

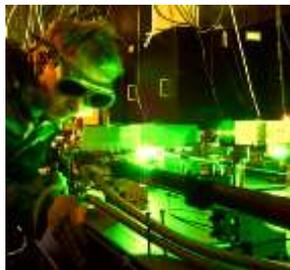


# The CLF – Part of the UK's National Labs

- Multi-disciplinary Centre of Excellence
- Academic access through peer-review
- Industrial access
- Programmes from all scientific Research Councils
- Last year ~400 unique scientists used CLF
- Advanced skills training – students, postdocs, and new academics
- Access to high performance computing in CLF/STFC

# CLF Facilities and Functions

GEMINI



High power, ultra-short pulse dual beams of 15 J, 30 fs pulses

Pulse every 20s

**High-power, ultra-intense lasers for extreme conditions science & applications**

VULCAN



Ultra high-power laser

Up to 1 PW peak power

Focused intensity  $> 10^{21} \text{ Wcm}^{-2}$

ARTEMIS



fs and as ultrafast spectroscopy

IR to soft x-ray

ULTRA

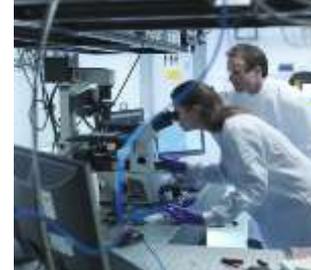


Ultrafast vibrational spectroscopy

Research Complex  
at Harwell

**Laser applications in the physical and life sciences (materials, chemistry, biology)**

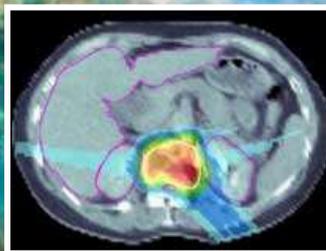
OCTOPUS



Imaging, laser tweezers and microscopy

# Extremely Powerful Laser Sources

- Access to extreme conditions / states - pressure, density, temperature, E-Field...
  - Scientifically rich – astrophysics, relativistic plasma physics, fusion, novel accelerators, sun, stars, planets,...
- Unique super-bright sources
  - Very energetic & penetrating electrons, protons, ions, neutrons, X-Rays,  $\gamma$ -Rays, THz ...



# Gemini - Plasma Accelerators

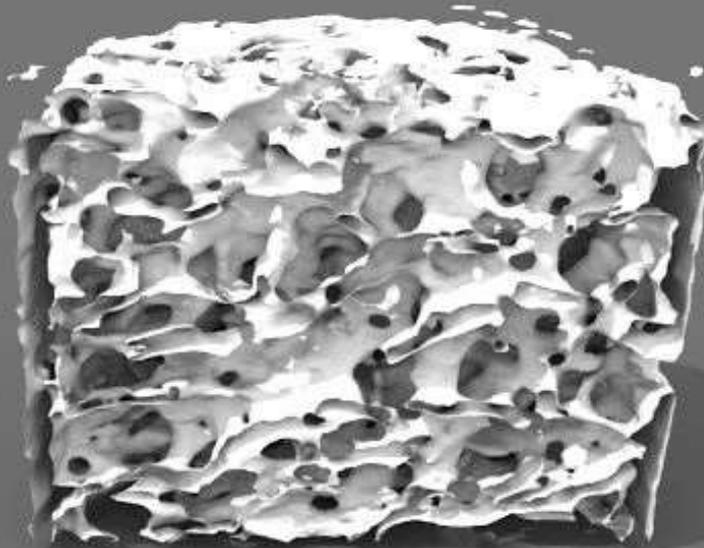
MRC

Medical  
Research  
Council

Imperial College  
London



NHS



*Gemini High Power Laser*

*Synchrotron*



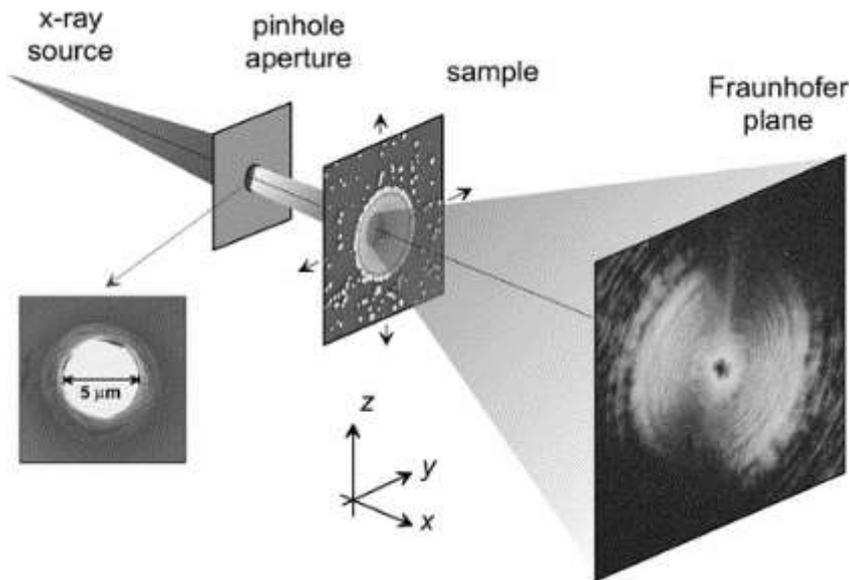
*microCT*



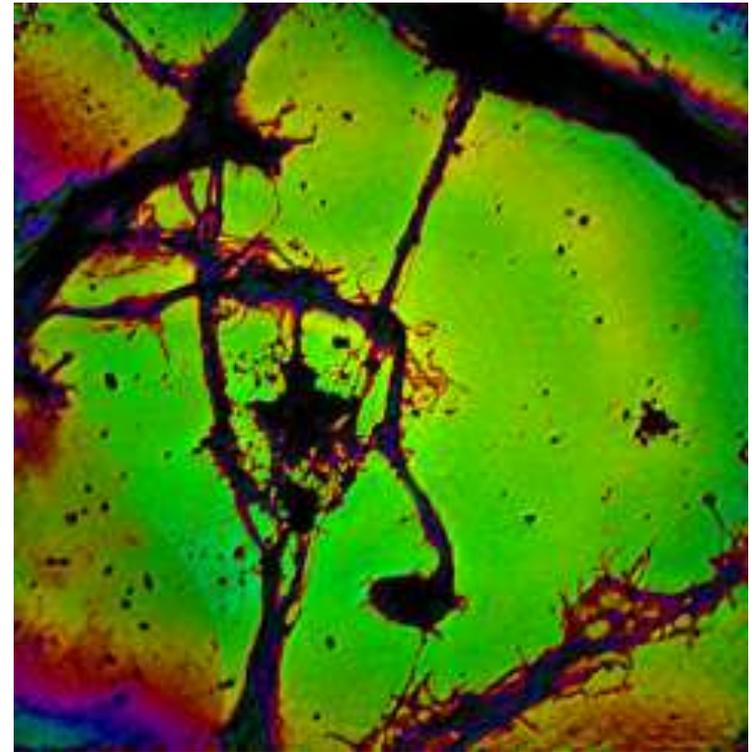
# Coherent Extreme UV imaging

## Ptychography (lens-less imaging)

- Wide area image built up by scanning over sample
- Iterative retrieval algorithm



Rodenburg, PRL **98**, 034801 (2007)  
Zhang, Ultramicroscopy, **158** 98 (2015)  
Baksh et al Opt Lett **41** 1317 (2016)

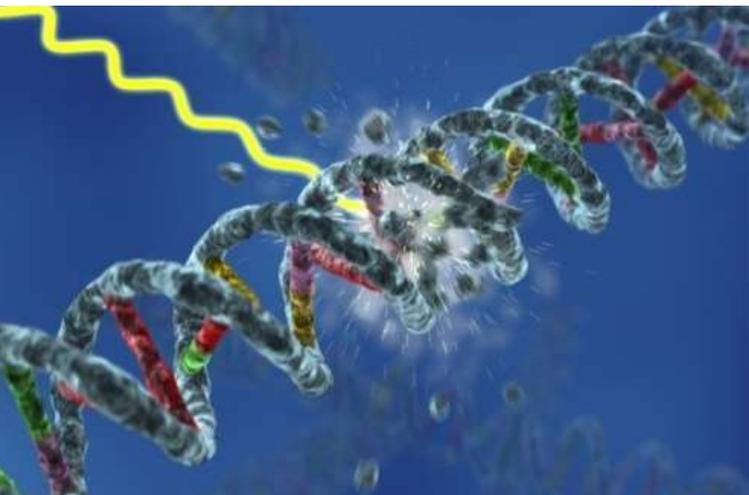


- **Mouse neurons imaged at 100 nm resolution**
- 29 eV high harmonics



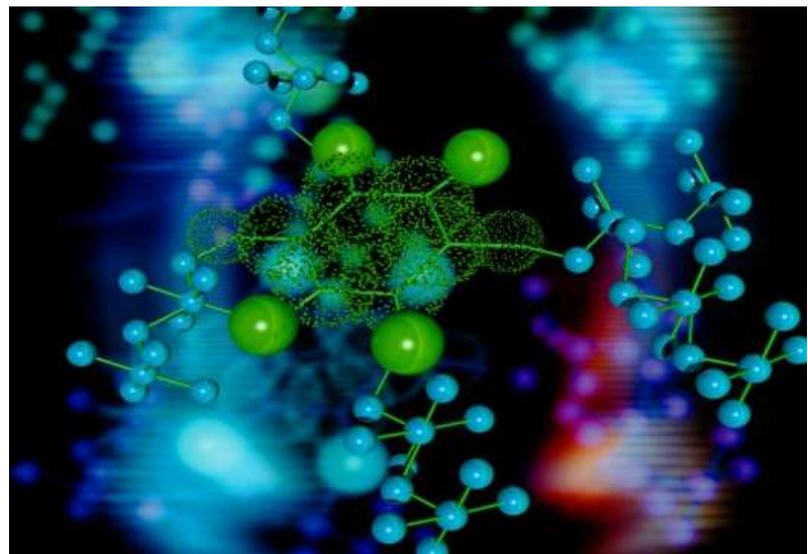
# ULTRA to investigate Molecular Dynamics

Ultrafast spectroscopy techniques to probe the links between molecular structure and function, in the “real world” environment.



**DNA damage.** ULTRA UV lasers can be used to initiate changes, which are then monitored using time-resolved infrared spectroscopy (*picoseconds to milliseconds*).

**Chemical reactions in solution.** The very high sensitivity of ULTRA allows reactions to be investigated in “real life” solution conditions (*femtoseconds to nanoseconds*).



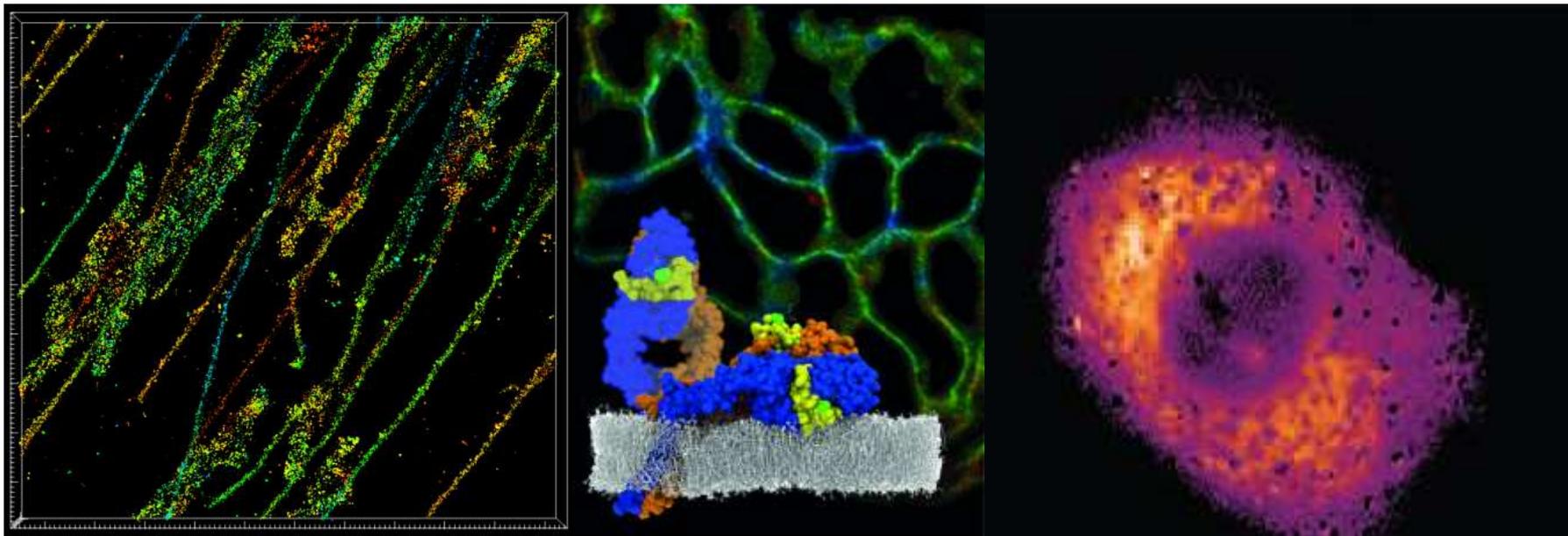


# Octopus for Imaging and Spectroscopy

A suite of advanced optical imaging stations for the life sciences

Imaging of biological systems on the nanoscale

Investigating the structure of molecules involved in cell signalling, the development of cancer and drug-target interaction.



**Techniques:** Super-resolution (STED, PALM/STORM, SIM); single and multiphoton confocal microscopy with fluorescence lifetime imaging; single molecule tracking and localisation techniques for characterisation of molecular interactions on the nanoscale.