# IPC updates

# Dealing with different lattices

**FCC lattice is continuously evolving**

- Many constraints from the machine itself, beam-beam interactions, civil engineering, …
- Changing the lattice will have impact on the production of beam backgrounds

**Baseline lattice at the Z pole assumes**

- 11200 bunches with ~25 ns spacing along the ring of 90 km
- Bunch charge of 2e12 electrons or positrons (similar for LHC)

**Recently, studies for this baseline lattice show electron cloud build up rapidly in the beam pipe, degrading the beam lifetime**

- Need to mitigate the e-cloud build-up without compromising the luminosity
- One proposal is to have very short pulses (5ns) and then a longer relaxation times
    - Not clear if detectors can deal with it
- Another proposal is to have 50 ns spacing (more time for the c-cloud to evaporate)
    - But to keep the same lumi, we need to double the charge
    - Studied today: study effect on IPC production and also on vertex occupancy

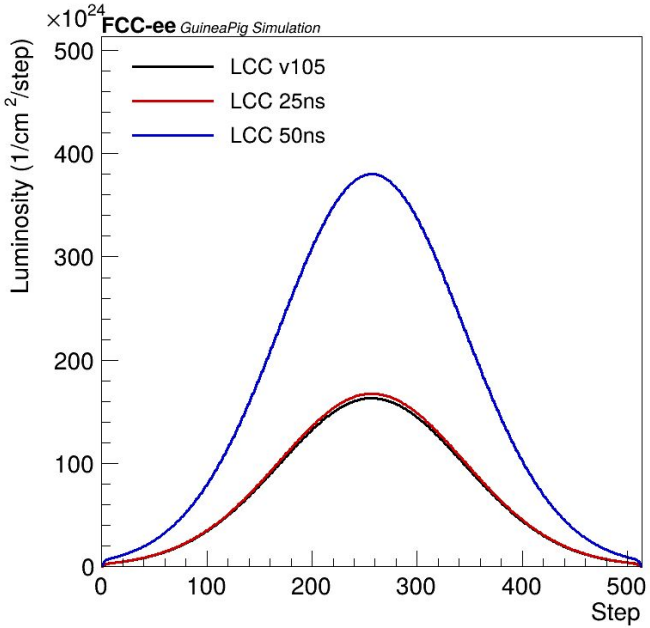
# LCC lattice parameters for 25 and 50 ns

| Inputs to GuineaPig | | | | |
|---|---|---|---|---|
| | **Units** | **LCC (v105) Reference till now** | **LCC 25 ns NEW** | **LCC 50 ns NEW** |
| sigma_x | nm | 7993.75 | 10478.55 | 10348.91 |
| sigma_y | nm | 35.20 | 54.07 | 64.60 |
| sigma_z | um | 16700.00 | 14900.00 | 22300.00 |
| beta_x | mm | 90.00 | 90.00 | 90.00 |
| beta_y | mm | 0.70 | 0.80 | 0.80 |
| Bunch density | 10^10 | 20.20 | 24.20 | 48.40 |
| Number of bunches | # | 12000 | 11200 | 5600 |
| Bunch crossing rate | MHz | 39.69 | 37.04 | 18.52 |

**Preliminary lattice configuration for 25 and 50 ns**

- Bunch density and number of bunches factor of 2 difference

# Luminosity spectra




| Luminosity | | |
|---|---|---|
| **Lattice** | **Per BX (1/cm2)** | **Inst. (1/cm2*s)** |
| LCC | 3.61e+28 | 143e+34 |
| LCC25 | 3.71e+28 | 137e+34 |
| LCC50 | 8.40e+28 | 156e+34 |

Ratio luminosity 50/25:

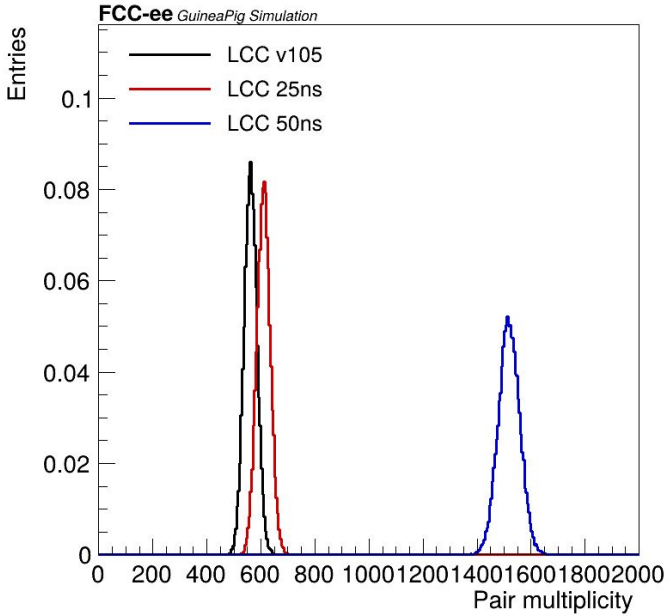
- Per BX: 2.26
- Time-averaged (inst): 1.14

→ LCC50 has 14% more inst. luminosity than LCC25

Luminosity calculated by GuineaPig per BX

Sum over luminosities per time step

# IPC creation




| Pair creation per BX | | |
|---|---|---|
| **Lattice** | **Avg (95% quant) pairs** | **95% quantile** |
| LCC | 561 | 601 |
| LCC25 | 609 | 651 |
| LCC50 | 1518 | 1583 |

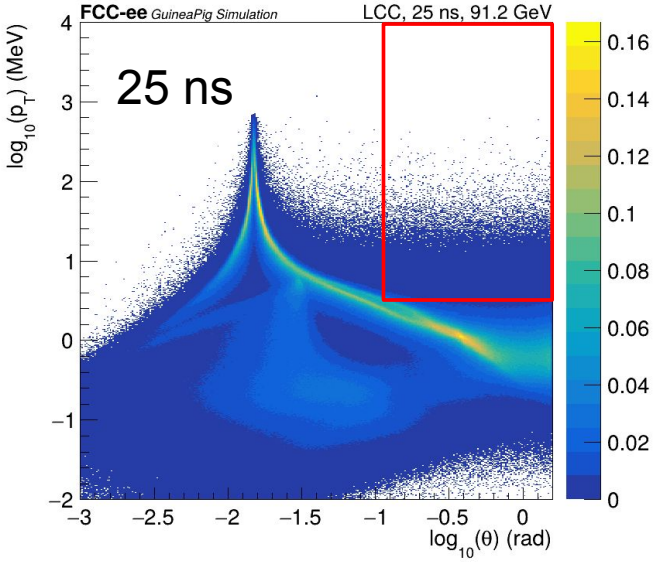
Ratio luminosity 50/25:

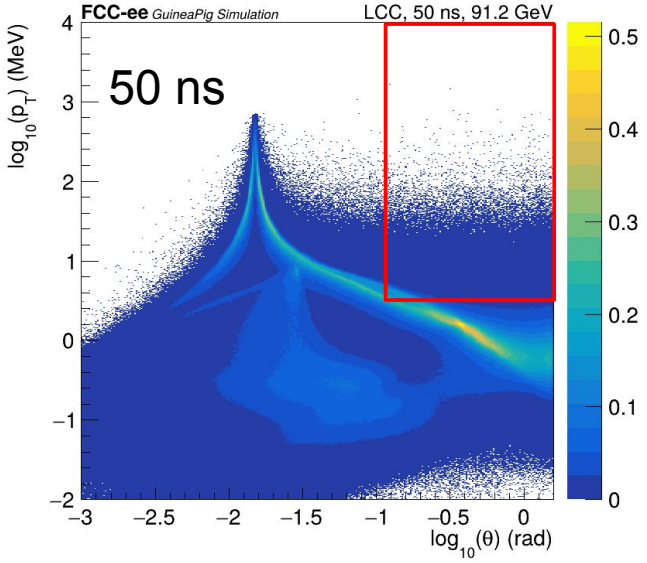
- Per BX: 2.50
- Time-averaged (inst): 1.25

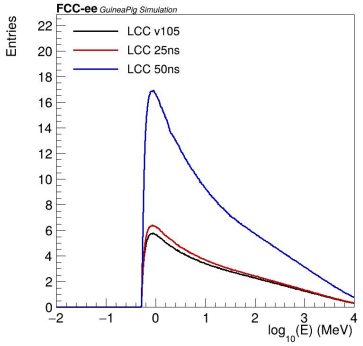
IPC production scales with per BX luminosity

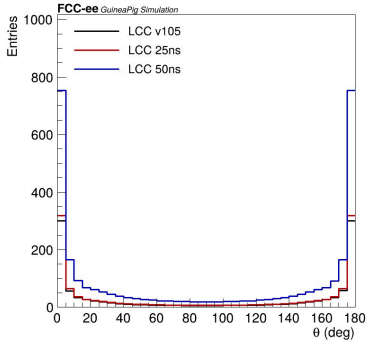
- Expected ~ 2.26 more IPCs created per BX for 50ns
- Slightly higher IPC production observed ~ 2.50
- Factor of 2.50/2.26 = 1.11 (11%)

# IPC kinematics



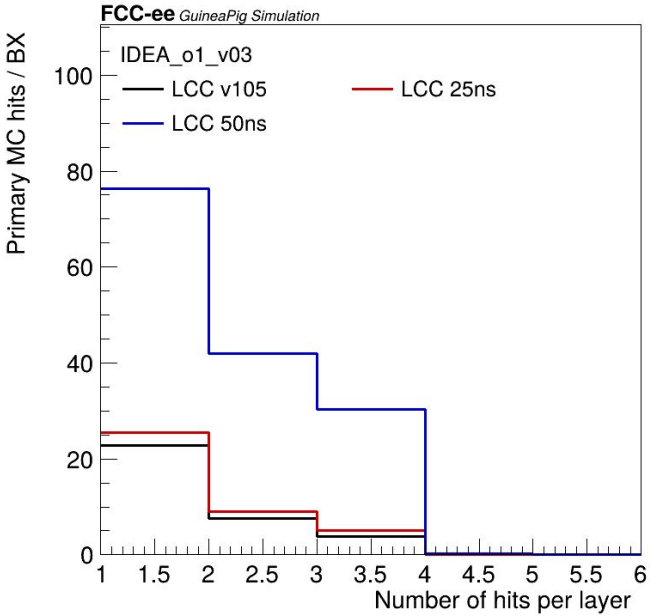




Slightly harder momentum spectrum for 50 ns

→ more IPCs in vertex phase space expected

# Vertex occupancy (IDEA_o1_v03)




| Average number of (primary) hits in layer 1 | | |
|---|---|---|
| **Lattice** | **Per BX** | **Per 100 ns readout window** |
| LCC | 23 | 92 (4BX) |
| LCC25 | 25 | 100 (4BX) |
| LCC50 | 76 | 152 (2BX) |

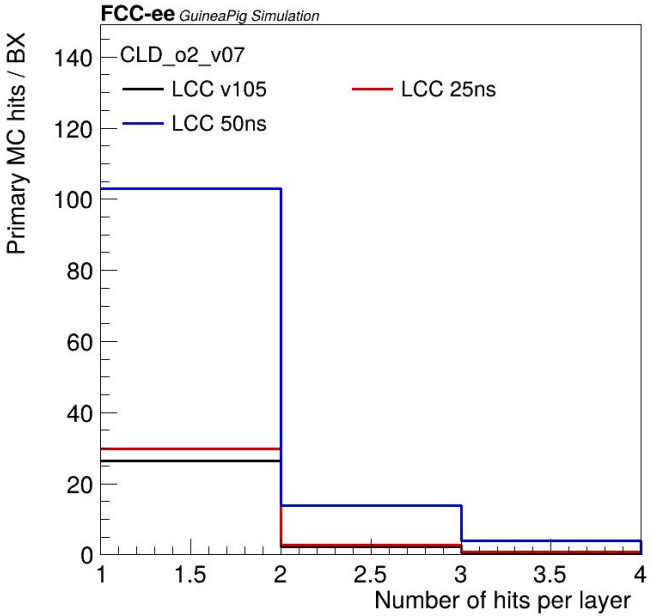
Ratio luminosity 50/25:

- Per BX: 3.04
- Time-averaged (inst): 1.52

Time-averaged, factor 1.52 more IPCs in first layer for 50 ns

- Primarily due to harder spectrum for 50 ns, where more IPCs are entering the vertex phase space (20%)
- Secondary due to slightly higher IPC pair creation (11%) and higher inst. luminosity (14%)

# Vertex occupancy (CLD_o2_v07)




| Average number of (primary) hits in layer 1 | | |
|---|---|---|
| **Lattice** | **Per BX** | **Per 100 ns readout window** |
| LCC | 26 | 104 (4BX) |
| LCC25 | 30 | 120 (4BX) |
| LCC50 | 103 | 206 (2BX) |

Ratio luminosity 50/25:

- Per BX: 3.43
- Time-averaged (inst): 1.72

Time-averaged, factor 1.76 more IPCs in first layer for 50 ns

- Primarily due to harder spectrum for 50 ns, where more IPCs are entering the vertex phase space (36%)
  - Higher than IDEA, due to longer z-extent
  - Also CLD slightly smaller radius
- Secondary due to slightly higher IPC pair creation (11%) and higher inst. luminosity (14%)

# Preliminary conclusions

**Comparison of LCC 25 and 50 ns lattices**

- Given the lattice parameters, 50ns has 14% more luminosity (as calculated by GuineaPig)
- The 50 ns lattice produces 11 % more IPCs due to the bunch dimensions and beam structure
- The 50 ns has a harder energy spectrum, more IPCs reaching the first vertex layer
    - 20% more for IDEA, 35% more for CLD