

Source Model Report

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1 Coherent Source Model

We define the upper limit of the FWHM of the intensity profile of the beam, I_{FWHM} , and the FWHM divergence of the beam, $d\theta_{FWHM}$:

Table 1: Modelled beam properties for 9.2 keV source generated by 100 pC beam charge.

Electron Beam Charge (pC)	100
Radiation Energy (keV)	9.2
Pulse Energy (mJ)	0.2
Pulse Duration (fs)	102
Pulse Width (μm)	40.14
Pulse Divergence (μrad)	5.27

where

$$I_{FWHM}^{upper} = 6 \ln \left(\frac{7.4 \times 10^3}{E[\text{keV}]} \right), \quad (1)$$

and

$$d\theta_{FWHM}^{upper} = \frac{17.2 - 6.4 \sqrt{q[\text{nC}]}}{E^{0.85}[\text{keV}]} \quad (2)$$

Plots of the profile of the beam in the real and reciprocal space are given in Figures 1 and 2 respectively.

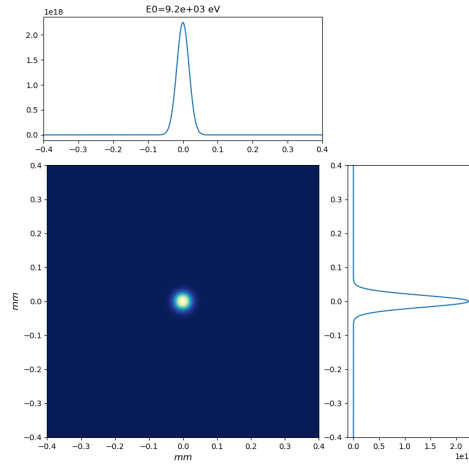


Figure 1: R-space beam intensity profile of 9.2 keV source radiation at $z = 0$, generated from a 0.1 nC beam current.

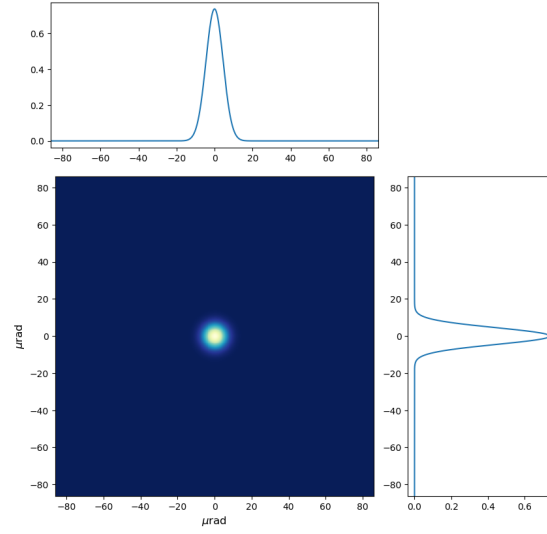


Figure 2: K-space beam profile of 9.2 keV source radiation at $z = 0$, generated from a 0.1 nC beam current.

Following Equation 1, the energy dependent beam width is presented in Figure 3 and demonstrates good convergence to the analytical model with increasing pixel density.

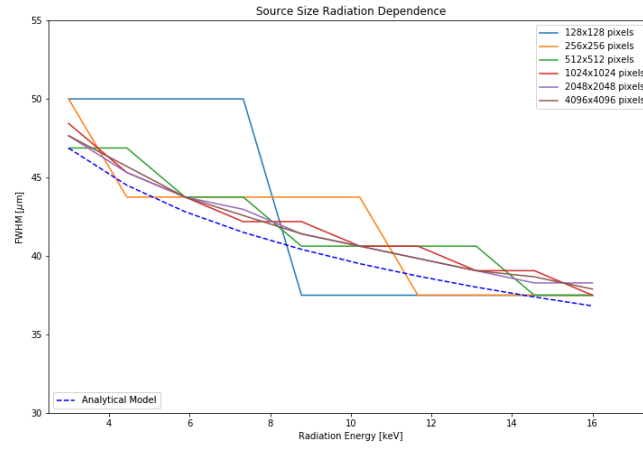


Figure 3: Comparison of simulated horizontal source width with analytical model (dashed) given in 1 for increasing pixel densities.

Figure 4 demonstrates only minor improvement in the convergence to the analytical result for pixel densities beyond 1024x1024. To reduce the computational load moving forward, the wavefield in the undulator exit-plane will be modelled on a 1024x1024 grid.

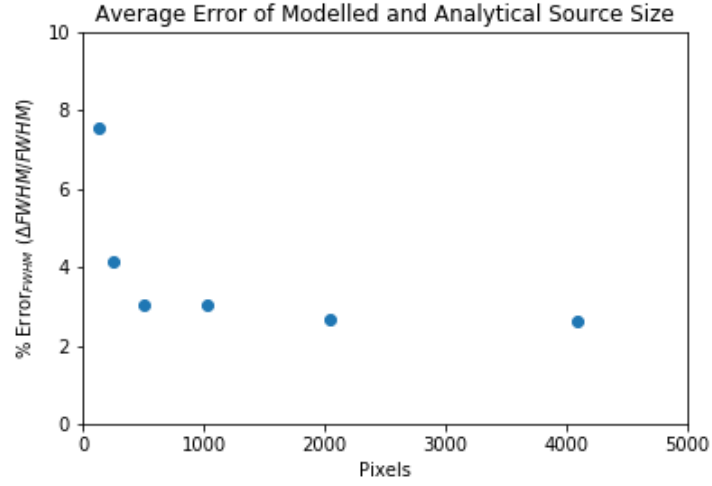


Figure 4: %Error of the measured and analytical beam profile FWHM with increasing pixel density

Finally, a comparison of the measured and analytical source divergences is presented in Figure 5, showing good agreement under varying beam conditions for a wavefront size of 1024x1024 pixels.

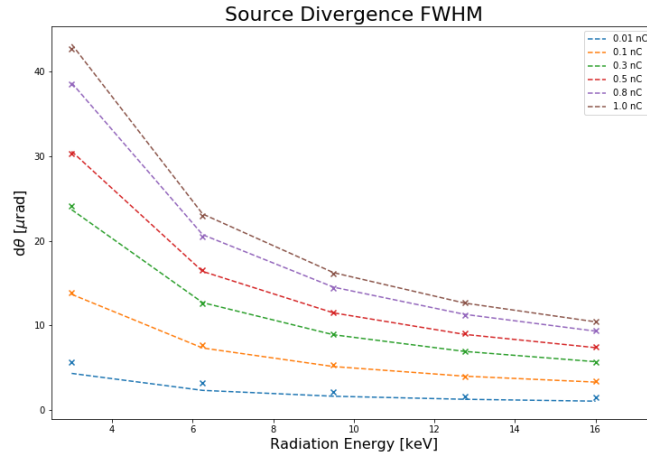


Figure 5: Measured (crosses) and Analytical source divergence for beam currents between 100 pC and 1 nC