PyroTracker User Manual

(Version 2.1.0 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.

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. The video's filename will appear in the bottom-right corner of the video navigation panel.

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 and the video navigation controls below it.
- **Right Panel:** Contains controls for tracking settings (like Auto-Advance), tabs for viewing track and point data, the "Scale Configuration" panel, and the "Coordinate System" management panel.

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 (▶ / ⏹) or press the Spacebar to play or pause the video at its recorded frame rate.
- **Jump to Frame:** 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. (See Section 8).
- **Jump to Point:** Shift+Click on a visible track marker in the image view to jump to the frame where that specific point was marked. (See Section 8).

The navigation panel also displays:

- Current Frame / Total Frames
- Current Time / Total Duration (MM:SS.mmm format)
- Video FPS (Frames Per Second)
- Loaded Filename (hover for full path)

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.
- **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.

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 "Scale Configuration" panel in the bottom-right.

- **Setting the Scale:** You can define the scale in two ways:
    - **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 show "-".
- **Reset Scale:** Click the **Reset** button (icon) to clear any defined scale. The input boxes will revert to "-", and data display will return to pixel units. The reset button is only active if a scale is currently set.
- **Display Units:** A checkbox labeled **"Display in meters"** allows you to toggle how coordinate data is shown in the "Points" table (see Section 9) and how it's potentially saved (see Section 11). This checkbox is only enabled if a valid, positive scale has been entered. If the scale is reset, this checkbox will become disabled and unchecked.

  Note: The live cursor position display (see below) will show *both* pixel and metric values simultaneously if a scale is set, regardless of this checkbox.

8. Coordinate System Management

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

- **Selecting Mode:** Choose between:
    - Top Left: Origin (0,0) at the top-left corner, Y increases downwards (standard image coordinates).
    - Bottom Left: Origin (0,0) at the *bottom*-left corner, Y increases upwards.

- Custom: Origin at a user-defined point, Y increases upwards.

- **Setting Custom Origin:**
  - Select the Custom radio button.
  - Click the Pick Custom button. Your cursor will change to a crosshair.
  - Click on the desired origin location directly on the video frame.
  - 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.

- **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. This helps verify your coordinate system setup.

- **Show Origin Marker:** Check or uncheck the Show Origin box to toggle the visibility of a marker (default red circle) on the video frame indicating the effective origin of the currently selected coordinate system.

Important: 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. You can select the active track in two ways:
   - **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. The corresponding row in the Tracks table will become selected.
3. **Navigate to a Frame:** Use the video navigation controls (slider, buttons, mouse wheel) to go to the frame where you want to mark the pyroclast's position.

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 at the clicked location (colors/styles depend on active status and Preferences).
    - The details (Frame, Time, X, Y) will appear in the "Points" tab for the active track.
    - The X, Y coordinates shown in the table reflect the currently selected *display* coordinate system and the unit (pixels or meters) selected in the "Scale Configuration" panel if a scale is active. The table headers for X and Y will indicate the current unit, e.g., "X [m]" or "Y [px]".
    - If you click again on the same frame for the same track, the existing point's position will be *updated* to the new click location.
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 (e.g., 1, 5, 10).

Deleting Data:

- **Delete a Specific Point:** Navigate to the frame containing the point you want to remove. Ensure the correct track is active. Press the Delete or Backspace key on your keyboard.
- **Delete an Entire Track:** Click the trash can icon (🗑) in the first column of the desired track's row in the "Tracks" table. You will be asked to confirm.

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* automatically navigate the video to the frame where that point was marked.

10. Track Visibility

You can control how tracks are displayed on the video frame using the radio buttons in the "Tracks" table:

- **Hidden (X icon):** The track is never shown.
- **Incremental (> icon):** Only the points up to and including the *current* video frame are shown, connected by lines. This is useful for visualizing the path as it unfolds.

- **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 for your data. The file will be saved in CSV (Comma Separated Values) 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 in the UI at the time of saving. Additionally, if a scale is set and "Display in meters" is checked in the "Scale Configuration" panel, you will be prompted whether to save the data in meters or pixels. If saved in meters, a conversion is applied.
    - The file also includes metadata about the video, the coordinate system used, the scale factor (m/px if set), and the units (px or m) in which the data points are stored. This metadata is commented out with '#' at the beginning of the lines.

      Precision Warning: If you choose to save data in meters, a dialog will warn you about potential precision loss compared to saving in raw pixel values and will allow you to confirm, save in pixels instead, or cancel the save operation.
- **Loading:**
    - First, load the *correct video file* corresponding to the track data you want to load (File -> Open Video...).
    - Then, go to File -> Load Tracks....
    - Select the previously saved CSV file.
    - You will be asked to confirm, as loading will replace any currently marked tracks.
    - The application will read the track data and the coordinate system settings from the file.
    - The UI will automatically switch to the coordinate system specified in the loaded file. The "Scale Configuration" panel will also update to reflect the loaded scale and unit preference. If the loaded data was saved in meters and a valid scale factor is present in the CSV, the data will be converted back to internal pixel units for processing.
      Important: If a CSV file indicates data is in meters but does not contain a valid scale factor, the loading will be aborted with an error message to prevent misinterpretation of data.

- If the other metadata in the CSV (like frame count or dimensions) doesn't match the currently loaded video, you will receive a warning, but you can choose to proceed.

12. Customizing Appearance (Preferences)

You can change the default colours and sizes used for drawing tracks and the origin marker:

1. Go to the Edit menu and select Preferences....
2. In the dialog box:
    - Click the Select... button next to any colour setting to open a colour chooser.
    - Adjust the numeric values for marker size and line width using the spin boxes.
3. Click Apply to see the changes immediately without closing the dialog, or click OK to apply changes and close the dialog. Click Cancel to discard changes.
4. Your preferences are saved automatically and will be loaded the next time you start PyroTracker.

13. Viewing Video Information

To see technical details about the currently loaded video:

1. Go to the File menu and select Video Information....
2. A dialog box will appear showing properties like dimensions, frame rate, duration, and codec information (if available).

14. About PyroTracker

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