Synchrotron-based Cineradiography using Coherent Hard X-rays for *in vivo* Studies of Organisms

Alexander Rack[1,2], Oliver Betz[3], Christian Schmitt[3], Lars Körner[3], Andreas Dieterich[3], Alexey Ershov[2], David Haas[2], Tilo Baumbach[2]

[1]European Synchrotron Radiation Facility, Grenoble, France

[2]Forschungszentrum Karlsruhe GmbH – ANKA, Karlsruhe, Germany

[3]Zoologisches Institut, Universität Tübingen, Germany

arack@snafu.de

Keywords: cineradiograpphy, micro-imaging, coherent X-rays, synchrotron, insects

The outstanding scientific value of time resolved imaging is known since the famous high-speed movies of living insects by Lucien Bull [1]. The use of synchrotron light sources allows the next step in the fast imaging development: the use of hard X-rays. Micro-radiography as an established method to image the internal structure of an object with micrometer resolution can be extended to study its temporal evolution as well. While direct converting pixel detectors are known which can acquire images with high frame rates [2] here detectors are needed with higher spatial resolution which can stand the highly intense synchrotron photon flux. Our approach is based on indirect pixel detectors which are already known for micro-imaging at synchrotron light sources [3, 4]. We combine those with CMOS cameras in order to achieve frame rates of 10 000 images per second or more, thus progressing to micro-radioscopy [5]. This allows for studies of living insects with frame rates up to 250 images per second (ANKA, TopoTomo beamline), see fig. 1. We applied this technique to individuals of the cockroach Periplaneta americana (Linné) for imaging basic insect mouthpart coordination and function. This research aims to compare quantitatively the kinematic patterns across major groups of insects and hence contribute to our understanding of the evolution of, e.g., insect feeding.

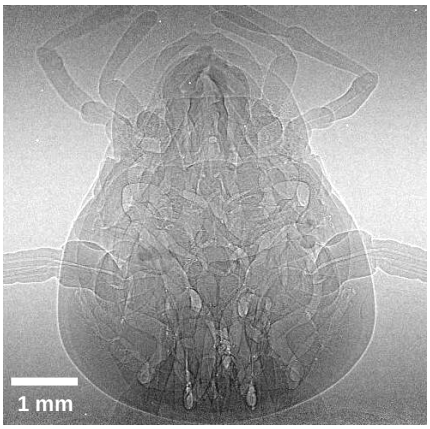

Figure 1. Radiograph of a living cockroach Periplaneta americana (250 FPS).

References:

1 L. Bull, *La Cinématographie*; Paris: Armand Collin (1928)

2 M. J. Renzi, M. W. Tate, A. Ercan, S. M. Gruner, E. Fontes, C. F. Powell, A. G. Mac-Phee, S. Narayanan, J. Wang, Y. Yue, R. Cuenca, *Rev. Sci. Instr.*, 73, 1621 (2002)

3 A. Koch, C. Raven, P. Spanne, A. Snigirev, *J. Opt. Soc. Am.*, 15, 1940 (1998)

4 A. Rack, S. Zabler, B. R. Müller, H. Riesemeier, G. Weidemann, A. Lange, J. Goebbels, M. Hentschel, W. Görner, *Nucl. Instr. & Meth. A*, 586, 327 (2008)

5 A. Rack, F. García-Moreno, O. Betz, C. Schmidt, L. Helfen, T. dos Santos Rolo, S. Zabler, J. Banhart, T. Baumbach, *IEEE Trans. Nucl. Sci.* (submitted 2008)