# Recent Experimental frequency maps at SLS and BESSY

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PhD position (10/2001-10/2004)

Collaboration with P. Kuske
Collaboration with A. Streun, M. Munoz, M. Boege

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   On momentum dynamics

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2. Recent Experimental Frequency Maps at BESSY

   On momentum dynamics

   - optics (17.85, 6.74) with zero chromaticities
   - Nice surprise !

3. Open discussions

# Collaboration with SLS

**April 2002** : First FMA Meeting with SLS team and first FM simulations for the bare lattice at (20.38, 8.16)

➔ Decision to modify one of the injection kickers to allow experimental FM measurements (simultaneous horizontal and vertical kicks)

**Summer 2003** : Installation of the pinger Magnet and first tests were promising
Thanks to M. Munoz a software architecture based on a server/client model has been developed and allows to centralize the tunes evaluation (see M.Munoz presentation for experimental set details)
Thanks to A.Streun an IDL on line application has been developed and resonances could be immediatly identified after FM acquisition

**March 2004** : The pinger Magnet was ready for use and invitation to participate to the first FM measurements

➔ Data Analysis is still in progress and first attempts are shown here

# Working conditions

SLS 9 families of sextupoles (2 harmonics)

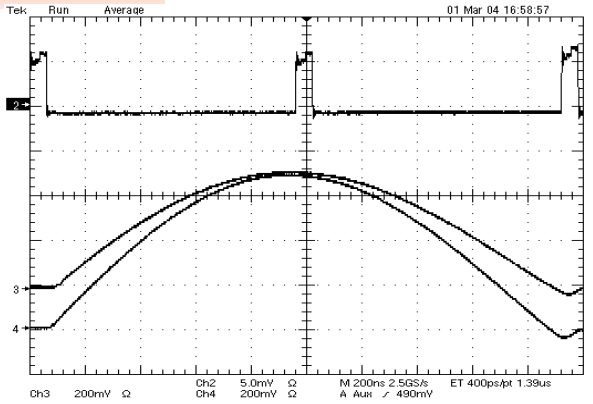
- Pinger Synchronisation with a train of 30 bunches

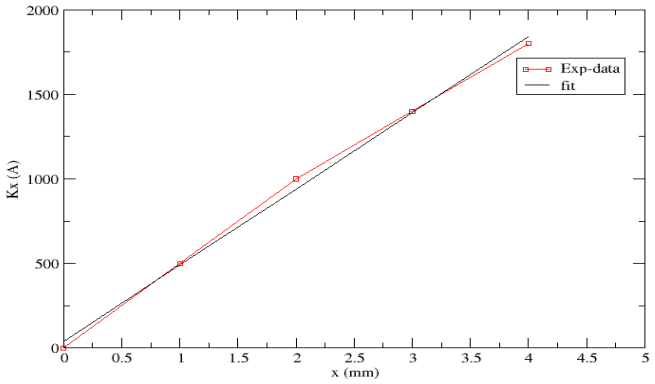
  (I= 10mA $\Rightarrow$ 0.3mA/bunch)

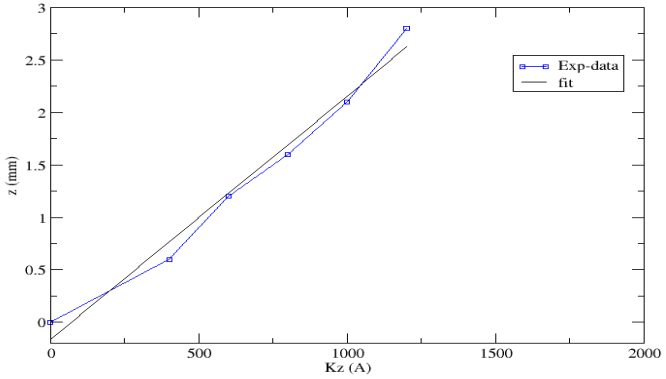
- Pinger calibration using a scraper

H

V




- For the zero chromaticities mode (experimental verification of both chromaticities $\xi_x = 0.05$ $\xi_z = -0.07$)
- For the high chromaticities mode (experimental verification of both chromaticities $\xi_x = 3.82$ $\xi_z = 4.93$)

# Working point (20.38, 8.16)

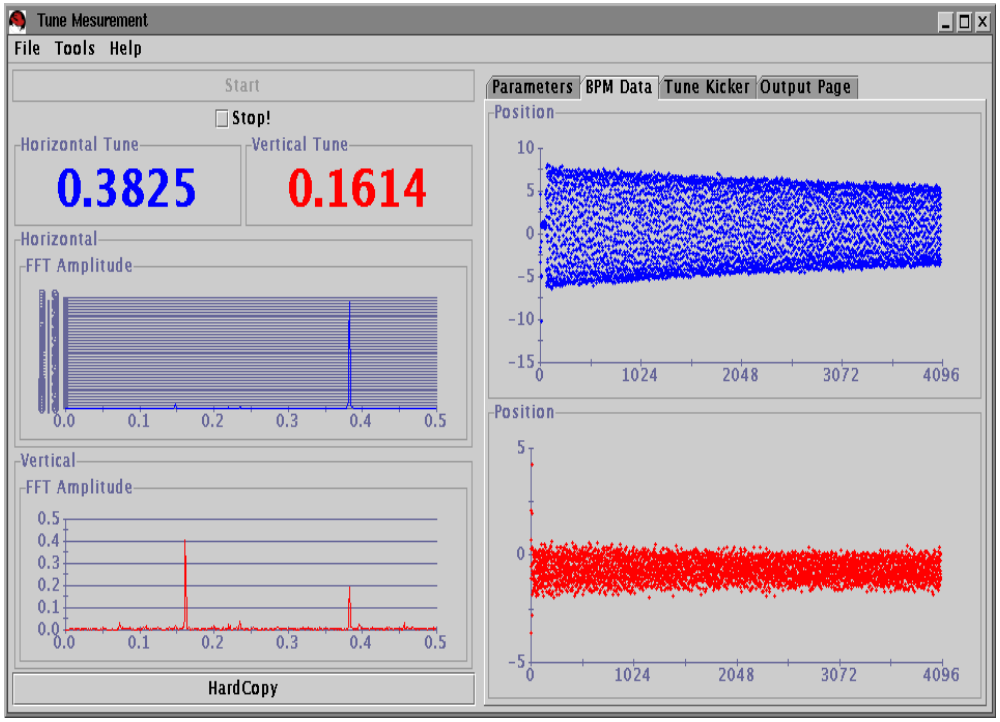
## zero chromaticities mode

- Frequencies determination using FFT
  - NAFF implemented but needs some modifications
- Range of amplitudes covered

  (x, z) = (5.3mm, 2.8mm) with a square root law

Max current in kicker (1800A, 1200A)

- Only 5.3 mm in horizontal




Very small decoherence on 516 turns

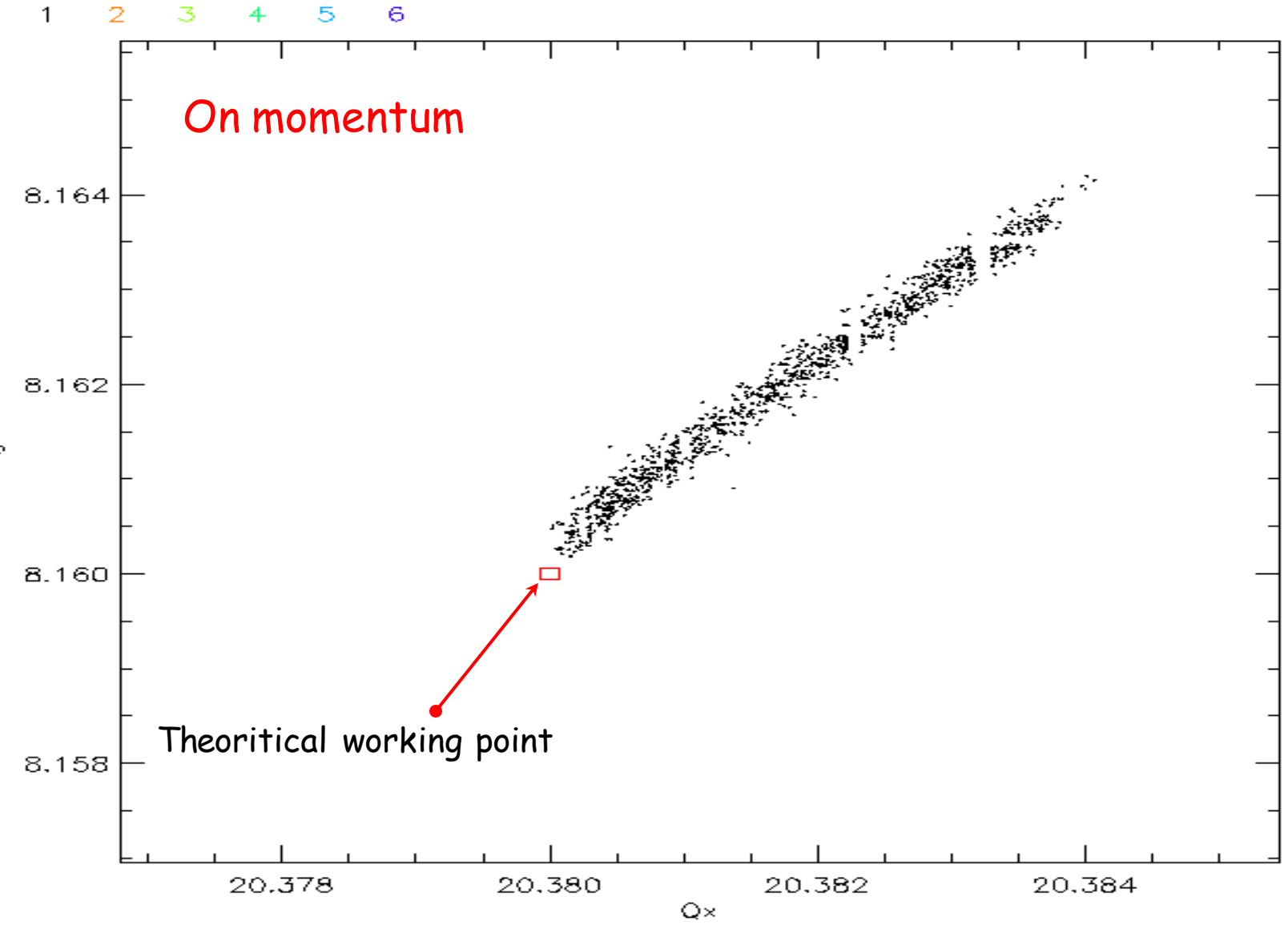
- Sampling 50*25

Very fine sampling of the small region possible to cover with the kicker limitation (example in horizontal some $10^{-1}$ mm at the begining then some $10^{-2}$ mm)

# Experimental frequency map at (20. 38, 8.16) and zero chromaticities

SLS

Very nice resonances revealed as desertions thanks to the fine sampling



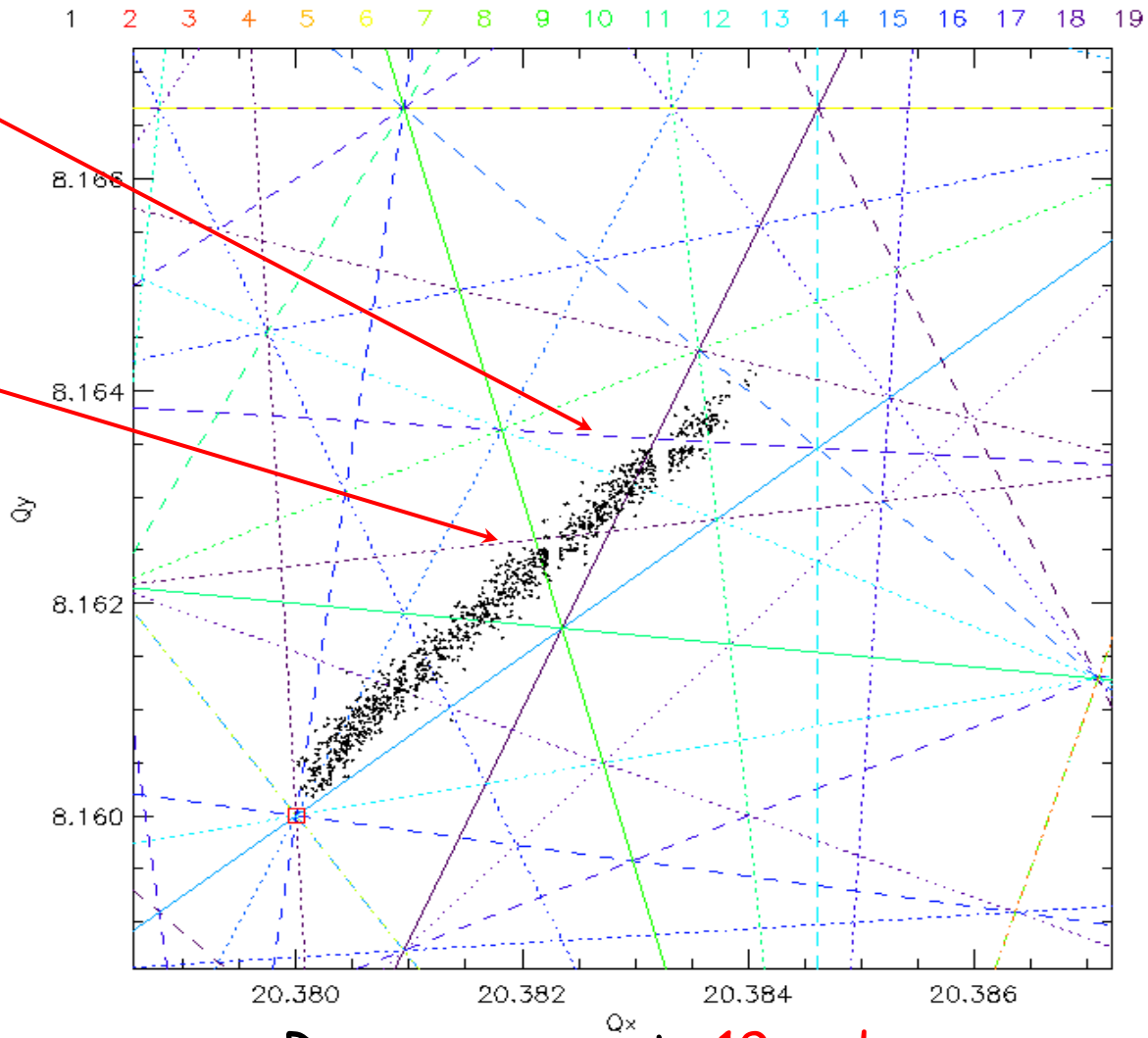
# Experimental frequency map at (20. 38, 8.16) and zero chromaticities

SLS

These resonances are of very high order

17 order non systematic

19 order skew



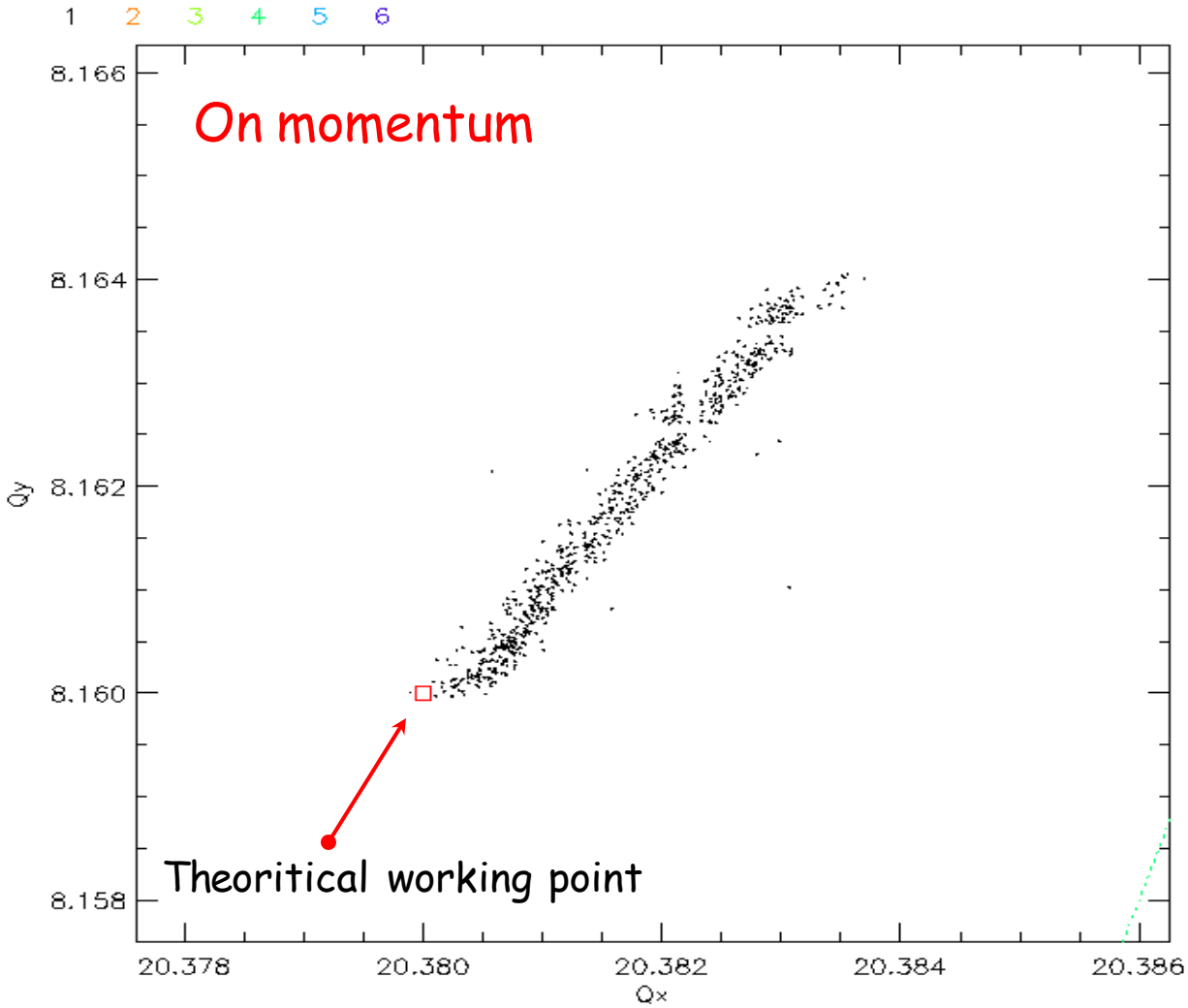

One has to go to higher orders to identify the others !

Resonances up to 19 order

# Experimental frequency map at (20. 38, 8.16) and high chromaticities

SLS

Very nice resonances revealed as desertions thanks to the fine sampling



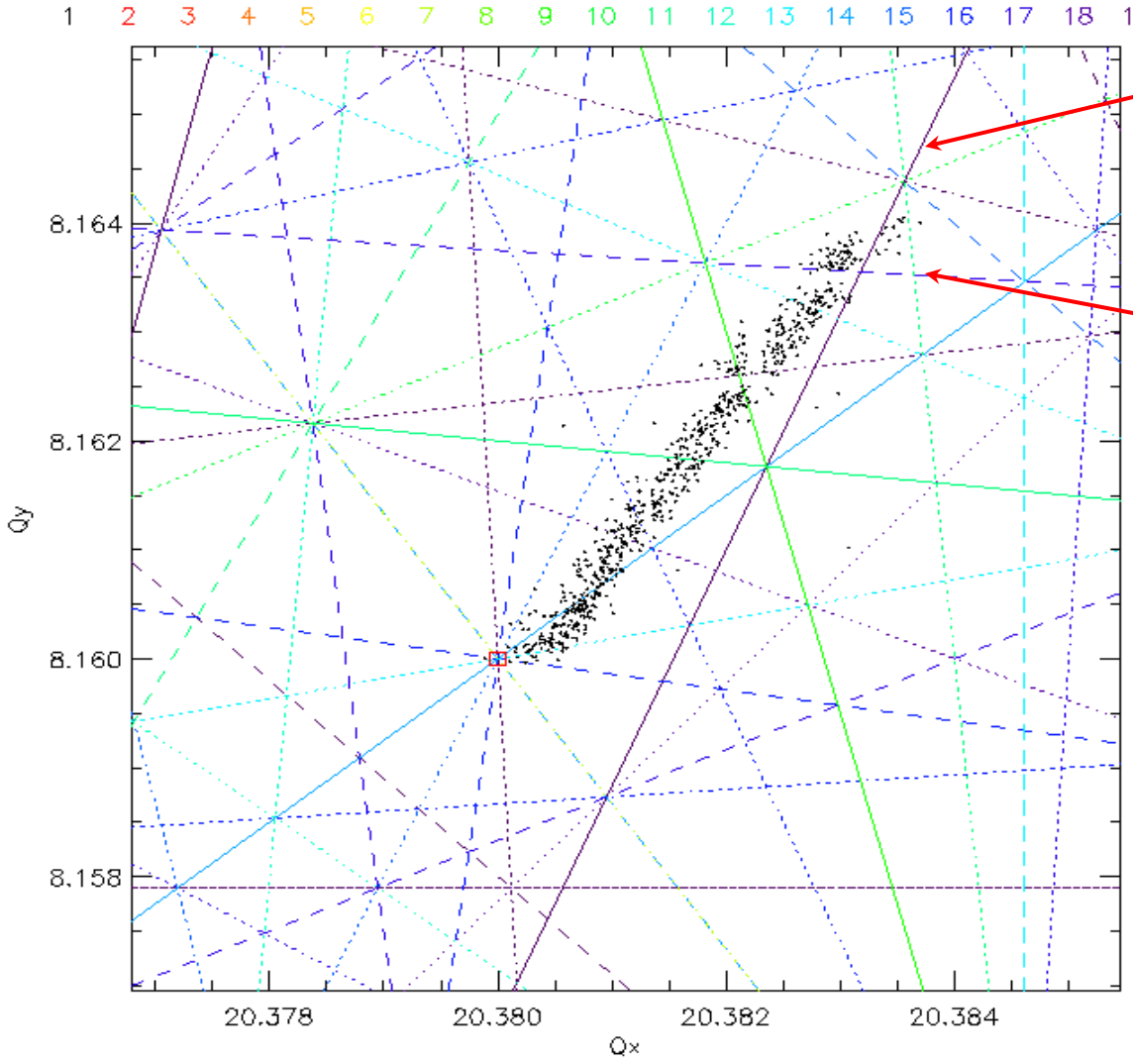

Sampling 36*29

high chromaticities means $\xi_x \approx 4$, $\xi_z \approx 5$

# Experimental frequency map at (20. 38, 8.16) and high chromaticities

SLS

On momentum




19 order systematic

17 order non systematic

These resonances are of very high order

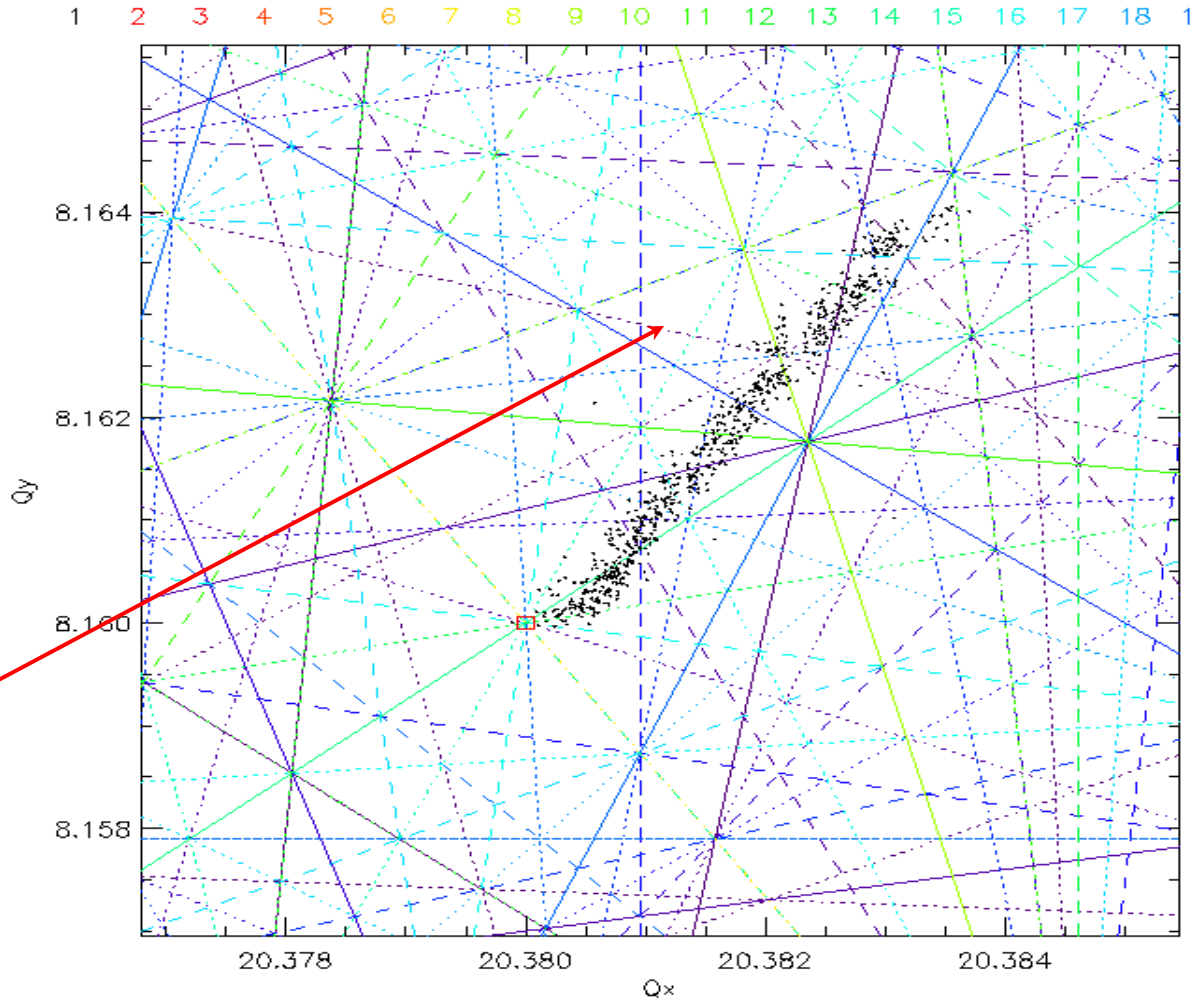
Resonances up to 19 order

# Experimental frequency map at (20. 38, 8.16) and high chromaticities

On momentum

These resonances are of very high order

24 order skew



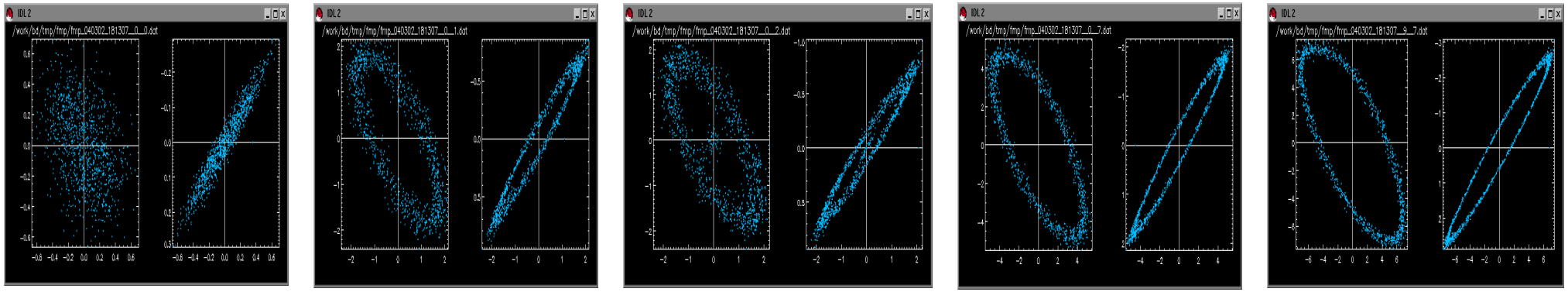

Resonances up to 24 order

- The reinjection is not yet automatic

- The X and Z positions are calculated on the BPM electronics (time consuming)

  ⇒ An other limitation on the kicks rate (1Hz in this case) & triggers in addition to tunes calculation and storage

- Observation of a strange coupling which necessitates more investigations : is the vertical kick pure or is the V-pinger rotated, ?



Phase space reconstruction : particle position in turn n+1 as a function of the position in turn n for a very small horizontal kick (almost 0) and increasing vertical kick

With courtesy of Andreas Streun

# Future important developements

## (see also M. Munoz presentation)

- Double the current in the kicker magnet for the horizontal kicks ⇒ factor 4 on the amplitudes ⇒ possibility to cover the whole dynamic aperture (~ 20 mm)

- Acquire a second turn by turn BPM and allow on line phase space representation

# Collaboration with BESSY

**December 2002** : First FMA simulations for the bare lattice at (17.85, 6.74) with positive chromaticities (routine operation mode)

**2003** : Thanks to P. Kuske developments have been done to allow experimental frequency maps measurements

**November 2003** : P. Kuske showed the first experimental frequency maps

**January 2004** : Invitation to participate to the FM measurements

➔ Data Analysis is still in progress and first attempts are shown here

**So Keep your ears and eyes quite open, there is a nice surprise to see !**

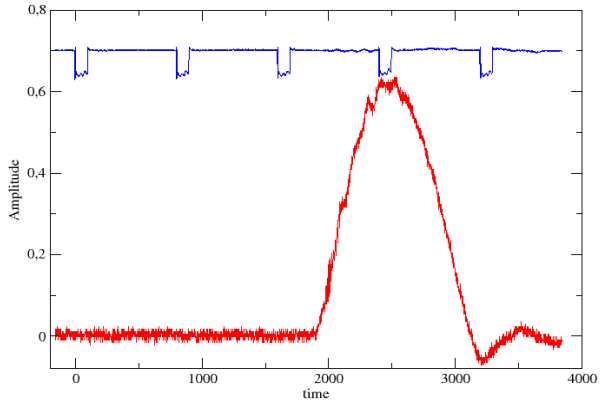
# Working conditions

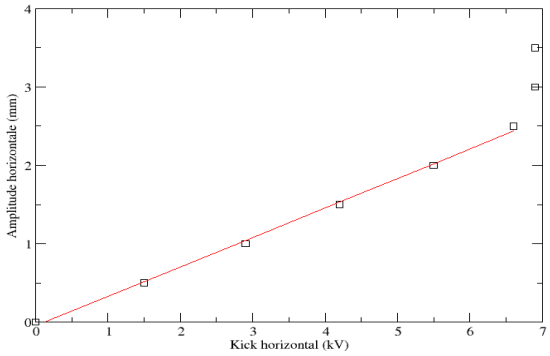
## BESSY

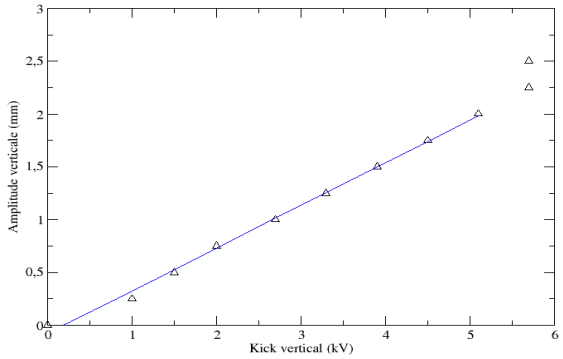
- Pinger Synchronisation with a train of 50 bunches

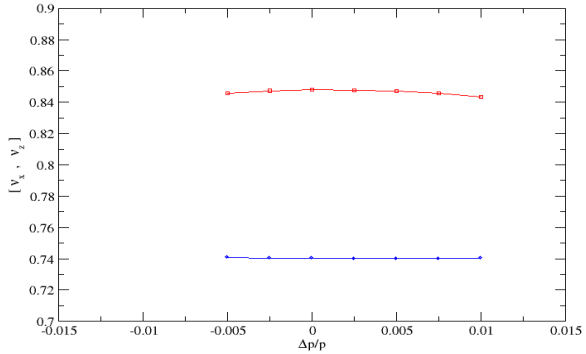
  (I= 5mA $\Rightarrow$ 0.1mA/bunch)

- Pinger calibration using a scraper



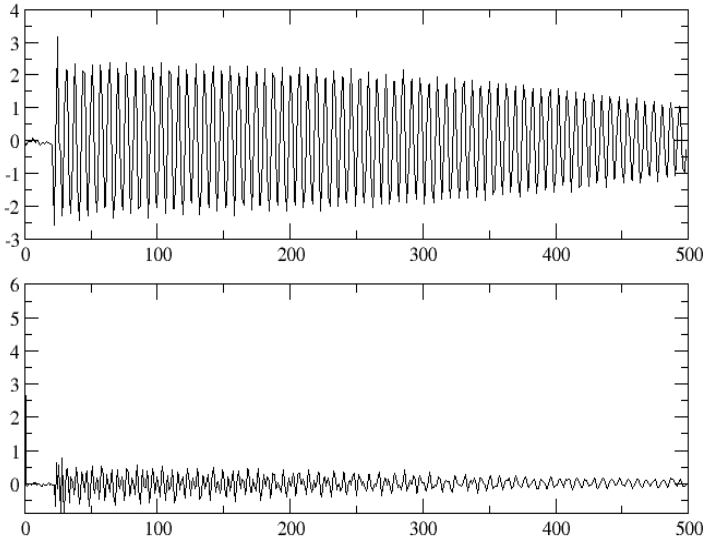



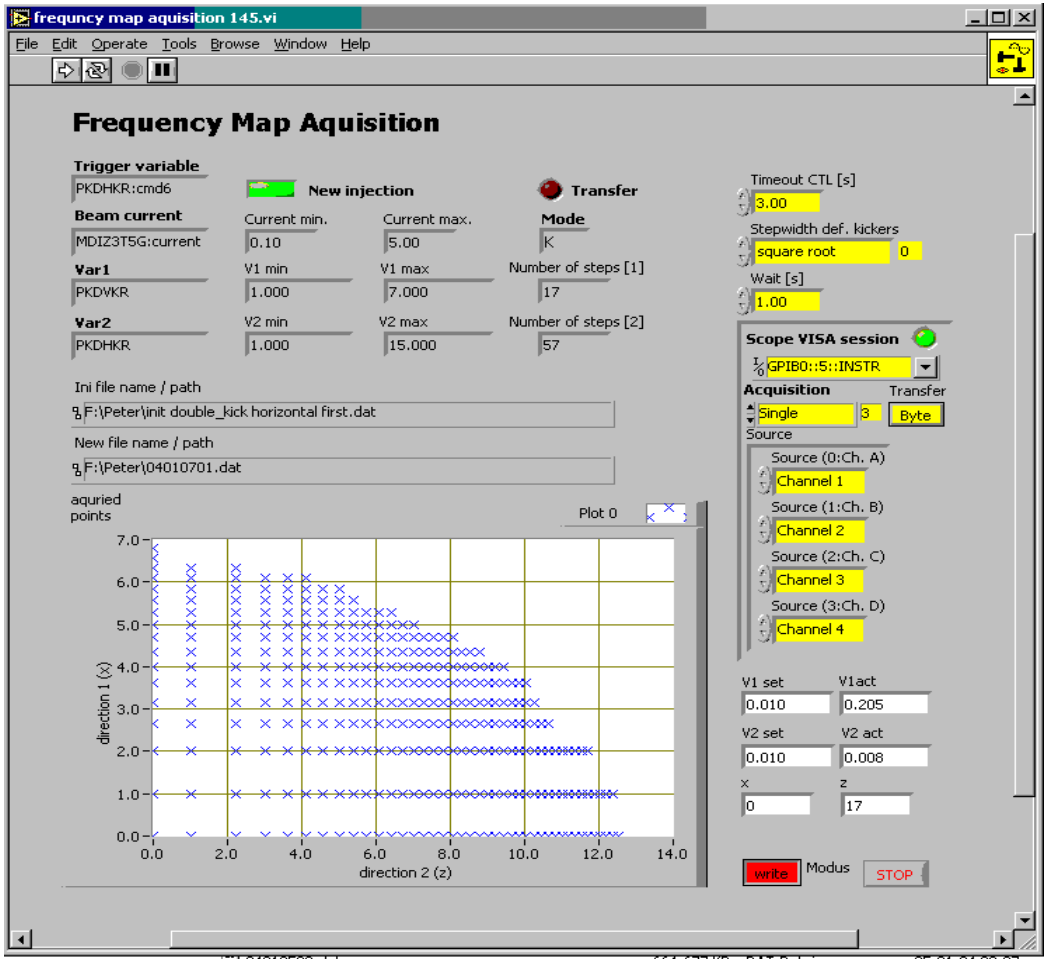




For the zero chromaticities mode (experimental verification of both chromaticities)

# BESSY



Non negligeable decoherence on 500 turns

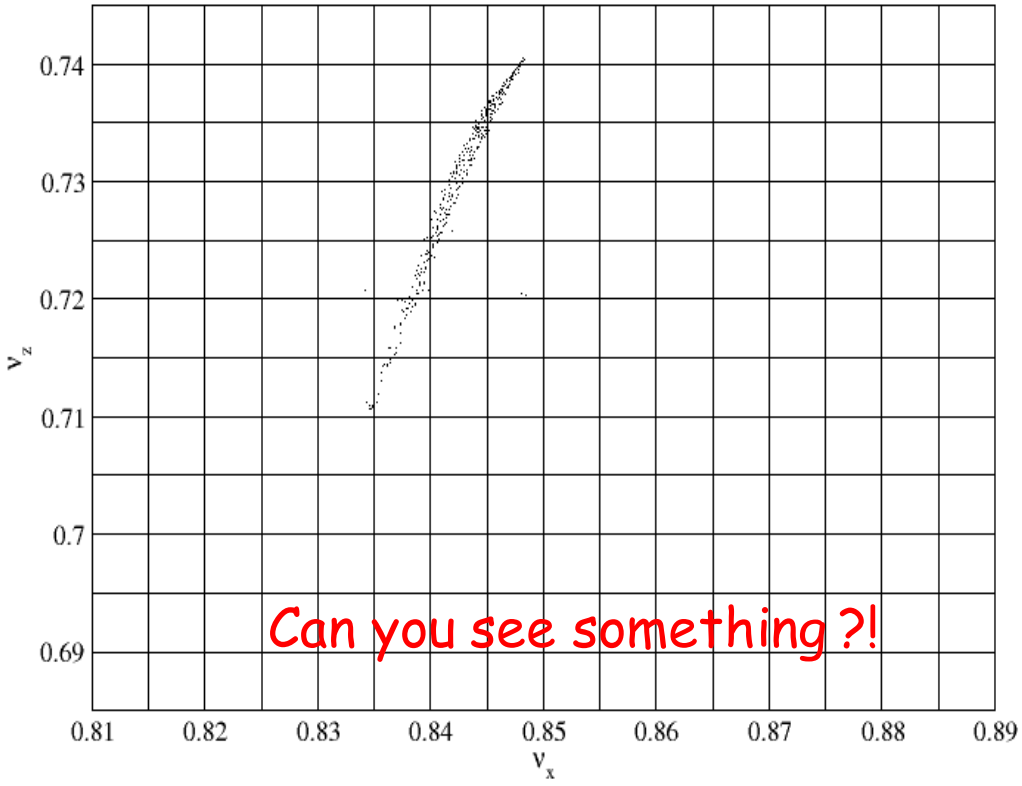


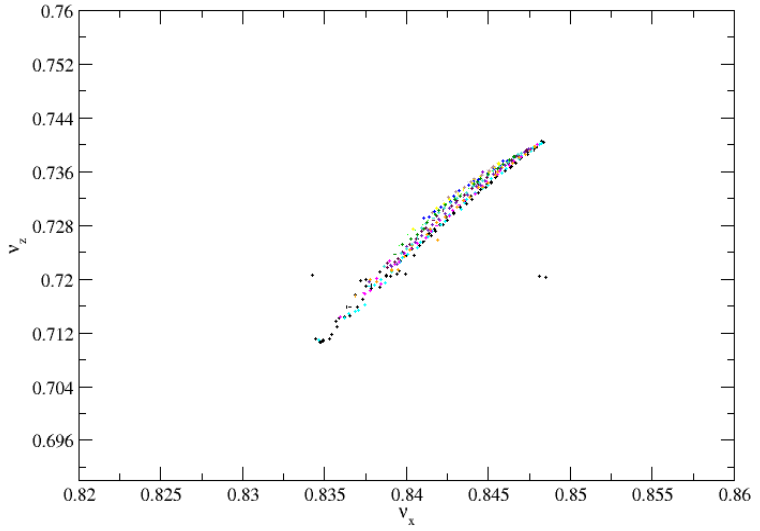

A sight on the control panel for frequency maps acquisition in the BESSY II control room

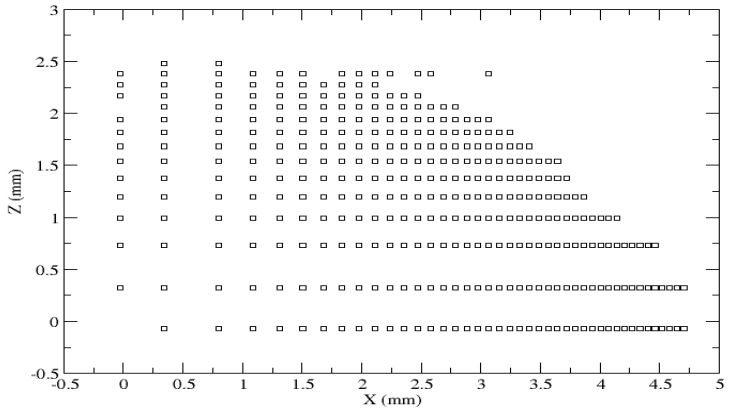
With courtesy of Peter Kuske

# Experimental frequency map at (17. 845, 6.74) and zero chromaticities

BESSY On momentum



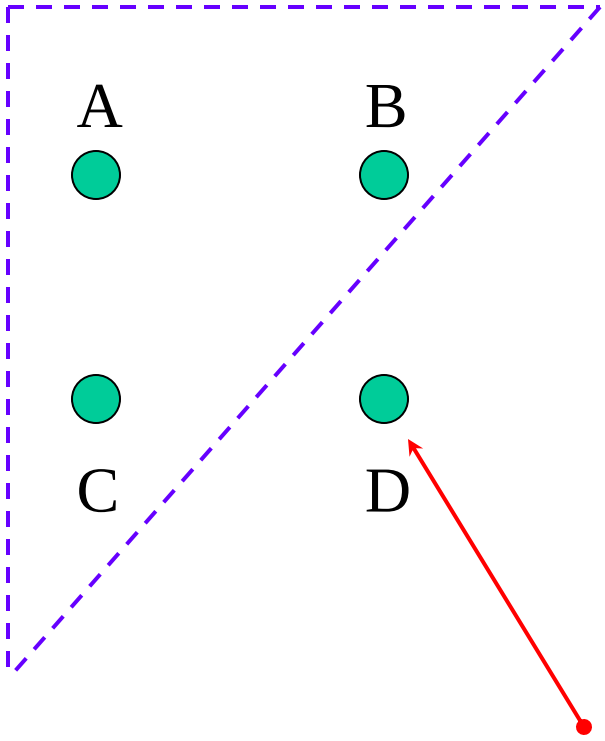




Colours there represents horizontal tunes dependance for fix vertical amplitude

# FIRST NICE COLOURED EXPERIMENTAL FREQUENCY MAP

The idea is to use the fourth electrode of the BPM to record the turn by turn current. The three others are reserved to the X and Z transverse positions




For turn by turn X and Z positions record

Definition of a loss rate as $\frac{I_i - I_f}{I_i}$

For turn by turn current record

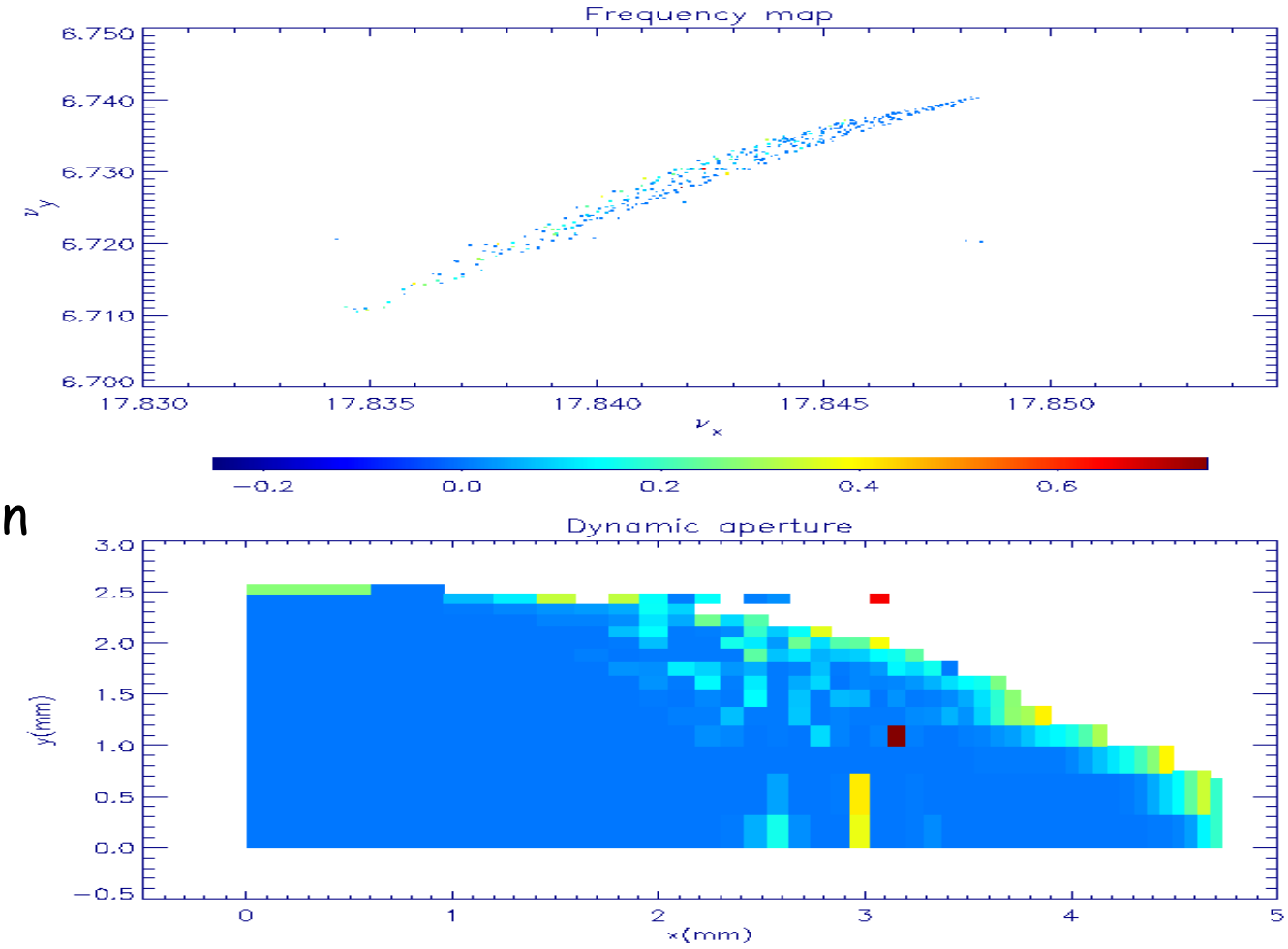
Which can be coded from blue No current loss to red maximum current loss

This can be stored for each couple of H and V kicks

# FIRST NICE COLOURED EXPERIMENTAL FM at (17. 845, 6.74) and zero chromaticities

## BESSY

On momentum

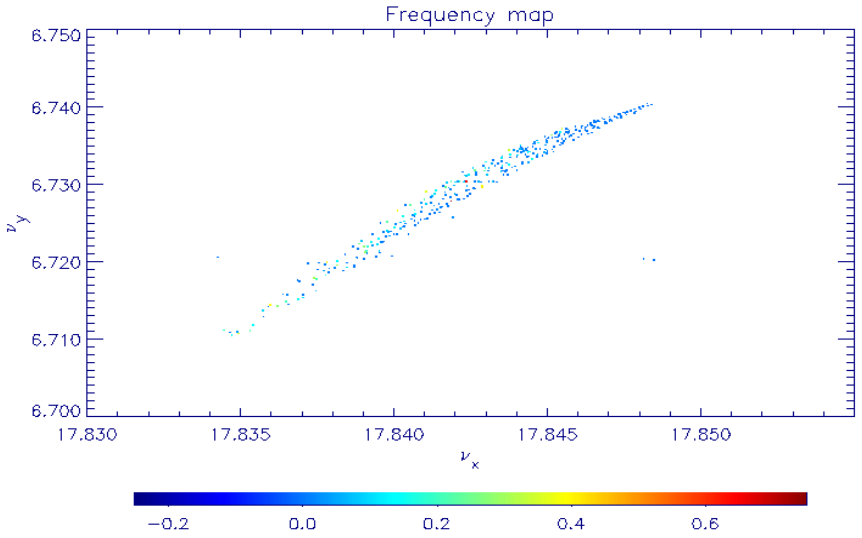


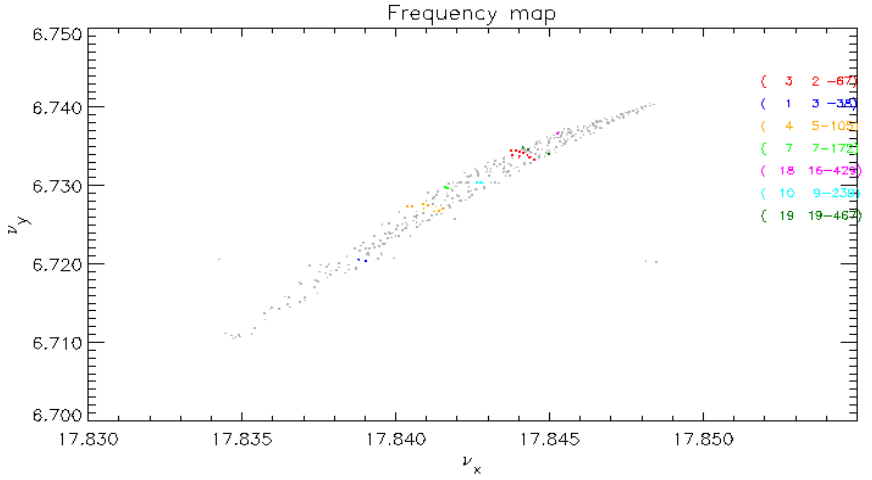

At the location of the low beta section

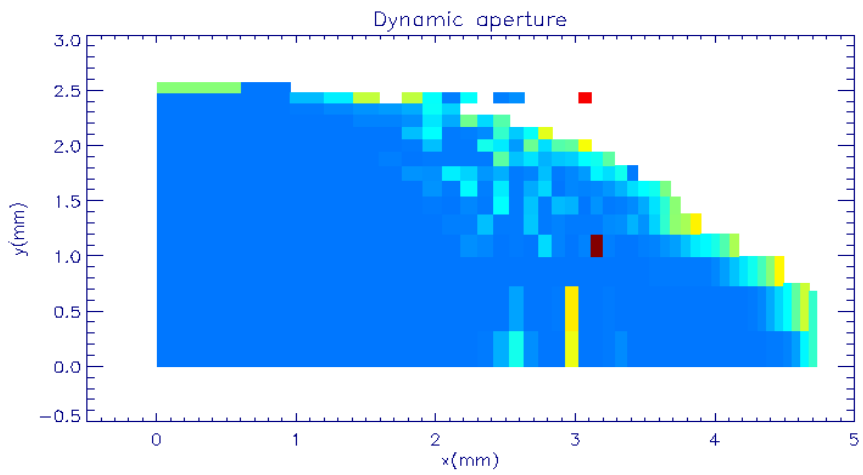
⇒ BESSY Aperture at the entrance of the machine = 17.4mm * 4mm

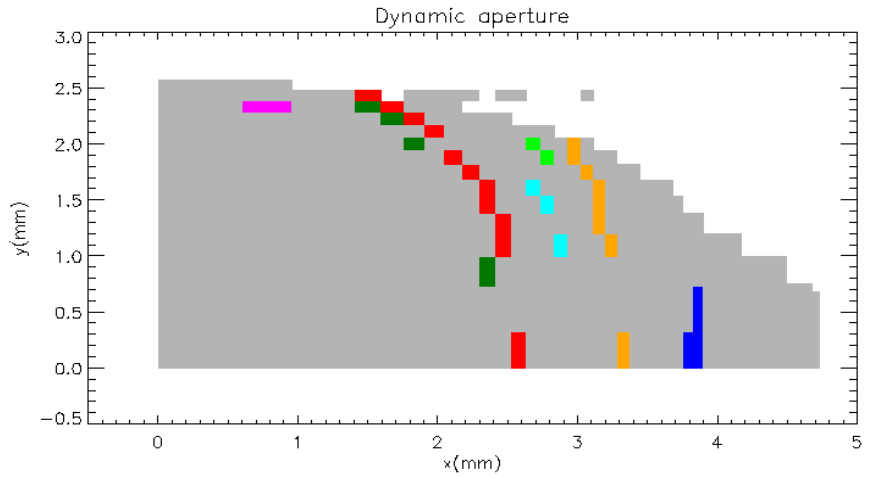
Which has to be compared to a good model reproducing the machine behaviour

# FIRST NICE COLOURED EXPERIMENTAL FM at (17. 845, 6.74) and zero chromaticities




BESSY

On momentum

At the location of the low beta section

# Next Step :looking into the model …….

Special Thanks to the SLS and the BESSY teams
for the nice and very interesting collaborations

Special Thanks also to the SLS team for allowing
the use of the IDL licence on distant machine

Special thanks to R. Nagaoka for interesting discussions
and to M.E Couprie for help