Implementation of a Dectris RIGI 4S and Libera Photon at 17-ID.

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Previous Equipment

• Oxford quad-diode BPM
• Oxford IC Plus Electronics

• Perceived problems
  – Sensitivity dependent on foil choice.
  – Foil is consumable.
  – Apparent lack of linearity with beam intensity.
  – Questionable product support.
  – Electronics box out of production.
Equipment Choice

• **Dectris RIGI 4S**
  - Pad size 2 x 1 mm
  - 6 µm gap between pads
  - 4.6 x 2.6 mm window area
  - 12 µm thick

• **Instrumentation Technologies Libera Photon**
  - Recommended by Dectris
  - Position calculations can be done in the box
  - Cost effective vs individual current amps
  - Provides bias voltage
  - Expansion possibilities
Perceived Benefits

• Direct X-ray detection
• Better linearity
• More durable
• No consumable parts
• No maintenance required
• Better customer support

• Downsides
  – Not a single-vendor option.
  – Requires some fabrication to integrate.
  – RIGI is very sensitive to beam shape.
Implementation

- Integrating the Libera into the control system.
- Fabricate a box for the RIGI 4S.
- Determining the bias voltage for the RIGI.
- Beam position calibration.
I-Tech Libera Photon

- RS485, ethernet and SFP data ports on front.
- Current inputs, PMC slot, triggers and sync ports on back.
- Connected to control system via ethernet.
Libera Current Range

- The Libera has 7 input current ranges.
- Operation can be on a single current range or autoranging.
  - Range is updated at 4 Hz.
  - Hysteresis is 0.3 V.

<table>
<thead>
<tr>
<th>Range Change</th>
<th>Increasing current</th>
<th>Decreasing current</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 1</td>
<td>~1.9 nA</td>
<td>~1.6 nA</td>
</tr>
<tr>
<td>1 – 2</td>
<td>~19 nA</td>
<td>~16 nA</td>
</tr>
<tr>
<td>2 – 3</td>
<td>~190 nA</td>
<td>~160 nA</td>
</tr>
<tr>
<td>3 – 4</td>
<td>~1.9 µA</td>
<td>~1.6 µA</td>
</tr>
<tr>
<td>4 – 5</td>
<td>~19 µA</td>
<td>~16 µA</td>
</tr>
<tr>
<td>5 – 6</td>
<td>~190 µA</td>
<td>~160 µA</td>
</tr>
</tbody>
</table>
RIGI 4S

• Smaller sensor appropriate for focused beam closer to sample.
• We designed and machined our own enclosure.
• Unit is installed in rough vacuum.
RIGI 4S Bias Voltage

- Voltage is supplied by the Libera.
  - Voltage is adjustable from -1 to -150 V.

- Dectris suggests -10 to -20 V.
  - ‘High’ flux: -10 to -20 V
  - ‘Low’ flux: 0 to -20 V

- -12 V was optimal.
  - Measured from -10 to -20 V with beam on and off.
  - The peak of background-subtracted intensity was at -12 V.
Libera Calibration

• Determine slope and offsets for beam motion.
  – $X = K_1((a+d)-(b+c))/(a+b+c+d) - \text{Off1}$
  – $Y = K_2((a+b)-(c+d))/(a+b+c+d) - \text{Off2}$

• Center beam.

• Center sensor in beam.

• Scan sensor through beam in 10 $\mu$m steps.
  – Measure reported position.
  – Calculate slope and offsets from graph.
  – Set parameters in Libera.
Calibration, pt 2

Scanning sensor through beam

Vertical

Horizontal
Calibration curve
On/Off Delay

 XBPM Start

 XBPM Intensity Decay

 Time (Sec)

 Intensity

 Pad Average
Energy vs Attenuation

- Moved from 8 keV to 13.5 keV
  - 1\textsuperscript{st} harmonic, 500 eV steps
- Optimized and centered beam.
- Moved beam off-center then started correction.
- From \(~68\% - \sim98\%\) attenuation, correction was successful.
- At low flux, beam position was not reported correctly.
  - High flux seemed to be less an issue.
Detector for Scans

- Monochromator 2nd crystal pitch scan.
  - Libera in autorange mode.
  - Autoranging makes scan interpretation difficult.
Detector for Scans, pt2

- Monochromator 2nd crystals pitch scans.
  - Libera in manual range 1 or 2.
Conclusions

• Integration and implementation was relatively easy.
• Sensitivity and linearity is useful over a large attenuation range.
• Autoranging can limit utility as a scan target or intensity monitor.
  – Just set it to manual mode and it can work fine.
• The RIGI has shown to be physically durable.
• The Libera has substantial built-in capabilities.
• Alterations to beam shape will require recalibration.
• Sensor gaps don’t appear to produce scan artifacts.

• Customer support from Dectris and I-Tech has been outstanding.
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