our team has a wealth of experience, having worked with many different types of samples from semiconductors and battery electrodes to dog hair and kitchen worktops, and can provide full analysis service including data fitting.

More advanced surface science experiments are available in addition to elemental analysis – please refer to the Photoemission page for more information.

Other Techniques at Warwick

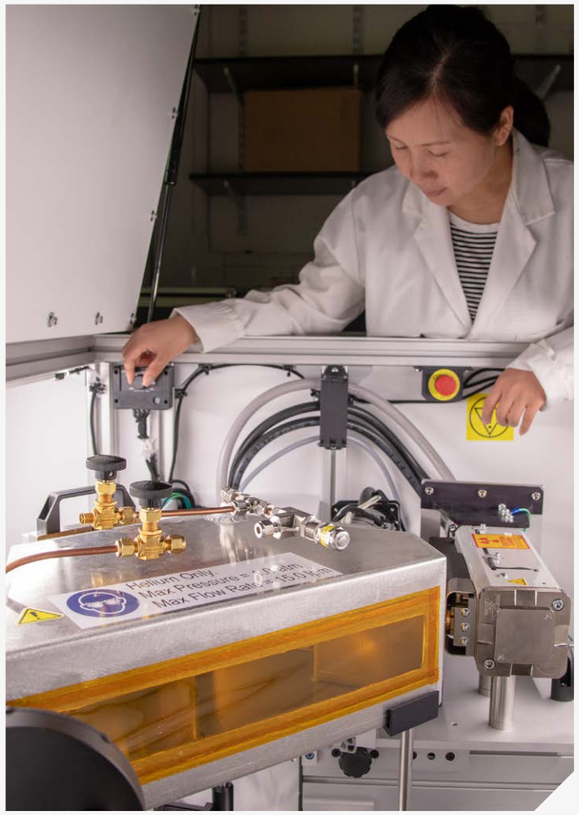
Whilst not part of the Research Technology Platforms, we can facilitate access to other elemental analysis instrumentation at Warwick including ICP-OES/MS for trace metal analysis, and traditional analytical methods.

Dr Chris Waldron

Warwick Scientific Services

Find out more

Warwick Scientific Services (WSS) supports external users – both from industry and other Higher Education Institutions (HEIs) – to access Warwick's world-class research equipment and expertise. This world-leading array of cutting-edge facilities provides analysis of a variety of sample types and we can also provide bespoke synthesis to your requirements.



INDUSTRY USERS

We have a wide range of industry clients ranging from start-ups and SMEs to consultancy firms and global product manufacturers. Our experts can help you understand your materials, products and systems to improve performance, enhance sustainability and drive innovation.

ACADEMIC INSTITUTIONS

Our facilities are also available to external academic researchers, whether you need access to a specific piece of equipment or to discuss options around a complex problem.

We can provide:

- Measurement, analysis and imaging services
- Interpretation and verification of results
- Bespoke training on equipment
- Contract or collaborative research opportunities
- Consultancy

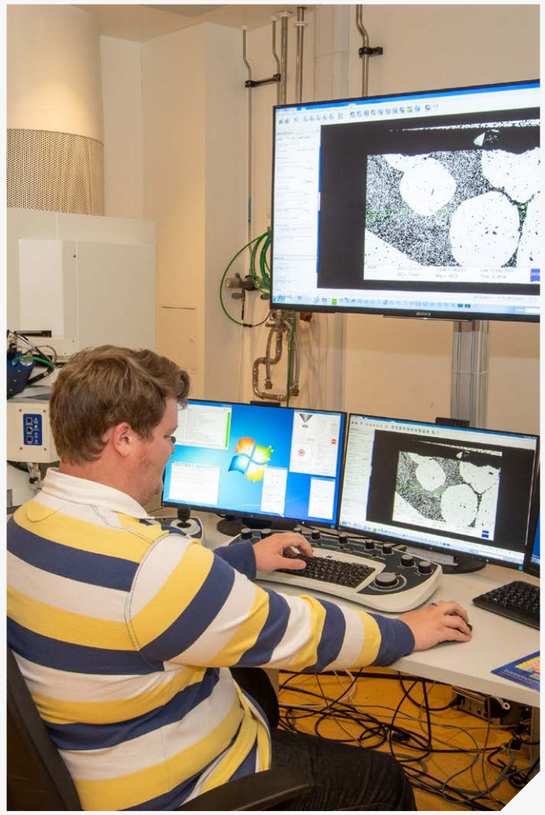
WSS is the first point of contact for all external enquiries. We will match you with the right specialist who will gain a detailed understanding of your requirements and develop a solution to your challenge.

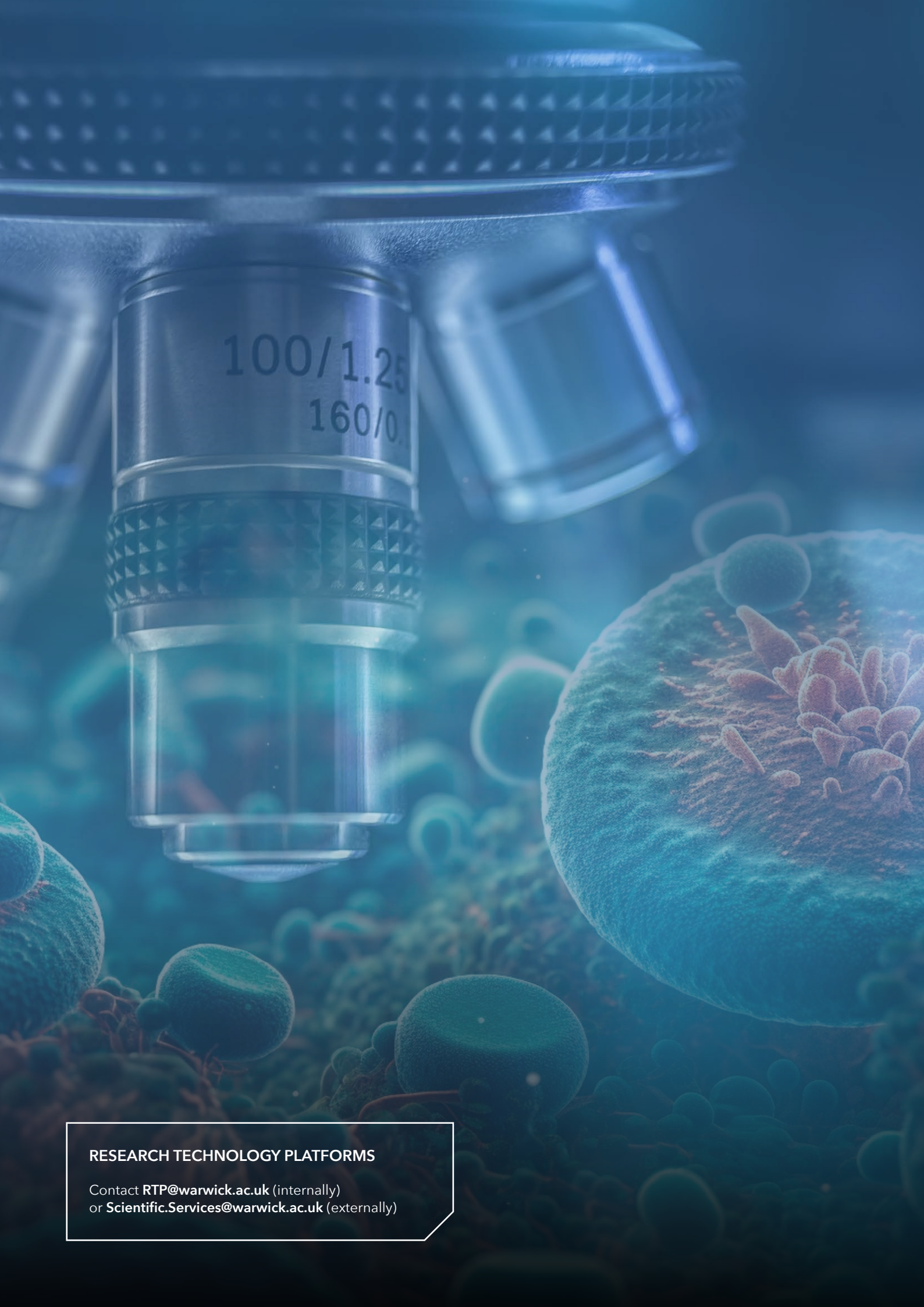
We offer a confidential and cost-effective service and provide rapid results. As a client you will have access to our online portal for quick turnaround of contracting, including an NDA and MTA for your convenience.

Giving businesses and academia access to the latest thinking, knowledge and analysis equipment in the field, WSS aims to foster innovation in research and development while facilitating relationships to inspire further collaboration.

To discuss your requirements please contact

Claire Gerard
Warwick Scientific Services Manager
c.gerard@warwick.ac.uk | 07385 145064





RESEARCH TECHNOLOGY PLATFORMS

Contact **RTP@warwick.ac.uk** (internally)
or **Scientific.Services@warwick.ac.uk** (externally)