**Data Pipeline Script & Automation**

Goal:

Automate extraction of laser spot position (“centroid”), log position vs. rotation speed, and output results for analysis—so anyone can reproduce, visualise, and statistically assess the outcome. This makes the experiment “plug-and-play” for collaborators and eliminates bias.

**Sample Python Automation Script (Outline)**

This is intended for a typical USB webcam or simple digital camera setup.

import cv2

import numpy as np

import matplotlib.pyplot as plt

import csv

# --- Parameters ---

video\_path = "experiment\_video.mp4" # Replace with your video file

output\_csv = "beam\_positions.csv"

# --- Data storage ---

frame\_numbers = []

beam\_x = []

beam\_y = []

# --- Open video ---

cap = cv2.VideoCapture(video\_path)

frame\_count = 0

while cap.isOpened():

ret, frame = cap.read()

if not ret:

break

gray = cv2.cvtColor(frame, cv2.COLOR\_BGR2GRAY)

\_, thresh = cv2.threshold(gray, 200, 255, cv2.THRESH\_BINARY) # Adjust threshold if needed

M = cv2.moments(thresh)

if M["m00"] > 0:

x = int(M["m10"] / M["m00"])

y = int(M["m01"] / M["m00"])

frame\_numbers.append(frame\_count)

beam\_x.append(x)

beam\_y.append(y)

frame\_count += 1

cap.release()

# --- Save results ---

with open(output\_csv, "w", newline="") as f:

writer = csv.writer(f)

writer.writerow(["Frame", "X", "Y"])

writer.writerows(zip(frame\_numbers, beam\_x, beam\_y))

# --- Plot result ---

plt.plot(frame\_numbers, beam\_x, label="X")

plt.plot(frame\_numbers, beam\_y, label="Y")

plt.xlabel("Frame")

plt.ylabel("Centroid Position (pixels)")

plt.legend()

plt.title("Laser Spot Centroid vs. Time")

plt.show()

**What This Script Does**

* Reads video of experiment (vacuum chamber, rotating or not)
* Detects and tracks the laser spot position frame-by-frame (using centroid algorithm)
* Outputs position vs. frame/time to CSV for later analysis
* Plots the result for instant visual check

**How to Use**

1. Record video of each run:
   * At each rotation speed (0 RPM, 1 RPM, …), record the laser spot for ~10–30 seconds.
2. Run script on each video.
3. Correlate RPM to frames/time (keep a log of start/stop times or encode in video filename).
4. Export data—combine all runs in a spreadsheet for statistical tests.

**Statistical Analysis**

* t-test or ANOVA comparing stationary vs. rotating (under vacuum vs. air)
* If a systematic shift is seen only when rotating under vacuum, MBT is supported