Beam-beam DA simulations with new operational scenario

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Overview

DA studies with beam-beam at:

1) Start of collisions for B1 & B2
   - r=1, β^*=1 m, CC OFF, I_{oct}=+510 A
   - r=1/2, β^*=1 m, CC OFF, I_{oct}=-490 A
   - r=1/2, β^*=1 m, CC OFF, I_{oct}=+470 A

/afs/cern.ch/eng/lhc/optics/HLLHCV1.5/ramp/opt_ramp_1000_1500_thin.madx
/afs/cern.ch/eng/lhc/optics/HLLHCV1.5/ats/opt_ats_1000_500_thin.madx

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2) End of β^*-leveling for B1 & B2
   - β^*=15 cm, CC ON, I_{oct}=-300 A
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   - Chromaticity & octupole scan.

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Simulation setup:

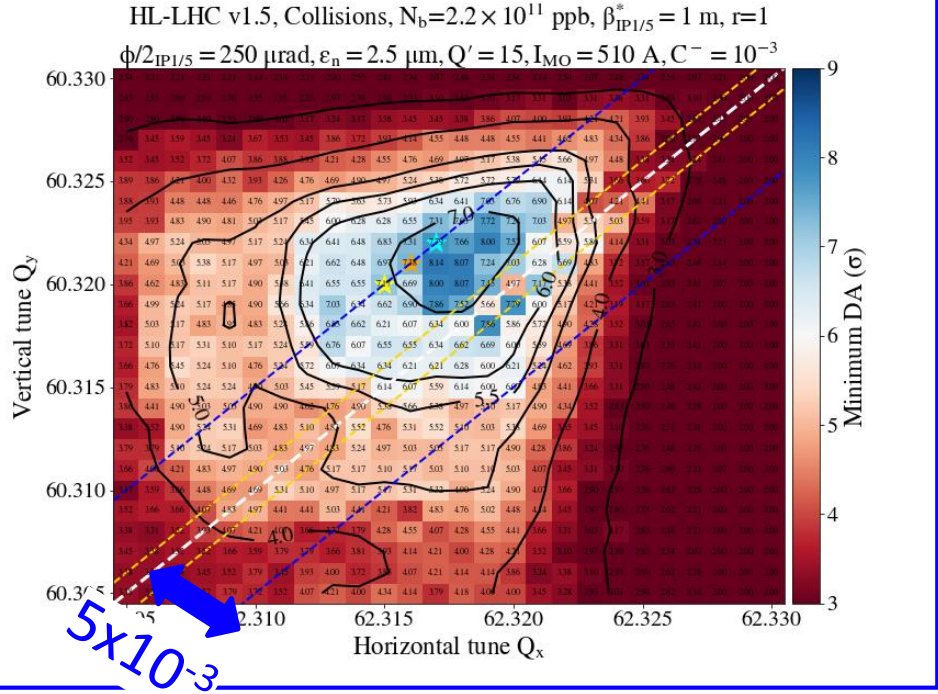
- HL-LHC v1.5
- New pythonic masks (**preliminary** results for B2 & beam-beam)
- $C^-=10^{-3}$
- $\phi/2_{IP1/5}$ = 250 µrad, $\delta p/p=27x10^{-5}$, 5 angles, 15 chroma

Start of collisions

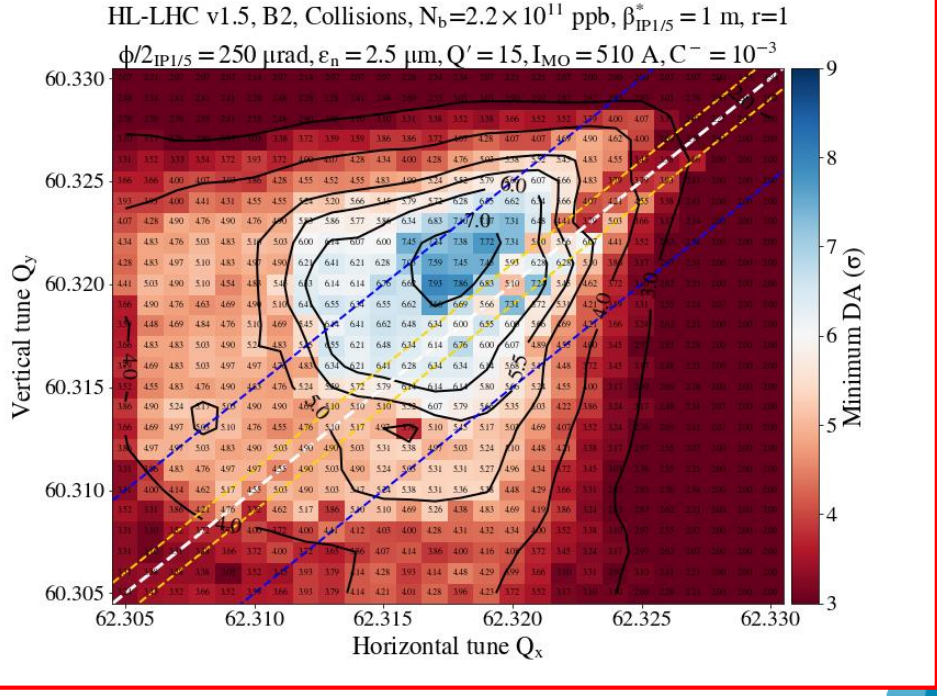
r=1, β*=1 m, positive octupoles

DA target: Minimum DA> 6 σ for $\Delta Q \geq 5 \times 10^{-3}$.

B1

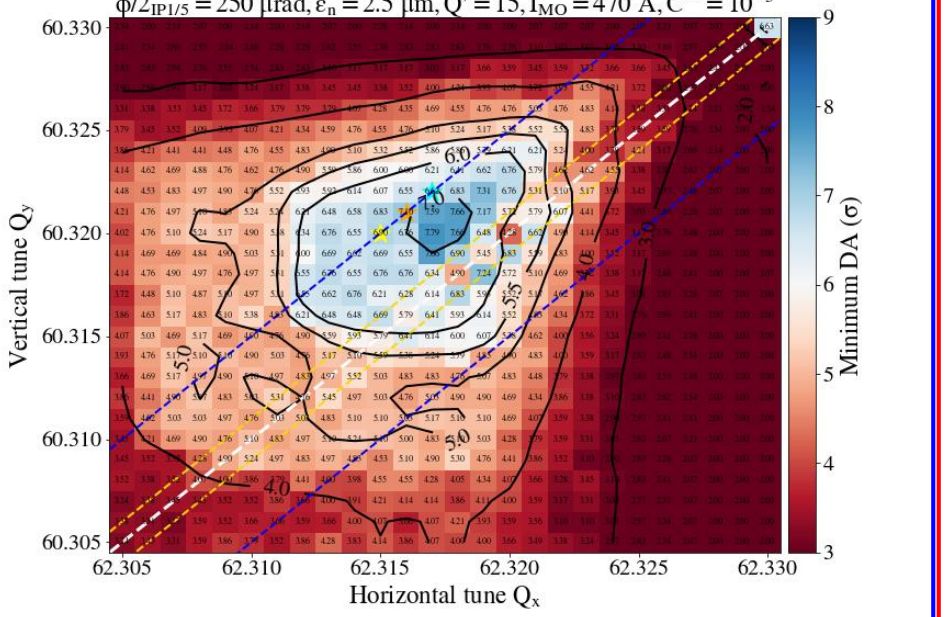


B2

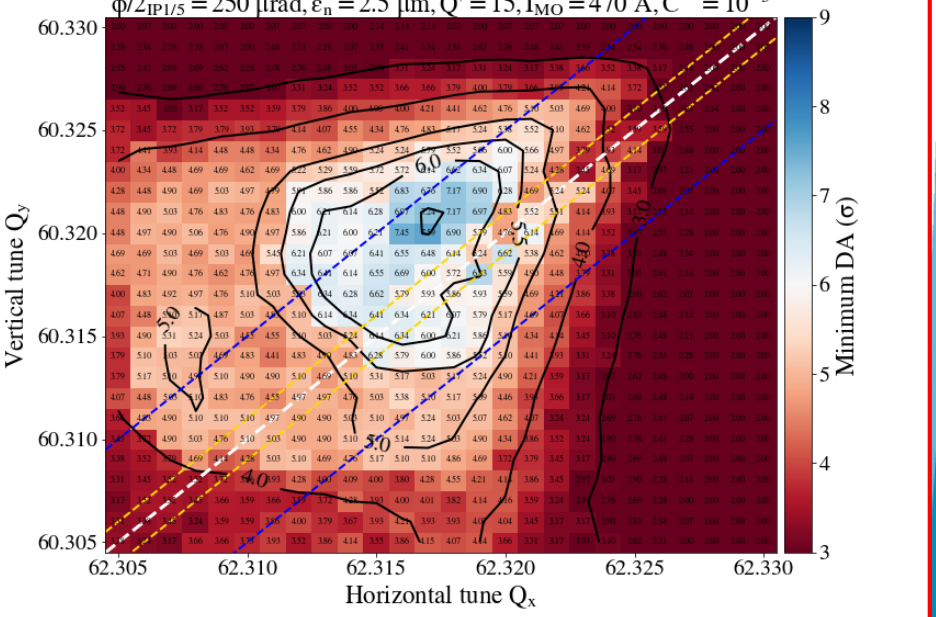


r=1/2, β*=1 m, positive octupoles

B1



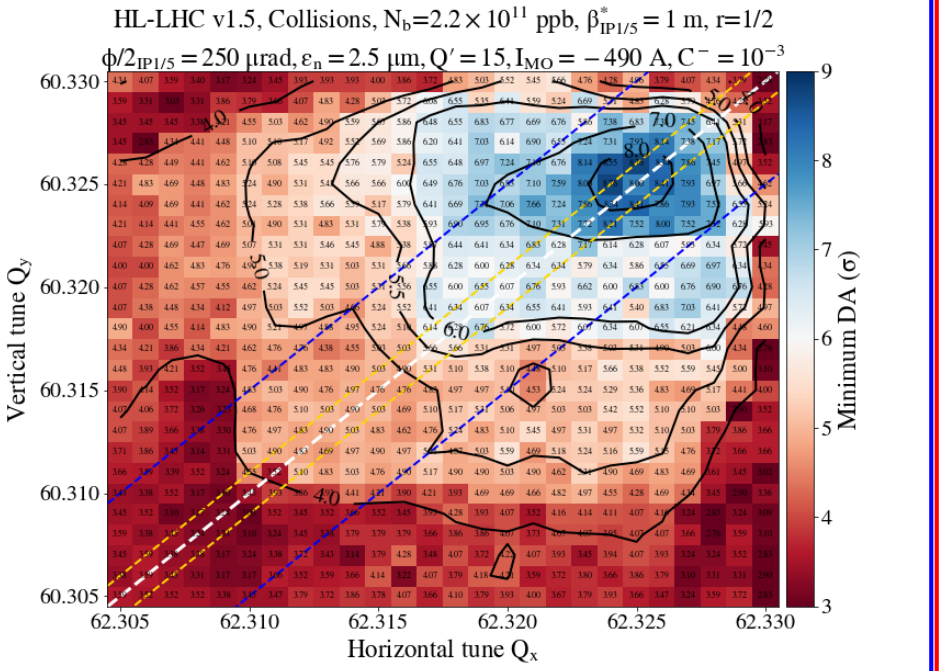
B2



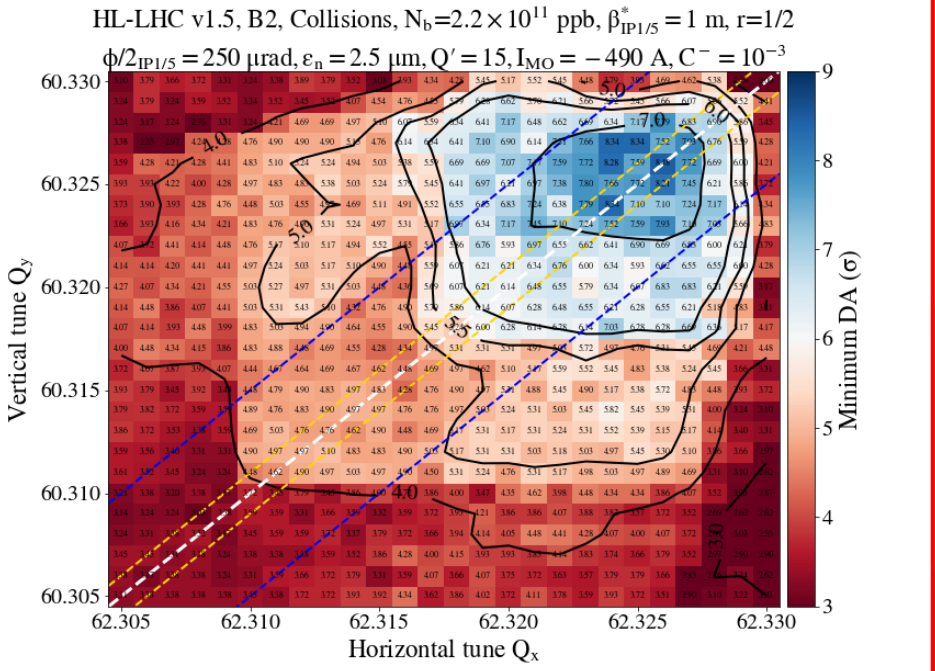
- Slight DA reduction with anti-telescope (although lower octupoles).

r=1/2, β*=1 m, negative octupoles

B1



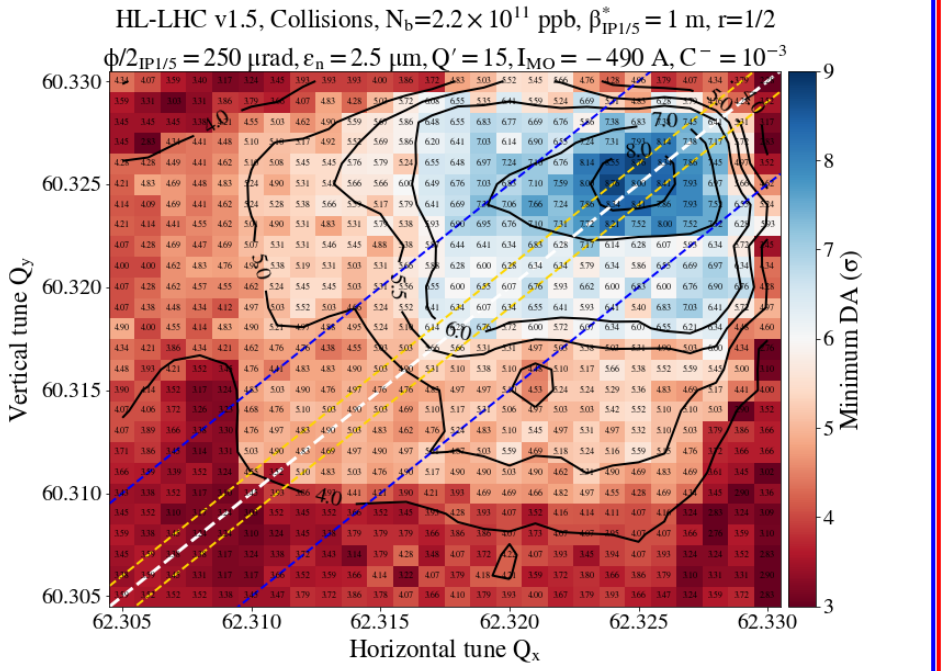
B2



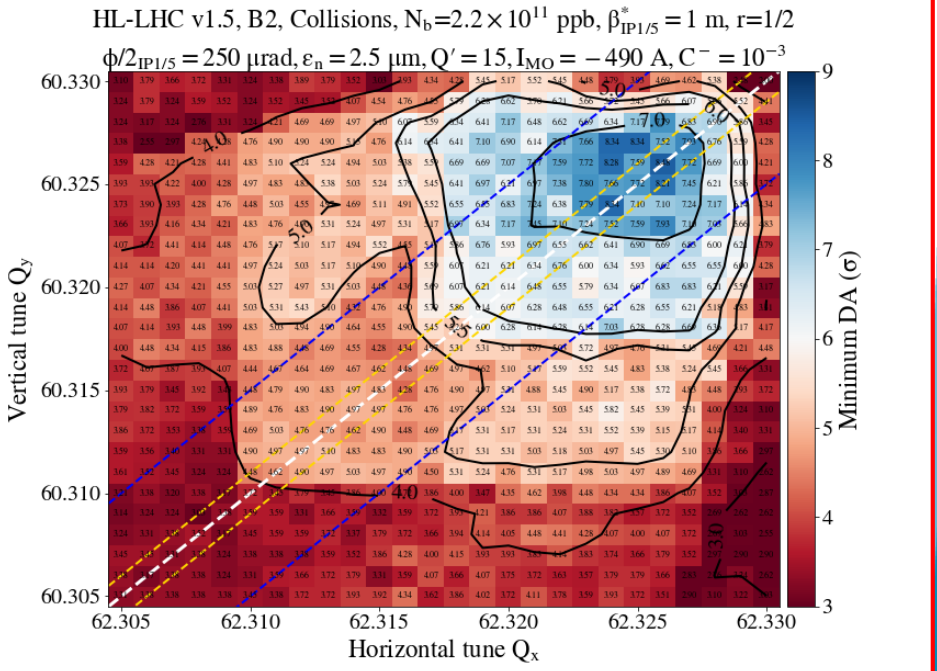
- Beneficial impact from negative octupoles.

r=1/2, β*=1 m, negative octupoles

B1



B2

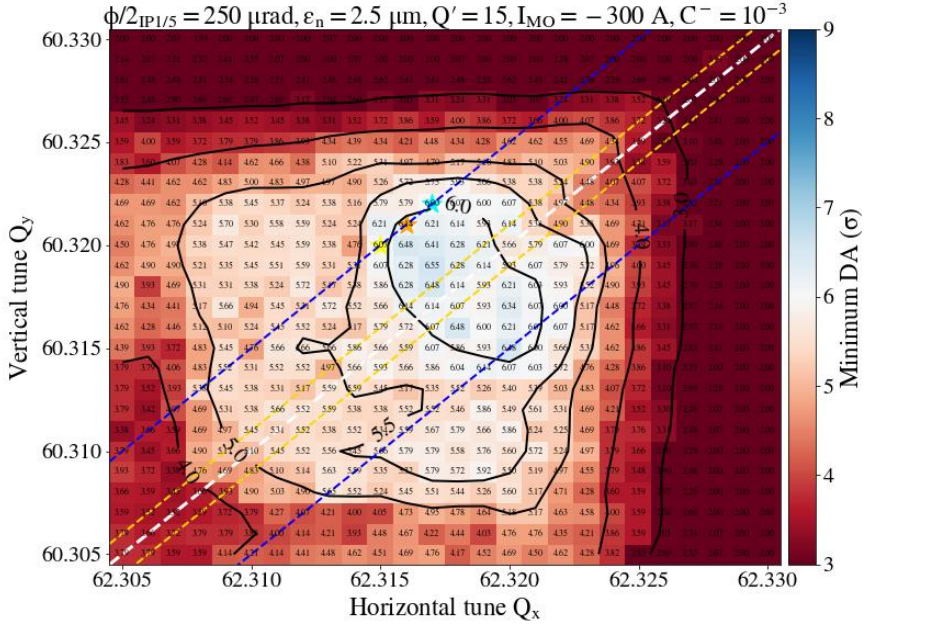


- ☑ For all 3 cases: several working points that meet the DA target.
- ➢ DA of B2 slightly worse (~0.5 σ) than B1.

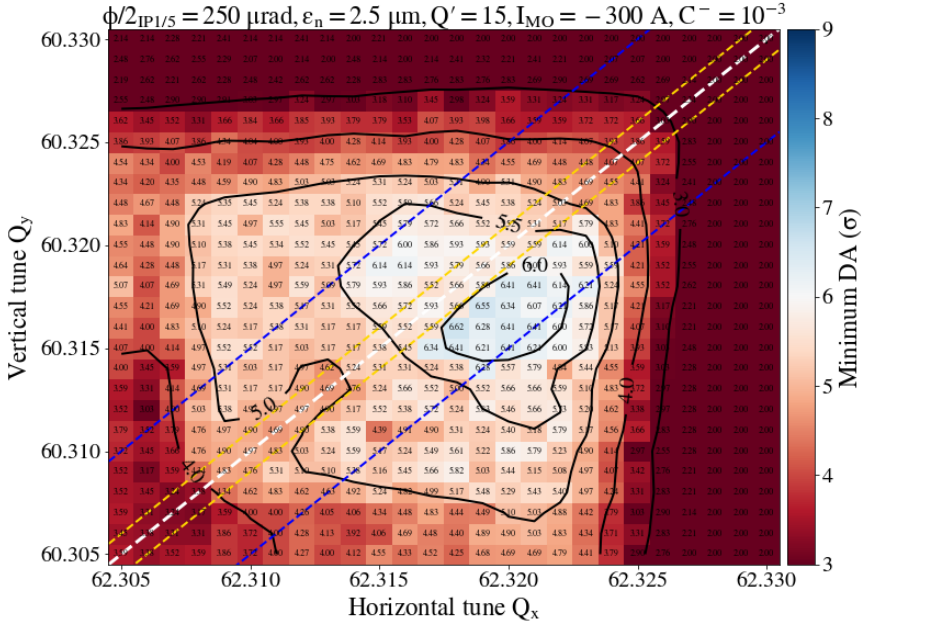
End of β*-leveling

β*=15 cm, negative octupoles

B1



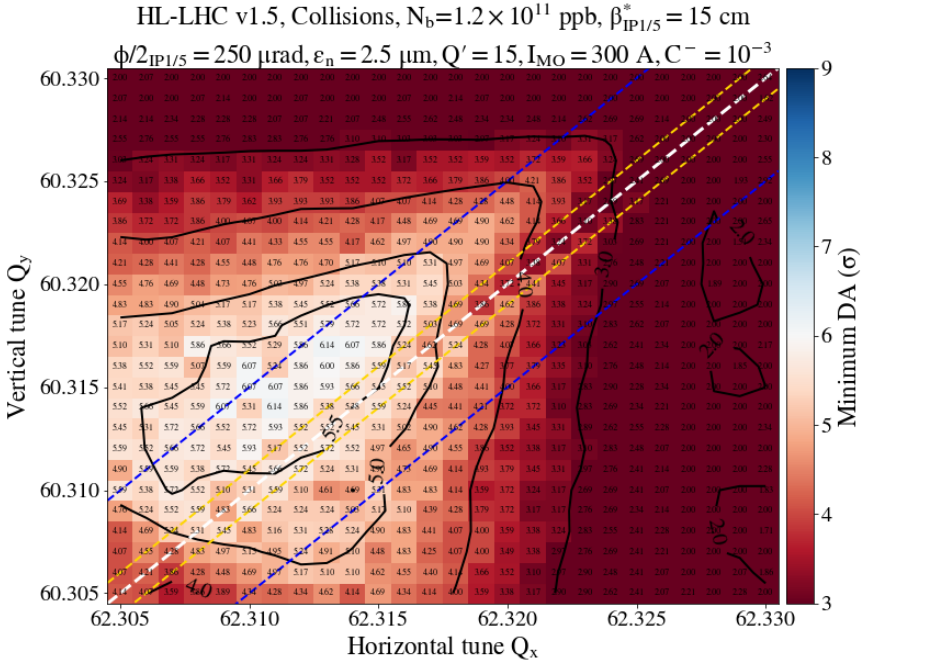
B2



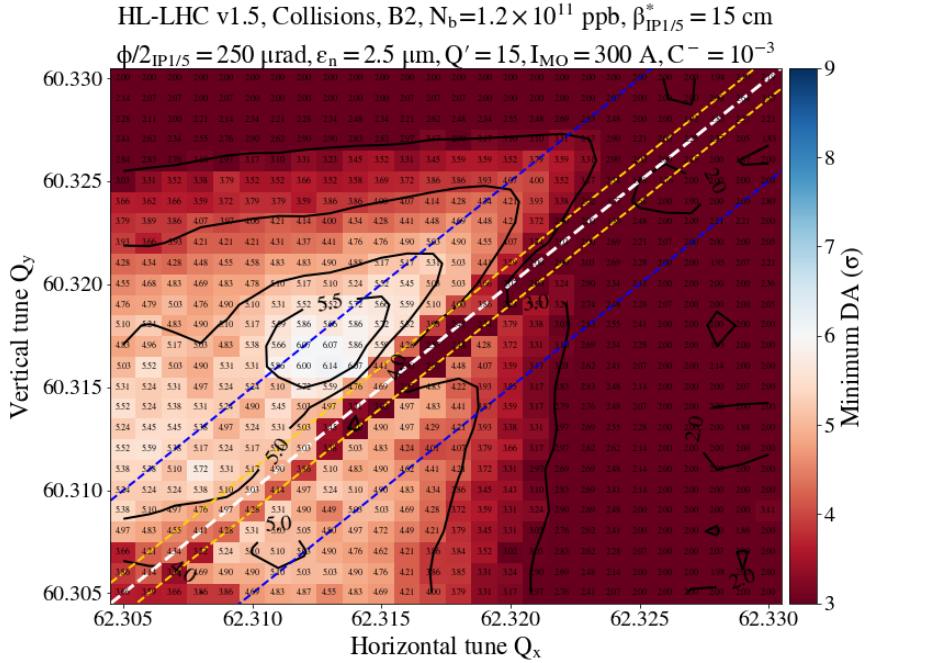
- Best working points throughout the whole collision process for B1 are **(62.315 60.320)**, **(62.316, 60.321)**, **(62.317, 60.322)**.

β*=15 cm, positive octupoles

B1



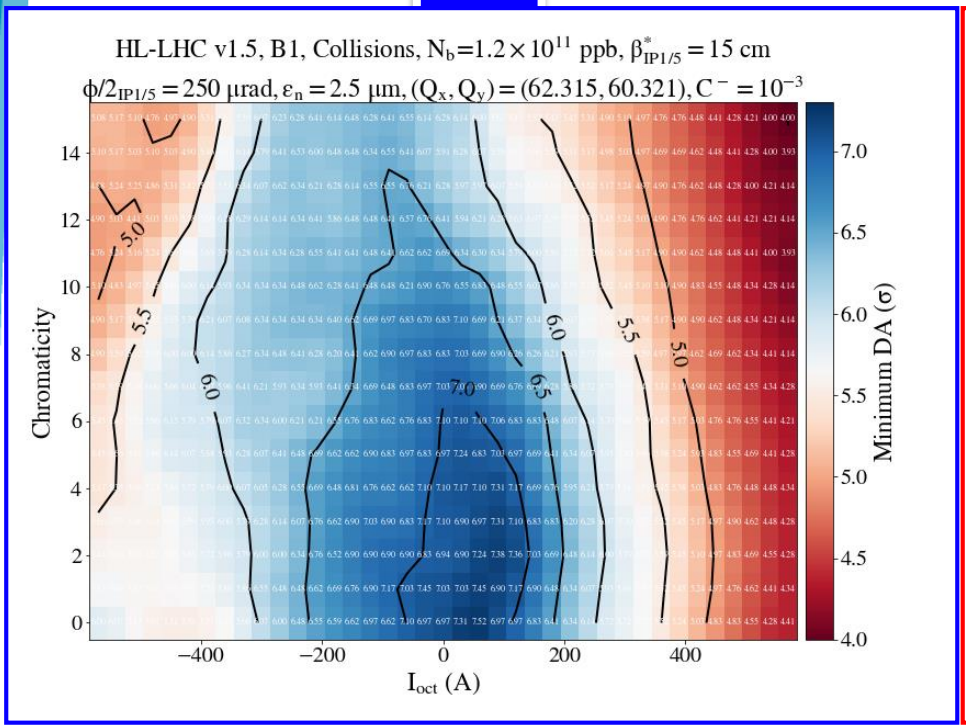
B2



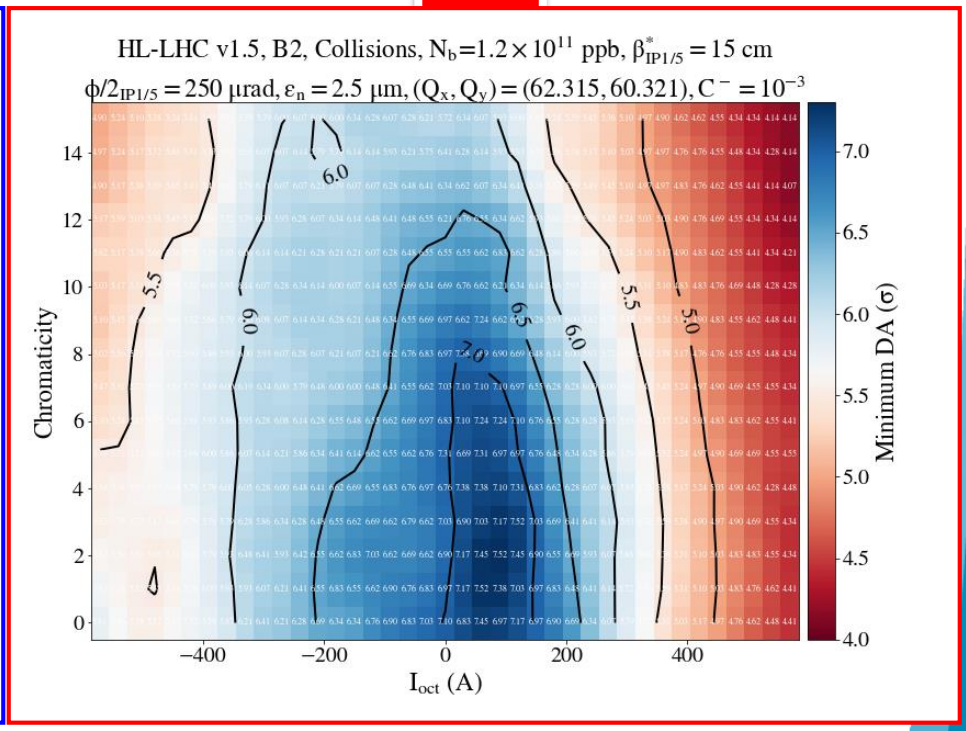
- 1 working point for B2, marginal for B1 (without IP1-IP5 phase advance optimizations).
- More pronounced DA asymmetry between the two beams around coupling resonance.

Chromaticity & octupoles scan

B1



B2



- For optimized working point (B1, EOL, negative octupoles, DA_{min}=6.21 σ).

Summary

- Meeting DA target for all three scenarios at start of collisions including coupling and beam-beam both for B1 and B2.
- Preliminary DA results of B2 slightly worse than B1 (~0.5 σ), to **further understand origin of asymmetry.**
- Best working points for the whole collision process for B1 is **(62.315 60.320), (62.316, 60.321), (62.317, 60.322).**
- No working point for B2 at the end of leveling with negative octupoles & 1 working point for positive octupoles **with the present configuration.**
- EOL & optimized working point, optimal regime for B1 I_{oct}=-250 to 150 A.

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- EOL & optimized working point, optimal regime for B1 I_{oct}=-250 to 150 A.

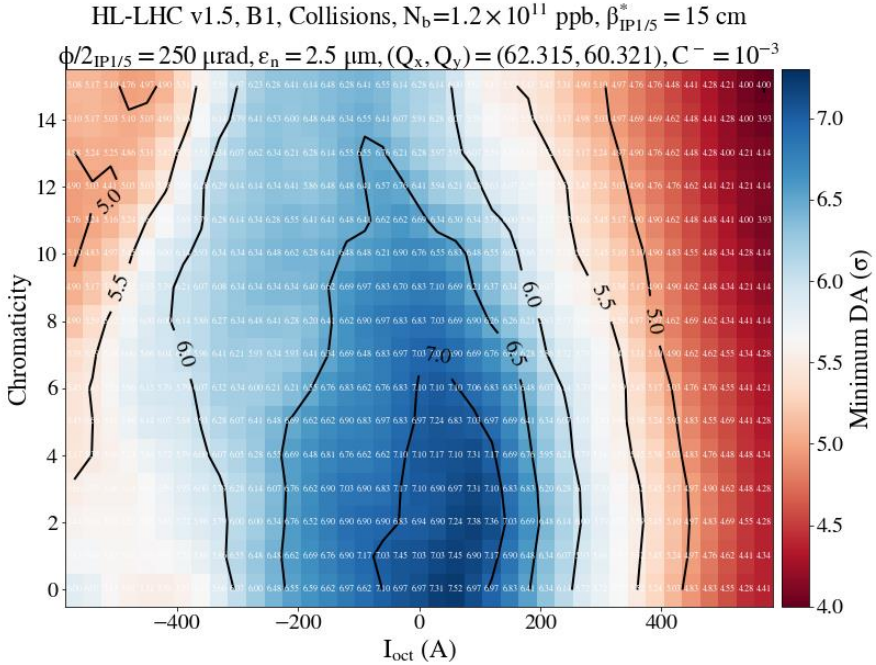
Next steps:

1. Further sanity checks and verification for Beam 2.
2. To identify origin of DA asymmetry between the two beams (especially around the coupling resonance at EOL).
3. Phase advance optimizations with beam-beam & complement no MS10 studies with beam-beam.

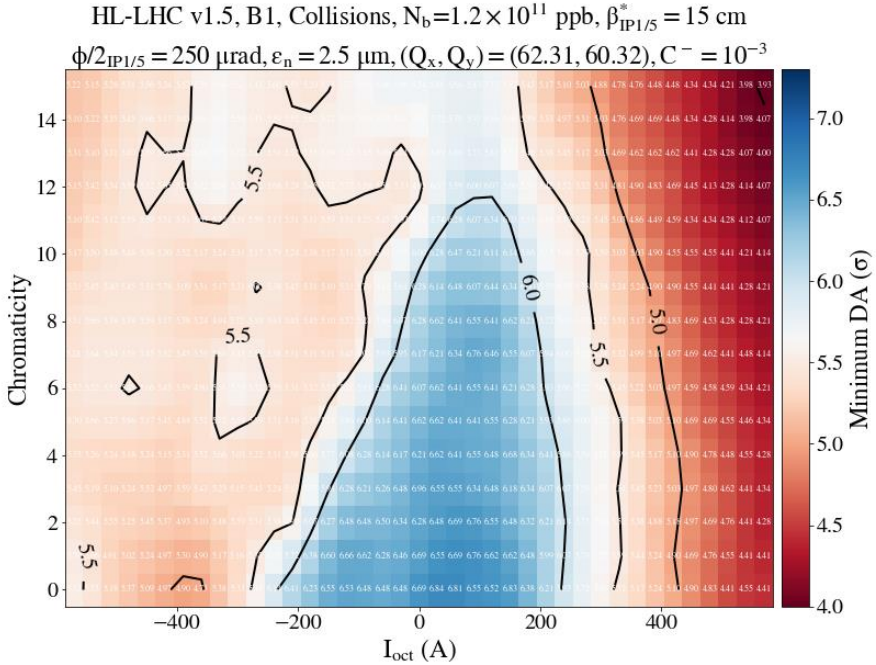
Backup

Chromaticity & octupoles scan

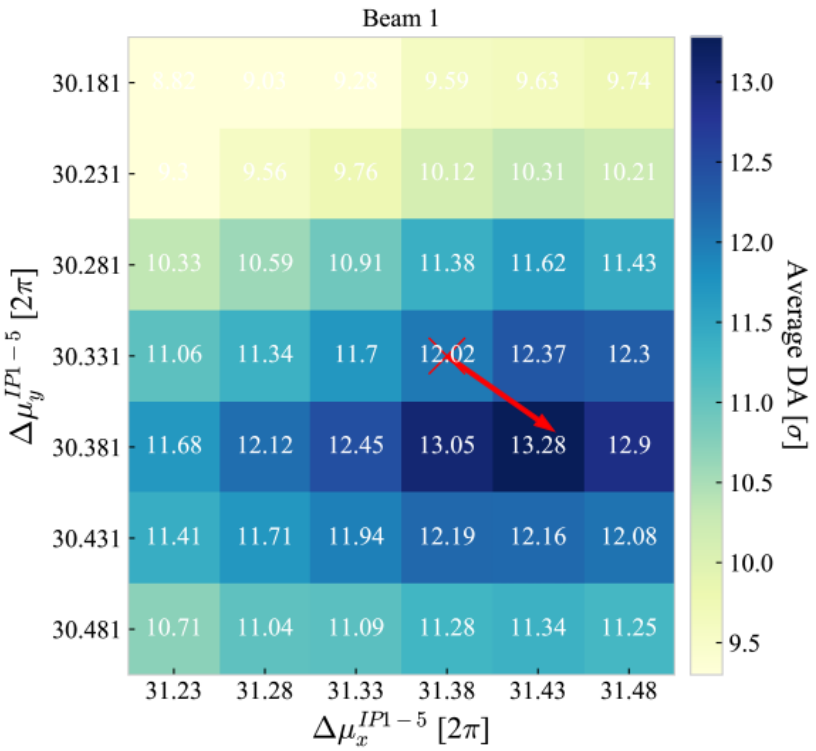
B1 optimized WP

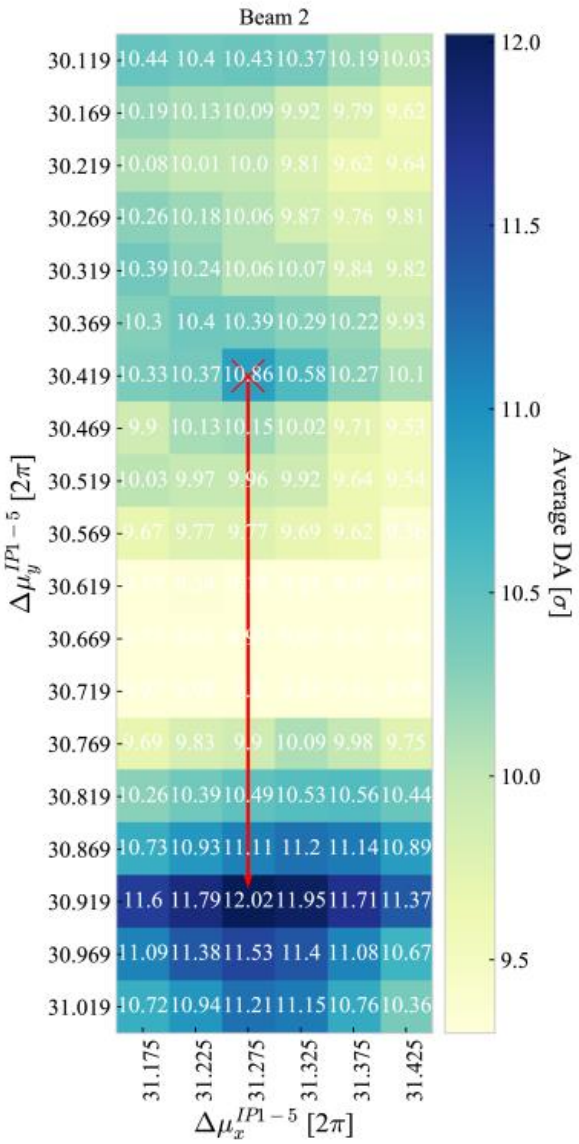


B1 nominal WP



Phase advance optimization





F. Plassard et al: *Sextupole scheme optimization for HL–LHC.*