Milou: a low-cost open-source line-following robot to study indoor air

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Supplementary Materials

1 Reference drawings of test chamber

1.1 HOBOs location in test chamber

To continuously monitor the temperature in the room without introducing more heat sources, we use HOBOs placed on the walls of the test chamber. Figure 1 shows the plan view of the test chamber with the location and height of the HOBOs used during this study.

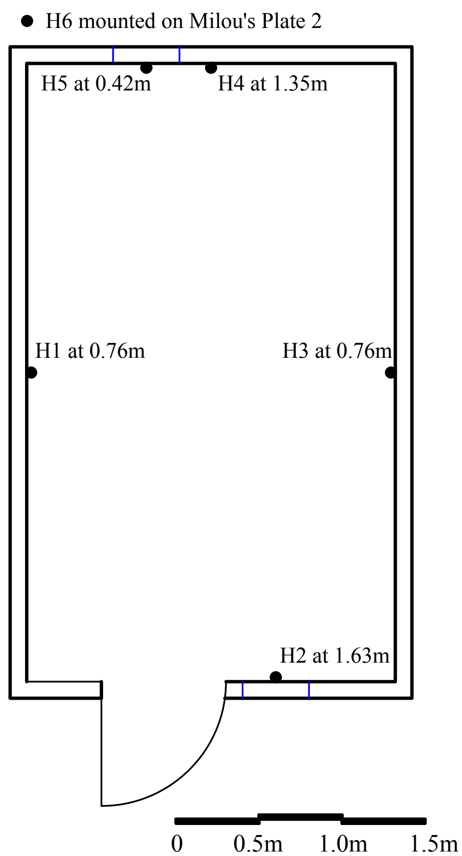

Figure 1: HOBOs locations in the test chamber with their associated heights.

1.2 Test chamber measurements

Figure 2 shows the plan view of the test chamber with all relevant dimensions to replicate the setups in this study.

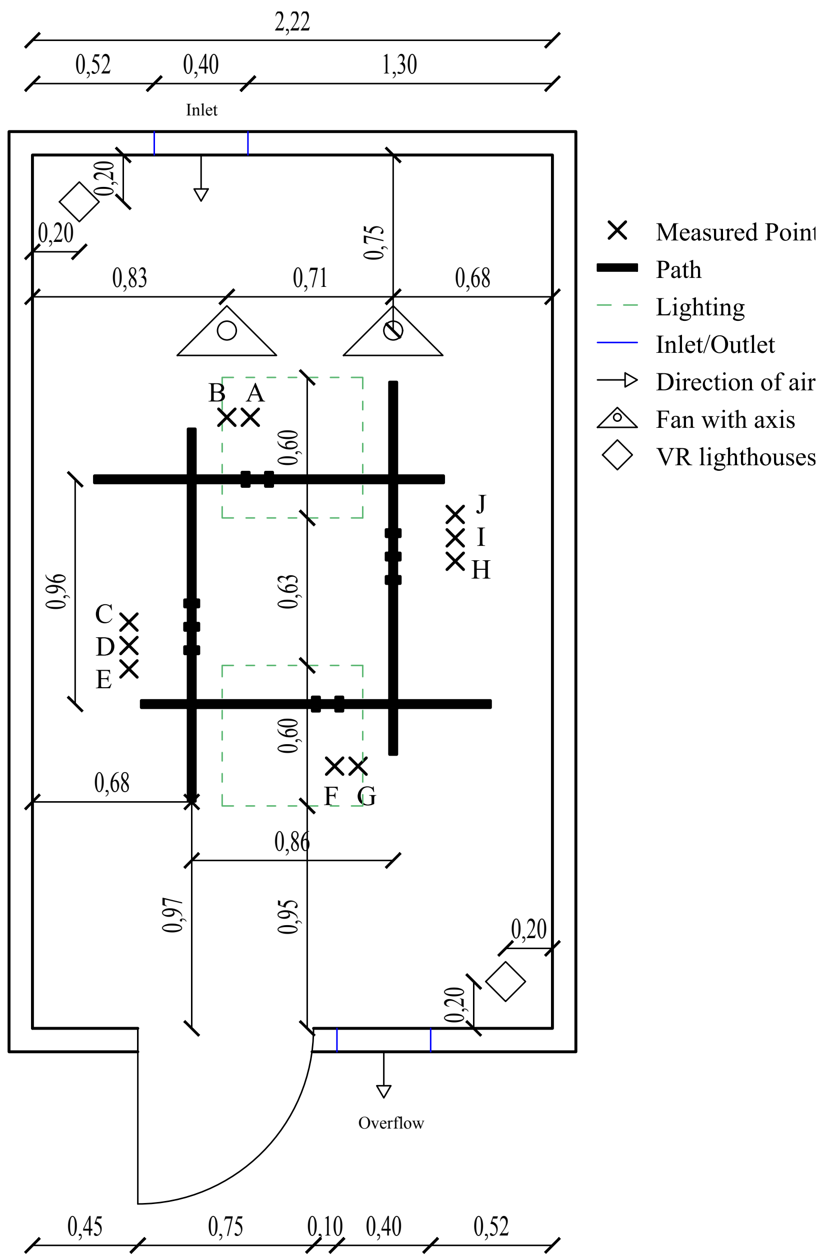

Figure 2: Test chamber with dimensions to locate the fans, the path, the lighthouses and the ventilation openings.

2 Temperature baseline case: Ceiling lights on and off

We preliminary measured the temperature in the test chamber to identify and quantify heat sources for Milou to measure. The experiment involved measuring the temperature in the test chamber under two different lighting conditions - ceiling lights off and on - with no other heat sources in the chamber. We placed 6 HOBOs - 5 on the walls and 1 in the middle of the chamber. The objective was to assess the impact of lighting on room temperature over the period of a workday from 8:00 to 17:00. We turned on the ceiling lights at 8:45 and turned them back off at 16:30. Figure 3 shows the temperature variation over two different days we conducted the measurements. We can observe an increase of around 1 °C over the 8-hour period.

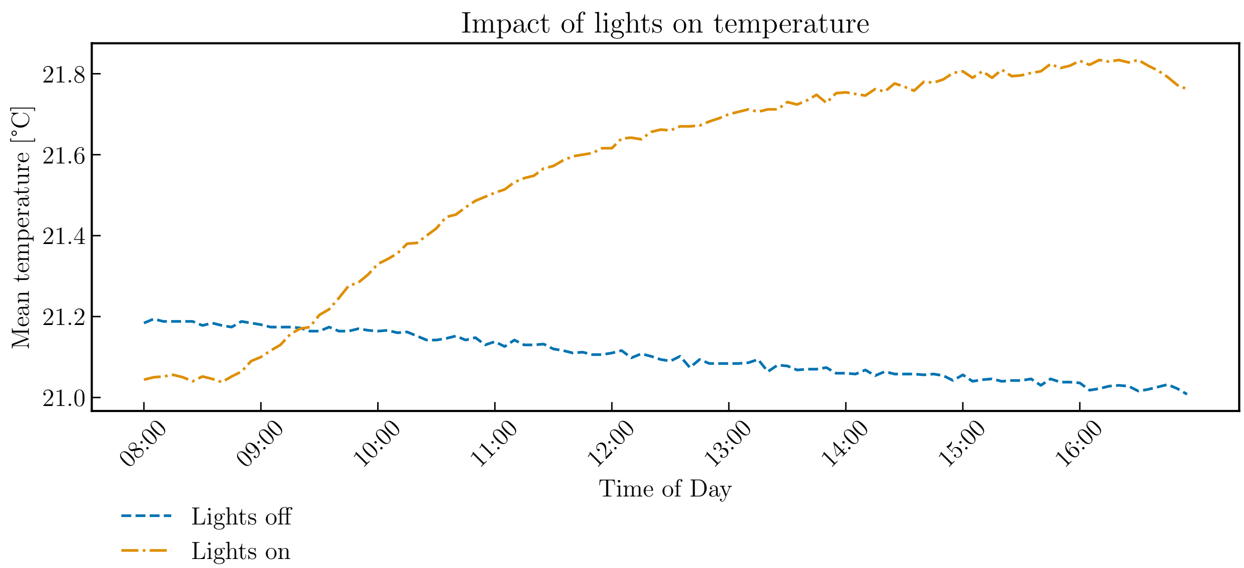

Figure 3: Temperature variation over time when ceiling lights are turned on in the test chamber.

3 Temperature repeatability test

To assess the repeatability of the temperature measurements, we repeated Setup 2 twice over two days and collected the data shown in Figures 4, 5, and 6. Only point D at probe 3 fails the statistical test; however, at point D probe 3, the distribution of the data and the mean temperatures of the two days of measurements (21.6°C) are similar, indicating that the statistical test is detecting small variations that are smaller than the accuracy of the measuring device.

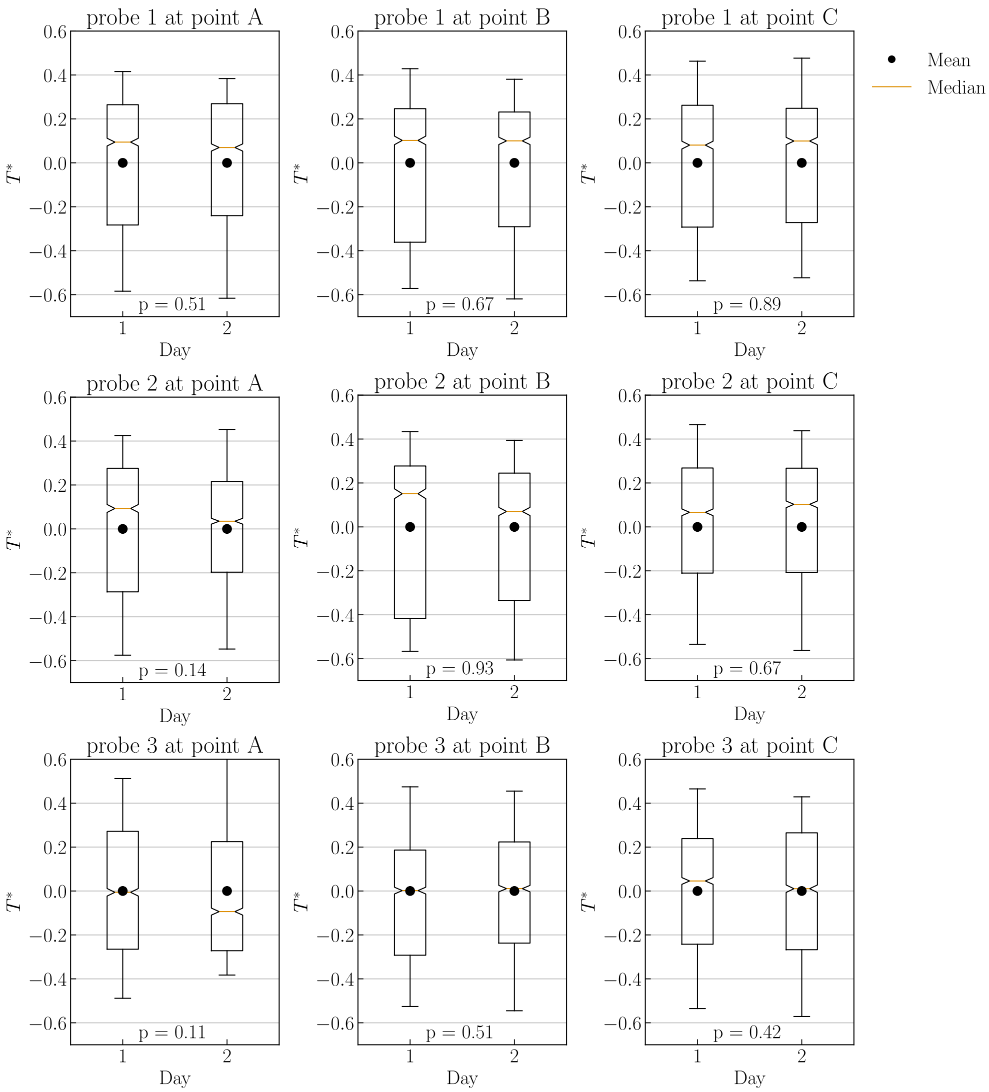

Figure 4: Normalised temperature variation over two sets of measurements using Setup 2 at points A, B and C. The p-value is the result of the wilcoxin test.

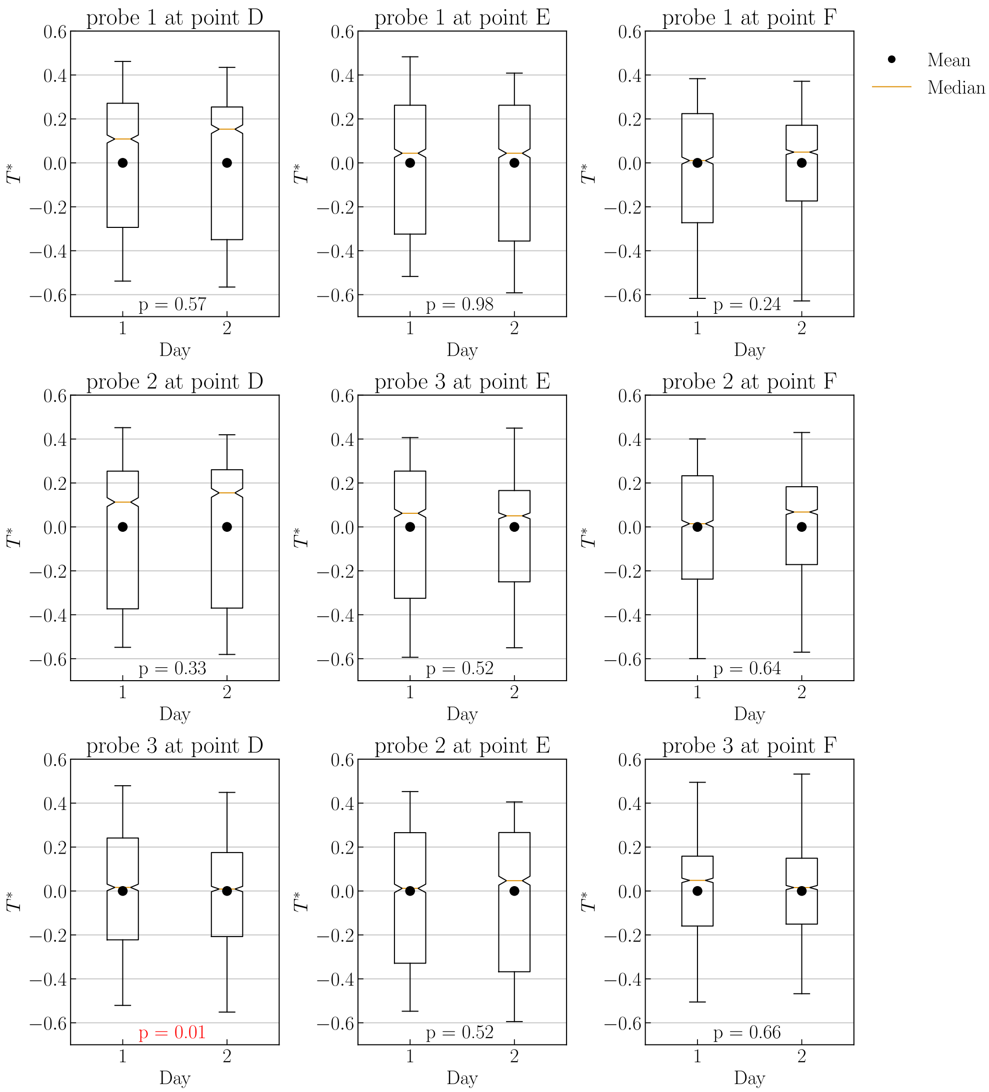

Figure 5: Normalised temperature variation over two sets of measurements using Setup 2 at points D, E and F. The p-value is the result of the wilcoxin test.

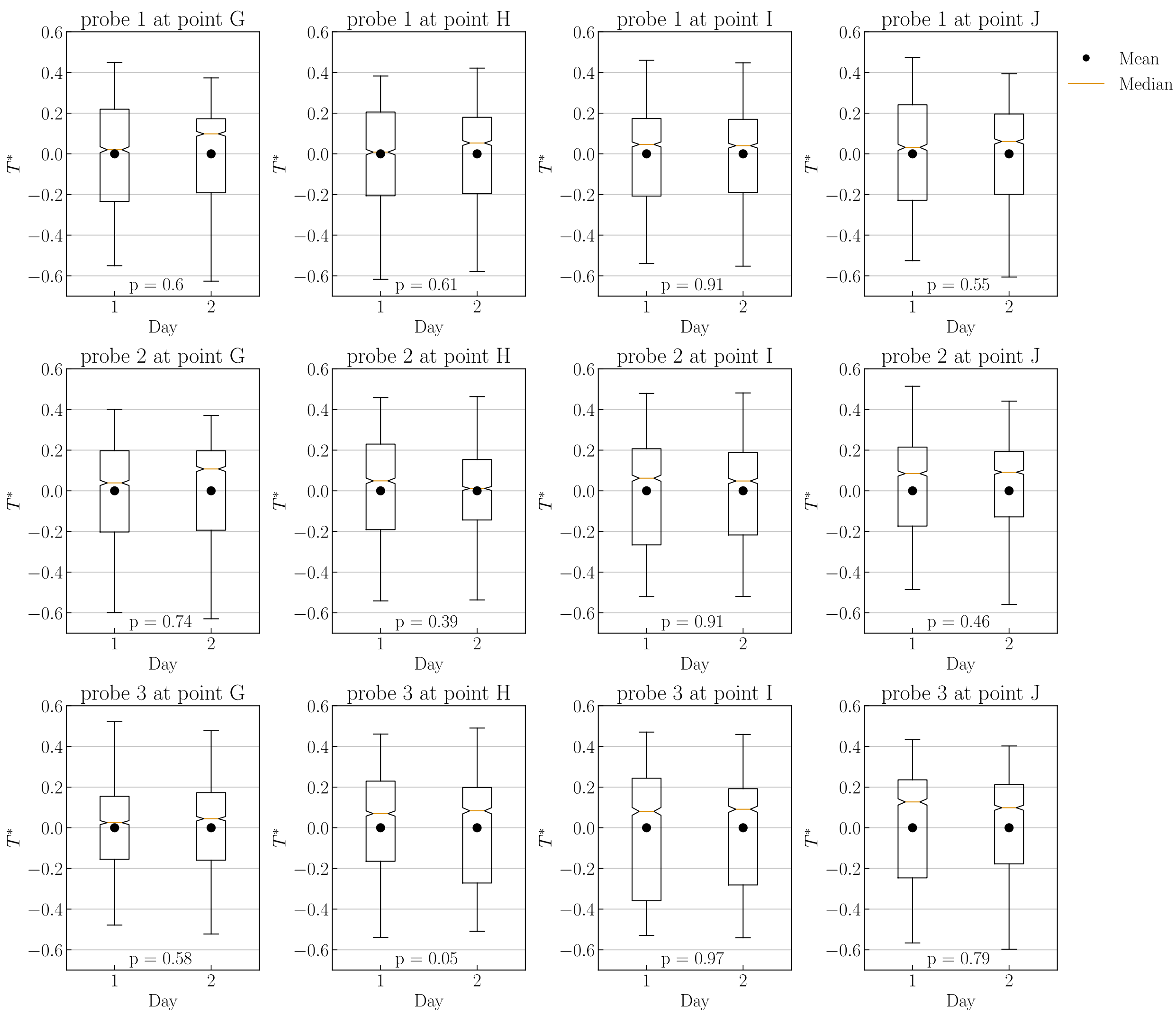

Figure 6: Normalised temperature variation over two sets of measurements using Setup 2 at points G, H, I and J. The p-value is the result of the wilcoxin test.

4 Normalised airflow velocity magnitudes at the ten points for Setup 2 and 3

To compare the measured airflow velocity magnitudes at each point and probe, we plot the boxplots of the measurements of the four laps with the p-value result of the Friedman test (See Figures 7, 8, 9, 10, 11, 12, 13, 14).

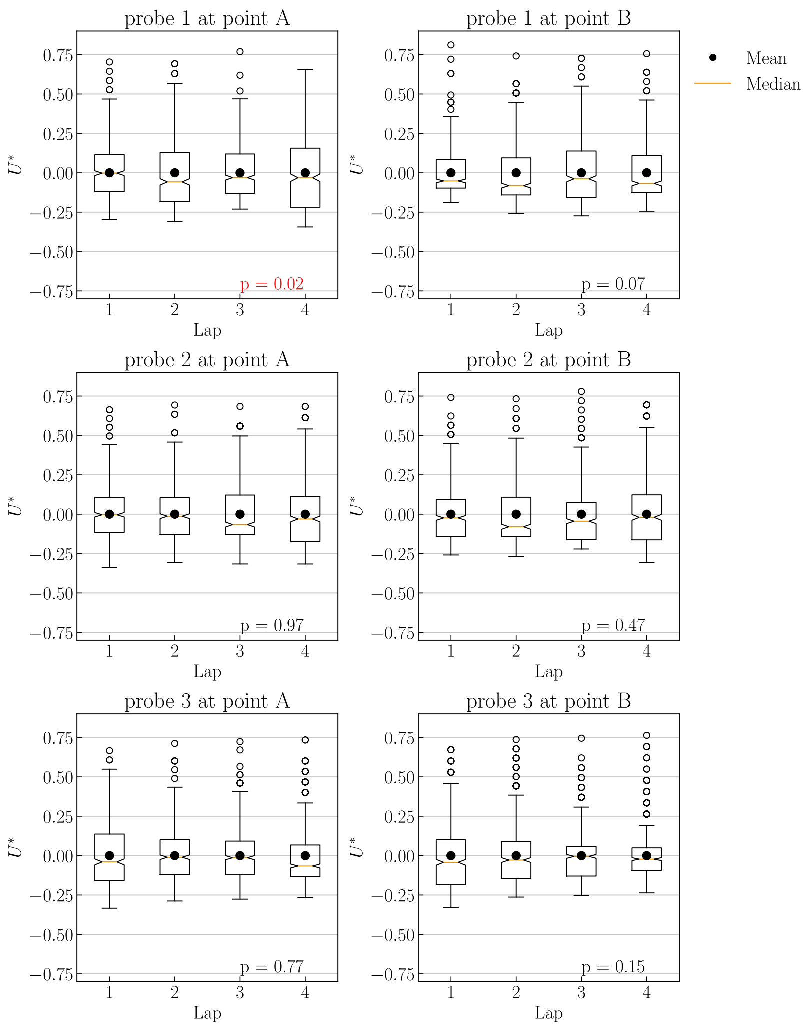

Figure 7: Airflow velocity magnitudes measured over four laps at points A and B at each of the three probes with no fans on - Setup 2. The p-value is the result of the Friedman test across the four laps.

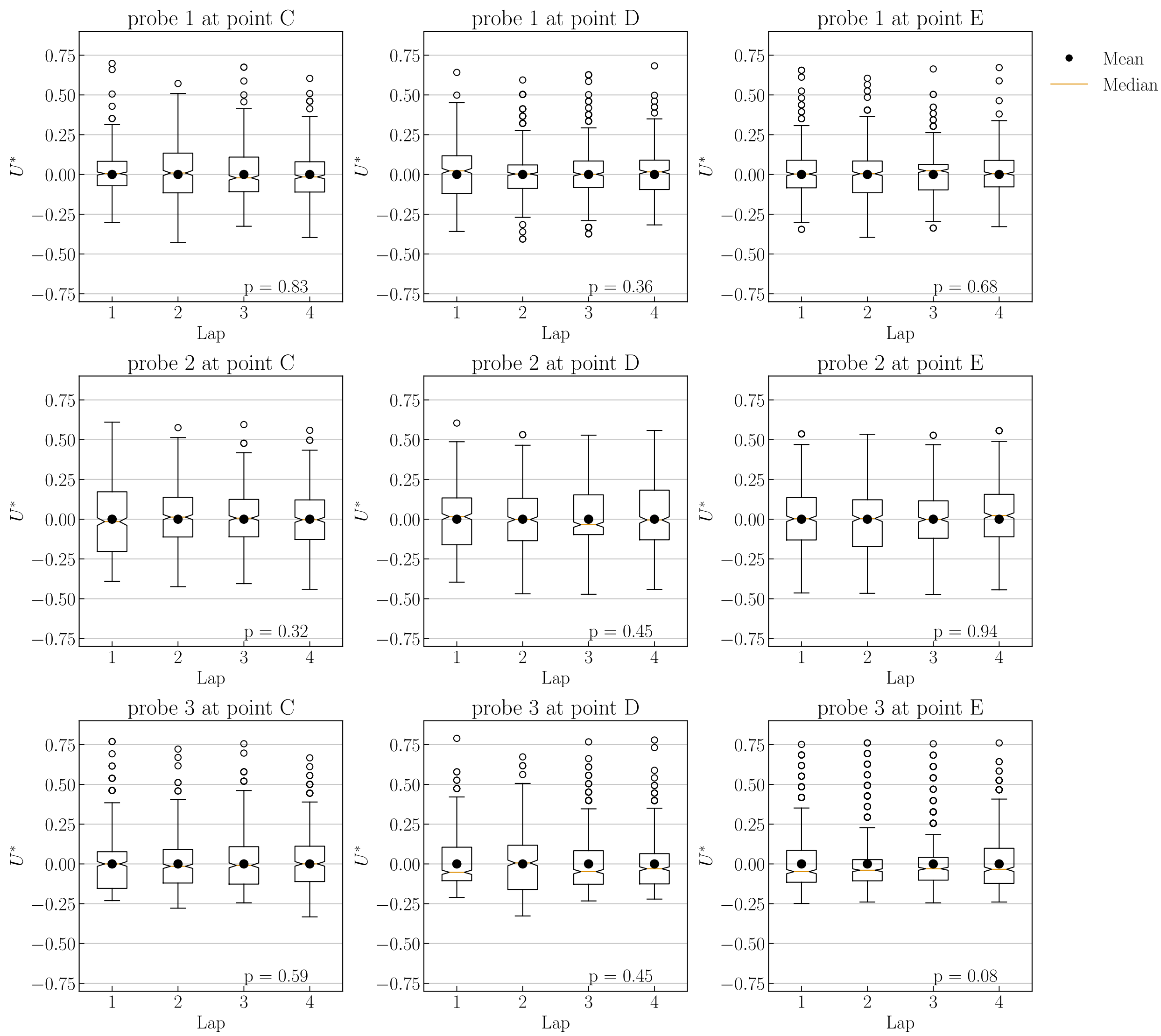

Figure 8: Airflow velocity magnitudes measured over four laps at points C, D, and E at each of the three probes with no fans on - Setup 2. The p-value is the result of the Friedman test across the four laps.

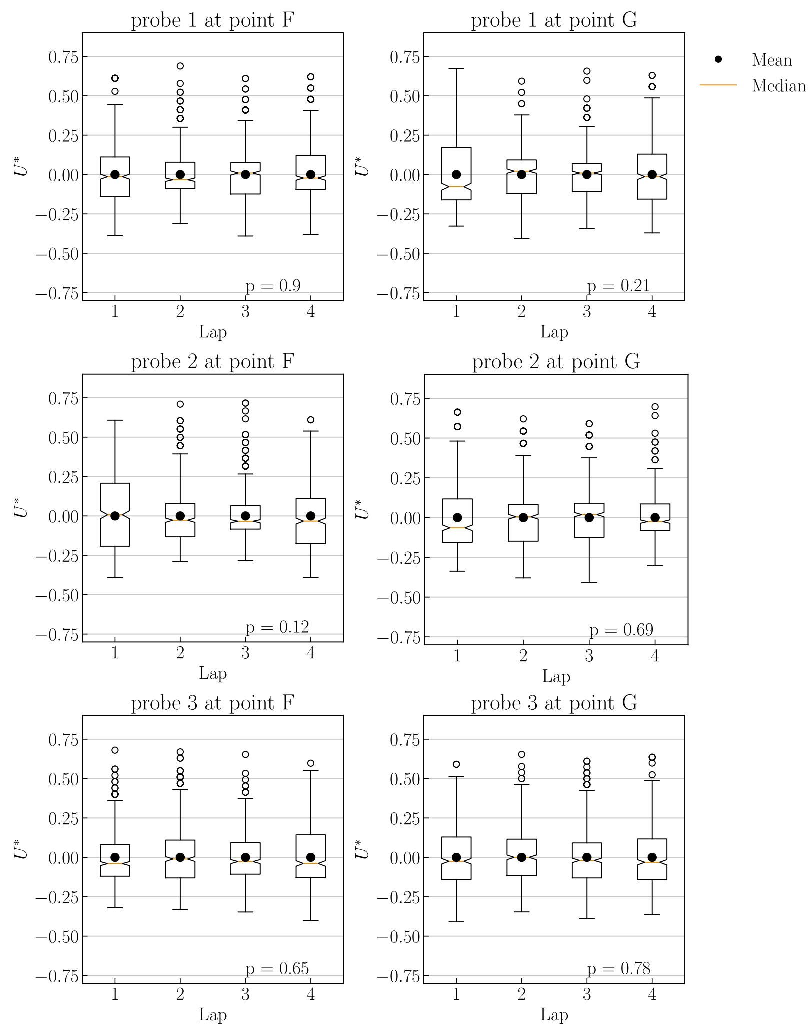

Figure 9: Airflow velocity magnitudes measured over four laps at points F and G at each of the three probes with no fans on - Setup 2. The p-value is the result of the Friedman test across the four laps.

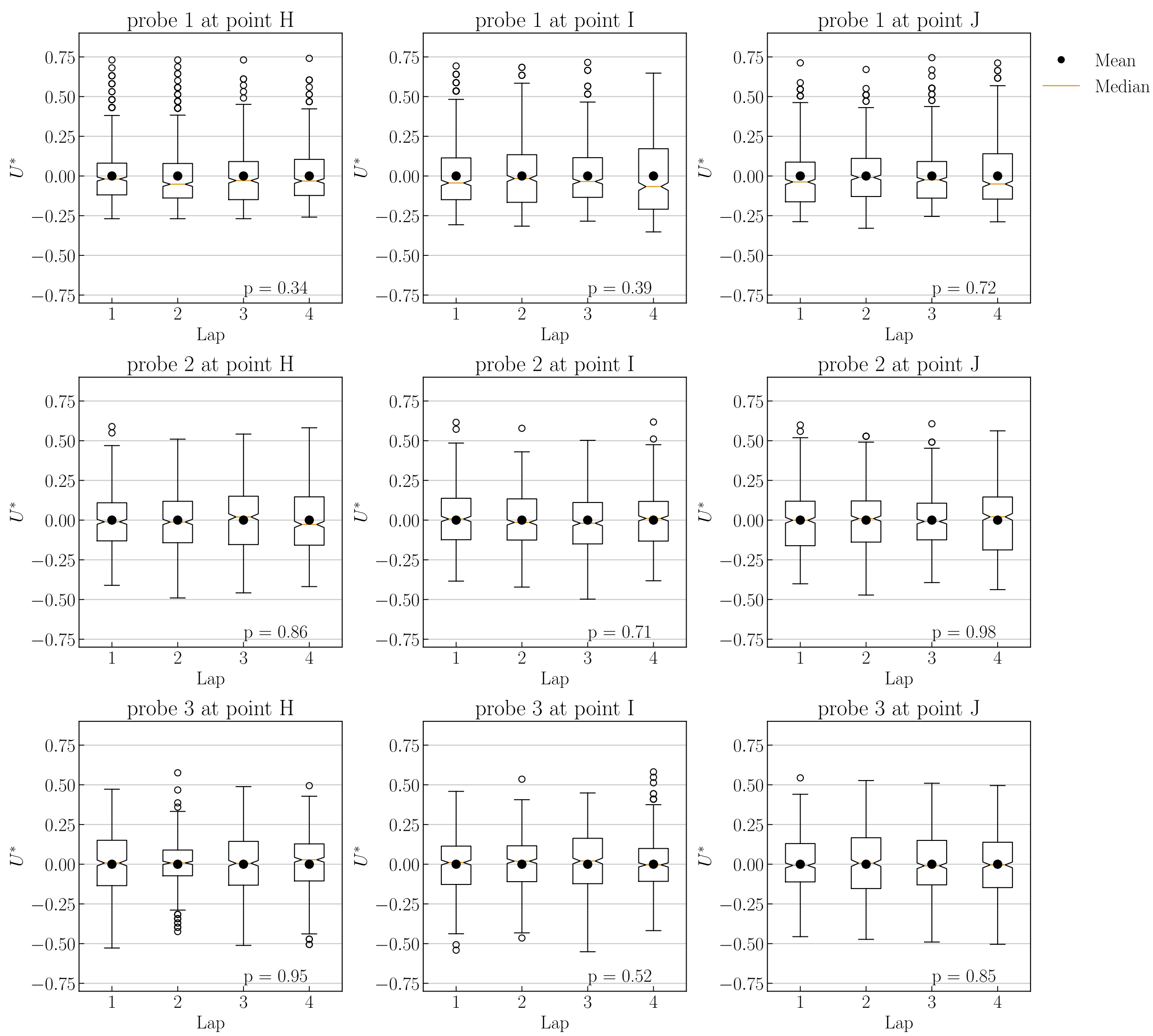

Figure 10: Airflow velocity magnitudes measured over four laps at points H, I, and J at each of the three probes with no fans on - Setup 2. The p-value is the result of the Friedman test across the four laps.

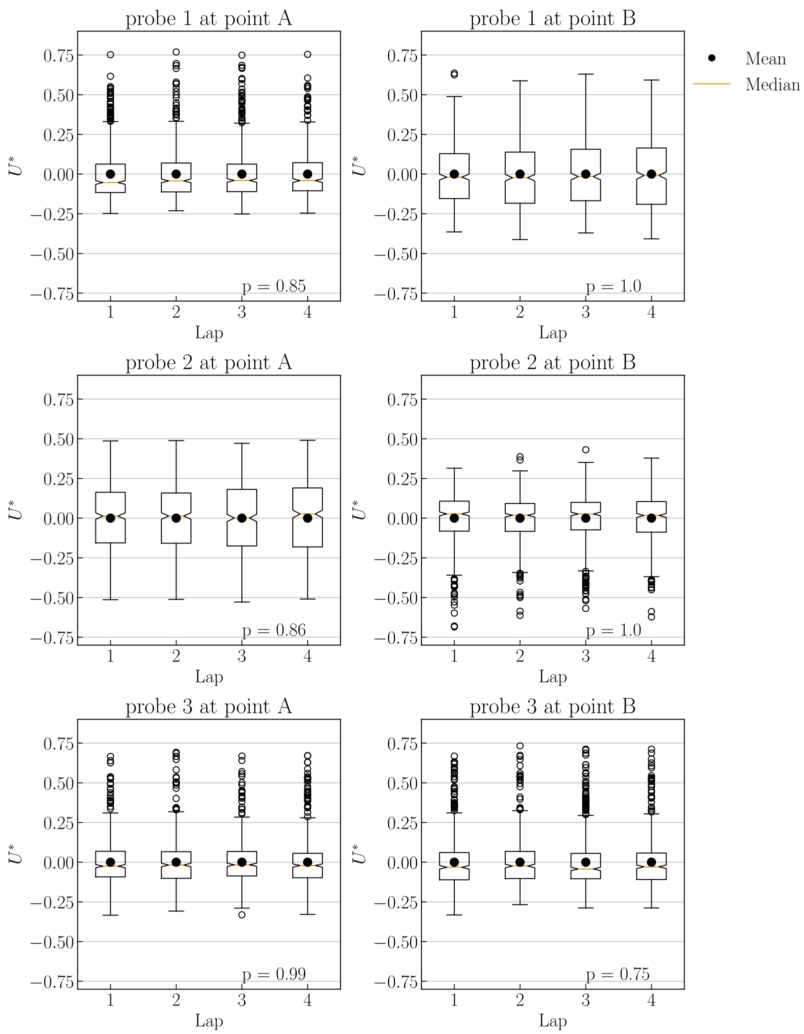

Figure 11: Airflow velocity magnitudes measured over four laps at points A and B at each of the three probes with two fans on - Setup 3. The p-value is the result of the Friedman test across the four laps.

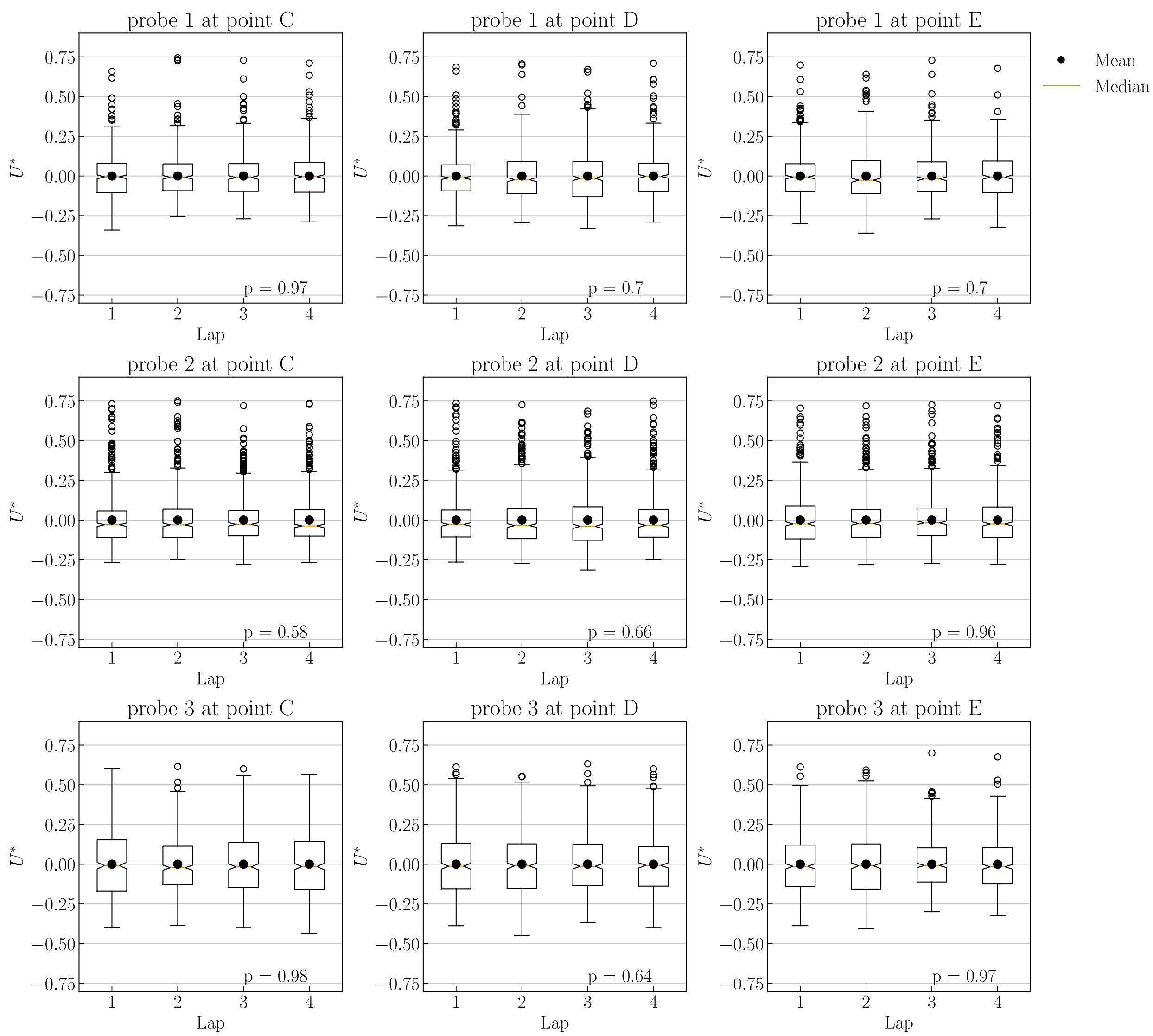

Figure 12: Airflow velocity magnitudes measured over four laps at points C, D, and E at each of the three probes with two fans on - Setup 3. The p-value is the result of the Friedman test across the four laps.

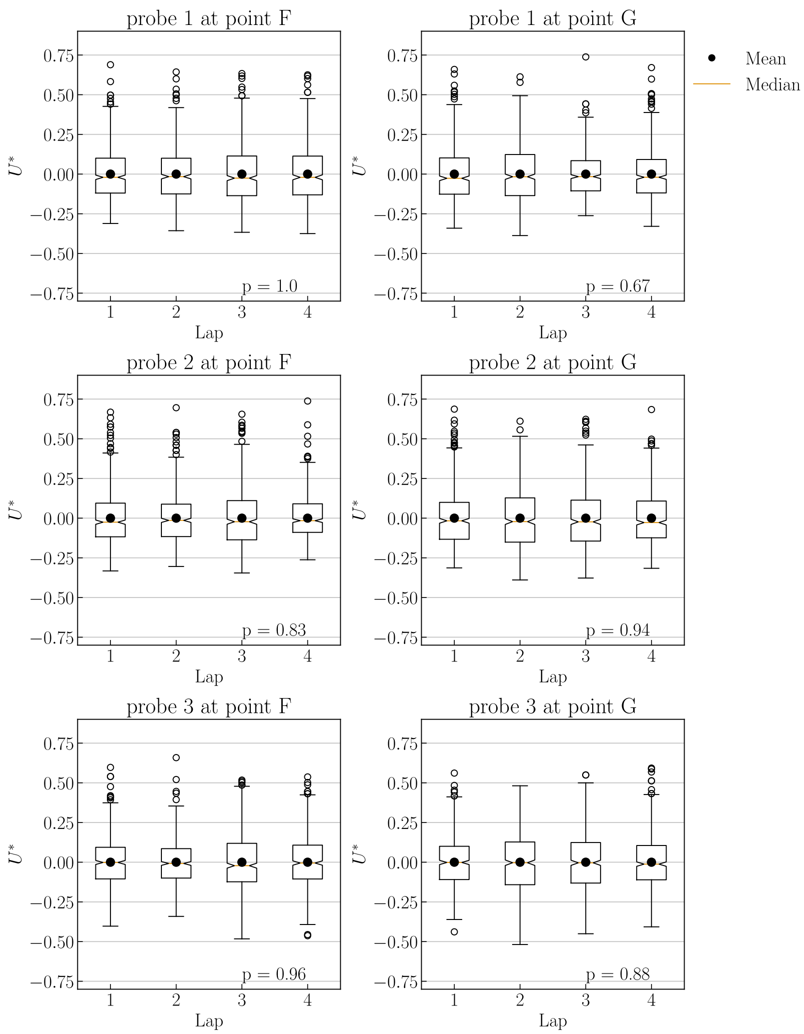

Figure 13: Airflow velocity magnitudes measured over four laps at points F and G at each of the three probes with two fans on - Setup 3. The p-value is the result of the Friedman test across the four laps.

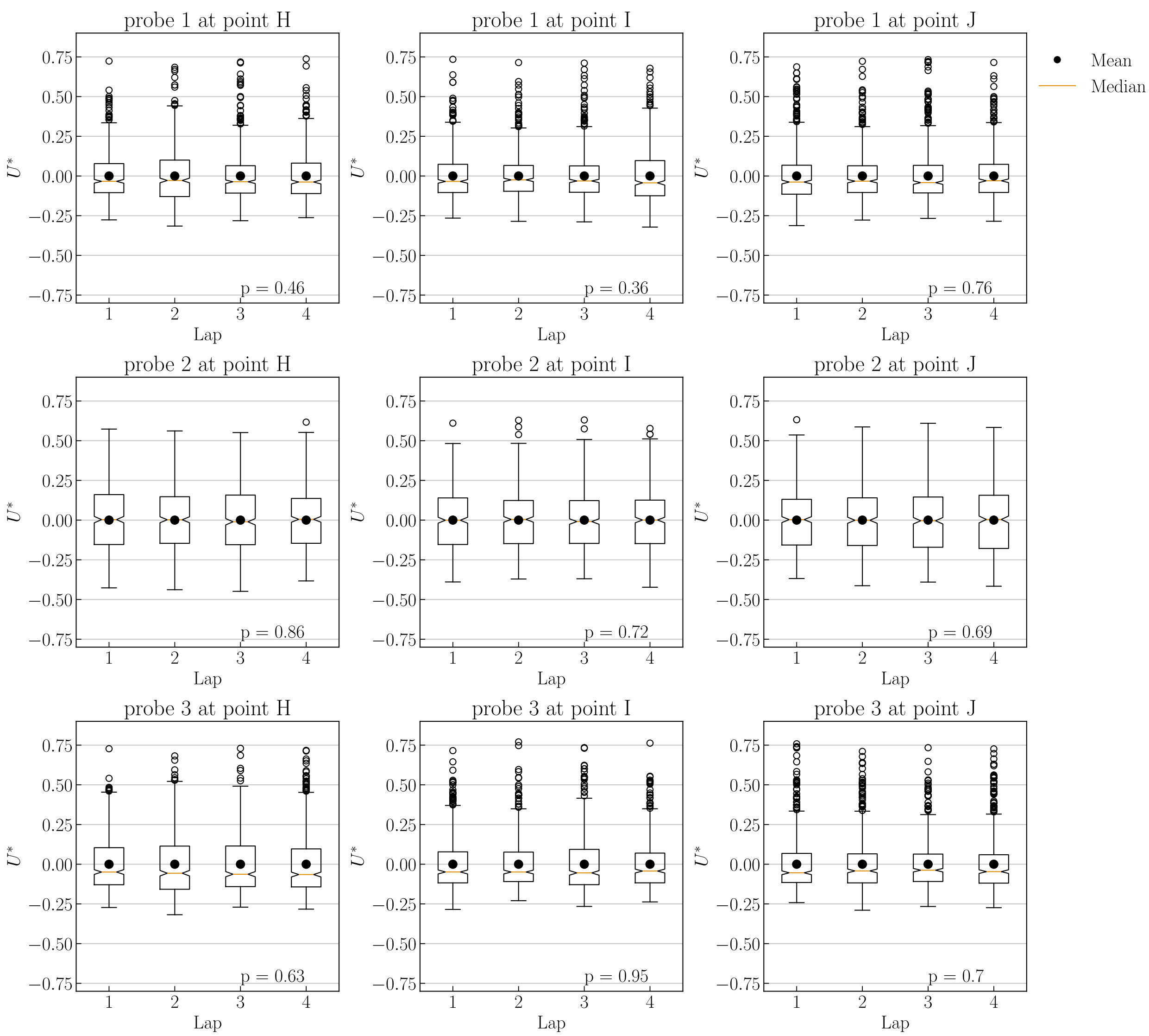

Figure 14: Airflow velocity magnitudes measured over four laps at points H, I, and J at each of the three probes with two fans on - Setup 3. The p-value is the result of the Friedman test across the four laps.