DESIGN AND DEVELOPMENT OF CONFIGURABLE BPM READOUT SYSTEM FOR IRANIAN LIGHT SOURCE FACILITY

Designed by MAH.ZAD.YAR

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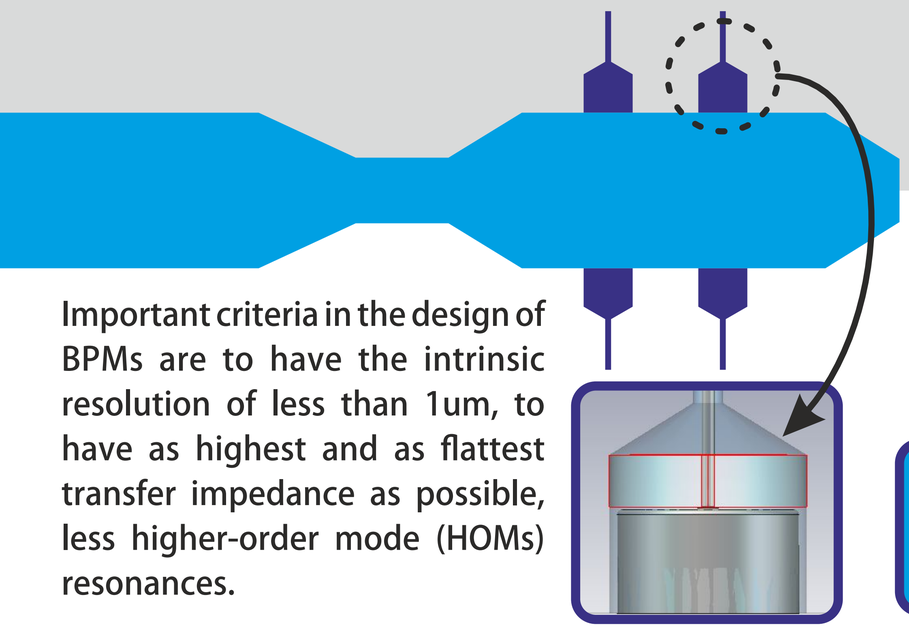
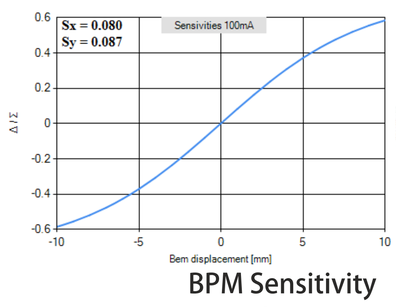
ABSTRACT

A configurable electronic system has been developed for button BPMs readout in the storage ring of Iranian Light Source Facility (ILSF). This system calculates the beam position through the output voltage of BPMs. Output signals of BPMs pass through a 500 MHz and 50ohm front-end for noise filtering and also gain control purposes. Then the signal is digitized based on under sampling method by a 130MHz ADC for further analysis in FPGA. Safe dynamic range of 0dBm to -90 dBm can be covered by this electronic system with white noise measured to be around -110dBm. Trigger for this electronic is 2-10Hz as Slow data acquisition for Slow orbit feedback system and 4-10KHz as Fast data acquisition for fast orbit feedback system. This paper describes the design, analysis, and measurements of the developed electronic system.

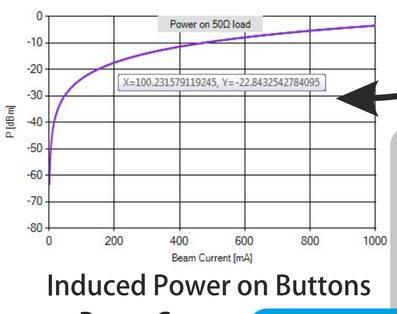


Important criteria in the design of BPMs are to have the intrinsic resolution of less than 1um, to have as highest and as flattest transfer impedance as possible, less higher-order mode (HOMs) resonances.

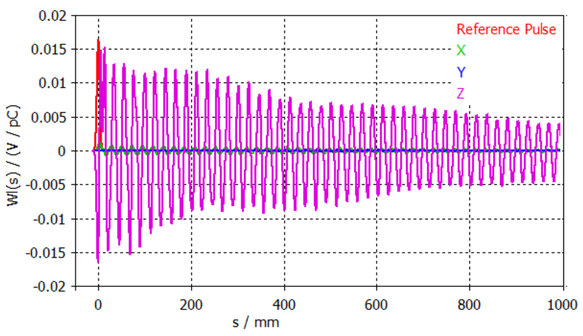
CALCULATED PARAMETERS



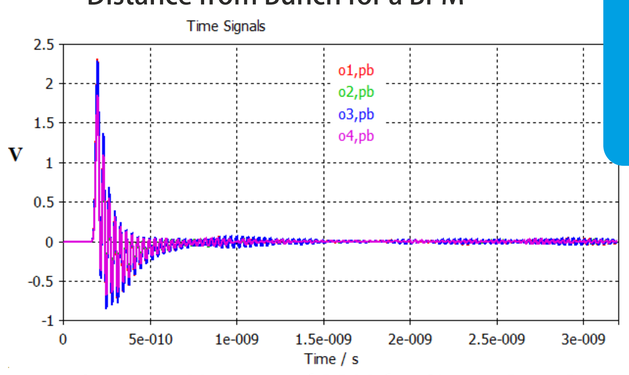
BPM Sensitivity vs Beam Displacement



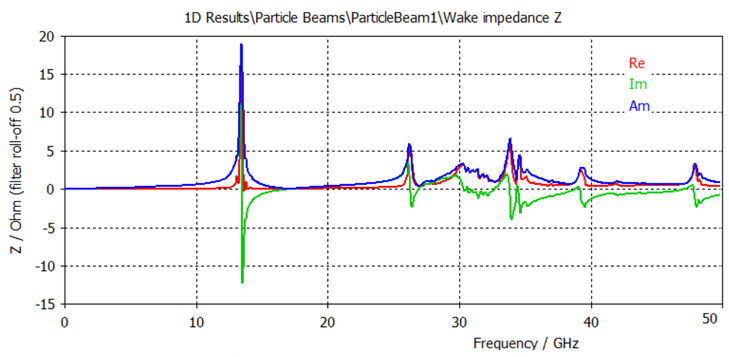
Induced Power on Buttons vs Beam Current



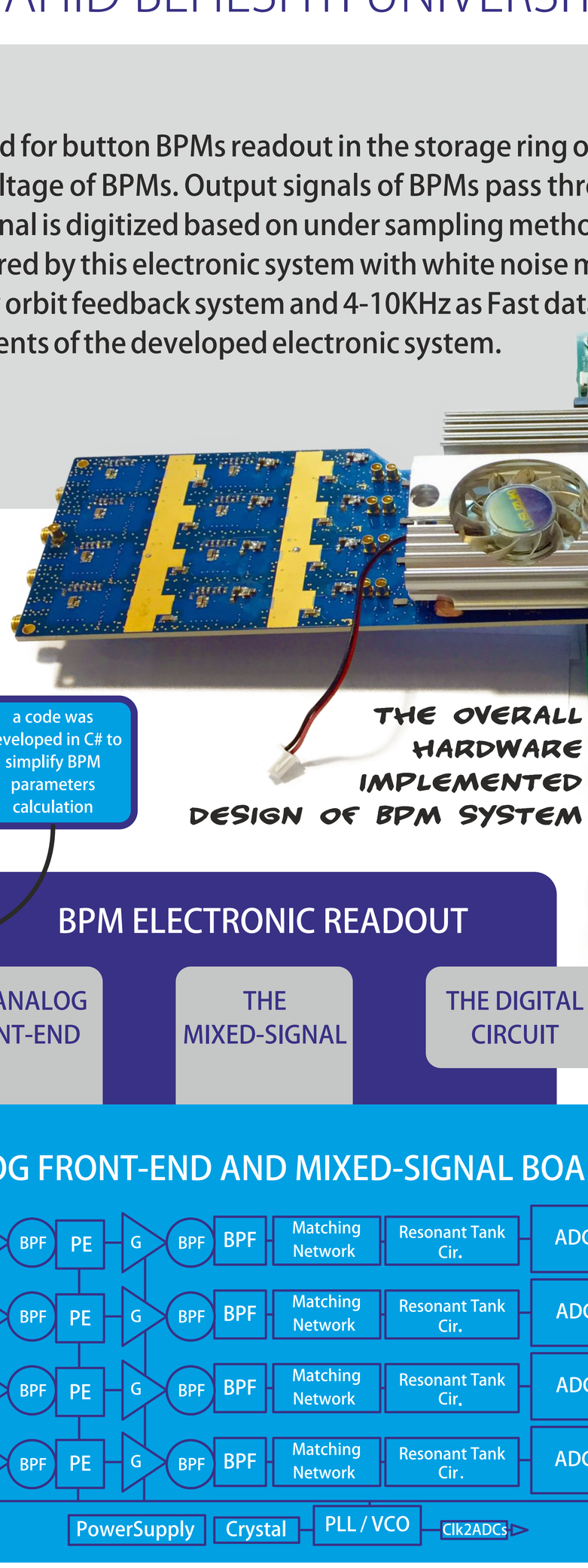
Wake Potential as Function of Distance from Bunch for a BPM

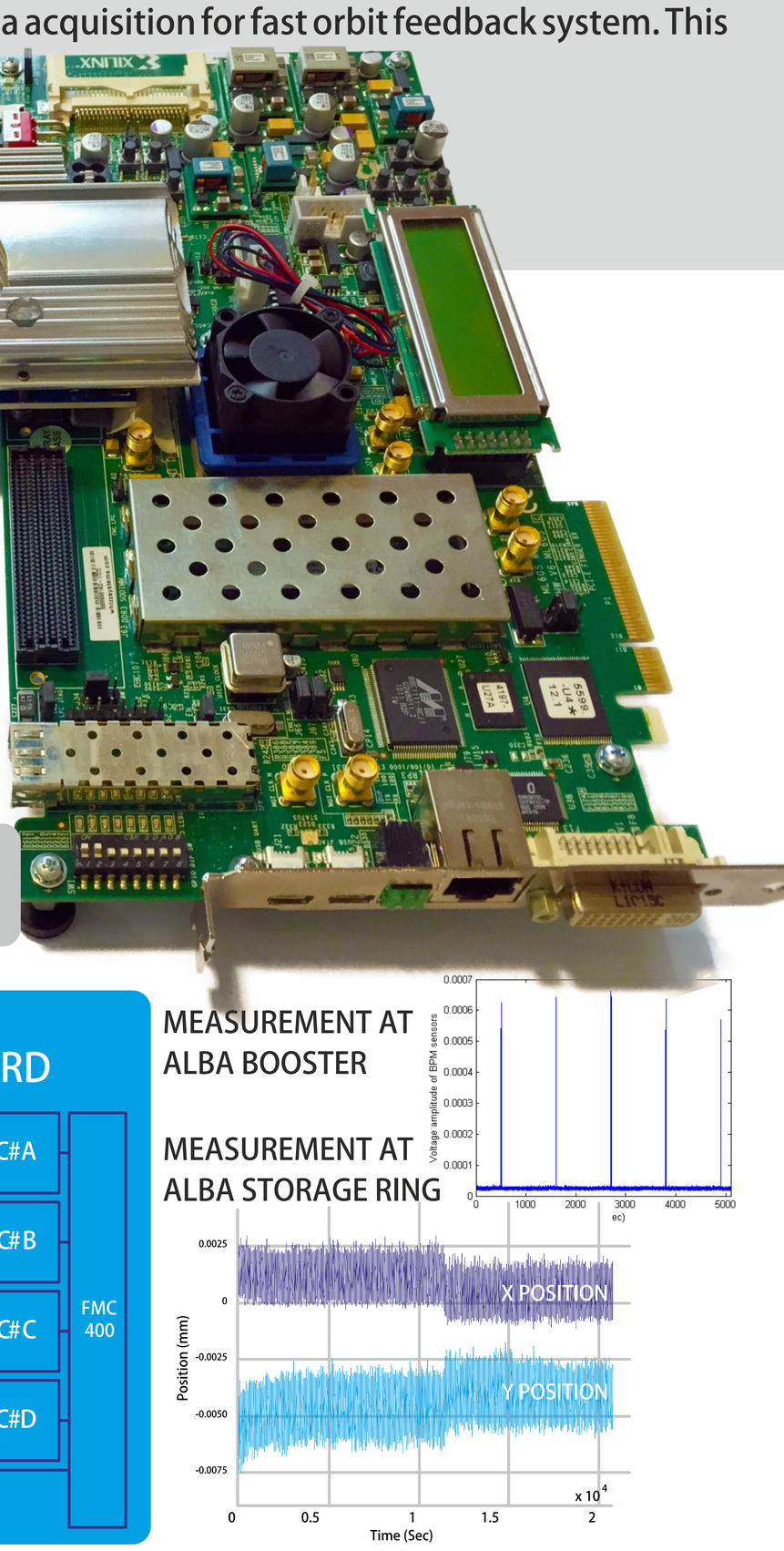


Induced Voltage of BPM for Single Pass Beam at Center of Vacuum Chamber



Real and Imaginary Parts of Longitudinal Coupling Impedance for a BPM



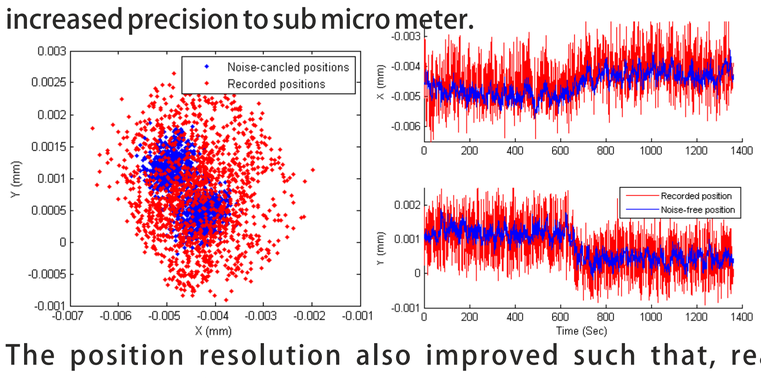


MEASUREMENT AT ALBA BOOSTER

MEASUREMENT AT ALBA STORAGE RING

NOISE REDUCTION BY PCA

We have used PCA (Principal Component Analysis) to reduce noise. First we filtered position data through 3 different frequency range; 0-0.1Hz, 0.1-0.2Hz, and 0.2-0.3Hz , by the way we go the max signal energy is below 0.29Hz. By using PCA through these frequency categories, we reduced noise and increased precision to sub micro meter.



The position resolution also improved such that, real measurement of the beam displacement is not clear as much as using PCA.

RESULTS

To get information about induced signal on ALBA button BPMs, measurement by oscilloscope with 50-ohm termination showed peak to peak voltage around 221mV equal to -9 dBm which is quite in our system's dynamic range. Resolution is around 0.2 um due to wide dynamic range up to -90 dBm and $K(\Delta V)=\Delta x$ formula which K is 10. After calibration of our system by using signal generator for each channel and finding coefficients due to its linear behavior between BPM output voltage and readout voltage, we started beam position measurements. Beam position calculation was done based on peak-peak voltage measurements and Δ/Σ equation.

ACKNOWLEDGMENT

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