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Cavity BPM System for DCLS

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•Introduction

Dalian Coherent Light Source (DCLS) is a new FEL facility under construction in China. The entire facility consists of the following parts:

- A photo-injector will produce electron pluses of 500 pC with normalized emittance below 1 mm·mrad
- The linear accelerator will accelerate the electrons to 300 Mev which consists of 6 S-band accelerator structures and a movable chicane for electron bunch compression
- The undulator complex where to generate the FEL radiation with wavelength of 50 ~ 150 nm
- The photo beam line and diagnostic line

Cavity BPM system comprised of cavity pick-up, dedicated RF front end and DAQ system is employed to measure the transverse position with a micron level resolution requirement in the undulator section.

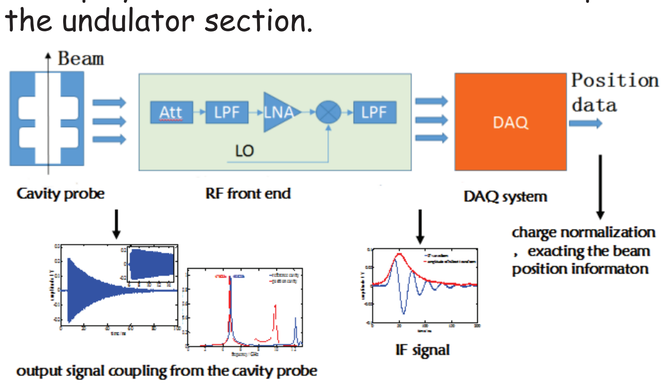
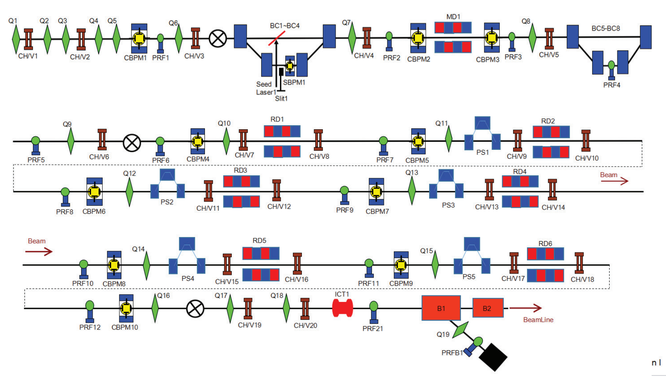


Diagram of the CBPM system



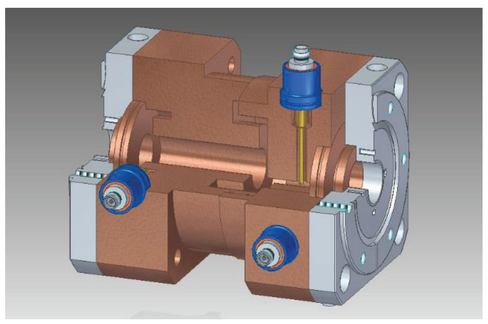
Schematic layout of CBPMs in the undulator section

•Design and Fabricate of the cavity pick-up

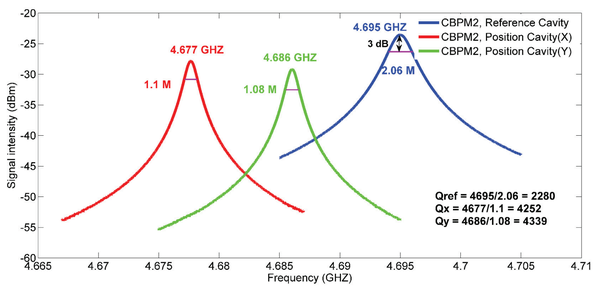
Cavity Design

Design parameters of the CBPM

Parameters	TM110	TM010
Resonant frequency	4.70 GHz	4.70 GHz
Q factory	~ 8000	~ 8000
Number of ports	4(X:2, Y:2)	2



Cold Test



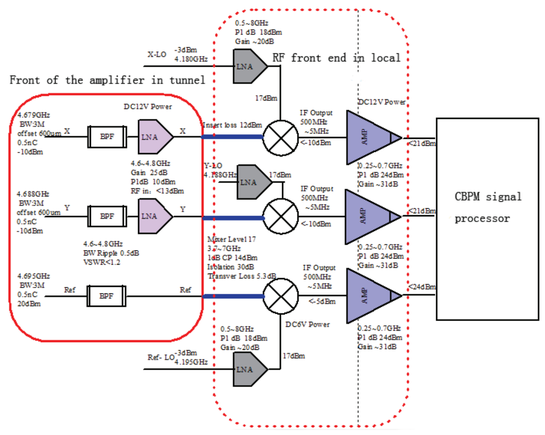
S21 parameter of the CBPM2 measured by network analyzer

Specification of the cavity processing

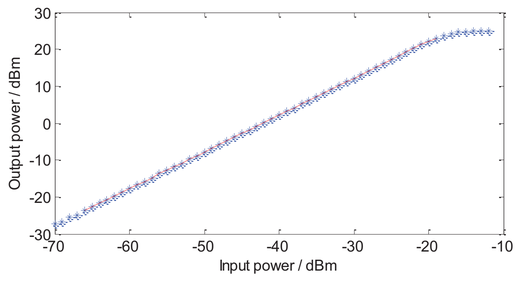
	Working frequency	Q factor
Reference cavity	4693±3 MHz	2230±10%
Position cavity(X)	4680±3 MHz	4250±10%
Position cavity(Y)	4688±3 MHz	4250±10%

Three sets of cavity prototype was processed and tested by network analyzer, and Combine with the designed parameters and processing technology, the specification of the cavity processing are determined.

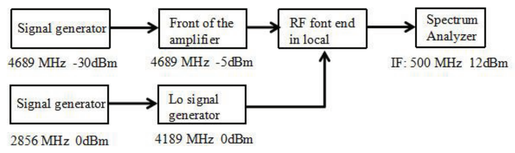
•RF Front end

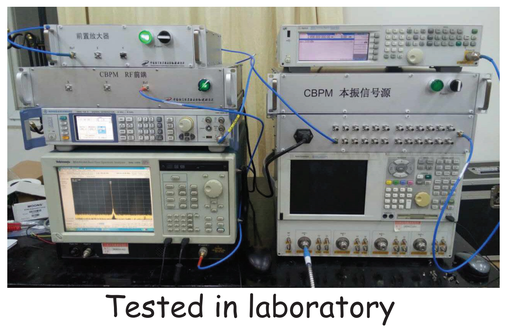


Two-stage amplifier structure is applied in the RF front end.



Gain line test of the whole RF front end

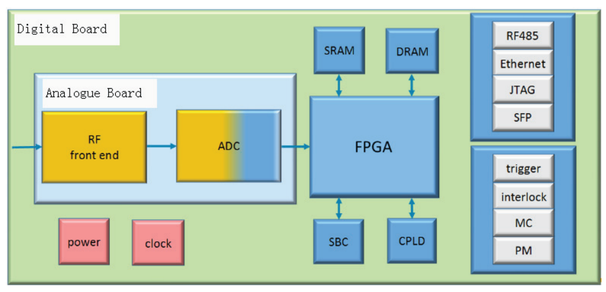




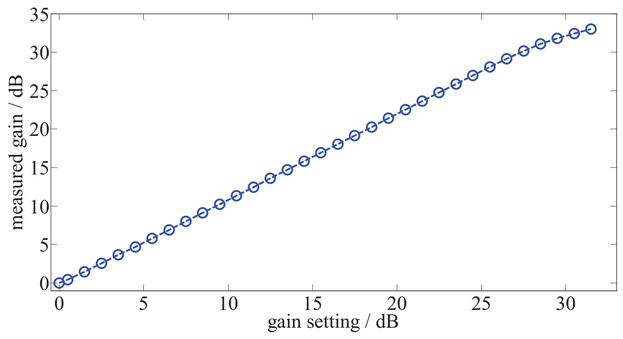
Tested in laboratory

- The test results are consistent with the design
- Considering the 12 dB attenuation of the cable between the two parts of the RF front end, the input power should be less than -7 dBm
- Good linearity in the effective working range

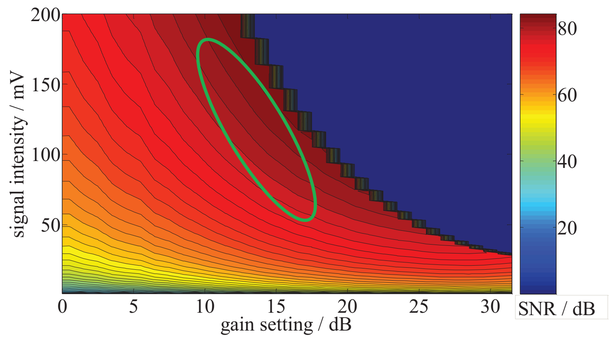
•DAQ system



Simplified diagram of the DBPM processor



Gain line test result of the DBPM prototype

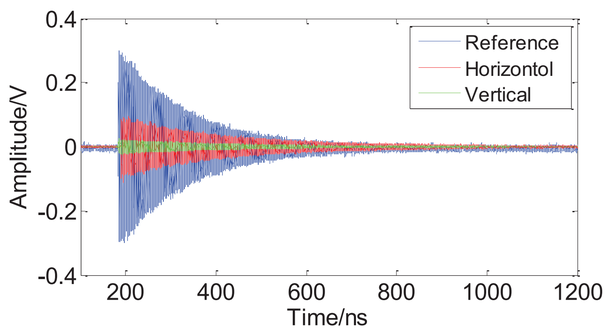


Mapping of the signal intensity and the gain setting of the DBPM prototype

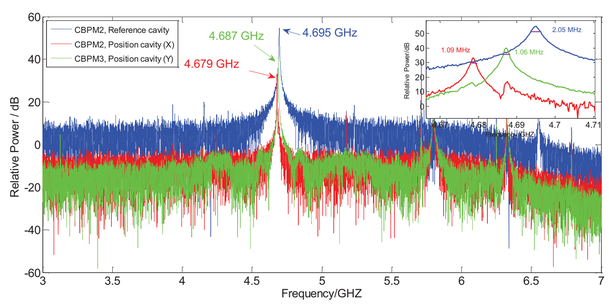
- The DBPM prototype has a better linear gain response
- The SNR is better than 75 dB when the intensity of the IF signal lager than 25 mVpp
- Can meet the requirement of the cavity BPM processor

•Beam test at SDUV

Cavity Evaluation



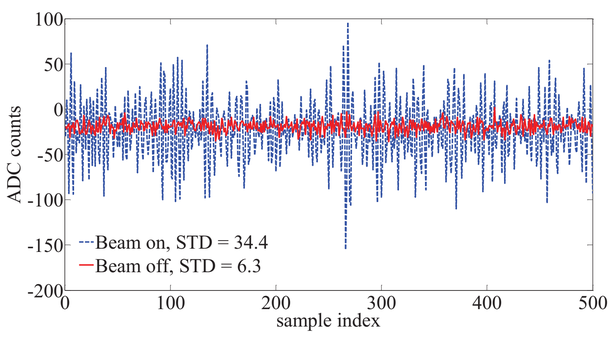
RF signals of the CBPM2



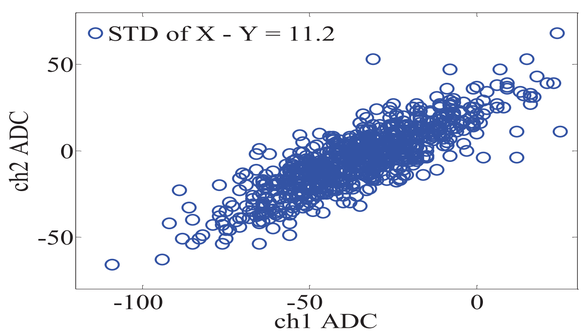
Frequency spectrum of the CBPM2

- The waves and frequency spectrum are consistent with expections
- The results with beam are agree with the cold test very well
- The results of S21 parameter can be the acceptance standard for cavity batch process

Noise assessment of the CBPM system



The level of the noise when beam on and off



The linear dependence of the noise picked up by different channels

- The amplitude of the interference signals with beam on is lager than the condition of beam off about 6 times
- The noise coupling to the system in the part of the RF front end

•Conclusion

DCLS is under the commission stage, And the CBPM system in undulator section has been designed and preliminary test with beam also completed:

- Test results with beam in cavity pick-up evaluation are consistent with the cold test with S21 parameter, which can be the acceptance standard of the batch processing to meet the requirement of the project.
- The output signal amplitude of the RF front end should be optimized within 100~200 mV to get the best SNR.
- The electromagnetic shielding, grounded of the electronics and the test of the background noise should be considered in the scene of installation.

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