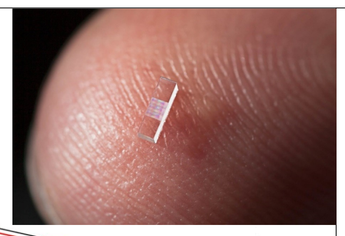
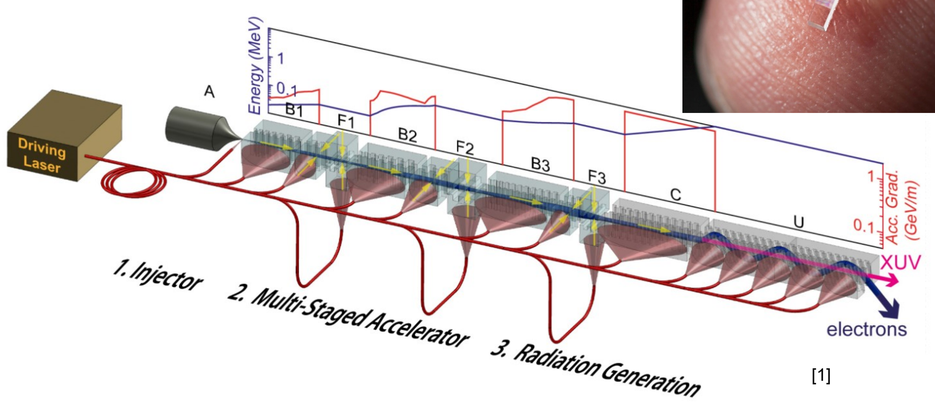
WG3 - 180
Parameter Studies on dielectric Gratings as Electron Accelerators.

W. Kuropka[1], R. W. Aßmann, U. Dorda, F. Mayet[1] (DESY, Hamburg, Germany)
[1]also University of Hamburg, Germany

Introduction

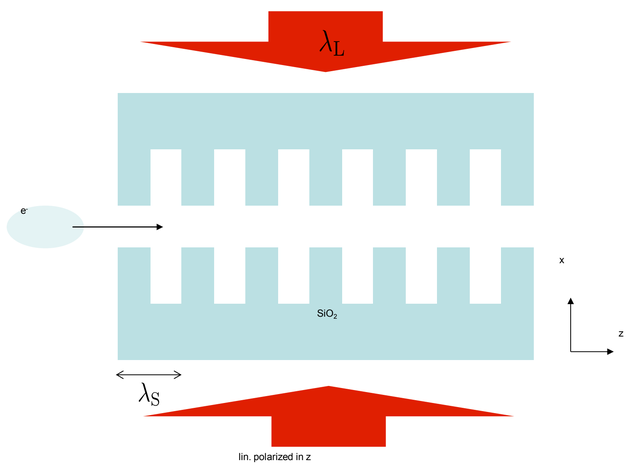


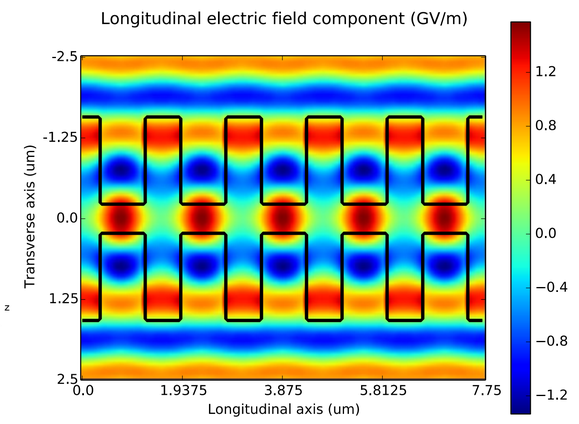


[1]

The Accelerator on a CHip International Program (ACHIP) is a research project funded by the Gordon and Betty Moore Foundation. It aims at the construction of a compact fully laser driven electron accelerator for radiation generation. Several Universities in Europe and the USA and the national Laboratories PSI, DESY and SLAC are involved. DESY Hamburg contributes with access to it's SINBAD accelerator research facility and support from the ARD and Laser groups.
We present a simulation based parameter study on grating-type DLAs w.r.t. the robustness of the structures against manufacturing uncertainties using the CST frequency solver [2].

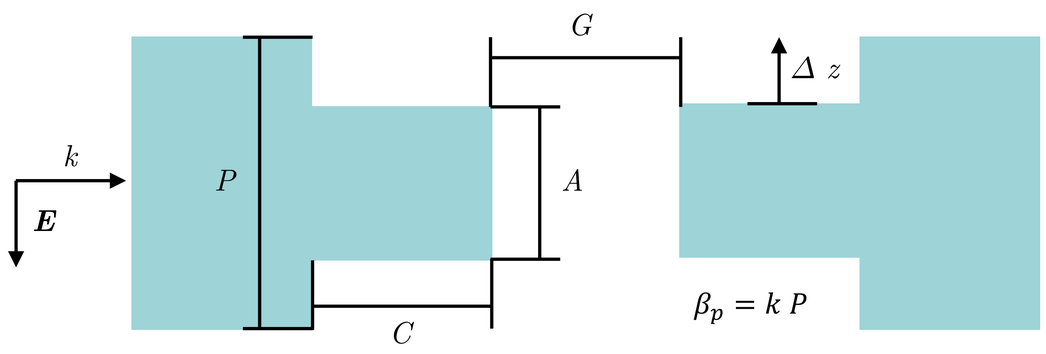
Grating-based laser driven acceleration structures



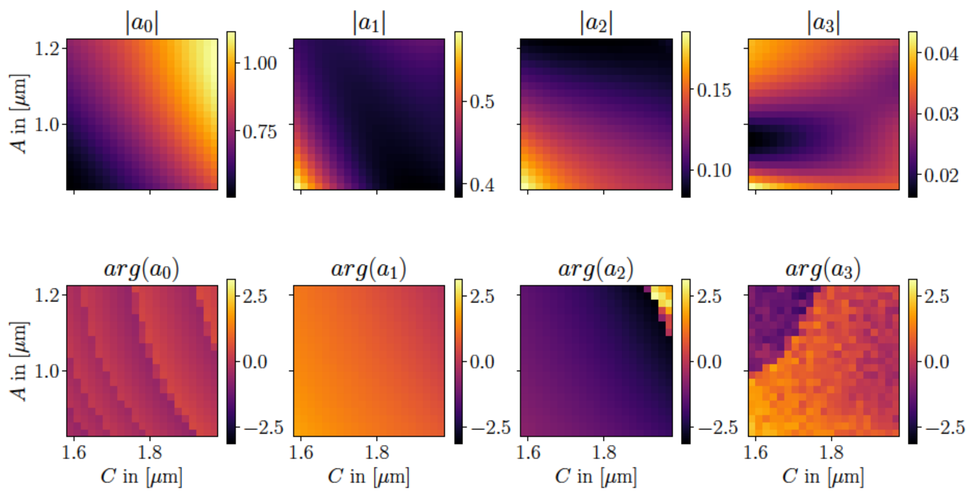


Dielectric materials recently gained more attention in accelerator research due to their high damage thresholds at optical frequencies. Lasers with high intensities can be used to realize high accelerating gradients, thus rendering the accelerator more compact.
The periodic diffraction fields in the gap along the z-axis can be described via spatial harmonics [3]. If the grating period matches the incoming wavelength, the first spatial harmonic has a speed of light phase velocity. The acceleration is transversely uniform over the gap, if it is small enough. This type of grating was also used in [4]

Single-Cell Simulation with CST Frequency Solver

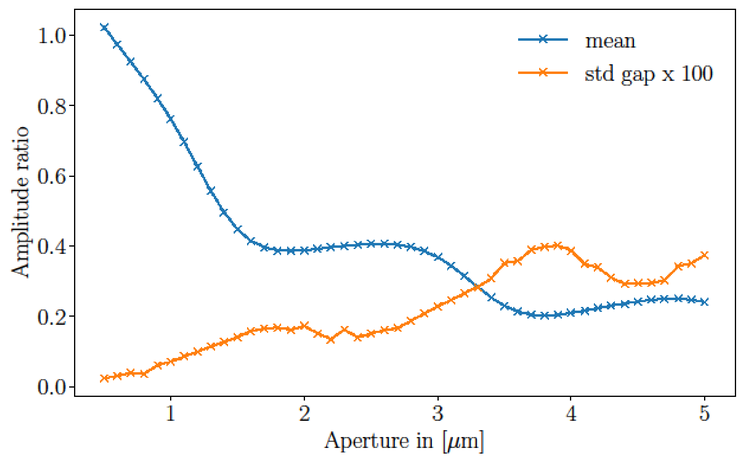


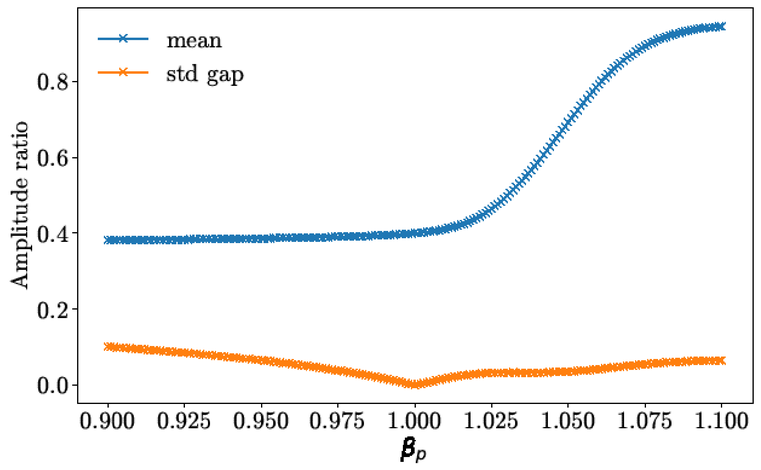
- Fused silica design for 2050nm/200fs/0.7mJ Ho:YLF laser amplifier as driver [5,6]
- Single period simulation
- Single-sided illumination
- Magnitudes of the spatial harmonics were calculated from the fields over the gap
- Design has been chosen for minimal dependence of the coupling into the first spatial harmonic on geometric parameters
- Manufacturing uncertainties of ± 10nm
- With pulse front tilt [7]: **1.19 GV/m peak gradient**, **1 MeV energy gain in 1mm structure** expected

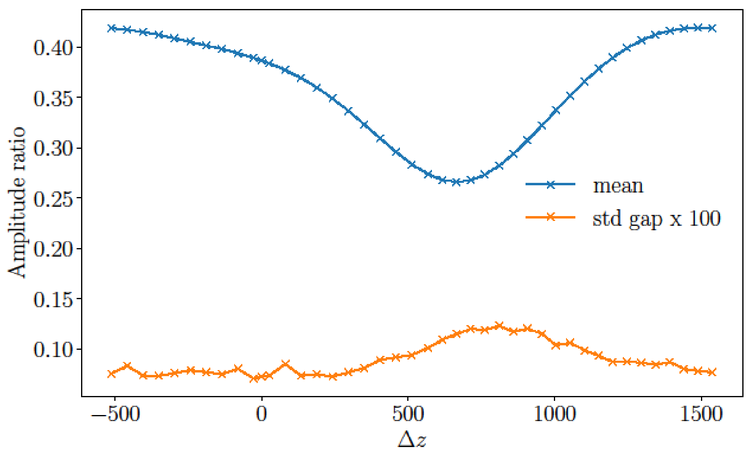


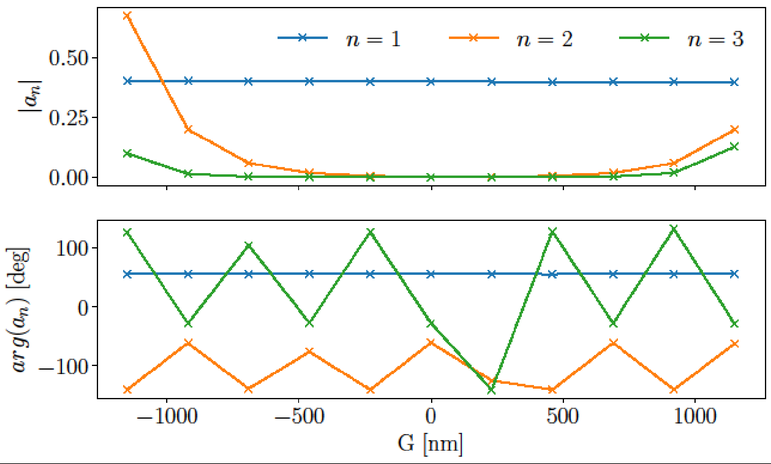
Final parameters

Parameter	Value
P	2050 nm
A	1025 nm
C	1780 nm
G	2300 nm









Conclusion

The devised design does not strongly change its coupling into the accelerating harmonic depending on the geometric parameters. Samples using the design above were already produced by Stanford Universities Solgaard group and are ready for experimental investigations w.r.t. to damage threshold and electron accceleration at the ARES linac within the SINBAD facility.

References

[1] ACHIP - https://achip.stanford.edu/
[2] CST - Computer Simulation Technology, www.cst.com
[3] L. Pilozzi et al., Phys. Rev. B 54, 10751 (1996)
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[7] D. Cesar et al., Opt. Express **26**, 29216-29224 (2018)

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