

Oxford Physics Group Projects 2018 - 2019: Atomic Weapons Establishment (AWE)
GP_003

Project title	Development of a pulse correlation reflectometer
Project type	Experimental with some computation
Company	Atomic Weapons Establishment (AWE)
Mentor	James Ferguson
Local supervisor	TBC
Project description	<p>The velocity that a detonation wave travels in a given explosive is a very important parameter in describing its performance. It is not only a method for comparing between different explosives but also an important parameter for the calibration of computer models. The most often used method of measuring this is using discrete time of arrival probes, however this means that long samples are required and changing velocities cannot be measured. For this reason a method of measuring this in a continuous manner is required. One method which has shown early promise is known as pulse correlation reflectometry.</p> <p>Pulse Correlation Reflectometry (PCR) is a technique based on time domain reflectometry (TDR), a technique used to measure the length of electrical cables and identify any faults along the cable. In PCR, only the round trip time for an electrical pulse to propagate the length of the cable, be reflected at the end, and return to the start is required. PCR requires a high repetition rate of pulses whereas this is not necessary in TDR.</p>

Measuring the lengths of electrical cables to high accuracy is essential in measurement systems where very short timescale events need to be recorded such as in a detector system on a particle accelerator. Furthermore, if an accurate distance measurement can be made at high repetition, a dynamic measurement of the length of a conductor being destroyed at a rapid rate may be made. This could potentially be applied to study detonation of explosives by dynamically measuring the length of a conductor in contact with the explosive.

For this work we would like you to build a PCR system from readily available laboratory equipment (essentially a function generator, cables, connectors and an oscilloscope) and determine the accuracy by which a cable length can be measured. With a knowledge of electrical theory, you can then explain the operation of the instrument you have built and determine what improvements to the instrumentation can be made and how measurement error could be reduced.

The goal of the project would be to determine if a PCR system, based on relatively standard laboratory equipment, could be used to determine physical properties of detonating explosives, in particular the velocity of the detonation wave through the material.