Science and Technology Facilities Council

Central Laser Facility

Science and Technology Facilities Council

ASTeC

clf.stfc.ac.uk

Magnetic Capture and Delivery for the EPAC EA1 Electron Beamline

A.R. Bainbridge[1,3], N. Bourgeois[2], J. Crone[1,3], O. Findlay[2], C. Hill[4], J.K. Jones[1,3], B.D. Muratori[1,3], H.L. Owen[1,3], T.H. Pacey[1,3], B.J.A. Shepherd[1,3], N.R. Thompson[1,3], Y. Saveliev[1,3], D. Angal-Kalinin[1,3], D.R. Symes[2]

1. *ASTeC, STFC Daresbury Laboratory, Sci-Tech Daresbury, Warrington WA4 4AD, UK*
2. *Central Laser Facility, STFC Rutherford Appleton Laboratory, Harwell Campus, UK*
3. *The Cockcroft Institute, Sci-Tech Daresbury, Warrington WA4 4AD, UK*
4. *Technology Department, STFC Daresbury Laboratory, Sci-Tech Daresbury, Warrington WA4 4AD, UK*

Introduction

The Extreme Photonics Applications Centre (EPAC) is a new national facility currently under construction at the Rutherford Appleton Laboratory, UK. EPAC will enable a wide variety of user experiments with a **state-of-the-art petawatt-class laser system**.

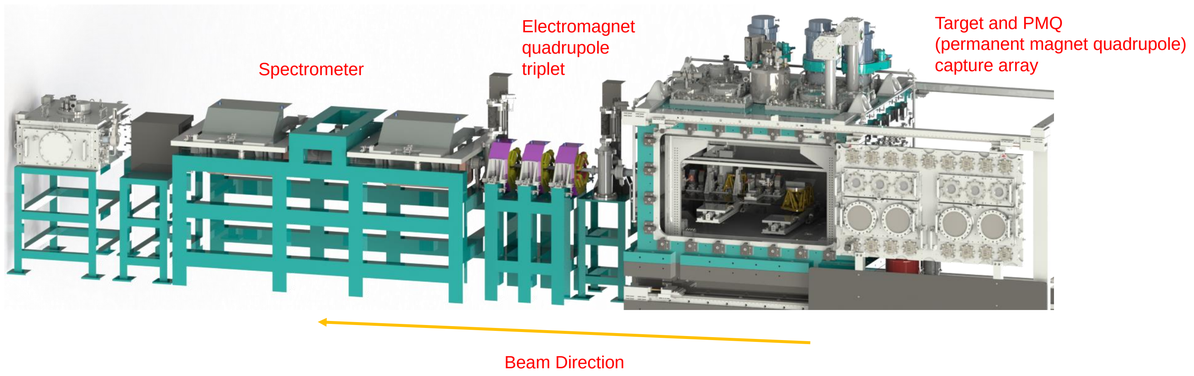
This will include laser wakefield acceleration of electrons to energies ranging from **100 MeV to 5 GeV** or higher. EPAC is designed to be flexible, allowing users to select the relevant central electron energy for their experiment.

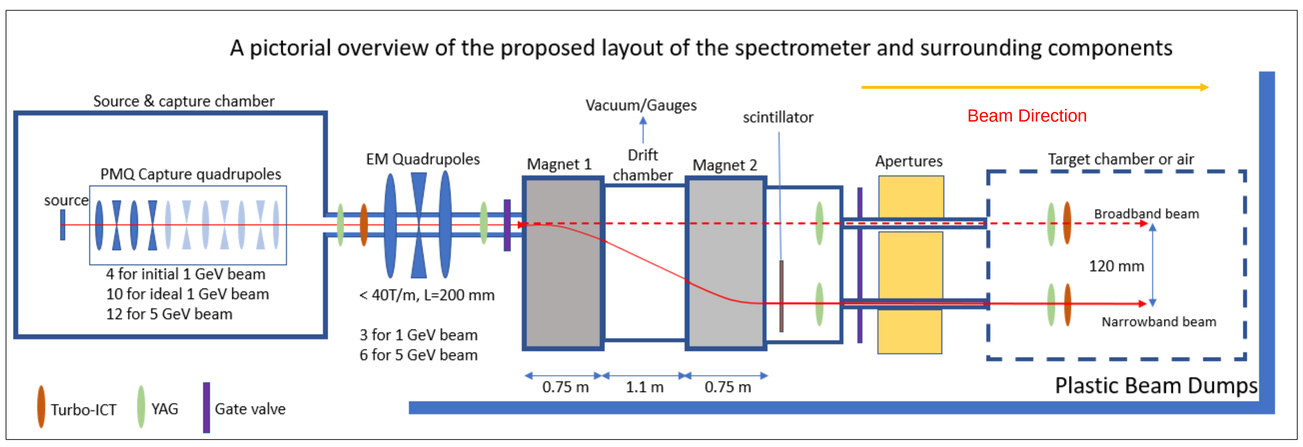
ASTeC/CLF have designed a beamline to:
1. Capture laser-plasma driven electrons with broad energy spread,
2. Measure their energy spectrum,
3. Perform selection of specific energies if necessary,
4. Deliver these electrons to a user interaction point.

Facilities based on LWFA technology are still in their early stages. We expect **high-divergence** electron bunches to be produced with **significant energy spreads** as much as 10%, accompanied by a long low-energy "tail". Energy spreads as small as 1% should be achievable after sufficient beam commissioning, in-line with other facilities.

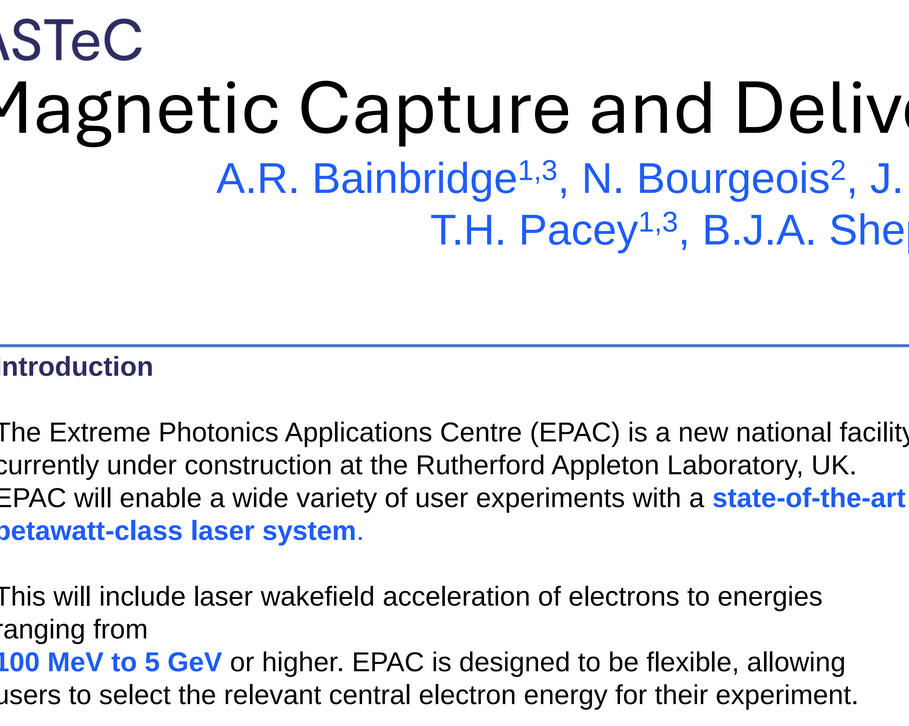
EPAC Building

EA1 beamline hall



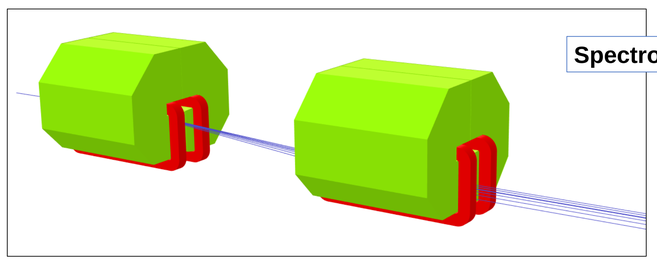


Schematic layout including spectrometry

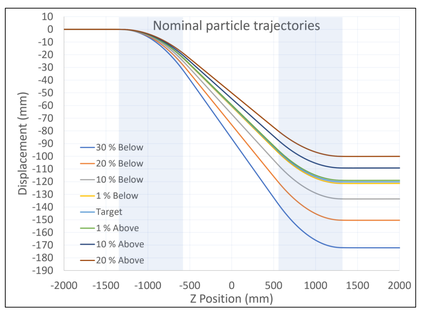


PMQ (permanent magnet quadrupole) capture array

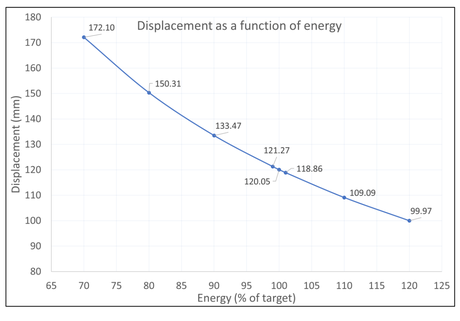
Double dipole spectrometer and energy measurement



Spectrometer tender issued

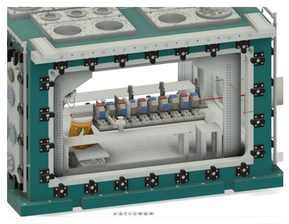


Simulated electron trajectories through the dipoles (shaded) showing the paths of energies above and below the target, assuming the field is chosen such that the target energy is displaced by 120 mm.



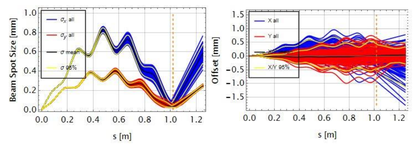
Relation between energy and displacement of electrons, assuming the correct field settings are used for the target energy.

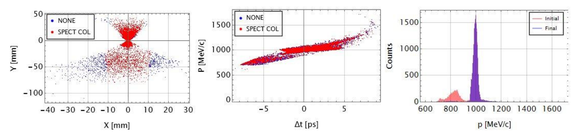
Beam capture optics and error analysis

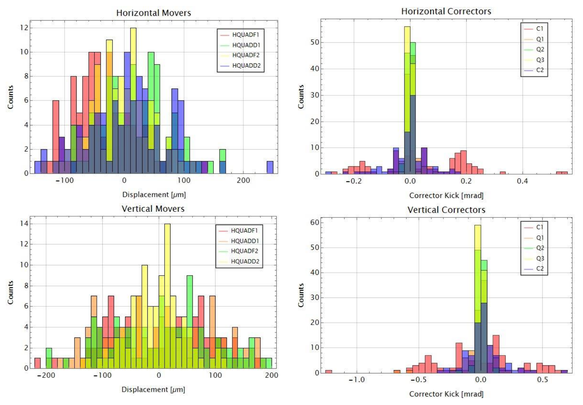


PMQ capture in target chamber

Misalignments (DX, DY, DZ = 50 μm) & quadrupole strength error (0.01) analysis of 100 trials in 1 GeV case.



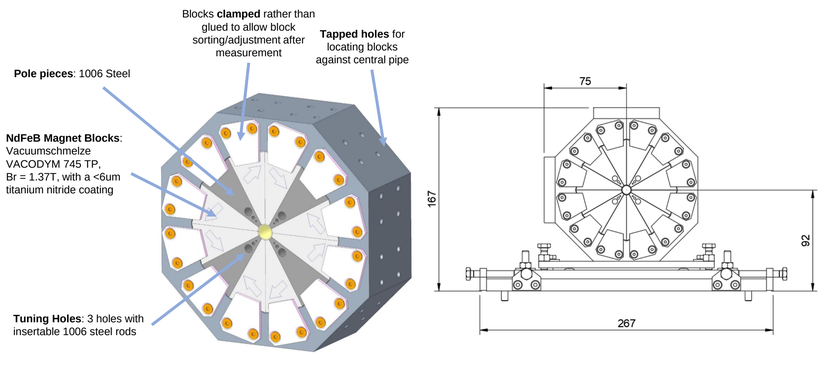




PMQ movers + dedicated steerers to correct for magnetic misalignments

Capture array + optics delivers good transmission, bandwidth and focal properties at several defined focal planes

PMQ design and manufacture



4 PMQs bought, 1 assembled so far