

## Rooting out the gremlins - stable LWFA operation at the PW frontier

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In labs worldwide, 100TW laser systems dominate systematic studies on laser-driven accelerators and secondary sources. The stable LWFA performance that has been achieved on such systems is vital for meaningful parameter studies and application-driven experiments. However, a recent upgrade of our previously highly stable 100 TW ATLAS laser system at LMU with a multi-PW capable final amplifier resulted in a significant drop in LWFA repeatability and performance per peak power, despite seeming excellent laser performance in traditional laser diagnostic instruments (measuring near & far field, spectrum, duration and contrast). Similar issues seem to affect other facilities entering the Petawatt realm. After nearly 4 years, we finally restored the former stability of LWFA. We learned valuable lessons about mitigating air turbulence effects on large beams, addressing spatio-temporal couplings, optimizing focusing geometry, and adapting longer gas targets for sophisticated injection methods. We will detail these solutions to help others facing similar challenges.

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