New features of the Fast Orbit Correction system of the ESRF storage ring

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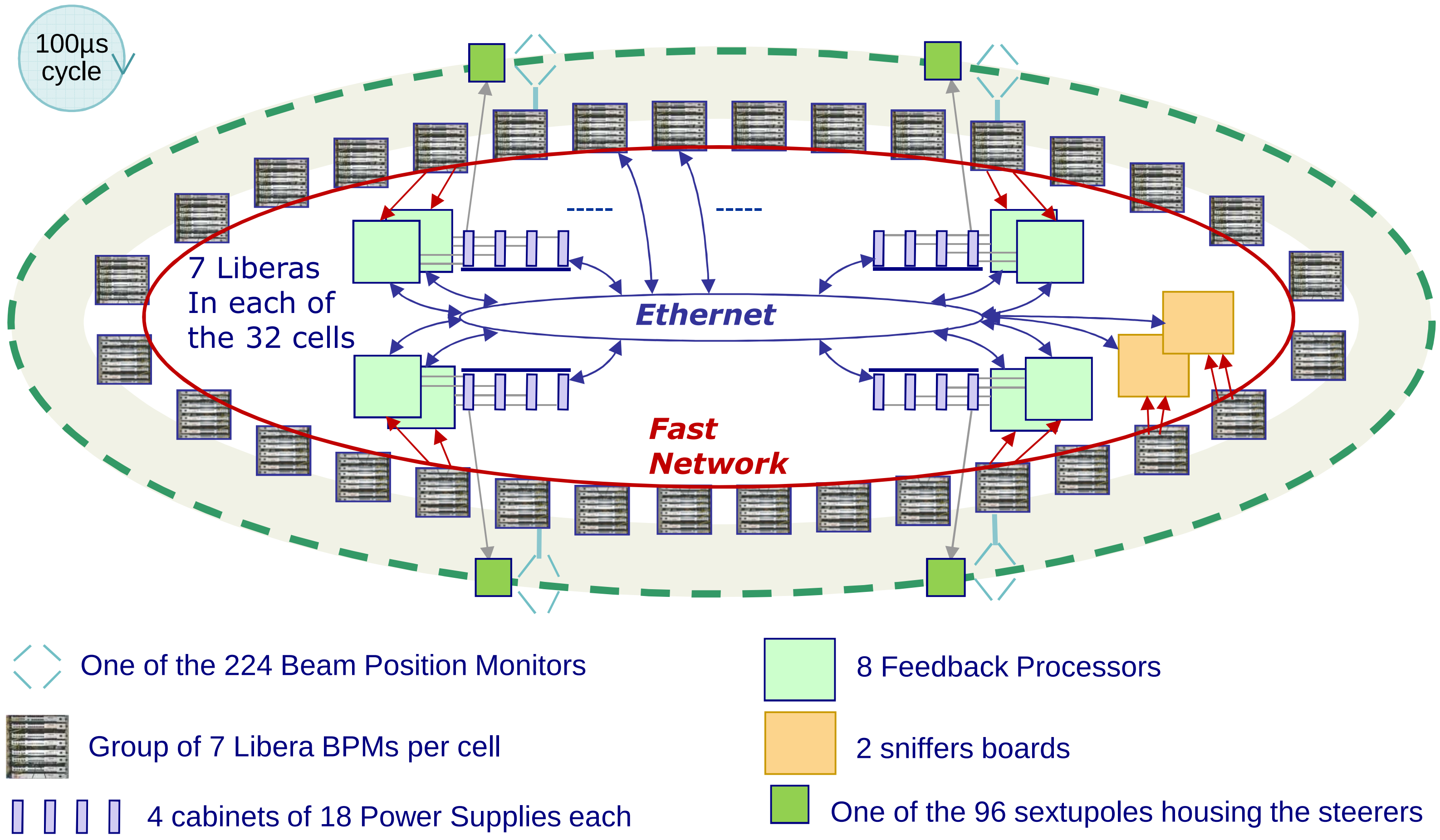
N.Tarteret (fda viewer)
F. Epaud (device server additions)
B. Roche: stored current addition debugging.
F. Uberto: fast Response Matrix Measurement FPGA firmware

System commissioned in 2012; since then several additions:

- Orbit control loop: RF frequency control
- Addition of a stored current monitoring in the CC data
- DLS fda archiver implementation (application)
- Fast response matrix measurement

Fast Orbit Feedback

Architecture



Fast Orbit Feedback

Steering magnets power supplies

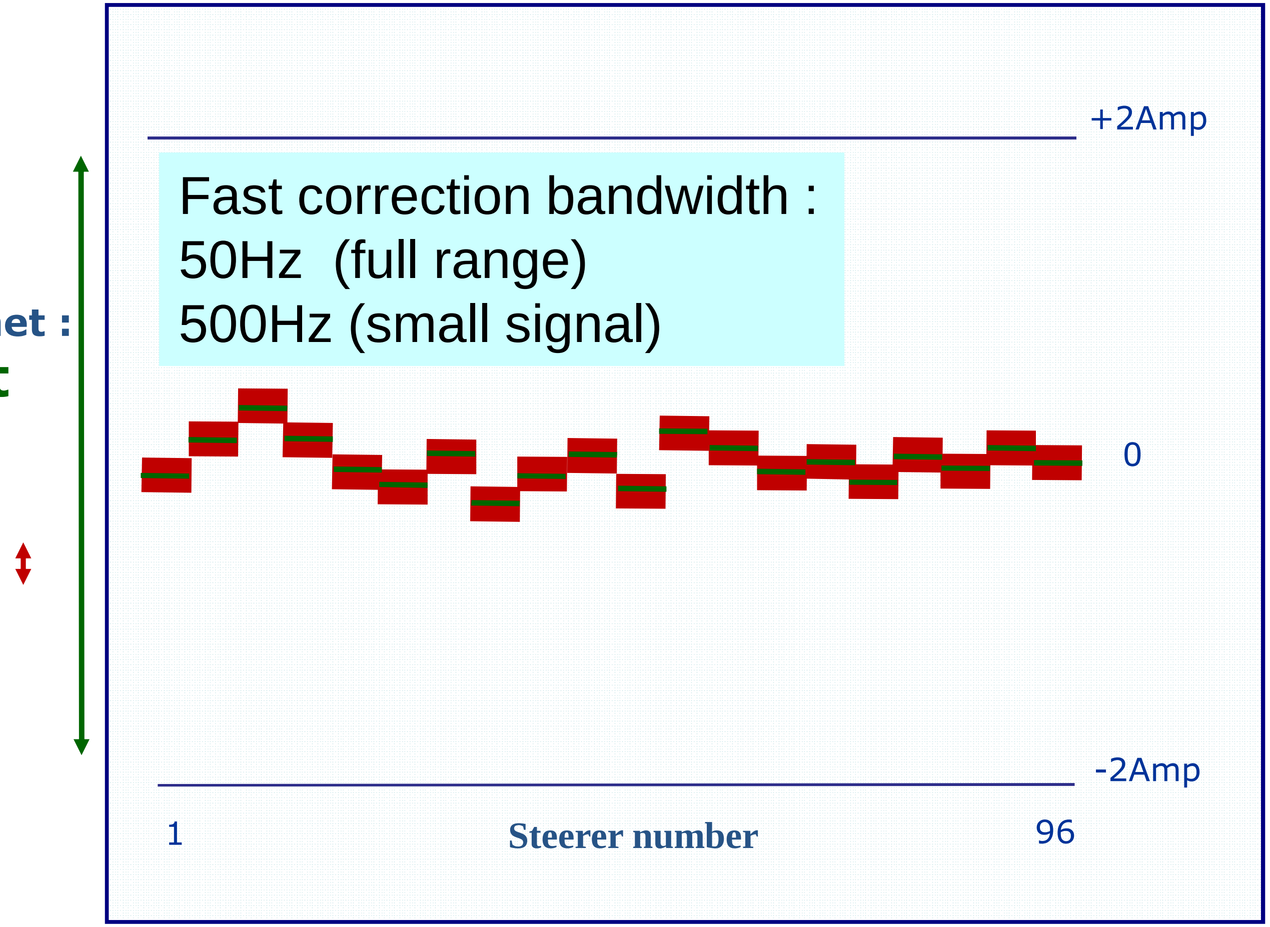
→ Each channel receives its setpoint from two sources

Static correction:
+/- 1.8 A maxi

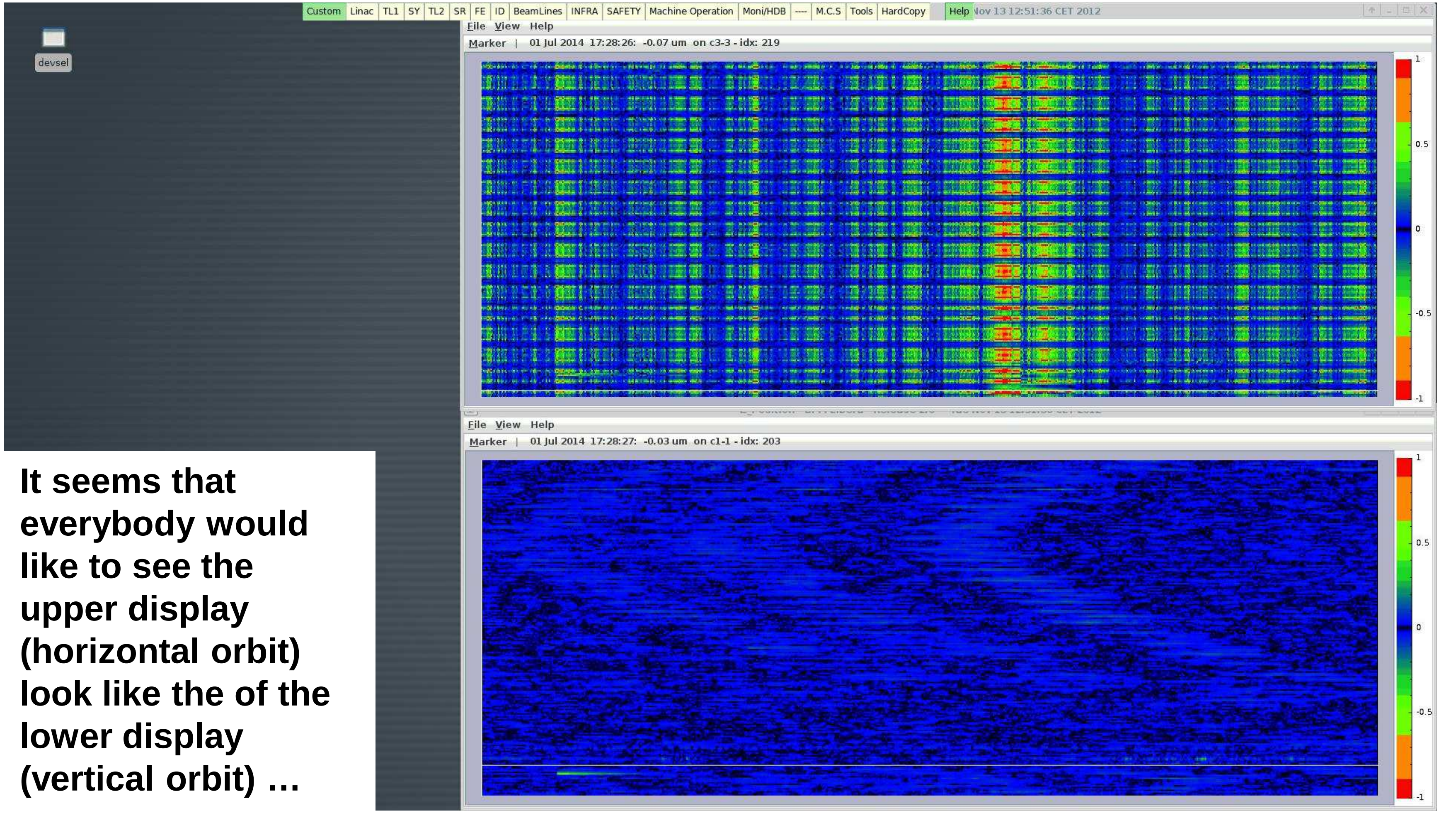
Setpoint from Ethernet :
Golden orbit

Dynamic correction:
+/- 200mA
Resolution = 3ppm

Setpoint at 10kHz from serial line :
FOFB



RF frequency related orbit stability



It seems that everybody would like to see the upper display (horizontal orbit) look like the of the lower display (vertical orbit) …

FOC algorithm

The horizontal orbit is corrected using a 225 inputs and 97 outputs correction matrix M_{corH}

M_{corH} Is conditioned in order to force the sum of the correction currents to be equal to zero (the sum of the correctors currents is sent to the 225^{th} input of the matrix)

The full correction requires the trim of the RF frequency (97^{th} output of the correction matrix)

The green pattern on the horizontal display is due to the limited resolution (.1Hz) and large response time (20 seconds) of the RF frequency trimming loop.

New algorithm tested

The horizontal orbit is now corrected using a 224 inputs and 96 outputs correction matrix M_{corH}

The sum of the fast correctors input can be non null; however, the sum of the currents downloaded to the slow inputs will still be null…

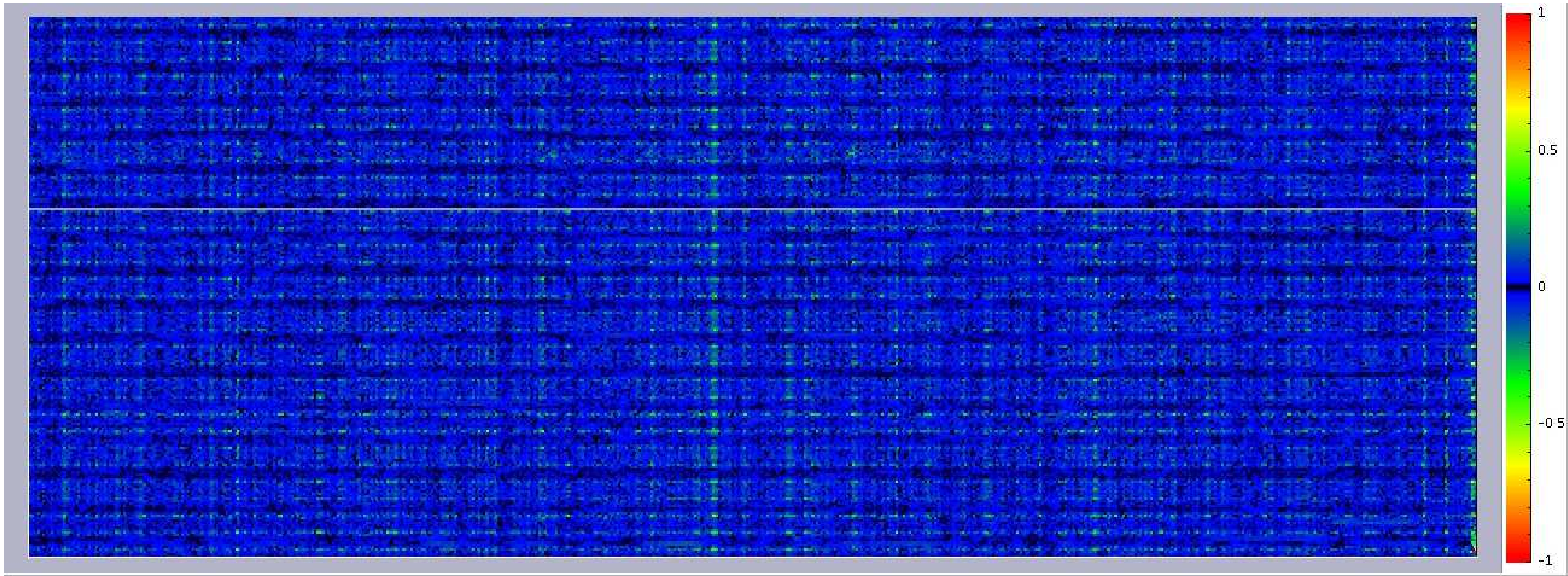
The non null sum of the fast correctors inputs will be read by the DS and used to set a trim of the RF frequency until this sum value is cancelled

Result

Left: new FOC algorithm running **Right: normal FOC algorithm running**

However it is a bit of a cosmetic trick, since a beam energy fluctuation is still there, even it does not show in the position fluctuation…

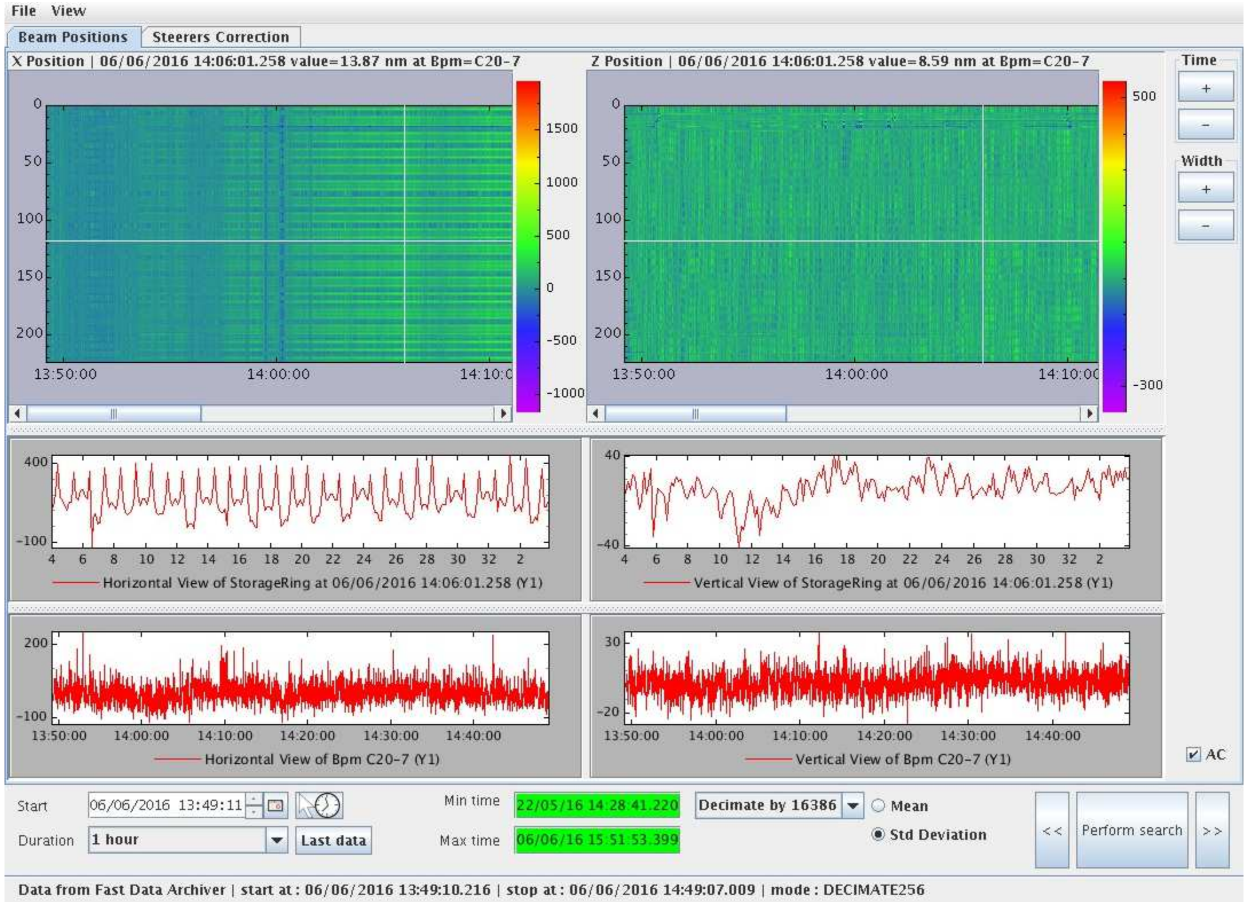
H plane: RF frequency control



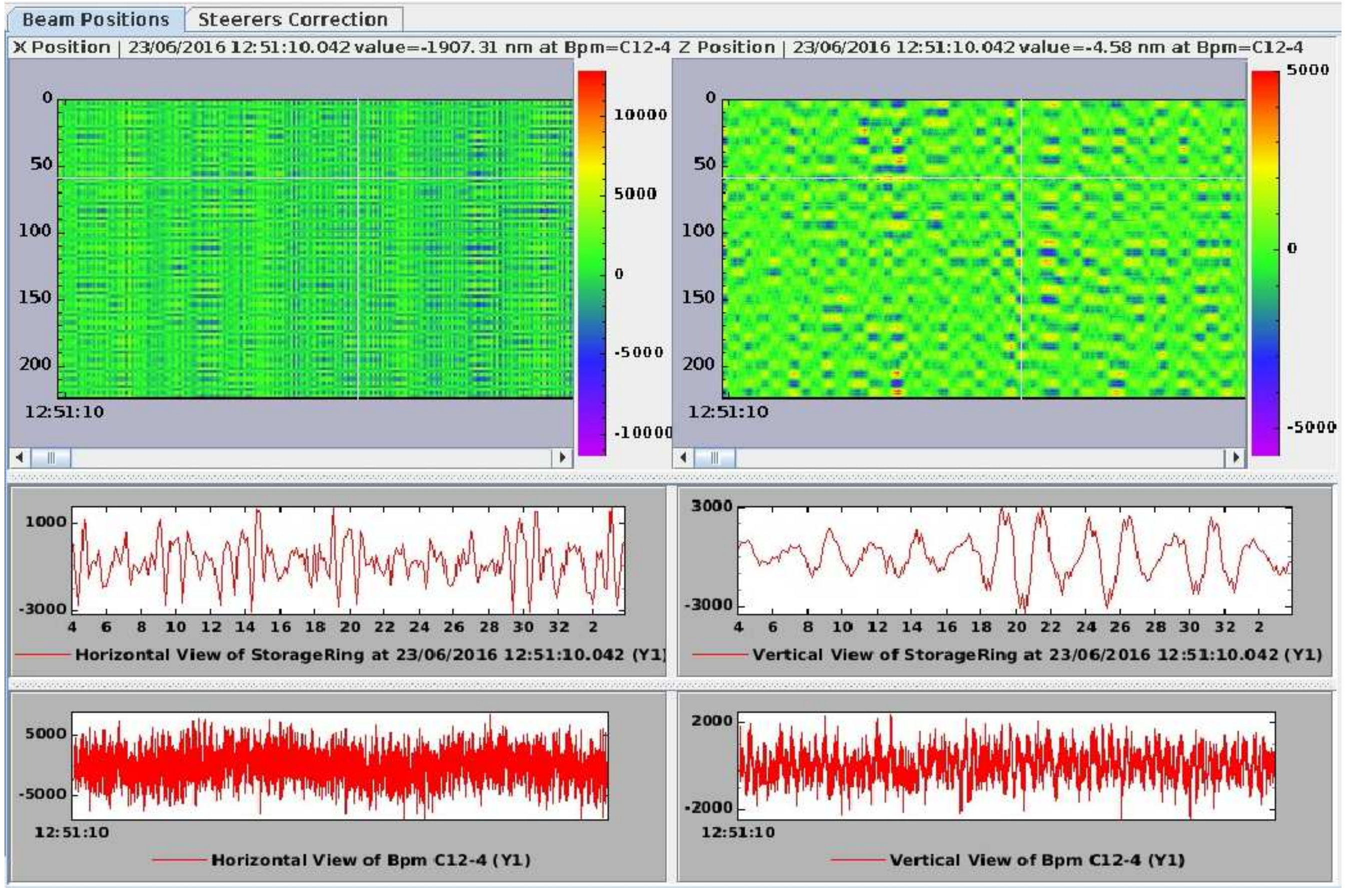
2016:

- New RF source:
- Frequency setting resolution: .01Hz
- RF frequency update rate up to 10Hz
- PID control loop bandwidth: .5Hz

APPLICATION FOR THE DISPLAY OF THE FDA DATA (10KHZ,10 days deep)



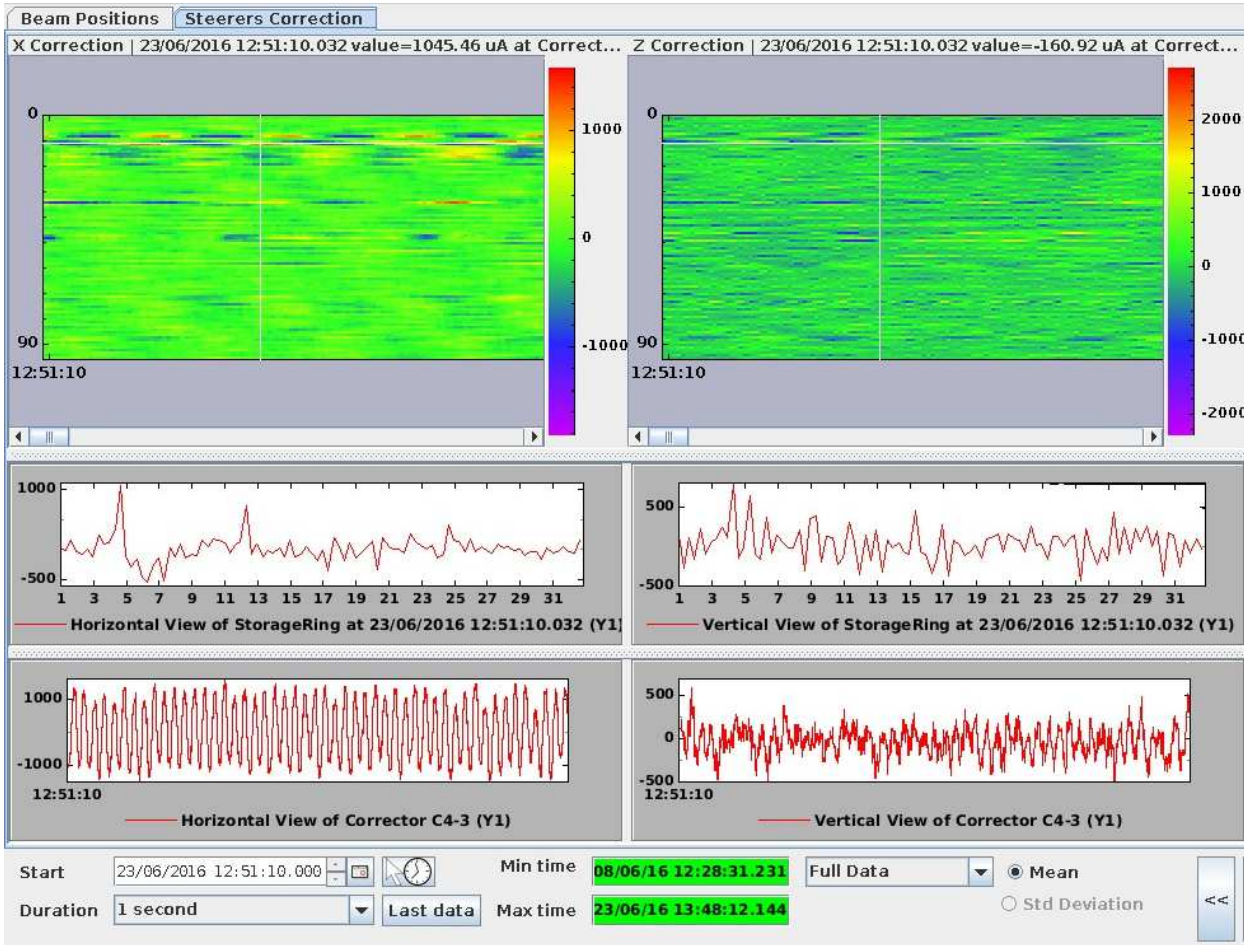
Fda viewer features



- Substraction of the rolling average =>

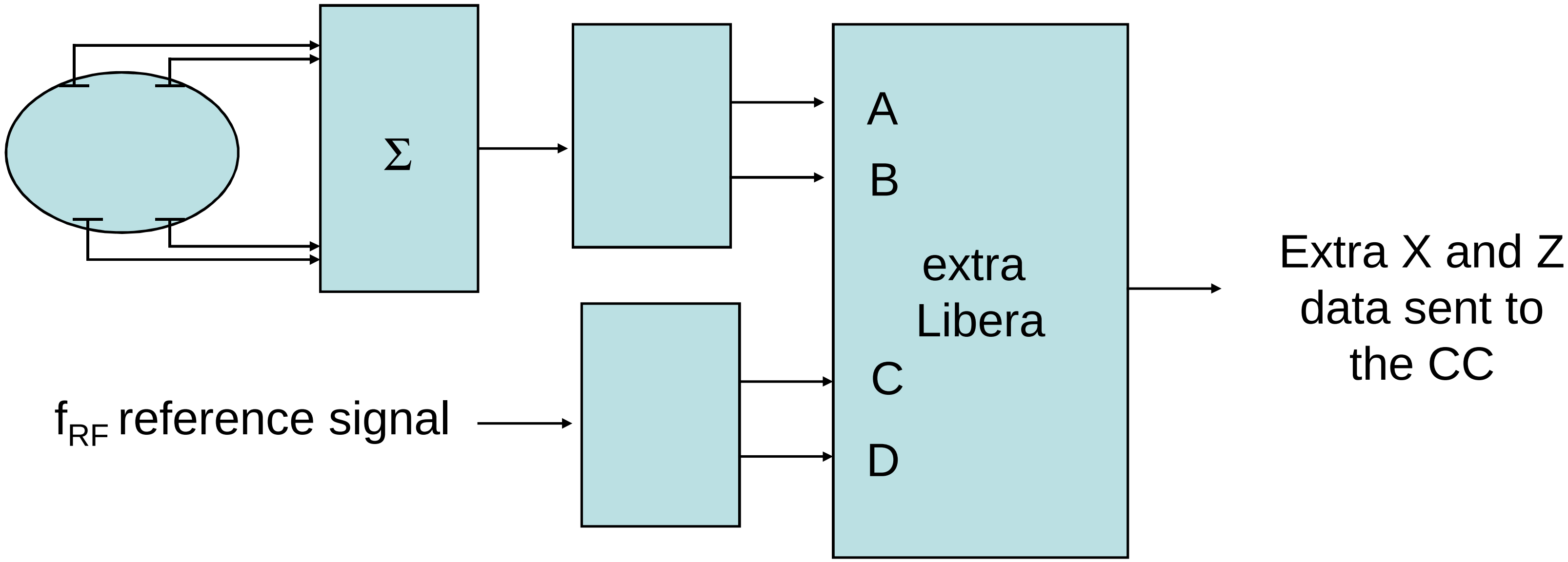
Makes the optics related pattern more visible..

Fda viewer features



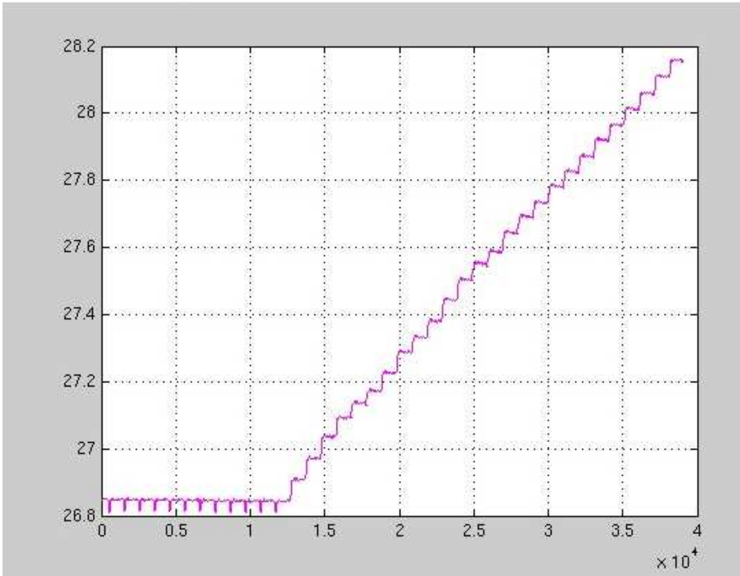
- Having the correctors strength in the CC data set is a big advantage

Adding the stored current to the CC data stream



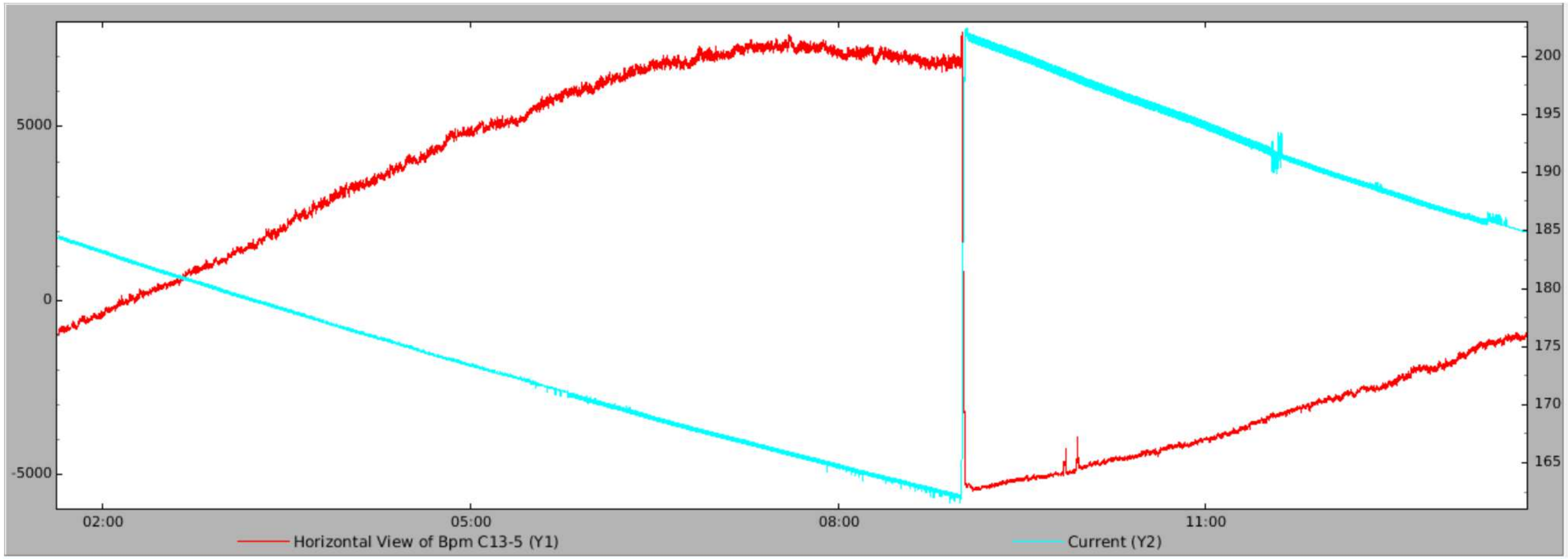
reference signal level adjusted to get:
I=100*(Z+15)/(15-Z)mA

Adding the stored current to the CC data set



- Good resolution: you can even monitor each step of the storage ring refill…

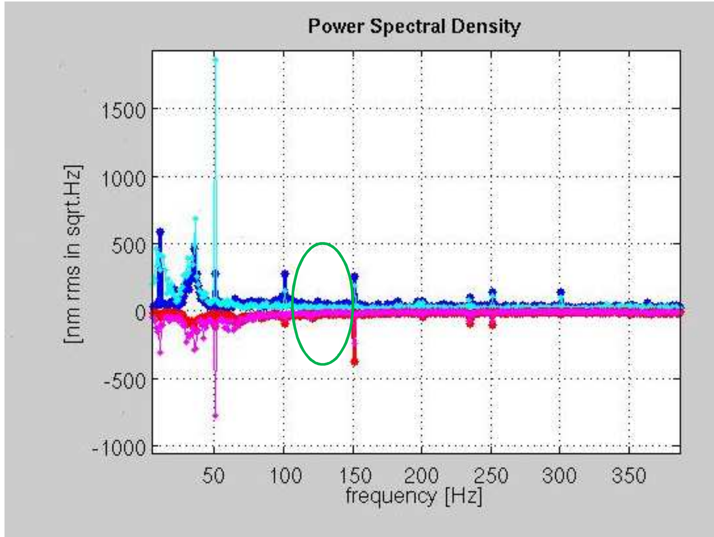
Adding the stored current to the CC data set



Fast response Matrix measurements

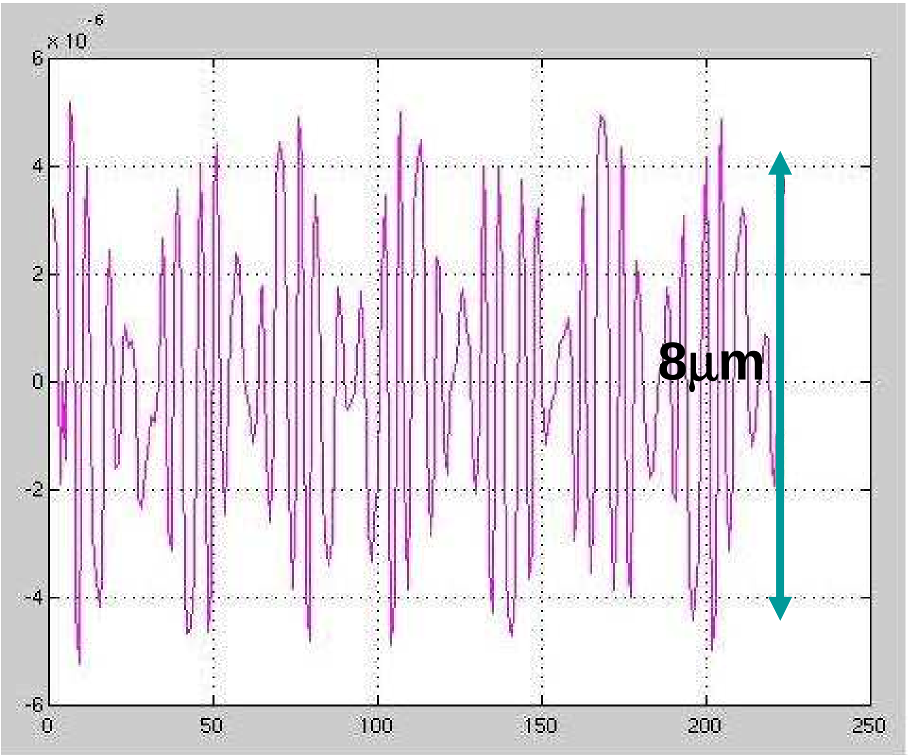
DLS idea:

- sine excitation in a low beam noise part of the spectrum
- Several orthogonal excitation used simultaneously on different correctors

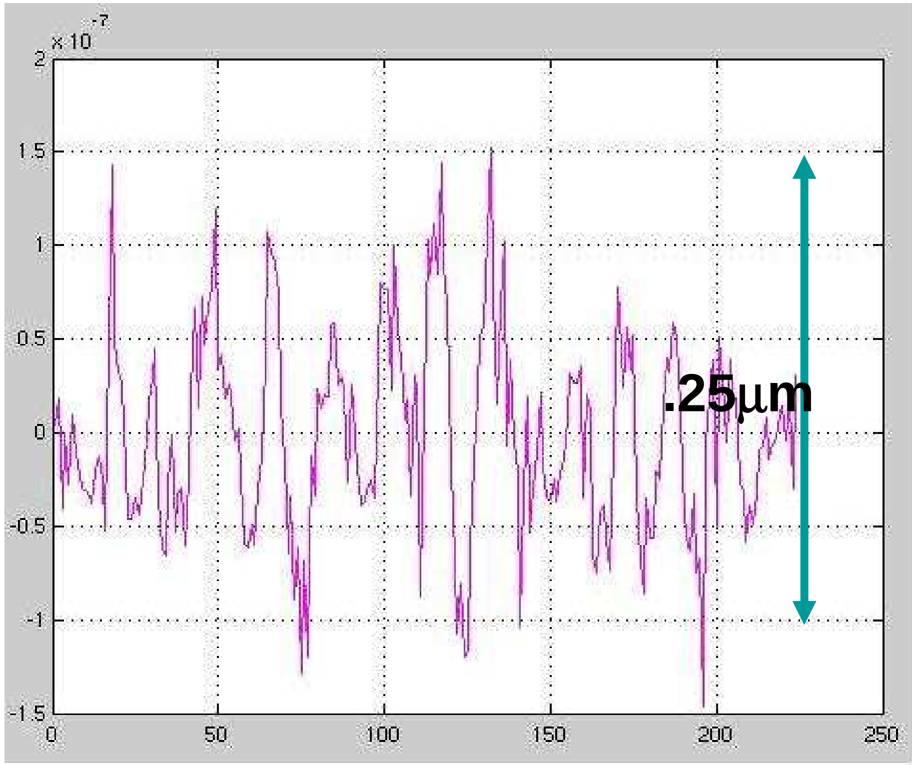


Goal:
Speed up the Response matrix recording during dedicated optics tuning sessions (no users).
<u>Low current, standard ID settings</u>

Optimum excitation scheme: Bursts of .5s sine excitation Best frequency range: 110Hz to 120Hz

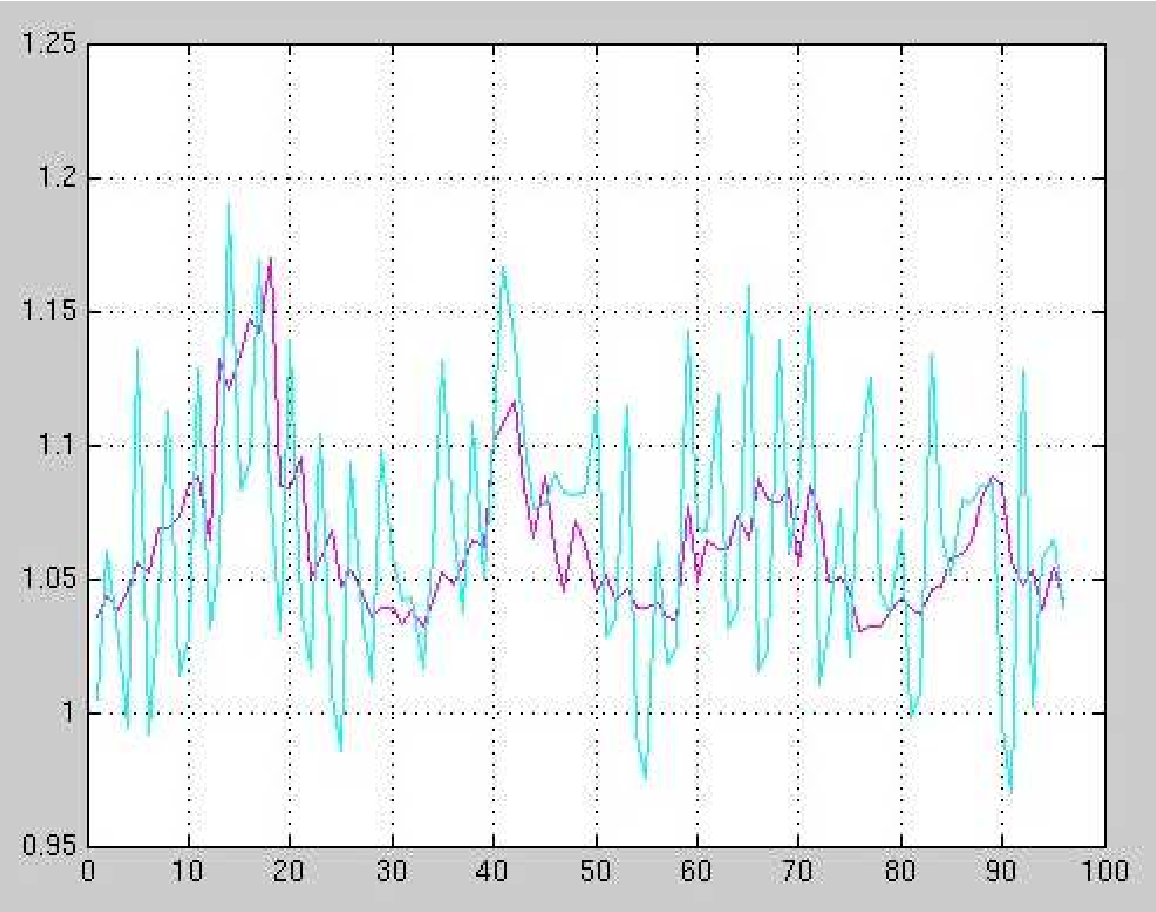


Right: H response



Left: V to H coupling response

Difference between the response at high frequency and DC =>calibration



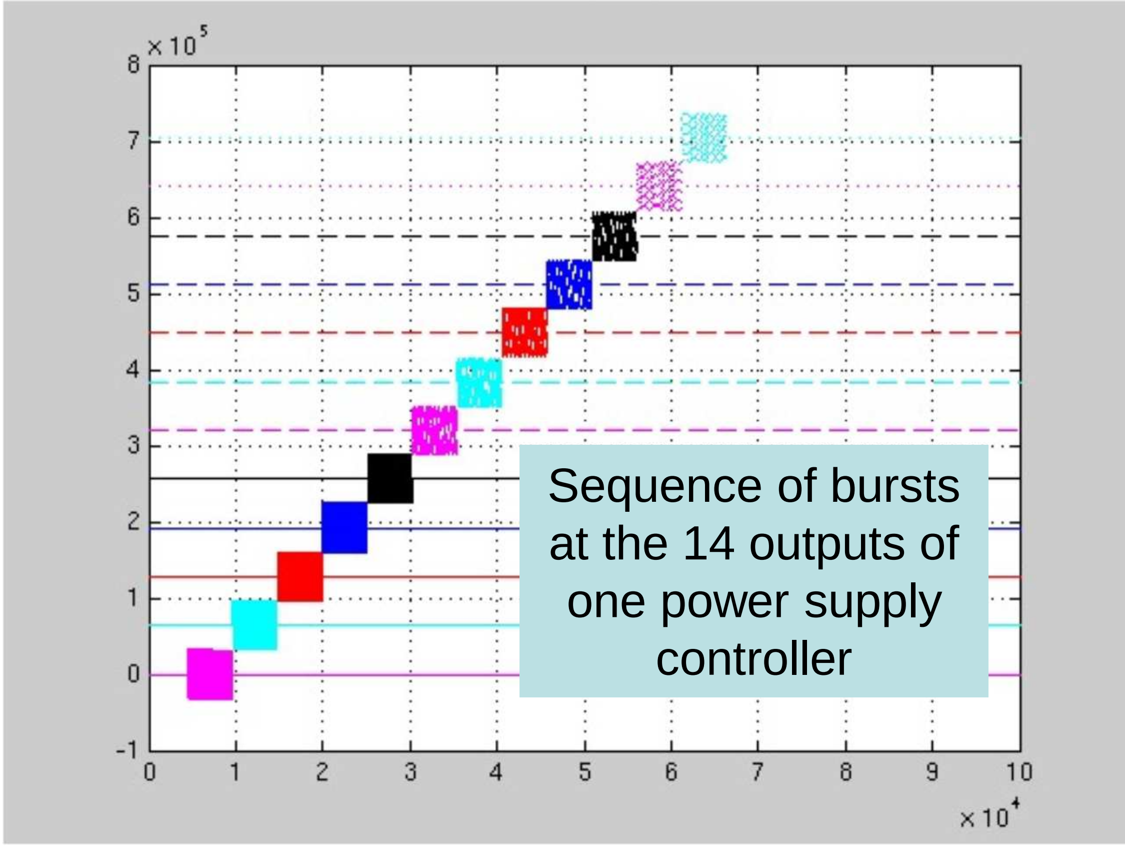
Purple = V :
Makes sense, related to the cable length

Blue= H :
Makes sense, related to the cable length +32 periods modulation?

One steerer active per record

H situation a bit puzzling, but reproducible measurements…

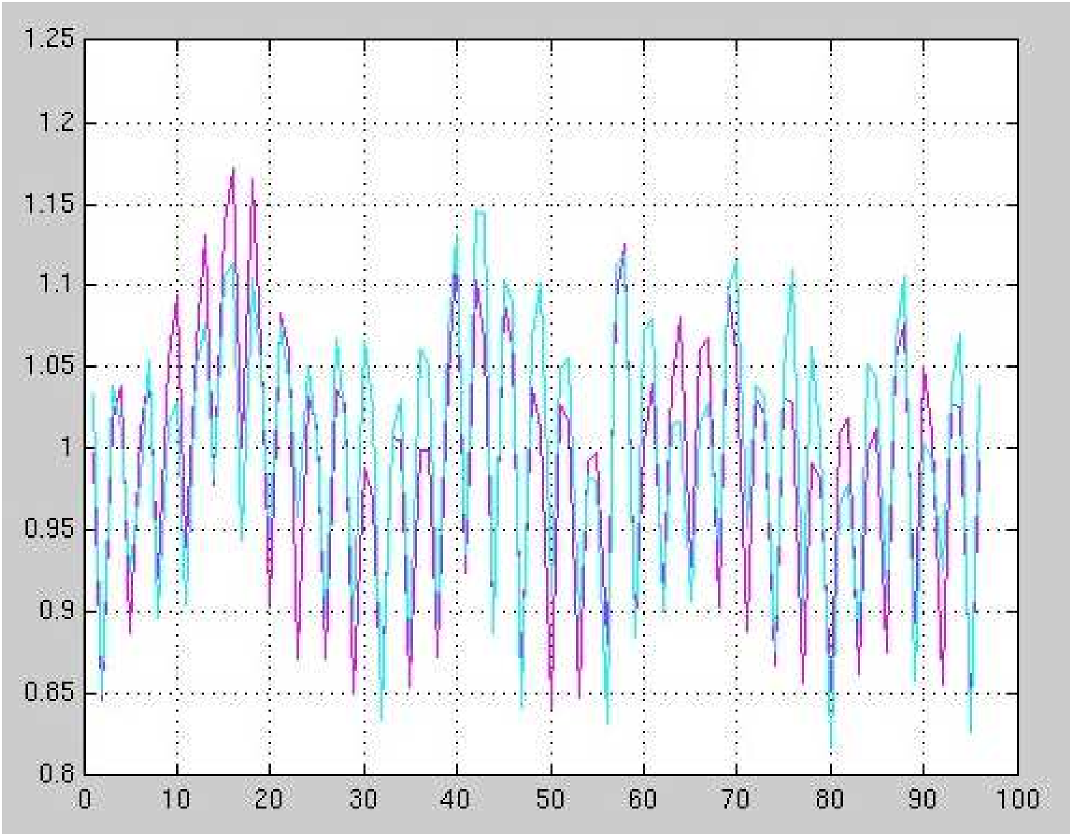
Bursts generation in the correctors power supply FPGA



Sequence of bursts at the 14 outputs of one power supply controller

8 correctors sending .5ms bursts with frequencies offset by 2Hz, simultaneously =>
8 independent orbit response can be recorded simultaneously without crosstalk

Difference between the response at high frequency and DC =>calibration



eight steerers simultaneously active per record