



Contribution ID: 1782 Contribution code: THPA009

Type: **Poster Presentation**

Optical pepper-pots: developing single-shot emittance diagnostics

Thursday, 11 May 2023 16:30 (2 hours)

Emittance measurements are a universal requirement when operating particle accelerators. Many techniques exist to achieve these measurements, each suiting the specific requirements of a machine. Most are multi-shot or invasive, and struggle to function with low energy beams or where space-charge effects are dominant. Generally, these limitations can be restricting, but especially so in emerging sectors such as novel acceleration or energy recovery linacs. To this end, two all-optical single-shot emittance measurements are being developed. In both cases the measurement is analogous to an optical version of the common pepper-pot diagnostic. The two methods are complementary: the first uses a micro-lens array (MLA); the second a digital micro-mirror device (DMD). Both systems can operate away from a beam waist and separate the optical beam radiation into beamlets rather than the beam itself; leaving potential for a non-invasive measurement. The benefits of using optical beam radiation are reduced beam scattering, simple designs, and suitability for low-energy/space-charge dominant beams. Presented is a series of benchmarking measurements and simulations with laser sources. Initial beam simulations, plans for first measurements, and the application to a machine learning virtual diagnostic are also discussed.

Funding Agency

This work is supported by the AWAKE-UK phase II project funded by STFC under grant ST/T001941/1 and the STFC Cockcroft Institute core grant ST/V001612/1.

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Session Classification: Thursday Poster Session

Track Classification: MC6: Beam Instrumentation, Controls, Feedback and Operational Aspects: MC6.T03: Beam Diagnostics and Instrumentation