Machine learning for beam profile classification in the operation of the ELI-NP high power laser

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The rapid advance in data manipulation together with the development of sophisticated and faster hardware (e.g., GPUs, TPUs, CUDA platforms, etc.) led to a new paradigm in science in which instances of artificial intelligence (AI) are put to work in order to provide solutions to real physical problems. Machine learning (ML) is one subfield of AI whose algorithms have been more utilized lately in conjunction with large data sets for finding characteristics or similarities or for predicting new peculiarities [1]. One of the research fields which can benefit substantially from the ML revolution is laser-plasma physics [2]. The interaction of high-power lasers with targets is notoriously complex due to the large number of variables and parameters, which describe the laser beam performance and the generated particles and fields [3]. One key aspect is the quality of the laser beam which is continuously monitored with optical diagnostics [4]. In particular, the laser beam profile measured at different points during the amplification stage is essential for delivering a well-shaped pulse. For a typical experiment performed daily a few thousands beam profiles are acquired with dedicated imaging diagnostics, which stem from the preparation of the laser beam and from the experimental shots. Here we present a method based on convolutional neural networks (CNNs) to sort and qualify the laser beam profiles (see Fig. 1) from the large amount of acquired data sets which can be subsequently linked to various stages of an experiment: tuning, alignment, optimization and shooting. The capability of the method and its potential to extend it to a larger diversity of variables is discussed.

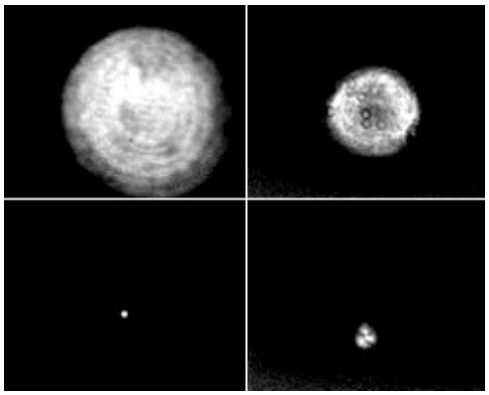

Figure 1: Near field (top) and far field profiles (bottom).

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References

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