Clio Instrument

Installation and Commissioning Plan

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Revision History

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1. Applicable Documents

N/A

2. Acronyms and Abbreviations

AO	Adaptive Optics
AOS	Adaptive Optics System
ASM	Adaptive Secondary Mirror
ITAR	International Traffic in Arms Regulation
MagAO	Magellan AO
MMT	Multiple Mirror Telescope
TBC	To Be Confirmed
TBD	To Be Determined
TBR	To Be Reviewed
UA	University of Arizona

3. Scope and System Overview

The purpose of this document is to capture the essential requirements and the plan for installation and commissioning of the Clio Instrument with the MagAO system. The hardware consists of:

- The Clio instrument
- Cables
- Electronics Support Rack
- NAS Mounting Ring
- Clio Storage/Service Cart

This document will be used as both reference and a tool for repeated installations. This document is anticipated to be updated as the procedures are modified, obsoleted, and/or improved.

4. General Installation Details

The Clio instrument is provided by the UA Clio PI, Philip Hinz to serve as the first light instrument for the MAGAO system. The instrument and support hardware were developed for use with the MMT AO system and have been thoroughly tested on that facility.

The installation is divided into the following phases:

1) Initial Instrument-Cart Mechanical Assembly,
2) Installation on the NAS
3) Alignment
4) Regular Instrument Preparation
5) Removal and Storage

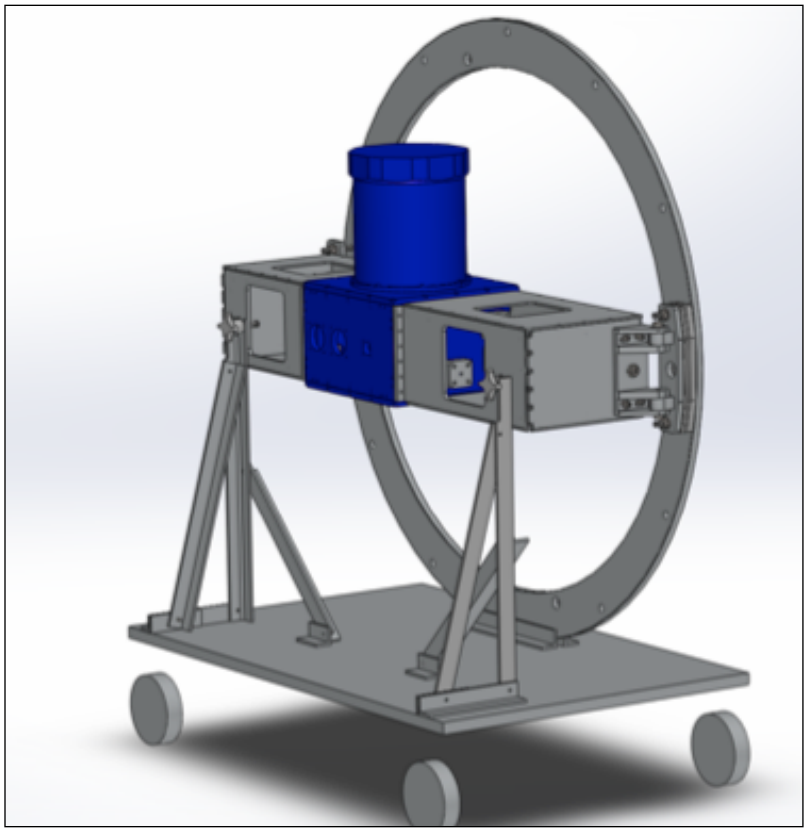


Figure 1. Clio mounted on storage cart.

5. Initial Instrument-Cart Mechanical Assembly

This section describes the tasks and procedures to mate the Clio instrument to the NAS mounting ring and the dedicated storage cart. These tasks are expected to be executed once, after the instrument has arrived at the Magellan facility. The initial assembly and mating to the NAS mounting ring are to be carried out under the direct oversight of the Clio PI or other designated by the Clio PI.

The procedure is:

1.1) Cart Assembly

1.1.1) Mount wheels on cart platform
1.1.2) Mount lower brackets for mounting ring clamp and forward holding brackets.

1.2) Clio Mounting Frame (extension) Assembly
1.2.1) Install the left and right side mounting frames
1.2.2) Install the left and right instrument-ring interface clevis mounts

1.3) Mounting Clio to NAS mounting ring
1.3.1) Rig the lifting web to the Clio instrument as shown in Figure 3.
1.3.2) Using the overhead crane, lift the Clio instrument onto the cart and loosely fasten the instrument to the cart angle brackets.
1.3.3) While maintaining crane tension on the Clio instrument, position the ring with the single thru hole at the bottom such that the clevis mounting studs on ring are

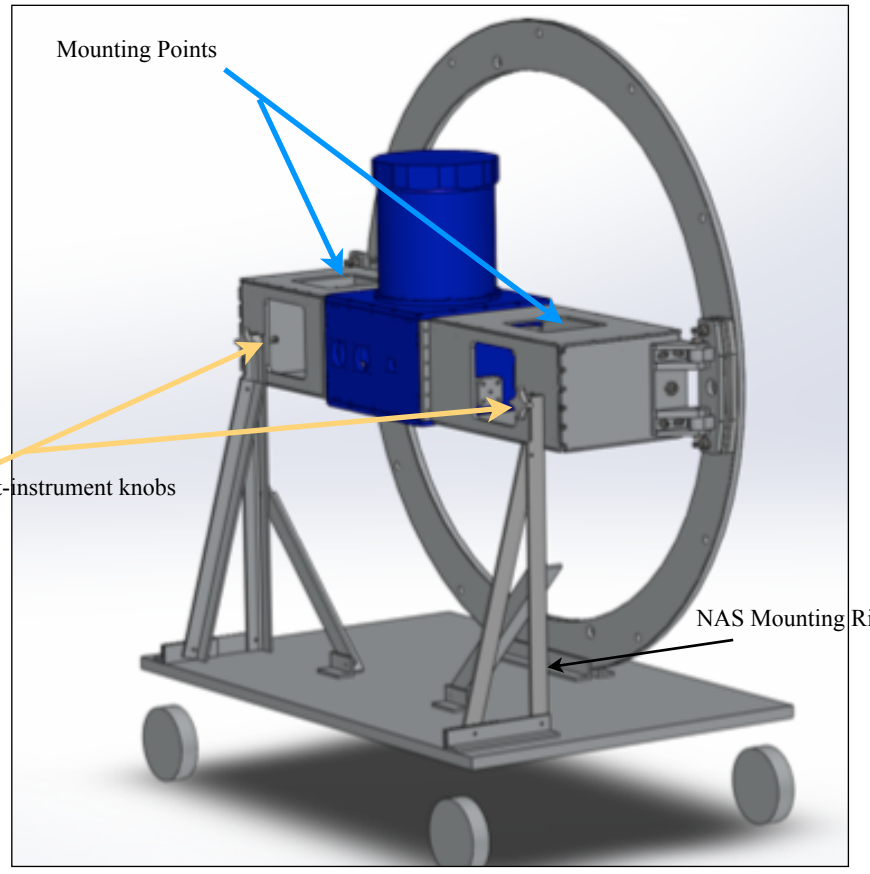


Figure 2: Lifting configuration of NAS Mounting Ring for Storage Cart mounting.

oriented as shown in figure 2, lift the NAS Mounting ring onto the cart. Two people

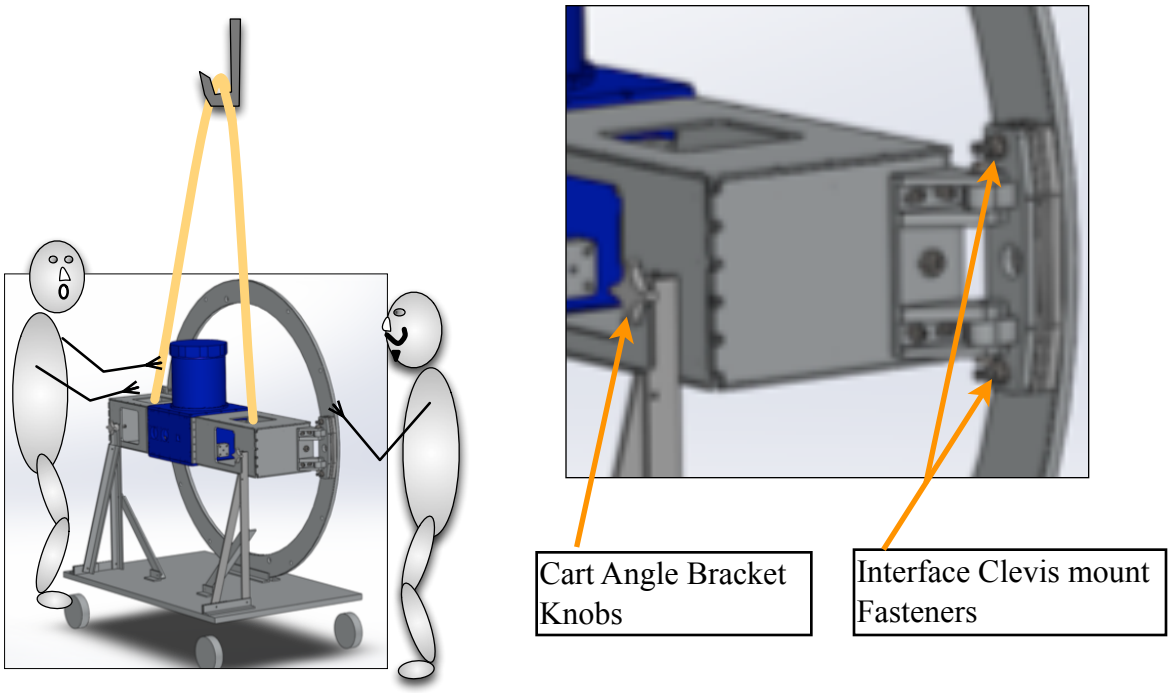


Figure 3: Manually lifting NAS Mounting Ring onto the cart. This is a three person task, two for lifting the ring and one person for fastening the instrument to the ring. Clio is suspended in place using the overhead crane.

will lift the ring while a third will apply the jam nuts to the clevis interface studs (see Figure 3).

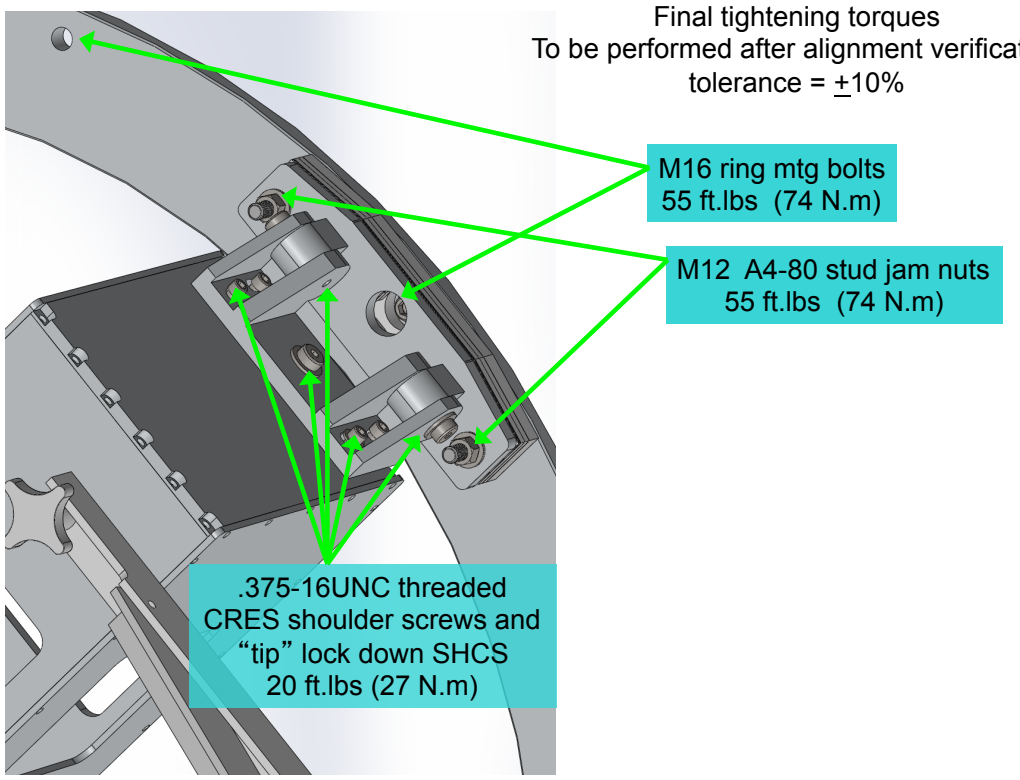


Figure 4: Torque specifications.

1.3.4) Tighten the Clio Mounting Frame knob, and the clevis jam nuts snugly or 1/4 turn past hand-tight (see figure 4).

1.3.5) Loosen the tension of the crane and remove the lifting web.

2.0) Installation on the NAS

2.1) Position the cart with Clio-Ring attached on the NAS platform

2.2) Rig the lifting webbing through the center of mass as shown in figure 5.

2.3) Apply tension to the crane so to prevent the load from shifting when the fasteners are removed from the cart interfaces

2.4) Remove the MAS Mounting Ring-Cart fastener.

2.5) Remove the Cart Bracket Knobs.

2.6) Lift CLIO completely off of the cart

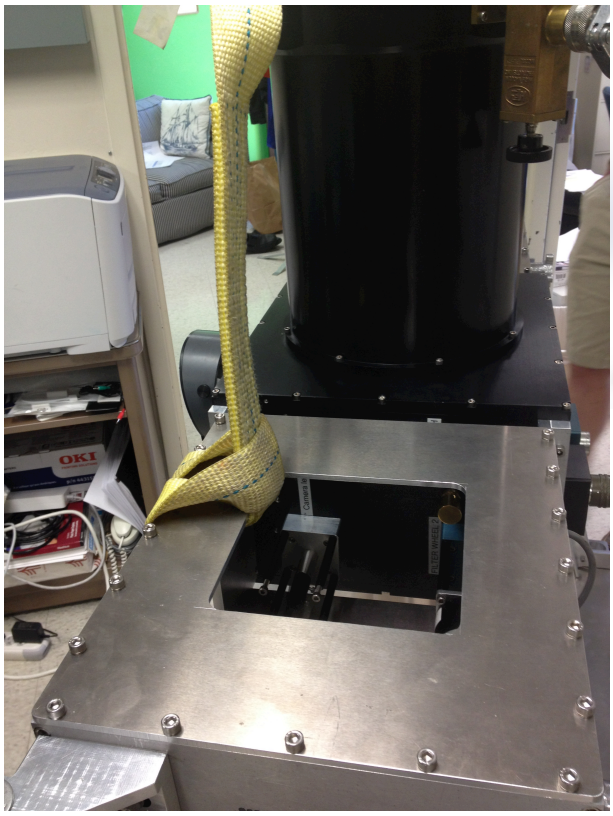
2.7) Lift CLIO to the NAS assembly and began mating with Nasmyth assembly

2.8) Began alignment with two tapered pins installed on the Nasmyth instrument-mounting ring.

2.9) Make sure flange is flush

2.10) Engage the 6 metric mounting M16 screws

2.11) Tighten the M16 fasteners to 1/4 turn past hand-tight. Appropriate torque will be applied after the instrument has been aligned.



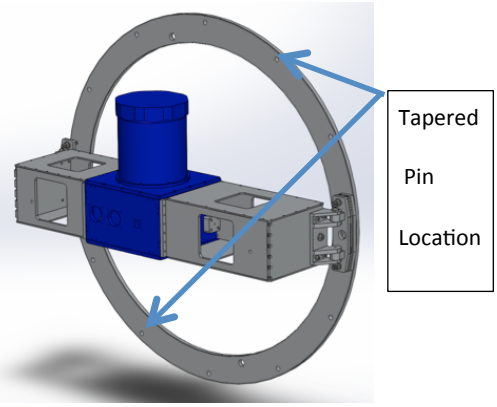


Figure 5: Lifting configuration of the Clio instrument and NAS mounting ring. The left image shows the rigging configuration, The cinch of the lifting web should be as shown so the web is located over the CG.

The right image show the location of the tapered pin hole that interface with the tapered pins on the NAS interface.

6. Instrument Preparations

6.1. Vacuum Pumpdown: *2-3 days before observing run*

Before cooling, Clio should be connected to the turbopump via the KF-40 flange shown in Figure 6. The vacuum achieve should be approximately $7x10^{-6}$ Torr before cryogenic cooldown commences.

Figure 6: KF-40 vacuum flange and vacuum valve of Clio.

6.2. LN_2 Cryogenic Cooldown: *12 hours before beginning of observing night*

The Clio instrument requires a minimum of 12 hours to completely cool down to a stable temperature. The detector is operational 6 hours after cooldown. It is thus preferable to begin cooldown the day before the Clio run starts.

6.2.1. Outer Vessel Cooldown

Only the outer vessel is filled during the first fill. The process takes typically 10 minutes for the LN_2 to condense in the reservoir. Fill until the liquid spurts out of the top of the fill tube.

Watch for the vapor to stop exiting from Clio after about 30 minutes. This indicates the LN_2 has boiled off. Refill the outer vessel a second time. the

LN_2 will have boiled off a 2nd time within 3 hours from the start of the cooldown. Refill the reservoir a third time.

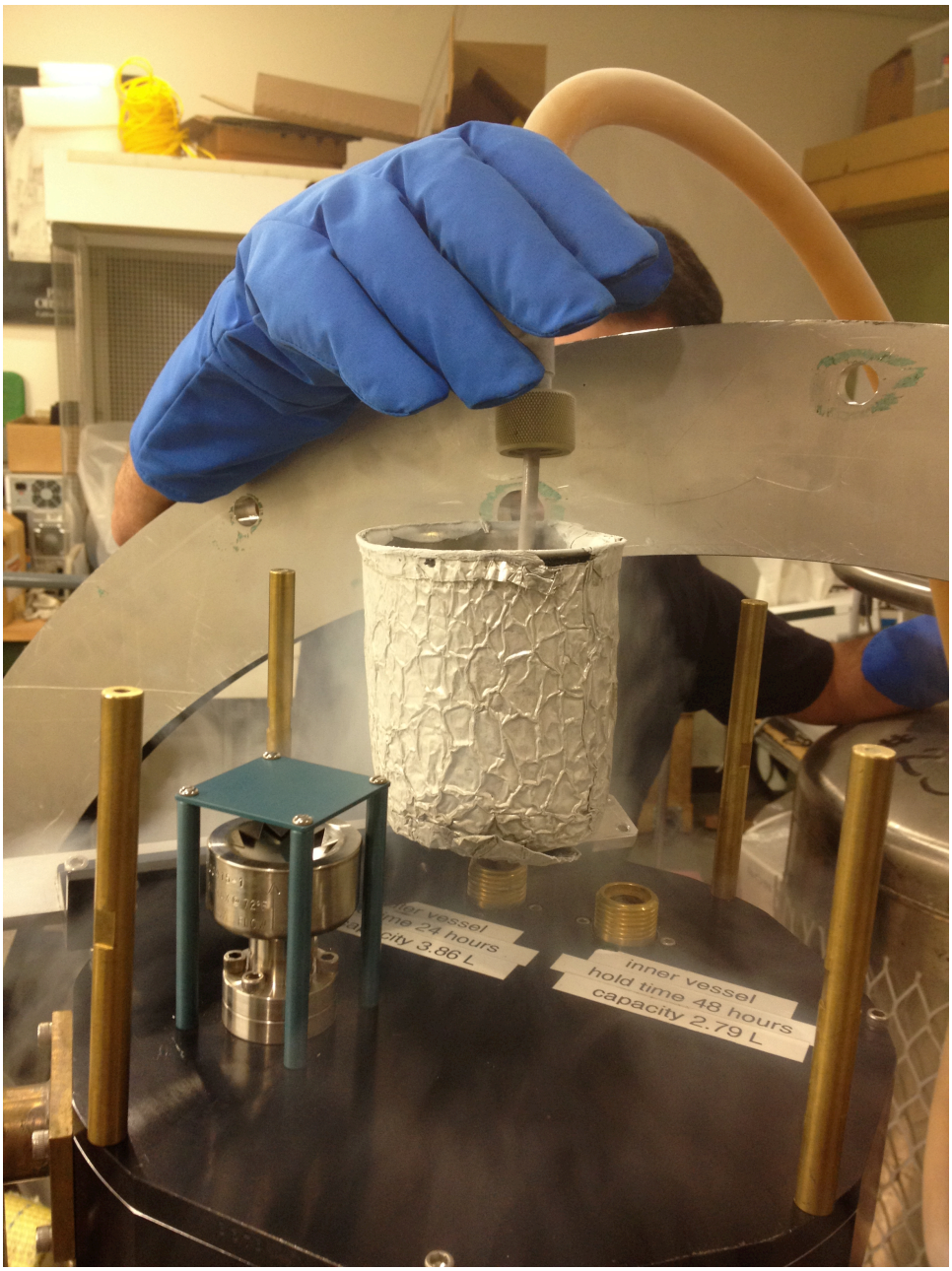


Figure 7: Cooling the outer reservoir of Clio instrument. A funnel is used here to facilitate the ingestion of LN2.

6.2.2. Inner Vessel Cooldown

When the outer vessel temperature is 150 K or below, you can fill the inner vessel. The limit of 150 K is important, as this is the temperature that the getter in the dewar activates.

DO NOT ATTEMPT TO FILL THE INNER RESERVOIR BEFORE THE OUTER RESERVOIR IS ABOVE 150K!

If the detector is the coldest surface in the dewar, the detector will attract all residual vapors!

Table 1: Typical Clio Cooldown

Fill	Vessel	Time from start	Optics Temperature (Channel B)
1st	outer	start	280 K
2nd	outer	30 min	220 K
3rd	outer+inner	3 hours	140 K
4th	outer+inner	6 hours	90 K

6.3. Vacuum pumping on the central reservoir

Approximately 4 hours prior to start of observing, the small diaphragm vacuum pump is to be connected to the inner reservoir of Clio. See Figure 8. The vacuum pump is located in the Clio electronics rack.

The vacuum pumping on the reservoir has the effect of reducing the LN2 temperature and eventually transitioning it into LN2 ice. This process will take approximately 4 hours.

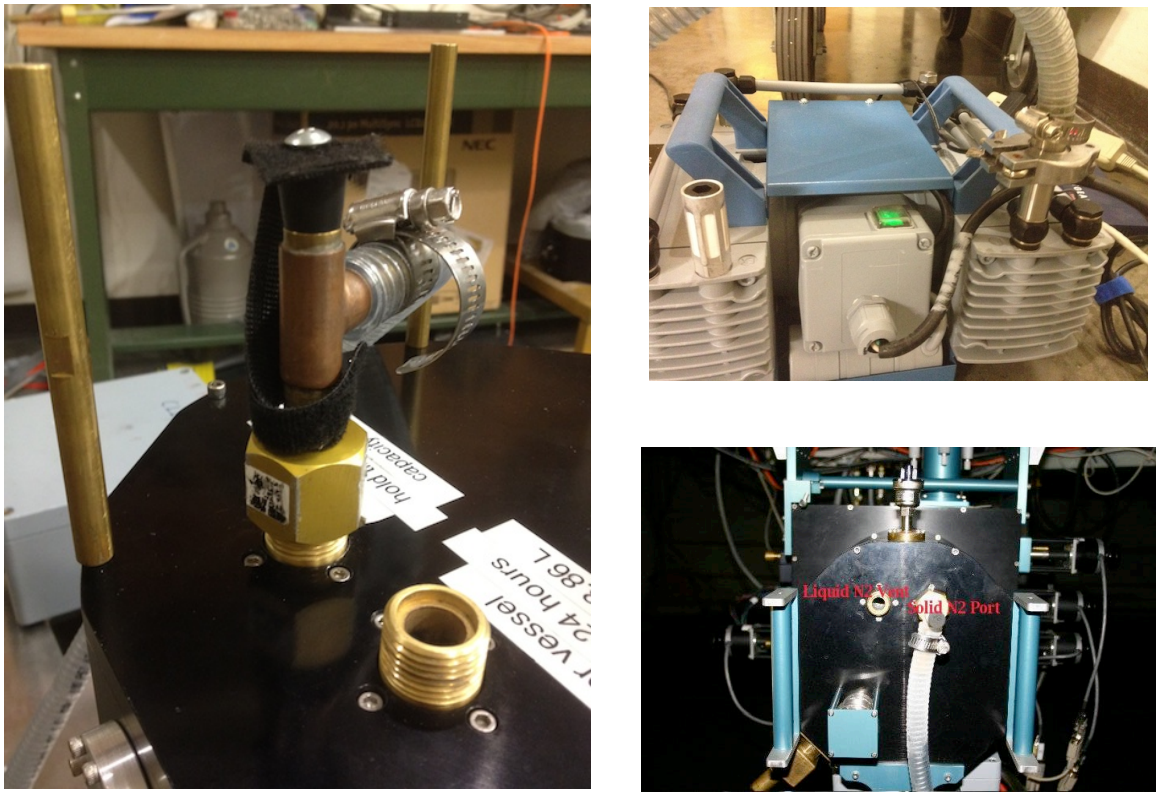


Figure 8: Left image is the inner reservoir pumpout fixture attached to fill port. Note rubber cork inserted at the top of fixture. This cork must stay in place during the pumping process. Top right image is the diaphragm vacuum pump, located in the Electronics support rack. Bottom right image is another view of the Clio inner reservoir being pumped. Note the frost buildup on the vacuum hose. This is a typical occurrence. The total solidification of the LN2 of the inner reservoir take approximately 3-4 hours.

Refilling Clio Reservoirs

The vertical orientation hold time for the LN2 reservoirs is 42 hrs and 50 hrs for the outer and inner respectively. The reservoir should be refilled daily while the instrument is operating.

Outer Reservoir Fill

The stainless steel fill rod inserted into the fill tube of the dewar. Open the LN2 valve so a moderate amount of LN2 pressure is present. A solid metal rod from the top drawer of the Clio electronics rack is used to restrain a loop of the elastic filling tube. When the LN2 is turned on, this prevents the metal filling tube shooting out of the tank. Holding it lightly in place until the cold vapor freezes the tube in place, it takes approximately 5 minutes to fill the LN2 reservoir. LN2 overflowing and spurting out of the top of the fill tube is the indication the reservoir is full.

Inner Dewar

The inner dewar will have very little boil off of liquid nitrogen each day. A fill time of 30-60 seconds is not unusual.

Temperature of the reservoirs is checked at the digital thermometer display on the Clio Electronics rack. The left top number on the lakeshore unit shows the detector temperature. The right top number shows the optics temperature. The right bottom number shows what percentage of the total heater output is being used to stabilize the detector.

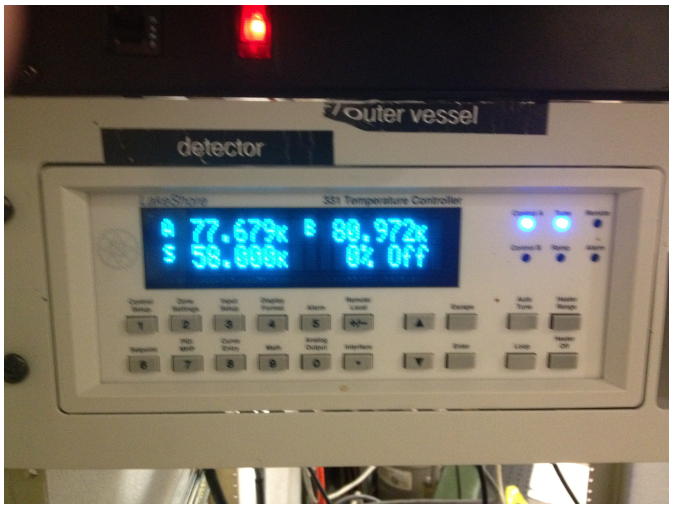


Figure 9: The lakeshore temperature controller in the Clio electronics rack. The top left value indicated the detector temperature while the top right is the outer reservoir temperature to which the optics are mechanical attached.

7. Rack and Connectors

Once the Clio has been safely mounted to the NAS port the electronics racks should be rolled out onto the NAS platform in the designated operational location.

7.1. Power

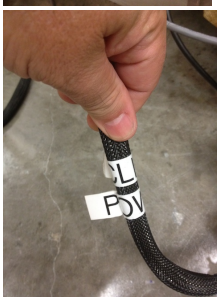
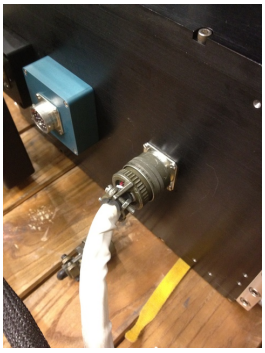
Connect the AC power connector to the 110 VAC connector on the electronics rack. The plug is located on the lower right panel of the rack.

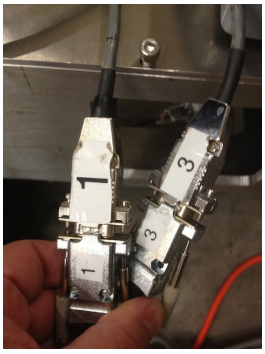
7.2. Coolant

Connect the facility coolant lines to the input and output coolant connectors located on the lower right rear of the rack.

7.3.Instrument Umbilical

The instrument umbilical is stowed on the right side of the rack. Carefully unwind the umbilical and connect the plugs as described in the table below.

Connector	Connector Type(s)	Designation	Image
Clio Power Supply. Two	Burdy XXX-xxxx 3-prong power	“Clio Power”	 
Internal Motors			
SDSU Controller			

Connector	Connector Type(s)	Designation	Image
SDSU Fiber Comm Fibers	SD Fiber connectors	“10BASET” “TX”	
Clio Preamp			
External Motors	DB9	Six motor connector labeled 1-6	

Connector	Connector Type(s)	Designation	Image
Preamp to SDSU controller. Single ended at preamp to split at SDSU controller			 

8. Alignment

Alignment of Clio consists of two sequential steps:

1. Tilting the camera to align the cold stop to the telescope entrance pupil.
2. Tilting the entrance window/dichroic to align the pupil on the MagAO WFS.

8.1. Cold Stop Alignment

The Clio instrument is adjusted so that the pupil imaging optics are inserted via the remote interface. This forms an image of the telescope entrance pupil on the detector. Once this location is noted on the detector, the cold stop is inserted via the camera interface. Any misalignment between the two apertures is adjusted by tilting the Clio cryostat in its mount.

The Clio cryostat has two shoulder bolts for rotation about its horizontal axis (when the fill tubes are pointed up). Shims on the camera mount will allow rotation of the camera around its vertical axis. This adjustment will only be needed during the initial mounting

of Clio. The pin location of the Clio mount ring will ensure repeatable mounting to the accuracy needed.

8.2. WFS Alignment

Once the cryostat is aligned, the entrance window dichroic will be adjusted to center the pupils on the MagAO WFS. This is done by imaging the CCD39 readout of the MagAO W unit, and adjusting the three threaded standoffs, until the pupil images are centered in the quadrants of the image.

8.3. Center of Rotation Check

Once Clio is observing a star, the center of the imaging field will be verified by adjusting the instrument rotator and noting the center of rotation. Any offset from the center of the detector by more than 250 pixels (~4 mm) internally, via modification of the Clio mount.

8.4. Final Torquing of Mounting Fasteners

One the alignment is complete the six M16 fasteners of the NAS Mounting Ring, the M12 Stud Jam Nuts, and the .375-16 UNC shoulder screws shall be torqued to the specified level indicated in Figure 4.

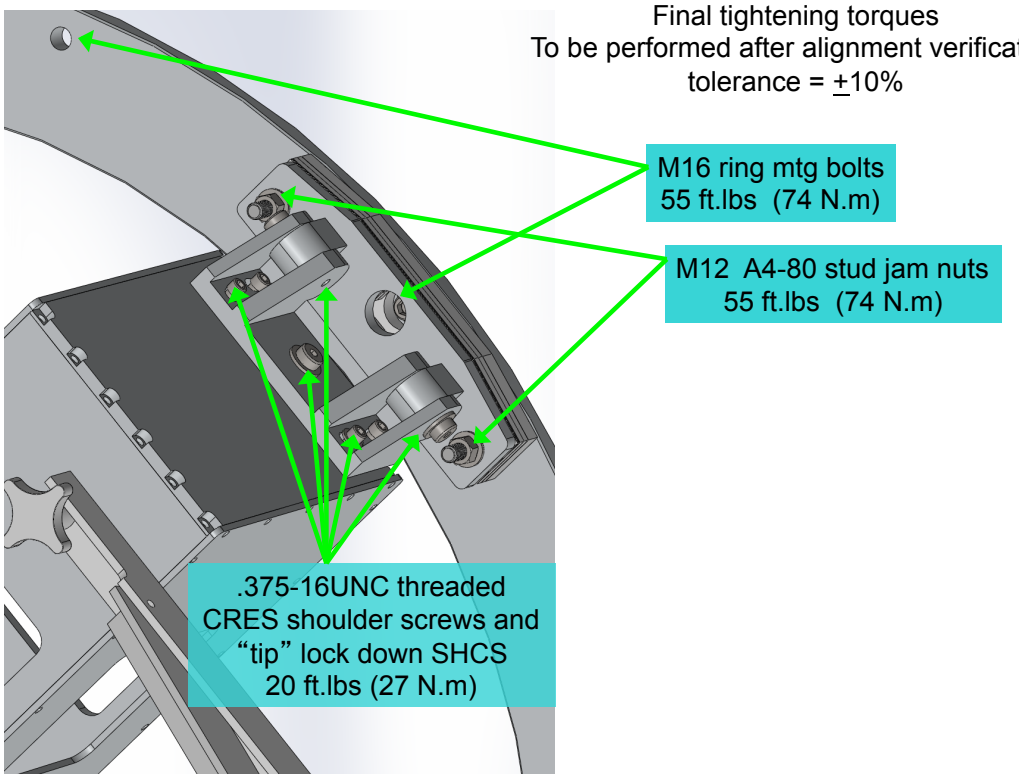


Figure 10: Torque specifications.

9. Commissioning Observations

Commissioning observations will consist of measuring background brightness, image quality, filter zero points, and sensitivity measurements will be tabulated for all filters in Clio.

9.1. Background flux measurements

Upon beginning on-sky operations, the sky flux of each filter will be recorded by simply observing the sky at zenith. This will be used to set up typical obseving procedures, and provide guidance to observers.

9.2. Image quality

The imaging quality of the Clio camera will be recorded via measurements of PSF's for a representative set of filters. Verification of acceptable Strehl will demonstrate the readiness of the instrument to carry out further observations.

9.3. Filter Zero Points

The photons/s will be recorded for a well understood IR standard star for all filters in the Clio instrument. This will provide rough sensitivity numbers and verify the performance of the camera.

9.4. Sensitivity measurements

Measurements of a faint standard star (or more likely a standard star with a faint companion) will be used to verify the noise performance of Clio in a representative set of filters. This will verify that the low flux performance of the camera is adequate for the planned science observations.

9.5. Automated Operation

The automated operation of Clio, when used with the MagAO system will be demonstrated. The open shutter efficiency will be tabulated for typical nodding/dithering sequences. Verification of proper sequencing, and a complete data set, with properly ingested FITS header information will provide the final data product for evaluating the suitability of Clio to begin science observations.

10. Removal from Telescope

10.1. Place the cover on the “snout”

10.2. Disconnection of the Umbilical

Each of the umbilical connectors should be carefully disconnected and the umbilical gently wrapped back on its stowage rack. Place the provided shorting plug onto the signal connector of the SDSU controller located under the Clio cryostat.

10.3. Dismounting Clio

The reverse procedure of mounting should be used for dismounting the Clio instrument from the telescope NAS port. Once landed on the cart, the cart angle bracket knobs should be hand tightened.

10.4. Clio Storage

The Clio instrument can be allowed to warmup on it own. The instrument is designed to reside on the cart during storage. The instrument should be stored under vacuum (≤10-3 torr).