HECTOSPEC FIBER POSITIONER
INSTALLATION AND REMOVAL PROCEDURE

December 8, 2003

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1.0 Introduction

Hectospec consists of a robotic positioner that will position 300 optical fibers at the f/5 focus of the converted MMT and a bench mounted moderate-dispersion spectrograph. Hectospec consists of three major parts: 1) the fiber positioner unit that is mounted on the telescope, 2) a large stationary spectrograph mounted on a 6 x 12 ft Invar-surfaced optical bench and 3) a 26 m-long bundle of optical fibers connecting the fiber positioner to the spectrograph. The Hectospec fiber positioner and optical fibers are also used with Hectochelle, which is a high-resolution echelle spectrograph.

The following outlines the procedure for installation and removal of the hectospec fiber positioner at the MMT 6.5M telescope.
2.0 Installing the Fiber Positioner on the Telescope

2.1 Removing the Positioner from the Garage

Make sure all test cables have been removed and stowed and instrument cables are mounted on cart cable hanger.

Ensure that the instrument lift is in its full up position and no lifting chains will contact the positioner when it is moved from the garage.

Rotate the cart casters to point towards the chamber using the portable jack to lift the cart if necessary.

Before moving cart out of storage area, make sure the cart jack screws (3) are backed off approximately 1” from floor.
Remove the cover from the fiber clearance slot. Remove/unhook fiber chain cable support from ceiling (1 place). Manually support fiber chain while moving cart out of storage area (garage) into telescope chamber.

2.2 Moving Instrument into the Chamber

Once instrument is out of storage and into the telescope chamber, remove retaining pin and extend cart pivot arm out until holes in pivot arm and cart frame line up. Re-install retaining pin into hole on cart to lock pivot arm.

NOTE: Push the fiber positioner by the cart (yellow) structure only.
Move instrument out of garage eastward until hole in pivot arm is located over floor pivot plate in floor under the catwalk.

**NOTE:** Be very careful to keep the fiber positioner moving in a straight path. The fiber chain must be continually supported and allowed to move freely during this operation.

Offload the fiber chain using the cable support hook hanging from under catwalk to support fiber chain.

Install threaded rod into pivot plate. Slip pivot sleeve through pivot arm hole and onto pivot rod. Slide sleeve down rod until sleeve bottoms out on pivot arm. See picture at top of page.

Rotate the casters so that they are tangent to the pivot point. This may require jacking of the cart to off-load casters.
2.3 Removing the Entrance Window Cover

Remove the Entrance Window Cover. This requires a minimum of 3 people. Remove six #10-32 SHCS that secure the cover to the entrance window frame, using a 5/32” ball driver.

**NOTE:** Do NOT remove the slotted screws, as these are part of the cover assembly.

Have two people lift the cover straight up while standing on either side of the cart and hand the cover to a 3rd person standing on the floor. Store the cover in a clean location in the instrument garage.

2.4 Rotate the Instrument/Cart About the Pivot Point

Rotate the cart about the pivot point until cart is perpendicular to north wall.

**NOTE:** The fiber chain must be supported and allowed to move freely during this operation.
Align fiber transition box to fiber transition support frame that is under catwalk. Rotate the positioner cart and fiber transition support gently until both flanges are flush.

Bolt fiber transition box to support on ladder with (4) 5/16-18 screws and washers from north facing side of fiber transition support.

2.5 Extending Fiber Chain/Moving Instrument onto Lift

Unbolt 8 bolts from transition box from upper gussets. Rotate/align positioner cart frame to mark on floor and rotate casters towards lift. Remove pivot pin and pivot sleeve from pivot plate. Slide pivot arm back into stowed position and insert pivot pin into hole to lock arm in place. **Verify that there are no obstructions hanging below the telescope that will contact or rub the positioner or entrance window.**
Rotate casters to point towards the lift. Move cart away from the ladder approximately $\frac{1}{2}$"-1” to facilitate the removal of the upper gussets. Remove bolts from gussets. Remove the upper gussets.

Attach pig to south end of cart.

**NOTE:** 2 people are required to guide the fiber chain out of the bin during the following operations
Very slowly back instrument away from transition support approximately 2 feet while carefully letting out fiber chain. Remove top panel from front of bin. When the bin is approximately 8 feet from the ladder, remove the lower panel. Two people must support the fiber chain so that the chain does not rest on the bottom edge of the fiber bin.

Align the cart to the lift.

**NOTES:**

- Instrument motion must be kept straight towards telescope.
- Keep clearance between the cart and the fiber chain.
- Be careful NOT to apply any side load to the fiber chain.

**CAUTION: Do NOT step over the fiber chain!!**

Set the telescope rotator to positive 6.9° toward the West (Counterclockwise while looking up at the rotator from beneath the telescope). Clean the rotator and instrument mounting surfaces.

Until the instrument is on the lift it will take 2 people (one on each side of the fiber chain) to guide the fiber chain out of the bin. Take great care not to touch the fiber bundles that are inside of the chain.

Position one person on each side of the instrument to guide it onto the instrument lift, while pulling it using the pig.

Watch for clearances between instrument and lift (east, south, west). Ensure that the jacking screws on cart do not hit the lift bumpers on the south side of the lift.

Verify the cart is parallel to the drive arcs with measuring tape – distance should be 49 ¾” on West Side and 49 5/8” from East side.
NOTE: it is very important to ensure that the cart is not skewed or the derotator struts will not fit.

2.6 Mating the Instrument with the Rotator Bearing

Once instrument is on the lift, lower the jackscrews to 1/8” off of the lift floor. Rough center the instrument to the telescope rotator bearing.
Lift the fiber chain off of the floor and secure it to the two eyehooks on the telescope cell using a lifting strap as shown. Fiber chain should be off of the floor (slightly higher than the yellow cart) so that the instrument cart can be rolled out without rubbing the fiber chain.

Temporary Fiber Chain Adjustable Hoisting Strap

Remove the electrical cable support hook on cart. Use mule tape to suspend cables to eye bolt in telescope cell. Remove the dust covers.
Retrieve 9 ¼” worth of cribbing to place under the instrument lift. The I-beam sections with handles are 8" and the aluminum blocks are 1 1/4”.

While watching the clearance of the instrument raise the lift until the rough guides just begin to engage. This will be more than 9”. The casters may require adjusting during this process.

Insert the I-beams and aluminum blocks under the lift. The I-beams should be rotated 45° so that a parallelogram effect is not created. The south I beams may need to be slid under the lift from the North Side.

Lower the lift onto the cribbing. Re-center the instrument.

Place three 6-ton hydraulic jacks under the cart frame. The fiber run precludes the use of a fourth. Ensure that the tops of the jacks have been screwed out several inches.
Insert the Megacam guide pins in a north and a south location.

Make measurements from the flat part of the rotator to the instrument flange to keep it level as the instrument is raised. Set an equal gap at 3 points 120° apart to establish parallelism of the instrument-mounting flange with the instrument rotator bearing. Do this by measuring from the bottom of the mirror cell to the bottom of the instrument-mounting flange.

Simultaneously jack up the instrument until the fine guides just begin to engage.

**NOTE:** Keep screwing down the static feet as the cart is lifted. This is for the safety of the crew and to make sure the instrument does not translate.

Use two ¼” aluminum plates as spacers under the feet before screwing them down.

Jiggle the instrument on the cart as the guides begin to engage the rotator bearing ID to ensure that nothing is binding.

While watching the fine guides, slowly jack the instrument. Continue to measure the rotator/instrument distance to keep the instrument parallel with the instrument rotator.

Once the fine guides have engaged, continue to slowly jack the instrument up until the instrument mounting flange is approximately 1/8” from the rotator.
Check the alignment of the instrument and rotator using the mounting bolts. If necessary, adjust the rotator until the holes line up.

(4) Outer Cables – Removed to Allow Access to Bolts with a Torque Wrench

Make sure the 4 outer cables are disconnected (2 on each side).

Insert all the bolts and hand-tighten.

Jack the instrument until the instrument mounting flange just makes contact with the rotator. Uniformly apply a light pre-load to the mounting flange using the three jacking screws.

IMPORTANT: Check periodically to see that there is still a light preload on the 3 jackscrews. This is to ensure that, as the mounting bolts are torqued, the instrument does not support the weight of the yellow cart.
Initially torque all mounting bolts to 600 in-lbs (50ft-lbs)

Final torque all mounting bolts to 840 in-lbs (70ft-lbs)

Reconnect the four outer cables. Reinstall the dust covers.

2.7 Installing the Derotator Struts

NOTE: Under no circumstances should the length of the derotator struts be changed beyond their adjustment limit. All white marks must be realigned after struts are in place.

Install all the derotator struts; they are numbered. Rotating the strut tube relative to the end clevises will provide +/- .06” of elongation to ease installation of the struts. Once installed, however, each strut’s length should be restored to its original length by rotating it back to its original position, by aligning the white marks. Never remove the small screws in the adjustment slots near each end of the struts. Once the struts are installed, tighten the large shoulder bolts at each end of the strut with a wrench until snug. Do not over tighten. The thread is much smaller than the head of the bolt.
IMPORTANT: DO NOT FORGET to remove the 2 screws that connect the derotator structure to two yellow struts on the cart. These screws provide the lateral restraint of the derotator during transportation only. These must be removed before lowering the cart.

VERY IMPORTANT: Do Not Forget to Remove The Screws (2 Places) Holding Derotator to the Cart

2.8 Separating the Instrument from the Cart

Confirm that there is still a preload on the jackscrews.

Remove the 1/2-13 bolts (4) per flange from the instrument/cart interface struts (24 bolts total).

NOTE: Double check to make sure that all of these bolts are removed.
Make sure the weight of the cart is on the (3) cart jackscrews. Remove the hydraulic jacks.

Rotate the BOTTOM of the (3) cart jack screws CCW to remove flange preload and lower the cart. Rotating from the bottom is done to ensure that the feet do not unscrew from the threaded rods. Watch for space between the yellow struts and the derotator.

Once a 1/2" gap opens between the cart and the derotator, put the hydraulic jacks back under the cart and take the load off of the (3) jackscrews.
Raise the jackscrews to set a 1/2" gap between the jackscrews and the lift using the 1/2" spacers (two 1/4" spacers) as guides to set the spacing. Remove the plates once the gap is set.

In unison, lower the hydraulic jacks until the weight is back on the jackscrews. Pump the hydraulic jacks once to lift the weight off of the jack screws and repeat this lowering process 1/2" at a time until the weight of the cart is on the casters. It may be necessary to use some cribbing under the hydraulic jacks during portions of this operation if they do not have sufficient stroke.

**NOTE: Turn the casters so that they all point north before the cart is fully lowered.**
2.9 Removing the Cart from Under the Instrument

Remove all the yellow struts from the cart except the one nearest the fiber run.

Remove the (2) feet and the (2) jackscrews from the south side of the cart.

Lower the North jackscrew. This is used as a brake.

Raise the lift enough to remove the I-beams and cribbing.

**NOTE:** While watching the clearance of the fiber run and electrical cables, lower the lift to the floor.
NOTE: Carefully check and adjust electrical cables under the positioner so that they clear the cart as it is rolled from underneath the positioner. Make sure that the cables are at least 20.5” above the lift.

Lift the north jackscrew. While watching the cables and fibers, roll the cart toward the North side of the chamber. Keep the cart straight as it is rolled off of the floor lift.
When the cart has cleared the lift extend the pivot arm.

Align the pivot point and insert the pivot screw and sleeve.

Turn the casters tangent to the pivot point.

Support the fibers and pivot the cart 90° towards the garage.

**NOTE: Be careful not to let the cart hit the fiber chain as the cart is pivoted. Lift the fiber chain as required.**

Remove the sleeve and pivot screw. Retract the pivot arm.

Roll the cart into the garage.
2.10 Connecting the Electrical Cables

Lay the cables out toward the North and untangle any twists.

Slide the cables under the fiber chain. Connect the cables to the drive arc connector panel.
NOTE: Remove temporary support strap under fiber chain.

Set the hardware limits to +/- 105 degrees. This is sub-limit 1 position. Set the software limits to +/- 100 degrees.

With someone manning the telescope emergency stop mushroom test the rotator. Check the spacing between the derotator and the instrument, near where the cabling comes out. The spacing should be ½” wide and ¾” high using the taped instrument ruler in the hardware box.

Completed installation!
3.0 Removing the Fiber Positioner from the Telescope

3.1 Moving the Cart Underneath the Fiber Positioner

Lift the fiber chain off of the floor and secure it to the two eyehooks on the telescope cell using a lifting strap as shown. The fiber chain should be off of the floor (slightly higher than the yellow cart) so that the instrument cart can be rolled in and out without rubbing the fiber chain.

IMPORTANT: Make sure that all power to the positioner is turned off. All lights on the Pulizzi in the electronic racks should be off. Follow the procedure below.

1. Press the E-stop on the “MMT Fiber Positioner Servo Driver Assembly”.
2. Turn off the two servo Pulizzis, P1 and P2.
3. Turn off the wavefront sensor computer. Open a vncviewer window to the wavefront computer. Press the “Exit” buttons on the waveserv and wavecamr windows. Close the cygwin windows. Press the Windows Start button at the lower left and press the Turn off computer button. When the dialog box appears complete the windows shutdown.
4. Turn off switch 3 on P7 (WFS DRV AC).
5. Turn off switch 4 on P7 (WFC AC).
6. Turn off switch 5 on P5 (WFS CTRL AC).
7. Turn off switches 8, 7, 6, and 1 on P5.
8. Turn off switches 4, 3, and 2 on P5.

Disconnect the cables from the patch panel. Cap all the connectors. Remove the mule strap and strain relief. Remove the cable strain relief plate (3/16" Allen). Set the cables on the floor and put the screws back in the bracket. Slide the cables under the fiber chain. Lay the cables out toward the North and untangle any twists.

Lift the cables over the support bars on the derotator. Again, make sure the cables are not twisted.
Tie the connector ends up to the telescope cell with mule tape to eyebolt. Bolt strain relief panel to derotator structure.

Roll the cart from the garage. Extend the pivot arm.

Remove both fiber bin front panels.

Align the pivot arm with the pivot plate and insert the sleeve and screw.

Turn the casters tangent to the pivot point.

While watching the fiber clearance rotate the cart around the pivot point.

**NOTE: Be careful not to let the cart hit the fiber chain as the cart is rotated. Lift the fiber chain as required.**
Rotate the casters toward the South.

Remove the sleeve and pivot screw. Retract the pivot arm.

Clear all tools from the curbs on the floor lift.

**NOTE: Watch the fiber run – have someone designated for this task at all times! Also watch the clearance between the electrical cables and the cart under the derotator.**

While watching the clearance of the fibers, push the cart onto the lift underneath the derotator.

Set the rotator to positive 6.9° toward the West (Counterclockwise while looking up at the rotator from beneath the telescope).

Verify the cart is parallel to the drive arcs with measuring tape – distance should be 49 ¾” from West side and 49 5/8” from East side.

Attach all the removable yellow struts onto the cart. Torque 5/16-24 bolts to 147 in-lbs (12 ft-lbs) and the 1/2-13 bolts to 542 in-lbs (45 ft-lbs).

Attach the two South static feet to the jack screws and adjust the alignment of the cart.

Turn all (3) static feet down to secure the cart.
3.2 Mating the Cart to the Fiber Positioner

Check the level of the cart.

Retrieve the 9 ¼” of cribbing - the 8” I-beams with handles and 1 ¼” aluminum blocks.

Raise the lift to approximately 4” below the point where the struts surfaces mate.

Insert the I-beams and the cribbing under the lift. Clock them to 45°.

Lower the lift onto the cribbing.
Align the cart struts with the fiber positioner struts. Use a ball driver as a guide to line up the boltholes between the two flanges.

Place 3 hydraulic jacks under the cart at the position of the jackscrews. Raise the hydraulic jacks until the jack heads just touch the bottom of the cart.

While checking the spacing under the jackscrews, jack the cart using the 3 hydraulic jacks simultaneously until two 1/4" plates fit under each jackscrew. Remove both plates and screw down the jackscrews until they are preloaded on the lift (not on the plates – the plates serve only as a spacing gauge to raise the cart uniformly).

Repeat this lifting process until the gap between the cart struts and fiber positioner struts is 1/4", check the alignment and adjust the cart as necessary during this operation.

Start threading in the 1/2-13 bolts (4 per strut flange - 24 bolts total).
Continue to raise the cart using the hydraulic jacks. When the strut flanges touch, make sure that all of the strut hardware is started.

Add a slight amount of upward preload to the flange using the (3) jackscrews (not the hydraulic jacks).

Torque all ½-13 bolts (24) connecting the yellow cart struts to the positioner to 45 ft-lbs.

**NOTE:** Periodically check the preload on the jackscrews to make sure the flanges are preloaded.
3.3 Removing the Derotator Struts

IMPORTANT: DO NOT FORGET to install the 2 screws that connect the derotator structure to two yellow struts on the cart. These screws provide the lateral restraint of the derotator during transportation.

Loosen the shoulder bolts on either end of each derotator-to-telescope strut. Carefully remove each strut and store them behind the West trunnion of the telescope.
3.4 Unbolting the Positioner from the Telescope

IMPORTANT: Re-check the preload on the (3) jackscrews to make sure that the positioner flange is preloaded to the telescope rotator flange.

Remove the four outer (2 on each side) motor cables to remove the bolts near the electronics box.

Use a breaker bar to loosen each of the 5/8" socket head cap bolts on the positioner flange (20 bolts total).

After all of the bolts are loosened and removed, reconnect the four cables. Double-check to make sure all the bolts have been removed (20 bolts total).
3.5 Lowering the Positioner

**NOTE: 3 people are required for this operation (one at each jack screw).**

Lower the positioner and cart using the jackscrews. Lower the jackscrews by turning the lower nut near the static feet 1/4 turn in unison. Turning the screw by the lower nut ensures that the jackscrew does not back out of the foot during lowering.

Make measurements from the flat part of the rotator to the instrument flange to keep it level as the instrument is lowered. Set an equal gap at 3 points 120° apart to establish parallelism of the instrument-mounting flange with the instrument rotator bearing. Do this by measuring from the bottom of the mirror cell to the bottom of the instrument-mounting flange.

**NOTE: This whole process is done with the jackscrews. Do not use the hydraulic jacks.**

Lower the instrument in this manner until the fine guide blocks are cleared. Jiggle the instrument to ensure nothing is binding.

Lower the instrument until the distance between the machined surface on the flange to the cell is 9 1/4". Measure from telescope mirror cell to bottom of thick part of the instrument flange (3 people).

Insert three hydraulic jacks and take the load off of the screw jacks. Make sure the valves on the jacks are closed.

Set the spacing under the jackscrews using two 1/4" plates.
Rotate the casters to point North.

Lower the cart using the hydraulic jack until static feet just touch. Jack the cart up one pump to take the load off of the static feet and screw up the static feet until the spacers fit. This will set up the next ½” lowering increment.

Repeat this lowering process until the cart is on the casters.

When the cart is on the casters, tighten down the static feet and remove the hydraulic jacks.

Raise the lift approximately 1.5” - enough to remove aluminum plates and I-beams from underneath the lift. The South I-beams will need to be passed under the lift in order to remove them.

**NOTE: Carefully Monitor the Cables and Fiber Chain. Readjust Fiber Chain Strap to Gain More Slack if Necessary.**

Make sure the static feet are tightened down. Lower the lift and instrument to the floor.
3.6 Moving the Instrument to the North Side of the Chamber

Insert the cable support post. Remove mule tape suspending cables to the eyebolt in telescope cell. Carefully drape the cables over the support post.

Remove the fiber chain support strap.
IMPORTANT: Verify That There Are No Obstructions Hanging Below the Telescope That Will Contact or Rub the Positioner or Entrance Window.

Loosen the static feet and, while two people support the fiber chain, very slowly back instrument off the lift while carefully inserting the fiber chain into the fiber bin.

NOTE: Push the Fiber Positioner By the Cart (Yellow) Structure Only.

When the bin is approximately 8 feet from the ladder, insert the lower fiber bin panel. Two people must support the fiber chain so that the chain does not rest on the bottom edge of the fiber bin.

NOTES:
- Instrument motion must be kept straight towards telescope.
- Keep clearance between the cart and the fiber chain.
- Be careful not to apply any side load to the fiber chain.

CAUTION: Do NOT step over the fiber chain!!

When the bin is approximately 2 feet from the ladder. Insert the top fiber bin panel.
Extend the pivot arm. Slowly move the cart until the pivot arm lines up with the pivot position. Drive with the pig while carefully guiding the fibers.

Insert the pivot screw and sleeve.

Rotate the casters tangent to the pivot point. The portable jack MUST be used for this operation to avoid translating the cart.
Rotate cart away from the ladder approximately $\frac{1}{2}''$-1'' to facilitate the installation of the upper gussets. Install the East and West gussets onto the fiber bin. Adjust cart rotation to fit both gussets behind transition box. Insert bolts to secure gussets.
Rotate/align positioner cart frame to mark on the floor. Jiggle both the cart and transition box until both flanges are flush.

Install 8 bolts from transition box to upper gussets.

Remove the (4) 5/16-18 screws and washers that attach the fiber transition box to the ladder.
3.7 Pivoting the Fiber Positioner

Rotate the cart about the pivot point 90° until cart is parallel to north wall.

IMPORTANT: The Fiber Chain Must Be Supported and Allowed to Move Freely During this Operation.

Remove pivot pin and pivot sleeve from pivot retainer. Slide pivot arm back into stowed position and insert pivot pin into hole to lock arm in place.

Rotate the casters towards the garage.
3.8 Replacing the Entrance Window Cover

Clean the entrance window COVER with Kim-Wipes and Isopropanol.

Replace the Entrance Window Cover. This requires a minimum of 3 people. Have one person lift the cover up to two people standing on either side of the cart. Position the cover over the entrance window. Attach the six #10-32 SHCS to secure the cover to the entrance window frame, using a 5/32” ball driver.
3.9 Moving Fiber Positioner into Instrument Garage

Make sure there is a clear path to the instrument garage. The west cooling air duct must be moved away from the rolling path of the instrument in chamber.

Disconnect the fiber chain cable support from under catwalk (1 place). Manually support fiber chain while moving cart from the telescope chamber into the storage area (garage).
While supporting the fibers, push the cart into the garage.

NOTE: Be very careful to keep the fiber positioner moving in a straight path. The fiber chain must be continually supported and allowed to move freely during this operation.

Offload the fiber chain using the cable support hook hanging from ceiling in instrument garage to support fiber chain.
Fiber positioner stored in instrument garage!