Lattice Optimizations Updates

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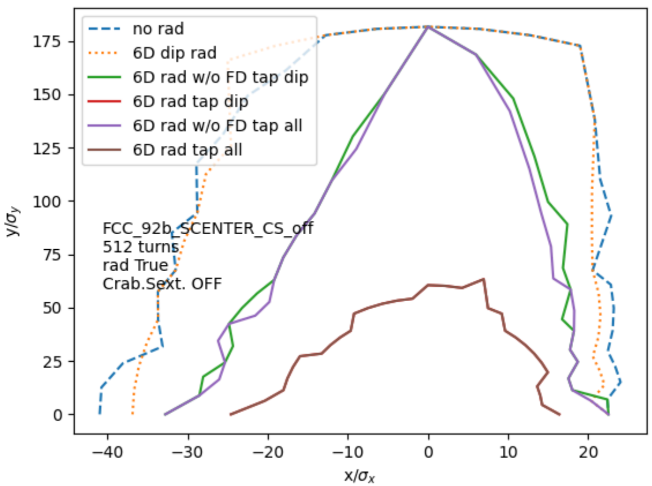
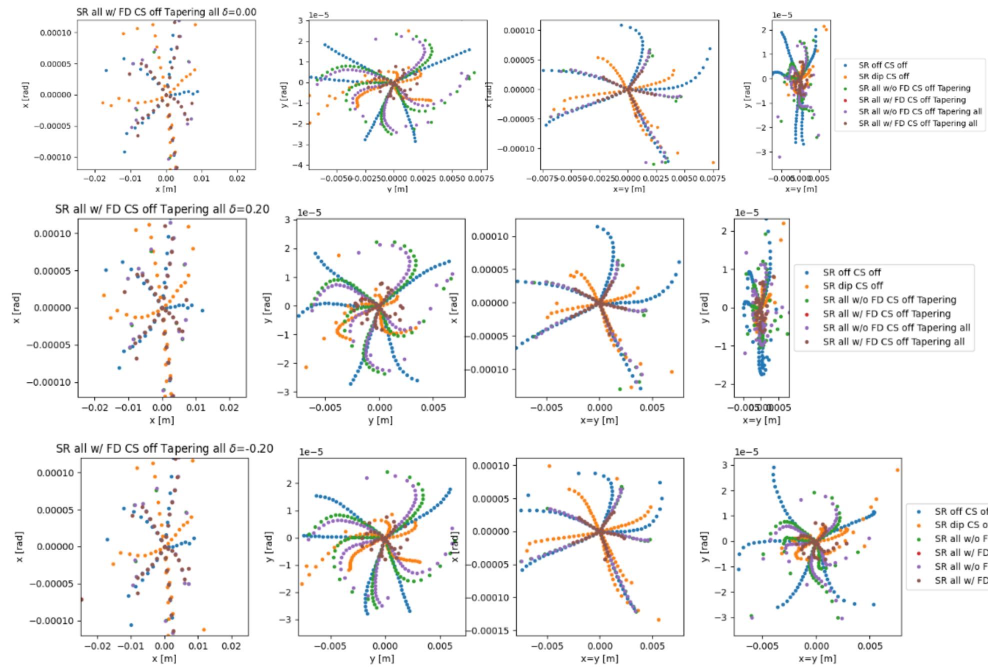
EFFECT OF TAPERING





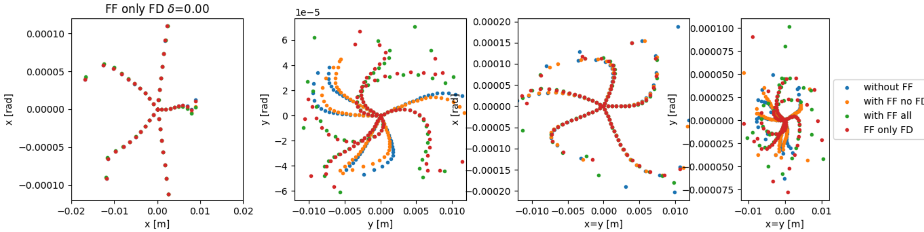
Tapering based on all radiating element or only on dipoles radiation does not make a relevant difference.

SR on @ 182.5GeV? YES. Curves red and brown are sharp identical (computation cross-chekced)

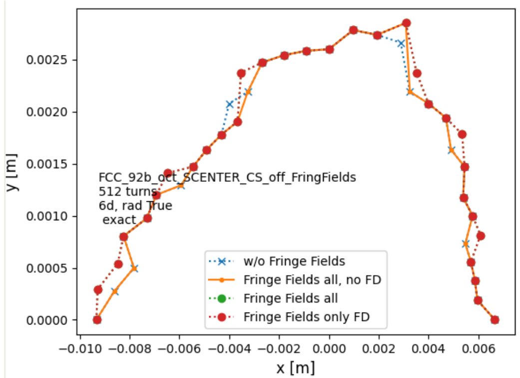
EFFECT OF QUADRUPOLE FRINGE FIELDS (LEE-WHITING'S FORMULA)

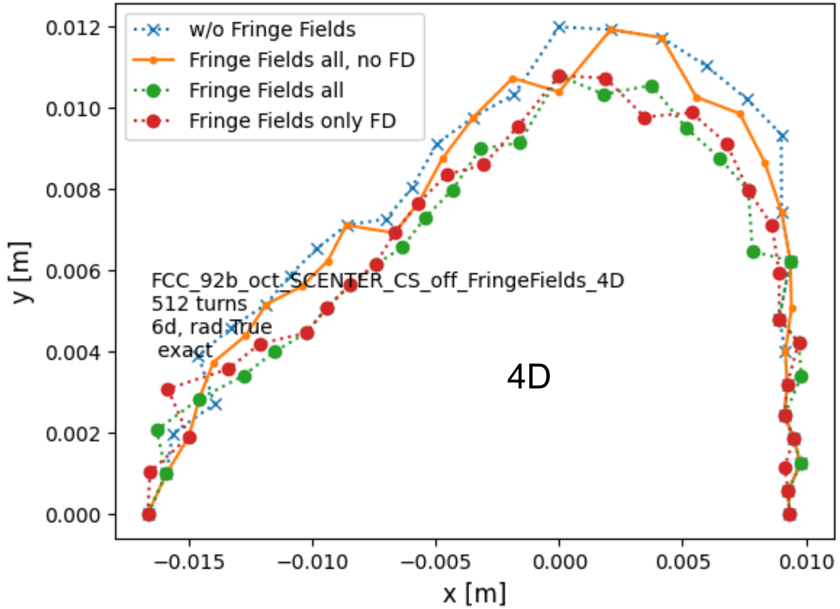
Final double is the dominant effect.

It is however negligible in presence of radiation.

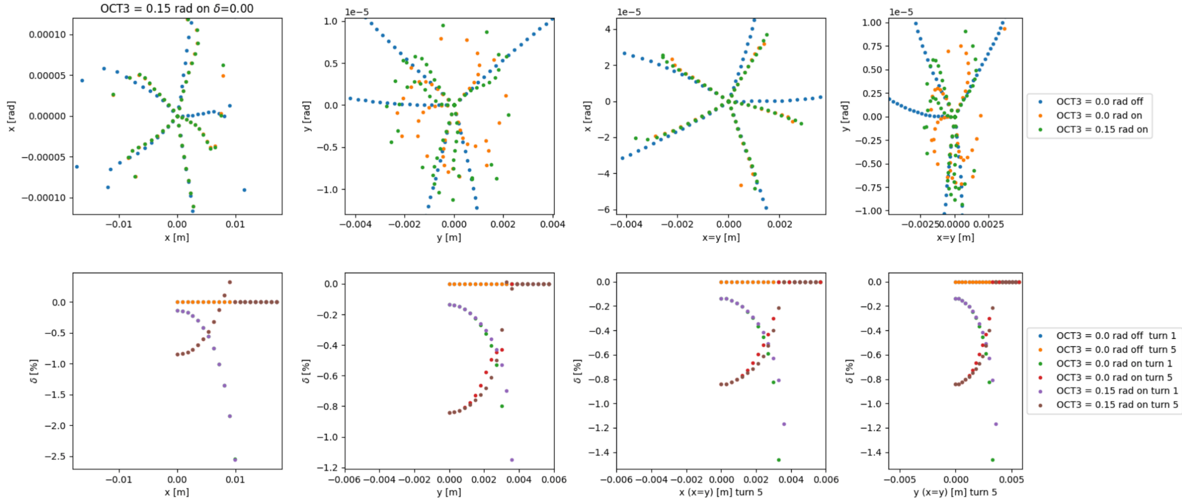


6D, radiation is dominant, Fringe Fields do not have visible effect

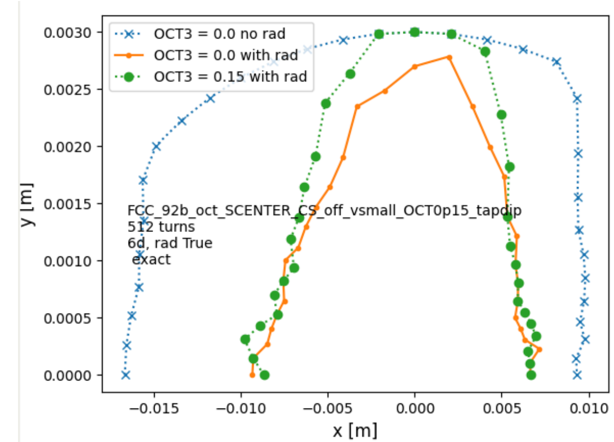




MITIGATION OF DETUNING WITH AMPLITUDE INTRODUCED BY FINAL DOUBLET SYNCH. RAD. USING AN OCTUPOLE IN THE FINAL DOUBLET



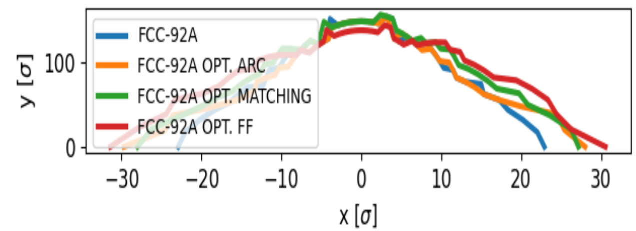
CrabSext OFF

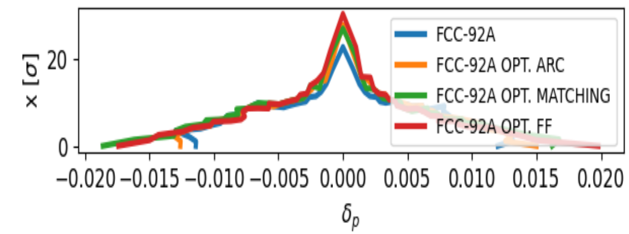


Detuning with amplitude is compensated, DA is not recovered as it is dominated by the energy deviation in one turn at large amplitude (0.8% dpp in one turn at 3mm vertical offset).

Show DA figures in beam sigmas:

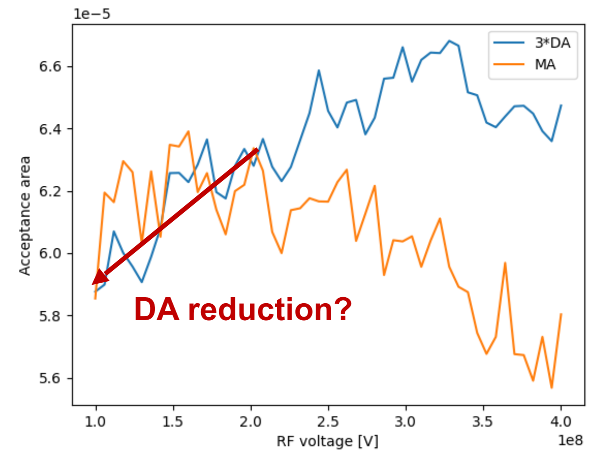
- Updated on indico
- Parameters @SCENTER:
  - *betax = 81m, betay= 255m*
  - *epsx = 6.85e-10 m.rad*
  - *epsy = 1.37e-12 m.rad = 0.002*epsx*
- Horizontal DA ~30 sigmas after optimizations
- Vertical DA ~120 sigmas after optimizations
- Momentum aperture ~2% after optimizations





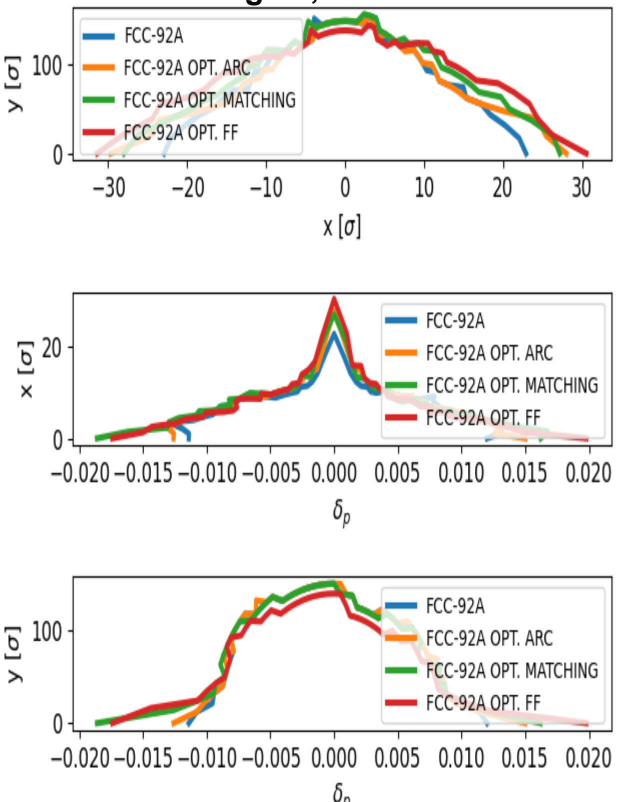
Use 80 MV RF voltage in stead of 200 MV:

- MA now limited by RF acceptance to ~1% (bucket height)
- We are not optimizing the **<u>lattice</u>** MA anymore
- Is this the optimal configuration:
  - *Reduction of lifetime?*
  - *Use higher harmonic cavities the lengthen bunch instead?*
- Try to optimize with lower RF voltage

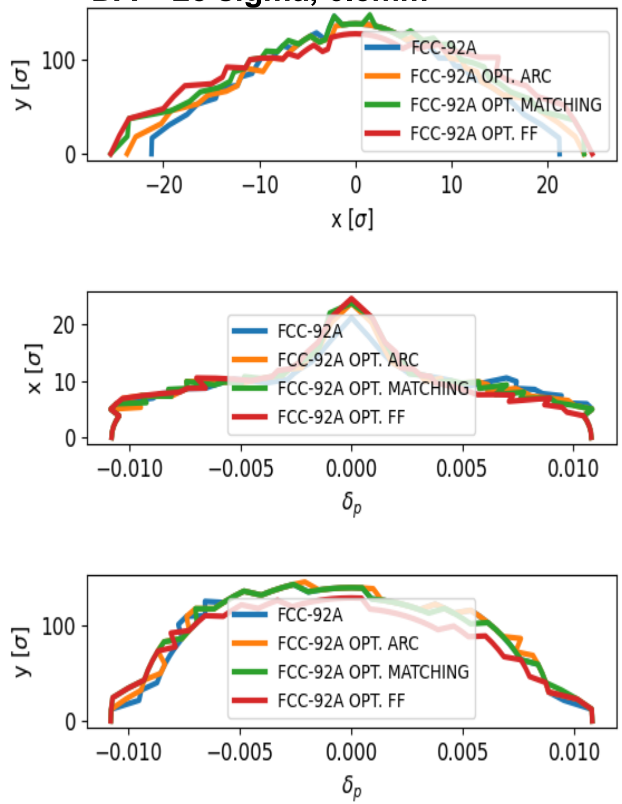


OPTIMIZATION RESULTS AT 80MV

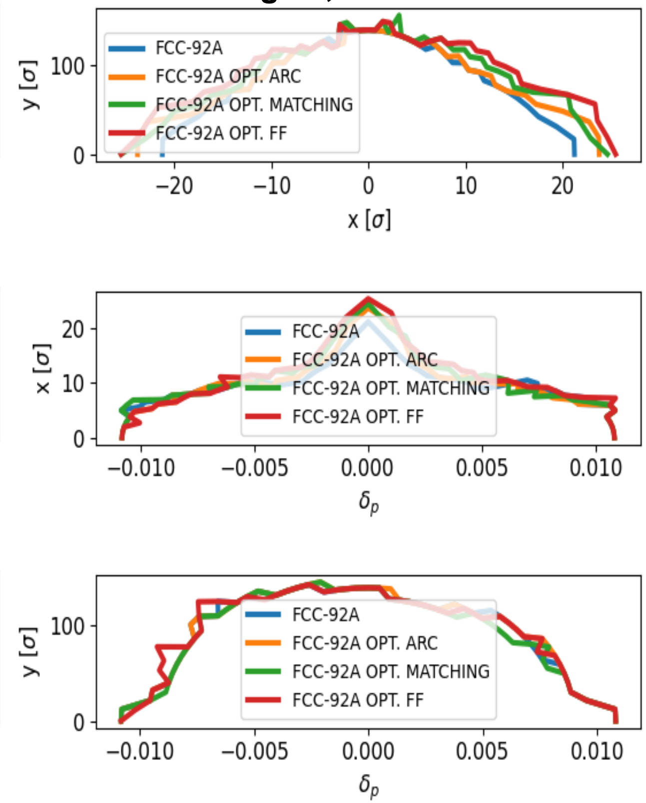
VRF=200 MV, Opt. @ 200 MV
DA ~ 30 sigma, 8mm



VRF=80 MV, Opt. @ 200 MV
DA ~ 25 sigma, 6.5mm



VRF=80 MV, Opt. @ 80 MV
DA ~ 27 sigma, 7mm

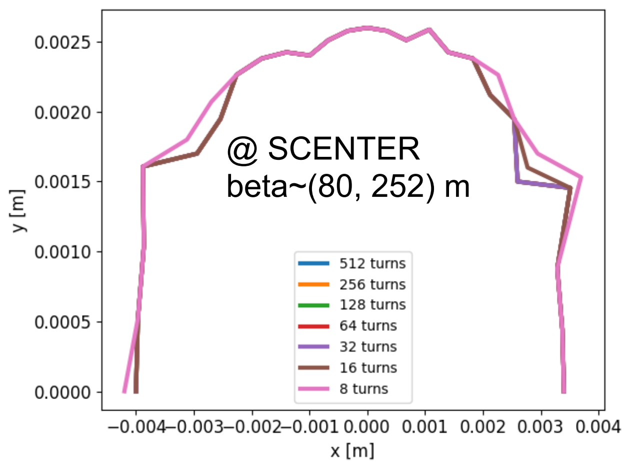


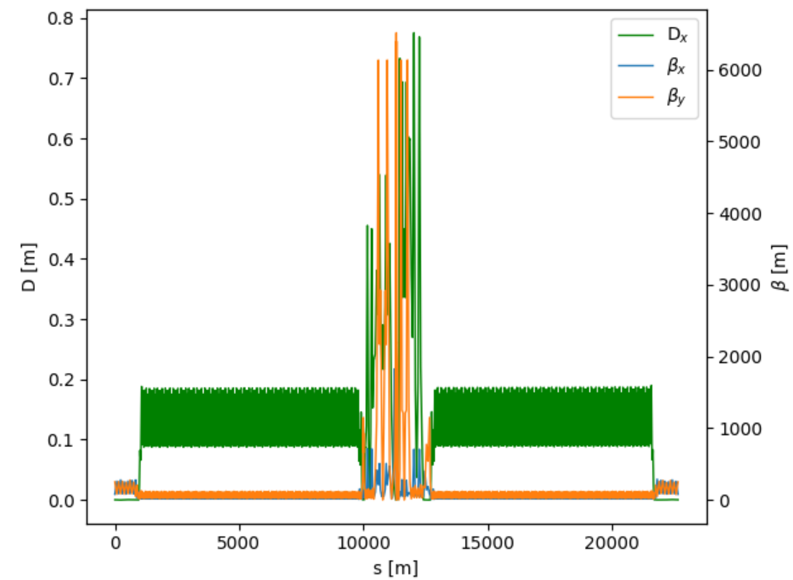
200MV->80MV: MA shrink to RF acceptance as expected, DA also reduced only partially recovered with optimization

FIRST LOOK AT TTBAR LATTICE

- **16 MV RF voltage used**
- **Tapering calculated with radiation effects from dipoles only, applied to all magnets**
- **Only 32 turns needed to reach DA convergence**
- **cs_frac=0.4, cs_comp=0.3**
- **Q'x < 0 → fit both Q' to 0.6 (H value)**

```
Frac. tunes (6D motion): [0.20497714 0.30419601 0.12189966]
                 Energy: 1.825000e+11 eV
      Energy loss / turn: 8.808215e+09 eV
        Mode emittances: [2.10241769e-09 6.87715914e-37 2.47447558e-06]
Damping partition numbers: [0.99990155 1.00000281 2.00009565]
          Damping times: [0.01253241 0.01253114 0.00626529] s
          Energy spread: 0.00148888
           Bunch length: 0.00166628 m
       Cavities voltage: 16000000000.0 V
      Synchrotron phase: 2.55861 rd
  Synchrotron frequency: 403.101 Hz
```





Smaller H-DA than Z lattice: can we do better?

OPTIMIZATION AND TAPERING

The tapering applies not only to dipoles but also to quadrupoles and sextupoles to preserve on/off-momentum optics:

- In pyAT, this is handled through a FieldScaling attribute
- Magnet strengths rescaled with this value

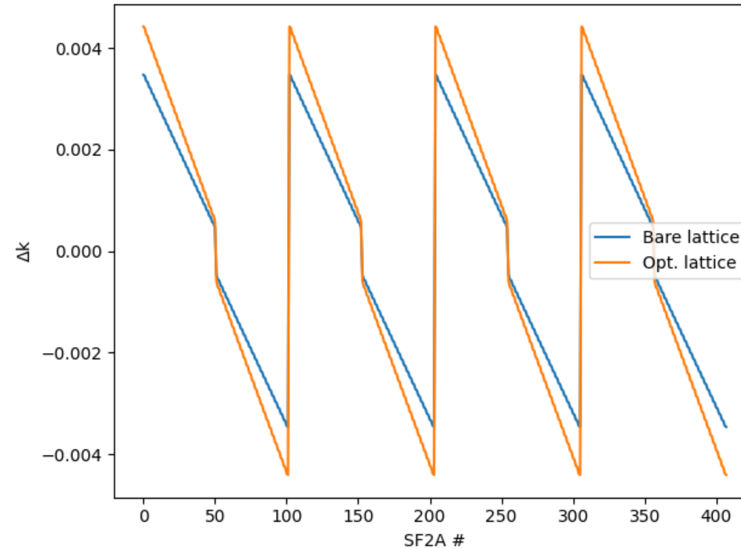
The present correction and optimization algorithms work with magnet families:

- Strengths of the whole family is changed then scaling of individual magnets applied
- Strength ratio between magnets preserved
- Applies to tune, chromaticity correction and all optimizations

Is this the correct way to handle tapering?

Is this how FCC will be operated?

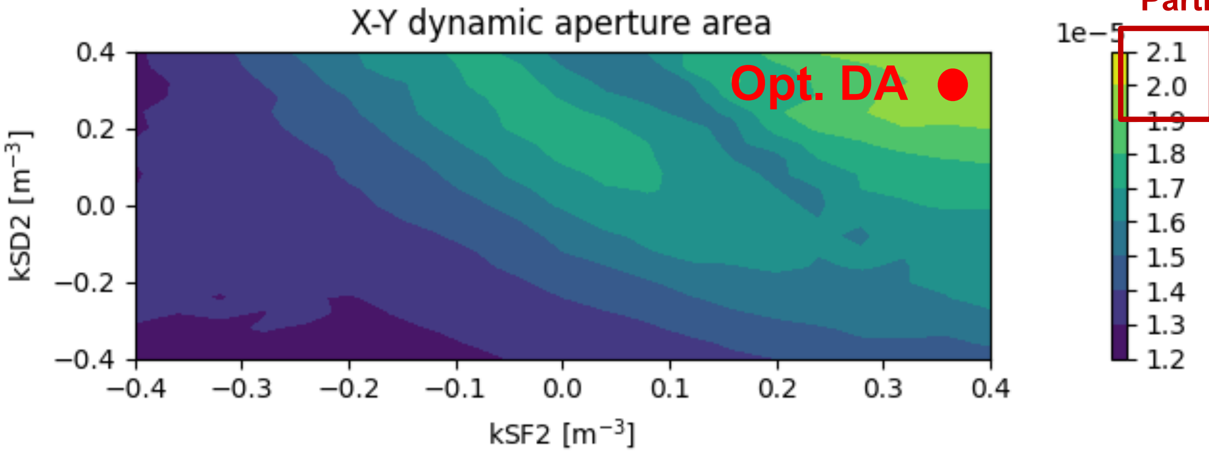
This issue would require more detailed studies to define a clear strategy

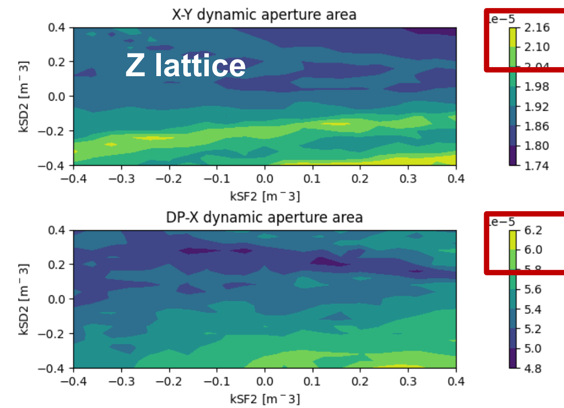


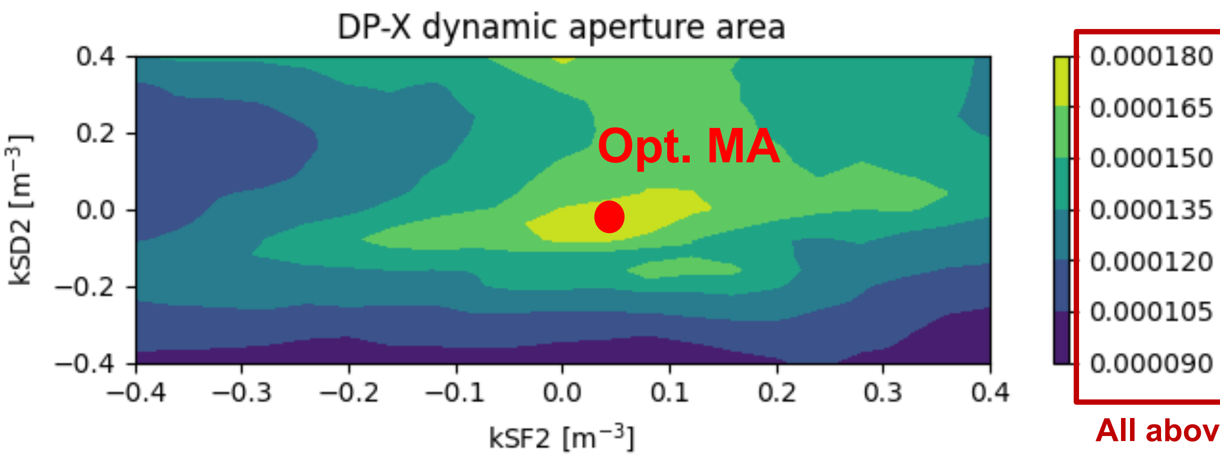
SF2A family optimization with tapering: constant scaling

ARC SEXTUPOLES

Partially recovering Z lattice DA





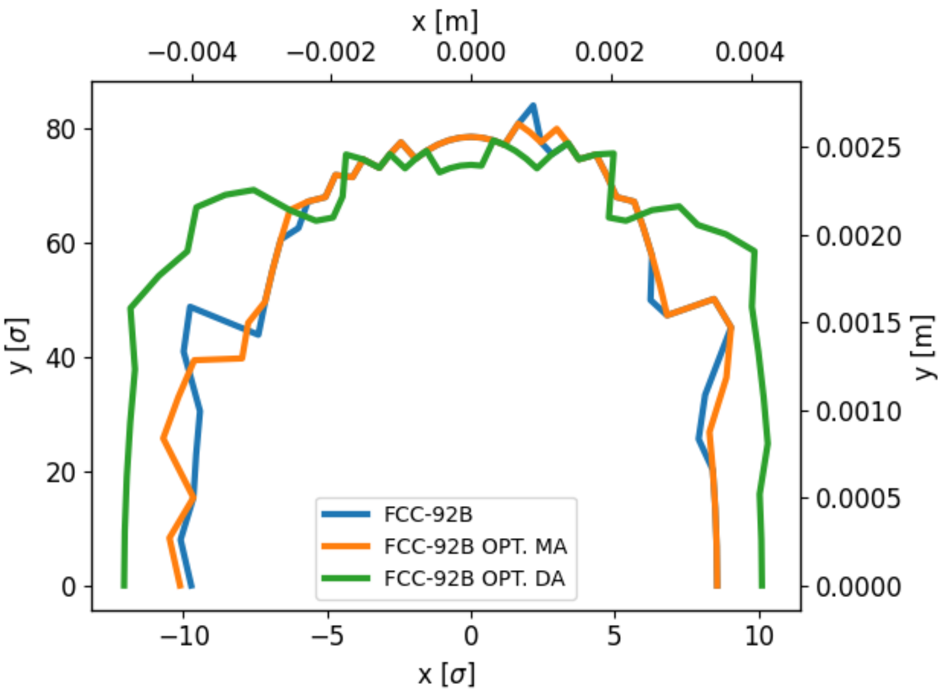


No common optimum for both DA and MA

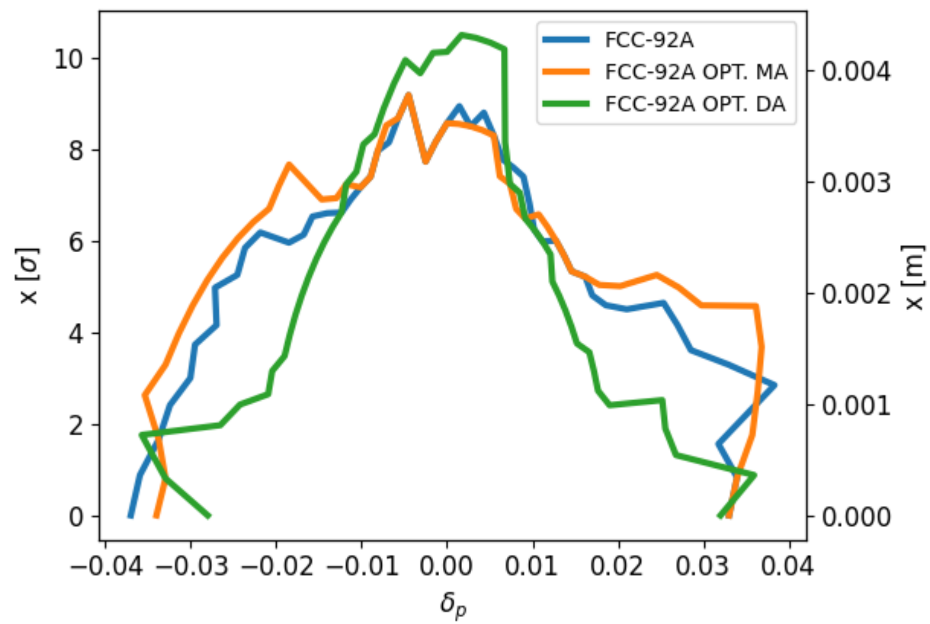
All above Z lattice MA

The European Synchrotron | ESRF

Dynamic aperture

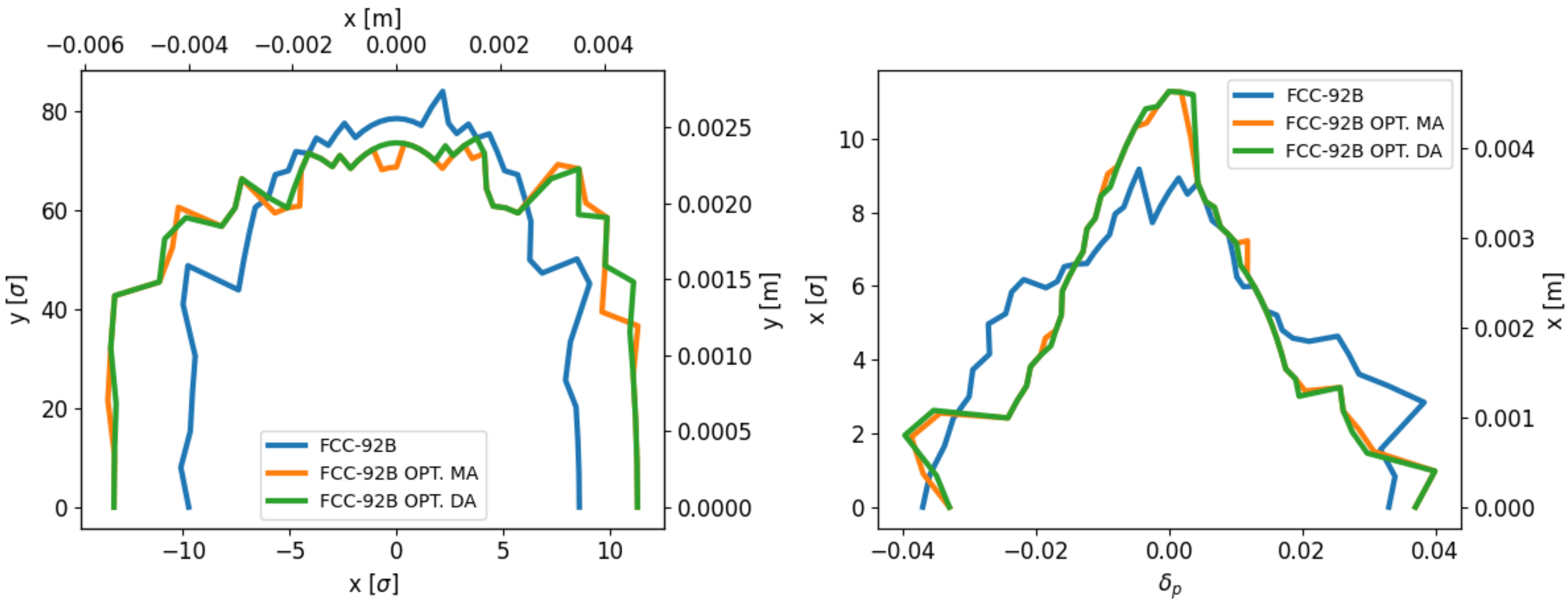


Momentum aperture



Should we favor DA? MA still large for all cases
Emittance of the LCCO optics is 2.1 nm.rad vs 0.68 nm.rad for the Z lattice
Contributes to a large extend to the reduction of DA in sigmas
Asymmetry +/- can be optimized vs injection efficiency (harmonic sextupole in LSS)

OPTIMIZED DA



Very preliminary optimization using only arc sextupoles starting from the optimal point for DA:

- DA increased to 5.5 mm (similar as bare Z lattice), ~13.2 sigmas (beam sigma is 15% large that baseline optics 2.1nm.rad vs 1.5 nm.rad emittance)
- Very small improvement in MA
- To be continued