PyroTracker User Manual

(Version 2.4.0 Beta)

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1 Introduction

Welcome to PyroTracker! This tool provides a graphical user interface (GUI) for tracking volcanic pyroclasts (or other objects) in eruption videos. Users can load a video, navigate through frames, manage different coordinate systems (Top-Left, Bottom-Left, Custom Origin), optionally define a pixel-to-meter scale manually or by drawing a line on a feature of known length, mark the changing position of specific pyroclasts over time to generate tracks, and create measurement lines. Project data, including element coordinates (always stored as raw Top-Left pixels), video metadata, coordinate system settings, and scale information, is saved to and loaded from JSON-based project files.

The application features interactive zoom and pan capabilities, frame-by-frame navigation, optional auto-advancing for track points, multi-element management (tracks and measurement lines) with visibility controls, on-screen information overlays (filename, time, frame number), an optional on-screen scale bar and scale definition line, persistent visual preferences, a video metadata viewer, export capabilities for video with overlays and individual frames, data export to CSV, and undo functionality for track point marking operations. A `View` menu provides centralized control for toggling the visibility of various on-screen overlays, including measurement line lengths.

2 Download and Installation

PyroTracker is distributed via GitHub.

1. Go to the **Latest Release page**.
2. Under the "Assets" section for the latest release, download the correct file for your operating system:
   - Windows: Download the `PyroTracker-windows.exe` file.
   - macOS: Download the `PyroTracker-macos.zip` file.
   - Linux: Download the `PyroTracker-linux` file.
3. Run the application:
   - Windows: Simply double-click the downloaded `PyroTracker-windows.exe` file. You might see a security warning ("Windows protected your PC"); click "More info" and then "Run anyway".
   - macOS: Double-click the downloaded `PyroTracker-macos.zip` file to unzip it. This will create a `PyroTracker.app` file. Double-click `PyroTracker.app` to run it. *Note: You might see a security warning ("App can't be opened because it is from an unidentified developer"). If so, right-click (or Ctrl-click) the* ***`PyroTracker.app`*** *file and select "Open", then confirm in the dialog box. You should only need to do this the first time.*
   - Linux: Open a terminal, navigate to the directory where you downloaded the file, make it executable using the command `chmod +x PyroTracker-linux`, and then run it using `./PyroTracker-linux`.

3 Getting Started

1. **Load a Video:**
   - Once the application window opens, go to the `File` menu and select `Open Video...`.
   - Browse to and select the video file you want to analyze (common formats like `.mp4`, `.avi`, `.mov`, `.mkv` are supported).
   - Click `Open`. The first frame of the video will appear in the main view area, and the video controls will become active. Information overlays (filename, time, frame number, if enabled) will also appear on the video viewport.

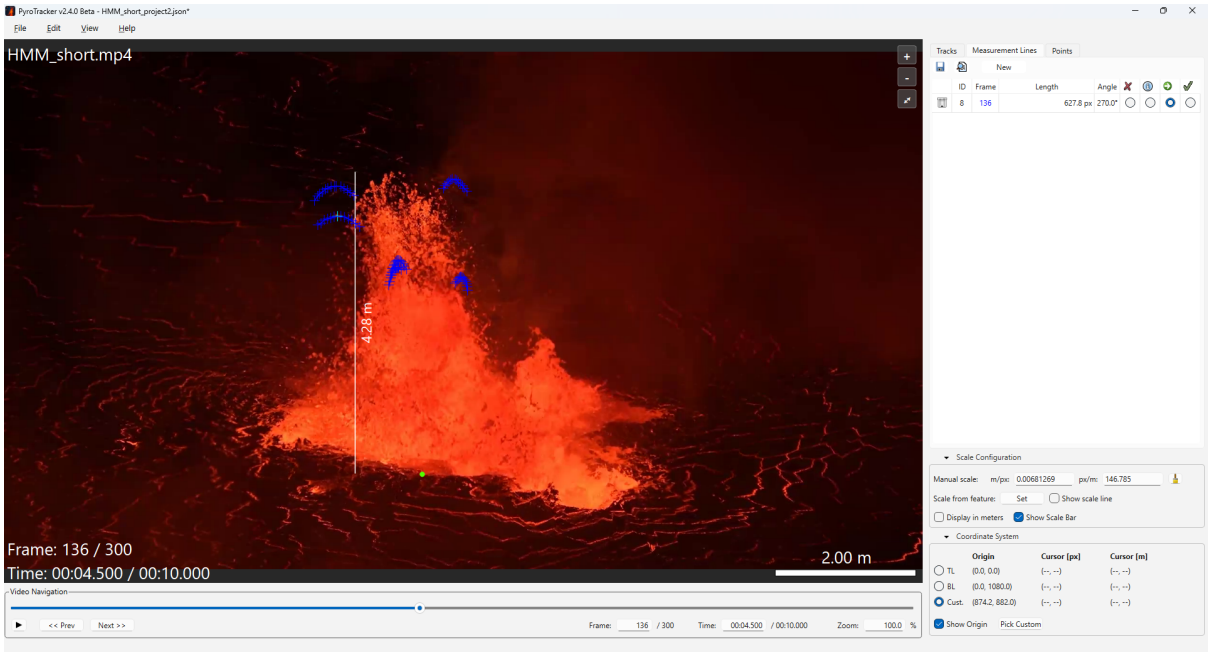

Figure 1: The user interface for PyroTracker showing the video display, data tables, and control panels.

4 Main Window Layout

The main window is divided into two main sections by a vertical splitter (which you can drag to resize):

- **Left Panel:** Contains the video display area (Image View) and the video navigation controls below it.
- **Right Panel:** Contains collapsible panels for "Scale Configuration" and "Coordinate System" management, and a tabbed widget for data display ("Tracks", "Measurement Lines", and "Points" tabs) along with controls for creating new elements and managing track auto-advance.

5 Video Navigation & Playback

You can move through the video using several methods:

- **Slider:** Drag the slider below the video frame to quickly scrub through the video.
- **Buttons:** Use the `« Prev` and `Next »` buttons for single-frame steps.
- **Mouse Wheel:** Hover the mouse cursor over the video frame and scroll your mouse wheel (`Scroll Up` = Previous Frame, `Scroll Down` = Next Frame).
- **Play/Pause:** Click the Play/Stop button (icon changes) or press the `Spacebar` to play or pause the video at its recorded frame rate.
- **Direct Frame/Time Input:** Enter a frame number or time (`MM:SS.mmm` or `SSS.mmm` format) into the respective fields in the navigation panel and press `Enter` to seek.
- **Jump to Frame (Table):** Click on a frame number in the "Start" or "End" columns of the "Tracks" table, the "Frame" column of the "Measurement Lines" table, or the "Frame" column of the "Points" table, to jump directly to that frame.
- **Jump to Point (Image View):** `Shift+Click` on a visible track marker in the image view to make that track active and jump to the frame where that specific point was marked.

The **video navigation panel** below the image view displays:

- Current Frame / Total Frames (e.g., "123 / 1000").
- Current Time / Total Duration (e.g., "00:05.123 / 00:40.000").

- Current Zoom percentage relative to "Fit View" (e.g., "150.0%").

Additionally, **information overlays** directly on the video viewport (visibility toggleable via the `View` menu) show:

- Video Filename (typically top-left).
- Current Time / Total Time (typically bottom-left).
- Current Frame / Total Frames (typically bottom-left, below time).

The application window title also displays the loaded video filename or project filename. Video FPS is available via `File -> Video Information...`.

6 Image View Interaction

The video display area allows for detailed inspection:

- **Zoom:** Hold down the `Ctrl` key and scroll the mouse wheel up (zoom in) or down (zoom out). Alternatively, use the `+` and `-` overlay buttons in the top-right corner of the view. You can also type a zoom percentage into the "Zoom" field in the navigation panel and press `Enter`.
- **Pan:** Click and hold the left mouse button on the image and drag to pan the view around when zoomed in.
- **Fit View:** Click the "Fit View" overlay button (two opposing arrows) in the top-right corner to reset the zoom and pan so the entire frame fits within the view area. This corresponds to 100% zoom in the zoom input field.

7 Scale Configuration

PyroTracker allows you to define a physical scale for your measurements, converting pixel measurements into physical units (e.g., meters). The controls are in the collapsible "Scale Configuration" panel in the right-hand section of the window.

- **Setting Scale Manually**:
  - `m/px`: Enter the value for meters per pixel (e.g., if 1 pixel in your video represents 0.05 meters, enter `0.05`).
  - `px/m`: Enter the value for pixels per meter (e.g., if 20 pixels represent 1 meter, enter `20`).
  - When you enter a value in one box and press `Enter` (or the input box loses focus), the other box will automatically calculate and display the reciprocal value.
- **Set Scale by Feature**:
  1. Click the `Set` button under "Scale from feature:".
  2. Your cursor will change to a crosshair. Click on the first point of a feature with a known length in the image view.
  3. Click on the second point of the feature. Hold `Shift` while clicking the second point to snap the line to common angles (e.g., horizontal, vertical, 45°).
  4. A dialog will appear showing the pixel distance of the line you drew. Enter the known real-world distance for this line in meters and click `OK`.

  The `m/px` and `px/m` values will update, and this defined line can be optionally displayed.
- **Reset Scale:** Click the Reset button (circular arrow icon) to clear any defined scale. The input boxes will clear, and data display will revert to pixel units. This button is only active if a scale is set.
- **Display Units:** The "Display in meters" checkbox allows you to toggle how coordinate data is shown in the "Points" table, measurement line lengths, and cursor coordinate displays. This checkbox is only enabled if a valid, positive scale has been entered.

- **Show Defined Scale Line:** The "Show scale line" checkbox (and `View -> Show Defined Scale Line` menu item) toggles the visibility of the line drawn using the "Set Scale by Feature" method. This is only enabled if a line has been defined. Its appearance (color, width, text size/color, end ticks) is customizable via `Edit -> Preferences...`.
- **Show Scale Bar:** The "Show Scale Bar" checkbox (and `View -> Show Scale Bar` menu item) toggles the visibility of a dynamic scale bar in the bottom-right of the image view. This is only enabled if a scale is set. The bar's length represents a round number in appropriate units (e.g., cm, m, km) and updates with zoom. Its appearance (color, font size, bar height) is customizable via `Edit -> Preferences...`.

8 Coordinate System Management

PyroTracker allows you to work with different coordinate systems. The controls are in the collapsible "Coordinate System" panel.

- **Selecting Mode:** Choose between:
  - **TL (Top Left):** Origin (0,0) at the top-left corner, Y increases downwards (standard image coordinates).
  - **BL (Bottom Left):** Origin (0,0 effectively at the video's bottom-left corner, after transformation), Y increases upwards. The Y-coordinate of the origin will be the video height.
  - **Cust. (Custom):** Origin at a user-defined point, Y increases upwards.
- **Setting Custom Origin**:
  1. Select the `Cust.` radio button.
  2. Click the `Pick Custom` button. Your cursor will change to a crosshair.
  3. Click on the desired origin location directly on the video frame.
  4. The mode will be set to Custom, and the panel will update to show the Top-Left coordinates of your chosen origin.
- **Origin Display:** The panel shows the effective origin coordinates (in the Top-Left system) for the currently selected mode next to each radio button.
- **Live Cursor Position:** As you move your mouse over the video frame, this section shows the cursor's coordinates transformed into each of the three systems (Top-Left, Bottom-Left, and Custom) simultaneously, in both pixels and meters (if scale is set).
- **Show Origin Marker:** Check or uncheck the "Show Origin" box (or use `View -> Show Origin Marker`) to toggle the visibility of a marker (default red circle) on the video frame indicating the effective origin of the currently selected coordinate system. The marker's appearance can be customized via `Edit -> Preferences...`.
- **Data Storage:** All element coordinates are internally stored and saved to project files as raw Top-Left pixel values, regardless of the currently active display coordinate system. Display transformations are applied on-the-fly.

9 Working with Elements (Tracks and Measurement Lines)

9.1 Tracks

Tracking involves creating "tracks" and marking the position of the corresponding pyroclast within each track on different frames.

- **Create a Track**:
  - Click the `New` button in the "Tracks" tab on the right panel.
  - Alternatively, go to the `Edit` menu and select `New Track` (or use the shortcut `Ctrl+N`).

  - A new row appears in the "Tracks" table, and this track becomes the "active" track (highlighted).

- **Select the Active Track:** Before adding points, ensure the correct track is active.
  - **Method 1 (Table):** Click anywhere on the row corresponding to the desired track in the "Tracks" table.
  - **Method 2 (Image View):** Hold down the `Ctrl` key and left-click on (or near) any visible marker belonging to the desired track in the main video view. To deselect all tracks, `Ctrl+Click` on a blank area of the image.
- **Add/Update a Point**:
  - Navigate to the desired frame.
  - Locate the pyroclast corresponding to the active track.
  - Left-click (without holding `Ctrl` or `Shift`) directly on the pyroclast's position in the video view.
  - A marker will appear. The details (Frame, Time, X, Y) will appear in the "Points" tab for the active track.
  - The X, Y coordinates shown in the "Points" table reflect the currently selected display coordinate system and unit (pixels or meters, indicated in headers).
  - If you click again on the same frame for the same track, the existing point's position will be updated.
- **Auto-Advance Feature**:
  - To automatically move to the next frame(s) after adding/updating a point, check the `Auto-advance` box in the "Tracks" tab controls.
  - Use the spin box next to it to set how many frames to advance.
- **Deleting Data (Tracks)**:
  - **Delete a Specific Point:** Navigate to the frame containing the point. Ensure the correct track is active. Press the `Delete` or `Backspace` key.
  - **Delete an Entire Track:** Click the trash can icon in the first column of the desired track's row in the "Tracks" table. Confirmation is required.
- **Undo Point Operation (Tracks)**:
  - Undo the last point addition, modification, or deletion for tracks using `Edit -> Undo Point Action` or the `Ctrl+Z` shortcut.
- **Selecting and Jumping (Shift+Click):**
  - If you want to quickly review a specific point and jump to its frame, hold down the `Shift` key and left-click on (or near) that point's marker in the video view. This will make that point's track active and navigate to the frame where that point was marked.

9.2 Measurement Lines

Create lines to measure distances and angles on a specific frame.

- **Create a Measurement Line:** Click the `New` button in the "Measurement Lines" tab. This makes the new line active.
- **Define Endpoints:** After creating a new line, the application enters line definition mode. Click two points on the *same* video frame to define the line's endpoints.
  - The cursor changes to a crosshair. Click the first point.
  - Move the cursor and click the second point. Hold `Shift` while defining the second point to snap the line to common angles (e.g., horizontal, vertical, 45°).

  - Press `Esc` to cancel line definition.

- **Display:** Defined lines are listed in the "Measurement Lines" table, showing their ID, definition frame, length (in current display units if scale is set, else pixels), and angle (0-360°, 0° to the right).
- **Length Label Visibility:** The visibility of length labels on the measurement lines can be toggled via the `View -> Show Measurement Line Lengths` menu item. The appearance of these labels is customizable via `Edit -> Preferences...`.
- **Visuals:** Line color and width (for normal and active/selected states) are customizable via `Edit -> Preferences...`.
- **Delete a Line:** Click the trash can icon in the first column of the desired line's row in the "Measurement Lines" table. Confirmation is required.
- **Select Active Line:** Click on a line's row in the "Measurement Lines" table to make it active. The corresponding line on the image view (if visible on the current frame) will be highlighted. The "Points" tab will show the coordinates of its two endpoints.

9.3 Element Visibility (Tracks and Lines)

Control how tracks and measurement lines are displayed using the radio buttons in their respective tables ("Tracks" tab, "Measurement Lines" tab):

- **Hidden (X icon):** The element is never shown.
- **Home Frame (Info icon):**
  - For **Tracks**: Markers visible only on frames with points. No lines are drawn between points.
  - For **Measurement Lines**: The line is visible only on the frame where it was defined.
- **Incremental (Arrow icon):**
  - For **Tracks**: Only points up to and including the current video frame are shown, connected by lines.
  - For **Measurement Lines**: The line is visible on its definition frame and all subsequent frames.
- **Always Visible (Tick icon):**
  - For **Tracks**: All points for the track are shown on every video frame, connected by lines.
  - For **Measurement Lines**: The line is shown on all video frames.

You can set the visibility for all elements of a specific type (all tracks or all lines) at once by clicking the corresponding icon (X, Info, Arrow, Tick) in the header row of their respective tables.

10 Project Management (Saving and Loading)

PyroTracker saves and loads entire project states, including all tracked elements, video information, scale settings, and coordinate system configurations, using a JSON file format.

- **Saving a Project:**
  - `File -> Save Project` (or `Ctrl+S`): Saves the current project to its previously specified file path. If the project has not been saved before (i.e., it's a new project or a video was just opened without an associated project file), this action will behave like "Save Project As...".
  - `File -> Save Project As...`: Allows you to save the current project state to a new or different `.json` file. This is useful for creating backups or different versions of your work.
  - Saved data includes: video filename and path (relative to project file), frame dimensions, FPS, all track data (points are stored as raw Top-Left pixel coordinates), all measurement line data (endpoints as raw Top-Left pixel coordinates), current scale factor (m/px), defined scale line coordinates (if any), coordinate system mode, custom origin coordinates (if applicable), and

the state of relevant UI toggles (like visibility of scale bar, scale line, origin marker, info overlays, and measurement line lengths).

- **Loading a Project:**
  - `File -> Open Project...`: Select a previously saved `.json` project file.
  - Loading a project will replace any current unsaved work (you will be prompted to save if there are unsaved changes).
  - The application will attempt to load the video file specified in the project (looking for it relative to the project file's location first).
  - All tracks, measurement lines, scale settings, coordinate system settings, and relevant UI display preferences (like overlay visibilities) stored in the project file will be restored.
  - If the video specified in the project file cannot be found, or if its metadata (like frame dimensions) mismatches the stored project metadata, warnings will be issued, but the element data will still be loaded.
- **Closing a Project:**
  - `File -> Close Project`: Closes the currently loaded video and all associated project data (tracks, lines, scale, etc.), resetting the application to its initial state. You will be prompted to save any unsaved changes before closing.
- **Unsaved Changes Indicator:** The application window title will display an asterisk (*) next to the filename if there are unsaved changes to the current project.

Figure 2: An example of an exported frame showing various overlays: tracks, information text, a defined scale line, and a scale bar.

11 Exporting Data & Visuals

- **Export Data (Simplified CSV)**:
  - `File -> Export Data -> Export Tracks (as CSV)...`: Exports all track data (ID, frame, time, X, Y) to a simple CSV file.

  - `File -> Export Data -> Export Lines (as CSV)...`: Exports all measurement line data (ID, definition frame, endpoint coordinates, length, angle) to a simple CSV file.
  - **Unit Choice Dialog:** For both CSV export types, a dialog will prompt you to choose whether to export coordinates and lengths in "Pixel Coordinates (current display system)" or "Real-World Units (meters, if scale is defined)".
  - **Quick Save/Copy Table Data:** Save and Copy icon buttons are available above both the "Tracks" and "Measurement Lines" tables.
    * Clicking the **Save icon** allows you to save the data from that specific table to a CSV file, using the units currently displayed in the application (i.e., if "Display in meters" is checked and scale is set, data is in meters; otherwise, pixels).
    * Clicking the **Copy icon** copies the data from that specific table to the clipboard in CSV format, also using the current display units.

- **Export Video with Overlays**:
  - `File -> Export Video with Overlays...` allows exporting the video with all visible overlays (tracks, measurement lines, origin marker, scale line, scale bar, info overlays). See Figure 2 for an example of overlays.
  - An "Export Options" dialog appears to select:
    * **Export Range:** Full video or a custom frame/time range.
    * **Export Resolution:** Current viewport resolution or the original video resolution.
  - You can then choose a save path and format (MP4 or AVI).
- **Export Current Frame to PNG**:
  - `File -> Export Current Frame to PNG...` saves the currently displayed frame, including all visible overlays, as a PNG image.
  - You will be prompted to choose between current viewport resolution or original video resolution.

12 Customizing Appearance (Preferences)

Change default colors and sizes via `Edit -> Preferences...`. The dialog has tabs for:

- **Tracks:** Colors for active/inactive track markers (current/other frames) and lines; marker size; line width.
- **Origin:** Origin marker color and size.
- **Scales**:
  - **Defined Feature Scale Line:** Line color, text color, text size, line width, show end ticks (checkbox), and tick length factor.
  - **On-Screen Scale Bar:** Bar & text color, bar height, text font size.
- **Info Overlays:** Text color and font size for Filename, Time, and Frame Number overlays.
- **Measurement Lines:** Line color (normal and active), line width, length label text color, length label font size, and a global toggle for showing length labels.

Click the color swatch to select colors, adjust numeric values for sizes/widths. Click `Apply` to see changes immediately, or `OK` to apply and close. `Cancel` discards changes made in the current dialog session. Preferences are saved and loaded automatically between application sessions.

13 Viewing Video Information

Go to `File -> Video Information...` to see technical details about the loaded video (e.g., dimensions, frame rate, duration, codec). You can copy values from this dialog using the right-click context menu.

14 About PyroTracker

Go to `Help -> About` to see application version information.