Intense X-ray science: the first 5 years of FLASH

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EDITORIAL

Intense X-ray science: the first 5 years of FLASH

Guest Editors**H Chapman***CFEL, Hamburg***J Ullrich***MP-K, Heidelberg and
ASG@CFEL, Hamburg***J M Rost***MPIPKS, Dresden and
ASG@CFEL, Hamburg*

The Free electron LASer in Hamburg, FLASH at DESY, is the first user facility which has, over the last five years, delivered short (10–50 fs) and intense (up to 10^{16} W cm⁻² peak intensity) light pulses. How big this technological progress really is becomes clear when one realizes that this light source is nine orders of magnitude more brilliant than state-of-the-art third-generation light sources.

How does matter behave when illuminated with such pulses? What are the fundamental mechanisms and phenomena? Clearly, this was virgin territory five years ago. The present compilation of results from FLASH is by no means complete but is intended to provide an overview of different types of pioneering experiments, including the highlights and surprises. The contributing authors have explored questions and used targets ranging from physics (condensed matter, plasmas, clusters, atoms and molecules) over chemistry (the quest for the time- and space-resolved visualization of chemical reactions) to biology, driven by the vision of realizing single-shot coherent diffractive imaging of individual species. The goal of tracing structural changes as a function of time and, thus, uncovering the functioning of matter is, in fact, common to all participating disciplines. This extends to the hope, nurtured by upcoming x-ray FELs, to be able to image in the future, nanostructures, large molecules, viruses, cells, etc, on atomic length and time scales, i.e. with Angstrom spatial and attosecond temporal resolution.

The articles are kept at a tutorial level in order to be accessible for the non-specialist, with references to original published work for in-depth information.

In addition, two articles by Jochen Schneider and Josef Feldhaus describe, respectively, the making of this remarkable new light source and its characteristics and possibilities.

We thank all the authors for their contributions and hope that you will enjoy reading them!