TO Panel
MCC Graphic User Interface
TO Hand Paddle

A Reference for the Telescope Operators.

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1. Introduction

The **TO Panel** is a hardware panel located in the operator area. This panel is use by the operator and provide hardware based input to the TCS3.

The **MCC GUI** (Master Control Console) is an X11 Windows-based application running on the TCS3 computer (hostname t1). This provide the Graphic User Interface for the Operator. Normally two copies are running on the TCS3 duel monitors located at the TO area. Up to five copies can be running at once. Normally, only the two TO copies of the GUI should be running.

The **TO Hand Paddle** is a hardware panel located in the operator's area. This hand paddle provide some offset and pointing map buttons.

2. The TO (Telescope Operator's) Panel

The TO Panel is physically attached to the tcs3 system via a cable into the T3 Servo Electronic box. It is located in the Telescope Operators Area. It provide numerous safety and convenience items for the operator.

2.1 Lockable safety switches

The following 3 safety controls are located with in the upper-left cover. These are safety controls that can be lock (using the key).

Dome Control – 3 position switch to select dome control mode:
  Locked – Software will not allow any movement (MCC GUI and Dome Handpaddle locked out).
  Handpaddle – Only the Dome handpaddle will control the dome's movement (software is locked out).
  Software – Dome control via the MCC GUI is enabled (Dome Handpaddle is locked out).

Limit Override – ON (Green LED is on) mean to override the hardware stop & brake limits for the HA & Dec axis.

Telescope Enable – OFF to disable HA,DEC AMP and engage telescope brakes. ON to allow servo control. Telescope enable should be OFF when the TCS Servo is not used.

2.2 Other Safety Controls

Emergency Stop – Press to disable Telescope & Dome movements via the safety board.

Mirror Cover Emergency Close – Open the normally operation mode, as mirror covers are control via the MCC GUI. In an Emergency (and the TCS software in inoperable), setting the switch to close will close the mirror covers.

There are 3 switch to control the max velocity of the telescope. There are 2 velocity limits in the tcs: 400 as/s, and 1600 as/s.

Automatic/Unsafe – When in Automatic , velocity of 1600 as/s is allow. When in unsafe, 400 as/s is the velocity limit, unless overridden by the One Shot or Supervised switch.

Supervised – During some moves (ie: slewing), the velocity limit can be raised to 1600 as/s by depressing this momentary switch. The ideal is the TO are to visually 'supervised' the telescope when pressing this switch.

One Shot Supervised and Supervised can be pressed together to allow the 1600 as/s limit for the duration of the move.

The Automatic & One Shot can be secured using the eyelet, allowing only the Supervised high speed moves.

Safety Board OK LED will be on when there are no latched errors on the safety board.
System Power LED is on when the system power is ON.
Brake ON LED is on when the HA & Dec brake are ON.

2.3 Remaining Controls

The **TO Joystick** is a self-centering 2 axis joystick. It is used for error adjustment during tracking, and velocity adjustment during MV moves. Review track and MV servo modes for MCC1.

During tracking the TO Joystick's can be used to adjust the pointing map in **NSEW** or **Spiral** mode. The toggle switch to the right of the joystick enables you to control this mode.

The **Floor light** control the dimmer for the Dome floor light. This hardware contol is independent of the computers.

The **Dome Light** (Off/On) control the dome florescence light via the tcs3 software.

The **Humidity** LED display the relative humidity (0 to 100%).

3. MCC GUI

The MCC GUI (Master Control Console) is an X11 Windows-based application running on the TCS3 computer (the computer **t1**). It provides the Graphic User Interface for the Operator. Normally two copies are running on the TCS3 duel monitors located at the TO area. Up to five copies can be running at once (for example, another computer displayed via Max). Normally, only the two copies of the GUI should be running.

3.1 General Layout

The GUI application has 3 main sections:

Main Buttons
MCC main tabs
MCC CLI (command line interface)

3.2 Main Buttons

At the top of the MCC GUI, the following Main Buttons appear:

About – brings up an ‘about’ dialog box.

FB0 to **FB6** – the GUI provides six Function Buttons. Function buttons can execute tcs commands stored in a text file. To associate a text file with a function button, you would enter the command: *m.SetButton # $PATH $FILENAME*. For example:

```
m.SetButton 0 /home/tcs3/data/mcc_macros zenith
```

would set FB0 to run the file “zenith” from path “`/home/tcs3/data/mcc_macros`”. The FB0 button would then execute it.

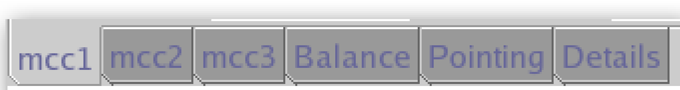
Hints: To make a macro file assignment permenant, place it in the ~/current/to/main/mcc/.mcc-init file.

Stop – cancel the currently executing macro file.

Notices – Brings up the ‘Notices’ popup dialog window for controlling sounds related to warning notices (see 2.1.4).

Quit – exits the GUI

3.3 MCC main tabs

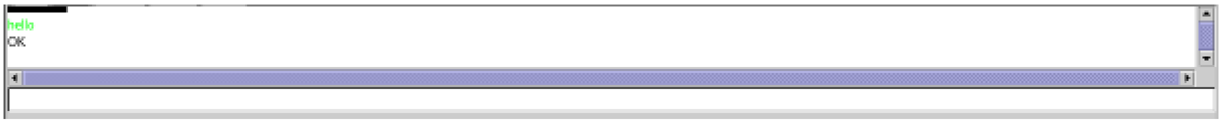


The GUI is organized as a set of tabs on the main window. Each tab will be covered in a separate section in this document.

Mcc1 – Mostly concerned with the HA, Dec, Dome and shutter control.
Mcc2 – General facility IO and show next object buffers.

Mcc3 – Less frequently used MCC widgets.
Balance – Counter weight control
Pointing – Pointing Map related widgets.
Details – Provides access to engineering screens which display many internal TCS3 variables.

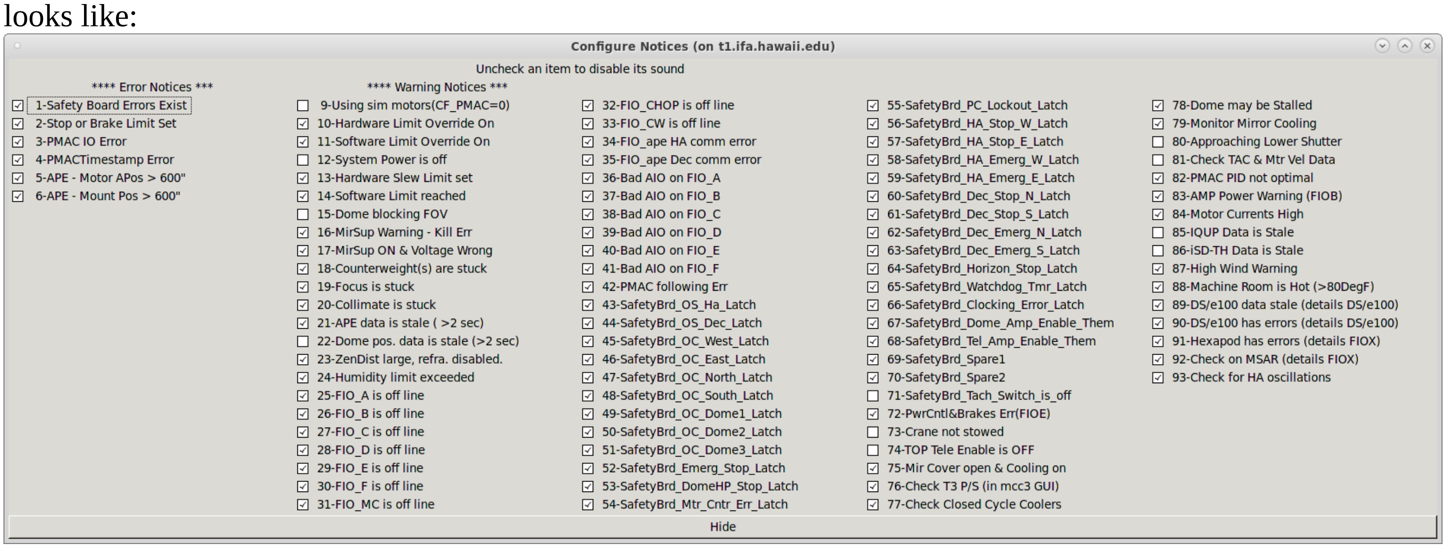
3.4 GUI CLI interface



This is the GUI Command Line Interface (CLI). Here you can manually enter tcs commands. First put your mouse cursor in the CLI area, then type in commands. Some status data also appears in the output window.

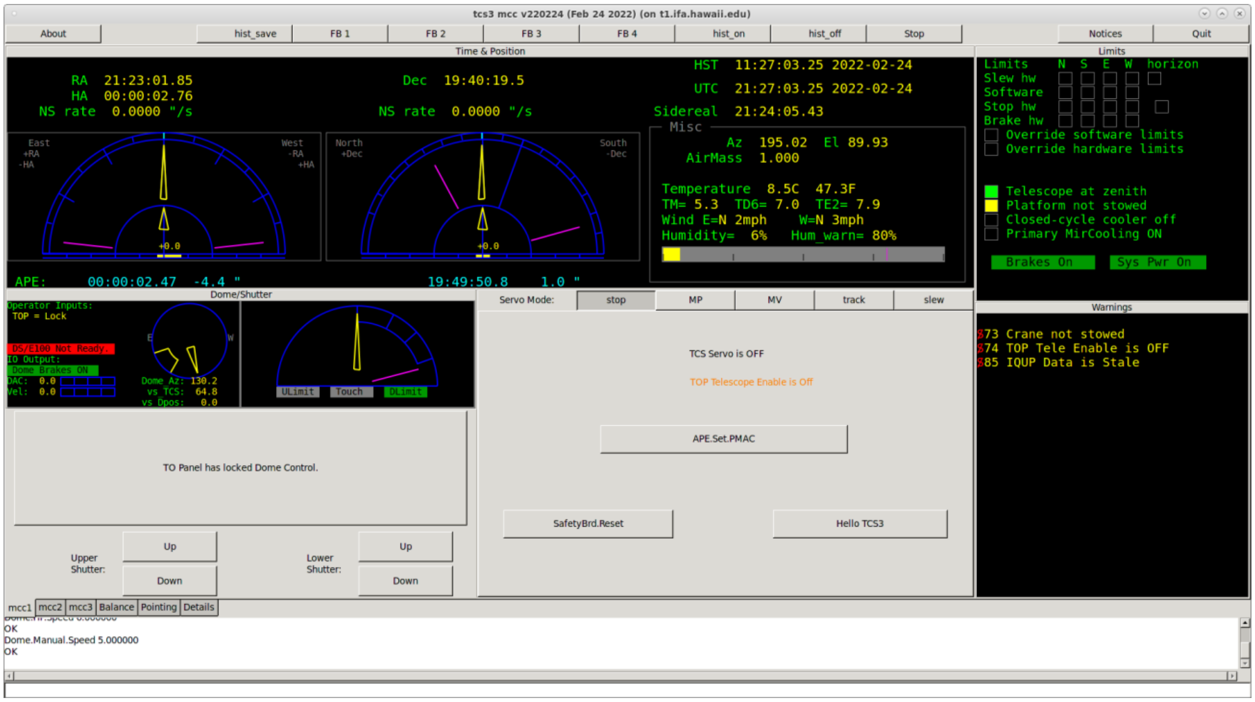
3.5 Notices dialog window

When the 'Notices' button on the main window is pressed, a dialog popup appears which allows control of sounds associated with the warning notices which are displayed in the mcc1 Warnings window. The dialog looks like:



The entries in the dialog box correspond to the list of possible error and warning notices that can be displayed in the 'Warnings' display area on the mcc1 window (see 2.2.4). If the check box to the left of an entry has a check in it, then if that message is activated in the 'Warnings' display an associated sound will be played about every 15 seconds. Uncheck the box to deactivate the sound associated with that notice message. Once the dialog box is visible, it can be dragged to any location on the desktop. To hide the dialog box, click the 'Hide' button at the bottom of the box.

3.6. MCC1 TAB



The MCC1 tab primarily contains widget that are concerned with the telescope, dome, and shutter positioning. Also some safety and warning indicators are located here.

Time & Position display

On the top, the sky RA, HA, Dec, and their non-sidereal rates are display in yellow text.
To the right, the time is display in HST, UTC, and the Sidereal Time.

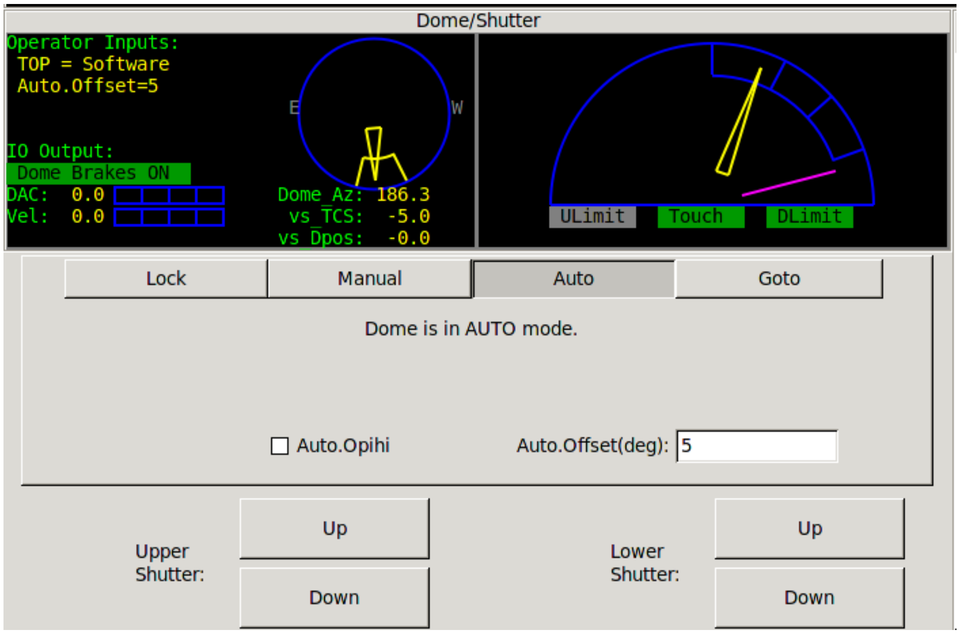
There are 2 diagram to represent the HA and Dec axis. Note the HA diagram is using East-to-the-left display convention.

- The larger yellow arrow is the current desired telescope position.
- The larger gray arrow should the actual position of the servo (often covered by the yellow arrow).
- The magenta line indicated where the software limit are.
- The inner dial show the speed of the axis using an arrow and text in arcsec/sec.
- The yellow bars below the diagram indicate the AMP command voltage to each of the 2 motor for each axis.
- The APE position is display in cyan, along with the difference of the APE and IE (incremental encoder).

The ‘Misc’ box in this display contains other positional and environmental information.

Dome/Shutter display & control

This window contains 3 sections:



This example show Dome Auto mode with an auto.offset of 5 degrees.

Dome Feedback

- The blue circle/dome show the azimuth of the slit. The *Dm AZ:* is the Dome's slit azimuth. North is on top and East (90 deg Az) is on the left. The yellow dome slit shows the Az of the dome.
- The yellow arrow show the azimuth of the telescope. Under the blue there are 3 values:
  - Dome_Az: this the dome Az in degrees.
  - vs_TCS: This is the difference between the TCS AZ, and the Dome Az.
  - vs_Dpos: The is the difference between the dome desired position (Dpos) and the current dome position (Dome_Az).
- The *Operator Inputs* list some IO setting important to dome control: Dome_Cntl setting (ie Lock), State of the TO Panel ("TOP"), if the HardPaddle is used, and if the Auto.ophihi, or Auto.Offset option are used.
- The *IO Output* show state of brakes, DAC (Amplifier input voltage), and dome velocity (in deg/sec).

Shutter Feedback

- The yellow arrow show the telescope's elevation, on the blue side view of the dome/slit.
- The blue shows a side view of the dome and illustrates the shutter's open position. The shutter opening is divided in to 3 segments. The meaning of the the top and bottom segments are:
  - Zenith to 1.125 Air mass (ZD 90 to 27.3 degrees) would be the area covered by the lower shutter when it is in its highest position (ULimit + Touch).
  - 1.5 Air mass to bottom (ZD 48 to 70 degrees) show the position of the lower shutter when it is down (DLimit)
- The magenta line illustrate is where the Horizontal hardware limits is (approx ZD of 70 degrees).
- The bottom has indicator for Upper Shutter UP (*ULimit*), Shutters Touching (*Touch*) , and Lower Shutter Down (DLimit) shutter switches.

Dome/Shutter control widgets.

- For software dome control to work, you much select Software on the Dome_Cnlt=Software on the TO Panel.
- The Dome Software Modes are : Lock, Manual, Auto, Goto.
  - Lock – Software will not attempt to move the dome.
  - Manual – using the widget provided, the operator has full manual control of the dome.

    - The slider allows you to control the range to apply of the dome amps, ie: 0.5 is half range (5V), 1.0 is full range (10V).
    - The buttons will command the dome to move left, right, or stop.
  - Auto – Auto mode will attempt to position the dome at the current telescope's Azimuth. Auto mode have 2 offset options:
    - Auto.Opihi – the dome's Dpos has the opihi offset added. With auto.opihi, the new dome DPos is shown with a cyan line in the circle diagram.
    - Auto.offset – You can set a fixed offset for the Dome DPos by then a degree value.
  - Goto – Allows the operation to enter the destination azimuth for a dome move.
- Shutter control – 2 sets of button are used to control the upper & lower shutter. Select Open or Close to move the appropriate shutter cart. You must click and continue holding the mouse during the move. Releasing the mouse button will stop the operation.

Limits display

This display shows the status of various limit switches, the system brakes, and system power.

A grid showing the state of the Slew, Software, Stop, and Brake limits for each axis (N, S, E, W), and the state of the Horizon Slew and Stop. These GUI's LED will blink with the limits are ON.

Override Software limits = Override toggle on MCC2 GUI is checked.
Override Hardware limits = Override limit switch on TOP is ON.

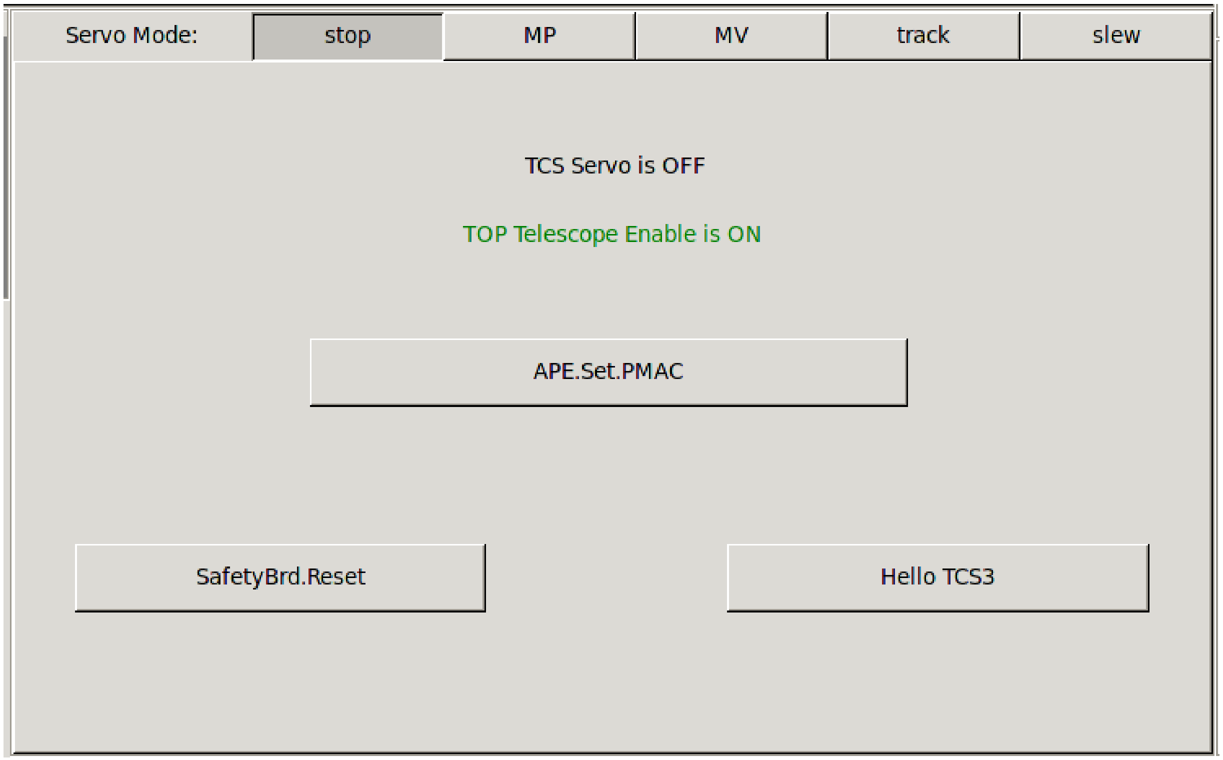
Telescope at Zenith = Both the HA and DEC hardware 'Zenith' indicator is ON.
Platform not stowed = platform under the telescope warning.
Closed-cycle cooler off = Cooler is off warning.
Primary mirror color on = Air blowing across the primary mirror warning.

Brake Off/On – indicates the state of the servo (HA/Dec) brakes.
Sys Pwr On – indicates the state of switch line power.

Servo

This window show the current servo mode. Steps for operation each servo mode is provide.

Servo - Stop – When the servo mode is STOP, the pmac PID loop is disabled (open Loop mode), and the brakes are ON. To exit stop mode, select another mode.

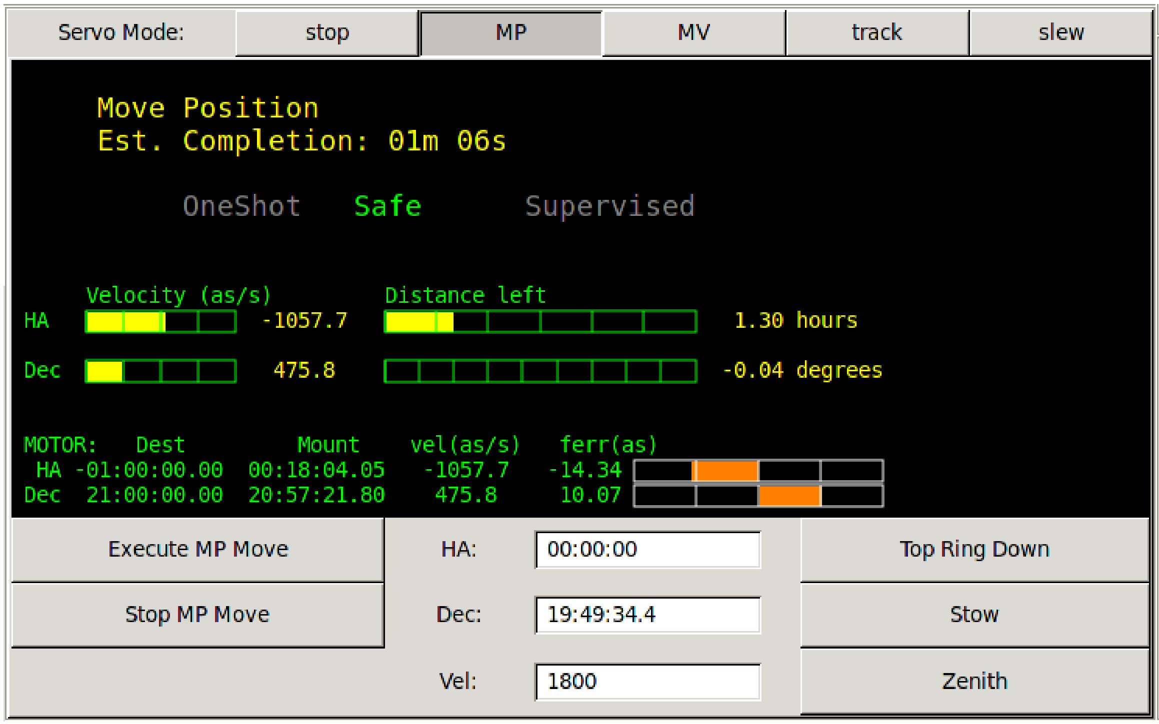


Stop mode means the servo is OFF. Brakes are On.
The label "TOP Telescope Enable is OFF/ON" indicates the state of the telescope enable switch on the TO Panel. When operator is not present in the TO area, this should be OFF to prevent remote uses from running the TCS.

Function you can perform in Stop mode:

- APE.Set.PMAC – The command initializes the position in the PMAC motor controller using the current APE position, or "Apes set the PMAC". This should be done at zenith at the start of the observing night.
- SafetyBrd.Reset – Sends a reset to the TCS3 safety board. When the safety board has errors, they are latched until the errors are cleared. Once cleared, you can resume servo operation. This button issues the safety board reset command.
- Hello TCS3 – A button that plays a sound file.

Servo - MP – MP is Move Position. This mode allows the operator to move to a HA Dec absolute position.



To perform an MP move:

- Click on the MP radio button to enter MP mode.
- Enter your HA, Dec destination position, and velocity, OR
- Press the buttons on the right (Top Ring Down, Stow, Zenith) to auto fill the HA, Dec destination positions with a pre-determined values.
- Click on **Execute MP Move** to begin.

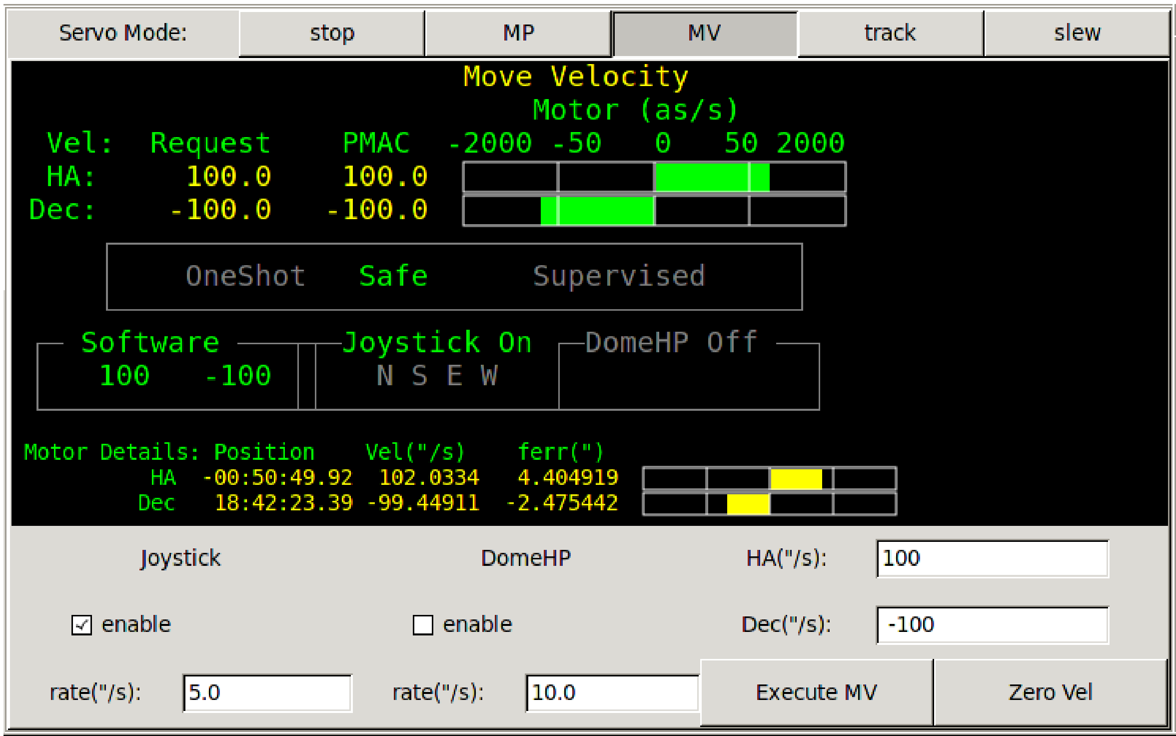
While in MP:

- The Servo window displays the status of the current move.
- The velocity is limited to 400 as/s unless the OneShot, Safe or Supervised buttons are used to allow high speed moves (from the TO Panel)
- You can enter new HA, Dec, Vel values and press **Execute MP Move** while a move is in progress.

To stop an MP move:

- Press the **Stop MP Move** button

Servo - MV – MV is Move Velocity. This mode allows the operator to move the telescope by specifying a velocity for each axis.



Enter the MV mode by clicking on the Servo Mode's MV radio button. You can now control the velocity using 3 methods: Joystick, DomeHP, or GUI. All inputs are used simultaneously.

Joystick:

- Enable the TO Joystick. (and Disable DomeHP).
- Enter your desired rate.
- Use the TO Panel's Joystick to change the velocity.

Dome HP

- Enable the DomeHP (and disable Joystick).
- Enter your desired rate.
- Use the dome hand paddle N,S,E,W buttons to move the telescope.

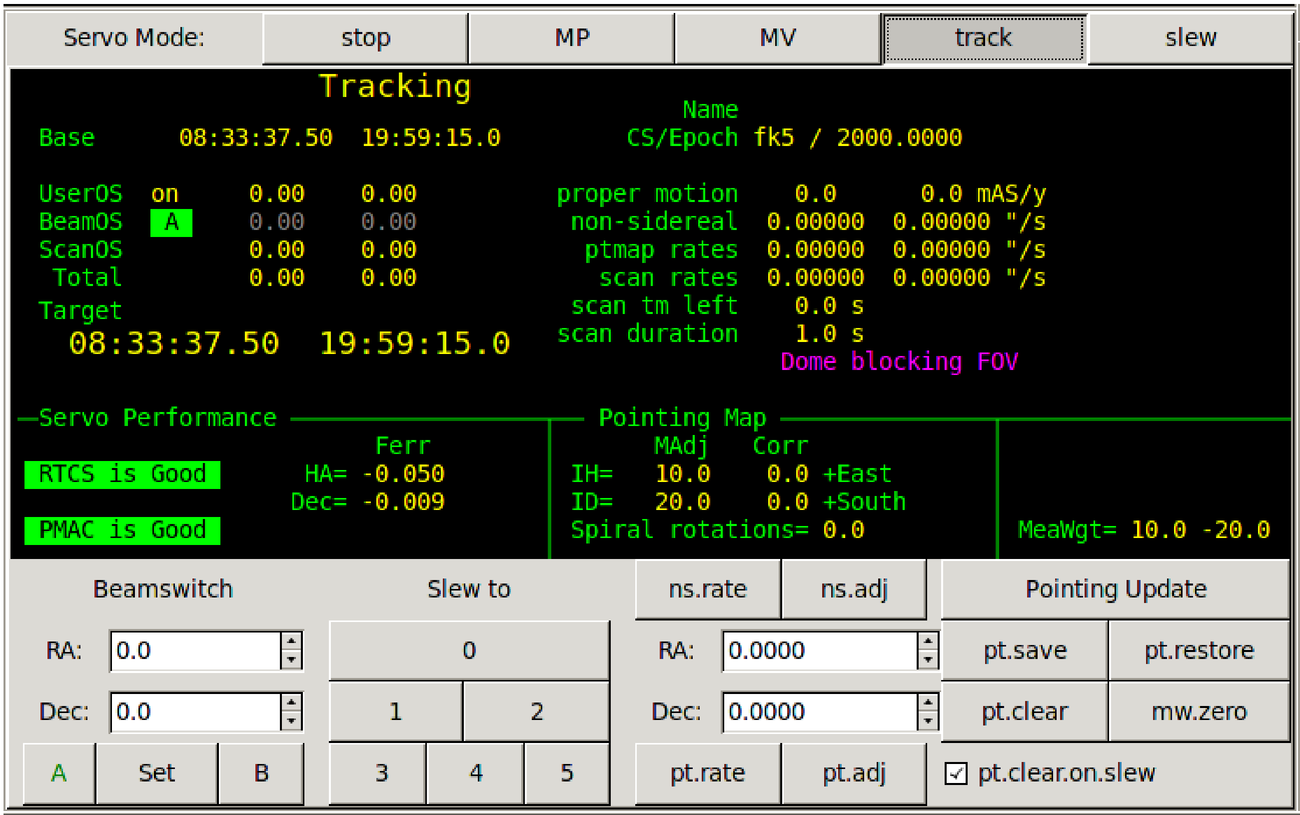
GUI

- Disable both the Joystick and DomeHP.
- Enter a HA and Dev velocity.
- Press 'Execute MV' to set telescope velocity.
- Press 'Stop' to set velocity to 0.

In the status area, the following information is displayed.

- The requested velocity is the sum of the Software + Joystick + domeHP inputs. The PMAC velocity is the commanded velocity to the motor controller. The bar graph displays to actual motor's velocity.
- The **OneShot**, **Safe**, and **Supervised** labels are colored GREEN or Gray to reflect the state of these TOPanel switches.
- **Software** label will be green if the rates are enter via the GUI, below show the requested rates in "/s. Enabling the Joystick or Dome Handpaddle will set the **Joystick ON** or **DomeHP On** labels green. If any buttons are pressed to command a velocity the 'N S E W' char will turn green.

Servo - Track – Track mode tracks the RA and Dec target position.



To start tracking:

- Click on the Servo Mode: **track** button.
- The position table (display in the feedback window) is used to determined the target position.

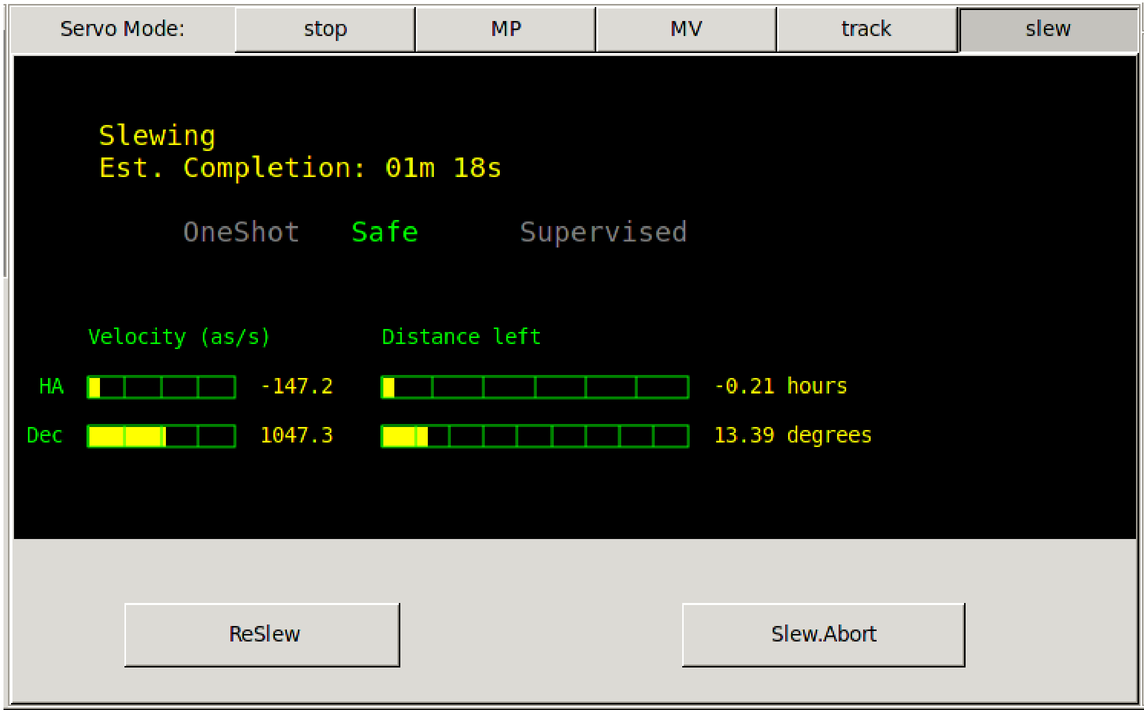
While Tracking:

- Position and offsets are display on the top left. Various rates (and other information) is display on the right.
- The performance of the RTCS and servo system (Motors) are summaries in “Servo Performance”. The status should always be “Good” or “OK”.
  - Good RTCS status means the commanded position to the PMAC matches the VTCS.
  - Good PMAC performance means the motor servo error is less that 0.1 arcseconds.
- The “Pointing Map” status shows key map variables.
  - MAdj is the MapAdjustment register (Map adjustments preserved during slews)
  - Corr is the total from the Peak, Spiral, and Rates registers.
  - The Spiral Position (in rotation) is also displayed.
- The lower-right status area has miscellaneous data
  - The ‘MeaWgt=’ label identifies the current value for the measurement widget. The measurement widget allow you to measure offset and Pointing map movement without needing to clear either the offset or pointing map. Use the ‘mw.zero’ to zero the values.
- Beam Switch controls include:
  - ‘A’ button – switch to beam A.

  - ‘Set’ button & RA/Dec offset spin buttons– Pressing ‘Set’ will set the beam offsets to these values loaded in the spin box numeric inputs.
  - ‘B’ button – switch to beam B.
- ‘Slew to’ includes:
  - Slew 0 – Slews to next object #0 (see MCC2’s next object list).
  - Slew 1 – Slews to next object #1.
  - Slew 2 – Slews to next object #2.
  - etc
- ‘Rates’ controls – allow setting the non-sidereal rate (ns.rate) and the pointing map rate (pt.rate).
  - To set the non-sidereal rate, enter the RA and Dec values using the spin buttons, and press **ns.rate** to issuing the ‘ns.rate RA DEC’ command.
  - To set the pointing map rate, enter the RA and Dec values using the spin buttons, and press **pt.rate** to issuing the ‘ps.rate IH ID’ command.
- Pointing buttons include:
  - **Pointing Update**– Issues the ‘pt.madj’ command to transfers correction (peak, spiral, rates) to the MAdj register. The MAdj registers hold IH, ID values that are saved from slew to slew.
  - **Pt.save** – Does a ‘pointing update and saves the IH/ID values to disk to be restored when starting the IC, or when doing a Last(pt.restore).
  - **Pt.restore** – Restore the MAdj values saved to disk with ‘pt.restore.
  - **Pt.clear** – Clears the Corr pointing registers (Pt.peak, pt.spiral, and pt.rates).
  - **mw.zero -** This ‘measurement widget zero’ button zeros the values display by the ‘MeaWgt=’ label.
  - Pt.clear.on.slew – This is normally set. It clears User Offsets, Set the beam to A, clear the Corr pointing (Peak, Sprial, Rate) at the start of a slew.

To stop Tracking:
- Enter another servo mode, for example, STOP.

Servo - Slew – The Slew mode slews to a RA and Dec sky position. The can only be started while Tracking, and when the slew is done, Tracking resumes.



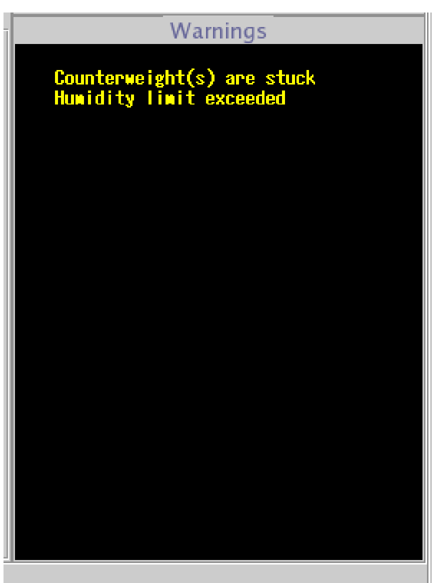
A slew is initiated from the tracking screen. Once the telescope is slewing this screen appears.
The status area display the estimated time to completion. The setting of the OneShot, Safe, and Supervised buttons are display. The HA/DEC velocity and Distance Left are display using a bar graph and text.

- ReSlew – Re commands the PMAC to slew. Due to a bug, some times the slew doesn't move the telescope (sits there with 0 velocity). Press this button to re-command the slew.
- Slew.Abort – Aborts the current slew. The current position is loaded into the tracking table's base, and tracking resumes.

Once the slew is done, the TCS will automatic start tracking.

Warning display

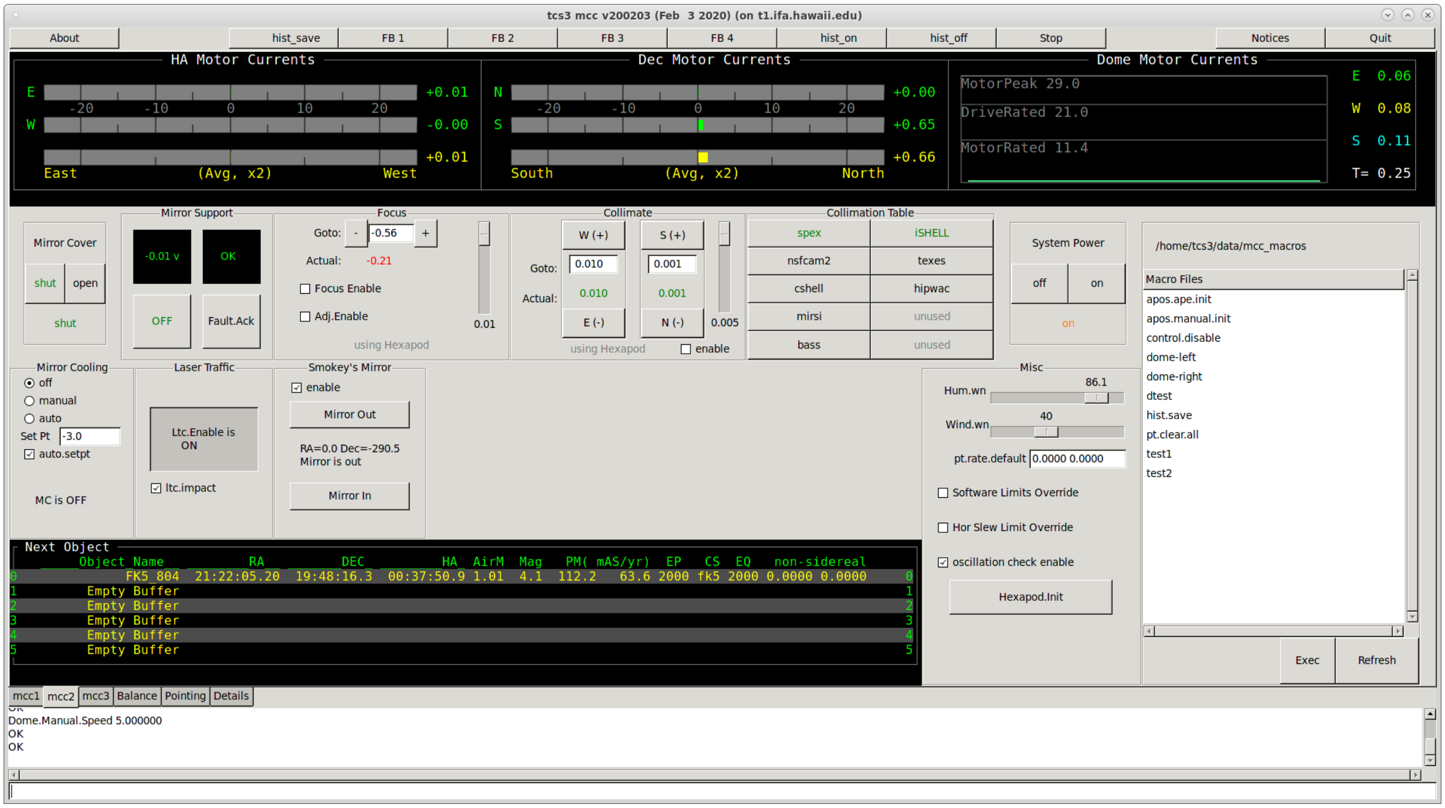
This window is used to display error and warning notices. A sound is associated with each notice, and the sounds may be controlled by the 'Notices' dialog (see 2.1.4). If the error or warning condition no longer exists, the message(s) will be cleared from the screen. Notices are displayed in order of importance.



In this sample display, warning notices are shown that indicate a counterweight stuck during a balance operation and that the current humidity level matches or exceeds the humidity warning threshold as currently set. Both of these conditions will cause a warning sound to be played every 15 seconds.

In this sample display, the same warnings are active as in the previous example, but the 'Notices' dialog has been used to deactivate the sounds associated with the humidity warning. This is indicated by the red symbol to the left of the warning text (an 'S' with a line through it).

3.7. MCC2 Tab



Motor Currents:

Ha, Dec, and Dome motor currents are displayed.
For HA and Dec, the yellow graphs show the differences of the motors (scaled up by 2 x)
For Dome current, the values should always be under Motor Rated 11.4, if not, notify the day crew.
Operators need to monitor HA and DEC currents while tracking to insure the telescope is in balance.

Mirror covers:

Select 'Shut' or 'Open' to close or open the mirror covers (Green color on button shows status of Mirror Drive output. The bottom label provide feedback on the position (input from the 'Open' switch on the Mirror covers).

Mirror Support:

The voltage for monitoring the mirror pressure is displayed.

Below the voltage, use the mirror.support OFF/On button to turn off/on the air support. The label to show the current state of the air support control (Off or ON). This button issues the *mirror.support* command. You muse be at Zenith for this command to execute.

The OK / FAULT label indicates the condition of the Kill_Support IO line. If Air Support is off due to a hardware error, the FAULT label is shown. You must clear the hardware fault, then press the 'Fault.Ack' button to return on an OK status. Then you may turn on Mirror Support (using the *OFF/On* button)

Focus:

This is the chopping secondary focus control , disable the focus when not using the chopper.

You can set the desire focus position by editing the "**Goto**" value. Either enter the value in the **text entry** area, or use the **-/+ button** to increment the desired position. The **slider** at the bottom controls the increment amount. This Goto value will update if the desired position is changed.
The Actual label show the actual position of the focus mechanism in volts as sampled by the TCS A/D. The text will be RED until the focus moved to the desired position.
The **Focus.Enable** check button, until Enable or Disables the software control loop to move the focus mechanism.
The **Focus.Adj.Enable** determine if the focus adjustment value is added to the user_dos to determine the desired postion.
If the tcs see the apos is not changing when commanded to move, a Focus_Stuck warning is display on MCC1.

Collimate:

To change collimation, you must have the collimation enabled by checking the enable checkbox.
Use the slider to set the desired increment value for the + and – buttons.
Click on the 'E', 'W', 'N', or 'S' button to change the desired collimation position
The Goto or desired position is shown in the Text Entry widget. You can also enter the desired postion in the text widget (remember to hit return) to specify the desired dpos.
The actual position, or apos, is shown next to the label 'Actual'. Green text indicated the actual position in within range of the desired position, otherwise the value is displayed in red.
On the bottom, a label show with secondary (chopper or hexapod) is currently in use.

Collimate/Focus Table:

The collimate table provides up to 10 preset collimation and focus positions for various instruments. To set the collimation using the table:

1. Enable Collimation and Focus
2. Click a button in collimation table. This will set the collimation and Focus Dpos to values stored in the table, and the collimation should move to this new position.

The button's Text colors provide the following information:

Green = Collimation Desired Position match this entry in the collimation table.
Black = This entry's position doesn't match the current collimation's dpos.
Gray = This is a unused table entry (text should say 'unused').

The data in the collimation table is read from /home/to/data/collimation.txt. Using a text editor you can update the entries in this file, or add new items. More detailed instruction on how to edit the collimation table is located the in 1201_Operators_Guide. This file is read when the IC is started. To re-read the file, type 'collimate.table.read' in the CLI interface. The FIOC Details display should the collimation table data for tcs3.

System Power – Turns off or On the system power.

Mirror Cooling

There are 2 widget for Mirror Cooling:
1) A radio button to set the mirror cooling mode to off, manual, or auto. Selecting the radio button will issue the mc.mode command to the TCS.
2) A label to show a status string. This is a short description on the mirror cooling status, some example are:

"MC is OFF" – summary of mc.mode off (Fan OFF, Heater OFF, Actuator at 0 volts)
"Manual Mode. Fan=On Heat=Off Act=10.0v" – summary of manual mode. The default setting for manual mode is for the cooling to be ON.

"AUTO and cooling ON." – Mc.mode is Auto, and cooling is ON (Fan ON, Heater OFF, Actuator at 5 volts).
"AUTO. Defrost 99%" – Mc.mode is Auto, but in Defrost mode (Fan OFF, heater ON, Actuator 0 volts), the percent indicate how long you are in the defrost cycle (about 30 minutes long).
"AUTO but cooling OFF" – mirror is below set point.

For detail status on the mirror cooling, see the Detail Tab, and view FIO_MC on the MCC GUI.
For addition documentation on mirror cooling see the TCS3 Design Documents T3-315x in http://irtfweb.ifa.hawaii.edu/~tcs3/tcs3/Design/document_index.html.

Laser Traffic:
These widget provide frequently used Laser Traffic options. When Lct.Enable is ON, the system should write the telescope position to the web site. The Ltc.impact checkbox when check will set IMPACT=YES.

Smokey's Mirror:

For convenience, widgets to control Smokey's mirror position is located on MCC2.
The **enable** checkbutton enables smokey control.
The **Mirror Out** button will move the on-axis mirror OUT of the beam.
The **Mirror In** button will move the on-axis mirror to the IN position.
Between the button, status should indicated the current position of the mirror.

Next Object List:

Display the next object list. The tcs3 'Next' command allow users to send slew request positions to the tcs. This request are display here. To slew to one of the item on the list use the 'Slew N' command, where N is a value from 0 to 5.

If a proper motion is in excess of 10 arcseconds per year, the PM values are colored red. Bad proper motion value had been sent to the TCS, this warning will help flag potential bad slew destinations.

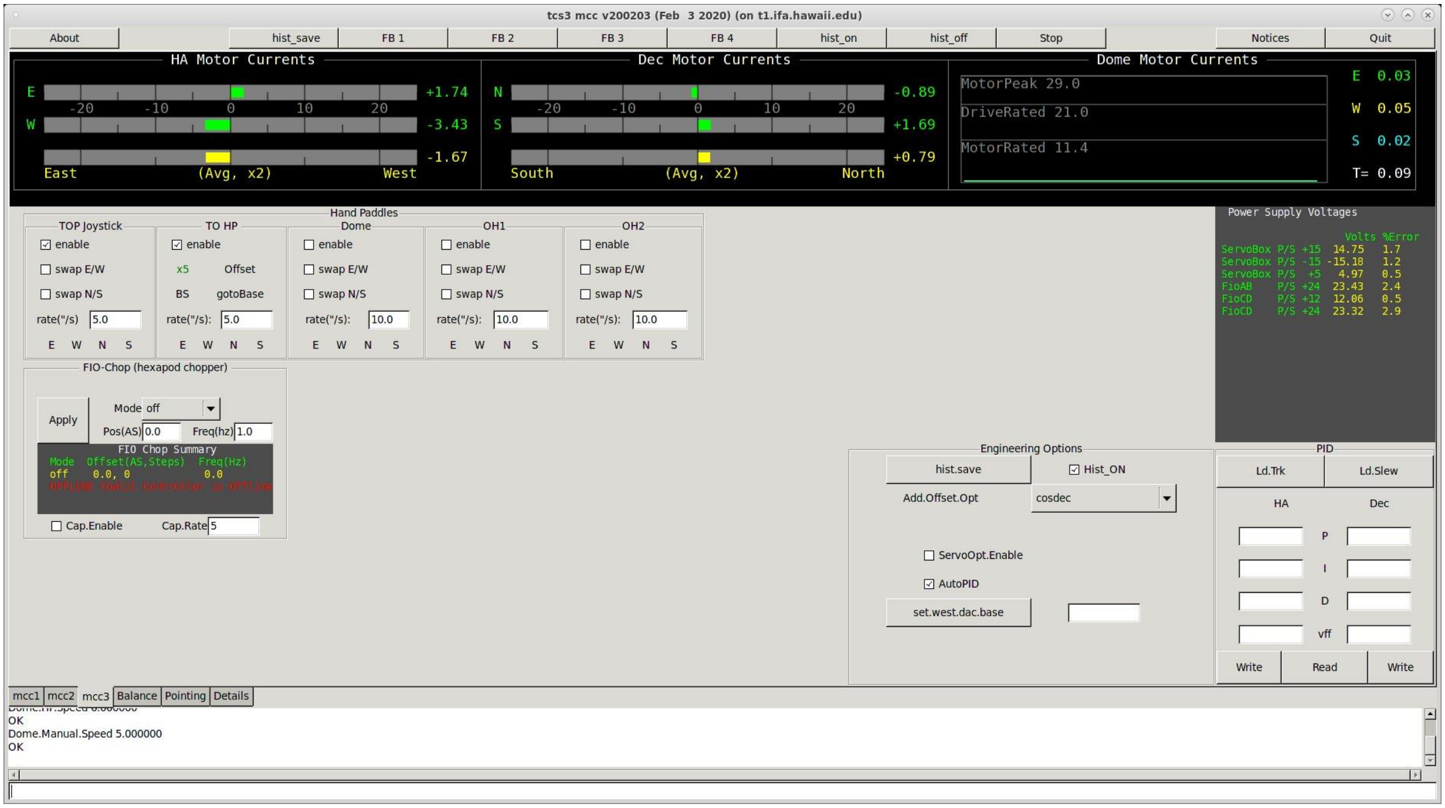
Misc: - a group of miscellance window are group here.

Hum.wn – This slider widget sets the Humidity Warning level. The page values is set to 5.
Wind.wm – This slider sets the High Wind Warning value in MPH. The page value is set to 5.
Pt.rate.default – these default pointing rate value are used to re-set the pointing rate after a slew.
Software Limit Override – Toggles the Sw.limits.override Off or On. When checked, software limits are ignored. See MCC GUI's Details -> Position table for value of various limits.
Hor Slew Limit Override – Toggles the HSlew.Limit.Override Off or On. When checked, the horizon slew hardware limit which limits velocity to 400 as/s is ignored.
Hexapod.Init – This button is request the fio_hexe run the hexapod init script. This script initializes the hexapod. However, this can also be accomplished using the hexeGUI, plus the HexeGUI provide better feedback that the TCS.

Macro Dialog Box:

To the right the macro dialog box is available. Text files of TCS3 commands can be execute by selecting, the pressing the Exec button. The directory contains the macro files is print at the top of the macro box. You can use a text editor / file manager to inspect/maintain these files.

3.8. MCC3 Tab



Motor Currents:

Ha, Dec, and Dome motor currents are displayed (The same as MCC2)

Hand Paddles: Options for each physical TCS3 hand paddles. Each hand paddle that has a N,S,E,W button has a set of widget to control the following properties:

Enable – Off/On to disable or enable hand paddle inputs.
Swap E/W – swap the E/W directions on the hand paddle.
Swap N/S – swap the N/S directions on the hand paddle.
Rate (as/s) – enter the velocity applied with the hand paddle's NSEW buttons.
'E W N S ' – these label indicate the status of the handpaddle button: Black=off; Green=ON or pressed.

The TOHP, also has the following labels to indicate the status of the following inputs (Black=off; Green=on):

X5 = 5x rate switch.
BS = beamswitch request button
Offset = pointing (off) or offset (On) adjustment mode.
Gotobase = goto base request button

Power Supply Voltage – This display area show the voltage of the power supplied in the TCS3 electronic boxes. The voltage are sampled by the FIOA Analog Inputs. If the voltage deviates from the specified voltages too much, the text color will changed from yellow to red.

The **FIO-Chop** are experimental widgets. Please ignore.

Engineering Options and PID

Item in these window are engineering option. Daycrew/TOs should not change them unless directed by the TCS3 technical support staff.

Vtcs.offset.opt – controls how the offset are added to the base, resulting in the target destination for tracking.
Hist_ON –Use this check box to enable/display the recording of the tcs History Data, 10 sec buffer of various TCS3 servo information at 20Hz.. This data is display in the Details tab's Perf-T and Perf-G displays.
Hist.Save – This button will write the contents of the History Data Buffers to the History Directory. This History Data Buffer hold 10 sec of various servo variables, sampled at 20Hz.

ServoOpt.Enable – When enabled, this allow some of the other widget to work, ie the set.west.dac.base.

Set.west.dac.base – button and text widget to allow setting the base DAC voltage for the west DAC. Implemented because of the HA Drive issue of 2019. See TCS3 Operator's guide for more details.

The following widget are not documented in this manual. Again see the tcs3 programmer for details. They should not be changed by the daycrew or TO unless directed by the TCS programmer.

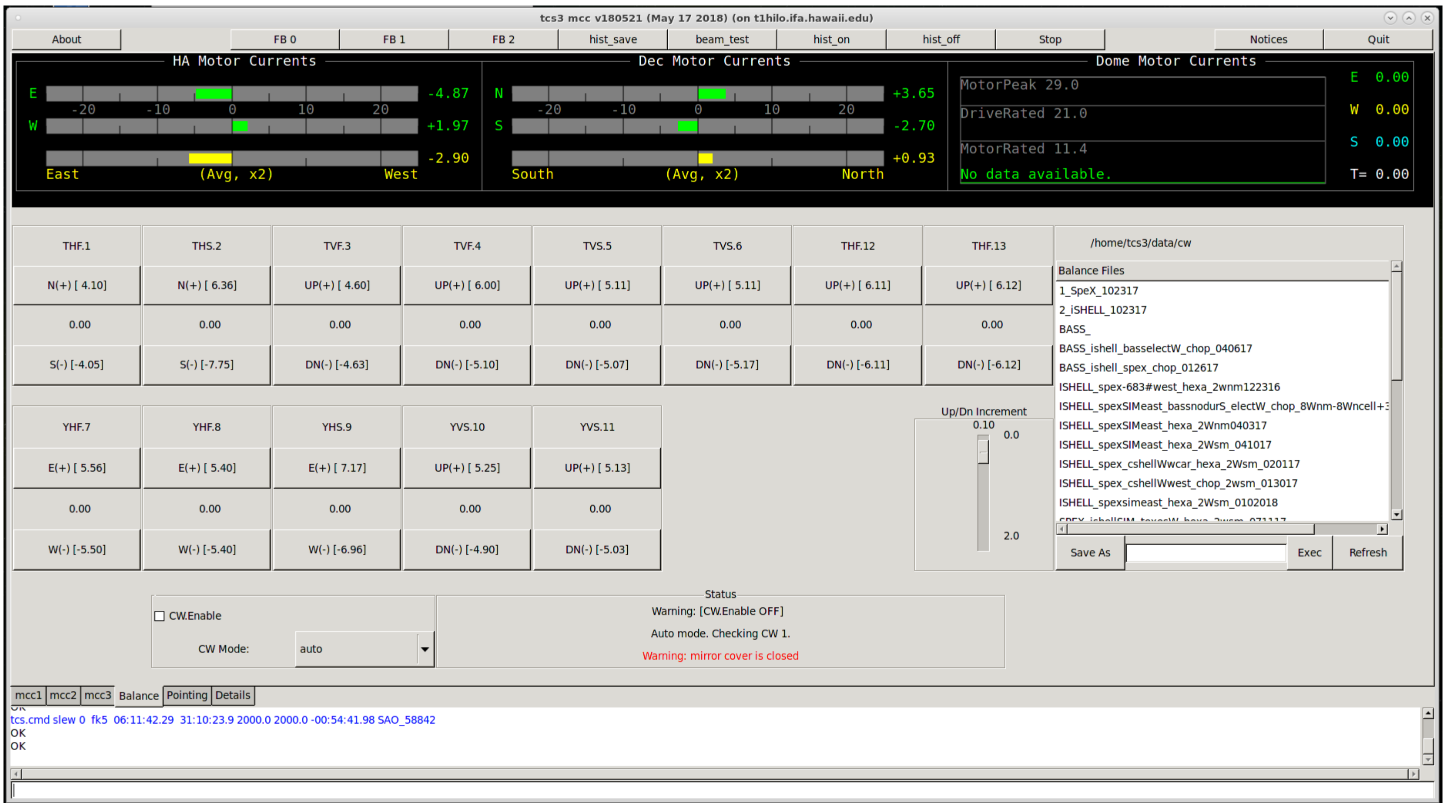
AutoPID – Note the default is enabled.
PID – undocumented. For used by TCS programmer only.

3.9. Balance Tab

Common elements appearing on the manual and auto mode screens:

Motor Currents:
Ha, Dec, and Dome motor currents are displayed.
For HA and Dec, the ‘d’ show the differences of the motors.
CW.Enable checkbutton
Click to enable or disable counterweight control.
CW Mode dropdown menu
Select either the manual or auto mode.
Status
Window displaying counterweight status information such as the enable status and any current counter-weight movement in progress.

Auto Mode:



Auto Mode Screen

‘UP’, ‘DOWN’, ‘EAST’,’ WEST’, ‘NORTH’, ‘SOUTH’ buttons [auto mode]:

Clicking these button will changed the Desired Position of the counterweights. The Actual Position is displayed on the widget. After changing the DPos, position display changes to Red and display both the desired and actual in this format, 0.00 >> 1.00. When the DPos has been reached, the display returns to black.

An ‘(S)’ in the position display indicates the counterweight is stuck – it has stop moving but has not reached it desired position.
An ‘(L)’ indicates it has reached a limit set in the software and can not be moved further in auto mode.

Notes:

The numbers next to each counterweight name refers to the counterweight numeric ID.
If counterweights are not enabled, the brakes are on, or the power is off, a warning message will appear in the status window.
Because the voltage indicating counterweight position fluctuates slightly, the test for reaching the desired position does must allow for this. This may result in the counterweight stopping at a position which does not exactly match the desired position voltage. .

Increment

Slider used to set the amount of voltage increment added or subtracted by each click on an ‘UP’, ‘DOWN’, ‘EAST’, ‘WEST’, ‘NORTH’, or ‘SOUTH’ button.

Balance Files

Counterweight position settings may be saved and restored as named files. The current save path is shown above the file list window. Executing a position file will load in the saved position for each counterweight, and the TCS will cycle through the counterweights to moving each one into positions. To save a set of counterweight positions, enter a file name in the file entry box and click the ‘Save As’ button. To execute a saved file, click on the file in the list and then click the ‘Exec’ button. The ‘Refresh’ button relists the files in the balance file directory. The directory path man be changed by the “CW.Dir” command (see the 1101_command user’s manual document).

The default CW.dir is “/home/tcs3/data/cw”.
By convention, the files are named using these rules:

1st name is capital, showing the instrument in the center of MIM.
Upto 3 names show what else is installed in the MIM.
Last part is the day the file was created in MMDDYY.
Name and date separted by “_”.

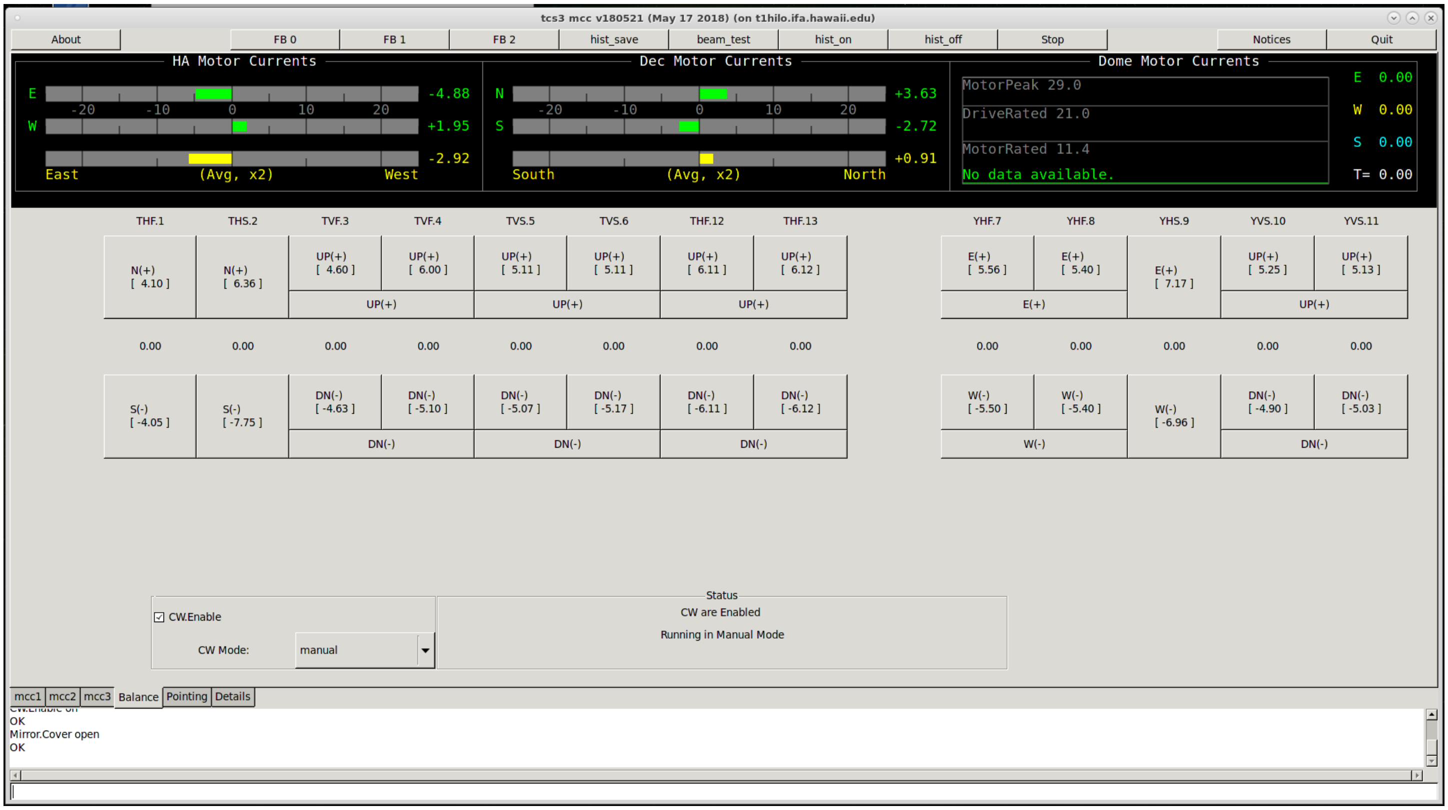
For example, this name “CSHELL_spex_hipwac_8wnm_020906” was created with CSHELL in the middle, and spex, hipwac, 8wnm installed on the MIM. Balance was done on Feb 09, 2006.

The content of the file is:

```
CW.Dpos 1   4.015
CW.Dpos 2   6.310
CW.Dpos 3   1.275
CW.Dpos 4   1.264
CW.Dpos 5  -4.966
CW.Dpos 6  -5.015
CW.Dpos 7  -0.819
CW.Dpos 8  -0.905
CW.Dpos 9  -2.248
CW.Dpos 10   5.158
CW.Dpos 11   5.066
```

The CW.Dpos is a TCS command to set the desired position of the counter weight.
The 2nd field is the counterweight numeric ID.
The 3rd field is the desired position of the counter weight in volts.

Manual Mode:



Manual Mode screen

‘UP’, ‘DOWN’, ‘EAST’, ‘WEST’, ‘NORTH’, ‘SOUTH’ buttons:

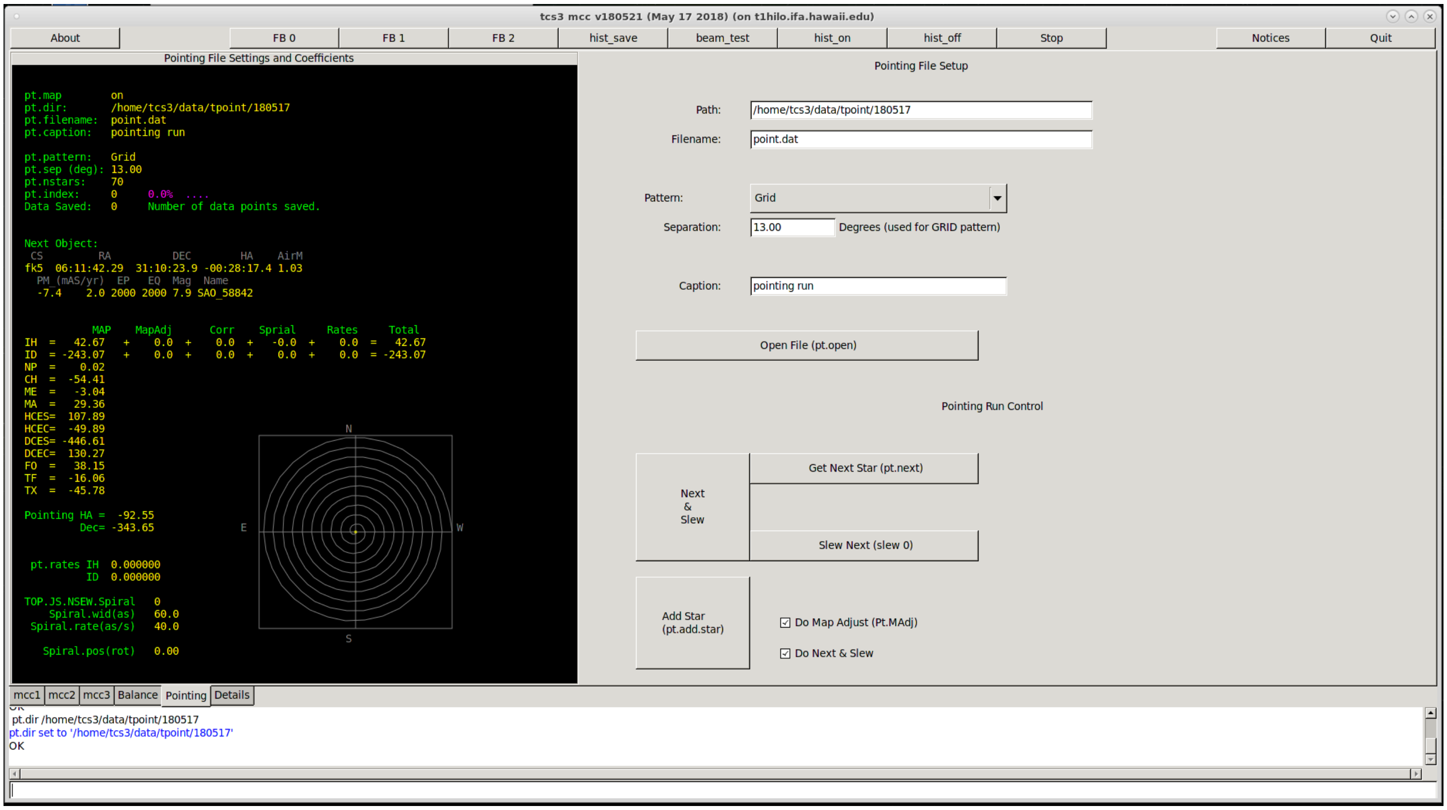
These buttons operate as in the auto mode to control the direction of movement for the selected counterweight, however in the manual mode the + or – control voltage will be applied for as long as the button is selected or until the counterweight hits a hard limit. In the manual mode only the actual position voltage is displayed, without the direction arrows, ‘(S)’ or ‘(L)’ indicators. The minimum and maximum position limits for each counterweight are displayed in [ ] in its button labels.

One other difference between the auto and manual modes is that some of the counterweights may be operated as linked pairs. This is implemented by the wide buttons linking pairs of counterweights. For example, The wide UP(+) under TVF(3) and TVF(4) move both counterweight up.

Note:

A warning appears in red in the status window if the mirror cover is closed, the system power is off, or the brakes are on since these will impact dynamic balancing (see screen shot above).

3.10. Pointing Tab



Pointing File Settings and Coefficients:

Displays the current values of the parameters associated with a pointing run and the pointing correction map.

Pointing File Setup:

Path:

Enter the full path for the directory where pointing run data file is to be stored.

Filename:.

Enter the name for the file where pointing run data is to be stored.

Separation:

Enter the number of degrees separation between stars in the pointing array to be generated.

Caption:

Enter a caption to be stored as part of the pointing file header information.

Open File button

Press to create and open the pointing file and to write out the header information to the file.

Pointing Run Control:

Get Next Star button

Press to load the position information for the next pointing target in the array.

Slew Next button:

Press to start the telescope slewing to the loaded target star position.

Next & Slew – combines the Get Net Star and Slew Next buttons.

Add Star button:
When the telescope has completed slewing to the target, press this button to store the telescope pointing information for the target star into the pointing file. Checking the ‘Do Map Adjust (Pt.map)’ will also add the offset to the pointing adjustment register. Checking the ‘Do Next & Slew’ will (after saving the data), get the Next Star and start the Slew.

The pointing run procedures are documented in document 1201_pointing_run.doc under the tcs3 user’s guide. Follow these procedure when doing a pointing run.

3.11. Details Tabs

The details tab provide access to engineering screens where the detailed information on the TCS3 can be viewed. To be used by the technical staff for trouble shooting. The individual items are not covered in this document, only a summary of the available engineering displays are listed:

Pos	Astronomy and servo motor positional data.
Time	Time and other VTCS informaiton variables.
Graph1	Performace graphs for TCS, mostly show server performance..
Graph2	Performace graphs for TCS, has motor current, collimation, focus, and guider corrections..
PMAC	The PMAC motor control details.
DS/e100	The Dome Servo and MotiFlex e100 servo drive details.
FIO-CHOP	Chopper details based on the galil controller is show (NOT OPERATIONAL)
App	Internal TCS3 & MCC process and application data.
FIOA	Facility IO device fioa details.
FIOB	Facility IO device fiob details
FIOC	Facility IO device fioc details
FIOD	Facility IO device fiod details
FIOE	Facility IO device fioe details.
FIOF	Facility IO device fiof details.
FIOCW	Facility IO device fiocw details (counterweight control using RIOs).
FIOMC	Facility IO device for the Mirror Cooling IO.
FIOX	Facility IO details for misc processes: Dome Serial input process details. Fio_ape process details. Laser Traffic Control details. IQUP Wind Speed details. Queries to smokey (IRTF Guider).
IQUP	IQUP information collect and used by the TCS is displayed here.

4. The TO (Telescope Operator's) Hand Panel

The TO Hand Panel is attach to the tcs3 system via the FIOCD box. It provides some buttons for offsetting and point map control. Here a photo of the hand paddle:

TO Hand Paddle (Top View) **TO Hand Paddle (Front-side).**

The TO Hand Paddle is to be used while the telescope is tracking.
To activate it, go to the MCC3 GUI and check the **enable** in the TOHP box. Also enter your desired rate in the **rate ("/s)** prompt..

On the front side of the TOHP, there is a **Pointing/Offset** slider switch. This sets the mode of some of the buttons on the top face to either pointing or offset. The N, S, E, W, and Go To Base button are affected by this mode setting:

<u>Pointing Mode:</u>

> In pointing mode, the **N, S, E, W** buttons will adjust the IH/ID values for the pointing map. The **Go To Base** button is equivalent to a pt.save.

<u>Offset Mode:</u>

In offset mode, the **N, S, E, W** buttons will adjust the UserOS values. The **Go To Base** button will set the UserOS to 0,0.

The **Beam Sw**. button will toggle the Beam Position.

The **N/S Swap** switch will swap the direction of the N and S buttons.

The **E/W Swap** switch will swap the direction of the E and W buttons.

The **5 X Rate** slider will set the rate to 5 times the rate set in the mcc3 GUI’s rate value for the TOHP.

T3Remote

The Remote GUI for TCS3

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1. Introduction

T3Remote is a mini-gui for the tcs3. It is intended to be used by observers and the Telescope Operator. It is installed and runs on the IRTF workstation. Multiple copies can be running by various number of users.

To start t3remote, type “t3remote” on you console terminal. The GUI should appear.

Usage: t3remote [–d] [–h hostname]

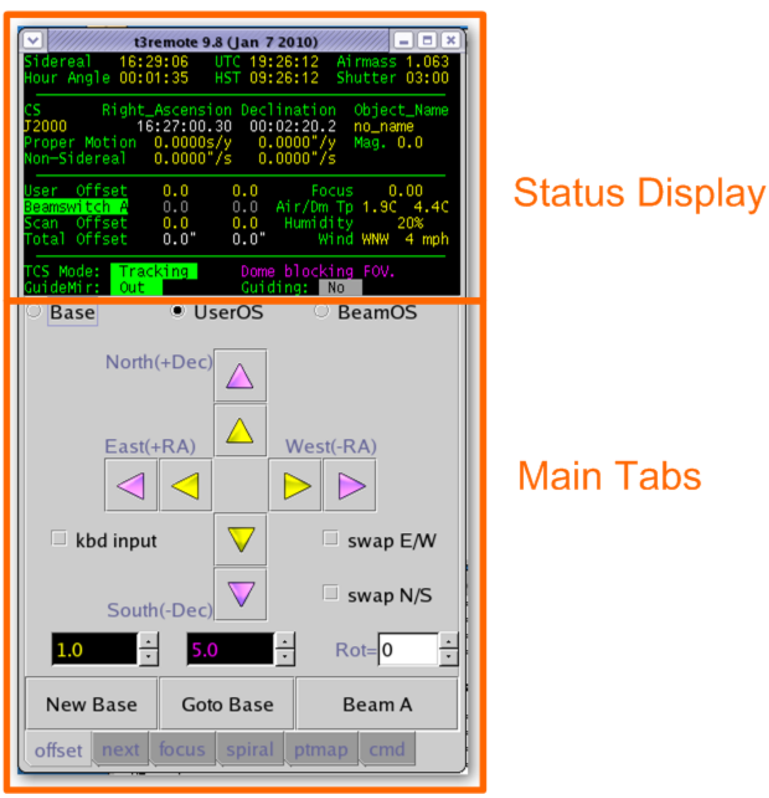
-d	Turn on the debug flag.
-h hostname	Sets the tcs3 computer’s hostname
-m	Use Medium size font for status. Hides the Main Tabs window.
-l	Use Large size font for status. Hides the Main Tabs window.
-t	Tabs only. The status display is hidden.

2. T3Remote

The GUI has 2 main sections:

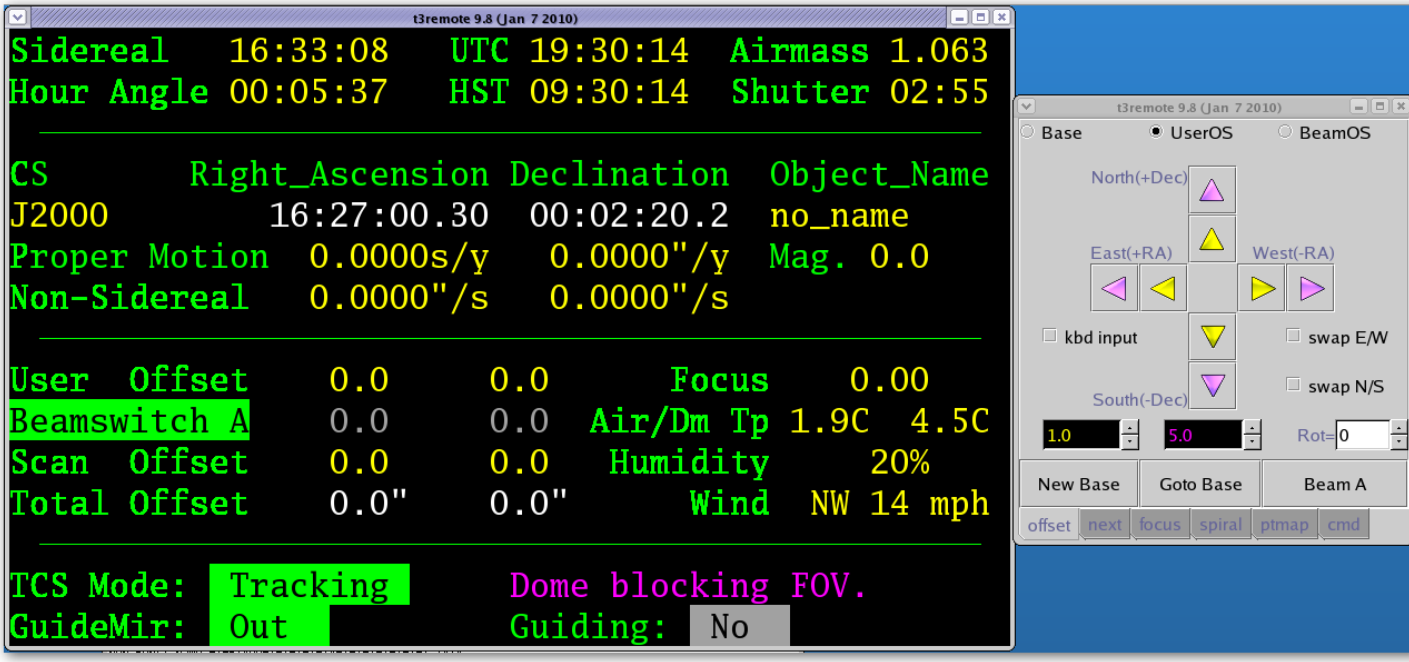
Status Display
Main Tab provides various types of control widgets to the TCS3.

Here is a picture of the GUI:

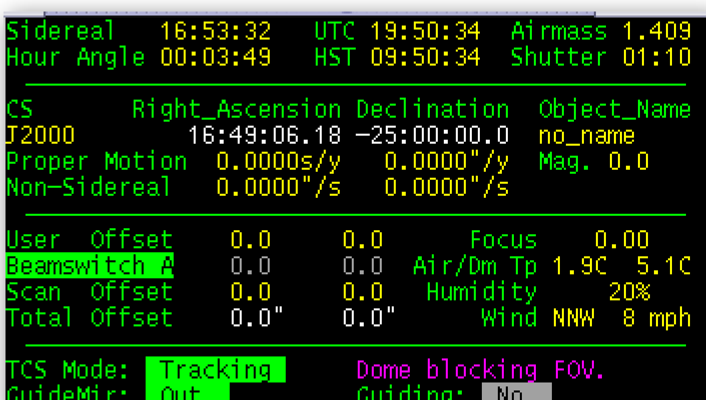


You can use larger font for the status using the –m or –l command line option. Using –m or –l will only display the status. You can run another copy using the –t, to display the Main Tab (without status) . There is an example, 2 t3remote running: 1) large fonts, 2) with tabs only.

> t3remote –l
> t3remote –t



3. Display Status Area



The Display Status Area provides status from the TCS3. Data provided includes:

Sidereal – The Local Sidereal Time.

Hour Angle – The observed Hour Angle position.
UTC – Coordinated Universal Time
HST – The local time, Hawaii Standard Time.
Airmass – Air mass
Shutter – Time in HH:MM until the shutter will block the field of view.

CS – The Celestially Coordination frame of reference for the RA and Dec positions.
J2000 = The FK5 reference frame using the Equinox of J2000.0
B1950 = The FK4 reference frame using the Equinox of B1950.0
App = Topocentric Apparent.
Other the 'FK4' or 'FK5' is display with its Equinox values.
Right Ascension – Target Right Ascension (target is base position + offsets).
Declination – Target Declination

Object Name – The object name field from the ptable (TCS3 position table).
Proper motion – display proper motion ra (s/yr) and dec ("/yr).
Non-Sidereal – The non-sidereal rate in "/s.
Mag. – The magnitude value from the position table.

User – User offset magnitude display; color coded yellow when applied, gray when disabled.
Beamswitch A or B – Indicates the beam position, and offset magnitude.
Scan – offset applied from the scan offset.
Total – display the total offset added to the base, resulting in the target RA Dec position.

Focus – display the actual focus position (actual is the position sensor value).
Temp. – The temperature in degree C.

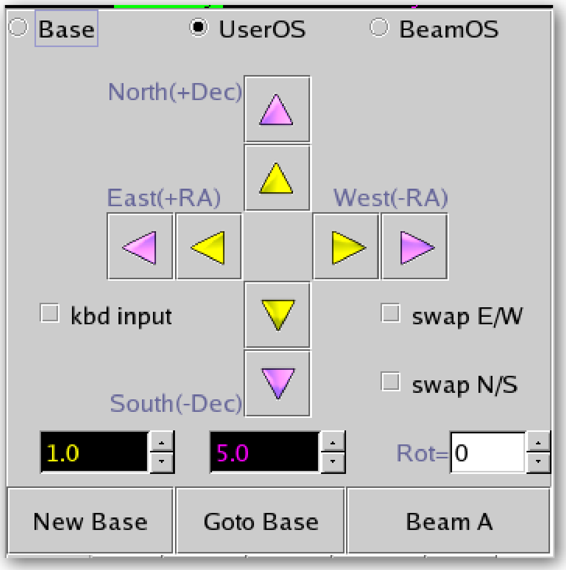
TCS Mode – provide to operating mode of the TCS. They are:
Stop – telescope is parked: servo is off; brakes are on.
MP – Move Postion mode (non-observing positional moves).
MV – Move Velocity mode (non-observing velocity moves).
Track – Track the sky position specifed by the tracking table.
slew – Slewing to a tracking position.

To the right of TCS Mode, relevant status is displayed for current TCS Mode.
During tracking, you may see:
Dome is ready
Dome moving..sec (where sec is estimated seconds in current move)
Dome blocking FOV (Field of view)
During Slew, the estimated time to the end of the slew is displayed.

GuideMir: Display the location of the off/on axis guider mirror.
Out – means the mirror in out of the optical path (green text).
In – means the mirror is blocking the optical path to the instrument (Red)
Unkn – means the position is not known by the TCS.

Guiding – Indicates if guiding is active (YES) or not (NO). Guiding YES, occurs when peaking up the pointing map using the guider or manually. YES is display when the TCS receives 5 guiding updates within the last 60 seconds.

4. Offset Tab



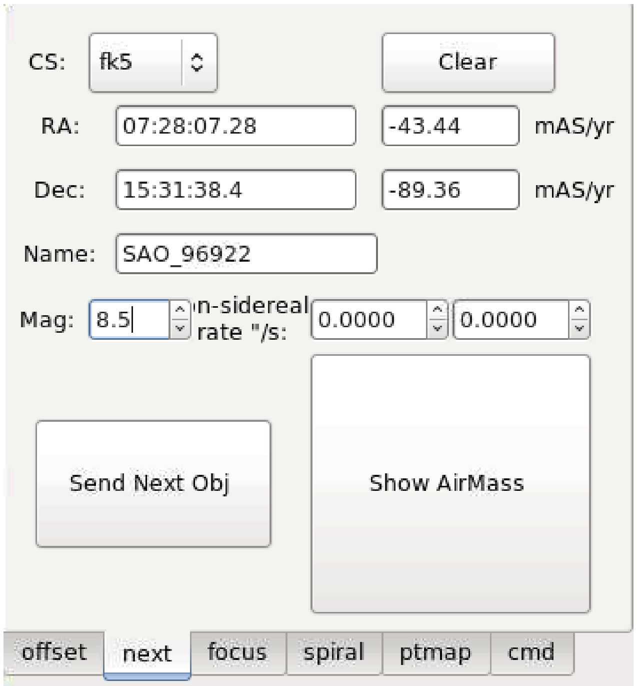
The Offset Tab allows the users to increment the base coordinates and/or offsets.
First select the coordinate to change from the top radio buttons:

- **Base** – Base RA and Dec position
- **UserOS** – User offsets.
- **BeamOS** – Beam offsets.

Use the **spinbuttons** (yellow and magenta input fields) near the bottom to set the magnitude of the offset. Units are in arc seconds, and the color indicate the which buttons they are for.
The **Rot=** input specifies a rotation for the offset request. The units are in degrees.
Click on the **Arrow Buttons** to move or change the OS values.
The **swap E/W** or **swap N/S** allows you to change the direction of the buttons.
The **kbd input**, when checked, allow the keyboard arrow key to function like the Yellow buttons.

The **NewBase** button will make the current position the new base (zeroing any active offsets).
The **Goto Base** button will zero the user offset (using "user.set 0 0 ").
The Beam Switch button's label will read **Beam A** or **Beam B** to indicated the current beam position. Press this button to toggle the beam position.

5. Next Tab



The Next Tab also you to send the next or slew destination to the TCS.
After entering the sky coordinates, and press the **Sent Next Obj** button to sent you slew request to the TCS.

CS – The Celestial Coordinate System Reference Frame:
Fk4 – The RA and DEC is in the FK4 Reference Frame. Its standard Equinox of B1950.0 is assumed.
Fk5 – The RA and DEC is in the FK5 Reference Frame. Its standard Equinox of J2000 is assumed.
Apparent – The RA and DEC is in geocentric apparent reference frame.
Note: For ICRS coordinates, used CS of fk5.
RA – Right Ascension in hours. Note the following formats are equivalent:

```
18:02:23.05
18 02 23.05
18.03973611
```

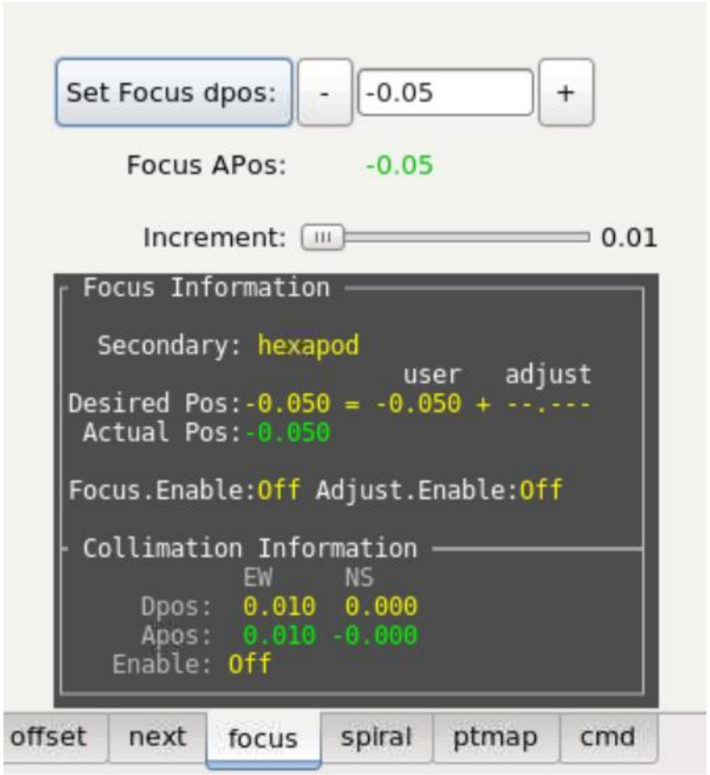
Dec – Declination in +/- degrees. Note the following formats are equivalent:

```
19:48:58.0
19 48 58.0
19.816111
```

PM – proper motion. RA proper motion in mAS/yr. Epoch for proper motion correct is implied by the CS value.
Name – a name for the object.
Mag – a visual magnitude (optional)
Non-sidereal rate "/s – RA and Dec non-sidereal rates in arcseconds/second.

Press the **Show AirMass** button to display the HA, and Airmass for the entered RA, Dec position.

6. Focus Tab



The Focus Tab allows the observer to change the telescope focus.

To set the focus desired position, enter a new value in the text widget, then press the **Set Focus dpos:** button. The new position should be updated in the Focus Information area.

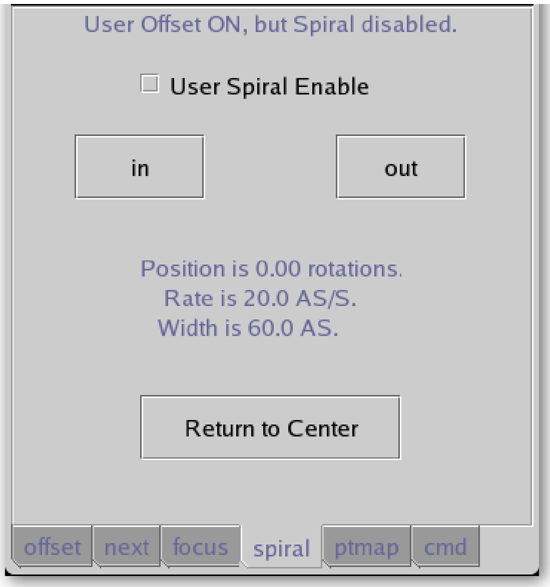
You can decrement or increment the desired focus position by pressing the **"-" and "+" buttons**. The incremented amount is control by the slider below labeled "**Increment**".

Focus APos The apos is the actual position returned by the focus position sensor. APos is GREEN when the focus in 'in position' or match the desired position. Red otherwise.

<u>Focus Information:</u>
The feedback area proves details on the focus and collimation values.
Secondary: The IRTF has 2 secondaries: hexapod, and chopper. This shows the current secondary being used.
Status or feedback information is presented in the black display area.
The **Desired Pos** is where the focus mechanism is commanded to. The position is determined by the **User Dpos** (entered by the user) plus the **Adjustment** value. The adjustment value is a temperature and telescope position adjustment applied in real-time. This adjustment value is used when **Adjust.Enable** is ON. Information on how temperature and position affect focus is in the TCS3 Operators Guide.

Collimation information is also displayed here. The desired position (Dpos) and Actual position (Apos) is display. Apos is GREEN when collimation in 'in position', otherwise Red is used. The Collimation Enable is shows if the collimation software loop is active (ON) or not (OFF).

7. (User) Spiral Tab



The Spiral Tab allows the observer to spiral the telescope. The spiral RA and Dec offset are place the the User Offset. To sprial, check the **User Spiral Enable**. Note that User Spiral disables user's offset.

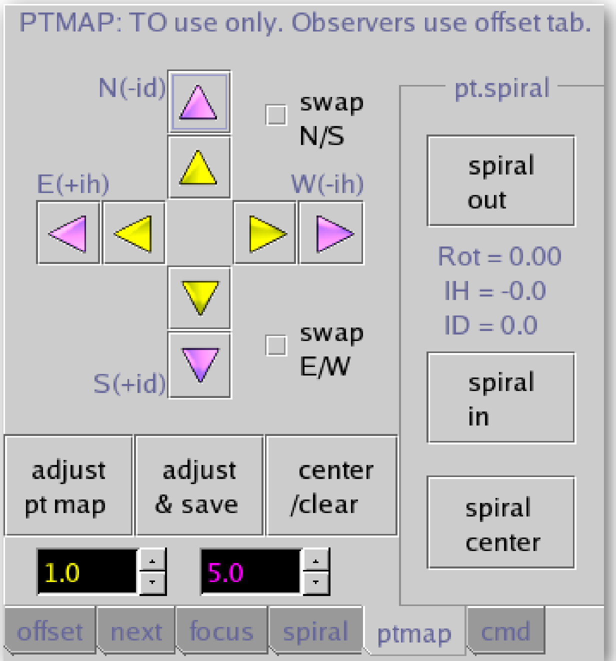
Press the **out** button to spiral outwards, use the **in** button to spiral inwards.

The **Position** tells you your location on the spiral in terms of rotations. The RA and Dec offset values can be seen on the **Users** (on the status display).

The **Rate** and **Width** is display for your reference. The TO can adjust these values using the User.Spiral.Rate and User.Spiral.Wid commands.

The **Return to Center** button set the rotation to 0 (center of the spiral).

8. PtMap Tab



The PtMap Tab is the Point Map Table. These controls should be used by the Telescope Operator only (not the Observer).

The **arrow keys** allow you to peak up the IH and ID corrections values. Use the **yellow and magenta spin buttons** to set the displacement, units are in arcseconds. The **swap N/S or E/W** check buttons allow you to reverse the HA or Dec directions.

Adjust pt map – issues pt.madj command to add corrections values to MAdj (Map Adjustment) registers.
Adjust & Save – issue pt.save: does a pt.madj AND saves MAdj values in the ic/pt.save.txt files for recall at restart.
Center/Clear – Issues Pt.clear to zeros the MAdj, Spiral, and Rates registers.

The pointing map spiral can be controlled using the widget in the pt.spiral frame.
Spiral out – spirals outwards.
Spiral in - spirals inwards.
Spiral center – issues Sp.center sets the rotation to 0.
The spiral Rotation, IH, ID vales are displayed inside the pr.spiral frame.

9. CMD Tab

The CMD Tab allows t3remote command to be typed in using the keyboard. These are not TCS3 command (command defined the tcs3 command dictionary). In normal operations, neither the TO or Observer should use this tab.

TCS3 Command Reference

1. Introduction

This document describes the set of commands available to the user through the TCS3 telescope control software. These commands may be entered directly on the Command Line Interface (CLI) of the TCS3 MCC graphical user interface screens, through a telnet connection, or indirectly through the use of widgets on the MCC screens or the t3_remote interface.

2. Summay of Commands by Catagory

2.1 Observing and Servo

Add.Offset.opt – Options when adding offset to base position.
Autopid – Enables or disable the autopid function.
Autopid.set – Specifies a set of PID coefficients.
Base - Load a new position into the position table base.
Base.inc - Increment the RA, Dec values of the base.
Beam.set - Specify the RA and Dec offsets for the beam
Beam.init – Initialize the beam offset.
Beam.inc - Apply an increment to the beam RA and Dec offsets
Beam.on or **Beam.B** - Enable application of the beam RA and Dec offsets
Beam.off or **Beam.A** - Disable application of the beam RA and Dec offsets
Beam.toggle - Toggle the beam offset enable status
Cat.search - Search catalog for the star closest to given RA/Dec within a specified radius
Cat.index - Search specified catalog by index and load results into 'next' buffer
CS - Set the default coordinate system
Epoch - Set the default epoch
Equinox - Set the default equinox
HSlew.Limit.Override – Override horizontal slew velocity limits.
Info - Return a selected subset of tcs information
Next.Clear - Clear a next star entry
Next – enter object data into the 'next' buffer (using RA, Dec coordinates).
Next.hadec – enter object data into the ‘next’ buffer using HA Dec coordindates.
NS.rate - Specifies an non-sidereal rate to be applied to the base position.
NS.rate.inc - Increments the base non-sidereal rate.
OS.2base - Transfer the enabled offsets and rates to the base and clear the offset values
MP - Execute a Motor Position move
MP.cnt - Specifiy the MP destination position in motor counts
MP.inc – Increments the MP destination position in arcseconds.
MP.Vel - Set the velocity for a motor position move
PID.Dec – Makes a requests to set the PID for the Dec axis.
PID.HA – Make a request to set the PID for the HA axis.
Polar.Motion - Specifies the earth's polar motion

MV - Execute a Motor Velocity move
Mw.zero – zero the measurement widget value.
Scan.Clear - Remove scan offsets to return to the original position
Scan.Go – Scans by moving to the offset ra, dec position.
Scan.Return – Scans by returning to the 0,0 offset position.
Scan.Set - Set up the parameters for scanning to an offset position
Slew - Slew to the next object in the specified buffer
Slew.Abort - Abort a slew and switch to track mode
Slew.Reslew – Re-issue a the slew command to the pmac (to fix "slew not slewing" problem).
Stop - Put the tcs system in the 'stop' mode
Sw.Limits.Override – Overrides software limt velocity controls.
Sw.Limits.Set – Set the software limits.
Track - Commands tcs to enter the 'track' servo mode
User.Inc - Apply an increment to user RA and Dec offsets
User.Init – Initialize the User Offsets.
User.Off - Disable user offsets
User.On - Enable user offsets
User.Set - Set the values for the user RA and Dec offsets
User.Toggle - Toggle the user offset enable setting
User.Spiral.Center – Move to the center of the user spiral..
User.Spiral.in – Move inwards on the user spiral trajectory.
User.Spiral.out – Move outwards on the user spiral trajectory.
User.Spiral.rate – Specify the velocity of the user spiral.
User.Spiral.stop – Stop moving on the user spiral.
User.Spiral.wid – Specify the with of 1 rotation of the user spiral
UT1Delta - Set the value of ut1 - utc.
Wavelength- Set the value of the observed wavelength

2.2. Facility Hardware Control

Ape.mode – Set the fio_ape execute mode.
Ape.Pos - Manual method for initialing the APE value.
Ape.set.pmac - Tells the tcs to initialize the position in the PMAC servo controller using the APEs..
Collimate.EW.Dpos- Set desired East/West collimation position
Collimate.EW.Dpos.Inc- Increment East/West collimation position
Collimate.NS.Dpos - Set desired North/South collimation position
Collimate.NS.Dpos.Inc – Increment North/South collimation position
Collimate.enable - Enable or disable collimation control loop
Collimate.table.read – Loads collimation table data into tcs3.
Collimation.table.set – Set the collimation desired position using the collimation table.
CW.Dir - Set the directory path for counterweight files
CW.Dpos- Set selected counterweight to position described as a voltage
CW.Enable - Enable or disable counterweight movements
CW.Manual.cntl - The CW command to set a counterweight up, down or off
CW.Mode - Select the counterweight operational mode
DHP.**enable** – Enables the DOME handpaddle.

DHP.swapEW – Swaps East and West inputs for the Dome HP.
DHP.swapNS – Swaps North and South inputs for the Dome HP.
DHP.rate – Sets the velocity for the Dome HP in as/s.
Dome.Auto.Offset – Set the an offset angle during auto (tracking) mode for dome control.
Dome.HP.Speed – Sets maximum speed for dome handpaddle mode.
Dome.Manual -Control dome motion while in manual mode
Dome.Manual.Speed – Sets the maximum speed for dome manual mode.
Dome.Mode - Set the dome movement control mode
Dome.Speed - Set the dome movement speed factor
Focus.Adj.Enable – Enables or disable the Temperatue and Position adjustment to the focus.
Focus.Enable - Enable or disable the focus control loop
Focus.Dpos - Set the desired focus position
Focus.Dpos.Inc - Increment or decrement the focus position
Hexapod.init – runs the Hexapod initialize maco file.
Humidity.Wn - Set relative humidity level to trigger warning.
Mirror.Cover - Open or close the mirror cover
MS.Support – Turn mirror support off or on.
MS.Fault.Ack - Re-enable mirror support after a fault
MC.Actuator – Mirror cooling fan control.
MC.Fan – Mirror cooling fan control.
MC.Heater – Mirror cooling Heater control.
MC.Mode – Sets the Mirror cooling mode.
MC.SetPt – Sets Mirror cooling set point temperature.
OH1.enable – Enables the OH1 handpaddle.
OH1.swapEW – Swaps East and West inputs for the OH1.
OH1.swapNS – Swaps North and South inputs for the OH1.
OH1.rate – Sets the velocity for the OH1 in as/s.
OH2.enable – Enables the OH2 handpaddle.
OH2.swapEW – Swaps East and West inputs for the OH2.
OH2.swapNS – Swaps North and South inputs for the OH2.
OH2.rate – Sets the velocity for the OH2 in as/s.
SafetyBrd.Reset – Reset the error latch on the safety board.
Secondary – Identifies the secondary in use (chopper or hexapod).
Shutter.Lower - Control the lower shutter
Shutter.Upper - Control the upper shutter
System.power – Turns system power on or off.
Track.NoIOnOffset.HA – Controls the integrator hold option during tracking.
Track.NoIOnOffset.Dec – Controls the integrator hold option during tracking.
TOHP.enable – Enables the TO Handpaddle inputs.
TOHP.rate – Sets the velocity form the TOHP in "/s.

2.3. Environmental and Other setup

Elevation - Set the elevation of the observatory
Humidity - Manually set the relative humidity
Latitude - Set the latitude of the observatory

LTOffset - Set the ut to local time offset
Pressure - Specifies the atmospheric pressure
TempK - Set ambient temperature value in degrees Kelvin
VTCS.Env.Update – Enables enviroment data updates from FIO inputs.

2.4. Laser Traffic Control

Ltc.Enable - Enable/disable Laser Traffic Control updates
Ltc.Filename - Set the full path for the LTC file name
Ltc.Fov - Set Laser Traffic Control Field of View
Ltc.Impact - Set the value for the Laser Traffic Control 'impact' field
Ltc.Period - Set period between LTC file updates

2.5. Pointing Map

Pt.Add.Star - Append the pointing data for the current star data to the tpoint file
Pt.Caption - Specify the text of a caption for the pointing data file
Pt.Clear – Clears all user pointing offsets and rates.
Pt.Convert - Converts current HA & Dec to numbers to enter into t3remote to test pt runs
Pt.Dir - Define the directory path for pointing data files
Pt.Find - Find the nearest guide star to the given HA and Dec and load into the next object buffer.
Pt.MAdj – Add pointing corrections (peak, spiral, rates) to the map via the MAdj registers.
Pt.MAdj.Set – Set the IH/ID values of the madj pointing register.
Pt.Map - Turn the pointing map on or off
Pt.Map.Set - Set a pointing map coefficient value
Pt.Next - Get the next (or specified) pointing object HA and Dec from table
Pt.Open - Open the pointing data file (see pt.dir and pt.filename)
Pt.Peak.Clear - Clear the Peak IH/ID pointing coefficient values.
Pt.Peak.Set - Set the Peak IH/ID pointing coefficient values.
Pt.Peak.Inc - Increment the value of the Peak IH/ID coefficients
Pt.Restore – Restores the last saved MAdj IH, ID values saved by pt.save.
Pt.Rate – Sets the pointing rates.
Pt.Rate.inc – Increments the pointing rate.
Pt.Save – Add IH, ID correction to the MAdj registor and save the value to disk.
Pt.Sep - Specify the separation between pointing targets
Pt.Spiral.In – Command to spiral inwards.
Pr.Spiral.Out – Command to spiral outwards.
Pt.Spiral.Stop – Stop the spiral..
Pt.Spiral.center – Centers the pointing map spiral.
Pt.Spiral.rate – Controls the pointing map spiral’s speed.
Pt.Spiral.wid – Controls the pointing map spiral’s size.
ID, IH, NP, CH, ME, MA, HCES, HCEC, DCES, DCEC, FO TF, TX – Commands to modify pointmap coefficients using their tpoint names (See **Pt.Map.Set**)

2.6. Application Control and Misc

Die - Terminate the main IC process
Dome.Sim - Enable or disable dome control simulation mode
FioA.Sim - Enable or disable the simulation mode for the fio_a processes
FioB.Sim - Enable or disable the simulation mode for the fio_b processes
Fioc.Env.Update - Enable or disable fio_c updating of vtcs environment variables
FioC.Sim - Enable or disable the simulation mode for the fio_c processes
FioD.Sim - Enable or disable the simulation mode for the fio_d processes
FioE.sim – Enable or diable the simulation mode for the fio_e process.
FioF.sim - Enable or disable the simulation mode for the fio_f processes
FioMC.sim- Enable or disable the simulation mode for the fio_mc process.
FioHexe.sim – Enable or disables the simulation mode for the fio_hexe process.
FioDome.Sim - Enable or disable the simulation mode for the fio_dome processes
Help - Print a list of available tcs3 commands
Hist – Enable/Disable recording of history data.
Hist.Dir - Set the directory path for the history file
Log - Log a message to the log file and XUI display(s)
Log.Err - Log message to log file, XUI display(s), and error log
Logxui - Log message to the XUI display(s)
Notice.Print – ON to enable print statements when a warning/error is played in IC xterm.
Notice.Text - Enable/disable display of an error or warning notice in the mcc 'Warnings' window
Notice.Sound - Enable/disable playing of the sound associated with a notice
Pstart - Start or kill and restart child task
Pstop - Kill a child application

3. TCS3 Commands Details

This section describes the full set of TCS3 commands, with syntax and an example for each.

Add.Offset.Opt – How to add offsets to the base position.

Syntax: `Ape.Mode` *{none|cosdec}*
none - Simple addition, target = base + offset.
cosdec - Apply cos(dec) to offset:
*target = base + (cos(dec)*offset).*

Example: Set to cosdec option
`Add.Offset.Opt cosdec`

Ape.Mode – Specifiy the mode for the fio_ape program. This program obtains the APE data for tcs3.

Syntax: `Ape.Mode` *{off|on|sim|simtac}*
Off - No update are performed.
On - Obtains APE data from APE hardware.
Sim - Simulate data using vtcs mount(ha,dec) position.
Simtac - read data from simtac lab computer.

Example: Set the mode to on
`Ape.mode on`

Ape.Pos – Manual method for initialing the APE value. In case of hardware failure you can set the APE using the following sequence of commands:

`Kill fio_ape`	Kill automatic apes update
`Ape.pos HA DEC`	Manually set ape position
`Ape.set.apos`	Initialize the APE position

Syntax: `Ape.Pos` *HA DEC*

Example: TO set the APE data pos to zenith:
`Ape.pos 00:00:00 19:49:34.39`

Ape.set.pmac – Tells the tcs to initialize the position in the PMAC servo controller.

Syntax: `ape.set.pmac`

Example: `ape.set.pmac`

Autopid – Enable/Disable the AutoPID feature. AutoPID allow you to auto load different PID value during tracking and slewing..

Syntax: `autopid` *{off|on}*

Example: `autopid off`

Autopid.Set – Specifies a set of auto PID coefficients.

Syntax: `autopid.set` *ID P I D*
`ID - Identifies the PID set. Vaild names are: track.ha, track.dec, slew.ha, slew.dec.`
`P I D - Numeric PID values. Ranges is -100000 to 100000.`

Example: `autopid track.ha 40000 75000 6000`

Base – Load a new position into the position table base.

Syntax: `base RA` *`Dec pm_ra pm_dec epoch equinox CS Name`*

`RA` - RA as time: hh:mm:ss.ss

`Dec` - Dec as angle: deg:mm:ss.ss

`pm_ra` - proper motion as sec(tm)/year. Optional, default = 0. In dRa/dt rather than cos(Dec)*dRA/dt.

`pm_dec` - proper motion as arcsec(tm)/year. Optional, default = 0

`epoch` – epoch in calendar years. Optional, Defaulted to ptable value.

`equinox` – equinox in calendar years Optional, Defaulted to ptable value.

`CS` - Coordinate system. Can be { FK5 | FK4 | APP }. Defaults to ptable value.

`Name` – Object name.

Example: Set the base position to the object SAO-93498:

```
Base 0:34:56.51 19:48:36.1 0.0011 -0.0270 200 2000 FK5 SAO-93498
```

Base.inc – Increment the RA, Dec values of the base.

Syntax: `base.inc` *`ra dec`*

`Ra dec` – value to increment in arcseconds.

Example: `Base.inc 0 1`

Beam.Init– Initializes the Beam offset by: making the current position the base (0,0), setting the ra, dec values to 0,0, and enabling the offset.

Syntax: `Beam.init`

Example: Initialize the Beam offsets

```
Beam.init
```

Beam.inc – Apply an increment to the beam RA and Dec offsets

Syntax: `beam.inc` *`ra dec`*

`Ra dec` – Offset increments in arcseconds

Example: Increment beam Dec offset by 1.8 arcseconds, leave RA offset as-is

```
Beam.inc 0 1.8
```

Beam.off – Disable application of the beam RA and Dec offsets

Syntax: `beam.off`

Example: Disable application of the current beam RA and Dec offsets

```
Beam.off
```

Beam.on – Enable application of the beam RA and Dec offsets

Syntax: `beam.on`

Example: Apply the current beam RA and Dec offset values

```
Beam.on
```

Beam.set – Specify the RA and Dec offsets for the beam

Syntax: `beam.set` *`ra dec`*

`Ra dec` – Offsets in arcseconds

Example: Set a beam offset of 10.2 arcseconds in RA, -6.5 arcseconds in Dec

`Beam.set 10.2 -6.5`

Beam.toggle – Toggle the beam offset enable status

Syntax: `beam.toggle`

Example: Toggle to alternate beam position

`Beam.toggle`

Cat.index – Search specified catalog by index and load results into 'next' buffer

Syntax: `cat.index` *`CAT Index`*

`CAT` - Catalog name (bsc5, fk5, gsc, text, sao, ukirt, hd_sao)

`Index` – catalog index of object to search for

Example: Load next buffer with GSC object with index 119001564

`Cat.Index gsc 119001564`

Cat.search – Search catalog for the star closest to given RA/Dec within a specified radius

Syntax: `Cat.search` *`CAT RA Dec Radius`*

`CAT` - Catalog name (bsc5, fk5, gsc, text, sao, ukirt, hd_sao, fk5m)

`RA` - RA as time: hh:mm:ss.ss

`Dec` - Dec as angle: deg:mm:ss.ss

`Radius` – Search radius around target RA/Dec in arcseconds

Example: Search GSC catalog for guide star within 200 arcsecond radius of object SAO-93498

`Cat.search gsc 0:34:56.51 19:48:36.1 200`

Collimate.enable – Enable or disable collimation control loop

Syntax: `collimate.enable` *`control`*

`control` – control command (OFF or ON)

Example: Turn collimation control loop off

`Collimate.enable off`

Collimate.EW.Dpos– Set desired East/West collimation position

Syntax: `collimate.ew.dpos` *`dpos`*

`dpos` – Target E/W collimation position as voltage Range is -4.80 to 8.08 volts for chopper, -43.63 to +43.63 for the Hexapod.

Example: Set East/West collimation position to 5.4 volts

`Collimate.EW.Dpos 5.4`

Collimate.EW.Dpos.Inc – Increments East/West collimation's desired position

Syntax: `collimate.ew.dpos.inc` *`inc`*

`inc` – Incremment value.

Example: Increments East/West collimation position to 0.1 units.

`Collimate.EW.Dpos.Inc 0.1`

Collimate.NS.Dpos – Set desired North/South collimation position

Syntax: `collimate.ns.dpos` *`dpos`*

`dpos` – Target N/S collimation position as voltage voltage Range is -9.0 to 4.06 volts for chopper, -43.63 to +43.63 for the Hexapod.

Example: Set North/South collimation position to -3.6 .
`Collimate.NS.Dpos -3.6`

Collimate.NS.Dpos.Inc – Increments North/South collimation's desired position
Syntax: `collimate.ns.dpos.inc` *`inc`*
`inc` – Incremment value.
Example: Increments North/South collimation position to 0.1 units.
`Collimate.NS.Dpos.Inc 0.1`

Collimate.Table.Read – Reads the file ~/data/collimate.txt and loads collimation table data into TCS3. As of 2/2020, default collimation and focus are provide by the collimation table.
Syntax: `collimate.table.read`
Example:
`Collimate.table.read`

Collimate.Table.Set – Sets the collimation's desired position using *name* and the collimation table data.
Syntax: `collimate.table.set` *`name`*
`name` – A text name of an entry in the collimation data.
Example: Set the collimation for spex
`Collimate.table.set spex`

CS – Set the default coordinate system
Syntax: `CS` *`coord_sys`*
`Coord_sys` – Coordinate system (fk4, fk5, app)
If using App, remember to set the ptable epoch to the current jepoch to 'time stamp' the apparent coordinates to the current date.
Example: Set default coordinate system to fk5
`CS fk5`

CW.Dir – Set the directory path for counterweight files
Syntax: `cw.dir` *`path`*
`path` – full path name (defaults to /home/tcs3/data/cw)
Example: Set counterweight path to /home/tcs3/data/cw_041214
`CW.dir cw.dir /home/tcs3/data/cw_041214`

CW.Dpos– Set selected counterweight to position described as a voltage
Syntax: `cw.dpos` *`name position`*
`name` – Name of the counterweight to be positioned (e.g. TV2S)
`position` – Desired counterweight position as voltage. If the voltage is outside the min/max range of the counterweight, it will be clipped to its min/max value.
Example: Move counterweight YH3F to position 4.23 volts
`CW.dpos yh3f 4.23`

CW.Enable – Enable or disable counterweight movements
Syntax: `cw.enable` *`control`*
`control` – Enable control (ON or OFF)

Example: Enable control of the counterweight system
`CW.enable on`

CW.Manual.cntl – The CW command to set a counterweight up, down or off
Syntax: `cw.manual.cntl` *`control`*
`control` – { off | 01.up | 01.dn | 02.up | 02.dn | .. | 10_11.up | 10_11.dn)
Example: Enable counterweight manual control mode
`CW.manual.cntl on`

CW.Mode – Select the counterweight operational mode
Syntax: `cw.mode` *`mode`*
`Mode` – operational mode (Auto | Manual | Lock)
Example: Place counterweights in manual mode
`CW.mode manual`

DHP.Enable – Enable/Esiable Dome Hand Paddle inputs.
Syntax: `DHP.enable` *`{off|on}`*
`Off` – ignores the dome handpaddle IO
`On` – accepts dome handpaddle inputs
Example: Enable the dome handpaddle.
`DHP.enable on`

DHP.Rate – Set the maximum velocity for the dome handpaddle.
Syntax: `DHP.rate` *`rate`*
`rate` – This value represents arcseconds/seconds. Range is 0 to 800 as/s.
Example: Set the rate to 200 as/s.
`DHP.rate 200`

DHP.swapEW – Swap the logic for the East and West buttons on the dome handpaddle.
Syntax: `DHP.swapEW` *`{off|on}`*
`Off` – East is east, …
`On` – East is west, …
Example: Set the default mapping
`DHP.swapEW off`

DHP.swapNS – Swap the logic for the North and South buttons on the dome handpaddle.
Syntax: `DHP.swapNS` *`{off|on}`*
`Off` – North is north, …
`On` – North is south, …
Example: Set the default mapping
`DHP.swapNS off`

Die – Terminate the main IC process
Syntax: `die`
Example: Terminate the current ic process

`Die`

Dome.Auto.Offset –Specifies an offset angel to be used during Dome Control's auto (tracking) mode.

Syntax: `dome.auto.offset` *`deg`*

`deg` `- offset in degrees (-180 to 180).`

Example: Set the auto offset value to 20 degrees:

`Dome.auto.offset 20`

Dome.Capture –Capture some dome serial data to a file. Debugging command.

Syntax: `dome.capture`

Example: Start the dome capture:

`Dome.capture`

Dome.Goto –Specifies a dome position for goto mode.

Syntax: `dome.goto` *`AZ_des`*

`AZ_deg` `- azimuth in degrees (0-360).`

Example: Moved the dome to a azimuth of 90 degrees:

`Dome.goto 90`

Dome.HP.Speed – Sets the maximum speed in dome handpaddle mode.

Syntax: `dome.HP.Speed` *`speed`*

`speed` – speed factor 0.0 to 1.0 maps to 0 to 10 volt max output to the Ampilifiers.

Example: Set the max speed to ½, or 0.5. Maxinum of 5 volt to the ampilifiers inputs.

`Dome.HP.Speed 0.5`

Dome.Manual –Control dome motion while in manual mode

Syntax: `dome.manual` *`motion`*

`motion` – Desired dome motion (forward, reverse, stop)

Example: Move dome in the reverse direction

`Dome.manual reverse`

Dome.Manual.Speed – Sets the maximum speed in dome manual mode.

Syntax: `dome.Manual.Speed` *`speed`*

`speed` – speed factor 0.0 to 1.0 maps to 0 to 10 volt max output to the Ampilifiers.

Example: Set the max speed to ½, or 0.5. Maxinum of 5 volt to the ampilifiers inputs.

`Dome.Manual.Speed 0.5`

Dome.Mode – Set the dome movement control mode

Syntax: `dome.manual` *`mode`*

`mode` – Dome movement control mode (auto | manual | lock)

Example: Put dome in manual control mode

`Dome.mode manual`

Dome.Sim – Enable or disable dome simulation mode

Syntax: `dome.sim` *`control`*

control – Dome simulation mode (ON or OFF)
Example: Turn dome simulation off
`Dome.sim off`

Dome.Speed – Set the dome movement speed factor
Syntax: `dome.speed` *speed*
speed – Speed as a factor of full speed (0.0 to 1.0)
Example: Set dome speed to half of full speed
`Dome.speed 0.5`

Elevation – Set the elevation of the observatory
Syntax: `elevation` *meters*
meters – Elevation of the observatory above sea level (meters)
Example: Set the elevation to 4168 meters above sea level
`Elevation 4168`

Epoch – Set the default epoch
Syntax: `epoch` *year*
year – Epoch of the CS as a calendar year (1900 to 2100)
Example: Set the default epoch to 1950
`Epoch 1950`

Equinox – Set the default equinox
Syntax: `equinox` *year*
year – Equinox as a calendar year (1900 to 2100)
Example: Set the default equinox value to 2000
`Equinox 2000`

FioA.Sim – Enable or disable the simulation mode for the fio_a processes
Syntax: `fioa.sim` *control*
control – Simulation mode control (OFF or ON)
Example: Turn the simulation mode off for fio_a processes
`Fioa.sim off`

FioB.Sim – Enable or disable the simulation mode for the fio_b processes
Syntax: `fiob.sim` *control*
control – Simulation mode control (OFF or ON)
Example: Turn the simulation mode on for fio_b processes
`Fiob.sim on`

FioC.Sim – Enable or disable the simulation mode for the fio_c processes
Syntax: `fioc.sim` *control*
control – Simulation mode control (OFF or ON)
Example: Turn the simulation mode off for fio_c processes
`Fioc.sim off`

FioDome.Sim – Enable or disable the simulation mode for the fio_dome processes
Syntax: `fiodome.sim` *`control`*
`control` – Simulation mode control (OFF or ON)
Example: Turn the simulation mode off for fio_dome processes
`Fiodome.sim off`

FioD.Sim – Enable or disable the simulation mode for the fio_d processes
Syntax: `fiod.sim` *`control`*
`control` – Simulation mode control (OFF or ON)
Example: Turn the simulation mode on for fio_d processes
`Fiod.sim off`

FioE.Sim – Enable or disable the simulation mode for the fio_e processes
Syntax: `fioe.sim` *`control`*
`control` – Simulation mode control (OFF or ON)
Example: Turn the simulation mode on for fio_e processes
`Fioe.sim on`

FioF.Sim – Enable or disable the simulation mode for the fio_f processes
Syntax: `fiof.sim` *`control`*
`control` – Simulation mode control (OFF or ON)
Example: Turn the simulation mode on for fio_f processes
`Fioe.sim on`

FioHexe.Sim – Enable or disable the simulation mode for the fio_hexe processes
Syntax: `fioHexe.sim` *`control`*
`control` – Simulation mode control (OFF or ON)
Example: Turn the simulation mode on for fio_hexe processes
`FioHexe.sim on`

FioMC.Sim – Enable or disable the simulation mode for the fio_mc processes
Syntax: `fioMC.sim` *`control`*
`control` – Simulation mode control (OFF or ON)
Example: Turn the simulation mode on for fio_mc processes
`FioMC.sim on`

Focus.Adj.Enable – Enable or disable the focus adjustment value. A focus adjustment value is calculated by the TCS based on the telescope truss temperature and it position. These values are applied to the TCS in real-time when adj.enable is ON.
Syntax: `focus.adj.enable` *`{ OFF | ON }`*
`OFF` – ignore the focus adjustment values. Dpos = user_dpos.
`ON` – apply adjustment value, dpos = user_dpos + adj.
Example: Turn on focus adjustment:
`Focus.adj.enable on`

Focus.Dpos – Set the desired focus position

Syntax: `focus.dpos` *`position`*

`position` – Desired focus position as voltage Range is -7.33 to 7.00 volts for the chopper, and -8 to 8 mm for the hexapod.

Example: Set the focus position to 2.4.

`Focus.dpos 2.4`

Focus.Dpos.Inc – Increment or decrement the focus position

Syntax: `focus.dpos.inc` *`pos_inc`*

`Pos_inc` – Position increment/decrement value.

Example: Decrements the focus position by 0.43.

`Focus.dpos.inc -0.43`

Focus.Enable – Enable or disable the focus control loop

Syntax: `focus.enable` *`control`*

`control` – Focus loop control (ON or OFF)

Example: Disable the focus control loop

`Focus.enable off`

Help – Print a list of available tcs3 commands

Syntax: `help`

Example: Print the list of commands

`Help`

Hexapod.Init – Will cause the TCS to run the hexapod init macro /home/tcs3/data/hexapod_init. TCS3 has limited feedback, so it is suggested the the hexegui be used to initialize the hexapod.

Syntax: `Hexapod.init`

Example: `Hexapod.init`

Hist – Enable/Disable the collection of the realtime history data. Off is useful to freeze the graphical dislay on the mcc to view the data.

Syntax: `Hist` *`{ off | on }`*

`on` – Collect the data.

`off` – Stop data collections.

Example: `Hist on`

Hist.Dir – Set the directory path for the history file

Syntax: `hist.dir` *`path`*

`path` – Directory path for the history file (defaults to /home/tcs3/data/hist)

Example: Set the history file directory path to /home/tcs3/data/hist

`Hist.dir /home/tcs3/data/hist`

HSlew.limit.override – Override the Horizontal Slew Limits. This command affect the software only.

Syntax: `HSlew.limit.override` *`{ off | on }`*

`on` – Override the limits

`off` – Slow down the max velocity to 400 as/s, if limit are trigged.

Example: Disable HSlew limit
`HSlew.limit.override on`

Humidity– Manually set the relative humidity
Syntax: `humidity` *`value`*
`value` – Relative humidity value (0.0 to 1.0)
Example: Set the relative humidity to 0.56
`Humidity 0.56`

Humidity.Wn – Set relative humidity level to trigger warning.
Syntax: `humidity.wn` *`value`*
`value` – Trigger a warning if relative humidity exceeds this value (0.0 – 1.0)
Example: Set the relative humidity warning level at 80%
`Humidity.wn 0.8`

Stop – Put the tcs system in the ‘Stop mode
Syntax: `Stop`
Example: Puts the TCS3 Servo in the stop mode. In Stop, the pmac is in open loop, telescope brakes are on.
`Stop`

Info – Return a selected subset of tcs information
Syntax: `info` *`selection`*
`selection` – The data to display using these identifiers: TM TMr SP SPr MP MPr OS OP OPr SM FO CO EN US DO PM ON NS WE SH MC GI SI WE1
The format of each selection are described below. Multiple selections can be made, for example: `info TM OP`

The format for each parameter is described below:

TM = UTC(yyyy/mm/dd) UTC(hh:mm:ss.ss) UTC_local(yyyy/mm/dd) UTC_local(hh:mm:ss.ss) Last(hh:mm:ss.ss)
TMr = UTC(mdj) UTC_local(mjd) Last(radians)

UTC is coordinated universal time.
UTC_local is the local time (HST).
Last is Local Apparent Sideral Time.

SP = target_ra(hh:mm:ss) Target_da(deg:mm:s) pm_ra(sec/year) pm_dec(arcsec/year) epoch(yyyy.y) equinox(yyyy.y) CS(string)
SPr = target_ra(radians) Target_dec(radinas) pm_ra(sec/year) pm_dec(arcsec/year) epoch(yyyy.y) equinox(yyyy.y) CS(string)

The target RA, Dec is where the telescope is pointing (Base position + any offset).
Pm_ra/dec is the proper motion data.
Epoch is the epoch of the RA, Dec coordinates.

Equinox – is the epoch of the coordinate system.
CS – identifies the coordinate system (fk5, fk4, app).

MP = mean_ra(hh:mm:ss) mean_da(deg:mm:s)
MPr = mean_ra(radians) mean_da(radians)

Mean_ra, dec – The mean (fk5, J2000 equinox, current epoch) RA and DEC.

OS = TotalOS(ra dec) UserOS(ra dec enable) BeamOS(ra dec enable) ScanOS(ra dec) [all in arcsec]

TotalOS – Total offset value.
UserOS – User offset magnitude of RA and DEC in arcseconds. Enable=1 of apply, 0 if ignored.
BeamOS – Beam offset magnitude of RA and DEC in arcseconds. Enable=1 of apply, 0 if ignored.
ScanOS – Scan offset magniture in RA and DEC.

OP = obs_ra(hh:mm:ss) obs_dec(deg:mm:s) obs_ha(hh:mm:ss) Am(1.00) Zn(deg) azimuth(deg) PA(deg)
OPr = obs_ra(radians) obs_dec(radians) obs_ha(radians) Am(1.00) Zn(deg) azimuth(deg) PA(deg)

Obs_ra, obs_dec, obs_ha – The observered RA and DEC, and Hour Angle coordinates.
Am is Airmass.
Zn is Zenith distance.
Azimuth is the telescope azimuth position.
PA is the parallatic angle.

SM = mode (track/slew/...) value

Mode is the current servo mode of the tcs3. They are: Track, slew, MV, MP, stop.
Value is data related to a particulare servo mode, for slew and MP the estimated completion time in seconds of the current move is retuned. All other mode return 0.

FO = Focus.dpos focus.apos focus.enable

Focus.dpos is the user requested focus position.
Focus.apos is the actual measured focus position.
Focus.enable is a flag (0 for OFF, 1 for ON) to indicate if remote focus commands are accepted by tcs3.

FO2 = Foscus.user_dpos Focus.adjustment Focus.dpos focus.apos focus.enable focus.adj.enable

Focus.user_dpos is the user requested focus position.
Focus.adjustment is the Temperature and Position adjustment value calculated by the TCS.
Focus.dpos is the desired position for the focus mechanism. dpos = user_dpos + adjust (if adj.enable is ON).
Focus.apos is the actual measured focus position.
Focus.enable is a flag (0 for OFF, 1 for ON) to indicate the software control loop is active. When OFF, focus position commands are not accepted by the TCS.
Focus.adj.enable flag is 0, or OFF when the adjustment value is ignore. When 1, or ON, the adjust value is added to user_dpos to get dpos.

CO = Coll_EW.dpos Coll_EW.apos Coll_NS.dpos Coll_NS.apos Collimation.enable

Coll_EW.dpos is the collimation EW desired position in volts.
Coll_EW.apos is the collimation EW actual position in volts.
Coll_NS.dpos is the collimation NS desired position in volts.
Coll_NS.apos is the collimation NS actual position in volts.
Collimation.enable is a flag (0 for OFF, 1 for ON) to indicate if collimation control is enable.

EN = Encoder data: motor_counts.ha(counts) motor_counts.dec(counts) apes.pos.ha(radians) apes.pos.dec(radians)

Motor_counts ha dec – Motor position in counts are reported by the Motor Controller Hardware (PMAC).
APE_pos ha dec – The Absolute Position Encoder position are reported by the APE Hardware.

US = User Spiral data: state position rate width

State: -1 for down, 0 for stop, 1 for up.
Position: position along the spiral where 2*PI is 1 rotation out from center.
Rate: Rate of speed while moving alow the spiral in as/s.
Width: Width of 1 rotation, ie at position 6.28 the xy offset would be [1*width, 0]

DO = Dome Info: az(deg) vel(deg/s)

Az: dome azimuth in degrees.
Vel: dome velocity in arcseconds/seconds.

PM = Pointing Map information: Map.IH(as) Map.ID(as) madj.IH(as) madj.ID(as) peak.IH(as) peak.ID(as) Sp.Rot Sp.IH(as) Sp.ID(as) Rates.pos.IH(as) Rate.pos.ID(as) Rate.vector.IH(as/s) Rate.vector.ID(as/s)

Map.IH/ID – The IH/ID values of the point map in arcseconds.
madj.IH/ID – The IH/ID values in the Map Adjustment registers, arcseconds.
peak.IH/ID – The IH/ID values in the Peak Adjustment registers, arcseconds.
Sp.Rot – Number of rotation for the spiral.
Sp.IH/ID – The IH/ID values for the Sprial registers, arcseconds.
Rates.pos.IH/ID – The IH/ID values from the pointing rates registers, arcseconds.
Rate.vector.IH/ID – The rates in the pointer rates register, arcseconds per seconds.

ON = Object_name Object_magnitude
ONS = Object_name Object_magnitude Object_source

Object_name: The object name in the ptable.
Object_magnitude: the magnitude from the ptable.
Object_source: Source for the information

NS = Non-sidereal rates: ra(as/s) dec(as/s)

Ra dec: the non-sidereal rates in the ptable.

WE = Weather: air_temperature(c) humidity(0-100) wind_speed(mph) Wind_dir(deg) dome_td6(c)

Air_temperature in celcius.
Humidity, 0 to 100.
Mean_Wind_speed West Sensor, mph
Wind_direction West Sensor, degrees.
Dome Temperature from sensor TD6 in celcius.

SH = sh_ulimit sh_touch sh_dlimit sh_block_time(hr)

Sh_ulimit – upper limit state of shutter, 0 or 1.
Sh_touch – The touch limit state, 0 or 1.
Sh_dlimit – The lower shutter down limit state, 0 or 1.
Block_time – Number of hours until view of field (while tracking) with be blocked by the shutter, hours.

MC = mc.air.in(degC) mc.air.out(degC) mc.glycol(degC) actuator(v) fan(0/1) heat(0/1) mc.pressure_err(0/1)

mc.air.in – Intake air temperature for mirror cooling in degrees C.
mc.air.out – Outtake air temperature for mirror cooling in degrees C.
mc.glycol – Glycol temperature used by mirror cooling in degrees C.
actuator – control value for mc.actuator command in volts.
Fan – control value for mc.fan command, 0 is OFF, 1 is ON.
Heat – control value for mc.heater command, 0 is OFF, 1 is ON.
mc.pressure_err – Mirror Cooling Pressure Error value , 0=no error, 1= pressure error.

SI = Secondary_information

Secondary_information: 0=chopper, 1=hexapod

GI = on-axis-mirror_state pt_peak_commands

On-axis-mirror – 1=IN, 0=OUT, -1=UnKnown
Pt_peak_commands = number of pt_peaks_* command over the last 60 sec. These are guider command send to the TCS.

WE1 = hmt300-humitidy(0-100) hm300-air_temp-degC hmt300.DewPt-degC

hmt300-humitidy(0-100) – HMT 300 humidity 1 to 100.
hm300-air_temp-degC - HMT 300 Air Temperature in DegC.
hmt300.DewPt-degC – HMT 300 Dew Point Temperature in DegC.

WE2 = BP MWSE WDE 0.0 0.0

BP – Pressure in mbar

MWSE – Mean Wind Speed, East sensor in MPH
WDE – Wind Direction, East Sensor in degrees.
2 zero values to follow. Reserved for future value.

MCS = mirror_cover mirror_support.offon mirror_support.volts mirror_support.fault_latch

Mirror_cover: 0=shut, 1=open
Mirror_support.offon: 0=off, 1=on
Mirror_support.volts: voltage representing mirror support air pressure.
Mirror_support.fault_latch: 0=OK, 1=FAULT

LS = Last Slew: valid cs eq ra(rad) dec(rad) pm.ra(s/y) pm.dec(as/y) pm.ep nsrate.ra(as/s) nsrate.dec(as/s) name source

valid: 0=data not valid; 1=valid
cs: coordinate system, ie “FK5”
eq: equinox of cs.
ra dec: ra and dec location in radans
pm.ra dec: proper motion
ep: epoch for the proper motion.
nsrate.ra dec: non-sidereal rate of the object.
name - name of the object
src – source of the information.

SE1 = Seeing data 1: DIMM_valid DIMM MASS_valid MASS TAU_valid TAU225GHZ
DIMM_valid: 0=not valid, 1=valid
DIMM: DIMM seeing value
MASS_valid: 0=not valie, 1=valid
MASS: MASS seeing value
TAU_valid: 0=not valid, 1=valid
TAU225GHZ – TAU seeing value.

Example: An example of each option is display below:

```
info TM
OK 2008-02-08 23:44:57.204 2008-02-08 13:44:57.20 22:36:54.44

info TMr
OK 54504.9899559505 54504.5732892839 5.923176443112

info SP
OK  22:36:25.63  19:46:07.7 0.0000 0.0000 2000.0 2000.0 fk5

info SPr
OK 5.91873876393661 0.34503048854095 0.0000 0.0000 2000.0 2000.0 fk5
```

```
info MP
OK  22:36:33.03  19:46:07.6

info MPr
OK 5.91925801245125 0.34503030521678

info OS
OK 0.0 0.0 0.0 0.0 0 0.0 0.0 0 0.0 0.0

info OP
OK  22:37:09.28  19:48:37.2  00:00:47.77 1.000 0.188 265.185 -85.120

info OPr
OK 5.92218610367147 0.34575561422440 0.00347363680141 1.000 0.188 265.185 -
85.120

info SM
OK stop 0

info FO
OK  -0.340 -0.338 0

Info FO2
OK 0.100 0.082 0.182 0.180 1 1

info CO
OK -2.71 -2.71 -2.15 -2.15 1

info EN
OK  13923 1426743 0.00199361128469 0.34680085134736

Info US
OK 0 0.00 20.0 60.0

Info DO
OK  116.6 2.0

Info PM
OK  91.1 -96.1 -11.0 -21.0 3.0 2.0 0.00 -0.0 0.0 0.0 0.0 0.0000 0.0000

Info ON
OK no_name 0.0

Info NS
OK 0.0000 0.0000

Info WE
OK 2.0 20.1 12.3 157.0

Info SH
OK 0 1 1 3.0000

Info SH
OK 0 1 1 2.9667

Info MC
OK 4.2 1.2 1.0 0.0 1 0
```

```
Info SI
OK 1

Info GI
OK 0 0


Info WE1
OK 10.5 10.9 -19.2

info we2
OK 620.80 15.4 57.0 0.0 0.0

info mcs
OK 0 0 -0.01 0

info ls
OK 0 fk5 2000.0 4.65260180469594 0.34603280752848 0.000000 0.000000 2000.000
0.000000 0.000000 noname unknown

info se1
OK 1 0.440 1 0.250 0 0.000
```

JS.Enable – Enable/Diable TO Panel Joystick inputs.

Syntax: `JS.enable` *`{off|on}`*

`Off` – disable the joystick inputs

`On` – enables the joystick inputs

Example: To enable the Joystick.

`JS.enable on`

JS.Rate – Set the maximum velocity for the TO Panel Joystick input.

Syntax: `JS.rate` *`rate`*

`rate` – This value represents arcseconds/seconds. Range is 0 to 800 as/s. When the tcs3, is in track mode it will limit the rate to under 60 as/s.

Example: Set the rate to 10 as/s.

`JS.rate 10`

JS.swapEW – Swap the logic for the East and West inputs on the TO Panel Joystick.

Syntax: `JS.swapEW` *`{off|on}`*

`Off` – East is east, …

`On` – East is west, …

Example: Set the default mapping

`JS.swapEW off`

JS.swapNS – Swap the logic for the North and South buttons on the TO Panel Joystick.

Syntax: `OH1.swapNS` *`{off|on}`*

`Off` – North is north, …

On – North is south, …

Example: Set the default mapping
`JS.swapNS off`

Latitude – Set the latitude of the observatory

Syntax: `latitude` *latitude hemisphere*
latitude – Latitude in deg:mm:ss (must be <= 90)
hemisphere – Hemisphere of the observatory (N or S)

Example: Set to 19 deg, 49 min, 34.39 sec north latitude
`Latitude 19:49:34.39 N`

Log – Log a message to the log file and XUI display(s)

Syntax: `log` *message*
message – Text of the message to be logged

Example: Log the message 'object obscured by upper level clouds'
`Log object obscured by upper level clouds`

Log.Err – Log message to log file, XUI display(s), and error log

Syntax: `log.err` *message*
message – Text of the message to be logged

Example: Log the error message 'unable to acquire outside air temperature'
`Log.err unable to acquire outside air temperature`

Log.xui – Log message to the XUI display(s)

Syntax: `logxui` *message*
message – Text of the message to be logged

Example: Display message 'starting run' on all XUI displays
`Log.xui starting run`

Longitude – Sets the telescope's longitude.

Syntax: `Longitude` *d:m:s E|W*
d:m:s – Longitude in deg, min, sec. Must be >= 180.
E W – Indicates East or West of Greenwich.

Example: The IRTF's longitude:
`Longitude 155:28:19.2 W`

Ltc.Enable – Enable/disable Laser Traffic Control updates

Syntax: `ltc.enable` *control*
control – LTC update control (ON or OFF)

Example: Turn LTC updating off
`Ltc.enable off`

Ltc.Filename– Set the full path for the LTC file name

Syntax: `ltc.filename` *filename*
filename – LTC filename and path (defaults to /tmp/tcs_data.txt)

Example: Set the LTC file name to /tmp/ltc_data_041214.txt
`Ltc.filename /tmp/ltc_data_041214.txt`

Ltc.Fov – Set Laser Traffic Control Field of View
Syntax: `ltc.fov` *`fov`*
`fov` – LTC field of view in degrees (0.001 to 1.6666667) [100 arcmin]
Example: Set LTC field of view to 0.01 deg
`Ltc.fov 0.01`

Ltc.Impact – Set the value for the Laser Traffic Control 'impact' field
Syntax: `ltc.impact` *`value`*
`value` – Value for LTC impact field (YES or NO)
Example: Set LTC impact field to NO
`Ltc.impact no`

Ltc.Period – Set period between LTC file updates
Syntax: `ltc.period` *`time`*
`time` – Time between file updates in seconds (5 to 300)
Example: Set LTC file update period to 60 seconds
`Ltc.period 60`

LTOffset – Set the ut to local time offset
Syntax: `ltoffset` *`time`*
`time` – Local time offset in minutes (-720 to 720)
Example: Set local time offset to – 600 minutes (-10 hours west)
`Ltoffset -600`

MC.Actuator – Sets the mirror cooling actuator voltage command used to control the glycol flow.
Syntax: `mc.actuator` *`volts`*
`Volts` – Control voltage for actuator. Range is 0 to 5.0 volts for close to fully open.
Example: Close the actuator, or turns off cooling.
`mc.actuator 0`

MC.fan – Sets the mirror cooling Fan control output to OFF or ON.
Syntax: `mc.Fan` *`{ off | on }`*
Example: Turning the fan on.
`mc.fan on`

MC.Heater – Sets the mirror cooling Heater control output to OFF or ON.
Syntax: `mc.heater` *`{ off | on }`*
Example: Turning the heater off.
`mc.heater off`

MC.Mode – Sets the mirror cooling control mode. The control mode tells the TCS how to control the mirror cooling
Syntax: `mc.mode` *`{ off | manual | auto }`*

off – Off turns the Fan OFF, Heater OFF, and Actuator to 0v.
manual – Allow the user to control the fan, heater, and actuator manually.
auto – TCS control mirroring cooling.

Example: Tuning of mirror cooling off.
`mc.mode off`

MC.SetPt – Sets the mirror cooling Set Point value in degrees C. The set point is the temperature you wish to cool the mirror to.

Syntax: `mc.setpt` *DegC*
Example: Enter a set point of 1 degree C.
`mc.setpt 1`

Mirror.Cover – Open or closes the mirror covers.

Syntax: `mirror.cover` *{ shut | open }*
Example: Close the mirror cover
`Mirror.cover shut`

Mirror.Support – Turns off/on the mirror support

Syntax: `Mirror.support` *{OFF | ON }*
Example: To turn mirror support on
`Mirror.support on`

MP – Execute a Motor Position move

Syntax: `mp` *HA Dec*
HA - HA as time: hh:mm:ss.ss
Dec - Dec as angle: deg:mm:ss.ss
Example: Do a motor position to the zenith
`Mp 00:00:00 19:49:34.39`

MP.inc – Increments the MP destination position in arcseconds.

Syntax: `mp.inc` *HA Dec*
HA - HA in arcseconds.
Dec - Dec in arcseconds
Example: Increments HA by 10, and dec by 20 arcseconds.
`Mp.inc 10 20`

MP.cnt – Specity the MP destination position in motor counts.

Syntax: `mp.cnt` *HA Dec*
HA - HA in motor counts.
Dec - Dec in motor counts
Example: Move to HA 0, Dec 0.
`Mp.cnt 0 0`

MP.Vel – Set the velocity for a motor position move

Syntax: `mp.vel` *velocity*
velocity – Velocity in as/s (1 to 1600)

Example: Set MP velocity to 400 as/s
`Mp.vel 400`

MS.Fault.Ack – Re-enable mirror support after a fault
Syntax: `ms.fault.ack`
Example: Re-enable mirror support after a fault
`Ms.fault.ack`

MV – Execute a Motor Velocity move
Syntax: `mv` *`HA Dec`*
`HA` - HA as time: hh:mm:ss.ss
`Dec` - Dec as angle: deg:mm:ss.ss
Example: Do a motor velocity move to the zenith
`Mv 00:00:00 19:49:34.39`

MW.Zero – Zeros the value of the measurement widget. The measure widget is a simple tool to allow the TO to make a distance measurement by moving the telescope using the Offsets (User, beam) or the IH, ID correction registers. Theses offsets are added to the measure widget, and are display in the tracking status area on MCC1. This command allow the TO to zero the values prior to any measurement.
Syntax: `mw.zero`
Example: `mw.zero`

Next – Enter object data into the 'next' buffer
Syntax: `next RA` *`Dec pm_ra pm_dec epoch equinox CS Name Mag NS_rate_RA NS_rate_Dec`*

`RA` - RA as time: hh:mm:ss.ss
`Dec` - Dec as angle: deg:mm:ss.ss
`pm_ra` - proper motion as sec(tm)/year. Optional, default = 0. In dRa/dt rather than cos(Dec)*dRA/dt.
`pm_dec` - proper motion as arcsec(tm)/year. Optional, default = 0
`epoch` – epoch in calendar years. Epoch used for proper motion correction. Optional, Defaulted to ptable value.
`equinox` – equinox of coordinate system, in calendar years. Optional, defaults to ptable value.
`CS` - Coordinate system. Can be { FK5 | FK4 | APP }. If not specifed, defaults to current ptable value. App is Topocentric apparent.
`Name` – Object name.
`Mag` – Magnitute of object.
`Ns_rate_ra` – RA non-sidereal rate in as/s.
`NS_rate_dec` – DEC non-sidereal reate in as/s.

When CS=FK5, the default epoch and equinox is 2000.0.
When CS=FK4, the default epoch and equinox is 1950.0.
When CS=App, the following field are ignored: pm_ra pm_dec, equinox and epoch.

Example: Set the star catalog next buffer to the object SAO-93498:

`Next 0:34:56.51 19:48:36.1 0.0011 -0.0270 2000 2000 FK5 SAO-93498 8.8 0.0 0.0`

Next.HADec – object data into the 'next' buffer using HA and Dec coordinates

Syntax: `next HA Dec`

HA - HA as time: hh:mm:ss.ss

Dec - Dec as angle: deg:mm:ss.ss

Example: Setup the next object to zenith, or 0 Hours Ha 19:50 degrees Dec.

`Next.hadec 0 19:50`

Next.Clear – Clear a next star entry

Syntax: `next.clear` *entry*

entry – Flag to select specific next entry (to, ob, sc)

Example: Clear the next observer object entry

`Next.clear ob`

Notice.Print – When ON, the audio task prints the notices detected when playing the sound. This output can be viewed in the IC xterm.

Syntax: `notice.print` *[off | on]*

off – Do not print..

on – Display messages.

Example: `Notice.print off`

Notice.Sound – Enable/disable playing of the sound associated with a notice

[Not intended for general use – notice indices may change between system releases]

Syntax: `notice.sound` *index offon*

index – Specify index of the notice sound to be enabled or disabled.

offon – disable/enable notice sound (off | on)

Example: Disable the sounds associated with the humidity warning notice

`Notice.sound 22 off`

Notice.Text – Enable/disable display of an error or warning notice in the mcc 'Warnings' window

[Not intended for general use – notice indices may change between system releases]

Syntax: `notice.text` *index offon*

index – Specify index of the notice to be enabled or disabled.

offon – disable/enable text display (off | on)

Example: Disable display of the humidity warning text

`Notice.text 22 off`

NS.rate – Specifies a non-sidereal rate to be applied to the base position.

Syntax: `ns.rate` *ra dec*

Ra dec – Rate in arcseconds/second

Example: To cancel the earth's rotation during tracking:

`ns.rate -15.0411 0`

NS.rate.inc – Increments the base non-sidereal rate.

Syntax: `ns.rate.inc` *ra dec*

Ra dec – Add these values to the base rates in arcseconds/second
Example: `ns.rate.inc 0 1.3`

OH1.Enable – Enable/Diable Observers Hand Paddle #1 inputs.
Syntax: `OH1.enable` *{off|on}*
Off – ignores the OH1 handpaddle IO
On – accepts OH1 handpaddle inputs
Example: Enable the OH1 handpaddle.
`OH1.enable on`

OH1.Rate – Set the maximum velocity for the OH1 handpaddle.
Syntax: `OH1.rate` *rate*
rate – This value represents arcseconds/seconds. Range is 0 to 60 as/s.
Example: Set the rate to 10 as/s.
`OH1.rate 10`

OH1.swapEW – Swap the logic for the East and West buttons on the OH1 handpaddle.
Syntax: `OH1.swapEW` *{off|on}*
Off – East is east, …
On – East is west, …
Example: Set the default mapping
`OH1.swapEW off`

OH1.swapNS – Swap the logic for the North and South buttons on the OH1 handpaddle.
Syntax: `OH1.swapNS` *{off|on}*
Off – North is north, …
On – North is south, …
Example: Set the default mapping
`OH1.swapNS off`

OH2.Enable – Enable/Diables Observers Hand Paddle #2 inputs.
Syntax: `OH2.enable` *{off|on}*
Off – ignores the OH2 handpaddle IO
On – accepts OH1 handpaddle inputs
Example: Enable the OH2 handpaddle.
`OH2.enable on`

OH2.Rate – Set the maximum velocity for the OH2 handpaddle.
Syntax: `OH2.rate` *rate*
rate – This value represents arcseconds/seconds. Range is 0 to 60 as/s.
Example: Set the rate to 10 as/s.
`OH2.rate 10`

OH2.swapEW – Swap the logic for the East and West buttons on the OH2 handpaddle.
Syntax: `OH2.swapEW` *{off|on}*

Off – East is east, …
On – East is west, …
Example: Set the default mapping
`OH2.swapEW off`

OH2.swapNS – Swap the logic for the North and South buttons on the OH2 handpaddle.
Syntax: `OH2.swapNS` *{off|on}*
Off – North is north, …
On – North is south, …
Example: Set the default mapping
`OH2.swapNS off`

OS.2base – Transfer the enabled offsets and rates to the base and clear the offset values
Syntax: `os.2base` *offset*
offset – Specify offset(s) to be transferred (User, Beam, All)
Example: Transfer the enabled beam offsets and rates to the base
`Os.2base beam`

PID.Dec – Makes a request to the rtcs to change the PID value for the Dec axis.
Syntax: `pid.dec` *P I D*
P I D – Numeric PID values. Range is -100000 to 100000.
Example: Set P=25000, I=75000, D=5000
`pid.dec 25000 75000 5000`

PID.HA – Makes a request to the rtcs to change the PID value for the HA axis.
Syntax: `pid.HA` *P I D*
P I D – Numeric PID values. Range is -100000 to 100000.
Example: Set P=25000, I=75000, D=5000
`pid.HA 25000 75000 5000`

Polar.Motion – Specifies the earth's polar motion
Syntax: `polar.motion` *ha dec*
ha – HA polar motion in arcseconds (-10 to 10)
dec – Dec polar motion in arcseconds (-10 to 10)
Example: Set polar motion to 5.1 arcseconds in HA, -3.5 in Dec
`Polar.motion 5.1 -3.5`

Pressure – Specifies the atmospheric pressure
Syntax: `pressure` *value*
value – Pressure in mBars (200 to 2000)
Example: Set atmospheric pressure value to 547.8 mBars
`Pressure 547.8`

Pstart – Start or kill and restart child task
Syntax: `Pstart` *task*

task – Task name (e.g. pslow, audio, …)
Example: Start (or kill and restart) the audio child process
`Pstart audio`

Pstop – Kill a child application
Syntax: `pstop` *task*
task – Task name (e.g. pslow, audio, …)
Example: Kill the pslow child process
`Pstop pslow`

Pt.Add.Star – Append the pointing data for the current star data to the tpoint file
Syntax: `pt.add.star`
Example: Append the current star's pointing data
`Pt.add.star`

Pt.Caption – Specify the text of a caption for the pointing data file
Syntax: `pt.caption` *text*
text – Text of the caption (max 80 characters)
Example: Set the caption to "Pointing run 17 December 2004"
`Pt.caption Pointing run 17 December 2004`

Pt.Clear – Clears all the non-map pointing offset and rates. These are pt.adj, pt.spiral, and pt.rate.
Syntax: `Pt.clear`
Example: `Pt.Clear`

Pt.Convert – Converts current HA & Dec to numbers to enter into t3remote to test pt runs [**temporary test command**]
Syntax: `pt.convert`
Example: Print the current HA and Dec converted to t3remote values
`Pt.convert`

Pt.Dir – Define the directory path for pointing data files
Syntax: `pt.dir` *path*
path – Directory path [defaults to /home/tcs3/data/tpoint/$DATE]
Example: Set the directory path to /home/tcs3/temp/tpoint
`Pt.dir /home/tcs3/temp/tpoint`

Pt.Filename – Set the name for the pointing file
Syntax: `pt.filename` *name*
name – Name to use for the pointing file
Example: Set the pointing file name to pt_test_number_2
`Pt.filename pt_test_number_2`

Pt.Find – Find the nearest guide star to the given HA and Dec and load into the next object buffer
Syntax: `pt.find` *ha dec*
ha – HA position in hh:`mm:ss.ss`

dec – Dec position in dd:mm:ss.ss

Example: Find the guide star closest to the position -00:00:01.35 00:01:12.42

`Pt.find -00:00:01.35 00:01:12.42`

Pt.MAdj – Adds the corrections (Peak, Spiral, Rates) to the MAdj (MapAdjustment) registers. The MAdj values are not cleared after a slew, thus is used to adjust the Map's IH/ID values. The Peak, Spiral, and Rates registers are zerored.

Syntax: `pt.madj`

Example: `Pt.madj`

Pt.MAdj.Set – Set the MAdj (MapAdjustment) IH/ID pointing coefficient values. The MAdj values are not cleared after a slew, thus is used to adjust the Map's IH/ID values.

Syntax: `pt.madj.set` *ID IH*

IH – IH correction in arcseconds.

ID – ID correction in arcseconds.

Example: Set the adjustment IH /ID coefficient value to 5, 10 arcseconds

`Pt.madj.set 5 10`

Pt.Map – Turn the pointing map on or off

Syntax: `pt.map` *control*

control – Turn the pointing map ON or OFF

Example: Turn the pointing map on

`Pt.map on`

Pt.Map.Set – Set a pointing map coefficient value.

Syntax: `pt.map.set` *id value*

id – ID of coefficient (IH, ID, NP, CH, ME, MA, FO, HCES, HCEC, DCES, DCEC, TF, TX)

value – Value for the coefficient

Example: Set the ID pointing coefficient to 141.5

`Pt.map.set ID 141.5`

Also coefficients can be set using their ID as keyworks. The following are valid tcs3 commands:

```
IH        +3.4330
ID      -108.2731
NP        -2.5460
CH       +13.3261
ME       +10.4966
MA       +31.2848
HCES     -70.4861
DCES      +7.7726
FO       +31.0086
TF       +11.0809
TX       -39.3999
```

Pt.Next – Get the next (or specified) pointing object HA and Dec from table

Syntax: `pt.next` *`index`*

`index` – Index of object [optional – defaults to the next in the list]

Example: Get the HA and Dec of the object with index 5

`Pt.next 5`

Pt.Open – Open the pointing data file (see *pt.dir* and *pt.filename*)

Syntax: `pt.open`

Example: Open the pointing data file

`Pt.open`

Pt.Peak.Clear – Clear the Peak IH/ID pointing coefficient values

Syntax: `pt.peak.clear`

Example: Clear the adjustment ID and IH values.

`Pt.peak.clear`

Pt.Peak.Inc – Increment the value of the Peak IH/ID coefficients.

Syntax: `pt.peak.inc` *`ha dec`*

`ha` – Increment the adjustment IH coefficient in arcseconds.

`dec` – Increment the adjustment ID coefficient in arcseconds.

Example: Increment the user IH by 23.9 and decrement the user ID by 4.3

`Pt.peak.inc 23.9 -4.3`

Pt.Peak.Set – Set the Peak IH/ID pointing coefficient values.

Syntax: `pt.peak.set` *`coeff value`*

`coeff` – Coefficient to be set (ID or IH)

`value` – Value to set the coefficient to (in arcseconds)

Example: Set the adjustment IH coefficient value to 9.2 arcseconds

`Pt.peak.set ih 9.2`

Pt.Rate– Sets the pointing correction rate. Positive values will move the telescope East & South, so the rate should be set to the measured drift. For example, if drifting West by 0.02 and North by 0.01 as/s, used pt.rate 0.02 0.01

Syntax: `pt.rate` *`ih id`*

`ih` – The HA axis rate in AS/S. Ranges is +/- 5 as/s.

`id` – The dec axis rate in AS/S. Ranges is +/- 5 as/s

Example: Set the ID pointing rate to 0.001 as/s

`Pt.rate 0 0.001`

Pt.Rate.inc – Increments the pointing rate. Positive values will move the telescope East & South, so the rate should be set to the measured drift. For example, if drifting West by 0.02 and North by 0.01 as/s, used pt.rate 0.02 0.01

Syntax: `pt.rate.inc` *`ih id`*

`ih` – The HA axis rate in AS/S. Ranges is +/- 5 as/s.

`id` – The dec axis rate in AS/S. Ranges is +/- 5 as/s

Example: Increments the IH pointing rate by 0.001 as/s

`Pt.rate.inc 0.001 0`

Pt.Restore – Clears the IH ID values in the Corrc, (Peak, Spiral, Rates) registers. And read the pt.save.txt file (created by pt.save), to load the last saved IH ID values into the MAdj registers..

Syntax: `pt.restore`
Example: `pt.restore`

Pt.Save – Makes the map ID, IH equal to the total value (Map + Adj + Spiral + Rates). The adj, spiral, and rates variable are reset to zero. The new map ID, IH values are written to a file, pt.save.txt, in the IC directory. If the TCS3 is re-started, the IC will used the lasted saved IH,ID values for the map.

Syntax: `pt.save`
Example: `Pt.save`

Pt.Sep – Specify the separation between pointing targets

Syntax: `pt.sep` *`separation`*
`separation` – Separation in degrees between pointing objects (5.0 to 30.0)
Example: Set up a pointing target array with a 20.0 degree separation
`Pt.sep 20.0`

Pt.Spiral.Center – Zero's the pointing map spiral's offset, return you to the center position.

Syntax: `Spiral.center`
Example: `Spiral.center`

Pt.Spiral.In – This command move the pointing map spiral inwards.

Syntax: `Pt.spiral.in`
Example: Start moving inward
`Pt.spiral.in`

Pt.Spiral.out – This command move the pointing map spiral out wards..

Syntax: `Pt.spiral.out`
Example: Start moving outward
`Pt.spiral.out`

Pt.spiral.rate – Sets the pointing map spiral velocity in as/s.

Syntax: `Pt.spiral.rate` *`vel`*
`Vel – velocity in as/s`, ranges is 10 to 70.
Example: `Pt.spiral.rate 40.0`

Pt.Spiral.Stop – This command stop the pointing map spiral.

Syntax: `Pt.spiral.Stop`
Example: Stops the pointing spiral
`Pt.spiral.stop`

Pt.spiral.wid – Sets the pointing map spiral width in arcseconds. Should be matched to your field of view.

Syntax: `Pt.spiral.wid` *`arcsec`*
`arcsec –` spiral's width in arcseconds, ranges is 10 to 180.
Example: `Pt.spiral.width 60`

SafetyBrd.Reset – Sents a reset pulse to the T3 Servo Electronic (clears safety board latched errors).
Syntax: `SafetyBrd.Reset`
Example: Send the reset command
`safetybrd.reset`

Scan.Clear – Turns off scaning, and sets to 0 the scan offset and duration.
Syntax: `scan.clear`
Example: `Scan.clear`

Scan.Go – Move to specified offset from the current position
Syntax: `scan.go`
Example: Start a scan as set up by *Scan.Se*
`Scan.go`

Scan.Return – scan by returning to the base (offset 0,0) position.
Syntax: `scan.return`
Example: Return to the original position
`Scan.return`

Scan.Set – Set up the parameters for scanning to an offset position
Syntax: `scan.set` *`ra dec time`*
`ra` – RA offset to be applied to the original position (arcseconds)
`dec` – Dec offset to be applied to the original position (arcseconds)
`time` – Duration of the move from the original to the offset position (seconds)
Example: Set up to offset by 200.2 arcsec in RA, -30.4 in Dec in a scan of 15.5 seconds
`Scan.set 200.2 -30.4 15.5`

Shutter.Lower – Control the lower shutter
Syntax: `shutter.lower` *`control`*
`control` – Shutter action (stop | down | up)
Example: Raise the lower shutter
`Shutter.lower up`

Shutter.Upper – Control the upper shutter
Syntax: `shutter.upper` *`control`*
`control` – Shutter action (stop | down | up)
Example: Stop the upper shutter movement
`Shutter.upper stop`

Slew – Slew to the next object in the specified buffer
Syntax: `Slew` *`buffer`*
`buffer` – Object buffer (TO, OB, or SC) [optional – defaults to TO]
Example: Slew to the next object in the SC next buffer
`Slew sc`

Slew.Abort – Abort a slew and switch to track mode

Syntax: `slew.abort`

Example: Abort the slew in progress and enter the track mode

`Slew.abort`

Slew.Reslew – Re-issue the slew command to the pmac. Something when commanded to slew, the PMAC will not move the axes. This command re-issue the command.

Syntax: `slew.reslew`

Example: `Slew.reslew`

Sw.Limits.Override – Control software limits

Syntax: `sw.limits.override` *`control`*

`control` – OFF or On {ON ignores software limits)

Example: Ignore software limits

`Sw.limits.override on`

Sw.Limits.Set – Sets the software limits. TCS only allow stricter software limits from the defaults. This command is used to restrict the TCS range for instrument configurations outside the ‘safety’ zone.

Syntax: `sw.limits.set` *`EAST WEST SOUTH NORTH`*

`EAST` – East limit in hours. Ranage is -1:00:00 to -05:35:00

`West` – West limit in hours. Ranage is 1:00:00 to 05:35:00

`SOUTH` – South limit in degrees. Ranage is 10:00:00 to -55:00:00

`NORTH` – North limit in degrees. Ranage is 30:00:00 to 67:00:00

Example: This example sets new software limits:

`Sw.limits.set -05:00:00 05:00:00 -45:00:00 45:00:00`

This example sets the software limits back to their defaults:

`Sw.limits.set -05:35:00 05:35:00 -55:00:00 67:00:00`

System.power – Turns system power on or off.

Syntax: `system.power` *`{off|on}`*

Example: Turn system power on

`System.power on`

TempK – Set ambient temperature value in degrees Kelvin

Syntax: `tempk` *`t`*

`t` – temperature in deg Kelvin (100 – 350)

Example: Set ambient temperature value to 120.4 degrees Kelvin

`Tempk 120.4`

Track – Commands tcs to enter the ‘track’ servo mode

Syntax: `track`

Example: Command tcs to enter track mode

`Track`

Track.NoIOnOffset.HA

Track.NoIOnOffSet.Dec – Turn off/on a flag telling the tcs3 to hold the pmac's integrator value during an offset. This command is not intended for observers, operators, or daycrew. It use should be reserved to the tcs3 servo engineer.

Syntax: `track.NoIonOffset.HA { off | on }`
`track.NoIonOffset.Dec { off | on }`
Example: To Hold the integrator during offsets on the HA axis:
`Track.NoIOnOffset.HA on`

TOHP.Enable – Enable/Diables TO Hand Paddle inputs.

Syntax: `TOHP.enable` *`{off|on}`*
`Off` – ignores the handpaddle IO
`On` – accepts handpaddle inputs
Example: Enable the TOHP handpaddle.
`TOHP.enable on`

TOHP.Rate – Set the maximum velocity for the handpaddle.

Syntax: `TOHP.rate` *`rate`*
`rate` – This value represents arcseconds/seconds. Range is 0 to 60 as/s.
Example: Set the rate to 10 as/s.
`TOHP.rate 10`

User.Init– Initializes the users offset by: making the current position the base (0,0), setting the ra, dec values to 0,0, and enabling the offset.

Syntax: `user.init`
Example: Initialize the user offsets
`User.init`

User.Inc – Apply an increment to user RA and Dec offsets

Syntax: `user.inc` *`ra dec`*
`ra` – RA offset increment (arcseconds)
`dec` – Dec offset increment (arcseconds)
Example: Apply an incremental Dec offset of -25.1 arcseconds
`User.inc 0 -25.1`

User.Off – Disable user offsets

Syntax: `user.off`
Example: Disable user offsets
`User.off`

User.On – Enable user offsets

Syntax: `user.on`
Example: Enable user offsets
`User.on`

User.Set – Set the values for the user RA and Dec offsets

Syntax: `user.set` *`ra dec`*

ra – Value of user RA offset (arcseconds)
dec – Value of user Dec offset (arcseconds)
Example: Set user Ra offset to 110.7 and Dec to -29.0 arcseconds
`User.set 110.7 -29`

User.Spiral.center – Zero's the user spiral's offset, return you to the center position.
Syntax: `User.Spiral.center`
Example: `User.spiral.center`

User.Spiral.in – Command to move inwards along the spiral.
Syntax: `User.Spiral.In`
Example: `User.Spiral.In`

User.Spiral.Out – Command to move outwards along the spiral.
Syntax: `User.Spiral.Out`
Example: `User.Spiral.Out`

User.Spiral.rate – Sets the user spiral velocity in as/s.
Syntax: `User.Spiral.rate` *vel*
Vel – velocity in as/s, ranges is 10 to 40.
Example: `Spiral.rate 40.0`

User.Spiral.Stop – Stops moving along the spiral.
Syntax: `User.Spiral.Stop`
Example: `User.Spiral.Stop`

User.Spiral.wid – Sets the spiral width in arcseconds. Should be matched to your field of view.
Syntax: `User.Spiral.wid` *arcsec*
arcsec – spiral's width in arcseconds, ranges is 10 to 180.
Example: `User.Spiral.wid 60`

User.Toggle – Toggle the user offset enable setting
Syntax: `user.toggle`
Example: Toggle currently enabled user offsets to disabled
`User.toggle`

UT1Delta – Set the value of ut1 – utc. This value is need to calculate UT1 (ut1 = utc + ut1delta). You can obtain this value from the International Earth Rotation Service 's Bulletin B reports. (http://maia.usno.navy.mil)
Syntax: `ut1delta` *sec*
sec – Value of ut1 – utc in seconds (-0.51 to 0.51)
Example: Set ut1 – utc delta value to 0.35 seconds
`Ut1delta 0.35`

VTCS.Env.Update – Enable or disable fio_c updating of vtcs environment variables
Syntax: `VTCS.env.update` *mode*

`Mode can be:`

0 – Don't update
1 - update from fio_c (old tcs1 HM & temp sensors).
2 – update from fio_a (Vaisala HMT300 Sensors).

Example: Updates the vtcs using the HMT300 device
`vtcs.env.update 2`

Wavelength– Set the value of the observed wavelength

Syntax: `wavelength m`
m – Wavelength in microns (0.1 – 50.0)

Example: Set observed wavelength to 43.8 microns
`Wavelength 43.8`

TCS3 Network Communication

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1. Introduction

The network interface allow communication to the tcs3 over the IRTF network. This document describes these interfaces.

2. Primary Network Interface

The primary network interface for tcs3 is a Remote Procedure Call (RPC) server to the hostname ‘tcs3_host’, which is an alias to t1. Details on this interface can be provide by the IRTF software staff on request.

3. Aux socket interface

An auxiliary socket interface to the tcs3 is also available. This aux socket interface is a telnet like session that can support both human and computer session.Details on this interface can be provided by the IRTF software staff on request.

4. t3io

t3io is a command line program that implements the tcs3 Remote Procedure Call (RPC) interface. It is a C program and is installed on all IRTF computers. For visitor’s instruments, the source code can be provide for porting to your instrument software. T3io is a text based program, TCS3 commands are give as argument and replys are printed on standard output. The t3io program can run from the command line, or called from other application. Rather than building the Remote Procedure Call (RPC) into you application, your application can call t3io (via a system call or fork).

An 'OK', followed by the reply is output for successful commands.
Otherwise, 'ERR' followed by an error code is printed.

```
usage: t3io [-v] [-h hostname] command
        -v = verbose flag
        -h = hostname
```

Example: Issuing the ‘info tm’ command to get time information from the tcs3.

```
> t3io info tm
OK 2006-08-02 00:19:55.792 2006-08-01 14:19:55.79 10:39:53.45
```

5. TCS3 Command Examples

Details on the TCS3 command are provide in document *1101 TCS3 Command Reference*. This section provide examples of commands that instruments could use to control or query data from the TCS3.

5.1 Info

The tcs3 *info* command is used to query position, time and other type of facility data. The info command's parameters will dictate the type of information returned.

For example, the 'info tm' will return UTC_data UTC_time LAST.

```
> t3io info tm
OK 2006-08-02 00:19:55.792 2006-08-01 14:19:55.79 10:39:53.45
```

Multiple type of information can be requested. This command probably returns everything you want to know:

```
> t3io info tm sp mp os op sm fo
OK 2006-08-02 00:44:44.760 2006-08-01 14:44:44.76 11:04:46.49  11:04:21.12 -00:00:17.6
0.0000 0.0000 2000.0 2000.0 fk5 11:04:21.12 -00:00:17.6 0.0 0.0 0.0 0.0 0 0.0 0.0 0 0.0
0.0  11:04:40.45 -00:01:57.3  00:00:06.04 1.063 19.859 180.074 -0.070 track  -0.320 -
0.321 1
```

Let's break down the reply:

`OK`
The ok tell us the command reply is good

`2006-08-02 00:44:44.760 2006-08-01 14:44:44.76 11:04:46.49`
The TM returns Time data: UTC_data UTC_time Local_date Local_time LAST

`11:04:21.12 -00:00:17.6 0.0000 0.0000 2000.0 2000.0 fk5`
The sp provides Sky position parameters: RA Dec pm_ra pm_dec epoch equinox coordinate_system

`11:04:21.12 -00:00:17.6`
The MP returns the means position (J2000.0 FK5 current epoch): ra dec

`0.0 0.0 0 0.0 0.0 0 0.0 0.0`
The OS provides Offset information total_ra total_dec user.ra user.dec user.enable beam.ra beam.dec beam.enable scan.ra scan.dec

`11:04:40.45 -00:01:57.3  00:00:06.04 1.063 19.859 180.074 -0.070`
The OP provides Observed Position: obs_ra obs_dec obs_ha airmass zenith_dist azimuth parallactic_angle

`track`
The SM provides the servo mode

`-0.320 -0.321 1`
The FO provides Focus_desired_pos Focus_actual_pos Focus_enable(0 or 1).

5.2 Beam Switch

T3io beam.init	- Use this command to setup for beam switch (make current position the base, zero and enable beamswitch).
T3io beam.set 10 20	- Sets the absolute value for the B Beam position.
T3io beam.a	- Goto the A beam position.

T3io beam.b - Goto the B beam position

5.3 User's Offset can be used in dittering or scaning macros.

T3io user.init	- Use this command to initialize user offset (make current position base, zero and enable offsets).
T3io user.set 10 20	- Sets the absolute displacement values.
T3io user.inc 1 -2	- Sets the relative displacement values. Increment offset by +1 -2
T3io user.on	- enable user offsets.
T3io user.off	- disable user offsets.

5.4. Other misc examples:

The *next* command allows a sky coordinations to be sent to the tcs3 system as possible slew targets. The TO can then slew to this position, Example of the next command:

```
> t3io next 12:22:42.0 20:08:56.5 -0.0012 -0.0170 2000.0 2000.0 FK5 SAO-82277
OK
```

5.5. Instrumentation macros

The IRTF instruments (spex, for example) allow tcs command to be embedded in to their macor files.
Check the instarument documentation for an example of embedding tcs command in a macro. Typically, it would be something like:

```
Tcs Beam.A
```

When 'tcs' is the instrument command, and the remaining text is the tcs3 command.
Most macros can be support using on the following command:

Offset commands:

`User.init`	– Initialize the user offset by make the current position 0,0 (without moving the telescope).
`User.inc ra dec`	– Apply an increment to the RA and Dec offsets.
`User.set ra dec`	- Set the RA and DEC offset to ra,dec.

Beam switch commands:

`Beam.Set 0.0 0.0`	- set the beam switch displacement.
`Beam.A`	– Puts the telescope in the A beam.
`Beam.B`	– Pust the telescope in the B beam.

6. Using the TCSD.V3 and Upgrading from TCS1 commands.

TCS1 used a program called tcsd to provide a network interface to the control system. TCS3 implement a similar deamon call tcsd.v3 running on the tcs3 computer ("tcs3_host"). tcsd.v3 to mimics the old network interface and translates a sub-set of tcs1 commands to the new tcs3 system. Older systems may not need to be converted to work with tcs3. This section documents the command tcsd.v3 supports, and can be used as a porting guide for tcs3.

If possible, please update you software to communication with tcs3 directly.

TCSD.V3 supported commands are listed below:

6.1 Beam Switch Commands

TCS1 command	**TCS3 command with similar function**
ABEAM	Beam.A
BBEAM	Beam.B
?BS	Info os
TW.BS	Beam.set
?TW.BS	Info os

6.2 Scan, Peak, and other offset related commands

TCS1 command	**TCS3 command with similar function**
C.PEAK	‘1 ra dec -1 C.PEAK’ = ‘user.init’ ‘1 ra dec 0 C.PEAK’ = ‘user.inc ra dec’ ‘1 ra dec 1 C.PEAK’ = ‘user.set ra dec’
C.SCN	‘1 ra dec -1 C.SCN’ = ‘user.init’ ‘1 ra dec 0 C.SCN’ = ‘user.inc ra dec’ ‘1 ra dec 1 C.SCN’ = ‘user.set ra dec’
?PEAK	Info os
?SCAN	Info os
?DISP	Info os

6.3 TCS Query commands

TCS1 command	**TCS3 command with similar function**
C.HST	Info tm
C.STIME	Info tm
TCS_INFO	Info mp op
TPD	Info mp op

6.4 Other commands

TCS1 command	**TCS3 command with similar function**
C.SLEW	Next

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A guide for the TCS3 Operator.

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1. Introduction

The manual provides note and instruction on using the TCS3. It is a tutorial style guide.

Operators should also refer to the User Manual references when using this guide.

Here are some key link allowing access to the TCS3 Documentation.

http://irtfweb.ifa.hawaii.edu/~tcs3/ TCS3 Home Page
http://irtfweb.ifa.hawaii.edu/~tcs3/tcs3/users_manual/ TCS3 Users (operational) manuals.
http://irtfweb.ifa.hawaii.edu/~tcs3/tcs3/Design/document_index.html TCS3 Design Schematics

In the Design Directory, these documents provide an overview of what available and allows quick access to a particular subject. Please review and understand these documents:

T3-1000-Document_Index – List the documents available.
T3-1010-TCS3_Block_Diagram – Display a block diagram of the documents.
T3-1011-TCS3_Block_Diagram-Item_Index – Provide reference for items in the block diagram.

2. Starting / Stopping the TCS3 Software / Computer

This document describes the procedures to start and stop the TCS3 application . Plus provides instructions on rebooting the TCS3 computers, t1 and t2.

The TCS3 has two linux computers that can run the TCS application. Their hostnames are 't1' and 't2'. Normally t1 is used for all tcs3 operations. The t2 computer is a backup to t1. All tcs operation are performed on t1, unless specifically instructed to use t2.

There is a KVM switch to select either the t1 or t2 computer. The KVM box is located in the TCS room and can be manually switched using buttons on the KVM. It also supports hot keys via the keyboard: press 'scroll lock', 'scroll lock', then the up-arrow.

Easy Startup

1. login in as the user 'to' using the project password.
2. In an xterm, type 'startic' to begin the TCS3 main instrument control program.
3. Click on the TCS3 icon to start the mcc GUI, and then set the tab to mcc1.
4. Click on the TCS3 icon to start the mcc GUI, and then set the tab to mcc2.

Shutdown.

Normally you would leave the TCS3 running at all times. Here are procedures to reboot or shutdown the computer.

1. Put TCS3 in Stop servo mode.
2. Set TO Panel's Telescope Enable to OFF
3. Turn system power on MCC2.
4. Type "Die" in the mcc command prompt to Kill the TCS3 applications (IC & MCC)
5. Desktop Logout menu, allows you to Logout, ShutDown or ReStart the computer.

Other methods:

ssh into the system as 'root' and type *reboot* or *halt* or *poweroff*.

Manual method to start the TCS3.

If the above method doesn't work, this section describes how to startup the applications via the command line (ie, in an xterm). The main binaries are located in the /home/to/VERSION directory, where 'current' is the default version. The t3remote application is copied to /usr/local/bin.

IC in an xterm running on T1 (as user TO)

```
> cd              # to insure you are at the home directory
> cd current/ic   # cd to the IC directory
> ic              # start the TCS3 IC
```

MCC in an xterm running on T1 (as user TO0

```
> cd              # to insure you are at the home directory
```

```
> cd current/mcc      # cd to the MCC directory
> mcc                 # start the MCC application
```

t3remote (any IRTF workstation, any user)

```
> t3remote
```

How to manually kill the IC process.

1. Login to the t1/t2 computers and become root.
2. Issue the pkill ic command.
3. Issue the ps –ef command to review the currently running processes

Problem - Shared memory from last IC still exist?

The following messages indicate the IC may be already running or some shared resource was not deleted when the IC was termindated.

```
ic: creating shared memory /shm_tcs3
pshm_create:shm_open(): File exists
ic: Can't create shared memory /shm_tcs3.
Another copy of ic may already be running
```

To clear up this problem, make sure the IC isn't already running. Also, the rm_ipc application may be run to try to delete shared resources:

```
~/current/ic/rm_ipc/rm_ipc
```

If this fails, reboot the PC.

3. Tracking and Slewing

Track and slew are TCS3 servo mode to support astronomical observations, the destination position of the servo based on a sky position. The Virtual TCS software process at 20Hz, calculates a mount position based on the data in the Position Table. The mount position is used to drive the servo.

General procedures for Tracking and Slewing are presented here. We will start from the STOP state, parked at zenith.

Tracking

Clear any SB Errors using **SafetyBrd.Reset** on MCC1 Stop window.

Turn On **System Power** in the MCC2 tab.

Insure the **Telescope Enable** on the TO Panel is in the ON position.

At zenith, the APE and Incremental Encoders should show 0 errors. To set the incremental encoder position in the PMAC motor controller, press the **APE.Set.PMAC**.

To re-load the last saved pointing map IH ID values,   press **Pointing 'Last'** button (does a 'pt.restore' command)..

Click on **track** in the mcc1 servo window.
The telescope should start tracking.
Confirm that the servo is working correctly. In the tracking feedback window, check the Servo Performance: RTCS and PMAC should be GOOD.

Slew a star near zenith and center the star on the cross-hairs by adjusting the pointing map.
At this point, press the **pointing SAVE** button to add the errors to the pointing map (and save it to disk).

Slewing

To slew, you must first be tracking, and have a next object loaded in the '**next object table**'. Next objects can be loaded using the next command, t3remote, or starcat.

Review the next object table, and slew to the object using the 'slew N' command. For convenience, a **slew 0** button is provide on mcc1's tracking window.

When starting a slew, check the MCC1 Time&Position display to insure the slew is operating correctly. Review the destination RA&DEC, and motor speeds.

To abort a slew: press the **slew.abort** button, the tcs should start tracking near the aborted located.
Or press **Stop**, to stop the servo and put the brakes on.

If the slew failed, start tracking and re-slew to the target.

Parking the Telescope

If you will be away from the operator area for an extend period of time (ie, lunch, instrument changes, end of shift) you should:

1. Goto Stop Mode (Turns off Brakes, Turns off the Servo)

2. Turn off TO Panel's Telescope Enable (Prevents anyone from moving the telescope using a remote GUI).

4. Pointing Map Basics

The tcs3 uses TPOINT for it pointing map correction. Information on TPOINT can be found on the tcs3 user's manual page.

The tcs3 pointing map, called **pt.map**, supports the following tpoint coefficients: IH, ID, NP, CH, ME, MA, HCES, HCEC, DCES, DCEC, FO, TF, TX. These are determine by a pointing run (see the pointing run procedures).

The IH and ID values are adjusted when peaking up the pointing map after slews. Here are the various IH/ID adjustment variables:
MAdj (or Map Adjustment register) – shows IH,ID values that are preserve between slews.
Corr (or Correction register) shows IH,ID adjustment from the Peak, Spiral, and Rate IH/ID offsets. These are reset during a slew. You can this of the Corr values are IH,ID adjustment for the current observing target. The Corr values can be added to the MAdj values using the **Pointing Update** button on MCC1.
The Corr and MAdj register are memory register, which can be lost if the tcs3 is restarted.
The MAdj values can be saved to disk using the **pt.save** command.
You can restore the last saved MAdj value using the **pt.restore** command

After the slew you can peak up on a star using:

1. TO Panel's joystick for N/S/E/W movements. Be sure the TOP joystick is enable in MCC3, and check the rate.
2. T3remote ptmap's arrow widgets..
3. TO Hand Paddle.

If you star is not the field of view, you can spiral by:

1. Using the TO Panel, change the joystick mode to **Spiral** on mcc3. The JoyStick's north will spiral OUT, and South will spiral IN.
2. Using T3remote's ptmap's pt.spiral widgets.

4.1 Tip for peaking up the pointing map or telescope position.

4.1.1. On your 1st Star near Zenith (good catalog position), the TO should:

- Center the star on the cross hairs by adjusting the pointing map's IH, ID.
- Press **pt.save** on MCC1 to save the MAdj IH ID values to disk . These values can be recalled using **pt.restore**. **pt.restore** get to back to a 'sane' value or restored the state of the point map at zenith.

4.1.2 Whenever the telescope is slewed to an object with good coordinates, the TO should:

- Center the star on the cross hairs by adjusting the pointing map Corr IH, ID register.
- Anytime you want to retain corrects on the next slew do a **Pointing Update.**

4.1.3 Whenever the telescope is slew to an object with 'bad' coordinates:

- Optional: slew to a nearby object that as a good coordinate and do 4.1.2 . This will adjust the pointing map for the current telescope position.

- Slew to your 'bad' object.

- Center the star on the cross hairs by the adjusting base position, (using t3remote User TAB, and click arrow in 'Base' mode). This preserves the pointing map, and RA and DEC sky coordinate values.

- If you center on an bad object by adjusting the pointing map, you degrade the pointing map, and the sky RA and DEC position.

4.1.4 Clear on Slew

The **clear on slew** toggle button tells the TCS to clear all user offset, set the beam position to Abeam. Zeros the Corr IH,ID register. Resets ptmap, or scan rates to zero. The is the default action of the TCS. When disabled:

- User offset are not cleared.
- Peak IH/ID values are not cleared.
- Sprial ID/ID values are not cleared.
- Pt.Rate offsets, and Rate are not clear.

This clear on slew could be used when you wish to preserved the User Offset/Corr IH,ID values between slews, when, doing many short slews in a local area in the sky. However, care should be taken disabling the **clear on slew** as some of these offset and rates many not apply to the new observing object.

4.2 Pointing FAQ:

1. Where and how are the point coefficients stored? And can I modify them?

After a pointing run, the resulting pointing map is written to ~/current/ic/.tcs-init. The is the startup file for the IC program. You should not modify these coefficients, as we wish to keep the original pointing map.

A pt.save command writes the MAdj value to ~/current/ic/pt.save.txt. The pt.save.txt file is executed at IC startup. You can edit/delete this file to change the initial MAdj values.

2. Where can I learn more about TPOINT?
The tcs3's user manual page has a link to the IRTF copy of the TPOINT manual.

5. MP and MV Servo Modes

MP and MV are 2 additional servo modes supported by the TCS. MP is move position, and MV is move velocity mode. These are mount orientated mode: they ignore the sky coordinates.

In MP stands for move position. Using the MCC1 GUI, enter the destination HA and DEC and execute the move.

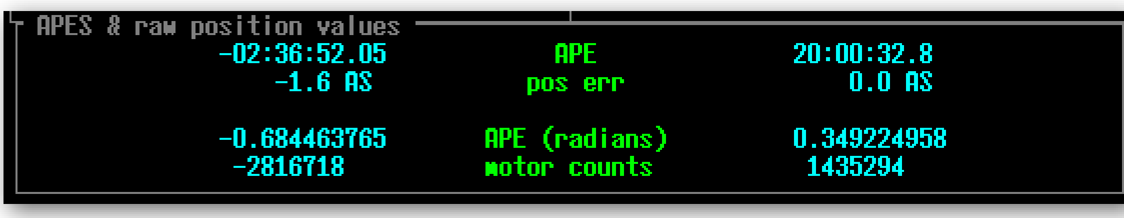
MV stands for move velocity: Use this mode to jog the axis at a specified velocity.
The dome hand paddle and TO Panel can be used to control the velocity. To use a hand paddle, enable the desired hard paddle and enter a rate. The hand paddle can now be used to control the velocity. In MV mode, the Joystick, DomeHP, or GUI mode can be used simultaneously.

In MV and MP mode the TCS software does a reverse mount-to-sky transformation to determine the sky position.

The **1101_MCC_GUI_and_TO_Panel.doc** provide a good guide on using these mode via the MCC GUI.

6. Using MP.Cnt (MP using Counts), and Raw APE/Motor Positions.

You can view the raw encoder position from the MCC GUI's *Details -> Pos* screen. Here is a sample of the 'APE & raw position values':



The raw ape values are in Radians.
The Motor counts are the PMAC actual position (incremental encoder count values).

In MP mode, you can also position the TCS in unit of incremental encoder counts, using the **MP.Cnt** command. For example, to move to 0 Ha and approximately 20 deg Dec do:

MP.cnt 0 1440000
(where 20 deg * 3600 deg/arc sec * 20 cnt / arcsec = 1440000 counts)

To move HA to 144000 (this is 10 rotation of the HA motor axis), and keep dec at ~ 20 degs.

MP.cnt 144000 1440000

7. Going beyond the software and hardware limits.

It important to remember the limit for the HA and DEC axis will trigger in the following order: Software, slew, stop, brake, Hard. Also the Horizon limit are based on elevation.

Review Appendix C to understand how limits are handled in the TCS3.

If you hit a limit, for example software or stop. You can going MV mode and reverse directions to move away from the limit.

You may need to travel beyond the limits. To do this you would need to disable the limit safety functions:

- Software Limit Override is a checkbox on the MCC2 GUI. Check it to disable software limits.
- Horizon Slew limits can be overridden on MCC2.
- The Stop, Brake, and Horizon Stop limits can be overridden by tuning ON the Limit Override switch on the TO Panel.

Once disable, you should be able to move to position beyond these limits.

8. Setting the Software Limits

Software limits are HA, and DEC limits within the software. They are used to prevent the operator from slewing the telescope beyond an established HA and DEC position. The default are:

HA:	-05:35:00	+05:35:00
Dec:	-55:00:00	+67:00:00

These limit can be changed using the command **sw.limits.set** command. The Daycrew is responsible for setting the correctly TCS software limits, per instrument configuration. The procedure for setting the limit are as follows:

1. Type 'die' on the MCC command line to quit the TCS software.

2. As the user 'to' on the 't1' computer, open an text editor.
   You can type 'gedit' in a terminal on the TCS computer to start an editor.
   In the text editor, open the file /home/to/current/ic/.tcs-init.

3. Within this file, you should see lines such as:

   ```
   # software limits used texes on 2012/01:
   # sw.limits.set -05:34:00 05:34:00 -50:00:00 48:00:00
   # normal software limits are:
   sw.limits.set -05:34:00 05:34:00 -55:00:00 67:00:00
   ```

   The sw.limit.sets command sets the East, West, South, and North software limits.

4. The '#' are comments. Set the appropriate software limits, by uncommenting or adding the correct command.

5. Restart the IC, and MCC Check the MCC Details->Position tab and confirm the software limits values are correct.

6. Email the IRTF Techgroup that the software limits have been changed.

9. The E100 Dome Servo System

In 2013, a new dome servo system based on the Baldor E100 Drives were installed at the IRTF. This sections highlights key information the operators and daycrew should know in order to use or deal with the system.

A block diragram of the Dome Servo System is provide in T3-3040-Dome_cntl-Overview. You should be familiar with the name, location, and function of the equipment. There is the PDF link: http://irtfweb.ifa.hawaii.edu/~tcs3/tcs3/Design/T3-3040-Dome_Cntl-Overview.pdf

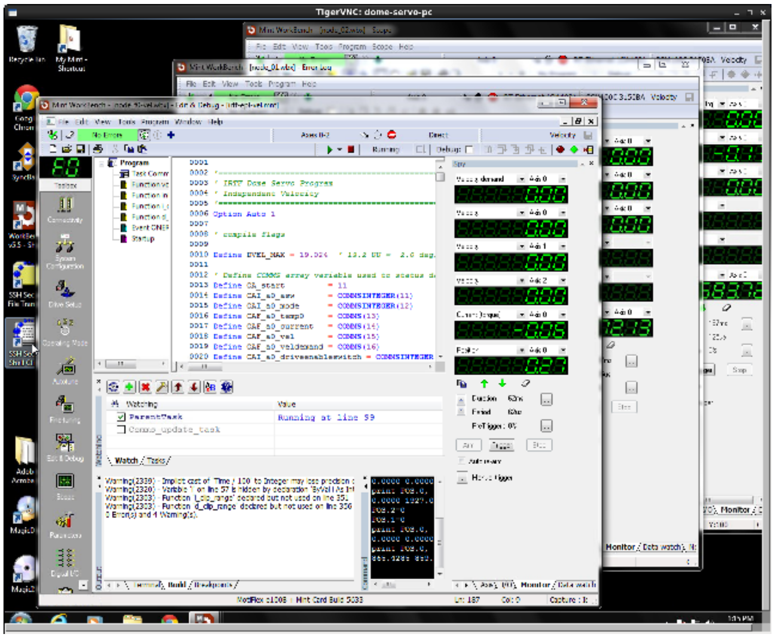
On MCC1, the Dome/Shutter area provides dome control and feedback for normal operations. If the a red message appear indicating the Dome Servo is not ready, further troubleshooting is needed.

1. Insure SafetyBoard Error are cleared, System Power is on, and the TO Panel Dome switch is not locked.
2. More information on the Dome Servo E100 system can be viewed on the MCC's Details Tab -> DS/e100. The user manual 1101_MCC_GUI_and_TO_Panel document has some information on this details screen.
3. The Dome-Servo-PC run the Baldor's MINT Workbench software. This is a comprehensive Windows application that provide full access to the E100 Drives. It does it all: Status Monitoring, Parameters editing, Tuning, Data Collection, Driving Commissioning , and Application Development. A few good things to know is including in the section.

Workbench on the Dome-Servo-PC.

The dome-servo-pc is located in the TCS control room, next to the Dome Servo Electronic box. This desktop is also accessible via VNC, ie "vncviewer dome-servo-pc:16000". Use the project password.

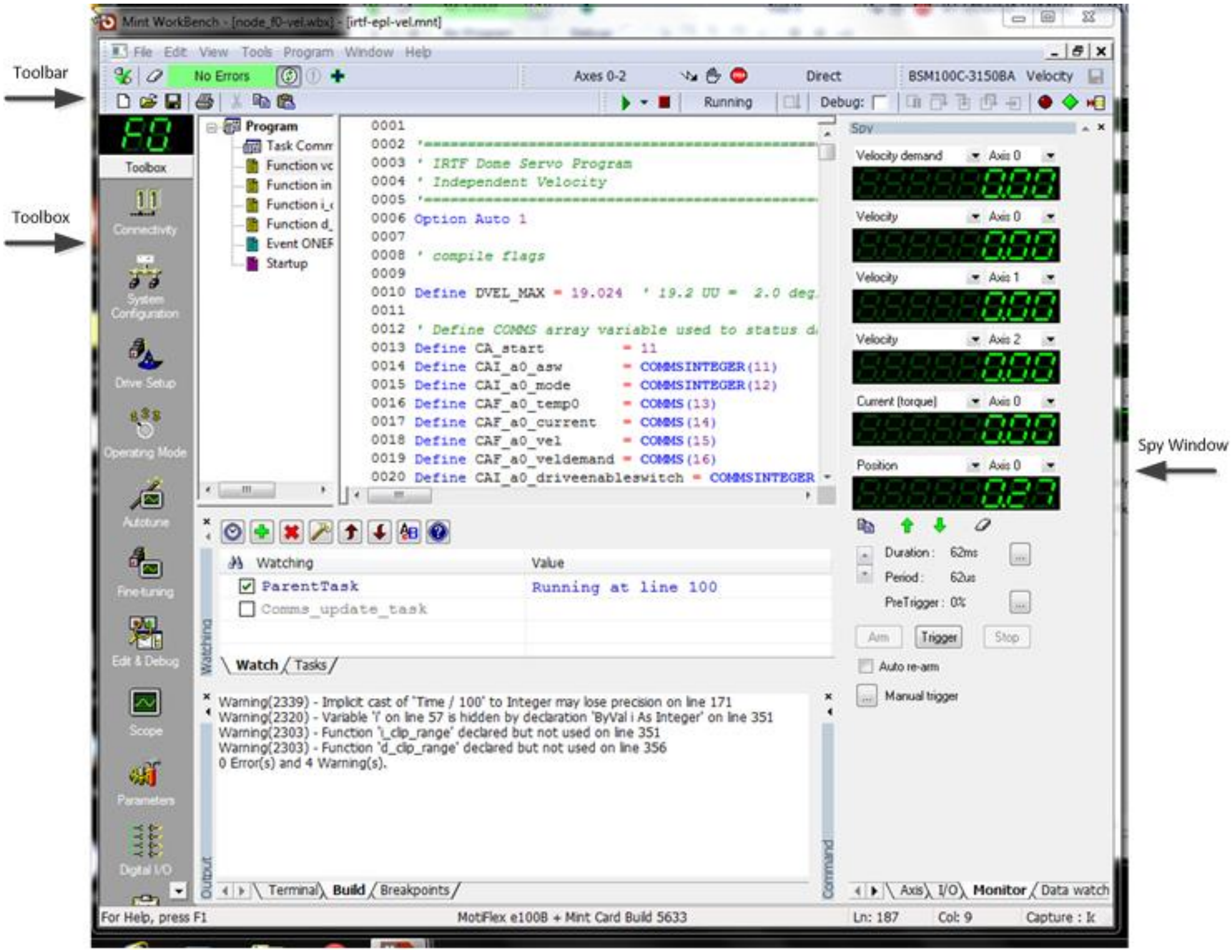
Normally there is 3 copies of the workbench running, one for each Drive. The workbench software communication to the drives over the USB connection. If not, you can access the My_Mint shortcut on the desktop, and run 3 workbench applications by double clicking on the .wbx for each node.



3 Workbench Applications running on the Dome-Servo-PC

Some vendor documentation is located here:
http://irtfweb.ifa.hawaii.edu/~tcs3/tcs3/vendor_info/Baldor/
But workbench built in documentation, and it probably better to first use the Help system under workbench.
It is more complete and up-to-date that the electronic documents.

There is a screen shot of the workbench:



Above the tool bar, there is the green on black LED style **node ID**. There will be either 'F0', '01', or '02'. This identifies the controller's ID that you are communication with. Be aware of this to insure to are accessing the correct controller.

The toolbar has some icons where you can check on **Errors**. The green "No Error" Bar will be red when the controller has errors. Click on error bar to display the error. The  attemps to clear the error. And the  should be press to keep appliation refreshed.

The **Toolbox** icon will change the middle area depending on the toolbox function selected. Many of the top icons run wizards that configure various aspect of the system, like Connectivity, System Configuration, Drive Setup, Operating Mode, AutoTune, FindTuning. These would be used only during initil setup, so avoid using them.
Some toolbox function could be useful:

Edit&Debug – on Node F0, we run an mint application. This toolbox allow access window related to program development. Becareful not to change the MINT program's source code. The watch window is usefull to show that the program is running. The Terminal window show console output of the program. And the Command window allow you to interactively type MINT command to the controller.

Normally the progam should be running, I like to 'check' the parentTask that the MINT program is running and when the dome is IDLE it is at or about line 100.

Scope – Using the Spy Window's monitor tab, you could capture and graph data using the Scope Toolbox.

Parameter – All the controller parameters can be viewed from the parameter toolbox. Be very careful because they can also be changed here too.

Errorlog – All error are log by the workbench. You can review past error here.

Clearing Errors

During operation if the Dome System stop due to error, It may be possible to clear the error and continue on with operations.

Resetting the controller

Sometime when error happen, the program may be interrupted . You will need to reset the E100 Drive. This is done by:

Locate the workbench for "F0".
Reset the controller by hitting "Tool-> Reset Controller".

Hopefully a 3 controllers will come up in an error free state.

10. The Hexapod Secondary

In 2013, a hexapod secondary was purchased, and put it into service. The TCS3 has the option of using the chopper or hexapod secondary. The focus and collimation is controlled by the secondary. The hexapod has a web page under the TCS3 located at: http://irtfweb.ifa.hawaii.edu/~tcs3/hexapod/. This site has a block diagram. Everyone should be familiar parts of the system.

10.1 Setting up the TCS3 with the correct secondary.

When changing the secondary, the TCS3 need to be configure to work with the correct secondary. To edit the tcs configuration file, type this on the t1 computer: **gedit /home/to/current/ic/.tcs-init,**

Ensure these lines are correct (note the # comment out a line).

```
#
# set to chopper or hexapod
#
#secondary chopper
secondary hexapod
```

In the above example, the chopper is commented out using the '#'. The TCS3 is configured for the hexapod.
Save the file and exit the editor.
Next quit and restart the TCS to read in the changes:

- Type 'die' in the MCC to quit.
- Restart the IC and MCC.

10.2 Initializing the hexapod

Before the hexapod can control the focus or collimation, it must be initialized. Go to the MCC GUI's MCC tab and select the **Hexapod.Init** button to initialized. This instructs the hexapod controller to home itself, and should take about 1 minute.

10.3 Other things to know about the hexapod.

The hexapod has a Ethernet port. This port is reserved so that the vendor's PC software can be used with the hexapod. The IP/number of name for the hexapod controller at the summit is "irtf-hexapod". The hexapod web page above has a copy of the vendor's CD containing all manual and software.

The TCS3 communicates with the hexapod using the controller's RS-232 port. This port is connect to the network using the digimim port 16.

The hexapod controller also has a keyboard and VGA port provide access to a simple GUI / Terminal. This can be accessed via the network. Refer to the hexapod web page.

On the MCC Details FIOX screen, some Hexapod data is displayed. The TCS3 queries the hexapod about 4 Hz. Position and Status information is provided. NS Collimation is the U axis. EW collimation is the V axis, and Focus is the Z axis. Note the white lettering “Hexapod u=NS v=EW z=Foc”.

This table compares the Chopper and Hexapod units.

		Hexapod	Chopper
NS Collimation	Min	-4.00 deg	-9.00 v
	Max	+4.00 deg	+4.06 v
	Resolution	0.001 deg	0.010 v
EW Collimation	Min	-4.00 deg	-4.80 v
	Max	+4.00 deg	+8.00 v
	Resolution	0.001 deg	0.010 v
Focus	Min	-8.00 mm	-7.32 v
	Max	+8.00 mm	+7.00 v
	Resolution	0.005 mm	0.005 v

According to M.Connelly:

0.142 degrees = 1v

1.7737mm = 1v

11. TCS3 and JPL Horizon ephemerides data.

The TCS3 accepts tracking data in the following coordinates system.

FK5/Any Equinox (FK5/J2000.0 is the default, which is the ICRF).

FK4/Any Equinox (FK4/B1950.0 is the default)

APP - Topocentric Apparent RA and DEC.
Includes Light deflection, annual aberration, Precession and nutation. And refraction.

TCS3 displays the Azimuth and Elevation values in Topocentric Apparent.

When using ephemerides, your best option is to use an Astrometric ICRF RA & DEC, which is the same as FK5 J2000.0.

1. Using JPL Horizon Astrometric RA & DEC (Highly recommended).

Horizon:
Your location should be Mauna Kea [568].
Select the ICRF/J200.0 format (Horizon's default).
Select Rates, RA & DEC
Enter Rates as nonsidereal rate (divide by 3600 to convert from "/hr to "/s).
For TCS3,
set CS=FK5, EQ=2000.0, EP=2000.0 (also TCS3's defaults).
Enter RA, Dec and non-sidereal rates.

2. Using JPL Horizon Apparent RA & DEC (not recommended).

Horizon:
Your location should be Mauna Kea [568].
Select Apparent RA & Dec
Select Rates, RA & DEC
Select the "standard atmosphere refraction model" option.
Enter rates as nonsidereal rate (divide by 3600 to convert from "/hr to "/s).
For TCS3,
set CS=APP.
Enter a-apparent RA, Dec from Horizon
Enter Rates as nonsidereal rate (divide by 3600 to convert from "/hr to "/s).
(All Topocentric Apparent object will need a tracking rates).

12. How to update the collimation table.

New collimation values can be enter into the MCC. These changes are not permanent. If the IC is restarted, it reads the default collimation values from the following files:

/home/to/data/collimate.txt – default collimation values for the chopper.
/home/to/data/collimate_hexa.txt – default collimation values for the hexapod.

When new default collimation values are determined, these files need to be updated.
The example below uses the ‘collimate.txt’, if updating hexapod values use ‘collimate_hexa.txt’

1. Open a text editor and edit the /home/to/data/collimate.txt file

- On the t1 computer, start gedit by clicking on the Application -> Accessories -> Text Editor menu.

2. Open the collimation file on the command line:

- In gedit, open the file HOME/data/collimate.txt

3. Edit

- To preserved a history of the collimation data, copy the current values, and comment them out by placing a ‘#’ in front of the lines.
- Edit the values.
- Save the file
- Quit gedit.

4. On the TCS MCC, type the follow in the command line interface to reload the new values in the TCS.

collimate.table.read then hit return

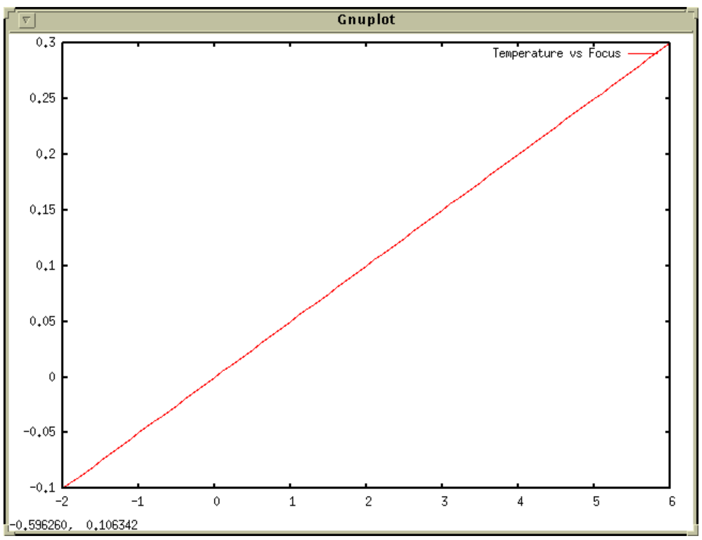
13. Focus Adjustment Graphs

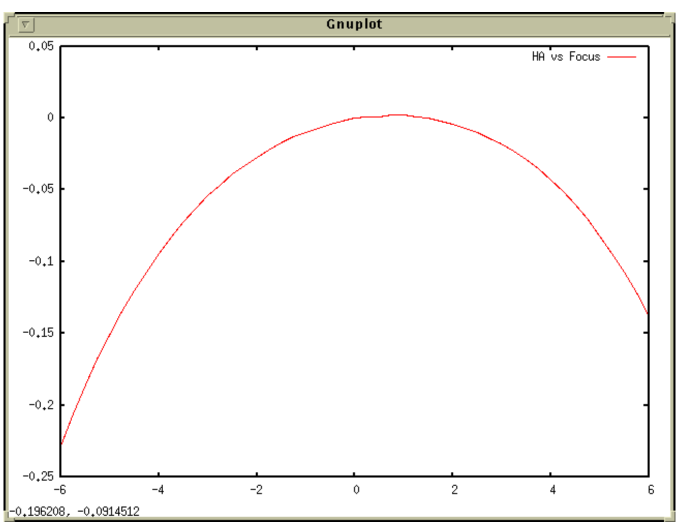
The tcs calculates a focus adjustment value based on change of temperature and position. The is done in the TCS focus loop with run at 10Hz. The adjustment formulas used are from the following documents:

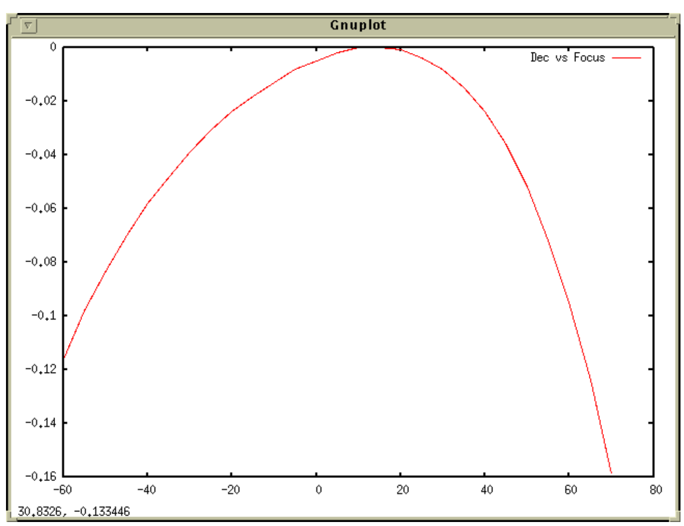
IRTF Focus vs. Temperature, Michael Connelley, Apr 8 2011
http://iborg.ifa.hawaii.edu:8080/Plone/irtf-projects/image-quality/Focus_temp.pdf/view

Mapping IRTF's Focus Shift vs. Pointing, Micheal Connelley, Apr 19 2011
http://iborg.ifa.hawaii.edu:8080/Plone/irtf-projects/image-quality/Focus_Pointing_Mapping.pdf/view

Here are graphs showing the focus changes based on temperature and position. This data was taken using the IRTF Chopping Secondary, thus the focus units are the LVDT voltages.



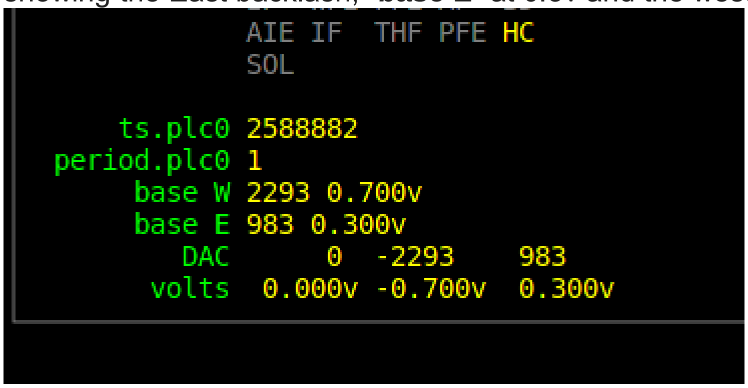




14. West DAC Base

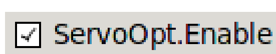
Due to the 2019 HA Drive issue, the west DAC base value has been changed from 0.3v (approx 1.1amps) to 0.7v (approx 4.1 amp) in Feb 2020. The ideal is that increasing the anti-backlash torque in the west gearbox is needed to maintain sufficient backlash. The East backlash is unchanged, still at 0.3v/1.1amp.

The backlash values used by the PMAC can be viewed on the **MCC->Details-> PMAC** screen. This screen is showing the East backlash, “**base E**” at 0.3v and the west (“**base W**”) at 0.7 volts.

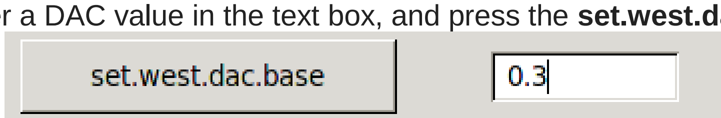


In addition to overcoming the backlash, 4.1amps could push the telescope towards the west. As a result, you may see the east motor servoing during tracking, but it could be using less amps than the west motor...The east motor is acting like a brake. This can also happen during slews, or not The currents on the west motor will always be about 4amp. And slewing east will result in higher currents on the east motor as it needs to overcome the 4amps of west backlash.

When the backlash currents are mismatch (West=4.1amp, East=1.1 amps), it will be difficult to assess the balance. The new version of the TCS does allow the operator to change the West DAC value. This is helpful when the counterweights need to be positioned using motor currents to determine balance. New widgets on MCC3 allows the west DAC to be changed. To changed the west DAC:

1. Go to MCC3
2. The TCS must be in **Stop** Mode, and the  must be enabled.

3. Enter a DAC value in the text box, and press the **set.west.dac.base button**, ie:



4. Check the **MCC->Details-> PMAC** screen, and ensure the **base W** value is set correctly.
5. Disable the **ServoOpt.Enable** to prevent other servo parameter to be accidentally changed.

15. Misc Problems and Solutions

1. No Sound from the speakers

The OS is not very reliable with configuring the sound. If the sound is not present, do the following:

1. Check the power & volume setting on the speakers.
2. In an xterm, run the *system-config-soundcard* program. Normally, just selecting the Play test sound button seem to get thing working.

2. What to do if the tracking exits and goes back to STOP mode?

Something the PMAC terminates the PID loop, and the TCS go back to Stop mode. If this happens, just restart tracking. You will have lost your position since while the stop mode wipes out your base and target position. So just re-slew back to your object.

3. What to do if the slew doesn't slew, or the MP, MV commands don't seem to execute. Or the PMAC doesn't seem to be accepting the move commands.

Remember that the PMAC is a computer. The TCS3 is basically one computer talking to another computer. Sometime this communication doesn't happen. In the case of the slew, not slewing. Try the 'ReSlew' button . This this doesn't work, go back to tracking, and re-issue the slew request.

In the case of MP, MV reissue the commands. Sometime you may need to go back to STOP and reenter the MV or MP mode.

I've seen the PMAC just not respond. In this case.

Goto Stop mode
Type 'die' in the MCC to kill the IC.
Restart the IC and MCC.

If this don't help, then to a cold boot of the system:

Goto Stop mode
Do a cold boot of the t1 computer (use the 'poweroff 'command as root).
Power on the PC after 10 seconds (Make sure you power up the host "t1").
Start the TCS3 software.

4. NAN is displayed on the MCC on some of the position values.

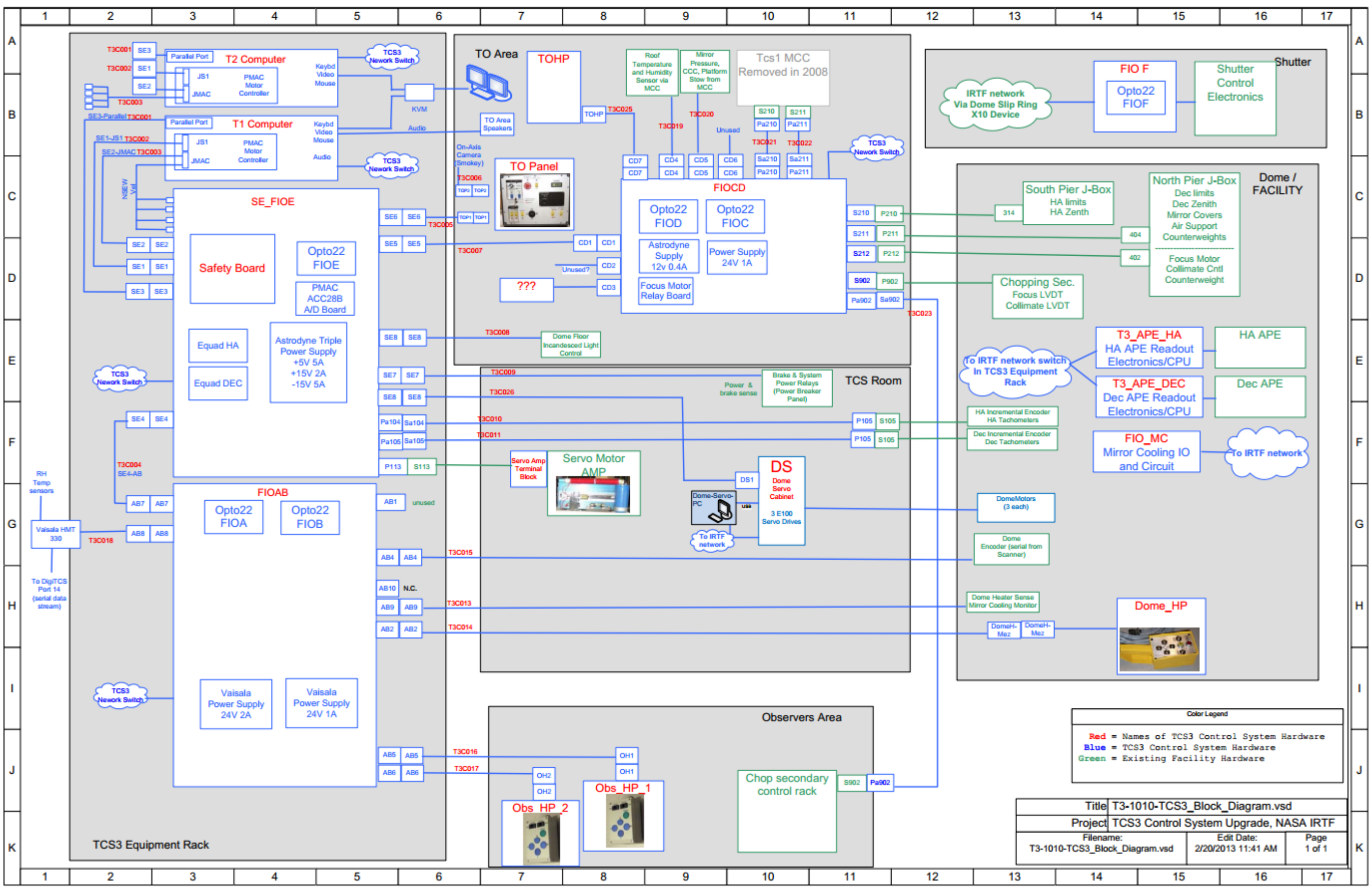
The NAN is illegal floating point number, ie "Not A Number". Mostly like a software bug, until I track it down, TO's should restart the IC:

1. To help me debug this take a screen capture with the mcc in Details->Pos and Pointing. See example: http://irtfweb.ifa.hawaii.edu/~denault/others/Screenshot.png (screen shot can be made using 'Actions->Take Screenshot' menu on T1.

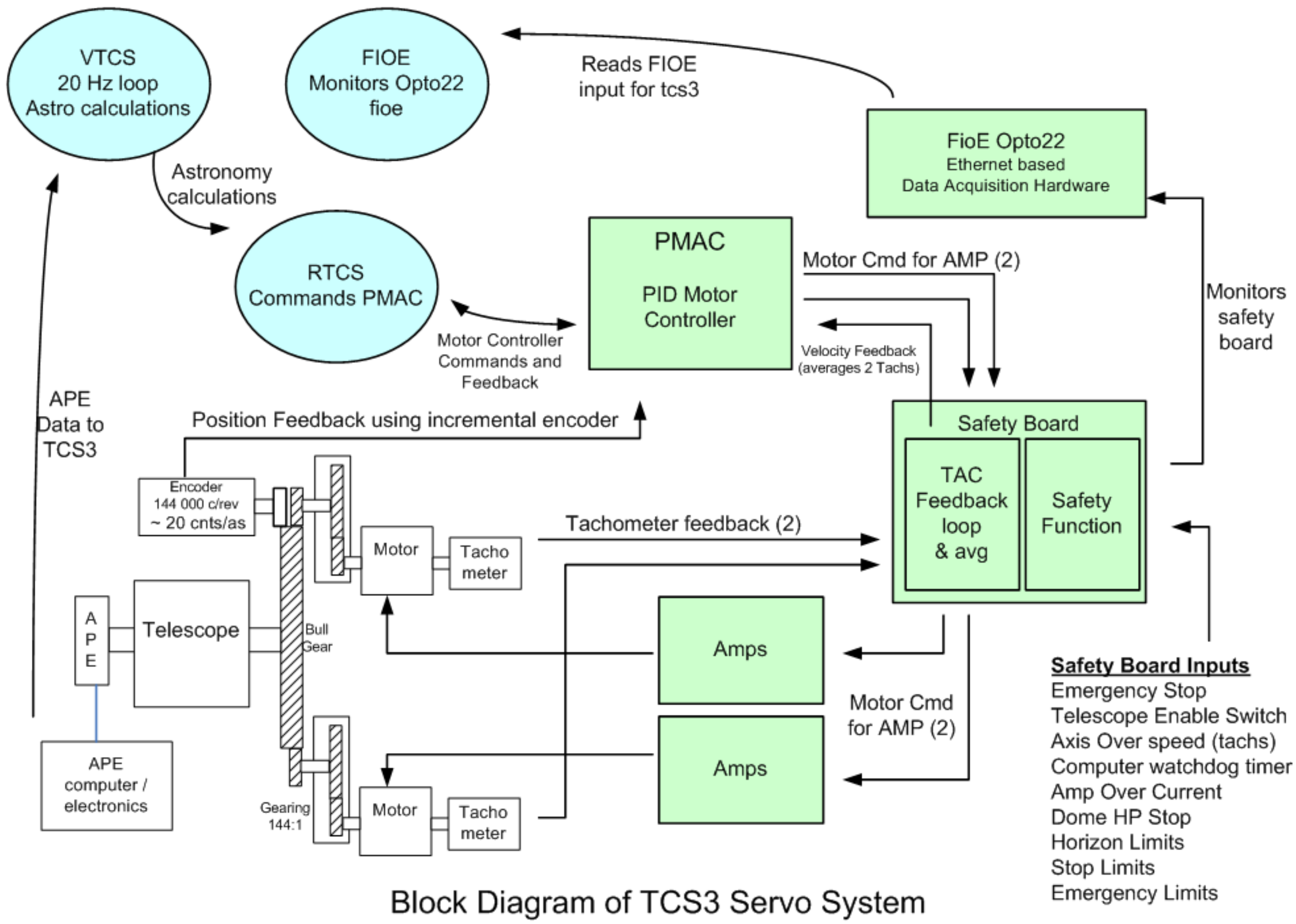
2. Goto Stop mode. (take note of your madj values).
3. Type 'die' to kill the IC & MCC.
4. Restart the IC and MCC.
5. Goto Zenith, In Stop mode, do a ape.reset.pmac.
6. Resume operations.

Appendix A – Block Diagrams of the TCS3 control system.

A block diagram of the tcs3 control system is maintained
[***http://irtfweb.ifa.hawaii.edu/~tcs3/tcs3/Design***](http://irtfweb.ifa.hawaii.edu/~tcs3/tcs3/Design)
The staff should be familiar with the TCS3 at this level. A of the block diagram is displayed here for reference.



It is also important to identify and understand the key components of the servo system.



Block Diagram of TCS3 Servo System

1. The Virtual TCS (VTCS) is a software process running at 20Hz, it calculates the mount position to observe a sky object. The Real TCS (RTCS) is another software process, it takes the mount position and commands the motor controller to follow a trajectory to track the sky object.
2. The PMAC is a PID-based motor controller. It is a PCI slot peripheral board located inside the T1 PC. It is commanded by the RTCS and is the servo controller for the TCS3. Each PMAC axis (HA and Dec) is configured to driver 2 DAC for the IRTF's dual motor configuration. For position feedback, an incremental encoder on the bull gear is used. For velocity feedback, the analog signals from each tachometer motor is averaged by the safety board and provide to the PMAC.
3. The Safety board is a custom built IRTF elelctronic board. It has 2 primary functions, the TAC feedback loop, and the safety function:
   a. A feedback loop for each motor is performed. The DAC output from the PMAC is conditioned before being applied to the amplifiers based on the tachometers for that motor. The 2 tachometer signals are also average and provide to the PMAC a its velocity sensor input.
   b. Various inputs are monitors by the safety function circuits. These signal can trigger a shutdown. When alerted the safety board will display the amplifiers and apply the telescope brakes.
4. Fioe is an opto22 data acquisition device. It samples various signals related to the servo system and safety board. The TCS3 application monitors this device, and will alert the operator when a safety condition has occurred.

Appendix B – The Position Table, Mean-to-Mount Calculations

The Position Table:

During tracking operations, the target TCS position is controlled by the position table. Here is an illustration of the information in the position table:

CS FK5	Base	
	19:49:34.39	20:28:19.2

Proper motion RA (s/yr)	Proper motion Dec(as/y)	Equinox	Epoch
0.000	0.000	2000.00	2000.00

Name	OS.enable	OffSets (as)	
User	off	0.00	0.00
Beam	off	0.00	0.00
Scan	off	0.00	0.00
TotalOS		0.00	0.00

NS Rates (as/s)		
	0.000000	0.000000

Scan Dest (as)		Time(sec)
0.00	0.00	0

Target		
	19:49:34.39	20:28:19.2

Base Position:

- CS is the Coordination System, which can be FK5, FK4, and Apparent. Related commands are:
  - cs { fk4 | fk5 | app }
- The Base provides the RA, Dec position. Proper motion defines the space motion of the BASE RA,Dec . Related commands are:
  - Base RA(hr) Dec(deg) [ra_pm (sec/yr) dec_pm (as/Yr) Ep Eq CS]
  - Base.inc ra(as) dec(as)
- Equinox is the cataglog equinox of the coordinate system. Epoch is the chronological references for the position. For FK5, the standard equinox and epoch are usually 2000.0. For FK4, they are 1950.0. For apparent, the equinox is not used, but the epoch dates the apparent coordinates. In most cases, when using apparent, set the epoch to the current julian epoch (Jan 01, 2010, would be *Epoch 2010.0*)
  Related commands are:
  - Epoch Yr
  - Equinox Yr
- NS rates allow you to track non-sidereal object.
  - ns.rate ra(as/s) dec(as/s)
  - ns.rate.inc ra(as/s) dec(as/s)

Off Sets:

The user and beam are both general purpose user offsets. It is suggest using UserOS for dithering and offsets, and BeamOS for Beamswitching. Related commands are:

- Beam.set ra(as) dec(as)
- Beam.clear
- Beam.inc ra(as) dec(as)
- Beam.on or Beam.B
- Beam.off or Beam.A

- Beam.toggle
- User.set ra(as) dec(as)
- User.clear
- User.inc ra(as) dec(as)
- User.on
- User.off
- User.toggle

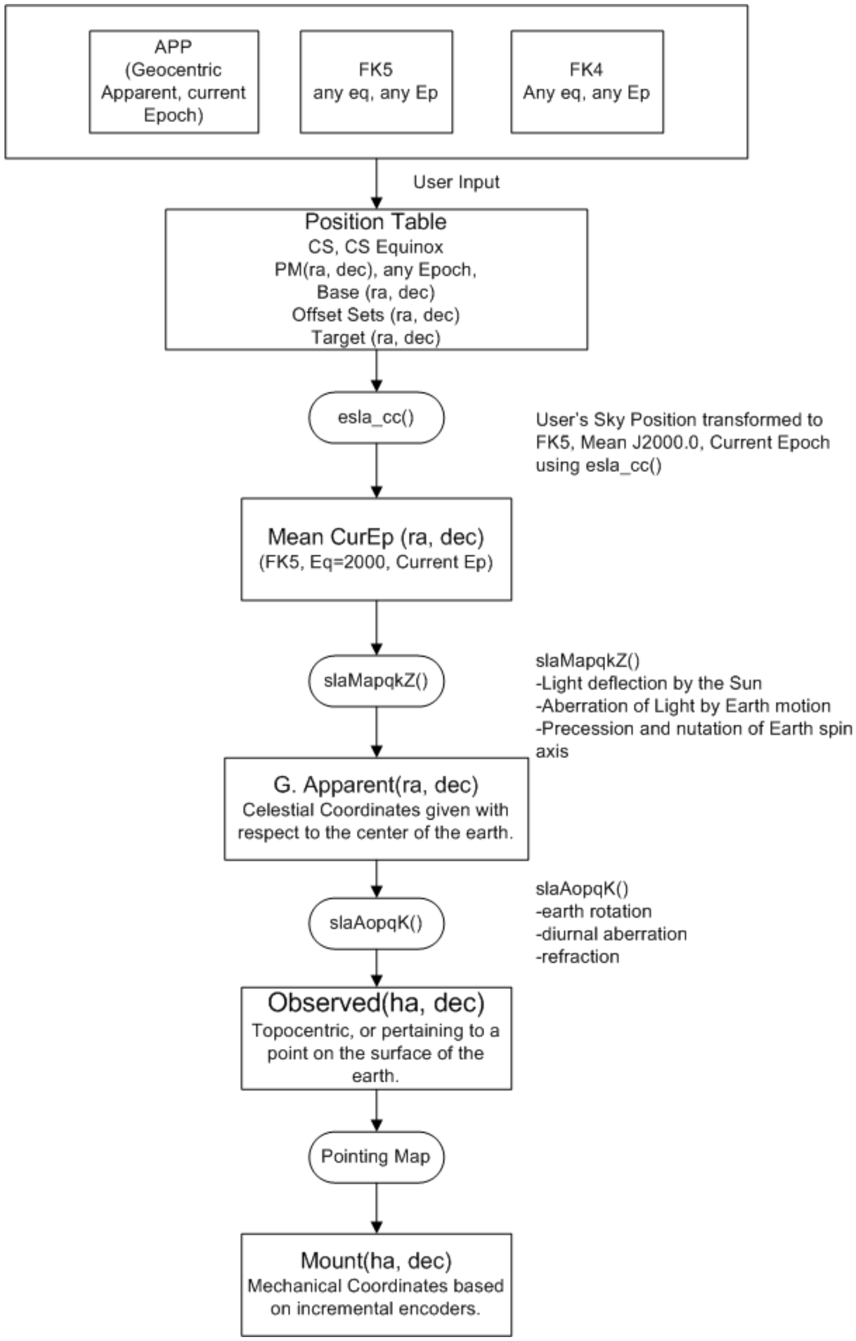
Scan is a special case offset, for scan across a target. Related commands are:

- Scan.set ra(as) dec(as) duration(sec)
- Scan.go
- Scan.return
- Scan.clear

Target Position

The base + offset are summed to produce the target position. This is the sky position the telescope the pointing at.

Mean to Mount Calculation Summary – It is important to understand the basic terms to describe position. The following diagram illustrates the terms and how the astronomical coordinates are transformed in TCS3.


APP
(Geocentric
Apparent, current
Epoch)
FK5
any eq, any Ep
FK4
Any eq, any Ep
User Input
Position Table
CS, CS Equinox
PM(ra, dec), any Epoch,
Base (ra, dec)
Offset Sets (ra, dec)
Target (ra, dec)
esla_cc()
User's Sky Position transformed to
FK5, Mean J2000.0, Current Epoch
using esla_cc()
Mean CurEp (ra, dec)
(FK5, Eq=2000, Current Ep)
slaMapqkZ()
slaMapqkZ()
-Light deflection by the Sun
-Aberration of Light by Earth motion
-Precession and nutation of Earth spin
axis
G. Apparent(ra, dec)
Celestial Coordinates given with
respect to the center of the earth.
slaAopqK()
slaAopqK()
-earth rotation
-diurnal aberration
-refraction
Observed(ha, dec)
Topocentric, or pertaining to a
point on the surface of the
earth.
Pointing Map
Mount(ha, dec)
Mechanical Coordinates based
on incremental encoders.

Appendix C – Telescope HA, Dec, Horizontal Limits

The follow types of limits exist in the TCS:

Software limits – Software Limit to limit the commanded position of the TCS. Handled by software.
Slew limit – hardware limit to limit max velocity from slew to tracking rates. Handled by software.
Stop limit – hardware limit. Handled by the Safety Board.
Brake limit – hardware limit to indicated emergency condition. Handled by the Safety Board.
Horizontal slew limit – A hardware limit. Handled by software.
Horizontal stop limit – A hardware limit. Handled by the Safety Board..
Speed limit – Internal position if passed, the software will reduce the velocity to tracking velocity. Handled by software.
Hard limit – Internal variables in the TCS3 software. RTCS will not command movement pass this limit. Handle by software.

Hardware safety limits (Stop, Brake, Hor Stop) can be overridden by the limit override switch on the TO Panel.
Software limits (Software, Hor Slew) have off/on toggle buttons on the GUI.
Speed, Hard cannot be overridden.

Summary of Limit Logic

	TRACK	SLEW	MP	MV	STOP
Software	Stop movement in the direction of limit. Goto STOP	End Slew. Goto STOP mode.	Stop movement in the direction of limit.	Stop movement in the direction of limit.	N/A
Slew	N/A	Reduce speed to tracking rates.	Reduce speed to tracking rates	Reduce speed to tracking rates.	N/A
Stop	Stop movement in direction of limit. Goto STOP	End slew. Goto STOP mode.	Stop movement in the direction of limit.	Stop movement in the direction of limit.	N/A
Horizontal Slew (19 Deg)	N/A	Reduce speed to tracking rate	Reduce speed to tracking rates	Reduce speed to racking rates	N/A
Horizontal Stop (10 Deg)	Stop tracking. Goto STOP	End slew. Goto STOP mode	Stop movement in the direction of limit.	Stop movement in the direction of limit.	N/A
Brake	Exit track mode. Goto STOP mode.	Exit Slew. Goto STOP mode.	Stop movement in the direction of limit.	Stop movement in the direction of limit.	Do not exit STOP mode.
Speed	N/A	Reduce speed to tracking rate.	Reduce speed to tracking rates.	Reduce speed to tracking rates.	N/A.
Hard	Stop movement in direction of limit. Goto STOP.	End Slew. Goto STOP Mode	Stop Movement in direction of limit.	Stop Movement in the direction of limit.	N/A

Table of Limit Values

	Speed	Slew HW (est)	Software	Stop HW (est.)	Brake HW (est)	Hard
EAST -HA	-05:15 hrs	-05:27 hrs	-05:35 hrs	-05:38 hrs	-05:57 hrs	-06:00 hrs
WEST +HA	05:15 hrs	+05:28 hrs	+05:35 hrs	+05:36 hrs	+5:57 hrs	+06:00 hrs
SOUTH -DEC	-50:00 deg	-53:07 deg	-55:00 deg	-56:42 deg	-59:28 deg	-65:00 deg
NORTH DEC	60:00 deg	+62:00 deg	+67:00 deg	+67:19 deg	+69:38 deg	+70:15 deg

Hor Slew Limit is 70.0 deg (est).
Hor Stop Limit is 75.0 deg (est).

Appendix D – List of MCC Errors and Warnings Notices

On mcc1 the warning window can display the following errors and warning messages. Appendix C further describes these messages. There are 3 type of Notices.

1. Error notices – are displayed in Red. These are problem most serious in nature.

1. Safety Board Errors Exist – A error condition exist on the t3 servo electronic safety board. The condition must be cleared in order to allow tcs3 servo operations.

2. Stop or Brake Limit Set – Physical limit switches on the HA and Dec axis, or Horizon limit have been tripped. These are axis limit switches.

3. PMAC IO Error – The tcs3 software was not able to communicate with the PMAC motor controller. To clear the condition: 1)Retry the operation. 2) restart the tcs3 IC. 3) reboot the tcs3 computer. 4) Call for technical assistance.

4. PMACTimestamp Error – This indicated the software loops in the PMAC motor controller are not executing. To clear the condition: 1)Retry the operation. 2) restart the tcs3 IC. 3) reboot the tcs3 computer. 4) Call for technical assistance.

5. APE – Motor Apos > 600” - The APE position differ from the Incremental Encoder Position (IPE) by more that 600”. Visually check the Telescope positions, APE value, and incremental encoder values. If there are no malfunctions in the position sensors, reset the position using APE.SET.PMACE in STOP mode.

6. APE – Mount Position > 600” - The APE position differ from VTCS target position by more than 600”. Visually check the Telescope positions, APE value, and incremental encoder values. If there are no malfunctions in the position sensors, reset the position using APE.SET.PMACE in STOP mode.

2. Warning Notices are less serious errors or message that indicate a condition the operation should be aware of. They are display in Yellow.

9. Using sim motors(CF_PMAC=0) – The software has be compiled to using simulated software motor. This is a engineering mode and should never be seen for IRTF operations.

10. Hardware Limit Override On – The hardware limit override switch on the TO Panel is ON.

11. Software Limit Override On – The software limit override (in mcc2) is ON.

12. System Power is off – The system power is off.

13. Hardware Slew Limit set – The hardware slew limit switch is ON.

14. Software Limit reached - The software limit position has been reached.

15. Dome blocking FOV – The Dome and Telescope Azimuth position differ by more that 2 degrees, thus the telescope's field of view may be blocked.

16. MirSup Warning - Kill Err - The mirror support that a KILL signal indicating a hardware fault has occurred. The KILL signal is true.

17. MirSup ON & Volts PSI Wrong – When tracking and the Mirror support is ON, the TCS monitors the mirror support's air pressure voltage. If it deviates from its intended value, this warning informs the operator that the mirror support's air pressure is likely incorrect. Check the MSAR details in FIOX and review the elevation, PSI for the regulator cmd, feedback, and safety sensor.

18. Counterweight(s) are stuck – While moving a counterweight, the position did not change after a few seconds, thus it is stuck. Maybe you reached the end of travel or some other failure occurred.

19. Focus is stuck - While moving the focus, the position did not change after a time interval, thus it is stuck. Maybe you reached the end of travel or some other failure occurred.

20. Collimate is stuck - While moving the collimated motors, the position did not change after a time interval, thus it is stuck. Maybe you reached the end of travel or some other failure occurred.

21. APE data is stale (>2 sec) – The ape are polled for new position at an interval greater that 5Hz. A new position was not received for more that 2 second, indicating a communication problem between the tcs3 comptuer and the ape computers (t3apeha or t3apedec).

22. Dome pos. data is stale (>2 sec) – The dome position is sent to the tcs3 via a serial stream. The dome_scanner output is feed into the fio_a opto22 serial module. The update rate is about 2 Hz. These message indicated no new data was received within 2 seconds. Further investigation is needed.

23. ZenDist large, refra. disabled. – When the zenith distance is > 85 degrees, the refraction calculation is disabled. This is because large zenith distance requires a huge amount of cpu time, and after this zenith distance it will soon overwhelm the computer.

24. Humidity limit exceeded – The humidity exceeds the limit set by the humidity.wn command.

25. FIO_A is off line – The opto22 device whose hostname is t3fioa is offline.

26. FIO_B is off line - The opto22 device whose hostname is t3fiob is offline.

27. FIO_C is off line - The opto22 device whose hostname is t3fioc is offline.

28. FIO_D is off line - The opto22 device whose hostname is t3fiod is offline.

29. FIO_E is off line - The opto22 device whose hostname is t3fioe is offline.

30. FIO_F is off line - The opto22 device whose hostname is t3fiof is offline.

31. FIO_MC is off line – The RIO device whose hostname is t3fiomc is offline.

32. FIO_CHOP is off line – The DMC-31011 controller using to run the 2019 chopper servo is offline.

33. FIO_CW is off line – The 2020 counter weight IO units (2 RIOs) are offline.

34. FIO_ape HA comm error – There was an error communicating with the fio_ape computer, hostname t3apeha. Check the embedded APE computer for HA.

35. FIO_ape Dec comm error - There was an error communicating with the fio_ape computer, hostname t3apedec. Check the embedded APE computer for DEC.

36. Bad AIO on FIO_A
37. Bad AIO on FIO_B
38. Bad AIO on FIO_C
39. Bad AIO on FIO_D
40. Bad AIO on FIO_E
41. Bad AIO on FIO_F – FIO A,B,C,D,E, and F are opto22 device. They have Analog In modules have can go bad. This TCS warning indicate the software see 'bad Analog In' values on a module. It is likely the module need to be replaced. Day Crew and TCS support staff need to be consulted. Details tab on MCC may help you determine which module is bad… but sometime the 1st analog module on the opto22 bus can cause the other to report bad data.

42. PMAC following Err – The following error in the pmac exceeds 1800 arcsec (0.5 degrees).

43. SafetyBrd_OS_Ha_Latch - The T3 Safety Board's Over Speed HA Latch is TRUE.

44. SafetyBrd_OS_Dec_Latch - The T3 Safety Board's Over Speed Dec Latch is TRUE.

45. SafetyBrd_OC_West_Latch - The T3 Safety Board's Over Current West Latch is TRUE.

46. SafetyBrd_OC_East_Latch - The T3 Safety Board's Over Current East Latch is TRUE.

47. SafetyBrd_OC_North_Latch - The T3 Safety Board's Over Current North Latch is TRUE.

48. SafetyBrd_OC_South_Latch - The T3 Safety Board's Over Current South Latch is TRUE.

49. SafetyBrd_OC_Dome1_Latch - The T3 Safety Board's Over Current Dome Motor 1 Latch is TRUE.

50. SafetyBrd_OC_Dome2_Latch - The T3 Safety Board's Over Current Dome Motor 2 Latch is TRUE.

51. SafetyBrd_OC_Dome3_Latch - The T3 Safety Board's Over Current Dome Motor 3 Latch is TRUE.

52. SafetyBrd_Emerg_Stop_Latch - The T3 Safety Board's Emerg Stop Latch is TRUE.

53. SafetyBrd_DomeHP_Stop_Latch - The T3 Safety Board's Dome Hand Paddle Stop Latch is TRUE.

54. SafetyBrd_Mtr_Cntr_Err_Latch - The T3 Safety Board's Motor Controller Err Latch is TRUE.

55. SafetyBrd_PC_Lockout_Latch - The T3 Safety Board's PC Lockout Latch is TRUE.

56. SafetyBrd_HA_Stop_W_Latch - The T3 Safety Board's West Stop Limit Latch is TRUE.

57. SafetyBrd_HA_Stop_E_Latch - The T3 Safety Board's East Stop Limit Latch is TRUE.

58. SafetyBrd_HA_Emerg_W_Latch - The T3 Safety Board's West Emergency (or Brake) Limit Latch is TRUE.

59. SafetyBrd_HA_Emerg_E_Latch - The T3 Safety Board's East Emergency (or Brake) Limit Latch is TRUE.

60. SafetyBrd_Dec_Stop_N_Latch - The T3 Safety Board's North Stop Limit Latch is TRUE.

61. SafetyBrd_Dec_Stop_S_Latch - The T3 Safety Board's South Stop Limit Latch is TRUE.

62. SafetyBrd_Dec_Emerg_N_Latch - The T3 Safety Board's North Emergency (or Brake) Limit Latch is TRUE.

63. SafetyBrd_Dec_Emerg_S_Latch - The T3 Safety Board's South Emergency (or Brake) Limit is TRUE.

64. SafetyBrd_Horizon_Stop_Latch - The T3 Safety Board's Horizon Latch is TRUE. The telescope is tipped over to far. (Hardware switch turns on when zenith distance is > 75 degrees).

65. SafetyBrd_Watchdog_Tmr_Latch - The T3 Safety Board's Watchdog Timer Latch is TRUE.

66. SafetyBrd_Clocking_Error_Latch – The T3 Safety Board's internal clock monitor has indicated a clocking or timeout error. This is an internal safety board error.

67. SafetyBrd_Dome_Amp_Enable_Therm – This error indicate there is a problem with the Enable Line or the Thermal Fuse on the Dome amplifiers. Try the Thermal Fuse Reset button on Dome Amplifier, else contact the Daycrew or IRTF EE.

68. SafetyBrd_Tel_Amp_Enable_Therm – This error indicate there is a problem with the Enable Line or the Thermal Fuse on the Telescope amplifiers. Stop the telescope, and turn off power. Contact the TCS3 support engineer.

69. SafetyBrd_Spare1 – A spare input on the safety board has triggered. This shouldn't happen. Contact the TCS3 support engineer.

70. SafetyBrd_Spare2 – A spare input on the safety board has triggered. This shouldn't happen. Contact the TCS3 support engineer

71. SafetyBrd_Tach_Switch_is_off – An internal switch on the safety board used to enable the tachometer feedback loop is OFF. The switch need to be turned on when operation the IRTF Summit Servo system. (It is off, when running in the Hilo test system).

72. PowCntl&Brakes Err(FIOE) – FIOE monitors the HA and Dec Brake _Enable (to control the breaks) and a _Sense line to confirm the start of the brakes. These signals to not match. Call IRTF superintendent or IRTF EE. Also check the status on MCC->Details->FIOE.

73. Crane not stowed – The dome crane is not stowed.

74. TOP Tele Enable is OFF – The TO Panel's Telescope Enable switch is OFF.

75. Mir Cover open & Cooling on – The Mirror Covers are open and the Mirror Cooling is ON.

76. Check T3 P/S (in mcc3 GUI) - The power supplies being monitored by FIOA/B have a > 5% error. Further investigation is required. Check the MCC GUI to identify the power supply triggering the error.

77. Check Closed Cycle Coolers – The closed cycle cooler warning signal is ON. Coolers may have tripped off.

78. Dome may be Stalled – The DAC (motor command) to the dome amplifiers is 2 volts or greater, but the dome velocity from the bar code sensor indicates not position change.

79. Monitor Mirror Cooling – The Operator should check or monitor the mirror cooling system. There may be an error in the system, or it is operating in a unusually mode You can check on the mirror cooling IO setting via the MCC Detail Tab. View the FIO_MC details.

80. Approaching Lower Shutter – The tcs3 thinks you are getting close to the lower shutter.

81. Check TAC& Mtr Vel Data – The data on the velocity sensor don't match. The velocity sensor are the velocity voltage from the tachometer (out of the safety board), and the incremental encoders.

82. PMAC PID not optimal – You do not have the correct PID value loaded in the PMAC controller. This can degrade servo performance while tracking/Observing. To fix ,
1. If it happens during tracking, just 'slew 0' to re-slew to the current object (TCS will try to reload the PIDs).
2. In order modes (ie MP), goto STOP mode, and re-enter servo mode.

83.AMP Power Warning (FIOB) - The system power is ON, but voltage to the servo amplifiers indicate there could be a problem. HA, Dec, and Dome AMPs require > 60 volts from the Power Supplies, check MCC GUI -> Details -> FIOB screen for AMP power supply voltages.

84. Motor Currents High – If any of the motor currents (East, West, North, South, Dome1, Dome2, Dome3) exceed some normal operational value this message and a audio warning will occurred. Quickly access the situation to insure the telescope or dome isn't stuck or impeded.

85. IQUP Data is Stale – The TCS3 gets some facility data (temperature, wind speed) from the IQUP system. This warning indicates some IQUP data is stale. Go to the Details -> FOX tab, and review the IQUP data.
The details show the timestamp of the data, normally data is taken at 180 or 360 second intervals or less.
Disregard any stale data, and report the problem to the technical staff.

86 IQUP TT range is large – The IQUP Truss temperature range is large. The focus adjustment (adjusting telescope focus with temperature) uses the IQUP TT3, 5, 7 (truss temperature) as inputs. This message indicated the range is > 5 degees which could indicated an error with the sensors as these temperature are normally a within a few degrees. Check Details->IQUP to see if the data is bad, if so, disable **Adj.Enable** on the focus.

87. iSD-TH is Stale – The iSD-TH unit this the omega.com Temperatue + Humidity sensor/controller used as the primary environmental and humidity sensor for the TCS. Stale data indicated the TCS is unable to query this information. This unit is located in the observer's area. The Details->FIOX has some information about this data.

88. High Wind Warning – A notice warning with sound alert should trigger when the wind speed exceed the high wind warning level, normally set at 35mph.

89. Machine Room is Hot (> 80 deg F) – The iqup sensor TMR5 is sample by the tcs. When the temperature exceeds 80 deg, then this warning appears. Operators/Staff should address the situation. Open the machine room door and use the fan to cool the room.

90. DS/e100 data stale (check details)
91. DS/e100 has errors (check details)
The DS/e100 refers to the Baldor E100 Dome Servo Drive system. The message indicate an issue with the servo system. Please review the Details ->DS/e100 tab. After reviewing the tab, hopefully a better assessment of the state of the dome servo could be provided. Also section **8. The E100 Dome Servo System**, has some instructions on using the Baldor Workbench Software to assist with trouble shooting any Dome Servo System issues.

92. Hexapod has errors (check details FIOX) – Please review the Details →Misc tab's Hexapod information. There is an issue with the hexapod. Also review section **9. The IRTF Hexapod Secondary**, has some information operation the hexapod.

93. Check on MSAR (details FIOX) – The TCS sensor errors with the Mirror Support Air Regulator system (the 2020 Cosin valve replacement). Review FIO X for details, and check on the hardware.

94. Check for HA oscillations – In 2019, the HA drive west gear box started inducting tracking oscillation. The TCS has a check to help the operator notice these oscillation. Please review the TCS tracking and servo data to insure correct operations.

3. Sound notices are audio message play via the computer's speaker output. Usually they are self explanatory.

completing slew – slew has reach its destination.
sm_stop – Entering Stop Mode.
sm_mp – Entering MP mode.
sm_mv – Entering MV mode.
sm_track – Entering track mode.
sm_slew – Entering slew mode.
sm_error_exiting – TCS is existing a servo mode due to an error.
system_power_off – The system power has been turned off.
humidity_rising
humidity_falling –The humidity crossed the warning point (falling or rising).
next_obj – The tcs has received a new data in its slew next buffer (sound is a bee-boo).
upper_shutter_up – Upper shutter limit turned ON.
shutters_touch – Shutter touch limited turned ON.
lower_shutter_dn – The lower shutter limit turned ON.
approaching_lower_shutter – You are getting near the lower shutter.
Can't do please check –Operator can't start the servo if the system power is off or safety board error exist.
start data recorded – audio freed back with pt.star.add is done.
dome is ready – When tracking the dome has lined up with the telescope.
move completed – The MP move has reached it destinations.
Brakes are set– TCS tells you when brake are engaged.
Beamswitch – A sound plays when a beam switch occurs.
Please reslew – Trying to slew, but velocity is 0. Operators needs to press the reslew button on the mcc1 GUI.
Last_Pointing_star – or "Completed pointing pattern" when the last star in the pointing pattern is recorded.
Motor Currents High – Check the TCS3 motor currents for the HA, DEC, and Dome motors.
High Wind Warning – Winds speed exceeds user-selected warning threshold, normally 35mph.
Bike Bell – indicated an audio request was make to the TCS (audio notice initiated by another IRTF computer, no the TCS.
Guidebox Signal is Low – The signal in the guidebox has changed, becoming lower. This could mean the guider's object has move outside it's guidebox.
Switch dome mode to stop – The dome may be stuck, so the TCS is switch the dome mode to stop.
Possible oscillations – TCS may have detected a HA drive oscillation during Tracking.

Pointing Run Procedures

Table of Contents

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Introduction

This document is intended as a checklist for generating a new set of TCS3 pointing coefficients, and is not intended to be a tutorial for new users. Should be done by an experienced TO or TCS3 program.

Doing pointing run require proficiently in unix, operation the TCS3. In the case of encoder ratios, be able to update the software.

In general, the procedure are to:

1. Run a benchmark with current map.
2 . Do a pointing run to collect data for analysis by **tpoint**. Then enter the new coefficients generated by **tpoint** into the system.
2. Run a benchmark with the new map. (Make sure it not worse)
3. Make the new coefficients the defaults for the TCS.

The resulting pointing tpoint data is located in /home/tcs3/data/tpoint/YYMMDD.
And index.html file is created as a log for the run and for the techgroup report. The best way to do a new pointing run is to copy the index.html into a new directory and follow along.
The link http://irtfweb.ifa.hawaii.edu/~tcs3/tcs3/data/tpoint
Previous run were log under the history section: ie, ~/public_html/tcs/tcs3/history/YYMM.

Before Starting:

1. It would be a good ideal to generate new encoder ratios. This can be done during the day.
2. Have SPEX in the center, and use SPEX collimation values.
3. At Zenith, re-read the APE to initialize the PMAC position. (In idle mode, do APE.Set.PMAC).
4. Insure the chopper is ON and in the center position.
5. Print the check list (Appendix A) and follow it.

1. General Procedures for collecting bench mark and pointing data.

Go to Zenith, enter idle mode, do a 'Ape.Set.PMAC'.

Enter tracking mode, peak up on a zenith star, and do the "pt.save" or (initialize pointing)

Use the 'Pointing' tab on mcc2.

Path to /home/tcs3/data/tpoint/YYMMDD
Set Filename to pointing.dat (if benchmarks, use b1.dat, b2.dat, etc)
Set Pattern to Grid for pointing run. (If benchmarks, select Benchmark13).
Set Separation to 13 (for a grid of 70 stars)
Set Caption to "pointing run" (optional, this is just a comment field)
Press the "Open File" button.
Press "Next & Slew" to go to the 1st star.
Repeat the following steps for all stars:

- After slew, put star on cross hairs.
- Press the "Add Star" button. (with "Do Map" and "Do Next & Slew" check).

2. Generate new pointing coefficients:

In an xterm 'ssh –l tcs3 t1'. cd to the pointing directory (/home/tcs3/data/tpoint/YYMMDD)
Run "tpoint tpoint_log".
At the tpoint "*" prompt, enter these commands:

```
indat  pointing.dat
call  irtf
fit
call  e9
gc p pointing.ps
outmod pointing_coeff.txt
quit
```

A bad data point will mess up the fit, do a 'SLIST' command to show the star list. From this output you can identify any bad points. Delete the line, and repeat the above commands. Do this until you get better that 15as RMS.

Examine the displayed results and perform other fitting if needed (see tpoint documentation). If any changes are made, be sure to reissue the "call e9", "gc p pointing.ps", and "outmod pointing_coeff.txt" commands so that all the new data is saved.
Type "quit" to exit tpoint

Convert .ps file to a .pdf. View graph with acroread.

```
> ps2pdf pointing.ps
> acroread pointing.pdf
```

3. Enter the new pointing coefficients into the TCS

Edit the .tcs-init and replace the old coefficients value with the new one.
Type 'die' on the mcc to termination the TCS, then restart.

Update both the /home/to/current/ic and TCS3 development version of the .tcs-init file.

Appendix A – Check list

Before the RUN

[ ] Day Crew should clean/inspect gears and encoders.
[ ] Measure the encoder ratios. Update TCS3 if deemed necessary.

Beginning of Run.

[ ] spex in the center; Check balance
[ ] Check collimation numbers; if chopper (ON and Centered)

Benchmark1

[ ] Ape.Set.PMAC at Zenith
[ ] Initialize pointing at a Zenith Star
[ ] Collect data using 'b1.dat' and Benchmark13 pattern.

Pointing Data

[ ] Ape.Set.PMAC at Zenith
[ ] Initialize pointing at a Zenith Star
[ ] Collect data using 'point.dat' and GRID with 13 degree separation (70 starts)

Tpoint.

[ ] Calculate new coefficients
[ ] Update default copy of .tcs-init
[ ] Update development copy of .tcs-init
[ ] Re-start TCS software to run with new pointing map coefficients.

Benchmark2

[ ] Ape.Set.PMAC at Zenith
[ ] Initialize pointing at a Zenith Star
[ ] Collect data using 'b2.dat' and Benchmark13 pattern.
[ ] Check b1 vs b2; Use the appropriate coefficients

Post-Run

[ ] Complete your report in /home/tcs3/data/tpoint/YYMMDD

Appendix B – Other Notes

1. Another way of compare the old map vs new tpoint coefficient is to use tpoint and plot the old map using your new data. An example:

- `indat p1.dat` Read in data
- `call irtf` setup standard IRTF parameters
- `fit` Fit to new map
- `ih XX.XX` Replace new map with coefficient from old map
- `id XX.XX`
- …
- `TX XX.XX`
- `Fix` Prevent terms from being changed.
- `Fit` Fit the terms.

1. What are the 9 standard plots? The ***G ydata xdata*** generates the plots. There is a summary of the 9 standard plots (left to right, top to bottom):

N	**G-command**	**X**	**Y**
1.	G X H	east-west error	hour angle
2.	G D D	declination error	declination
3.	G Z Z	zenith error	zenith
4.	G X D	east-west error	declination
5.	G D H	declination error	hour angel
6.	G P H	ha/dec nonperpendicularity	hour angle
7.	GSCAT E	scatter plot of errors	
8.	GDIST	plot distribution of the pointing errors	
9.	GMAP	Cartesian cylindrical plot.	

Appendix C –Pointing Measurement - Taking a benchmark 13 dataset.

The TO maybe asked to take a measurement of the pointmap by taking a benchmark13 data set
The procedures are as follows:

1. GO Zenith, Stop the TCS, and do an APE.Set.PMAC

2. Start tracking, peak up on a zenith star, and do a pt.save
   Leave the off-axis mirror (smokey) in the IN position.

3. On MCC2, go to the Pointing tab

   - Set **Path** to /home/tcs3/data/tpoint/benchmark
   - Set **Filename** to YYMMDD-inst.date, where 'inst' indicates what instrument in the observing MIM position.
     - Example for spex on 2017-03-24: **170324-spex.dat**
     - Example for ishell on 2017-03-26: **170326-ishell.dat**
   - Set **Pattern** to 'Benchmark13'
   - Ignore **Separation**, and **Caption** inputs.

4. Start collecting data:

   1. Press **Open File** button to start.
   2. Press "**Next & Slew**" to slew to the 1st star.
   3. Repeat the following steps for all stars:
      - After the slew, put star on cross hairs.
      - Press the "**Add Star**" button.

5. Send an email to denault@hawaii.edu saying the benchmark was successful taken (or not).

1

Determining and Using New Encoder Ratios

This document describes the procedures to measure the incremental encoder ratio. And describes the steps to use the encoder ratio in the TCS.

Introduction

The incremental encoder ratio can be measured using the APE encoders as a reference. We move the TCS3 and record the APE postion and number of counts moved. This data is then used to determine the encoder ratios. This procdure can easily be done by hand. However, we have written a program to help with data collection, calculation, and data storage. This program is called encoder_util. Collecting this data can be done by the TO or Daycrew. Using the new encoder values require modification of the tcs3 source code, this is done by the tcs3 programmer.

The data collected for determining encoder ratios should be located in the directory /home/tcs3/data/encoders/.

Once new encoder ratio have been determined, the these value must be put into the TCS software. This would be done the by TCS programmer.

1. Using encoder_util

The encoder_util program guides you though the data collection, calculation, and data archival steps. The program works by asking you to do a series of 9 moves. At the end of each move, the APE and incremental counts are obtains. And the end, the encoder ratios for each move and an average is presented. Note the destination of the moves presented by the cal_encoder_ratio program are suggestions, you can use this program using your own destination points.

To run the program:

1. Position the telescope at Zenith and reinitize the TCS incremental encoder with the APEs: Do an APE.Set.PMAC from mcc1 in idle mode.
2. Open an xterm on t1, or ssh to t1 as to (`>ssh t1 -l to`).
3. cd to data/encoders:
    a. `> cd ~/data/encoders`
4. Type `encoder_util`
5. Perform the following commands:
    a. r.get – follow the on screen commands to collect the data. Lower the slew rate to 1400 as/s.
    b. r.show – view the data and ratios from the xterm.
    c. r.save – save the data to a file.

2. Programmer's Notes

The APE-Apos values also give you a good indication if the current encoder ratios are too larger or small.

A negative slope means ration are too small (new ratios should be larger).
A positive slope means the ration are too big (new ratios should be smaller).

The source code for the encoder_util is located in /home/tcs3/src/tcs3/encoder_util.
For tcs3, a link in ~/bin points to ~/src/tcs3/encoder_util/encoder_util.
For to, the execuable is installed in /home/to/bin.

To use the new encoder ratios, you will need to modifiy the TCS3 main code, recompile, and install the new version.

The TCS3 Main code is located in /home/tcs3/src/tcs3/main/VERSION.

The ./t3lib/t3_defines.h files contains the encoder ratio are a define, ie:

```
#define HA_DAS2CNT        (19.93064353)      // HA  arcsec to counts
#define HA_DCNT2AS        (1.0/HA_DAS2CNT)   //     counts to arcsec
#define DEC_DAS2CNT       (19.96953869)      // DEC arcsec to counts
#define DEC_DCNT2AS       (1.0/DEC_DAS2CNT)  //     counts to arcsec
```

You must modifiy theses values, recompile and re-install the tcs3. See the README.txt file in the main source directory.

The PMAC uses 20 cnt/as for some of its limits: velocity limit, acceleration limits, etc. There is no need to change these as long the as encoder ratios are about 20 cnt/sec.