



2023 HGF – OCPC – Programme for the involvement of postdocs in bilateral collaboration projects

Part A

Title of the project:

High-power lasers via quasi-guided nonlinear optics

Helmholtz Centre and institute:

GSI GmbH - Helmholtz-Institute Jena

Project leader:

Dr. Christoph Heyl

Contact Information of Project Supervisor: (Email, telephone)

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Web-address:

Institute: <https://www.hi-jena.de/en/>

Research profile of the PI: <https://scholar.google.de/citations?user=Rozet04AAAAJ&hl=en&oi=ao>

Department: (at the Helmholtz centre or Institute)

Helmholtz-Institute Jena

Programme Coordinator (Email, telephone)

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Description of the project (max. 1 page):

Ultrafast lasers reaching extremely high powers within short fractions of time enable a plethora of applications. Many of these applications benefit from sources with higher average and peak powers. Following mode-locked dye and titanium-doped sapphire lasers, broadband optical parametric amplifiers have emerged as high peak- and average power ultrashort pulse lasers. A much more power-efficient alternative is provided by direct post-compression of high-power diode-pumped ytterbium lasers—a route that advanced to another level with the invention of a novel spectral broadening approach, the multi-pass cell technique. The method has enabled benchmark results yielding sub-50-fs pulses at average powers exceeding 1 kW, has facilitated femtosecond post-compression at pulse energies above 100 mJ with large compression ratios, and supports picosecond to few-cycle pulses with compact setups. The striking progress of the technique in the past five years puts light sources with tens to hundreds of TW peak and multiple



kW of average power in sight—an entirely new parameter regime for ultrafast lasers [1]. Our group is pushing the frontiers of this technology and has demonstrated recent milestones including record mJ-class pulse compression of picosecond pulses into the few-cycle regime [2], record compression factors reached using all-bulk spectral broadening [3] as well as high-power lasers efficiently converted to wavelengths outside the gain bandwidth of laser amplifier media [4].

This project focusses on exploring the limits of multi-past post-compression concepts with an emphasis on new routes towards high-peak power pulse production, following and extending recent proposals by our group [5] as well as targeting largely extended spectral coverage of ultrafast lasers [4]. The planned work will be closely connected to targeted applications demanding ultrahigh peak-power, high repetition rate lasers such as plasma accelerators and laser-driven extreme ultraviolet sources. Our laboratory is outstandingly equipped with all necessary tools and instrumentation for laser and nonlinear optics research and development. You will be working under guidance of experts in the field including Dr. Christoph Heyl (Dep. group leader at DESY, Hamburg, and group leader Helmholtz-Institute Jena, Germany). The main project focus can be adjusted depending on the candidate's research interest.

Project-related recent references published by the PI:

- [1] Viotti et al., **Optica** 2022: <https://doi.org/10.1364/OPTICA.449225>
[2] P. Balla, A. Bin Wahid et al., **Optics Letters** 2021: <https://doi.org/10.1364/OL.388665>
[3] M. Seidel et al., to be published in **Ultrafast Science** 2022:
<https://doi.org/10.48550/arXiv.2111.12834>
[4] P. Balla et al., **Nature Photonics** 2023: <https://doi.org/10.1038/s41566-022-01121-9>
[5] Heyl et al., **Journal of Physics: Photonics** 2022:
<https://doi.org/10.1088/2515-7647/ac483a>

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

Not specified

Required qualification of the post-doc:

- PhD in Physics or Electrical Engineering
- Experience with lasers and nonlinear optics
- Additional skills in electronics / frequency combs are beneficial



PART B

Documents to be provided by the post-doc, necessary for an application to OCPC via a postdoc-station in China, which is affiliated to a research institution like a university:

- Detailed description of the interest in joining the project (motivation letter)
- Curriculum vitae, copies of degrees
- List of publications
- 2 letters of recommendation
- Proof of command of English language

PART C

Additional requirements to be fulfilled by the post-doc:

- Max. age of 35 years
- PhD degree not older than 5 years
- Very good command of the English language
- Strong ability to work independently and in a team