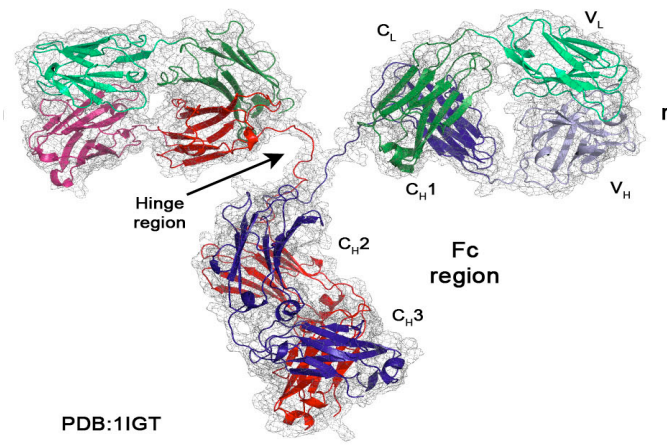
Alison Rodger Capabilities

Structure & function of biomacromolecules



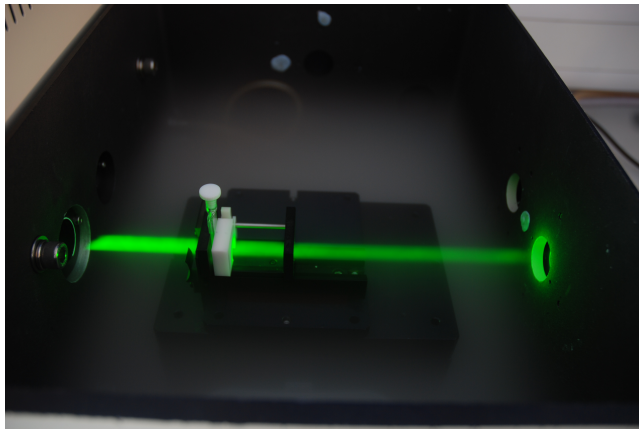
- Circular dichroism and ROA for protein 2ndary structure
- Drug binding modes
- World leading linear dichroism facilities

Develop new spectroscopies for complicated biomolecular systems including protein fibres (cytoskeleton or prions), membrane systems, DNA-drug systems, cellular structures.

- ❖ Fluorescence detected LD
- ❖ Raman linear difference

Alison Rodger Challenges

- Many of our spectroscopy techniques involve flow. Fluid dynamics.
- Where does the light go? What is signal, what scattering, what rubbish?
- **We need interesting samples.**
- Will Raman linear difference be really useful???



Is Raman optical activity useful or just difficult?

Integration of techniques.

Prof. P.M. Rodger: Capabilities

- Methods:
  - Molecular dynamics simulations
  - Statistical mechanics
- Applications include:
  - Complex interfaces
  - Biomolecules and biominerals
  - Self assembly
  - Control of crystal nucleation and growth

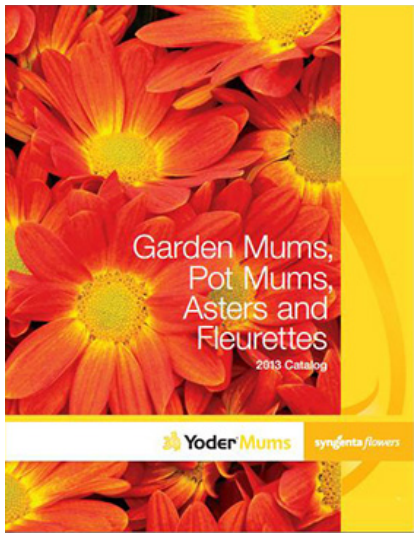
Prof. P.M. Rodger: Challenges

- Molecular simulation at long timescales
- Simulation of rare events (*e.g.* reactive transitions or nucleation)
- Reliable force-fields, especially for mixed organic/inorganic systems

Mark Seymour - Capabilities

At syngenta's Jealott's Hill site we have:

- Separation science (LC, GC, CE)
- Mass spectrometry (small molecule, proteins, polymers)
- NMR (400, 500 and 600MHz with cold probe)
- Various optical techniques
- Optical and electron microscopy
- Various physical chemistry techniques
- Computation and modelling
- Loads of other stuff
- Lots of plants



Mark Seymour - Challenges

Current challenges include:

- Chemical analysis of dust from seed coatings during manufacture.
- End-group analysis in polymers and macro initiators
- Determining modifications in proteins and/or RNA by mass spec
- Methods for detecting poorly ionizing peptides in digests
- Sensors in complex environments e.g. methyl salicylate in plants
- Chemical analysis of seed surfaces
- Measuring the rate at which a population of pure crystals grows or dissolves in a viscous medium
- Polymer characterization
- Face-specific adsorption of polymers at crystal surfaces
- Non-invasive 3D imaging of pelleted (coated) seeds
- Enhancing S/N in FTMS
- Ultra-high resolution liquid chromatography
- Complementary ionization techniques for LC-MS
- Predicting aqueous solubility from a chemical structure

Ann Dixon: Capabilities

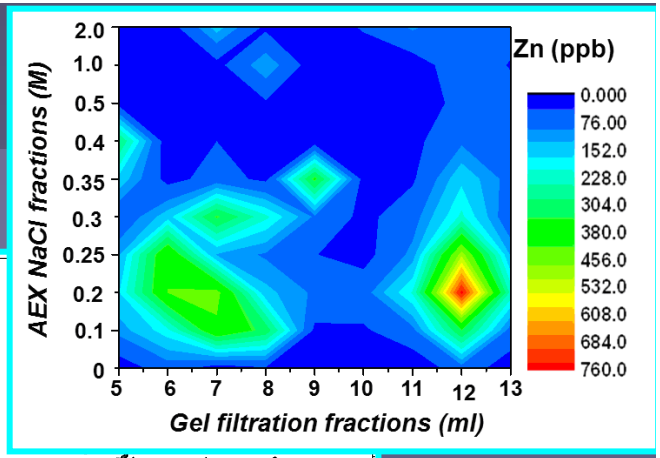
- Membrane protein expression and purification, refolding and reconstitution
- Analyses of membrane protein interactions using genetic assays and biophysical methods (TOXCAT, GALLEX, AUC, CD, and more)
- 2D and 3D protein NMR methods for analyses of protein-protein interactions (including membrane proteins), ligand binding and structure determination
- NMR for measurements of dynamics
- Core molecular biology methods
- Peptide design, synthesis and purification

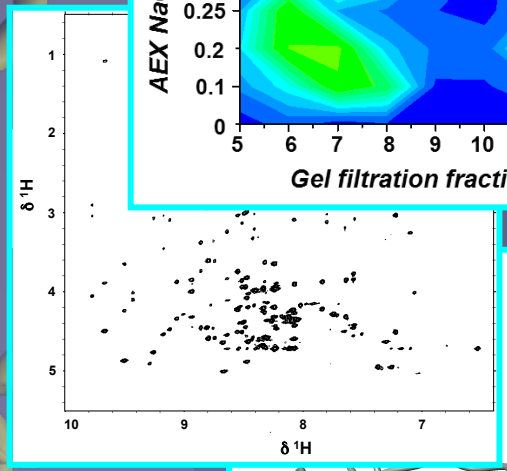
Ann Dixon: Challenges

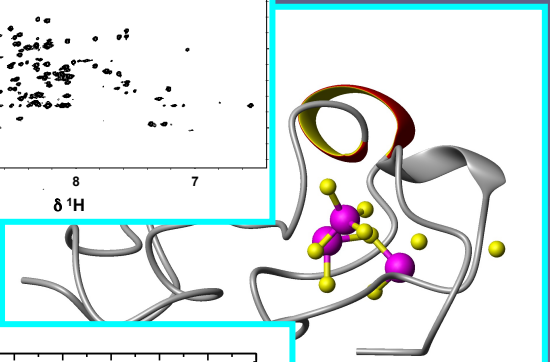
- Signal : noise of NMR data
- Low protein yields, especially for membrane proteins and proteins with isotopic labels
- Robust methods to obtains high quality data for proteins in membranes and lipid bilayers
- New, more biologically relevant membrane mimetics for use in solution NMR
- Alterative methods for measuring binding affinities and activity

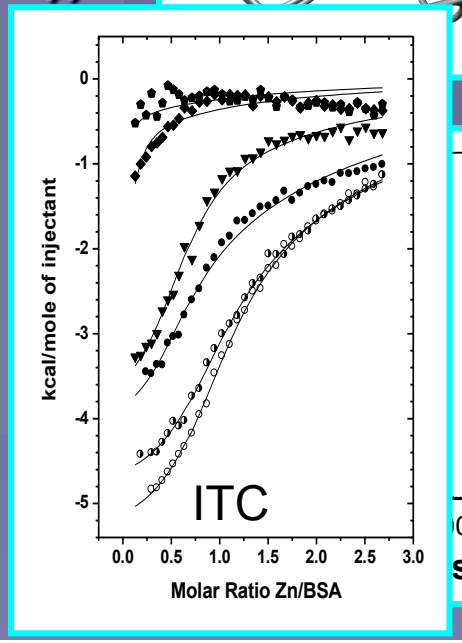
Blindauer lab

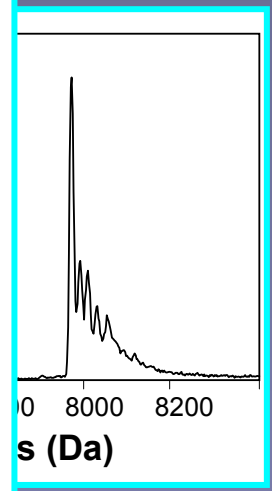
- Bio-Analytical Chemistry
- Focus on **metal metabolism**, including that of **plants**,[1] and in context of **human health**[2]
- Development of **metallo-proteomics** approaches[3] (protein chromatography, biological and inorganic Mass Spectrometry (ICP-MS))
- Structure determination (by **solution NMR**) of metal-handling proteins
- Characterisation of intact (metallo)proteins by **native ESI-MS** and other biophysical techniques







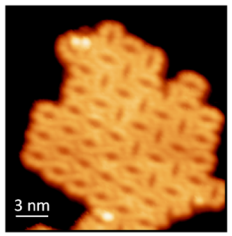


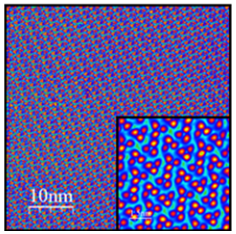


[1] Blindauer and Schmid, *Metallomics* 2010
[2] Barnett et al., Biochem. Biophys.Acta 2013
[3] Barnett *et al.*, *Anal. BioAnal. Chem.* 2012

Giovanni Costantini

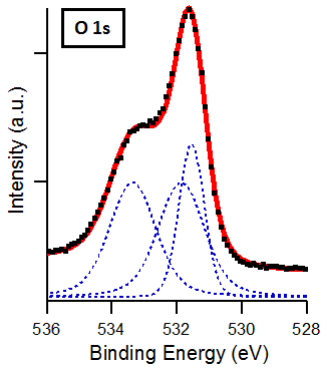
Molecular self-assembly @ surfaces

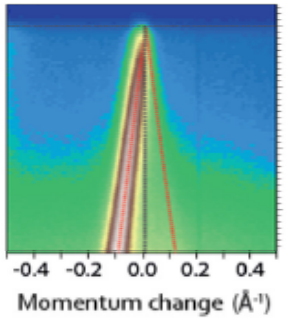




Capabilities

- Thin film growth
- Surface morphology down to the molecular scale
- Surface chemical composition
- Surface electronic properties



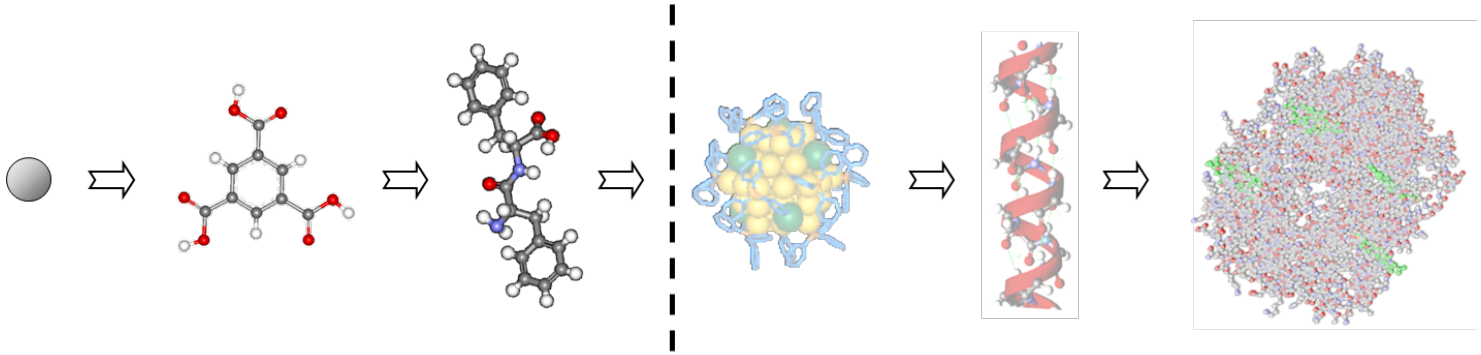


Links to

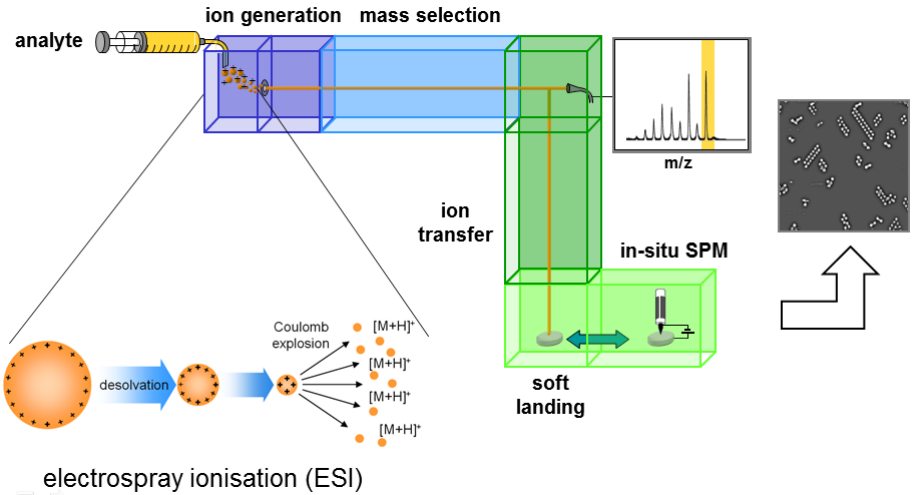
- Electron microscopies
- Theoretical simulations (MD, Monte Carlo, DFT)

Giovanni Costantini

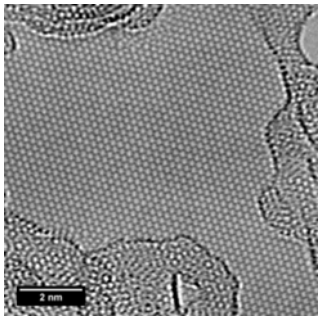
Challenges



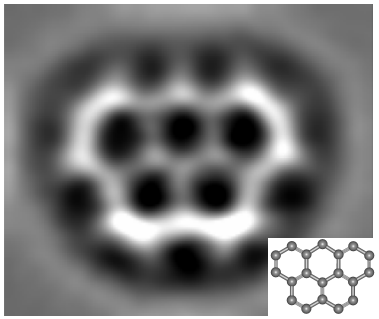
Preparative Mass Spectrometry



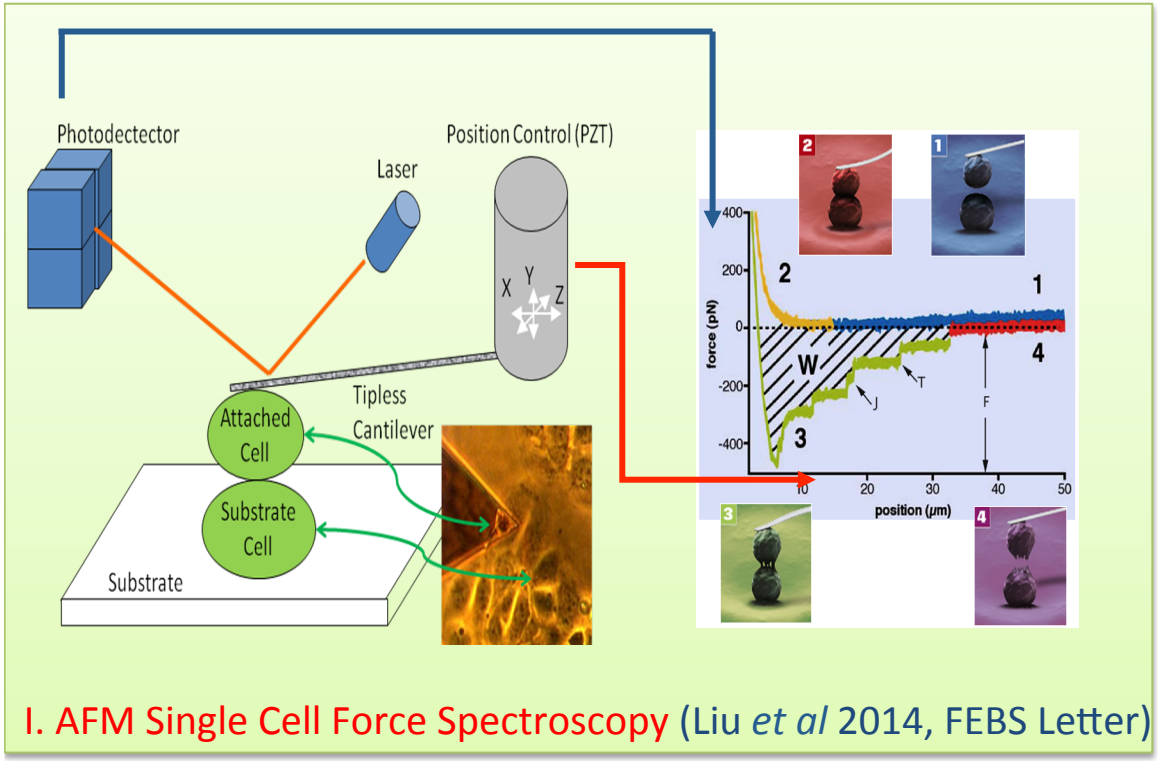
High-res TEM



Ultra high-res SPM

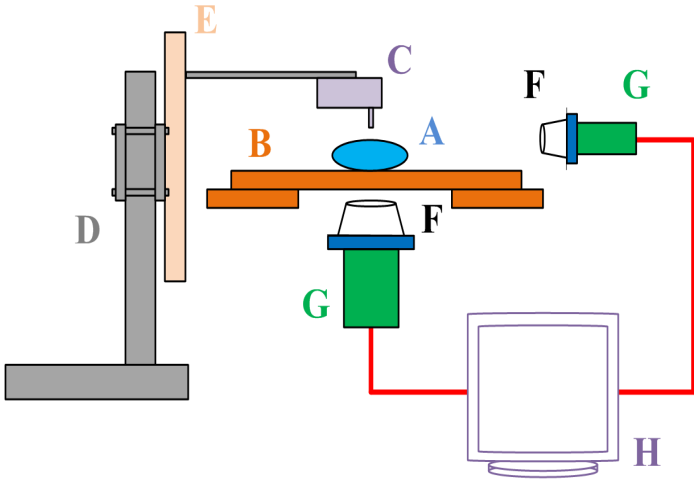


< *Isaac Liu*> Capabilities- *Nano-Bio Force Spectroscopy*

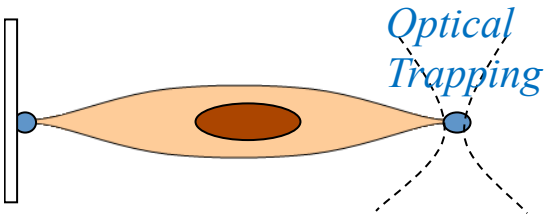


I. AFM Single Cell Force Spectroscopy (Liu *et al* 2014, FEBS Letter)

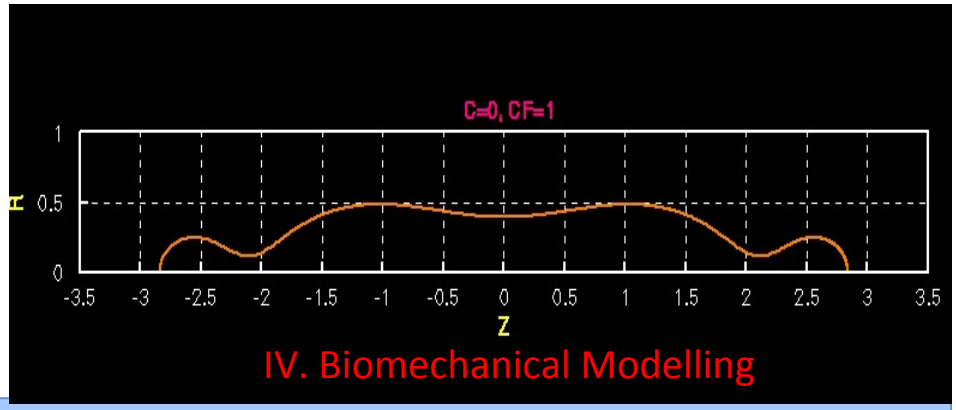
A. Biological Cell
B. X-Y Axis Stage
C. Force Transducer
D. Arm
E. Z Axis Stage
F. Microscope Lens
G. CCD Camera
H. Computer Screen



II. Single Cell Mechanotransduction



III. Optical Tweezers for Single Cells
(Zhang & Liu, Roy Soc Interface 2008)

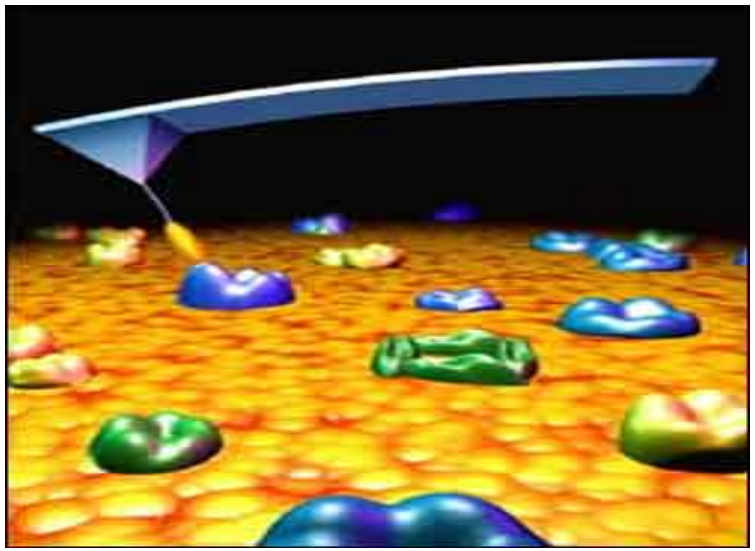


IV. Biomechanical Modelling

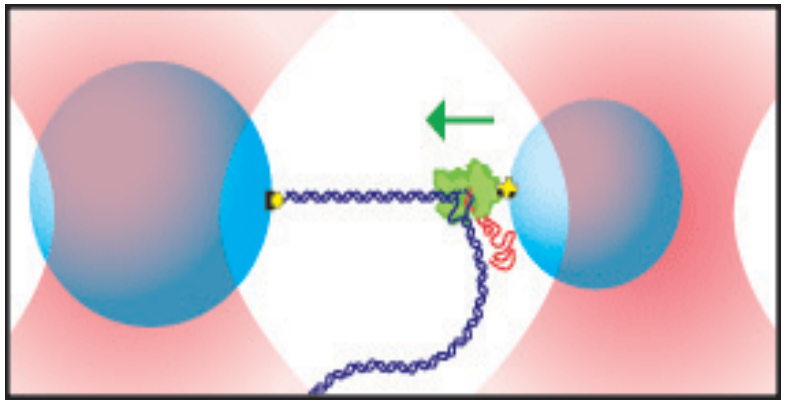
10-11th March, 2014

MASC CDT Inaugural Industry Partnership Event

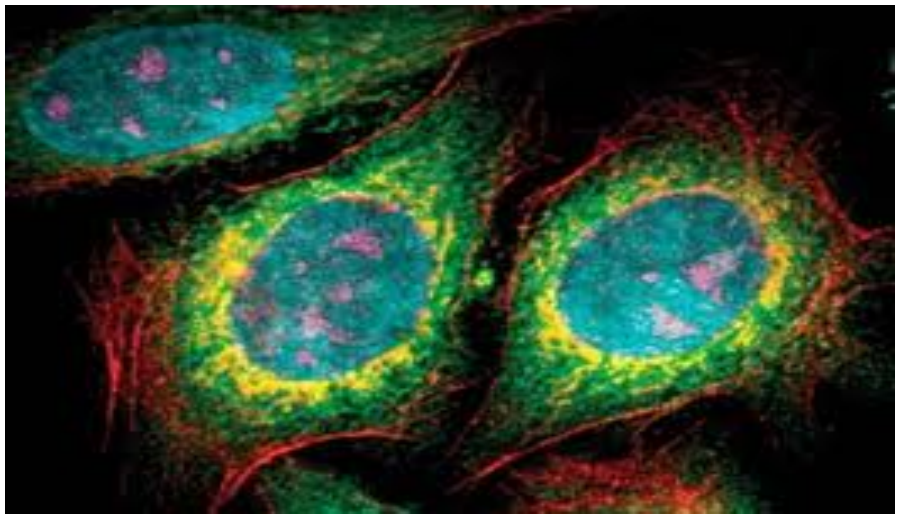
Challenges-Bridging Gaps between Cell & Molecule



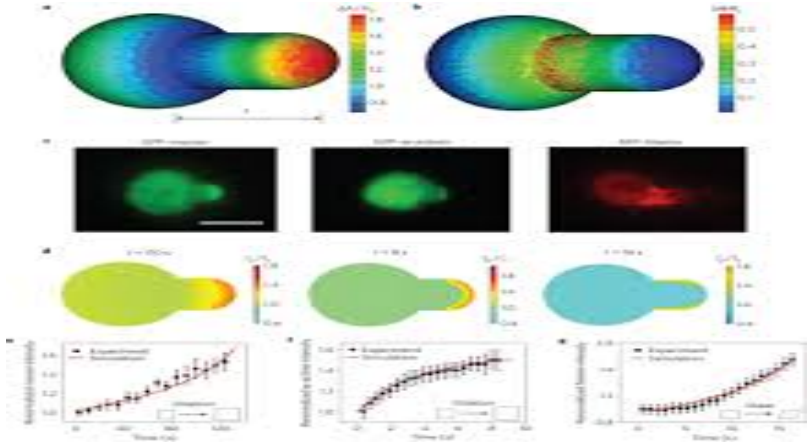
Distinguish molecule force from cellular force



Optical tweezers for measuring molecule force

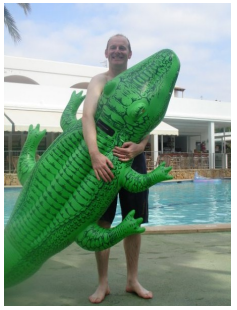


Molecule-level imaging for living cell



Multi-scale biomechanical modelling (Images adopted from Nature Materials, 12, p.1064 (2013))

Tony Bristow-AstraZeneca



- Associate Principal Scientist in mass spectrometry within Pharmaceutical Development at AstraZeneca in Macclesfield.
- Focuses on the application and development of mass spectrometry at all stages in the development of pharmaceuticals.
- Chair of the British Mass Spectrometry Society (BMSS).

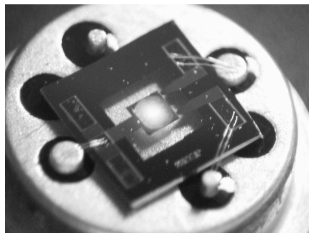
Tony Bristow-AstraZeneca

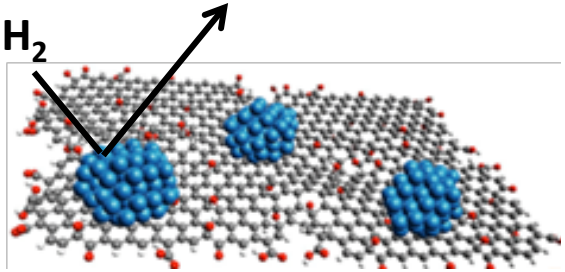
- Characterisation of complex pharmaceutical ingredients and batch to batch variability (excipients).
- Trace quantitation of organic molecules (potential genotoxic impurities).
- Trace quantitation of metals.
- Removal of metals.
- Delivering processing understanding in all areas of pharmaceutical development (drug substance and product).
- On-line particle/granule size distribution measurements and on-line porosity measurements.
- Surface characterisation and properties - when are they important to processes (blending, granulation, compression, dissolution)
- New modalities – oligonucleotides and antibody drug conjugates (ADCs).

Tony Bristow-AstraZeneca

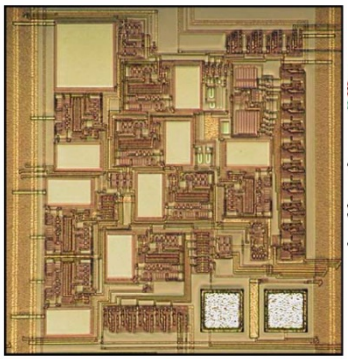
- Detection of low levels of one polymorph in the presence of another (and amount of crystalline in amorphous & vice versa).
- Assessment of differences in solid state properties of active pharmaceutical ingredients.
- Quantitative on-line reaction monitoring.
- Detection of low molecular weight non-UV active polar molecules in excess of API.
- Understanding dissolution behaviour of our products and how this may be changed on stability.
- Studying dynamic multi-component systems at a small scale, as opposed to single measurements on single components. Examples drug release from nanoparticles.

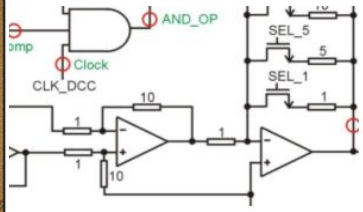
Dr James Covington: Capabilities



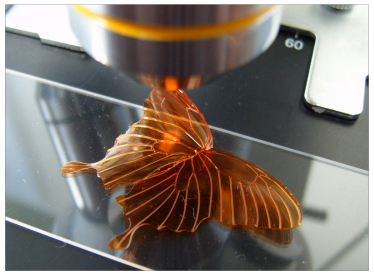


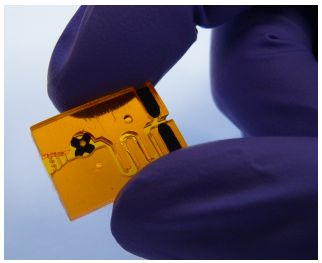
- Development of Microsensors/systems
- Focus on Gas Phase detection
- Extensive test facilities for material/sensor development



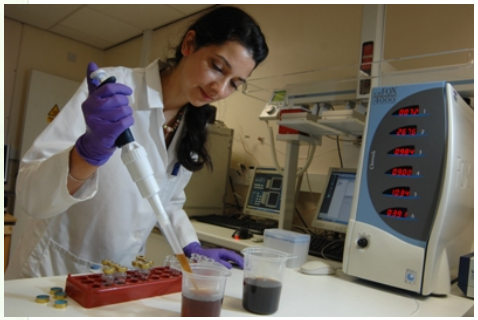


- Material/transducer integration
- Smart/ASIC electronic design





- 3D Micro-printing facility
- Manufacture of micro-fluidic devices
- Composite material development



- System development for artificial olfaction
- Industrial applications of sensor systems and of gas phase analysis of samples

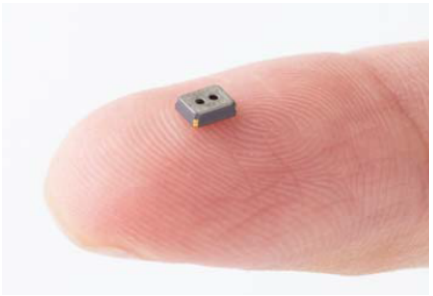
School of Engineering; J.A.Covington@warwick.ac.uk

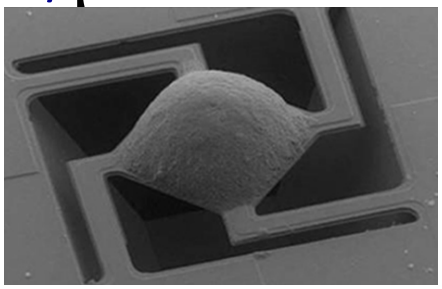
Dr James Covington: Challenges

Innovative Sensors…

Solving Problems of:

- Sensitivity….ppm/ppb/ppt
- Selectivity……Single chemical
- Cost…..Under £100? £10? £1?
- Form Factor…..Small/Mini/Micro?
- Low Power….mW/μW





- By novel materials – substrates - operational modes & filters

…in Complex Environments

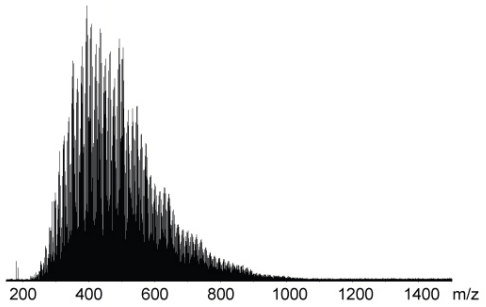
- Security , CWAs and TICs
- Distributed sensor networks

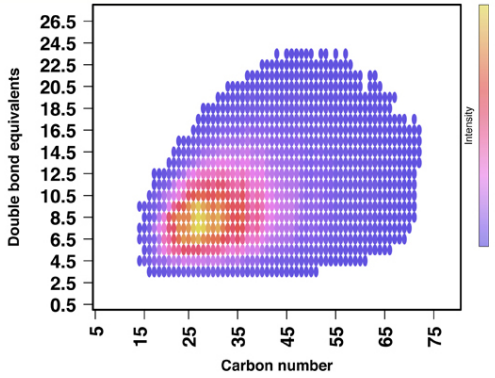
- POCT for medical diagnosis
- Personalized healthcare & monitoring

School of Engineering; J.A.Covington@warwick.ac.uk

Mark P. Barrow - Capabilities

- Fourier transform ion cyclotron resonance mass spectrometry
- Ultrahigh resolution analysis of complex mixtures
- Range of different ionization, dissociation, and chromatographic methods available
- Petroleum and environmental samples
- Data analysis to produce profiles which can be compared (e.g. before and after a process)





Mark P. Barrow - Challenges

Industrial/environmental challenges

- Production and processing of petroleum
- Biofuels
- Environmental effects upon petroleum profiles
- Environmental monitoring methods (e.g. oil sands industry)

Analytical challenges

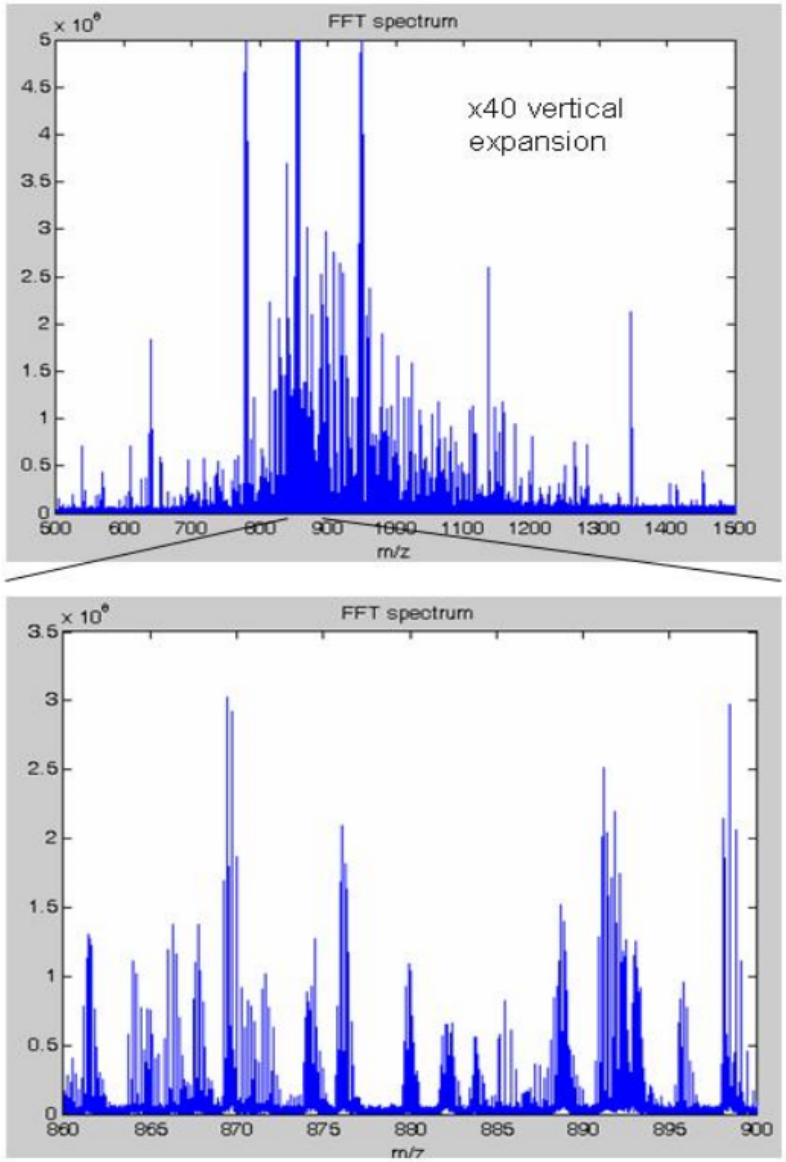
- Ionization methods
- Structural information
- Data analysis and data mining
- Correlation of molecular composition with sample properties

FTICR Mass Spectrometry Instrumentation

Prof. Peter B. O'Connor

Capabilities:

- Bruker 12T SolariX FTICR mass spectrometer
  - ESI, nanospray, NanoLCMS
  - CAD/SORI/ECD/ETD/EID/EDD
  - MALDI and MALDI-imaging
  - APPI, APCI, EI
  - GCMS and LCMS
  - MS^n
- Custom instruments
  - UV photo dissociation spectroscopy
  - 2D FTICR mass spectrometry
  - New ionization sources



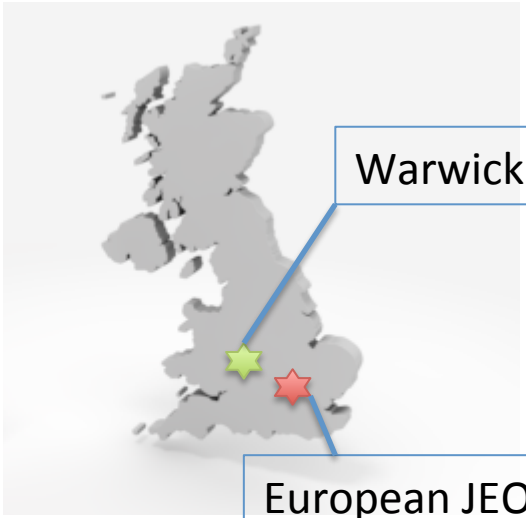
High quality MS^n spectra

>500,000 resolving power and sub-ppm mass accuracy on all fragments

- Protein identification and sequencing
- Protein modifications
  - Deamidation, Glycation, etc
  - Protein – drug interactions (Cancer therapeutics)
  - Protein complexes
- Drug molecule structures
- Glycan (and other oligosaccharide) structural analysis
- DNA modifications
- Polymers (sequencing, endgroups, etc)

JEOL Ltd. Capabilities

Available to access to NMR spectrometers in JEOL Ltd HQ and JEOL UK Ltd

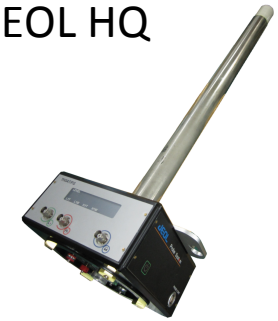


Warwick University

European JEOL demo center (Welwyn Garden City)

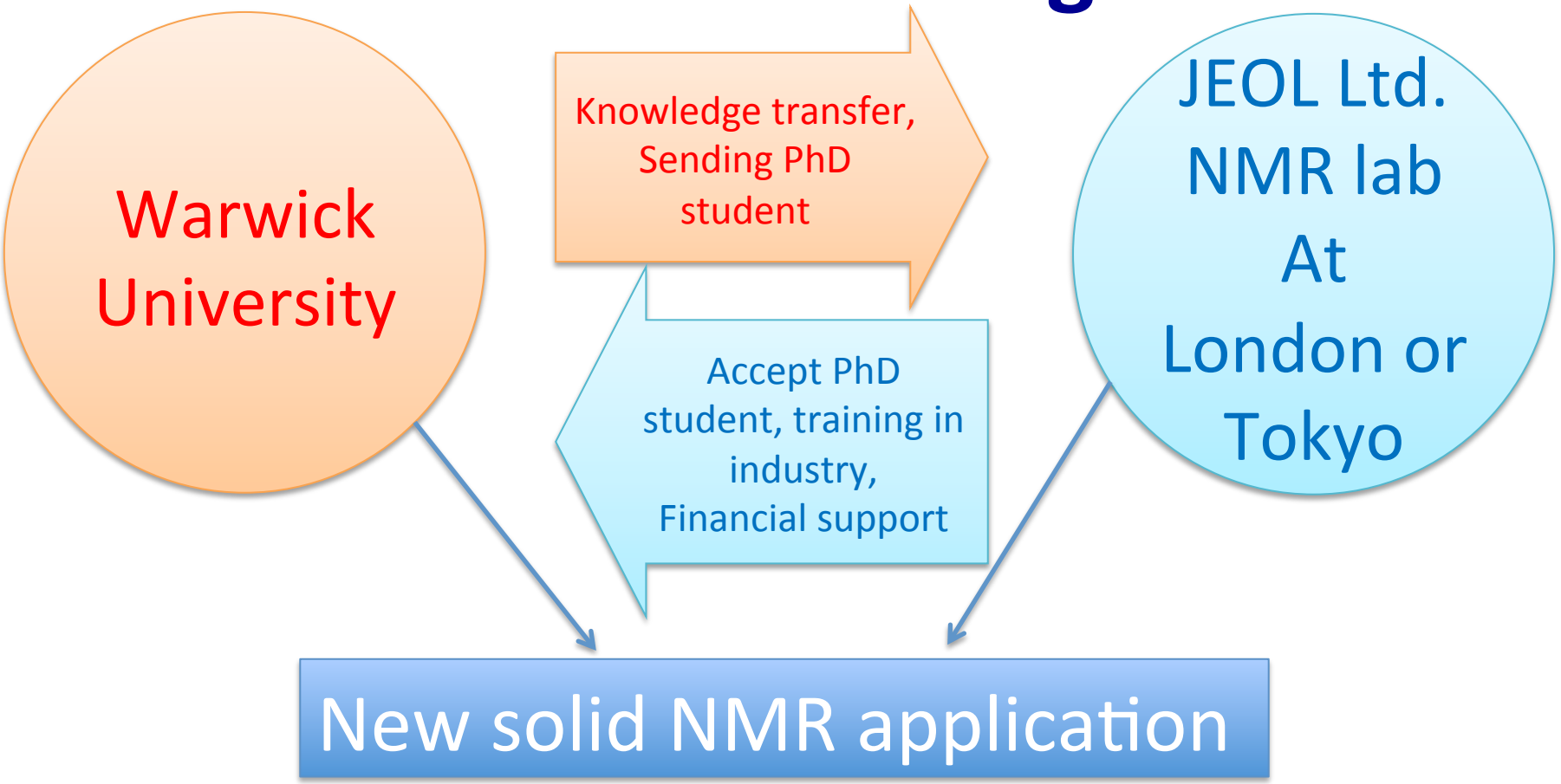
Tokyo HQ laboratory (Tokyo, Japan)

Support travel fee to access to JEOL HQ laboratory (Tokyo, Japan)



Warwick University is able to access to 400~600 MHz solid NMR spectrometers
0.75 (110 kHz MAS) ~ 8mm (~600ul sample volume) MAS probe is available

JEOL Ltd. Challenges



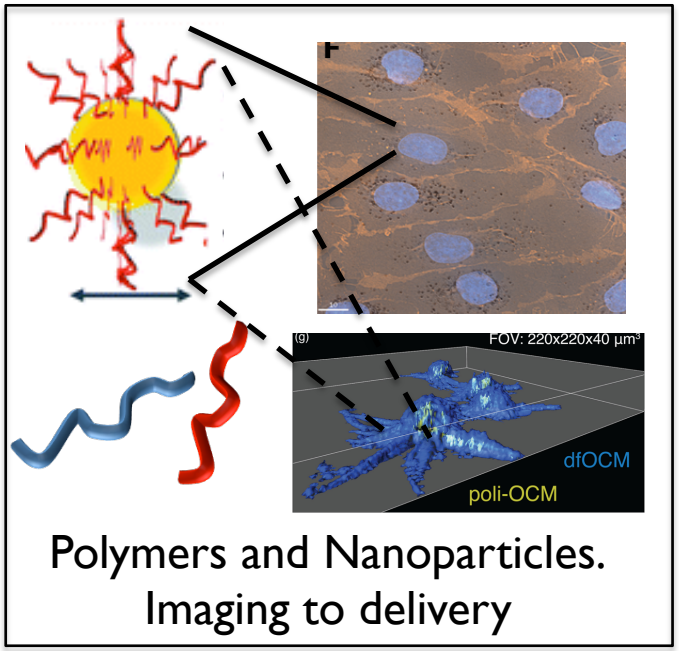
Ultra high speed MAS which JEOL developed is focusing for new solid NMR application.

This technique is expected for Biology, Pharmacy, Material, etc…

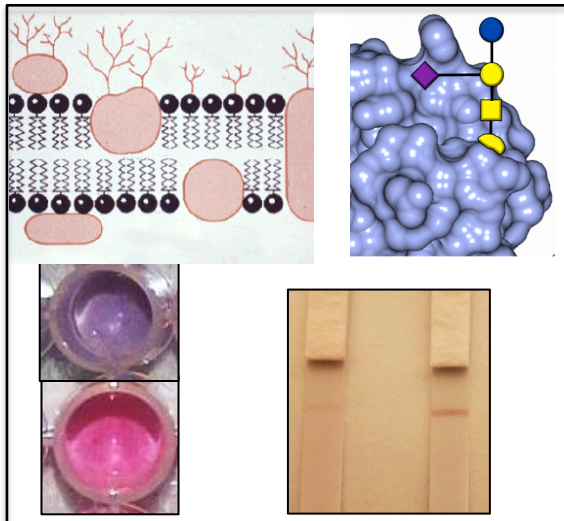
Matthew I. Gibson Capabilities

Interfacing Materials with Biology –

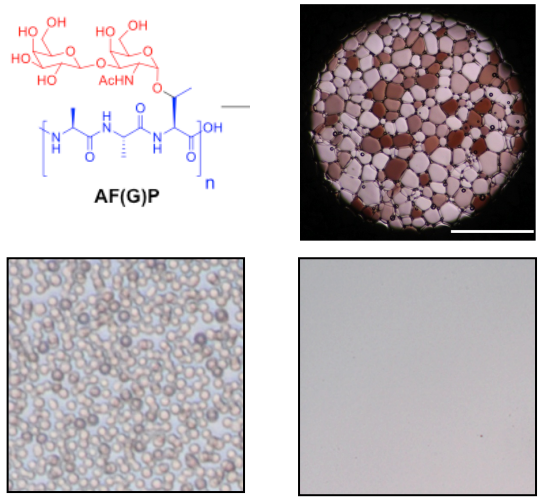
m.i.gibson@warwick.ac.uk
www.warwick.ac.uk/go/gibsongroup



Polymers and Nanoparticles.
Imaging to delivery



Analytical GlycoSciences
and (low cost) Biosensing



(Cryo)storage of
Proteins, cells and tissues

Cell Culture, Biosensing, Cryopreservation, Glycoscience, Antibodies, Carbohydrates, Polymers

Nature Commun, ***2014***, *5, 3244* *Chem. Sci* ***2014***,, *Angew. Chem. Int. Ed.*, **2012**, 51, 7812,, *Angew Chem. Int. Ed.*, **2008**; *J.Am. Chem. Soc.*, **2010**, 132, 15130, *Angew. Chem. Int. Ed.*, **2009**,48, 48,

Matthew I. Gibson Challenges

- Protein and Cell based Therapy Stability, storage, distribution
- Cellular analytics. How to measure in vivo/in vitro

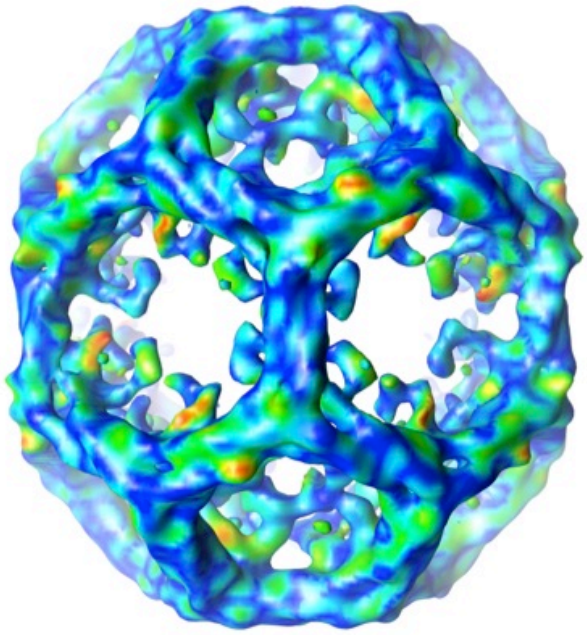
- 'Accessibility' of mathematical methods to analyse available datasets (bioinformatics)

- Interconnected thinking. Breaking down barriers between people's 'labels'
- Defining challenges and solutions based on need, rather than fitting to preferred solutions

Corinne Smith - Capabilities

- Biophysical Analysis of protein mechanism using electron microscopy, fluorescence, light scattering ITC and SPR

- 3D structure determination of macromolecular complexes using cryo-electron microscopy and single particle analysis



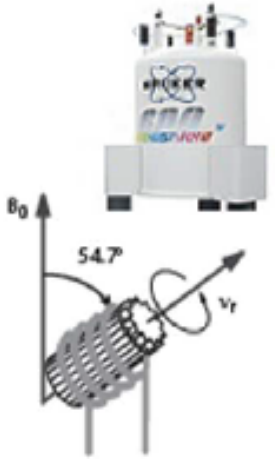
Corinne Smith – Challenges
Mechanisms of endocytosis

- How can we control the assembly of clathrin triskelions into clathrin cage structures?

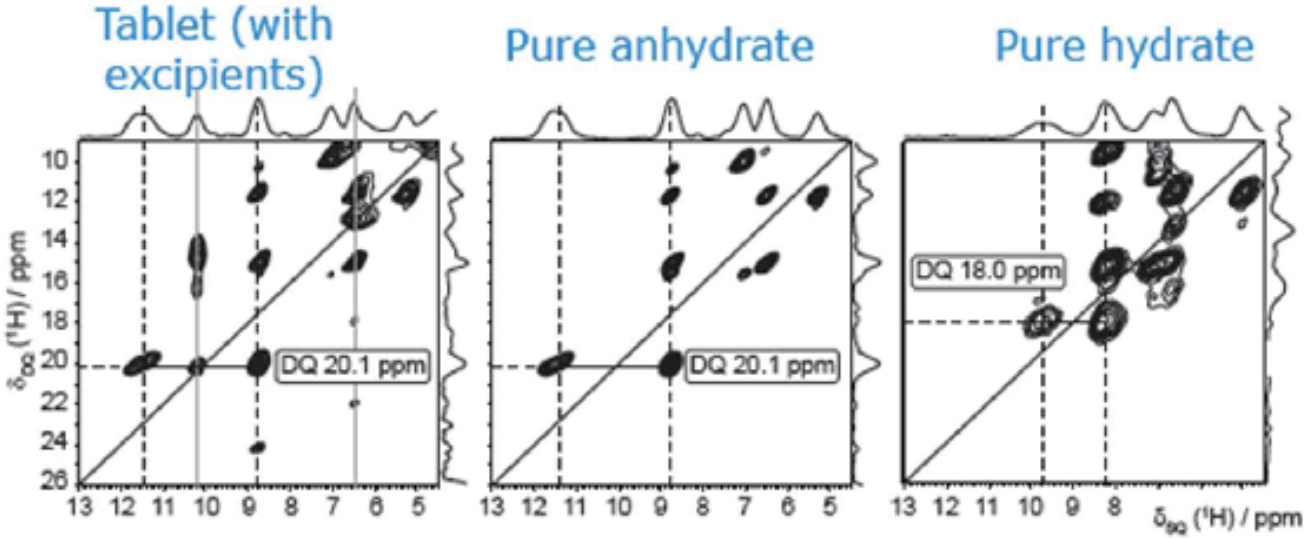
- How can we analyse neutron scattering data for heterogeneous clathrin cages structures?

- How can we interpret the significance of weak binding events in clathrin-mediated endocytosis?

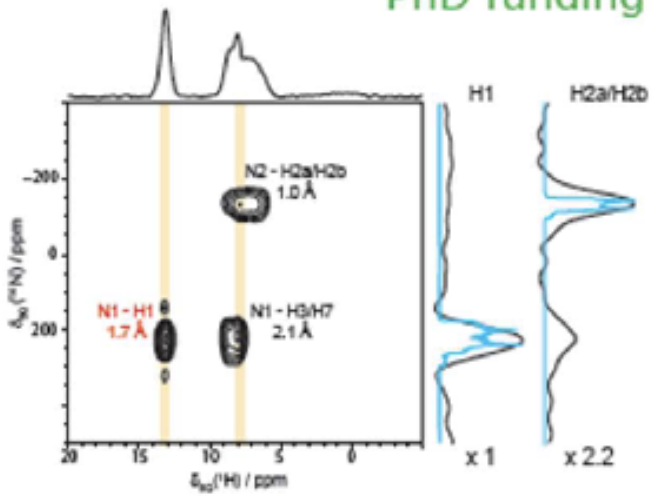
Steven P. Brown: Pharmaceutical Research



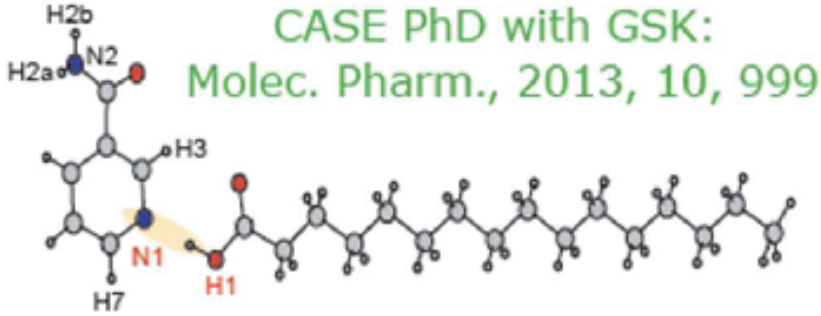
Solid-State MAS NMR



PhD funding from AZ: Angew. Chem., 2007, 46, 8036



CASE PhD with GSK: Molec. Pharm., 2013, 10, 999

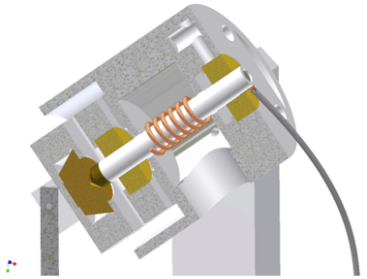


nicotinamide-palmitic acid

THE UNIVERSITY OF WARWICK

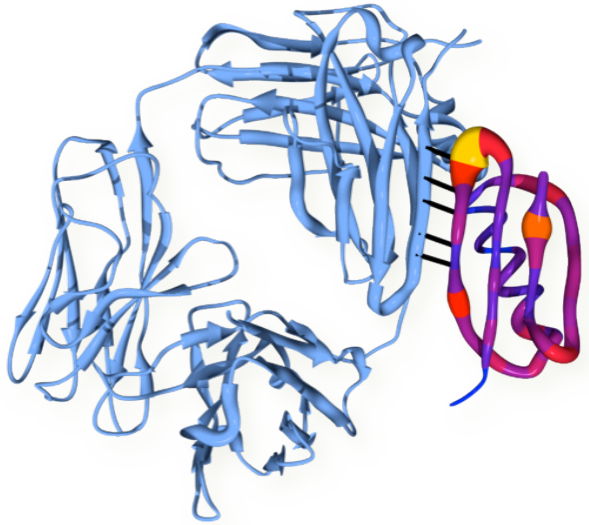
<J. Lewandowski> Capabilities

- Solid-state NMR
- Main expertise structure and dynamics of proteins: fibrils, membrane proteins, protein complexes
- Molecular interactions
- Fast magic angle spinning and working with small amounts of material



<J. Lewandowski> Challenges

- Quantification of protein motions by relaxation
- Structure and dynamics of large biomolecular complexes – needs integrated approaches
- Sensitivity
- Optimal sample preparation



Dr Simon Spencer: Capabilities

- Bayesian statistics (handling uncertainty)

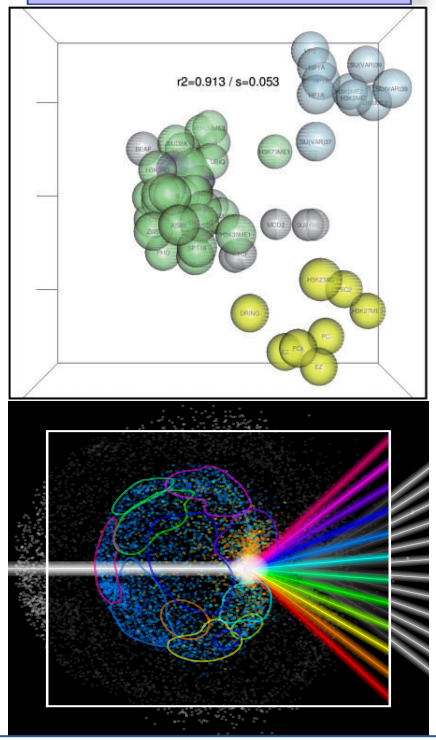
Dr Simon Spencer: Challenges

- Getting hold of datasets
- Getting hold of datasets with replicates

David Rossell (Stats). Capabilities

Statistical methods for biostats & bioinformatics

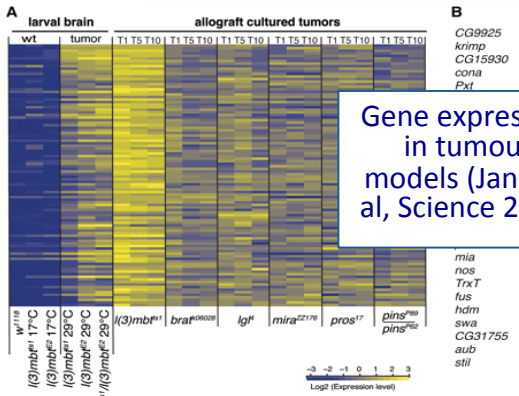
Visualization



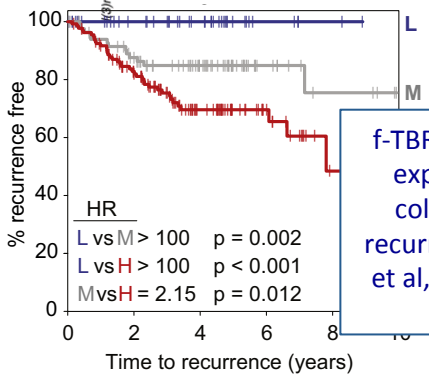
Epigenetic factors & state of genes in modEncode

(Font-Burgada et al, NAR 2014)

Data analysis

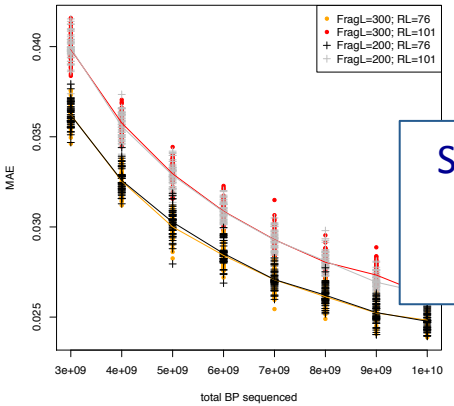


Gene expression in tumour models (Janic et al, Science 2011)

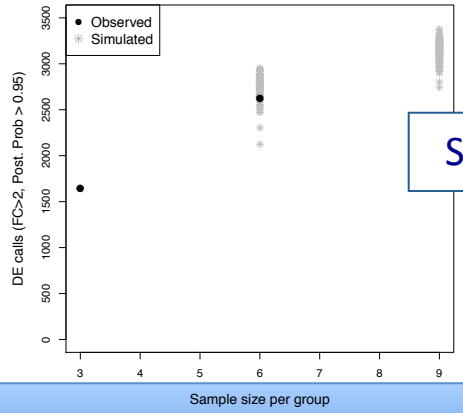


f-TBRS signature expression & colon cancer recurrence (Calon et al, Cancer Cell 2012)

Experimental design



Sequencing depth & setup



Sample size

10-11th March, 2014

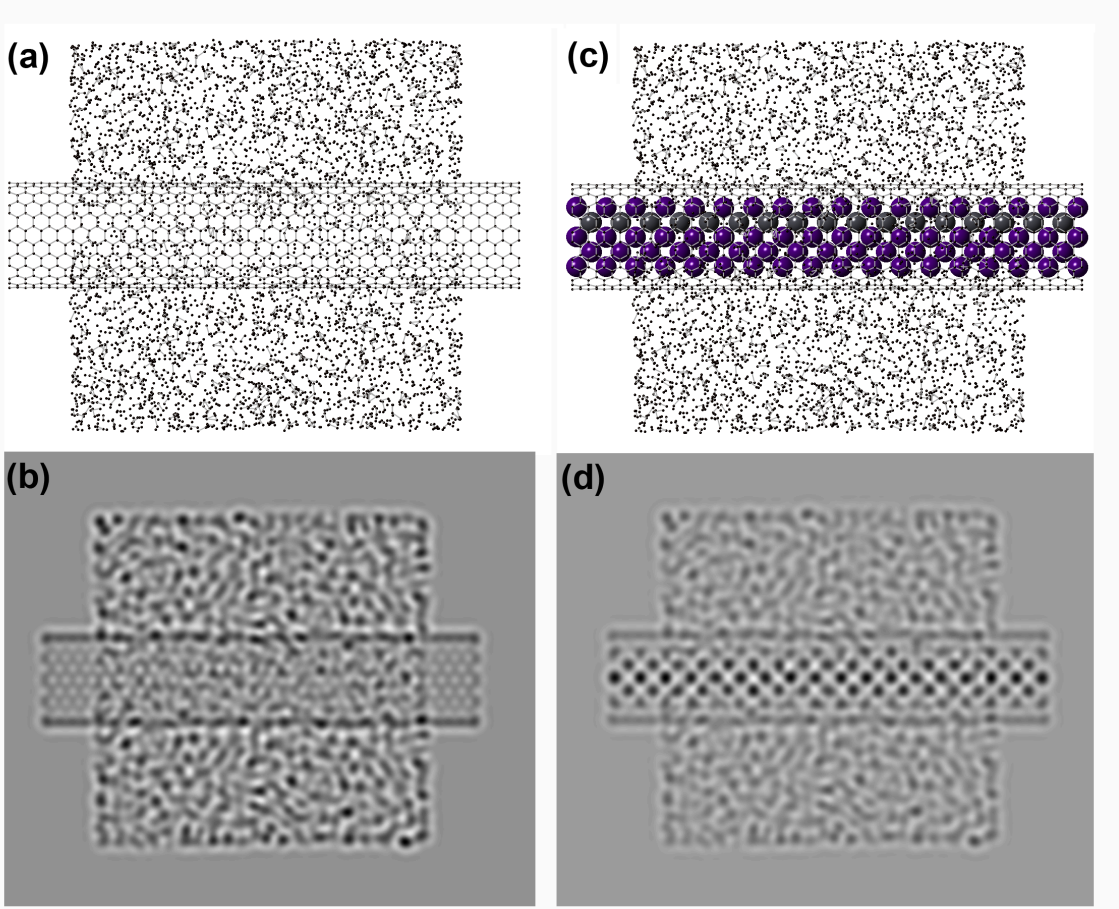
MASC CDT Inaugural Industry Partnership Event

David Rossell (stats). Challenges

- Methods for RNA-sequencing
  - Assessment of novel gene isoforms
  - Differential expression at isoform level
- Visualization
  - Comparison across conditions
  - Networks / integrated maps
- Bayesian methods for Big Data
  - Model selection
  - False positive control

Dr Jeremy Sloan Electron Microscopy

ARM 200F
Aberration Corrected TEM



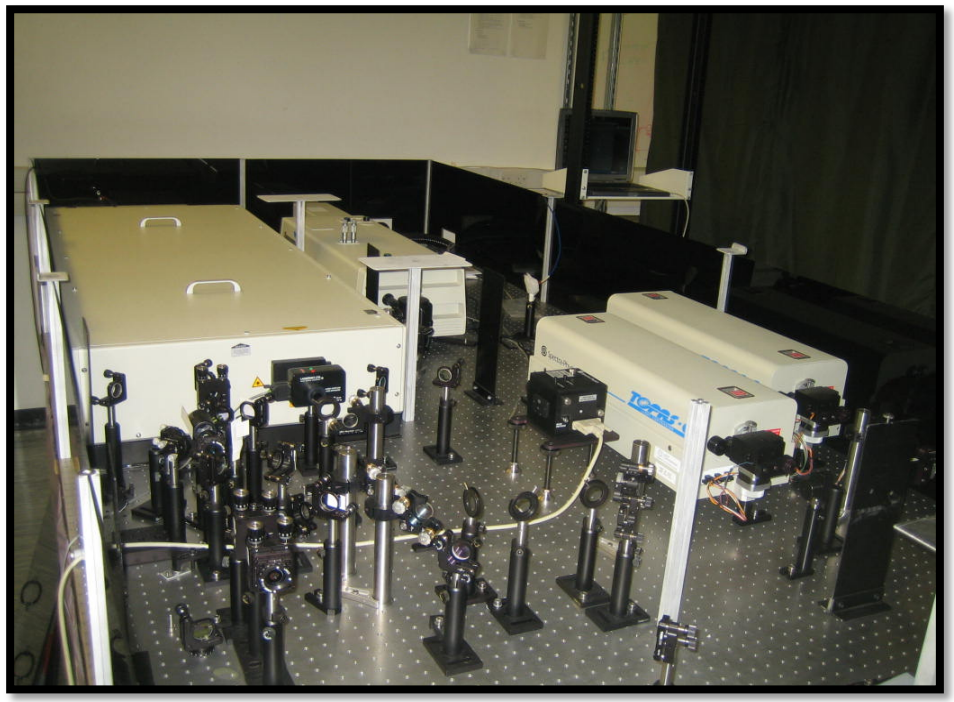
Filled Nanotubes
Providing Contrast enhancement

High performance electron microscopy

- Dr. Jeremy Sloan, Physics Microscopy group
- High contrast carbon nanotube composites for imaging in polymer composites and biomaterials
- Low kV (80 kV) imaging of carbon-based materials
- Exit Wave Reconstruction for extracting Phase Imaging information from light elements (C, N, O etc.)

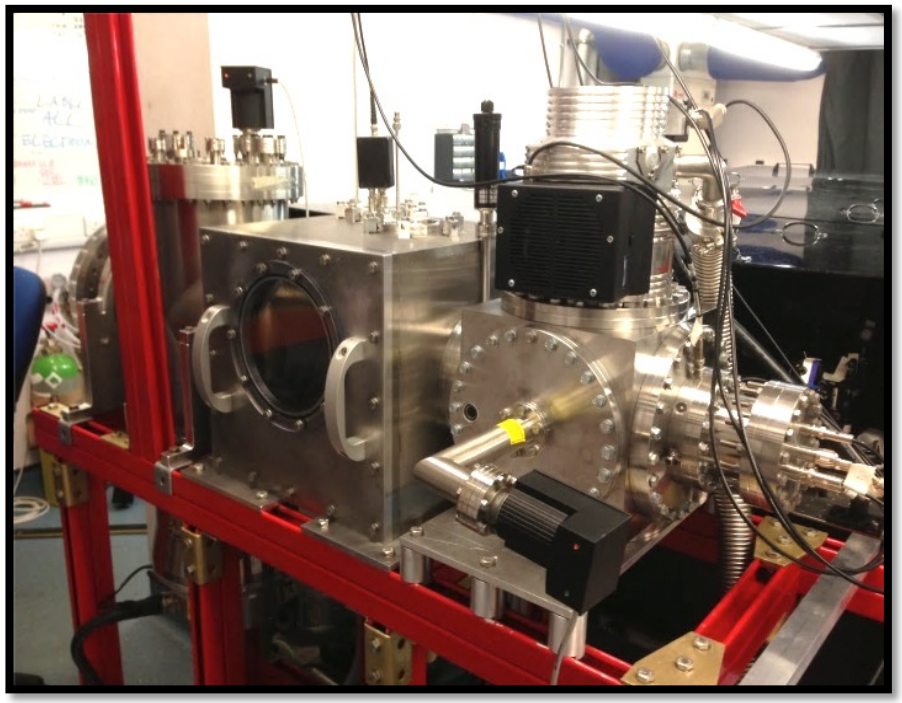
Vas Stavros: Capabilities

Technique 1



Ultrafast laser spectroscopy

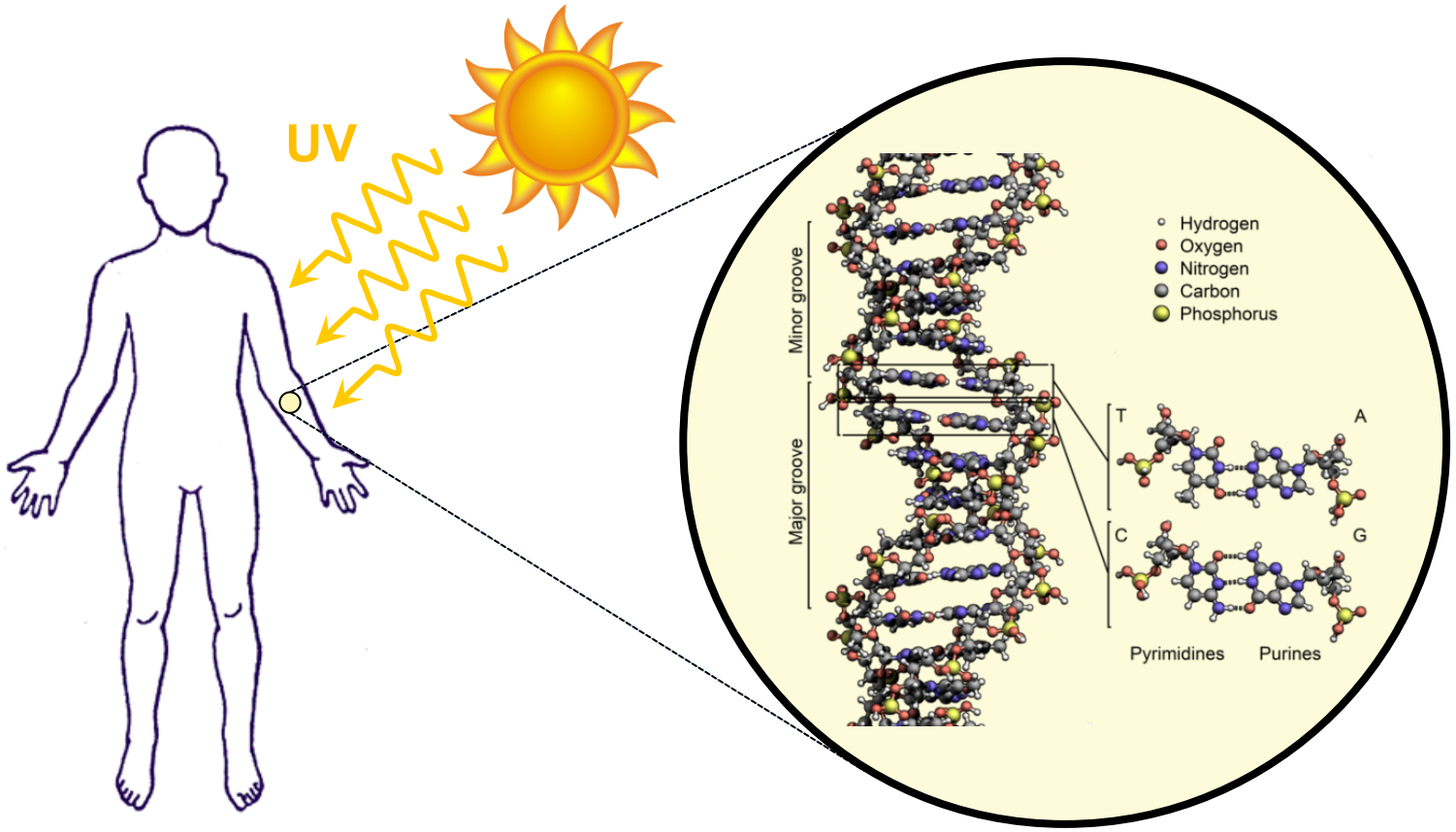
Technique 2



Time-of-flight mass spectrometry and velocity map ion imaging

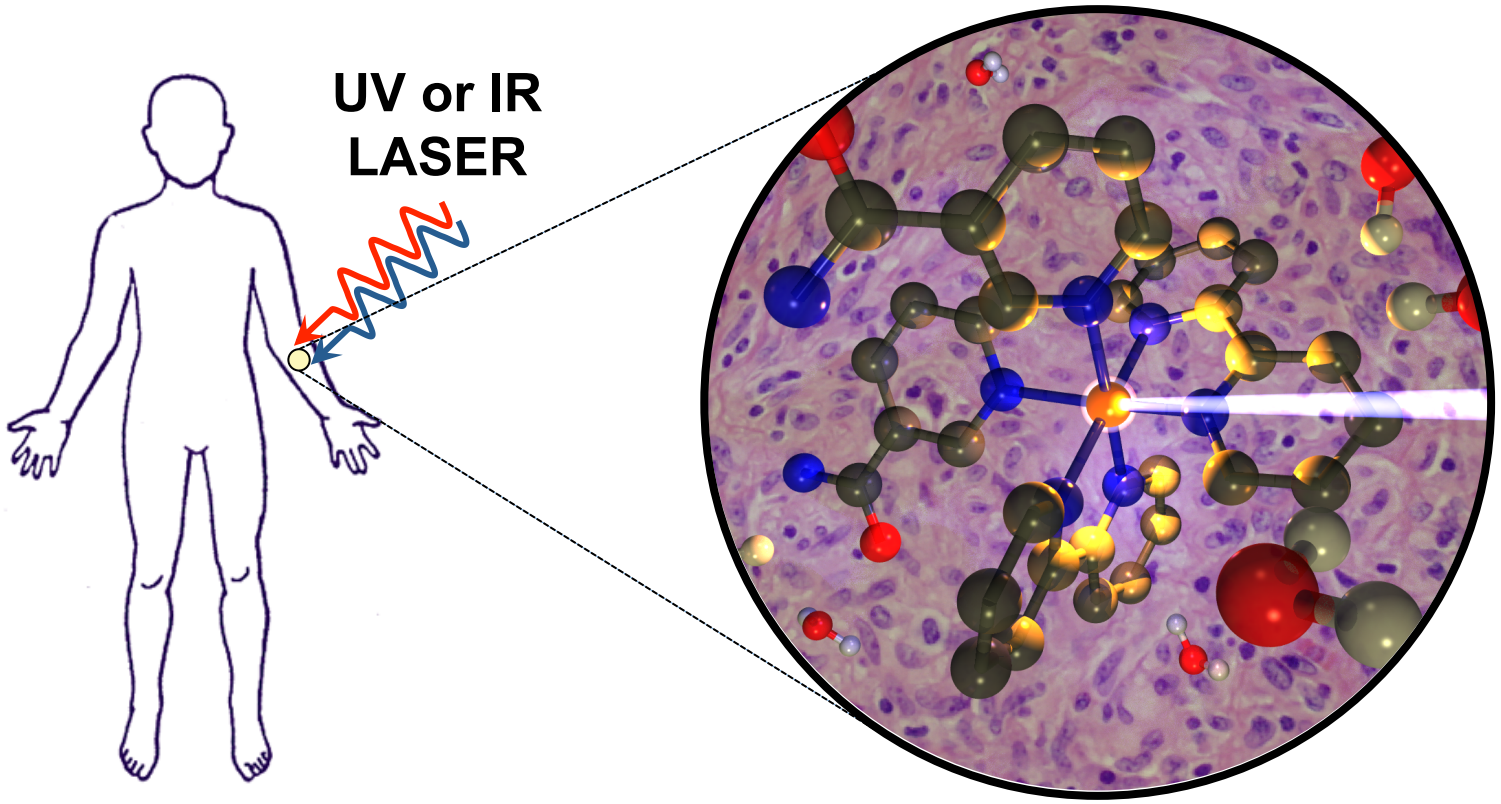
Vas Stavros: Challenges

Photoprotection



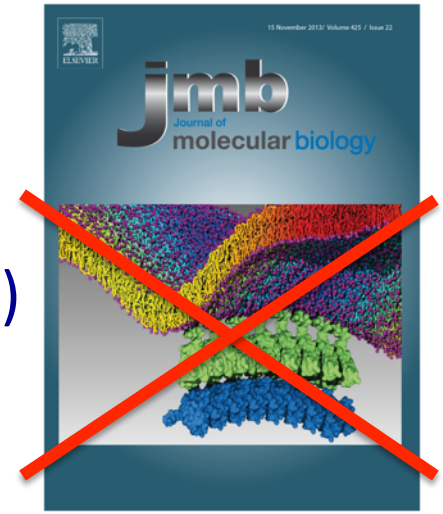
Vas Stavros: Challenges

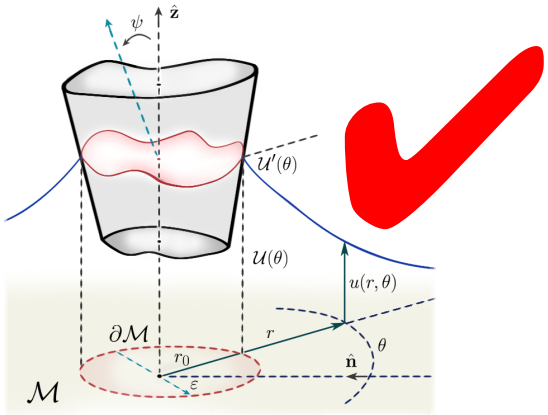
Photoactivation



Matthew Turner Capabilities

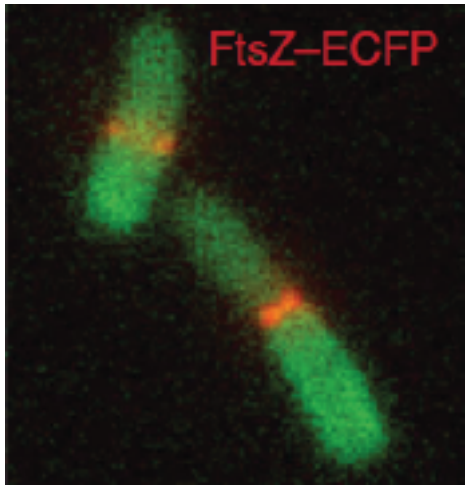
- Theory (mesoscale)
  - aggressively simplified pen-and-paper models
- Physics of the cell (mostly out of equilibrium)
  - Membranes
    - Tension vs rigidity; trafficking & sorting
  - Fibrillar aggregates
    - Kinetics, mechanics, thermodynamics
  - Neuroscience
    - Network activity – theory & experiment
  - Genetic networks
    - Coupled to physics





Matthew Turner Challenges

- How to obtain data on membrane structure, sorting and trafficking, e.g. in Golgi/ER
- How to constrain (and test) a minimal model for FtsZ-mediated cell division.
- How to probe connection between *physics* and *genetics*?
- etc



Alex Ashcroft, Unilever Capabilities

- Main research centre for Unilever Home and Personal Care (HPC) is at Port Sunlight, Wirral
- Roughly 800 people working on R&D in support of HPC brands including Axe/Lynx, Signal/ Mentadent, Dove, Tresemme, Persil, Cif, Comfort
- Have funded numerous PhD students and Post Docs with Pat Unwin's group over the years, and currently have a PhD running and looking to set up another Post Doc
- Have permanent staff employed to assist with TSB grant applications

Alex Ashcroft, Unilever Challenges

- Looking for mechanistic understanding of deposition to and removal from surfaces relevant to Personal Care applications (e.g. skin, hair, teeth, gums) that can provide new technical opportunities
- Looking for new measurement capabilities that will allow us to differentiate our technologies from those of our competitors and/or make unique claims

UWSP Ltd Capabilities

- The University of Warwick Science Park operates a complete business ecosystem for pre- start, start-up and all stages of the business life cycle through the supply of space, support, networks and expertise .
- UWSP also provides:
- Enterprise Workshops, Clinics, Mentoring and 1:1 Consultation
- Short courses through UOW on business establishment and development
- Ignite- a complete start up package for new or developing businesses.
- Internal and external workshops on Marketing, Finance, Ideation, Strategy and Business Development.
- Links to external networks of expertise and skills

UWSP Ltd Challenges

- Establishing better matches between industry and academic goals in the SME community.
- Getting the message out about UWSPs skills and capabilities.
- Recruiting and developing the next generation of high tech, high growth businesses.
- Explaining and expanding the capabilities of the Science Park.
- Providing appropriate support for the UOW community.
- Maintaining and developing a community of professionals committed to business development.
- Identifying sources of support both academic and industrial.

www.warwicksciencepark.co.uk

Warwick Ventures - Capabilities

- Translation of research into
  - Economic & social impact
  - Reputation for research excellence
  - Financial return
- Manage & commercialise University's IP
  - Proof of concept funding
  - Licences to industry
  - Spinout companies
- Commercially experienced team

Warwick Ventures - Challenges

- REF Impact 2020
  - Identifying targets and applying resources NOW in order to maximise impact in 5 years' time
- Proof of Concept funding and strategy
  - Securing and applying more funds, using project management and external expertise and resources in a way that generates more Impact
- More effective research commercialisation
  - Engaging with internal & external partners, alumni and other Warwick stakeholders to expand our commercial network for access to:
    - Markets – what pulls technology out of the laboratory
    - Management – an experienced commercial team attracted by the Market opportunity
    - Money – available if you have Market + Management

Professor Charles Hutchinson

Clinical Radiology Imaging

We cover:

- **Magnetic Resonance (1.5 and 3T)**
- **Computed Tomography (Spiral CT at 128 slice, 0.625 pitch. Dual energy CT and Veo (low dose) capable)**
- **Positron Emission Tomography (PET-CT)with F18 and SPECT (Single proton emission-CT)**
- **Ultrasound with 3D and 4D imaging, power Doppler**
- **Image analysis techniques,**
  - **anatomical and dynamic**

Challenges

We are interested in:

- Pediatric Imaging (Dr Caron Parsons)
  - Characterisation of Necrotising Entrocolitis on ultrasound
- Pulmonary disease (Dr Emma Helm)
  - Characterisation of Usual Interstitial Pneumonia on CT
- Nuclear Medicine (Dr Olu Adensanya)
  - Early diagnosis of infection in joint replacements
- Magnetic Resonance
  - Tissue classification (Dr Terence Jones), Brown fat and Myositis
  - Hypoxia Imaging (Dr Ravjit Sagoo), at simulated altitude

- We also provide a good link to other clinical specialties as well as links with engineering, computer science and statistics

Dr Andrew Reason - Capabilities

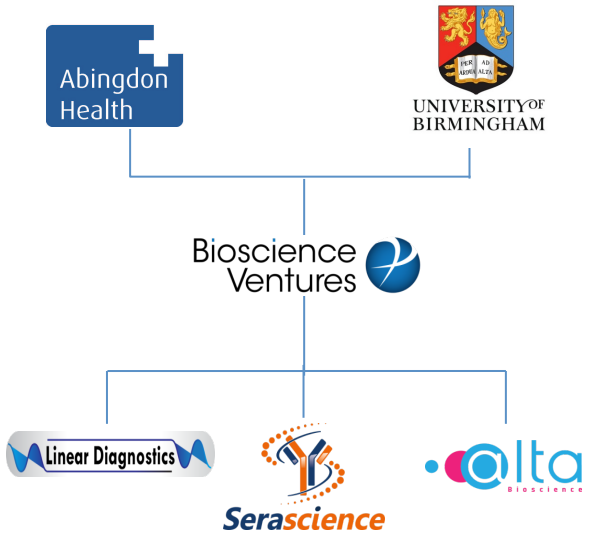
- I am a biochemist specializing in structural analysis of biopharmaceuticals
- I have worked within the service provision side of the biopharma industry for the last 20 years and have helped gain regulatory approval for more than 100 biopharma products
- My area of expertise resides within the commercialization of high end analytics for assessing the primary, secondary and tertiary structure of proteins and glycoproteins – including chromatography, electrophoresis, mass spectrometry and spectroscopy

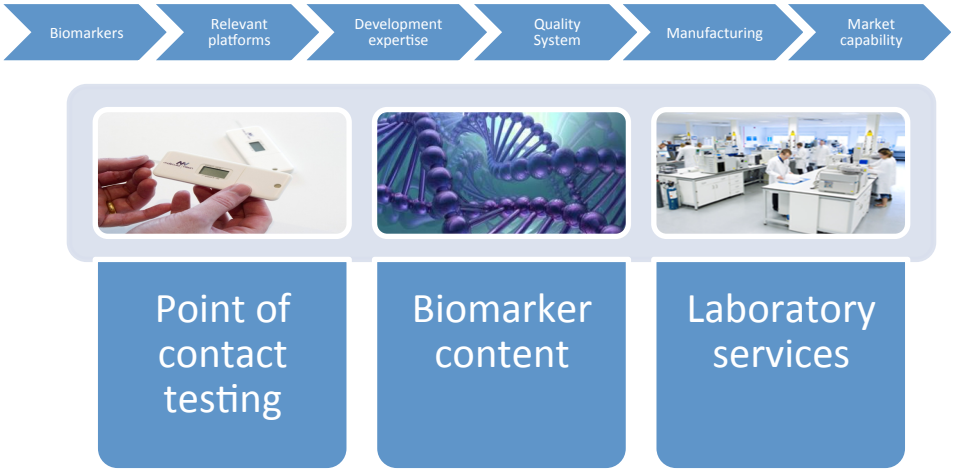
Andrew Reason - Challenges

- Secondary and tertiary structure analyses of biopharmaceuticals are routinely performed, at present, using Circular Dichroism (CD) and Fourier Transform-Infra Red (FT-IR). Nuclear Magnetic Resonance (NMR) is also used as a high end comparability tool (but does not provide data that can be rationalized to tertiary structure, in most cases)
- The US FDA see Hydrogen Deuterium Exchange-Mass Spectrometry (HDX-MS) filling the gap between the lower resolving CD/FT-IR and NMR
- Is HDX-MS the way to go or are there other techniques which could be brought to bear to fill this gap?

Linear Diagnostics Ltd: Capabilities

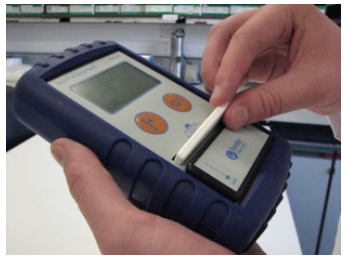
- Development of novel diagnostics for medical, food and defence sectors
- Nano-biotech and handheld readers
- Part of a larger group

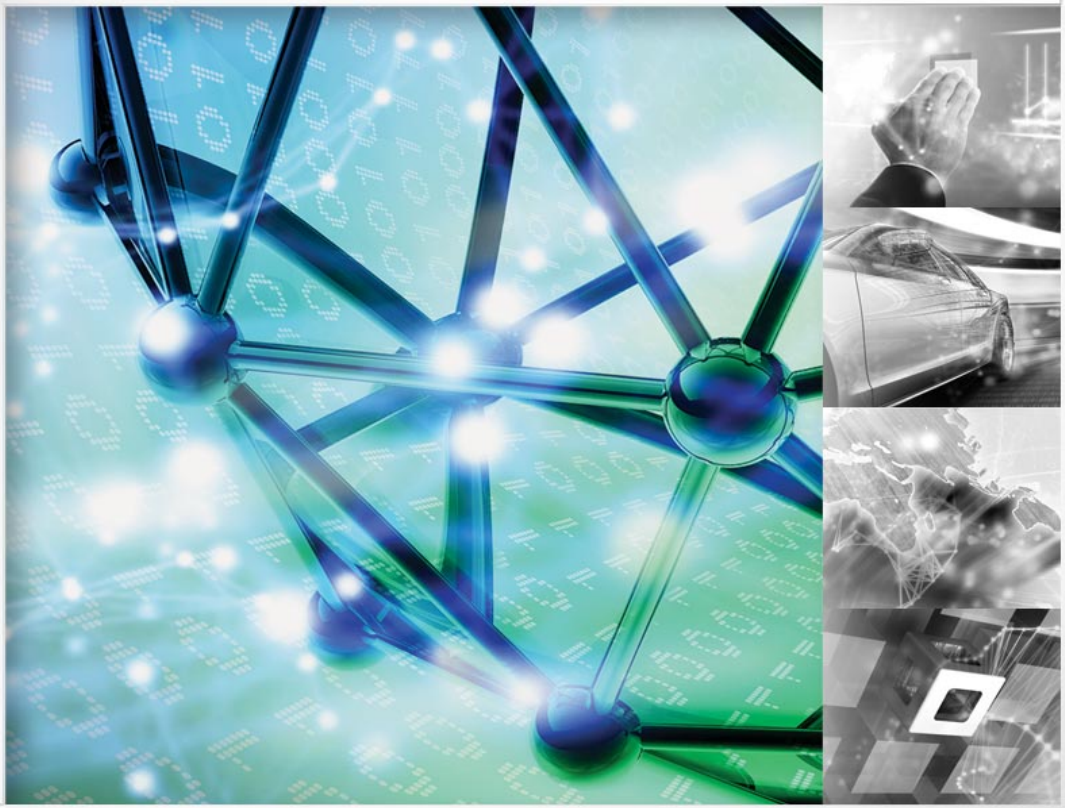




Linear Diagnostics Ltd: Challenges

- Optimization of conjugation chemistries
- Reader developments
- Assay formatting





MASC Centre for Doctoral training

Lubrizol Additives

11th March 2014

Lubrizol

Capabilities

SUCCESS TOGETHER

Lubrizol Additives

- Automotive additive synthesis and manufacture
- Lubricant formulating
- Oil analysis techniques
- Field and engine testing of automotive lubricants

Analytical science

- Standard industry oil analysis techniques
- Rheology
- Colloid science
- Tribology
- Surface science
- Screening tool and bench test development

Challenges

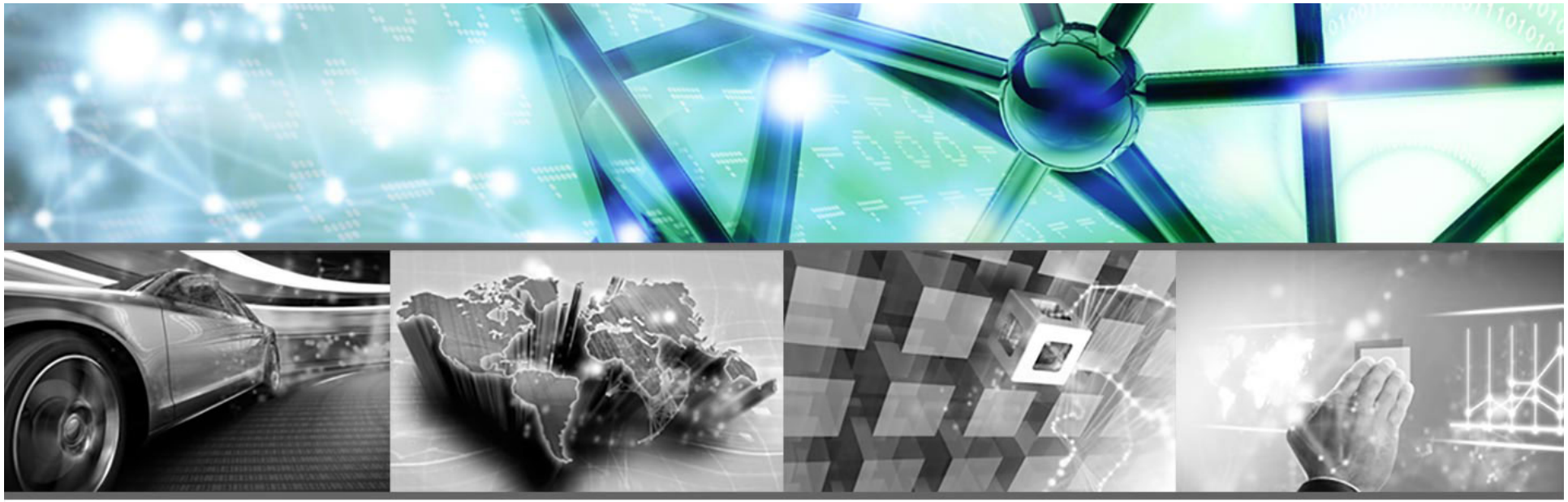
SUCCESS TOGETHER

Lubrizol Additives

- Improving oil fuel economy without effecting engine durability
- Effect of new automotive hardware on the durability of lubricating oils
- Effect of alternative fuels on the durability of lubricating oils

Analytical science

- Most techniques designed for aqueous systems
  - Often less published material in oil based systems
- Analysis and mechanistic study of interactions in complex mixtures of oil soluble components



SUCCESS TOGETHER

Working together, achieving great things

When your company and ours combine energies, great things can happen. You bring ideas, challenges and opportunities. We'll bring powerful additive and market expertise, unmatched testing capabilities, integrated global supply and an independent approach to help you differentiate and succeed.

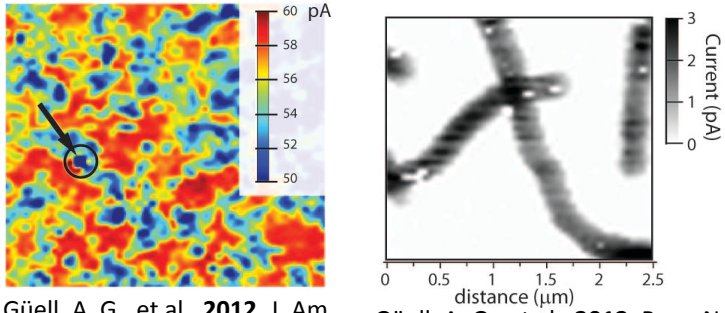
Warwick Electrochemistry & Interfaces Group

www.warwick.ac.uk/electrochemistry (email: p.r.unwin@warwick.ac.uk)

- **40 people** *probing*, *mapping,* and *analysing* processes any **surface/interface** you can think off with ***unique capability***!

Electrode reactivity (batteries, fuel cells, sensors….)

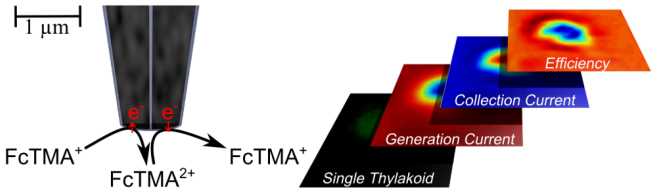
Graphene **Nanotubes**



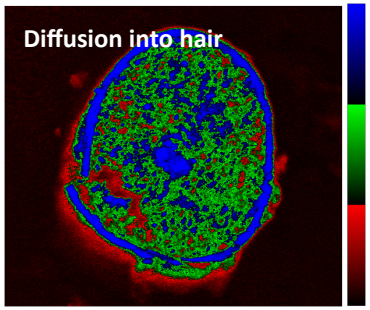
Güell, A. G., et al., **2012,** J. Am. Chem. Soc., 134(17), 7258–7261. doi:10.1021/ja3014902

Güell, A. G., et al., **2012,** Proc. Natl. Acad. Sci. USA, 109(29), 11487–11492.

Biophysical processes in tissues, membranes and living cells

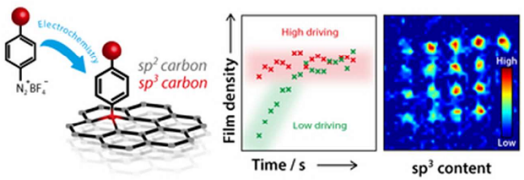


Nanoscale photosynthesis

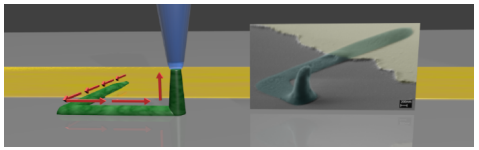


McKelvey, K., et al., **2013,** Analytical Chemistry, 85(15), 7519–26.
Nadappuram, B. P., et al., **2013,** Analytical Chemistry., *85*(17), 8070–8074.

Patterning and printing

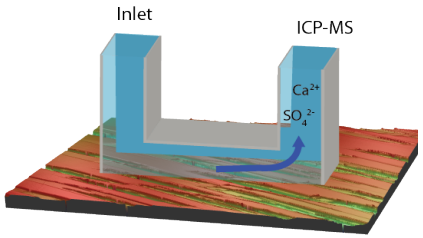


Kirkman, P. M., et al., **2014,** J. Am. Chem. Soc, 136(1), 36–9.

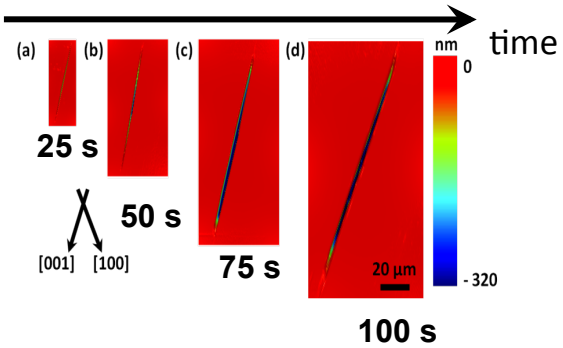


McKelvey, K., et al., **2013,** Chem. Comm., 49(29), 2986–2988.

Crystal growth & dissolution



J. Phys. Chem. C, **2011**, 115, 10147



Phys. Chem. Chem. Phys., **2013**, 15, 1956–1965.

Warwick Electrochemistry & Interfaces Group **Challenges**

- Multidimensional/parameter imaging/probing – dream is **"lab on a tip"**
- From "stills" to **video rate functional imaging**
- Handling/presenting large and **complex data sets**
- Applications in even more **complex environments**
- *At any time, work with up to 6 companies – seek to expand*