Automated control and optimisation of high-intensity laser-solid interactions at up to 5 Hz

C. A. J. Palmer[1], M. J. V. Streeter[1], B. Loughran[1], H. Ahmed[2], S. Astbury[2], M. Balcazar[3], M. Borghesi[1], N. Bourgeois[2], C. B. Curry[4], S. J. D. Dann[2], S. Dilorio[3], N. P. Dover[5], T. Dzelzainis[2], O. Ettlinger[5], M. Gauthier[4], L. Giuffrida[6], G. D. Glenn[4], S. Glenzer[4], R. Gray[7], J. Green[2], G. Hicks[5], C. Hyland[1], V. Istokskaia[6], M. King[7], D. Margarone[1,6], O. McCusker[1], P. McKenna[7], Z. Najmudin[5], C. Parisuana[4], P. Parsons[2], C. Spindloe[2], D. R. Symes[2], A. G. R. Thomas[3], F. S. Treffert[4] and N. Xu[5].

1 *Queen's University Belfast, Belfast, Northern Ireland, U. K.*
2 *Central Laser Facility, Rutherford Appleton Laboratory, Chilton, Oxfordshire, U. K.*
3 *University of Michigan, Ann Arbor, U. S.*
4 *SLAC National Accelerator Laboratory, Stanford, U. S.*
5 *Imperial College London, London, U. K.*
6 *ELI Beamlines, Prague, Czech Republic*
7 *Strathclyde University, Glasgow, U. K.*

The exploitation of new multi-Hz, relativistically-intense laser facilities for laser-driven acceleration of MeV protons holds numerous technical challenges. In recent years, there has been a large community effort to develop refreshable targets with suitable parameters and positional accuracy, together with online diagnostics robust to EMP so that the potential of these new facilities can be fully exploited. This has led to multiple experiments in which increased data rate has enabled higher resolution 1D parameters scans and repeat measurements to support improved quantification of accelerator stability [1]. Here, we present results from a recent experiment in which automated laser-control enabled parameter scanning with ~100,000 laser-shots at up to 5 Hz. As well as 2D mapping of the parameter space, online feedback between diagnostics and control of laser parameters, including spatial and temporal shaping, allowed for optimisation of the interaction for desirable particle beam characteristics.

[1] Noaman-ul-Haq et al., PRSTAB (2017); Gauthier et al., APL (2017); Morrison et al., NJP (2018); Dover et al., HEDP (2020).