DRIFT CONTROL ENGINES STABILIZE TOP-UP OPERATION AT BESSY II

Thomas Birke — Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

HZB Helmholtz Zentrum Berlin

Motivation

Transversal Tune Feedback
Beam quality depends on pointing stability and stable shape and size of synchrotron beam. These parameters transform to electron beam orbit and tune stability.

Other systems need tunes to be kept stable:
- RF Knockout system - Single bunch purity
- Bunch-by-bunch feedback systems
- Pulse picking by resonant excitation (PPRE)

Pathlength Correction — Master Oscillator Feedback
Adjusting the RF master oscillator to the real pathlength of the beam is a central measure to keep beam energy stable at the desired value.

Transversal Tune Feedback

Standard ID-gap Feedforward

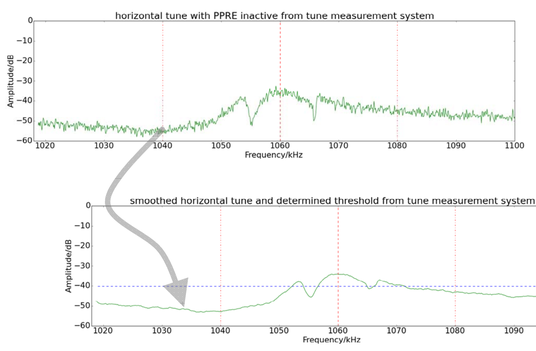
1st order correction of ID-induced tune shift made by interpolating empirically produced tune-feedforward tables
(27 tune-shifting-parameters × max. 49 quadrupole magnets → 1059 active tables).

Analysis of spectrum to find the correct tune

Peak find
Typically not the best choice

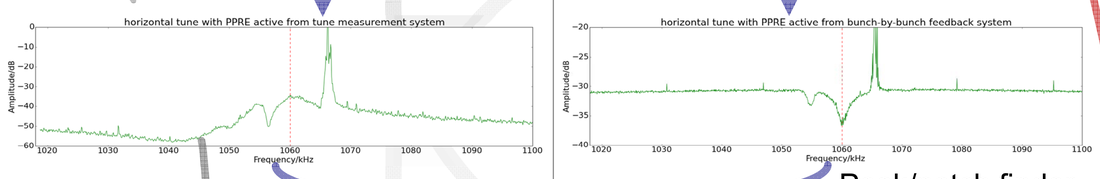
Peak find smoothed
Better, but tune-peak often not highest

Area above threshold
Current method of choice if tune is identifiable. Lower threshold until several separate peaks exceed and select the peak with highest area below



Multi-Source Tune determination from general Beammotion

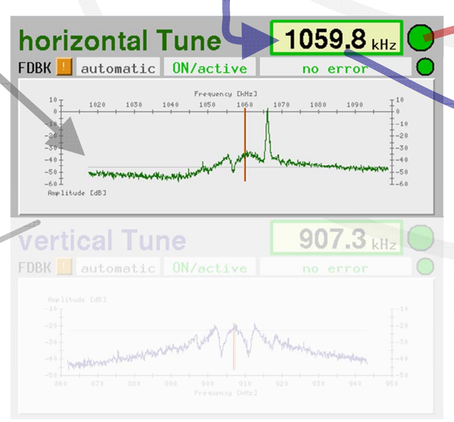
Diagonal Striplines → ***Fast ADC/PXI LabVIEW, FFT***
Pickup Electrode → ***dimtel Bunch-by-bunch FDBK***



Peak/notch finder

Source selector

Stripline Spectrum displayed for verification



Error Handling

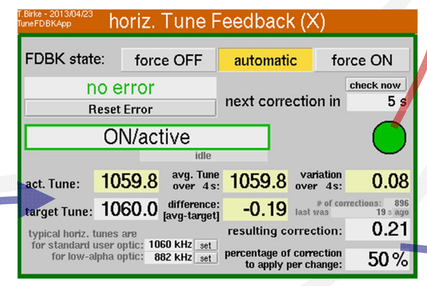
Bad correction
Two consecutive ineffective corrections

Measurement Error
Measurement delivers unstable data or tune is undeterminable

Too much to correct
Measured tune is outside of configured window of allowed automatic corrections

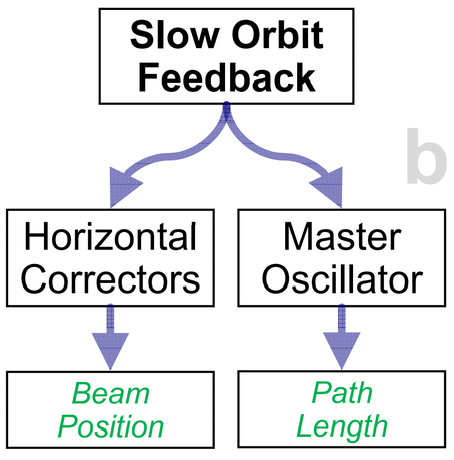
Check for successful correction

Applying correction “with caution”

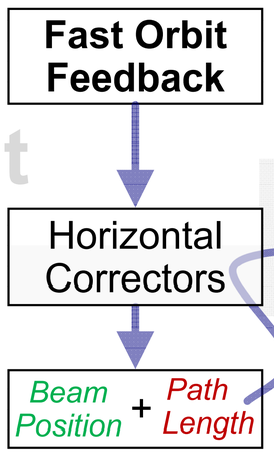


No corrections if
- Bunch-by-bunch Feedback not running
- Minimum ring current not reached
- Too close to injection
- Variation of tune too high

Pathlength Correction



but

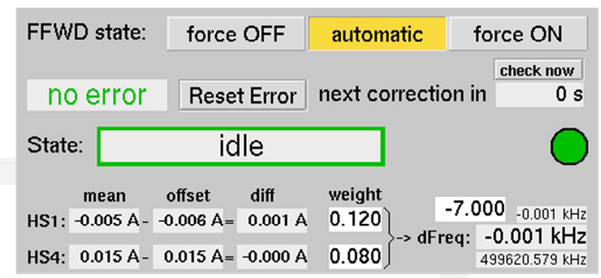


Straight forward implementation of **SOFB** schema for modifying master oscillator is *not possible* for **FOFB**!

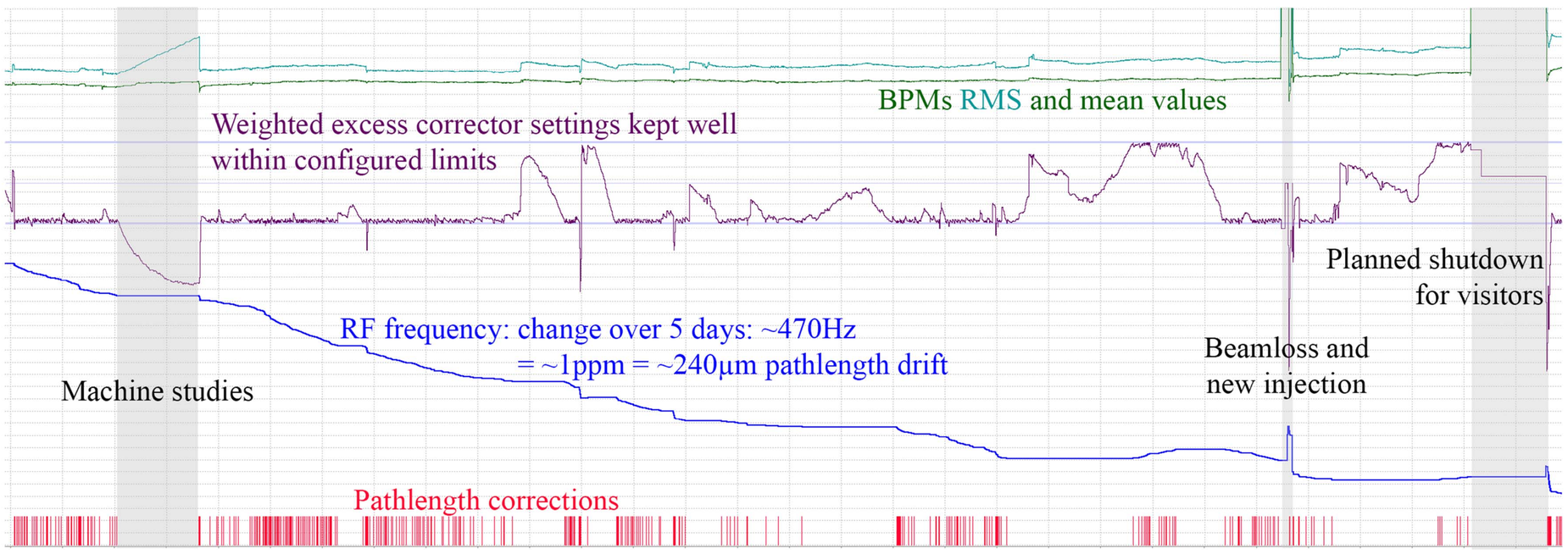
Instead, excess values accumulate in setpoints of horizontal corrector families

Master oscillator frequency change is calculated from excess average strength of horizontal corrector settings according to previously observed relations

$$RF_{change} = \left[\begin{array}{c} (\overline{HS1} - HS1_{offset}) \times HS1_{weight} \\ + \\ (\overline{HS4} - HS4_{offset}) \times HS4_{weight} \end{array} \right] \times RF_{scale}$$



As frequency change is applied, FOFB reduces corrector settings accordingly



No corrections if ...
- Fast orbit feedback is not running
- Minimum ring current not reached
- Too close to injection

Error Handling

Bad correction
ineffective correction detected

Left:
Plot of ~ 400 pathlength corrections over 5 days after one week of low current low-α operation. Shown are the sum of the weighted excess corrector settings and the resulting RF frequency. BPM RMS and mean values are stable within 1µm

[1] A. Schälicke, P. Goslawski, M. Ries, M. Ruprecht, „Status and Performance of Bunch-by-Bunch Feedback at BESSY-II and MLS“, IPAC2014, Dresden, Germany (2014) _ [2] K. Holldack, R. Ovsyannikov, P. Kuske, R. Müller, A. Schälicke, M. Scheer, M. Gorgoi, D. Kühn, T. Leitner, S. Svensson, N. Mårtenson, A. Föhlisch, „Single bunch X-ray pulses on demand from a multi-bunch synchrotron radiation source“, Nature Communications 5, Article Number 4010 (2014) _ R. Müller, T. Birke, M. Diehn, D. Engel, B. Franksen, R. Görgen, P. Kuske, R. Lange, I. Müller, A. Schälicke, G. Schindhelm, „Fast Orbit Feedback at BESSY-II: Performance and Operational Experiences“, IPAC 2013, Shanghaui, China)2013 _ R. Bakker, K. Holldack, P. Kuske, R. Müller, „Orbit Control at BESSY-II: Present Performance and Plans“, EPAC 2000, Vienna, Austria (2000)

Thomas Birke
thomas.birke@helmholtz-berlin.de

Fon +49-30-8062-14934
Fax +49-30-8062-14980

www.helmholtz-berlin.de