Motivation

Summary

Results

Conclusion
The interplay of external sources of noise in the presence of a large tune spread may become problematic in the LHC and HL-LHC due to strong head-on beam-beam interaction.

- The variation of the emittance growth rate with a controlled source of noise was successfully tested last year (→ Good agreement with models).
- Losses were compatible with burn off, but an important blowup w/o controlled noise was observed, hypothesised as an effect of the ADT with high intensity bunches (no dedicated setup performed).

→ Test empirically the effect of the ADT on colliding high brightness bunches (with proper setup) allowing to:

- Evaluate the ADT driven noise
  → Quantify the impact of the low-noise ADT upgrade
- Evaluate the machine noise floor
- Demonstrate beam quality preservation with high beam-beam tune shift
The ADT was setup for high intensity (2E11 p) bunches

After two fills where the beam quality was deteriorated by coherent instabilities at flat top and during the squeeze, high brightness bunches were brought into collision in IPs 1, 5 and later 8

- Needed 550 A in the octupoles, $Q' = 18$ and a damping time about 30 turns from the ADT and a good control of the tune separation during ramp and squeeze
- A total beam-beam tune shift about 0.03 was reached
- In collision, $Q'$ was reverted to 15

Using the gating possibilities of the ADT, different bunches experienced different gains
Impact of the ADT with standard bandwidth

- Colliding head-on in IP1 and 5 (total beam-beam tune shift of ~2E-2), the relative emittance growth rate follows the weak-strong model prediction with a relative noise amplitude between 5E-5 and 8E-5 from the lattice (ground motion, PC ripple) and an ADT effective pickup resolution of 0.9 μm
  → Compatible with expectations

- The relative emittance growth rate of the non-colliding bunch is compatible with IBS prediction (~10 %/h in the horizontal plane)

- Colliding in IP1, 5 and 8, large losses were observed in B2 and a large emittance growth in B1
  → Onset of incoherent effects for a total beam-beam tune shift approaching 3E-2?

→ Further test in MD2157
Impact of ADT with enhanced bandwidth

- A weak effect from the bandwidth is expected for single bunches → Difficult to measure

- The impact may be more significant with bunch trains → To be tested during a physics fill
Conclusion

- No show stopper found for HL-LHC with a total beam-beam tune shift of 0.02 (w/o long-range)
- Significant effect of IP8 colliding head-on ($\Delta Q \sim 0.03$), to be further investigated
- The relative noise floor of the machine at the betatron frequencies was estimated to $\sim 5E-5$
- Transverse profiles indicate a significant tail population
- The effective pickup noise floor (main source of noise in the ADT) was estimated to $\sim 1\mu m$

→ As opposed to HL-LHC tune shifts, the model predicts that, with low a beam-beam parameter (LHC) a large ADT gain is beneficial in collision
  → To be tested in physics (possibly start or middle of fill)
- To recover this effect with large beam-beam tune shifts, the noise of the ADT needs to be reduced (on going work)
- The effect of the enhanced BW is unclear → would be better tested in physics (possibly start or middle of fill)
B1, colliding in IP1 and 5
B2, colling in IP1, 5 and 8

Enhanced bandwidth

HB1, bunch 882
IP8 in collision
Change of gains

VB1, bunch 882

VB2, bunch 882
Colling in IP1, 5 and 8

HB1, bunch 1776

VB1, bunch 1776

HB2, bunch 1776

VB2, bunch 1776
Non colliding bunches

B2 non-colliding bunch got unstable during the ramp
B1, colliding in IP1, 5 and 8
B2, colling in IP1 and 5