# Multiple Particle Tracker
## January, 2020

This is a beta release of version 1.9.2 of the particle tracker for Windows 10.

The supporting website is here: http://flux.mit.edu/blog/particle-tracker from where you can download the particle tracker along with a video file to test it.

There is no absolute or implied warranty with the software.  Please feel free to share it widely and critique it generously. Your feedback and suggestions will help us improve the tracker.

The particle tracker is designed to track multiple particles from a video feed in stark contrast against a background. The particles may be brighter or darker than the background. The tracker can track up to 30 particles and be aware of up to 40 detected segments in the image. Data from the tracker can be accessed for quantitative analysis.

**Required Hardware**

You will need:

(i)     A PC running Windows 10, with at least 1GB RAM and 1GHz 32-bit or faster processor.

(ii)    A video acquisition device (also known as *framegrabber*), which may be connected to one of the interface ports of the computer including USB, Firewire or PC-CARD slot (and its variants). The framegrabber must support a video-for-windows (vfw) mode.

**How to install the Software**

Download ptack-install.zip**,** currently version 1.9.2 Beta *modified for Windows 10 installation.* This is a ".zip" file. Best to save it on your computer, unpack it. Then run the *ptrack-install.exe* file within. Kindly ignore a potential windows warning that "Running this app might put your PC at risk," by selecting "More Info" and then the "Run Anyway" tab that appears.  The Installer will then proceed to install a "Marshall & Ravela" tab within "All Programs" where you will find "Particle Tracker."  You should also download this simple but large test data File; please unzip it prior to playing it in the tracker.

## How to run the Software

Click on the "Particle Tracker" icon to fire up the app. You should see something similar to the image below.
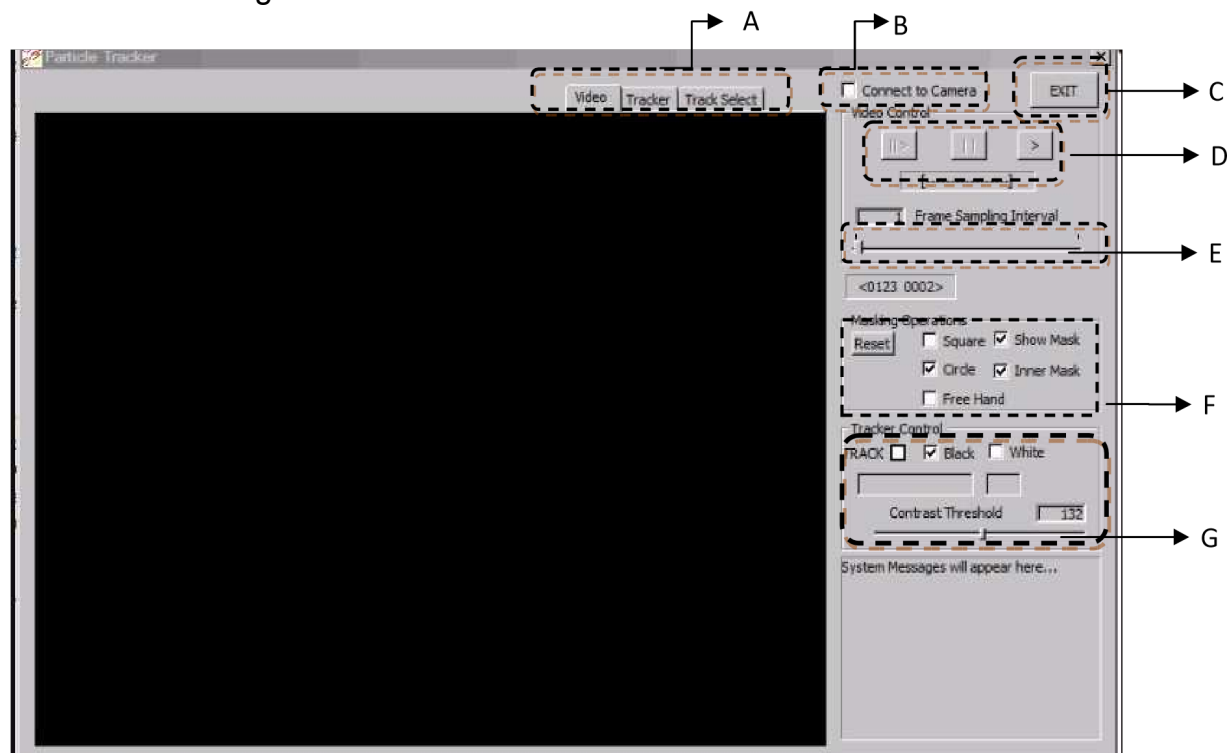


You can put the tracker though its paces by either connecting it to a camera (see B below) and/or connecting to a test avi file (a video recording of a fluid experiment - see D below).

Here are the options available to you – labels A, B etc refer to the particle tracker interface above:

A. The *Video/Tracker/Select Track* tabs allow you one of three views. These are: a look at the raw *Video* with track overlays, a *Tracker* view depicting detected segments and tracks (when the tracker is turned on), and a *Track Select* view, which depicts the track selected for saving in a file.

B. *Connect to Camera*: This option allows you to connect to an available acquisition device (video) and uses the video for windows (*vfw*) interface to do it. If you've successfully connected, the main pane in Video tab (now black) will show a live video.

C. *Exit* the application any time using this button (duh)!

D. When unconnected to the camera, you can use the *play* (>, right) button to play an avi file. The avi file must be uncompressed, 24-bit, 640x480. The *pause*
(II middle) button can be used to pause the video and the *step* (II>, left) button can be used to step one frame at a time, which is a useful feature to step through the tracker and understand how it works (or fails).
E. The *Frame Sampling Interval* option determines the number of frames that the tracker skips, which is useful for very slowly moving particles when the motion cues are turned on. You can ignore this feature in this beta version.
F. The *Masking Operations* section of the tracker allows you to create masks. By selecting an appropriate check-box, you can create square masks or circular ones and paint a free hand mask if you wish. By checking the inner mask check box, you can create an annulus that masks out regions outside it. This is useful for certain experiments. The left mouse button allows you to reposition the centers of the square or circular masks.
G. The *Tracker Control* section allows you to run the tracker. By selecting the *TRACK* checkbox detected particles are tracked over successive frames. If you are using the offline mode by running the tracker on an AVI file, then you may step through individual frames if you wish (see step D). The *Black* or *White* checkboxes allow you to specify whether the particle is darker or brighter than the background and the *Contrast Threshold* slider allows you to set a relative threshold for classifying a pixel as black or white. It is best to adjust the tracker in the *TRACK* mode (i.e. while tracking particles) whilst looking at it in the *Tracker* view (A).

**Mouse Moves**

1. Left mouse button (click and drag): This can be used to adjust the radii of the inner and outer masks.
2. Left mouse button (double-click): By double clicking the left mouse button, you re-center the square or circular mask to the clicked position.
3. Right mouse button (single-click): Clicking the right mouse button provides several options, including:
   - Selecting a track for saving to file.
   - Clearing the logs and reinitializing the tracker.
   - Exporting a picture of the current tracker state to the clipboard.
   - Setting up the path to the directory where the data file is saved.

These are discussed next.
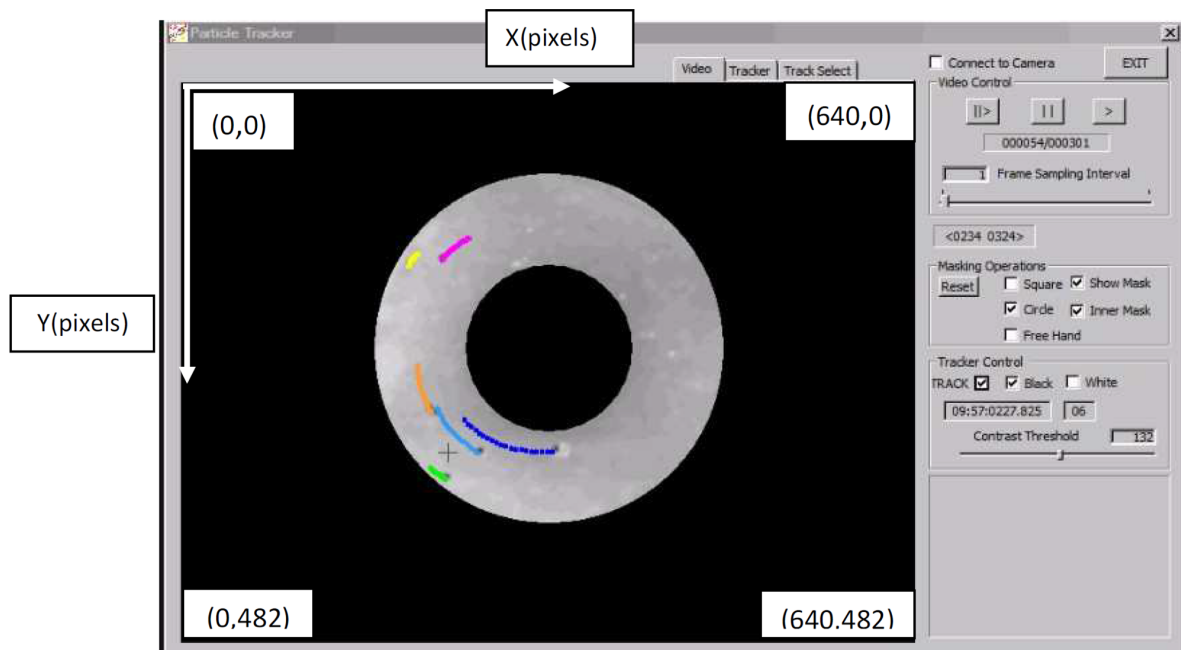
The above figure shows the state of the tracker as it runs a video file (a simple test file is provided with the software). Notice it is at frame 54 out of 301 frames in the video. The contrast is at the default value of 132, by selecting an inner mask, we choose an annular workspace. Black particles are being tracked and in this frame *ptrack* shows having detected 06 particles in the video tab-view.

Also shown are the (X,Y) coordinates in pixel units with, by convention, X increasing to the right from 0 to 640, Y increasing down from 0 to 482. The tracker yields the coordinates of points in (X,Y) pixel space – see below.

Conversion to physical units can readily be made in post-processing by noting the physical dimension of the field of view and its corresponding pixel dimension and calculating the conversion factor.
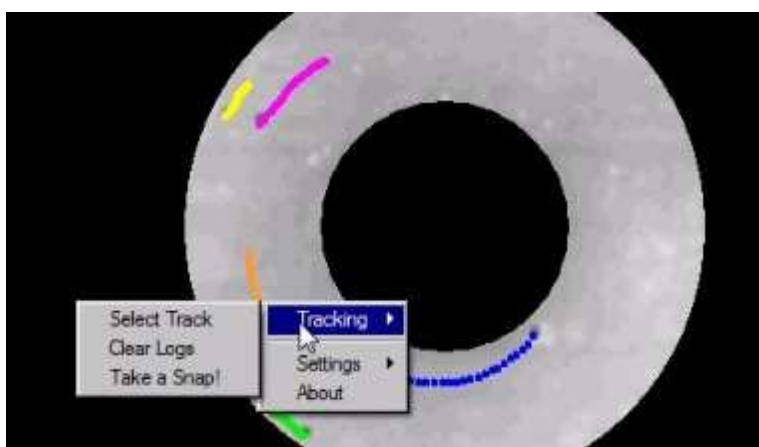


Shown here are the menu options obtained by selecting the right mouse buttons and the sub-options for the tracking items. The *Select Track* option selects the track on which the mouse was clicked. The *Clear Logs* option clears the tracker state (it assigns colors afresh).

This option is useful when the tracker becomes cluttered with particles either due to false detections or having too many of them. The *Take a Snap* option allows you to copy a picture of the current state on to the clipboard, which can be pasted into a word-like document.
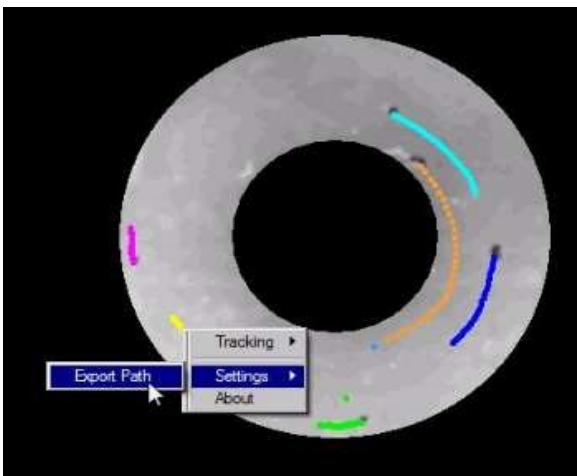


Under the S*ettings* option, the *Export Path* sub-option allows you to set the directory where the tracker saves its tracks when you use the *Select Track* option, as shown above. The default is the '*My Documents*' directory. Here, the tracker saves a file with a name that looks like:



ptracks-2008-11-17-09-56-30.txt .

The name includes the date, hour and second when you launched the current *ptrack* session.

Within this file, you will find tracks listed as follows:

$NEW TRACK                                          *This indicates the start of a new track.*

HR    MIN   SEC   MSEC  X(px)  Y(px)  *Time (hh mm ss mmmm) and Position (x, y in pixels)*

| HR | MIN | SEC | MSEC | X(px) | Y(px) |
|----|-----|-----|------|-------|-------|
| 09 | 57  | 21  | 0432 | 0209  | 0247  |
| 09 | 57  | 21  | 0772 | 0208  | 0244  |
| 09 | 57  | 22  | 0103 | 0208  | 0242  |

| 09 | 57 | 22 | 0314 | 0208 | 0239 |
| 09 | 57 | 22 | 0541 | 0208 | 0236 |
| 09 | 57 | 22 | 0797 | 0208 | 0234 |
| 09 | 57 | 23 | 0028 | 0208 | 0232 |
| 09 | 57 | 23 | 0266 | 0208 | 0229 |
| 09 | 57 | 23 | 0508 | 0208 | 0227 |
| 09 | 57 | 23 | 0754 | 0209 | 0225 |
| 09 | 57 | 23 | 0992 | 0208 | 0223 |
| 09 | 57 | 24 | 0285 | 0209 | 0221 |
| 09 | 57 | 24 | 0488 | 0209 | 0219 |
| 09 | 57 | 24 | 0720 | 0210 | 0217 |
| 09 | 57 | 24 | 0939 | 0210 | 0215 |
| 09 | 57 | 25 | 0249 | 0211 | 0212 |

$$END TRACK                       *This is the end of a track*

If you select multiple tracks, one after the other, they are simply appended. The individual fields are tab separated and records are delimited by a newline/carriage return, so you can read this into most data-processing programs (such as MATLAB or EXCEL).

Notes on converting from pixel coordinates to cartesian and polar coordinates can be found here: http://weathertank.mit.edu/pixel-coordinates