Title: **Development of automated plasma accelerators with machine learning algorithms**
Supervisors: Matthew Streeter (QUB) and Dan Symes (CLF)
Duration: 4 years funding pending award
Location: Flexible between QUB and CLF - at least one year to be spent at the CLF over the PhD duration.

Plasma accelerators have the potential to revolutionise particle accelerator technology due to their extremely high accelerating fields and short pulse durations. Harnessing data-driven algorithms to optimise plasma accelerators will enable them to reach their full potential by controlling the highly non-linear plasma physics at their core. This 4-year, fully funded PhD project will aim to build experimental tools for the automatic optimisation of plasma accelerators combining hands-on experimental work with the development of robust data handling, analysis, and modelling tools using cutting-edge machine learning algorithms.

The software tools developed during this project will include control of the properties of a high-power, ultra-short laser pulse and the plasma target with which it interacts. Real-time analysis of the experimental diagnostics will be used to build machine learning models of the accelerator performance, and then to guide the optimisation of the interaction to produce particle beams ideally suited to their applications. During the project, the student will join a team of international researchers to perform these experiments at facilities including Central Laser Facility near Oxford and new ZEUS laser at Michigan University.

The developments of this project will be used to enhance the utility of plasma accelerators at the Extreme Photonics Application Centre (EPAC), a newly constructed £82M STFC facility. The generated particle beams will be used for novel scientific and industrial applications such as ultra-fast x-ray spectroscopy and radiobiology, rapid x-ray tomography and gamma-ray imaging in collaboration with applications experts.

In addition to the code development and experiments, the PhD student will also travel to international schools and conferences (to share their results with the community through poster and oral presentations) and perform computer simulations to support experimental planning and data analysis. This PhD will provide the student with broad research experience and a suite of highly transferable skills for research and industry.

Suggested references for further details on relevant topics:

[1] Shalloo *et al.* Automation and control of laser wakefield accelerators using Bayesian optimization. *Nature Communications* **11**, 6355 (2020). https://doi.org/10.1038/s41467-020-20245-6

[2] Maier *et al.* Decoding Sources of Energy Variability in a Laser-Plasma Accelerator. Phys. Rev. X **10**, 031039 (2020) https://doi.org/10.1103/PhysRevX.10.031039