

# Frequency maps for the V16 lattices

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M.Biagini, P.Raimondi

# Frequency maps

Diffusion rate

$$D = \log\left(\sqrt{\frac{(\nu_{x,[0, \frac{NT}{2}]} - \nu_{x, [\frac{NT}{2} + 1, NT]})^2 + (\nu_{y,[0, \frac{NT}{2}]} - \nu_{y, [\frac{NT}{2} + 1, NT]})^2}{\frac{NT}{2}}}\right)$$

Half number of turns NT

H Tune for the first half turns

V Tune for the first half turns

H Tune for the second half of turns

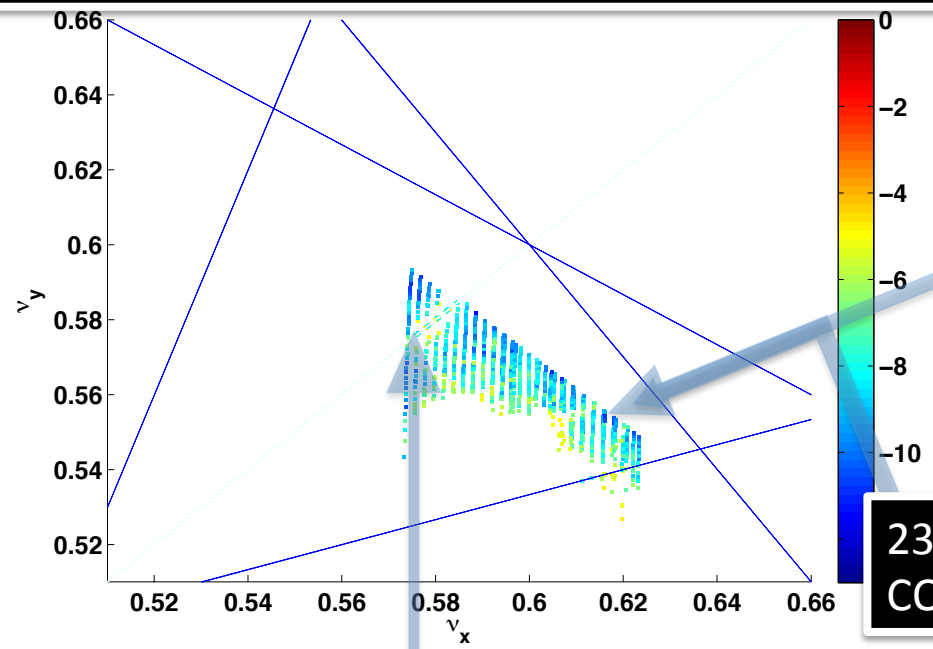
V Tune for the second half of turns

A small diffusion rate indicates that the particle motion is stable, a large diffusion rate indicates a chaotic motion that may lead to particle losses.

Evaluate the Diffusion rate over many turns for particles starting at various amplitudes, to see the effect of non linear terms in the lattice. Optimize the lattice to achieve the best diffusion rates.

TRACKING with MADX-PTC  
Tunes at injection from NAAF

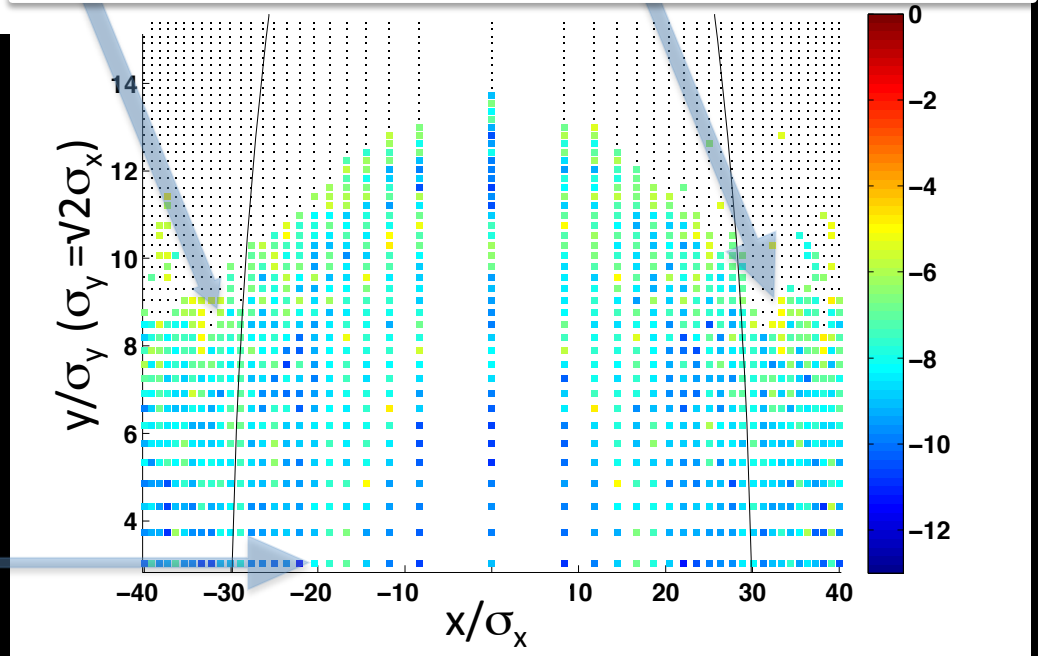
2300 e<sup>+</sup> tracked for 1024 turns  
FREQUENCY MAP



# Frequency maps

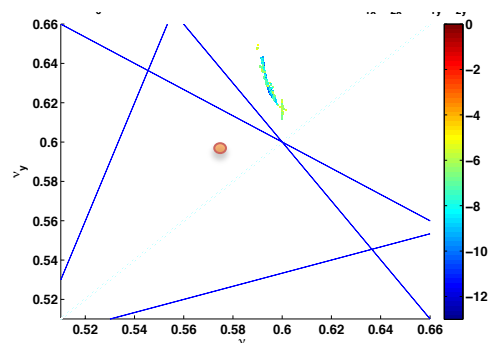
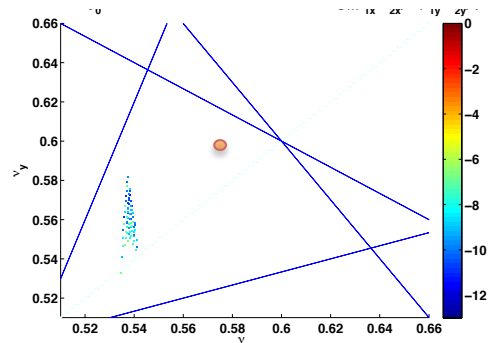
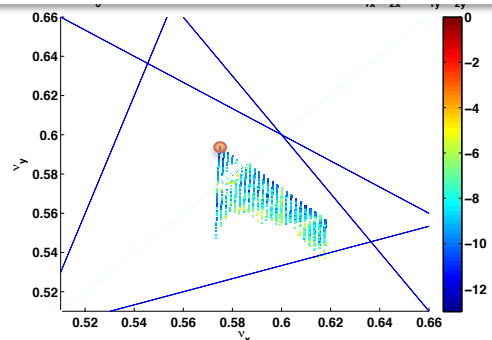
2300 e<sup>+</sup> tracked for 1024 turns  
CONFIGURATIONS SPACE

Direct map  
between  
configuration  
space and  
frequency space

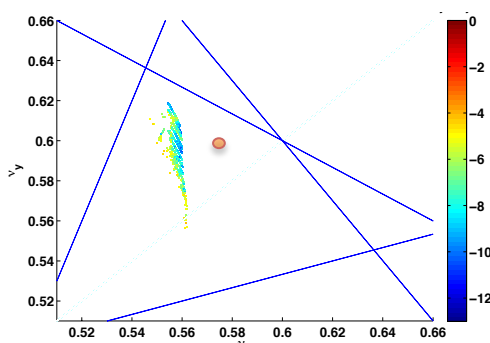
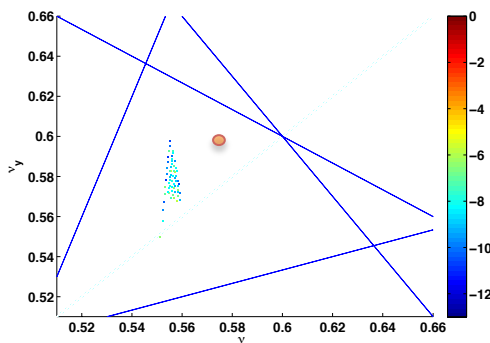
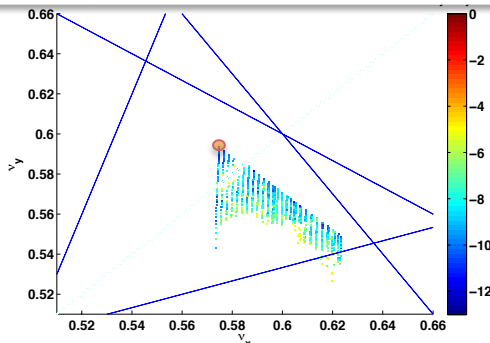


# Frequency maps off momentum

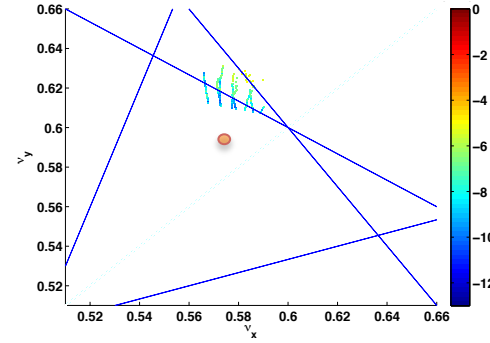
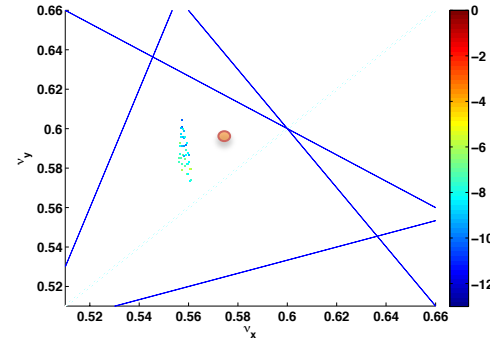
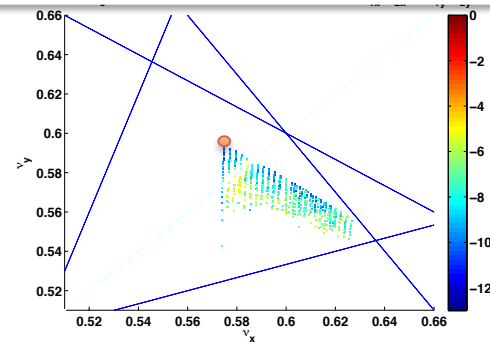
HER 0



HER



LER



$Dp/p=0$

$Dp/p=+1\%$

$Dp/p=-1\%$

No fringes, oct off, sext on

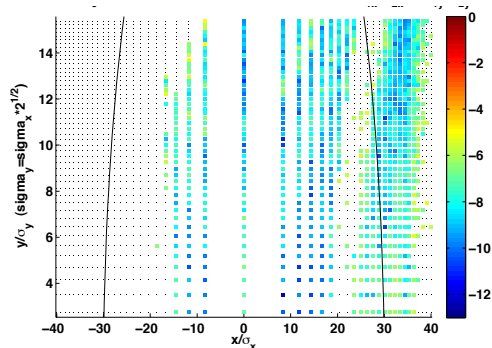
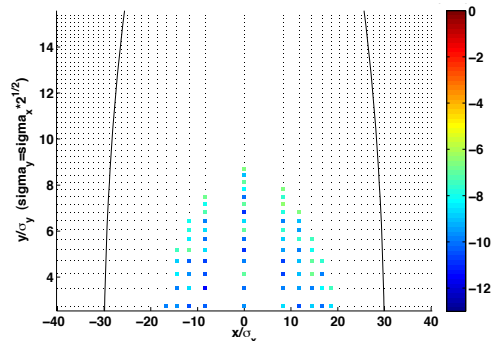
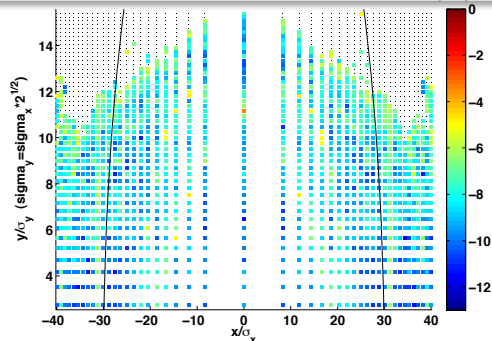
# Configuration space off momentum

$Dp/p=0$

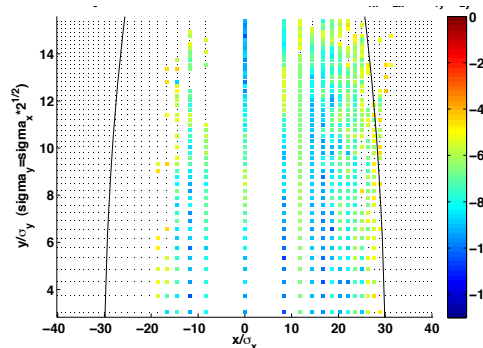
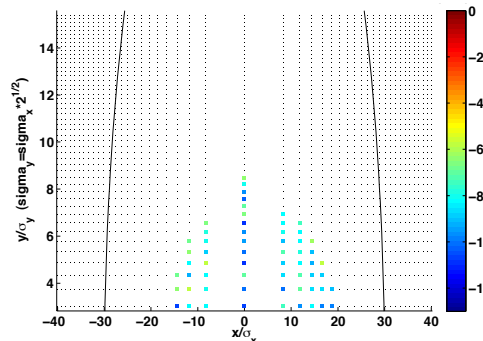
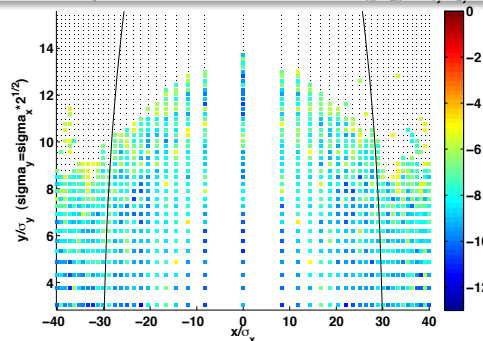
$Dp/p=+1\%$

$Dp/p=-1\%$

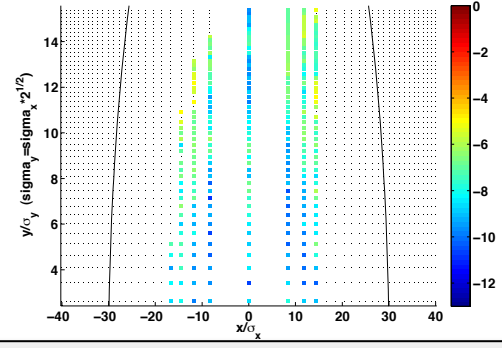
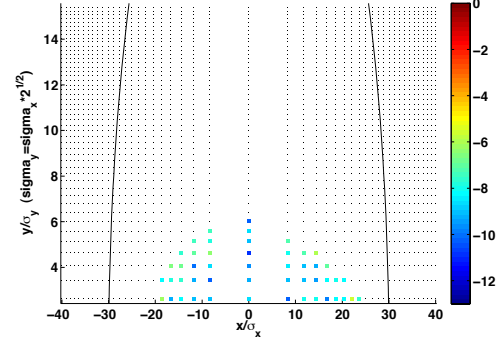
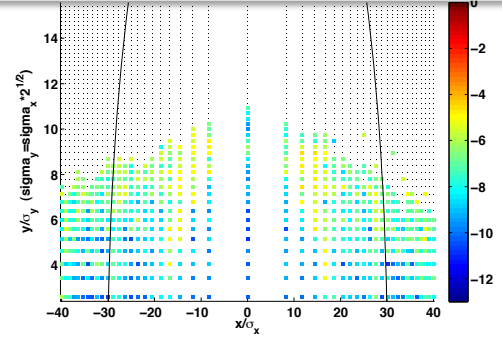
HER 0



HER



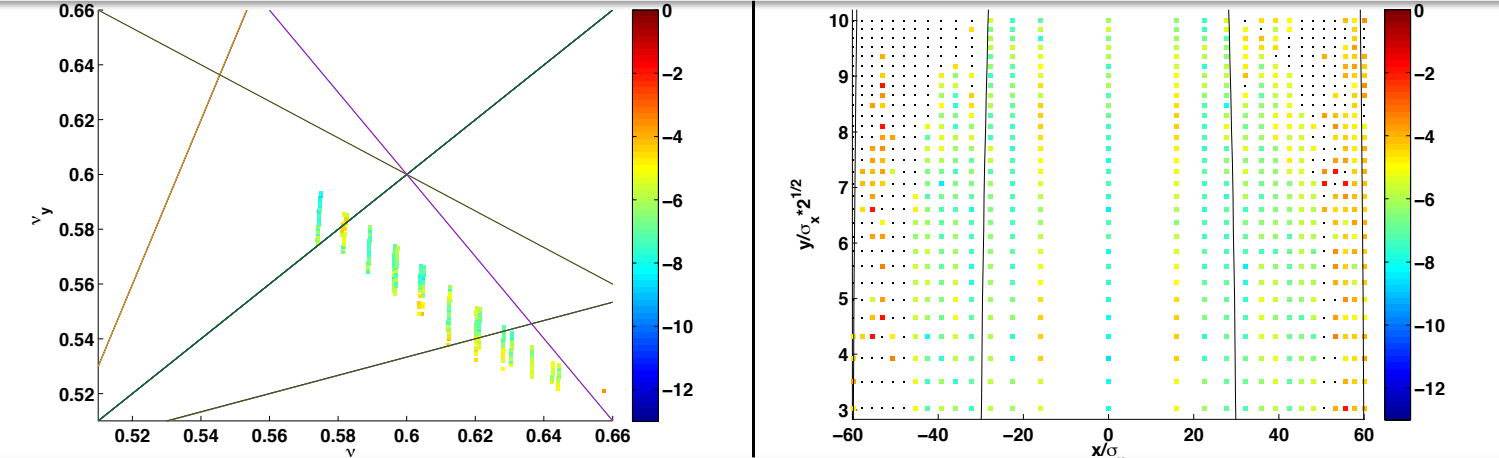
LER



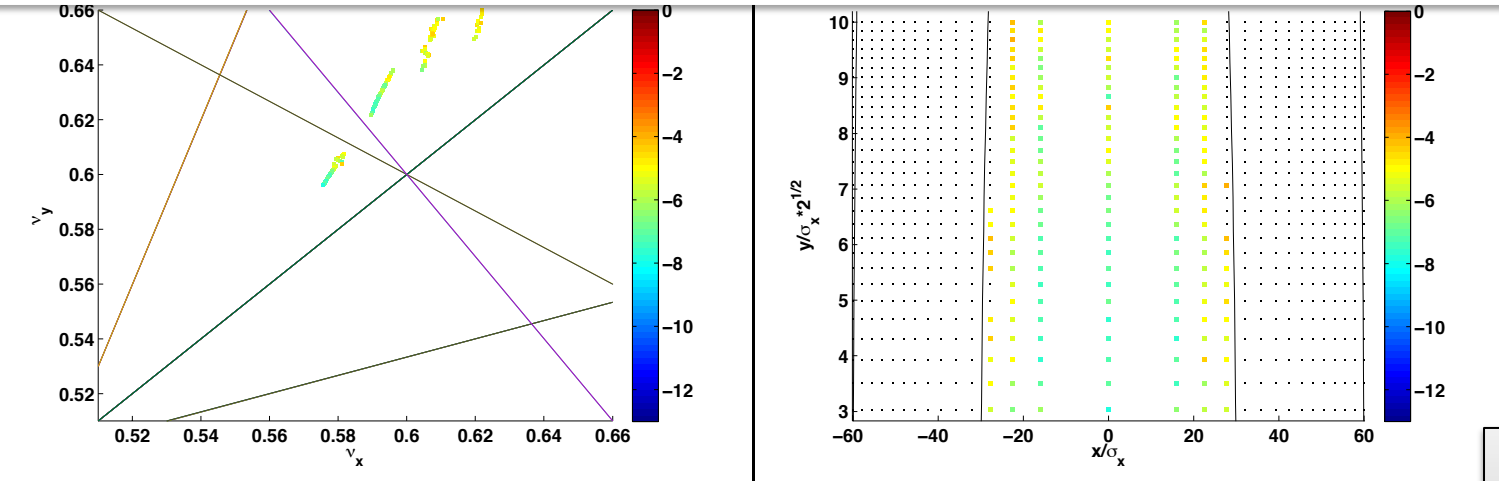
No fringes, oct off, sext on

# Frequency map w fringe fields

Sextupoles  $Dp/p=0$  no fringes no octupole



Sextupoles  $Dp/p=0$  with fringes no octupole

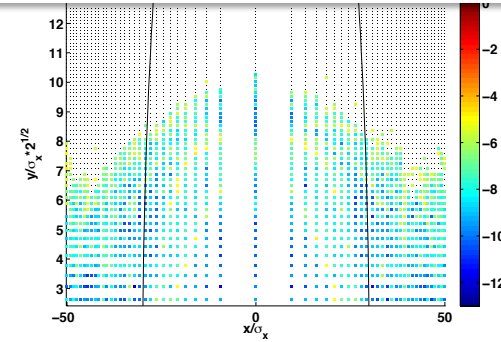
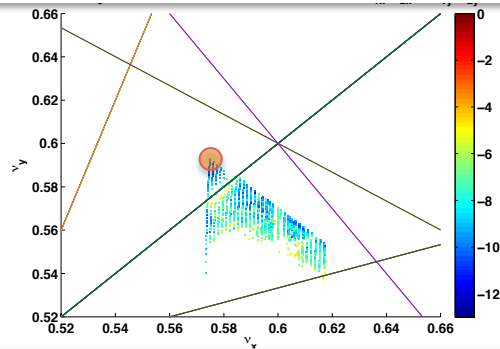


Radial cut not observed in mad8! Benchmarking needed.

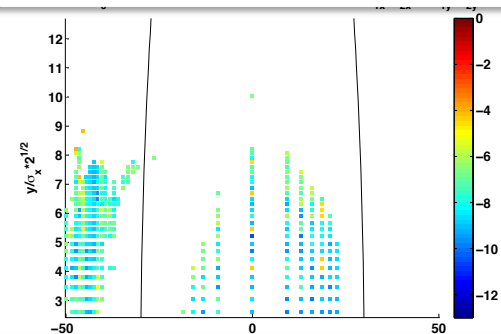
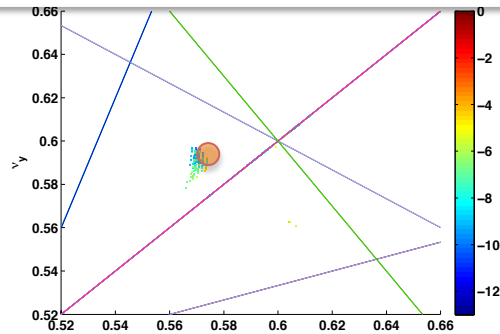
Less turns,  
turn  
everything  
more yellow

# Frequency map with errors and corrected DP/P=0

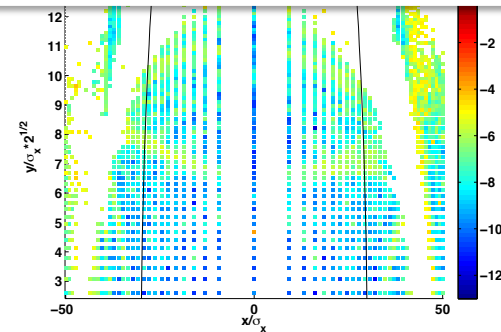
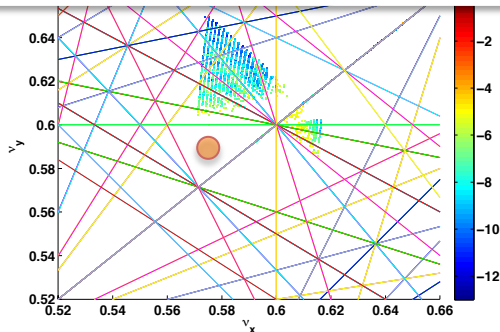
Sextupoles on,  $D_p/p=0$



Sextupoles on,  $D_p/p=0$ , Misalignments and tilts of quadrupole and sextupoles 10um (FF)



Corrected with 204 correctors (after every quadrupole and sextupole) not original tunes.



# Working point scan

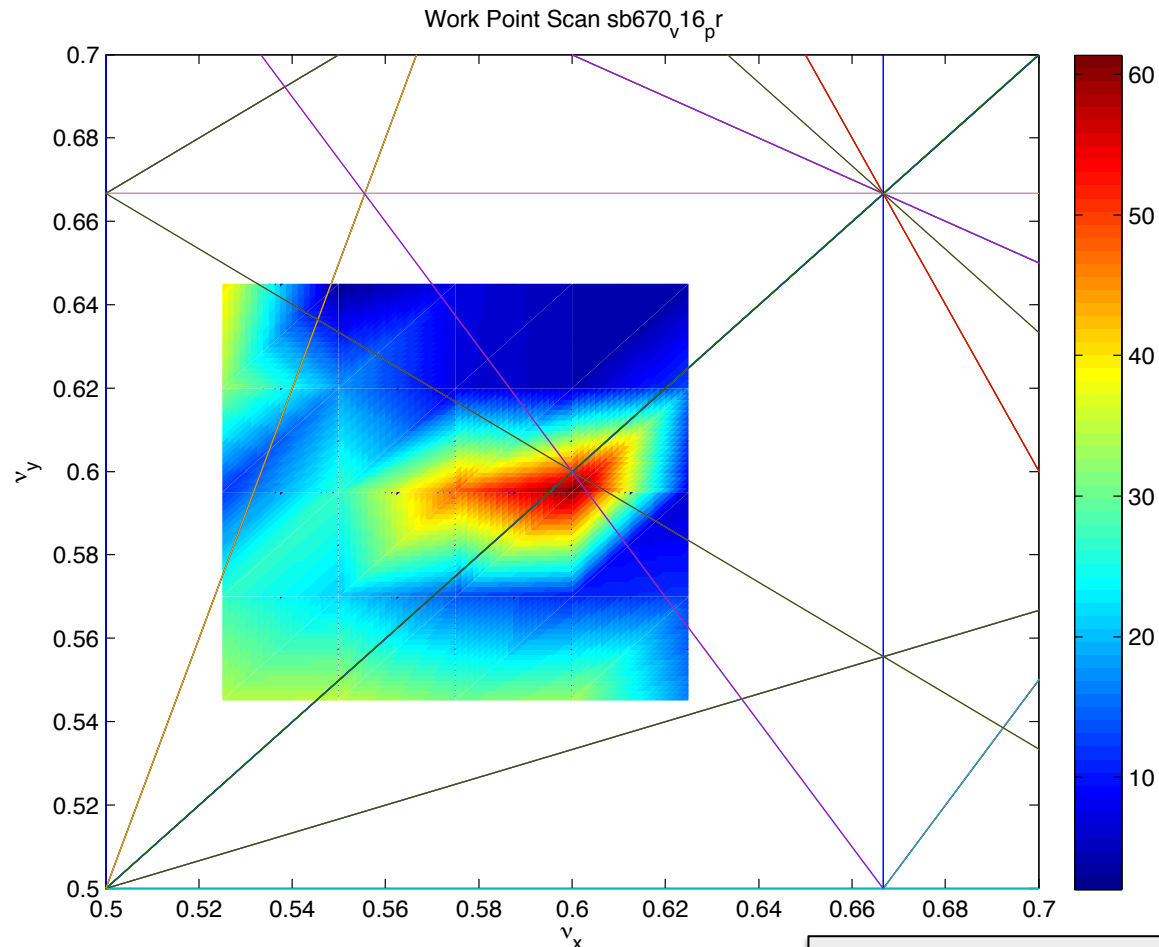
$$W = kN_{lost} + \sum \log\left(\sqrt{\frac{(\nu_{x,[0,\frac{NT}{2}]} - \nu_{x,[\frac{NT}{2}+1,NT]})^2 + (\nu_{y,[0,\frac{NT}{2}]} - \nu_{y,[\frac{NT}{2}+1,NT]})^2}{\frac{NT}{2}}}\right)$$

Color is sum of tune diffusion rates + contribution of lost particles.

Lattice misaligned corrected and retuned.

BLUE means no lost particles and tune diffusion low.

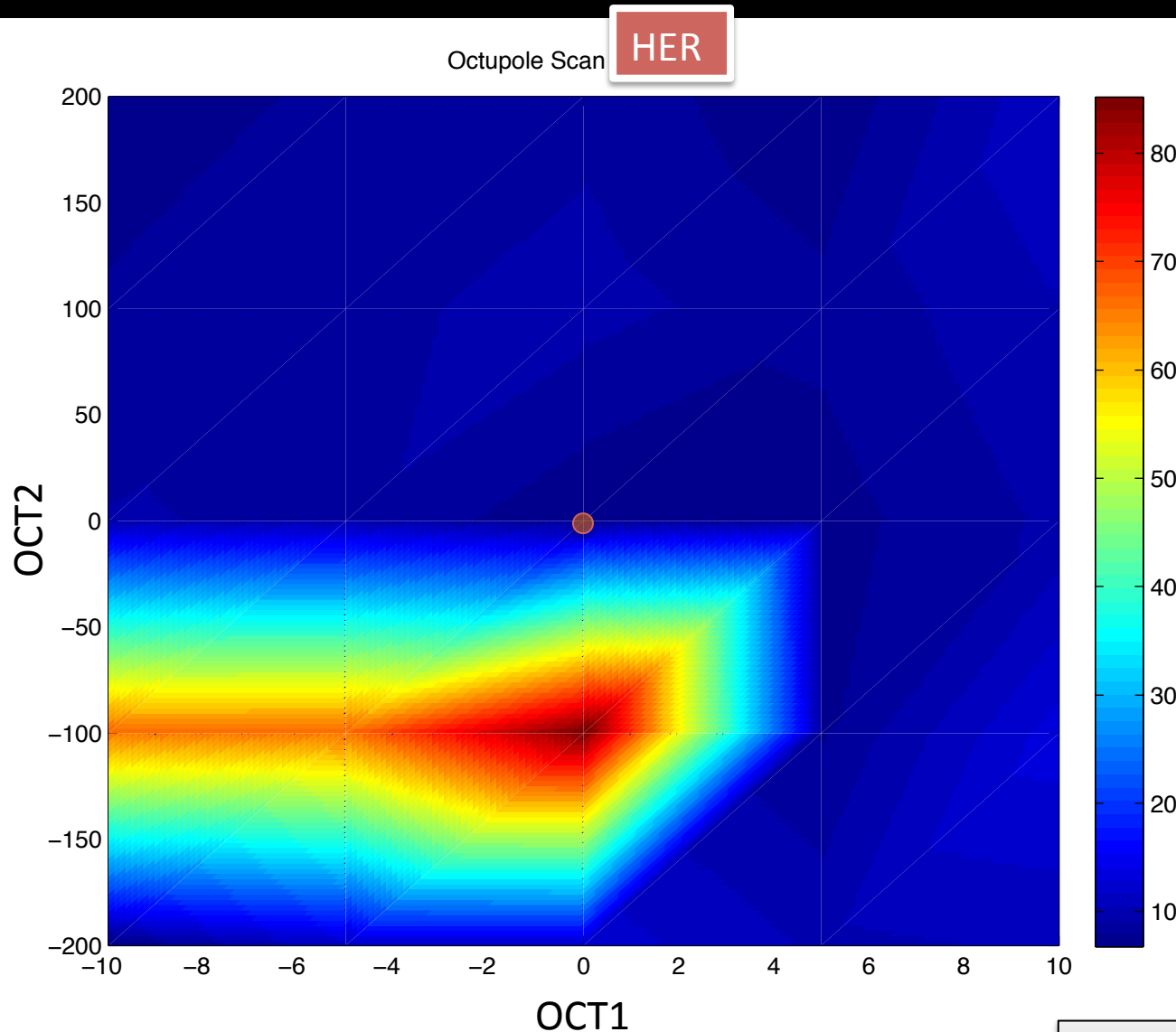
RED means lost particles and high diffusion.



Scan interpolates 5X5 points



# Optimization of octupoles strengths



Every point is the result of 144 particles tracked for 128 turns. (1h, using parallel cpu's)

From the points in this scans none is better than (0,0) ... Work still to be done.

Use PTC-knobs?

Scan interpolates 5X5 points

# Conclusions

WORK JUST STARTED, shows good potential.

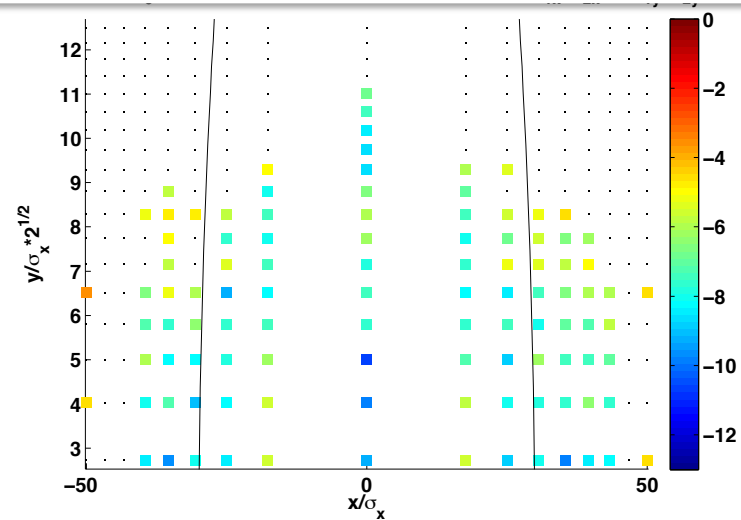
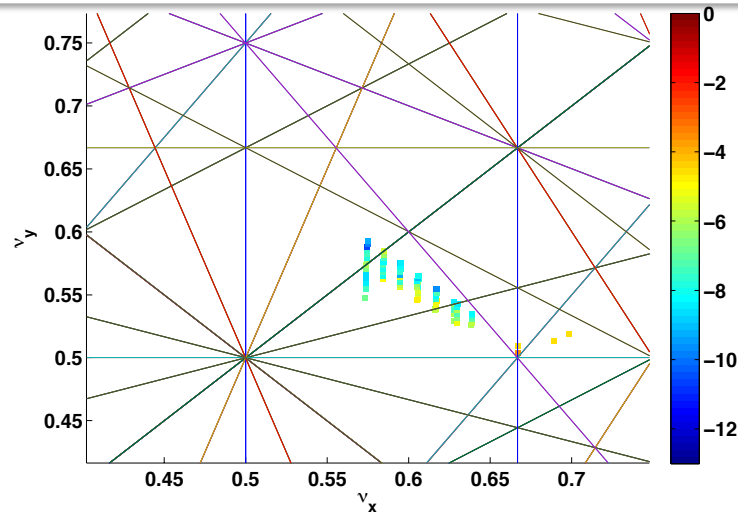
Needs checks on fringing in MADX

Needs optimization of octupoles and WPs

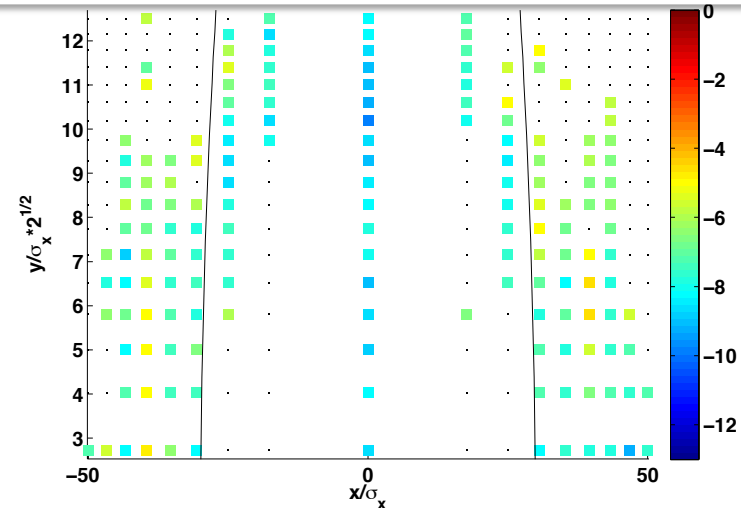
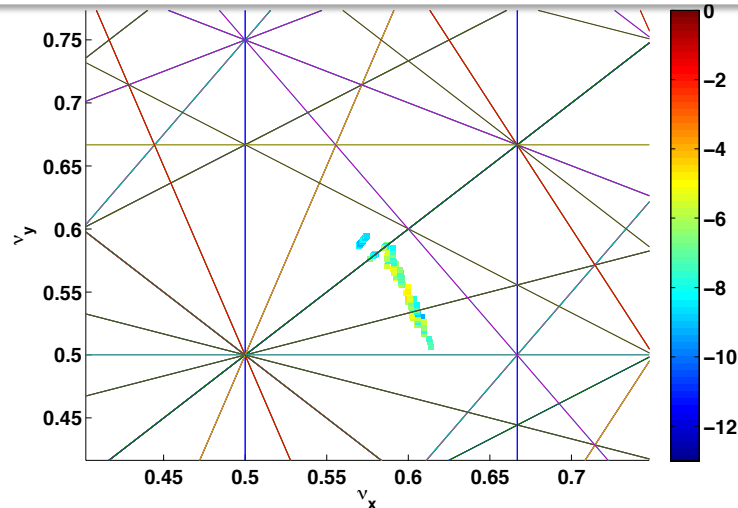


# Frequency map w & w/o octupoles

Sextupoles  $Dp/p=0$  no fringes no octupoles

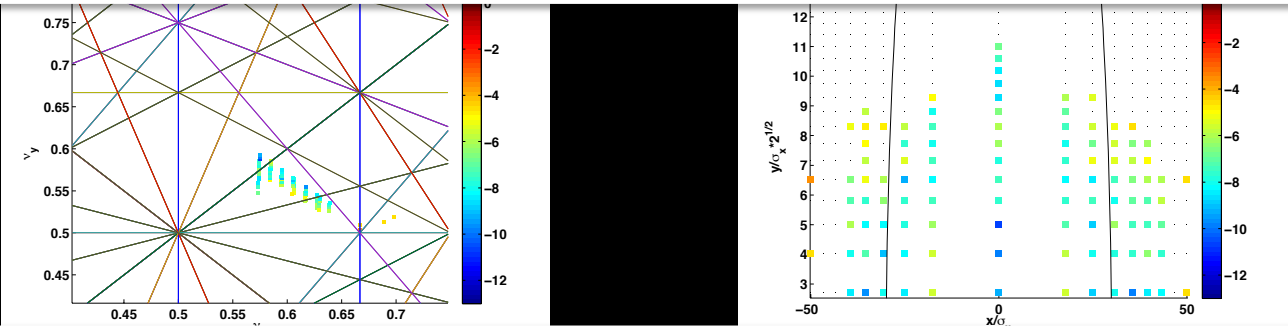


Octupoles and Decapoles not optimized, fringes non included.

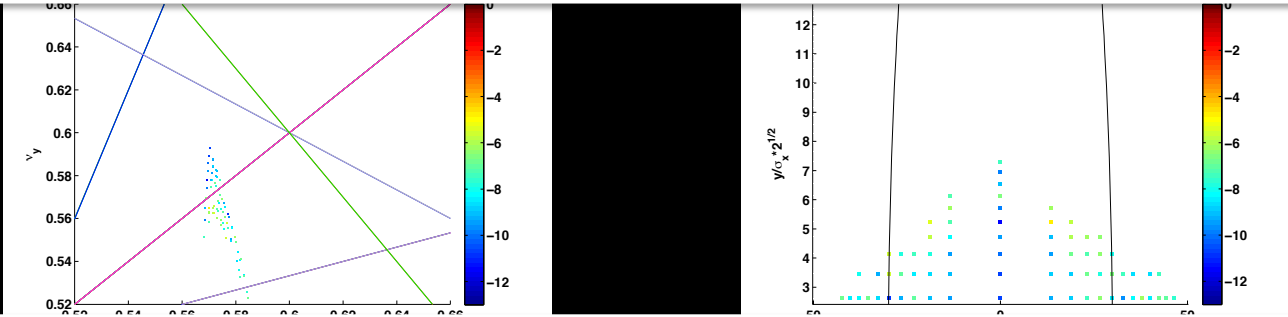


# Frequency map off momentum

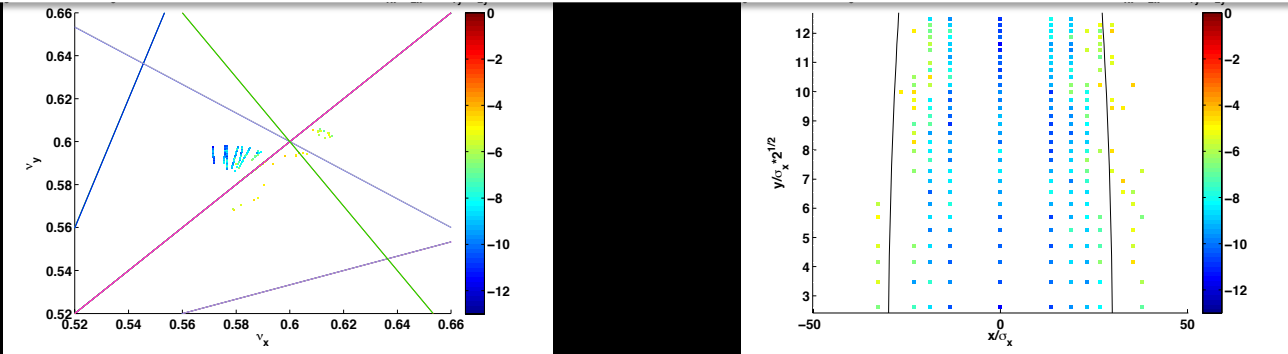
Sextupoles on,  $D_p/p=0$



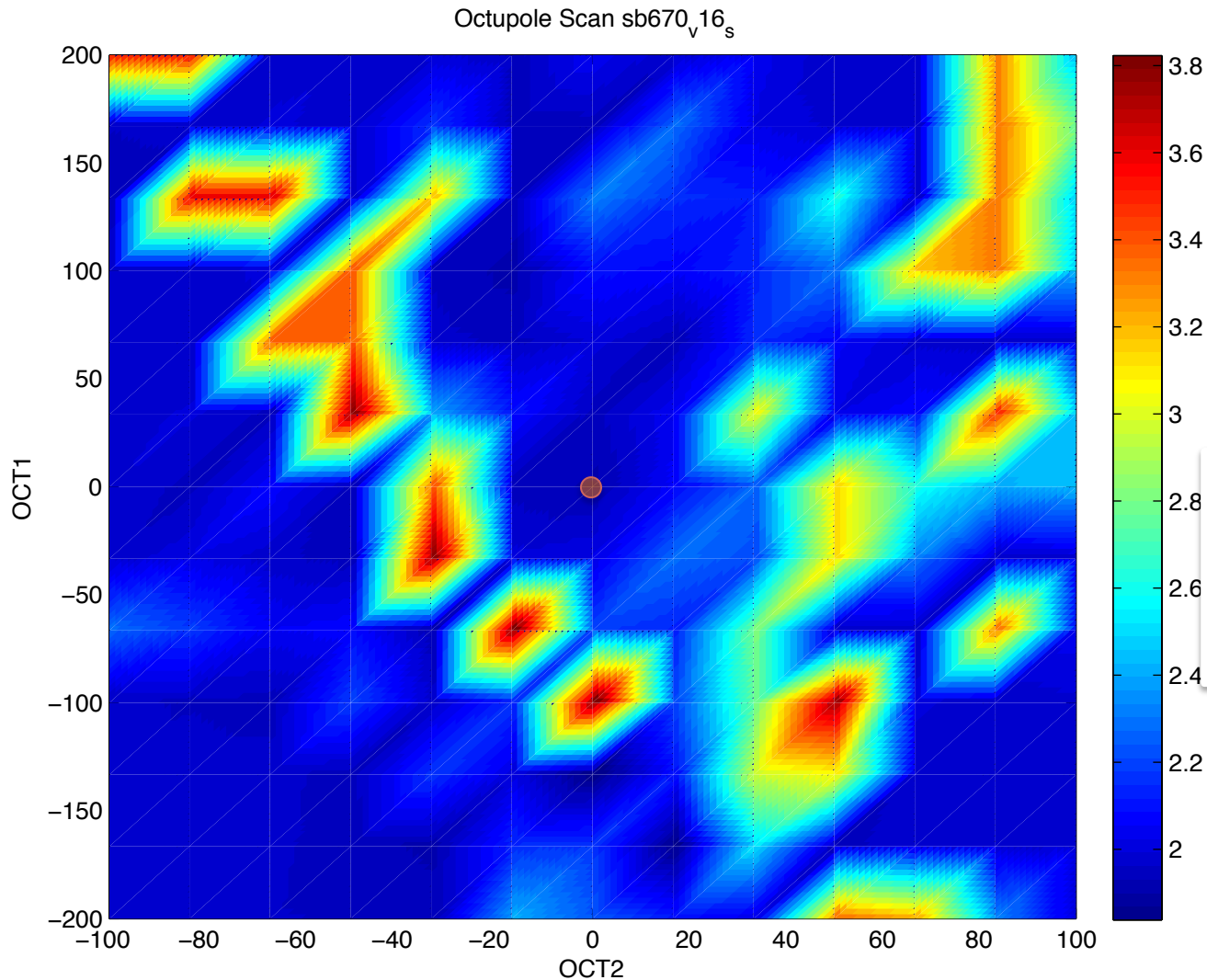
$D_p/p = +0.5\%$  (not rematched)



$D_p/p = -0.5\%$  (not rematched)



# Optimization of octupoles strengths



Every point is the result of 144 particles tracked for 128 turns. (8h, using parallel cpu's)

From the points in this scans none is better than (0,0) ... Work still to be done.

Scan interpolates 13X13 points