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Free-electron lasers and *JSR*

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'X-ray Laser Advances' featured in the top ten for 'Breakthrough of the Year 2012' (http://www.sciencemag.org/site/special/btoy2012/) chosen by the journal *Science*. The determination of new details in the crystal structure of the trypanosomal protein Cathepsin B was recognized by the award (Redecke *et al.*, 2013). Diffraction data of tiny *in vivo* grown crystals were collected using intense femtosecond X-ray free-electron laser (FEL) flashes from the LINAC Coherent Light Source (LCLS), the first hard X-ray FEL (Emma *et al.*, 2010).

The technical and scientific progress enabled by X-ray FELs is astounding. The changes are as dramatic as some 30 years ago when dedicated storage rings began to come into operation. The same sense of excitement prevails and similar pioneering spirits are shared by the community. The LCLS, the first hard X-ray laser to become operational, provides, for example, X-ray flashes with pulse durations as short as sub-ten femtoseconds, containing up to 10^{13} transversely coherent photons in a narrow spectral bandwidth, at X-ray energies ranging from 500 eV to 10 keV. Typical irradiances obtainable by focusing are in the 10^{18} to 10^{21} W cm^{-2} range.

Since the commissioning of the LCLS in 2009, both long-anticipated and unexpected results have been obtained. For example, the concept of diffraction before destruction, first proposed by Solem in 1986, has been demonstrated for viruses (Seibert *et al.*, 2011), protein nanocrystals (Chapman *et al.*, 2011) and airborne particulate matter (Loh *et al.*, 2012), indicating that nuclear-motion-based damage effects can be outrun if sufficiently short intense X-ray pulses are used (Solem, 1986; Neutze *et al.*, 2000). Nevertheless, electronic damage takes place and multiphoton absorption results in very rapid sequential photoejection of inner-shell electrons, producing 'hollow' atoms and an intensity-induced X-ray transparency in light atoms (Young *et al.*, 2010). Unexpectedly, in high-Z atoms, charge states have been observed that are higher than those achievable by the last ionic state that can be ionized with one photon. These high-charge states are created *via* excitation of transient resonances in highly charged ions (Rudek *et al.*, 2012). This severe electronic damage may be exploited for high-intensity multi-wavelength anomalous dispersion phasing approaches for crystal structure determination using FELs (Son *et al.*, 2011).

Different machine concepts have been realised and are being developed further. First seeding approaches have been implemented to improve the quality and properties of the SASE beam (Shintake *et al.*, 2008). Currently, the LCLS in Stanford, USA, and SACLA in Harima, Japan, are the only hard X-ray FELs. To increase the availability of this scarce resource, different concepts for multiplexing are currently being explored.

New FELs are being built such as the SwissFEL, the European XFEL, the Korean FEL and LCLS-II, an upgrade of the LCLS. Given the exciting developments with FELs, the *Journal of Synchrotron Radiation*'s intensified coverage of free-electron lasers, which is now prominently reflected on the journal's cover, is very timely. The journal provides a home for rapid communications of scientific results obtained with these sources as well as of developments in instrumentation and methods. I was brought in as an Editor to serve as a point of contact for FELrelated topics and I am looking forward to serving the wider FEL community as well as the synchrotron radiation structural biology community. We plan to put together a special issue on Free-Electron Laser Science and Technology where we will be soliciting authors who have something 'special' to communicate to the wider community of synchrotron radiation and FEL scientists, may they be chemists or biologists, condensed matter physicists or material scientists. We wish to make the *Journal of Synchrotron Radiation* the natural home for reporting the technical advances as well as the scientific breakthroughs in the field.

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