

Operation experiences of 10 Hz PW-class laser at ELI ALPS during the first ramping up phase

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Development of petawatt lasers took a turn in the recent years towards increased robustness, more stable pulse parameters, higher repetition rates and also improved pulse duration, beyond the main goal of chasing the highest available peak powers. The HF-2PW laser of ELI ALPS [1] reflects on all these aspects by reaching its first operation phase. This represents a new milestone in the world of user-ready petawatt-class lasers [2].

The HF-2PW laser's hybrid architecture is based on an OPCPA seeded Ti:Sa amplification chain, which was specifically designed to produce high contrast 17 fs pulses at an unprecedented high average power of >300 W. This enormous thermal load requires a careful approach, hence the system is operated at the 10 J energy level with 23 fs pulse duration at 10 Hz repetition rate during the first ramping up phase. Amplified pulses are transported from the laser bay about 40 meters towards the highly shielded bunker area to be compressed very close to the surface high harmonic generation and electron acceleration beamlines. Output parameters of the seeder, amplification stages, and the compressor are continuously monitored. Long term stability of the pulse energy was found to be <1% rms, while the near field and far field spatial distributions, and the output spectrum were also kept stable for the whole day. Full energy compression was also tested at 10 Hz repetition rate, and was found to be stable for >2 hours of operation. The laser is operated 5 days a week, which we use to fine-tune the beam in order to best fit the development of the beamlines. One can expect that many challenges are needed to be tackled on a day-to-day basis with a cutting-edge system like this. In this paper, we discuss our experiences and share our approaches towards solutions.

References

1. S. Kühn, et al, J. Phys. B: At. Mol. Opt. Phys. 50 132002 (2017).
2. F. Falcoz, Proc. SPIE PC11980, Solid State Lasers XXXI: Technology and Devices, PC119800A (2022).

Short abstract

The 10 Hz repetition rate HF-2PW laser of ELI ALPS, which was designed to operate at 300 W average power, is being commissioned during the first ramping up phase. The system is currently running at the 10 J energy level and full energy compression was demonstrated for >2 hours of continuous operation with a pulse duration of 23 fs. Day-to-day operation represents an important milestone among next generation high peak and average power laser systems. During this period, fine tuning of pulse parameters, investigation of stability and reliability of the system is performed. Valuable experiences during operation are discussed in this paper.