

Design and Engineering of Modern Beam Diagnostics

Longitudinal Profilers Homework

1A: At the FAST electron linac at electron beamline, there is a streak camera observing a transition radiation screen. The streak camera has been calibrated to be 0.5 ps / pixel. An image is taken without the sweep on to measure the resolution contribution of the finite opening size of the input slit. The rms is 7 pixels. What is the rms of the slit in picoseconds?

1B: An image is taken with the sweep on. The rms of the image is 12 pixels. What is the approximate rms bunch length after correcting for the slit width?

1C: The imaging system between the transition radiation screen and the streak camera contains a vacuum window and lenses. The path length through the material totals 5 cm. The speed of light through the optics depends on the index of refraction, n , of the material. In turn, the index of refraction depends on the wavelength of the light. Let us assume that the lenses are made of quartz (also called SiO₂). The index of refraction of quartz at various wavelengths can be found at

<https://refractiveindex.info/?shelf=main&book=SiO2&page=Malitson>

If the streak camera is sensitive to light from 400 nm to 700 nm, what is the difference in travel time through the lenses for light at those two wavelengths? This time difference (or more accurately, half the time difference to approximate rms) is another resolution term that should be subtracted in quadrature from the measurement.