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Phase space control and net energy gain in photonic chip based accelerators

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Particle accelerators have a wide variety of applications in science, industry and medicine. Shrinking these devices to chip-based solutions would, as well as reducing costs, allow new tools such as a miniature endoscopic electron irradiation device. The individual components needed to create particle accelerators on a chip had all been established, but a beam confinement system that could handle nano- and micrometer-sized objects was still necessary. Due to transverse forces acting on the electrons traversing the structure, significant particle losses and dephasing limits the current throughput. We used the alternating phase focusing (APF) [1,2] adopted from accelerator physics to directly control the transverse phase space of the electron beam and confine the beam in a submicrometer wide channel. In this talk we will show the results of a low-loss electron transport over a 77.7 micrometer long nanostructure and the current state of the experiment to build a particle accelerator with significant energy gain on a mm sized chip.

[1] Niedermayer, U., Egenolf, T., Boine-Frankenheim, O., Hommelhoff, P., Phys. Rev. Lett. 121, 214801 (2018).

[2] Shiloh, R., Illmer, J., Chlouba, T., Yousefi, P., Schönenberger, N., Niedermayer, U., Mittelbach, A., Hommelhoff, P., Nature 597, 498–502 (2021).

Primary author: Ms KRAUS, Stefanie (Chair of laserphysics (FAU))

Co-authors: SHILOH, Roy (FAU Erlangen-Nürnberg); CHLOUBA, Tomas (Friedrich-Alexander University); ILLMER, Johannes (Chair for Laserphysics, FAU); BRUECKNER, Leon (Friedrich-Alexander University); Mr LITZEL, Julian (Friedrich-Alexander University); HOMMELHOFF, Peter (University of Erlangen and Max Planck Institute of Quantum Optics)

Presenter: Ms KRAUS, Stefanie (Chair of laserphysics (FAU))

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