The ISOCAM field-of-view distortion correction.

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We describe results from new re-analysis of the the ISOCAM field-of-view distortion. We comapre 450 cluster and other high stellar density fields with the Two Micron All Sky Survey (2MASS) to derive new estimates for the ISOCAM field-of-view distortions. The inclusion of the 2MASS catalog allows us to efficiently compute the distortion correction for over 4000 stars. The focus is to provie more accurate estimates for ISOCAM astrometry and all subsequent processing steps (ie mosaick creation, flux calibration, flat-field, etc. We define the distortion as any departure from an ideal detector. The idea detector is described completely by the CDELTn, CRPIXn, CRVALn, and the CROTA2 FITS keywords on a tangential projection. We model the distortions as a 3^{rd} order polynomial with cross-terms. In this contribution we describe the procedure for determining the distortion, the implentation and resulting effects on the ISOCAM astrometric measurements, mosaicking and flux calibration with vivid color illustrations.

MOTIVATIONS:

The main motivations for more accurate distortion corrections are:

1. Improved Astrometry. Given the large PFOV of ISO, accurate astrometry from ISOCAM images is crucial for follow-up work, as well as for high confidence in cross-identification.

2. Improved Mosaicking. If the distortions are not properly accounted for, the final mosaicked image will further distort the mosaicked image by smearing the sources.

3. Flux Calibration. The flat-field introduces flux calibration errors when no distortion correction is applied.

INPUT DATA:

A). ISO

450 Clusters containing ~6000 individual sources. The sources are distributed uniformly over the detector and range in Signal-to-Noise Ratio (SNR) from 5 to ~100.

The so-called "ghost" datasets. The "ghost" datasets were obtained by moving the star in a rectangular grid (usually 9x9) on the detector array.

B). 2MASS

The ISOCAM data (above) were selected from a larger sample by using only the positions for which 2MASS data (images and catalogs) were available.

SOURCES OF OPTICAL DISTORTION:

* Pin-cushion from ISOCAM optics. Abberations in the optical system of ISOCAM results in a pin-cushion distortion.
* Magnification. The ISOCAM filters magnify the image.
* Tilt of the detector plane with respect to the optical axis.

DEFINITION OF DISTORTION:

For our purposes, we define distortion as deviations from an ideal detector -- one with constant PFOV in both directions. Alternatively, the ideal detector is one which is described by the standard FITS header. Note that for small areas on the sky, the effects of spherical geometry can be ignored.

MODELLING THE DISTORTION:

For each detector axis, the relationship between distorted and undistorted co-ordinate value is described by a 3rd order polynomial with cross-terms. This approach is similar to one adopted for the HST. However, unlike HST, we shift the origin to the center of the array. With this as origin the first two terms of the polynomials can now be interpreted as physical quantities (see below).

PROCEDURE:

* Measure observed positions
* Match these to 2MASS sources. The 2MASS survey was selected over POSS2 for two main reasons. 2MASS has a point source catalog, and many of the stars observed in ISO are also observed with 2MASS.
* Predict the co-ordinates of the sources from the ISOCAM header.
* The difference between predicted and observed (2MASS) co-ordinates is the distortion (see definition of distortion).
* Fit it with the model described below.

CAVEATS AND ASSUMPTIONS:

* The accuracy of the PSF fitting procedure is observed to depend on the source signal. The magnitude of this error is derived from simulations.

* We assume that the wheel jitter can be modeled independently as an offset on top of a global distortion pattern. We tested this by comparing distortion pattern derived from the so-called ``left'' and ``right'' positions. At the edges the pattern differed by approximately 0.5 pixels.

RESULTS:

* The results from 4 filters (LW1, LW2, LW3, LW10) were used to calibrate the optical distortion model of Koryo Okumura (see Okumura's contribution in this meeting).

* Based on the (above) calibration, we have derived forward (correction direction) and backward (generation direction) distortion coefficients for all ISOCAM filters.

* A typical distortion pattern is shown in Figure 1.

* Our method yields distortion correction which are accurate to ~0.1 pixel (1-sigma) when the amount of wheel jitter is previously known. If no jitter correction is available, the error is roughly 1 ISOCAM pixel.

* The PFOV of ISOCAM deviates by up to 6% from the nominal adopted PFOV values. By correcting for this effect, relative offsets are more accurately determined.

* Figure 2 shows a comparison between the distorted and distortion corrected mosaic. The improvements are clearly visible.

HOW TO APPLY DISTORTION CORRECTION:

* CIA 5.0 will contain automatic routines for applying distortion corrections. Figure 3 shows the widget currently being implemented in CIA 5.0.

Figure 1: A typical ISOCAM distortion pattern. The solid line shows the distorted postions relative to the undistorted (dotted line) position. The pattern is shown without a zero-point offset. The magnitude of the distortion is ~1 pixel towards the edges of the array.

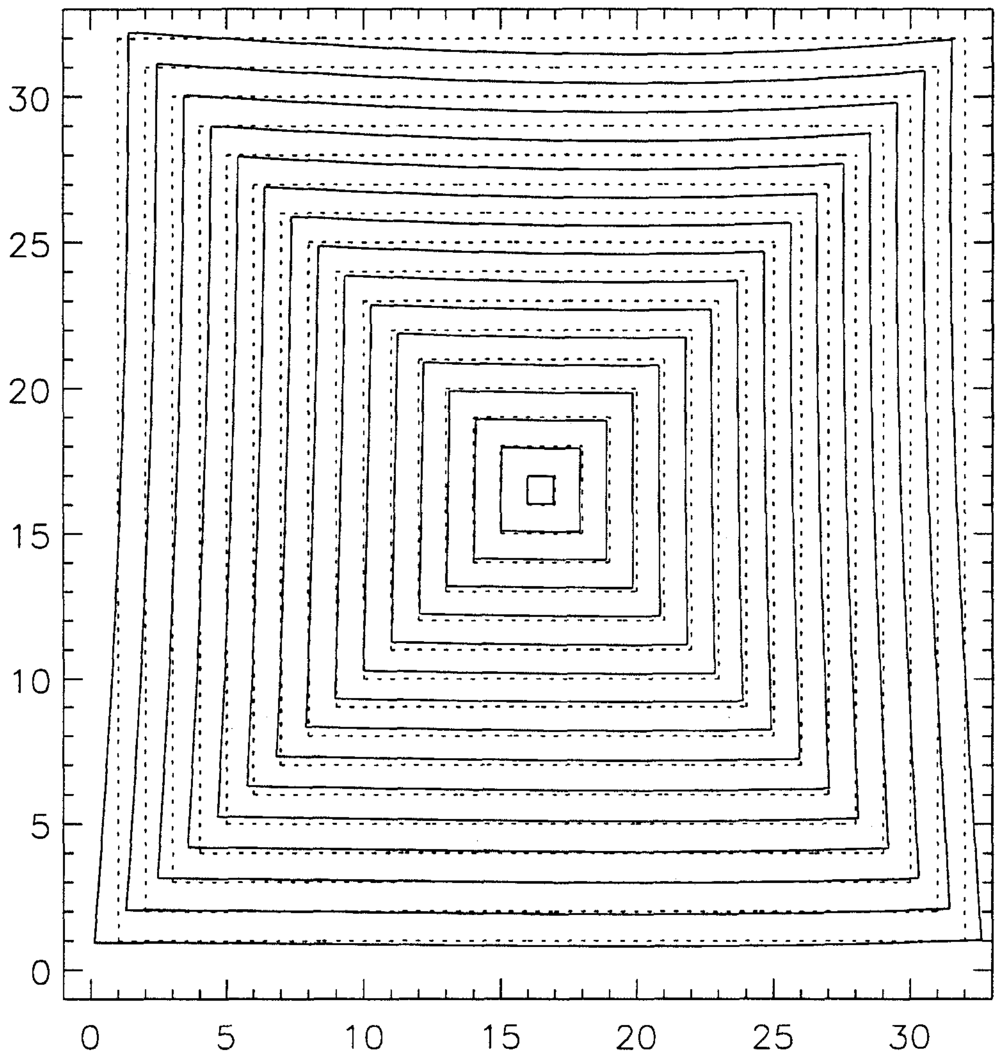
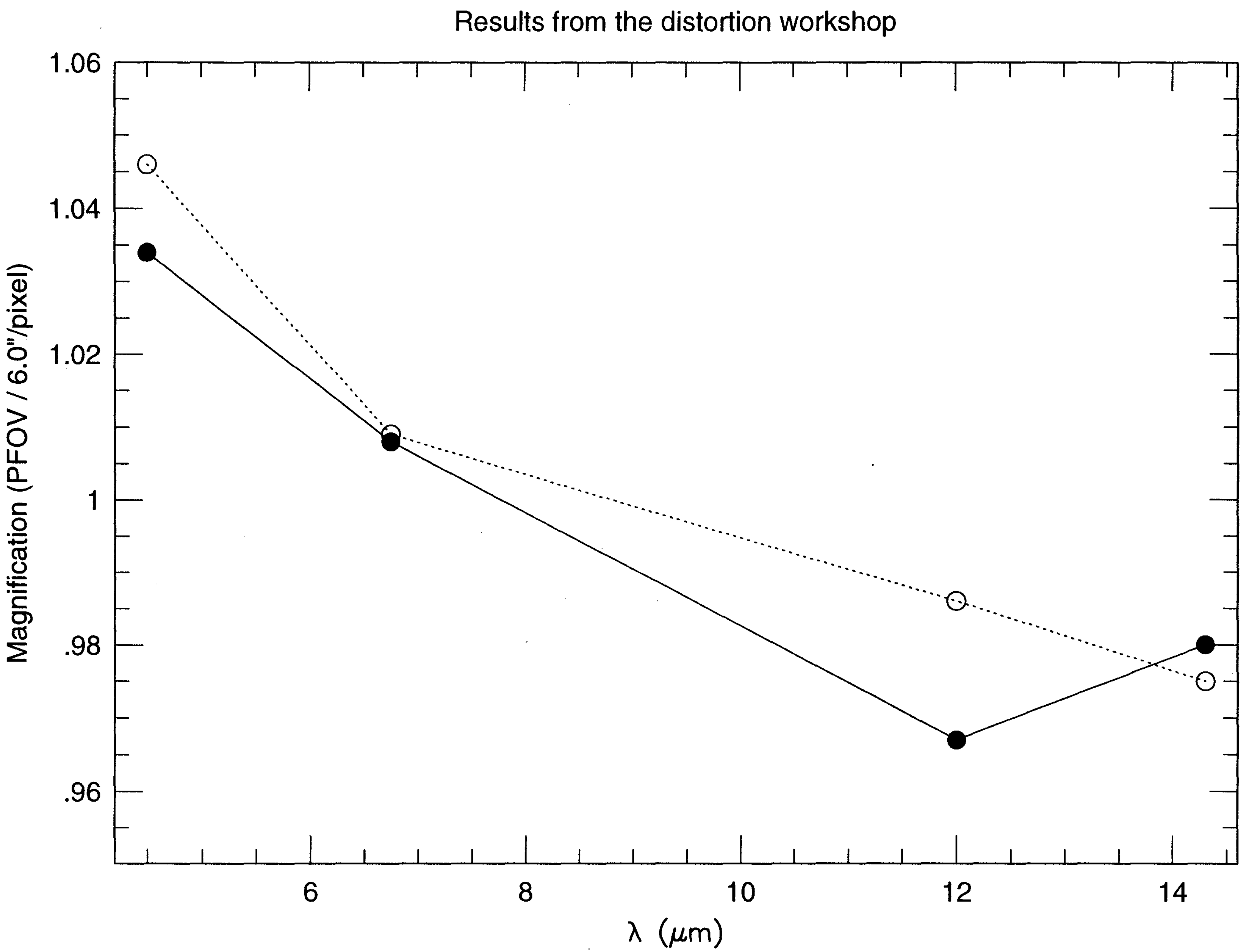


Fig. 1.— A typical distortion patter in the correction direction and no zero point offset.

Figure 2: The ISOCAM PFOV as a function of wavelength (filter). There are clear deviations between the nominal (6.0 arc-second/pix) and the observed PFOV. These deviations become significant noise contributor for mosaicking and astrometry procedures.


Results from the distortion workshop
Magnification (PFOV / 6.0"/pixel)
λ (μm)
1.06
1.04
1.02
1
.98
.96
6
8
10
12
14