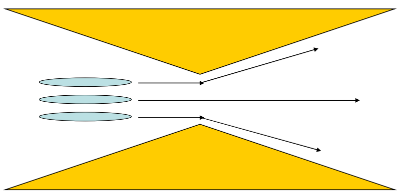
Collimator Wakefield Theory

Wakefields from collimators deflect offset beams, leading to jitter amplification and emittance dilution.

Theoretical models exist for geometric and resistive contributions to the kick.

Wakefields in NLC design are within specifications.



Jitter amplification: beam with *n* sigmas jitter ➔ $n\,(1 + A^2)^{1/2}$ sigmas (offset beam receives kick)

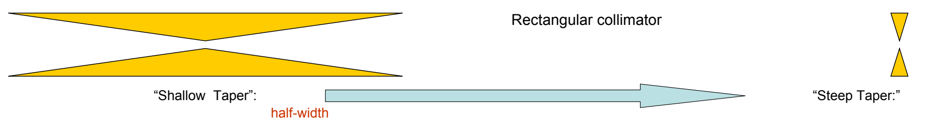
Emittance growth: beam with *n* sigmas jitter ➔ fractional emittance growth of $(0.4An)^2$ (tail kicked more than head)

How do we calculate A?

Geometric Wakefields:

Depend on gap height, gap width, taper angle, bunch length

Complex theory with 3 regimes



half-width

$$A = \frac{\sqrt{\pi}}{2}\,\frac{N r_e}{\gamma}\,\frac{\theta_T h}{\sigma_z r^2}\,\beta \qquad \sqrt{\frac{\theta_T r}{\sigma_z}} << \frac{r}{h}$$

half-gap

$$\boxed{A = 2.7\,\frac{N r_e}{\gamma}\sqrt{\frac{\theta_T}{\sigma_z r^3}}\,\beta}$$

$$A = \frac{N r_e}{\gamma}\,\frac{1}{r^2}\,\beta \qquad \sqrt{\frac{\theta_T r}{\sigma_z}} > 1$$

Resistive Wakefields:

Simpler theory with bunch length, collimator gap and length, conductivity

$$A = F_G\,\frac{N r_e}{\gamma}\,\frac{\Gamma(0.25)}{\sqrt{2\pi^3}}\,\frac{L}{r^3}\sqrt{\frac{c}{\sigma_z \sigma}}\,\beta$$

$F_G = 1$, round collimator

$= \pi^2/8$, rectangular collimator

NLC Collimation System:

From *TRC Report*, Chapter 7 (2003):

	TESLA	NLC	CLIC
δ spoilers	0.054	0.045	0.16
δ absorbers	0.034	0.016	0.37
β spoilers	0.55	0.59	1.67
β absorbers	0.51	0.014	0.33
FF spoilers	0.73	--	0.32
FF absorbers	0.38	0.53	--
Total A_y	2.26	1.20	2.84

A_y → 0.7 @ 500 GeV CM with tail-folding octupoles – Emittance growth < 1%

A_y α $1/E_{beam}$ – may limit luminosity at lower energies and preclude 1/E lumi scaling!