Optimized Electron Beam Distributions from a Photoemission Source

Tianzhe Xu (Northern Illinois University)

5/9/2018

BLAST Workshop 2018

Linearly-ramped current profile for dielectric wakefield accelerator

$$\mathcal{R} \equiv |\frac{E_+}{E_-}|$$

maximum accelerating field behind the drive bunch

maximum decelerating field within the drive bunch

- Enhanced energy gain with high transformer ratio ${\cal R}$
- Limited transformer ratio for symmetric bunch (beam loading effect)



The voltage induced by three different asymmetric current distributions. bunch head at t=0

Photocathode laser shaping



A proposed configuration for pulse-shaping



(a) shaping of a laser pulse (b) longitudinal phase space of the bunch (c) excited wakefield in a dielectric accelerator (bunch head at z= 0)

- Bunch distribution distorted for high charge densities
- Additional optimization required after photoemission

Injector

- Adapted from LCLS-II injector design
- Cavity fields (~20 MV/m)



Injector configuration used to test the bunch shaping and the evolution of longitudinal distribution along the beamline (bunch head on the right)

Merit function for bunch shape



Optimization with DEAP

- Penalty for particle loss or negative skewness
- Parameters: ϕ_{gun} , $\phi_{buncher}$, ϕ_{linac} , and position of the linac
- Pareto front hall of fame



• NSGA-II for multi-objective optimization (skewness, linearity, emittance)





Optimized longitudinal distributions



More on DEAP and IMPACT-T

- Parallelization through SCOOP **from** scoop **import** futures futures.map(runIMPACT, population)
- Multi-objective optimization (NSGA-II, SPEA2, MO-CMA-ES)
- Hall of fame of best individuals ever lived

Optimization for beamline design

