PyroTracker User Manual

(Version 2.3.0 Beta)

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1. Introduction

Welcome to PyroTracker! This tool is designed to help researchers manually track the movement of volcanic pyroclasts (or other objects) within eruption videos. You can load a video, navigate frame by frame, define coordinate systems, optionally set a physical scale (e.g., meters per pixel), mark object positions across multiple frames to create tracks, customize the appearance, and save your tracking data to a standard CSV file for later analysis. Track data can be displayed and saved in either pixel units or physical units (e.g., meters) if a scale is defined. The application features on-screen information overlays (filename, time, frame number) and a dedicated "View" menu to control the visibility of these and other visual aids.

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 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) will also appear on the video viewport.

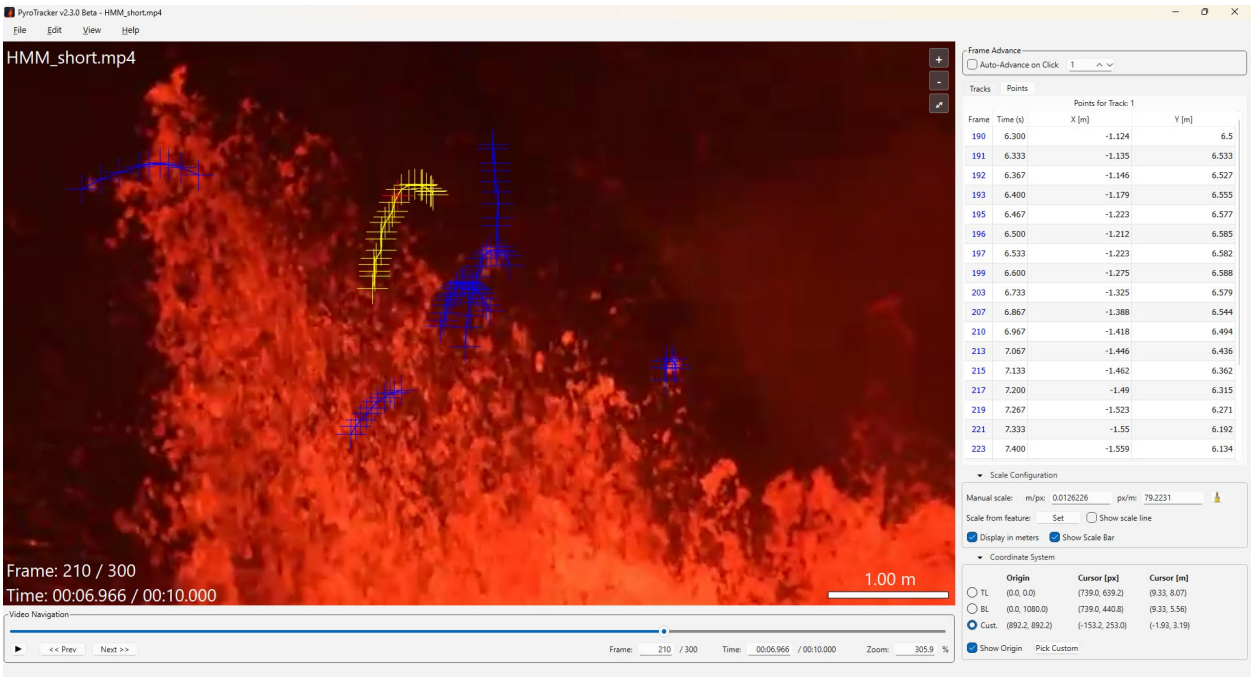

Figure 1. *The user interface for PyroTracker*

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 controls for tracking settings (like Auto-Advance), tabs for viewing track and point data ("Tracks" and "Points" tabs), the "Scale Configuration"

panel, and the “Coordinate System” management panel. These panels are collapsible.

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, 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 and its 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 (⤢) 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.
  - If no scale is set, both boxes will be empty or show “-”.
- **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.
  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 and how it’s potentially saved. This checkbox is only enabled if a valid, positive scale has been entered. The live cursor position display (see Section 8) will show both pixel and metric values simultaneously if a scale is set, regardless of this checkbox.
- **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.
  - **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...`.
- **Important for Saving/Loading:** The coordinate system you have selected when you save your tracks determines how the X, Y coordinates are written in the CSV file. When you load tracks, the system automatically switches to the coordinate system saved in that file.

9. Tracking Pyroclasts

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

- **Workflow:**
  1. **Create a Track:**

        - Click the `New Track` button at the bottom of 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).
    2. **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.
        - The corresponding row in the Tracks table will become selected (or deselected).
    3. **Navigate to a Frame:** Use the video navigation controls.
    4. **Add/Update a Point:**
        - Locate the pyroclast corresponding to the active track on the current frame.
        - 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.
    5. **Repeat:** Navigate to other frames and repeat Step 4 to build up the track.
- **Auto-Advance Feature:**
    - To automatically move to the next frame(s) after adding/updating a point, check the `Auto-Advance on Click` box in the "Frame Advance" panel (top-right).
    - Use the spin box next to it to set how many frames to advance.
- **Deleting Data:**
    - **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:**

    - Undo the last point addition, modification, or deletion 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.

10. Track Visibility

Control how tracks are displayed using the radio buttons in the "Tracks" table:

- **Hidden (X icon):** The track is never shown.
- **Incremental (> icon):** Only points up to and including the current video frame are shown, connected by lines.
- **Always Visible (✓ icon):** All points for the track are shown on every video frame, connected by lines.

You can set the visibility for all tracks at once by clicking the corresponding icon (X, >, ✓) in the header row of the "Tracks" table.

11. Saving and Loading Tracks

- **Saving:**
    - Go to `File -> Save Tracks As...`.
    - Choose a filename and location. Data is saved in CSV format.
    - The CSV file contains all marked points (track_id, frame_index, time_ms, x, y).
    - The X and Y coordinates are saved according to the coordinate system selected at the time of saving.
    - If a scale is set and "Display in meters" is checked, you will be prompted to save data in meters or pixels.
    - The file also includes metadata (video info, app version, coordinate system, scale factor, data units, defined scale line coordinates) commented with '#' at the start of lines.
    - **Precision Warning:** If saving in meters, a dialog warns about potential precision loss and offers options to confirm, save in pixels, or cancel.
- **Loading:**
    - First, load the correct video file (`File -> Open Video...`).
    - Then, go to `File -> Load Tracks...`.
    - Select the CSV file. Loading replaces current tracks (confirmation required).
    - The application reads track data and settings (coordinate system, scale, units, defined scale line) from the file.

- The UI updates to reflect loaded settings.
- If loaded data was saved in meters with a valid scale factor, it's converted back to internal pixel units.
- **Important:** Loading a CSV specifying data in meters will fail if a valid scale factor is missing.
- If other CSV metadata (e.g., frame count) mismatches the current video, a warning is shown, but you can proceed.

12. Exporting Data & Visuals

- **Export Video with Overlays:**
  - `File -> Export Video with Overlays...` allows exporting the video with all visible overlays (tracks, origin marker, scale line, scale bar, info 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.

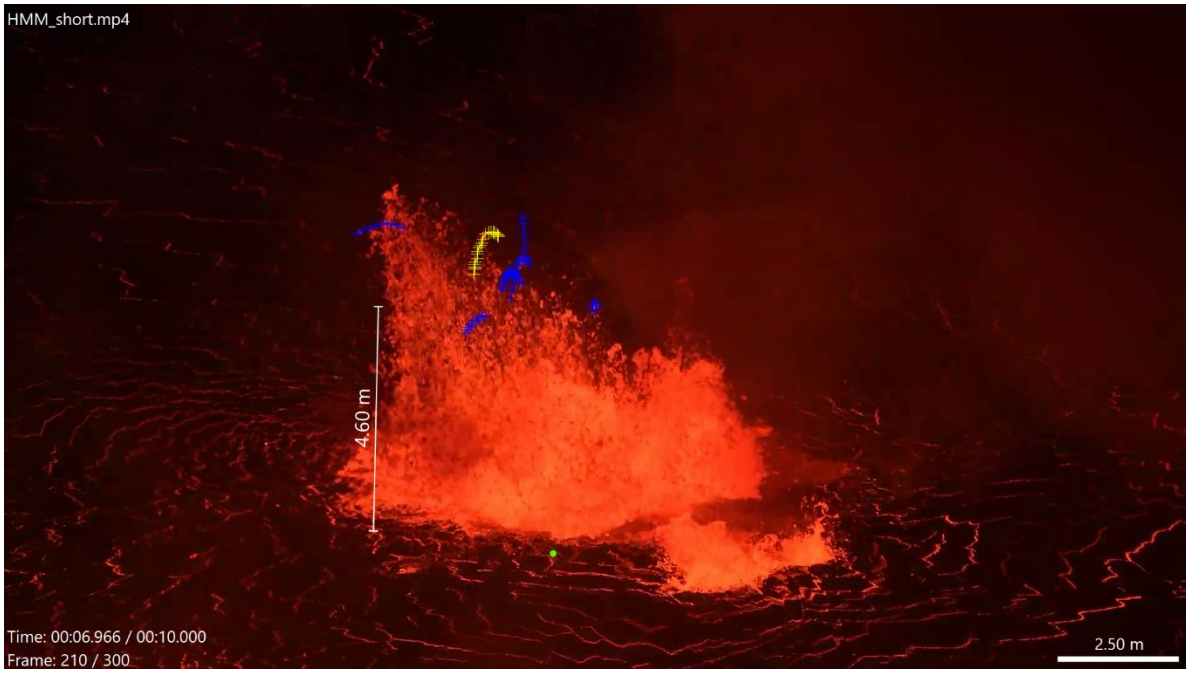

Figure 2. *An exported frame with overlays.*

13. 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.

Click `Select...` for colors, adjust numeric values for sizes. Click `Apply` to see changes immediately, or `OK` to apply and close. `Cancel` discards changes. Preferences are saved and loaded automatically.

14. Viewing Video Information

Go to `File -> Video Information...` to see technical details about the loaded video (dimensions, frame rate, duration, codec, etc.).

15. About PyroTracker

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