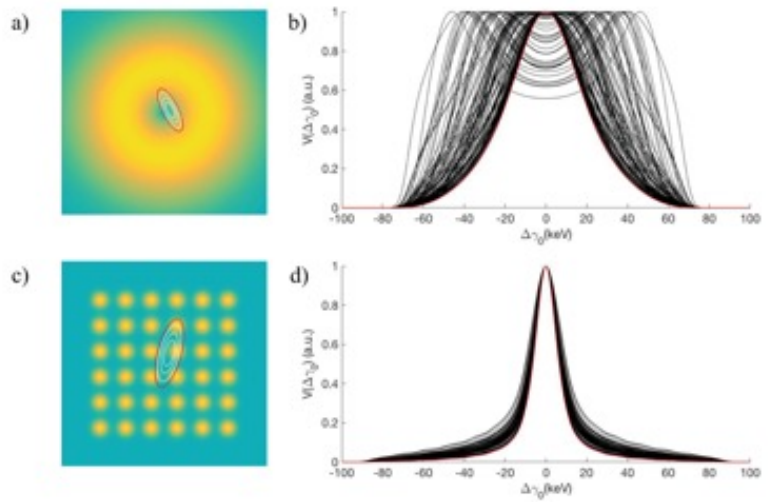
Advanced Laser Heater Shaping for Microbunching Instability Suppression in Free Electron Lasers

Sergio Carbajo*, Zhirong Huang, Nikolas Liebster, Wei Liu, Daniel Ratner, Jingyi Tang, and Sharon Vetter

SLAC National Accelerator Laboratory, USA

**scarbajo@stanford.edu*

We present two laser heater shaping solutions based on Laguerre-Gaussian and discrete beamlet array distributions that significantly outperform current microbunching instability suppression approaches in free-electron lasers. The microbunching instability (MBI) is known to degrade emission performance in free-electron lasers (FEL). This instability can be suppressed by increasing the uncorrelated energy spread of the electron bunch with either a superconducting wiggler or a laser heater (LH)[1]. Recent theoretical studies have investigated Laguerre-Gaussian (LG) and other unconventional transverse beam distributions that may provide better suppression of microbunching[2]. For instance, the LG01 mode has been proven to provide a mathematically ideal solution to suppressing MBI. We examine the effect transverse jitter and beam ellipticity on energy distributions induced by the current LH to resemble realistic beam operations at FELs based on routine LCLS operations as our case study. The qualitative results are transferable to other x-ray FELs. Under these practical considerations, we propose alternative LH designs that outperform state-of-the-art LH architectures based on LG01 beams and an array of small Gaussian beamlets, henceforth referred to as Beamlet Array (BA).



a) LG01 laser and **b)** corresponding electron bunch energy redistribution overlays, and **c)** BA laser and **d)** corresponding electron bunch energy redistribution overlays for a 3:1 ellipticity electron bunch (in contour lines) with random transverse offset jitter.

References

[1] Huang et al., PRSTAB vol. 7, no. 7,p. 74401, Jul. 2004.

[2] Li et al., Proceedings, 37th International FEL 2015, Daejeon, Korea, August 23-28, 2015.