Screen Ruler

Software from Great Shefford Observatory

Table of contents

Overview

version 1.0.34 Rev 02Jan2022

Screen Ruler is a resizeable, semi-transparent window that can be placed over other windows. It contains a moveable and resizeable line used as a ruler to read off measurements from underlying images. It is designed to speed up the identification of astronomical images in a sequence taken of a moving object such as a minor planet or comet, where the object passes close to field stars or galaxies. These images can then be left out from further processing, allowing more accurate measurement of the object's position and brightness.

Screen Ruler is designed to be used in situations where the minor planet or comet is too faint to be visible in individual images, only being revealed after digitally stacking multiple images together using software such as Astrometrica. If the moving object is bright and easily seen on individual exposures there is no need to use Screen Ruler, it will be obvious which images need to be left out. Also in some instances a good result may be obtained by using median stacking functionality, but, especially with smaller focal length systems, this may not give optimal results.

The Ruler is drawn on the Screen Ruler window to represent the motion of an asteroid or comet. Information about the images being used is entered in the Screen Ruler Control window, allowing the location of the mouse to indicate the images where the minor planet or comet is close to background objects.

Screen Ruler can be used in several different scenarios, these are covered in tutorials:

- **Simple**, using a linear interpolation between the first and last images used in a stacked image
- **Intermediate**, using images stacked for the object's motion and another with zero motion to increase precision and to identify all field stars involved
- **Advanced**, same as Intermediate, but extracting exposure information directly from the FITS images being stacked, giving extra precision and allowing the selected images to be copied to a separate folder for ease of stacking for the final measurements.

Please see the tutorials for further details.

System requirements
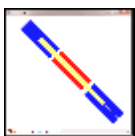
Screen Ruler is a 32-bit program that runs on 32-bit or 64-bit Windows 7, 8 or 10 systems.

The program requires Windows .Net Framework 4.6.1 or later to be installed.
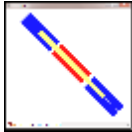
Installation

The installation file can be downloaded from https://birtwhistle.org.uk/SoftwareDownloads.htm

Unzip the **setup.exe** and **setup.msi** files into a local temporary folder

Run **setup.exe**.

A standard Windows setup dialogue will be displayed, acceptance of the license agreement is required to complete the installation.
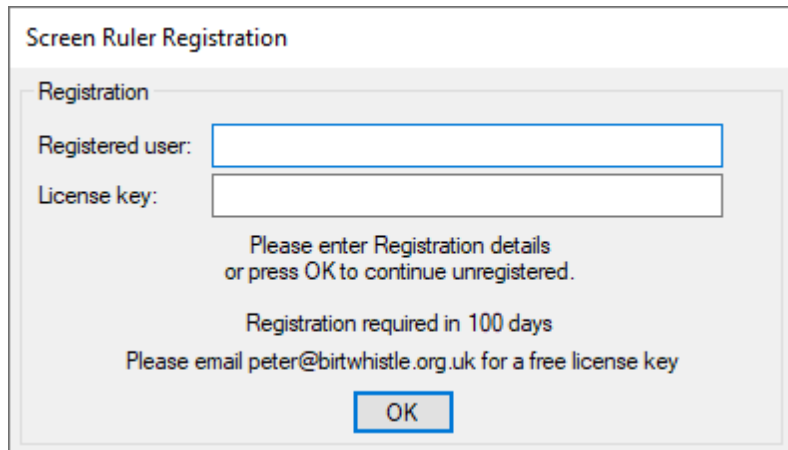
The setup creates a **program group** called "J95Soft" and adds an **icon** for "Screen Ruler"

After successful installation the downloaded installation zip file, setup.exe and setup.msi files can be deleted.

The program can be uninstalled from **Programs and Features** in **Control Panel**.

Registration

The program requires registering and will display a registration screen for the first 100 days. During that time, please request a **free license key** to register the program.

After successful registration this screen will no longer display at startup but is still accessible from the About screen to view the **Registered user** name.

The **Registered user** and **License key** details should be retained, as they may be needed again in case the program is re-installed.

What's new

V1.0.35 (05 Mar 2022):
Fixes:
Minor internal modifications

V1.0.34 (15 Oct 2021):
New functionality:
Draw ruler by dragging mouse
Add an arrow to the end of the Ruler line
Simplify setting of the Ruler start and end positions
Select and deselect FITS images by dragging mouse on Screen Ruler
Copy selected FITS image files to a folder for stacking
Undo and Redo changes made to the position of the ruler
Allow times in FITS DATE-OBS keyword to be configured as start, mid, or end of exposure times.
Add Help (this documentation) via new 🔵 Help toolstrip button
Replace 🔵 Instructions with "Instruction summary" help topic
Add a Check for Updates to notify user when new versions of Screen Ruler are available for download

V1.0.33 (30 Jul 2021):
Fixes:
Cursor position along ruler was not calculating accurately when line was nearly vertical or horizontal

V1.0.32 (18 Mar 2021):
Fixes:
Internal toolstrip behaviour modifications

V1.0.31 (02 Mar 2021):
Fixes:
Registration modifications

V1.0.29 (04 Feb 2021):
Initial public release

Getting help

For help and support please use the contact page at https://birtwhistle.org.uk/ContactUs.htm

Getting Started

Read through the Screen Ruler window topic to review the main components of the Screen Ruler. Then work through at least Tutorial I to attain a basic understanding of how to use Screen Ruler.

If Screen Ruler is installed it can be used with some of the images in the tutorials to try out basic measurements, even if track and stack software or other FITS images are not available.

Screen Ruler windows

Screen Ruler displays two windows when first started, the **Screen Ruler** window and the **Control** window.

The **Screen Ruler** window is semi-transparent and floats above other windows and includes a resizeable line or ruler. It is designed to be placed over images stacked in Astrometrica.
The **Control window** is where all settings and image information are entered.
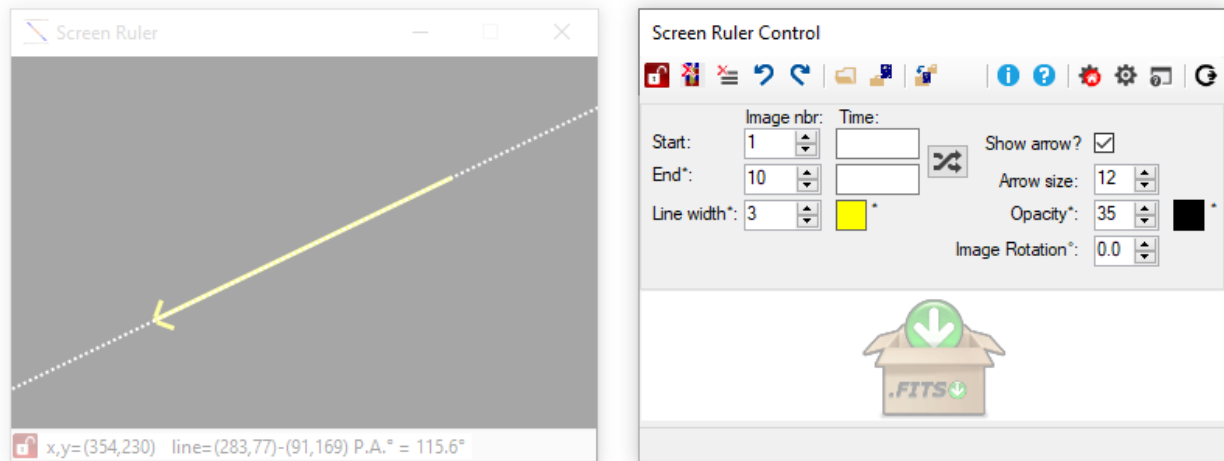
These and other windows are described in detail in the following sections:

[Control window](#)
[Screen Ruler window](#)
[Magnifier window](#)
[Settings window](#)
[About window](#)

Control window

Control window

The Control window consists of four areas:

- a set of [toolstrip buttons](#)
- a [Settings area](#)
- a [FITS files area](#)

- a [Status message area](#)

Toolstrip buttons

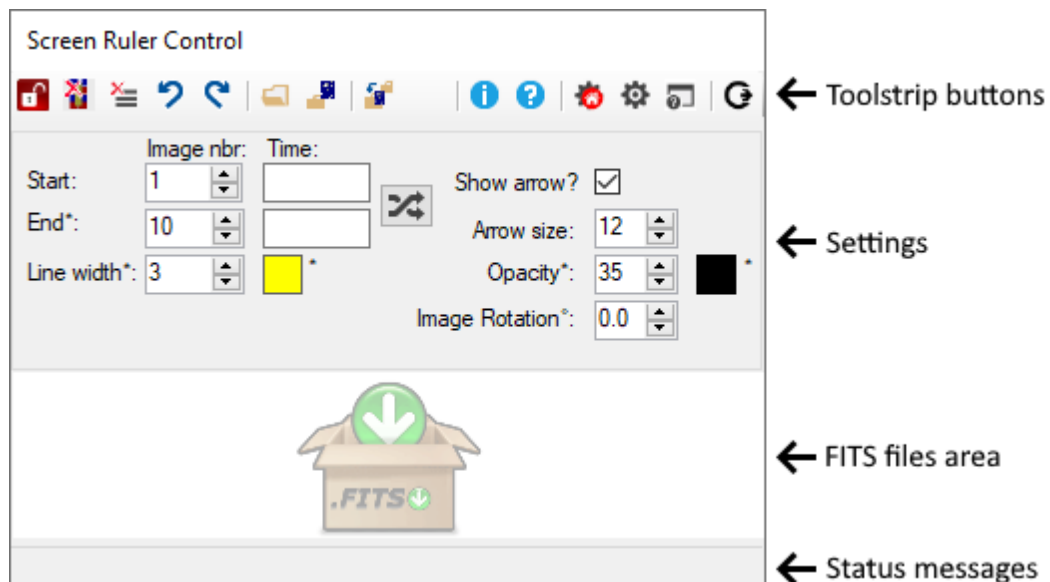## Control window toolstrip buttons

Hover mouse over a button for a description and click for details

Locked / Unlocked

Locked   **Unlocked**

This button toggles between two states, Locked and Unlocked. It controls how the Screen Ruler position is adjusted when using the **keyboard**. This is useful when using the [Magnifier window](#) to set the start or end positions accurately.

When the program starts the Ruler is Unlocked.

Unlocked (Adjust Ruler START or END position)

When the Screen Ruler is unlocked the keyboard arrow keys adjust either the ruler start or the end position.

Press the arrow keys to adjust the ruler **START position.** The mouse is placed over the **START** position.
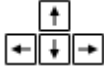
Hold **Ctrl** & press the arrow keys to adjust the ruler **END position.** The mouse is placed over **END** position.

When moving the start or end position, hold **Shift** to move **5x faster**.

🔒 Locked (MOVE entire ruler)

When the Screen Ruler is locked the keyboard arrow keys move the entire ruler.

Press the ⬆⬅⬇➡ arrow keys to **MOVE ENTIRE RULER.** The mouse is placed over the **START position**.

Hold **Ctrl** & press the ⬆⬅⬇➡ arrow keys to **MOVE ENTIRE RULER.** The mouse is placed over the **END position**.

When moving the ruler, hold **Shift** to move **5x faster**.

Show / Clear exposure boundaries

Show exposure boundaries   **Clear exposure boundaries**

This button toggles between two states, **Show exposure boundaries** and **Clear exposure boundaries**. It is only enabled for use if there are FITS files listed in the FITS files area.

When FITS files are dropped in the FITS files area, lines of alternating colour are drawn on the ruler indicating the start and end points of each exposure and the button is set to 🔀 **Clear exposure boundaries**.
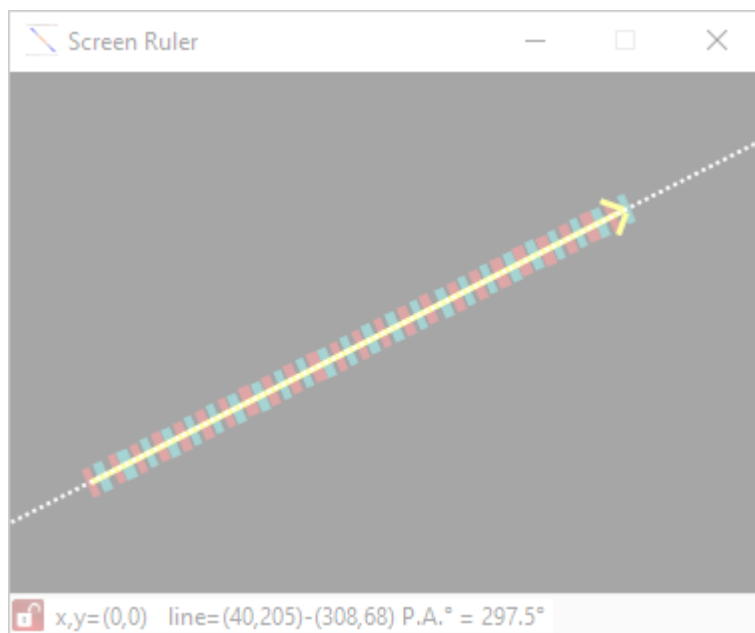
Press the 🔀 **Clear exposure boundaries** button to remove the exposure boundaries:
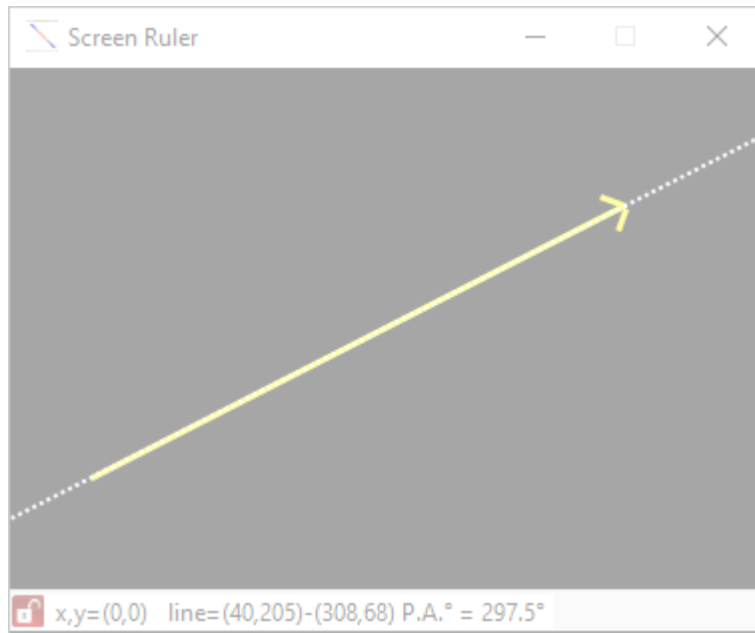
The button changes to 🏠 **Show exposure boundaries**, press it again to re-display the exposure boundaries.

No changes are actually made to the list of FITS files when using this button, only whether the exposure boundaries are displayed on the Screen Ruler.

The colours of selected and unselected exposure boundaries and also their line widths can be changed from the ⚙ Settings window using the Exposure Markings settings.

Clear file list

 Clear file list

Enabled only when FITS files are listed in the FITS files area. Press to remove all files from the list. To re-fill the list, FITS files must be dropped onto the FITS files area again.

Undo / Redo

 Undo   **Redo**

Allows changes to the position of the Screen Ruler to be undone, or re-done.

Changes can result from dragging a new line with the mouse, or by adjusting the start or end position of the ruler or by moving the entire ruler.

The keyboard shortcuts **Ctrl+Z** for Undo and **Ctrl+Y** for Redo can be used instead of the toolstrip buttons. **Right-clicking** the mouse on the Screen Ruler window will also display a **context menu** with Undo and Redo options.

Note: Undo and Redo does NOT affect the selection and de-selection of files in the FITS files area, just changes to the position of the line.

Open FITS file source folder

 Open FITS file source folder

Opens the folder named in the FITSSourceFolder program setting using Windows Explorer. The button is only enabled if the folder exists.

Used in conjunction with the Open FITS file stacking folder and Copy selected files buttons. The FITS file source folder and FITS file stacking folder must be different for the Copy

selected files button to be enabled.

Set the name of the source folder either from the ⚙ Settings window, or by dragging and dropping the source folder (or a file in that folder) from Windows Explorer onto the 🗁 **Open FITS source folder** toolstrip button.

The currently configured folder name is displayed as a tooltip when the mouse hovers over the 🗁 **Open FITS source folder** button. Only the folder name and parent folder name are shown for compactness, formatted as:

> Open FITS file source folder:
> > Parent folder name > Folder name

Open FITS file stacking folder

Open FITS file stacking folder

Opens the folder named in the FITSStackingFolder program setting using Windows Explorer. The button is only enabled if the folder exists.

Used in conjunction with the 🗁 Open FITS file source folder and 📋 Copy selected files buttons.
The FITS file source folder and FITS file stacking folder must be different for the Copy selected files button to be enabled.

Set the name of the stacking folder from the ⚙ Settings window, or by dragging and dropping the stacking folder (or a file in that folder) from Windows Explorer onto the 📁 **Open FITS stacking folder** toolstrip button.

The currently configured folder name is displayed as a tooltip when the mouse hovers over the 📁 **Open FITS stacking folder** button. Only the folder name and parent folder name are shown for compactness, formatted as:

> Open FITS file stacking folder:
> > Parent folder name > Folder name

Copy selected files

Copy selected files

Copies selected FITS files from the FITS file source folder to the FITS file stacking folder. Used to quickly isolate files for stacking after selections have been made on the Screen Ruler.

The button is only enabled when the following conditions are met:
- The FITS file source folder exists
- The FITS file stacking folder exists
- The FITS file source folder and FITS file stacking folder are not the same folder
- There are FITS files listed in the FITS files area

When the Copy selected files button is pressed, the FITS files currently selected in the FITS files area are copied from the **FITS file source folder** to the **FITS file stacking folder**. If there are any other files already in the stacking folder a prompt will be displayed similar to:

> **Delete *x* excess files in stacking folder '> Parent folder > Stacking folder' before copying new selection in?**

Options are:
- **Yes** (All files will be deleted from the stacking folder, then the selected files will be copied in)
- **No** (The selected files will be copied into the stacking folder, adding to any existing files)
- **Cancel** (Abandon the copy operation)

The currently configured folder names are displayed as a tooltip when the mouse hovers over the **Copy selected files** button. Only the folder name and parent folder names are shown for compactness, formatted as:

> Copy selected files:
> > from source folder: > Parent folder name > Source folder name
> > to stacking folder: > Parent folder name > Stacking folder name

Instructions

Instructions

Displays the Instruction Summary help topic, designed as a quick guide to the Screen Ruler mouse and keyboard controls.

When using the Screen Ruler, to conserve screen space the Instruction Summary is most conveniently viewed by hiding the Help System tabs by pressing the button at the top of the Help System window.

Help

Help

Displays this documentation

Save current settings marked with * as new defaults

 Save current settings marked with * as new defaults

Some internal settings used by the Screen Ruler can be set up as defaults that will be used each time the program starts. These are *separate* from those that can be maintained from the Settings window.

Pressing the toolstrip button will set the current values of the settings listed below as the new defaults to be used each time the program is started.
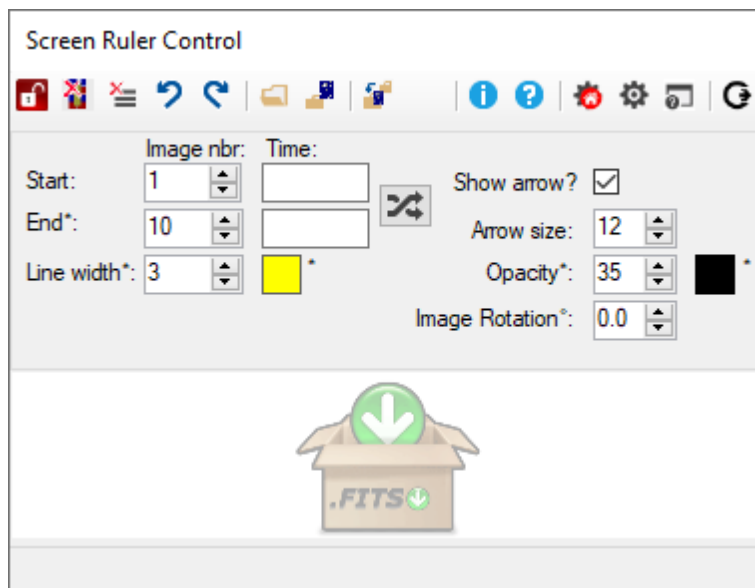
Some can be adjusted on the Control window and they are indicated with a * above. See the Settings area for details. They are:

- End Image number
- Line width
- Ruler colour
- Opacity
- Screen Ruler background colour

The remaining internal settings that are saved as new defaults are:

- Initial location of the Control window
- Initial location and size of the Screen Ruler window
- Initial location, size and magnification of the Magnifier window
- Initial visibility of the Screen Ruler Perpendicular line
- Initial location of the Settings window

To set new defaults:
- Modify any of the settings marked with a * on the Control window that require changing.
- Position the Control window to where it will be required when the program next starts.

- Position and resize the Screen Ruler window where it will be required.
- Press **F9** to toggle the perpendicular line on or off as required.
- Press **F12** to display the Magnifier window, then position it, optionally dock it (with **Ctrl+F12**), size it and set the magnification as required.
- Press ⚙ Settings to display the Settings window and position it as required, then press **OK** to return to the Control window.
- Press the 🔥 **Save current settings marked with * as new defaults** button.

Note: The locations of the windows can be reset to the top left of the primary screen by holding the **Shift+Ctrl** keys when starting the Screen Ruler.

Settings

⚙ **Settings**

Displays the Settings window.

The Settings window is displayed modally, it must be closed before continuing to use the Screen Ruler.

About

 About

Displays the [About window](#).

The About window is displayed modally, it must be closed before continuing to use the Screen Ruler.

Exit

 Exit

Press Exit to close all Screen Ruler windows. Equivalent to pressing the Close button (X) in the control box of the Screen Ruler window.

Settings area

Control window Settings area
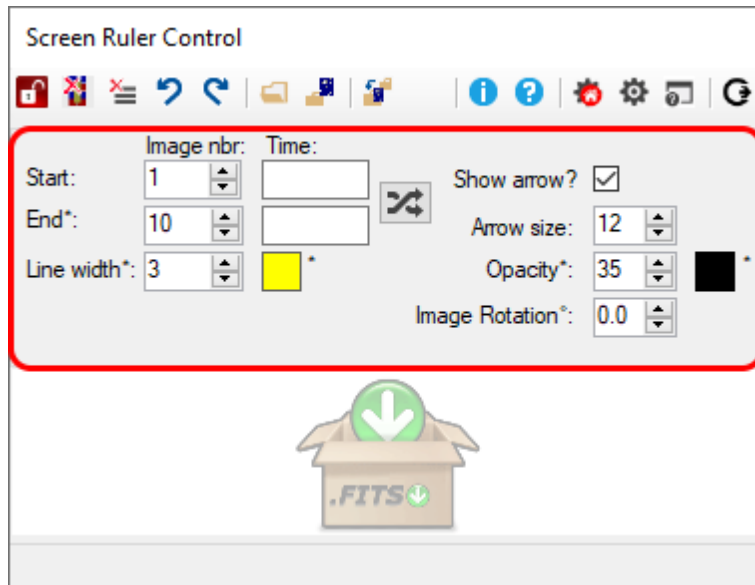
Note: Some controls are marked with a * if their current values can be saved as the default value using the 🐞 Save as new defaults button.

Start and End Image nbr:

Values for Start and End image number must be entered manually unless FITS files are dropped into the FITS files area.

If entering manually, images are assumed to be equally spaced in time. Enter a sequential number for the first and last image used.

Start and End can range from 1 to 9999. The Start number can be greater than 1. The End number must be greater than the Start number. The current End number can be saved as the default value using the 🐞 Save as new defaults button.

Start and End Time:

Start and End times are optional, but if present will be used to calculate the time relating to the mouse position on the Screen Ruler window. See Displaying coordinates via the mouse. Values for Start and End time must be entered manually unless FITS files are dropped into the FITS files area.

If entering times manually, enter a time for the first and last image used. The times are entered as 24 h values in hhmmss (hours, minutes, seconds) format or in hh:mm:ss format. If the Start time is after the End time then it is assumed that midnight has been crossed and the End time is in the day following the Start day. Enter a convenient but consistent time used in your images, e.g. use the exposure start time for both Start and End times, or the exposure mid-time for both Start and End times.

⤬ Swap button:

Swaps the start and end coordinates of the Screen Ruler line, reversing the direction of the Screen Ruler arrow if displayed. The Start and End numbers and the Start and End times if present are left unchanged.

Show arrow? and **Arrow size:**

Tick the Show arrow? control to display an arrowhead at the end point of the Screen Ruler line. Use the Arrow Size control to increase or decrease the arrowhead size, between 5 - 20 pixels.

Line width and colour:
Change the width of the Screen Ruler line, between 1 - 6 pixels. Click on the coloured square to choose a colour for the Screen Ruler line. The current settings for both controls can be saved as default values using the Save as new defaults button.
Note that the thin dotted extension line on either end of the Screen Ruler is always displayed and is not adjustable.

Opacity % and **colour:**
Opacity % controls the semi-transparency of the Screen Ruler, in the range 5 % (almost invisible) to 100 % (completely opaque). When the Screen Ruler window has focus and the Alt key is pressed the Opacity is temporarily changed to 1%, effectively hiding the ruler. Click on the coloured square to choose a background colour for the Screen Ruler window. The current settings for both controls can be saved as default values using the Save as new defaults button.

Image rotation °:
The position angle in degrees (P.A.°) of the Screen Ruler line is displayed in the status area of the Screen Ruler window:

P.A.° uses the convention North = 0°, East = 90°, South = 180°, West = 270°, i.e.:
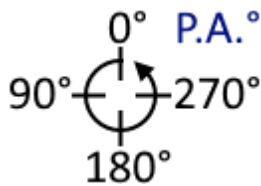
Astronomical images may not be aligned so that North is exactly "up" and therefore the value of the P.A.° on the Screen Ruler may be in error. Use this control to correct for the rotation in the underlying images if the Ruler is being used to measure position angles in images. The value required is the value of "Rotation" in the Astrometrica log after an image is solved which is also the value of the negated FITS keyword CROTA2 i.e. (-1 * CROTA2) if present in the FITS file. Image rotation° is automatically set if FITS files dropped into the FITS files area contain the FITS keyword CROTA1 or CROTA2. The rotation value value is taken from the first of the dropped FITS files that contain a valid value.

FITS files area

Control window FITS files area

Information can be automatically extracted from the underlying (unstacked) FITS files by selecting all the files being used for analysis in Windows Explorer, then dragging and dropping them onto the FITS files area of the Control window.
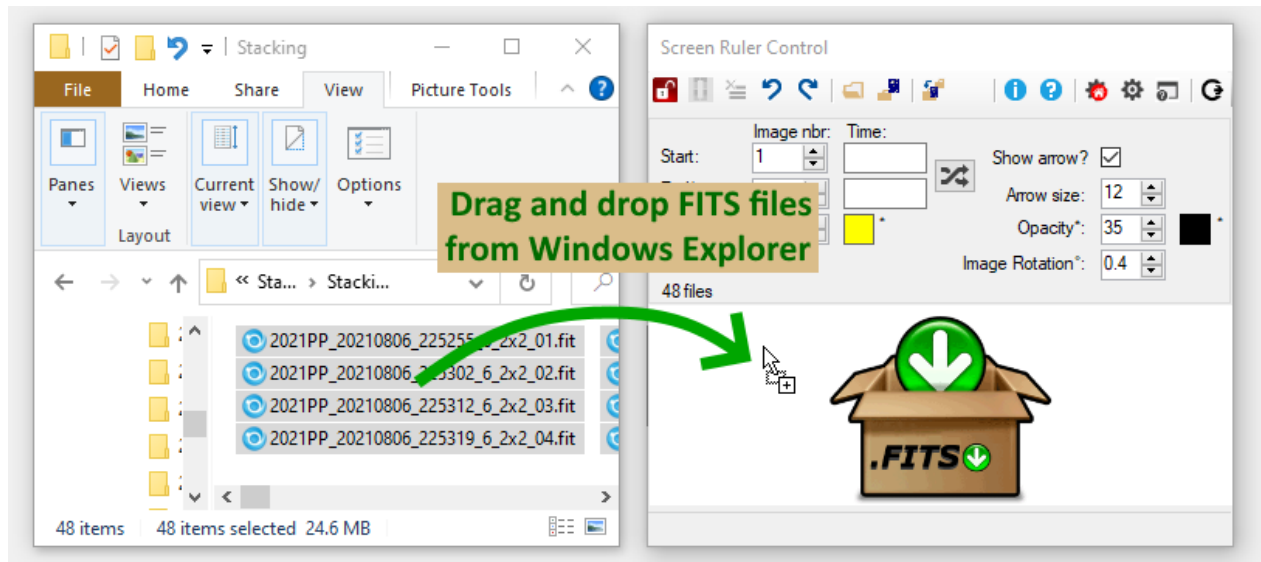
When this is complete, the FITS files area changes to display a list of the valid dropped files. FITS files must have a file extension (or suffix) listed in the blank separated list of FITS file extensions in the ImageFileExtension setting and must contain a minimum set of FITS keywords to allow the exposure start date and time to be determined. SeeRecognised FITS keywords.

Here 48 files used in the Tutorials have been dropped onto the FITS files area. Each line consists of a sequential image number (from 1 to the number of images in the list), the exposure start date/time and the FITS file name. The Control window can be resized to show more of the file information. The Start and End Image numbers and the Start and End Times in the Control window are automatically set to the values extracted from the files.
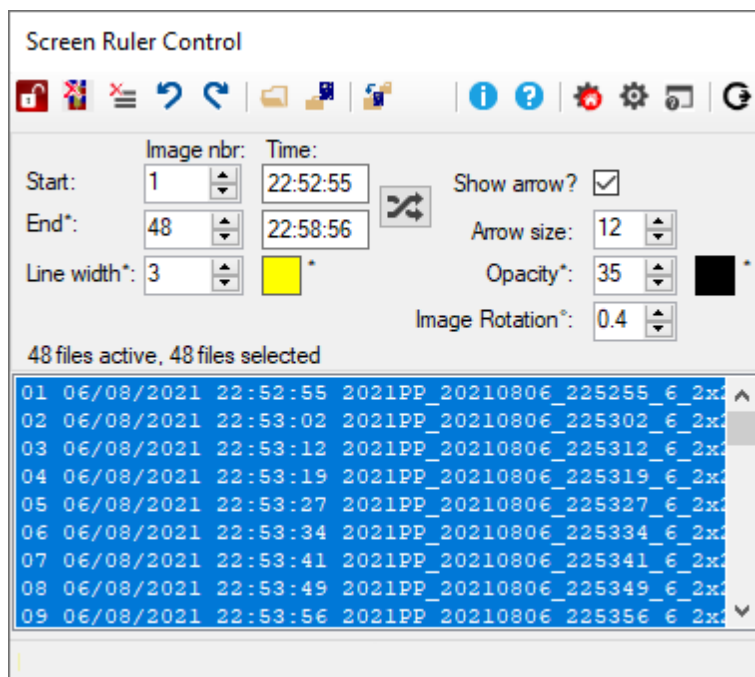
All lines are selected by default but files can be deselected directly from the list in the Control window, or by using the mouse on the Screen Ruler window.

Status messages

Control window Status messages

Informational, warning and error notifications are shown at the bottom of the Control window.

Here, a folder has been dragged onto the 'Open FITS files source folder' toolstrip button to update the FITSSourceFolder setting. The status message area displays the outcome of the operation, showing the folder name and its parent:
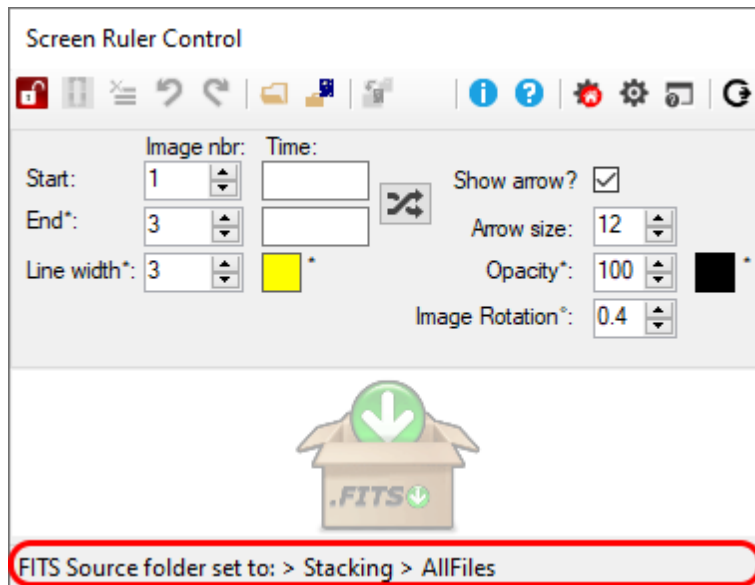
Note: If a long message is generated, either resize the Control window to display the entire message, or hold the mouse over the message to display the information as a tooltip.

Screen Ruler window

Screen Ruler window

The Screen Ruler window is a resizeable, semi-transparent window that can be placed over other windows. It contains a moveable and resizeable line used as a ruler to read off measurements from underlying images. The parts of the Screen Ruler (on the left) are shown here, as well as the source of the Mouse information coming from the Control window on the right.
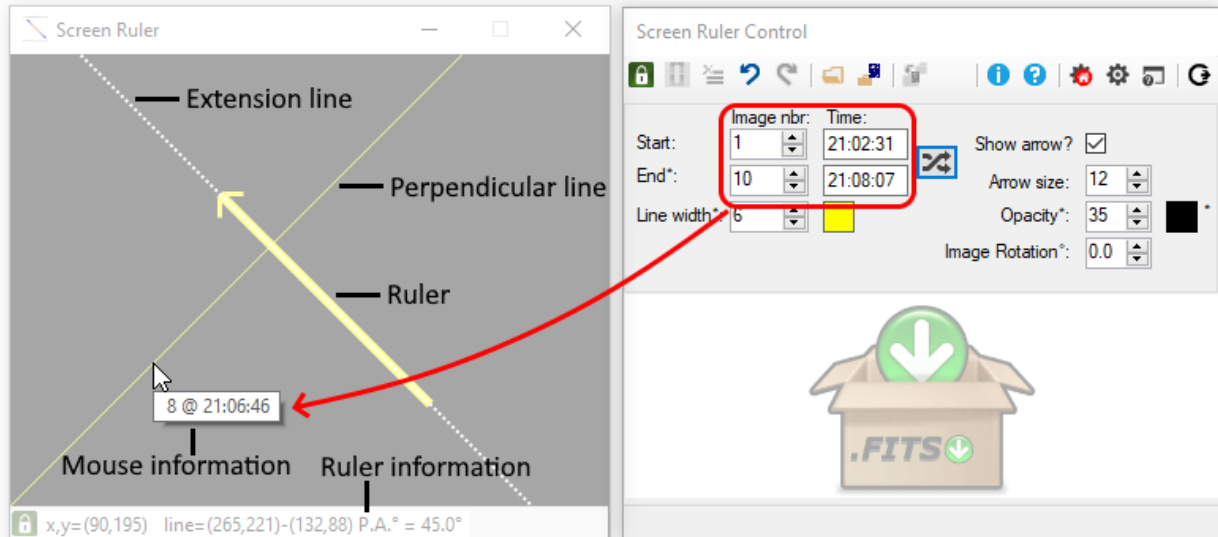
Ruler:

The ruler is a straight line that can be drawn on the semi-transparent window. There are a number of ways to draw the ruler or change its position:

- Drag a fresh line by holding the left hand mouse button while moving the mouse
- Set the starting point by positioning the mouse at the required place and:
  - pressing the Home key, or
  - pressing the Enter key, or
  - holding Shift and clicking the left mouse button
- Set the ending point by positioning the mouse at the required place and:
  - pressing the End key, or
  - holding Ctrl and pressing the Enter key, or
  - holding Shift and clicking the right mouse button
- Move the starting point when the ruler is 🔓 unlocked by pressing the arrow keys
- Move the ending point when the ruler is 🔓 unlocked by holding Ctrl and pressing the arrow keys
- Move the entire ruler when the ruler is 🔒 locked by pressing the arrow keys
- Move the Screen Ruler window by dragging the title bar with the mouse moves the Ruler along with the window
- Hold Ctrl while moving the Screen Ruler window to leave the Ruler stationary

The ruler width and colour are adjustable from the Control window Settings area.

Image information can be entered into the Control window Settings area so that when the mouse hovers over the Screen Ruler window, information indicated by the mouse position is displayed as a tooltip next to the mouse cursor. The information always includes a sequential image number and can optionally include a time or a FITS file name if FITS files have been dropped on the Control window FITS files area. In the screen print above, the mouse position is used to interpolate between the start and end image numbers (1 and 10) and the start and end times (21:02:31 and 21:08:07) entered in the Control window to produce the tooltip information "8 @ 21:06:46", i.e. the nearest point on the ruler to the mouse position is at image number 8 and the estimated time for that position is 21:06:46.

The ruler can be temporarily hidden when moving the mouse over the Screen Ruler window by

holding the Alt key.

Ruler arrowhead:
An optional arrowhead can be displayed at the end point of the ruler. See the Control window
[Show arrow?](#) check box for details.

Extension line:
A thin white, dotted extension line extends either end of the ruler. This line is always displayed
and is not adjustable. It is used to extrapolate the image number and optionally time from the
mouse position when it is outside the limits of the ruler.

Perpendicular line:
Press the **F9** key to toggle on or off the display of a thin yellow line from the mouse position,
perpendicular to the ruler. This crosses the ruler at the closest point between ruler and mouse.
Various actions use this crossing point rather than the actual mouse position, even if the
perpendicular line is not displayed, such as:
- the interpolated image number, time or FITS file name displayed in the mouse tooltip are
  calculated for the crossing point
- when dragging the mouse while holding **Shift+Ctrl** or **Ctrl** to select or deselect FITS files, the
  files affected are determined from the crossing points at the start and end of the dragging
  operation.

Ruler information:
The status area at the bottom of the Screen Ruler window shows the current x,y position of the
mouse pointer and the start and end points of the Ruler. Coordinates start at (0,0) in the top left
corner of the Screen Ruler window and increase downwards and to the right.
Also displayed is the position angle (P.A.°) of the Ruler, measured in degrees. This is the angle
subtended by a vertical line with origin at the Ruler start point and the Ruler itself, increasing in
an anticlockwise direction, which is the convention used by the Minor Planet Center, where
North = 0° and East = 90°. If images are not perfectly aligned with North up an adjustment to
correct the calculated P.A.° value can be manually entered in the Control window, or if FITS files
containing the CROTA1 FITS keyword are dropped on the Control window it is automatically set.
See [Image Rotation °](#).

Adding, selecting and copying FITS files

Adding FITS files to Screen Ruler

Unstacked FITS files that contain a set of [required FITS keywords](#) can be dragged and dropped
from Windows Explorer to the Control window, see [FITS files area](#). This adds the exposure times
and file names to the FITS files area and by default all the files are selected in that list.

Normally if a stacked image is being examined using Screen Ruler, all the individual FITS files
available for stacking would be added to the FITS files area. Then, one or more stacks of those
images would be used with Screen Ruler to determine whether any of the individual FITS files
should be discarded because the target moving object was too close to field stars or galaxies
during those exposures, see the [Tutorials](#) for further details.

The exposure times and exposure lengths are used to mark alternating coloured lines on the

Screen Ruler at the exact start and end points corresponding to each exposure start and end time, i.e. here 48 FITS files have been dropped on the Control window, causing the exposure borders to appear on the ruler:
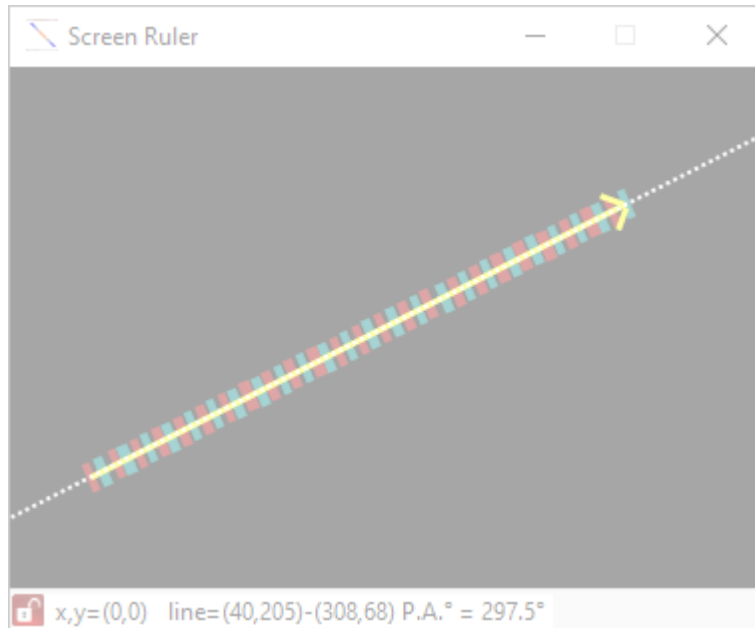
Selecting and deselecting FITS files

The exposure boundary associated with a FITS file can be selected or deselected. Selected exposure boundaries alternate in colour, in the example above red and aqua are used. There is a single colour used for deselected files. The selected and deselected exposure boundary colours are chosen using the ⚙ Settings window Exposure Markings settings. The width of selected and deselected boundaries can also be set independently from there.

All FITS files are initially **selected** when first dropped on the Control window. Files can be **deselected** and **reselected** from either the Control window FITS files area, or directly from the Screen Ruler, both methods require the use of the mouse:

- **From the Control window FITS files area:** Files can be deselected or reselected from the list of files. The file list follows standard Windows conventions on selection (e.g. click on a line to select that line and deselect all others, press Ctrl+A to select all lines, hold Ctrl while clicking on a line to change the selected status of just that line, etc.).

- **From the Screen Ruler window:** To deselect multiple files, hold the **Ctrl** key while **dragging** the mouse on the Screen Ruler window. Deselected files can be reselected by holding the **Shift+Ctrl** keys while **dragging** the mouse on the Screen Ruler window. Toggle the selection for an individual file by pointing the mouse to the exposure boundary and pressing the **F7** function key.

When either method is used, the list of files is positioned so that the most recent change in selection can be viewed in the Control window.

Copying FITS files

Having selected and deselected FITS files, depending on whether background stars and galaxies interfere with them, as a convenience to make stacking of just the selected files easier, the ![icon] **Copy selected files** button can be used to copy just the selected FITS files from the previously configured [FITS Source files folder](#) to the [FITS Files stacking folder](#). See ![icon] [Copy selected files](#) for more details.

Magnifier window

Magnifier window
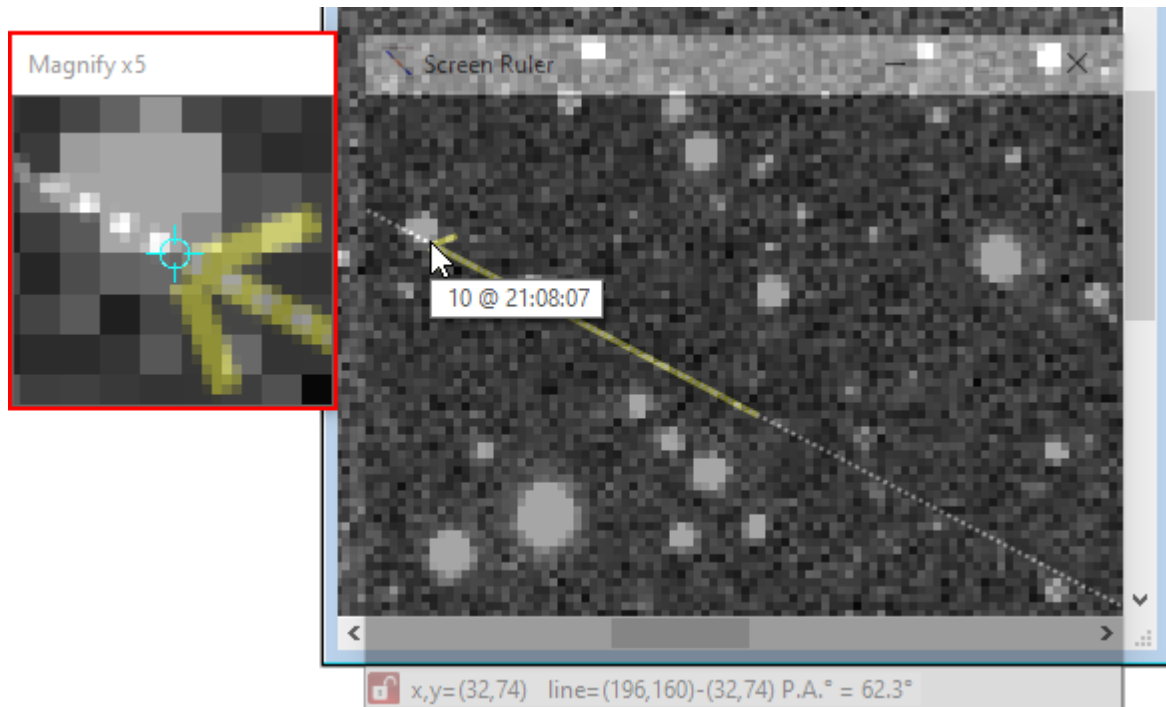
The Magnifier window is toggled on and off by pressing the **F12** function key.

The **magnification** can be changed between x1 and x20 by pressing the **+** or **-** keys, or by using the **mouse wheel**.

Press the **Alt** key when moving the mouse over the Screen Ruler window to temporarily **hide the Screen Ruler** line, to aid accurate positioning of the Ruler start or end points with the Magnifier.

The Magnifier window can be moved and is resizeable. It can also be **docked** to the corner of the Screen Ruler window closest to the mouse position by holding **Ctrl** and pressing the **F12** function key, even if the magnifier window is previously hidden. When docked, the Magnifier window moves with the Screen Ruler when the Screen Ruler window is moved or resized. Moving the Magnifier window separately (by dragging its title bar) **undocks** it from the Screen Ruler window again.

There are 8 docking positions around the Screen Ruler window as shown here:
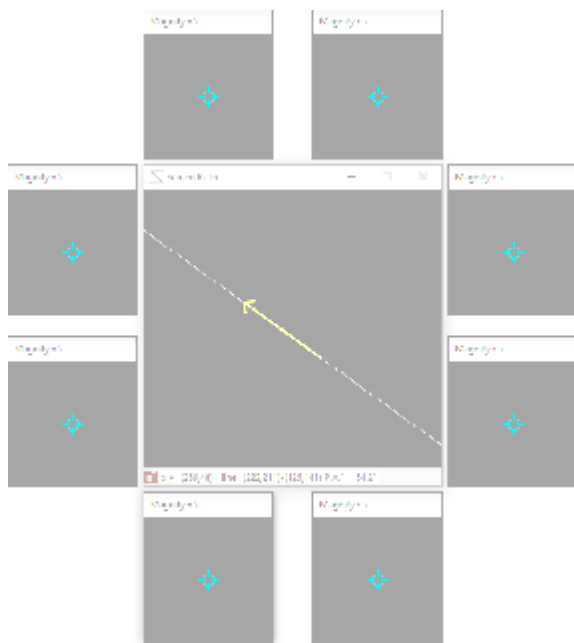
The current Magnifier window position, size and magnification can be set to default the next time the program is started by using the ⬛ Save as new defaults button, including if docked, the docked location.

Settings window

Settings window

The Settings window is displayed by pressing the ⚙ Settings button on the toolstrip.

Program settings can be viewed and maintained from the Settings window. The settings are described in detail in Settings.

The Settings window is displayed modally, it must be closed before continuing to use the Screen Ruler.

The areas and controls on the screen are described below:
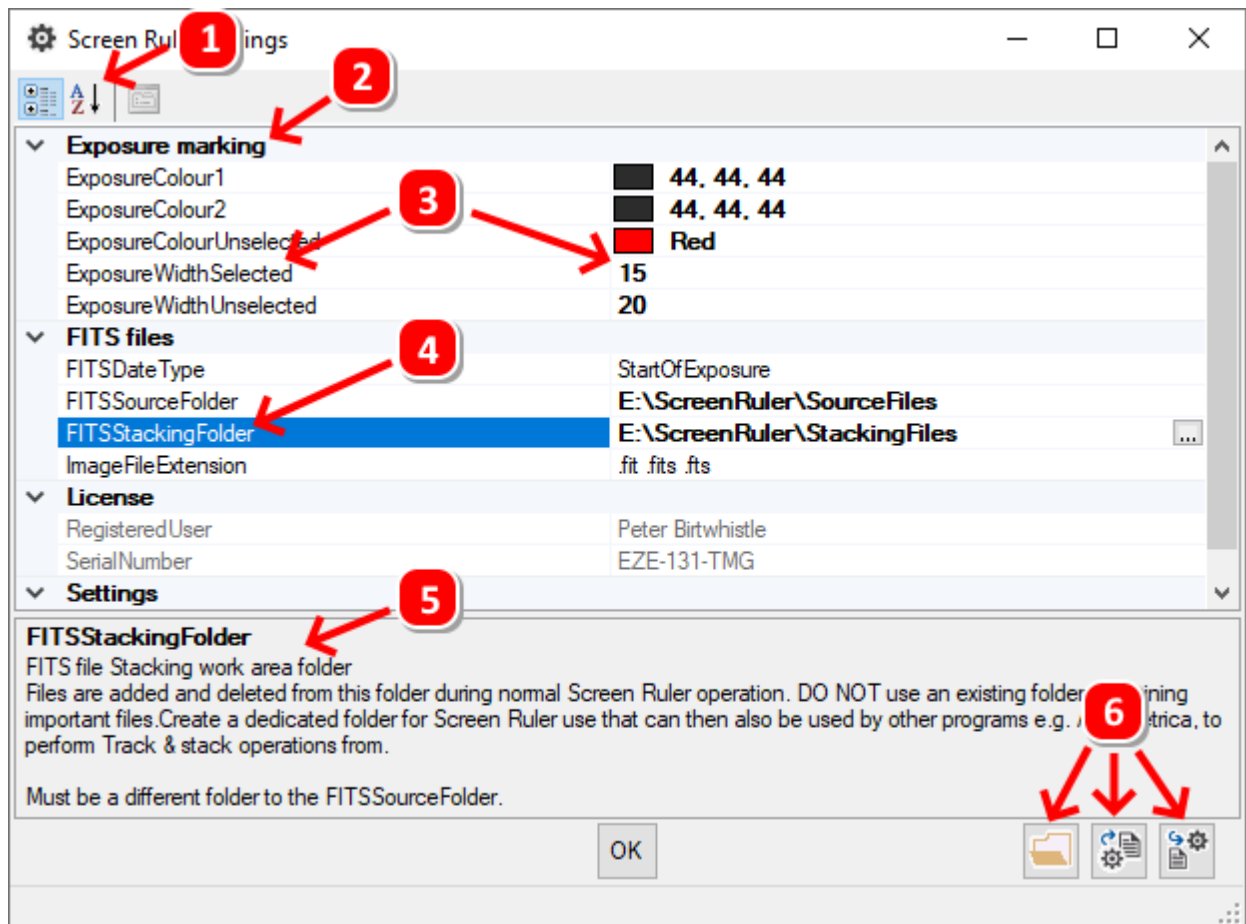
1. Order by **Category** (the default sort order), or order **alphabetically** by Setting.
2. **Category** (settings with similar usage are grouped in the same category when ordered by Category)
3. **Setting name** and **value**. Some settings have default values. When the defaults are changed the value appears in **bold**.
4. **Selected setting** highlighted by mouse click
5. **Extended description** displayed for the selected setting. Drag the horizontal separator line to resize the description area.
6. **Settings export** and **import** buttons:

When changing folder names or colours a small button appears on the right hand side to help select the required value (e.g. the button shown on the right of FITSStackingFolder above).

Settings Management

Open Settings Export Folder with Windows Explorer

Opens the folder named in the SettingsExportFolder setting using Windows Explorer

Export settings to a text file in the Settings Export Folder

Settings can be exported to a text file and used to restore (import) settings if needed, e.g. if the program has to be re-installed.
The **SettingsExportFolder** setting must be configured before settings can be exported.
The exported settings are contained in a tab-delimited file named

<machinename>.ScreenRuler.AppSettings.<yyyymmdd>_<hhmmss>.cfg where
<machinename> is the name of the computer
<yyyymmdd> and <hhmmss> is the date and time when the settings were exported.

Import settings

To import settings previously exported, use one of the following methods:
- Drag and drop a valid settings .cfg file on the Import button.
- Press the Import button to be prompted with:

Either copy and paste one or more tab-delimited settings from a valid settings .cfg file, or enter the file name (including full path) of a valid .cfg file. The settings will be imported when OK is pressed.

When settings are imported, all the incoming settings will overwrite any matching existing settings. Any existing settings that are not included in the import will be left unchanged.
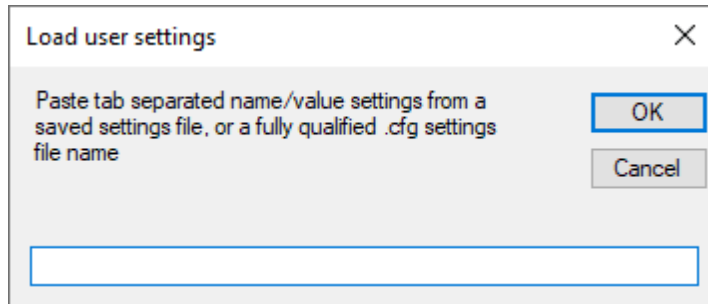
Settings

Settings can be displayed and modified by pressing the ⚙ Settings button on the toolstrip.

Settings are grouped into categories for convenience and are described below:

Category	Setting	Description
Exposure markings		
	ExposureColour1	First of two colours for selected exposures start and end point markings.
	ExposureColour2	Second of two colours for selected exposures start and end point markings.
	ExposureColourUnselected	Colour for unselected exposures start and end point markings.
	ExposureWidthSelected	The line width of selected exposures (in pixels). The valid range is 1 - 20.
	ExposureWidthUnselected	The line width of unselected exposures (in pixels). The valid range is 1 - 20.
FITS files		
	FITSDateType	The type of date represented by the DATE-OBS keyword in the FITS file header. Choose one of: • Start of Exposure (default) • Middle of Exposure

		• End of Exposure This setting is used in conjunction with the FITS header values of exposure date/time and duration of exposure to calculate the FITS files start and end of exposure time for the placement of exposure boundary lines on the Screen Ruler.
	FITSSourceFolder	FITS file source folder path. Selected files are copied from this folder to the FITSStackingFolder when the Copy selected files toolstrip button is pressed.
	FITSStackingFolder	FITS file Stacking work area folder Files are added and deleted from this folder during normal Screen Ruler operation. DO NOT use an existing folder containing important files. Create a dedicated folder for Screen Ruler use that can then also be used by other programs e.g. Astrometrica, to perform Track & stack operations from. Must be a different folder to the FITSSourceFolder.
	ImageFileExtension	FITS image file extensions (or suffixes) allowed to be dropped on the Screen Ruler Control window. If more than one value is required, separate with blanks, e.g.: .fit .fits .fts
Settings		
	SettingsExportFolder	Folder to export (backup) application settings text files into.

About window

About window

The About window is displayed by pressing the 🔲 About button in the toolstrip and shows program details including version information:

Use the 🏠 home page link to display the Screen Ruler page on the Great Shefford Observatory website.

The Registration screen can be accessed using the **Register** button to enter or display registration details.

A message is displayed on the Screen Ruler Control window when a **new version** is available and links to the **what's new** and **download** pages are then provided on the About window. The **Check for Updates** button can be pressed at any time to repeat the check.

An internet connection is required for the version update checks and web page links.
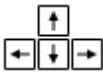
Press **OK** to return to the Screen Ruler. The About window is displayed modally, it must be closed before continuing to use the Screen Ruler.

About Screen Ruler

Great Shefford
Observatory

🏠 home page

Measure stacked image exposure start/end points

ScreenRuler.exe
Version 1.0.0.33 (2021 Aug 20 14:26:34)

Copyright © Peter Birtwhistle 2010 - 2021
Great Shefford Observatory
email: peter@birtwhistle.org.uk

Register   New version 1.0.0.34 is available
             what's new
Check for   downloads
Updates

Ok
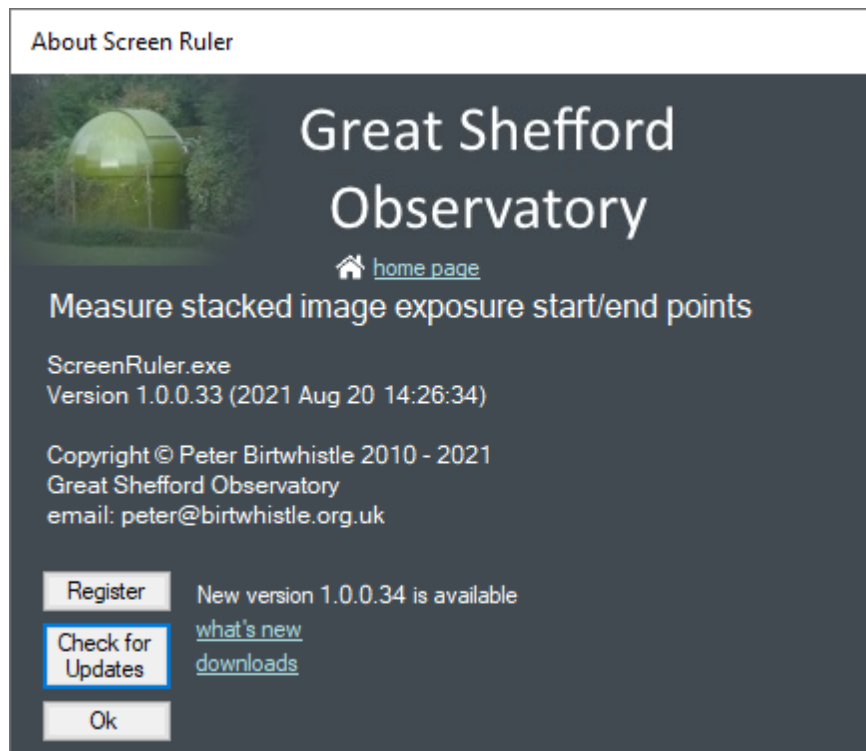
Instruction Summary

To:	Action:
Set Ruler Position	
Draw ruler	**Drag with mouse** (Hold the left mouse button down while moving the mouse and then release button to draw a line)
Set ruler START POINT at current mouse location	Hold **Shift** and **left-click mouse**, or
	Press **Enter** key, or
	Press **Home** key
Set ruler END POINT at current mouse location	Hold **Shift** and **right-click mouse**, or
	Hold **Ctrl** and press **Enter key**, or
	Press **End** key
Adjust Ruler Position	
Adjust ruler START or END point (screen 🔓 unlocked)	Press [arrow keys] **Arrow keys** to **adjust** ruler **START position**, mouse positioned over **START position**
	Hold **Ctrl** & press [arrow keys] **Arrow keys** to **adjust END position**, mouse positioned over **END position.** Hold **Shift** to move **5x faster**.
Undo or Redo ruler changes	Press ↺ ↻
MOVE entire ruler (screen 🔒 locked)	Press [arrow keys] **Arrow keys** to **MOVE ENTIRE RULER**, mouse positioned over **START position**
	Hold **Ctrl** & press [arrow keys] **Arrow keys** to **MOVE ENTIRE RULER**, mouse positioned over **END position.**

	Hold **Shift** to move **5x faster**.
Exposure Boundaries	
Toggle selection of a single exposure boundary	Position mouse on an exposure boundary and press **F7** to toggle selection on/off
Select multiple exposure boundaries	Hold **Shift+Ctrl** while **dragging mouse** along exposure boundaries
Deselect multiple exposure boundaries	Hold **Ctrl** while **dragging mouse** along exposure boundaries
Other Ruler Controls	
Toggle **PERPENDICULAR LINE** on/off	Press **F9** key
Hide ruler	Hold **Alt** while **moving mouse** or pressing **arrow keys**
Pin ruler position while moving Screen Ruler window	Hold **Ctrl** while **dragging or resizing screen ruler window** to leave ruler pinned to the same background point
Magnifier	
Note: Click on the Screen Ruler or the Control window to allow Magnifier actions to be received	
Toggle **MAGNIFIER** window on/off	Press **F12** function key
DOCK Magnifier	Dock to **corner** of Ruler window nearest mouse position - hold **Ctrl** key and press **F12** function key
UNDOCK Magnifier	Drag the Magnifier window with the mouse to a different place
Zoom Magnifier	Use **Mouse wheel**, or press "**+**" or "**-**" keys
Magnified location	Centred on mouse position
Magnified location when ↑ ← ↓ → **arrow keys pressed**	Magnifier defaults to being centred over the **START** position. Hold **Ctrl** to centre magnifier over **END** position when arrow keys pressed

Tutorials

Tutorials

The tutorials use stacked images of a moving object with the Screen Ruler to identify which of the underlying unstacked images can be rejected due to the moving object being too close to field stars and galaxies.

Tutorial I stretches the Ruler along the length of a star trail that is interfering with the image of a moving object, allowing the images around where the trail crosses the moving object to be identified. The method is quick and simple but may not identify more than the most obvious interfering background trails.

Tutorial II uses three different stacks from the same underlying set of images to more rigorously identify all field stars and galaxies that get in the way of the moving object. The stacks are:
        - a stack of the star background (stacked with zero motion) to reveal fainter sources more clearly
        - a stack of some or all available images stacked using the object's motion that allow

the object to be seen (even though it may be partially obscured by star trails)
　　　- a stack of just the first and the last available image, again stacked using the object's motion, to accurately define the length of star trails

Tutorial III uses the same method as Tutorial II but uses information automatically extracted from the underlying FITS files to mark on the ruler where the moving object is located on each image. Images can be rejected by dragging the mouse along the ruler where background stars are seen, the remaining set of selected FITS files can then be copied to a separate folder to make re-stacking easy.

Tutorial I - Simple (using one stacked image)

Tutorial I - Simple (using one stacked image)

Task: Identify the image files involved where a moving object passes close to a field star so those images can be rejected in further processing.

Materials required:

- A set of individual images of a moving object to be stacked (48 images are used in this tutorial).
- A stack of all the available images, combined using the object's motion.

(Only the stacked image is needed for this tutorial)

Method:

Track & Stack a set of images using the object's motion with a program such as Astrometrica. The target object needs to be visible, but partially obscured by the trails of background stars or galaxies.

Here 48 images of fast moving minor planet 2021 PP have been stacked together using Astrometrica. The minor planet can be seen as a bump on the trail of a bright star:
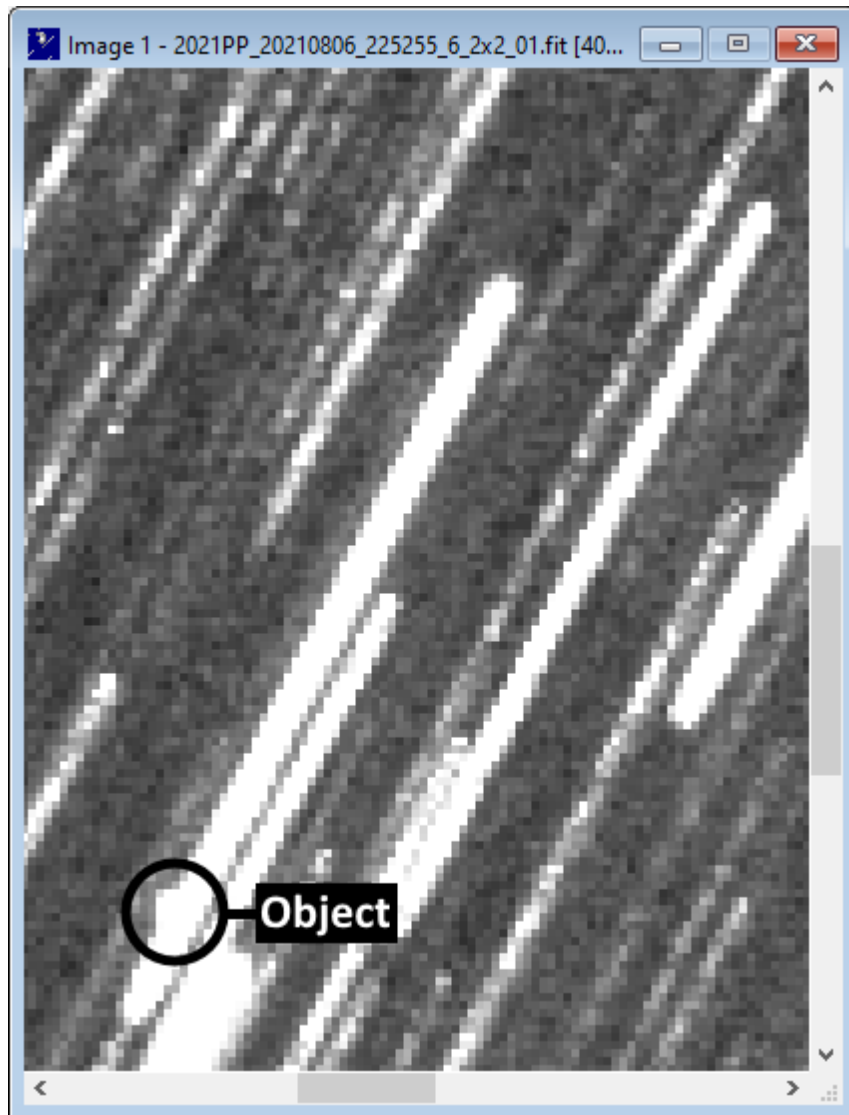
The minor planet was moving from bottom left to top right and the stacking process has compensated for that movement, keeping the minor planet in one place and causing the stars to appear as trails. With the minor planet held stationary, the position of the stars in the **first** image are at the top right of the corresponding trails and the position in the **last** image is at bottom left:
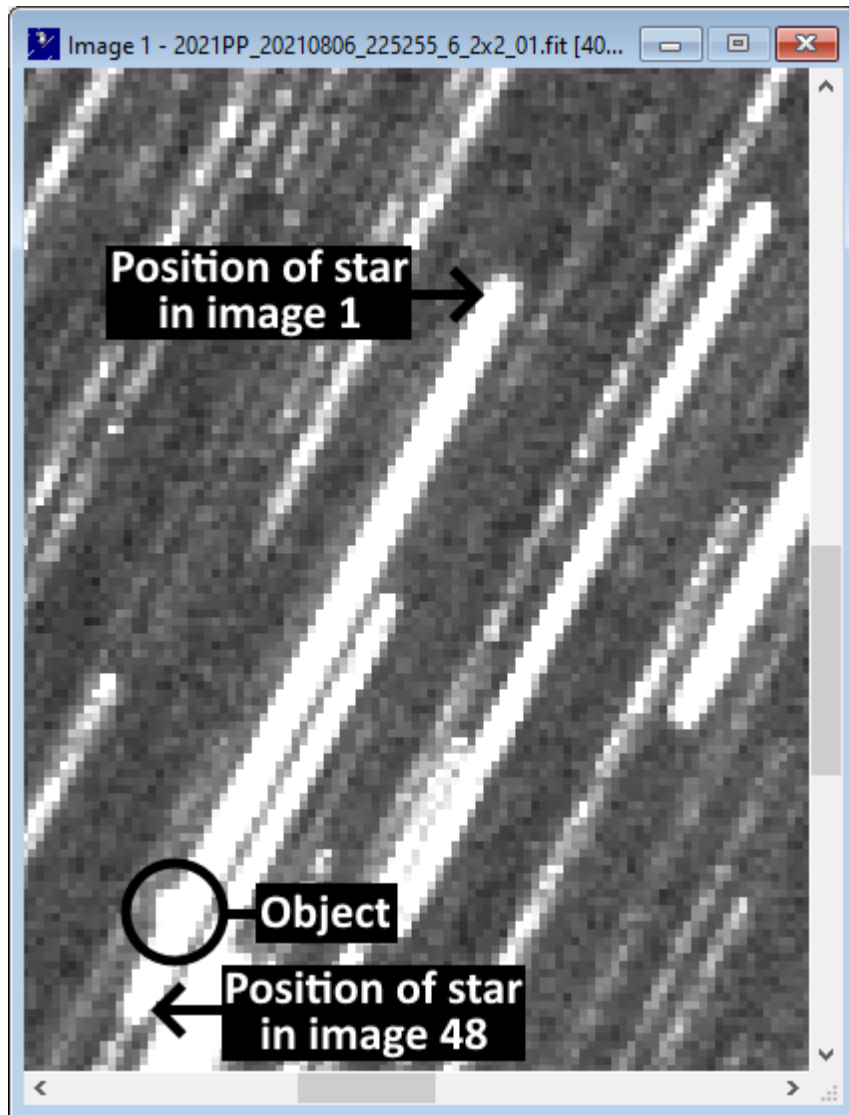
Start the Screen Ruler application then position the semi-transparent Screen Ruler window over the stacked image and resize to completely cover the star trail that is partially obscuring the minor planet..

Then use the mouse to drag a line on the Screen Ruler window from top right to bottom left along that star trail (hold the left hand mouse button down while moving the mouse).

As the Screen Ruler window is semi-transparent and easily overlooked, it is shaded red here for clarity:
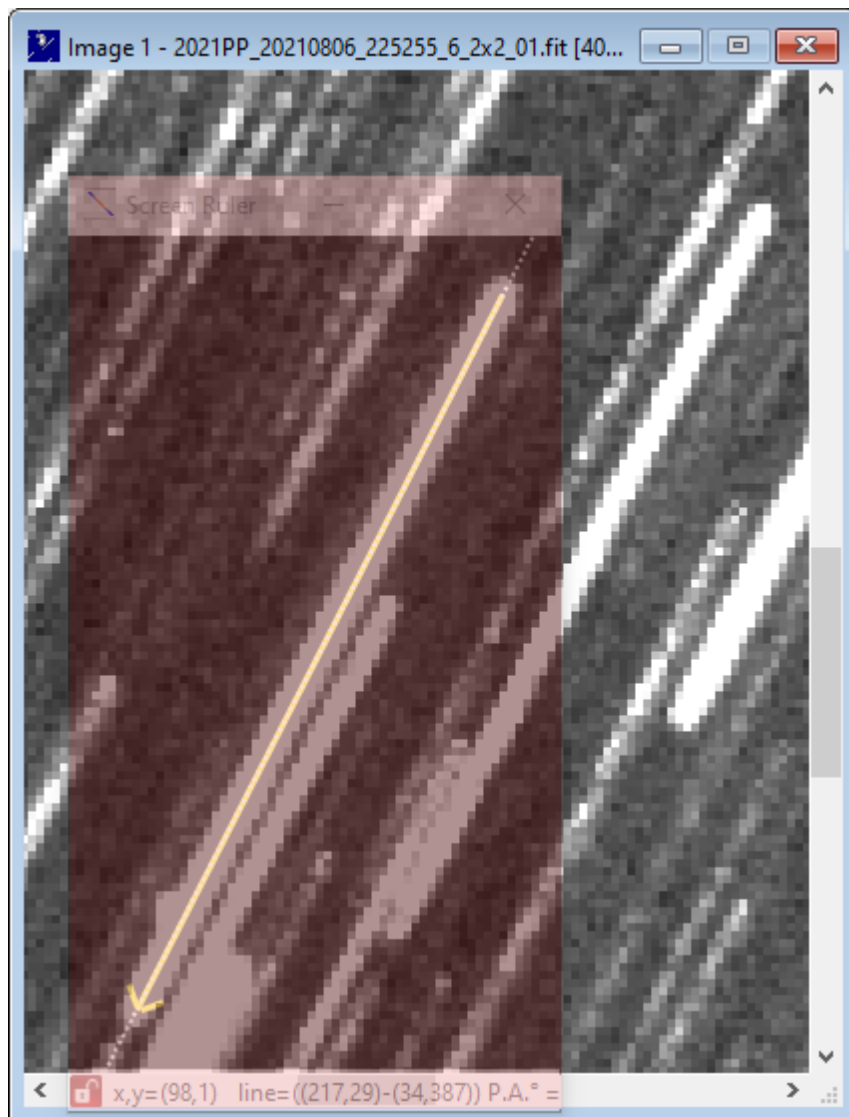
The end of the line is marked with an arrow head. If the line has been drawn in the opposite direction, with the arrowhead pointing upwards then press the ⤭ Swap start and end coordinates button on the Screen Ruler Control window.

Enter the start and end image numbers in the Screen Ruler Control window (Start = 1, End = 48). Optionally also enter the start of exposure times for the first and last images (First = 22:52:55, Last = 22:58:56). Times can be entered with or without the colon ":" separators:
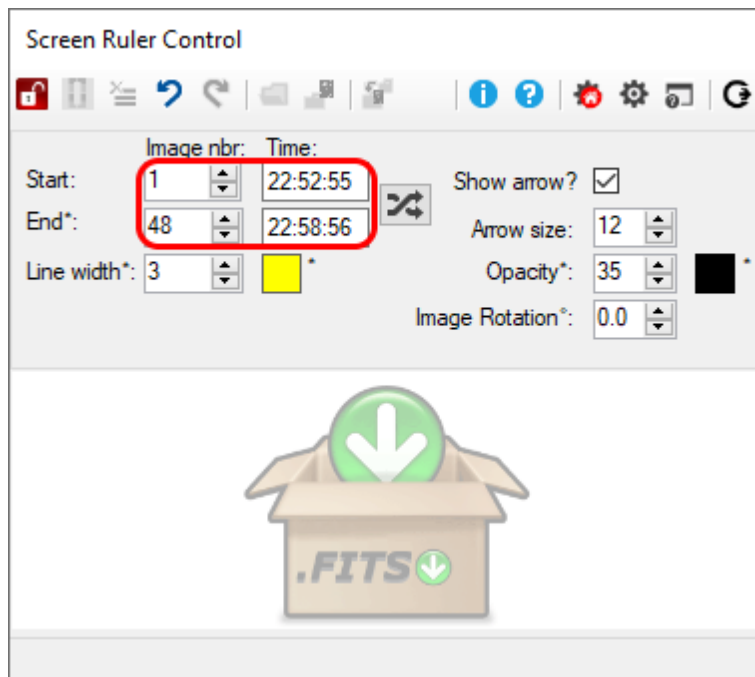
Click the mouse onto the Screen Ruler window so it regains focus. Move the mouse on either side of the bump on the star trail to display the range of image numbers likely to be obscuring the minor planet. If times have also been entered then the calculated time corresponding to the mouse position will also be shown:
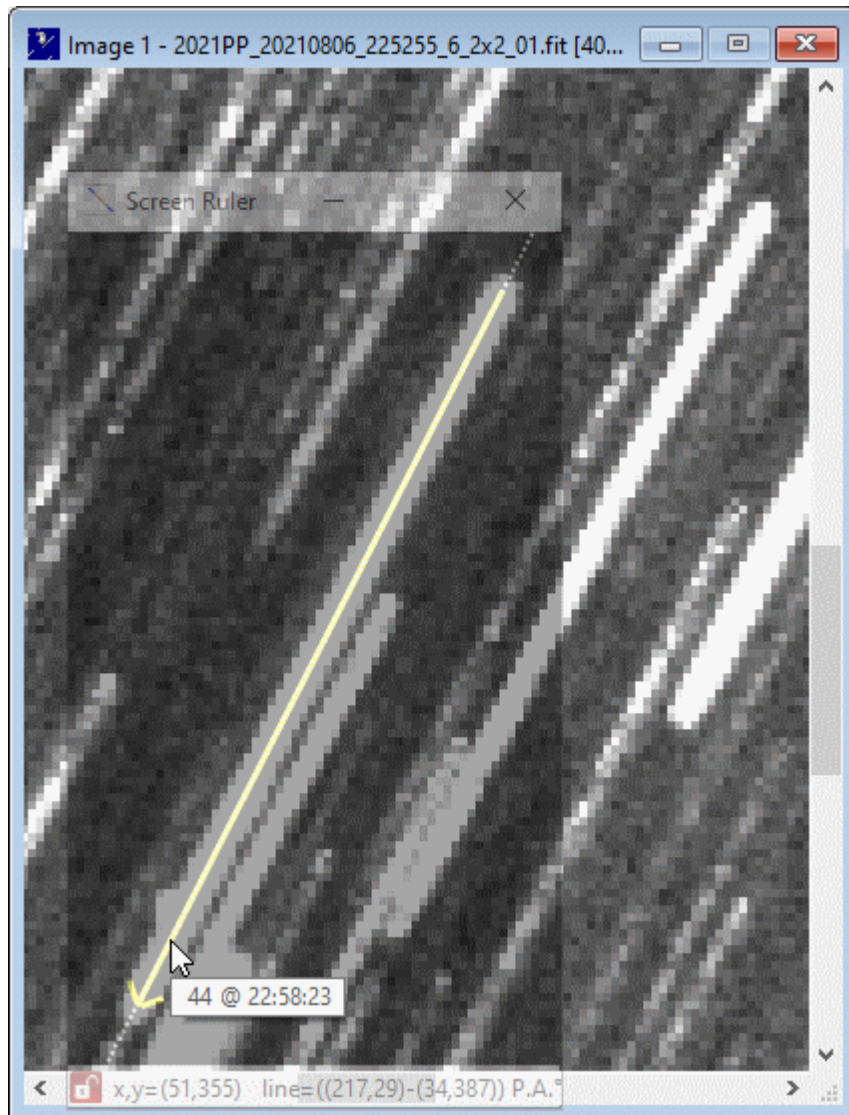
Tip: Try this by entering the image numbers (and times) into the Screen Ruler Control window and position the Screen Ruler *window over the image above, drag the ruler along the star trail, then use the mouse to read out the image numbers and times.*

Images 40 to 44 are indicated to be close to the position of the minor planet, so the original images are now re-stacked, but this time leaving out images 40-44.

The result now clearly shows the minor planet but also reveals that another fainter star trail also passes through the image of the object:
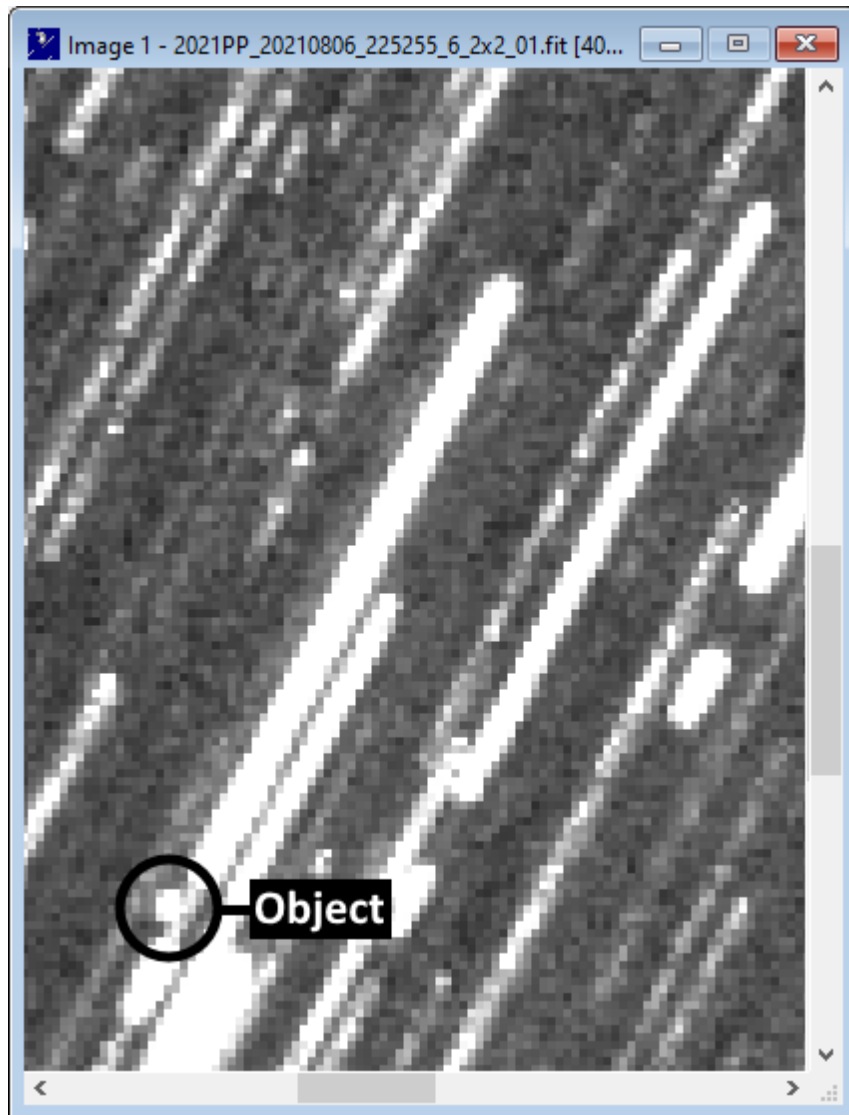
[Tutorial 2](#) covers the quick identification of ALL the field stars and galaxies that the moving object comes close to, rather than just the brightest.

Tutorial II - Intermediate (using three stacks)

Tutorial II - Intermediate (using three stacked images)

Task: Identify the image files involved where a moving object passes close to ANY field star so those images can be rejected in further processing

Materials required:

- A set of individual images of a moving object, used to generate the following three stacks:

Stack A - a stack of some or all of the available images, combined using the object's motion that allow the object to be seen (even though it may be partially obscured by star trails)
Stack B - a stack of the first and last image only, combined using the object's motion, to accurately determine the full extent of the object's motion.
Stack C - a stack of at least the first three, preferably the first 10+ images, stacked with ZERO

motion, to reveal the fainter field stars and galaxies.

Note: This tutorial gives instructions using Astrometrica to blink these three stacks. If using other software, equivalent functionality will be required.

Steps:

1. Create Stack A
2. Create Stack B
3. Create Stack C
4. Blink stacks A, B and C
5. Draw Ruler the length of the star trails
6. Position the start of Ruler over object
7. Show object path against star background
8. Use mouse to locate images to be rejected
9. Result - Stack only the selected images
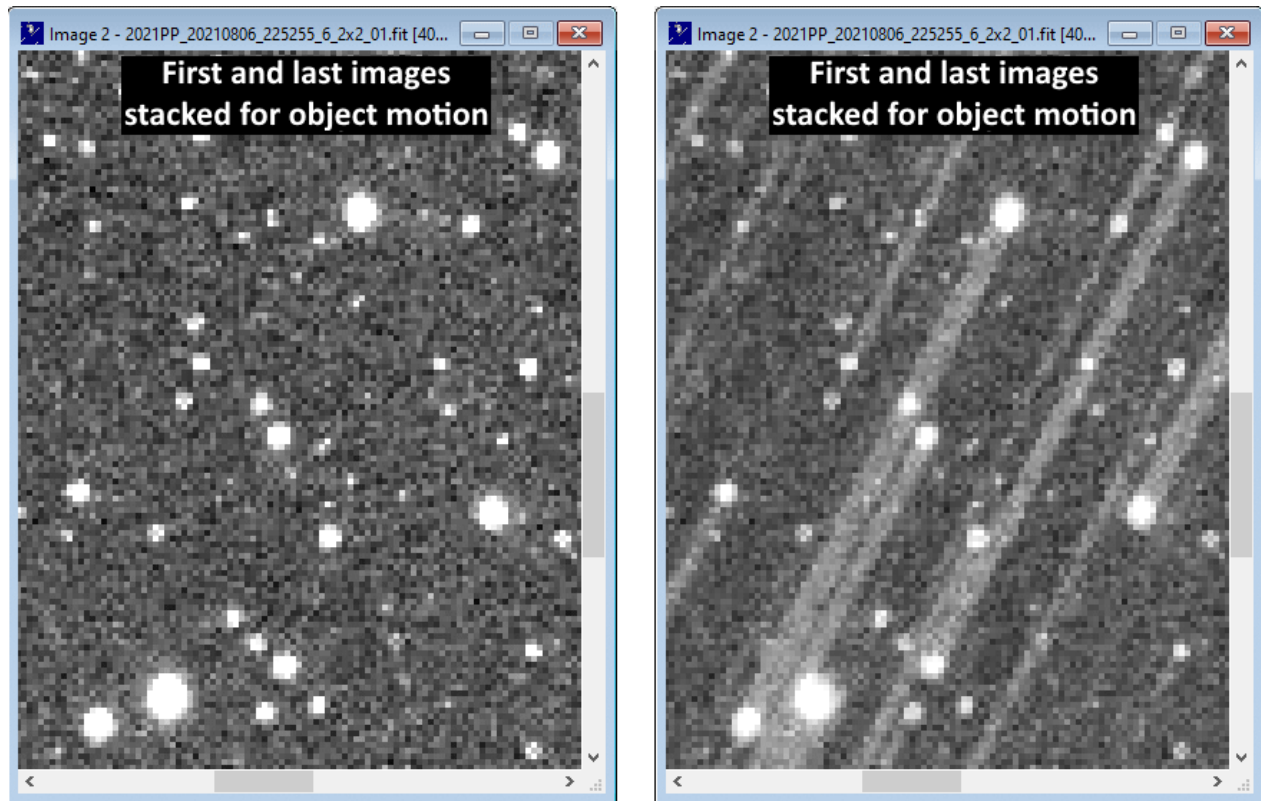
Step 1. Create Stack A
Track & stack a set of images using the object's motion with a program such as Astrometrica. The target object needs to be visible, but not all the images need to be used. Here the result from Tutorial I is used, images 1-39 and 45-48 of fast moving minor planet 2021 PP are stacked together. The minor planet is visible with a faint trail of a star close by:
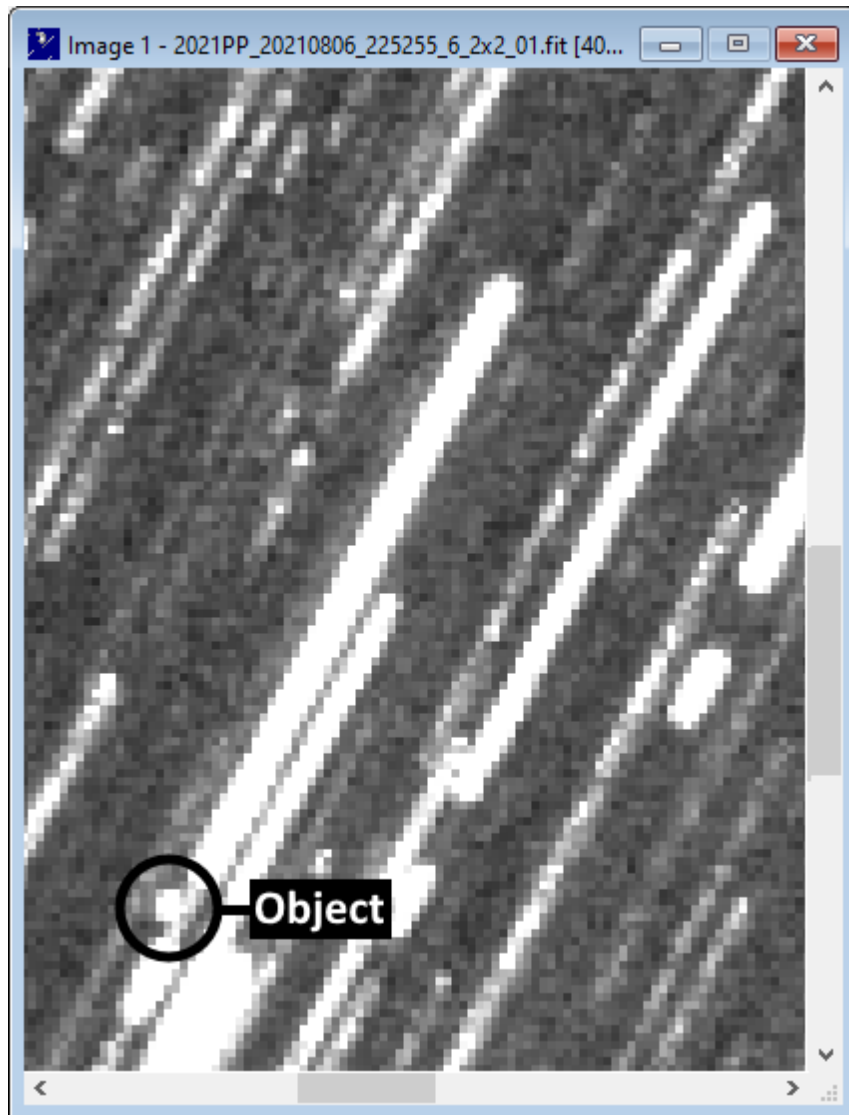
Step 2. Create Stack B

Track & stack the first and last images, again using the object's motion. This will be used to accurately determine the start and end points of one of the star trails.
Here Stack B is displayed on the left. On the right the star trails from a stack of all images has been superimposed to highlight which of the star images relate to the first and last image of the same star.

Step 3. Create Stack C

Stack a number of images with ZERO motion to reveal fainter field stars and galaxies. Images 1-10 have been stacked here with zero motion:
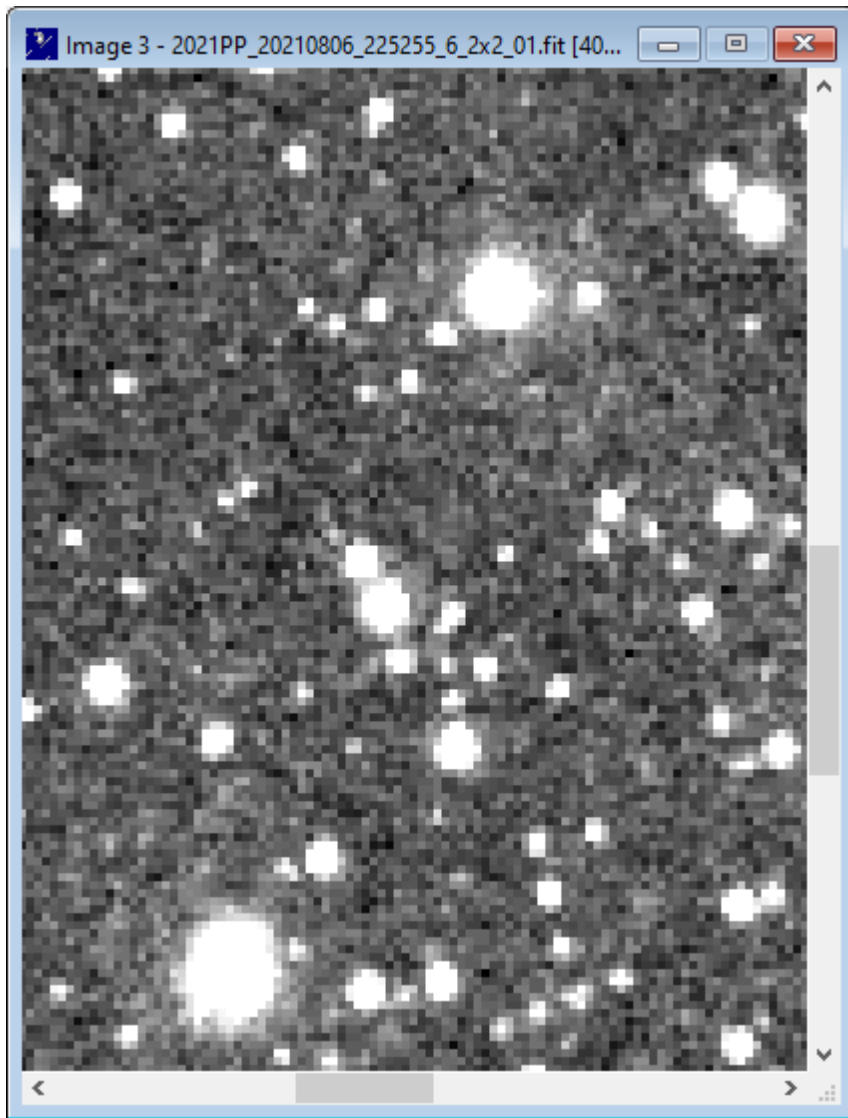
Step 4. Blink stacks A, B and C

Take the option to *Blink current images* (in Astrometrica press Ctrl+B). Magnify and resize the Astrometrica blink window so that the object is visible and the window is large enough to also show at least one complete star trail

Here stacks A, B and C are being blinked and the window has been resized so that the object is visible towards the bottom left and there are also some complete star trails visible:
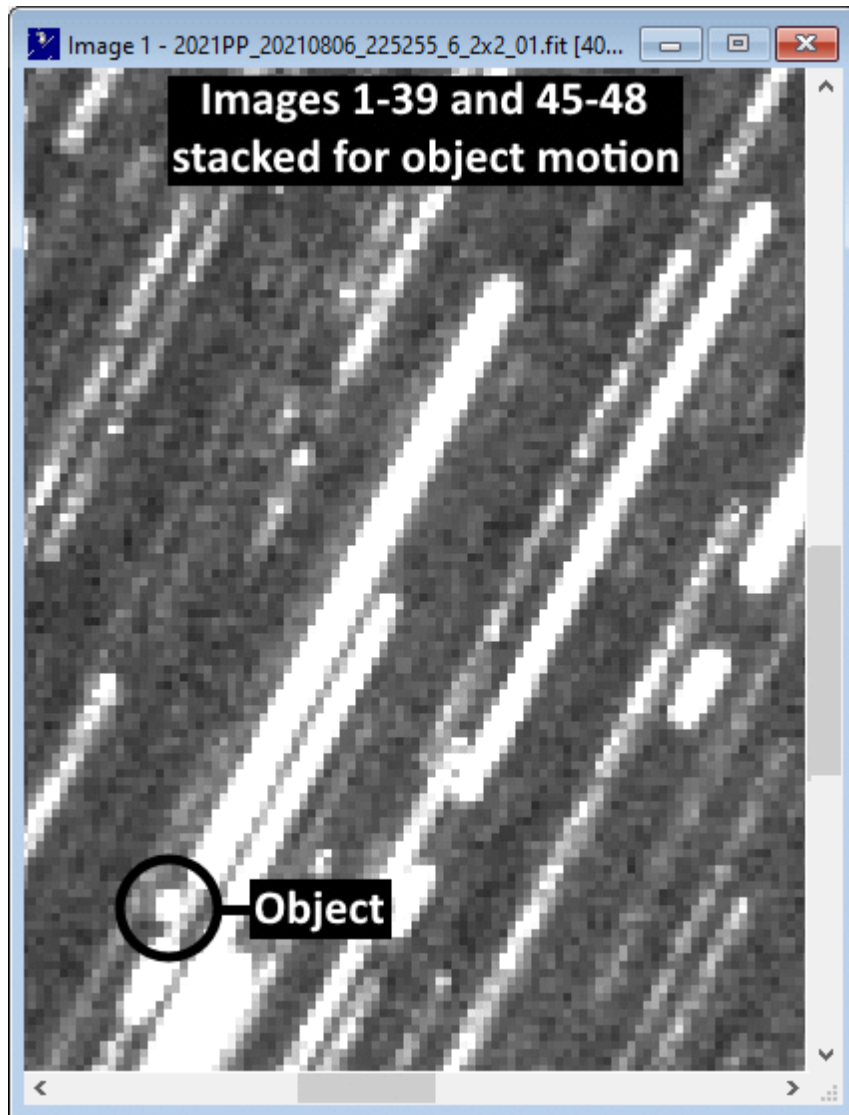
## Step 5. Draw Ruler the length of the star trails

In Astrometrica press Ctrl+F10 (Step forward) and Shift+Ctrl+F10 (Step backward) to review the stars available and identify a suitable relatively faint star (so the images of the star are small and easily centred) where both images of the star are visible in stack B of the first and last exposures. Then step forward until Stack B is displayed (the stack of the first and last images only). Move and resize the Screen Ruler window so that it completely covers the start and end of a star trail.

Drag a line in the direction of the minor planet's motion from the start to the end image of the selected star. Note, this is the *opposite* direction to the instructions in Tutorial I, where the apparent motion of the star was being measured. Here the apparent motion of the minor planet is being measured.
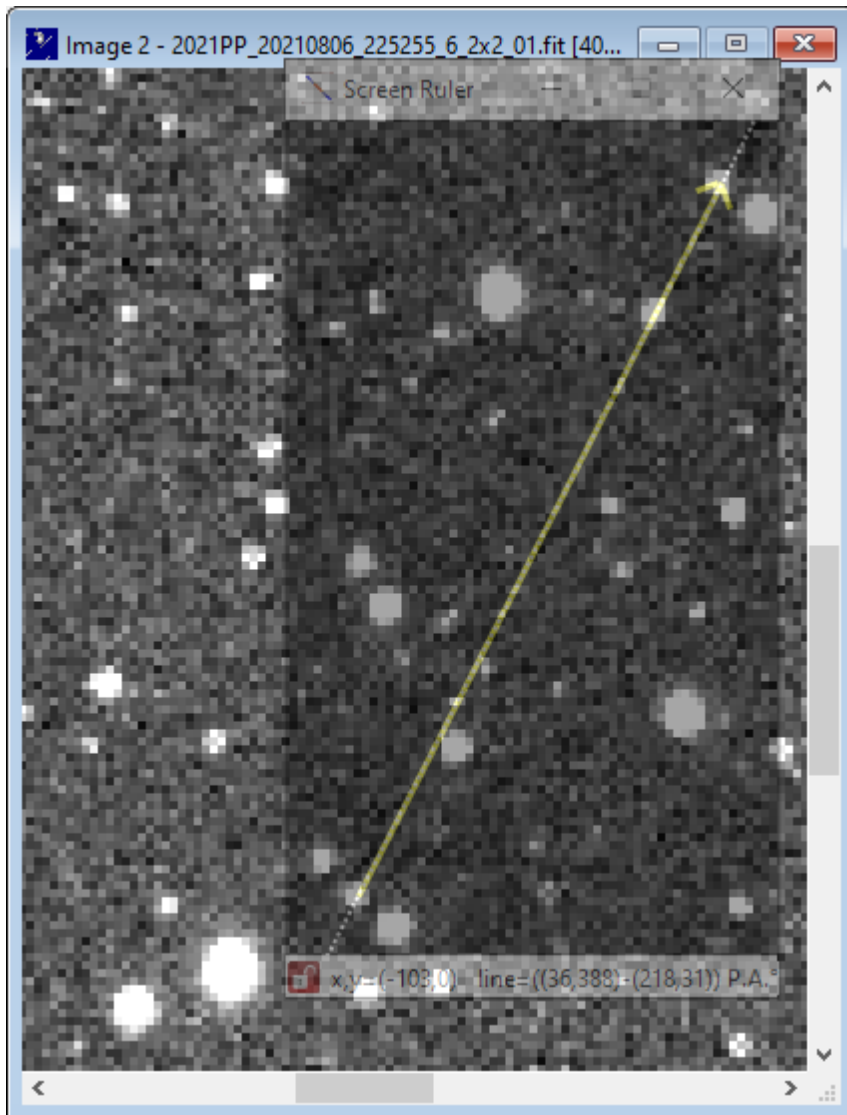
Step 6. Position the start of Ruler over object

In Astrometrica press Ctrl+F10 (Step forward) until Stack A is displayed (the stack showing the object with trailed stars).

Drag the entire Screen Ruler window (by clicking on the Screen Ruler window title bar, holding the left mouse button and dragging the mouse) to position the start of the ruler line in the centre of the object:
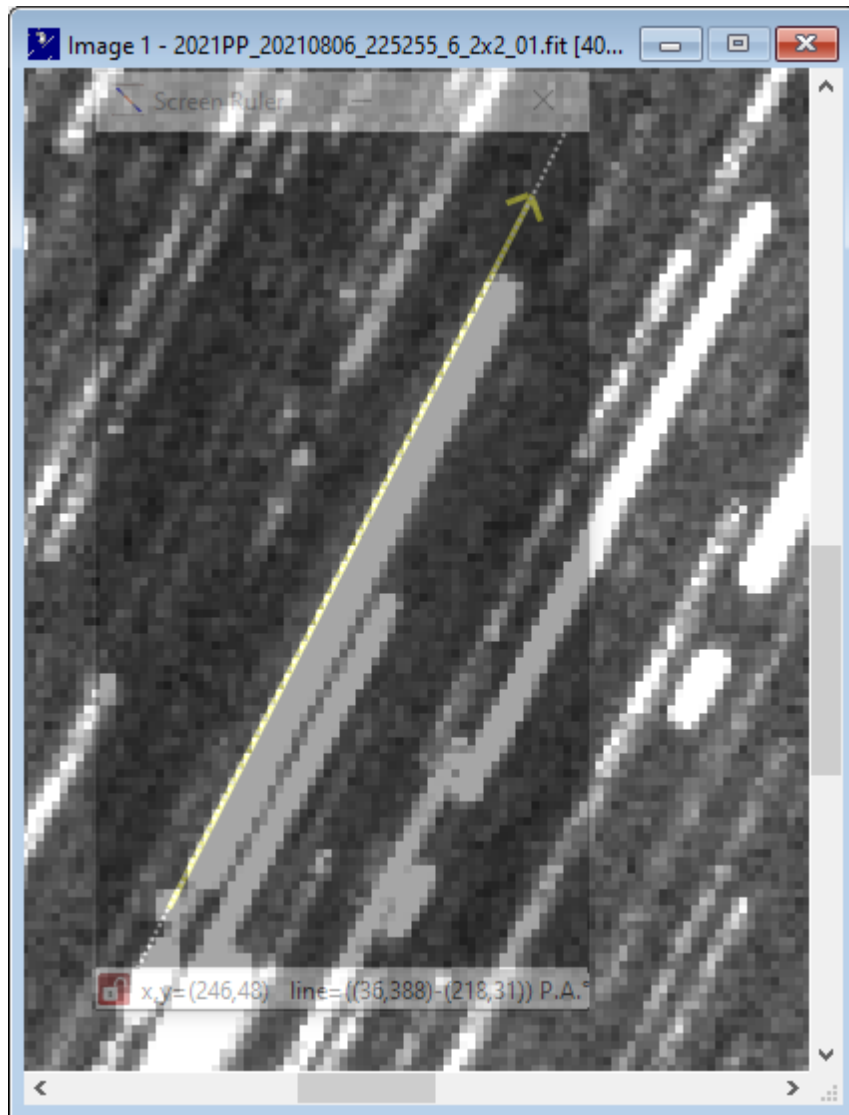
Step 7. Show object path against star background

Without moving the Screen Ruler window, in Astrometrica press Ctrl+F10 (Step forward) until Stack C is displayed (the ZERO motion stack).

The ruler line now accurately indicates the track of the minor planet from the first to the last available image.
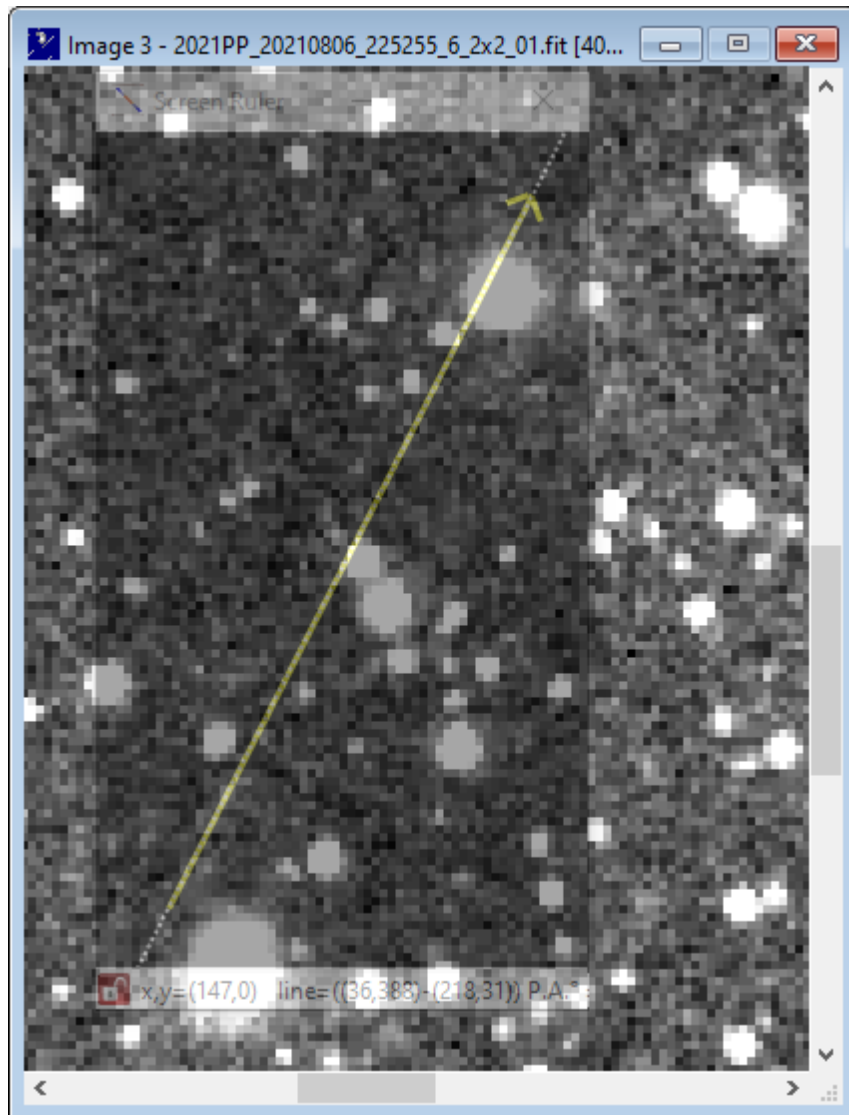
Step 8. Use mouse to locate images to be rejected

It is now apparent that the object passed a star near the middle of the set of images and came close to a fainter star just before becoming involved in the glow of the bright star at top left (which was the only star identified in Tutorial I).

Moving the mouse along the ruler now indicates that images 23-26 and 38-45 should be left out of the stacks:
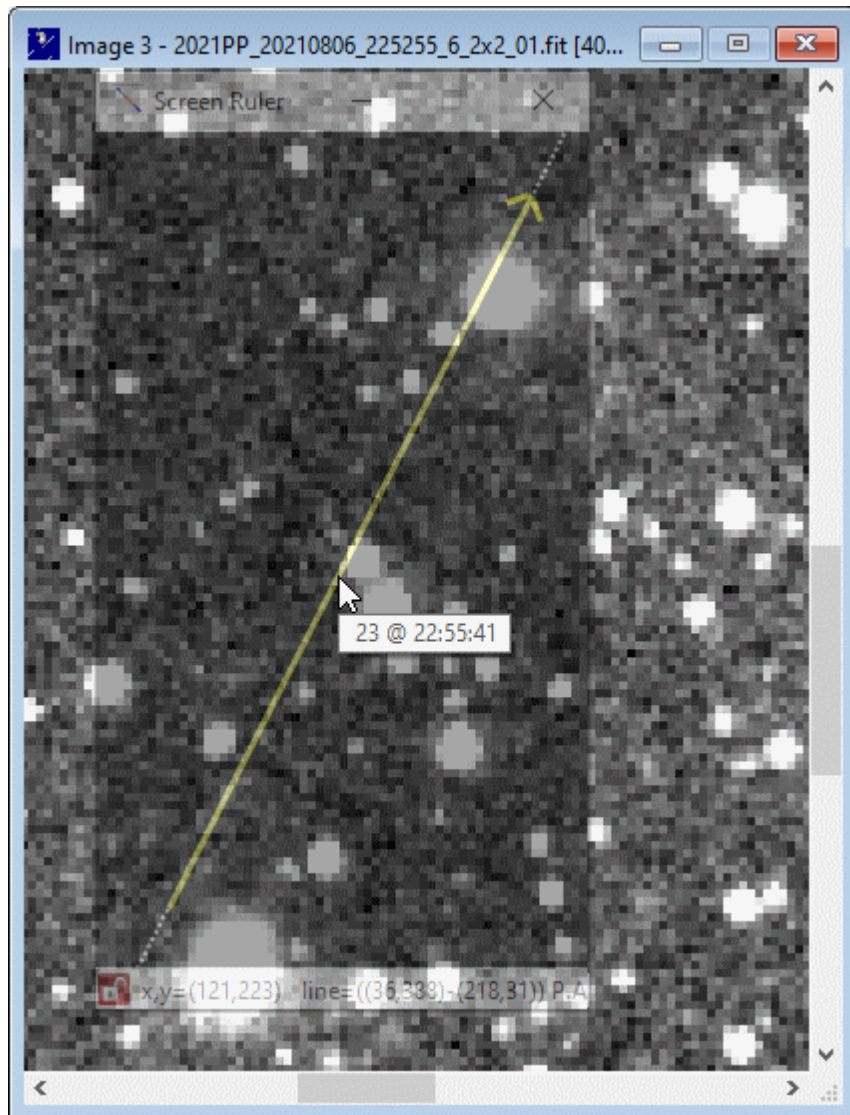
Step 9. Result - Stack only the selected images

The final result, stacking images 1-22, 27-37 and 46-48 shows the object without any star trails crossing it. Compare with the Tutorial I result:

Stacked Image - 2021PP_20210806_225255_6_2x2_0 ...

Object
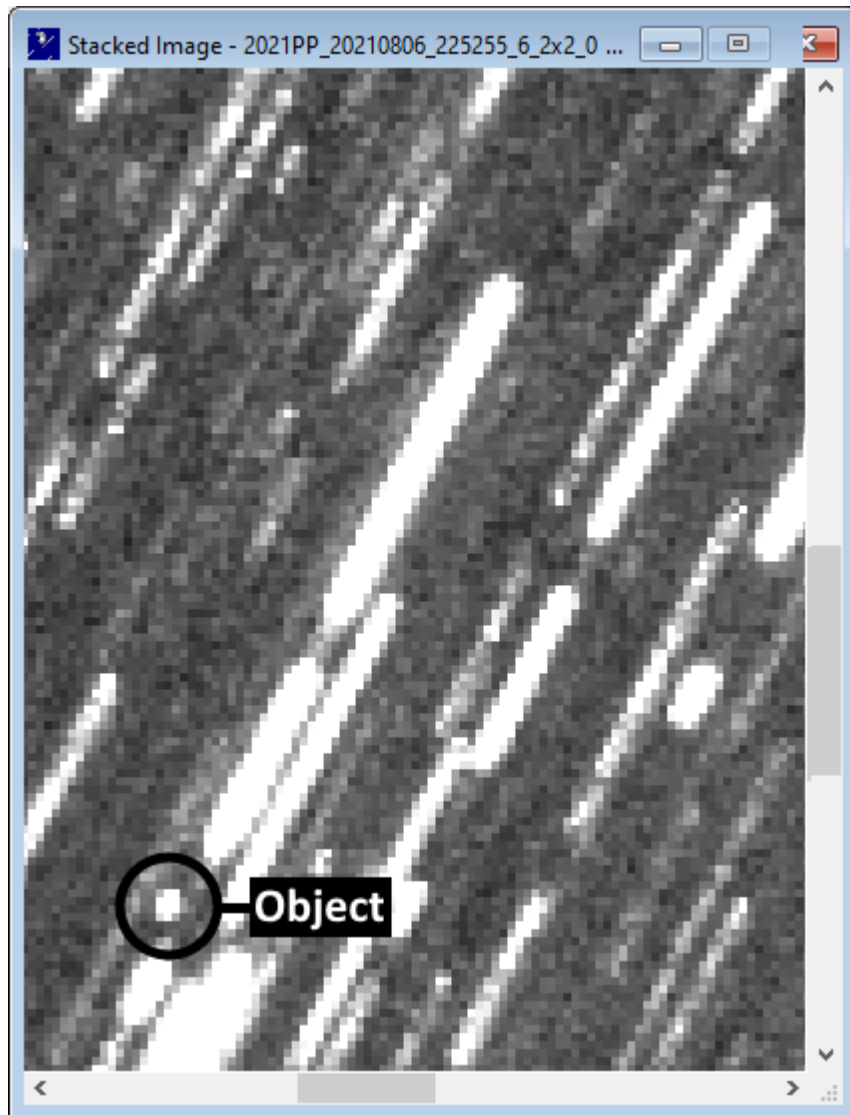
Tutorial II result
Tutorial I result

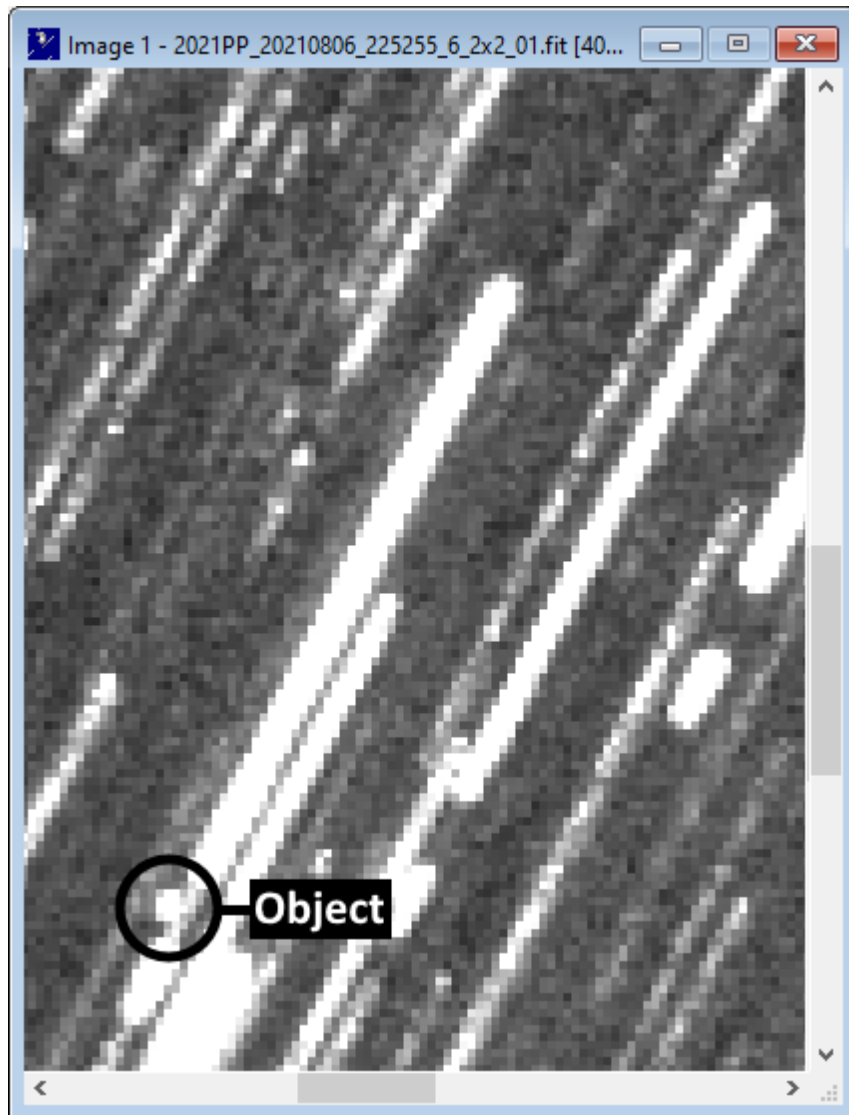[Tutorial III](#) - **Advanced (using three stacked images and FITs file information)** extends the Tutorial II method by displaying on the Ruler the start and end of exposure for each file used, extracted directly from the FITS files.

Tutorial III - Advanced (using three stacks and FITS file info)

Tutorial III - Advanced (using three stacked images and FITs file information)

Task: Identify the image files involved where a moving object passes close to ANY field star so those images can be rejected in further processing

Materials required:

- A set of individual images of a moving object, used to generate the following three stacks:

Stack A - a stack of some or all of the available images, combined using the object's motion that

allow the object to be seen (even though it may be partially obscured by star trails)
Stack B - a stack of the first and last image only, combined using the object's motion, to accurately determine the full extent of the object's motion.
Stack C - a stack of at least the first three, preferably the first 10+ images, stacked with ZERO motion, to reveal all the field stars and galaxies.

Note: This tutorial gives instructions using Astrometrica to blink these three stacks. If using other software, equivalent functionality will be required.

Steps:

1. Follow Tutorial II to Step 7 (Show object path against star background)
2. Drag and drop FITS files on the Screen Ruler Control window
3. Deselect the files to be rejected
4. Copy just the selected files to a folder for stacking
5. Result - Stack the files copied to the Stacking folder

Step 1. Follow Tutorial II to Step 7 (Show object path against star background)

Follow Tutorial II to step 7 where the enhanced star background (from combining a number of images with zero motion) is overlaid with the Screen Ruler line, now accurately indicating the track of the moving object from the first to the last available image.
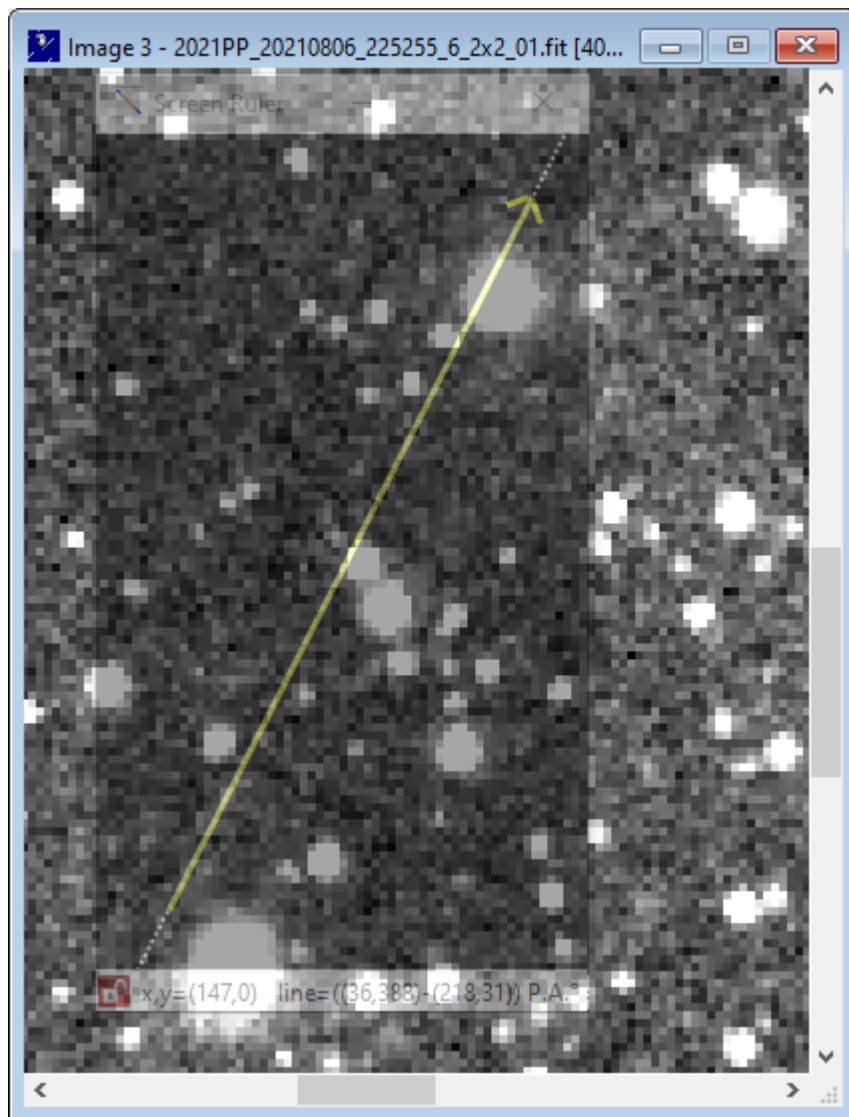
Step 2. Drag and drop FITS files on to Screen Ruler Control window

In Windows Explorer select all the FITS files and use the mouse to drag and drop them on the FITS files area of the Control window:
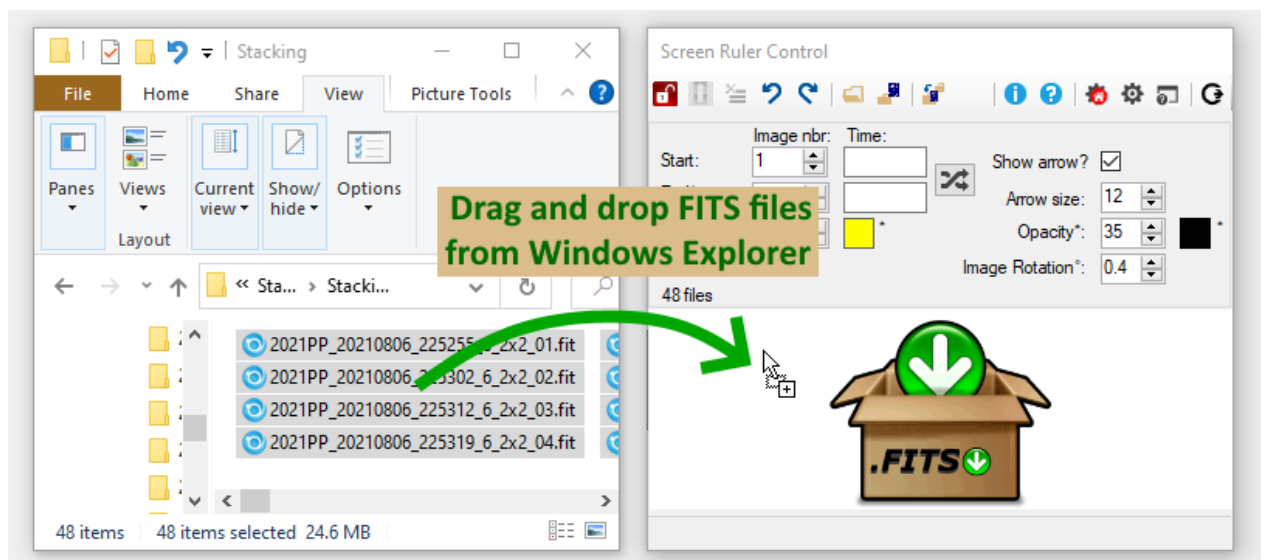
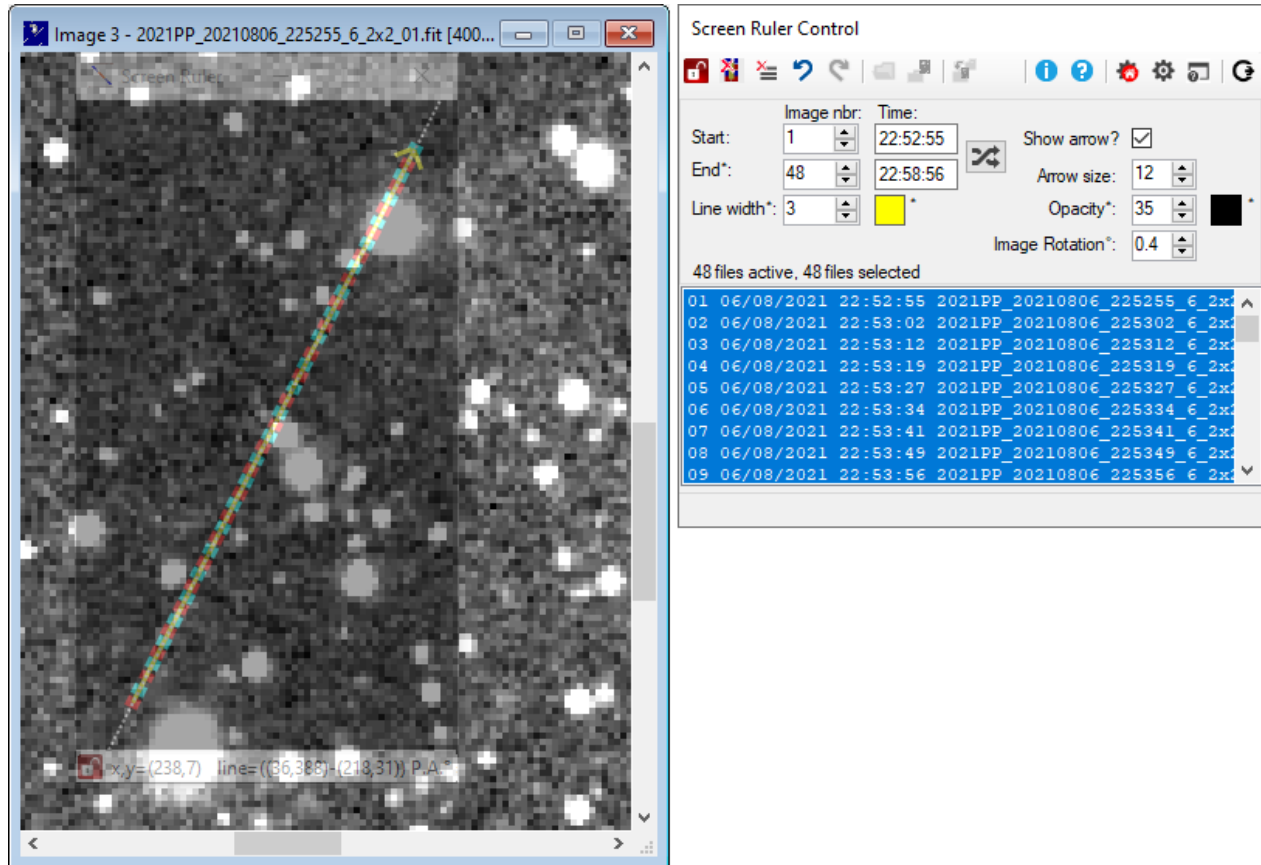When the files are dropped the Screen Ruler window changes to show blocks of alternating colour representing the start and end exposure time for each image. The Screen Ruler Control window area where the FITs files were dropped shows a list of the files and by default they are all selected.


Step 3. Deselect the files to be rejected

Initially all files are selected. Selected files appear with alternating colours, in the example above using red and aqua. Files can be *deselected* by either using the list of files in the Control window, or by holding the **Ctrl** key while **dragging** the mouse on the Screen Ruler window. The Control window list follows standard Windows conventions on selection (e.g. click on a line to select one line and deselect all others, press Ctrl+A to select all, hold Ctrl while clicking on a file to change the selected status of just that line etc.).

In the example here deselected files are shown dimmed and not coloured. Deselected files can be *reselected* by either using the list of files in the Control window, or by holding the **Shift+Ctrl** keys while **dragging** the mouse on the Screen Ruler window.

Now, use the mouse to deselect files where the object passes close to field stars by holding the Ctrl key and dragging the mouse along the appropriate parts of the Screen Ruler window. The files selected in the Control window are automatically updated:
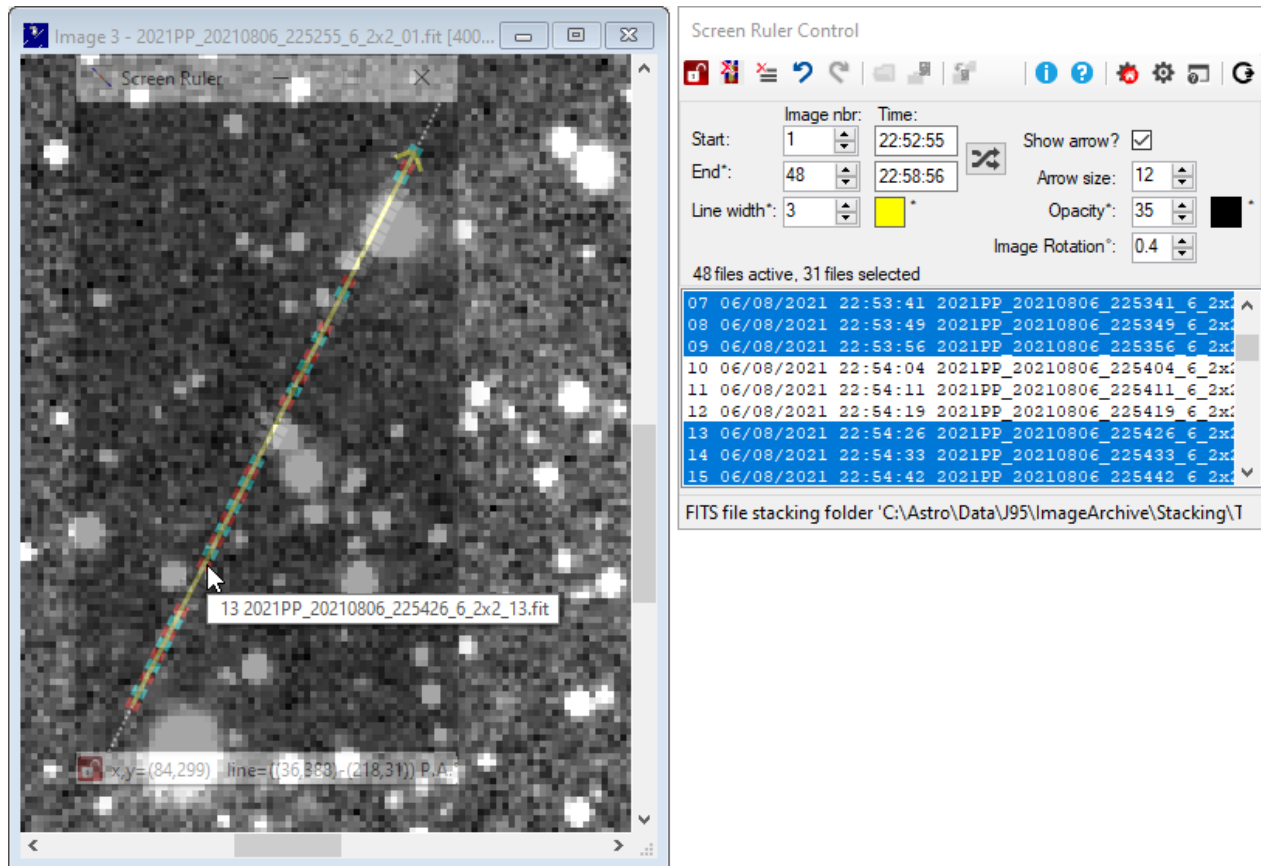
If files need to be reselected, either use the list on the Control window, or hold Shift+Ctrl while dragging the mouse, or place the mouse on a file location and press the **F7** function key to toggle the selection of individual files on or off.

Note that when the mouse is moved along the ruler the tooltip now reads out the **FITs file name** as well as the image sequence number.

Step 4. Copy just the selected files to a folder for stacking

Rather than manually noting the image numbers needing to be rejected, and then manually selecting just the required images in Astrometrica, the Screen Ruler can copy the selected files from a **source** folder to a destination "*stacking*" folder where the required image files can be conveniently selected for the final stacking process.

The source and stacking folders are configured in the Settings window with the FITSSourceFolder and FITSStackingFolder settings, but can also be quickly set by dragging from Windows Explorer either the respective folder, or a FITS file in the folder to the equivalent toolstrip button in the Control window, 🖼 for the source folder or 🖼 for the stacking folder. Here the source folder is being set, but the stacking folder can be set in the same way:
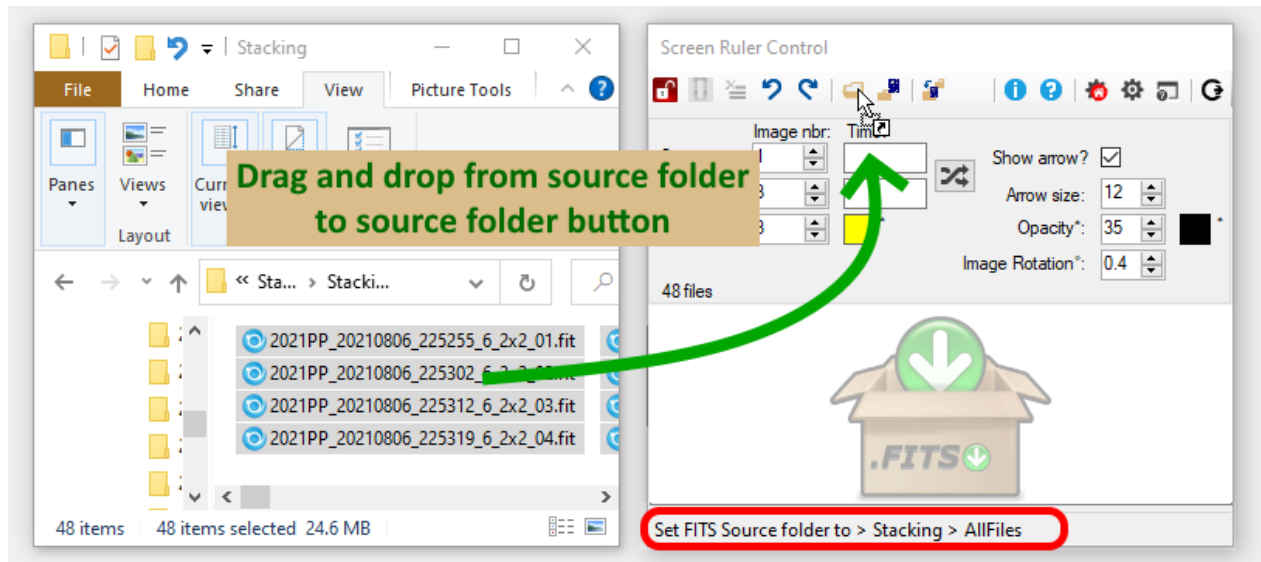
When the **FITSSourceFolder** and **FITSStackingFolder** settings contain valid folder names, press the **Open Source Folder** and **Open Stacking Folder** buttons to open those folders using Windows Explorer. Only when both settings are valid and refer to *different* folders will the **Copy selected files** button then be available.
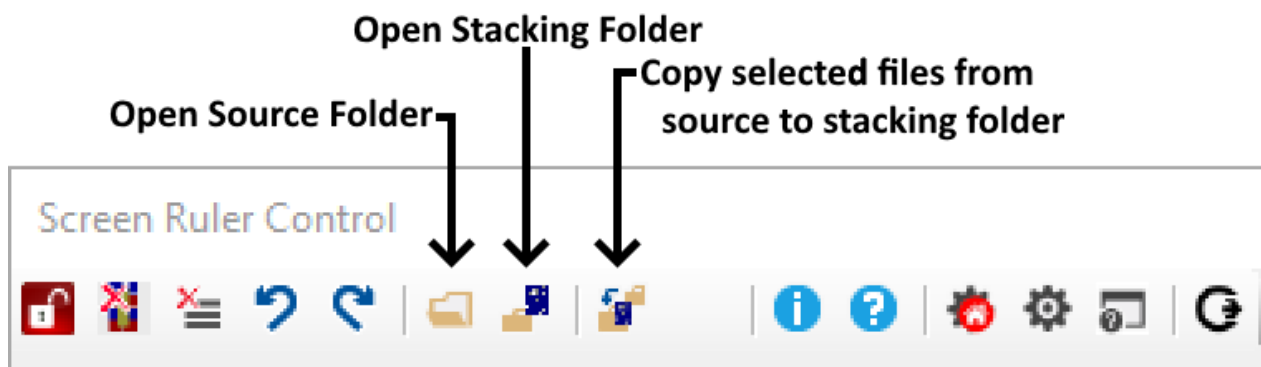
To check the folder names are correct before pressing the Copy selected files button, hover the mouse over the button, the action to be performed by the button will be displayed, for example:
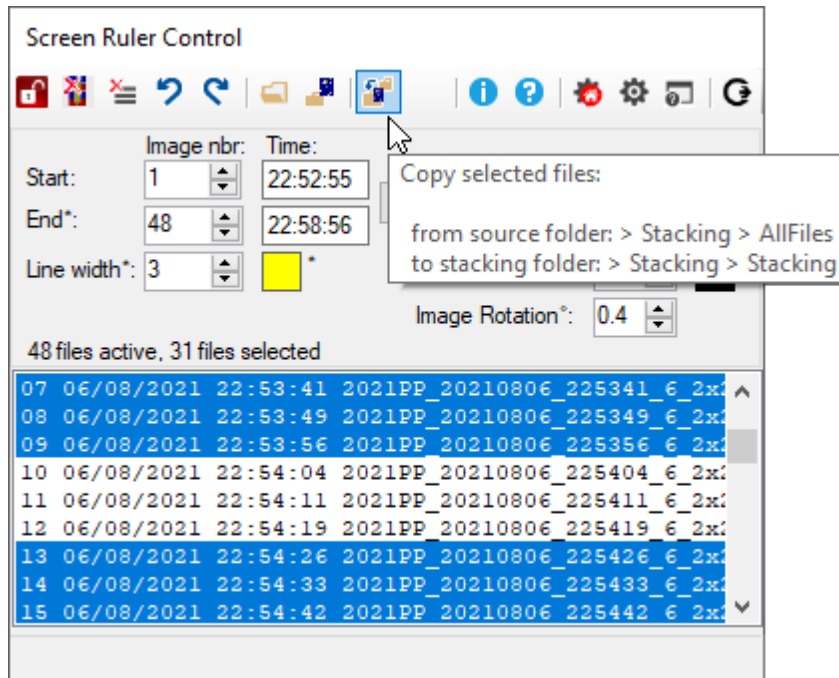
Step 5. Result - Stack the files copied to the Stacking folder

Stacking the files selected and copied into the stacking folder in step 4, i.e. files 1-9, 13-22, 27-33, 36-37 and 46-48 produces this result, with the moving object completely separated from all the background star trails. Astrometry and photometry can now be confidently measured from the stacked image:
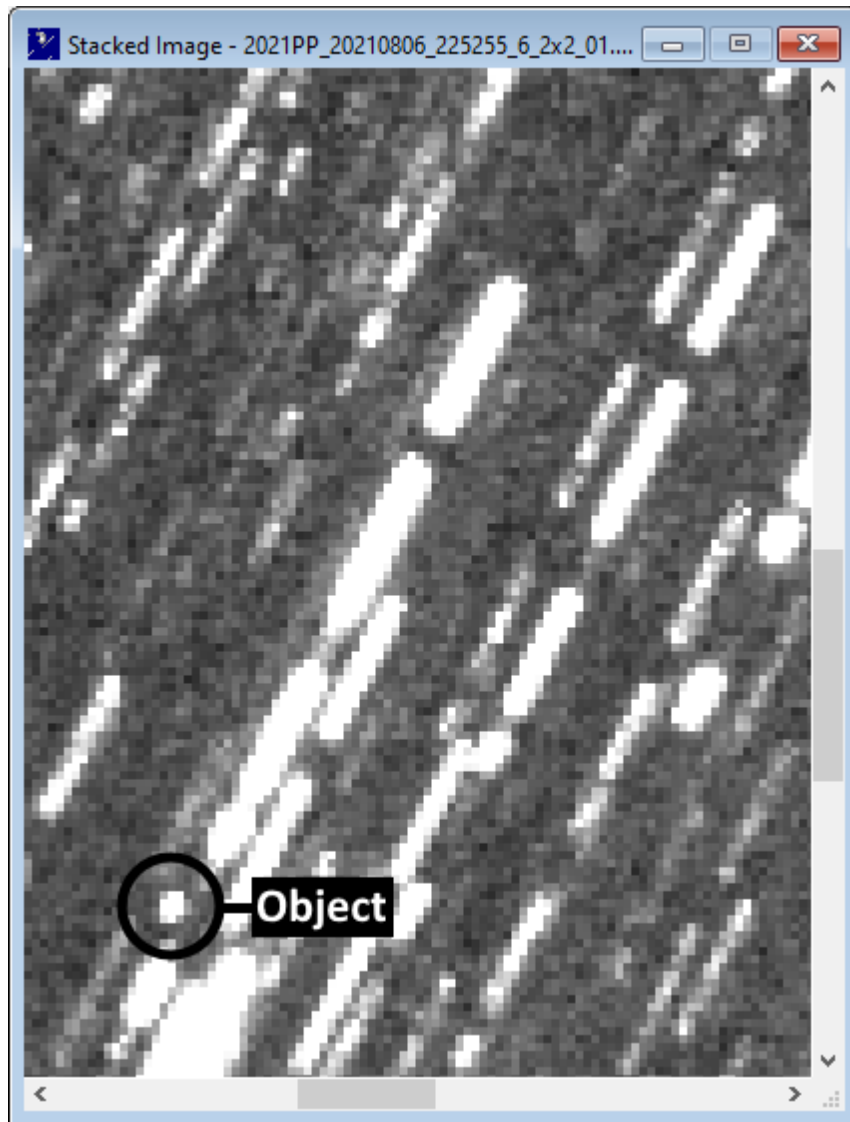
Tutorial III

Glossary

Astrometrica

A Windows program by Herbert Raab providing professional quality astrometric reduction, track & stack, automated moving object detection functionality and more. See theAstrometrica website.

Screen Ruler is designed to work with Astrometrica but other equivalent software that can track and stack multiple images and blink the stacked images can be also be used with Screen Ruler.

Exposure boundary

When FITS files are dragged and dropped onto the Control window FITS files area, exposure boundary lines are added to the Screen Ruler window to indicate where each exposure starts and stops along the length of the Ruler. The date and time recorded in the FITS keywords within the FITS header of each file, together with the exposure duration are used to position the exposure boundaries.

The accurate placement of the Screen Ruler is covered in Tutorial III, but the accuracy of the placement of the exposure boundaries along the ruler is dependent on the accuracy of the time information stored in the FITS keywords and the correct configuration of the FITSDateType setting.

Exposure boundaries can be selected or unselected. Adjacent selected exposure boundaries are shown with alternating colours. Unselected exposure boundaries are shown with a single, separate colour. The width of the exposure boundaries can be configured, selected and unselected exposure boundaries can have different widths. The colours and line widths are configured in the Exposure Markings category of the ⚙ Settings window.

Example

Screen Ruler window
Here 8 FITS images of a fast moving artificial satellite (34265U = 2009-010B) have been stacked together with zero motion, so that the stars appear as points but the moving object appears as 8 streaks as it moved from right to left through the field of view. Each exposure was 5.0 seconds duration and the object was moving at 14.7 arc seconds per second. The gaps between the end of one exposure and the start of the next can be seen to be uneven, with larger gaps between images 1 and 2 and between 6 and 7.

The Screen Ruler has been dragged from the mid-point of the first to the mid-point of the last streak, so the direction of motion is indicated by the arrow on the left end of the ruler. The Ruler has been positioned slightly below the streaks for clarity. The exposure boundaries appear as alternating blocks of red and aqua colour. The right hand end of each block equates to the exposure start time and the left hand end the exposure end time.
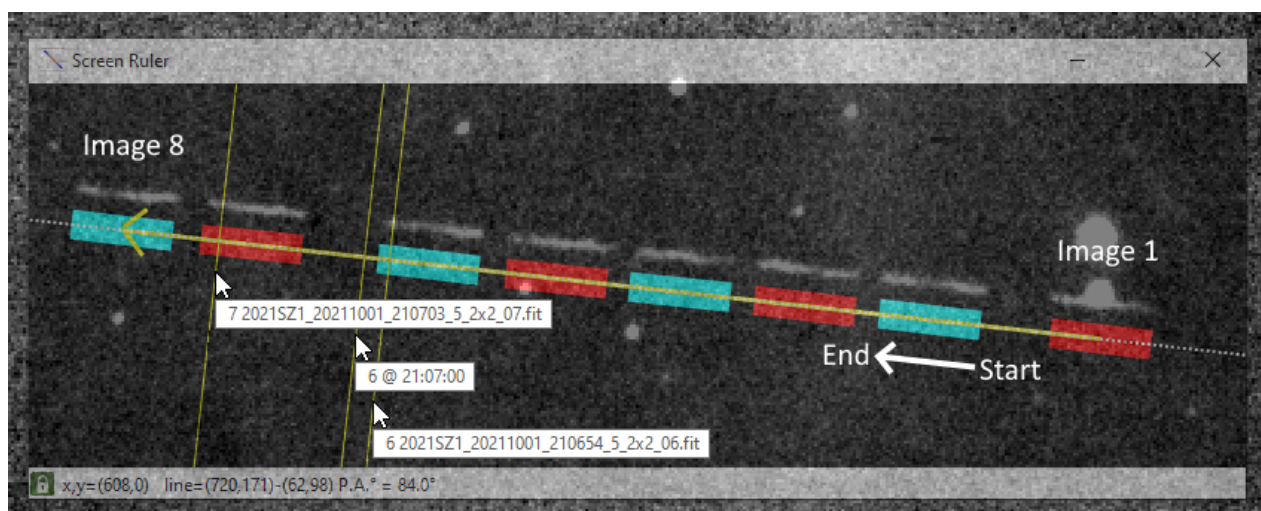
The Perpendicular line has been turned on by pressing F9 and the mouse moved to three positions to indicate the different information displayed in the mouse tooltip when positioned on or between exposure boundaries. The three sets of tooltip information have been superimposed.

Two of the perpendicular lines cross the exposure boundary coloured blocks for images 6 and 7. The associated mouse tooltips display the image sequence number and the underlying file name.

There is no file name to display at the mouse tooltip for the middle line, falling between the exposure boundaries for images 6 and 7. Instead an interpolated value for the image sequence number (6) is shown, assuming the exposures are evenly spaced from first to last. However, the time shown (21:07:00) accurately indicates the time when the object was at the crossing point of the perpendicular line and the Ruler.

Control window

Dropping the 8 FITS files on the Control window automatically selects all 8 in the file list, each line shows the sequential number, the exposure start time and the name of the FITS file.
Note that the Start and End image numbers are automatically set and the Start and End times are set from the time information contained in the FITS files:
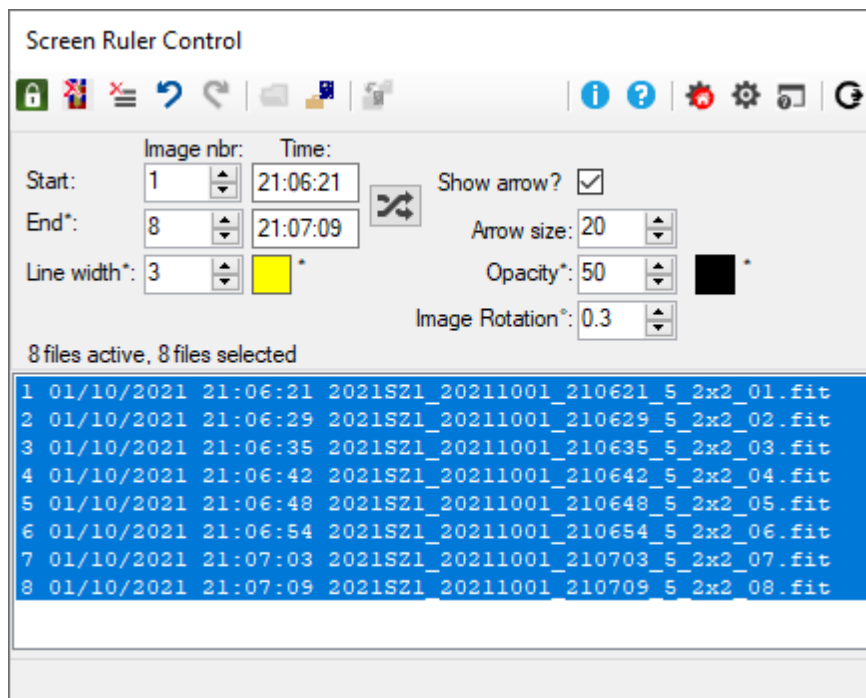
FITS

Flexible Image Transport System (FITS) is an open standard file format and is the most commonly used digital file format for astronomical images. Files are suffixed .fits .fit or .fts. For an overview see the wikipedia entry and more detailed information at the NASA/Goddard Space Flight Center FITS Support office website.

As well as containing an image, FITS files can contain metadata further describing the image, such as sky coordinates, the exposure length and the date and time the image was taken. These

are stored and retrieved as keyword/value pairs.

Appendices

Displaying coordinates at the mouse position

The image number and optionally, time and FITS file name associated with the mouse location are displayed on the Screen Ruler window using a tooltip near the mouse cursor.

The information displayed are for the point on the ruler closest to the mouse. This point can be seen more clearly by turning on the Perpendicular line by pressing the F9 key. Press F9 again to turn it off.

Here a set of 10 FITS files have been dropped onto the Control window so that the exposure boundaries are displayed on the Screen Ruler. The end of the Ruler is pointing to the lower right, at the arrowhead. The F9 key has been pressed to display the perpendicular line and the closest point from the mouse to the ruler can be seen to be the 2nd image in the set of 10. The mouse tooltip displays the sequential image number (2) and the FITS file name of the 2nd image. If the perpendicular line falls between two exposure boundaries then the sequential image number and the time rather than FITS file name are displayed.
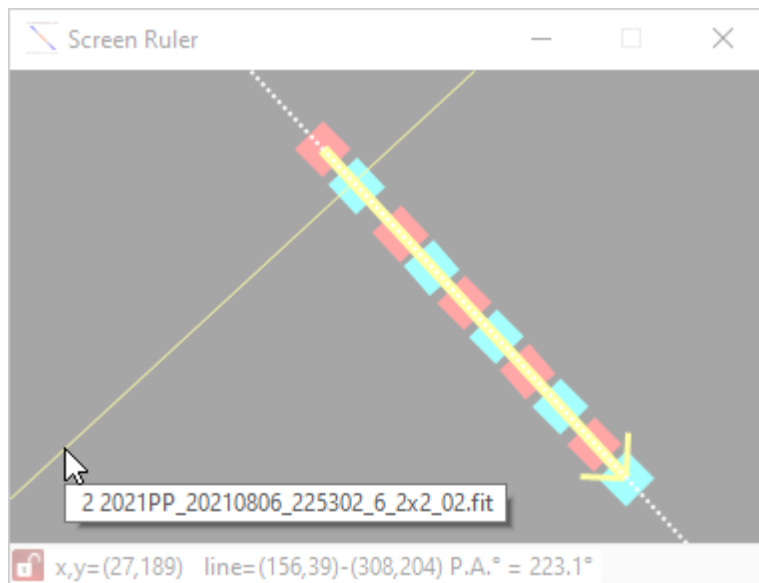
Function keys

The following Function keys are used by Screen Ruler:

F7 - Toggle the selection of individual files on or off

When FITS files have been added to the Control window FITS files area, F7 will toggle the selection of individual files on the Ruler, changing the colour of the exposure boundary line for

that file. See [Adding, selecting and copying FITS files](#).

F9 - Toggle the ruler [Perpendicular line](#) on or off

F12 - Toggle the [Magnifier window](#) on or off

Keep on Top

The Screen Ruler is designed to operate as the topmost window, so that it floats above other software windows such as Astrometrica.

When needing to work exclusively with another window, e.g. when re-stacking images with Astrometrica, the Screen Ruler can be minimised for convenience. The Minimise control is found only on the Screen Ruler window but minimises the Screen Ruler, the Screen Ruler Control and the Magnifier windows at the same time.

Recognised FITS keywords

Screen Ruler uses the following FITS keywords if available.

Note that the date and time of exposure and the duration of exposure are required for accurate placement of exposure boundaries on the Screen Ruler.

FITS Keyword	Usage:
CROTA1 **CROTA2**	When FITS files are dragged and dropped onto the [FITS files area](#) of the Control window, the first FITS file that contains either the **CROTA2** or **CROTA1** FITS keyword is used to extract the image rotation value from that keyword. The [Image Rotation°](#) value on the Control window is loaded with the negative of the keyword value. CROTA2 is used in preference to CROTA1 if both are present. They should both contain the same value. If neither are available the Image Rotation can be manually entered from the Control window.
DATE-OBS **TIME-OBS**	Used to extract the exposure date and time from FITS files in the [FITS files area](#) of the Control window. If **DATE-OBS** is present and in ISO 8601 long format ('CCYY-MM-DDThh:mm:ss[.sss...]') the date and time are used as the exposure time. If **DATE-OBS** is present and in ISO 8601 short format ('CCYY-MM-DD') or old 6 character FITS format ('DD-MM-YY') then the **TIME-OBS** value is combined with the **DATE-OBS** value and used as the exposure time. The exposure time and the exposure duration are combined using the [FITSDateType](#) setting to calculate exposure start and end times.
EXPOSURE **EXPTIME**	Used to extract the exposure duration (in seconds) from FITS files in the [FITS files area](#) of the Control window. **EXPOSURE** is used in preference to **EXPTIME** for the exposure duration. If neither are present then a value of 0 is used. The exposure time and the exposure duration are combined using the [FITSDateType](#) setting to calculate exposure start and end times.