



Contribution ID: 1983 Contribution code: WEPM031

Type: **Poster Presentation**

High gradient hybrid halbach quadrupoles with a novel 3-Bit gradient tuning system

Wednesday, 10 May 2023 16:30 (2 hours)

This paper presents the magnetic design, mechanical design and assembly tooling design for four 500T/m Hybrid Halbach Quadrupoles with an aperture radius of 4mm. The quadrupoles will be used for capture of a 1-5 GeV electron beam produced in a plasma acceleration stage at the Extreme Photonics Application Centre which is currently under construction at Rutherford Appleton Laboratory in the United Kingdom. In order to meet the stringent requirement dictated by beam dynamics studies, that the peak gradient of the four quadrupoles should vary by less than 1% in the presence of economically achievable engineering tolerances and magnetic field uniformity of the permanent magnet blocks, the design features a novel '3-bit tuning system' in which three steel rods can be inserted in 8 different combinations into each steel magnet pole to tune the gradient in evenly spaced steps of 0.8% over a full range of 6%. This 3-bit tuning system can be used to ensure the specification on uniformity over the four quads is achieved.

Funding Agency

Footnotes

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Primary author: THOMPSON, Neil (Science and Technology Facilities Council)

Co-author: HILL, Clive (Science and Technology Facilities Council)

Presenter: THOMPSON, Neil (Science and Technology Facilities Council)

Session Classification: Wednesday Poster Session

Track Classification: MC7: Accelerator Technology and Sustainability: MC7.T09: Room Temperature Magnets