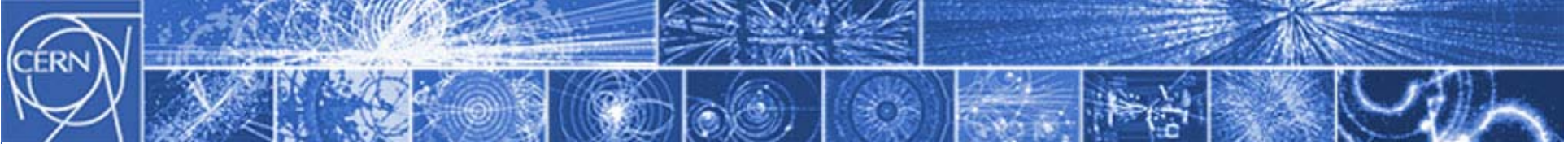


5. PERSPECTIVES WITH LOW EMITTANCES (1/5)

The new injectors are designed to provide beam with much higher brightness.



How much could the LHC characteristics be improved with lower transverse emittances?



5. PERSPECTIVES WITH LOW EMITTANCES (2/5)

LUMINOSITY FORMULAE

Luminosity is given by:

$$L = \frac{f_{rev} \gamma}{2r_p} n_b \frac{1}{\beta^*} N_b \Delta Q_{bb} F_{profile} F_{hg}$$

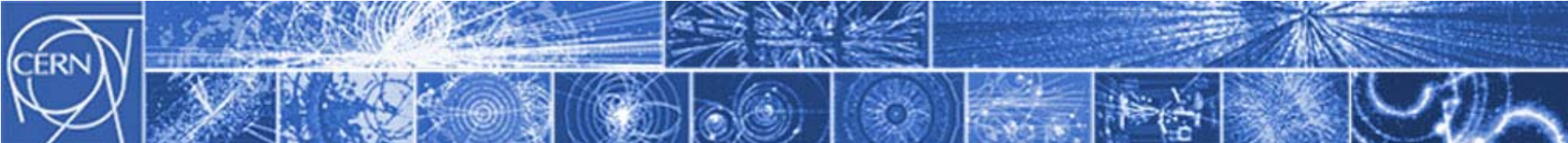
where ΔQ_{bb} = total beam-beam tune shift

$$\Delta Q_{bb} \cong - \frac{N_b}{\epsilon_N} \frac{r_p}{2\pi \sqrt{1 + \phi^2}}$$

with a tight constraint on its maximum value

and ϕ = Piwinski angle

$$\phi = \theta \sigma_z / (2\sigma^*)$$



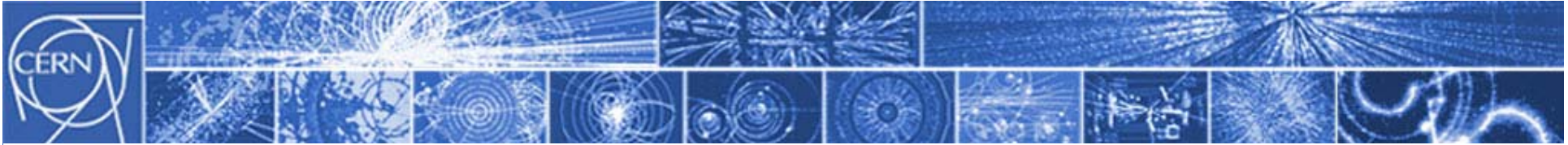
5. PERSPECTIVES WITH LOW EMITTANCES (3/5)

25 ns bunch spacing + IR Upgrade phase-1 + LINAC4

Maximum luminosity
with $\epsilon^*=3.75$ mm.mrad:
 1.47×10^{34} cm⁻²s⁻¹

	Nominal	Nominal with IR phase 1	Nominal with IR phase 1 and reduced emittance
N_b ($\times 10^{11}$)	1.15	1.15	1.15
ϵ (μm)	3.75	3.75	2.54
β^*	0.55	0.25	0.25
σ^* (μm)	16.58	11.18	9.20
Crossing angle (mrad)	0.290	0.440	0.360
σ_z (mm)	75.50	75.50	75.50
ϕ (Piwinski angle)	0.66	1.49	1.48
ΔQ_{bb} head-on	1.00	0.67	0.99
Luminosity	1.00	1.47	2.18
Luminosity lifetime (h)	22.00	14.95	10.08

Maximum luminosity
with $\epsilon^*=2.54$ mm.mrad:
 2.18×10^{34} cm⁻²s⁻¹

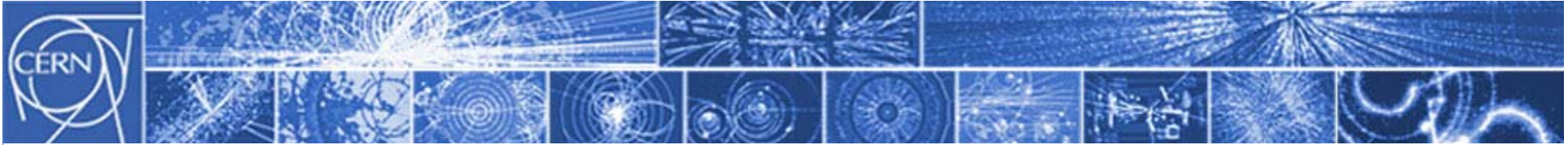


5. PERSPECTIVES WITH LOW EMITTANCES (4/5)

25 ns bunch spacing + IR Upgrade phase-2 & New Injectors...

	Nominal	Ultimate	Ultimate with $\beta^*=0.25$ m	Ultimate with $\beta^*=0.25$ m and reduced emittance	> Ultimate with $\beta^*=0.1$ m and reduced emittance
N_b ($\times 10^{11}$)	1.15	1.70	1.70	1.70	2.36
ε (μm)	3.75	3.75	3.75	2.60	2.60
β^*	0.55	0.50	0.25	0.25	0.10
σ^* (μm)	16.58	15.81	11.18	9.31	5.89
Crossing angle (mrad)	0.290	0.315	0.440	0.365	0.580
σ_z (mm)	75.50	75.50	75.50	75.50	75.50
ϕ (Piwinski angle)	0.66	0.75	1.49	1.48	3.72
ΔQ_{bb} head-on	1.00	1.42	0.99	1.43	0.92
Luminosity	1.00	2.30	3.22	4.65	10.40
Luminosity lifetime (h)	22.00	14.13	10.11	6.99	4.34

**Maximum luminosity with $\varepsilon^*=2.6$ mm.mrad:
 $10.4 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$**



5. PERSPECTIVES WITH LOW EMITTANCES (5/5)

Additional remarks:

- 25 ns bunch spacing has always been assumed,
- the ratio N/ϵ in the case of the phase-1 upgrade is the one foreseen with Linac4,
- the ratio N/ϵ in the case of the phase-2 upgrade is the one foreseen with the new injectors,
- the intensity assumed in the case of the phase-2 upgrade is the one foreseen in the “LPA” scenario...



**The new injectors are at the design stage.
It is still time to refine their specifications and make sure that their
impact on LHC performance will be maximized!**