SLAC is developing a new X-band Cavity BPM receiver for use in the LCLS-II for use in the LCLS-II. The Linac Coherent Light Source II (LCLS-II) will be a free electron laser (FEL) at SLAC producing coherent 0.5-77 Angstroms hard and soft x-rays. To achieve this level of performance precise, stable alignment of the electron beam in the undulator is required. The LCLS-II cavity BPM system will provide single shot resolution better than 50 nm resolution at 200 pC. The Cavity BPM heterodyne receiver is located in the tunnel close to the cavity BPM. The receiver will process the TM010 monopole reference cavity signal and a TM110 dipole cavity signal at approximately 11 GHz using a heterodyne technique. The heterodyne receiver will be capable of detecting a multibunch beam with a 50 ns fill pattern. A new LAN communication daughter board will allow the receiver to talk to an input-output-controller (IOC) over 100 meters to set gains, control the programmable dielectric resonator oscillator, enable self-test, and monitor the status of the receiver. We will describe the design methodology including noise analysis, distortion analysis.

### BPM Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>&lt; 1 micron</td>
<td>200 pC &lt; Q &lt; 1 nC over ±1 mm range</td>
</tr>
<tr>
<td>Offset Stability</td>
<td>&lt; ±1 micron</td>
<td>1 hour ± 1 mm range, 20 ± 0.56 C</td>
</tr>
<tr>
<td>Gain Stability</td>
<td>± 10 %</td>
<td>1 mm range, 20 ± 0.56 C</td>
</tr>
<tr>
<td>Aperture</td>
<td>10 mm</td>
<td></td>
</tr>
</tbody>
</table>

### Design

- Avoid monopole mode in position cavity
- Cavity-waveguide coupler rejects monopole mode by symmetry
- Predecessor at KEK’s ATF
  - 16 mm resolution in test
- Choices
  - Single, degenerate X&Y cavity
  - Reference cavity per BPM
- BPMs tuned and cold tested before brazing
- Tuned by micro machining end-caps
- Good correlation between cold test data before and after braze
- Position and reference cavities machined in common block
- Closed with end-caps

### µTCA Platform

- High density plug connectors up to 5 GHz available (µTCA) – interface on rear adapters
- High Availability standard architectures (µTCA)
- Hot swap modules demonstrated (µTCA)
- Gigabit communications w/ embedded processor chips, high speed 12-16 bit samplers ADC-DAC commodity products, more to come...!
- IPMI interfaces let you know status of temperatures, power, cooling, module present
- Cannot afford to NOT explore latest technologies.

### µTCA SLAC RTM and SIS 119 MHz Digitizer

This figure shows the Vadatech Version of a 10-Channel 119MHz/s ADC.

ADC:
- 10-Channel in µTCA Package Designed by SIS
- 10 Channel RTM designed by SLAC
- digitizes IF at 119MSa/s
- 16-bit (11 effective see figure)
- Xilinx Virtex-5 FPGA
- Block reads
- Can perform digital downconversion

The figure is a plot of the frequency spectrum of a 25MHz tone being digitized at 100MHz. ENOB was calculated using Matlab by fitting the data to a sine wave.