UVIT Detector's Distortions

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Distortions ..

- Necessary for good astrometry
- Two parts
  - Optics
  - Distortions in the Detector

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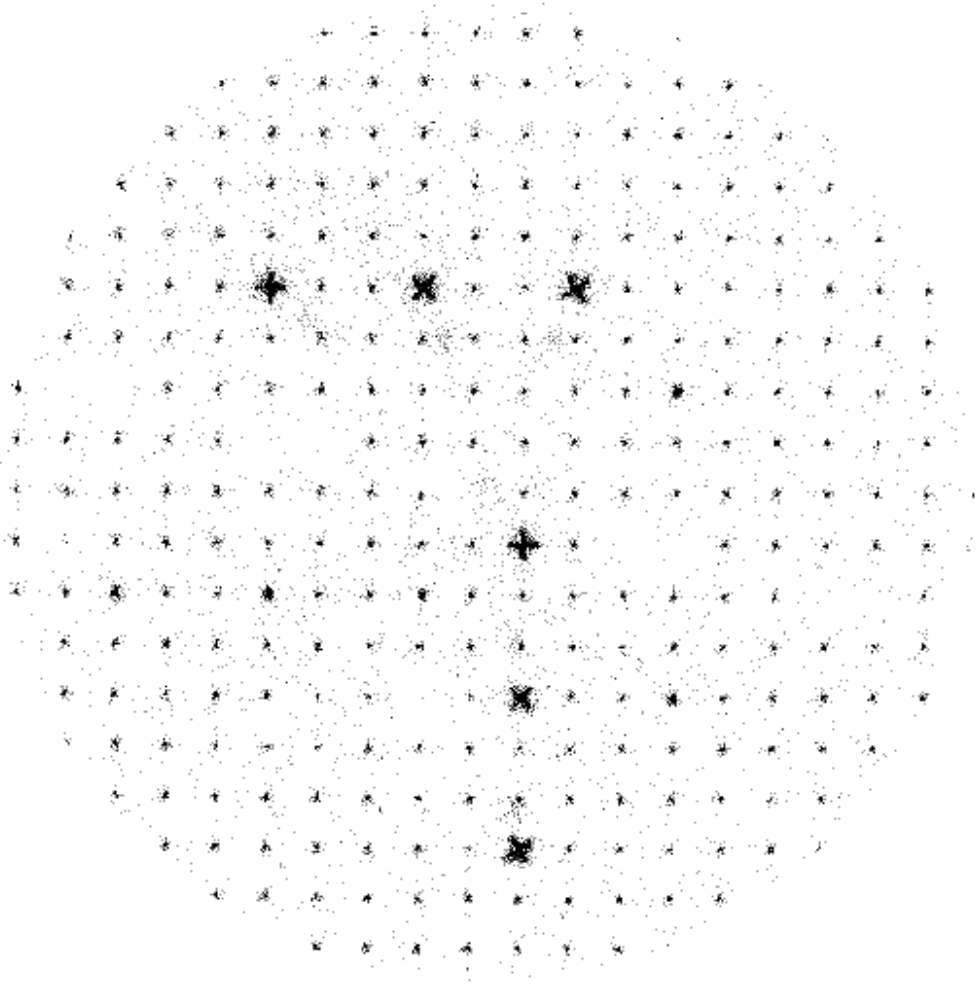
- Two parts
  - Optics
    Zemax simulations
  - Distortions in the Detector
    Imperfections in Fiber-taper construction

Observations



Mask pattern with regular grid of pin-holes

- daofind + 2d gaussians
- multiple detections removed manually
  larger & un-even holes removed

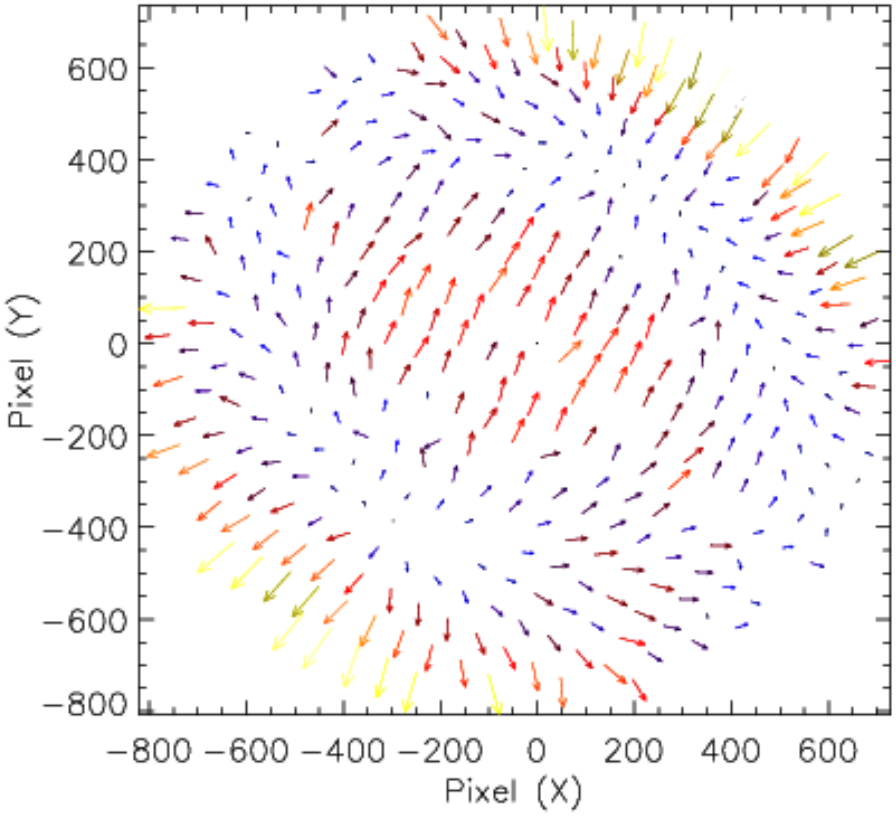
Mask Pattern

- Can differ from expected regular pattern in fabrication
- Actual positions of the pattern is needed

- The mask imaged at IUCAA with IFOSC Spectrometer
- IFOSC spectrometer need two correction

1. Wedge effect:
   Angle between focal plane and CCD Exposure in two rotations
2. Radial Distortion :
   By simulating optics in Zemax

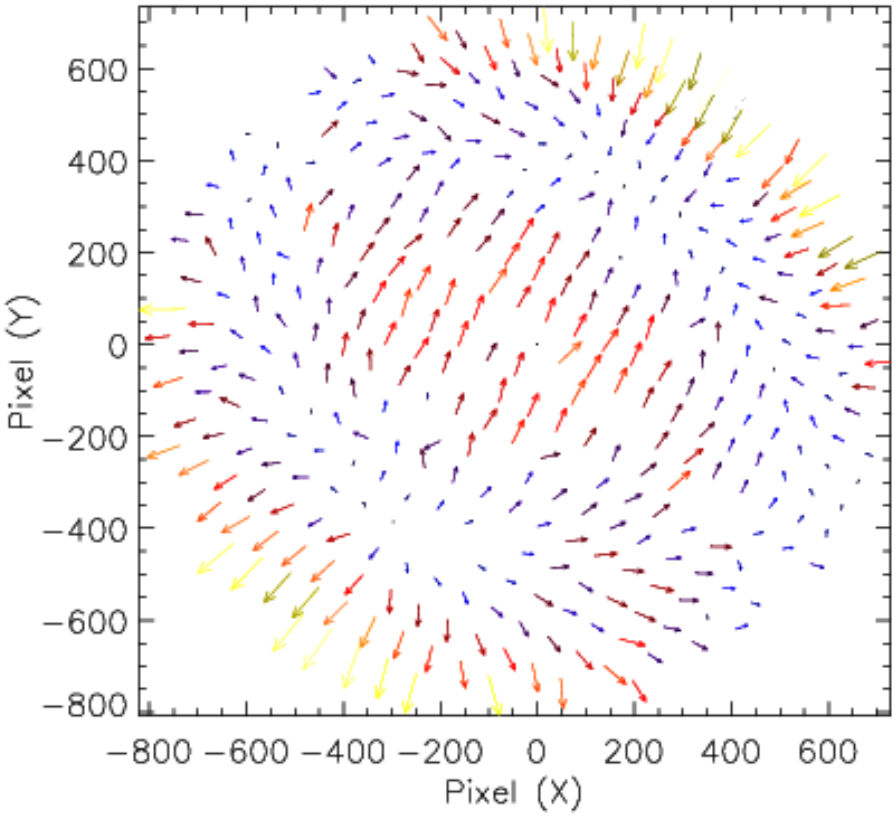
Mask Pattern Corrections

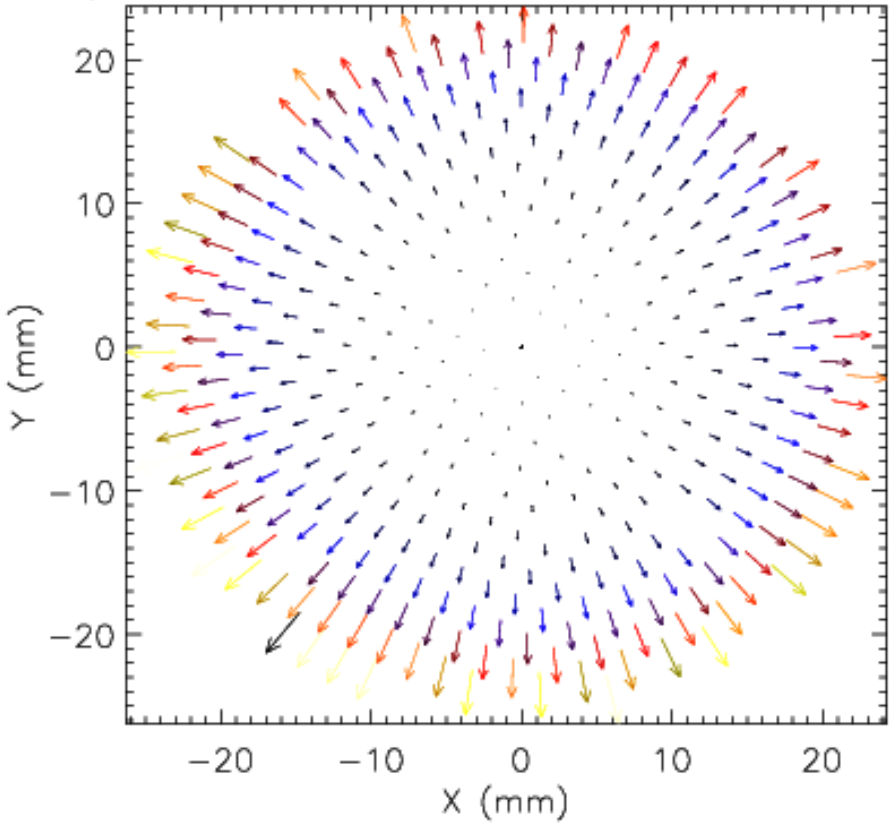


<0.05	0.05-0.1	0.1-0.15	0.15-0.2
253	188	45	17

in pixel

Mask Pattern Corrections





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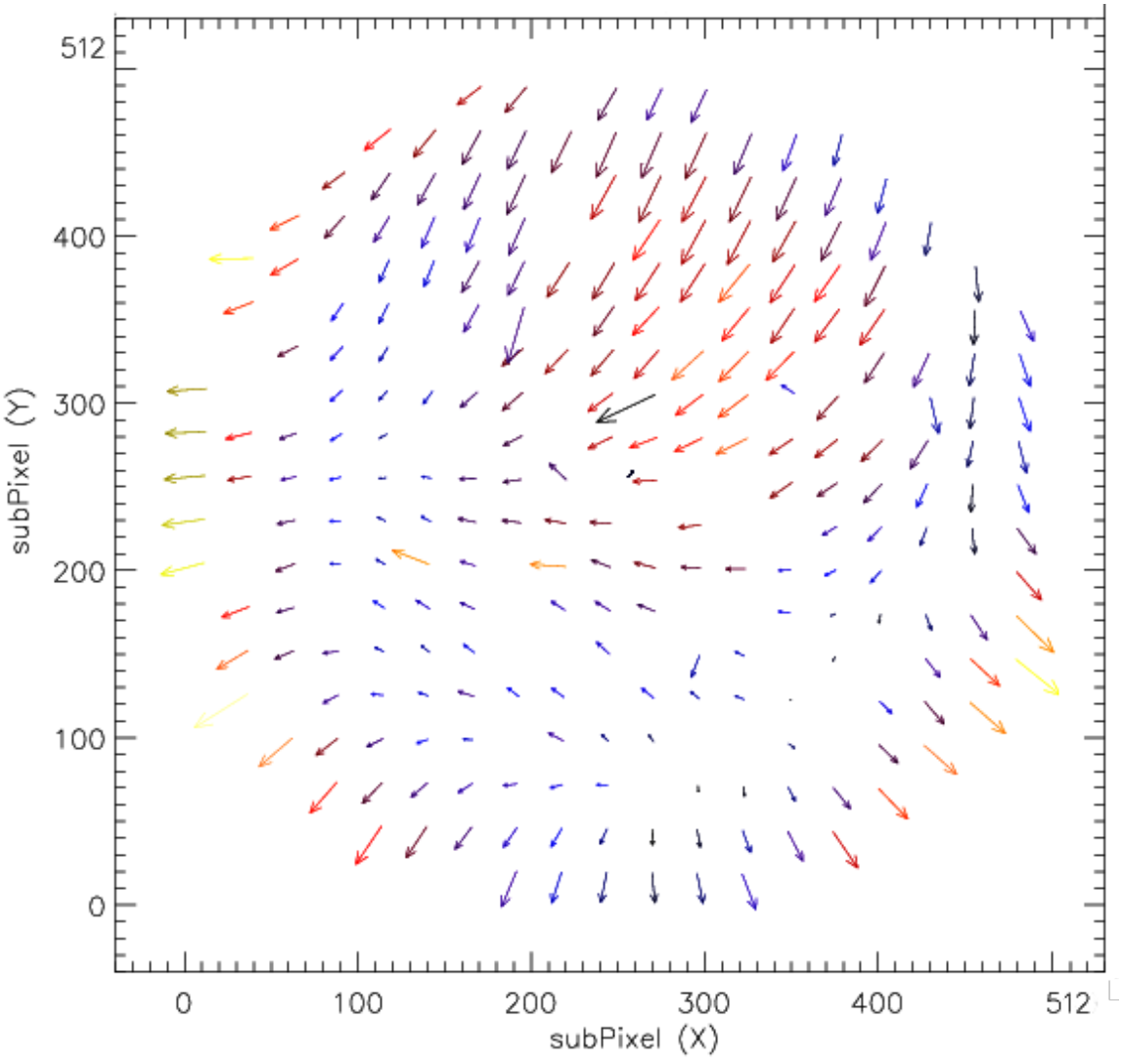
in pixel

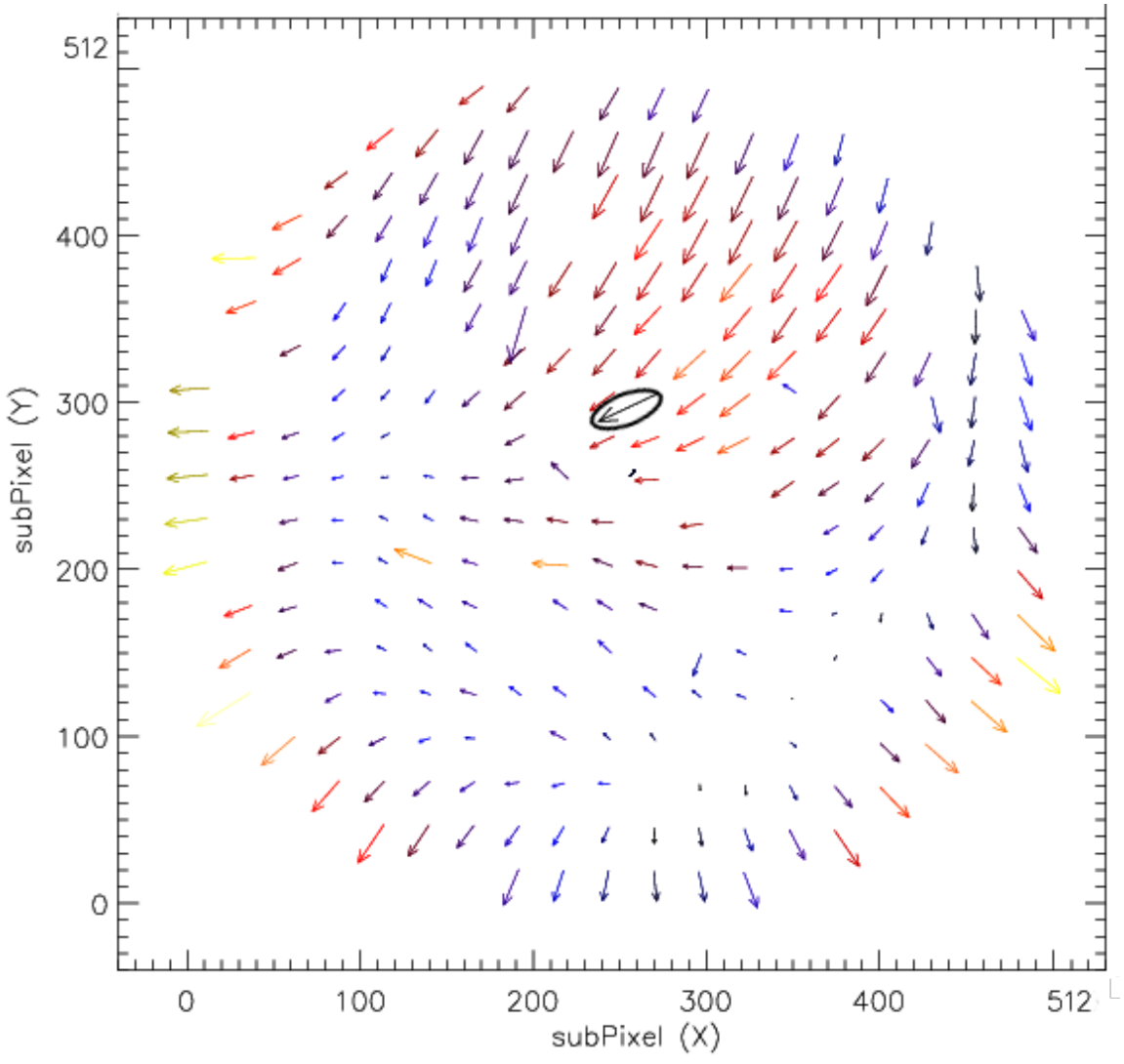
<10 (μm)	10-20	20-30	30-40	40-50
132	94	77	58	20

<1 (pix)	1-2	2-3	3-4
169	115	79	18

UVIT CPU Distortion Estimation



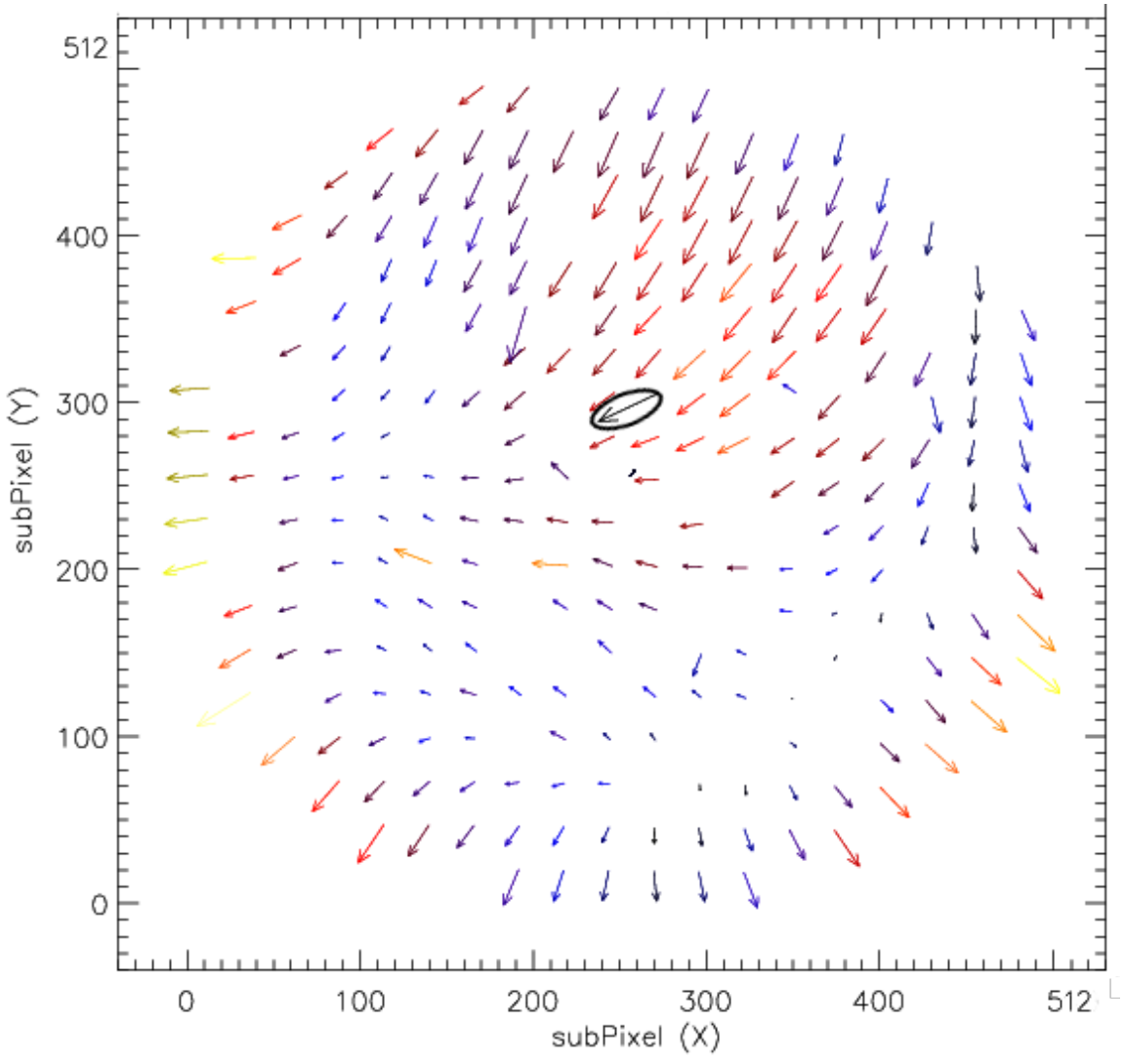
UVIT CPU Distortion Estimation



Range (pix)	N
< 0.5	29
0.5-1.0	64
1.0-1.5	64
1.5-2.0	60
2.0-2.5	19
2.5-3.0	3

Max Distortion: 2.89 pix (star250)

UVIT CPU Distortion Estimation



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Thanks

Radial Distortion Correction

The distortion of the IFOSC optics is given by

$$r' = r * 2.244/5 + r^2 * (0.010/625) + r^4 * (0.016/(625 * 625))$$

where, 'r'' is the radius from centre of the CCD in "mm" and "r" is the radius on the object plane in "mm".

The correction for the distortion and the magnification is:

$$\frac{2.244}{5} r = r' - \left(\frac{5}{2.244} r'\right)^2 \times \frac{0.010}{625} - \left(\frac{5}{2.224} r'\right)^4 \times \frac{0.016}{(625 * 625)}$$

Rotation and Offset Estimation

$$(x_i', y_i') = (g[x_i \cos\theta - y_i \sin\theta] - x_0, g[x_i \sin\theta - y_i \cos\theta] - y_0)$$

Minimize the distance between center position and translated positions, $f(g, \theta, x_0, y_0)$,

$$= \sum_i [x_i' - g(x_i \cos\theta - y_i \sin\theta) - x_0]^2 + [y_i' - g(x_i \sin\theta - y_i \cos\theta)$$

For $\theta \sim 0$, $\sin\theta = 0$ and $\cos\theta = 1$ and g $= 1$

$$f(x_0, y_0) = \sum_i [x_i' - (x_i - y_i\theta) - x_0]^2 + [y_i' - (x_i\theta - y_i) - y_0]^2$$