# Diagnosing relativistic electron beams with intense laser pulses

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**Overview**

In Laser Wakefield Acceleration (LWFA), a high intensity laser pulse is used to drive a plasma wave which supports an electric field on the order of 100 gigavolt per meter (1000s of times stronger fields than conventional accelerators). These electric fields can be used to accelerate electron beams to ultra-relativistic energies in just a few millimetres of plasma. Electron beams accelerated in this way can have extremely short bunch durations, on the order of 1 femtosecond, with an energy chirp such that the particle energy varies along the longitudinal axis of the bunch. Diagnosing the properties of these beams is extremely challenging and of great importance for many of their applications.

This project will make use of analytical theory and numerical simulations to determine the properties of LWFA accelerated beams and to explore concepts for diagnosing them in high power laser laboratories. The final goal will be to demonstrate a working concept in a particle-in-cell simulation and determine the laser requirements for making a successful measurement.

**Required Background**

Some basic programming experience in Matlab or Python would be beneficial. The main physics topics are electromagnetism, optics and relativity.

**Further Reading**

The simulations will be performed using the open-source code FBPIC (fbpic.github.io) which can run on a standard computer/laptop.

To gain more insight into laser wakefield acceleration, explore the interactive animation at <https://kaldera.desy.de/>.