Measurement of the Vertically Focused Beam Profile at 9-ID

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The vertically focussing mirrror (VFM) at the 9-ID CMC-CAT beamline is a 3-stripe (Rh, Ni and Au) mirror on a polished ULE substrate. Together with the horizontal focusing mirror, it forms a Kirkpatrick-Baez configuration, capable of providing a 1:1 image of the source at the experimental hutches, 60 to 80 m downstream from the source. The VFM is situated in the front optical enclosure (FOE), 4 m downstream from the monochromator. The reflecting surface is 600mm (l) by 120 mm (w) and can accept a incident beam height of about 1.4 mm. The bending radius can be varied from ∞ to1.5 km thereby changing the position of the focus.

For a flat mirror, bent to a cylinder, the bending radius (R_m) depends on the image and object distances (F_1 and F_2, respectively) and the angle of incidence of the x-ray beam (q).

$$R_m = \frac{2F_1F_2}{(F_1 + F_2)\sin q}$$

The object distance from the source to the mirror, F_1, is fixed at 34430 mm, while the image distance and incident angle can be varied. For the current set up, the image distance, F_2, was 25570 mm, and q was 2.32 mrad (a maximum incident angle of 4 mrad is possible) giving a bending radius of 12.642 km. This agrees with the gauge curve of bending radius vs bender motor position provided by the manufacturer. Eventually the software will be upgraded so that it will be possible to enter a focal distance and directly have the mirror bender move to the appropriate position.

In order to test the focussing capability of the mirror we set up a 65 µm pinhole in the secondary optical enclosure, 60 m from the source. The pinhole was spark drilled in a 250 µm thick steel plate and was mounted on an X-Y translation stage with a resolution of .0015 mm in the vertical Y direction and .003 mm in the horizontal X direction. A PIN diode detector was used to measure the direct beam flux.

The beam was aligned to reflect off the Rh coating with the angle of incidence set to 2.32 mrad. X-Y profiles were taken with the bender at different settings corresponding to unfocused and focused beams. For the purpose of this characterisation, the beam size was limited to 0.8 mm (v) x 2.1 mm (h) by the white beam slit.

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Figure 1 shows the surface plots of the X-Y profiles for two different bender motor positions, 3000 (unfocused) and 45000 (focused). The significant structure in the unfocused beam appears to result from the inhomogeneous reflectivity of the mirror. This structure however disappears once the beam is focused.

Profiles were also measured for bender positions of 40000 and 45000. The vertical Y profiles for all bender positions are shown in Figure 2. The widths of the peaks

indicate the vertical size of the beam. Two dimensions contribute to the measured vertical size of the beam: the electron vertical source size and the pinhole size. The theoretical vertical source size (FWHM) is 61 µm (http://www.aps.anl.gov/aod/params/params.html), which convoluted with the 65 µm pinhole, gives a vertical beam size of 89 µm. The widths given for the three focused positions were obtained from gaussian plus polynomial fits to the data. From these we see that the smallest convoluted beam size obtained was 112 µm which corresponds to an incident beam size of 91 µm. Also note that the beam position moves vertically by 0.4 mm between focused and unfocused conditions. This is probably due to the beam not being centered vertically on the mirror.

Figure 1: Surface X-Yprofiles for VFM bender positions of (a) 3000 and (b) 45000.

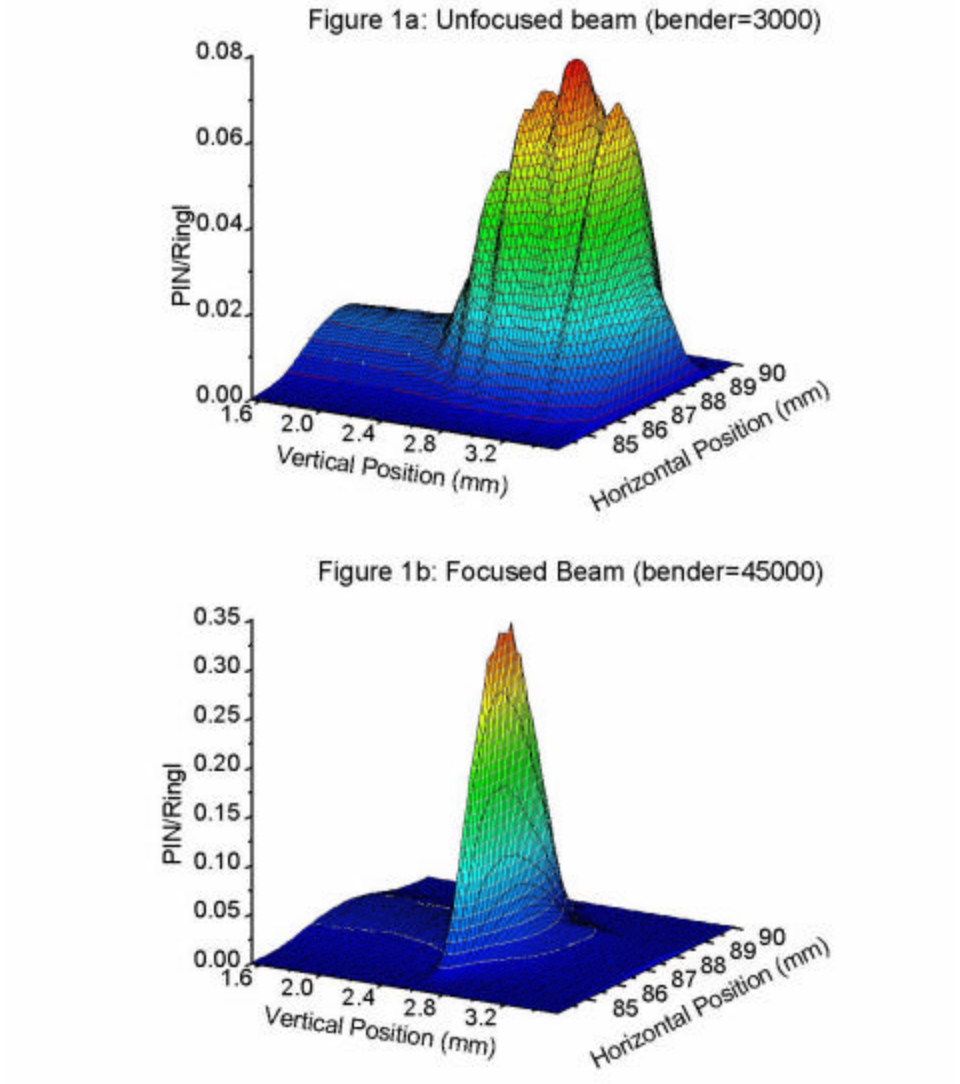

Figure 2: Y-scans for different positions of the bender.