ESRF High Power Laser Facility project Coupling absorption spectroscopy and laser driven shock experiments

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Is it worthwhile to couple high power ns lasers to a third generation synchrotron, when free electron lasers provides a very intense fs X-ray sources and when high power laser sources provide ideal conditions for dynamic compression? Beyond the competition, it is interesting to identify the scientific fields where each source can provide the best scientific yield. With its source stability characteristics, its well established techniques, its relatively easy and cheap beam access, a third generation synchrotron is a very good facility to perform dynamic compression studies in complement to free electron lasers and large laser facilities. In particular, two science cases have been identified at the European Synchrotron Radiation Facility (ESRF), the physics and chemistry of highly compressed condensed matter and the dynamic behavior of matter and materials under high strain rate.

Since 5 years intensive test campaigns have been conducted to evaluate the data quality and pertinence of such projects using imaging [1], [2], absorption spectroscopy [3], [4], and diffraction techniques [5]. The positive outcome of these tests have led to the realization of the High Power Laser Facility (HPLF) project. The project is structured in two phases:

Phase I (2018-2021): Couple a 100 J (upgradable to 200 J) ns-shaped laser to X-ray absorption spectroscopy on ID24 (HPLF-I).

Phase II (from 2023): Couple an upgraded version of the same laser to X-ray diffraction and X-ray imaging on an adjacent beamline (HPLF-II).

The Front End of the laser will be delivered and commissioned in 2018. It will be installed directly inside the experimental hutch of the XAS energy dispersive beamline ID24, as has been done for previous laser shock experiments. The final 100 J configuration of the laser (FE and three amplification stages) will be delivered and installed in the laser clean room in 2020 at the restart of the ESRF after the implementation of the new accelerator complex, named Extremely Brilliant Source (EBS).

In the presentation, I will discuss the possibility offered by a third generation synchrotron in the field of dynamic compression with recent examples. I will then present the status of the HPLF project, highlighting technical choices and first results. I will finish with the main advantages of the new EBS characteristics for the HPLF project.

References

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