

IV. Research courses on new X-ray sciences – New Science in the VUV to Soft X-Ray Regime

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The series of research courses addresses new directions of X-ray research, in particular new methods of X-ray scattering and new scientific applications. The courses intend to provide fundamental information to young and future researchers in order that they can establish themselves in the emerging field of X-ray sciences or to obtain complementary information with respect to applications of X-ray research. The courses therefore mainly address diploma students, PhD students and young researchers after their PhD. The schedule of the courses is very compact with twelve 90 min lectures over three days. This fourth course was held in the upper floor of the experimental hall of the VUV-FEL (see figure below) giving a nice introduction to one of the main topics of the course, namely the discussion of experiments to be carried out using FEL radiation from the VUV-FEL. Enough time for discussion, a visit of the FEL installations at TTF, a poster session for the participants, and social events in the evenings provided the possibility for an intense exchange between participants and lecturers. Like in previous years the course was free of charge and accommodation at the DESY guesthouse was provided to the participants.

The course received high attention, both from participants and from lecturers, since new light sources for intense and ultra-short radiation in the VUV- to soft X-ray regime currently emerge. These sources will open a new window for scientific applications. Most prominent here are free-electron lasers, with the first user facility becoming operational in 2005, but also optical laser-based installations have made huge progress. In addition, the combination of high field and short wavelength is a new area of interaction of researchers from the high-field laser community and from the short-wavelength synchrotron radiation community. Speakers and participants of the course originated from both areas. The lecture programme addressed two key areas: (a) the discussion of the properties of different sources and the requirements to diagnostics for experiments in this regime, and (b) the scientific applications from atomic physics via complex systems to solid state physics. In the following, a brief summary of the presented material is given.



The properties of sources for VUV to soft x-ray radiation were presented starting with the well-known characteristics of storage ring synchrotron radiation and introducing recent developments like slicing sources, free-electron lasers (FEL), and laser sources based on the HHG scheme. The new sources provide pulses of duration well below picoseconds, even reaching into the attosecond domain in the case of HHG sources. Other parameters like photons per pulse, wavelength regime or coherence vary largely between the sources. Therefore the appropriate source must be defined depending on the requirements of the scientific application. A particular requirement of accelerator-based FEL sources is the topic of synchronization of FEL and optical laser radiation. This synchronization is required for ultra-fast time-domain experiments applying pump-probe techniques and recent experiments have shown a synchronization of the order 100 fs. This accuracy can be improved by an order of magnitude over the coming years. Experimental techniques using the new sources span a huge area with scattering techniques, photo-electron and ion spectroscopy, but also soft x-ray spectroscopy will be a key technique. These techniques are applied to solve scientific problems that yet cannot be addressed. Examples of applications in the fields of atomic and molecular physics, cluster physics, high-resolution solid state spectroscopy, surface and magnetization dynamics, non-linear and multi-photon processes, and of high energy density sciences were presented to motivate the scientific interest in this domain

This course had been announced by email to key people in the domain of VUV and soft X-ray experiments and by distribution via mailing lists of European laser research and synchrotron radiation programs. Furthermore, a poster had been distributed to several large-scale facilities in Europe. The capacity of the course was fully exploited by the twelve speakers, about 50 participants and several in-house researchers following the lectures. About half of the participants came from EU member states, Russia and Canada. The twelve speakers (5 non-German, 7 German) came from leading institutions in the European science area. It was very well received by the participants that many of the lectures stayed for the whole event thus allowing to discuss during the breaks and after the sessions.

Information about the DESY research course series *New X-ray-Sciences* can be found on the web: <http://www-hasylab-desy.de/conferences/Xray-Course>. The organizer would like to thank the external speakers for making the success of the course possible. Financial support by the European Commission under HPRI-CT-1999-40001 (European round-table on synchrotron radiation and free-electron lasers) is gratefully acknowledged.