12k Mosaic Surface Positions

D. Hale
Caltech Optical Observatories
M/S 105-24, 1200 E California Blvd., Pasadena, CA 91125
dhale@astro.caltech.edu

May 26, 2008

Abstract

This document reports on profilometry measurements of the 12k Mosaic camera for the purpose of determining the relative positions of various surfaces (dewar, window, detector). Profilometry results on an engineering grade CCID-20 detector are also reported.

Contents

List of Figures

List of Tables

1 Introduction

The COO Profilometer was used to measure the positions of the surfaces within the 12k Mosaic camera. These measurements are used to determine the relative spacing between the various surfaces.

2 Procedure

2.1 12k Mosaic

The 12k Mosaic camera was placed on the top plate of the profilometer, offset from the opening in the top plate in order to allow the displacement sensor to see every available surface without repositioning the camera between measurements. The approximate placement of the camera is represented in Figure 1. This placement allowed me to see the outside of the dewar, the window, and the detector surface, through the 160×250 mm opening in the top plate of the profilometer. The camera was warm. Although there was likely some level of vacuum in the dewar, it was not recently pumped out and was probably not at an extremely high vacuum due to the known vacuum leaks. The dewar pressure was not recorded.

2.2 CCID-20

An engineering grade CCID-20 detector (the type used in Mosaic) was also measured with profilometry in order to determine the height of the connector above a detector. While not a direct measurement of a Mosaic detector, this avoided the problems and risks associated with disassembling the Mosaic dewar.

The detector package was mounted to a frame which was screwed inside a plastic box. The box was placed inverted on the top profilometer platform. Appropriate spacers were added to the displacement sensor to place it within range of the profile of the detector, and the angle and gain of the displacement sensor were manually optimized.

3 Measurements

3.1 12k Mosaic

All measurements are referenced to the dewar surface. A best fit plane to the dewar surface was determined and this plane was removed from all of the surfaces measured. Thus, the dewar surface has a mean value $\bar{Z} = 0$ mm. Any visible slope in the remaining surfaces are relative to the outer dewar surface. Measurements away from the displacement sensor (ie. upwards, into the dewar) have a negative sign. A summary of the Mosaic data are shown in Table 1.

3.2 CCID-20

The CCID-20 measurements (Table 2) are referenced to the detector surface; a plane is fitted to the detector surface and removed from all of the measurements. Figure 7 shows the raw data, with a plane fitted to the detector plane portion before subtraction.

surface	$\bar{Z}$ [mm]	σ [mm]	Δ [mm]
Dewar	0.000	0.038	
Window Front	-1.667	0.032	1.667
Window Back	-14.358	0.027	12.691
Detector	-24.292	0.025	9.934

Table 1: Summary of Mosaic measurements. $\bar{Z}$ is displacement relative to a plane fit to the dewar surface. Window Back & Detector have been corrected for refraction. σ is the standard deviation of the mean. Δ is the difference between a surface and the previous surface.

surface	$\bar{Z}$ [mm]	σ [mm]
detector	0.000	0.024
connector	1.387	0.110

Table 2: Summary of CCID-20 measurements. $\bar{Z}$ is displacement relative to a plane fit to the detector surface. σ is the standard deviation of the mean.

4 Remarks

The weight and placement of the Mosaic dewar on the profilometer caused a noticeable slope in the measurements which was removed in the fitting of a plane to the dewar surface. Since this same dewar-fit-plane was removed from all of the other surfaces, and no particularly outstanding slope is seen, it appears that the surfaces are reasonably parallel.

Although the standard deviation is ≈ 30 μm, the peak-to-valley is on the order of 100 μm. No calibration was applied to these data, but previous measurements (on the LIGO flat) have shown that the P-V of the profilometer stage is on the order of 10 μm.

Some "bow" is evident in the window, as perhaps better seen in Figure 2. The direction of the bow is inward (toward the dewar) and is likely caused by atmospheric pressure.

The data are shown graphically in the following figures. The distribution of Z values ("height") as a function of X and Y are shown in Figures 3, 4, 5, 6 for 12k Mosaic, and in Figures 8 and 9 for the engineering grade CCID-20. The raw, unfit data and procedure of fitting and removing a plane is illustrated only for the CCID-20 because it was less complicated to represent (Figure 7), but the principle is the same for the Mosaic camera.

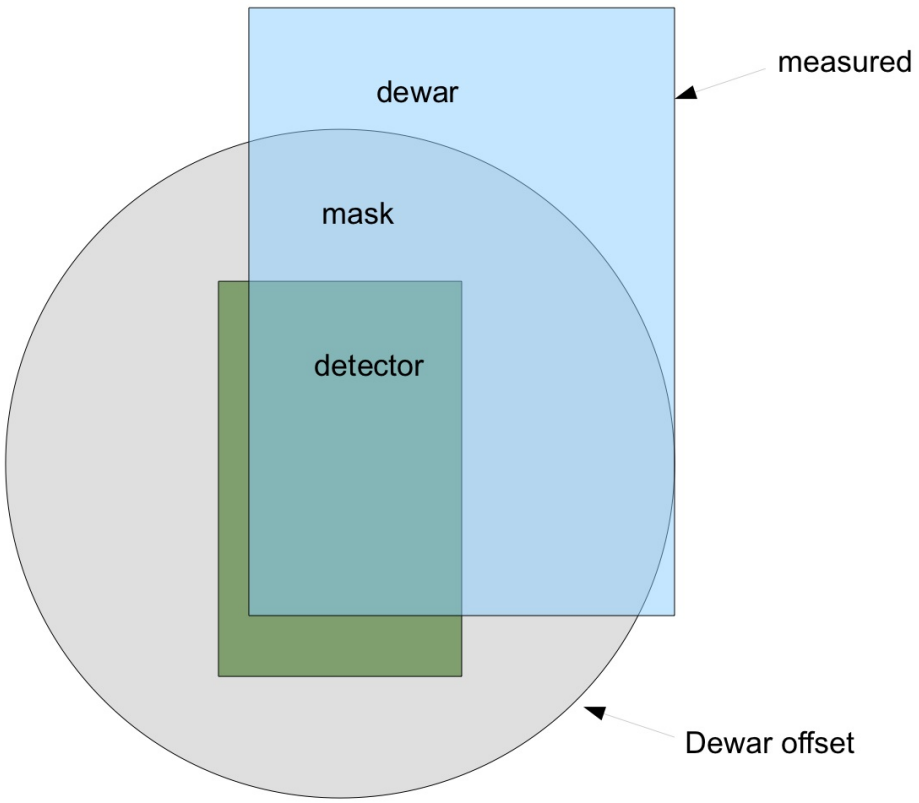

Figure 1: Approximate Dewar placement on the profilometer. Dewar was offset so that part of the dewar and detector would be visible at the same time.

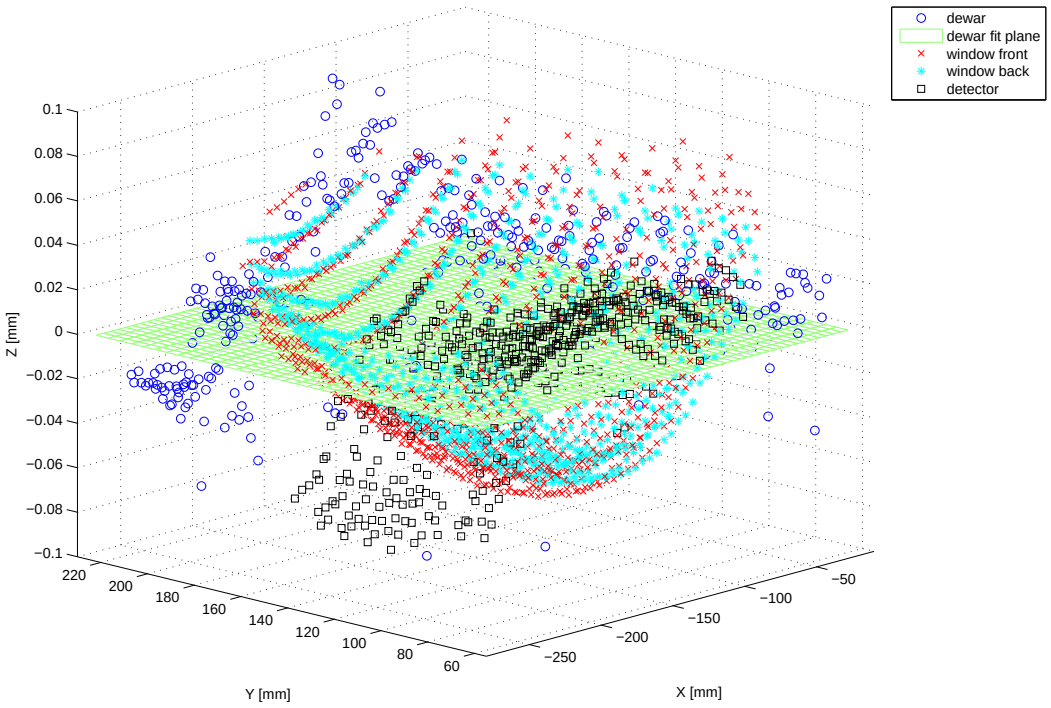

Figure 2: All Mosaic surfaces together. Each is referenced to the dewar plane, but here also the mean of each surface has been subtracted so that they can be compared together. Deviations from the plane (shown in green) represent deviations from the dewar surface.

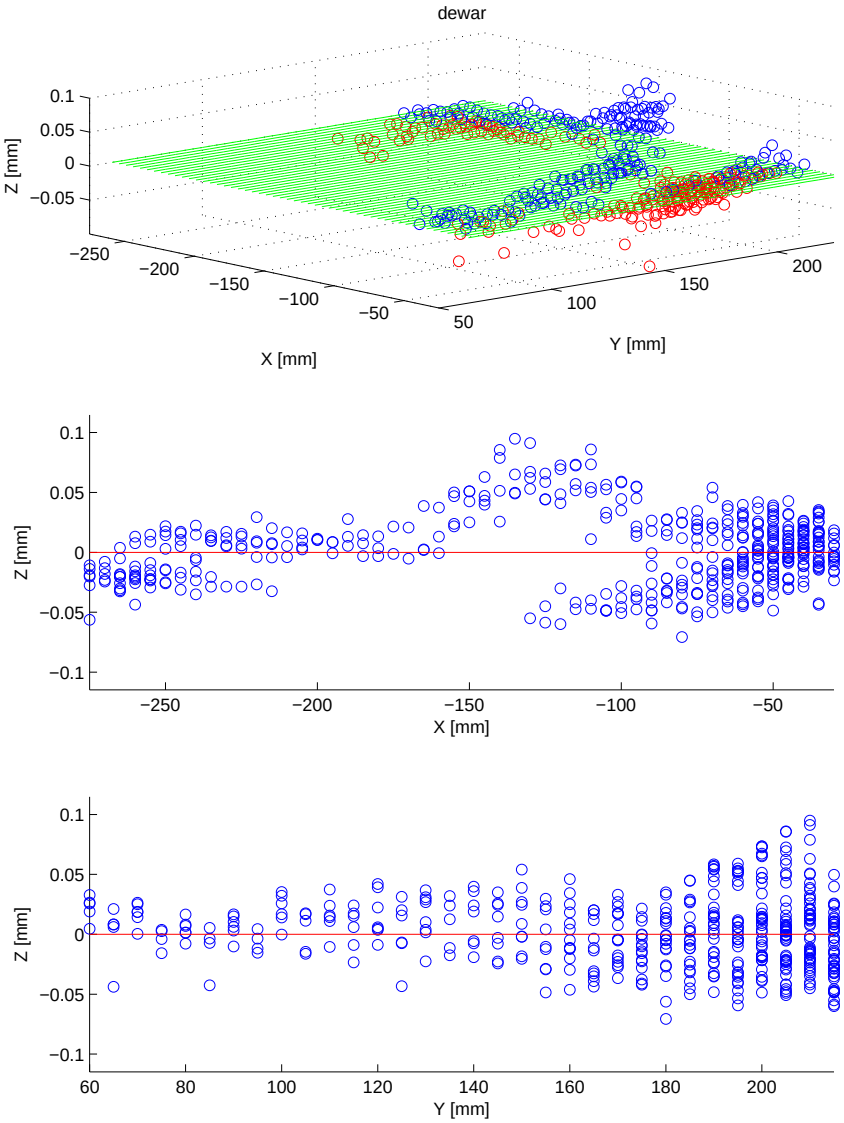

Figure 3: Distribution of height values for the dewar after removing a fitted plane. The mean of the resulting distribution is $\bar{Z} = 0$ mm as shown above. In the top panel, points above the plane are shown in blue and those below are red for clarity.

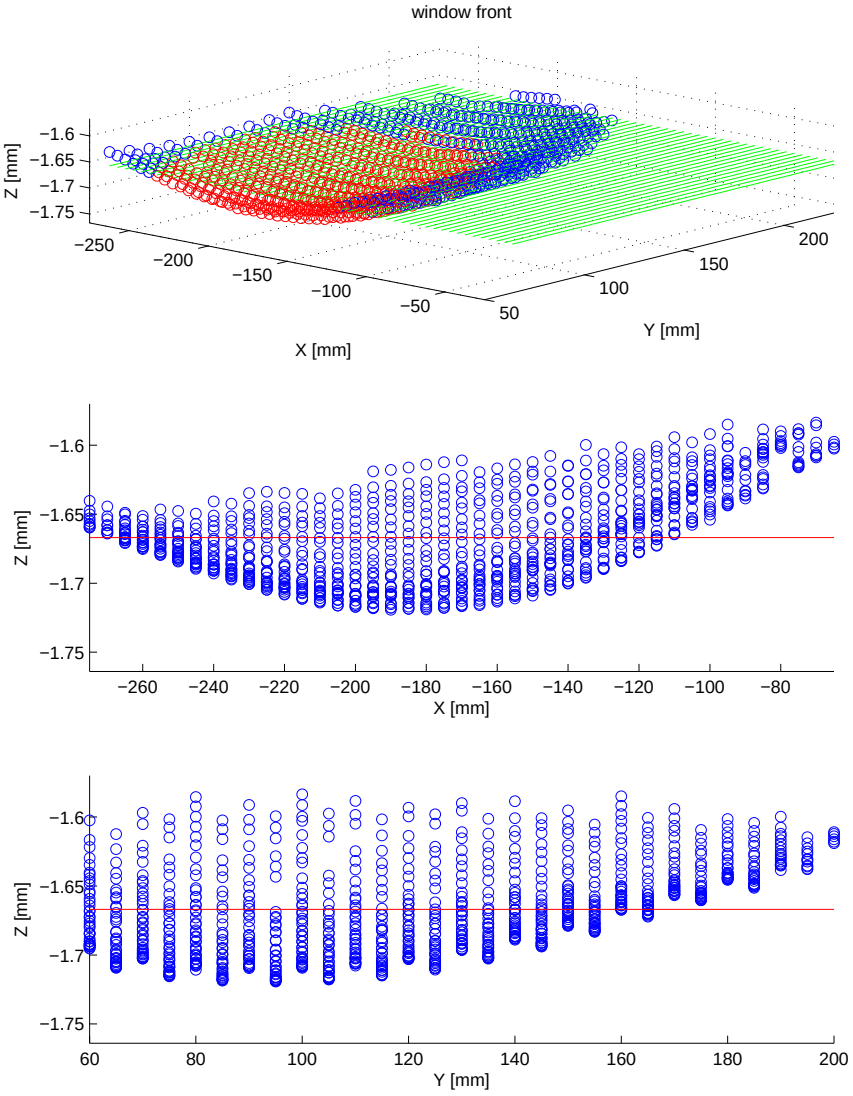

Figure 4: Distribution of height values for the window front, after removing the dewar plane. The Z axis represents height above the outer dewar surface. In the top panel, points above the mean are shown in blue and those below are in red.

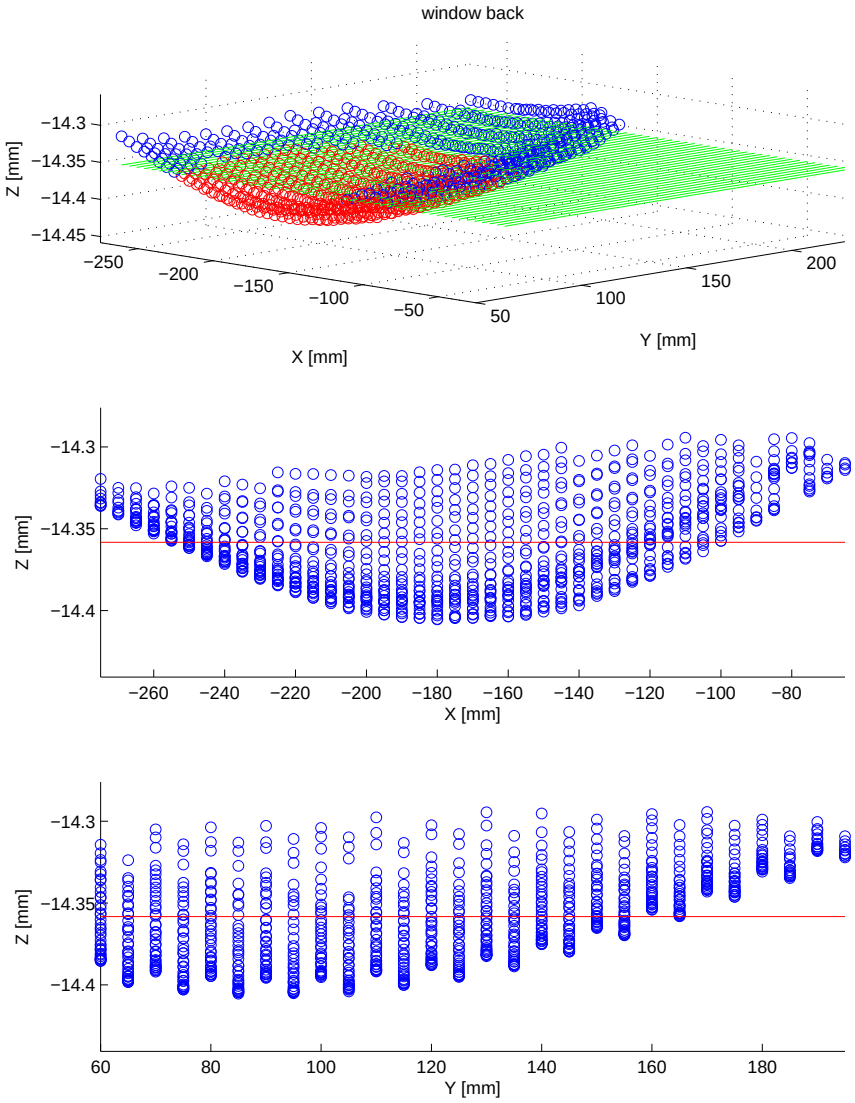

Figure 5: Distribution of height values for the window back, after removing the dewar plane. The Z axis represents height above the outer dewar surface. In the top panel, points above the mean are shown in blue and those below are in red.

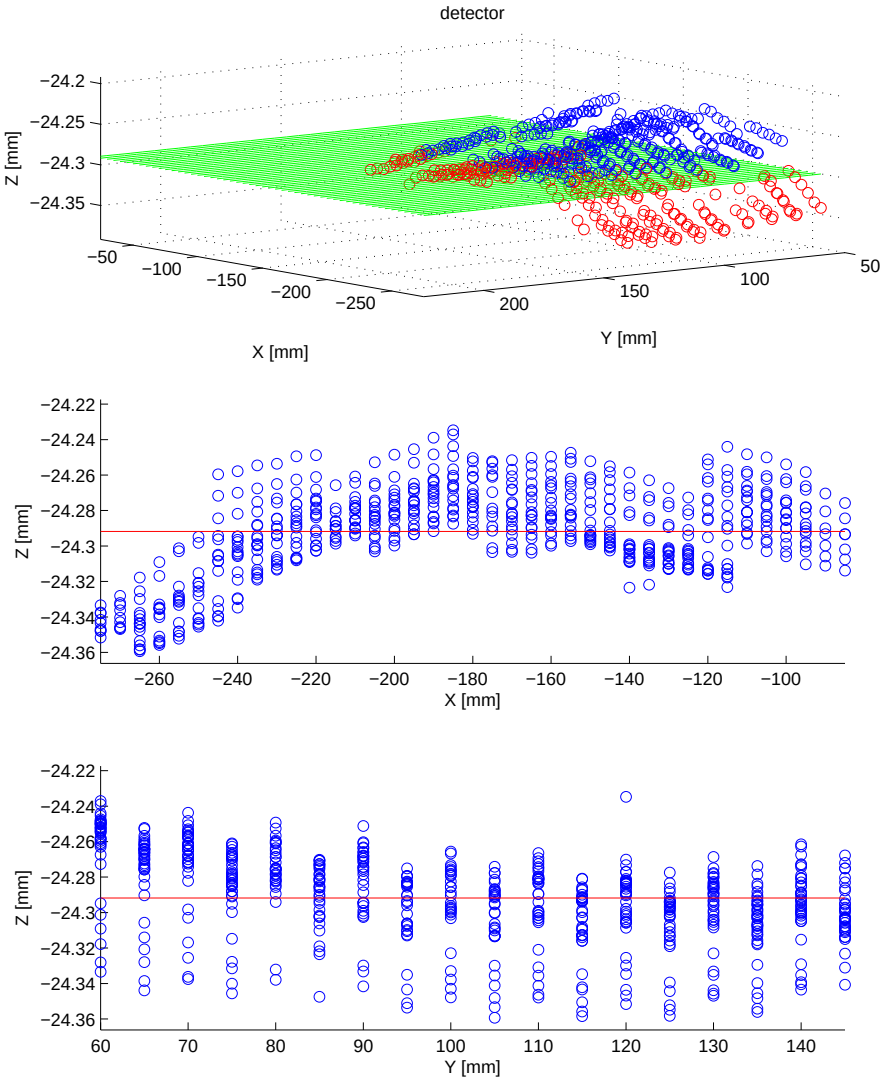

Figure 6: Distribution of height values for the detector, after removing the dewar plane. The Z axis represents height above the outer dewar surface. In the top panel, points above the mean are shown in blue and those below are in red.

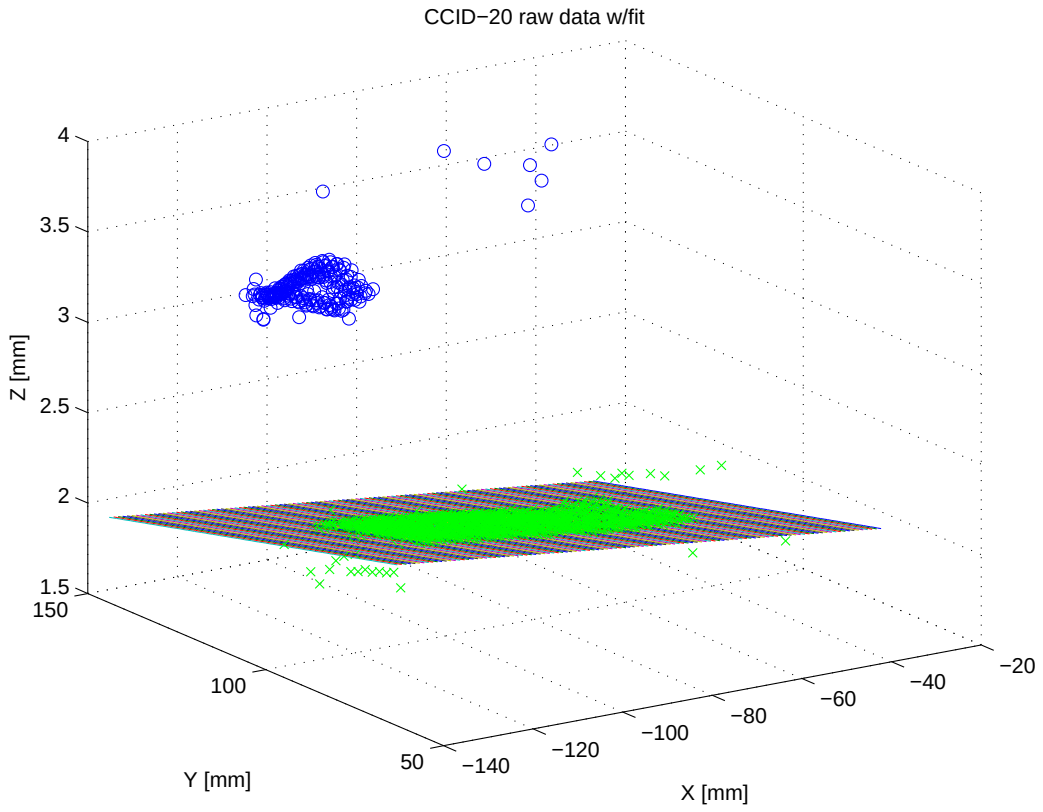

Figure 7: CCID-20 Raw data with fit. The green crosses are measurements of the detector and the blue circles are of the connector. A plane fitted to the detector data is shown. The plane has not yet been removed from the data shown in this figure.

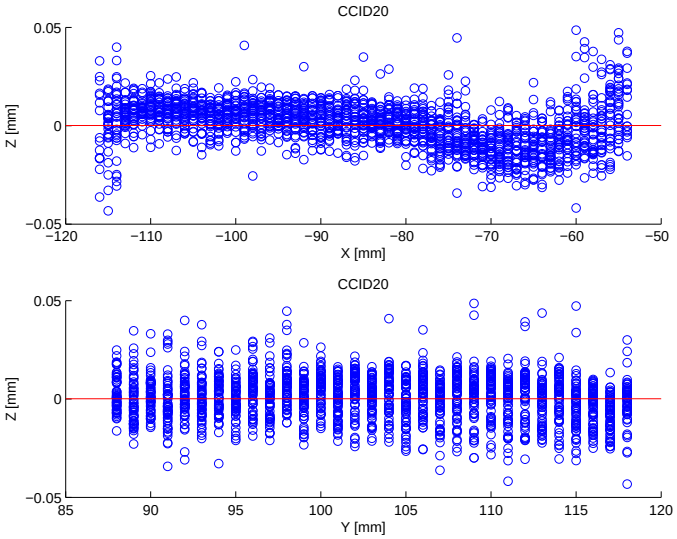

Figure 8: Distribution of height values of the CCID-20 detector surface, after removing the plane, shown as a function of X and Y.

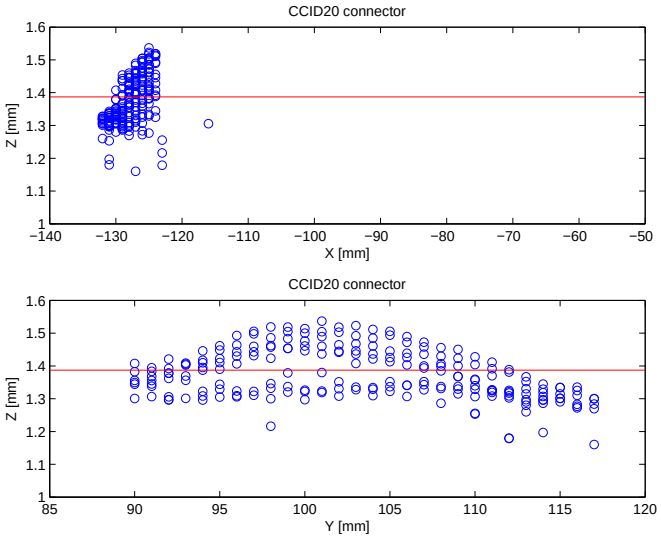

Figure 9: Distribution of height values of the CCID-20 connector relative to the detector surface, after removing the plane, shown as a function of X and Y.