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ISR PERFORMANCE REPORT

Luminosity with beams of different heights

If one has different working lines in the two rings, generally the horizontal aperture will not be the same. This implies that the beams can have different heights if beam shaving is applied. The question arises how much do we gain in luminosity for given currents by making one beam smaller than the other.

To get some idea about the expected decrease of the effective height, five different distribution functions in vertical direction have been considered. The real distribution in the beam seems to lie between the $\cos^2$-distribution and the gaussian as comparison with the profiles obtained by E. Jones from the BP-monitor shows.

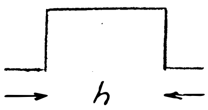
The results in terms of the effective height h defined by

$$h^{-1} = \int_{-h_2/2}^{+h_2/2} \rho_1(z)\ \rho_2(z)dz \qquad h_2 \leqslant h_1$$

$$\int_{-h_1/2}^{+h_1/2} \rho_1(z)dz = \int_{-h_2/2}^{+h_2/2} \rho_2(z)dz = 1$$

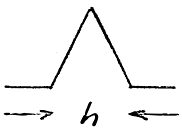
are shown below as function of the total heights h_i of the single beam. The term preceding the bracket is the effective height for equal beams given also in ref. 1, the term in the brackets gives the factor which can be gained by making h_2 smaller than h_1. This factor is plotted in Fig. 1. Although it is apparently rather modest for h_2/h_1 near 1, one should not disregard it completely in our struggle for percents in luminosity.

1. Rectangular distribution



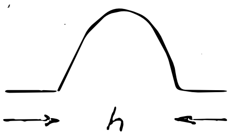
$$h^{-1} = \frac{1}{h_1}$$

2. Triangular distribution



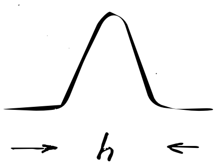
$$h^{-1} = \frac{4}{3h_1}(1{,}5 - 0{,}5\ h_2/h_1)$$

3. Parabolic distribution



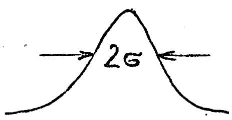
$$h^{-1} = \frac{6}{5h_1}\left[1{,}25 - 0{,}25\left(\frac{h_2}{h_1}\right)^2\right]$$

4. Cos^2-distribution



$$h^{-1} = \frac{3}{2h_1}\left(\frac{2h_2}{3h_1\pi}\ \frac{\sin \pi \frac{h_2}{h_1}}{1 - \left(\frac{h_2}{h_1}\right)^2} + \frac{2h_1}{3h_2\pi}\ \sin \pi \frac{h_2}{h_1} + \frac{2}{3}\right)$$

5. Gaussian (not truncated)

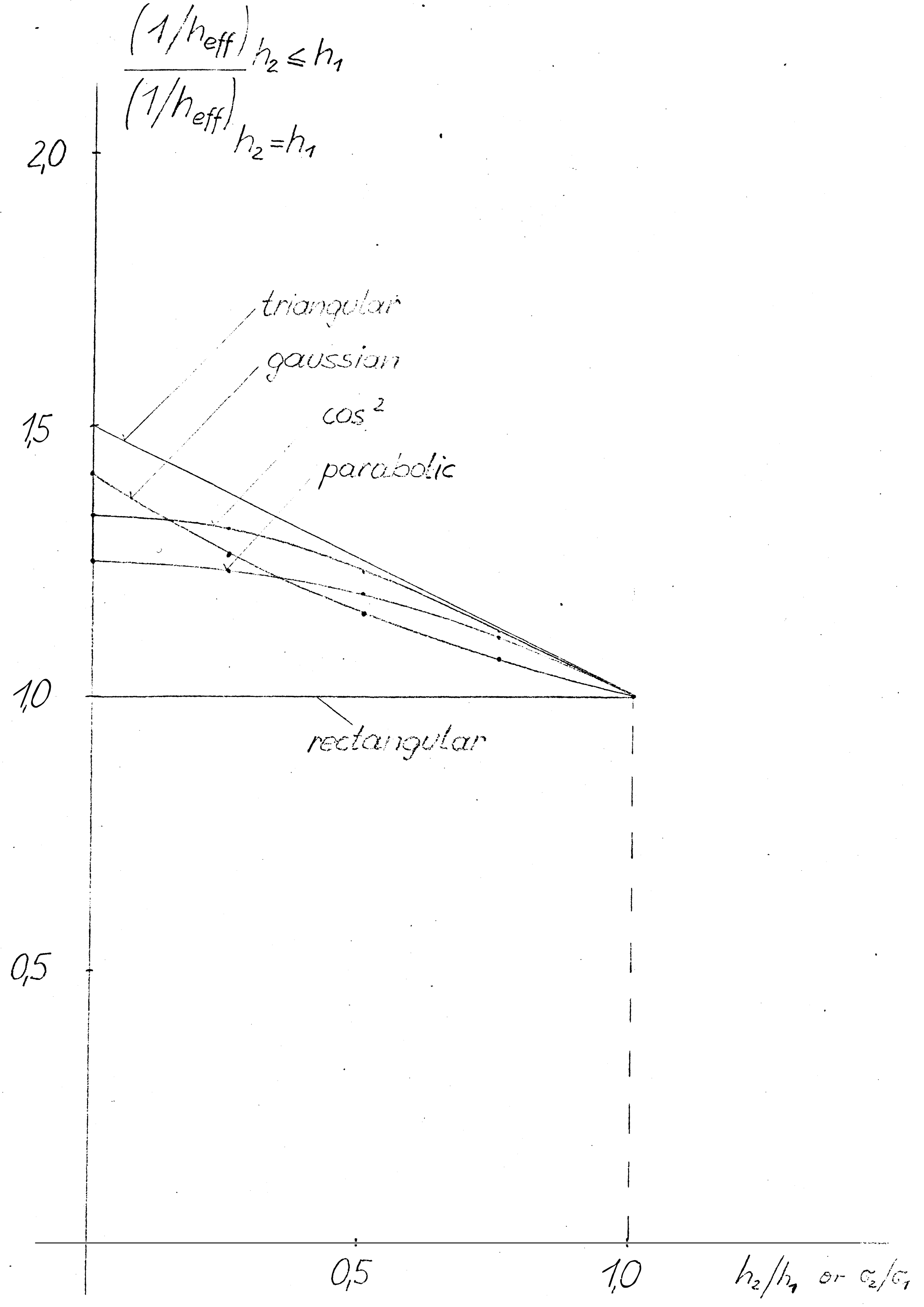


$$h^{-1} = \frac{1}{\sqrt{2\pi}\ 2\sigma}\left(\frac{2}{1 + \frac{\sigma_2}{\sigma_1}}\right)^{\frac{1}{2}}$$

K. Hübner

1) H.G. Hereward, "How good is the r.m.s. ...", MPS/DL 63-15,1969.

Fig. 1



$\frac{(1/h_{eff})_{h_2 \leq h_1}}{(1/h_{eff})_{h_2 = h_1}}$
2,0
1,5
1,0
0,5
triangular
gaussian
$\cos^2$
parabolic
rectangular
0,5
1,0
h_2/h_1 or σ_2/σ_1