L-25 **Thu. 19. 06., 17^{30}-18^{10}**

Watching chemical reaction dynamics with ultrashort X-ray pulses

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Keywords: Time-resolved X-ray spectroscopy, Synchrotron radiation, X-ray Free-electron laser

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Ultrafast structural dynamics is an emerging field aiming to deliver a detailed understanding of the elementary steps in reacting chemical species, which involve changes in their nuclear, electronic and spin states. Such processes are vital ingredients in chemistry and biology, but also in technological applications, including efficient charge transport in light harvesting molecules and ultrafast switchable molecular magnets.

In order to unravel this complex dynamic behavior we have implemented a suite of ultrafast X-ray spectroscopic and scattering tools to zoom into both the electronic and nuclear structures, with the goal to ultimately deliver a molecular movie of ongoing chemical processes. In view of the many potential applications in chemical and biological dynamics it is desirable to increase the sensitivity level of such experiments as well as to decrease the time resolution into the femtosecond time domain.

We present our benchmark results using a versatile setup that permits simultaneous measurements of ultrafast X-ray absorption and emission spectroscopies combined with X-ray scattering, which has been recently implemented by us at different synchrotrons [1-2] and XFELs [3]. We applied it to study different photochemical reactions, ranging from nascent radicals in solution, molecular spin transitions, ligand exchange reactions, to photocatalytic systems, with the goal to deliver a deeper understanding of the elementary steps in chemical reactivity.

Acknowledgments: This work was supported by the European XFEL GmbH and the DFG Sonderforschungsbereich 925 “Light-induced dynamics and control of correlated quantum systems” (Project A4).

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L-26 **Fri. 20. 06., 18^{30}-18^{10}**

Present status and future development of SOLARIS project

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Project SOLARIS – the first Polish Synchrotron Radiation Source [1] has entered the crucial stage. The building construction with the backbone installations of cooling water and electrical systems has been completed and accepted on the 5th of May 2014. The tenders for all the major components of the machine have been resolved and hardware is ready for delivery or in production. Contracts for integration of the machine with the building installation have been awarded and the installation of the machine begins in June 2014.

The project, financed from EU Structural Funds is executed by Jagiellonian University. It is possible only due to unprecedented collaboration with MAX-lab tem in Lund, where new SR facility is being constructed, consisting of two storage rings of 1.5 and 3.0 GeV. Polish synchrotron is a replica of the smaller (96m circumference) 1.5 GeV ring. The revolutionary design of double bending achromats (DBA) forming the MAXlab storage rings [2] was made available to SOLARIS, allowing the facility to implement the technology for the first time.

The current status of the project as well as the timetable of the installation including the target milestones will be presented. The future plans of the development of the facility, including the improvement of the source and construction of the next batch of the experimental beamlines will be discussed.

Acknowledgments: The order is co-funded by the European Union from the European Regional Development Fund and state budget within the framework of the Innovative Economy Operational Programme, 2007-2013, (POIG.02.01.00-12-213/09).

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