Waves/Sound Bonus Problem:

Some physics students were collecting resonance data with PVC pipes that were open on both ends. One of the students got bored and decided to throw a 40cm long pipe across the classroom. The pipe rotated end-over-end, hatchet-style, nearly missing another student. An argument ensued over how fast the pipe was thrown, the thrower contending that it "wasn't going very fast." Luckily, the student who experienced the near miss was capturing video at the time of the throw, and the pipe was traveling directly toward the student's smartphone. The phone escaped unscathed, as one end of the pipe hit a lab table, causing the pipe to bounce off course at the last moment. Remembering the periodic whistling/hooting sound that the pipe made as it rotated through the air, the student with the phone decided to use audio from the video to try to determine the pipe's speed.

With a "plot spectrum" app, the student created graphs of the flying pipe's harmonics. The graph below (broken up to fit on this page) represents those harmonics at one moment in time during the pipe's flight. Careful scrutiny of the graph reveals two superimposed sets of pipe harmonics, each corresponding to a different fundamental frequency.

Additional Notes and Info:

1) By analyzing other moments during the pipe's flight, the student realized that the difference between the two fundamental frequencies changed periodically. The graph below represents a time when the difference between the two fundamentals was at a maximum.

2) The temperature in the classroom was 72°F.

3) The pipe's mass was uniformly distributed along its length.

4) As you may have guessed, frequencies below 2,000Hz were either lost or unclear, so they are not represented in the graph below.

Find the pipe's translational speed.