# Fast Orbit Feedback at BESSY II: Performance and Operational Experiences

R. Müller, T. Birke, M. Diehn, D. Engel, B. Franksen, R. Görgen, P. Kuske, R. Lange, I. Müller, A. Schälicke, G. Schindhelm

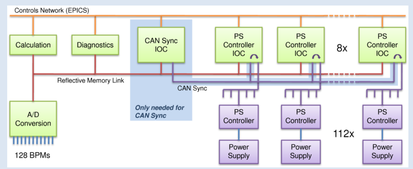
HZB Helmholtz Zentrum Berlin

WEPME002

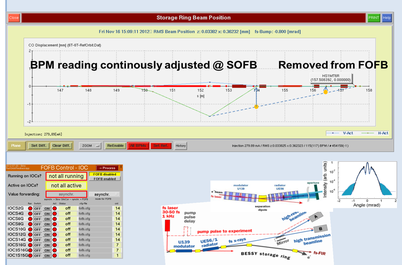
## Abstract

**At the 3rd generation light source BESSY II the first phase of a fast orbit feedback system (FOFB) has been put into operation in September 2012. In this first phase the aim was to achieve noise suppression in the 1 Hz to a few 10 Hz range, mostly avoiding expensive upgrades to existing hardware, such as beam position monitors and the CAN based set-point transmission to the power supplies. Only worn out power supplies were replaced with newer, faster versions. The paper describes capabilities of the phase I FOFB with respect to beam motion transient suppression, low frequency damping, high frequency noise generation and operational integration and stability aspects.**

## Set-Up

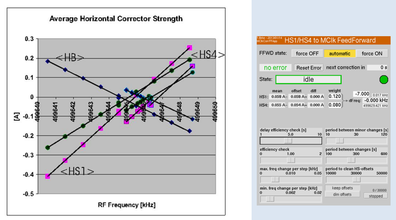



Existing CAN bus attached power supply controllers could be utilized by a custom set point transmission, bypassing EPICS slow controls on dedicated CAN segments configured for data rates up to 200 Hz.



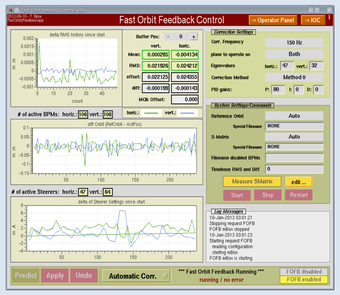

Exclusive corrector access in ``FOFB enabled" or ``FOFB active" mode creates delicate operational constraints. Example: femto slicing beam separation bump.


Operators user interface features the same look and feel for both the SOFB (top) and the FOFB (bottom).




The appropriate RF frequency change is calculated from the excess average strength of the horizontal corrector families

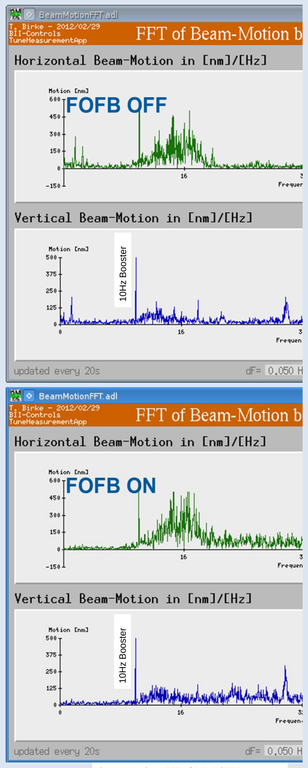


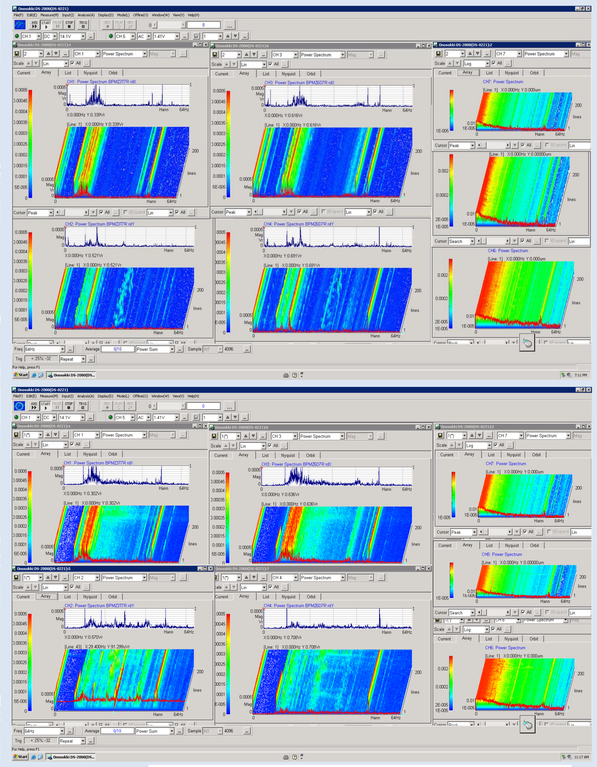

# Summary

- **Even the ``raw", unrefined status of the FOFB phase I system provides significant improvements: transients are efficiently suppressed, the over-all operability and reliability is convincing.**
- **Beam motion in the frequency range <10 Hz is reduced substantially.**
- **No DC effects have been observed and the path length is well controlled.**
- **Objective evidence as well as clear valuation of the achievements of the present FOFB set-up on user experiments is not easy to get and still pending. Accordingly the possible benefit of a FOFB phase II for the experiments performed at BESSY is not assessable yet.**

## "Fast" Properties




Operators view: FFT of BPMZ3T7R



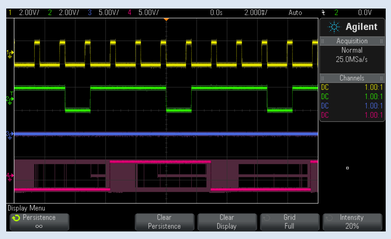
Long term monitoring of 2 BPMs (left/middle) and 3 vibrational sensors (2x hor., 1 ver./right diagrams)

## Beam Motion 0.02 Hz … 300Hz

- beyond 10 Hz additional noise is visible, that needs to be understood and is currently under investigation.
- This is also evident in the resulting integrated rms beam motion, see Table 1, which is far from satisfying.
- Probably it has to be accounted to deficiencies in the set point data synchronization that need to be eliminated (right figure)
- some 2µm originate from the 10 Hz booster synchrotron.

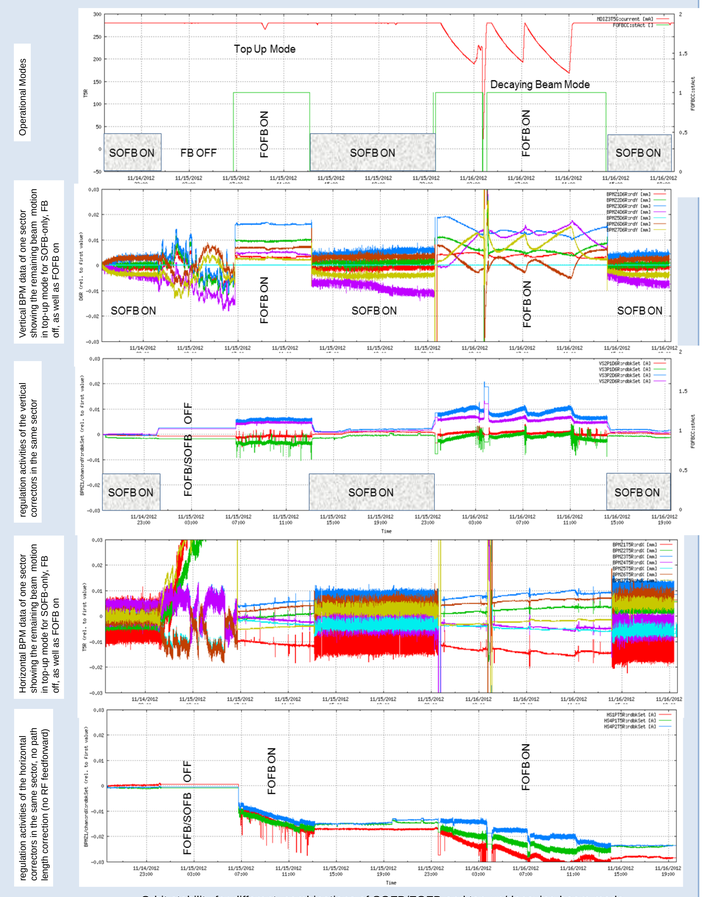
Table 1: Integrated rms beam motion (0.02-300 Hz) with and without FOFB in its present status, comparison with 10% beam stability target in brackets. (bandwidth ∼ 10 Hz). See R. Bartolini [5] for a facilities overview.

| Mode | Horizontal | Vertical |
|---|---|---|
| FB OFF | $4\mu m (25\mu m)$ | $1.5\mu m (2.5\mu m)$ |
| 300 mA Hybrid | $5.5\mu m (25\mu m)$ | $3\mu m (2.5\mu m)$ |
| 13.5 mA SB | $9\mu m (25\mu m)$ | $5\mu m (2.5\mu m)$ |
| 100 mA low-$\alpha$ | $9\mu m$ | $4\mu m$ |
| 15 mA low-$\alpha$ | $14\mu m$ | $7\mu m$ |




[5] R. Bartolini, Performance and Trends of Storage Ring Light Sources, EPAC 2008, Genoa, Italy, TUXM02, Slide 20 in http://accelconf.web.cern.ch/AccelConf/e08/talks/tuxm02_talk.pdf

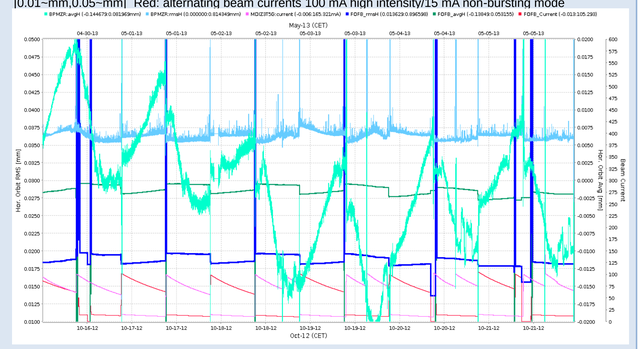
## Slow Properties




Orbit stability for different combinations of SOFB/FOFB and top-up/decaying beam mode.

## Significant Improvements in low-$\alpha$ Mode

Comparison of wo complete weeks of low-$\alpha$ operation. Light colors, noisy lines: Oct. 2012, SOFB only. Dark colors, smooth lines: May 2013, FOFB. Green: average position [-0.02~mm,0.02~mm], blue: rms deviation [0.01~mm,0.05~mm] Red: alternating beam currents 100 mA high intensity/15 mA non-bursting mode




**Roland Müller**
Roland.Mueller@helmholtz-berlin.de
Fon +49-30-8061-14849
Fax +49-30-8062-14632

**www.helmholtz-berlin.de**