Optimum run time, integrated luminosity, etc.

$$\frac{1}{N_b}\frac{\Delta N_b}{\Delta t} = n_{IP} L \sigma \frac{1}{n_b}\frac{1}{N_b} + c\left(\frac{N}{V}\right)_{vac} \sigma_{vac}$$

collisions, gas scattering

$$N_b \approx \frac{N_b^0}{1 + n_{IP} L \sigma N_b^0 t / n_b} \equiv \frac{N_b^0}{1 + t/\tau}$$

intensity evolution for collisions only

$$\frac{1}{\varepsilon_x}\frac{\Delta \varepsilon_x}{\Delta t} = \frac{1}{\tau_{IBS}(N_b, \varepsilon_x, \varepsilon_y, \sigma_z, \sigma_\delta, \ldots)} \propto N_b^2$$

IBS growth rate

collision lifetime with σ~100 mbarn, n_{IP}~2:
$L_{peak}=10^{34}$ $cm^{-2}s^{-1}$ in 2008 bunches, N_b~1.15×10^{11}: τ_{eff}~τ~32 h (effectively 16 h)
$L_{peak}=10^{35}$ $cm^{-2}s^{-1}$ in 5016 bunches, N_b~1.7×10^{11}: τ_{eff}~τ~12 h (effectively 6 h)

τ_{gas} > 100 h (effectively 50 h)
τ_{IBS}~105 h (x emittance growth time, effectively 210 h)

in first approximation we can neglect the contributions from gas scattering and IBS consider $$L(t) = \frac{\hat{L}}{\left(1 + t/\tau_{eff}\right)^2}$$ instead of exponential decay (Walter, Francesco,…)

$$L_{ave} = \frac{\hat{L}\,\tau_{eff}\,T_{coll}}{\left(\tau_{eff} + T_{coll}\right)\left(T_{coll} + T_{turnaround}\right)}$$ average luminosity

$$\rightarrow \quad T_{coll,optimum} = \sqrt{\tau_{eff}\,T_{turnaround}}$$ optimum run time

L_{peak} [cm^{-2} s^{-1}]	beam lifetime τ_{eff} [h]	$T_{turnaround}$ [h]	T_{coll} [h]	Int *L* over 200 days (in parentheses are numbers from Francesco)
10^{34}	32	10	17.9	71 (66)
10^{34}	32	5	12.6	89 (85)
10^{35}	12	10	11.0	472 (434)
10^{35}	12	5	7.7	638 (608)