2025 Helmholtz – OCPC – Programme

for the involvement of Chinese postdocs in bilateral collaboration projects

PART A

Title of the project:

Multi-mirror multi-pass cell spectral broadening

DESY Division & Group:

DESY-FS

Project leader/supervisor:

Dr. Marcus Seidel

Phone: +49 40 8998-6034
E-mail: marcus.seidel@desy.de

Web-address:

https://photon-science.desy.de/

Programme Coordinator (Email, telephone and telefax)

Martin Sandhop; martin.sandhop@desy.de; +49 40 8998 4172

Description of the project (max. 1 page)**:**

Nonlinear post-compression of optical ultrashort pulses is a highly efficient technique for shortening pulse durations and enhancing peak power. Herriott-type multi-pass cells (MPCs), initially invented as optical delay lines, have emerged in recent years as a spectral broadening platform that is highly robust and excellent for average power scaling [1]. Therefore, it is ideal for the needs of cutting-edge ultrafast laser technology.

MPC spectral broadening provides the unique ability to obtain more than 30-fold pulse duration shortening a single compression stage with above 90 % power efficiency [1]. Recently, picosecond pulses have been compressed to less than 10 fs duration in two consecutive stages, i.e. compression factors of more than 100 have been demonstrated [2,3]. The proposed project aims to achieve significantly higher spectral broadening factors by utilizing novel MPC geometries, which allow for longer nonlinear interaction lengths. These MPCs pave the way for compact nonlinear pulse compression schemes for high-power Joule-class lasers which will become the building blocks of future laser-based particle accelerators.

The objectives of the postdoctoral researcher are the development of an effective alignment strategy for the novel MPCs, the demonstration of efficient pulse compression, the careful characterization of spatio-temporal laser properties after spectral broadening as well as the investigation of energy scalability from the multi-mJ to sub-J energy levels. The work will be mainly experimental, but should be accompanied by simulations to interpret and predict experimental results.

[1] A.-L. Viotti, M. Seidel, E. Escoto, S. Rajhans, W.P. Leemanns, I. Hartl, and C. M. Heyl, “Multi-Pass Cells for Post-Compression of Ultrashort Laser Pulses”, Optica 9, 197 (2022).

[2] A.-L. Viotti, C. Li, G. Arisholm, L. Winkelmann, I. Hartl, C.M. Heyl, and M. Seidel, “Few-cycle

pulse generation by double-stage hybrid multi-pass multi-plate nonlinear pulse compression", Optics Letters 48, 984 (2023).
[3] S. Rajhans et al., "Post-compression of multi-millijoule picosecond pulses to few-cycles approaching the terawatt regime", Optics Letters 48, 4753 (2023).

Description of existing or sought Chinese collaboration partner institute (max. half page)**:**

I am strongly interested in strengthening the collaboration with the State Key Laboratory of Intense Field Laser Physics at the Shanghai Institute of Optics and Fine Mechanics / Chinese Academy of Sciences. I am in contact with Prof. Jianhui Bin and received an application from Wenhai Liang who has achieved already remarkable results in the field of nonlinear pulse compression. He has expressed his interest in the OCPC program.

Required qualification of the postdoc:

- PhD in optics/photonics, physics or equivalent
- Experience with ultrafast lasers, nonlinear optics
- Additional skills in optics simulation (e.g. with matlab, python), nonlinear pulse propagation are a plus
- Language requirement: fluent in written and oral English