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# A Kirkpatrick-Baez Microscope for the National Ignition Facility

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The expected resolution across the FOV is shown in Fig. 3 as a solid line, and it is seen the measured FWHM of the bar-hole interface matches well to this prediction. The measurements have had the diffraction contribution from the source subtracted in quadrature to estimate the expected operation of the optic at 10.2keV where diffraction is negligible.

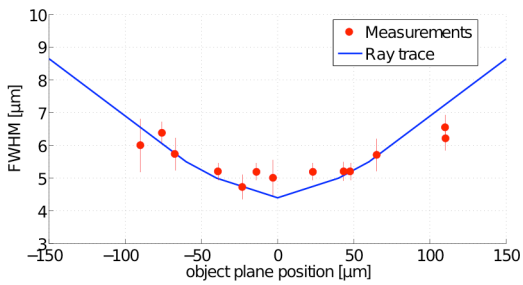


FIG. 3. FWHM measurements across the FOV shown in Fig. 2b plotted against the expected resolution determined from geometric ray tracing.

It is found the optic achieves < 7µm (FWHM) resolution across a 200µm field of view meeting the requirements for ICF imaging. The KBM resolution is dominated by the effect of coma aberration, which varies linearly across the FOV and is proportional the object-mirror distance and the length of the mirror that is illuminated. The domination of coma in the resolution across the FOV allows the pointing of the diagnostic to the object to be decoupled from the optimum optical axis of the optic. In this manner the following section will describe a modification of the x ray set-up to allow the center of the FOV for each channel in a mirror pack to be found and corrected on the CMM such that they intersect.

## III. SYSTEM FOR ALIGNING THE MIRROR PACK

Fig. 4a shows a schematic optical set up for the KBM mirror pack, shown in Fig. 1, allowing individual channel alignment to be determined through measurement of coma to assess the pointing of the 4 channels with respect to each other. Due to the physical size of the mirrors the channels must be set apart from each other, which means the line of sight each channel has through the grid to the source is different and separated by a parallax angle (θ~44mrad). A finder grid with a pattern designed such that each 300µm illumination is unique, is mounted so that it is translatable under vacuum. The grid is then positioned with its center (which contains a fine resolution pattern of 15µm bar width and 30µm periodicity, Fig. 4b) in the optimum resolution region for the first channel. This is determined by measuring the resolution across the FOV as shown in Fig. 4c where the coma aberration dominated resolution is fit for each mirror axis and the intersection of the minima in each plane gives the translation required on the grid to correct the channel pointing so that the center of the FOV intersects the center of the finder grid.

The source can then be translated without moving the grid to illuminate the view of the second (the 3rd, then 4th) channel where a similar measurement of resolution, gives the offset in pointing from the first channel with a ~10µm accuracy to the center of the finder grid. This will inform a correction to the channel positioning which will be performed on the CMM. In addition the final position of the image from each channel at the CCD can be observed. Once aligned each channels FOV will overlap the direct line of sight through the mirror pack axis, allowing the 4 channels to be pointed using the NIF alignment systems.

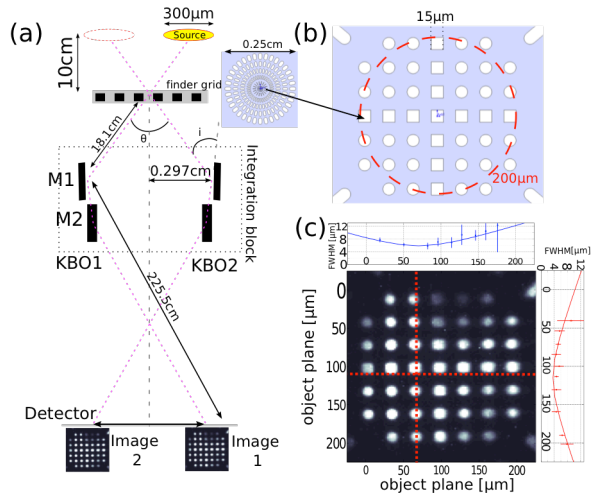


FIG. 4. (a) Optical set up to allow pointing for each channel to be determined using a 300µm translatable source and movable finder grid. (b) Fine resolution region of finder grid. (c) Image for single channel showing determination of the optical axis from coma aberration for each mirror, indicated by the intersection of the dashed lines on the image, marking the pointing of the optic to the finder grid.

In conclusion, a KBM system has been designed and tested for deployment on NIF and has shown to have resolution of <7µm (FWHM) across a 200µm field of view. The domination of coma aberration in the system allows a novel alignment scheme to test the precision assembly of the optic on a CMM and assure alignment of the 4 KBM channels on NIF when fielded for ICF experiments.

## ACKNOWLEDGMENTS

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