TMT P2 actuator assembly outline

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Introduction

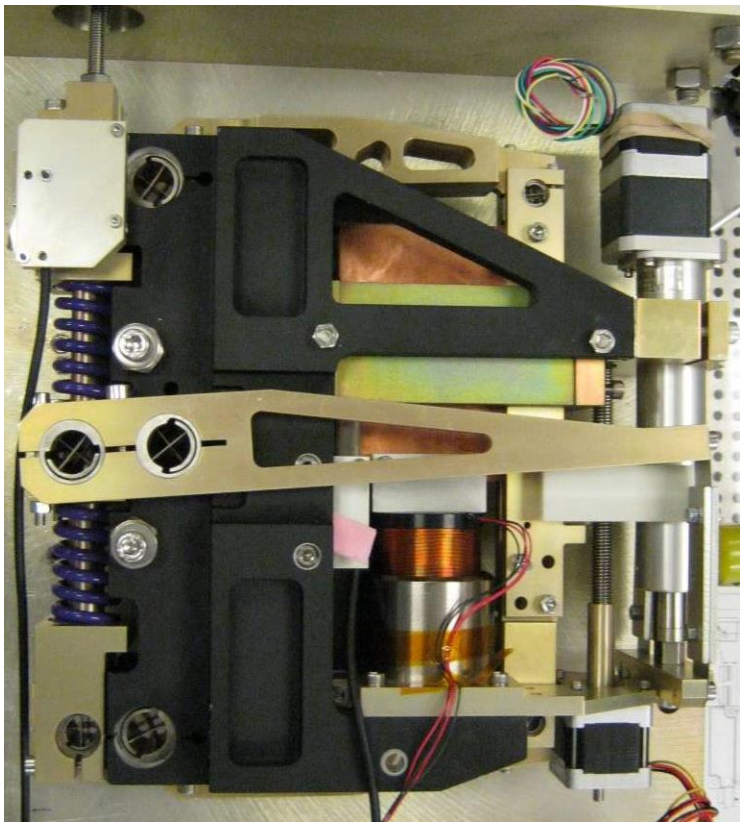
This document outlines the assembly process for the TMT P2 segment actuator. The objective is to identify the important steps and the overall assembly sequence in order to scope the task. It is not intended to be a formal or complete procedure. This document will evolve as more experience is gained assembling additional actuators.

A few notes: this document contains photographs of the first two actuator prototypes. Actuator #1 was built following the drawings at http://www.tmt.org/documents, posted on 15 Jun 2010. This is the baseline actuator. Actuator #2 is similar, except that it uses composite bearings in place of the J-20 flex pivots (TMT-201), and uses different actuator arms (TMT-105, -126); it is being evaluated to see if this cost-savings measure will provide acceptable offload performance. The assembly sequence is the same for both actuators unless otherwise noted in square brackets.

All fasteners are metric, except for the ¼-28 screw that attaches the actuator end block to the Digit actuator.

Based on experience with the first two actuators, there have been minor changes to some of the drawings, which will be reposted before subsequent actuator copies are built.

Assembled actuator #1



Machined Parts (from TMT.CTR.PRE.10.052.REL01, 15 Jun 2010)

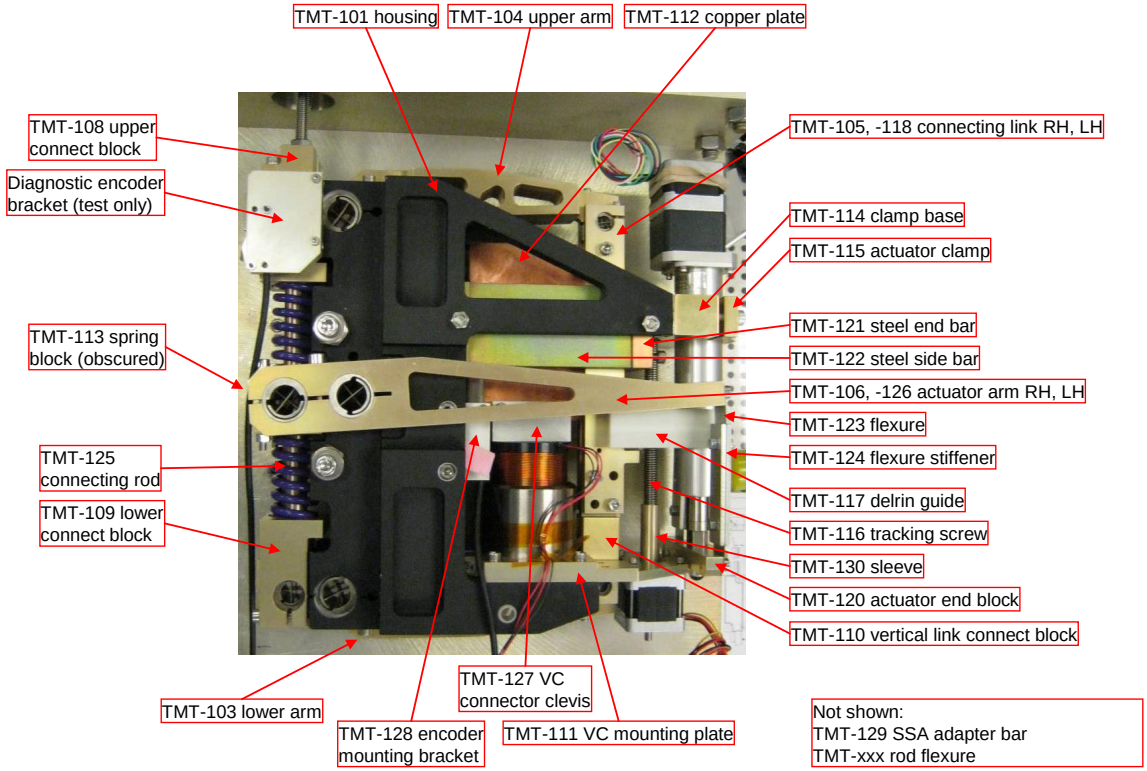
TMT-101	SAT_MACHINED_HOUSING_RH
TMT-103	LOWER_ARM
TMT-104	UPPER_ARM
TMT-105	CONNECTING_LINK_RH_REV_B
TMT-106	ACTUATOR_ARM_RH
TMT-108	UPPER_CONNECT_BLOCK
TMT-109	LOWER_CONNECT_BLOCK
TMT-110	VERT_LINK_CONNECT_BLOCK
TMT-111	VC_MOUNTING_PLATE_REV_B
TMT-112	COPPER_PLATE
TMT-113	SPRING_BLOCK
TMT-114	CLAMP_BASE
TMT-115	ACTUATOR_CLAMP
TMT-116	TRACKING_SCREW
TMT-117	DELRIN_GUIDE
TMT-118	CONNECTING_LINK_LH
TMT-119	SLEEVE
TMT-120	ACTUATOR_END_BLOCK
TMT-121	STEEL_END_BAR
TMT-122	STEEL_SIDE_BAR
TMT-123	FLEXURE
TMT-124	FLEXURE_STIFFENER
TMT-125	CONNECTING_ROD
TMT-126	ACTUATOR_ARM_LH
TMT-127	VC_CONNECT_CLEVIS
TMT-128	ENCODER_MTG_BRKT
TMT-129	SSA_ADAPTER_BAR
TMT-130	TRACKING_SCREW_SLEEVE

[Note: two revisions of tracking screw sleeve drawing were inadvertently included in the drawing archive. Drawing TMT-130 should be used, and -119 deleted.]

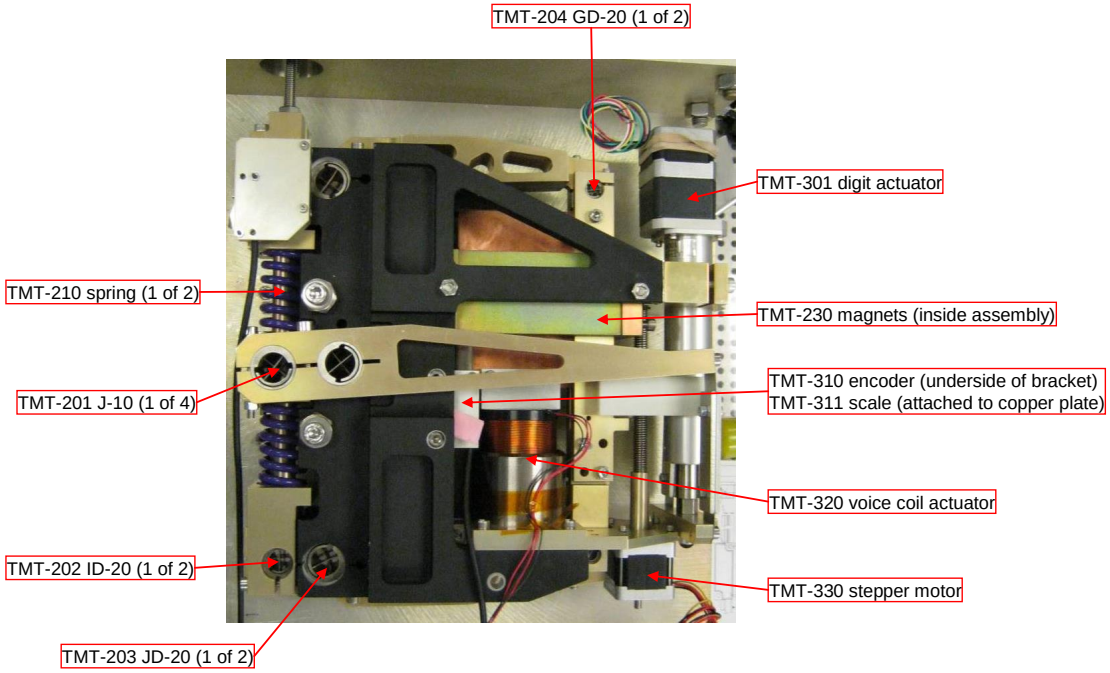
Procured parts (from TMT.CTR.PRE.10.052.REL01, 15 Jun 2010)

Procured mechanical parts		
TMT201	4	1" flex pivot C-Flex J-20
TMT202	2	0.75" flex pivot C-Flex ID-20
TMT203	2	1" flex pivot C-Flex JD-20
TMT204	2	0.5" flex pivot C-Flex GD-20
TMT210	2	Compression spring, TBD
TMT220	1	Assorted fasteners
TMT230	2	2" x 2" x 1/2" N52 NdFeB magnet
Procured active parts		
TMT301	1	UltraMotion Digit linear actuator D-A.083-HT17-3.5 (final model may change slightly)
TMT310	1	Micro-E Systems MII linear encoder, MII5850
TMT311	1	Micro-E Systems MII scale, 303-R3683-01
TMT320	1	Voice-coil actuator, H2W NCC15-24-050-1R
TMT330	1	Stepper motor NEMA17, Anaheim Automation 15Y202D-LW4 or similar
TMT340	1	Limit switches, Hall sensor IC, indicator magnet

The assembled actuator annotated with the machined parts.



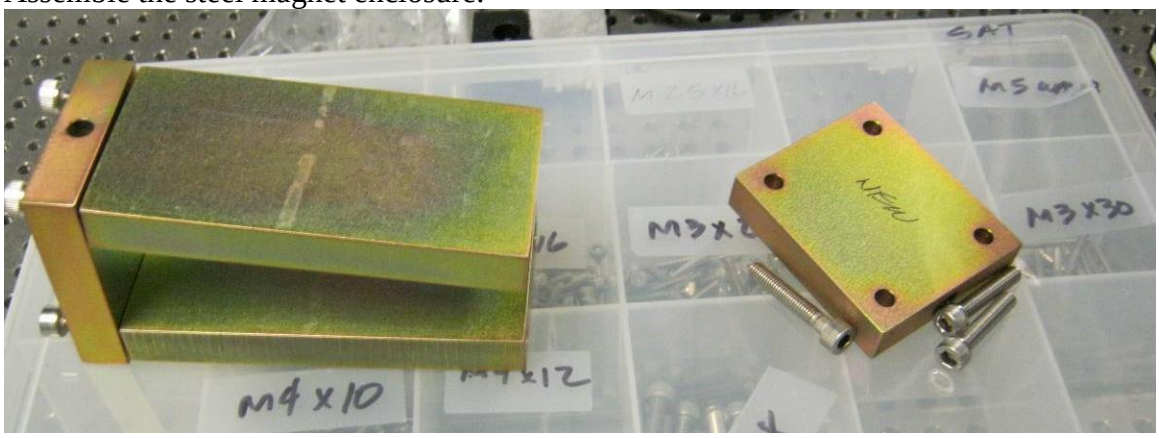
The assembled actuator annotated with the procured parts.



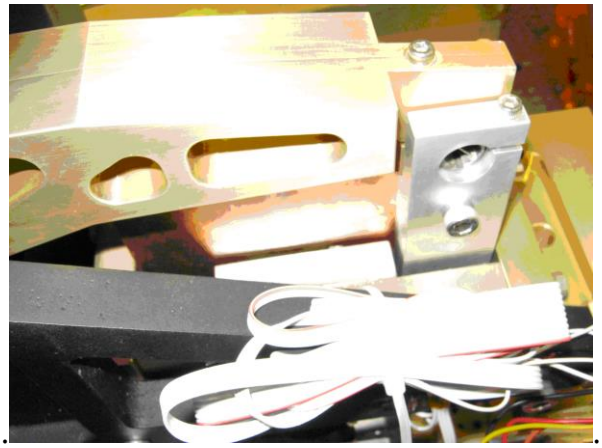
Assembly process

1. Assemble and install the magnetic damper

Assemble the steel magnet enclosure.



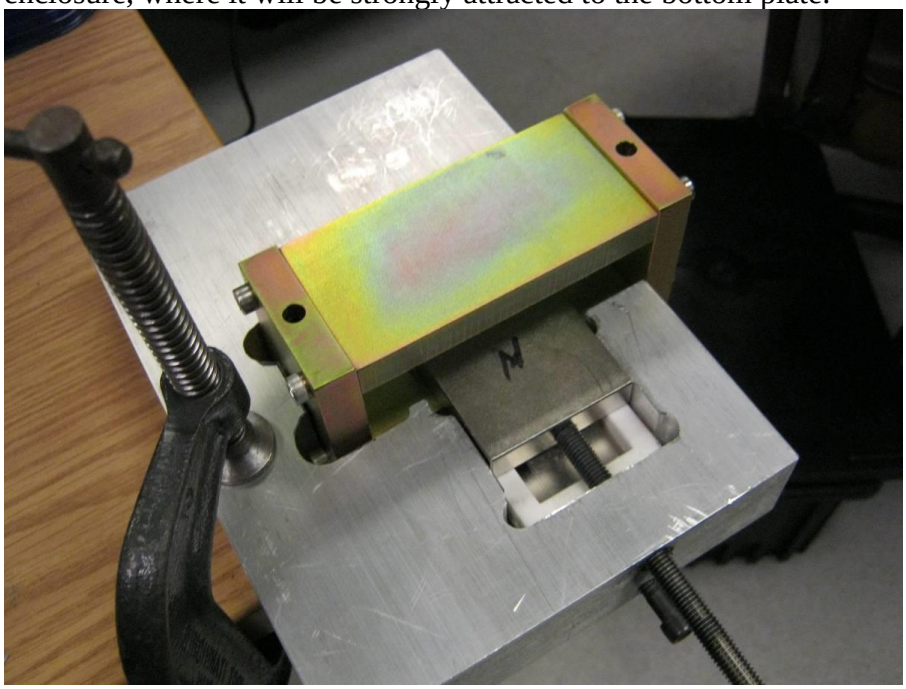
Insert the magnets. The magnets are mounted one to the bottom plate, one to the top plate, with their poles aligned (e.g. the N pole of the bottom magnet and the S pole of the top magnet face the gap, so that if the steel flux return were not present, the magnets would pull themselves together). They are centered approximately 5 mm left of the centerline to allow at least 2 mm clearance for the connecting link, as shown here in the assembled actuator:



WARNING!!! The magnets to be installed are very powerful. They are attracted to each other and to steel parts with >100# force at short distances. Wear leather gloves when handling and installing the magnets. Use extreme care not to get magnets near steel parts or work surfaces, other magnets, or each other, until they are installed in the enclosure (which closes the magnetic circuit).

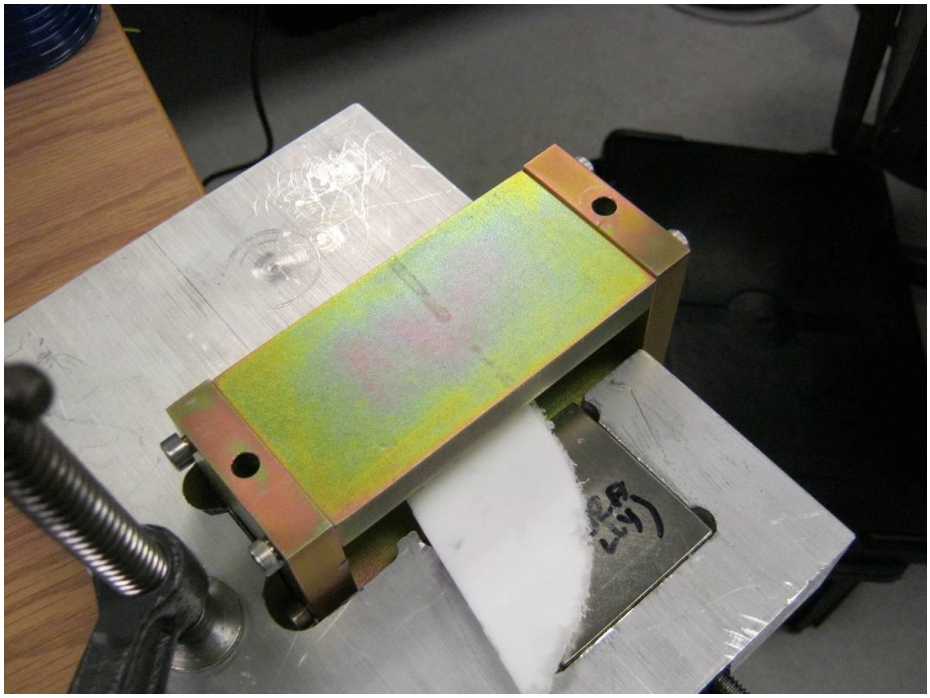
The magnets are usually shipped from the manufacturer in a stack with plastic spacers between magnets. We built a simple aluminum tool for separating and inserting the magnets, described below. Other assembly processes are possible.

Use the magnet jig to remove a magnet from the stack and push it into the magnet enclosure, where it will be strongly attracted to the bottom plate.



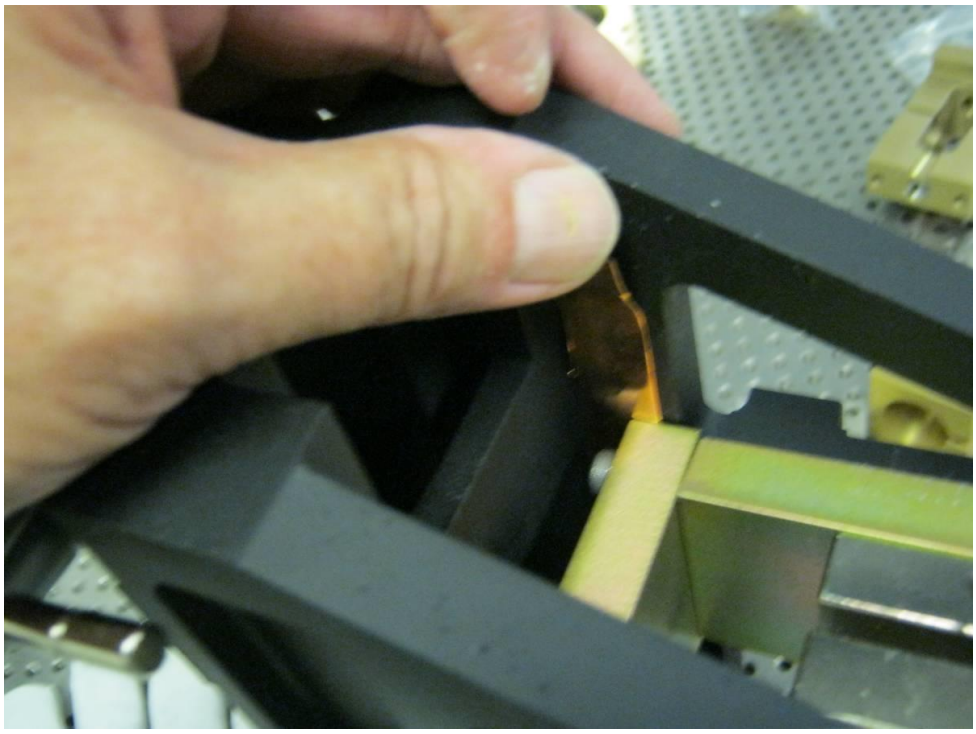
(You can see in the photo the annular square plastic spacer which separates the magnets in the stack.)

Flip the magnet enclosure over, and also the magnet stack, and install the other magnet so that poles are aligned as described above Use a plastic spacer, slightly thinner than the gap, to keep the magnets apart until the second magnet is in contact with its plate.



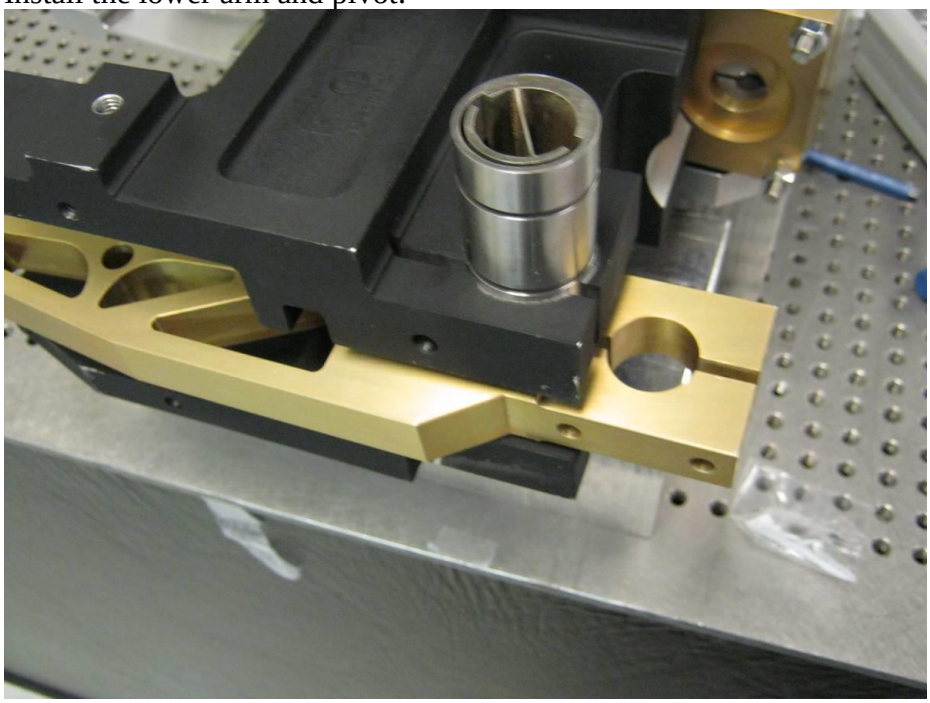
After installation, the attraction of the magnets to the steel plates will keep them in place in the assembly. For production, we would probably use some wicking adhesive, but that's not needed for the prototypes.

Mount the magnet assembly in the actuator casting. Shim the magnet enclosure symmetrically at the inner end to take up any casting clearance. Otherwise the casting could crack when the mounting bolts are tightened.

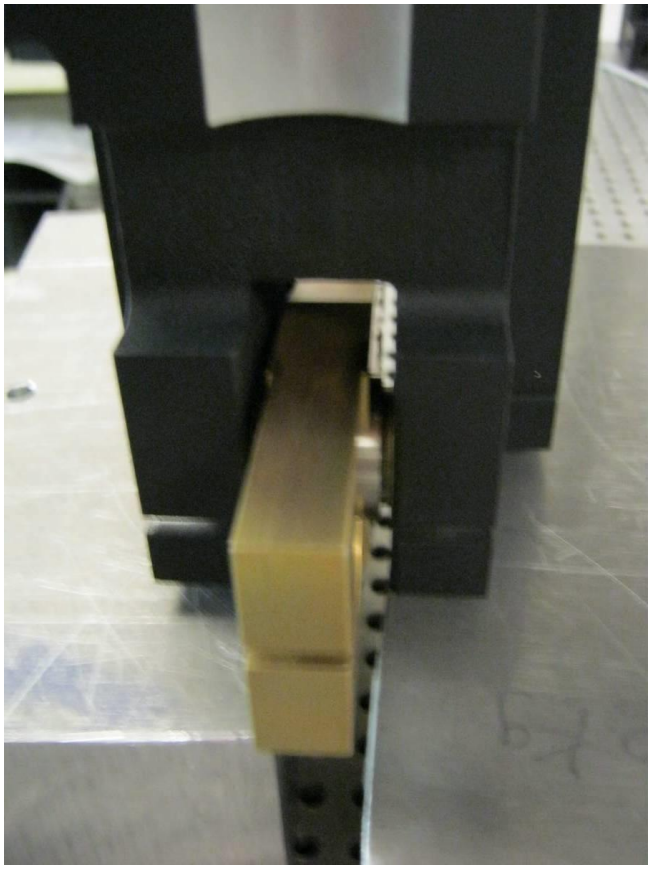


2. Assemble and install pivots and the four-bar linkage – part I

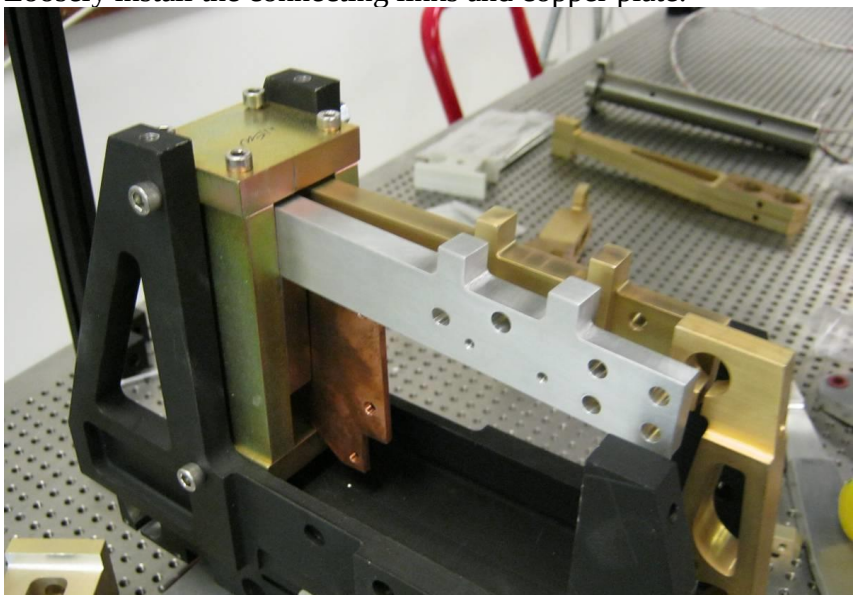
Install the lower arm and pivot.



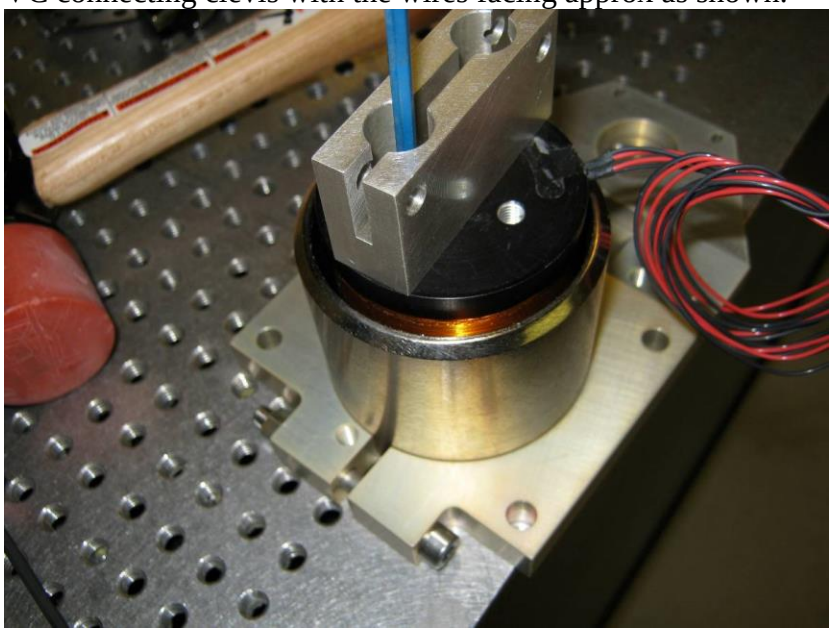
Center the pivot to within 0.5 mm. The actuator is shown set on two blocks which support the frame, not the arm. A simple jig should be designed for this purpose.



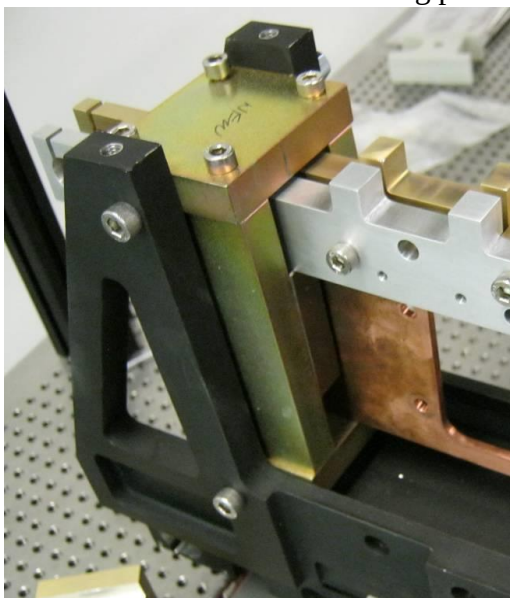
Loosely install the connecting links and copper plate.

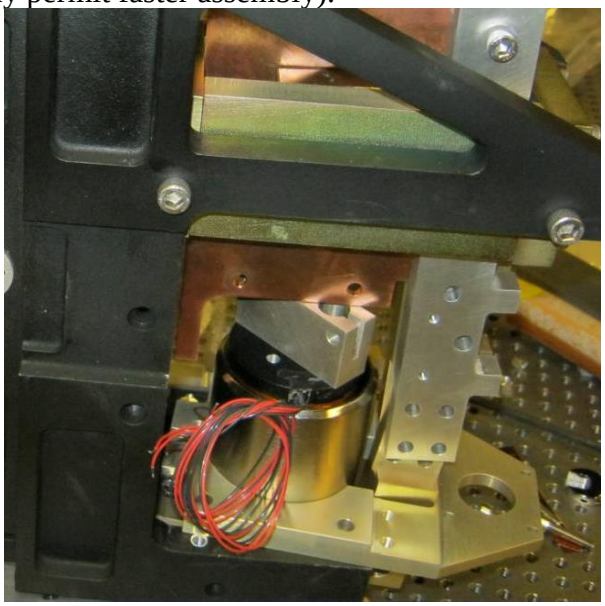


Assemble the voice coil in the VC mounting plate. Make sure the magnet is seated fully into the mounting plate before tightening the clamp bolt. Assemble the coil and upper VC connecting clevis with the wires facing approx as shown.



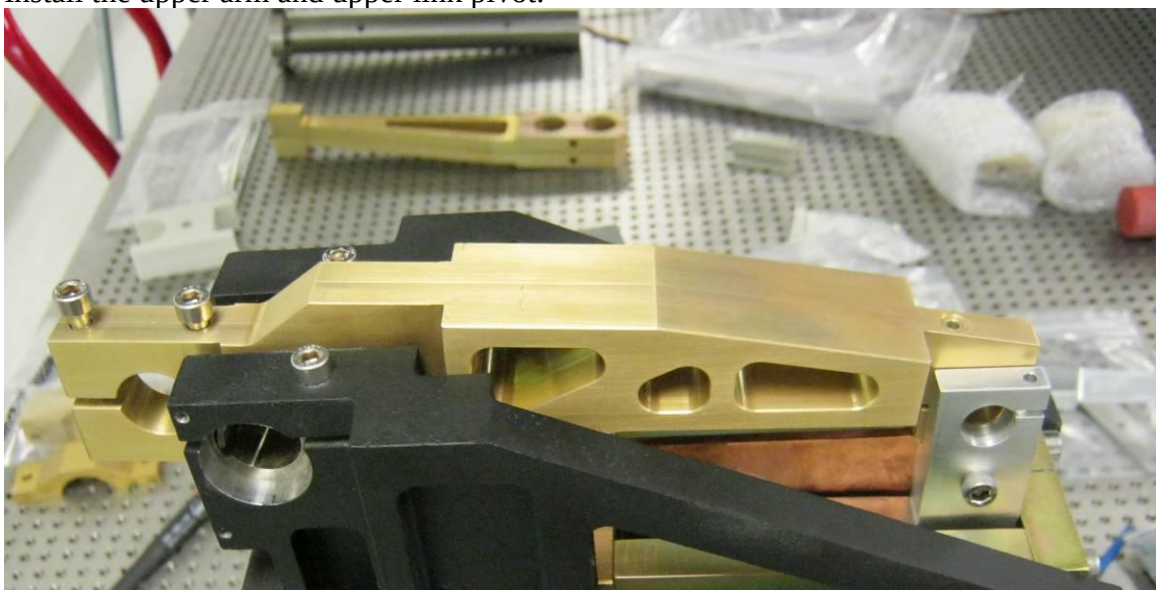
Install the voice coil assembly between the connecting link and lower arm. Install at least one bolt between the two links. (This step is subject to future change, where a modification to the VC mounting plate may permit faster assembly).





Align the voice coil to the copper plate and install screws and nuts through the clevis and the copper plate.

Install the upper arm and upper link pivot.



3. Assemble and install pivots and the four-bar linkage – part II

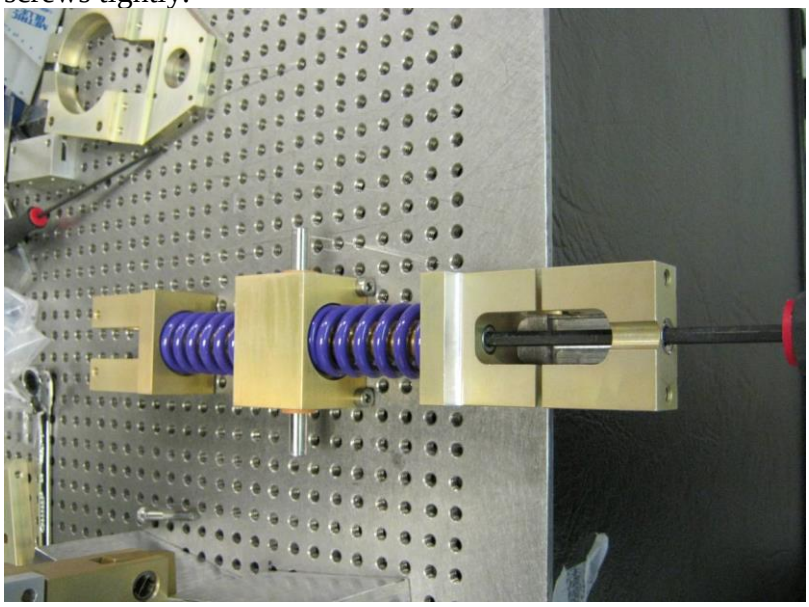
Install the J-20 offload bearings in the housing, and clamp them in place. The bearings should be inserted until they are flush with the inside surface of the housing. (The photo, below, is for actuator #2, but the flexure bearings install in the same location).

[For Actuator #2 only: Insert the dowel pins axles in the bushings, and install them a distance TBD from the outside of the housing].

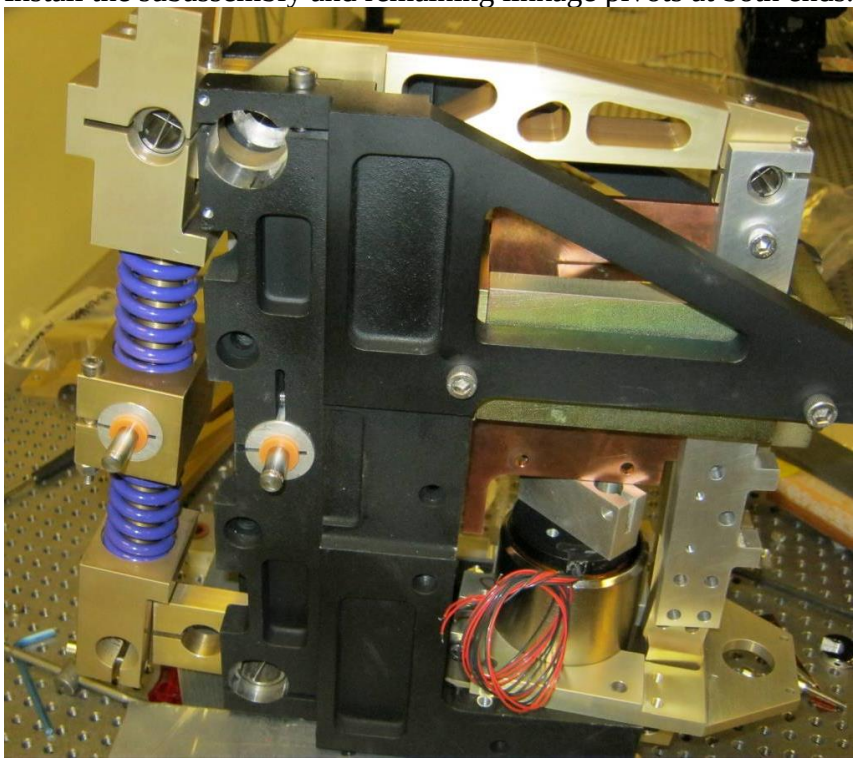
Install the J-20 offload bearings in the spring block, and clamp them in place. The bearings should be inserted until they are flush with the inside radius of the block. (The photo, below, is for actuator #2, but the flexure bearings install in the same location).

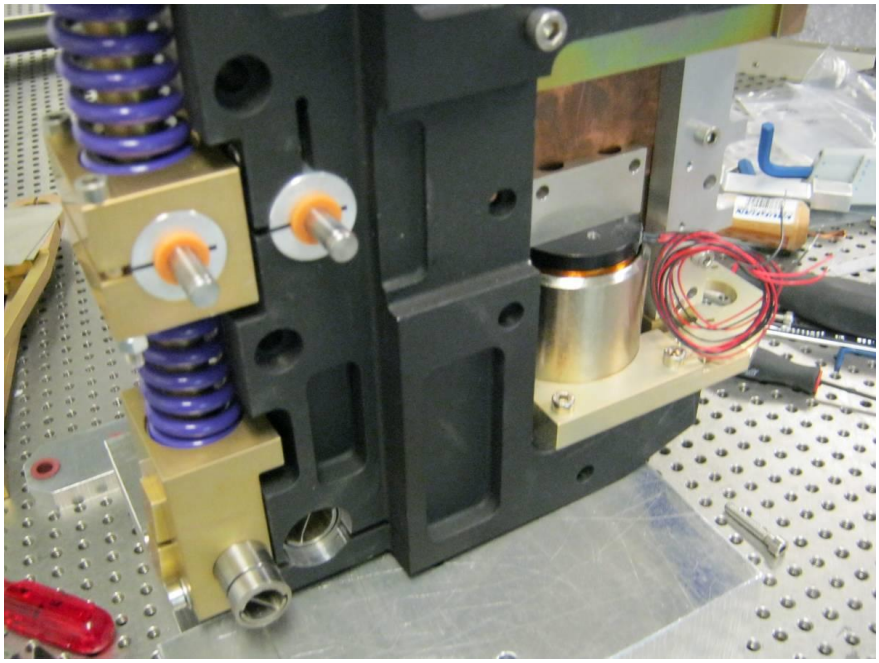
[For Actuator #2 only: Insert the dowel pins axles in the bushings, and install them a distance TBD from the outside of the block.]

Assemble the spring block, springs, upper and lower connection blocks, pivot blocks and connecting rod as shown on a flat surface. The blocks must all align after torquing the screws tightly.

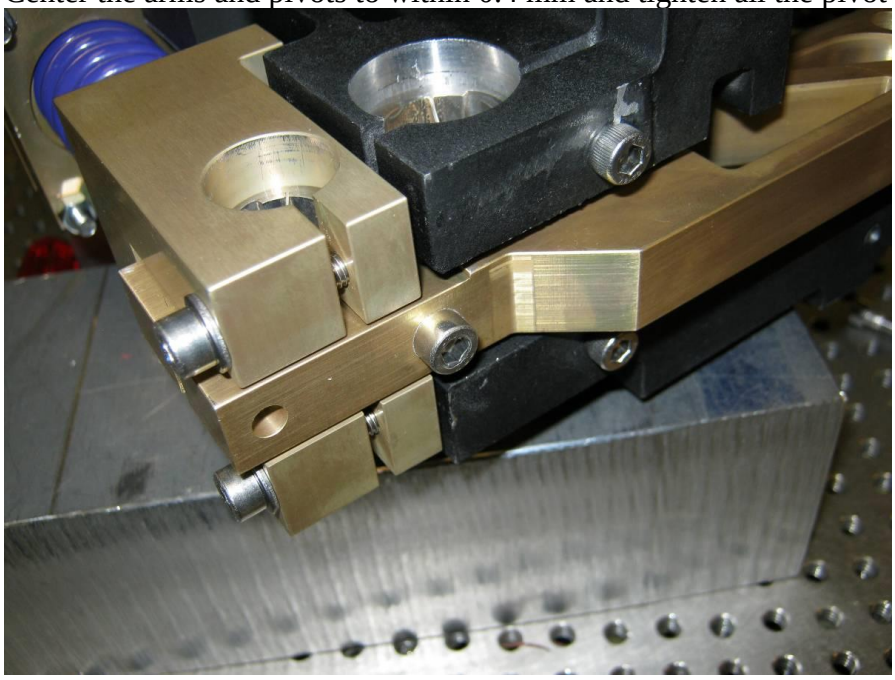


Install the subassembly and remaining linkage pivots at both ends.

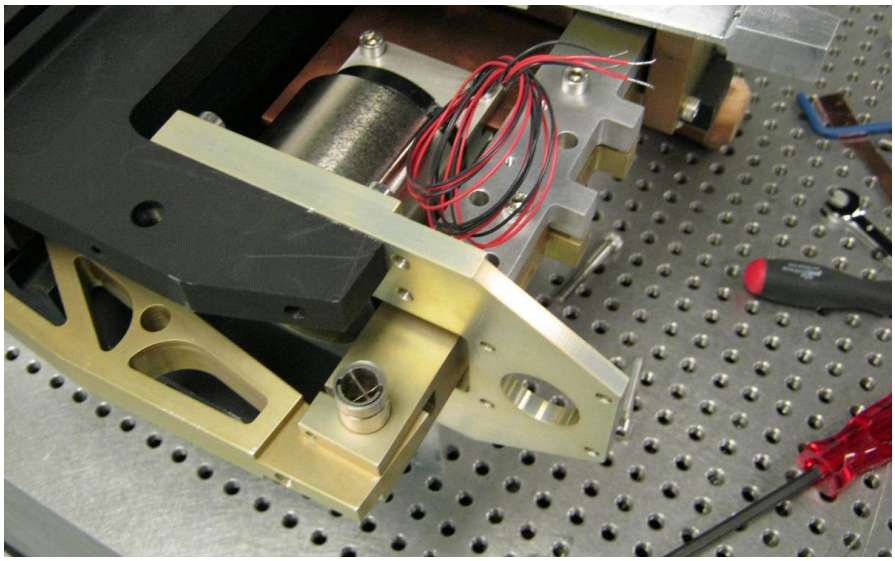




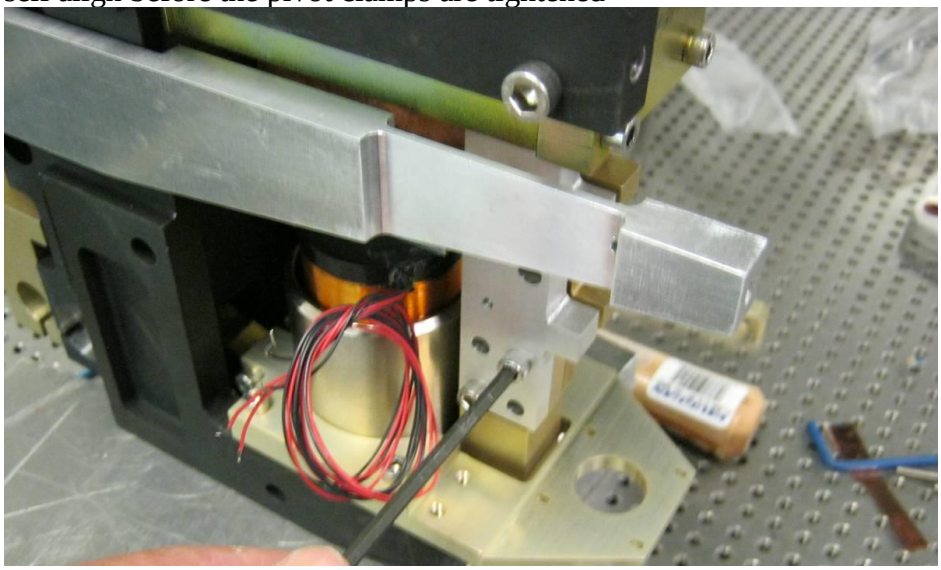
Center the arms and pivots to within 0.4 mm and tighten all the pivot clamping screws.



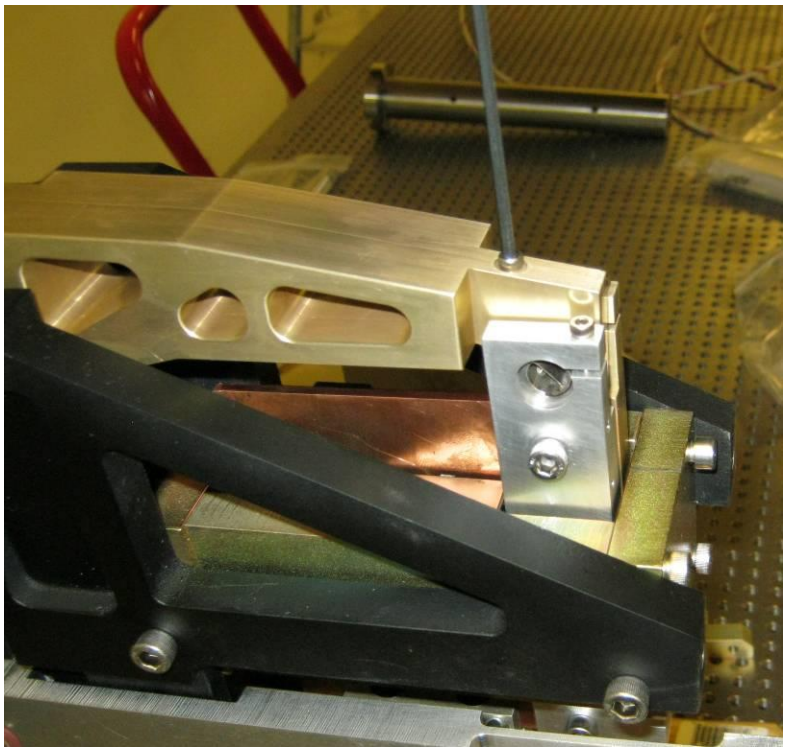
Install the vertical link connection, and the linkage pivots on the other end of the actuator and the screws which clamp the pivots.



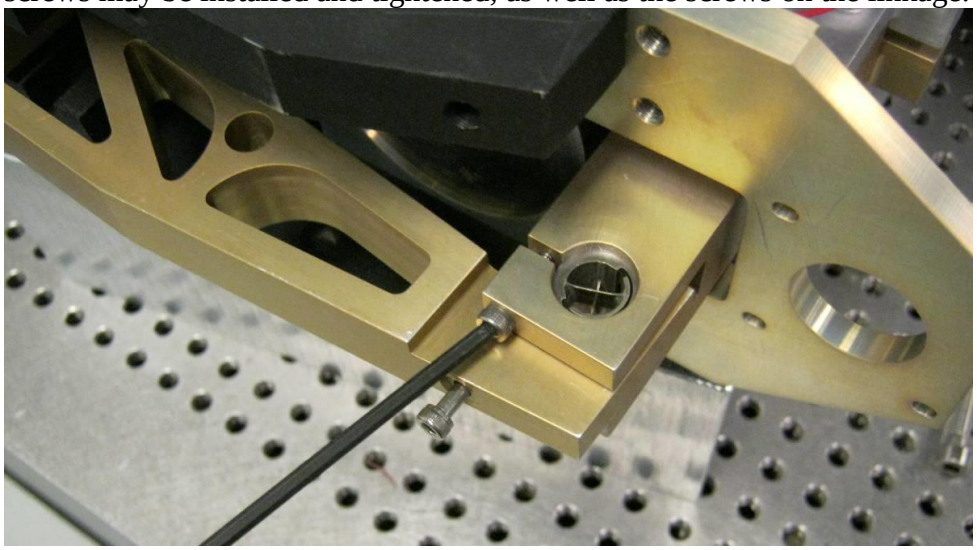
Loosely install the bolts to connect the linkage. Do not tighten yet as the linkage must self align before the pivot clamps are tightened



Center the flexure pivots in the arms and tighten the arm screws only.



After aligning the linkage and voice coil, and centering the pivots, all the pivot clamp screws may be installed and tightened, as well as the screws on the linkage.

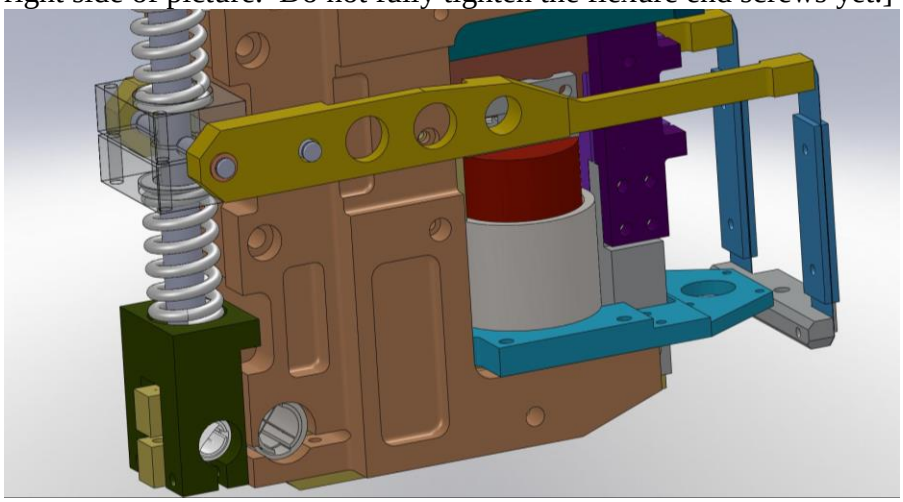


Inspect the mechanism. Check that all fasteners have been tightened. The four bar linkage should travel freely over its full range of travel with no binding or interference. In particular, there should be no contact between the copper plate and the inside of the magnetic damper, and between the voice coil's coil assembly and magnetic field assembly.

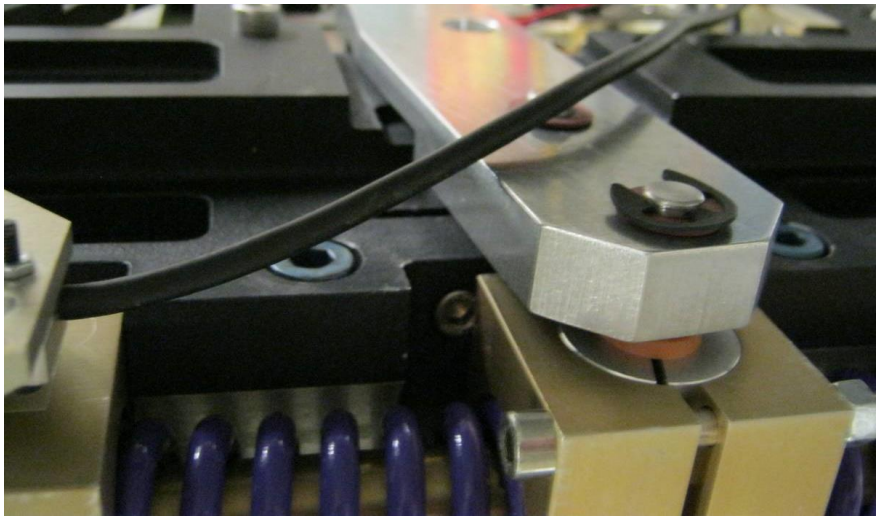
4. Install the offload mechanism

Install the actuator offload arms and clamp the flexure bearings. Attach the flexure stiffeners to the blade flexures, and install them as shown on right side of picture. Do not fully tighten the flexure end screws yet.

[For Actuator #2 only: Install the offload arms and plastic pivot bushings. Be sure to install the plastic spacer washers behind the arms to prevent the arm from touching the casting. Attach the flexure stiffeners to the blade flexures, and install them as shown on right side of picture. Do not fully tighten the flexure end screws yet.]



[For Actuator #2 only: Install C clip retainers, 4 places, on the dowel pins.]

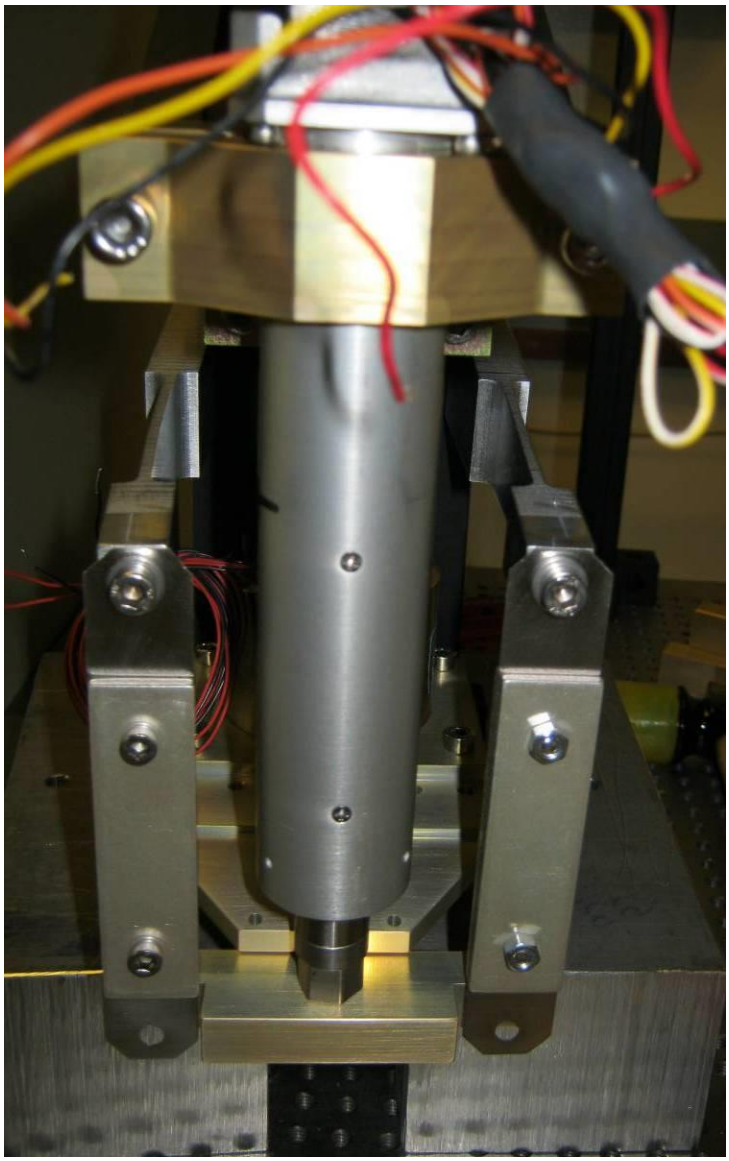


Verify that the actuator arms can move freely over their range of travel.

Install the actuator end block to the end of the Digit actuator. When tightening the attachment screw, use a wrench on the flats of the actuator output shaft to avoid putting a torque on the actuator (which could damage the internal anti-rotation device).

If the snubber is to be installed, do it at this stage. Instructions for installing the snubber are given at the end.

Install the offload actuator clamp halves and the actuator and hand tighten.



Position the actuator in the clamp at a distance of 35mm from the bottom of the motor. Orient the motor so that the actuator end block is parallel to the back of the VC mounting plate, and tighten the clamping screws (In final production model assembly, a simple gauge will be used to locate the actuator). Now tighten the screws at both ends of the blade flexures.

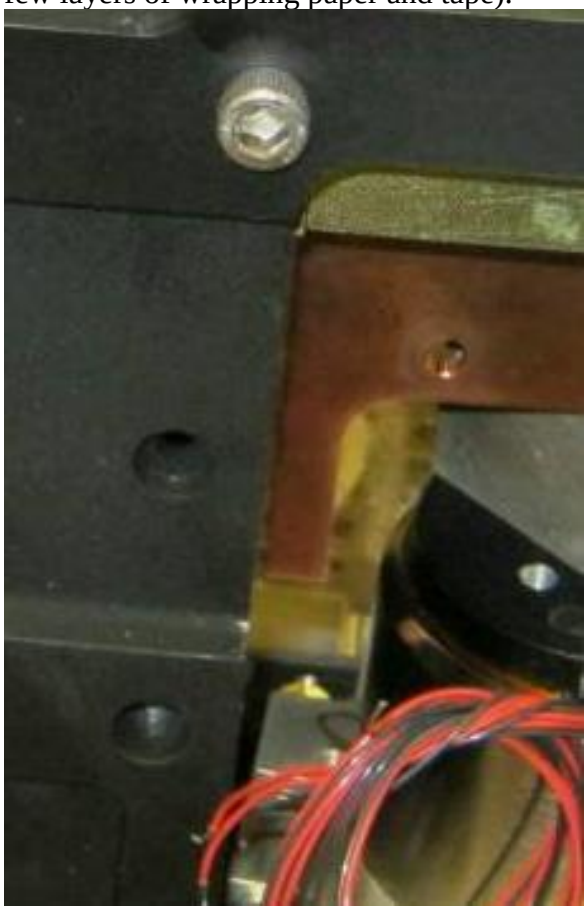
Remaining tasks

Encoder installation

If a Mercury II Alignment Tool (ATMII5000-S; an electronics box with status LEDs that connects to the encoder output) is available, install the encoder(s). Otherwise skip the encoder installation.

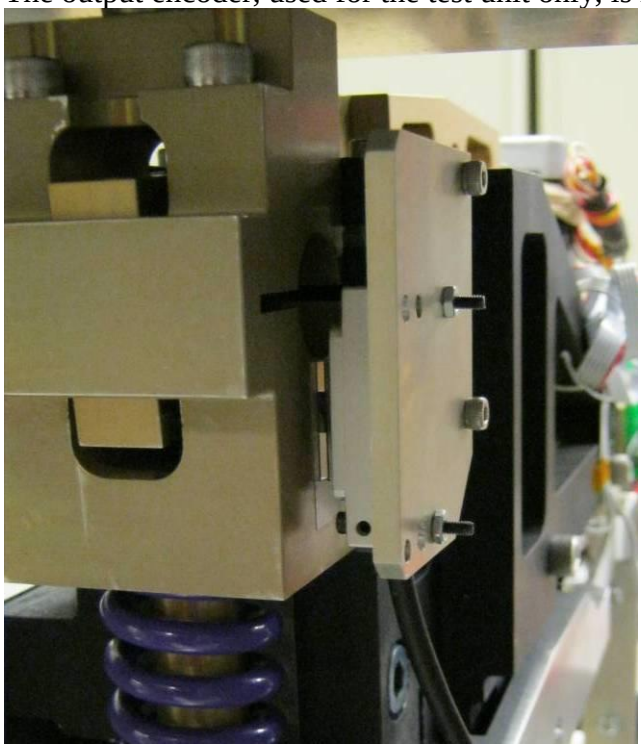
Install the encoder scale: it is attached to the tang at the bottom of the copper pate at a distance TBD from the bottom and TBD from the edge closest to the voice coil. For the prototype, it is positioned manually and attached using tape adhesive.

(For production, the scale would be installed on the copper plate earlier in the process using a locating template and a UV-curing epoxy, and then protected until this stage by a few layers of wrapping paper and tape).



Mount the encoder head to the encoder bracket, and mount the bracket to the housing. To avoid scratching the encoder scale, use a soft cloth to keep the parts from touching until the screws are tightened. (For production, the encoder would also be installed earlier in the process, and protected until this stage by a few layers of wrapping paper and tape.)

The output encoder, used for the test unit only, is installed following a similar procedure.



For both encoders, use the Mercury II encoder alignment tool and verify proper signal over the range of travel of the actuator.

Snubber installation

Install the plastic bushings at both ends of the 8 mm hole in the actuator clamp base. Remove the offload motor if has already been attached. Thread the tracking screw into the Delrin guide; insert the screw through the hole and align the guide with the tabs on the linkage. Attach the tracking screw sleeve to the NEMA 17 motor, and install the motor at the bottom of the VC mounting place. Attach the tracking sleeve to the tracking screw, and attach a retaining clip to the top of the tracking screw where it extends through the actuator clamp base. Reattach the offload motor.

SSA adapter bar attachment

This bar attaches to the back of the actuator, and is used for mounting the actuator to the SSA. Do not attach it at this stage.