Supplemental Material

Spatially-Resolved Elemental Analysis, Spectroscopy and Diffraction at the GSECARS Sector at the Advanced Photon Source

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Number of pages: 6

Number of figures: 4

Number of tables: 1
**Supplemental Fig. S1:** Overview schematic of the GSECARS Sector 13 layout after the canted undulator upgrade. The sector consists of a bending magnet port (13BM) with two stations (13BM-C, 13BM-D) and an insertion device port (13ID) with three stations (13ID-C, 13ID-D, and 13ID-E). The X-ray microprobe station 13ID-E was produced by installing a wall in the existing 13ID-C station. Four stations can operate simultaneously: 13BM-C, 13BM-D, 13ID-E and 13ID-C or D.
**Supplemental Table S1: Overview of Sector 13 Instruments and Techniques**

<table>
<thead>
<tr>
<th>Station</th>
<th>Instrument</th>
<th>Technique</th>
<th>Source</th>
<th>Energy Range (keV)</th>
<th>Monochromator</th>
<th>Max Flux @ 10 keV (photons/sec)</th>
<th>Spot Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-ID-C</td>
<td>General Purpose Diffractometer</td>
<td>Interface scattering, grazing incidence XAFS, Inelastic x-ray scattering</td>
<td>Undulator 1 (3.0 cm)</td>
<td>4-45</td>
<td>DCM Si(111)</td>
<td>1 x 10^{13}</td>
<td>60x20 µm focused</td>
</tr>
<tr>
<td>13-ID-D</td>
<td>Laser-heated Diamond Anvil Cell, Multianvil Press (1000-ton)</td>
<td>DAC: monochromatic diffraction, emission spectroscopy Press: monochromatic &amp; energy dispersive diffraction, radiography</td>
<td>Undulator 1 (3.0 cm)</td>
<td>4-45</td>
<td>DCM Si(111)</td>
<td>1 x 10^{13} unfocused; 1 x 10^{11} focused</td>
<td>3x2 µm focused; 3x1 mm unfocused</td>
</tr>
<tr>
<td>13-ID-D</td>
<td>Laser-heated Diamond Anvil Cell, Multianvil Press (1000-ton)</td>
<td></td>
<td>10-75</td>
<td>DCM Si(311)</td>
<td>2 x 10^{12} unfocused; 2 x 10^{10} focused</td>
<td>3x2 µm focused; 3x1 mm unfocused</td>
<td></td>
</tr>
<tr>
<td>13-ID-E</td>
<td>X-ray Microprobe</td>
<td>Trace element microanalysis, fluorescence microtomography, microXAFS, microdiffraction</td>
<td>Undulator 2 (3.6 cm)</td>
<td>2.4-28</td>
<td>DCM: Si(111)</td>
<td>6 x 10^{12}</td>
<td>1x1 µm focused</td>
</tr>
<tr>
<td>13-ID-E</td>
<td>X-ray Microprobe</td>
<td></td>
<td>5.4-28</td>
<td>DCM: Si(311)</td>
<td>1 x 10^{12}</td>
<td>1x1 µm focused</td>
<td></td>
</tr>
<tr>
<td>13-ID-D</td>
<td>General Purpose Diffractometer</td>
<td>Interface scattering, diamond anvil cell diffraction (single crystal), powder diffraction</td>
<td>Bending Magnet</td>
<td>15</td>
<td>Si(111)</td>
<td>1 x 10^{12} @ 15 keV</td>
<td>23x28 µm focused; 10x3 mm unfocused</td>
</tr>
<tr>
<td>13-ID-D</td>
<td>General Purpose Diffractometer</td>
<td></td>
<td>30</td>
<td>Si(311)</td>
<td>8 x 10^{11} @ 30 keV</td>
<td>26x28 µm focused; 10x3 mm unfocused</td>
<td></td>
</tr>
<tr>
<td>13-ID-D</td>
<td>General Purpose Diffractometer</td>
<td></td>
<td>45</td>
<td>Si(333)</td>
<td>1 x 10^{12} @ 45 keV</td>
<td>26x28 µm focused; 10x3 mm unfocused</td>
<td></td>
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<tr>
<td>13-BM-C</td>
<td>Laser-heated Diamond Anvil Cell, Multianvil Press (250-ton), diamond anvil cell, XAFS</td>
<td>Tomography: absorption &amp; phase-contrast; Press: monochromatic &amp; energy-dispersive diffraction, tomography &amp; radiography; DAC: monochromatic diffraction, Brillouin spectroscopy,</td>
<td>Bending Magnet</td>
<td>4.5-70</td>
<td>DCM Si(111)</td>
<td>1 x 10^{9}</td>
<td>6x12 µm focused; 50x4 mm unfocused</td>
</tr>
<tr>
<td>13-BM-D</td>
<td>Laser-heated Diamond Anvil Cell, Multianvil Press (250-ton), diamond anvil cell, XAFS</td>
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</table>
Supplemental Figure S2: On-axis brilliance for undulators with various periods. GSECARS has U3.0 (purple) installed in the downstream position to supply the high energy branch (13ID-C/D) and U3.6 (similar to U3.55, black) in the upstream position to supply the lower energy branch (13ID-E).
Supplemental Figure S3: X-ray optics layout (not to scale) of the 13ID canted undulator insertion device port. The 13ID XRM uses the upstream, U36 undulator (outboard beam). This beam is monochromatized by a Si(111)/Si(311) cryogenic, fixed offset instrument and then deflected further outboard by 12 mrad using two deflecting mirrors. A shielded pipe carrying the 13ID-C/D beam downstream resides ~300 mm inboard of the XRM beam position within the 13ID-E station.

Mono energy range 2.3-29 keV

Mono energy range 5 - 65 keV and 100 W white beam
Supplemental Figure S4: Comparison of brilliance for the 36mm period undulator currently at 13ID-E (black) with that for a 30mm period undulator and the proposed MBA lattice upgrade to the APS giving the same nominal energy range of 2.3 to 30 keV (blue).