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Development of an ion-optical achromat for high-energy proton imaging

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Lens based proton radiography is a powerful diagnostics technique capable of resolving ultra-fast processes on the ns-scale in dense matter with unprecedented micrometer spatial resolution. This unique performance is currently realized by the use of a chromatic imaging system consisting of four quadrupole magnets that are configured to suppress the most significant 2nd order position dependent chromatic aberrations of the proton distribution*. Systems of this kind are currently in operation in Germany (PRIOR-II at GSI, 4.5GeV p+) and in the US (pRad at LANL, 800 MeV p+).
As energy dependent 2nd order chromatic aberrations cannot be cancelled by any means, many experiments using dense targets suffer from a reduced depth of field caused by a large amount of energy loss straggling. This leads to a degraded image quality and also limits the physics output of those experiments.
In order to compensate for this, a prototype ion-optical achromatic imaging lens is currently being developed for low-energy 25MeV electron beams. Achromatic lenses are already in use at particle accelerator facilities in e.g. fragment separators, however, the developed system will be the very first of its kind designed solely for imaging purposes. The final 5-cell design consisting of 25 ion-optical elements has passed the design stage and is foreseen to be commissioned in 2024. It is planned to then expand this capability to the 800MeV proton beam of the LANSCE accelerator at LANL.

Funding Agency

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Footnotes

- F.E. Merrill, Flash Proton Radiography, Review of Accelerator Science and Technology Vol. 8, 2015

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Author: Dr SCHANZ, Martin (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

Co-authors: ALLISON, Jason (Los Alamos National Laboratory); FREEMAN, Matthew (Los Alamos National Laboratory); MARIAM, Fesseha (Los Alamos National Laboratory); NEUKIRCH, Levi (Los Alamos National Laboratory)

Presenter: Dr SCHANZ, Martin (GSI Helmholtzzentrum für Schwerionenforschung GmbH)

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