

# EFFECT OF INCOHERENT DEPTH OF FIELD FOR BEAM HALO MEASUREMENT WITH THE CORONAGRAPH IN SuperKEKB

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## Abstract

In the case of beam profile measurement by imaging system, observed apparent beam profile will change by the incoherent depth of field (IDF). This apparent change of beam profile, especially extra beam tail in one side has certain influence for beam halo measurement using the coronagraph, because it has a large dynamic range of 6-digit contrast. Since the magnitude of asymmetric tail is depending to bending radius, this effect is larger in large high energy physics machine which has a long bending radius. This effect is studied with geometrical optics and coronagraph measurement of beam halo in the SuperKEKB. As a conclusion, the IDF effect has significant effect in the beam halo observation with coronagraph at SuperKEKB.

## EFFECT OF INCOHERENT DEPTH OF FIELD FOR APPARENT DEFORMATION OF BEAM PROFILE

$$\sigma_a(x) = \int I(\theta) \cdot \frac{\exp\left[-\frac{[\xi - \rho\{1 - \cos(\theta)\}]^2}{2\sigma^2}\right]}{\sigma \cdot \sqrt{2\pi}} d\theta$$

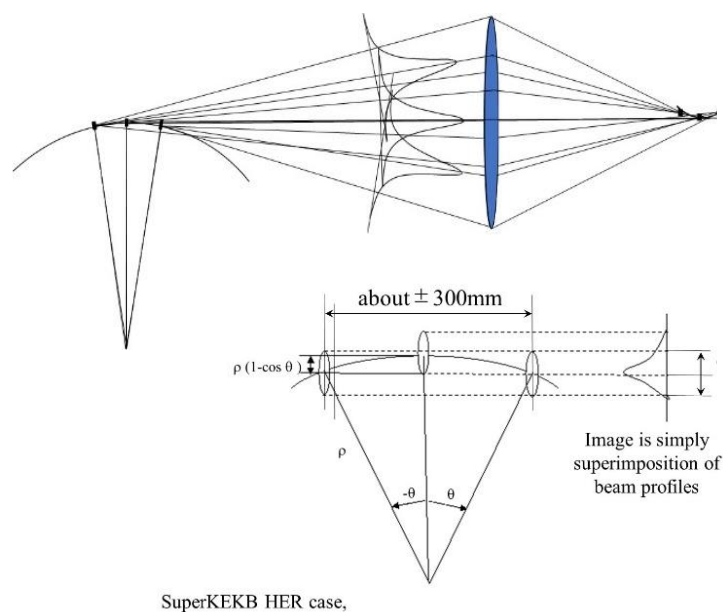


Figure 1: Apparent beam profile with the IDF effect by the instantaneous opening of the SR in the horizontal plane in the SuperKEKB HER case.

$$I(\theta) = \int \frac{e^2}{3\pi^2 c} \left(\frac{\omega\rho}{c}\right)^2 \left(\frac{1}{\gamma^2} + (\psi + \theta)^2\right)^2 \left[ K_{\frac{2}{3}}^2(\zeta) + \frac{\psi^2}{\frac{1}{\gamma^2} + \psi^2} K_{\frac{1}{3}}^2(\zeta) \right] d\psi$$

$$\zeta = \frac{\rho}{3c} \left(\frac{1}{\gamma^2} + \psi^2\right)$$

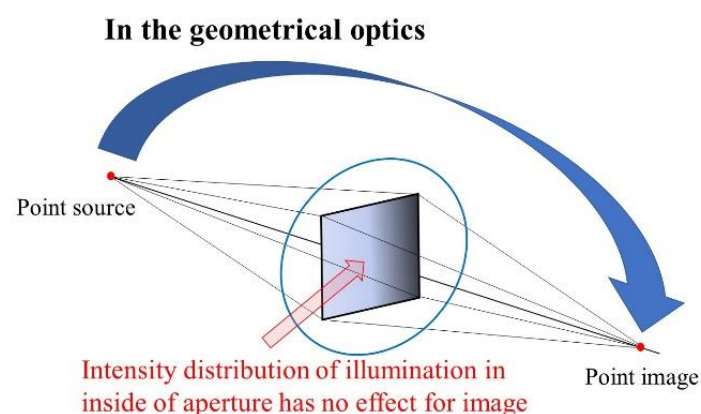


Figure 2: Point to point transfer of source point into imaging point in the geometrical optics.

Table 1. parameter of bending source

	HER	LER
Beanding radius	580.0m	177.4m
Beam Energy	7 GeV	4GeV
Horizontal beam size	226mm	177mm

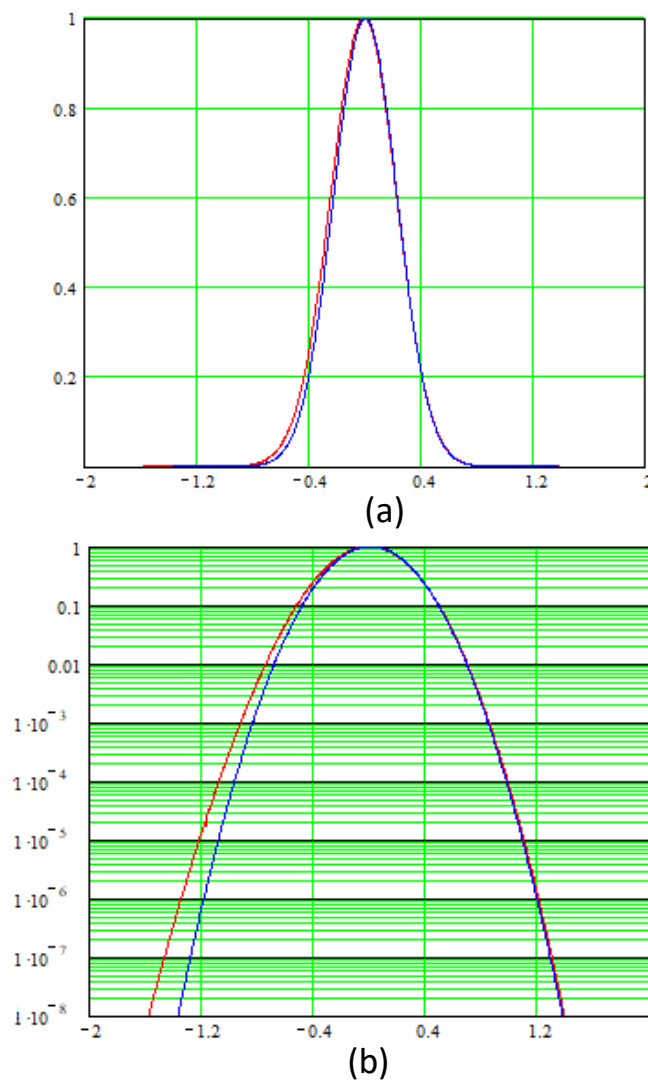


Figure 3: Simulation result of horizontal beam profile image for HER. (a) leaner scale, (b) log scale. Red line: beam profile image with IDF, blue line without IDF.

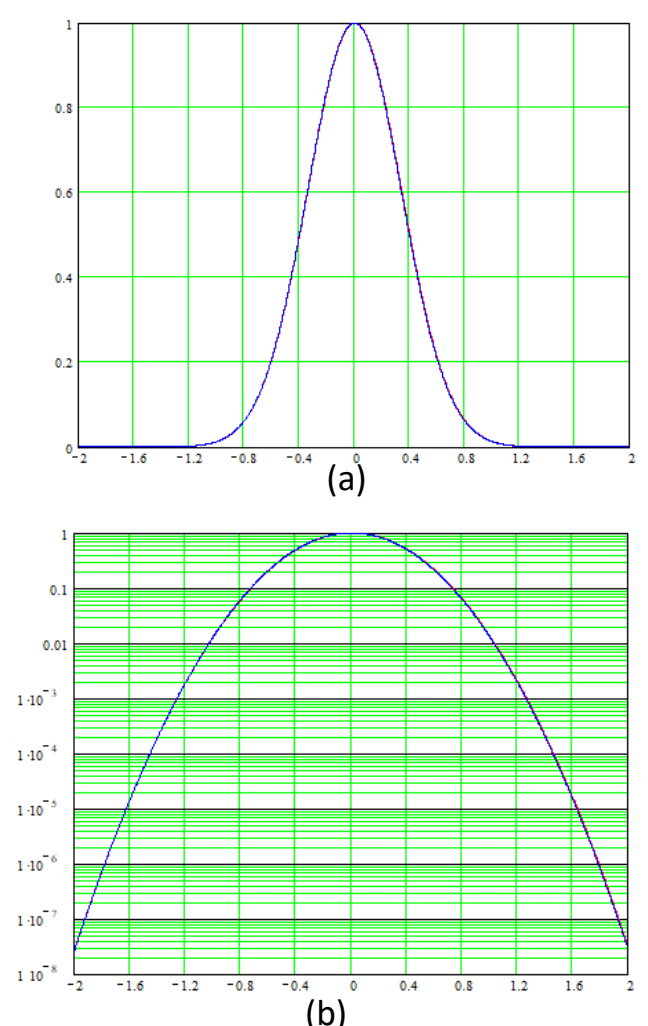


Figure 4: Simulation result of beam profile image for LER. (a): leaner scale, (b): log scale. Red line: beam profile image with IDF, blue line without IDF, but both curvatures are almost same and overlapped in each other.

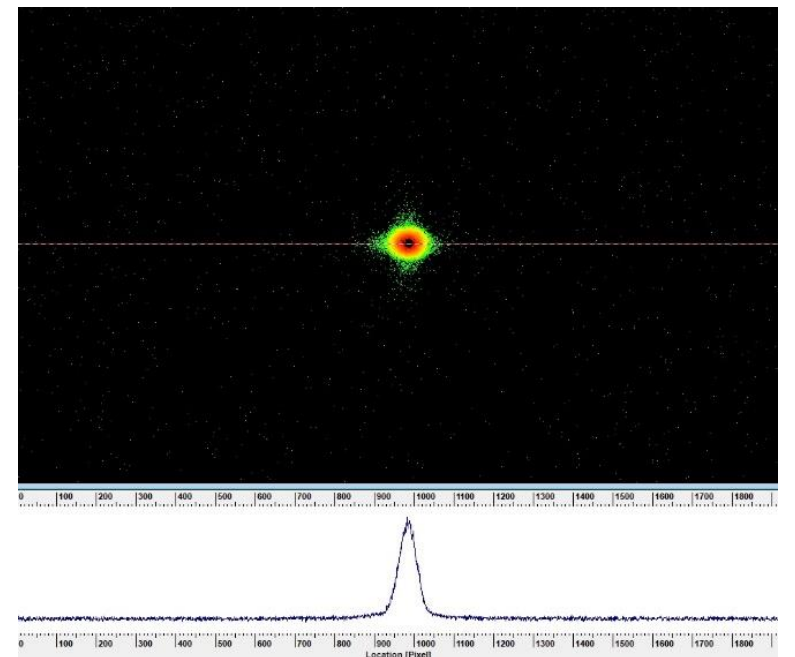


Figure 5: Result of observed beam core profile in HER. Upper: beam core image, lower horizontal profile of the image.

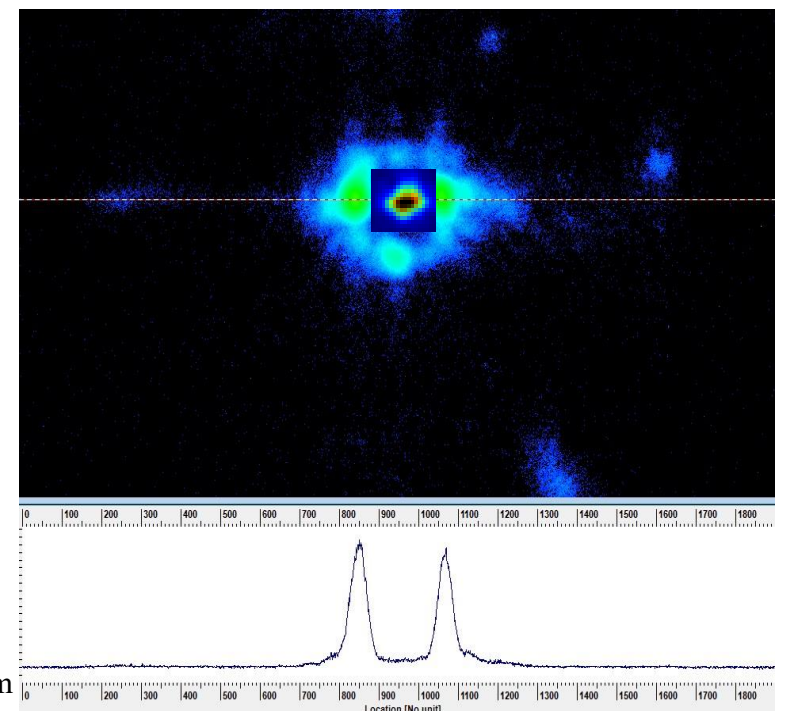


Figure 6: Result of beam halo observation with the coronagraph in 6-digit contrast in HER. Upper: beam halo image, lower: horizontal profile of the halo image.

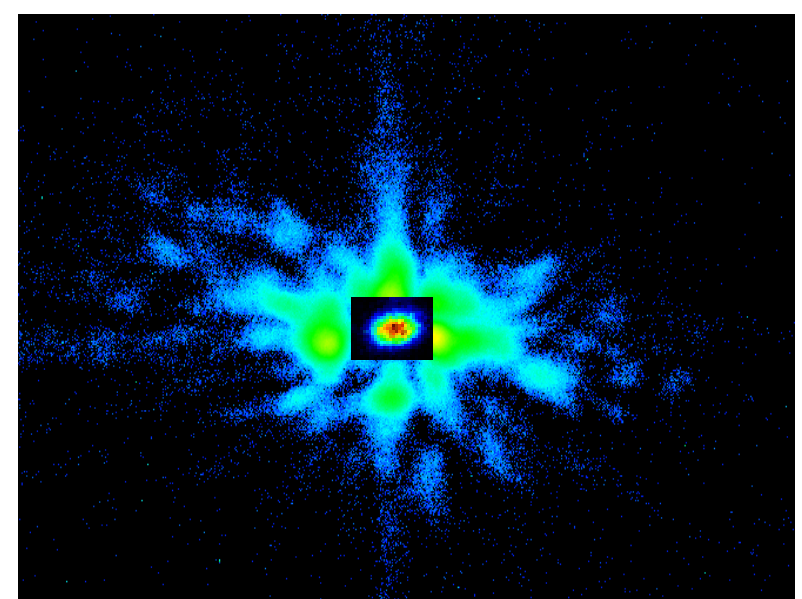


Figure 7: Result of beam halo observation with the coronagraph in 6-digit contrast in LER.

## CONCLUSION

The effect of IDF for beam core image and beam halo image by using the coronagraph are studied with geometrical optics and experimentally observed for both of HER and LER in the SuperKEKB. From the observation result, we observed no significant effect of IDF in horizontal halo profile of both of HER and LER. We can conclude IDF effect is enough smaller in the halo observation with the coronagraph in SuperKEKB.