Zwischenbericht (Sachbericht)

Förderinstrument:	Postdoktorandenprogramm
Impulsfonds-Förderkennzeichen:	PD-004
Projekttitel:	Temporal Characterizaton of Femtosecond X-ray Pulses and Beam-driven Wakefield Acceleration Experiments
Postdoktorand/in:	Dr. Christopher Behrens
Helmholtz-Zentrum:	DESY
Berichtszeitraum (=Kalenderjahr!):	01/2013-12/2013

1) Arbeitsfortschritt / Meilensteine

Welche Fortschritte wurden im geplanten Arbeitsprogramm gemacht. Nehmen Sie explizit Bezug auf das im Antrag beschriebene Programm und die dort aufgeführten Meilensteine. Waren Abweichungen vom Programm notwendig?

One oft the two main projects - **Temporal Characterization of Femtosecond X-ray Pulses**- has been successfully completed. The proposed technique for **Simultaneous temporal diagnosis of electron and x-ray pulses by using a transverse deflecting r.f. structure** has been demonstrated with exceptional results at LCLS. The results have been communicated in several talks at international conferences, and a paper has been accepted for publication in Nature Communications. Further publications with theoretical and experimental results are in preparation. This project has been carried out within the one-year stay at SLAC-Stanford in CA, USA. Collaborations with colleagues at SLAC are still on-going.

Within the topic **THz streaking technique for simultaneous x-ray temporal and arrival time information**, a paper on the demonstration, using THz streaking, of an all-optical synchronization system demonstrating overall performance at the femtosecond level at FLASH has been submitted to Nature Communications. Furthermore, a beam time proposal for a novel user experiment at FLASH planned for 2014 utilizing THz streaking has been granted. This work is based on a collaboration with colleagues from the MPSD at CFEL.

The second main **topic Beam-driven wakefield acceleration experiments** has a strong emphasis in the second year of this fellowship (2014). To date, extensive simulations and design work have been done, eventually leading to an official project at DESY on beam-driven wakefield acceleration called FLASHForward. The project proposal is close to submission. As part of the simulations work, a paper on High-quality electron beams from field-induced ionization injection has been published in NIM-A. Based on work during the stay at SLAC, a paper - also relevant for wakefield experiments at FLASH - on Coherent-Radiation Spectroscopy of Few-Femtosecond Electron Bunches has been published in PRL. In order work more effectively on new ideas, a Ph.D. student has been hired to work on new schemes making plasma-based accelerator more reasonable and useful for photon science applications.

In summary, all the proposed projects are evolving well and within the planned budget and time schedule. Beside the publications mentioned above, several conference papers and a textbook have been prepared.

2) Finanz-/Zeitplan

Können Sie Finanz- und Zeitplan einhalten oder sind Anpassungen notwendig?

The budget and time schedule meet the original planning. No changes are required.

3) Publikationen / Preise

Journal papers:

- C. Behrens, F-J. Decker, Y. Ding *et al*., *Few-femtosecond time-resolved measurements of X-ray free-electron lasers*, accepted for publication in Nature Communication, April 2014.
- S. Schulz, I. Grguras, C. Behrens *et al*., *Femtosecond, all-optical synchronization of an X-ray free-electron laser*, submitted to Nature Communication, April 2014.
- T. J. Maxwell, C. Behrens, Y. Ding *et al*., *Coherent-Radiation Spectroscopy of Few-Femtosecond Electron Bunches Using a Middle-Infrared Prism Spectrometer*, PRL, **111**, 184801, 2013.
- A. Martinez de la Ossa, C. Behrens, J. Grebenyuk *et al*., *High-quality electron beams from field-induced ionization injection in the strong blow-out regime of beam-driven plasma accelerators*, NIM-A, **740**, 231, 2013.

Books:

- P. Schmueser, M. Dohlus, J. Rossbach, and C. Behrens, *Free-Electron Lasers in the Ultraviolet and X-Ray Regime: Physical Principles, Experimental Results, Technical Realization*, 2nd edition, Springer-Verlag, Berlin (2013).

Conference papers:

- C. Behrens, *Review of Femtosecond x-ray pulse temporal characterization in free-electron lasers*, Proc. SPIE 8849, Advances in X-ray Free-Electron Lasers: Radiation Schemes, X-ray Optics, and Instrumentation, San Diego, USA (2013).
- P. Krejcik, F.-J. Decker, Y. Ding, J.C. Frisch, Z. Huang, J.R. Lewandowski, H. Loos, J.L. Turner, J.W. Wang, M.-H. Wang, J.J. Welch, and C. Behrens, *Commissioning the New LCLS X-band Transverse Deflecting Cavity with Femtosecond Resolution*, Proceedings of the 2nd International Beam Instrumentation Conference, Oxford, UK, 2013, TUAL2.
- M. Yan, C. Behrens, C. Gerth, R. Kammering, F. Obier, V. Rybnikov, A. Langner, and J. Wychowaniak, *First Realization and Performance Study of a Single-Shot Longitudinal Bunch Profile Monitor Utilizing a Transverse Deflecting Structure*, Proceedings of the 2nd International Beam Instrumentation Conference, Oxford, UK, 2013, TUPC36.
- E. Hass, C. Behrens, C. Gerth, B. Schmidt, M. Yan, and S. Wesch, *Longitudinal Bunch Profile Reconstruction Using Broadband Coherent Radiation at FLASH*, Proceedings of the 2nd International Beam Instrumentation Conference, Oxford, UK, 2013, MOPC37.
- Y. Ding, J.Frisch, Z. Huang, P. Krejcik, J.R. Lewandowski, H.Loos, J. W. Wang, M-H Wang, J. Welch, and C. Behrens, *Commissioning of the X-band Transverse Deflector for Femtosecond Electron/X-Ray pulse Length Measurements at LCLS*, Proceedings of the 4th International Particle Accelerator Conference, Shanghai, China, 2013, WEOBB201.
- G. Kube, C. Behrens, S. Weisse, W. Lauth, A.S. Gogolev, Y. Popov, and A. Potylitsyn, *Investigation of the Applicability of Parametric X-ray Radiation for Transverse Beam Profile Diagnostics*, Proceedings of the 4th International Particle Accelerator Conference, Shanghai, China, 2013, MOPME011.