

# GA-assisted Single-shot 3D-charge-density reconstruction of a laser wakefield kilo-ampere electron bunch via a TR-EO detector

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The realization of a compact X-ray free-electron laser for pump-probe applications is a popular topic in the research of laser wakefield acceleration. The 3D charge density is closely related with the 6D brightness that primarily determines the lasing process in the undulator. However, this parameter has not been experimentally measured in previous studies. We measured the 3D charge density of the electron bunch by simultaneously performing OTR imaging and electro-optic sampling. Detailed 3D structures were reconstructed using a genetic algorithm. The electron bunch possesses a transverse size of less than 30 micrometers. The current profile shows a multi-peak structure. The main peak has a duration of  $< 10$  fs and a peak current of approximately 1 kA. The peak electron 3D number density is  $> 9 \times 10^{21} \text{ m}^{-3}$ .

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