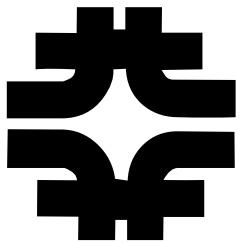
On Automated Betatron Coupling Measurements Using the Tevatron Tune Meter.



Paul Lebrun

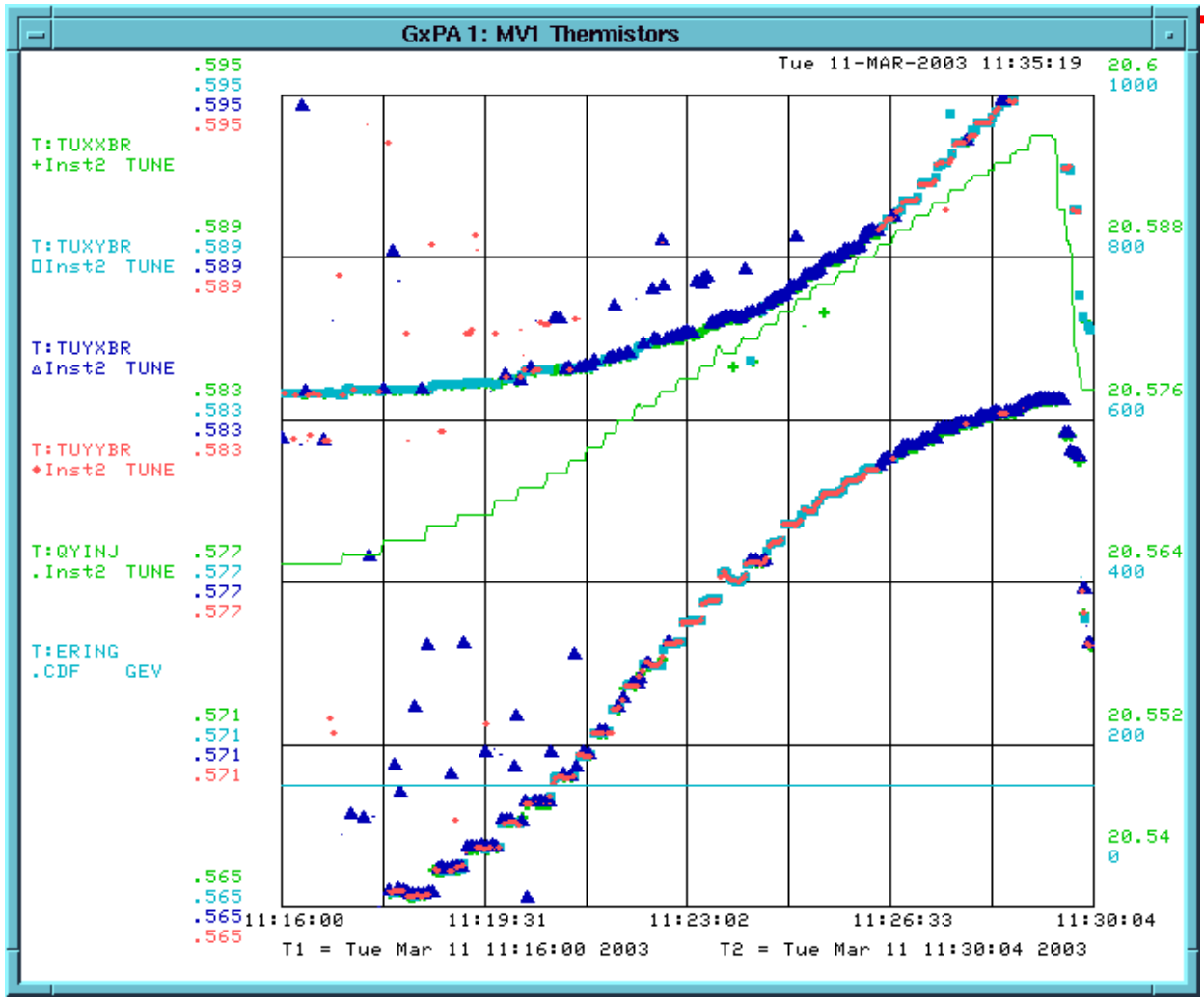
Fermilab

March 11-14 2003

Beam Study Report: Using the Tune Meter..

- Goals :
  - Advertise the Tune Meter to..
  - Automate the measurements of betatron coupling and Chromaticity using the Tune Meter, accurately.
  - Faster Tevatron Tune up.
- Method
  - Step 1: Construct a Tune Meter.
  - Step2: Using the Tune Meter.
    - Knob T:QYINJ, record T:TUXXBR, T:TUXYBR, T:TUYXBR, T:TUYYBR
    - Fit the data, without manual selection of that data!.

Raw Data Taken March 11, 11:16 – 11:29 A.M. F



Classical picture of coupled harmonic oscillators.

Accurate data!

Caveats:

Which one is X, Y ?

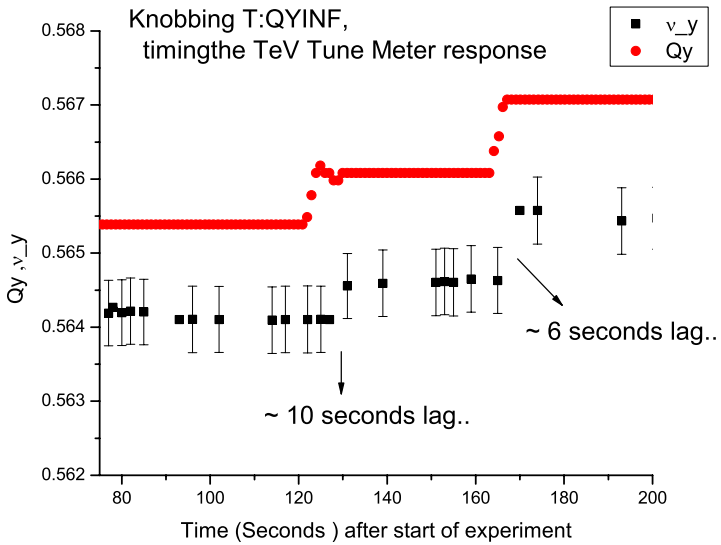
Data is noisy: The Tune Meter fitter got occasionally the wrong answer.

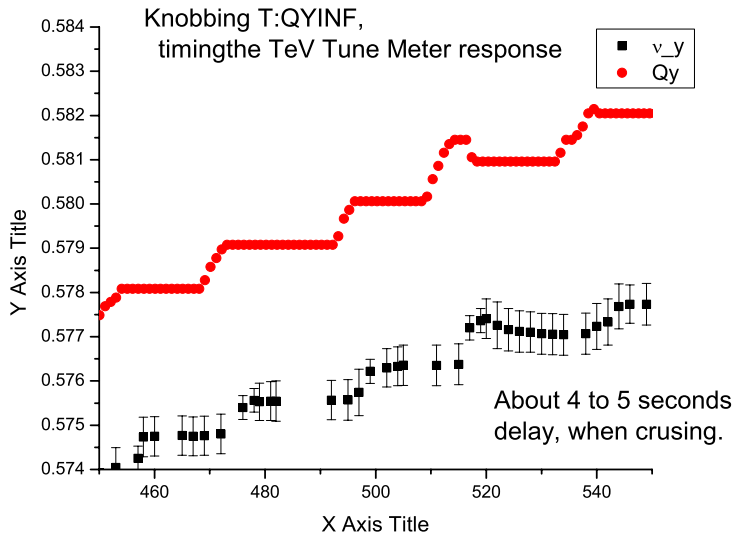
Time delay between setting and getting a Tune answer…

Can we get accurate number

Out of this data, automatically?

Correcting for the Time Lag between setting and measurements..

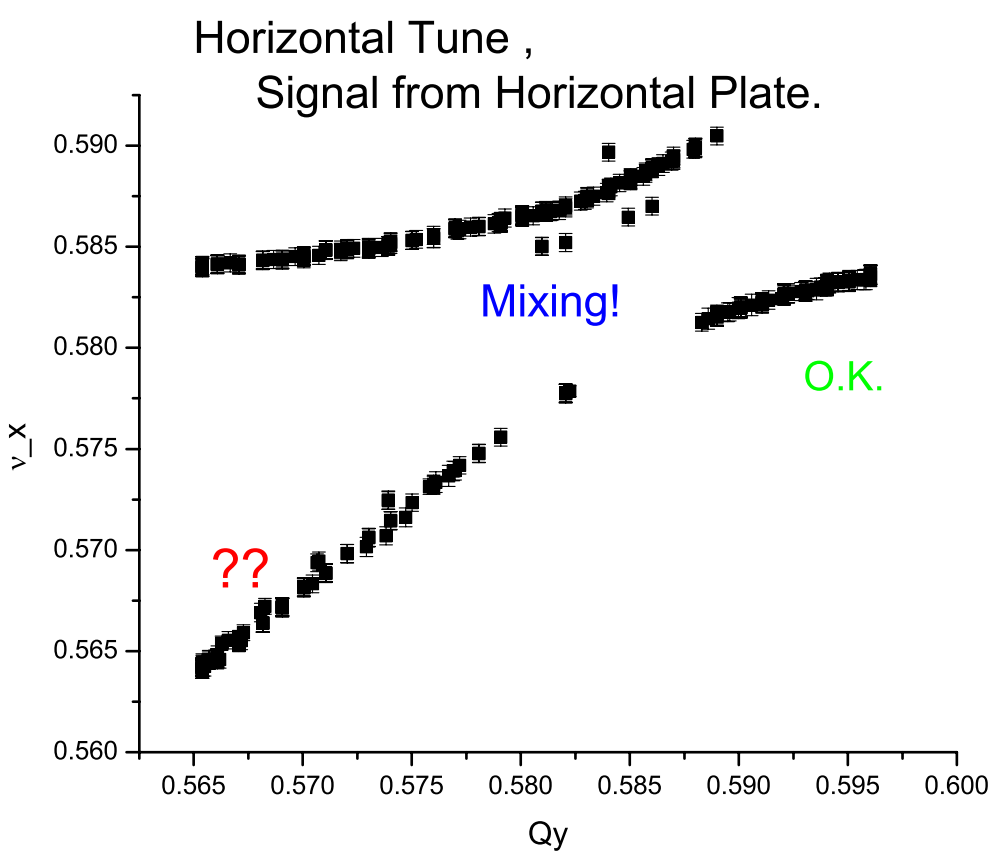




- For now, empirically setting it to 5 seconds. How come ?

~1 seconds for the Spectrum Analyzer to scan/sample, 1 to 2 seconds for GPIB D.A., 1 to 2 seconds for fitting and reporting the answer to ACNET.

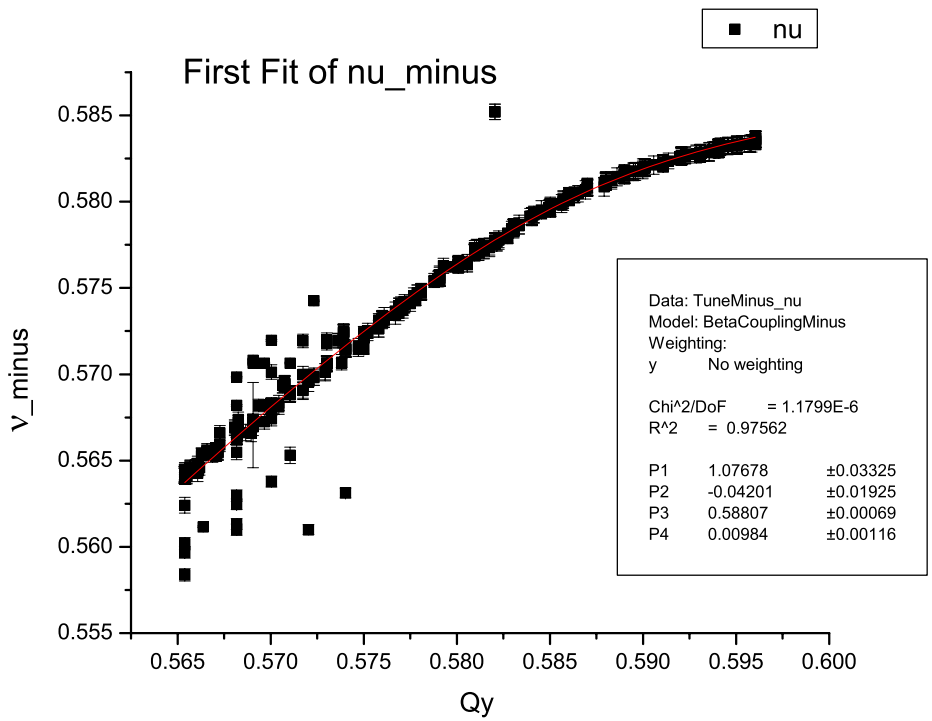
Failures of the Tune Directionality (X vs Y) logical Assignment



Based on the relative strength of the fitted resonance, compare the two signals from X and Y pick-up.
They might not be calibrated the same way!
In addition, for a substantial section of the explored Q_y range, this assignment is physically meaningless!.

Do we care ?

Combining X & Y Pick-up Signals, for "-" Eigenstate.

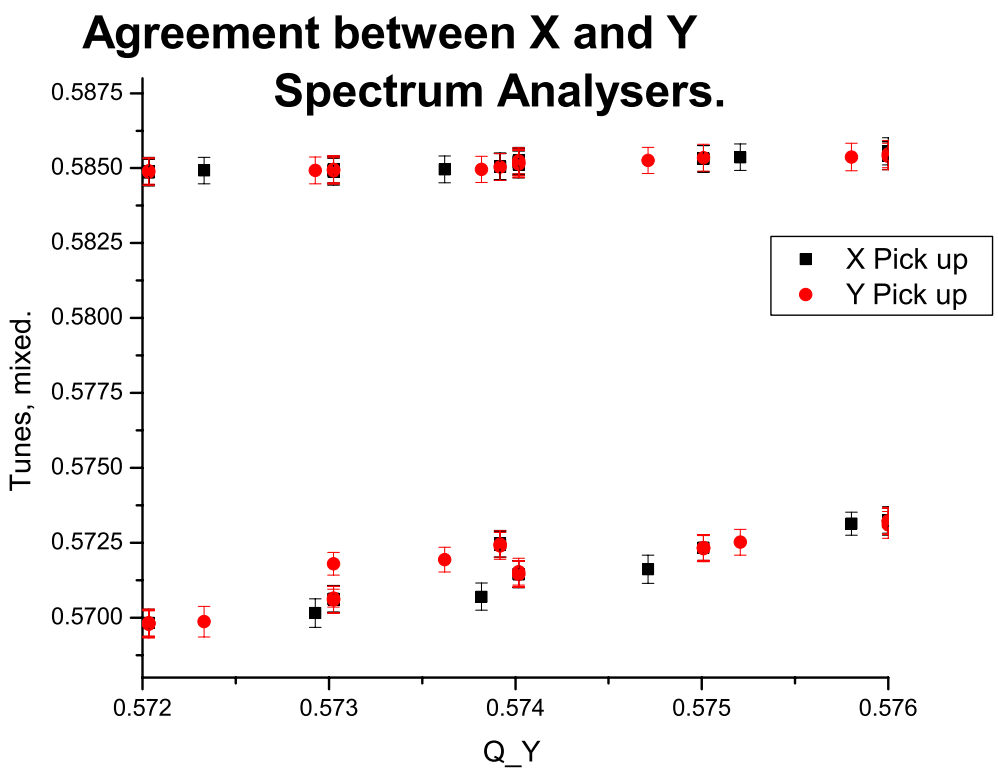


Simply select the low frequency curve. The average common frequency ν_0 has been set by "eye"… (So far, the only deviation from an automated procedure)

A first guess on the ν_y calibration in term of Q_y had to be guessed .. Which is O.K.,

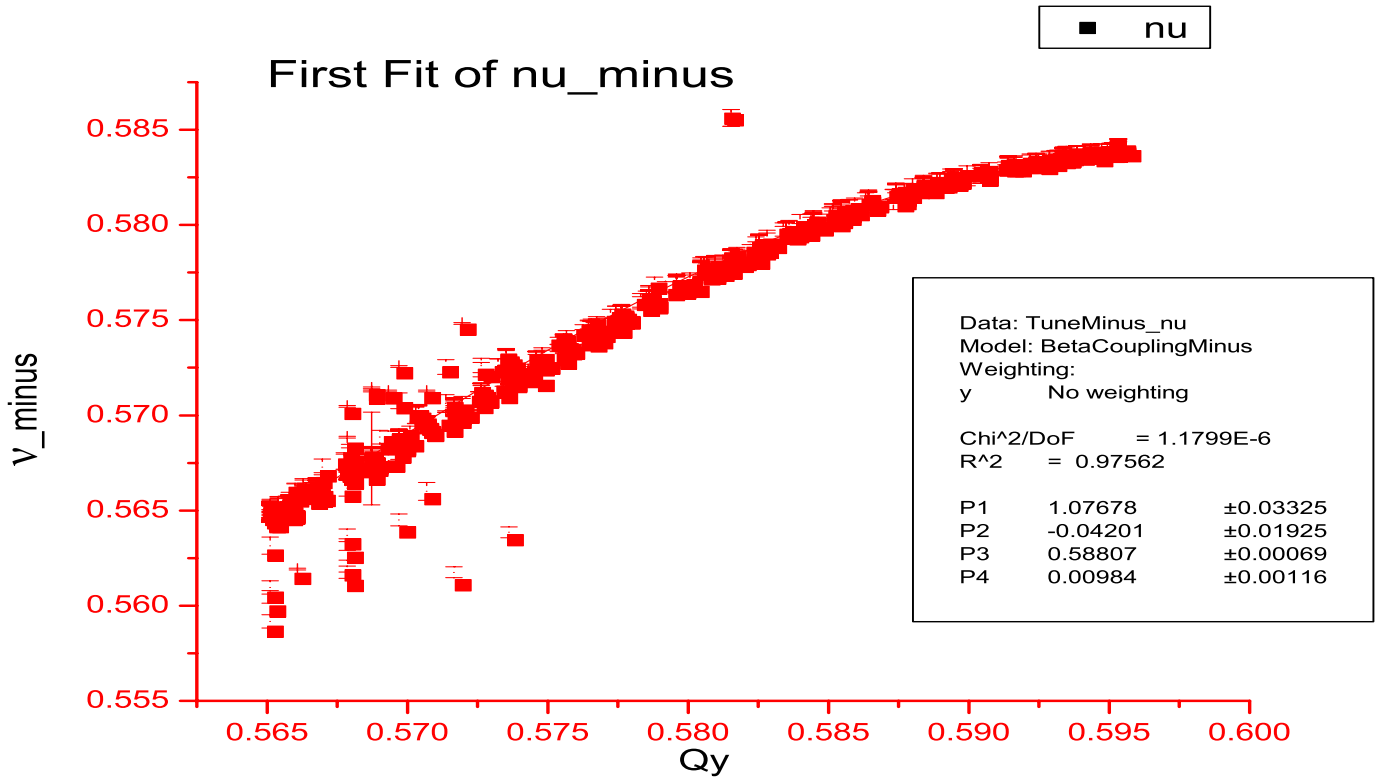
It can not change very much!.

Agreement between X & Y Pick-up Signals.



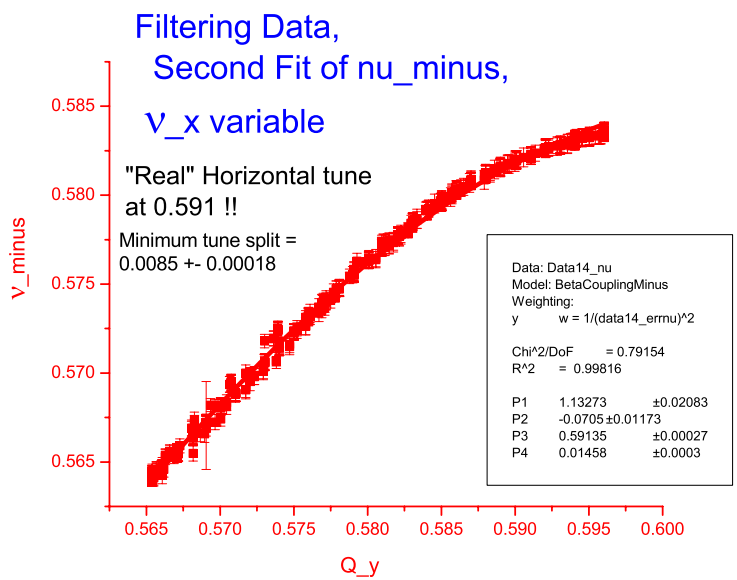
Besides occasional wrong choice of the correct Synchrotron line, we have good agreement..

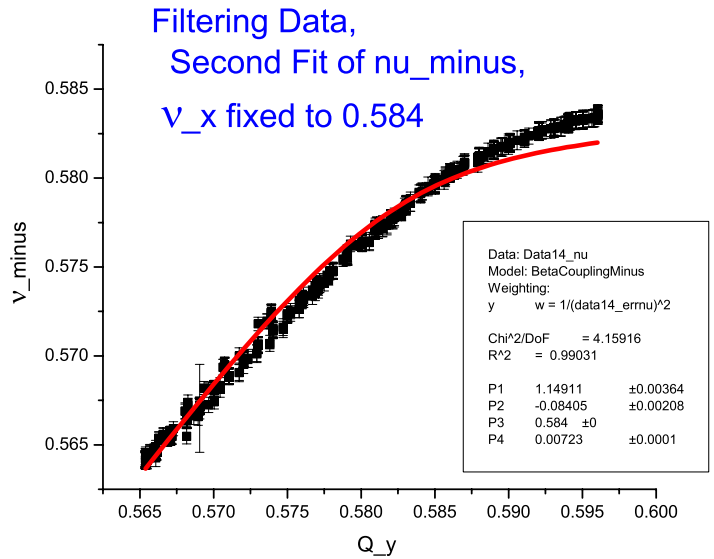
First Fit of the "-" eigenstate data, all "-" data



$\nu_y = P1*Q_y + P2,\ P3 = \nu_x,\ P4 = q^2$

Second Fit of the "-" eigenstate data, selected "-" data"



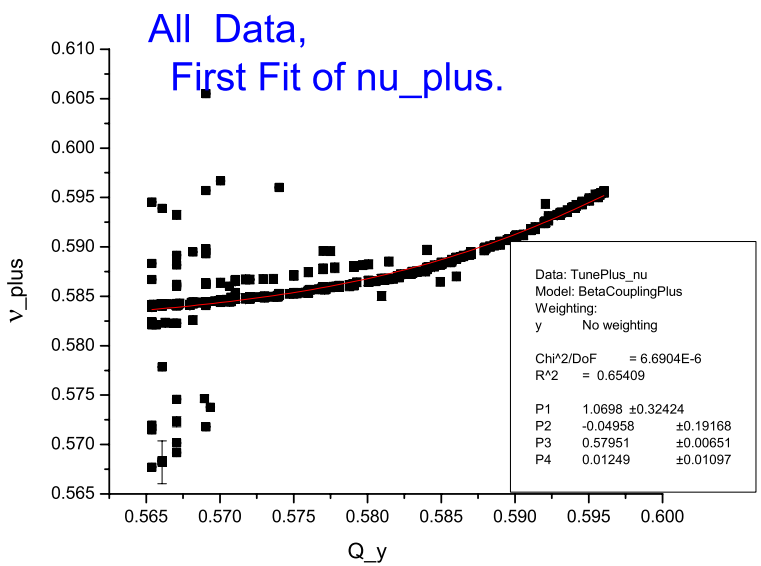


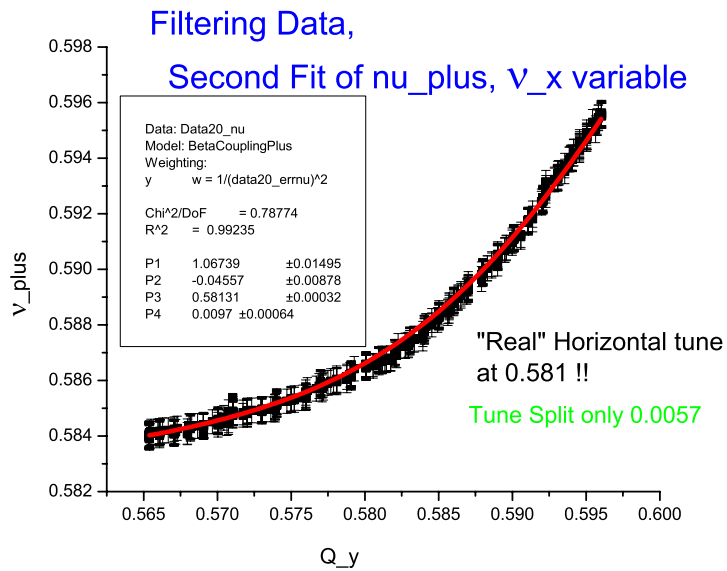
Rejecting data points more than 0.001 away from the previous fit. Refit!. (D. A. Edwards & M. Syphers, page 146, formula 5.12)

→better chi-square.

→But ! Wrong value for the horizontal (high) tune!

Fits of the "+" Eigenstate data





Despite additional noise, the procedure converged.
The q^2 coupling factor and horizontal tune do not agree with The "-" sample.

Status… What are the next steps?

Tune Meter: Make it a production tools!

- Well documented procedure to re-start the software, if need be.
  => Need the help of Control to write an OAC or "pseudo OAC"
  (C++ requirement)
- Web Page documenting this "virtual Instrument" Physics software
  Need to write (yack!..)

Application for the Tune Meter.

Repeat the experiment described above, wit the Java based "Accelerator Studies" in collaboration with Luciano Piccoli.
Do the Coupling fits in Java instead of Origin 7 => fully automated Java application. Write a similar procedure to measure Chromaticity.

Beam Physics:

Did I use the correct formula to extract coupling factor and Horizontal and vertical tunes away from mixing?
If so, the linear coupling theory does not fit the data !
Will the automatic procedure works when the coupling is smaller?
Why was the minimum tune split of 0.0088 so large ?