Horizontal Crossing Angle

Necessary only at warm machines

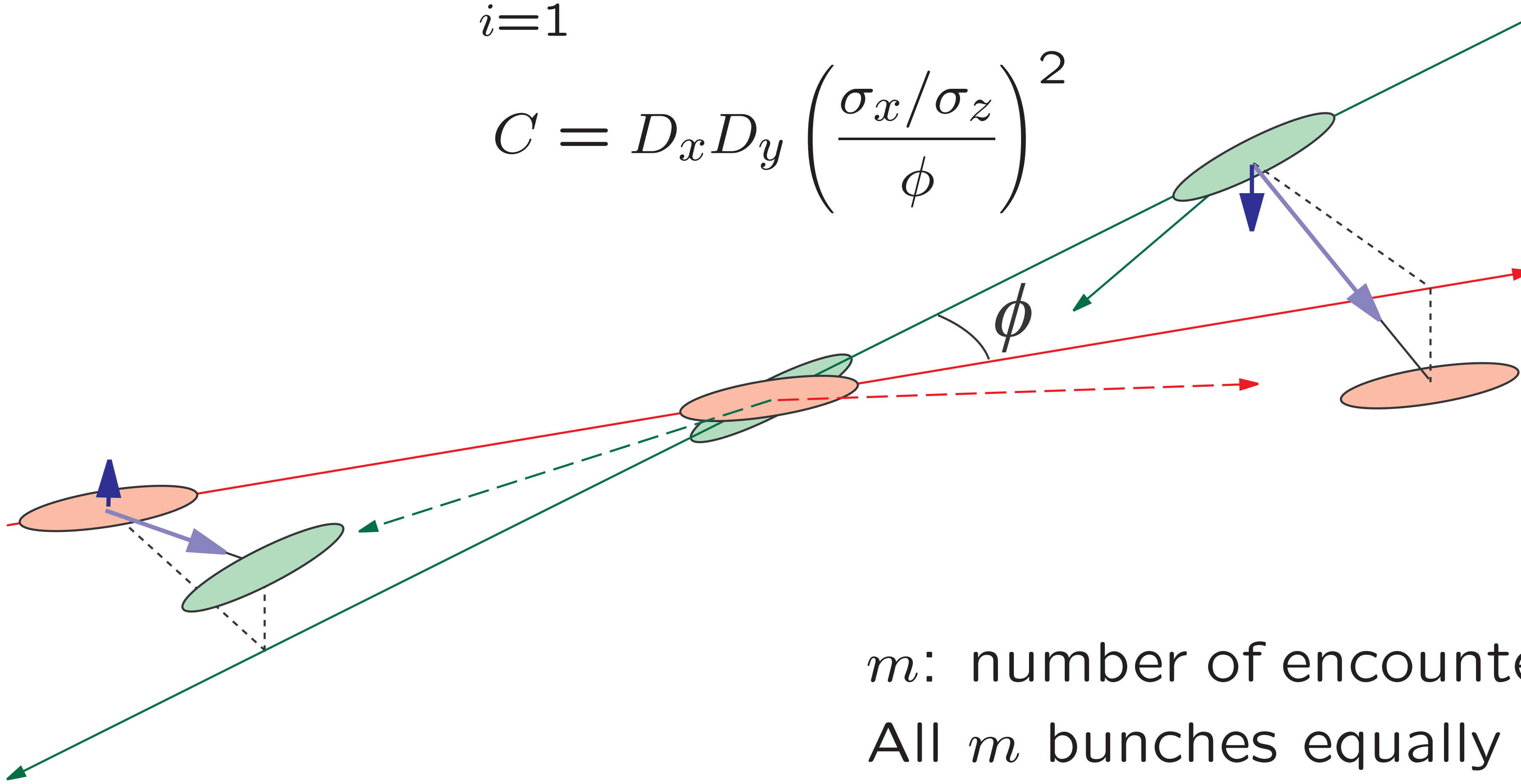
Multi-bunch Crossing Instability

by Yokoya

- $\Delta_k^{\pm} \equiv$ vertical offset
  of k-th $e^{\pm}$ bunch at IP
- Evolution of $\Delta_k = \Delta_k^{+} - \Delta_k^{-}$ is

$$\Delta_k = C \sum_{i=1}^{m} F(\Delta_{k-i}) + \Delta_{k,0},$$

$$C = D_x D_y \left(\frac{\sigma_x / \sigma_z}{\phi} \right)^2$$

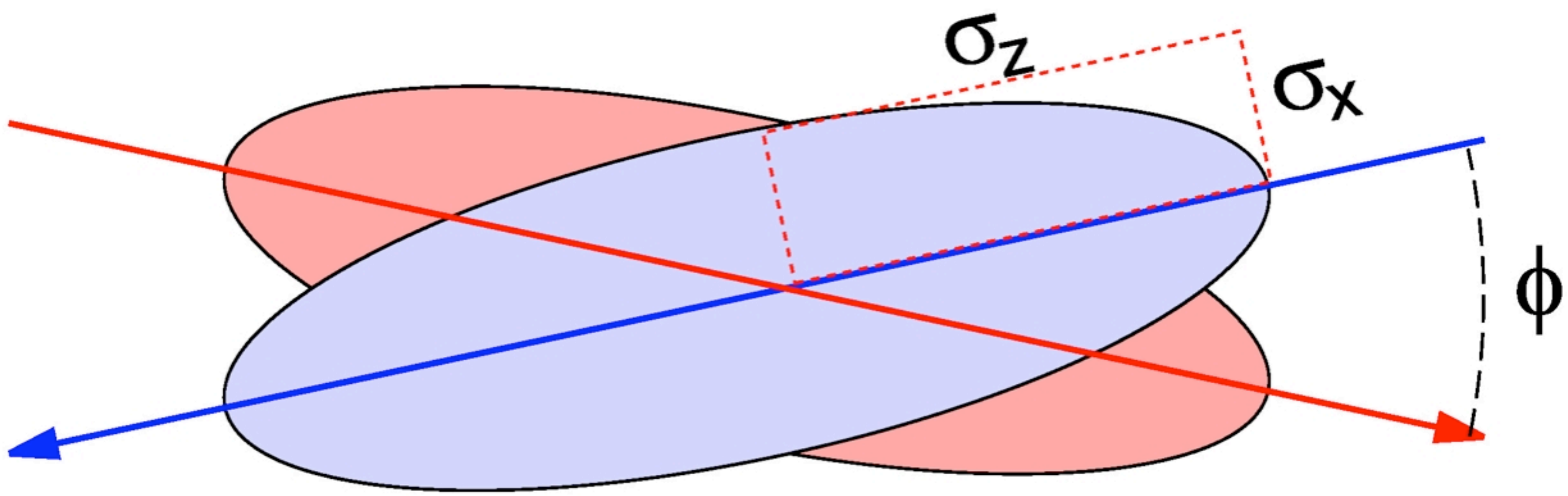


m: number of encounters in IR region

All m bunches equally contribute

IR: Crossing Angle Issue

K.Yokoya



$$\frac{2\sigma_x}{\sigma_z} = 4.4 \times 10^{-3}$$

$$\text{Small angle}: \quad \phi \lesssim \frac{2\sigma_x}{\sigma_z}, \qquad \text{Large angle}: \quad \phi \gtrsim \frac{2\sigma_x}{\sigma_z}$$

Why Small Crossing Angle ?

7 mrad vs

- Detector $\cos\theta$ coverage
- Timing of crab cavity 50 vs 16 fs
- Radiation in the solenoid magnet

$\sigma(\delta y) \propto \phi^{5/2} = 0.074\text{nm with } \phi = 20\text{mrad}$

Why Large Crossing Angle ?

20 mrad

- Background to the detector
- Multi-bunch crossing instability $\frac{\Delta y}{\sigma_y} =$ 1.8 vs 0.6
- Design of the final quadrupole magnet
- Layout of the beam dump

at L*=3.5m

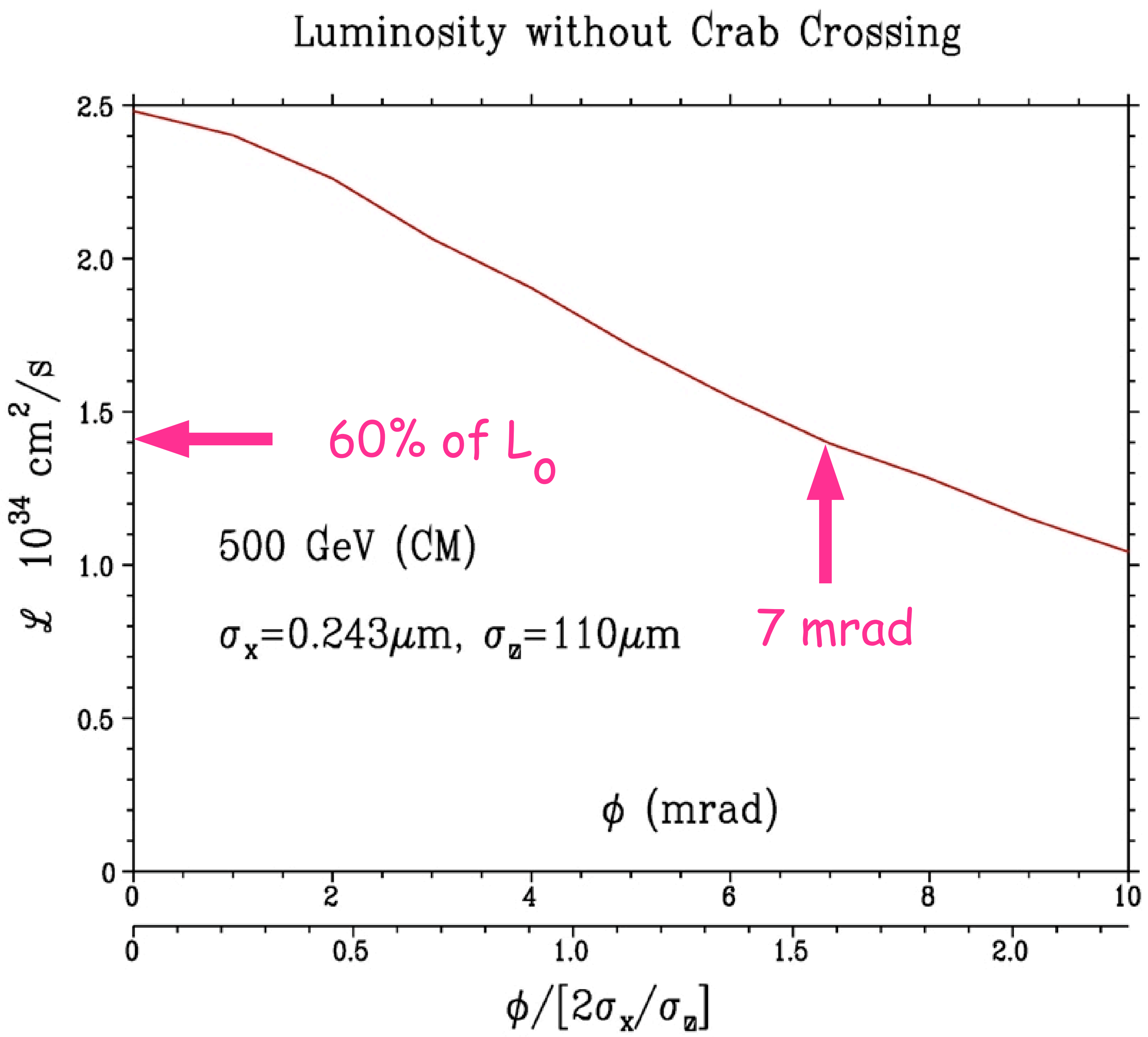
($\Delta_y^o = 0.5\sigma_y$)

IR: 7 mrad Crossing Angle

K.Yokoya

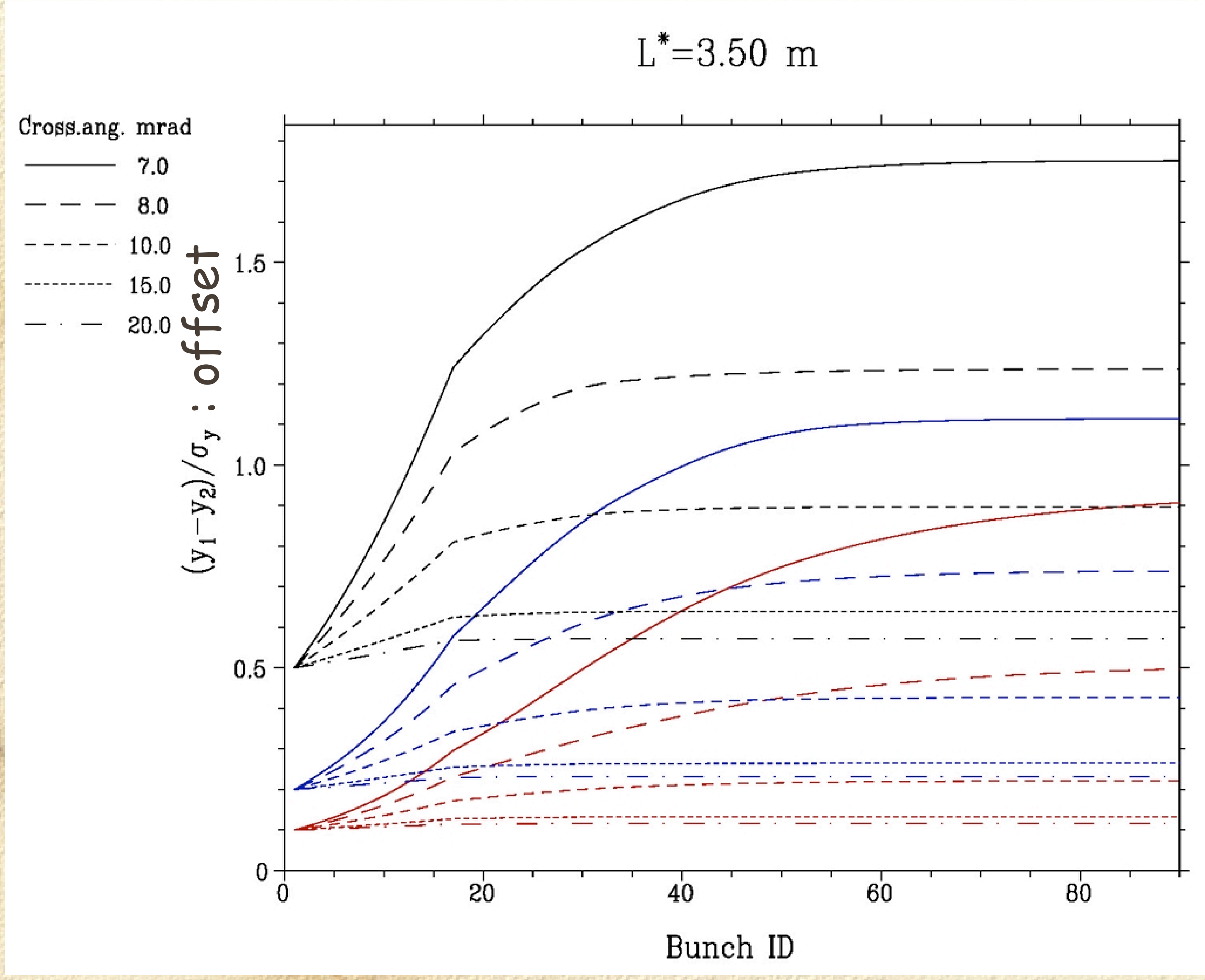
- We decided $\phi \approx 7$mrad many years ago
- Background tolerable
- Luminosity loss not too significant (σ_x was larger than today's value, σ_z was smaller)

Luminosity vs. $\phi \Rightarrow$ by today's params.

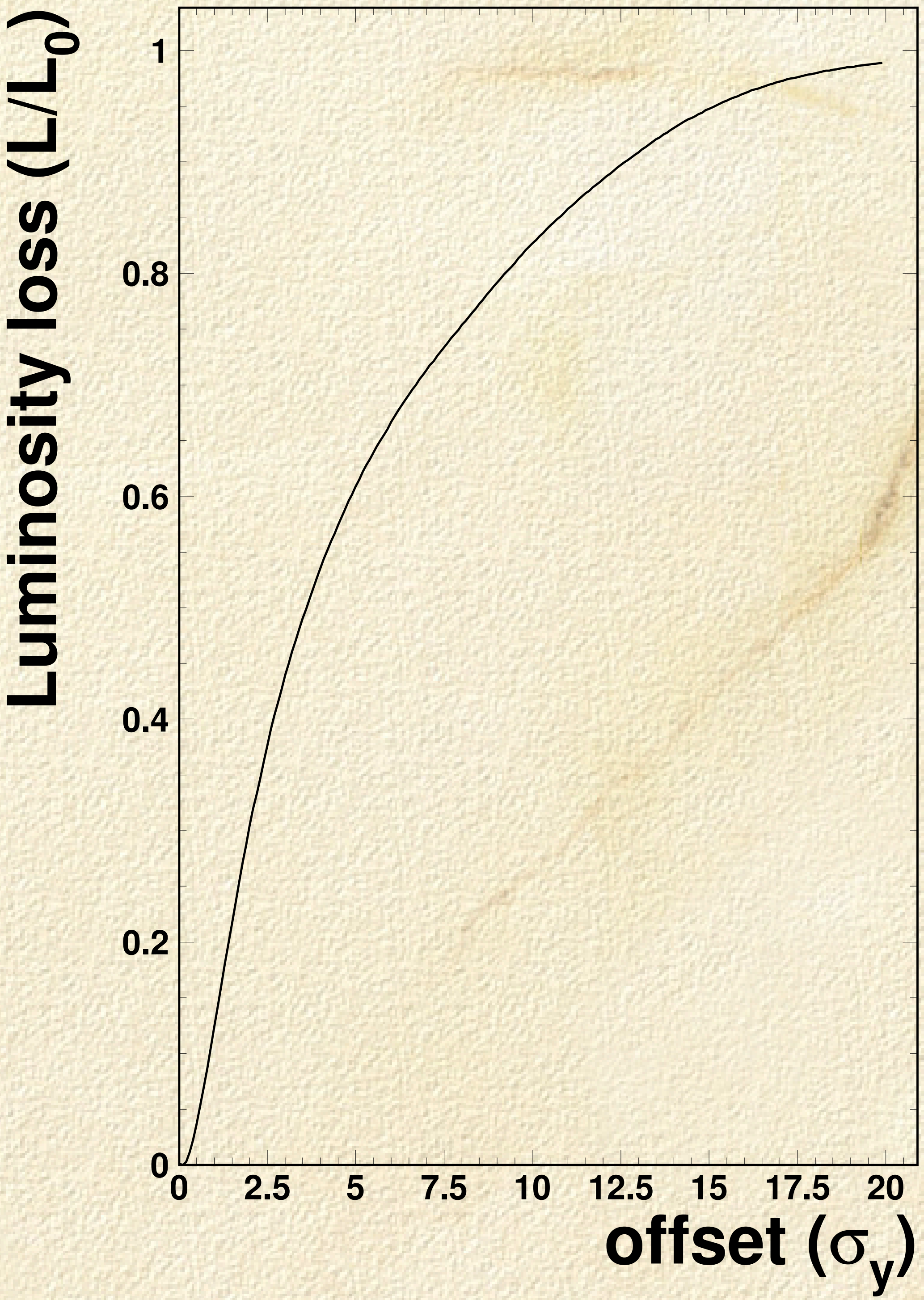


Multibunch Crossing Instability

Luminosity loss due to offset



CAIN calculation by N.Delerue



The offset must be corrected by Fast Feedback !