



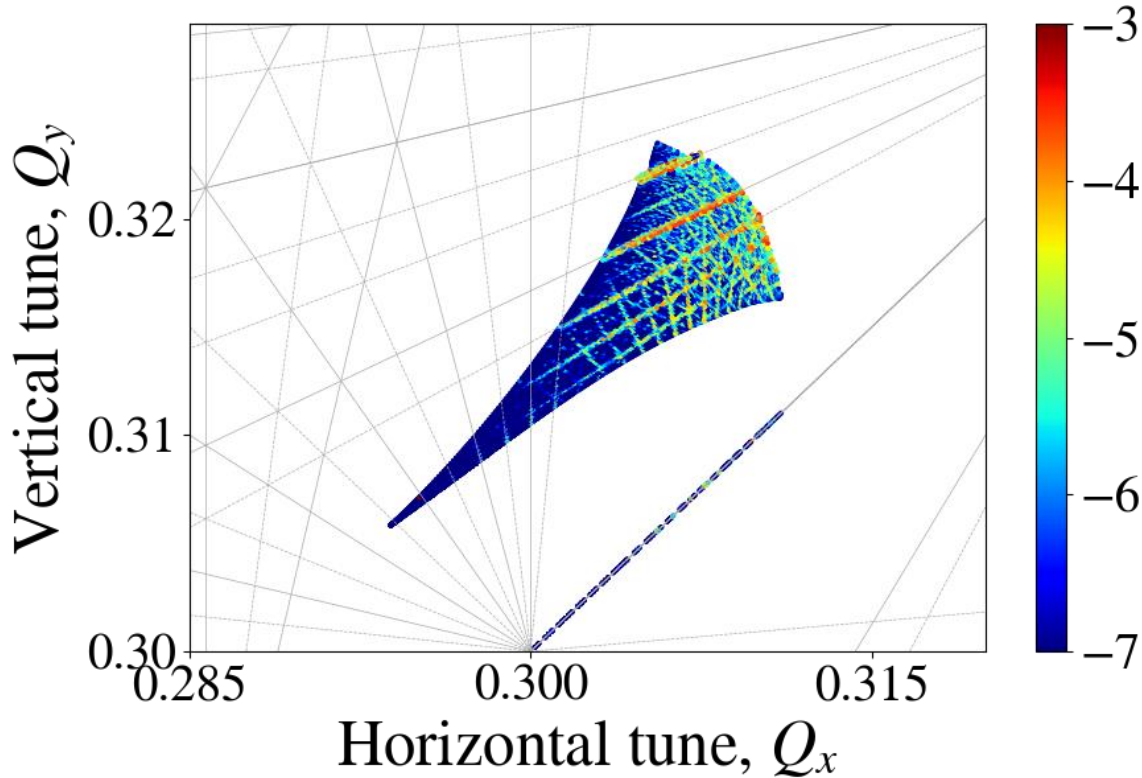
DA studies with flat optics for HL-LHC

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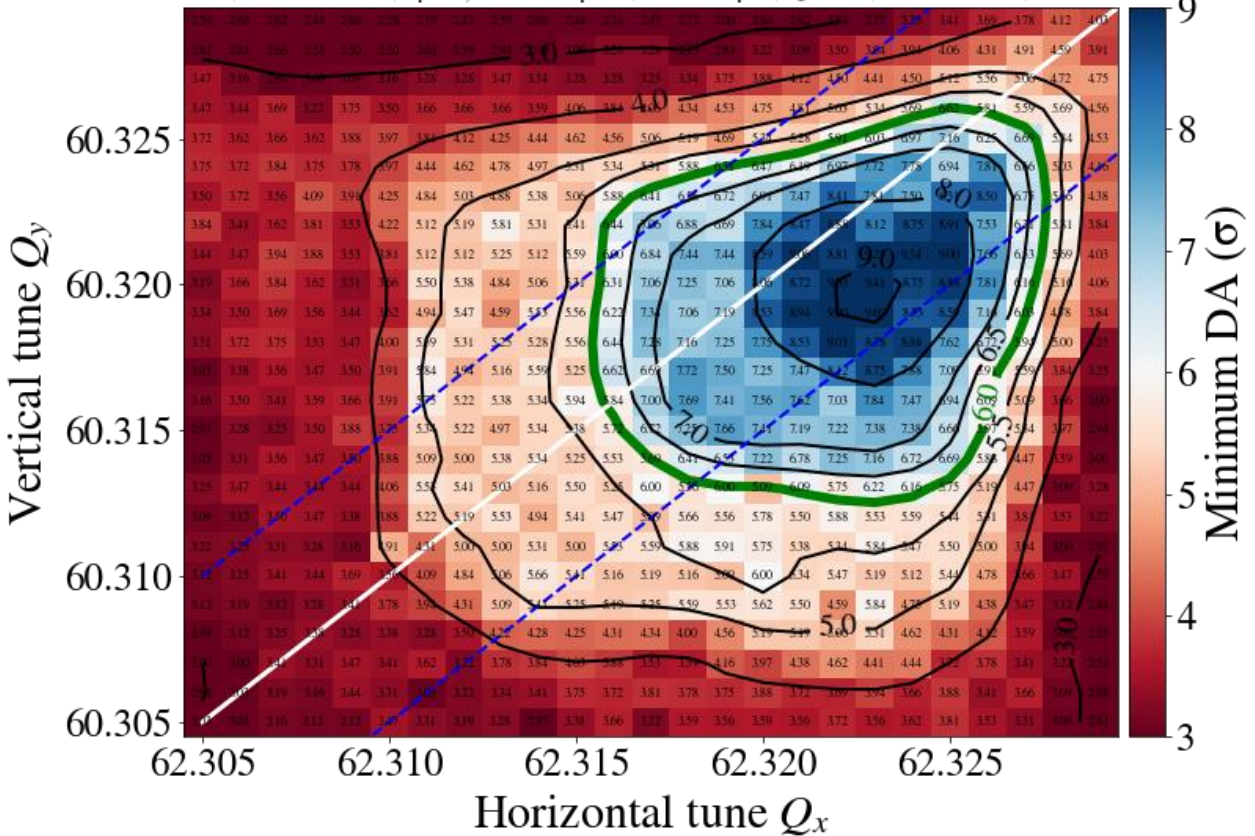
Parameters

- Goal is to show a preliminary scenario for start & end of luminosity leveling that is feasible based on DA.
- General parameters: 7 TeV, $\phi/2$ IP1/5 = 250 μ rad, $\phi/2$ V external crossing IP8 = 170 μ rad, $\sigma_L = 7.61$ cm, 2.5 μ m rad, $Q' = 15$, $C^- = 10^{-3}$
- Start of leveling:
 - 0.5/1 m, H(IP1)/V(IP5) crossing, with crab cavities ([new optics from Riccardo](#))
 - 2.2e11 ppb, $I_{MO} = 300$ A
- End of leveling ([207th WP2](#)):
 - 7.5/18 cm, H(IP1)/V(IP5) crossing, with crab cavities
 - 1e11 ppb, $I_{MO} = 100$ A

SOL $\beta^*=0.5/1$ m with CC



HL-LHC v1.5, Flat optics, Start of leveling
 $N_b = 2.2 \times 10^{11}$ ppb, $\beta_{y,IP1}^* = 0.5$ m, $\beta_{x,IP1}^* = 1$ m, $\phi/2IP1(H)/5(V) = 250$ μ rad
 CC ON, $\sigma_z = 7.61$ cm, $\phi/2V,IP8 = 170$ μ rad, $\epsilon_n = 2.5$ μ m, $Q' = 15$, $I_{MO} = 300$ A, $C^- = 10^{-3}$



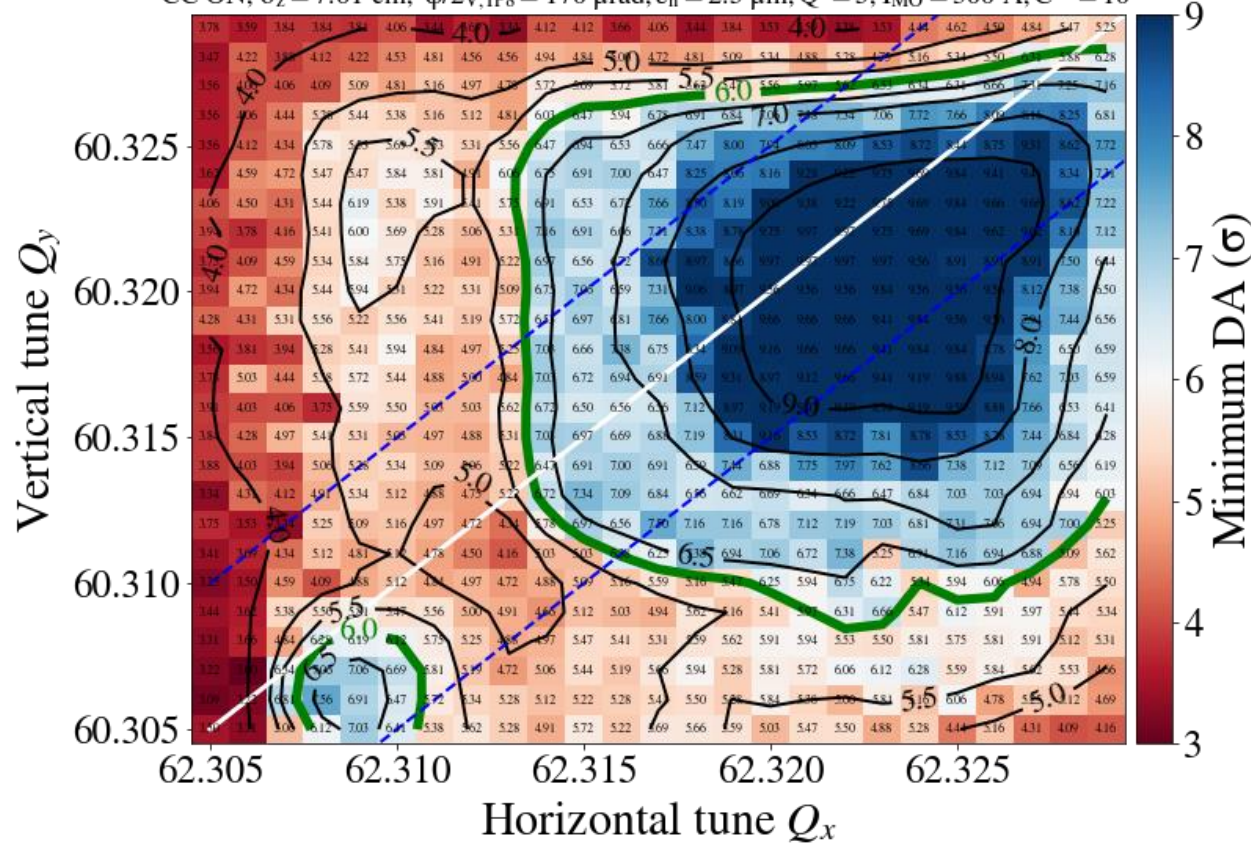
SOL $\beta^*=0.5/1$ m with CC

$Q'=5$

HL-LHC v1.5, Flat optics, Start of leveling

$N_b = 2.2 \times 10^{11}$ ppb, $\beta_{y,IP1}^* = 0.5$ m, $\beta_{x,IP1}^* = 1$ m, $\phi/2IP1(H)/5(V) = 250$ μ rad

CC ON, $\sigma_z = 7.61$ cm, $\phi/2V_{IP8} = 170$ μ rad, $\epsilon_n = 2.5$ μ m, $Q' = 5$, $I_{MO} = 300$ A, $C^- = 10^{-3}$

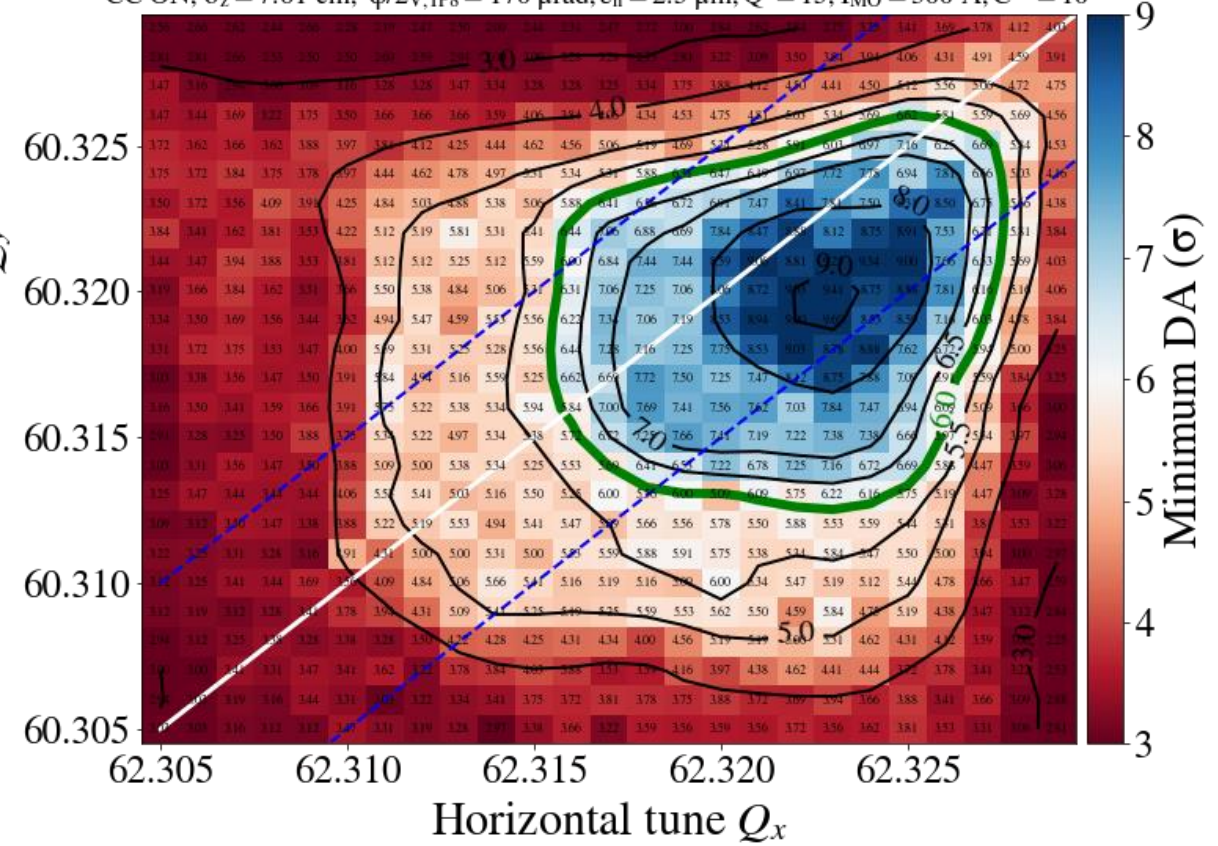


$Q'=15$

HL-LHC v1.5, Flat optics, Start of leveling

$N_b = 2.2 \times 10^{11}$ ppb, $\beta_{y,IP1}^* = 0.5$ m, $\beta_{x,IP1}^* = 1$ m, $\phi/2IP1(H)/5(V) = 250$ μ rad

CC ON, $\sigma_z = 7.61$ cm, $\phi/2V_{IP8} = 170$ μ rad, $\epsilon_n = 2.5$ μ m, $Q' = 15$, $I_{MO} = 300$ A, $C^- = 10^{-3}$

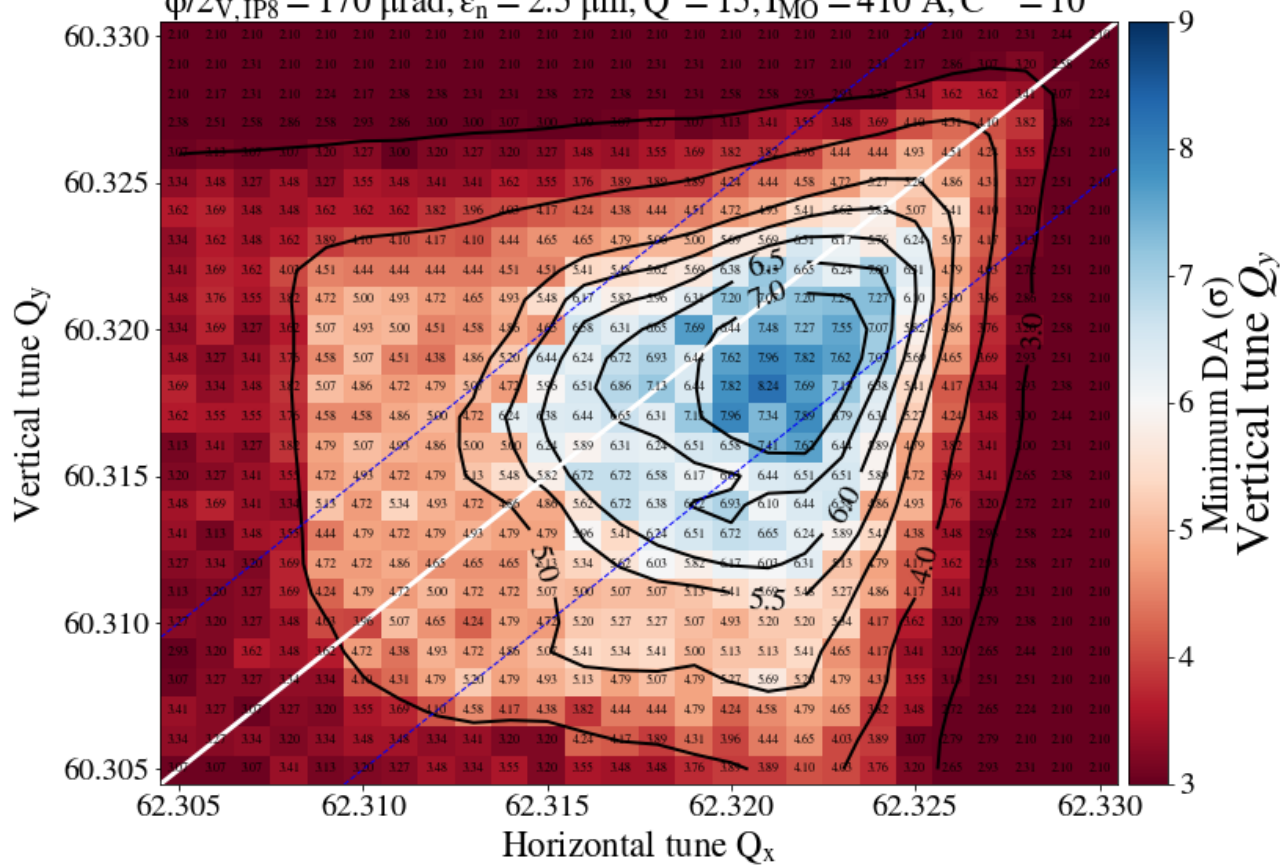


A comparison with round optics

Round optics

HL-LHC v1.5, MS.10, $N_b = 2.3 \times 10^{11}$ ppb, $\beta_{IP1/5}^* = 1$ m, $\phi/2_{IP1/5} = 250$ μ rad

$\phi/2_{V,IP8} = 170$ μ rad, $\epsilon_n = 2.5$ μ m, $Q' = 15$, $I_{MO} = 410$ A, $C^- = 10^{-3}$

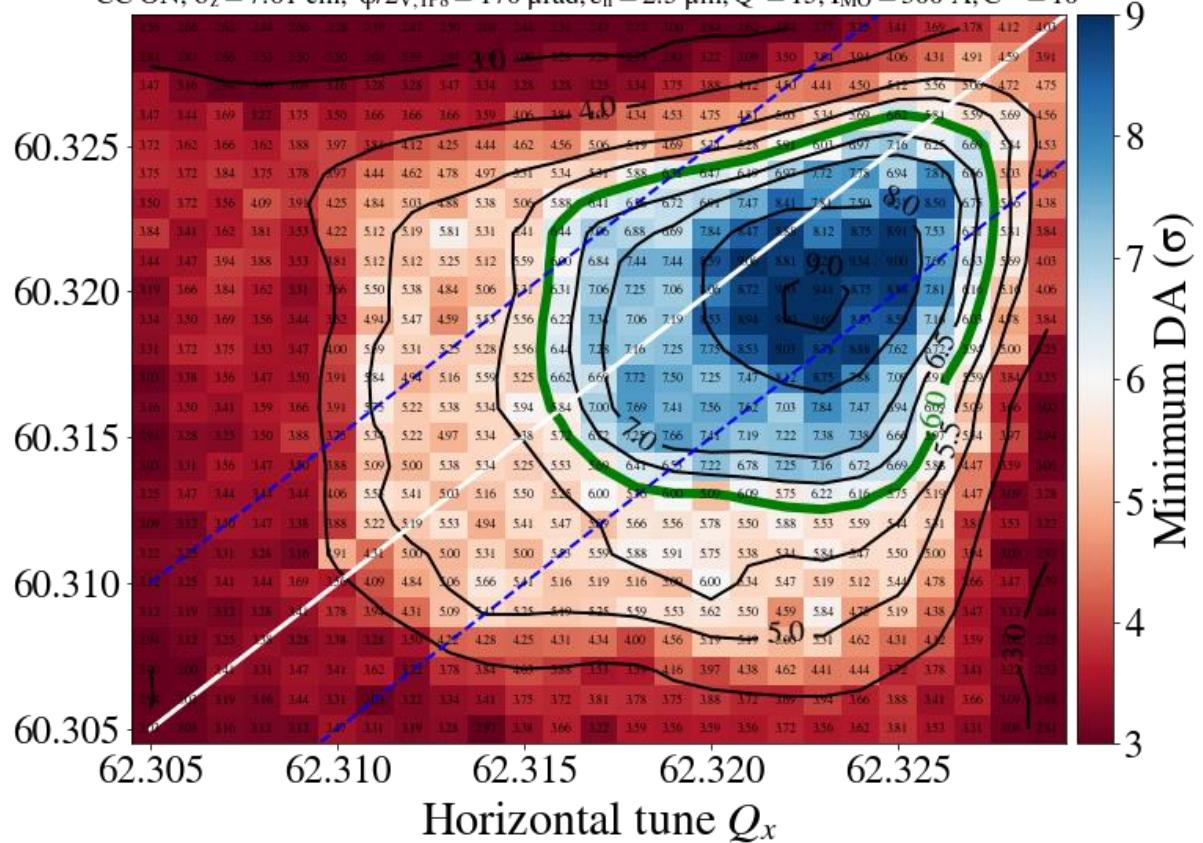


Flat optics

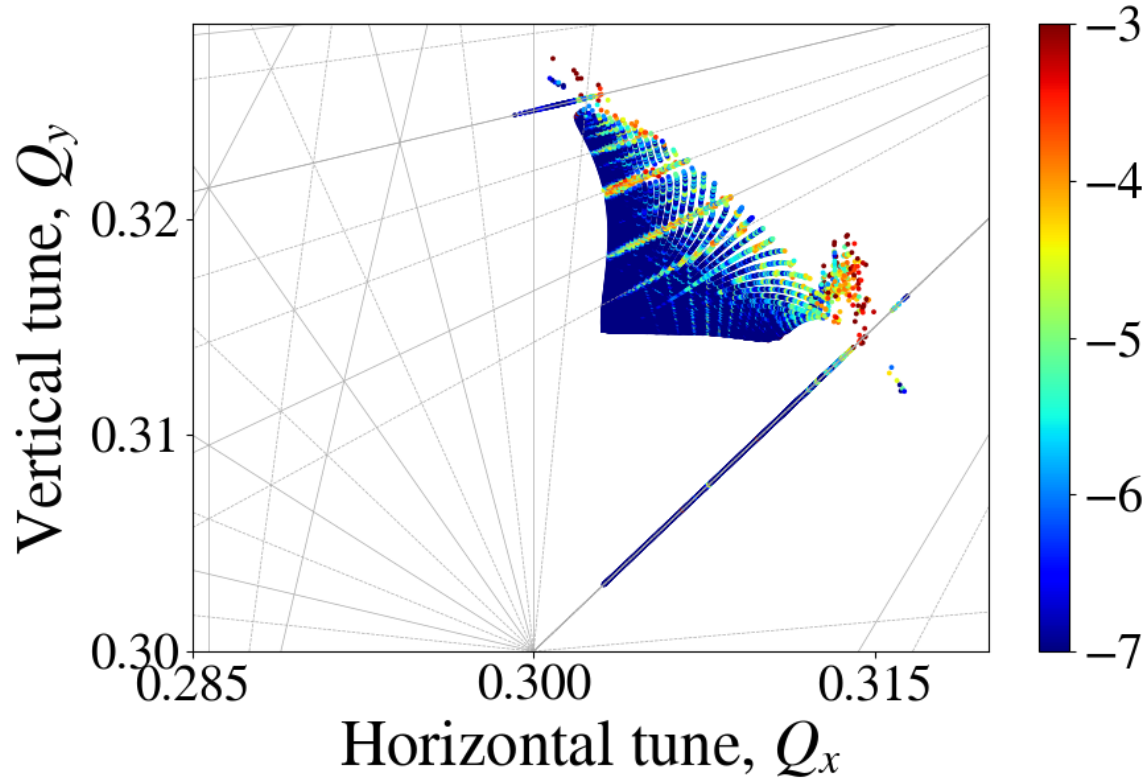
HL-LHC v1.5, Flat optics, Start of leveling

$N_b = 2.2 \times 10^{11}$ ppb, $\beta_{y,IP1}^* = 0.5$ m, $\beta_{x,IP1}^* = 1$ m, $\phi/2_{IP1(H)/5(V)} = 250$ μ rad

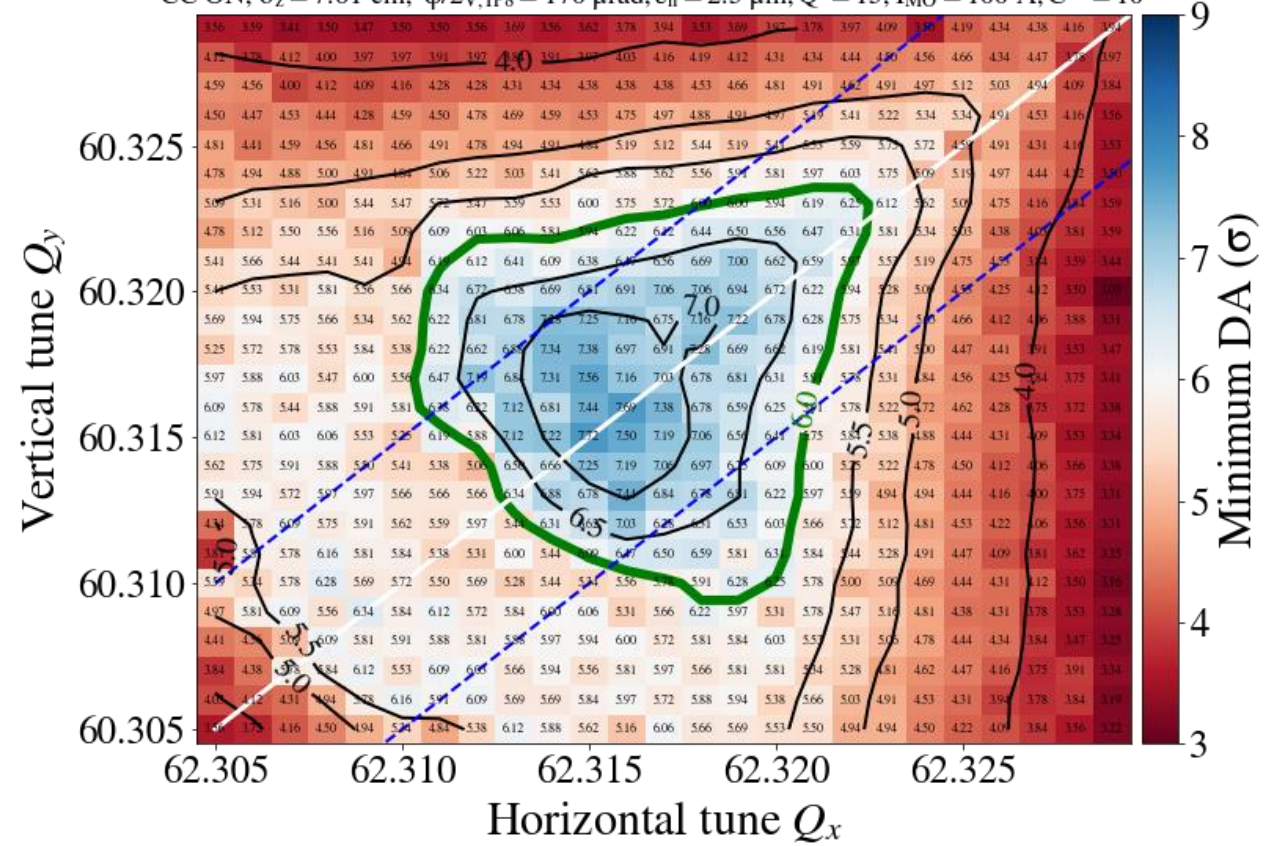
CC ON, $\sigma_z = 7.61$ cm, $\phi/2_{V,IP8} = 170$ μ rad, $\epsilon_n = 2.5$ μ m, $Q' = 15$, $I_{MO} = 300$ A, $C^- = 10^{-3}$



EOL $\beta^* = 7.5/18$ cm with CC



HL-LHC v1.5, Flat optics, End of leveling
 $N_b = 1 \times 10^{11}$ ppb, $\beta_{y,IP1}^* = 7.5$ cm, $\beta_{x,IP1}^* = 18$ cm, $\phi/2_{IP1(H)/5(V)} = 250$ μ rad
 CC ON, $\sigma_z = 7.61$ cm, $\phi/2_{V,IP8} = 170$ μ rad, $\epsilon_n = 2.5$ μ m, $Q' = 15$, $I_{MO} = 100$ A, $C^- = 10^{-3}$

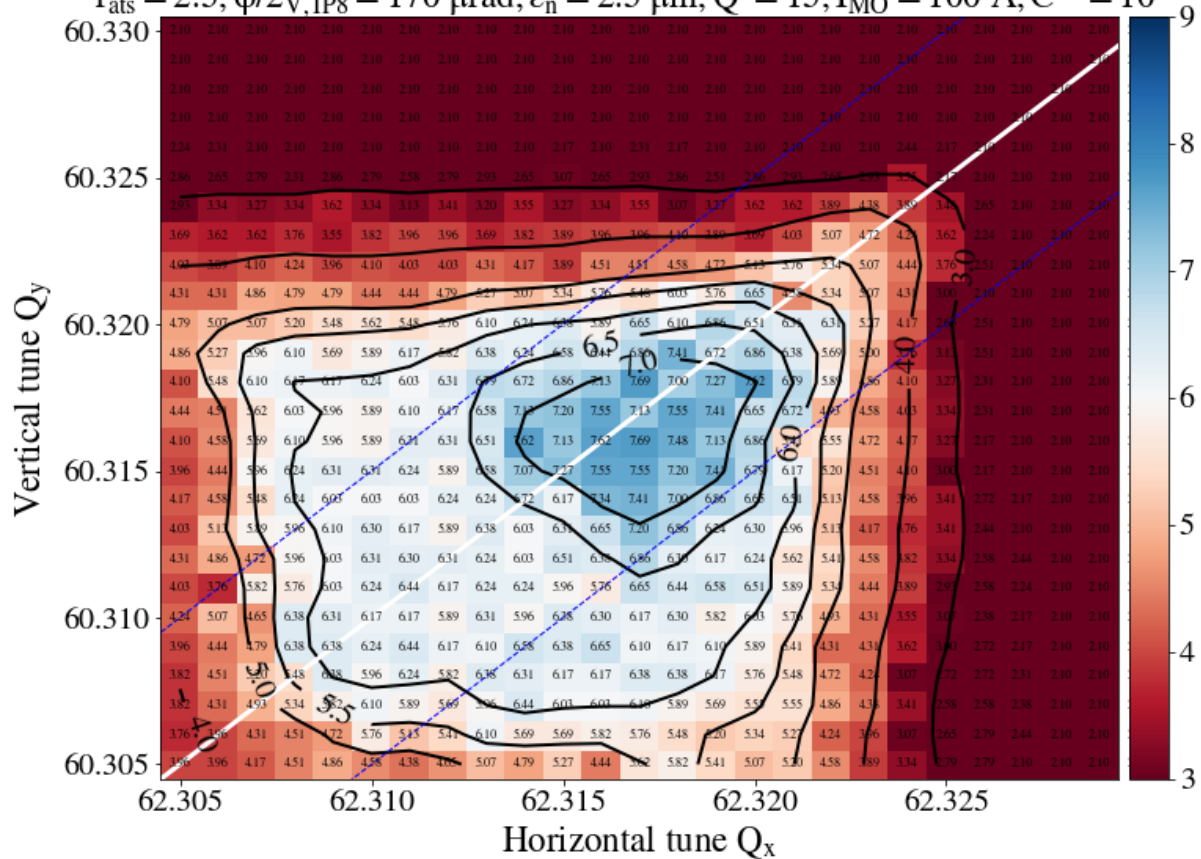


A comparison with round optics

Round optics

HL-LHC v1.5, with MS.10, $N_b = 1.3 \times 10^{11}$ ppb, $\beta_{IP1/5}^* = 20$ cm, $\phi/2_{IP1/5} = 250$ μ rad

$r_{ats} = 2.5$, $\phi/2_{V,IP8} = 170$ μ rad, $\epsilon_n = 2.5$ μ m, $Q' = 15$, $I_{MO} = 100$ A, $C^- = 10^{-3}$

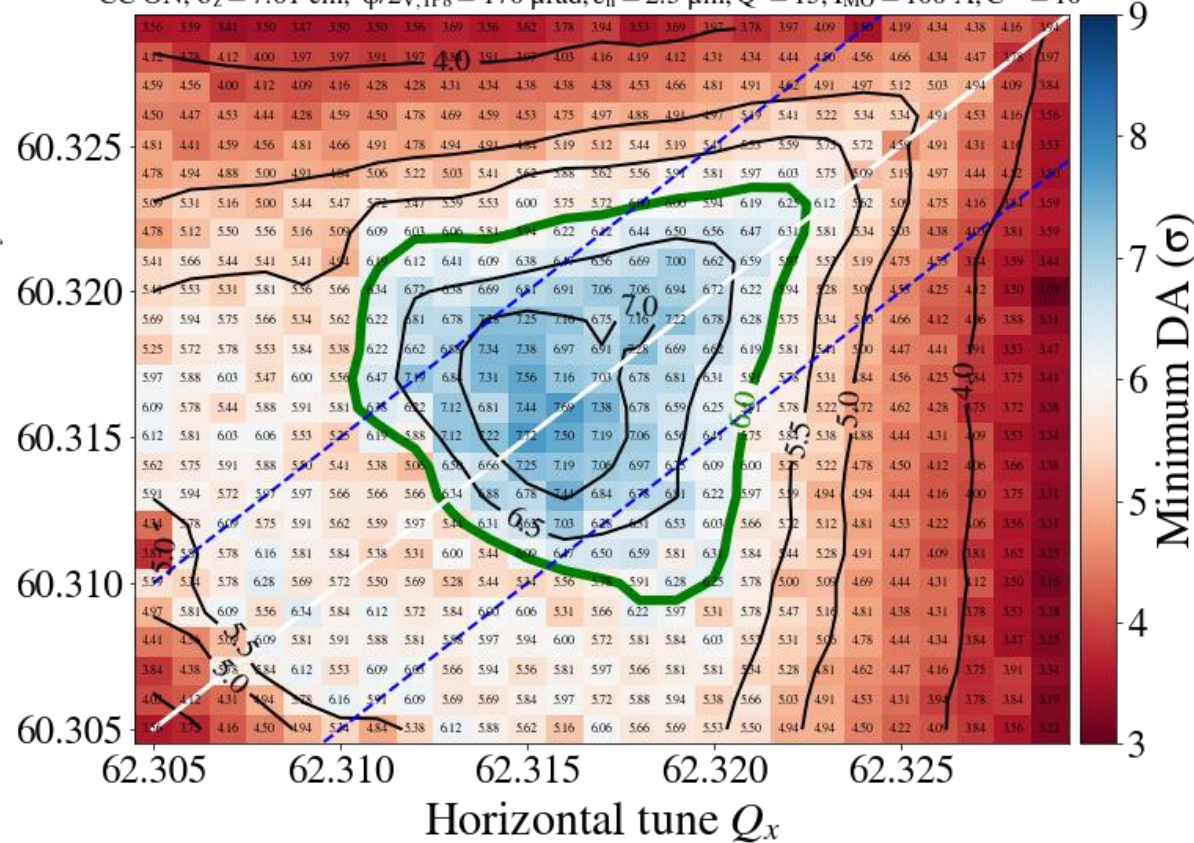


Flat optics

HL-LHC v1.5, Flat optics, End of leveling

$N_b = 1 \times 10^{11}$ ppb, $\beta_{y,IP1}^* = 7.5$ cm, $\beta_{x,IP1}^* = 18$ cm, $\phi/2_{IP1(H)/5(V)} = 250$ μ rad

CC ON, $\sigma_z = 7.61$ cm, $\phi/2_{V,IP8} = 170$ μ rad, $\epsilon_n = 2.5$ μ m, $Q' = 15$, $I_{MO} = 100$ A, $C^- = 10^{-3}$



Conclusions

At the moment, feasible scenarios based on DA for:

- Start of leveling:
 - $I_{MO}=300$ A, $2.2e11$ ppb, $\beta^*=0.5/1$ m, with CC, $\varphi/2_{IP1/5}=250$ μ rad
- End of leveling:
 - $I_{MO}=100$ A, $1.0e11$ ppb, $\beta^*=7.5/18$ cm, with CC, $\varphi/2_{IP1/5}=250$ μ rad