

# A few considerations

→ Peak Lumi limitation → IT aperture

→ PAC-MAN

→ Bunch length

# Peak luminosity limitations

(based on the parameters “HL-LHC kickoff+”)

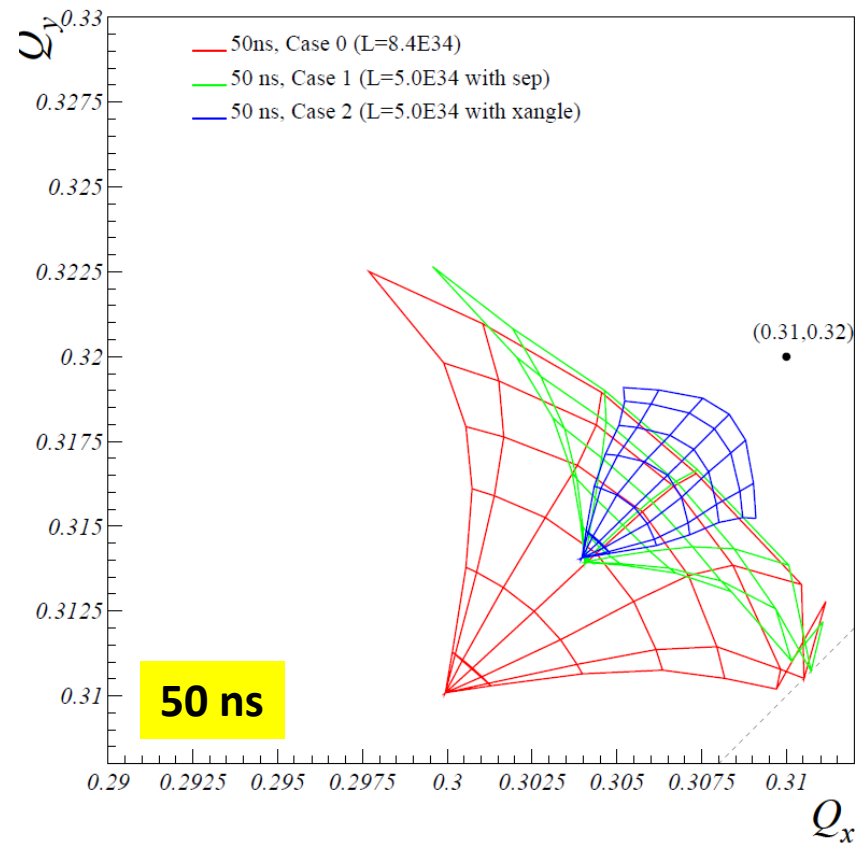
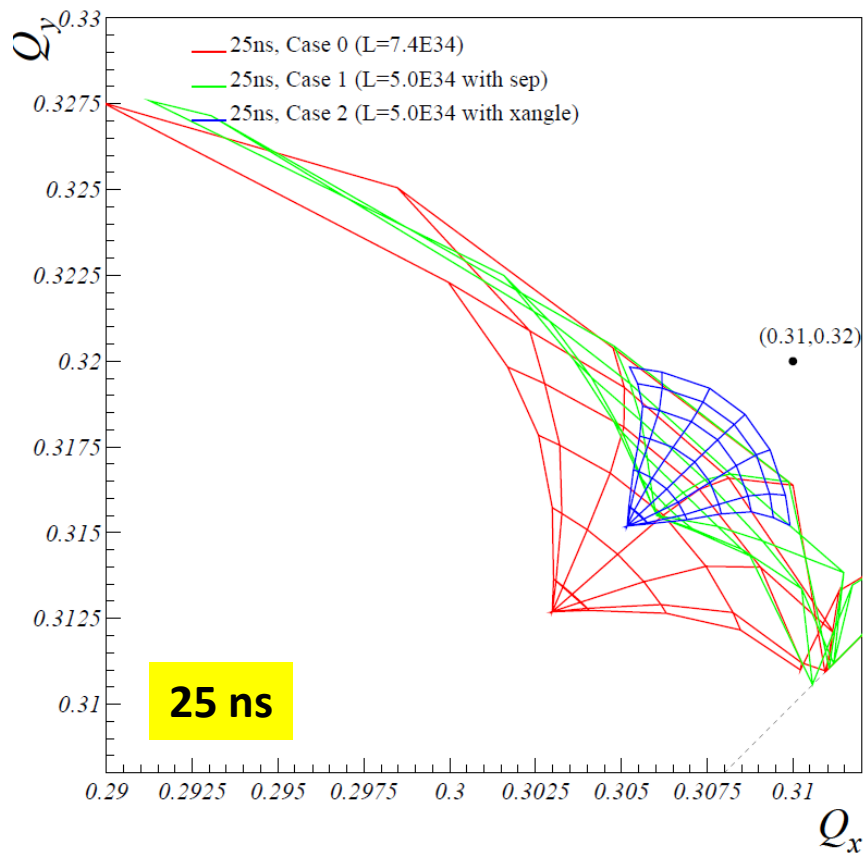
→ **Peak lumi larger than 5E34** (from OB’s talk)

Parameter	nominal	25ns	50ns
N	1.15E+11	<b>2.0E+11</b>	<b>3.3E+11</b>
$n_b$	2808	2808	1404
beam current [A]	0.58	<b>1.02</b>	<b>0.84</b>
beam separation [ $\sigma$ ]	10	10	10
$\beta^*$ [m]	0.55	<b>0.15</b>	<b>0.15</b>
$\varepsilon_n$ [ $\mu\text{m}$ ]	3.75	2.5	3.0
$\varepsilon_L$ [eVs]	2.51	2.5	2.5
Piwinski parameter	0.68	<b>2.5</b>	<b>2.5</b>
geom. reduction	0.83	<b>0.37</b>	<b>0.37</b>
beam-beam / IP	3.10E-03	<b>3.9E-03</b>	<b>5.0E-03</b>
Peak Luminosity	1 10 <sup>34</sup>	<b>7.4 10<sup>34</sup></b>	<b>8.4 10<sup>34</sup></b>

→ **What to do at the beginning of the coast?**

Anti-crabing (!), parallel sep. (LR!!) or more X-angle (demand on the IT/D1/Q4/D2 aperture, especially for 50 ns with bigger peak lumi and bigger emittance!!!)

Assuming 2 IR's and **21 LR's per IP side** (Phase I, could be up to 24 for the HL-LHC)



- Crossing angle seems to be the best (only?) way: 15.5/17.7sigma needed for 25/50ns.
- Even larger Piwinsky angle **up to 4.5 for 50 ns!**
- **For 50 ns (also with larger emittance) the IT aperture will be substantially larger**

# Pacman bunches

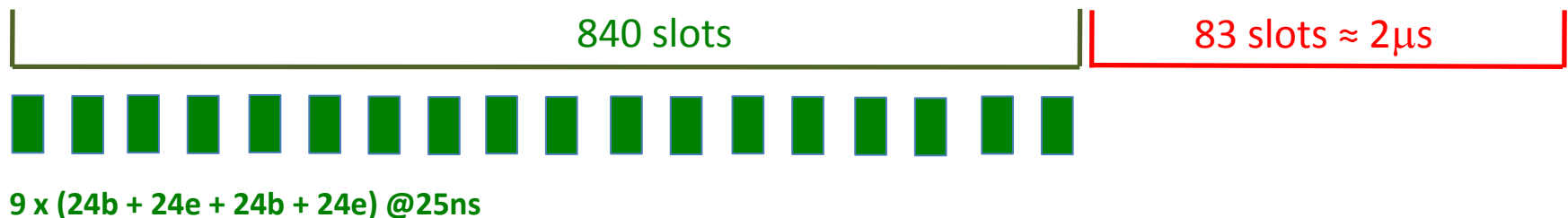
→ Sooner or later there will be **more PAC MAN than nominal bunches** because the IT is longer, e.g. for 25 ns:

- **Nominal LHC**: 30 pacman per batch with 15 LR's per IP side.
- **Phase I** : 42 pacman per batch with 21 LR's per IP side.
- **HL-LHC** : **up to 48 pacman** against **24 nominal**

→ Eliminating the nominal bunches with **25 ns micro-batches of 24 bunches** will also

- 1) Eliminate the Pacman effect itself,
- 2) Halve the number of LR's (as for 50 ns)
- 3) With more bunches than for 50 ns (~1800)

→ Possible SPS filling scheme **micro-batches** (courtesy of G. Rumolo)



→ Can the bunch charge be the same as the one offered for 50 ns (2.5E11) with e.g. 2.5 mum emittance?

# The “taboo” of the bunch length

## What’s about halving the bunch length?

→ 5 cm compatible with 16 MV and 1 eVs injected emittance, but Landau cavity needed!

→ 4 cm would require “only” doubling the existing RF, which looks reasonable compared to 40MV crab-cavity per beam!

→ A new parameter world can be opened for such a bunch length, which is also much less demanding in Piwinsky angle and beta\* aspect ratio (flat optics) without crab.