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# A wavefront propagation study of the effect of apertures in laser transports on the beam profile achieved with relay imaging illuminated circular masks

Relay imaging an illuminated circular mask is a common way of projecting a laser beam onto the photocathode in an RF photo-injector whilst generating a round laser beam spot with a sharp-edged profile. The mask is illuminated with the laser beam and an optical system images the mask onto the cathode. Geometrical optics predicts the beam on the cathode will be an exact replica of the intensity profile at the aperture. However, in physical optics, generating a sharp-edged profile requires an infinite Fourier series of spatial harmonics. The Gibb's phenomenon shows that truncating the Fourier series at any point, for example with the finite aperture of the transport system, results in a peak at the edge and ripples over the beam profile.

This work explores this effect using a wavefront propagation code. We show that the finite aperture of the transport can have a marked effect on the final image even when an aperture truncates the beam at very low intensity. Small beams at the cathode require correspondingly larger apertures in the transport. This has significant implications when a small beam size is required at the cathode because the apertures in RF photo-injector guns can be very restrictive and asymmetric with respect to the laser beam centre. Furthermore, when a 'virtual cathode' is used to monitor the laser beam profile, the beam profile at the actual cathode may be significantly different to that at the virtual cathode unless the path to the virtual cathode has identical apertures.

## Journal of Synchrotron Radiation Special Issue: will you submit your contribution?

yes

**Primary authors:** Mr ROPER, Mark (STFC Daresbury Laboratory); Ms MORROW, Katie (STFC Daresbury Laboratory)

**Presenter:** Mr ROPER, Mark (STFC Daresbury Laboratory)

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