Funding Programme: Postdoc Programme
Project ID No.: PD-007
Project Title: CONTROLLED GENERATION AND ADVANCED DIAGNOSIS OF ULTRA-SHORT PLASMA-ACCELERATED ELECTRON BUNCHES
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Helmholtz Centre: DESY
Report Period (Calendar year): 01/2014-12/2014

1) Scientific Progress / Milestones
Please give details of how your work plan has progressed with specific reference to the work programme and milestones described in the original proposal. Have changes in the work plan necessary?

Project 1: Development and characterisation of tailored gas targets for controlled acceleration.

Project 1a: Integrated gas jet and capillary targets.
Progress has been made with target development and characterisation of targets for both ionisation and downramp injection. Diagnosis of the longitudinal distribution of the gas species, essential for ionisation injection experiments, has been achieved. Demonstration of the targets is expected to be slightly delayed, due to scheduling issues of the high power laser, but will be completed soon. The target design for downramp injection has proved to be more challenging and milestone 2 has not yet been completed. Currently, target design simulations are focusing on downramp injection, and openFOAM simulations of targets for a DESY-lead experiment at FACET and a collaborative experiment with Imperial College London at the Rutherford Appleton Laboratory (RAL) are ongoing. Targets, and diagnostics for longitudinal characterisation of the target density profile, are under construction for use in DESY based experiments this summer.

Project 1b: Tailored targets.
Studies of the effect of longitudinal density tailoring using OSIRIS revealed divergence control at the exit of the plasma to be of greater importance than dephasing for improving beam quality. Control of the divergence of the electron bunch as it leaves the target is vital for the prevention of emittance growth and impacts both beam and laser-driven wakefield accelerators. Therefore, the focus of the OpenFOAM simulations and target design has been on the study of divergence control. The conceptual design for a target which will be used during experiments at FLASHForward, DESY, has been fixed. Conceptual design has also been completed for targets to be deployed during month 24. These experiments will investigate the observed divergence control and benchmark the simulation results. Technical design of the targets is ongoing.

Project 1c: Arbitrarily shaped capillary construction.
Guiding tests (milestone 5) with simple geometries have been completed. There is a delay with completion of the guiding tests with more complex geometries due to a delay in fabrication. This will be solved through the outsourcing of capillary manufacture to companies that have already been identified.

Project 2: Development of a single-shot diagnostic for full bunch characterisation

Project 2a: Transition radiation.
Calibration of the NIR broadband spectrometer has been performed at FLASH and this spectrometer was deployed, together with additional spectrometers extending the measured wavelength range into the visible region of the spectrum, during an experiment at the Rutherford Appleton Laboratory in January 2014 (milestone 8 reached ahead of schedule). Analysis of the results is currently ongoing. This broadband visible-IR spectrometer is the prototype for spectrometers which are currently under development for use at FLASH, FLASHForward and within laser-driven plasma acceleration experiments based at DESY. In August 2014, a transition radiation based diagnostic operating in the visible (incoherent) region of the spectrum was deployed during an experimental campaign at POLARIS, Helmholtz Center Jena, in collaboration with the group of Prof. M. C. Kaluza (milestone 7). The results indicated insufficient signal to noise ratio for the electron bunch characteristics available during the experiment. Current development focuses on improvement of the signal to noise ratio and the improved ITR spectrometer will be redeployed later this year.

Project 2b: Optical transverse deflecting structure.
The research of the PhD student, who is funded externally to this programme and was foreseen to complete the feasibility study, has been redirected and therefore the study has been suspended due to lack of manpower.

2) Financial Plan / Time Schedule
Can you comply with the financial plan and time schedule or do you see a need for adjustment?

I can comply with the financial schedule.

Adjustments to the experimental schedule are necessary in order to accommodate external partners and availability of external facilities. These adjustments are flexible.

3) Publications / Prizes

Lars Goldberg, Lucas Schaper, Tobias Kleinwächter, Jan-Patrick Schwinkendorf, Charlotte Palmer, Jens Osterhoff
Characterisation of Gas Targets for Plasma-Wakefield Acceleration
IPAC’14, Dresden.

FLASHForward - Future-orientated wakefield-accelerator research and development at FLASH.
HPL Christmas meeting 2014, RAL.

Lars Goldberg, Lucas Schaper, Tobias Kleinwächter, Jan-Patrick Schwinkendorf, Charlotte Palmer, Jens Osterhoff
Characterization of Gas Targets for Plasma-Wakefield Acceleration
AAC 2014, California.

Jan-Patrick Schwinkendorf, Steffen Wunderlich, Charlotte A. J. Palmer, Nicolas Bourgeois, James Cowley, Christopher Thornton, Gavin Cheung, Simon M. Hooker, Bernhard Schmidt, Jens Osterhoff
Transition Radiation from LWFA at Astra-Gemini
AAC 2014, California.

S. Wunderlich, E. Hass, B. Schmidt, M. Yan
A Double-Prism Spectrometer for the Longitudinal Diagnosis of Femtosecond Electron Bunches with Mid-
4) Satisfaction

*How satisfied are you with the general working conditions provided by the Helmholtz Centre / partner university? Is there anything that meets your criticism?*

DESY have provided an extremely supportive working environment.

Aside from the funds there has been little support from Helmholtz. I was informed, on inquiring, that the training courses run in association with the Post-doc programme were only available to German speaking participants and that this School was the only means by which to access the mentoring that was mentioned in the advertisement of the programme. I find this disappointing for a scheme that encourages international applicants.