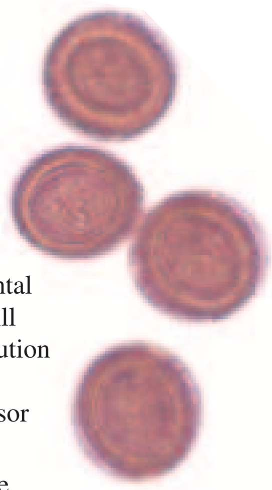
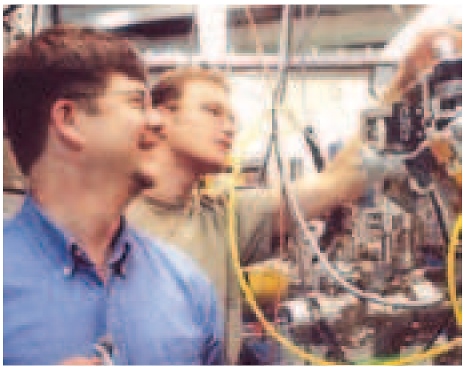
Physicists collaborate for INVISIBLE WORLDS





Professor Jacobsen, left, with a student in his laboratory.

For those who ponder the mysteries of molecular science and how it works at the extra-molecular level – that is, up here in the visible world – here's good advice: talk to a bilingual physicist.

Perhaps one like Professor Chris Jacobsen, a US physicist in residence recently at La Trobe's Institute for Advanced Studies, who simplifies the nano-scale mysteries of electron microscopy in the sub-cellular world of biology by talking about sawing a centimeter-thick slice through your car to see how the transmission works.

It's a bit like visualising the anatomy of a mosquito by dismantling a bulldozer, but you get the picture: they're both compositions of intricate engineering.

So it isn't difficult to imagine a scene in the physics labs at La Trobe or at his home institute (Stony Brook University, New York), with Professor Jacobsen and his colleagues brainstorming the barricades of yet-to-be-known applications of physics to discover revolutionary new ways of imaging the invisible world of biology.

Among his fellow-scientists at La Trobe recently, Professor Jacobsen contributed similarly innovative techniques to take the newly-emerging science of coherent X-ray imaging a step closer to its ultimate goal – to use the ever-brightening sources of coherent light from facilities such as synchrotrons to image the atomic structure of a single protein molecule.

One of a closely-knit world community of physicists, biochemists and biologists drawn together by their common goal, Professor Jacobsen is collaborating with Melbourne-based scientists in the ARC Centre of Excellence for Coherent X-Ray Science (see previous page) to help push high-resolution X-ray imagery into a new realm - beyond the limitations currently experienced using such techniques as light microscopy, crystallography and electron microscopy.

They are seeking a technique to obtain three-dimensional, tomographic images of the inside structure of a single cell at the finest possible resolution – ultimately, they hope, at the molecular level – without first damaging the cell.

Calling on Professor Jacobsen's own work at Stony Brook (most recently demonstrating X-ray diffraction microscopy to image an intact freeze-dried yeast cell), and the pioneering science of Professors John Miao at the University of California (the first scientist to demonstrate coherent diffraction as an imaging technique), and Henry Chapman, Group Leader at Lawrence Livermore National Laboratory, California (also instrumental in developing these techniques), the Melbourne group has designed a new experiment they believe will carry the science across its next threshold.

Brainstorming with physicists, biochemists and biologists.

Professor Jacobsen has worked with the physicists, biochemists and biologists at La Trobe and other institutions involved in the Centre for the past few months to design the concept and refine the hardware to undertake the experiment.

Like the sliced-up car, the apparent simplicity of the hardware belies the complexity of the concept behind it: in fact the engineering as well as the physics and the biochemistry involved are precise and complex.

'We've had a series of brainstorming sessions where we've tried to design a new approach, to build on the imaging apparatus we've developed for our own work in the US – both to make an improved version of that, and to devise a new experimental approach that will move high resolution X-ray imagery forward,' Professor Jacobsen says.

'The way these things go is you sketch out something that is rough, you develop a viable approach, then you have to sit down and do the nitty-gritty of design – and that takes a long time.

'We now have the conceptual design, and the bulk of the detailed design will be done here at La Trobe. That will take six months, and to get it built will take another six months, then I'll come back and we'll look at it again to see if it works.'

While Professor Jacobsen's sawn-up car nicely illustrates the contrast between X-ray imagery and electron microscopy (with electron microscopy you can't see how the transmission relates to the engine), La Trobe QEII Research Fellow and physicist Dr Andrew Peele has a tendency to explain in stereo:

'Electron microscopy gives you the cross section in greater detail; X-rays give you the full volume,' he says.

For the coherent headlights required to illuminate the experiment, the scientists will consult their in-house beamline mechanics: Beamline Scientist and Group Leader at the Advanced Photon Synchrotron in Chicago, Dr Ian McNulty, Beamline Group Leader Professor Ishikawa at the Spring 8 Synchrotron in (Tokyo), and collaborators at the National Synchrotron Radiation Research Centre, Taiwan.

For the high-octane brain-waves facilitating this venture, Professor Jacobsen looks directly to the inter-institutional ARC Centre of Excellence for Coherent X-ray Science.

'There's not quite anything like this world-wide, it's unique,' he says.