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 pulses of 500 pC with normalized emittance below 1 nm·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 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.

-Design and Fabricate of the cavity pick-up

Cavity Design

Design parameters of the CBPM:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>TM110</th>
<th>TM010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resonant frequency</td>
<td>4.70 GHz</td>
<td>4.70 GHz</td>
</tr>
<tr>
<td>Q factor</td>
<td>~ 8000</td>
<td>~ 8000</td>
</tr>
<tr>
<td>Number of ports</td>
<td>(X:2, Y:2)</td>
<td>2</td>
</tr>
</tbody>
</table>

Cold Test

S21 parameter of the CBPM2 measured by network analyzer:

- Reference cavity: 4693 ± 3 MHz (22.8 ± 10%)
- Position cavity (X): 4680 ± 3 MHz (24.5 ± 10%)
- Position cavity (Y): 4688 ± 3 MHz (24.5 ± 10%)

Specification of the cavity processing:

<table>
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<th>Working frequency</th>
<th>Q factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference cavity</td>
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</tr>
<tr>
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<td>4688 ± 3 MHz (24.5 ± 10%)</td>
</tr>
</tbody>
</table>

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.

-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:

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

-Beam test at SDUV

Cavity Evaluation

RF signals of the CBPM2:

Frequency spectrum of the CBPM2:

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:

-Conclusion

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

- The waves and frequency spectrum are consistent with expectations.
- 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.
- The amplitude of the interference signals with beam on is larger than the condition of beam off about 6 times.
- The noise coupling to the system in the part of the RF front end.
- The DBPM prototype has a better linear gain response.
- The SNR is better than 75 dB when the intensity of the IF signal larger than 25 mVpp.
- Can meet the requirement of the cavity BPM processor.

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