Status Report: Beam Dynamics for the MAX IV 3 GeV Storage Ring

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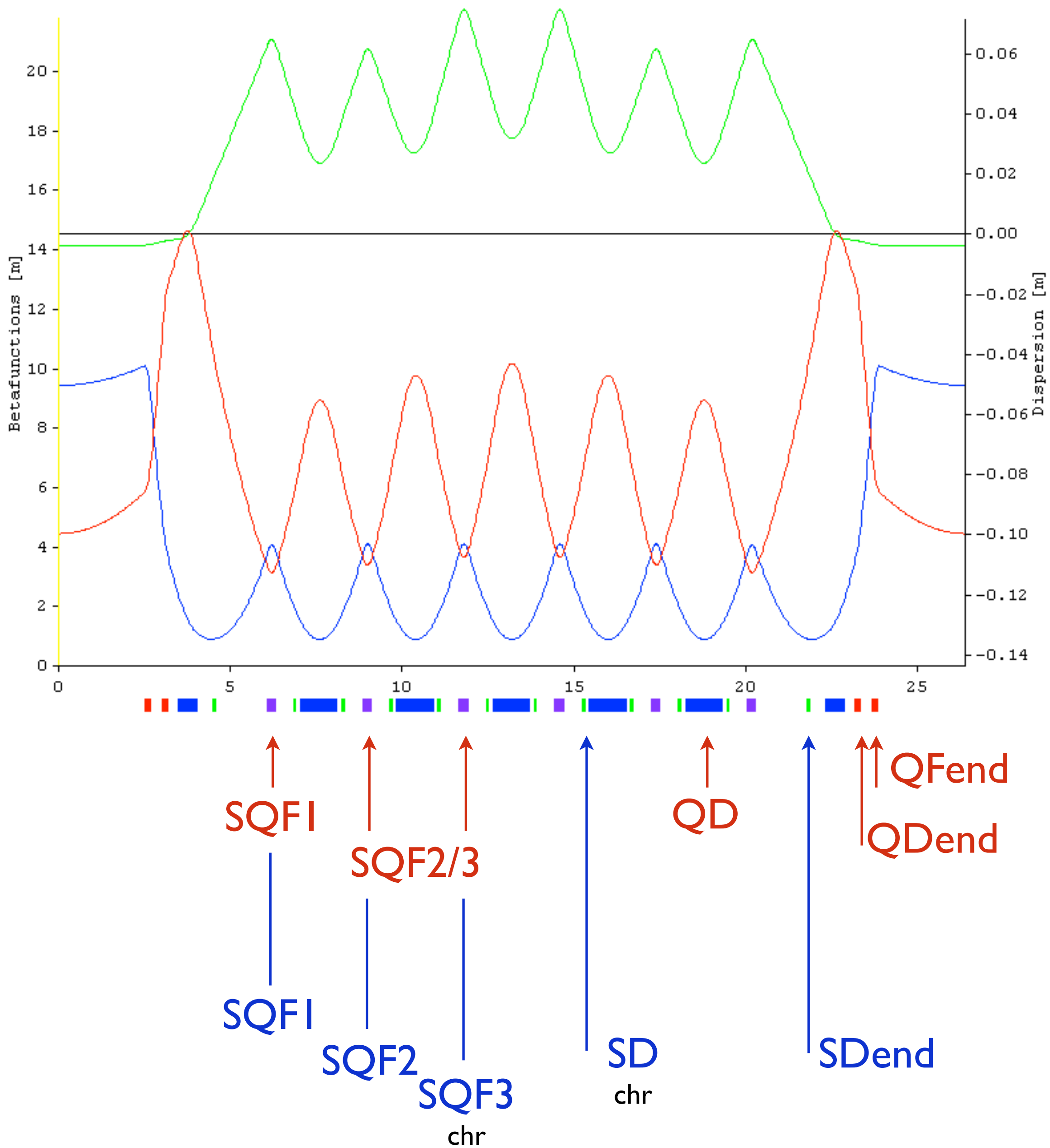
The Previous 3 GeV Storage Ring Achromat



RING: 20 achromats

- 19 available straights (5m)
- L = 527.76 m
- $\nu_x = 42.22$
- $\nu_y = 14.27$
- $\varepsilon_0 = 0.324$ nm rad
- $\xi_{x,0} = -50.588$
- $\xi_{y,0} = -40.746$

5 quadrupole families

5 sextupole families

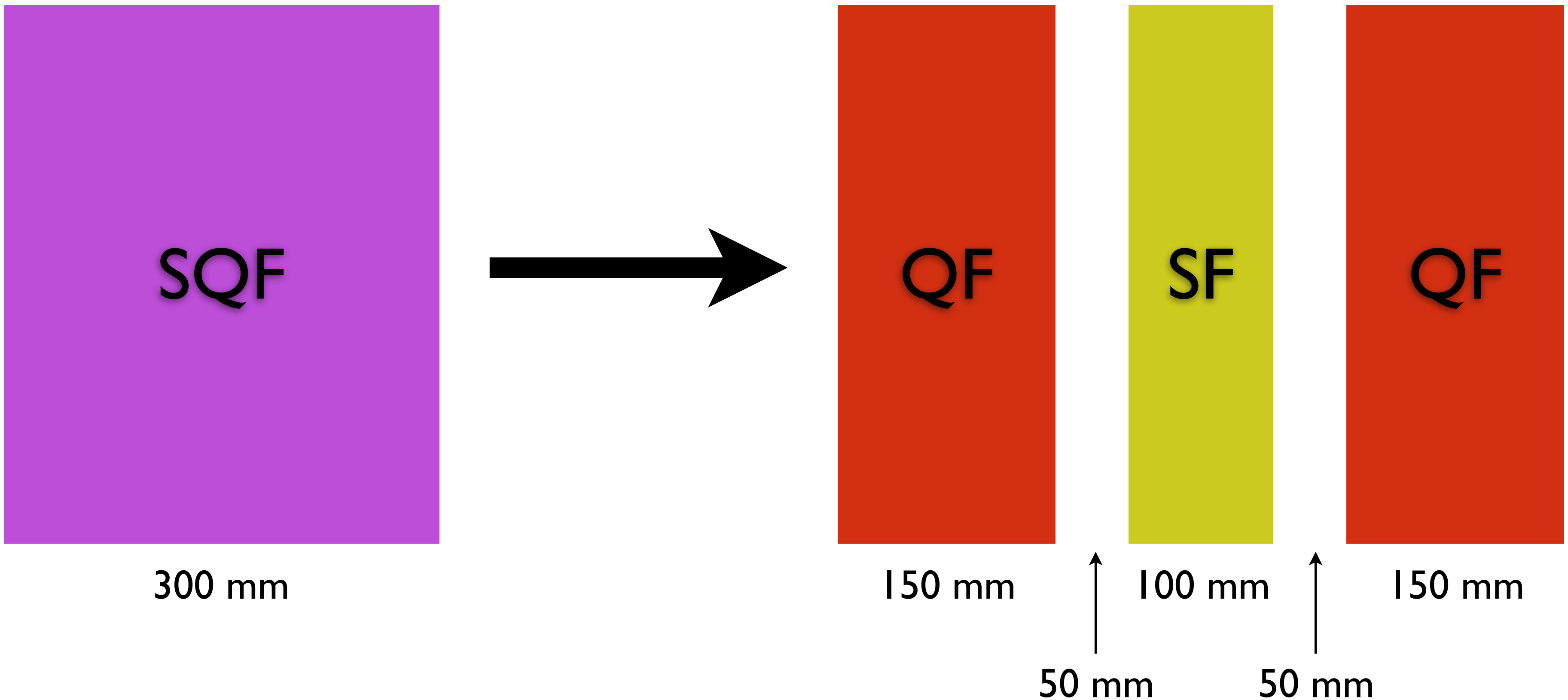
chr = used to correct chromaticity

What we didn't like about it...

- Sextupole component in the combined function SQF3 magnet was too high (710 T/m^2)
- Combined function magnets mean there is no simple way to tune the sextupole strength without changing the focusing
  $\longrightarrow$ back leg windings, small trim sextupoles, ...
- Lattice momentum acceptance was too low (closer to 3% than to 5%)

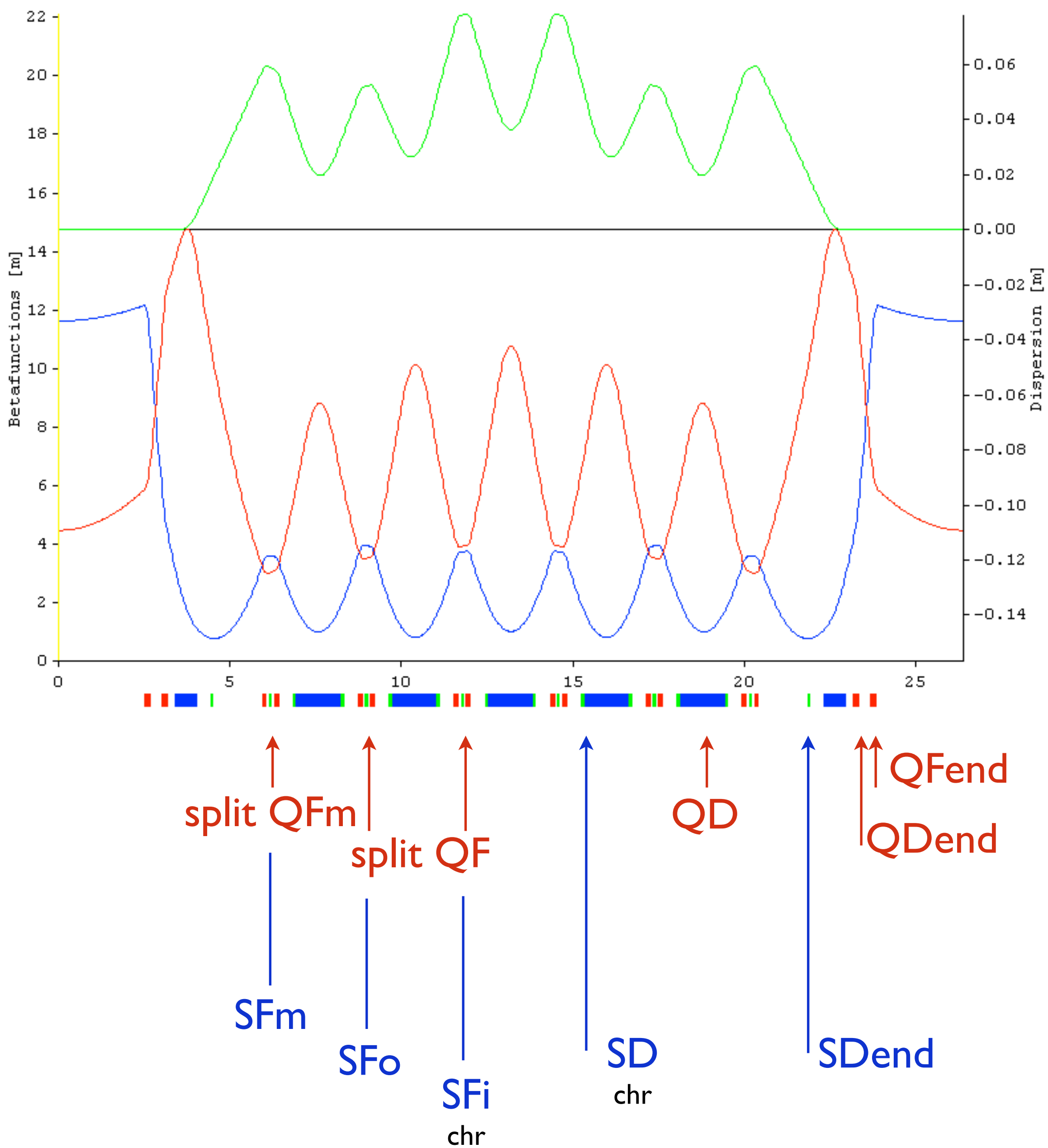
➡ Try a new lattice with split quads and dedicated sextupoles

Split Magnet Lattice Idea



- 100 mm dedicated sextupoles are feasible (max req. strength 2300 T/m^2)
- We gain separate tuning capability
- 50 mm gaps can be used for BPMs and/or correctors...
  ... or integrate correctors into sextupoles (SLS)

Split Magnet Lattice Idea: Achromat



RING: 20 achromats

- 19 available straights (5m)
- L = 527.76 m
- $\nu_x = 42.22$
- $\nu_y = 14.27$
- $\varepsilon_0 = 0.321$ nm rad
- $\eta^* = 0.0$ m ($\longrightarrow$ incr. β_x^*)
- $\xi_{x,0} = -52.562$
- $\xi_{y,0} = -40.731$

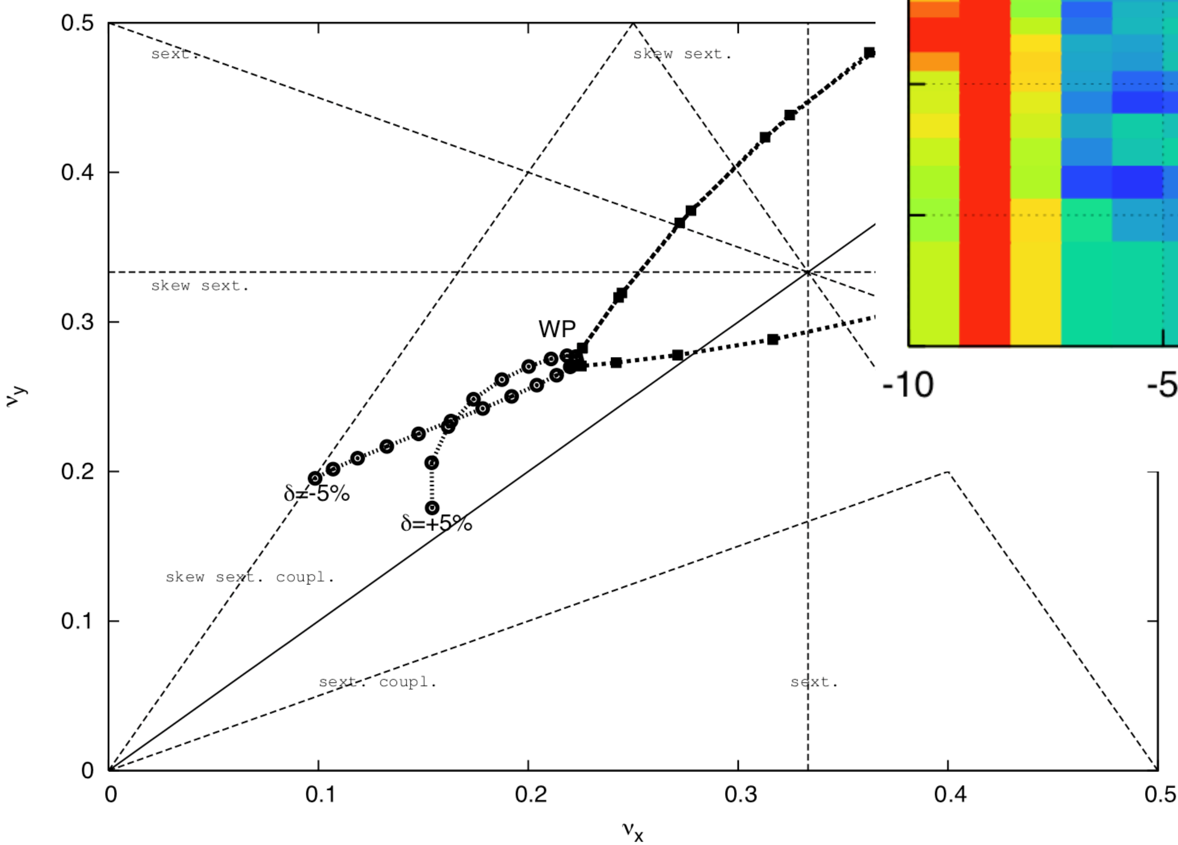
5 quadrupole families

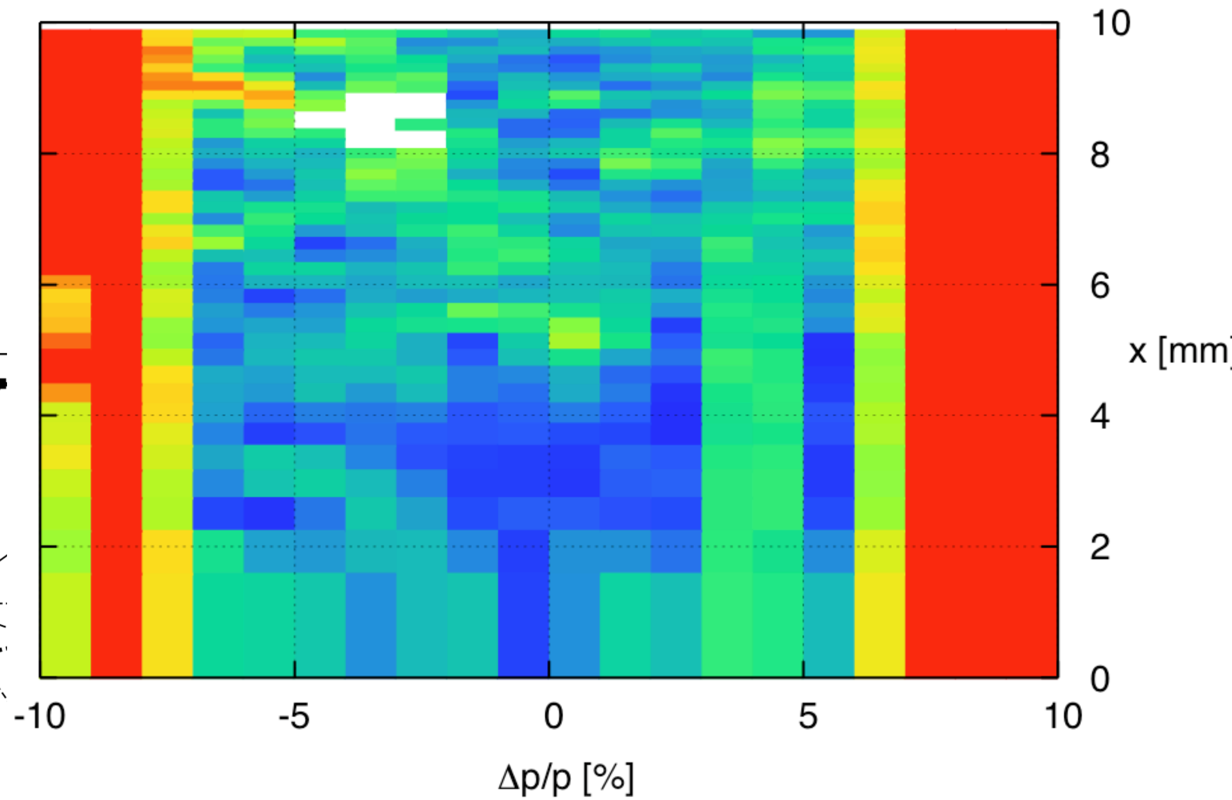
5 sextupole families

chr = used to correct chromaticity

Split Magnet Lattice Idea: Chromatic Tune Shifts

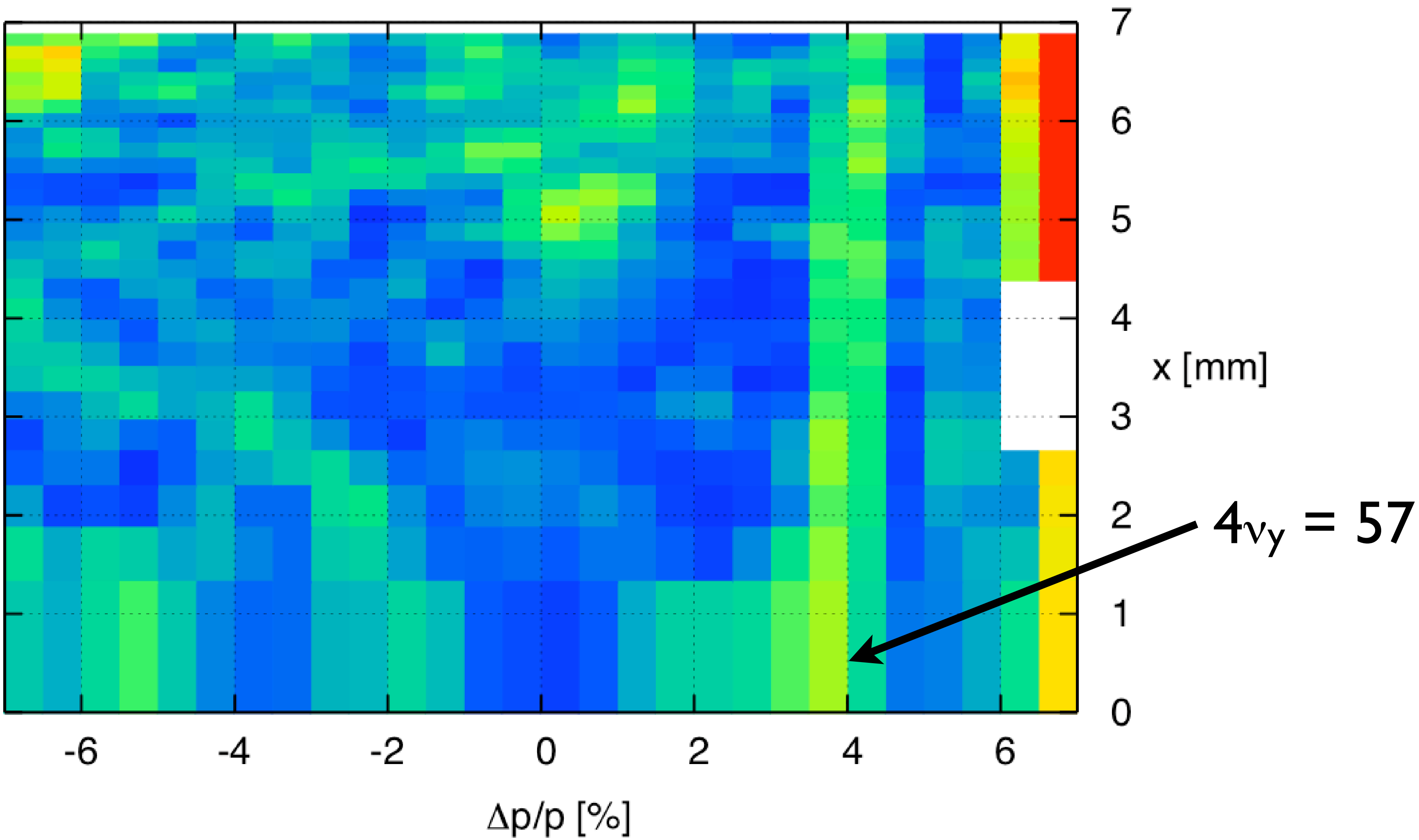
- Chromaticities low ⟶ small chromatic tune shift ⟶ good mom. acceptance





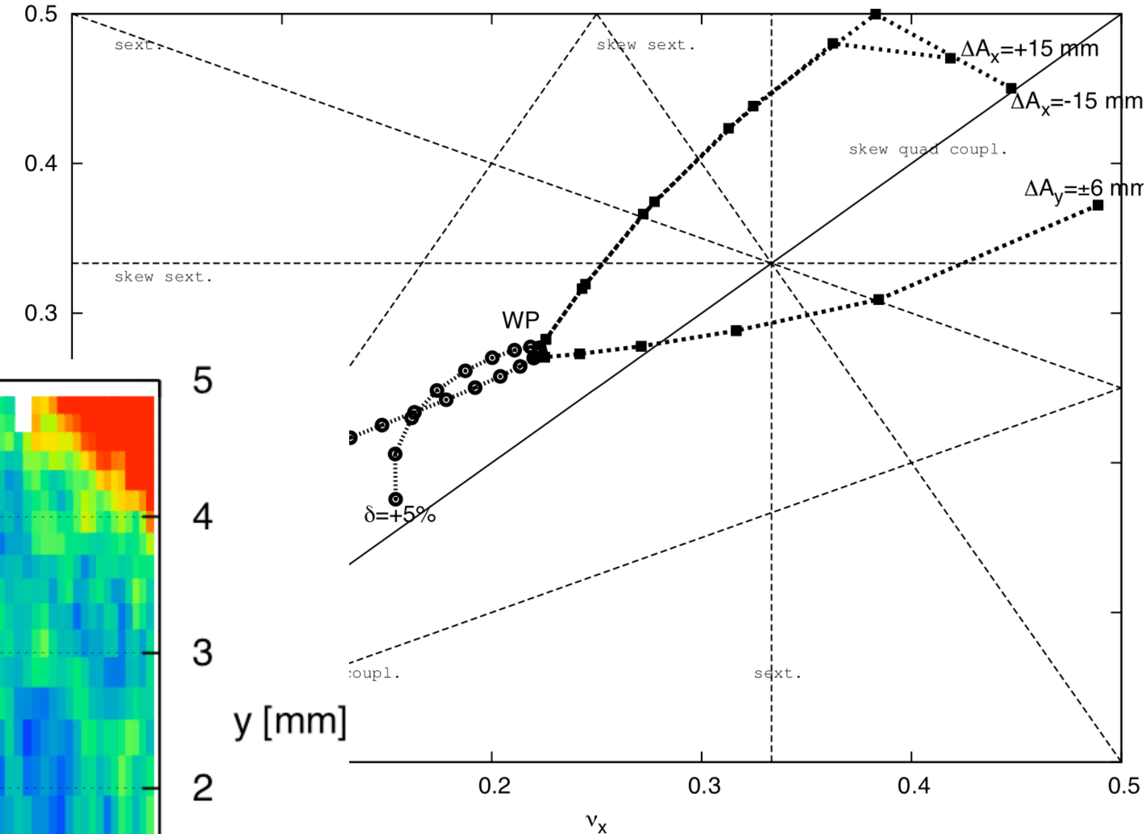
Split Magnet Lattice Idea: Chromatic Tune Shifts

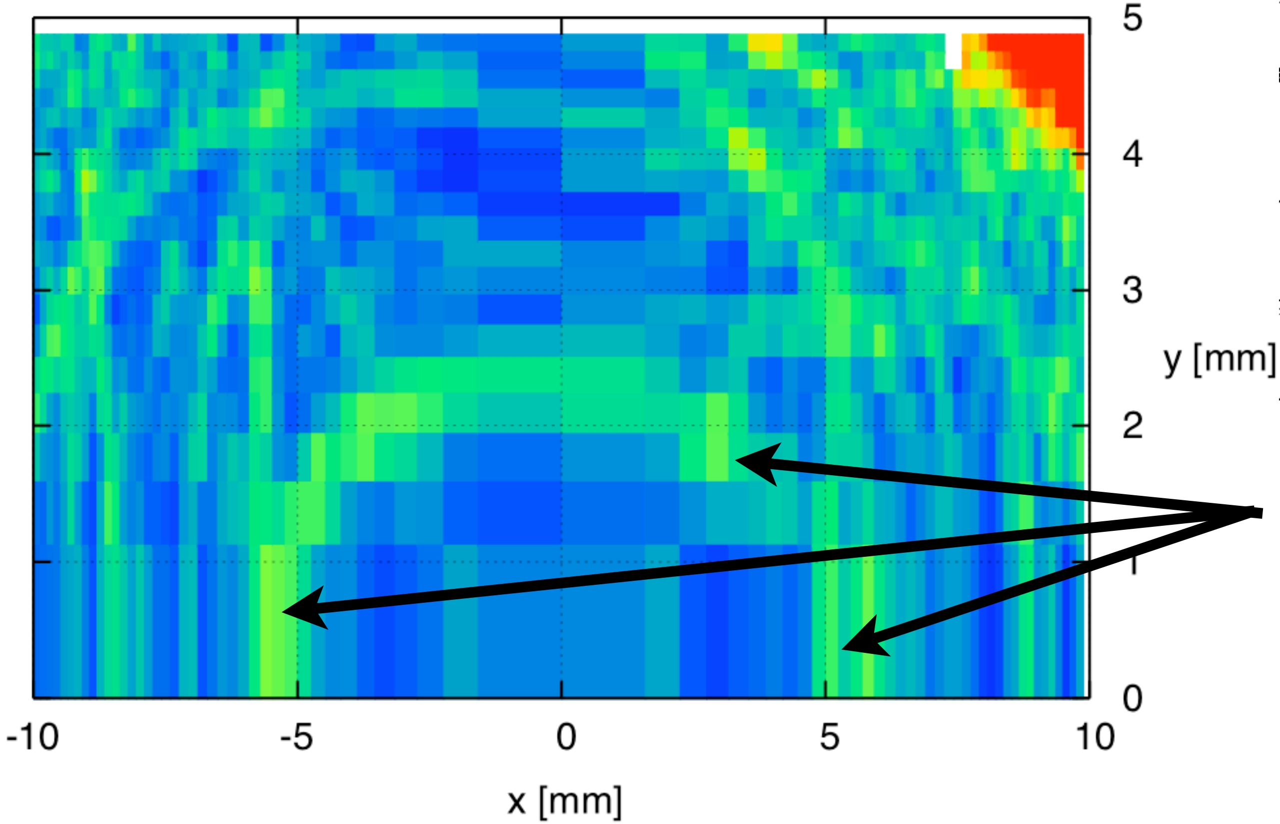
- Is the momentum acceptance really that good?



Split Magnet Lattice Idea: Dynamic Aperture

- DA looks good on a larger scale, but there are some unpleasant details...
- ... and a couple of nasty troublemaker candidates





$$\nu_x + 2\nu_y = 71$$
$$3\nu_y = 43$$
$$4\nu_x = 169$$

So what now?

- First, need to get a clearer picture of involved resonances
  $\longrightarrow$ ongoing work, but takes (CPU) time

- Small shift of WP could move resonant behavior just outside of the required aperture window / momentum acceptance
  $\longrightarrow$ delicate because of so many constraints
  $\longrightarrow$ but if done "adiabatically" hopefully dynamic behavior won't change much

- For technical reasons we might need more splitting (200 mm $\rightarrow$ 250 mm)

And what if that fails?

- Some tricks applied in the split lattice case...
  - modified $\beta_{x,y}^*$
  - longer matching quad
  - different weighting of the higher-order Hamiltonian driving terms
- ...can be "retrofitted" to the original combined magnet lattice (ongoing work)