WEPMS028

icalepcs 2011

Online evaluation of new DBPM processors at SINAP

leng@sinap.ac.cn

Yongbin Leng, Xing Yi, Longwei Lai, Guoqing Huang, Yingbing Yan

SSRF, SINAP, Jiading, Shanghai 201800, P.R. China

Introduction

•Two prototypes of new DBPM processor were initiated at SINAP since 2008.

•The first algorithm evaluation prototype is based on commercial ADC board to evaluate signal processing blocks.

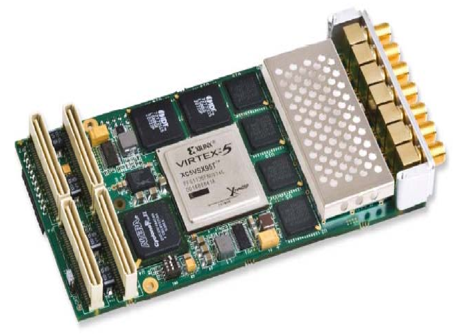
•The second prototype is home-made from chips level to build a hardware frame.

•Two prototypes merged together after lab test.

•Online evaluation has been carried on to verify the performance of hardware and software of this new DBPM processor.

algorithm evaluation prototype

ICS-1554A-002



●4-channel,

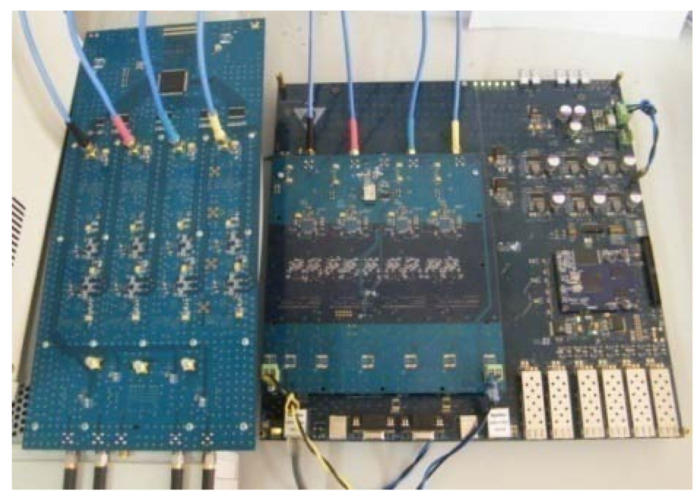
●160 MHz 16-bit ADC,

● Xilinx Virtex-5 SX95T FPGA,

●PCI-X 64-bit/133 MHz master/target burst mode DMA capable

L.W. Lai, Y.B. Leng, X. Yi, etc., "The Study and Implementation of Signal Processing Algorithm for Digital Beam Position Monitor", PAC2011, New York, United States, 2011

hardware frame prototype



X. Yi, Y.B. Leng, L.W. Lai, etc., "A Calibration Method for the RF Front-end Asymmetry of the DBPM Processor", DIPAC2011, Hamburg, Germany, 2011: 56-58

Spatial resolution evaluation

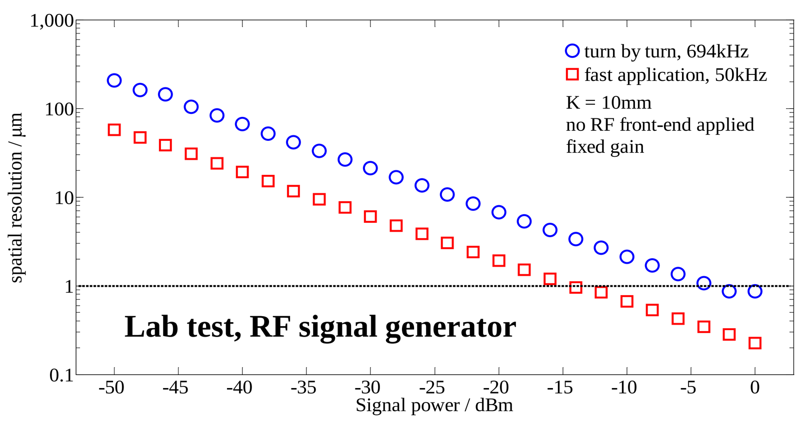
•Few microns resolution @ TBT and sub microns resolution @ 50kHz achieved in lab test

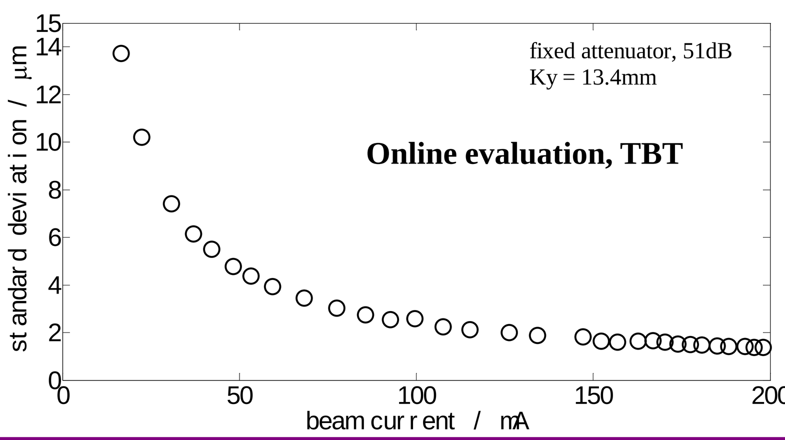
•Better than 2 microns @ TBT when beam current larger than 100 mA

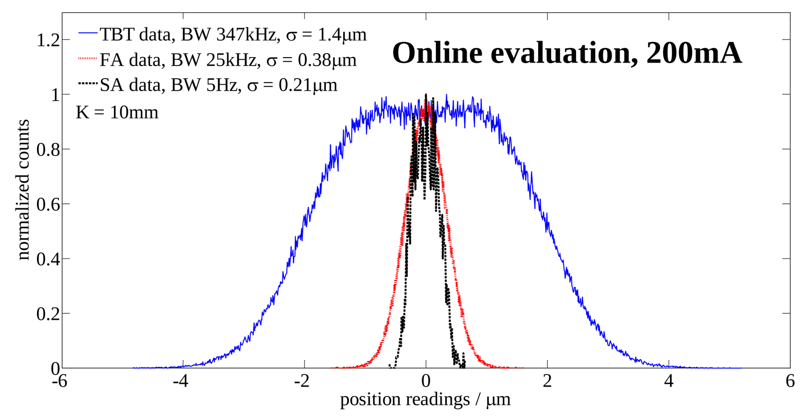
•Better than 1.4 microns @ TBT

•Better than 0.38 microns @ 50 kHz

•Better than 0.21 microns @ 10 Hz





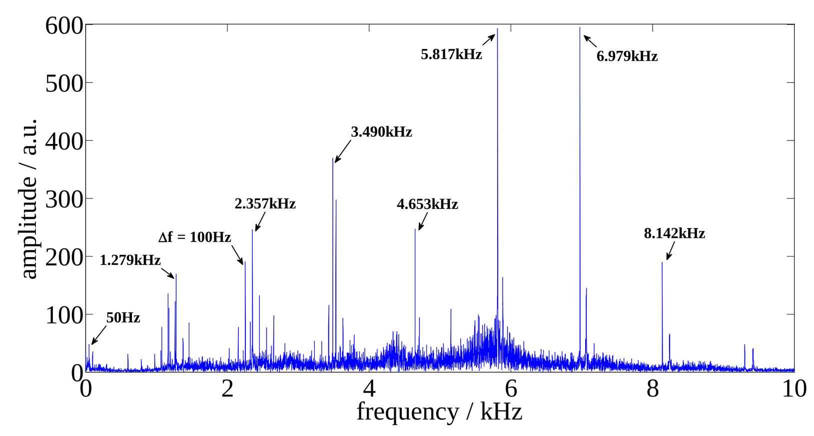


Fast application (50 kHz) data interface

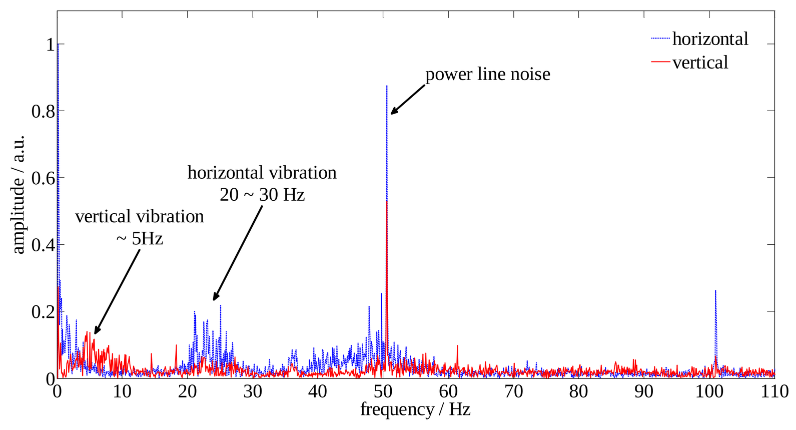
•50 kHz fast application data interface with a 500k samples FIFO buffer is implemented.

•The energy oscillation, narrow band electronics noise from LLRF, 50 Hz power line noise probably coupled from magnet PS, and noise from gird vibration have been recorded precisely. The functionality and quality of FA data interface are confirmed.

•Sub Hz frequency resolution and sub micron spatial resolution makes FA interface to be a very powerful diagnostics tools for orbit noise analyze.



Orbit noise below 10 kHz



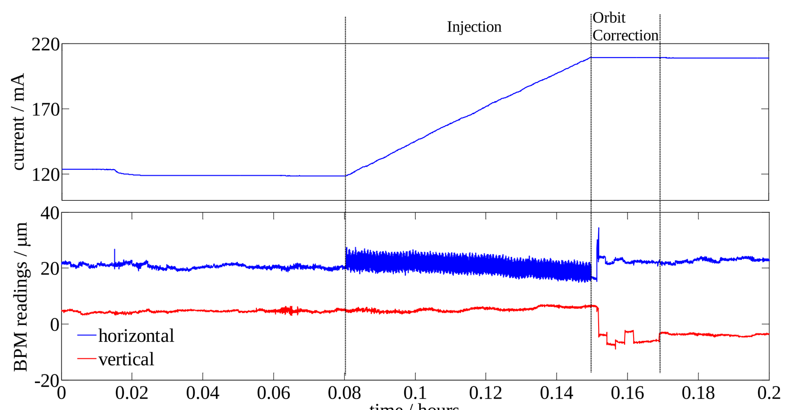
Orbit noise below 100 Hz

Slow application (10 Hz) data interface

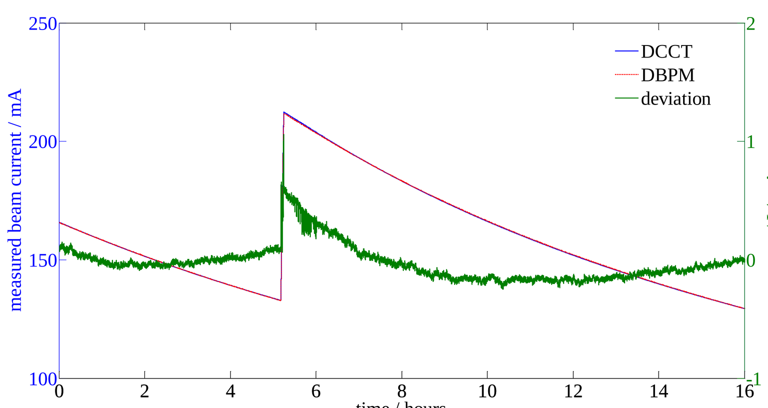
•The real orbit movement has been recorded precisely before, during and after injection. The functionality and quality of SA data interface are confirmed.

•The linearity of SA sum signal is good enough for beam current and lifetime measurement. Experiments showed the very good agreement between DCCT and new DBPM.

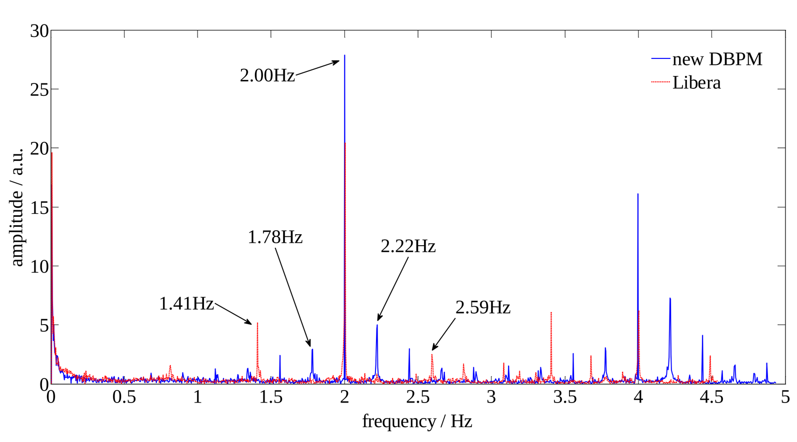
•Some low frequency narrow band noise (0.22Hz) is observed. It is not clear yet that the noise comes from beam, hardware or software of processor. More study and optimization need to be done.



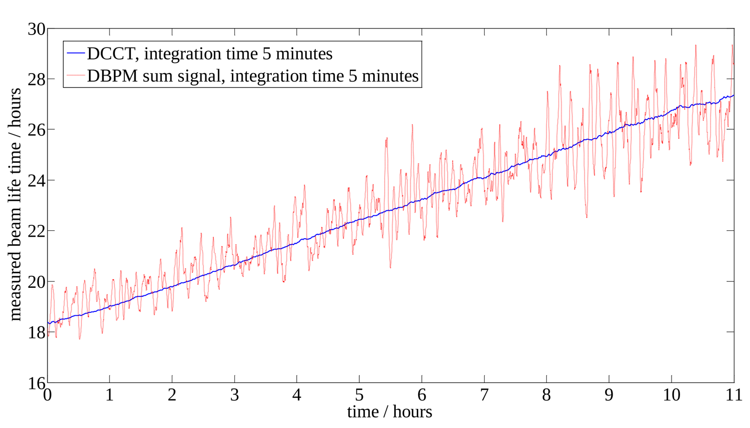
Orbit movement captured during injection



Beam current measurement



FFT of SA position data during injection. 2 Hz is injection rate. The source of 0.22Hz sideband is not clear yet.



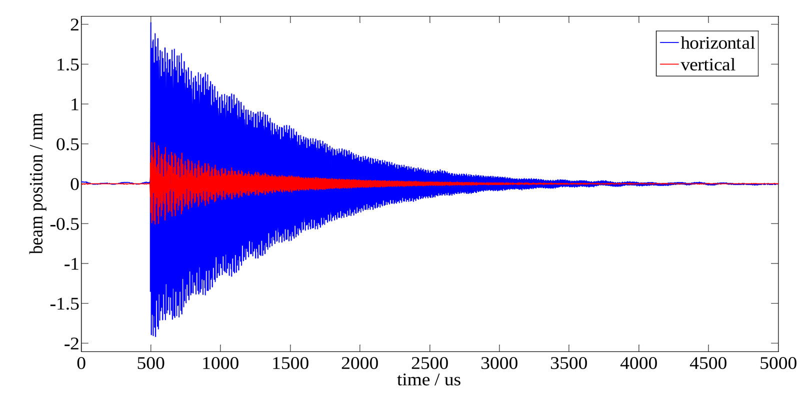
Beam lifetime calculated from sum signal. Resolution is not good as DCCT. But average value has very good agreement with DCCT.

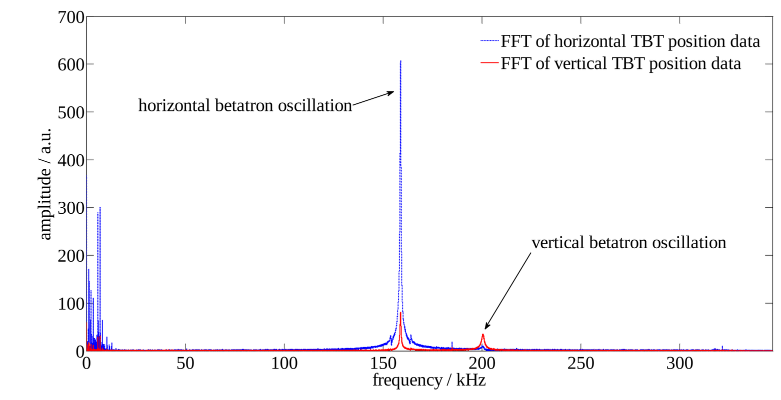
Turn-by-turn (694 kHz) data interface

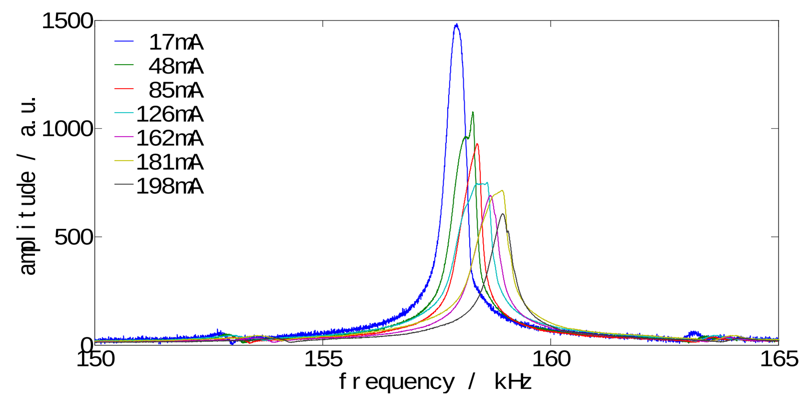
•Turn-by-turn (694 kHz) data interface with a 500k samples FIFO buffer is implemented.

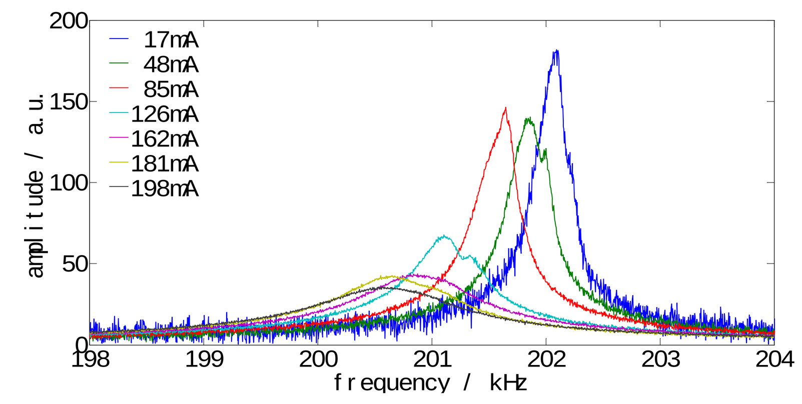
•Demonstration of fabric tune measurement has been performed. Tune shifts and betatron oscillation peak splitting were recorded precisely. Beam impedance could be retrieved from this measurement. The functionality and quality of TBT data interface are confirmed.

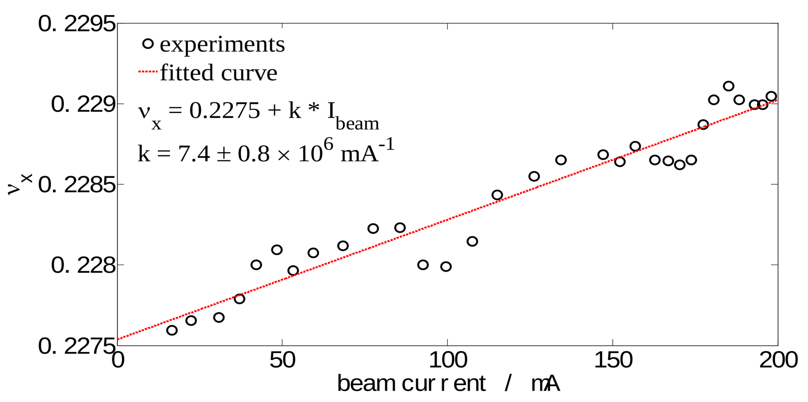
•Frequency resolution of Hz level and spatial resolution of micron level makes TBT interface to be a very powerful diagnostics tools for machine study.

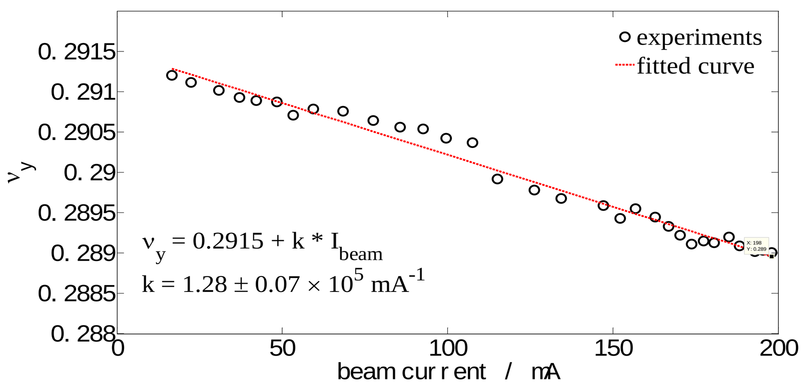










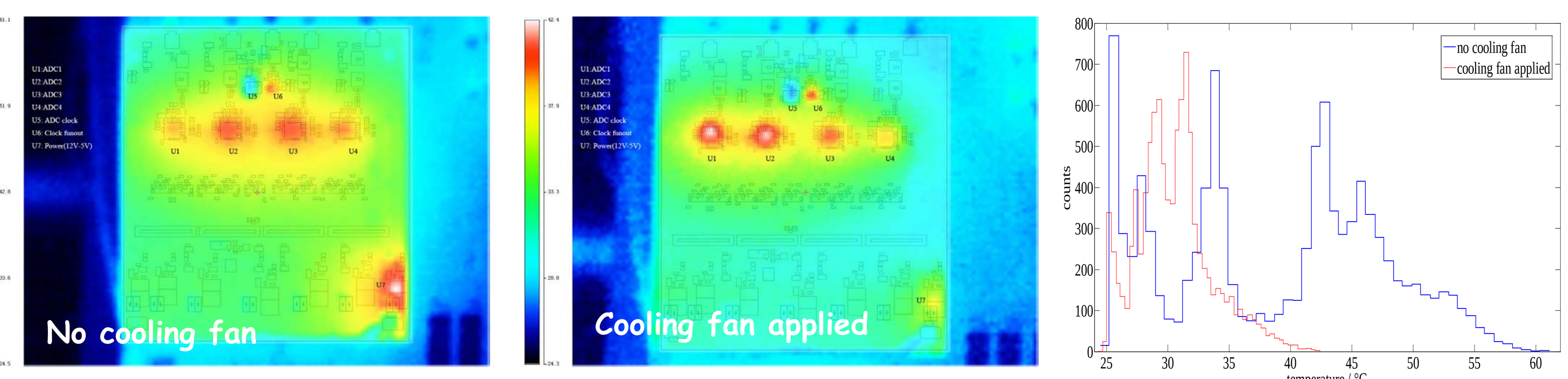


Thermal loading investigation

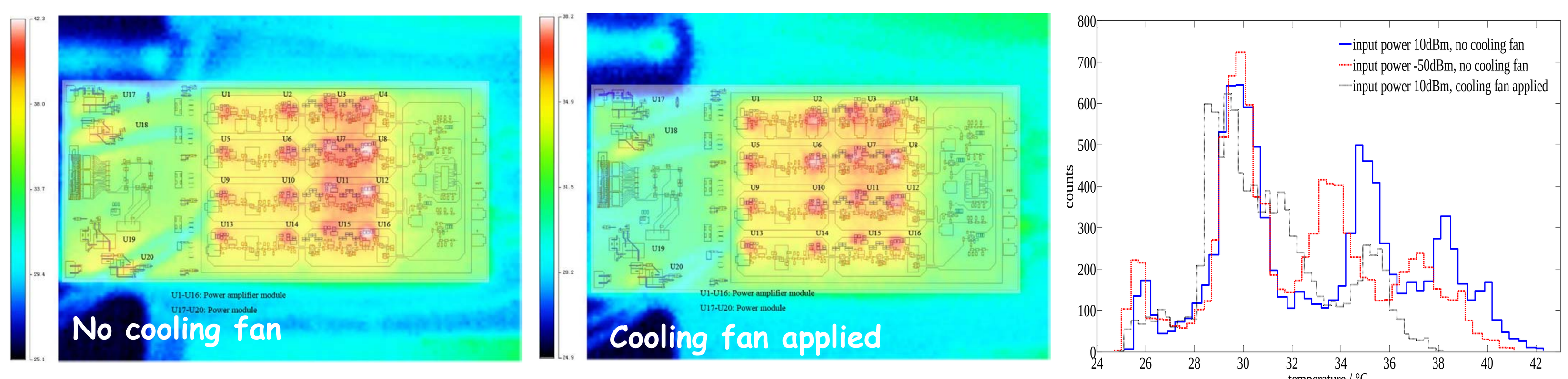
•The first three major thermal producers are ADC, RF amplifier and PS chips

•The cooling fan is very helpful for ADC module: the temperatures of ADC chips decrease from 60 degree to 42 degree; the average temperature of PCB board decreases from 43 degree to 32 degree

•Air cooling is not a critical issue for RF front-end module in this case



ADC module



RF front-end module

Conclusion

A prototype of new digital BPM processor has been evaluated online at SSRF storage ring. Major signal processing blocks including TBT, FA and SA have been tested. Thermal loadings of RF and ADC module were investigated. Evaluation results show that the functionality and performance are comparable with commercial products and satisfied the requirements of operation and machine study. Evaluation results confirmed the current design. The next technical prototype will be built soon.