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The Center of Vision
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December 8, 2017

SFA Option

Super-Fine Adjustment Option for Foveal Mounts: Installation Manual

READ ME FIRST

This option adds steps to the installation procedures found in the

Foveal Camera Mount Installation Manual.

Reading through this manual first, and then the other manual should make the overall installation process clearer.

Please read both manuals before installing your first Foveal Camera Mount with the SFA.

Contact Me If You Have Any Questions, Comments or Suggestions.

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1. Overview

The **Foveal Rigid Camera Mounts** and **Foveal Fine-adjustment Camera Mounts** are finely adjustable camera 2- and 3-axis mounts for small-to-medium sized "box" cameras, camera enclosures and instruments, such as lasers. They allow each position of the pan, tilt and, in 3-axis models, roll axes to be locked down so they cannot be casually changed, either deliberately or accidentally. The Rigid Mounts are intended for environments where they will be subjected to extreme bumps or twisting forces. The Foveal Fine-adjustment Mounts are less expensive and less robust 2-axis mount designed for less demanding environments. See:

http://www.FovealMounts.com/rigid_mount.html
http://www.FovealMounts.com/fine_mount.html

However, as the working distance of the camera or instrument gets longer the angle adjustments are more difficult, The 32 thread-per-inch screws used for changing pan and tilt may be too course for very fine adjustment.

We designed an Extra Fine Adjustment (**EFA**) option that uses finer threaded screws to give you finer pan and tilt control.

The angle change that used to take one turn of the position screw now takes about three turns.

But sometimes even that was not fine enough.

So we found a way to, in effect, make angle change that used to take one full turn of the EFA position screw now takes 15 turns.

2. Details of the Differential Adjuster

The **Super-Fine Adjustment** (SFA) option uses the Thorlabs Differential Adjuster (DA) to create the *very* fine motions that push the Pan Clamp and Tilt Clamps *very* small distances. The mechanical advantage inherent in the DAs also makes very fine motions very forceful.

The DA has the same ¼-80 outside thread as the screws we use for our **Extra Fine Adjustment** (EFA) Option.[1] A 5/64 inch hex key is used to turn the DA in its threaded bushing. Thus, as with the EFA Option, each turn of the DA will change the Pan or Tilt Angle about 1 degree as it pushes against the Pan or Tilt Clamp. However, the DA has a second hex socket *inside* the outer socket. See **Figure 2-1**.

A 1/16 inch hex hey will turn the mechanism inside which will extend, or retract, the internal Push Rod 0.025 mm per turn. 16 turns of the smaller hex key changes the Push Rod position by 0.4 mm.

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1. **www.FovealMounts.com/rigid_mount.html#ExtraFineAdjustment**

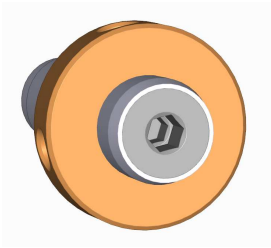


Figure 2-1. The Differential Adjuster uses two sizes of hex key.
A 5/64 inch hex key engages the outer socket. a 1/16 inch hex key engages the inner socket.

It takes 15 turns of the inner socket to change the Pan or Tilt Angle about 1 degree.
Clockwise rotation of the inner socket ***retracts*** the Push Rod; **Counterclockwise** rotation ***extends*** it.
See **Figure 2-2**.

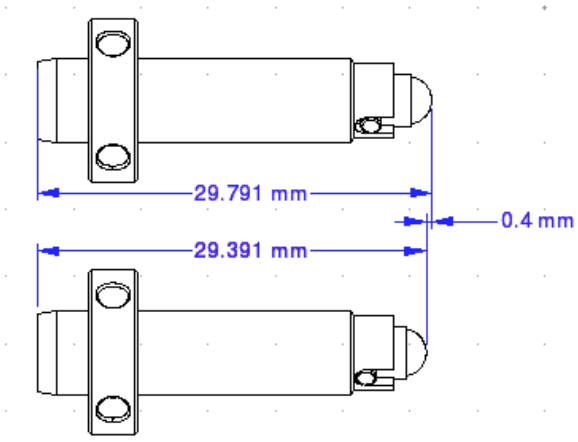


Figure 2-2. Adjusting the Push Rod changes the Differential Adjuster length just 0.4 mm.
Clockwise rotation of the inner socket ***retracts*** the Push Rod. **Counterclockwise** rotation ***extends*** it.

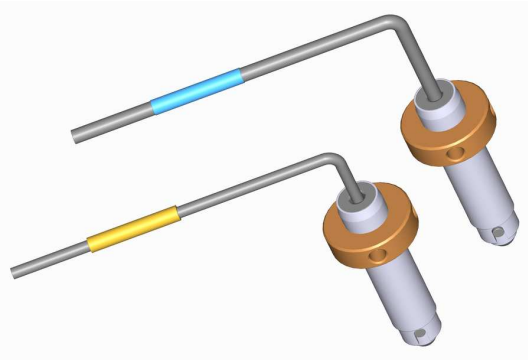
3. Steps to make Super Fine Adjustments to the Tilt axis. Adjusting the Pan axis uses the same steps.

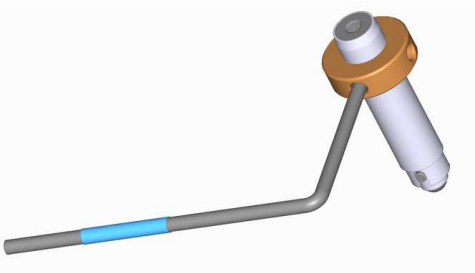
With each order of Foveal Mounts with the **Super Fine Adjustment** option, we ship an additional pair of hex keys for the Differential Adjusters.

The 5/64 inch hex key, marked with blue shrink tubing, is used to make coarse adjustments of the Adjusters.
It also is used to engage the holes in the sides of the Lock Nuts.

The 1/16 inch hex key, marked with yellow shrink tubing, engages the internal Push Rod of the Adjuster.
Turning the yellow hex key ***counterclockwise*** *extends* the Push Rod; ***clockwise*** *retracts* it.

We refer to them as the blue and yellow hex keys.





3.1 Elements of the Super Fine Adjustment option.

Adjuster: The Thorlabs Differential Adjuster.

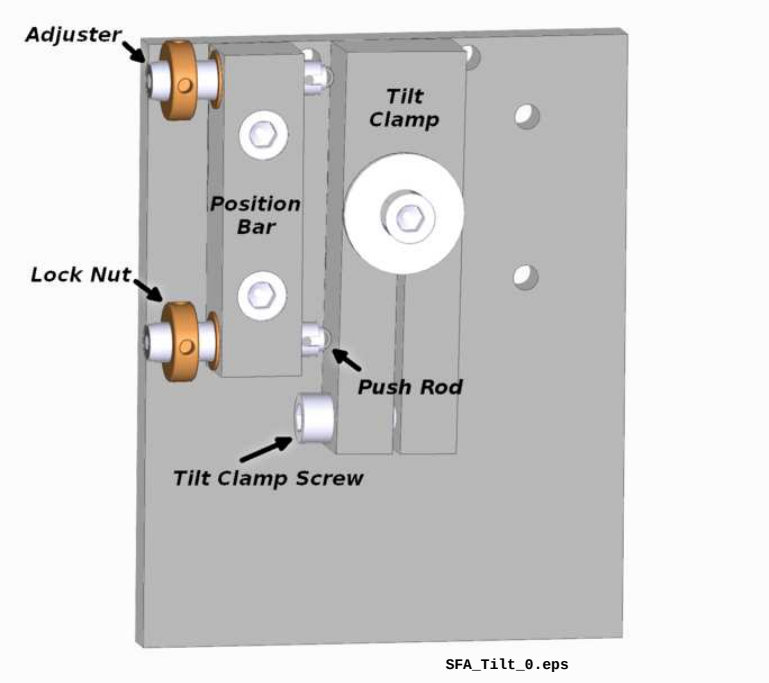
Lock Nut: Used to clamp the Adjuster to the Position Bar.
The Lock Nut can be finger tightened.
It can also be tightened using the blue hex key.

Push Rod: Travels within the Adjuster. 16 turns of the yellow hex key moves it 0.4 mm. Makes very fine adjustment of the Tilt Clamp, and hence the Tilt Table, possible. The Lock Nut must be tight before adjusting the Push Rod.

Position Bar: Supports the Adjusters and provides the force that holds the Tilt Clamp in position.

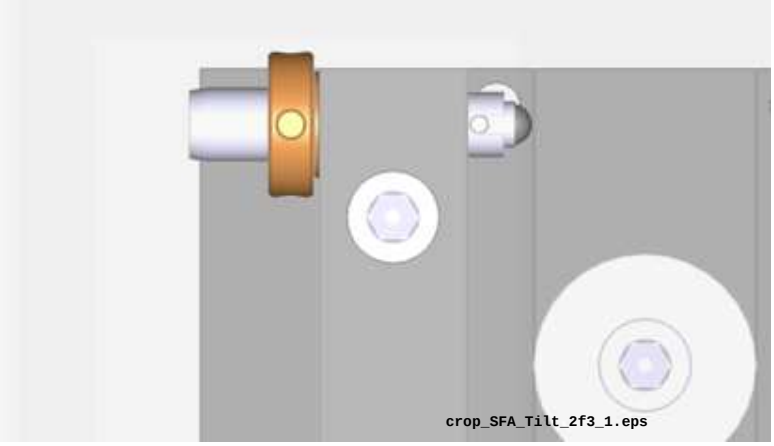
Tilt Clamp: Allows the Tilt Table to rotate 360° when the Tilt Clamp Screw is loose. Fastens firmly to the Tilt Table when the Tilt Clamp Screw is tightened.

Tilt Clamp Screw: Tightens the Tilt Clamp to limit the rotation of the Tilt Table.

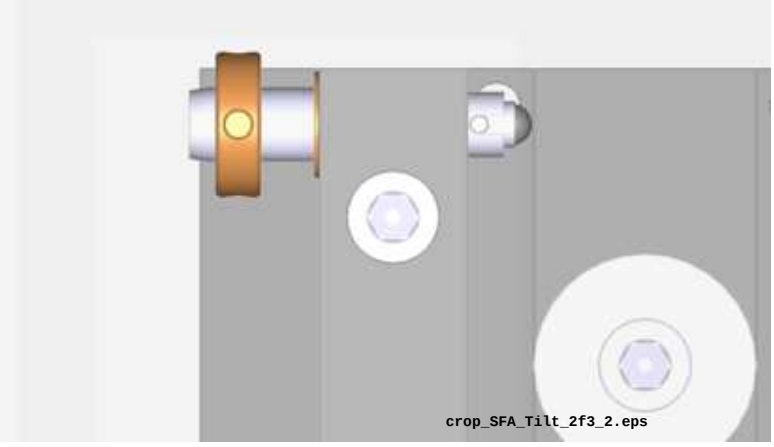


3.2 Set the Adjuster Push Rods at the middle of their travel.

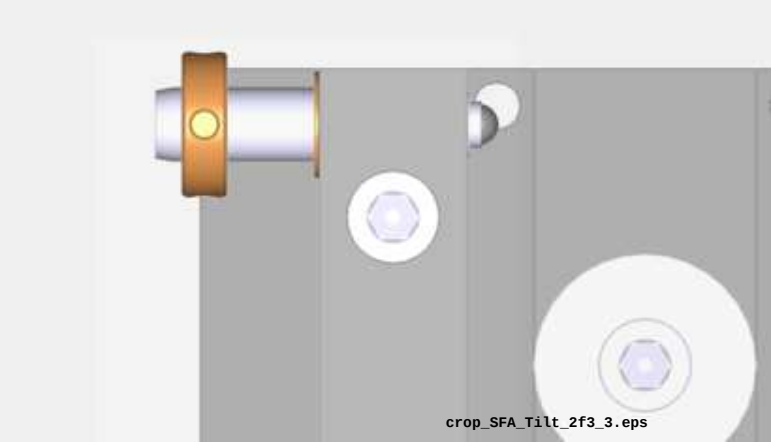
☐ It is likely that you will find the Adjusters are locked against the Tilt Clamp.



☐ Loosen the Lock Nut on both Adjusters. Use the blue hex key to engage the holes in the Lock Nuts if necessary.



☐ Use the blue hex key to back the Adjusters well away from the Tilt Clamp.



☐ Lock the Adjusters to the Position Bar with the Lock Nuts finger tight.

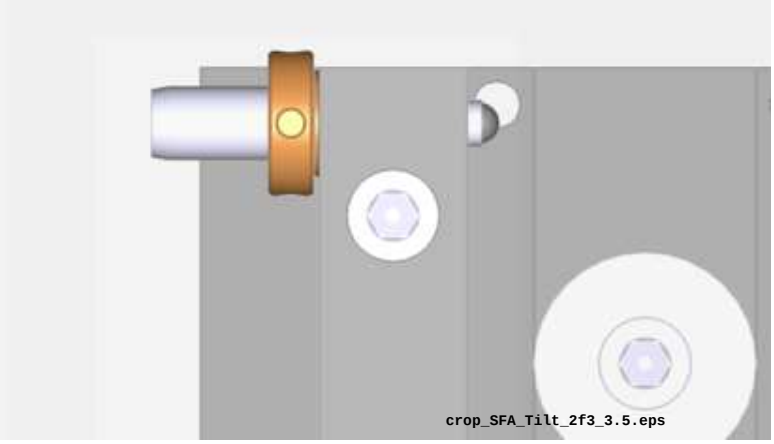
☐ Use the yellow hex key to set each Push Rod to one end of its range of travel.

☐ Turn the yellow hex key in the other direction 8 turns.

The Adjusters' Push Rods are now at the center of their range of travel.

☐ Loosen the Lock Nut on both Adjusters.

☐ Use the blue hex key to drive each Adjuster so the ball end of the Push Rod almost touches the Tilt Clamp.



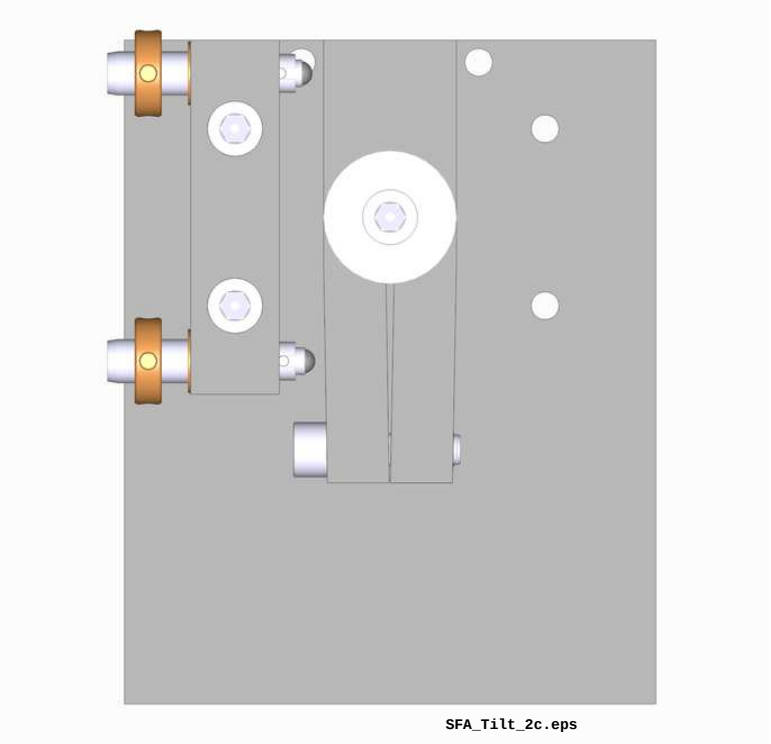
3.3 Set the Tilt Table to *approximately* the correct position by hand

☐ Loosen the Tilt Clamp Screw.

☐ Position the Tilt Clamp to approximately the middle of it's travel relative to the Position Bar.
Said another way, the edge of the Tilt Clamp should be parallel to the edge of the Position Bar.

☐ Position the Tilt Table so the tilt angle is as close as possible to the desired position. When done, make sure the Tilt Clamp is back to the middle of travel.

☐ Tighten the Tilt Clamp Screw. NOTE that the gap in the Clamp closes together and the ends actually touch.

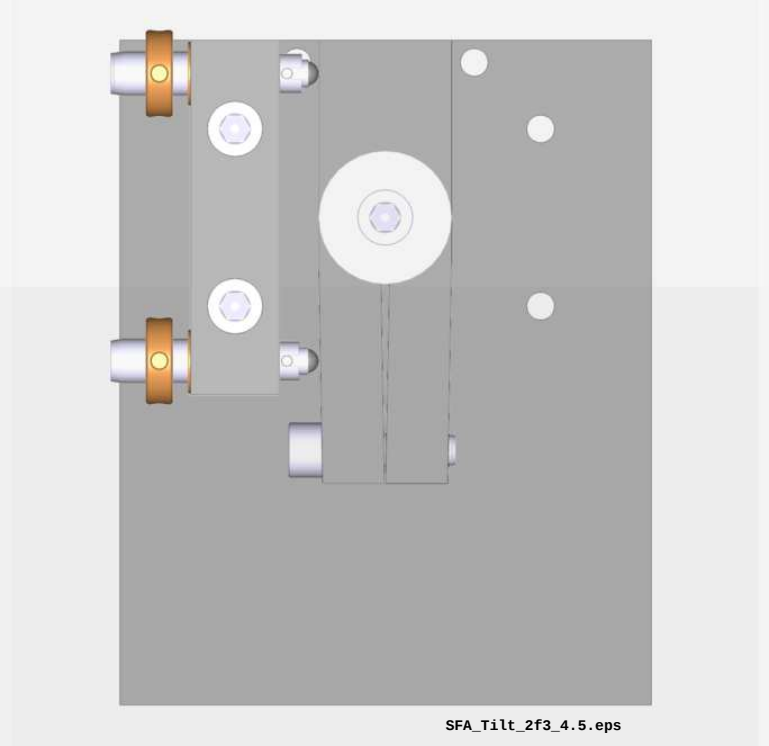


☐ Use the blue hex key to position the both Adjusters against the Tilt Clamp.

☐ Use the blue hex key with the Adjusters to make changes to the Tilt Table position that bring it even closer to the desired position.

This is done by driving one Adjuster against the Tilt Clamp while retracting the other to make room for the Tilt Clamp rotation.

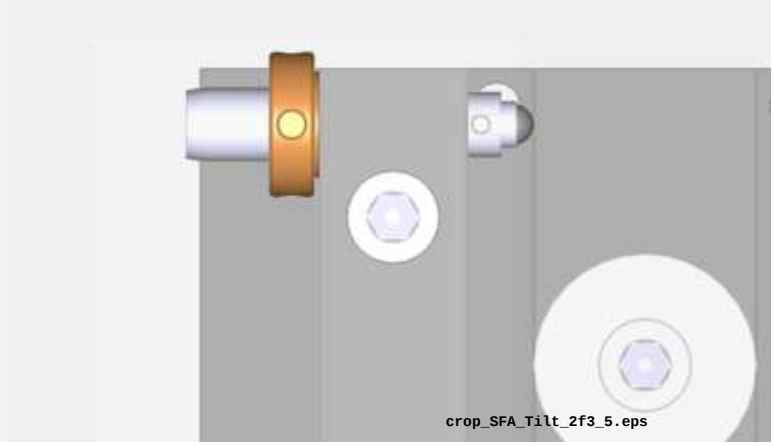
When finished, both Adjusters should be firmly against the Tilt Clamp.



☐ Tighten the Lock Nuts with your fingers.

☐ CAREFULLY use the blue hex key to fully tighten the Lock Nuts.
DO NOT OVER TIGHTEN.

At this point the Tilt Table should be very close to the desired position and firmly locked.



3.4 Set the Tilt Table to *exactly* the correct position using the Adjuster Push Rods.

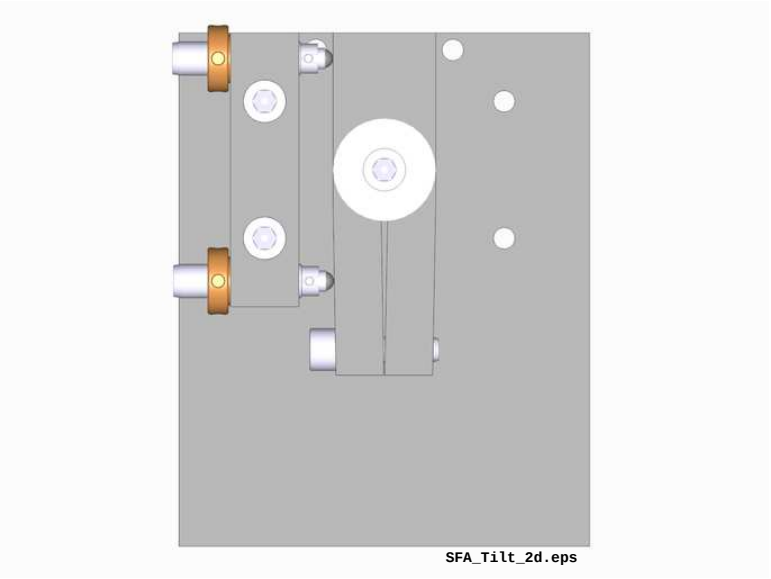
For these steps use the yellow hex key to engage the internal socket of each Adjuster.
Recall that turning the yellow hex key counterclockwise *extends* the Push Rod.

☐ Select the Adjuster which will rotate the Tilt Table in the desired direction. The Top Adjuster will drive the Tilt Clamp clockwise, the bottom one counterclockwise.

☐ SLOWLY drive the chosen Adjuster's Push Rod by turning the yellow key counterclockwise.
Make note of how far the key is turned. You may want to back out the same distance.
It will push on the Tilt Clamp and thus *slowly* turn it and the Tilt Table.

This motion will be barely perceptible looking at the mount, but should be noticeable in the camera image position.

☐ If the Tilt Table is going in the *desired* direction, stop. Use the yellow key to loosen the other Adjuster's Push Rod by the same amount.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*If the Tilt Table is going in the **wrong** direction, return the yellow key to the original position and start over again with the other Adjuster.*

☐ Continue, by alternately extending the Adjuster's Push Rod that improves the Tilt Table position and retracting the opposing one.

If adjusting the Push Rods brings you up against a *hard stop* you have reached its end of travel.
Put both Push Rods back to the middle of travel by:
With the blue hex key ...
- Loosen the Lock Nut.
- Back the Adjuster out a little bit.

With the yellow hex key ...
- Reposition the Push Rod to the middle of travel, 8 turns.

With the blue hex key ...
- Drive the Adjuster into firm contact with the Tilt Clamp.
- Tighten the Lock Nut.

Continue to use the yellow hex key to alternately retract and extend the Push Rods.

☐ When the Tilt Table is in the desired position, stop.

3.5 Firmly lock the Tilt Table position.

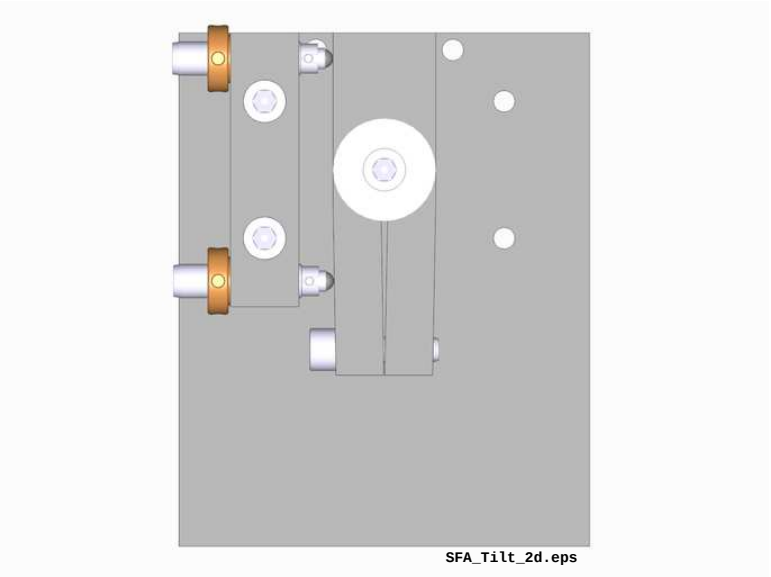
☐ Use the yellow hex key to alternately extend *both* of the Push Rods, a fraction of a turn at a time.

The Tilt Table will make smaller and smaller adjustments and lock ever tighter.

☐ Determining when to stop extending the Push Rods is bit of a judgement call.

The aluminum of Tilt Clamp deforms under the pressure of the Push Rods.

When the Tilt Table is in the desired position ***the adjustment is finished.***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4. Details of the Differential Adjustment Mechanism

For those who want to know what the insides of the Differential Adjustment Mechanism looks like . . .

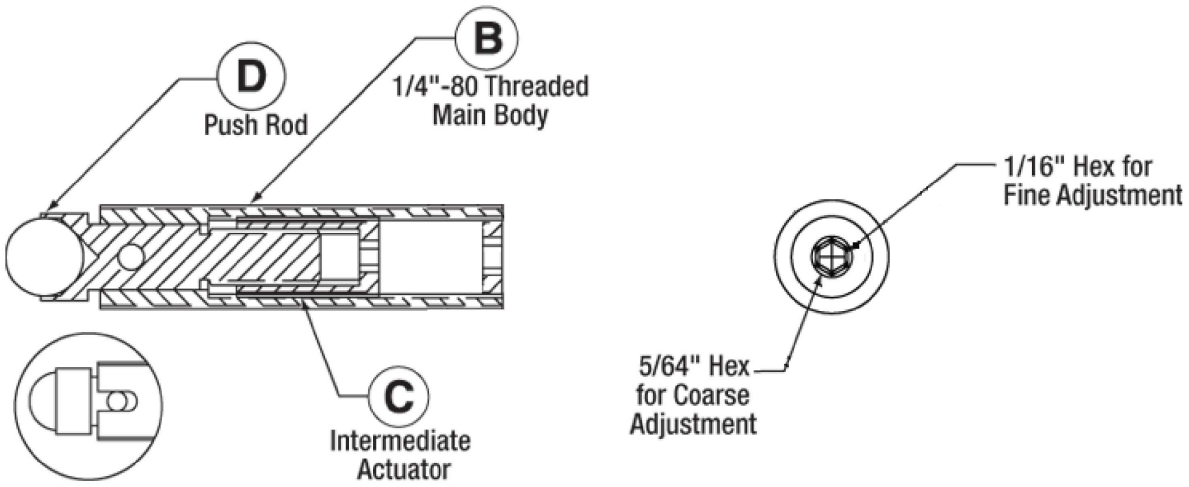

Figure 4-1. Differential Adjuster: mechanical detail
information and drawing courtesy of Thorlabs Inc.

4.1 Coarse Adjustment

The 1/4"-80 externally Threaded Main Body **B**, is shown in **Figure 4-1**.[2] A 5/64" hex key can be used to make the coarse angular adjustment of the Pan or Tilt axis of the Foveal Mount. Each full turn of the Threaded Main Body moves the Pan or Tilt angle approximately 1 degree.

4.2 Fine Adjustment

The fine-adjustment is made by inserting a 1/16" hex wrench through the clearance hole to engage the Intermediate Actuator **C** inside the Main Body. Each full turn moves the Pan or Tilt angle approximately $1/15^{th}$ degree.

The Fine Adjustment is limited to 17 turns.

4.3 Details of the Intermediate Actuator

Each rotation of the Intermediate Actuator **C** displaces the Push Rod **D** just 25 µm.[3]

The Main Body **B** has an internal M3 x 0.40 mm thread. This thread holds the Intermediate Actuator **C**, which may be rotated by a 1/16" hex wrench. The key to the design is that the Intermediate Actuator is both internally and externally threaded allowing a differential movement to be achieved between the Intermediate Actuator **C** and the Push Rod **D**.

The external thread of the Intermediate Actuator is the same M3 x 0.40 mm thread internal to the Main Body. When the Intermediate Actuator is rotated clockwise, it moves out of the Main Body by 400 µm per revolution. Connected to the internal thread of the Intermediate Actuator is the Push Rod. It mates to the Intermediate Actuator via a M3 x 0.375 mm thread and is restricted from rotating by the Main Body. (See detail in **Figure 4-1**.) As the Intermediate Actuator is rotated, it advances at the rate of 400 µm/rev, but the Push Rod retreats at 375 µm/rev. This results in a differential motion of the Push Rod that is equal to the net difference of the pitch of the two threads for total displacement of 25 µm/rev.

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2. The Thorlabs Differential Adjusters are sold with a Removable Knob which we do not use. Hence it is not in this diagram. It would have been labeled **A**.

3. µm = *micrometer*