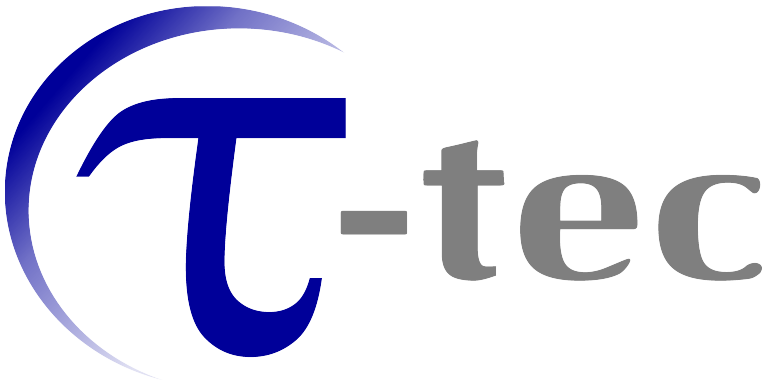
AsTelOS GUI
User Manual

Version 1.3-6

Document ID:

GUI_FW:AsTelOS-Manual

Revision 579 as of July 8, 2011 16:29:22



Revision history:

Date	Version	Changes
16.12.2009	1.0	initial revision (ms)
17.12.2009	1.1	spelling corrected (mr,ms)
22.02.2010	1.2	Stellarium Server (3.4, 6.1.3), Axes Offset (4.8), catalog searching (6.6), log files (7.4) (ms)
26.05.2010	1.2-2	new screenshots, Telescope 3D (4.3), Axes Positions (4.4), Cabinet (4.5), Target Editing (4.10), Target Options (4.11), general revision, PDF hyperlinks, layout (mr,ms)
07.07.2010	1.2-4	preferences (3), Axes Positions (3.6.2), Radar View (4.2), Tycho2, NGC/IC catalog (6.6.5, 6.6.6) (ms)
16.08.2010	1.3-0	Pointing Model Wizard (4.9.1), fit quality (4.9), measurement quality/distribution in radar view (4.2), Axes Offsets view (3.6.1) (ms)
15.09.2010	1.3-1	WDI (4.11) (ms)
04.10.2010	1.3-2	TLE data in Telescope Target view (4.10), TLE pass in radar view (4.2) (ms)
16.12.2010	1.3-4	Custom Catalog view (4.12), persistent Telescope Target view (4.10) (ms)
14.02.2011	1.3-5	camera support (3.1, 6.7, 4.13), Pointing Model Wizard (4.9.1) (ms)
30.04.2011	1.3-6	Heavens-Above (3.2.1, 6.6.7) and Sesame (3.2.2, 6.6.8) as catalogs (ms)

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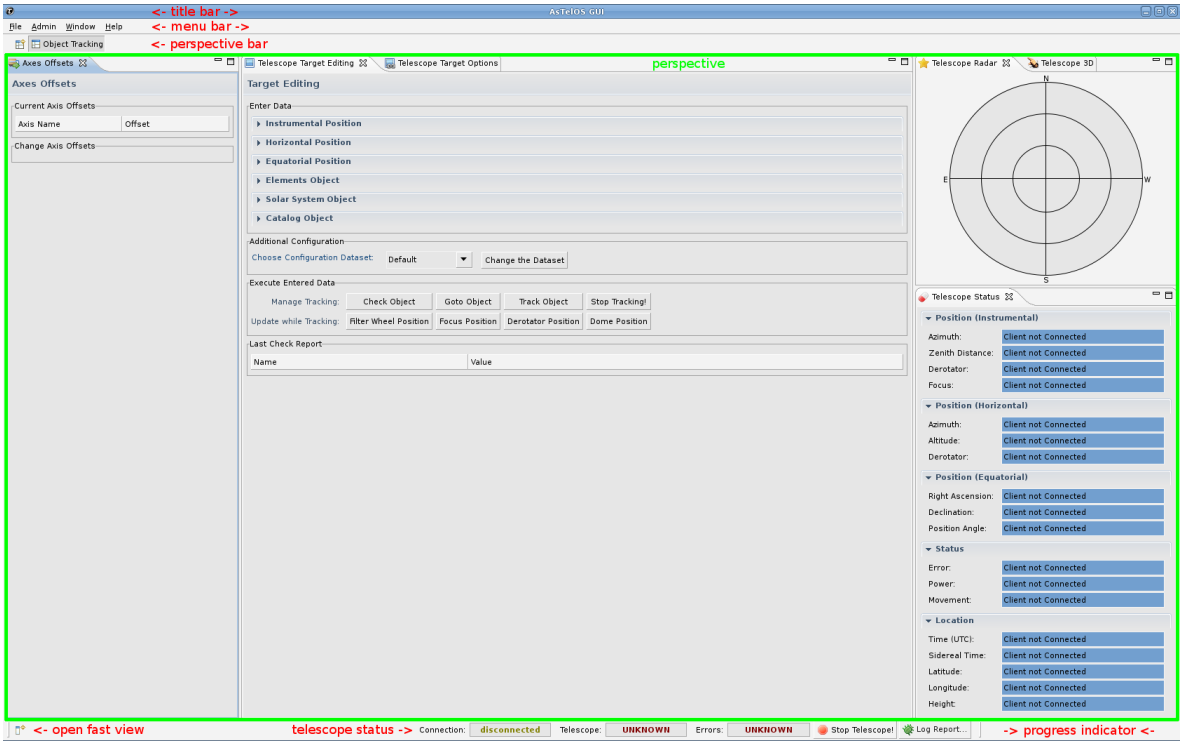
Document ID: `GUI_FW:AsTelOS-Manual`
Revision 579 as of July 8, 2011 16:29:22 by Mario Sämisch

`AsTelOS-Manual.lyx 579 2011-07-08 16:29:22Z saemisch`

Contents

1 Terminology

This product is based on Eclipse Rich-Client-Platform (RCP) technology[1]. The naming definitions are in accordance with the Eclipse-RCP. A short overview about the nomenclature also used throughout the manual is given here.



An Eclipse-RCP window can consist of the following components (from top to bottom – as seen above in the image):

'title bar' as the top row is known from other programs — it contains the name of the program (AsTelOS GUI).

'menu bar' provides access to different menu items:

- 'File'

  'Exit' exit AsTelOS GUI.

- 'Admin'

  'TPL Connection' Manually establish or abort the TPL[2] connection to the TSI[3] service. This interaction is only for administrative purposes and should not be used.
  Note: The automatic (re)connect ability (see section 6.1.2 on page 51) should be used by default.

  'Error Log...' Open the 'Error Log' view (see section 4.15 on page 46) that lists internally logged error events. As these errors often do not affect the user

[1] http://www.eclipse.org
[2] Telescope Protocol Language
[3] Telescope Software Interface

interaction, this menu entry is also for administrative purposes — unless otherwise noted. See to the explanation of the workbench for what a *view* is.

- 'Window'

  'Reset Perspective' Reset the perspective layout and the opened views to the last saved state, or, if it was not saved before, to the default state.

  'Save Perspective' Save the current layout and the opened views, overwriting the last saved or default state of this perspective. Be careful in doing so!

  'Close Perspective' Close the currently shown perspective. Any changes made in the layout will be lost.

  'Preferences...' Open the preferences dialog from where different program settings can be changed (see section 3 on page 10).

- 'Help'

  'About' Open the 'About' dialog with copyright information of the manufacturer (see section 2.3 on page 9).

'cool bar' contains draggable items:

'perspective bar' Shows the already opened perspectives and provides access to a dialog from where others can be opened (see also section 5.1 on page 47). See the explanation of the workbench for what a *perspective* is.

'workbench' is the main interaction area where the user can interact with views.

'perspective' A perspective defines a set of shown views and their locations.

'view' A view can be understood as a sub-window that concentrates GUI[4]-widgets for a specific purpose (e.g. display status, trigger action). Views are characterized by their tabs atop. By clicking (and holding) the tab they can be moved around and rearranged to modify the perspective.

'status line' offers a place e.g. to indicate the common state of AsTelOS GUI.

'fast view field' Show a dialog to open an available view that is floating above the workbench.

'telescope status' Present the condensed state of the telescope (see section 2.2 on page 8).

'progress indicator' The execution of an internal job is indicated within this area. Double-clicking into this area opens the 'Progress' view (see section 4.14 on page 46) that informs about running jobs.

Note: The term 'job' denotes in this document an internal structure to provide extended management functionality to concurrent processing tasks.

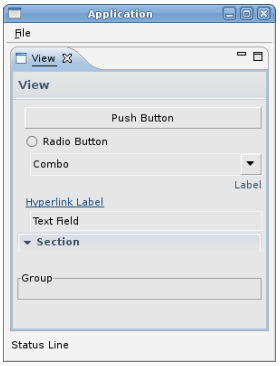
Other GUI terms — partly already mentioned above:

'dialog' is a modal window above the program window — probably blocking interaction with it.

'message box' is a modal window that shows an information or requests guidance by the user (e.g.through [YES], [NO], [CANCEL] buttons).

[4] graphical user interface

'widget' is a simple GUI element (as illustrated in the following image):



'push button' a simple button.

'radio button' a set of (mostly round) choices from which one can be chosen.

'combo box' an expandable list with textual choices. Sometimes the choice can by typed in directly.

'table' formats the presented data like a spreadsheet with rows for each data element and columns for the different data types.

'label' contains only text to explain the meaning of other input widgets.

'hyperlink label' extended version of a normal label, which triggers further action, when clicked (e.g. linking to a web page).

'text field' is an input field to enter textual information.

'section' is an expandable field (by clicking onto the tab) that contains other, thematically related widgets.

'group' is a bordered area that contains other, thematically related widgets.

Note: The GUI provides the look and feel of the operating system the software is running on. That's why the shown screen shots may differ from the real experience with AsTelOS GUI.

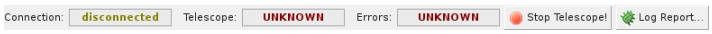
2 Generic Elements

2.1 Splash Screen

While starting up, AsTelOS GUI presents a splash screen that explains what is done and how far the start up process has come so far:

2.2 Telescope Status (Status Line)

An overview of the telescope status is shown in the status line:



The specific messages within the text fields are colored to allow a quick assessment of their severity:

green proper function — no user intervention needed.

yellow problem detected — user intervention advisable if the current state is not intended.

red severe problem detected — user intervention is necessary.

The status messages can be:

'Connection' status:

'established' (green) — TPL connection to the TSI service is up and running.

'disconnected' (yellow) — no connection is detected.

'Telescope' status:

'tracking' (green) — telescope is following the trajectory precisely (only if powered up — see 6.3 on page 54 about how to do that).

'slewing' (yellow) — telescope is in motion (only if powered up).

'stopped' (yellow) — telescope is not in motion (only if powered up).

'transiting' (yellow) — powering up/down in progress.

'shut down' (yellow) — telescope is powered off.

'blocking error' (red) — error that blocks the operation.

'emergency off' (red) — emergency off button pressed.

'local mode' (red) — no remote operations allowed.

'UNKNOWN' (red) — status could not be determined.

'Error' status:

'none' (green) — operational.

'INFO' (yellow) informative condition — not affecting the operation.

'WARNING' (yellow) critical condition — not (yet) disabling the telescope

'ERROR' (red) serious condition — disabling important parts of the telescope system.

'PANIC' (red) severe condition — blocking the whole telescope.

'no hardware' (red) — no telescope hardware found.

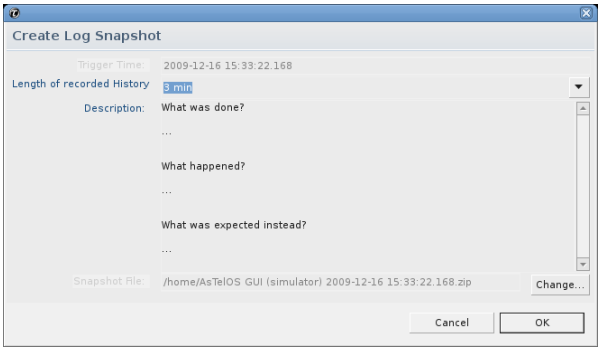
'no license' (red) — no valid TSI license data found.

'UNKNOWN' (red) — status could not be determined.

Two buttons are available:

Stop Telescope! Clicking this button stops the telescope quickly in an ordered manner. However, this function does not replace the hardware emergency stop buttons on the telescope, as it should not be relied on in critical or dangerous situations!

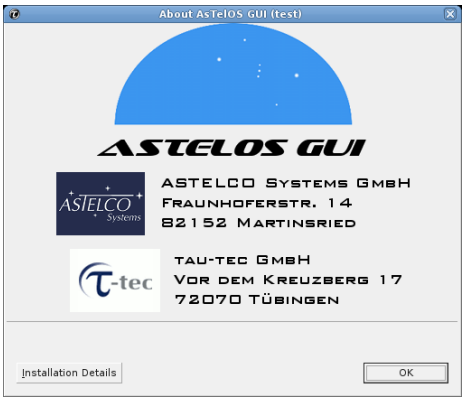
Log Report... A dialog is shown if the log report button is clicked on:



With this dialog, a just experienced problem, error or crash can be easily reported. For that purpose, a description of the last actions and the occurred problem can be entered (see section 7.1 on page 63) as well as a time span for the included snapshot from the log files. The time span is relative to the time the dialog was opened, so the dialog can be filled in without hurry. The created snapshot file can be found under the displayed path — which is also changeable.

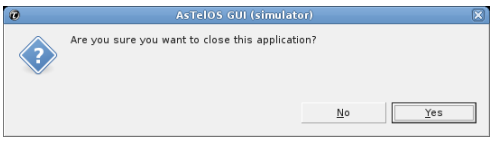
2.3 About

The 'About AsTelOS GUI' dialog provides the legal information about the telescope manufacturing company and the software developing company:



2.4 Exit

If AsTelOS GUI should be shut down, a dialog is shown to confirm that the user really intends to do so:

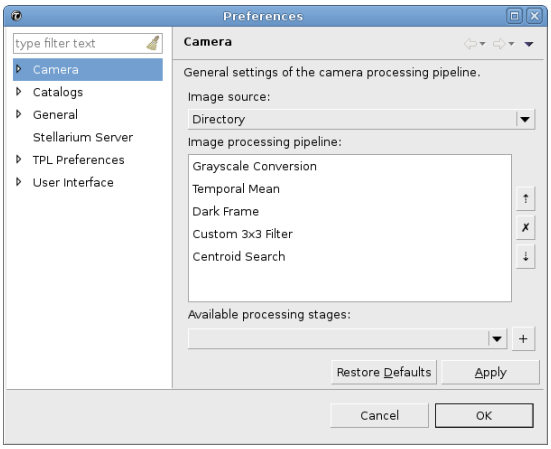


This additional step prevents an unintended interruption of operation with AsTelOS GUI.

3 Preferences

The 'Preferences' dialog provides a generic access to change settings made available by different AsTelOS GUI parts. Sub-pages can be selected within the tree presented in the left section of the dialog. The following subsections that are ordered according to the settings tree will describe these settings pages in more detail.

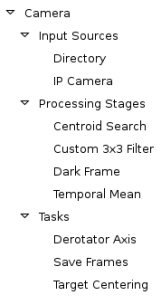
Given settings can be restored to their former value by clicking the 'Restore Defaults' buttons or 'Cancel'. 'OK' and 'Apply' save them with resp. without closing the preferences dialog:



3.1 Camera

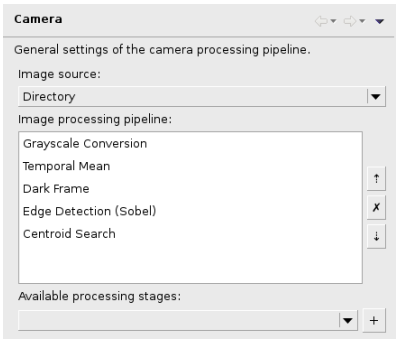
3.1.1 Structure

The camera settings provide numerous settings that are grouped into sub—section to provide more structured overview. As the components are highly modularized the following image of a specific structure can only be taken as an example:



3.1.2 Page: Camera

The topmost camera preference page contains central information what camera input is used and how the camera process pipeline is build up:



Settings:

Image Source The currently used input source can be selected with the drop—down list. The specific settings of the sources are described in the next section.

Image processing pipeline The stages of the processing pipeline are visible in the middle. The selected stage can be moved up (towards image source), removed or moved down (towards end of the pipeline) with the buttons at the right.

Available processing stages A new stages can be added to the processing pipeline by selection from the drop—down list below the pipeline and clicking the button to the right.

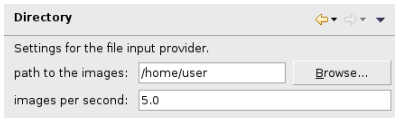
Note: Every state could be added only once. The processing result and the speed depends highly on what, how much stages are added, their order and setting. See section 6.7 on page 60 about insight in altering the processing pipeline.

3.1.3 Section: Input Sources

The main preference page of the input sources section leads to the preference pages of the specific source.

It is advised that the output frame rate is set to a frame rate barely above the processing speed of the whole pipeline. The pipeline is not overflown but images are ignored if the pipeline is already filled.

Directory The images of a directory are loaded and presented as input for the pipeline. This input source can be used to fine-tune the processing pipeline.



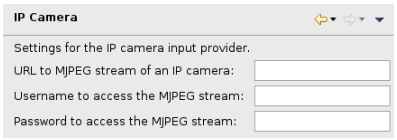
Settings:

Path to the images contains the path to an existing directory. All images (bmp, png, jpg, gif) are successively loaded as input.

Note: The images should be the same size otherwise the result might be unpredictable behavior.

images per second the number of images loaded per second and delivered to the pipeline.

IP Camera IP—Cameras that provide a MJPEG stream can be used to serve as input source.



Settings:

URL to MJPEG stream the URL with protocol, server name, port and path to the MJPEG stream of the camera.

Note: Such a MJPEG stream might be accessible even if the camera does not provide a direct link to it.

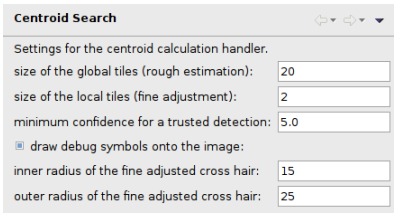
Username User name for the HTTP authentication if the stream is protected for anonymous access.

Password Password for the HTTP authentication if the stream is protected for anonymous access.

3.1.4 Section Processing Stages

The main preference page of the processing stages section leads to the preference pages of the specific stage.

Centroid Search Settings for the processing stage that searches for a bright target. This search happens in two stages. First the brightest area of the image is guessed. Second the (for brightness) weighted mean is calculated.



Settings:

size of global tiles The size to search for the brightest area is restricted with this setting.

Note: The used area is twice as large as the given value here.

size of local tiles The size of the points used to calculate the final position within the area found before.

minimum confidence for a trusted detection The confidence threshold for which a target can be trusted as a real object.

Note: This value is heavily depending on the processing pipeline and the input

draw debug symbols Several debug symbols will be added to the output image:

- The brightest and second brightest tile is shown.

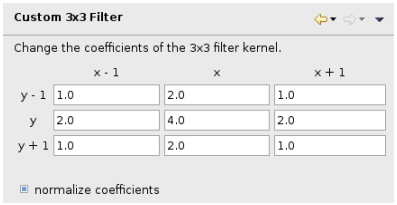
- The cross hair pointing to the final position is drawn.
- The confidence of the detected target is shown to the upper right of the final position.
- A lock-circle around the final position as well as a dot in the upper left corner of the image is drawn if the detected target was more powerful than the given confidence.

Note: Activating this option will render any further operations on the image useless.

inner radius of cross hair (debug setting) The cross hair can be set to leave the inner area free with this setting.

outer radius of cross hair (debug setting) The maximum length of the cross hair that is drawn from the final position.

Custom 3x3 Filter To apply a filter with custom coefficients this filter handler could be used in the processing pipeline.



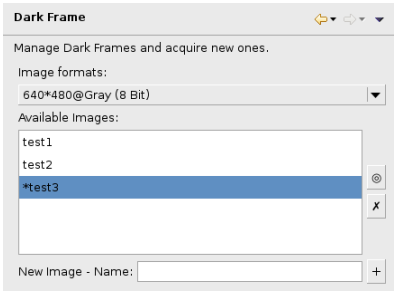
Settings:

coefficients (x+/-1,y+/-1) The filter values for any (x,y) pixel and their nearest neighbors.

Note: Resulting brightness values outside minimal (black) or maximal (white) are limited to their extreme values.

normalize coefficients will scale the coefficients that the sum of all equals one. This mean the mean brightness is not changed.

Dark Frame To subtract static brightness influencing the image this processing stage can be used. Using this stage helps a lot in centroid detecting!



Available Settings and Inputs:

Image Formats The image format for which dark frames are available. The format contains of the width, height and type of the image.

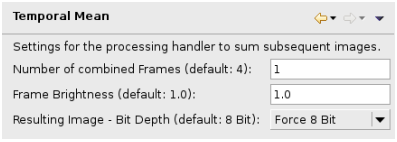
Available Images The dark images that are available for the selected format. The name is prepended with an asterisk if the image is the default one for the format.

Note: The buttons to the left of the list are used to set the selected image as the new default (bullseye) and to remove the selected image ('x'). Removing a file is not undoable!

New Image — Name To add the last image processed through the handler as dark frame a name must to entered in the provided text field and the plus—button has to be pressed.

Note: If the name starts with an asterisk the new dark image is also the new default one.

Temporal Mean Reducing the effect of noise contained within the image due to calculating a temporal average.



Available Settings:

Number of combined Frames The specified number of frames are combined to a final image.

Note: The resulting frames per second are decimated equivalent to the number of used used for combining.

Frame Brightness The resulting frame can be lightened up or darkened as this brightness factor is specified.

Resulting Image Bit Depth Sets how the bit depth of every color channel for output' images is determined.

Force 8 Bit The bit depth is always 8 bit.

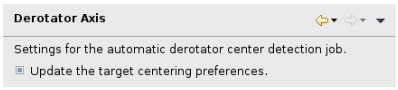
Force 16 Bit The bit depth is always 16 bit.

No Change The bit depth is the same as of the input image.

3.1.5 Section: Tasks

The main preference page of the tasks section leads to the preference pages of the specific executable task.

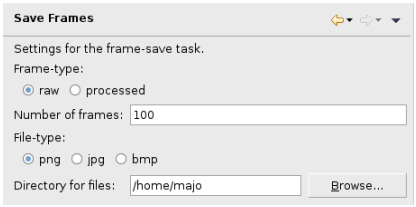
Derotator Axis The derotator at the currently active port is moved one time around to gather position of an star in the image field. This is used to calculate the rotation center.



Settings:

Update the target centering preferences If the rotation center could be calculated successfully the preferences of the target centering job (see next paragraph) can be updated with this information.

Save Frames To save a number of frame some settings can be customized.



Settings:

Frame type Using the raw input the saved imaged are not changed and can be used for replay ('Directory' as input source). The processed version is the result from the processing pipeline and can be used e.g. for documentary purposes.

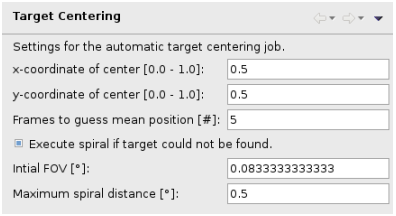
Number of frames The number of frames that are captured by one capture task.

Note: The capture task can be aborted!

File type The type the image is saved as. These can be png (lossless compression), jpg (compression with 100% quality) and bmp (uncompressed)—files.

Directory for files The directory where the data are saved to. The files are stored to a subdirectory named after the Unix—time (milliseconds since midnight, 01.01.1970 UT) of the start time. The files itself are named with increasing numbers. Additionally the meta data of every image is stored as property files with the same name, but txt as extension.

Target Centering This job uses main telescope axis offset to position a target in the center of the image.



Settings:

x-coordinate of target The relative coordinate where the image center on the x-axis is situated.

Note: Relative coordinates means that 0.0 is the left border and 1.0 right one.

y-coordinate of target The relative coordinate where the image center on the y-axis is situated.

Note: Relative coordinates means that 0.0 is the top border and 1.0 bottom.

Frames to guess mean position The number of frames that are used to guess a mean position and the deviation from it.

Execute spiral if target could not be found. If no target was found an spiral with the offsets could be executed to search for a target nearby.

Note: The following options are not available if this check box is disabled.

Initial FOV The initial FOV is used to set the closeness of the spiral rounds.

Note: Entering a too large value will result in gaps between the spiral round whereas at too small value will only result in longer execution time.

Maximum spiral distance The maximum distance from the initial center is set here. The number of rounds to be executed with the FOV parameter is automatically determined.

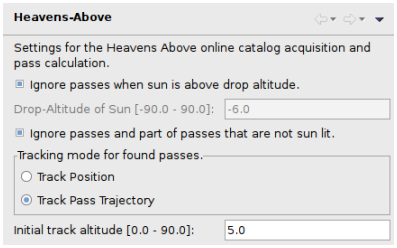
Note: Entering a large value will result in increased probability of identifying the wrong target (decreased specificity) whereas a small value only decreases the probability of catching a target at all (decreased sensitivity).

3.2 Catalogs

The main catalog preference page contains no configuration settings. Catalogs that need configuration will provide sub-pages below this node.

3.2.1 Heavens-Above

Several settings can be changed regarding the acquisition of orbit data for satellites and calculation of their passes.



The settings are:

Ignore passes when sun is above drop altitude. Enables the next input field. Passes are interpreted as invisible if the sun is above the specified altitude.

Drop Altitude of the sun. The altitude of the sun as indicator for a too bright sky. Negative values are interpreted as beyond the horizon.

Ignore passes and part of passes that are not sunlit. When checked, parts of passes are ignored in the calculation of the duration and set/rise times if the satellite is not sunlit. Passes that are completely shadowed are ignored at all.

Tracking mode for found passes explained in the 'Two Line Elements' section of the 'Telescope Target Editing' view (see section 4.10 on page 37):

Track Position the telescope will slew and track the initial position.

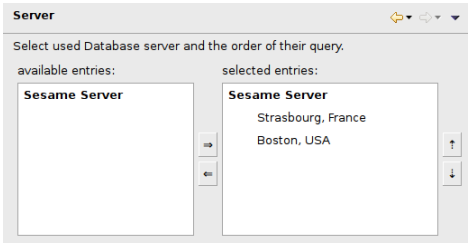
Track Pass Trajectory the telescope will wait at the initial position but follow the satellite on its pass trajectory.

Initial track altitude. The telescope tracks/waits at the position where the satellite pass reaches the specified altitude the first time.

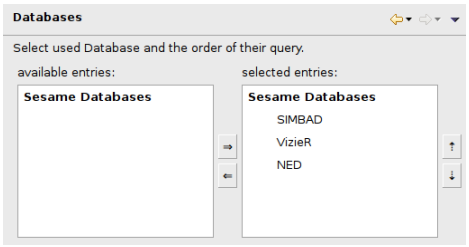
3.2.2 Sesame

The main preference page contains no options but two sub-pages allow the configuration of the sesame catalog.

Sesame server The primary and additional backup sesame servers (in the order they should be used in case of a server failure) can be setup here:

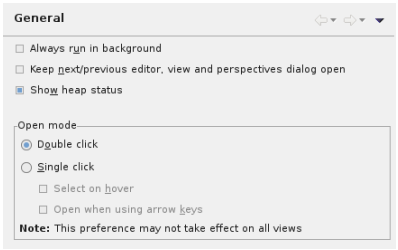


Sesame Database Sesame can retrieve data from different databases: NED, SIMBAD and VizieR. Which of these databases should be used and in what order can be setup here:



3.3 General

Settings on the 'General' node are inherited from the Eclipse RCP framework, so not all may be used by AsTelOS GUI.



Some of the settings are of special interest:

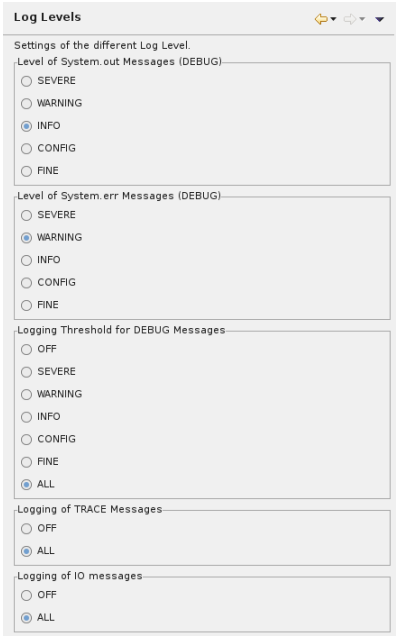
Always run in background If this check box is selected, the eclipse job dialogs are hidden — This check box is also shown in the eclipse job dialogs. Unselect this to show the dialogs again.

Show heap status Selecting this check box will show an UI element (see below) that informs about the currently used and the maximum available heap memory:

Note: Clicking the trash button forces the execution of a garbage collection — doing so is not advised!

3.3.1 Log Levels

Settings from the 'Log Levels' node apply to the internal logging. Either these are the levels of the generated messages or the minimum threshold for messages to be logged.



Available settings are:

Message Level: System.out Define the log level that will be assigned to messages from the System.out channel, when they are output to the DEBUG log file.

Message Level: System.err Define the log level that will be assigned to messages from the System.err channel, when they are output to the DEBUG log file.

Logging Threshold: DEBUG Define the threshold for the DEBUG output (inclusive).

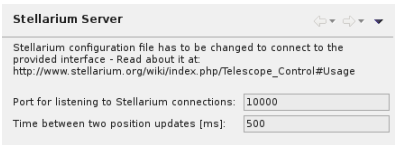
Logging Threshold: TRACE Selects if TRACE message (for entering and leaving internal methods — if supported) should be logged or not.

Logging Threshold: IO Selects if IO messages (between AsTelOS GUI and the connected TSI service) should be logged or not.

Note: The default values make sure that as many information as possible are logged to ease later debugging. Do not alter these settings if you are not sure what to do!

3.4 Stellarium Server

AsTelOS GUI includes a server that provides access for Stellarium[5] clients. The default settings may be altered in case of conflicts with other running programs. In this case, the configuration example for Stellarium in section 6.1.3 on page 52 has to be adapted accordingly.



[5] Stellarium website: http://stellarium.org

Available settings are:

listening port The port the Stellarium server listens on (default: 10000).

update time The time between position updates that the Stellarium server sends to the connected clients. The same interval applies to the checking for new object coordinates received from the Stellarium clients.

3.5 TPL Preferences

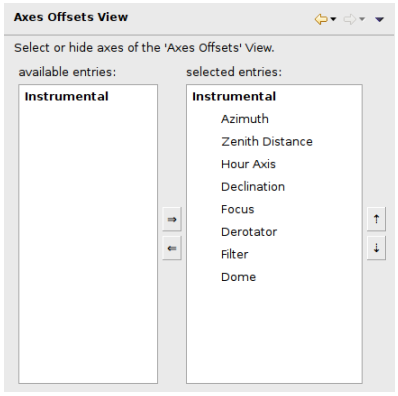
Using these preference pages is explained within section 6.1.1 and 6.1.2 on page 51.

3.6 User Interface

Elements of the user interface that can be customized are listed under this preference item.

3.6.1 Axes Offsets View

To show only the axes in the 'Axes Offsets' view (section 4.8) that are of interest, others can be hidden within this preference page:



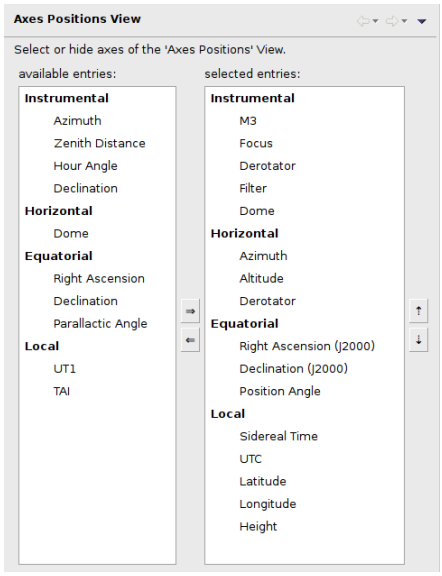
The different axes are sorted by the category of their coordinate system. In the left column the hidden axes and in the right one the shown axes can be found.

To show or hide one or more axes they have to be selected in the appropriate column and the upper (show) or lower (hide) button between the columns has to be clicked. If a bold category descriptor is selected all axes of this category are shown/hidden regardless of a selection made to other axes of the same category.

Shown axes of a category can be sorted in another order with selecting them and clicking one of the two buttons at the at the right border.

3.6.2 Axes Positions View

To show only the axes in the 'Axes Positions' view (section 4.4) that are of interest, others can be hidden within this preference page:



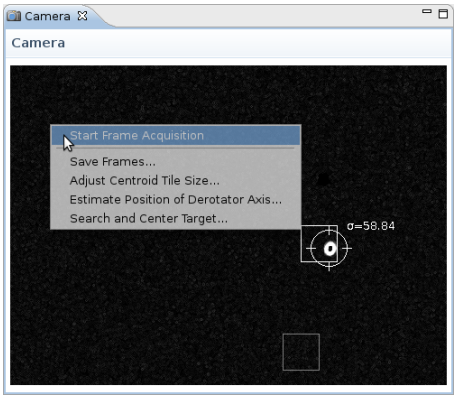
The steps to hide or show one or more specific axes or categories are the same as described in section 3.6.1.

3.6.3 Camera View

To watch the captured camera frames or the result of the camera pipeline the 'Camera View' can be used. What is shown can be set in the preferences dialog, described in section 3.1 on page 10.

The example image of the camera pipeline shows the processed camera frame overlaid with debugging information from the 'Centroid Search' processing stage (see section 6.7 on page 60):

To control some aspects of the camera pipeline the camera view provides a context menu:



The entries of the context menu:

Start/Stop Frame Acquisition Checking this entry the camera pipeline will start or stop capturing frames.

Note: Even if capturing is stopped a job accessing the camera pipeline can trigger capturing frames.

Save Frames... Start a camera job that saves the next frames. The number is specified in the camera preferences.

Adjust Centroid Tile Size... Start a camera job that will determine a suitable size of tiles for the centroid stage.

Note: A target must be visible in the camera frame and the 'Centroid Search' processing stage must be added to the pipeline.

Estimate Position of Derotator Axis... Start a camera job that estimates the geometric center of the derotator on the camera chip.

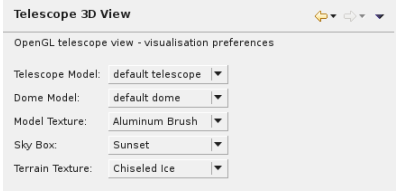
Note: A target must be visible in the camera frame, the 'Centroid Search' processing stage must be added to the pipeline and a derotator must be attached to the port that is currently in use.

Search and Center Target... Start a camera job that searches a target with spiraling the offsets (if configured in that way) and center it in the position that is specified in the preferences (default: center of image).

Note: A target must be visible in the camera frame, or near to the current fov — depending on the given preferences. Also the 'Centroid Search' processing stage must be added to the pipeline.

3.6.4 Telescope 3D View

Several settings are provided to alter the displayed scene of the 'Telescope 3D' view (see section 4.3 on page 24).



Available settings are:

Telescope Model: The 3D model of the displayed telescope.

Dome Model: The 3D model of the displayed telescope dome.

Note: The dome model is only displayed if a dome is available.

Model Texture: The texture that is applied to the surfaces of the model (both telescope and dome).

Sky Box: A sky box includes wall textures with lighting information for the whole scene.

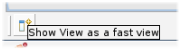
Terrain Texture: The texture that is applied to the floor.

4 Views

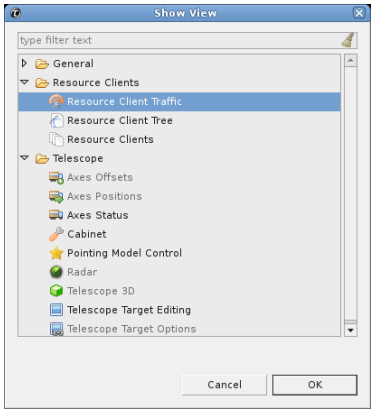
4.1 Handling Views

The main way to access a view is to open a perspective that contains it (see section 5 on page 47). Another generic way to open a view is to open it as a fast view (see the image in section 1 on page 5).

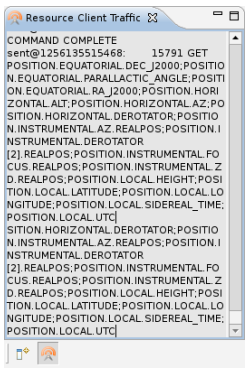
Clicking the fast view button



opens the fast view dialog:



Open a view from a category as a fast view by selecting it and clicking 'OK':

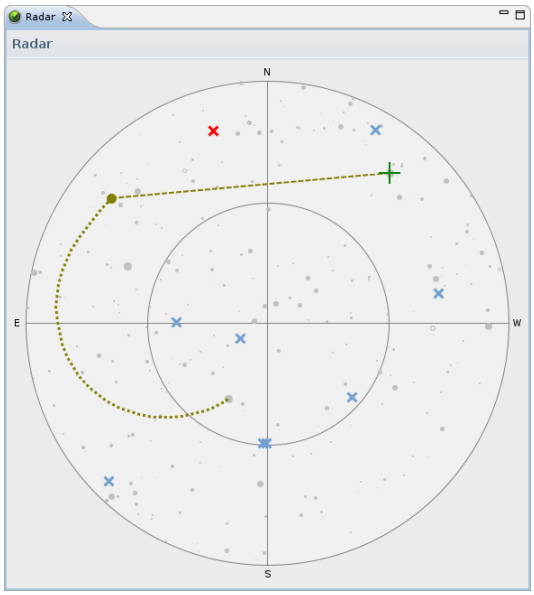


A fast view makes the view floating above the currently opened perspective and shows its icon near the fast view button. The view can be moved around and added to the currently seen perspective by dropping it onto or between the other views.

Note: Views also may be opened through other interactions — even by clicking a menu item. Because AsTelOS GUI is based on the powerful Eclipse-RCP technology, doing these things is very flexible and couldn't be explained in every detail: feel free to explore it.

4.2 Radar

The 'Radar' view shows the current telescope pointing direction. The sky can be interpreted as looking up to the zenith, which is located in the middle of the view. The horizon is at the outer ring and the cardinal directions (north, east, south, west) are marked on the edge.



A context menu is available that can be used to interact with the view. It is listing actions for objects that are near the position of the executed right click together with some generic actions.

These elements are visualised:

Telescope Pointing The current pointing of the telescope is shown with a large filled blob. The color of this dot reflect the current tracking state and is the same as in the 'Telescope' field of the status line (see section 2.2).

Telescope Trajectory A custom telescope trajectory e.g. to follow an object can be drawn to visualise this path. It is mainly used for showing the passes of satellites specified by their 'Two Line Elements' (see section 4.10.

Pointing History The last telescope pointings are shown as a dotted line in the same color as the pointing blob.

Telescope Target Whenever the visibility of an object is checked in the 'Telescope Target Editing' view and the target found to be above the horizon an upright cross is displayed at the initial target position. It is colored as if the telescope is in the tracking state.
Additionally a dashed line is draw between the current pointing and this target marker in the color for the slewing state.

Pointing Model Measurements Taken measurements will be displayed with small “x”s. These can be shown and also hidden again through the context menu of this view. This menu also reveals the name of a nearby measurement — if one was given.

Note: The specific coloring depends on the operating system settings. The only exception are red colored measurements visualizing their bad fit: $> 3 \cdot \sigma$ deviation from the mean error of the fit distribution.

Tycho2 Stars Stars up to the fifth magnitude are show with filled blobs of different sizes. Within the context menu it can be selected that the properties of nearby stars are loaded into a new ’Telescope Target Editing’ view and or that the telescope immediately starts slewing to it.

Note: Drawing the stars is optional and depends on the availability of the Tycho2 catalog plug-in.

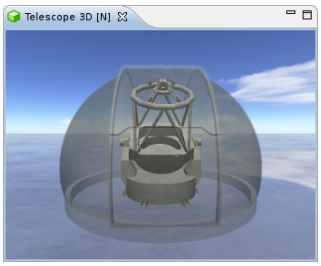
NGC Objects NGC/IC objects up to the fifth magnitude are shown with outlined blobs of different sizes. They can be handled the same way as the Tycho2 stars.

Note: Drawing these objects is optional and depends on the availability of the NGC catalog plug-in.

4.3 Telescope 3D

Another representation of the current telescope pointing direction in the horizontal coordinate system is provided by the ’Telescope 3D’ view.

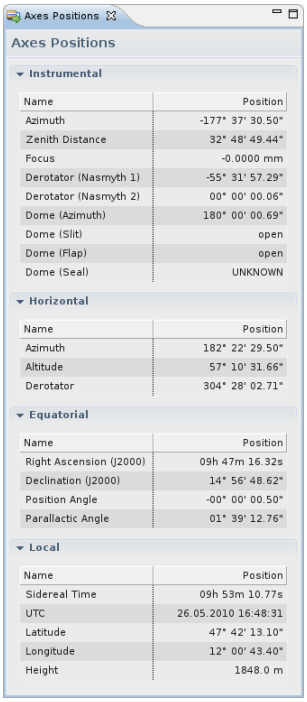
A telescope model visualizes the azimuth and altitude pointing. If a dome is available a transparent model will be shown around the telescope. It visualizes the current azimuth of the telescope and the open/close state of the shutter:



The initial viewing direction is toward the north. After changing the default direction, the current one is shown in the title of the view. By right-clicking into the view, holding down the button and moving the cursor, the viewing direction can be altered.

4.4 Axes Positions

The ’Axes Positions’ view provides more sophisticated information about the position of the telescope axes and the pointing direction of the telescope. The shown axes can be configured as described in section 3.6.2.



The available sections contain:

'Instrumental' position of the telescope axes in instrumental (uncorrected) coordinates.

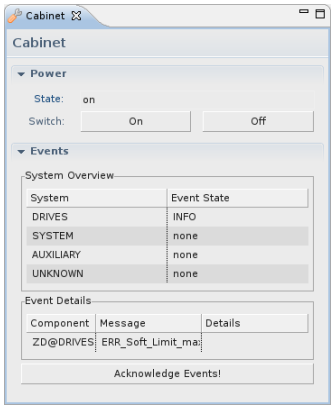
'Horizontal' the current telescope pointing direction in the horizontal coordinate system. The pointing model and refraction are taken into account.

'Equatorial' the current telescope pointing direction in the J2000.0 equatorial coordinate system.

'Local' current sidereal time, UTC[6] and telescope site location as configured or reported from the telescope system (e.g. from a connected GPS[7] device).

4.5 Cabinet

With the 'Cabinet' view (referring to the control cabinet of the telescope system), reported errors can be investigated and the power of the telescope can be switched on and off:



[6] Universal Time Coordinated
[7] Global Positioning System

It consists of two sections:

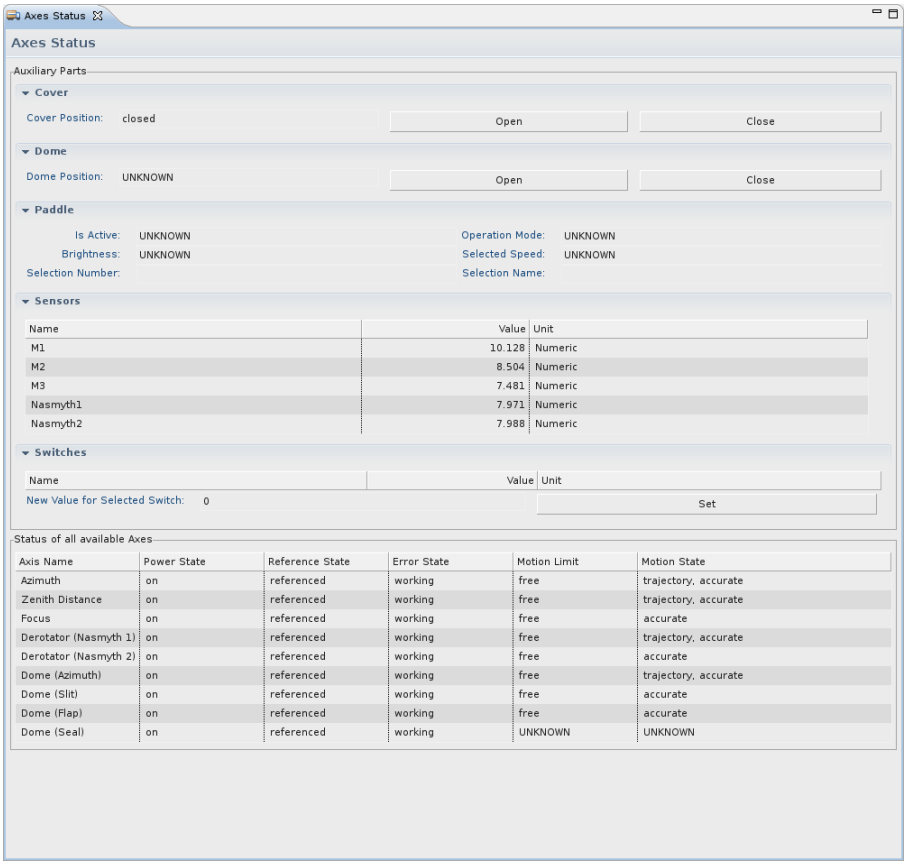
'Telescope Power' shows the current power state ('off', 'transitioning', 'on'). With the provided buttons the telescope power can be changed to the desired state.

'Telescope Errors' gives an overview over the telescope systems (Drives, System, Auxiliary, Unknown) and their event state (Info, Warning, Error, Panic). It further lists all the reported error messages with the involved component, event message and an optional description.

Note: 'Acknowledge and Clear' the reported errors only, if they do not imply a severe problem with the telescope. Especially, if the same severe error rises more often, the telescope may be damaged by acknowledging the error again and again.

4.6 Axes Status

The 'Axes Status' view provides an overview and basic interaction with the available instrumental axes.



For thematic separation there are two groups:

'Auxiliary Parts' contains auxiliary axes that partly provide buttons to change their state. The sections are:

'Cover' shows the current position of the mirror cover and open/close it manually.

'Dome' shows the current position of the dome enclosure and open/close it manually.

'Paddle' shows the current state and settings done at the paddle[8]. This includes:

'Is Active' reports the state of the paddle ('enabled', 'disabled').

'Operation Mode' reports the external mode of the paddle ('enabled', 'disabled').

'Brightness' reports the button backlight brightness of the paddle. This varies between 0 and 1.

'Selected Speed' reports the selected speed setting of the speed rotary knob. This varies between 0 and 1.

'Selection Number' reports the paddle axis selection number.

'Selection Name' reports a description of the axis selection number above.

'Sensors' The table contains the available sensors with their specific name, current value and their associated unit.

'Switches' A switch is similar to a sensor, but can be set to a desired value.

'Status of all available Axes' show a detailed status of the available telescope axes. The columns contain information about:

'Axis Name' with the name of the axis.

'Power State' shows the current power situation of the axis. Possible values are:

'off' The axis is not powered and therefore cannot move.

'transitioning' The power state for the axis is changing.

'on' The axis is powered up and theoretically movable (see the other states).

'Reference State' shows the state of the referencing[9] for each axis. Possible values are:

'not referenced' The axis has no knowledge about its absolute position.

'referencing' The axis is trying to find a reference mark.

'referenced' The axis has found a reference mark and has therefore precise information about its absolute position.

'Error State' shows the reported error of each axis. Possible values are:

'working' The axis is fully operational.

'ERROR' The error state is followed by a raw error code.

'Motion Limit' shows if the axis is constrained in their motion. Possible values are:

'free' The axis is fully operational.

'LIMITED' The limited state is followed by a raw error code.

'Motion State' shows the reported motion flags for each axis. These flags are:

'stopped' The axis is not in motion.

'move' The axis is moving.

[8] The paddle is a manual control device directly connected to the telescope. It allows moving the telescope axes e.g. for centering objects in the eye piece. It might not be available on every telescope.

[9] index or zero-point search

'trajectory' The axis is executing a trajectory.

'accurate' The executed trajectory is followed with high precision.

'BLOCKED' The axis cannot move.

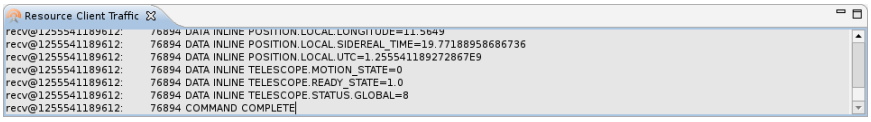
'AT LIMIT' The axis reached its soft limit and is therefore stopped.

Note: There may be more than one flag displayed — but some combinations are not occurring (e.g. 'stopped' and 'move').

Note: Because only the axes and parts that are available at the telescope will be shown, not all rows in the status table and sections of the 'Auxiliary Parts' group may be visible.

4.7 Resource Client Traffic

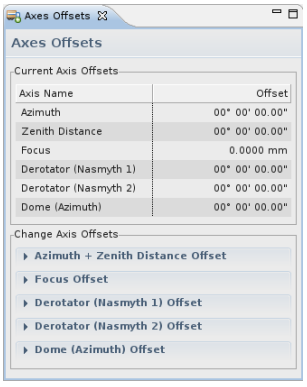
The 'Resource Client Traffic' view allows the inspection of the data-flow on the TPL connection to the TSI service. As this provides information on a very technical level, it is mainly for monitoring reasons and not further explained.



Note: This traffic messages as well as more debug information is logged by AsTelOS GUI (see section 7.4 on page 64).

4.8 Axes Offsets

The 'Axes Offsets' view displays all available axes and presents their current offsets within the table at the top. They can be altered by entering new offsets directly into the table or with the panels underneath:



The 'Change Axis Offsets' section is able to present two panel types to input new offsets:

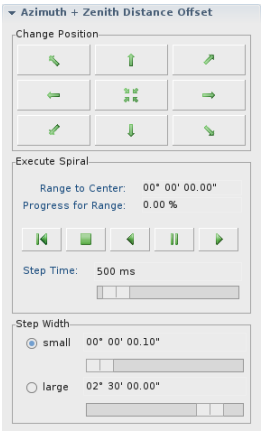
Main Axes section controls two axes: the first main axis is e.g. Azimuth or Right Ascension and the second main axis is e.g. Zenith Distance or Declination. To change the axis offsets manually a 3 by 3 button grid is provided where the first main axis is linked to the horizontal buttons and the second axis to the vertical ones. Diagonally arranged buttons

(at the edges of the 3 by 3 grid) change both axes. The middle button resets both offsets back to zero.
To scan the area around the current position, the offsets can be changed automatically in a 'spiral' pattern. With the provided buttons the spiral can be:

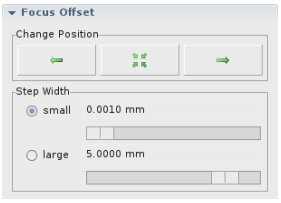
- stopped and return to the previous offsets
- stopped without changing the current offsets
- rewind with decreasing distance to the center (if the spiral was already executing)
- paused (clicking again will proceed with spiraling)
- started with increasing distance to the center

The minimal interval between two spiral steps can be changed with the step time field. The distance between two consecutive spiral rounds can be changed using the step width controls — e.g. matching the field of view of an used eyepiece or camera.

Note: The step time of an executed spiral is updated immediately, but the step width will only be updated, if the spiral is freshly started.



Auxiliary Axis contains only one axis. For these the offset can be decreased (left), reset (middle) and increased (right).

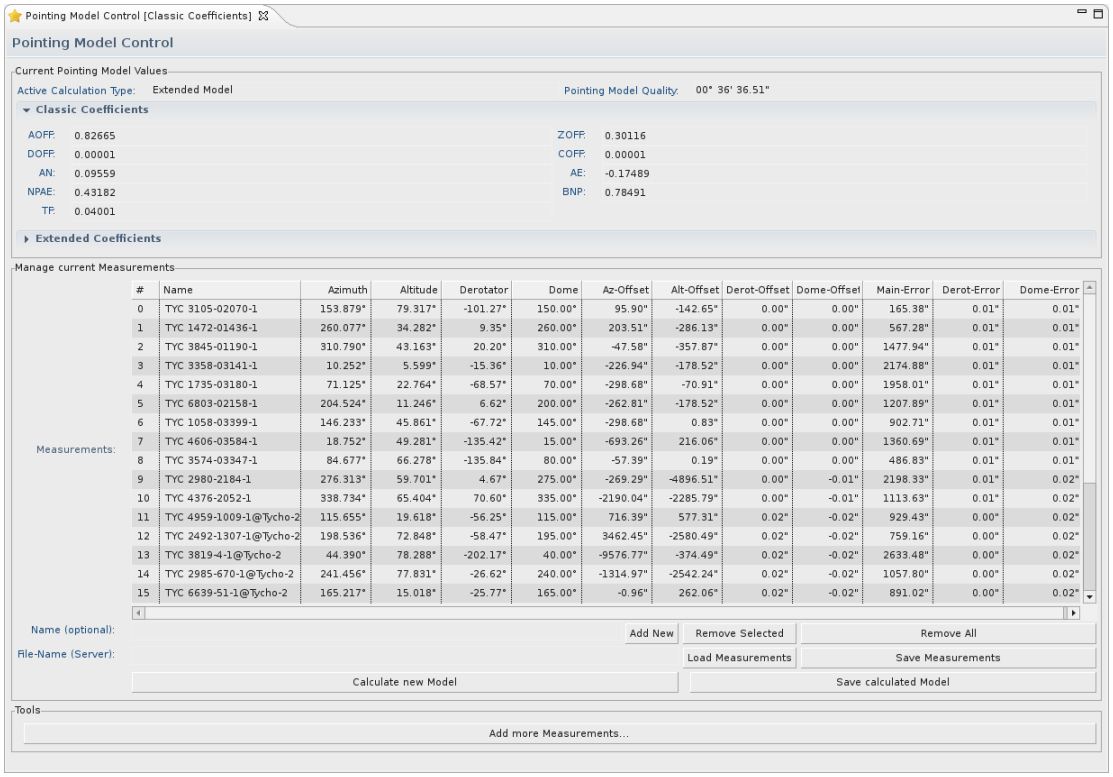


To provide a more flexible way of changing the offset, two step widths (small and large) can be prepared for each section. Selecting them is possible in a static way just by choosing the appropriate radio button. The step width can also be selected by pressing the Ctrl-Key (small step) or the Alt-Key (large step) — releasing the keys will restore the previous static selection.

Note: Altering the offsets applies directly to the instrumental axis. By changing them too far the axis can reach soft limits — that will trigger an information message.

4.9 Pointing Model Control

The 'Pointing Model Control' view helps making a pointing model or improve an existing one by adding more measurements.



The two groups separate the measurements[10] from the coefficients calculated with the help of the measurements. The groups are:

'Current Pointing Model Values' with the sections (coefficients are given in degree):

'Classic Coefficients' with 9 correction terms. This model is meant to be used for smaller telescopes or for a first, rough model.

AOFF azimuth offset.

ZOFF zenith distance offset.

DOFF derotator offset.

COFF astrodome offset.

AN tilt of azimuth axis toward north.

AE tilt of azimuth axis toward east.

NPAE perpendicularity error of azimuth and zenith distance axis.

BNP perpendicularity error of optical and zenith distance axis.

TF sagging of the tube.

'Extended Coefficients' with 25 correction terms. This model should be used for larger telescope or to improve the pointing precision.

AOFF azimuth offset.

ZOFF zenith distance offset.

DOFF derotator offset.

[10] Measurement as offset between the instrumental position of a sky object to the calculated theoretical position.

COFF astrodome offset.

AAN tilt of azimuth axis toward north (azimuth part).

ZAN tilt of azimuth axis toward north (zenith distance part).

AAE tilt of azimuth axis toward east (azimuth part).

ZAE tilt of azimuth axis toward east (zenith distance part).

NPAE perpendicularity error of azimuth and zenith distance axis.

BNP perpendicularity error of optical and zenith distance axis.

AES Azimuth encoder eccentricity (sine part).

AEC Azimuth encoder eccentricity (cosine part).

ZES Zenith distance encoder eccentricity (sine part).

ZEC Zenith distance encoder eccentricity (cosine part).

AS2A Azimuth correction with double azimuth argument (sine part).

AC2A Azimuth correction with double azimuth argument (cosine part).

AS3A Azimuth correction with triple azimuth argument (sine part).

AC3A Azimuth correction with triple azimuth argument (cosine part).

ZS2A Zenith Distance correction with double azimuth argument (sine part).

ZC2A Zenith Distance correction with double azimuth argument (cosine part).

ZS3A Zenith Distance correction with triple azimuth argument (sine part).

ZC3A Zenith Distance correction with triple azimuth argument (cosine part).

ZS4A Zenith Distance correction with quadruple azimuth argument (sine part).

ZC4A Zenith Distance correction with quadruple azimuth argument (cosine part).

C5 Zenith distance correction with inverse cosine of azimuth of azimuth.

Note: Only one coefficient section can be extended at the same time.

'Manage current Measurements' consists of five parts:

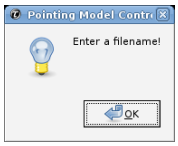
'Measurements' table gives an overview of the taken measurements. The table columns contain the object name and the axes positions with their offset and fit error. The error of the altitude and azimuth axis are combined to the main axes error. To show the overall fit error as well as that of the measurements the pointing model has to be calculated.

'Name' text field contains the name of the taken measurement. If none is given, the name is tried to be retrieved from the tracked target entry. It is also possible to remove one selected or all measurement in the measurements table.

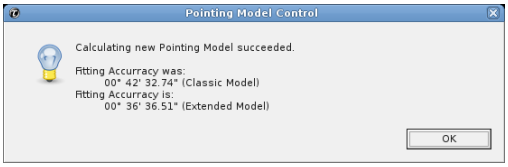
Note: Removing unsaved measurements will result in information loss. There will be no confirmation dialog! This is especially dangerous for the 'Remove All' button — that's why: Beware your clicks!

'File-Name (Server)' is for the file name on the connected TSI server where the current measurements are saved to or loaded from. Measurements loaded from a file are appended to the shown list.

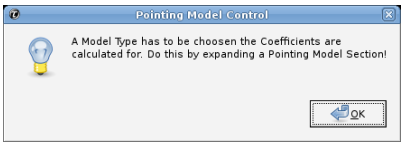
Note: Available measurements that are not saved will be lost if the TSI server is shut down. Saving or loading the available measurements requires a file name. A message box will occur if none has been entered yet:



'Calculate new Model' processes the listed measurements within the table to a pointing model. When new pointing model coefficients have been calculated a message box is shown that tells the overall fit error of the calculation used before and the current one:



Note: Extending a pointing model section specifies the calculation of a classic or extended model. If no section is extended this message box will pop up:



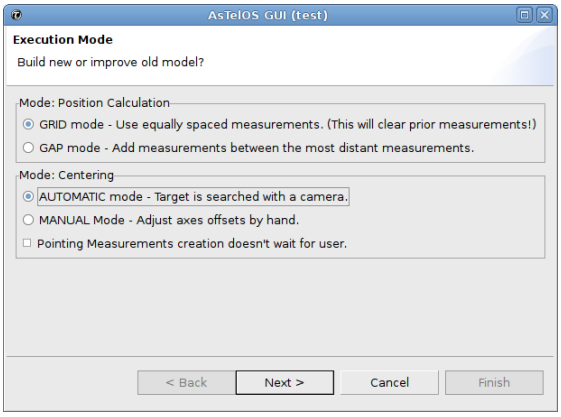
'Save calculated Model' to set the last calculated pointing model as the default one that is loaded in the future.

Note: Apply axes offsets with the 'Axes Offset' view (see section 4.8 on page 28).

'Tools' contains a wizard that helps with creating or improving a pointing model. This helper tool is started by clicking the 'Add more Measurements...' button and explained in subsection 4.9.1.

4.9.1 Pointing Model Wizard

The pointing model wizard helps in adding measurements for an improved pointing model quality. When the wizard is started the used mode has to be selected. A reasonable preselection is done respecting the suitability of the modes.

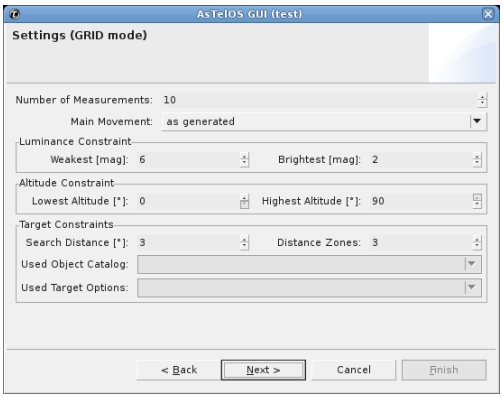


Position Calculation modes

GRID calculates measurement position equally spaced on the sky — this mode is preselected if no measurement was added before.

\+ Measurement positions are precalculated and slewing can be optimized to speed up pointing model creation.

\- Doesn't take care for existing measurements which might lead to previous measurements lieing close to taken ones.



Settings for the GRID mode:

'Number of Measurements' the total number of measurements added with this wizard run.

'Main Movement' set the sorting of the generated ideal measurement positions. Possible values are:

'as generated' unordered as generated. Measurements are ordered within a spiral around azimuth and increasing altitude.

'altitude' sorts the measurement positions by altitude causing the telescope to move large distances in azimuth.

'azimuth' sorts the measurement positions by azimuth causing the telescope to move large distances in altitude.

'Luminance Constraint' set the limits for the weakest and brightest objects that should be selected as a measurement position.

'Altitude Constraint' set the limits for the lowest and highest measurement positions.

Note: These limits might be slightly left when searching for a suitable target near the ideal measurement position.

'Target Constraint' gives limits when searching for a suitable measurement targets:

'Search Distance' maximal distance of a target around the calculated measurement position.

'Distance Zones' number of equally spaced zones around the measurement position to iterative find the nearest, but also suitable measurement target.

'Used Object Catalog' the catalog to select the measurement targets from.

Note: If no catalog is available the wizard cannot be used.

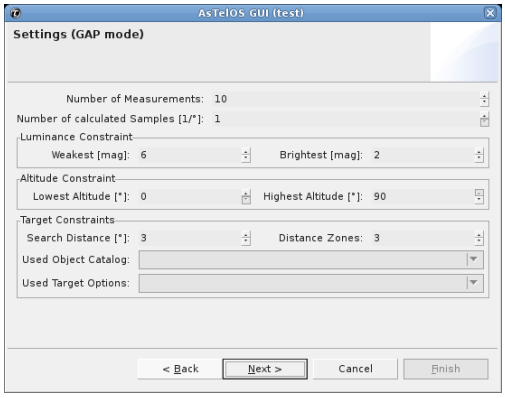
'Used Target Options' the target options to use for slewing to selected measurement targets.

Note: If selected target options contain incomplete information about the used port or filter similar dialog are shown as described in section 4.11.

GAP calculates the density of the currently added measurements to search for the largest gap. Adding a measurement leads to an distribution of measurements equally distributed over the sky — this mode is preselected if measurements were already added.

\+ This process takes care for already added measurements — a rerun increases the density with minimized risk of measurements lieing to close to each other.

\- Successive measurements might lie far apart causing slews over long distances.



Settings for the GAP mode:

'Number of Measurements' the total number of measurements added with this wizard run.

'Number of calculated Samples' The number of calculated density samples per degree.

Note: Should only be increased in case of lots of measurements already taken — it has a large performance influence!

'Luminance Constraint' set the limits for the weakest and brightest objects that should be selected as a measurement position.

'Altitude Constraint' set the limits for the lowest and highest measurement positions.

Note: These limits might be slightly left when searching for a suitable target near the ideal measurement position.

'Target Constraint' gives limits when searching for a suitable measurement targets:

'Search Distance' maximal distance of a target around the calculated measurement position.

'Distance Zones' number of equally spaced zones around the measurement position to iterative find the nearest, but also suitable measurement target.

'Used Object Catalog' the catalog to select the measurement targets from.

Note: If no catalog is available the wizard cannot be used.

'Used Target Options' the target options to use for slewing to selected measurement targets.

Note: If selected target options contain incomplete information about the used port or filter corresponding dialogs are shown as described in section 4.11.

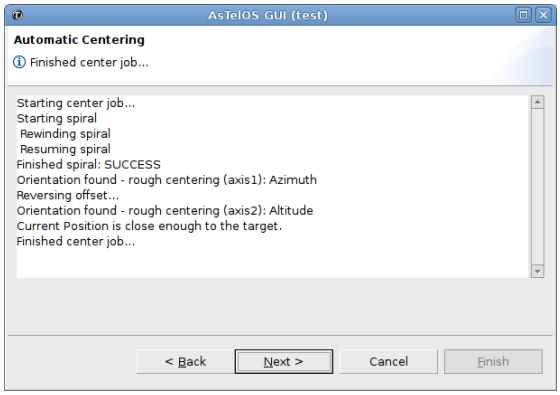
Centering modes When the target object is reached and the telescope is tracking it has to be centered. This can be done with different modes explained here.

AUTOMATIC mode

To use this mode an IP-Cam providing an MJPEG-Stream must be mounted to the selected telescope port and configured properly in AsTelOS (see section 3.1.3 on page 11).

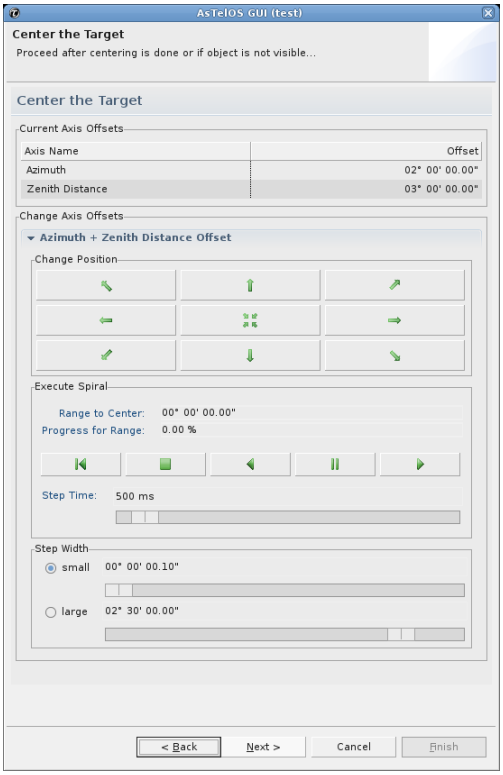
The progress and success of the centering can be checked in the 'Camera' view.

To omit the ability to verify the centering result manually the 'Pointing Measurement creation doesn't wait for user.' checkbox can be selected. Guessing of the final result state is also done by the automatic process:



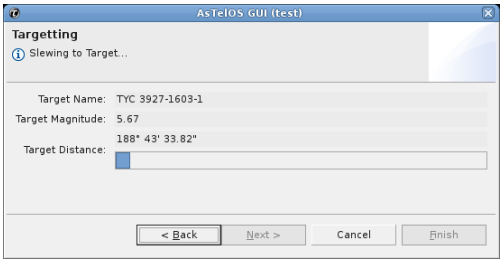
MANUAL mode

This mode relates to the 'Axis Offsets' view which is explained in section 4.8 on page 28. To center the target it has to be centered on a custom camera or with an eye piece and setting the offsets with the provided inputs:



If all settings are entered the wizard selects the first target. To prevent selecting targets that are far apart the ideal pointing the search is done with increasing search distance — as configured in the wizard page before.

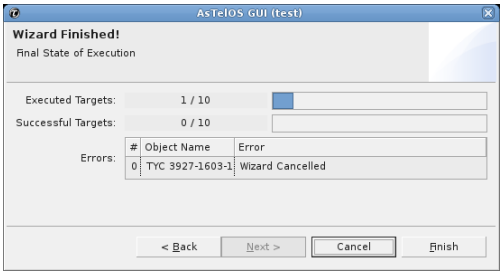
The slewing progress to the selected target is displayed with this wizard page:



When the target is reached and the telescope is tracking it the next page is shown. It depends on the choosen centering mode which panel is shown here.

If a target could not be found or non-ambigously identified, on the next wizard page a check box can be selected stating 'Object could not be found!'. The wizard proceeds with the next target ignoring this one.

Finally when cancelling or finishing the wizard a last result page is show:



Displayed information here is:

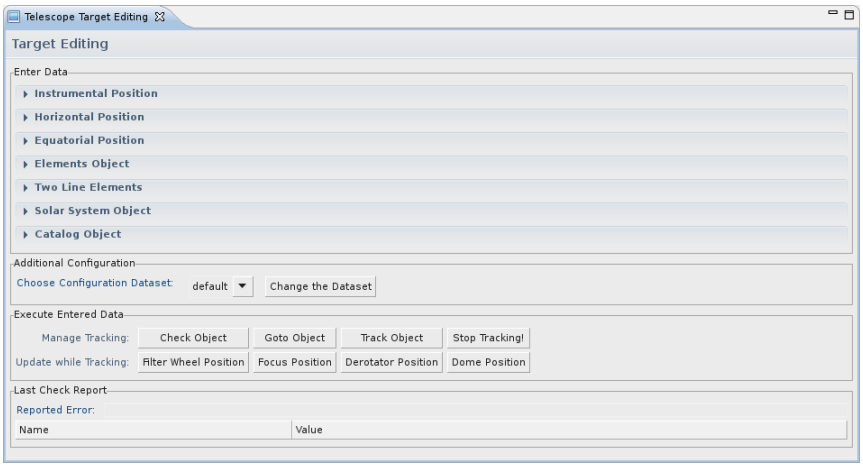
'Executed Targets' with the number of the targets that were started to be taken.

'Successful Targets' with the number of measurements successfully added.

'Errors' table contains an overview over the started targets with the cause of their failure — if any.

4.10 Telescope Target Editing

The 'Telescope Target Editing' view provides the interface to choose an object or enter the target parameter/data using different coordinate systems:



Note: It is possible to open more than one 'Telescope Target Editing' view to prepare different targets.

The widgets in this view are separated into four groups:

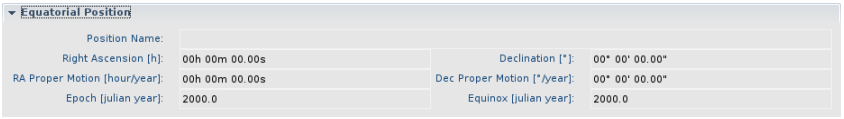
'Enter Data' contains the different target types[11]:

'Instrumental Position' contains input fields for the name of the object and the values for the azimuth and zenith distance axes:

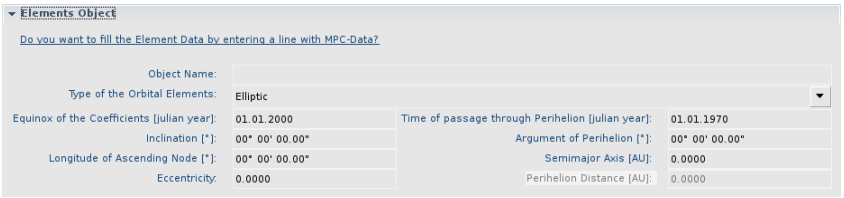
'Horizontal Position' contains input fields for the azimuth, altitude and name of the target:

[11] The name of the enlarged target type section is appended to the view title and the target name of that section replaces the title.

'Equatorial Position' contains more input fields which reflect the higher complexity of equatorial data. Additionally to the name, right ascension and declination the proper motion, epoch and equinox of the target can be provided:

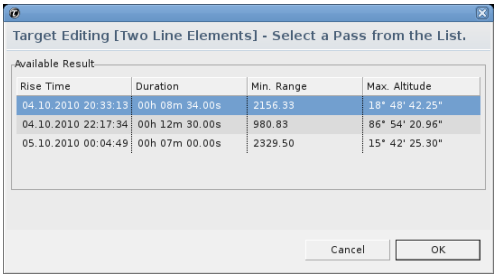


'Elements Object' contains the parameters for orbital elements of ecliptic, parabolic or near parabolic nature — parameters that do not apply to the element type are disabled. These objects are e.g. comets and asteroids. Clicking the hyperlink label with the question for 'MPC-Data' provides a text field to enter data in the MPC[12] format[13] and reveals another hyperlink label to access current MPC-data on line[14]:



'Two Line Elements' contains input fields to enter TLE data of one satellite:

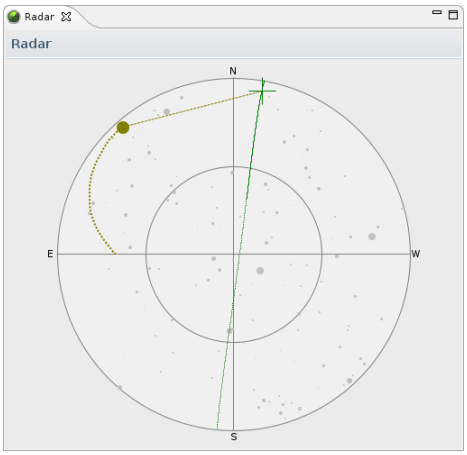
The 'TLE' input field takes the Two Line Elements with an optional object name. It can be checked for passes with an minimal altitude in the next hours as specified. By clicking the 'Pick a Pass...' button a selection dialog is show to choose between the found passes:



Sorting the result list for an entry in ascending/descending order can be acquired by clicking the according head elements of the table. The 'Rise Time' and 'Set Time' refer to the 'Minimal Rise-Altitude' whereas the 'Duration' refers to the whole trajectory span. If the satellite didn't rise or set in the checked span of time the corresponding table field is empty.

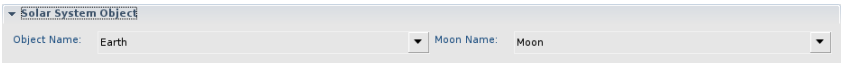
[12] Minor Planet Center
[13] http://www.cfa.harvard.edu/iau/info/CometOrbitFormat.html
[14] http://www.cfa.harvard.edu/iau/Ephemerides/Comets/Soft00Cmt.txt

Selecting an entry within the list shows the specific trajectory within the 'Radar' view (see section 4.2). The position the telescope is slewing to is marked by a cross. This initial position can be influenced by changing the value of the 'Minimal Slew-Altitude' input field. It is the first calculated pass position where the satellite reaches the given altitude:

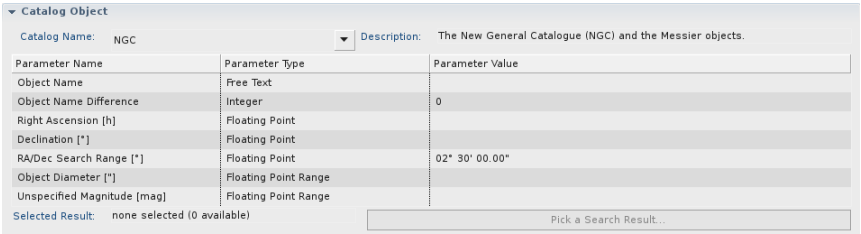


The trajectory path is drawn as a solid line when the satellite is expected to be sunlit — otherwise a dotted line is drawn. How the trajectory is executed can be selected with the 'Pass Tracking Mode' combo box. When using 'Track Pass Trajectory' the telescope will execute the calculated trajectory. But using 'Track Position' the telescope tracks the horizontal position marked by the cross.

'Solar System Object' contains predefined calculation routines for the planets (with Pluto) and some of their moons:

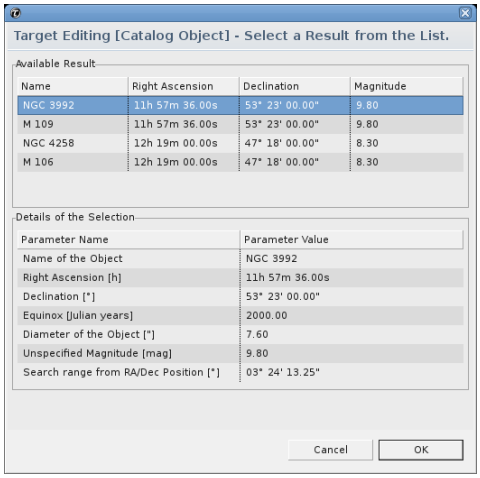


'Catalog Object' contains a flexible access to catalogs. Objects can be obtained from these by selecting and entering different search parameters instead of typing their celestial coordinates. E.g. the name may be entered directly or a search is triggered within a certain radius around the given equatorial coordinate:



Note: The 'Pick a Search Result...' button is disabled if the current search parameters matched no catalog entry.

If the search matches more than one object, these can be selected in the shown dialog. It can be accessed through the 'Pick another Search Result' button. It is also automatically shown when the search encountered ambiguous results using the 'Check Object', 'Goto Object' or 'Track Object' of the execution group (see below):



The head elements of the table with the search results can be clicked to sort the rows by this field in ascending/descending order.

- More detailed explanations can be found in section 6.6 on page 56.

'Additional Configuration' attaches a specific set of additional target options to the selected target. The default option set is selected at first but also another set may be selected from the combo box. A shortcut to edit the selected options set is provided with clicking the 'Change the Dataset' button. The 'Telescope Target Options' view with the selected options set is opened (see section 4.11 on page 42).

'Execute Entered Data' contains two lines with buttons.

1. The first row includes:

   'Check Object' triggers sending the target and options data to the telescope and generates a check report or error message.

   *Note:*When checking a target the telescope is not moved nor any activity that is currently executed is interrupted.

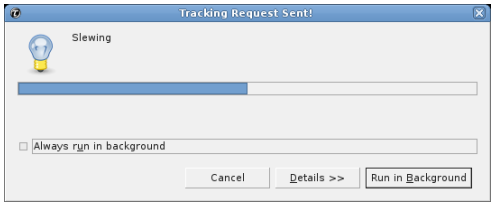
   'Goto Object' additionally to checking the telescope is moved to the target position — if it is possible to do so.

   'Track Object' additionally to go to the telescope starts tracking.

   'Stop Tracking!' stops an ongoing tracking — no update of the check report.

   Notes[15]:

   - If the port or filter settings in the chosen configuration dataset is invalid the specific selection dialog of the 'Telescope Target Options' view (see section 4.11 on page 42) is shown.
   - The slewing of the telescope to a target object is visualized with a dialog. It shows the progress as the convergence between the current telescope position and the target position:

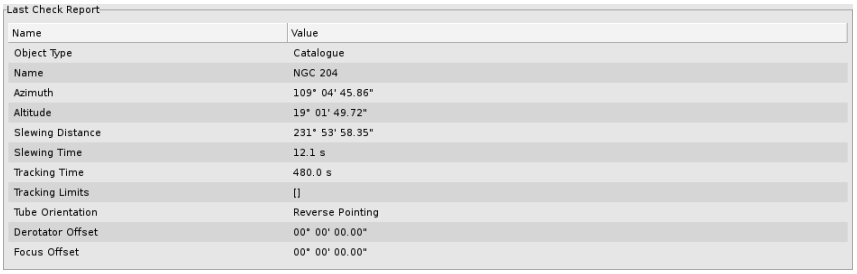


[15] Does not apply to the 'Stop Tracking!' button.

The Dialog can be cancelled. When doing so, AsTelOS GUI will try to stop the telescope!

2. The second row of buttons updates filter wheel/focus/derotator/dome positions. These are taken from the options set — but only if the telescope is currently tracking and the positions are not determined automatically.

'Last Check Report' concentrates information about the entered target (as a check report):



or displays errors that prevented the execution:

Note: The number and type of presented report fields may vary with the chosen position and object type.

4.10.1 Extension - Custom Catalog

The 'Telescope Target Editing' view can be customized by other plug-ins. This is done by the custom catalog plug-in with icons in the header of each target type section:

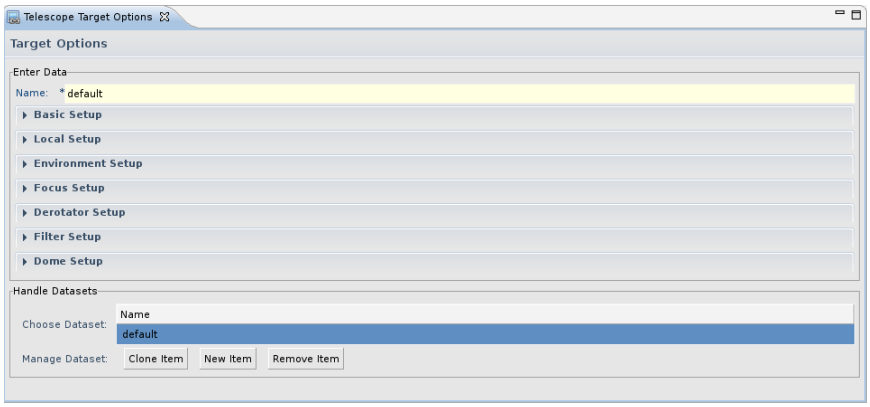
The two icons are used to:

1. Add the current values of the related target section to the custom catalog. The target must have a custom name - if a field for this is available. If an object with the same name already exists in the custom catalog a warning is generated and the object has to be removed from the catalog before the current one can be added.
2. Open the 'Custom Catalog' view and deal with the entries that were added before. See section 4.12 on page 45 for more details about this view.

Note: The data of this catalog are stored within the 'customdb' database. When cleaning up this cached program data the database file must be preserved. See the section 7.4 on page 64 where these files can be found.

4.11 Telescope Target Options

The 'Telescope Target Options' view provides access to secondary target options. These help the TSI service to calculate an appropriate solution for the transmitted targets.

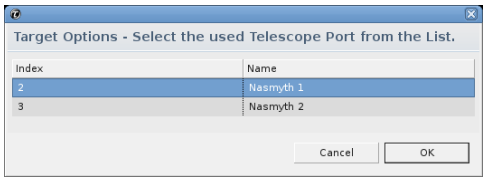


There are two groups shown:

Enter Data offers several sections to alter the currently selected data set:

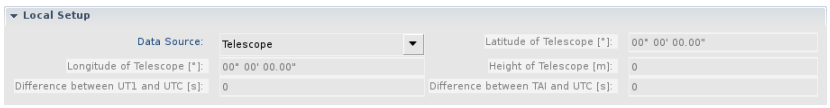
'Basic Setup' contains entries describing how the telescope should slew to its target ('Optimization'), where it should track ('Tracking Orientation of the ZD Axis' — only useful if zenith distance axis can track on both sides of the zenith), what should be considered at the calculation ('Use Refraction Correction') and how long it should be able to track before reaching any limit ('Minimal Tracking Time'):

Important is the setting of the port for the observation ('Used Telescope Port' — applies for telescopes with rotating M3 mirror). This is done by clicking the 'Select another Port' button — the port selection dialog is opened:

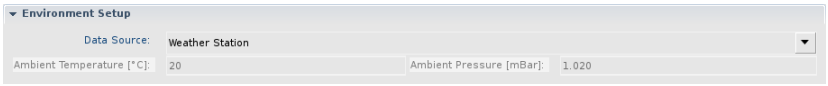


Note: The 'Telescope Target Editing' view will show this selection dialog if an invalid port setting was found (see section 4.10 on page 37).

'Local Setup' is used to enter time settings and location data of the telescope site. It can be chosen between using the telescope/GPS as the source or enter the data directly ('Data Source'):



'Environment Setup' Enter the values or select the source of the ambient temperature and pressure.



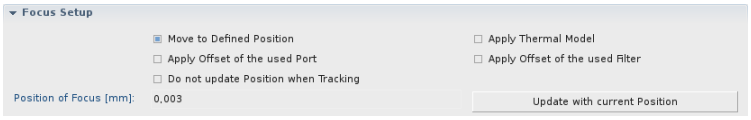
selectable Data Sources:

User Defined — enter the values in the fields below.

Weather Station — use the weather station connected to the cabinet.

External Weather Station (via Weather Data Injector) — use the WDI program to forward the current ambient pressure and temperature.

'Focus Setup' Select the correction terms used for the calculation of the focus position:



The 'Update with Current Position' button copies the current focus position into the focus position field left to it.

Note: The acquired position includes the current focus offset as well as applied corrections. This can lead to unexpected results, when the correction is then applied again or when the existing focus offset is not set to zero after using this button.

'Derotator Setup' Choose between different derotator modes ('Derotator Tracking Mode'):

'Off' — the derotator will not be used.

'Custom Offset as fixed Position' — the entered offset will be used as derotator position.

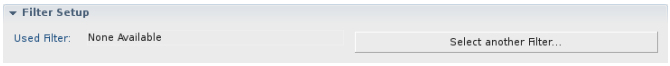
'True Orientation with custom Offset' — true orientation tracks e.g. north to be in the same image direction of a camera attached to the derotator. An additional offset can be applied.

'True Orientation with Multiple of 90 Degree Offset' — true orientation but with additional integer multiple of 90 degrees applied — to reach the target position faster.

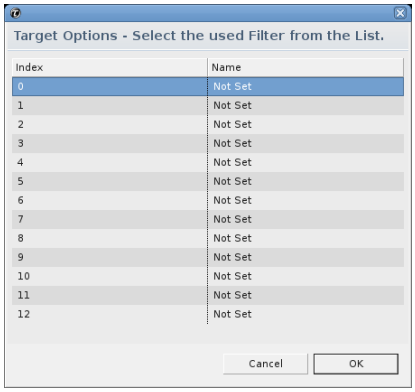
'True Orientation with Multiple of 90 Degree and custom Offset' — same as above but with the additional offset entered.

'True Orientation with arbitrary Offset' — the derotator starts tracking at the current position (no slewing at the start of the tracking).

'Filter Setup' The currently chosen filter for the selected port can be seen with its specific name and index position — if available at all:



Another filter can be chosen by clicking the 'Select another Filter' button — the filter selection dialog is opened:



Note: The 'Telescope Target Editing' view will show this selection dialog if an invalid filter setting was found (see section 4.10 on page 37).

'Dome Setup' Enter the maximum position deviation and offset of the dome as well as a the specific dome behavior:

'Off' — the dome will not be used.

'Custom Offset as fixed Position' — the entered offset will be used as the dome position.

'Discrete Movement' — the dome will be moved if the deviation between current and target position exceeds the given maximum deviation.

'Discrete Movement with custom Offset' — as above additionally with the entered offset.

'Continuous Movement' — the dome will be moved steadily with the telescope.

'Continuous Movement with custom Offset' — as above additionally with the entered offset.

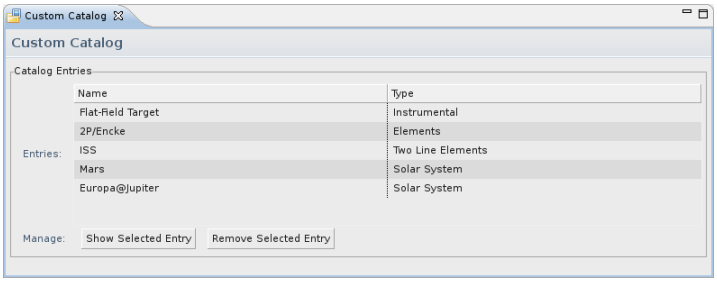
Handle Datasets allows managing existing datasets as well as creating new ones. The 'Manage Dataset' buttons will affect the currently selected item in the 'Choose Dataset' table:

- 'Clone Item' clones the data set and appends '[cloned]' to the name of the new set.
- 'New Item' adds a data set with basic settings and drops it under the current selection.
- 'Remove Item' removes the data set.

Note: Removing the default data set leads to adding another default dataset with basic settings. The name of the default data is locked, but another data set may be equally named.

4.12 Custom Catalog

The 'Custom Catalog' view lists the entries in the catalog that were added before by the user ('Entries') and buttons to manage the data sets ('Manage'):



The available buttons are:

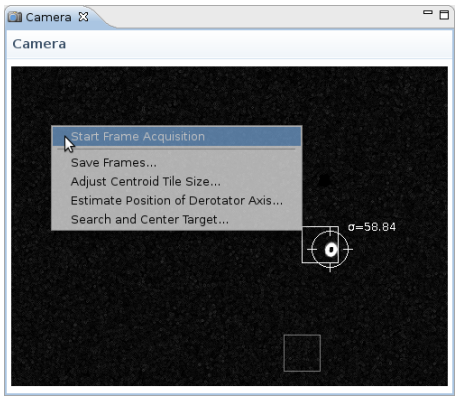
'Show Selected Entry' All the selected entries from the 'Entries'-table above are opened in a separate 'Telescope Target Editing' view (see section 4.10 on page 37). As their native section is used all details of the objects are revealed.

'Remove Selected Entry' Remove the entries currently selected in the 'Entries'-table above. These will be removed without further asking!

Note: Selecting more than one entry of the 'Entries'-table is possible!

4.13 Camera

To look at the raw or processed output of the camera image processing pipeline this view can be used. The preferences are explained in section **??** on page ??. What is shown on a processed image depends on the setup of the pipeline itself, explained in section 6.7 on page 60.



The 'Camera' view provides a context menu with the following settings:

Start/Stop frame acquisition Will start or stop the acquisition of camera frames.

Note: Camera tasks might trigger acquisition of frames even if acquisition is disable in this view — these frames will also be shown here.

Save Frames Start camera task that captures frames as specified in the preferences of this view (section **??**).

Adjust Centroid Tile Size Start camera task that changes the global and local tile sizes of the centroid processing stage (see **??**).

Note: This task only functions properly if a recognized target is within the camera frame and the centroid processing stage is added to the image processing pipeline.

Estimate Position of Derotator Axis Start the camera task to search for the derotator axis in the camera frame(section **??**).

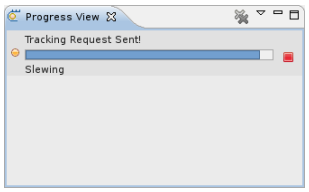
Note: This task only functions properly if a recognized target is within the camera frame and the centroid processing stage is added to the image processing pipeline.

Search and Center Target Start the camera task for search (execute spiral if enabled) and center a target (section **??**).

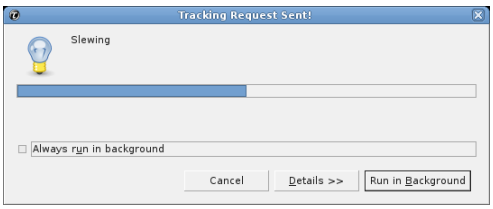
Note: This task only functions properly if a recognized target is within the camera frame and the centroid processing stage is added to the image processing pipeline.

4.14 Progress

The 'Progress' view lists all running or queued jobs. These are internal helper objects that encapsulates an activity — independent from others. The View can be opened by double-clicking on the progress indicator.



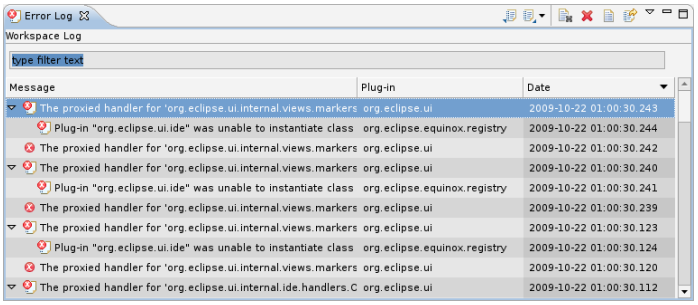
Jobs are triggered by user interaction with AsTelOS GUI or from the program itself and may also be shown with a dialog notifying the current operation — e.g.:



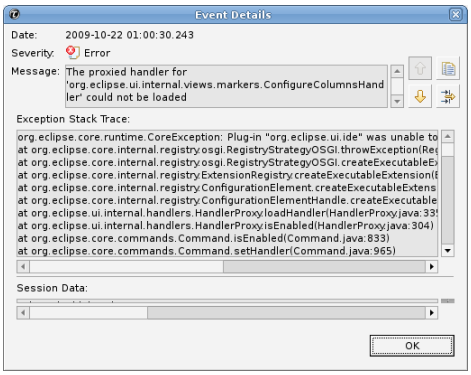
Note: Even if jobs seems to be stoppable (by showing the stop button), they might not support this. For job dialogs that support cancellation this is explicitly declared.

4.15 Error Log

The 'Error Log' view gives an overview about internal errors.



Most of the listed problems shouldn't give cause for concern. Only if unexpected things happen, it makes sense to investigate logged problems that happened at roughly the same time. Double clicking a logged event opens a dialog with more details:



Here the 'Exception Stack Trace' is most interesting because it can help to find the source of a misbehavior.

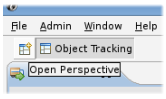
5 Perspectives

This section will introduce the default perspectives that assemble the views presented within section 4 on page 22.

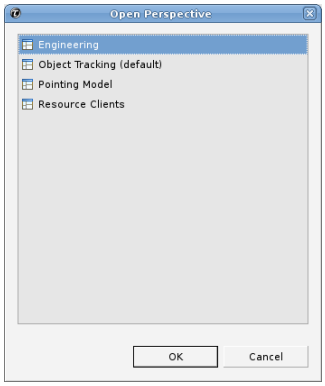
The default layout situated on the right contains several views (see section 4.2 on page 23, section 4.3 on page 24 and section 4.4 on page 24) to visualize the current telescope pointing. Remaining space is used for the specific purpose of the particular perspective. On the left, views are located for basic interaction and in the middle for more advanced issues.

5.1 Handling Perspectives

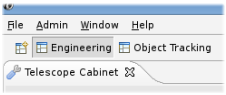
To open a perspective click on the left button within the perspective bar (see image in section 1 on page 5):



The 'Open perspective' dialog is opened and shows the available perspectives:



Choose the desired perspective from the list and open it by clicking 'OK'. Open perspectives are shown as markers within the perspective bar. Switching over to another perspective is now possible just by clicking onto its marker:

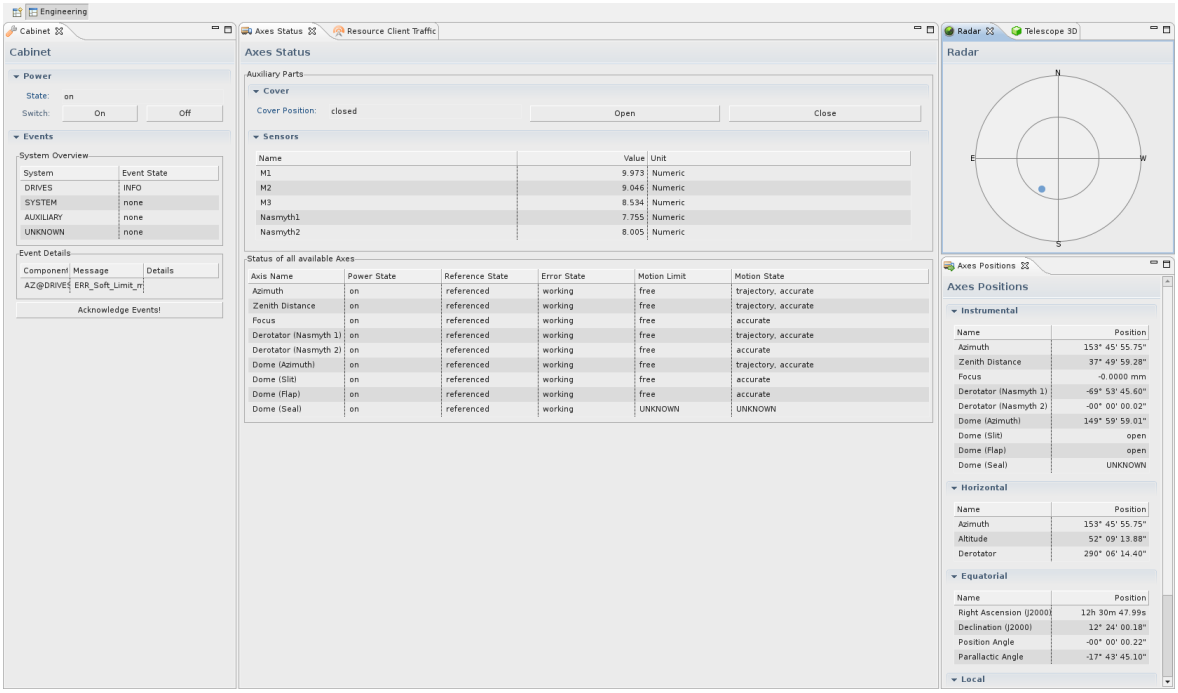


Each of these markers provide a context menu (right click their perspective marker) where the perspective can be e.g. closed or saved under another name.

Note: The arrangement of the opened views as well as the opened perspectives are saved when closing the program.

5.2 Engineering

The 'Engineering' perspective consist additionally to the basic views of the 'Cabinet' view (see section 4.5 on page 25) in the left with the 'Axes Status' (see section 4.6 on page 26) and 'Resource Client Traffic' (see section 4.7 on page 28) views in the middle:

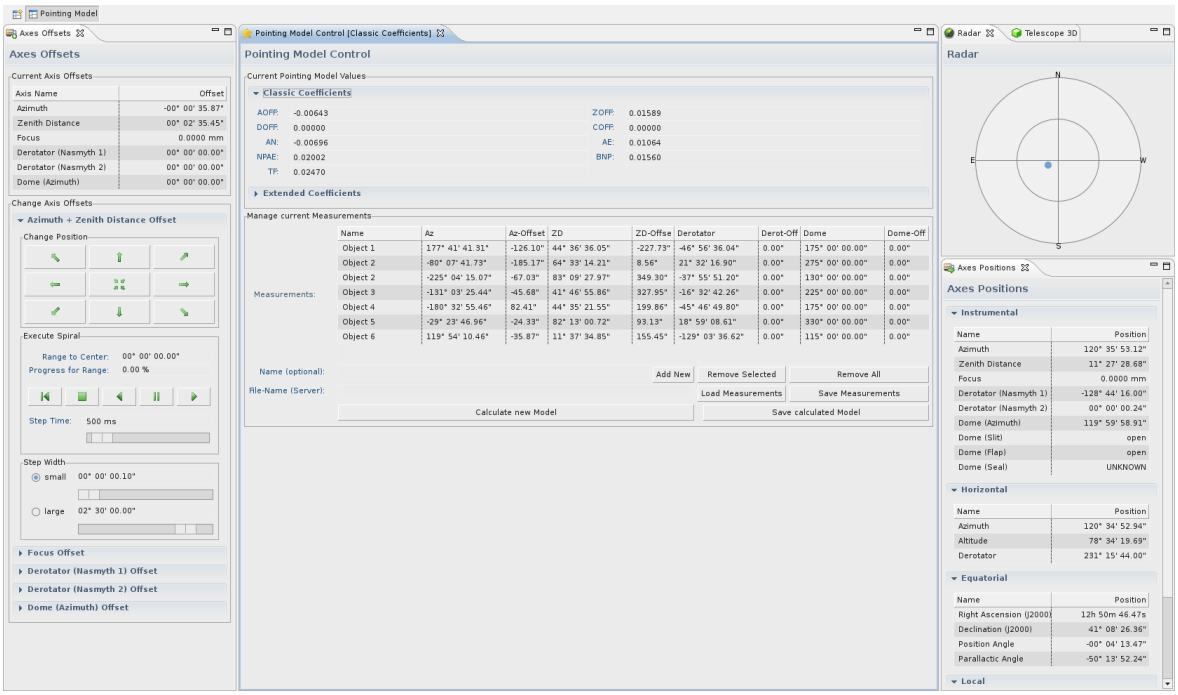


The purpose of this perspective is to:

- Prepare the telescope for operation and shut down (see section 6.3 on page 54).
- Check the telescope axes if a tracking problem arises (see section 7.2 on page 63).

5.3 Pointing Model

The 'Pointing Model' perspective consist additionally to the basic views of the 'Axes Offsets' view (see section 4.6 on page 26) in the left with the 'Pointing Model Control' (see section 4.9 on page 29) view in the middle:

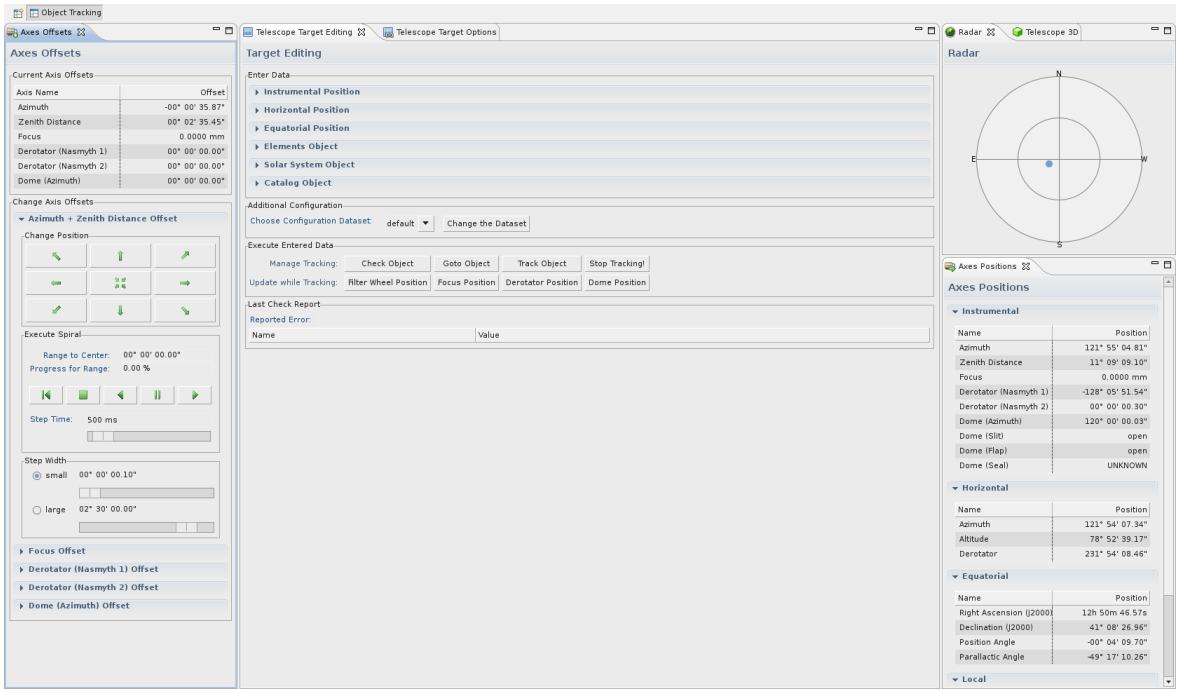


The purpose of this perspective is to:

- Make or improve the pointing model of the telescope (see section 6.4 on page 55).

5.4 Object Tracking

The 'Object Tracking' perspective consist additionally to the basic views of the 'Axes Offsets' view (see section 4.6 on page 26) in the left with the linked 'Telescope Target Editing' (see section 4.10 on page 37) and 'Telescope Target Options' (see section 4.11 on page 42) views in the middle:



The purpose of this perspective is to:

- Set the tracking parameters, choose the target and let the telescope track it (see section 6.5 on page 55).

6 How To

6.1 Setup the Software

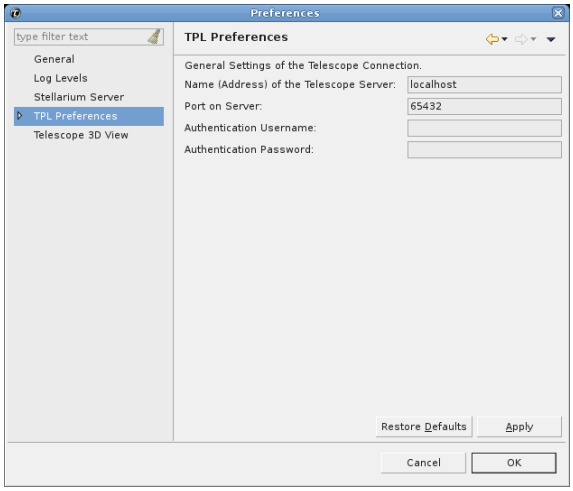
After a fresh installation of AsTelOS GUI, site specific settings have to be made — these are explained in the following subsections.

Note: The other articles from the 'How To' chapter assume that AsTelOS GUI is successfully connected to the TSI service.

6.1.1 Configure Telescope Connection

To be operational, a connection to the TSI service must be established:

1. Open the preferences dialog as described in section 3 on page 10.
2. Choose the 'TPL Preferences' page. The actual site specific settings may vary. Defaults are:



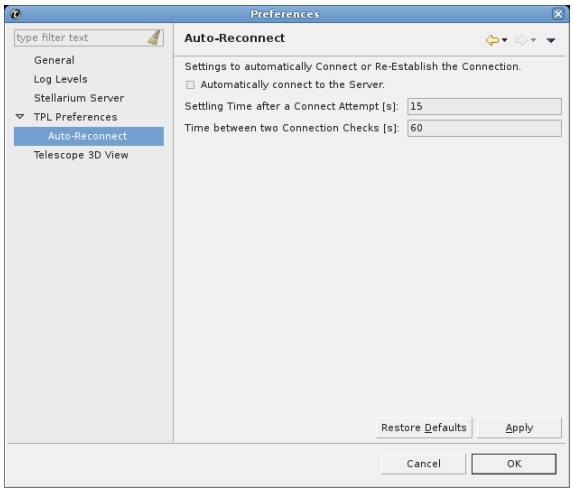
- address of the TSI server: *localhost*
- service port on the server: *65432*
- authentication username: *admin*
- authentication password: *admin*

Note: The manual connect and disconnect function is available after acknowledging the input — but the auto-connect should be enabled, too (see section 6.1.2).

6.1.2 Configure Auto-Connect

For more persistence and convenience, the TPL connection can be automatically monitored.

1. Open the preference dialog and expand the 'TPL Preferences' tree.
2. Enable the 'Automatically Connect to the Server' checkbox to let AsTelOS GUI autonomously connect to the TSI service.



3. Instantly after enabling and acknowledging this setting this feature becomes active.
4. For the feature to work, it is necessary, that the correct connection data is entered (see section 6.1.1 on the preceding page).

Note: With this feature enabled AsTelOS GUI will try to connect by itself after the start up and even connection losses.

6.1.3 Configure Stellarium

Below, only the absolute necessary steps are described. First the telescope plug-in used with Stellarium and after that the direct method used for versions without telescope plug-in is explained. More information about the latter one is available within the official instructions[16].

Download the Stellarium program for the used platform and install it. *Note:* For many Linux distributions, Stellarium can be found within the official repositories.

Telescope Plug-in (0.10.5 or newer)

1. Start Stellarium. Choose the configuration window in the left pane (or press 'F2'). Go to the extension tab and select the 'Telescope Control' plug-in.
2. Select the checkbox to load the plug-in at the startup of Stellarium and close Stellarium.
3. Open the extension tab again (see the second step). Click the config button that opens the config dialog of the telescope plug-in.
4. Clicking the 'Add' button will open a dialog window to configure the new telescope connection.
   a) Choose 'External Software or a remote computer'.
   b) Enter a name for the shown telescope position like 'AsTelOS'.
   c) Select the 'Start/connect at startup' check-box.
   d) In the 'Connection Setting' section the 'TCP Port' must be set to the value given within the AsTelOS configuration. Default value there is 10000.
   e) Click 'OK' to save the changes.

Telescope Control (0.10.1 or newer)

1. Edit the Stellarium `config.ini`:

   Note: For Linux, it may be found at within the `.stellarium` folder in the user home directory.

   a) Switch on the telescope support within section `astro`:

   ```
   [astro]
    flag_telescopes = true
    flag_telescope_name = true
   ```

   b) Add section `telescopes` to declare how the telescope servers (e.g. AsTelOS GUI) can be reached:

   ```
   [telescopes]
    1 = AsTelOS:TCP:localhost:10000:500000
   ```

   Interesting settings here are:

   1 is the key binding for the telescope within Stellarium.

   AsTelOS is the displayed name of the telescope.

[16] Stellarium Telescope tutorial at: http://stellarium.org/wiki/index.php/Telescope_Control

localhost is the name or IP where the server (and therefore AsTelOS) is running on.

10000 is the default port of the Stellarium server.

500000 is the delay in *micro*seconds for displaying the 'current' telescope location — this is used for interpolation and should be in the same region as the update time for sending the telescope positions.

Note: Do not get confused with the settings for a TPL server! AsTelOS GUI includes its own Stellarium server — see section 3.4 on page 18 about how the configuration can be seen and changed.

2. Start Stellarium, enter the site location. After setting up, search[17] for AsTelOS. The point of view is changed to look into the same direction as the telescope.
3. Selecting a target and pressing `Ctrl + 1`[18] will open a Telescope Target Editing view (see section 4.10 on page 37) that contains the coordinates of the selected target. Such an automatically created target is missing its specific name, but can be tracked right away as described in section 6.5 on page 55.
4. Feel free to explore and customize Stellarium.

6.2 Efficient Data Input

The data presented within AsTelOS GUI is mostly given in one of a few different formats. Shortcuts can be used to input data in these formats more quickly:

degree data

- used for:
  - azimuth, zenith distance, declination, derotator
- AsTelOS GUI formatting (example):
  - 27° 57' 26.38"
- possible manual input shortcuts:
  - 27d 57' 26.38"
  - 27d 57.43967'
  - 27 57 26.38
  - 27.957

hour data

- used for:
  - right ascension
- AsTelOS GUI formatting (example):
  - 07h 31m 30.91s
- possible manual input shortcuts:

[17] input field for searching is displayed by pressing `Ctrl + F`
[18] The specific number depends on the key-binding from the configuration made above.

  - 7h 31m 30.91s
  - 7h 31.51517m
  - 07 31 30.91
  - 7.525

millimeter data

- used for:
  - focus
- AsTelOS GUI formatting (example):
  - 3.78 mm
- possible manual input shortcuts:
  - 3.78

Note: The program will always complain about wrong formatted input — feel free to try out formattings.

6.3 Power Up/Down the Telescope

Changing the power state of the telescope is explained with using the 'Engineering' perspective (see section 5.2 on page 48 and section 5.1 on page 47 how to open a perspective).

1. Open the 'Engineering' perspective.
2. The 'Telescope Cabinet' view provides within the section 'Telescope Power' the buttons 'On' and 'Off' which consequently powers the telescope on and off. Click the 'On' button.
3. Wait until the 'State' textfield above the buttons indicates 'on'.

   Note: While powering up, the axes states can be watched changing within the 'Axes Status' view.
4. After the power state switched to 'on' and no errors occurred (see section 7.1 on page 63) the telescope is fully operational.
5. Maybe it is necessary to open the dome, telescope covers or toggle some switches — this can be done within the 'Auxiliary Parts' section of the 'Axes Status' view. The TSI may do so automatically, if configured.
6. ... do your work with the telescope ...
7. Before powering down: close the dome, cover or toggle switches if necessary. The TSI may do so automatically, if configured.
8. Click the 'Off' button within the 'Telescope Cabinet' view.
9. Wait until the 'State' signals off.

Note: Powering down includes the slewing of the axes to their home positions. Powering up requires occasionally referencing of the axes — hence they will move then, too.

6.4 Making a Pointing Model

A telescope has various static and dynamic pointing errors. These have to be compensated with the help of star measurements. Support for this is provided in the 'Pointing Model' (see section 5.3 on page 49) accompanied with the 'Object Tracking' perspective (see section 5.4 on page 49).

1. Open the 'Object Tracking' perspective.
2. Choose and track a celestial target with precisely known coordinates (generally stars from a catalog — like 'Tycho'). The star should be bright enough to clearly locate it on the camera or eyepiece, but not too bright to avoid outshining.
3. Center the target by changing the main axes offsets within the 'Axes Offsets' view. There are some ways to generate the necessary feedback — with increasing precision:
   a) Center it through an eye piece. This is a rough method e.g. to catch the target when building a pointing model from scratch. Precision can be increased by using an eye piece with cross hair.
   b) Center the target within the recorded picture of a camera.
   c) Determine the mechanical derotator axis within the recorded camera picture by rotating the derotator using offsets in the 'Axes Offsets' view and center the target onto the rotation center.
4. Open the 'Pointing Model' perspective.
5. Enter a name for the measurement — if not done with the input of the current target. Click the 'Add New' button.
6. Proceed with 1. until enough measurements have been done.
7. If the measurements are done they can and should be saved. If doing many measurements it is strongly recommended to save regularly. A meaningful filename has to be typed in (and noted!) for the file. With clicking 'Save Measurements' the measurements are saved into that file on the TSI server.
8. Choose a pointing model (classic or extended) by expanding the appropriate section within the 'Pointing Model Control' view.

   Note: The minimum count of measurements that should be used is roughly equal to the count of coefficients the selected pointing model has.

6.5 Track Target

Tracking a celestial target requires a useable pointing model (see section 5.3 on page 49). Intended for choosing and slewing to such targets is the 'Object Tracking' perspective (see section 5.4 on page 49).

1. Open the 'Object Tracking' perspective.
2. In the 'Telescope Target Editing' view the data of the destined target can be entered using an appropriate section.

   Note: Let this section stay expanded as this will indicate AsTelOS GUI which position or object type to use.
3. In the 'Telescope Target Editing' view choose the data set with the additionally target options. If there is not an appropriate set available:

a) Select a data set that should be altered, click the 'Change the Dataset' button and make the changes.
Change back to the 'Telescope Target Editing' view.

b) Select the 'Telescope Target Options' with clicking its tab.
An existing data set can be cloned (click 'Clone Item' button) and changed or a new one created (click 'New Item') and set up from scratch.
Change back to the 'Telescope Target Editing' view and select the newly created data set.

Note: If a new data set is created, it should be equipped with an unique and meaningful name.

4. Click the 'Check Object' button to examine possible problems.
5. Click the 'Track Object' button to let the telescope slew to the position and start tracking there.
6. If the targeted object is not centered properly, the 'Axes Offsets' view can be used to correct a small position deviation. Be sure to reset the offsets back to zero after observing the target.

   Note: Use this only as a makeshift for imprecise, but not better known coordinates as otherwise e.g. the pointing model may be bad (see section 6.4 on the preceding page).

6.6 Searching within Catalogs

6.6.1 General Approach for Searching

An overview about querying a catalog is provided here. It is meant to get an idea on how to use the catalog search — explanatory gaps are filled with the details from subsequent sections.

1. Switch to or open a 'Telescope Target Editing' view (see section 4.10 on page 37).
2. Open the catalog section and fill in search constraints that will hopefully include the desired objects.
3. Click the 'Pick a Search Result...', 'Check Object', 'Goto Object' or 'Track Object' button to search the catalog and to start an additional action for the found object, if desired.

   a) If there was more than one object found, one of the matching targets can be selected from the dialog that automatically opens.

   Note: When using the 'Pick a Search Result...' button, the selection dialog is shown whenever one or more results are available.

   b) Select an object from the list by clicking 'OK' will execute the triggered action again on the specified object (e.g. start the tracking if before 'Track Object' was clicked).

   Note: If the search resulted in exactly one result, this target is selected and for all other actions beside the 'Pick a Search Result...' button the further actions are executed. Any problems that might occur are shown within the concluding message box and/or the error field of the catalog-report section.

4. Clicking the 'Pick a Search Result...' button will show the selection dialog again, allowing to select a different match.

6.6.2 Data Field Types

For searching a catalog in a structured, but also flexible way there are data fields that have a defined and catalog independent meaning for the data that they contain. A specific catalog may support only a subset of these data fields for input, but may also support more of them in the output.

To ease handling, the data fields are of a specific type that restricts the input of free-text:

Free Text (T) All typeable characters are accepted.

Integer (I) Only numbers are accepted.

Floating Point (F) Numbers with fraction are allowed.

Floating Point Range (R) In this field a range of allowed floating point values can be defined. The minimum and maximum is separated by a semicolon. An open end can be defined by omitting the part before or after the separator.

For all data fields applies that an empty field is ignored! And even if the typed input values are accepted by the input field itself, they might be limited further by the catalog. Hitting these limits will be reported at least by a subsequent message box.

6.6.3 Data Fields

Below is a list of the currently defined data fields. As new catalogs get supported, this list may be extended in future versions. Since different catalogs include different data fields, they usually will support only a subset of these data fields. The field type of the data field is given in parenthesis:

Object Name (T) the catalog specific name for an object.

Object Type (T) the catalog specific type of an object.

Altitude (F) the Altitude position — in degrees (as described in section 6.2).

Azimuth (F) the Azimuth position — in degrees (as described in section 6.2).

Right Ascension (F) the RA position — in hours (as described in section 6.2).

Declination (F) the DEC position — in degrees (as described in section 6.2).

RA/DEC Search Range (F) the search distance for objects to a defined RA, DEC or RA&DEC position — in degrees (as described in section 6.2).

RA Proper Motion (R) the proper motion in right ascension — in milliarcseconds per year.

DEC Proper Motion (R) the proper motion in declination — in milliarcseconds per year.

Equinox (R) the equinox as the zero point of the proper motion — in years.

Object Diameter (R) the diameter of the object — in arcseconds.

Unspecified Magnitude (R) the brightness of the object for an undefined spectral sensitiveness — in magnitudes.

Visual Magnitude (R) the brightness of the object for the visual spectral band — in magnitudes.

Blue Magnitude (R) the brightness of the object for the blue spectral band — in magnitudes.

BV Color (R) the color as the difference between the visual and the blue magnitude — in magnitudes.

6.6.4 Custom Catalog

The catalog contains objects added by the user and provides a generic and slim access to them. The following field are supported:

- 'Object Name'
- 'Object Type'[19]

6.6.5 NGC/IC Catalog[20]

The catalog objects support the following data fields:

- 'Object Name'[21]
- 'Right Ascension', 'Declination', 'RA/DEC Search Range', Equinox[22]
- 'Object Diameter', 'Unspecified Magnitude'

Some data field are used together to represent different use cases:

- If 'Right Ascension', 'Declination' and 'RA/DEC Search Range' are all specified, a search for objects around the given RA/DEC position is triggered. If the range is not given, a default value (2.5 degree) is chosen.
  - If one of 'Right Ascension' or 'Declination' is missing the 'RA/DEC Search Range' gives the maximal distance for objects to the given coordinate. If the range is not given, a default value ($\frac{\sqrt{2.5}}{100} \approx 1'$, so that the matching area is nearly equal to the search circle around a RA/DEC position).
  - All other data fields which allow a range of values to be entered are processed independently and will further narrow down the resulting objects.

All the basic use cases can be combined in a search request, narrowing down the resulting objects independently.

6.6.6 Tycho2 Catalog[23]

The Tycho2 catalog behaves much like the NGC/IC catalog (see section 6.6.5). The remaining differences are given by other catalog data being available.

Available data fields are:

- 'Object Name'[24]
- 'Right Ascension', 'Declination', 'RA/DEC Search Range'
- 'RA Proper Motion', 'DEC Proper Motion', 'Visual Magnitude', 'BV Color'

[19] The used target types are: Instrumental, Horizontal, Equatorial, Elements, Two-Line-Elements, Solar System and Catalog.
[20] http://cdsarc.u-strasbg.fr/cgi-bin/qcat?VII/118
[21] The catalog specific naming scheme is 'NGC', 'IC' or 'M' as prefix followed by a white space and an index number. ? can be used to denote an abitrary char and * for any length of arbitrary chars.
[22] Is a fixed value for all entries to register the custom B2000.0 equinox.
[23] http://cdsarc.u-strasbg.fr/cgi-bin/qcat?I/259
[24] The catalog specific name is e.g. 'TYC 5949-277-1' for Sirius. ? can be used to denote an abitrary char and * for any length of arbitrary chars.

The catalog is converted from its raw notation to a more powerful database representation at the very first start[25]. Because of the significant size of the catalog and the number of entries this process takes some minutes. The progress made so far can be watched in the 'Radar' view (section 4.2) — maximize it to have an even better look.

Note: Starting AsTelOS the next time after the conversion was done the database is compacted — this takes also a couple of minutes. In this time span the database isn't available!

6.6.7 Heavens-Above online catalog

Available data fields to search for are:

- 'Object Name'[26]
- 'Altitude'[27]
- 'Visual Magnitude'[28]
- 'Search Time'

The answer contains one entry for every pass. Data Fields that are delivered:

- 'Rise-Time', 'Set-Time', 'Pass-Time'
- 'Altitude', 'Range', 'Visual Magnitude'

Heavens-Above service is used to acquire the TLE of satellites passing in the questioned time span. The catalog is only available online and therefore using it requires a working internet connection.

Note: As the catalog connector is designed with screen-scraping techniques it can stop working if the format of the delivered data is changed.

6.6.8 Sesame Name Resolver online catalog

Available data field to search is:

- 'Object Name'

The answer may contain the following data fields:

- 'Name', 'Type'
- 'Right Ascension', 'Declination'
- 'RA Proper Motion', 'DEC Proper Motion'
- U/B/V/R/I/J/H/K-Magnitude

Sesame name resolver is an online service with a standardized Web-API. It uses primarily Simbad and NED for name resolution. For the usage a working internet connection is necessary.

Note: As the format of the API is fixed it is not expected that the service voids function but this possibility couldn't be excluded either.

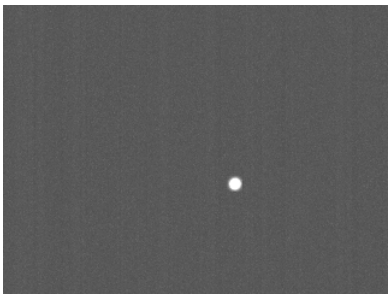
[25] Closing AsTelOS during the conversion process is possible as AsTelOS will recover from this, but will loose the already made progress.
[26] The catalog specific name is e.g. 'TYC 5949-277-1' for Sirius. ? can be used to denote an abitrary char and * for any length of arbitrary chars.
[27] Minimal altitude a specific
[28] Minimal magnitude a specific pass must reach to be reported.

6.7 Insights into the camera processing pipeline

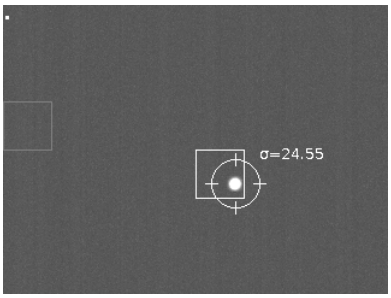
Where and how to change the processing pipeline is described in section 3.1 on page 10 describing the according preference pages.

6.7.1 Available processing stages

To demonstrate the effect of the different stages this example image is processed through each of them:



Centroid Search To search for the brightest spot in the image this stage works in two part. First: identifying the brightest area of the image and second: searching for the mean position of the spot. On the image debug symbols are drawn:



The debug symbols are:

Lock Dot in the upper left corner of the image. This is shown if the accumulated brightness over the whole size of the detected spot is larger than the set threshold (see the preferences in section 3.1) in regard to the variability of the background.

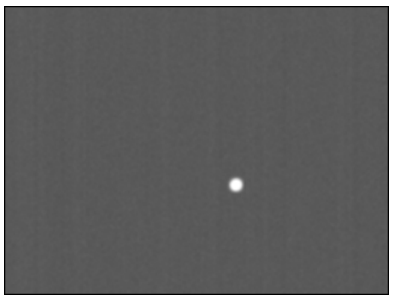
Lock Circle around the detected spot is also shown if the spot exeeds the set threshold.

Cross-Hair showing the detected position of the detected spot — even if the threshold criteria was not reached.

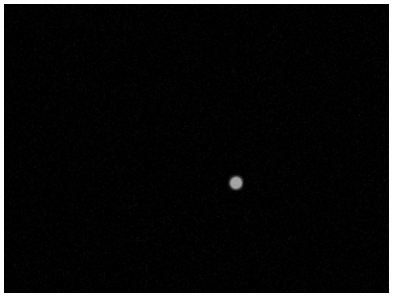
Significance number is always printed to the upper right of the detected spot.

Tiles are shown with the brightest and the second brightest area in the image.

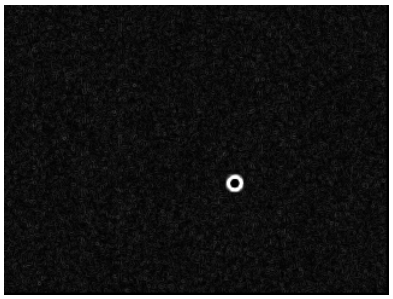
Custom 3x3 Filter The custom 3x3 filter provides a customizable 3x3 matrix that can be applied to the image. The default parameters are set to realize a gaussian filter:



Dark Frame To subtract the static influence e.g. of hot pixels, thermal or read-out noise a dark image can be subtracted with this processing stage. This aids in reducing the mean value and flattens deviations of the background:

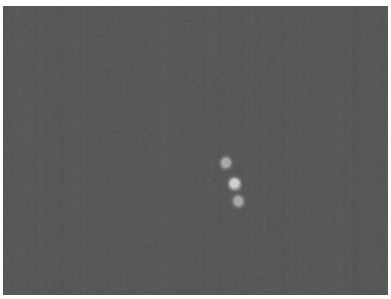


Edge Detection (Sobel) A star is expected to be a spot with more or less steep edge. Applying the sobel edge detection filter yields in amplifying the signal of such a spot. The image shouldn't be too noisy if using this filter otherwise the result might be worsened:



Grayscale Conversion Reducing the calculation effort of later processing stages the image might be reduced to a monochromatic version. This is realized with this processing stage.

Temporal Mean If the camera input is too noisy a temporal averaging could be applied. The rate of output images is reduced by be number of images used for averaging. This is only useful for targets that does not move too much between the different images. Instead objects might show up multiple times:



6.7.2 The default pipeline

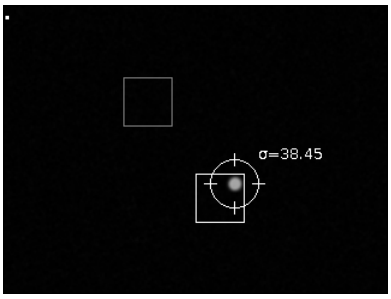
By default the pipeline is build up in this order:

1. The grayscale conversion should reduce the futher calculation effort. This means only the brightness is calculated not multiple color channels as for RGB.
2. Temporal mean is applied to reduce the load on the next processing stages. A sufficient rate might be one or two images per second, but this depends also on the available computation power. More images might be ignored if the pipeline is fully loaded resulting in an information loss. Therefore the images are used to reduce the noise.

   Note: The image acquisiting rate is expected as five frames per second. If the actual rate differs much the number of frames used for temporal averaging should be adopted (see section 3.1).
3. Removing static residuals and to flatten the image background the dark frame subtraction is utilized.

   Note: A suitable dark frame must be saved before this step could be fully working. This is done when no light is reaching the camera but it is capturing images. In the preference setting a dark image can be added (see section 3.1).
4. Applying a spatial average with the custom 3x3 filter is done as the last image preparation.
5. At the very last stage the centroid search is executed to check for a target in the so far prepared image.

The pipeline results is for the example image this output — the object is clearly detected:



7 Trouble Shooting

This section cares about common problems and how to deal with them.

7.1 Telescope Errors reported

Errors — more precisely: events the user has to acknowledge — are reported so that the user can react adequately:

1. Signaling reported errors is done through the telescope status panel situated in the status line (see section 2.2 on page 8). If the 'Error' text field reports 'INFO', 'WARN', 'ERROR' or 'PANIC' these events can be investigated more thoroughly.
2. Open the 'Engineering' perspective (see section 5.2 on page 48) and examine the errors within the 'Telescope Errors' section.
3. If the presented event indicates no hardware problem (e.g. reaching soft limit of an axis due to adding large offsets): Click the 'Clear and Acknowledge' button.
4. If the presented event indicates a hardware problem or is persistent (occurs again and again) report it (see section 7.3).

   Note: Acknowledging a persistent problem repeatedly may result in hardware damage!

7.2 Telescope not tracking

The telescope was ordered to track a target but the 'Telescope' text field within the telescope status panel (see section 2.2 on page 8) did not reach the 'tracking' state. A similar problem is if the 'Telescope' state toggles between 'tracking' and 'slewing'.

1. Open the 'Engineering' perspective (see section 5.2 on page 48) and examine the axes status within the 'Axes Status' view. Pay attention to the 'Motion State' column. The axes used for the current tracking should show at least the flags 'trajectory' and 'accurate' often in combination with 'move'.
2. Check for which tracking axis the 'accurate' flag is not shown while the telescope is 'slewing'. Some explanations are common but depend on the axis that is responsible for this misbehavior:

   a) Azimuth axis may be to slow if the azimuthal telescope points near the zenith.

   b) Derotator axis may be imprecise if the load is very different from that used to tune it.
3. If this behavior is unexplainable or should be corrected, report it (see section 7.3).

7.3 Reporting a Failure

If AsTelOS GUI has undergone a failure or the software/hardware did not work as expected, follow these steps, if possible. This will be helpful for the investigation:

1. Within AsTelOS GUI, click the 'Log Report...' button (see section 2.2 on page 8).
2. Fill in the description field:

   a) what was done...

   b) what happened...

   c) what was expected...

3. Select the time span for that data from the log files should be integrated in the report snapshot — make sure that this goes back to at least a little before the moment the problem occurred, while keeping in mind that a too long snapshot could make it difficult to find the moment of failure.
4. Set the location and name of the created snapshot file — if needed. Remember the path.
5. *Optional:* Check if the suspicious behavior can be reproduced. Make a note about the trials within the description field.
6. *Optional:* If the behavior can be reproduced: Is it present if AsTelOS GUI is restarted? The TSI service? The telescope control cabinet?
7. *Optional:* Check within the 'Error Log' view if there were events reported that happened at the time of the failure (see section 4.15 on page 46).
8. Contact the manufacturer and send the created snapshot file(s).

If AsTelOS GUI is not functioning or other problems prohibit following the guide above a more generic approach to this is described below:

1. Note the current date, time, timezone of the time.
2. Describe what was done.
3. Describe what happened.
4. Describe what was expected.
5. *Optional:* Check if the suspicious behavior can be reproduced. Note date, time and outcome for each trial.
6. *Optional:* If the behavior can be reproduced: Is it present if AsTelOS GUI is restarted? The TSI service? The telescope control cabinet?
7. *Optional:* Check within the 'Error Log' view if there were events reported that happened at the time of the failure (see section 4.15 on page 46).
8. Contact the manufacturer.

7.4 Cache-File Structure

In addition to section 7.3 on the previous page the file structure of the program cache is explained as the wish to explore it might arise. The base directory is located within the home directory of the user (e.g. 'observer') that uses the program, for example:

```
/home/observer/.tau-tec/AsTelOS GUI
```

Two sub-directories are used to mark persistent configurations (`/config`) and restorable data files (`/data`).

7.4.1 Configuration Directory

Files stored at this location are used to save preferences that belong to the current user. They might be backed up to restore all settings made in AsTelOS GUI.

Current configuration data located here:

/.metadata the directory contains files that store settings — mainly UI dependent. As the files are created by the Eclipse RCP used by AsTelOS GUI they are not explained further here.

log.properties with settings about the logging that can be changed as described in section 3.3.1 on page 18.

7.4.2 Data Directory

The files stored at this location are either for caching purposes or logging tasks. If this directory grows too big, it may be deleted — AsTelOS GUI will recover from it. *Note:* Shut down AsTelOS GUI first if you are planning to erase it.

There are different sub-directories used for saving logging information:

/DataBase The sub-directories apply each to one Java-DB database that is used within the program.

/Debug The files inside are used in rotation scheme with the newest file named 'Debug_0.log'. It contains are various messages from the program that should help with debugging.

/IO The files inside are also used in a rotation scheme with the newest file called 'IO_0.log'. Here is all TPL traffic between AsTelOS GUI and the TSI service stored.

/orekit The files are used by Orekit that helps in calculating apparent position for TLEs.

/Snapshots If a user triggers taking a log snapshot (as described in section 2.2 on page 8) a copy of the snapshot is archived here.

/Trace The files inside uses the rotation scheme, too and the newest file is 'Trace_0.log'. Detailed messages about entering and leaving internal functions are stored.

Other data files are:

application.lock is used as communication interface to prevent AsTelOS GUI from being started twice on the same computer.