HET Mirror Piston

February 1999 Implementation

prepared by

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1. Introduction

This is a short report on the work performed on setting piston of the HET mirror. It also presents data taken to test the accuracy of the final product.

2. Procedure

This work was performed between February 9th to February 14th, 1999. The spherometer has been upgraded by replacing the dial indicator with a Chicago Dial digital indicator with RS-232 data download capability. We set the indicator resolution to 5 µm throughout the alignment. Most of the segments were measured with a hanging operator, some measurements of edge segments were done with the operator standing on the truss.

Prior to start, the state of the mirror was as follows:

- There are 8 solid mount segments: 4 – 15 – 18 – 41 – 45 – 68 – 71 – 82. These are not part of the mirror.
- The following segments had never been pistoned since their installation last October: 1 – 2 – 3 – 5 – 6 – 7 – 8 – 11 – 13 – 16 – 89.
- The following segments had been recently re-installed to remove chipped segments from the dome environment: 10 – 80 – 83.
- The last time piston had been performed was July 7th – 9th, 1998.

The segments were left in a stacked status at the end of the previous night work. The dome was conditioned until piston alignment was performed in the afternoon. It is estimated that the stack alignment remained within 5 arcseconds (mirror) during piston alignment (i.e a possible influence of 12.5 µm on piston measurements). Segments were measured with respect to only one of their neighbor with little cross-checking. Whenever cross checking was performed the piston measured was within the ±25 µm requirement specs.

3. Results

Figure 1 shows the measurements pattern used and the piston adjustments that were applied. The RMS value of the piston adjustments applied as measured from rings 1 to 3 segments (minus segment 16) was ±150 µm RMS. We do not include ring 4 - 5 segments in this calculation as the number of segments that needed to be roughed in would distort the statistics and are unreliable of how the mirror is holding piston alignment. It seems fairly safe to ascertain that once properly pistoned the mirror holds its piston figure to within ±200 µm RMS over extended period of time (months).

On February 12th, a cold front caused some segment control problems. To ascertain how well the mirror maintained piston alignment during the passage of a cold front dropping the temperature by 20 degree Celsius in less than 24 hours, we decided to re-measure the edge segments against each others. The results are presented in Figs. 2 – 3, and Table 1. The bottom edge segments were not yet pistoned at that time. The segment-to-segment piston measurements yield an RMS of ±42 µm. From the measurements, we can determine the shape of the mirror edge. By stringing the piston measurements together and referencing all the values to a mean position of 0 (i.e. the reference sphere), we generate the plot presented in Fig. 3. The segment piston position RMS is ±52 µm. It is envisioned to perform the necessary measurements to generate Figs. 2 and 3 weekly to monitor the progress of the mirror piston alignment.

As can be noted from the underlined numbers distribution in Fig. 1, it was surprising to find at least 6 segments that had been previously pistoned, had not been re-installed, and still needed roughing-in. A possible explanation for this state of affair is that all six segments sit next to a solid month segment. It is plausible that during installation of the solid mount segments, these neighboring segments were disturbed somehow.

Another item of note is that when performing large piston moves (i.e. 300 to 500 µm), it was often found that applying a correction of the same size as the measured piston misalignment would actually overshoot by approximately 5%. This might indicate a need to alter the lever-arm ratio number in SPS.

4. Conclusions

At the completion of piston alignment, the mirror piston figure is approximately ±50 µm RMS (±100 µm RMS if one wants to be conservative). This should contribute only about 0.12” (0.23”) to sky imaging quality (not taking into account possible systematic global asphericity of the primary mirror figure).

5. Acknowledgment

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Figure Captions

Fig. 1. Diagram of the mirror array showing the pattern of measurements used when pistoning the segments. The lower number in each hexagon is the segment ID number; the upper italicized numbers are the piston adjustments performed. The arrows point toward the reference segments, which is where the three pads of the spherometer rested during the measurements. Do not think of the arrows as indicating the order of measurements. Reference segments were often brought into alignment with the rest of the array by putting the spherometer on them, measuring an already aligned segment, then reversing the polarity of the reading when applying adjustment. Hatched segments are solid mounts. Underlined piston numbers are imprecise and indicate a segment that necessitated roughing-in (we only noted the measurement value to the nearest 0.1 mm for those cases and roughing-in a segment causes us to loose track of the exact piston adjustment being applied to it). Segments that needed roughing-in also show an extra filled arrow. The normal arrow shows the measurement pattern used when we discovered that those segments needed roughing-in; the filled arrow show the pattern used to bring these segments in alignment after rough-in.

Fig. 2. Plot showing edge segment piston measurement performed on February 12th. The labels shown at the top of the plot describe the nature of the measurement. 10 – 6 means that segment 10 was measured with the spherometer pads resting on segment 6 (i.e segment 6 as reference).

Fig. 3. Plot showing edge segment piston position calculated from the data shown in Fig 2. The labels shown at the top of the plot give the segment ID number. The reference surface is defined as giving a mean segment piston position of 0.

Fig. 1

Notes:
1. COC view
2. mirror 86 is at the 'top'

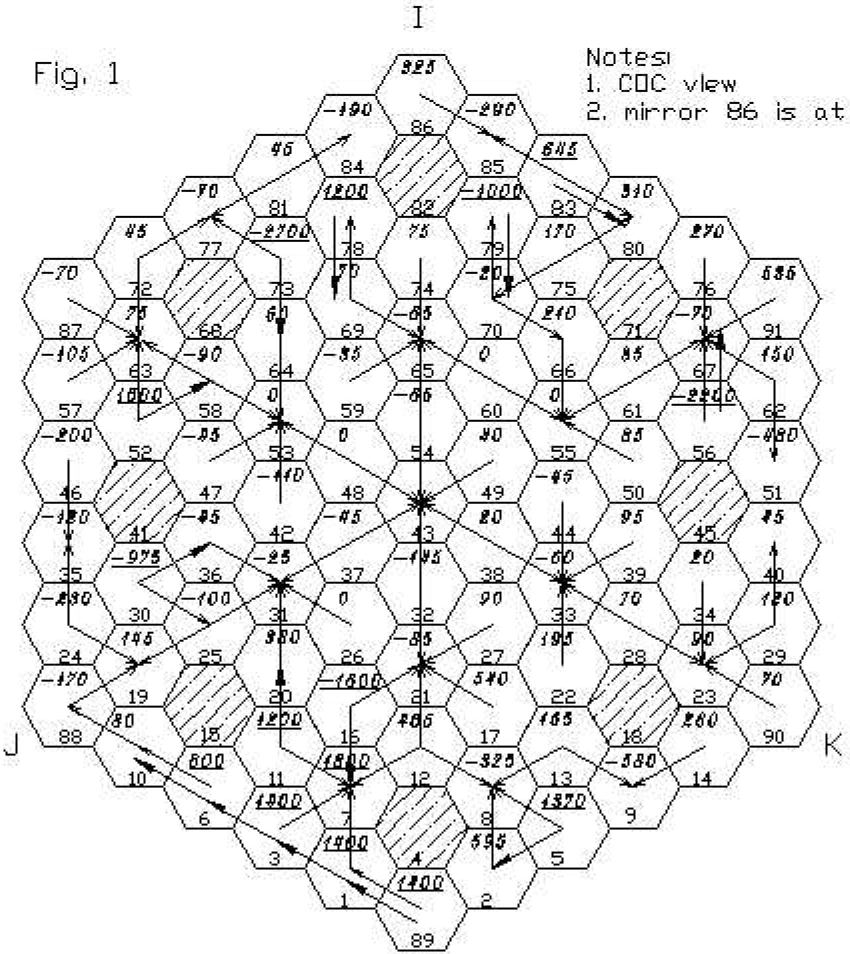
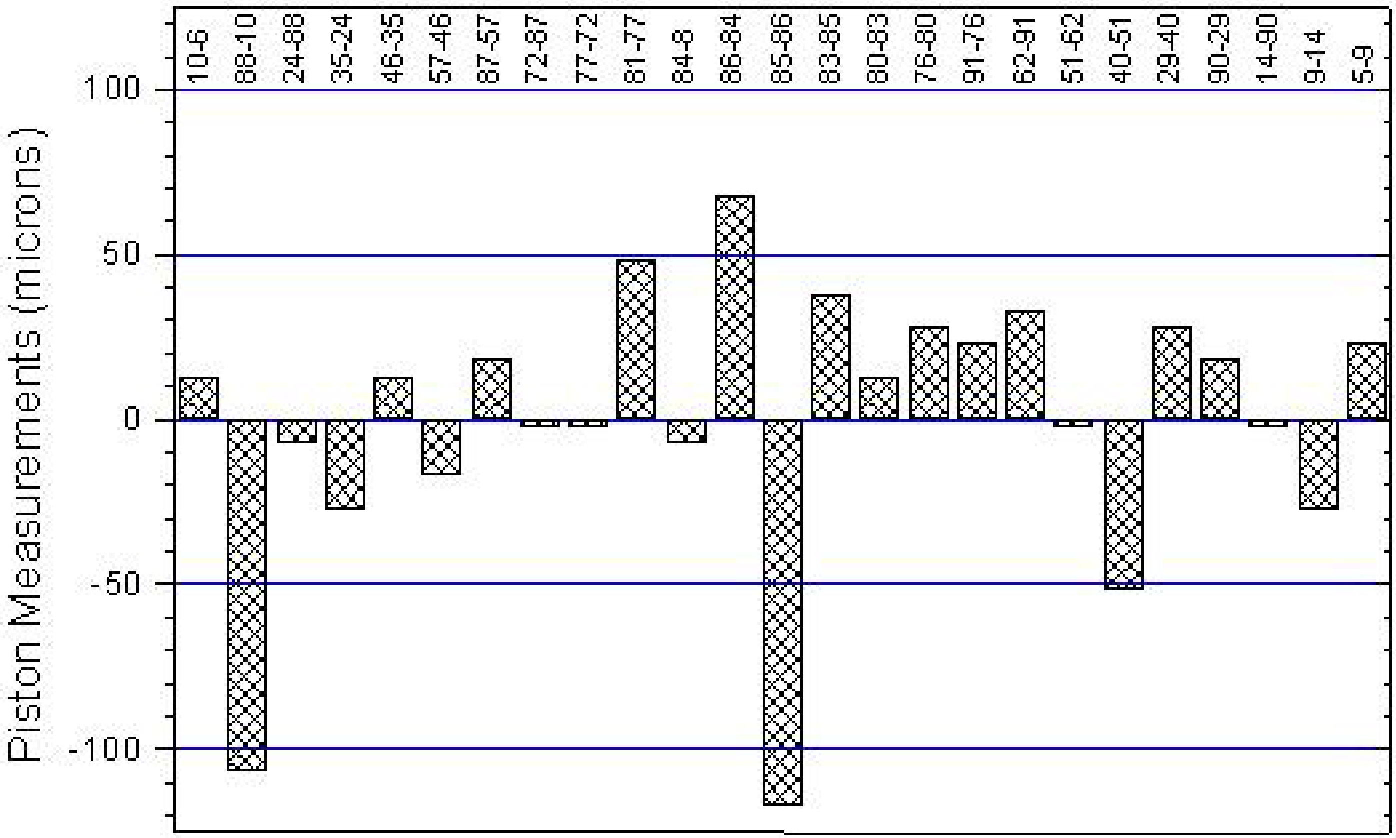


Fig. 2 HET Mirror Piston Measurement



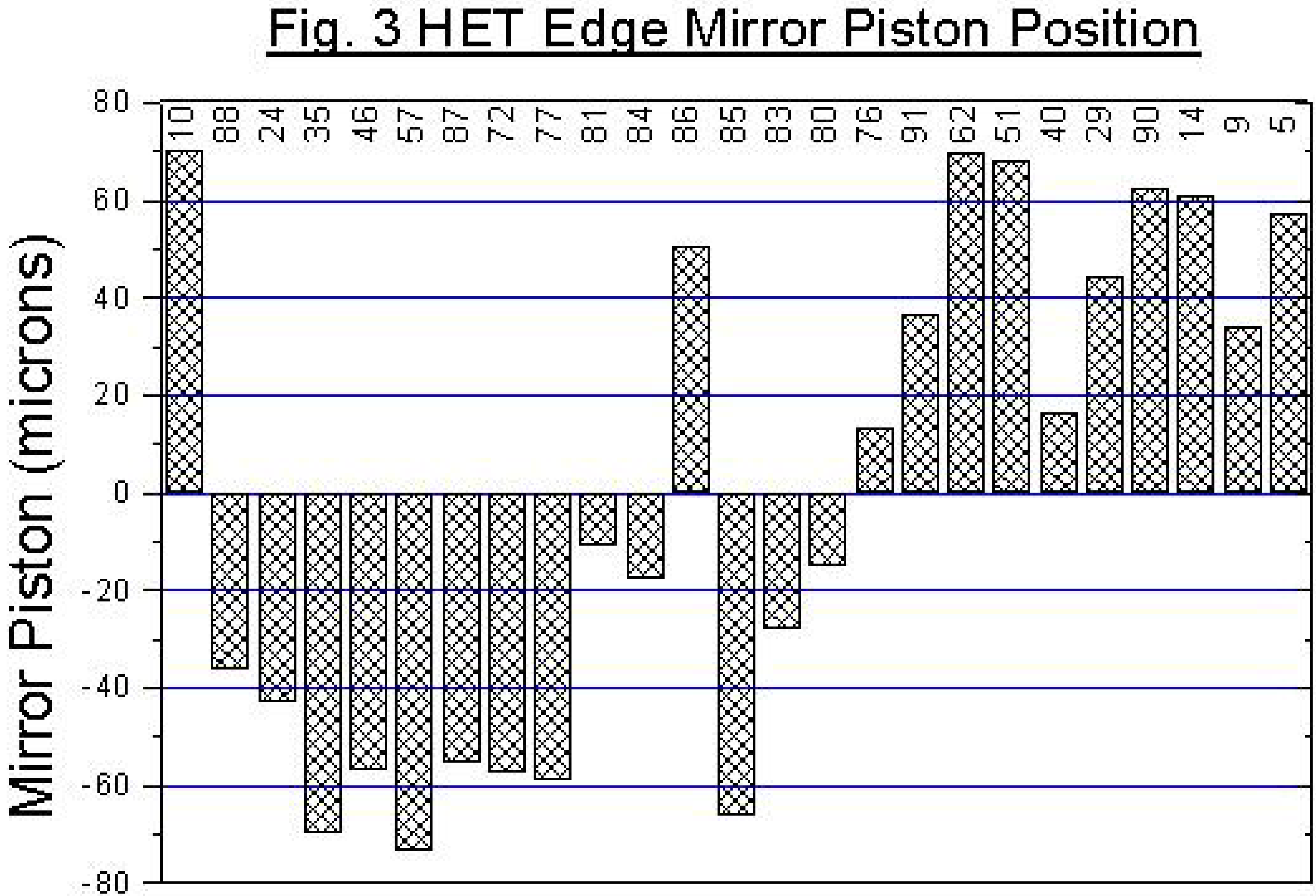


Fig. 3 HET Edge Mirror Piston Position
Mirror Piston (microns)
80
60
40
20
0
-20
-40
-60
-80
10
88
24
35
46
57
87
72
77
81
84
86
85
83
80
76
91
62
51
40
29
90
14
9
5