Overview of Bimorph Mirrors
at
Diamond Light Source

Andy Dent
Experimental Coordinator

ACTOP08, Trieste
Bimorph or Conventional?

Require “clean” Gaussian shape with no long tails, especially in high demagnification regime.
Likely to move focal position or wish to ensure quality beam “off-focus” ie wish to focus on detector, but maintain regular beam at sample.
Correct for distortions eg heat bump from other optics.
Improve overall slope error of optic.
# Beamlines with Bimorph Mirrors (1)

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<thead>
<tr>
<th>Beamline</th>
<th>Science</th>
<th>Length of mirror and no of electrodes</th>
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<tr>
<td>I02, I03, I04</td>
<td>Macromolecular Crystallography</td>
<td>1050 HFM (14) 600 VFM (8)</td>
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<td>I07</td>
<td>Surfaces and Interfaces</td>
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<td>I18</td>
<td>Microfocus Spectroscopy</td>
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## Beamlines with Bimorph Mirrors (2)

<table>
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<td>I19</td>
<td>Small Molecule Crystalline Diffraction</td>
<td>600 VFM (16) 1050 HFM (32)</td>
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<td>900 HFM (12) 600 VFM (32)</td>
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<td>I24</td>
<td>Microfocus MX</td>
<td>1050 HPFM (16) 600 VPFM (32) 220 VMFM (12) 280 HMFM (8)</td>
</tr>
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</table>
I02, I03, I04

Spot size ca 150x 120\(\mu\)m just using more or less the same voltages on each electrode – aiming for 150x20\(\mu\)m when fully commissioned

Other beamline issues (mono, robot) have had priority, so little has been done, other than to “manually” focus the mirrors
Design features:
Beam is horizontally focussed (2:1) and vertically collimated by the first (conventional) mirror
Beam size at focus point (Secondary Slits) is virtual source for the KB pair and is used to control beam size HR by separate mirror pairs
Bimorph KB’s.

Had most effort to understand performance. Spot limited to 3mm by vibrations, but recently mirror damaged.
Beamline I07: Surface Diffraction

Energy Range: 6-30keV

Beam Size: 30µm×100µm with mirror

Two hutch design essential; first with fast flexible diffractometer (many sample environments) and second with large heavy duty diffractometer (e.g. UHV in-situ).

GISAXS experiments available.

Beamline being built. Mirrors measured in metrology lab and matrix used to correct shape.
I07 Bimorph slope error

![Graph showing slope error over scan length with different iterations and error metrics.](image)
I19: Small Molecule Diffraction

EH1: fast single-crystal diffractometer with robotic sample changer for high-throughput

EH2: heavy duty diffractometer for long lead-time experiments and large sample-environment cells.

E: 5-25 keV
\(\Delta E/E: <2 \times 10^{-4}\)
Spot: 50×50µm;

Being prepared for user operation. The bimorph mirrors are not yet in the beam.
I22 for SAXS

- Wavelength 0.6Å – 3.0Å, ca. 4-20keV maximised at 8-12keV, continuously tuneable.
- Bandpass $10^{-2}$, $10^{-4}$ selectable
- Beamsize at sample 100μm (V) – 300μm(H), with standard focussing, 1μm x 1μm with micro-focussing
- Length scale 10Å - 10000Å (1μm)
Bimorph Results for I22 – so far!

• Slit scans performed using in-house x-ray camera.
• Centroids of beamlets monitored.
• Results ported to Accel/Elettra software for correction matrix. Best result so far on I22 opposite.
• Problems with random vibrations elsewhere on beamline preventing improvement on this so far so far.

450µm x 250µm (h x v)

Horizontally currently at 390µm
I24 Optical design

- 6.5 – 25keV energy range
- two stage demagnification
  - secondary source and slit at 42.7 – 44.0m from source
  - microfocus mirrors mounted on 700mm in vacuum translation
  - beam sizes of 5 – 50 µm required at sample position
I24 Prefocusing Mirrors

- FMB Oxford
- VPFM –
  - 600mm
  - 32 electrodes paired using 16 power supplies
- HPFM
  - 1050mm
  - 7 electrodes and 7 power supplies
- 20µm × 48µm secondary source focal spot achieved with calculated elliptical bend but no additional corrections
- Very little work done on microfocus mirrors to date but a 20µm by 20µm beam has been achieved.

**Vertical pre-focus (FWHM is 20µm)**

**Horizontal pre-focus (FWHM is 48µm)**
Summary and Acknowledgements

NEED TO ENSURE REST OF BEAMLINE (AND SOURCE) STABLE AND OPTIMISED BEFORE CAN REALLY TAKE ADVANTAGE OF BIMORPHS.

Liz Duke I02,I03,I04
Chris Nicklin I07
Paul Quinn, Fred Mosselmans I18
Dave Allan I19
Nick Terrill, Marc Malfois I22
Gwyndaf Evans, Armin Wagner I24