

Annual Report

Funding Programme:	IVF: Helmholtz International Labs
Project ID No.:	InterLabs-0002
Project Title:	CAS-Helmholtz International Laboratory on Free-Electron Laser Science and Technology (CHILFEL)
Principal Investigator:	Elke Plönjes/Dong Wang and Hans Weise/Zhi Liu
Report Period (=Calendar Year):	2019

1) Scientific progress / project development / milestones / publications / awards

After the initial CHILFEL kick-off meeting on January 31, 2019 in Berlin, DESY and European XFEL were approached by government authorities to review their institutional procedures in connection with this cooperation, mainly concerning dual use and export control. In compliance with this, DESY and European XFEL needed to put their collaborative activities within the CHILFEL Joint Laboratory on hold from April 2019 and undergo a thorough analysis of the parameters for this collaboration. After an in-depth work package-analysis of CHILFEL and self-assessment of institutional aspects of dual use and export control compliance was undertaken, the partners intend to continue as planned and with an additional DURC (dual use research of concern)-Board included in the governance of CHILFEL with our scientific collaboration in the Joint Laboratory in 2020.

Due to the decision in April 2019 to put CHILFEL on hold until further analysis of dual use for the research topics of the project, only a very limited number of activities took place in 2019. Some preparatory discussions were kept going and activities involving early-career researchers and engineers, which had already been agreed on in April 2019, were conducted as planned to the benefit of the young scientists.

DESY and European XFEL members of CHILFEL participated in several meetings during 2019.

- Berlin CHILFEL Kick-off Meeting and Steering Committee Meeting (Jan 30-31)
- PI-meeting (April 10)
- Steering Committee VideoCon (April 12)
- SHINE Forum (April 23-24)
- PI-meeting (May 10)
- Hongjun Gao, Deputy Secretary General of CAS, and delegation visit DESY (May 23)
- PI-meeting (June 3)
- Vice Chairman of Science and Technology Commission of Shanghai Municipality (STCSM), Zhu Qigao, and delegation visit DESY and XFEL (July 3)
- FEL Dual-use international expert meeting at DESY (Nov 4-5)
- WP5 related lab and industry visit in Shanghai (Nov 11-13)
- PI-meeting follow-up to dual-use meeting and preparation of wp-analysis (Nov 15)
- Helmholtz Office Beijing Head visits DESY (Dec 11) in connection with AK International (Dec 12-13)

WP1: Science Applications at soft and hard X-ray FELs

This work package consists of three tasks:

- *Towards Molecular Movies using Time-Resolved Coincidence Spectroscopy*
- *Coherent Diffractive Imaging: Serial Femtosecond Crystallography and Beyond*
- *Femtosecond X-ray Spectroscopy*

Due to the on-hold status of the international lab since April 2019, most of the planned actions of this work package have been postponed until the reactivation of the project. Some progress on the scientific exchange, on meetings and on the interactions with relevance to the scientific goals of WP1 can be reported, though:

- E. Plönjes, C. Bressler and other CHILFEL PIs from DESY and European XFEL participated in the visit of Hong He, Helmholtz office Beijing (Dec 11, 2019).
- Y. Jiang, ShanghaiTech University joined the program committee of the Science@FELs 2020 conference for recommendation of invited speakers. The Science@FELs 2020 is held on 14-17 September 2020 at DESY Hamburg, Germany.
- Towards the end of 2019, Y. Jiang has started a discussion with M. Meyer, European XFEL on cooperative R&D for a high-resolution eTOF (electron time of flight) detector.
- A. Mancuso, European XFEL visited ShanghaiTech University and SHINE and presented a talk entitled "Serial crystallography and more at megahertz rates: Early science from the European X-ray Free Electron Laser" (Jun 2019) – Invited by Y. Jiang.
- J. Fan and Z. Sun, ShanghaiTech University participated in the single-particle coherent diffraction imaging experiment at European XFEL SPB endstation in May 2019.
- Y. Tong, ShanghaiTech University participated in the commissioning of the nano-focusing K-B mirrors at European XFEL SPB endstation in October 2019.
- Task 1.3.: Based on the Year-1 workplan of WP1-Task3, one Chinese post-doc will be hired and work at FXE at EU.XFEL to participate in the ultrafast science project. One candidate was identified and accepted by both PIs. However, the process is at halt due to the temporary suspension of CHIFEL in 2019.

WP2: Novel x-ray detectors

X. Ju from Shanghai Tech University and member of Detector System Group at Beamlines & Endstations Division of the SHINE project joined the DESY Detector group in August 2019 as planned before April 2019 under the supervision of H. Graafsma. He started working on calibration and debugging efforts of the AGIPD systems, in order to learn more about X-ray detectors for XFELs. By now he has a reasonable understanding of the system, and is starting to produce results that help the project forward. He also was introduced to the CMOS imager PERCIVAL.

WP3: FEL Seeding Schemes and femtosecond Synchronization:

Task 3.1: FEL Seeding Scheme

- S. Ackermann (successor of B. Faatz) and G. Paraskaki have completed the research on a "Novel method for the generation of stable radiation from free-electron lasers at high repetition-rates" and submitted a paper to Physical Review X. SARI was included in the first discussions on this topic before CHILFEL was put on hold.
- At the CHILFEL kick-off meeting, first discussions on Task 3.1 and 3.2 for the future projects were conducted between the partners.

Task 3.2: Femtosecond Synchronization

The development in Task 3.2 focuses on an "Advanced Bunch Arrival Monitor". To improve the resolution of bunch arrival time measurements towards sub-femtoseconds precision, at DESY (without participation of SINAP due to the on-hold decision for CHILFEL) RF simulations have been started on a new beam signal pickup design. The new pickup design should allow for RF signals up to 80 GHz bandwidth using a vacuum integrated printed circuit board and has a smaller aperture in order to increase the RF signal strength.

WP 4: Advanced FEL instrumentation and Data Management and Analysis

Task 4.1: Cross-correlation techniques and pulse duration characterization

In 2019, research at FLASH, DESY was conducted to test a new spatio-temporal overlap tool between XUV and THz pulses, based on the so-called XUV plasma switch principle. Changes of the optical properties of silicon, induced by intense XUV pulses are probed with THz

radiation. This method offers a temporal precision within the duration of the THz pulse (picosecond range) and can be implemented for both, FEL and HHG sources. This research will form part of the PhD work of E. Zapolnova, DESY.

Task 4.2: Advanced Instrumentation for Time-Resolved Photoelectron Spectroscopy

Due to the on-hold status of the international lab since April 2019, further actions on this task have been postponed until the reactivation of the project.

Task 4.3: Data management and analysis

- Preparation for the Berlin kick-off meeting jointly between European XFEL and SHINE (Huaidong) in early January 2019.
- At SHINE, the construction of the IT infrastructures, including CPU, GPU clusters, and high-speed storage and high volume long term storage, and 40Gb high speed network were finished independent of the CHILFEL cooperation, in support of the SBP experiments. At the same time, data handling, management, and analysis, including the frameworks for the experiment control, online DAQ, DMA, as well as S2E simulations, are under development.

WP 5: Preparation and Coordination of future German-Chinese cooperation on superconducting RF-Technology

A secondment agreement between DESY and SARI was detailed and is finally ready for signature on both sides. The cooperation is the execution of education and training of three radiofrequency engineers or scientists in the field of superconducting cavity tests. The work also includes common Research and Development activities related to cavities to be fabricated using so-called Large Grain material. Although scope and objectives of the activities are within the framework of CHILFEL, the funding of the WP5 program is completely externally organized as it involves project funds from the Shanghai hard x-ray FEL.

2) Involvement of early-career researchers: status and developments

Due to the on-hold status of the international lab since April 2019, hiring of early-career researchers and further actions on project funding have been postponed until the reactivation of the project. In-kind contributions by all participating partners have continued.

WP1:

Due to the on-hold status of the international lab since April 2019, hiring of early-career researchers has been postponed until the reactivation of the project.

WP2:

Dr. Xudong Ju, Shanghai Tech is getting trained in XFEL detectors since August 2019 (as planned before April 2019) with good progress.

WP3:

Task 3.1: G. Paraskaki, DESY has been hired as a PhD student for task 3.1 before the project hold in April 2019. Therefore, her training at FLASH has continued and led to first publishable results. G. Paraskaki and S. Ackermann have participated in the FEL19 conference in Hamburg.

Task 3.2: AT DESY, hiring of a PhD candidate has been postponed until the re-start of CHILFEL in 2020.

WP4:

Task 4.1: E. Zapolnova, DESY contributes to this task, which will form part of her PhD thesis to be submitted to the University Hamburg in 2020.

Task 4.2: Task is on hold.

Task 4.3: Preparation of the program to host researchers and software engineers in 2020.

WP5:

As part of the secondment agreement two young RF engineers / scientists (Y. Liu and Ch. Luo) are hosted by DESY since end of July 2019. Both were and still are trained in all aspects of SRF cavity testing. They are integrated in the DESY SRF group MSL, and successfully join many of the daily activities.

3) Development of the institutional partnership / sustainability outlook**WP1:**

Due to the on-hold status of the international lab since April 2019, further interactions between DESY, European XFEL and Shine have been postponed until the reactivation of the project.

WP2:

X. Ju is providing an efficient and effective link between the DESY detector group and the Shanghai group responsible for detectors. Additional collaborations on related projects are actively being pursued (exchange program)

WP3:**Task 3.1:**

- G. Paraskaki and B. Faatz visited SARI, Shanghai for a first hands-on insight on the operation of the existing facility and to take part in SXFEL commissioning and experiments. Also, this visit was used for discussions on a seeding scheme and plan for FLASH, Hamburg.
- Starting 2020, B. Faatz permanently moved to China, handing over the work package at DESY to S. Ackermann. This will strengthen the collaboration once it continues.
- In Aug. 2019, during the FEL19 conference in Hamburg, discussions on seeding, self-seeding and synchronization took place between the involved parties from both sides.
- At European XFEL, Ch. Feng gave a talk on SXFEL seeding experiments.

Task 3.2: Task is on hold.

WP4:

Task 4.1: Due to the on-hold status of the international lab since April 2019, further interactions between DESY, European XFEL and SHINE have been postponed until the reactivation of the project.

Task 4.2: Task is on hold.

Task 4.3: Preparation for reactivation in 2020 of bilateral connections on data management, controls and analysis with Z. Zhu.

WP5:

- Frequent exchange between SRF experts at SHINE and DESY helps to establish cooperation regarding the production of special Large Grain cavities. DESY supports with background information (specifications, procedures) and helps with the communication between SHINE and European Industry.
- Institutional partnership was also further developed by scientific exchange during e.g. the SHINE Forum in April 2019, the FEL Conference in Hamburg (August 2019) and an extended Laboratory visit at SHINE, IHEP Beijing, Wuxi Company, in November 2019.

The partnership between the institutes in Shanghai and Hamburg has intensified on the topic of institutional self-analysis and assessment of dual-use research of concern. An in-depth review of the CHILFEL cooperation and assessment of the potential ethical and dual use risks within the FEL science and technology cooperation has led to an institutional self-assessment on guidelines on good scientific practice, user access to infrastructures and data, compliance with regulations on dual-use research of concern and ethical issues. An international expert meeting under the headline "Use of Free Electron Lasers and beyond: Scientific, technological and legal aspects of dual use in international scientific cooperation" connected the partners

even more and improved a common understanding of each other's viewpoints, institutional and legal ramifications.

4) Financial plan / additional third-party funding obtained

WP5:

After signature of the secondment agreement SARI will financially support the supervision of SHINE personnel by DESY.

In general, the project spending is clearly under budget due to the exceptional circumstance of putting many activities on hold and hence the project did not produce any cost (kick-off event in January and one PhD-position). In-kind contributions by DESY and the partners were made in minimal amount for activities in the first quarter of 2019 and then mainly personnel (early-career researchers).