Lobster Eye Optics Point Spread Function and Sensitivity

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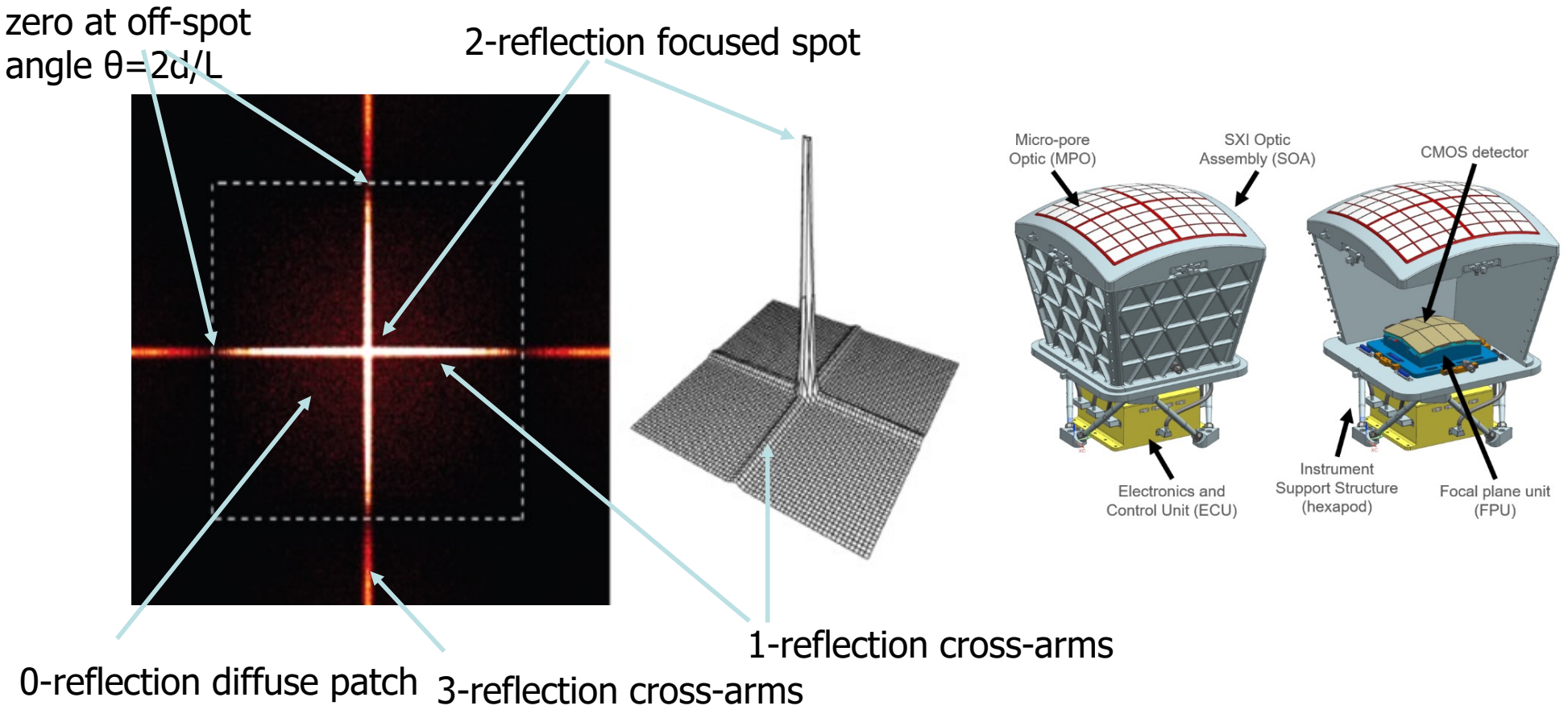
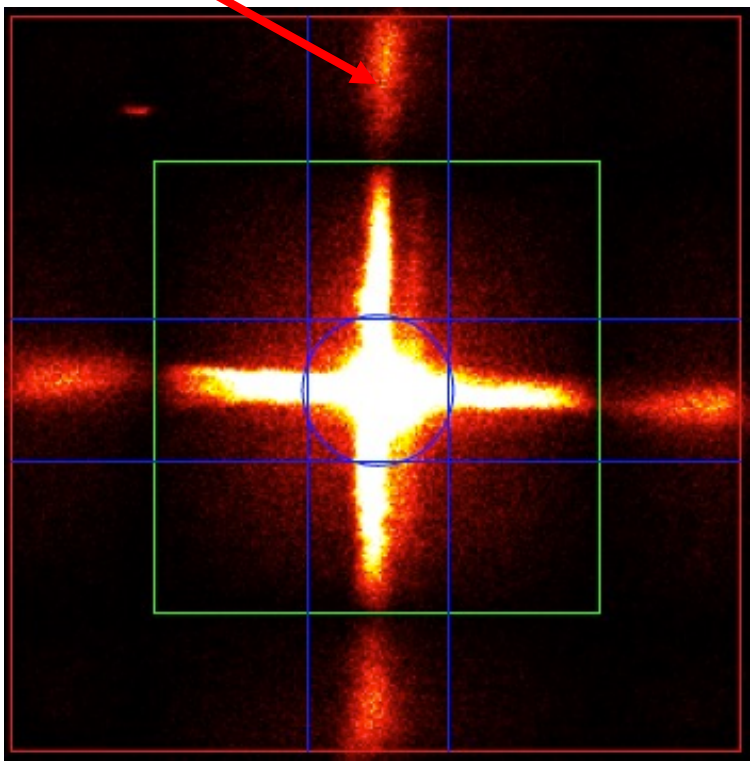
Components of the PSF

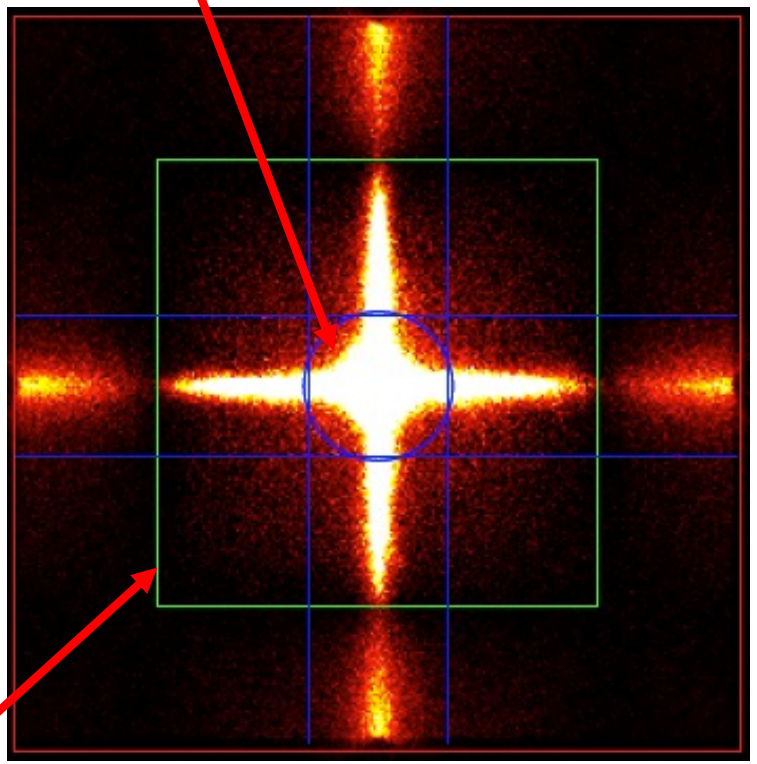


Measured PSF of MPO at 1.49 keV

3-reflection flux seen outside 2H x 2H square – shows reflection efficiency is high

Circular beam contains areas with low source flux dominated by background





X-ray data – Leicester TTF

Simulated PSF – ray tracing

Green square size 2H x 2H used for analysis of cross-beam – defines the full effective area.

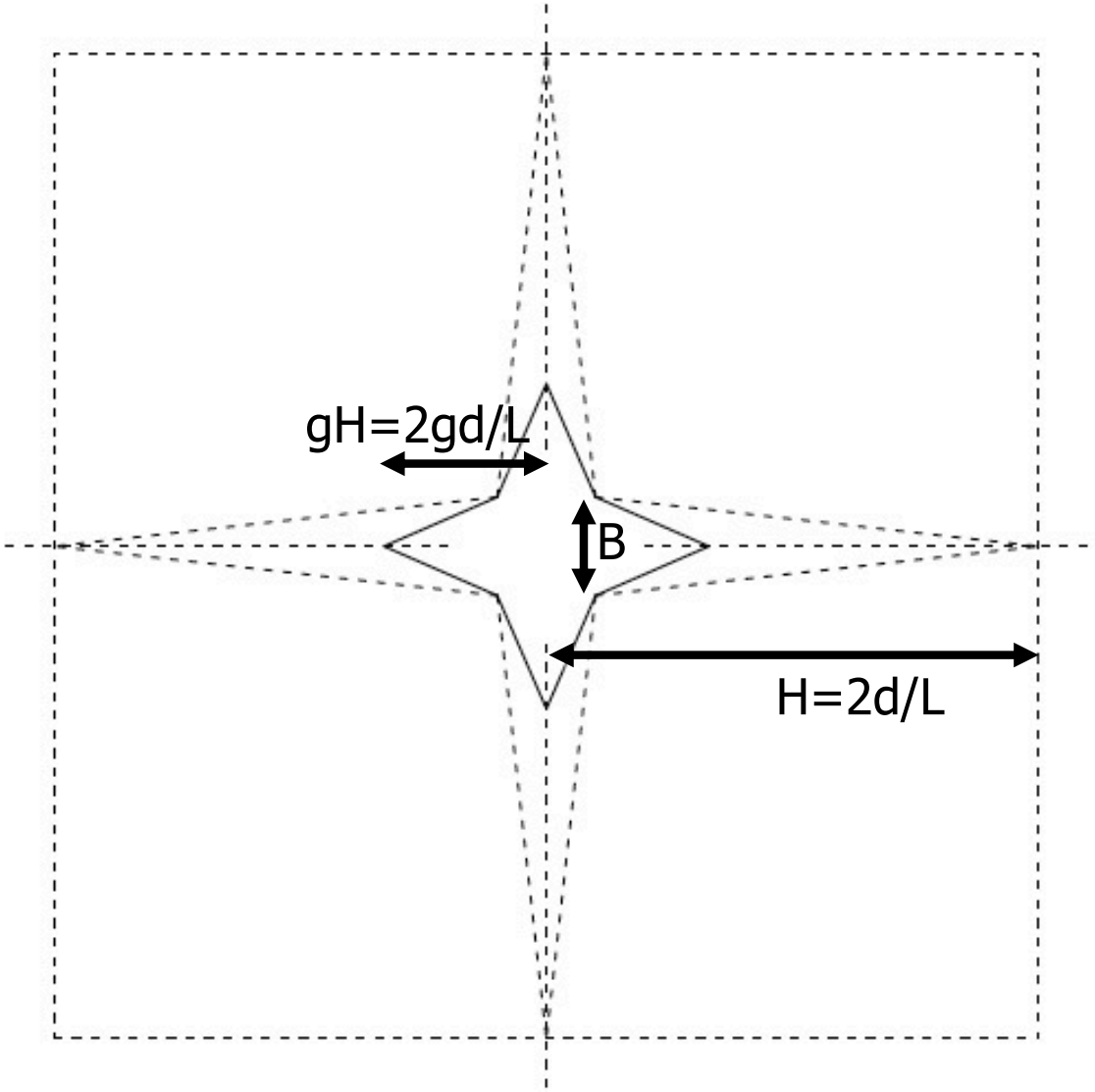
Maximise instrument sensivity

- Don’t use a circular beam in calculations
- Construct a mathematical model which represents the PSF accurately – check using detailed ray-tracing (and real data!)
- This allows for minimum background under source PSF

- See if changing the PSF fraction used increases sensitivity as a function of exposure time
- NB Need something practical to use on-board (can be more computationally demanding on-ground)

- Also need to allow for the frame (shadowing) – causes small sensitivity fluctuations across the FOV (cf vignetting). Allow for this in the instrument “sensitivity” by using a weighted mean

Lobster Eye Cross-beam



A conventional circular (or square) beam is not a good match to the PSF shape

Instead we define a cross-beam

Adjust B and g so that cross-beam contains 50% of detected flux from source and the sky area of the beam is a minimum

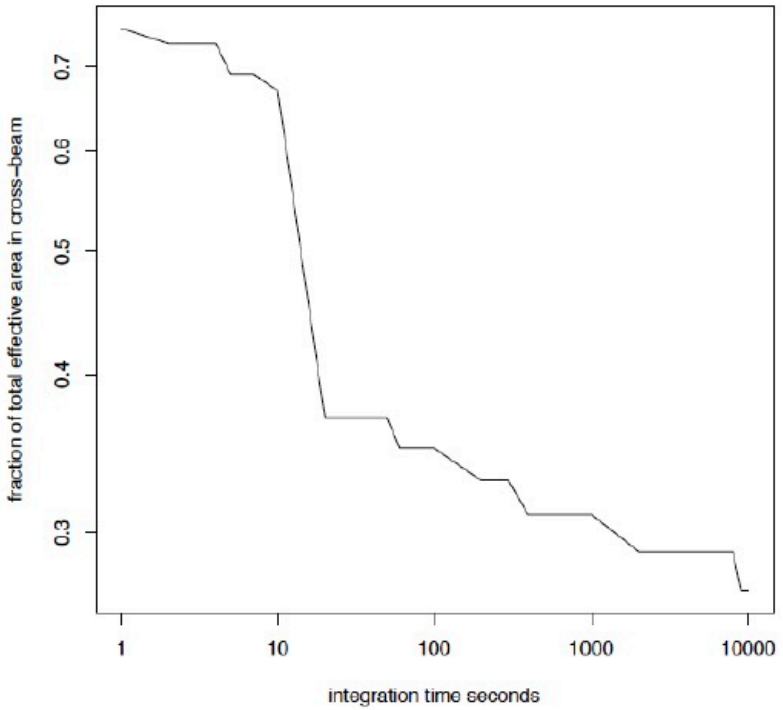
g≈0.333 independent of B

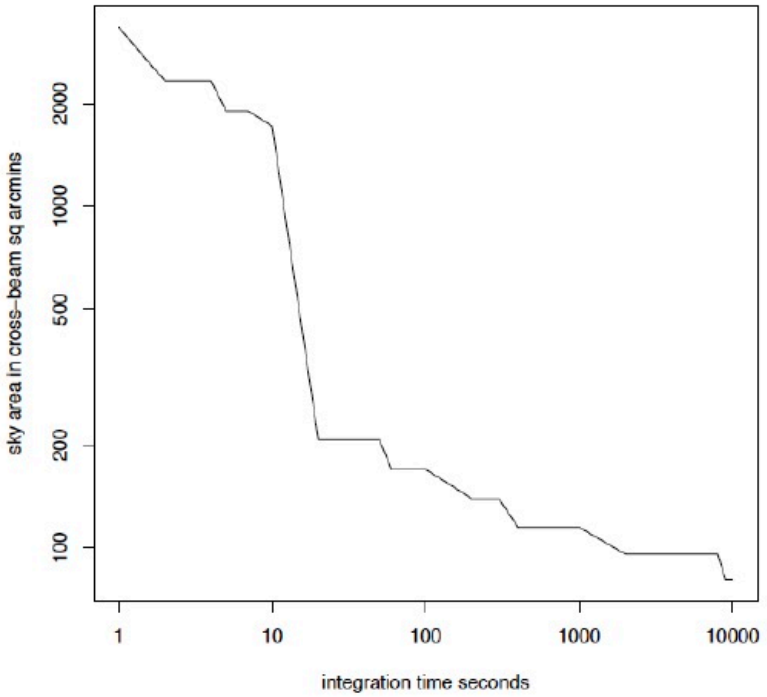
B is a measure of the Half Energy Width of the PSF

B_{HEW} is a robust measure of the angular resolution

Example calculation

Optimum Area Fraction and Sky Area





Example calculation

1 seconds
0.75% area
3343 sq arcmins

5 seconds
0.69% area
1901 sq arcmins

10 seconds
0.67% area
1715 sq arcmins

30 seconds
0.37% area
207 sq arcmins

100 seconds
0.35% area
170 sq arcmins

1000 seconds
0.31% area
115 sq arcmins

Future work

- Revisit and improve work done previously for THESEUS
- Allow for X-ray sky and detector background
- Need to optomise trigger design (we have ideas but this needs more simulations)
- To maximise the trigger rate may involve a multi-stage process on-board (e.g. low S/N 1D histogram search + higher S/N 2D PSF pattern match). This may also be exposure time dependent.
- Are there better ways to do triggers on-ground (all the photons are sent down)