The challenges facing structural sciences

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Theory predicts that with an ultra-short and extremely bright coherent X-ray pulse, a single diffraction pattern may be recorded from a large macromolecule, a virus, or a cell before the sample explodes and turns into a plasma. The over-sampled diffraction pattern permits phase retrieval and hence structure determination. X-ray lasers capable to deliver ultra bright and very short X-ray pulses for such experiments have recently started operations. Free-electron lasers are the most brilliant sources of X-rays to date, exceeding the peak brilliance of conventional synchrotrons by a factor of 10 billion, and improving. In the duration of a single flash, the beam focused to a micron-sized spot has the same power density as all the sunlight hitting the Earth, focused to a millimetre square. The interaction of an intense X-ray pulse with matter is profoundly different from that of an optical pulse. A necessary goal of research is to explore photon-material interactions in strong X-ray fields. Our aim in biology is to step beyond conventional damage limits and develop the science and technology required to enable high-resolution imaging of biological objects. The talk will summarise imaging results from the Linac Coherent Light Source.