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Multi-GeV monoenergetic electron beams from an optical shock front accelerator [BALLROOM]

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Laser-accelerated electron beams have been the subject of intense research in the last few decades. The general direction in the field is the development towards ultralow beam emittance, necessitating controlled injection methods to ensure electron trapping in the laser-driven plasma wave. Due to its simplicity, one of the more popular injection mechanisms relies on a downward step in gas density created by a shock wave oriented perpendicularly to the wakefield propagation direction. Upon crossing this step, the plasma wave breaks and locally injects a bunch of electrons, leading to quasi-monoenergetic electron bunches due to the uniform acceleration distance for all particles. A main drawback of this scheme is the fact that this braking wave injects the electrons into a phase of the wake that is close to the zero-field crossing, leading to a significantly reduced electron energy compared to the self-injection scheme yielding broadband pulses. The consequence has been an energy limit of approx. 1 GeV for such shock-injected bunches. With a novel optical method to generate the shock, we can gain additional degrees of freedom such as a flexible density ratio before and after the shock, allowing to shift the injection point more into the high-field phase of the plasma wave. Using this approach, we have recently demonstrated 2-2.5 GeV, monoenergetic electron beams from our ATLAS laser facility. Such beams are intended to drive our experiments into Breit-Wheeler pair creation in the non-perturbative regime.

Working group

invited speaker

Primary authors: Mr KOZAN, Alperen (FSU Jena); KARSCH, Stefan (Ludwig-Maximilians-Universität München, Munich, Germany)

Co-authors: Mrs VON GRAFENSTEIN, Katinka (LMU München); Mr FOERSTER, Moritz (LMU München); Mr HABERSTROH, Florian (LMU München); Mr IRSHAD, Faran (LMU München); Dr LIN, Jinpu (LMU München); Dr SALGADO, Felipe (FSU Jena); Mr TRAVAC, Enes (LMU München); Mr WEISSE, Nils (LMU München); Dr ZIRKELBACH, Johannes (LMU München); Dr DOEPP, Andreas (LMU München); Prof. ZEPF, Matthew (FSU Jena)

Presenter: KARSCH, Stefan (Ludwig-Maximilians-Universität München, Munich, Germany)

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