PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM RESEARCH TEST
NCAP-DRI-PAEB-20-11

2020 Volvo S60 T6 AWD Momentum

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Final Report

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16. Abstract These research tests were conducted on the subject 2020 Volvo S60 T6 AWD Momentum in accordance with the specifications of the National Highway Traffic Safety Administration's draft test procedure in docket NHTSA-2019-0102-0005 to confirm the performance of a Pedestrian Automatic Emergency Braking system, with modifications to include use of an articulated pedestrian test mannequin and additional tests speeds and lighting conditions.			
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TABLE OF CONTENTS

SECTION **PAGE**

I. INTRODUCTION 1

II. DATA SHEETS 3

Data Sheet 1: Test Results Summary 4

Data Sheet 2: Vehicle Data 14

Data Sheet 3: Test Conditions 15

Data Sheet 4: Pedestrian Automatic Emergency Braking System Operation 20

III. TEST PROCEDURES 24

A. Test Procedure Overview 24

B. SV Approach to a Crossing Pedestrian (S1) 26

C. SV Approach to a Pedestrian Walking Along/Against Traffic (S4) 42

D. Summary of Scenarios 48

E. Pre-Test Brake Burnishing 54

F. Pedestrian Test Mannequin and Motion System 54

G. Instrumentation 55

H. Pre-Test Brake Burnishing 58

APPENDIX A Photographs A-1

APPENDIX B Excerpts from Owner's Manual B-1

APPENDIX C Run Logs C-1

APPENDIX D Time Histories D-1

Section I

INTRODUCTION

Pedestrian Automatic Emergency Braking (PAEB) systems are a subset of Automatic Emergency Braking (AEB) systems. PAEB systems are designed to avoid or mitigate vehicle crashes with pedestrians by automatically applying the Subject Vehicle's (SV's) brakes when the system determines that, without intervention, collision with a pedestrian will occur. PAEB systems typically work as an extension of Forward Collision Warning (FCW) systems, which alert the driver to the possibility of a collision unless driver action is taken. PAEB systems employ sensors capable of detecting pedestrians in the forward path. Current PAEB technology typically involves RADAR, LIDAR, or vision-based (camera) sensors, and measurement of vehicle operating conditions such as speed, driver steering, and brake application, etc. Algorithms in the system's Central Processing Unit (CPU) use this information to continuously monitor the likelihood of a collision with a pedestrian and command a brake actuator to apply the brakes when necessary.

The test procedure contained herein provides methods and specifications for collecting performance data on PAEB systems for light vehicles with gross vehicle weight ratings of up to 4,536 kg (10,000 lbs).

The test method used to evaluate PAEB performance on the test track was prescribed by NHTSA in a test procedure titled, "Pedestrian Automatic Emergency Brake System Confirmation Test (Working Final)", dated September 2019 (Docket NHTSA-2019-0102-0005). For the testing reported herein, an articulating Pedestrian Test Mannequin (PTM) was used for testing, as opposed to a poseable one prescribed. Furthermore, additional test conditions were used, involving additional SV test speeds and nighttime tests using the SV's high beam headlights and low beam headlights.

The PAEB tests include ten pedestrian pre-crash test scenarios. There are seven (S1) crossing test scenarios in which a pedestrian is traveling across the SV's lane of travel. In the first three S1 test scenarios, an SV approaches an adult PTM starting on the right-hand side of the lane of travel (i.e., nearside) and moving towards the left-hand side (i.e., offside) with a point of impact at (a) 25% overlap from the passenger side of the SV, (b) 50% overlap, and (c) 75% overlap. In the S1d scenario, the SV approaches a crossing child PTM running from behind parked vehicles from the right-hand side of the lane towards the left-hand side with the point of impact at 50% overlap. In the S1e scenario, the SV approaches an adult PTM running from the left side of the lane towards the right with a 50% overlap point of impact. The S1f and S1g scenarios are false positive tests. In the S1f scenario, the SV approaches an adult PTM, which begins moving from the right-hand side of the lane but safely stops short of entering the SV's lane of travel. In the S1g scenario, the adult PTM also crosses from the right-hand side of the lane towards the left-hand side, but safely crosses the lane of travel completely.

There are also three (S4) in-path scenarios in which an adult pedestrian is

either standing or walking away from the vehicle within the SV's lane of travel. In the first two test scenarios, the SV approaches a stationary adult PTM in its lane of travel at a 25% overlap point of impact. In the S4a scenario, the PTM is facing away from the approaching SV. In the S4b scenario, the PTM is facing towards the SV (S4b). In the third test scenario (S4c), the SV approaches an adult PTM while the PTM is traveling within and in the same direction as the SV's lane of travel at a 25% overlap point of impact.

For all of these tests, the adult and child PTM's are strikable mannequins with visual and radar reflectivity characteristics representing a pedestrian. In test scenario S1d, the child PTM has the characteristics of the 7-year-old child. All of the other test scenarios use an adult PTM with the characteristics of a 50th percentile adult male.

The false positive scenarios (S1f and S1g) are used to evaluate the propensity of a PAEB system to inappropriately activate in a non-critical driving scenario that does not present a safety risk to the SV occupant(s) or pedestrian.

The purpose of the testing reported herein was to objectively quantify the performance of a PAEB system installed on a 2020 Volvo S60 T6 AWD Momentum. This test is part of the Crash Avoidance program to assess Pedestrian Automatic Braking Systems sponsored by the National Highway Traffic Safety Administration (NHTSA) under Contract No. DTNH22-14-D-00333.

The test reported herein is one of a series of research and development tests accomplished for the purpose of refining test procedures, protocols, and specifications, as well as data analysis parameters and presentation methods that are preliminarily described in NHTSA 's test procedure titled, "Pedestrian Automatic Emergency Brake System Confirmation Test (Working Draft)", dated September 2019 (Docket NHTSA-2019-0102-0005). Some of these procedural details changed over the course of the test series in order to address unanticipated concerns or ambiguities, and also in recognition of the different characteristics of AEB implementation by the various manufacturers. In particular, the threshold for determining the onset of PAEB braking was originally set at -0.15 g, and subsequently changed to -0.03 g later in the series. As a result, some of the results indicate the earlier threshold and some the later. The results presented herein are for the -0.15 g threshold.

Section II

DATA SHEETS

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 1 of 10)

2020 Volvo S60 T6 AWD Momentum

VIN: *7JRA22TKXLG03xxxx*

Day Test Date: *2/7/2020*

Night Test Date: *2/4/2020*

System Setting: *Early*

Upper Capabilities

Scenario	Maximum Test Speed Without Consistent SV-to-PTM Contact[1]		
	Daytime (km/h)	Night-High Beam (km/h)	Night-Low Beam (km/h)
S1a	40		
S1b	60	60	*
S1c	16		
S1d	45	*	*
S1e	60	35	*
S1f			
S1g			
S4a	16	11	16
S4b	16		
S4c	16	45	*

* All test series resulted in consistent SV-to-PTM contact

[1] Consistent SV-to-PTM Contact is defined as the SV contacting the PTM in more than 3 trials at a given test speed.

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 2 of 10)

2020 Volvo S60 T6 AWD Momentum

S1a: SV Encounters an Adult PTM Crossing at 5 km/h from the Nearside at 25% Overlap

Speed (km/h)	Daytime			Night-High Beam			Night-Low Beam		
	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)
	Total	Without Contact		Total	Without Contact		Total	Without Contact	
16	5	5	15.9						
40	5	5	40.0						

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

2020 Volvo S60 T6 AWD Momentum

S1b: SV Encounters an Adult PTM Crossing at 5 km/h from the Nearside at 50% Overlap

Speed (km/h)	Daytime			Night-High Beam			Night-Low Beam		
	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)
	Total	Without Contact		Total	Without Contact		Total	Without Contact	
11				5	2	4.3	3	0	0.2
16	5	5	15.8	3	0	5.0	3	0	4.0
20	5	5	20.1	5	4	16.2			
30	5	3	19.5	5	5	29.7			
35							3	0	12.1
40	5	3	22.5	5	5	35.9	3	0	4.5
50	5	5	43.4	5	5	44.0			
60	5	3	39.9	5	4	54.4			

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

2020 Volvo S60 T6 AWD Momentum

S1c: SV Encounters an Adult PTM Crossing at 5 km/h from the Nearside at 75% Overlap

Speed (km/h)	Daytime			Night-High Beam			Night-Low Beam		
	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)
	Total	Without Contact		Total	Without Contact		Total	Without Contact	
16	5	5	16.1						
40	9	6	25.3						

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

2020 Volvo S60 T6 AWD Momentum

S1d: SV Encounters a Crossing Child PTM Running at 5 km/h

From Behind Parked Cars from the Nearside at 50% Overlap

Speed (km/h)	Daytime			Night-High Beam			Night-Low Beam		
	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)
	Total	Without Contact		Total	Without Contact		Total	Without Contact	
11				4	1	2.9	3	0	0.0
16	5	5	16.0	3	0	2.3	4	1	3.9
20	5	5	20.0						
30	5	5	30.2						
35				3	0	16.1	4	0	9.5
40	5	4	36.5	3	0	12.2	3	0	3.3
45	5	4	43.9						
60									

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

2020 Volvo S60 T6 AWD Momentum

S1e: SV Encounters an Adult PTM Running at 8 km/h from the Offside at 50% Overlap

Speed (km/h)	Daytime			Night-High Beam			Night-Low Beam		
	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)
	Total	Without Contact		Total	Without Contact		Total	Without Contact	
35				3	3	32.8	3	0	No Warning
40	5	5	31.9	4	1	13.4	3	0	0.3
50	7	7	36.2						
60	5	5	42.8						

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

2020 Volvo S60 T6 AWD Momentum

S1f, S1g: Peak Deceleration Summary

(Day tests only)

S1f: SV Encounters an Adult PTM Crossing at 5 km/h from the Nearside that Stops Short of the Entering the SV Path of Travel

S1g: SV Encounters an Adult PTM Crossing at 5 km/h from the Nearside that Clears the SV Path of Travel

Trial Number	S1f SV: 40 km/h PTM: 5 km/h	S1g SV: 40 km/h PTM: 5 km/h
	Peak Deceleration (g)	
1	0.41	0.20
2	0.47	-0.20
3	0.88	0.10
4	0.97	-0.10
5	1.07	

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 8 of 10)

2020 Volvo S60 T6 AWD Momentum

S4a: SV Encounters a Stationary Adult PTM Facing Away from the SV in the SV Lane of Travel at 25% Overlap

Speed (km/h)	Daytime			Night-High Beam			Night-Low Beam		
	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)
	Total	Without Contact		Total	Without Contact		Total	Without Contact	
11				5	5	11.0			
16	5	5	16.2	3	0	8.0	5	5	16.0
35				3	0	12.3	3	0	15.6
40	3	0	2.0	5	2	18.0	3	0	0.10
50									
60									
70									
80									

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 9 of 10)

2020 Volvo S60 T6 AWD Momentum

S4b: SV Encounters a Stationary Adult PTM Facing Toward the SV in the SV Lane of Travel at 25% Overlap

Speed (km/h)	Daytime			Night-High Beam			Night-Low Beam		
	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)
	Total	Without Contact		Total	Without Contact		Total	Without Contact	
16	5	5	16.0						
40	4	1	11.9						

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

(Page 10 of 10)

2020 Volvo S60 T6 AWD Momentum

S4c: SV Encounters an Adult PTM Traveling at 5 km/h in the SV Lane of Travel at 25% Overlap

Speed (km/h)	Daytime			Night-High Beam			Night-Low Beam		
	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)	# of Valid Trials		Avg Speed Reduction (km/h)
	Total	Without Contact		Total	Without Contact		Total	Without Contact	
11				4	1	3.5	4	0	0.7
16	5	4	13.3	5	2	7.3	4	1	4.8
35							3	0	2.5
40	3	0	5.1	7	6	37.6	4	0	0.9
45				5	5	44.7			
50				5	2	36.1			
60									
70									
80									

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 2: VEHICLE DATA

(Page 1 of 1)

2020 Volvo S60 T6 AWD Momentum

TEST VEHICLE INFORMATION

VIN: *7JRA22TKXLG03xxxx*

Body Style: *Sedan* Color: *Osmium Grey Metallic*

Date Received: *1/27/2020* Odometer Reading: *10 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *VOLVO CAR CORPORATION*

Date of manufacture: *08/19*

Vehicle Type: *PC (Passenger Car)*

DATA FROM TIRE PLACARD:

Tires size as stated on Tire Placard: Front: *235/45 R18*

Rear: *235/45 R18*

Recommended cold tire pressure: Front: *250 kPa (36 psi)*

Rear: *250 kPa (36 psi)*

TIRES

Tire manufacturer and model: *Continental ProContact TX*

Front tire size: *235/45 R18 98H*

Rear tire size: *235/45 R18 98H*

Front tire DOT prefix: *VYFUWCCO*

Rear tire DOT prefix: *VYFUWCCO*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 3: TEST CONDITIONS

(Page 1 of 5)

2020 Volvo S60 T6 AWD Momentum

DAYTIME TEST GENERAL INFORMATION

Test date: *2/7/2020*

AMBIENT CONDITIONS

Air temperature: *18.9 C (66 F)*

Wind speed: *2.6 m/s (5.8 mph)*

X Wind speed ≤ 10 m/s (22 mph)

X Tests were not performed during periods of inclement weather. This includes, but is not limited to, rain, snow, hail, fog, smoke, or ash.

X Tests were conducted during daylight hours with good atmospheric visibility (defined as an absence of fog and the ability to see clearly for more than 5000 meters). The tests were not conducted with the vehicle oriented into the sun during very low sun angle conditions, where the sun is oriented 15 degrees or less from horizontal, and camera “washout” or system inoperability results.

The tests were conducted in an area void of overhead signs, bridges, or other significant structures over or near the testing site. Each trial was conducted with no vehicles, obstructions, or stationary objects within one lane width of either side of the SV path, unless otherwise specified. Shadows cast by objects other than the SV, test equipment, or the obstructing vehicles were not present in the SV lane of travel, or within one lane width of either side of the SV path

OBSTRUCTION VEHICLES

Forward obstructing vehicle: *1999 Honda Accord*

Rear obstructing vehicle: *2012 Toyota Highlander*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM

DATA SHEET 3: TEST CONDITIONS

(Page 2 of 5)

2020 Volvo S60 T6 AWD Momentum

VEHICLE PREPARATION (DAY)

Verify the following:

All non-consumable fluids at 100% capacity:	**X**
Fuel tank is full:	**X**
Tire pressures are set to manufacturer's recommended cold tire pressure:	**X**

Front: *250 kPa (36 psi)*

Rear: *250 kPa (36 psi)*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 3: TEST CONDITIONS

(Page 3 of 5)

2020 Volvo S60 T6 AWD Momentum

NIGHTTIME TEST GENERAL INFORMATION

Test date: *2/4/2020*

AMBIENT CONDITIONS

Air temperature: *2.2 C (36 F)*

Wind speed: *1.5 m/s (3.5 mph)*

X Wind speed ≤ 10 m/s (22 mph)

X Tests were not performed during periods of inclement weather. This includes, but is not limited to, rain, snow, hail, fog, smoke, or ash.

X The tests were conducted between 1 hour after sunset and 1 hour before sunrise with good atmospheric visibility. There was no streetlighting.

The tests were conducted in an area void of overhead signs, bridges, or other significant structures over or near the testing site. Each trial was conducted with no vehicles, obstructions, or stationary objects within one lane width of either side of the SV path, unless otherwise specified. Shadows cast by objects other than the SV, test equipment, or the obstructing vehicles were not present in the SV lane of travel, or within one lane width of either side of the SV path.

OBSTRUCTION VEHICLES

Forward obstructing vehicle: *1999 Honda Accord*

Rear obstructing vehicle: *2012 Toyota Highlander*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 3: TEST CONDITIONS

(Page 4 of 5)

2020 Volvo S60 T6 AWD Momentum

VEHICLE PREPARATION (NIGHT)

Verify the following:

All non-consumable fluids at 100% capacity:	**X**
Fuel tank is full:	**X**
Tire pressures are set to manufacturer's recommended cold tire pressure:	**X**

Front: *250 kPa (36 psi)*

Rear: *250 kPa (36 psi)*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 3: TEST CONDITIONS

(Page 5 of 5)

2020 Volvo S60 T6 AWD Momentum

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*548.4 kg (1209 lb)*	Right Front:	*523.9 kg (1155 lb)*
Left Rear:	*436.8 kg (963 lb)*	Right Rear:	*421.8 kg (930 lb)*
		Total:	*1930.9 kg (4257 lb)*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 4: PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM OPERATION

(Page 1 of 4)

2020 Volvo S60 T6 AWD Momentum

Name of the PAEB option, option package, etc.:

City Safety

Type and location of sensors the system uses:

Radar/camera fusion. Both sensors are located behind the windshield.

Are there any available settings for the PAEB system (i.e. Range adjustment, etc.)?

X Yes

____ No

If yes, please provide a full description.

City Safety is always active, but the function's warning distance can be adjusted.

The alert distance determines the sensitivity of the system and regulates the distance at which the light, sound and brake pulsations will be activated.

To select warning distance:

1. Select Settings My Car IntelliSafe in the center display's Top view.

2. Under City Safety Warning, tap Late, Normal or Early

System setting used for test (if applicable): *Early*

How is the PAEB alert presented to the driver?

(Check all that apply)

X Warning light

X Buzzer or audible alarm

____ Vibration

X Other

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 4: PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM OPERATION

(Page 2 of 4)

2020 Volvo S60 T6 AWD Momentum

Describe the method by which the driver is alerted. For example, if the warning is a light, where is it located, its color, size, words or symbol, does it flash on and off, etc. If it is a sound, describe if it is a constant beep or a repeated beep. If it is a vibration, describe where it is felt (e.g., pedals, steering wheel), the dominant frequency (and possibly magnitude), the type of warning (light, audible, vibration, or combination), etc.

Visual alert - The first visual alert will be a collision warning in the instrument panel. If City Safety applies the brakes, a text message will appear in the instrument panel to notify the driver that the function is/was activated. See Appendix A, Figure A-15.

Auditory alert – The auditory alert is a 1588 Hz tone pulsed approximately 7 times per second.

Haptic alert - Short brake pulses (the pulsation varies according to the vehicle's speed). The seat belt pretensioner may be activated when the AEB function is triggered. At lower speeds, during hard braking or if the accelerator pedal is pressed, the brake pedal pulsation warning will not be given. The intensity of the brake pedal pulsations varies according to the vehicle's speed.

Does the vehicle system require an initialization sequence/procedure? ____ Yes

X No

If yes, please provide a full description.

No initialization process is required for the function to be active. It's recommended though that in addition to the procedure in CIB & DBS test protocols, the vehicle has been pre-conditioned with normal driving on public roads. Preferably multiple driving cycles with a total of 60 miles.

What are the minimum and maximum vehicle speeds over which the PAEB system is active?

Minimum: *4 km/h (2.5 mph) (Per manufacturer supplied information)*

Maximum: *80 km/h (50 mph) (Per manufacturer supplied information)*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 4: PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM OPERATION

(Page 3 of 4)

2020 Volvo S60 T6 AWD Momentum

Will the system deactivate due to repeated PAEB activations, impacts or near-misses? **X** Yes / ____ No

If yes, please provide a full description.

No deactivation occurs. There is a three seconds time-out after each intervention but after that the system is activated automatically again.

Is there a way to deactivate the system? ____ Yes / **X** No

If yes, please provide a full description including the switch location and method of operation, any associated instrument panel indicator, etc.

Are there other driving modes or conditions that render PAEB inoperable or reduce its effectiveness? **X** Yes / ____ No

If yes, please provide a full description.

The potential limitations of the system sensors are described in pages 301-302 of the Owner's Manual shown in Appendix B pages B-2 and B3.

Limitations related to pedestrian detection are described on page 311 of the Owner's Manual shown in Appendix B page B9.

Overall City Safety limitations are described in pages 316-318 of the Owner's Manual shown in Appendix B pages B-10 and B12.

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 4: PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM OPERATION

(Page 4 of 4)

2020 Volvo S60 T6 AWD Momentum

Notes:

From the Owner's Manual: City Safety is an aid intended to assist the driver is a collision with a pedestrian, large animal, cyclist or vehicle is imminent.

City Safety can help the driver avoid a collision with a vehicle, cyclist or large animal ahead by reducing the vehicle's speed using its automatic braking function.

If the difference in speed is greater than the speeds specified below, the City Safety autobrake function cannot prevent a collision, but it can help mitigate its effects. City Safety can help prevent a collision with a pedestrian ahead by reducing your vehicle's speed by up to 45 km/h (28 mph).

Section III

TEST PROCEDURES

A. Test Procedure Overview

Ten test scenarios were used, as follows:

S1a. Subject Vehicle (SV) Encounters a Crossing Adult Pedestrian Test Mannequin (PTM) from the Nearside at 25% Overlap

S1b. SV Encounters a Crossing Adult PTM from the Nearside at 50% Overlap

S1c. SV Encounters a Crossing Adult PTM from the Nearside at 75% Overlap

S1d. SV Encounters a Crossing Child PTM Running from Behind Parked Cars from the Nearside at 50% Overlap

S1e. SV Encounters a Crossing Adult PTM Running from the Offside at 50% Overlap

S1f. SV Encounters a Crossing Adult PTM From the Nearside and Stops Short of Entering the SV Path of Travel

S1g. SV Encounters a Crossing Adult PTM From the Nearside and Clears the SV Path of Travel

S4a. SV Encounters a Stationary Adult PTM on the Nearside of the Road Facing Away from the SV at 25% Overlap

S4b. SV Encounters a Stationary Adult PTM on the Nearside of the Road Facing Toward the SV at 25% Overlap

S4c. SV Encounters an Adult PTM on the Nearside of the Road Walking in the Same Direction as the SV at 25% Overlap

The 89 different combinations of scenario, nominal SV speeds, and lighting conditions are listed in Table 1. This includes 35 daytime, 27 low beam nighttime, and 27 high beam nighttime combinations. Testing generally started at the lowest test speed in Table 1 and progressed through higher test speeds.

For all scenarios, the 16 and 40 km/h speeds were considered to be the “non-conditional”

speeds. Testing at these speeds was conducted without regard to whether the results showed that "consistent contact" occurred between the SV and PTM. Consistent contact was defined as the SV contacting the PTM in three or more test trials at a given speed. If this occurred, then testing at any higher speeds was not conducted. Rather, the speed would be stepped down by 5 km/h and testing of that scenario and lighting treatment would be conducted at that lower speed. This was done to more precisely identify the highest speed at which the vehicle's PAEB system was able to avoid colliding with the PTM.

So, for example, for Scenario S1d, if the vehicle did not contact the PTM at 16, 20, or 30 km/h, but did contact the PTM in three trials at 40 km/h, then testing would be done at 35 km/h. However, testing would not be done at 50 or 60 km/h. Note that there were 20 possible scenario and ambient lighting condition combinations that could involve testing at the "step down" speed, for a total of 109 possible test combinations.

Table 1. Test Scenario, Speed, and Lighting Condition Matrix

	Nominal SV Speeds (km/h)								Lighting Condition		
										Night	
Scenario	16	20	30	40	50	60	70	80	Day	Low Beams	High Beams
S1a	X	-	-	X	-	-	-	-	X	-	-
S1b	X	X*	X*	X	X*	X*	-	-	X	X*	X*
S1c	X	-	-	X	-	-	-	-	X	-	-
S1d	X	X*	X*	X	X*	X*	-	-	X	X*	X*
S1e	-	-	-	X	X*	X*	-	-	X	X*	X*
S1f	-	-	-	X	-	-	-	-	X	-	-
S1g	-	-	-	X	-	-	-	-	X	-	-
S4a	X	-	-	X	X*	X*	X*	X*	X	X*	X*
S4b	X	-	-	X	-	-	-	-	X	-	-
S4c	-	-	-	X	-	-	-	-	X	X*	X*

* Additional test condition (i.e., not part of the test procedure titled, "Pedestrian Automatic Emergency Brake System Confirmation Test (Working Final)", dated September 2019.

All of the test trials were performed with SV automatic transmissions in ‘‘Drive’’ or with manual transmissions in the highest gear capable of sustaining the desired test speed. Manual transmission clutches remained engaged during all maneuvers.

An overview of each of the test procedures follows.

B. SV Approach to a Crossing Pedestrian (S1)

1. S1 TEST SCENARIOS

The following S1 test scenarios were used to evaluate PAEB system performance.

a. S1a-b-c Scenarios – SV Encounters a Crossing Adult PTM from the Nearside at 25/50/75% Overlap

These tests evaluate the ability of the SV PAEB system to detect and respond to a crossing adult pedestrian walking into the SV path from the nearside.

Figure 1 below illustrates the S1a, S1b, and S1c test scenarios. See Table 3 for details on the test setup.

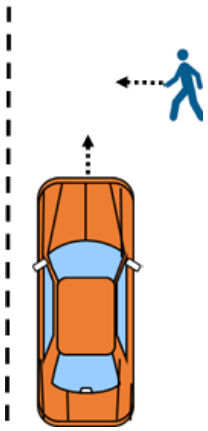


Figure 1. Scenarios S1a, b, c; Nearside Crossing Adult Pedestrian Walking 25/50/75% Overlap

- S1a test conditions:
  - SV Speeds (km/h): 16, 40
  - PTM Speed (km/h): 5
  - PTM Type: Adult
  - Overlap: 25%
  - Direction of PTM Approach: Nearside

- S1b test conditions:
    - SV Speeds (km/h): 16, 20, 30, 40, 50, 60
    - PTM Speed (km/h): 5
    - PTM Type: Adult
    - Overlap: 50%
    - Direction of PTM Approach: Nearside

- S1c test conditions:
    - SV Speeds (km/h): 16, 40
    - PTM Speed (km/h): 5
    - PTM Type: Adult
    - Overlap: 75%
    - Direction of PTM Approach: Nearside

b. S1d Scenario – SV Encounters a Crossing Child PTM Running from Behind Parked Cars from the Nearside at 50% Overlap

This test evaluates the ability of the SV PAEB system to detect and respond to a crossing child pedestrian running into the SV path from behind parked vehicles from the nearside.

Figure 2 below illustrates the S1d test scenario. See Table 3 for details on the test setup.

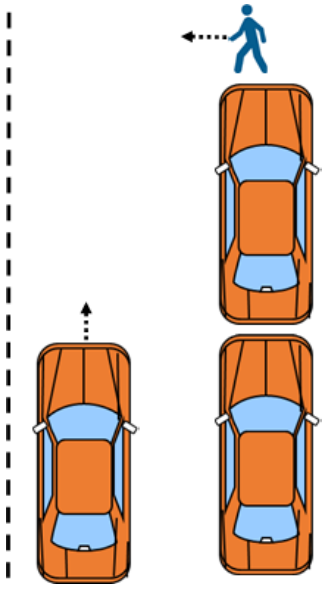


Figure 2. Scenario S1d; Nearside Obstructed Crossing Child Running, 50% Overlap

- S1d test conditions:
    - SV Speeds (km/h): 16, 20, 30, 40, 50, 60
    - PTM Speed (km/h): 5
    - PTM Type: Child
    - Overlap: 50%
    - Direction of PTM Approach: Nearside

c. S1e Scenario – SV Encounters a Crossing Adult PTM from the Offside at 50% Overlap

This test evaluates the ability of the SV PAEB system to detect and respond to a crossing adult pedestrian running into the SV path from the offside.

Figure 3 below illustrates the S1e test condition. See Table 4 for details on the test setup.

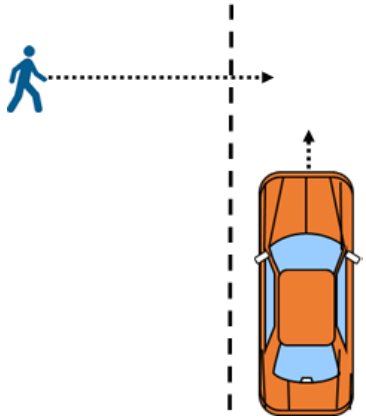


Figure 3. Scenario S1e Offside Crossing Adult Running 50% Overlap

- S1e test conditions:
    - SV Speeds (km/h): 40, 50, 60
    - PTM Speed (km/h): 8
    - PTM Type: Adult
    - Overlap: 50%
    - Direction of PTM Approach: Offside

d. S1f Scenario – SV Encounters a Crossing Adult PTM from the Nearside that Stops Short of Entering the SV Travel Path

This test evaluates how the SV PAEB system will respond to a crossing adult pedestrian walking from the nearside that stops short of entering the vehicles path.

Figure 4 below illustrates the S1f test condition. See Table 3 for details on the test setup.

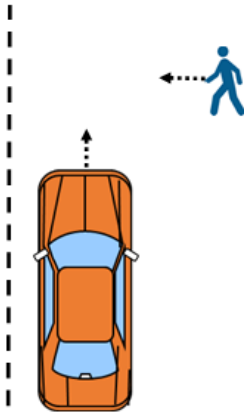


Figure 4. Scenario S1f; Nearside Crossing Adult Walking Stops Short

- S1f test conditions:
  - SV Speeds (km/h): 40
  - PTM Speed (km/h): 5
  - PTM Type: Adult
  - Overlap: 0% (stops short of vehicle path)
  - Direction of PTM Approach: Nearside

e. S1g Scenario – SV Encounters a Crossing Adult PTM from the Nearside that Clears the SV Travel Path

This test evaluates how the SV PAEB system will respond to a crossing adult pedestrian walking from the nearside that clears the vehicle's path. Figure 5 below illustrates the setup for the S1g test condition. See Table 3 for details on the test setup.

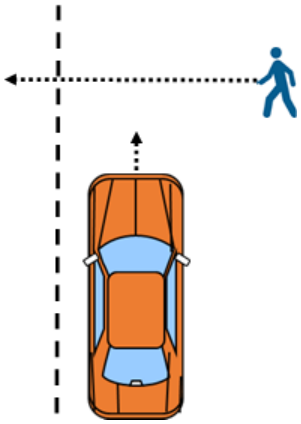


Figure 5. Scenario S1g; Nearside Crossing Adult Walking Clears Path

- S1g test conditions:
    - SV Speeds (km/h): 40
    - PTM Speed (km/h): 5
    - PTM Type: Adult
    - Overlap: 100% (crosses beyond vehicle path)
    - Direction of PTM Approach: Nearside

2. PEDESTRIAN TEST MANNEQUIN PLACEMENT AND MOVEMENT

For tests S1a-b-c-d-f-g, the PTM was positioned 3.5 m (11.5 ft) from the SV centerline on the nearside with its orientation perpendicular to the SV centerline. For test S1e, the PTM was positioned 5.5 m (18.0 ft) from the SV centerline on the offside with its orientation also perpendicular to the SV centerline.

Trigger timing for the S1 tests assumed that the SV will approach the crossing PTM at a constant speed with no PAEB system intervention. Trigger timing for the

- S1a test was set up so that the PTM would contact the front of the SV at 25% of the SV width (i.e., on the passenger side of the vehicle).
- S1b-d-e tests were set up so that the PTM would contact the front of the SV at 50% of the SV width (i.e., the center of the SV).
- S1c test was set up so that the PTM would contact on the front of the SV at 75% of the SV width (i.e., on the driver side of the vehicle).
- S1f test was set up so that the PTM would contact the front of the SV at 50% of the SV width, but the PTM forward motion was stopped at -25% of the SV width. This means that the PMT did not enter the direct path of the SV.
- S1g test was set up so that the PTM would clear the direct path of the SV. For calculating trigger timing for PTM motion 125% of the SV width was used.

a. PTM Position as a Function of SV Position

i. PTM Position Validity Criterion

In the course of testing PAEB systems, it is necessary to confirm that the required conflict scenario was presented to each vehicle in a repeatable and verifiable fashion, trial after trial. This is particularly important in the pedestrian crossing scenarios (S1a-g). For the purposes of these tests, the ideal PTM lateral lane position (Y_{PTM}) is expressed as a function of SV position longitudinally within the lane (X_{SV} - i.e., headway between the front of the SV to the contact-side of the PTM.). That is:

$$Y_{PTM} = f(X_{SV})$$

Note that the terms “longitudinal” and “lateral” herein are defined relative to the SV lane

of travel. Therefore, PTM lateral lane position refers to the PTM position across the lane.

On this basis, the validity of a given trial is determined by computing the sample-by-sample difference of the measured Y_{PTM} position and the ideal position, and then applying a tolerance. The tolerance chosen as the validity criterion for the S1 scenarios was 10% of the width of a typical 1.8-meter-wide vehicle, or 0.18 m (18 cm).

ii. Methodology

In order to compute a positional error of the PTM (laterally within the lane) it is necessary to pre-compute the ideal positional relationship between the SV longitudinal lane position and the lateral position of the PTM based on the parameters specified per scenario, assuming the SV had not begun its avoidance maneuver. These parameters include:

- SV speed (v_{SV})
- PTM speed (v_{PTM})
- Percent Overlap at Impact (%OL)
- PTM start distance (Y_{PTM0})
- PTM acceleration distance (D_{acc})
- PTM Move distance (D_{move})
- SV width (W_{SV})

From these parameters, the spatial relationship of the PTM relative to the SV position along the travel lane is determined.

Figure 6 illustrates the coordinate system used for the validation of Scenario 1 (S1a, b, c, d, e, f, g).

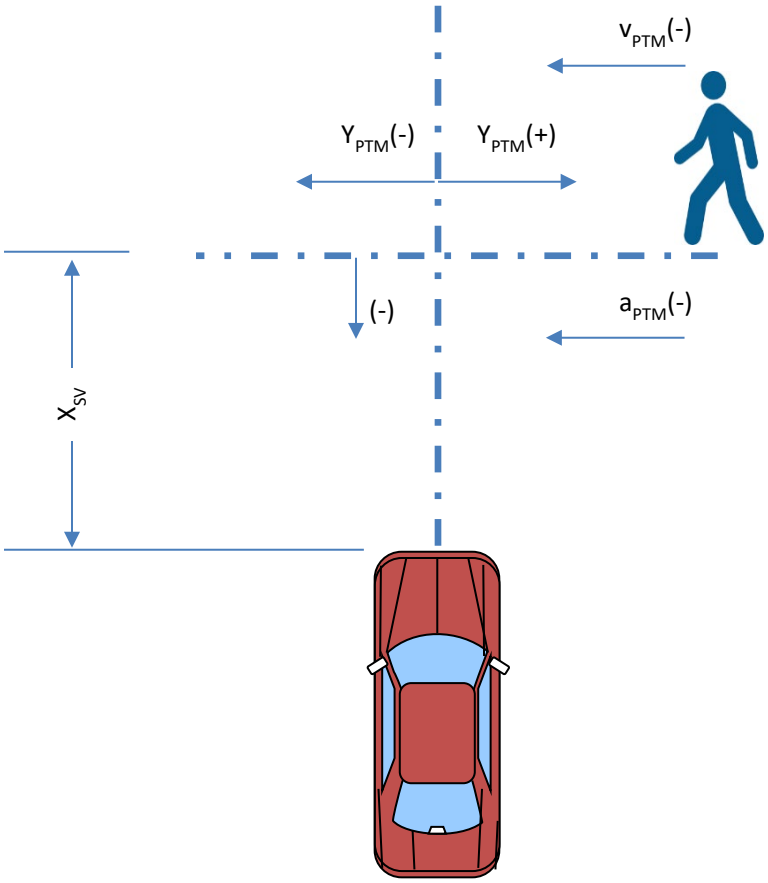


Figure 6. Coordinate System for Validation of Scenario 1

Note that Y_{PTM} is measured relative to the center of the lane (in this case, shown coincident with the center of the SV) with positive values to the right (as viewed from the SV). Note also that X_{SV} is measured parallel to the travel lane between the near edge of the PTM and the front-most point of the SV, such that X_{SV} is negative during the approach phase.

Figure 7 illustrates the ideal lateral lane position of the PTM as a function of SV longitudinal lane position, taking each scenario parameter into consideration.

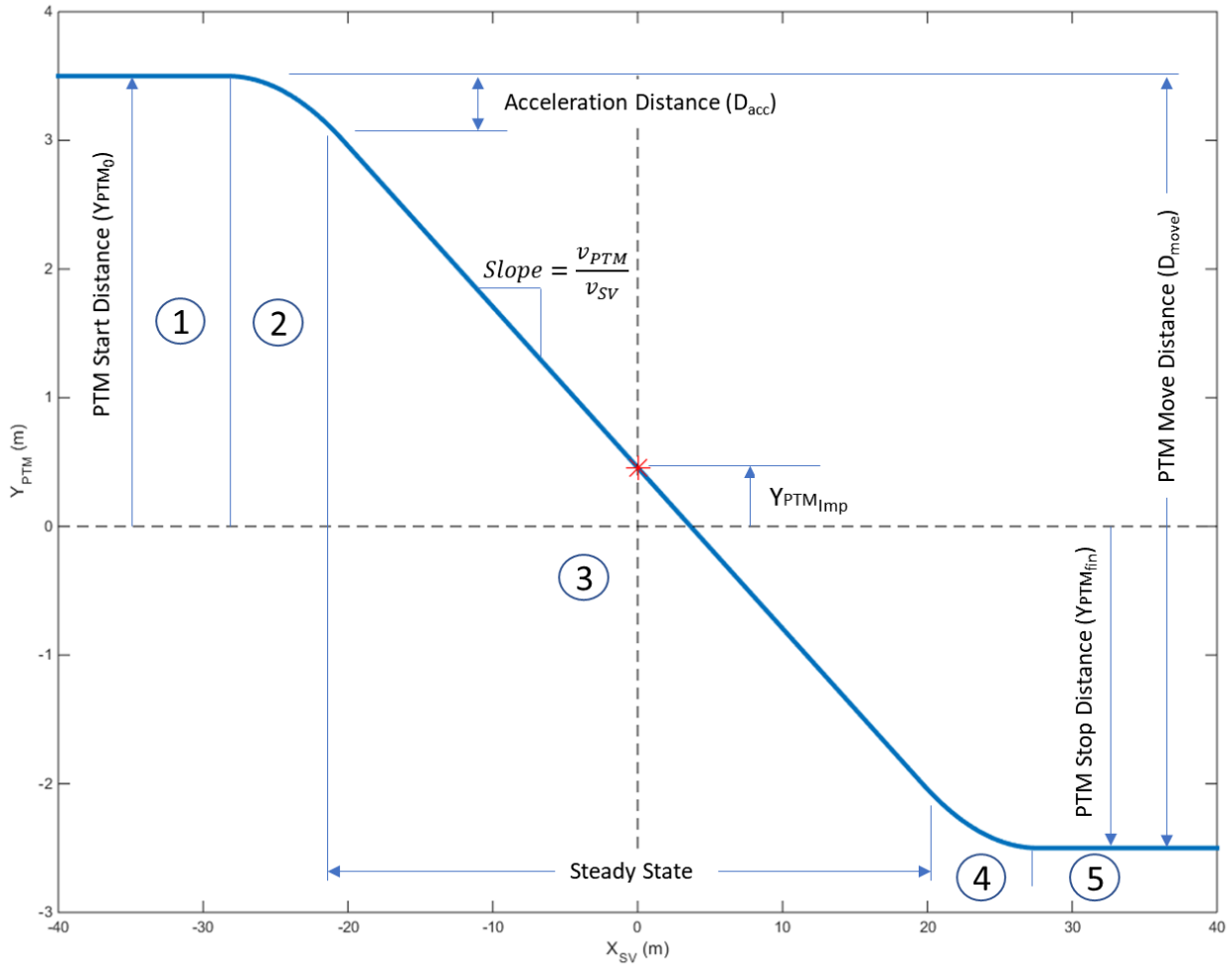


Figure 7. PTM Lateral Lane Position as a Function of SV Longitudinal Lane Position

The ideal trajectory of the PTM lateral lane position as a function of headway is computed in 5 separate domains. These domains are:

- Stationary domain, initial: The PTM is stationary at the side of the roadway as the SV approaches
- Acceleration domain: The PTM accelerates to its prescribed speed over a prescribed distance
- Steady State domain: The PTM speed, v_{PTM}, and SV speed, v_{SV}, are both steady-state. Note that $Y_{PTM_{imp}}$ is defined as the offset distance at impact (if there is no intervention by the PAEB system or driver braking)
- Deceleration domain: The PTM decelerates from its prescribed speed to rest over a prescribed distance (relevant only for scenario S1f)
- Stationary domain, final: The PTM is stationary at its final position as the SV

proceeds in the lane (relevant only for scenario S1f)

The boundaries of these domains are:

- X_{SV} at PTM motion start ($X_{SV\ PTM\ Start}$)
- X_{SV} at PTM steady state start ($X_{SV\ SS\ Start}$)
- X_{SV} at PTM steady state end ($X_{SV\ SS\ end}$)
- X_{SV} at PTM motion stop ($X_{SV\ PTM\ Stop}$)

Table 2 provides the domain boundaries for each PAEB scenario for the standard scenario SV speeds. Note that the details of the calculations follow.

Table 2. Domain Boundaries Per Scenario

Scenario		Domain (X_{SV},Y_{PTM})			
Type	SV Speed (km/h)	PTM Start (m)	Steady State Start (m)	Steady State End (m)	PTM Stop (m)
S1a	16	(-11.34, 3.50)	(-8.14, 3.00)	(7.86, -2.00)	(11.06, -2.50)
	40	(-28.34, 3.50)	(-20.34, 3.00)	(19.66, -2.00)	(27.66, -2.50)
S1b	16	(-12.80, 3.50)	(-9.60, 3.00)	(6.40, -2.00)	(9.60, -2.50)
	40	(-32.00, 3.50)	(-24.00, 3.00)	(16.00, -2.00)	(24.00, -2.50)
S1c	16	(-14.26, 3.50)	(-11.06, 3.00)	(4.94, -2.00)	(8.14, -2.50)
	40	(-35.66, 3.50)	(-27.66, 3.00)	(12.34, -2.00)	(20.34, -2.50)
S1d	16	(-12.80, 3.50)	(-9.60, 3.00)	(6.40, -2.00)	(9.60, -2.50)
	40	(-32.00, 3.50)	(-24.00, 3.00)	(16.00, -2.00)	(24.00, -2.50)
S1e	40	(-32.50, -5.50)	(-22.50, -4.50)	(12.50, 2.50)	(22.50, 3.50)
S1f	40	(-32.00, 3.50)	(-24.00, 3.00)	W_{SV} Dependent	W_{SV} Dependent
S1g	40	(-42.97, 3.50)	(-34.97, 3.00)	(5.03, -2.00)	(13.03, -2.50)

In order to compute the values for these domain boundaries, it is necessary to compute several intermediate values:

Y_{PTM} at the point of impact, as defined by the Percent Overlap specified by the scenario:

$$Y_{PTM_{imp}} = (50\% - \%OL)W_{SV}$$

where,

W_{SV} = SV width (assumed here to be 1.8 meters)

In scenario S1f, in which the PTM comes to rest without entering the SV lane of travel

such that no collision can occur, it is also necessary to compute the deceleration and stop distances:

$$Y_{PTM_{fin}} = Y_{PTM_0} - D_{move}$$

where,

$Y_{PTM_{fin}}$ = final position of PTM with respect to the lane

Y_{PTM_0} = initial position of PTM with respect to the lane

D_{move} = distance moved by the PTM, defined by scenario

In the acceleration domain, it is assumed that the PTM undergoes constant acceleration from rest to the specified PTM speed, such that the acceleration can be computed as:

$$a = \frac{{v_{PTM}}^2}{2D_{acc}}$$

where,

v_{PTM} = velocity of PTM, defined by scenario

D_{acc} = acceleration distance of PTM, defined by scenario

The longitudinal distance covered by the SV during the acceleration phase of the PTM is computed as:

$$\Delta X_{SV_{acc}} = \frac{2D_{acc}v_{SV}}{v_{PTM}}$$

where,

$\Delta X_{SV_{acc}}$ = Change in SV longitudinal lane position during the acceleration of the PTM

v_{SV} = SV velocity, defined by scenario

Computing the domain boundaries:

$$X_{SV_{SS\ start}} = \left[Y_{PTM_0} - D_{acc} - Y_{PTM_{Imp}}\right]\frac{v_{SV}}{v_{PTM}}$$

$$X_{SV_{SS\ end}} = \left[Y_{PTM_{fin}} + D_{acc} - Y_{PTM_{Imp}}\right]\frac{v_{SV}}{v_{PTM}}$$

$$X_{SV_{PTM\ start}} = \Delta X_{SV_{acc}} + X_{SV_{SS\ Start}}$$

$$X_{SV_{PTM\ stop}} = X_{SV_{SS\ end}} - \Delta X_{SV_{acc}}$$

where,

$X_{SV_{SS\ start}}$ = SV longitudinal lane position at the beginning of steady state domain

$X_{SV_{SS\ end}}$ = SV longitudinal lane position at the end of steady state domain

$X_{SV_{PTM\ start}}$ = SV longitudinal lane position at the start of PTM motion

$X_{SV_{PTM\ stop}}$ = SV longitudinal lane position at the end of PTM motion

Finally, lateral lane position values are computed for each domain.

Domain 1 (Stationary):

$$Y_{PTM} = Y_{PTM_0} \quad \text{for} \quad X_{SV} \leq X_{SV_{PTM\ start}}$$

Domain 2 (Acceleration):

$$Y_{PTM} = Y_{PTM_0} - \frac{1}{2}a_{PTM}\left[\frac{X_{SV} - X_{SV_{PTM\ Start}}}{v_{SV}}\right]^2 \quad \text{for} \quad X_{SV_{PTM\ start}} < X_{SV} \leq X_{SV_{SS\ start}}$$

where,

a_{PTM} = PTM acceleration, defined by scenario

X_{SV} = measured SV longitudinal lane position

Domain 3 (Steady State):

$$Y_{PTM} = \frac{v_{PTM}}{v_{SV}} X_{SV} + Y_{PTM_{imp}} \qquad \text{for} \quad X_{SV_{SS\ start}} < X_{SV} \leq X_{SV_{SS\ end}}$$

Domain 4 (Deceleration):

$$Y_{PTM} = Y_{PTM_{fin}} + D_{acc} + v_{PTM} \frac{\left(X_{SV} - X_{SV_{SS\ end}}\right)}{v_{SV}} + \frac{1}{2} a_{PTM} \left[\frac{X_{SV} - X_{SV_{SS\ end}}}{v_{SV}}\right]^2$$

$$\text{for} \quad X_{SV_{SS\ end}} < X_{SV} \leq X_{SV_{PTM\ stop}}$$

Domain 5 (Stationary):

$$Y_{PTM} = Y_{PTM_{fin}} \qquad \text{for} \quad X_{SV} > X_{SV_{PTM\ stop}}$$

After each trial is completed, the measured X_{SV} values are used to compute ideal Y_{PTM} values, sample-by-sample. Measured Y_{PTM} values are then compared to the ideal Y_{PTM} values in order to compute a lateral lane position error for the PTM:

$$Y_{PTM_{err}} = Y_{PTM_{ideal}} - Y_{PTM_{meas}}$$

Y_{PTM} error is then plotted in the time domain for the entire validity window and checked to determine exceedances beyond the acceptable threshold of ±18 cm (or 10% of a typical 1.8m wide vehicle). The validity window started at 4.0 sec Time-To-Collision (TTC) and ends at the earliest of any of the following:

- SV braking is initiated
- SV-to-PTM contact occurs
- The front of the SV crosses the X_{SV} zero point

3. OBSTRUCTION VEHICLES

Two parked vehicles positioned along the nearside of the test lane were used as obstructions. The obstructions blocked the view of the pedestrian from the vehicle sensors limiting the reveal time (the time that the vehicle's sensors have to process that a pedestrian is approaching the SV lane of travel).

4. SV ZERO POSITION

- The SV and PTM were centered on the SV centerline with the PTM facing the direction specified for each test scenario.

- The front-most location of the SV was positioned such that it just contacted the PTM. This was the "zero position." The zero position did not change based on different overlap test conditions. Note that the determination of whether there was a collision between the SV and PTM is based on whether the zero position has been crossed. This means that for this purpose, the front of the SV is considered to have a rectangular shape (even if it actually has some curvature). Note also that the arms of the PTM were not considered contact points.

- The zero position was documented both prior to and immediately after conduct of a test series.

5. LAST MOMENT BRAKING

In order to reduce the likelihood of damage to both the PTM and test vehicle, it was determined that Last Moment Braking (LMB) would be implemented for scenarios in which the nominal speed was 40 km/h or higher. LMB is defined as braking applied by the driver to reduce the speed and energy of the collision with the PTM in the event that a collision becomes impossible to avoid.

LMB was implemented as follows: the computer onboard the SV continuously computed and monitored TTC. If TTC dropped below a preset value (i.e. 1.0 sec) and no alert or braking had been provided by the PAEB system at that time, then the computer would provide an audible beep, and the driver would apply the brakes forcefully and as quickly as possible. When LMB was used, the preset TTC value was selected such that a collision would be inevitable (i.e., even immediate maximum braking would not reduce SV speed enough to avoid colliding with the PTM). Thus, the overall outcome of the trial (collision/no collision) would not be affected by the use of LMB.

6. TEST TRIAL CONDUCT AND VALIDITY (S1)

An overview of each test trial is as follows: For each trial for the S1 scenarios, the SV and PTM were first positioned at their respective start positions. The SV was accelerated to its nominal test speed, and the driver maintained its position in the center of the lane. When the SV was at a designated longitudinal distance from the PTM, the PTM accelerated to its nominal test speed. If a PAEB alert was issued by the vehicle, the driver then fully released the throttle (within 500 ms of the alert). After the vehicle either came to a stop or passed through the plane defined by the PTM's movement which was perpendicular to the SV's line of travel, the trial was concluded.

a. PTM Validity

For each test trial to be valid, the following criteria were required to be met.

- The PTM was secured to the apparatus used for motion such that its position relative to the apparatus remained constant.
- The PTM was at the start position distance on the PTM path from the SV path and did not move until the triggering criteria for motion were met.
- PTM start position nearside: 3.5 m±2.54 cm (11.4 ft±1 in)
- PTM start position offside: 5.5 m±2.54 cm (18.04 ft±1 in)
- When triggered, the PTM was accelerated to the test speed over the required distance and held at that test speed until the PTM was clear of the SV path, stopped short of entering the SV path, or was contacted by the SV.
- PTM speed:
    - 5 km/h (3.1 mph) within an acceleration distance of 0.5 m (1.64 ft)
    - 8 km/h (4.9 mph) within acceleration distance 1.0 m (3.28 ft)
- PTM position: ±0.18m from ideal lateral position within the lane, as a function of SV longitudinal position within the lane[2].
- While the PTM was in motion, the PTM path remained perpendicular to the SV centerline. Lateral deviations induced by wind, equipment, or surface conditions were monitored.

b. SV Validity

For an individual test trial to be valid, the following criteria were required to be met:

- The SV driver seatbelt was latched.
- The SV driver cycled the ignition prior to each run.
- The front initial brake temperature (IBT) was between 149°F (65°C) and 212°F (100°C) at the onset of each test.
    - If the IBT was less than 149°F (65°C), the brakes were heated to the IBT by making one or more brake applications from a speed of 31.1 mph (50 km/h), at a deceleration rate not greater than 0.31g (3 m/s²).
    - If the IBT was greater than 212°F (100°C), the SV was driven at speeds up to 62.1 mph (100 km/h) until the IBT specified in this section was reached.
- The SV was driven at the nominal speed specified for each test. The speed tolerance was ±1.0 km/h.
- The following requirements were held true throughout each trial.

[2] The ideal lateral position of the PTM within the lane was calculated as a function of SV longitudinal lane position as described in Section III B 2 a ii and shown in Figure 7.

- The driver used the least amount of steering input necessary to maintain the SV position in the center of the test lane. The lateral distance between the centerline of the SV and the center of the travel lane did not deviate more than ± 20 cm (8 in). A measurement and display of SV lateral lane position was presented to the driver in order to regulate the lateral lane position during the execution of a trial. These data were also recorded and used as validation of lane position in post-process.
- The yaw rate of the SV did not exceed ±1.0 deg/s.
- The SV driver modulated the throttle, using smooth inputs, to maintain a constant SV speed ±1.0 km/h.
- With the exception of LMB (described above), the SV driver did not apply any force to the brake pedal until the end of the test unless the PTM was contacted or the front of the SV had crossed the path of the PTM.

- The SV throttle was fully released within 500 ms after the SV PAEB warning event was presented (visual, haptic, or audible). If no SV warning event was presented by the SV PAEB system, the SV driver modulated the throttle to maintain a constant speed until either the onset of PAEB or, if the SV's PAEB system did not activate, the end of the test occurred (i.e., contact with the PTM occurred).

c. Validity Period

- The valid test interval began when the longitudinal TTC of the SV = 4.0 seconds.
- For scenarios S1a-b-c-d-e, the test ended when any of the following occurred:
  - The SV contacted the PTM; or
  - The SV stopped (via PAEB) before contacting the PTM; or
  - The PTM cleared the direct path of the SV.
- For scenarios S1f-g, the test ended when either of the following occurred:
  - The front of the SV crossed the path of the PTM (i.e., the front most location of the SV front bumper crosses the zero position.
  - The SV stopped (via PAEB).

d. End-of-Test Instructions

After the test was complete, the SV driver manually applied force to the brake pedal, bringing the vehicle to a stop (if necessary), and placed the transmission in park (automatic transmission) or neutral (manual transmission).

The test trial was then complete.

e. Number of Test Trial Repeats

Combinations of test speeds, and lighting conditions were tested as shown in Table 1.

Five repeat trials were conducted for each test condition. As noted above, for all scenarios, the 16 and 40 km/h speeds were considered to be the "non-conditional" speeds. Testing at these speeds was conducted without regard to whether the results showed that "consistent contact" occurred between the SV and PTM. Consistent contact was defined as the SV contacting the PTM in three or more test trials at a given speed. If this occurred, then testing at any higher speeds was not conducted. Rather, the speed would be reduced by 5 km/h and testing of that scenario and lighting treatment would be conducted at that lower speed. This was done to more precisely identify the highest speed at which the vehicle's PAEB system was able to avoid colliding with the PTM.

f. Speed Reduction (S1a-b-c-d-e)

The magnitude of the SV speed reduction attributable to PAEB intervention (as shown in Datasheet 1) was calculated in one of two ways, depending on whether or not a test trial concluded with the SV colliding with the PTM.

- If the SV contacted the PTM during a test trial, the PAEB speed reduction was calculated by subtracting the SV speed at the time of contact (i.e., when longitudinal range becomes zero) from the average SV speed calculated at TTC = 4.0 seconds.
- If the SV did not contact the PTM during a test trial (i.e., PAEB intervention prevented the crash), the SV speed at the time of SV and PTM contact was taken to be zero. The speed reduction was therefore equal to the SV speed at TTC = 4.0 seconds.

g. Deceleration (S1f-g)

The peak SV deceleration within the validity period was documented for each test trial performed for the S1f-g scenarios.

h. Pass/Fail Criteria

There were no pass/fail criteria for these research tests.

C. SV Approach to a Pedestrian Walking Along/Against Traffic (S4)

1. S4 TEST SCENARIOS

a. S4a Scenario – SV Encounters a Stationary Adult PTM on the Nearside of the Road Facing Away from the SV at 25% Overlap

This test evaluates the ability of the SV PAEB system to detect and respond to an adult pedestrian standing in front of the vehicle on the nearside of the road facing away from the approaching SV.

Figure 8 below illustrates the test setup for the S4a test. See Table 5 for details on the test setup.

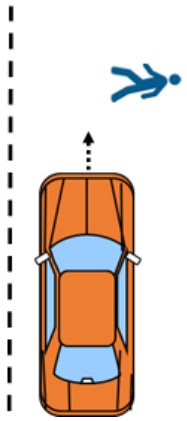


Figure 8. Scenario S4a; Nearside Standing Adult Facing Away From SV, 25% Overlap

- S4a test conditions:
  - SV Speeds (km/h): 16, 40
  - PTM Speed (km/h): 0
  - PTM Type: Adult
  - Overlap: 25%
  - Direction of PTM Approach: Facing away from the SV

b. S4b Scenario – SV Encounters a Stationary Adult PTM on the Nearside of the Road Facing Towards the SV at 25% Overlap

This test evaluates the ability of the SV PAEB system to detect and respond to an adult pedestrian standing in front of the vehicle on the nearside of the road facing towards the approaching SV.

Figure 9 below illustrates the test setup for the S4b test scenario. See Table 5 for details on the test setup.

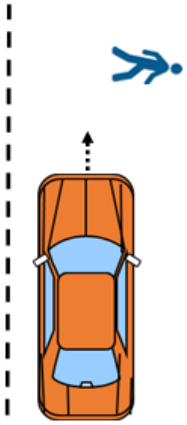


Figure 9. Scenario S4b; Nearside Standing Adult Facing Towards SV, 25% Overlap

- S4b test conditions:
    - SV Speeds (km/h): 16, 40
    - PTM Speed (km/h): 0
    - PTM Type: Adult
    - Overlap: 25%
    - Direction of PTM Approach: Facing towards the SV

c. S4c Scenario – SV Encounters an Adult PTM on the Nearside of the Road Walking Away from the SV, but in the Same Direction as the SV, at 25% Overlap

This test evaluates the ability of the SV PAEB system to detect and respond to an adult pedestrian walking in front of the vehicle on the nearside of the road facing away from the approaching SV.

Figure below illustrates the test setup for the S4c test scenario. See Table 5 for details on the test setup.

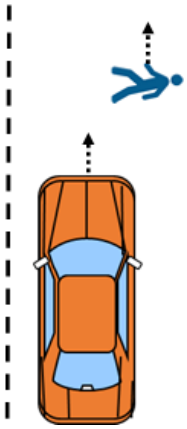


Figure 10. Scenario S4c; Nearside Walking Adult Away From SV, 25% Overlap

- S4c test conditions:
    - SV Speeds (km/h): 40
    - PTM Speed (km/h): 5
    - PTM Type: Adult
    - Overlap: 25%
    - Direction of PTM Approach: Facing and moving away from SV

2. PEDESTRIAN TEST MANNEQUIN PLACEMENT AND MOVEMENT

For the S4a-b-c scenarios, the PTM was positioned in the direct path of the SV at a 25% overlap on the nearside. The orientation of the PTM was either facing towards or away from the SV and was either stationary or moving for the duration of the tests.

The PTM was stationary in scenarios S4a and S4b, and therefore, no trigger timing was required.

Trigger timing for the S4c scenario was set up so that the PTM was moving and had reached steady state speed before TTC has been reduced to 7 seconds (i.e., 7 seconds before SV-to-PTM contact would occur if there was no PAEB system intervention).

3. SV ZERO POSITION

- The SV was centered on the SV path at the start of the test lane. The PTM was located on the PTM path which was parallel to the SV path inside the test lane located on the nearside. The SV overlap was 25% of the SV width, which was the distance between the SV centerline path and the PTM centerline path. The PTM faced the direction specified for each test scenario.
- The SV was positioned such that it just contacted the PTM. This was the “zero position.” Note that the determination of whether there was a collision between the SV and PTM was based on whether the zero position had been crossed. Note also that the arms of the PTM were not considered contact points.
- The zero position was documented prior to, and immediately after, conduct of a test series.

4. LAST MOMENT BRAKING

In order to reduce the likelihood of damage to both the PTM and test vehicle, it was determined that Last Moment Braking (LMB) would be implemented for scenarios in which the nominal speed was 40 km/h or higher. LMB is defined as braking applied by the driver to reduce the speed and energy of the collision with the PTM in the event that a collision becomes impossible to avoid.

LMB was implemented as follows: the computer onboard the SV continuously computed and monitored TTC. If TTC dropped below a preset value (i.e., 1.0 sec) and no alert or braking had been provided by the PAEB system at that time, then the computer would provide an audible beep, and the driver would apply the brakes forcefully and as quickly as possible. When LMB was used, the preset TTC value was selected such that a collision would be inevitable (i.e., even immediate maximum braking would not reduce SV speed enough to avoid colliding with the PTM). Thus, the overall outcome of the trial (collision/no collision) would not be affected by the use of LMB.

5. TEST TRIAL CONDUCT AND VALIDITY

An overview of each test trial is as follows: For each trial for the S4 scenarios, the SV and PTM were first positioned at their respective start positions. The SV was accelerated to its nominal test speed, and the driver maintained its position in the center of the lane. When the SV was at a designated longitudinal distance from the PTM, the PTM accelerated to its nominal test speed (S4c only). If a PAEB alert was issued by the vehicle, the driver then fully released the throttle (within 500 ms of the alert). After the vehicle either came to a stop or passed through the plane defined by the PTM's movement (S4c only), which is parallel to the SV's line of travel, the trial was concluded.

a. PTM Validity

For all S4 scenarios, a required condition for validity of every trial was that the PTM was secured to the motion apparatus such that its position relative to the apparatus remained constant throughout the test.

For the S4c scenario, the following additional criteria were required for test validity:

- The PTM was at the start position distance on the PTM path and did not move until the triggering criteria for motion were met.
- When triggered, the PTM was accelerated to the test speed over the required distance and held at that test speed until a contact event or the SV speed was reduced to zero and no contact had occurred.
    - PTM speed: 5 km/h (3.1 mph) within an acceleration distance of 1.0 m (3.28 ft)
    - PTM position: ±0.18 m from the ideal lateral position within the lane, as a function of SV longitudinal position within the lane[3].
- While the PTM was in motion, the PTM path remained parallel to the SV path. Lateral deviations induced by wind, equipment, or surface conditions were monitored.

b. SV Validity

For an individual test trial to be valid, the following criteria were required to be met:

- The SV driver seatbelt was latched.
- The SV driver cycled the ignition prior to each run.
- The front IBT was between 149°F (65°C) and 212°F (100°C) at the onset of each test.
    - If the IBT was less than 149°F (65°C), the brakes were heated to the IBT by making one or more brake applications from a speed of 31.1 mph (50 km/h), at a deceleration rate not greater than 0.31g (3 m/s²).

[3] The ideal lateral position of the PTM within the lane was calculated as a function of SV longitudinal lane position as described in Section III B 2 a ii and shown in Figure 7.

- If the IBT was greater than 212°F (100°C), the SV was driven at speeds up to 62.1 mph (100 km/h) until the IBT specified in this section is reached.

- The SV was driven at the nominal speed specified for each test. The speed tolerance was ±1.0 km/h
- For scenario S4c only, PTM motion began when the longitudinal TTC of the SV = 7.0 seconds.
- The following requirements were held true throughout each trial:
  - The driver used the least amount of steering input necessary to maintain the SV position in the center of the test lane. The lateral distance between the centerline of the SV and the center of the travel lane did not deviate more than ± 20 cm (8 in). A measurement and display of SV lateral lane position was presented to the driver in order to regulate the lateral lane position during the execution of a trial. These data were also recorded and used as validation of lane position in post-process.
  - The yaw rate of the SV did not exceed ± 1.0 deg/s.
  - The SV driver modulated the throttle, using smooth inputs, to maintain a constant SV speed ±1.0 km/h.
  - With the exception of LMB (described above), the SV driver did not apply any force to the brake pedal until the end of the test unless the PTM was contacted by the SV.
- The SV throttle was fully released within 500 msec after the SV PAEB warning event was presented (visual, haptic, or audible). If no SV warning event was presented by the SV PAEB system, the SV driver modulated the throttle to maintain constant speed until either the onset of PAEB or, if the SV's PAEB system did not activate, the end of the test occurred (i.e., contact with the PTM occurred).

c. Validity Period

- The valid test interval began when the longitudinal TTC of the SV was 4.0 seconds.
- For scenarios S4a-b, the test ended when either of the following occurred:
  - The SV came into contact with the PTM; or
  - The SV came to a stop before making contact with the PTM.
- For scenario S4c, the test ended when either of the following occurred:
  - The SV came into contact with the PTM; or
  - 1 second after the velocity of the SV became less than or equal to that of the PTM.

d. End-of-Test Instructions

After the test was complete, the SV driver manually applied force to the brake pedal, bringing the vehicle to a stop (if necessary), and placed the transmission in park (automatic transmission) or neutral (manual transmission).

The test trial was then complete.

e. Number of Test Trial Repeats

Combinations of test speeds, and lighting conditions were tested as shown in Table 1. Five repeat trials were conducted for each test condition. As noted above, for all scenarios, the 16 and 40 km/h speeds were considered to be the "non-conditional" speeds. Testing at these speeds was conducted without regard to whether the results showed that "consistent contact" occurred between the SV and PTM. Consistent contact was defined as the SV contacting the PTM in three or more test trials at a given speed. If this occurred, then testing at any higher speeds was not conducted. Rather, the speed would be reduced by 5 km/h and testing of that scenario and lighting treatment would be conducted at that lower speed. This was done to more precisely identify the highest speed at which the vehicle's PAEB system was able to avoid colliding with the PTM.

f. Speed Reduction

The magnitude of the SV speed reduction attributable to PAEB intervention (as shown in Datasheet 1) was calculated in one of two ways, depending on whether a test trial concluded with the SV colliding with the PTM.

- If the SV contacted the PTM during a test trial, the PAEB speed reduction was calculated by subtracting the SV speed at the time of contact (i.e., when the longitudinal range becomes zero) from the average SV speed calculated at TTC = 4.0 seconds.
- If the SV did not contact the PTM during a test trial (i.e., PAEB intervention prevented the crash):
    - Scenario S4a-b: The SV speed at the time of SV and PTM contact was taken to be zero. The speed reduction was therefore equal to the SV speed at TTC = 4.0 seconds.
    - Scenario S4c: The PAEB speed reduction was calculated by subtracting the SV speed at the minimum longitudinal SV-to-PTM range during the validity period from the SV speed at TTC = 4.0 seconds.

g. Pass/Fail Criteria

There were no pass/fail criteria for these research tests.

D. Summary of Scenarios

Figure 11 illustrates the offset conditions used for the different scenarios and Tables 3 through 6 provide summaries of the scenario setups.

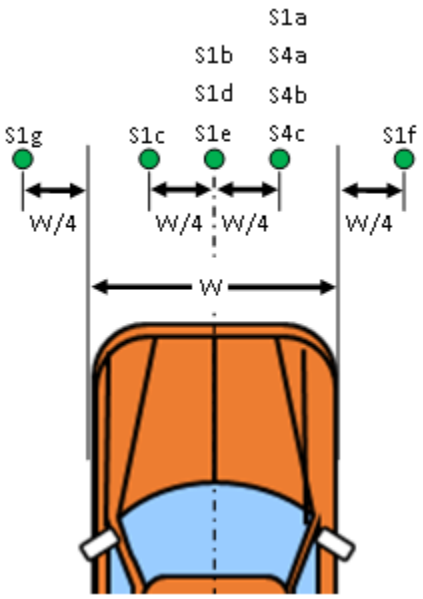


Figure 11. Offset Conditions

Table 3. Summary of S1a-b-c-d-f-g Scenarios Setup

PTM Type	Adult (S1a-b-c-f-g) Child (S1d)		**Drawing illustrates setup but is not to scale**
PTM Location	Nearside		
PTM Action	Crossing SV Path (S1a-b-c-d-g)		
	Not crossing SV Path (S1f)		
PTM Move Distance	6 m (19 ft)		
PTM Start Distance	3.5 m (11.48 ft)		
PTM Acceleration Distance	0.5 m (1.64 ft)		
Overlap *(Determined from the SV width. Measurement transferred to the location on the PTM path. Minus 25% and 125% do not result in SV-PTM contact.)*	S1a	25%	
	S1 b-d	50%	
	S1c	75%	
	S1f	-25%	
	S1g	125%	
SV Start Distance	182 m (600ft)		
Lane Width *(Not standard lane width. Adopted to SV width. Lane width should be centered on SV path.)*	SV Width + 40 cm (16 in)		
Lane Length *(Based on 4.0 TTC and SV speed = 40 km/h (25 mph).)*	44m (145 ft)		
Obstruction *(S1d only)*	PV1D1	1m (3.2 ft)	
	PV2D1		
	PVD1		

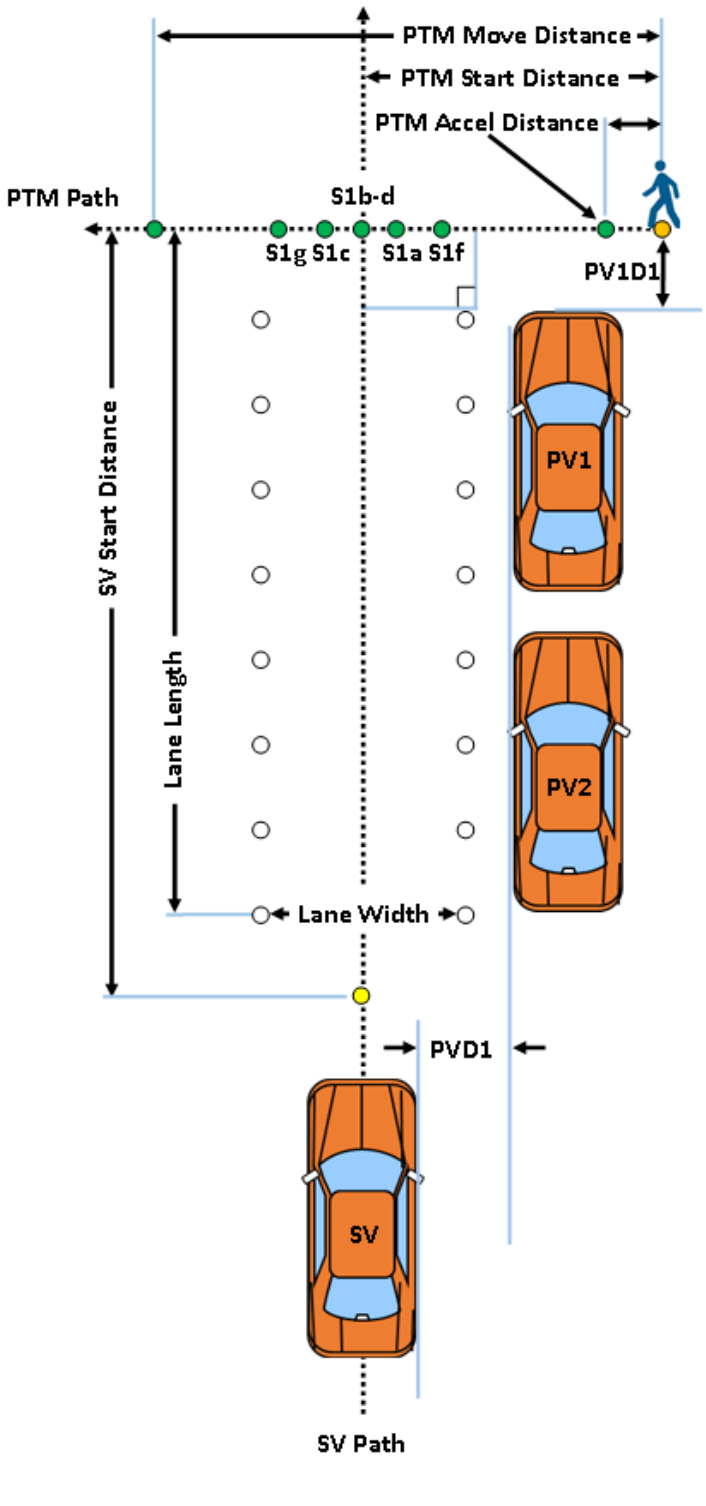


Table 4. Summary of S1e Scenario Setup

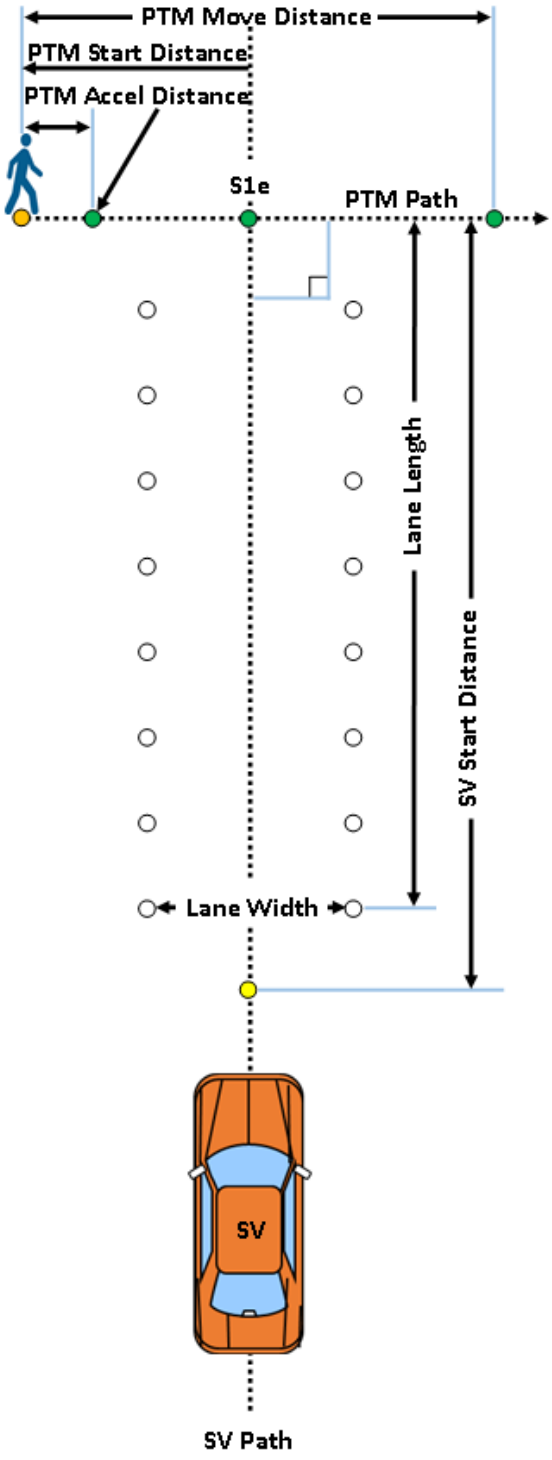
PTM Type	Adult	**Drawing illustrates setup but is not to scale**
PTM Location	Offside	
PTM Action	Crossing SV Path	
PTM Move Distance	9 m (29.5 ft)	
PTM Start Distance	5.5 m (18 ft)	
PTM Acceleration Distance	1.0 m (3.2 ft)	
Overlap *(Determined from the SV width. Measurement transferred to the location on the PTM path.*	50%	
SV Start Distance	182 m (600ft)	
Lane Width *(Not standard lane width. Adapted to SV width. Lane width should be centered on SV path.)*	SV Width + 40 cm (16 in)	
Lane Length *(Based on 4.0 sec TTC and SV speed = 40 km/h (25 mph).)*	44m (145 ft)	

Table 5. Summary of S4a-b Scenarios Setup

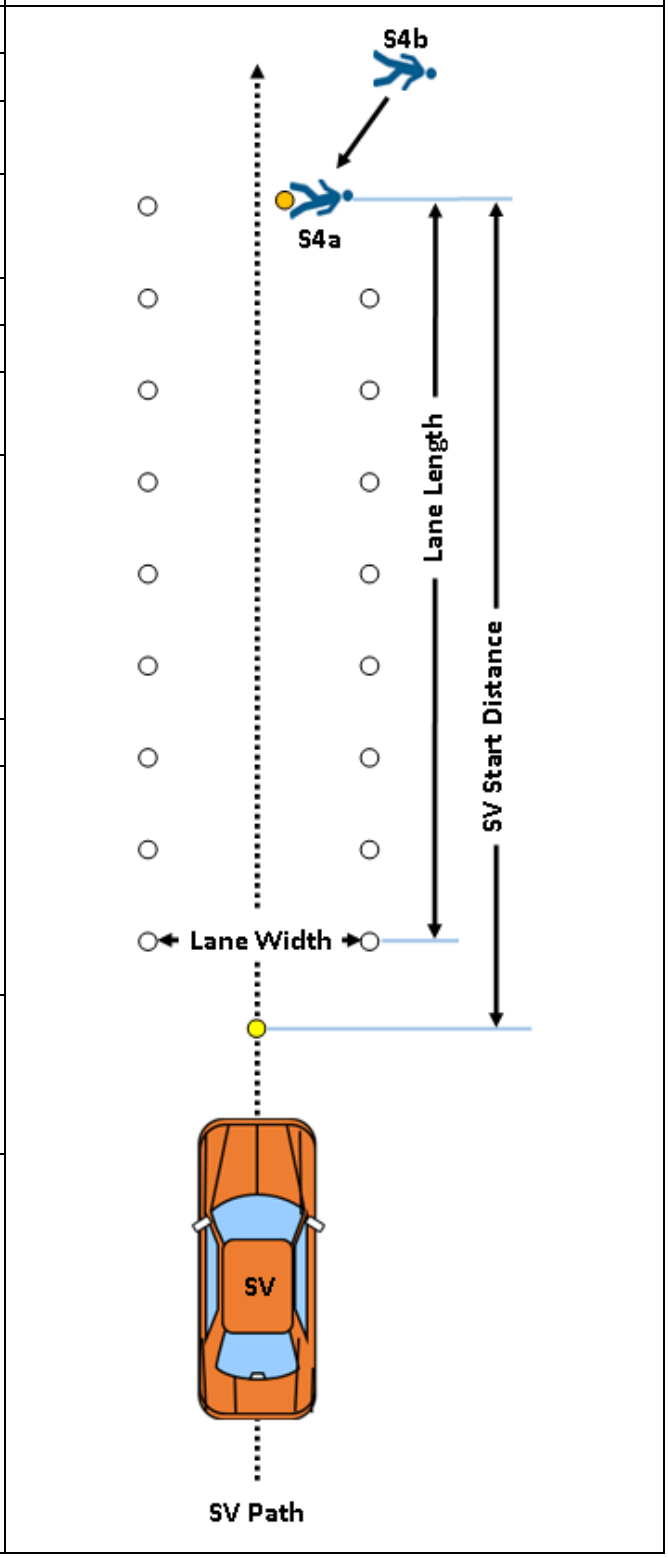
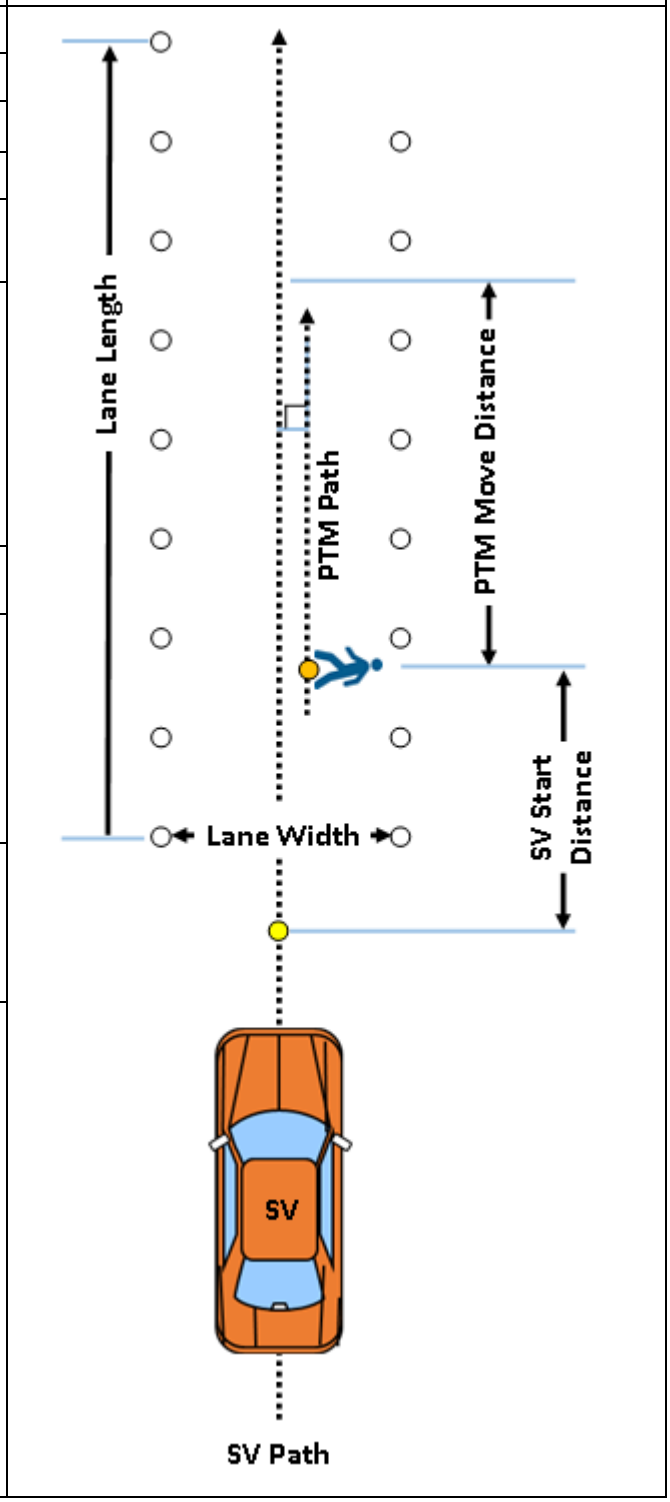
S4a-b Scenario			Drawing illustrates setup but is not to scale
PTM Type	Adult		
PTM Location	Nearside In-Path		
PTM Action	S4a	Stationary Facing Away	
	S4b	Stationary Facing Towards	
PTM Move Distance	NA		
PTM Start Distance	NA		
PTM Acceleration Distance	NA		
Overlap *(Determined from the SV width. Measurement transferred to the location on the PTM path.*	25%		
SV Start Distance	182 m (600ft)		
Lane Width *(Not standard lane width. Adapted to SV width. Lane width should be centered on SV path.)*	SV Width + 40 cm (16 in)		
Lane Length *(Based on 4.0 sec TTC and SV speed = 40 km/h (25 mph).)*	44m (145 ft)		

Table 6. Summary of S4c Scenario Setup

PTM Type	Adult	**Drawing illustrates setup but is not to scale**
PTM Location	Nearside In-Path	
PTM Action	Moving Away	
PTM Move Distance	17 m (55 ft)	
PTM Start Distance	NA	
PTM Acceleration Distance	1m (3.28 ft)	
Overlap *(Determined from the SV width. Measurement transferred to the location on the PTM path.*	25%	
SV Start Distance	182 m (600ft)	
Lane Width *(Not standard lane width. Adapted to SV width. Lane width should be centered on SV path.)*	SV Width + 40 cm (16 in)	
Lane Length *(Based on 4.0 sec TTC and SV speed = 40 km/h (25 mph).)*	44m (145 ft)	

E. Pre-Test Brake Burnishing

To achieve full brake system capability, and to ensure consistent performance, the procedure defined in section 14.1.2 and section 14.1.3 of NHTSA Laboratory Test Procedure for FMVSS No. 135 Light Vehicle Brake Systems (TP-135-01) was used to burnish new SV brake components.

- The SV was loaded to its GVWR.
- From a speed of 49.7 mph (80 km/h), 200 stops were performed with an average deceleration of 0.31g (3.0 m/s²) during each stop.
    - Each stop was performed with the transmission in gear.
    - The Initial Brake Temperature (IBT), defined as the average brake pad or lining friction material temperature on the highest-temperature axle of the SV at the onset of a test trial, was ≤ 100°C (212°F) at the onset of each stop.
    - The interval from the onset of one stop to the onset of the next was either the time necessary to reduce the IBT to ≤ 100°C (212°F), or the distance of 2 km (1.24 miles), whichever occurred first.
    - The vehicle was accelerated to 49.7 mph (80 km/h) after each stop and that speed was maintained until initiating the next.

1. SV BRAKE WARM-UP AND TEMPERATURE MAINTENANCE DURING TESTING

The IBT was between 149°F (65°C) and 212°F (100°C) at the onset of each test.

- If the IBT was less than 149°F (65°C), the brakes were heated to the IBT by making one or more brake applications from a speed of 31.1 mph (50 km/h), at a deceleration rate not greater than 0.31g (3 m/s²).
- If the IBT was greater than 212°F (100°C), the SV was driven at speeds up to 62.1 mph (100 km/h) until the IBT specified was reached

F. Pedestrian Test Mannequin and Motion System

Adult and child Pedestrian Test Mannequins (PTMs) from 4activeSystems were used for these tests. These are articulated mannequins with movable legs and poseable arms. Note that these mannequins are used in EuroNCAP PAEB testing.

The mannequins are strikeable objects with certain characteristics representative of

humans. The adult mannequin represents a 50th percentile adult male, and the child mannequin represents a 7-year-old child. They were designed to be recognized by mono and stereo cameras, as well as by radar and infrared systems.

The motion system used for these tests was the Micro Low Profile Robotic Vehicle (µLPRV) developed by Dynamic Research, Inc. The µLPRV is a small robotic platform that is self-contained, self-propelled, self-guided, and programmable, such that it can follow 2-dimensional trajectories in coordination with the SV. The µLPRV comprises an over-runnable chassis, drive system, steering system, DGPS/IMU sensor, wireless communication system, and control software in order to measure and control the movements of the µLPRV during a test sequence. The pedestrian mannequins are affixed by means of a central clear plastic post. At the base of the clear plastic post, a plastic-covered steel flange is captured by a horseshoe-shaped clamp that attaches to a ferrous plate secured to the upper surface of the µLPRV by magnetic attraction between the ferrous plate on the surface of the µLPRV and the high-power magnets in the horseshoe shaped clamp.

In operation, position and velocity information from the SV are transmitted continuously over a WiFi network to a control computer. The control computer coordinates the motions of the µLPRV and the SV, so that the scenarios can be controlled in a precise and repeatable way.

G. Instrumentation

Table 7 lists the sensors, signal conditioning, and data acquisition equipment used for these tests.

Table 7. Test Instrumentation and Equipment

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Tire Pressure Gauge	Vehicle Tire Pressure	0-100 psi 0-690 kPa	< 1% error between 20 and	Omega DPG8001	17042707002	By: DRI Date: 7/3/2019 Due: 7/3/2020
Platform Scales	Vehicle Total, Wheel, and Axle Load	1500 lb/platform 6672 N/	0.5% of applied load	Intercomp SW I	1110M206352	By: DRI Date: 1/6/2020 Due: 1/6/2021
Linear (string) encoder	Throttle pedal travel	10 in 254 mm	0.1 in 2.54 mm	UniMeasure LX-EP	45040532	By: DRI Date: 5/10/2019 Due: 5/10/2020
SV Multi-Axis Inertial Sensing System	Position; Longitudinal, Lateral, and Vertical Accels; Lateral, Longitudinal and Vertical Velocities; Roll, Pitch, Yaw Rates; Roll, Pitch, Yaw Angles	Latitude: ±90º Longitude: ±180º Altitude: 0-18 km Velocity: 0-1000 knots Accel: ±5g Angular Rate: ±300 º/s Angular Disp: ±180º	Position: ±2 cm Velocity: 0.1 km/h Accel: ≤ 0.05% Angular Rate: ≤ 0.05% Roll/Pitch Angle: ±0.05º Heading Angle: ±0.1º	Oxford xNAV 550	015360	By: Oxford Technical Solutions Date: 1/31/2020 Due: 1/31/2022
PTT Multi-Axis Inertial Sensing System					015477	By: Oxford Technical Solutions Date: 9/12/2018 Due: 9/12/2020

Table 7. Test Instrumentation and Equipment (continued)

Type	Output	Range	Accuracy, Other Primary Specs	Mfr, Model	Serial Number	Calibration Dates Last Due
Coordinate Measurement Machine	Inertial Sensing System Coordinates	0-8 ft 0-2.4 m	±.0020 in. ±.051 mm (Single point articulation accuracy)	Faro Arm, Fusion	UO8-05-08-06636	By: DRI Date: 1/6/2020 Due: 1/6/2021
Microphone	Sound (to measure time at alert)	Frequency Response: 80 Hz – 20 kHz	Signal-to-noise: 64 dB, 1 kHz at 1 Pa	Audio-Technica AT899	NA	NA
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 msec	DRI designed and developed Light Sensor	NA	NA
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	NA	NA
Type	**Description**			**Mfr, Model**		**Serial Number**
Data Acquisition System	Data acquisition is achieved using a dSPACE MicroAutoBox II. Data from the Oxford IMU, including Longitudinal, Lateral, and Vertical Acceleration, Roll, Yaw, and Pitch Rate, Forward and Lateral Velocity, Roll and Pitch Angle are sent over Ethernet to the MicroAutoBox. The Oxford IMUs are calibrated per the manufacturer's recommended schedule (listed above).			dSPACE Micro-Autobox II 1401/1513		
				Base Board		549068
				I/O Board		588523

H. Pre-Test Brake Burnishing

To achieve full brake system capability, and to ensure consistent performance, the procedure defined in section 14.1.2 and section 14.1.3 of NHTSA Laboratory Test Procedure for FMVSS No. 135 Light Vehicle Brake Systems (TP-135-01) was used to burnish new SV brake components.

- The SV was loaded to its GVWR.
- From a speed of 49.7 mph (80 km/h), 200 stops were performed with an average deceleration of 0.31g (3.0 m/s²) during each stop.
    - Each stop was performed with the transmission in gear.
    - The Initial Brake Temperature (IBT), defined as the average brake pad or lining friction material temperature on the highest-temperature axle of the SV at the onset of a test trial, was ≤ 100°C (212°F) at the onset of each stop.
    - The interval from the onset of one stop to the onset of the next was either the time necessary to reduce the IBT to ≤ 100°C (212°F), or the distance of 2 km (1.24 miles), whichever occurred first.
    - The vehicle was accelerated to 49.7 mph (80 km/h) after each stop and that speed was maintained until initiating the next.

2. SV BRAKE WARM-UP AND TEMPERATURE MAINTENANCE DURING TESTING

The IBT was between 149°F (65°C) and 212°F (100°C) at the onset of each test.

- If the IBT was less than 149°F (65°C), the brakes were heated to the IBT by making one or more brake applications from a speed of 31.1 mph (50 km/h), at a deceleration rate not greater than 0.31g (3 m/s²).
- If the IBT was greater than 212°F (100°C), the SV was driven at speeds up to 62.1 mph (100 km/h) until the IBT specified was reached.

APPENDIX A

Photographs

LIST OF FIGURES

		Page
Figure A1.	Front View of Subject Vehicle As-Delivered	A-3
Figure A2.	Rear View of Subject Vehicle As-Delivered	A-4
Figure A3.	Front View of Subject Vehicle As-Tested	A-5
Figure A4.	Rear View of Subject Vehicle As-Tested	A-6
Figure A5.	Window Sticker (Monroney Label)	A-7
Figure A6.	Vehicle Certification Label	A-8
Figure A7.	Tire Placard	A-9
Figure A8.	Adult and Child Pedestrian Surrogates and Motion Platform	A-10
Figure A9.	Child Pedestrian Surrogate and Obstructing Vehicles for Scenario S1d	A-11
Figure A10.	DGPS, Inertial Measurement Unit and MicroAutoBox Installed in Subject Vehicle	A-12
Figure A11.	Sensor for Detecting Auditory Alert	A-13
Figure A12.	Sensor for Detecting Visual Alert	A-14
Figure A13.	Computer Installed in Subject Vehicle	A-15
Figure A14.	PAEB Setup Menus	A-16
Figure A15.	Visual Alert	A-17



Figure A1. Front View of Subject Vehicle As-Delivered



Figure A2. Rear View of Subject Vehicle As-Delivered



Figure A3. Front View of Subject Vehicle As-Tested



Figure A4. Rear View of Subject Vehicle As-Tested

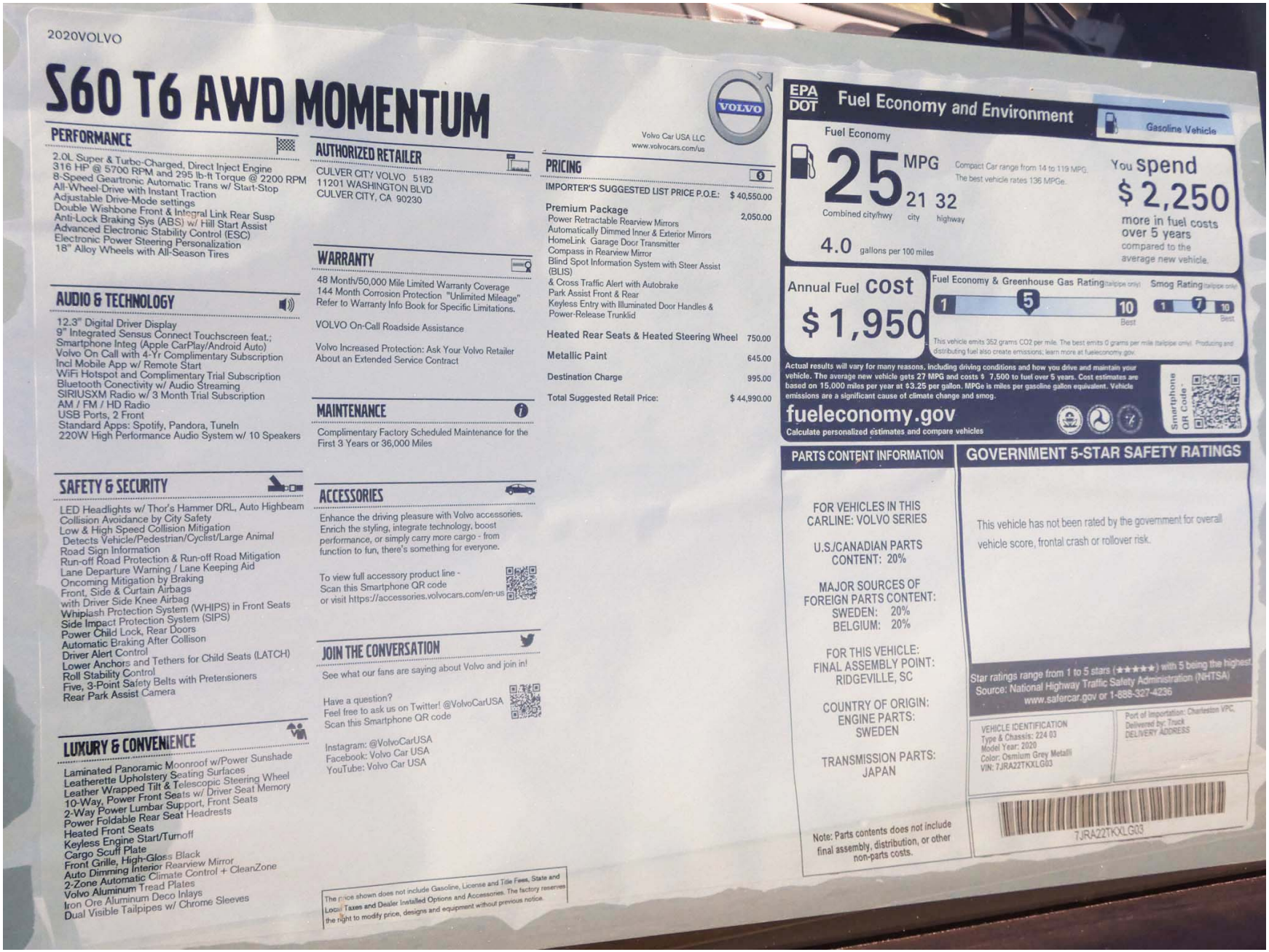


Figure A5. Window Sticker (Monroney Label)



Figure A6. Vehicle Certification Label

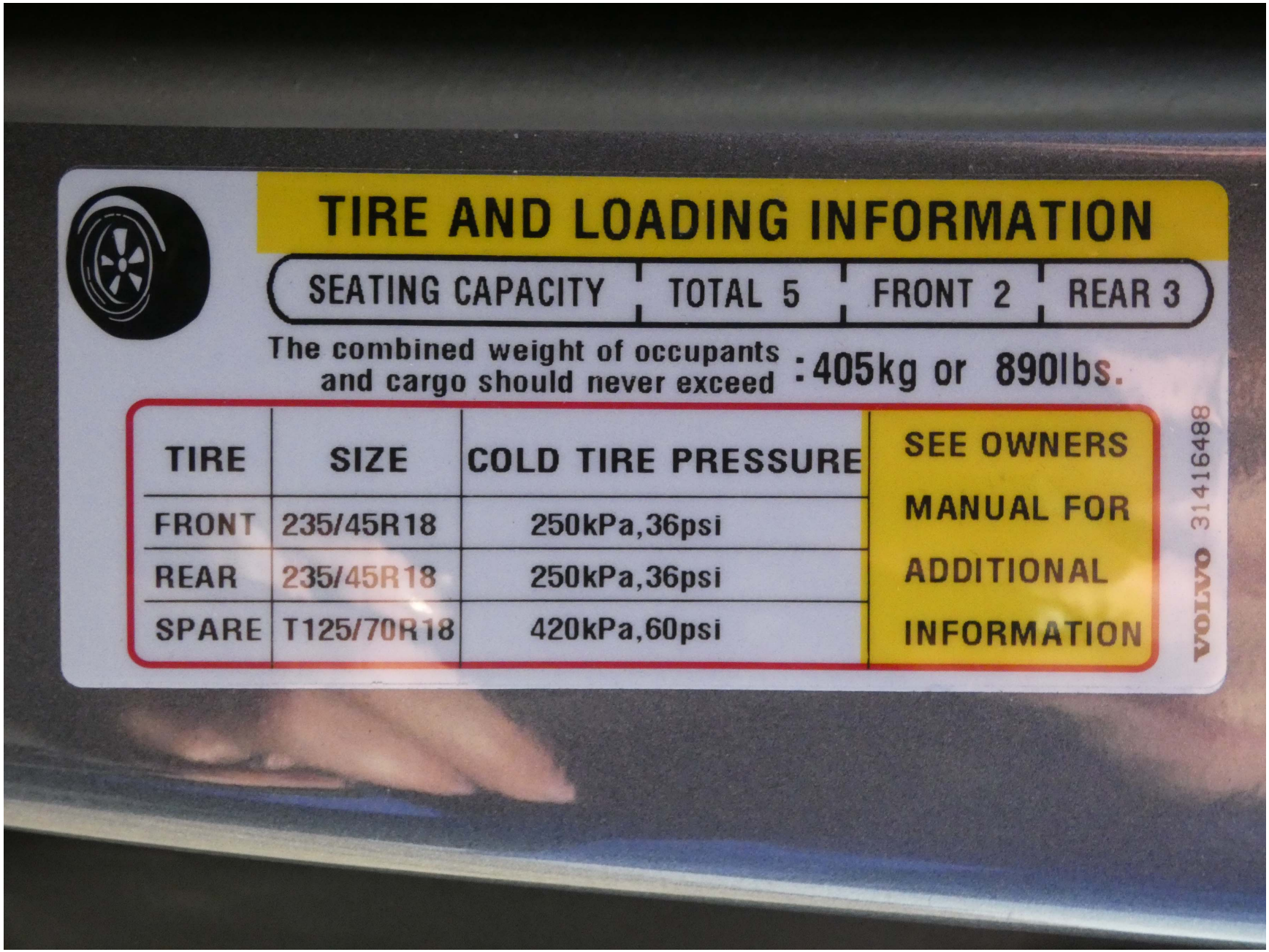


Figure A7. Tire Placard





Figure A8. Adult and Child Pedestrian Surrogates and Motion Platform

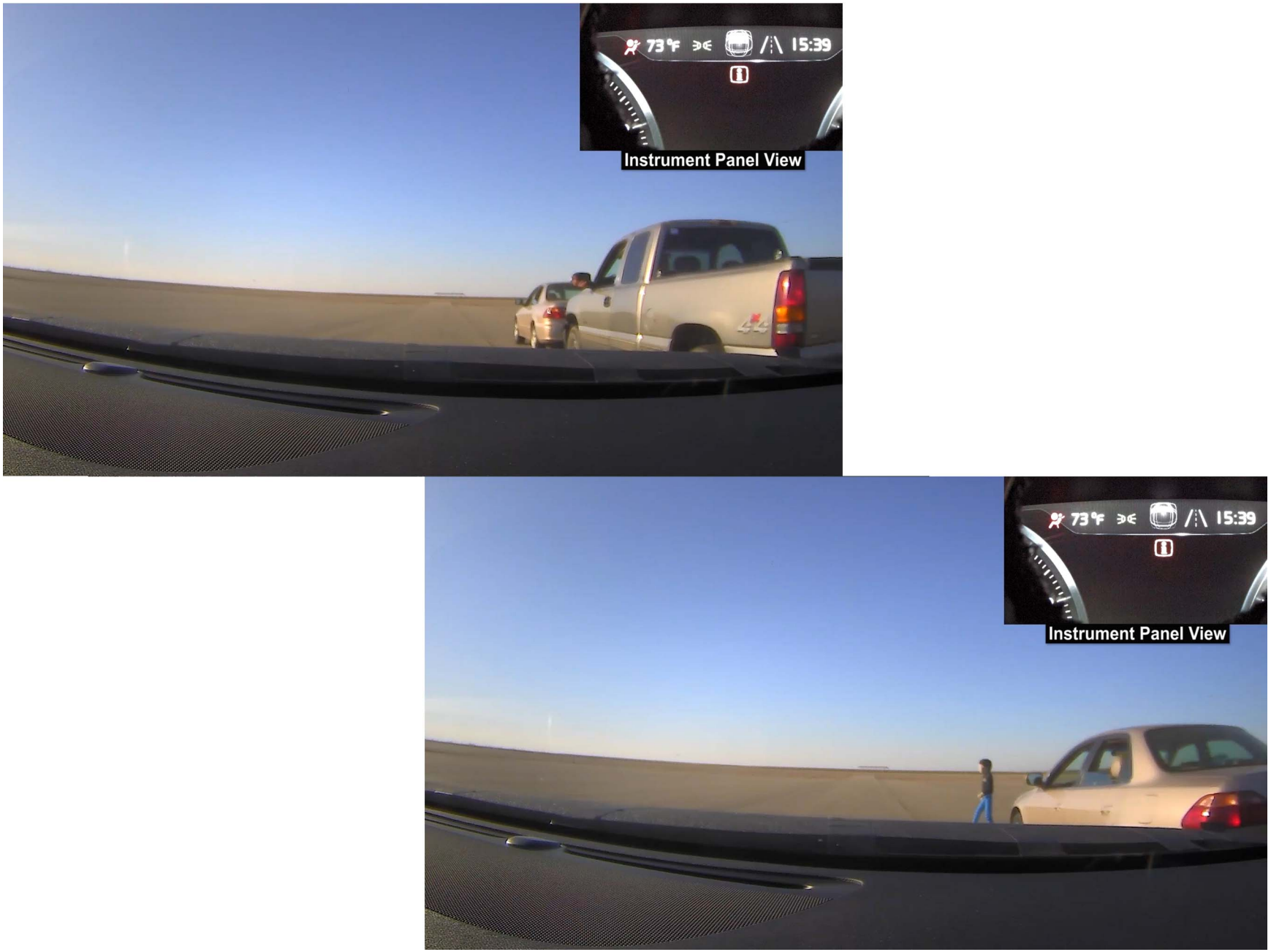


Figure A9. Child Pedestrian Surrogate and Obstructing Vehicles for Scenario S1d



Figure A10. DGPS, Inertial Measurement Unit and MicroAutoBox Installed in Subject Vehicle



Figure A11. Sensor for Detecting Auditory Alert



Figure A12. Sensor for Detecting Visual Alert



Figure A13. Computer Installed in Subject Vehicle

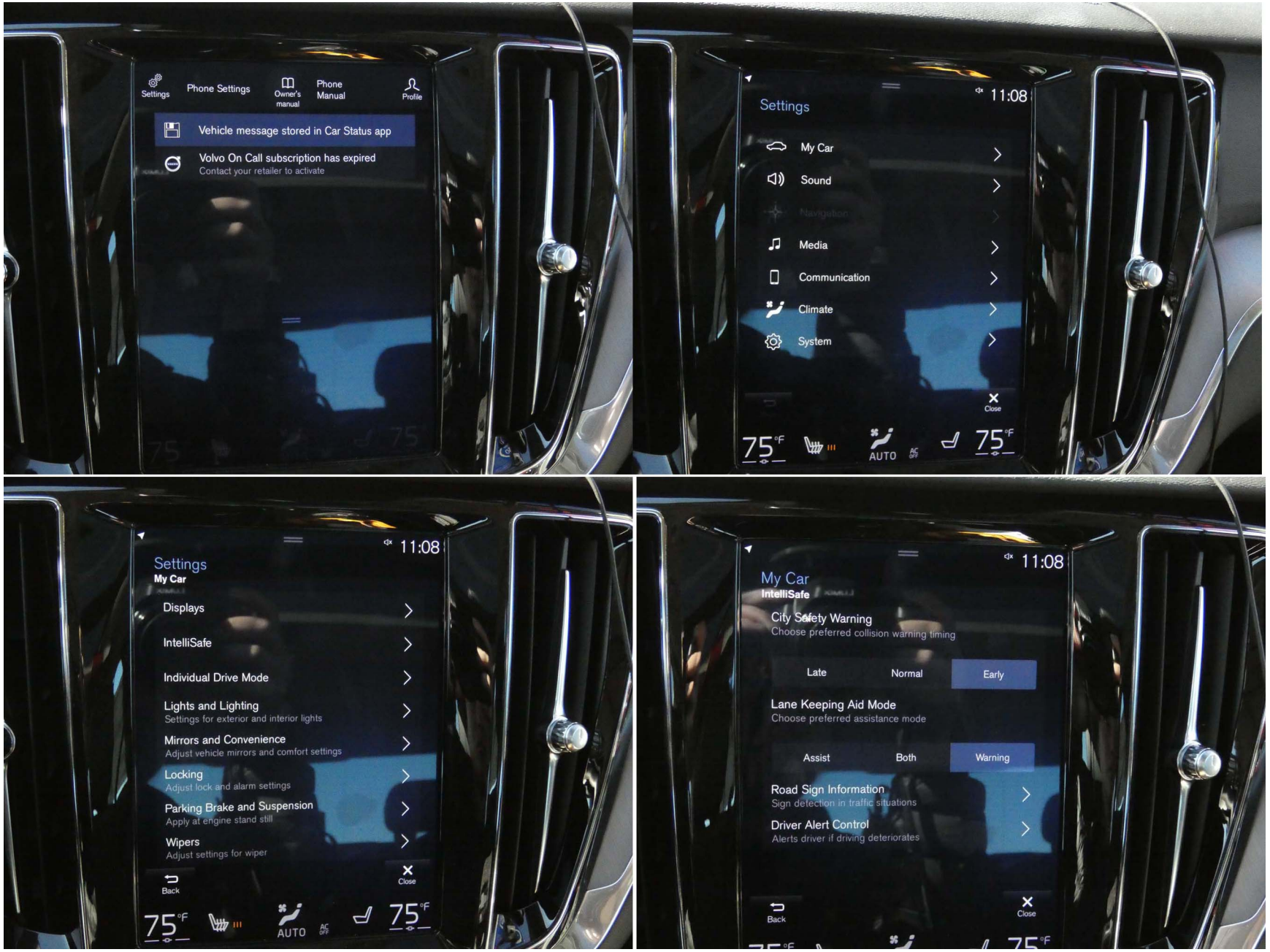


Figure A14. PAEB Setup Menus



Figure A15. Visual Alert

APPENDIX B

Excerpts from Owner’s Manual

Camera/radar sensor limitations

The camera and radar sensor used by several of the driver support functions has certain limitations, which also affect the functions using the camera and radar sensor. The driver should be aware of the following limitations:

Camera and radar

Obstructed camera



The area marked in the illustration must be cleaned regularly and kept free of decals, objects, solar film, etc.

The camera is located on the upper interior section of the windshield along with the radar sensor.

Do not place, affix or mount anything on the inside or outside of the windshield, or in front of or around the camera and radar sensor – this could disrupt camera and radar-based functions. It could cause functions to be reduced, deactivated completely or to produce an incorrect function response.

If this symbol and the message "**Windscreen sensor Sensor blocked, see Owner's manual**" is displayed in the instrument panel, it means that the camera and radar sensor are unable to detect other vehicles, cyclists, pedestrians and large animals in front of the vehicle and that the vehicle's camera and radar-based functions may be obstructed.

The following table shows some of the situations that can cause the message to be displayed, and suggested actions:

Cause	Action
The area of the windshield in front of the camera/radar sensor is dirty or covered by ice or snow.	Clean the windshield in front of the camera/radar sensor and remove dirt, ice and snow.
Thick fog, heavy rain or snow is blocking the radar signals or the camera's range of visibility.	No action. Heavy precipitation may sometimes prevent the camera/radar sensor from functioning.

Cause	Action
Water or snow is spraying/swirling up and blocking the radar signals or the camera's range of visibility.	No action. Very wet or snow-covered roads may sometimes prevent the camera/radar sensor from functioning.
There is dirt between the inside of the windshield and the camera/radar sensor.	Consult a workshop to have the area of the windshield on the inside of the camera's casing cleaned. An authorized Volvo workshop is recommended.
Bright sunlight.	No action. The camera/radar sensor will reset automatically when lighting conditions improve.

High temperatures
If the temperature in the passenger compartment is very high, the camera/radar sensor will switch off temporarily for approx. 15 minutes after the engine is started to protect its electronic components. When the temperature has cooled sufficiently, the camera/radar sensor will automatically restart.

Damaged windshield

NOTE

Failure to take action could result in reduced performance for the driver support systems that use the camera and radar unit. It could cause functions to be reduced, deactivated completely or to produce an incorrect function response.

To avoid the risk of malfunction of the driver support systems that use the radar sensor, the following also apply:

- If there are cracks, scratches or stone chips on the windshield in front of any of the camera and radar sensor "windows" and this covers an area of about 0.5 × 3.0 mm (0.02 × 0.12 in.) or more, contact a workshop to have the windshield replaced[53].
- Volvo advises **against** repairing cracks, scratches or stone chips in the area in front of the camera and radar sensor – the entire windshield should instead be replaced.
- Before replacing the windshield, contact a workshop[53] to verify that the right windshield has been ordered and installed.
- The same type of windshield wipers or wipers approved by Volvo should be used for replacement.
- If the windshield is replaced, the camera and radar sensor must be recalibrated by a workshop[53] to help ensure proper functioning of all of the vehicle's camera and radar-based systems.

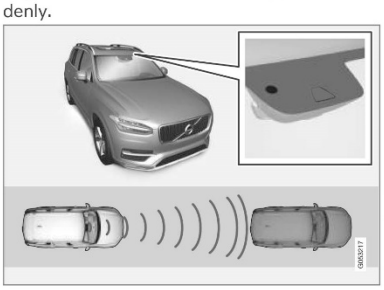
Radar

Vehicle speed
The radar sensor's ability to detect a vehicle ahead is significantly reduced if the speed of the vehicle ahead differs greatly from your vehicle's speed.

[53] An authorized Volvo workshop is recommended.

City Safety™

City Safety[54] can alert the driver with light, sound and pulsations in the brake pedal to help the driver detect pedestrians, cyclists, large animals and vehicles that appear suddenly.



Location of the camera and radar sensor.

City Safety can help prevent a collision or lower the vehicle's speed at the point of impact.

City Safety is an aid intended to assist the driver if a collision with a pedestrian, large animal, cyclist or vehicle is imminent.

City Safety can help the driver avoid a collision when e.g. driving in stop-and-go traffic, when changes in the traffic ahead and driver distraction could lead to an incident.

The function assists the driver by automatically applying the brakes if there is an imminent risk of a collision and the driver does not react in time by braking and/or steering away.

City Safety activates a brief, forceful braking in an attempt to stop your vehicle immediately behind the vehicle or object ahead.

City Safety is activated in situations in which the driver should have applied the brakes much earlier, which means that the system will not be able to assist the driver in all situations.

City Safety is designed to be activated as late as possible to help avoid unnecessary intervention. Automatic braking will only be applied after or during a collision warning.

Normally, the occupants of the vehicle will not be aware of City Safety except when the system intervenes when a collision is imminent.

⚠ WARNING

- The function is supplementary driver support intended to facilitate driving and help make it safer – it cannot handle all situations in all traffic, weather and road conditions.
- The driver is advised to read all sections in the Owner's Manual about this function to learn of its limitations, which the driver must be aware of before using the function.
- Driver support functions are not a substitute for the driver's attention and judgment. The driver is always responsible for ensuring the vehicle is driven in a safe manner, at the appropriate speed, with an appropriate distance to other vehicles, and in accordance with current traffic rules and regulations.

Related information

- Driver support systems (p. 260)
- City Safety sub-functions (p. 307)
- Setting a warning distance for City Safety (p. 309)
- Detecting obstacles with City Safety (p. 310)

[54] This function is not available on all markets.

- City Safety braking for oncoming vehicles (p. 315)
- Automatic braking during delayed evasive maneuvers with City Safety (p. 315)
- City Safety in crossing traffic (p. 312)
- City Safety steering assistance for evasive maneuver (p. 314)
- City Safety limitations (p. 316)
- City Safety messages (p. 319)

City Safety sub-functions

City Safety[55] can help the driver avoid a collision with a vehicle, cyclist or large animal ahead by reducing the vehicle's speed using its automatic braking function.
If the difference in speed is greater than the speeds specified below, the City Safety auto-brake function cannot prevent a collision, but it can help mitigate its effects.

Vehicles
City Safety can help prevent a collision with a vehicle ahead by reducing your vehicle's speed by up to 60 km/h (37 mph).

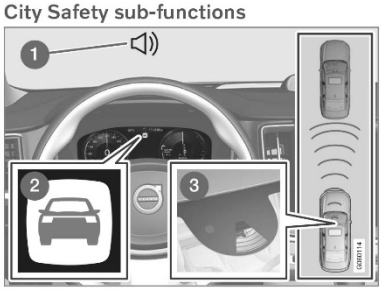
Cyclists
City Safety can help prevent a collision with a cyclist ahead by reducing your vehicle's speed by up to 50 km/h (30 mph).

Pedestrians
City Safety can help prevent a collision with a pedestrian ahead by reducing your vehicle's speed by up to 45 km/h (28 mph).

Large animals
If there is a risk of colliding with a large animal, City Safety can help reduce your vehicle's speed by up to 15 km/h (9 mph).

The braking function for large animals is primarily intended to mitigate the force of a collision at higher speeds. Braking is most effective at speeds above 70 km/h (43 mph) and less effective at lower speeds.

City Safety sub-functions



Function overview.

1. Acoustic collision warning signal
2. Collision warning symbol
3. Camera/radar sensor distance monitoring

City Safety carries out three steps in the following order:

1. Collision warning
2. Brake assistance
3. Auto-brake

Descriptions of what happens in these three steps are provided below.

55 This function is not available on all markets.

1 - Collision warning
The driver is first alerted to the risk of an imminent collision.

In vehicles equipped with a head-up display*, a flashing warning symbol will be displayed on the windshield.



Collision warning symbol on the windshield.

NOTE

Visual warnings on the windshield may be difficult to notice in cases of strong sunlight, reflections, extreme light contrasts, or if the driver is wearing sunglasses or is not looking straight ahead.

City Safety can detect pedestrians, cyclists or vehicles that are stationary, are moving in the same direction as your vehicle and are ahead of your vehicle. City Safety can also detect pedestrians, cyclists or large animals that are crossing the road in front of your vehicle.

If there is a risk of a collision with a pedestrian, large animal, cyclist or another vehicle, the driver will be alerted with light, sound and pulsations in the brake pedal. At lower speeds, during hard braking or if the accelerator pedal is pressed, the brake pedal pulsation warning will not be given. The intensity of the brake pedal pulsations varies according to the vehicle's speed.

2 - Brake assistance
If the risk of a collision increases after the collision warning, brake support will be activated.

If the system determines that the pressure the driver is exerting on the brake pedal is insufficient to prevent the collision, brake support will increase pressure.

3 - Auto-brake
The automatic braking function is activated at the last moment.

If the driver has not taken evasive action by this stage and a collision is imminent, the automatic braking function will be triggered. This occurs whether or not the driver is pressing the brake pedal. Full braking force will be applied to reduce the speed at impact or reduced braking effect will be applied if this is sufficient to avoid the collision.

The seat belt tensioner may be activated when the automatic braking function is triggered.

In certain situations, auto-braking may begin with a limited braking force before applying full braking force.

If City Safety has prevented a collision, the vehicle will be kept at a standstill until the driver takes action. If the vehicle has slowed to avoid colliding with a slower-moving vehicle ahead, your speed will be reduced to that vehicle's speed.

Auto-braking can always be cancelled if the driver presses hard on the accelerator pedal.

NOTE

When City Safety activates the brakes, the brake lights come on.

When City Safety applies the brakes, a text message will appear in the instrument panel to notify the driver that the function is/was activated.

WARNING

City Safety may not be used to change how the driver operates the vehicle. The driver must not only rely on City Safety to brake the vehicle.

* Option/accessory.

Related information

- City Safety™ (p. 306)
- City Safety in crossing traffic (p. 312)
- City Safety braking for oncoming vehicles (p. 315)
- City Safety limitations (p. 316)
- Head-up display* (p. 139)
- Seat belt tensioners (p. 50)

Setting a warning distance for City Safety

City Safety[56] is always active, but the function's warning distance can be adjusted.

NOTE

The City Safety function cannot be deactivated. It is activated automatically each time the engine/electric motor is started.

The alert distance determines the sensitivity of the system and regulates the distance at which the light, sound and brake pulsations will be activated.

To select warning distance:

1. Select **Settings** ➔ **My Car** ➔ **IntelliSafe** in the center display's Top view.
2. Under **City Safety Warning**, tap **Late**, **Normal** or **Early** to set the desired warning distance.

If the driver feels that the **Early** setting is giving too many warnings or finds them irritating, the **Normal** or **Late** warning distance settings can be selected instead.

If the driver feels that the warnings are too frequent and distracting, the warning distance can be reduced. This will reduce the total number of warnings, but it will also result in City Safety providing warnings at a later stage.

The **Late** warning distance setting should therefore only be used in exceptional cases, such as when a more dynamic driving style is preferred.

56 This function is not available on all markets.

▸▸

WARNING

- No automatic system can guarantee 100% correct function in all situations. You should therefore never test use of City Safety in the direction of people, animals or vehicles – this could lead to severe damage, serious personal injury or even death.
- City Safety warns the driver if there is a risk of collision, but the function cannot reduce the driver's reaction time.
- Even if the warning distance has been set to **Early**, warnings may be perceived as late in certain situations – e.g. when there are large speed differences or if the vehicle ahead suddenly brakes heavily.
- With the warning distance set to **Early**, warnings come further in advance. This may cause the warnings to come more frequently than with warning distance **Normal**, but is recommended since it can make City Safety more effective.

NOTE

The warning with direction indicators for Rear Collision Warning* is deactivated if the collision warning distance in the City Safety function is set to the lowest level "**Late**".

The seat belt tensioning and braking functions remain active.

Related information

- City Safety™ (p. 306)
- City Safety limitations (p. 316)
- Rear Collision Warning* (p. 320)

Detecting obstacles with City Safety

City Safety[57] can help the driver detect other vehicles, cyclists, large animals and pedestrians.

Vehicles

City Safety can detect most vehicles that are stationary or are moving in the same direction as your vehicle. In some cases, it can also detect oncoming vehicles and crossing traffic.

For City Safety to be able to detect a vehicle in the dark, its headlights and taillights must be on and clearly visible.

Cyclists



Examples of what City Safety would interpret to be a cyclist: clear body and bicycle shapes.

57 This function is not available on all markets.

* Option/accessory.

For good performance, the system's function for cyclist detection needs the clearest possible information about the contours of the bicycle and of the cyclist's head, arm, shoulders, legs, torso and lower body in combination with normal human movements.

If large portions of the cyclist's body or the bicycle itself are not visible to the function's camera, it will not be able to detect a cyclist.

The system can only detect adult cyclists riding on bicycles intended for adults.

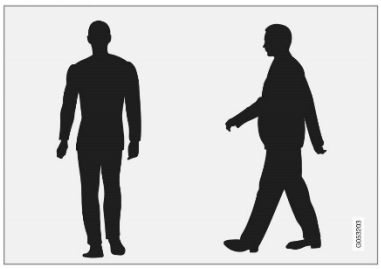
⚠ WARNING

City Safety is supplementary driver support, but it cannot detect all cyclists in all situations and, for example, cannot see:

- partially obscured cyclists.
- cyclists if the background contrast of the cyclist is poor - warning and brake interventions may then be late or not occur at all.
- cyclists in clothing that hides their body contour.
- bikes loaded with large objects.

The driver is always responsible for ensuring that the vehicle is driven correctly and with a safety distance suitable for the speed.

Pedestrians



Examples of what the system considers to be a pedestrian: clear body contours.

For good performance, the system's function for pedestrian detection needs the clearest possible information about the contours of the pedestrian's head, arm, shoulders, legs, torso and lower body in combination with normal human movements.

In order to detect a pedestrian, there must be a contrast to the background, which could depend on clothing, weather conditions, etc. If there is little contrast, the person may be detected late or not at all, which may result in a delayed reaction from the system or no reaction at all.

City Safety can detect pedestrians even in dark conditions if they are illuminated by the vehicle's headlights.

⚠ WARNING

City Safety is supplementary driver support, but it cannot detect all pedestrians in all situations and, for example, cannot see:

- partially obscured pedestrians, people in clothing that hides their body contour or pedestrians shorter than 80 cm (32 in.).
- pedestrians if the background contrast of the pedestrians is poor - warning and brake interventions may then be late or not occur at all.
- pedestrians who are carrying large objects.

The driver is always responsible for ensuring that the vehicle is driven correctly and with a safety distance suitable for the speed.

▸▸

- your lane must have clear side lane markings
- your vehicle must be positioned straight in your lane
- the oncoming vehicle must be positioned within your vehicle's lane markings
- the oncoming vehicle's headlights must be on
- the function can only handle "front-to-front" collisions
- the function can only detect vehicles with four wheels.

WARNING

Warnings and brake interventions due to an imminent collision with an oncoming vehicle always come very late.

Related information

- City Safety™ (p. 306)
- City Safety limitations (p. 316)

City Safety limitations

City Safety[60] functionality may be reduced in certain situations.

Surroundings

Low objects

Hanging objects, such as flags for overhanging loads or accessories such as auxiliary lights or front protective grids that extend beyond the height of the hood, may limit City Safety functionality.

Slippery road conditions

The extended braking distance on slippery roads may reduce City Safety's capacity to help avoid a collision. In these types of situations, the Anti-lock Braking System and Electronic Stability Control (ESC[61]) are designed for optimal braking power with maintained stability.

Backlighting

The visual warning signal in the windshield may be difficult to detect in bright sunlight, if there are reflections, or if the driver is wearing sunglasses or not looking straight ahead.

Heat

If the temperature in the passenger compartment is high due to e.g. bright sunlight, the visual warning signal in the windshield may be temporarily disabled.

Camera and radar sensor's field of vision

The camera's field of vision is limited and in certain situations, it may be unable to detect pedestrians, large animals, cyclists or vehicles, or it may detect them later than expected.

Vehicles that are dirty may be detected later than clean vehicles, and in dark conditions, motorcycles may be detected late or not at all.

If a text message displayed in the instrument panel indicates that the camera/radar sensor is obstructed, it may be difficult for City Safety to detect pedestrians, large animals, cyclists, vehicles or lane markings in front of the vehicle. City Safety functionality may therefore be reduced.

Text messages may not be displayed for all situations in which the windshield sensors are blocked. The driver must therefore always keep the windshield in front of the camera/radar sensor clean.

CAUTION

Only a workshop may perform maintenance on driver support components – an authorized Volvo workshop is recommended.

60 This function is not available on all markets.
61 Electronic Stability Control

Driver intervention

Backing up
City Safety is temporarily deactivated when the vehicle is backing up.

Low speed
City Safety is not activated at very low speeds under 4 km/h (3 mph). The system will therefore not intervene in situations in which your vehicle is approaching another vehicle very slowly, such as when parking.

Active driver
Action by the driver always has priority. City Safety will therefore not react or will react at a later stage with a warning or intervention in situations in which the driver is clearly steering and operating the accelerator pedal, even if a collision is unavoidable.

An active and aware driving style may therefore delay collision warnings and intervention in order to minimize unnecessary warnings.

Other limitations

⚠ WARNING

The driver support system only issues a warning for obstacles detected by its radar sensor – thus, a warning may come after a delay or not at all.

- Never wait for a warning or assistance. Apply the brakes when necessary.

⚠ WARNING

- Warnings and brake interventions can be triggered late or not at all if the traffic situation or external influences prevent the camera and radar unit from properly detecting pedestrians, cyclists, large animals or vehicles ahead of the vehicle.
- To be able to detect vehicles at night, its front and rear lights must work and illuminate clearly.
- The camera and radar unit have a limited range for pedestrians and cyclists – the system can provide effective warnings and brake interventions if the relative speed is lower than 50 km/h (30 mph). For stationary or slow-moving vehicles, warnings and brake interventions are effective at vehicle speeds of up to 70 km/h (43 mph). Speed reduction for large animals is less than 15 km/h (9 mph) and can be achieved at vehicle speeds over 70 km/h (43 mph). At lower speeds, the warning and brake intervention for large animals is less effective.
- Warnings for stationary or slow-moving vehicles and large animals can be disengaged due to darkness or poor visibility.
- Warnings and brake interventions for pedestrians and cyclists are disengaged at vehicle speeds over 80 km/h (50 mph).
- Do not place, affix or mount anything on the inside or outside of the windshield, or in front of or around the camera and radar unit – this could disrupt camera-based functions.
- Objects, snow, ice or dirt in the area of the camera sensor can reduce the function, disengage it completely or give an improper function response.

▸▸

WARNING

- The City Safety auto-brake function can prevent a collision or reduce collision speed, but to ensure full brake performance the driver should always depress the brake pedal – even when the car auto-brakes.
- The warning and steering assistance are only activated if there is a high risk of collision – you must therefore never wait for the collision warning or City Safety to intervene.
- Warnings and brake interventions for pedestrians and cyclists are disengaged at vehicle speeds over 80 km/h (50 mph).
- City Safety does not activate auto-braking intervention during heavy acceleration.

NOTE

The function uses the vehicle's camera and radar sensor, which has certain general limitations.

Market limitations

City Safety is not available in all countries. If City Safety is not shown in the center display's **Settings** menu, your vehicle is not equipped with this function.

In the center display's Top view, tap:

- **Settings ➔ My Car ➔ IntelliSafe**

Related information

- City Safety™ (p. 306)
- Camera/radar sensor limitations (p. 301)

APPENDIX C

Run Log

Run Log for Daytime Tests

Subject Vehicle: *2020 Volvo S60 T6 AWD Momentum* Test Date: *2/7/2020*

Adult Pedestrian Test Mannequin: *Articulated 4A Adult* Test Driver: *S. Rhim*

Child Pedestrian Test Mannequin: *Articulated 4A Child*

Forward Obstructing Vehicle: *1999 Honda Accord*

Rear Obstructing Vehicle: *2012 Toyota Highlander*

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
1	S1a	0	Day	Static							
2	S1a	16	Day	Y	1.42	0.87	16.0	1.07	0.49	NC	
3	S1a	16	Day	Y	1.34	1.82	16.0	1.14	0.73	NC	
4	S1a	16	Day	Y	1.44	1.98	15.5	1.13	0.76	NC	
5	S1a	16	Day	Y	1.48	1.86	15.8	1.11	0.75	NC	
6	S1a	16	Day	Y	1.43	1.93	16.0	1.09	0.78	NC	
7	S1a	0	Day	Static							
8	S1a	40	Day	N							PTM lateral
9	S1a	40	Day	N							PTM lateral
10	S1a	40	Day	Y	1.46	0.84	39.8	1.12	1.14	NC	
11	S1a	40	Day	Y	1.35	1.09	40.3	1.06	0.96	NC	
12	S1a	40	Day	N							PTM lateral
13	S1a	40	Day	Y	1.41	1.35	39.8	1.04	1.02	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
14	S1a	40	Day	N							PTM lateral
15	S1a	40	Day	Y	1.31	1.50	40.2	1.05	0.92	NC	
16	S1a	40	Day	Y	1.39	1.05	40.0	1.08	1.22	NC	
17	S1b	0	Day	Static							
18	S1b	16	Day	Y	1.74	2.07	16.0	1.05	0.80	NC	
19	S1b	16	Day	N							PTM lateral
20	S1b	16	Day	N							PTM lateral
21	S1b	16	Day	Y	1.66	1.97	15.9	1.03	0.77	NC	
22	S1b	16	Day	Y	1.74	1.85	15.8	1.04	0.75	NC	
23	S1b	16	Day	N							PTM lateral
24	S1b	16	Day	N							PTM lateral
25	S1b	16	Day	N							PTM lateral
26	S1b	16	Day	N							PTM lateral
27	S1b	16	Day	Y	1.59	1.88	15.8	1.08	0.76	NC	
28	S1b	16	Day	N							PTM lateral
29	S1b	16	Day	Y	1.53	1.97	15.7	1.03	0.76	NC	
30	S1b	0	Day	Static							
157	S1b	0	Day	Static							
158	S1b	20	Day	Y	1.62	2.16	20.5	1.05	0.83	NC	
159	S1b	20	Day	Y	1.75	1.98	19.6	0.95	0.80	NC	
160	S1b	20	Day	N							PTM lateral

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
161	S1b	20	Day	Y	1.67	2.03	20.1	0.98	0.83	NC	
162	S1b	20	Day	N							PTM lateral
163	S1b	20	Day	Y	1.72	1.94	20.0	0.97	0.81	NC	
164	S1b	20	Day	Y	1.58	2.30	20.2	1.07	0.80	NC	
165	S1b	0	Day	Static							
166	S1b	30	Day	Y	1.73	0.00	2.9	0.45	0.09	Contact	
167	S1b	30	Day	Y	1.61	0.00	5.1	0.85	0.17	Contact	
168	S1b	30	Day	Y	1.51	1.88	29.9	1.02	0.90	NC	
169	S1b	30	Day	Y	1.53	2.62	29.9	1.05	0.97	NC	
170	S1b	30	Day	Y	1.50	1.23	29.9	1.07	1.03	NC	
171	S1b	0	Day	Static							
31	S1b	40	Day	N							SV speed
32	S1b	40	Day	Y	1.77	0.97	36.4	1.01	0.99	NC	
33	S1b	40	Day	N							SV lateral
34	S1b	40	Day	Y	1.73	0.00	1.5	0.03		Contact	No intervention
35	S1b	40	Day	Y	1.60	1.04	36.6	1.14	1.25	NC	
36	S1b	0	Day	Static							Brake applied
37	S1b	40	Day	Y	1.53	0.93	36.6	1.10	1.20	NC	
38	S1b	40	Day	Y	1.64	0.00	1.4	0.02		Contact	No intervention
172	S1b	50	Day	Y	1.51	0.73	46.7	1.12	1.12	NC	
173	S1b	50	Day	Y	1.66	0.95	41.6	1.05	1.18	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
174	S1b	50	Day	N							PTM lateral
175	S1b	50	Day	Y	1.53	0.82	46.2	1.09	1.00	NC	
176	S1b	50	Day	Y	1.85	1.51	38.1	1.13	1.05	NC	
177	S1b	50	Day	Y	1.49	1.27	44.5	1.07	1.11	NC	
178	S1b	0	Day	Static							
179	S1b	60	Day	Y	1.54	0.91	48.7	1.08	1.18	NC	
180	S1b	60	Day	Y	1.57	0.73	51.6	1.04	1.24	NC	
181	S1b	60	Day	Y	1.36	0.00	1.2	0.03		Contact	
182	S1b	60	Day	Y	1.41	0.98	61.1	1.09	0.96	NC	
183	S1b	60	Day	Y	0.93	0.00	36.9	1.08	0.87	Contact	
39	S1c	0	Day	Static							
40	S1c	16	Day	Y	1.87	1.96	16.0	1.09	0.77	NC	
41	S1c	16	Day	Y	1.92	1.94	16.2	1.06	0.76	NC	
42	S1c	16	Day	Y	1.93	1.96	16.4	1.08	0.76	NC	
43	S1c	16	Day	Y	1.90	1.92	16.2	1.03	0.77	NC	
44	S1c	16	Day	Y	1.82	1.99	15.8	1.07	0.79	NC	
45	S1c	0	Day	Static							
46	S1c	40	Day	Y	1.74	1.41	31.1	1.08	0.94	NC	
47	S1c	40	Day	Y	1.74	0.00	1.4	0.03		Contact	No intervention
48	S1c	40	Day	Y	1.88	0.00	1.6	0.02		Contact	No intervention

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
49	S1c	40	Day	Y	1.59	0.00	1.7	0.02		Contact	No intervention
50	S1c	0	Day	Static							
51	S1c	40	Day	N							Channels reversed
52	S1c	40	Day	N							PTM lateral error
53	S1c	40	Day	Y	1.93	0.66	37.6	1.20	1.00	NC	
54	S1c	40	Day	Y	1.84	1.15	40.5	1.17	1.09	NC	
55	S1c	40	Day	Y	2.04	1.34	38.5	1.14	1.12	NC	
56	S1c	40	Day	Y	2.09	1.07	39.3	1.17	1.08	NC	
57	S1c	40	Day	Y	2.06	0.76	36.2	1.19	1.00	NC	
116	S1d	0	Day	Static							
117	S1d	16	Day	Y	0.80	1.76	15.9	1.06	0.69	NC	
118	S1d	16	Day	Y	0.80	1.74	16.1	1.06	0.69	NC	
119	S1d	16	Day	Y	0.74	1.62	16.2	0.99	0.65	NC	
120	S1d	16	Day	Y	1.00	2.36	16.0	1.04	0.86	NC	
121	S1d	16	Day	Y	0.89	2.10	16.0	1.00	0.78	NC	
122	S1d	0	Day	Static							
123	S1d	20	Day	N							PTM lateral
124	S1d	20	Day	Y	0.84	2.30	20.1	1.09	0.78	NC	
125	S1d	20	Day	Y	0.89	2.18	20.1	1.07	0.77	NC	
126	S1d	20	Day	Y	0.77	2.03	20.1	1.06	0.74	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
127	S1d	20	Day	Y	0.98	2.32	19.9	1.05	0.81	NC	
128	S1d	20	Day	Y	0.77	1.59	19.9	1.05	0.66	NC	
129	S1d	0	Day	Static							
130	S1d	30	Day	Y	0.76	1.90	30.1	1.09	0.73	NC	
131	S1d	30	Day	Y	0.72	0.46	29.6	1.21	0.56	NC	
132	S1d	30	Day	Y	0.80	2.08	30.4	1.10	0.75	NC	
133	S1d	30	Day	Y	0.81	2.39	30.1	1.06	0.80	NC	
134	S1d	30	Day	Y	0.89	2.15	30.8	1.08	0.84	NC	
135	S1d	0	Day	Static							
136	S1d	40	Day	N							Can’t process run
137	S1d	40	Day	Y	0.81	0.00	23.9	1.15	0.75	Contact	
138	S1d	40	Day	Y	0.84	1.82	40.3	1.12	0.83	NC	
139	S1d	40	Day	Y	0.78	1.17	40.0	1.07	0.75	NC	
140	S1d	40	Day	N							PTM lateral
141	S1d	40	Day	Y	0.76	0.98	39.9	1.10	0.72	NC	
142	S1d	40	Day	Y	0.83	1.15	38.4	1.10	0.79	NC	
143	S1d	0	Day	Static							
144	S1d	40	Day	N							PTM lateral
151	S1d	45	Day	Y	0.77	0.61	44.9	1.10	0.77	NC	
152	S1d	45	Day	Y	0.80	0.15	44.7	1.05	0.72	NC	
153	S1d	45	Day	Y	0.79	0.92	44.7	1.13	0.77	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
154	S1d	45	Day	Y	0.76	0.00	40.1	1.15	0.71	Contact	
155	S1d	45	Day	Y	0.80	0.53	44.9	1.10	0.77	NC	
156	S1d	0	Day	Static							
145	S1d	50	Day	Y	0.85	0.67	45.7	1.16	0.83	NC	
146	S1d	50	Day	Y	0.67	0.00	19.1	1.18	0.61	Contact	
147	S1d	50	Day	Y	0.75	0.00	37.1	1.10	0.75	Contact	
148	S1d	50	Day	Y	0.82	0.23	49.9	1.16	0.80	NC	
149	S1d	50	Day	Y	0.67	0.00	26.5	1.09	0.63	Contact	
150	S1d	0	Day	Static							
71	S1e	0	Day	Static							
72	S1e	40	Day	N							PTM lateral error
73	S1e	40	Day	Y	1.19	1.45	32.1	1.12	0.88	NC	
74	S1e	40	Day	Y	1.34	1.63	30.6	1.11	0.99	NC	
75	S1e	40	Day	Y	1.35	2.34	32.7	1.03	1.07	NC	
76	S1e	40	Day	Y	1.23	2.77	33.1	1.01	1.17	NC	
77	S1e	40	Day	Y	1.33	1.59	30.9	1.10	0.98	NC	
202	S1e	0	Day	Static							
203	S1e	50	Day	N							PTM lateral
204	S1e	50	Day	Y	1.35	1.64	35.4	1.05	1.01	NC	
205	S1e	50	Day	Y	1.39	1.55	39.5	1.10	1.24	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
206	S1e	50	Day	N							PTM lateral
207	S1e	50	Day	N							PTM lateral
208	S1e	50	Day	N							PTM lateral
209	S1e	50	Day	N							PTM lateral
210	S1e	50	Day	N							PTM lateral
211	S1e	50	Day	Y	1.39	1.67	33.5	1.10	1.08	NC	
212	S1e	50	Day	N							PTM lateral
213	S1e	50	Day	N							PTM lateral
214	S1e	50	Day	Y	1.25	1.98	34.8	1.06	1.16	NC	
216	S1e	0	Day	Static							
223	S1e	50	Day	Y	1.27	1.17	37.4	1.06	0.91	NC	
224	S1e	50	Day	Y	1.30	2.53	35.8	1.00	1.20	NC	
225	S1e	50	Day	Y	1.27	1.65	37.1	1.06	0.96	NC	
217	S1e	60	Day	Y	1.32	1.44	50.2	1.07	1.24	NC	
218	S1e	60	Day	Y	1.18	1.18	45.4	1.05	1.03	NC	
219	S1e	60	Day	Y	1.22	1.53	38.2	1.10	1.12	NC	
220	S1e	60	Day	Y	1.20	1.29	40.2	1.01	1.12	NC	
221	S1e	60	Day	Y	1.28	1.56	39.8	1.11	1.12	NC	
222	S1e	0	Day	Static							
78	S1e	0	Day	Static							
58	S1f	0	Day	Static							

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
59	S1f	40	Day	Y	1.60	0.00	13.0	0.41	1.26	NC	
60	S1f	40	Day	Y	1.69	0.00	9.5	0.47	1.22	NC	
61	S1f	40	Day	Y	1.44	0.00	16.7	0.88	1.17	NC	
62	S1f	40	Day	Y	1.70	0.00	22.2	0.97	1.14	NC	
63	S1f	40	Day	Y	1.62	0.00	24.4	1.07	1.05	NC	
64	S1g	0	Day	Static							
65	S1g	40	Day	Y		0.00	0.2	0.05			No warning, No intervention
66	S1g	40	Day	Y		0.00	-0.2	0.05			No warning, No intervention
67	S1g	40	Day	Y		0.00	0.1	0.04			No warning, No intervention
68	S1g	40	Day	Y		0.00	-0.1	0.05			No warning
69	S1g	40	Day	N							SV Speed
70	S1g	0	Day	Static							
94	S4a	0	Day	Static							
95	S4a	16	Day	Y	1.81	1.16	16.1	1.12	0.57	NC	
96	S4a	16	Day	Y	1.80	1.19	16.5	1.12	0.58	NC	
97	S4a	16	Day	Y	1.83	1.17	16.2	1.06	0.57	NC	
98	S4a	16	Day	Y	1.82	1.10	15.9	1.10	0.55	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
99	S4a	16	Day	Y	1.78	1.07	16.3	1.09	0.53	NC	
100	S4a	0	Day	Static							
101	S4a	40	Day	Y	2.32	0.00	2.4	0.09		Contact	
102	S4a	40	Day	Y	1.73	0.00	1.8	0.08		Contact	
103	S4a	40	Day	Y	2.07	0.00	1.9	0.03		Contact	
79	S4b	0	Day	Static							
80	S4b	16	Day	Y	1.80	1.34	15.8	1.11	0.62	NC	
81	S4b	16	Day	N							No audio
82	S4b	16	Day	N							No audio
83	S4b	0	Day	Static							
84	S4b	16	Day	N							No audio
85	S4b	16	Day	Y	1.84	1.29	16.1	1.06	0.59	NC	
86	S4b	16	Day	Y	1.84	1.29	15.8	1.12	0.60	NC	
87	S4b	16	Day	Y	1.87	1.39	16.1	1.09	0.63	NC	
88	S4b	16	Day	Y	1.85	1.32	16.3	1.07	0.61	NC	
89	S4b	0	Day	Static							
90	S4b	40	Day	Y	2.29	0.00	2.8	0.05		Contact	
91	S4b	40	Day	Y	2.23	0.00	2.2	0.03		Contact	
92	S4b	40	Day	Y	2.37	0.89	39.8	1.09	1.09	NC	
93	S4b	40	Day	Y	2.29	0.00	2.8	0.03		Contact	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact (NC)	Notes
104	S4c	0	Day	Static							
109	S4c	0	Day	Static							
110	S4c	16	Day	Y	1.67	0.31	16.2	1.05	0.33	NC	
111	S4c	16	Day	Y	1.02	0.00	0.9	0.02		Contact	
112	S4c	16	Day	Y	1.86	1.22	16.2	1.12	0.64	NC	
113	S4c	16	Day	Y	1.72	1.38	16.7	1.02	0.70	NC	
114	S4c	16	Day	Y	1.51	1.26	16.4	1.05	0.66	NC	
105	S4c	40	Day	Y	1.82	0.00	7.3	0.96	0.21	Contact	
106	S4c	40	Day	Y	2.04	0.00	3.2	0.41	0.09	Contact	
107	S4c	40	Day	Y	1.67	0.00	4.7	0.70	0.14	Contact	
108	S4c	0	Day	Static							
115	S4c	0	Day	Static							

Run Log for Nighttime Tests

Subject Vehicle: *2020 Volvo S60 T6 AWD Momentum*

Test Date: *2/4/2020*

Adult Pedestrian Test Mannequin: *Articulated 4A Adult*

Test Driver: *J. Robel*

Child Pedestrian Test Mannequin: *Articulated 4A Child*

Forward Obstructing Vehicle: *1999 Honda Accord*

Rear Obstructing Vehicle: *2012 Toyota Highlander*

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
14	S1b	11	NHB	Y	0.93	0.12	10.9	1.18	0.27	NC	
15	S1b	11	NHB	Y	0.82	0.12	7.7	0.88	0.45	NC	
16	S1b	11	NHB	Y	1.05	0.00	2.0	0.18	0.75	Contact	
17	S1b	11	NHB	Y	0.76	0.00	0.2	0.01		Contact	
18	S1b	11	NHB	Y	0.88	0.00	0.6	0.03		Contact	
19	S1b	0	NHB	Static							
20	S1b	0	NHB	Static							
1	S1b	0	NHB	Static							
2	S1b	16	NHB	N							Brakes applied
3	S1b	16	NHB	N							Lateral error
4	S1b	16	NHB	Y	0.83	0.00	8.4	0.35	0.73	Contact	
5	S1b	16	NHB	Y	1.05	0.00	5.9	0.91	0.17	Contact	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
23	S1b	16	NHB	Y	0.84	0.00	0.7	0.06		Contact	No intervention
67	S1b	20	NHB	Y	1.35	1.96	19.8	0.82	0.86	NC	
68	S1b	20	NHB	N							PTM lateral
69	S1b	20	NHB	Y	1.58	0.00	13.8	1.10	0.56	NC	No contact due to bumper shape
70	S1b	20	NHB	Y	1.64	0.00	11.2	0.65	0.81	Contact	
71	S1b	20	NHB	N							PTM lateral
72	S1b	20	NHB	Y	1.67	0.81	19.9	1.20	0.84	NC	
73	S1b	20	NHB	Y	1.63	0.00	16.3	0.74	0.72	NC	No contact due to bumper shape
74	S1b	0	NHB	Static							
61	S1b	30	NHB	Y	1.28	1.67	29.8	1.04	0.88	NC	
62	S1b	30	NHB	Y	1.19	1.71	29.8	1.07	0.83	NC	
63	S1b	30	NHB	Y	1.41	1.50	30.1	1.20	0.66	NC	
64	S1b	30	NHB	Y	1.60	1.77	29.8	1.18	0.68	NC	
65	S1b	30	NHB	Y	1.71	1.78	29.2	1.15	0.70	NC	
66	S1b	0	NHB	Static							
26	S1b	40	NHB	Y	1.24	0.98	36.0	1.18	0.88	NC	
27	S1b	0	NHB	Static							
28	S1b	40	NHB	Y	1.66	1.15	36.0	1.19	0.90	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
29	S1b	40	NHB	Y	1.54	0.81	36.1	1.19	1.03	NC	
30	S1b	40	NHB	Y	1.55	1.04	36.0	1.19	1.09	NC	
31	S1b	0	NHB	Static							PTM lateral error
32	S1b	40	NHB	Y	1.71	1.04	35.2	1.21	0.94	NC	
43	S1b	50	NHB	N							Can't process run
44	S1b	50	NHB	Y	1.53	0.73	42.5	1.19	1.04	NC	
45	S1b	50	NHB	N							Can't process run
46	S1b	50	NHB	Y	1.58	1.07	49.8	1.22	1.10	NC	
47	S1b	50	NHB	N							Can't process run
48	S1b	50	NHB	Y	1.51	1.00	42.0	1.17	1.17	NC	
49	S1b	50	NHB	N							Throttle
50	S1b	50	NHB	Y	1.47	0.86	43.4	1.16	1.08	NC	
51	S1b	0	NHB	Static							
52	S1b	60	NHB	N							PTM lateral
53	S1b	60	NHB	N							SV yaw rate
54	S1b	60	NHB	Y	1.31	0.66	59.8	1.19	0.99	NC	
55	S1b	60	NHB	Y	1.38	0.90	60.0	1.18	1.04	NC	
56	S1b	60	NHB	Y	1.11	0.92	60.7	1.18	0.95	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
57	S1b	60	NHB	Y	1.29	0.00	44.4	1.17	0.97	Contact	
58	S1b	0	NHB	Static							
59	S1b	60	NHB	Y	1.44	0.01	47.1	1.15	1.11	NC	
60	S1b	0	NHB	Static							
184	S1d	11	NHB	N							PTM lateral
185	S1d	11	NHB	Y	0.77	0.64	11.0	1.23	0.43	NC	
186	S1d	11	NHB	Y		0.00	0.0	0.04		Contact	No warning, No intervention
187	S1d	11	NHB	Y		0.00	0.5	0.03		Contact	No warning, No intervention
188	S1d	11	NHB	Y		0.00	0.2	0.04		Contact	No warning, No intervention
189	S1d	0	NHB	Static							
180	S1d	16	NHB	Y		0.00	0.3	0.02		Contact	No warning, No intervention
181	S1d	16	NHB	Y		0.00	0.0	0.04		Contact	No warning, No intervention
182	S1d	16	NHB	Y	0.24	0.00	6.7	0.72	0.24	Contact	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
183	S1d	0	NHB	Static							
179	S1d	0	NHB	Static							
195	S1d	35	NHB	Y	0.56	0.00	21.2	1.11	0.47	Contact	
196	S1d	35	NHB	Y	0.63	0.00	26.0	1.12	0.53	Contact	
197	S1d	35	NHB	Y	0.33	0.00	1.2	0.05		Contact	No intervention
198	S1d	0	NHB	Static							
190	S1d	40	NHB	N							External lighting
191	S1d	40	NHB	Y	0.49	0.00	15.7	1.11	0.41	Contact	
192	S1d	40	NHB	Y	0.43	0.00	8.0	1.09	0.26	Contact	
193	S1d	40	NHB	Y	0.49	0.00	13.0	1.17	0.36	Contact	
194	S1d	0	NHB	Static							
176	S1e	35	NHB	Y	1.20	0.74	35.0	1.12	0.63	NC	
177	S1e	35	NHB	Y	1.25	0.79	35.1	1.12	0.68	NC	
178	S1e	35	NHB	Y	1.27	1.43	28.2	1.01	0.93	NC	
171	S1e	40	NHB	Y	1.25	0.00	5.2	0.89	0.17	Contact	
172	S1e	40	NHB	N							Throttle
173	S1e	40	NHB	Y	1.36	1.91	30.7	1.02	1.02	NC	
174	S1e	40	NHB	Y	1.15	0.00	5.9	1.02	0.19	Contact	
175	S1e	0	NHB	Static							

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
118	S4a	11	NHB	Y	1.74	0.31	11.2	1.22	0.32	NC	
119	S4a	11	NHB	Y	1.51	0.49	11.1	1.24	0.39	NC	
120	S4a	11	NHB	Y	1.72	0.63	10.8	1.18	0.45	NC	
121	S4a	11	NHB	Y	1.71	0.88	10.9	1.19	0.54	NC	
122	S4a	11	NHB	Y	1.73	0.84	10.8	1.19	0.52	NC	
123	S4a	0	NHB	Static							
114	S4a	16	NHB	Y	1.71	0.00	14.5	0.75	0.55	Contact	
115	S4a	16	NHB	Y	1.82	0.00	6.1	0.88	0.15	Contact	
116	S4a	16	NHB	Y	1.75	0.00	3.3	0.54	0.09	Contact	
117	S4a	0	NHB	Static							
137	S4a	35	NHB	Y	2.07	0.00	9.4	1.17	0.26	Contact	
138	S4a	35	NHB	Y	1.91	0.00	18.4	1.05	0.95	Contact	
139	S4a	35	NHB	Y	1.95	0.00	9.1	1.12	0.24	Contact	
140	S4a	0	NHB	Static							
130	S4a	40	NHB	Y	2.02	0.95	39.6	1.08	1.04	NC	
131	S4a	40	NHB	Y	1.96	0.86	40.0	1.10	1.08	NC	
132	S4a	0	NHB	Static							PTM lateral
133	S4a	40	NHB	Y	1.99	0.00	2.9	0.39	0.06	Contact	
134	S4a	40	NHB	Y	2.14	0.00	4.3	0.61	0.12	Contact	
135	S4a	40	NHB	Y	1.92	0.00	3.4	0.49	0.08	Contact	
136	S4a	0	NHB	Static							
113	S4a	0	NHB	Static							

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
81	S4c	11	NHB	N							Brakes applied
82	S4c	11	NHB	Y	1.70	0.00	1.0	0.02		Contact	No intervention
83	S4c	11	NHB	Y	1.71	0.00	0.5	0.02		Contact	No intervention
84	S4c	11	NHB	N							PTM lateral
85	S4c	11	NHB	Y	1.31	0.35	11.4	1.19	0.38	NC	
86	S4c	11	NHB	Y	1.65	0.00	1.2	0.01		Contact	No intervention
87	S4c	0	NHB	Static							
75	S4c	16	NHB	Y	1.71	0.00	1.5	0.02		Contact	No intervention
76	S4c	16	NHB	Y	1.72	0.07	16.2	1.20	0.22	NC	
77	S4c	16	NHB	Y	1.67	0.00	1.3	0.02		Contact	No intervention
78	S4c	16	NHB	Y	1.72	1.22	16.1	1.17	0.67	NC	
79	S4c	16	NHB	Y	1.72	0.00	1.6	0.02		Contact	No intervention
80	S4c	0	NHB	Static							
88	S4c	40	NHB	N							PTM lateral
89	S4c	40	NHB	N							Brakes applied
90	S4c	40	NHB	Y	2.38	0.00	25.5	0.93	1.08	Contact	
91	S4c	40	NHB	N							PTM lateral
92	S4c	40	NHB	Y	2.01	1.26	39.9	1.05	1.11	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
93	S4c	40	NHB	Y	2.23	1.40	39.6	1.22	1.10	NC	
94	S4c	40	NHB	N							Brakes applied
95	S4c	40	NHB	Y	1.90	1.25	39.6	1.17	1.02	NC	
96	S4c	40	NHB	Y	1.80	1.34	39.4	1.15	1.02	NC	
97	S4c	40	NHB	Y	2.31	1.54	39.8	1.15	0.86	NC	
98	S4c	40	NHB	Y	2.03	1.66	39.6	1.08	0.95	NC	
99	S4c	0	NHB	Static							
100	S4c	0	NHB	Static							
108	S4c	45	NHB	Y	2.38	1.04	44.9	1.08	1.21	NC	
109	S4c	45	NHB	Y	2.36	1.51	44.5	1.02	1.15	NC	
110	S4c	45	NHB	Y	2.07	1.25	44.7	1.14	1.19	NC	
111	S4c	45	NHB	Y	2.29	1.18	44.6	1.17	1.14	NC	
112	S4c	45	NHB	Y	2.23	1.34	44.6	1.14	1.15	NC	
101	S4c	50	NHB	Y	2.55	0.00	40.0	1.17	1.26	Contact	
102	S4c	50	NHB	Y	2.07	0.00	3.6	0.14		Contact	No intervention
103	S4c	50	NHB	N							PTM lateral
104	S4c	50	NHB	Y	2.11	0.92	49.8	1.19	1.22	NC	
105	S4c	50	NHB	Y	2.33	0.89	49.5	1.14	1.06	NC	
106	S4c	50	NHB	Y	2.21	0.00	37.6	1.19	0.95	Contact	
107	S4c	0	NHB	Static							

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
11	S1b	11	NLB	N							PTM lateral
12	S1b	11	NLB	Y	0.97	0.00	0.7	0.03		Contact	No intervention
13	S1b	11	NLB	Y		0.00	0.0	0.04		Contact	No warning, No intervention
24	S1b	11	NLB	N							Lateral error
25	S1b	11	NLB	Y	0.80	0.00	0.8	0.17	0.01	Contact	
6	S1b	16	NLB	Y	0.57	0.00	0.9	0.13		Contact	No intervention
7	S1b	16	NLB	N							Lateral error
8	S1b	16	NLB	N							Throttle
9	S1b	16	NLB	N							Throttle
10	S1b	16	NLB	Y		0.00	-0.2	0.02		Contact	No intervention
21	S1b	16	NLB	N							Throttle
22	S1b	16	NLB	Y	-0.08	0.00	-0.1	0.01		Contact	No intervention
36	S1b	35	NLB	N							SV speed
37	S1b	35	NLB	N							PTM lateral error
38	S1b	35	NLB	Y	0.66	0.00	12.7	0.99	0.66	Contact	
39	S1b	35	NLB	N							SV yaw rate, lateral error, brake
40	S1b	35	NLB	Y	0.56	0.00	23.2	1.16	0.55	Contact	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
41	S1b	35	NLB	Y		0.00	0.3	0.00		Contact	No warning, No intervention
42	S1b	0	NLB	Static							
33	S1b	40	NLB	Y	0.40	0.00	11.2	1.21	0.37	Contact	
34	S1b	40	NLB	Y	0.14	0.00	2.1	0.63	0.13	Contact	
35	S1b	40	NLB	Y		0.00	0.1	0.01		Contact	No warning, No intervention
205	S1d	11	NLB	Y		0.00	0.0	0.05		Contact	No warning, No intervention
206	S1d	11	NLB	N							PTM lateral
207	S1d	11	NLB	N							PTM lateral
208	S1d	11	NLB	Y	0.10	0.00	0.0	0.03		Contact	No intervention
209	S1d	11	NLB	Y		0.00	0.1	0.04		Contact	No warning, No intervention
210	S1d	0	NLB	Static							
199	S1d	16	NLB	N							External lighting

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
200	S1d	16	NLB	Y		0.00	0.0	0.04		Contact	No warning, No intervention
201	S1d	16	NLB	Y	0.54	0.65	15.5	1.12	0.43	NC	
202	S1d	16	NLB	Y		0.00	0.2	0.04		Contact	No warning, No intervention
203	S1d	16	NLB	Y		0.00	0.0	0.04		Contact	No warning, No intervention
204	S1d	0	NLB	Static							
216	S1d	35	NLB	Y	0.39	0.00	6.6	1.04	0.24	Contact	
217	S1d	35	NLB	Y	0.35	0.00	7.4	1.01	0.26	Contact	
218	S1d	35	NLB	Y	0.44	0.00	10.5	1.09	0.31	Contact	
219	S1d	35	NLB	Y	0.46	0.00	13.4	1.13	0.42	Contact	
220	S1d	0	NLB	Static							
211	S1d	40	NLB	N							PTM lateral
212	S1d	40	NLB	Y	0.23	0.00	5.2	0.77	0.22	Contact	
213	S1d	40	NLB	Y	0.18	0.00	1.5	0.50	0.09	Contact	
214	S1d	40	NLB	Y	0.25	0.00	3.3	0.75	0.14	Contact	
215	S1d	0	NLB	Static							
170	S1e	0	NLB	Static							

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
221	S1e	0	NLB	Static							
229	S1e	35	NLB	Y						Contact	Driver braking
230	S1e	35	NLB	Y						Contact	Driver braking
231	S1e	35	NLB	N							Can't process run
232	S1e	35	NLB	Y						Contact	Driver braking
233	S1e	0	NLB	Static							
222	S1e	40	NLB	N							PTM lateral
223	S1e	40	NLB	Y		0.00	0.2	0.00		Contact	No warning, No intervention
224	S1e	40	NLB	N							PTM lateral
225	S1e	40	NLB	N							PTM lateral
226	S1e	0	NLB	Static							
227	S1e	40	NLB	Y		0.00	0.0	0.02		Contact	No warning, No intervention
228	S1e	40	NLB	Y	0.17	0.00	0.8	0.21	0.06	Contact	
124	S4a	16	NLB	Y	1.83	1.37	15.8	1.21	0.61	NC	
125	S4a	16	NLB	Y	1.82	1.33	15.8	1.18	0.60	NC	

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
126	S4a	16	NLB	Y	1.81	1.39	16.0	1.19	0.62	NC	
127	S4a	16	NLB	Y	1.87	1.35	16.0	1.10	0.61	NC	
128	S4a	16	NLB	Y	1.80	1.25	16.2	1.20	0.58	NC	
129	S4a	0	NLB	Static							
148	S4a	35	NLB	Y	0.68	0.00	28.9	1.14	0.65	Contact	
149	S4a	35	NLB	Y	0.30	0.00	1.9	0.27	0.33	Contact	
150	S4a	35	NLB	Y	0.45	0.00	16.0	1.19	0.39	Contact	
141	S4a	40	NLB	N							PTM lateral
142	S4a	40	NLB	N							PTM lateral
143	S4a	40	NLB	Y		0.00	0.2	0.02		Contact	No warning, No intervention
144	S4a	40	NLB	Y		0.00	-0.1	0.01		Contact	No warning, No intervention
145	S4a	40	NLB	N							PTM lateral
146	S4a	40	NLB	Y		0.00	0.2	0.03		Contact	No warning, No intervention
147	S4a	0	NLB	Static							
156	S4c	11	NLB	Y	1.41	0.00	0.7	0.02		Contact	No intervention

Run	Test Type	SV Speed (km/h)	Lighting Condition	Valid Run?	FCW TTC (s)	Minimum Distance (m)	Speed Reduction (km/h)	Peak Decel (g)	PAEB TTC (sec)	Contact/No Contact	Notes
157	S4c	11	NLB	Y	0.77	0.00	0.4	0.03		Contact	No intervention
158	S4c	11	NLB	Y	1.49	0.00	0.8	0.02		Contact	No intervention
159	S4c	11	NLB	Y	0.75	0.00	0.9	0.01		Contact	No intervention
160	S4c	0	NLB	Static							
151	S4c	16	NLB	Y	1.56	0.95	16.0	1.18	0.56	NC	
152	S4c	16	NLB	Y	1.43	0.00	1.0	0.02		Contact	No intervention
153	S4c	16	NLB	Y	1.54	0.00	1.0	0.02		Contact	No intervention
154	S4c	16	NLB	Y	1.61	0.00	1.2	0.02		Contact	No intervention
155	S4c	0	NLB	Static							
166	S4c	35	NLB	Y	1.10	0.00	0.8	0.03		Contact	No intervention
167	S4c	35	NLB	Y	0.68	0.00	2.6	0.21	0.60	Contact	
168	S4c	35	NLB	Y	1.00	0.00	4.1	0.65	0.94	Contact	
169	S4c	0	NLB	Static							
161	S4c	40	NLB	Y	0.16	0.00	0.3	0.03		Contact	No intervention
162	S4c	40	NLB	Y	0.19	0.00	0.1	0.02		Contact	No intervention
163	S4c	40	NLB	Y	0.81	0.00	2.4	0.16	0.75	Contact	
164	S4c	40	NLB	Y	0.37	0.00	0.9	0.04		Contact	No intervention
165	S4c	0	NLB	Static							

APPENDIX D

Time History Plots

LIST OF FIGURES

Page
Figure D1. Example Time History for a Passing Run D-13
Figure D2. Example Time History for a Failed Run D-14
Figure D3. Example Time History for an Invalid Run Due to PTM Lateral Error D-15
Figure D4. Example Time History for an Invalid Run Due to SV Lateral Error D-16
Figure D5. Example Time History for an Invalid Run Due to Throttle Error D-17
Figure D6. Time History for PAEB Run 2, S1a, Daytime, 16 km/h D-18
Figure D7. Time History for PAEB Run 3, S1a, Daytime, 16 km/h D-19
Figure D8. Time History for PAEB Run 4, S1a, Daytime, 16 km/h D-20
Figure D9. Time History for PAEB Run 5, S1a, Daytime, 16 km/h D-21
Figure D10. Time History for PAEB Run 6, S1a, Daytime, 16 km/h D-22
Figure D11. Time History for PAEB Run 10, S1a, Daytime, 40 km/h D-23
Figure D12. Time History for PAEB Run 11, S1a, Daytime, 40 km/h D-24
Figure D13. Time History for PAEB Run 13, S1a, Daytime, 40 km/h D-25
Figure D14. Time History for PAEB Run 15, S1a, Daytime, 40 km/h D-26
Figure D15. Time History for PAEB Run 16, S1a, Daytime, 40 km/h D-27
Figure D16. Time History for PAEB Run 18, S1b, Daytime, 16 km/h D-28
Figure D17. Time History for PAEB Run 21, S1b, Daytime, 16 km/h D-29
Figure D18. Time History for PAEB Run 22, S1b, Daytime, 16 km/h D-30
Figure D19. Time History for PAEB Run 27, S1b, Daytime, 16 km/h D-31
Figure D20. Time History for PAEB Run 29, S1b, Daytime, 16 km/h D-32
Figure D21. Time History for PAEB Run 158, S1b, Daytime, 20 km/h D-33
Figure D22. Time History for PAEB Run 159, S1b, Daytime, 20 km/h D-34
Figure D23. Time History for PAEB Run 161, S1b, Daytime, 20 km/h D-35
Figure D24. Time History for PAEB Run 163, S1b, Daytime, 20 km/h D-36
Figure D25. Time History for PAEB Run 164, S1b, Daytime, 20 km/h D-37
Figure D26. Time History for PAEB Run 166, S1b, Daytime, 30 km/h D-38
Figure D27. Time History for PAEB Run 167, S1b, Daytime, 30 km/h D-39
Figure D28. Time History for PAEB Run 168, S1b, Daytime, 30 km/h D-40
Figure D29. Time History for PAEB Run 169, S1b, Daytime, 30 km/h D-41
Figure D30. Time History for PAEB Run 170, S1b, Daytime, 30 km/h D-42
Figure D31. Time History for PAEB Run 32, S1b, Daytime, 40 km/h D-43
Figure D32. Time History for PAEB Run 34, S1b, Daytime, 40 km/h D-44
Figure D33. Time History for PAEB Run 35, S1b, Daytime, 40 km/h D-45
Figure D34. Time History for PAEB Run 37, S1b, Daytime, 40 km/h D-46
Figure D35. Time History for PAEB Run 38, S1b, Daytime, 40 km/h D-47
Figure D36. Time History for PAEB Run 172, S1b, Daytime, 50 km/h D-48
Figure D37. Time History for PAEB Run 173, S1b, Daytime, 50 km/h D-49
Figure D38. Time History for PAEB Run 175, S1b, Daytime, 50 km/h D-50
Figure D39. Time History for PAEB Run 176, S1b, Daytime, 50 km/h D-51
Figure D40. Time History for PAEB Run 177, S1b, Daytime, 50 km/h D-52

Figure D41. Time History for PAEB Run 179, S1b, Daytime, 60 km/h D-53
Figure D42. Time History for PAEB Run 180, S1b, Daytime, 60 km/h D-54
Figure D43. Time History for PAEB Run 181, S1b, Daytime, 60 km/h D-55
Figure D44. Time History for PAEB Run 182, S1b, Daytime, 60 km/h D-56
Figure D45. Time History for PAEB Run 183, S1b, Daytime, 60 km/h D-57
Figure D46. Time History for PAEB Run 40, S1c, Daytime, 16 km/h D-58
Figure D47. Time History for PAEB Run 41, S1c, Daytime, 16 km/h D-59
Figure D48. Time History for PAEB Run 42, S1c, Daytime, 16 km/h D-60
Figure D49. Time History for PAEB Run 43, S1c, Daytime, 16 km/h D-61
Figure D50. Time History for PAEB Run 44, S1c, Daytime, 16 km/h D-62
Figure D51. Time History for PAEB Run 46, S1c, Daytime, 40 km/h D-63
Figure D52. Time History for PAEB Run 47, S1c, Daytime, 40 km/h D-64
Figure D53. Time History for PAEB Run 48, S1c, Daytime, 40 km/h D-65
Figure D54. Time History for PAEB Run 49, S1c, Daytime, 40 km/h D-66
Figure D55. Time History for PAEB Run 53, S1c, Daytime, 40 km/h D-67
Figure D56. Time History for PAEB Run 54, S1c, Daytime, 40 km/h D-68
Figure D57. Time History for PAEB Run 55, S1c, Daytime, 40 km/h D-69
Figure D58. Time History for PAEB Run 56, S1c, Daytime, 40 km/h D-70
Figure D59. Time History for PAEB Run 57, S1c, Daytime, 40 km/h D-71
Figure D60. Time History for PAEB Run 117, S1d, Daytime, 16 km/h D-72
Figure D61. Time History for PAEB Run 118, S1d, Daytime, 16 km/h D-73
Figure D62. Time History for PAEB Run 119, S1d, Daytime, 16 km/h D-74
Figure D63. Time History for PAEB Run 120, S1d, Daytime, 16 km/h D-75
Figure D64. Time History for PAEB Run 121, S1d, Daytime, 16 km/h D-76
Figure D65. Time History for PAEB Run 124, S1d, Daytime, 20 km/h D-77
Figure D66. Time History for PAEB Run 125, S1d, Daytime, 20 km/h D-78
Figure D67. Time History for PAEB Run 126, S1d, Daytime, 20 km/h D-79
Figure D68. Time History for PAEB Run 127, S1d, Daytime, 20 km/h D-80
Figure D69. Time History for PAEB Run 128, S1d, Daytime, 20 km/h D-81
Figure D70. Time History for PAEB Run 130, S1d, Daytime, 30 km/h D-82
Figure D71. Time History for PAEB Run 131, S1d, Daytime, 30 km/h D-83
Figure D72. Time History for PAEB Run 132, S1d, Daytime, 30 km/h D-84
Figure D73. Time History for PAEB Run 133, S1d, Daytime, 30 km/h D-85
Figure D74. Time History for PAEB Run 134, S1d, Daytime, 30 km/h D-86
Figure D75. Time History for PAEB Run 137, S1d, Daytime, 40 km/h D-87
Figure D76. Time History for PAEB Run 138, S1d, Daytime, 40 km/h D-88
Figure D77. Time History for PAEB Run 139, S1d, Daytime, 40 km/h D-89
Figure D78. Time History for PAEB Run 141, S1d, Daytime, 40 km/h D-90
Figure D79. Time History for PAEB Run 142, S1d, Daytime, 40 km/h D-91
Figure D80. Time History for PAEB Run 151, S1d, Daytime, 45 km/h D-92
Figure D81. Time History for PAEB Run 152, S1d, Daytime, 45 km/h D-93
Figure D82. Time History for PAEB Run 153, S1d, Daytime, 45 km/h D-94
Figure D83. Time History for PAEB Run 154, S1d, Daytime, 45 km/h D-95

Figure D84. Time History for PAEB Run 155, S1d, Daytime, 45 km/h D-96
Figure D85. Time History for PAEB Run 145, S1d, Daytime, 50 km/h D-97
Figure D86. Time History for PAEB Run 146, S1d, Daytime, 50 km/h D-98
Figure D87. Time History for PAEB Run 147, S1d, Daytime, 50 km/h D-99
Figure D88. Time History for PAEB Run 148, S1d, Daytime, 50 km/h D-100
Figure D89. Time History for PAEB Run 149, S1d, Daytime, 50 km/h D-101
Figure D90. Time History for PAEB Run 73, S1e, Daytime, 40 km/h D-102
Figure D91. Time History for PAEB Run 74, S1e, Daytime, 40 km/h D-103
Figure D92. Time History for PAEB Run 75, S1e, Daytime, 40 km/h D-104
Figure D93. Time History for PAEB Run 76, S1e, Daytime, 40 km/h D-105
Figure D94. Time History for PAEB Run 77, S1e, Daytime, 40 km/h D-106
Figure D95. Time History for PAEB Run 204, S1e, Daytime, 50 km/h D-107
Figure D96. Time History for PAEB Run 205, S1e, Daytime, 50 km/h D-108
Figure D97. Time History for PAEB Run 211, S1e, Daytime, 50 km/h D-109
Figure D98. Time History for PAEB Run 214, S1e, Daytime, 50 km/h D-110
Figure D99. Time History for PAEB Run 223, S1e, Daytime, 50 km/h D-111
Figure D100. Time History for PAEB Run 224, S1e, Daytime, 50 km/h D-112
Figure D101. Time History for PAEB Run 225, S1e, Daytime, 50 km/h D-113
Figure D102. Time History for PAEB Run 217, S1e, Daytime, 60 km/h D-114
Figure D103. Time History for PAEB Run 218, S1e, Daytime, 60 km/h D-115
Figure D104. Time History for PAEB Run 219, S1e, Daytime, 60 km/h D-116
Figure D105. Time History for PAEB Run 220, S1e, Daytime, 60 km/h D-117
Figure D106. Time History for PAEB Run 221, S1e, Daytime, 60 km/h D-118
Figure D107. Time History for PAEB Run 59, S1f, Daytime, 40 km/h D-119
Figure D108. Time History for PAEB Run 60, S1f, Daytime, 40 km/h D-120
Figure D109. Time History for PAEB Run 61, S1f, Daytime, 40 km/h D-121
Figure D110. Time History for PAEB Run 62, S1f, Daytime, 40 km/h D-122
Figure D111. Time History for PAEB Run 63, S1f, Daytime, 40 km/h D-123
Figure D112. Time History for PAEB Run 65, S1g, Daytime, 40 km/h D-124
Figure D113. Time History for PAEB Run 66, S1g, Daytime, 40 km/h D-125
Figure D114. Time History for PAEB Run 67, S1g, Daytime, 40 km/h D-126
Figure D115. Time History for PAEB Run 68, S1g, Daytime, 40 km/h D-127
Figure D116. Time History for PAEB Run 95, S4a, Daytime, 16 km/h D-128
Figure D117. Time History for PAEB Run 96, S4a, Daytime, 16 km/h D-129
Figure D118. Time History for PAEB Run 97, S4a, Daytime, 16 km/h D-130
Figure D119. Time History for PAEB Run 98, S4a, Daytime, 16 km/h D-131
Figure D120. Time History for PAEB Run 99, S4a, Daytime, 16 km/h D-132
Figure D121. Time History for PAEB Run 101, S4a, Daytime, 40 km/h D-133
Figure D122. Time History for PAEB Run 102, S4a, Daytime, 40 km/h D-134
Figure D123. Time History for PAEB Run 103, S4a, Daytime, 40 km/h D-135
Figure D124. Time History for PAEB Run 80, S4b, Daytime, 16 km/h D-136
Figure D125. Time History for PAEB Run 85, S4b, Daytime, 16 km/h D-137
Figure D126. Time History for PAEB Run 86, S4b, Daytime, 16 km/h D-138

Figure D127. Time History for PAEB Run 87, S4b, Daytime, 16 km/h D-139
Figure D128. Time History for PAEB Run 88, S4b, Daytime, 16 km/h D-140
Figure D129. Time History for PAEB Run 90, S4b, Daytime, 40 km/h D-141
Figure D130. Time History for PAEB Run 91, S4b, Daytime, 40 km/h D-142
Figure D131. Time History for PAEB Run 92, S4b, Daytime, 40 km/h D-143
Figure D132. Time History for PAEB Run 93, S4b, Daytime, 40 km/h D-144
Figure D133. Time History for PAEB Run 110, S4c, Daytime, 16 km/h D-145
Figure D134. Time History for PAEB Run 111, S4c, Daytime, 16 km/h D-146
Figure D135. Time History for PAEB Run 112, S4c, Daytime, 16 km/h D-147
Figure D136. Time History for PAEB Run 113, S4c, Daytime, 16 km/h D-148
Figure D137. Time History for PAEB Run 114, S4c, Daytime, 16 km/h D-149
Figure D138. Time History for PAEB Run 105, S4c, Daytime, 40 km/h D-150
Figure D139. Time History for PAEB Run 106, S4c, Daytime, 40 km/h D-151
Figure D140. Time History for PAEB Run 107, S4c, Daytime, 40 km/h D-152
Figure D141. Time History for PAEB Run 14, S1b, Night, High Beam, 11 km/h D-153
Figure D142. Time History for PAEB Run 15, S1b, Night, High Beam, 11 km/h D-154
Figure D143. Time History for PAEB Run 16, S1b, Night, High Beam, 11 km/h D-155
Figure D144. Time History for PAEB Run 17, S1b, Night, High Beam, 11 km/h D-156
Figure D145. Time History for PAEB Run 18, S1b, Night, High Beam, 11 km/h D-157
Figure D146. Time History for PAEB Run 4, S1b, Night, High Beam, 16 km/h D-158
Figure D147. Time History for PAEB Run 5, S1b, Night, High Beam, 16 km/h D-159
Figure D148. Time History for PAEB Run 23, S1b, Night, High Beam, 16 km/h D-160
Figure D149. Time History for PAEB Run 67, S1b, Night, High Beam, 20 km/h D-161
Figure D150. Time History for PAEB Run 69, S1b, Night, High Beam, 20 km/h D-162
Figure D151. Time History for PAEB Run 70, S1b, Night, High Beam, 20 km/h D-163
Figure D152. Time History for PAEB Run 72, S1b, Night, High Beam, 20 km/h D-164
Figure D153. Time History for PAEB Run 73, S1b, Night, High Beam, 20 km/h D-165
Figure D154. Time History for PAEB Run 61, S1b, Night, High Beam, 30 km/h D-166
Figure D155. Time History for PAEB Run 62, S1b, Night, High Beam, 30 km/h D-167
Figure D156. Time History for PAEB Run 63, S1b, Night, High Beam, 30 km/h D-168
Figure D157. Time History for PAEB Run 64, S1b, Night, High Beam, 30 km/h D-169
Figure D158. Time History for PAEB Run 65, S1b, Night, High Beam, 30 km/h D-170
Figure D159. Time History for PAEB Run 26, S1b, Night, High Beam, 40 km/h D-171
Figure D160. Time History for PAEB Run 28, S1b, Night, High Beam, 40 km/h D-172
Figure D161. Time History for PAEB Run 29, S1b, Night, High Beam, 40 km/h D-173
Figure D162. Time History for PAEB Run 30, S1b, Night, High Beam, 40 km/h D-174
Figure D163. Time History for PAEB Run 32, S1b, Night, High Beam, 40 km/h D-175
Figure D164. Time History for PAEB Run 44, S1b, Night, High Beam, 50 km/h D-176
Figure D165. Time History for PAEB Run 46, S1b, Night, High Beam, 50 km/h D-177
Figure D166. Time History for PAEB Run 48, S1b, Night, High Beam, 50 km/h D-178
Figure D167. Time History for PAEB Run 50, S1b, Night, High Beam, 50 km/h D-179
Figure D168. Time History for PAEB Run 54, S1b, Night, High Beam, 60 km/h D-180
Figure D169. Time History for PAEB Run 55, S1b, Night, High Beam, 60 km/h D-181

Figure D170. Time History for PAEB Run 56, S1b, Night, High Beam, 60 km/h D-182
Figure D171. Time History for PAEB Run 57, S1b, Night, High Beam, 60 km/h D-183
Figure D172. Time History for PAEB Run 59, S1b, Night, High Beam, 60 km/h D-184
Figure D173. Time History for PAEB Run 185, S1d, Night, High Beam, 11 km/h D-185
Figure D174. Time History for PAEB Run 186, S1d, Night, High Beam, 11 km/h D-186
Figure D175. Time History for PAEB Run 187, S1d, Night, High Beam, 11 km/h D-187
Figure D176. Time History for PAEB Run 188, S1d, Night, High Beam, 11 km/h D-188
Figure D177. Time History for PAEB Run 180, S1d, Night, High Beam, 16 km/h D-189
Figure D178. Time History for PAEB Run 181, S1d, Night, High Beam, 16 km/h D-190
Figure D179. Time History for PAEB Run 182, S1d, Night, High Beam, 16 km/h D-191
Figure D180. Time History for PAEB Run 195, S1d, Night, High Beam, 35 km/h D-192
Figure D181. Time History for PAEB Run 196, S1d, Night, High Beam, 35 km/h D-193
Figure D182. Time History for PAEB Run 197, S1d, Night, High Beam, 35 km/h D-194
Figure D183. Time History for PAEB Run 191, S1d, Night, High Beam, 40 km/h D-195
Figure D184. Time History for PAEB Run 192, S1d, Night, High Beam, 40 km/h D-196
Figure D185. Time History for PAEB Run 193, S1d, Night, High Beam, 40 km/h D-197
Figure D186. Time History for PAEB Run 176, S1e, Night, High Beam, 35 km/h D-198
Figure D187. Time History for PAEB Run 177, S1e, Night, High Beam, 35 km/h D-199
Figure D188. Time History for PAEB Run 178, S1e, Night, High Beam, 35 km/h D-200
Figure D189. Time History for PAEB Run 171, S1e, Night, High Beam, 40 km/h D-201
Figure D190. Time History for PAEB Run 173, S1e, Night, High Beam, 40 km/h D-202
Figure D191. Time History for PAEB Run 174, S1e, Night, High Beam, 40 km/h D-203
Figure D192. Time History for PAEB Run 118, S4a, Night, High Beam, 11 km/h D-204
Figure D193. Time History for PAEB Run 119, S4a, Night, High Beam, 11 km/h D-205
Figure D194. Time History for PAEB Run 120, S4a, Night, High Beam, 11 km/h D-206
Figure D195. Time History for PAEB Run 121, S4a, Night, High Beam, 11 km/h D-207
Figure D196. Time History for PAEB Run 122, S4a, Night, High Beam, 11 km/h D-208
Figure D197. Time History for PAEB Run 114, S4a, Night, High Beam, 16 km/h D-209
Figure D198. Time History for PAEB Run 115, S4a, Night, High Beam, 16 km/h D-210
Figure D199. Time History for PAEB Run 116, S4a, Night, High Beam, 16 km/h D-211
Figure D200. Time History for PAEB Run 137, S4a, Night, High Beam, 35 km/h D-212
Figure D201. Time History for PAEB Run 138, S4a, Night, High Beam, 35 km/h D-213
Figure D202. Time History for PAEB Run 139, S4a, Night, High Beam, 35 km/h D-214
Figure D203. Time History for PAEB Run 130, S4a, Night, High Beam, 40 km/h D-215
Figure D204. Time History for PAEB Run 131, S4a, Night, High Beam, 40 km/h D-216
Figure D205. Time History for PAEB Run 133, S4a, Night, High Beam, 40 km/h D-217
Figure D206. Time History for PAEB Run 134, S4a, Night, High Beam, 40 km/h D-218
Figure D207. Time History for PAEB Run 135, S4a, Night, High Beam, 40 km/h D-219
Figure D208. Time History for PAEB Run 82, S4c, Night, High Beam, 11 km/h D-220
Figure D209. Time History for PAEB Run 83, S4c, Night, High Beam, 11 km/h D-221
Figure D210. Time History for PAEB Run 85, S4c, Night, High Beam, 11 km/h D-222
Figure D211. Time History for PAEB Run 86, S4c, Night, High Beam, 11 km/h D-223
Figure D212. Time History for PAEB Run 75, S4c, Night, High Beam, 16 km/h D-224

Figure D213. Time History for PAEB Run 76, S4c, Night, High Beam, 16 km/h D-225
Figure D214. Time History for PAEB Run 77, S4c, Night, High Beam, 16 km/h D-226
Figure D215. Time History for PAEB Run 78, S4c, Night, High Beam, 16 km/h D-227
Figure D216. Time History for PAEB Run 79, S4c, Night, High Beam, 16 km/h D-228
Figure D217. Time History for PAEB Run 90, S4c, Night, High Beam, 40 km/h D-229
Figure D218. Time History for PAEB Run 92, S4c, Night, High Beam, 40 km/h D-230
Figure D219. Time History for PAEB Run 93, S4c, Night, High Beam, 40 km/h D-231
Figure D220. Time History for PAEB Run 95, S4c, Night, High Beam, 40 km/h D-232
Figure D221. Time History for PAEB Run 96, S4c, Night, High Beam, 40 km/h D-233
Figure D222. Time History for PAEB Run 97, S4c, Night, High Beam, 40 km/h D-234
Figure D223. Time History for PAEB Run 98, S4c, Night, High Beam, 40 km/h D-235
Figure D224. Time History for PAEB Run 108, S4c, Night, High Beam, 45 km/h D-236
Figure D225. Time History for PAEB Run 109, S4c, Night, High Beam, 45 km/h D-237
Figure D226. Time History for PAEB Run 110, S4c, Night, High Beam, 45 km/h D-238
Figure D227. Time History for PAEB Run 111, S4c, Night, High Beam, 45 km/h D-239
Figure D228. Time History for PAEB Run 112, S4c, Night, High Beam, 45 km/h D-240
Figure D229. Time History for PAEB Run 101, S4c, Night, High Beam, 50 km/h D-241
Figure D230. Time History for PAEB Run 102, S4c, Night, High Beam, 50 km/h D-242
Figure D231. Time History for PAEB Run 104, S4c, Night, High Beam, 50 km/h D-243
Figure D232. Time History for PAEB Run 105, S4c, Night, High Beam, 50 km/h D-244
Figure D233. Time History for PAEB Run 106, S4c, Night, High Beam, 50 km/h D-245
Figure D234. Time History for PAEB Run 12, S1b, Night, Low Beam, 11 km/h D-246
Figure D235. Time History for PAEB Run 13, S1b, Night, Low Beam, 11 km/h D-247
Figure D236. Time History for PAEB Run 25, S1b, Night, Low Beam, 11 km/h D-248
Figure D237. Time History for PAEB Run 6, S1b, Night, Low Beam, 16 km/h D-249
Figure D238. Time History for PAEB Run 10, S1b, Night, Low Beam, 16 km/h D-250
Figure D239. Time History for PAEB Run 22, S1b, Night, Low Beam, 16 km/h D-251
Figure D240. Time History for PAEB Run 38, S1b, Night, Low Beam, 35 km/h D-252
Figure D241. Time History for PAEB Run 40, S1b, Night, Low Beam, 35 km/h D-253
Figure D242. Time History for PAEB Run 41, S1b, Night, Low Beam, 35 km/h D-254
Figure D243. Time History for PAEB Run 33, S1b, Night, Low Beam, 40 km/h D-255
Figure D244. Time History for PAEB Run 34, S1b, Night, Low Beam, 40 km/h D-256
Figure D245. Time History for PAEB Run 35, S1b, Night, Low Beam, 40 km/h D-257
Figure D246. Time History for PAEB Run 205, S1d, Night, Low Beam, 11 km/h D-258
Figure D247. Time History for PAEB Run 208, S1d, Night, Low Beam, 11 km/h D-259
Figure D248. Time History for PAEB Run 209, S1d, Night, Low Beam, 11 km/h D-260
Figure D249. Time History for PAEB Run 200, S1d, Night, Low Beam, 16 km/h D-261
Figure D250. Time History for PAEB Run 201, S1d, Night, Low Beam, 16 km/h D-262
Figure D251. Time History for PAEB Run 202, S1d, Night, Low Beam, 16 km/h D-263
Figure D252. Time History for PAEB Run 203, S1d, Night, Low Beam, 16 km/h D-264
Figure D253. Time History for PAEB Run 216, S1d, Night, Low Beam, 35 km/h D-265
Figure D254. Time History for PAEB Run 217, S1d, Night, Low Beam, 35 km/h D-266
Figure D255. Time History for PAEB Run 218, S1d, Night, Low Beam, 35 km/h D-267

Figure D256. Time History for PAEB Run 219, S1d, Night, Low Beam, 35 km/h D-268
Figure D257. Time History for PAEB Run 212, S1d, Night, Low Beam, 40 km/h D-269
Figure D258. Time History for PAEB Run 213, S1d, Night, Low Beam, 40 km/h D-270
Figure D259. Time History for PAEB Run 214, S1d, Night, Low Beam, 40 km/h D-271
Figure D260. Time History for PAEB Run 229, S1e, Night, Low Beam, 35 km/h D-272
Figure D261. Time History for PAEB Run 230, S1e, Night, Low Beam, 35 km/h D-273
Figure D262. Time History for PAEB Run 232, S1e, Night, Low Beam, 35 km/h D-274
Figure D263. Time History for PAEB Run 223, S1e, Night, Low Beam, 40 km/h D-275
Figure D264. Time History for PAEB Run 227, S1e, Night, Low Beam, 40 km/h D-276
Figure D265. Time History for PAEB Run 228, S1e, Night, Low Beam, 40 km/h D-277
Figure D266. Time History for PAEB Run 124, S4a, Night, Low Beam, 16 km/h D-278
Figure D267. Time History for PAEB Run 125, S4a, Night, Low Beam, 16 km/h D-279
Figure D268. Time History for PAEB Run 126, S4a, Night, Low Beam, 16 km/h D-280
Figure D269. Time History for PAEB Run 127, S4a, Night, Low Beam, 16 km/h D-281
Figure D270. Time History for PAEB Run 128, S4a, Night, Low Beam, 16 km/h D-282
Figure D271. Time History for PAEB Run 148, S4a, Night, Low Beam, 35 km/h D-283
Figure D272. Time History for PAEB Run 149, S4a, Night, Low Beam, 35 km/h D-284
Figure D273. Time History for PAEB Run 150, S4a, Night, Low Beam, 35 km/h D-285
Figure D274. Time History for PAEB Run 143, S4a, Night, Low Beam, 40 km/h D-286
Figure D275. Time History for PAEB Run 144, S4a, Night, Low Beam, 40 km/h D-287
Figure D276. Time History for PAEB Run 146, S4a, Night, Low Beam, 40 km/h D-288
Figure D277. Time History for PAEB Run 156, S4c, Night, Low Beam, 11 km/h D-289
Figure D278. Time History for PAEB Run 157, S4c, Night, Low Beam, 11 km/h D-290
Figure D279. Time History for PAEB Run 158, S4c, Night, Low Beam, 11 km/h D-291
Figure D280. Time History for PAEB Run 159, S4c, Night, Low Beam, 11 km/h D-292
Figure D281. Time History for PAEB Run 151, S4c, Night, Low Beam, 16 km/h D-293
Figure D282. Time History for PAEB Run 152, S4c, Night, Low Beam, 16 km/h D-294
Figure D283. Time History for PAEB Run 153, S4c, Night, Low Beam, 16 km/h D-295
Figure D284. Time History for PAEB Run 154, S4c, Night, Low Beam, 16 km/h D-296
Figure D285. Time History for PAEB Run 166, S4c, Night, Low Beam, 35 km/h D-297
Figure D286. Time History for PAEB Run 167, S4c, Night, Low Beam, 35 km/h D-298
Figure D287. Time History for PAEB Run 168, S4c, Night, Low Beam, 35 km/h D-299
Figure D288. Time History for PAEB Run 161, S4c, Night, Low Beam, 40 km/h D-300
Figure D289. Time History for PAEB Run 162, S4c, Night, Low Beam, 40 km/h D-301
Figure D290. Time History for PAEB Run 163, S4c, Night, Low Beam, 40 km/h D-302
Figure D291. Time History for PAEB Run 164, S4c, Night, Low Beam, 40 km/h D-303

Time History Plot Description

A set of time history plots is provided for each valid run in the test series. Each set of plots comprises time varying data from both the Subject Vehicle (SV) and the Pedestrian Test Mannequin (PTM), as well as pass/fail envelopes and thresholds. The following is a description of data types shown in the time history plots, as well as a description of the color codes indicating to which vehicle the data pertain.

Time history figures include the following sub-plots:

- FCW Warning – Displays the audible Forward Collision Warning alert. The alert data are filtered, rectified, and normalized. The vertical scale is 0 to 1.

  A vertical black bar on the plot indicates the TTC (sec) at the first moment of the warning issued by the FCW system. The FCW TTC is displayed to the right of the subplot in green.

- Headway (m) – Longitudinal separation (gap) between the front-most point of the SV and the PTM as defined by a rectangle. The minimum headway during the run is displayed to the right of the subplot.

  If no impact occurs, a green circle is displayed at the moment of minimum headway distance. If impact occurs, a red asterisk is displayed at the moment of impact and the word “Contact” is displayed in red. Additionally, along the time history data for the headway, the line is marked in bold if the PTM is within the forward path of the SV, and it is thin if the PTM is outside of the forward path of the SV.

- SV/PTM Speed (km/h) – Speed of the SV and PTM (if any). The speed reduction experienced by the SV is displayed to the right of the subplot. The tolerance for SV speed is ±1.0 km/h (required until the FCW alert is given). Note that there is no tolerance for PTM speed because PTM motion validity is a function of SV longitudinal position.

- Yaw Rate (deg/sec) – Yaw rate of the SV. Its tolerance is ±1.0 deg/sec (required until there is PAEB system braking).

- Lateral Error (m) – For both the SV and PTM, Lateral Error is measured in the reference frame of the lane of travel. Note that for crossing (S1) test scenarios, Lateral Error for the PTM is the same as Longitudinal Error in its reference frame.

For the SV, lateral error is defined to be the lateral distance between the centerline of the SV and the center of the lane of travel. Its tolerance is ±0.20 m.

For the PTM in longitudinal (S4) test scenarios, the lateral error is defined to be the distance between the centerline of the PTM and its associated defined lateral position in the lane of travel. Its tolerance is ±0.18 m

For the PTM in crossing (S1) test scenarios, the lateral error is defined to be the distance between the centerline of the PTM and its prescribed lateral position across the lane of travel as calculated by the defined SV longitudinal position and impact profiles provided by the test procedure. Its tolerance is ±0.18 m

- Ax (g) – Longitudinal acceleration of the SV. A dashed line is displayed at -0.15 g, which is used as the threshold to indicate PAEB braking. When the SV's Ax crosses this threshold, this indicates the moment of first PAEB system braking. The TTC (sec) at first PAEB system braking is calculated and displayed to the right of the subplot, in green. Also, the peak value of Ax for the SV is shown on the subplot.

- Pedal Positions – Normalized positions of the accelerator pedal and brake pedal. As the brake pedal is only a contact switch; the position reading will either be 0 (off) or a 1 (on). A red "Brk" (indicating test invalidity) will appear to the right of the plot if the brake pedal was applied at any time during the run. The accelerator pedal is normalized, such that throttle off equals zero and wide-open throttle equals one. The throttle is required to be off starting 0.5 sec after an audible FCW alert is provided.

Envelopes and Thresholds

Some of the time history plot figures contain either green envelopes and/or black threshold lines. These envelopes and thresholds are used to programmatically and visually determine the validity of a given test run. Envelope and threshold exceedances are indicated with either red shading or red asterisks, and red text is placed to the right side of the plot indicating the type of exceedance. Such exceedances indicate either that the test was invalid or that there was contact between the SV and PTM.

For plots with green envelopes, in order for the test to be valid, the time-varying data must not exceed the envelope boundaries at any time. Exceedances of a green envelope are indicated by red shading in the area between the measured time-varying data and the envelope boundaries.

Color Codes

Color codes have been adopted to easily identify which data correspond to which vehicle, as well as to indicate the types of envelopes and thresholds used in the plots.

Color codes can be broken into four categories:

1. Time-varying data color codes:

    - Blue = SV data
    - Magenta = PTM data
    - Brown = Relative data between SV and PTM (i.e., headway distance)

2. Validation envelope and threshold color codes:

    - Green envelope = time varying data must be within the envelope at all times in order to be valid
    - Black threshold (Dashed) = for reference only – this can include warning level thresholds, TTC thresholds, and acceleration thresholds

3. Individual data point color codes:

    - Green circle = passing or valid value at a given moment in time
    - Red asterisk = failing or invalid value at a given moment in time

4. Text color codes:

    - Green = passing or valid value
    - Red = failing or invalid value

Other Notations

- Contact – Indicates that contact was made between the SV and PTM.
- ENV – Indicates that the value for that variable was outside of its specified validity envelope.
- NG – Indicates that the value for that variable was outside of bounds and therefore “No Good”.
- No Wng – No warning was detected.
- PTM – Indicates that the value for the Pedestrian Test Mannequin was out of bounds.
- SV – Indicates that the value for the Subject Vehicle was out of bounds.
- SR – Shows the speed reduction value.
- Thr – Indicates that the requirements for the throttle were not met.

The minimum (worst) GPS fix type is displayed in the lower right corner of each page. The only valid fix type is RTK fixed (displayed in green). If the fix type during any portion of the test was anything other than RTK fixed, then “RTK Fixed OR LESS!!” is displayed in red.

Examples of time history plots for each test type (including passing, failing and invalid runs) are shown in Figures D1 through Figure D5. Figures D1 and D2 show typical passing and failing runs. Figures D3 through D5 show examples of invalid runs. Time history data plots for the tests of the vehicle under consideration herein are provided beginning with Figure D6.

The test reported herein is one of a series of research and development tests accomplished for the purpose of refining test procedures, protocols, and specifications, as well as data analysis parameters and presentation methods that are preliminarily described in NHTSA ‘s test procedure titled, “Pedestrian Automatic Emergency Brake System Confirmation Test (Working Draft)”, dated September 2019 (Docket NHTSA-2019-0102-0005). Some of these procedural details changed over the course of the test series in order to address unanticipated concerns or ambiguities, and also in recognition of the different characteristics of AEB implementation by the various manufacturers. In particular, the threshold for determining the onset of PAEB braking was originally set at -0.15 g, and subsequently changed to -0.03 g later in the series. As a result, some of the results indicate the earlier threshold and some the later. The results presented herein are for the -0.15 g threshold.

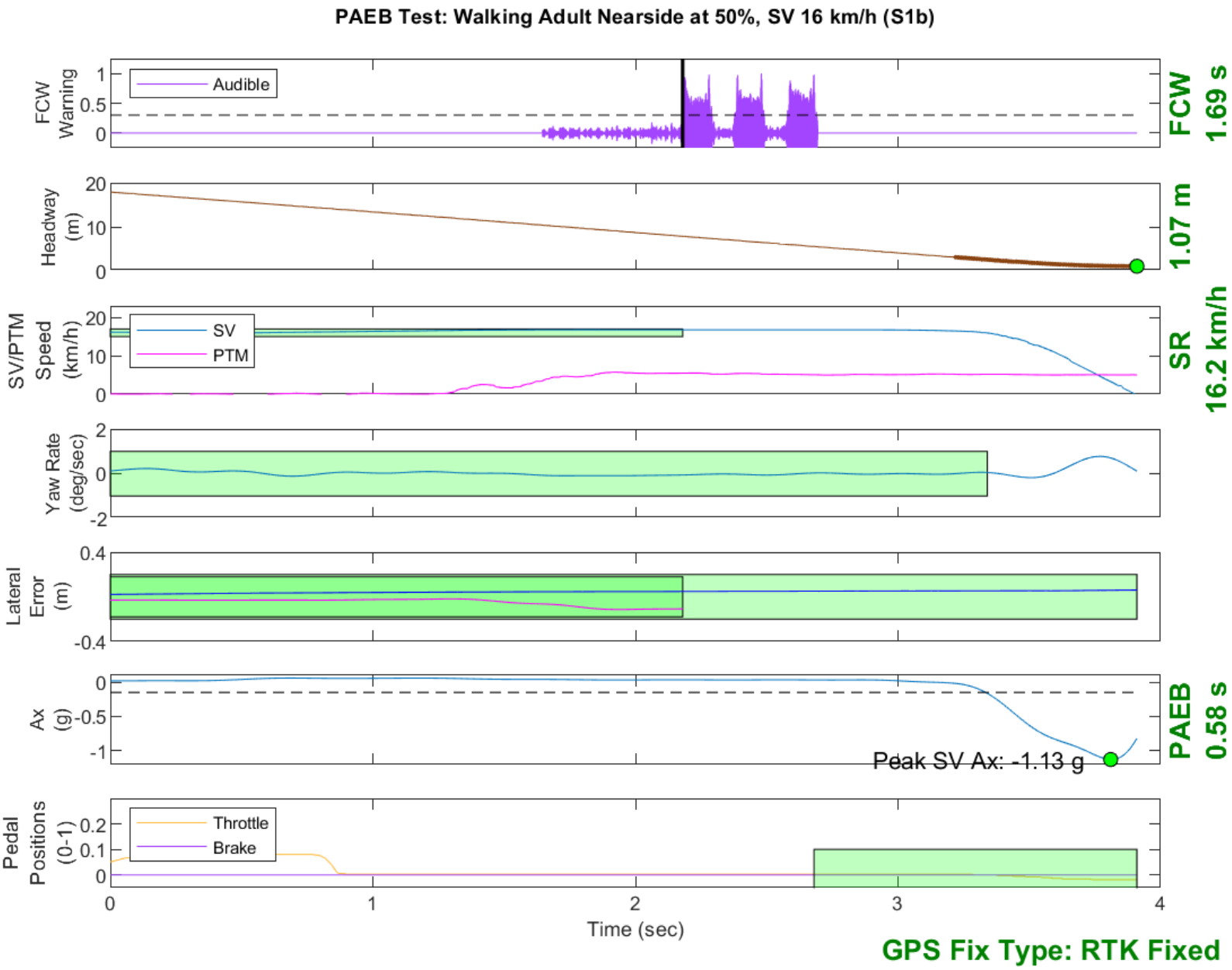


Figure D1. Example Time History for a Passing Run

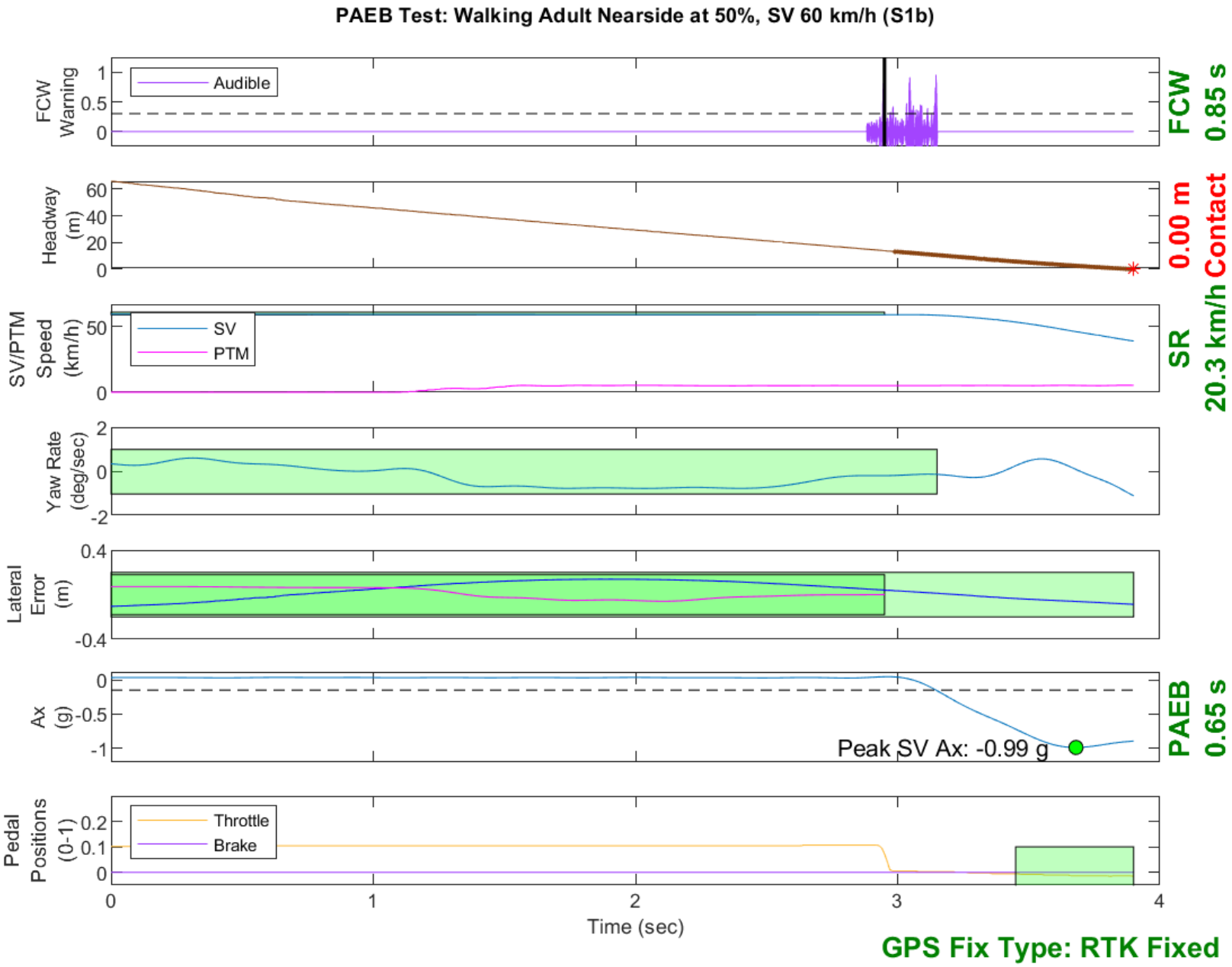


Figure D2. Example Time History for a Failed Run

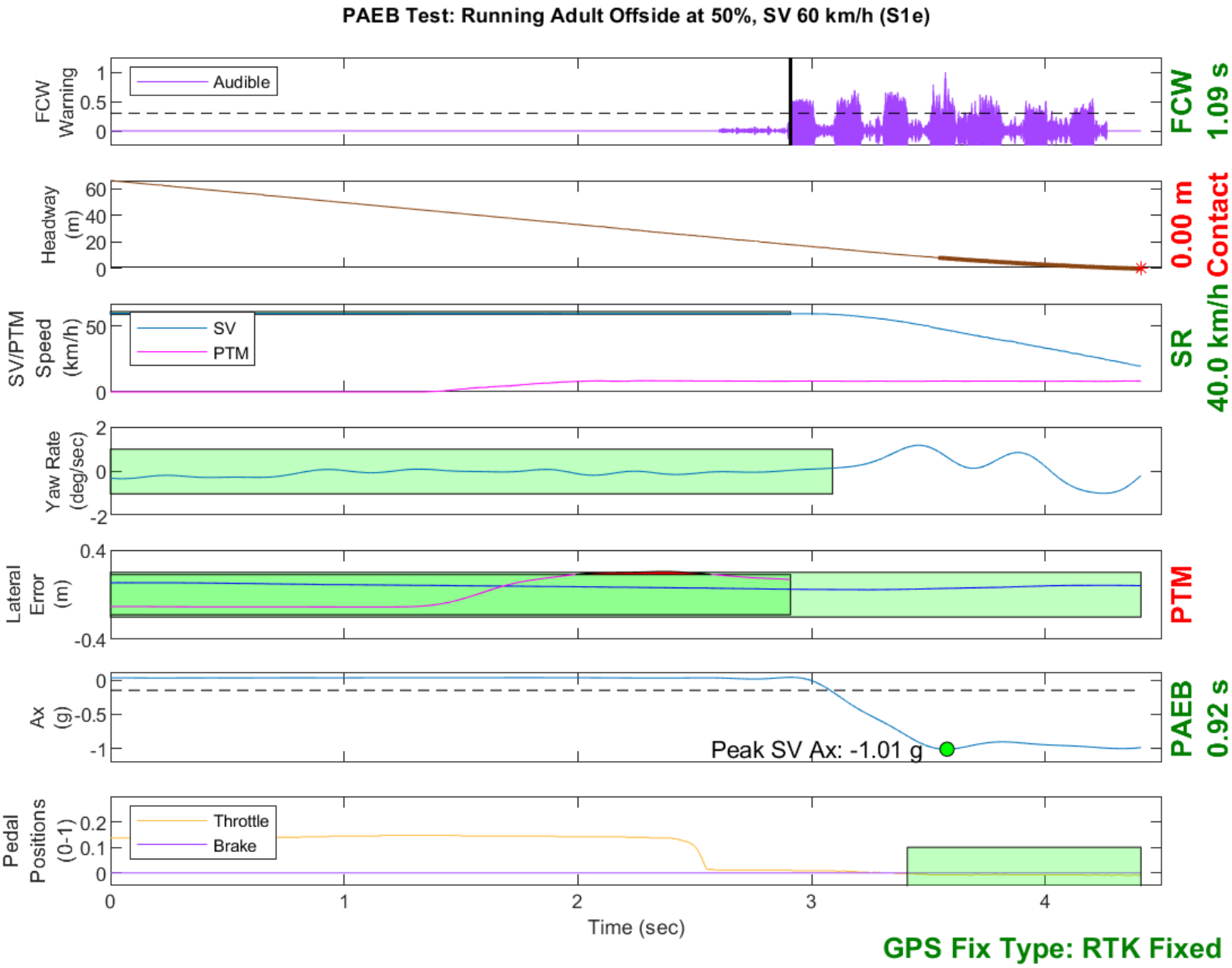


Figure D3. Example Time History for an Invalid Run Due to PTM Lateral Error

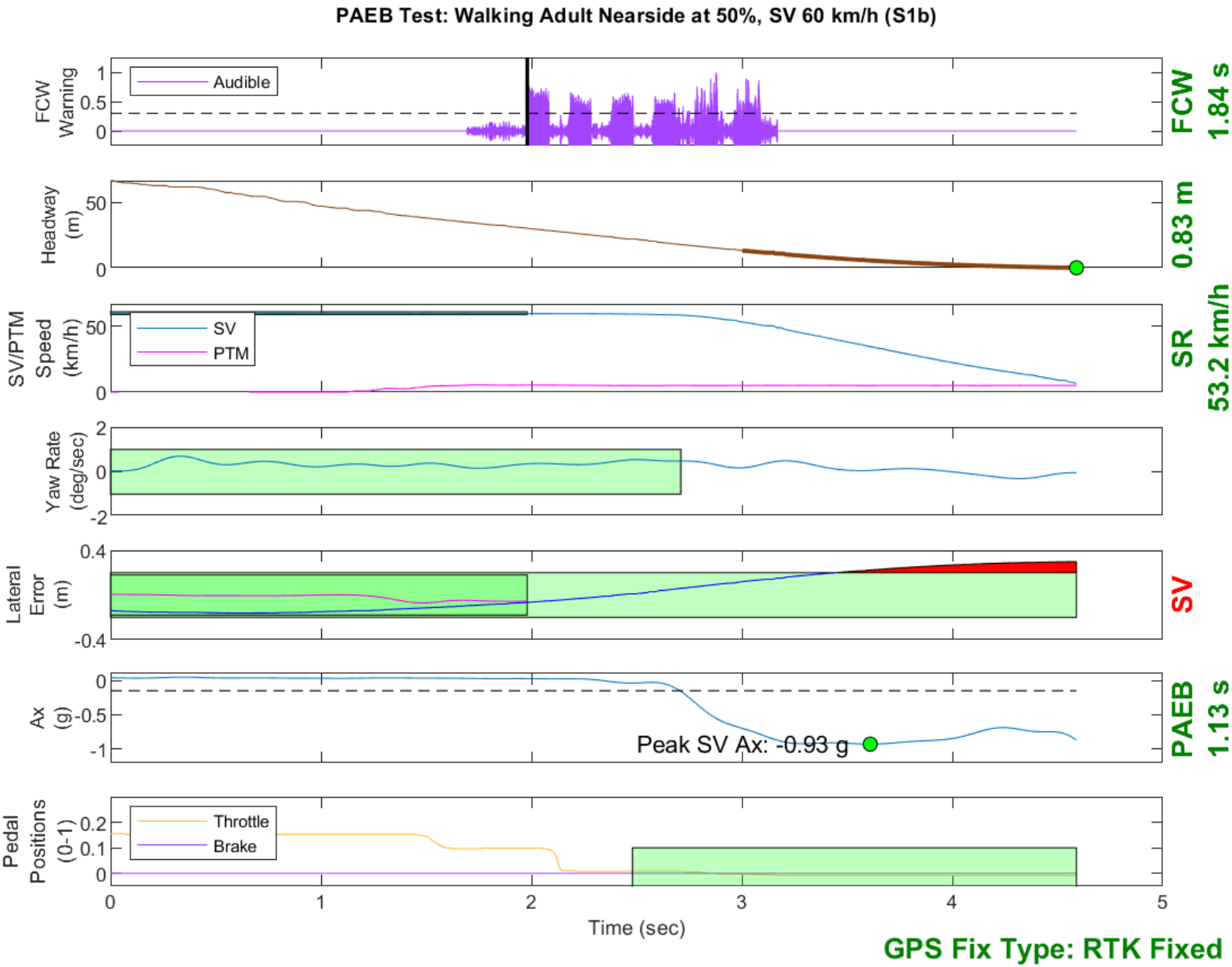


Figure D4. Example Time History for an Invalid Run Due to SV Lateral Error

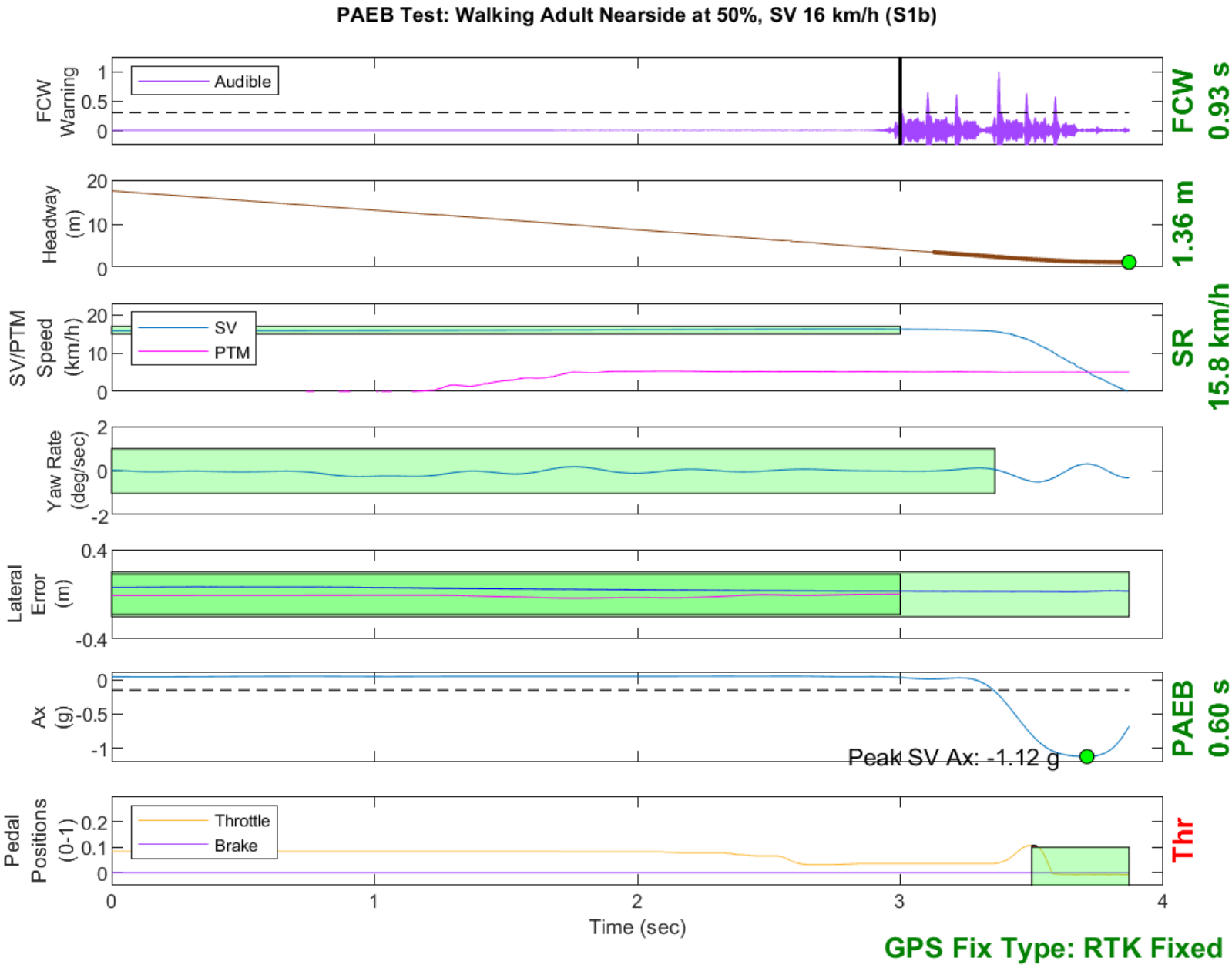


Figure D5. Example Time History for an Invalid Run Due to Throttle Error

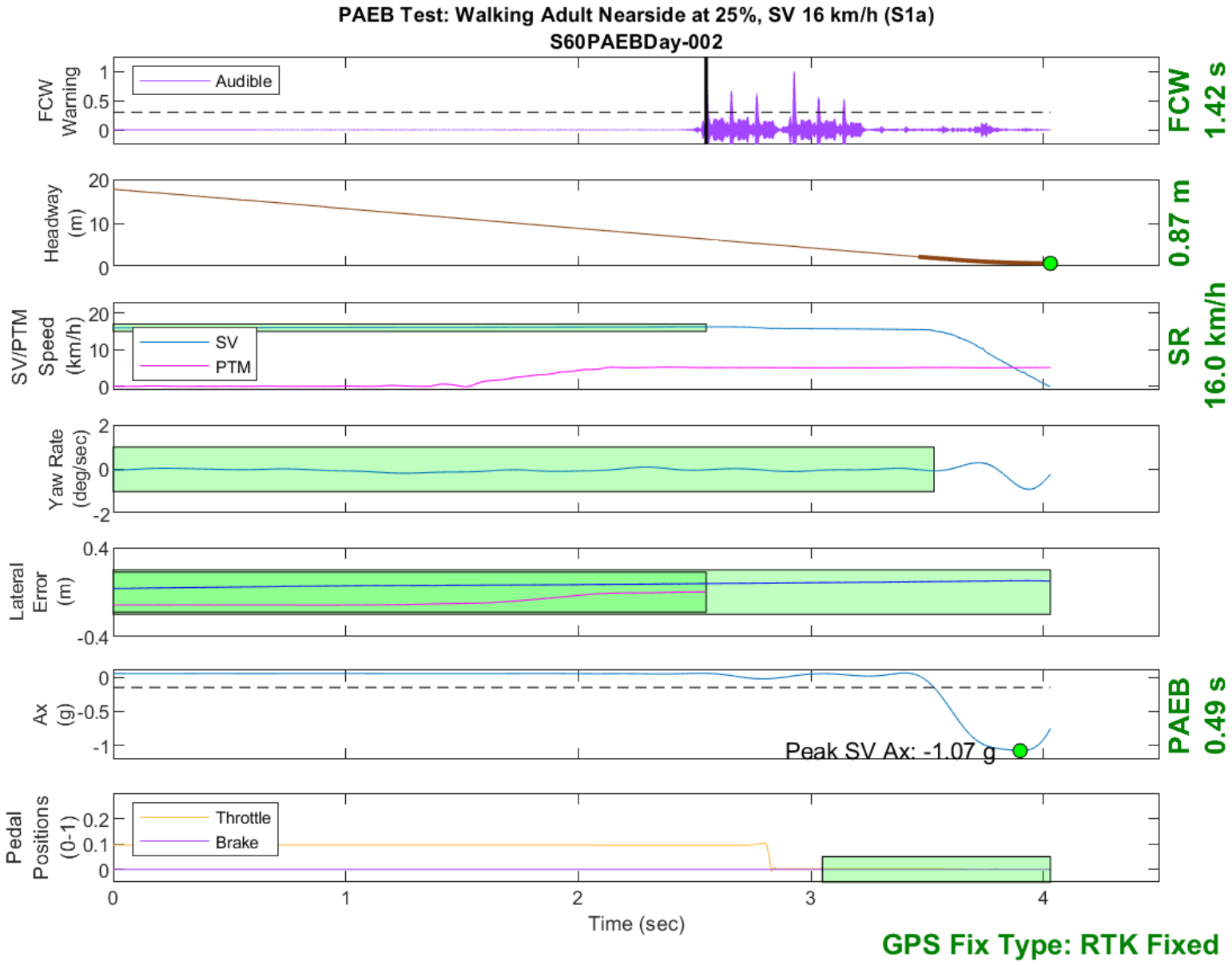


Figure D6. Time History for PAEB Run 2, S1a, Daytime, 16 km/h

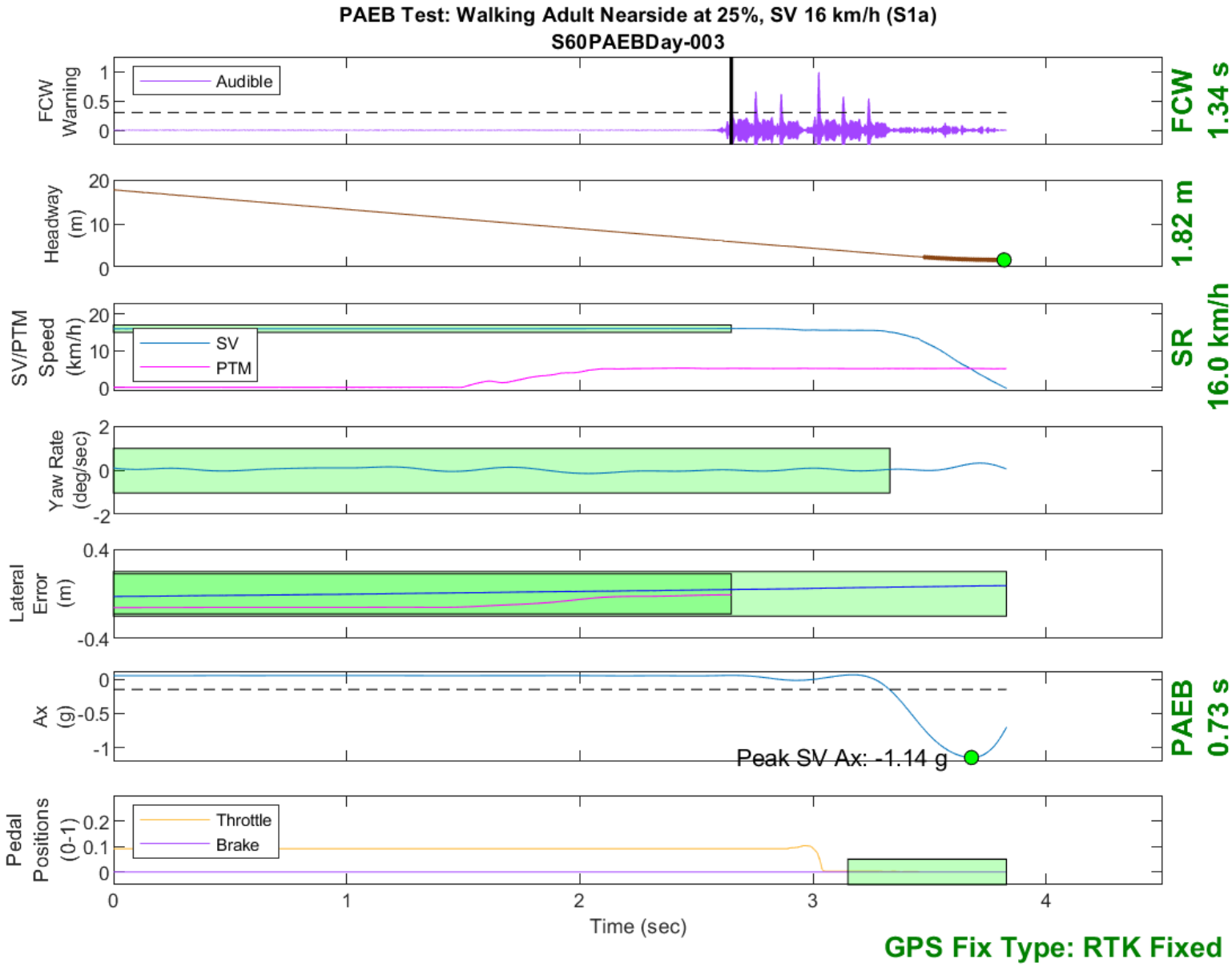


Figure D7. Time History for PAEB Run 3, S1a, Daytime, 16 km/h

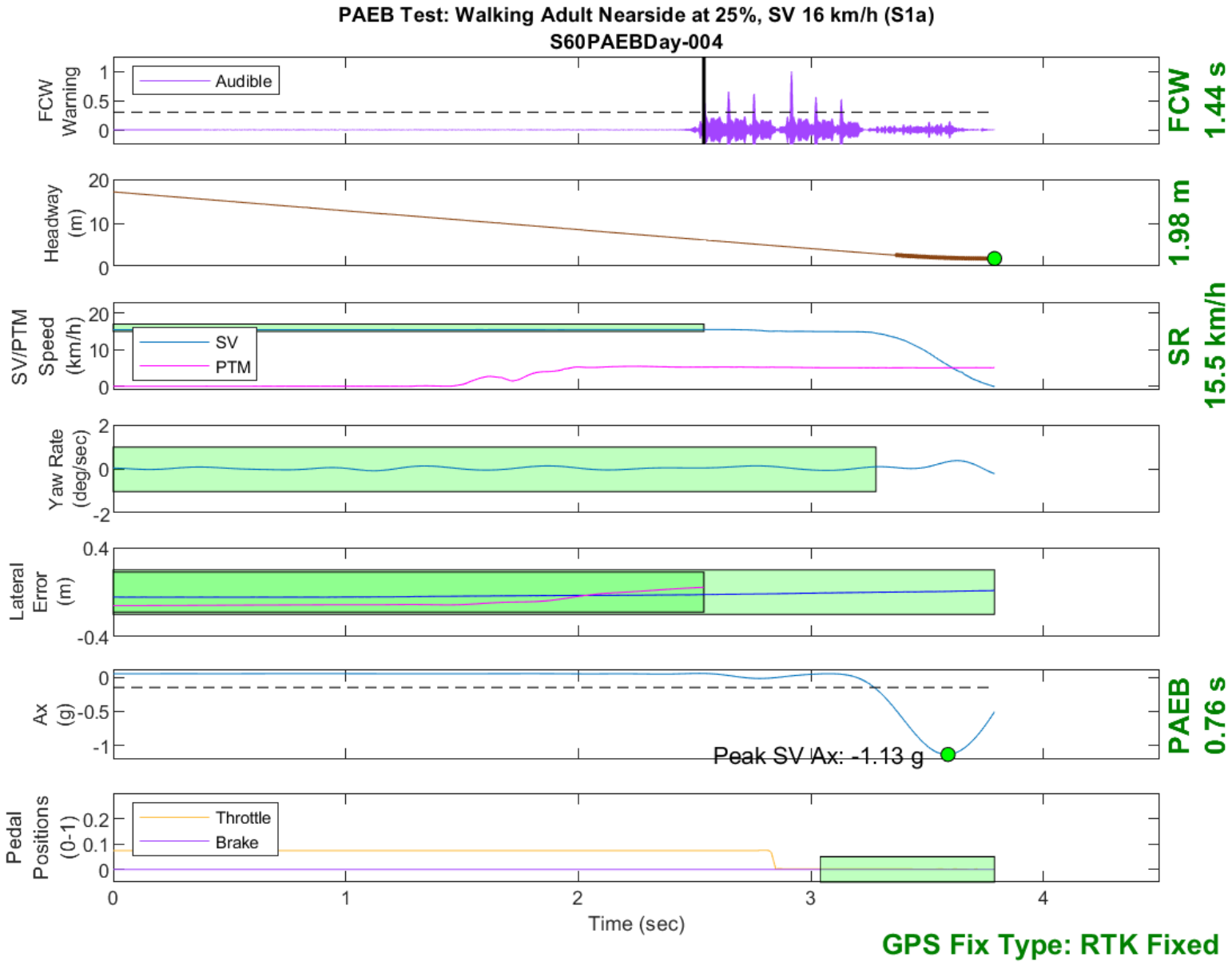


Figure D8. Time History for PAEB Run 4, S1a, Daytime, 16 km/h

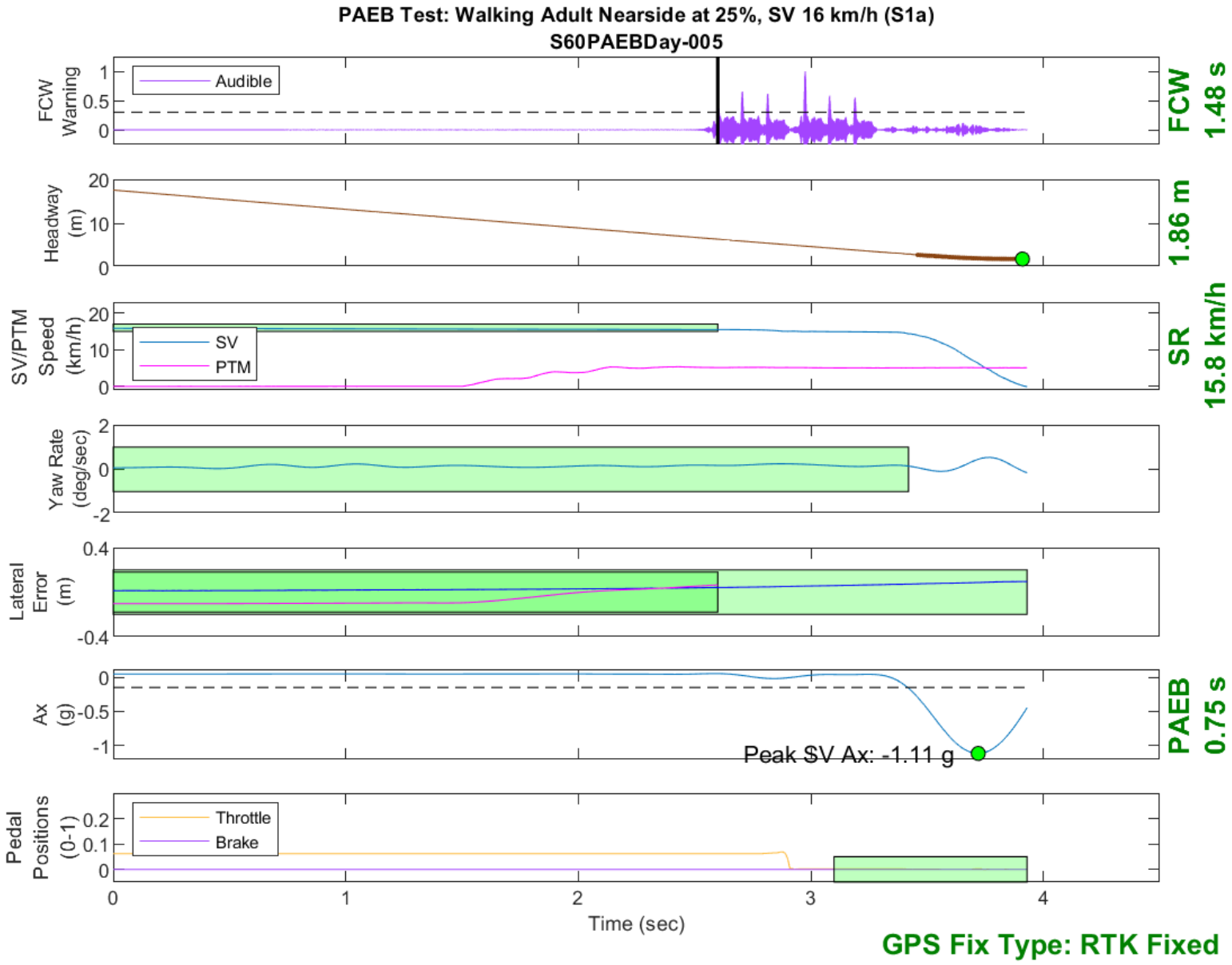


Figure D9. Time History for PAEB Run 5, S1a, Daytime, 16 km/h

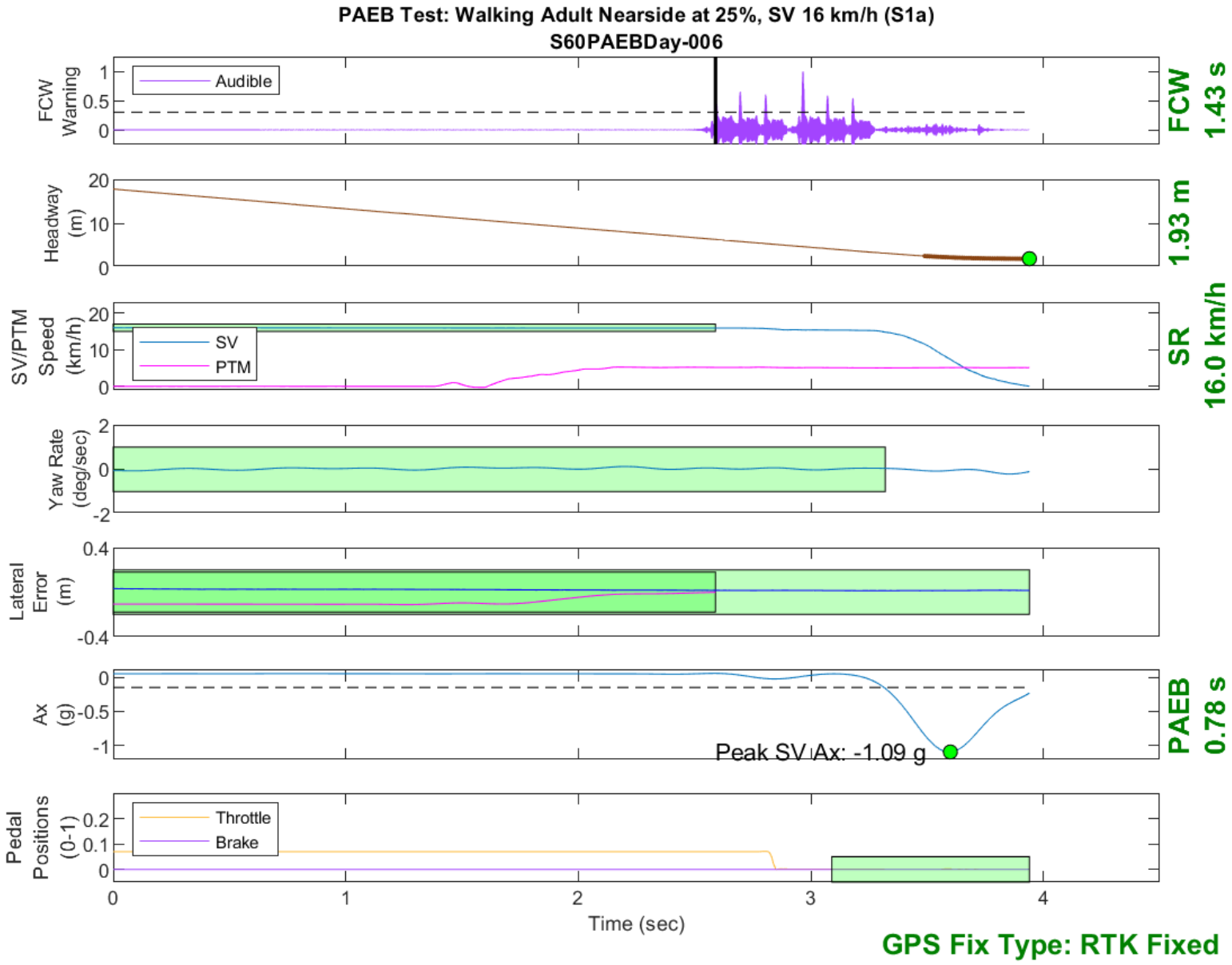


Figure D10. Time History for PAEB Run 6, S1a, Daytime, 16 km/h



Figure D11. Time History for PAEB Run 10, S1a, Daytime, 40 km/h

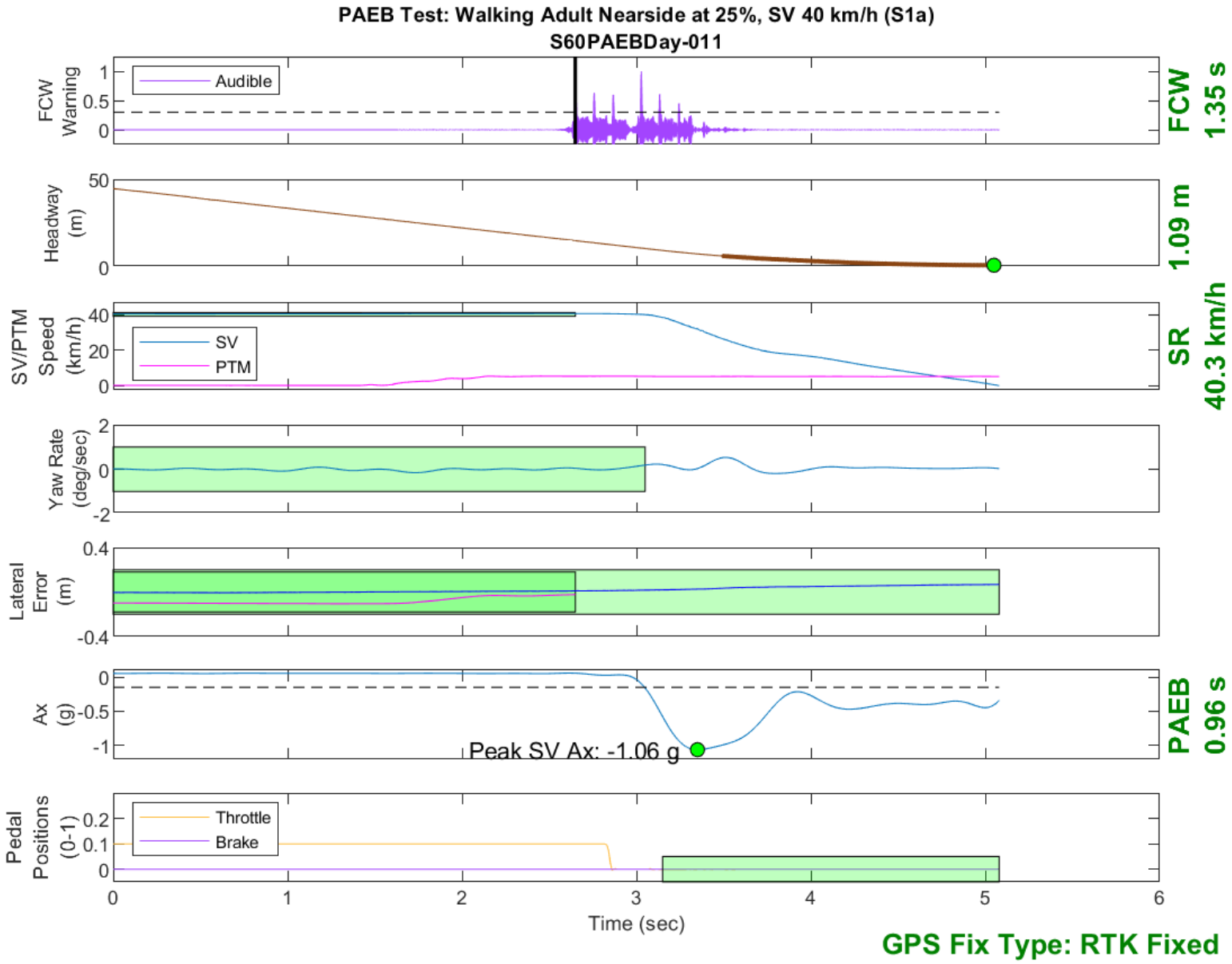


Figure D12. Time History for PAEB Run 11, S1a, Daytime, 40 km/h

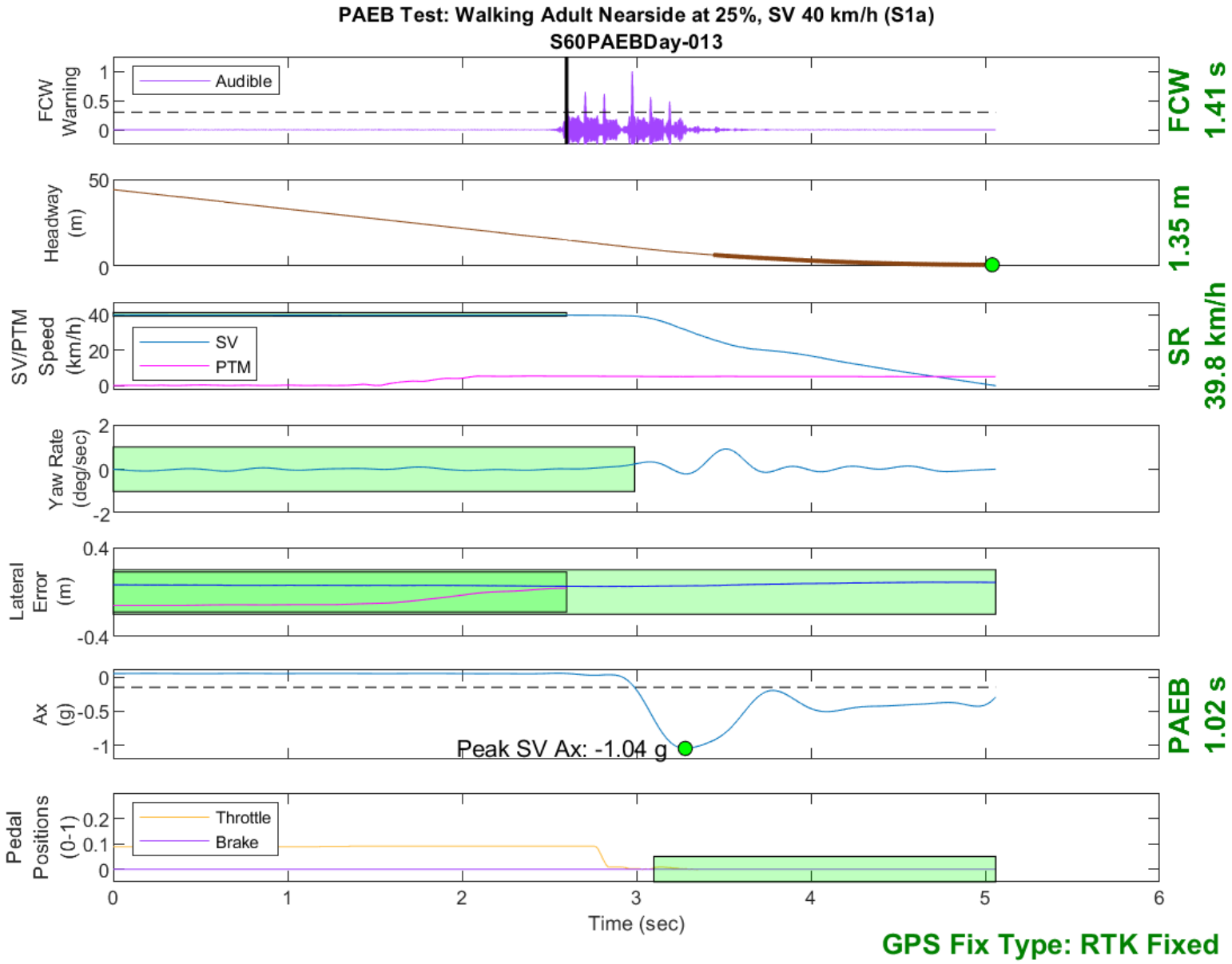


Figure D13. Time History for PAEB Run 13, S1a, Daytime, 40 km/h

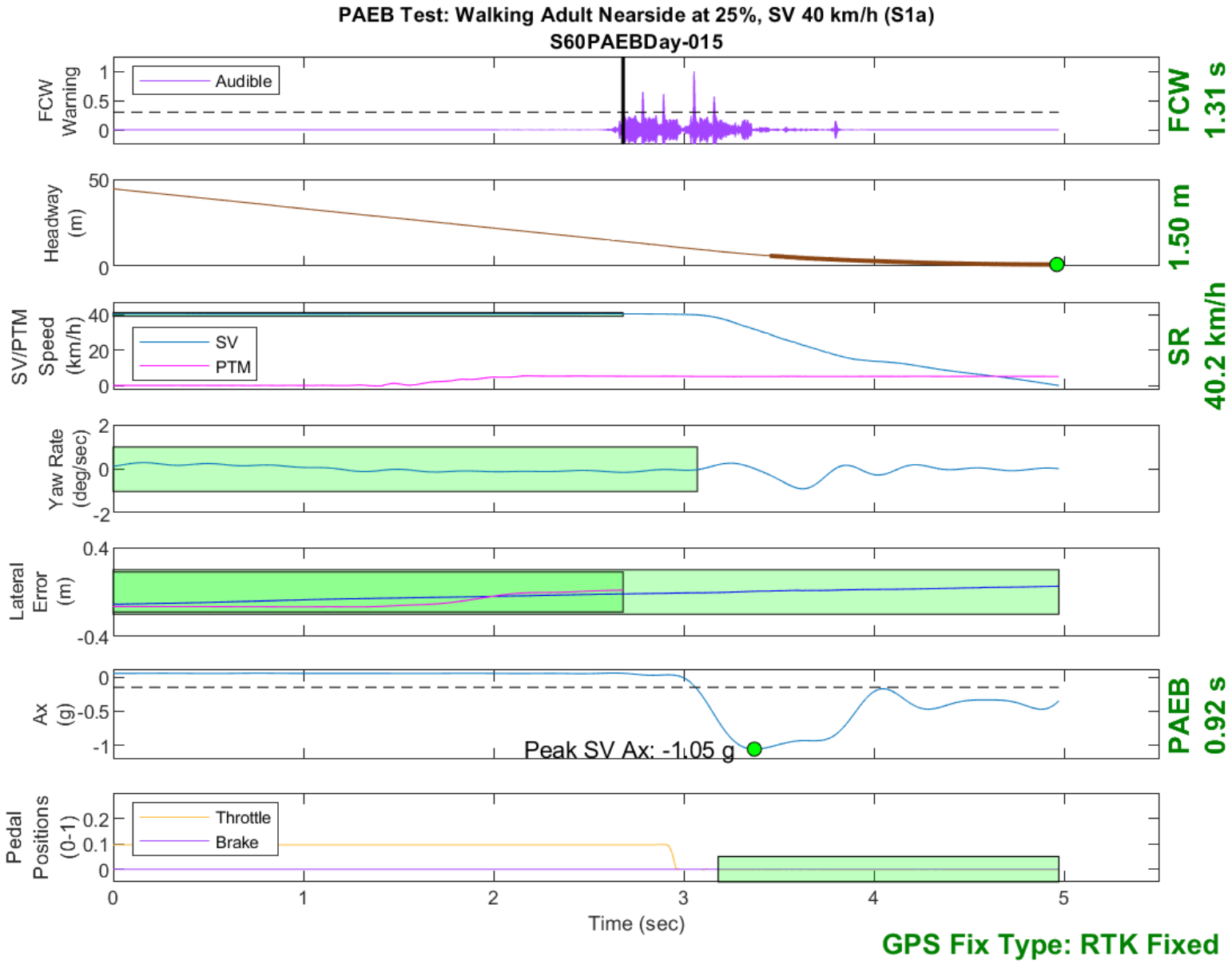


Figure D14. Time History for PAEB Run 15, S1a, Daytime, 40 km/h

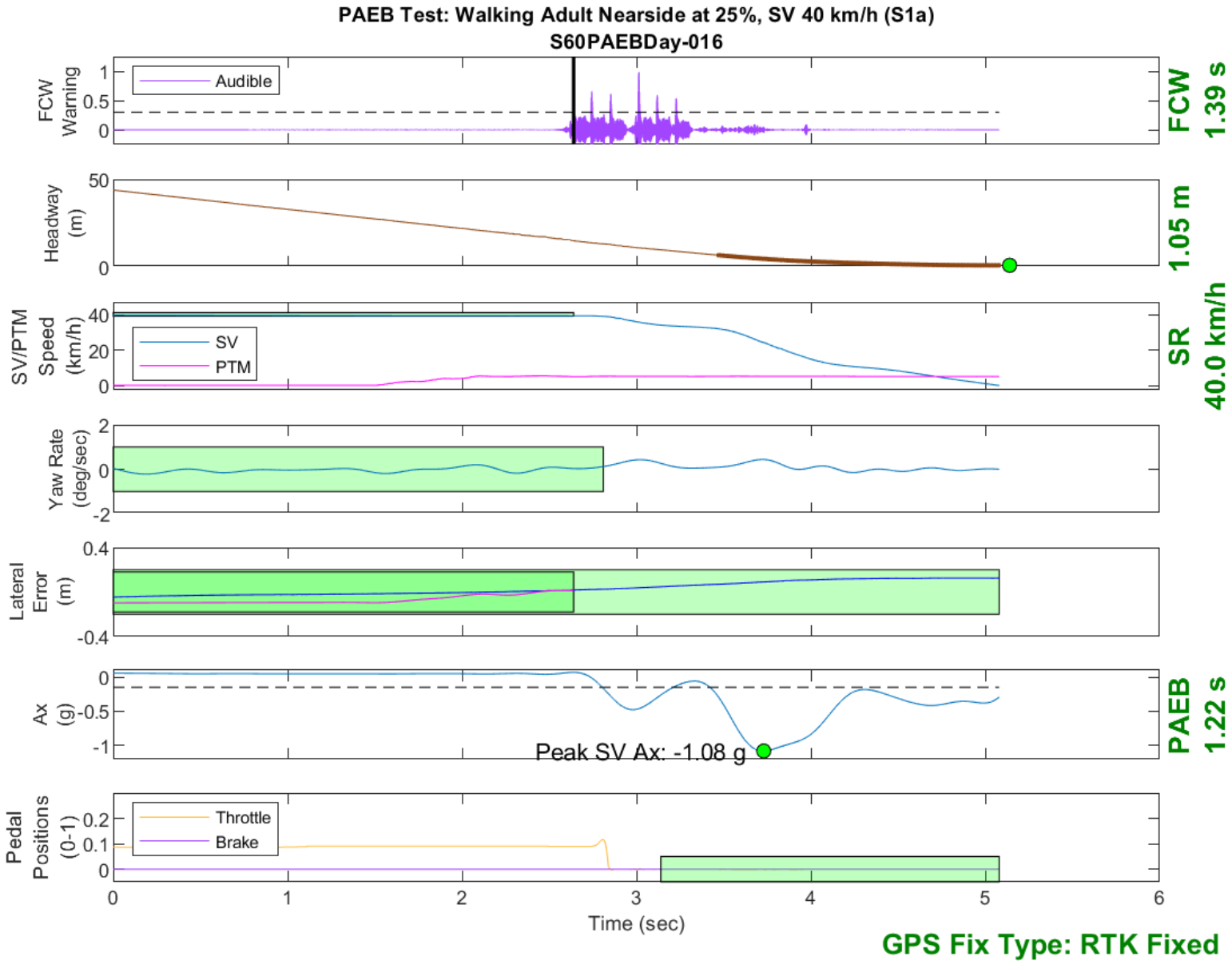


Figure D15. Time History for PAEB Run 16, S1a, Daytime, 40 km/h

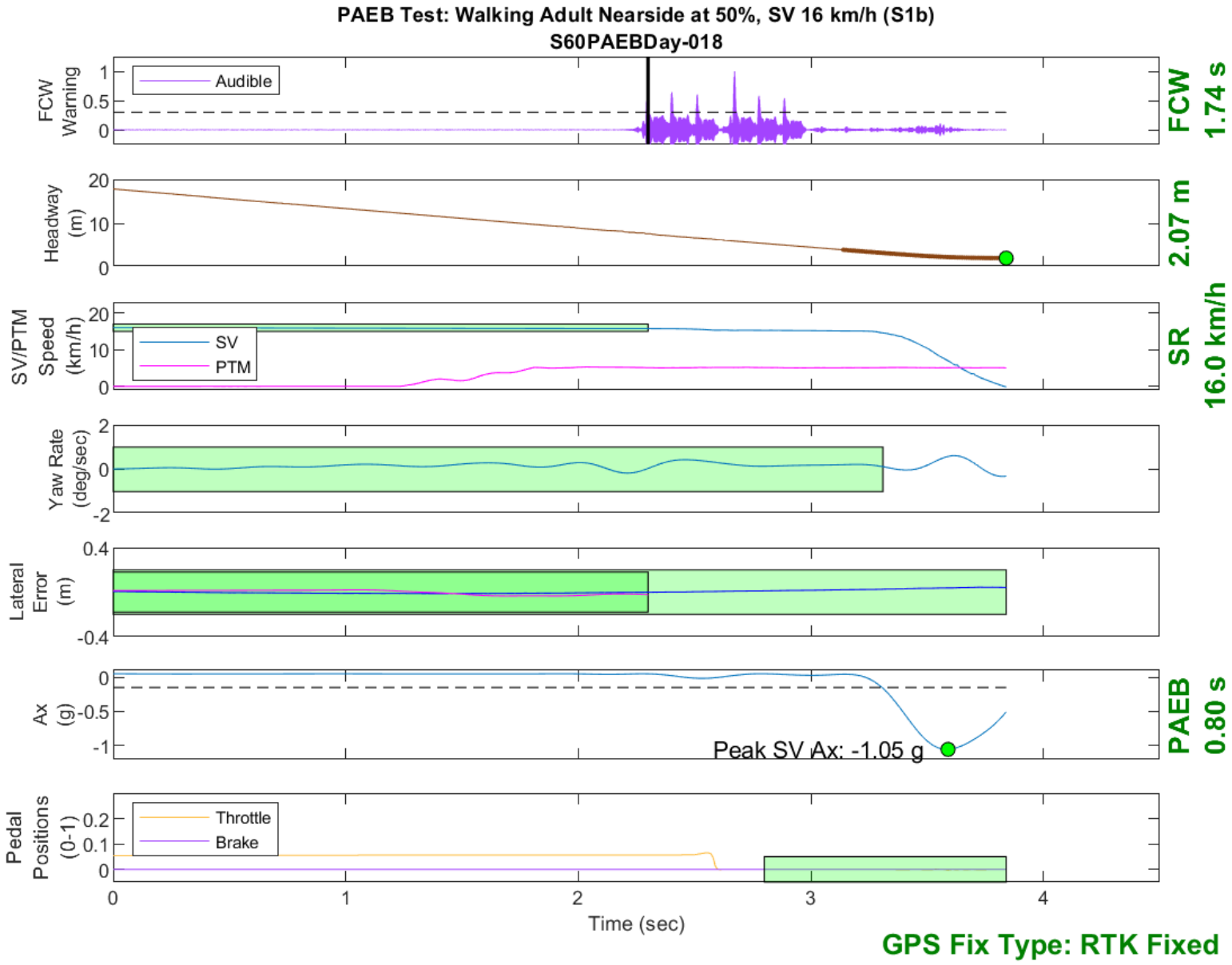


Figure D16. Time History for PAEB Run 18, S1b, Daytime, 16 km/h

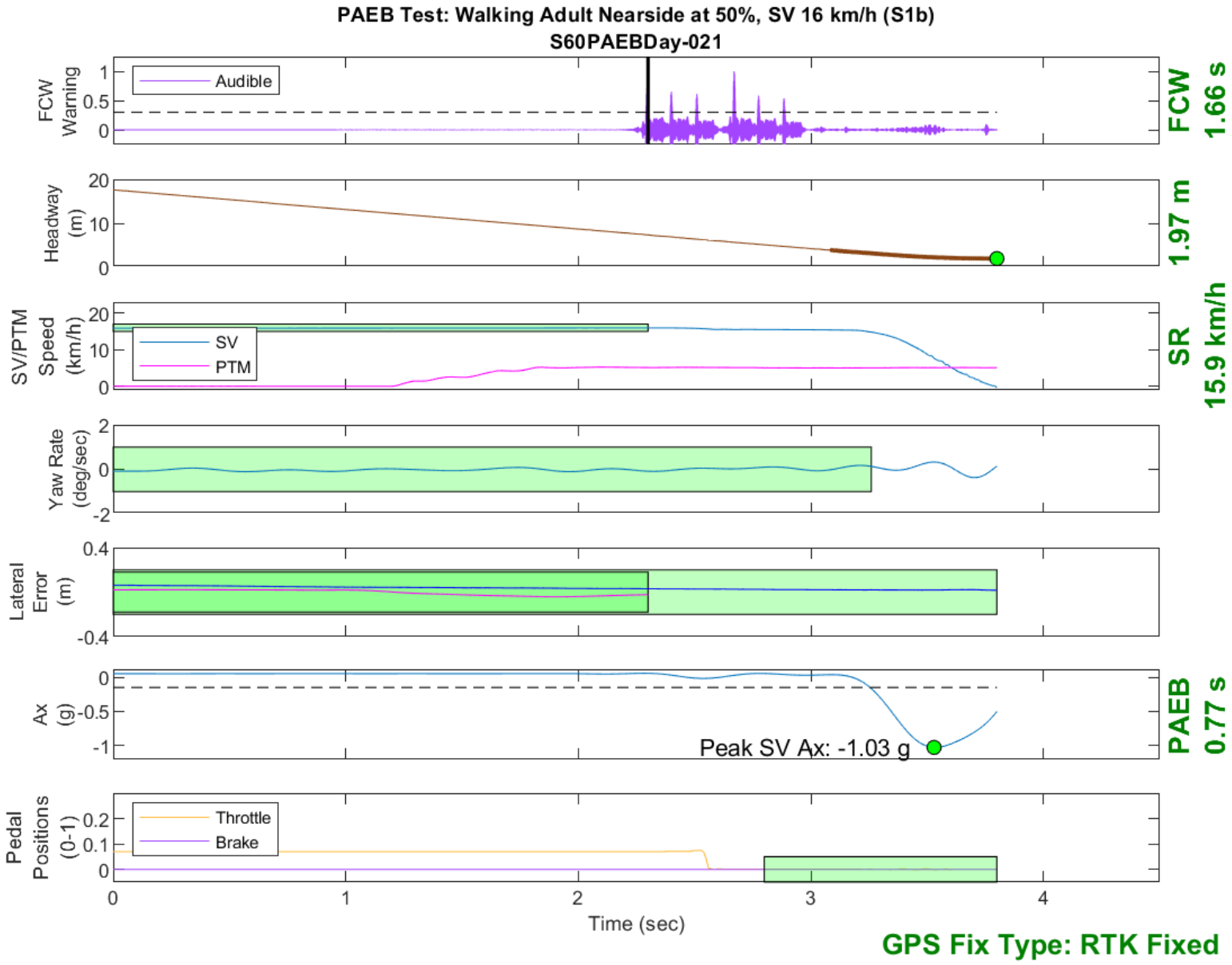


Figure D17. Time History for PAEB Run 21, S1b, Daytime, 16 km/h

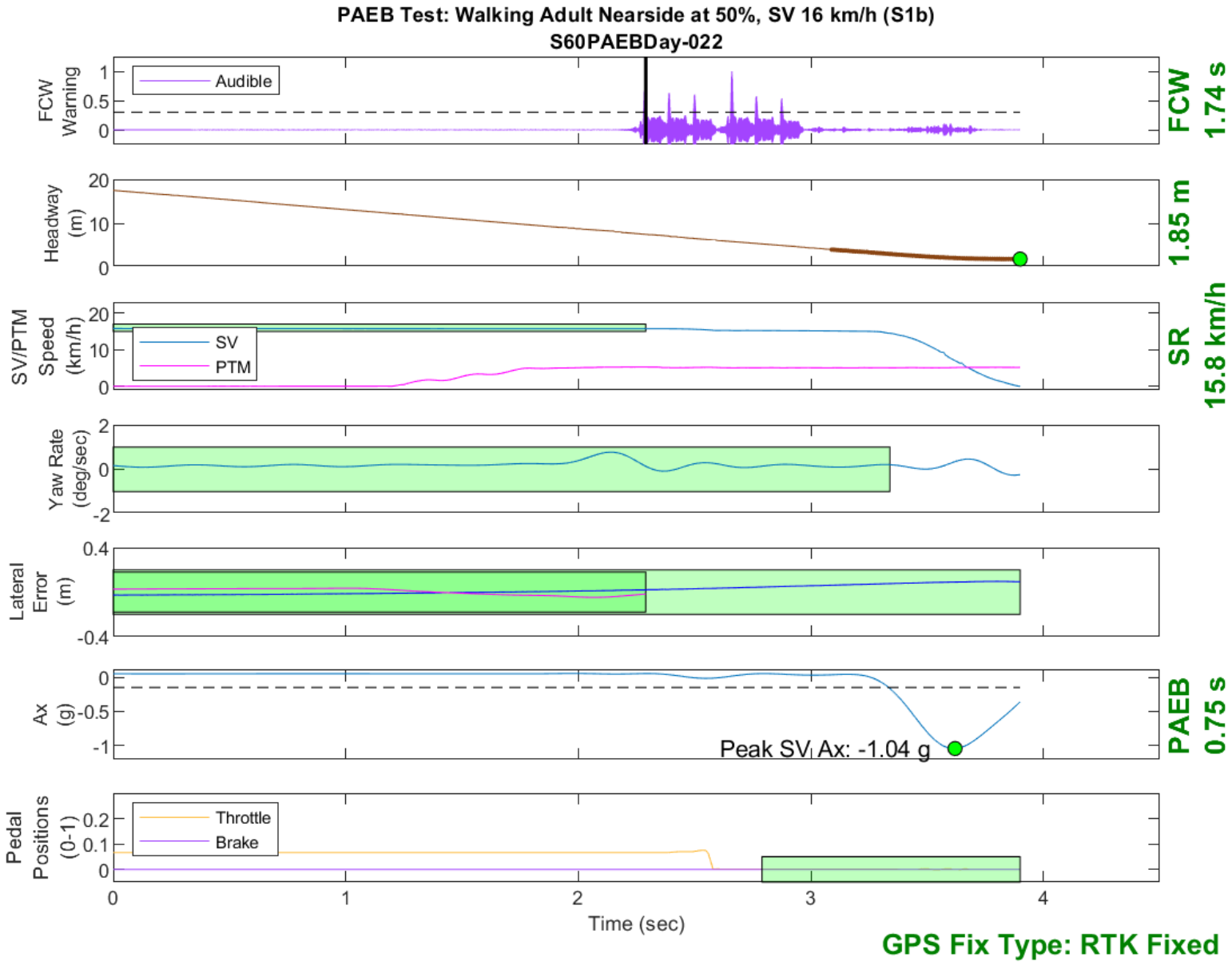


Figure D18. Time History for PAEB Run 22, S1b, Daytime, 16 km/h

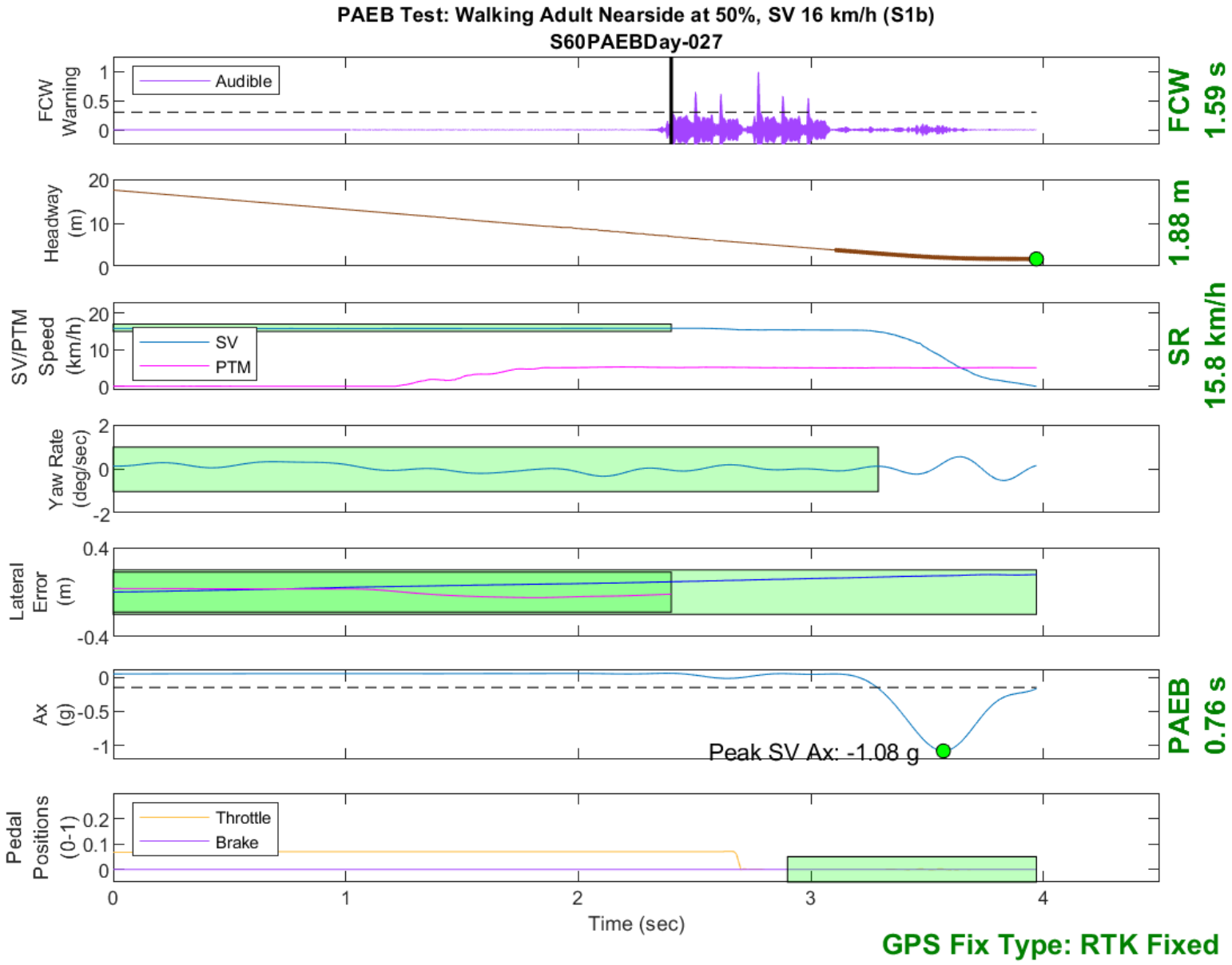


Figure D19. Time History for PAEB Run 27, S1b, Daytime, 16 km/h

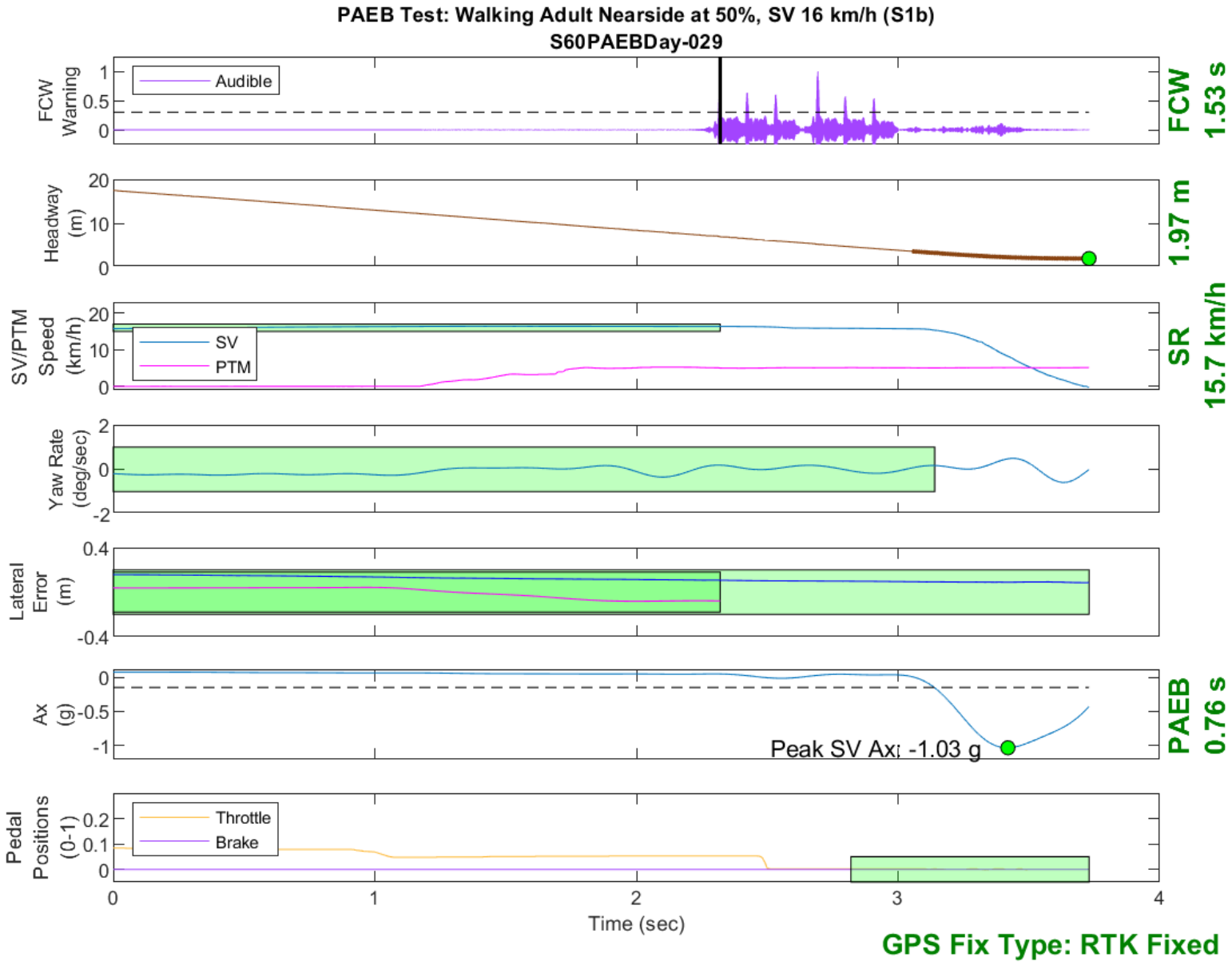


Figure D20. Time History for PAEB Run 29, S1b, Daytime, 16 km/h

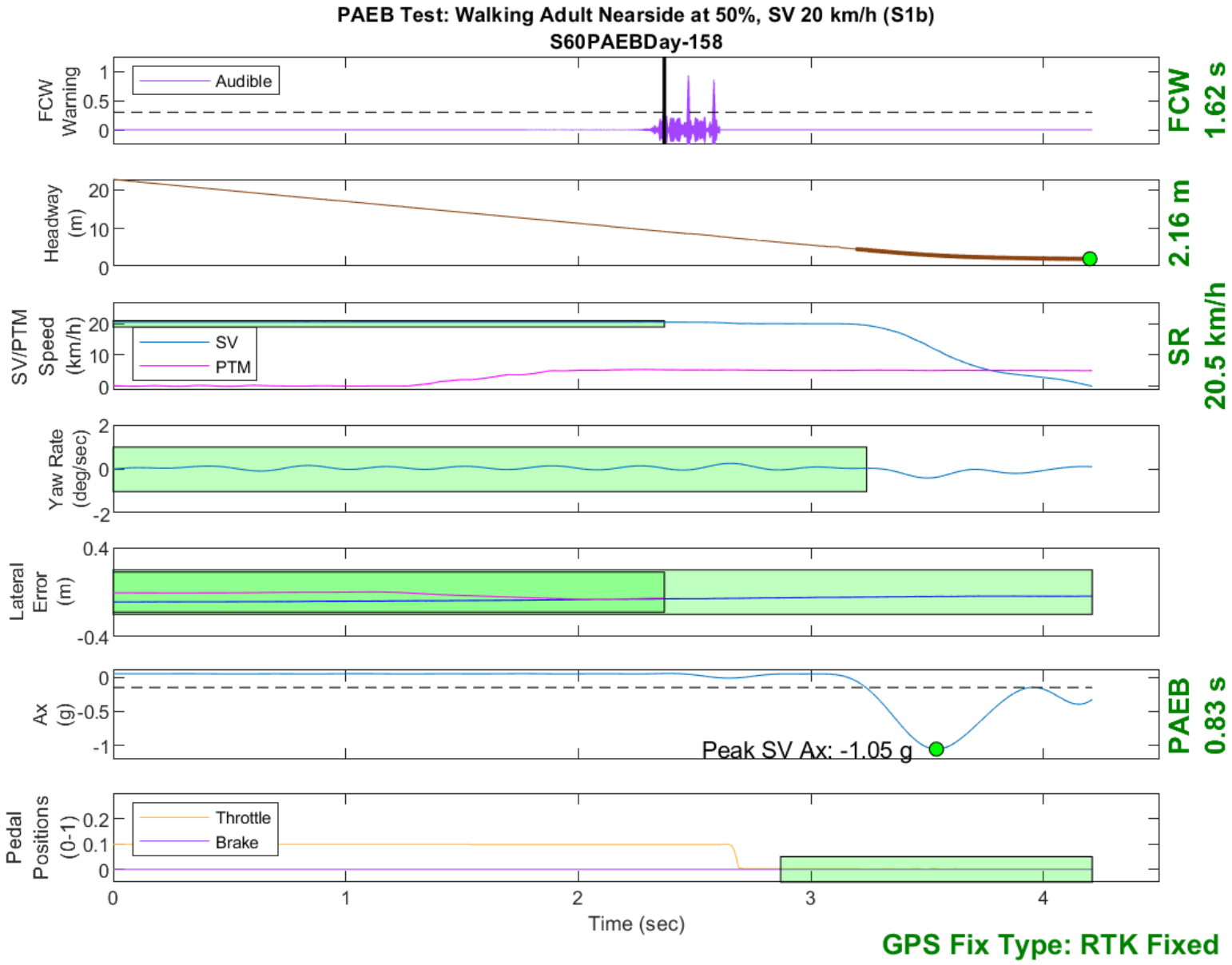


Figure D21. Time History for PAEB Run 158, S1b, Daytime, 20 km/h

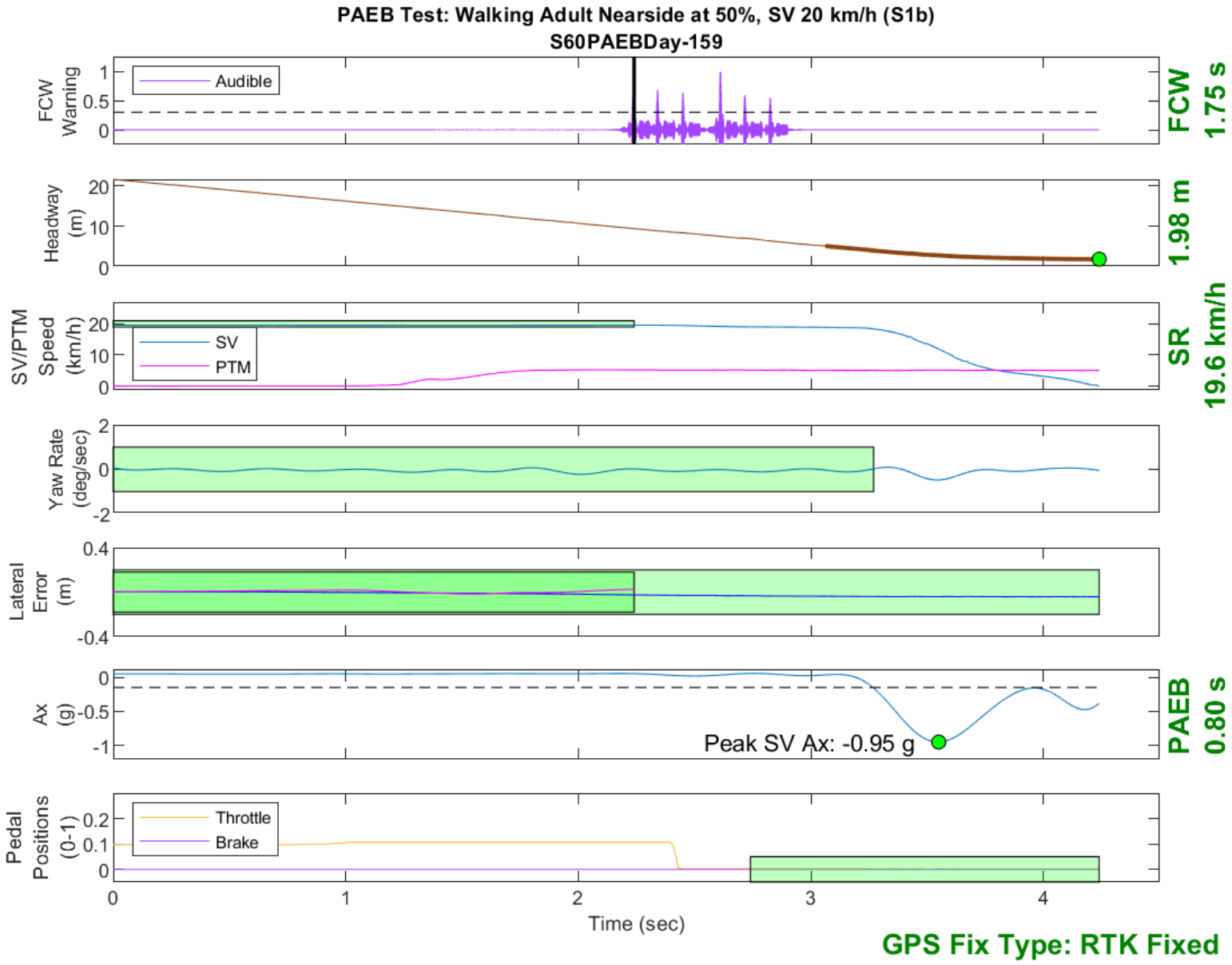


Figure D22. Time History for PAEB Run 159, S1b, Daytime, 20 km/h

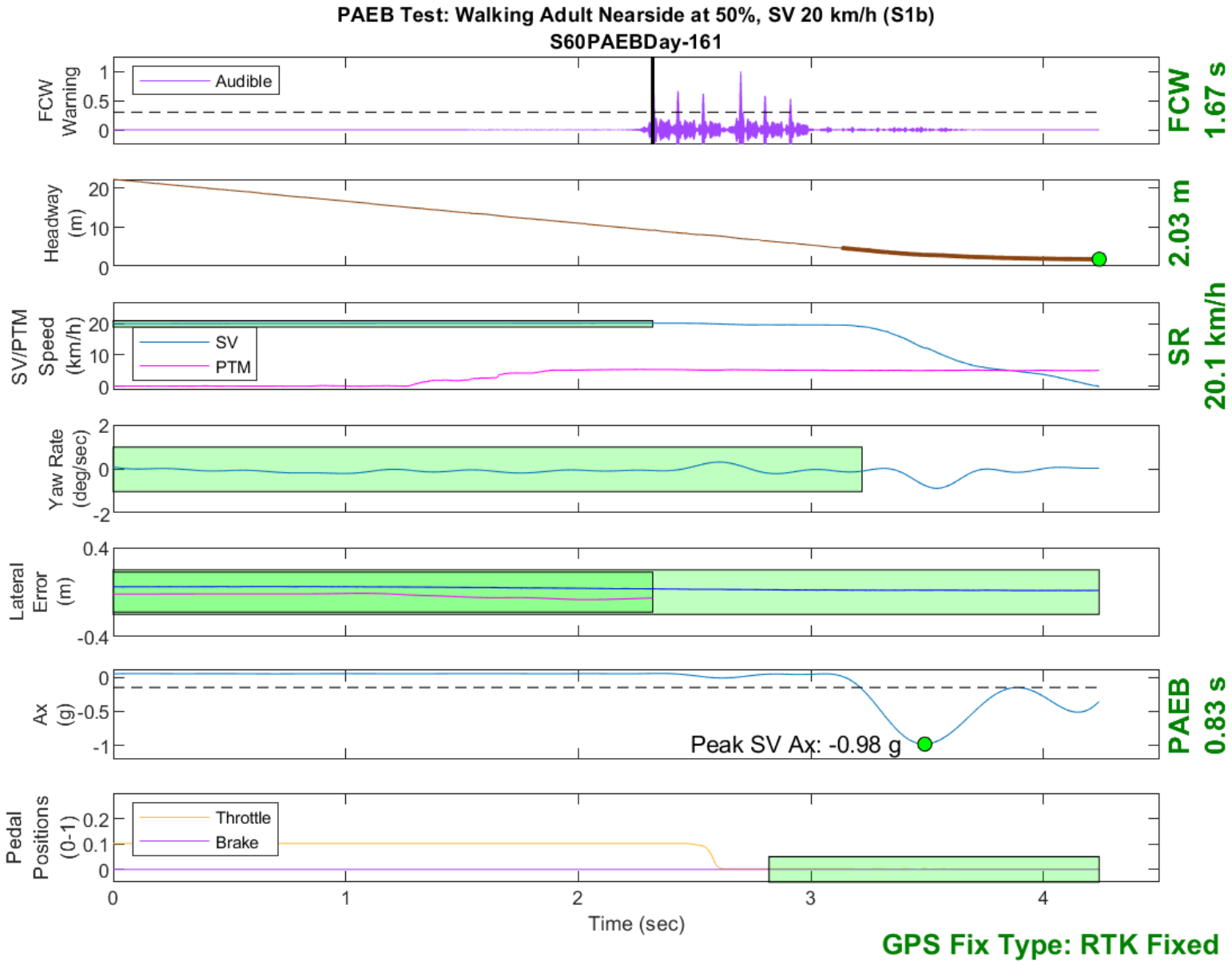


Figure D23. Time History for PAEB Run 161, S1b, Daytime, 20 km/h

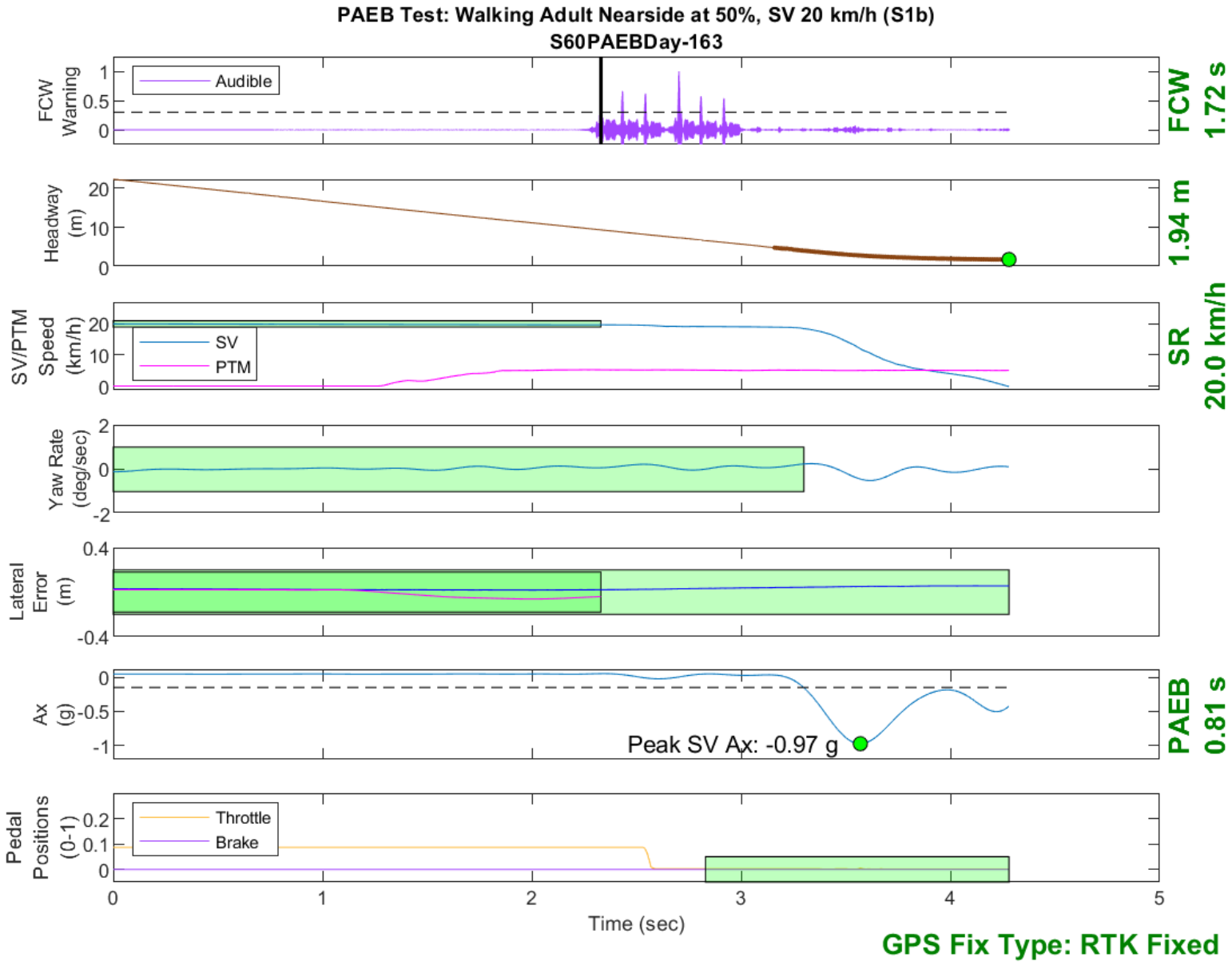


Figure D24. Time History for PAEB Run 163, S1b, Daytime, 20 km/h

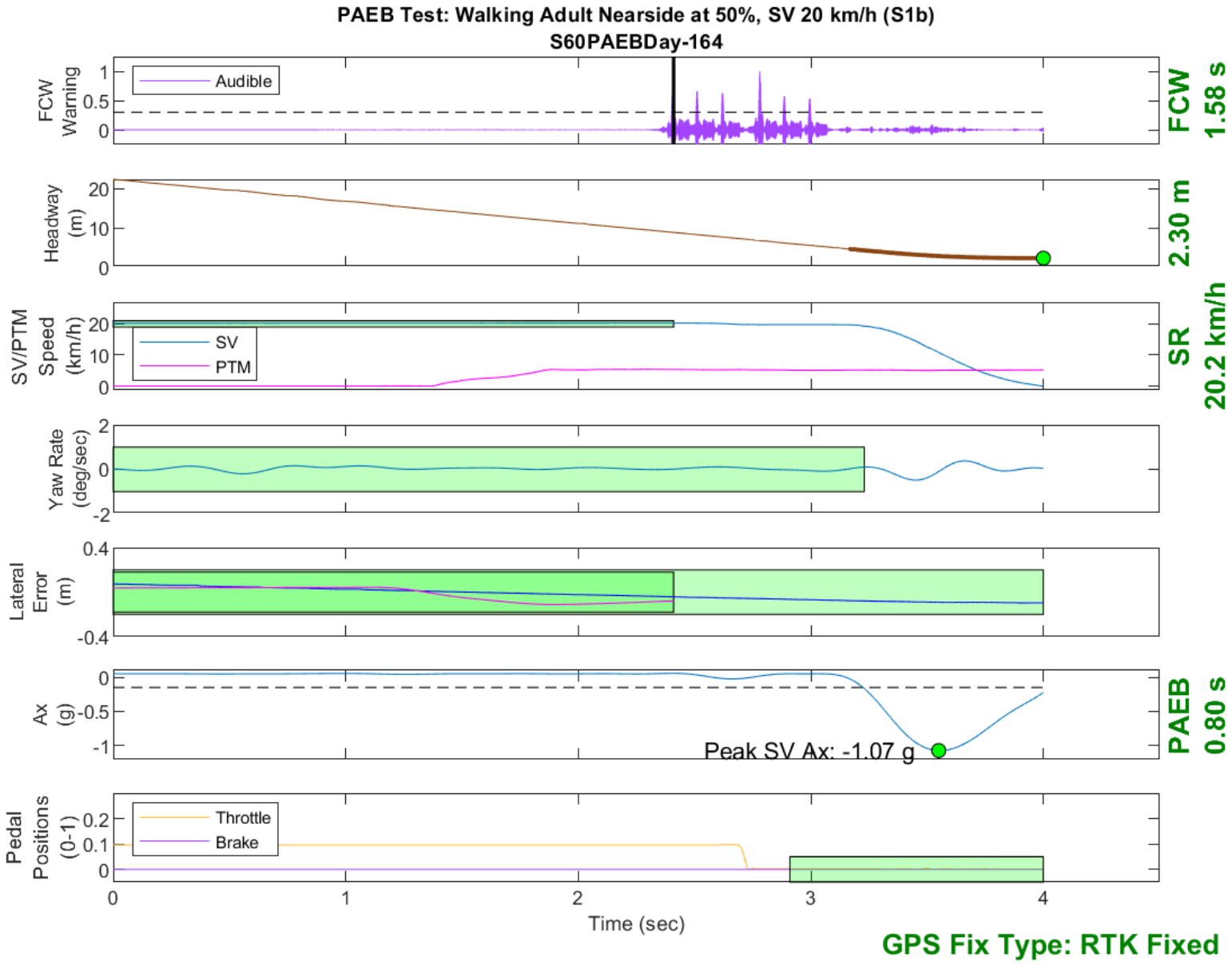


Figure D25. Time History for PAEB Run 164, S1b, Daytime, 20 km/h

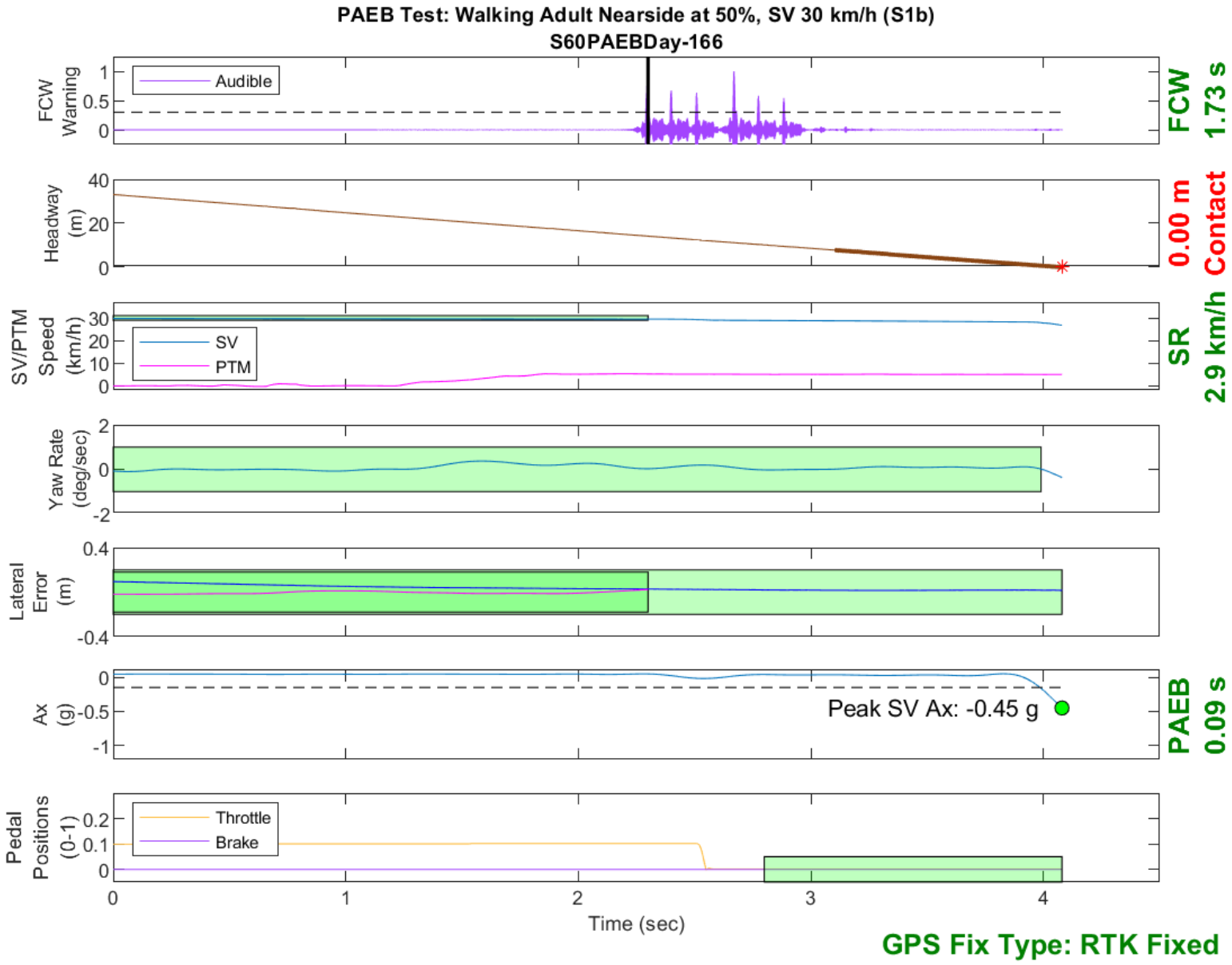


Figure D26. Time History for PAEB Run 166, S1b, Daytime, 30 km/h

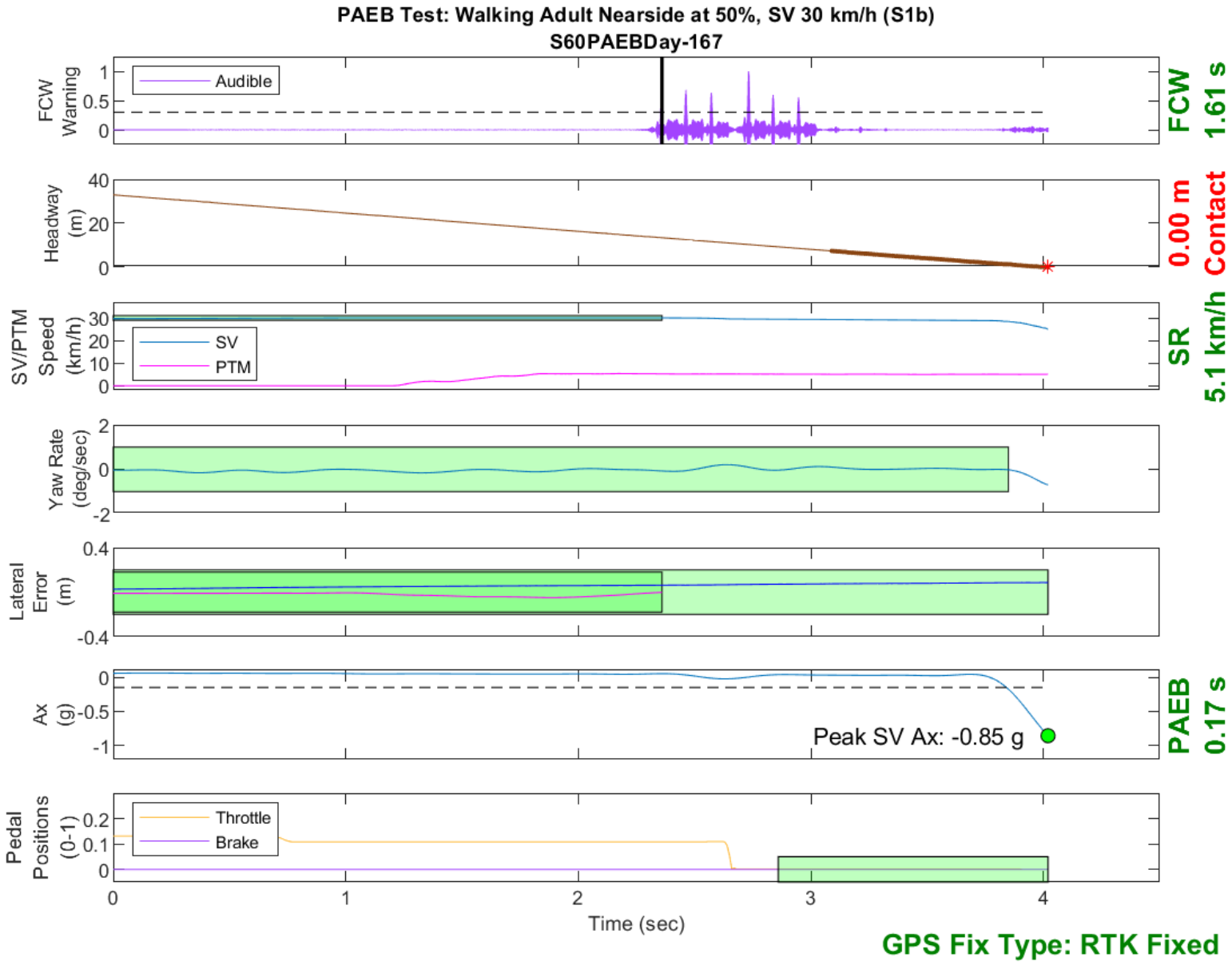


Figure D27. Time History for PAEB Run 167, S1b, Daytime, 30 km/h

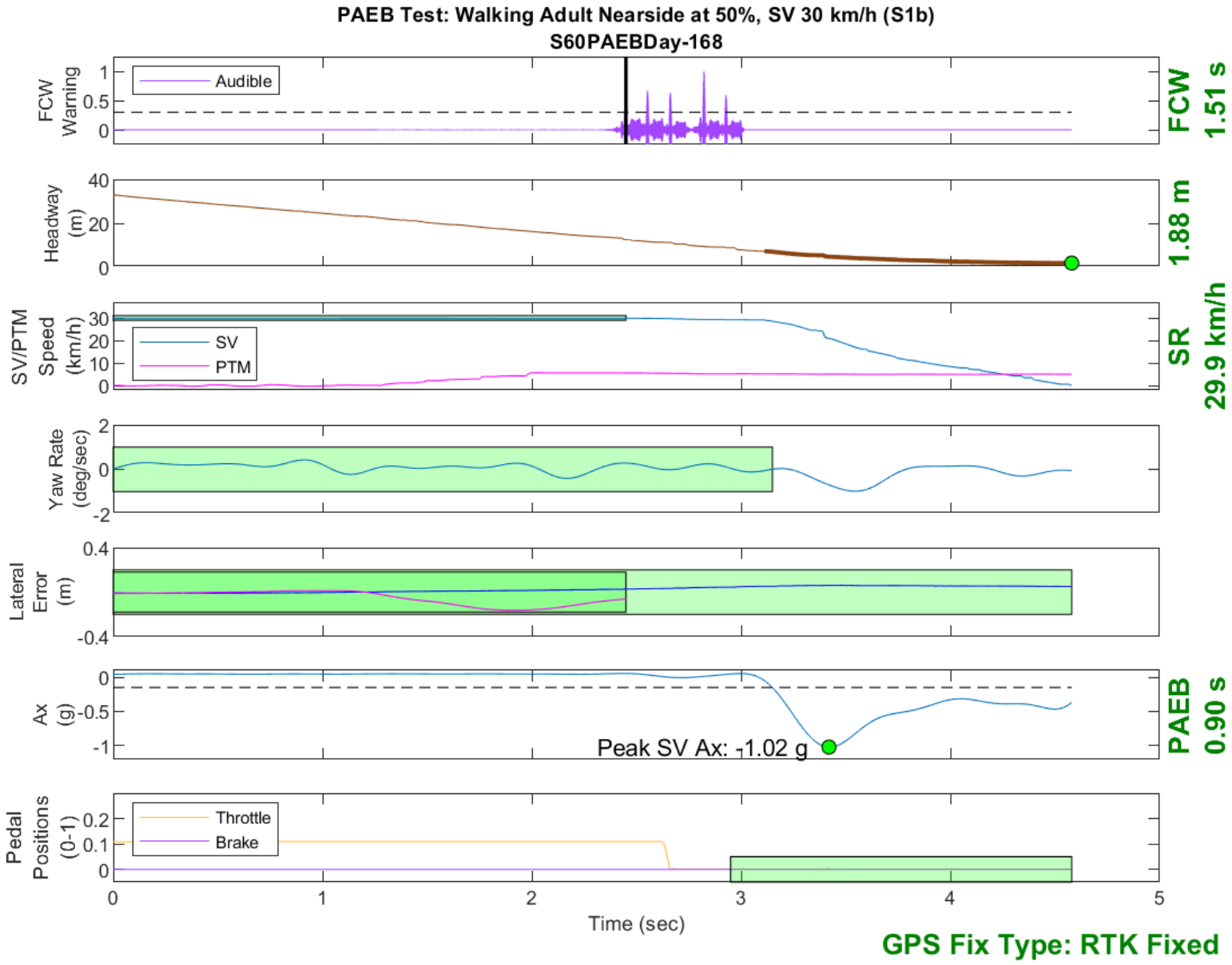


Figure D28. Time History for PAEB Run 168, S1b, Daytime, 30 km/h

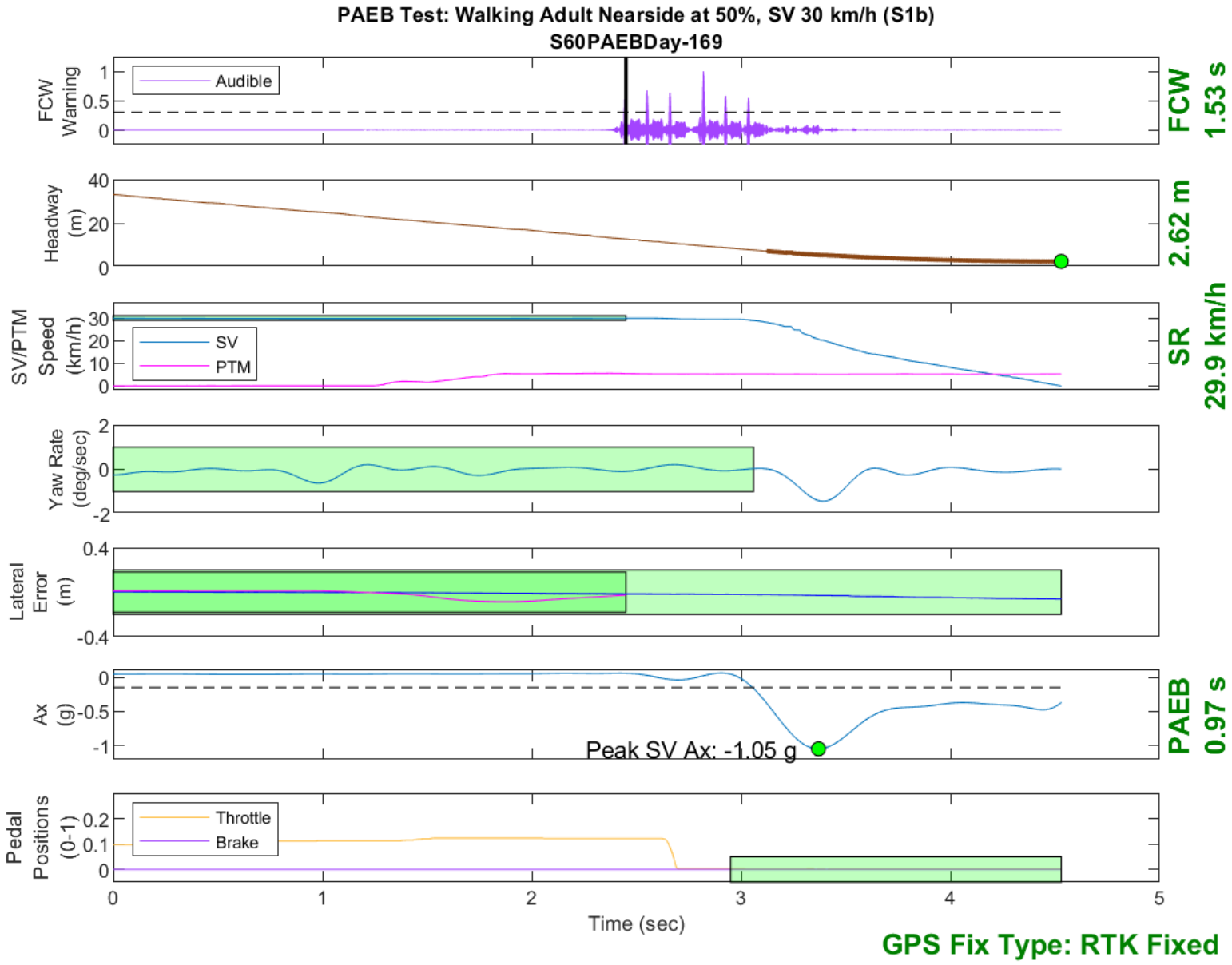


Figure D29. Time History for PAEB Run 169, S1b, Daytime, 30 km/h

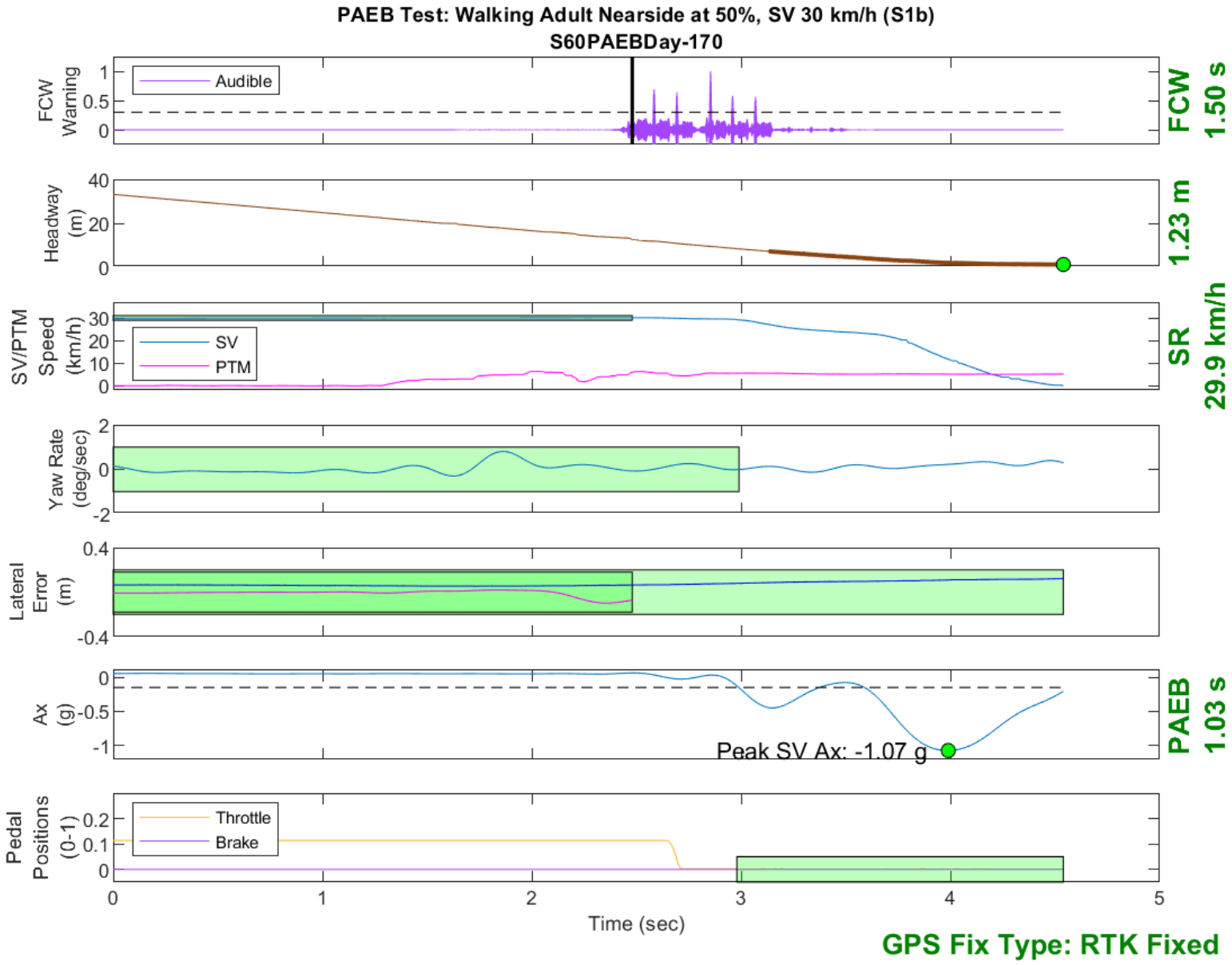


Figure D30. Time History for PAEB Run 170, S1b, Daytime, 30 km/h

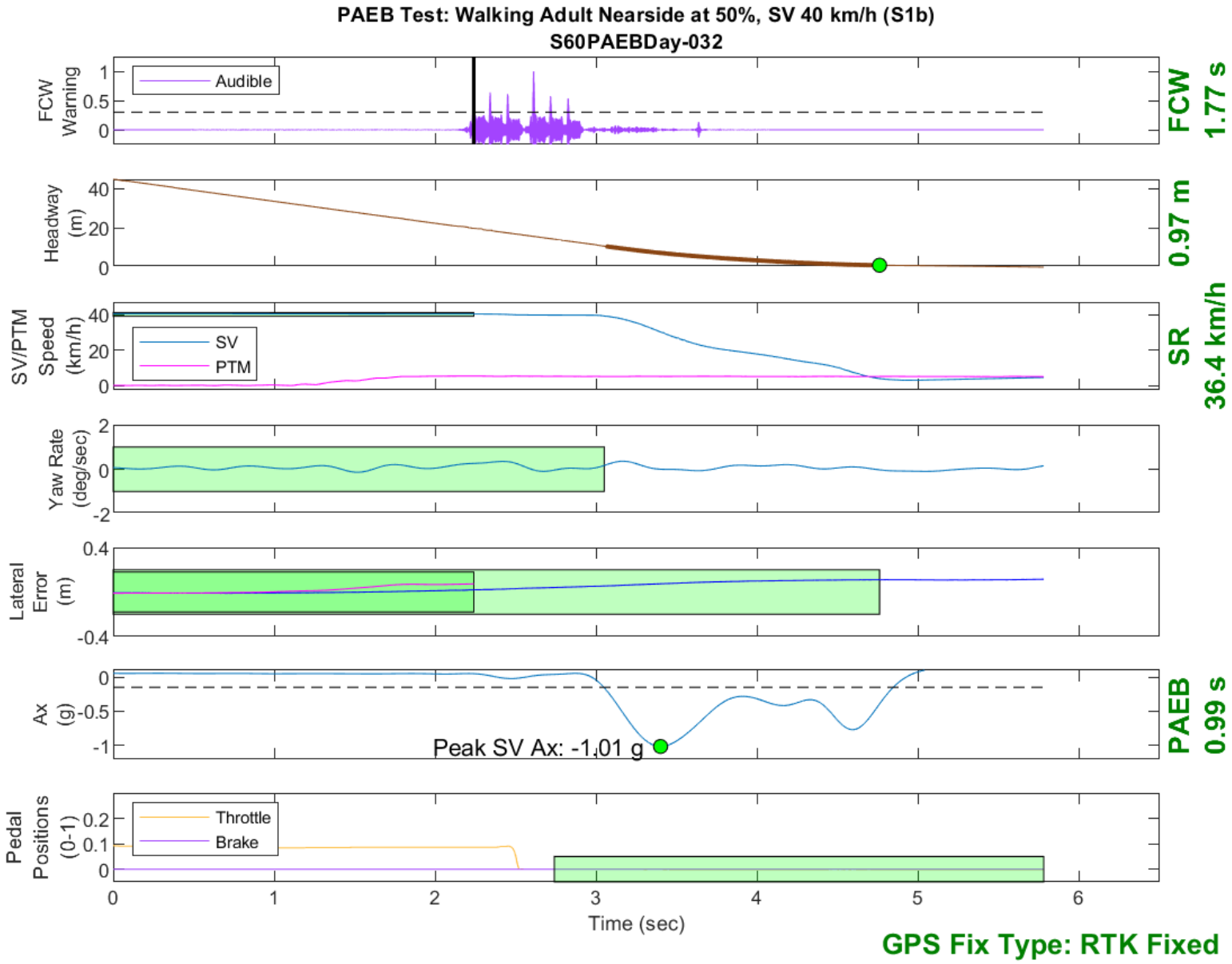


Figure D31. Time History for PAEB Run 32, S1b, Daytime, 40 km/h

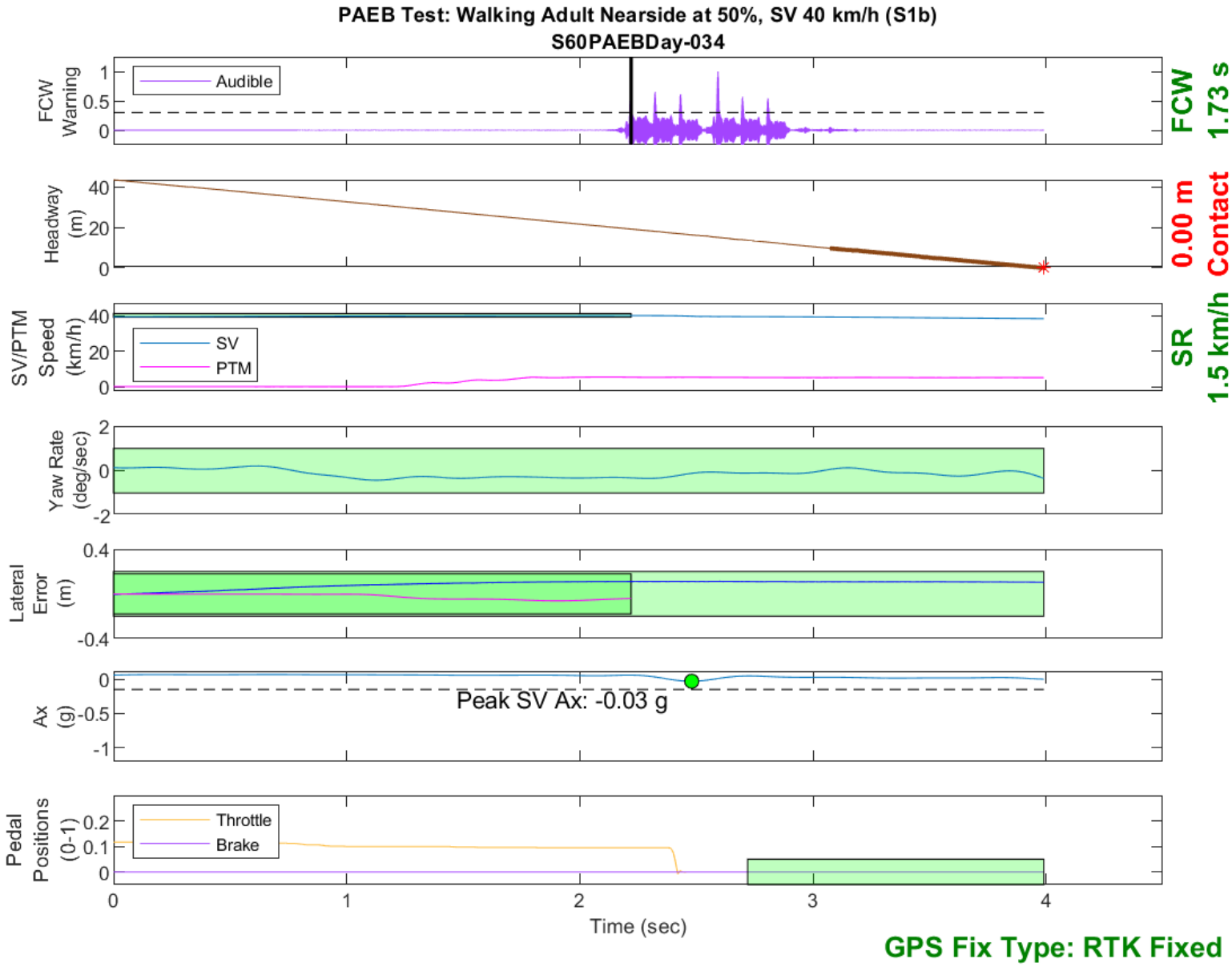


Figure D32. Time History for PAEB Run 34, S1b, Daytime, 40 km/h

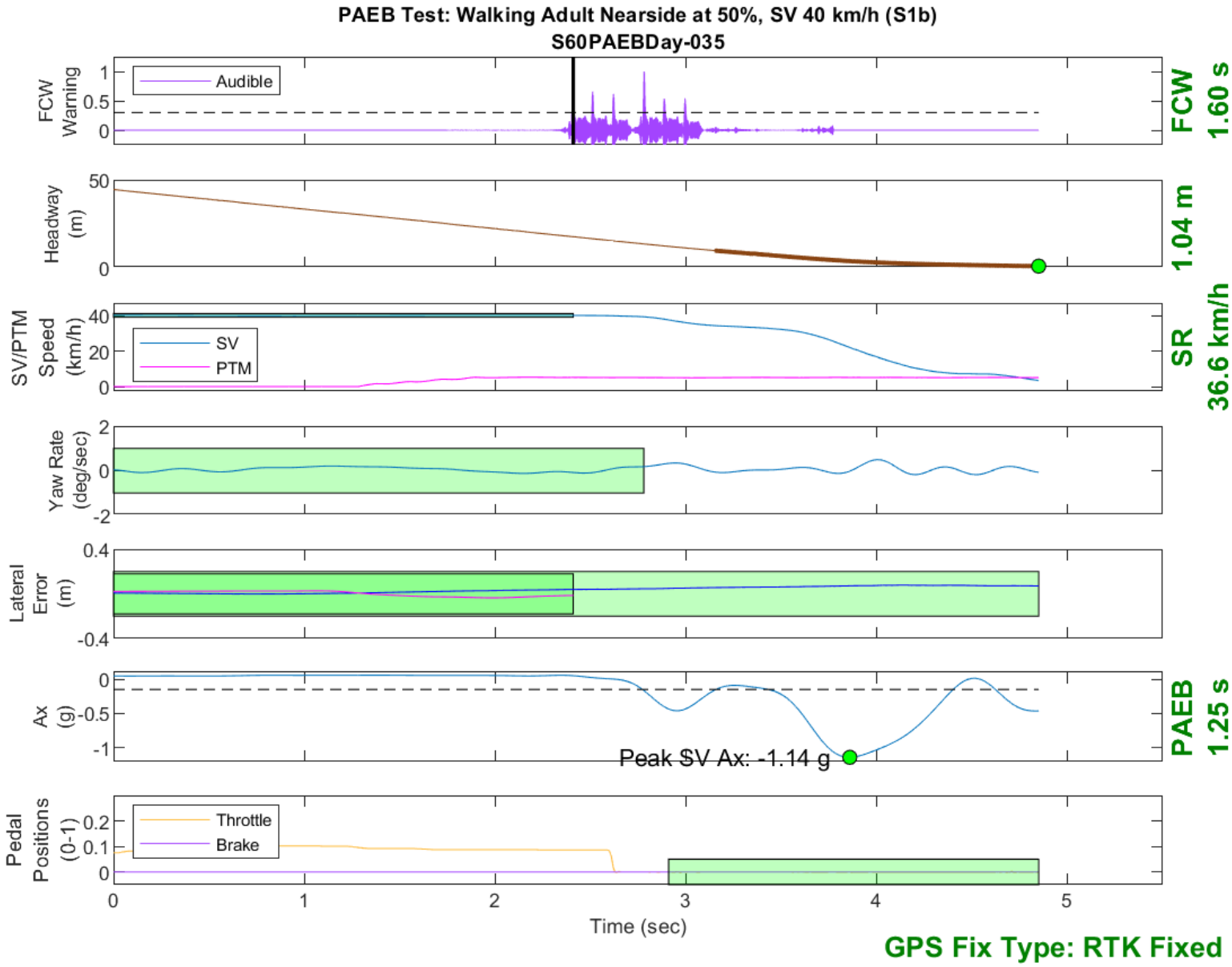


Figure D33. Time History for PAEB Run 35, S1b, Daytime, 40 km/h

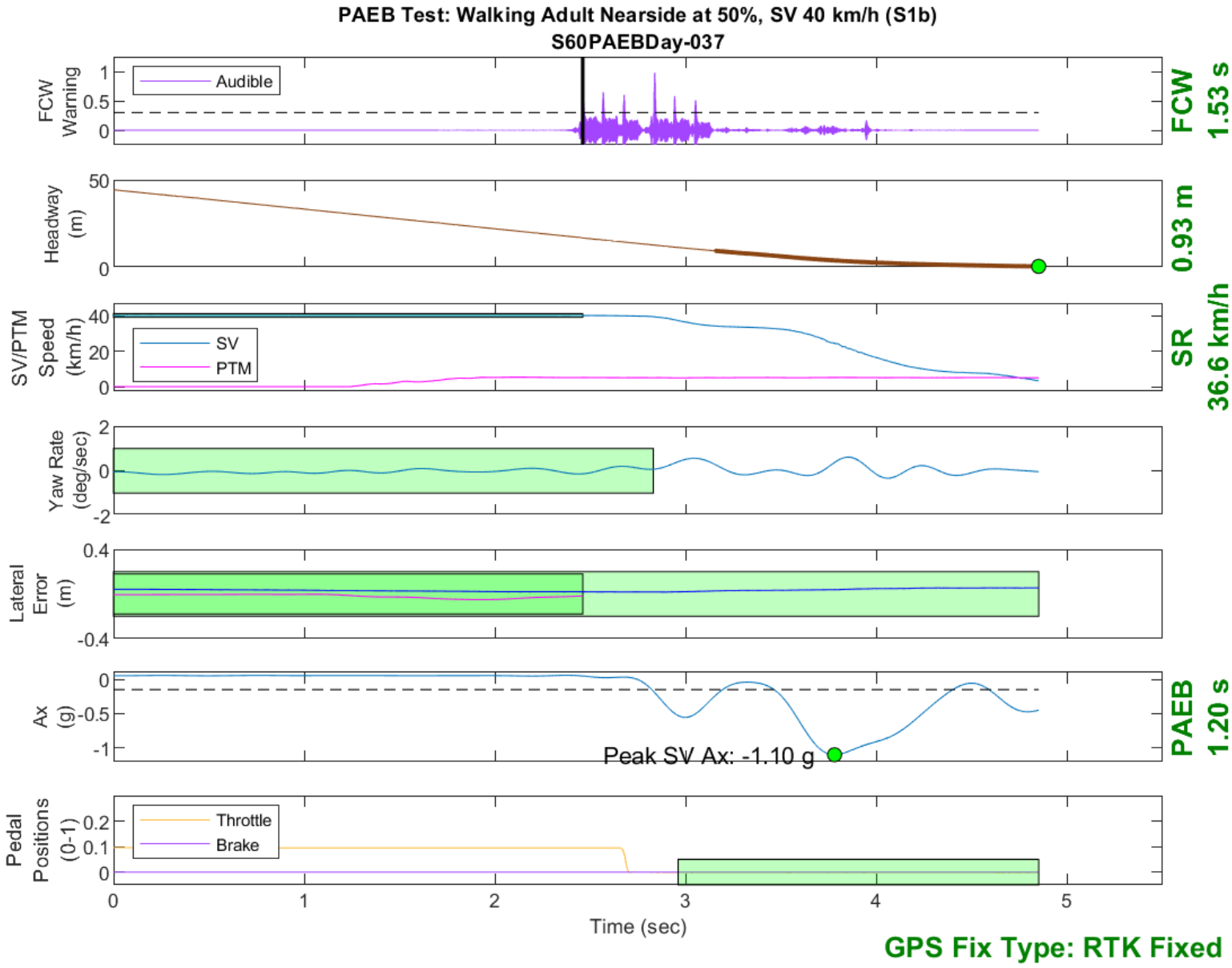


Figure D34. Time History for PAEB Run 37, S1b, Daytime, 40 km/h

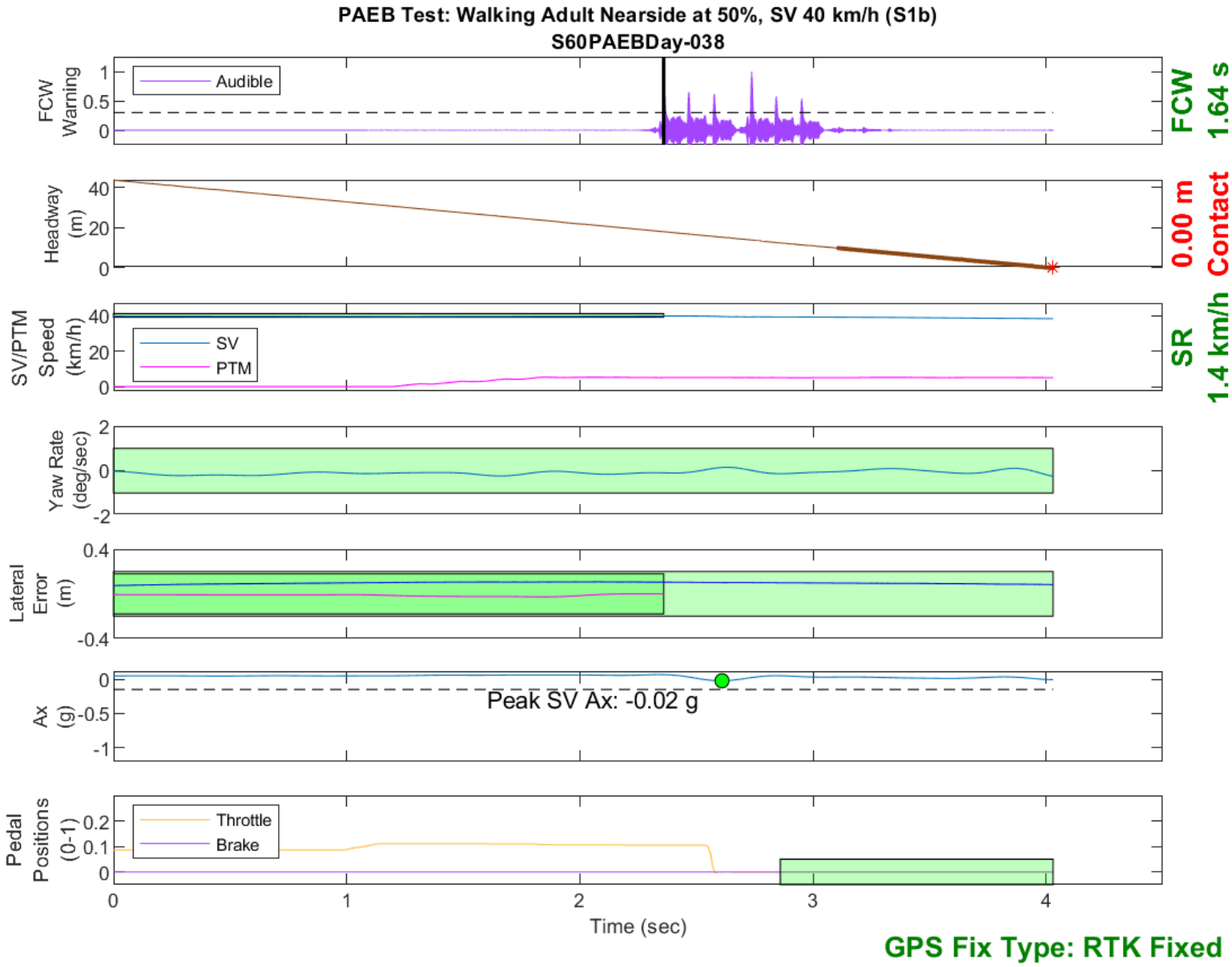


Figure D35. Time History for PAEB Run 38, S1b, Daytime, 40 km/h

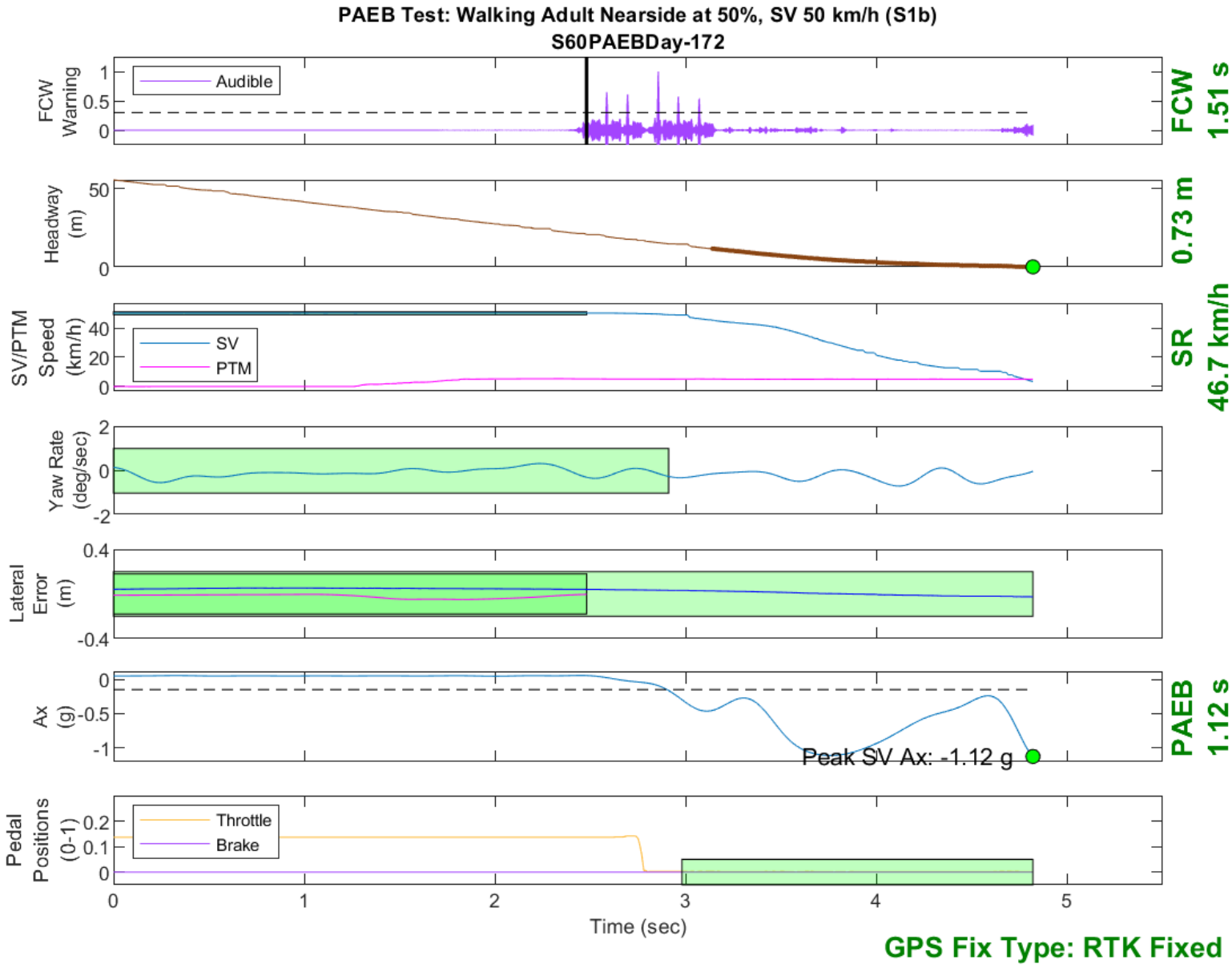


Figure D36. Time History for PAEB Run 172, S1b, Daytime, 50 km/h

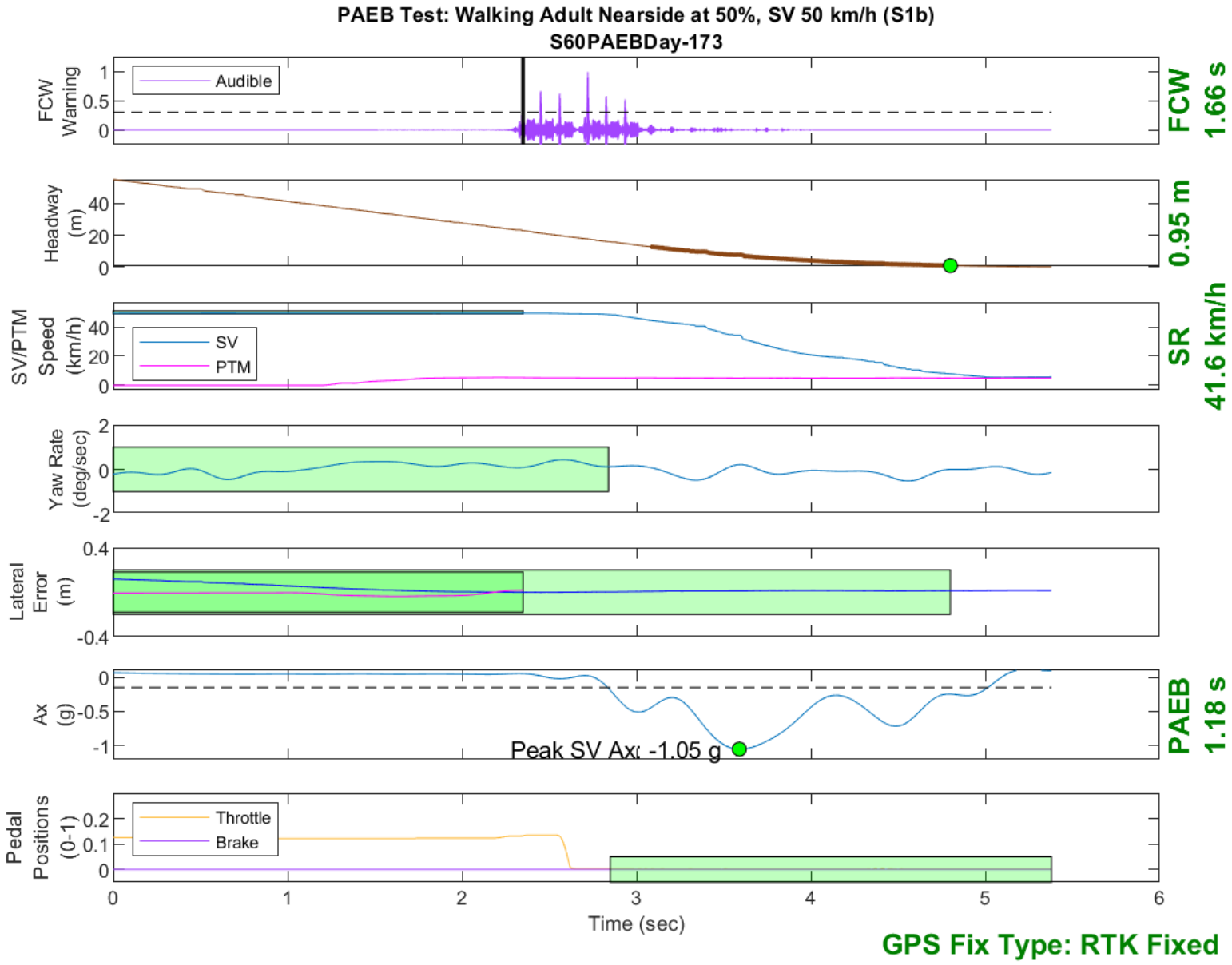


Figure D37. Time History for PAEB Run 173, S1b, Daytime, 50 km/h

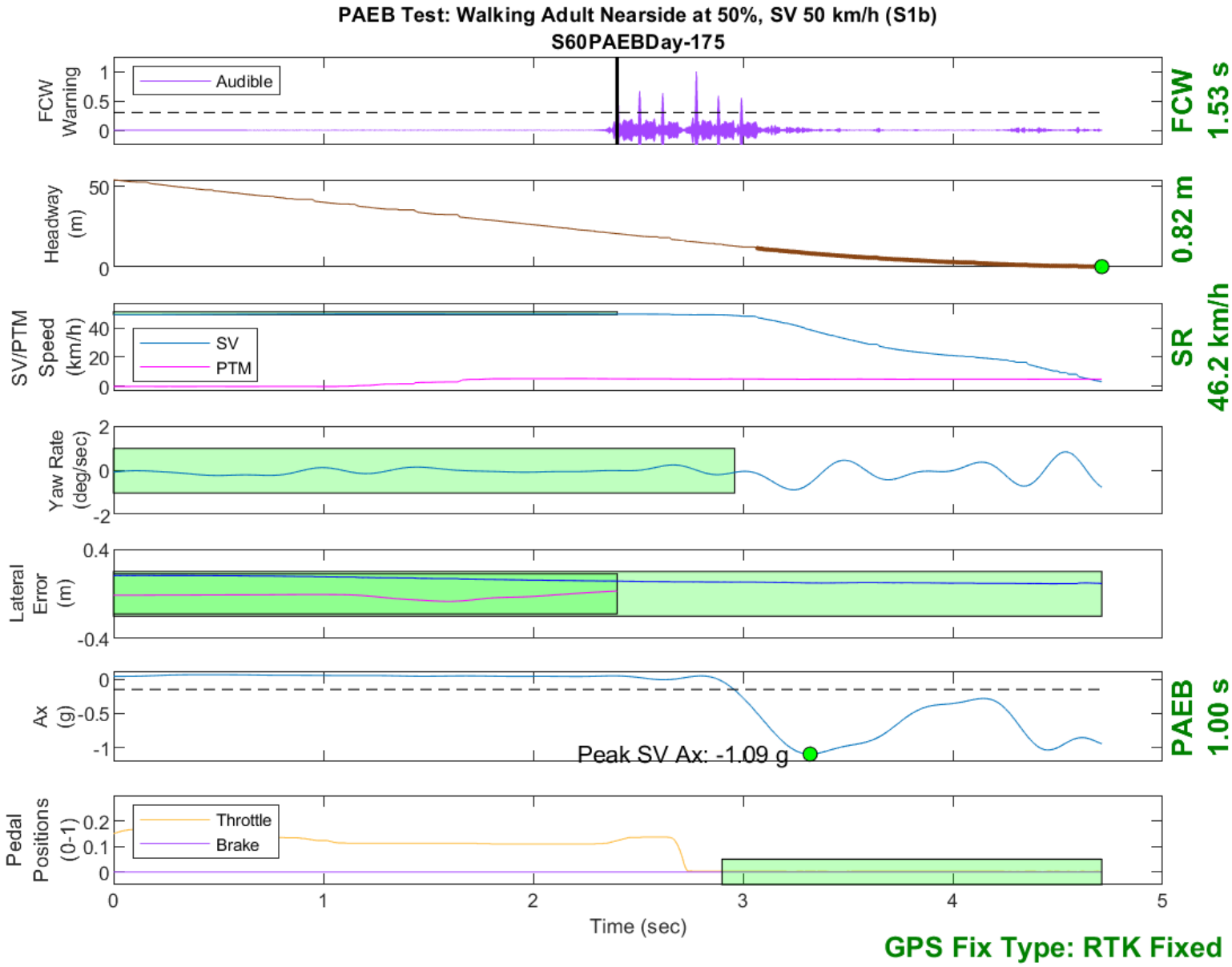


Figure D38. Time History for PAEB Run 175, S1b, Daytime, 50 km/h

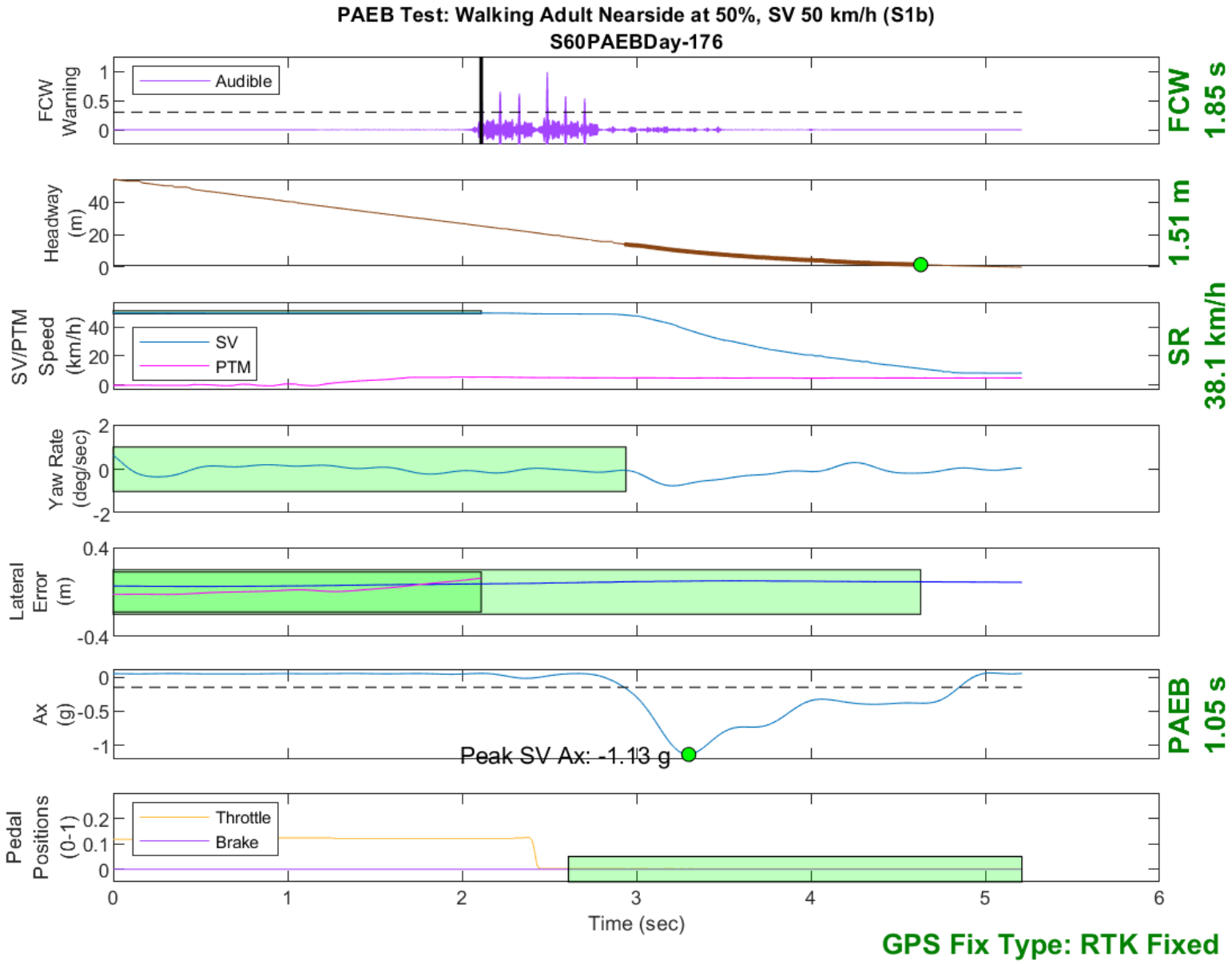


Figure D39. Time History for PAEB Run 176, S1b, Daytime, 50 km/h

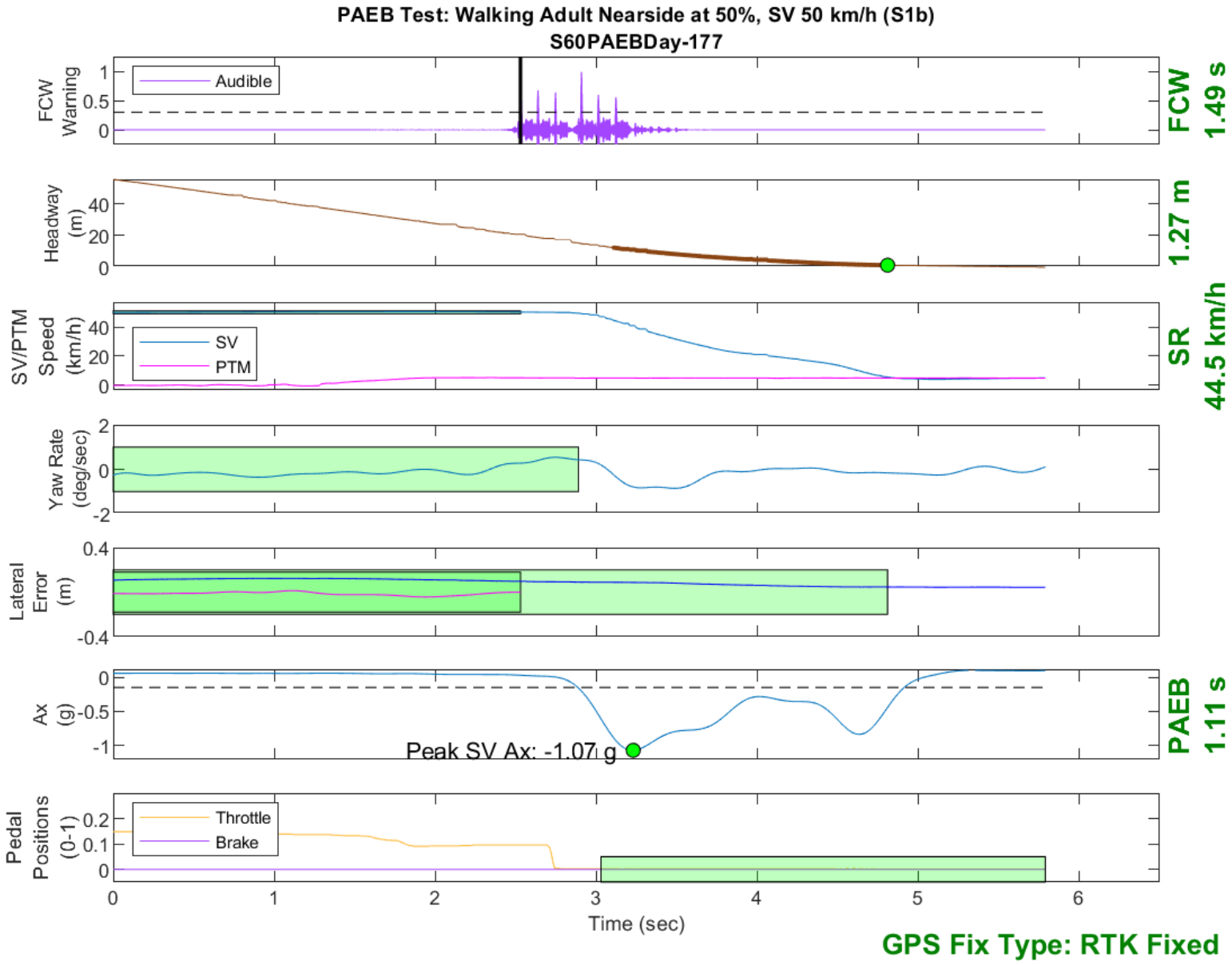


Figure D40. Time History for PAEB Run 177, S1b, Daytime, 50 km/h

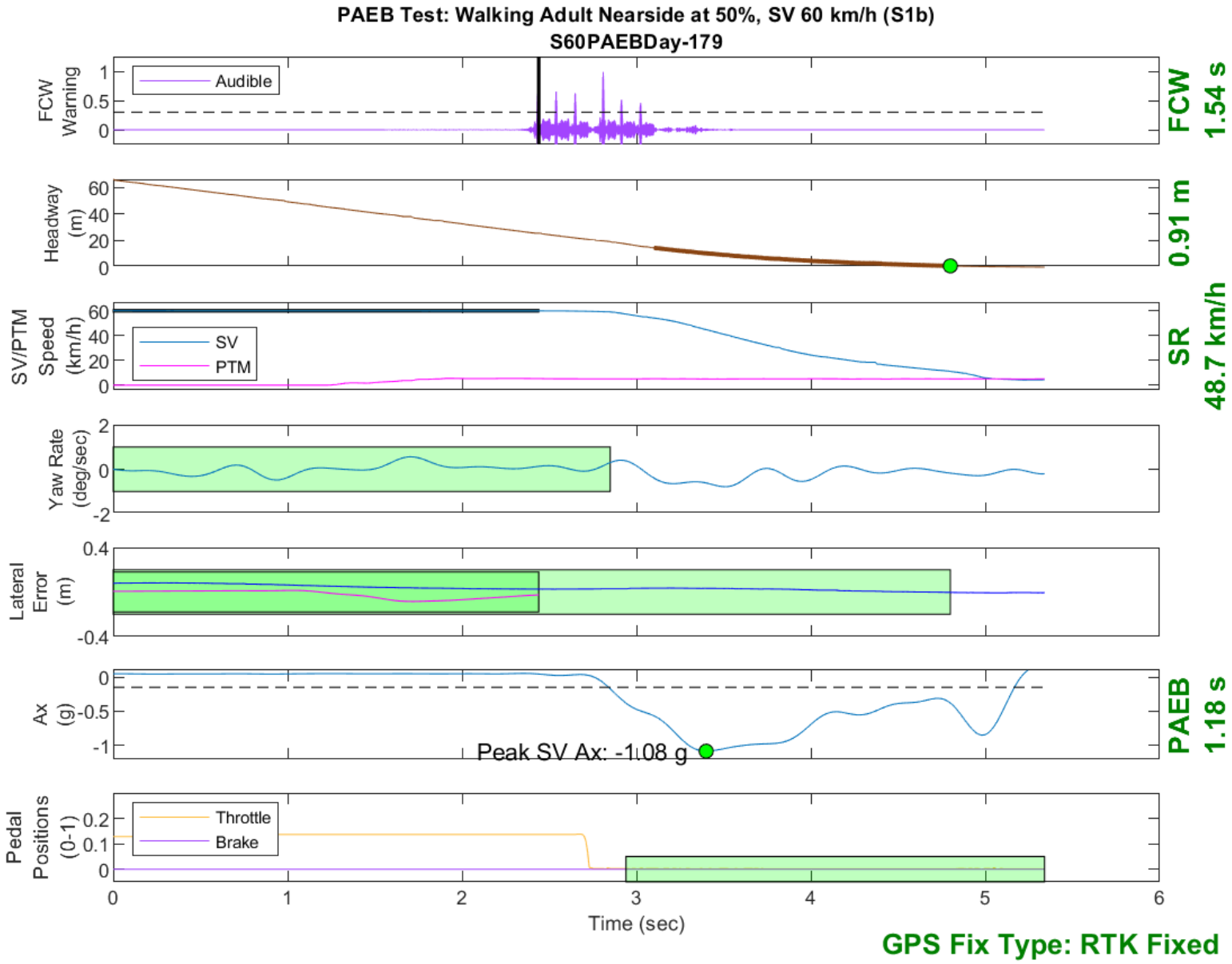


Figure D41. Time History for PAEB Run 179, S1b, Daytime, 60 km/h

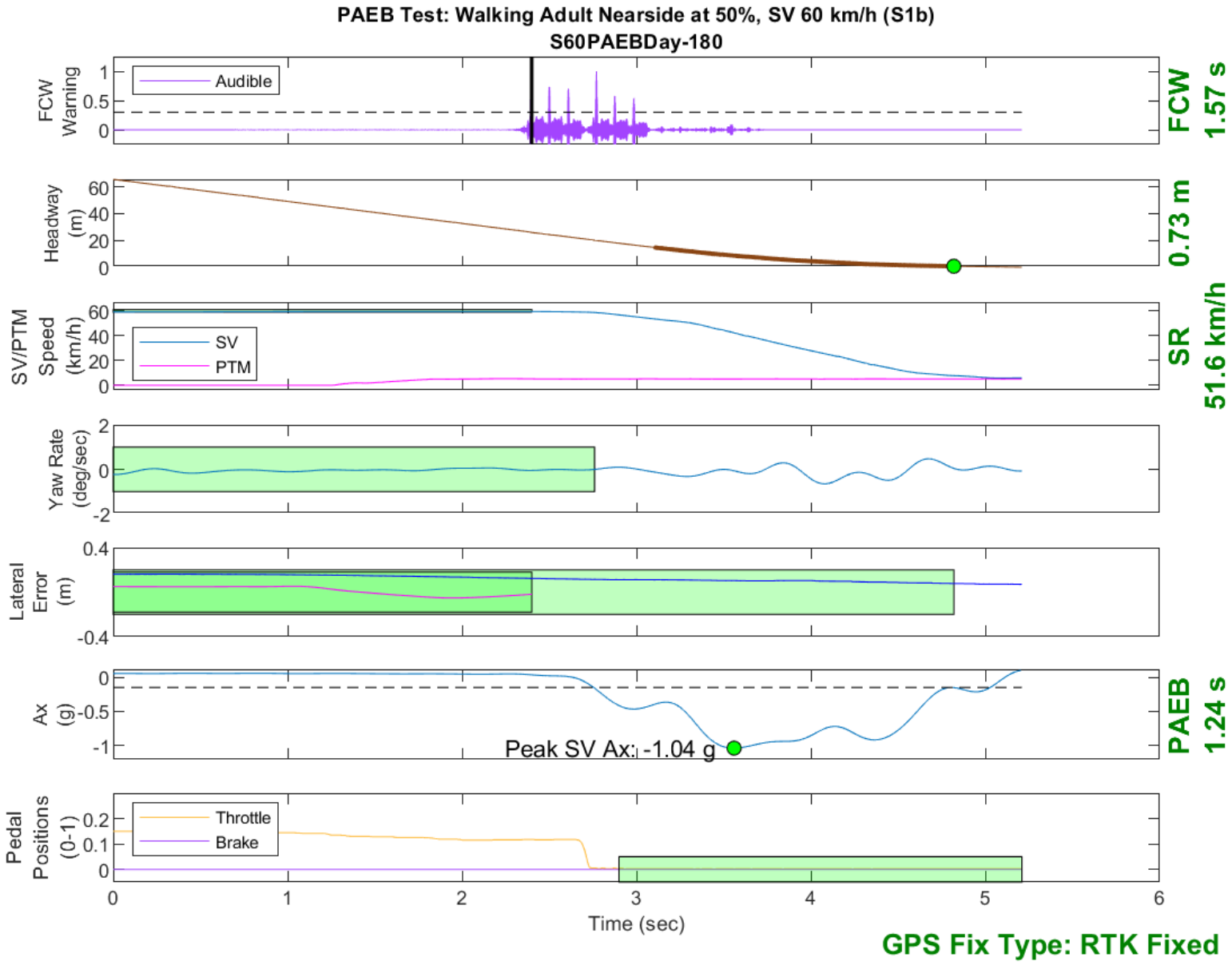


Figure D42. Time History for PAEB Run 180, S1b, Daytime, 60 km/h

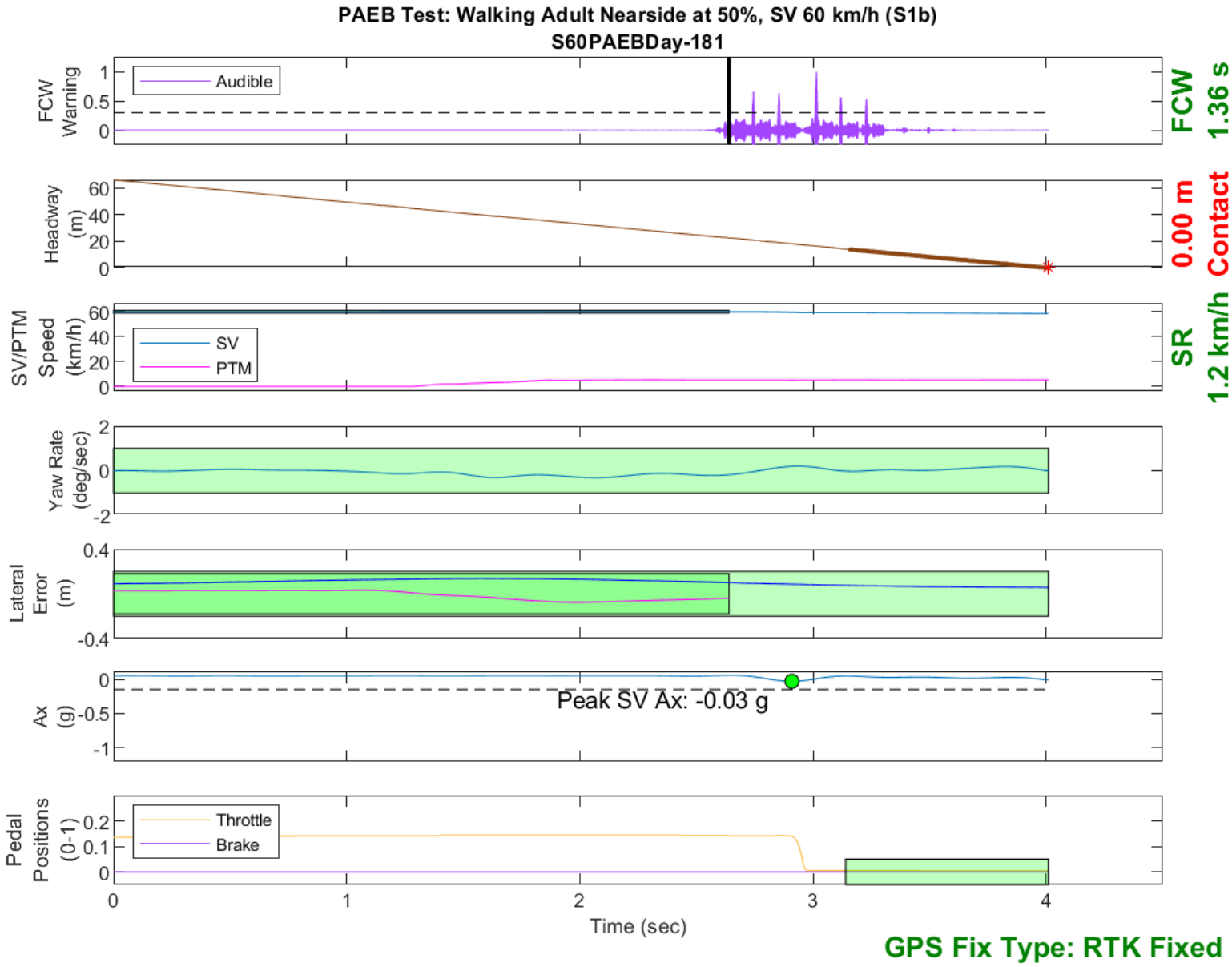


Figure D43. Time History for PAEB Run 181, S1b, Daytime, 60 km/h

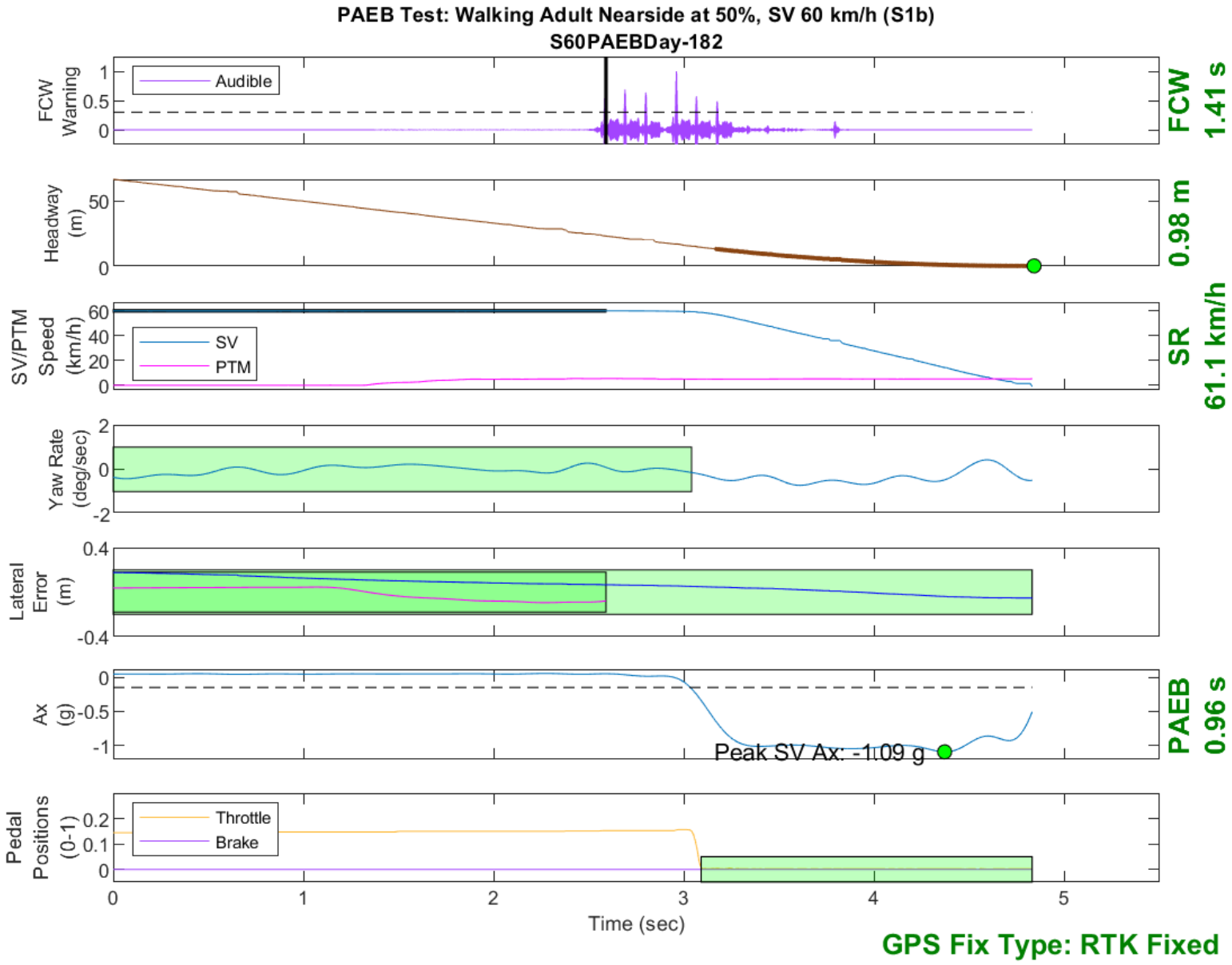


Figure D44. Time History for PAEB Run 182, S1b, Daytime, 60 km/h

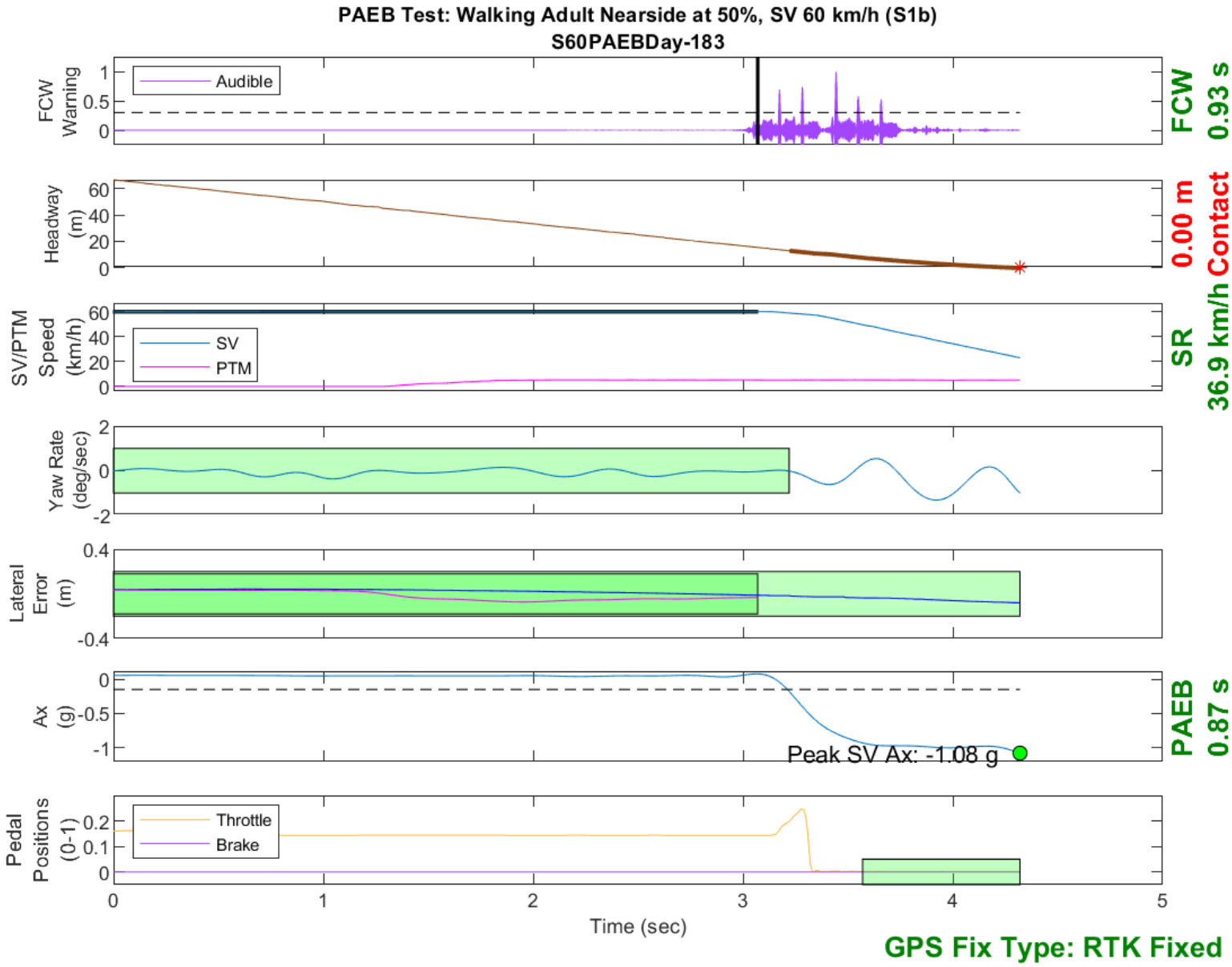


Figure D45. Time History for PAEB Run 183, S1b, Daytime, 60 km/h

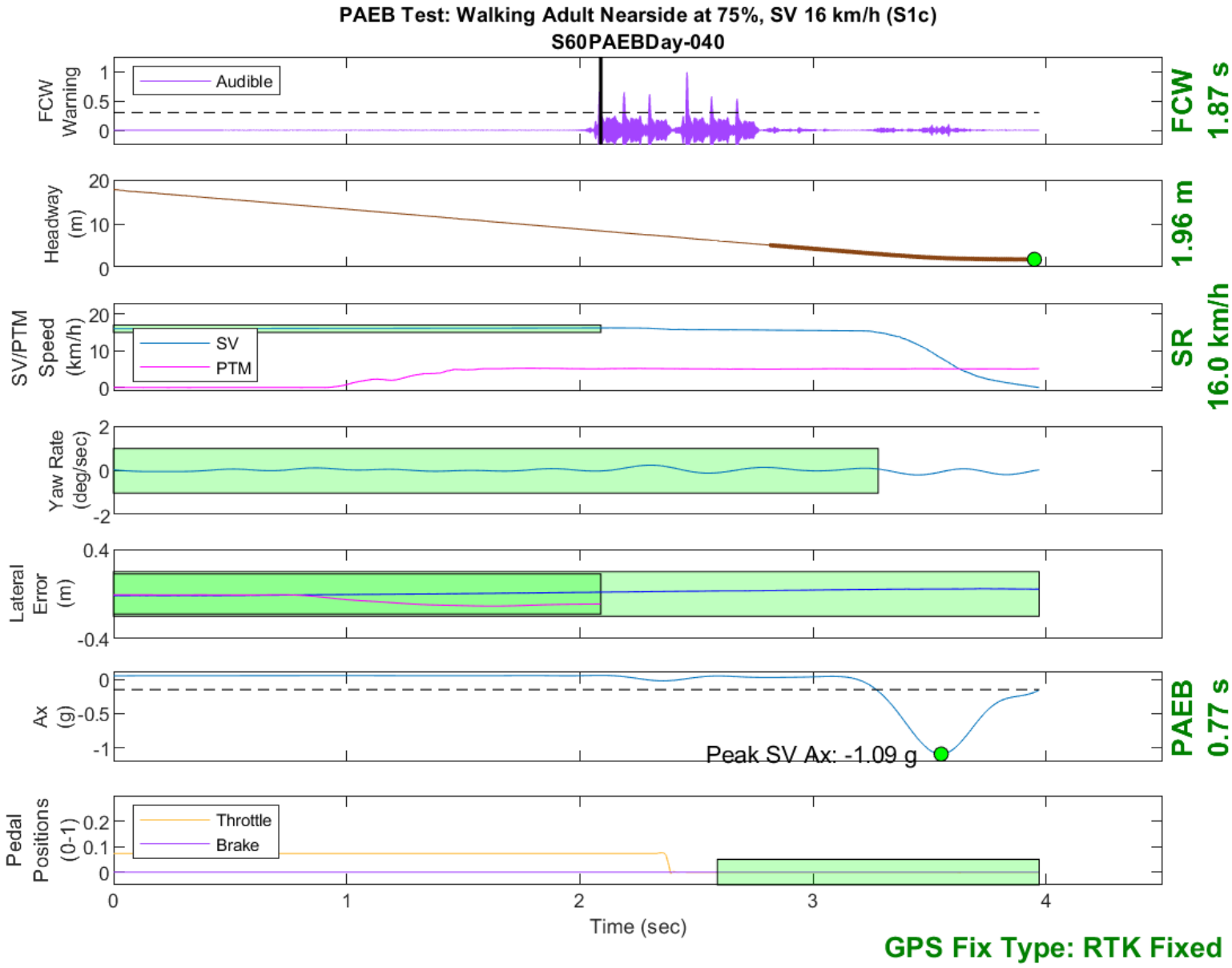


Figure D46. Time History for PAEB Run 40, S1c, Daytime, 16 km/h

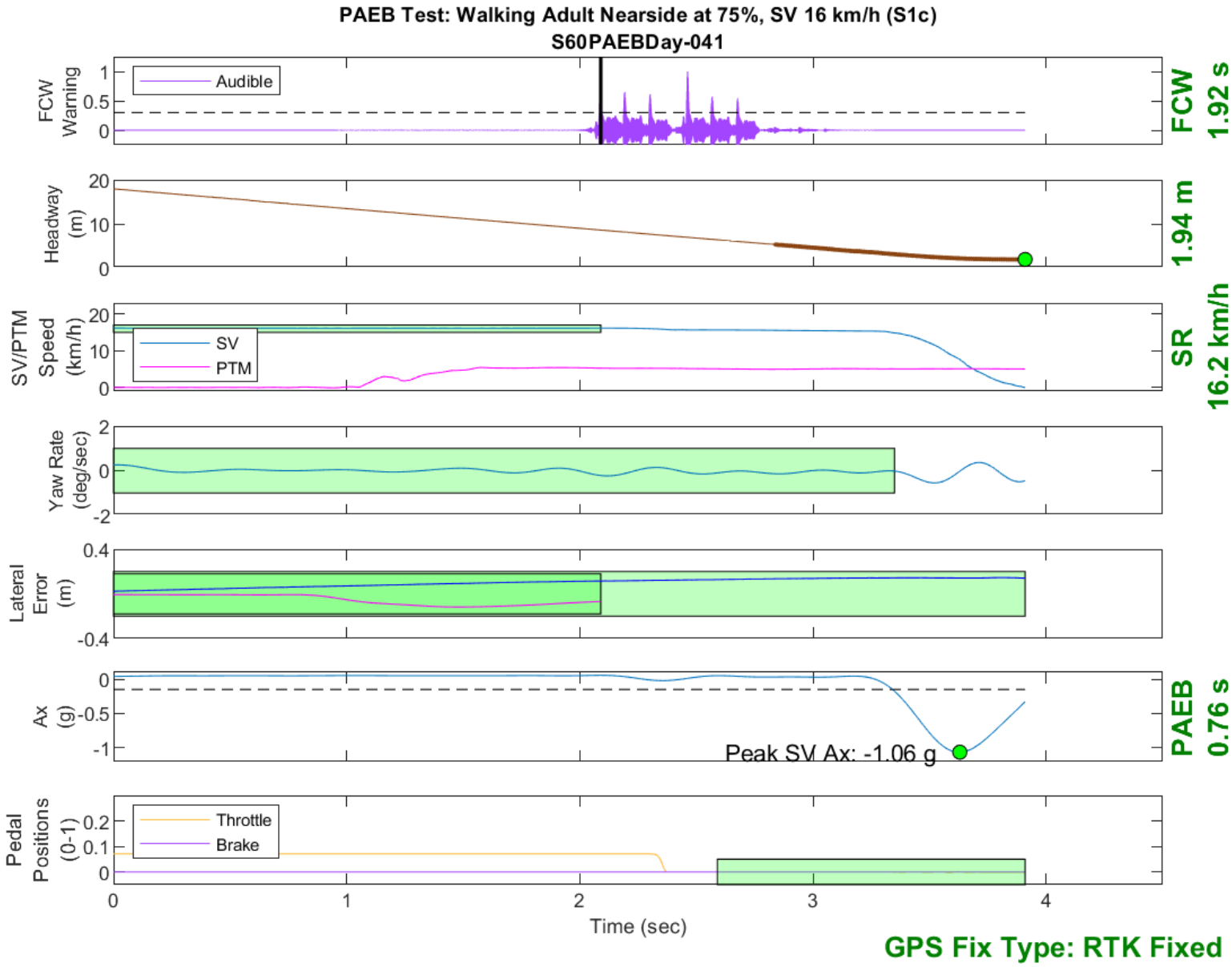


Figure D47. Time History for PAEB Run 41, S1c, Daytime, 16 km/h

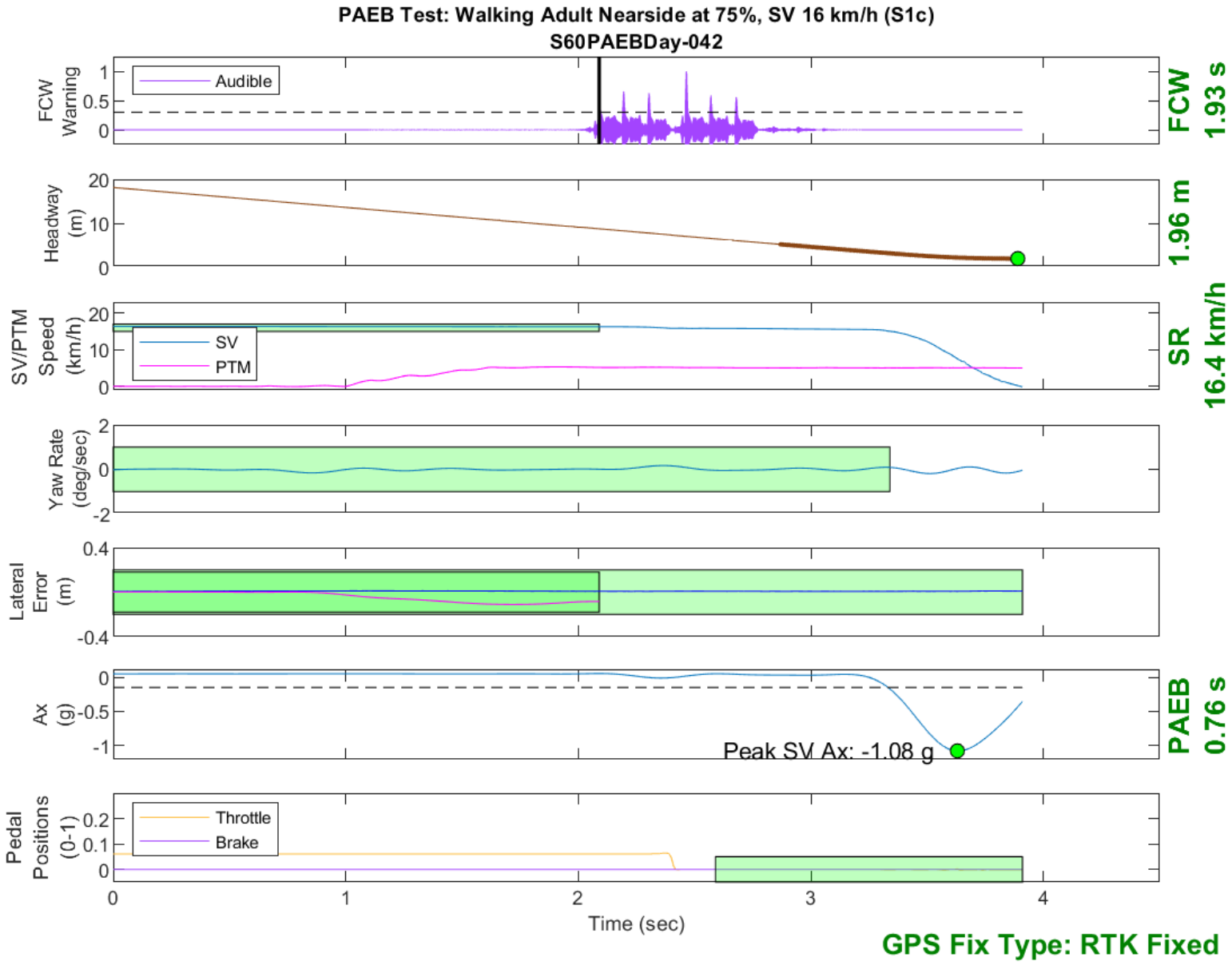


Figure D48. Time History for PAEB Run 42, S1c, Daytime, 16 km/h

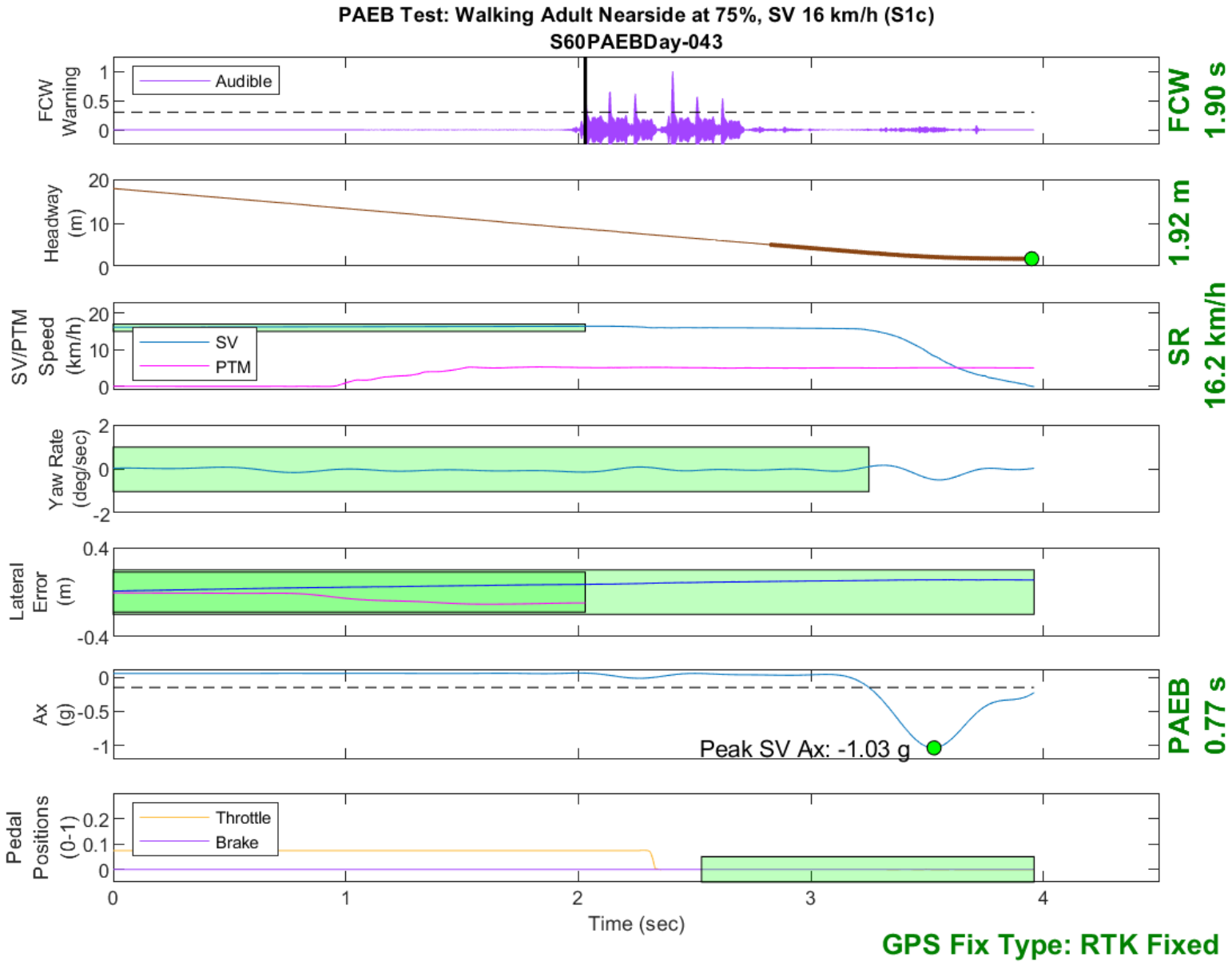


Figure D49. Time History for PAEB Run 43, S1c, Daytime, 16 km/h

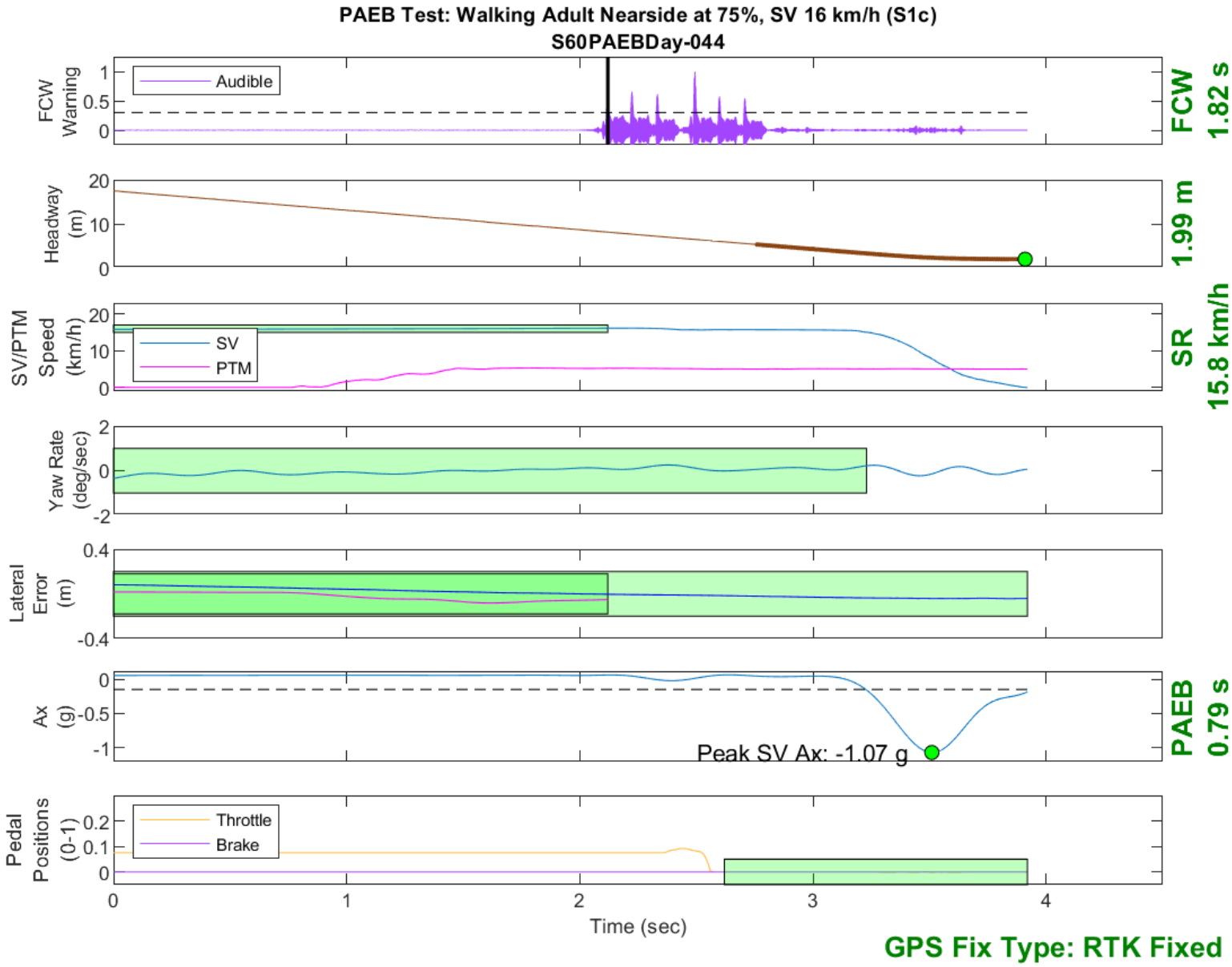


Figure D50. Time History for PAEB Run 44, S1c, Daytime, 16 km/h

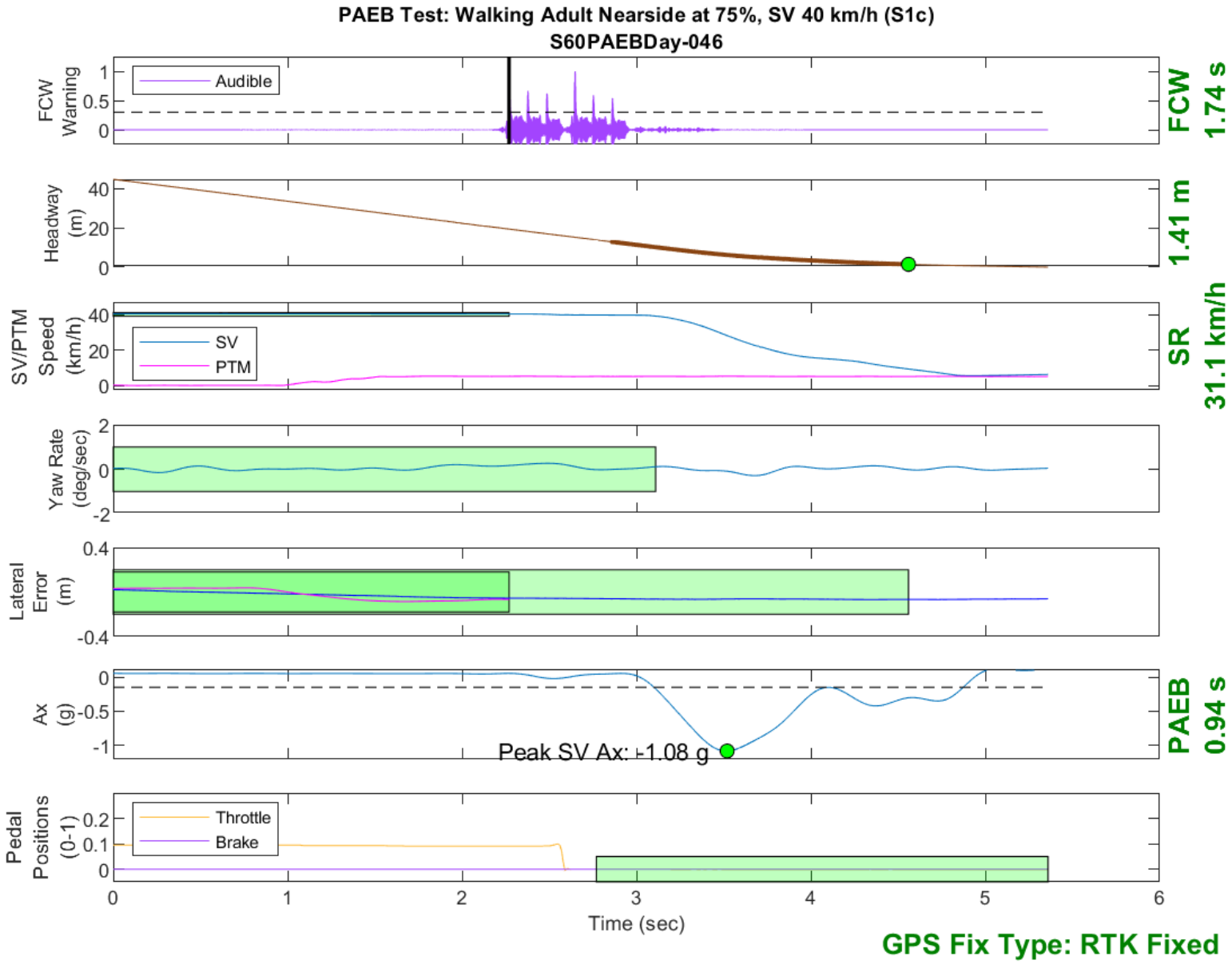


Figure D51. Time History for PAEB Run 46, S1c, Daytime, 40 km/h

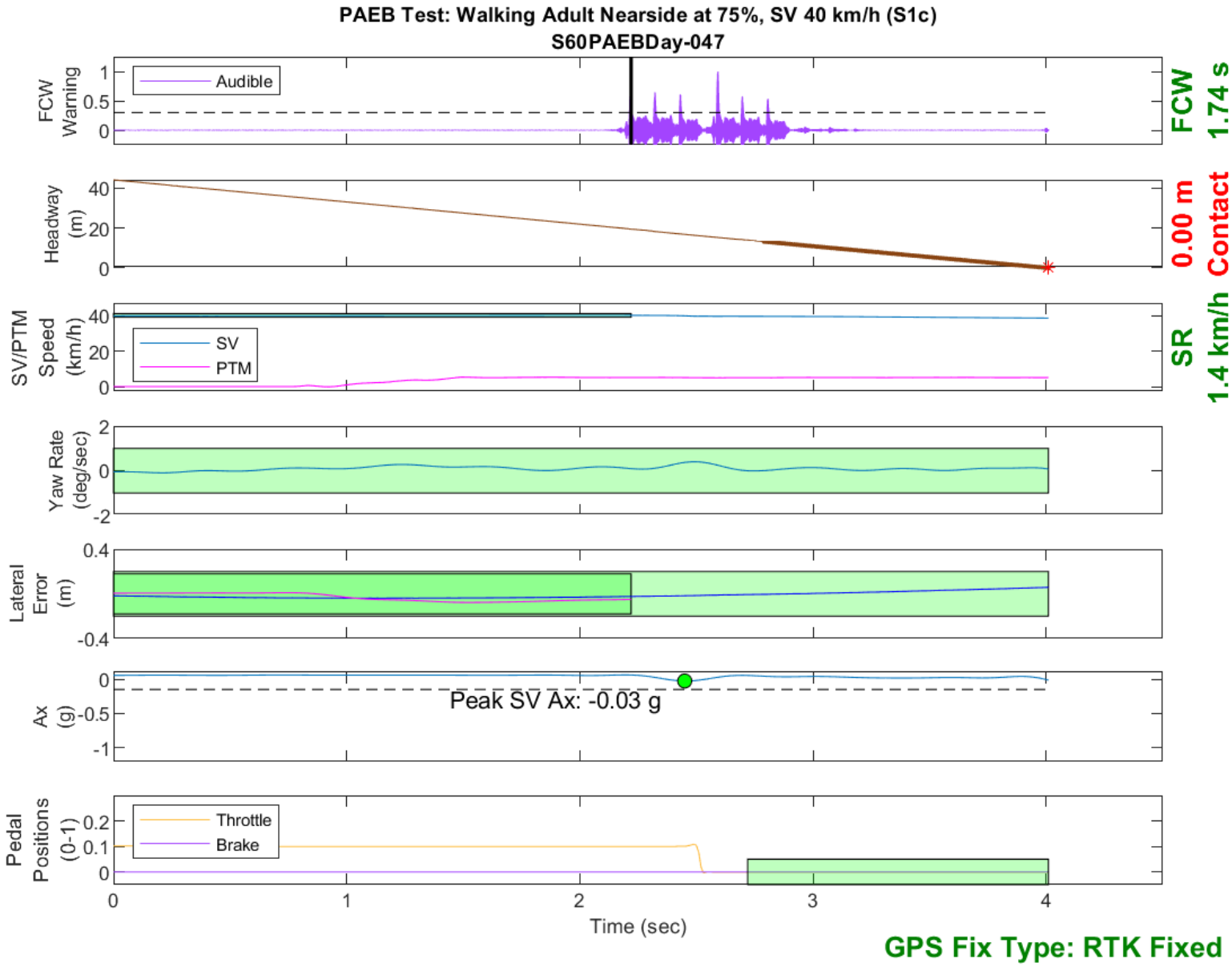


Figure D52. Time History for PAEB Run 47, S1c, Daytime, 40 km/h

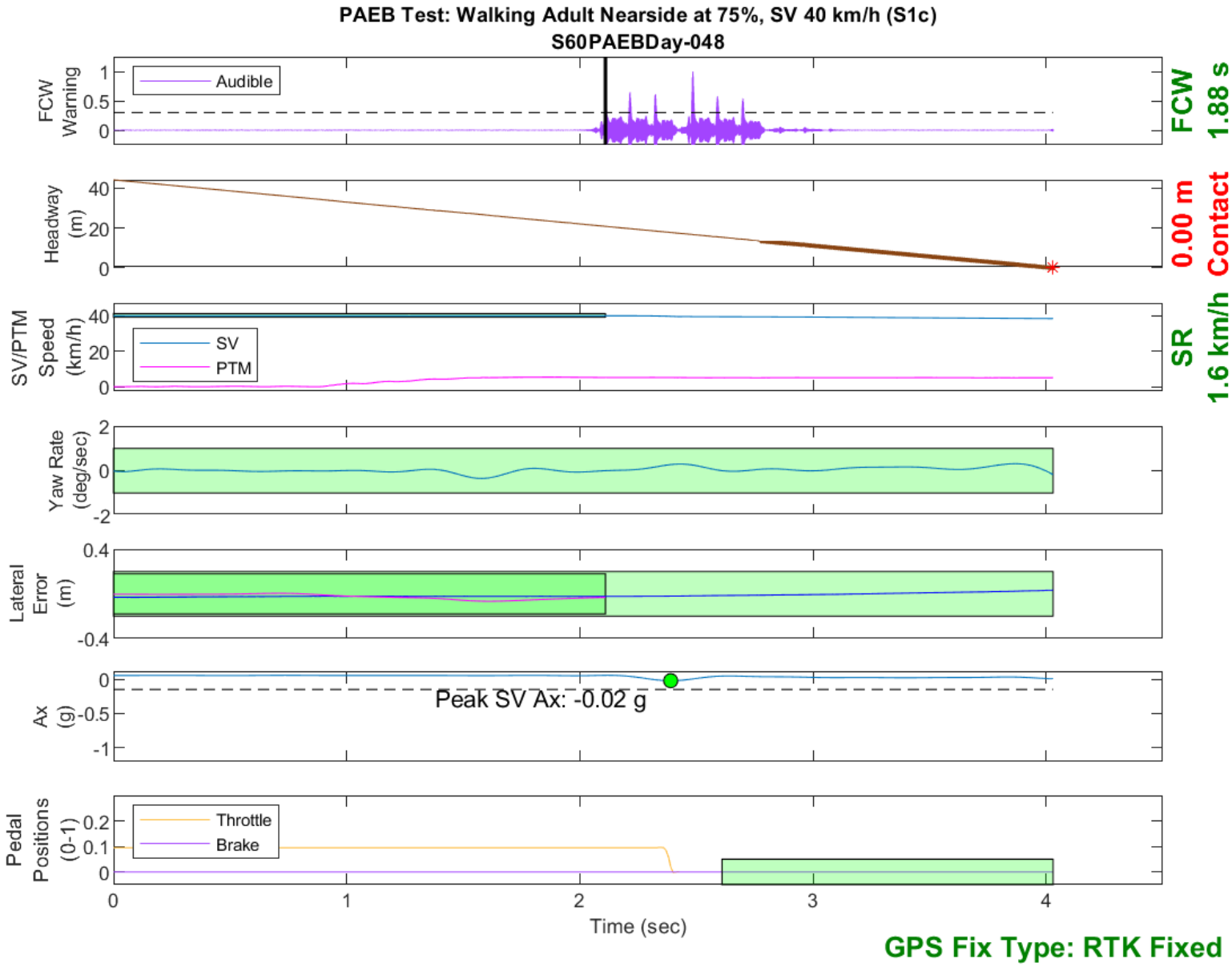


Figure D53. Time History for PAEB Run 48, S1c, Daytime, 40 km/h

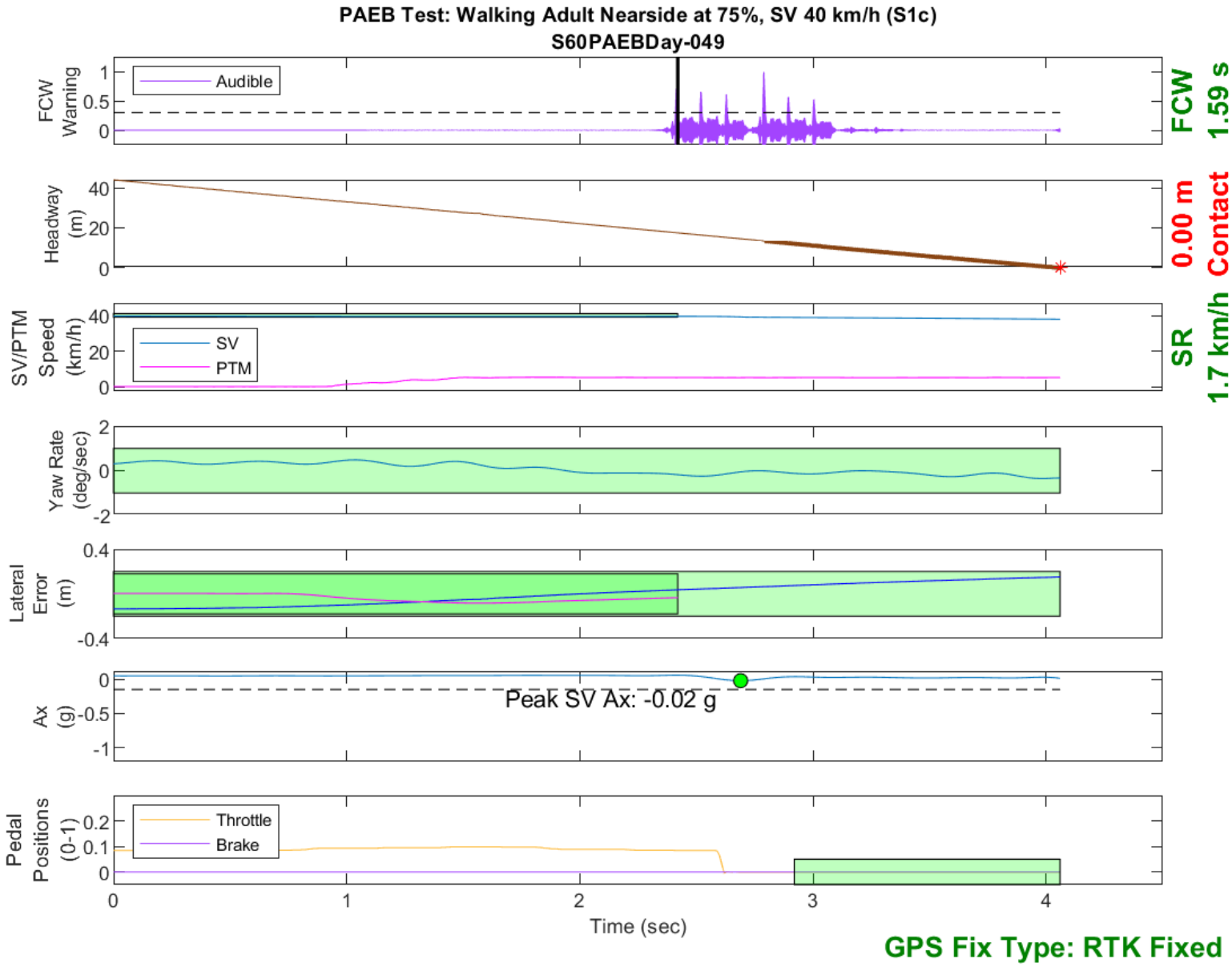


Figure D54. Time History for PAEB Run 49, S1c, Daytime, 40 km/h

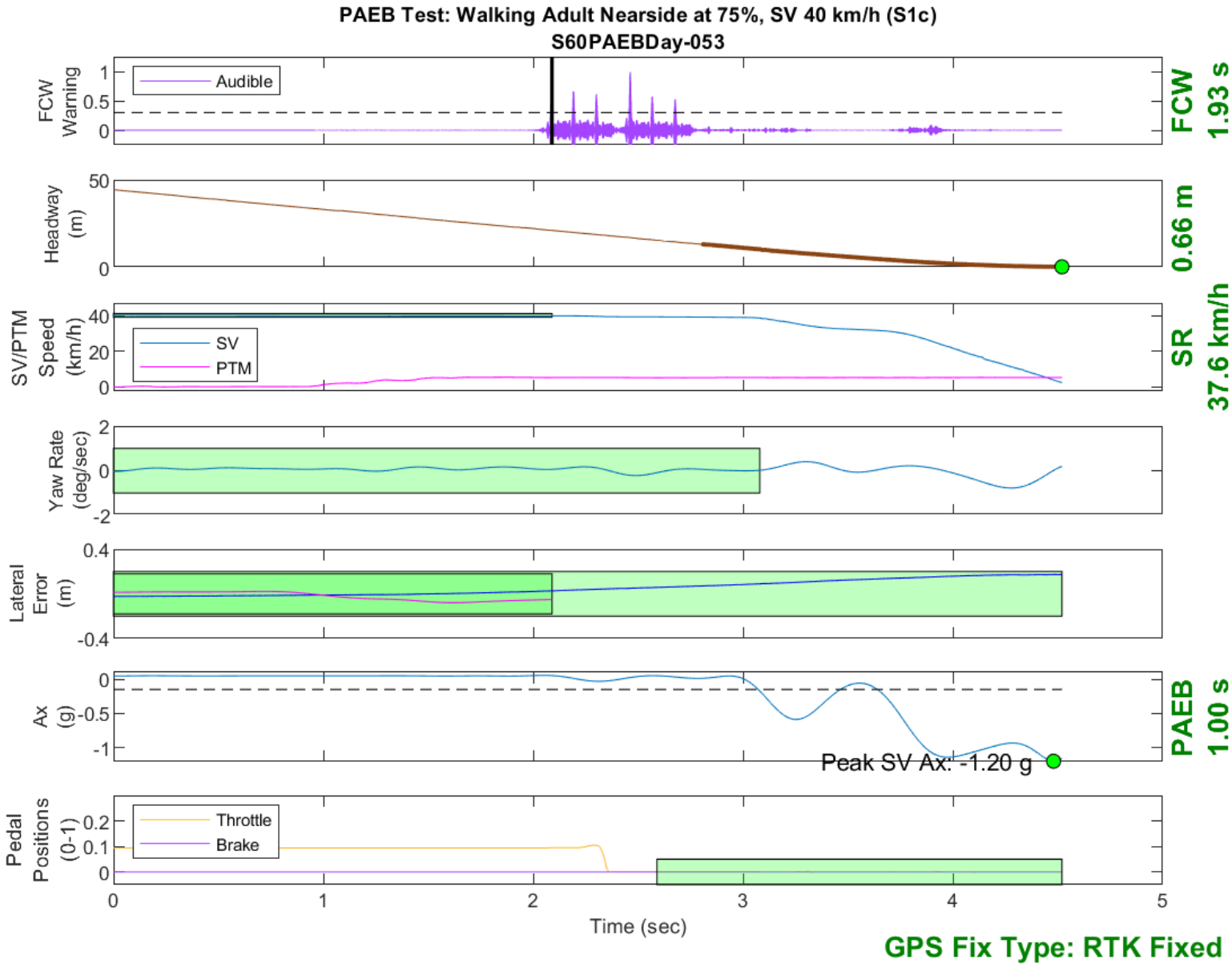


Figure D55. Time History for PAEB Run 53, S1c, Daytime, 40 km/h

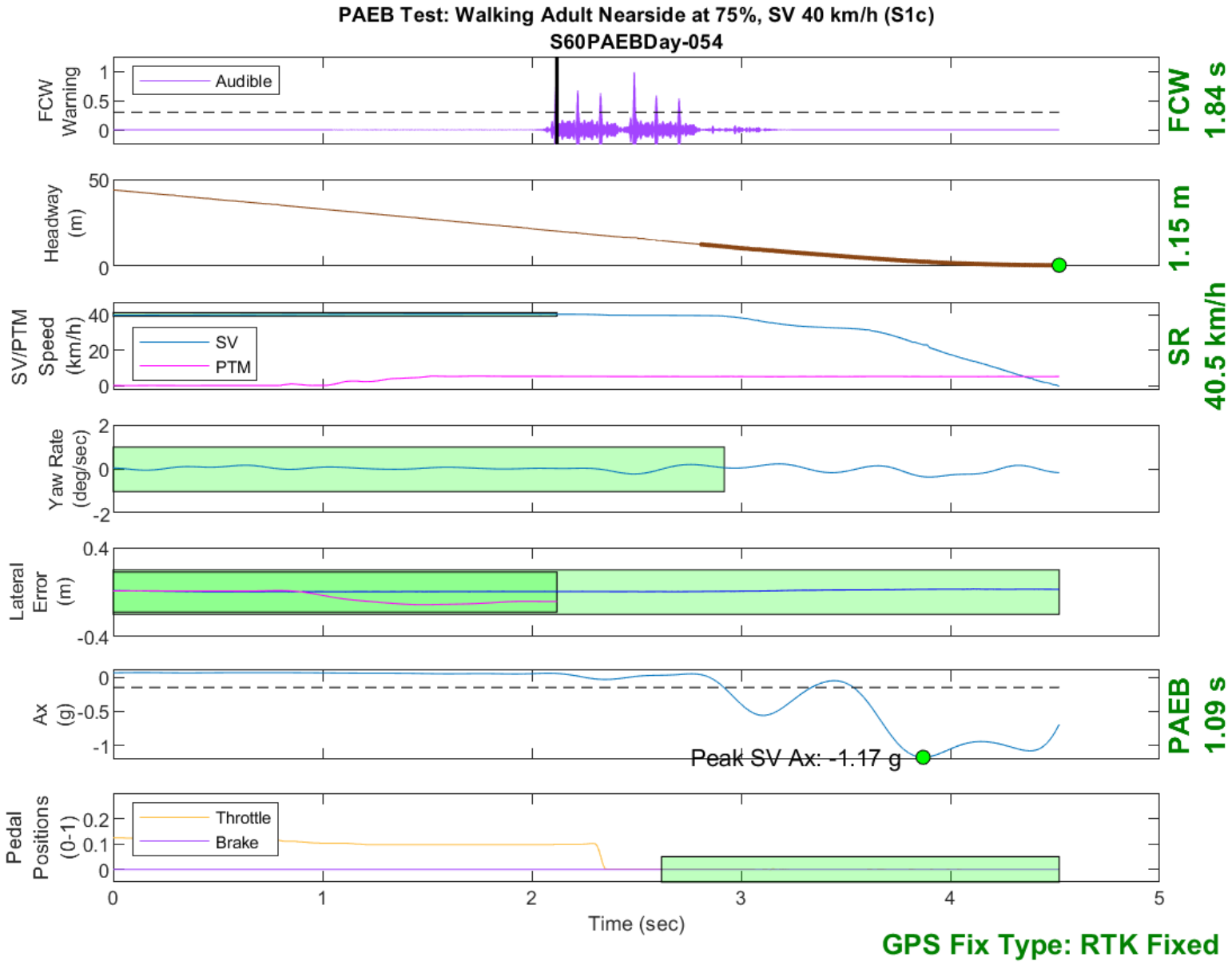


Figure D56. Time History for PAEB Run 54, S1c, Daytime, 40 km/h

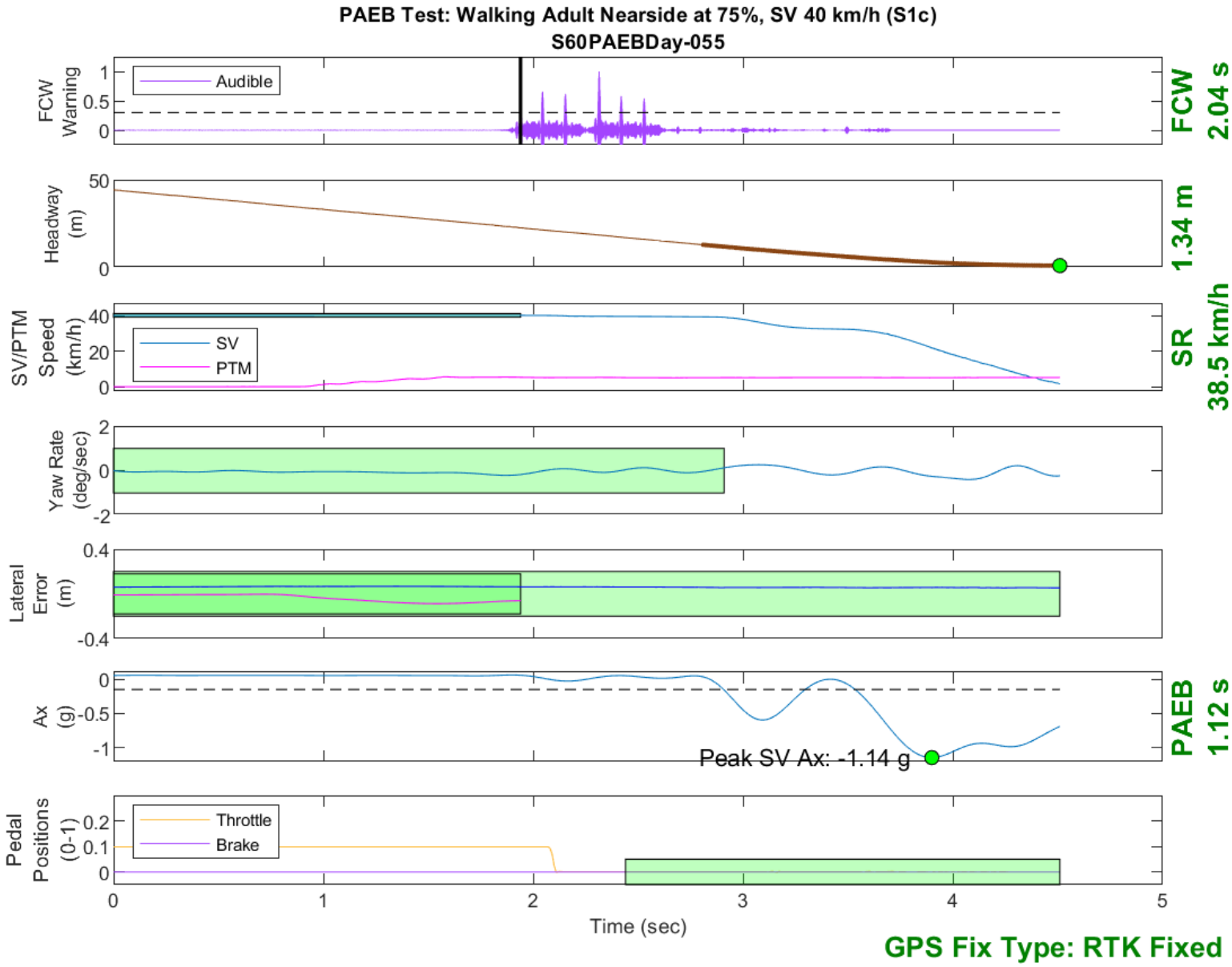


Figure D57. Time History for PAEB Run 55, S1c, Daytime, 40 km/h

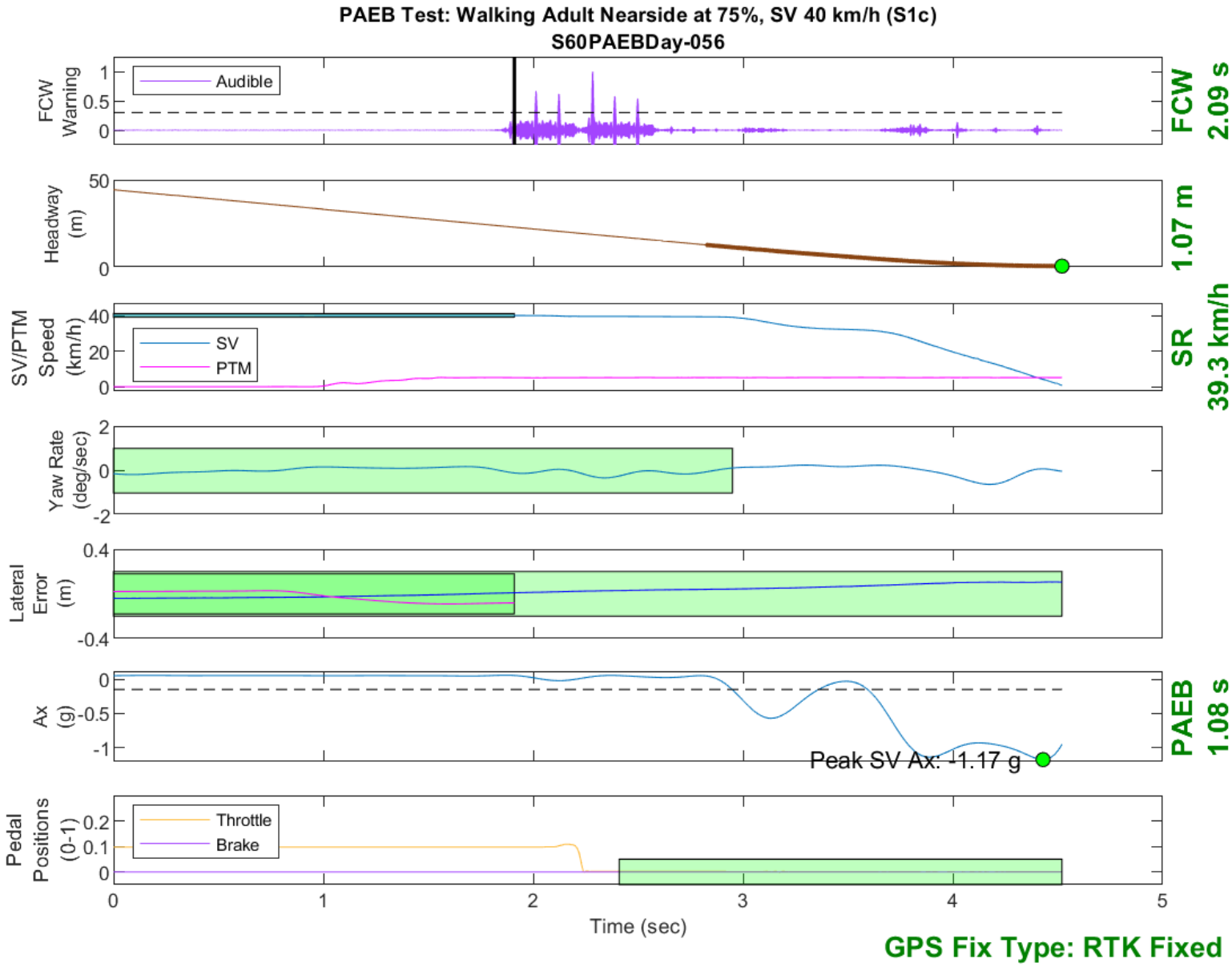


Figure D58. Time History for PAEB Run 56, S1c, Daytime, 40 km/h

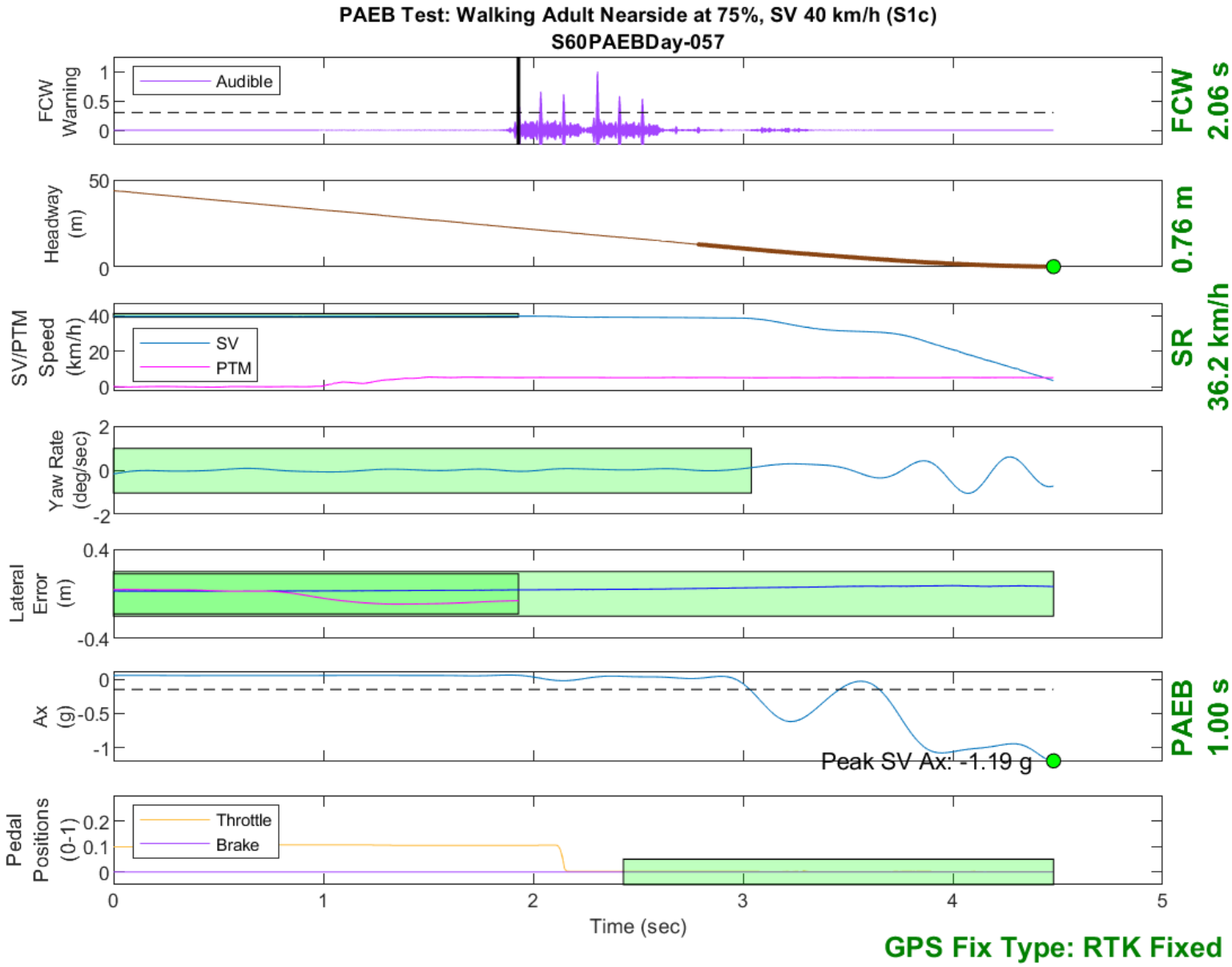


Figure D59. Time History for PAEB Run 57, S1c, Daytime, 40 km/h

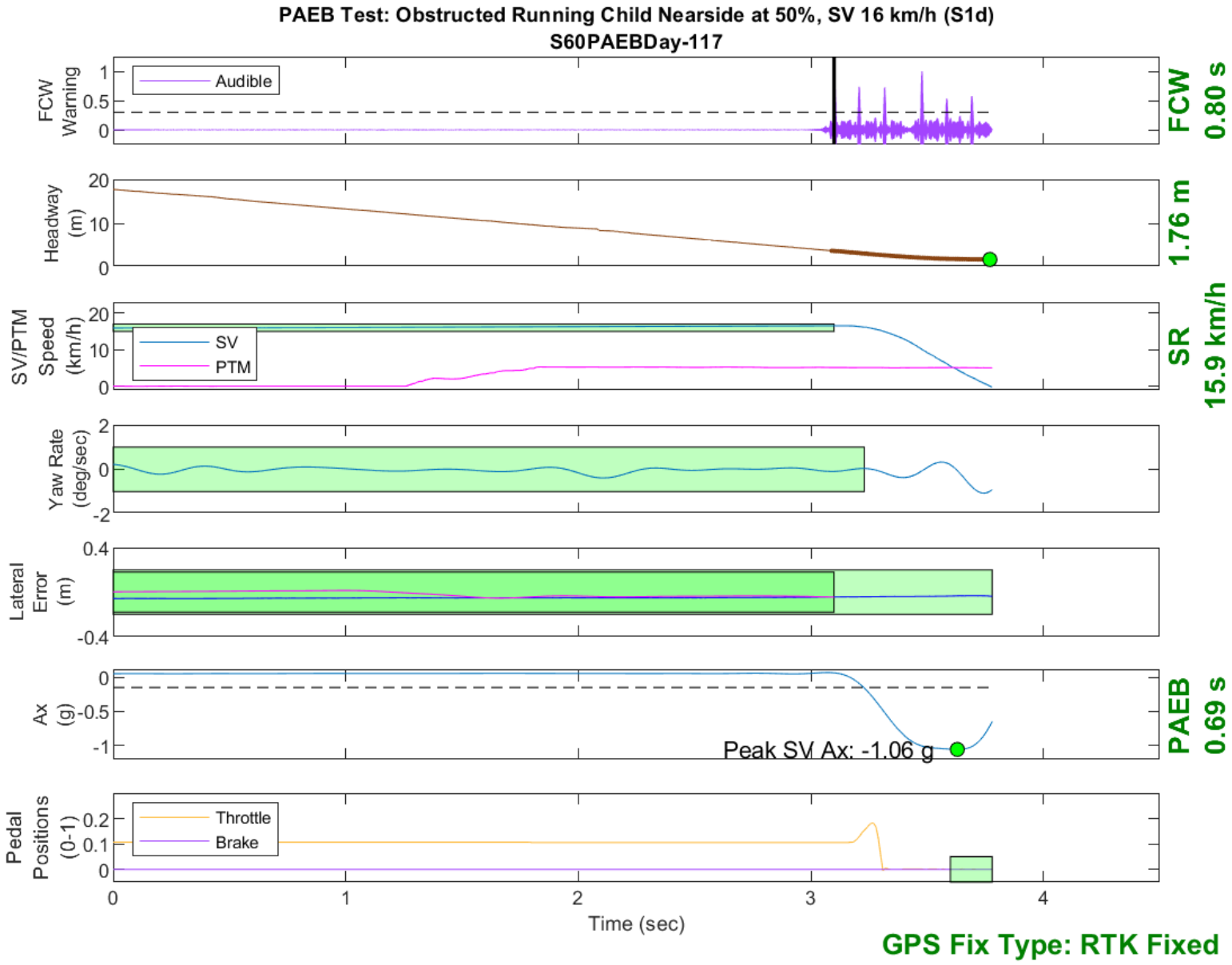


Figure D60. Time History for PAEB Run 117, S1d, Daytime, 16 km/h

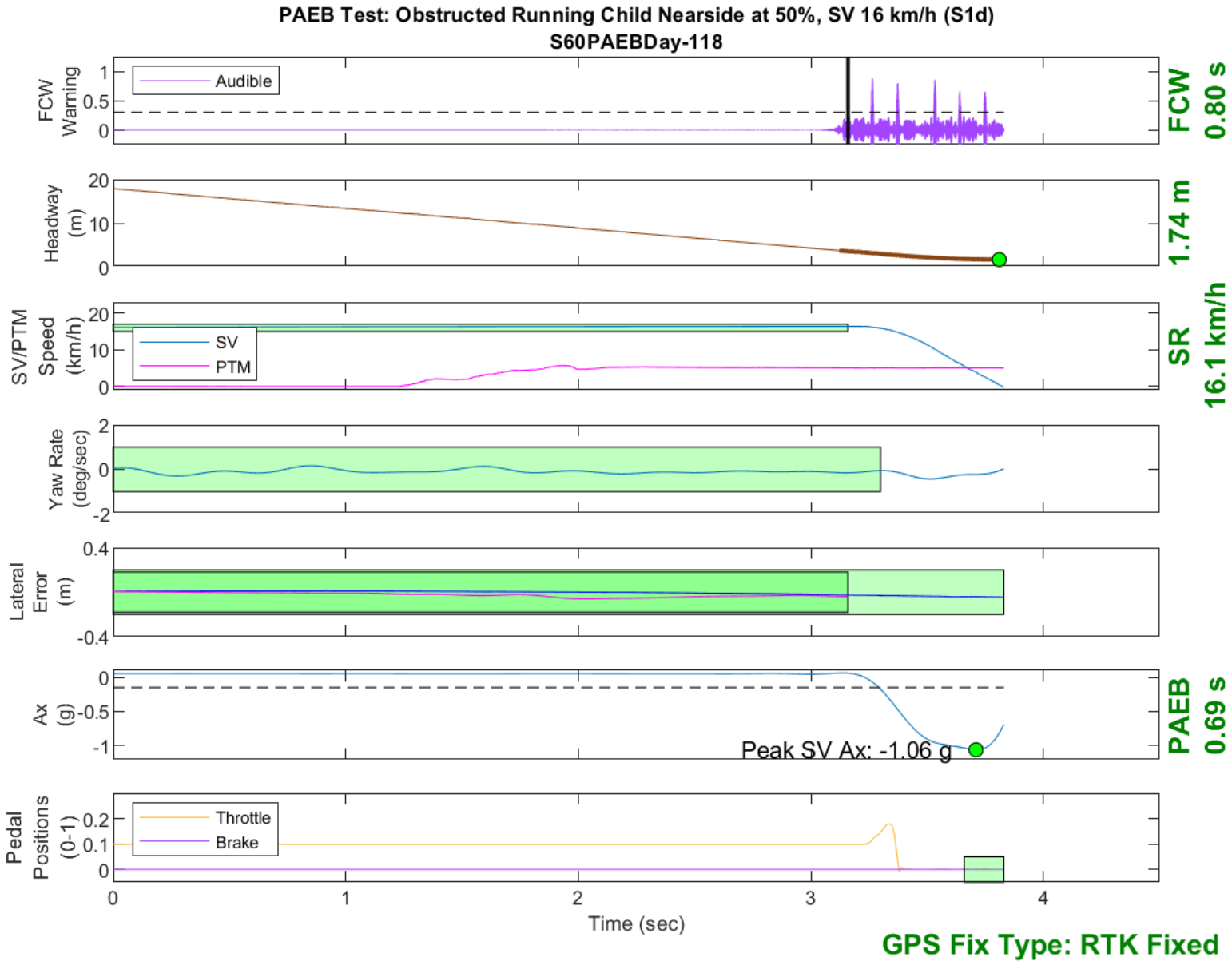


Figure D61. Time History for PAEB Run 118, S1d, Daytime, 16 km/h

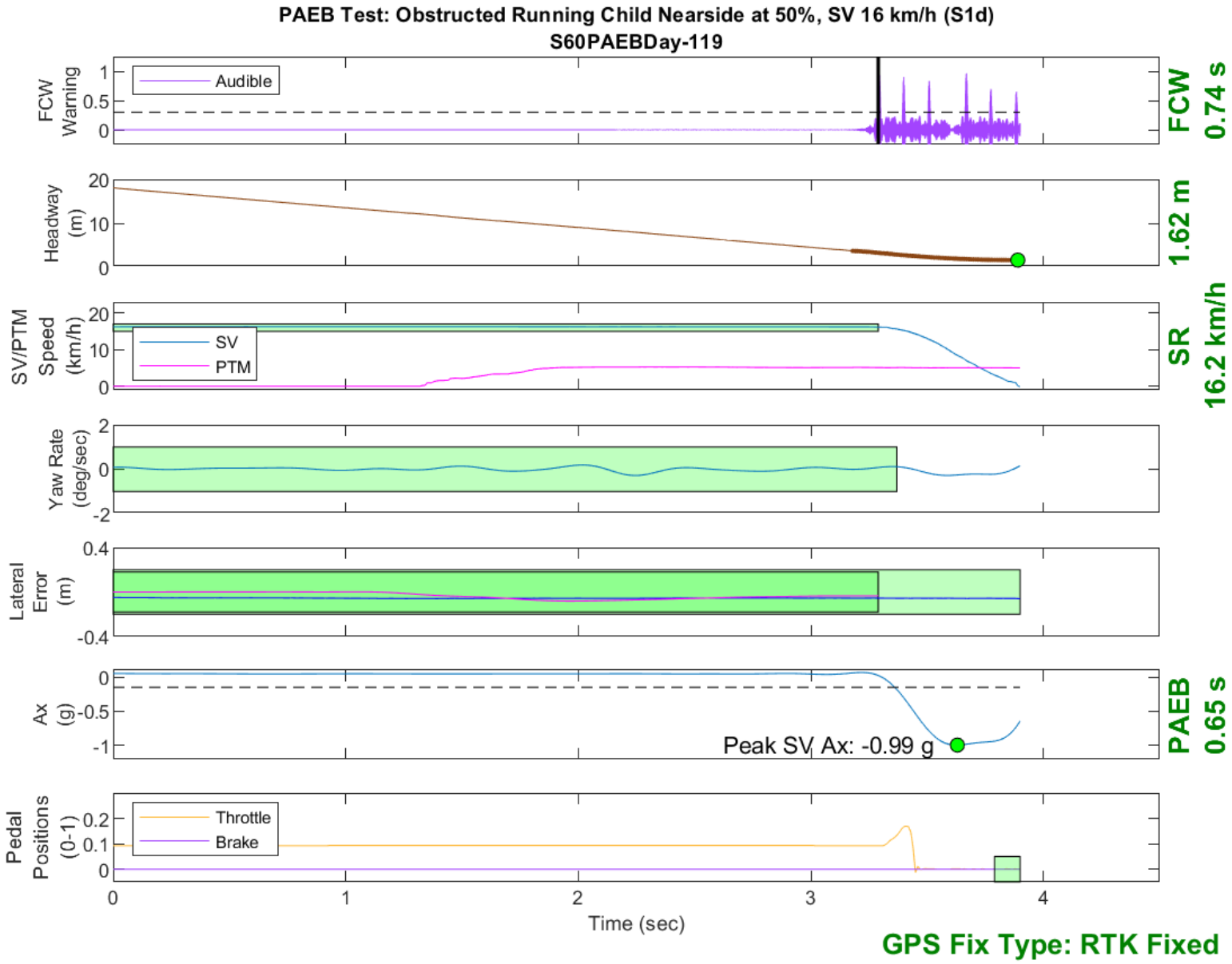


Figure D62. Time History for PAEB Run 119, S1d, Daytime, 16 km/h

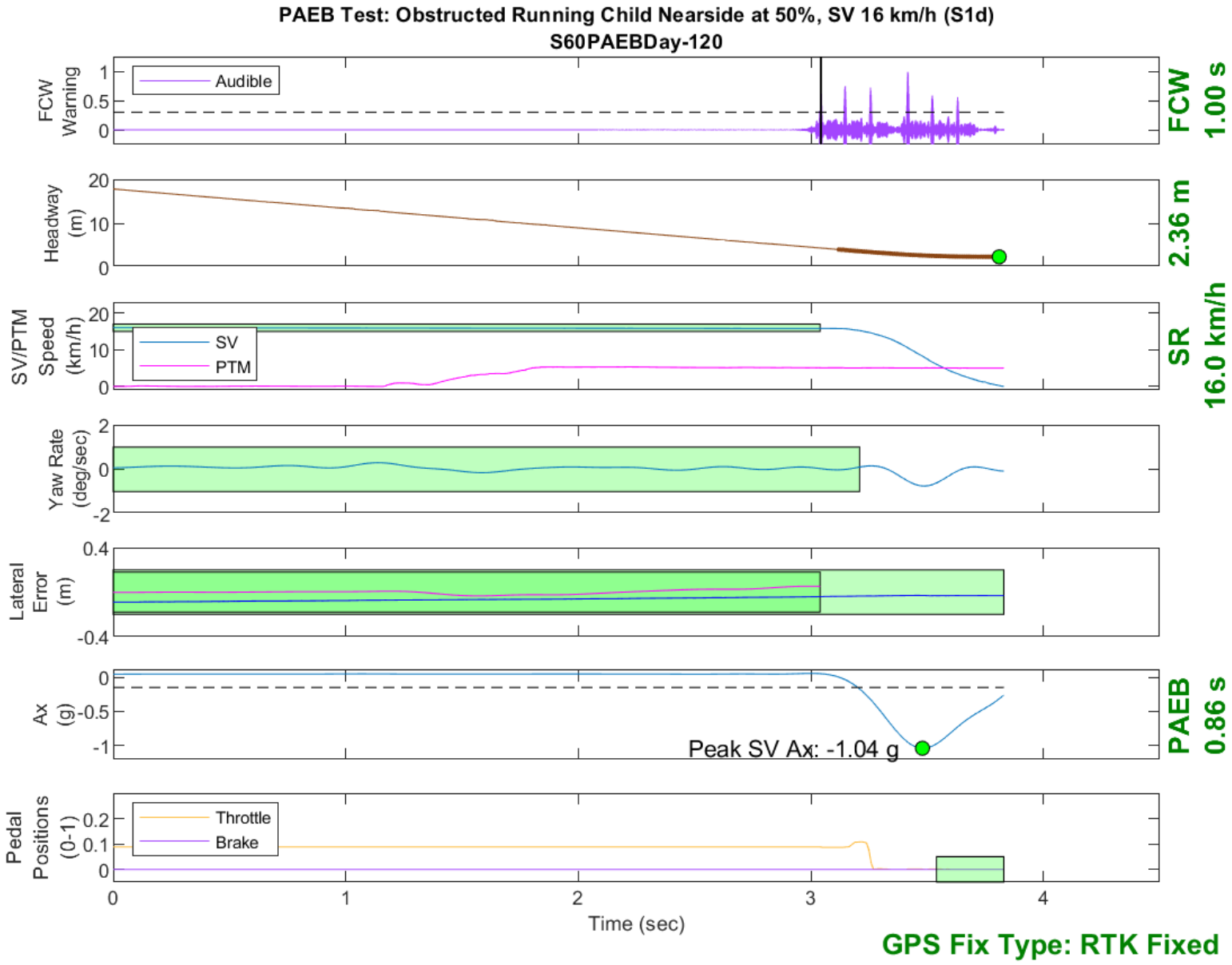


Figure D63. Time History for PAEB Run 120, S1d, Daytime, 16 km/h

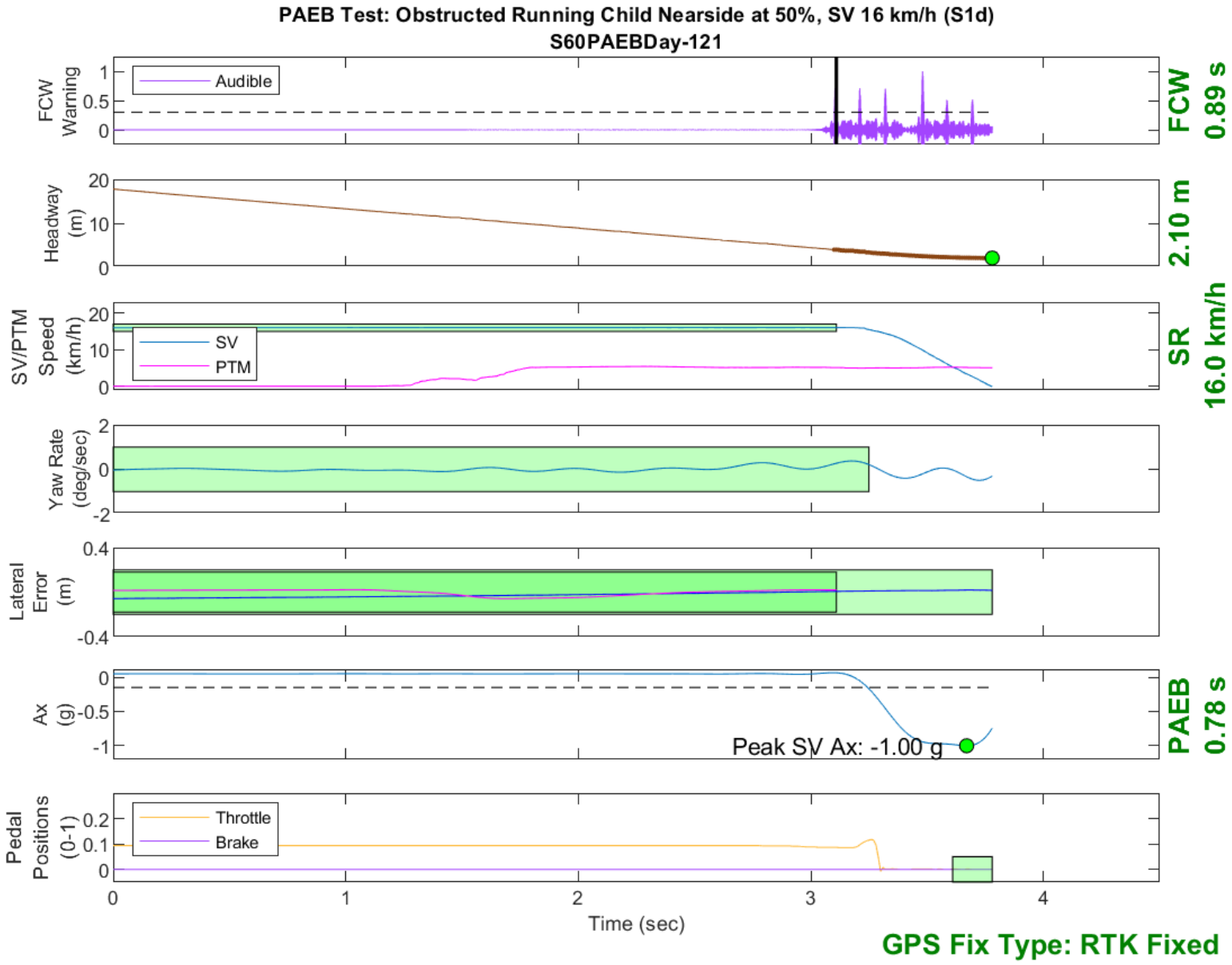


Figure D64. Time History for PAEB Run 121, S1d, Daytime, 16 km/h

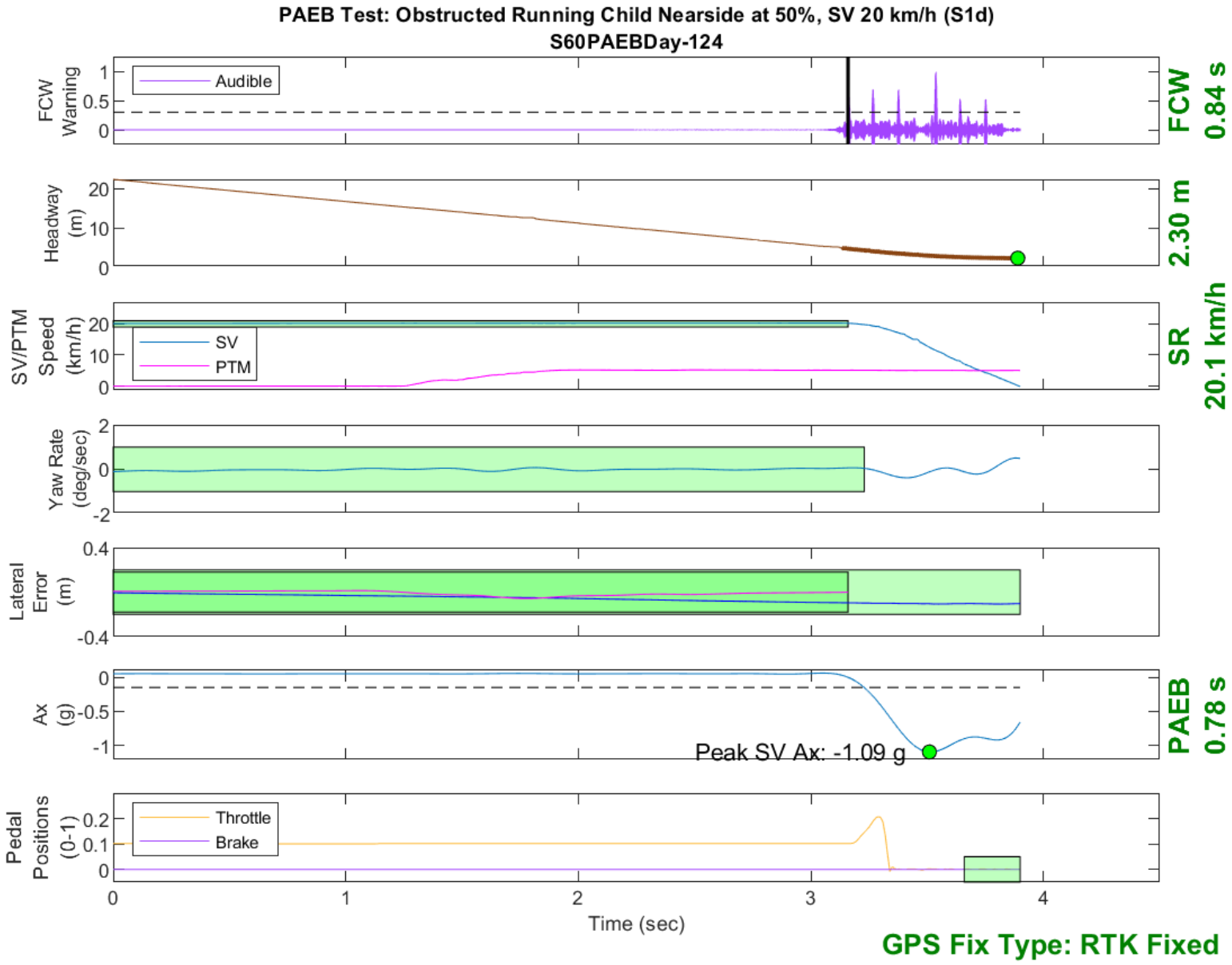


Figure D65. Time History for PAEB Run 124, S1d, Daytime, 20 km/h

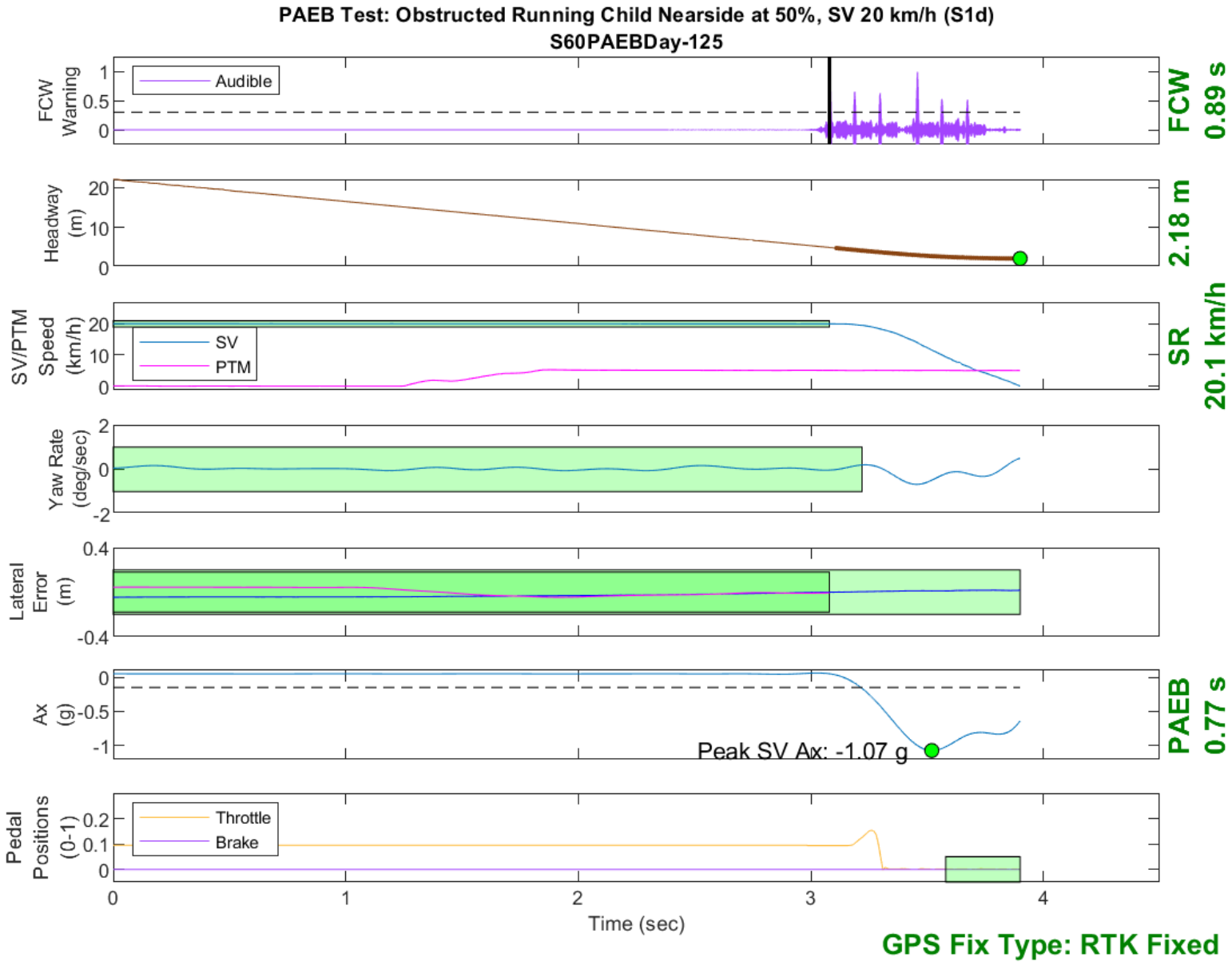


Figure D66. Time History for PAEB Run 125, S1d, Daytime, 20 km/h

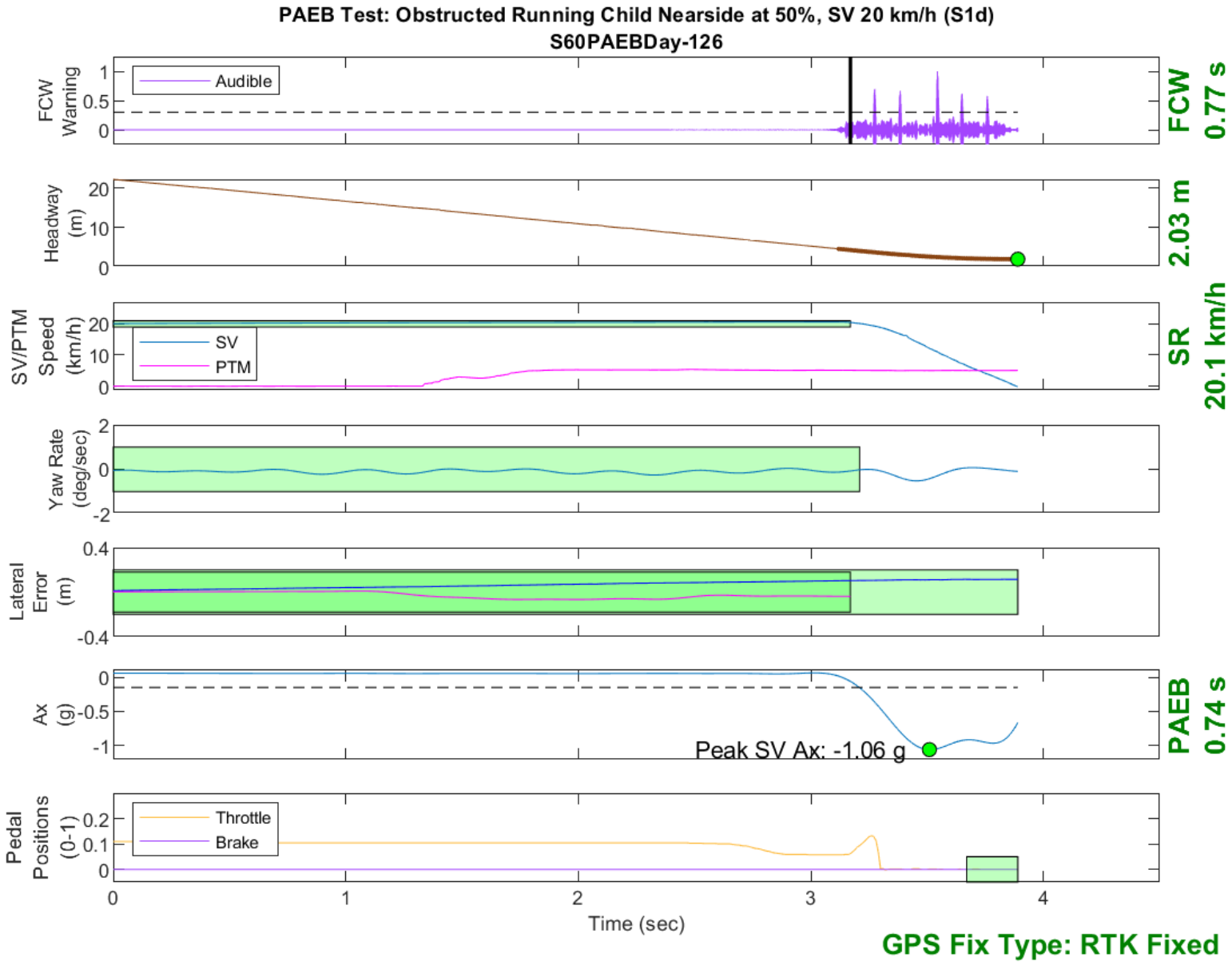


Figure D67. Time History for PAEB Run 126, S1d, Daytime, 20 km/h

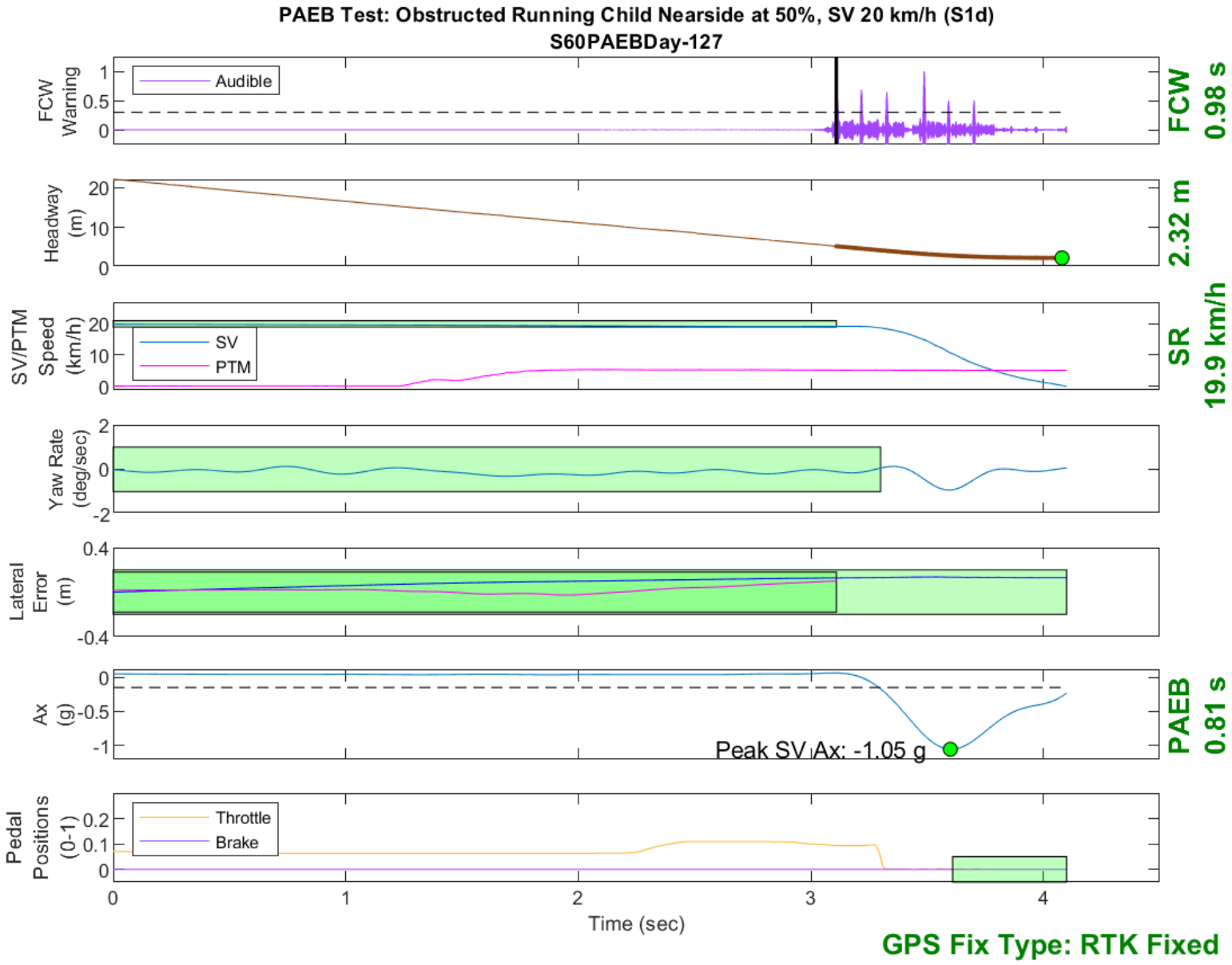


Figure D68. Time History for PAEB Run 127, S1d, Daytime, 20 km/h

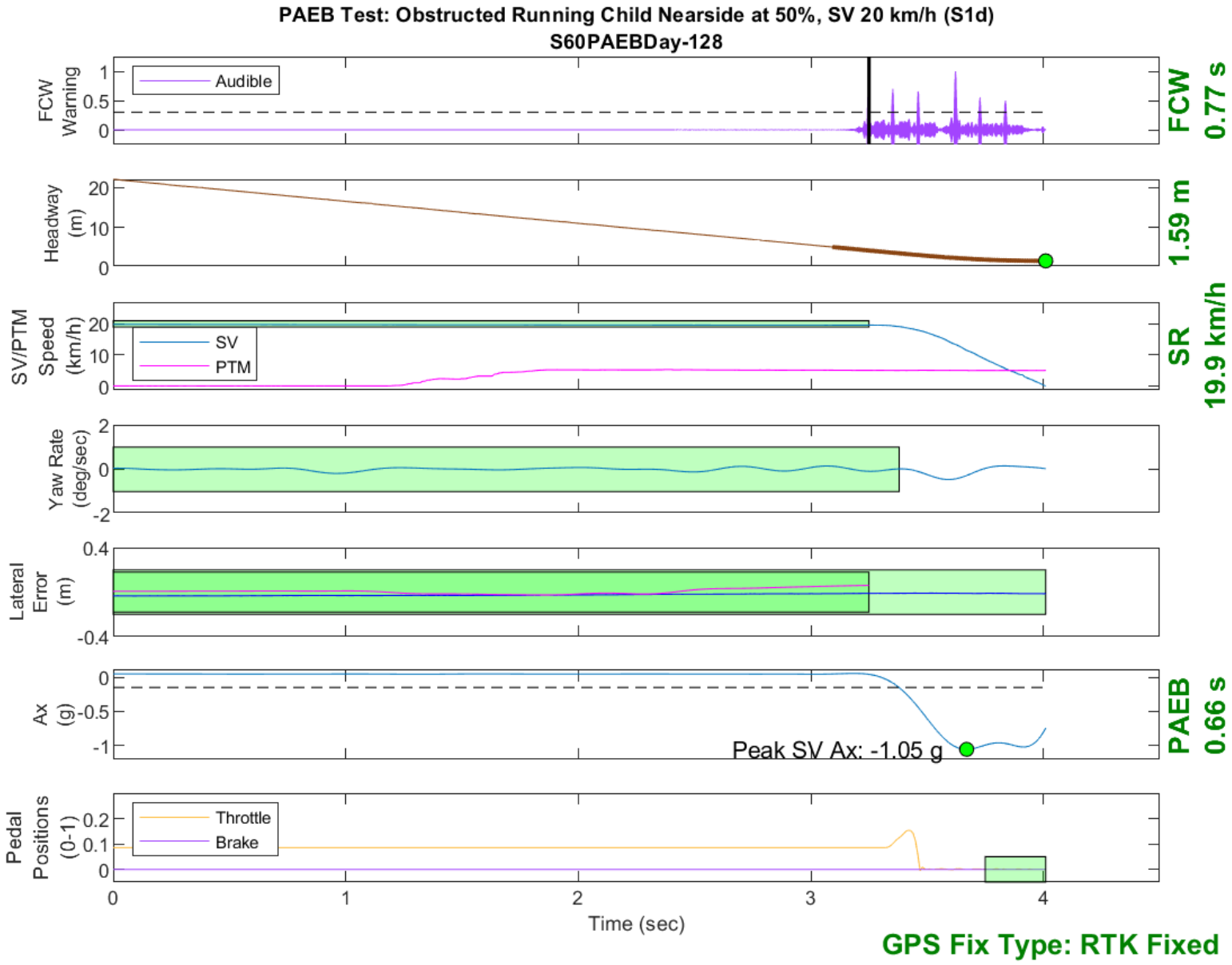


Figure D69. Time History for PAEB Run 128, S1d, Daytime, 20 km/h

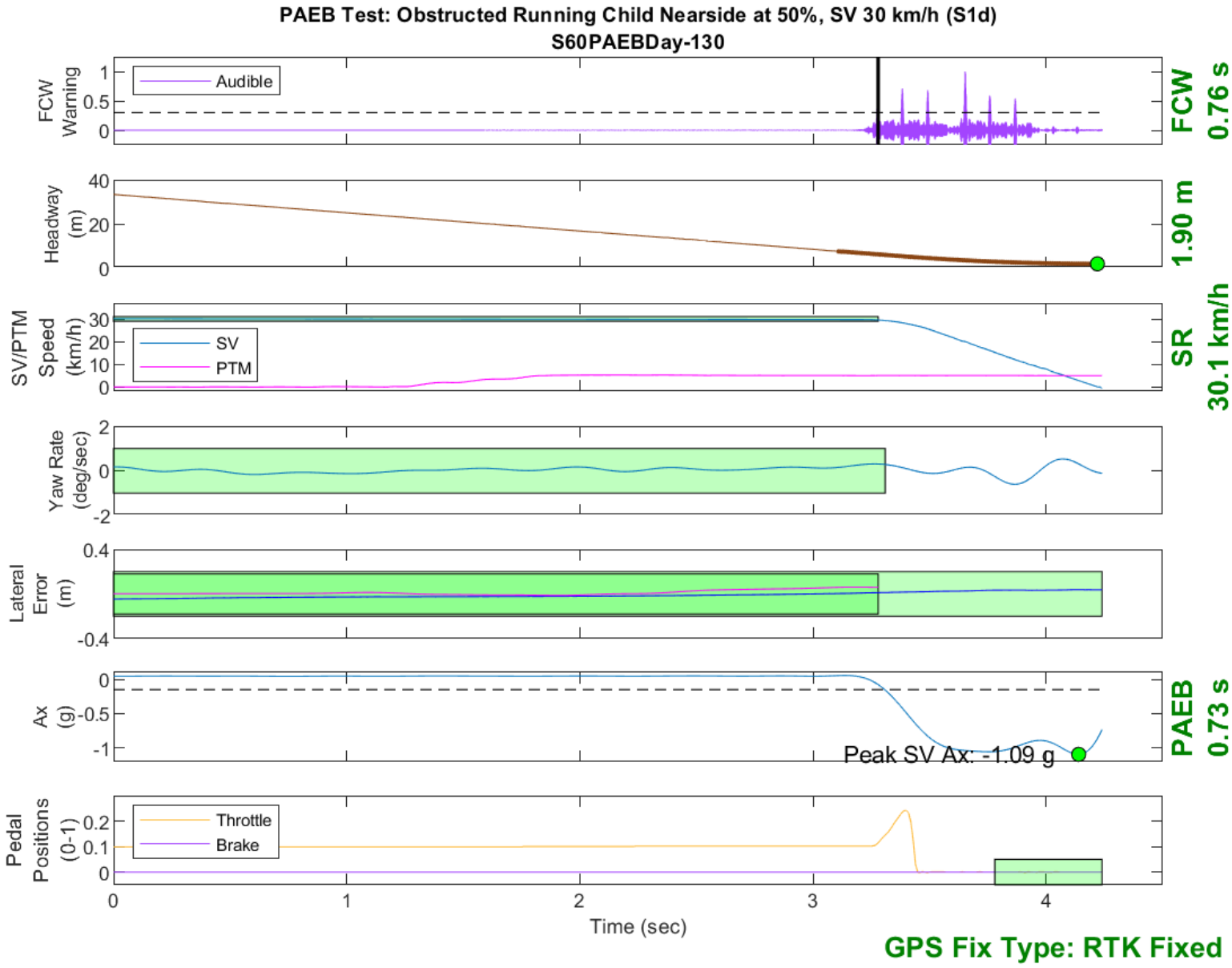


Figure D70. Time History for PAEB Run 130, S1d, Daytime, 30 km/h

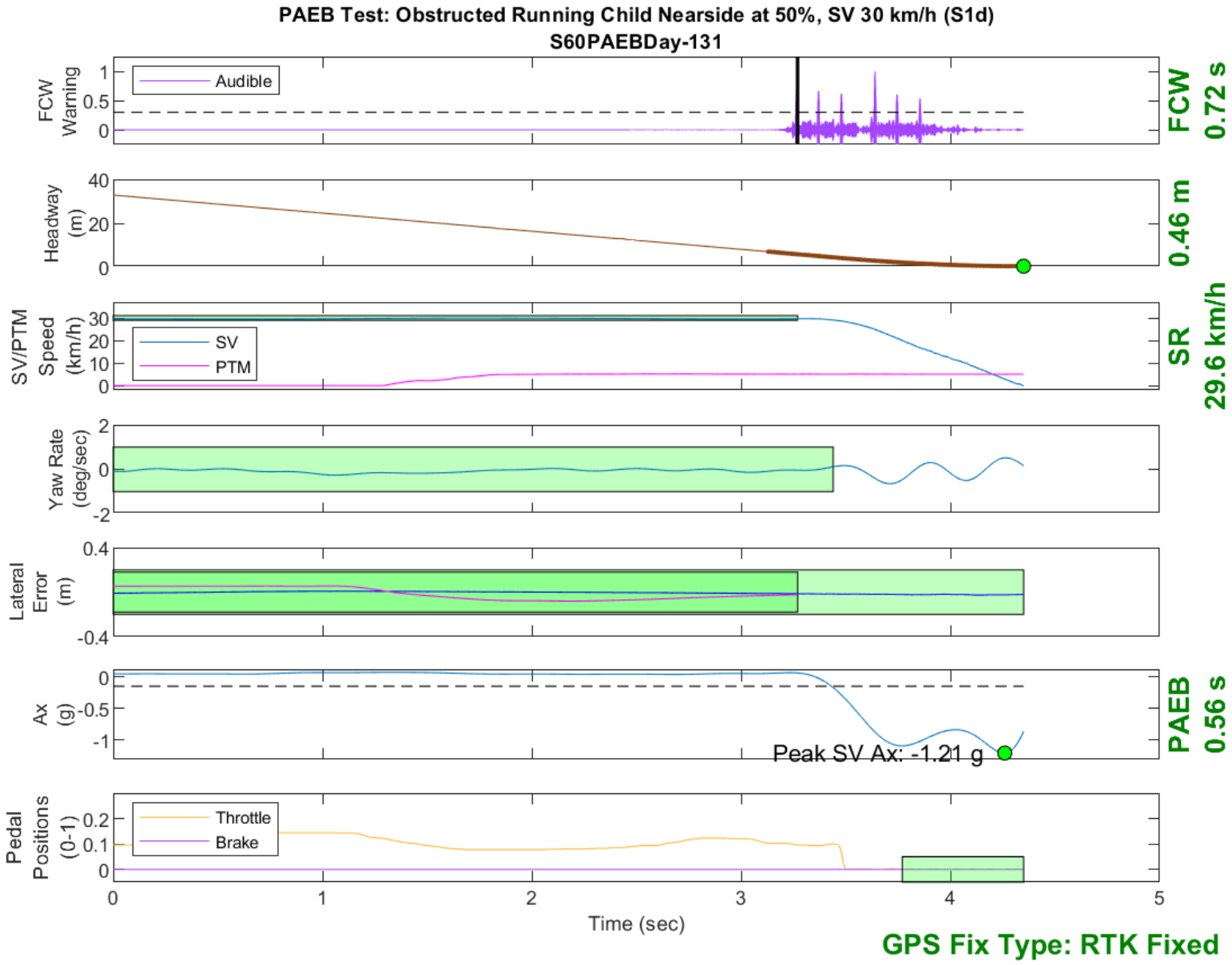


Figure D71. Time History for PAEB Run 131, S1d, Daytime, 30 km/h

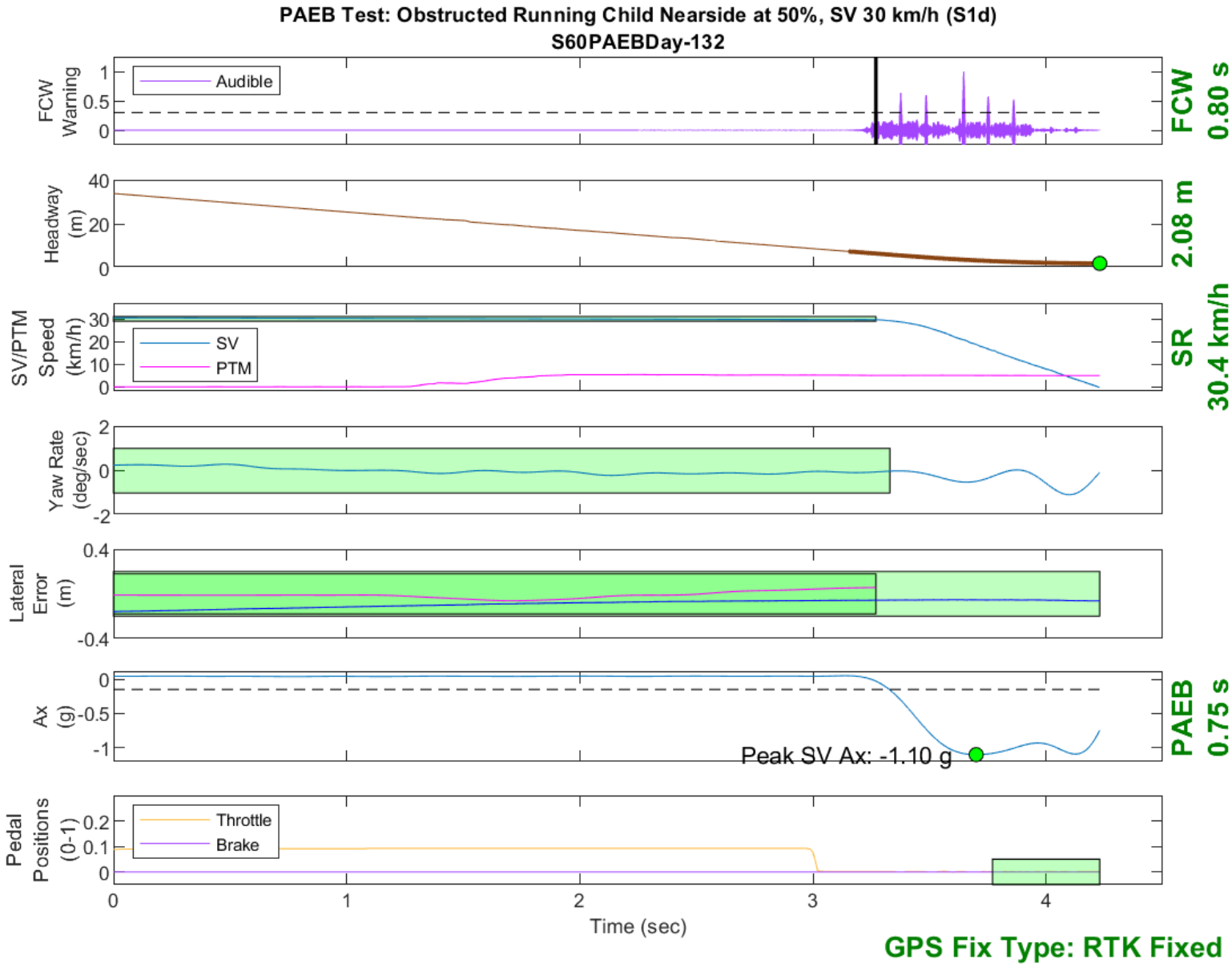


Figure D72. Time History for PAEB Run 132, S1d, Daytime, 30 km/h

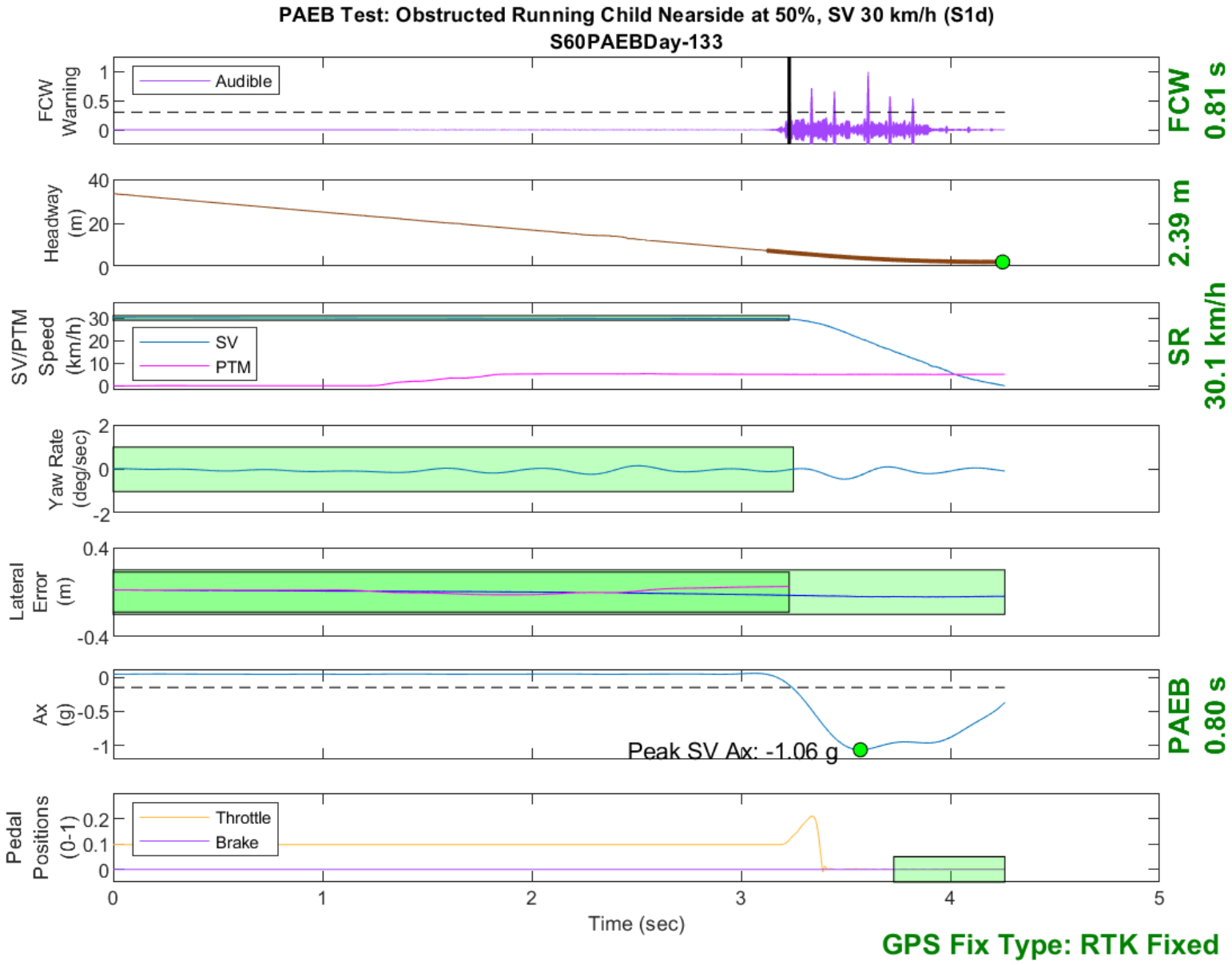


Figure D73. Time History for PAEB Run 133, S1d, Daytime, 30 km/h

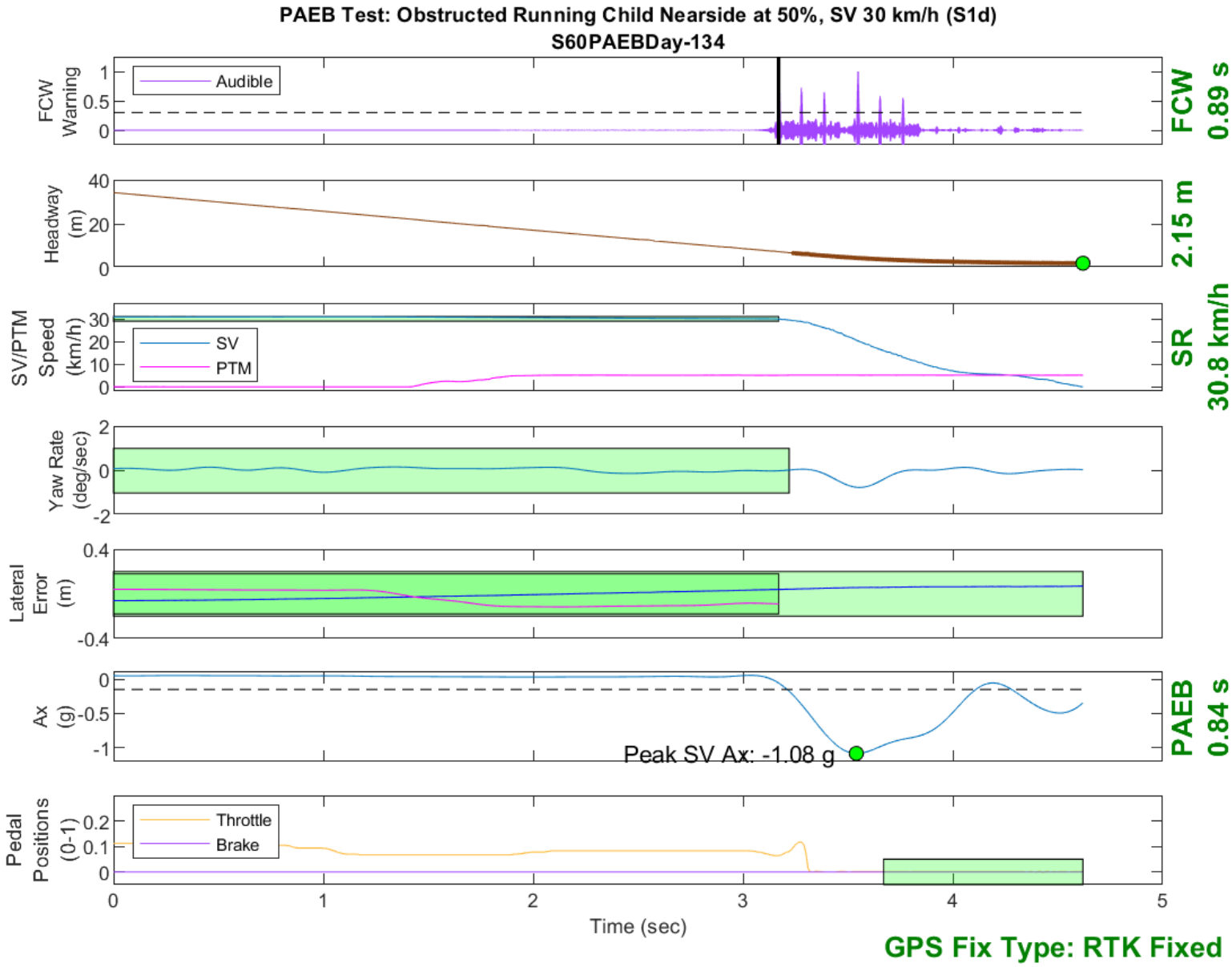


Figure D74. Time History for PAEB Run 134, S1d, Daytime, 30 km/h

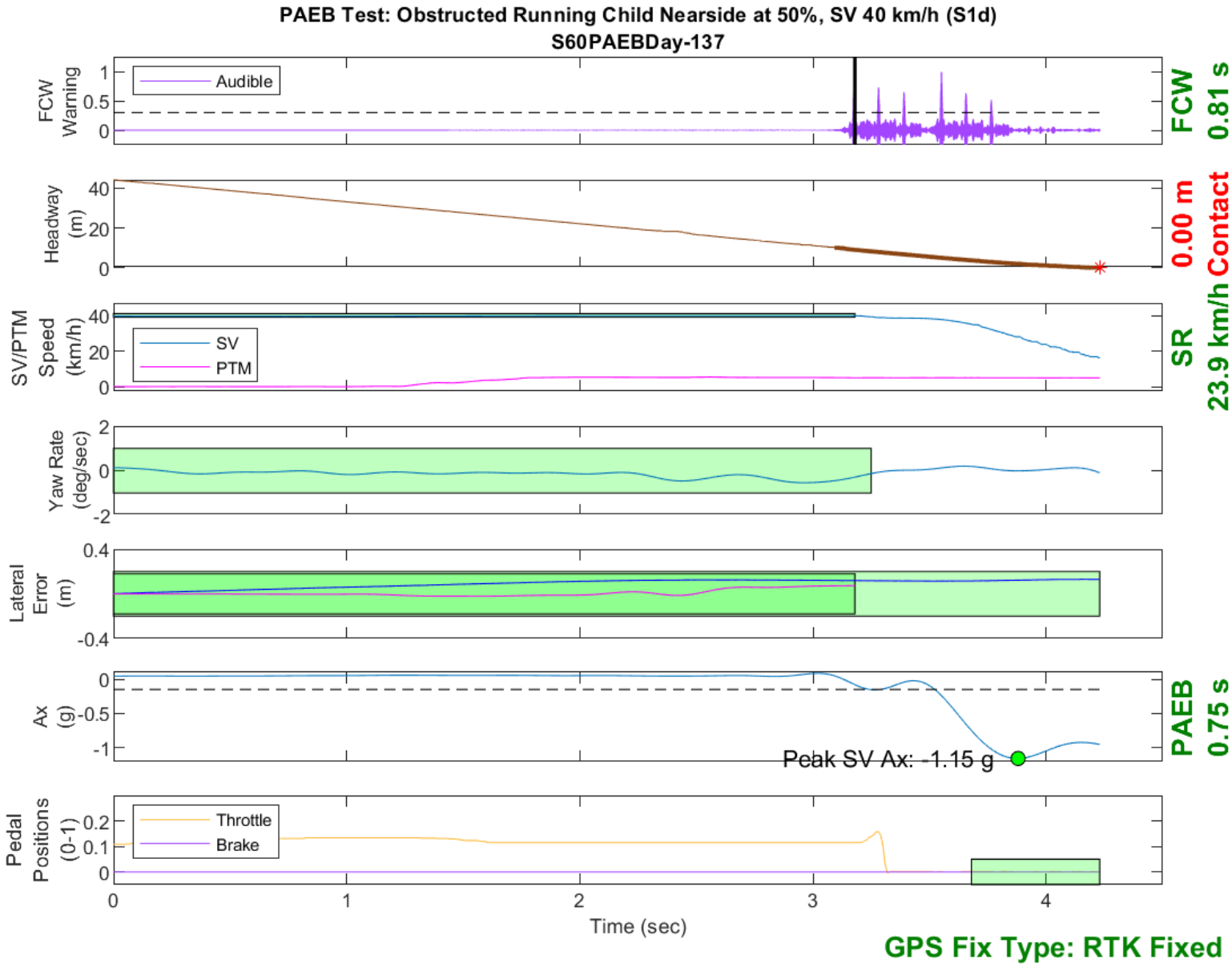


Figure D75. Time History for PAEB Run 137, S1d, Daytime, 40 km/h

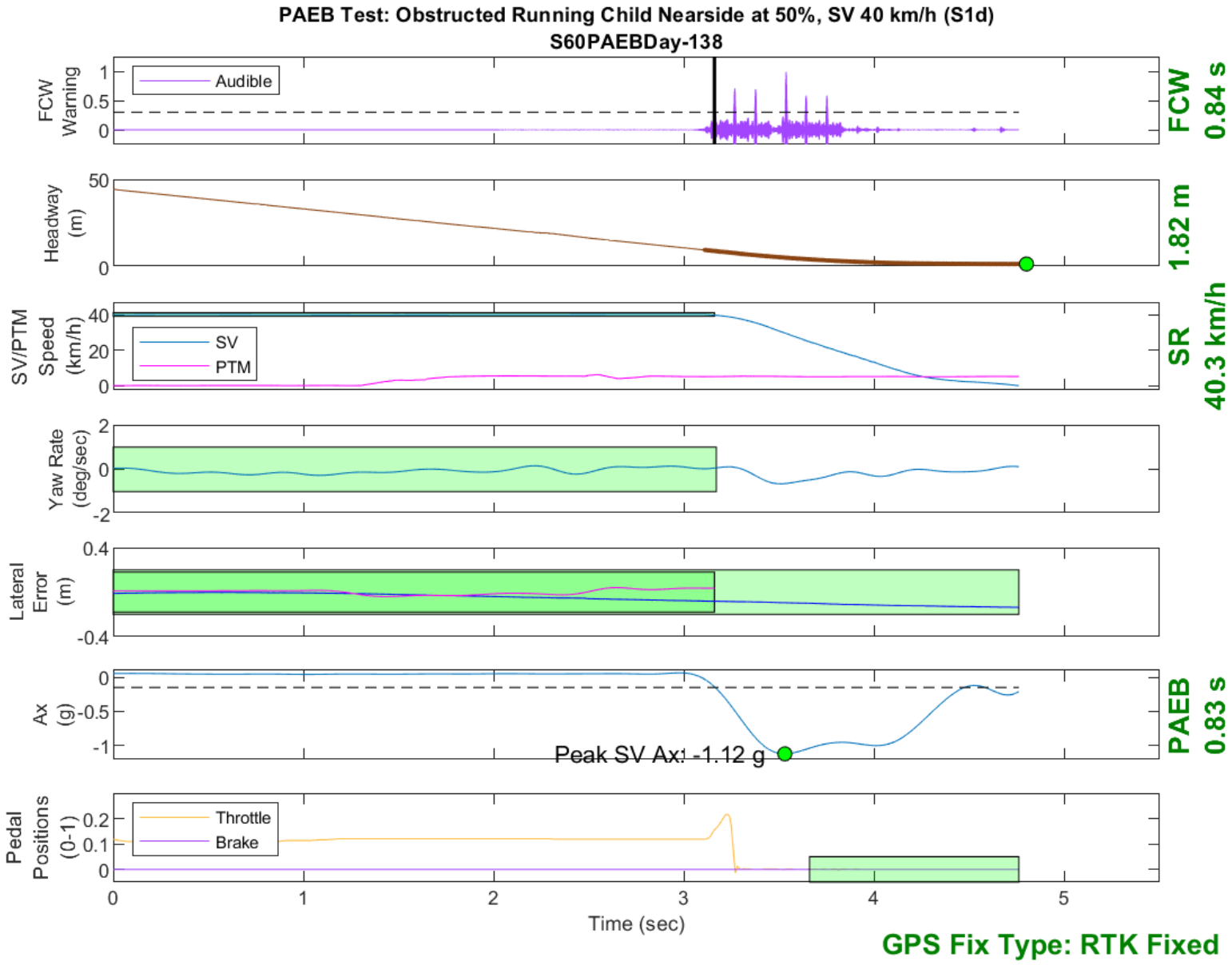


Figure D76. Time History for PAEB Run 138, S1d, Daytime, 40 km/h

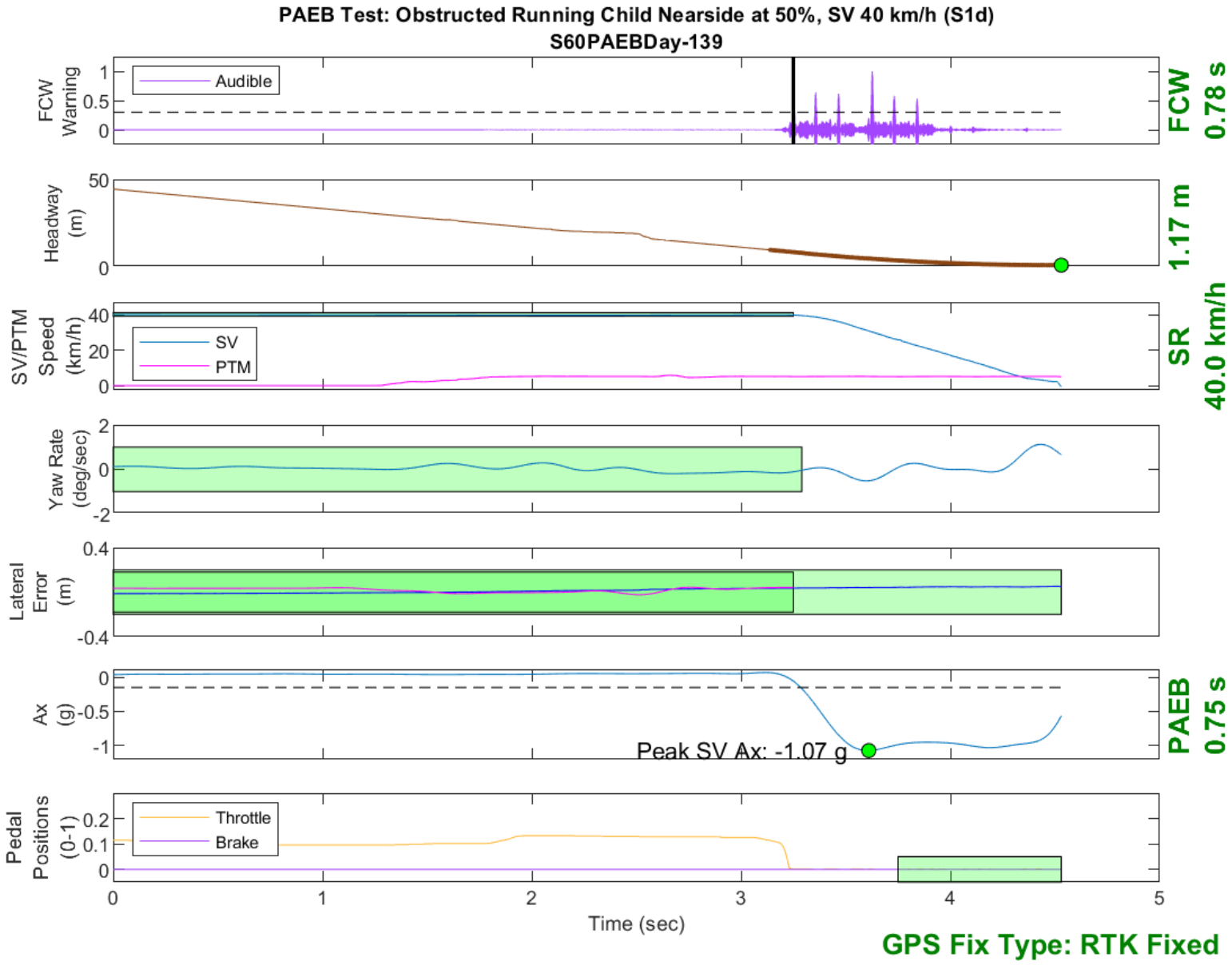


Figure D77. Time History for PAEB Run 139, S1d, Daytime, 40 km/h

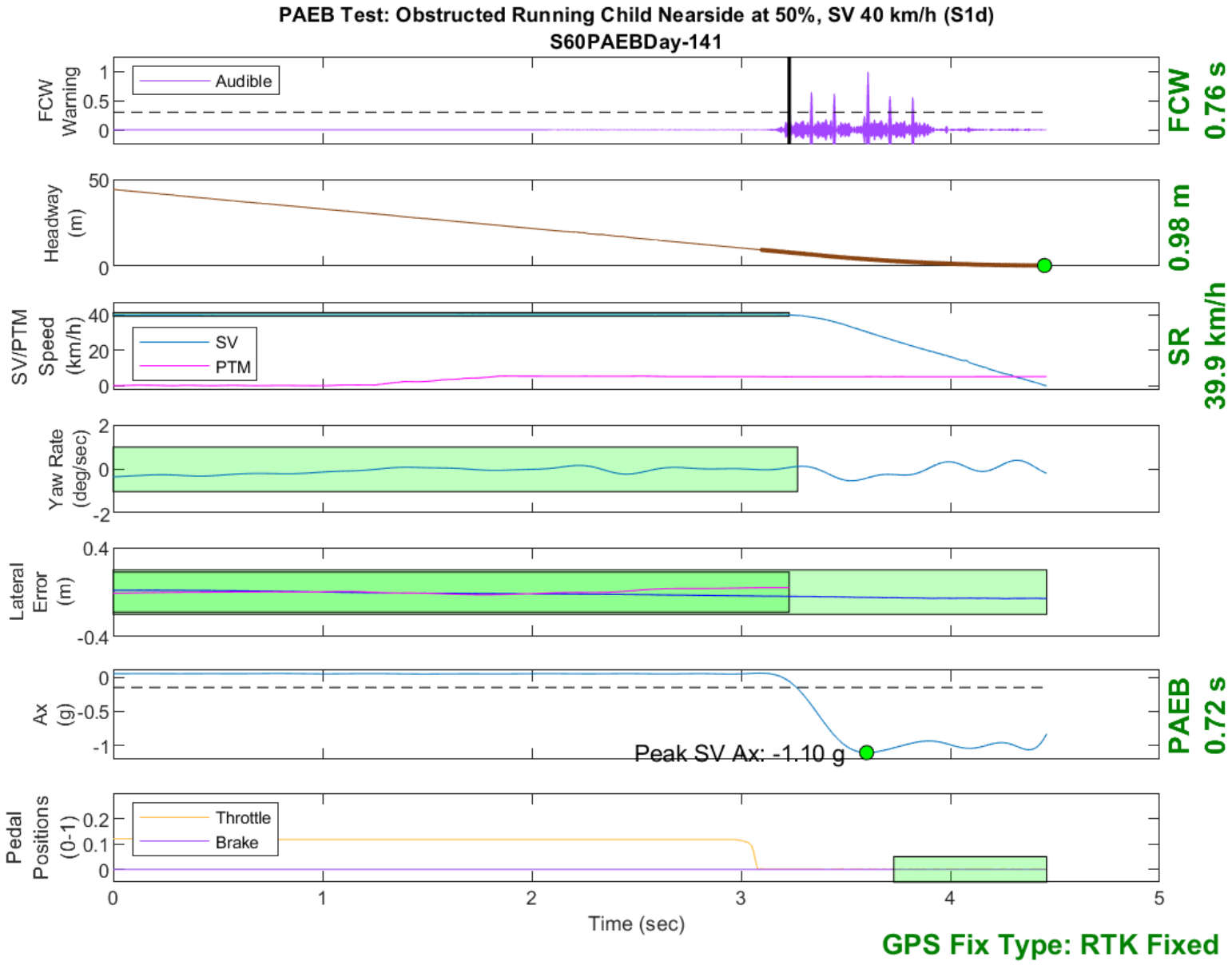


Figure D78. Time History for PAEB Run 141, S1d, Daytime, 40 km/h

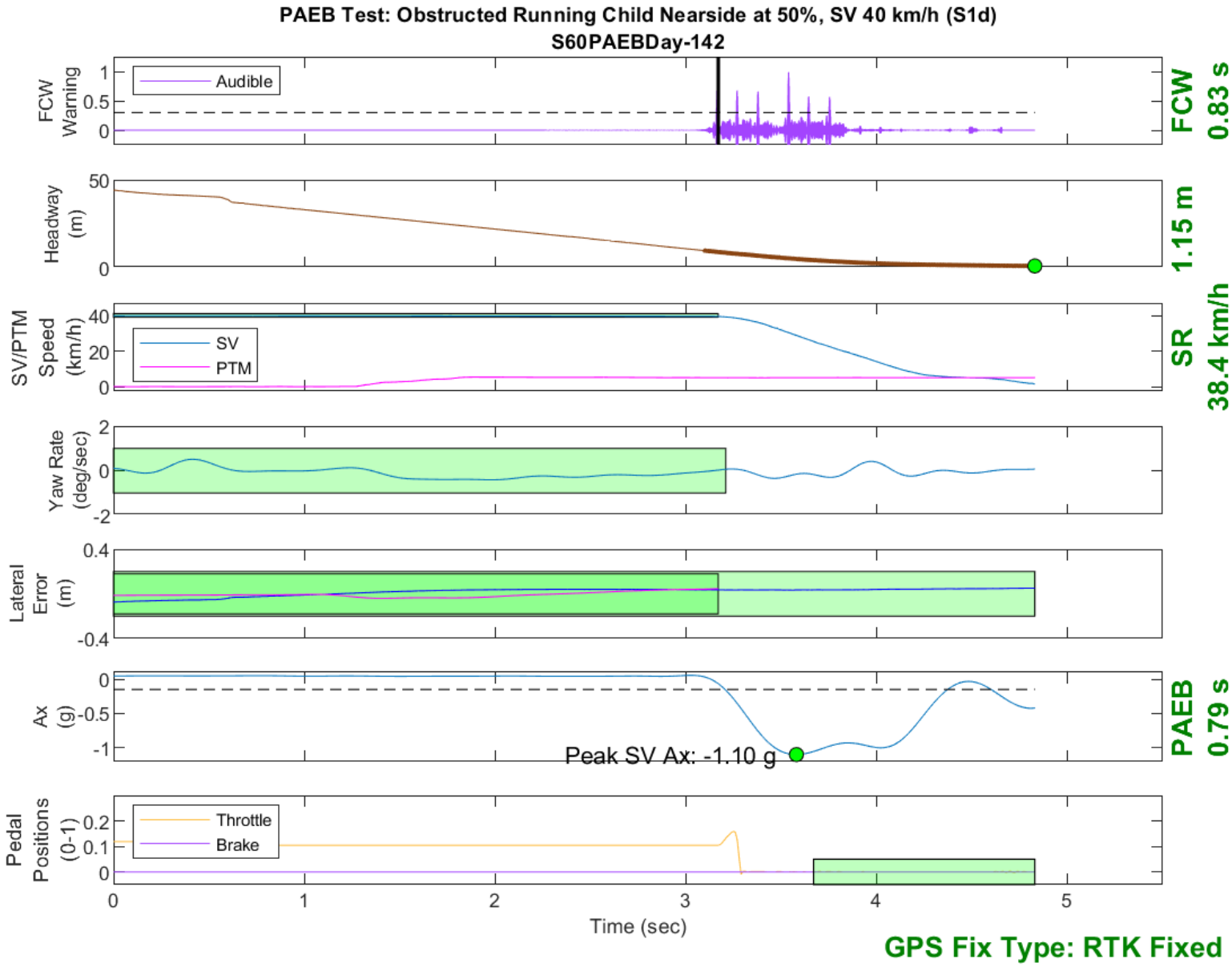


Figure D79. Time History for PAEB Run 142, S1d, Daytime, 40 km/h

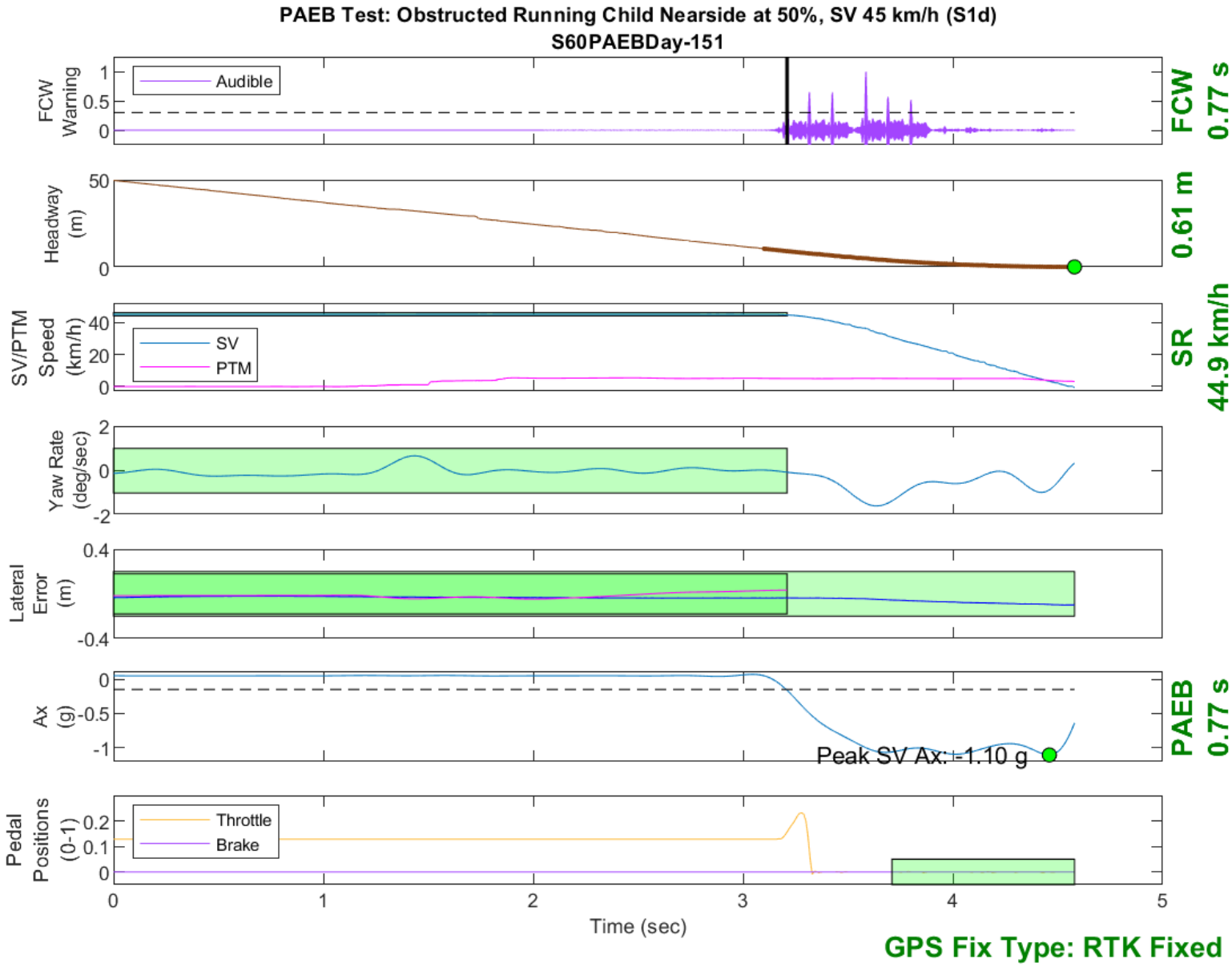


Figure D80. Time History for PAEB Run 151, S1d, Daytime, 45 km/h

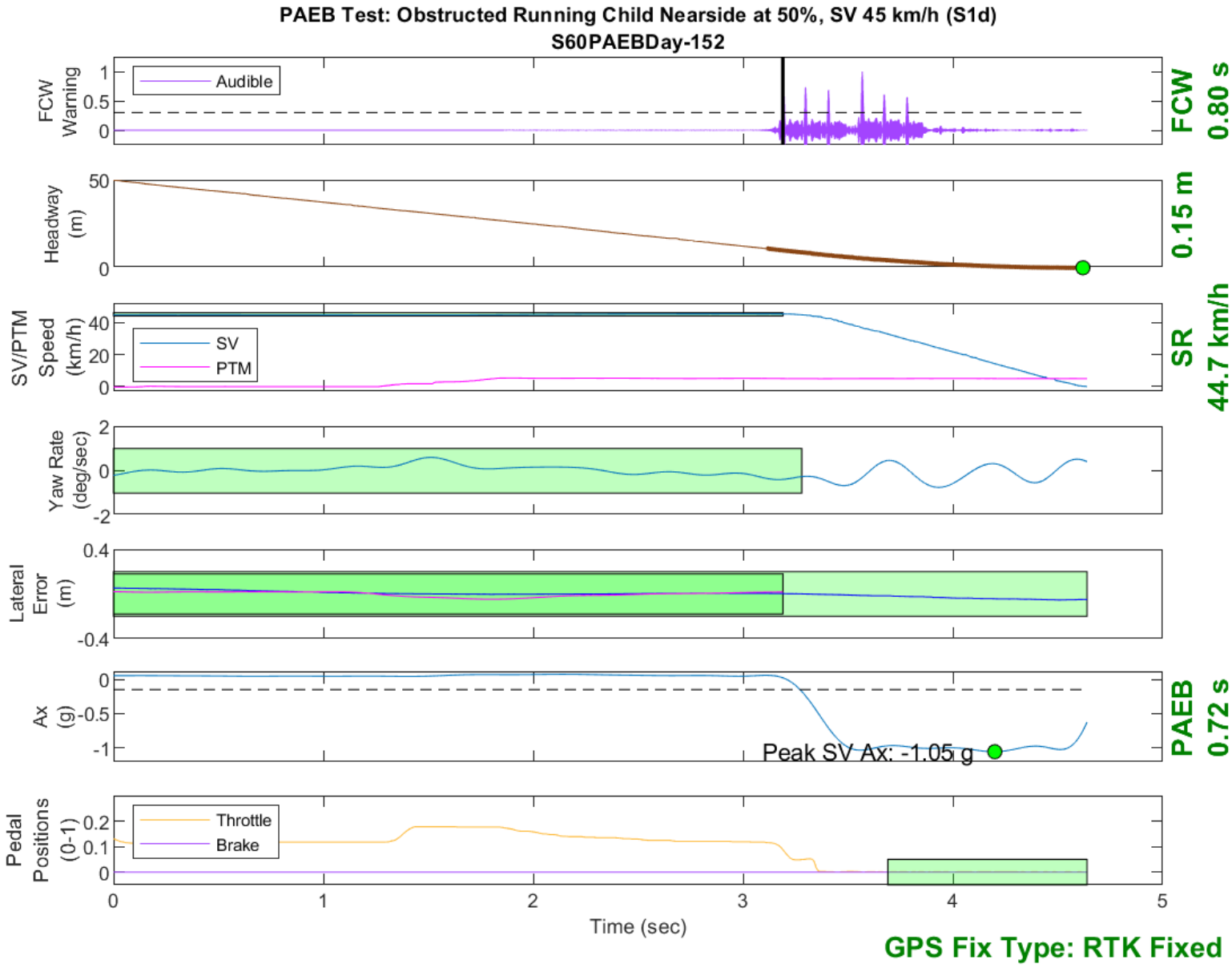


Figure D81. Time History for PAEB Run 152, S1d, Daytime, 45 km/h

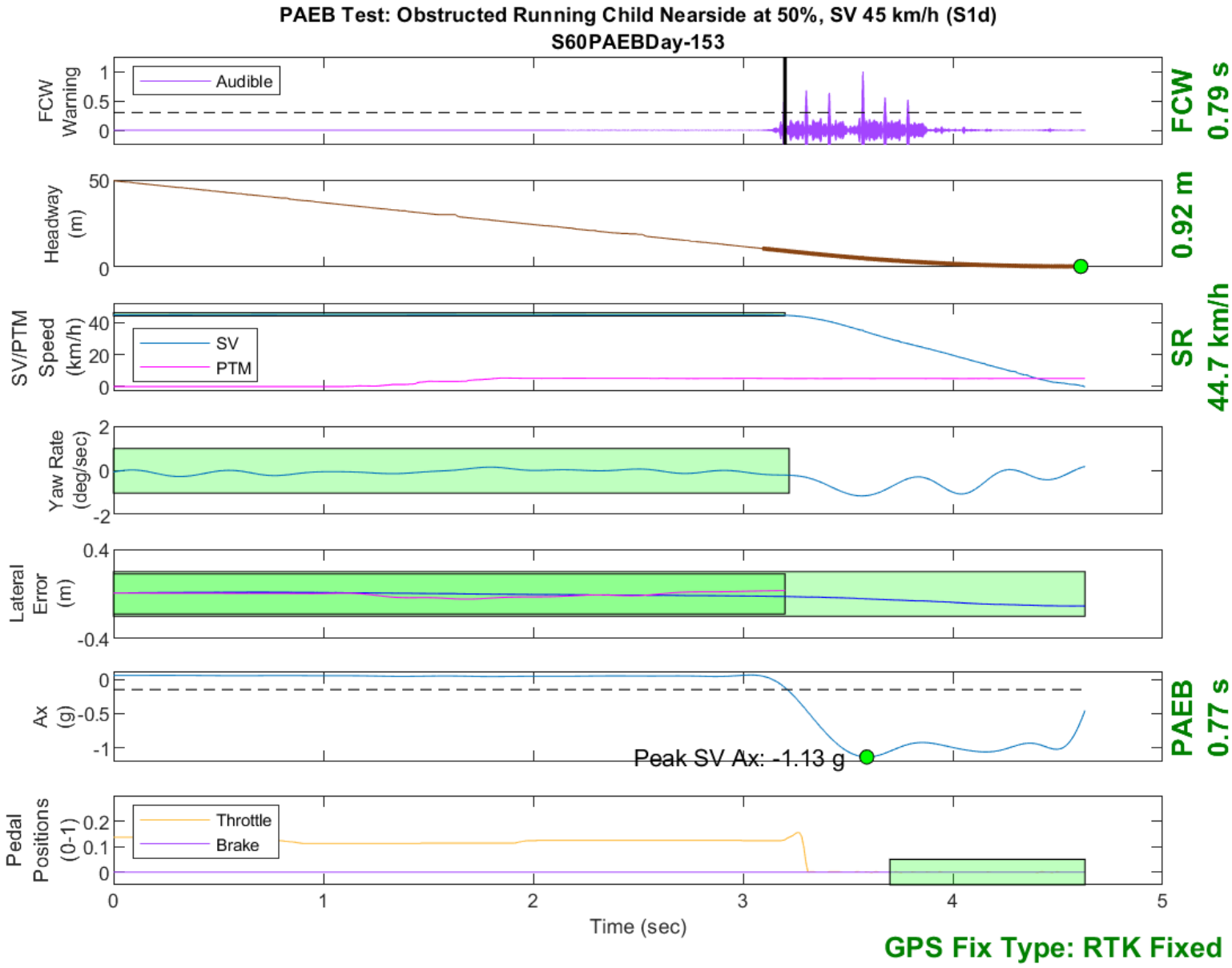


Figure D82. Time History for PAEB Run 153, S1d, Daytime, 45 km/h

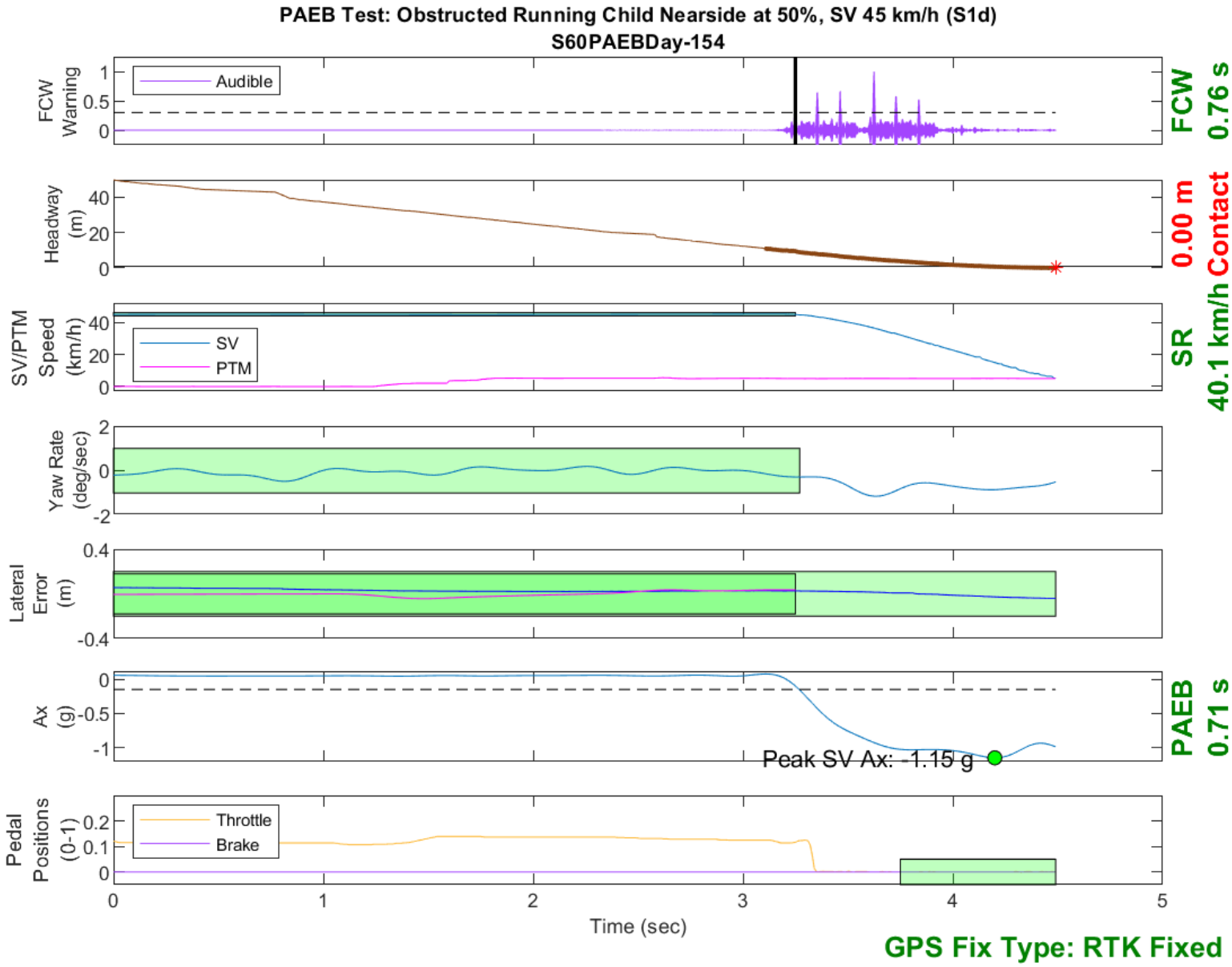


Figure D83. Time History for PAEB Run 154, S1d, Daytime, 45 km/h

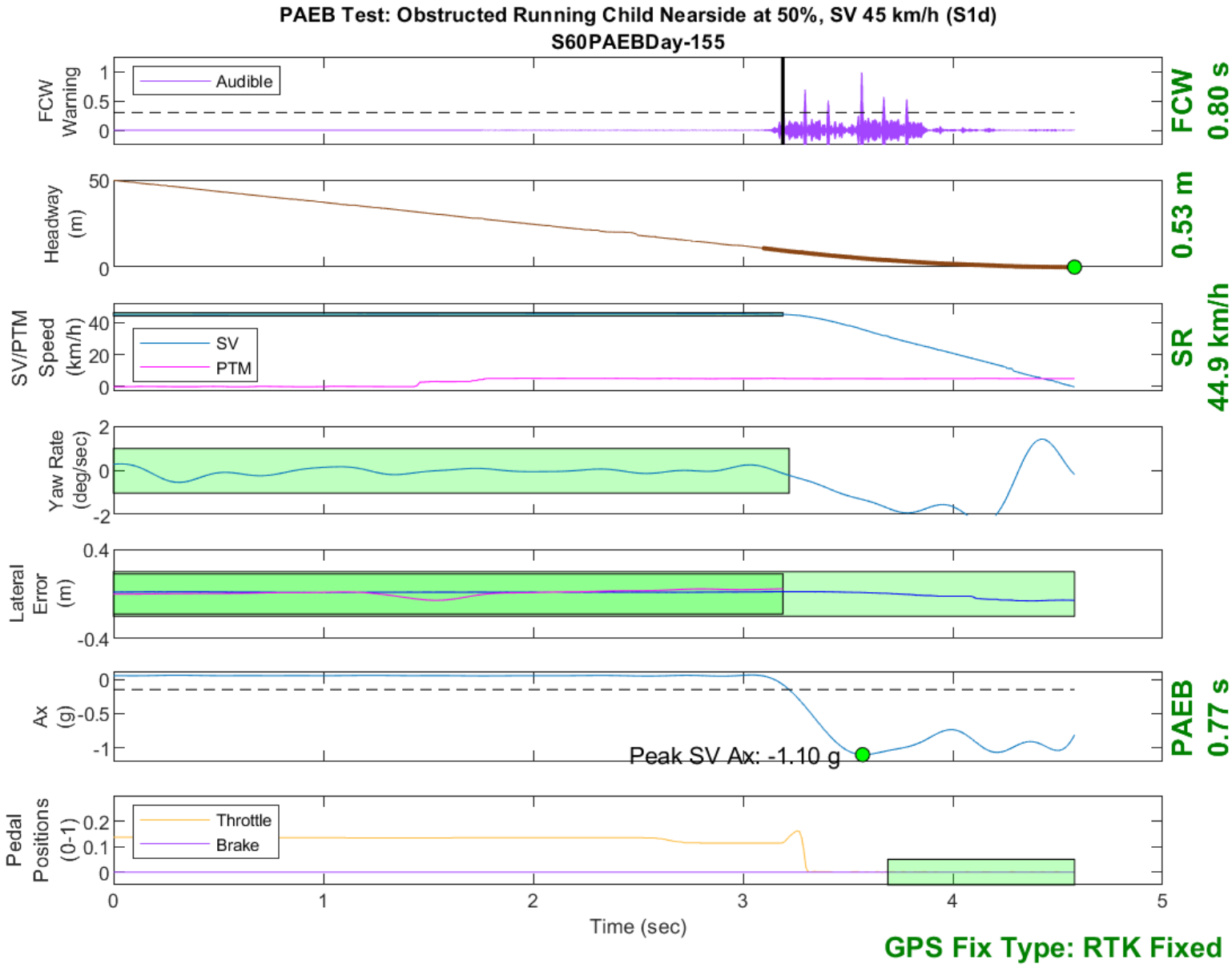


Figure D84. Time History for PAEB Run 155, S1d, Daytime, 45 km/h

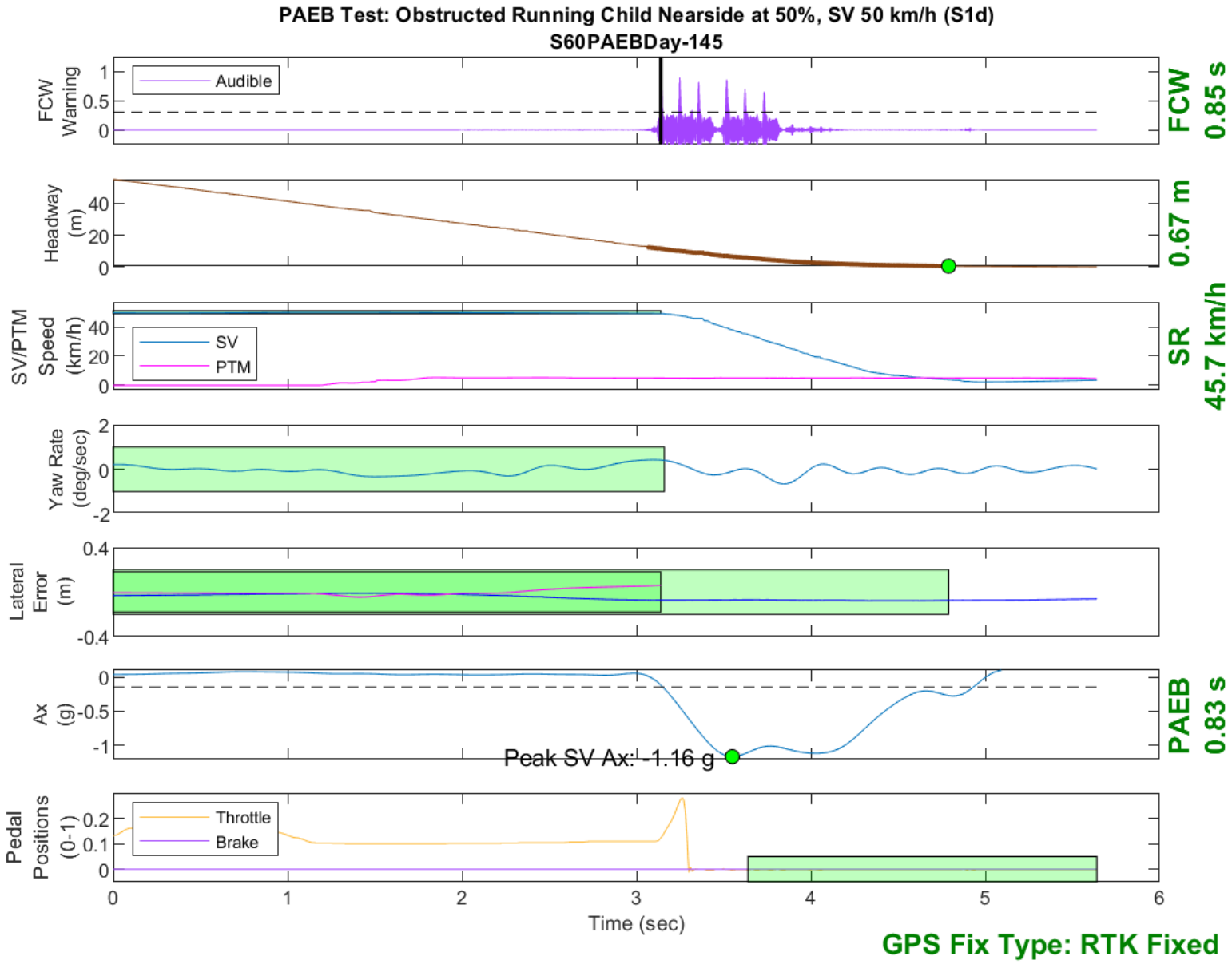


Figure D85. Time History for PAEB Run 145, S1d, Daytime, 50 km/h

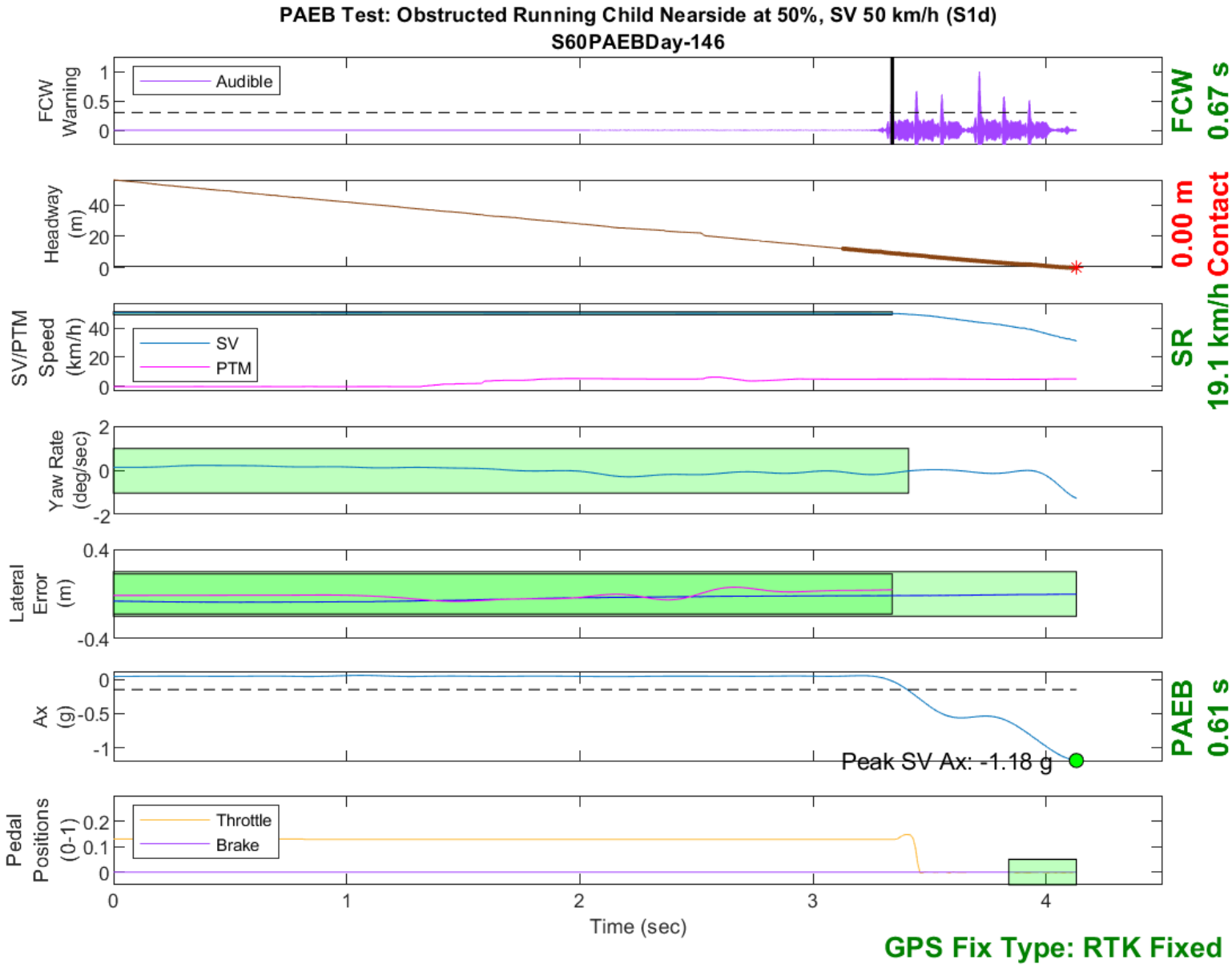


Figure D86. Time History for PAEB Run 146, S1d, Daytime, 50 km/h

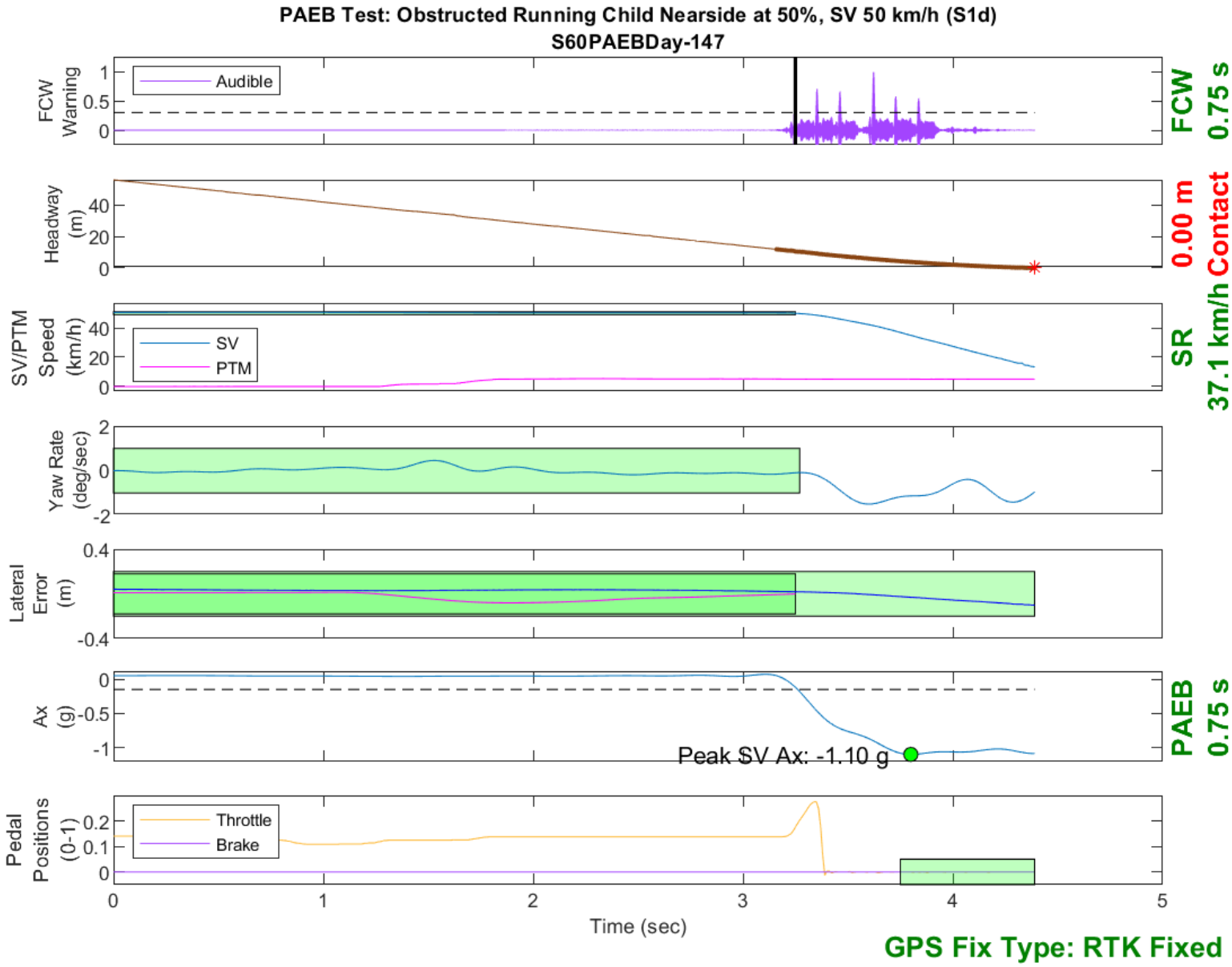


Figure D87. Time History for PAEB Run 147, S1d, Daytime, 50 km/h

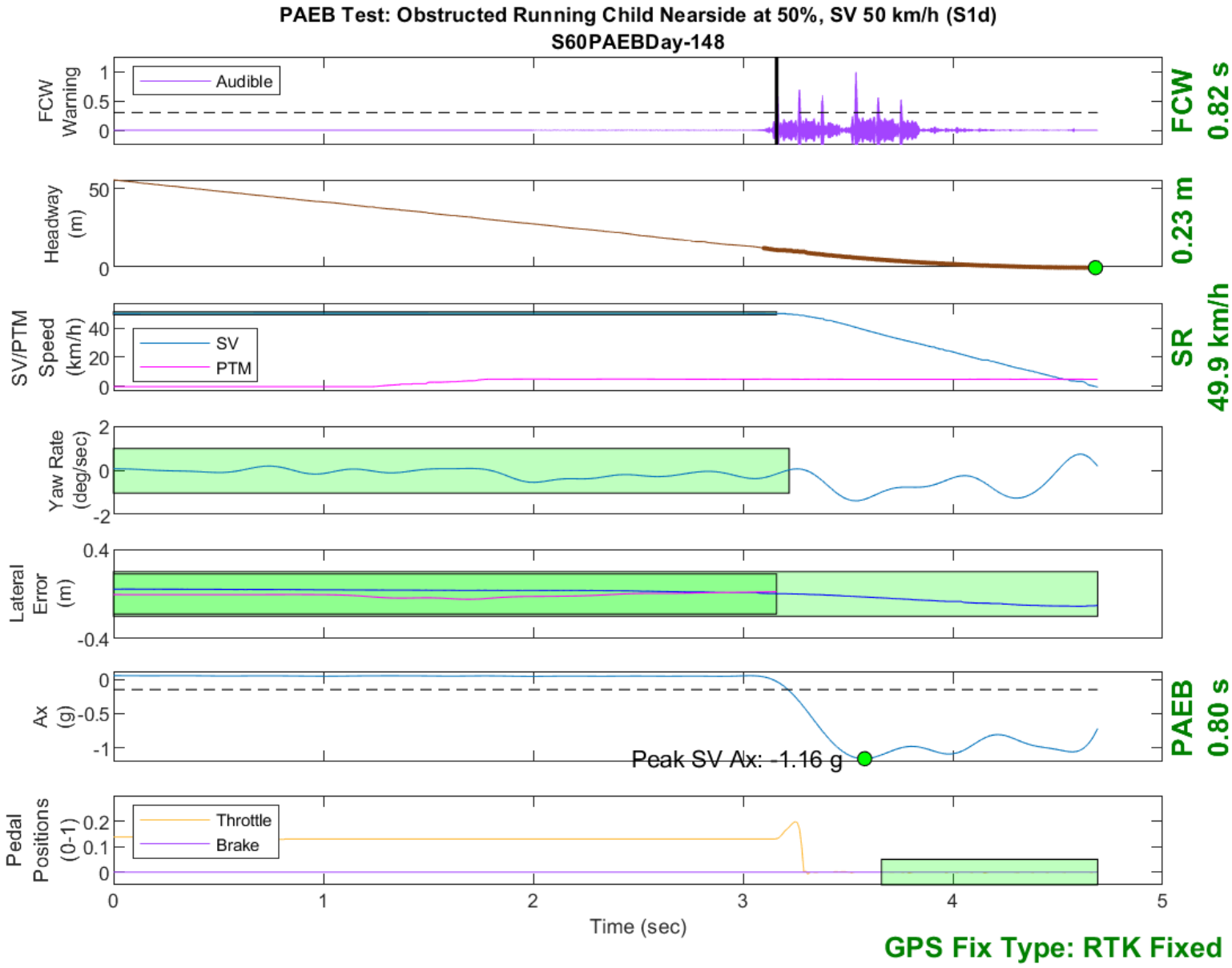


Figure D88. Time History for PAEB Run 148, S1d, Daytime, 50 km/h

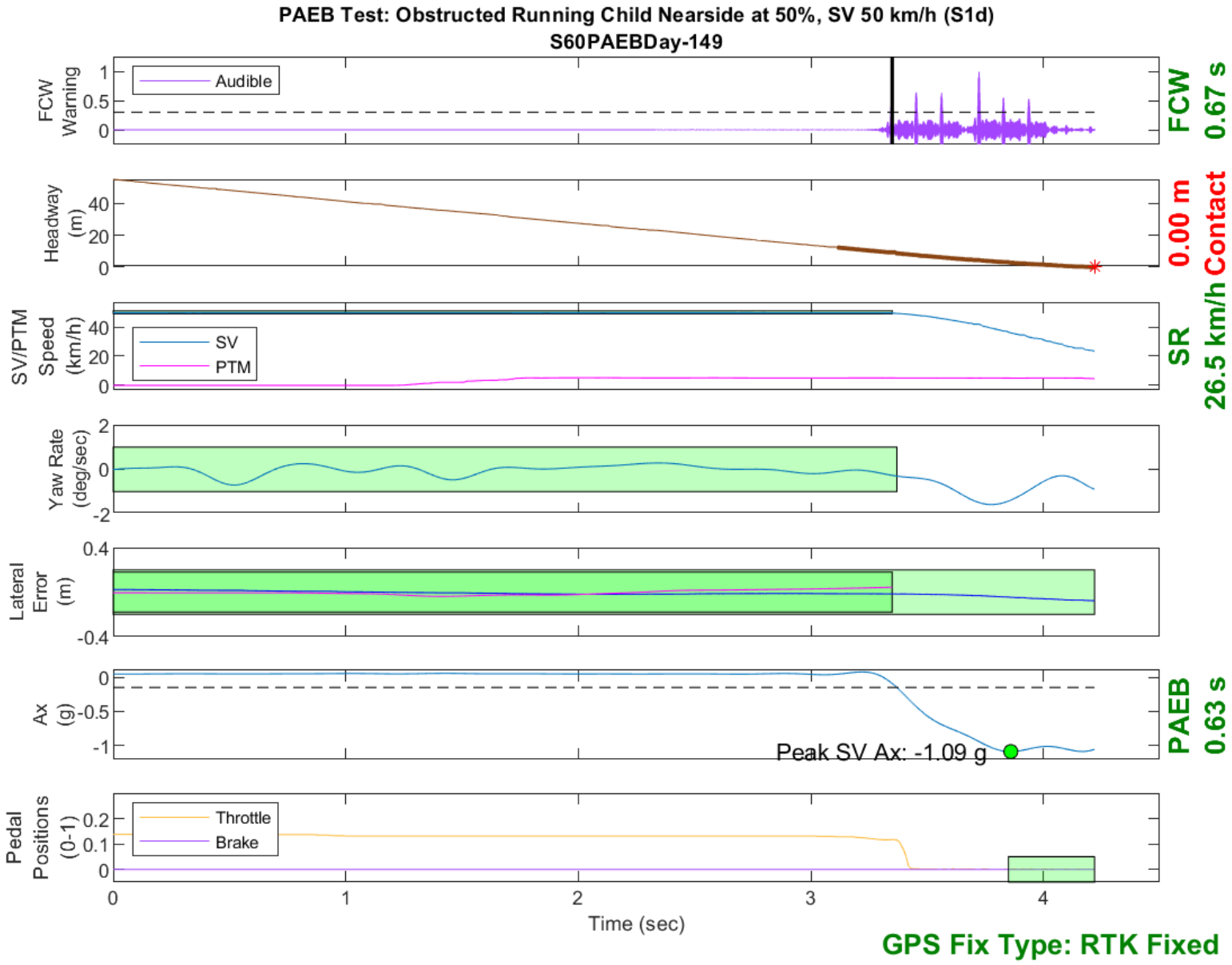


Figure D89. Time History for PAEB Run 149, S1d, Daytime, 50 km/h

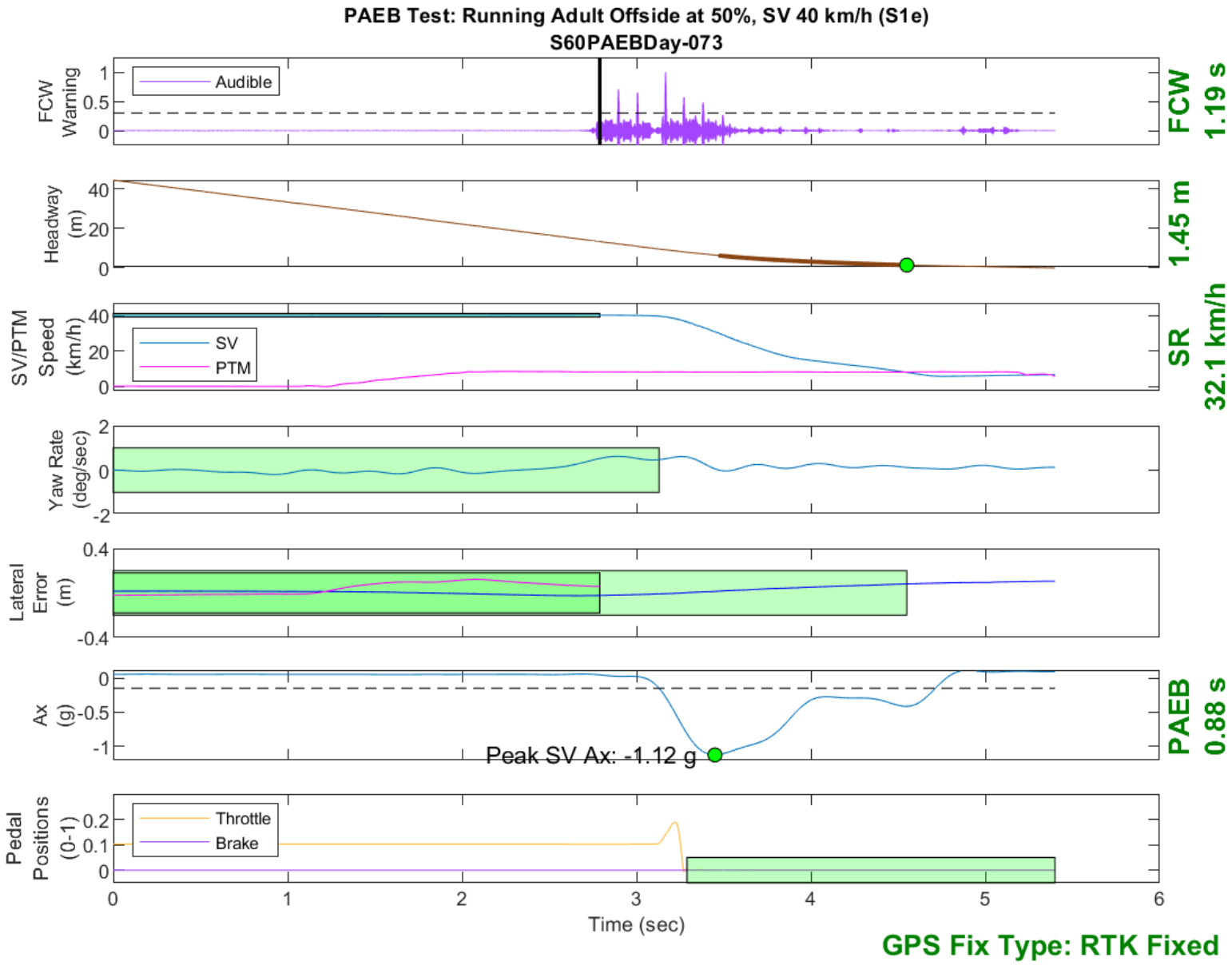


Figure D90. Time History for PAEB Run 73, S1e, Daytime, 40 km/h

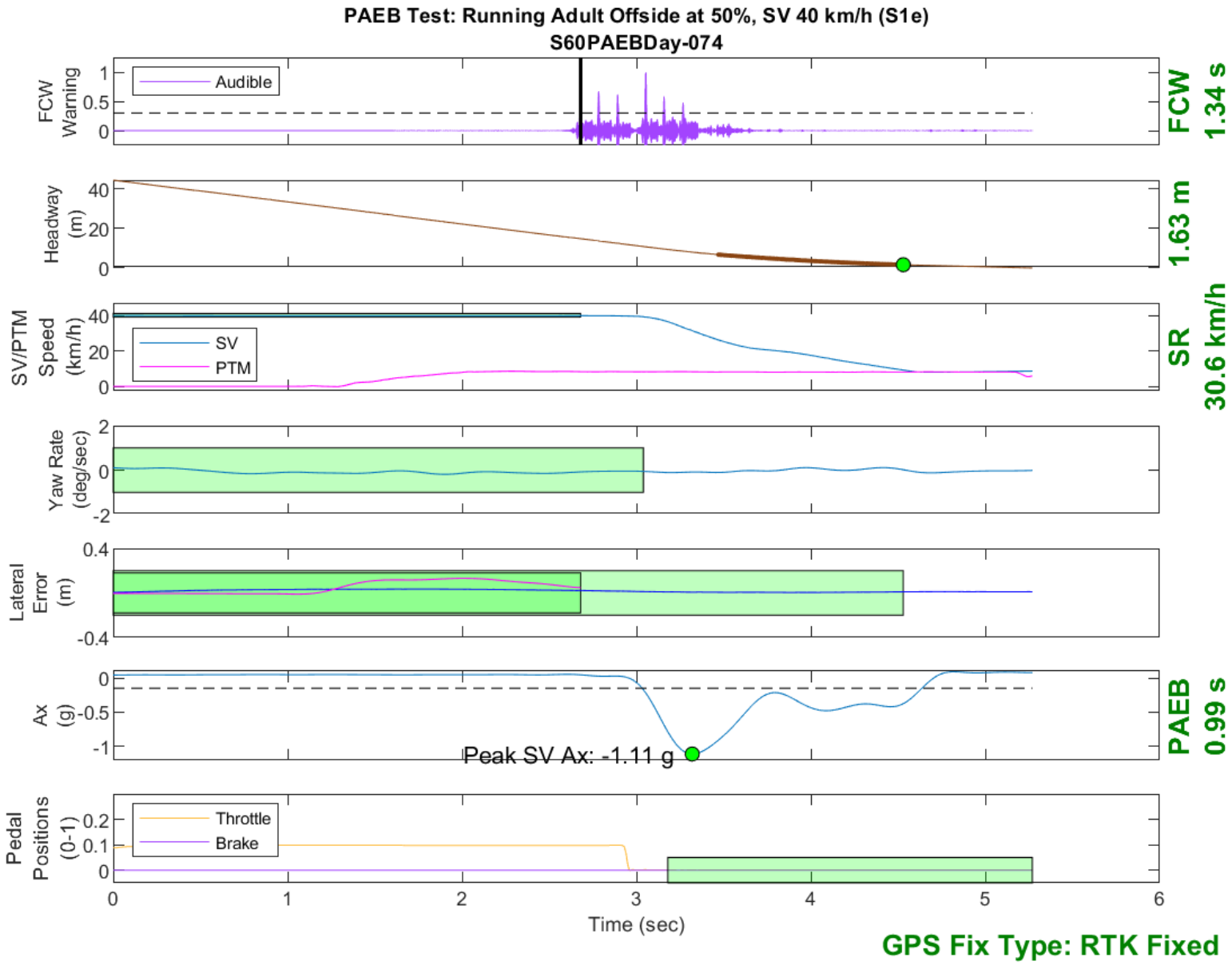


Figure D91. Time History for PAEB Run 74, S1e, Daytime, 40 km/h

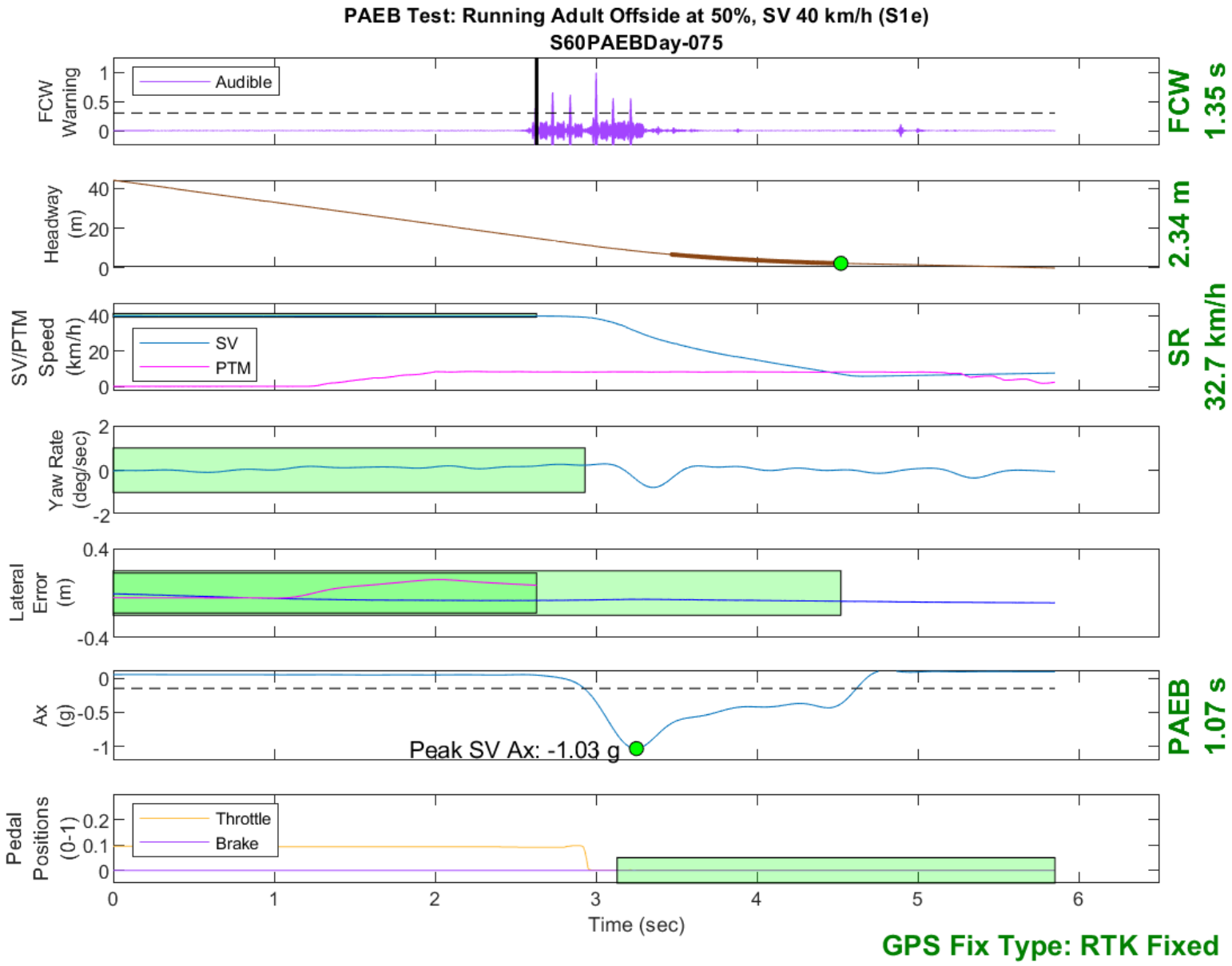


Figure D92. Time History for PAEB Run 75, S1e, Daytime, 40 km/h

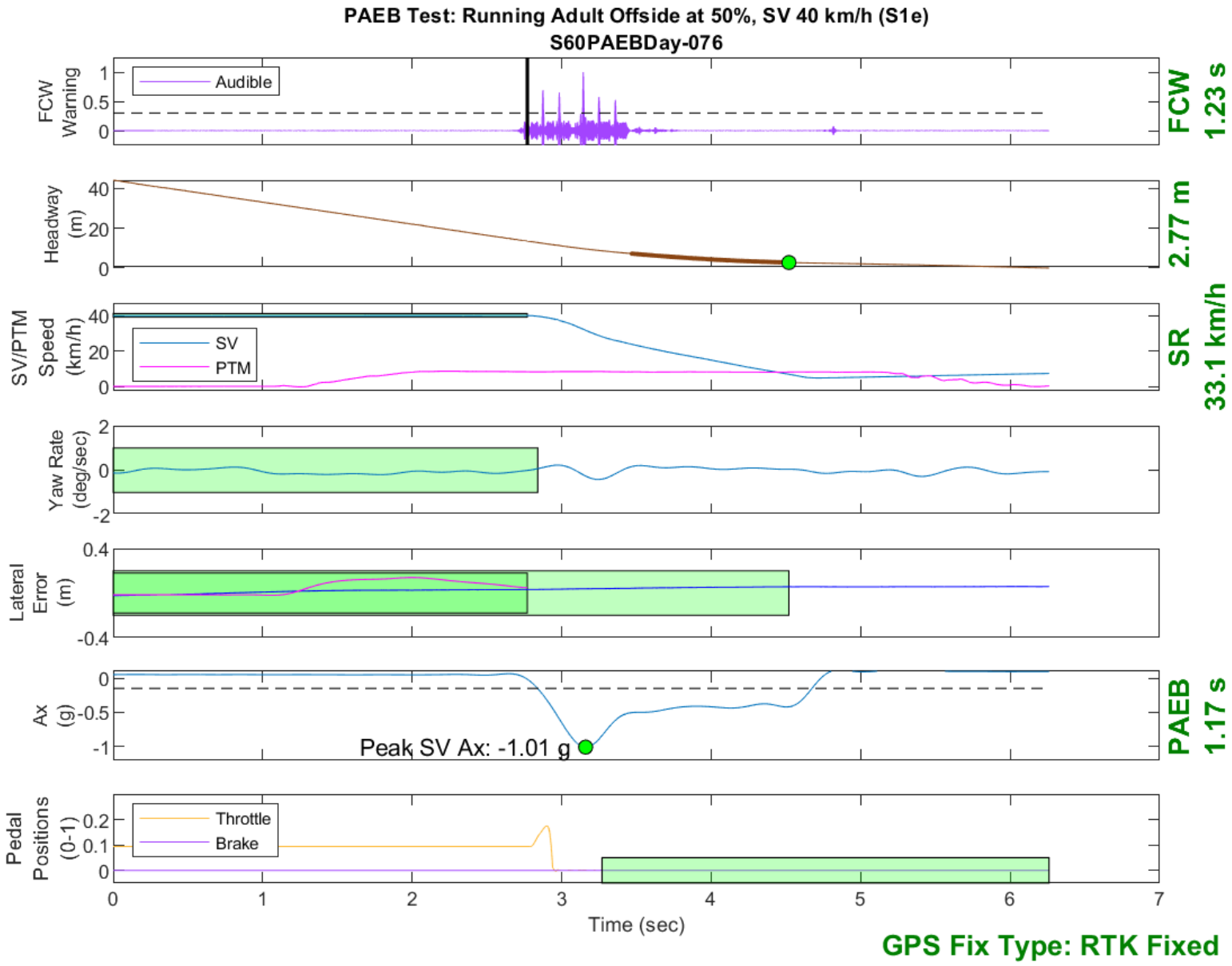


Figure D93. Time History for PAEB Run 76, S1e, Daytime, 40 km/h

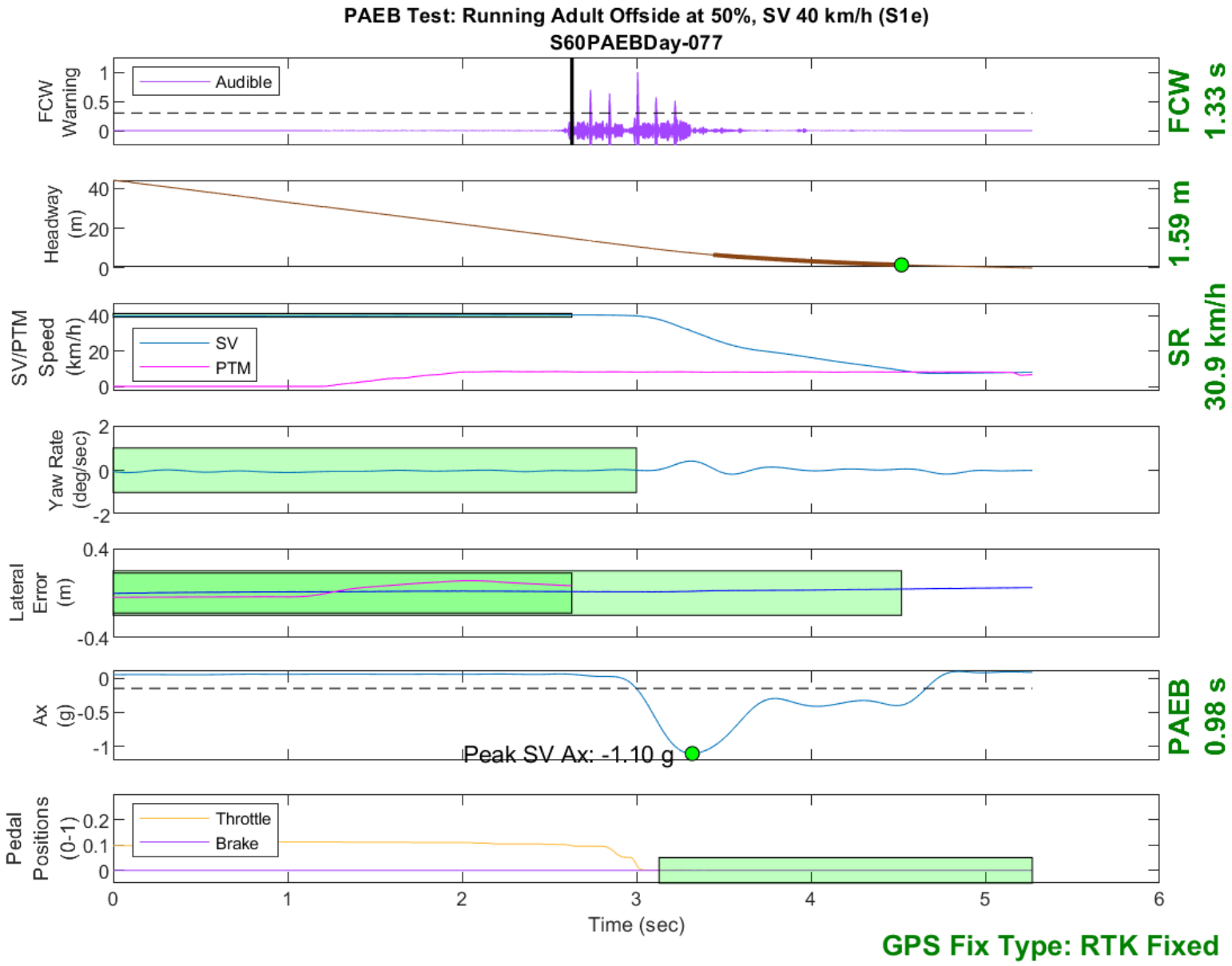


Figure D94. Time History for PAEB Run 77, S1e, Daytime, 40 km/h

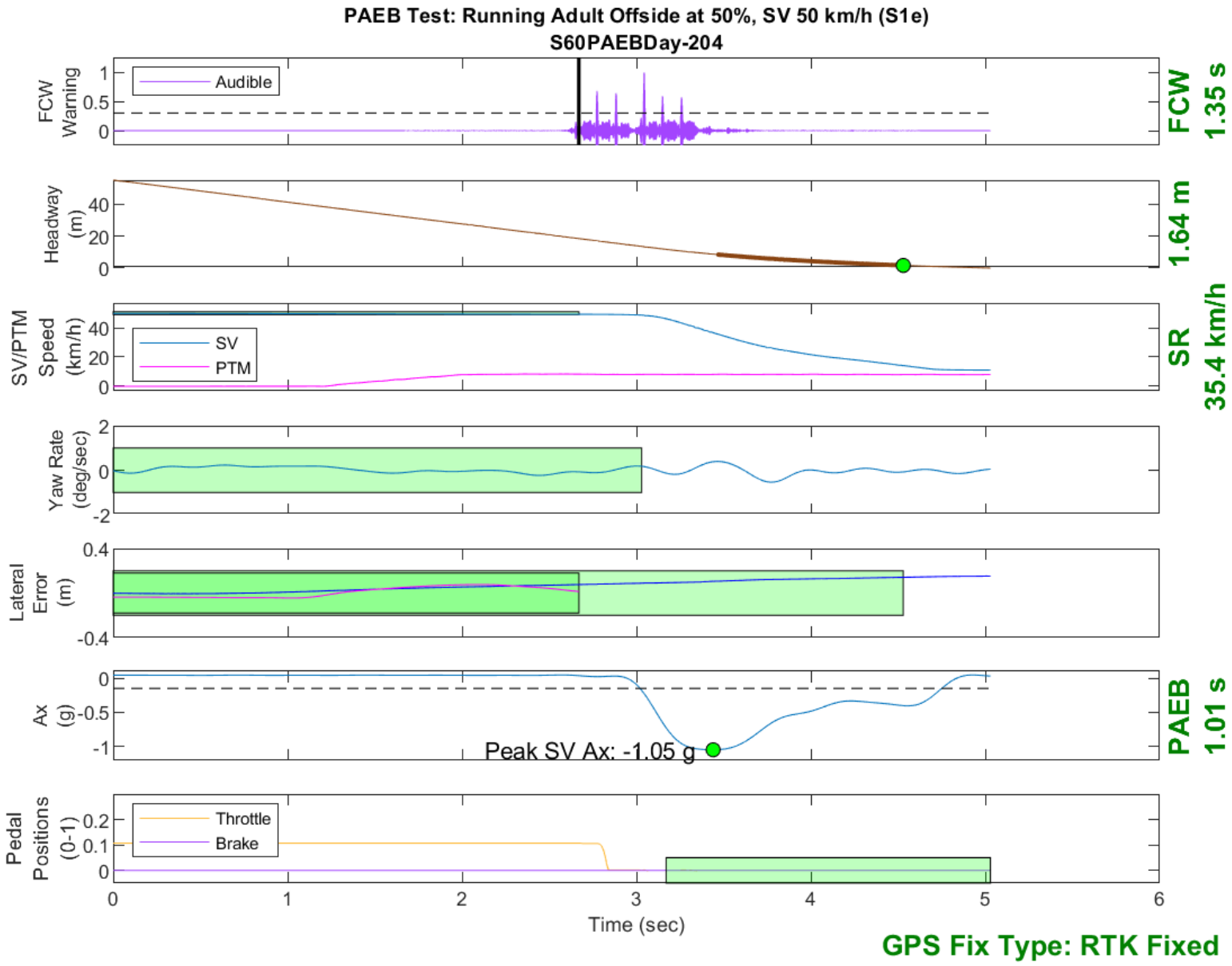


Figure D95. Time History for PAEB Run 204, S1e, Daytime, 50 km/h

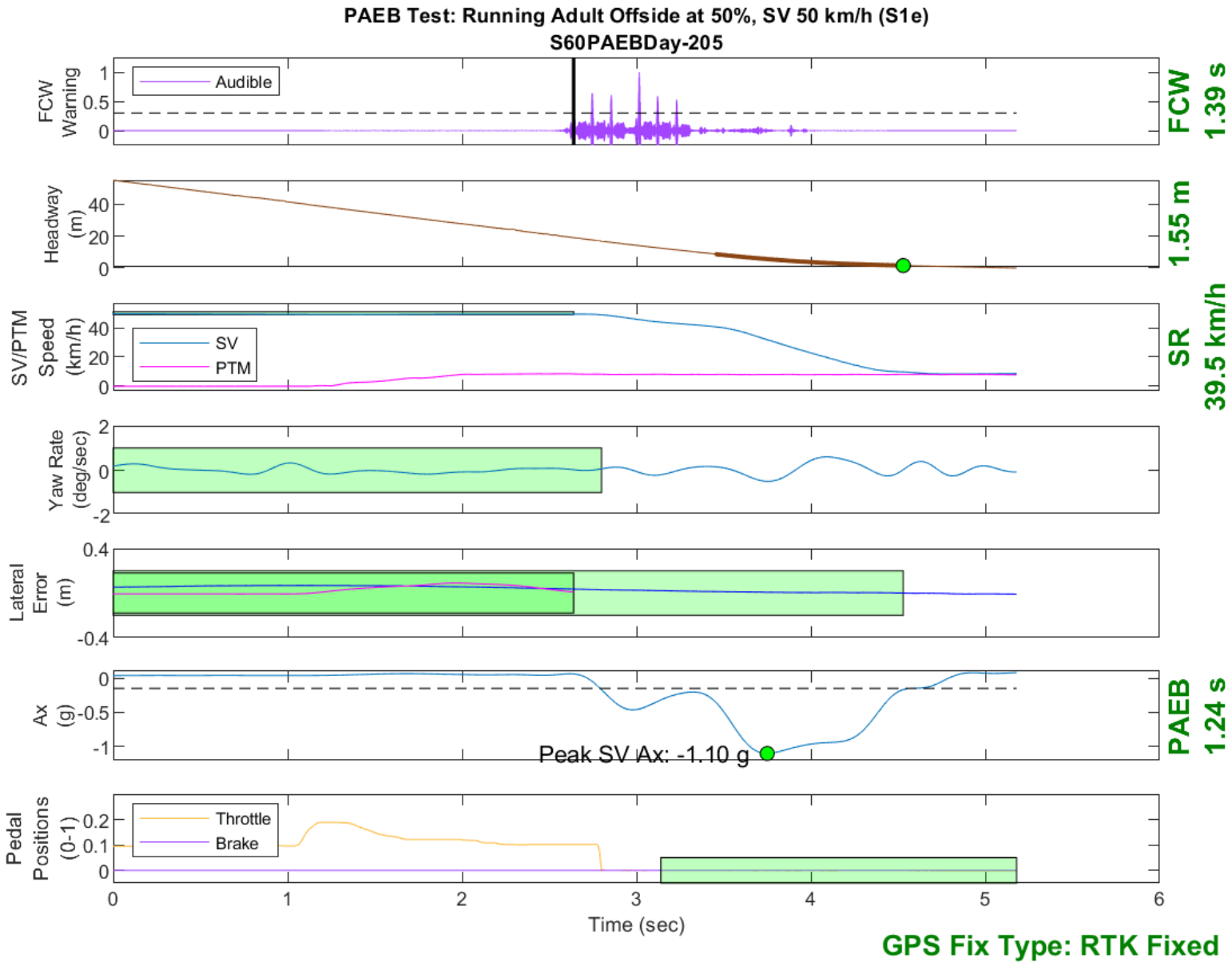


Figure D96. Time History for PAEB Run 205, S1e, Daytime, 50 km/h

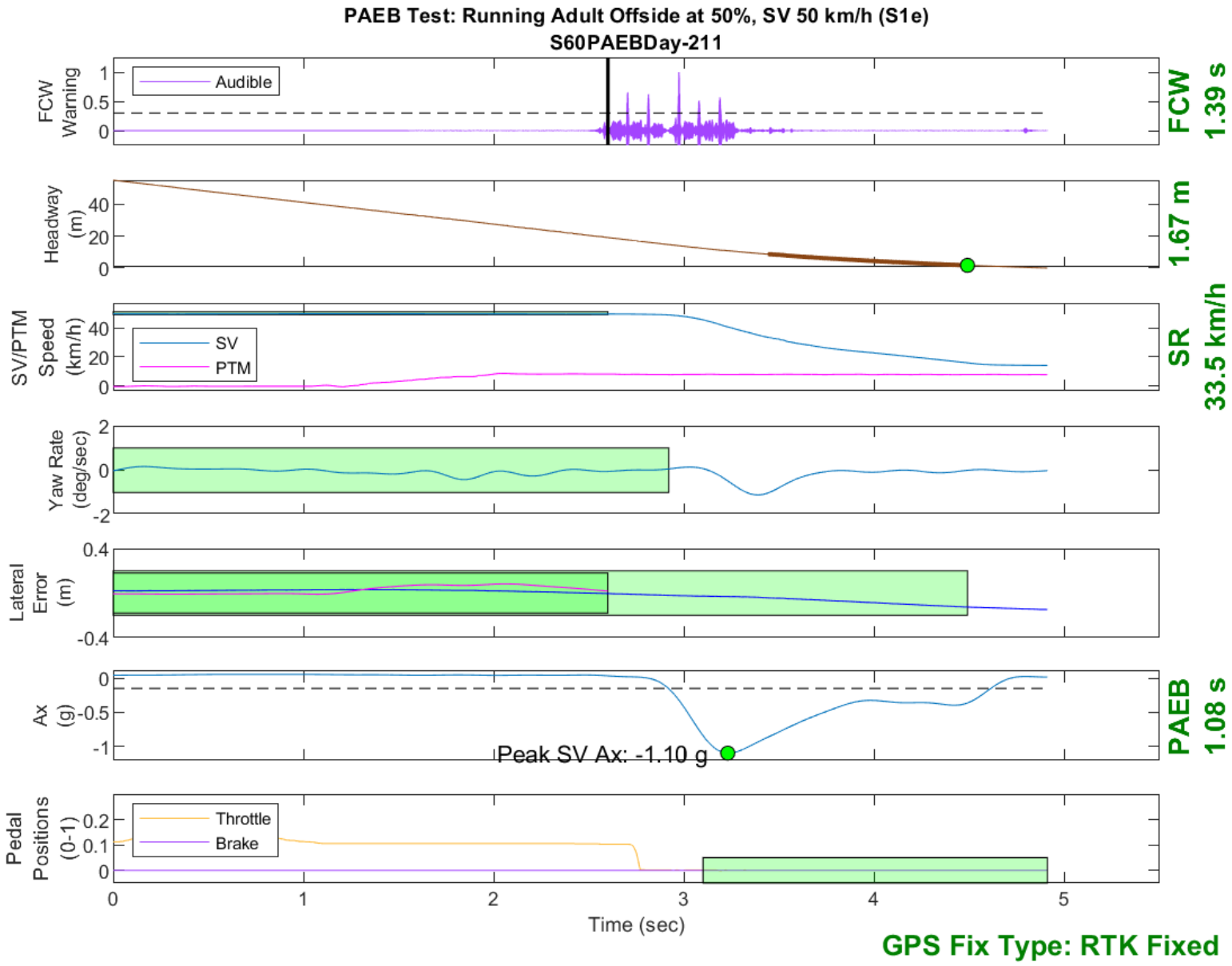


Figure D97. Time History for PAEB Run 211, S1e, Daytime, 50 km/h

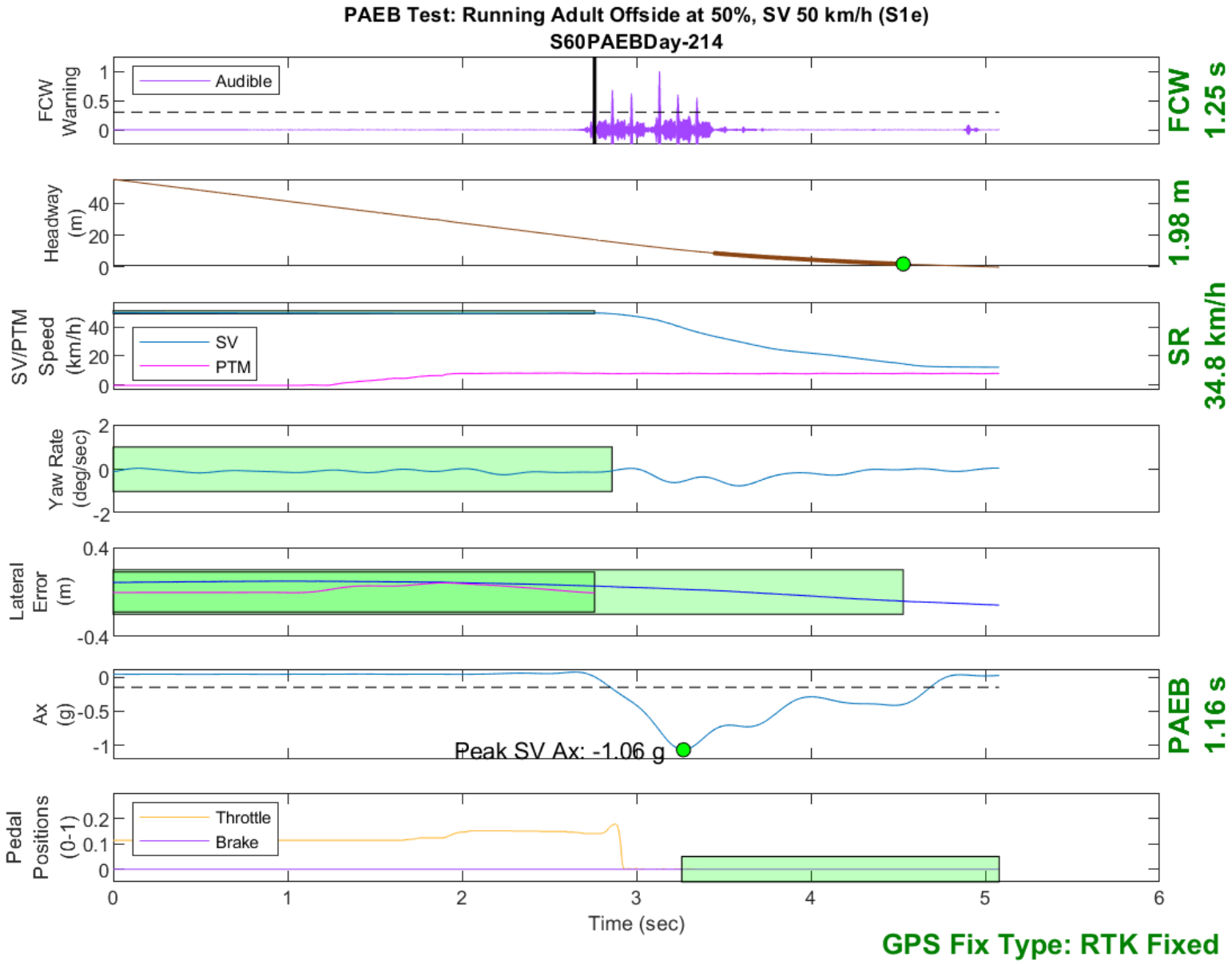


Figure D98. Time History for PAEB Run 214, S1e, Daytime, 50 km/h

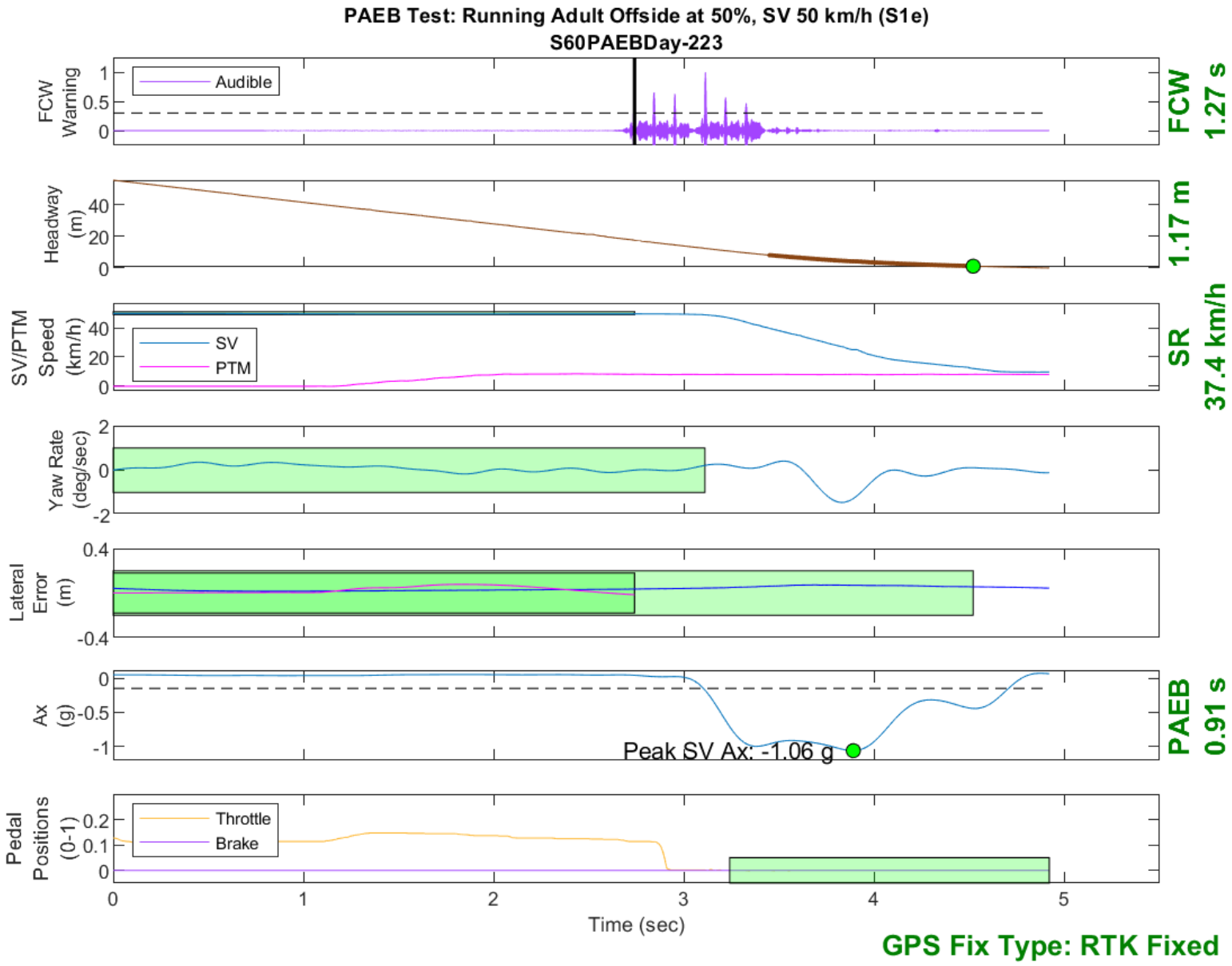


Figure D99. Time History for PAEB Run 223, S1e, Daytime, 50 km/h

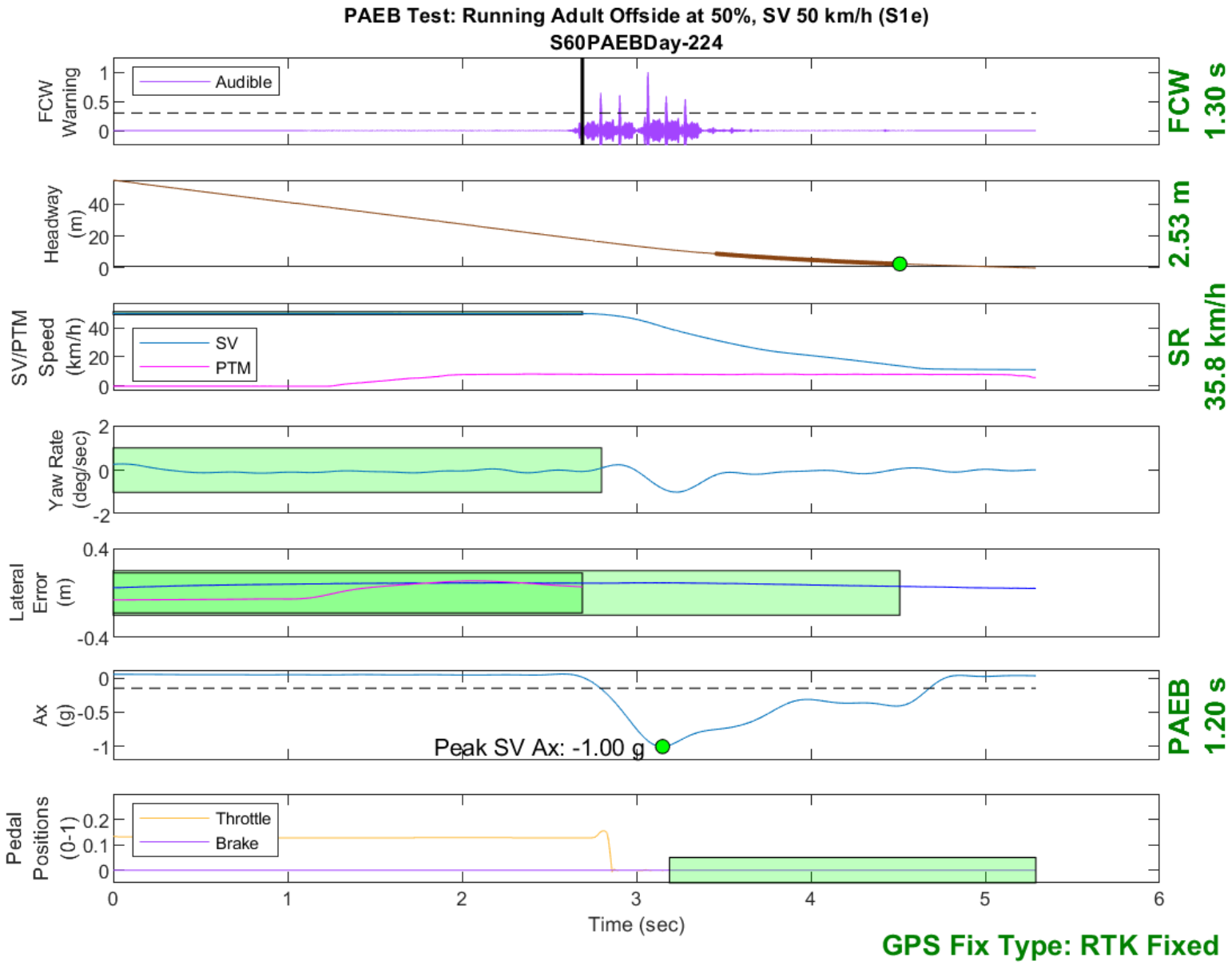


Figure D100. Time History for PAEB Run 224, S1e, Daytime, 50 km/h

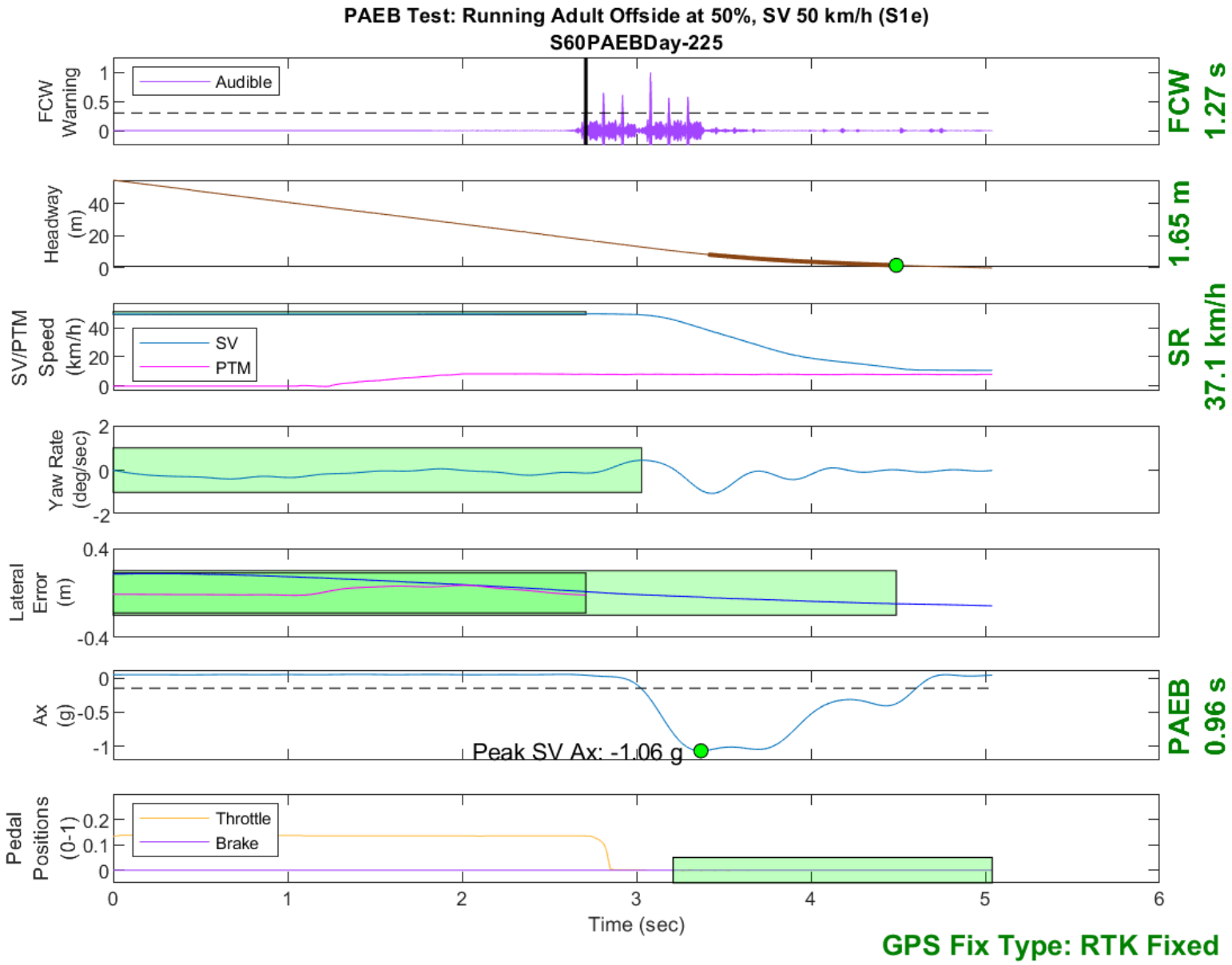


Figure D101. Time History for PAEB Run 225, S1e, Daytime, 50 km/h

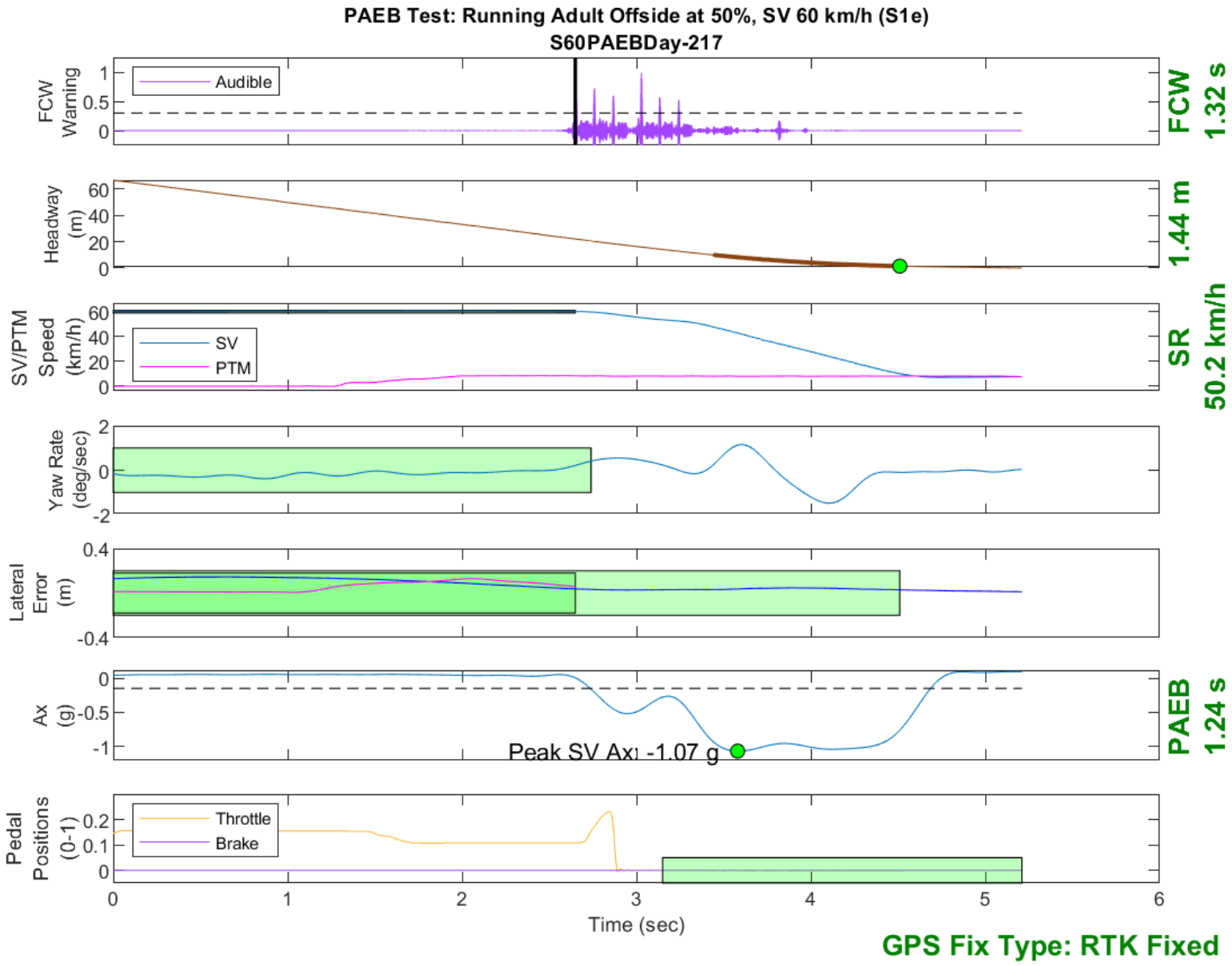


Figure D102. Time History for PAEB Run 217, S1e, Daytime, 60 km/h

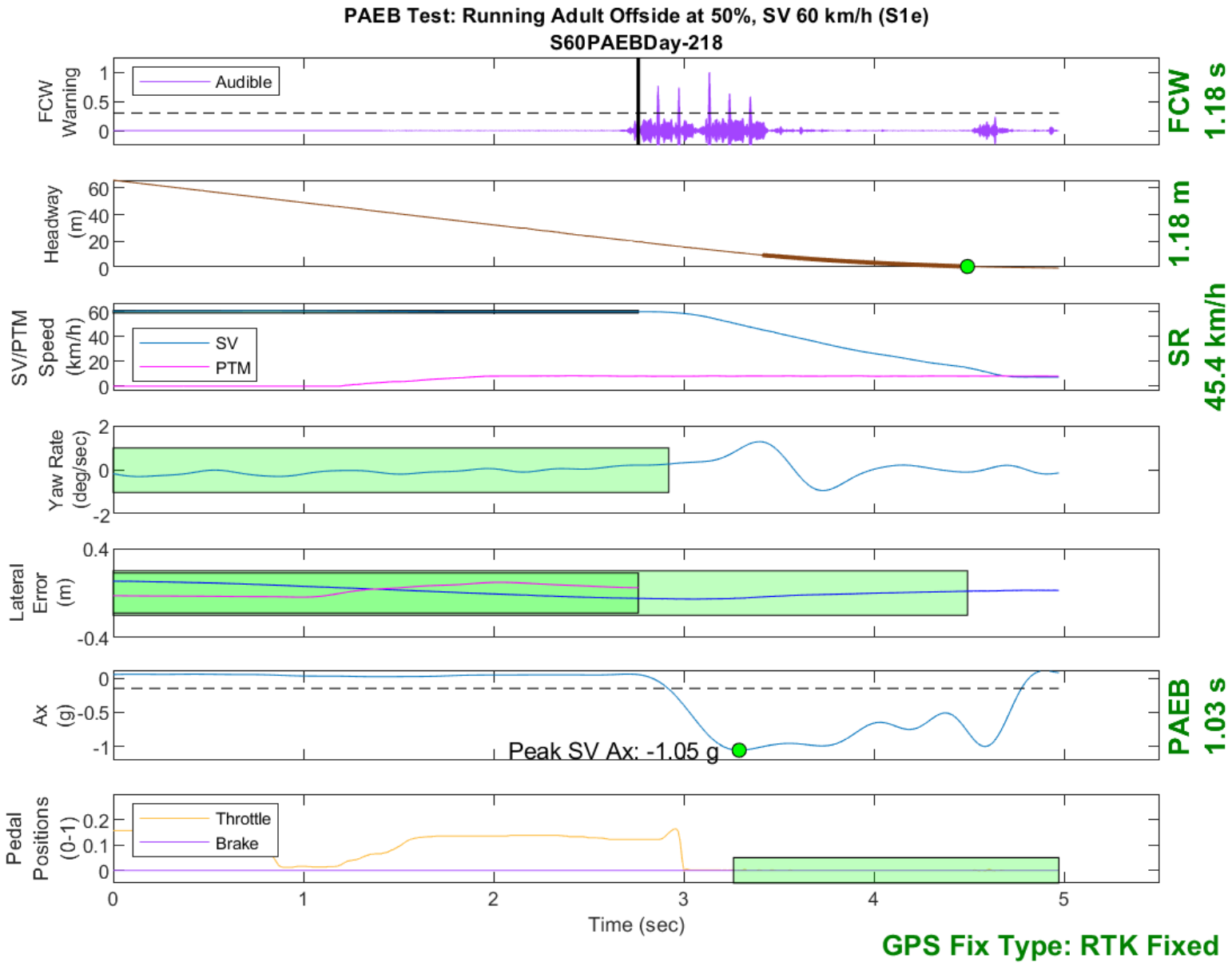


Figure D103. Time History for PAEB Run 218, S1e, Daytime, 60 km/h

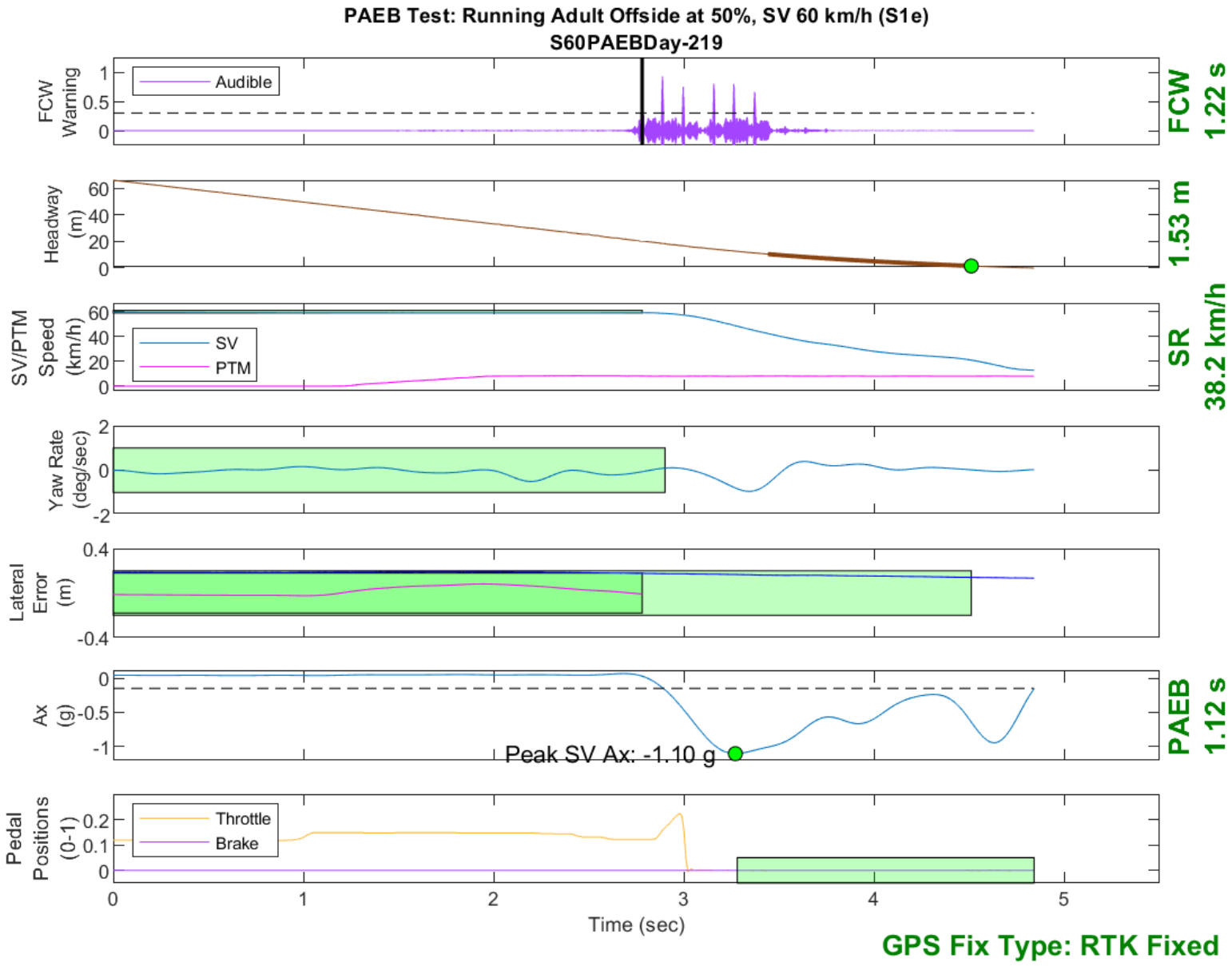


Figure D104. Time History for PAEB Run 219, S1e, Daytime, 60 km/h

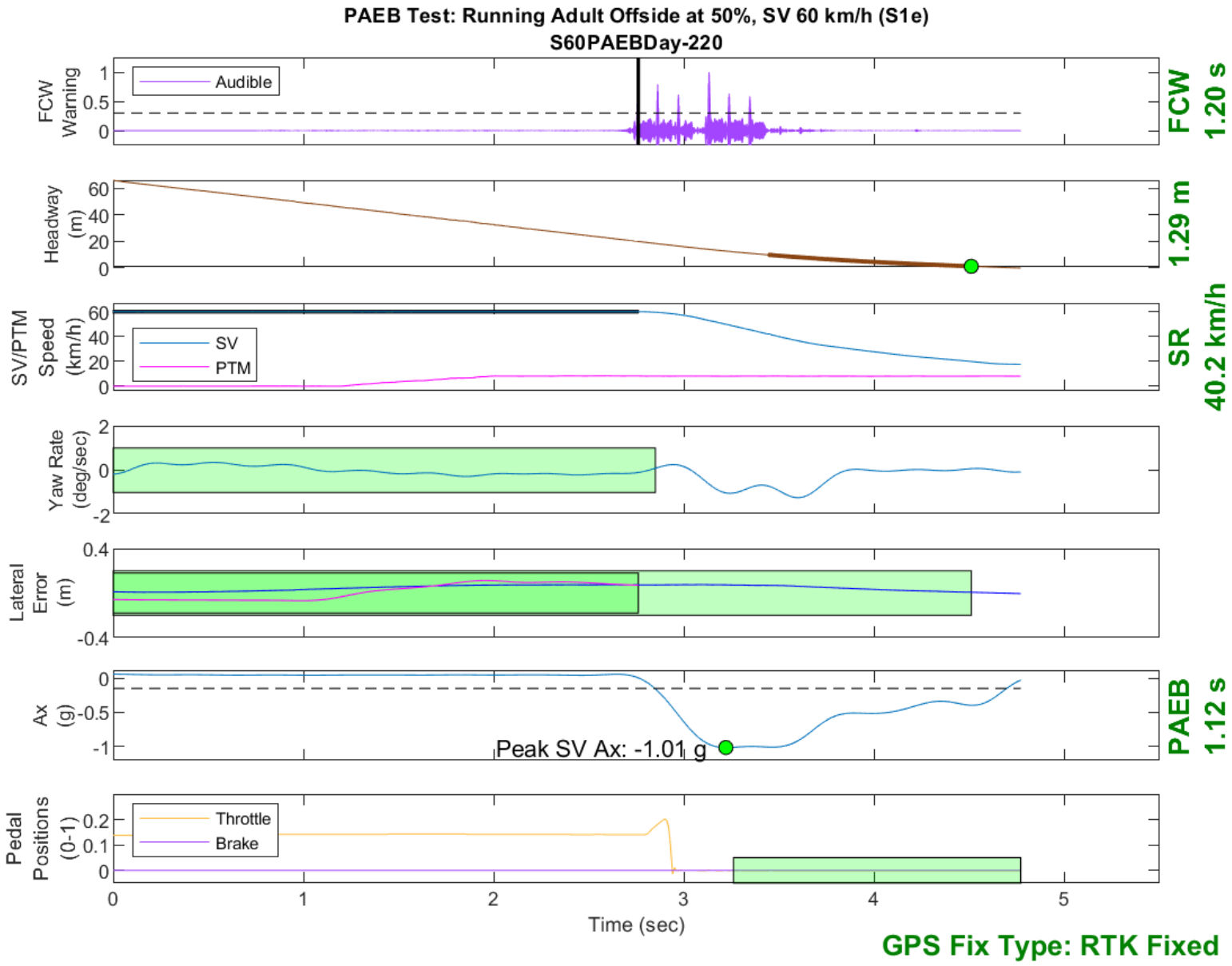


Figure D105. Time History for PAEB Run 220, S1e, Daytime, 60 km/h

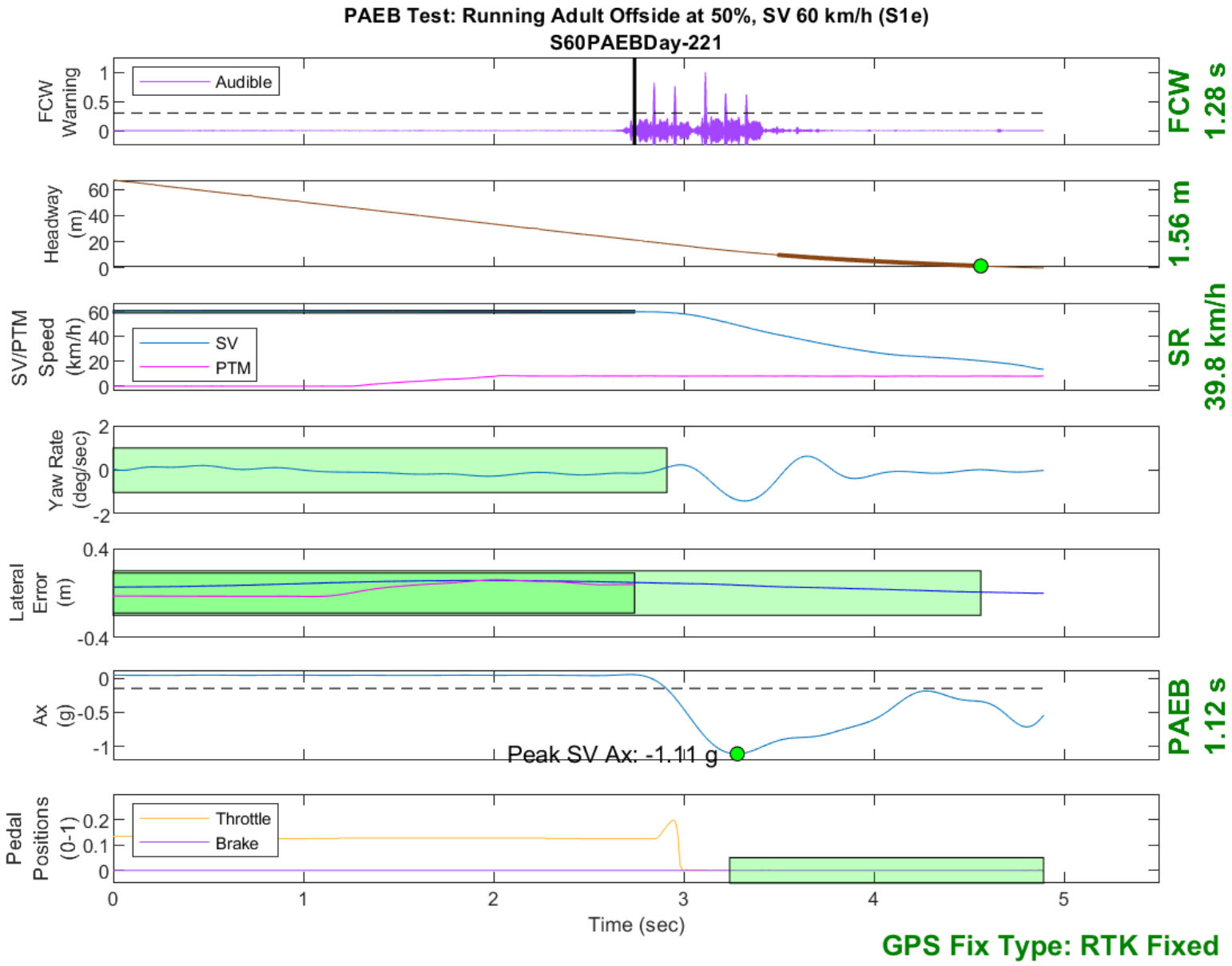


Figure D106. Time History for PAEB Run 221, S1e, Daytime, 60 km/h

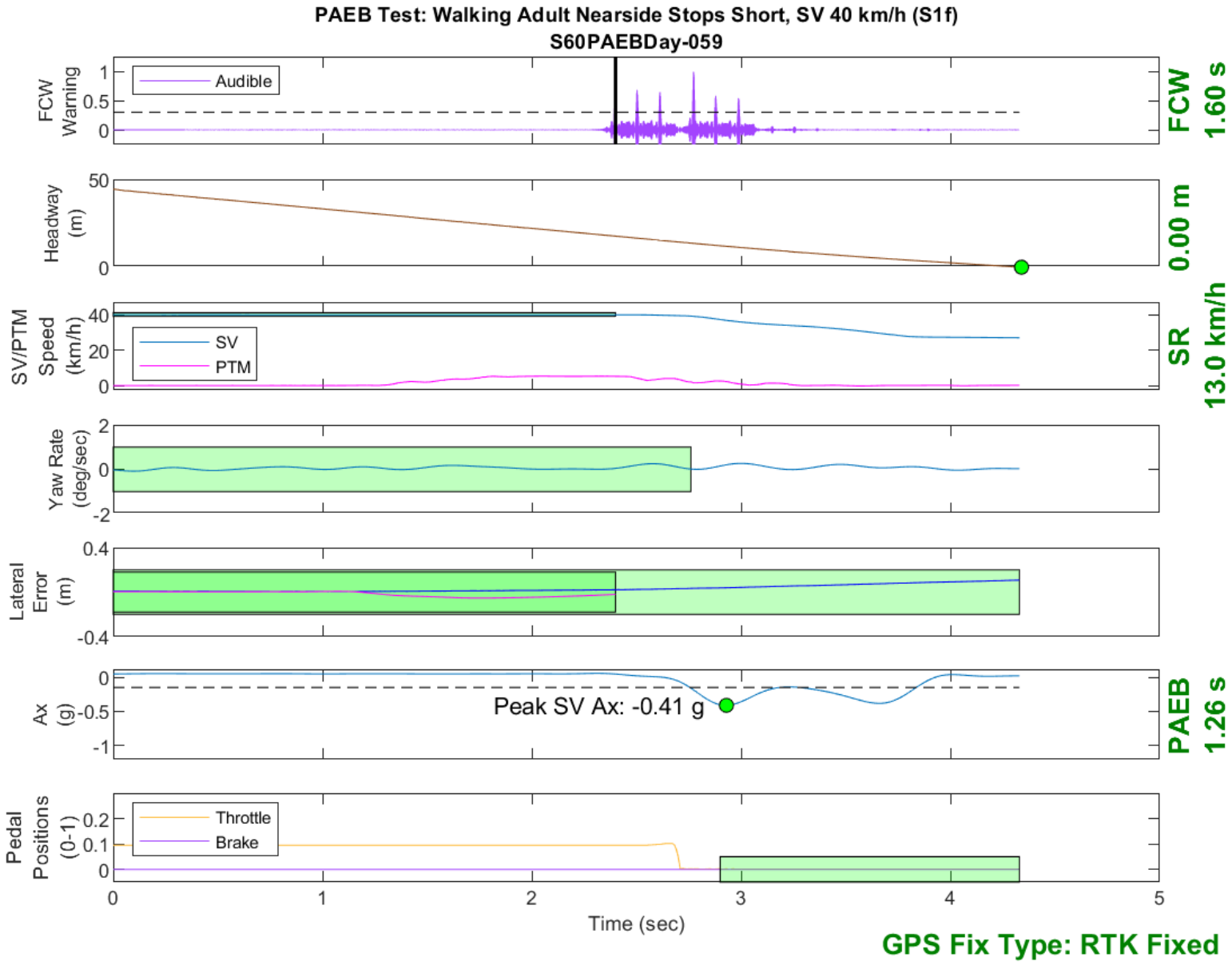


Figure D107. Time History for PAEB Run 59, S1f, Daytime, 40 km/h

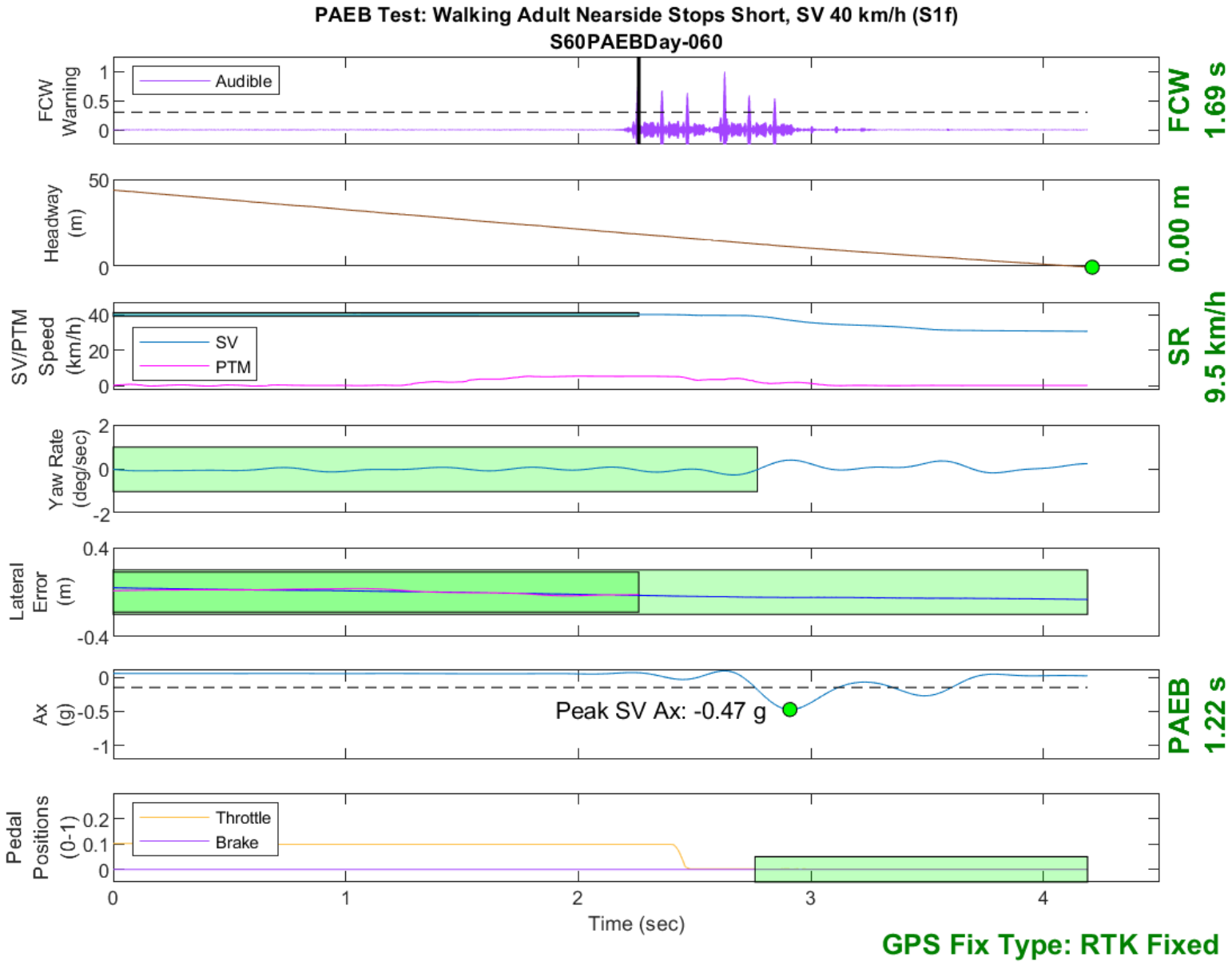


Figure D108. Time History for PAEB Run 60, S1f, Daytime, 40 km/h

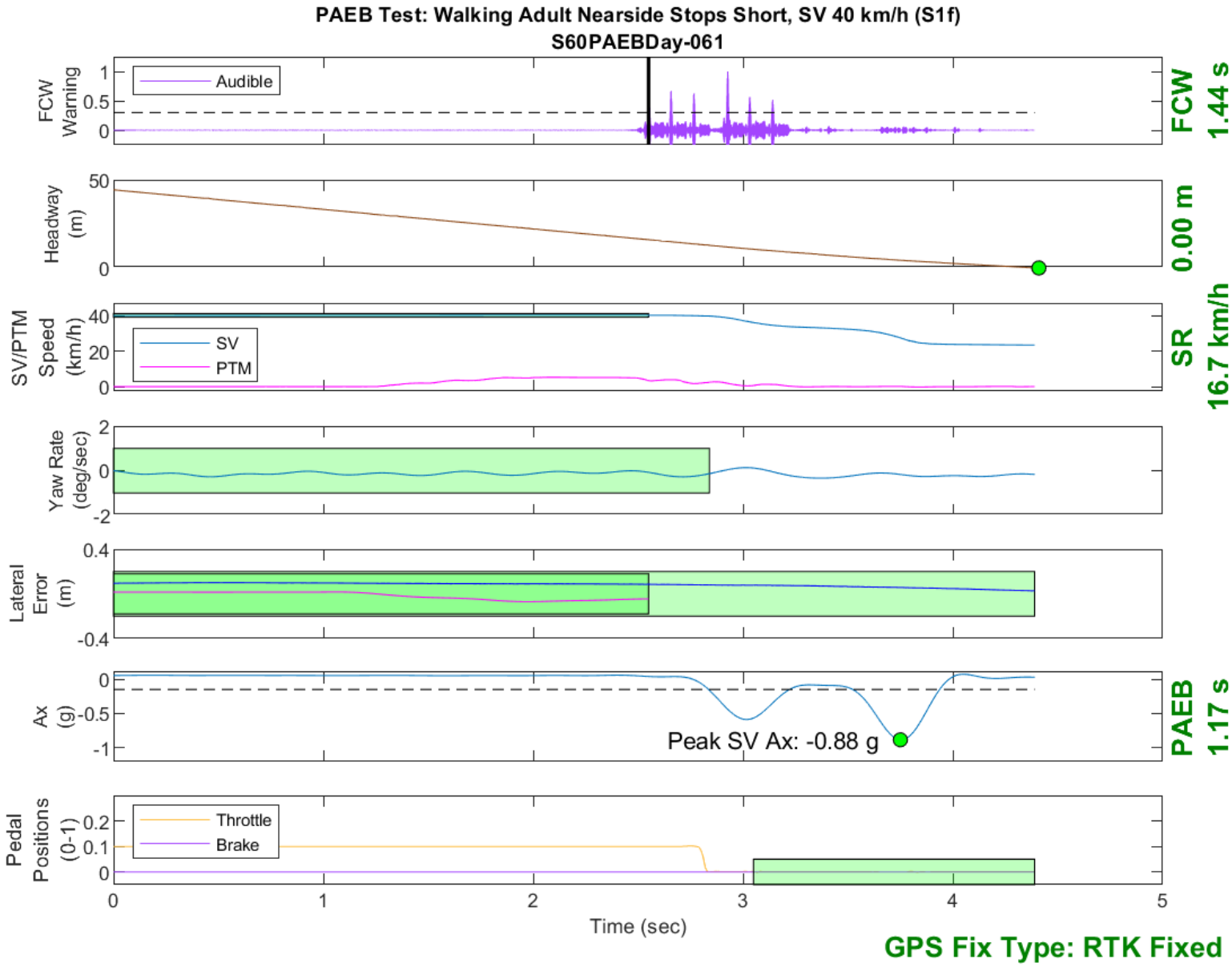


Figure D109. Time History for PAEB Run 61, S1f, Daytime, 40 km/h

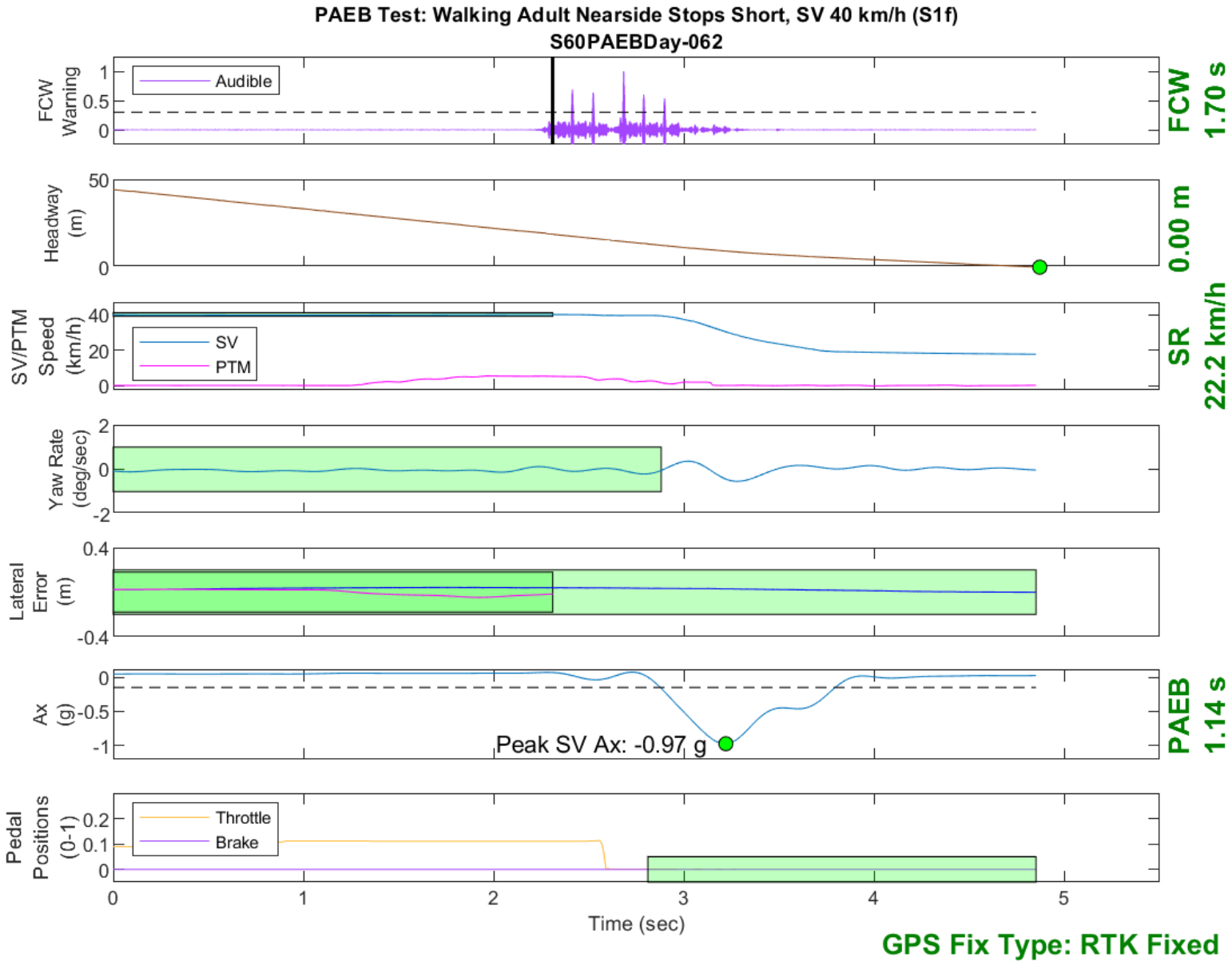


Figure D110. Time History for PAEB Run 62, S1f, Daytime, 40 km/h

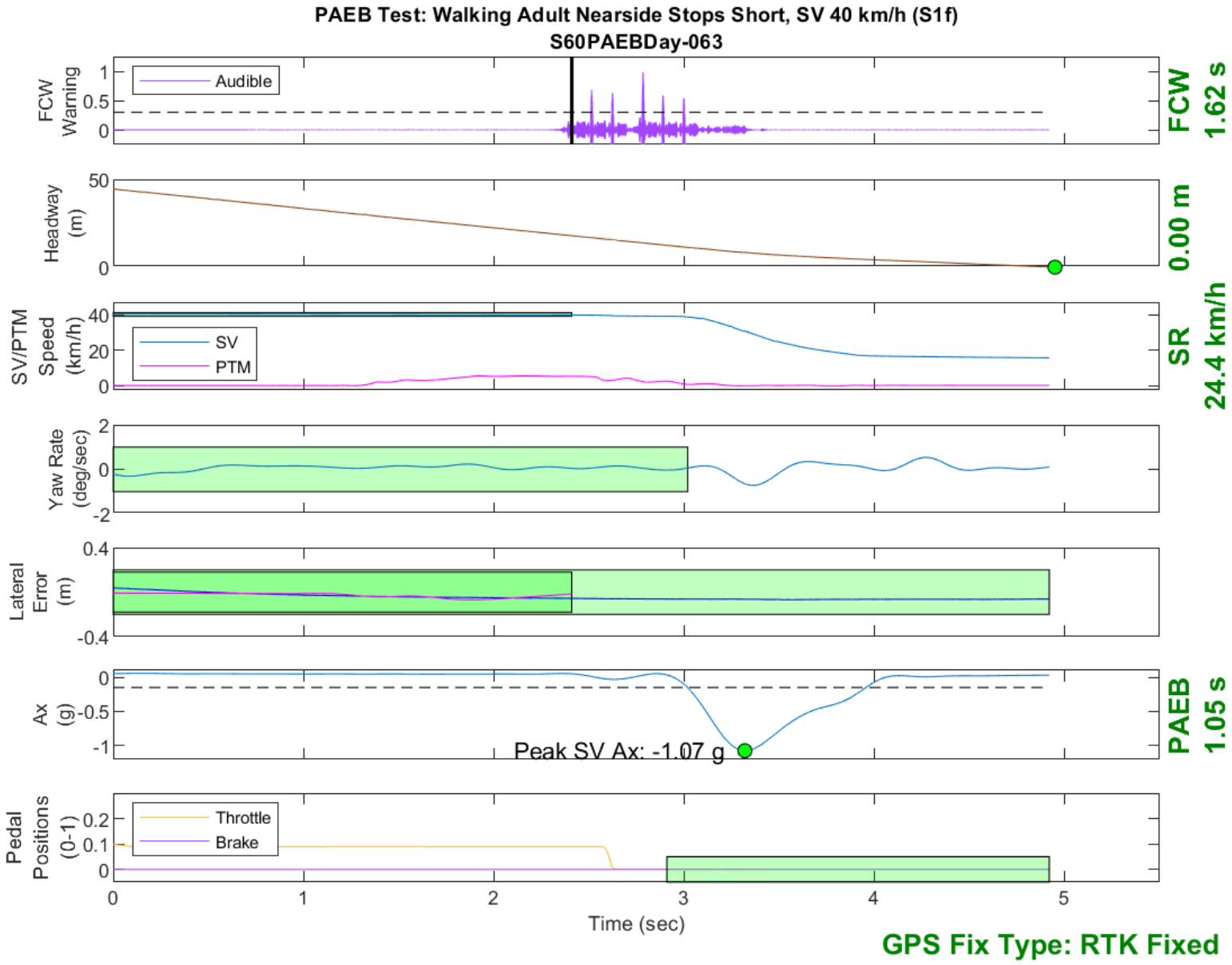


Figure D111. Time History for PAEB Run 63, S1f, Daytime, 40 km/h

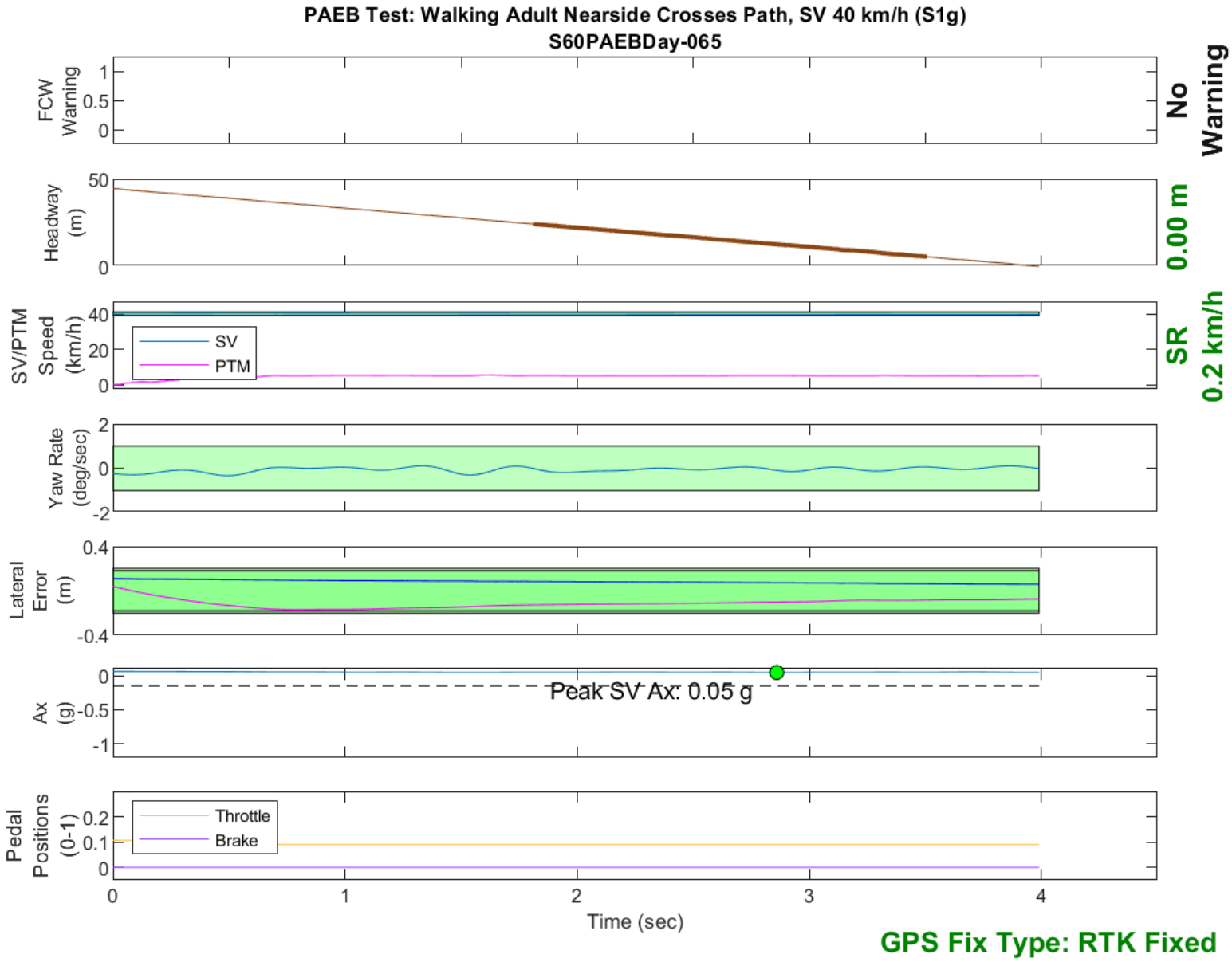


Figure D112. Time History for PAEB Run 65, S1g, Daytime, 40 km/h

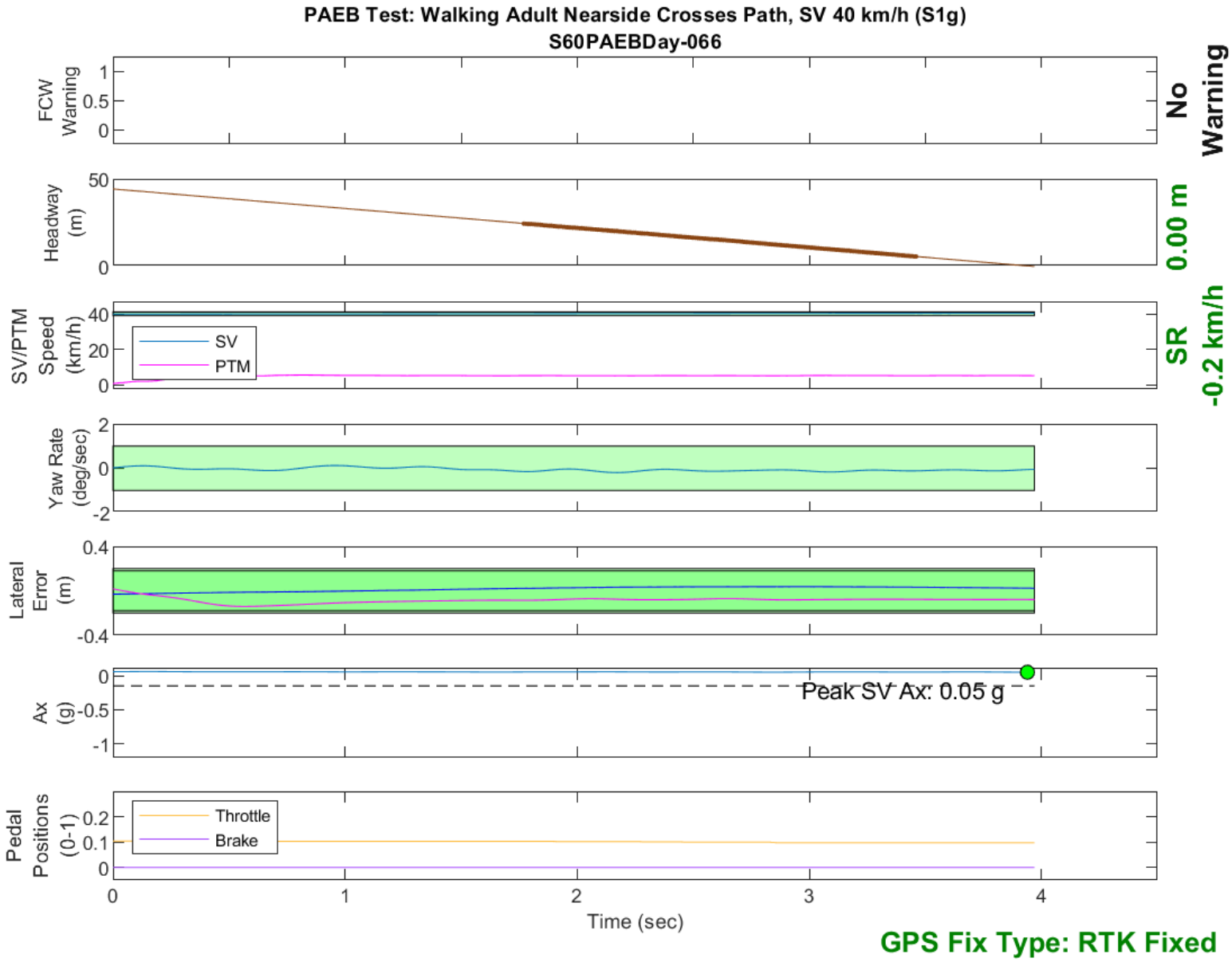


Figure D113. Time History for PAEB Run 66, S1g, Daytime, 40 km/h

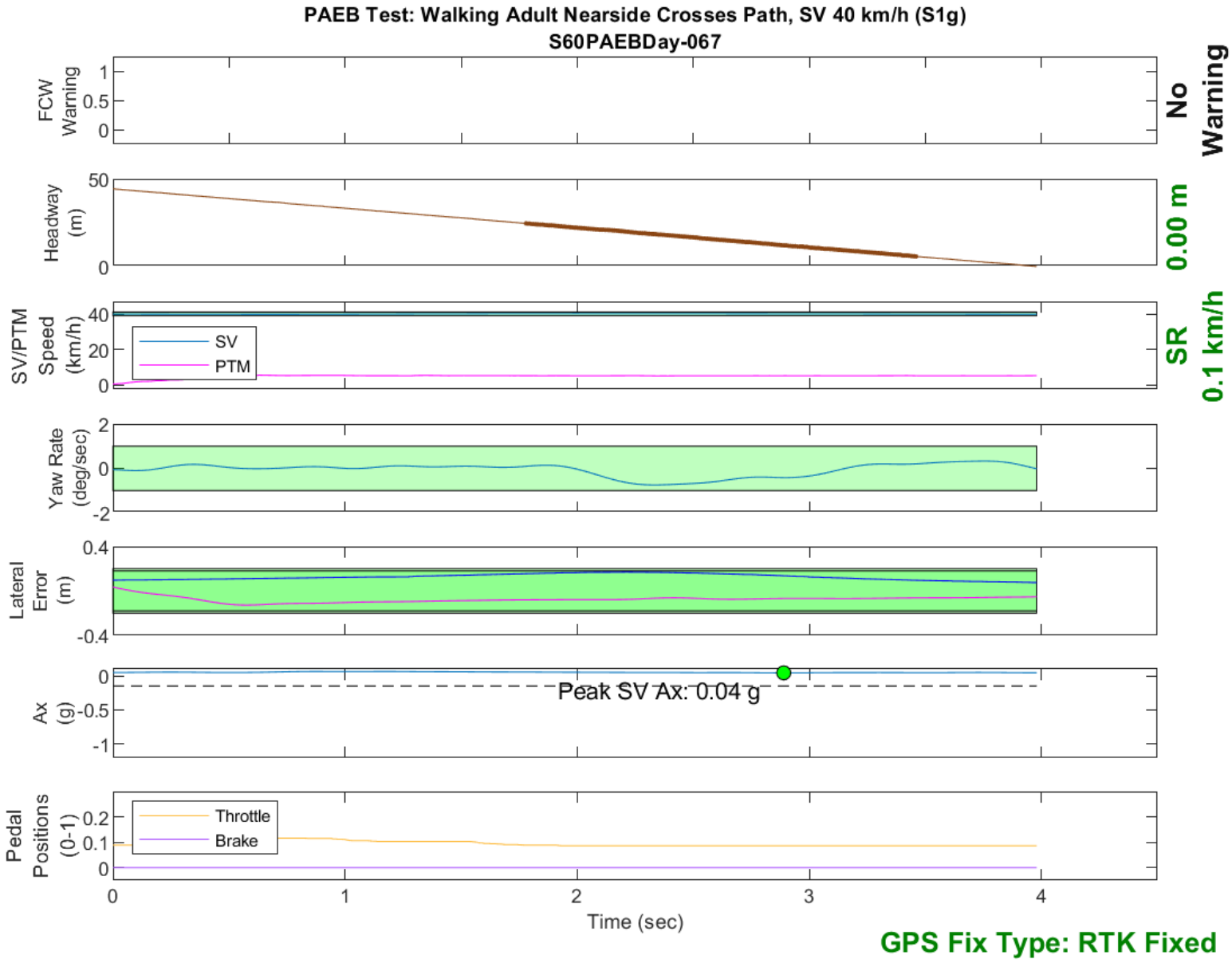


Figure D114. Time History for PAEB Run 67, S1g, Daytime, 40 km/h

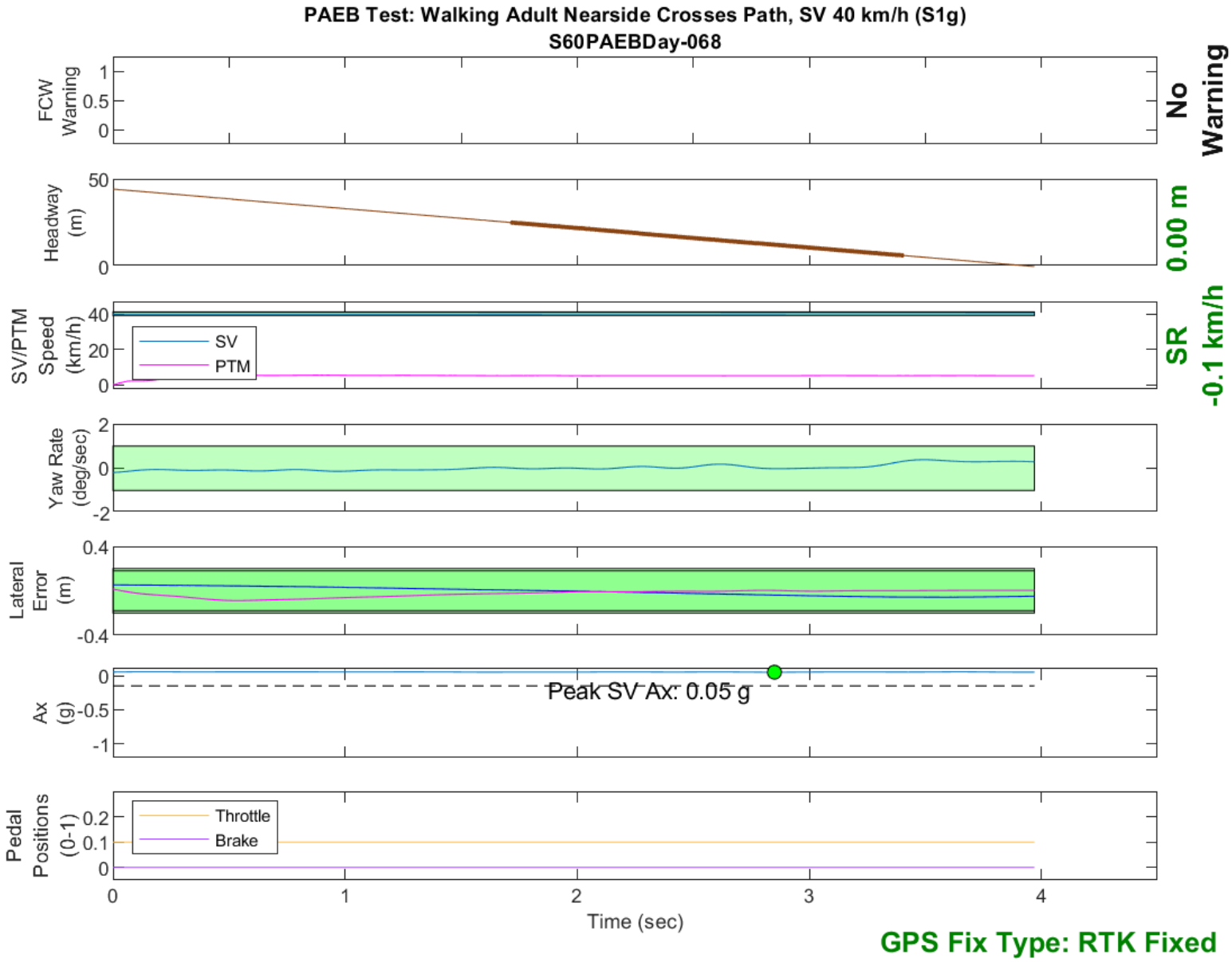


Figure D115. Time History for PAEB Run 68, S1g, Daytime, 40 km/h

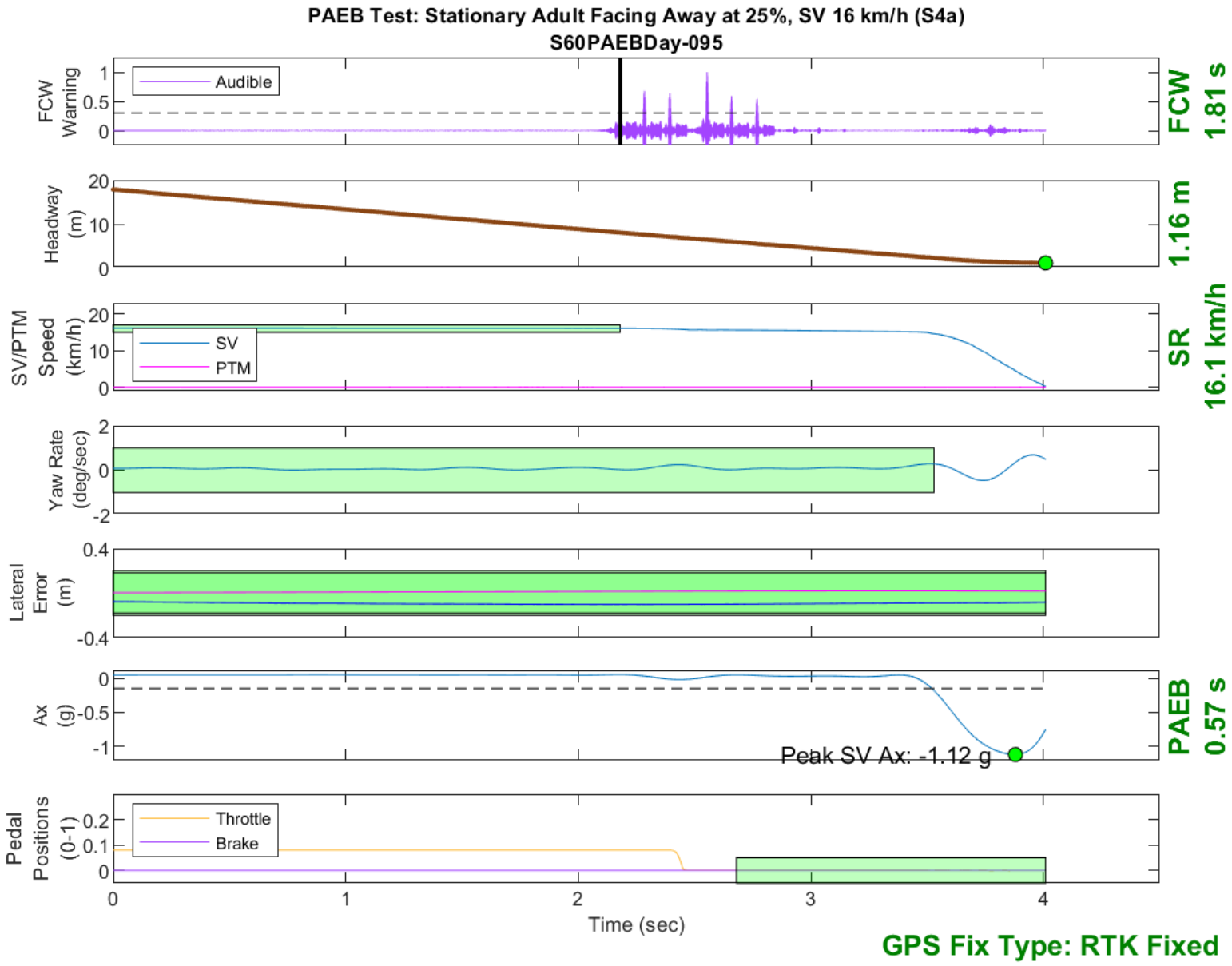


Figure D116. Time History for PAEB Run 95, S4a, Daytime, 16 km/h

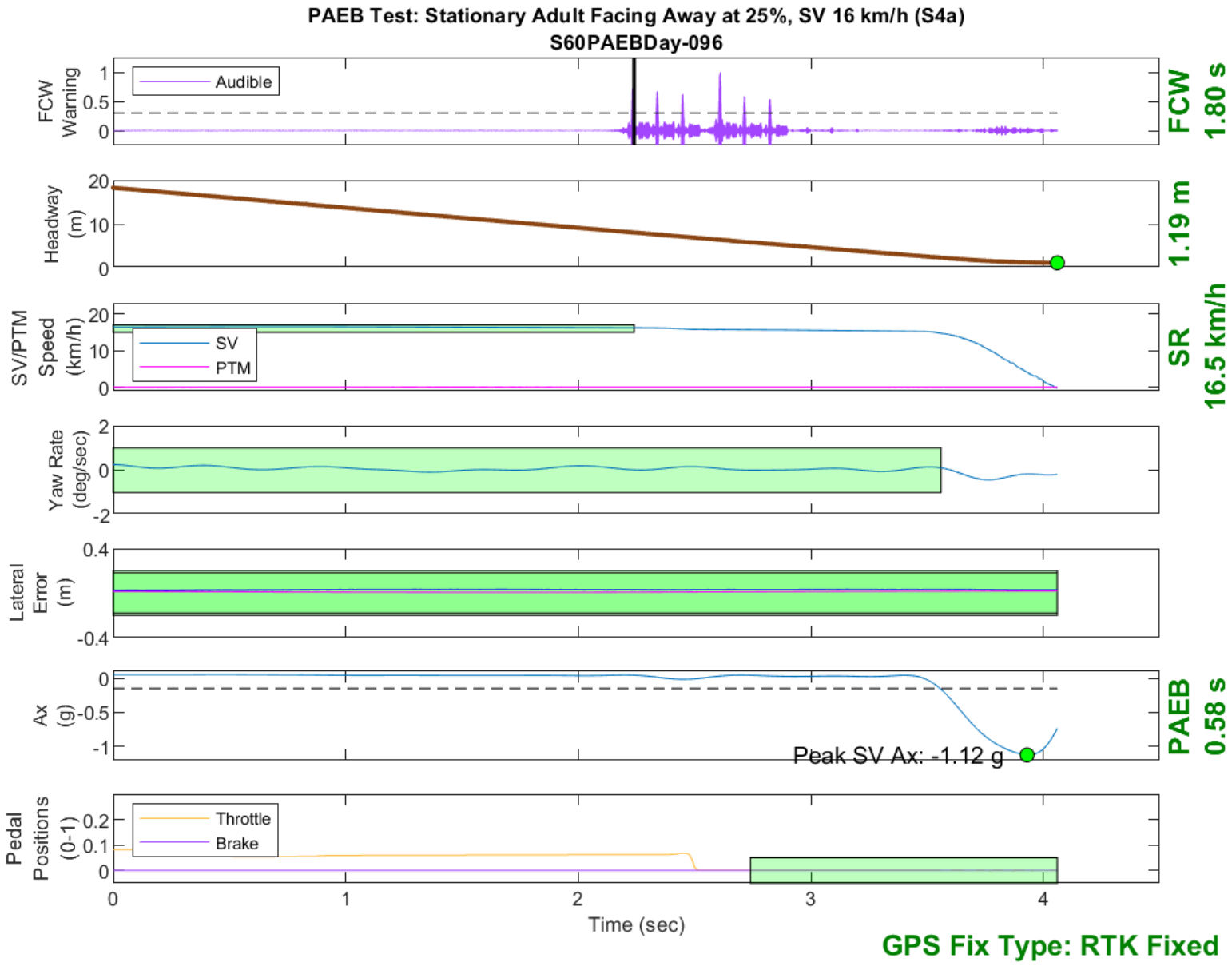


Figure D117. Time History for PAEB Run 96, S4a, Daytime, 16 km/h

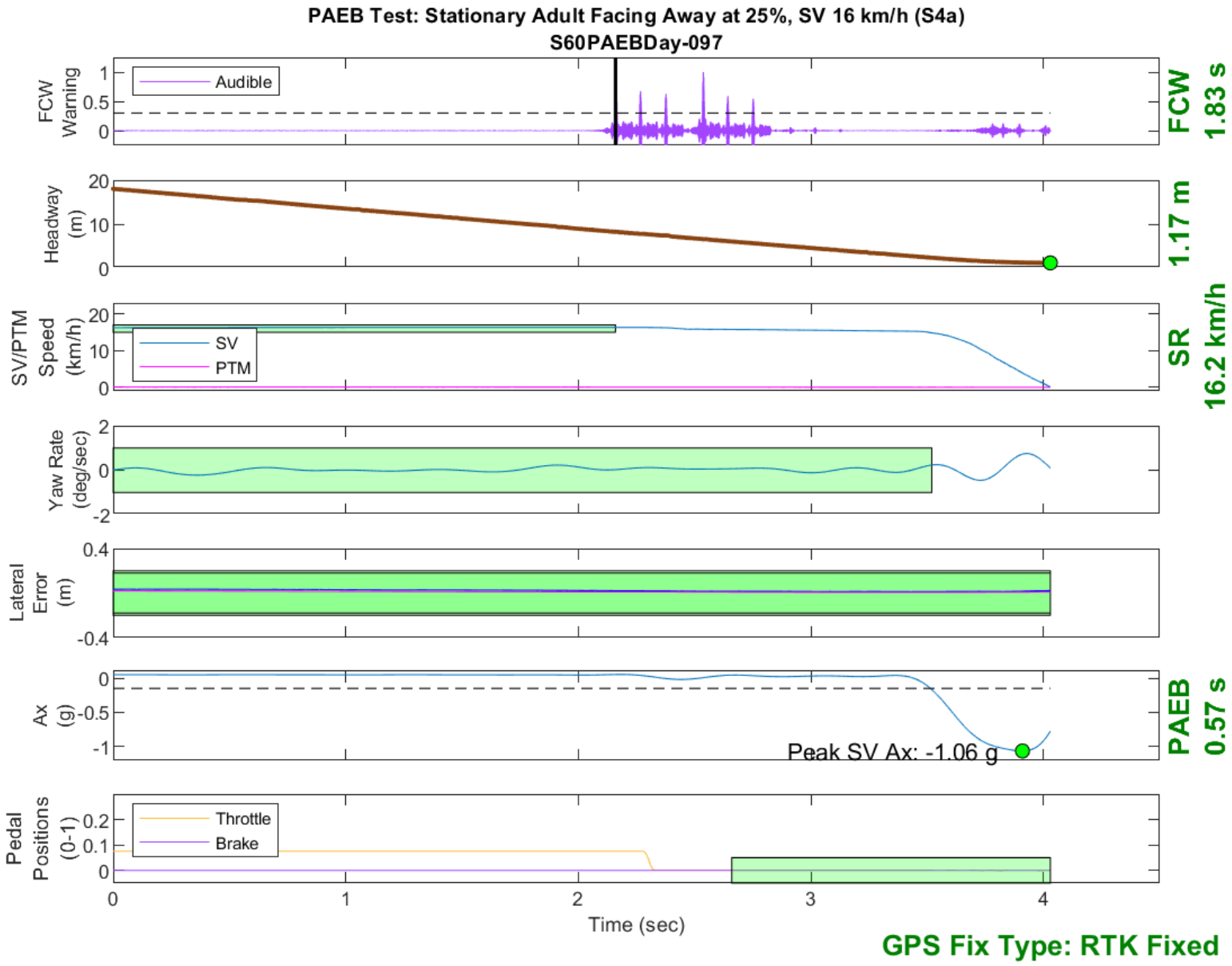


Figure D118. Time History for PAEB Run 97, S4a, Daytime, 16 km/h

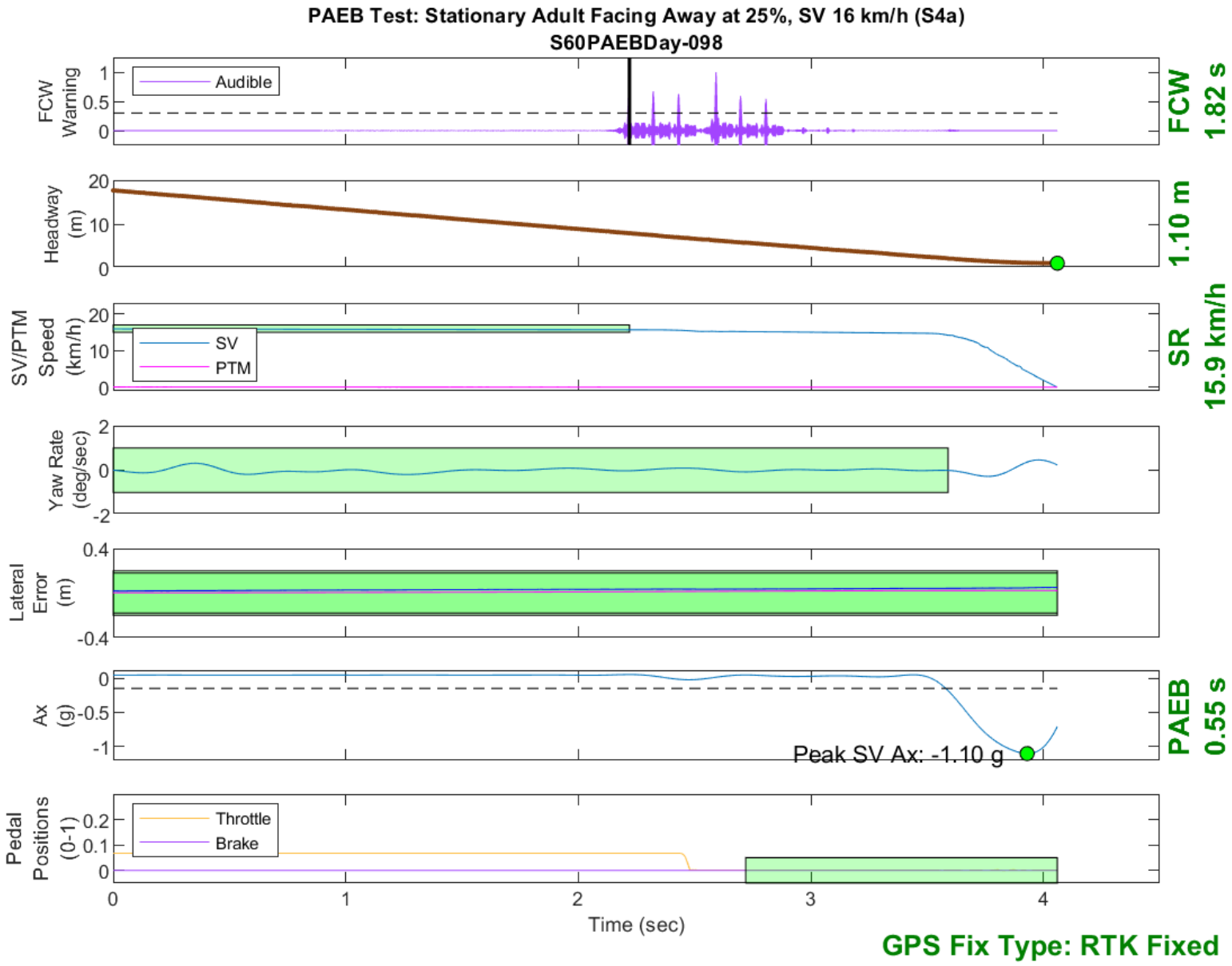


Figure D119. Time History for PAEB Run 98, S4a, Daytime, 16 km/h

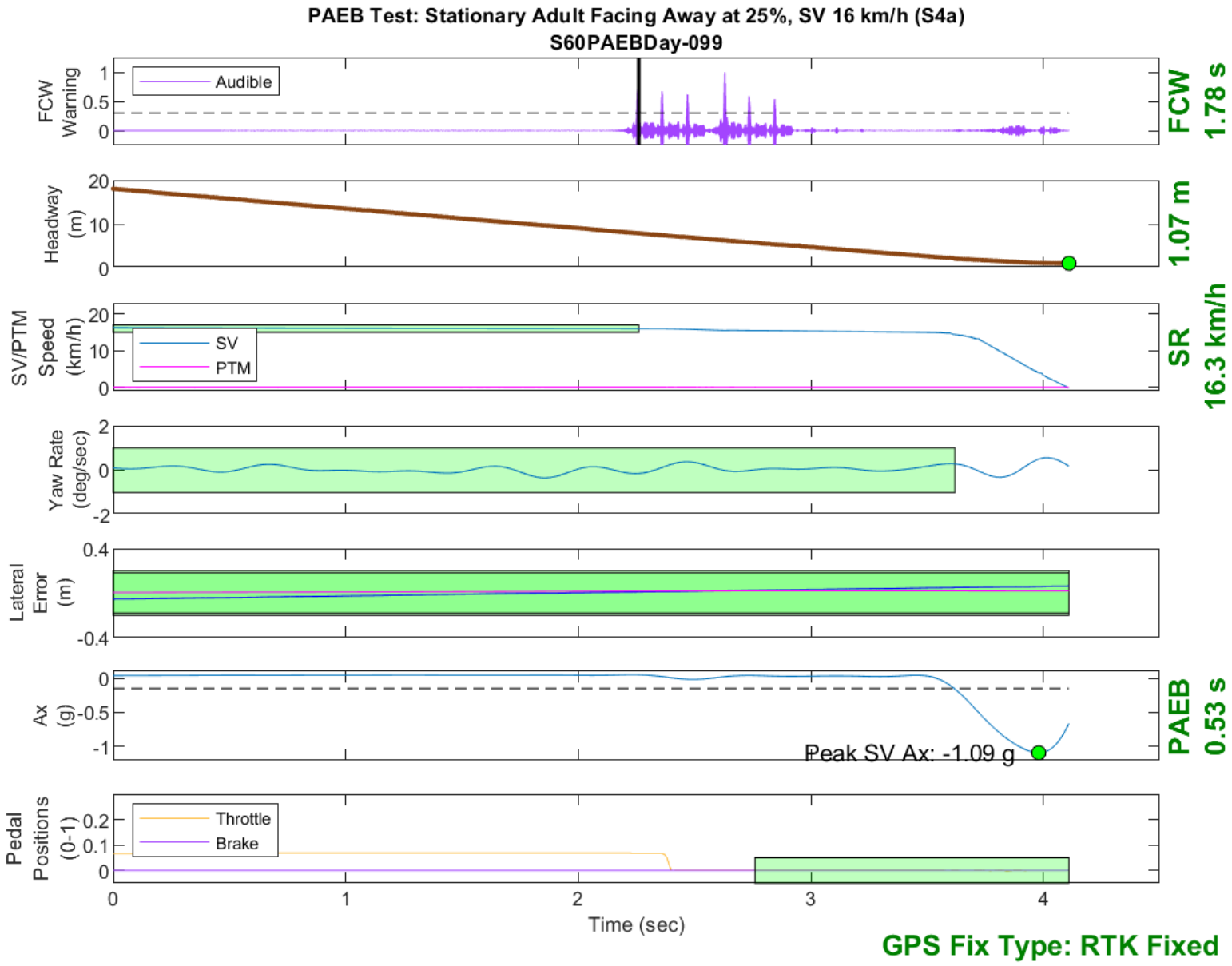


Figure D120. Time History for PAEB Run 99, S4a, Daytime, 16 km/h



Figure D121. Time History for PAEB Run 101, S4a, Daytime, 40 km/h

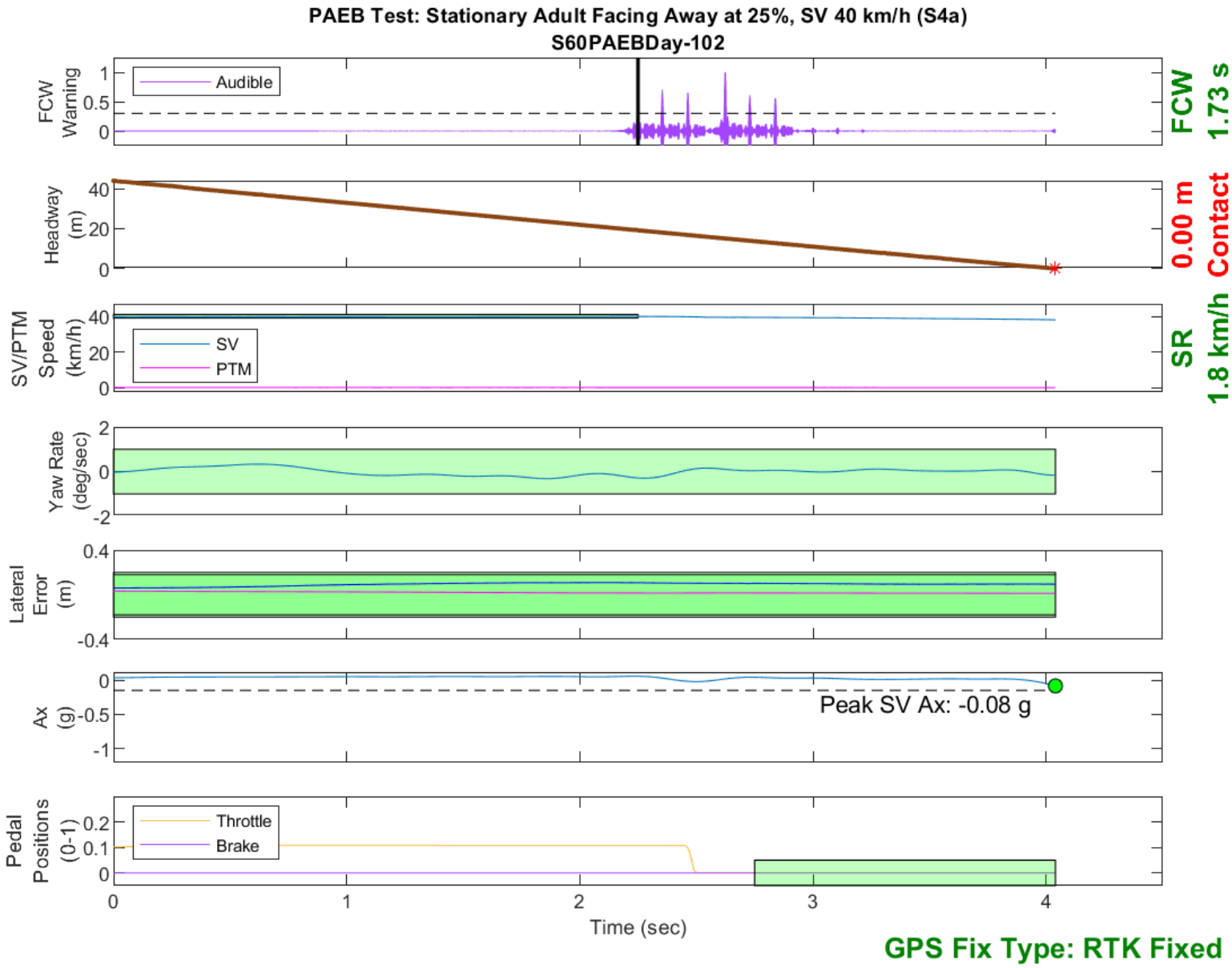


Figure D122. Time History for PAEB Run 102, S4a, Daytime, 40 km/h

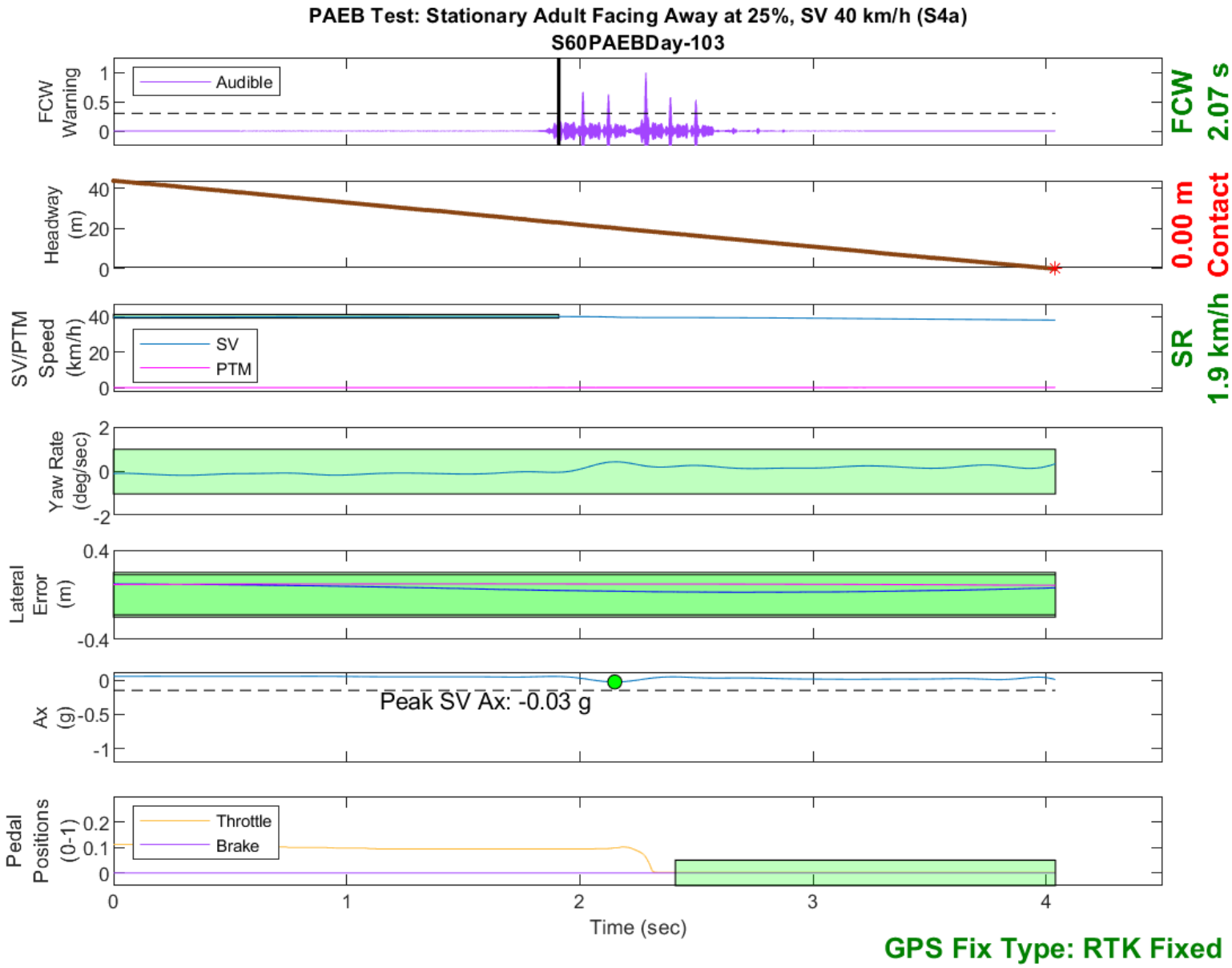


Figure D123. Time History for PAEB Run 103, S4a, Daytime, 40 km/h

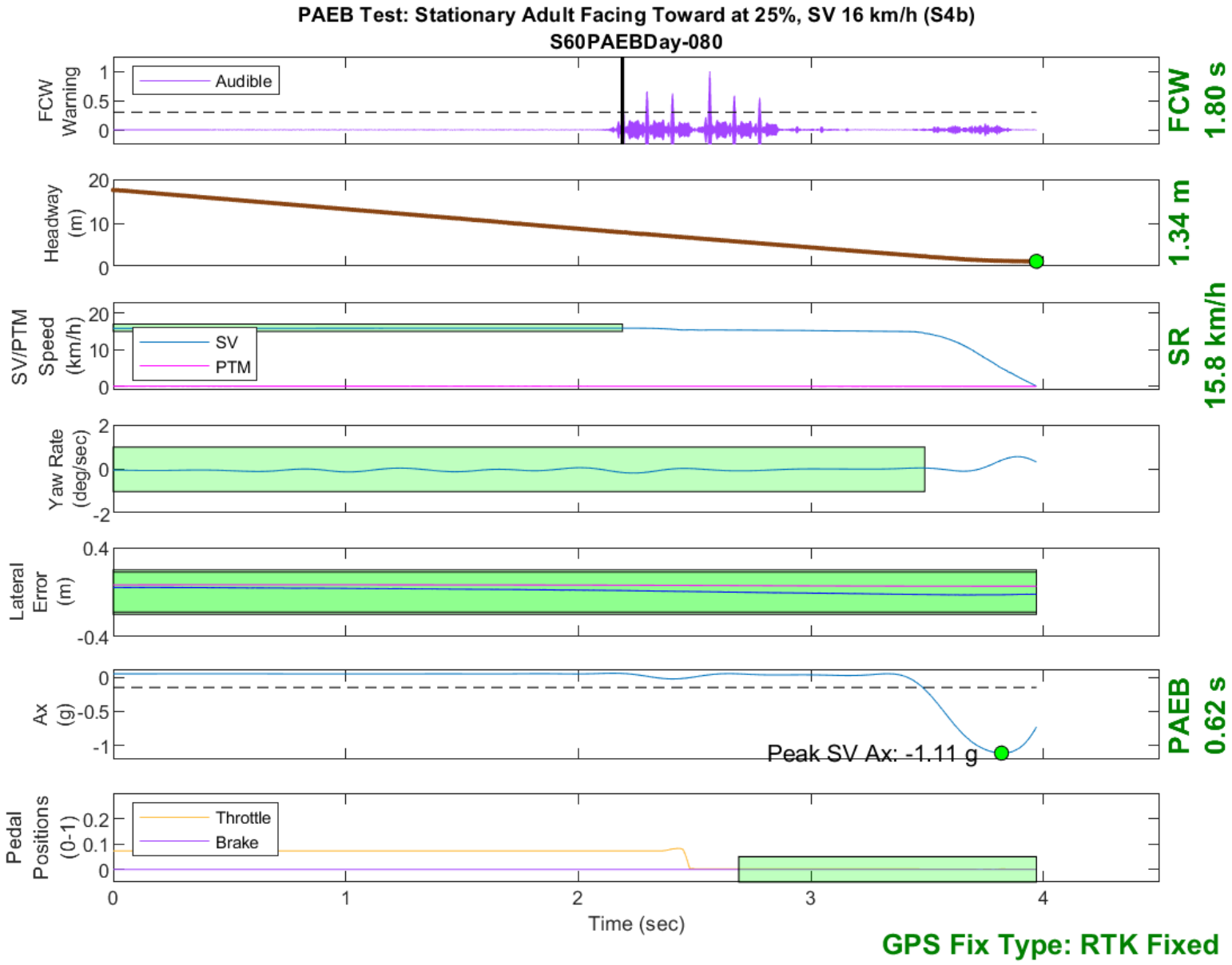


Figure D124. Time History for PAEB Run 80, S4b, Daytime, 16 km/h

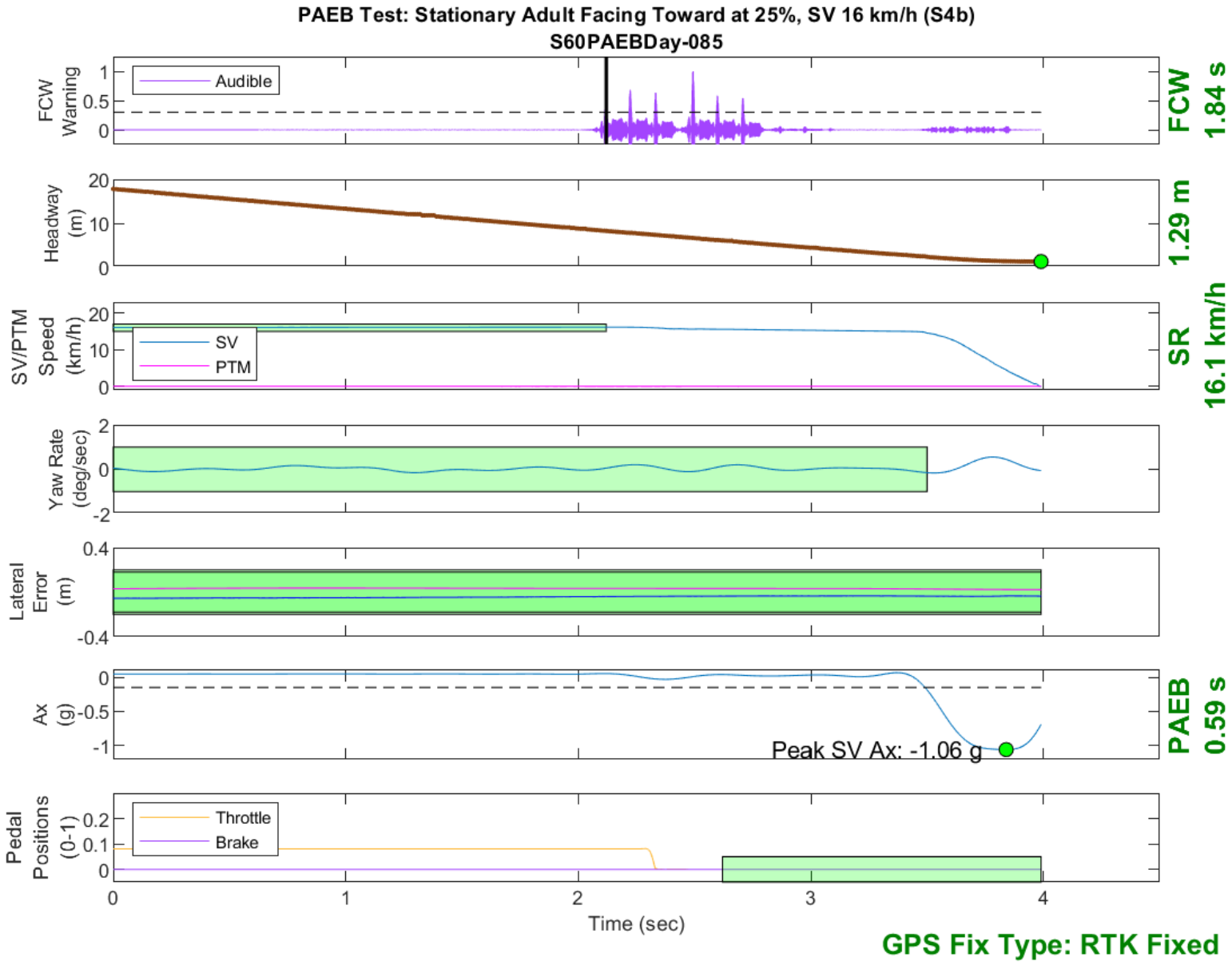


Figure D125. Time History for PAEB Run 85, S4b, Daytime, 16 km/h

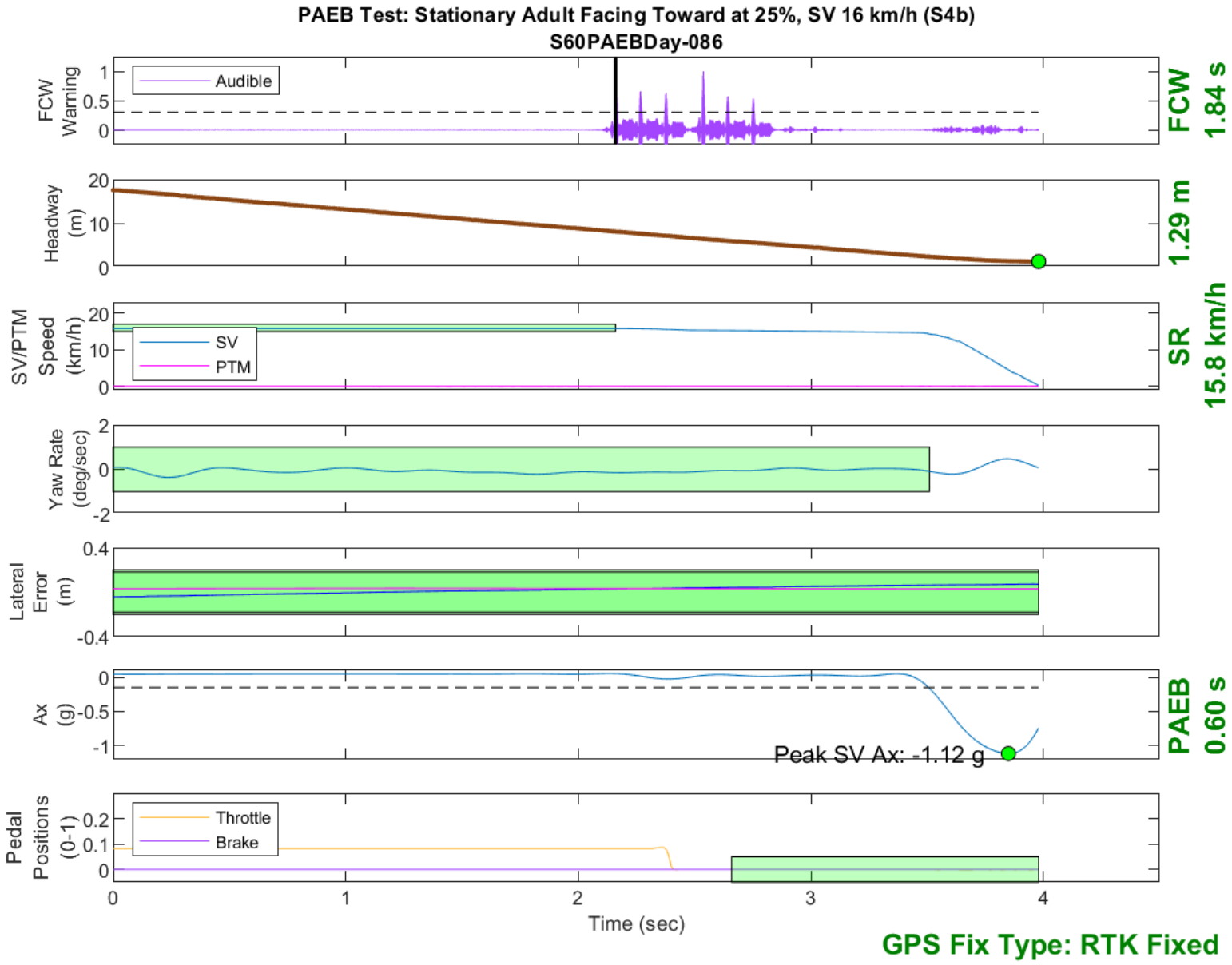


Figure D126. Time History for PAEB Run 86, S4b, Daytime, 16 km/h

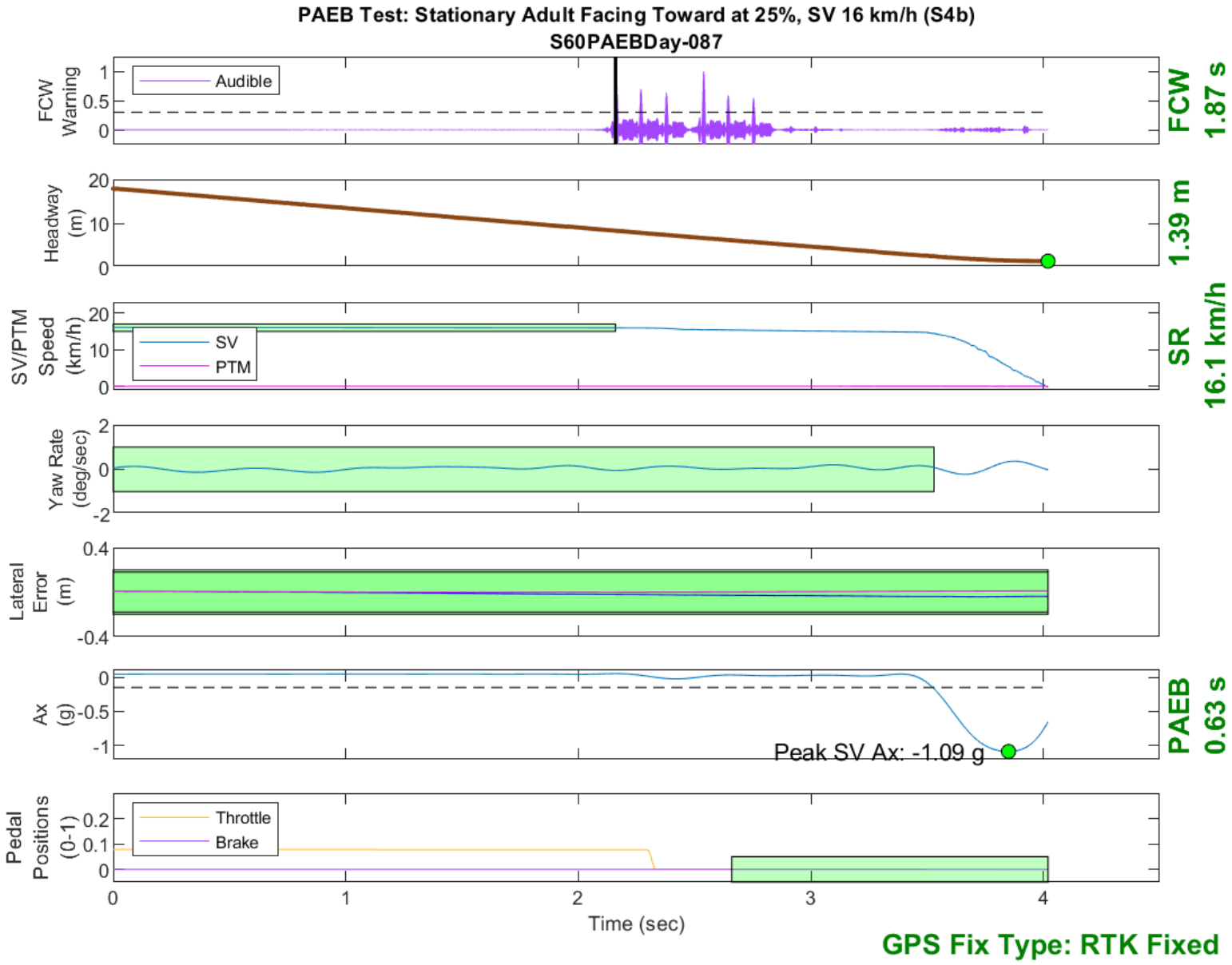


Figure D127. Time History for PAEB Run 87, S4b, Daytime, 16 km/h

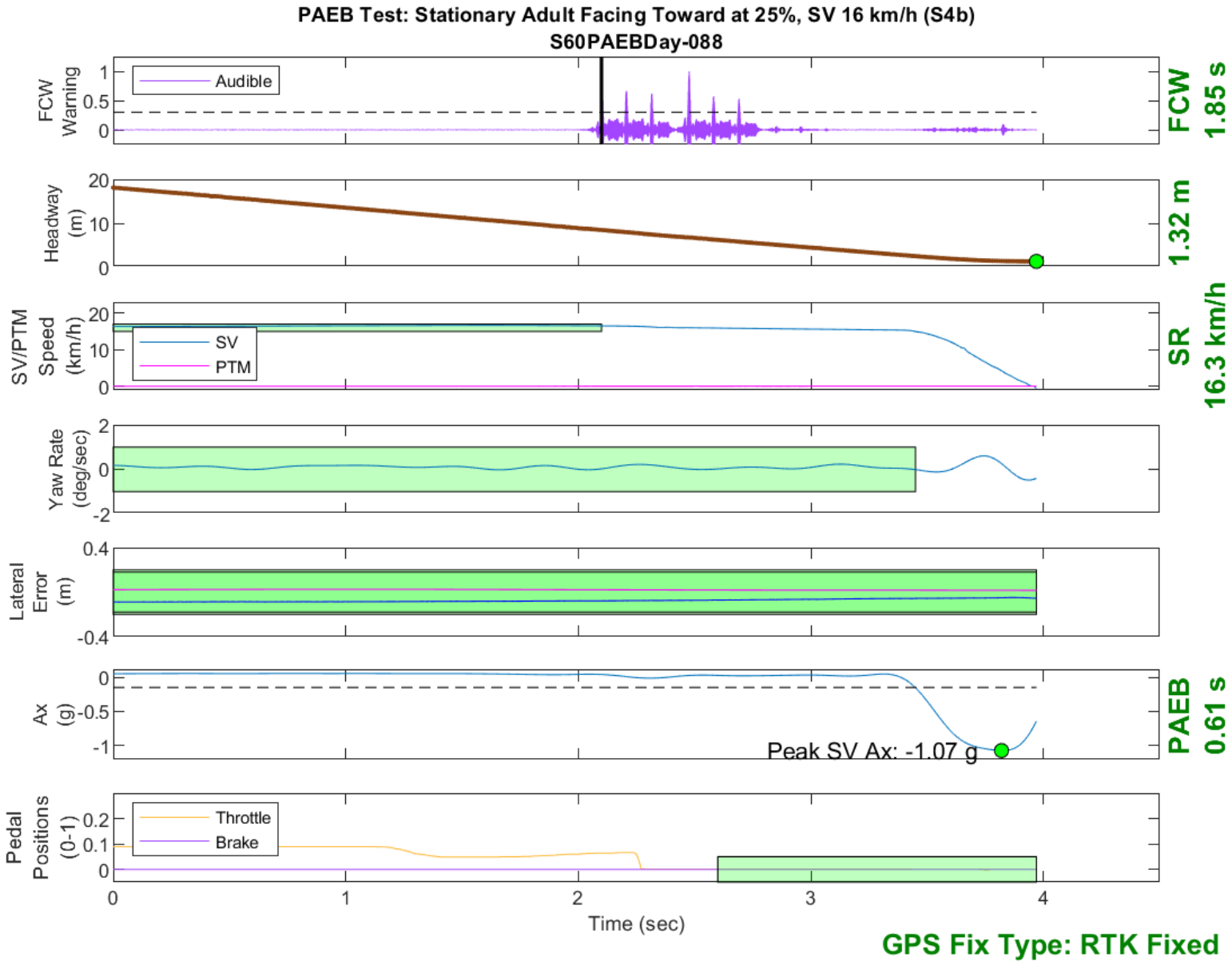


Figure D128. Time History for PAEB Run 88, S4b, Daytime, 16 km/h

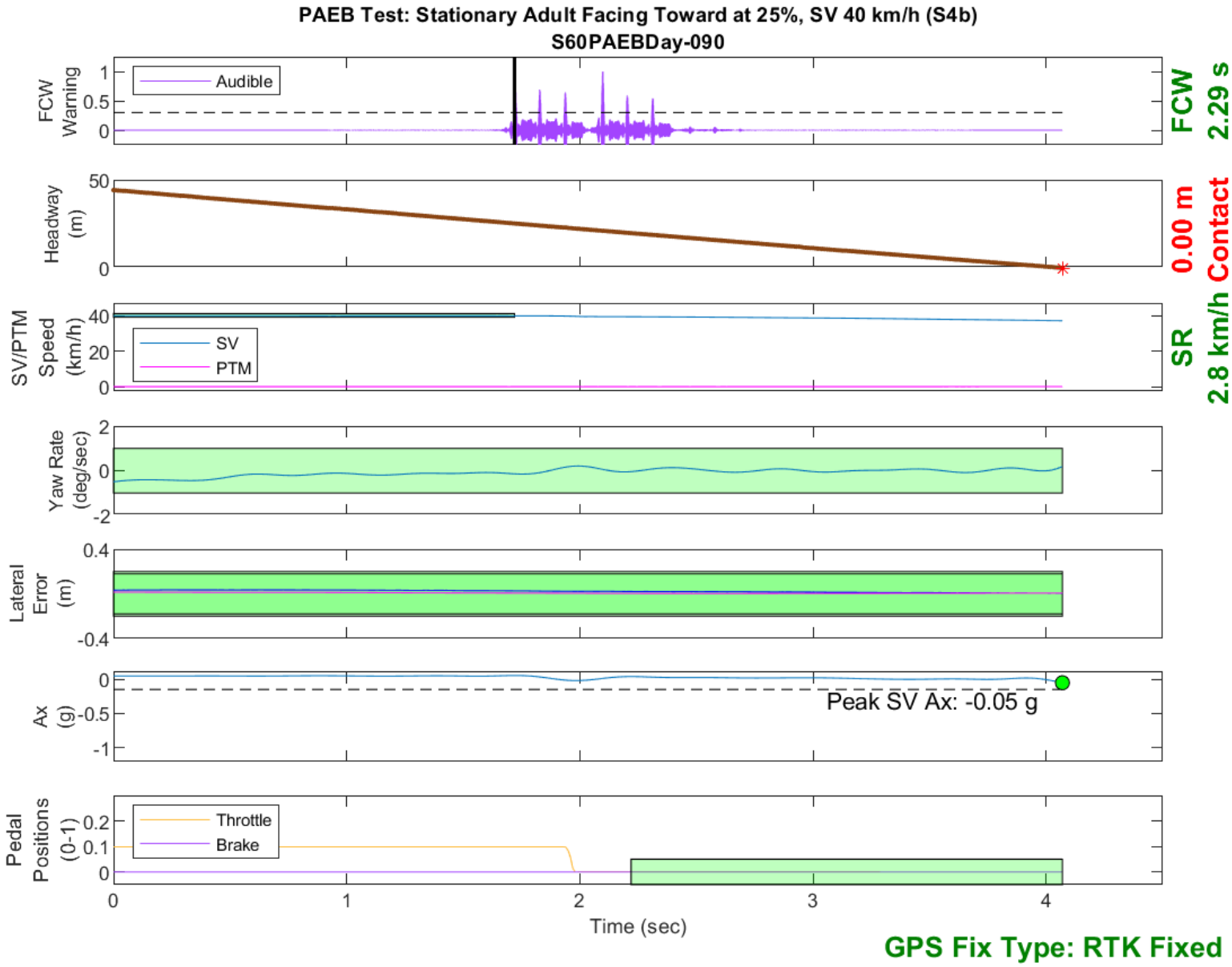


Figure D129. Time History for PAEB Run 90, S4b, Daytime, 40 km/h

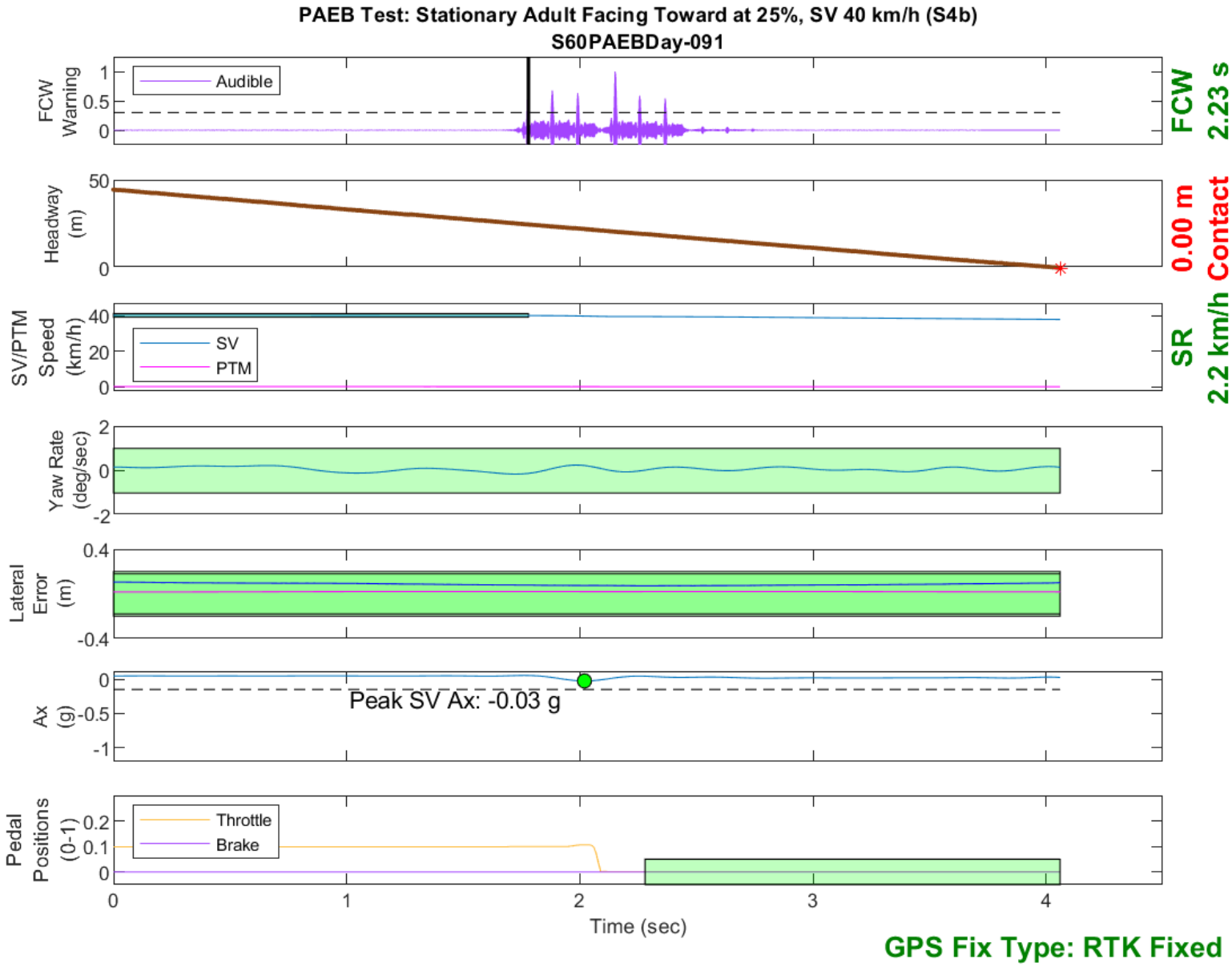


Figure D130. Time History for PAEB Run 91, S4b, Daytime, 40 km/h

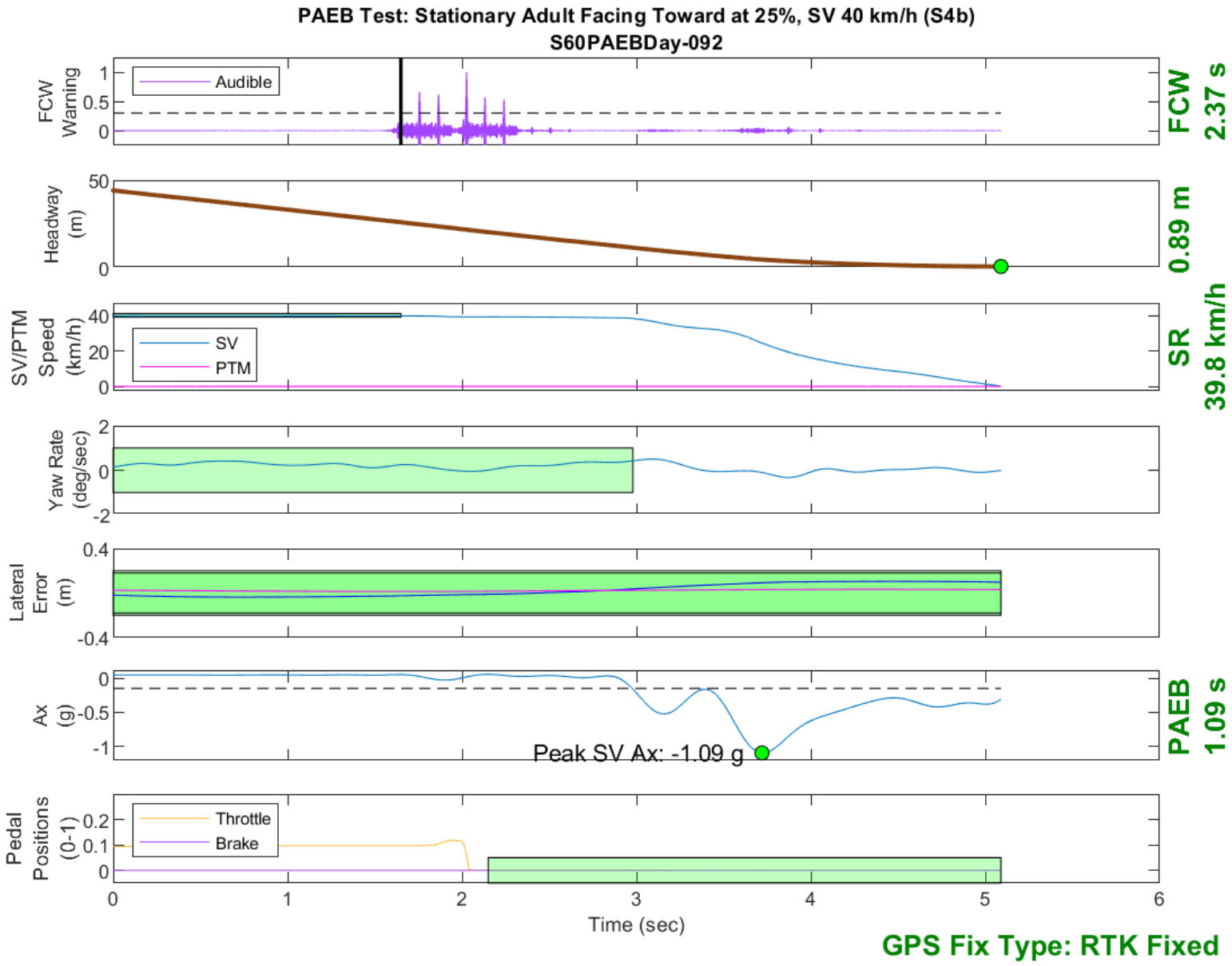


Figure D131. Time History for PAEB Run 92, S4b, Daytime, 40 km/h

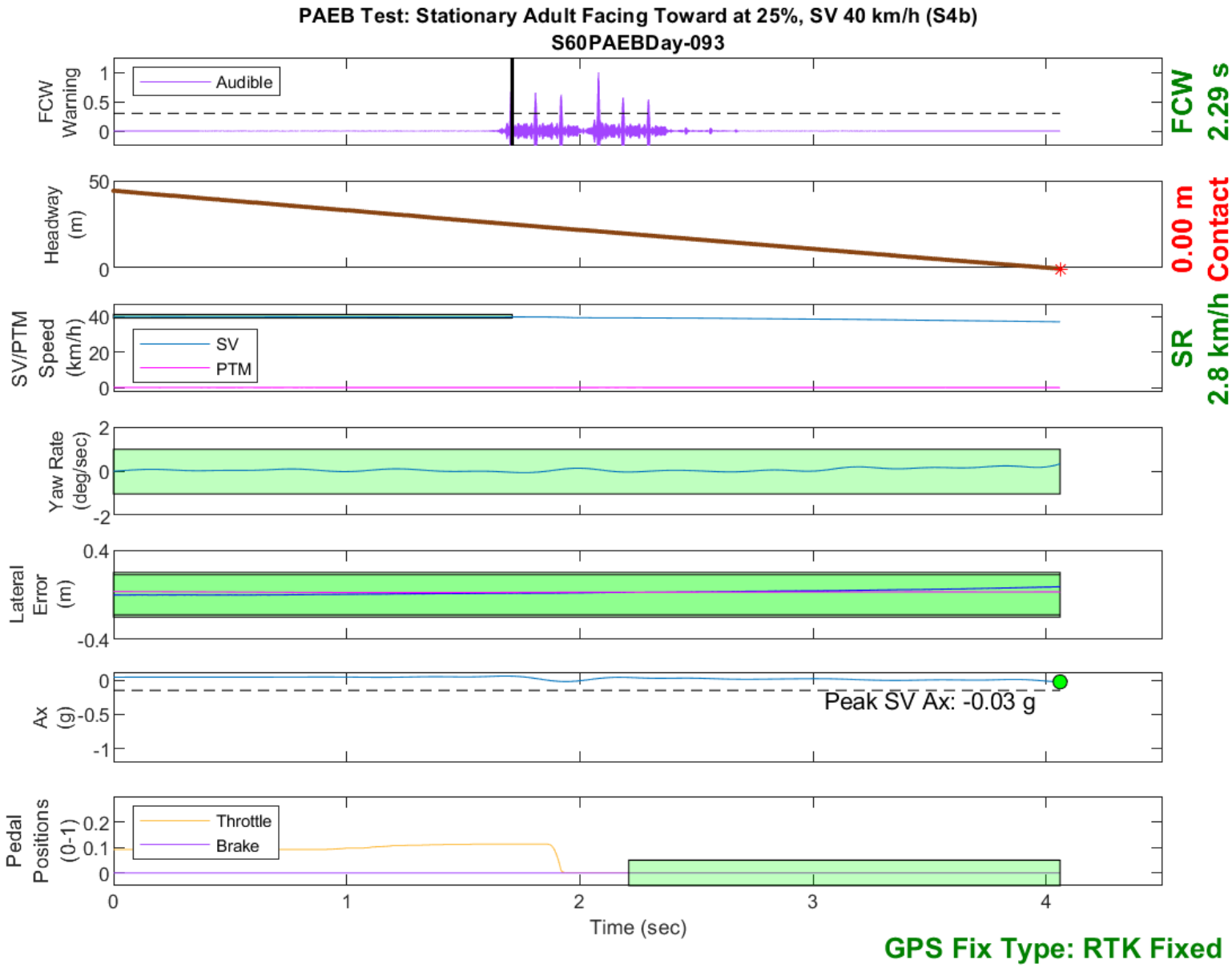


Figure D132. Time History for PAEB Run 93, S4b, Daytime, 40 km/h

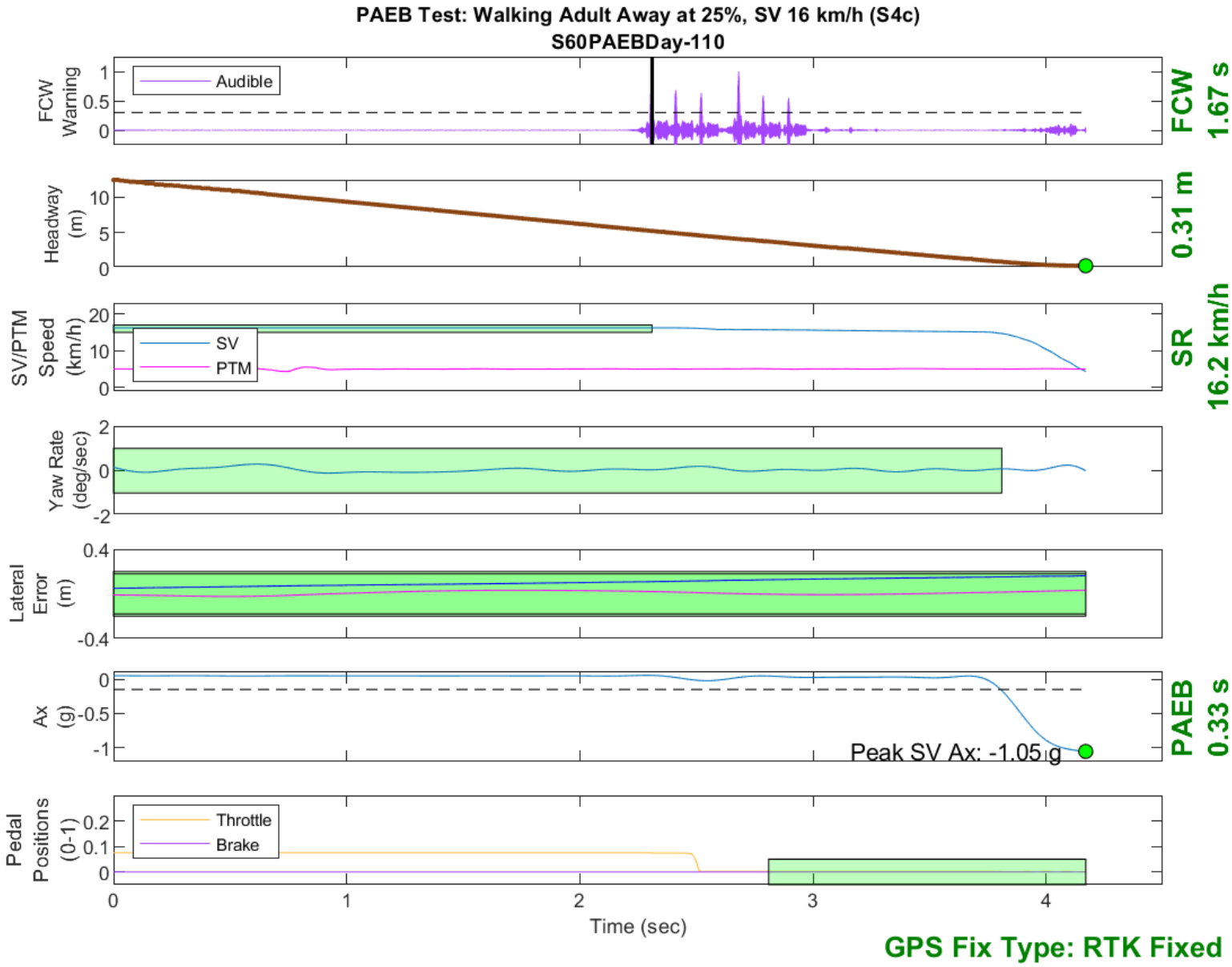


Figure D133. Time History for PAEB Run 110, S4c, Daytime, 16 km/h

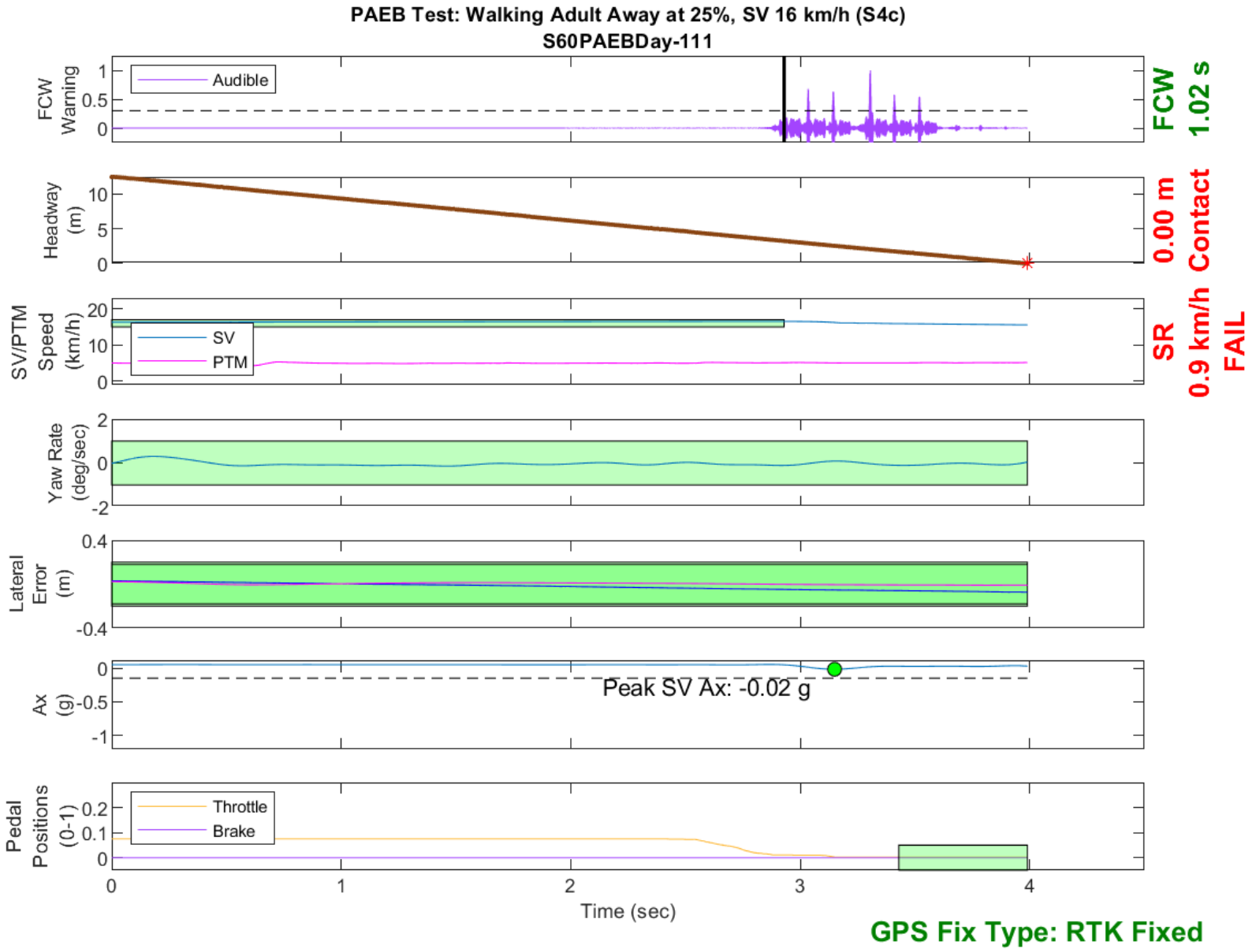


Figure D134. Time History for PAEB Run 111, S4c, Daytime, 16 km/h

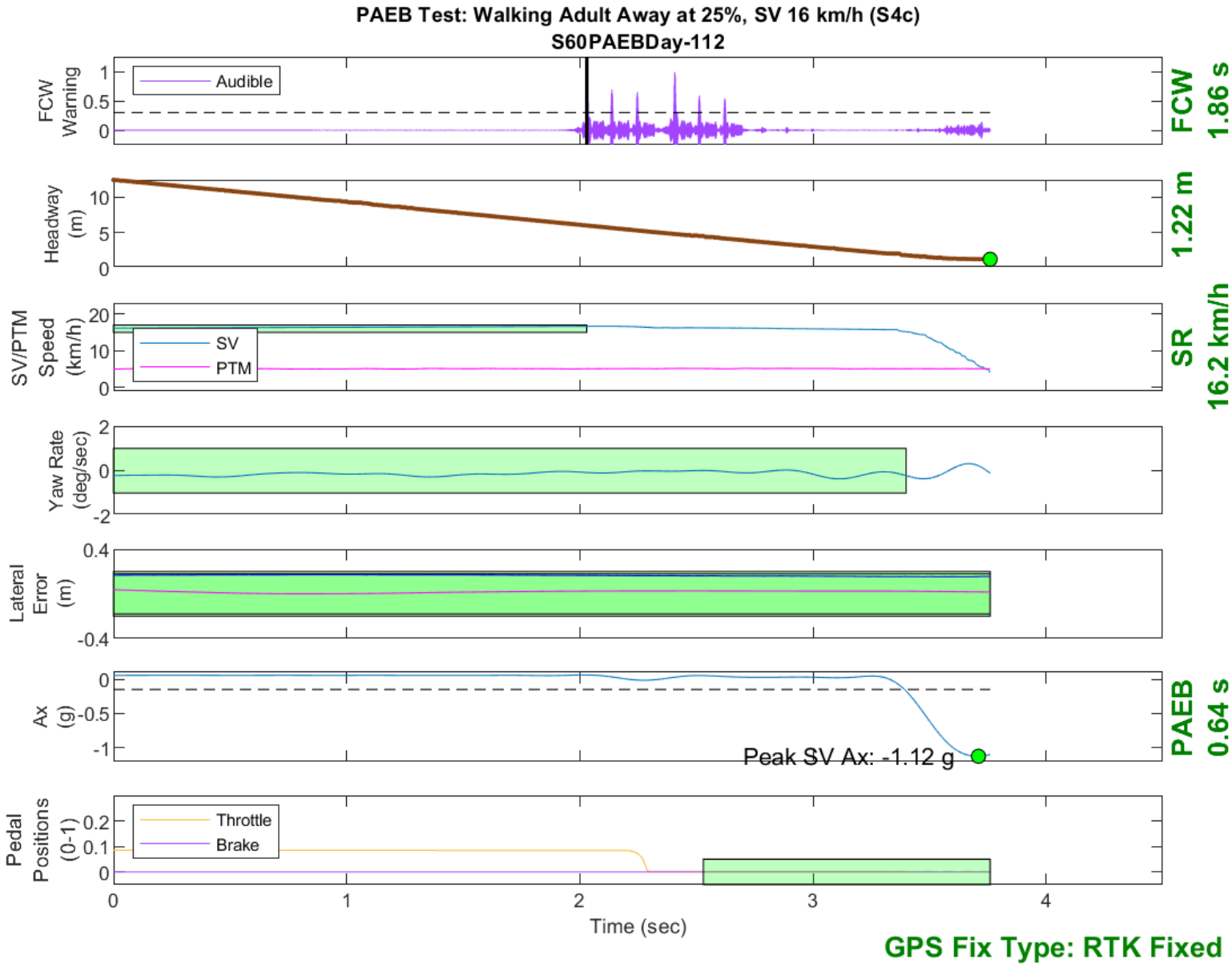


Figure D135. Time History for PAEB Run 112, S4c, Daytime, 16 km/h

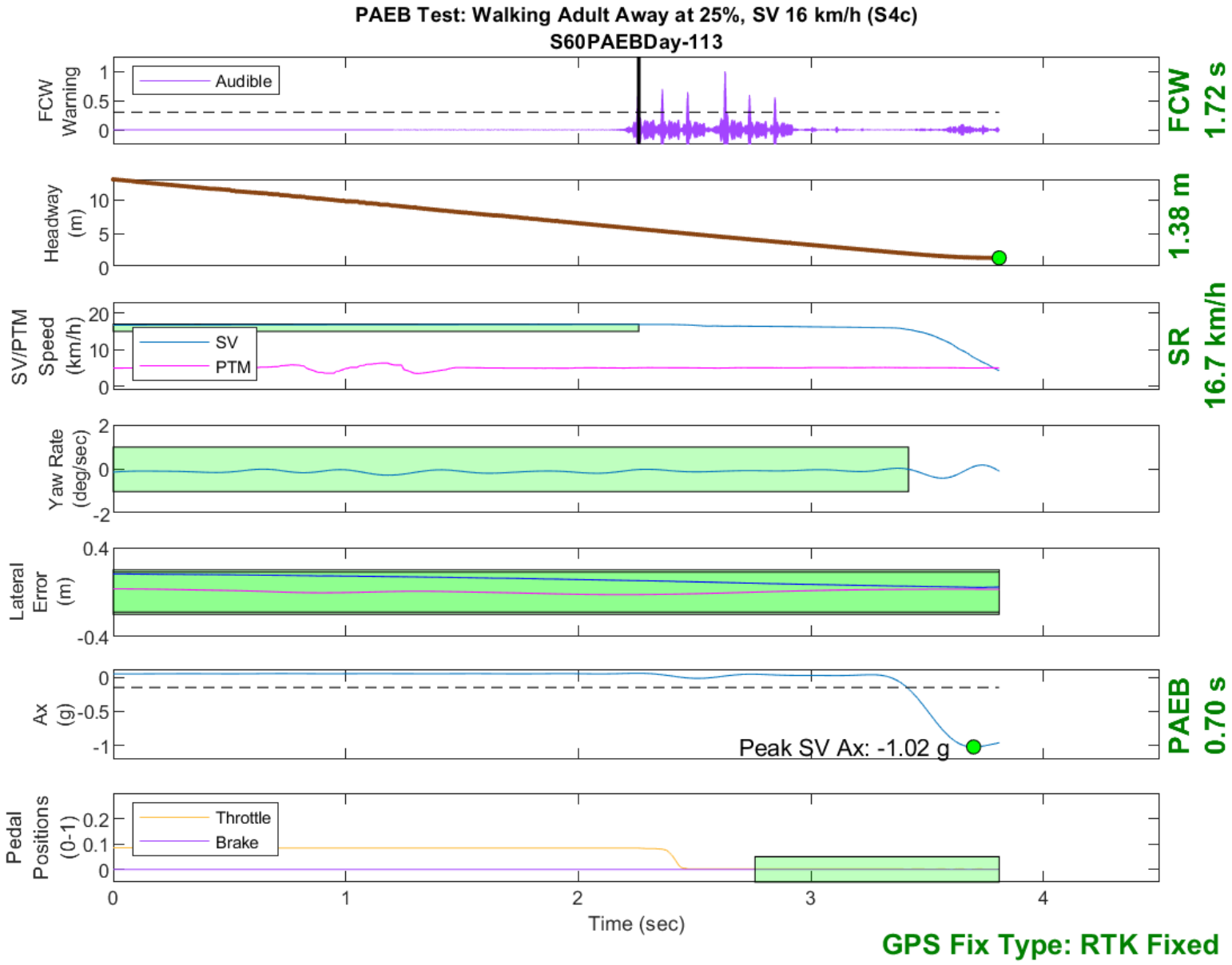


Figure D136. Time History for PAEB Run 113, S4c, Daytime, 16 km/h

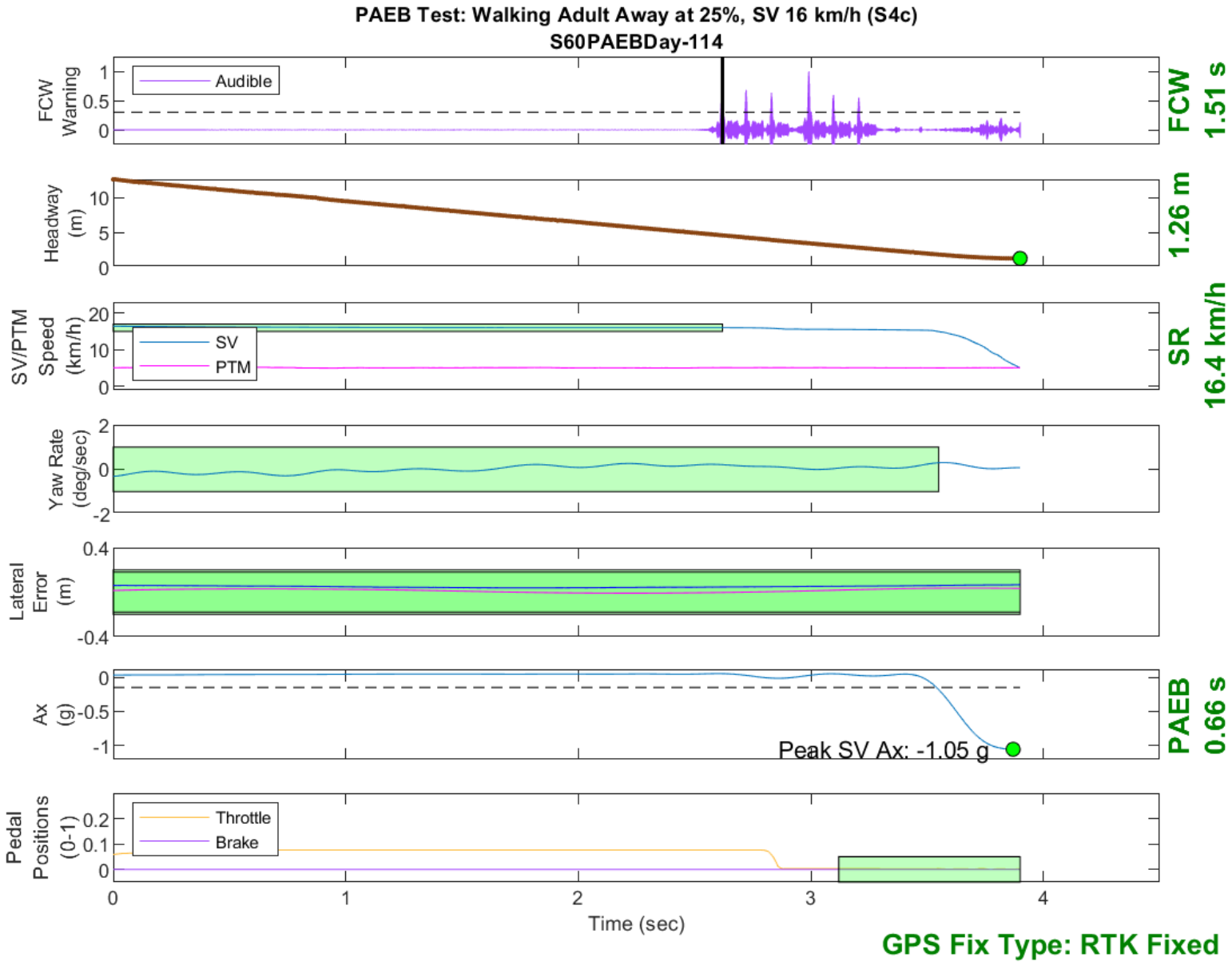


Figure D137. Time History for PAEB Run 114, S4c, Daytime, 16 km/h

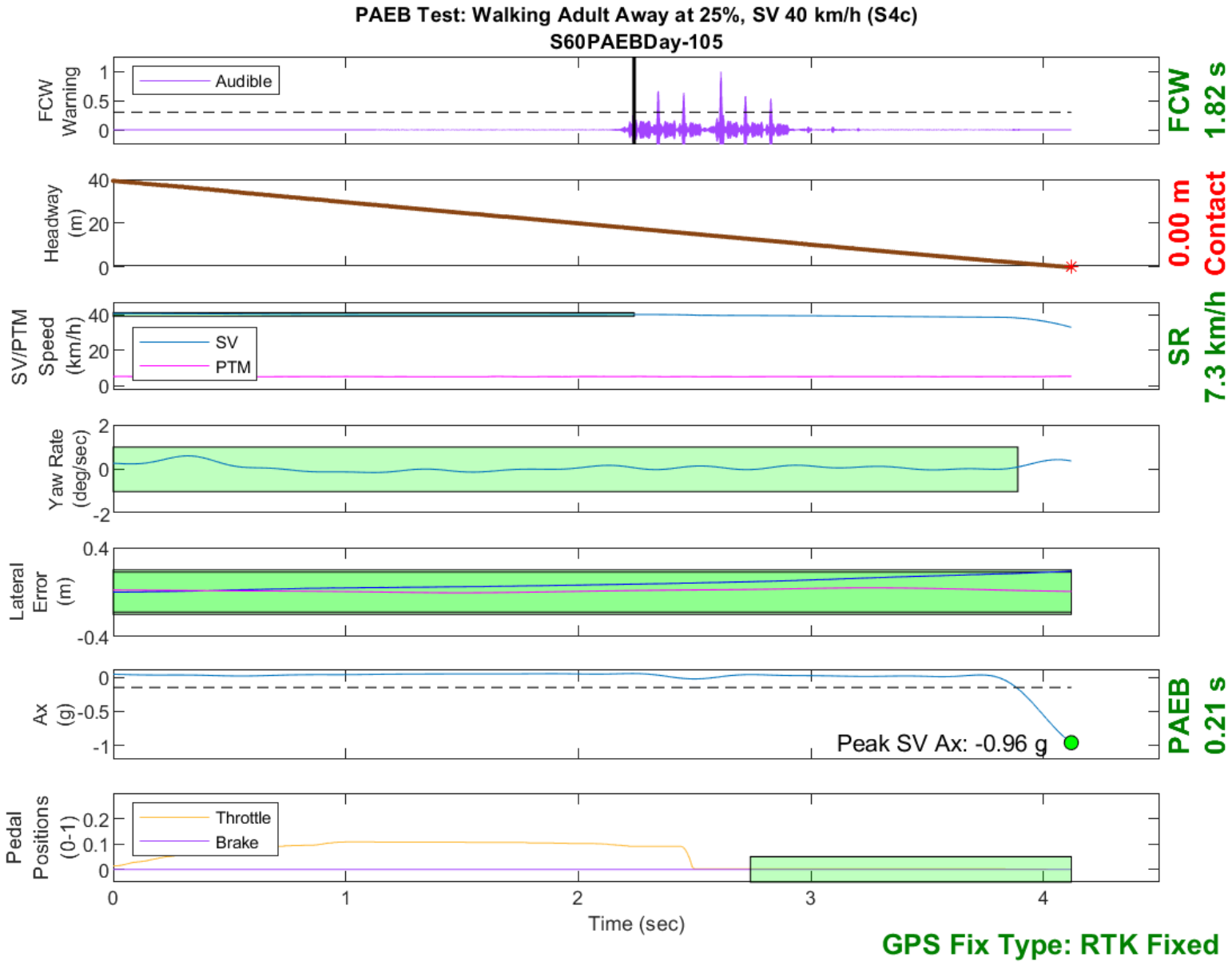


Figure D138. Time History for PAEB Run 105, S4c, Daytime, 40 km/h

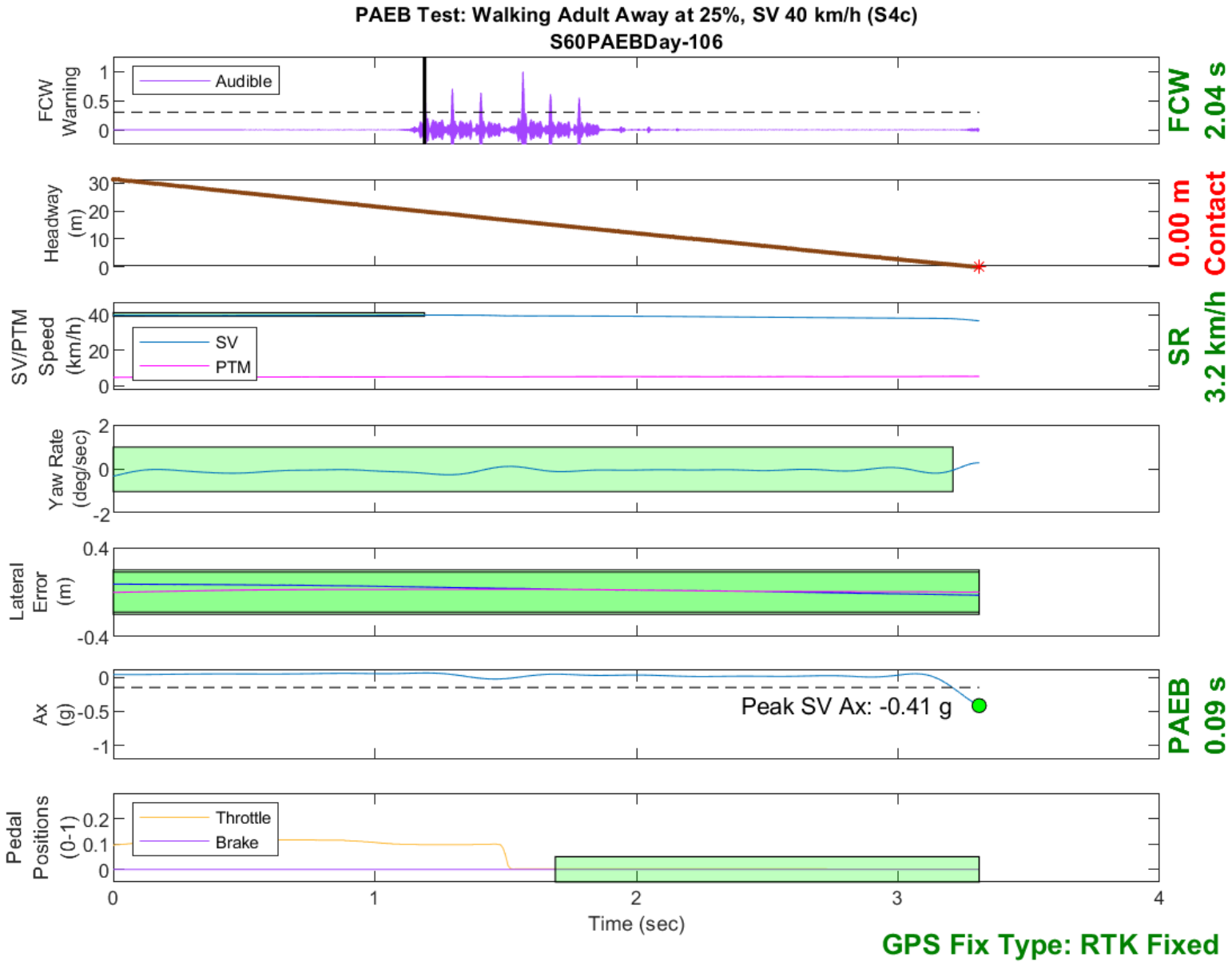


Figure D139. Time History for PAEB Run 106, S4c, Daytime, 40 km/h

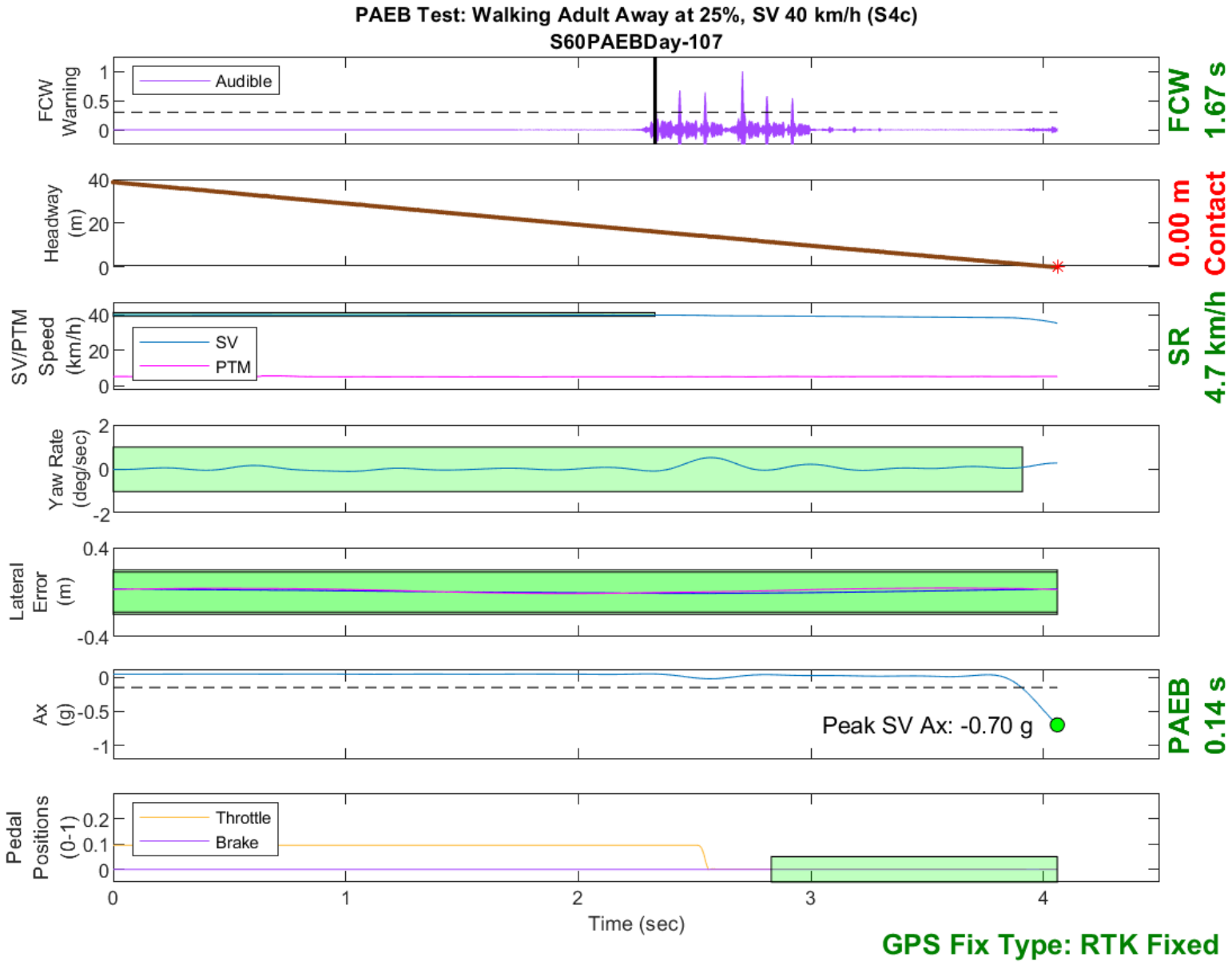


Figure D140. Time History for PAEB Run 107, S4c, Daytime, 40 km/h



Figure D141. Time History for PAEB Run 14, S1b, Night, High Beam, 11 km/h

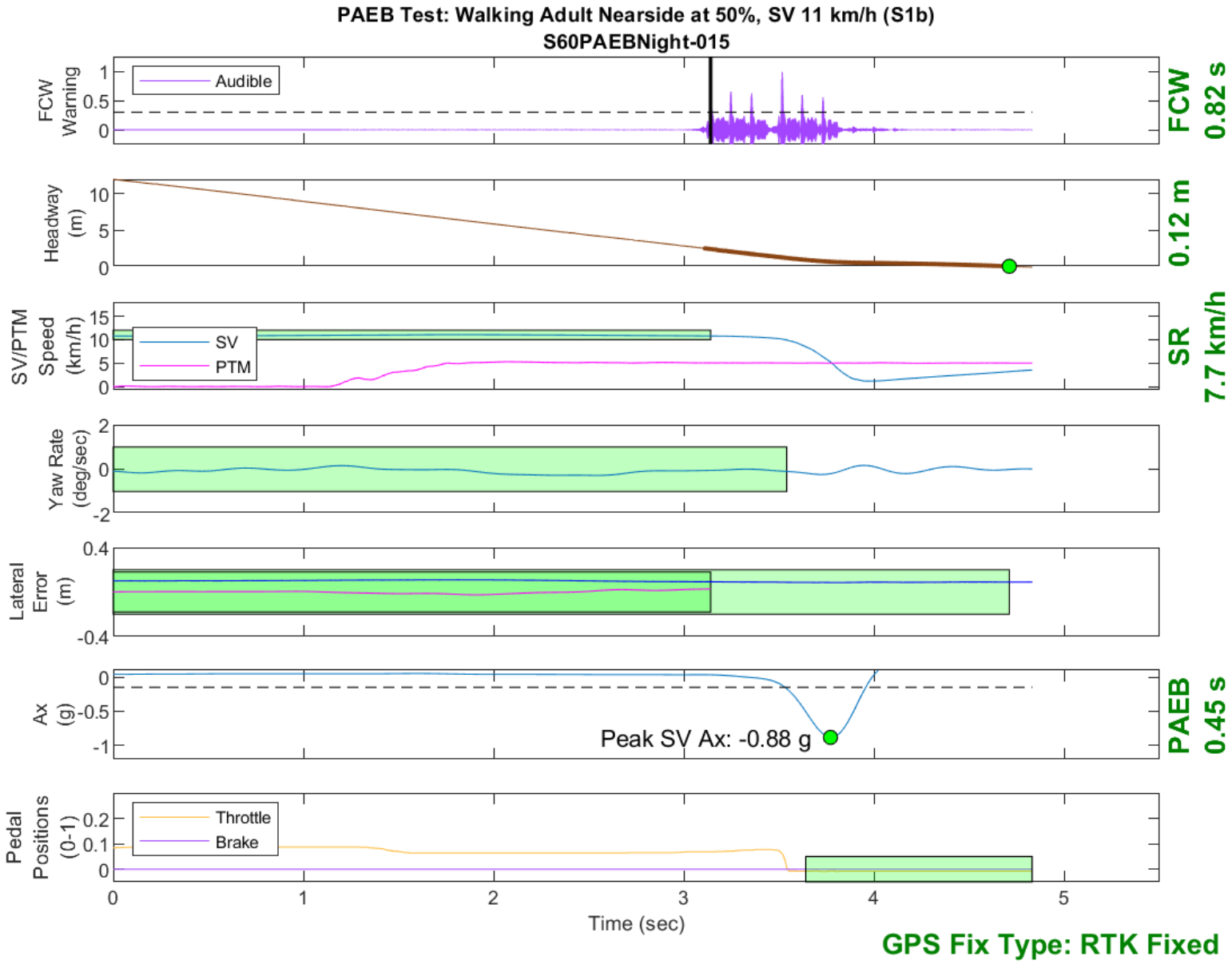


Figure D142. Time History for PAEB Run 15, S1b, Night, High Beam, 11 km/h

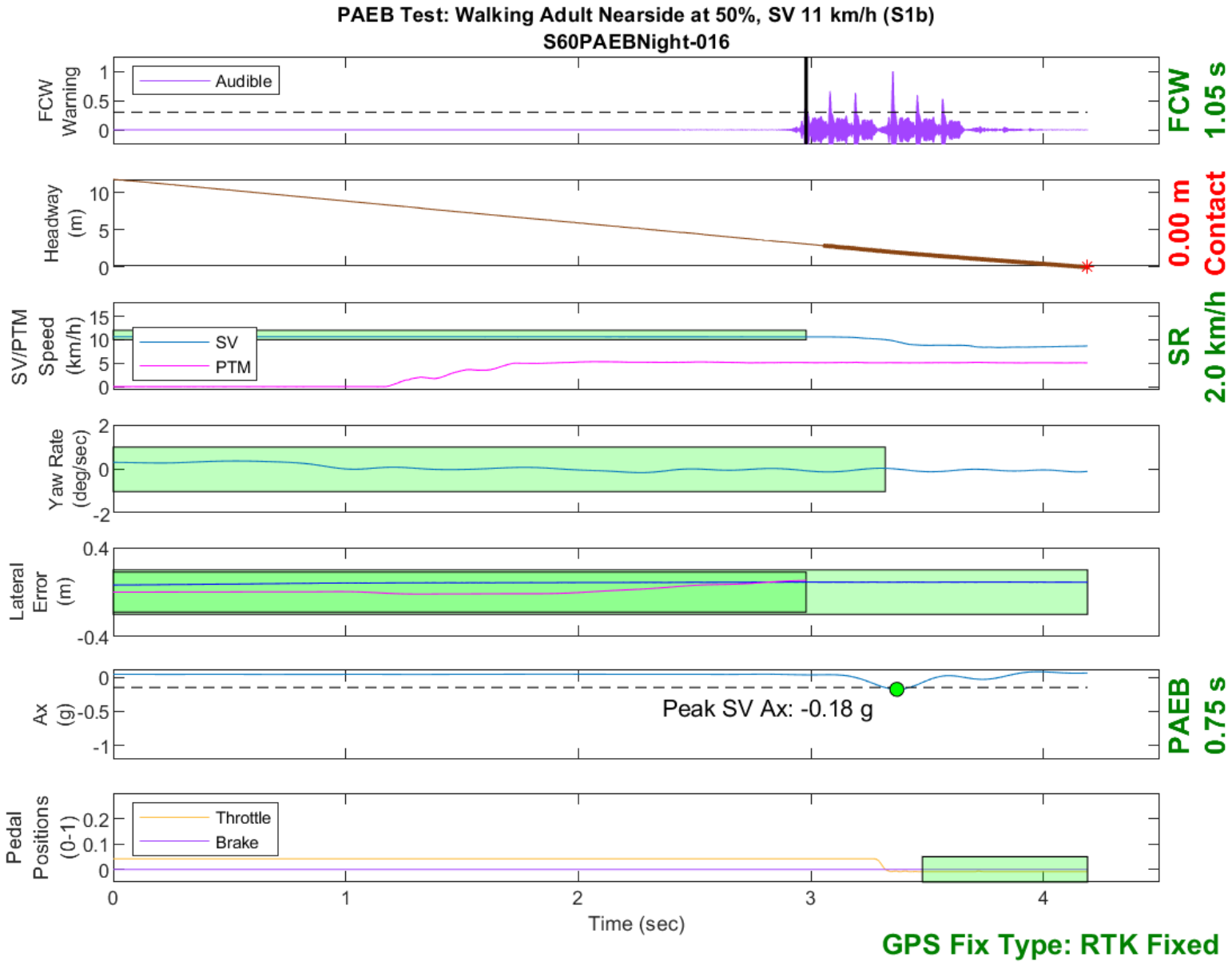


Figure D143. Time History for PAEB Run 16, S1b, Night, High Beam, 11 km/h

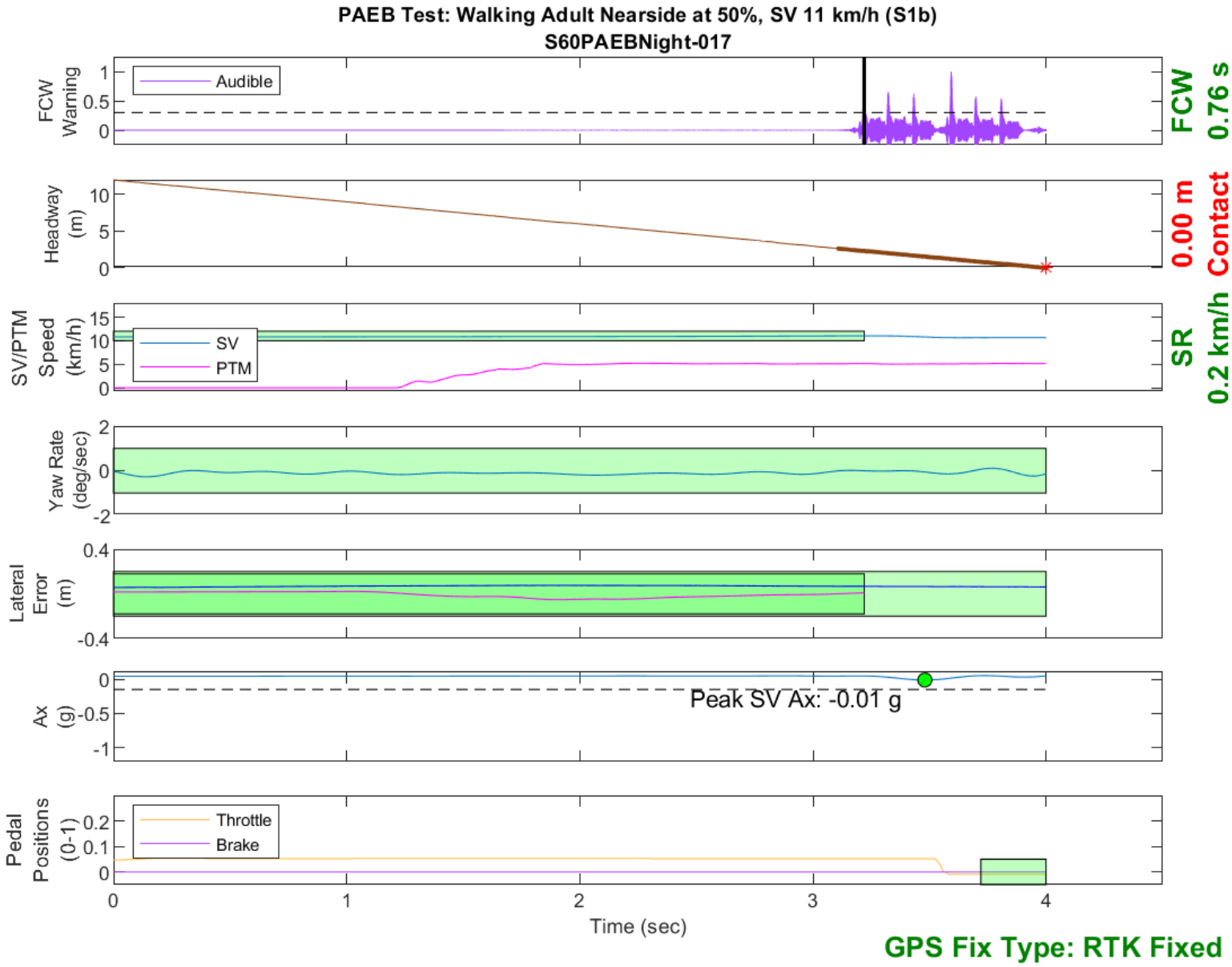


Figure D144. Time History for PAEB Run 17, S1b, Night, High Beam, 11 km/h

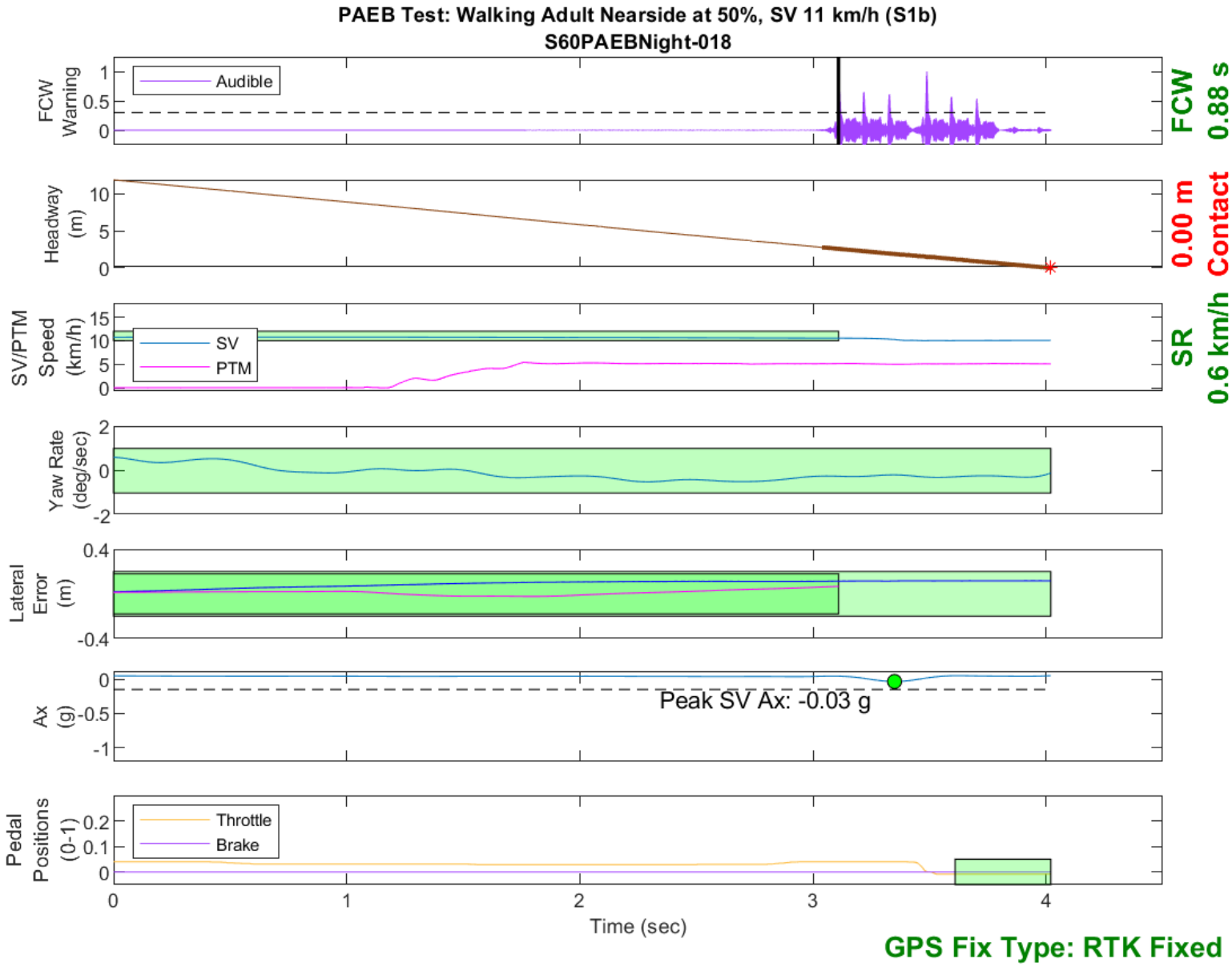


Figure D145. Time History for PAEB Run 18, S1b, Night, High Beam, 11 km/h

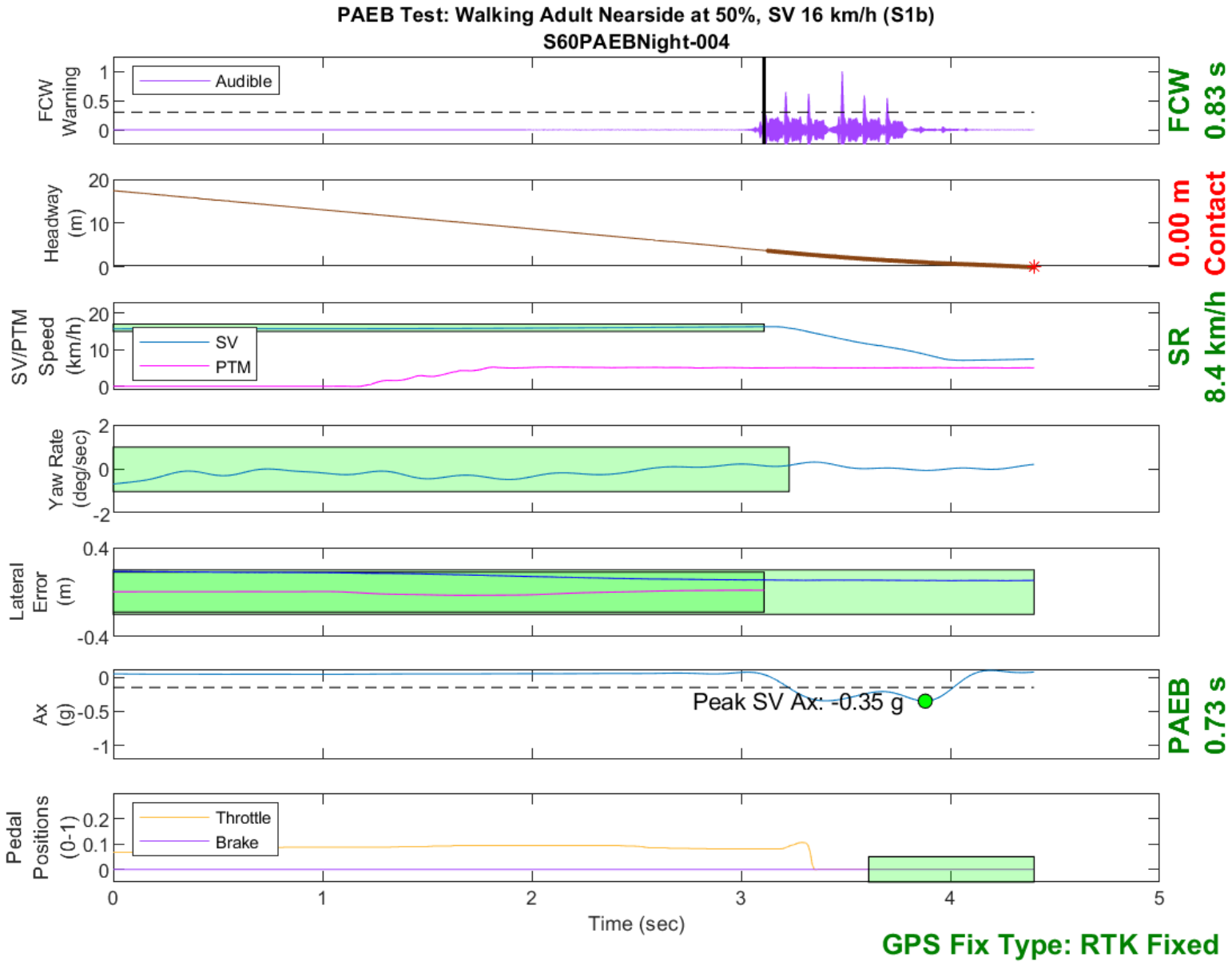


Figure D146. Time History for PAEB Run 4, S1b, Night, High Beam, 16 km/h

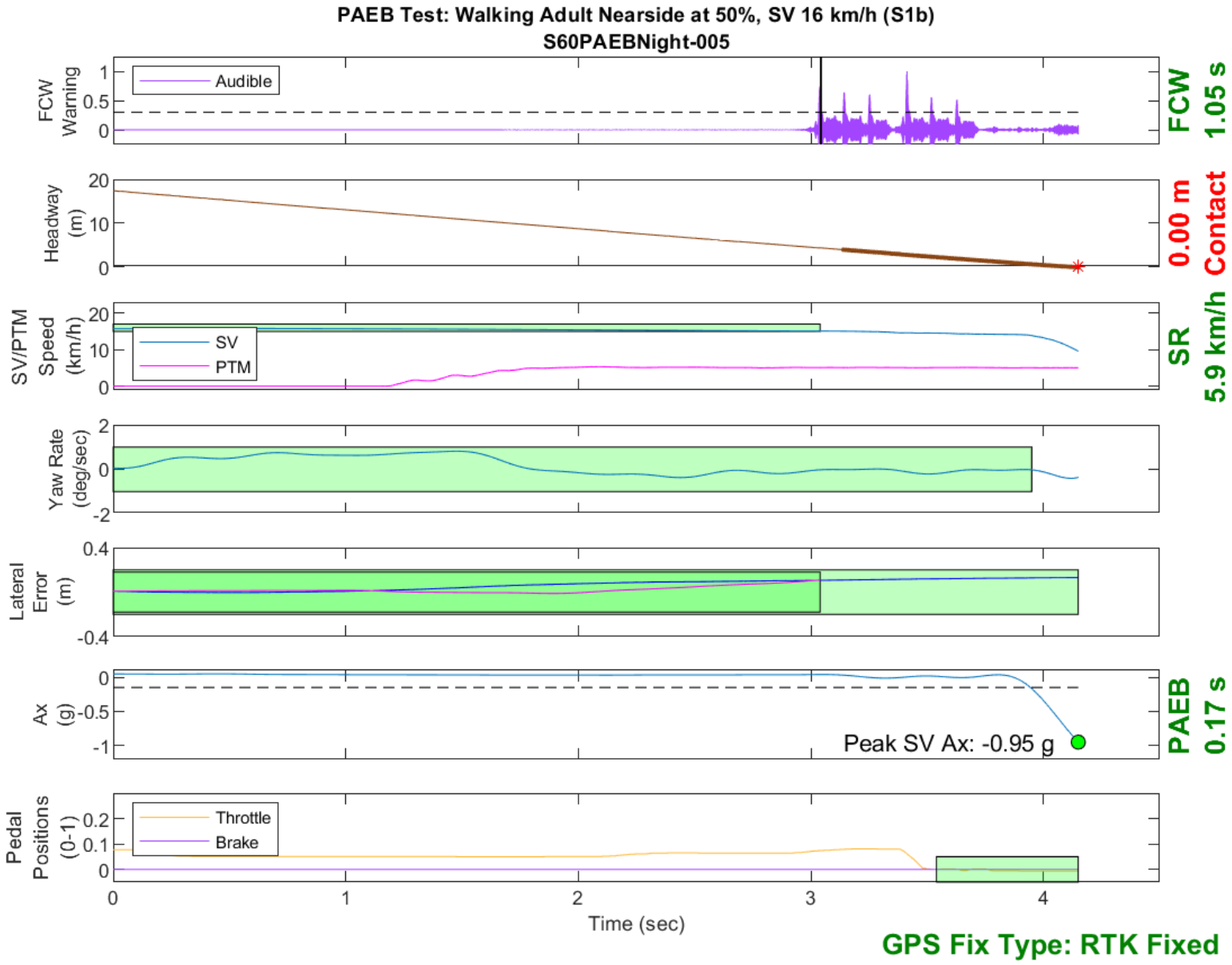


Figure D147. Time History for PAEB Run 5, S1b, Night, High Beam, 16 km/h

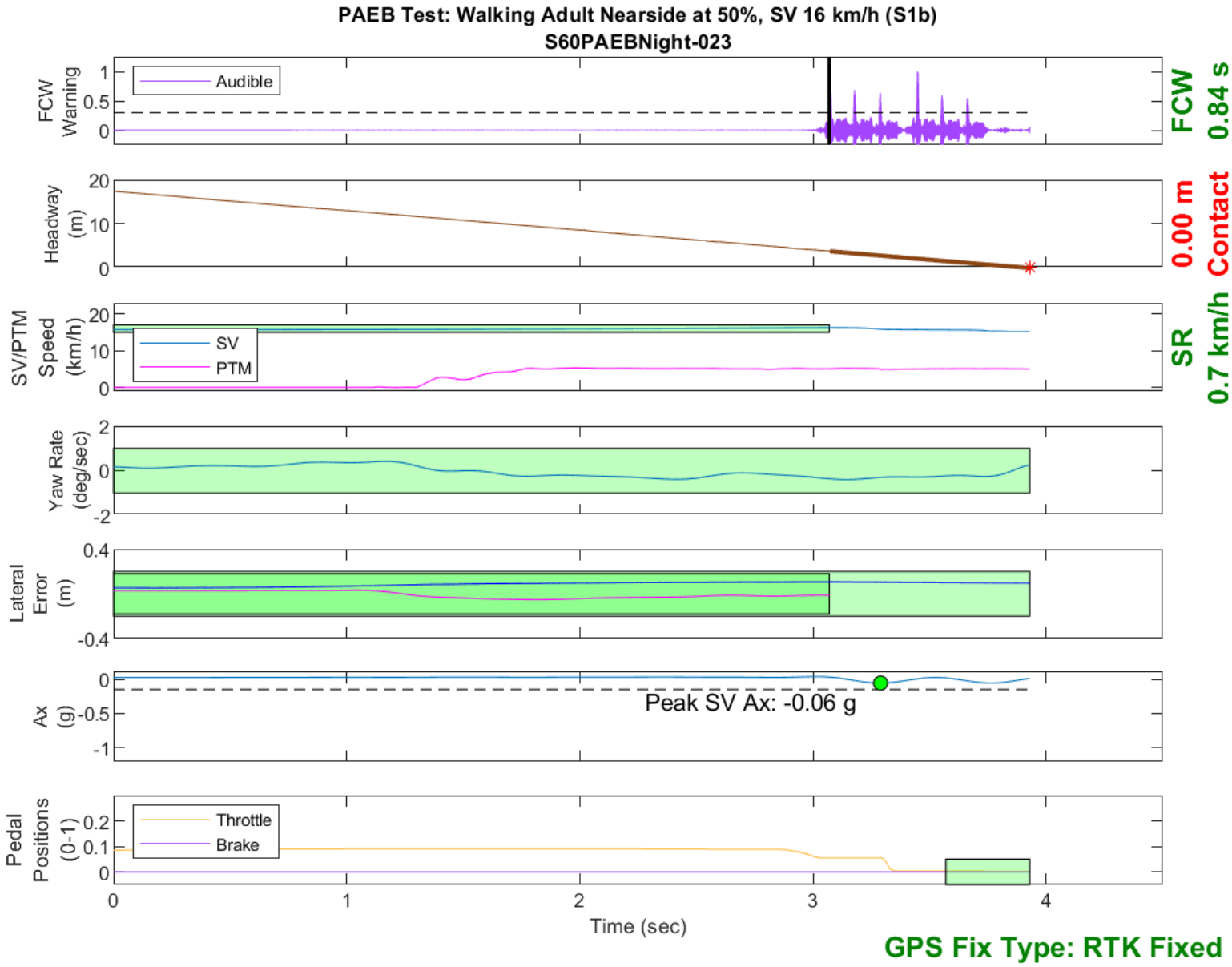


Figure D148. Time History for PAEB Run 23, S1b, Night, High Beam, 16 km/h

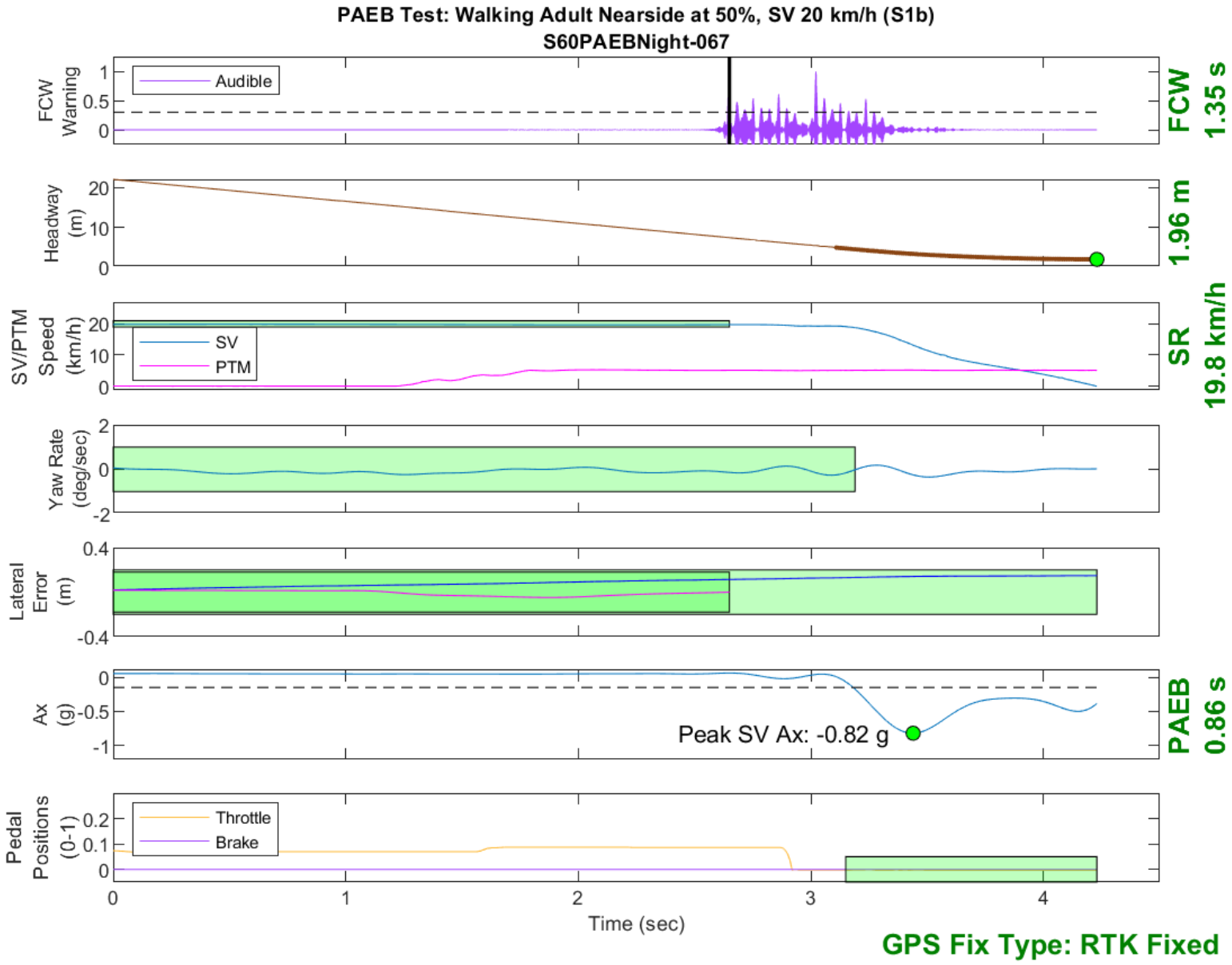


Figure D149. Time History for PAEB Run 67, S1b, Night, High Beam, 20 km/h

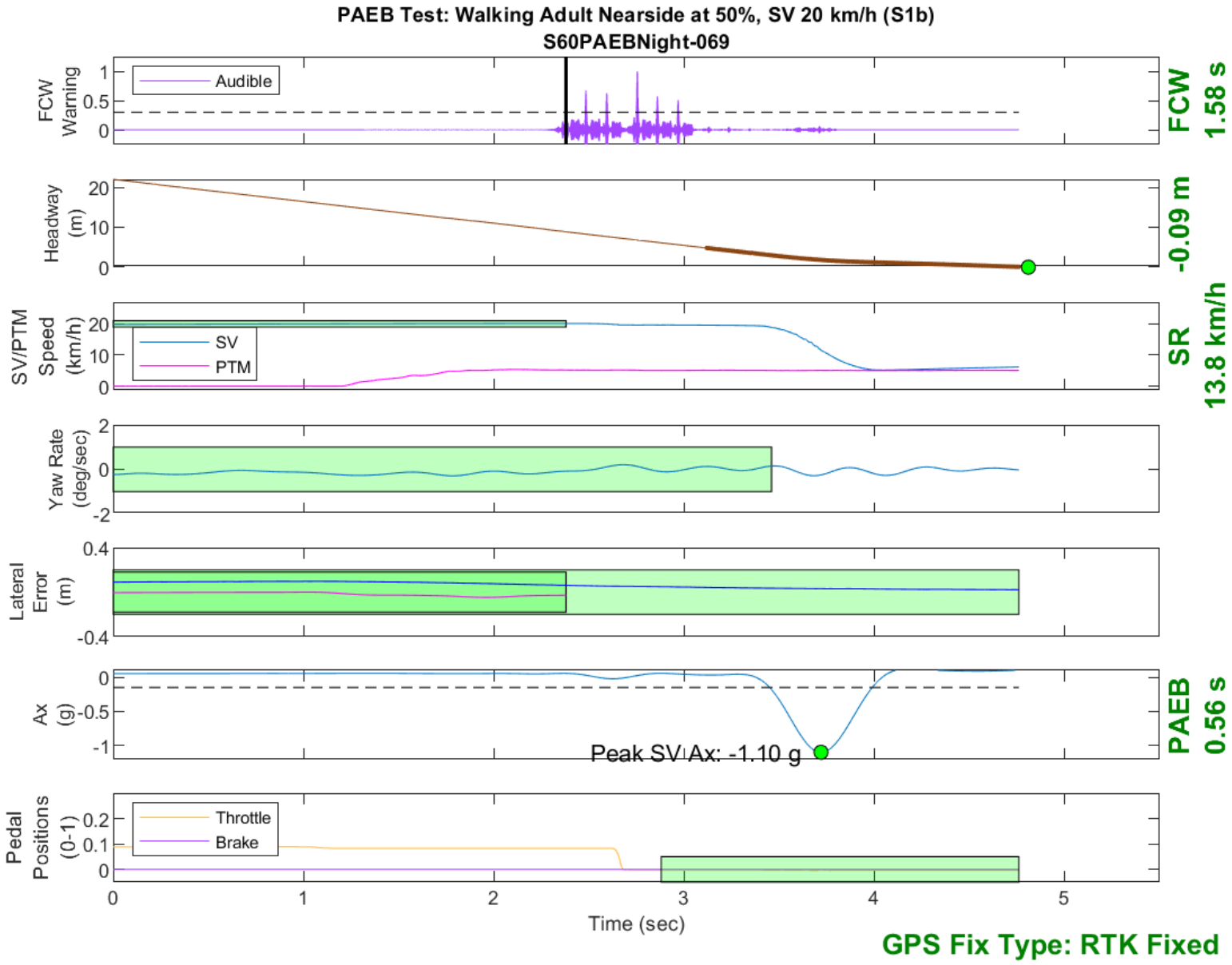


Figure D150. Time History for PAEB Run 69, S1b, Night, High Beam, 20 km/h

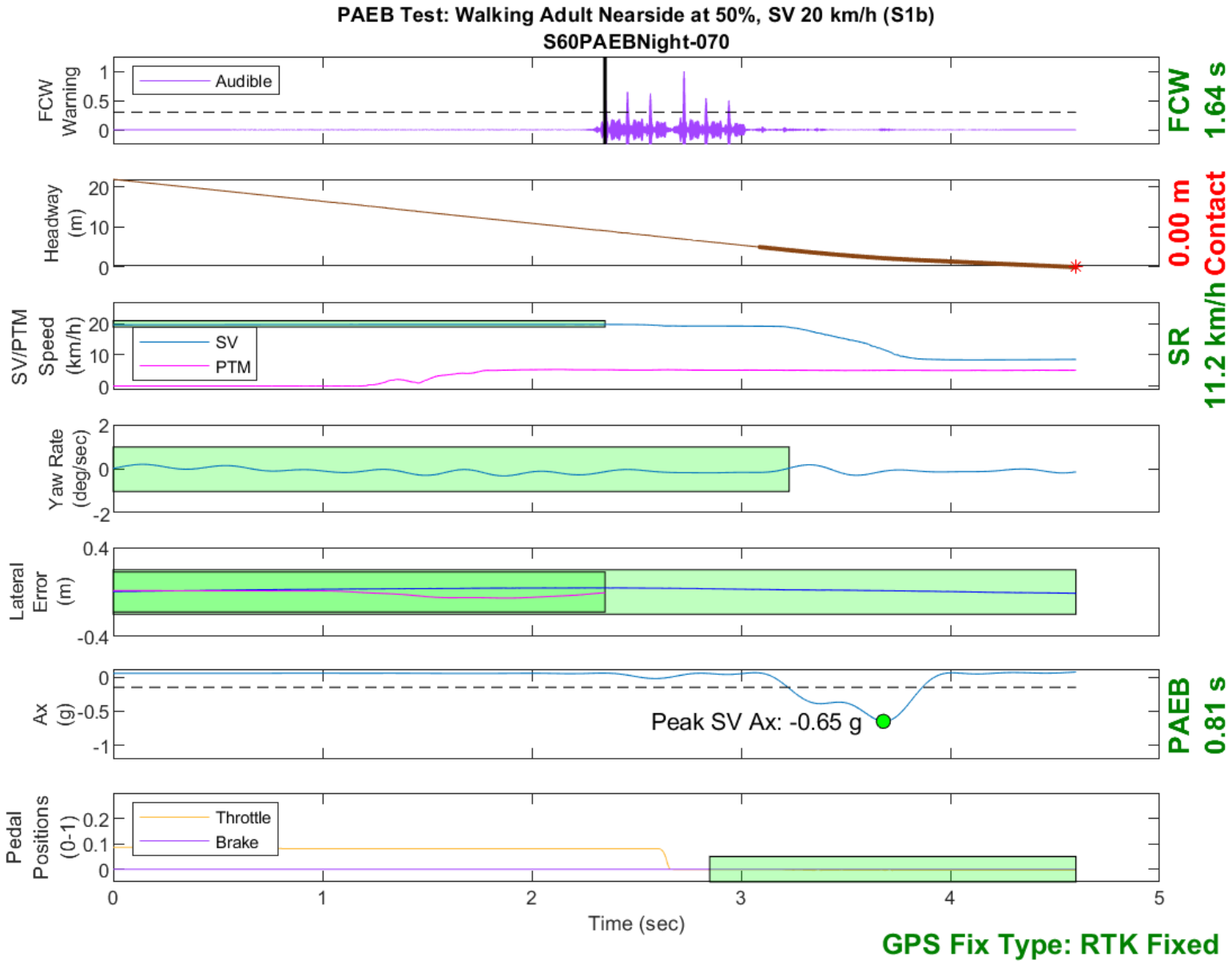


Figure D151. Time History for PAEB Run 70, S1b, Night, High Beam, 20 km/h

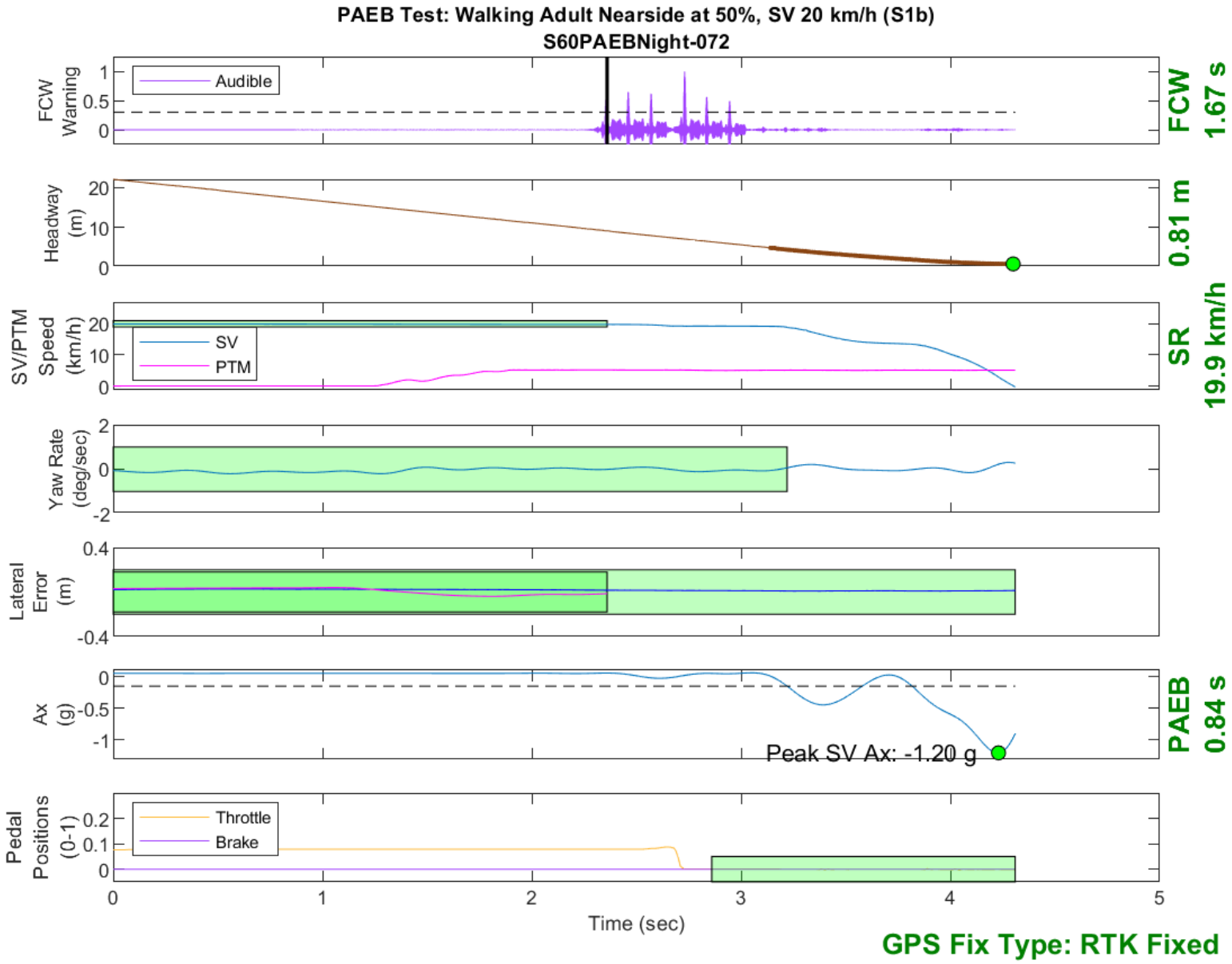


Figure D152. Time History for PAEB Run 72, S1b, Night, High Beam, 20 km/h

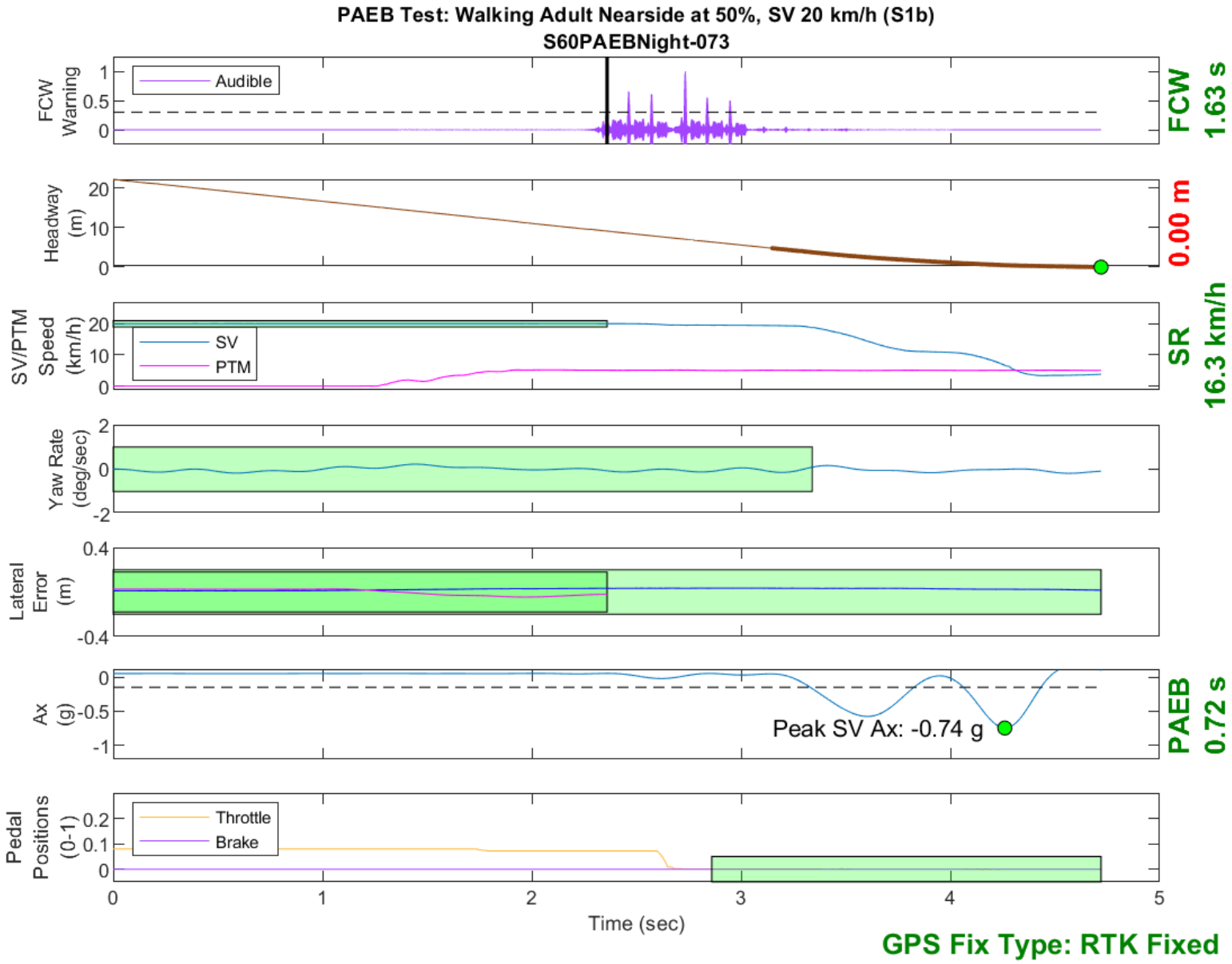


Figure D153. Time History for PAEB Run 73, S1b, Night, High Beam, 20 km/h

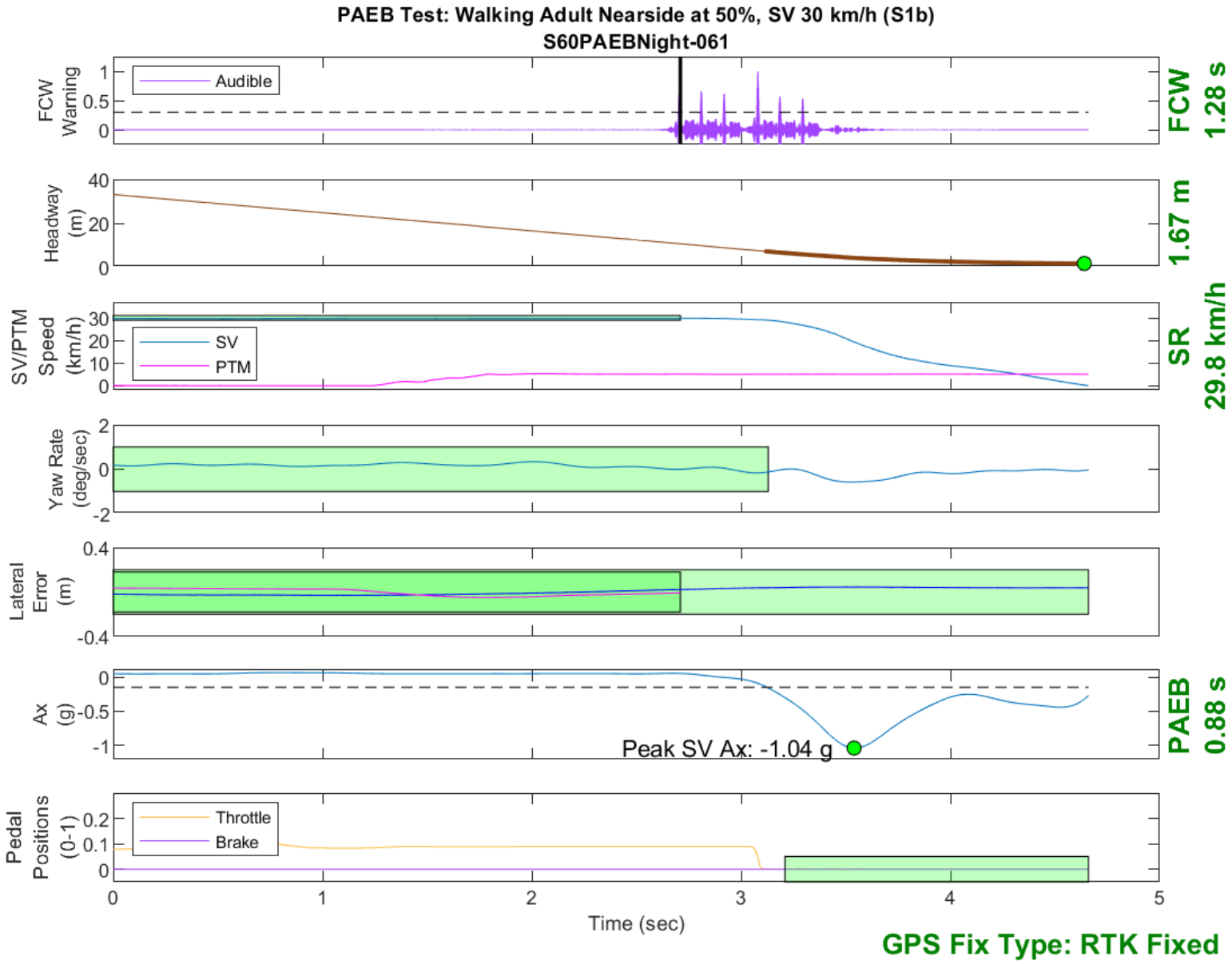


Figure D154. Time History for PAEB Run 61, S1b, Night, High Beam, 30 km/h

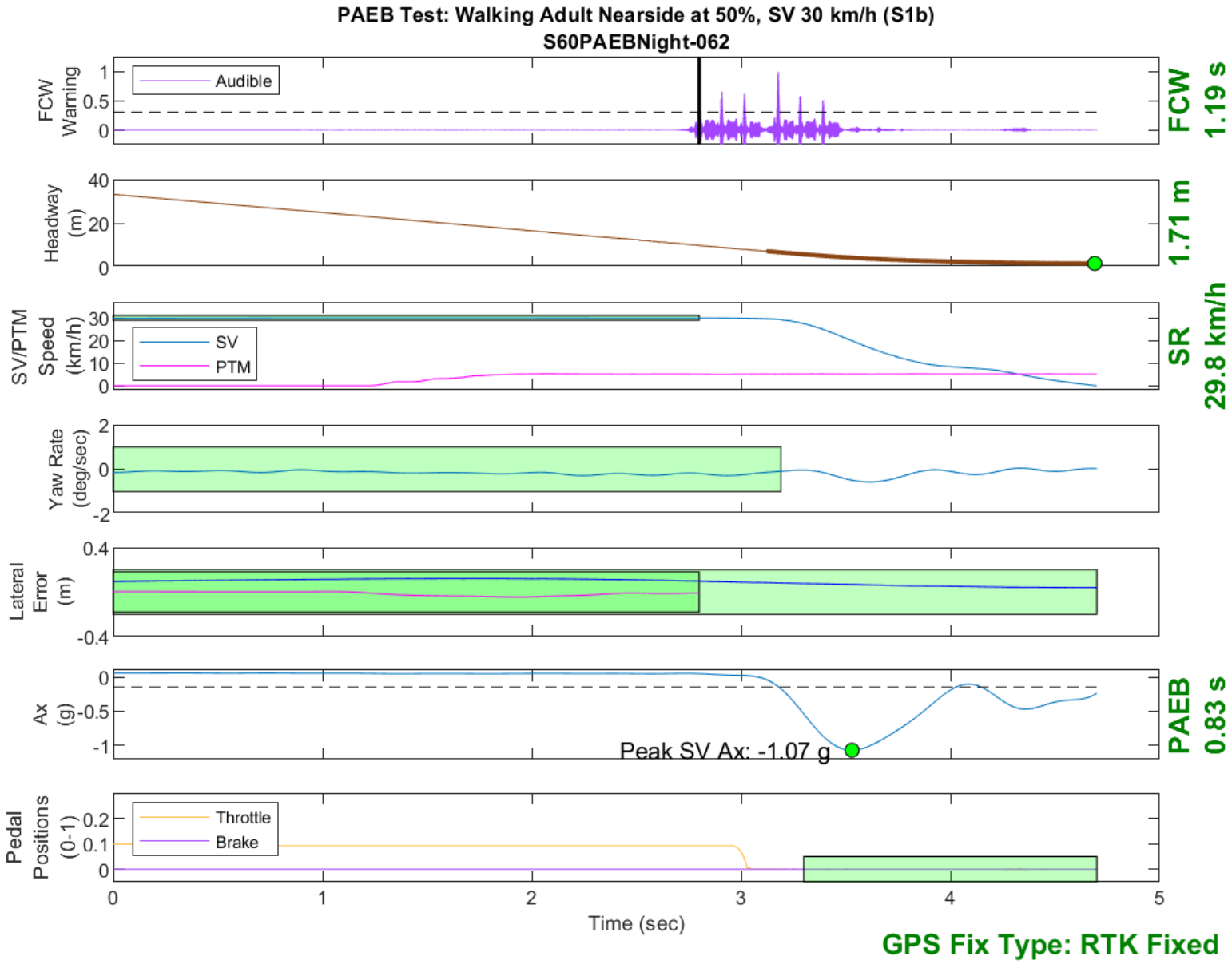


Figure D155. Time History for PAEB Run 62, S1b, Night, High Beam, 30 km/h

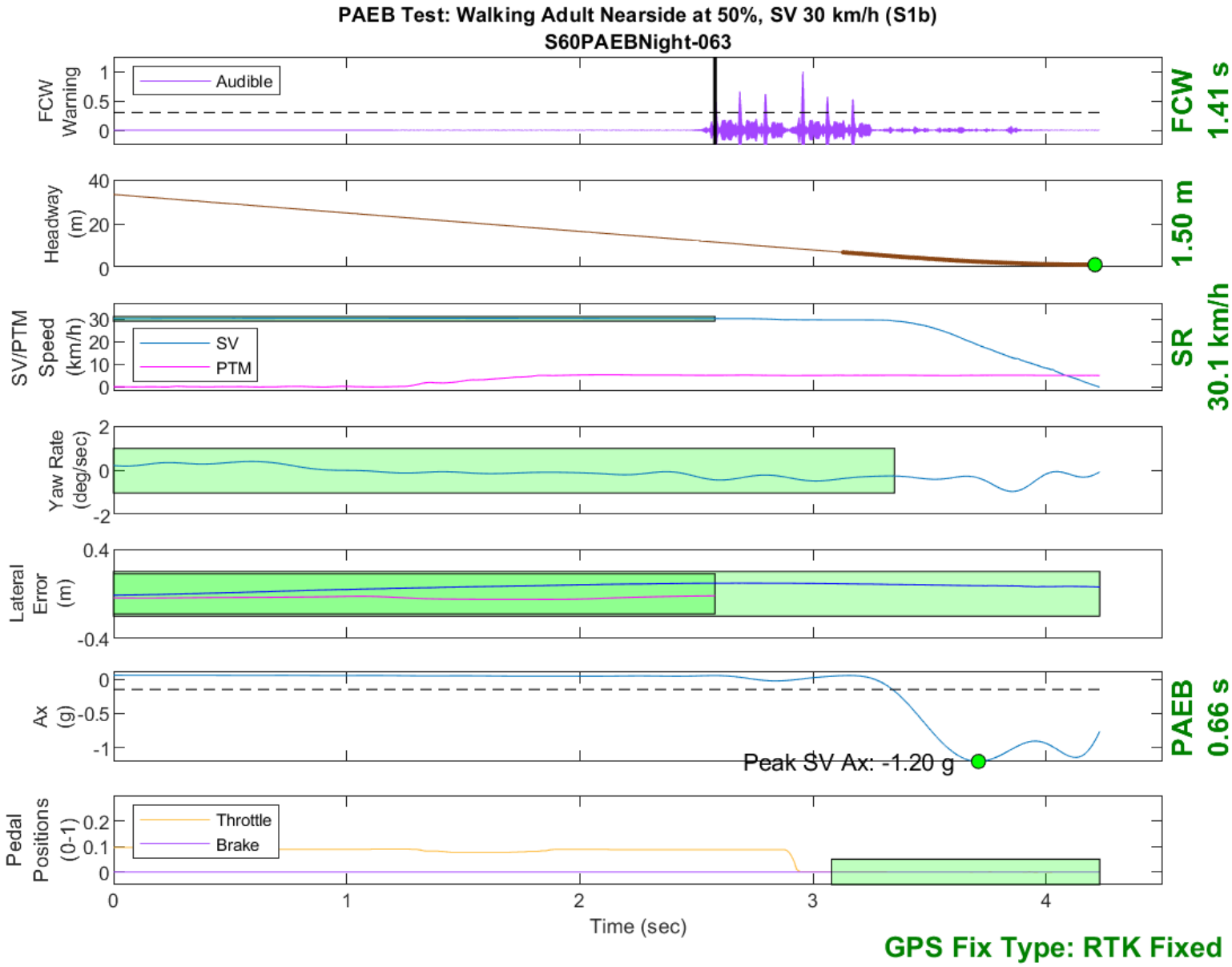


Figure D156. Time History for PAEB Run 63, S1b, Night, High Beam, 30 km/h

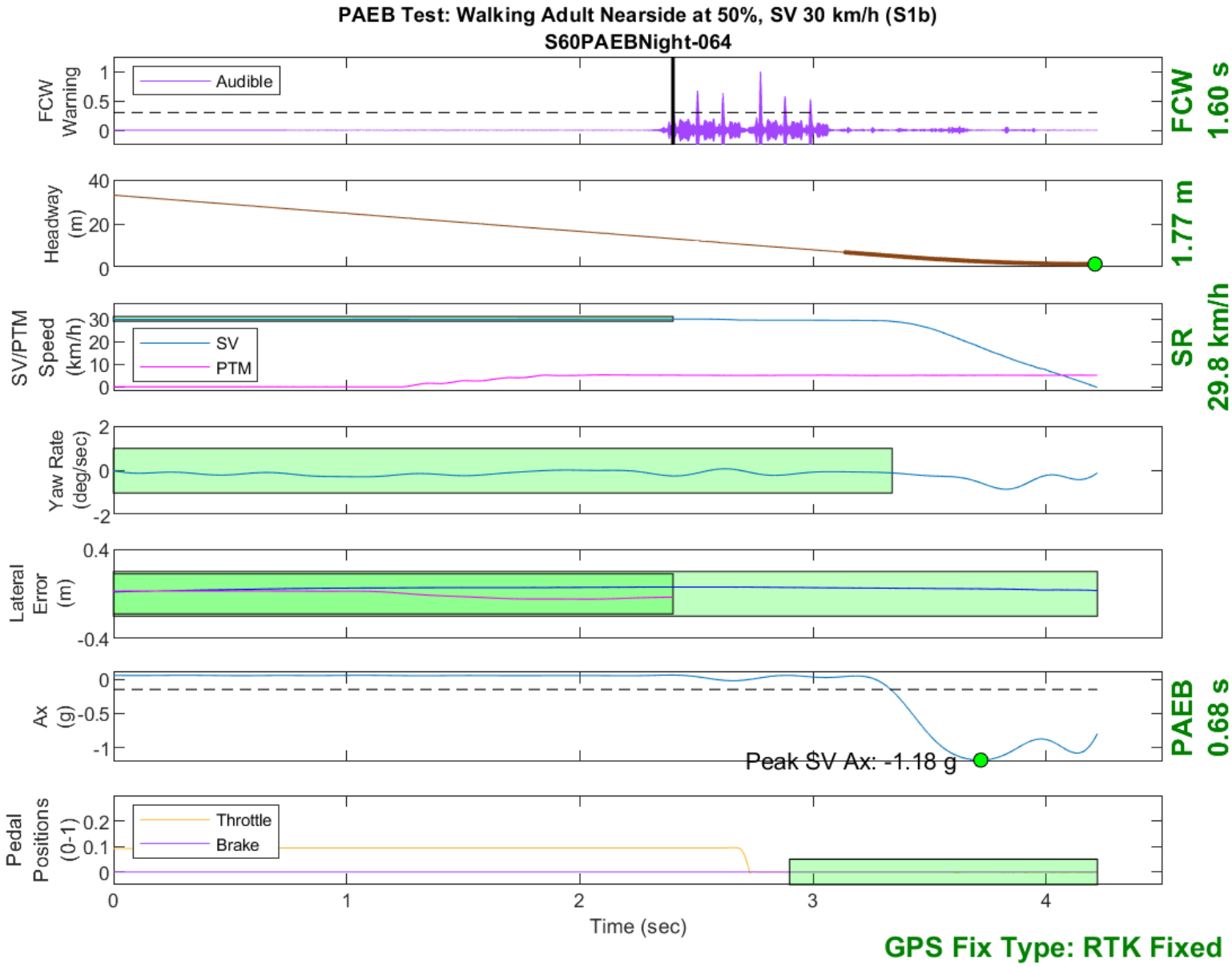


Figure D157. Time History for PAEB Run 64, S1b, Night, High Beam, 30 km/h

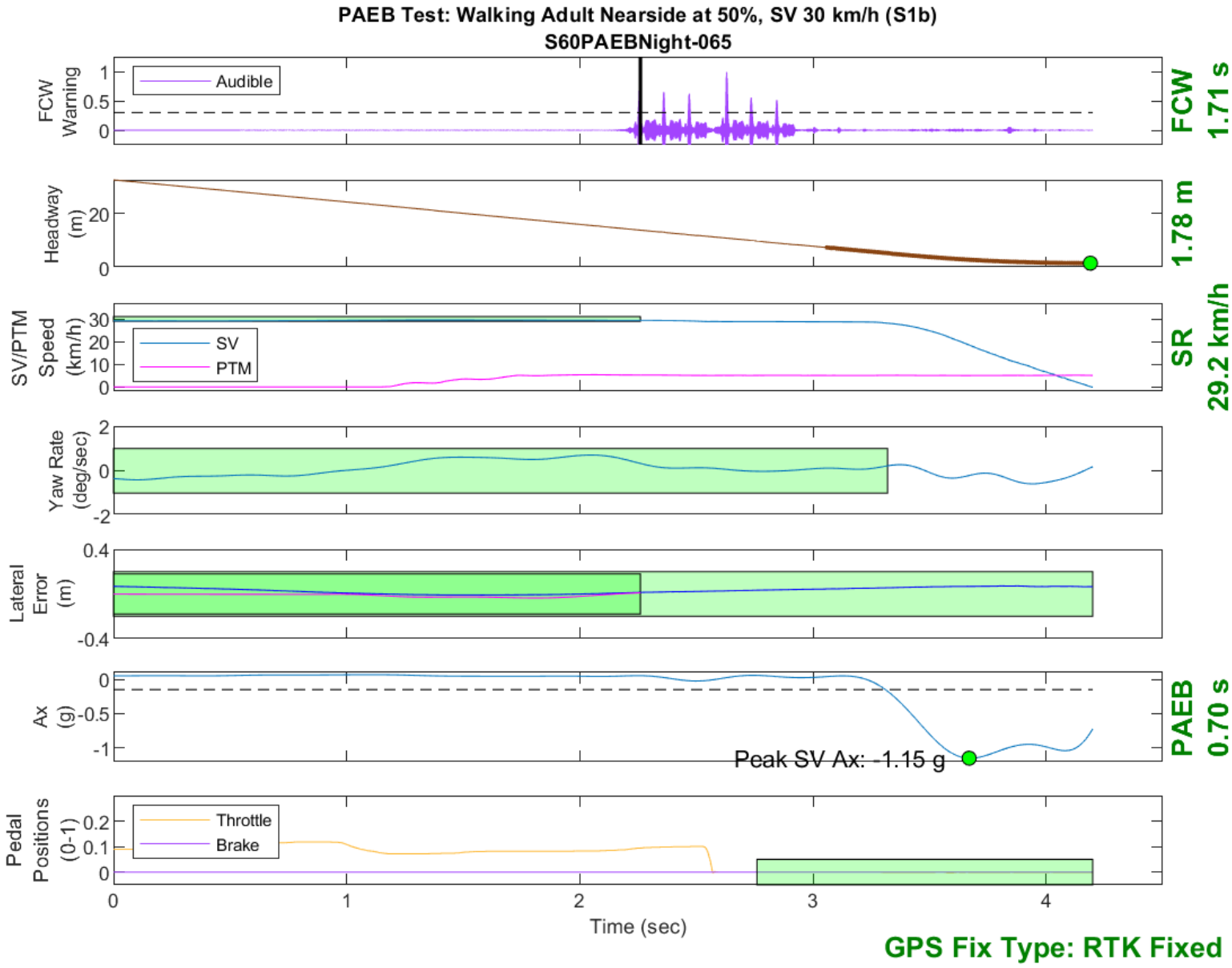


Figure D158. Time History for PAEB Run 65, S1b, Night, High Beam, 30 km/h

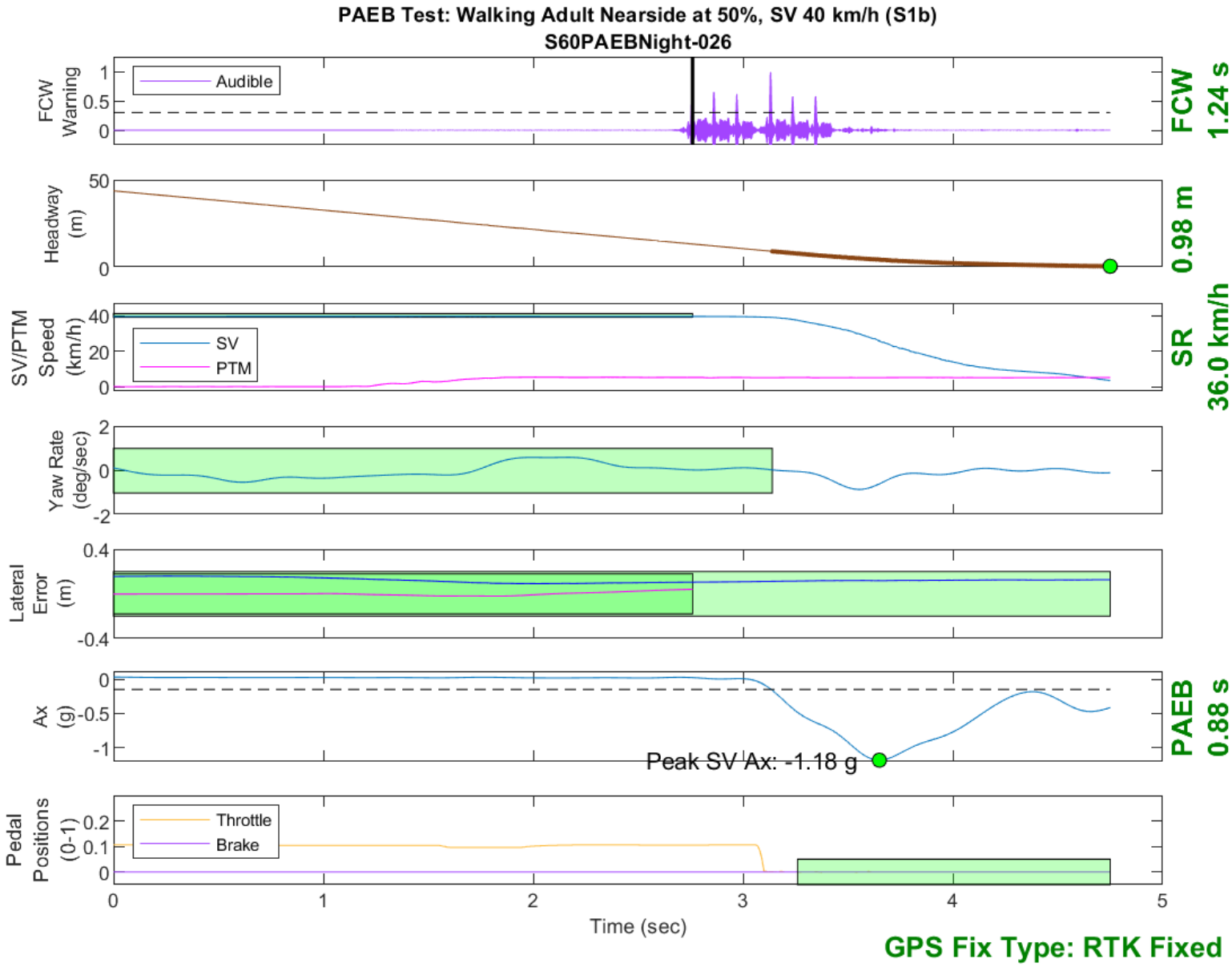


Figure D159. Time History for PAEB Run 26, S1b, Night, High Beam, 40 km/h

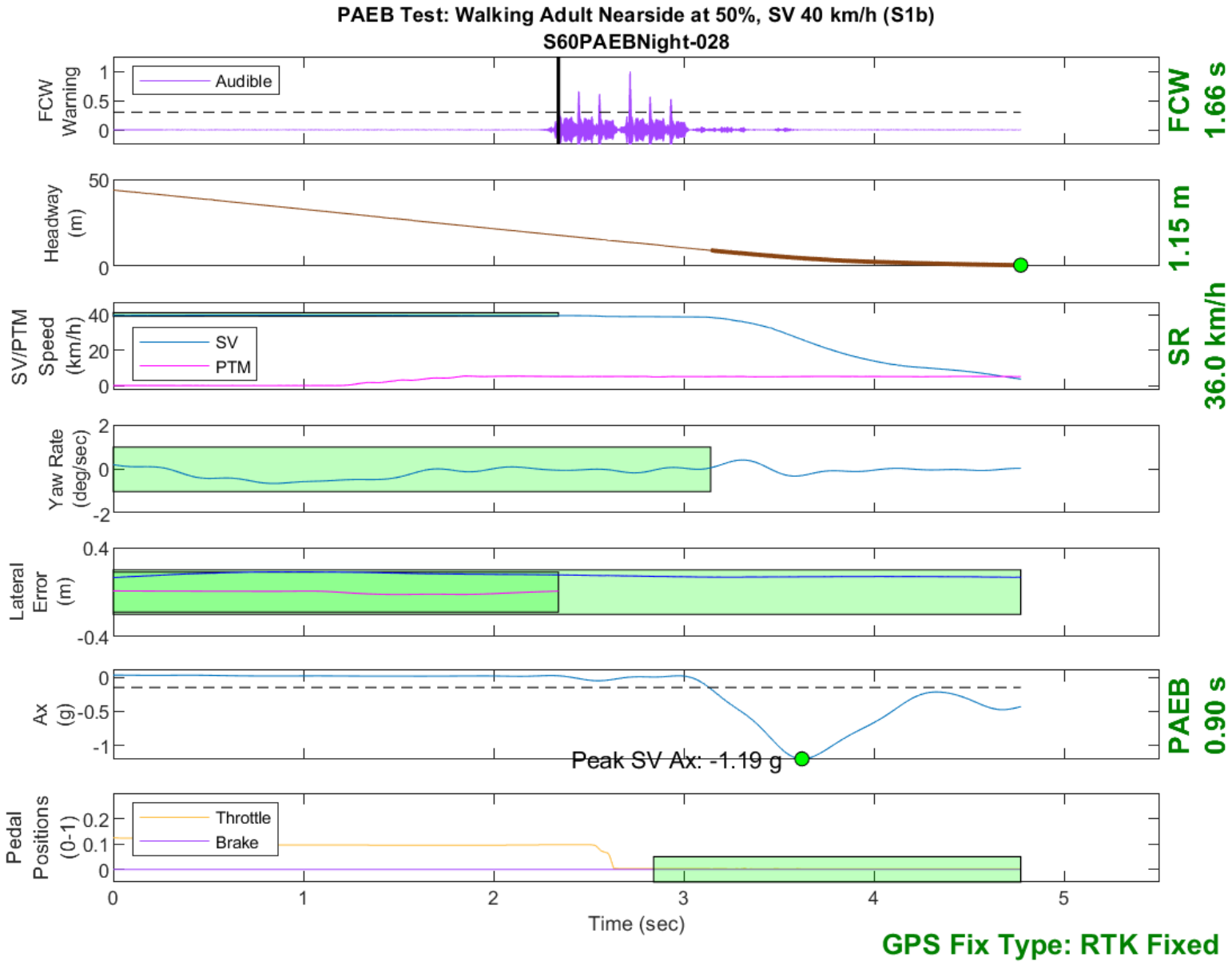


Figure D160. Time History for PAEB Run 28, S1b, Night, High Beam, 40 km/h

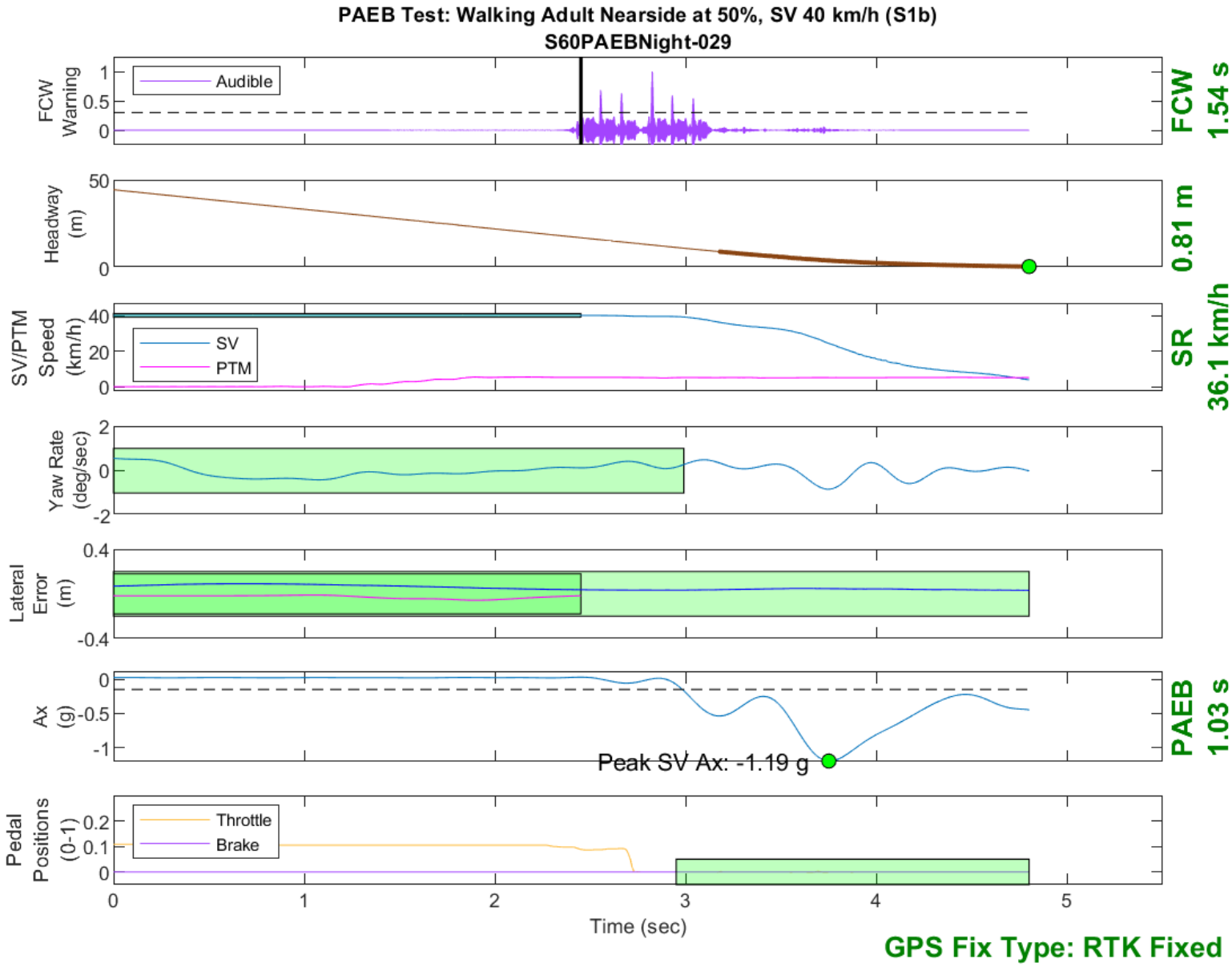


Figure D161. Time History for PAEB Run 29, S1b, Night, High Beam, 40 km/h

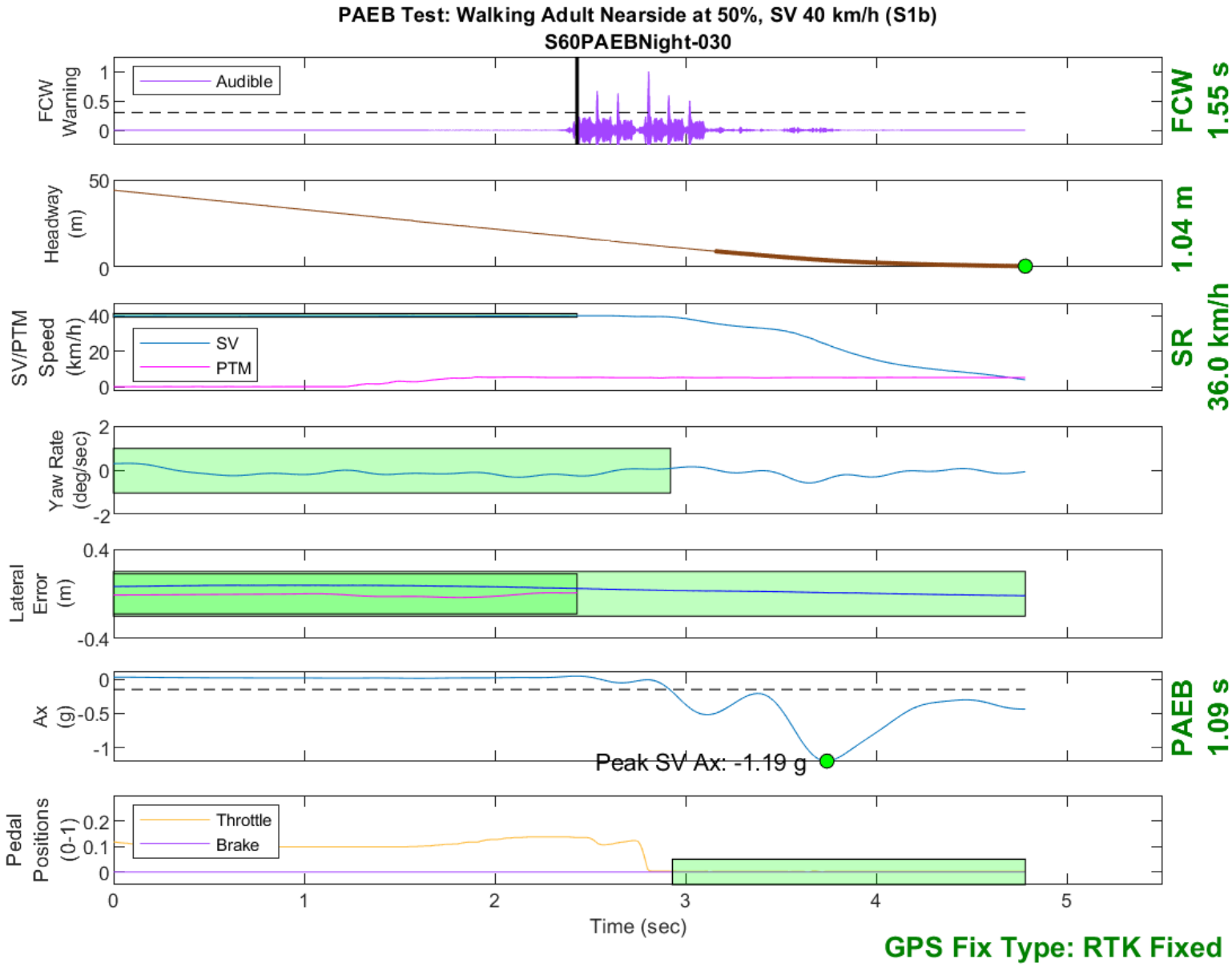


Figure D162. Time History for PAEB Run 30, S1b, Night, High Beam, 40 km/h

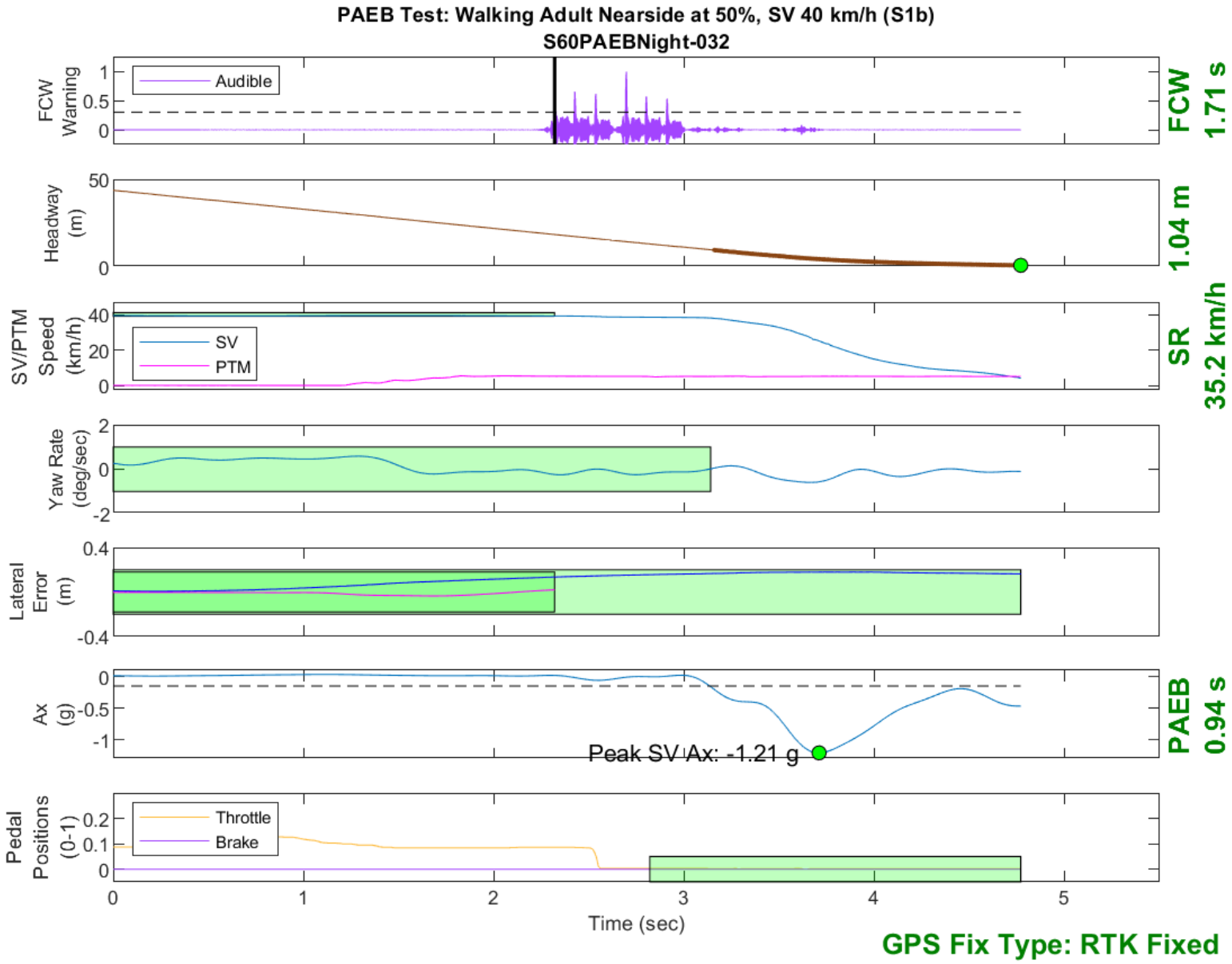


Figure D163. Time History for PAEB Run 32, S1b, Night, High Beam, 40 km/h

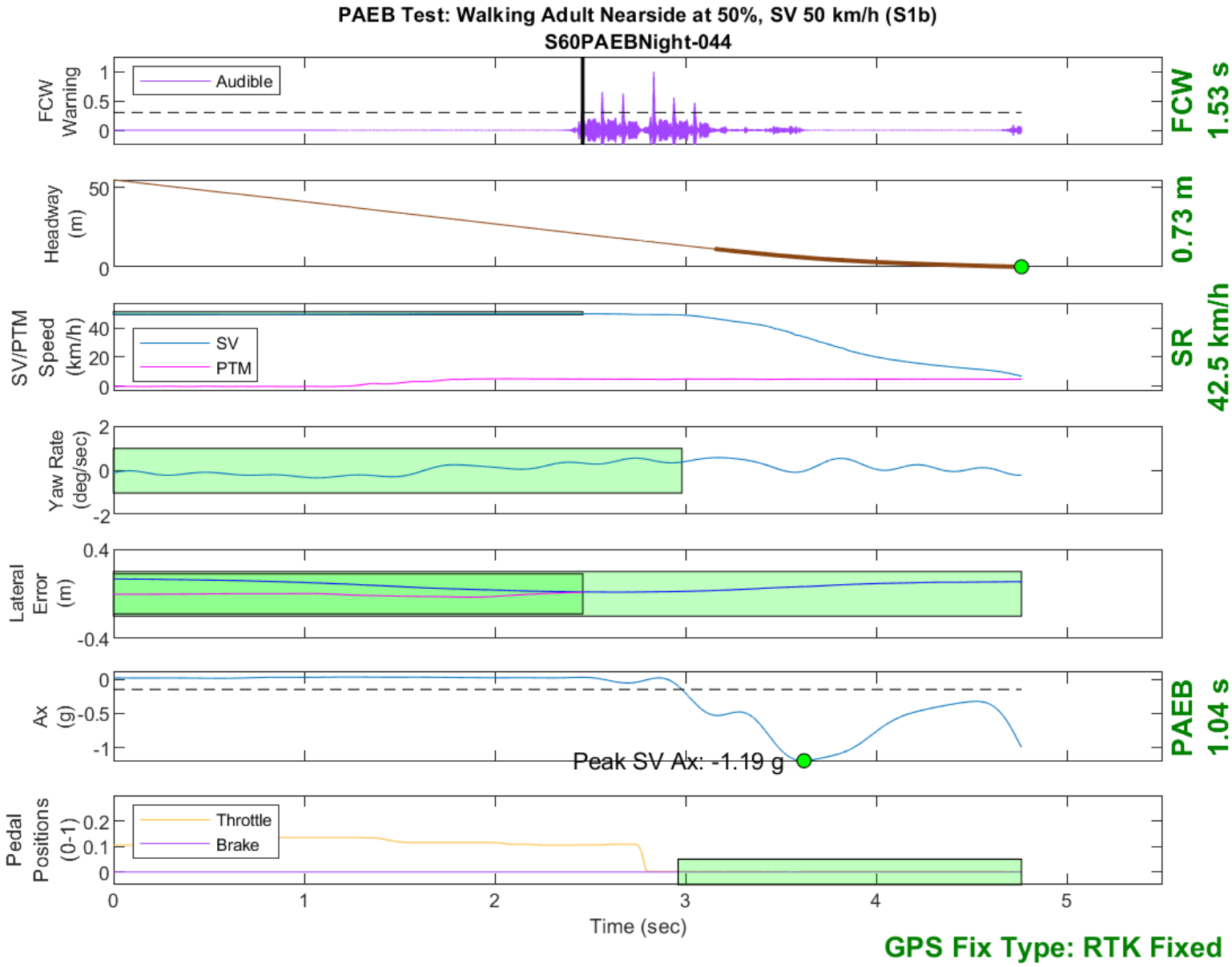


Figure D164. Time History for PAEB Run 44, S1b, Night, High Beam, 50 km/h

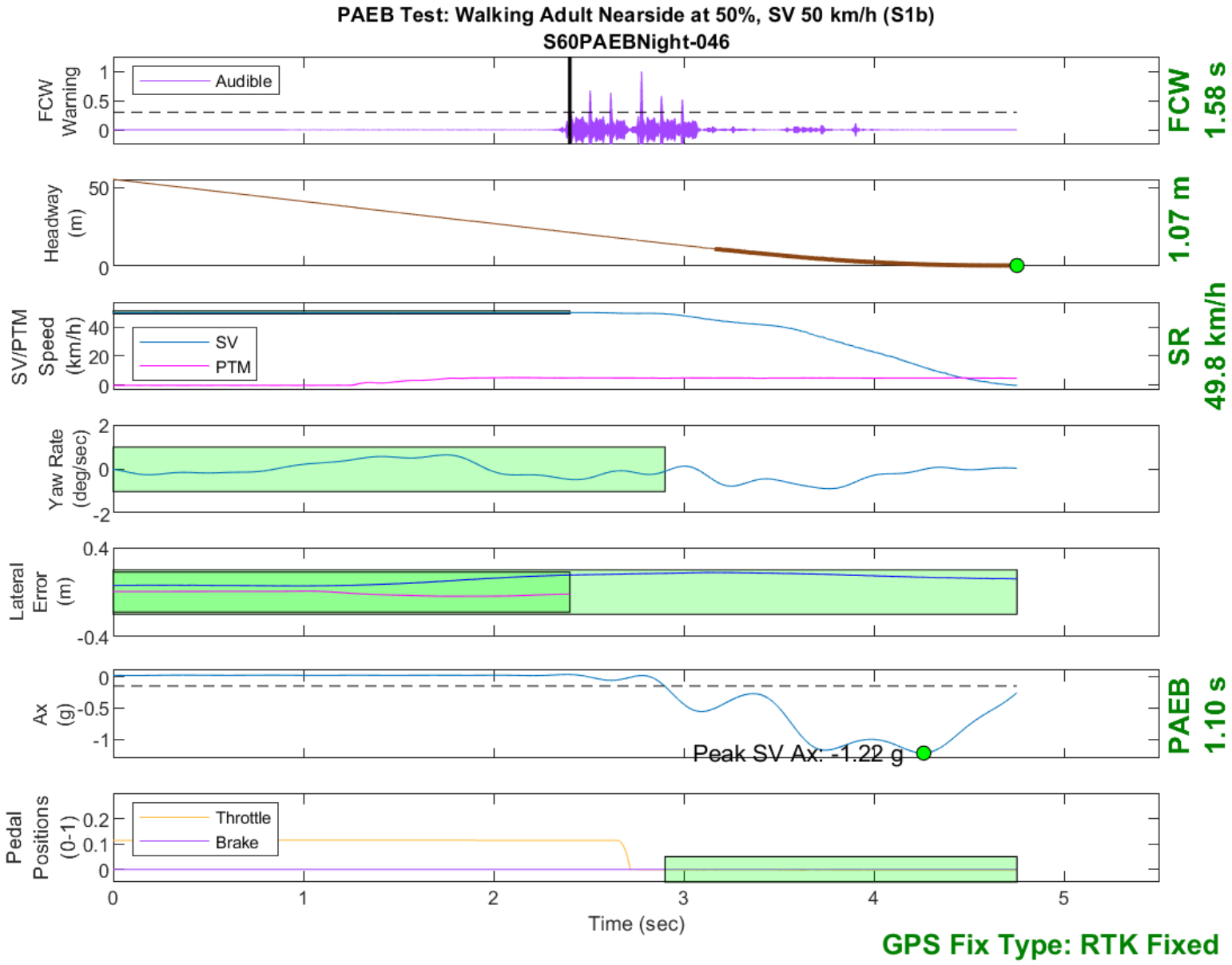


Figure D165. Time History for PAEB Run 46, S1b, Night, High Beam, 50 km/h

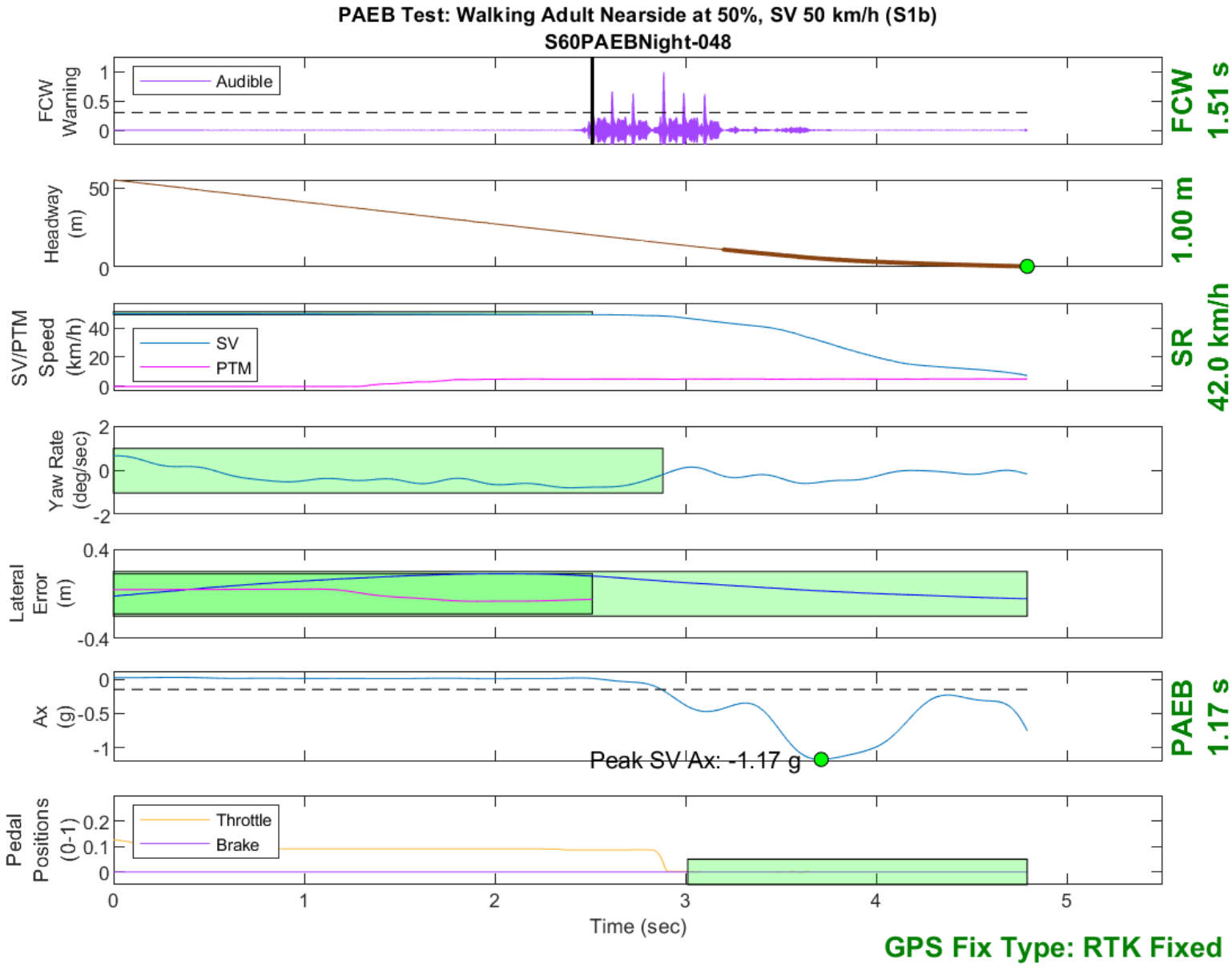


Figure D166. Time History for PAEB Run 48, S1b, Night, High Beam, 50 km/h

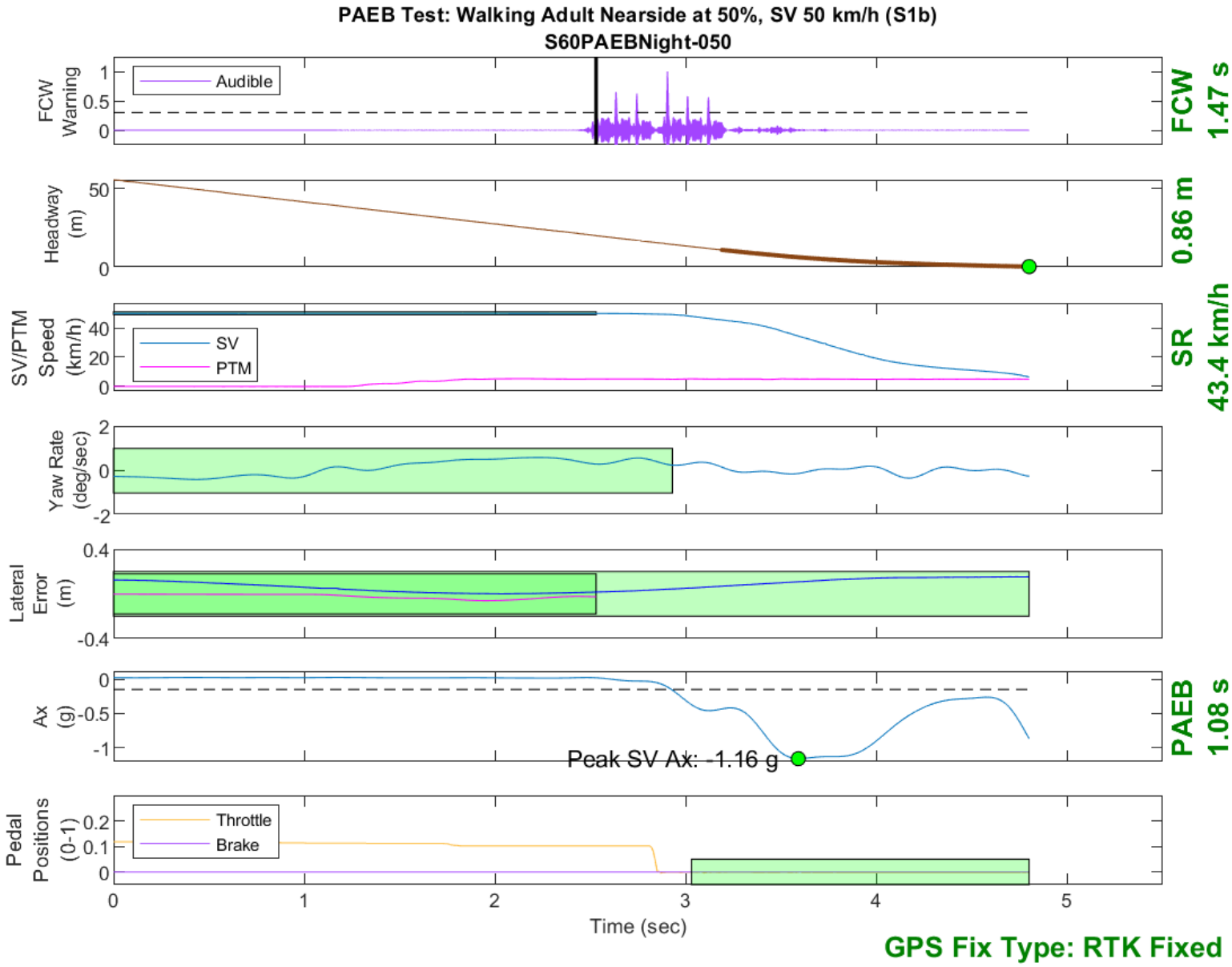


Figure D167. Time History for PAEB Run 50, S1b, Night, High Beam, 50 km/h

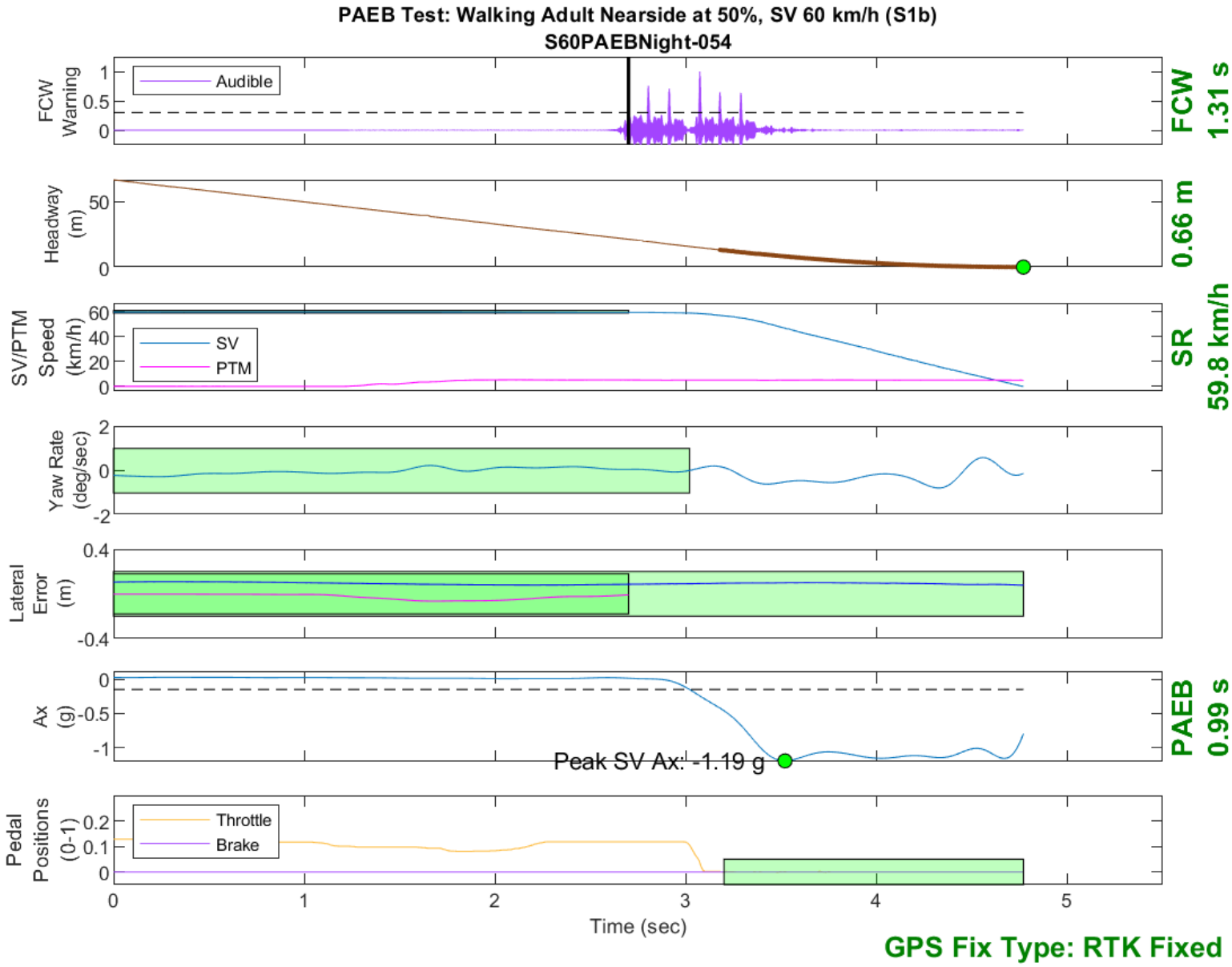


Figure D168. Time History for PAEB Run 54, S1b, Night, High Beam, 60 km/h

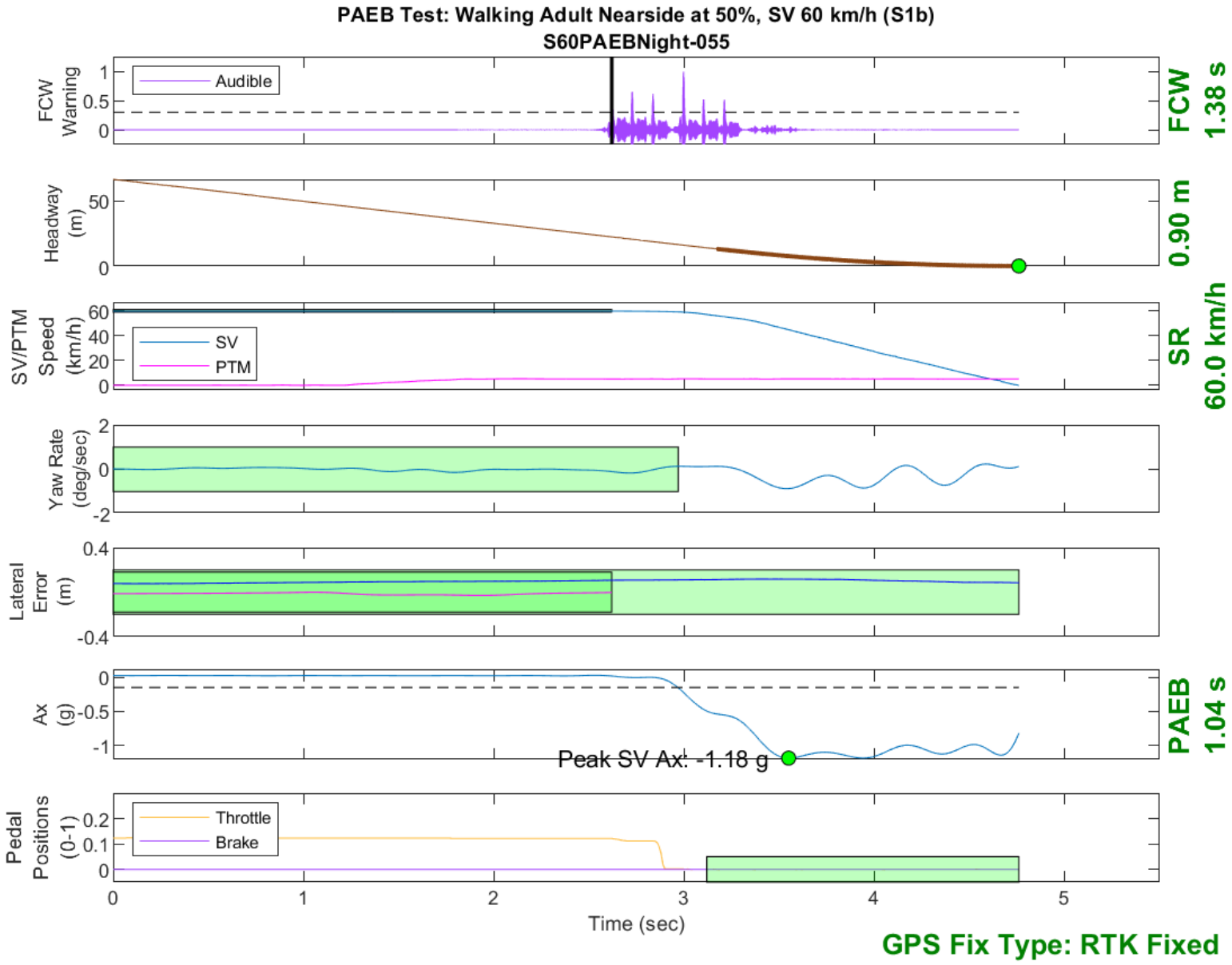


Figure D169. Time History for PAEB Run 55, S1b, Night, High Beam, 60 km/h

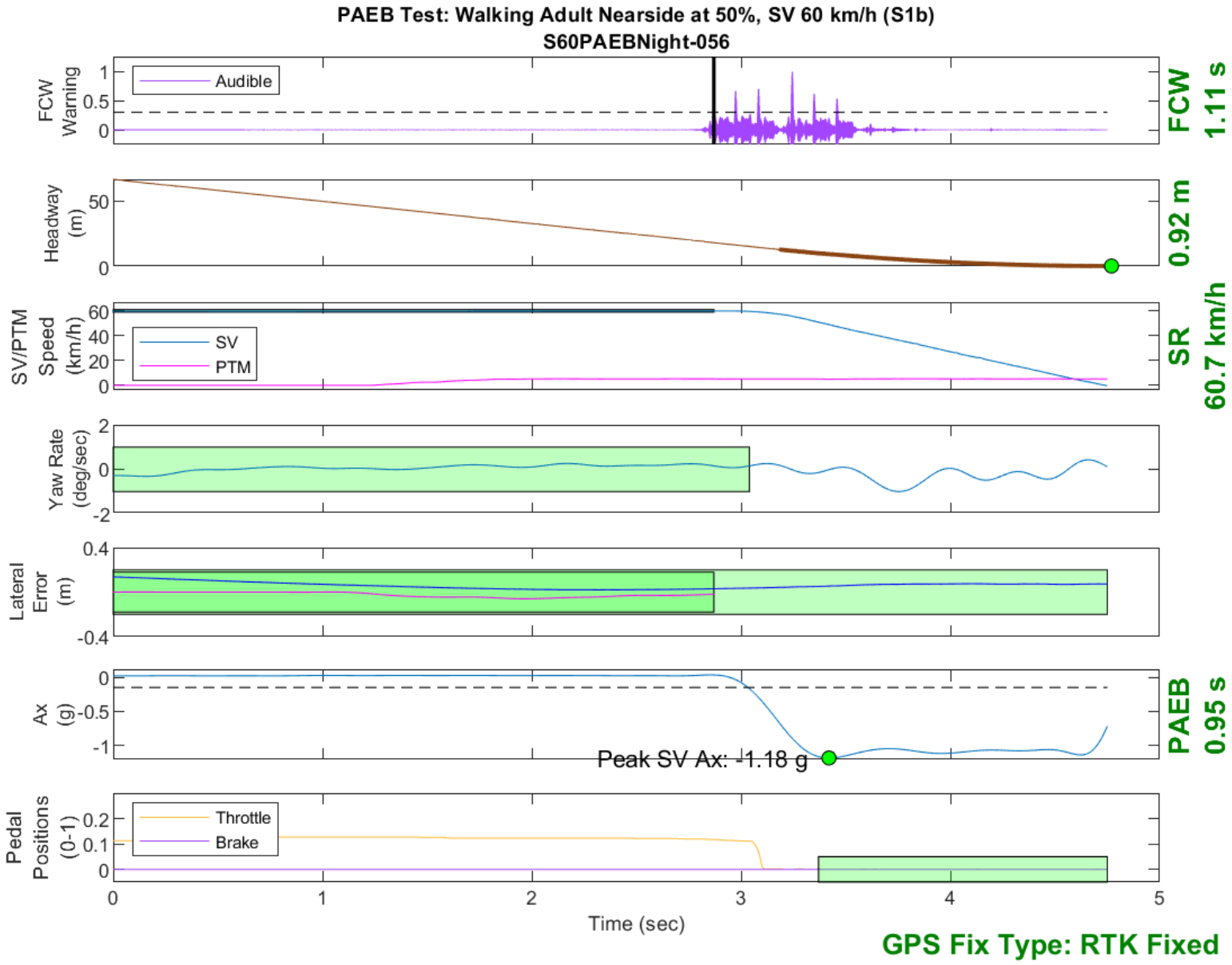


Figure D170. Time History for PAEB Run 56, S1b, Night, High Beam, 60 km/h

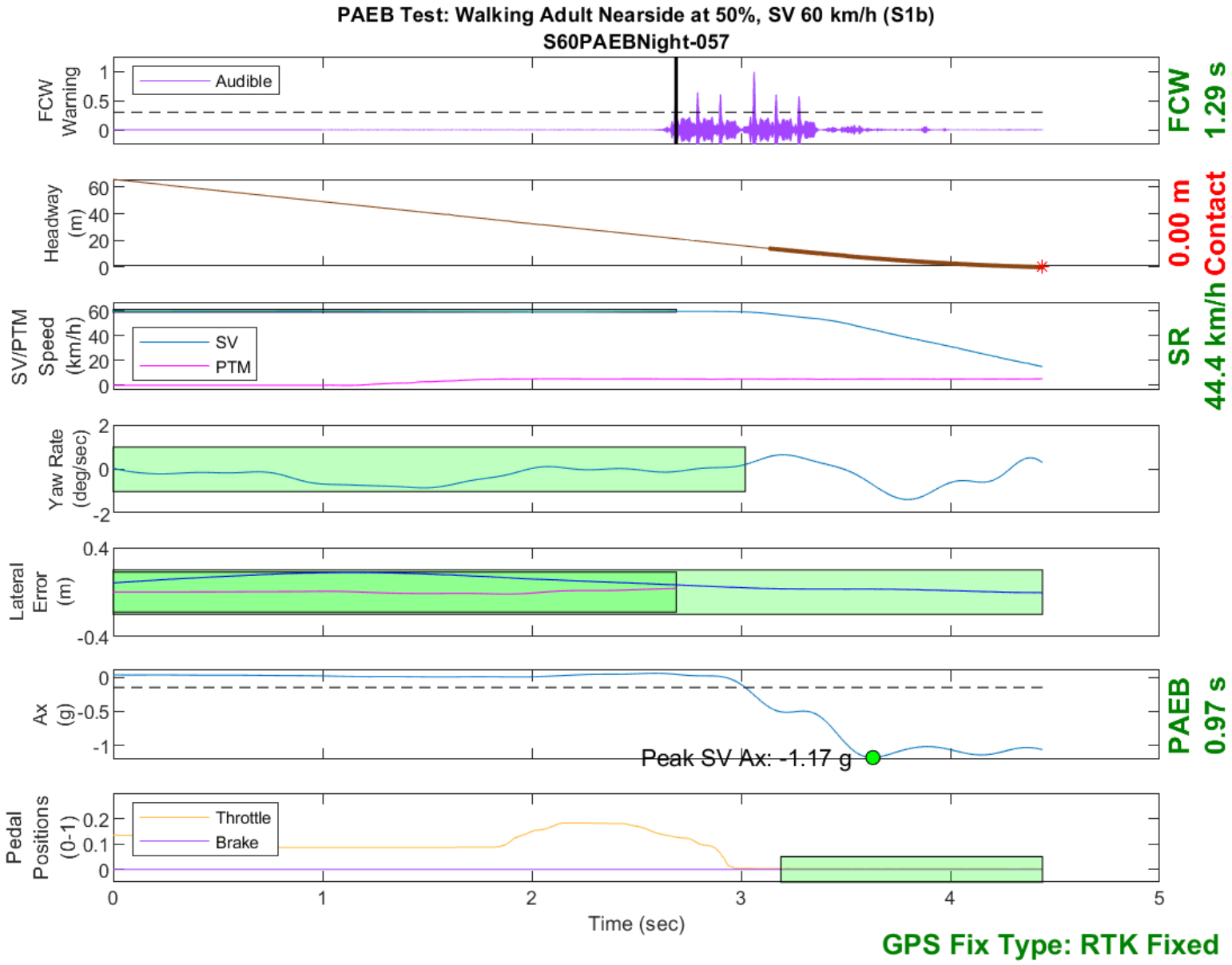


Figure D171. Time History for PAEB Run 57, S1b, Night, High Beam, 60 km/h

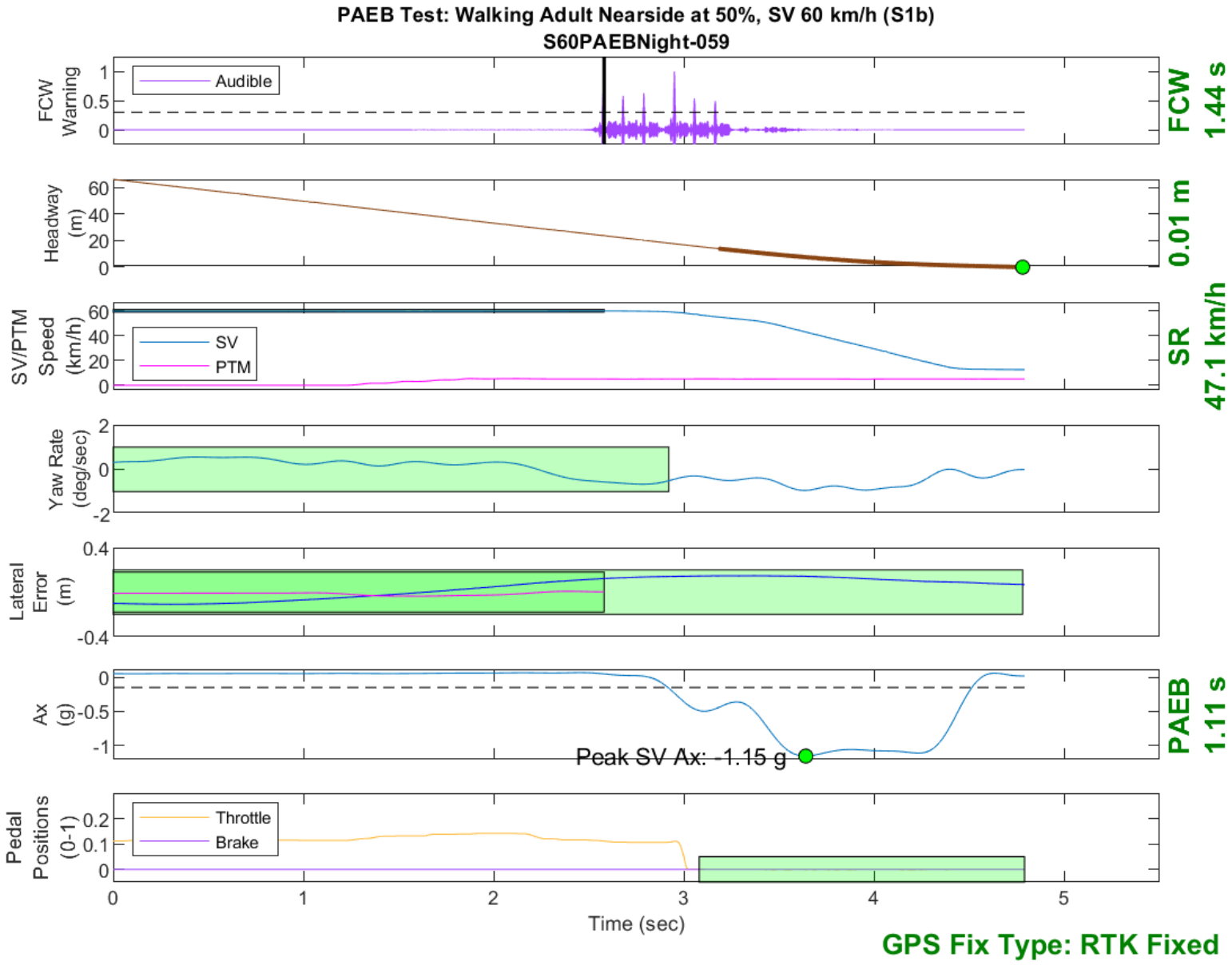


Figure D172. Time History for PAEB Run 59, S1b, Night, High Beam, 60 km/h

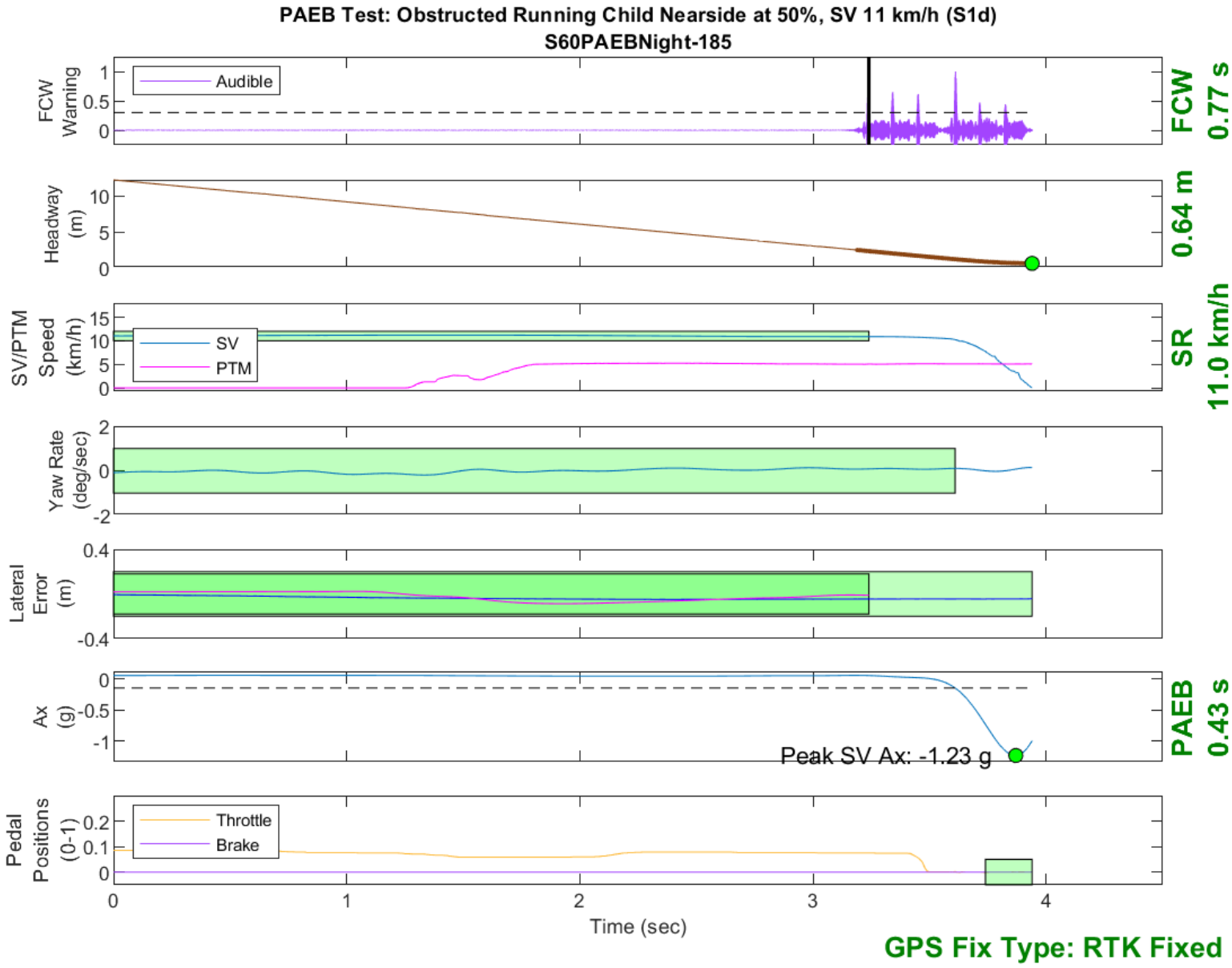


Figure D173. Time History for PAEB Run 185, S1d, Night, High Beam, 11 km/h

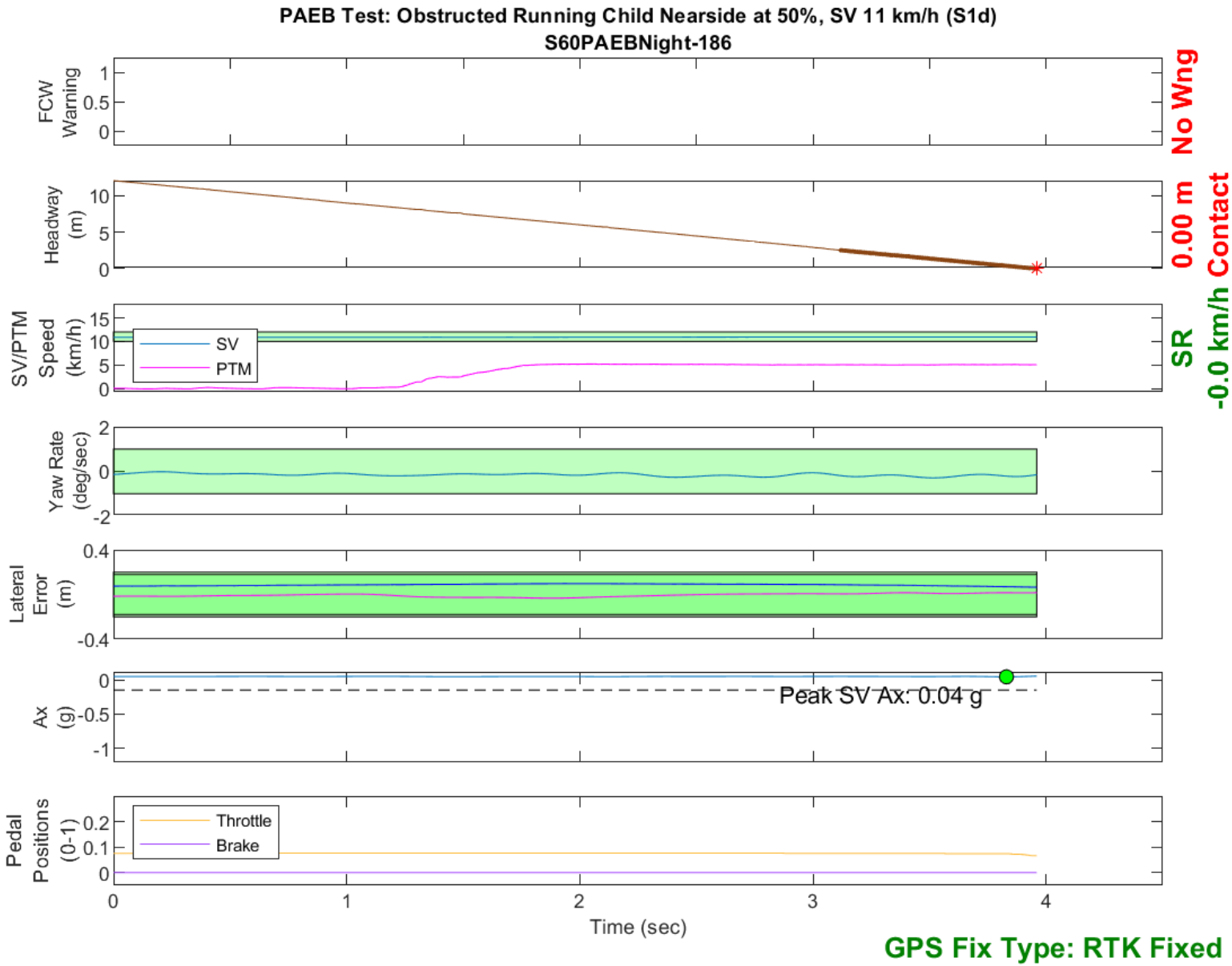


Figure D174. Time History for PAEB Run 186, S1d, Night, High Beam, 11 km/h

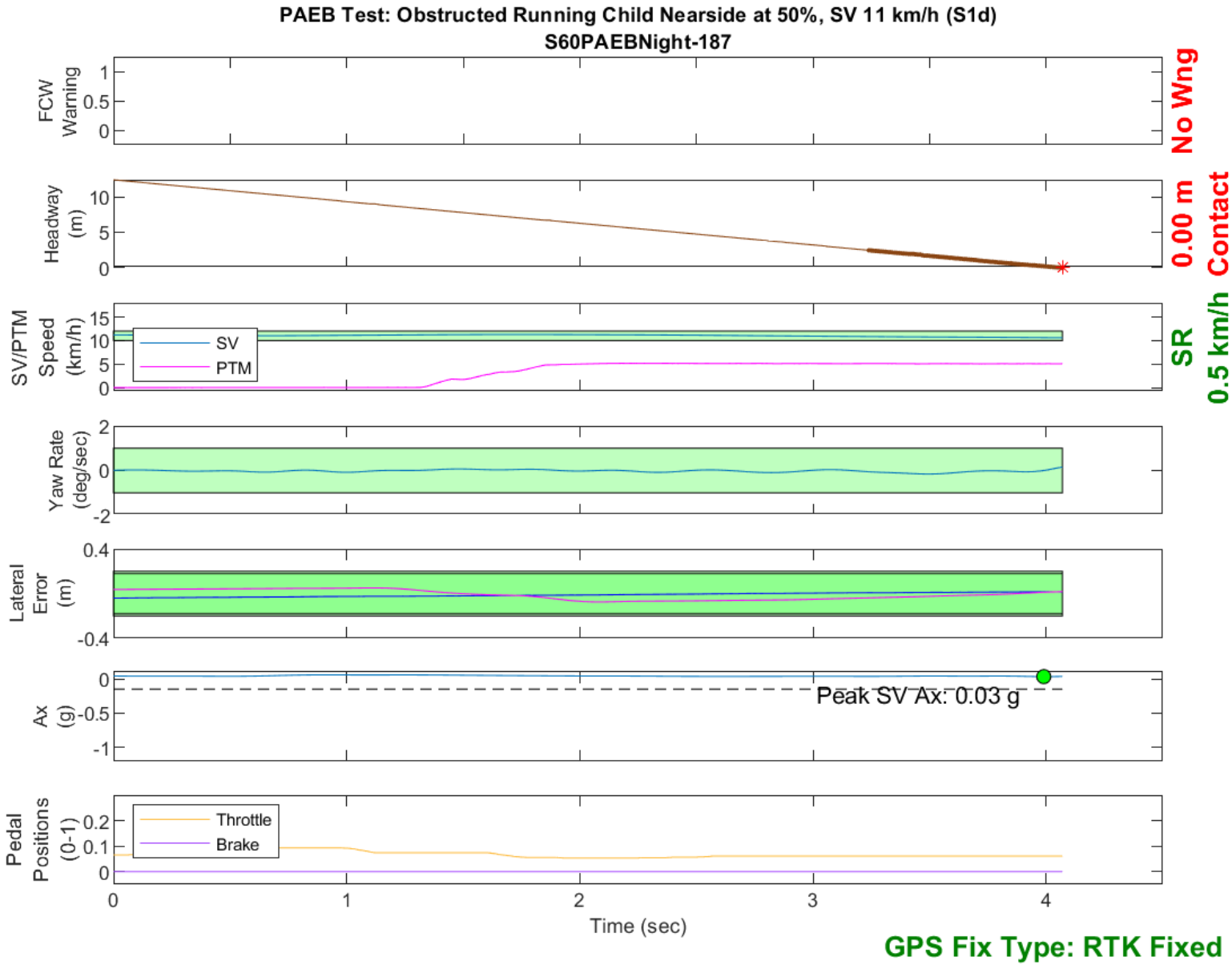


Figure D175. Time History for PAEB Run 187, S1d, Night, High Beam, 11 km/h

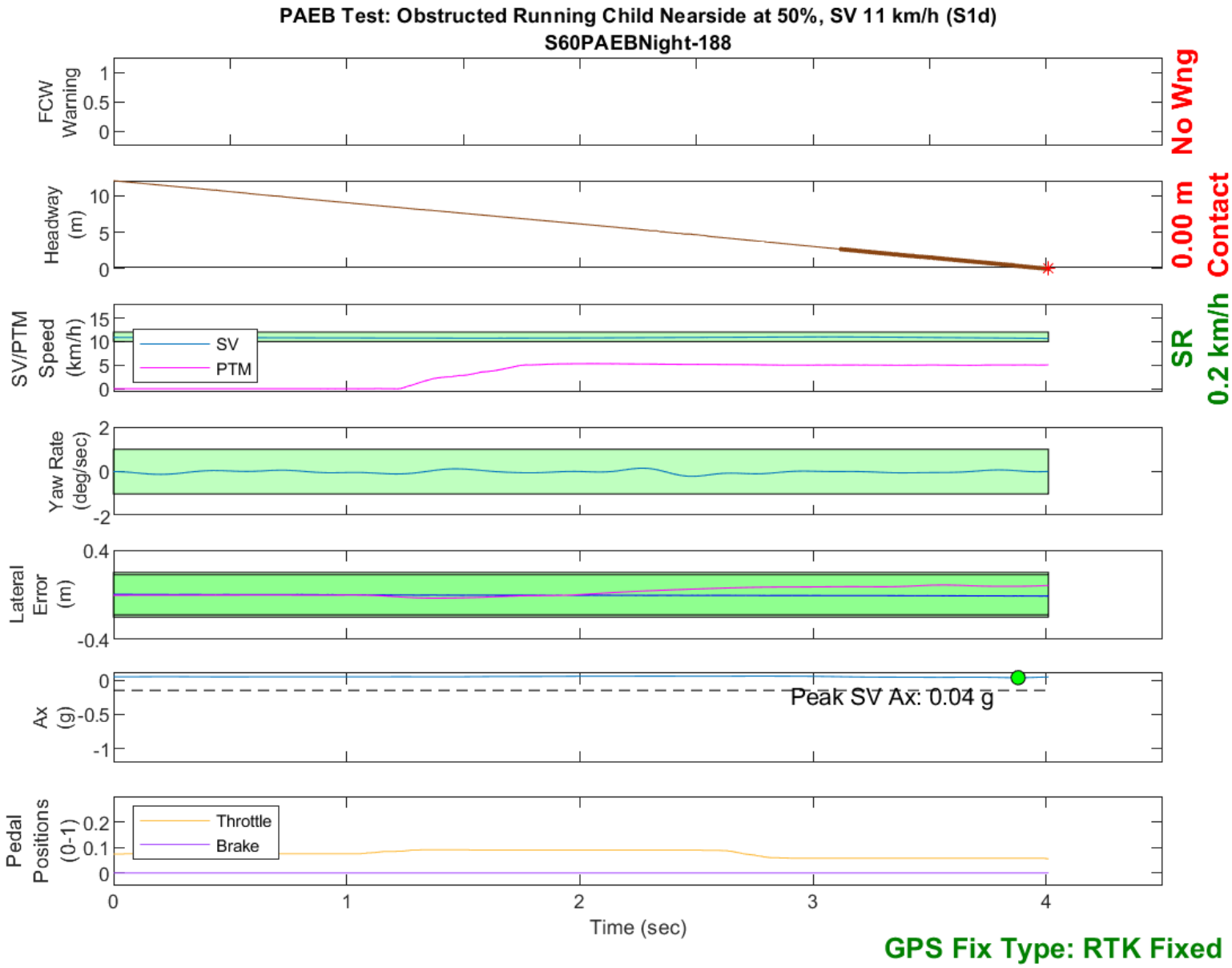


Figure D176. Time History for PAEB Run 188, S1d, Night, High Beam, 11 km/h

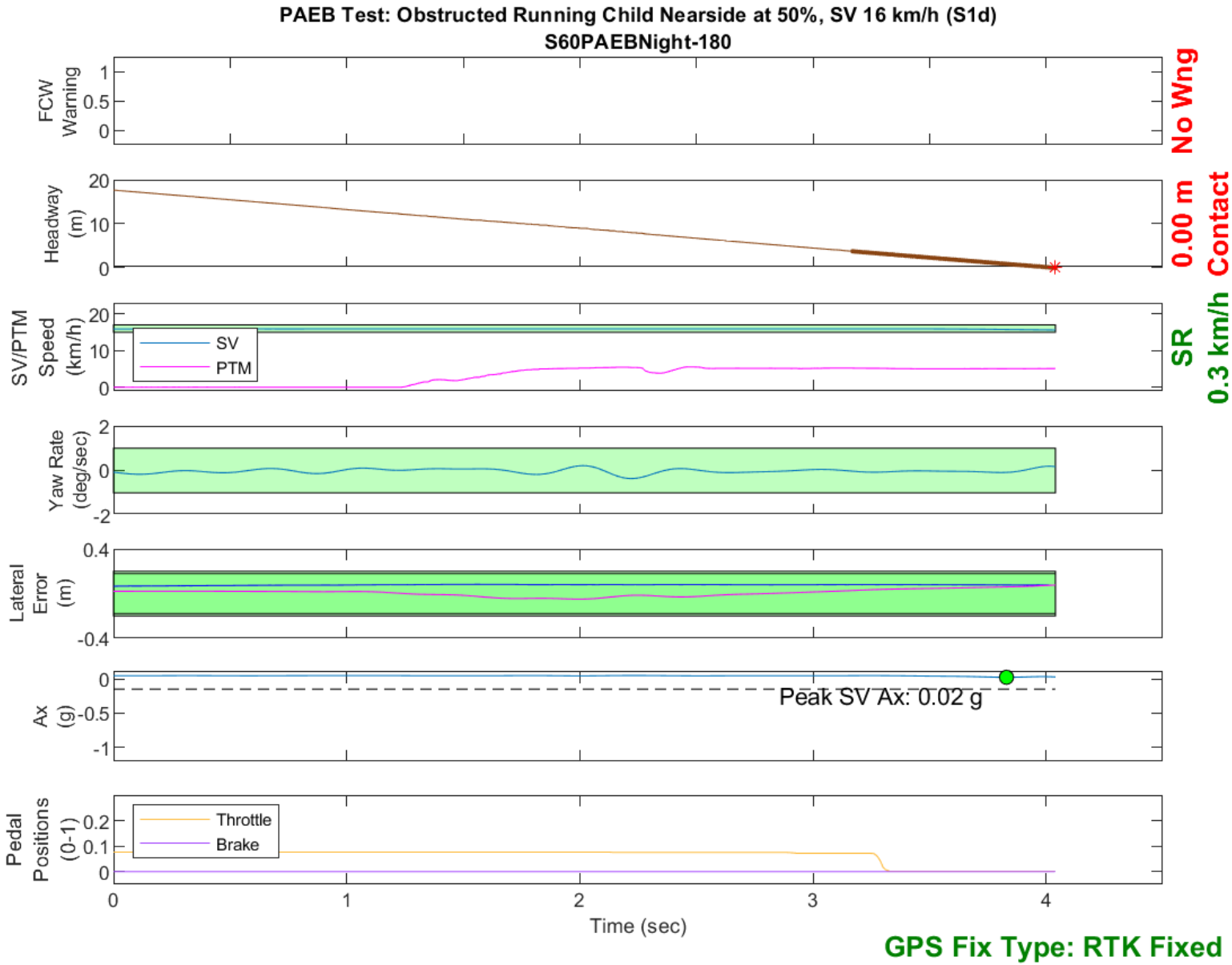


Figure D177. Time History for PAEB Run 180, S1d, Night, High Beam, 16 km/h

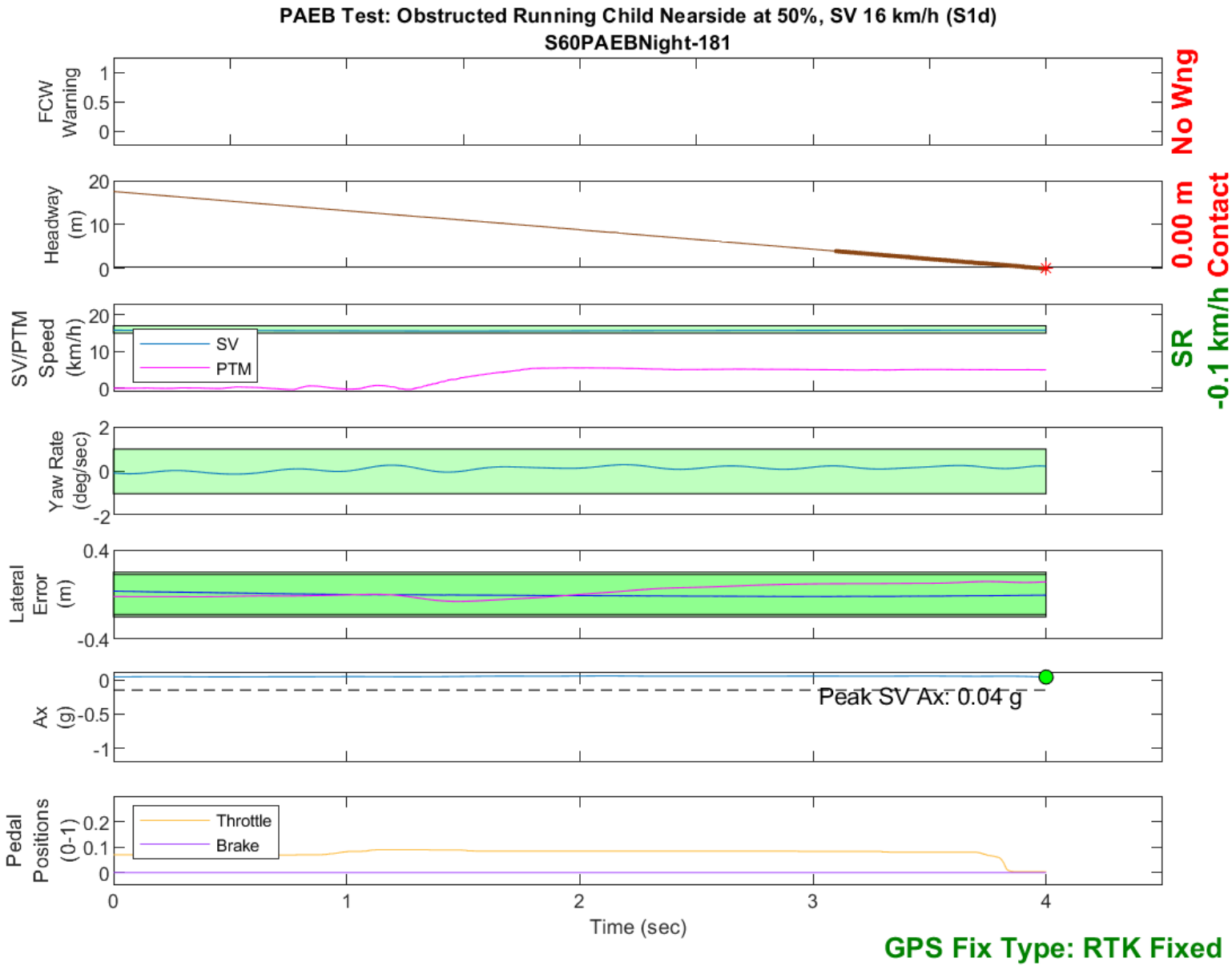


Figure D178. Time History for PAEB Run 181, S1d, Night, High Beam, 16 km/h

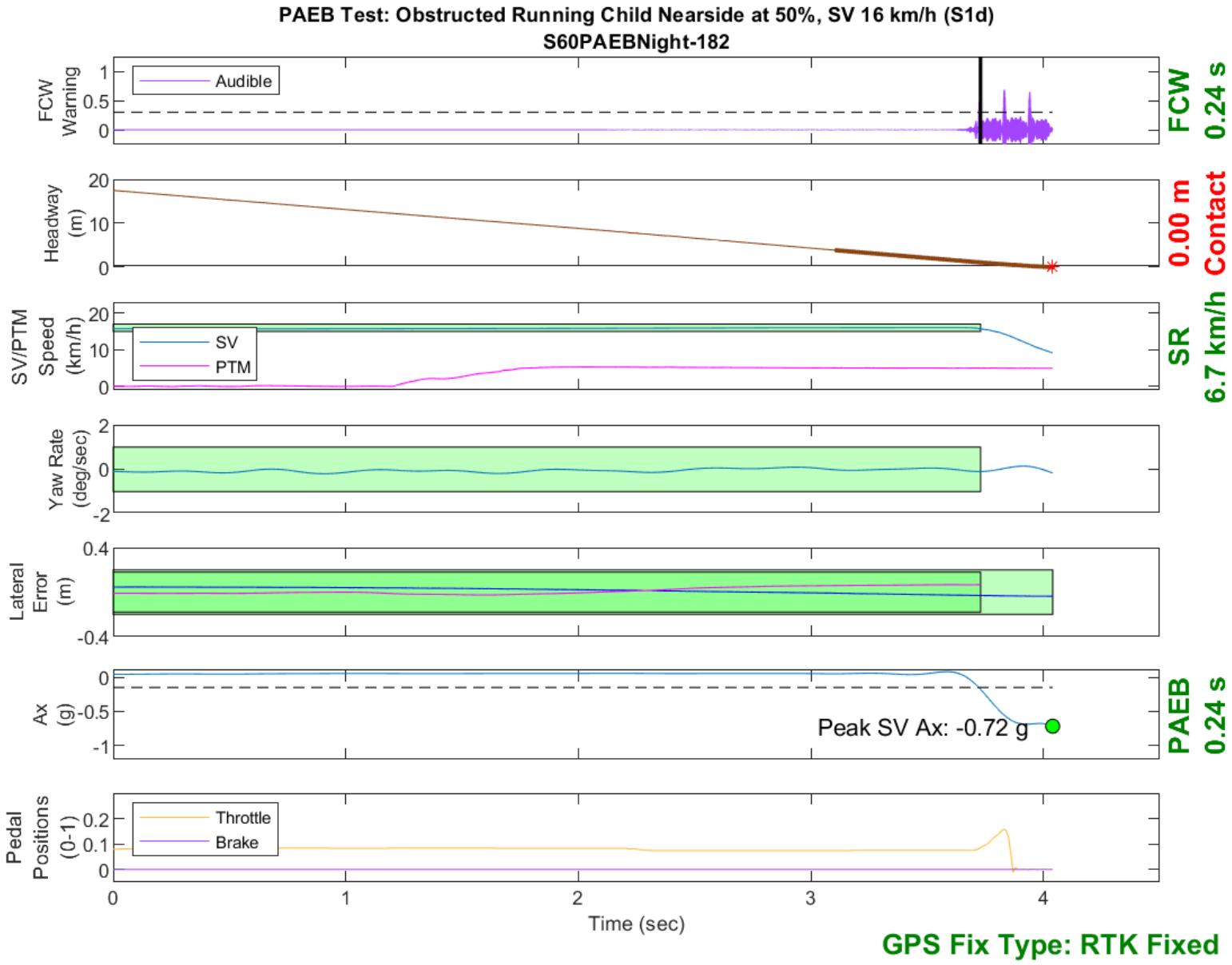


Figure D179. Time History for PAEB Run 182, S1d, Night, High Beam, 16 km/h

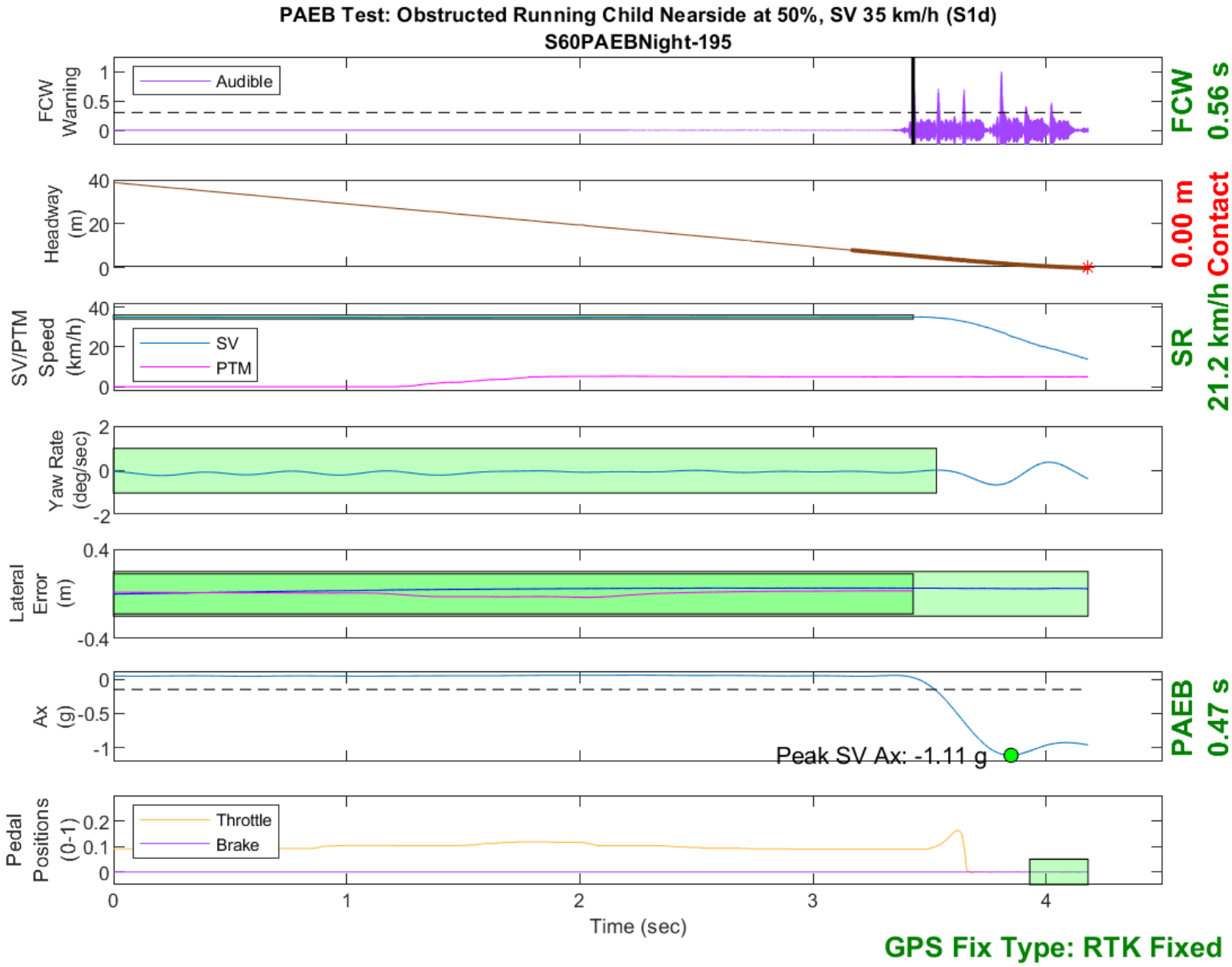


Figure D180. Time History for PAEB Run 195, S1d, Night, High Beam, 35 km/h

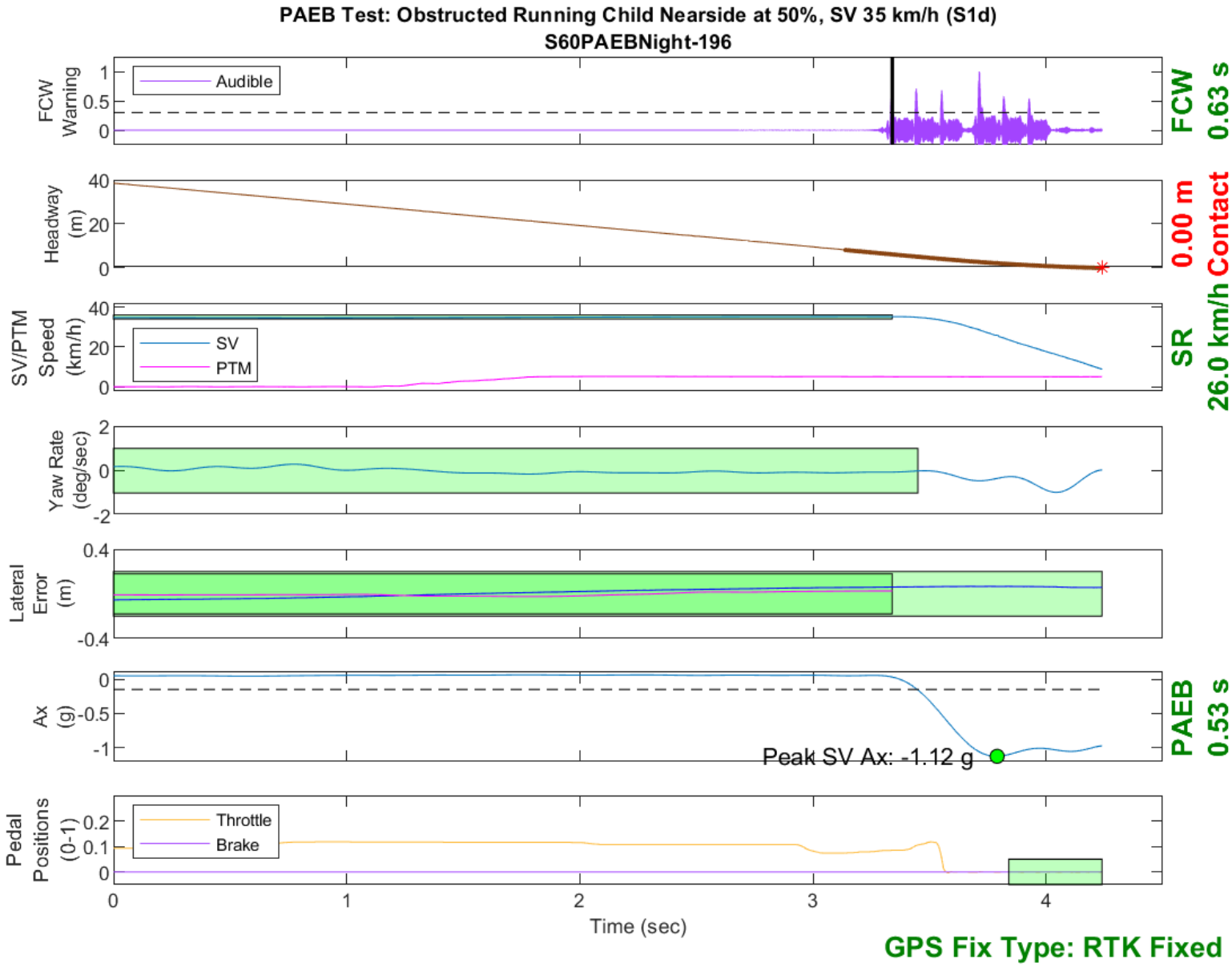


Figure D181. Time History for PAEB Run 196, S1d, Night, High Beam, 35 km/h

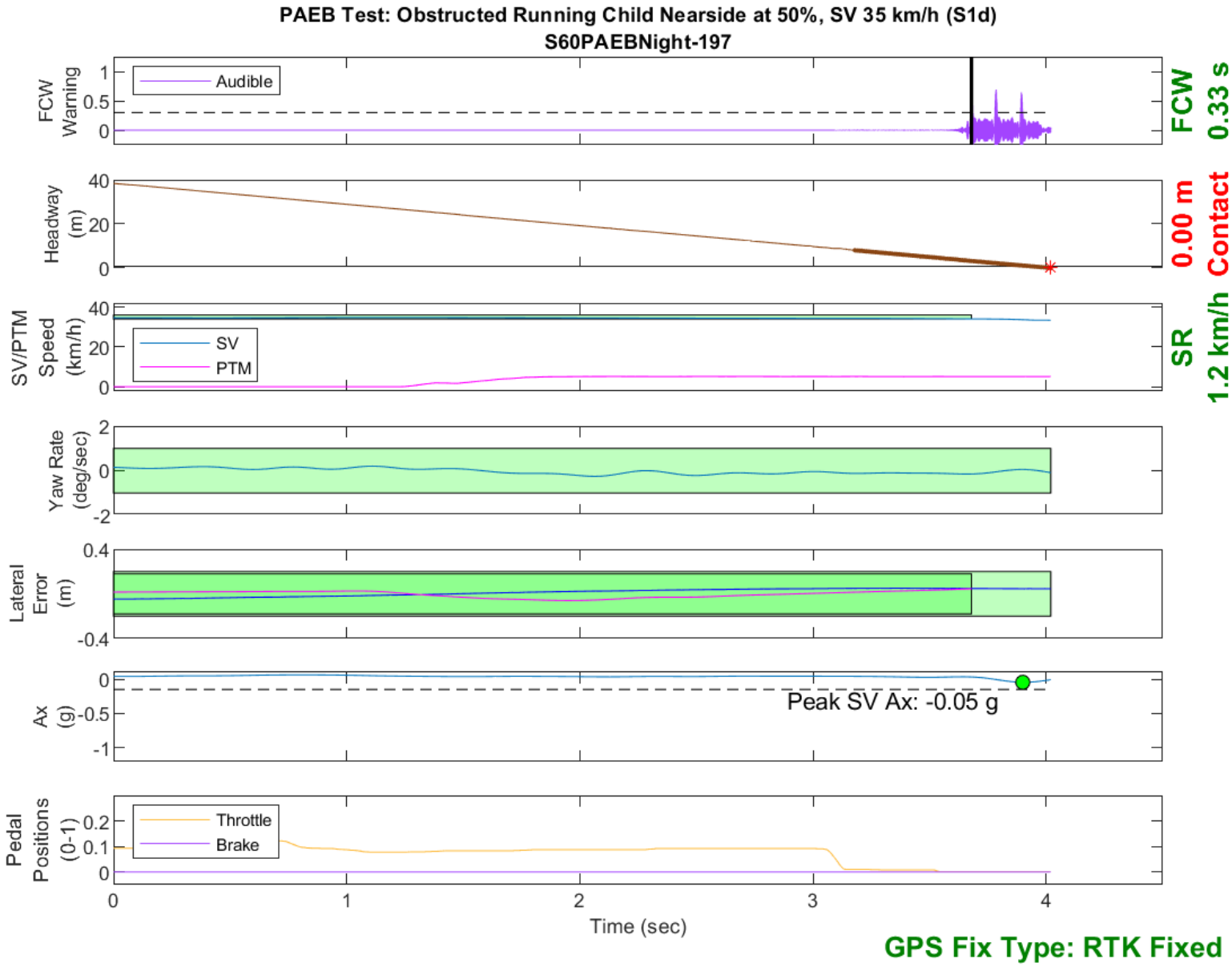


Figure D182. Time History for PAEB Run 197, S1d, Night, High Beam, 35 km/h

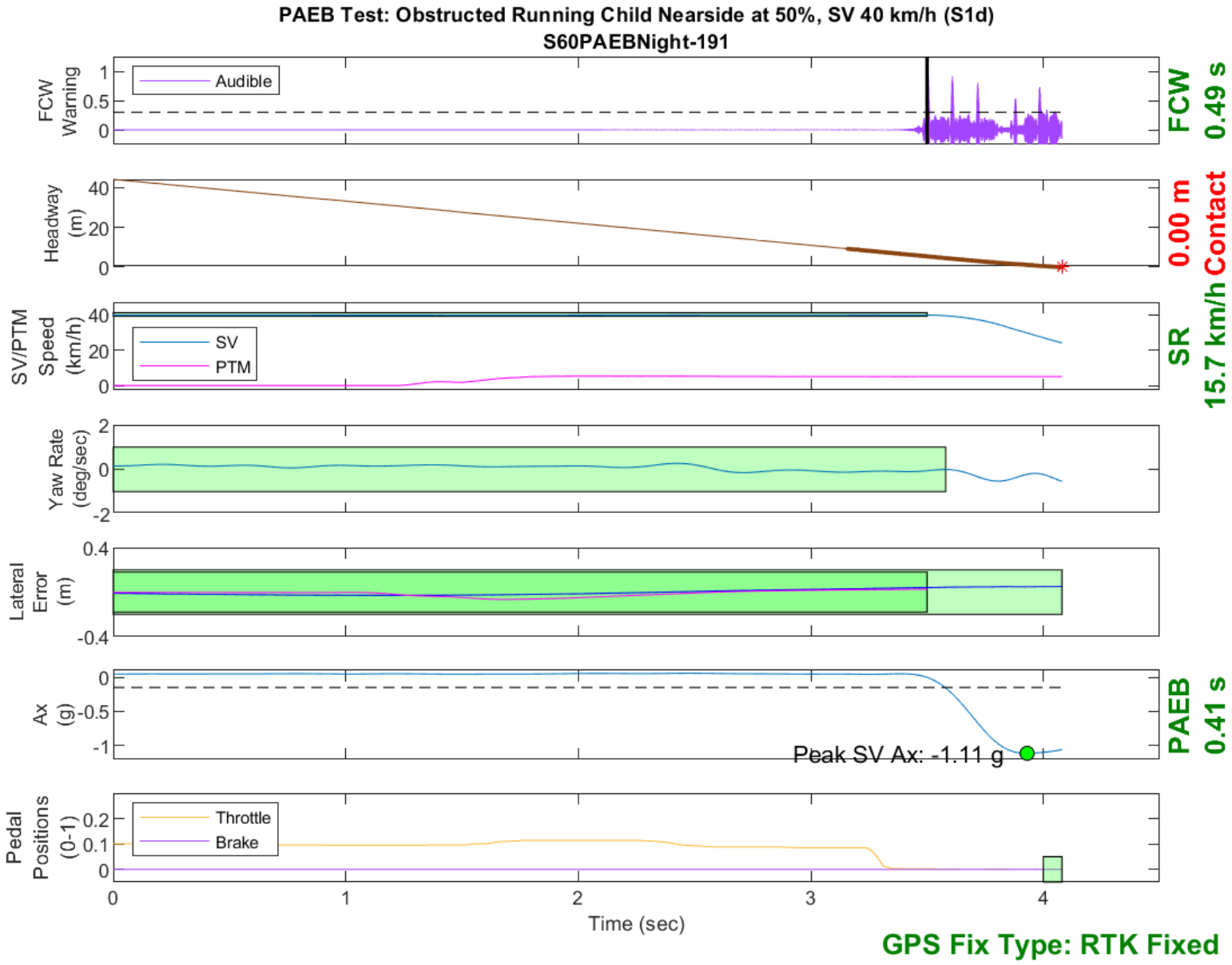


Figure D183. Time History for PAEB Run 191, S1d, Night, High Beam, 40 km/h

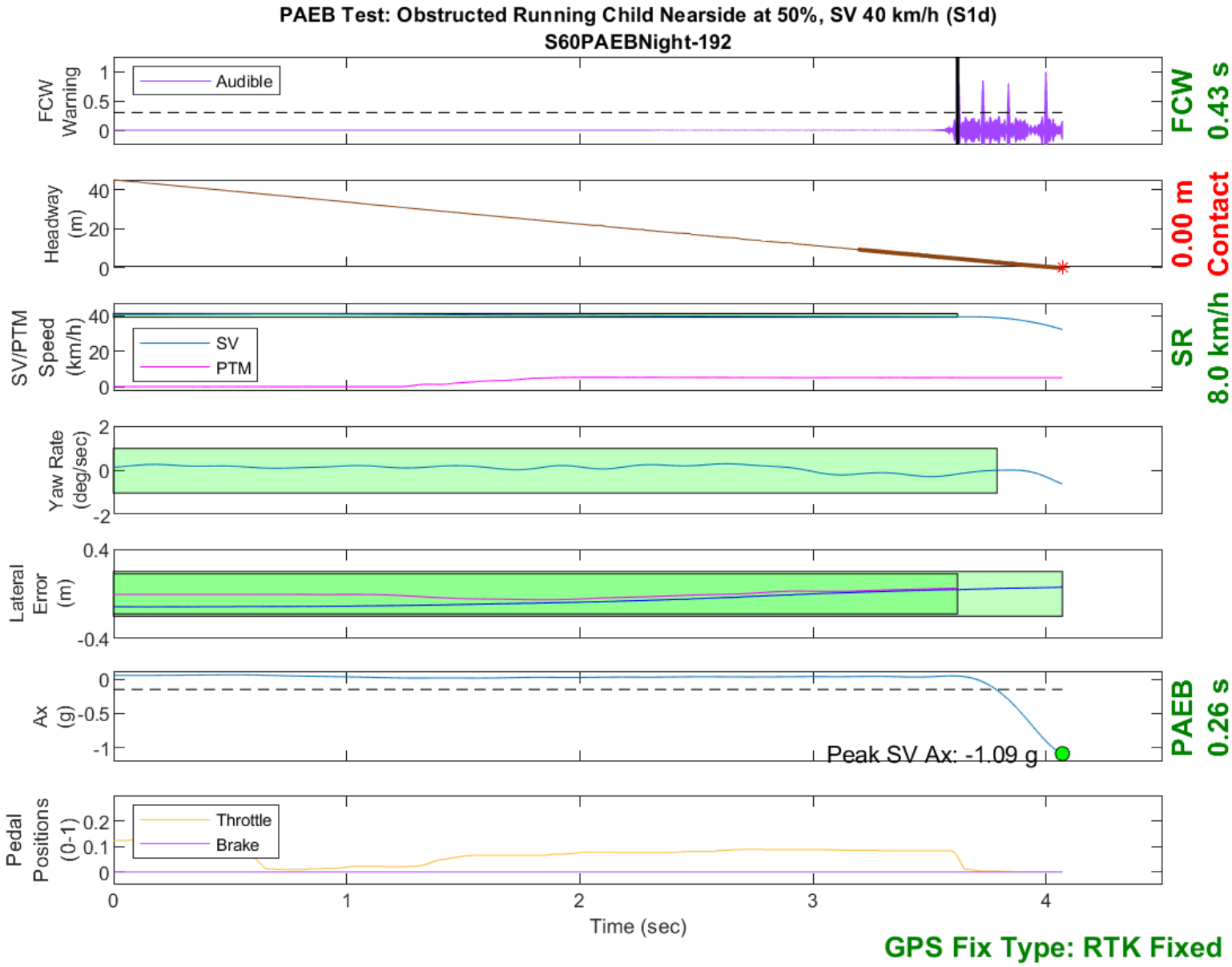


Figure D184. Time History for PAEB Run 192, S1d, Night, High Beam, 40 km/h

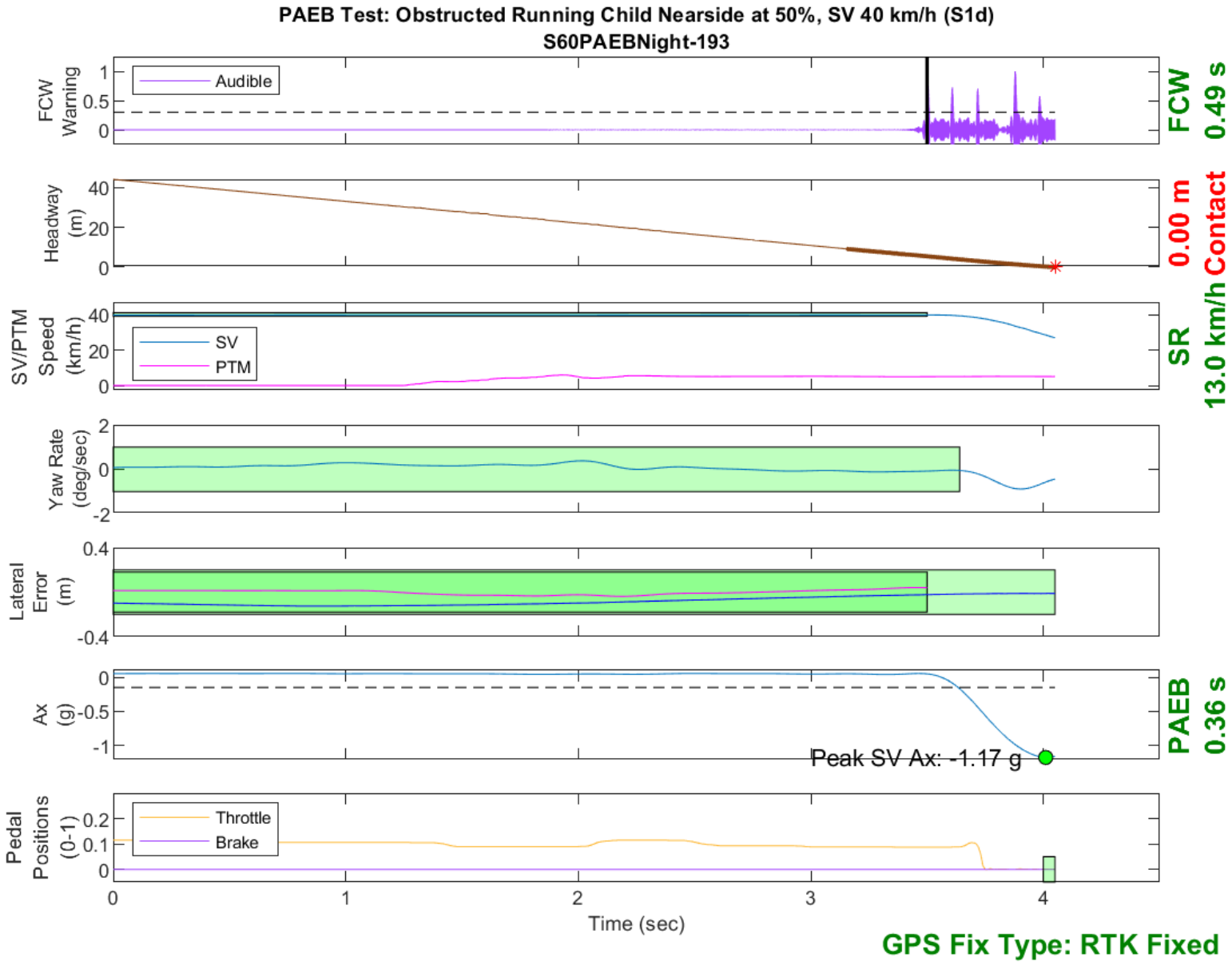


Figure D185. Time History for PAEB Run 193, S1d, Night, High Beam, 40 km/h

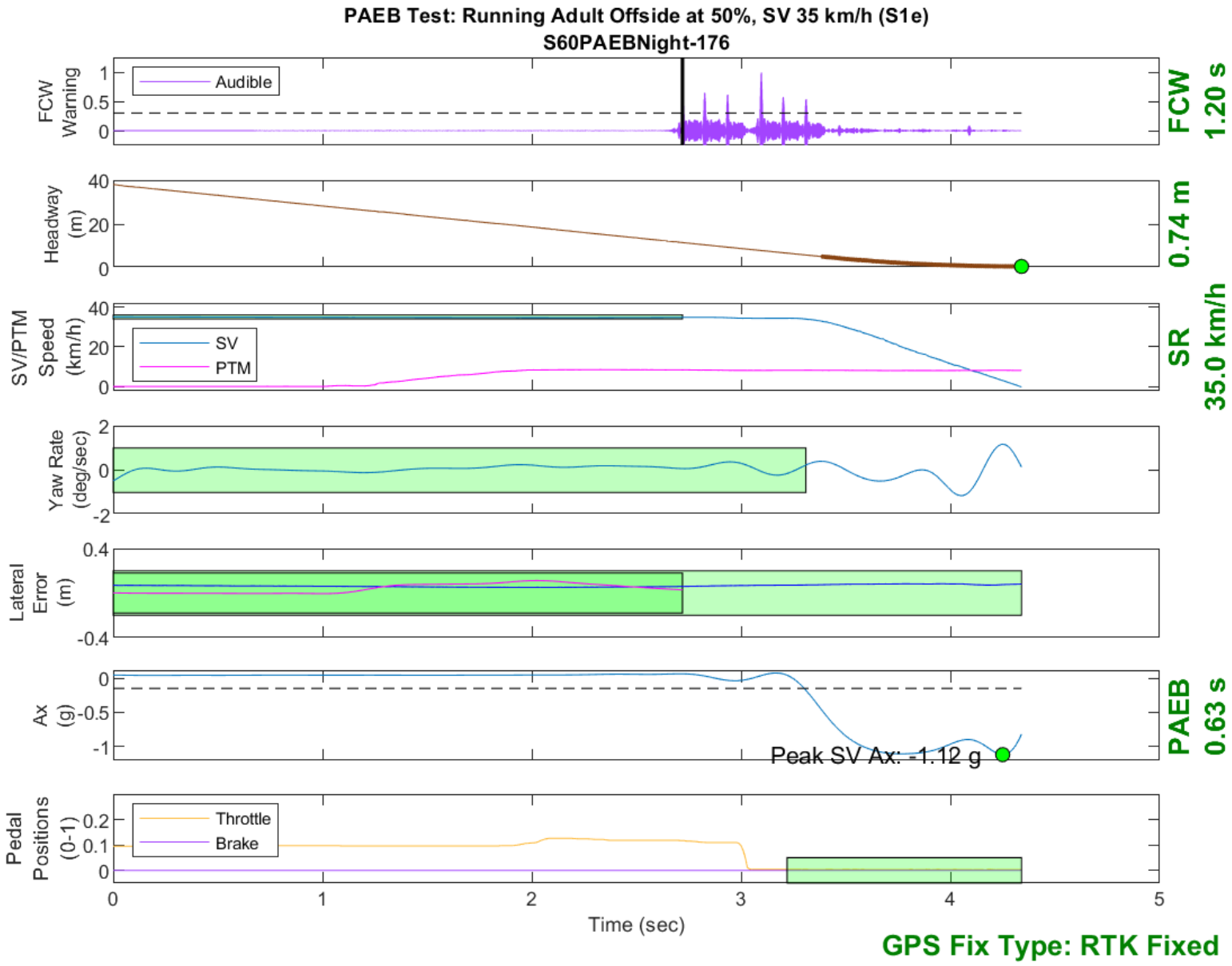


Figure D186. Time History for PAEB Run 176, S1e, Night, High Beam, 35 km/h

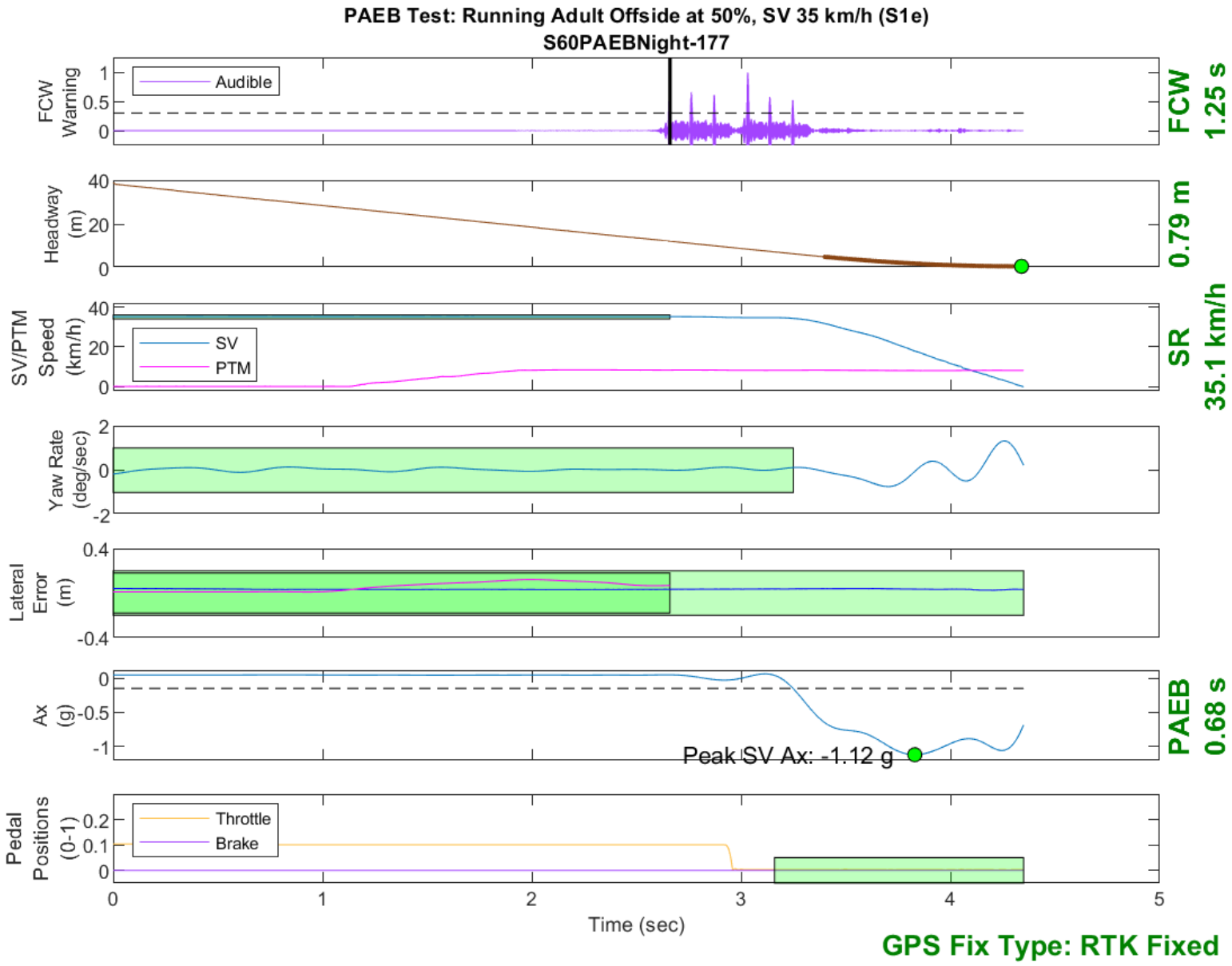


Figure D187. Time History for PAEB Run 177, S1e, Night, High Beam, 35 km/h

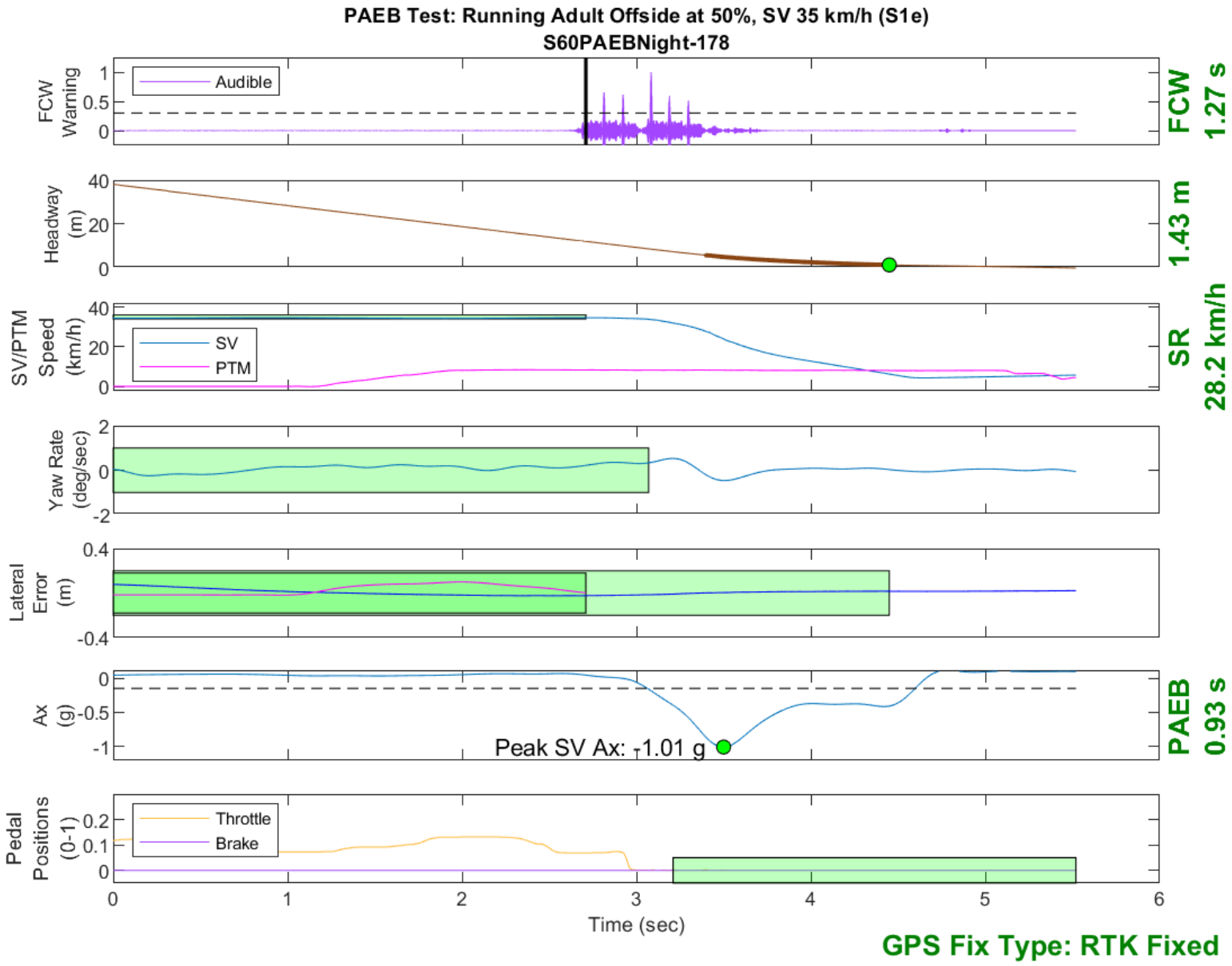


Figure D188. Time History for PAEB Run 178, S1e, Night, High Beam, 35 km/h

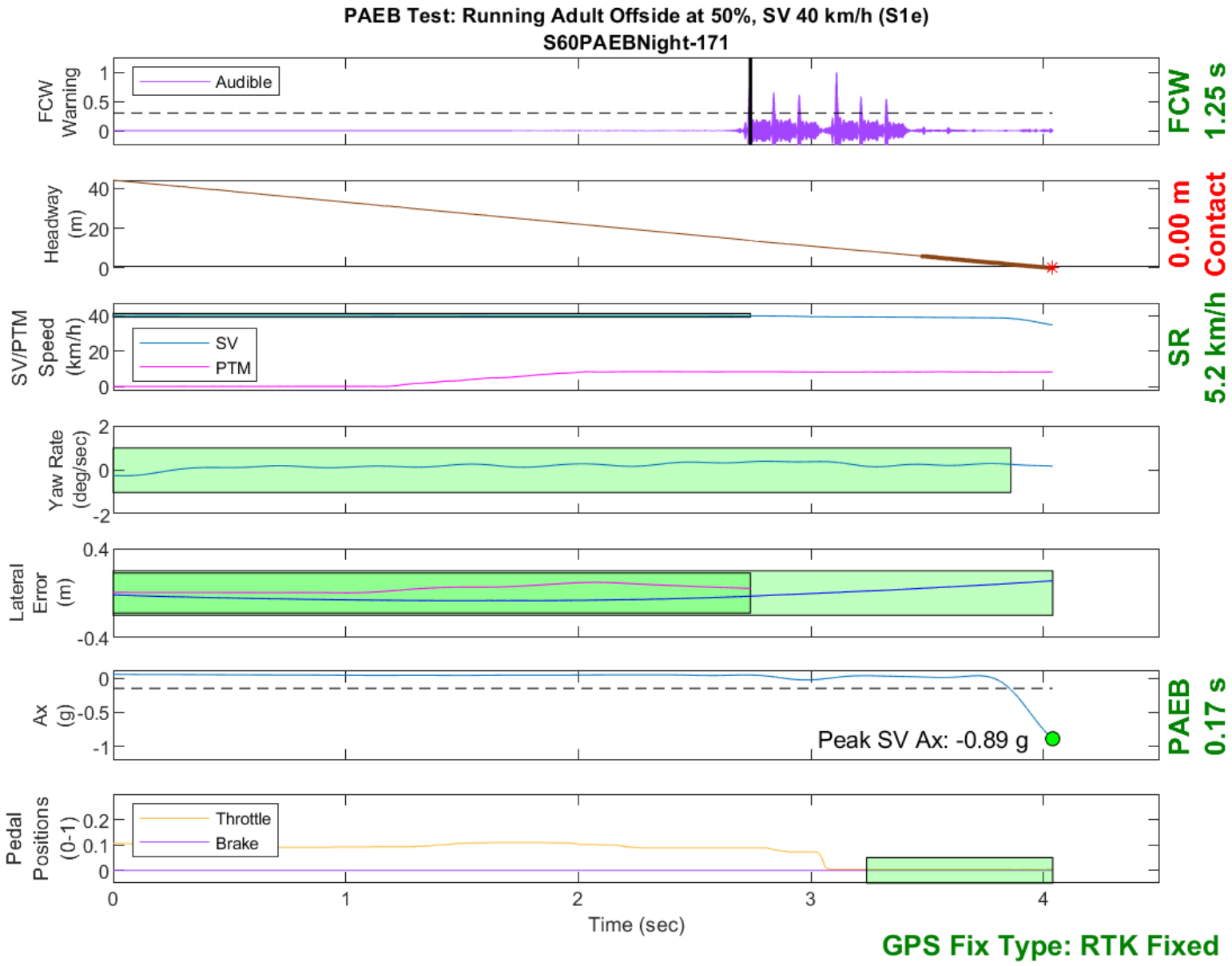


Figure D189. Time History for PAEB Run 171, S1e, Night, High Beam, 40 km/h

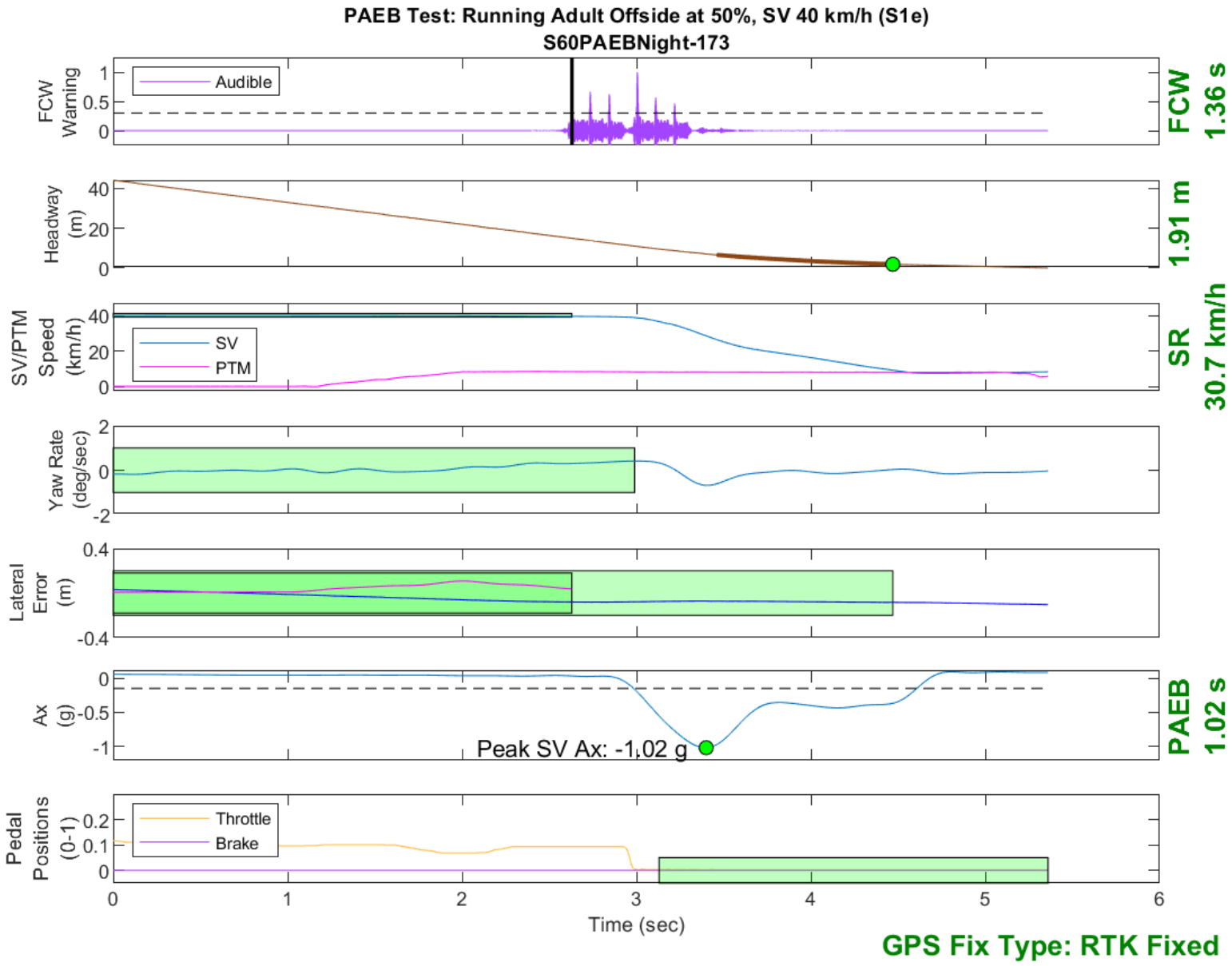


Figure D190. Time History for PAEB Run 173, S1e, Night, High Beam, 40 km/h

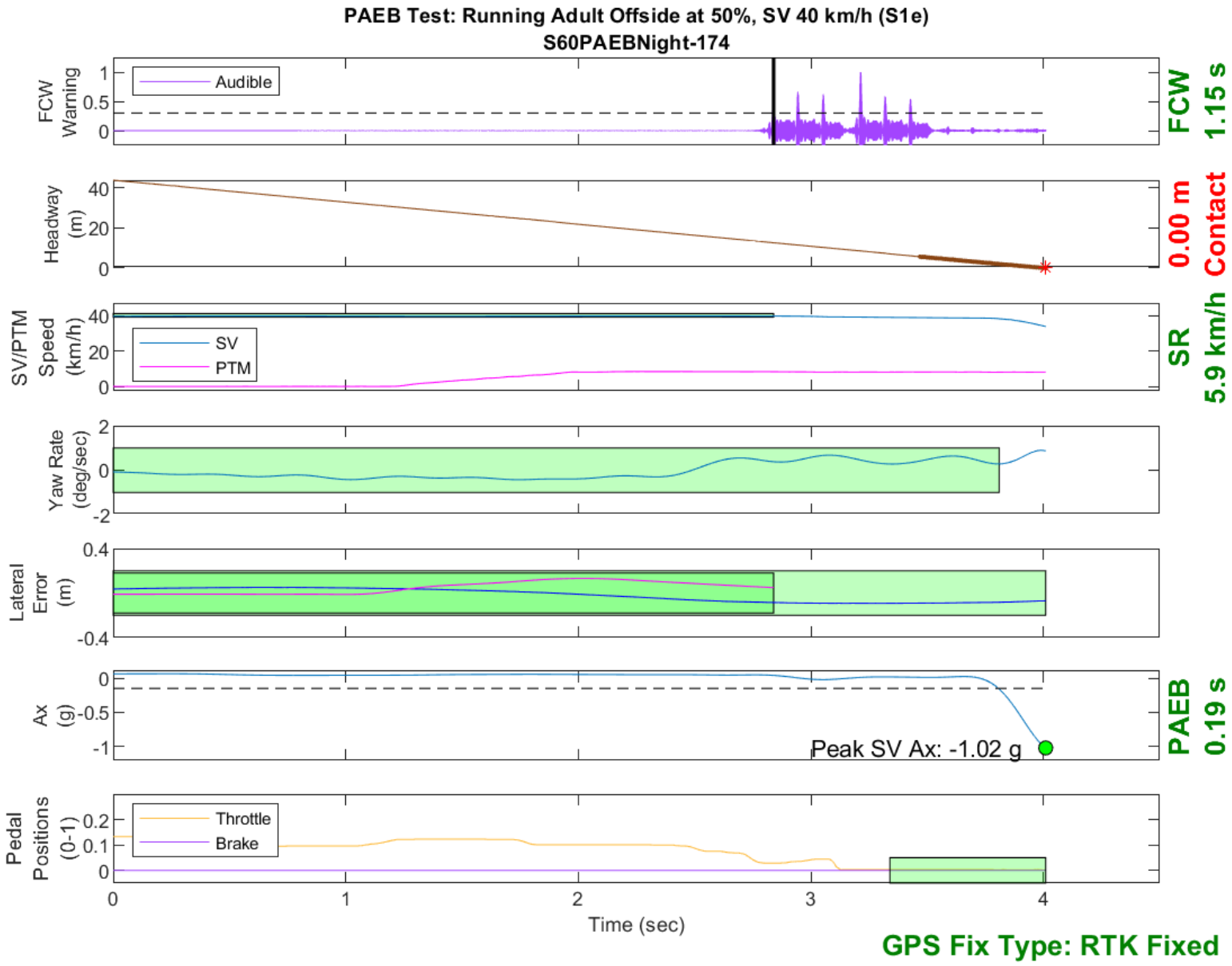


Figure D191. Time History for PAEB Run 174, S1e, Night, High Beam, 40 km/h

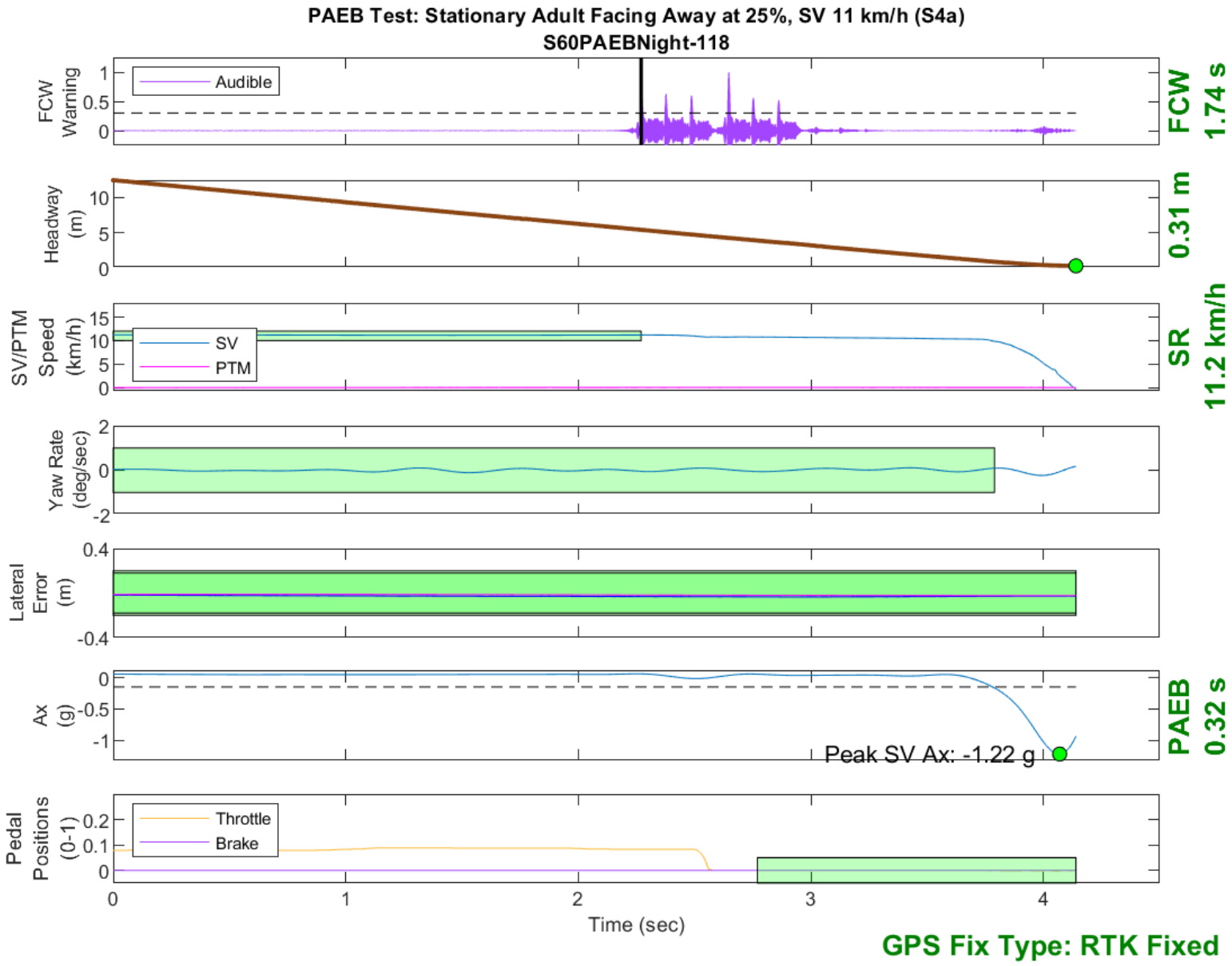


Figure D192. Time History for PAEB Run 118, S4a, Night, High Beam, 11 km/h

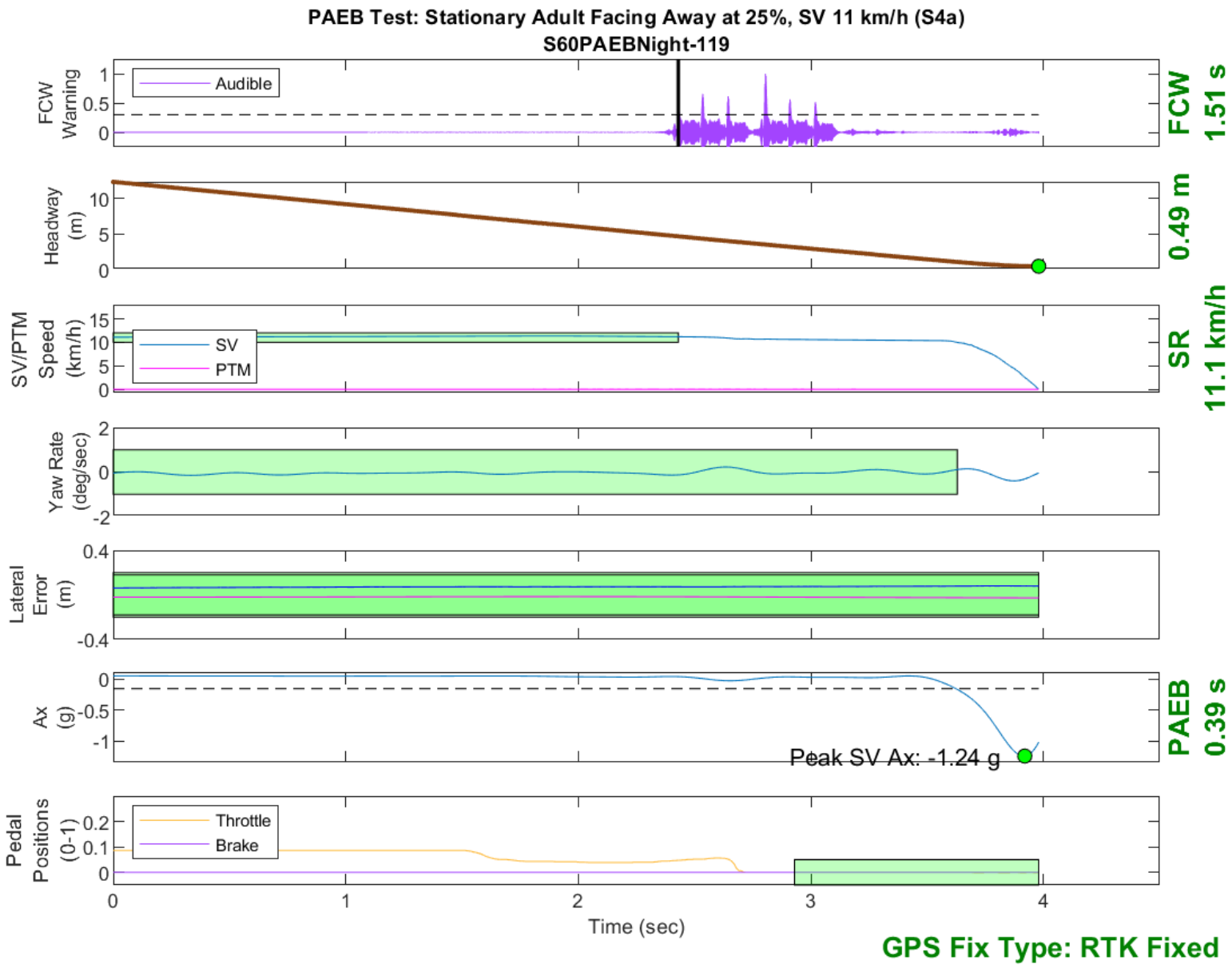


Figure D193. Time History for PAEB Run 119, S4a, Night, High Beam, 11 km/h

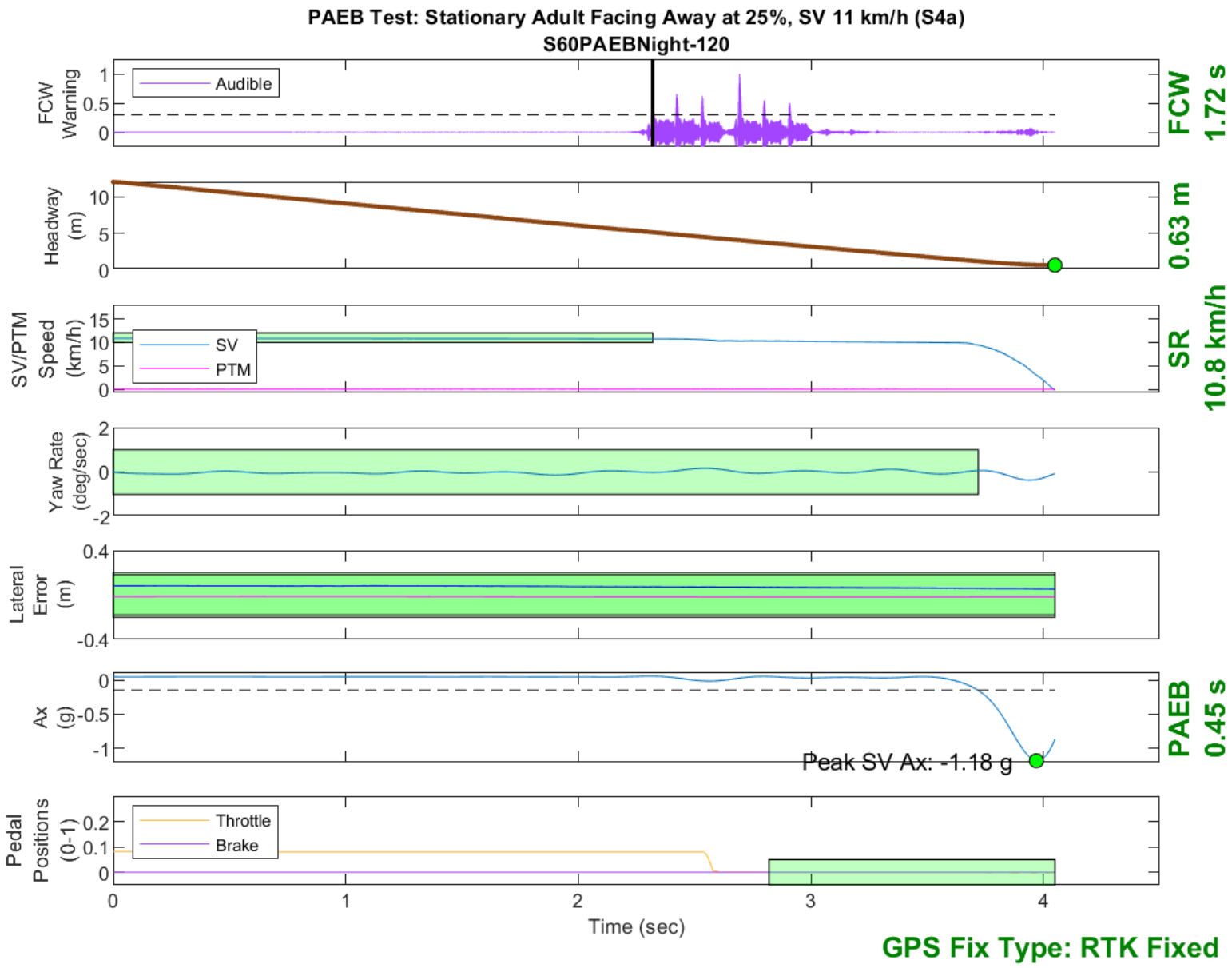


Figure D194. Time History for PAEB Run 120, S4a, Night, High Beam, 11 km/h

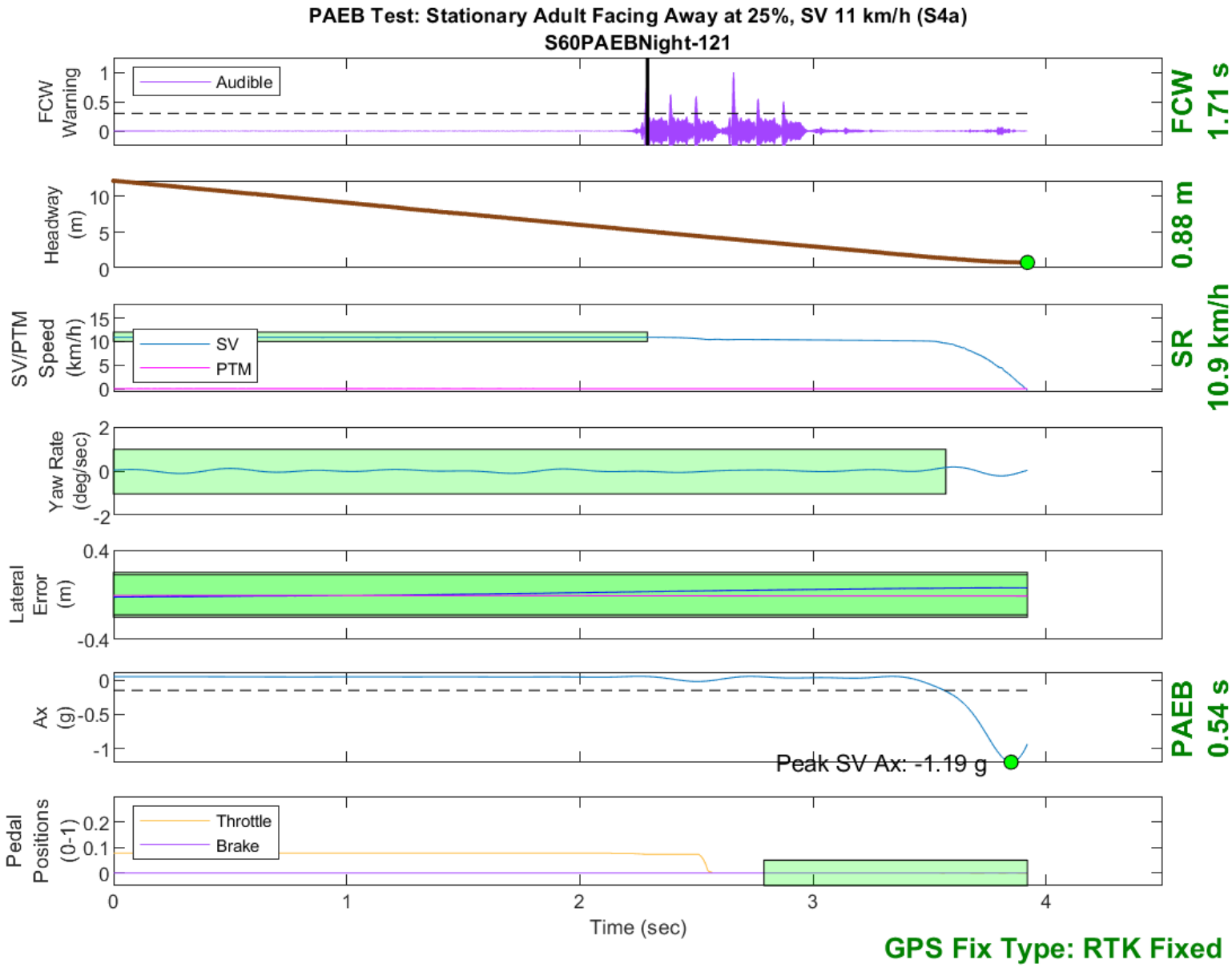


Figure D195. Time History for PAEB Run 121, S4a, Night, High Beam, 11 km/h

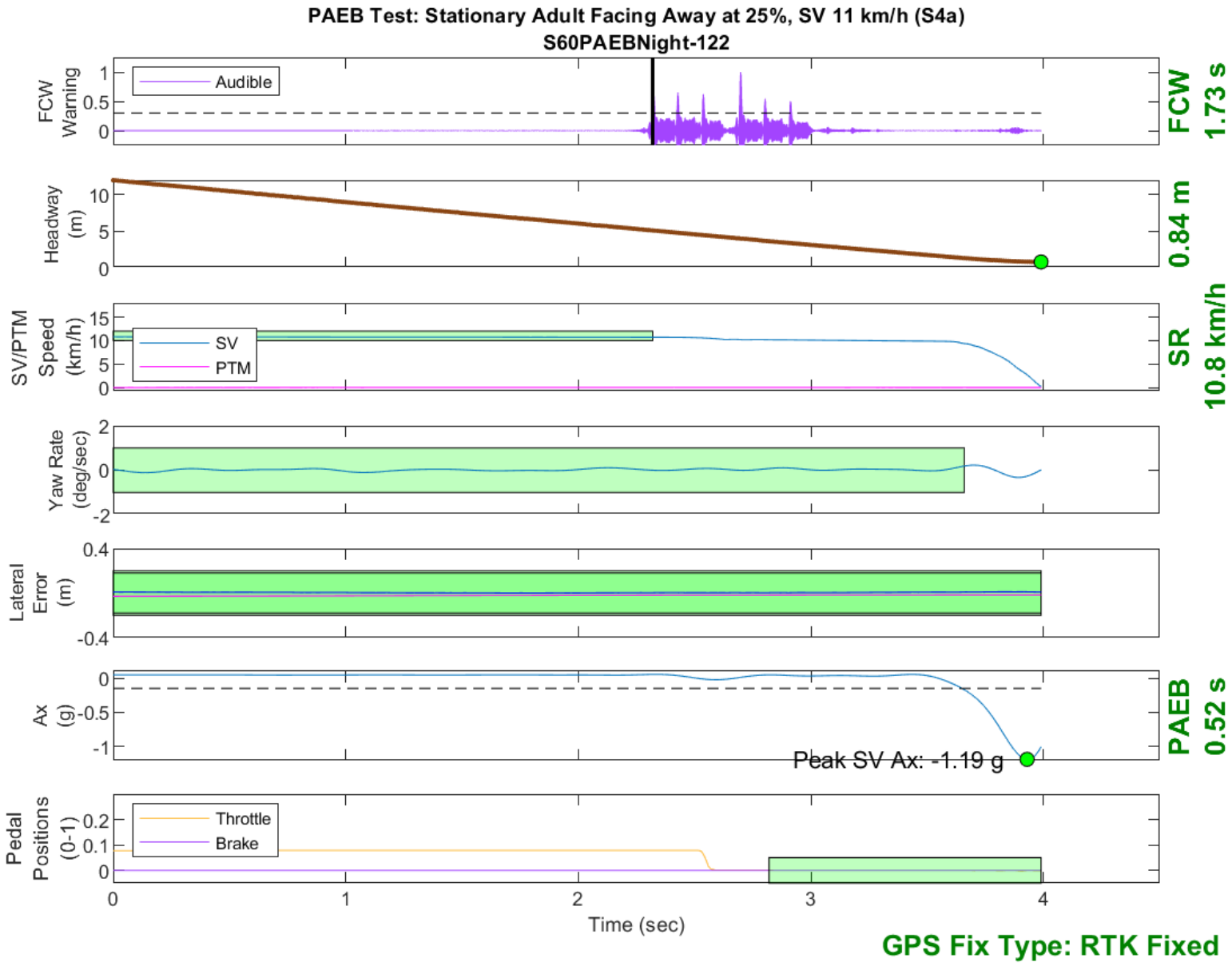


Figure D196. Time History for PAEB Run 122, S4a, Night, High Beam, 11 km/h

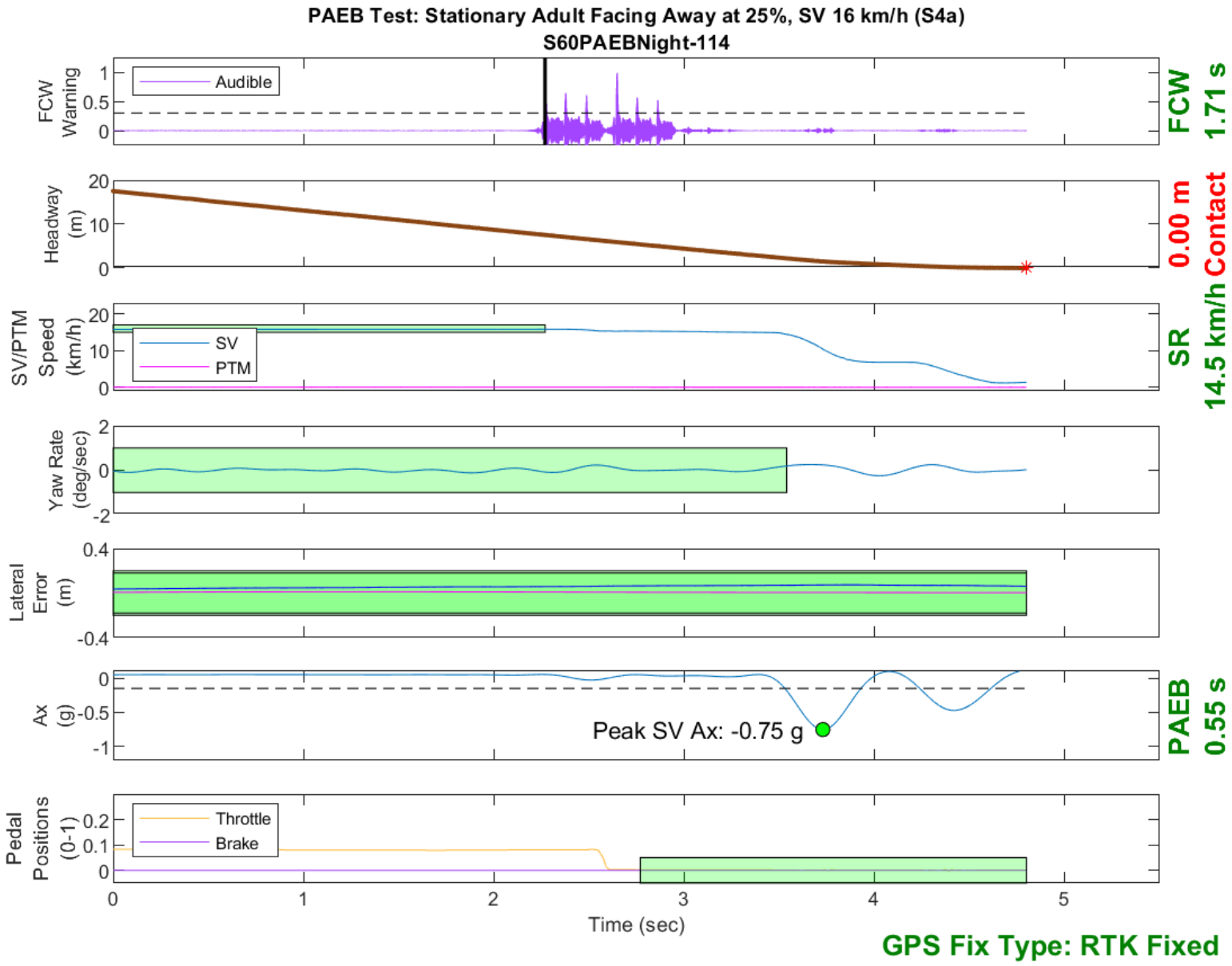


Figure D197. Time History for PAEB Run 114, S4a, Night, High Beam, 16 km/h

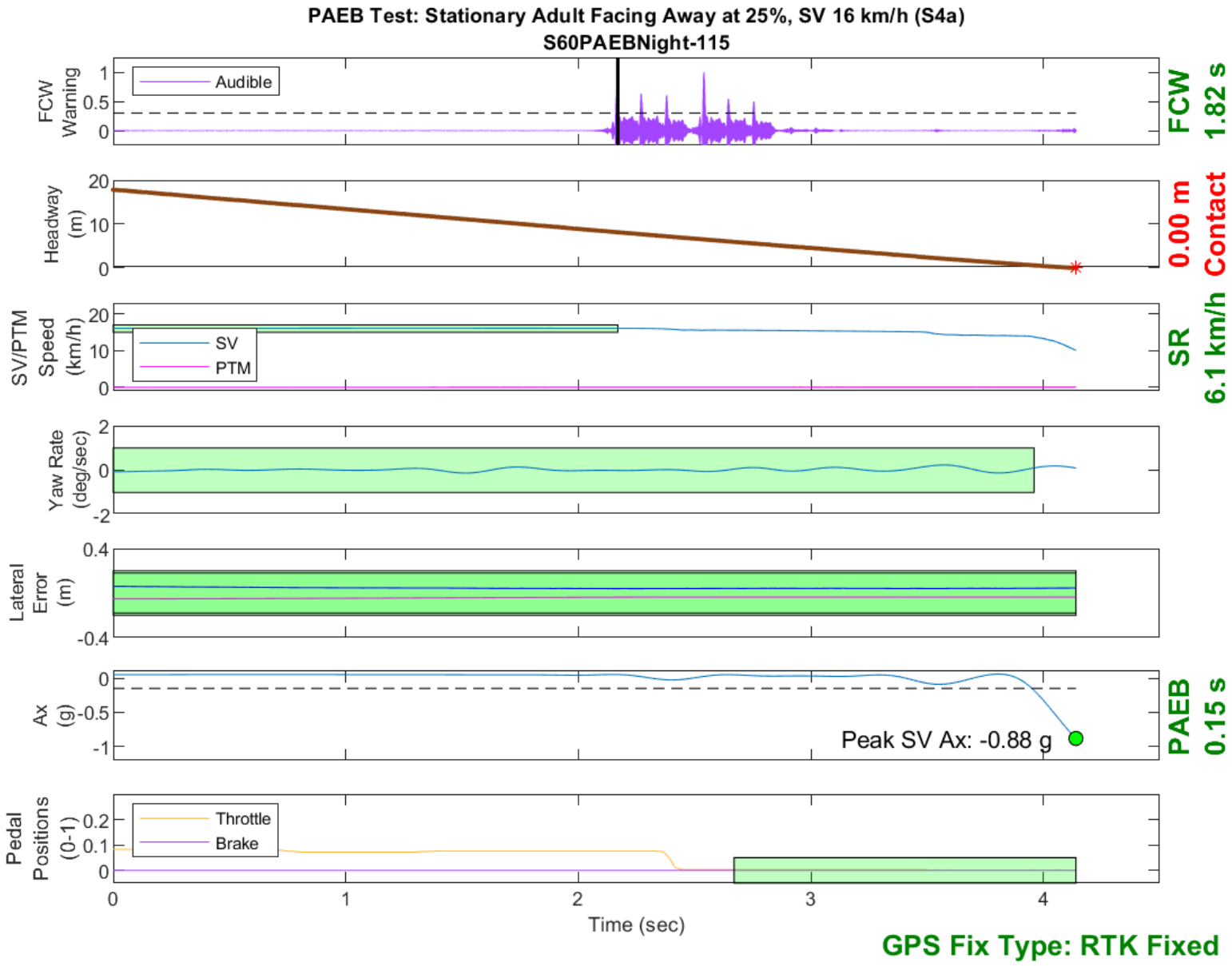


Figure D198. Time History for PAEB Run 115, S4a, Night, High Beam, 16 km/h

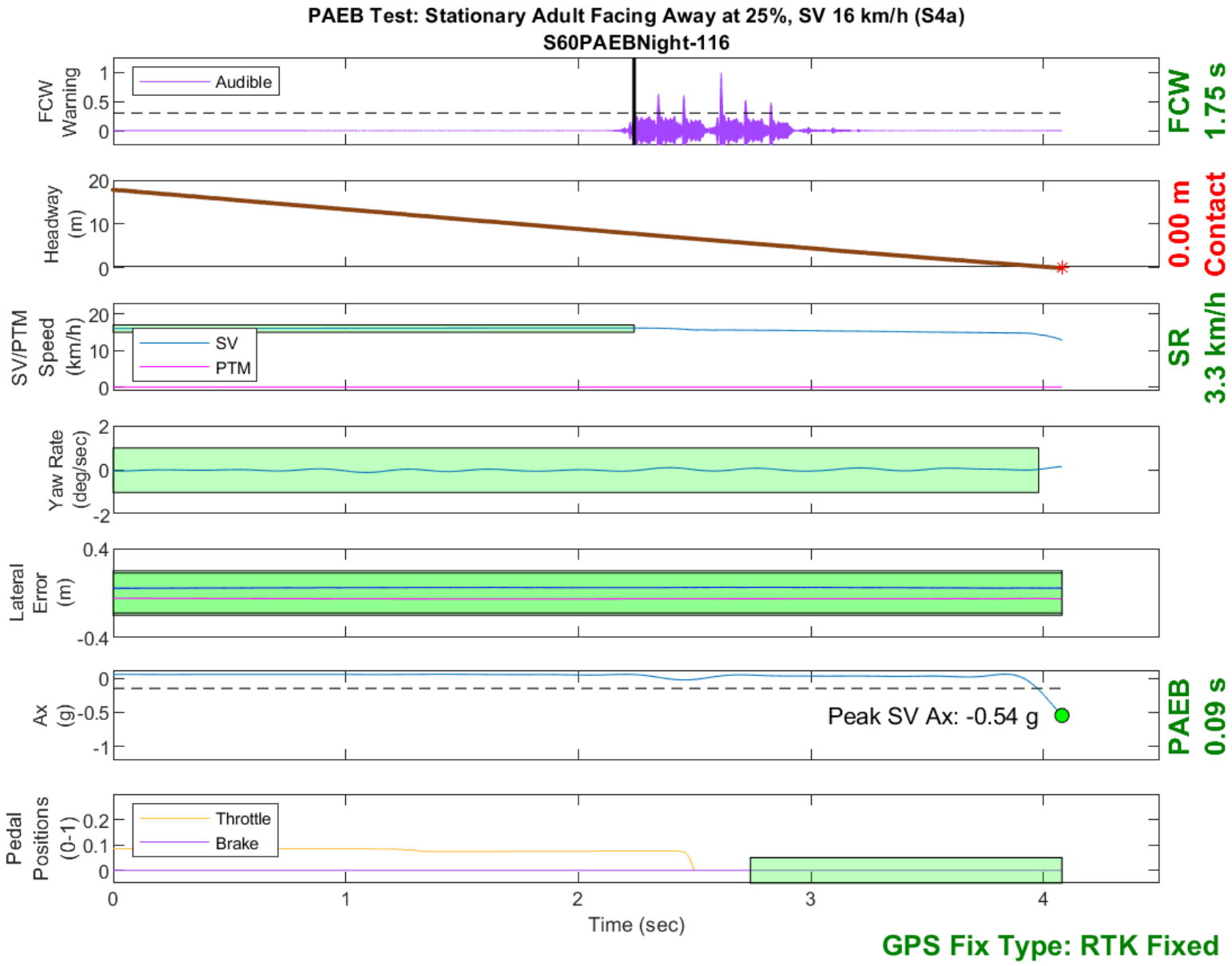


Figure D199. Time History for PAEB Run 116, S4a, Night, High Beam, 16 km/h

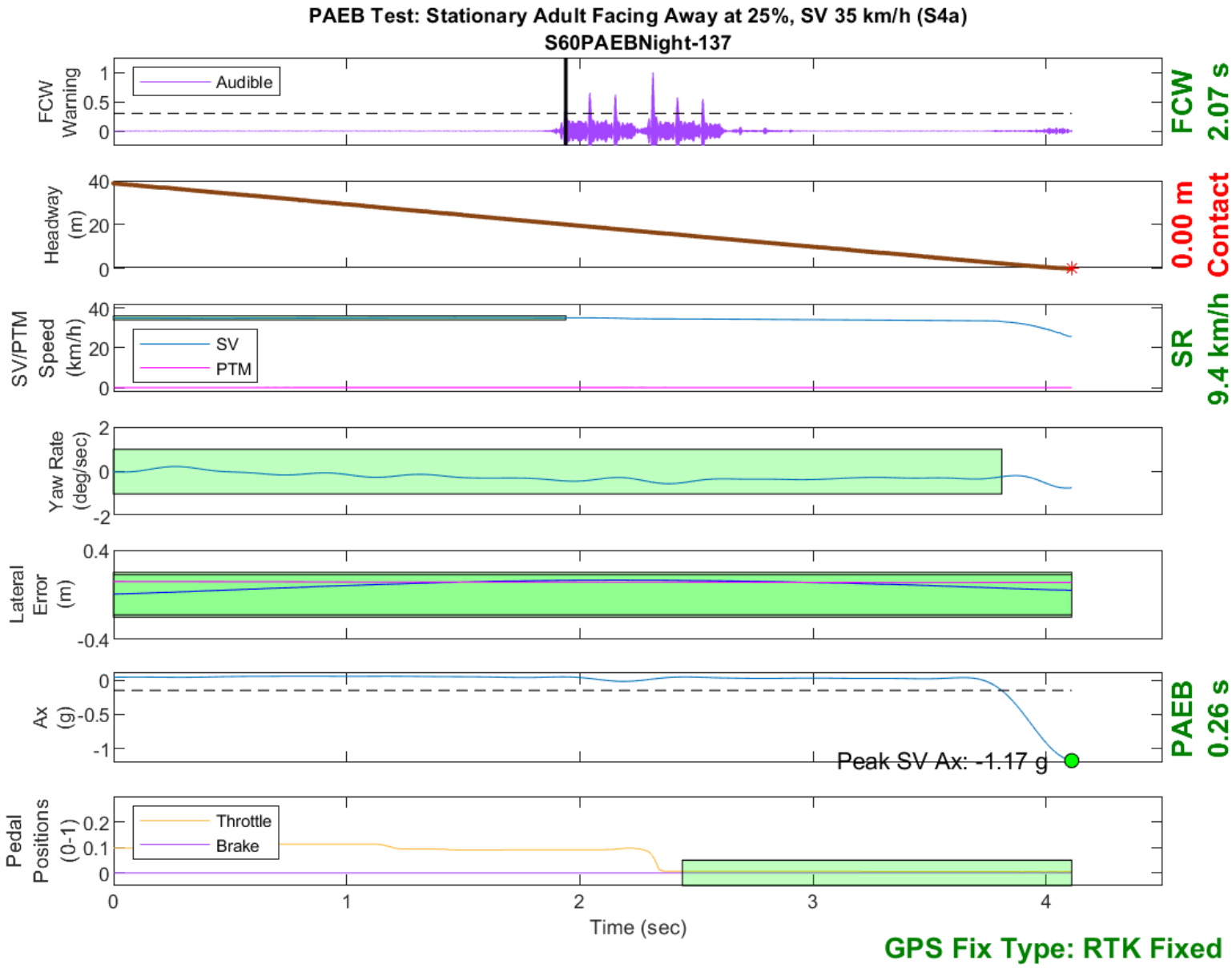


Figure D200. Time History for PAEB Run 137, S4a, Night, High Beam, 35 km/h

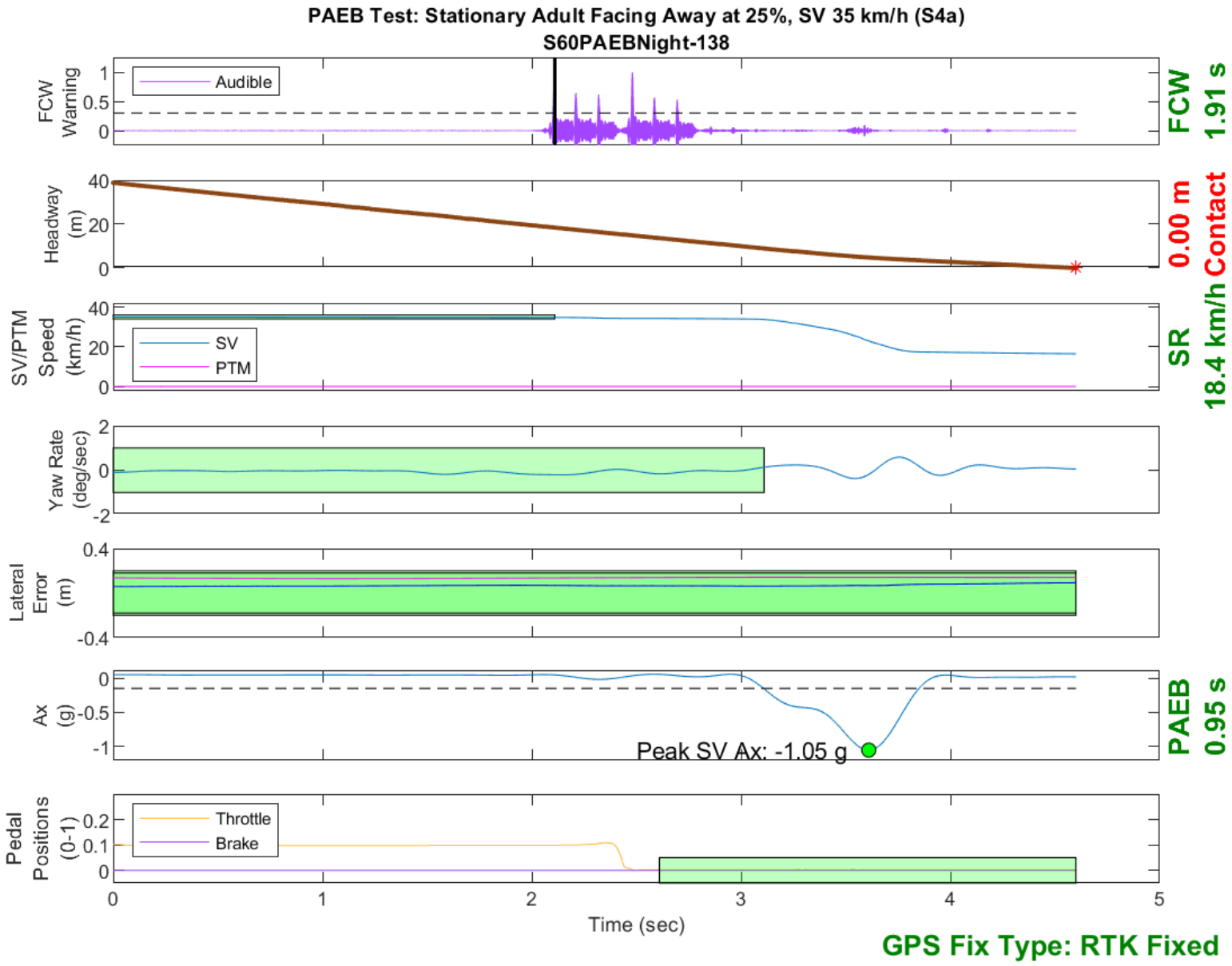


Figure D201. Time History for PAEB Run 138, S4a, Night, High Beam, 35 km/h

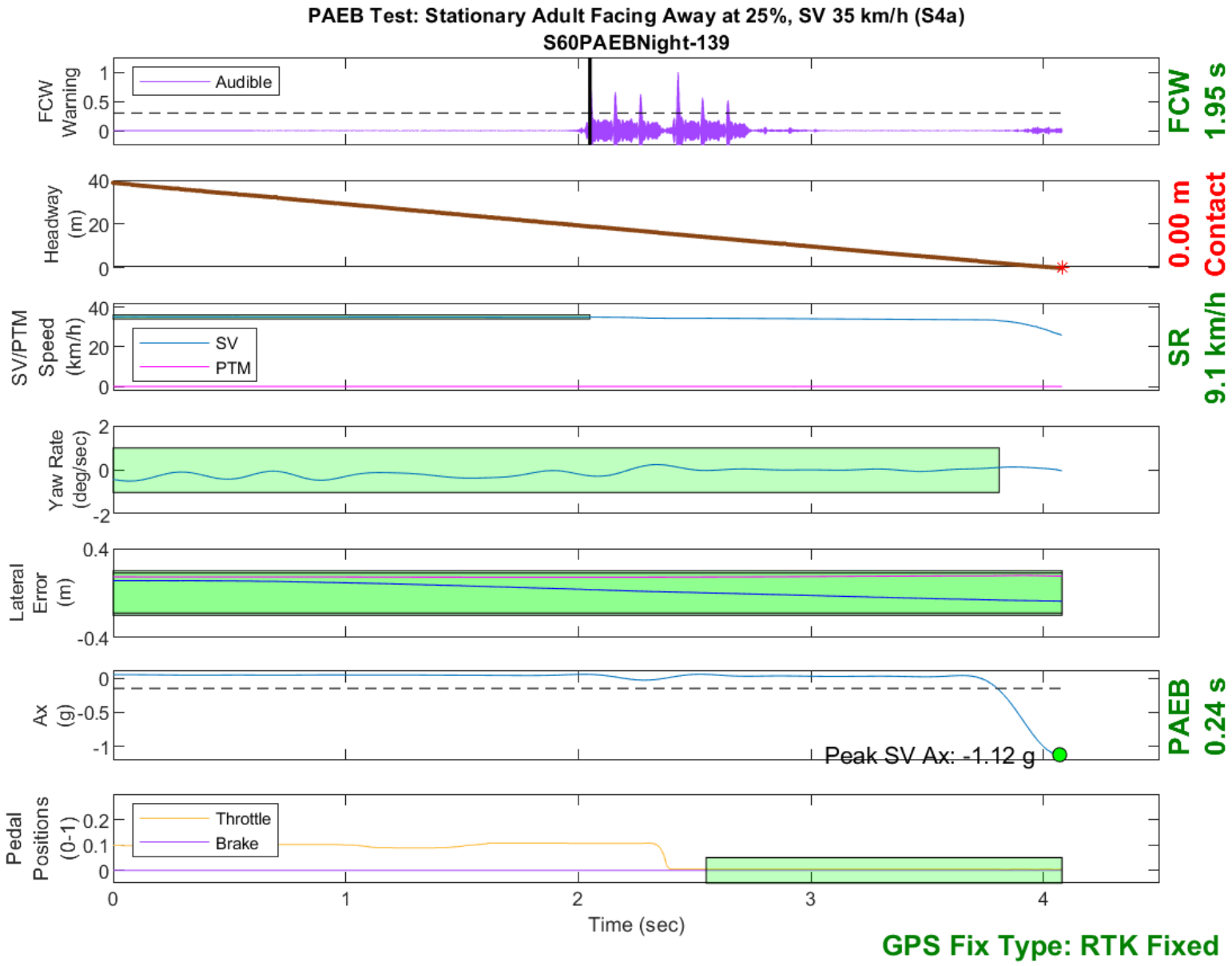


Figure D202. Time History for PAEB Run 139, S4a, Night, High Beam, 35 km/h

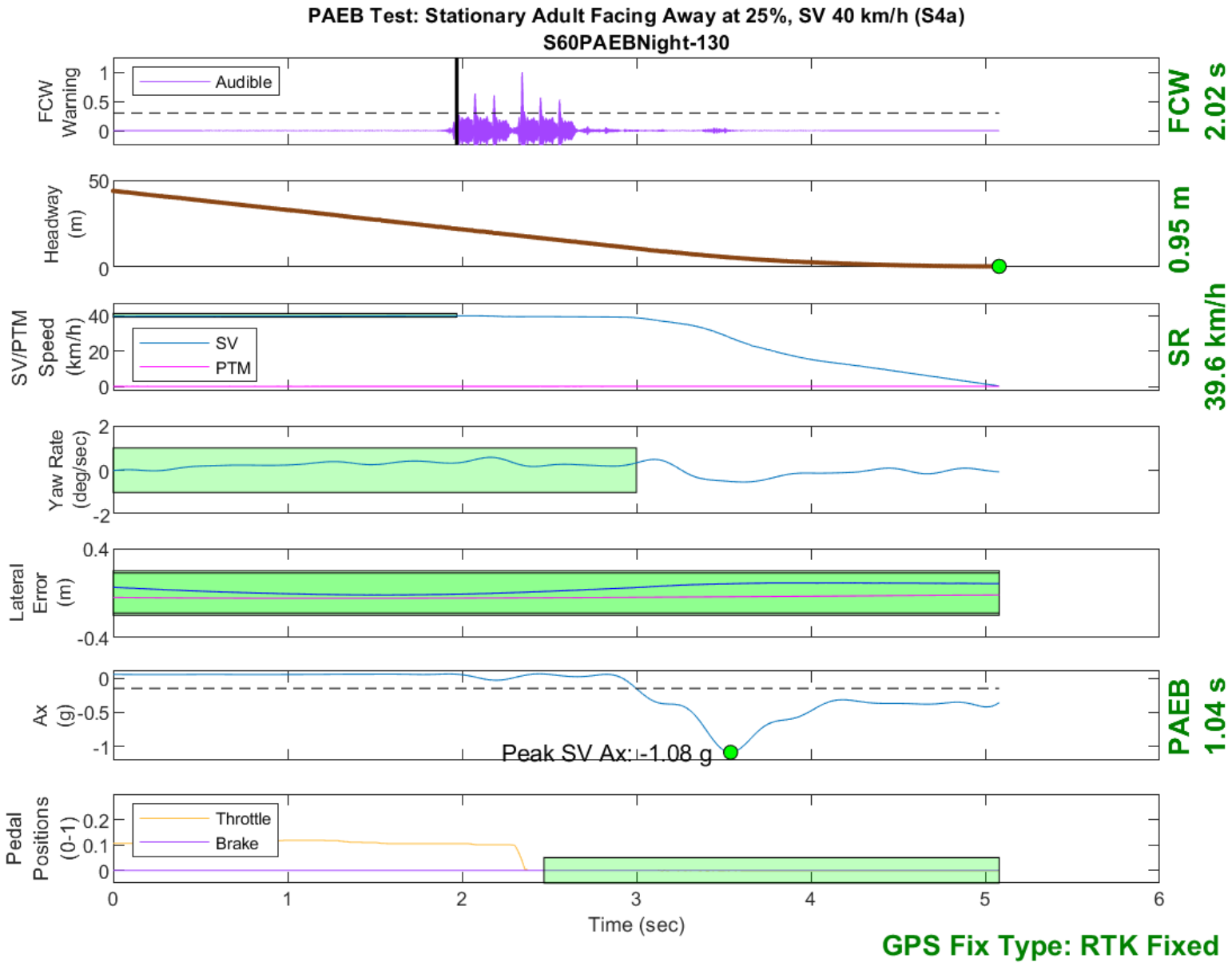


Figure D203. Time History for PAEB Run 130, S4a, Night, High Beam, 40 km/h

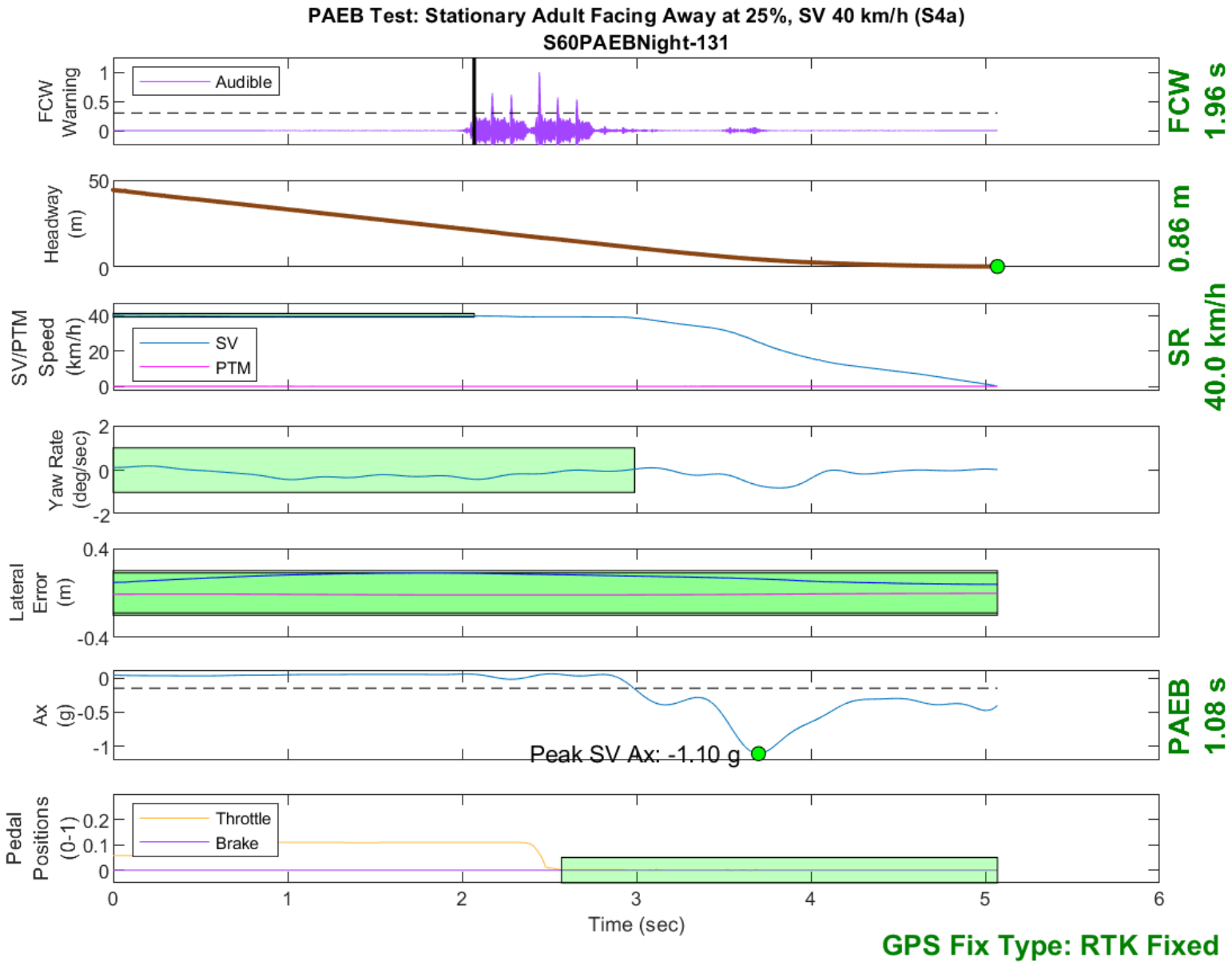


Figure D204. Time History for PAEB Run 131, S4a, Night, High Beam, 40 km/h

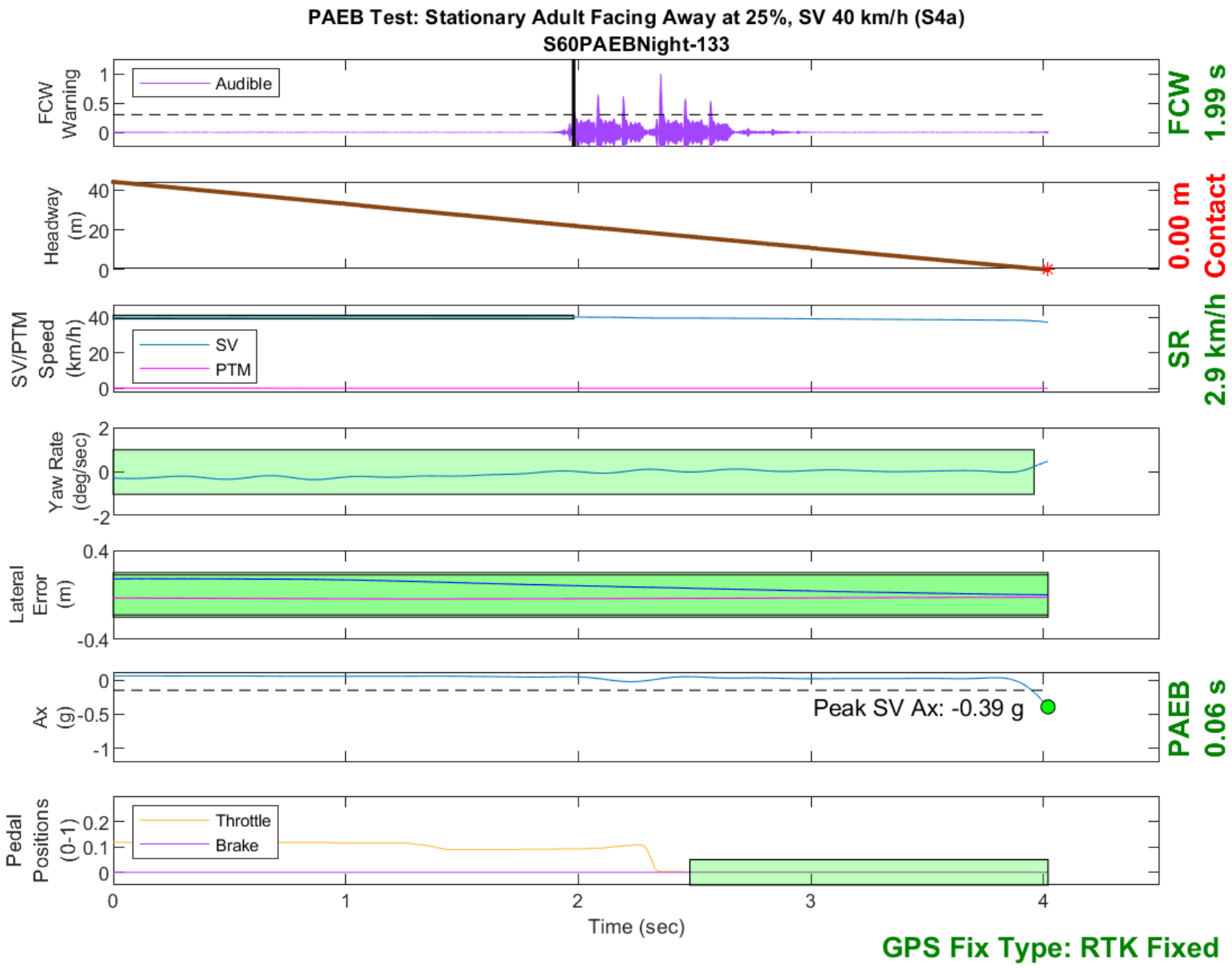


Figure D205. Time History for PAEB Run 133, S4a, Night, High Beam, 40 km/h



Figure D206. Time History for PAEB Run 134, S4a, Night, High Beam, 40 km/h

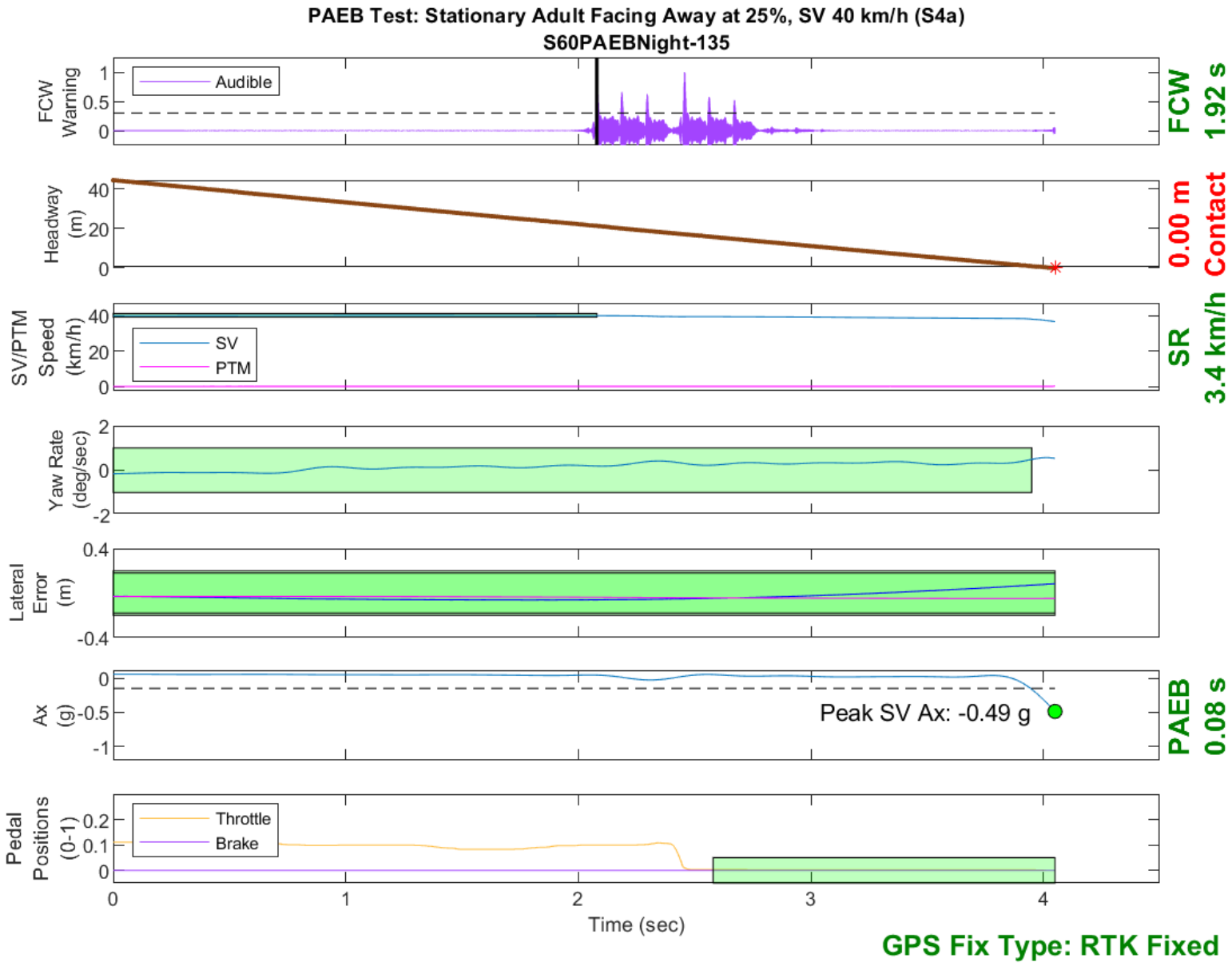


Figure D207. Time History for PAEB Run 135, S4a, Night, High Beam, 40 km/h

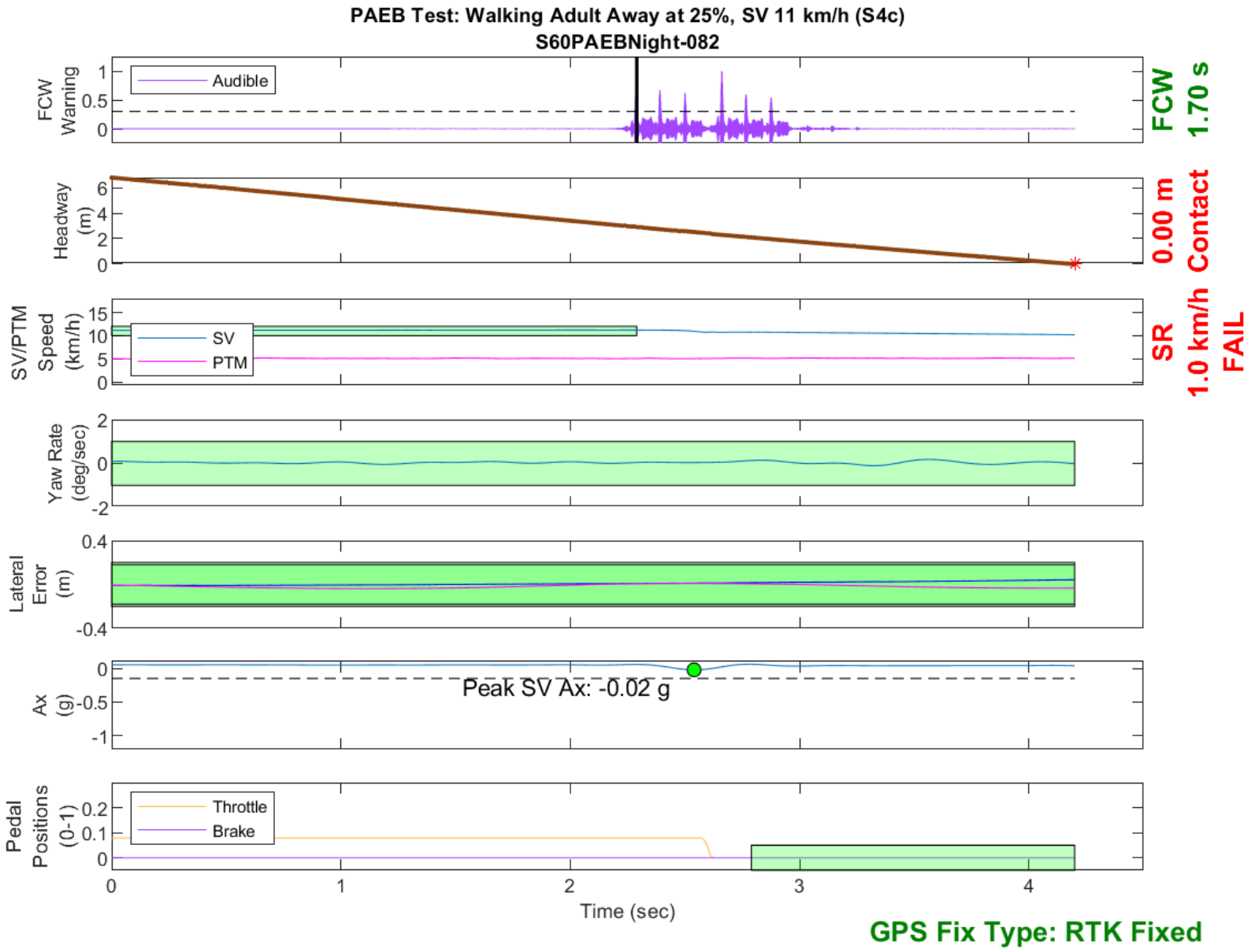


Figure D208. Time History for PAEB Run 82, S4c, Night, High Beam, 11 km/h

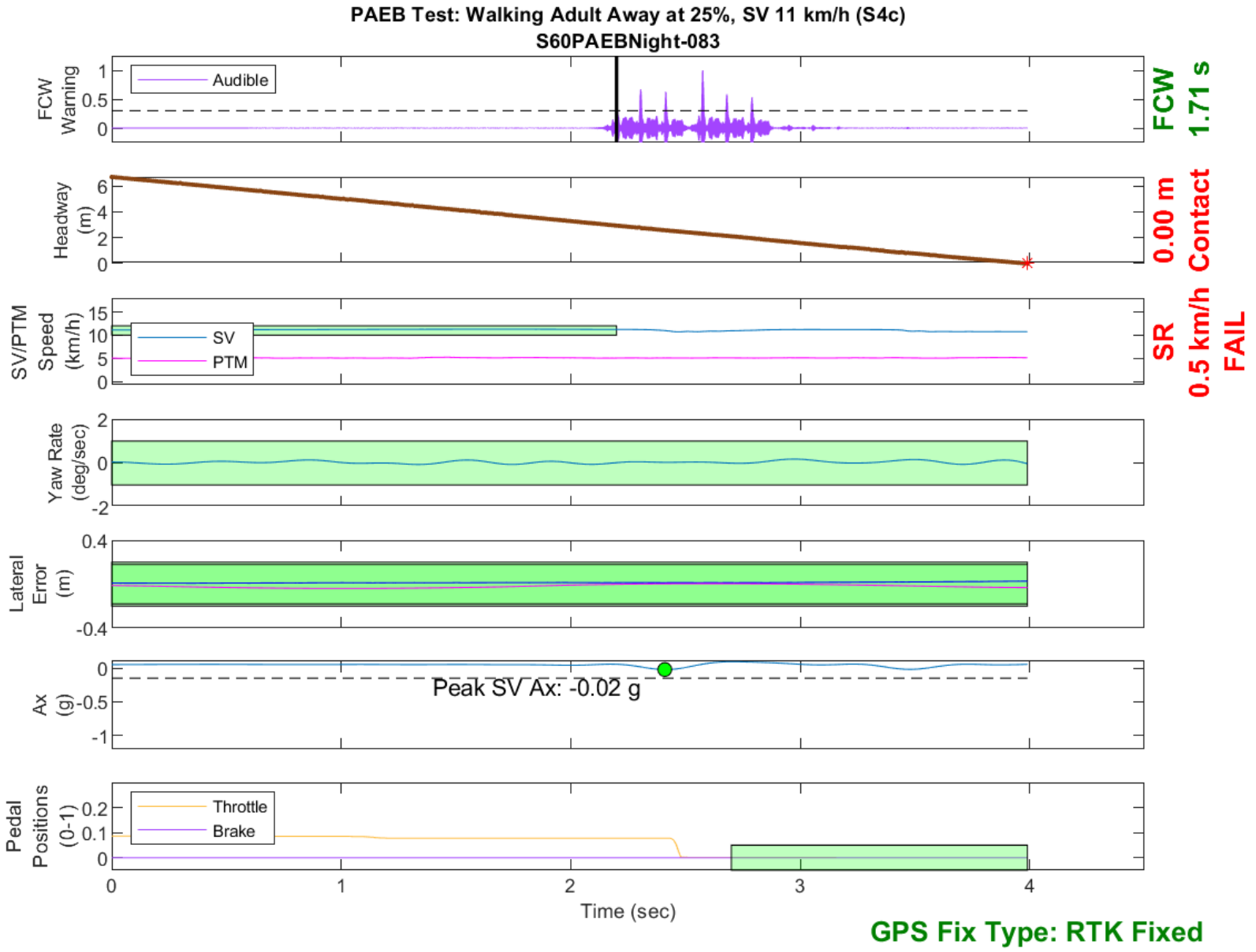


Figure D209. Time History for PAEB Run 83, S4c, Night, High Beam, 11 km/h

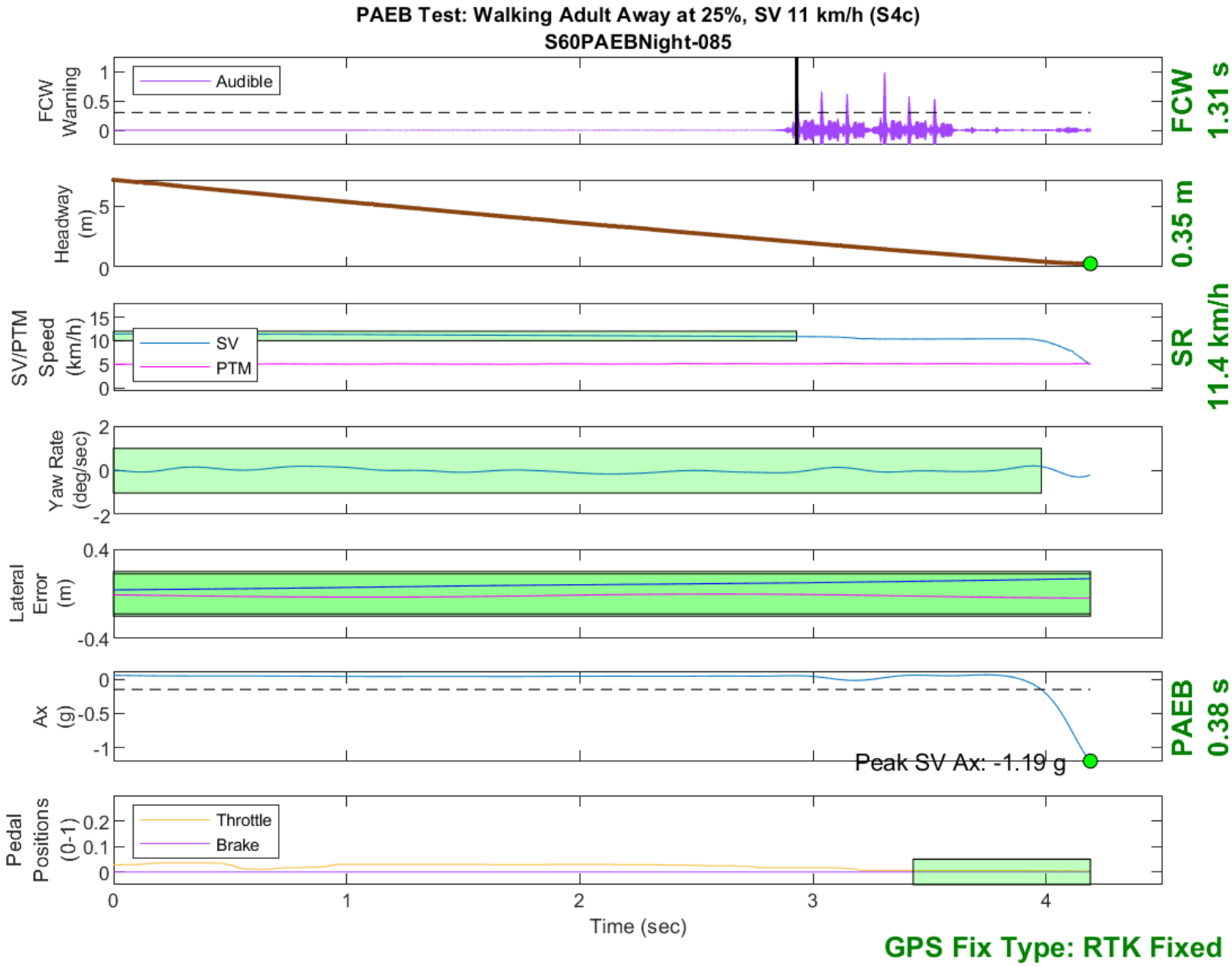


Figure D210. Time History for PAEB Run 85, S4c, Night, High Beam, 11 km/h

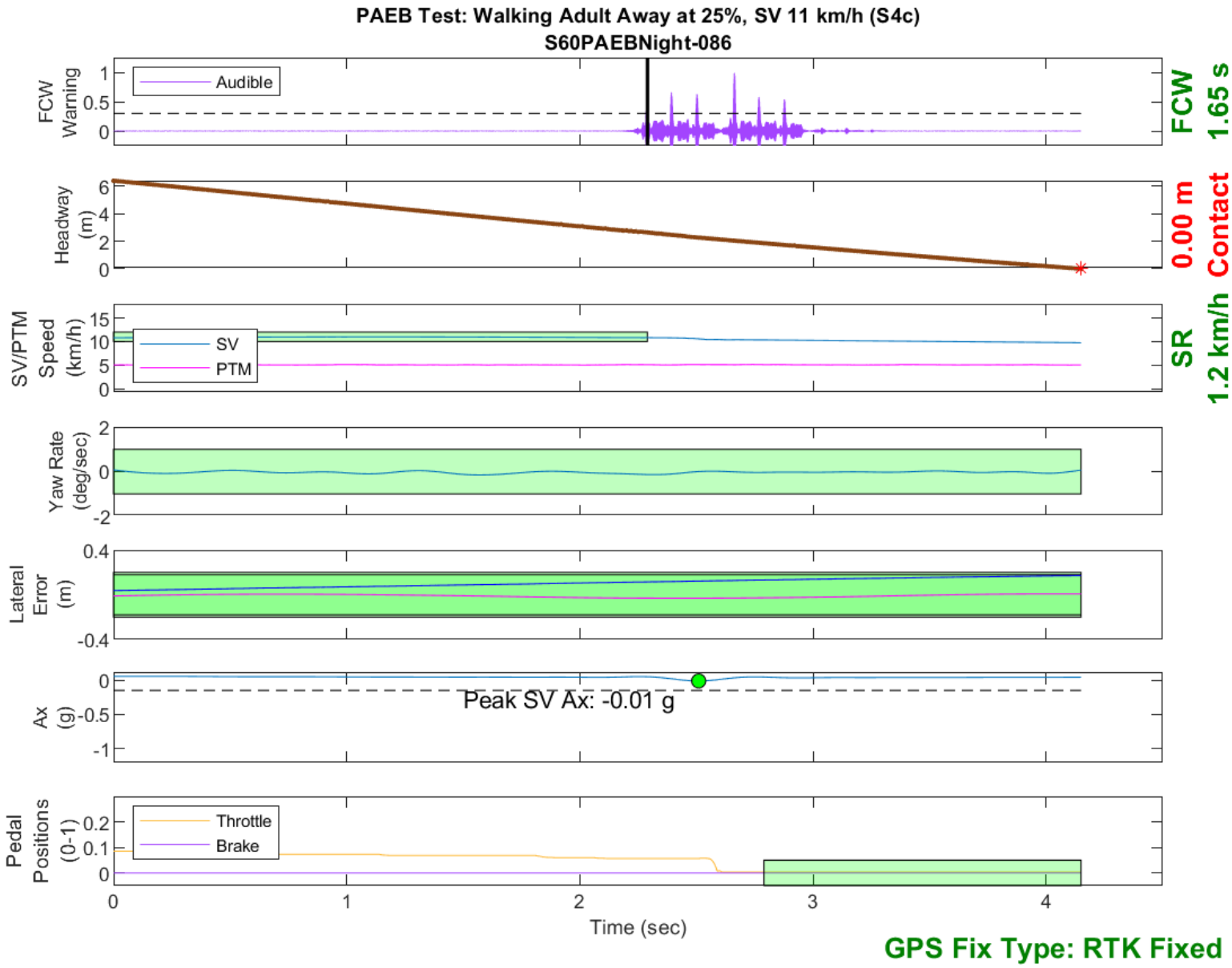


Figure D211. Time History for PAEB Run 86, S4c, Night, High Beam, 11 km/h

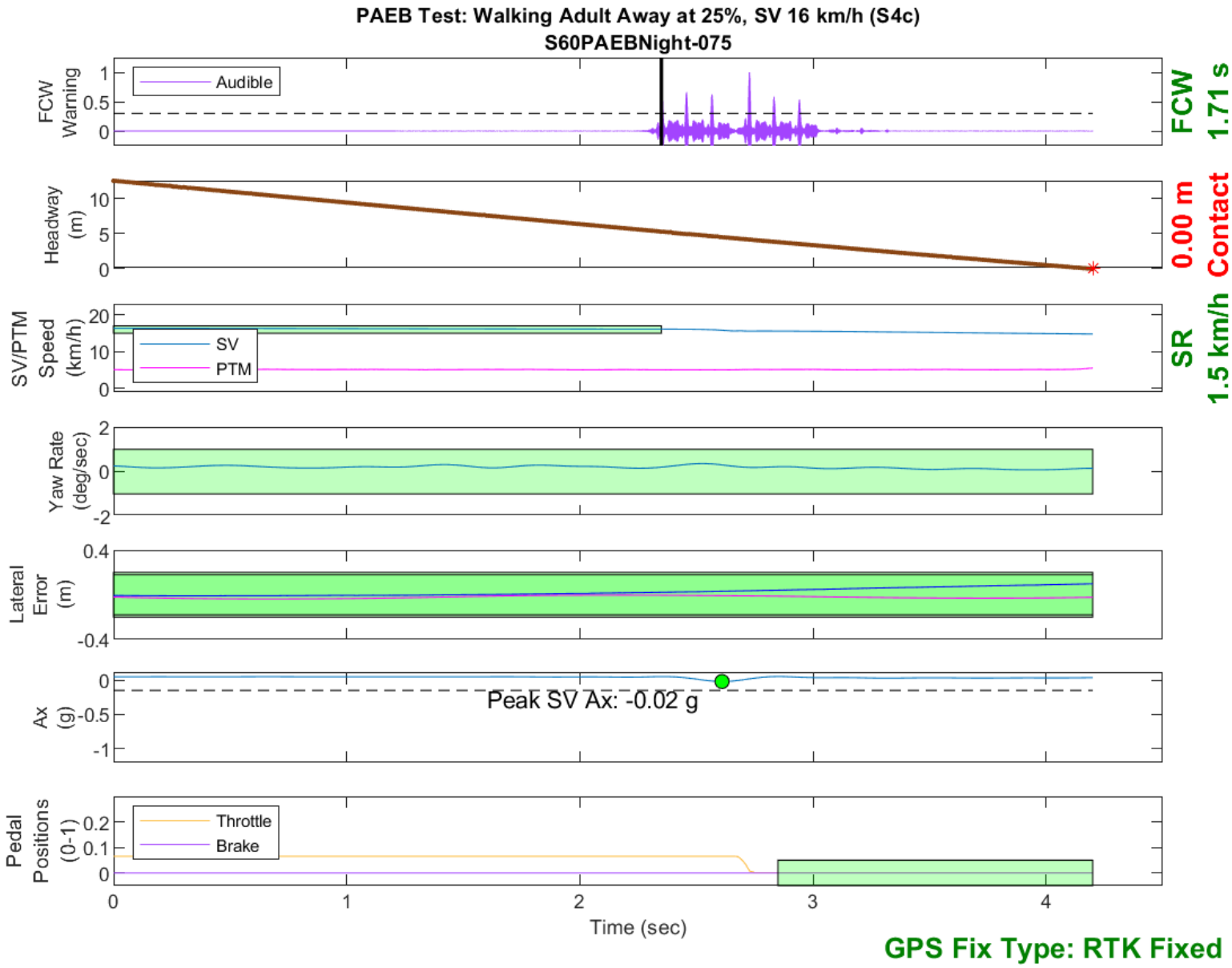


Figure D212. Time History for PAEB Run 75, S4c, Night, High Beam, 16 km/h

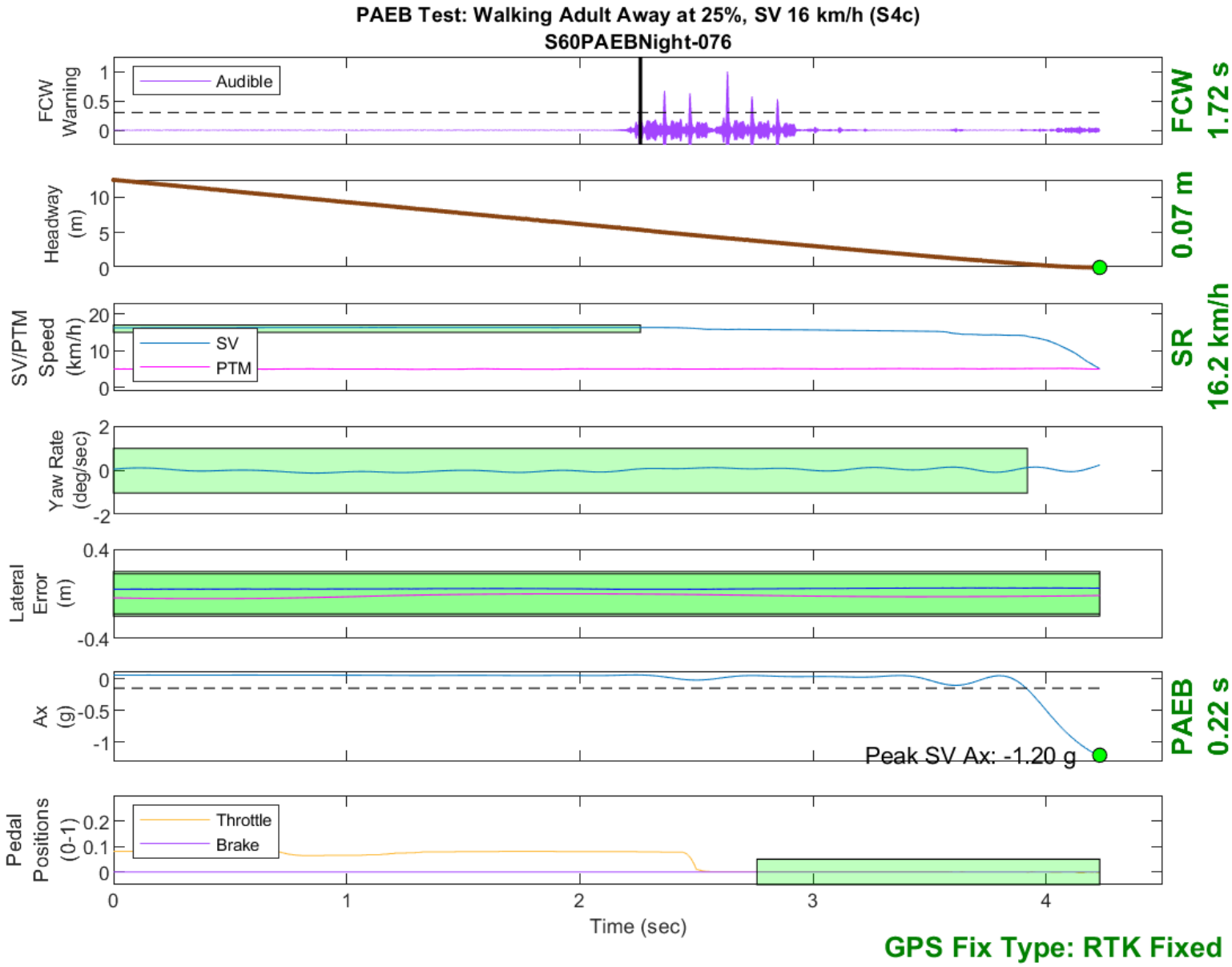


Figure D213. Time History for PAEB Run 76, S4c, Night, High Beam, 16 km/h

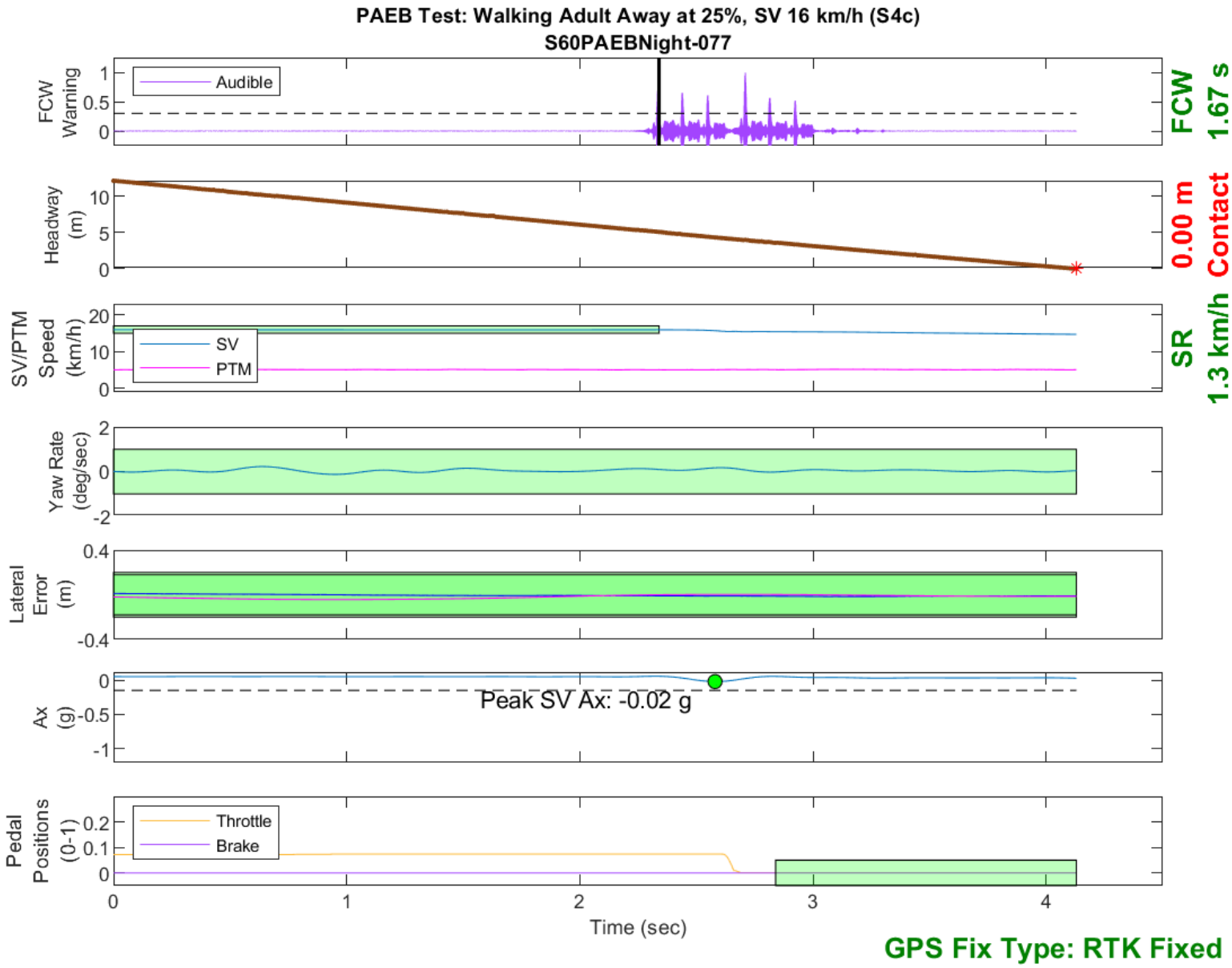


Figure D214. Time History for PAEB Run 77, S4c, Night, High Beam, 16 km/h

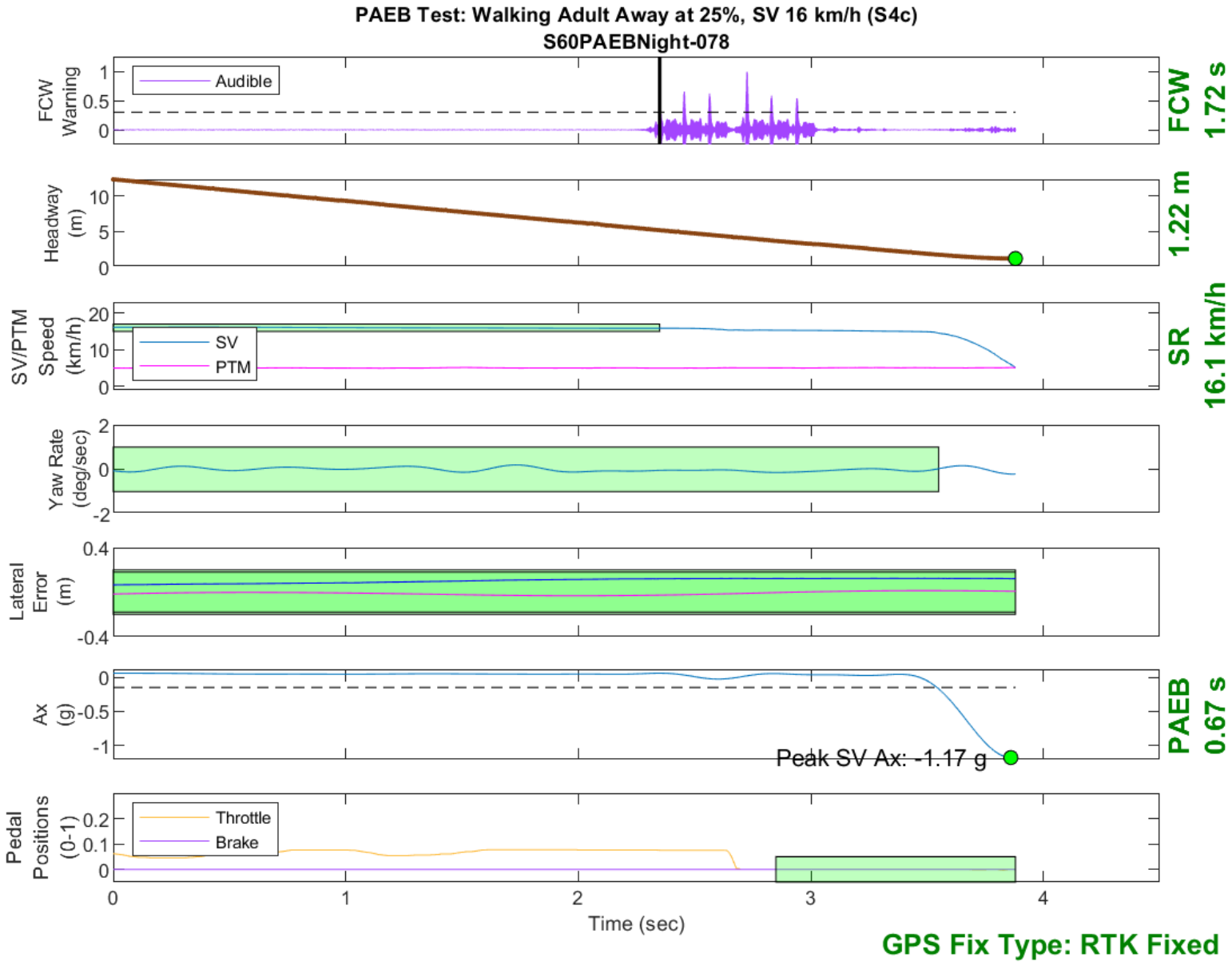


Figure D215. Time History for PAEB Run 78, S4c, Night, High Beam, 16 km/h

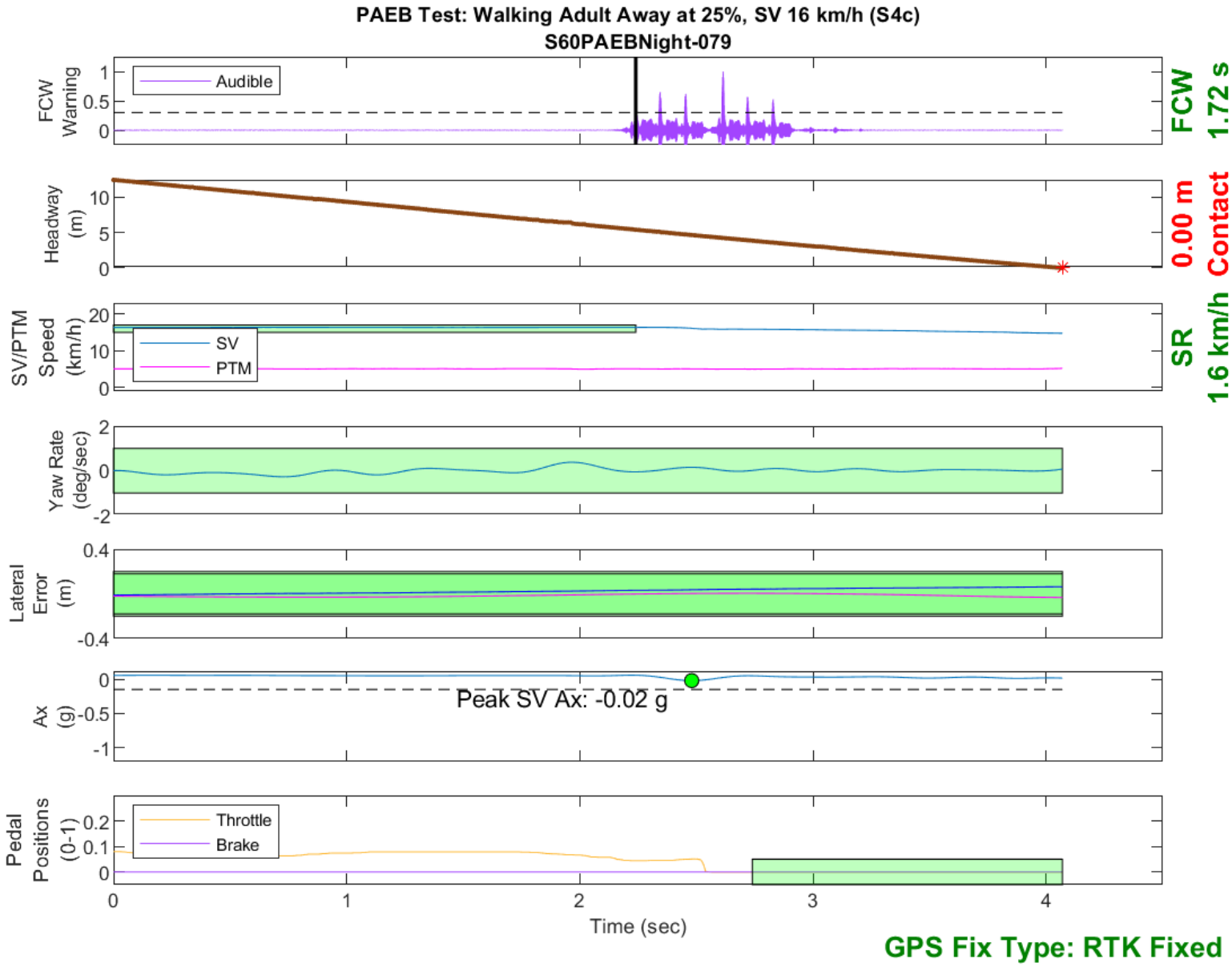


Figure D216. Time History for PAEB Run 79, S4c, Night, High Beam, 16 km/h

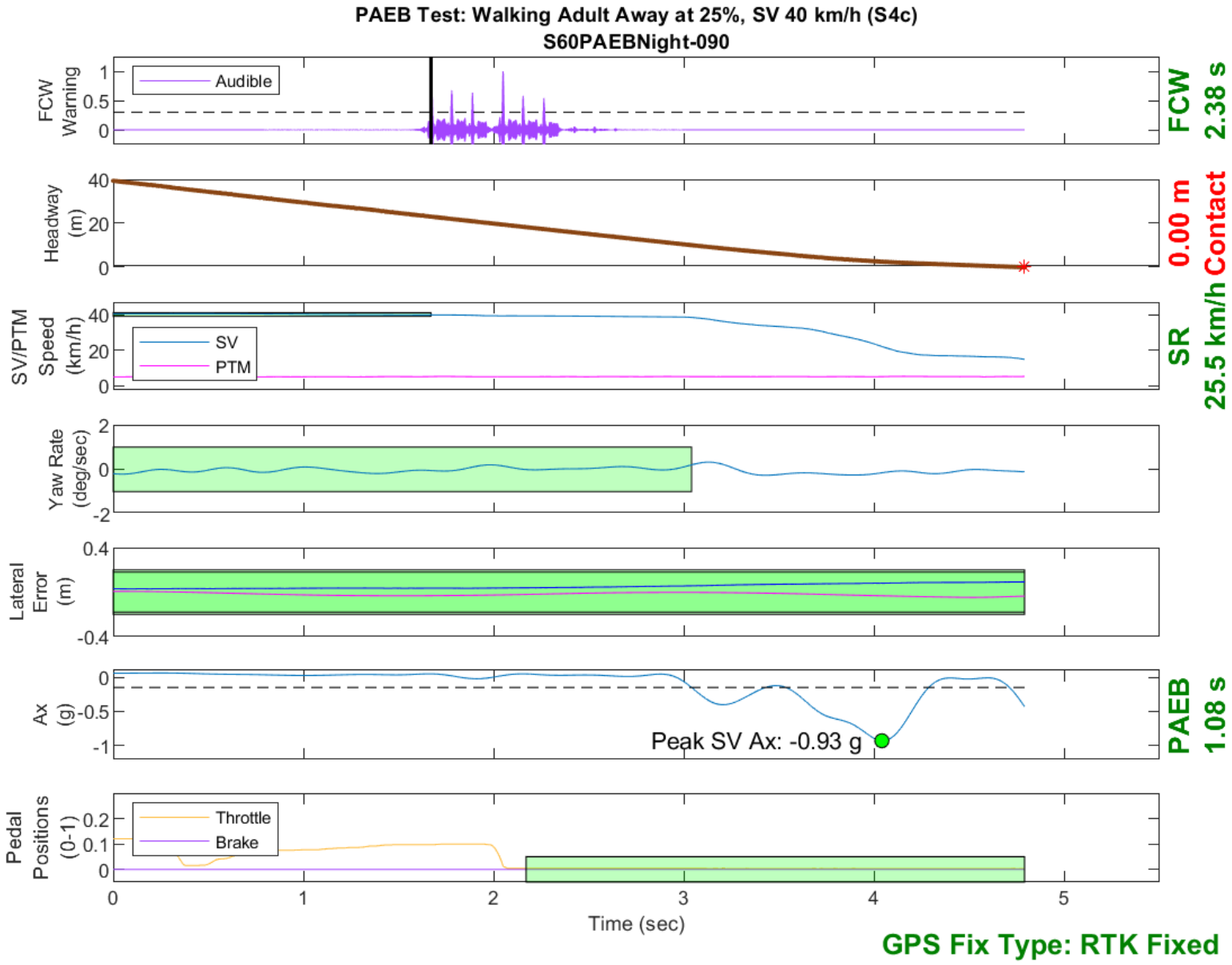


Figure D217. Time History for PAEB Run 90, S4c, Night, High Beam, 40 km/h

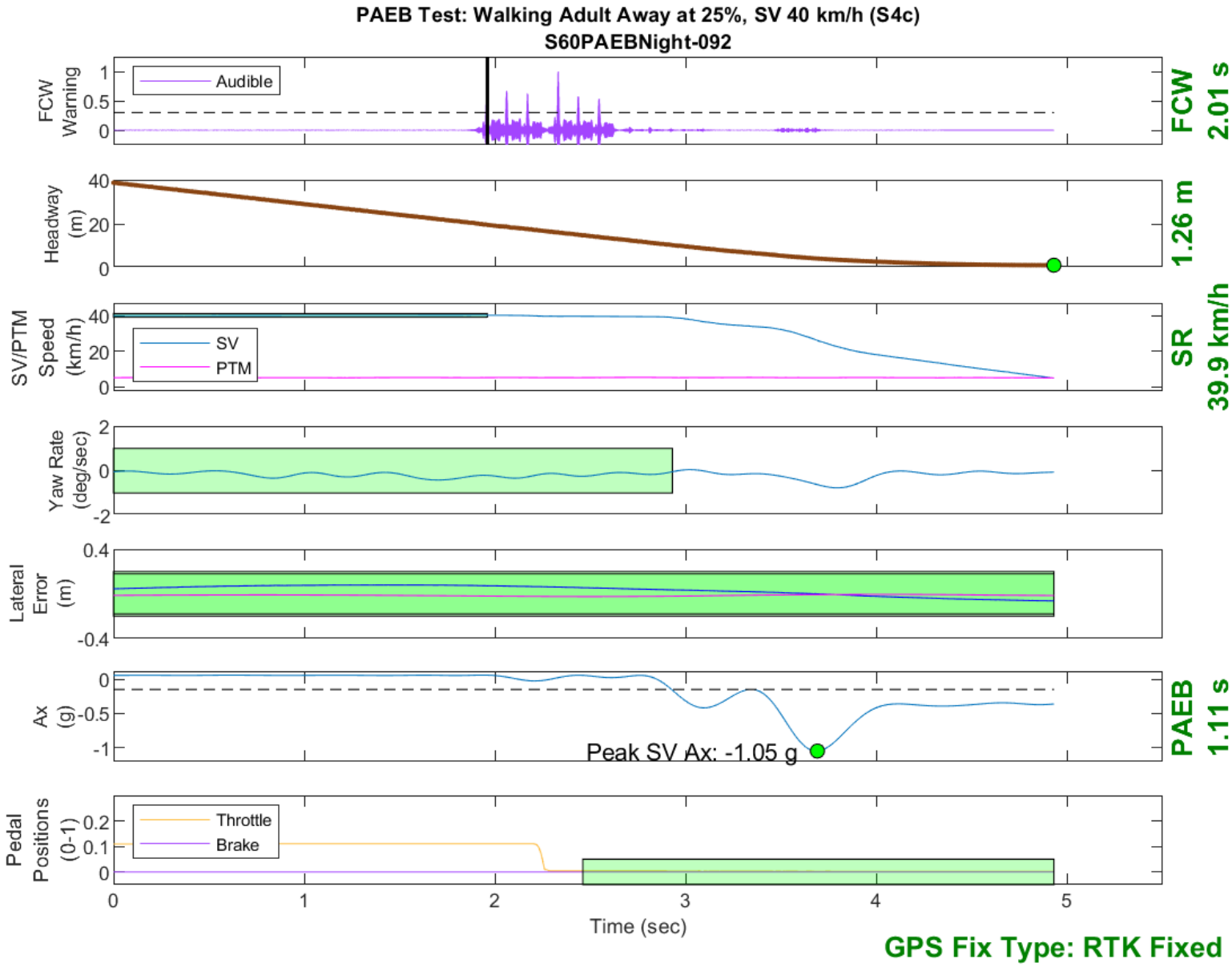


Figure D218. Time History for PAEB Run 92, S4c, Night, High Beam, 40 km/h

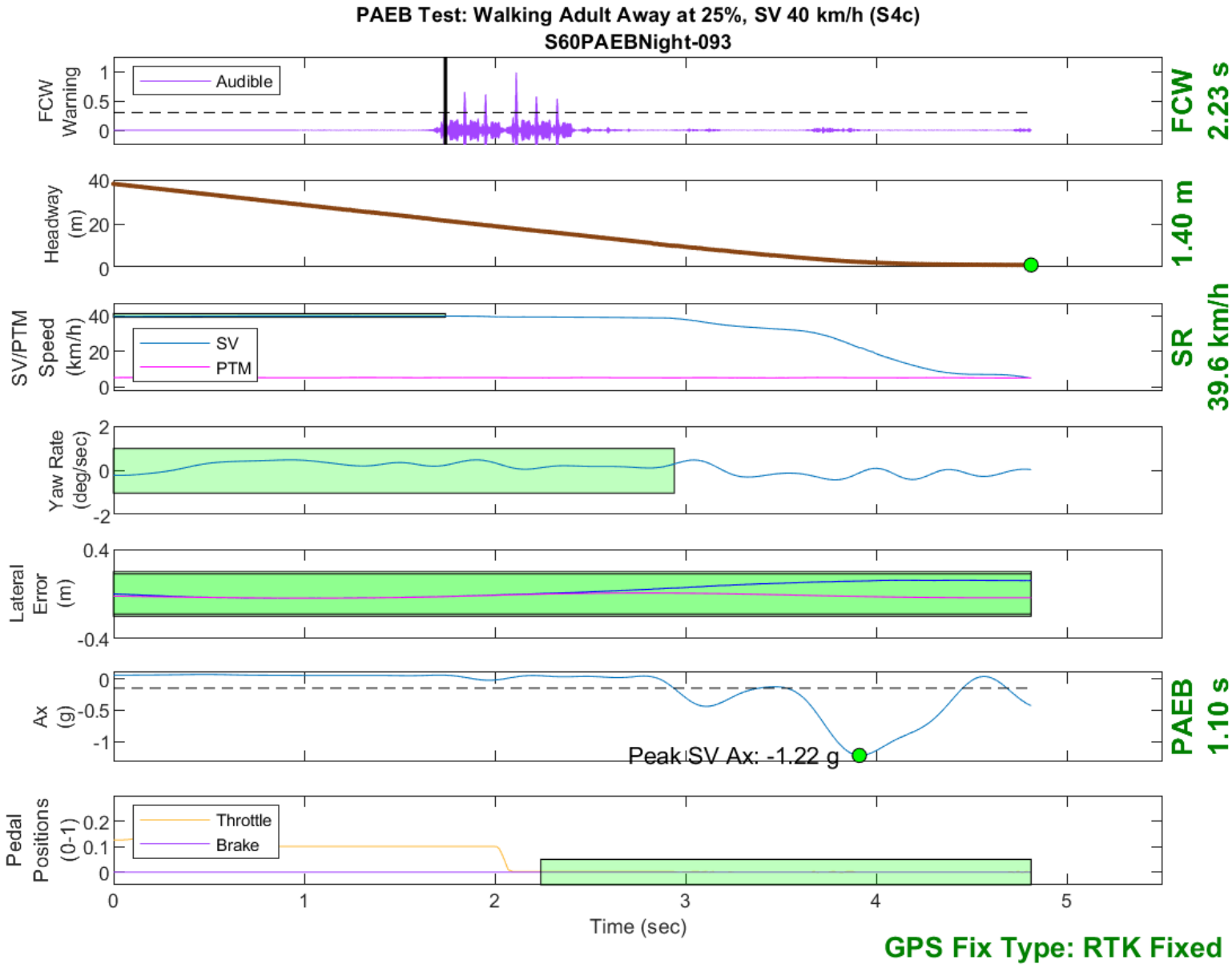


Figure D219. Time History for PAEB Run 93, S4c, Night, High Beam, 40 km/h

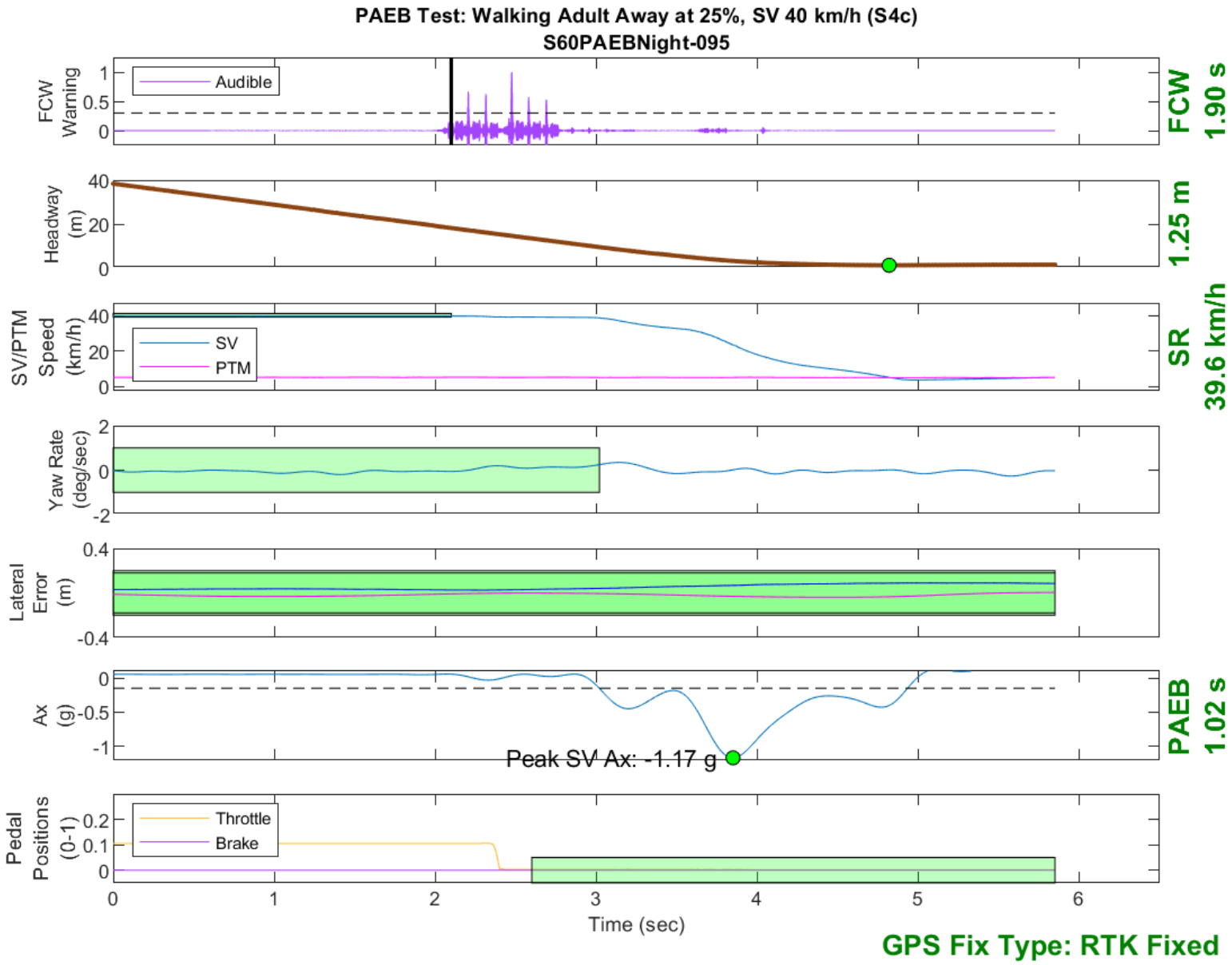


Figure D220. Time History for PAEB Run 95, S4c, Night, High Beam, 40 km/h

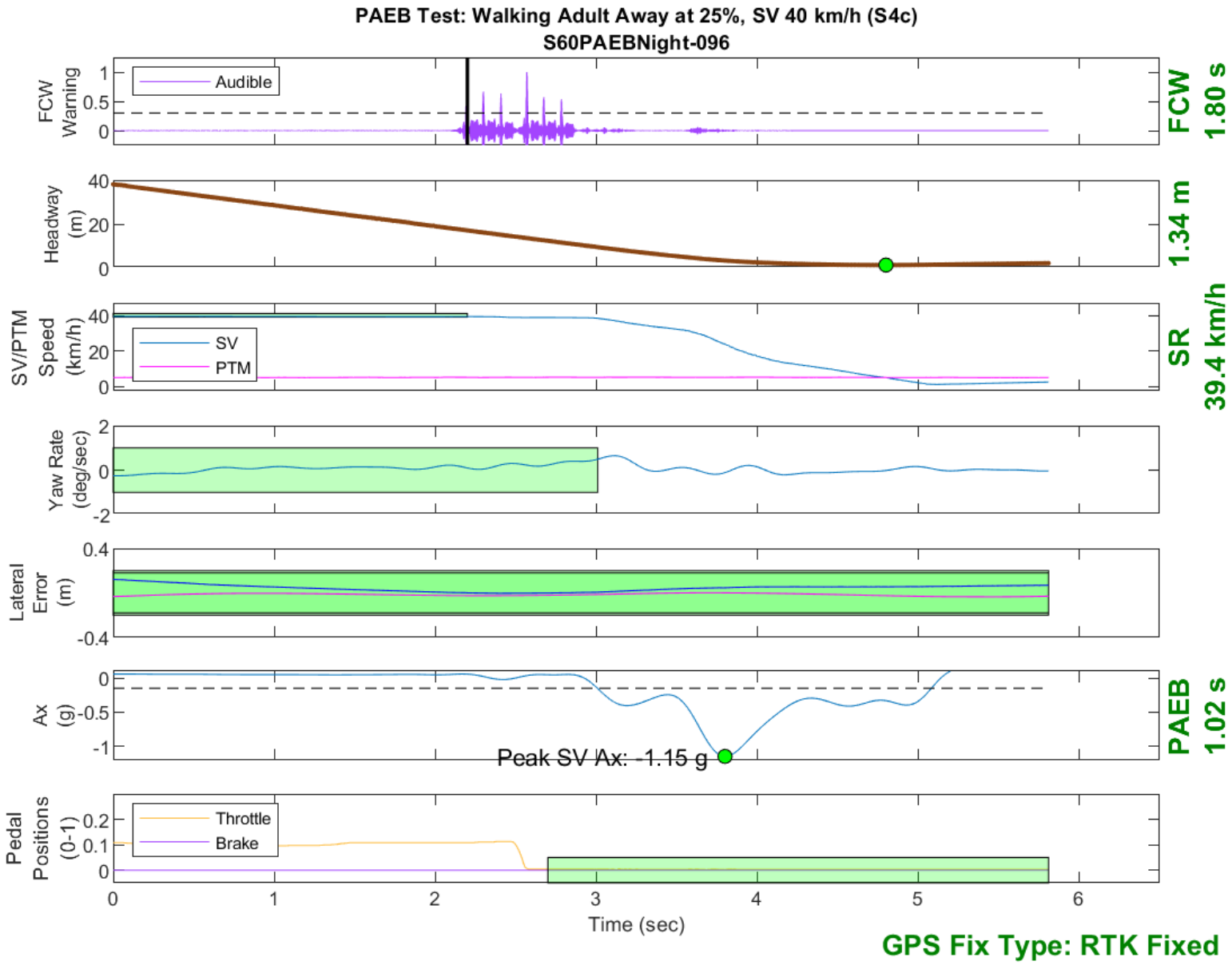


Figure D221. Time History for PAEB Run 96, S4c, Night, High Beam, 40 km/h

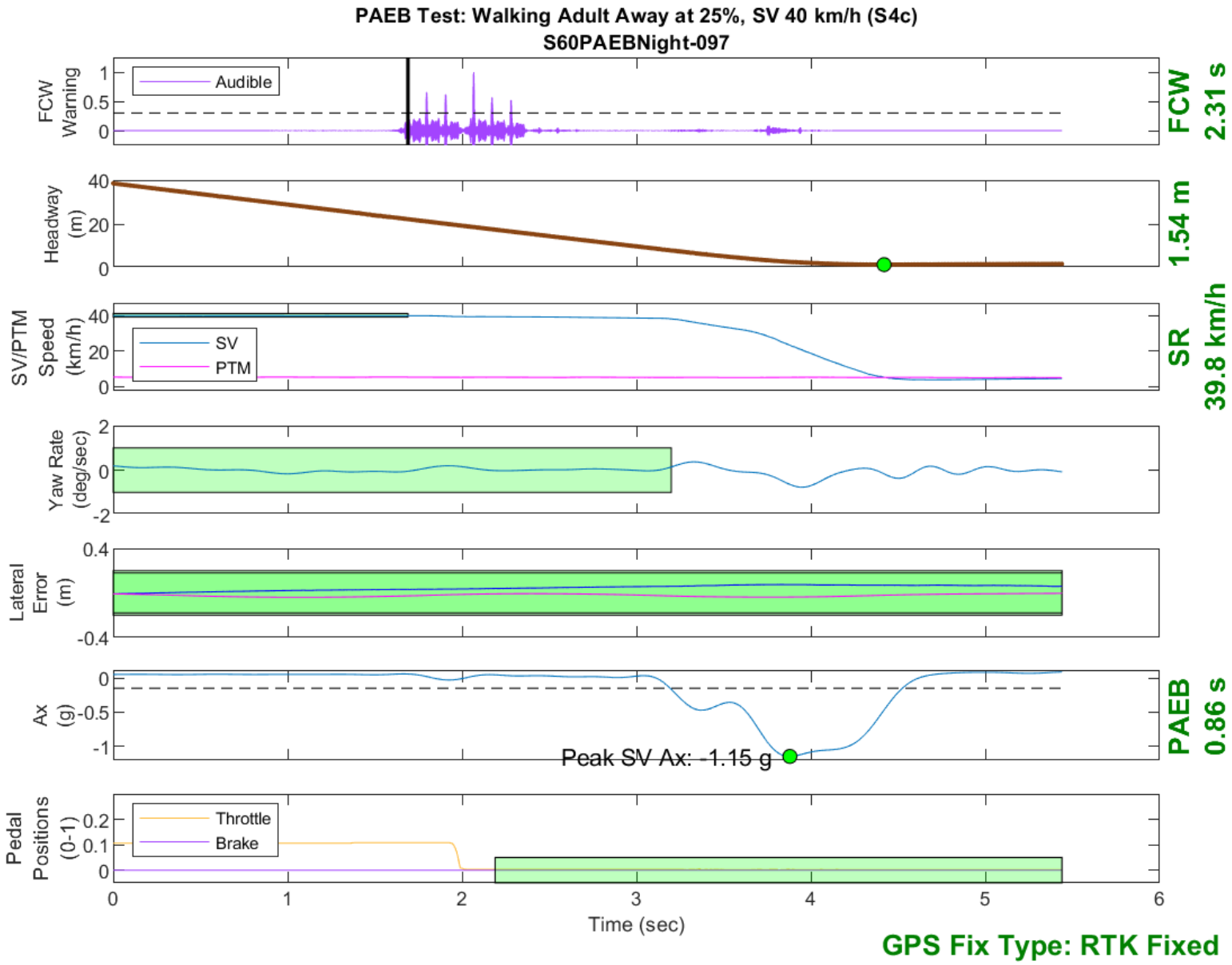


Figure D222. Time History for PAEB Run 97, S4c, Night, High Beam, 40 km/h

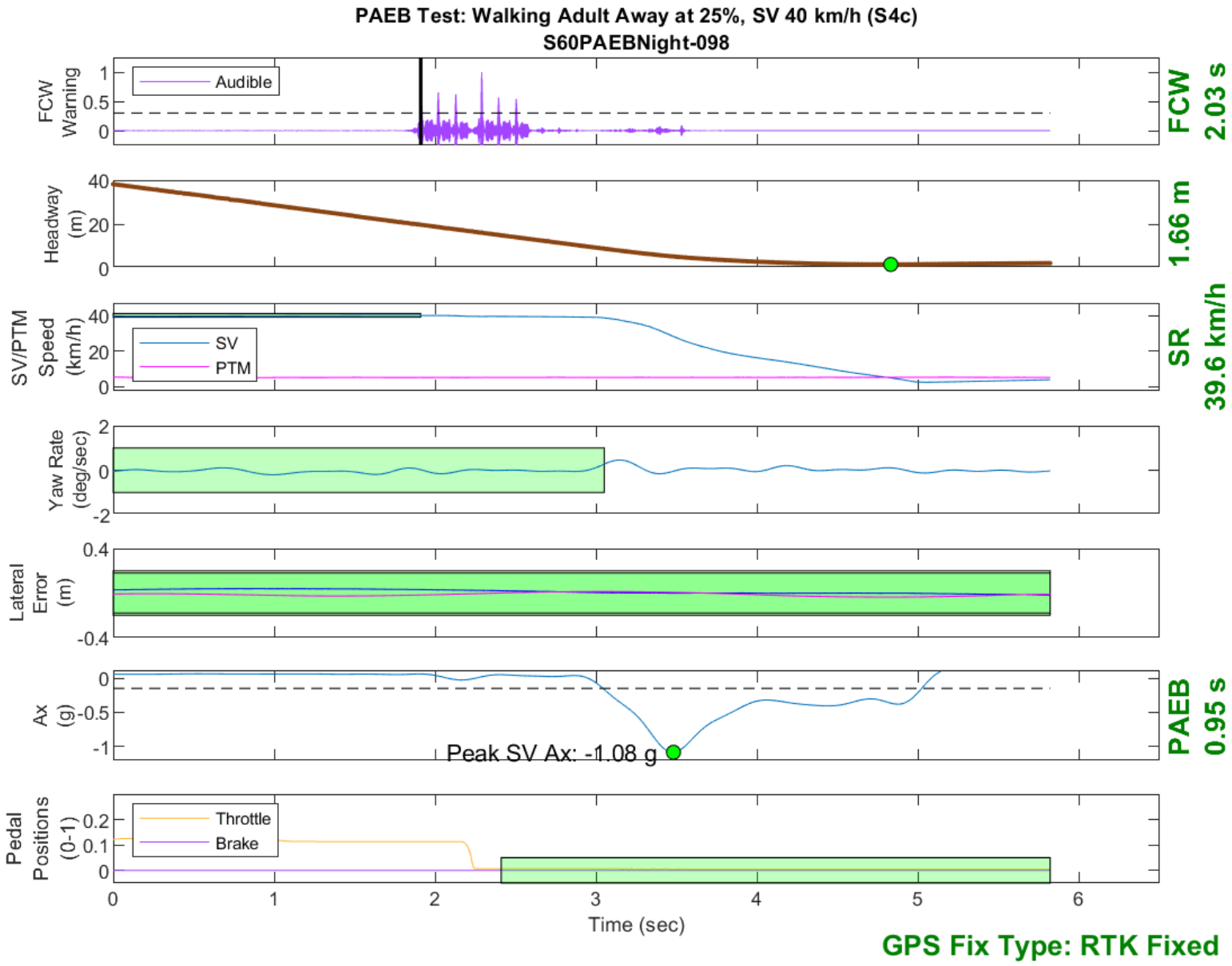


Figure D223. Time History for PAEB Run 98, S4c, Night, High Beam, 40 km/h

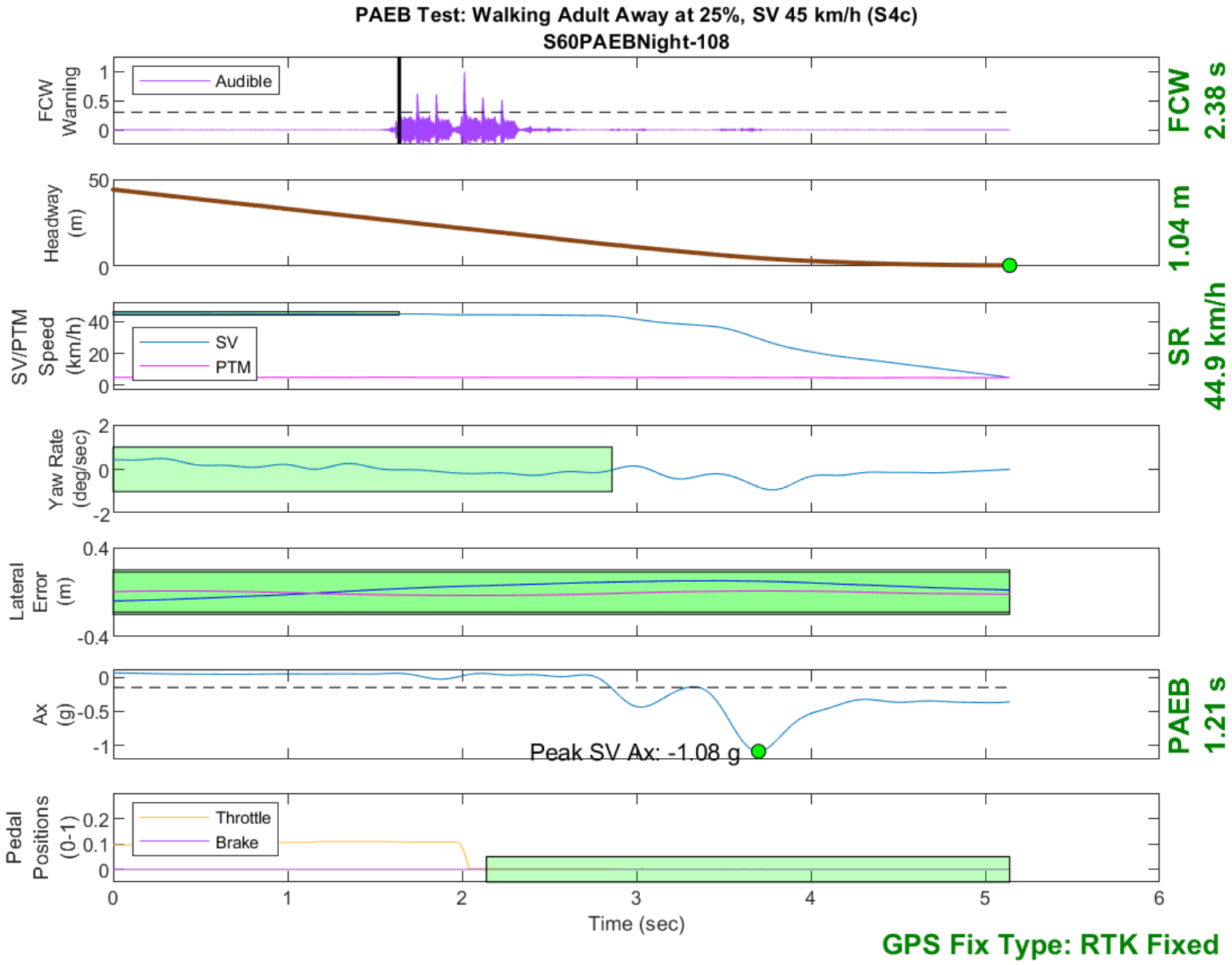


Figure D224. Time History for PAEB Run 108, S4c, Night, High Beam, 45 km/h

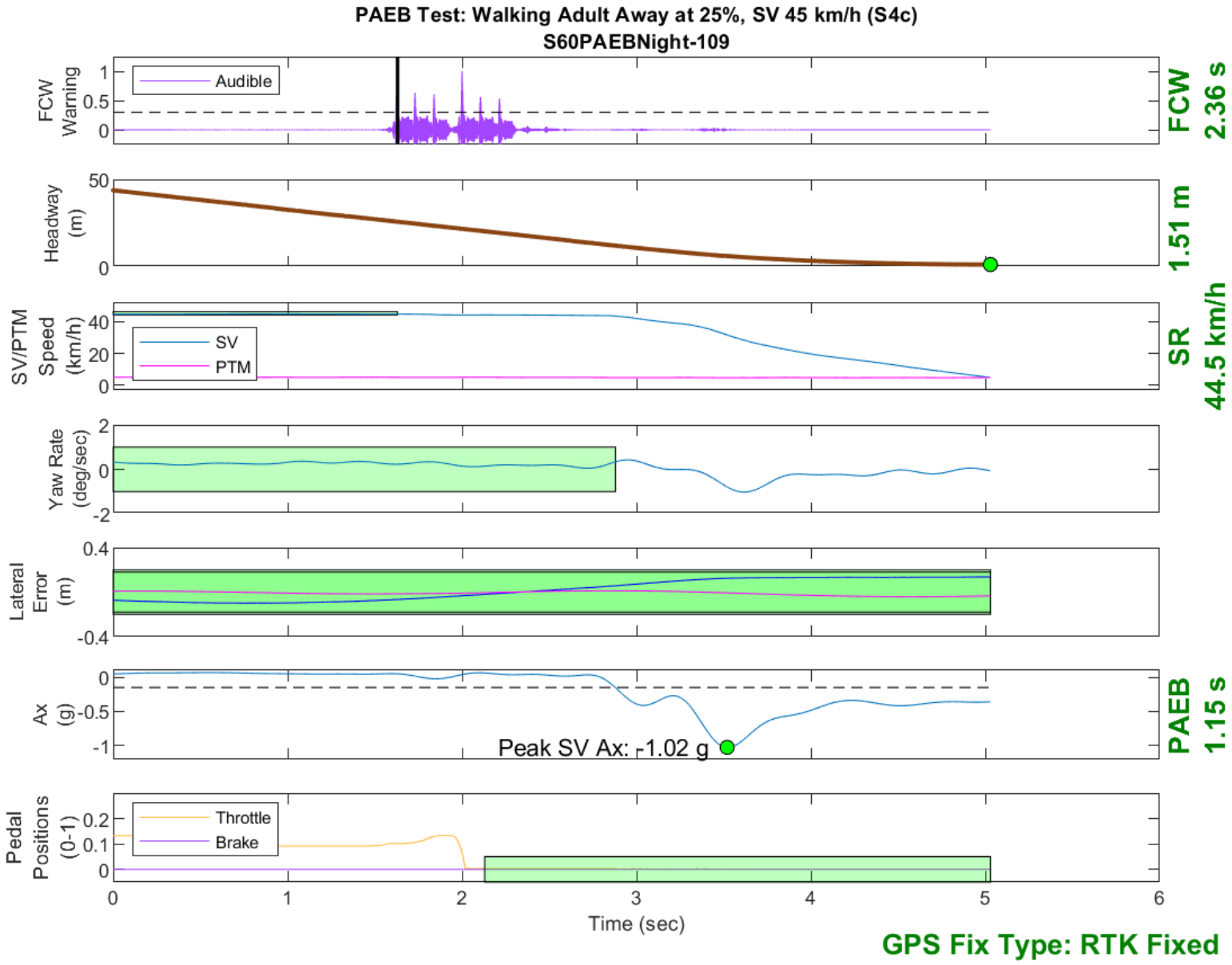


Figure D225. Time History for PAEB Run 109, S4c, Night, High Beam, 45 km/h

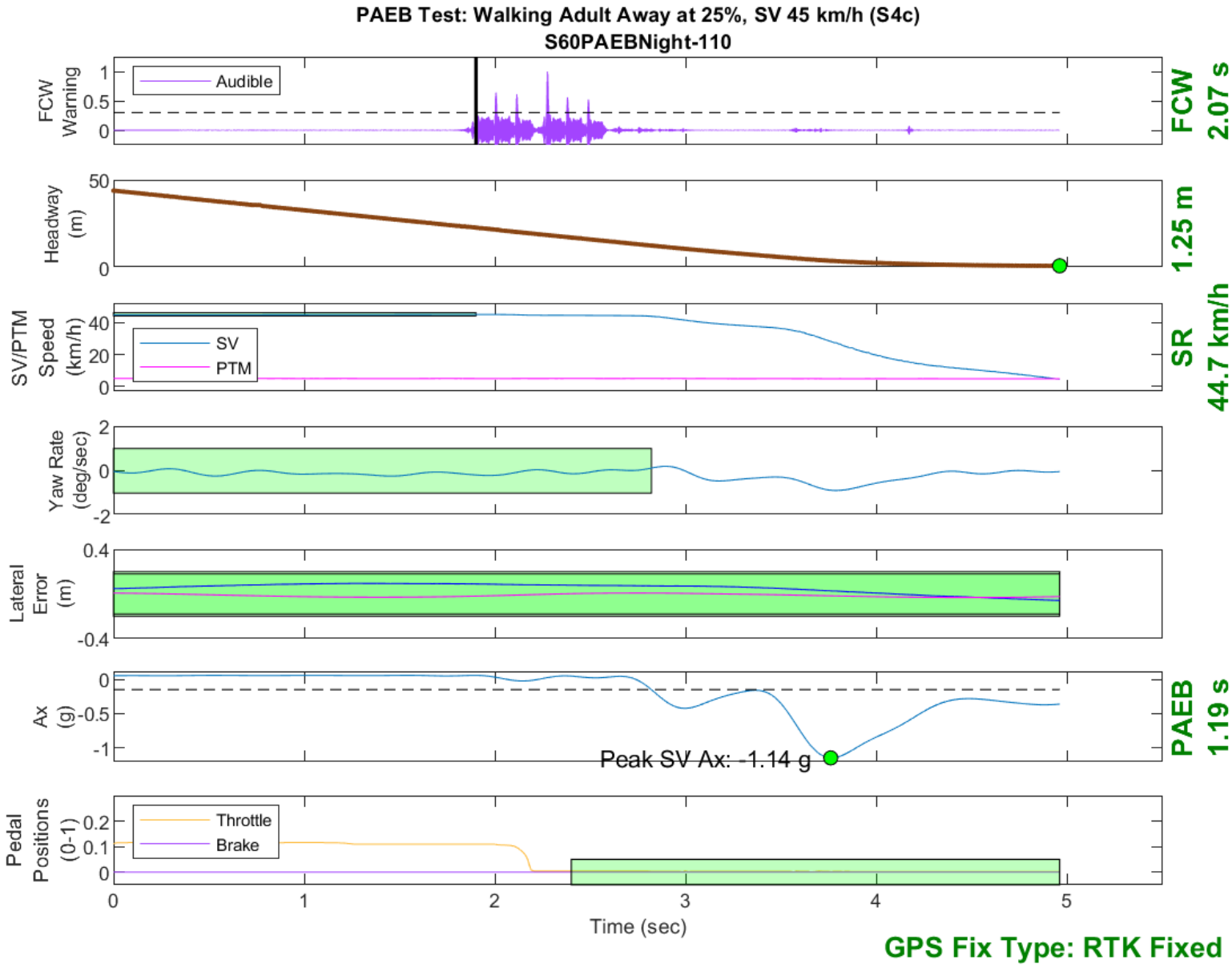


Figure D226. Time History for PAEB Run 110, S4c, Night, High Beam, 45 km/h

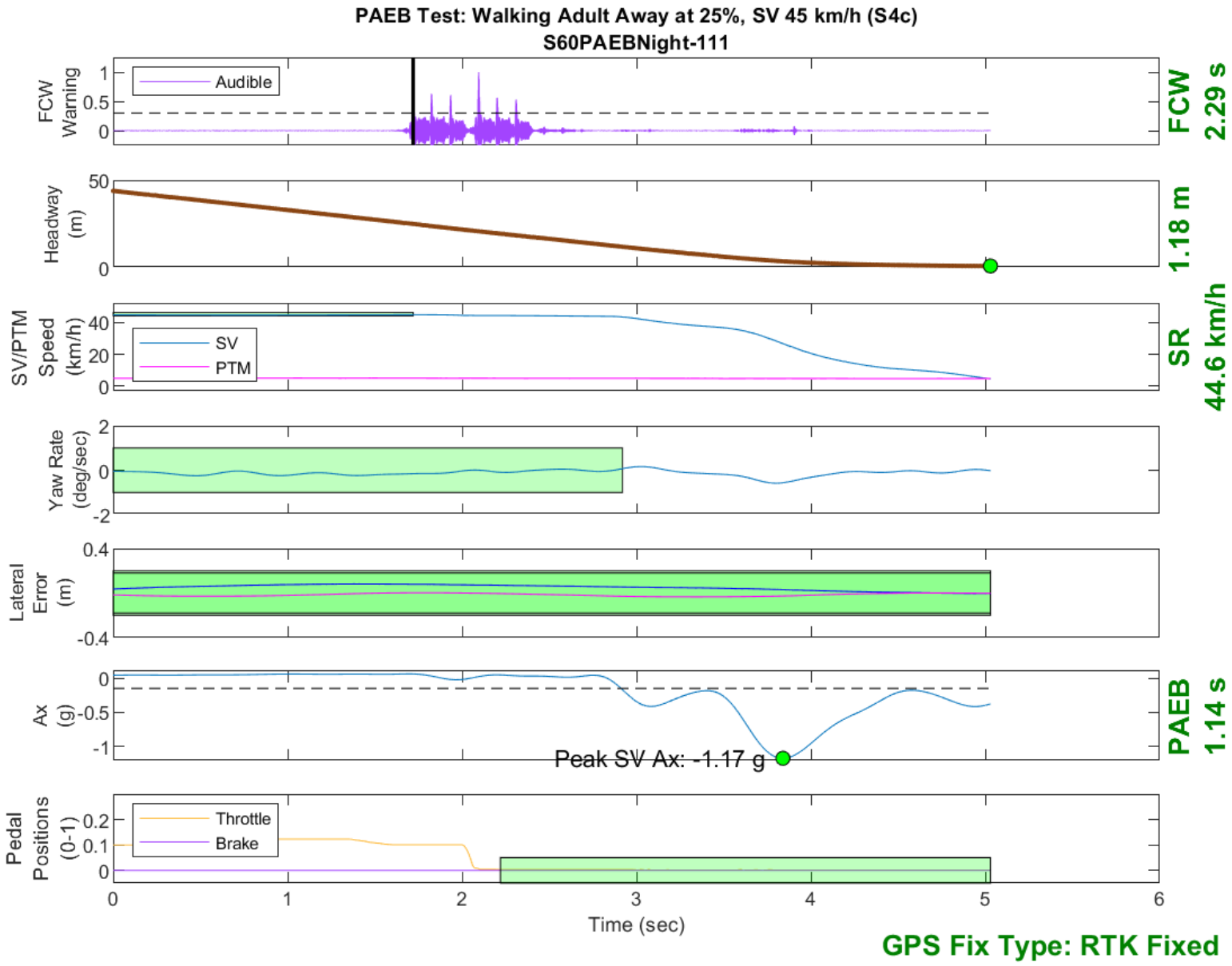


Figure D227. Time History for PAEB Run 111, S4c, Night, High Beam, 45 km/h

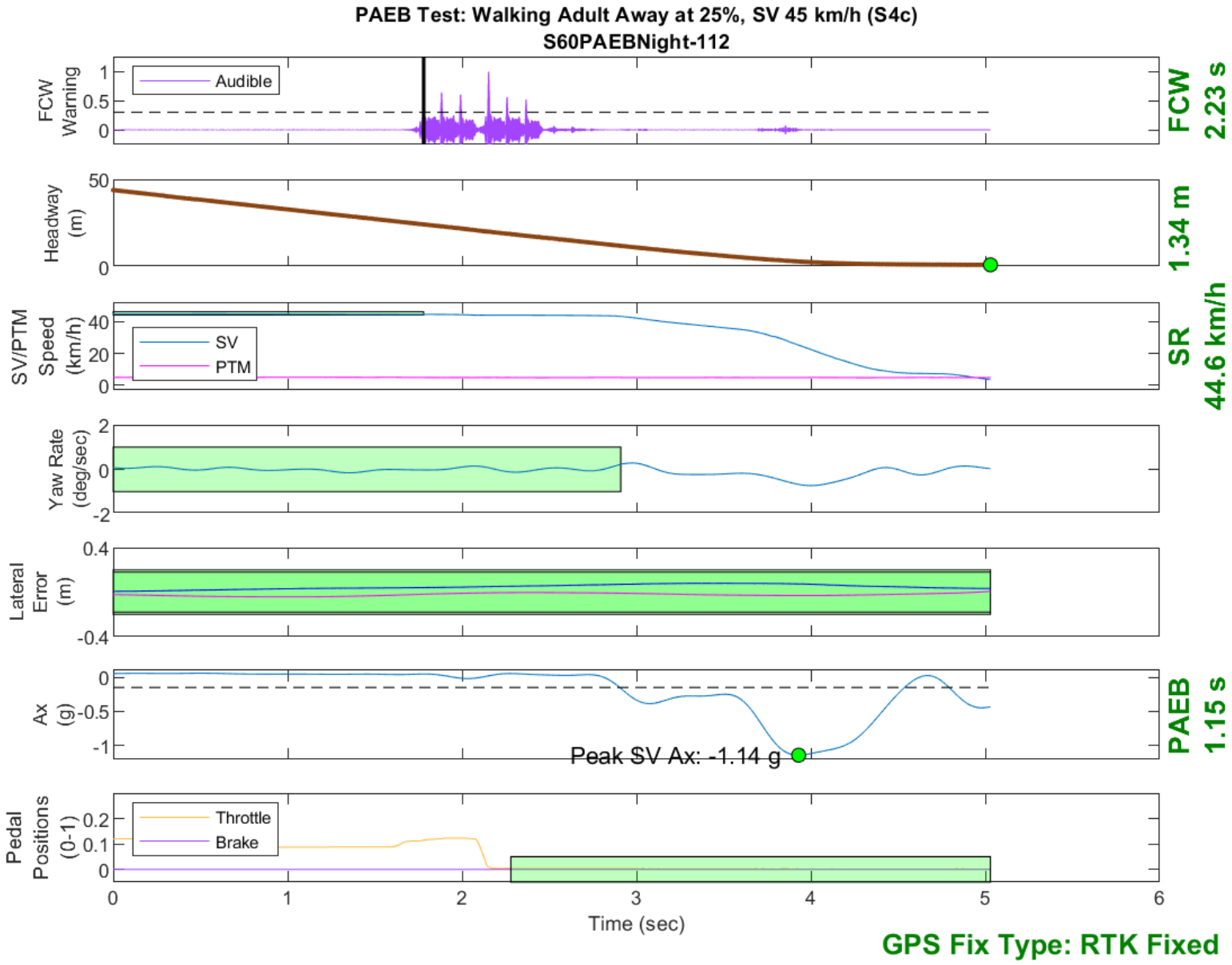


Figure D228. Time History for PAEB Run 112, S4c, Night, High Beam, 45 km/h

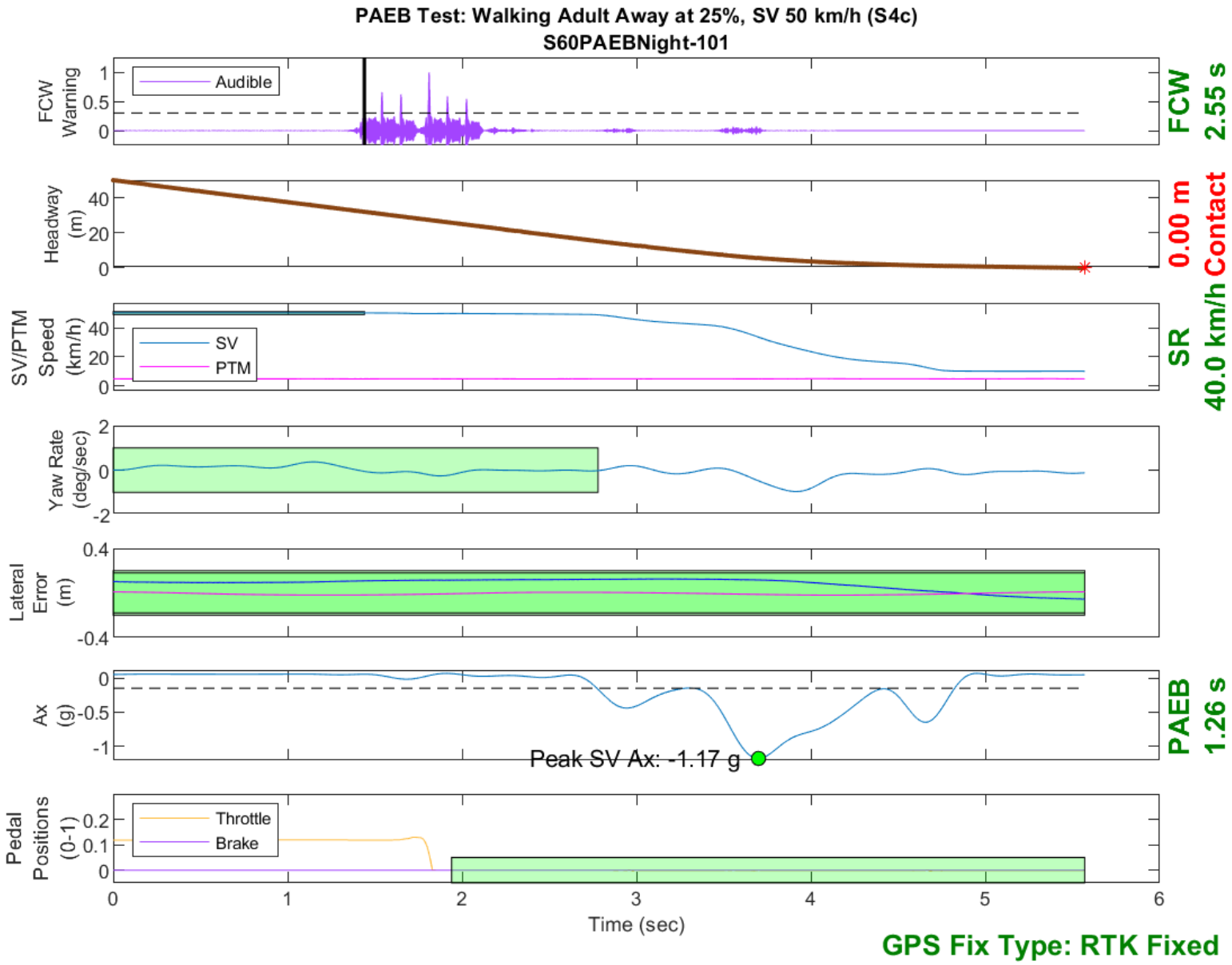


Figure D229. Time History for PAEB Run 101, S4c, Night, High Beam, 50 km/h



Figure D230. Time History for PAEB Run 102, S4c, Night, High Beam, 50 km/h

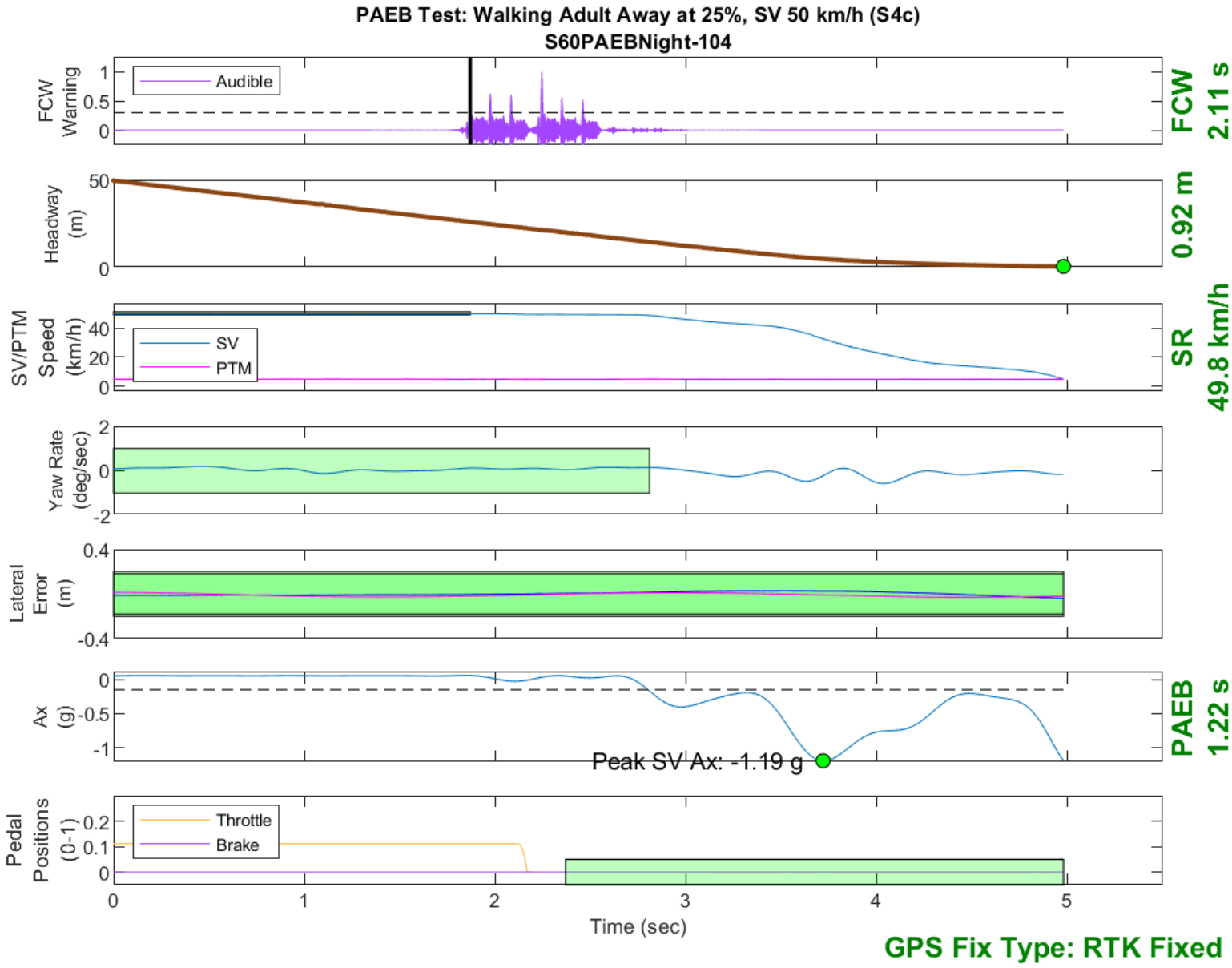


Figure D231. Time History for PAEB Run 104, S4c, Night, High Beam, 50 km/h

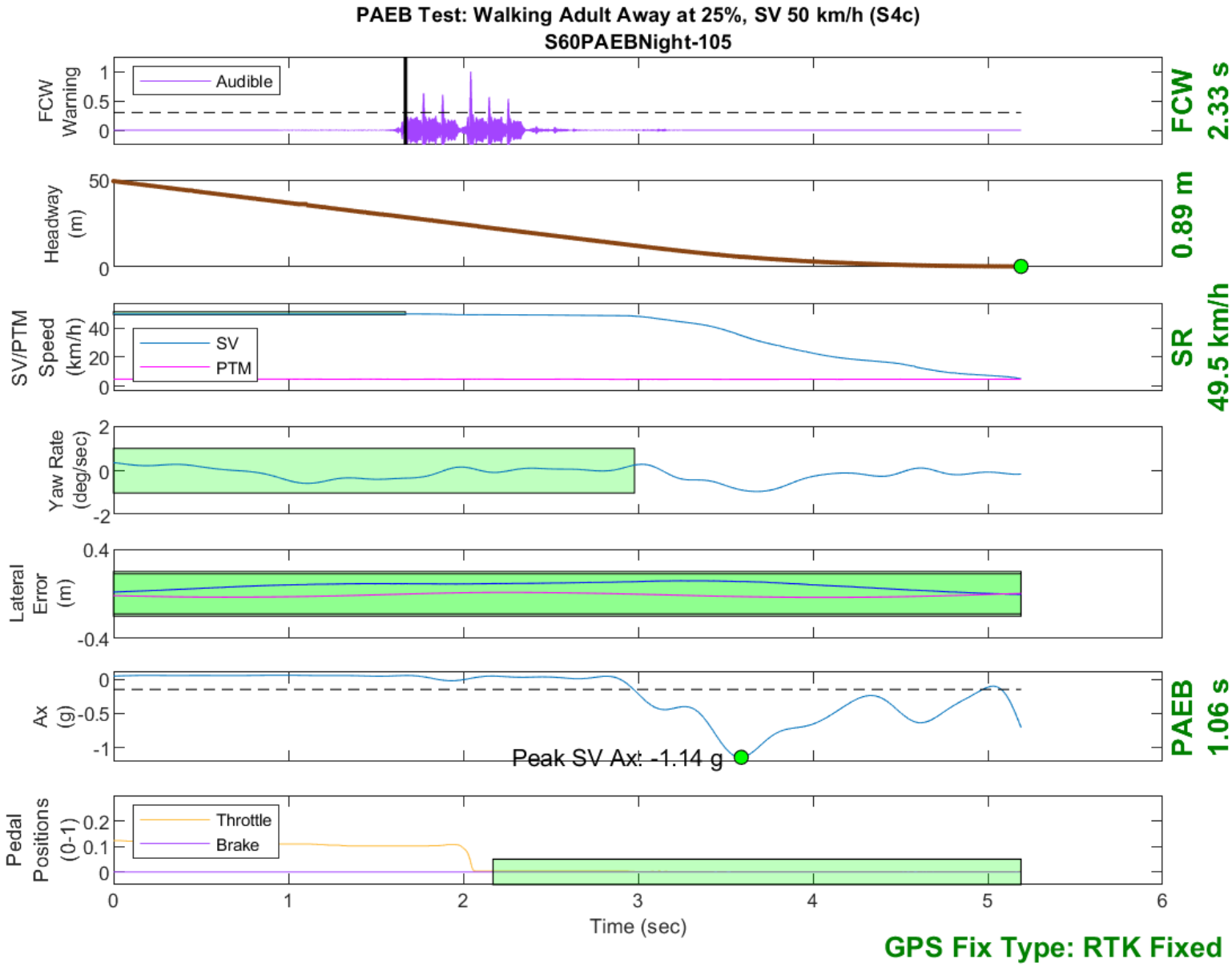


Figure D232. Time History for PAEB Run 105, S4c, Night, High Beam, 50 km/h

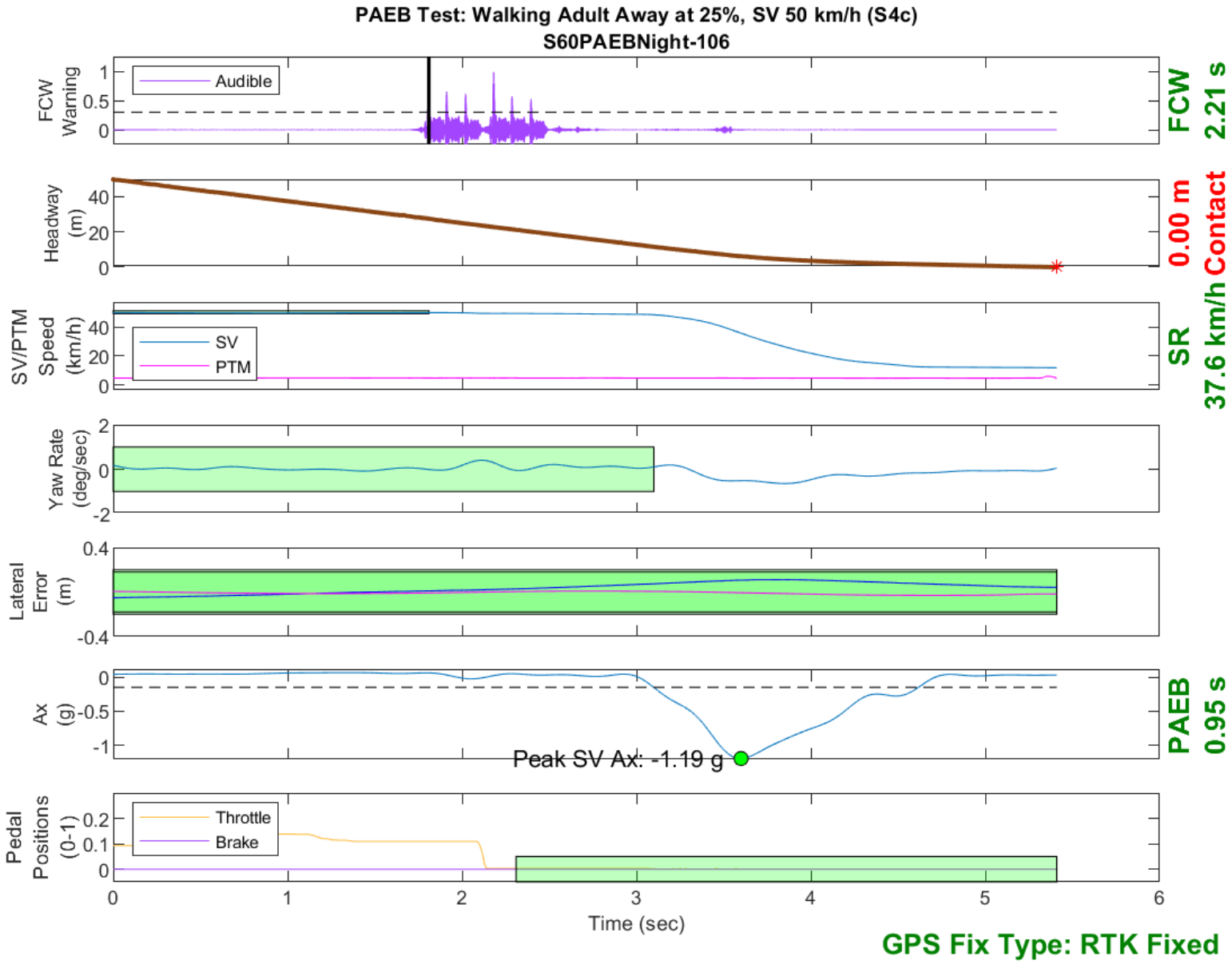


Figure D233. Time History for PAEB Run 106, S4c, Night, High Beam, 50 km/h

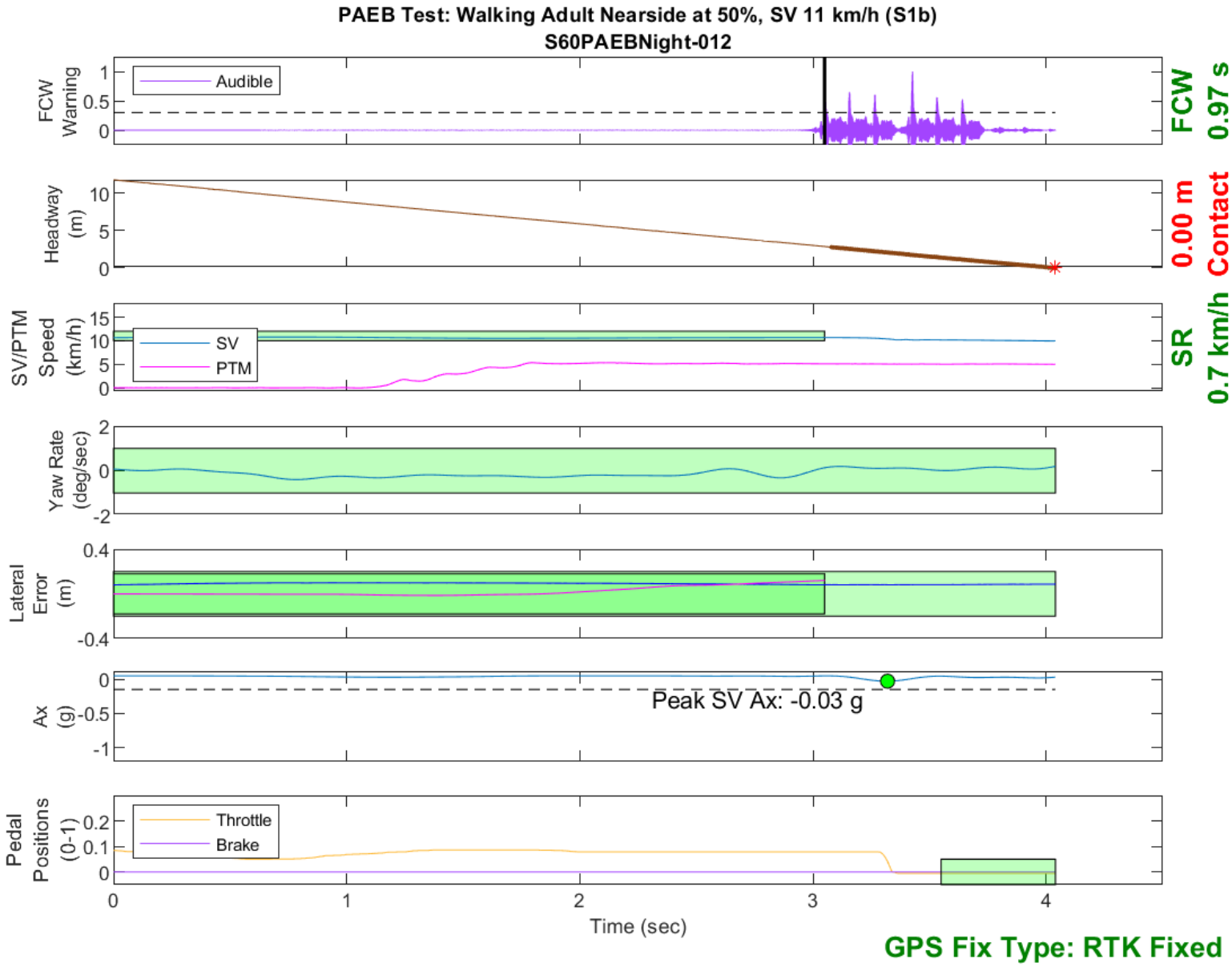


Figure D234. Time History for PAEB Run 12, S1b, Night, Low Beam, 11 km/h

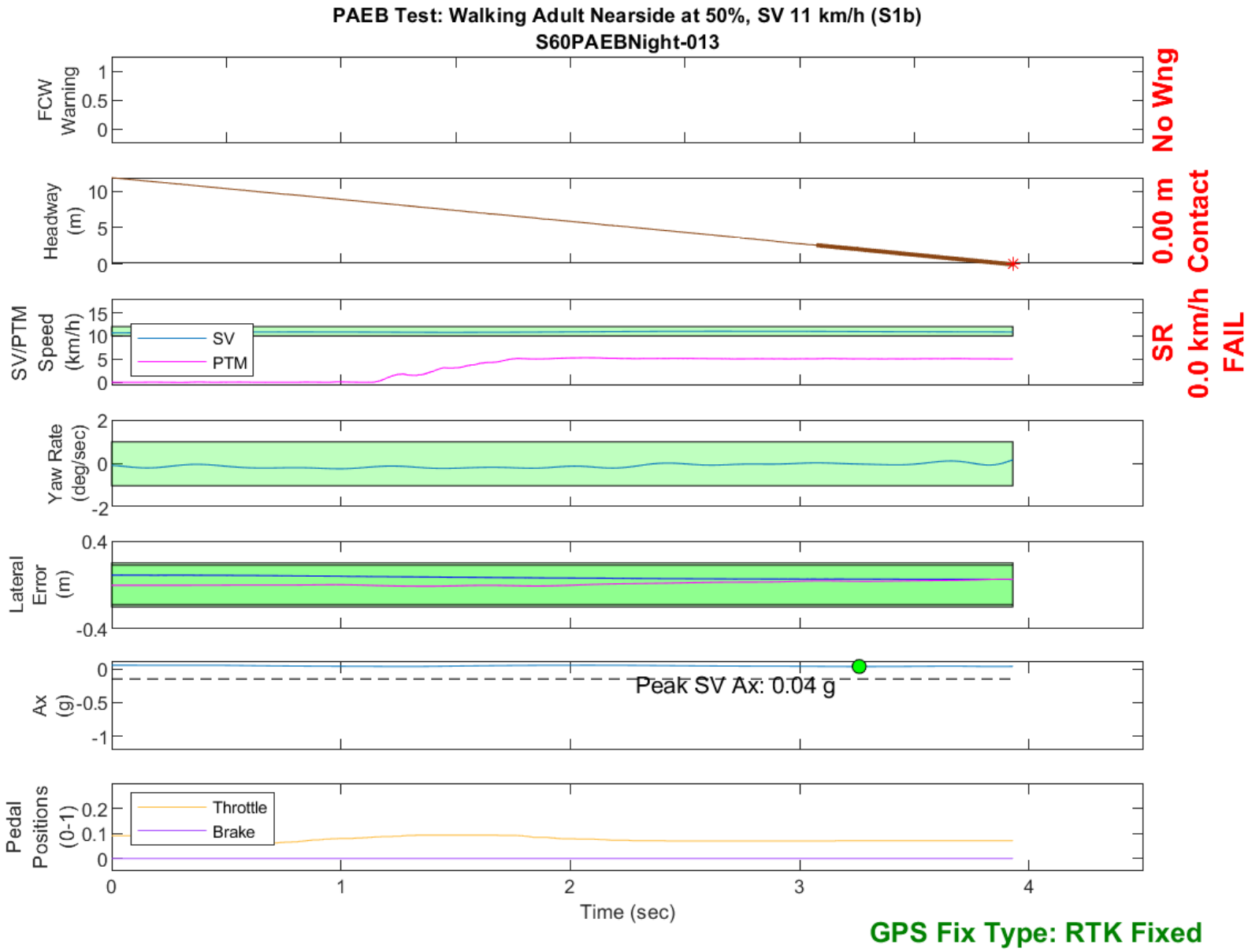


Figure D235. Time History for PAEB Run 13, S1b, Night, Low Beam, 11 km/h

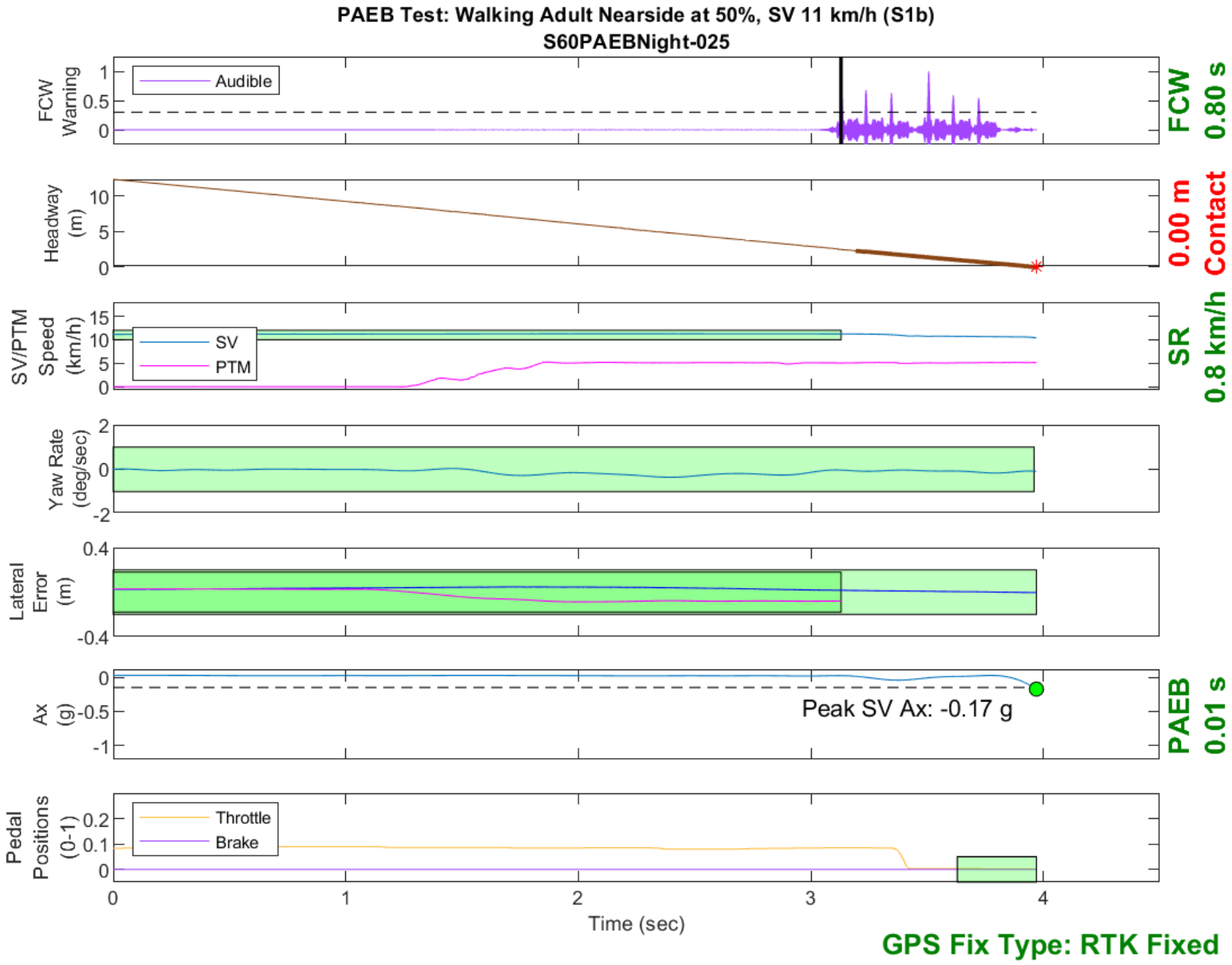


Figure D236. Time History for PAEB Run 25, S1b, Night, Low Beam, 11 km/h

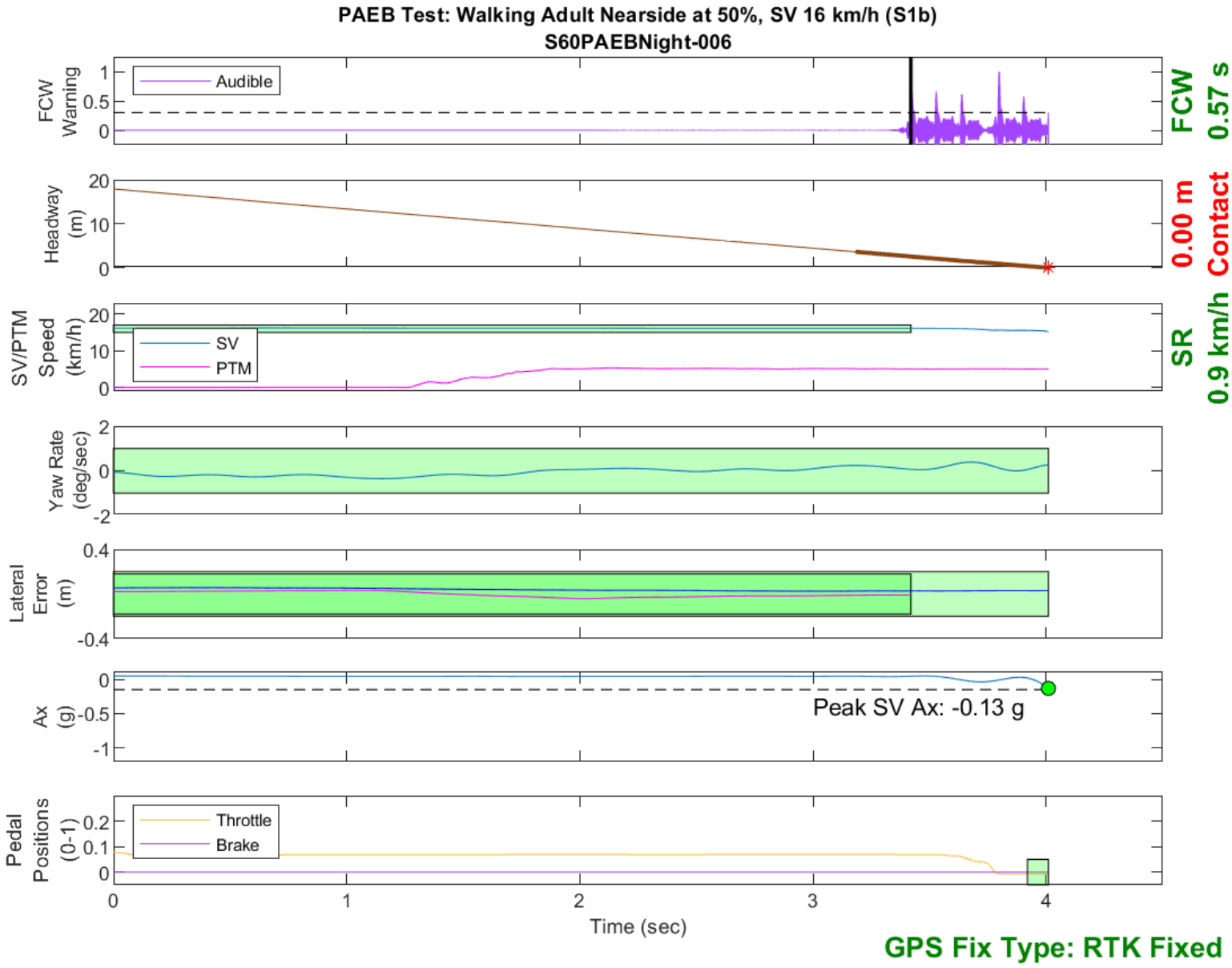


Figure D237. Time History for PAEB Run 6, S1b, Night, Low Beam, 16 km/h

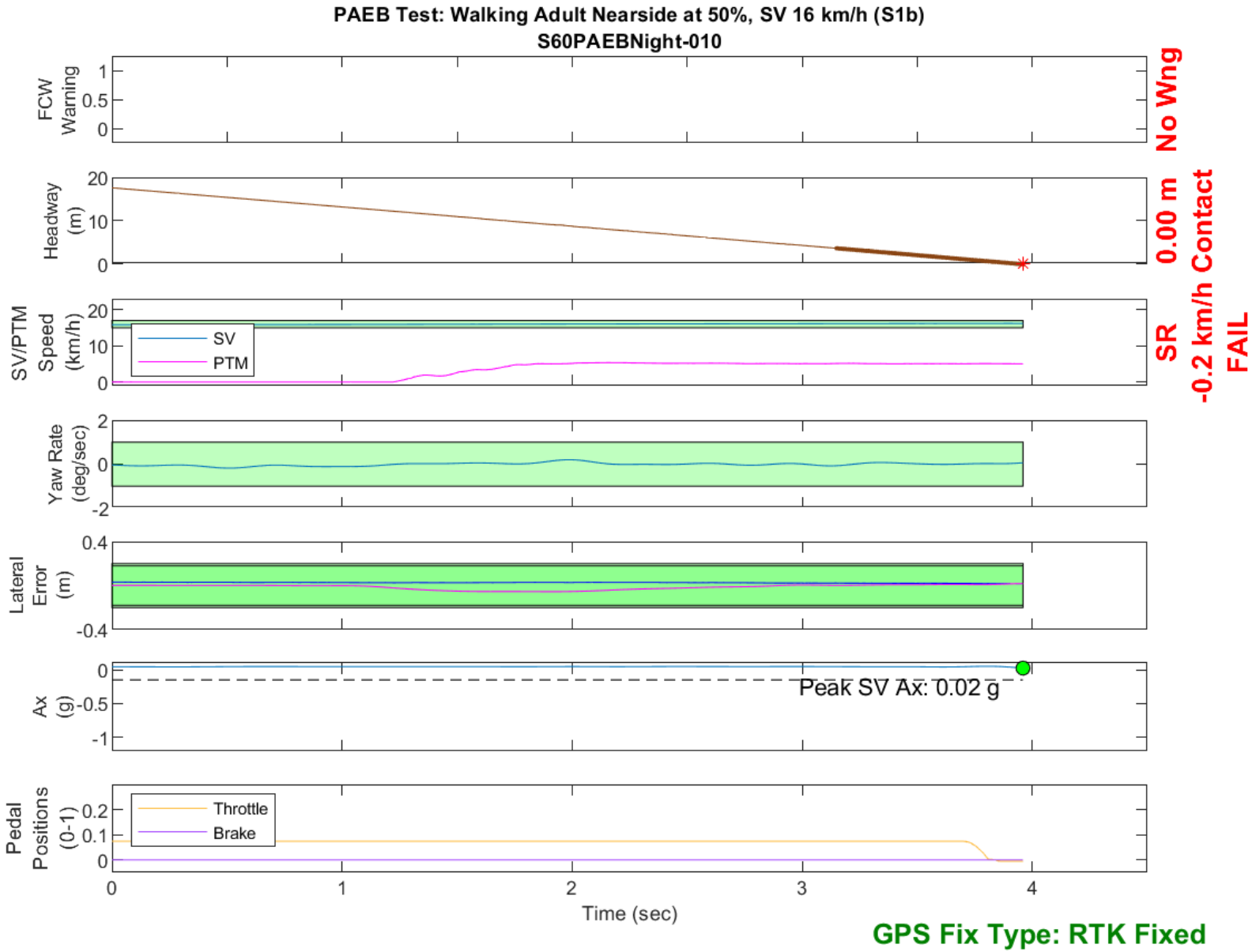


Figure D238. Time History for PAEB Run 10, S1b, Night, Low Beam, 16 km/h

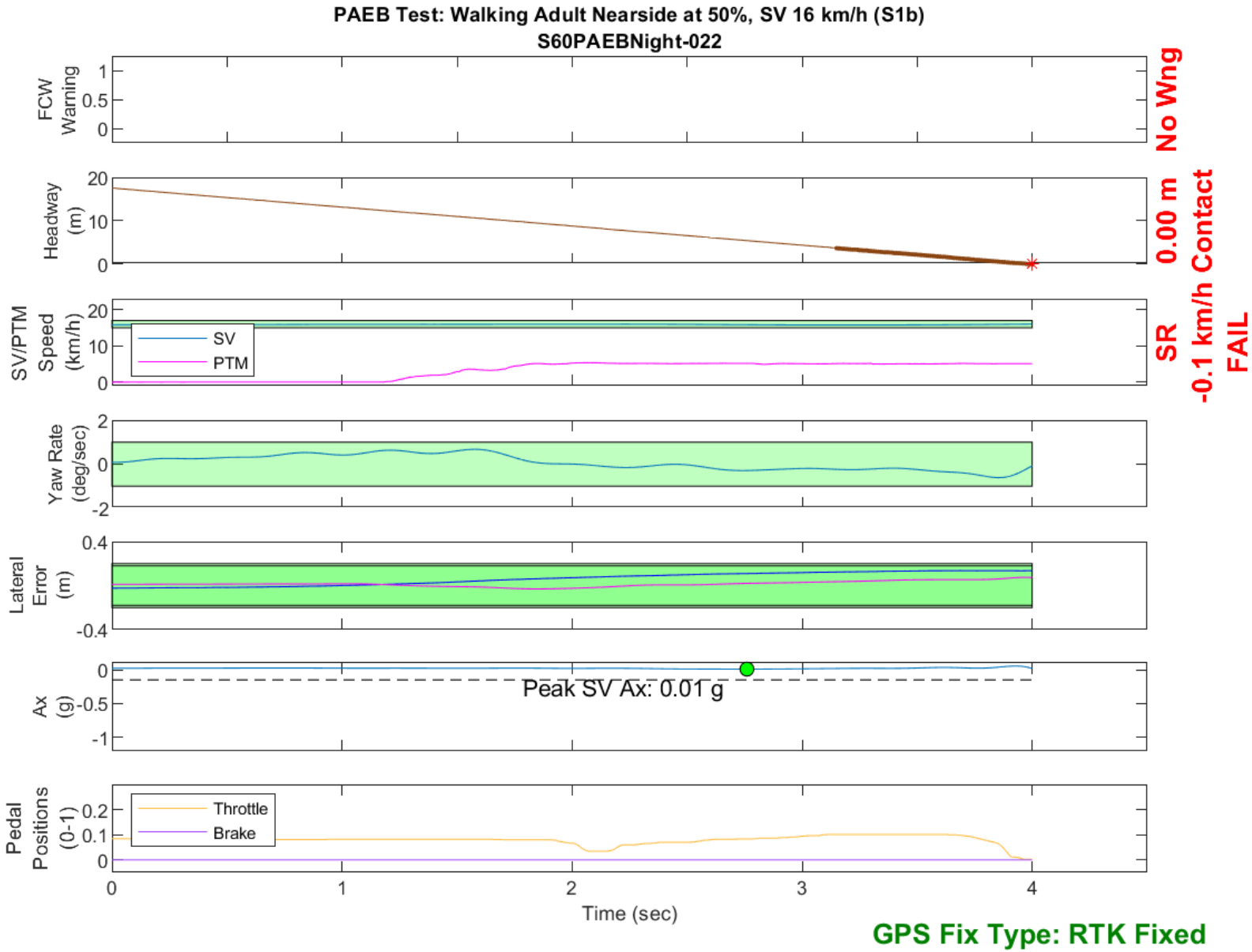


Figure D239. Time History for PAEB Run 22, S1b, Night, Low Beam, 16 km/h

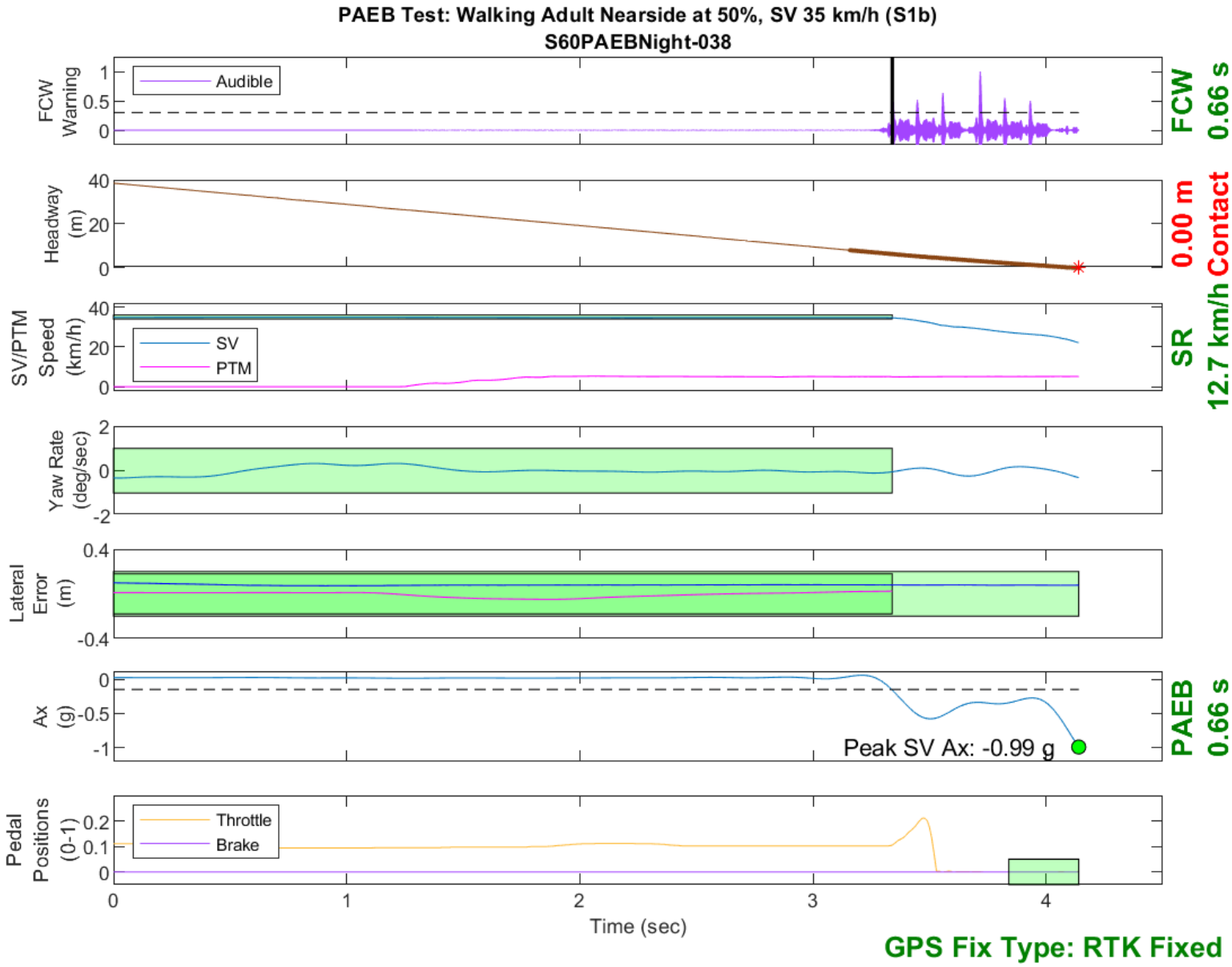


Figure D240. Time History for PAEB Run 38, S1b, Night, Low Beam, 35 km/h

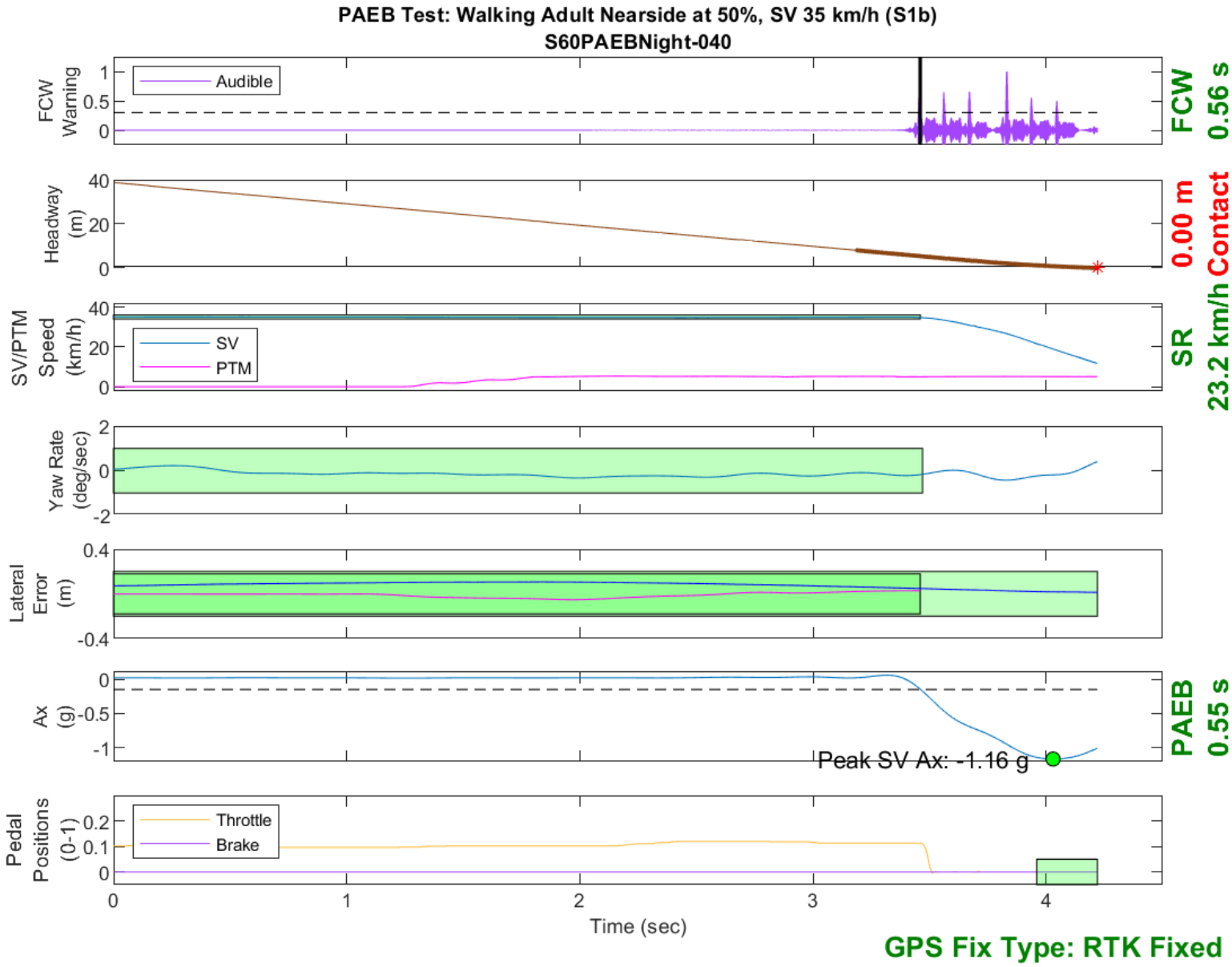


Figure D241. Time History for PAEB Run 40, S1b, Night, Low Beam, 35 km/h

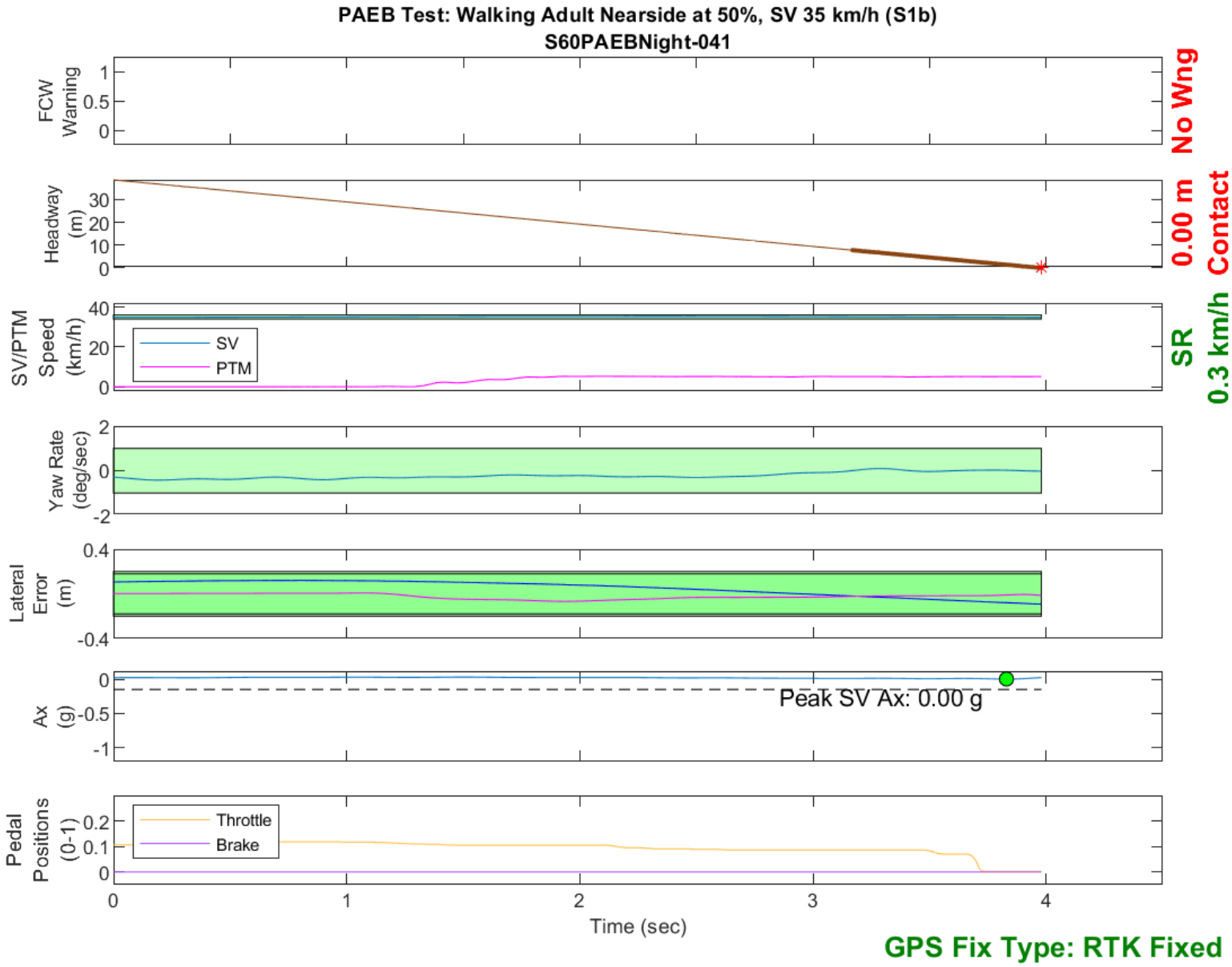


Figure D242. Time History for PAEB Run 41, S1b, Night, Low Beam, 35 km/h



Figure D243. Time History for PAEB Run 33, S1b, Night, Low Beam, 40 km/h

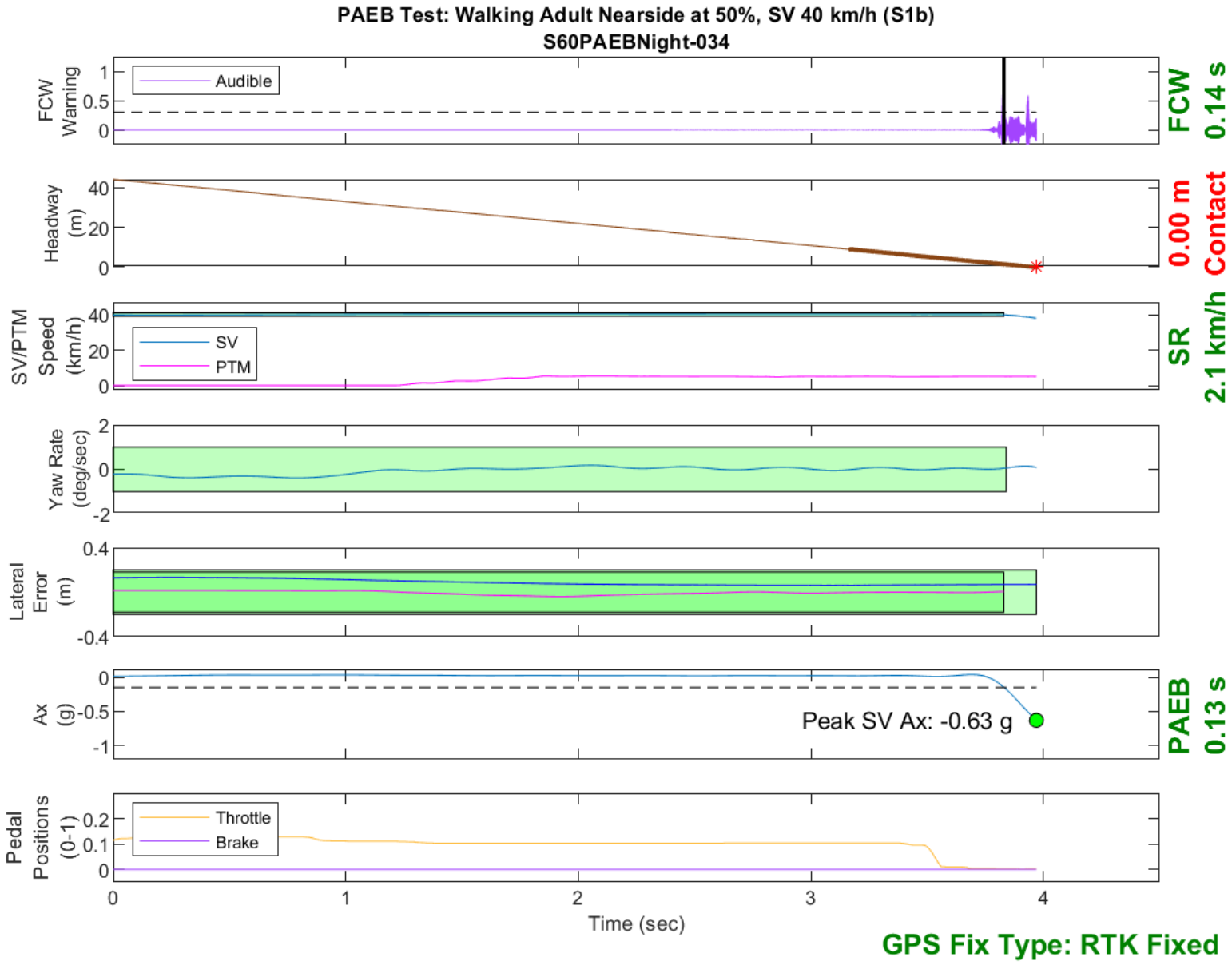


Figure D244. Time History for PAEB Run 34, S1b, Night, Low Beam, 40 km/h

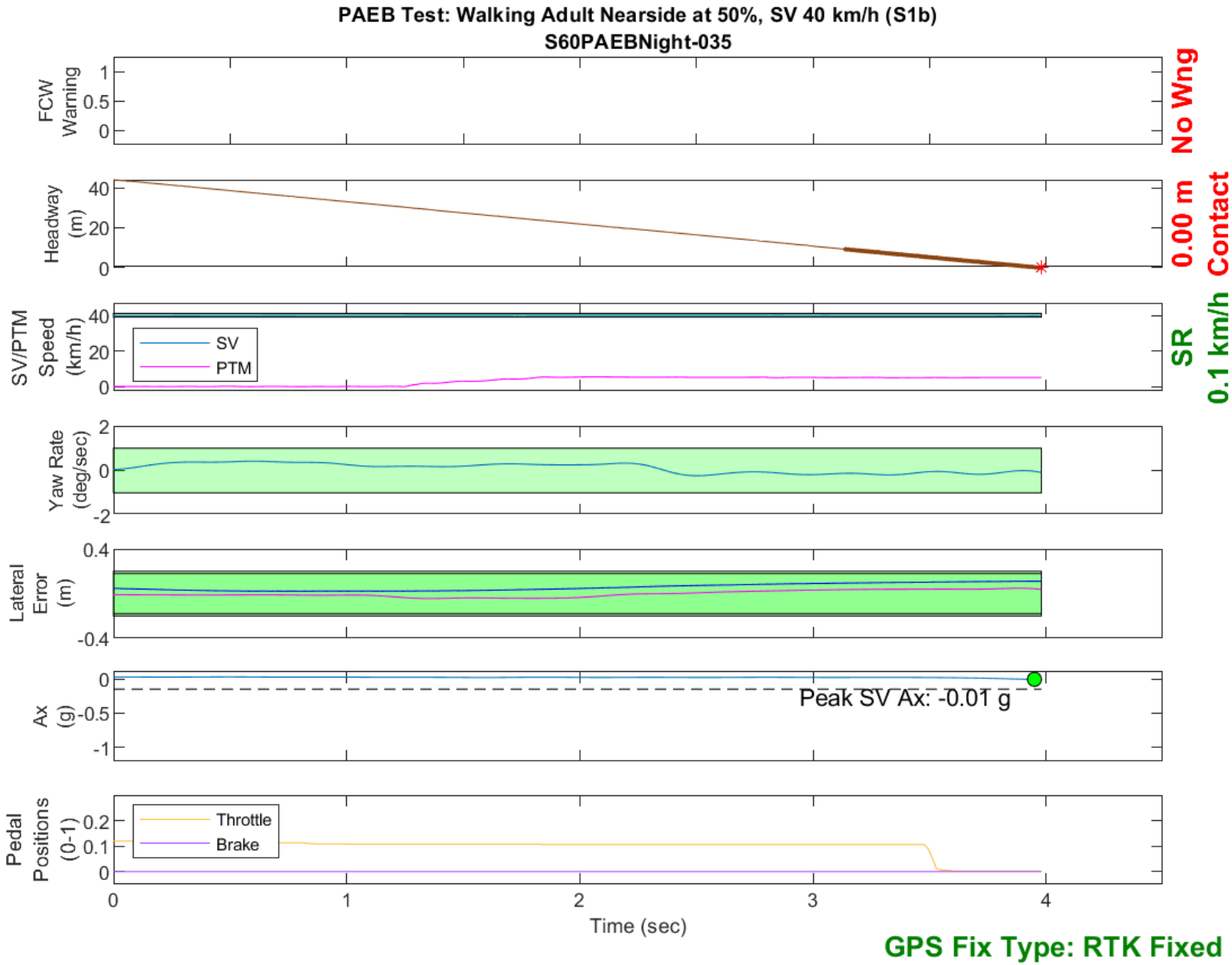


Figure D245. Time History for PAEB Run 35, S1b, Night, Low Beam, 40 km/h

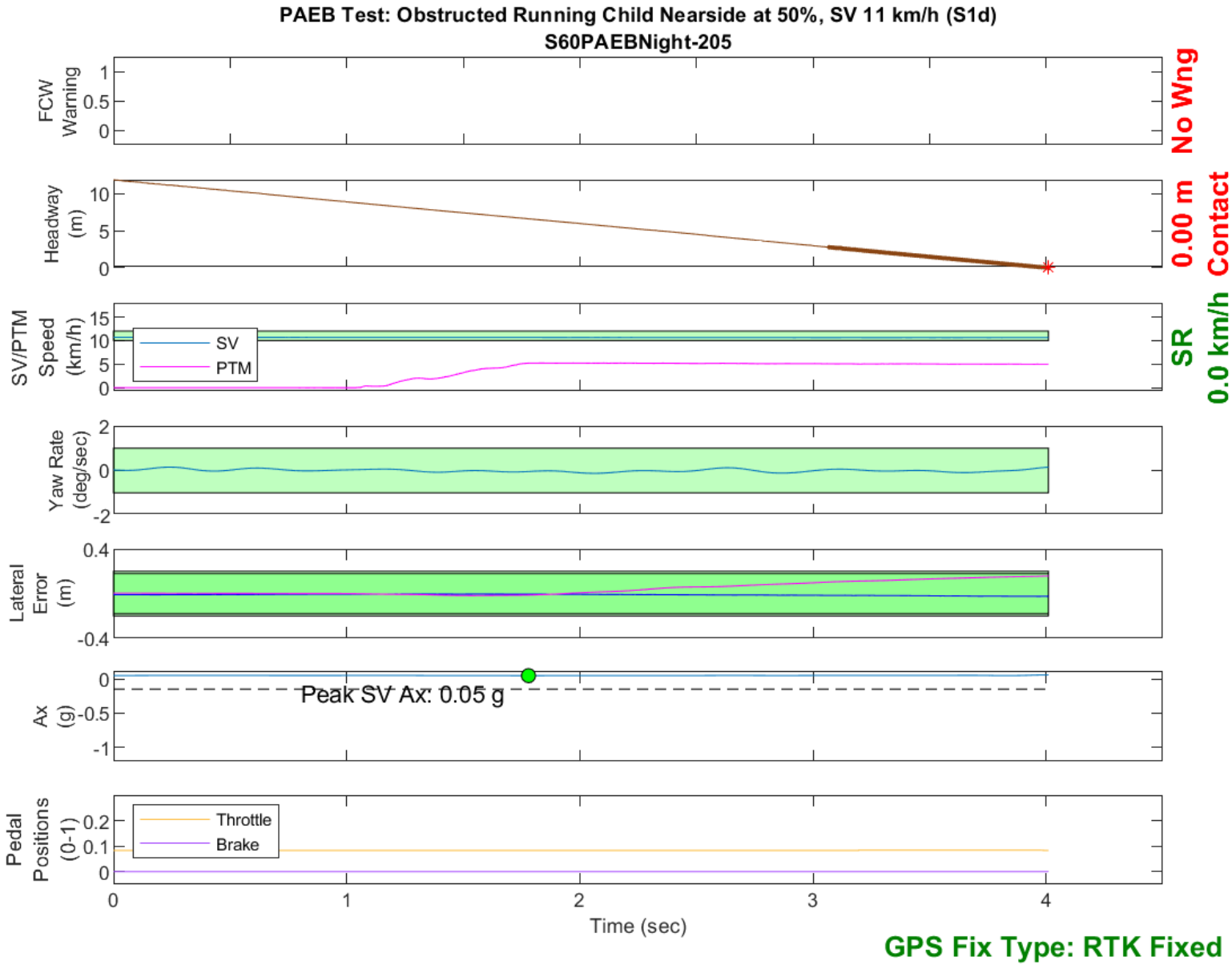


Figure D246. Time History for PAEB Run 205, S1d, Night, Low Beam, 11 km/h

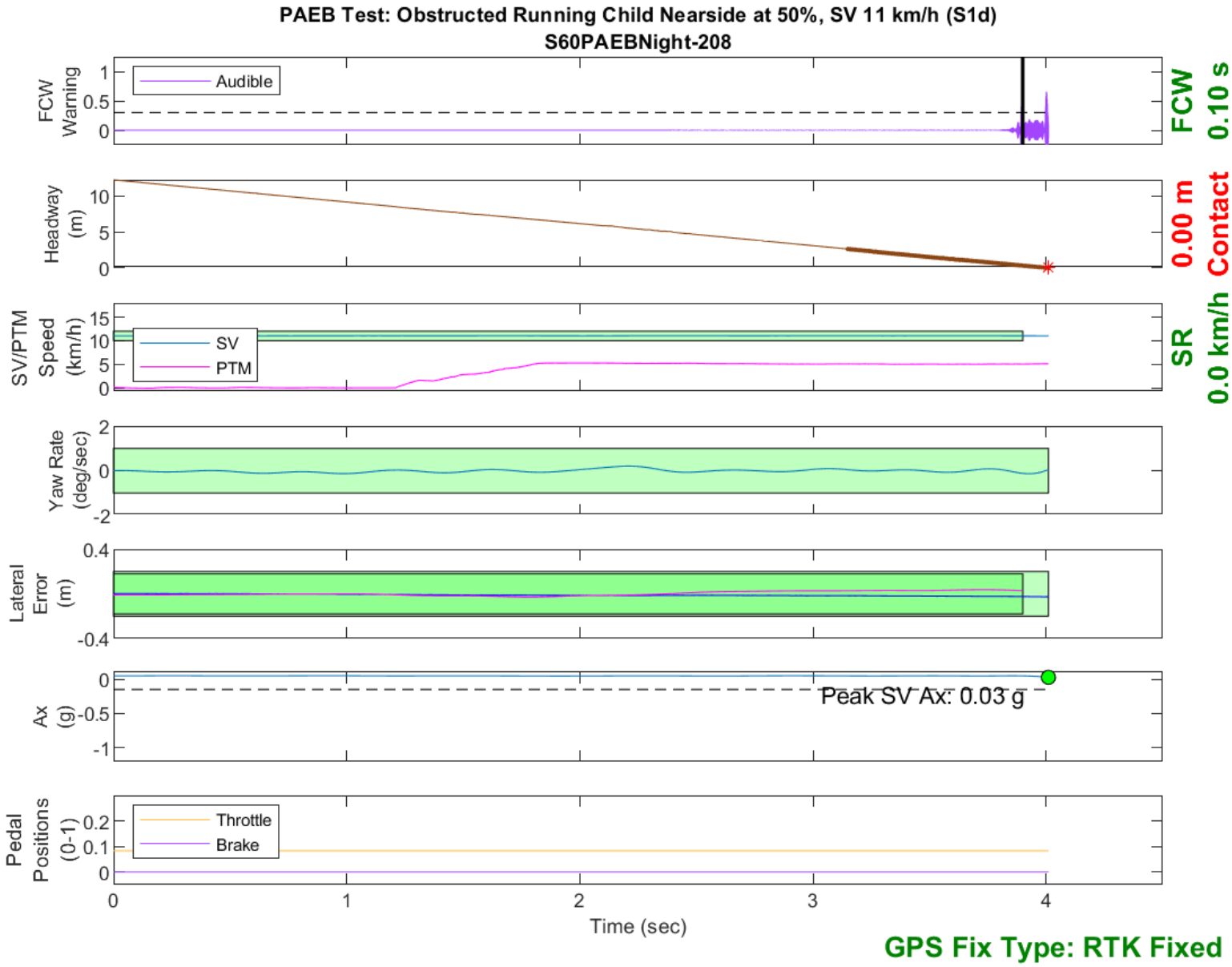


Figure D247. Time History for PAEB Run 208, S1d, Night, Low Beam, 11 km/h

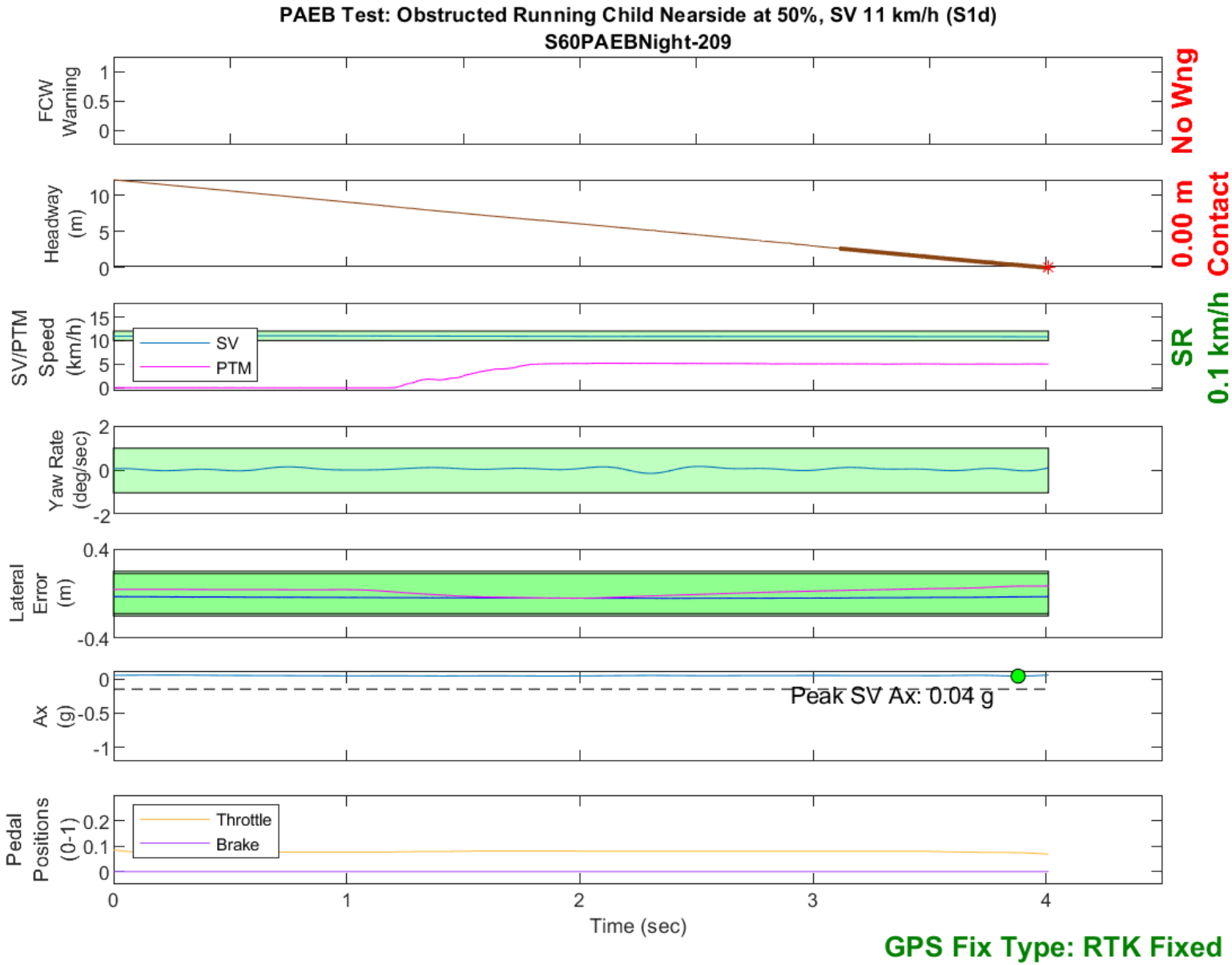


Figure D248. Time History for PAEB Run 209, S1d, Night, Low Beam, 11 km/h

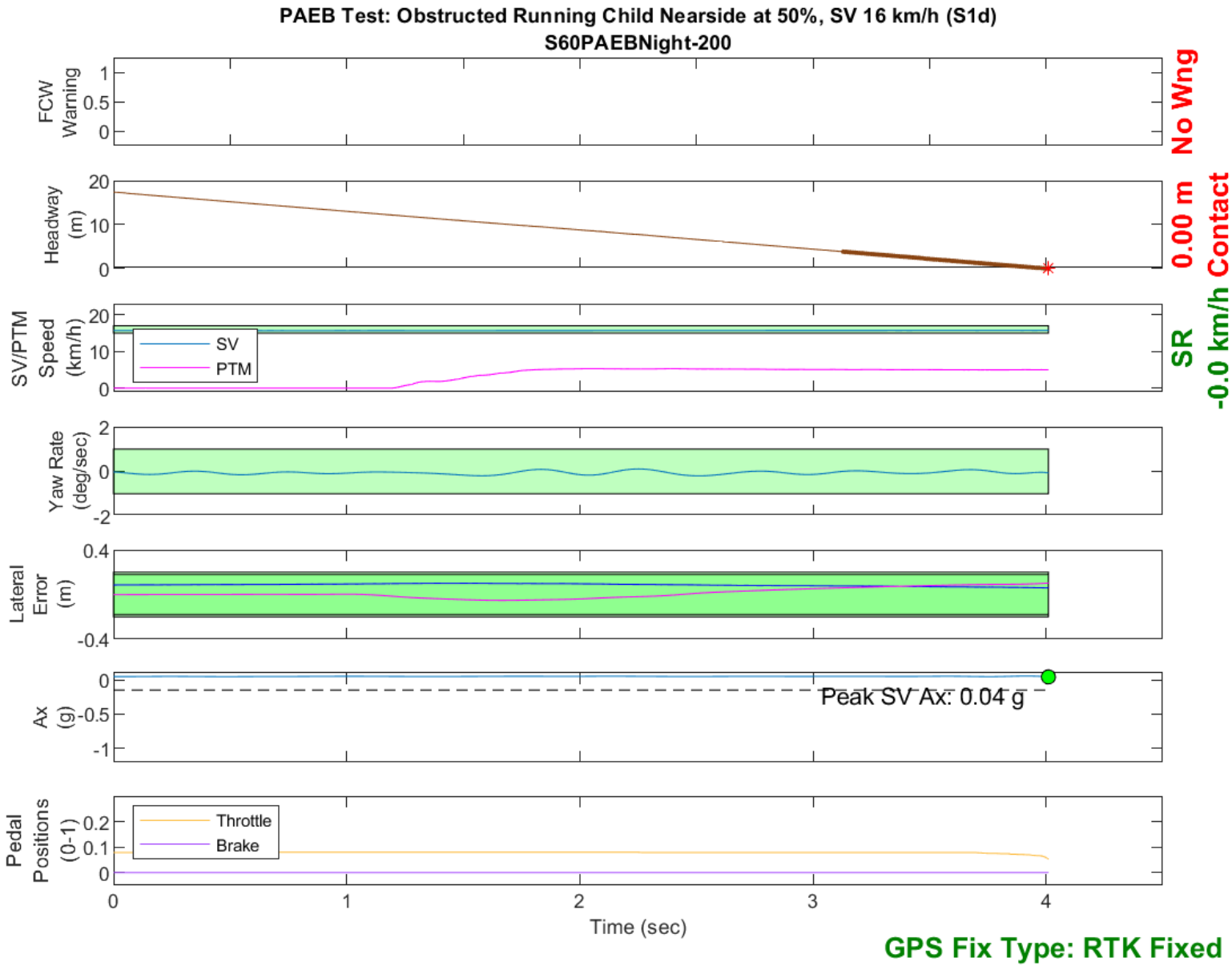


Figure D249. Time History for PAEB Run 200, S1d, Night, Low Beam, 16 km/h

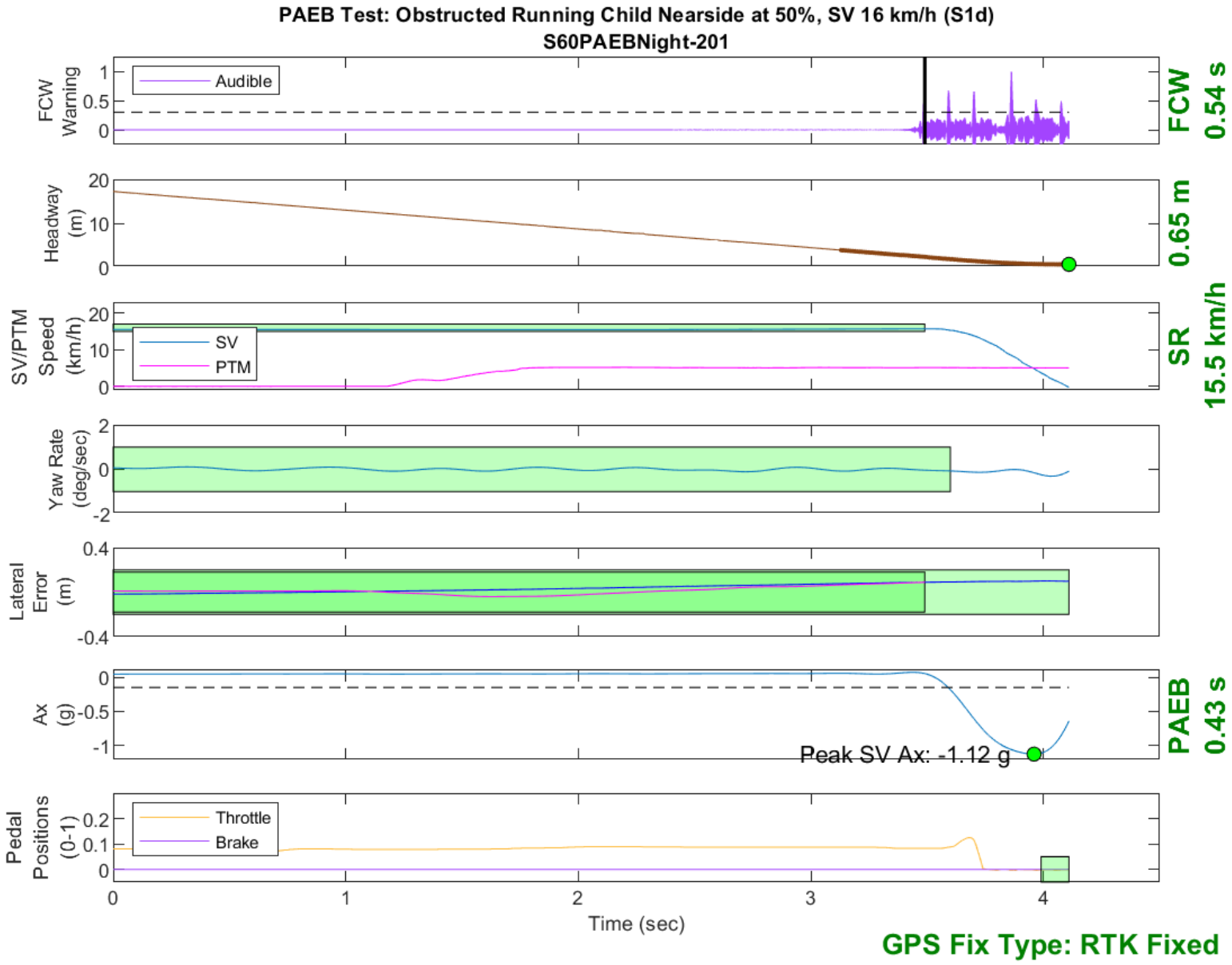


Figure D250. Time History for PAEB Run 201, S1d, Night, Low Beam, 16 km/h

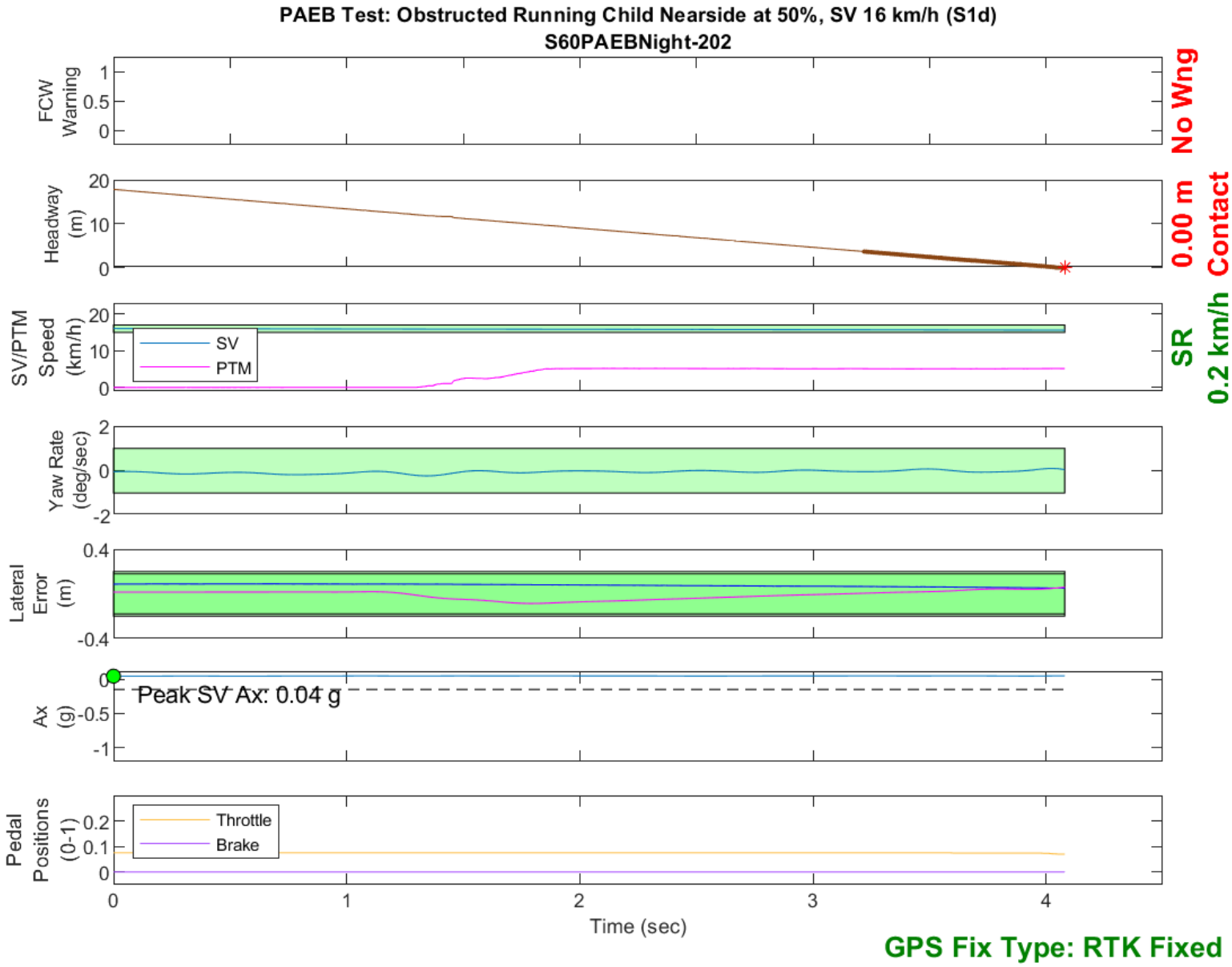


Figure D251. Time History for PAEB Run 202, S1d, Night, Low Beam, 16 km/h

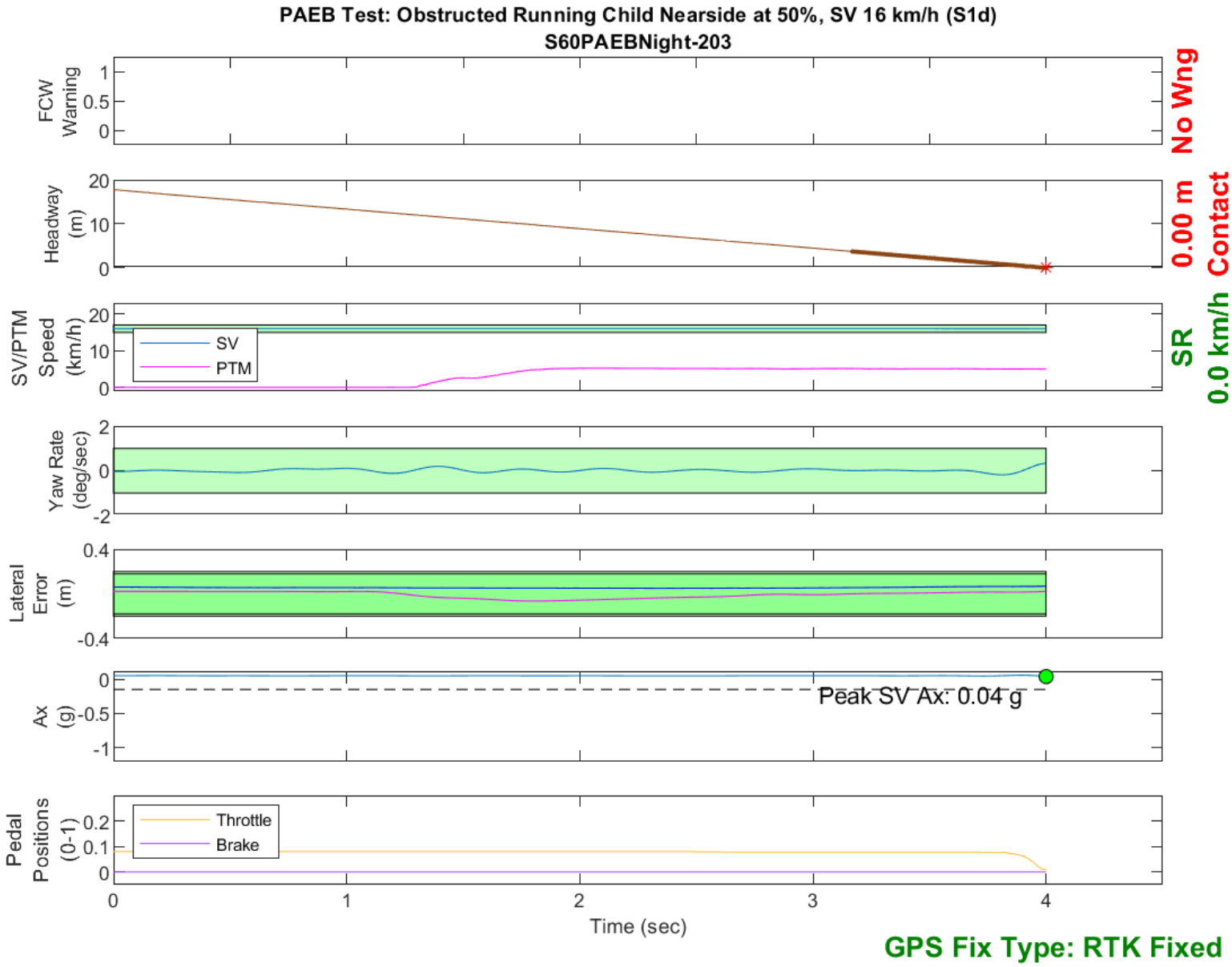


Figure D252. Time History for PAEB Run 203, S1d, Night, Low Beam, 16 km/h

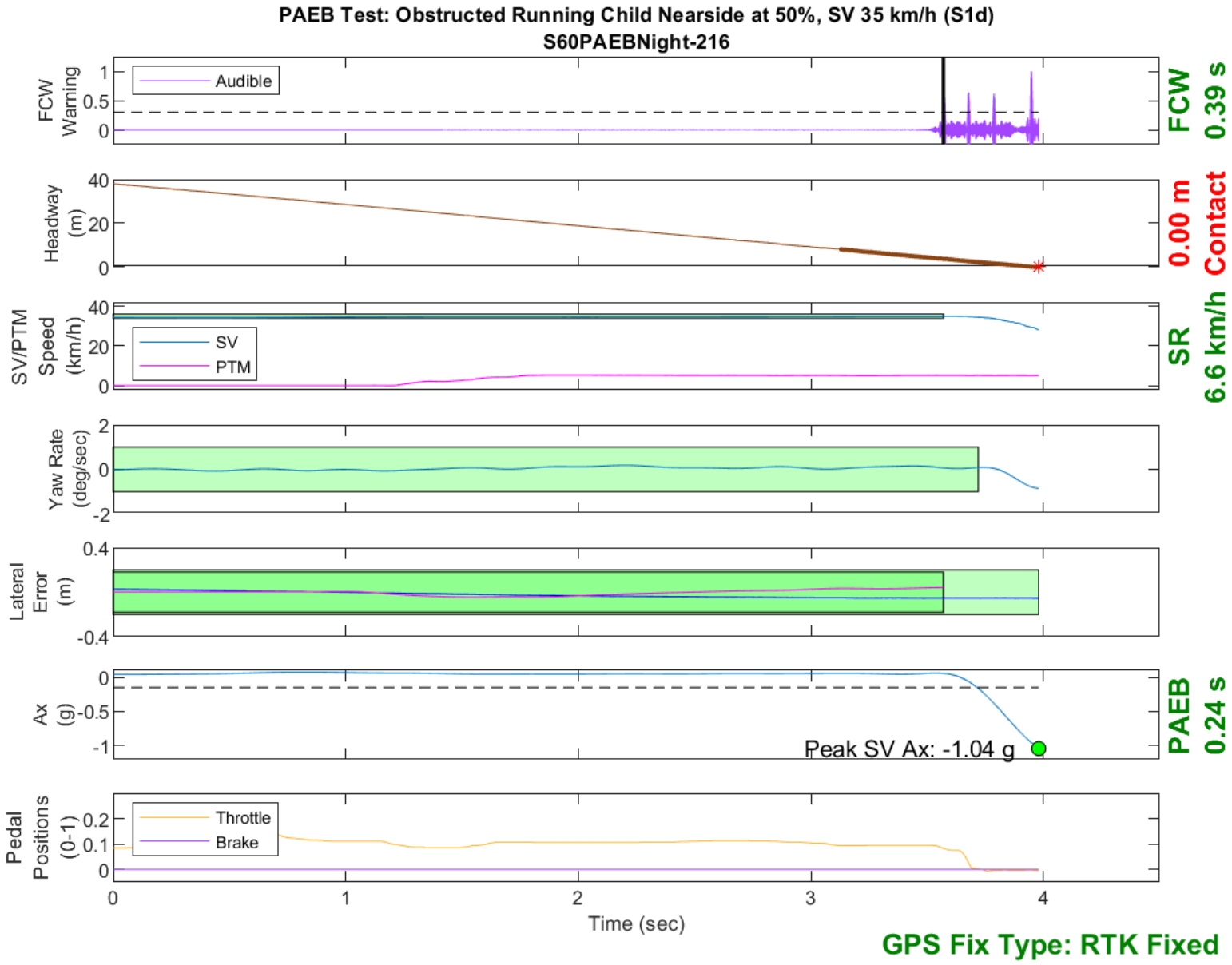


Figure D253. Time History for PAEB Run 216, S1d, Night, Low Beam, 35 km/h

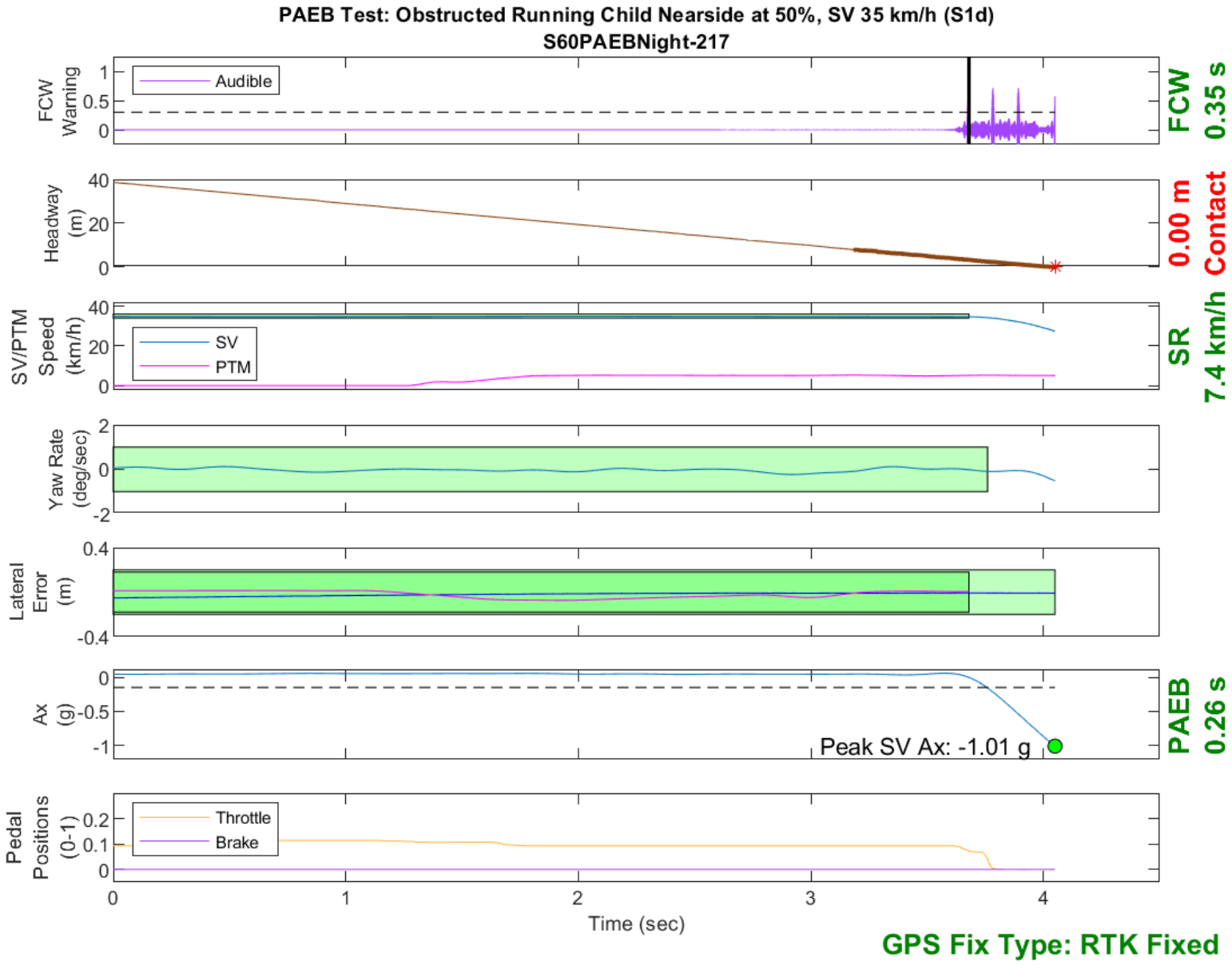


Figure D254. Time History for PAEB Run 217, S1d, Night, Low Beam, 35 km/h

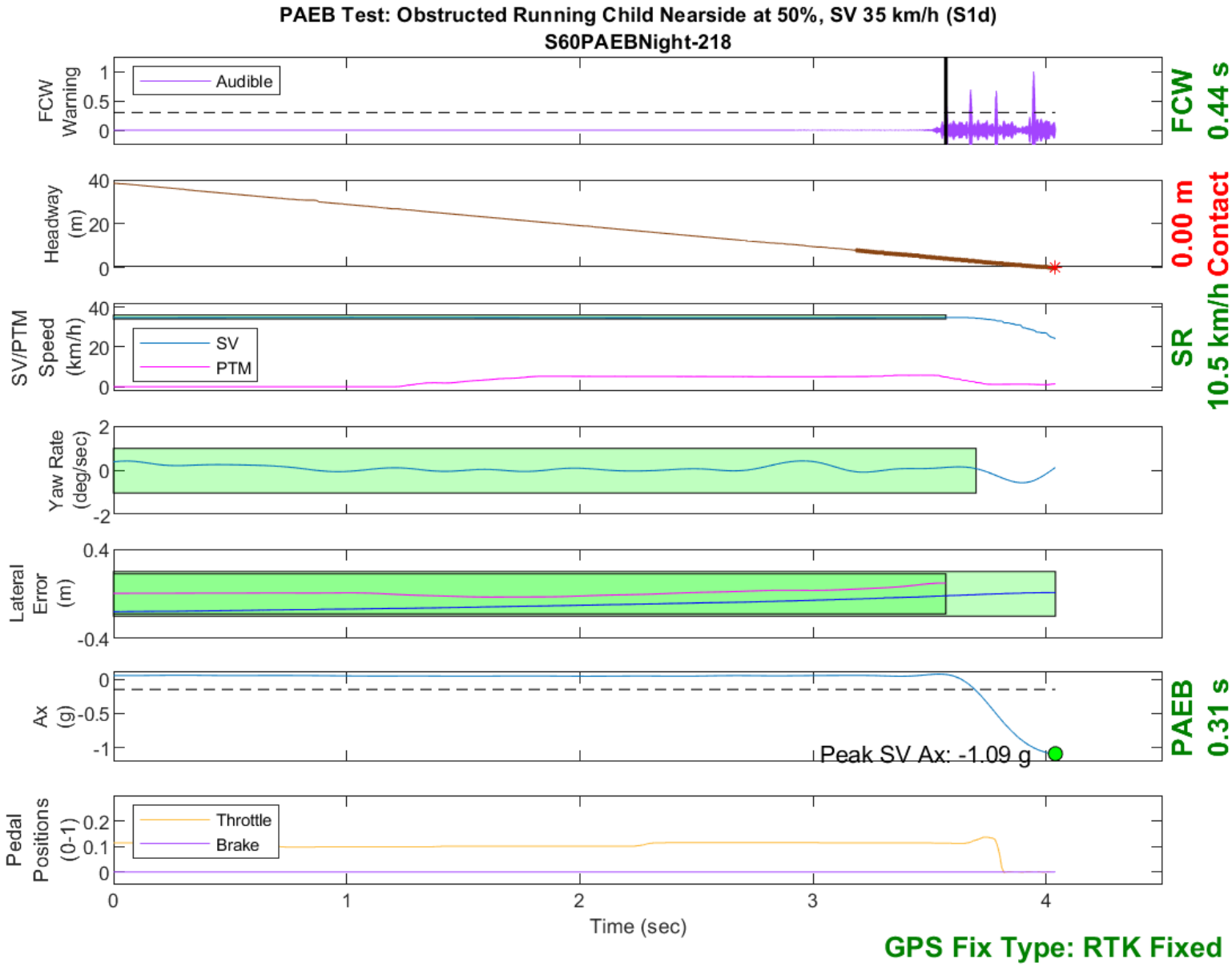


Figure D255. Time History for PAEB Run 218, S1d, Night, Low Beam, 35 km/h

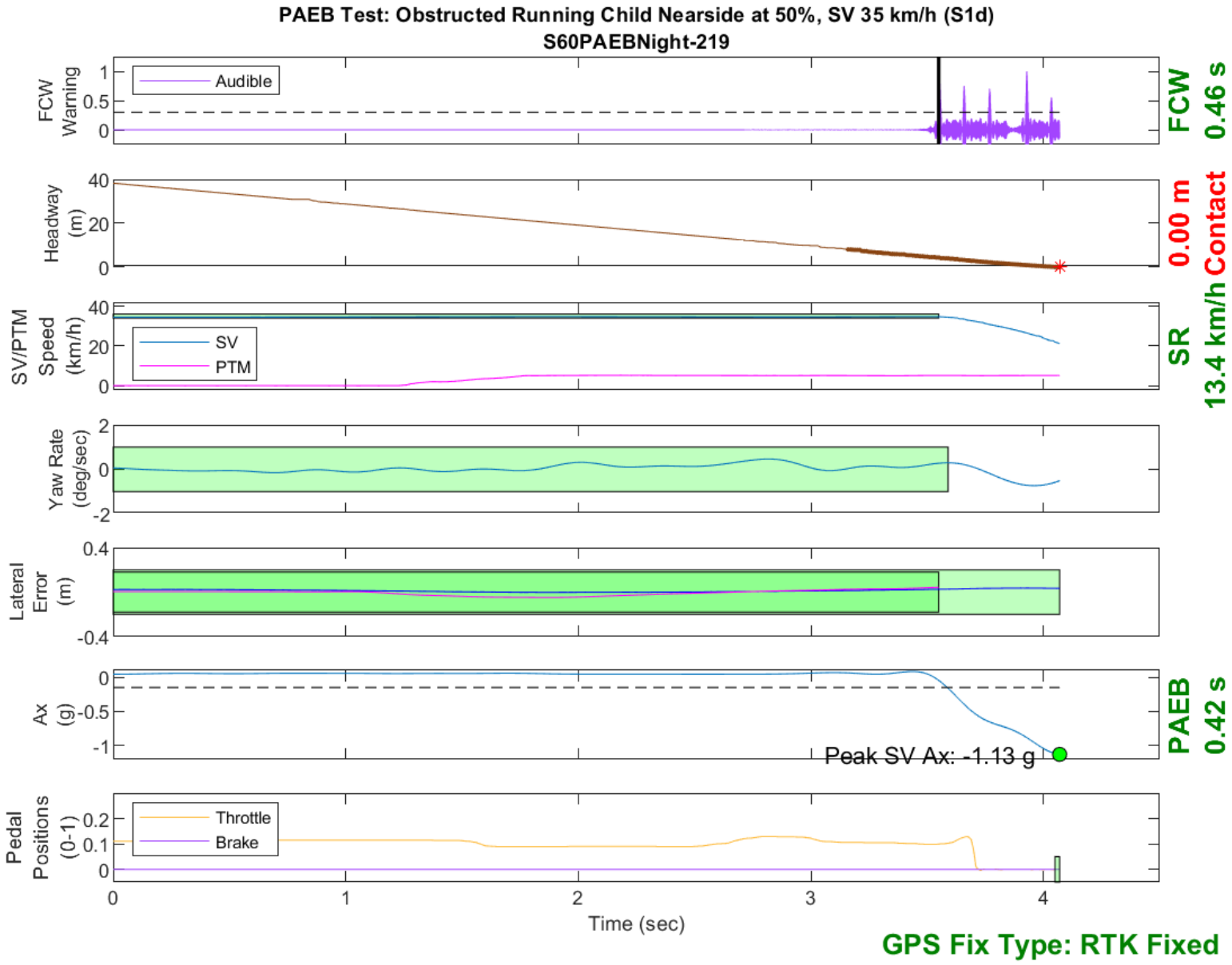


Figure D256. Time History for PAEB Run 219, S1d, Night, Low Beam, 35 km/h

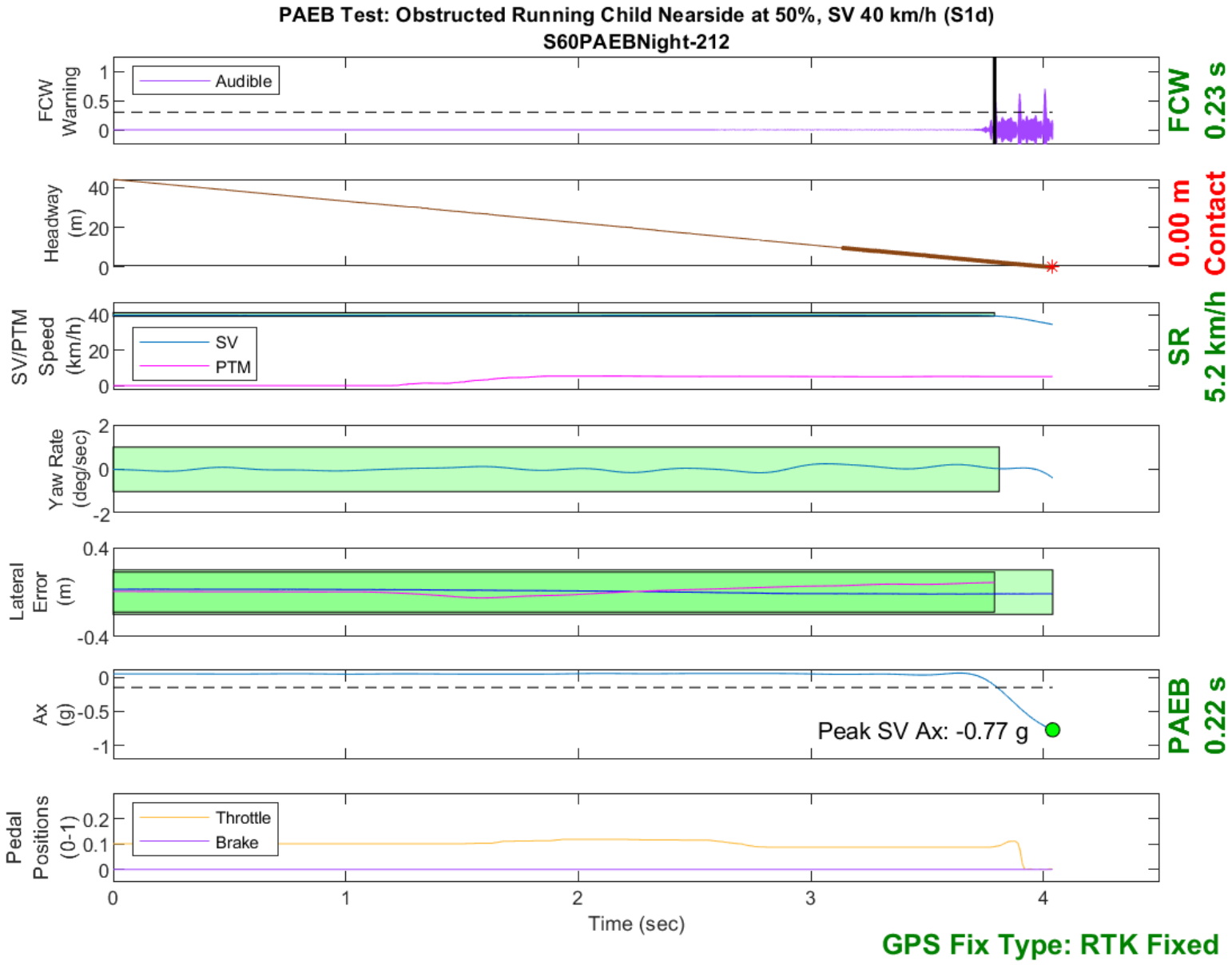


Figure D257. Time History for PAEB Run 212, S1d, Night, Low Beam, 40 km/h

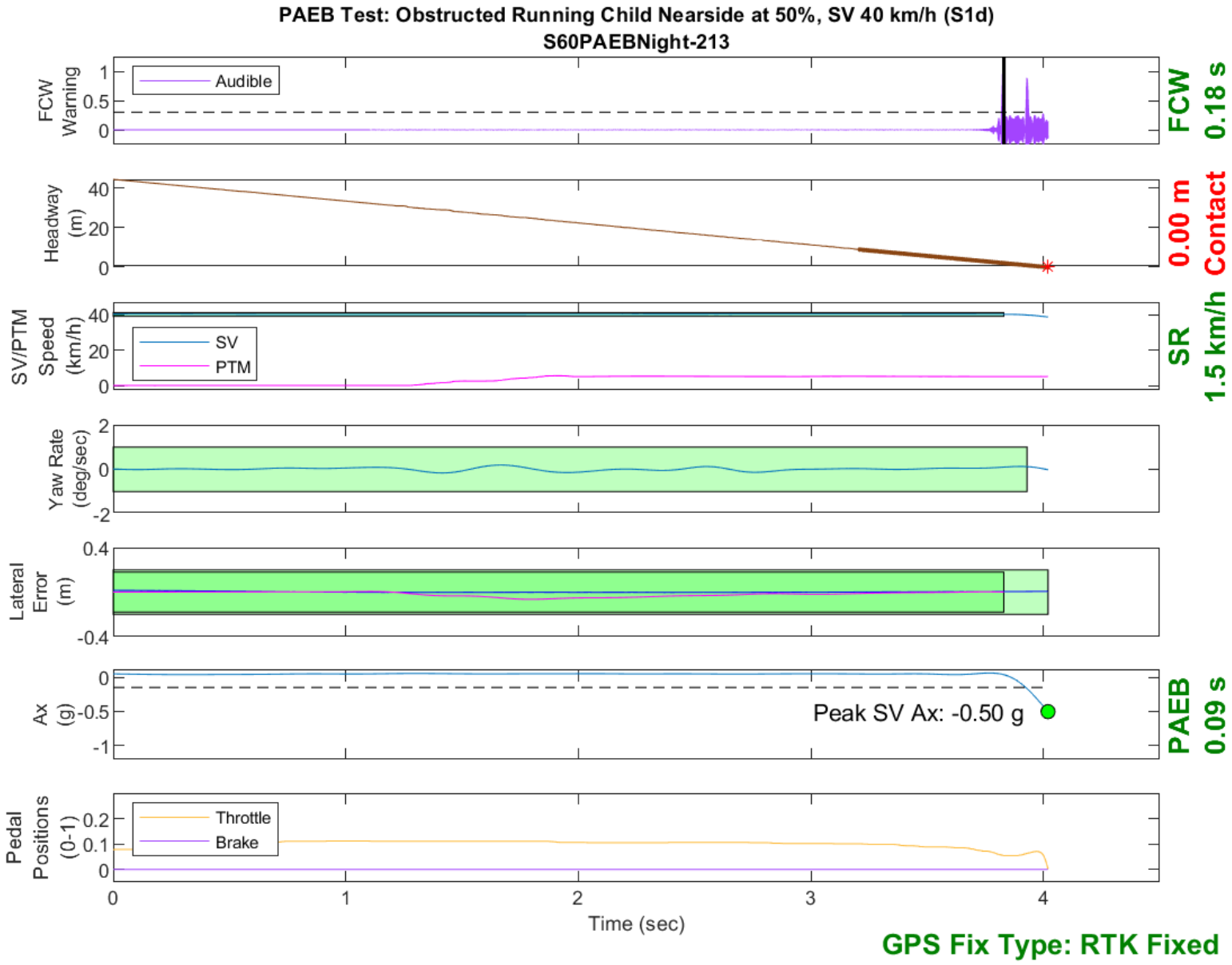


Figure D258. Time History for PAEB Run 213, S1d, Night, Low Beam, 40 km/h

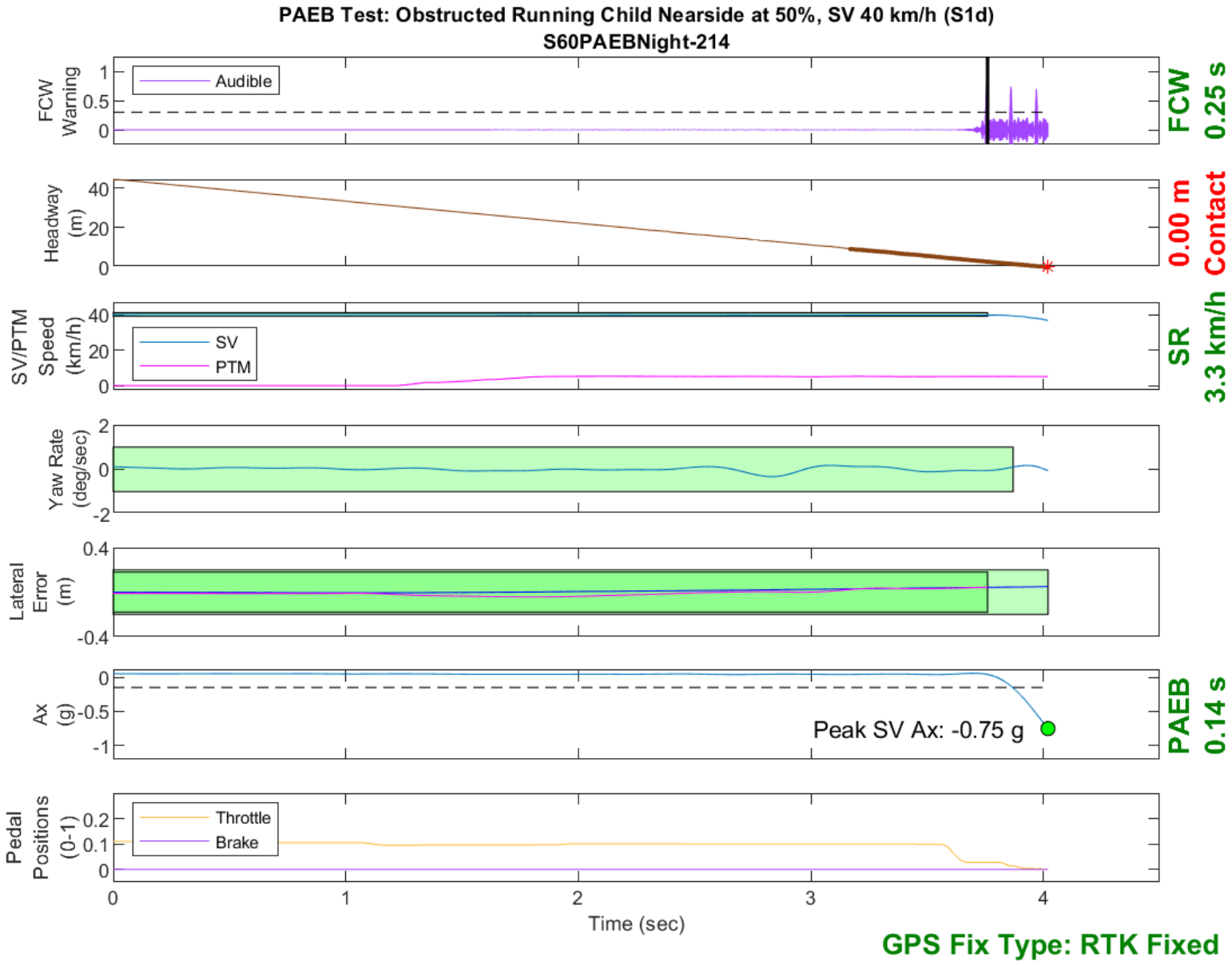


Figure D259. Time History for PAEB Run 214, S1d, Night, Low Beam, 40 km/h

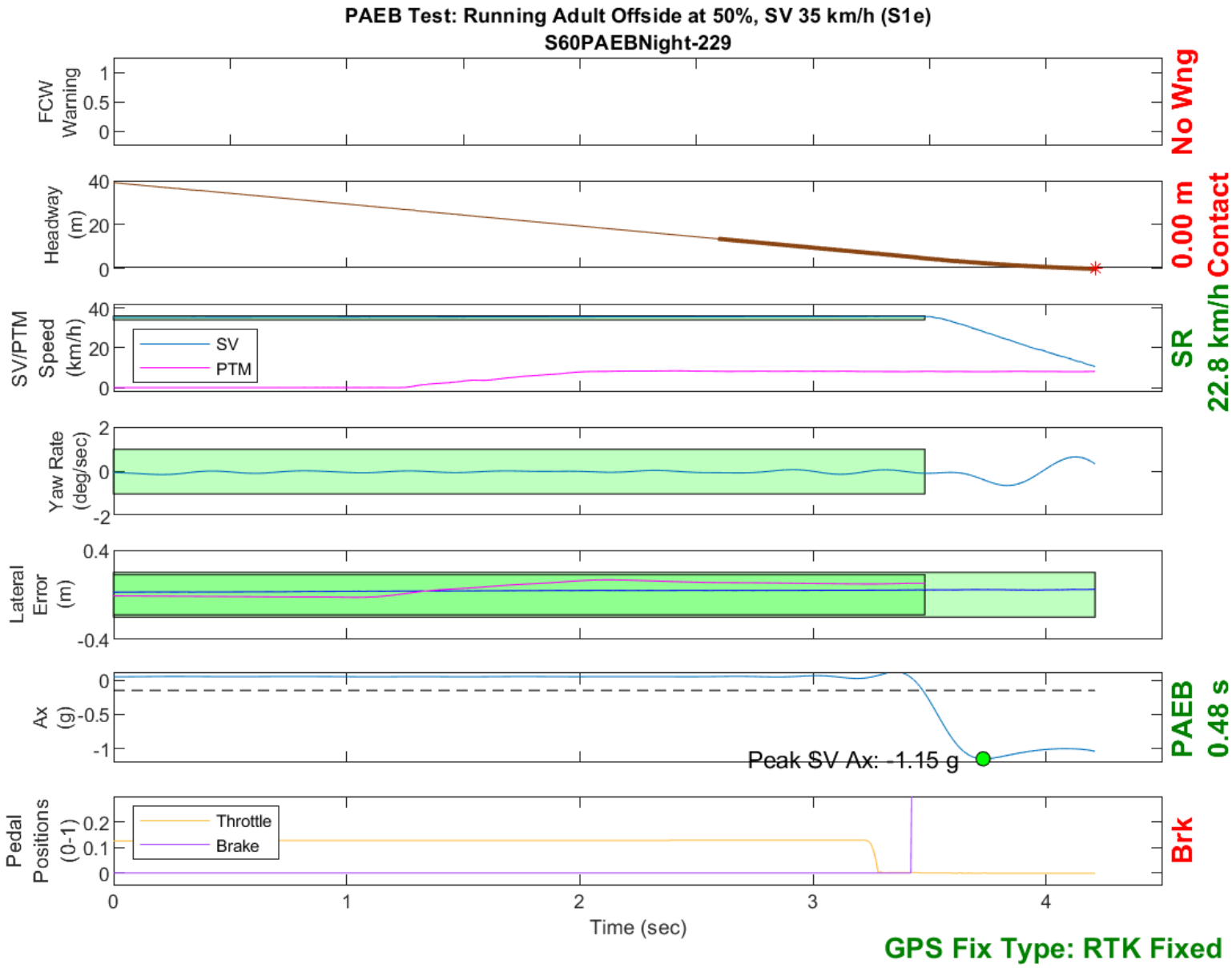


Figure D260. Time History for PAEB Run 229, S1e, Night, Low Beam, 35 km/h

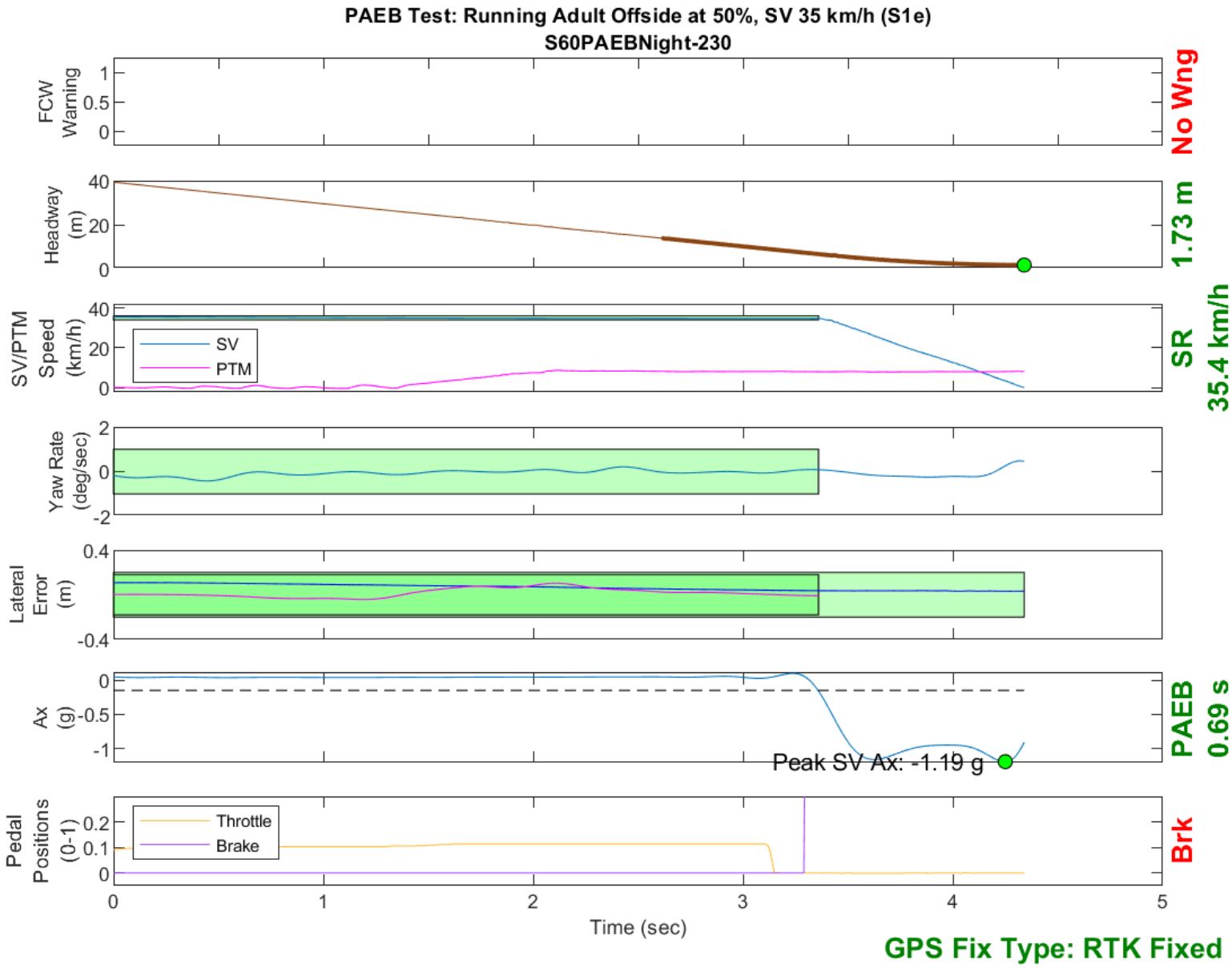


Figure D261. Time History for PAEB Run 230, S1e, Night, Low Beam, 35 km/h

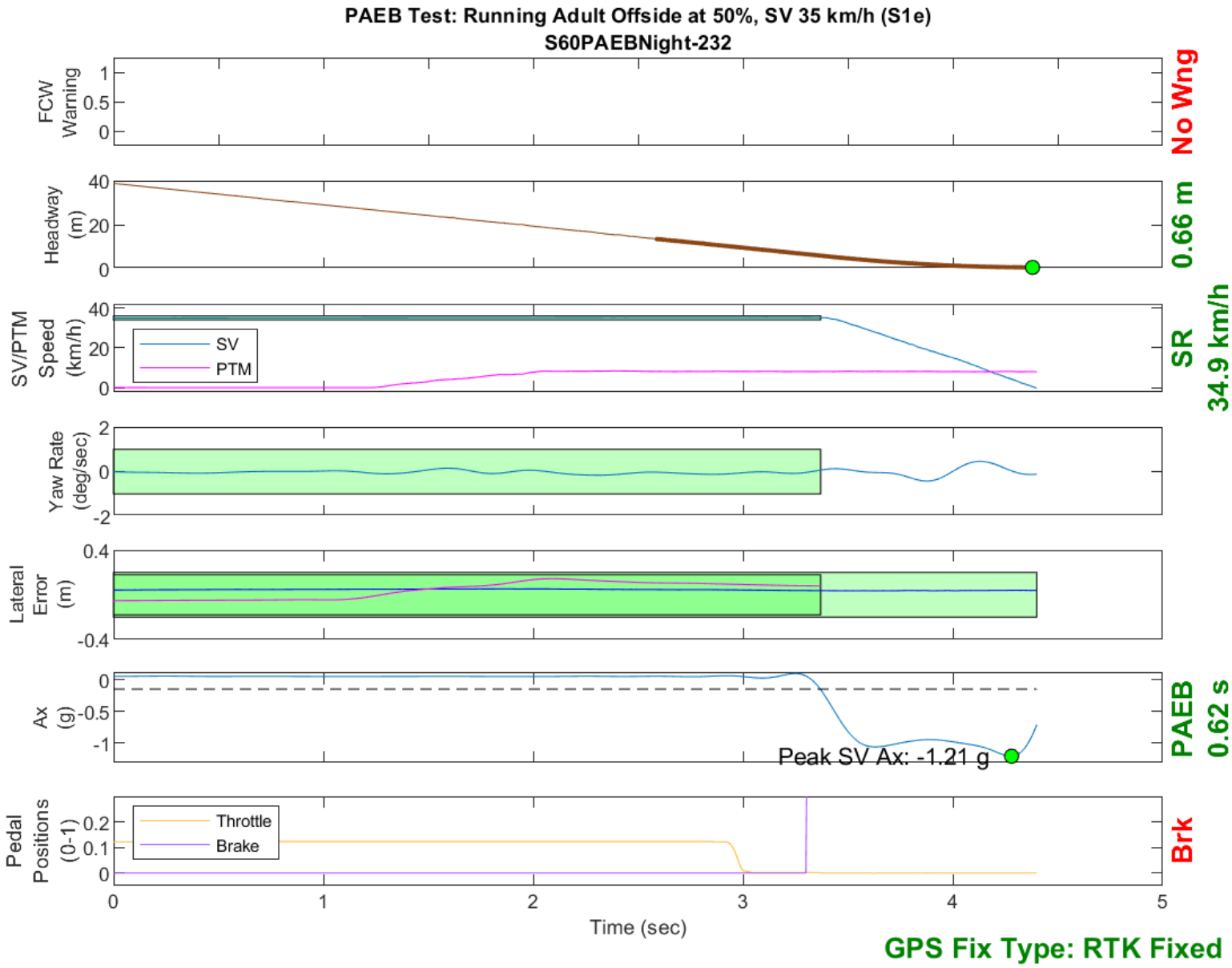


Figure D262. Time History for PAEB Run 232, S1e, Night, Low Beam, 35 km/h

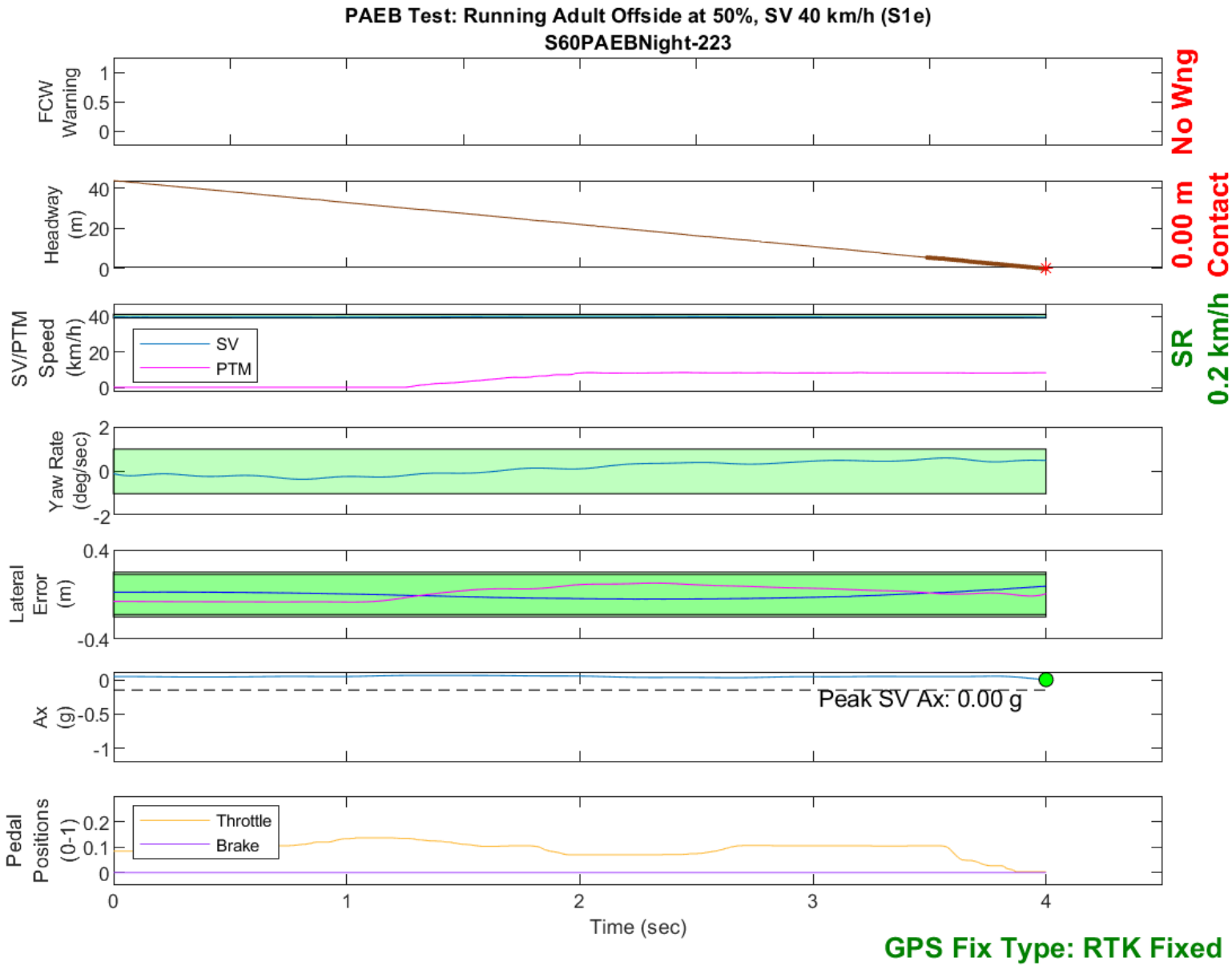


Figure D263. Time History for PAEB Run 223, S1e, Night, Low Beam, 40 km/h

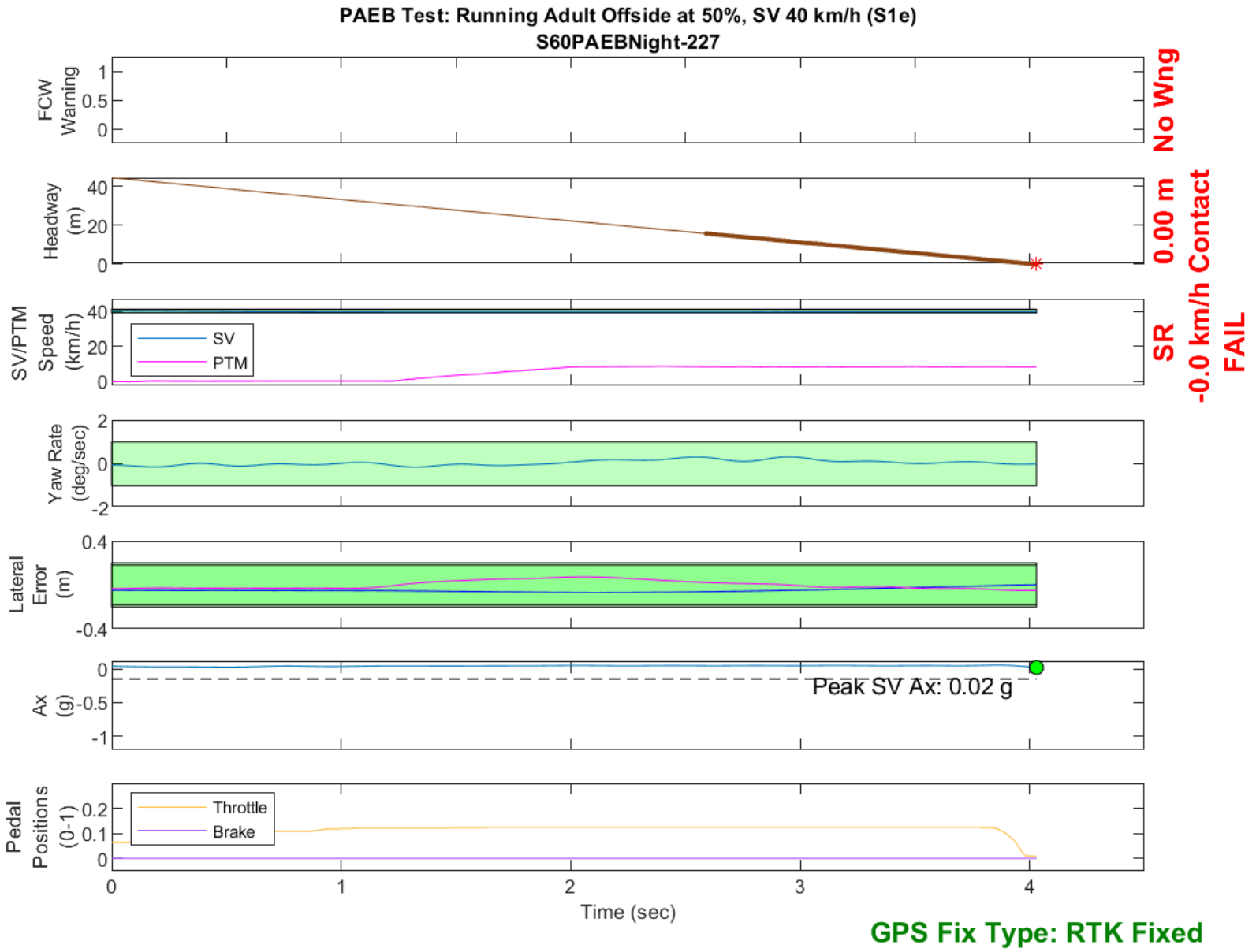


Figure D264. Time History for PAEB Run 227, S1e, Night, Low Beam, 40 km/h

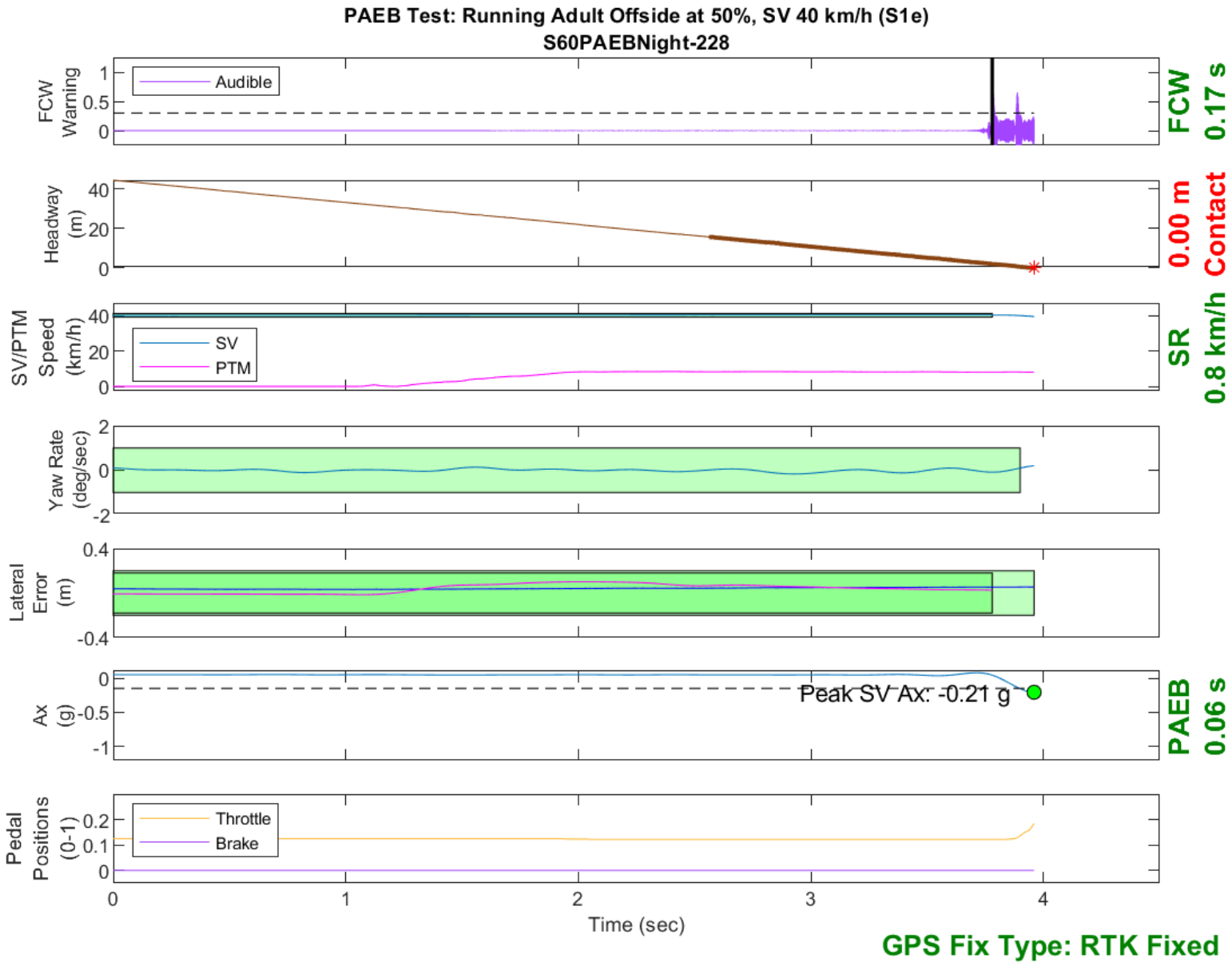


Figure D265. Time History for PAEB Run 228, S1e, Night, Low Beam, 40 km/h

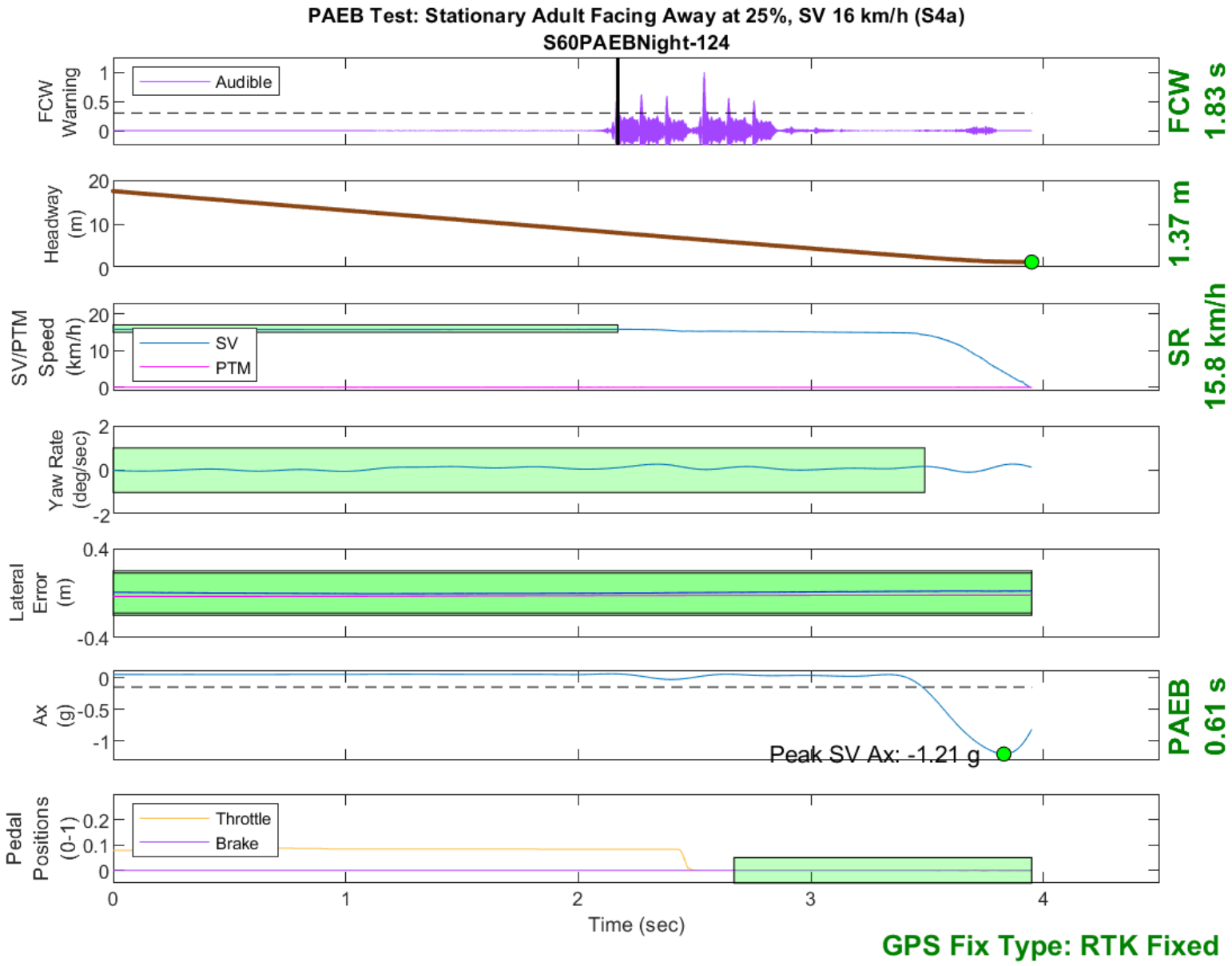


Figure D266. Time History for PAEB Run 124, S4a, Night, Low Beam, 16 km/h

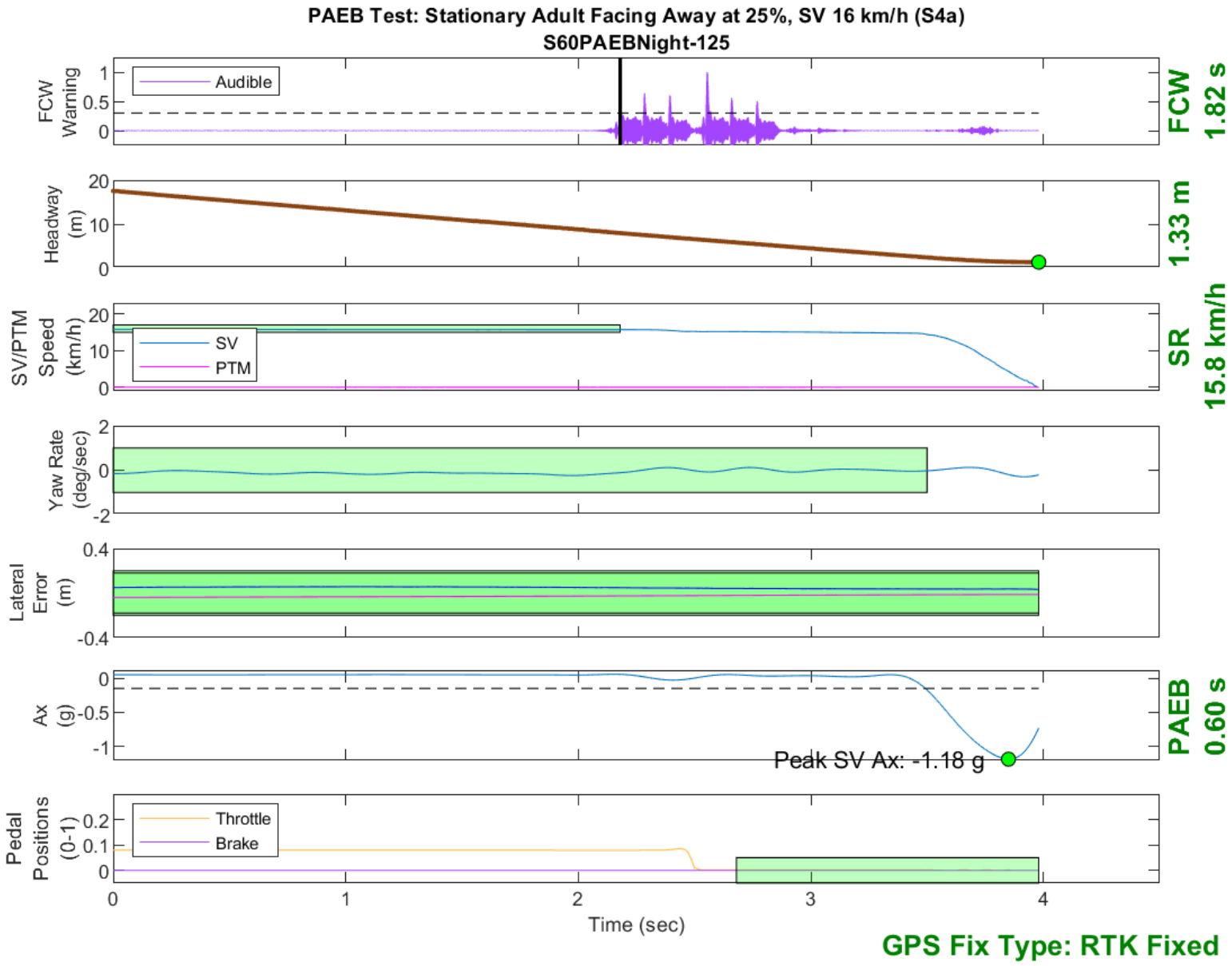


Figure D267. Time History for PAEB Run 125, S4a, Night, Low Beam, 16 km/h

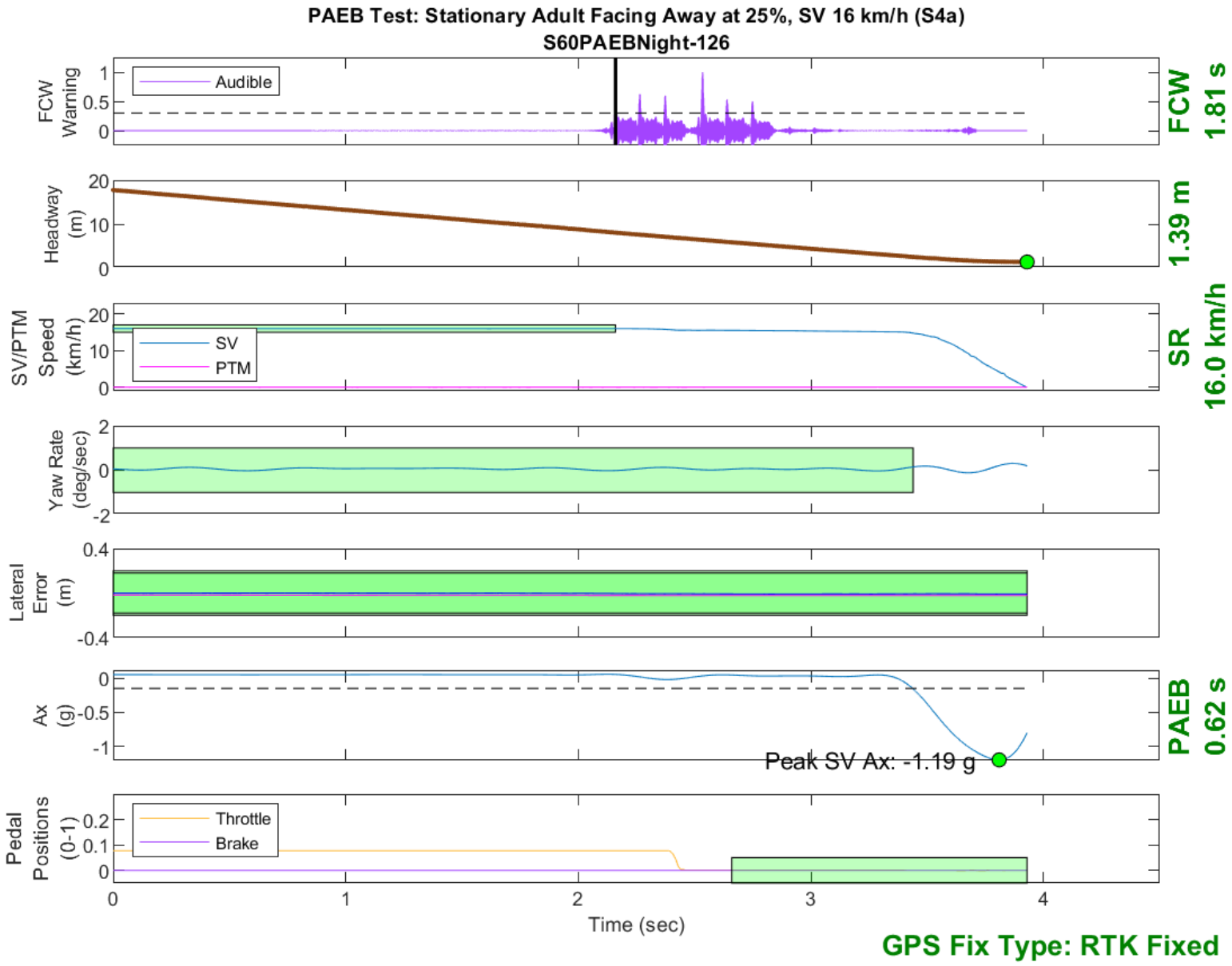


Figure D268. Time History for PAEB Run 126, S4a, Night, Low Beam, 16 km/h

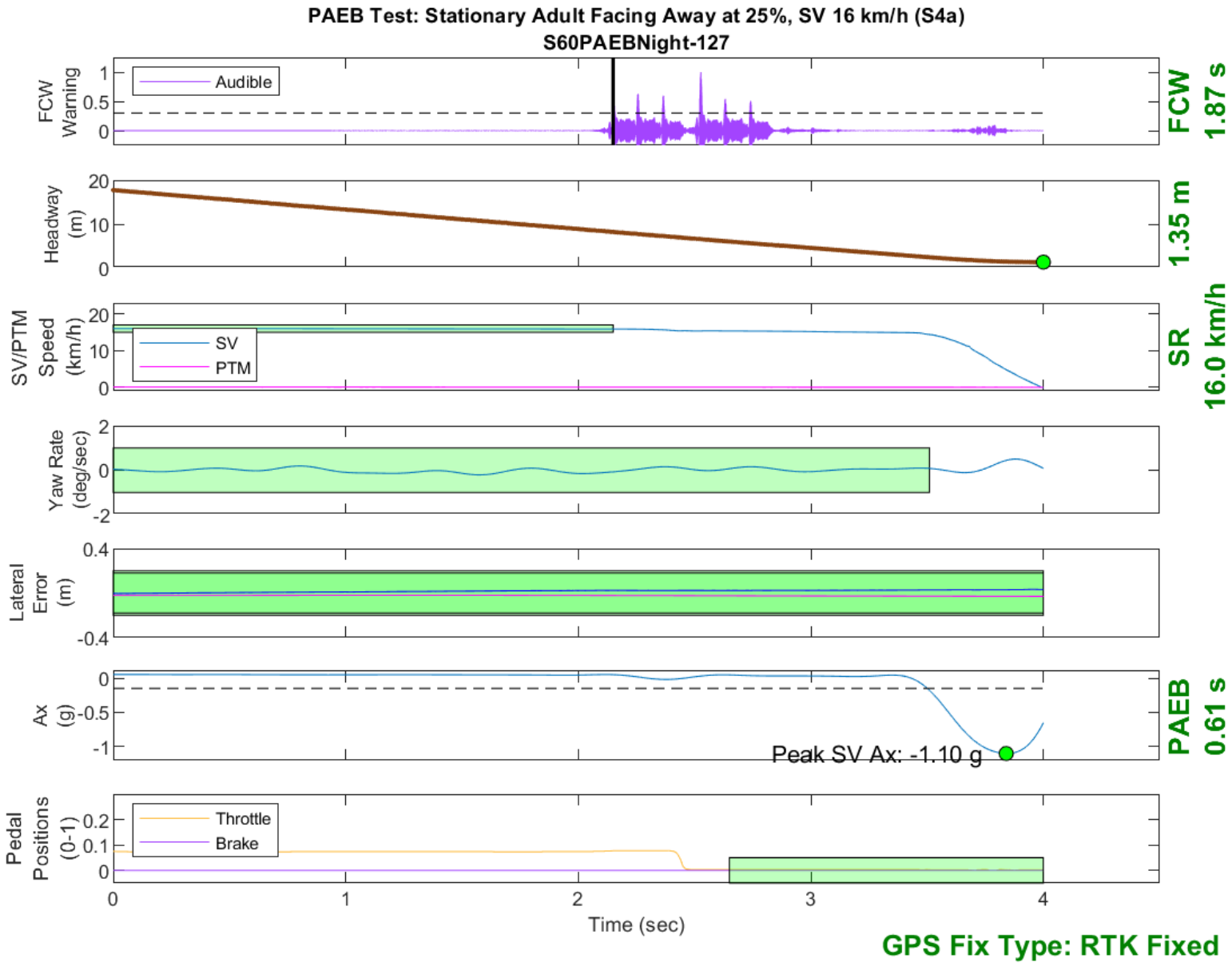


Figure D269. Time History for PAEB Run 127, S4a, Night, Low Beam, 16 km/h

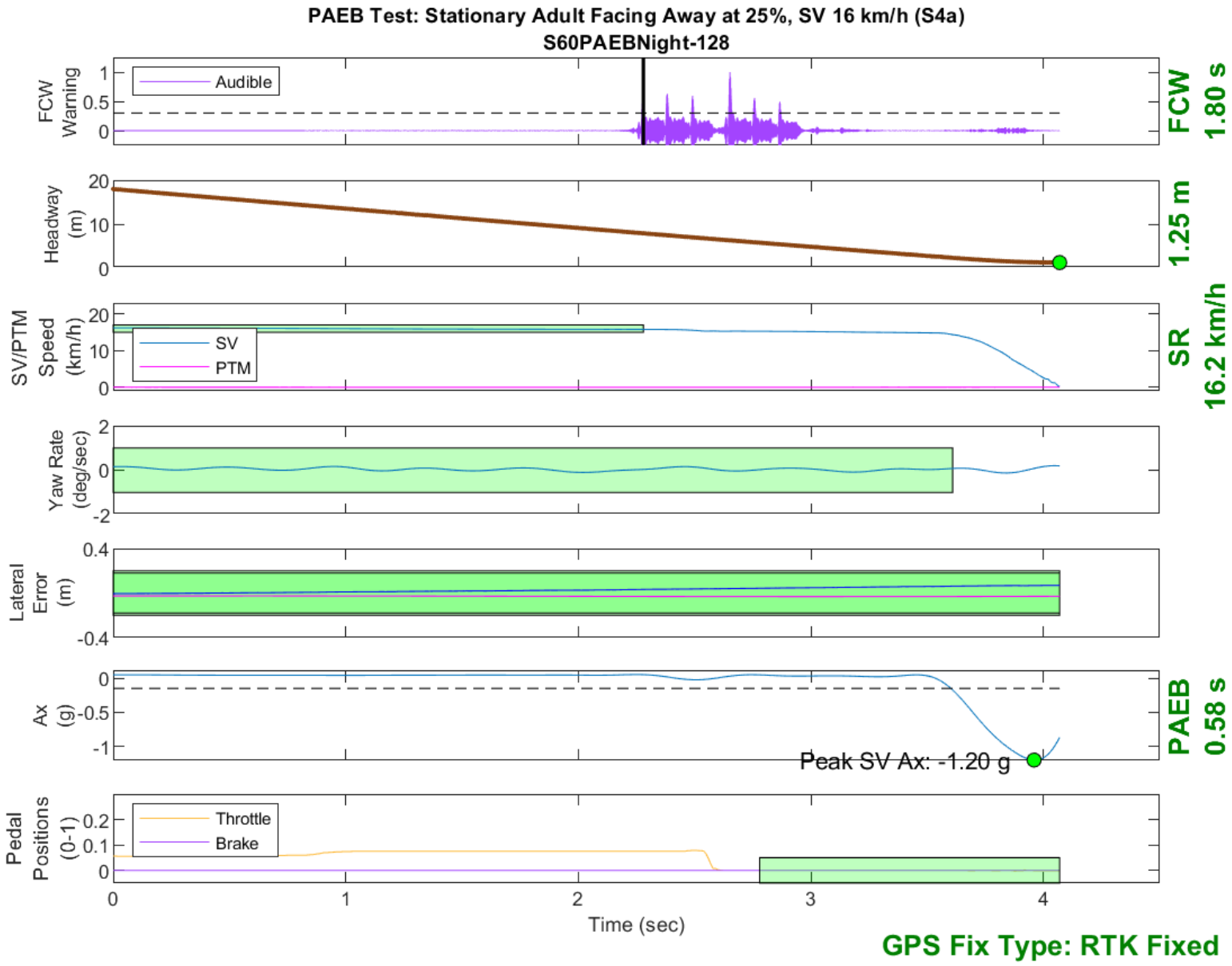


Figure D270. Time History for PAEB Run 128, S4a, Night, Low Beam, 16 km/h

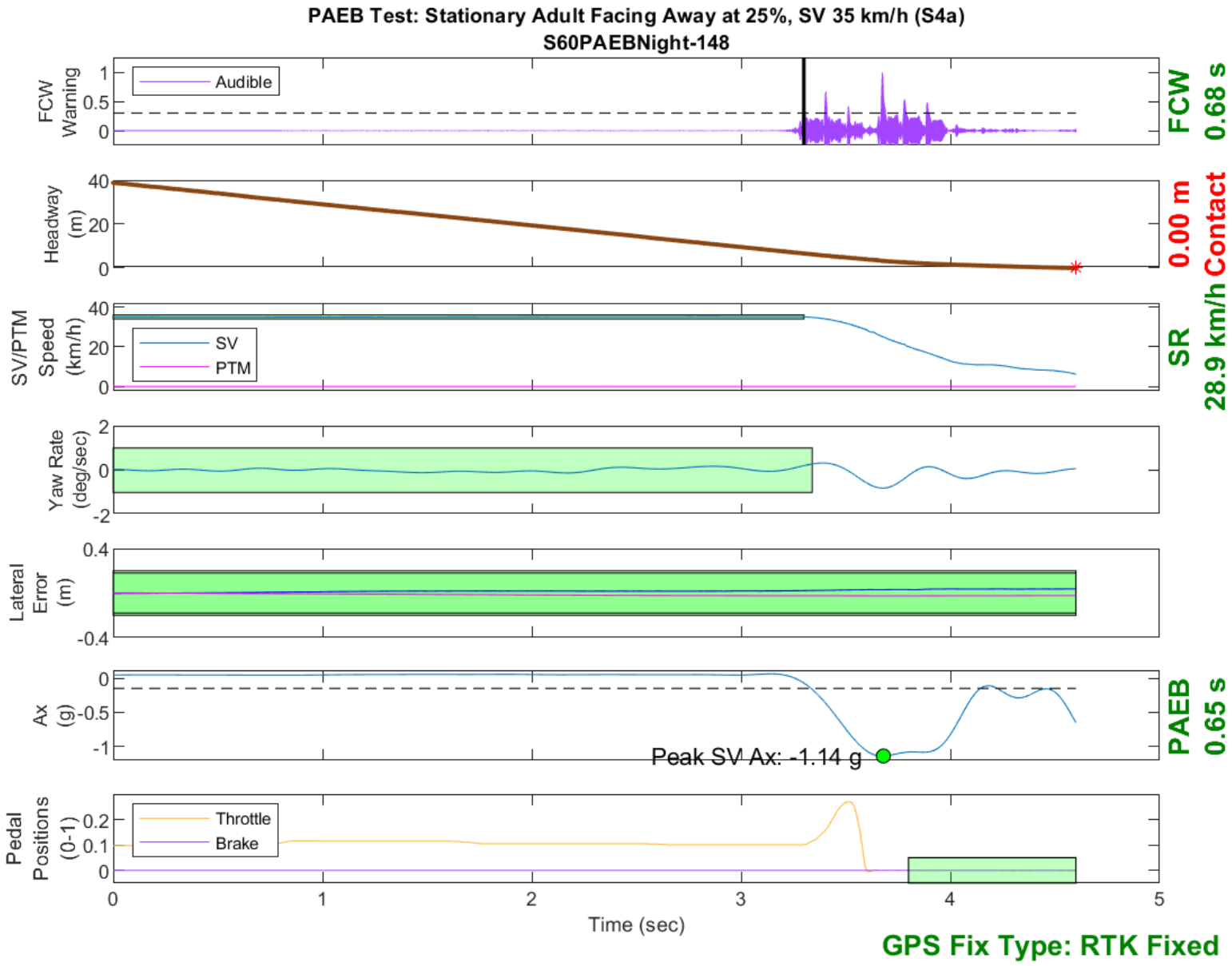


Figure D271. Time History for PAEB Run 148, S4a, Night, Low Beam, 35 km/h

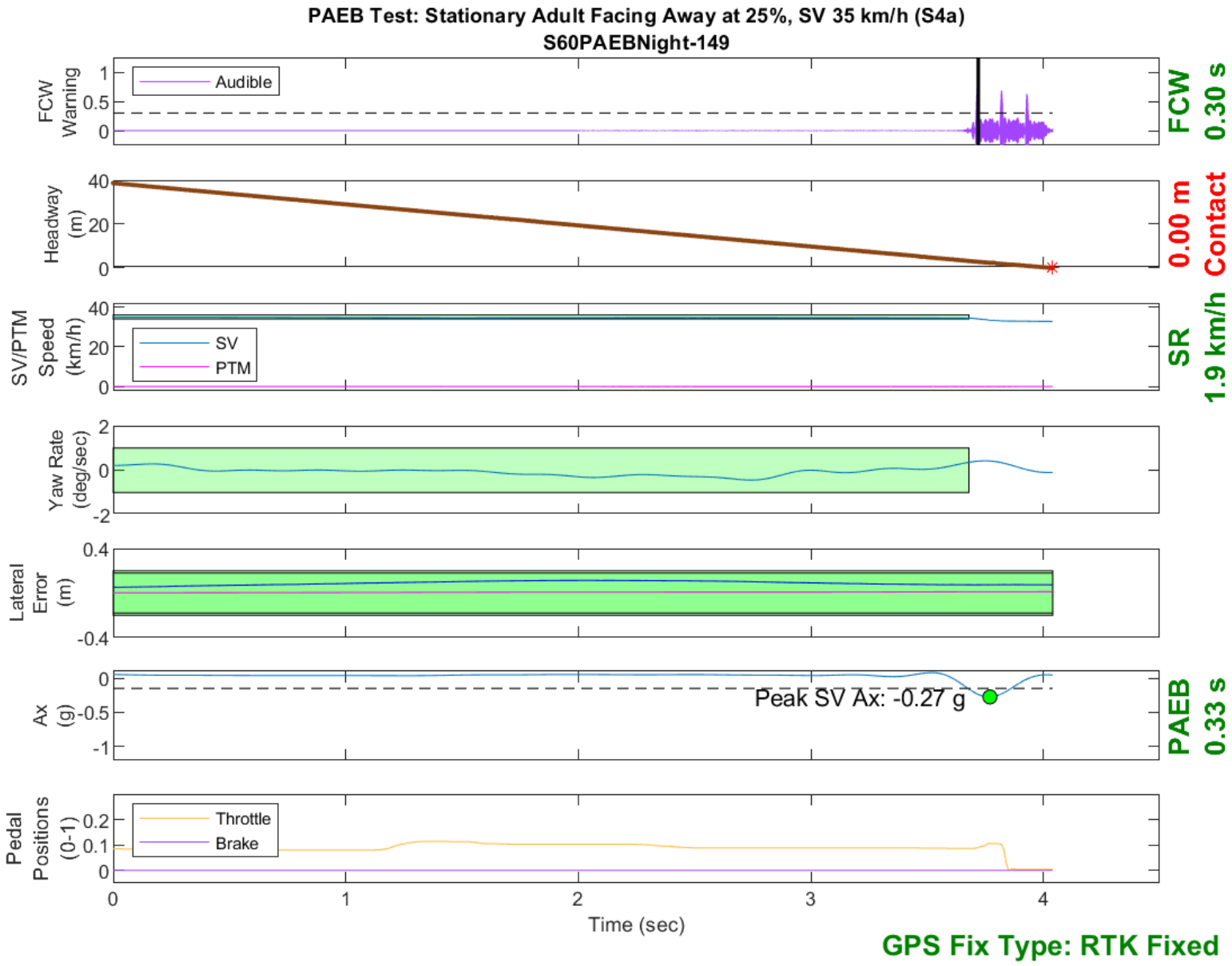


Figure D272. Time History for PAEB Run 149, S4a, Night, Low Beam, 35 km/h

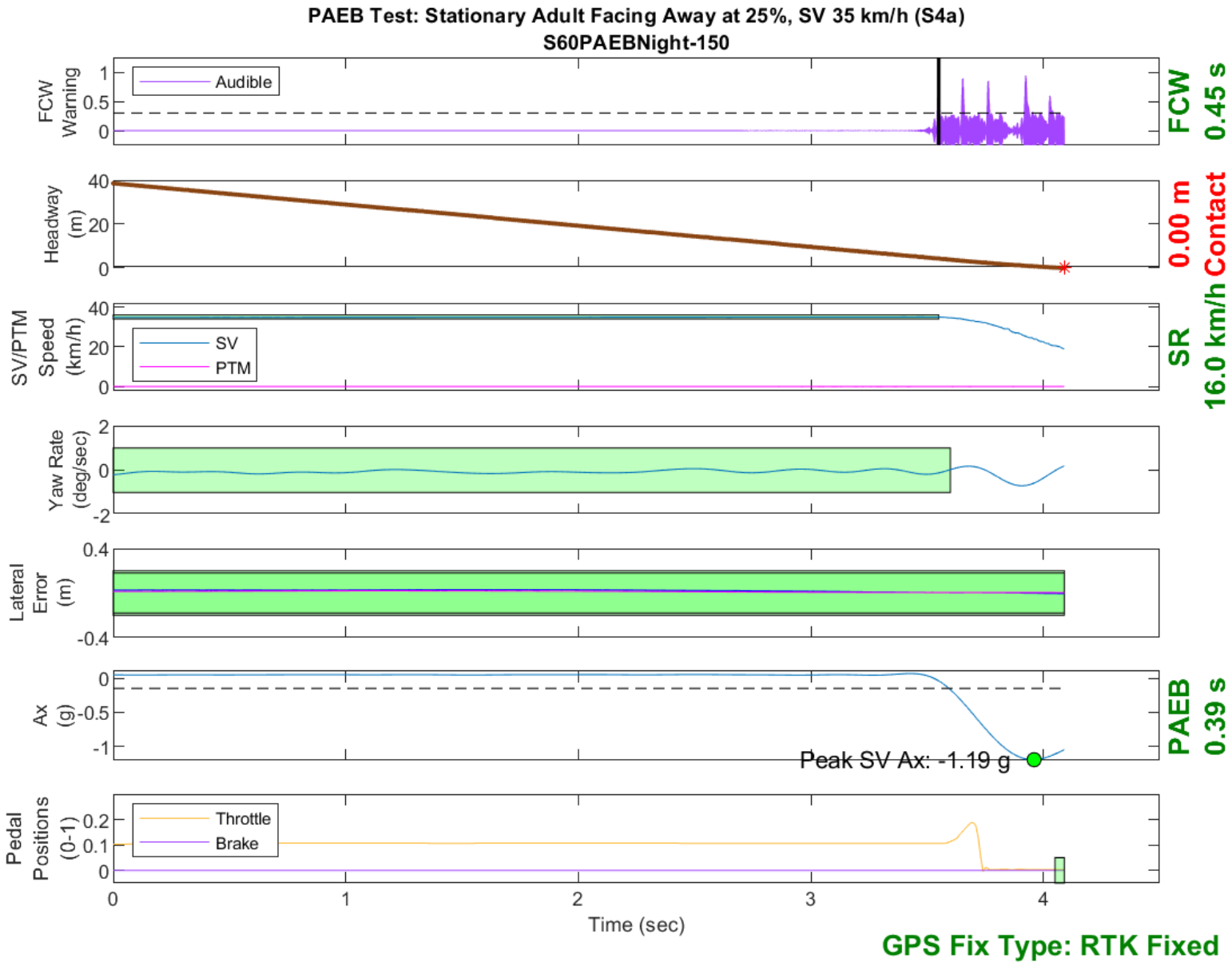


Figure D273. Time History for PAEB Run 150, S4a, Night, Low Beam, 35 km/h

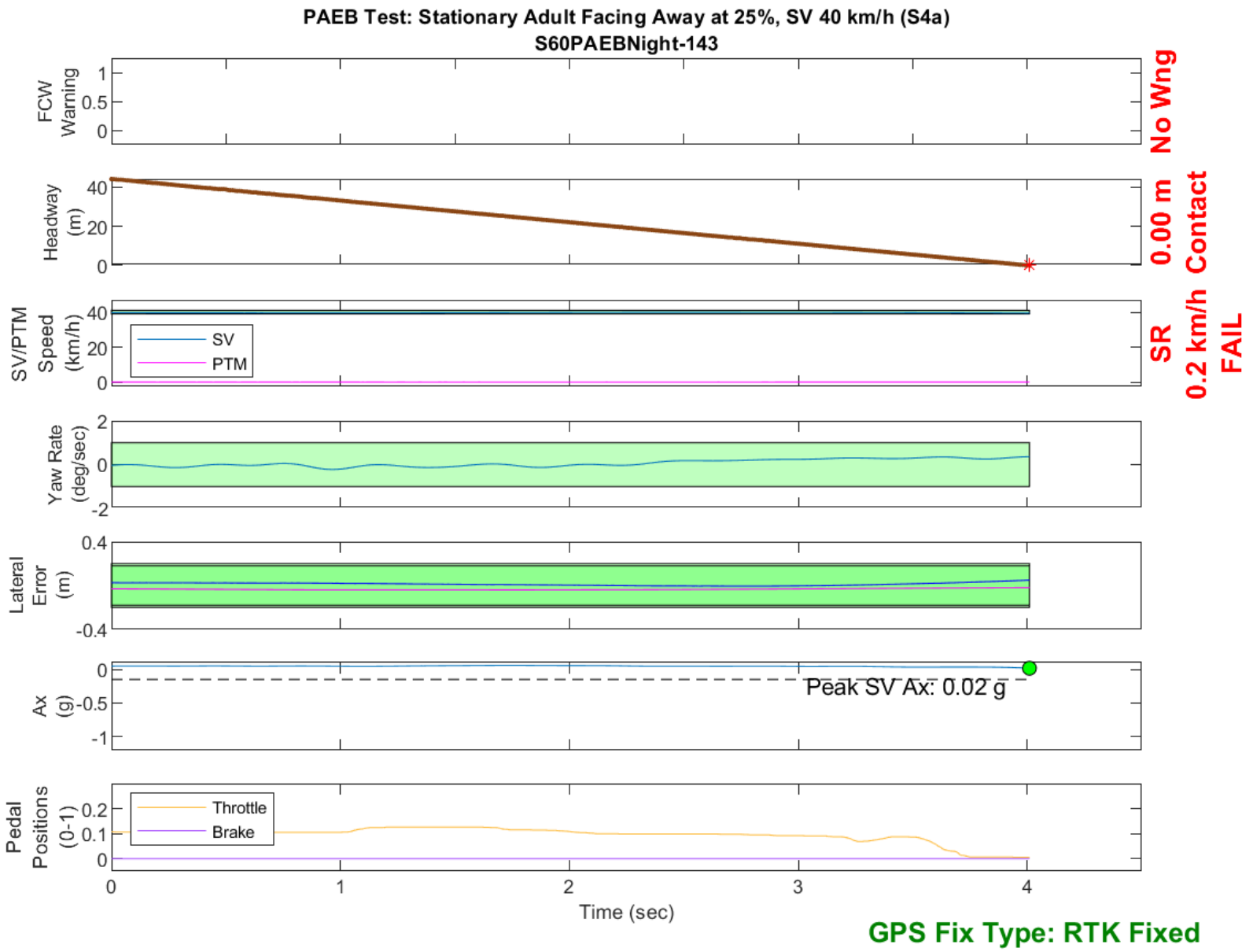


Figure D274. Time History for PAEB Run 143, S4a, Night, Low Beam, 40 km/h

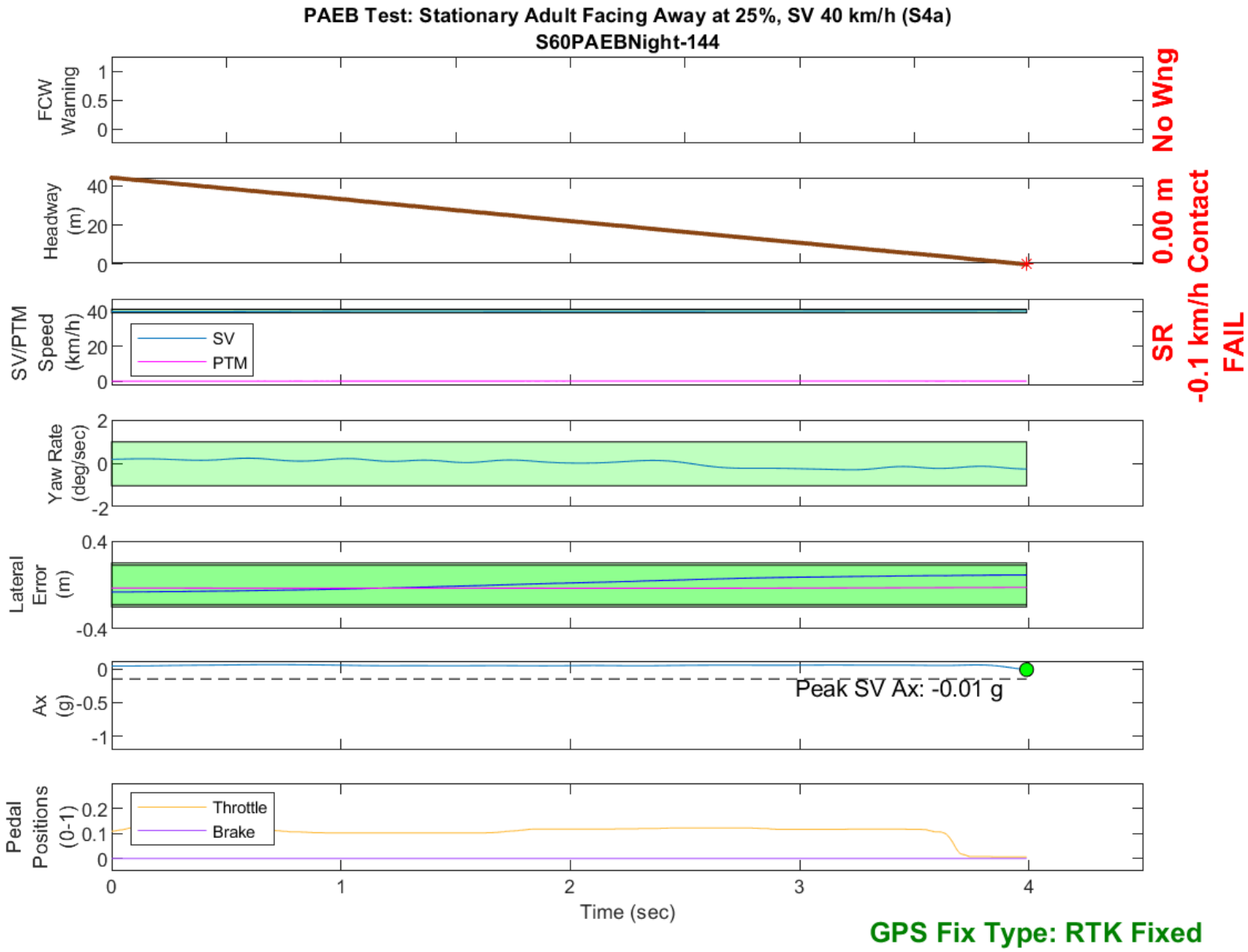


Figure D275. Time History for PAEB Run 144, S4a, Night, Low Beam, 40 km/h

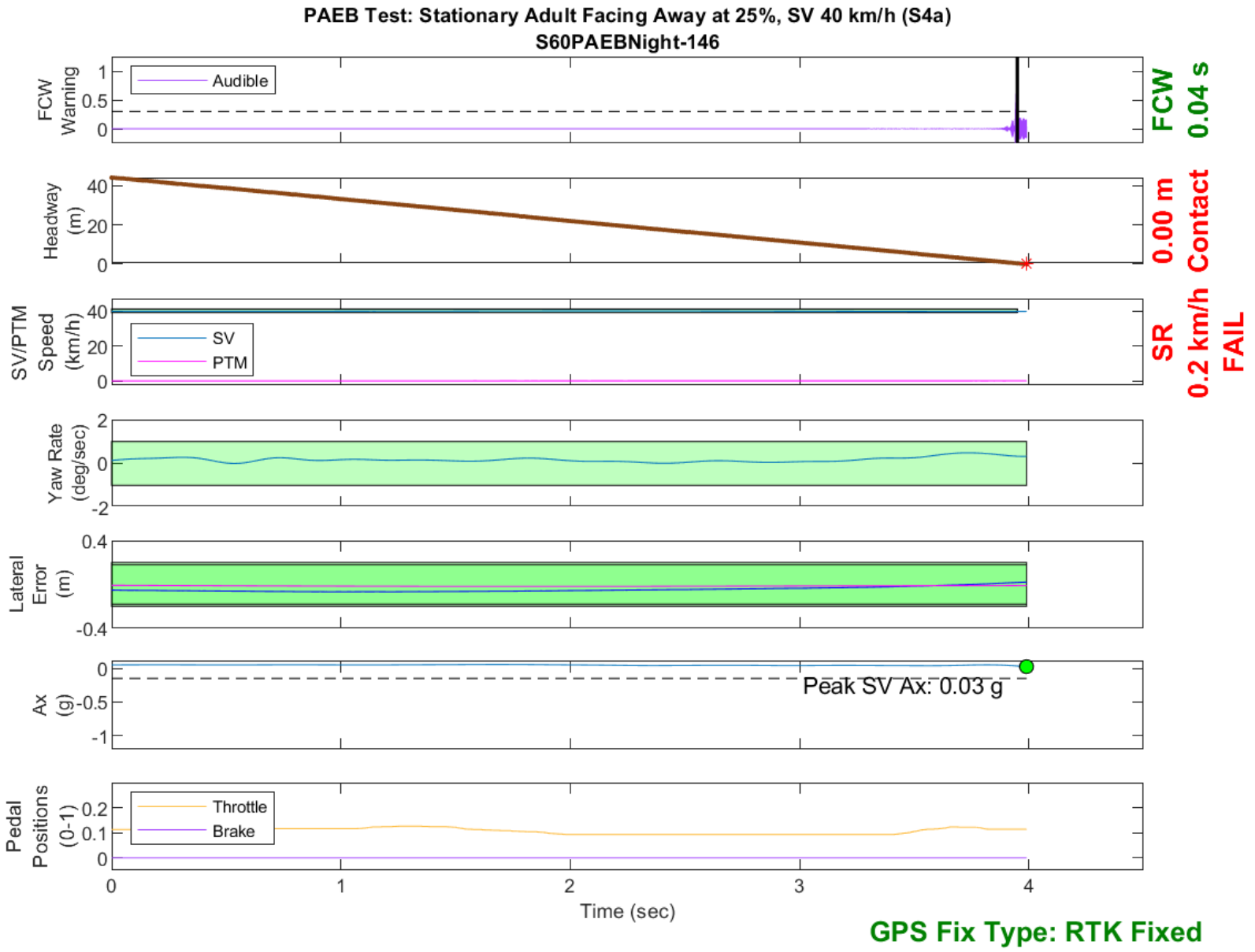


Figure D276. Time History for PAEB Run 146, S4a, Night, Low Beam, 40 km/h

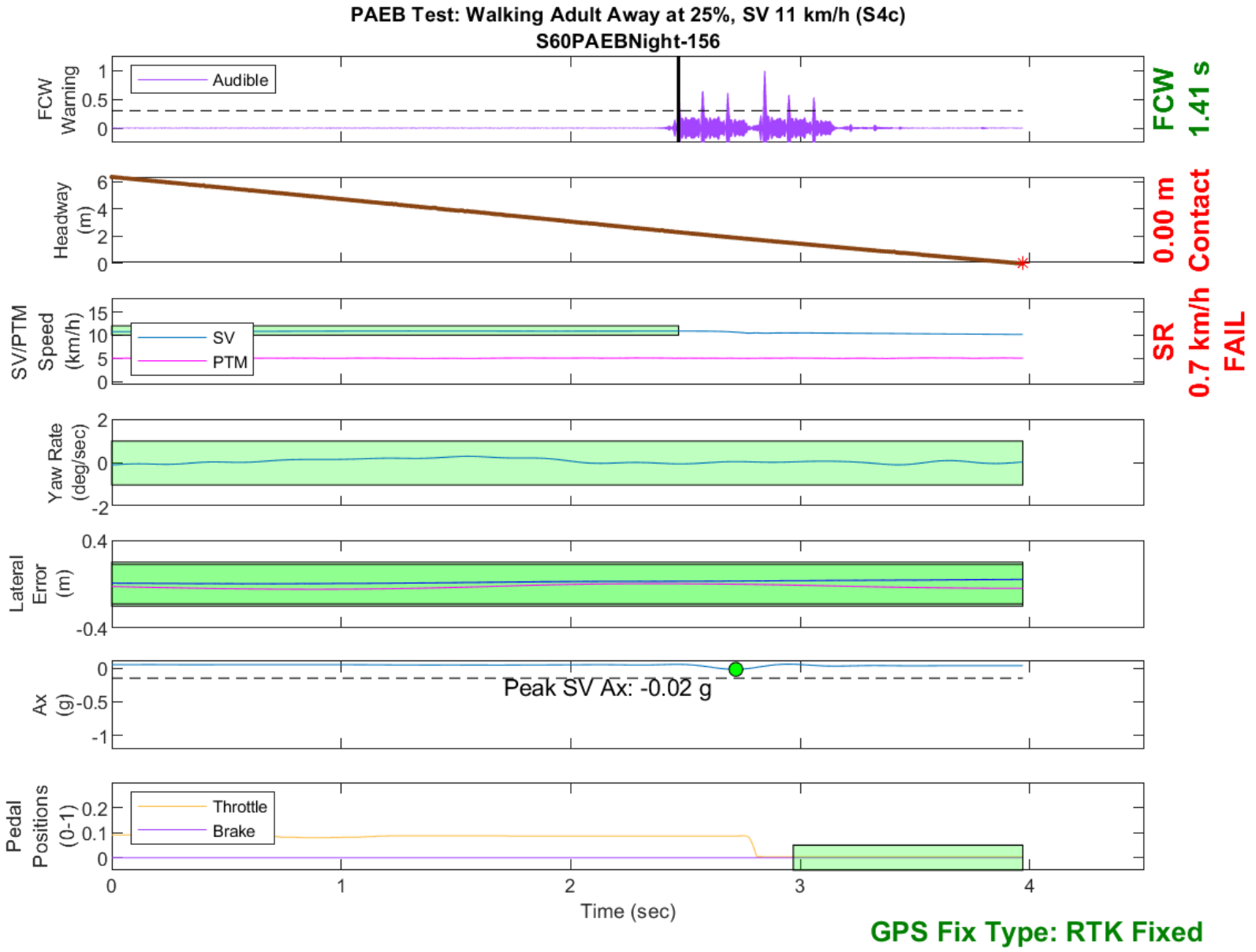


Figure D277. Time History for PAEB Run 156, S4c, Night, Low Beam, 11 km/h

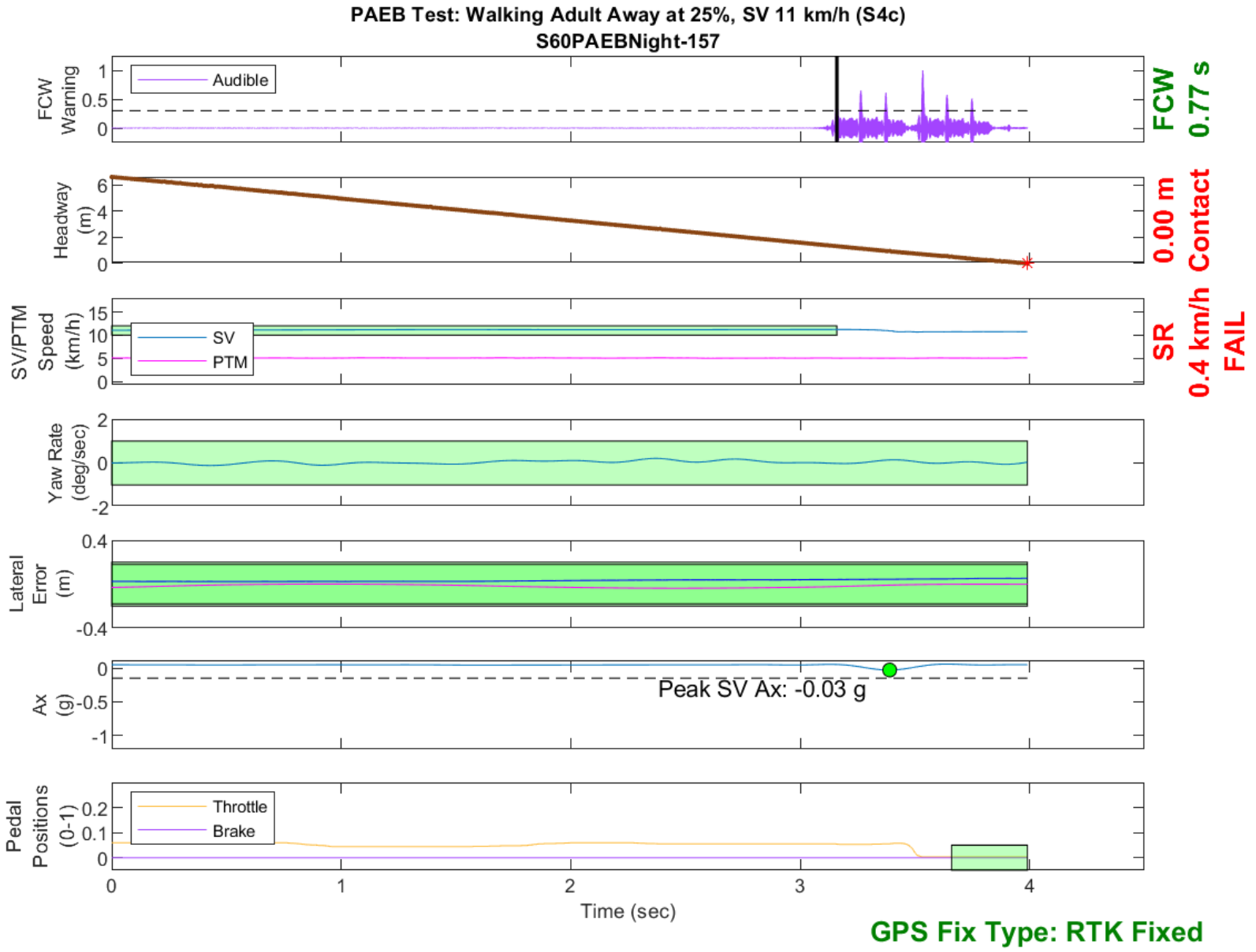


Figure D278. Time History for PAEB Run 157, S4c, Night, Low Beam, 11 km/h

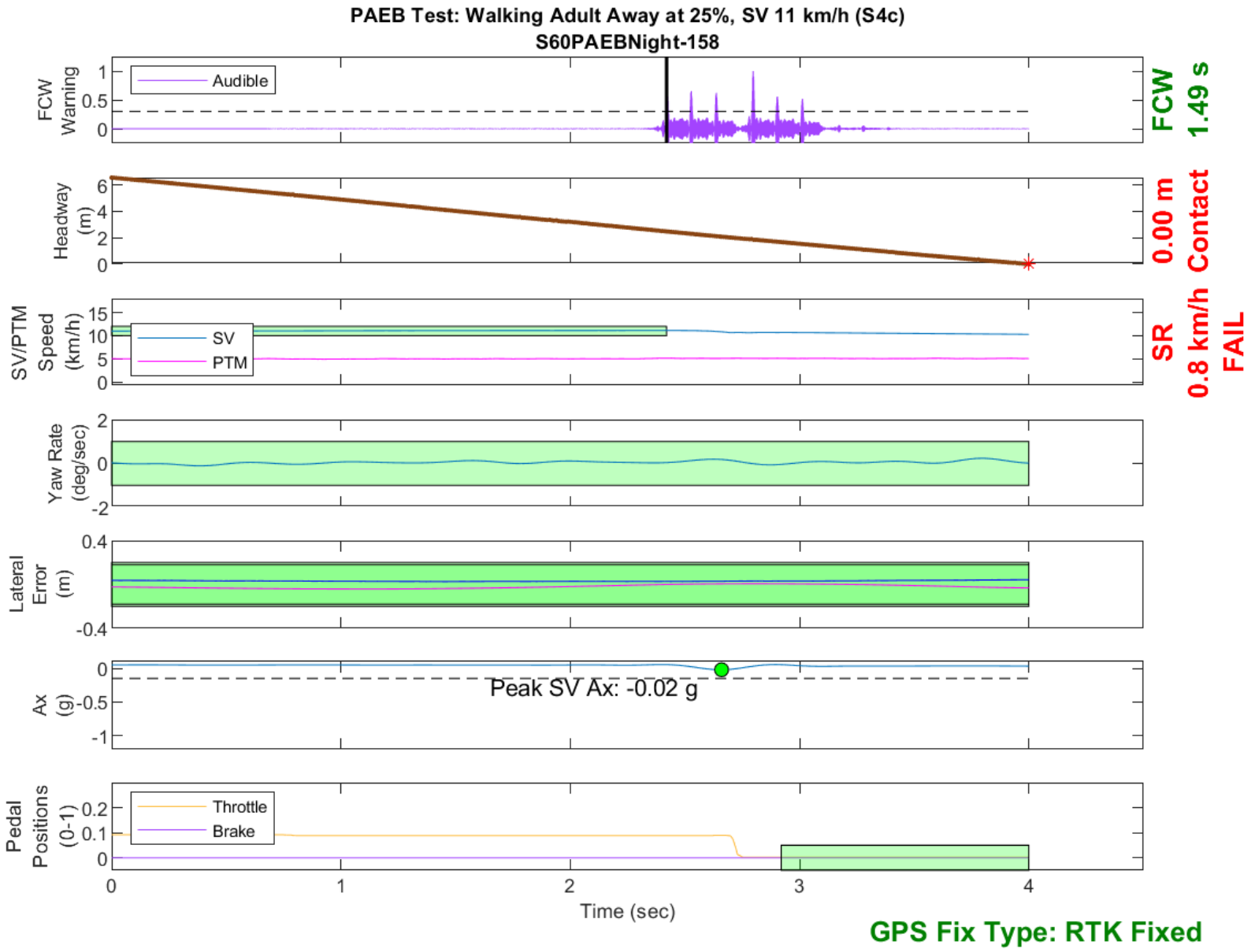


Figure D279. Time History for PAEB Run 158, S4c, Night, Low Beam, 11 km/h

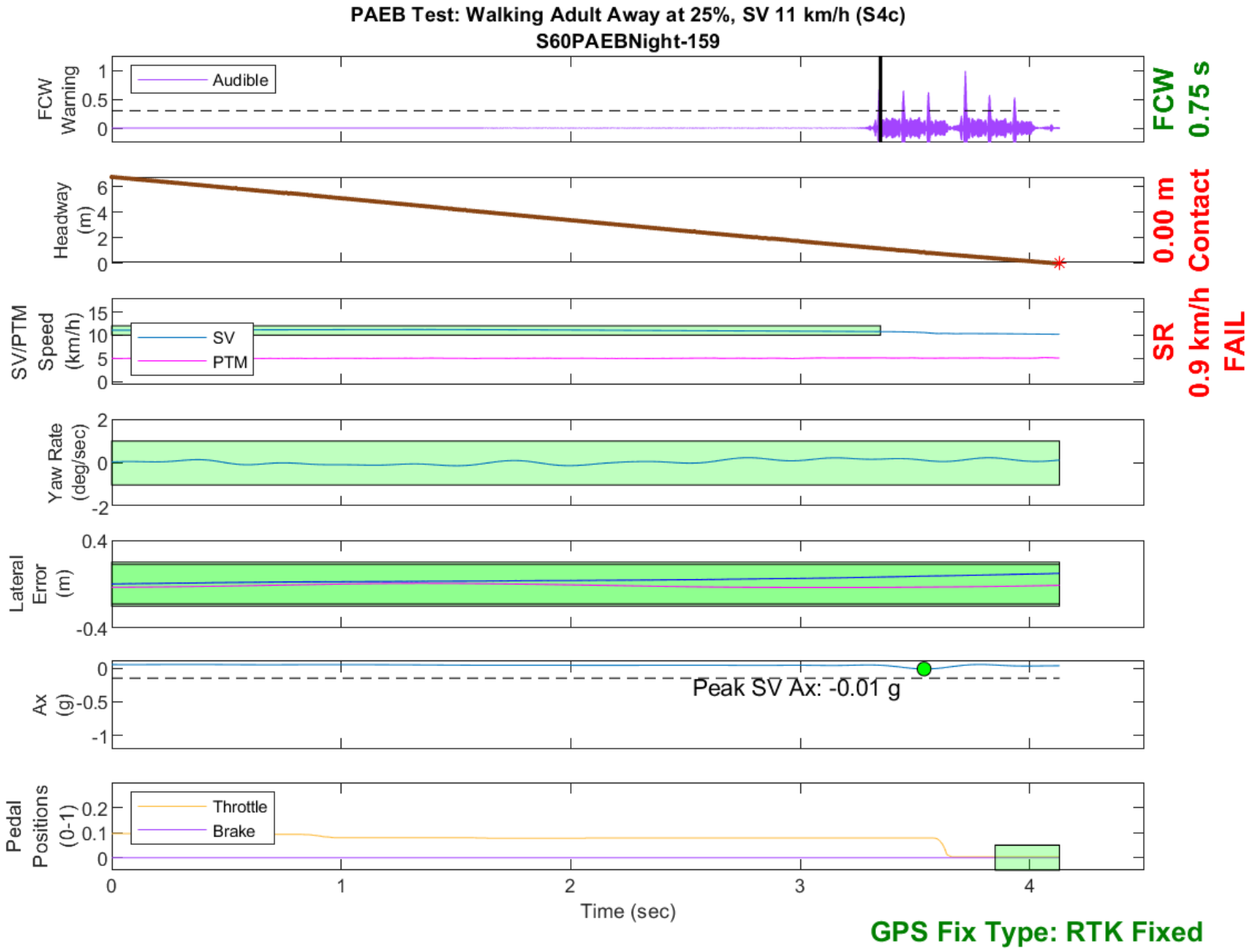


Figure D280. Time History for PAEB Run 159, S4c, Night, Low Beam, 11 km/h

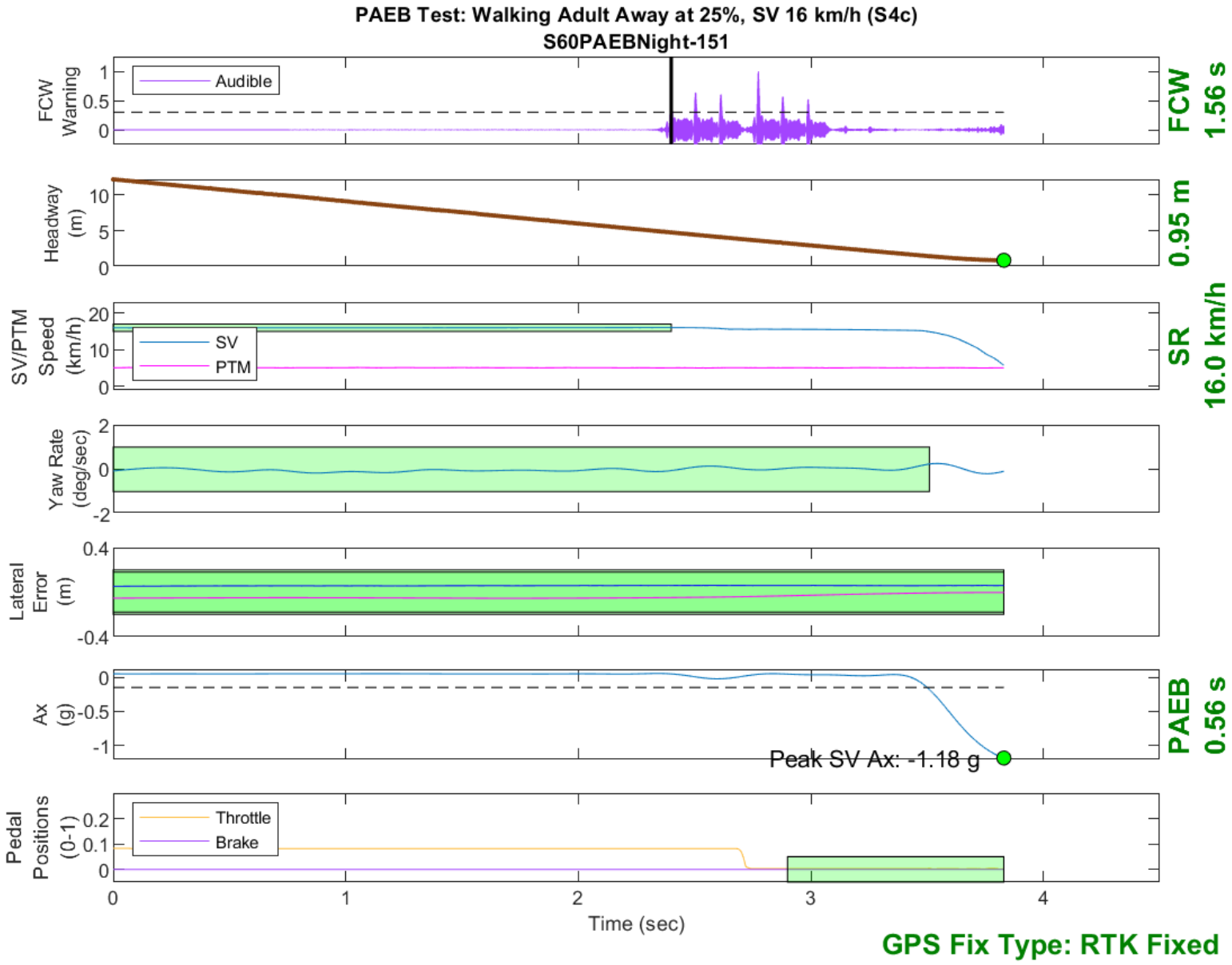


Figure D281. Time History for PAEB Run 151, S4c, Night, Low Beam, 16 km/h

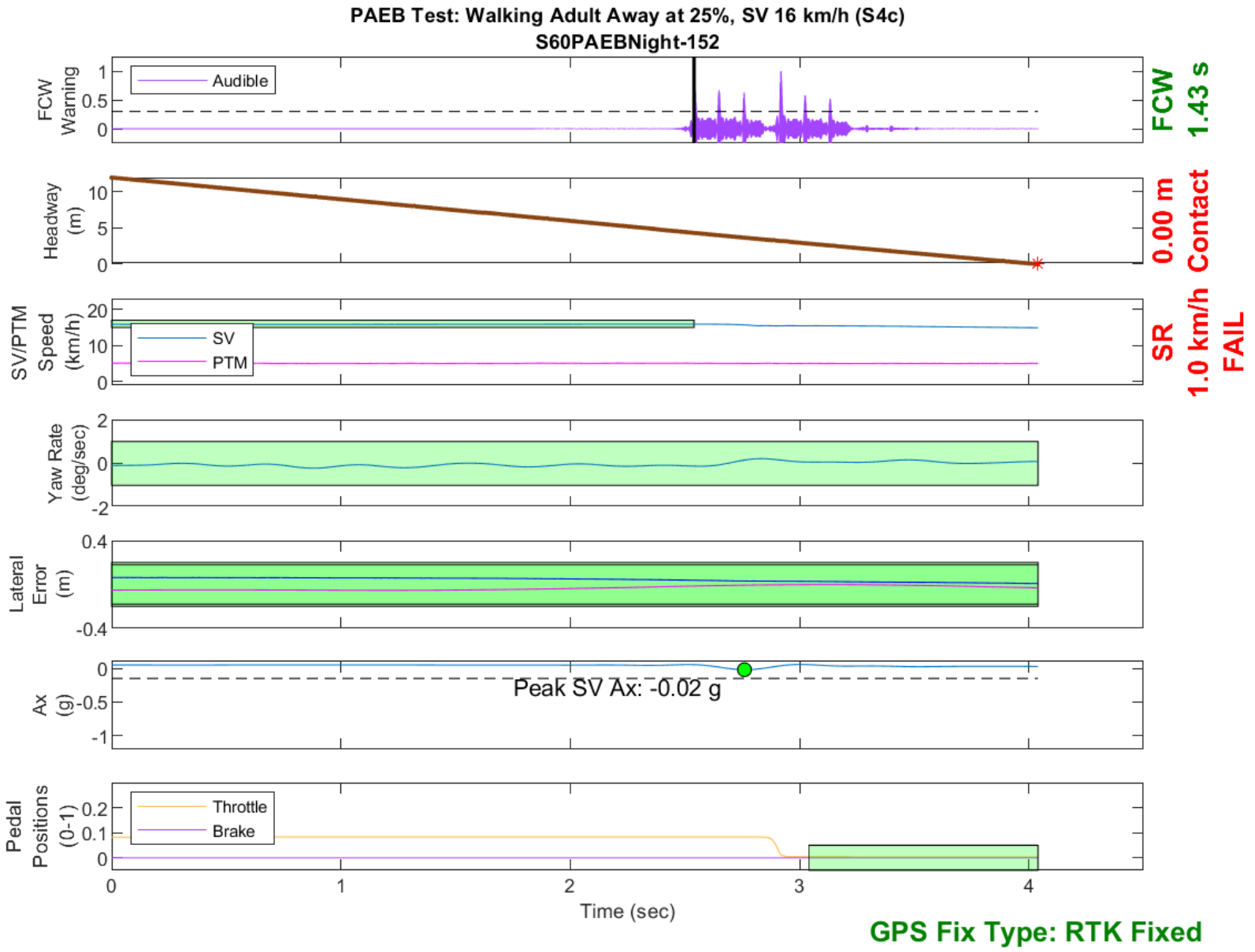


Figure D282. Time History for PAEB Run 152, S4c, Night, Low Beam, 16 km/h

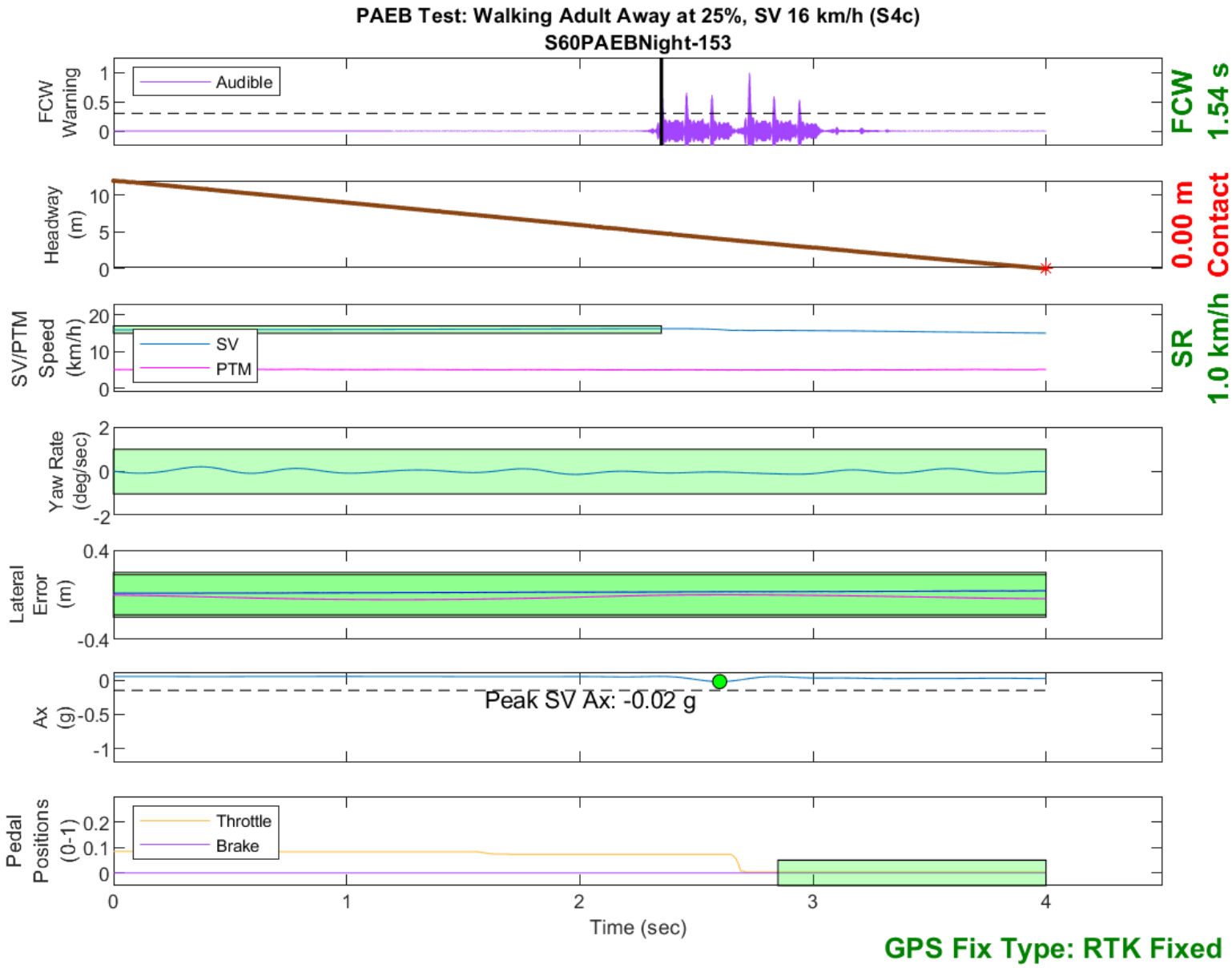


Figure D283. Time History for PAEB Run 153, S4c, Night, Low Beam, 16 km/h

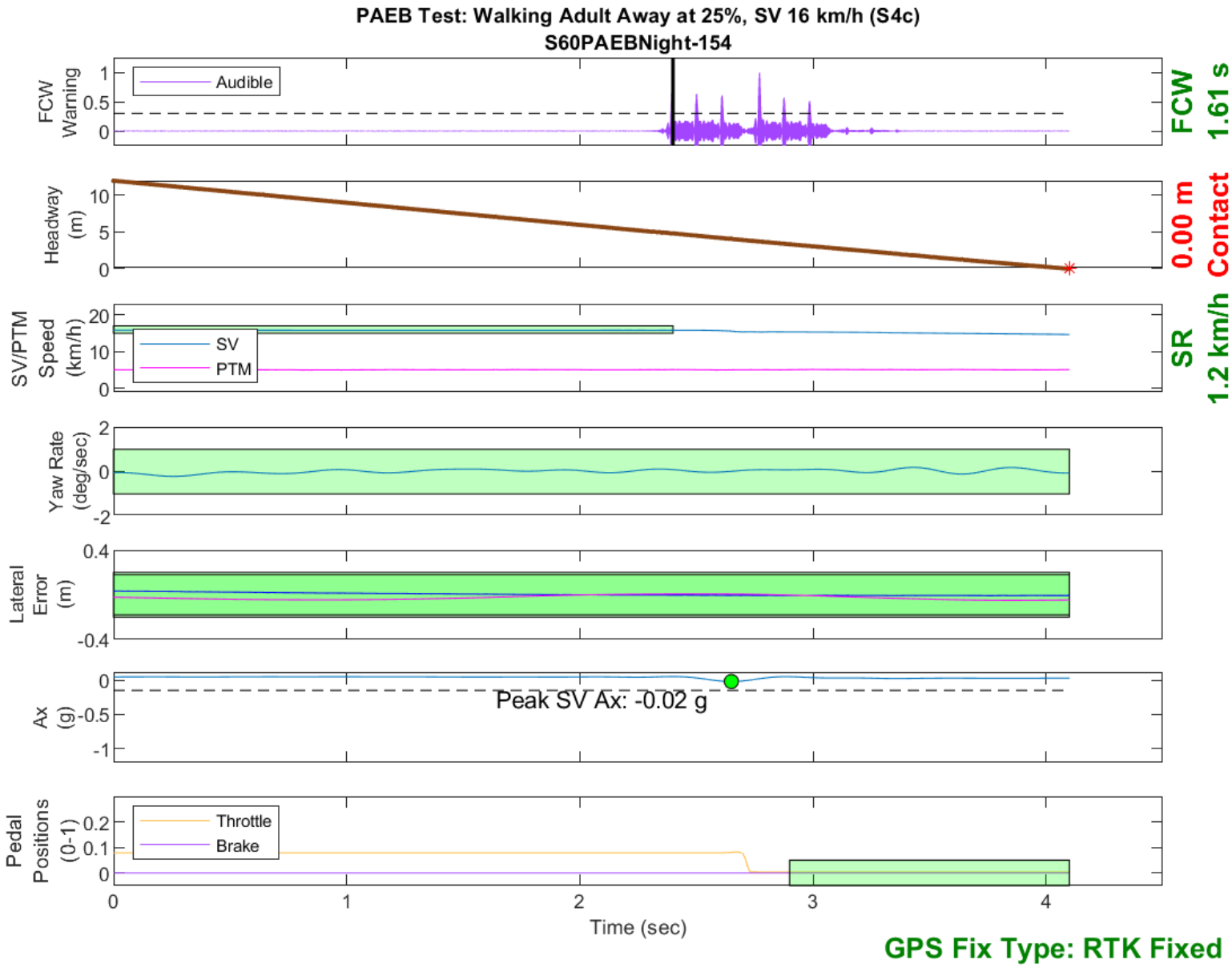


Figure D284. Time History for PAEB Run 154, S4c, Night, Low Beam, 16 km/h

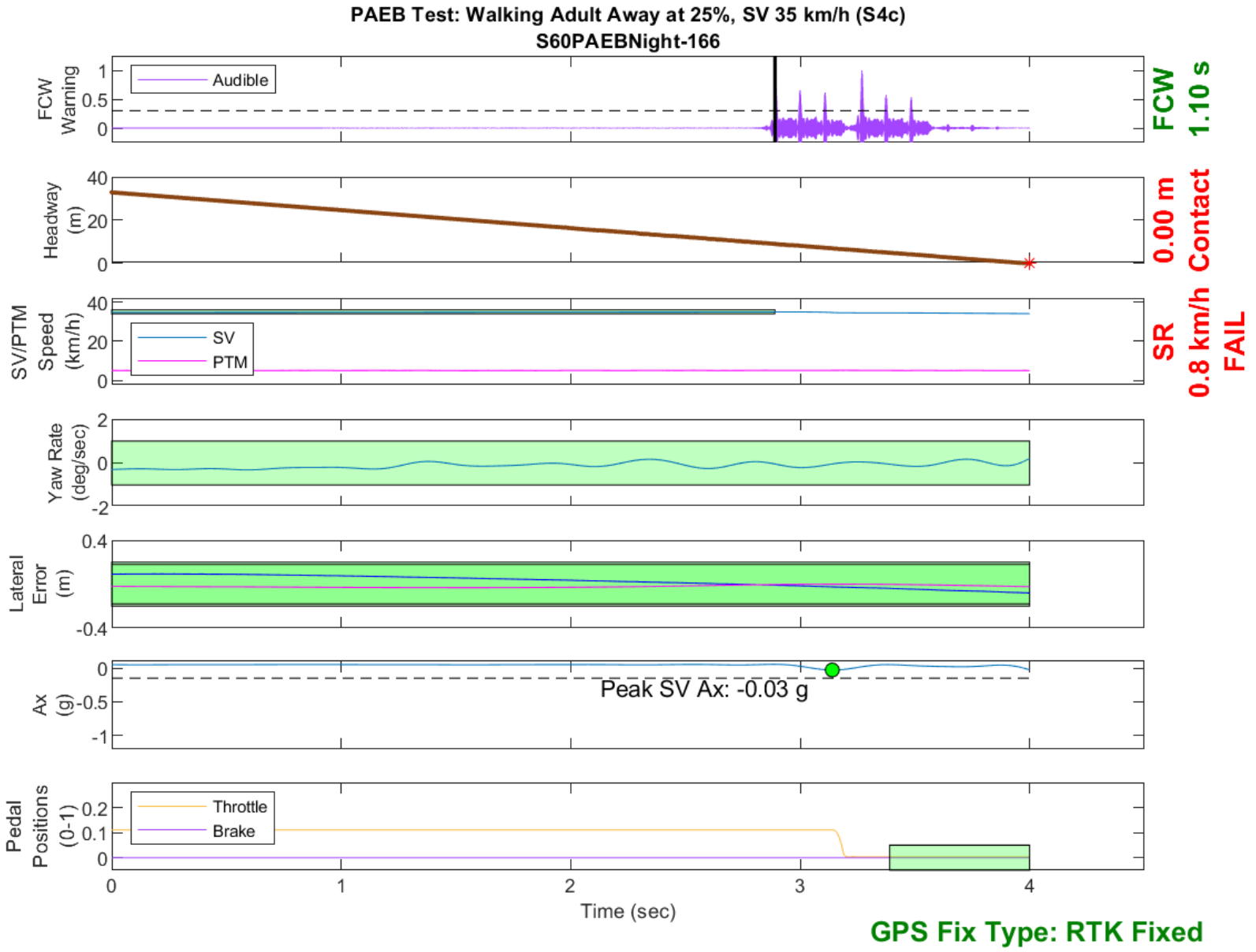


Figure D285. Time History for PAEB Run 166, S4c, Night, Low Beam, 35 km/h

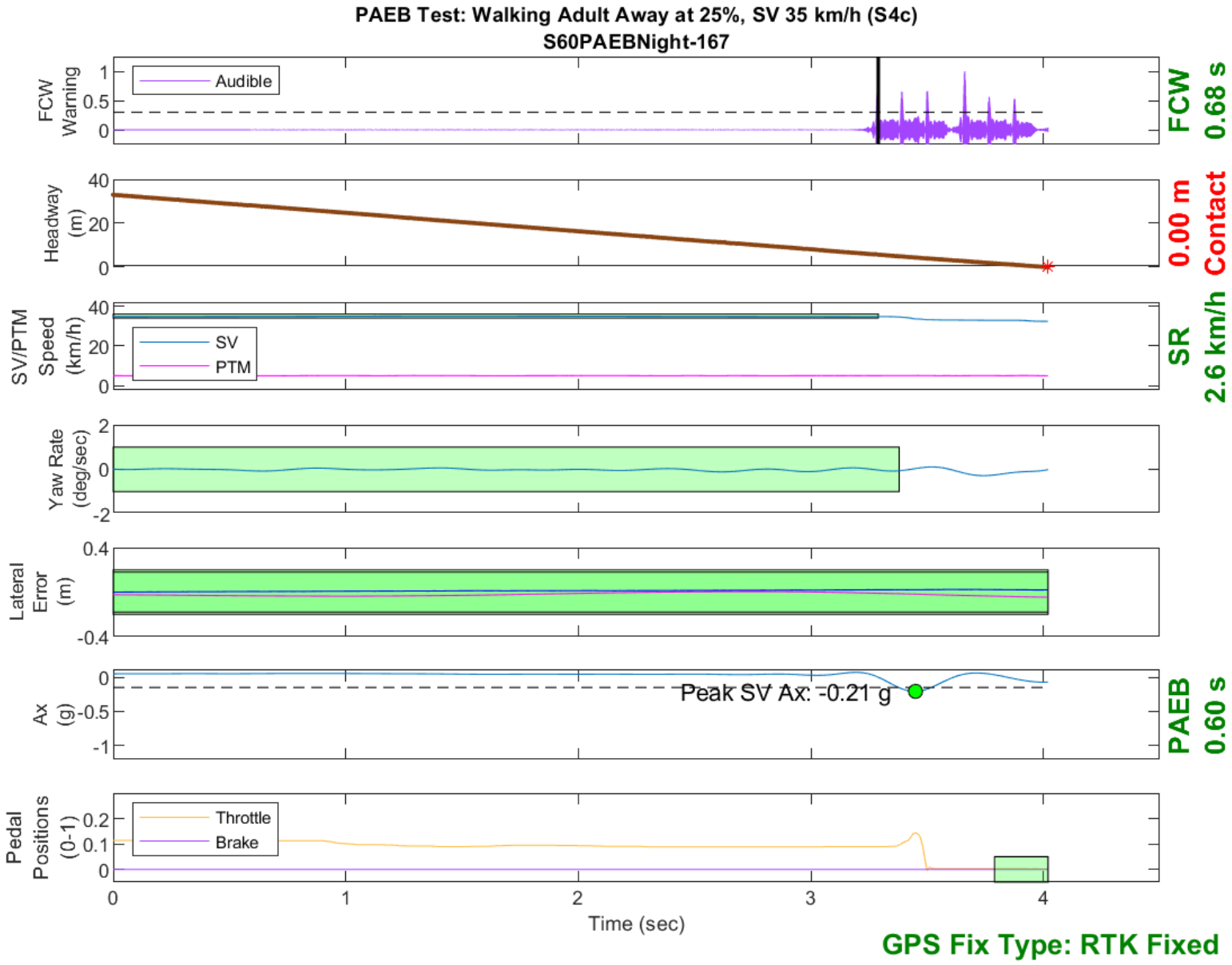


Figure D286. Time History for PAEB Run 167, S4c, Night, Low Beam, 35 km/h

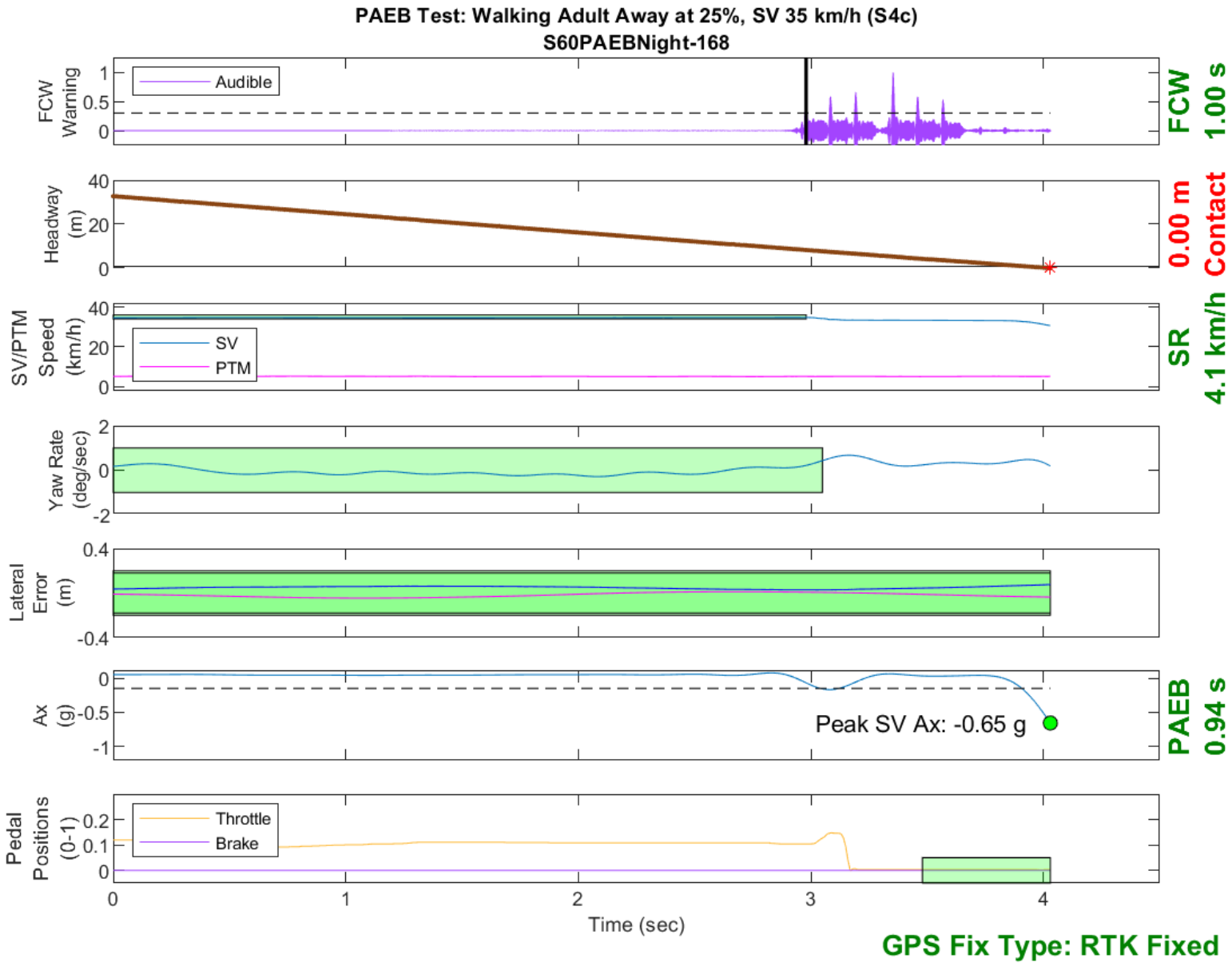


Figure D287. Time History for PAEB Run 168, S4c, Night, Low Beam, 35 km/h

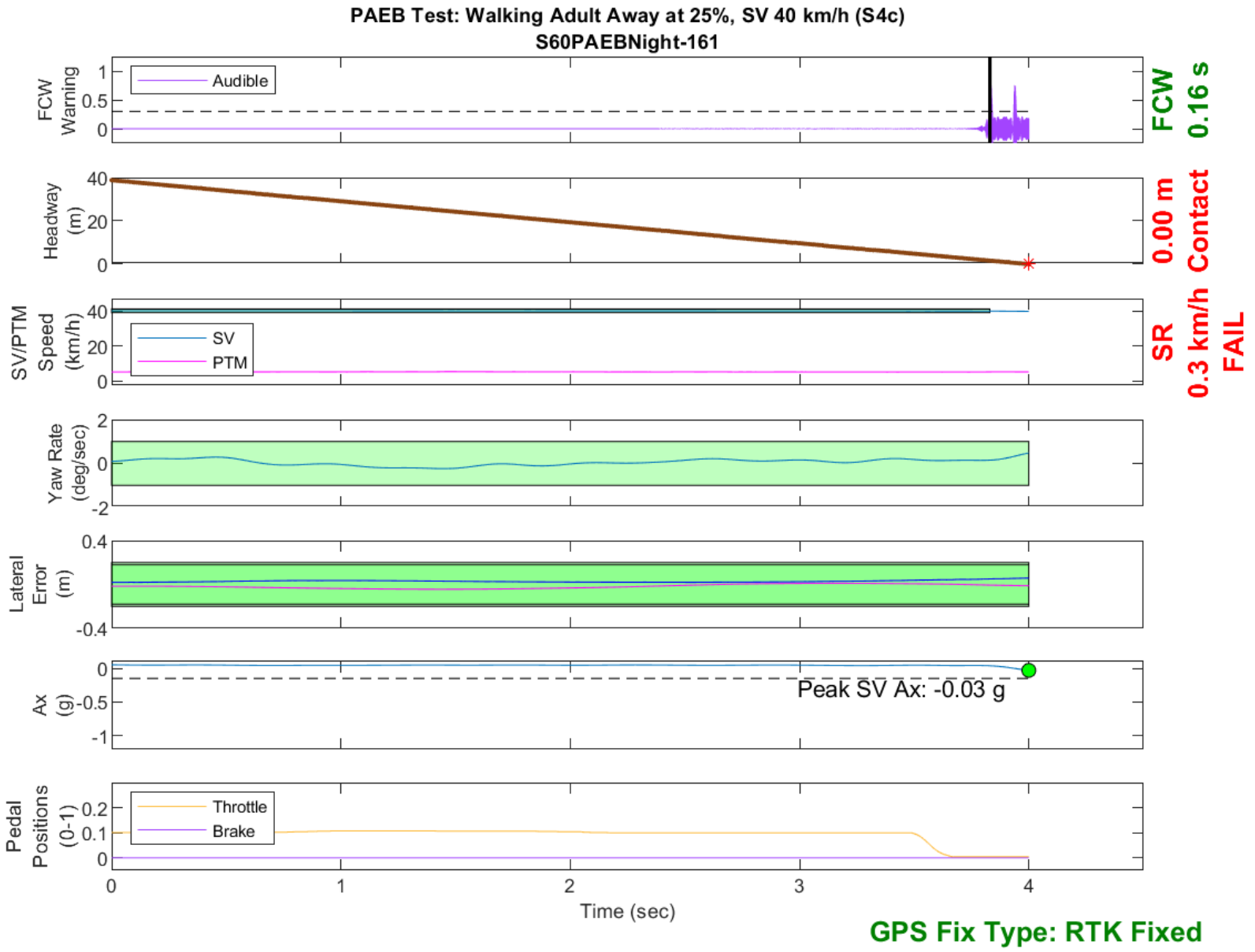


Figure D288. Time History for PAEB Run 161, S4c, Night, Low Beam, 40 km/h

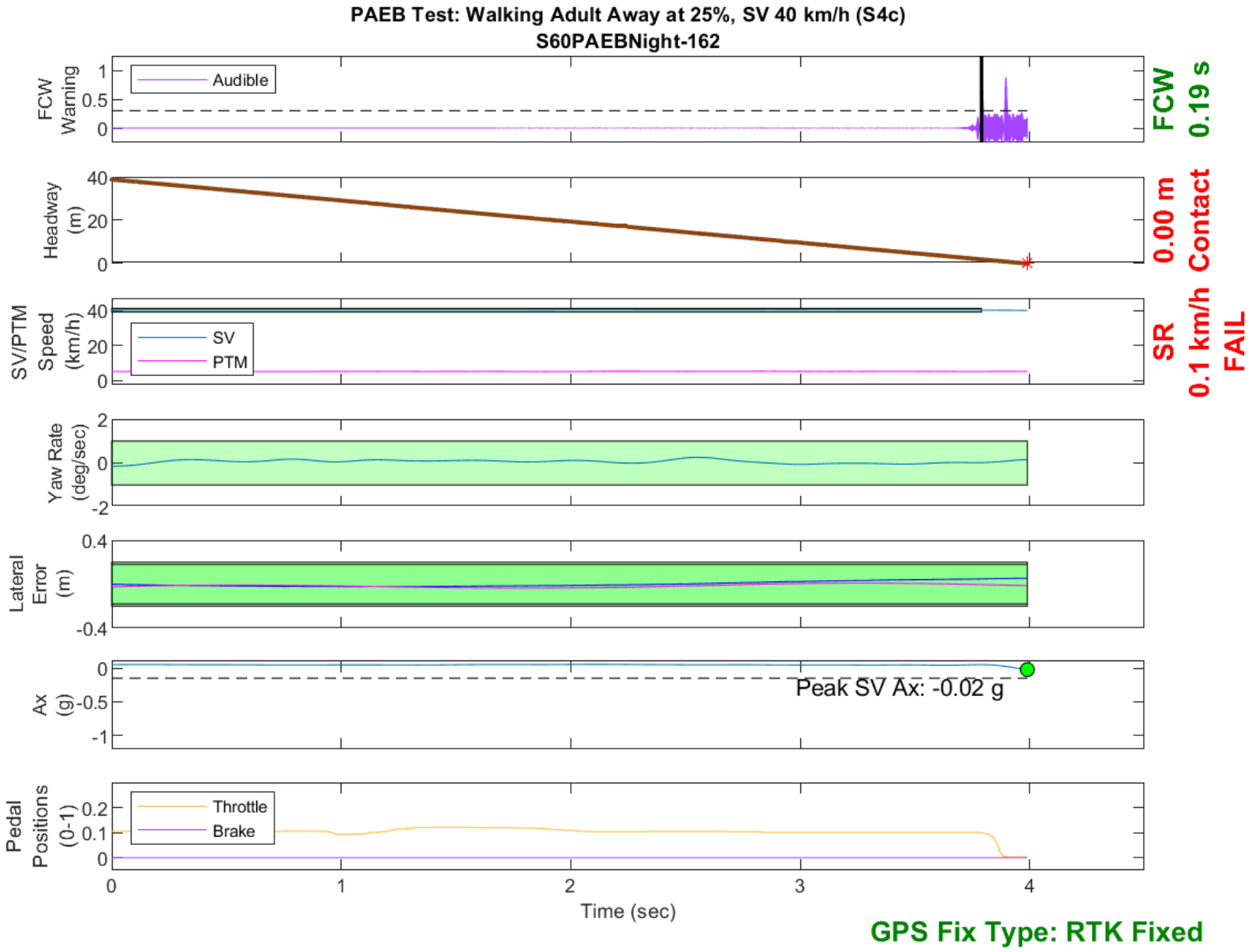


Figure D289. Time History for PAEB Run 162, S4c, Night, Low Beam, 40 km/h

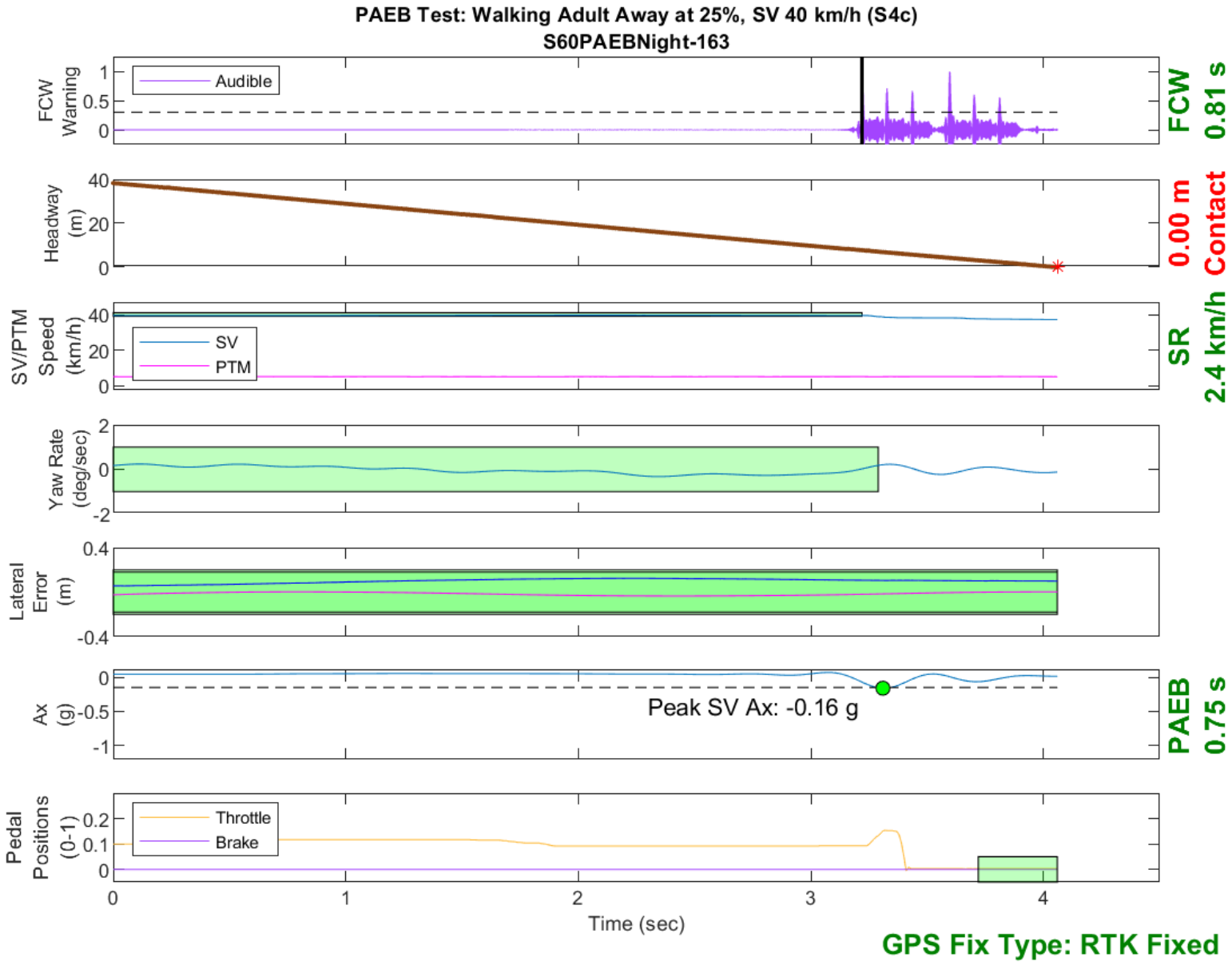


Figure D290. Time History for PAEB Run 163, S4c, Night, Low Beam, 40 km/h

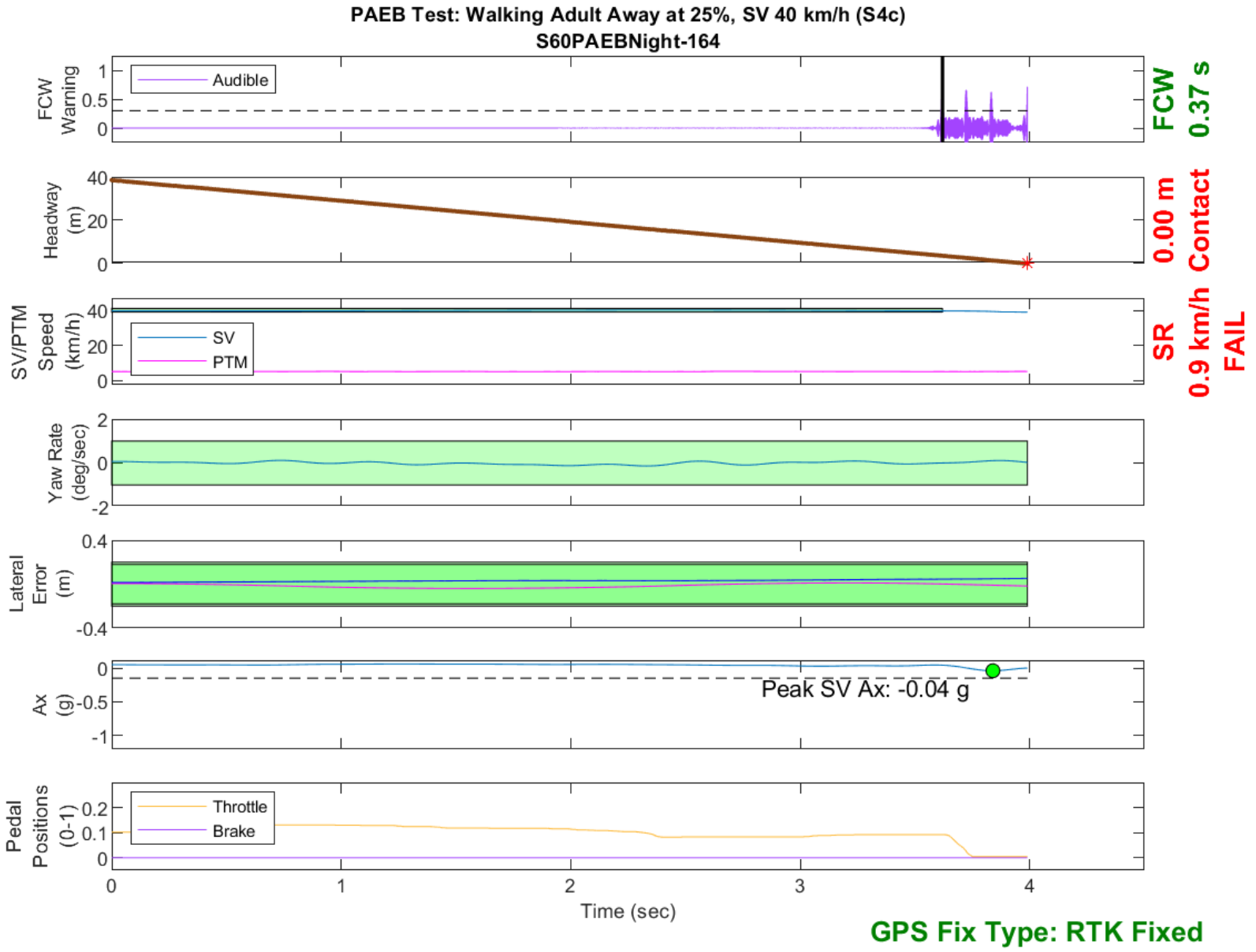


Figure D291. Time History for PAEB Run 164, S4c, Night, Low Beam, 40 km/h