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Simulations of efficient Raman amplification into the multi-Petawatt regime R. TRINES, R. BINGHAM, P. NORREYS, STFC Rutherford Appleton Laboratory, Didcot, UK, F. FIÚZA, R.A. FONSECA, L.O. SILVA, GoLP/Instituto de Plasmas e Fusão Nuclear, IST, Lisbon, Portugal, R.A. CAIRNS, University of St Andrews, Fife, UK — The laser architectures being considered for the Extreme Light Infrastructure (ELI) facility are based upon solid state lasers which are very successful in providing petawatt peak powers to target. The breakdown threshold for optical components in these systems, however, demands meter-scale beams. For a number of years, Raman amplification, an approach mostly free of breakdown problems, has promised a breakthrough by the use of much smaller amplifying media, i.e. (millimetre diameter wide) plasmas, but to date, only 60 GW peak powers have been obtained in the laboratory, far short of the desired multi-petawatt regime. Here we show, through the first large scale multi-dimensional particle-in-cell simulations of this process, that multi-petawatt peak powers can be reached only in a narrow parameter window dictated by the growth of plasma instabilities. The control of these instabilities promises greatly reduced costs and complexity of intense lasers, allowing much greater access to higher intensity regimes for fundamental science and industrial applications. Furthermore, it is shown that this process scales to short wavelengths allowing compression of free electron laser pulses to attosecond duration.

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