

# FEL PRIZE LECTURE: THE LIMITS OF BEAM BRIGHTNESS FROM PHOTOCATHODE RF GUNS

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## *Abstract*

Electron source and gun technology by its nature is a multi-disciplined endeavor requiring knowledge of beam dynamics with RF fields, static fields and space charge forces as well as the chemistry and surface science related to electron emission and ultra-high vacuum. The need for a broad range of disciplines results because the electrons undergo a sequence of processes involving emission, acceleration and optical matching. This talk describes the physical process of each step with the goal of estimating its lowest possible contribution to the total emittance. The physics of electron emission, space charge forces, and the electron optics of the RF and magnetic fields will be developed and the emittance growth assessed for the gun and low energy portion of the injector. The thermal emittance and other properties of metal and semi-conductor cathodes are briefly reviewed, and the affect these properties have upon the limiting emittance and the gun design will be summarized. And finally, the space charge emittance compensation technique and the Ferrario matching criteria for the booster linac are discussed and critiqued for their emittance limits.

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