PRELIMINARY

Impact of Coupling and its correction to collective effects (The DA part)

G. Arduini, X. Buffat, R. De Maria,
N. Karastathis, E. Métral, Y. Papaphilippou,
R. Tomas, *et al.*

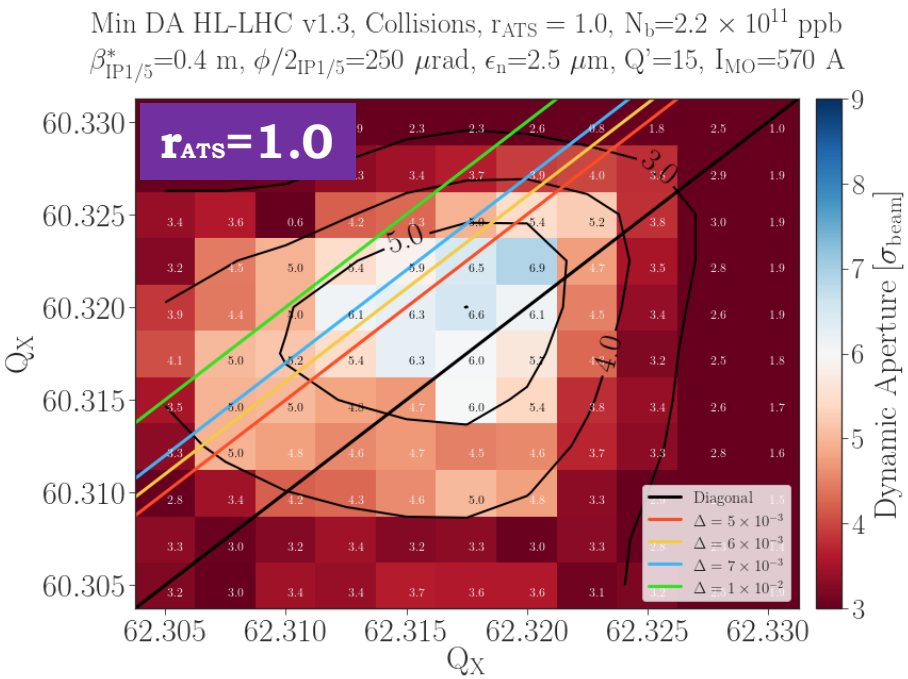
WP2 Meeting
17.09.2019

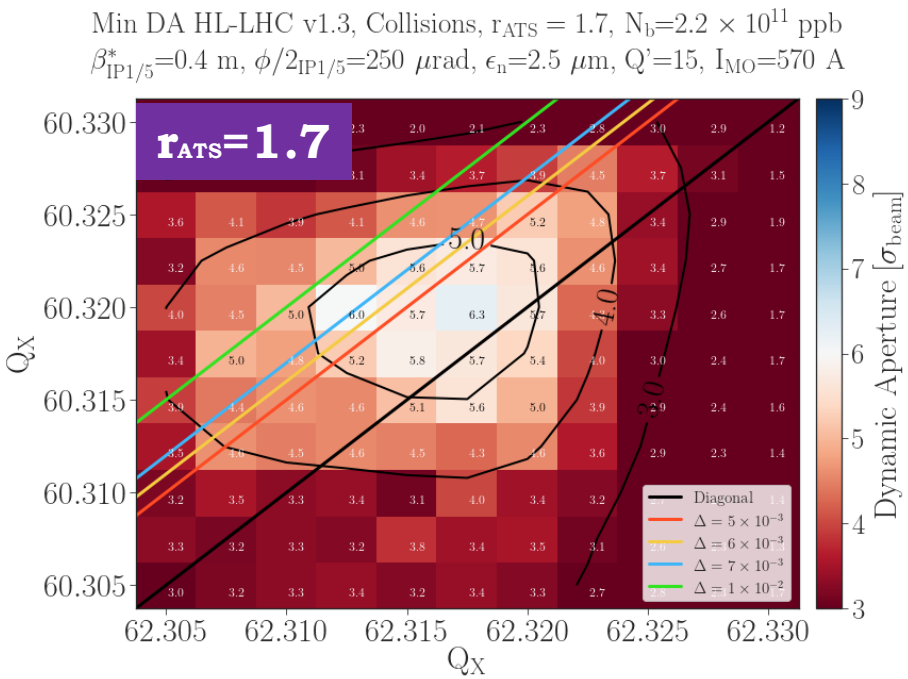
Introduction

- Usual DA simulations (1M turns, 0-10σ, 5 angles) have been employed to identify the available parameter space at the start of collisions, taking into account
  - Start of leveling **β***: **0.4 m , 0.6 m**
  - Start of leveling **telescopic index**: **1.7, 1.9, 2.2, 2.5**
  - **Octupole polarity**
  - WP & **Tune Split** : **5e-3, 6e-3, 7e-3, 10e-3**
  - Start of leveling **bunch intensity**: **1.7 - 2.2e11 ppb**

Quick Look at $I_{MO}>0$

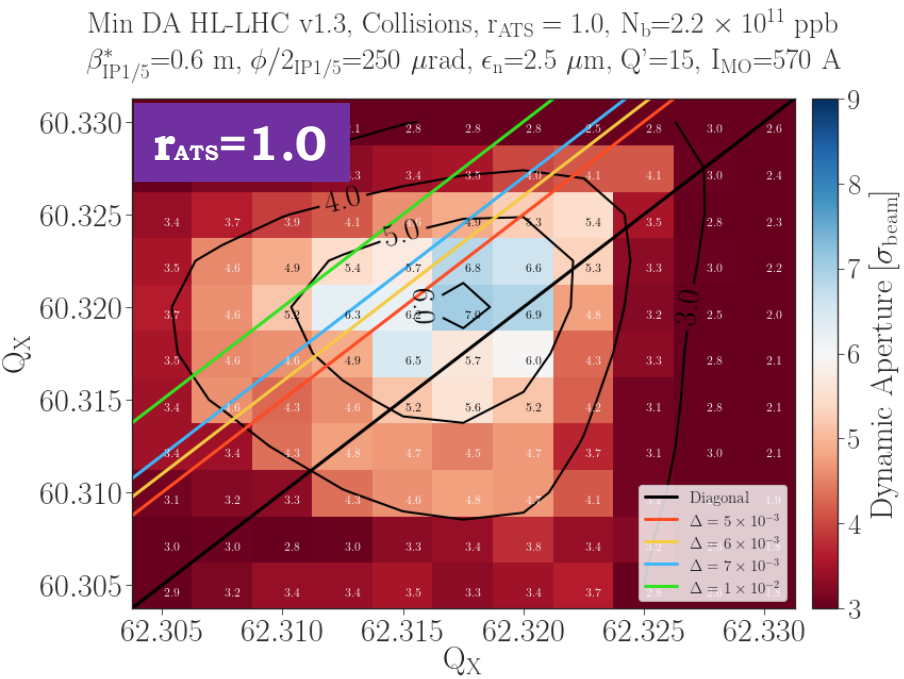
β* = 0.4 m , IMO = 570 A

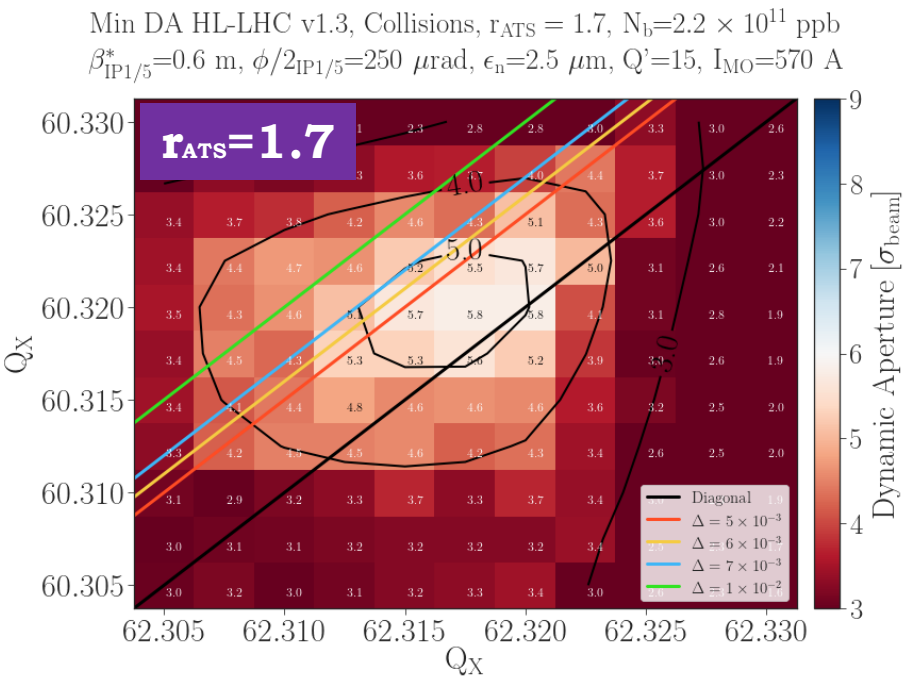




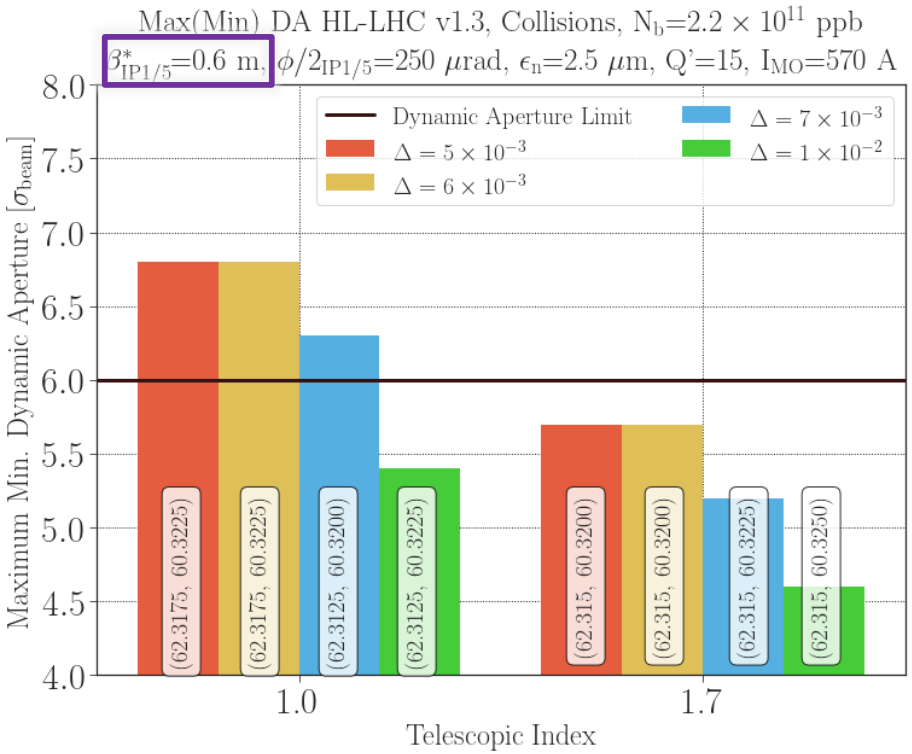
- Bit pessimistic since the full 570A of octupole current are used in both cases.

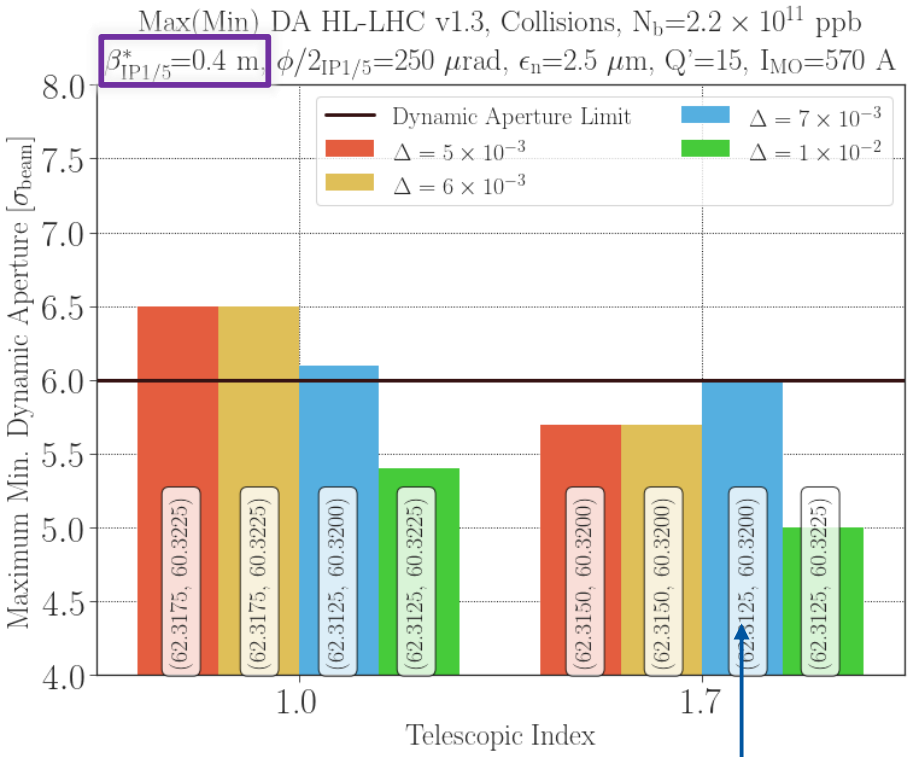
β* = 0.6 m , I_{MO} = 570 A





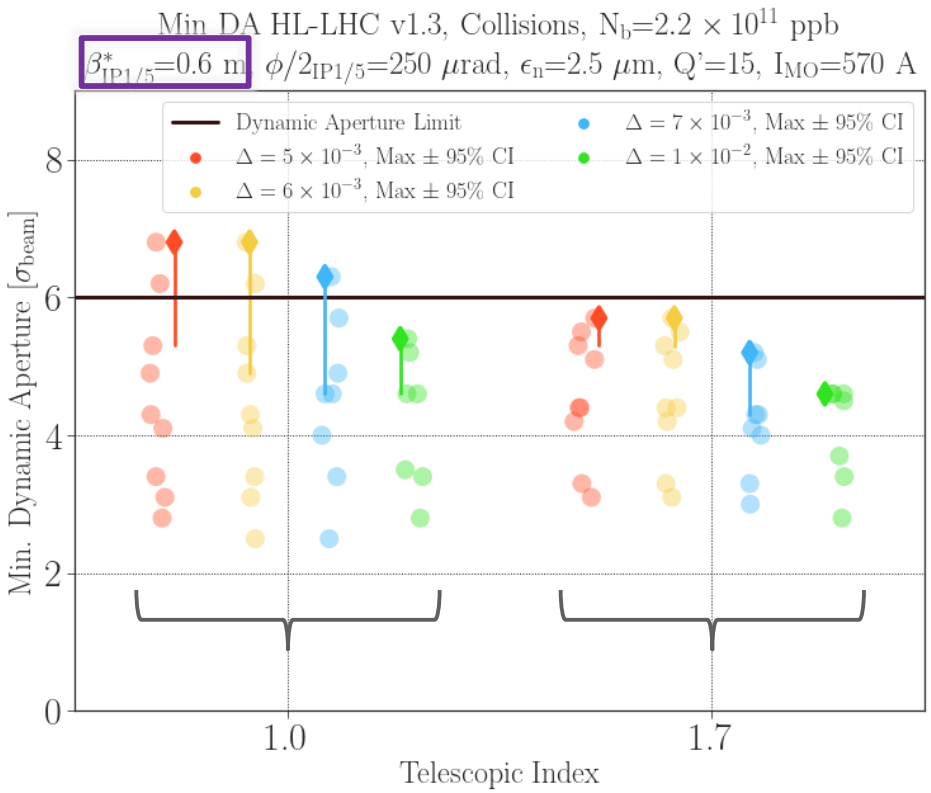
Summary on I_{MO} = 570 A

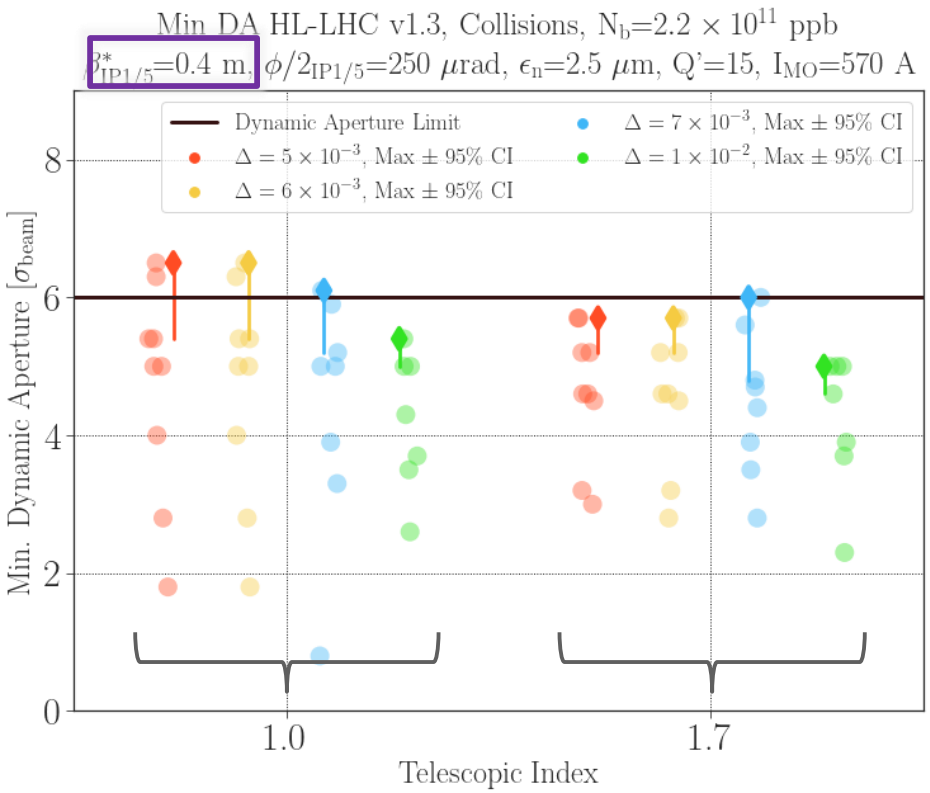




Single point otherwise 5.6

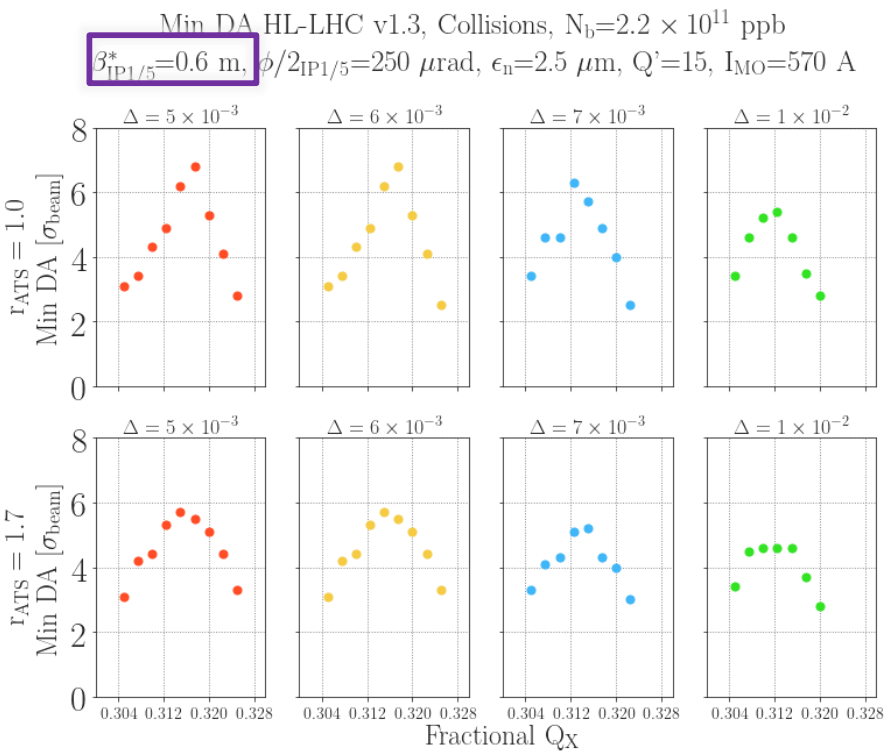
Summary on I_{MO} = 570 A

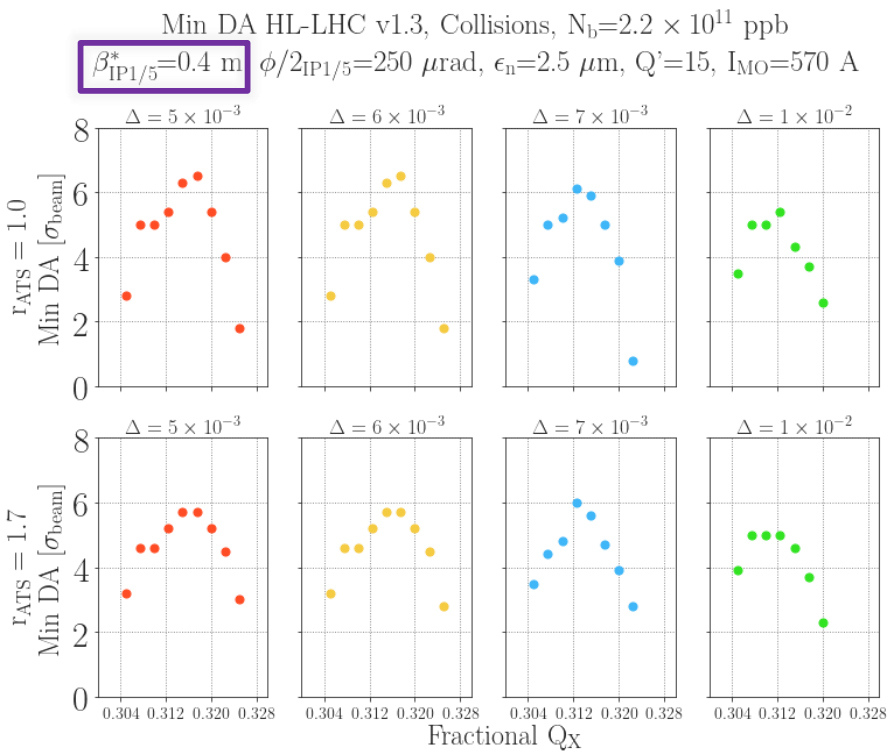




- The points (circles) show the minimum DA along the diagonal with a given Δ.
- The diamond show the maximum minimum DA found in the subset, with the associated α=0.05 confidence level (95% CI) (errorbar).

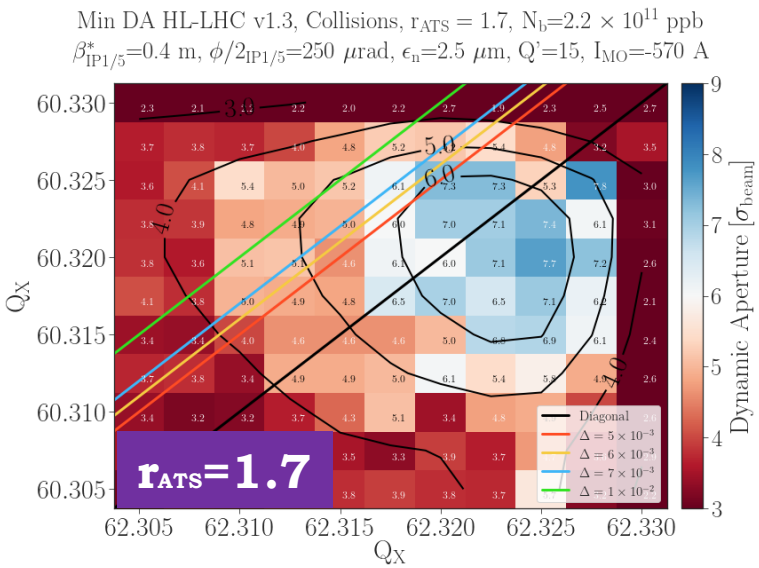
Summary on I_{MO} = 570 A

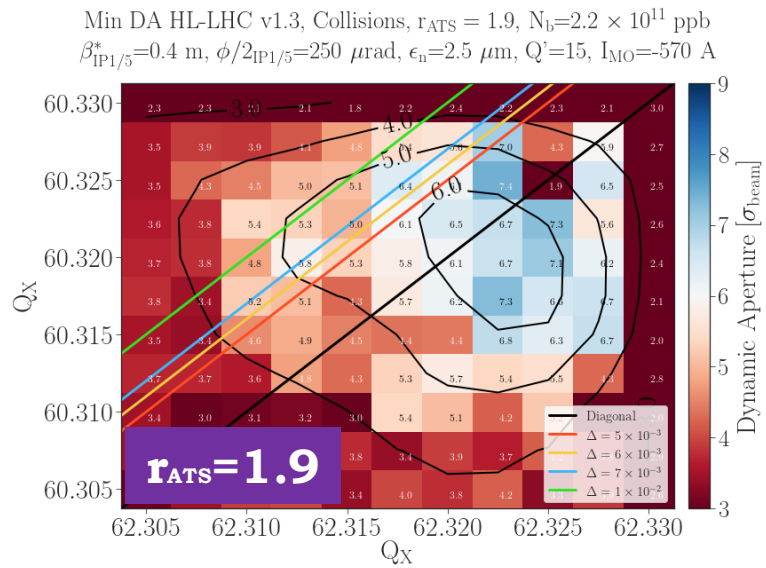


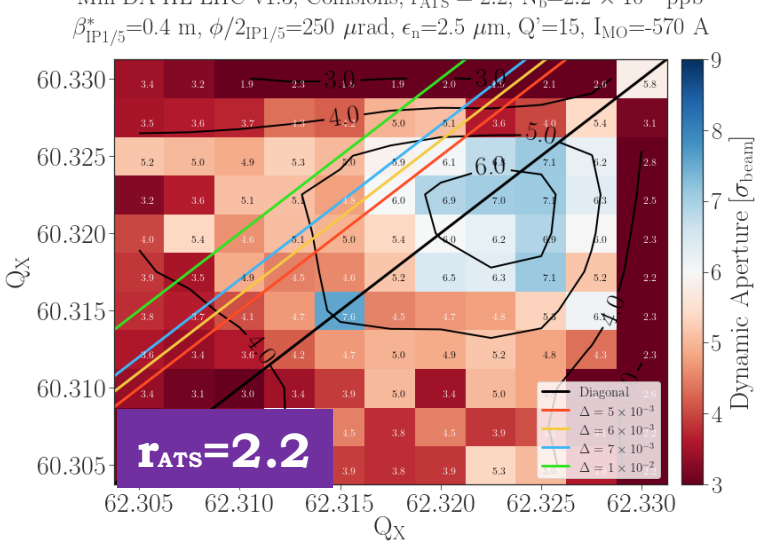


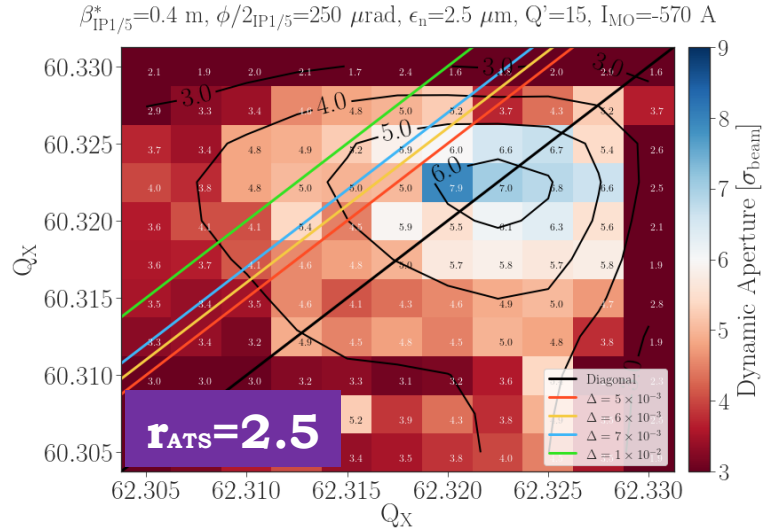
$I_{MO}<0$

β* = 0.4 m , IMO = -570 A

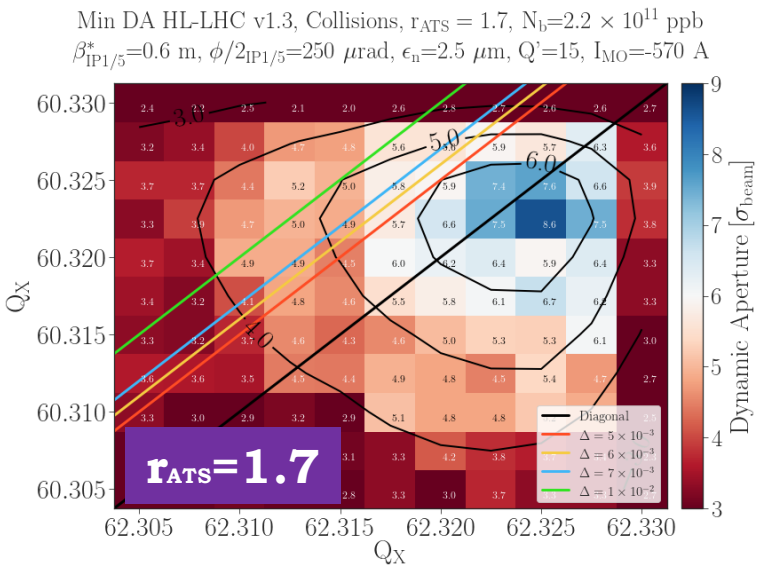


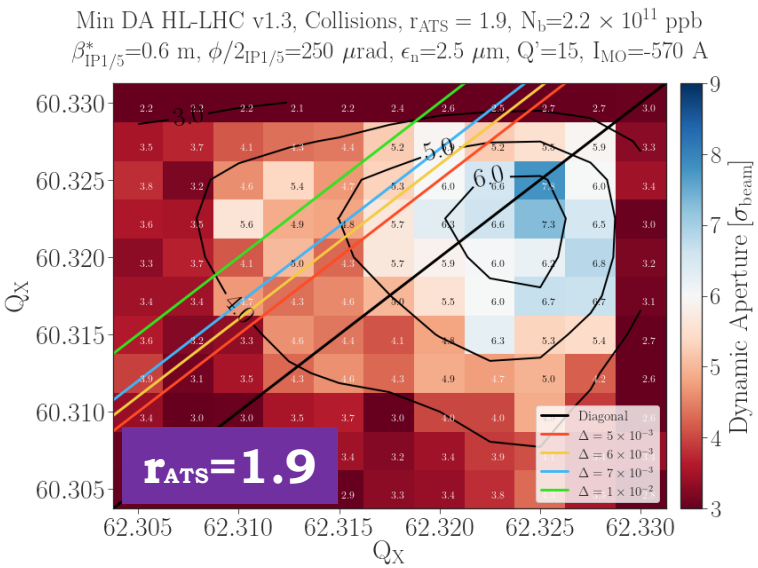


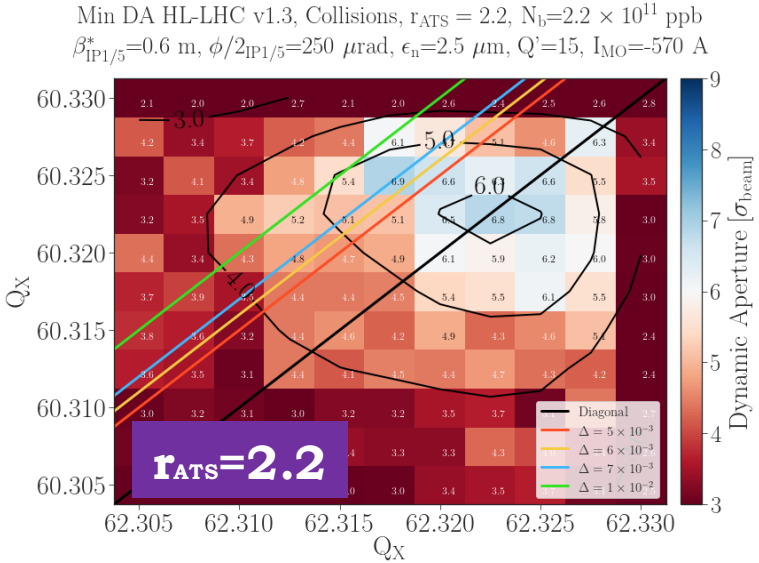


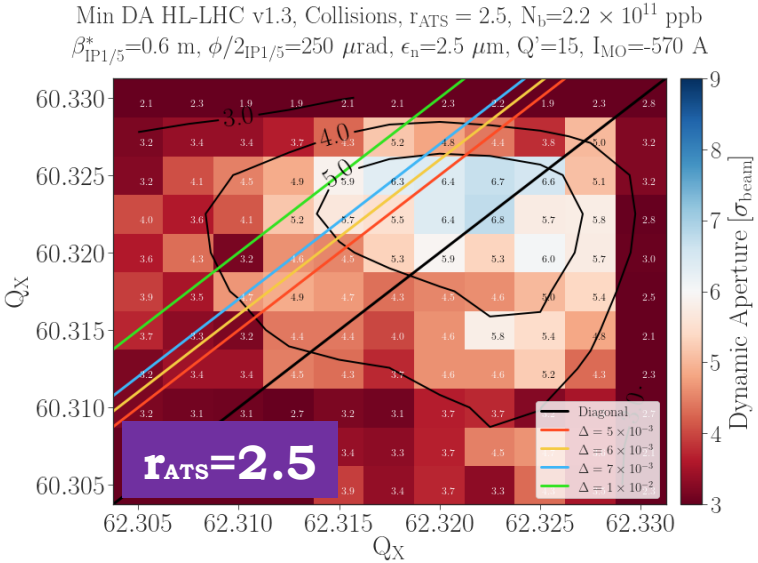


β* = 0.6 m , IMO = -570 A



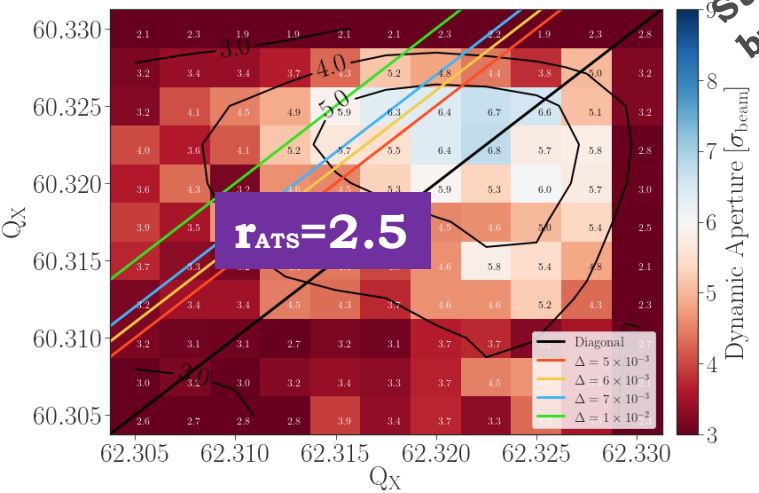






Asynchronous Collapse & CC

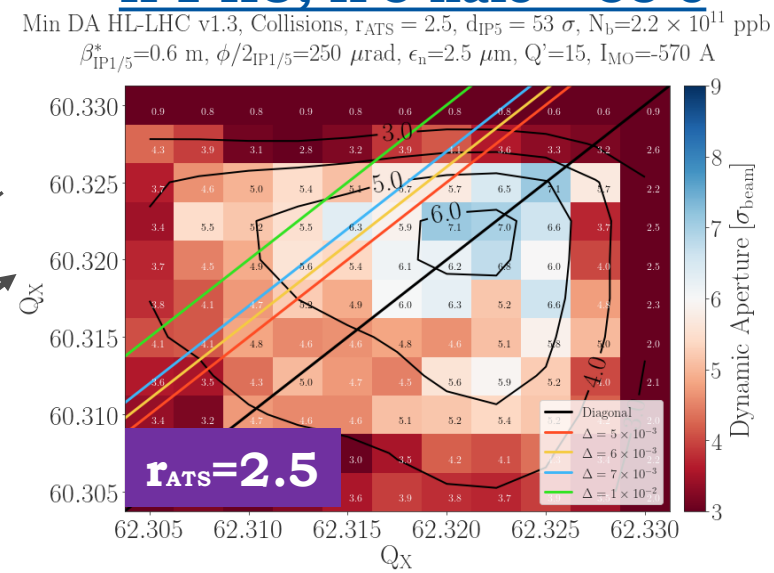
Both IPs HO & CC on



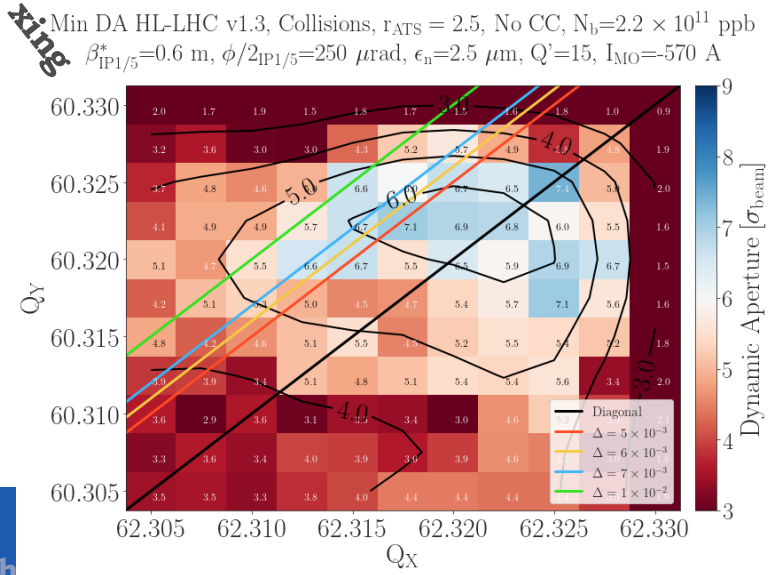
Still a bit tight, but almost +1σ in the worst case.

The increased xing opens up the available DA space.

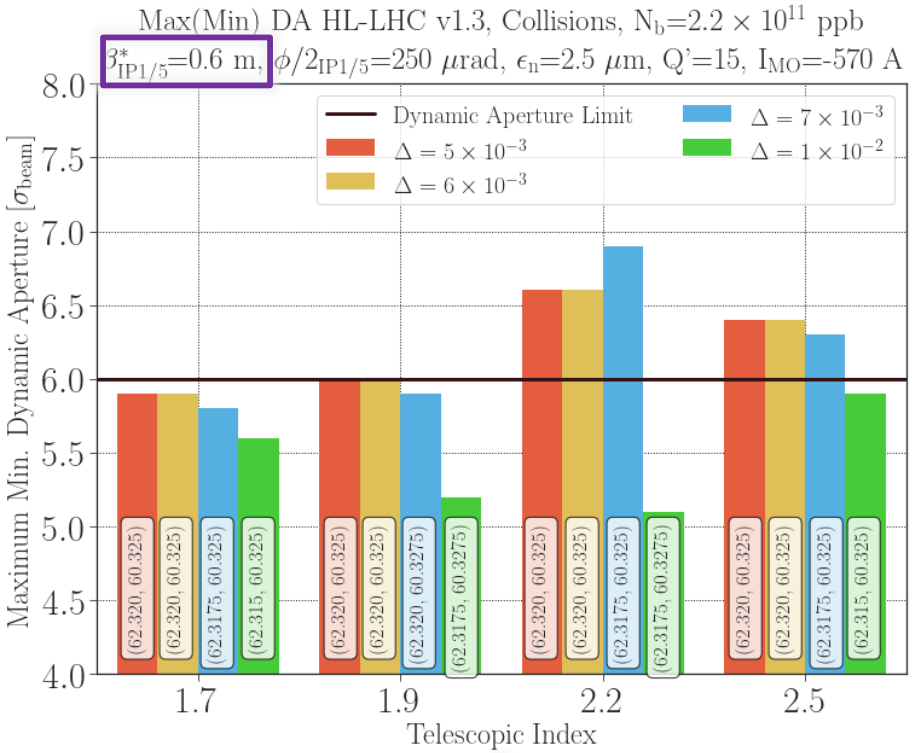
IP1 HO, IP5 halo = 53 σ

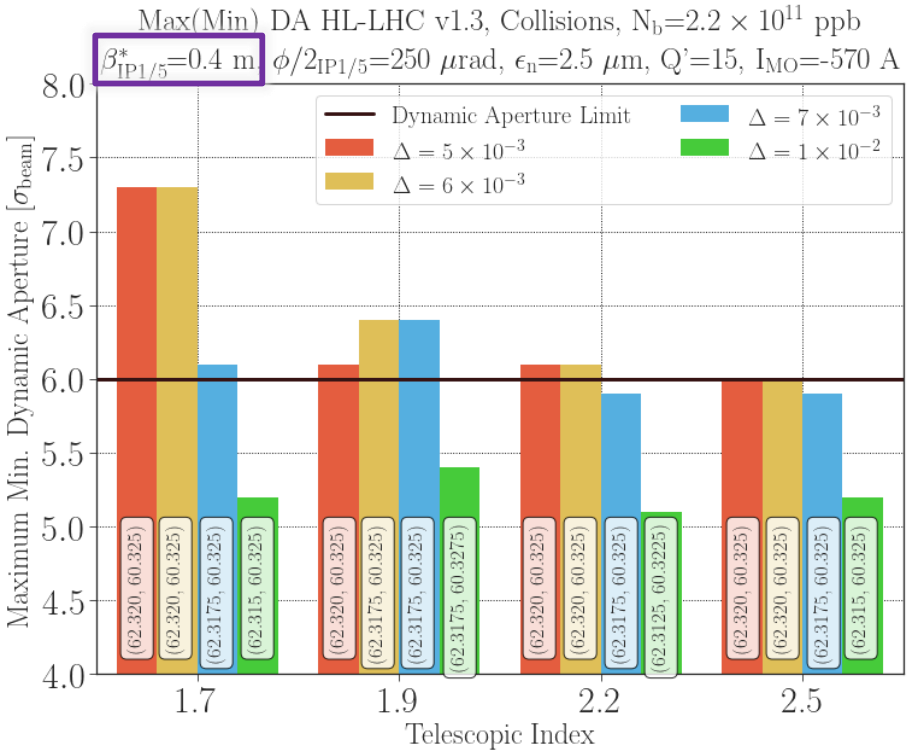


Both IPs HO & CC off



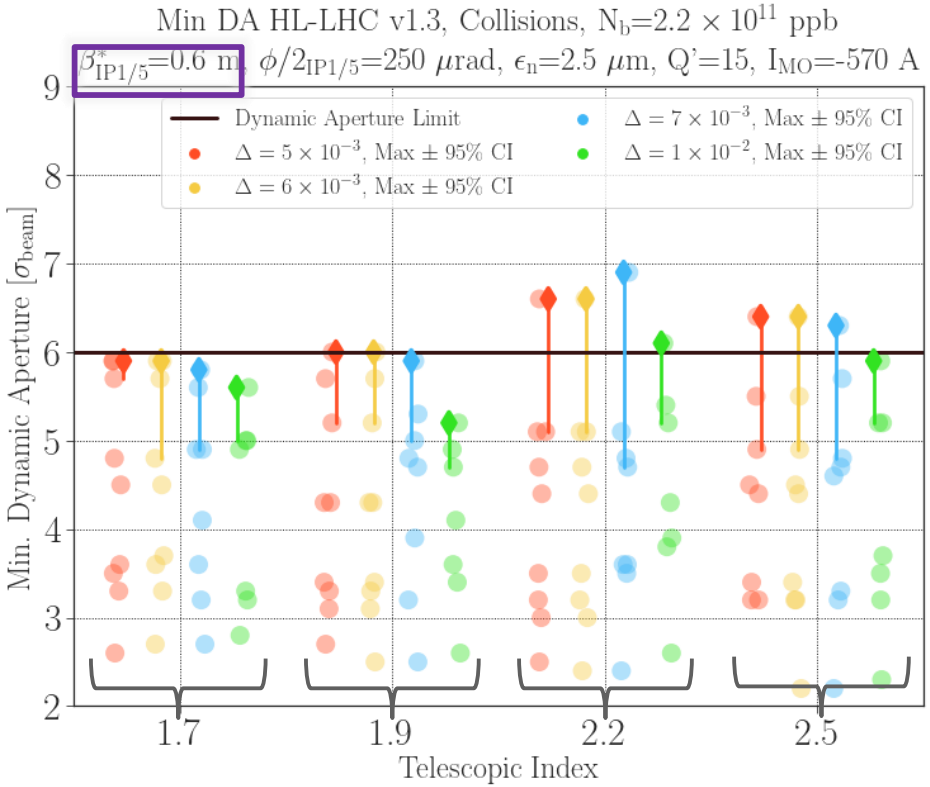
Summary of I_{MO} = -570 A

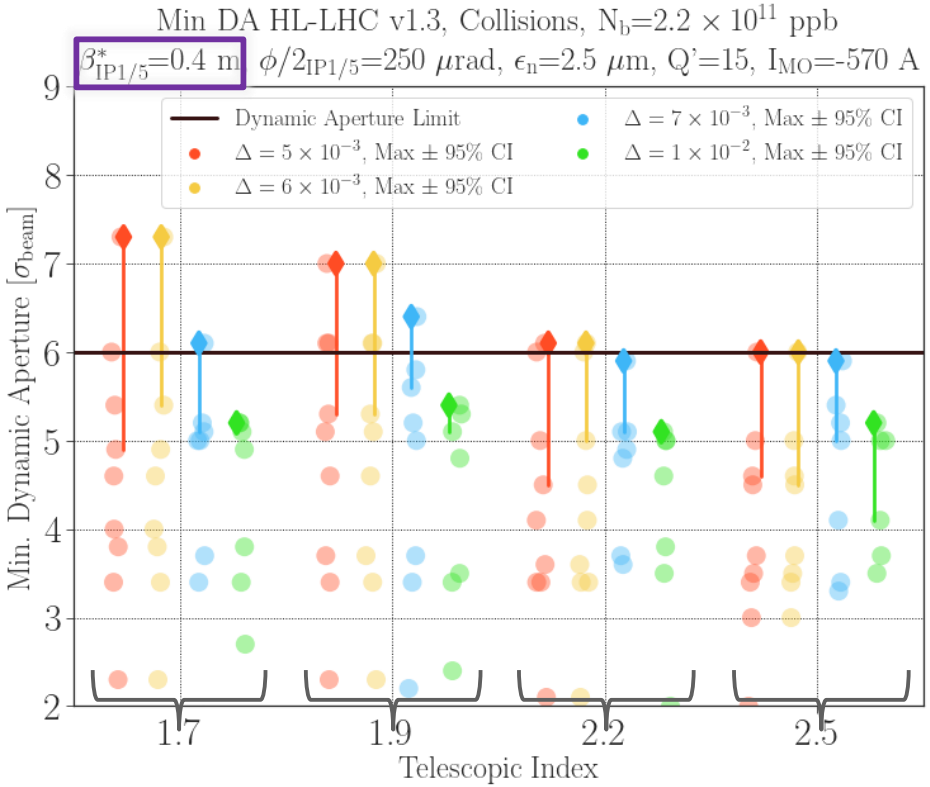




Not really representative of the overall contours.

Summary of I_{MO} = -570 A

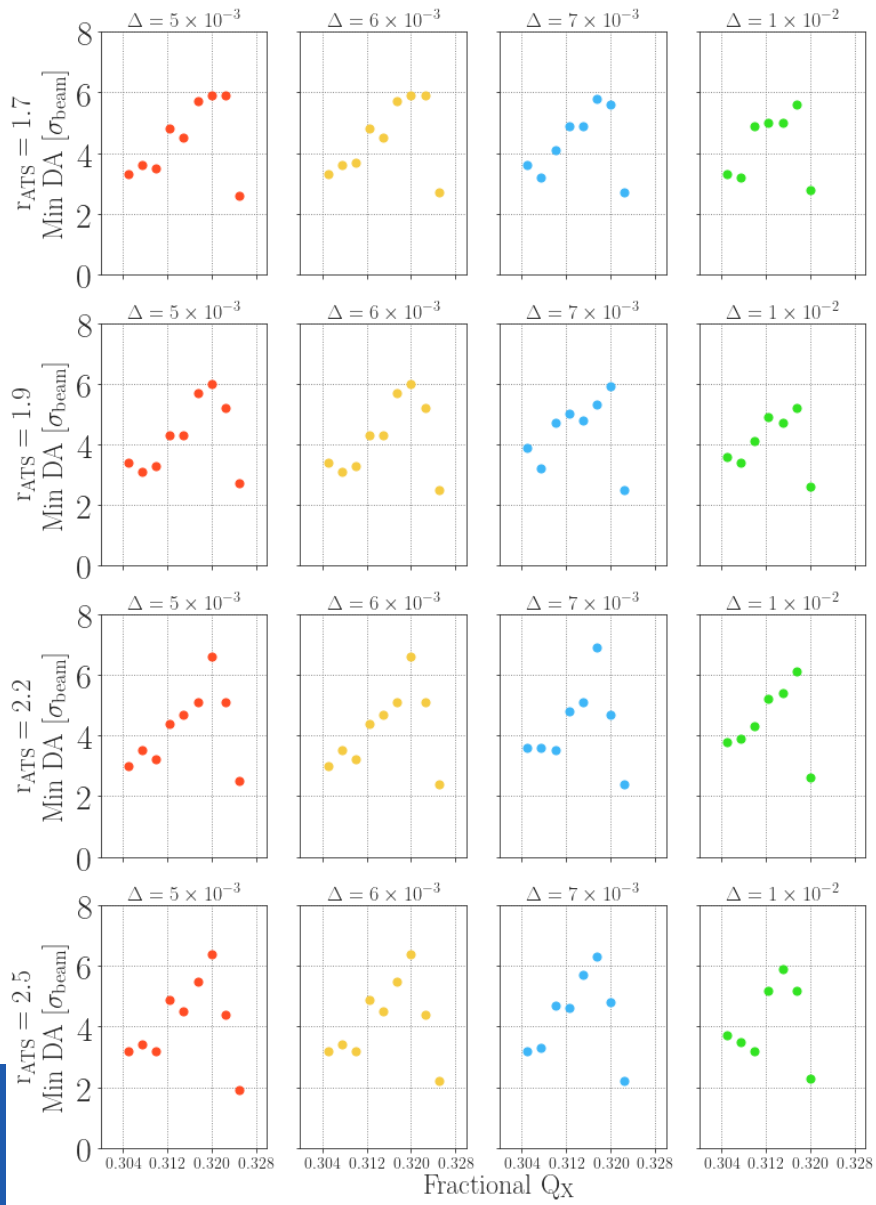


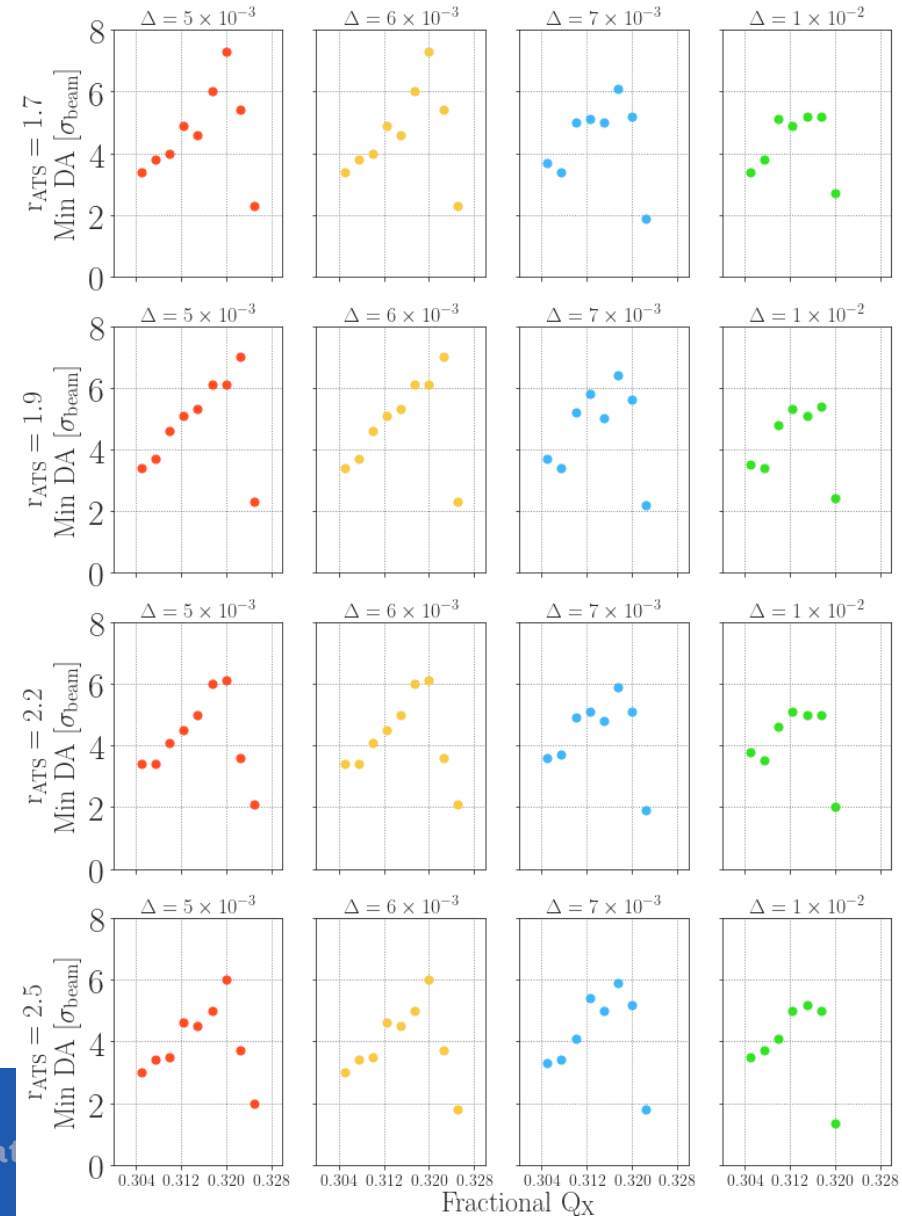


Overall the 5, 6 and 7e-3 behave quite similar.
1e-2 is almost out of the question in all configurations.

N.B.: Notice the larger "error bars".

Summary of I_{MO} = -570 A

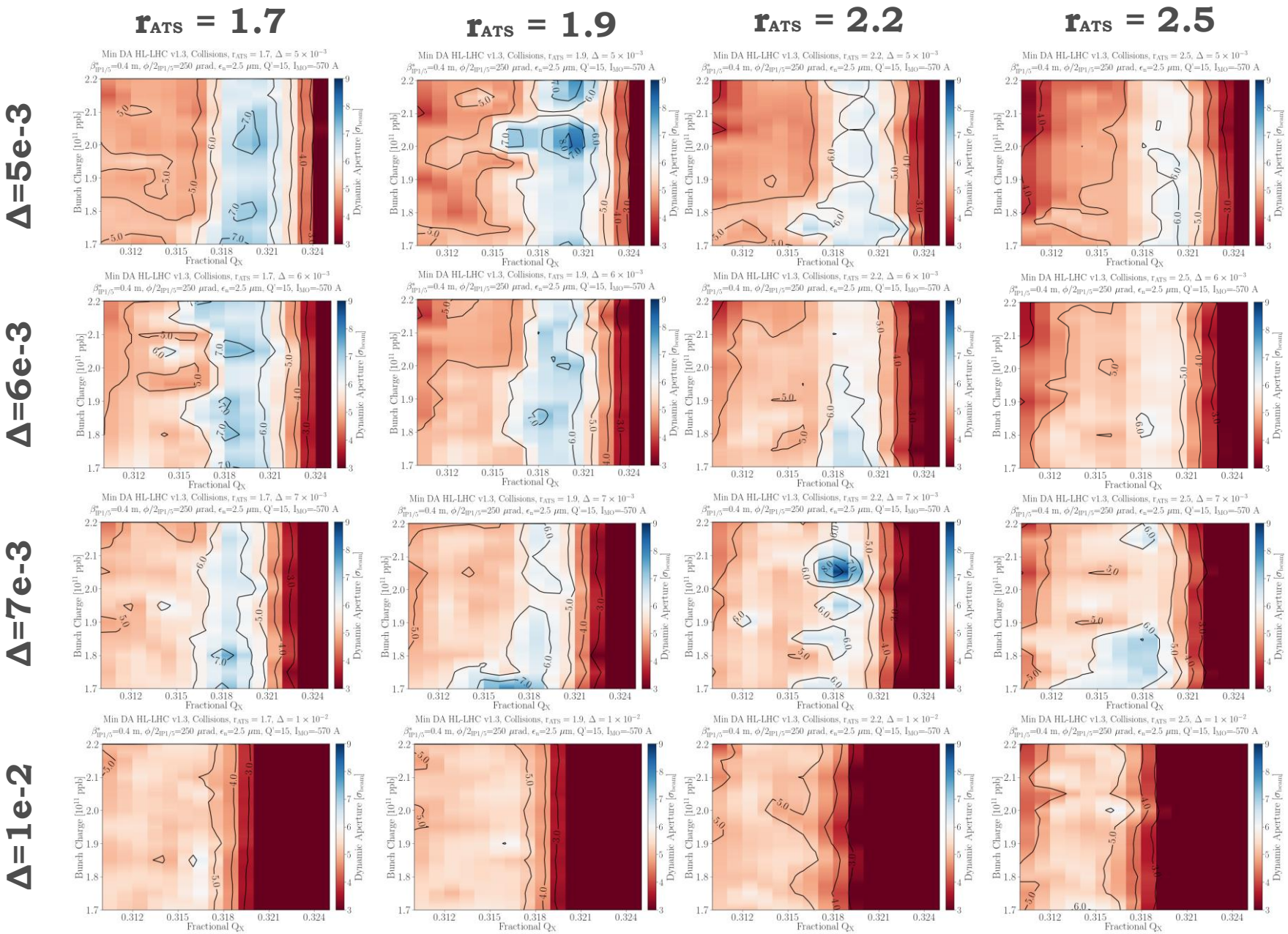




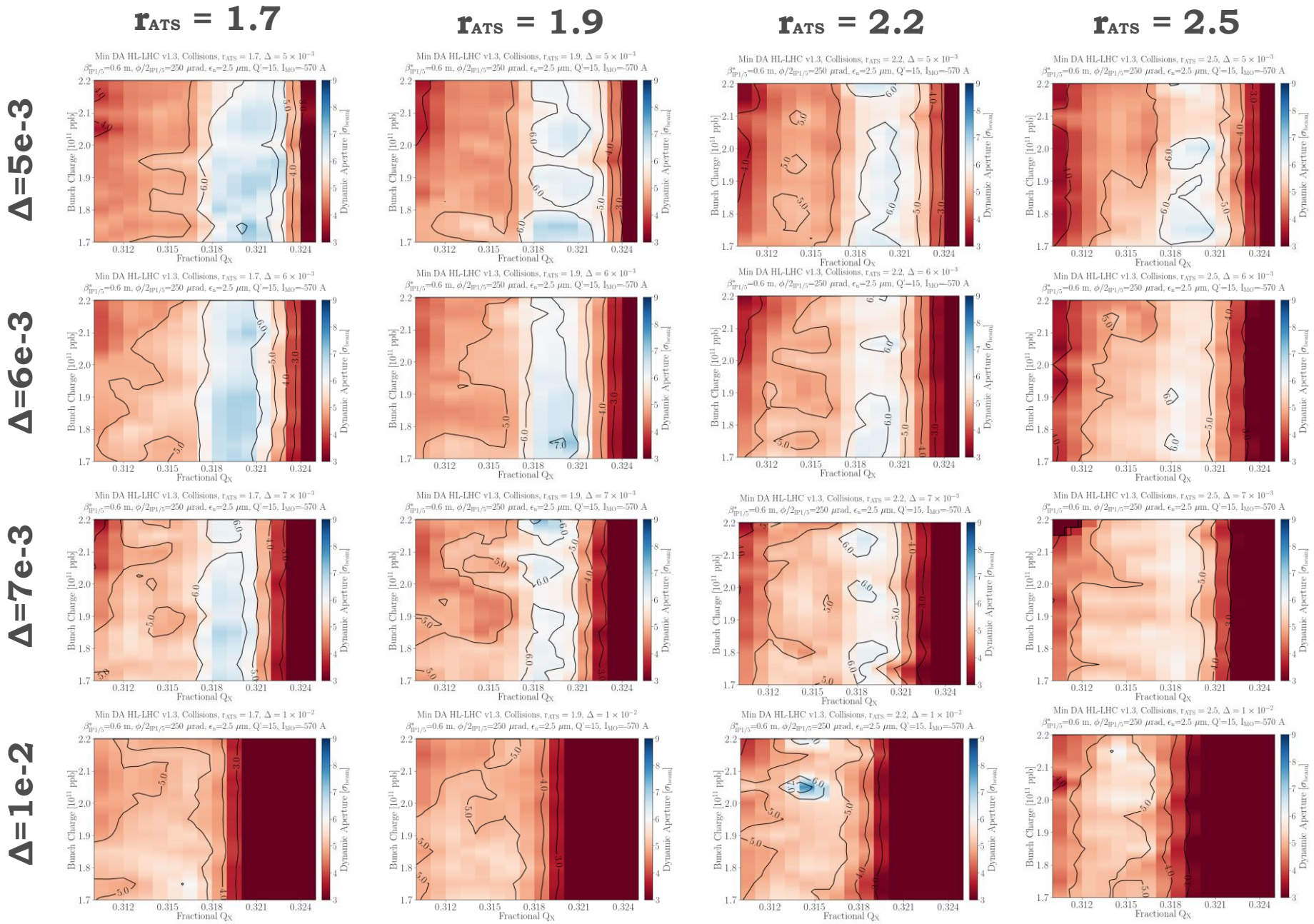
Karastat

Bunch Intensity Limit

β* = 0.4 m


rATS = 1.7
rATS = 1.9
rATS = 2.2
rATS = 2.5
Δ=5e-3
Δ=6e-3
Δ=7e-3
Δ=1e-2
Min DA HL-LHC v1.3, Collisions, rATS = 1.7, Δ = 5 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.9, Δ = 5 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.2, Δ = 5 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.5, Δ = 5 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.7, Δ = 6 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.9, Δ = 6 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.2, Δ = 6 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.5, Δ = 6 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.7, Δ = 7 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.9, Δ = 7 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.2, Δ = 7 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.5, Δ = 7 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.7, Δ = 1 × 10−2
Min DA HL-LHC v1.3, Collisions, rATS = 1.9, Δ = 1 × 10−2
Min DA HL-LHC v1.3, Collisions, rATS = 2.2, Δ = 1 × 10−2
Min DA HL-LHC v1.3, Collisions, rATS = 2.5, Δ = 1 × 10−2
β*IP1/5=0.4 m, φ/2IP1/5=250 μrad, εn=2.5 μm, Q'=15, IMO=−570 A
Bunch Charge [10^11 ppb]
Fractional QX
Dynamic Aperture [σbeam]

β* = 0.6 m


rATS = 1.7
rATS = 1.9
rATS = 2.2
rATS = 2.5
Δ=5e-3
Δ=6e-3
Δ=7e-3
Δ=1e-2
Min DA HL-LHC v1.3, Collisions, rATS = 1.7, Δ = 5 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.9, Δ = 5 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.2, Δ = 5 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.5, Δ = 5 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.7, Δ = 6 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.9, Δ = 6 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.2, Δ = 6 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.5, Δ = 6 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.7, Δ = 7 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.9, Δ = 7 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.2, Δ = 7 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 2.5, Δ = 7 × 10−3
Min DA HL-LHC v1.3, Collisions, rATS = 1.7, Δ = 1 × 10−2
Min DA HL-LHC v1.3, Collisions, rATS = 1.9, Δ = 1 × 10−2
Min DA HL-LHC v1.3, Collisions, rATS = 2.2, Δ = 1 × 10−2
Min DA HL-LHC v1.3, Collisions, rATS = 2.5, Δ = 1 × 10−2
β*IP1/5=0.6 m, φ/2IP1/5=250 μrad, εn=2.5 μm, Q'=15, IMO=-570 A
Bunch Charge [10^11 ppb]
Fractional QX
Dynamic Aperture [σbeam]

Bunch Intensity Discussion

- A Δ=1e-2 is **not favorable** for DA under any configuration.

- For the same Δ a limit on intensity can be found selecting the tele-index
  - In most cases adjusting the WP we regain the lost DA.
  - No significant problems with tele-index of 1.7 and Δ < 1e-2
  - We can also survive with tele-index of 1.9 and Δ < 5-6e-3, without sacrificing bunch intensity.
  - A tele-index of 2.2 yields restricted area of DA which is very sensitive on the tune and even more on the tune split.

- Variation of DA along the same configuration reveals the impact of the **head-on**
  - Moving the tune along y (instead of along the diagonal) could result in increased DA.

- **N.B.:** *What has been presented so far has a* ***hard assumption*** *on a minimal effect of the* ***coupling*** *on the overall result (level, shape, area and position of the iso-DA contours). A closer look with the additional coupling knob would provide more precise results.*