WFC3/UVIS Filter Dependence of Geometric Distortions

Catherine A. Martlin[1], Vera Kozhurina-Platais[1], Myles Mckay[1], Elena Sabbi[1].
[1]Space Telescope Science Institute.

Abstract

The *WFC3/UVIS* filter wheel contains a multitude of filters that cover a large range of wavelengths from far ultraviolet to the infrared. Previously, studies were completed on the most used *UVIS* filters to examine astrometric irregularities caused by image distortions due to the optical assembly of HST and variabilities in the composition of individual filters due to their manufacturing process. We report recent updates to reference files of an additional 22 *UVIS* filters following further investigation into the large-scale filter-distinct geometric distortions and fine-scale filter-dependent distortions. **Furthermore, we present results on which solutions were created as well as results of a study on a selection of unique polynomial coefficient terms to better investigate these systematic filter-dependent patterns.**

These updates will provide important enhancements for ***HST/WFC3*** users as they allow more accurate alignment of images to aid in obtaining high precision astrometry results across the range of ***UVIS*** filters.

Motivation

There are three reference files that can be applied to UVIS/WFC3 data to aid in correcting for geometric distortions caused by:

(1) the lithographic pattern caused by the manufacturing of the CCD[2],
(2) the unique manufacturing of the individual filters[4], and
(3) the optical assembly of the Hubble telescope system[1].

Previously, the majority of the 63 UVIS filters used the Instrument Distortion Coefficient (IDCTAB) solution derived for F606W in place of individual solutions to correct for the large scale distortions caused by the optical assembly.

14 UVIS filters were first updated and those individual solutions decreased astrometric errors to a level of 1.0 mas or 0.02 pixels[1]. As seen in the upper right plots, many filters still had large residuals when using the F606W solution. Therefore, another 22 filters were updated and the differences in their individual solutions were studied as seen in the plots on the lower right.

Reference File Updates

We published updates to the following UVIS filters in the Instrument Distortion Coefficient Table (**IDCTAB**) and delivered individual **NPOLFILE** correction files for each filter as well:

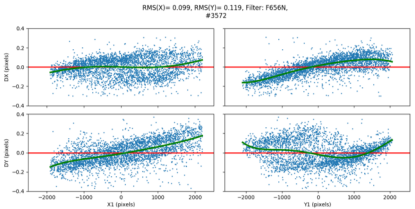
F280N, F343N, F373N, F390M, F395N, F410M, F467M, F469N, F487N, F502N, F547M, F631N, F645N, F656N, F658N, F665N, F673N, F680N, F689M, F763M, and F845M.

The precision of these reference files is integral, along with the **D2IMFILE**, in the *Drizzlepac* software for combining dithered WFC3/UVIS images to enhance the spatial resolution and detection limit necessary for precision astrometry[1].

The 22 new geometric coefficient solutions and 2D look-up tables were solved for using observations of Omega Cen from Calibration Proposal 14393. The same solution methods were used as published in ISR 2009-33 (Kozhurina-Platais, V, et. al), ISR 2014-12 (Kozhurina-Platais, V) and will be published on in Martlin, et al (in progress).

References

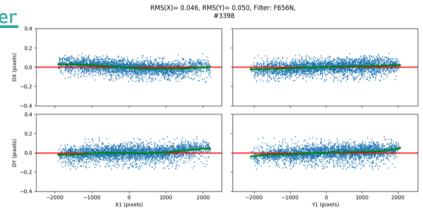
1. Kozhurina-Platais, V. "Astrometric Correction for WFC3/UVIS Filter-Dependent Component of Distortion". ISR 2014-12.
2. Kozhurina-Platais, V, et al. "Astrometric Correction for WFC3/UVIS Lithographic-Mask Pattern". ISR 2013-14
3. Kozhurina-Platais, V., et al. "WFC3 SMOV Proposal 11444 – UVIS Geometric Distortion Calibration.". ISR 2009-33.
4. Sabbi, E. "UVIS Filter Wedge Check". ISR 2012-001.



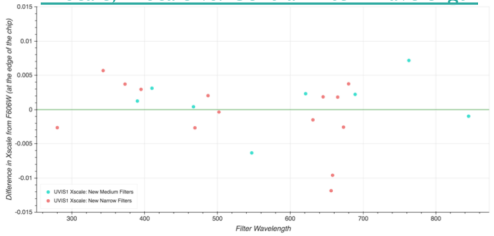
F656N Individual Solution: Before and After

Left: TWEAKREG solution residuals from matching a F656N UVIS image of Omega Cen to a F606W image using the F606W geometric solutions for both filters.

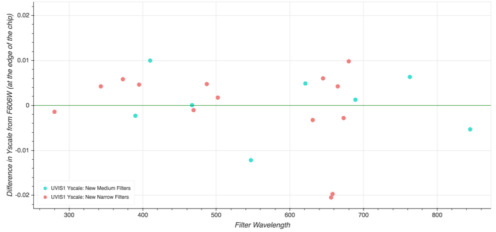
Right: TWEAKREG solution residuals for the same F656N and F606W match using filter specific solutions.



X-Scale, Y-Scale vs. Central Filter Wavelength



Measurements of the difference (in pixels) from the F606W solution of the X-scale (above) and Y-scale (below) of all updated WFC3/UVIS filters at the edge of chip 2 (UVIS1). We see expected relationships between the scale values of nearby filters as well as occasional larger deviations likely due to factors such as filter wedge[4].



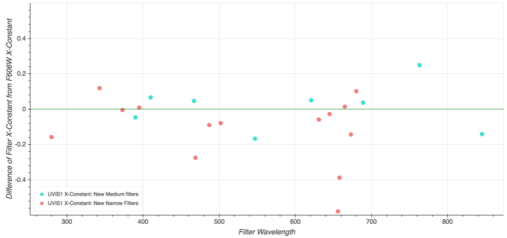
The X-scale and Y-scale (left) are measurements of the linear terms of the geometric distortion. Plotting of this difference, at the edge of the chip, helps demonstrate the distortion extremes that can be found between images, especially from different filters.

Every filter has the same X and Y constant for UVIS2 as their reference point and we provide updated values for UVIS1 for all updated filters. The X and Y constant, or shifts, are also known as the V2/V3 HST coordinate reference points. V2REF/V3REF are used to transform the coordinate system of the image from that of the WFC3/UVIS detector coordinate system into sky tangential plane.

Conclusions

We can see throughout this study that there are substantial differences between the various coefficients important to precise astrometry and coordinate system work which depends heavily on the UVIS filter used. Our updates will allow for more precise solutions for creating drizzled products and allow for greater precision in astrometry work.

X-Constant, Y-Constant vs. Central Filter Wavelength



Measurements of the difference in V2REF (above) and V3REF (below) of an individual filter from the F606W solution for chip 2 (UVIS1).