Lobster eye: Data processing from two 1D modules

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Introduction

Precise X-Ray telescopes usually have Wolter type optics. Their disadvantage is narrow field of view – up to 1 deg. Another type of X-Ray optics is Lobster Eye (LE). It has wider field of view (up to 360 deg.) suitable for all sky monitoring. Lobster Eye optics can have different arrangements - Angel‘s or Schmidt‘s (two-dimensional) or it is possible to have only one-dimensional optics. Single 1D optics cannot display real image, only line focus. Mathematical combination of two 1D images – taken perpendicular to each other, can be reconstructed 2D image, same as by 2D optics in Schmidt’s arrangement. Two 1D modules have advantage in increased energy gain. X-Ray optics work on reflection principle, Schmidt’s, Angel’s or Wolter arrangement have 2 reflection which cause attenuation of the beam. 1D optics have only one reflection, so there is better gain (lower loss in reflections) and are more suitable for lower intensive sources.

Image reconstruction on generated data

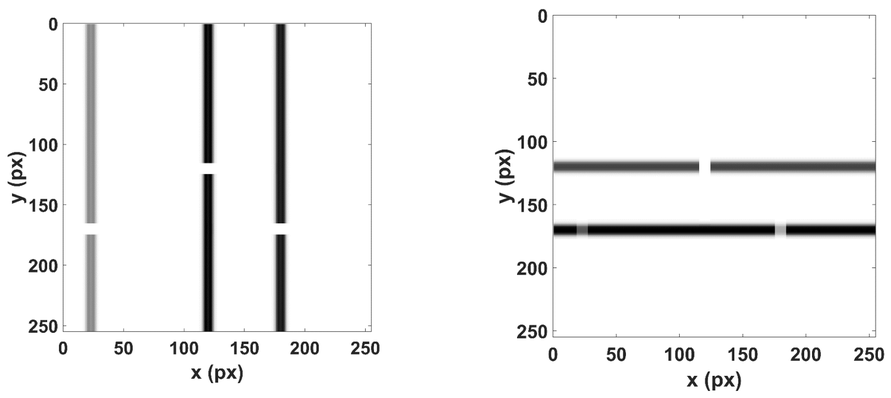

Fig. 3: Generated 1D images for vertical module (left) and for horizontal module (right) with three sources.

Images in Fig. 3 are generated for three X-ray sources with different intensity. Two of them are place on the same y position. The sources generate shade on the detector from the mask. Based on this property, it is possible to determine their direction and position on the detector.

Subsequent mathematical processing achieve the right position of the sources as in Fig. 4, not the intesity.

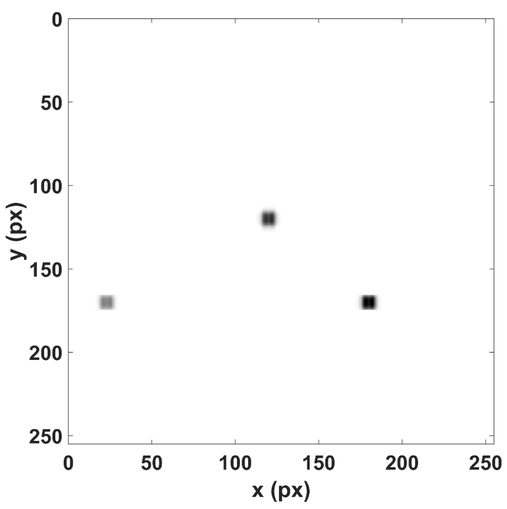

Fig. 4: Resulting 2D reconstruction from two 1D modules

Two 1D optics

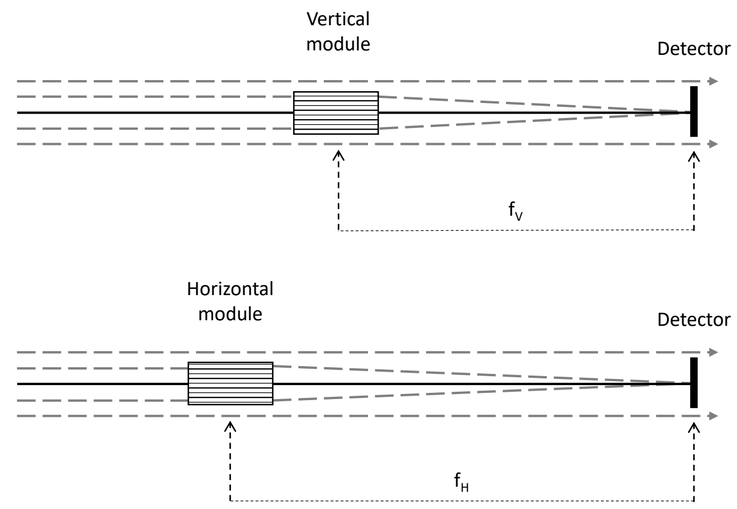

Fig. 1: Two independent 1D LE optics

In picture Fig. 1 is illustration of two independent 1D Lobster eye modules with two independent detectors. In case of two 1D optics, the focus length can be same, for horizontal and vertical module, but advantage in different focal length is that modules can be put side by side and then can be used as an 2D optics. Parameters of used optics are following:

f_V = 960 mm
f_H = 1190 mm

In front of both optics is placed shade, in Fig. 2.

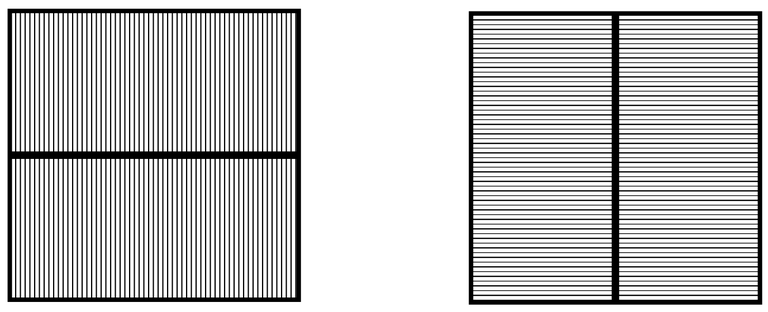

Fig. 2: Schematic of input aperture for vertical module (left) and for horizontal module (right) with a mask

Detector

Simulations were made for a Timepix detector which have resolution 256x256 pixels and is sensitive in energy range from 3 keV to 30 keV in combination with these Lobster eye optics.

Conclusion

This poster present how to determine position of the X-ray sources from two 1D images. They are only simulations, how to do it. Next step is to apply this method to the real measured data and improve detection algorithm.

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