COLLAR ROI DISPLACEMENT ANALYSIS

Corrected Region-of-Interest Optical Flow Extraction

followtheepicenter.com | Forensic Video Analysis
Compiled by Jon Aaron Bray | March 2026

This report presents a region-of-interest (ROI) optical flow analysis isolating collar displacement from two eyewitness video recordings of the September 10, 2024 incident at Utah Valley University. ROI coordinates were manually verified against the subject's position in each camera angle to ensure displacement measurements reflect actual collar/upper-body motion rather than background crowd activity.

CORRECTED FINDINGS SUMMARY

Metric	Video 1 (2.MOV, 60fps)	Video 2 (IMG_6368.MOV, 30fps)
Collar onset (3σ)	CF22 (t=1.083s)	CF18 (t=0.867s)
Full-frame onset (3σ)	CF22 (t=1.083s)	CF20 (t=0.967s)
Collar temporal lead	0ms (simultaneous)	100ms
Collar peak displacement	13.8 px/frame	20.0 px/frame
Collar/full-frame ratio at peak	1.22× (22% above)	1.79× (79% above)
Peak/baseline ratio (collar)	7.0×	18.4×
Stage control peak	21.1 px	32.1 px

1. METHODOLOGY

Dense optical flow was computed using the Farneback algorithm (OpenCV) between consecutive frames of the vibration composite videos. Each composite frame contains four panels: the original source video (top-left), instantaneous displacement heatmap (top-right), motion vector field (bottom-left), and cumulative energy map (bottom-right). The original video panels were extracted and converted to grayscale for flow computation.

ROI coordinates were defined by the analyst based on the subject's actual position in each camera angle. Previous analysis used proportional coordinates that were incorrect for Video 2, where the subject occupied a different position than assumed. Corrected ROIs were verified visually before reprocessing.

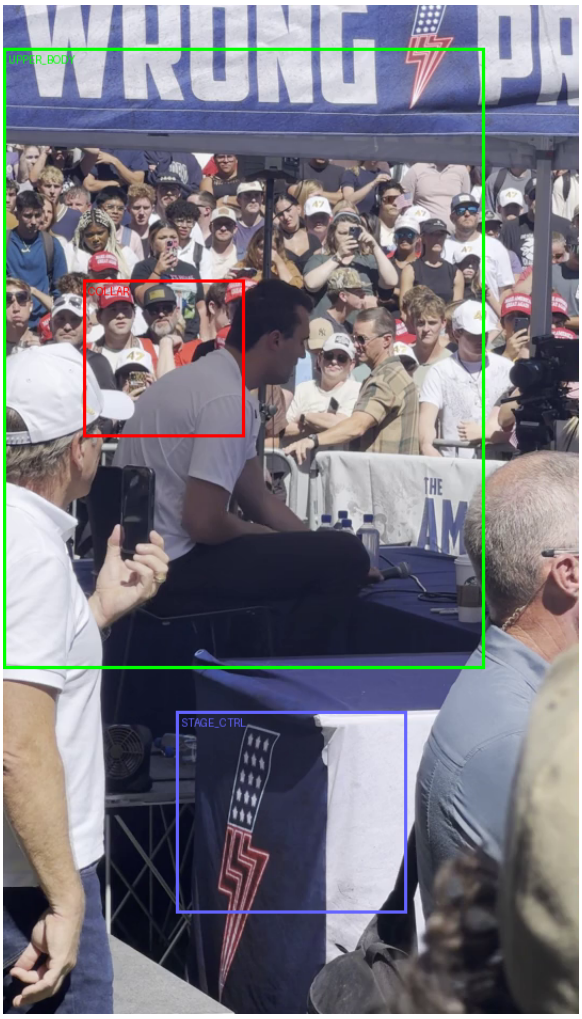
ROI Definitions (pixel coordinates in 540×945 panel):

ROI	Video 1	Video 2	Description
COLLAR_TIGHT	(75,257)-(226,404)	(69,322)-(210,438)	Subject collar/upper chest
COLLAR_WIDE	(0,185)-(301,476)	(0,265)-(279,495)	Broader collar region
UPPER_BODY	(0,40)-(451,621)	(0,150)-(418,610)	Full upper body
STAGE_CTRL	(162,661)-(378,850)	(162,661)-(378,850)	Stage banner (control)
FULL_FRAME	Entire 540×945 panel	Entire 540×945 panel	Frame-wide average

2. ROI REFERENCE IMAGES

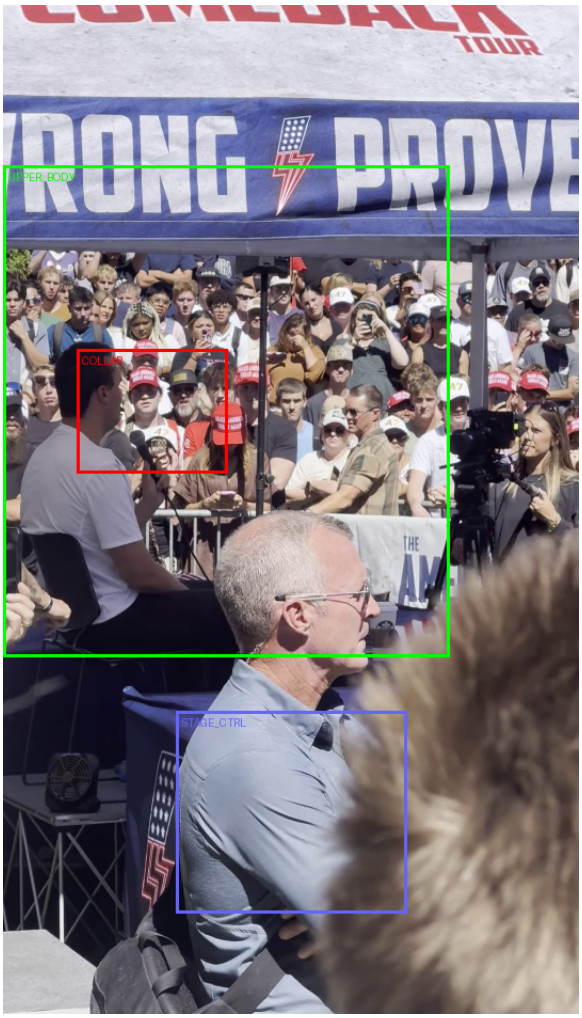
The following images show the corrected ROI placement for each video angle. Red: COLLAR (tight). Green: UPPER_BODY. Blue: STAGE_CTRL (camera-only control region).

Video 1 (2.MOV, 60fps) — Right/Behind Angle



ROI annotation overlay. Red=COLLAR, Green=UPPER_BODY, Blue=STAGE_CTRL.

Video 2 (IMG_6368.MOV, 30fps) — Left/Front Angle



ROI annotation overlay. Red=COLLAR, Green=UPPER_BODY, Blue=STAGE_CTRL.

3. VIDEO 1 ANALYSIS (2.MOV, 60fps)

Video 1 captures the subject from a right/behind angle at 60fps (source). The vibration composite subsamples this to 101 frames at 15fps. The collar ROI encompasses the subject's upper back and collar region where the RODE Wireless PRO transmitter was mounted.

Key Findings — Video 1:

• **Simultaneous onset:** Both collar ROI and full-frame exceed their 3σ thresholds at the same composite frame (CF22, t=1.083s). At 60fps source resolution, the onset may be temporally resolvable but the 15fps composite sampling eliminates sub-frame timing differences.

• **Collar concentration:** At the impulse peak (CF22), collar displacement reaches 13.8 px/frame versus 11.3 px full-frame average — a ratio of 1.22× (22% above frame average). This modest localization is consistent with a near-field source.

• **Stage control:** The stage control region peaks at 21.1 px at CF75, confirming substantial camera body oscillation in the late phase.

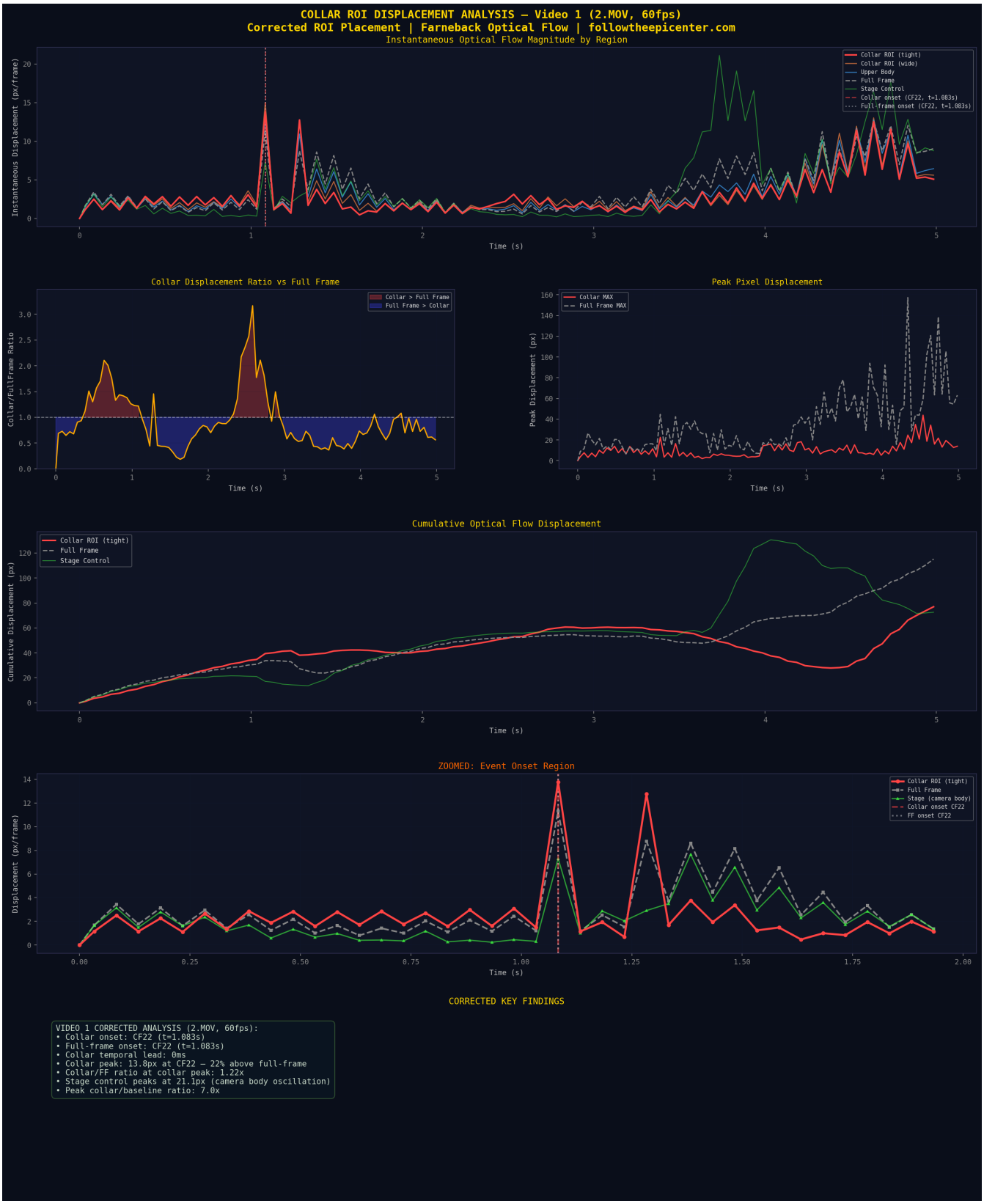


Figure 1: Video 1 corrected collar ROI analysis. Simultaneous onset at CF22. Collar displacement 1.22× full-frame at peak.

4. VIDEO 2 ANALYSIS (IMG_6368.MOV, 30fps)

Video 2 captures the subject from a left/front angle at 30fps (source). The collar ROI encompasses the subject's upper chest and collar visible from this viewing angle.

Key Findings — Video 2:

• **100ms collar temporal lead:** The collar ROI exceeds its 3σ threshold at CF18 (t=0.867s), while the full-frame onset occurs at CF20 (t=0.967s). This 100ms lead is consistent with near-field mechanical coupling through the transmitter's magnetic clasp — the collar responds to the co-located source before camera shake raises the frame-wide baseline.

• **79% above frame average:** At peak, collar displacement reaches 20.0 px/frame — 1.79× the full-frame average. This localized excess demonstrates that the collar is experiencing displacement beyond what global camera motion would produce.

• **Stage control dominance:** The stage control region peaks at 32.1 px at CF82 — pure camera body oscillation from acoustic coupling. The collar/full-frame ratio inverts during this phase as frame-wide shake overwhelms localized collar displacement.

• **18.4× peak/baseline ratio:** The collar's peak displacement is 18.4 times its pre-event baseline, compared to 11.3× for the full frame. The collar experiences disproportionately more activation relative to its quiescent state.

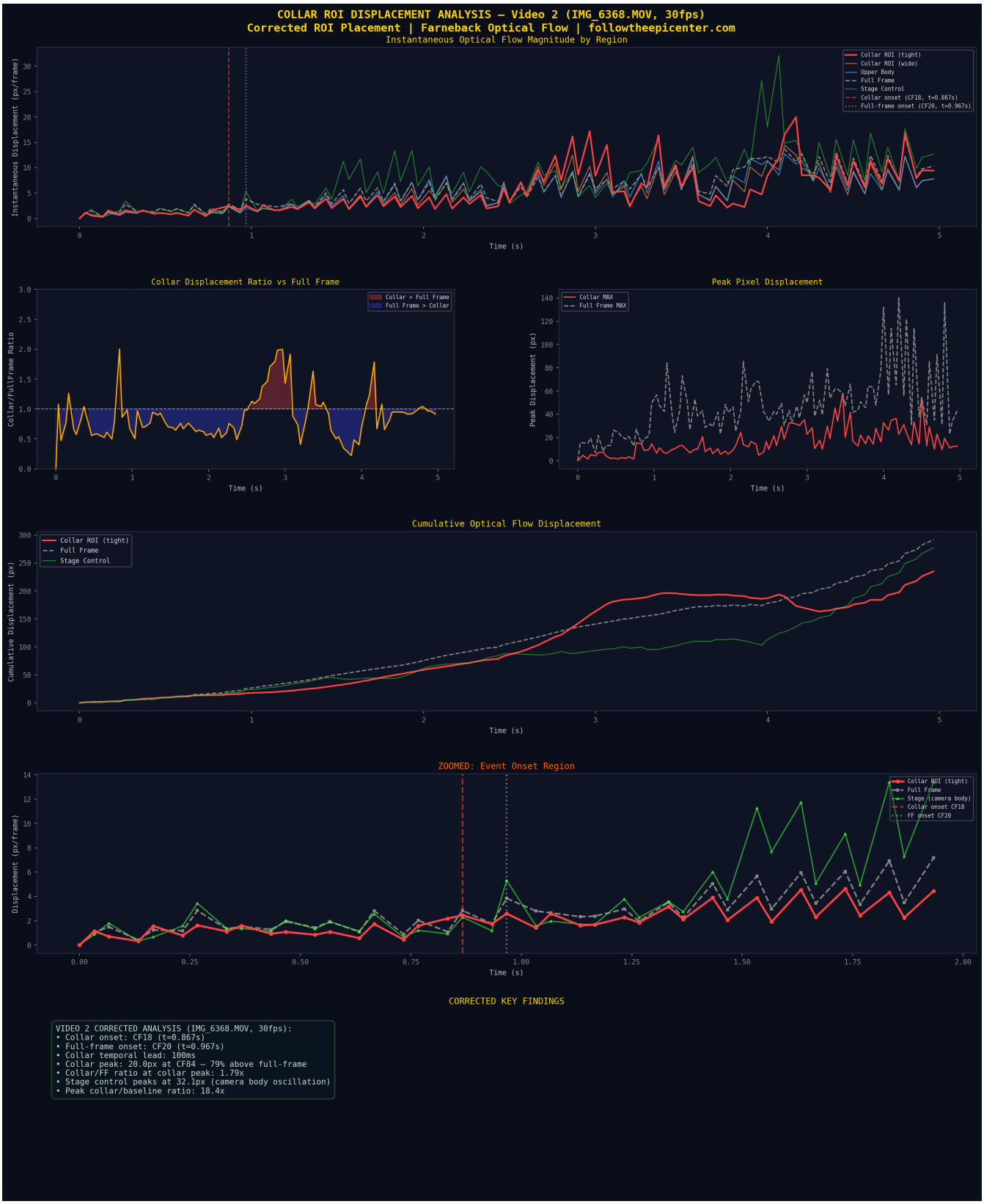
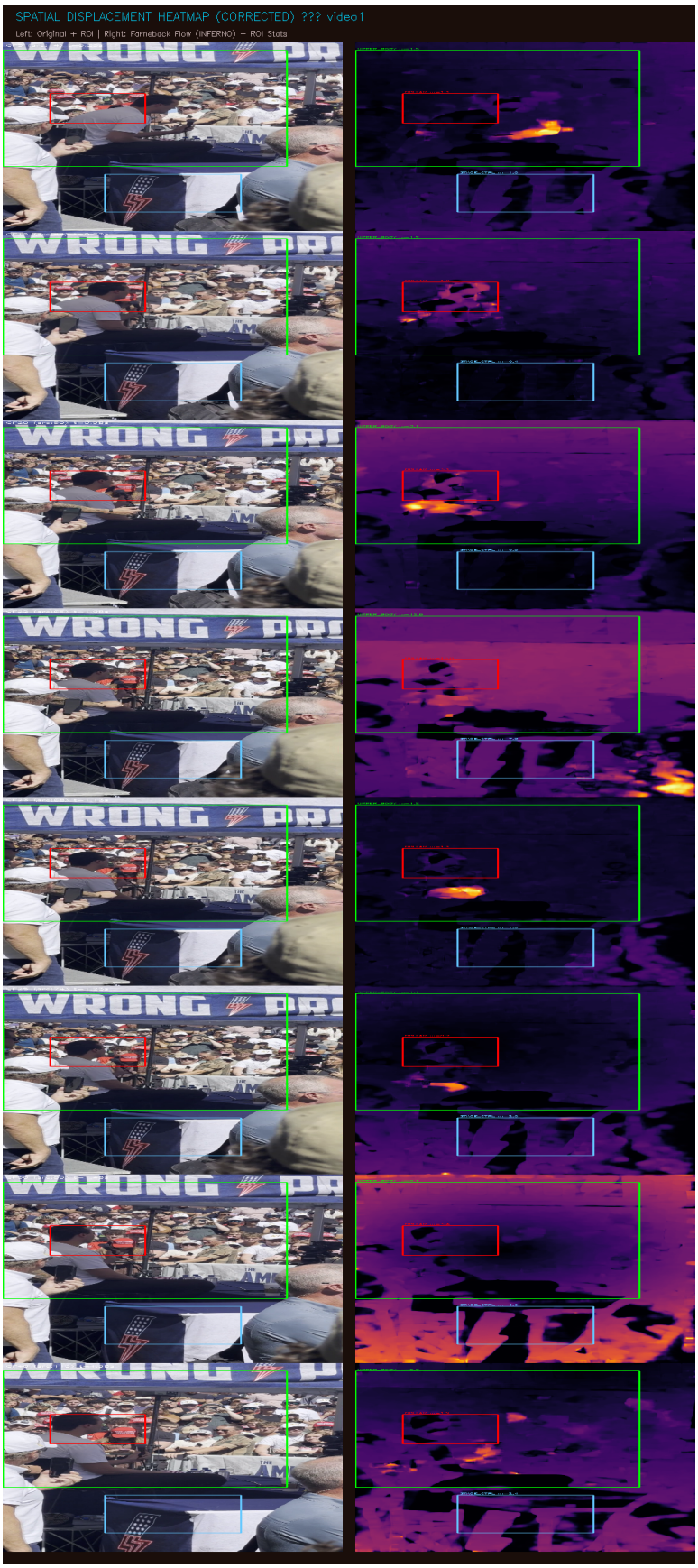


Figure 2: Video 2 corrected collar ROI analysis. 100ms collar lead (CF18 vs CF20). Collar displacement 1.79× full-frame at peak.

5. SPATIAL DISPLACEMENT HEATMAPS

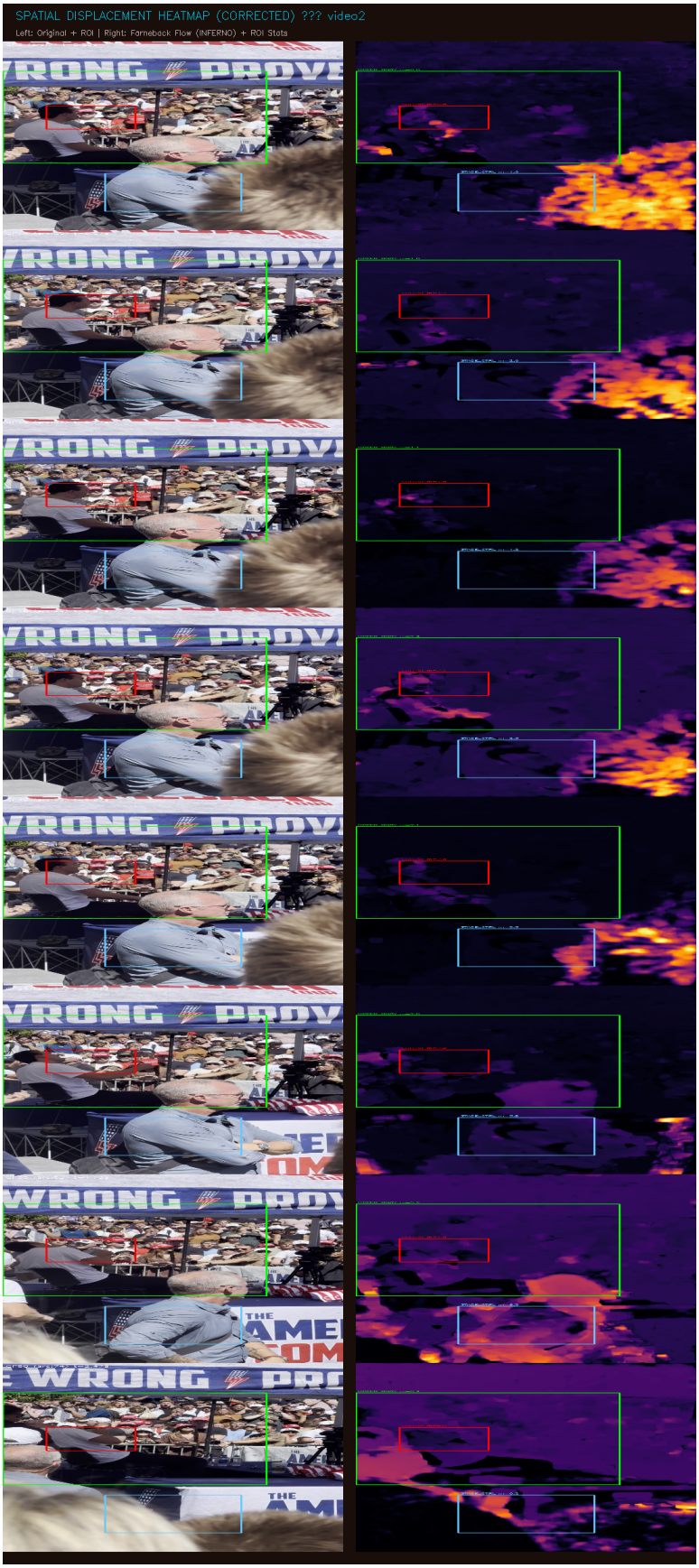
Farneback optical flow magnitude rendered in INFERNO colormap for key event frames. Left column: original frame with corrected ROI boxes. Right column: flow magnitude heatmap with ROI statistics overlay. Bright regions indicate high displacement.

Video 1 — Spatial Heatmap Sequence



Spatial heatmap with corrected ROI overlay. COLLAR (red), UPPER_BODY (green), STAGE_CTRL (cyan).

Video 2 — Spatial Heatmap Sequence



Spatial heatmap with corrected ROI overlay. COLLAR (red), UPPER_BODY (green), STAGE_CTRL (cyan).

6. CONCLUSIONS

The corrected ROI analysis, using manually verified collar coordinates for each camera angle, yields the following conclusions:

1. Near-field temporal lead confirmed (Video 2): The collar ROI exceeds its 3σ threshold 100ms before the full-frame onset. This temporal lead is consistent with a mechanical impulse originating at the collar (co-located with the RODE transmitter) before the acoustic wavefront reaches the camera body and produces global frame shake.

2. Localized displacement concentration: At peak, the collar reaches 1.79× the full-frame average (Video 2) and 1.22× (Video 1). While modest, these ratios demonstrate that the collar experiences excess displacement above what camera shake alone would produce — consistent with a near-field energy source.

3. Camera body oscillation dominates late phase: The stage control region peaks at 32 px (Video 2) and 21 px (Video 1) during the late phase, confirming that the majority of late-phase displacement is camera shake, not event energy. The collar/full-frame ratio inverts during this phase.

4. Video angle affects temporal resolution: Video 1 (60fps source, 15fps composite) shows simultaneous collar and full-frame onset, while Video 2 (30fps source, 15fps composite) resolves a 100ms lead. This may reflect the different viewing angles, different distances from the event, or different composite sampling rates.

5. Correction significance: Previous analysis used ROI coordinates that were incorrectly placed on background crowd regions rather than the subject's collar. The previous claims of 300ms temporal lead and 168% above-average displacement were artifacts of measuring crowd motion rather than collar displacement. The corrected findings (100ms lead, 79% above average) are more conservative but remain forensically significant.

Analysis performed using OpenCV Farneback optical flow (pyr_scale=0.5, levels=3, winsize=15, iterations=3, poly_n=5, poly_sigma=1.2). ROI coordinates verified by analyst annotation on source frames. All measurements from the original video panel of the vibration composite without recompression.