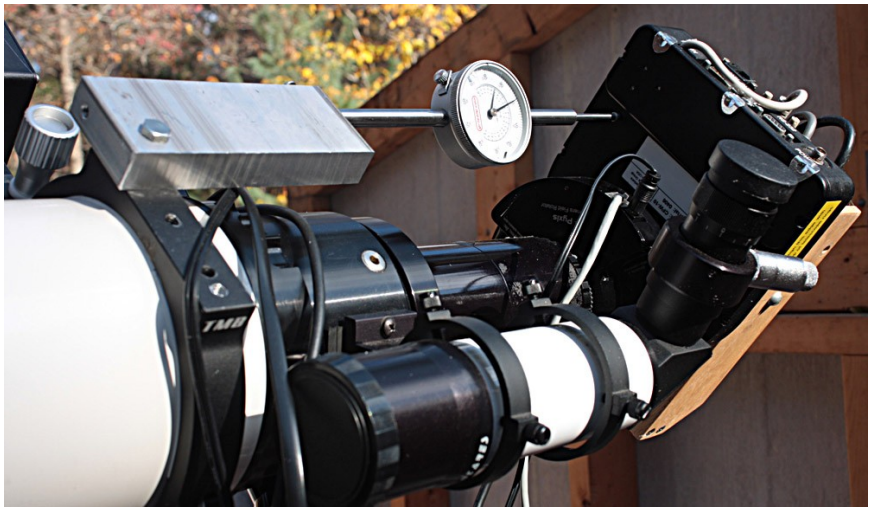
Analysis of Feather Touch Motorized Focuser Repeatability

Mike Dodd, November 9, 2008

The Feather Touch (FT) focuser uses a stepper motor to move the drawtube in and out. I have noticed cases of poor positional repeatability when the FT is controlled by FocusMax. This document presents the results of tests to measure the FT's repeatability, and what I did to improve it..

To conduct the tests, I securely attached a dial caliper to the top of a telescope mounting ring, arranged so its tip pressed against the IFW color filter wheel installed on the imaging camera. Here is a photograph of the test setup.



To begin, I positioned the telescope approximately level and set the FT to an arbitrary position with the drawtube mostly racked-in, then adjusted the dial caliper to a zero-reference reading. I applied power to the FT focuser control box, and verified that the display read 0000. I launched FocusMax and verified that its position display also read 0000. All focuser positioning during the test was accomplished using the FocusMax Jog control window. With the telescope still level, I used FocusMax to position the FT from 0 to 500, from 500 to 1000, then back from 1000 to 500, and from 500 to 0. Table 1 shows the dial caliper reading, in thousandths of an inch, at the end of each movement. The FT ASCOM driver stepper motor speed was set to 255 for this test. The test measures repeatability, so the important numbers in this table are the variances between the "outbound" and "inbound" ending positions. The absolute caliper measurements are irrelevant.

Table 1: Reference positions, telescope level, stepper motor speed 255

Movement	***End Reading***	***Variance From Outbound Position***
Zero reference	0	N/A
0 → 500	60	N/A
500 → 1000	17	N/A
1000 → 500	58.5	**-0.0015"**
500 → 0	0	0

After taking the reference measurements, the telescope was moved to an elevation of 78°, where all

subsequent measurements were made. I performed four runs. The first two runs duplicated the reference positions shown above, 0 → 500 → 1000 → 500 → 0. The third and fourth runs moved the focuser from 0 directly to1000 without the intermediate stop at 500, and back from 1000 to 0.The stepper motor speed was set to 255 for the first two runs, and to 64 for the final two runs. The following tables show the results from the four runs with the telescope elevated to 78°.

Table 2: First run with telescope elevation 78°, stepper motor speed 255

Movement	***End Reading***	***Variance From Outbound Position***	***Variance From Same Position in Table 1 (telescope level)***
Zero reference	0	N/A	0
0 → 500	58	N/A	**-0.002"**
500 → 1000	15	N/A	**-0.002"**
1000 → 500	56	**-0.002"**	**-0.0025"**
500 → 0	91	**-0.009"**	**-0.009"**
-32 steps on hand box needed to reach zero reference after 500 → 0 movement			

Table 3: Second run with telescope elevation 78°, stepper motor speed 255

Movement	***End Reading***	***Variance From Outbound Position***	***Variance From Same Position in Table 1 (telescope level)***
Zero reference	0	N/A	0
0 → 500	59	N/A	**-0.001"**
500 → 1000	16	N/A	**-0.001"**
1000 → 500	57.5	**-0.0015"**	**-0.0025"**
500 → 0	95.5	**-0.0045"**	**-0.009"**
-16 steps on hand box needed to reach zero reference after 500 → 0 movement			

Table 4: Third run with telescope elevation 78°, stepper motor speed 64

Movement	***End Reading***	***Variance From Outbound Position***	***Variance From Same Position in Table 1 (telescope level)***
Zero reference	0	N/A	0
0 → 1000	16	N/A	**-0.001"**
1000 → 0	98	**-0.002"**	**-0.002"**
-5 steps on hand box needed to reach zero reference after 1000 → 0 movement			

Table 5: Fourth run with telescope elevation 78°, stepper motor speed 64

Movement	***End Reading***	***Variance From Outbound Position***	***Variance From Same Position in Table 1 (telescope level)***
Zero reference	0	N/A	0
0 → 1000	16	N/A	**-0.001"**
1000 → 0	98	**-0.002"**	**-0.002"**
-7 steps on hand box needed to reach zero reference after 1000 → 0 movement			

Conclusions

To achieve these results, I loosened the drawtube friction adjustment screw on the Feather Touch focuser, as well as the tension screw on the focuser knob shaft.

Not surprisingly, it appears that stepper motor speed is a significant factor in repeatability. With the speed set to 255 and the telescope elevated to 78°, moving from the zero reference to position 1000 and back to zero again resulted in a variance of 0.009" in the first run and half that (0.0045") in the second run. Reducing the stepper motor speed to 64 resulted in a variance of only 0.002" in the third and fourth runs.

I speculate that the stepper motor isn't powerful enough to instantly stop the drawtube from moving outward at high speed (downward when the telescope is pointing high in the sky). In the "inbound" direction, the motor probably isn't powerful enough to push the drawtube and camera equipment upward accurately at high speed. A more powerful stepper motor would allow accurate and reliable operation at higher speed.

The Feather Touch ASCOM driver indicates the focuser moves 7.28 microns per motor step. This is 0.00287" per step, or slightly more than the 0.002" variance in the third and fourth runs. The fact that I had to move the focuser drawtube in an additional 5 steps (third run) and 7 steps (fourth run) to reach the zero reference point after returning from position 1000 indicates there is some backlash in the motor reduction gears. I set the ASCOM driver backlash value to 5 to compensate for this.

The critical focus zone (CFZ) for my TMB-130SS telescope and ST-8 camera is 0.0042" (107.8 microns). The FT repositioned to one-half this value (0.002") on the third and fourth runs with the stepper motor speed set to 64, so I conclude the FT will be able to achieve focus within the CFZ.

For sure, the Feather Touch friction and tension adjusting screws should be loosened until there is almost no resistance against drawtube movement. In addition, the ASCOM driver stepper motor speed should be set to a low value. After seeing the results with the motor speed set at 64, I reduced it further to 32 for normal operation. FocusMax built13 good V-curves with these settings, and focused accurately afterward.