European Synchrotron Radiation Facility

The Orbit Correction Scheme of the New EBS of the ESRF

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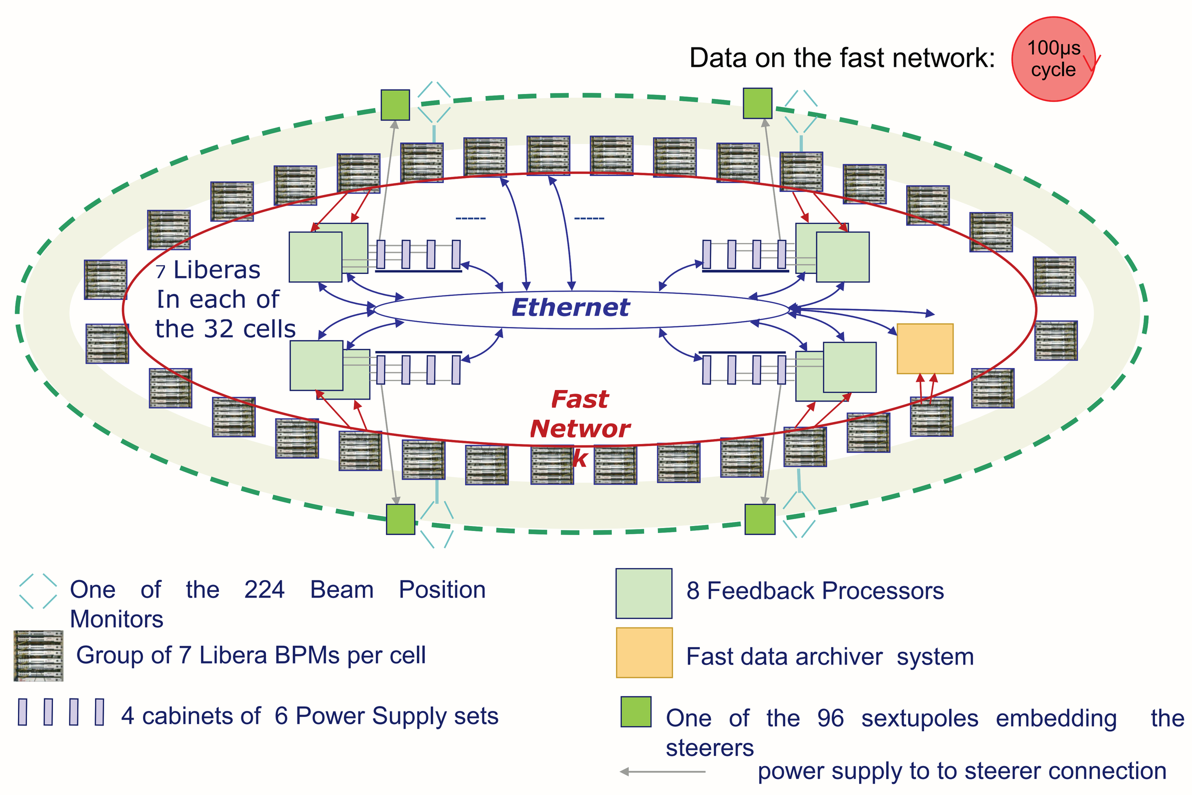
The ESRF storage ring is going to be upgraded into an Extremely Bright Source (EBS). The orbit correction system of the EBS ring will require 320 BPMs and 288 correctors instead of 224 BPMs and 96 correctors for the present ring. On the new ring, we are planning to reuse 192 *Libera Brilliance* electronics and 96 fast corrector power supplies and the 8 FPGA controllers of the present system and to add 128 new BPMs electronics and 196 new corrector power supplies. These new BPM electronics and power supplies will not have the fast 10 KHz data broadcast capability of the components of the present system. So we plan to implement a hybrid slow/fast correction scheme on the SR of the EBS in order to reuse the present fast orbit correction system on a reduced set of the BPMs and correctors and combine this fast orbit correction with an orbit correction performed at a slower rate using the full set of BPMs and correctors. We have made simulations to predict the efficiency of this scheme for the EBS and tested on the present ring a similar orbit correction scheme using only 160 BPMs and 64 correctors for the fast correction. We will present the results of our simulations and experiments.

Present fast Orbit Feedback layout



COMPONENTS OF THE EBS NEW ORBIT CORRECTION SYSTEM

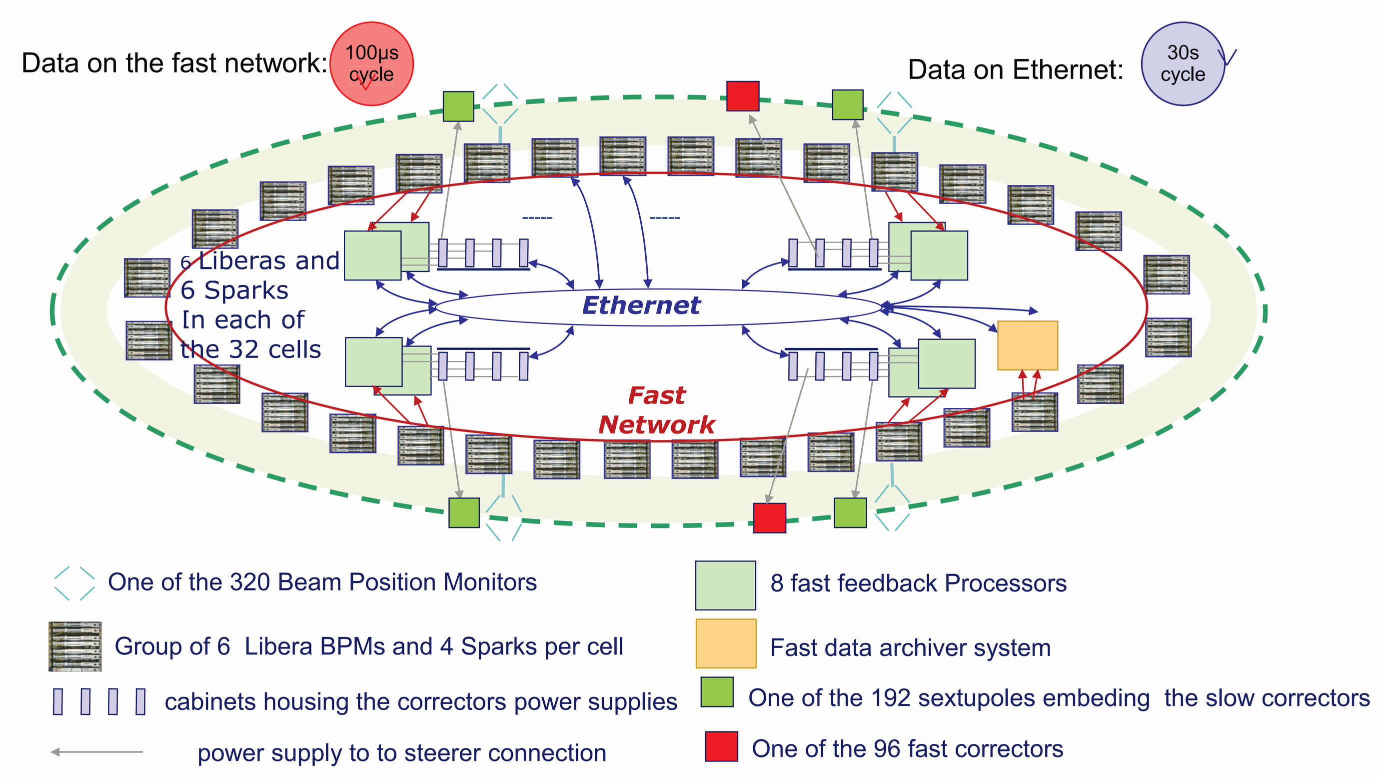
REUSED FROM THE PRESENT RING ORBIT CORRECTION SYSTEM:

- 192 *Libera Brillance* electronics
- 96 fast correctors power supplies driving low inductance corrector magnets
- 8 power supply FPGA controller boards
- The *Communication Controller* network interconnecting these components

NEW COMPONENTS:

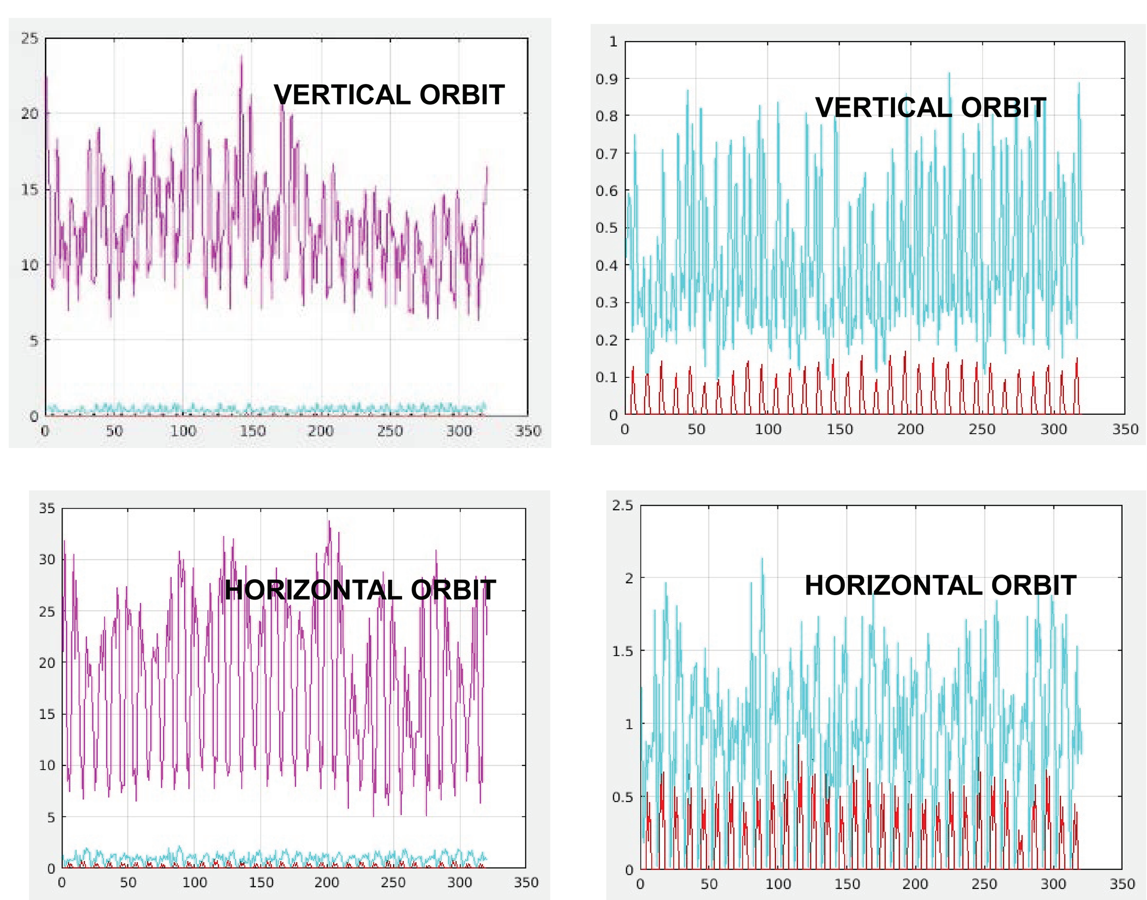
128 new simpler BPM electronics (no connection to the *Communication Controller*)
192 sets of slow power supplies for the correctors embedded in the sextupoles

Hybrid Fast/Slow Orbit Feedback layout



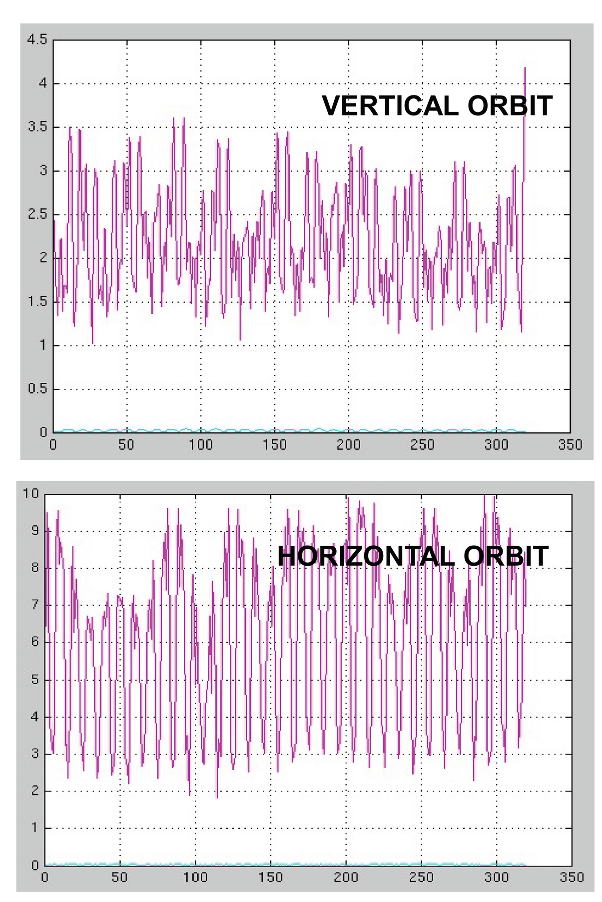
COMPARISON OF THE ORBIT CORECTION USING THE FULL OR REDUCED SET OF BPMs AND CORRECTORS

10 sets of random quadrupole magnet displacements



Magenta:
Orbit distortion at the location of the 320 BPMs
Blue:
Orbit measured using 192 BPMs and corrected using 96 fast correctors
Red:
Orbit measured using 320 BPMs and corrected using 288 correctors

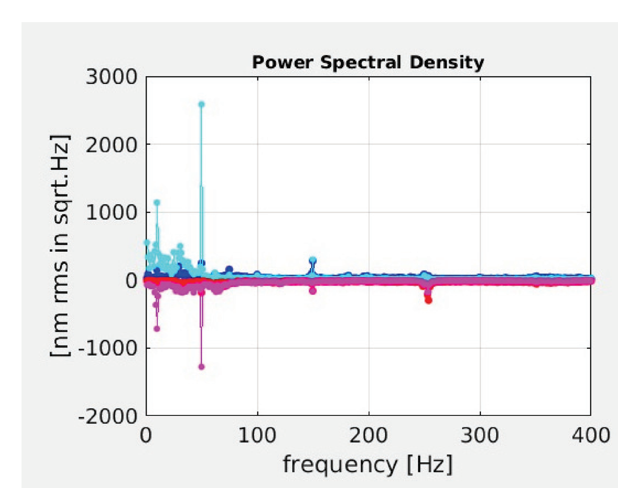
10 sets of random kicks in the middle of the 32 straight sections



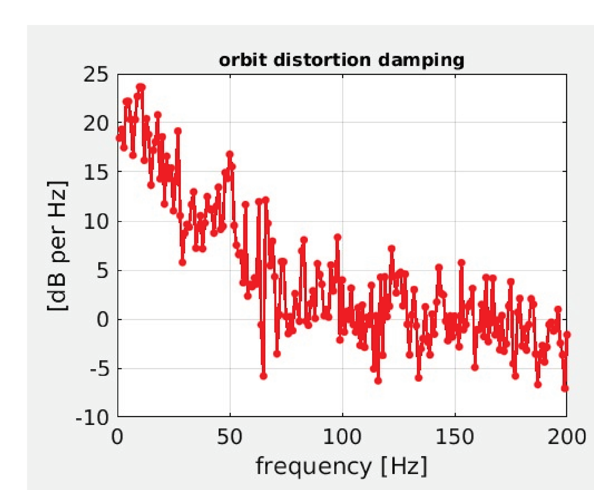
Magenta:
Orbit distortion at the location of the 320 BPMs
Blue:
Orbit measured using 192 BPMs and corrected using 96 fast correctors

RESIDUAL ORBIT DISTORTION

Limited number of BPMs and correctors versus limited bandwidth



Integrated spectrum of the orbit distortion:
Light blue: horizontal without feedback,
Dark blue: horizontal with feedback,
Purple: vertical without feedback,
Red: vertical with feedback



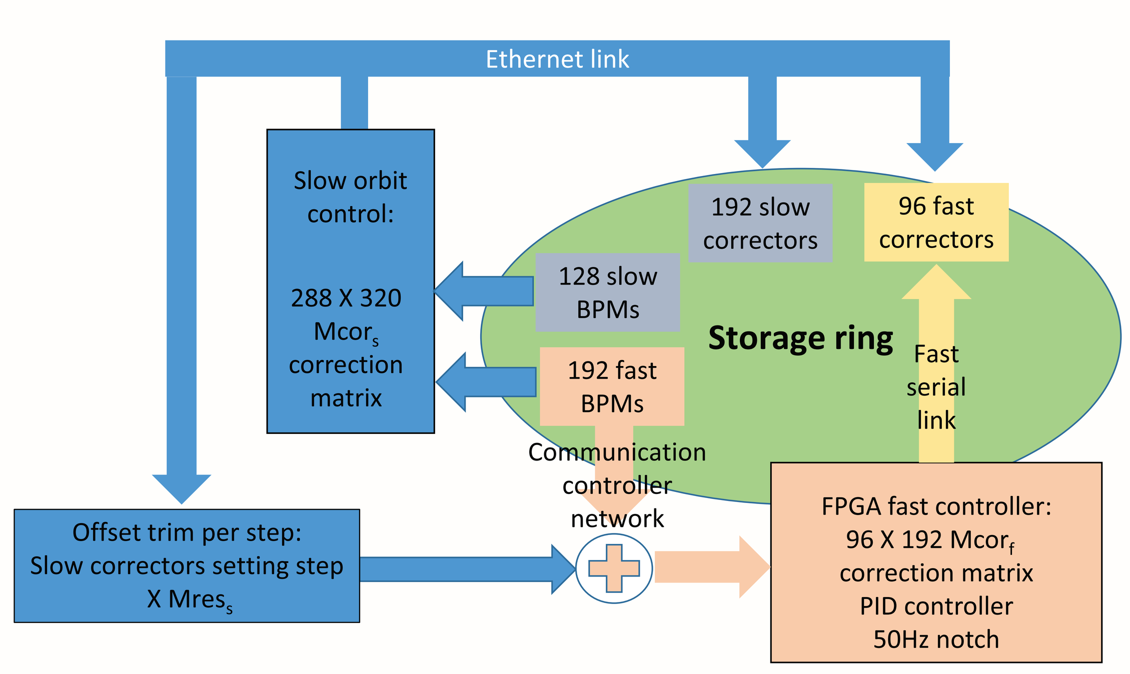
Fast correction effect versus frequency in dB

THE REDUCTION OF THE DAMPING OF THE ORBIT DISTORTION DUE TO THE REDUCTION OF THE BPM AND CORRECTORS NUMBER IS NEGLIGIBLE ABOVE 1Hz

TEST OF THE ALGORITHM BASED ON THE SLOW TRIM OF THE BPM OFFSETS

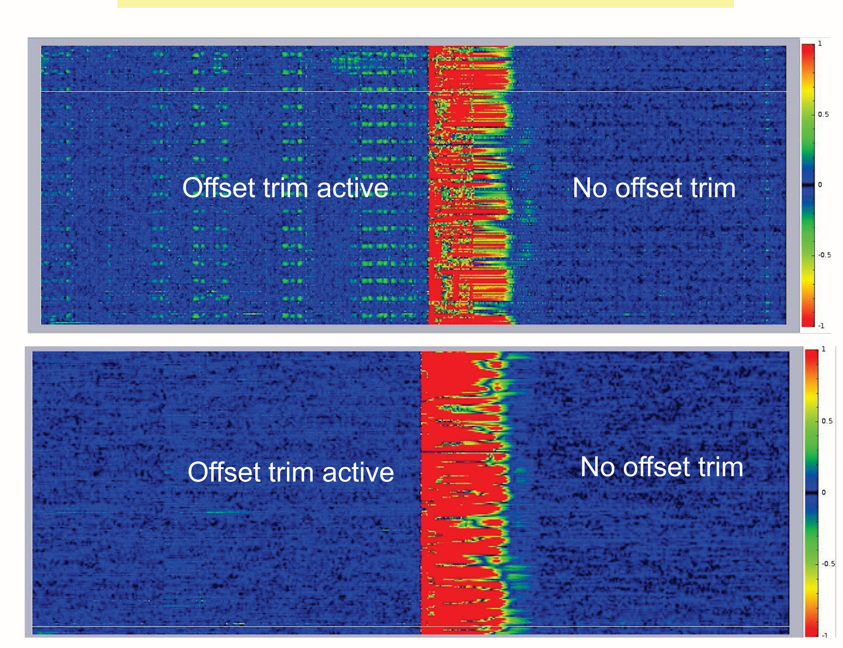
OFFSET TRIM OF THE FAST CORRECTION:

- Add the average over 1 s of $CorX_f$ and $CorZ_f$ to the settings $CorX_s$ and $CorZ_s$ in order to suppress the contribution of the fast correction to the DC correction.
- Measure the orbit X_s and Z_s using the 320 BPMs.
- Get the optimal settings $CorX_s$ and $CorZ_s$ of the slow correctors using the full matrix M_{cors}
- Get the orbit change DX_s and DZ_s that would result from the application of the new corrector settings, if the fast orbit correction was not active.
- Add DX_s and DZ_s to the offsets X_{off} and Z_{off} in order to get $X_f=0$ and $Z_f=0$ with the new X_s and Z_s orbit which will prevent the fast correction from interfering with the slow correction.
- Apply the new settings $CorX_s$ and $CorZ_s$



Hybrid slow/fast orbit control flow chart

TEST RESULT
MEDIUM TERM ORBIT STABILITY



- Horizontal scale: 12 minutes full span
- Upper plot: horizontal plane
- Lower plot : vertical plane
- Vertical scale: BPM 1 to 224
- Colour scale: +/1µm full scale, red=1µm

Many thanks to Philippa GAGET for her help in the printing of this poster