PEDESTRIAN AUTOMATIC EMERGENCY BRAKING
SYSTEM RESEARCH TEST
NCAP-DRI-PAEB-20-09

2020 Subaru Outback Premium/LDD

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Final Report

Prepared Under Contract No. DTNH22-14-D-00333

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15. Supplementary Notes

16. Abstract

These research tests were conducted on the subject 2020 Subaru Outback Premium/LDD 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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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 Draft)", 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 the 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. 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 strikeable 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 50^{th} 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 Subaru Outback Premium/LDD. 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 -0.03 g threshold.

Section II

DATA SHEETS

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

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2020 Subaru Outback Premium/LDD

VIN: *4S4BTACC3L319xxxx*

Day Test Date: *6/2/2020*

Night Test Date: *6/2/2020*

System Setting: *Pre-Collision Braking On*

Upper Capabilities

	Maximum Test Speed Without Consistent SV-to-PTM Contact[1]		
Scenario	**Daytime (km/h)**	**Night-High Beam (km/h)**	**Night-Low Beam (km/h)**
S1a	40		
S1b	55	55	40
S1c	40		
S1d	35	20	*
S1e	60	35	35
S1f			
S1g			
S4a	55	16	16
S4b	40		
S4c	65	40	16

* 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.

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	6	3	10.8						
40	5	5	39.9						

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	
16	5	5	15.6	5	3	11.9	5	4	13.2
20	6	6	20.2	5	3	17.7	5	3	16.1
30	5	5	29.7	5	5	30.0	5	5	30.0
40	5	5	40.0	5	4	32.9	5	5	40.0
45							5	2	31.5
50	5	5	49.1	6	6	49.7	3	0	29.5
55	5	5	51.9	5	4	51.9			
60	4	1	43.9	4	1	42.0			

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 1: TEST RESULTS SUMMARY

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2020 Subaru Outback Premium/LDD

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	16.2						
40	5	5	34.1						

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							1	1	10.1
16	5	5	16.2	5	4	13.9	4	1	6.4
20	6	6	19.9	5	3	14.6			
25				5	2	13.8			
30	5	5	30.0	4	1	11.1			
35	5	4	32.7						
40	3	0	19.7	3	0	26.7	3	0	8.8

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				6	5	34.6	5	4	33.0
40	6	6	35.4	5	0	24.2	3	0	24.1
50	5	5	40.2						
60	5	4	42.5						

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	0.29	0.04
2	0.37	0.04
3	0.33	0.34
4	0.30	0.30
5	0.30	0.05

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	
16	5	5	15.9	5	5	15.6	5	3	10.3
35				4	1	9.4	3	0	1.2
40	5	5	40.0	5	2	16.6	3	0	0.7
50	5	5	49.8						
55	5	4	54.7*						
60	3	0	53.0						

* Last Moment Braking for a single run - note that speed reduction for runs with Last Moment Braking are not included in the calculation for Average Speed Reduction

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	15.9						
40	5	5	40.2						

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	
16	5	5	15.8	5	5	16.2	5	5	15.9
35							4	1	18.2
40	5	5	39.8	5	3	27.1	3	0	4.0
45				5	2	22.1			
50	5	5	49.8	4	0	3.6			
60	5	5	59.8						
65	5	5	64.8						
70	3	0	53.4						

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 2: VEHICLE DATA

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2020 Subaru Outback Premium/LDD

TEST VEHICLE INFORMATION

VIN: *4S4BTACC3L319xxxx*

Body Style: *SUV* Color: *Magnetite Gray Metallic*

Date Received: *5/14/2020* Odometer Reading: *114 mi*

DATA FROM VEHICLE'S CERTIFICATON LABEL

Vehicle manufactured by: *Subaru Corporation*

Date of manufacture: *2/20*

Vehicle Type: *MPV*

DATA FROM TIRE PLACARD

Tires size as stated on Tire Placard:	Front:	*225/65R17*
	Rear:	*225/65R17*
Recommended cold tire pressure:	Front:	*240 kPa (35 psi)*
	Rear:	*230 kPa (33 psi)*

TIRES

Tire manufacturer and model:	*Yokohama Avid GT*
Front tire size:	*225/65R17 102H*
Rear tire size:	*225/65R17 102H*
Front tire DOT prefix:	*4UF5 6JK*
Rear tire DOT prefix:	*4UF5 6JK*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 3: TEST CONDITIONS

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2020 Subaru Outback Premium/LDD

DAYTIME TEST GENERAL INFORMATION

Test date: *6/2/2020*

AMBIENT CONDITIONS

Air temperature: *32.2 C (90 F)*

Wind speed: *3.6 m/s (8.1 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*

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: *240 kPa (35 psi)*

Rear: *230 kPa (33 psi)*

NIGHTTIME TEST GENERAL INFORMATION

Test date: *6/2/2020*

AMBIENT CONDITIONS

Air temperature: *26.7 C (80 F)*

Wind speed: *0.0 m/s (0.0 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

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2020 Subaru Outback Premium/LDD

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: *240 kPa (35 psi)*

Rear: *230 kPa (33 psi)*

WEIGHT

Weight of vehicle as tested including driver and instrumentation

Left Front:	*518.9 kg (1144 lb)*	Right Front:	*474.9 kg (1047 lb)*
Left Rear:	*400.1 kg (882 lb)*	Right Rear:	*378.3 kg (834 lb)*
		Total:	*1772.2 kg (3907 lb)*

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 4: PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM OPERATION

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2020 Subaru Outback Premium/LDD

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

Pre-Collision Braking System, as a sub-function of Eyesight. It is specified on the Monroney label as Eyesight Driver-Assist System w/ Automatic Emergency Braking.

Type and location of sensors the system uses:

Stereo (2) cameras located behind the windshield near the rearview mirror.

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

____ Yes

X No

If yes, please provide a full description.

System setting used for test (if applicable): *Pre-Collision Braking On*

How is the PAEB alert presented to the driver?

(Check all that apply)

X Warning light

X Buzzer or audible alarm

____ Vibration

____ Other

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.

The visual alert alternates between two graphics, shown in Appendix A, Figure A14. The auditory alert is a tone centered at 2200 HZ and pulsed approximately 8 times per second.

DATA SHEET 4: PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM OPERATION

2020 Subaru Outback Premium/LDD

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

____ No

If yes, please provide a full description.

Initialization is accomplished by operation on a public road for about 1 hour. The initialization should be performed under the following conditions and should not be performed in inclement weather:

1. Dry road surfaces

2. Daylight hours

3. Public road with both left and right lane markings

4. If traffic exists, keep a comfortable distance from a lead vehicle

5. Maintain the posted speed limit

If the vehicle ignition is turned off and the engine is restarted following each test run, it's NOT necessary to reinitialize the system.

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

Minimum: *1.6 km/h (1 mph) (Per manufacturer supplied information)*

Maximum: *160 km/h (100 mph) (Per manufacturer supplied information)*

Will the system deactivate due to repeated PAEB activations, impacts or near-misses? **X** Yes

____ No

If yes, please provide a full description.

If the Pre-Collision Braking System OFF indicator light illuminates, AEB is NOT operational. For example, if AEB has operated 3 times in one driving cycle, AEB will NO longer operate. To reactivate, restart the engine. After the engine is restarted, it takes approximately 7 seconds for the pre-collision braking system to activate.

PEDESTRIAN AUTOMATIC EMERGENCY BRAKING

DATA SHEET 4: PEDESTRIAN AUTOMATIC EMERGENCY BRAKING SYSTEM OPERATION

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2020 Subaru Outback Premium/LDD

Is there a way to deactivate the system? **X** Yes

___ No

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

System settings are accessed by means of a touch screen center screen. The hierarchy is:

Settings

Driver Assistance

Pre-Collision Braking

Select: Setting On or Setting Off

The system is automatically reactivated after cycling the ignition.

Please see EyeSight Owner's Manual, Pages 126 and 127. These are shown in Appendix B, Pages B-33 and B-34. See also Appendix A, Figure A13.

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.

Limitations of the system are addressed at length in the EyeSight Owner's Manual, Pages 5-9 and Pages 27-31. These are shown in Appendix B, Pages B-2 through B-6 and Pages B-17 through B-21. Limitations specific to pedestrians are addressed in the Owner's Manual, Page 35, shown in Appendix B, Page B-25.

Notes:

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 except S4c, 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

Scenario	Nominal SV Speeds (km/h)								Lighting Condition		
									Day	Night	
	16	20	30	40	50	60	70	80		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 Draft)", 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.

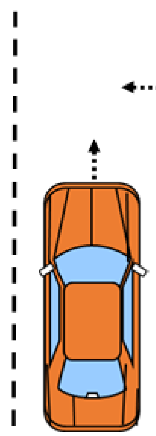


Figure 1. Scenarios S1a, b, c; Nearside Crossing Adult Pedestrian Walking 25/50/75% Overlap

- 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.

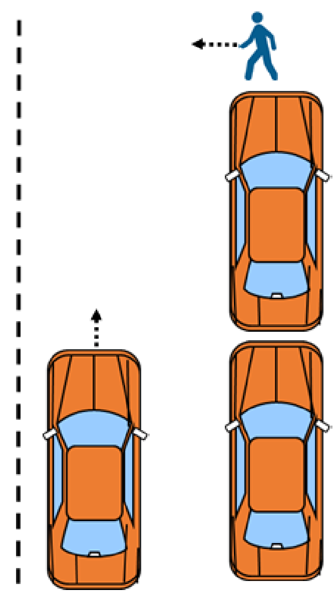


Figure 2. Scenario S1d; Nearside Obstructed Crossing Child Running, 50% Overlap

- 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.

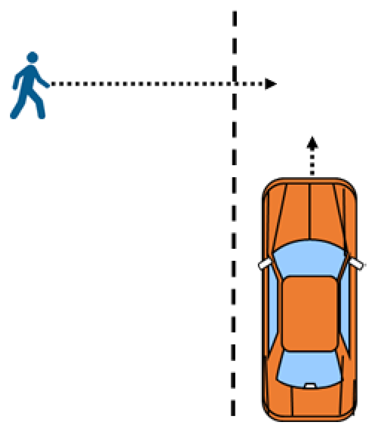


Figure 3. Scenario S1e; Offside Crossing Adult Running 50% Overlap

- 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.

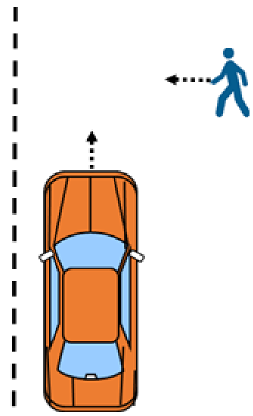


Figure 4. Scenario S1f; Nearside Crossing Adult Walking Stops Short

- 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.

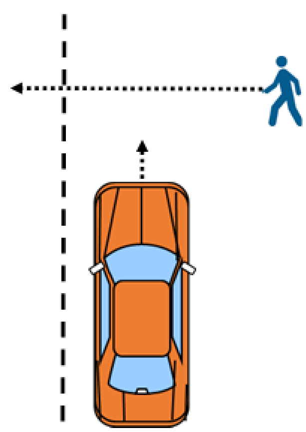


Figure 5. Scenario S1g; Nearside Crossing Adult Walking Clears Path

- 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).

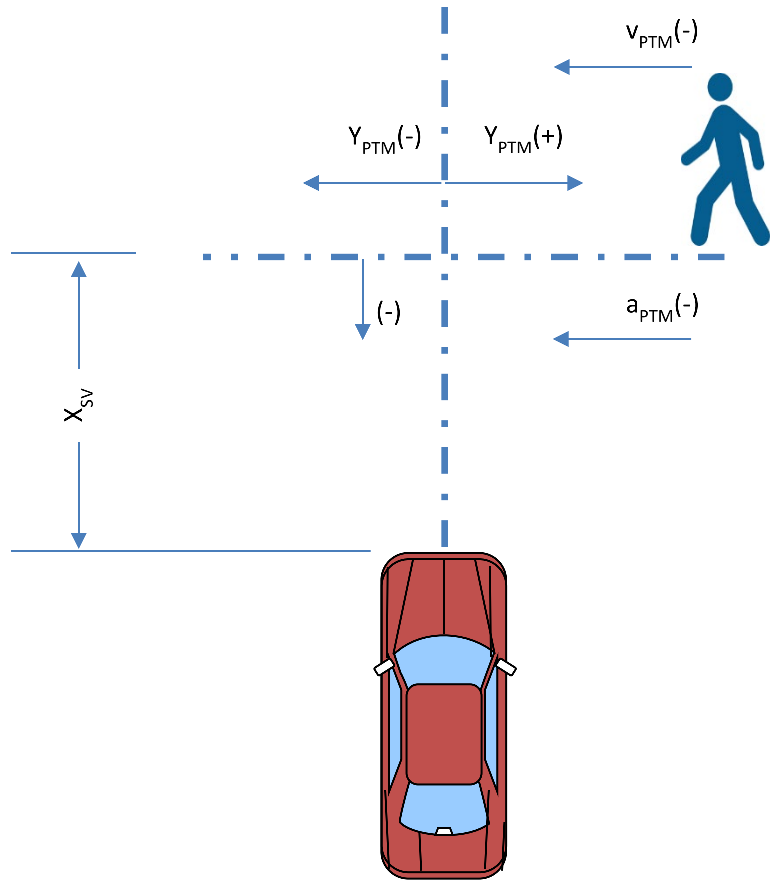


Figure 6. Coordinate System for Validation of Scenario 1

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.

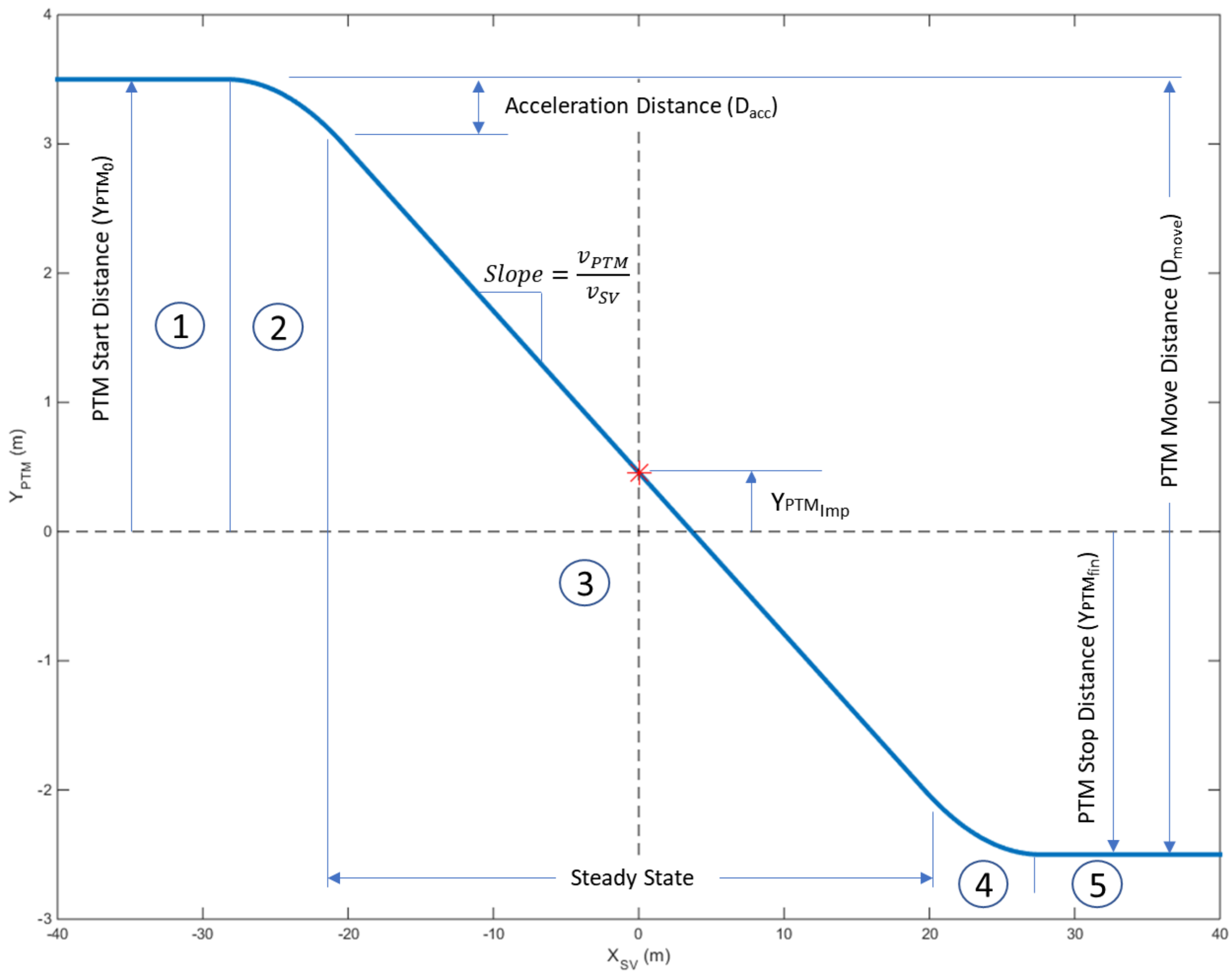


Figure 7. PTM Lateral Lane Position as a Function of SV Longitudinal Lane Position

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):

$$Y_{PTM} = Y_{PTM_0} \qquad \text{for} \quad X_{SV} \le X_{SV_{PTM\,start}}$$

Domain 2 (Acceleration):

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

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 1.8 m 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). "Parked Obstruction Vehicle 1 (PV1) was a mid-sized sedan (1999 Honda Accord) positioned closest to the pedestrian path. Parked Obstruction Vehicle 2 (PV2) was a mid-sized Sport Utility Vehicle (2012 Toyota Highlander) positioned behind PV1.

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, except S4c, 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. <u>S4 TEST SCENARIOS</u>

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.

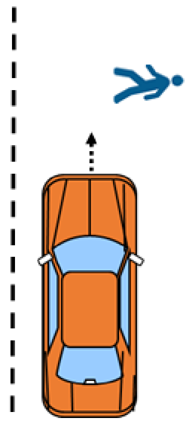


Figure 8. Scenario S4a; Nearside Standing Adult Facing Away From SV, 25% Overlap

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

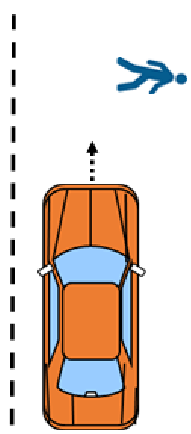


Figure 9. Scenario S4b; Nearside Standing Adult Facing Towards SV, 25% Overlap

- S4b test conditions:
  - SV Speeds (km/h): 16, 40
  - PTM Speed (km/h): 0
  - PTM Type: Adult
  - Overlap: 25%
  - Direction of PTM Approach: Nearside, 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 10 below illustrates the test setup for the S4c test scenario. See Table 5 for details on the test setup.

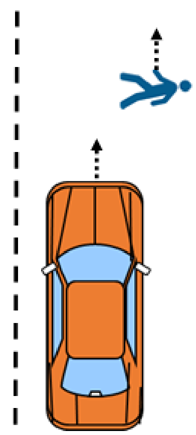


Figure 10. Scenario S4c; Nearside Walking Adult Away From SV, 25% Overlap

- S4c test conditions:
  - SV Speeds (km/h): 40
  - PTM Speed (km/h): 5
  - PTM Type: Adult
  - Overlap: 25%
  - Direction of PTM Approach: Nearside, 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 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 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, except S4c, 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):
  - Scenarios 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.

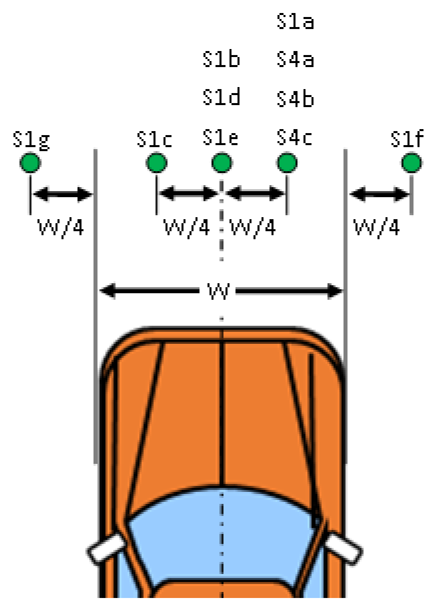


Figure 11. Offset Conditions

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

PTM Type	Adult (S1a-b-c-f-g) Child (S1d)	
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-to-PTM contact.)*	S1a	25%
	S1 b-d	50%
	S1c	75%
	S1f	-25%
	S1g	125%
SV Start Distance	182 m (600 ft)	
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).)*	44 m (145 ft)	
Obstruction *(S1d only)*	PV1D1	1 m (3.2 ft)
	PV2D1	
	PVD1	

Drawing illustrates setup but is not to scale

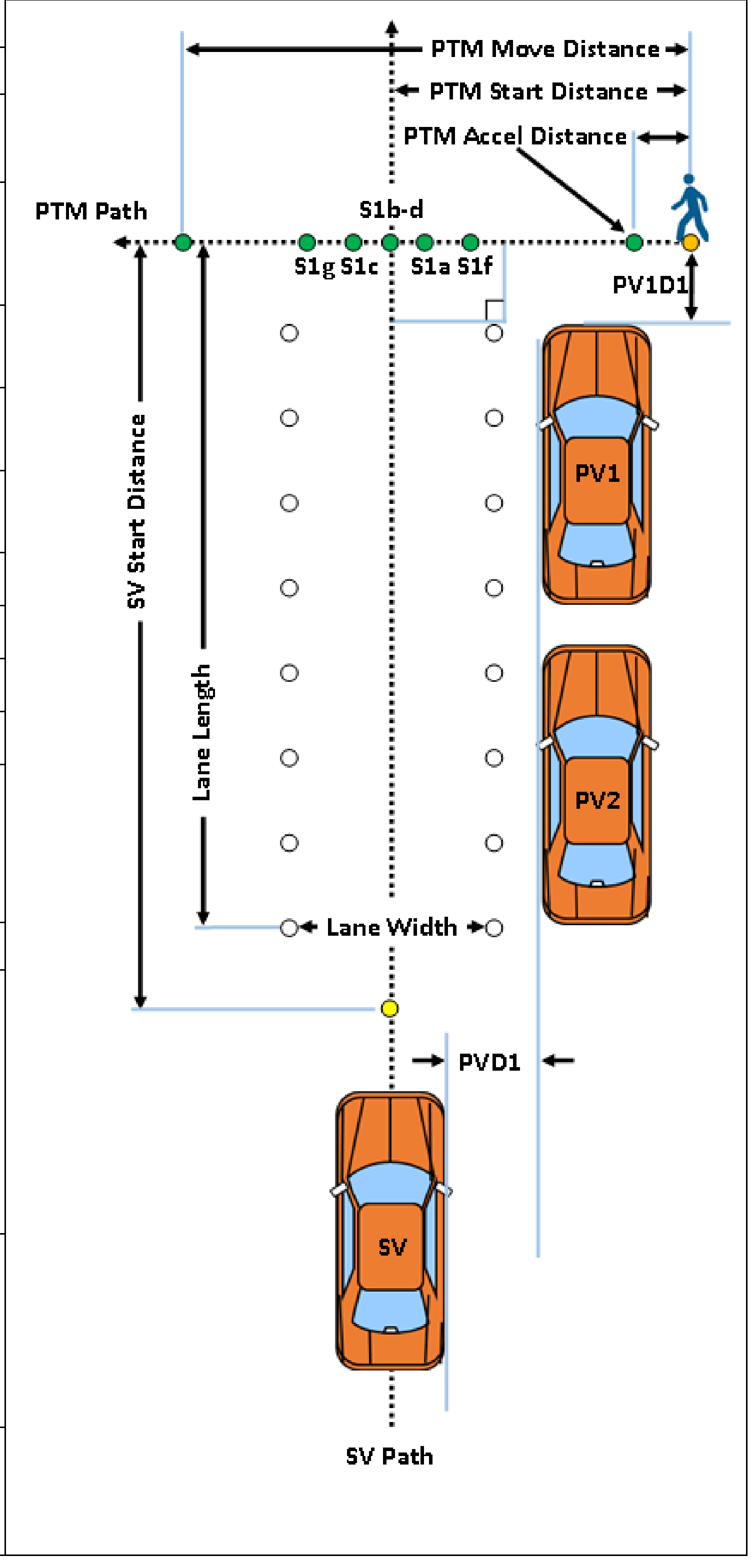


Table 4. Summary of S1e Scenario Setup

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 (600 ft)	
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).)*	44 m (145 ft)	

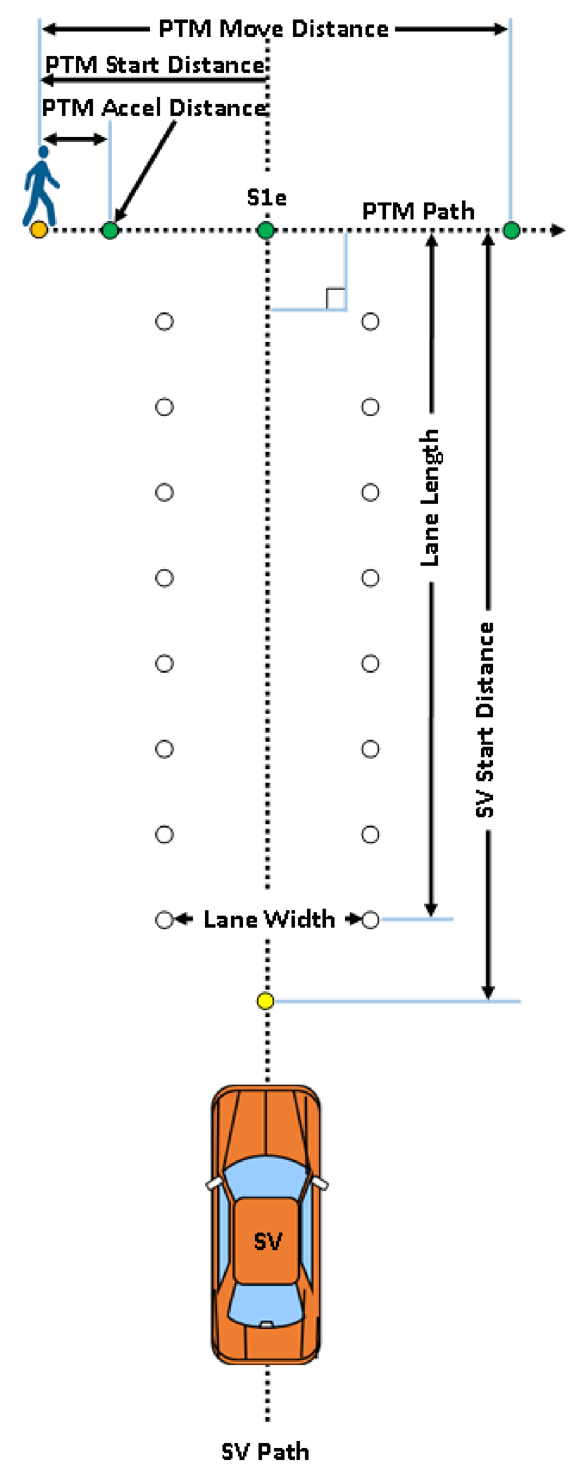


Table 5. Summary of S4a-b Scenarios Setup

PTM Type	Adult		**Drawing illustrates setup but is not to scale**
PTM Location	Nearside In-Path		
PTM Action	S4a	Stationary Facing Away	
	S4b	Stationary Facing Towards	
PTM Move Distance	N/A		
PTM Start Distance	N/A		
PTM Acceleration Distance	N/A		
Overlap *(Determined from the SV width. Measurement transferred to the location on the PTM path.)*	25%		
SV Start Distance	182 m (600 ft)		
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).)*	44 m (145 ft)		

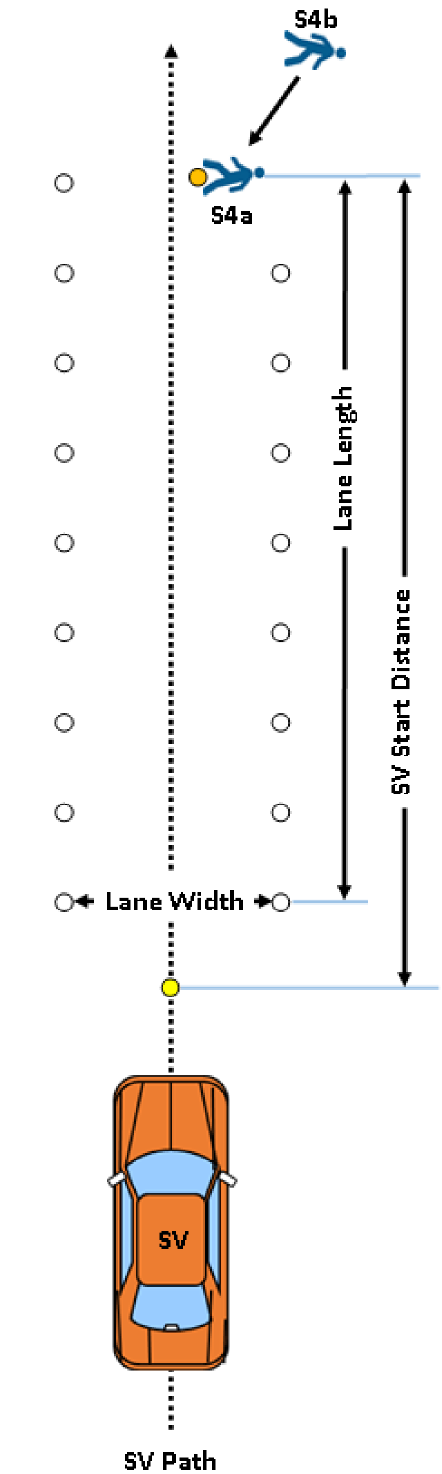
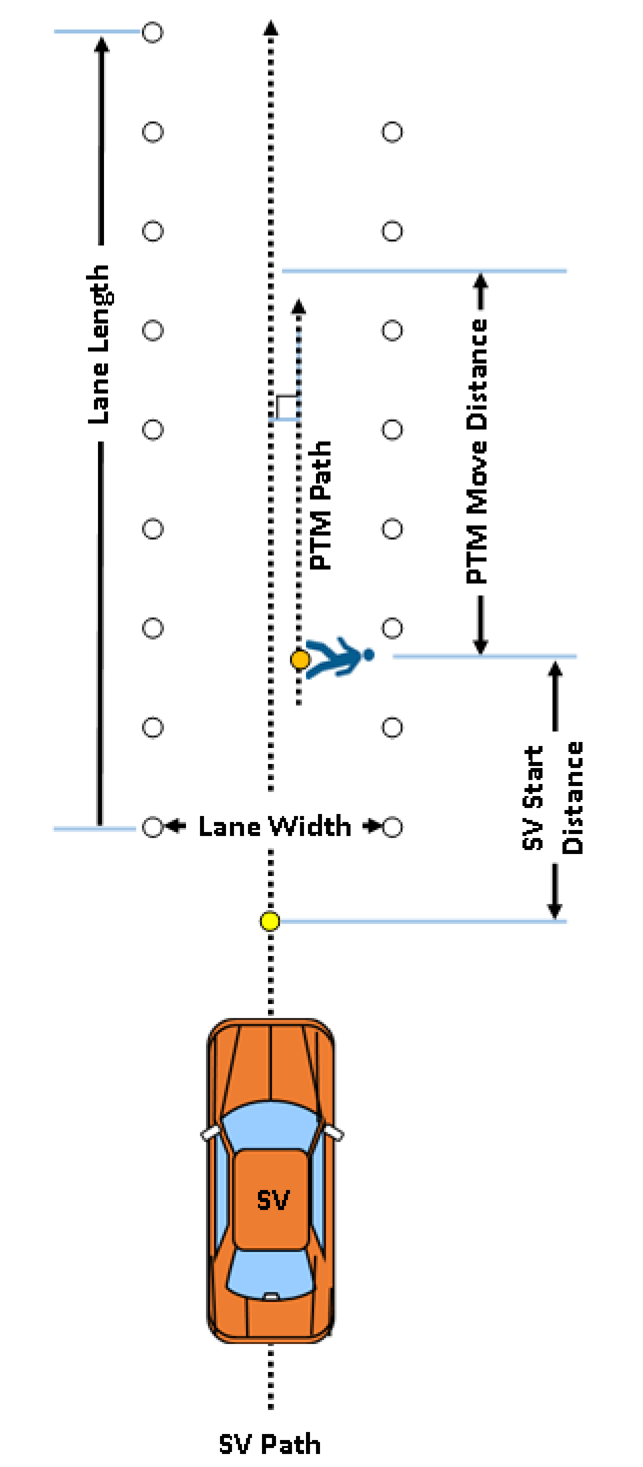


Table 6. Summary of S4c Scenario Setup

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	N/A	
PTM Acceleration Distance	1 m (3.28 ft)	
Overlap *(Determined from the SV width. Measurement transferred to the location on the PTM path.)*	25%	
SV Start Distance	182 m (600 ft)	
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).)*	44 m (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. <u>SV BRAKE WARM-UP AND TEMPERATURE MAINTENANCE DURING TESTING</u>

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 Euro NCAP PAEB testing.

The mannequins are strikeable objects with certain characteristics representative of humans. The adult mannequin represents a 50^{th} 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: 8/18/2020 Due: 8/18/2021
Platform Scales	Vehicle Total, Wheel, and Axle Load	2200 lb/platform	0.1% of reading	Intercomp SW wireless	0410MN20001	By: DRI Date: 4/20/2020 Due: 4/20/2021
Linear (string) encoder	Throttle pedal travel	10 in 254 mm	0.1 in 2.54 mm	UniMeasure LX-EP	49041189	By: DRI Date: 5/22/2020 Due: 5/22/2021
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	Accels ± 10g, Angular Rate ±100 deg/s, Angle >45 deg, Velocity >200 km/h	Accels .01g, Angular Rate 0.05 deg/s, Angle 0.05 deg, Velocity 0.1 km/h	Oxford Inertial +	2258	By: Oxford Technical Solutions Date: 5/3/2019 Due: 5/3/2021
PTT Multi-Axis Inertial Sensing System					24504	By: Oxford Technical Solutions Date: 7/18/2019 Due: 7/18/2021

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	N/A	N/A
Light Sensor	Light intensity (to measure time at alert)	Spectral Bandwidth: 440-800 nm	Rise time < 10 ms	DRI designed and developed Light Sensor	N/A	N/A
Accelerometer	Acceleration (to measure time at alert)	±5g	≤ 3% of full range	Silicon Designs, 2210-005	N/A	N/A

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. <u>SV BRAKE WARM-UP AND TEMPERATURE MAINTENANCE DURING TESTING</u>

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

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

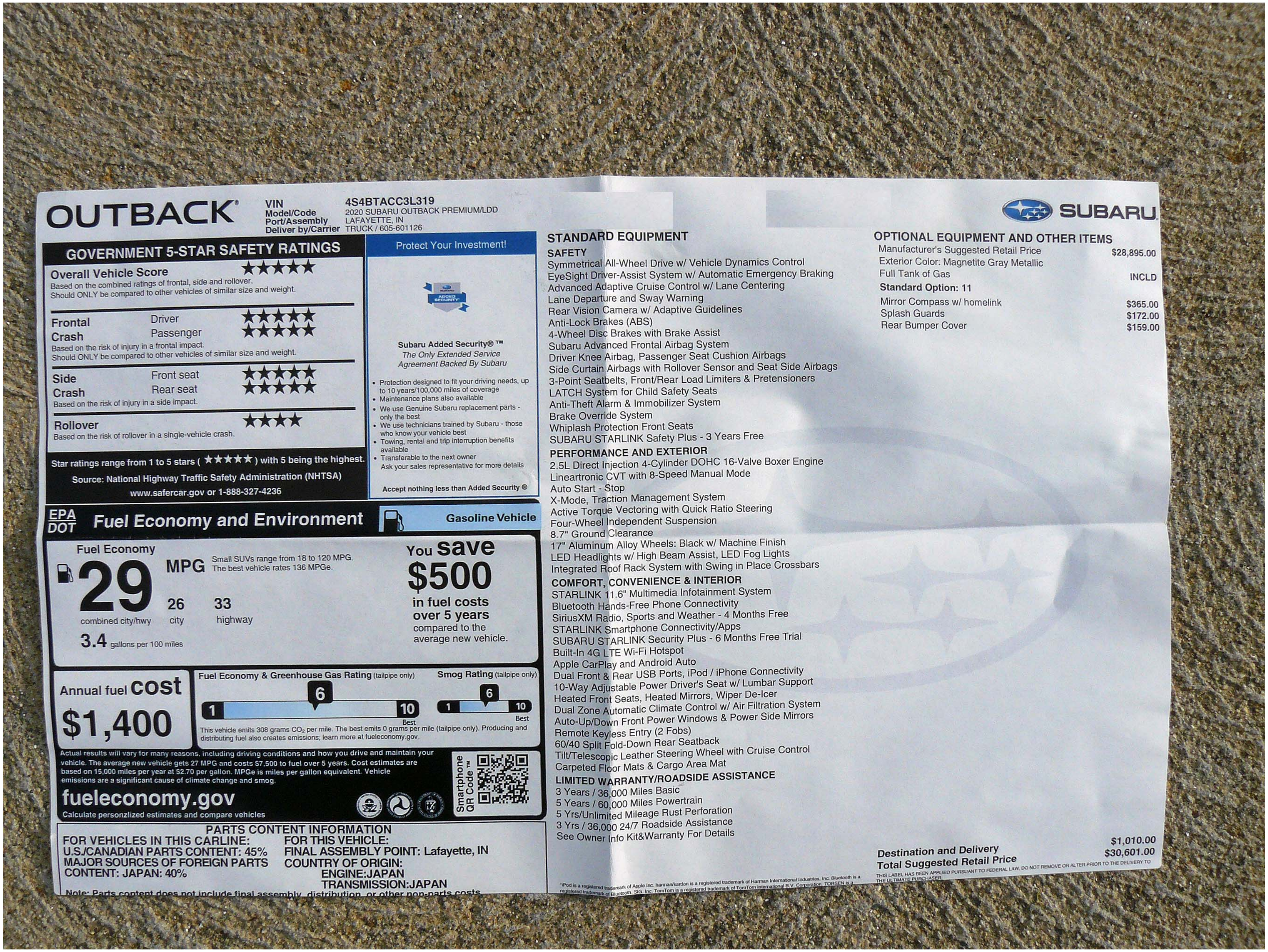


Figure A5. Window Sticker (Monroney Label)

Figure A6. Vehicle Certification Label

Figure A7. Tire Placard

Figure A8. Adult and Child Pedestrian Surrogates and Motion Platform

Figure A9. Obstruction Vehicles

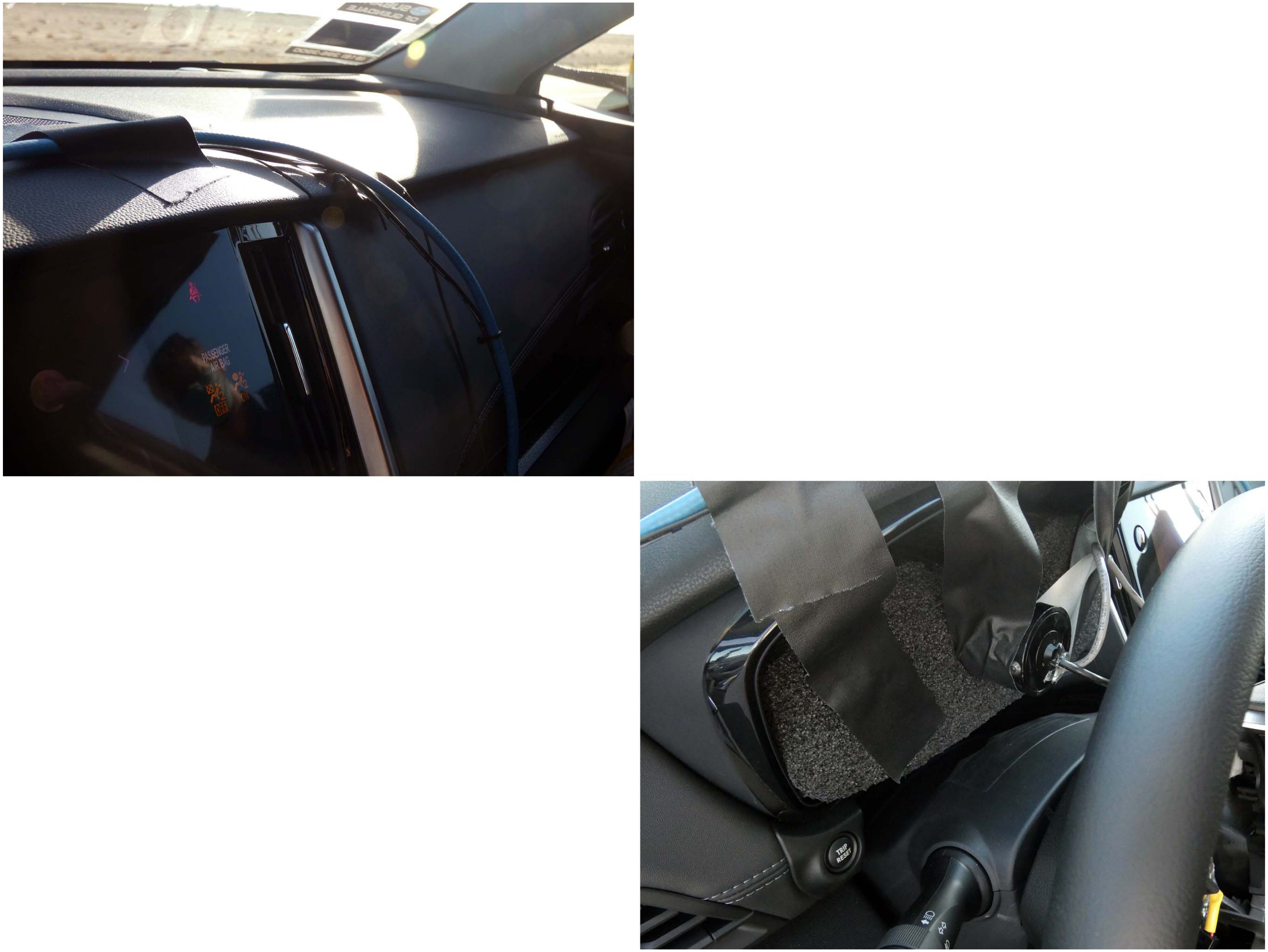


Figure A10. Sensors for Detecting Auditory and Visual Alerts

Figure A11. DGPS, Inertial Measurement Unit, and MicroAutoBox Installed in Subject Vehicle

Figure A12. Computer Installed in Subject Vehicle

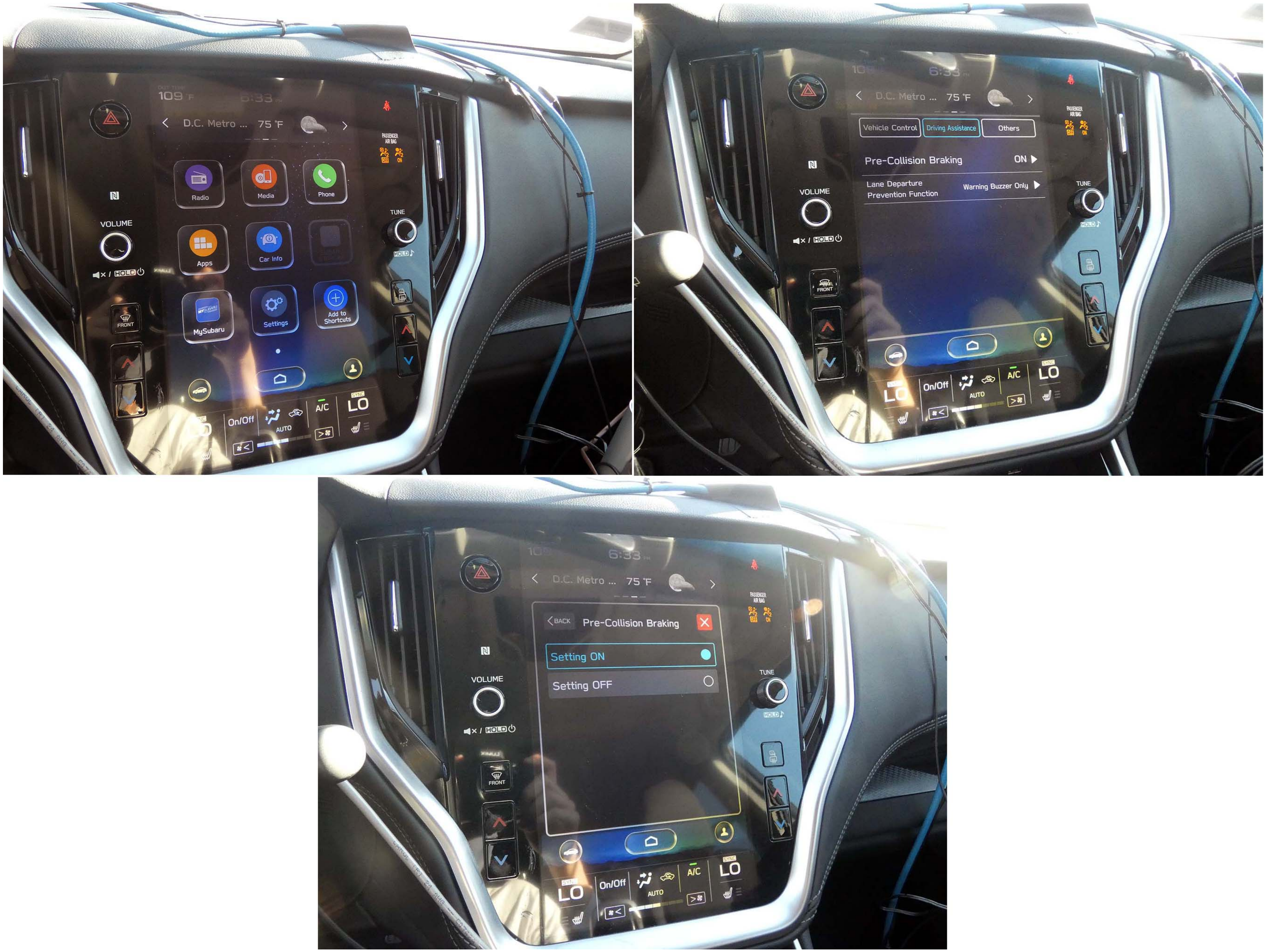


Figure A13. AEB Setup Menus

Figure A14. Visual Alert

APPENDIX B

Excerpts from Owner's Manual

In LHD vehicles, EyeSight is configured for driving on the right-hand side of the road. However, it can be reconfigured by changing the Driving Lane Customize setting for driving on the left-hand side.*

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If the setting for the traffic lane (driving side of the road) does not match the traffic lane, full EyeSight performance may not be available.

***: Characteristics and settings that are affected by specific differences between RHD and LHD vehicles cannot be changed.**

- The system may not operate correctly under the conditions listed below. When these conditions occur, turn off the Pre-Collision Braking System. Also, do not use Adaptive Cruise Control, Lane Centering Function, Lane Departure Prevention Function or Conventional Cruise Control.
  - The tire pressure is not correct.*1
  - The temporary spare tire is installed.*1
  - Tires that are unevenly worn or tires with uneven wear patterns are installed.*1
  - Tires that are the wrong size are installed.*1
  - A flat tire has been fixed temporarily with a tire repair kit.
  - The suspension has been modified (including a genuine SUBARU suspension that has been modified).
  - An object that obstructs the stereo camera's view is installed on the vehicle.
  - The headlights are dirty or they have snow and ice or dirt on them. (Objects are not correctly illuminated and are difficult to detect.)
  - The optical axes are not aligned correctly. (Objects are not correctly illuminated and are difficult to detect.)
  - The lights including headlights and fog lights have been modified.
  - Vehicle operation has become unstable due to an accident or malfunction.
  - The brake system warning light is illuminated in red.*2
  - A heavy cargo is loaded onto or inside the vehicle.
  - The maximum number of occupants is exceeded.
  - The combination meter is not operating properly; such as when the lights do not illuminate, the beeps do not sound, the display is different from when it is normal, etc.*3

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- The system will not operate correctly in the following conditions. Do not use Adaptive Cruise Control, Lane Centering Function, Lane Departure Prevention Function or Conventional Cruise Control.
  - The wheels are out of balance (e.g., the balance weight is removed or misaligned).*1
  - The wheels are out of alignment.*1
  - A trailer or another vehicle, etc. is being towed.
- The system may not operate properly under the following conditions. Do not use Lane Centering Function.
  - There is an abnormal vibration in the steering wheel or the steering wheel is heavier than usual.
  - The steering wheel has been replaced with parts other than genuine SUBARU parts.

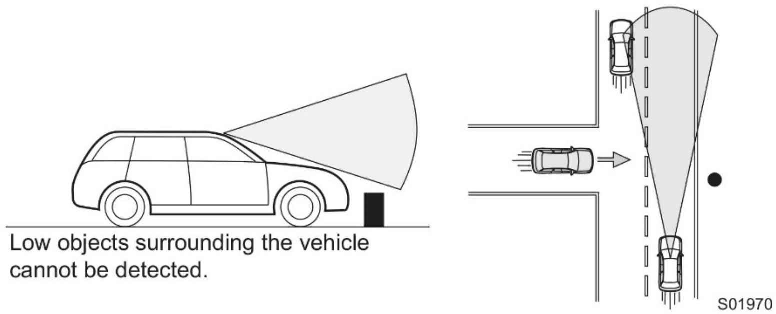
*1: The wheels and tires have functions that are critically important. Be sure to use the correct ones. For details, refer to the Owner's Manual for your vehicle.

*2: If the brake system warning light does not turn off, immediately pull the vehicle over in a safe place and contact a SUBARU dealer to have the system inspected. For details, refer to the Owner's Manual for your vehicle.

*3: For details about the combination meter, refer to the Owner's Manual for your vehicle.

CAUTION

- The characteristics of the stereo camera are similar to those of human eyes. For this reason, conditions that make it difficult for the driver to see in the forward direction have the same effect on the stereo camera. They also make it difficult for the system to detect vehicles, obstacles, and traffic lanes.
- Detection by the EyeSight system is limited to objects that are within the range of the stereo camera's field of view. Also, after an object enters the range of the camera's field of view, it may take some time for the system to detect it as a controllable target and to warn the driver.



- Under the conditions listed below, it will become more difficult for the system to detect the vehicle in front, motorcycles, bicycles, pedestrians and obstacles on the road, and lane markers. Also, EyeSight may temporarily stop operating. However, the temporary stop will be canceled once these conditions have improved and the vehicle is driven for a short period of time.
  - Bad weather (for example heavy rain, a blizzard or thick fog). In particular, the system is more likely to temporarily stop operating when there is an oil film adhering to the windshield, a glass coating has been applied, or poorly performing wipers are used.
  - Strong light is coming from the front (sunlight or headlight beams of oncoming traffic, etc.).
  - The windshield washer is in use.
  - Raindrops, water drops, or dirt on the windshield are not wiped off sufficiently.
  - The windshield has become fogged, scratched, or snow, dirt, dust or frost has adhered to it, or it is otherwise affected. These will reduce the stereo camera's field of view.
  - The vehicle is tilted at an extreme angle due to loaded cargo or other factors.

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⇒ Continued from previous page

- Visibility is poor due to sand, smoke or water vapor blowing in the wind, or the front vision is obscured due to water splashes, snow, dirt or dust stir up generated by the vehicle in front or oncoming traffic.
- The stereo camera's field of view is obstructed (for example by a canoe on the roof of the vehicle).
- Through the entrance or exit of a tunnel
- The rear aspect of the vehicle in front is low, small or irregular (for example a low bed trailer, etc.).
- The obstacle is a fence, a wall or a shutter, etc. with a uniform pattern (a striped pattern, brick, etc.) or with no pattern in front.
- The obstacle is a wall or door made of glass or a mirror in front.
- Driving at night or in a tunnel when there is a vehicle in front that does not have its taillights on
- Driving through a banner or flag, low branches on a tree or thick/tall vegetation
- On steep uphill or downhill grades
- The stereo camera is obstructed by a hand, etc. (If even one of the lenses is obstructed, the system does not operate properly.)
- It is completely dark and no objects are detected.
- The area around the vehicle has a uniform color (such as when completely covered in snow, etc.).
- Accurate detection is not possible due to reflections in the windshield.

• Under the conditions listed below, EyeSight may temporarily stop operating. If this occurs, EyeSight will resume operating when the conditions improve.
  - The temperature inside the vehicle is high, such as after the vehicle was left in bright sunshine, or the temperature inside the vehicle is low, such as after the vehicle was left in an extremely cold environment.
  - Immediately after the engine starts

• Under the conditions listed below, it is difficult to recognize vehicles in front, motorcycles, pedestrians, obstacles on the road, traffic lanes, etc. Also, the EyeSight system may temporarily stop operating. If the EyeSight system repeatedly stops operating several times, contact a SUBARU dealer and have the system inspected.
  - The stereo camera lenses are smeared such as from fingerprints.
  - The stereo camera has become misaligned due to a strong impact.

- When there is a malfunction in the EyeSight system, turn off the Pre-Collision Braking System (⇒ page 41) and the Lane Departure Warning (⇒ page 102), and stop using the Adaptive Cruise Control, Lane Centering Function, Lane Departure Prevention Function and Conventional Cruise Control. Contact a SUBARU dealer and have the system inspected.
- When the Vehicle Dynamics Control warning light is illuminated, the Pre-Collision Braking System may not operate properly. If the indicator light is illuminated, turn off the Pre-Collision Braking System. Also, do not use the Adaptive Cruise Control or Conventional Cruise Control.

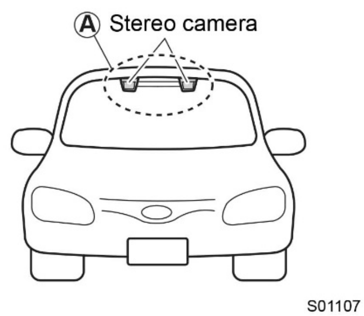
NOTE

EyeSight records and stores the following data when the Pre-Collision Braking System is operated. It does not record conversations or other audio data.

- Stereo camera image data
- Distance from the vehicle in front
- Vehicle speed
- Steering wheel turning angle
- Lateral movement with regards to the direction of travel
- Accelerator pedal operation status
- Brake pedal operation status
- Select lever position
- Odometer reading
- Data related to ABS, Vehicle Dynamics Control and Traction Control Function
  SUBARU and third parties contracted by SUBARU may acquire and use the recorded data for the purpose of vehicle research and development. SUBARU and third parties contracted by SUBARU will not disclose or provide the acquired data to any other third party except under the following conditions.
  - The vehicle owner has given his/her consent.
  - The disclosure/provision is based on a court order or other legally enforceable request.
  - Data that has been modified so that the user and vehicle cannot be identified is provided to a research institution for statistical processing or similar purposes.

Handling of the Stereo Camera

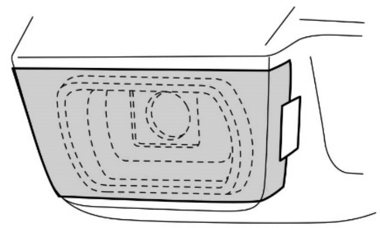
The stereo camera is located on the front map lights unit.



CAUTION

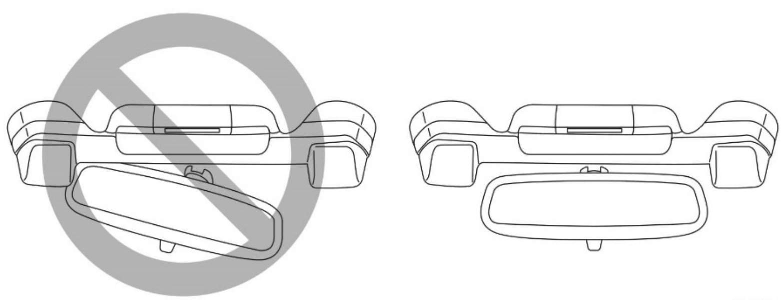
- The stereo camera monitors and detects smears or blurs on the front of the camera. However, detection is not 100% accurate.
  Under certain conditions, the function may fail to detect smears or blurs on the front of the stereo camera accurately. In addition, this function may not detect that there is snow or ice on the windshield close to the stereo camera. In such conditions, be sure to keep the windshield clean at all times (indicated by Ⓐ). Otherwise the system may not operate correctly. When this function detects that the front of the stereo camera is smeared or blurred, no EyeSight functions can be activated except for Conventional Cruise Control.
- The stereo camera lenses are precision components. Always observe the following precautions especially when handling them.
  - Never touch the stereo camera lenses, and do not attempt to wipe or clean the lenses. Doing so could damage or soil the lens, and lead to improper system performance.
    If you ever touch a lens for any reason, be sure to contact a SUBARU dealer.

- When cleaning the windshield, cover the front of the camera casing with paper that does not collect dust, such as copy paper. Affix the paper to prevent glass cleaner from getting on the camera lenses. At this point, make sure that the tape's adhesive surface does not come in contact with the windshield or the lens. Be sure to remove the paper after cleaning.


S03066

- When having the inside of windshield cleaned at a service station, etc., be sure to request that the attendant covers the camera covers before washing the vehicle.
- Do not subject the stereo camera to a strong impact.
- Do not remove or disassemble the stereo camera.
- Do not change the positions where the stereo camera is installed or modify any of the surrounding structures.

• Do not install an interior rearview mirror other than a genuine SUBARU rearview mirror (such as a wide-type mirror) and the sun visor. Also, use the rearview mirror so that it does not obstruct the stereo camera. Failure to do so may affect the stereo camera's field of view and could prevent the EyeSight system from functioning properly.


S00509

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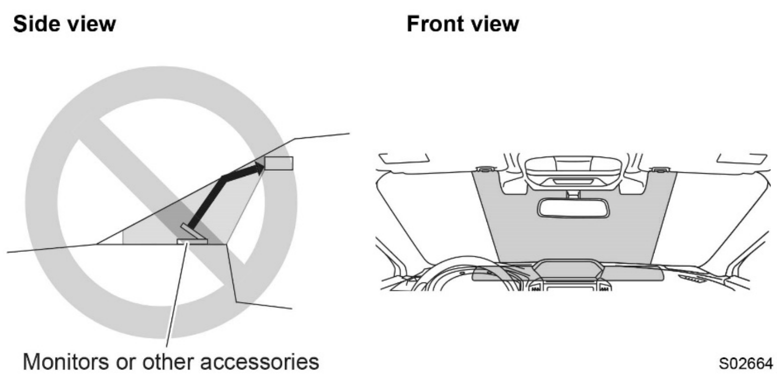
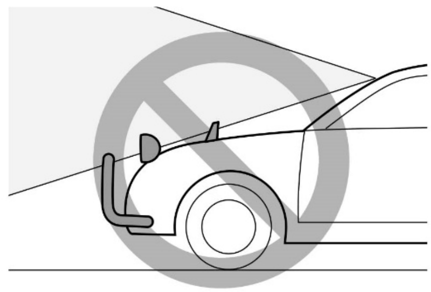
- Do not install any accessories other than the ones designated by SUBARU on the prohibited areas shown in the illustrations (gray zones).
  Even if some accessories are installed on the outside of the prohibited areas, abnormal operation of EyeSight may occur due to the reflection of the light or any objects. In this situation, move the accessories. For details, contact a SUBARU dealer.



- Do not place any objects on top of the instrument panel. The stereo camera may not be able to detect objects accurately and the EyeSight system may not function properly due to reflections in the windshield. For details, contact a SUBARU dealer.
- If the top of the instrument panel is polished with chemicals or other substances, the stereo camera may not be able to detect objects accurately and the EyeSight system may not operate properly due to reflections in the windshield.
- Do not install any wiper blades other than genuine SUBARU wiper blades. Doing so may affect the stereo camera’s field of view and could prevent the EyeSight system from functioning properly.
- Replace damaged wiper blades or worn wiper blade rubbers as soon as possible. Using damaged wiper blades or worn wiper blade rubbers may cause streaking on the windshield. The stereo camera may not be able to detect objects accurately and the EyeSight system may not function properly due to streaks or droplets remaining on the windshield.

- Do not install any accessories on the front side such as on the hood or the grille. It may affect the camera view and the system may not operate correctly.



- Make sure that the cargo loaded on the roof does not interfere in the stereo camera's field of view. Obstructing the stereo camera's view may impair the system operation. For details, contact a SUBARU dealer.
- Keep the windshield (outside and inside) clean at all times. When the windshield has become fogged, or it has a dirt or an oil film on it, the stereo camera may not detect objects accurately and the EyeSight system may not operate correctly. Never mount any device to the center air vent, as any airflow change may impact performance of the EyeSight system.
- Do not place any stickers or accessories on the windshield (outside or inside). If you have to do so (for example, legally required or electronic toll tag), avoid the area directly in front of the camera. Otherwise, it may adversely affect the field of view of the stereo camera and can cause improper operation of the system. For details, contact a SUBARU dealer.
- Do not use any glass coating agents or similar substances on the windshield. Doing so may interfere with the proper operation of the system.
- Do not install any film or an additional layer of glass on the windshield. The system may not operate correctly.
- If there are scratches or cracks on the windshield, contact a SUBARU dealer.
- To have the windshield replaced or repaired, contact a SUBARU dealer. Do not install a windshield other than a genuine SUBARU windshield. The stereo camera may not be able to detect objects accurately and the EyeSight system may not operate properly.

EyeSight Functions

EyeSight includes the following functions.

■Pre-Collision Braking System

This function uses a following distance warning feature to warn the driver to take evasive action when there is the possibility of a collision with a vehicle or obstacle in front of you. If the driver does not take evasive action, the brakes are applied automatically to help reduce vehicle collision damage or, if possible, help prevent a collision.
⇒ Page 27

■Advanced Adaptive Cruise Control

Adaptive Cruise Control

This function maintains the set vehicle speed and when there is a vehicle in front in the same traffic lane, it follows the speed of the vehicle in front up to the maximum of the set vehicle speed.
⇒ Page 43

Lane Centering Function

This function helps suppress lane drifting by detecting lane markings (e.g., white lines) and the lead vehicle on expressways, freeways and interstate highways, and by assisting steering operation. Lane Centering Function will work only when the Adaptive Cruise Control is activated.
⇒ Page 71

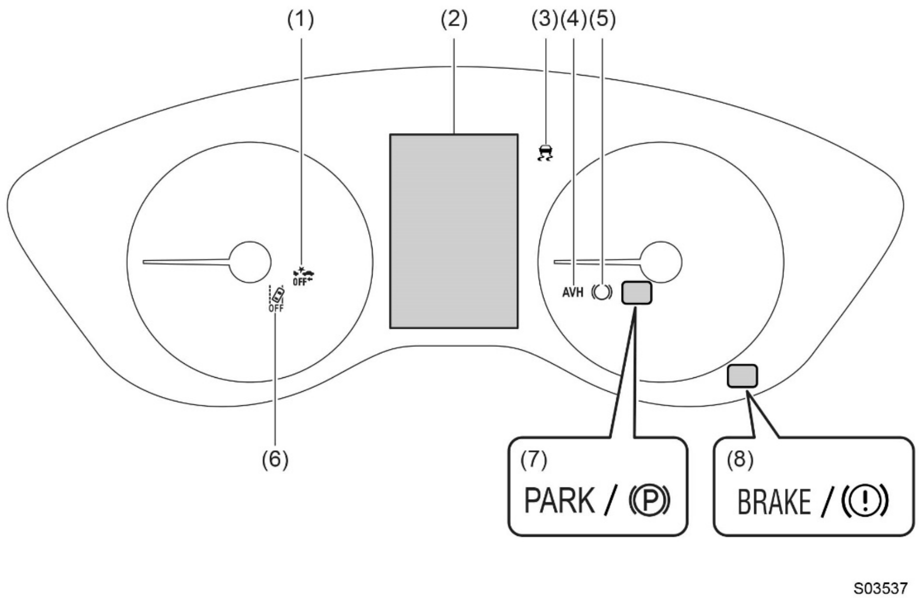
■Lane Departure Prevention Function

When driving on expressways, freeways, or interstate highways, the system recognizes the lane markings on both sides of the vehicle. If the vehicle appears likely to depart from the lane, the system assists with steering operation in the direction that prevents the lane departure, preventing the vehicle from leaving the lane.
⇒ Page 84

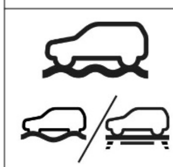
■Pre-Collision Throttle Management

This function reduces accidental forward movement caused by the select lever being placed in the wrong position or the accelerator pedal being accidentally depressed, or depressed too strongly.
⇒ Page 93

Instrument panel display layout



(1) Pre-Collision Braking System OFF indicator light
(2) Combination meter display
(3) Vehicle Dynamics Control warning light
(4) Auto Vehicle Hold ON indicator light
(5) Auto Vehicle Hold operation indicator light
(6) Lane Departure Warning OFF indicator light
(7) Electronic parking brake indicator light
(8) Brake system warning light

	**Select lever/gear position indicator** This indicator illuminates and shows which position the select lever or the gear is in.
	**EyeSight warning indicator (yellow)** • This indicator illuminates or flashes when a malfunction occurs in the EyeSight system. • When it is illuminated or flashing, none of the EyeSight functions can be used (including Adaptive Cruise Control and the Pre-Collision Braking System, etc.). ⇒ Page 122
	**EyeSight temporary stop indicator (white)** • This indicator illuminates when the EyeSight system is temporarily stopped. • When the ignition switch is placed in the ON position, it will illuminate if the (CRUISE) switch or (Lane Centering) switch is set to ON within approximately 7 seconds of the engine starting. It turns off when approximately 7 seconds have elapsed since the engine started. • When it is illuminated, none of the EyeSight functions can be used except for Conventional Cruise Control. ⇒ Page 124
	**Auto Start Stop indicator (green) (also used as Auto Start Stop warning indicator (yellow))** • This indicator illuminates in yellow when the ignition switch is turned to the ON position, and then it turns off after the engine starts. • It illuminates in green while the Auto Start Stop system operates. It turns off after the engine restarts. • It illuminates in yellow if a malfunction occurs in the Auto Start Stop system.
	**Auto Start Stop OFF indicator** This indicator illuminates when the Auto Start Stop system is turned off. It turns off when the Auto Start Stop system is turned on. ⇒ Refer to the vehicle Owner's Manual for details.
	**Auto Start Stop No Activity Detected indicator light** When a vehicle is stopped, the indicator light illuminates when the operating conditions of the Auto Start Stop system are not met. The light will turn off when the vehicle starts driving.
	**X-MODE indicator (if equipped)** The X-MODE indicator illuminates when the X-MODE is on. ⇒ Refer to the vehicle Owner's Manual for details.

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	**Lane Departure Warning OFF indicator light** • This indicator light illuminates when the Lane Departure Warning and Lane Sway Warning are off. • It also illuminates when the ignition switch is turned to the ON position. Approximately 7 seconds after the engine starts, the Lane Departure Warning OFF indicator light will turn off or remain illuminated depending on the current status (ON or OFF). ⇒ Pages 102 and 105
	**Pre-Collision Braking System OFF indicator light** • This indicator light illuminates when the Pre-Collision Braking System and Pre-Collision Throttle Management are off. • It also illuminates when the ignition switch is turned to the ON position, and then turns off approximately 7 seconds after the engine starts. ⇒ Pages 42 and 99
	**Lane indicator** • This indicator illuminates in gray when the Lane Departure Prevention Function is turned on. • It illuminates in white under the following conditions. - The Lane Departure Prevention Function goes into the standby status. - Lane Centering Function is operating by detecting the lane markings. • It illuminates in yellow when the Lane Departure Prevention Function is operating. ⇒ Pages 80 and 89
BRAKE / (!)	**Brake system warning light** If the brake system warning light illuminates when the electronic parking brake is released while driving, turn the Pre-Collision Braking System off. At this time, do not use the Conventional Cruise Control mode or Adaptive Cruise Control mode. If the brake system warning light does not turn off, immediately pull the vehicle over to a safe location. Contact a SUBARU dealer to have the system inspected. ⇒ Refer to the vehicle Owner's Manual for details.
PARK / (P)	**Electronic parking brake indicator light** This indicator light illuminates when the electronic parking brake is applied. ⇒ Refer to the vehicle Owner's Manual for details.
	**Your vehicle indicator** When the brake pedal is depressed or the brake control function is activated, the brake indicator light illuminates in red.

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Center information display

(1) (2) (3)

(1) Pre-Collision Braking System indicator
(2) Lane Departure/Sway Warning indicator
(3) EyeSight Assist Monitor

S03520

The settings of the on-board systems can be changed by operating the center information display.
Warning screens will be displayed on the center information display as needed.

●Pre-Collision Braking System indicator

This indicator illuminates when the Pre-Collision Braking System is on.

●Lane Departure/Sway Warning indicator

This indicator illuminates when the Lane Departure Warning and Lane Sway Warning are on.

●EyeSight Assist Monitor

This indicator illuminates when the EyeSight Assist Monitor is on.

■ Changing settings

The EyeSight settings can be changed by operating the center information display.
⇒ Page 126

The following systems can also be turned ON/OFF by operating the center information display.
- Vehicle Dynamics Control
- X-MODE (if equipped)
- Auto Vehicle Hold (AVH)

⇒ Refer to the vehicle Owner's Manual for details.

■ Warning screens

The following warning screens will be displayed on the center information display.

Item	Displayed screen
Pre-Collision Braking System warning (first braking and secondary braking)	 S03539
"Obstacle Detected" warning	
Lane Centering Function warning (no-operation of the steering wheel)	 S03540
Lane Centering Function cancellation (no-operation of the steering wheel)	 S03541

Pre-Collision Braking System

When there is the risk of a rear-end collision with an obstacle in front, the EyeSight system helps to prevent or minimize a collision by warning the driver. If the driver still does not take evasive action to avoid a collision, the brakes can be automatically applied just before the collision in order to reduce impact damage, or if possible, prevent the collision. If the driver takes evasive action to avoid a collision, Pre-Collision Braking Assist will operate in order to help the driver to prevent or minimize the collision.
This system can be effective not only with direct rear-end collisions, but also with offset rear-end collisions. This function can be activated when the select lever is in the D, M or N positions.

⚠ WARNING

- Never use the Pre-Collision Braking System and Pre-Collision Braking Assist to stop your car or avoid a collision under ordinary conditions. These functions cannot prevent collisions under all conditions. If the driver relies only on the Pre-Collision Braking System for Brake operation, collisions may occur.
- When a warning is activated, pay attention to the front of the vehicle and its surroundings, and operate the brake pedal and/or take other actions if necessary.
- The EyeSight Pre-Collision Braking System is primarily designed to prevent rear-end collisions with other vehicles when possible or to minimize damage and injuries in the event of a collision. In addition to other vehicles, things such as motorbikes, bicycles and pedestrians can also be treated as obstacles. However, there may be cases when detection is not possible depending on a variety of conditions*2. For example, when a vehicle is viewed from the side, oncoming vehicle, vehicles approaching in reverse, small animals or children, or walls or doors are not likely to be detected.
- The Pre-Collision Braking System will operate at the point when it determines that a collision cannot be avoided and is designed to apply strong braking force just before a collision. The result of this varies depending on a variety of conditions*2. Because of this, performance of this function will not always be the same.
- When the Pre-Collision Braking System is activated, it will continue to operate even if the accelerator pedal is partially depressed. However, it will be canceled if the accelerator pedal is suddenly or fully depressed.
- If the driver depresses the brake pedal or turns the steering wheel, the system may determine that this constitutes evasive action by the driver, and the automatic braking control may not activate in order to allow the driver full control.

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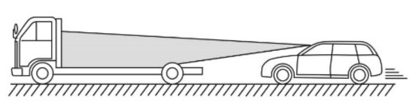
- When the difference in speed with the obstacle in front is the following figure*1 or more, it may not be possible to avoid a collision. Even if the speed difference is the following figure*1 or less, in cases such as when another vehicle cuts in front of you, or in other cases depending on visibility, the condition of road surface and other factors*2, the function may be unable to stop the vehicle or may not activate. Pre-Collision Braking Assist also may not activate depending on the conditions*2 listed below.

*1: For vehicles: approximately 30 mph (50 km/h),
For pedestrians: approximately 21 mph (35 km/h)

*2: Conditions in which the Pre-Collision Braking System cannot detect obstacles:

- Distance to obstacle in front of you, speed difference, proximity conditions, lateral displacement (the amount of offset)
- Vehicle conditions (amount of load, number of occupants, etc.)
- Road conditions (grade, slipperiness, shape, bumps, etc.)
- Visibility ahead is poor (rain, snow, fog or smoke, etc.).
- The detected object is something other than a vehicle, motorcycle, bicycle or pedestrian.
  - A domestic animal or other animal (a dog or deer, etc.)
  - A guardrail, telephone pole, tree, fence or wall, etc.
- Even if the obstacle is a motorcycle, bicycle or pedestrian, depending on the brightness of the surroundings as well as the relative movement, and aspect or angle of the object, there may be cases when the system cannot detect it.
- The system determines that operation by the driver (based on accelerator pedal operation, braking, steering wheel angle, etc.) is intended as evasive action.
- Vehicle maintenance status (brake systems, tire wear, tire pressure, whether a temporary spare tire is being used, etc.)
- A trailer or another vehicle, etc. is being towed.
- The brakes are cold due to the outside temperature being low or just after starting the engine.
- The brakes are overheated on downhill grades (braking performance is reduced).
- In rain or after washing the vehicle (the brakes are wet and braking performance is reduced)

- Recognition conditions of the stereo camera
  In particular, the function may be unable to stop the vehicle or may not activate in the following cases.
  - Bad weather (for example heavy rain, a blizzard or thick fog)
  - Visibility is poor due to sand, smoke or water vapor blowing in the wind, or the front vision is obscured due to water splashes, snow, dirt or dust stir up generated by the vehicle in front or oncoming traffic.
  - At night or in a tunnel without the headlights on
  - At night or in a tunnel when there is a vehicle in front that does not have its taillights on
  - Approaching a motorcycle, bicycle or pedestrian at night
  - Ambient light is poor in the evening or early morning.
  - A vehicle, motorcycle, bicycle or pedestrian is outside the area illuminated by the headlights.
  - Strong light is coming from the front (for example, sunlight at dawn, sunset or headlight beams, etc.).
  - The windshield has become fogged, scratched, or snow, dirt, dust or frost has adhered to it, or it is otherwise affected.
  - Fluid has not been fully wiped off the windshield during or after washer use.
  - The target cannot be correctly recognized because the stereo camera's view is obstructed by water droplets from rain or the window washer, or by the wiper blades.
  - The stereo camera's field of view is obstructed (for example by a canoe on the roof of the vehicle).
  - The rear aspect of the vehicle in front is low, small or irregular (the system may recognize another part of the vehicle as its rear and will determine operation from that).
    - There is an empty truck or trailer with no rear and/or side panels on the cargo bed.
    - With vehicles that have cargo protruding from their back ends
    - With non-standard shaped vehicles (vehicle transporters or vehicles with a sidecar fitted, etc.)
    - The height of the vehicle is low, etc.


S02133

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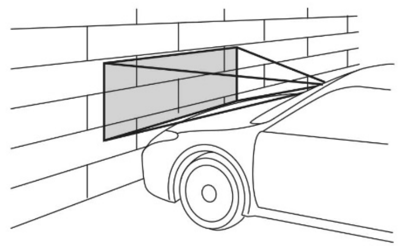
- There is a wall, etc. in front of a stopped vehicle.
- There is another object near the vehicle.
- A vehicle, etc. has its side facing you.
- With vehicles that are backing up or with oncoming vehicles, etc.
- The size and height of an obstacle is smaller than the limitations of the stereo camera's recognition capability.
  - With small animals or children, etc.
  - With pedestrians who are sitting or lying down
- The detected object is a fence or wall, etc. with a uniform pattern (a striped pattern or brick pattern, etc.).
- There is a wall or door made of glass or a mirror in front.
- The vehicle in front suddenly swerves, accelerates, or decelerates.
- A vehicle, motorcycle, bicycle or pedestrian suddenly cuts in from the side or suddenly runs in front of you.



S00653

- Your vehicle is immediately behind an obstacle after changing lanes.
- There is a vehicle, motorcycle, bicycle or pedestrian in a location close to your vehicle's bumper.
- The speed difference between your vehicle and an obstacle is 4 mph (5 km/h) or less (As braking is performed once the obstacle is in close proximity to your vehicle, depending on the shape and size of the obstacle, there may be some cases when the obstacle is outside the range of the camera's field of view.).
- On sharp curves, steep uphill grades or steep downhill grades
- On a bumpy or unpaved road
- There are changes in brightness, such as at a tunnel entrance or exit.

- Do not test Pre-Collision Braking System on its own. It may operate improperly and cause an accident.
- The system may not operate correctly under the conditions listed below. When these conditions occur, turn off the Pre-Collision Braking System.
  - The tire pressure is not correct.*1
  - The temporary spare tire is installed.*1
  - Tires that are unevenly worn or tires with uneven wear patterns are installed.*1

- Tires that are the wrong size are installed.*1
- A flat tire has been fixed temporarily with a tire repair kit.
- The suspension has been modified (including a genuine SUBARU suspension that has been modified).
- An object that obstructs the stereo camera's view is installed on the vehicle.
- The headlights are dirty or they have snow and ice or dirt on them. (Objects are not correctly illuminated and are difficult to detect.)
- The optical axes are not aligned correctly. (Objects are not correctly illuminated and are difficult to detect.)
- The lights including headlights and fog lights have been modified.
- Vehicle operation has become unstable due to an accident or malfunction.
- The brake system warning light is illuminated in red.*2
- A heavy cargo is loaded onto or inside the vehicle.
- The maximum number of occupants is exceeded.
- The combination meter is not operating properly; such as when the lights do not illuminate, the beeps do not sound, the display is different from when it is normal, etc.*3

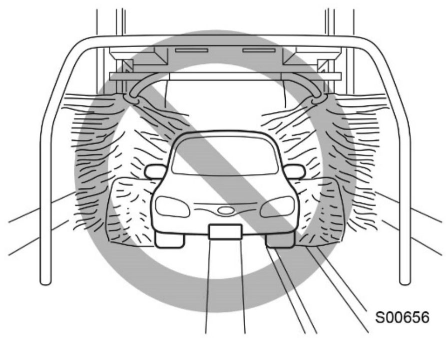
*1: The wheels and tires have functions that are critically important. Be sure to use the correct ones. For details, refer to the Owner's Manual for your vehicle.

*2: If the brake system warning light does not turn off, immediately pull the vehicle over in a safe place and contact a SUBARU dealer to have the system inspected. For details, refer to the Owner's Manual for your vehicle.

*3: For details about the combination meter, refer to the Owner's Manual for your vehicle.

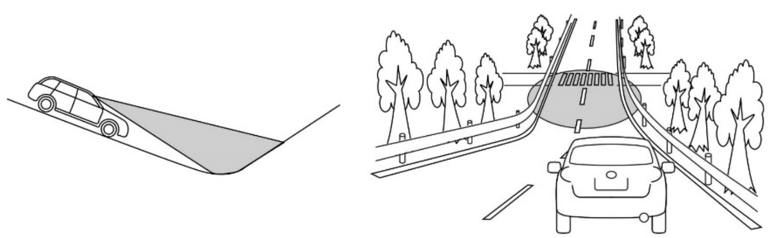
CAUTION

- In the following situations, turn off the Pre-Collision Braking System. Otherwise the Pre-Collision Braking System may activate unexpectedly.
  - The vehicle is being towed.
  - The vehicle is being loaded onto a carrier.
  - A chassis dynamometer, free-rollers or similar equipment is being used.
  - A mechanic lifts up the vehicle, starts the engine and spins the wheels freely.
  - Passing hanging banners, flags or branches
  - Thick/tall vegetation is touching the vehicle.
  - Driving on a race track
  - In a drive-through car wash



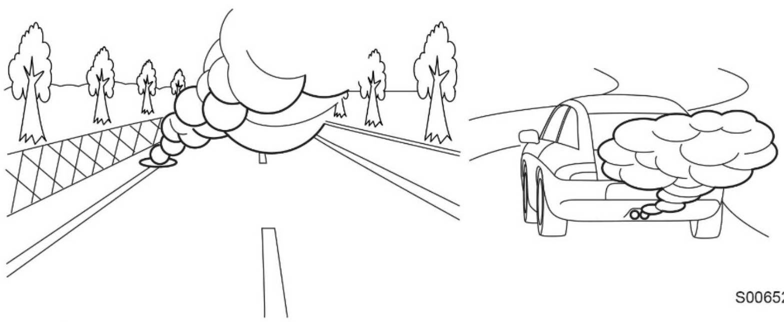
S00656

- The Pre-Collision Braking System may activate in the following situations. Therefore concentrate on safe driving.
  - Passing through an automatic gate (opening and shutting)
  - Driving close to the vehicle in front
  - Driving in a location where the grade of the road changes rapidly



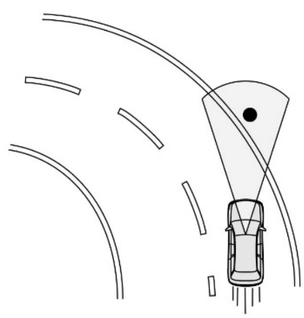
S01264

- Visibility is poor due to sand, smoke or water vapor blowing in the wind, or the front vision is obscured due to water splashes, snow, dirt or dust stir up generated by the vehicle in front or oncoming traffic.
- Passing through clouds of steam or smoke, etc.
- In adverse weather, such as heavy snow or snowstorms
- The exhaust gas emitted by the vehicle in front is clearly visible in cold weather, etc.

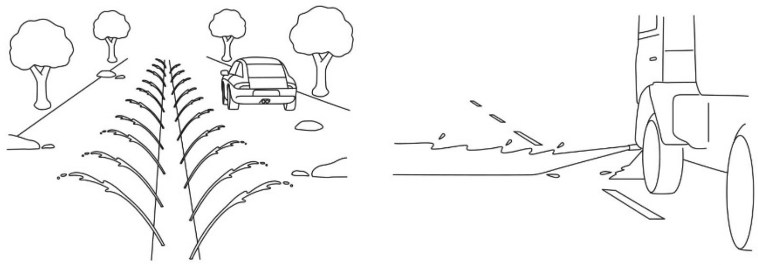


S00652

- There is an obstacle on a curve or intersection.
- A vehicle or an object is being narrowly passed.
- Stopping very close to a wall or a vehicle in front
- Passing through water spray from road sprinklers or snow clearing sprinklers on the road



S02669



S02636

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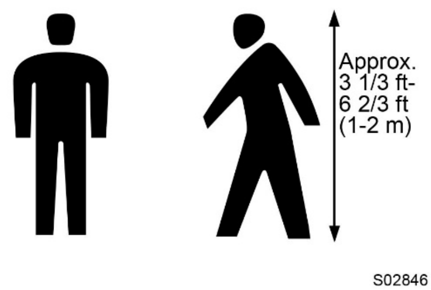
- If there is cargo or installed accessories, etc. that are protruding beyond the edge of the front bumper, the vehicle’s length will increase and the system may not be able to prevent a collision.
- If the driver operates the brake pedal during automatic braking, the pedal may feel stiff; however, this is normal. By depressing the brake pedal further you can apply more braking force.

NOTE

Some unusual noises may be audible during automatic braking. This is caused by the braking control and is normal.

■ Detection of pedestrians

The EyeSight system can also detect pedestrians. The EyeSight system detects pedestrians from their size, shape and movement. The system detects a pedestrian when the contour of the head and shoulders are clear.



⚠ WARNING

The EyeSight system's Pre-Collision Braking function also identifies pedestrians as obstacles. However, depending on the conditions, there may be cases when the system cannot detect a pedestrian. In the following conditions, the possibility that the system may not be able to detect a pedestrian as an object is particularly high.

- Pedestrians are walking in a group.
- A pedestrian is next to a wall or other obstacle.
- A pedestrian is using an umbrella.
- A pedestrian is wearing clothes that are a similar color to the surrounding environment.
- A pedestrian is carrying bulky luggage.
- A pedestrian is bent over, crouching down or lying down.
- A pedestrian is in a dark location.
- A pedestrian suddenly crosses in front of you from the side or suddenly runs in front of you.

Pre-Collision Braking System operation

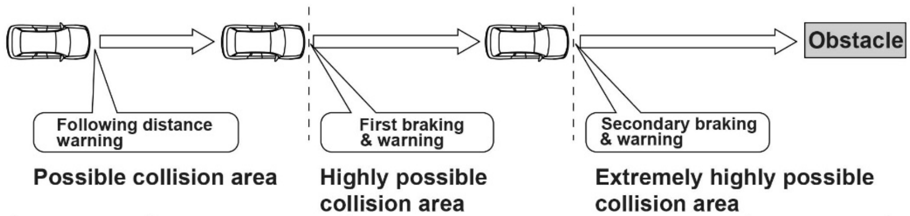
When there is an obstacle in front of you during driving, the system activates in the following sequence in order to warn the driver and to activate braking control and the brake lights.

Following Distance Warning:
When the system determines that there is a risk of collision, an alert sounds repeated short beeps and the indicators on the combination meter display illuminate to warn the driver.
The Following Distance Warning operates when Adaptive Cruise Control is not activated.
When the driver depresses the brake pedal to decelerate and achieves a suitable following distance, the warning is canceled.

First Braking and Warning:
When the system determines that there is a high risk of collision with an obstacle in front, an alert sounds repeated short beeps and the indicators on the combination meter display and the center information display illuminate to warn the driver. Braking control may be activated and in some situations, engine output may also be controlled. If the system determines that the amount of evasive action (braking, steering, etc.) taken by the driver has reduced the risk of collision, braking activation is canceled.

Secondary Braking and Warning:
If the system then determines that the risk of collision is extremely high, the alert changes to a continuous beeping sound and stronger braking control is activated. Despite any evasive action taken by the driver, if the system subsequently determines that a collision is unavoidable, braking and engine output are controlled by the system.

When the vehicle is stopped by secondary braking, the driver should depress the brake pedal in order to ensure that the vehicle stays stopped.



Operating system	Strength of Automatic Braking	Indication on the combination meter display	Alert type
Following distance warning	No brake control		Repeated short beeps
First braking	Moderate		Repeated short beeps
Secondary braking	Strong		Continuous beep

S03559

NOTE

- To release the brake control after the vehicle has come to a stop through Pre-Collision Braking System, perform the following.
  - Depress the brake pedal.
  - Depress the accelerator pedal (except when the select lever is in the N position).
  - Shift the select lever into the P position.
- After stopping with secondary braking, in the following cases, brake control will be released and the electronic parking brake will be applied.
  (For details about how to release the electronic parking brake, refer to the Owner’s Manual for your vehicle.)
  - Approximately 2 minutes have elapsed since stopping and the brake pedal is not depressed.
  - Any door (except the rear gate/trunk) is opened.
  - The driver’s seatbelt is unfastened.
  - The EyeSight system has a malfunction.
  - The EyeSight system has stopped temporarily.

Continued on next page ⇒

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- Neither first braking nor secondary braking will operate in the following cases.
  - The vehicle speed is approximately 1 mph (1 km/h) or less (When the select lever is in the N position and your vehicle speed is approximately 2 mph (4 km/h) or less) or 100 mph (160 km/h) or more.
  - Vehicle Dynamics Control is active.
- If the system detects the brake lights of the vehicle in front, your vehicle will start decelerating earlier than if it does not.
- There are some cases where the first braking is applied for a longer period of time. One of the reasons for this is due to a large speed difference with an obstacle in front. In those cases, stronger or weaker braking control may be activated.

■ Pre-Collision Braking System operation indicator

After the Pre-Collision Braking System operation, a message appears and stays in the warning screen area of the combination meter display for a certain period of time.

▼ If the Pre-Collision Braking System stopped operating before the vehicle came to a stop

The message appears and stays in the warning screen area of the combination meter display to indicate that the Pre-Collision Braking System has activated. This screen will be displayed for 10 seconds.

S03129

▼If the Pre-Collision Braking System continued operating until the vehicle came to a stop

The screen displays the message “Apply Brake To Hold Position” to urge the driver to depress the brake pedal. At this time the alert sounds. This screen will be displayed for approximately 2 minutes until the driver depresses the brake pedal.

S02962

If the brake pedal is depressed or 2 minutes have elapsed, a message changes and stays in the warning screen area of the combination meter display to indicate that the Pre-Collision Braking System has activated. This screen will be displayed for 10 seconds.

S03130

Pre-Collision Braking Assist operation

When the Pre-Collision Braking System is activated (when the system determines that there is a high risk of collision with an obstacle in front), if the driver depresses the brake pedal, the system determines that this is emergency braking and activates braking assist automatically.

CAUTION

If the driver depresses the brake pedal while following distance warning is activated, the Pre-Collision Braking Assist will not work. The vehicle decelerates with the normal braking force operated by the driver.

NOTE

- Pre-Collision Braking Assist function does not operate when the vehicle speed is approximately 7 mph (10 km/h) or less or 100 mph (160 km/h) or more.
- For information about the brake assist function, refer to the Owner's Manual for your vehicle.

Turning on/off the Pre-Collision Braking System

Operate the center information display to turn on/off the Pre-Collision Braking System (including Pre-Collision Braking Assist).
This function is turned on by selecting “Setting ON” on the “Pre-Collision Braking” screen of the EyeSight settings.
This function is turned off by selecting “Setting OFF” on the “Pre-Collision Braking” screen of the EyeSight settings.
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The Pre-Collision Braking System on/off setting interlocks with the Pre-Collision Throttle Management setting.

- When this system is turned off, the Pre-Collision Braking System OFF indicator light illuminates.
- When this system is turned on, the Pre-Collision Braking System OFF indicator light turns off.

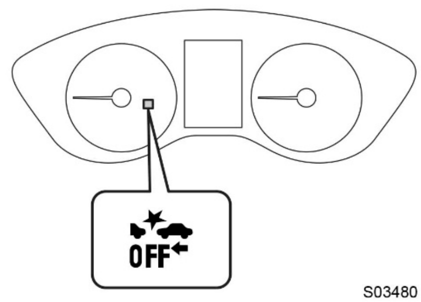
NOTE

Even when the Pre-Collision Braking System is turned off, if the engine is turned off and then restarted, the Pre-Collision Braking System will be turned on. The system default setting when the vehicle is restarted is on.

■Pre-Collision Braking System OFF indicator light

This indicator light illuminates when the ignition switch is turned to the ON position, and remains illuminated for approximately 7 seconds after the engine starts. It turns on when the Pre-Collision Braking System and Pre-Collision Throttle Management are turned off. It also illuminates under the following conditions.

- The EyeSight system has a malfunction.
  ⇒ Page 122
- The EyeSight system has stopped temporarily.
  ⇒ Page 124

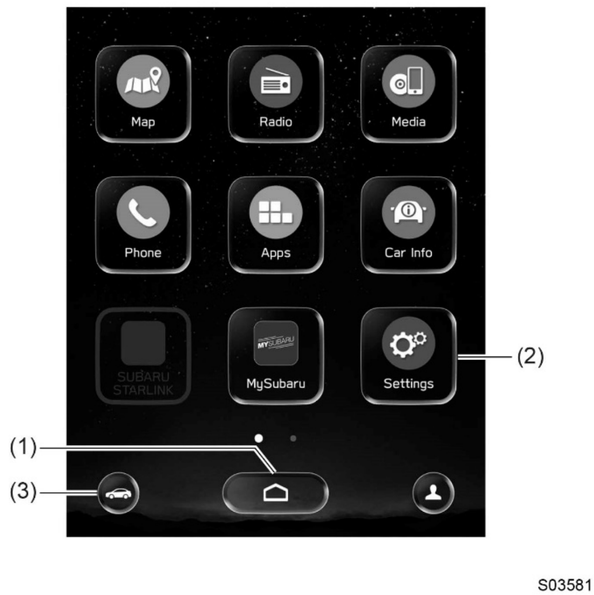


NOTE

When the Pre-Collision Braking System OFF indicator light is turned on, the Pre-Collision Braking System (including the Pre-Collision Braking Assist function) and Pre-Collision Throttle Management do not operate.

Changing settings

■ 11.6-inch display models (if equipped)



(1) HOME icon
(2) Settings icon
(3) Car settings icon

Change the EyeSight system setting as follows:
1. Touch (HOME).
2. → (Settings)
3. → “Car”
4. Select the preferred menu.

The setting adjustments to the following items can be manually changed to meet your personal requirements.

Item		Setting
EyeSight	Pre-Collision Braking	Setting ON/Setting OFF
	Lane Departure Prevention Function	All Functions/ Lane Departure Prevention Function Only/ Warning Buzzer Only/ OFF
	Cruise Control Acceleration Characteristics	Lv. 1 (Eco)/ Lv. 2 (Comfort)/ Lv. 3 (Standard)/ Lv. 4 (Dynamic)
	Select Drive on Left/Drive on Right	Right Lane/ Left Lane
	Lead Vehicle Acquisition Sound	ON/OFF
	Lead Vehicle Moving Monitor	ON/OFF
EyeSight Assist Monitor	Red Indicator	ON/OFF
	Yellow Indicator	ON/OFF
	Green Indicator	ON/OFF
Warning Volume	—	Min/Mid/Max

Touch (Car settings icon) to display the items that are changeable while driving.
Change the EyeSight system setting as follows:

1. Touch (Car settings icon).
2. Select the preferred menu.

Item		Setting
Driving Assistance	Pre-Collision Braking	Setting ON/Setting OFF
	Lane Departure Prevention Function	All Functions/ Lane Departure Prevention Function Only/ Warning Buzzer Only/ OFF
Others	Cruise Control Acceleration Characteristics	Lv. 1 (Eco)/ Lv. 2 (Comfort)/ Lv. 3 (Standard)/ Lv. 4 (Dynamic)
	Warning Volume	Min/Mid/Max

APPENDIX C

Run Log

Run Log for Daytime Tests

Subject Vehicle: *2020 Subaru Outback Premium/LDD* Test Date: *6/2/2020*

Adult Pedestrian Test Mannequin: *Articulated 4A Adult* Test Driver: *A. Ricci*

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
43	Static Run (1m)										
44	**S1a**	**16**	**Day**	Y	0.71	0.98	15.6	0.98	0.72	NC	
45				Y	0.65	0.00	6.7	0.43	0.72	Contact	
46				N							Uneven PTM speed
47				Y	0.76	1.19	16.2	0.86	0.77	NC	
48				Y	0.63	0.00	3.4	0.18	0.66	Contact	
49				Y	0.57	0.00	6.0	0.45	0.59	Contact	
50				Y	0.70	1.03	16.9	0.93	0.72	NC	
51	**S1a**	**40**	**Day**	Y	1.41	1.00	39.6	0.98	1.43	NC	
52				Y	1.46	1.02	39.9	0.98	1.50	NC	
53				Y	1.45	0.93	39.8	0.93	1.49	NC	
54				Y	1.41	0.95	40.2	0.95	1.47	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
55	**S1a**	**40**	**Day**	Y	1.52	0.88	39.9	0.92	1.53	NC	
56	Static Run (1 m)										
1	Static Run (1 m)										
2	**S1b**	**16**	**Day**	Y	1.04	1.12	15.8	0.94	1.05	NC	
3				Y	1.00	1.04	15.2	0.91	1.05	NC	
4				N							PTM lateral
5				Y	0.98	1.05	16.2	0.94	1.02	NC	
6				Y	1.13	1.15	15.4	0.99	1.14	NC	
7				Y	1.02	1.09	15.4	0.86	1.07	NC	
15	**S1b**	**20**	**Day**	N							Dummy legs not moving
16				Y	1.14	1.07	19.9	0.71	1.20	NC	
17				Y	1.10	1.01	20.0	0.99	1.12	NC	
18				Y	1.15	1.02	20.7	0.84	1.18	NC	
19				Y	1.08	1.26	20.1	0.85	1.09	NC	
20				Y	1.17	1.07	19.7	0.87	1.19	NC	
21				Y	1.15	1.09	20.5	0.88	1.18	NC	
22	**S1b**	**30**	**Day**	Y	1.28	0.96	29.6	0.98	1.30	NC	
23				Y	1.30	1.09	30.0	0.94	1.32	NC	
24				Y	1.30	1.06	29.6	0.92	1.36	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
25	**S1b**	**30**	**Day**	Y	1.30	1.04	29.9	0.98	1.33	NC	
26				Y	1.29	1.08	29.5	0.93	1.33	NC	
8	**S1b**	**40**	**Day**	Y	1.49	1.14	39.5	0.90	1.51	NC	Video flickering
9				Y	1.55	1.07	40.2	0.97	1.58	NC	
10				Y	1.43	1.07	40.3	0.98	1.48	NC	
11				Y	1.49	1.04	40.1	0.96	1.53	NC	
12				Y	1.45	1.00	40.0	0.98	1.46	NC	
13	Static Run (1 m), End of 6/2										
14	Static Run (1 m), Start of 6/3										
27	**S1b**	**50**	**Day**	Y	1.49	1.02	47.8	0.88	1.51	NC	
28				N							Dummy legs not moving
29				Y	1.47	0.91	50.7	0.93	1.51	NC	
30				Y	1.46	1.27	49.5	0.85	1.50	NC	
31				Y	1.58	1.48	48.5	0.81	1.63	NC	
32				Y	1.56	1.09	48.9	0.85	1.59	NC	
37	**S1b**	**55**	**Day**	Y	1.21	0.00	45.2	0.93	1.23	NC	
38				Y	1.49	0.98	53.6	0.88	1.52	NC	
39				Y	1.43	0.76	53.1	0.96	1.46	NC	
40				Y	1.44	1.04	55.3	0.96	1.47	NC	
41				Y	1.34	0.24	52.2	0.92	1.37	NC	
42	Static Run (1 m)										

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
33	**S1b**	**60**	**Day**	Y	1.16	0.00	39.8	0.97	1.20	Contact	
34				Y	1.43	0.18	53.5	0.90	1.46	NC	
35				Y	1.09	0.00	38.7	0.95	1.14	Contact	
36				Y	1.25	0.00	43.5	0.94	1.28	Contact	
57	**S1c**	**16**	**Day**	N							PTM lateral
58				Y	1.05	1.02	15.9	0.86	1.11	NC	
59				Y	0.98	1.16	16.3	0.89	1.03	NC	
60				Y	0.99	1.16	15.8	0.92	1.00	NC	
61				Y	1.11	0.70	16.9	0.76	1.15	NC	
62				N							PTM lateral
63				Y	1.03	1.12	16.3	0.90	1.05	NC	
64	**S1c**	**40**	**Day**	Y	1.52	1.17	34.4	0.86	1.56	NC	
65				Y	1.43	0.76	33.4	0.92	1.47	NC	
66				Y	1.37	0.85	34.6	0.95	1.41	NC	
67				Y	1.49	1.09	35.5	0.85	1.51	NC	
68				Y	1.42	0.83	32.5	0.90	1.45	NC	
176	**S1d**	**16**	**Day**	Y	0.97	0.91	16.5	0.92	1.02	NC	
177				Y	0.84	0.95	15.8	0.94	0.83	NC	
178				Y	0.95	1.09	15.9	0.88	1.00	NC	
179				Y	1.02	0.88	16.1	0.90	1.05	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
180	**S1d**	**16**	**Day**	Y	0.92	1.01	16.7	0.95	0.91	NC	
186	**S1d**	**20**	**Day**	Y	0.92	1.24	19.7	0.83	0.95	NC	
187				Y	1.04	1.03	20.5	0.77	1.08	NC	
188				Y	0.96	1.14	20.4	0.85	1.01	NC	
189				Y	1.10	0.87	19.8	0.93	1.12	NC	
190				Y	1.06	0.86	19.5	0.91	1.10	NC	
191				Y	1.05	0.87	19.4	0.91	1.12	NC	
192	**S1d**	**30**	**Day**	Y	0.87	0.43	30.0	0.91	0.92	NC	
193				Y	0.82	0.37	30.0	0.92	0.88	NC	
194				Y	1.12	1.00	29.9	0.96	1.16	NC	
195				Y	0.97	0.67	30.1	0.99	1.01	NC	
196				Y	0.97	0.87	29.8	0.98	1.04	NC	
197	**S1d**	**35**	**Day**	Y	0.83	0.64	35.4	0.93	0.87	NC	
198				Y	1.06	0.38	34.8	0.89	1.09	NC	
199				Y	0.84	0.00	23.8	0.88	0.89	Contact	
200				Y	0.91	1.14	34.8	0.90	0.91	NC	
201				Y	1.12	0.63	34.8	0.90	1.16	NC	
202	Static run										
181	**S1d**	**40**	**Day**	N							PTM lateral
182				Y	0.08	0.00	0.6	0.20	0.10	Contact	
183				Static run							
184				Y	0.74	0.00	26.6	0.95	0.78	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
185	**S1d**	**40**	**Day**	Y	0.92	0.00	31.8	0.92	0.96	Contact	
76	**S1e**	**40**	**Day**	Static run							
77				N							Hit guy wire
78				Y	1.48	1.28	34.6	0.84	1.53	NC	
79				Y	1.43	1.57	35.1	0.82	1.45	NC	
80				Y	1.41	1.27	35.5	0.86	1.49	NC	
81				Y	1.52	1.31	36.1	0.92	1.58	NC	
82				Y	1.49	1.32	34.7	0.85	1.54	NC	
83				Y	1.49	1.26	36.6	0.85	1.53	NC	
84	**S1e**	**50**	**Day**	Y	1.47	0.36	40.3	1.02	1.52	NC	
85				Y	1.45	0.63	40.3	0.95	1.49	NC	
86				N							PTM lateral error
87				Y	1.48	0.67	40.6	0.96	1.52	NC	
88				Y	1.58	0.91	39.7	0.90	1.62	NC	
89				N							PTM lateral error
90				Y	1.52	0.82	40.2	0.95	1.56	NC	
91	**S1e**	**60**	**Day**	Y	1.42	0.57	44.3	0.95	1.45	NC	
92				Y	1.36	-0.18	42.0	0.92	1.40	NC	No front contact, cleared before hitting side of bumper
93				Y	1.42	0.52	44.2	0.92	1.47	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
94	**S1e**	**60**	**Day**	Y	1.48	0.64	45.2	0.99	1.52	NC	
95				Y	1.20	0.00	36.8	0.89	1.22	Contact	
96	Static Run (1 m)										
69	Static run										
70	**S1f**	**40**	**Day**	Y	1.50	0.00	12.3	0.29	1.53	NC	
71				Y	1.52	0.00	13.6	0.37	1.56	NC	
72				Y	1.50	0.00	12.8	0.33	1.52	NC	
73				Y	1.46	0.00	11.4	0.30	1.48	NC	
74				Y	1.49	0.00	12.2	0.30	1.52	NC	
75	Static Run (1m)										
97	Static Run (1 m)										
98	**S1g**	**40**	**Day**	N							PTM lateral error
99				N							PTM lateral error
100				N							PTM lateral error
101				Y	1.34	0.00	1.1	0.04		NC	No AEB
102				Y	1.19	0.00	1.2	0.04		NC	No AEB
103				Y	1.56	0.00	10.0	0.34	0.97	NC	
104				Y	1.54	0.00	4.9	0.30	1.03	NC	
105				Y	1.55	0.00	2.1	0.05		NC	No AEB
106	Static Run (1m)										

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
119	Static run										
120	S4a	16	Day	N							Wrong test type selected
121				Y	1.95	0.95	15.5	0.90	0.99	NC	
122				Y	1.93	0.91	16.1	0.90	0.91	NC	
123				Y	1.91	0.76	15.8	0.88	1.03	NC	
124				Y	1.95	0.75	16.5	0.87	1.00	NC	
125				Y	1.91	0.95	15.6	0.92	0.88	NC	
126	S4a	40	Day	Y	2.49	1.18	39.9	0.89	1.56	NC	
127				Y	2.72	0.79	39.9	0.92	1.56	NC	
128				Y	2.77	0.95	40.0	0.96	1.41	NC	
129				Y	2.82	0.77	40.0	0.99	1.40	NC	
130				Y	2.48	0.95	40.1	0.98	1.39	NC	
131	S4a	50	Day	Y	1.97	0.62	49.6	1.01	1.52	NC	
132				Y		0.63	49.5	0.99	1.52	NC	No warning
133				Y	3.00	0.98	50.2	0.93	1.67	NC	
134				N							Yaw rate, windshield broken
135				Static run							
136				Y	2.77	0.75	49.5	0.95	1.45	NC	
137				Y	3.04	1.08	50.0	0.82	1.59	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
141	**S4a**	**55**	**Day**	Y	2.93	0.80	54.5	0.95	1.53	NC	
142				Y	0.86	0.00	32.4	1.03	0.82	Contact	Driver last moment braking
143				Y	1.98	1.16	54.8	0.91	1.55	NC	
144				Y	2.03	0.87	54.9	0.92	1.51	NC	
145				Y	2.73	1.05	54.5	0.89	1.59	NC	
138	**S4a**	**60**	**Day**	Y	2.47	0.00	52.3	0.93	1.50	Contact	
139				Y	1.79	0.00	52.0	0.87	1.65	Contact	
140				Y	2.80	0.00	54.7	0.87	1.57	Contact	
107	Static run										
108	**S4b**	**16**	**Day**	Y	1.99	0.94	15.6	0.86	1.14	NC	
109				Y	1.90	0.98	16.0	0.90	0.98	NC	
110				Y	1.90	0.87	16.4	0.89	1.02	NC	
111				Y	1.93	0.94	15.7	0.89	1.04	NC	
112				Y	1.97	1.01	15.6	0.88	1.04	NC	
113	**S4b**	**40**	**Day**	Y	2.83	0.95	40.3	1.01	1.56	NC	
114				Y	2.63	0.94	39.9	0.99	1.48	NC	
115				Y	2.81	1.09	40.1	0.96	1.49	NC	
116				Y	3.02	0.72	40.2	0.90	1.55	NC	
117				Y	2.88	0.79	40.3	0.91	1.52	NC	
118	Static Run (1m)										

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
146	Static run										
147	**S4c**	**16**	**Day**	Y	1.60	0.82	15.6	0.88	0.84	NC	
148				Y	1.93	0.90	15.7	0.85	0.91	NC	
149				Y	1.72	0.66	15.9	0.82	0.85	NC	
150				Y	1.67	0.77	16.4	0.83	1.57	NC	
151				Y	1.94	0.87	15.2	0.85	1.86	NC	
152	**S4c**	**40**	**Day**	Y	2.50	1.18	40.0	0.82	1.47	NC	
153				Y	2.52	0.99	40.0	0.88	2.01	NC	
154				Y	2.58	1.17	39.6	0.91	1.37	NC	
155				Y	2.60	1.24	39.9	0.87	1.52	NC	
156				Y	2.67	0.96	39.6	0.90	1.53	NC	
157	**S4c**	**50**	**Day**	Y	2.91	1.08	49.8	0.90	1.49	NC	
158				Y	2.68	1.92	50.2	0.81	1.47	NC	
159				Y	3.05	1.19	49.7	0.89	1.60	NC	
160				Y	2.86	1.43	49.7	0.84	1.58	NC	
161				Y	2.94	1.03	49.8	0.88	1.60	NC	
162	**S4c**	**60**	**Day**	Y	3.14	1.02	59.8	0.92	1.41	NC	
163				Y	3.27	0.91	60.1	0.96	1.54	NC	
164				Y	2.79	0.95	59.4	0.89	1.59	NC	
165				Y	3.11	0.30	60.0	0.91	1.43	NC	
166				Y	3.10	0.97	59.6	0.84	1.61	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
170	**S4c**	**65**	**Day**	Y	2.80	0.05	64.5	0.90	1.47	NC	
171				Y	2.88	0.55	64.5	0.89	1.46	NC	
172				Y	2.99	0.35	64.6	0.91	1.49	NC	
173				Y	2.92	0.64	64.9	0.90	1.62	NC	
174				Y	2.73	0.26	65.4	0.93	1.50	NC	
175	Static run										
167	**S4c**	**70**	**Day**	Y	2.72	0.00	60.8	0.93	1.56	Contact	
168				Y	2.84	0.00	51.4	0.89	1.51	Contact	
169				Y	2.68	0.00	48.1	0.92	1.49	Contact	

Run Log for Nighttime Tests

Subject Vehicle: *2020 Subaru Outback Premium/LDD*

Test Date: *6/2/2020*

Adult Pedestrian Test Mannequin: *Articulated 4A Adult*

Test Driver: *N. Wong*

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
8	**S1b**	**16**	**NHB**	Y	0.85	0.99	16.3	0.89	0.90	NC	
9				Y		0.00	0.0	0.02		Contact	No warning, no AEB
10				Y	0.38	0.00	10.8	0.87	0.41	Contact	
11				Y	0.72	1.07	15.9	0.88	0.71	NC	
12				N							PTM lateral error
13				Y	1.04	1.03	16.3	0.95	1.09	NC	
44	**S1b**	**20**	**NHB**	Y	1.09	0.34	19.5	1.03	0.55	NC	
45				Y	1.13	0.99	19.4	0.87	1.18	NC	
46				Y	1.12	0.98	19.3	0.86	1.18	NC	
47				Y	1.12	0.00	17.1	0.92	0.49	Contact	
48				N							SV speed
49				Y	1.02	0.00	13.2	0.92	0.46	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
50	**S1b**	**30**	**NHB**	Y	1.34	0.93	29.1	1.01	1.37	NC	
51				Y	1.32	1.20	30.1	0.87	1.35	NC	
52				Y	1.32	1.08	29.9	0.86	1.35	NC	
53				Y	1.20	0.97	30.3	0.97	1.23	NC	Video dropouts
54				Y	1.28	0.99	30.6	0.97	1.30	NC	
19	**S1b**	**40**	**NHB**	Y	1.39	1.00	40.1	0.97	1.43	NC	
20				Y	0.74	0.00	4.3	0.35	0.79	Contact	
21				Y	1.48	1.10	39.9	0.93	1.50	NC	
22				Y	1.43	1.07	39.8	0.92	1.46	NC	
23				Y	1.46	1.05	40.2	1.01	1.47	NC	
24	**S1b**	**50**	**NHB**	Y	1.46	1.01	51.3	0.95	1.51	NC	
25				Y	1.45	0.83	43.5	1.01	1.44	NC	
26				Y	1.47	1.31	50.5	0.94	1.52	NC	
27				Y	1.45	0.91	51.5	0.92	1.52	NC	
28				Y	1.45	0.81	49.2	0.99	1.49	NC	
29				Y	1.35	0.74	51.9	0.99	1.38	NC	
62	**S1b**	**55**	**NHB**	N							SV yaw
63				Y	1.45	0.94	53.5	0.98	1.47	NC	
64				Y	1.32	0.02	53.8	1.00	1.37	NC	
65				Y	1.22	0.00	45.3	0.97	1.23	Contact	
66				Y	1.37	0.64	54.5	1.00	1.40	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
67	**S1b**	**55**	**NHB**	N							SV yaw
68				Y	1.47	1.04	52.3	0.90	1.49	NC	
69	**S1b**	**60**	**NHB**	Y	1.50	0.74	55.9	0.97	1.53	NC	
70				Static Run, 6/3/2020: Temp 31 C, 0 knots, 0.05 lux							
71				Y	1.32	0.00	46.1	0.92	1.34	Contact	
72				Y	1.10	0.00	36.0	0.95	1.15	Contact	
73				Y	0.93	0.00	30.0	0.98	0.95	Contact	
163	**S1d**	**16**	**NHB**	Y	0.48	0.22	16.1	0.96	0.51	NC	
164				Y	0.54	0.62	16.2	0.95	0.55	NC	
165				Y	0.26	0.00	5.6	0.88	0.28	Contact	
166				N							SV speed
167				Y	0.77	0.81	15.7	0.96	0.80	NC	
168				N							Legs did not move
169				Y	0.91	0.82	15.7	0.95	0.94	NC	
180	**S1d**	**20**	**NHB**	N							PTM lateral error
181				Y	0.55	0.29	20.4	0.87	0.58	NC	
182				Y	0.86	1.15	19.7	0.89	0.93	NC	
183				Y	0.38	0.00	12.3	0.97	0.43	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
184	**S1d**	**20**	**NHB**	Y		0.00	0.0	0.01		Contact	No warning, no AEB
185				Y	0.67	1.08	20.6	0.94	0.68	NC	
190	**S1d**	**25**	**NHB**	Y	0.30	0.00	6.1	0.82	0.34	Contact	
191				Y	0.81	0.83	24.7	1.00	0.90	NC	
192				Y	0.94	1.06	25.7	0.93	0.99	NC	
193				Y	0.23	0.00	2.2	0.65	0.21	Contact	
194				Y	0.41	0.00	10.3	0.90	0.42	Contact	
186	**S1d**	**30**	**NHB**	Y	0.34	0.00	7.6	0.85	0.36	Contact	
187				Y	0.82	0.80	30.5	0.95	0.87	NC	
188				Y	0.32	0.00	6.4	0.91	0.34	Contact	
189				Y		0.00	0.0	0.01		Contact	No warning, no AEB
170	**S1d**	**40**	**NHB**	Y	0.73	0.00	25.0	0.91	0.75	Contact	
171				N							Legs did not move
172				Y	0.77	0.00	26.9	0.88	0.81	Contact	
173				Y	0.78	0.00	28.2	0.91	0.80	Contact	
84	**S1e**	**35**	**NHB**	Y	1.06	0.84	36.8	1.03	1.10	NC	
85				Y	0.77	0.00	29.3	0.94	0.82	Contact	
86				Y	0.89	0.30	36.2	1.02	0.97	NC	
87				Y	0.94	0.45	34.8	0.99	1.82	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
88	**S1e**	**35**	**NHB**	Y	0.99	0.73	36.0	1.01	1.02	NC	
89				Y	0.79	0.15	34.3	0.93	0.86	NC	
78	**S1e**	**40**	**NHB**	N							SV yaw
79				Y	0.98	-0.10	35.7	0.94	1.03	Contact	
80				Y	0.78	-0.07	34.8	0.95	0.79	Contact	
81				Y	0.59	0.00	17.9	0.90	0.63	Contact	
82				Y	0.71	0.00	23.2	0.91	0.73	Contact	
83				Y	0.41	0.00	9.3	0.86	0.43	Contact	
136	**S4a**	**16**	**NHB**	Y	1.61	0.85	15.7	0.96	1.47	NC	
137				Y	1.61	0.85	15.6	0.96	0.66	NC	
138				Y	1.84	1.09	15.4	0.94	1.01	NC	
139				Y	1.93	1.06	15.9	0.94	0.93	NC	
140				Y	1.53	0.70	15.6	1.00	0.59	NC	
154	**S4a**	**35**	**NHB**	Y	0.87	0.00	0.6	0.05		Contact	No AEB
155				Y	0.91	0.00	1.2	0.05		Contact	No AEB
156				Y	1.89	0.55	35.0	1.00	1.04	NC	
157				Y	0.98	0.00	0.8	0.06		Contact	No AEB
145	**S4a**	**40**	**NHB**	N							SV yaw
146				Y	0.89	0.00	0.7	0.05		Contact	No AEB
147				Y	2.79	0.83	40.1	1.00	1.34	NC	
148				Y	1.04	0.00	1.5	0.32	0.12	Contact	
149				Y	2.57	0.93	39.6	0.99	1.47	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
150	**S4a**	**40**	**NHB**	Y	0.88	0.00	0.9	0.05		Contact	No AEB
102	**S4c**	**16**	**NHB**	Y	1.45	0.56	16.6	0.78	1.05	NC	
103				Y	1.47	0.76	16.1	0.80	0.74	NC	
104				Y	1.53	0.70	16.0	0.84	1.07	NC	
105				Y	1.82	0.55	15.3	0.80	0.88	NC	
106				Y	1.26	0.54	16.8	0.72	1.10	NC	
111	**S4c**	**40**	**NHB**	Y	1.47	0.00	12.5	0.84	0.52	Contact	
112				Y	1.15	0.00	2.8	0.49	0.20	Contact	
113				Y	2.63	1.54	39.6	0.84	1.55	NC	
114				Y	2.61	0.98	40.5	0.93	1.29	NC	
115				Y	2.63	1.27	40.1	0.90	1.48	NC	
125	**S4c**	**45**	**NHB**	Y	2.27	1.51	44.9	0.81	1.46	NC	
126				Y	1.34	0.00	7.1	0.81	0.39	Contact	
127				Y	1.28	0.00	7.5	0.81	0.38	Contact	
128				Y	2.22	1.29	44.9	0.85	1.46	NC	
129				Y	1.25	0.00	6.0	0.77	0.32	Contact	
120	**S4c**	**50**	**NHB**	Y	1.12	0.00	2.7	0.59	0.20	Contact	
121				Y	1.25	0.00	5.0	0.80	0.30	Contact	
122				N							SV speed
123				Y	1.09	0.00	2.7	0.42	1.15	Contact	
124				Y	1.24	0.00	4.1	0.66	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 (NC)	Notes
1	Static run										
2	**S1b**	**16**	**NLB**	Y	0.46	0.27	16.1	0.90	0.48	NC	Video cutout during AEB event
3				Y	0.37	0.00	2.6	0.32	0.43	Contact	
4				Y	0.60	0.82	15.4	0.96	0.61	NC	
5				Y	0.68	0.68	15.5	0.98	0.74	NC	
6				N							SV speed
7				Y	0.71	1.00	16.2	0.85	0.76	NC	
38	**S1b**	**20**	**NLB**	N							Wrong PTM path file
39				Y	0.42	0.00	13.2	0.90	0.44	Contact	
40				Y	0.40	0.00	7.7	0.89	0.37	Contact	
41				Y	1.13	1.00	19.8	0.86	1.17	NC	
42				Y	1.14	1.05	19.8	0.81	1.18	NC	
43				Y	0.61	0.61	20.1	0.93	0.62	NC	
55	**S1b**	**30**	**NLB**	N							Wrong headlights
56				N							Wrong headlights
57				Y	1.31	1.07	29.8	0.91	1.33	NC	
58				Y	1.25	0.96	29.9	0.95	1.29	NC	
59				Y	1.22	0.99	30.3	0.94	1.25	NC	Video dropouts
60				Y	1.21	0.93	30.1	0.95	1.28	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
61	**S1b**	**30**	**NLB**	Y	1.26	0.95	30.1	0.93	1.30	NC	
14	**S1b**	**40**	**NLB**	Y	0.88	0.09	40.1	0.94	0.89	NC	
15				Y	1.03	0.74	40.7	1.01	1.05	NC	
16				Y	0.94	0.51	40.2	1.03	0.96	NC	
17				Y	0.98	0.65	39.7	0.96	1.00	NC	
18				Y	1.01	0.58	39.3	0.94	1.03	NC	
33	**S1b**	**45**	**NLB**	Y	0.97	0.41	45.3	1.01	0.99	NC	
34				Y	1.03	0.85	45.4	1.02	1.06	NC	
35				Y	0.74	0.00	24.4	0.91	0.77	Contact	
36				Y	0.67	0.00	21.0	0.94	0.70	Contact	
37				Y	0.71	0.00	21.4	0.93	0.72	Contact	
30	**S1b**	**50**	**NLB**	Y	0.76	0.00	22.9	0.92	0.78	Contact	
31				Y	0.88	0.00	32.7	1.00	0.88	Contact	
32				Y	0.86	0.00	32.8	1.00	0.88	Contact	
178	**S1d**	**11**	**NLB**	N							PTM lateral error
179				N							PTM lateral error, SV speed
195				N							PTM lateral
196				N							PTM lateral, SV speed

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
197	S1d	11	NLB	Y	0.52	0.64	10.1	0.96	0.56	NC	
198				N							PTM lateral error
199				N							Unable to hold 11kph or PTM lateral, stopping test
158	Static run										
159	S1d	16	NLB	Y	0.26	0.00	5.0	0.82	0.31	Contact	
160				Y	0.66	0.90	15.2	0.85	0.67	NC	
161				Y	0.28	0.00	5.0	0.89	0.29	Contact	
162				Y	0.29	0.00	0.3	0.15	0.09	Contact	Late AEB
174	S1d	40	NLB	Y	0.37	0.00	7.4	0.81	0.37	Contact	
175				N							SV speed
176				Y	0.61	0.00	18.9	0.87	0.65	Contact	
177				Y		0.00	0.1	0.02		Contact	No warning, no AEB
90	S1e	35	NLB	Y	1.25	0.82	34.8	1.01	1.29	NC	
91				Y	1.31	1.09	34.6	0.88	1.35	NC	
92				Y	0.74	0.00	25.9	0.92	0.79	Contact	
93				Y	0.93	0.26	33.7	0.93	0.98	NC	
94				Y	1.22	1.04	35.8	0.99	1.26	NC	
95	Static Run										
74	Static Run										

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
75	**S1e**	**40**	**NLB**	Y	0.77	0.00	27.9	0.93	0.78	Contact	
76				Y	0.79	0.00	24.8	0.93	0.84	Contact	
77				Y	0.68	0.00	19.5	0.92	0.74	Contact	
130	Static Run										
131	**S4a**	**16**	**NLB**	Y	1.65	0.62	16.5	0.95	0.80	NC	
132				Y	1.05	0.00	2.2	0.42	0.17	Contact	
133				Y	1.60	0.74	15.8	0.97	0.81	NC	
134				Y	1.49	0.57	15.4	1.00	0.59	NC	
135				Y	1.05	0.00	1.7	0.30	0.13	Contact	
151	**S4a**	**35**	**NLB**	Y	0.88	0.00	0.9	0.05		Contact	No AEB
152				Y	0.85	0.00	1.0	0.05		Contact	No AEB
153				Y	0.88	0.00	1.7	0.05		Contact	No AEB
141	**S4a**	**40**	**NLB**	Y	0.79	0.00	0.9	0.06		Contact	No AEB
142				N							Support vehicle headlights on
143				Y	0.87	0.00	0.5	0.05		Contact	No AEB
144				Y	0.90	0.00	0.6	0.04		Contact	No AEB
96	Static Run										

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
97	**S4c**	**16**	**NLB**	Y	1.59	0.59	16.0	0.85	1.02	NC	
98				Y	1.75	0.78	15.7	0.86	0.93	NC	
99				Y	1.82	0.81	16.1	0.92	0.84	NC	
100				Y	1.73	0.69	15.8	0.88	0.78	NC	
101				Y	1.77	0.75	15.9	0.89	0.98	NC	
116	**S4c**	**35**	**NLB**	Y	1.74	0.46	35.2	0.91	0.78	NC	
117				Y	1.52	0.00	22.4	0.90	0.64	Contact	
118				Y	1.18	0.00	4.4	0.70	0.28	Contact	
119				Y	1.36	0.00	10.9	0.86	0.46	Contact	
107	**S4c**	**40**	**NLB**	Y	1.28	0.00	5.6	0.76	0.31	Contact	
108				Y	1.16	0.00	3.4	0.63	0.27	Contact	Windshield cracked
109				Static Run, testing resumed 6/9							
110				Y	1.13	0.00	2.9	0.60	0.21	Contact	

APPENDIX D

Time History Plots

LIST OF FIGURES

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. When no warning is detected the plot will display “No Wng” in red except that for scenarios S1f and S1g, for which no contact is the appropriate result, “No Warning” will be displayed in black.

  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. Note that there are cases where minimum headway can be zero without collision. Because the plan view of the from profile of a vehicle is generally not rectangular, and headway is calculated from the front-most point of the vehicle. It is possible to have zero headway without. Also, for scenarios S1f and S1g, zero headway is appropriate since these are false positive tests.

  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 speed tolerance applies until the until the FCW alert is given. If the PAEB intervenes before the FCW alert, the speed tolerance applies until the onset of PAEB braking. Note that there is no tolerance for PTM speed because PTM motion validity is a function of SV longitudinal position. Speed reduction (SR) values are shown in red when contact occurred.

- 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 -0.03 g, which is used as the threshold to indicate PAEB braking. The onset of PAEB system braking is found by finding the moment when the SV's Ax crosses the threshold of -0.15 g. Once this point is found, the first moment when the SV Ax is below the indicated -0.03 g threshold but before the Ax crosses the -0.15 g point, is determined and said to be the moment of first PAEB 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 either an audible FCW alert is provided or the onset of PAEB braking, whichever occurs first.

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 -0.03 g threshold.

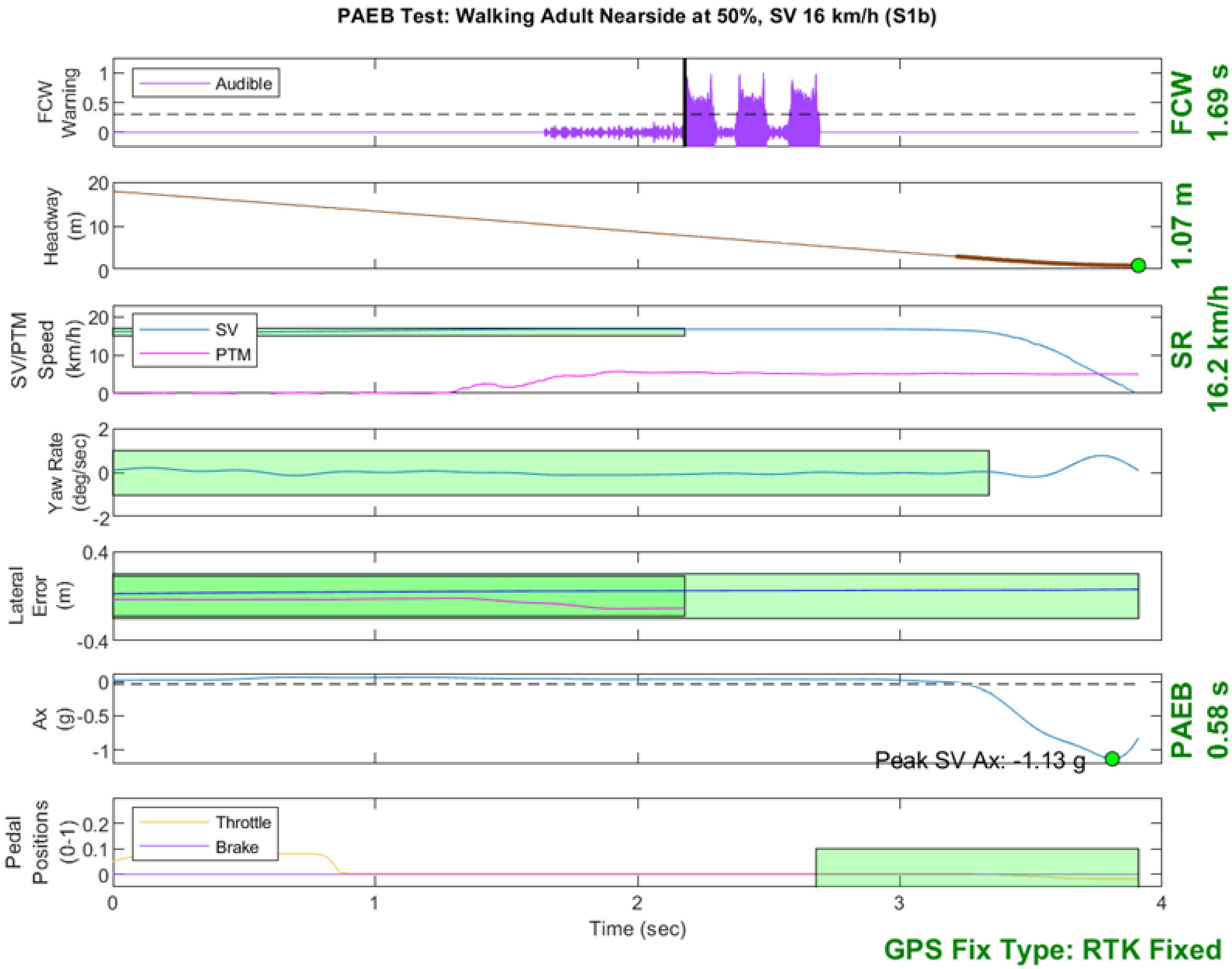


Figure D1. Example Time History for a Passing Run

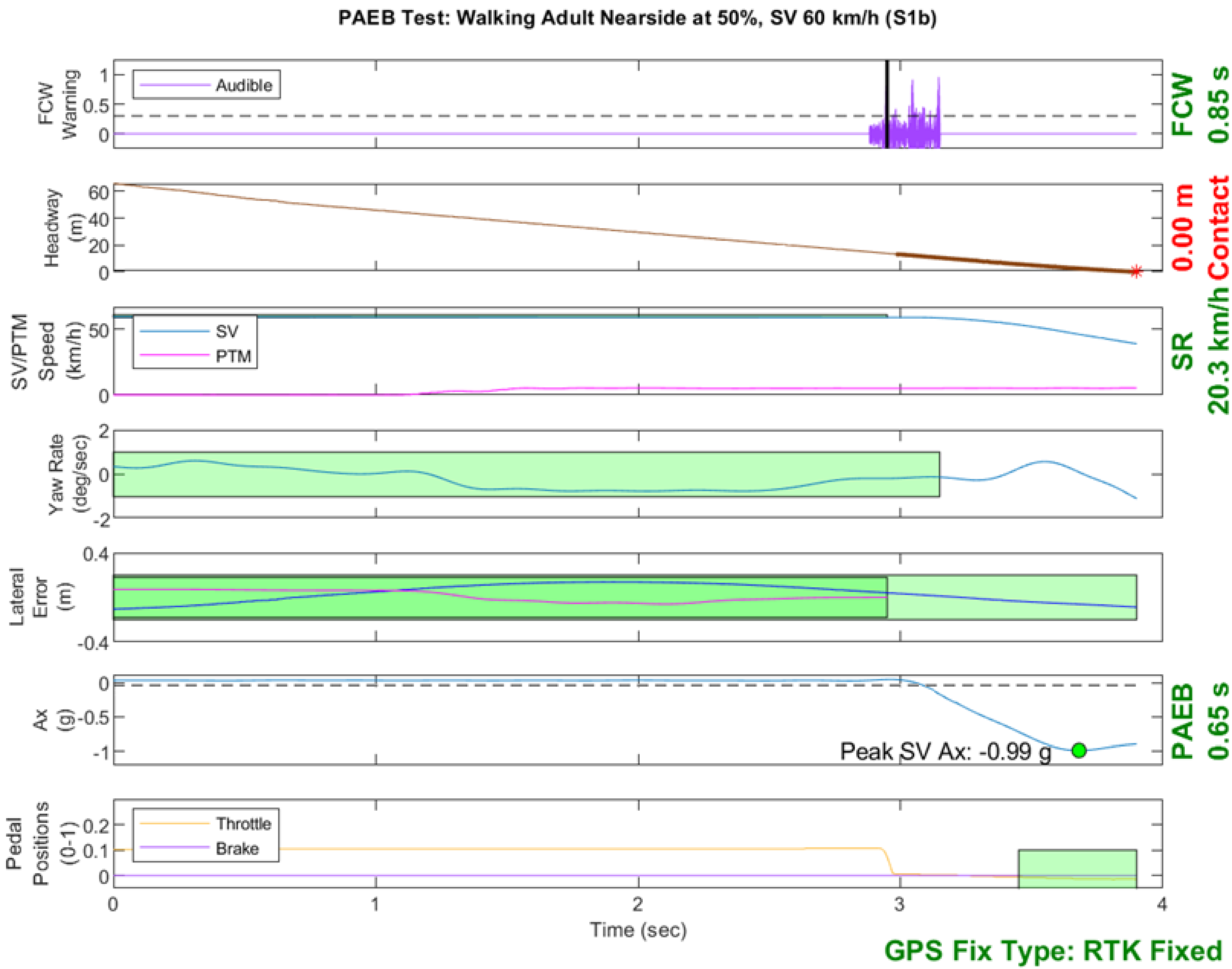


Figure D2. Example Time History for a Failed Run

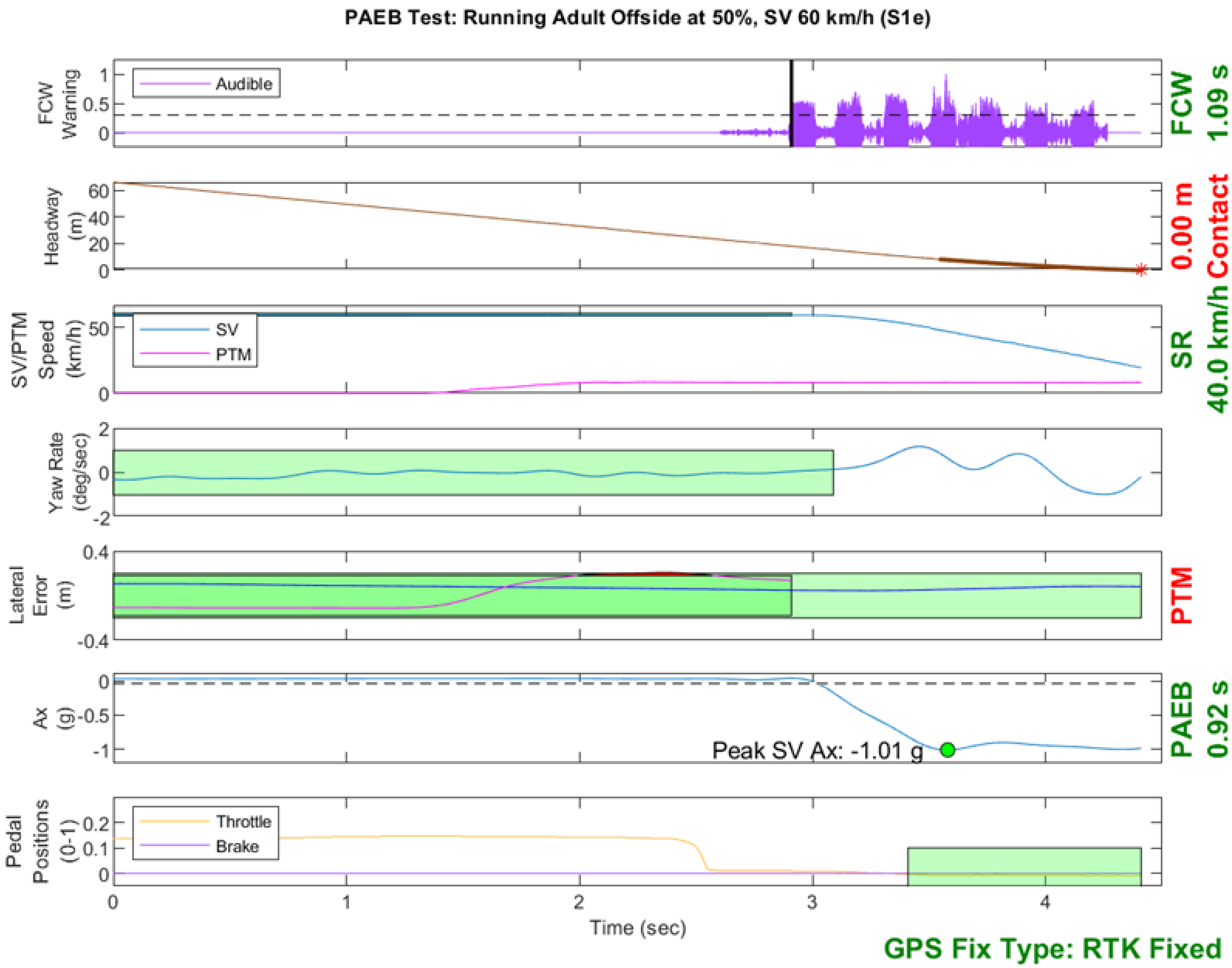


Figure D3. Example Time History for an Invalid Run Due to PTM Lateral Error

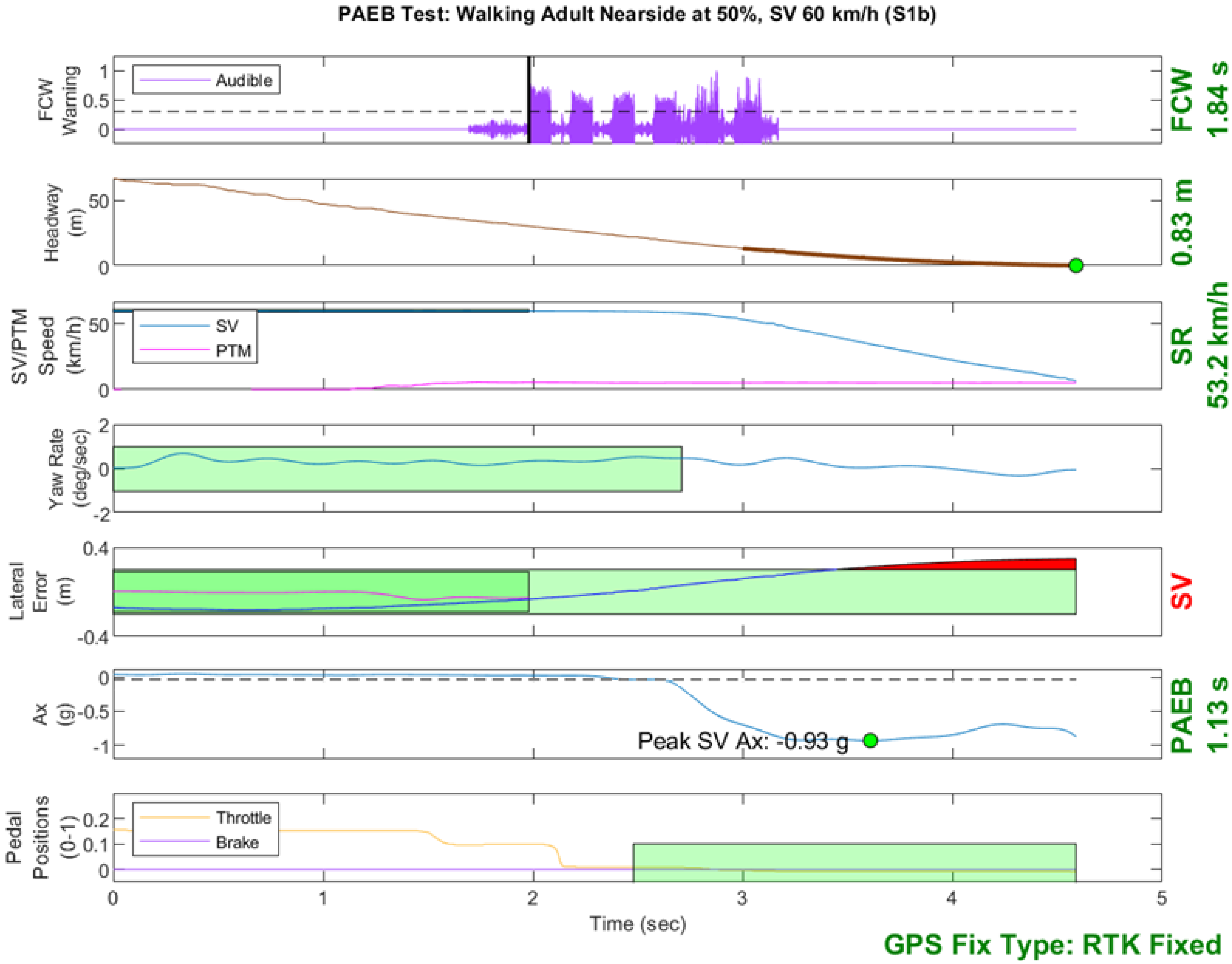


Figure D4. Example Time History for an Invalid Run Due to SV Lateral Error

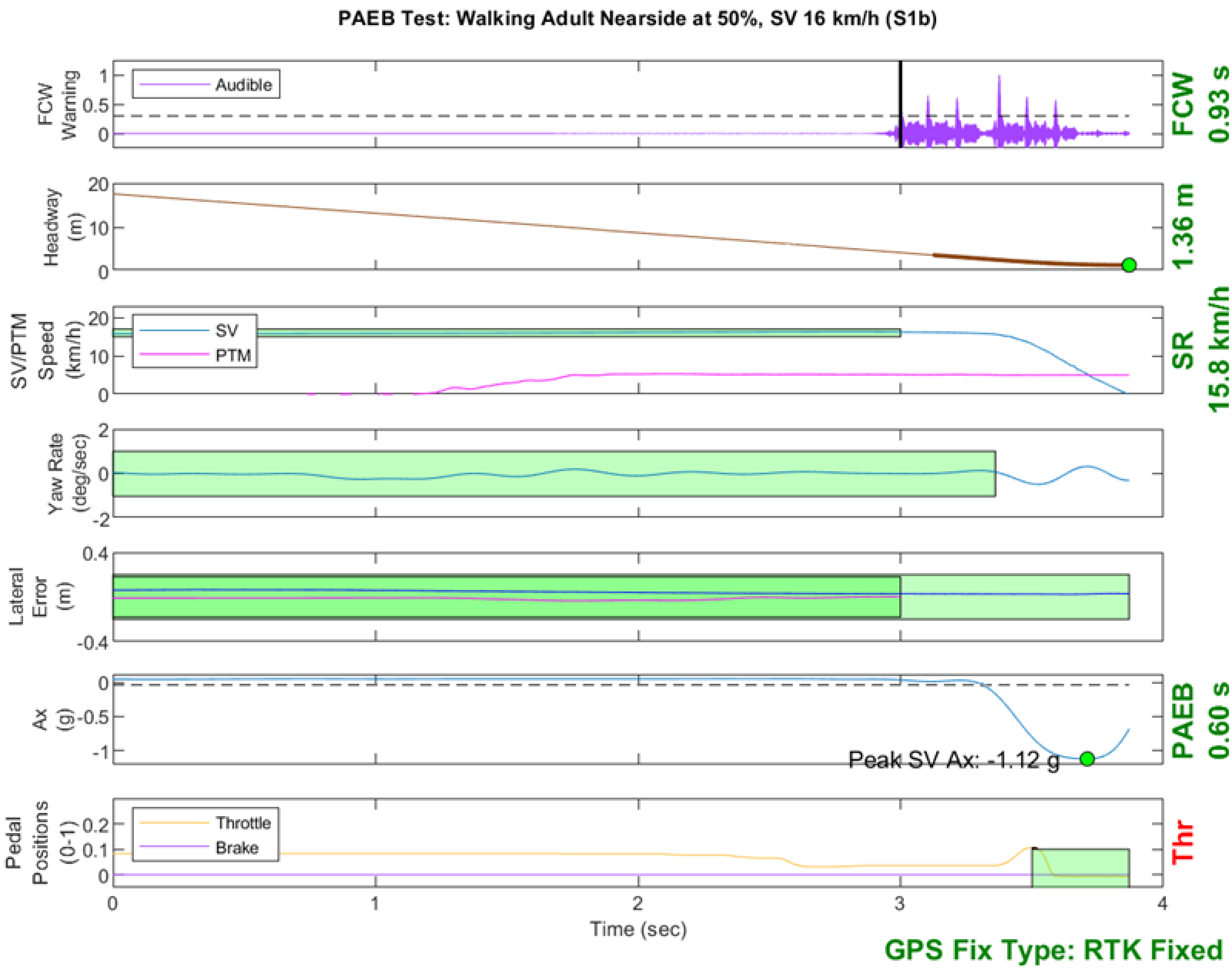


Figure D5. Example Time History for an Invalid Run Due to Throttle Error

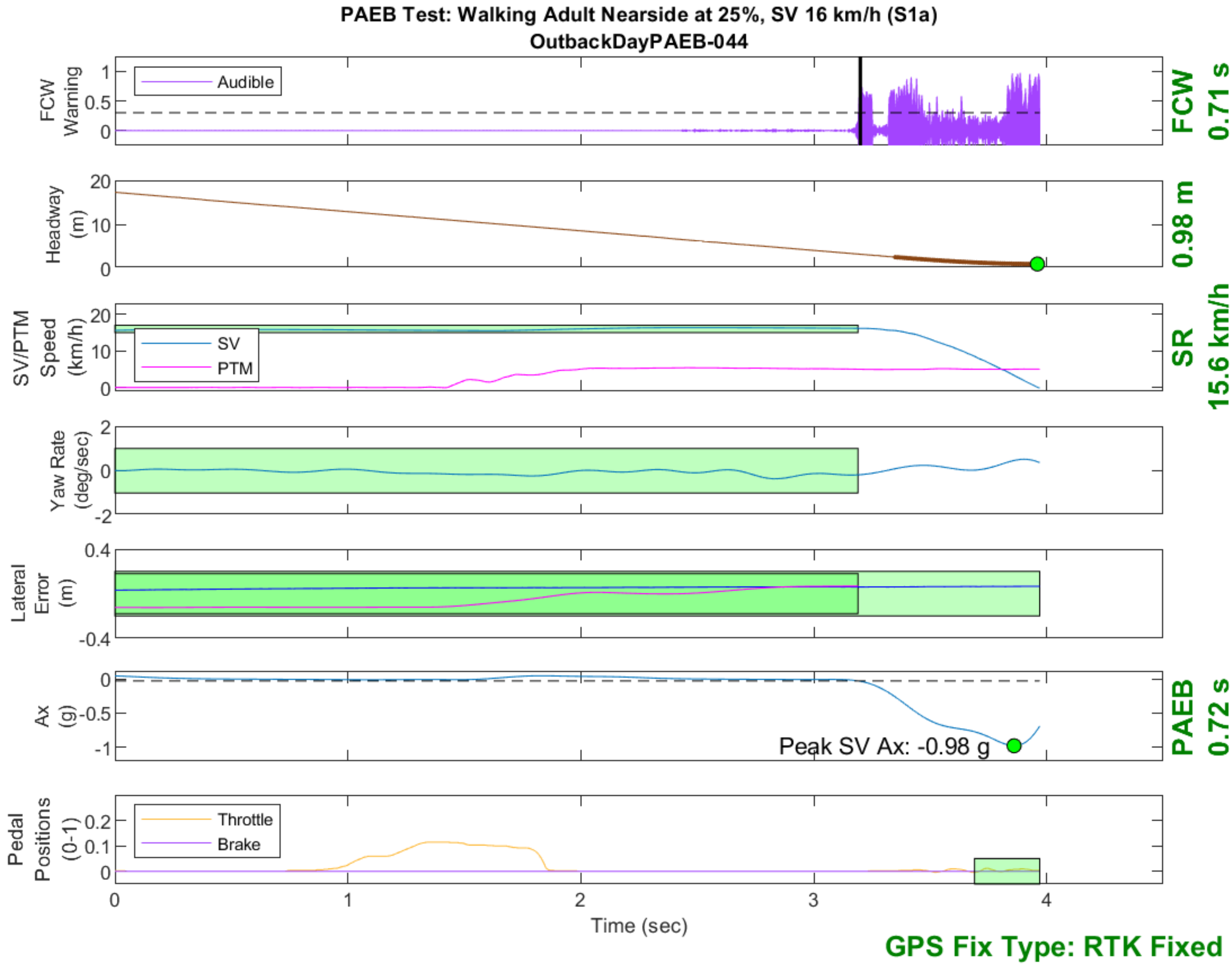


Figure D6. Time History for PAEB Run 44, S1a, Daytime, 16 km/h

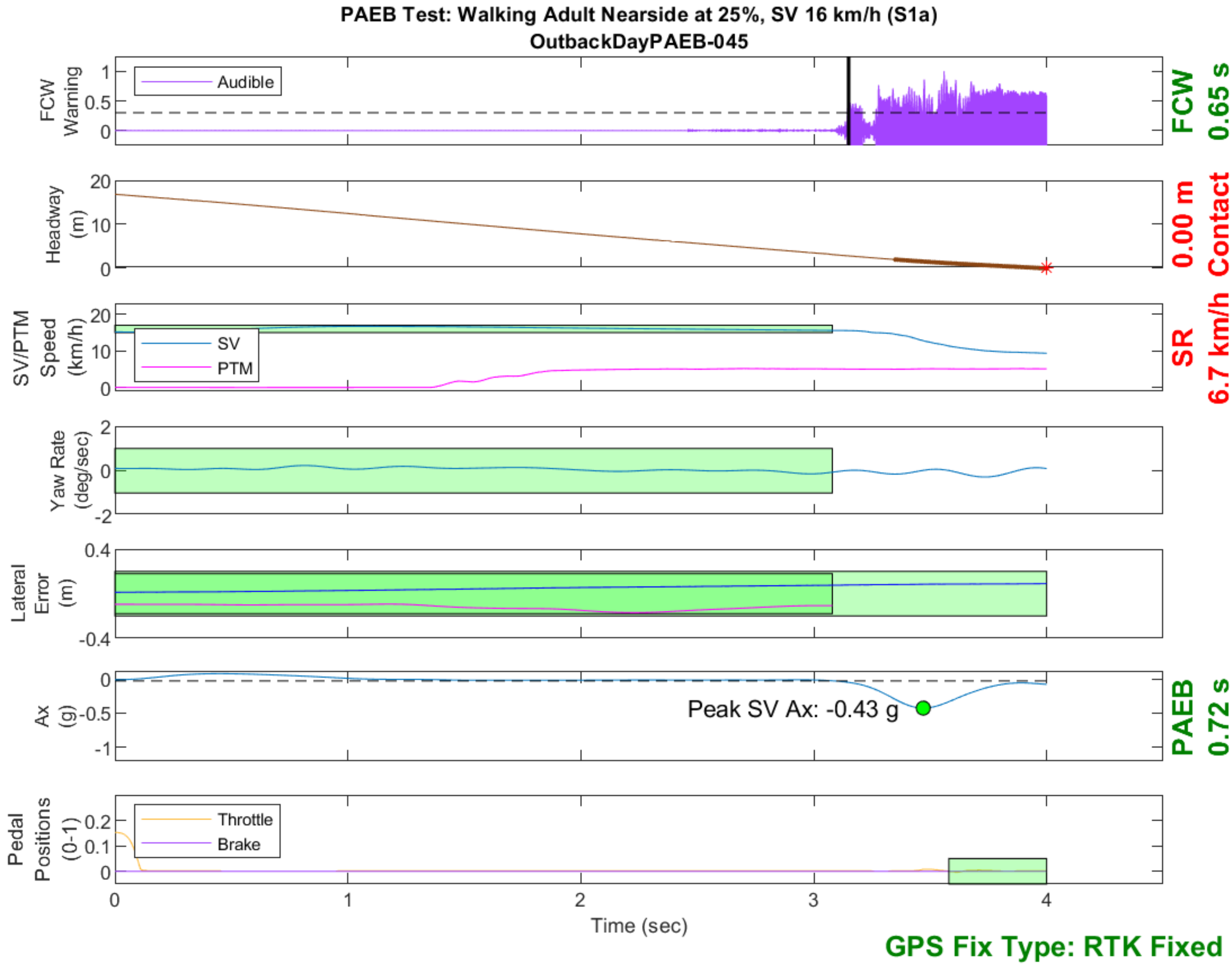


Figure D7. Time History for PAEB Run 45, S1a, Daytime, 16 km/h

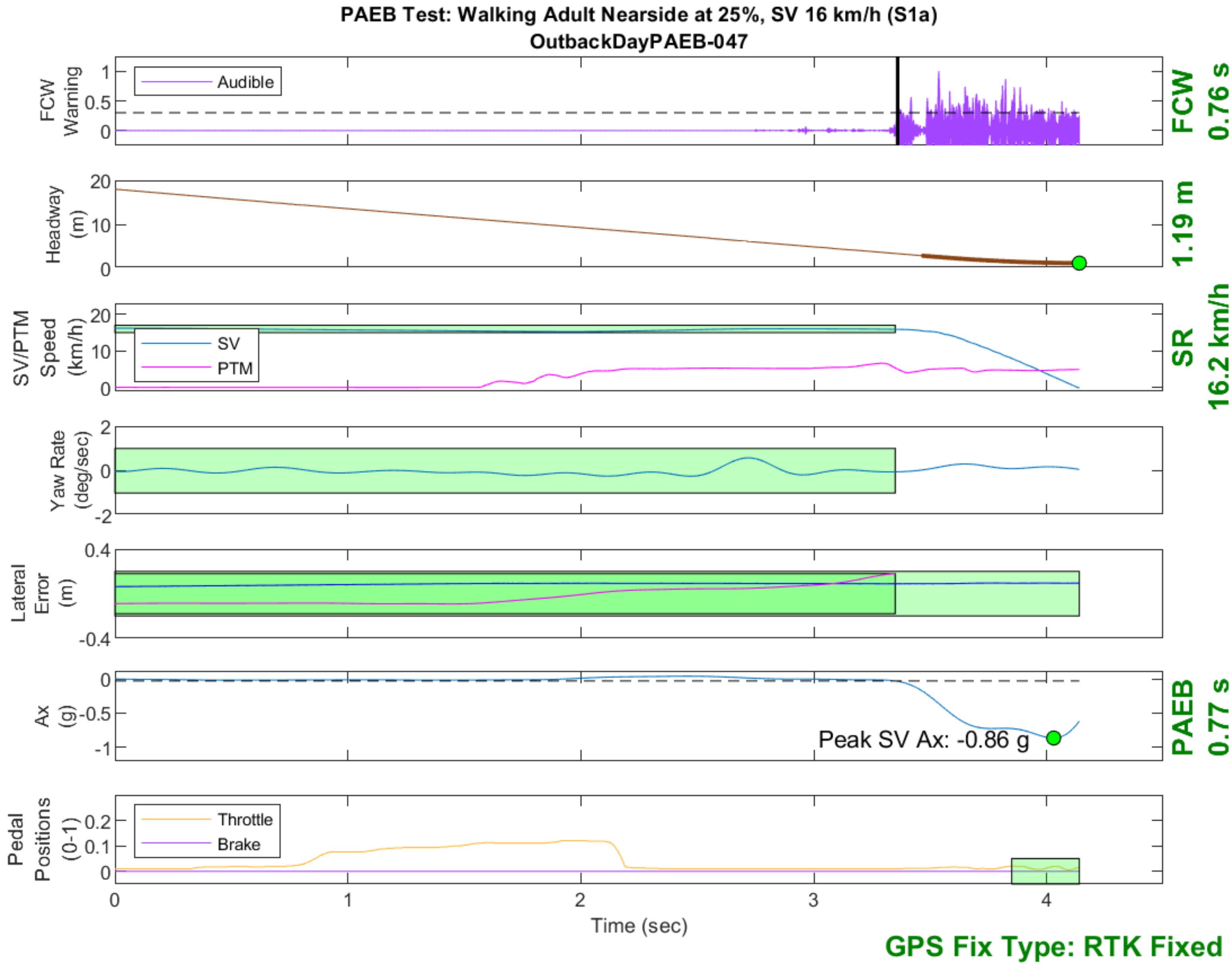


Figure D8. Time History for PAEB Run 47, S1a, Daytime, 16 km/h

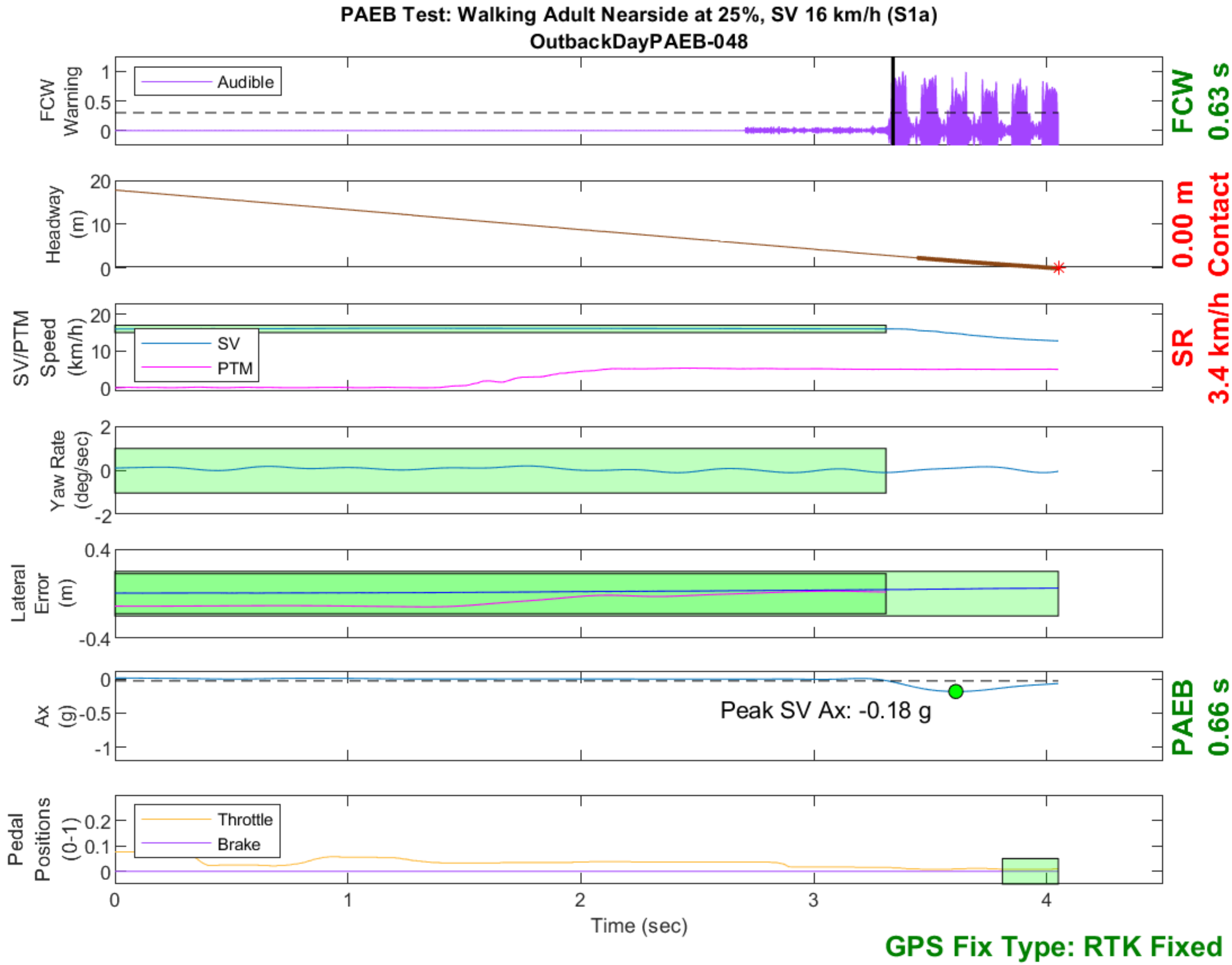


Figure D9. Time History for PAEB Run 48, S1a, Daytime, 16 km/h

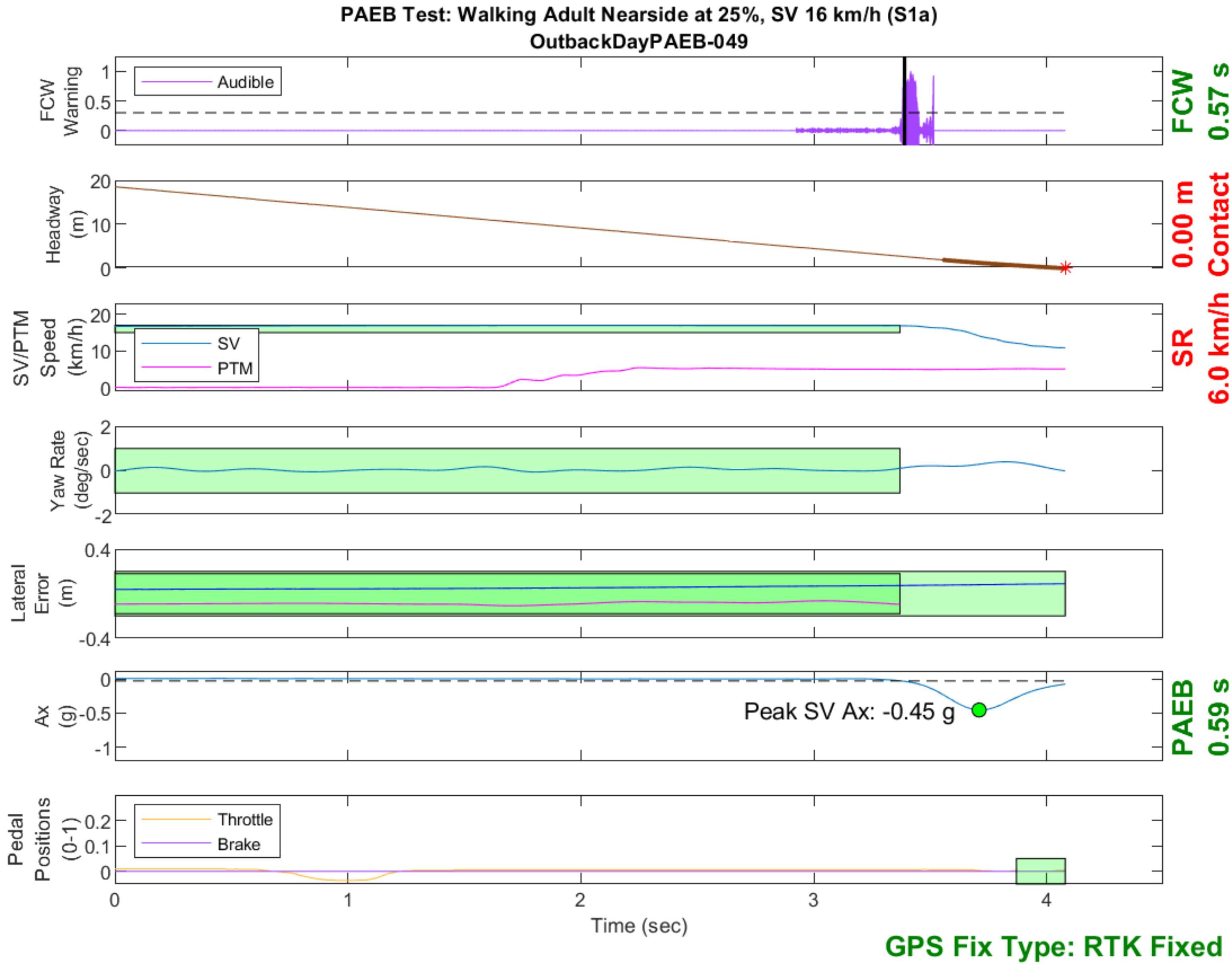


Figure D10. Time History for PAEB Run 49, S1a, Daytime, 16 km/h

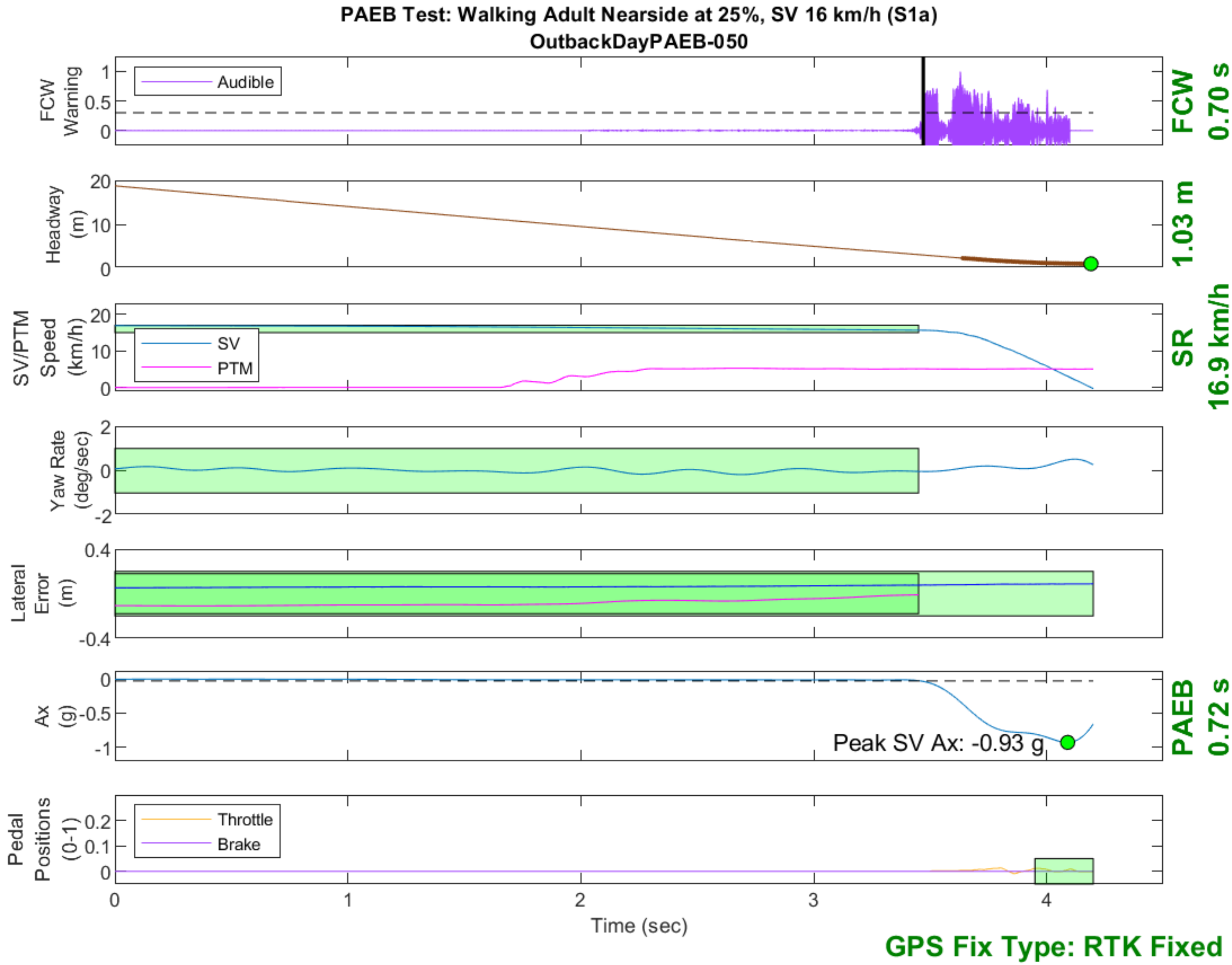


Figure D11. Time History for PAEB Run 50, S1a, Daytime, 16 km/h

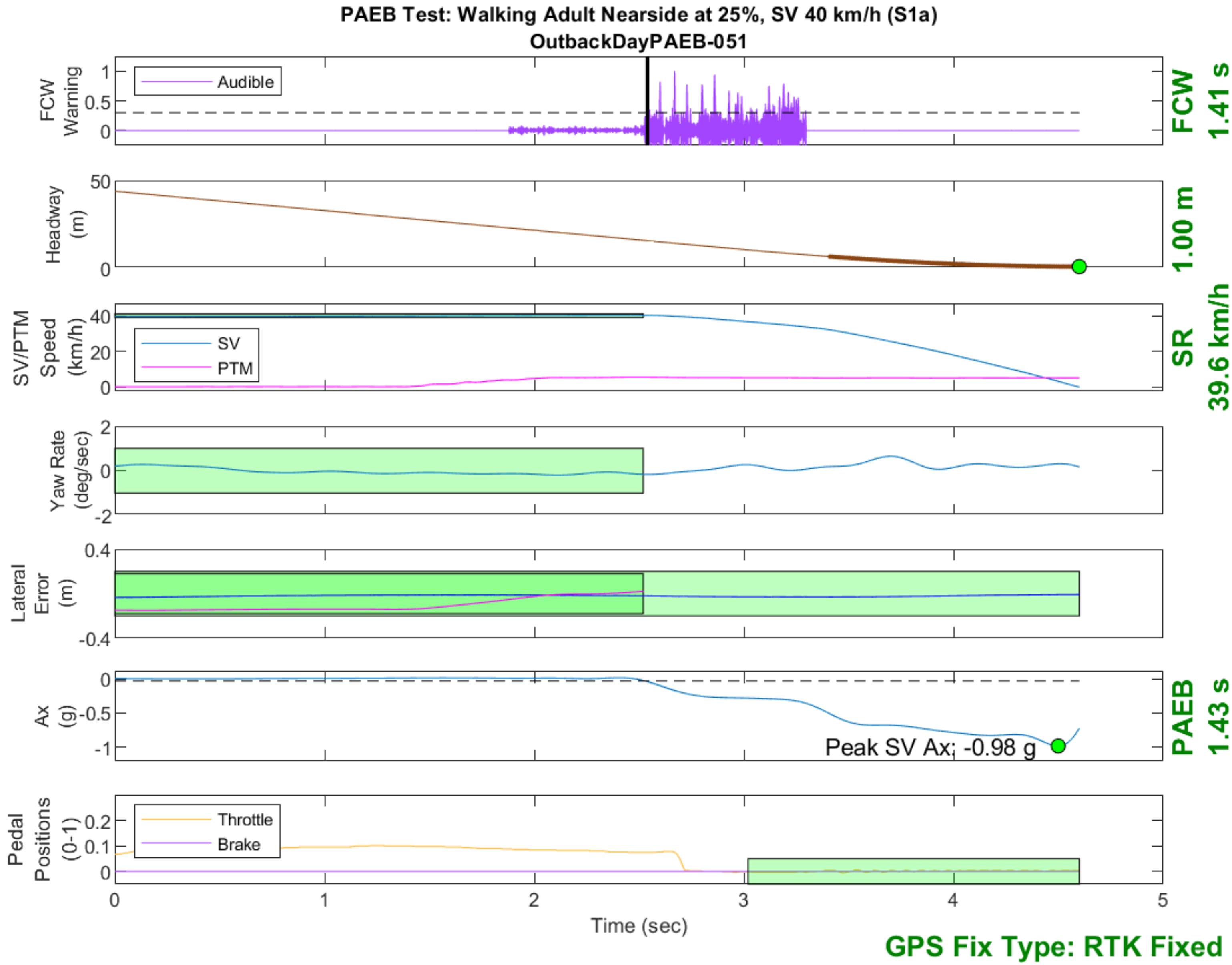


Figure D12. Time History for PAEB Run 51, S1a, Daytime, 40 km/h

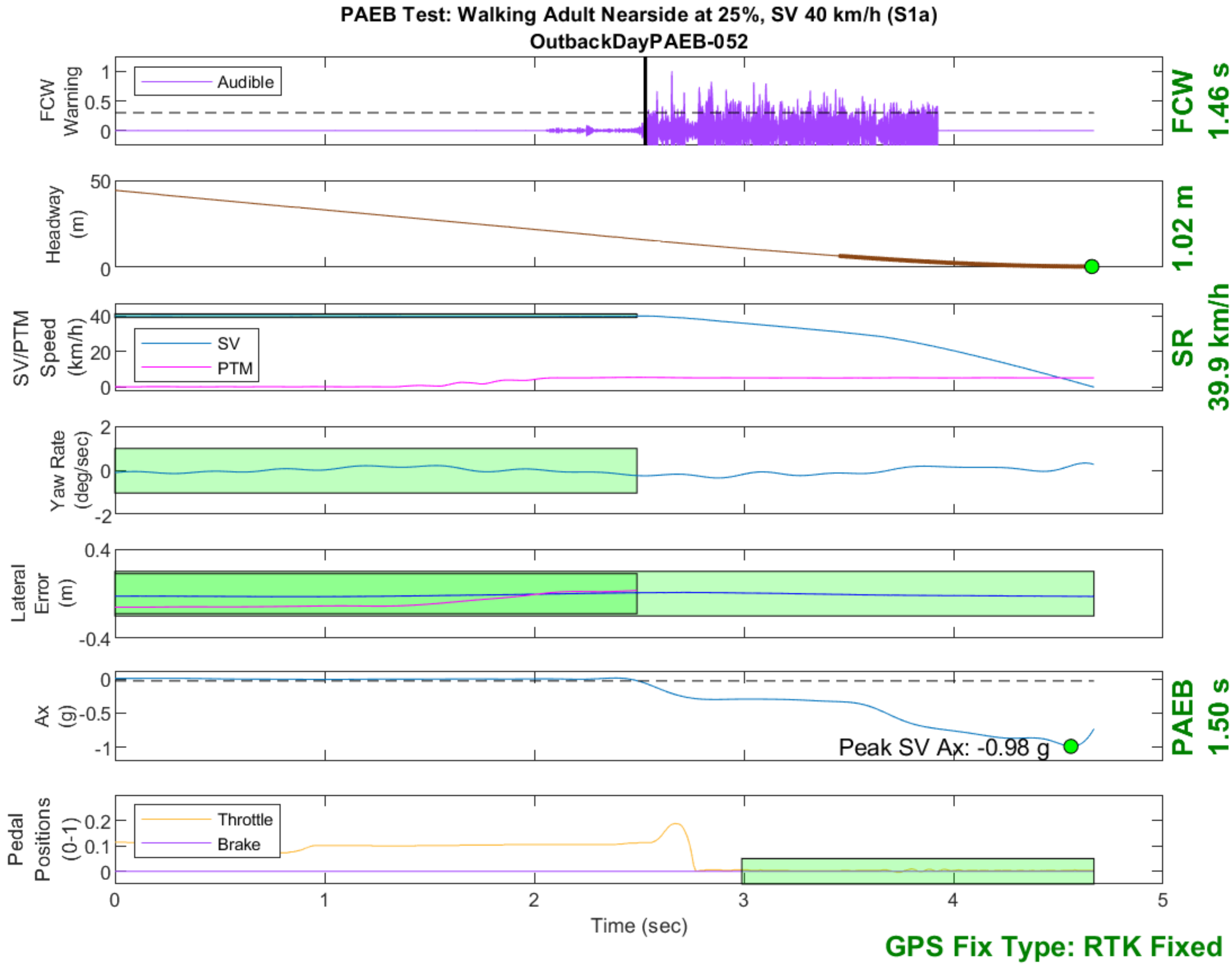


Figure D13. Time History for PAEB Run 52, S1a, Daytime, 40 km/h

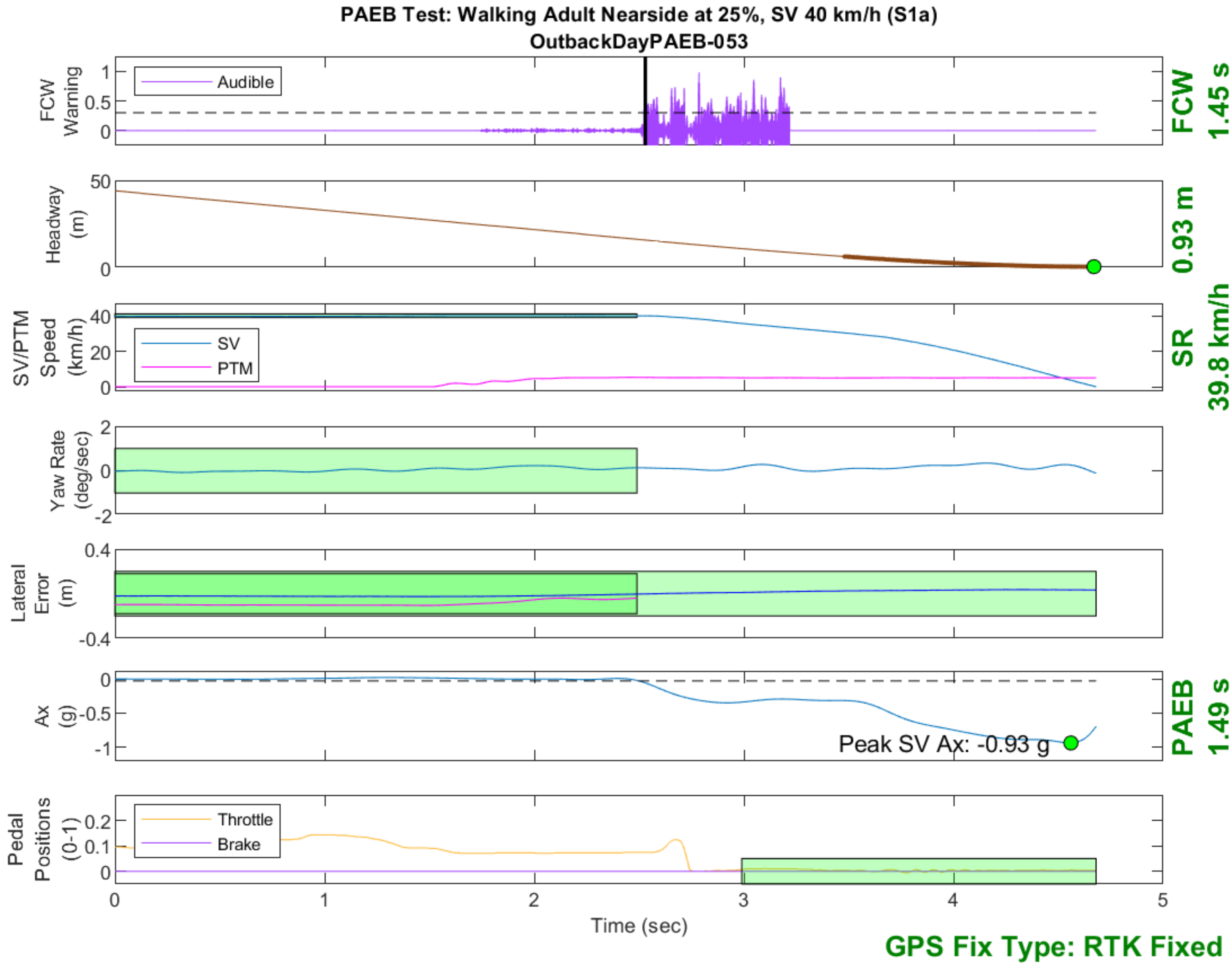


Figure D14. Time History for PAEB Run 53, S1a, Daytime, 40 km/h

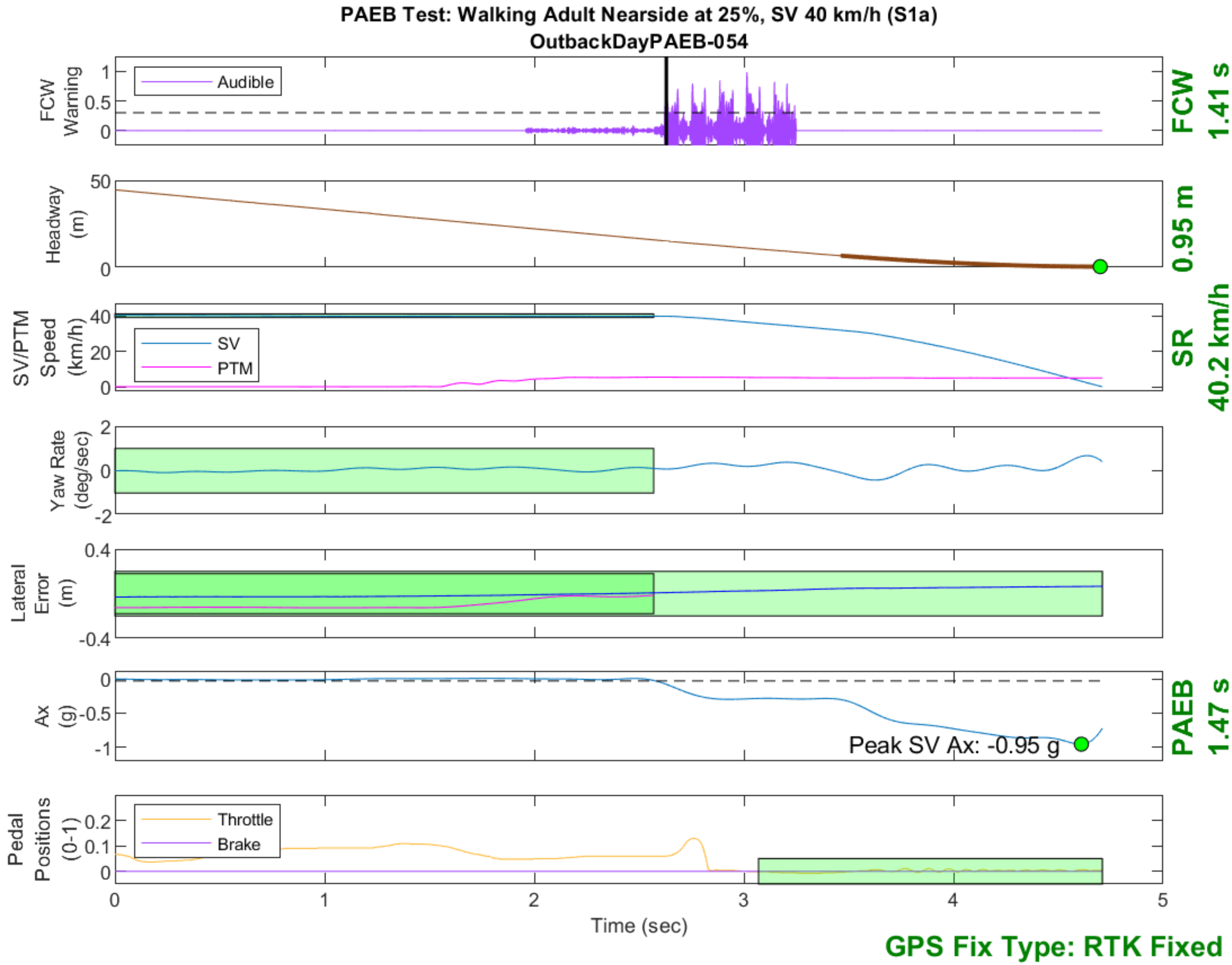


Figure D15. Time History for PAEB Run 54, S1a, Daytime, 40 km/h

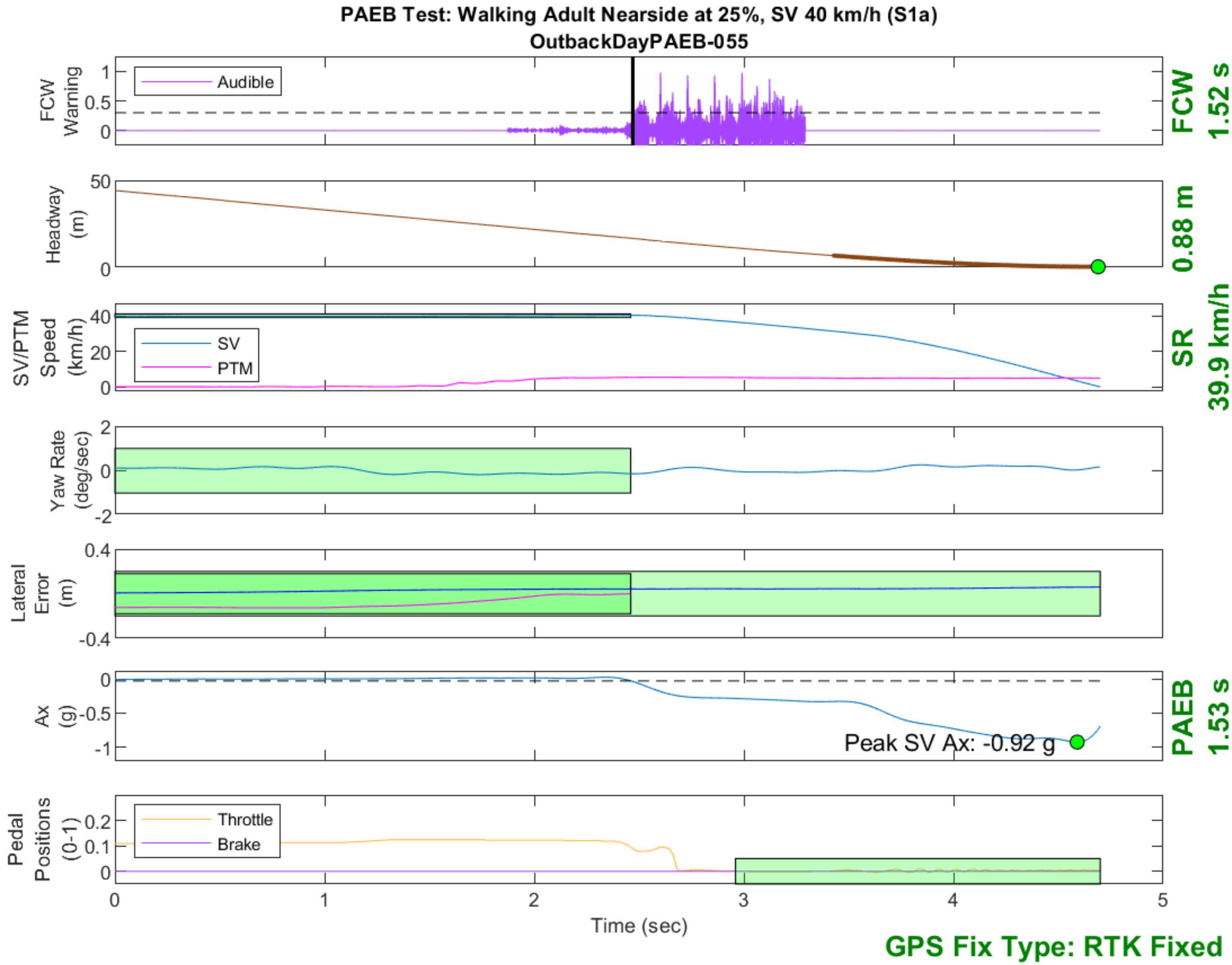


Figure D16. Time History for PAEB Run 55, S1a, Daytime, 40 km/h

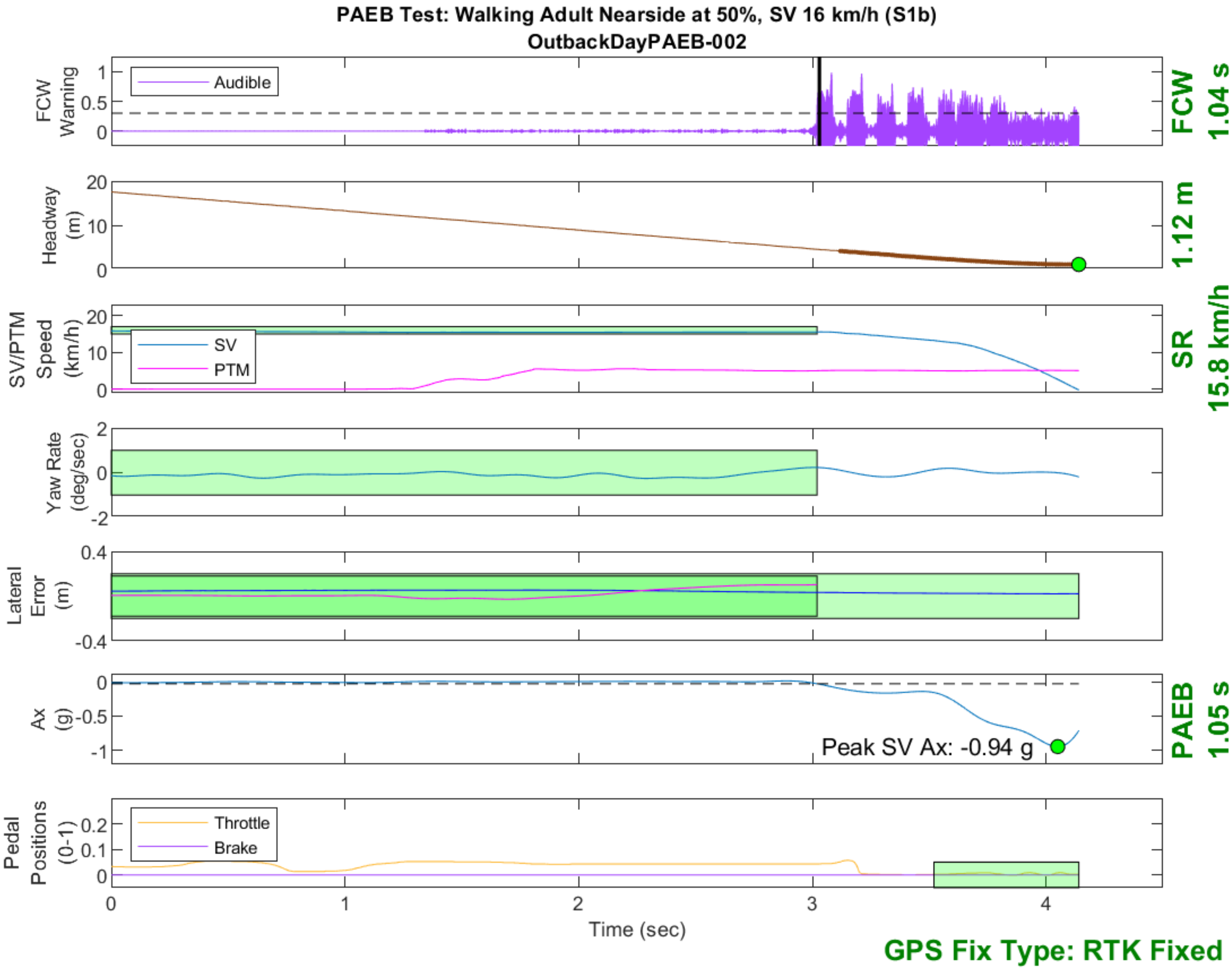


Figure D17. Time History for PAEB Run 2, S1b, Daytime, 16 km/h

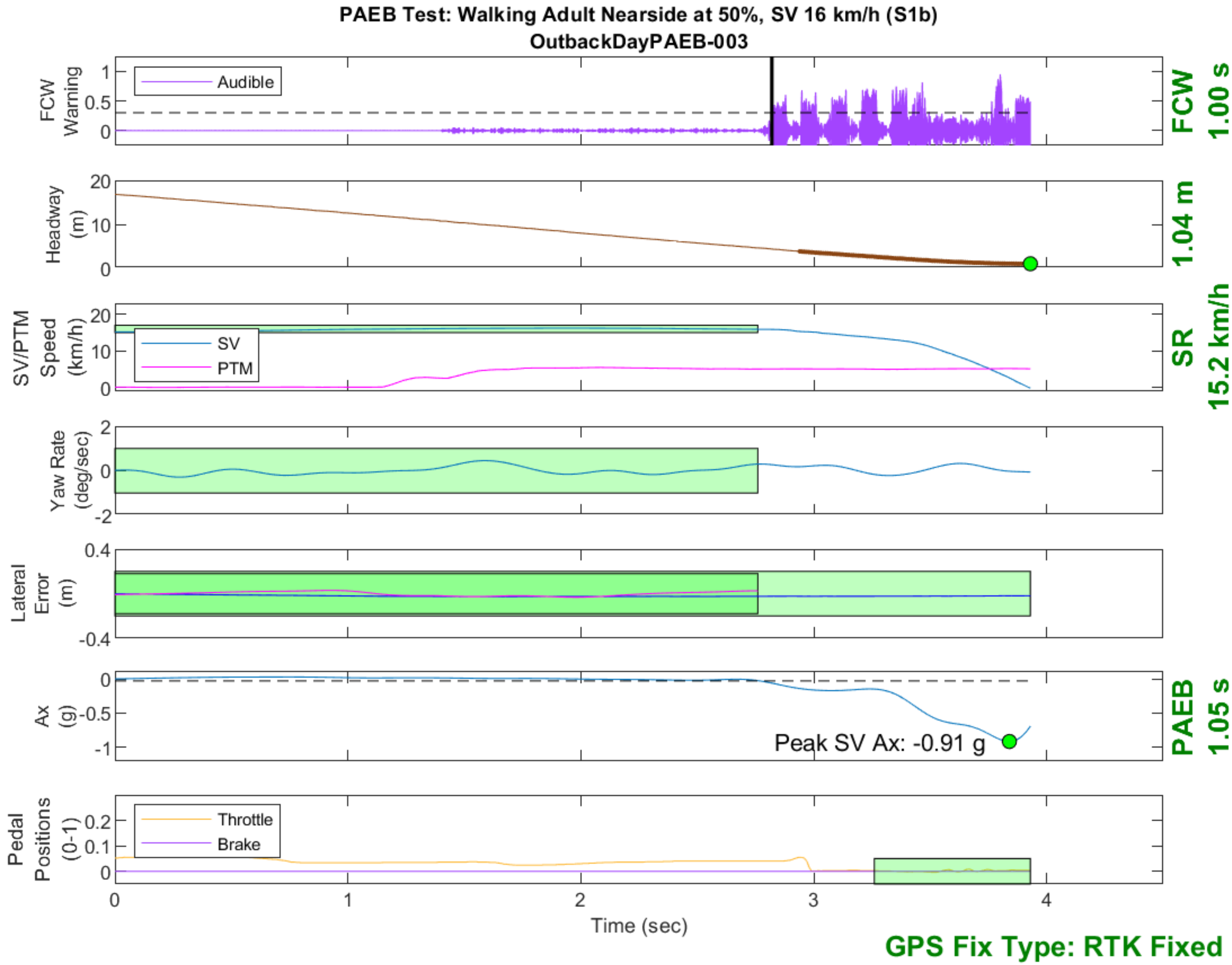


Figure D18. Time History for PAEB Run 3, S1b, Daytime, 16 km/h

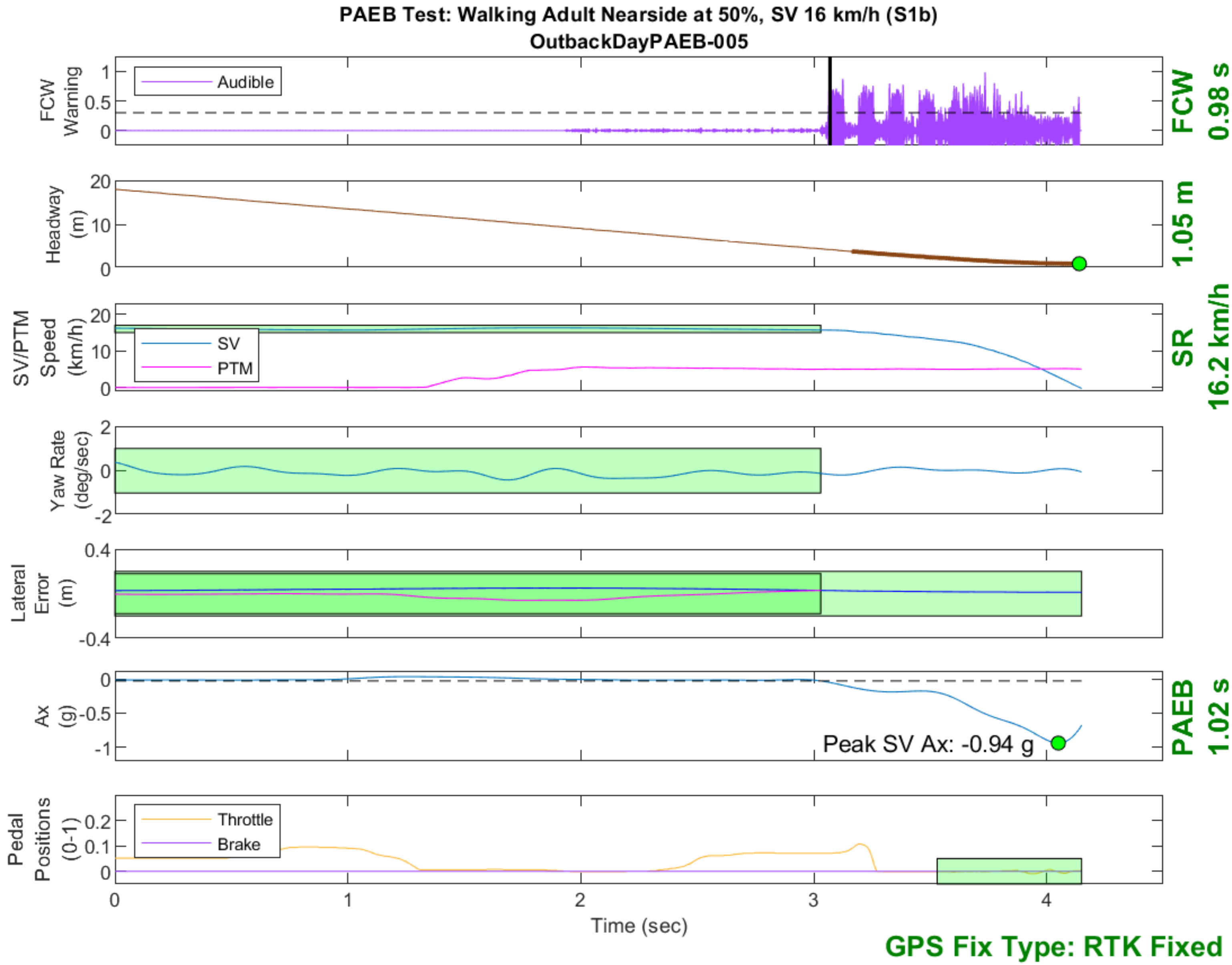


Figure D19. Time History for PAEB Run 5, S1b, Daytime, 16 km/h

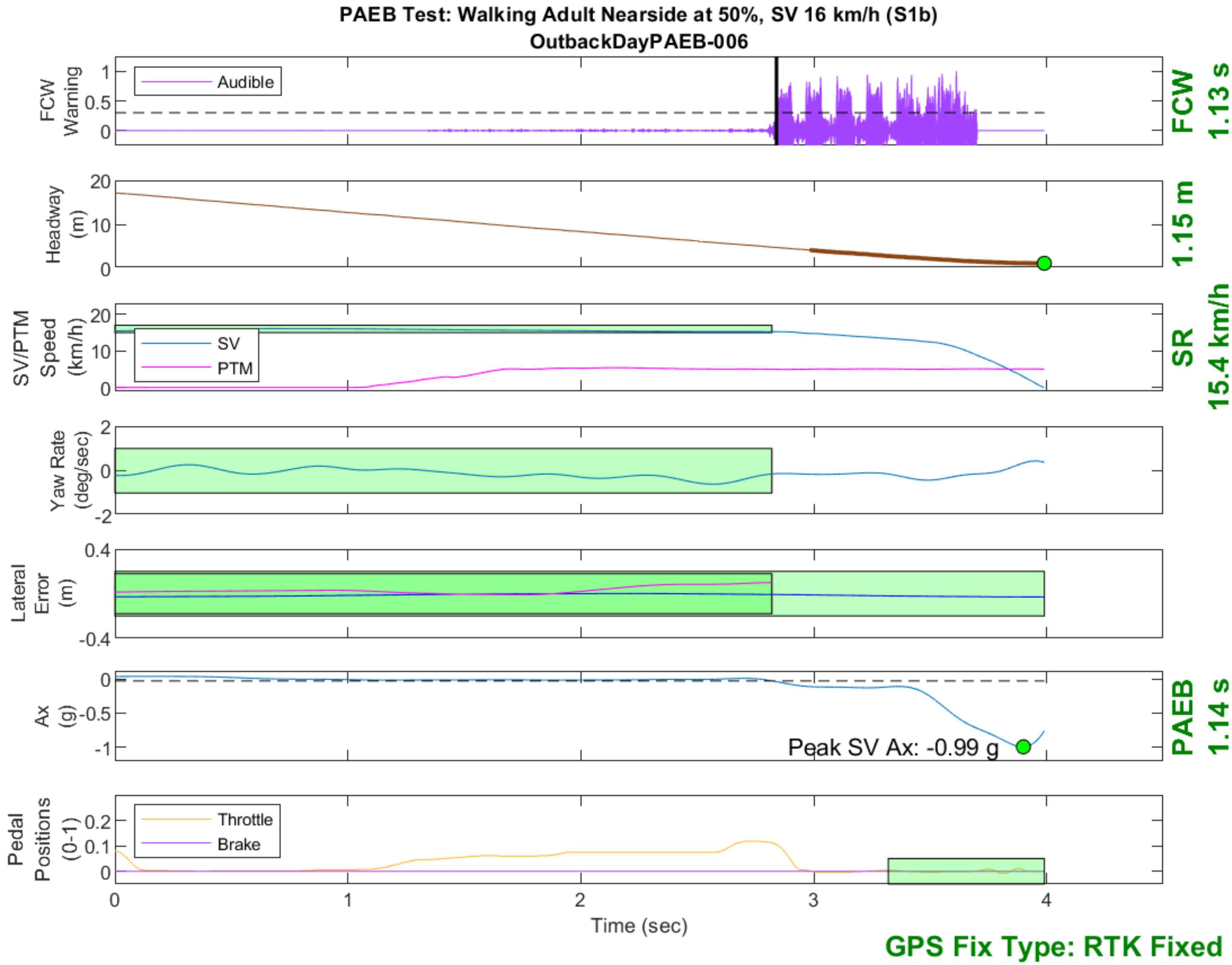


Figure D20. Time History for PAEB Run 6, S1b, Daytime, 16 km/h

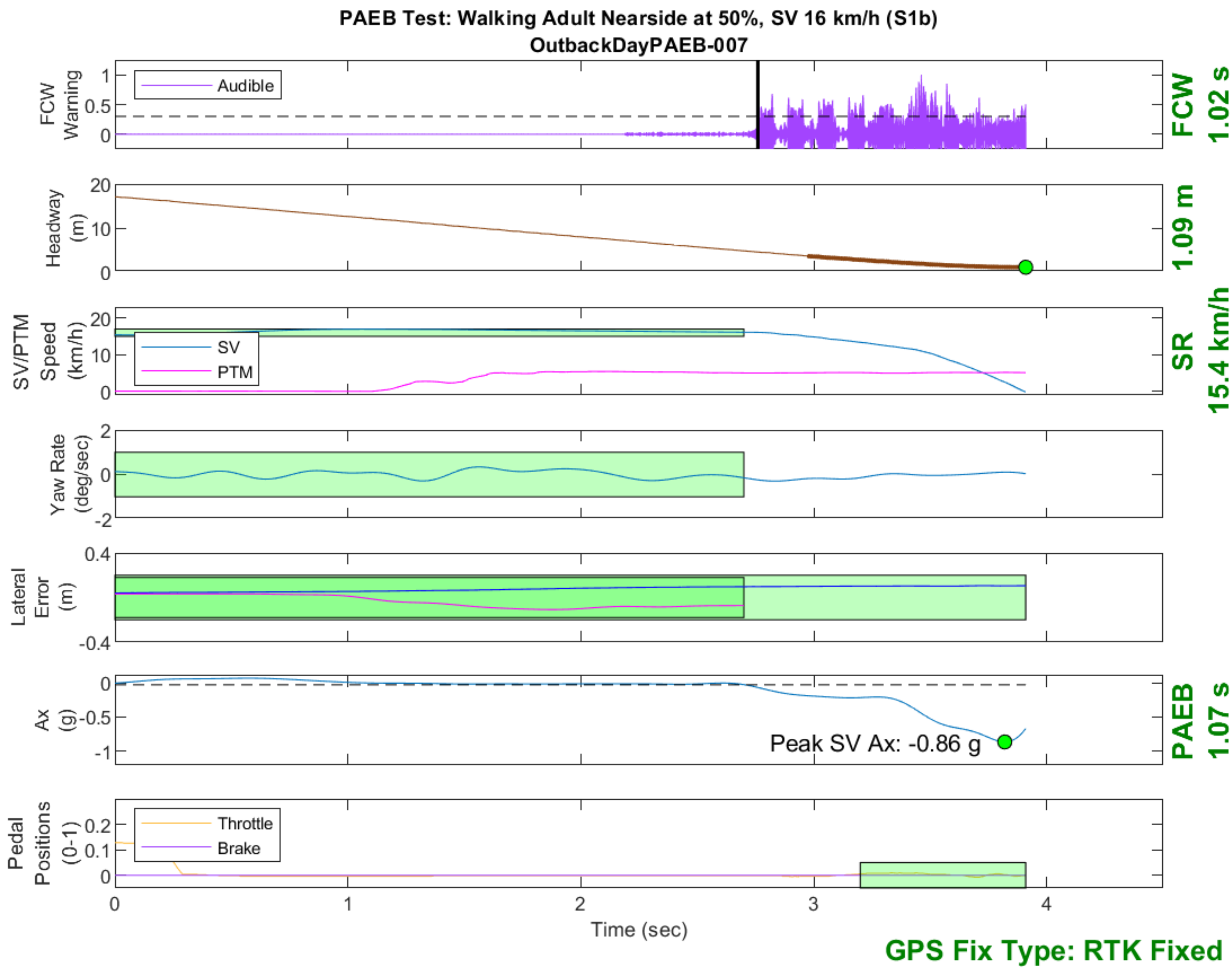


Figure D21. Time History for PAEB Run 7, S1b, Daytime, 16 km/h

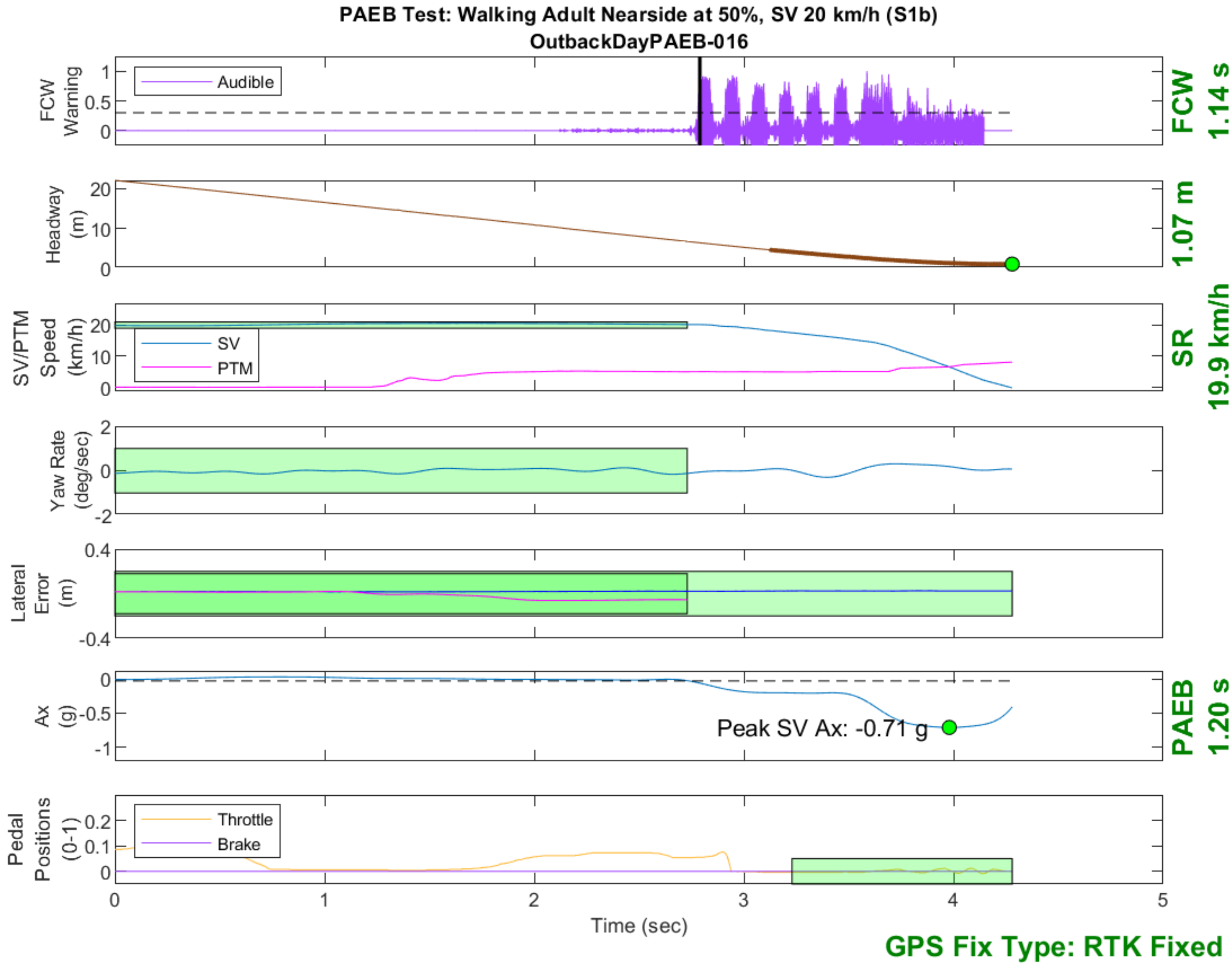


Figure D22. Time History for PAEB Run 16, S1b, Daytime, 20 km/h

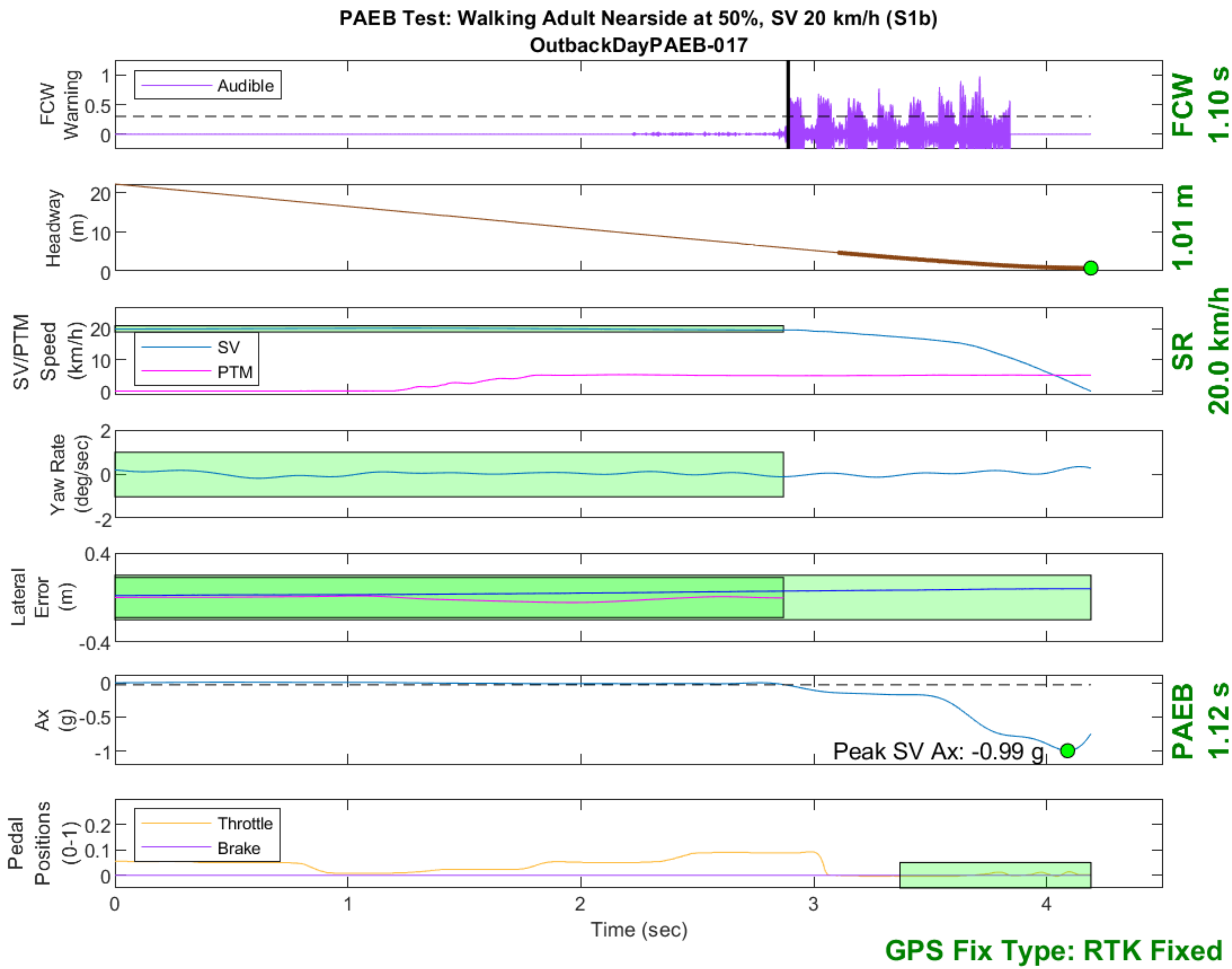


Figure D23. Time History for PAEB Run 17, S1b, Daytime, 20 km/h

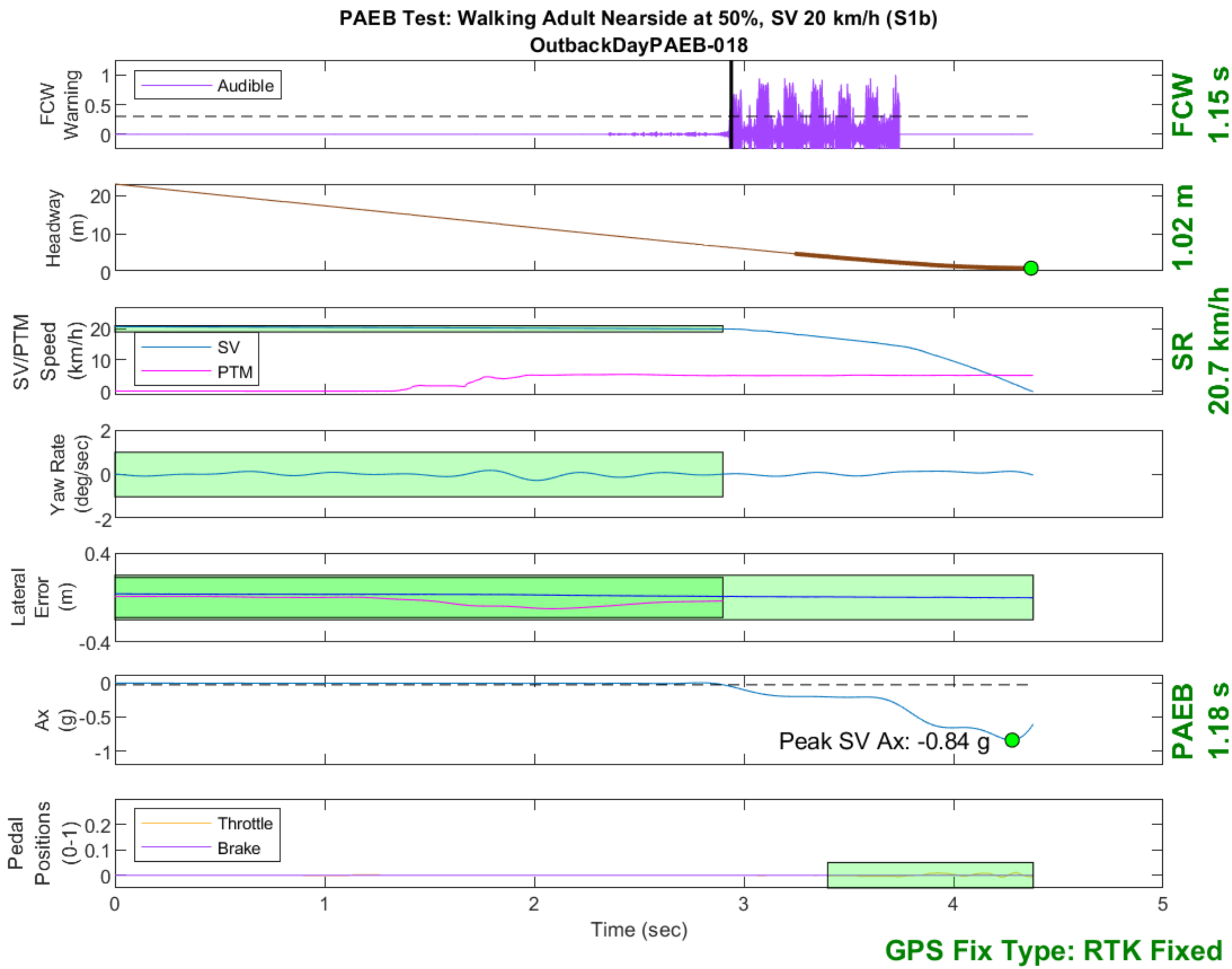


Figure D24. Time History for PAEB Run 18, S1b, Daytime, 20 km/h

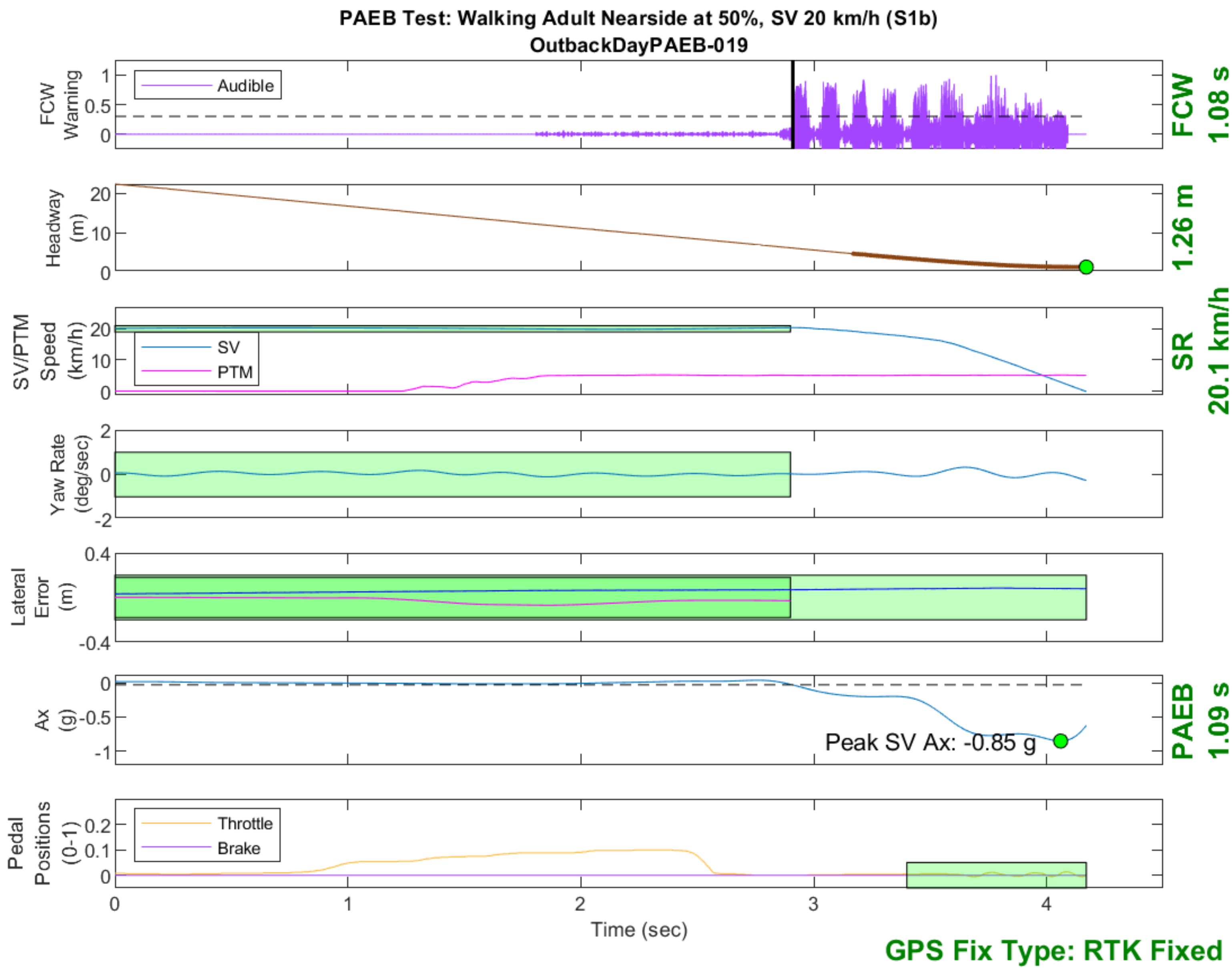


Figure D25. Time History for PAEB Run 19, S1b, Daytime, 20 km/h

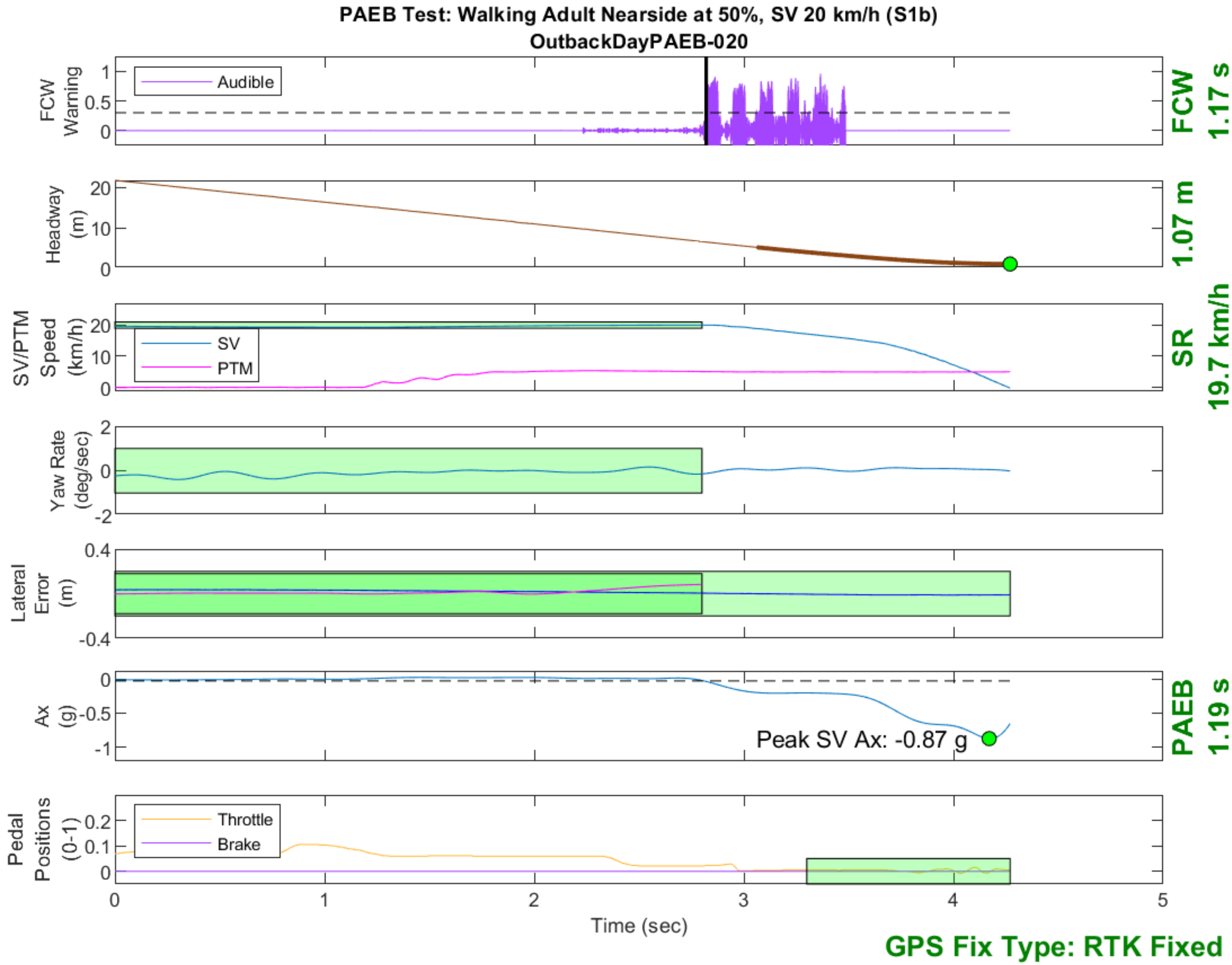


Figure D26. Time History for PAEB Run 20, S1b, Daytime, 20 km/h

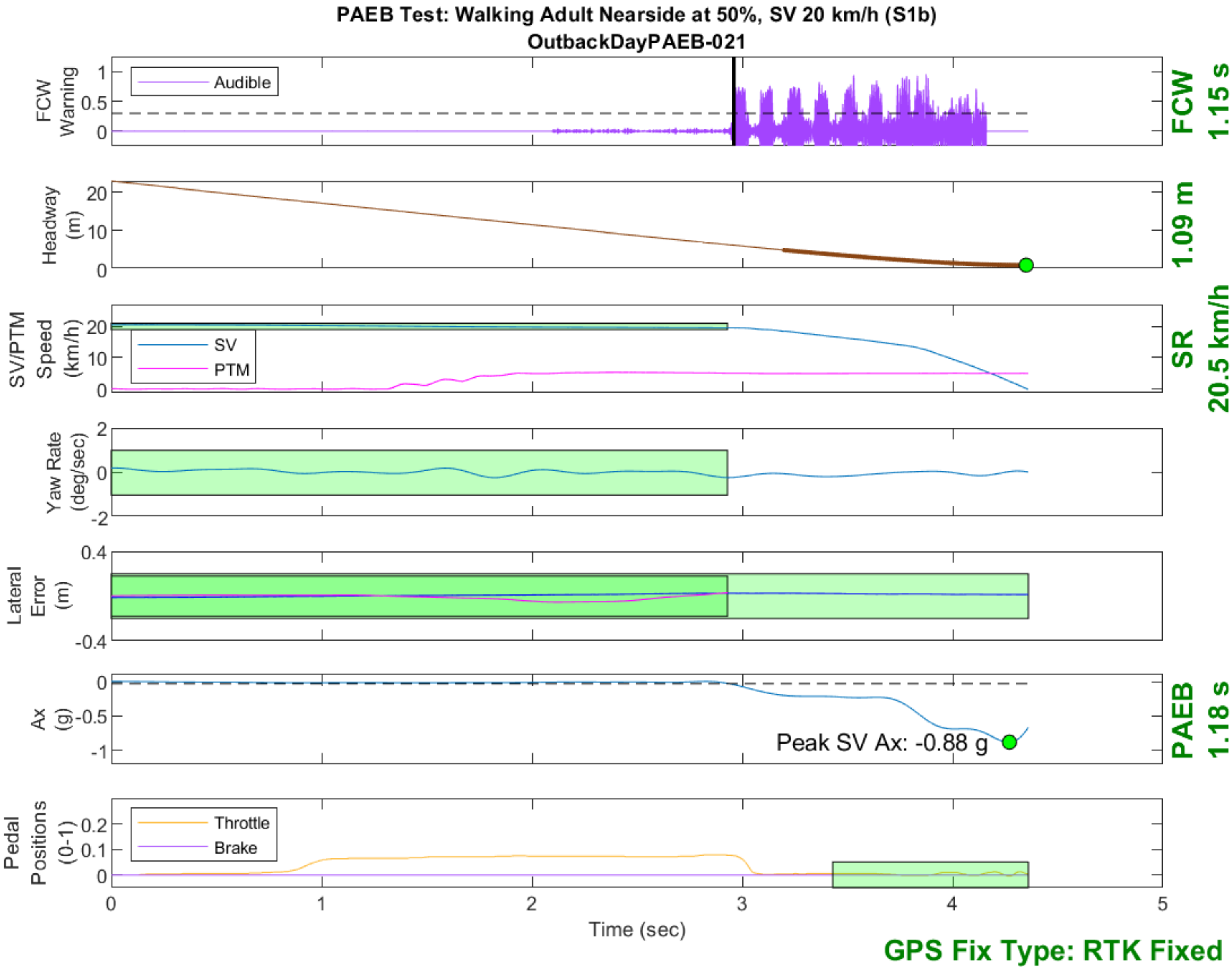


Figure D27. Time History for PAEB Run 21, S1b, Daytime, 20 km/h

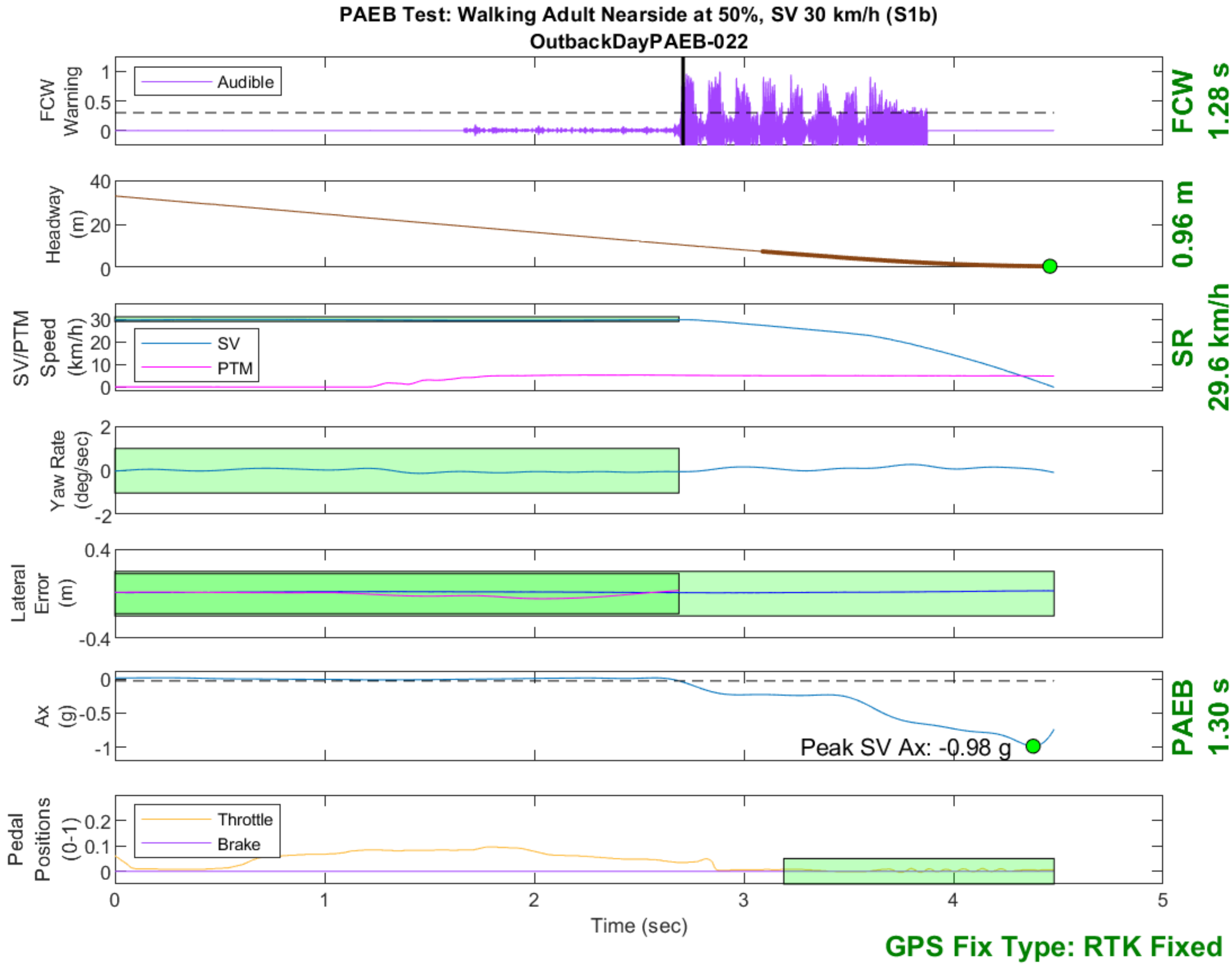


Figure D28. Time History for PAEB Run 22, S1b, Daytime, 30 km/h

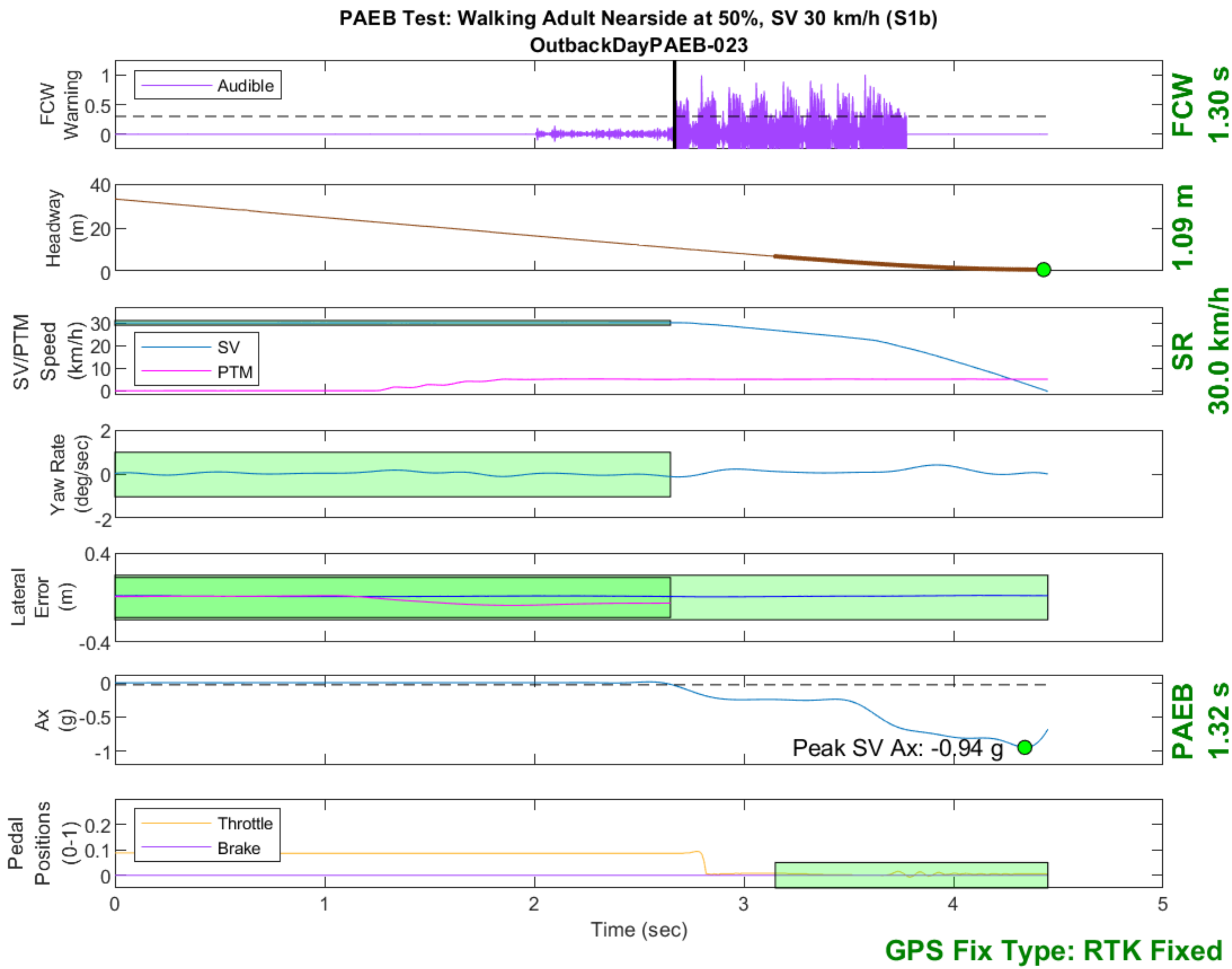


Figure D29. Time History for PAEB Run 23, S1b, Daytime, 30 km/h

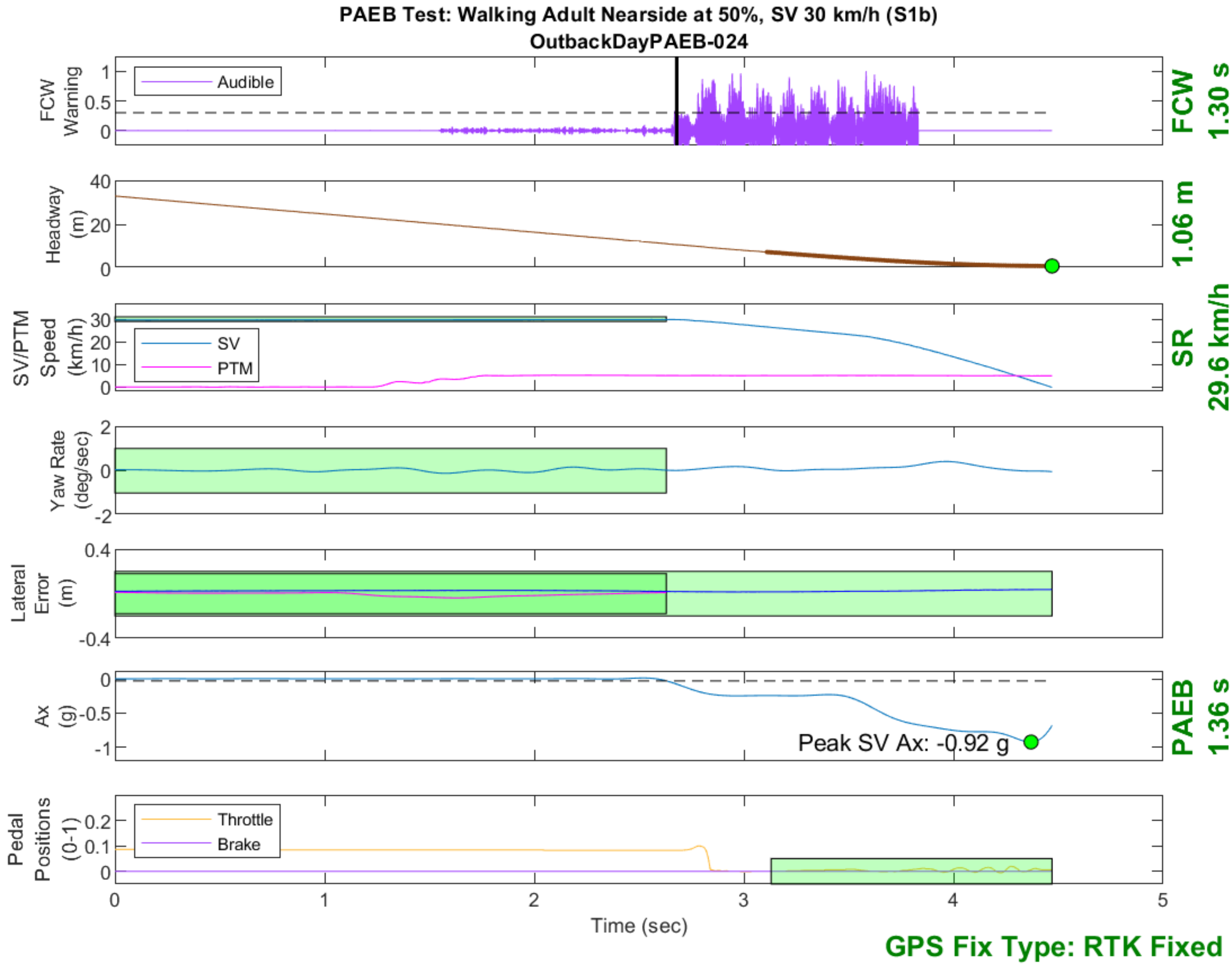


Figure D30. Time History for PAEB Run 24, S1b, Daytime, 30 km/h

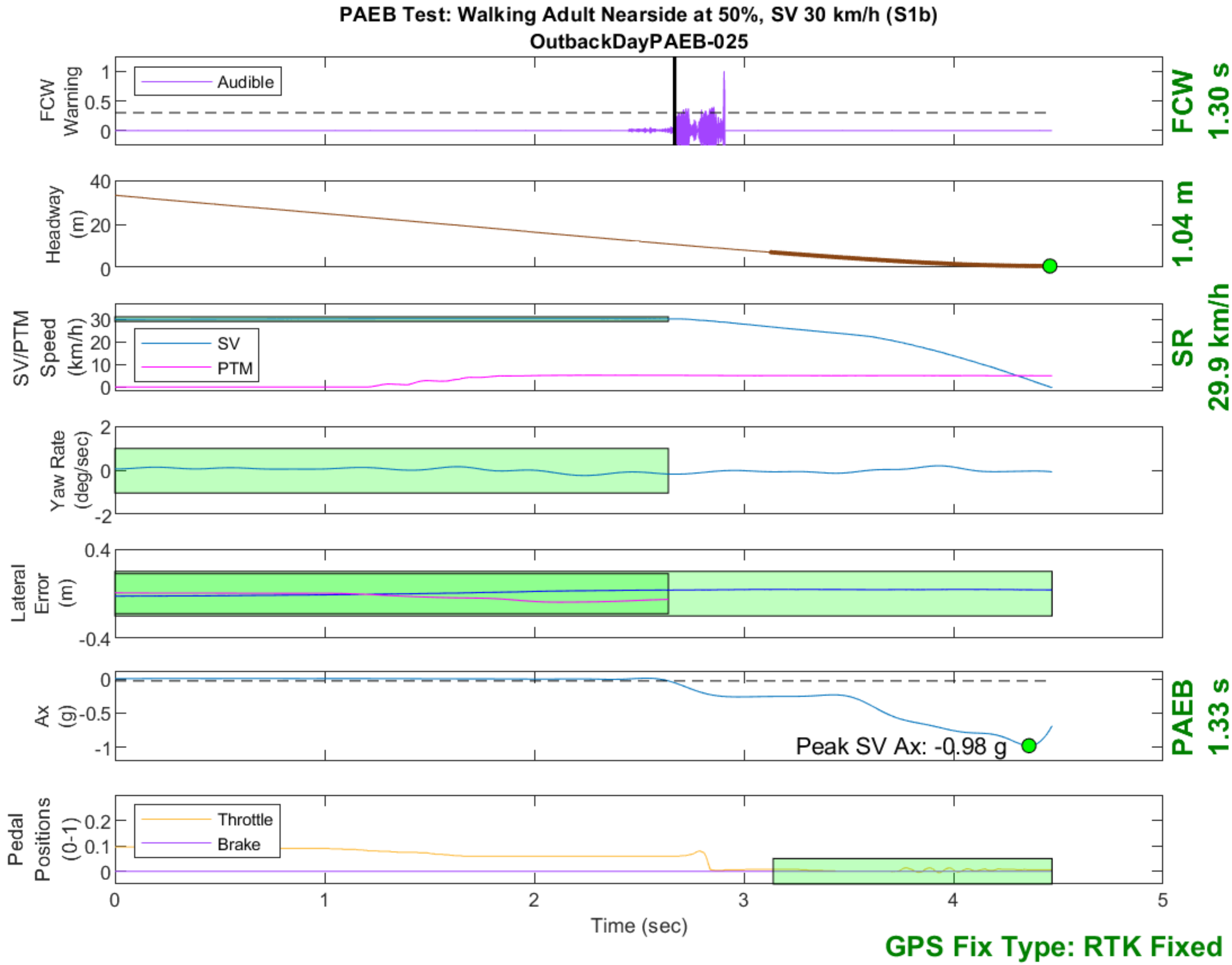


Figure D31. Time History for PAEB Run 25, S1b, Daytime, 30 km/h

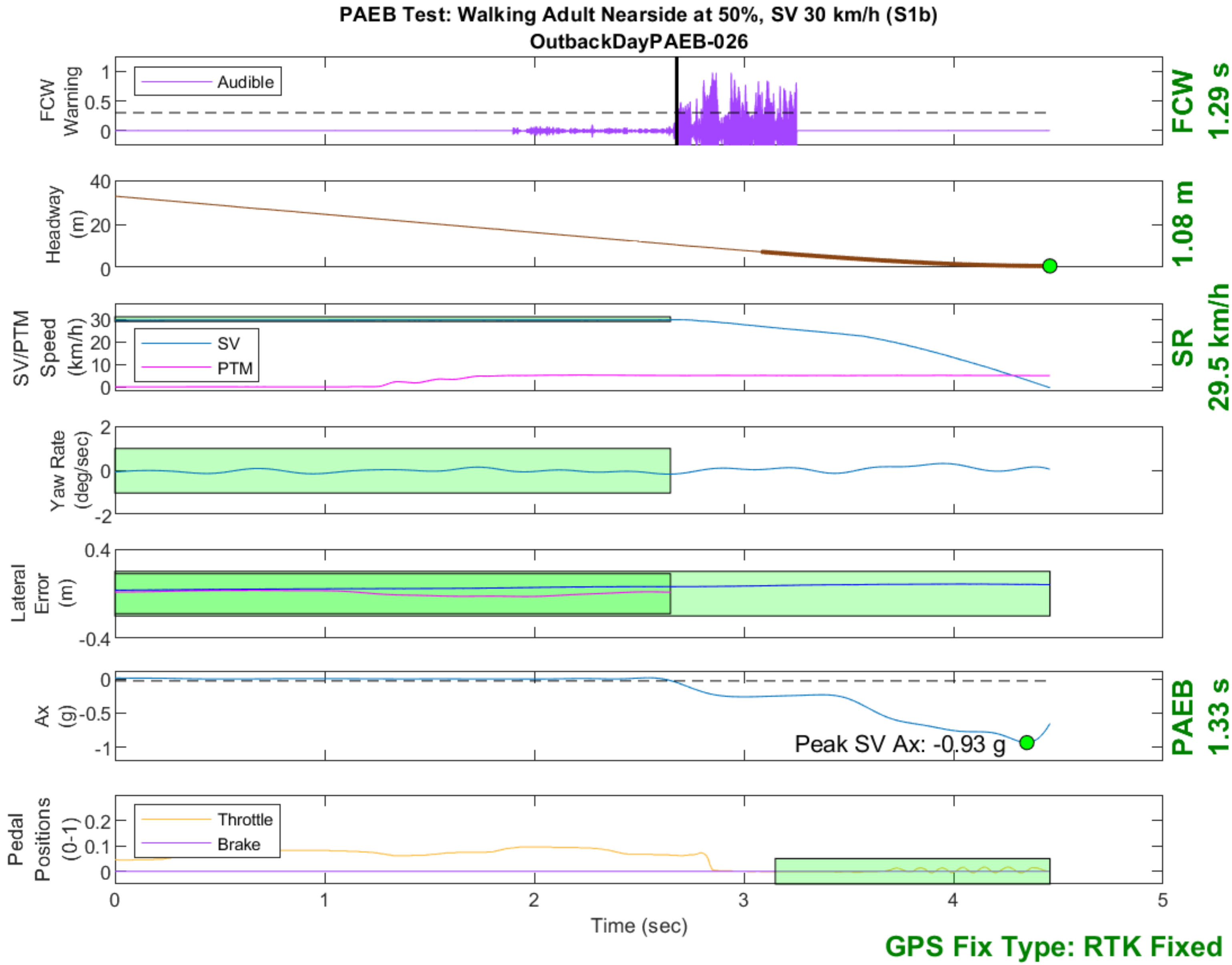


Figure D32. Time History for PAEB Run 26, S1b, Daytime, 30 km/h

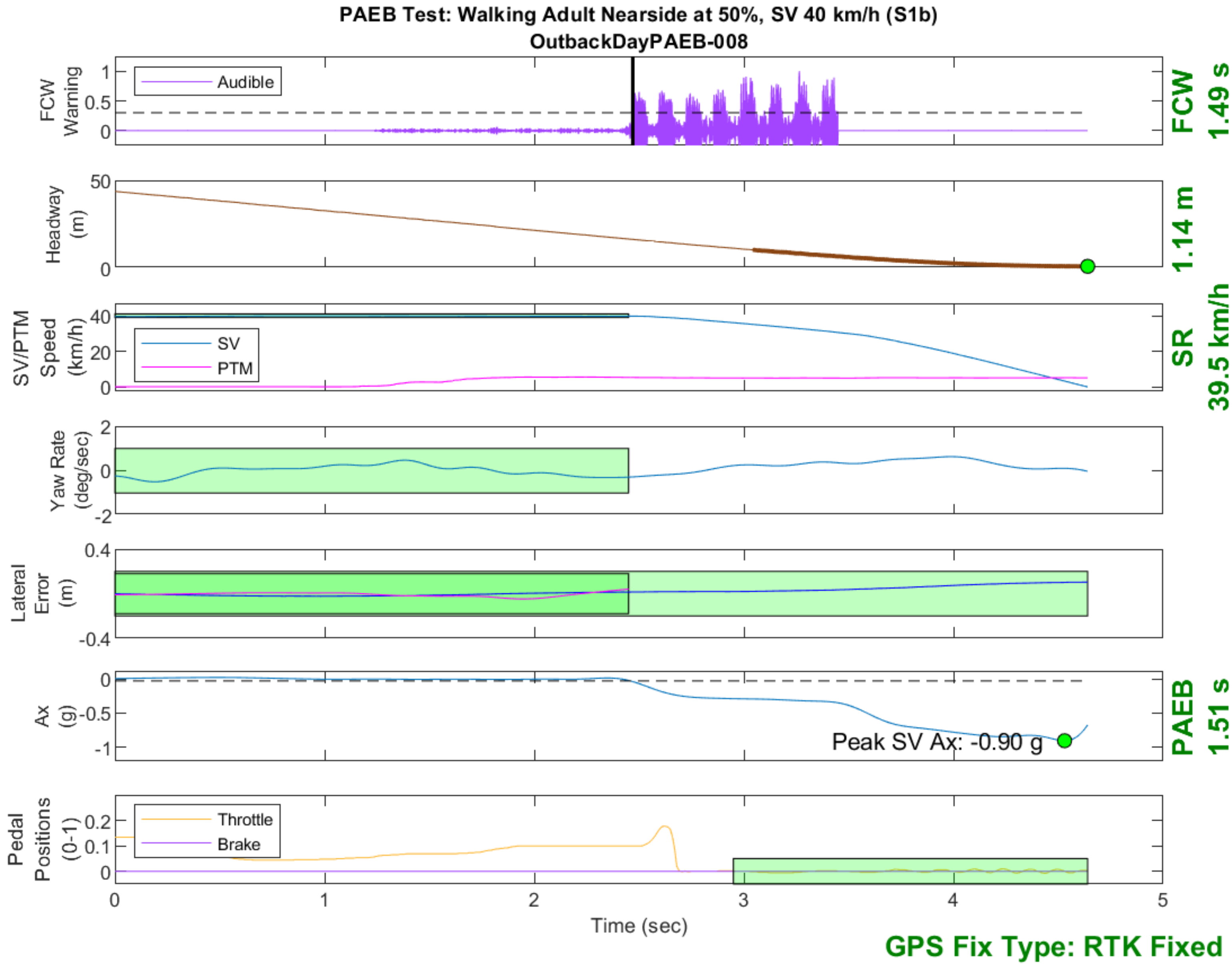


Figure D33. Time History for PAEB Run 8, S1b, Daytime, 40 km/h

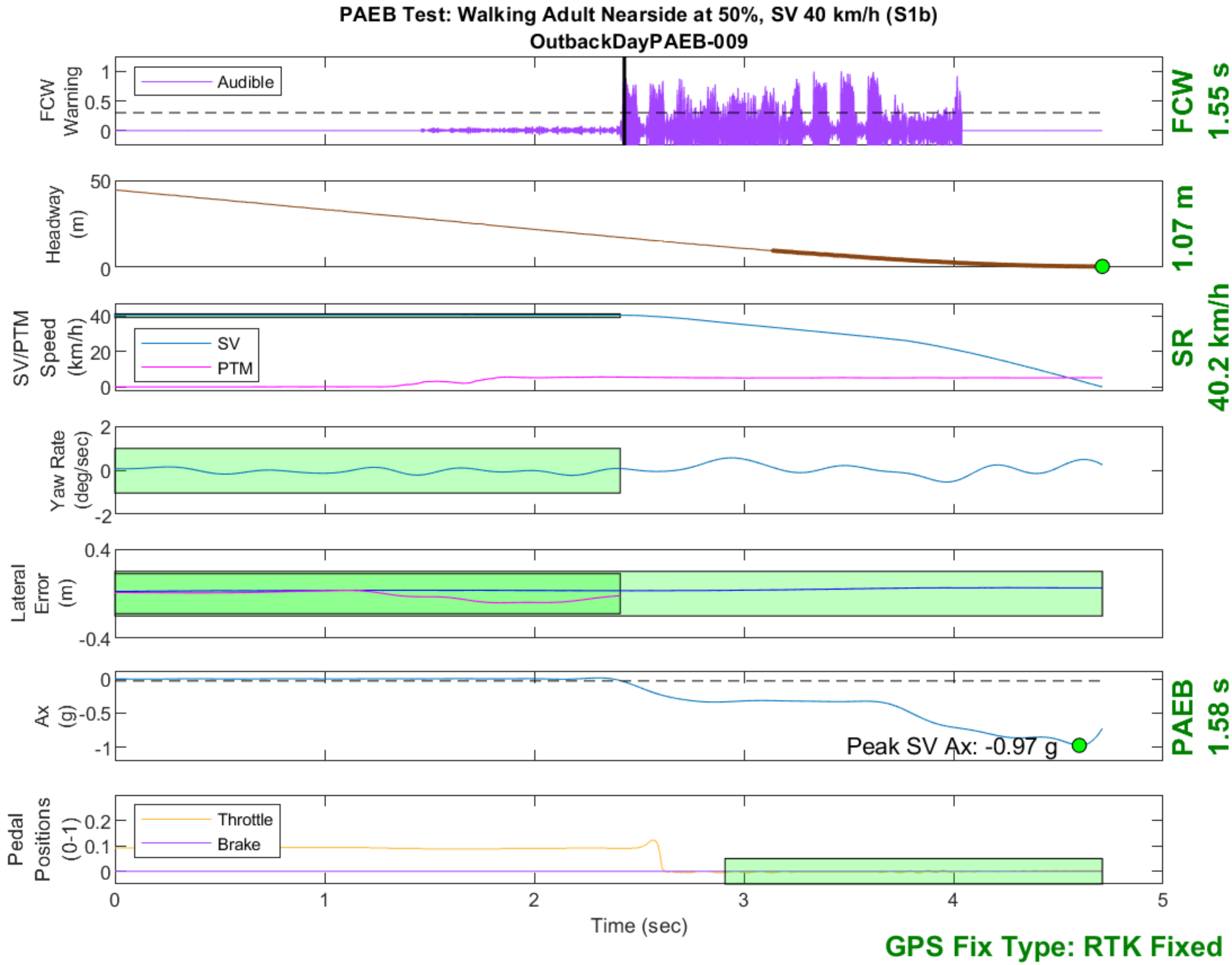


Figure D34. Time History for PAEB Run 9, S1b, Daytime, 40 km/h

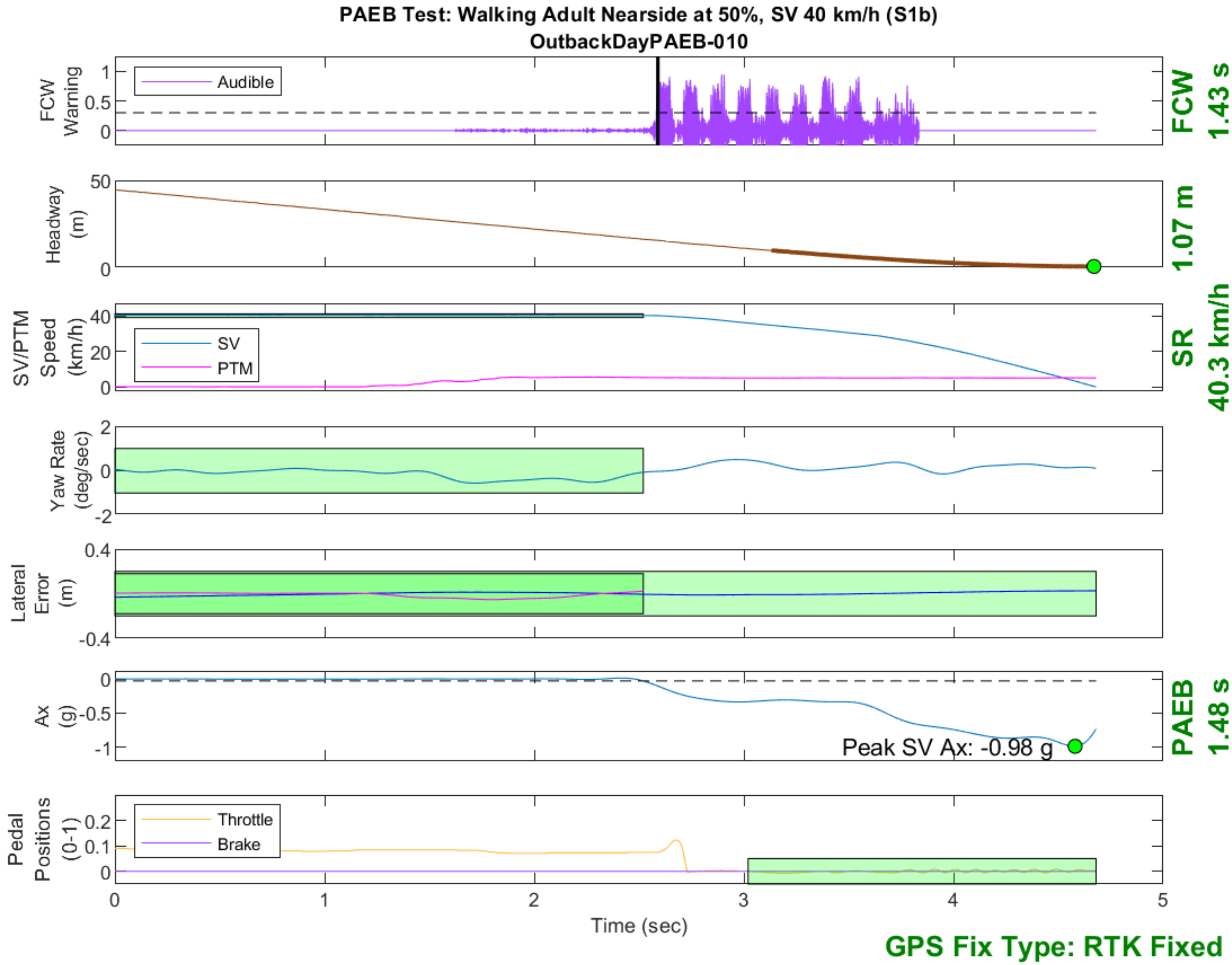


Figure D35. Time History for PAEB Run 10, S1b, Daytime, 40 km/h

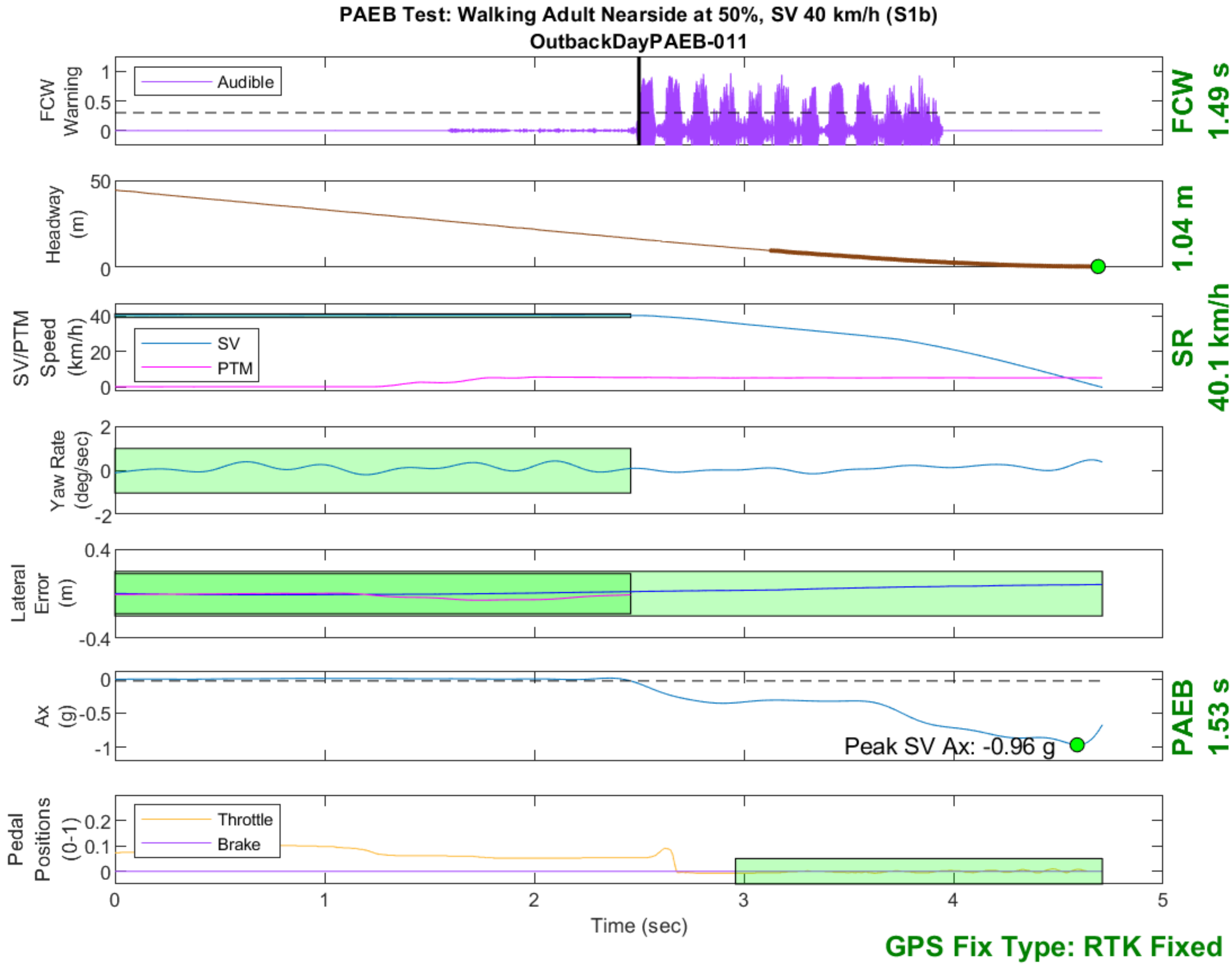


Figure D36. Time History for PAEB Run 11, S1b, Daytime, 40 km/h

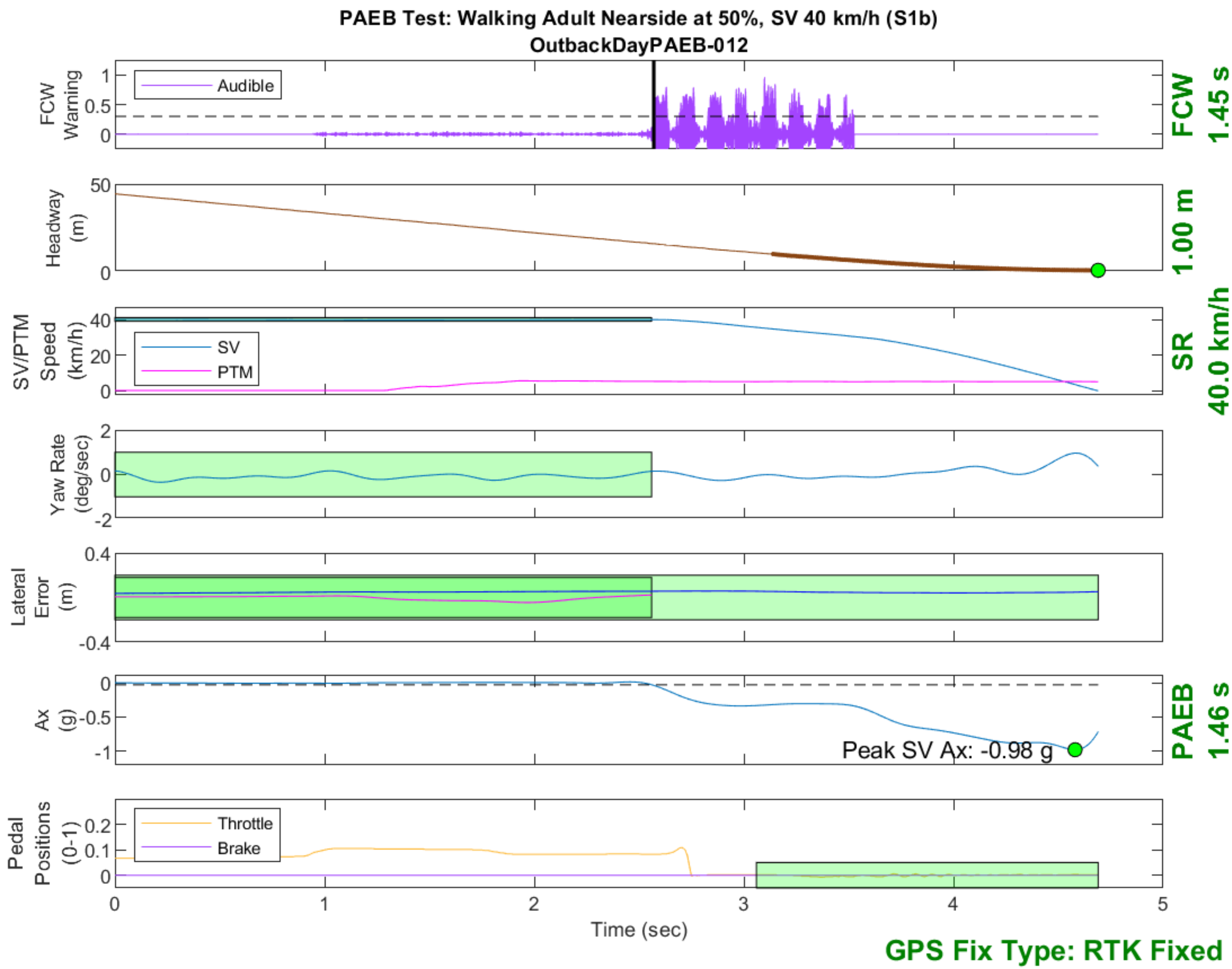


Figure D37. Time History for PAEB Run 12, S1b, Daytime, 40 km/h

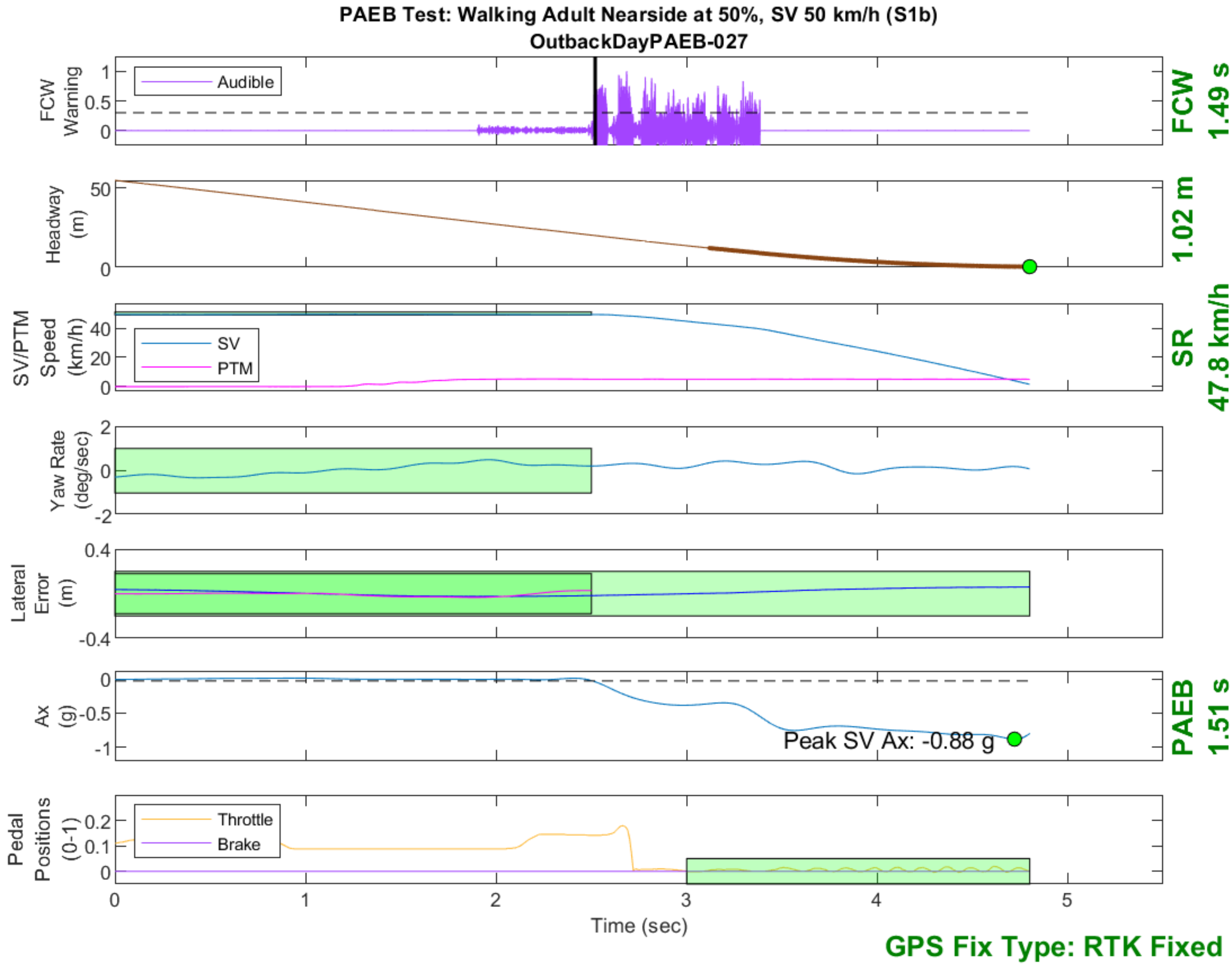


Figure D38. Time History for PAEB Run 27, S1b, Daytime, 50 km/h

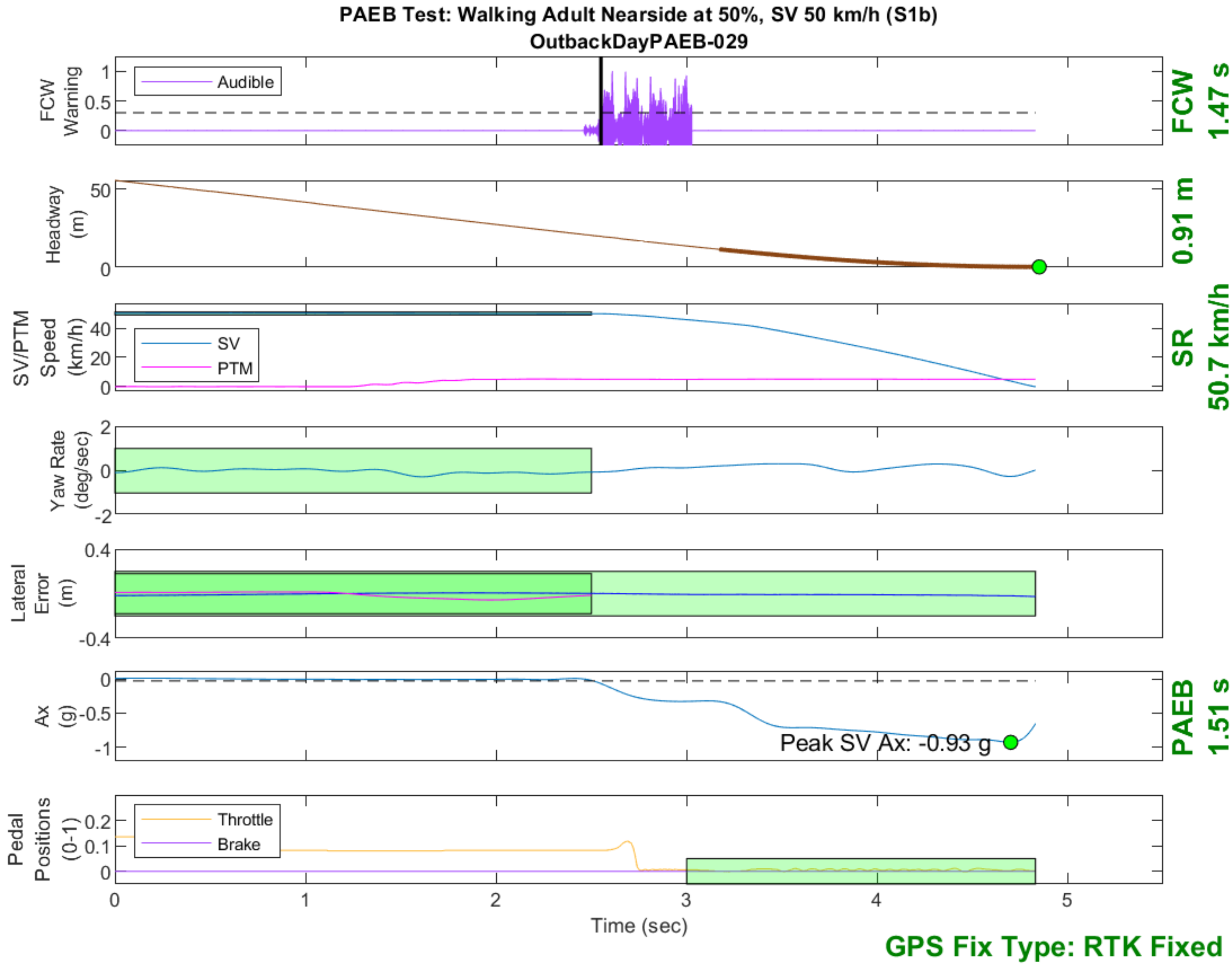


Figure D39. Time History for PAEB Run 29, S1b, Daytime, 50 km/h

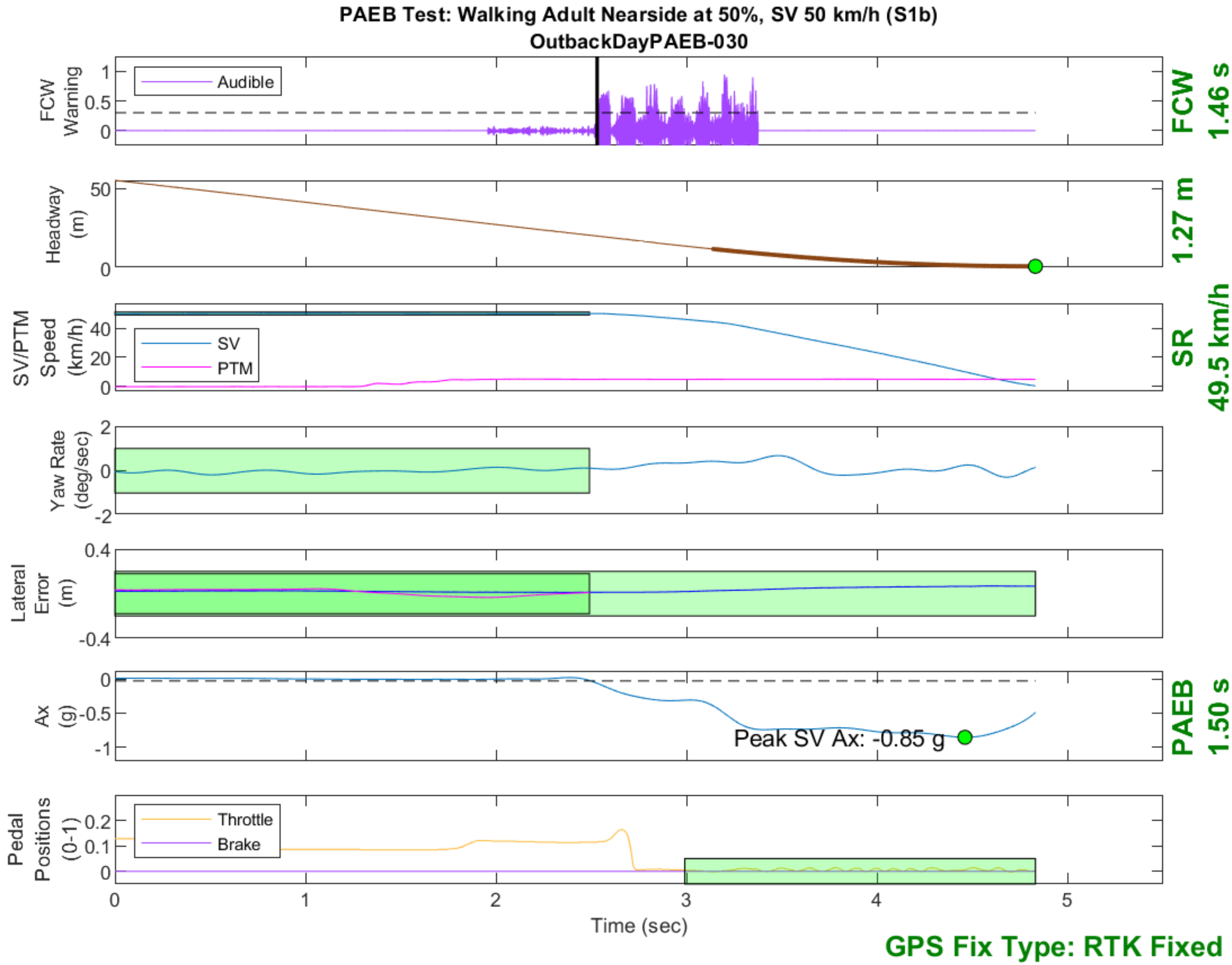


Figure D40. Time History for PAEB Run 30, S1b, Daytime, 50 km/h

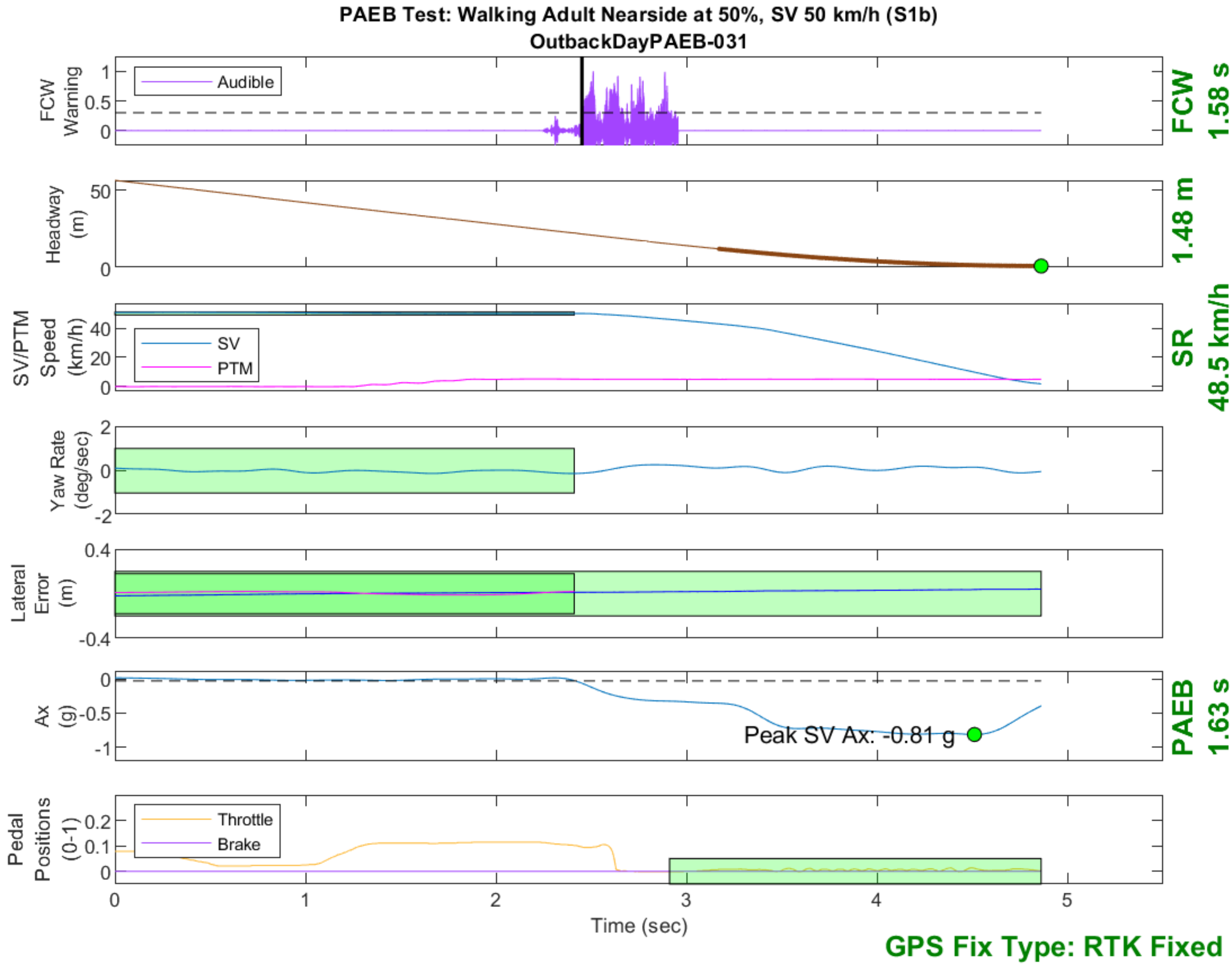


Figure D41. Time History for PAEB Run 31, S1b, Daytime, 50 km/h

Figure D42. Time History for PAEB Run 32, S1b, Daytime, 50 km/h

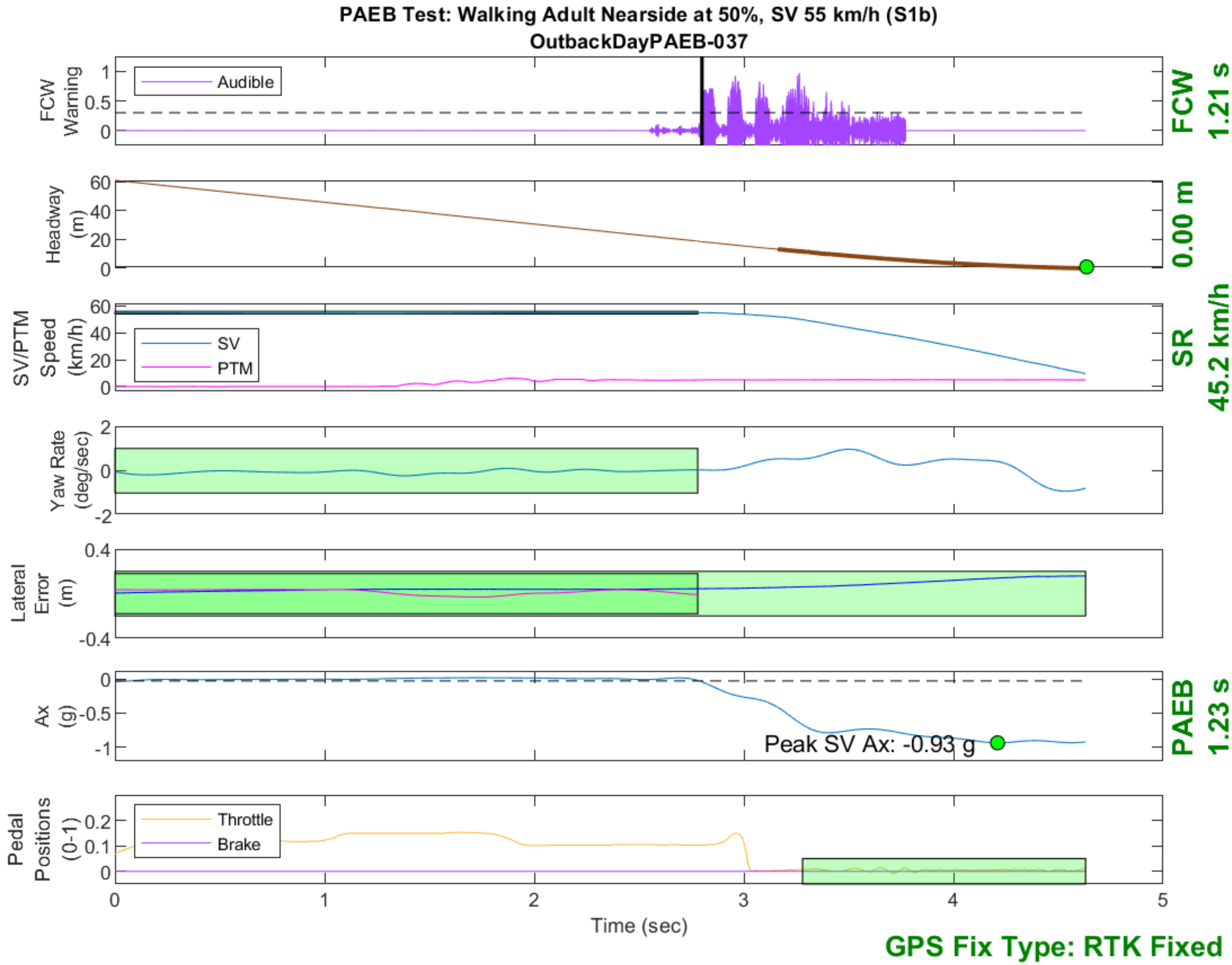


Figure D43. Time History for PAEB Run 37, S1b, Daytime, 55 km/h

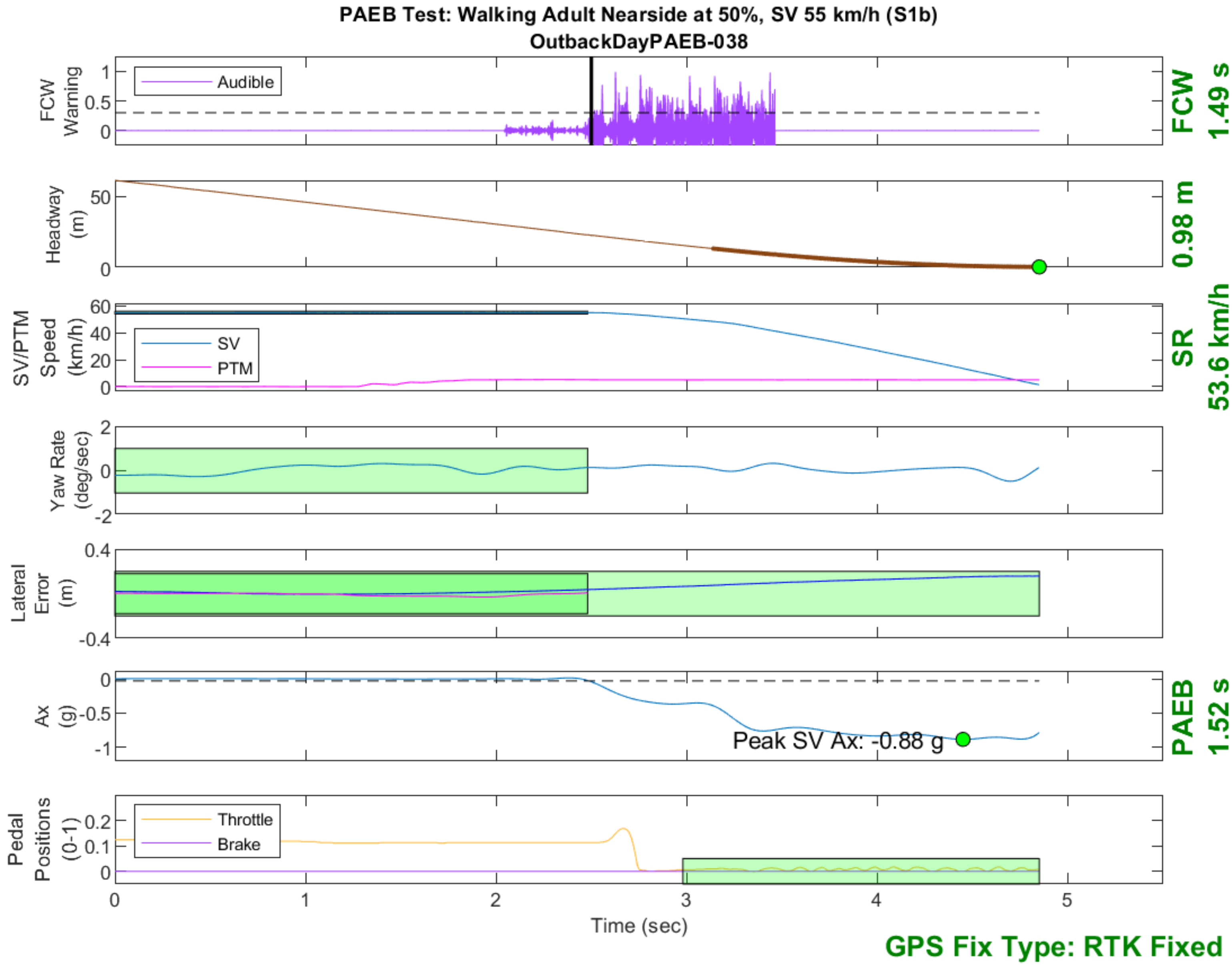


Figure D44. Time History for PAEB Run 38, S1b, Daytime, 55 km/h

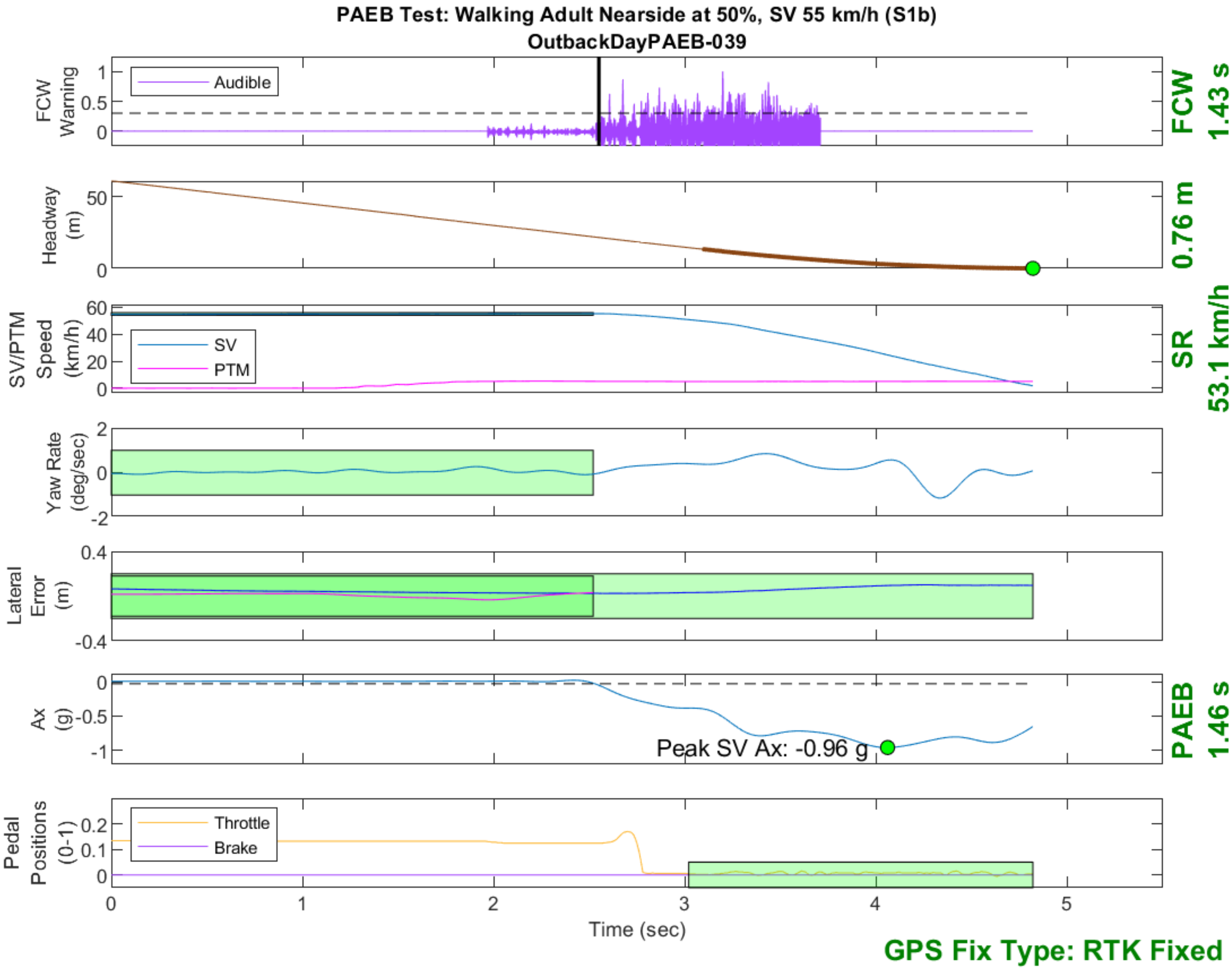


Figure D45. Time History for PAEB Run 39, S1b, Daytime, 55 km/h

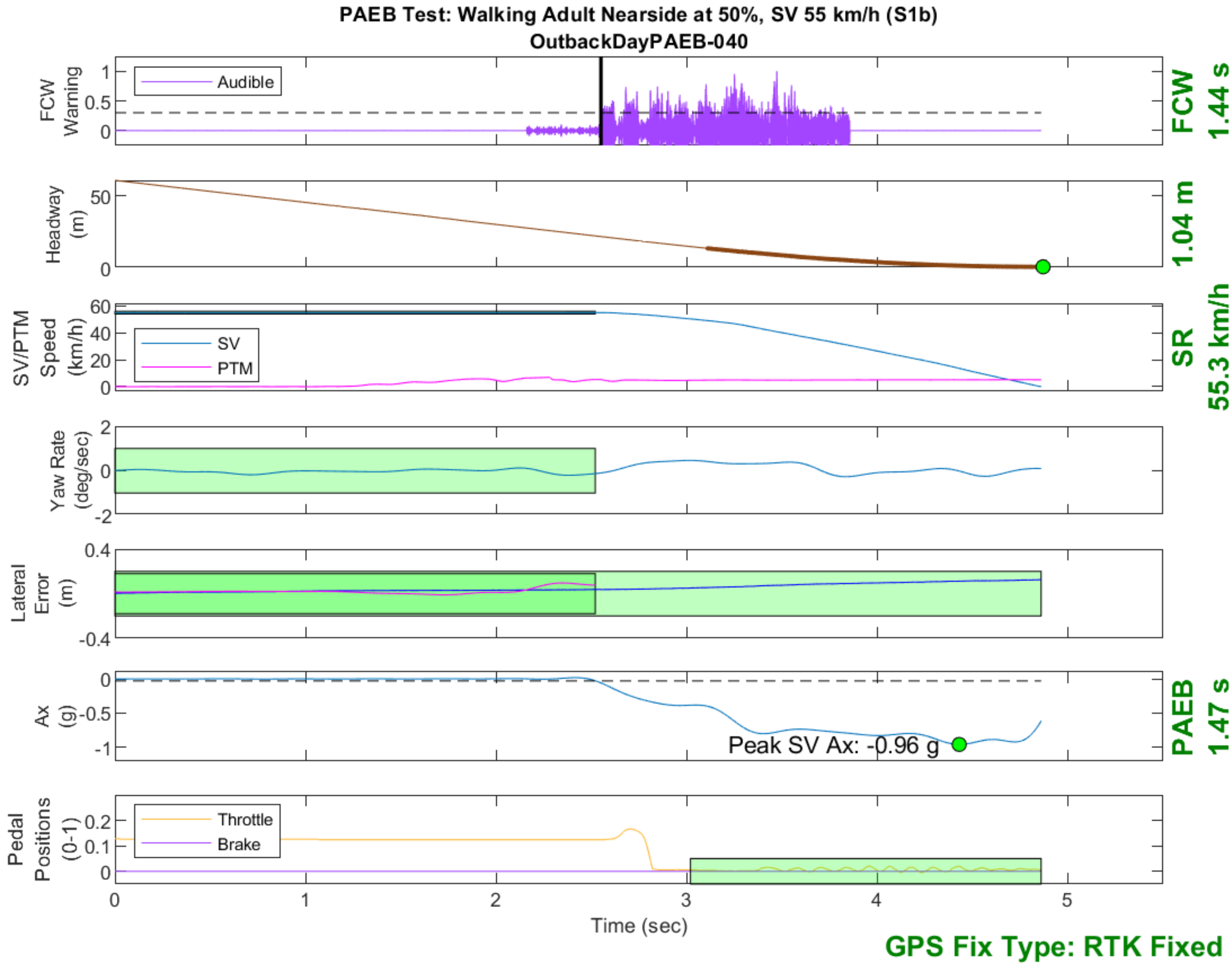


Figure D46. Time History for PAEB Run 40, S1b, Daytime, 55 km/h

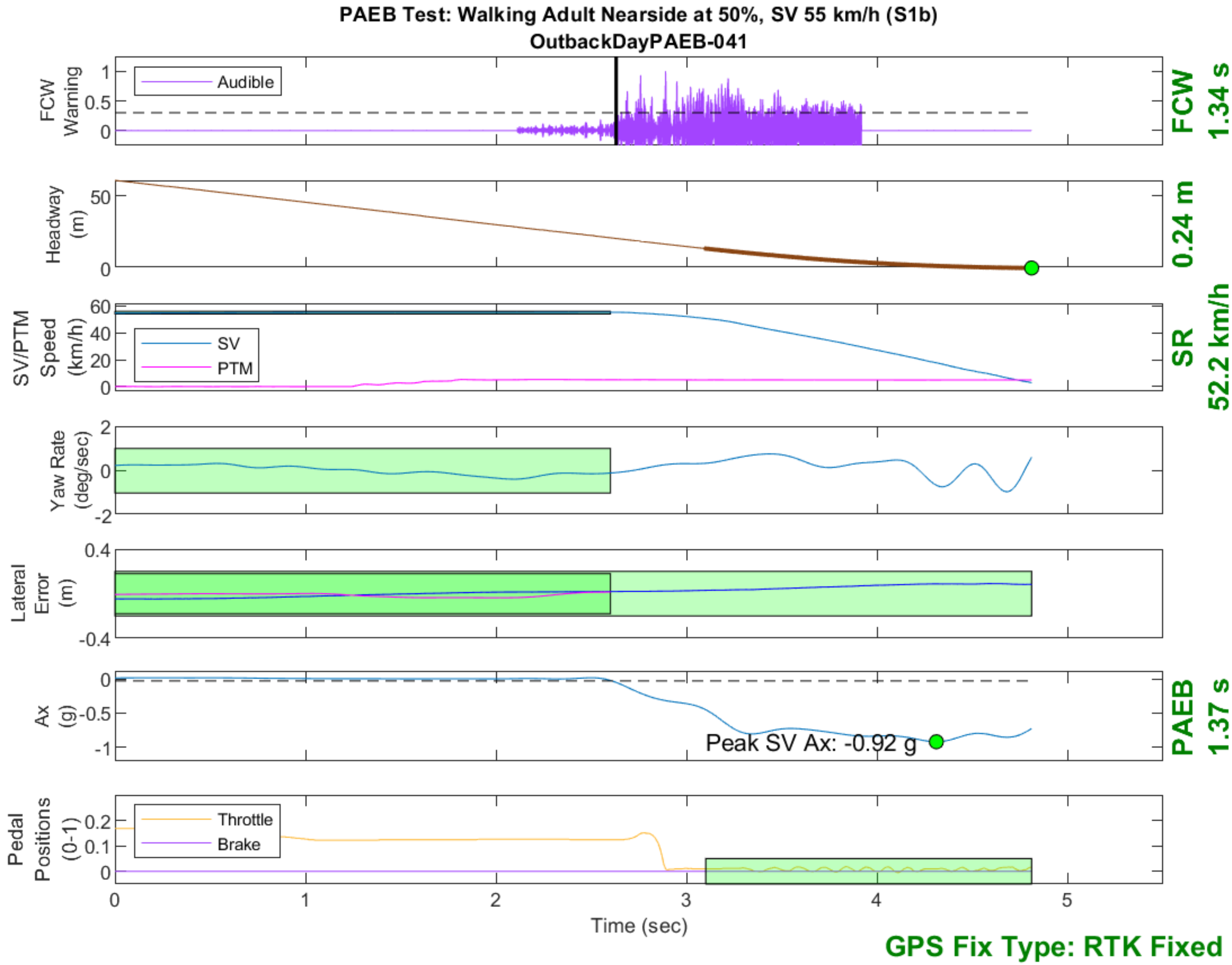


Figure D47. Time History for PAEB Run 41, S1b, Daytime, 55 km/h

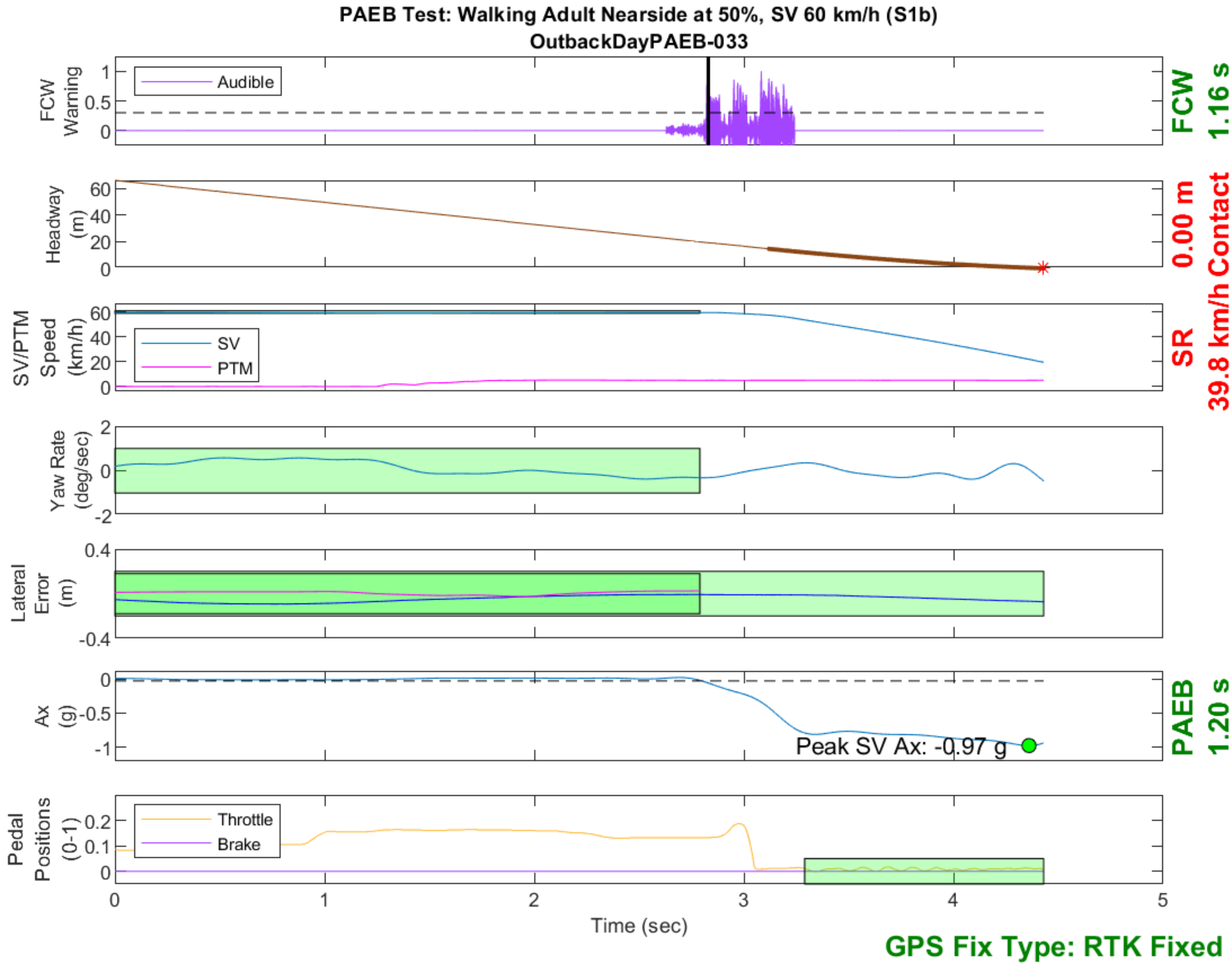


Figure D48. Time History for PAEB Run 33, S1b, Daytime, 60 km/h

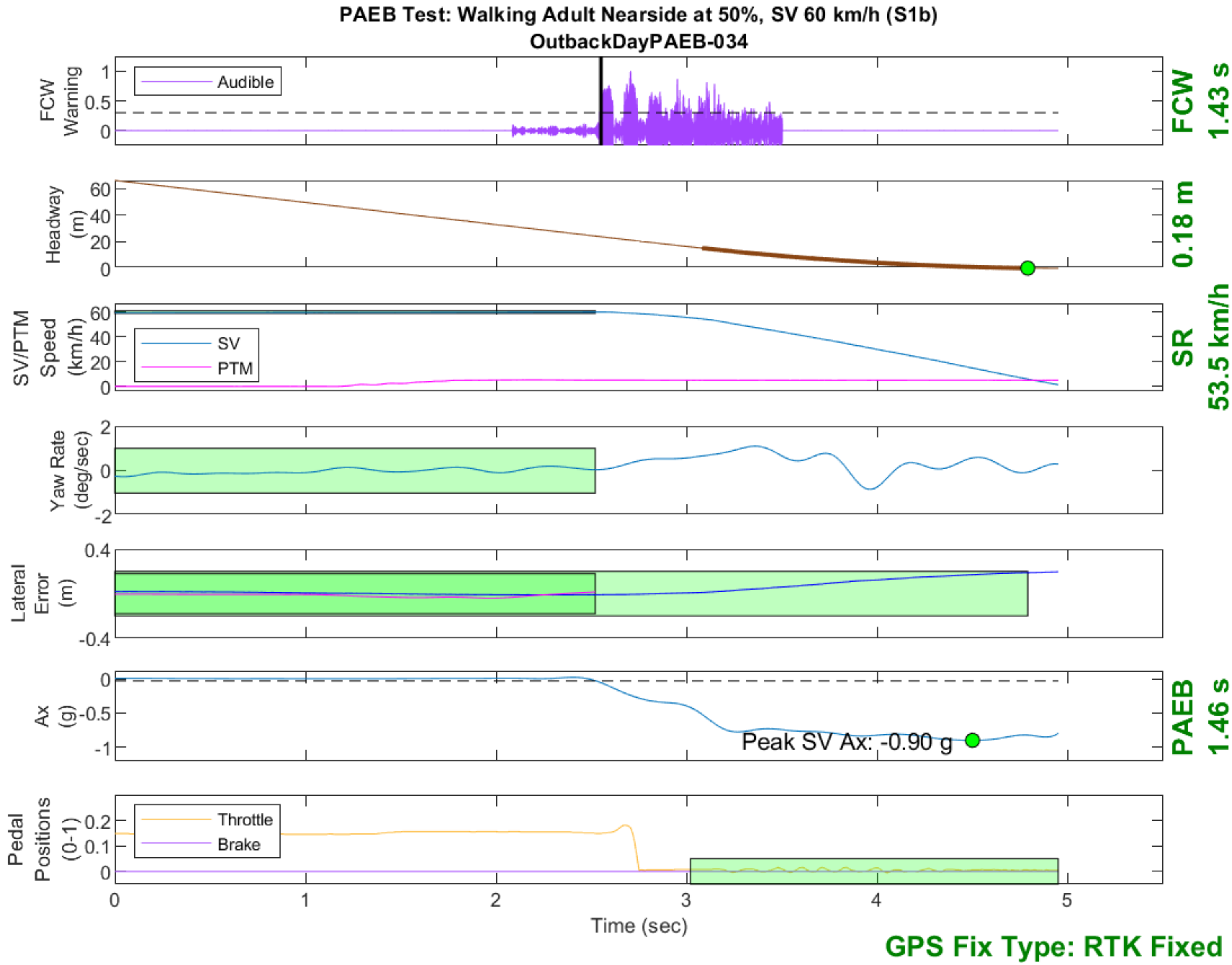


Figure D49. Time History for PAEB Run 34, S1b, Daytime, 60 km/h

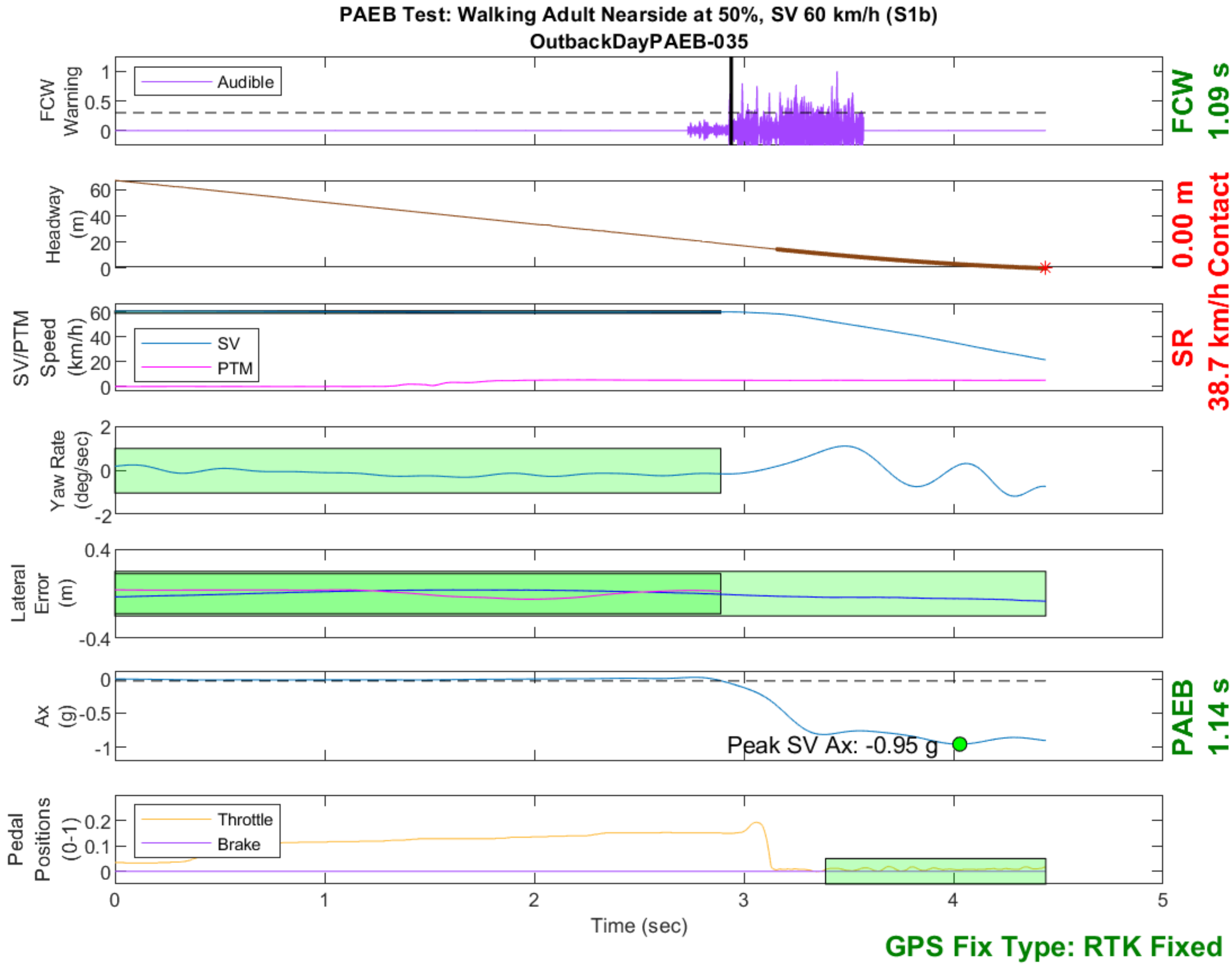


Figure D50. Time History for PAEB Run 35, S1b, Daytime, 60 km/h

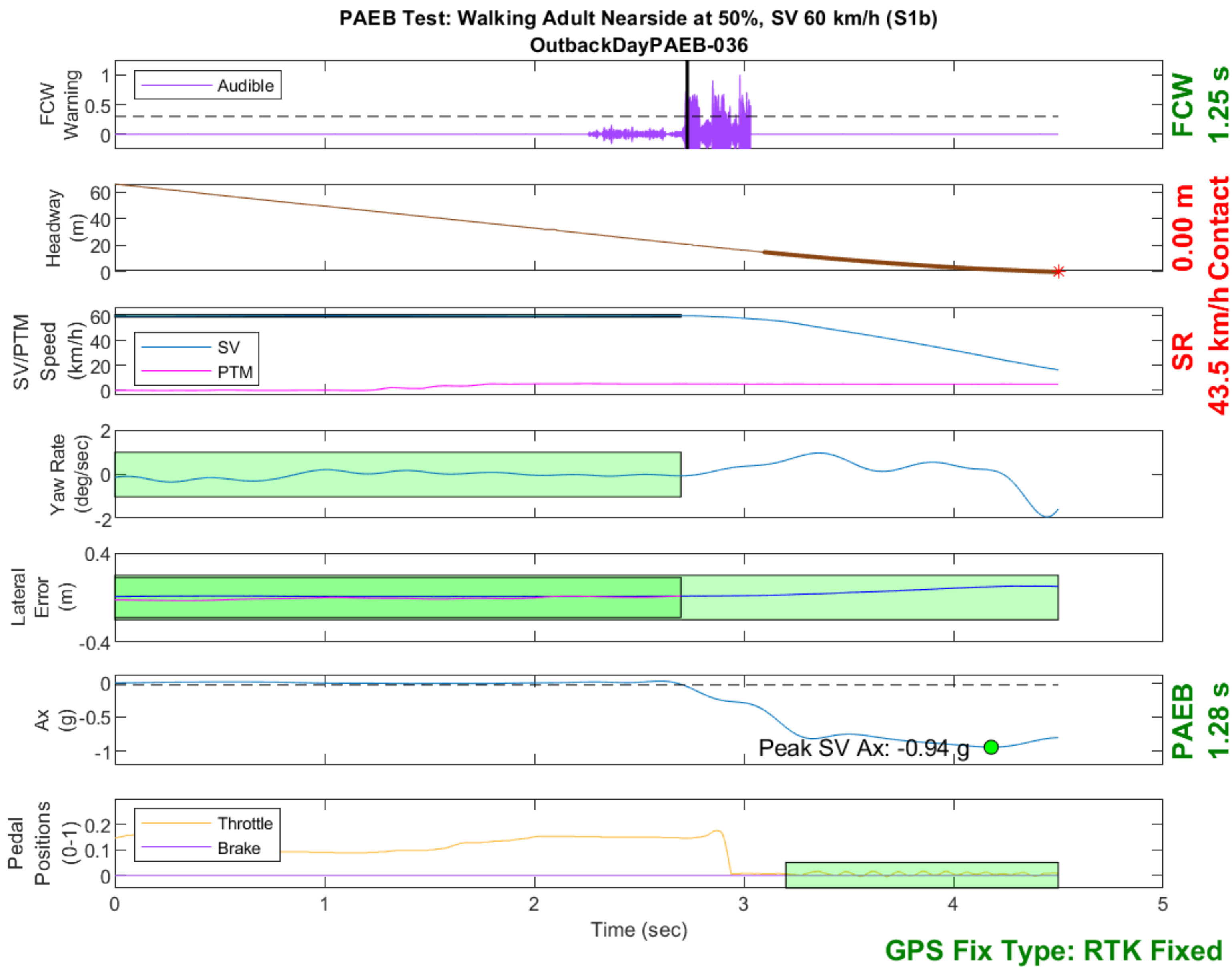


Figure D51. Time History for PAEB Run 36, S1b, Daytime, 60 km/h

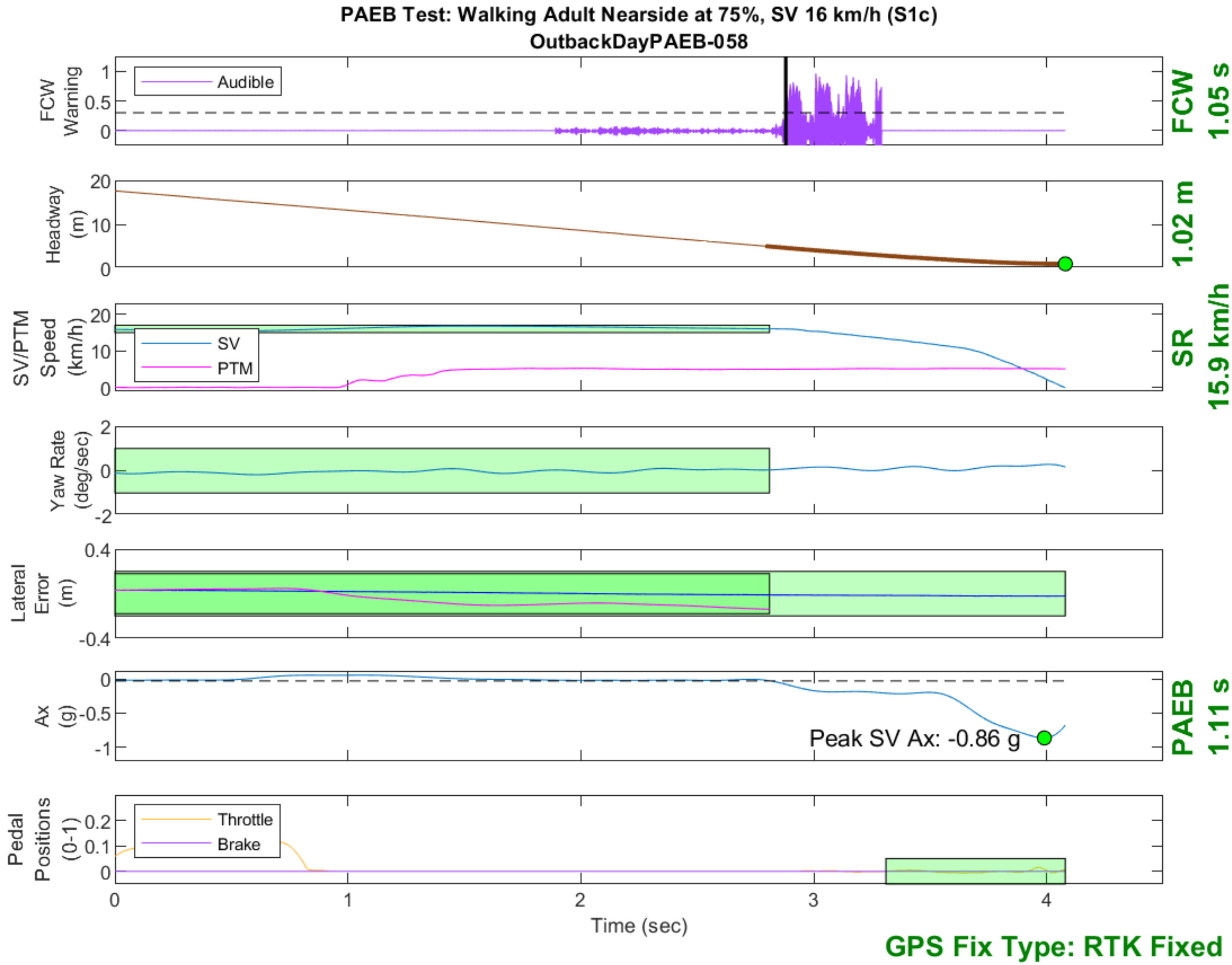


Figure D52. Time History for PAEB Run 58, S1c, Daytime, 16 km/h

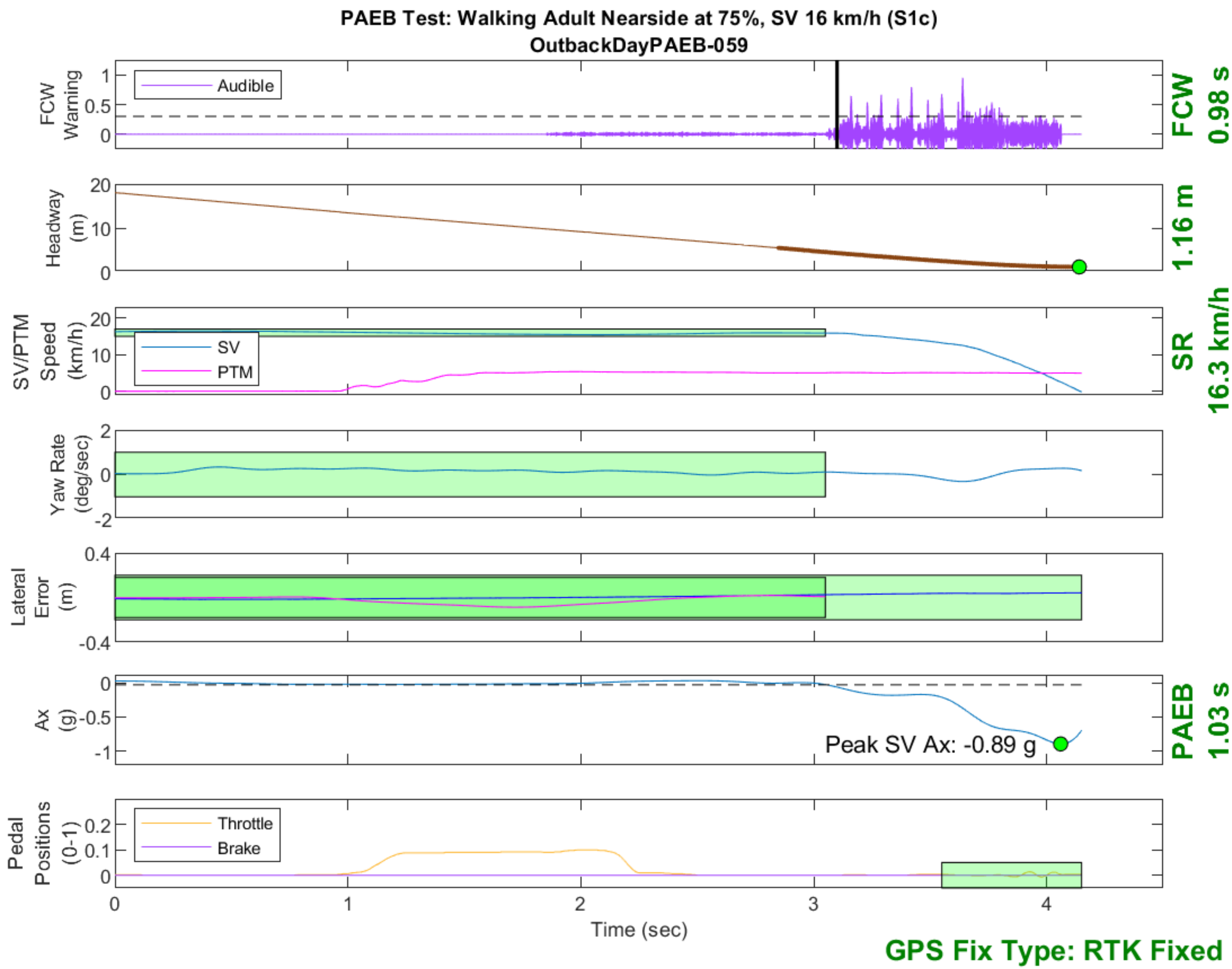


Figure D53. Time History for PAEB Run 59, S1c, Daytime, 16 km/h

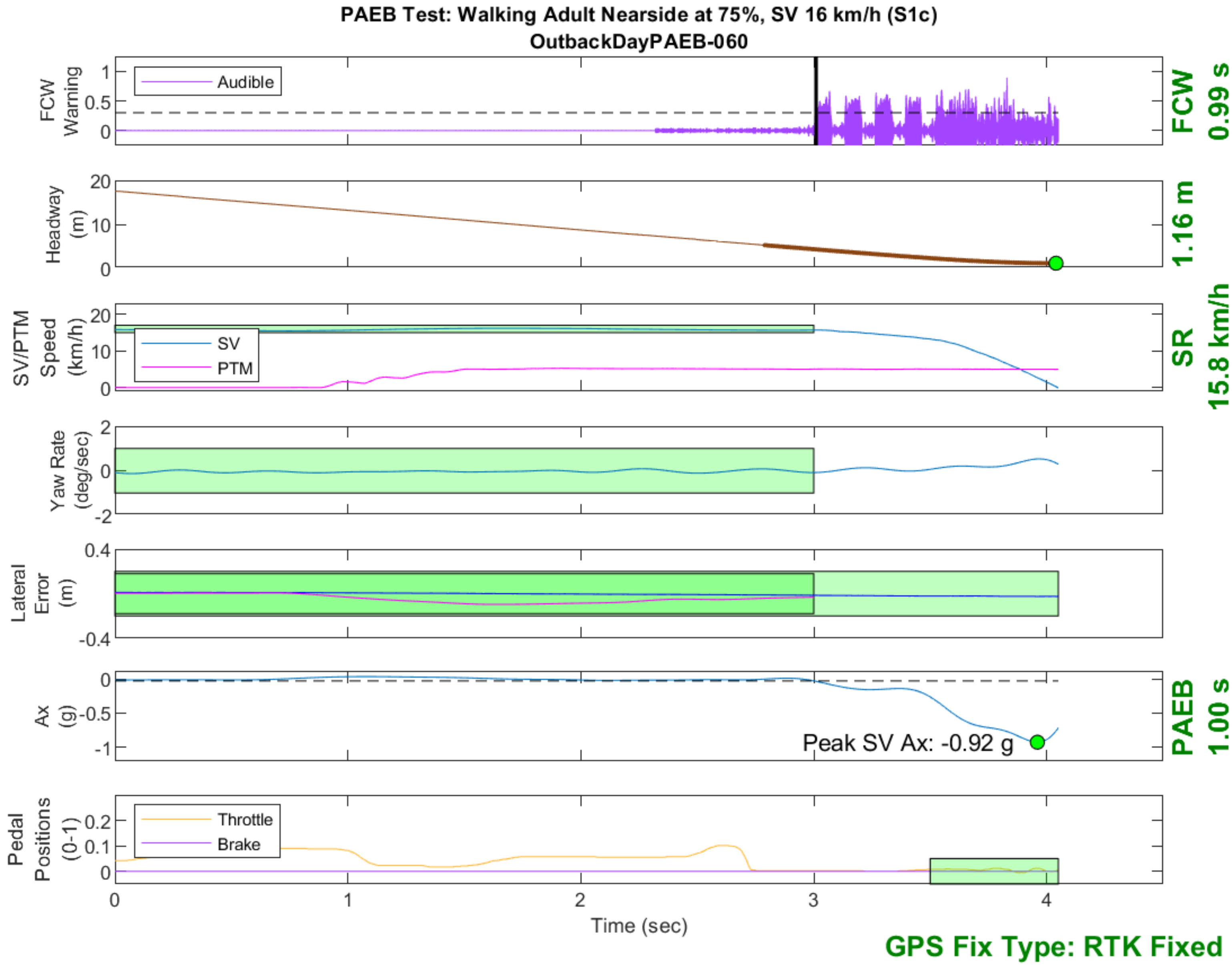


Figure D54. Time History for PAEB Run 60, S1c, Daytime, 16 km/h

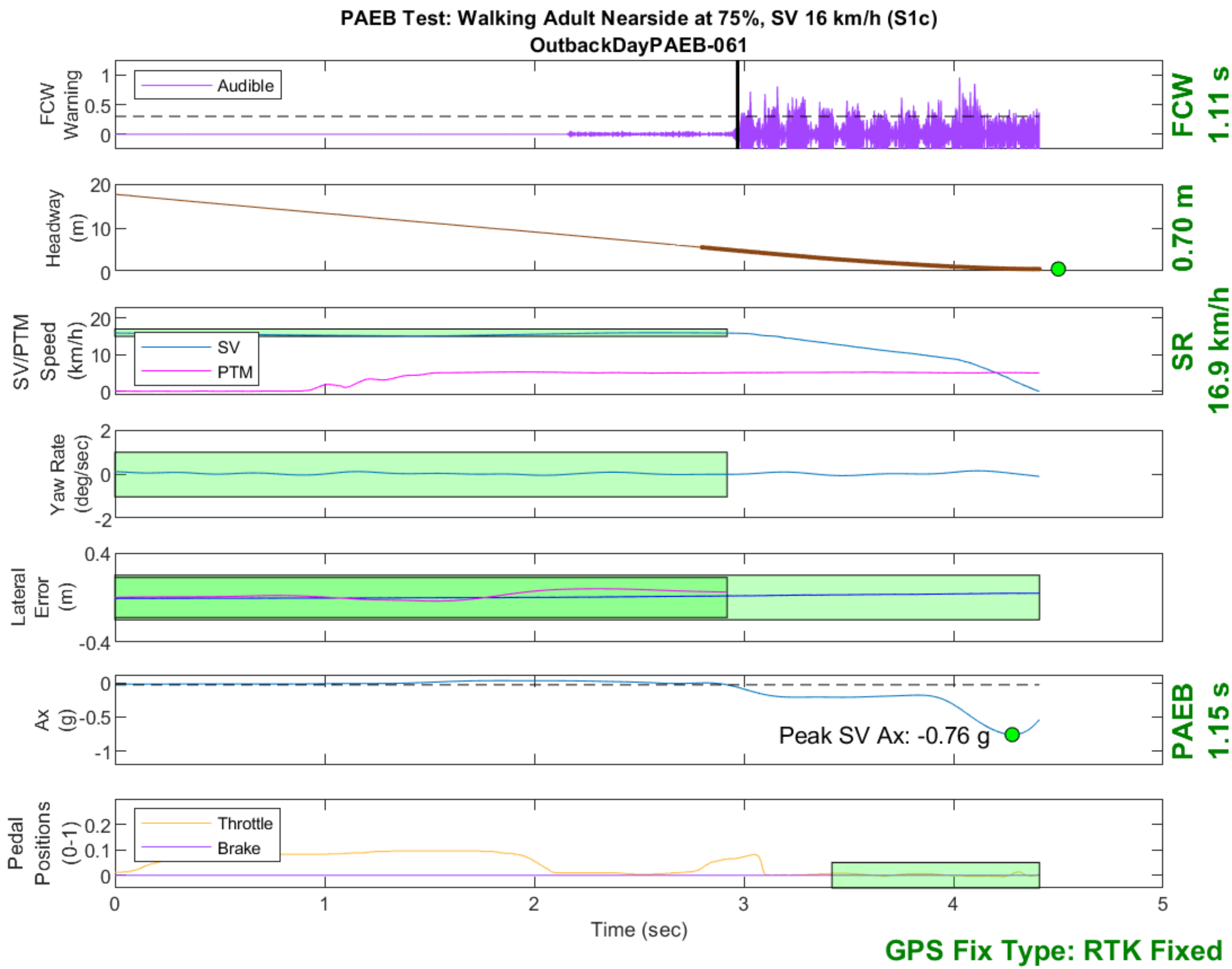


Figure D55. Time History for PAEB Run 61, S1c, Daytime, 16 km/h

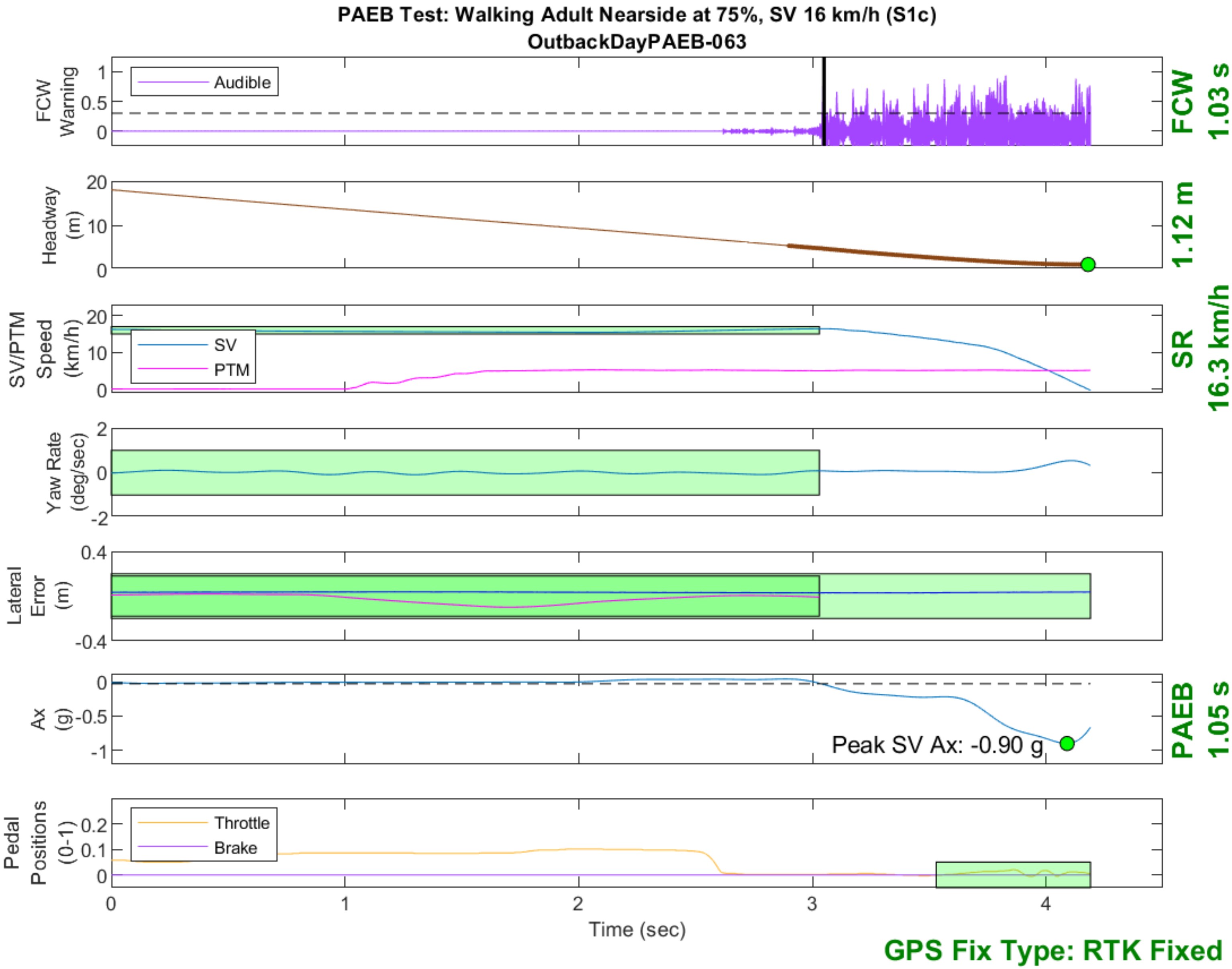


Figure D56. Time History for PAEB Run 63, S1c, Daytime, 16 km/h

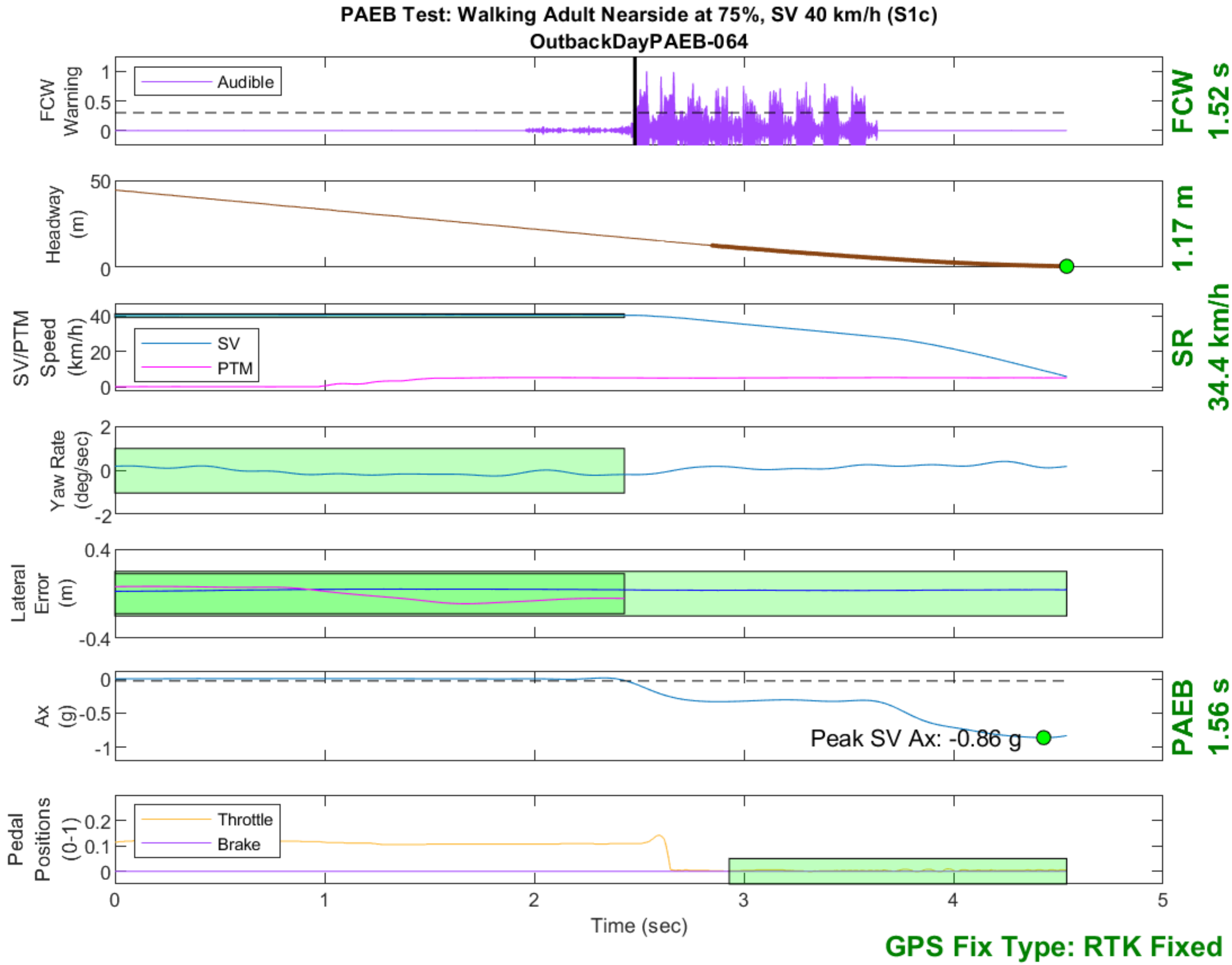


Figure D57. Time History for PAEB Run 64, S1c, Daytime, 40 km/h

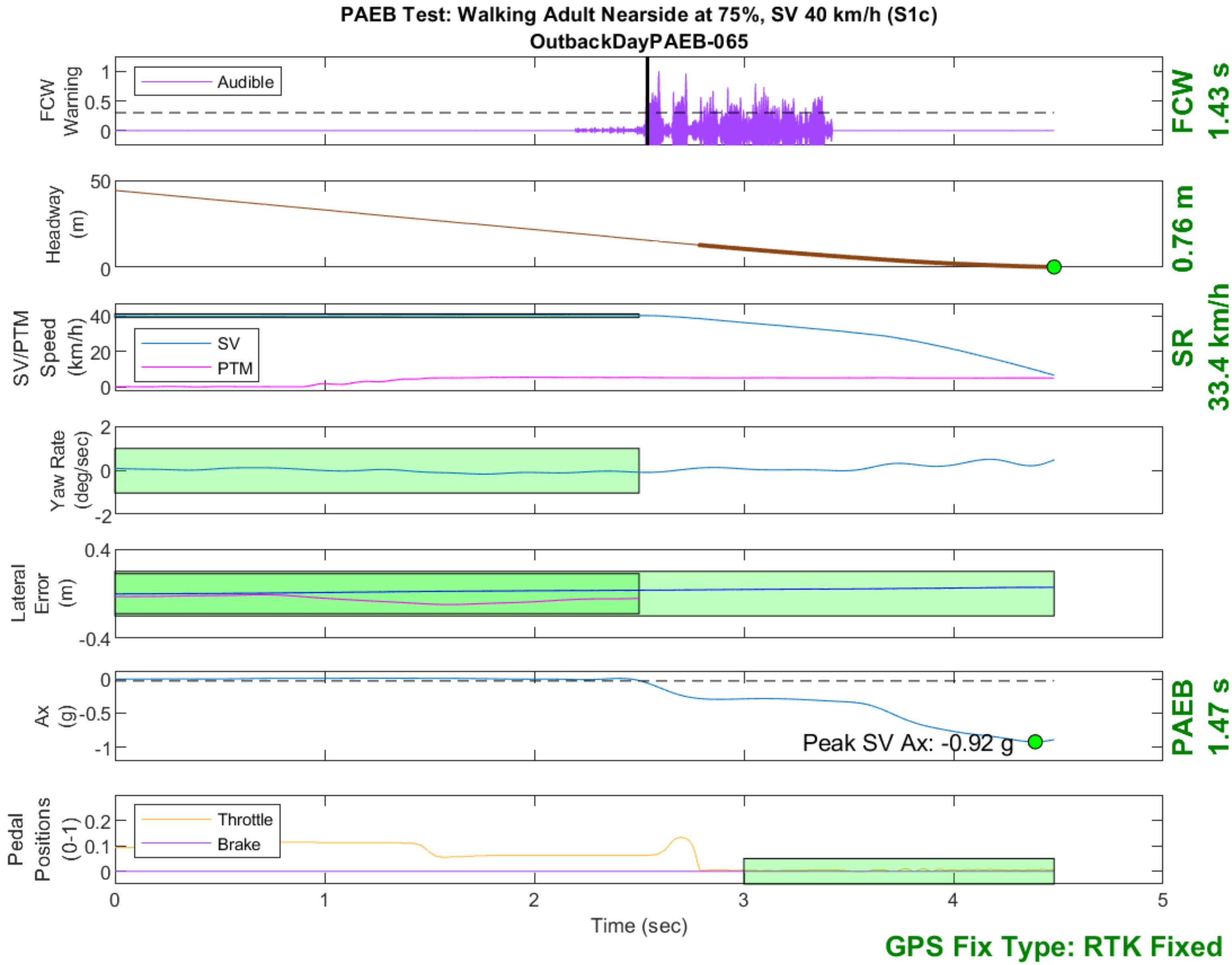


Figure D58. Time History for PAEB Run 65, S1c, Daytime, 40 km/h

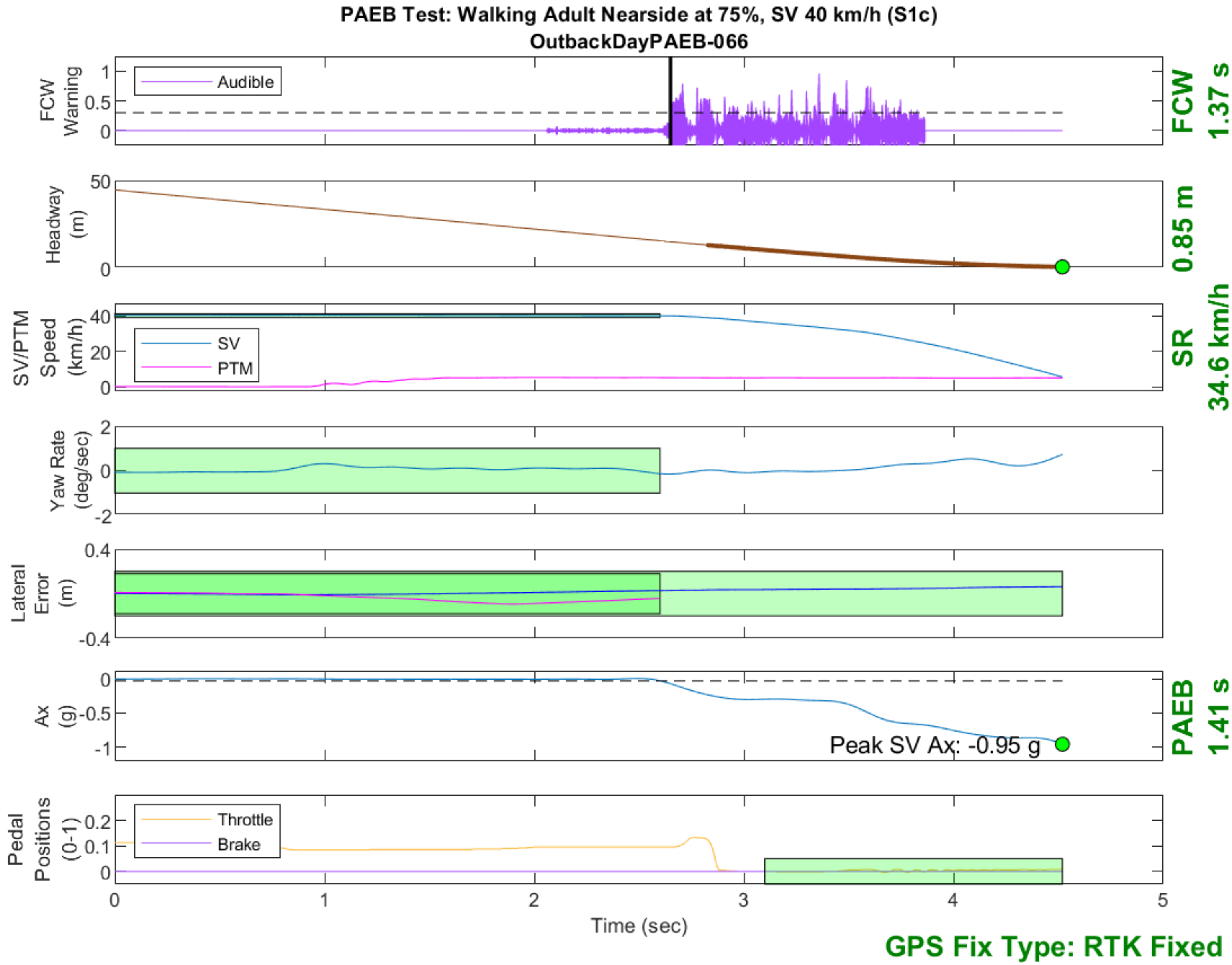


Figure D59. Time History for PAEB Run 66, S1c, Daytime, 40 km/h

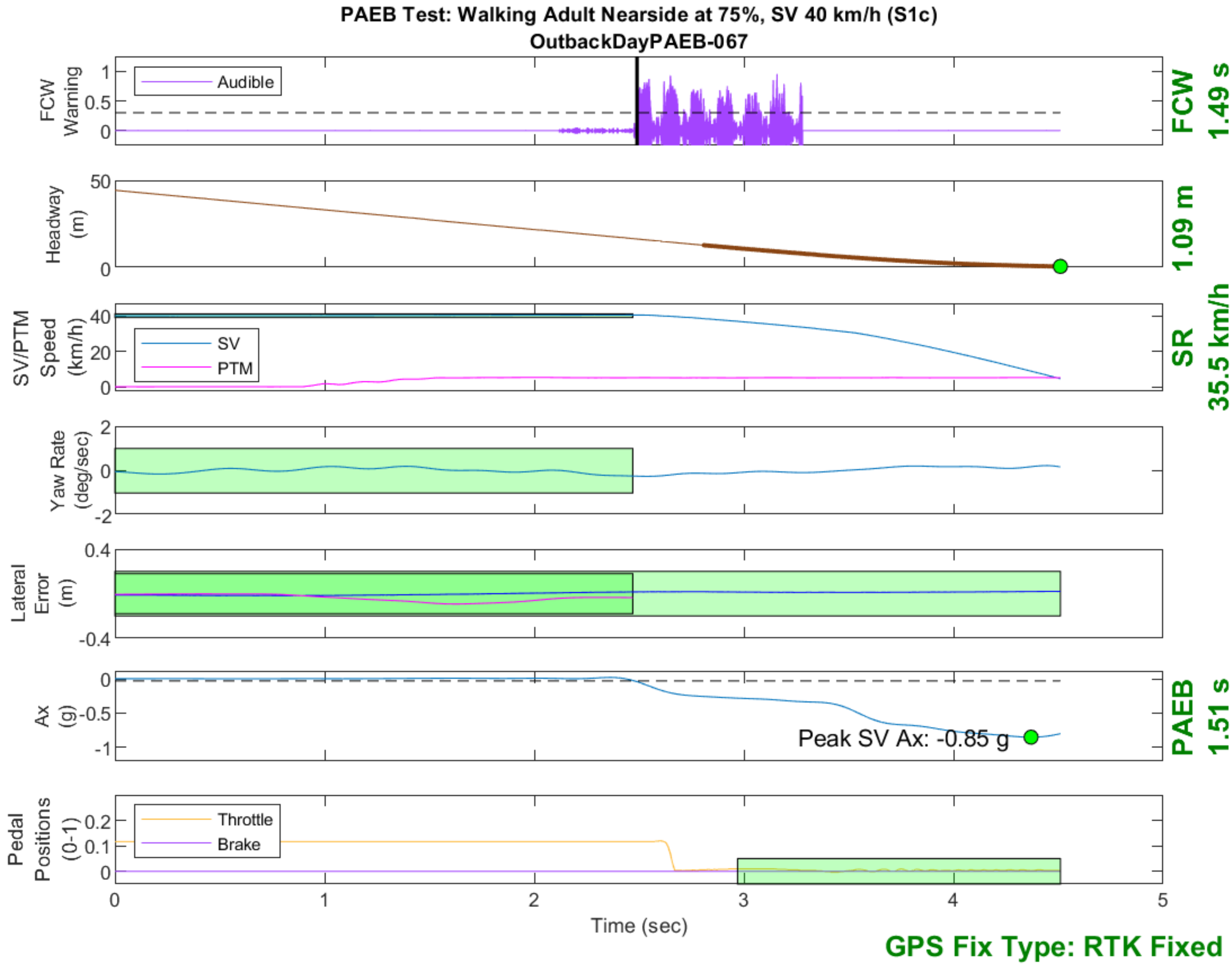


Figure D60. Time History for PAEB Run 67, S1c, Daytime, 40 km/h

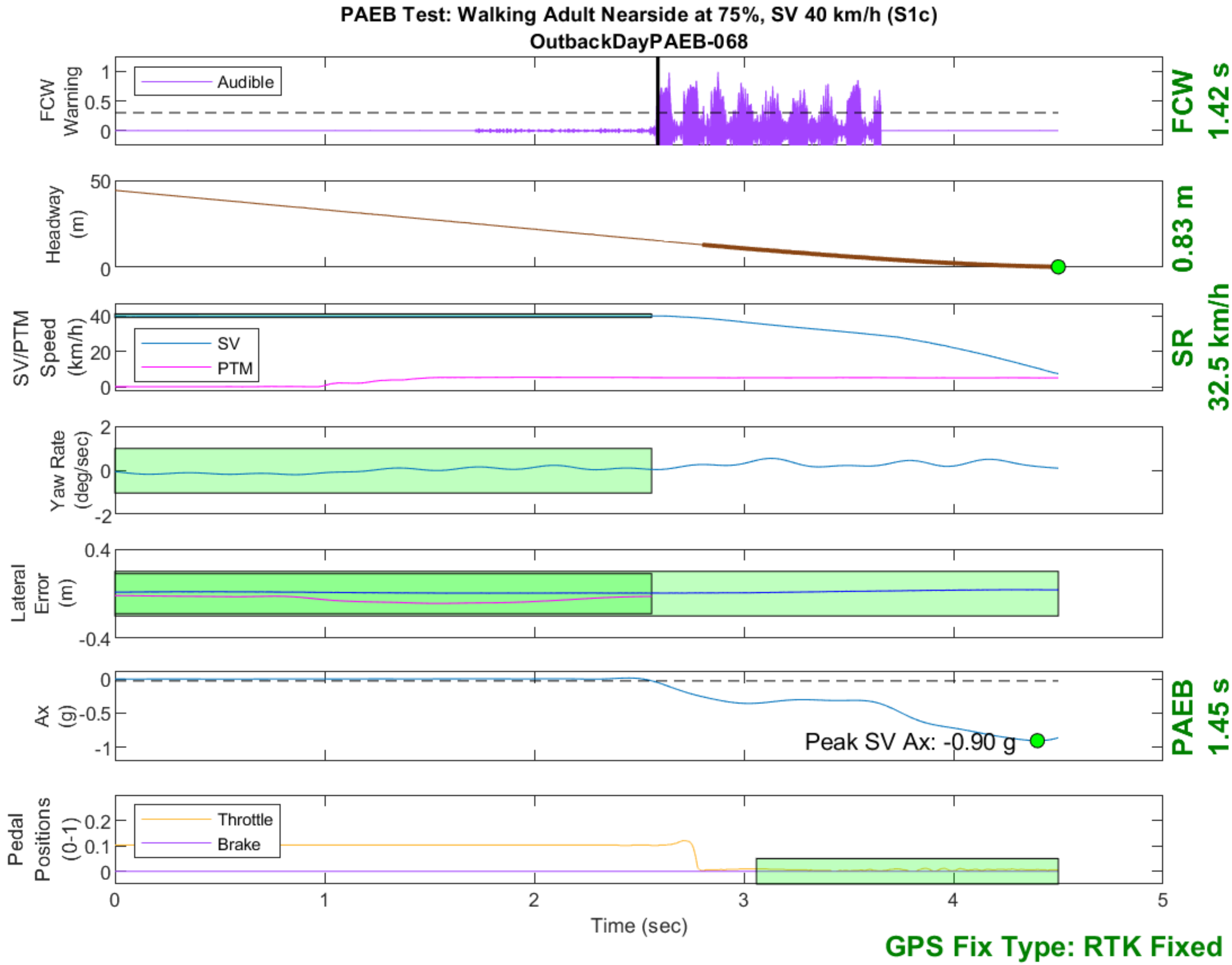


Figure D61. Time History for PAEB Run 68, S1c, Daytime, 40 km/h

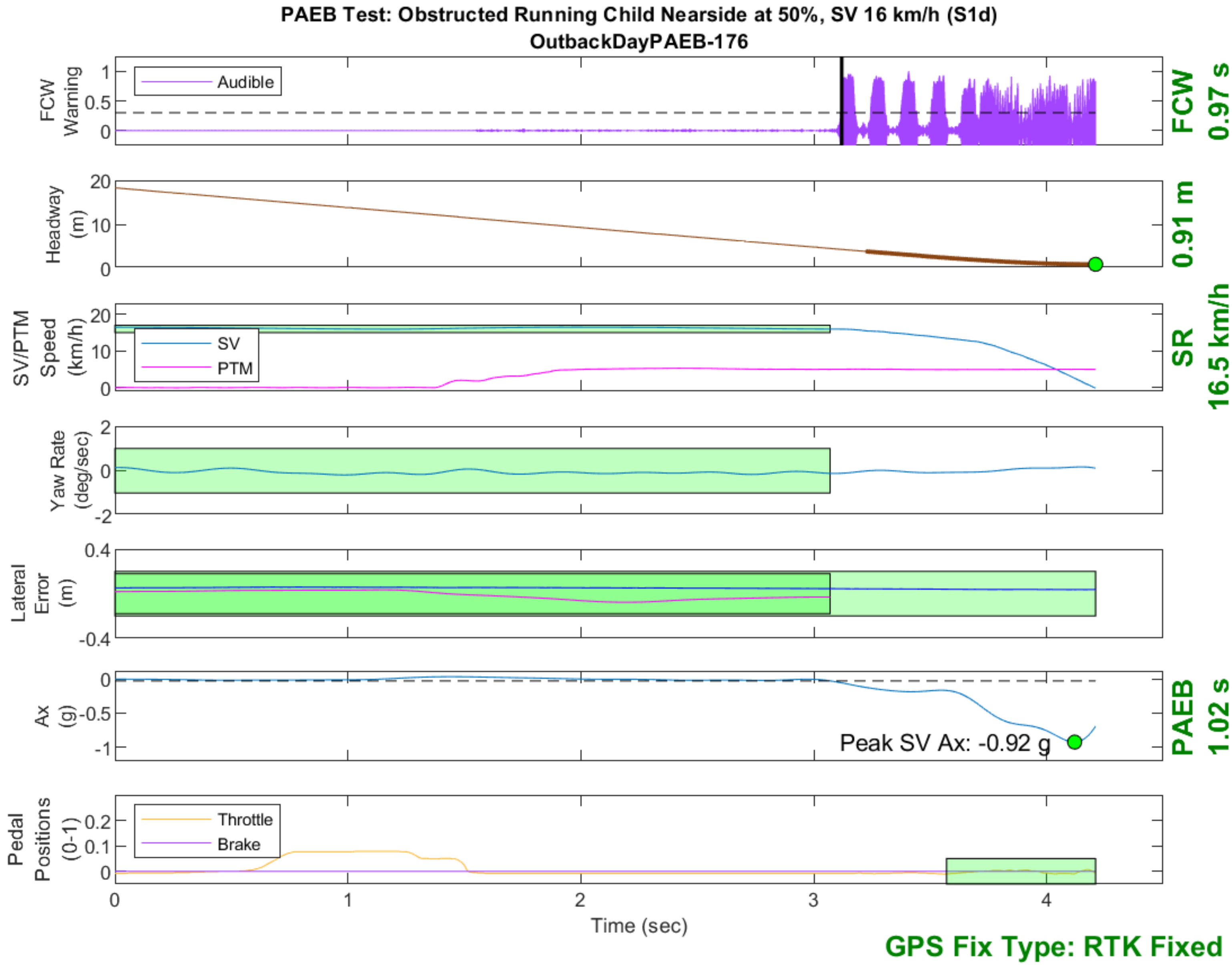


Figure D62. Time History for PAEB Run 176, S1d, Daytime, 16 km/h

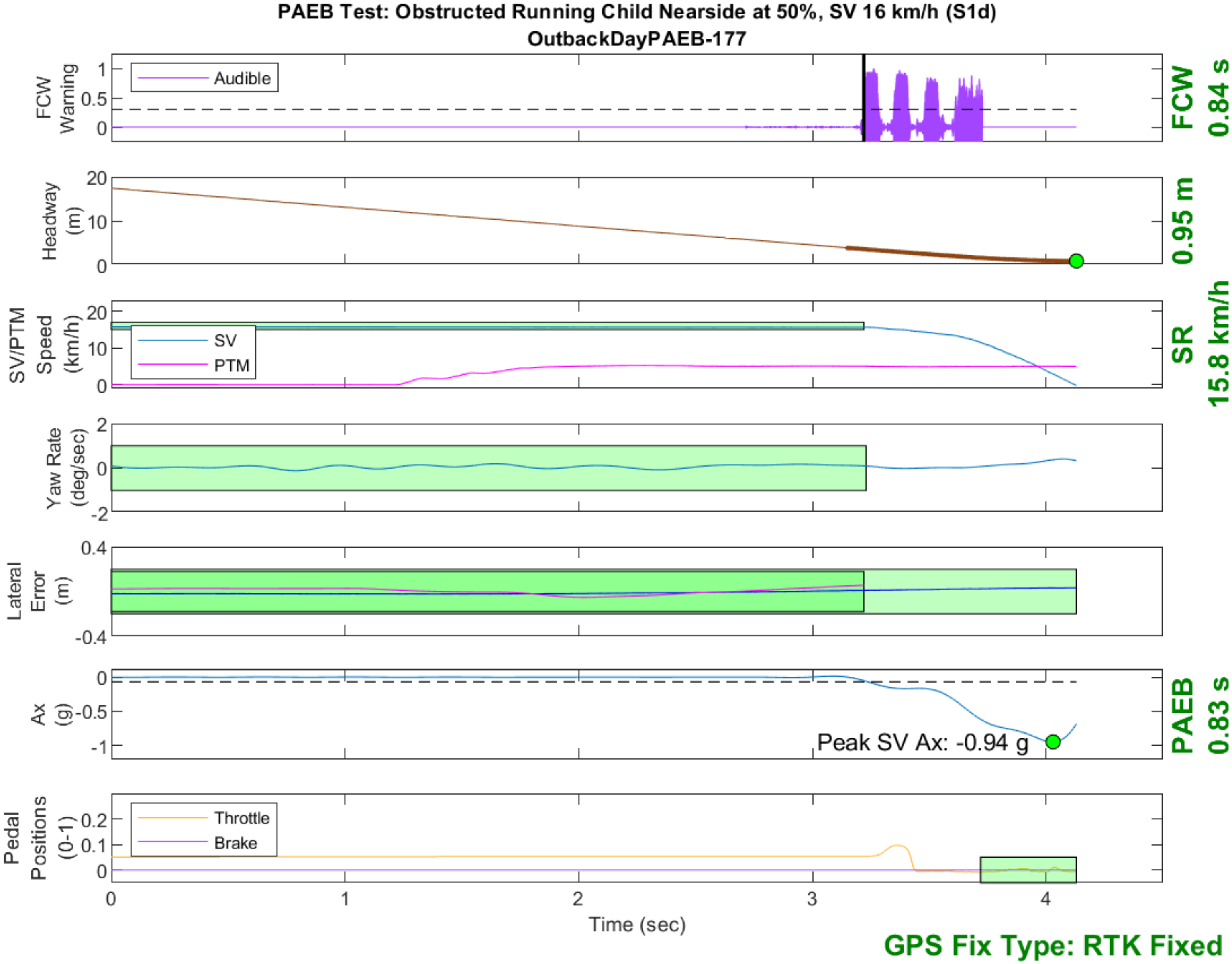


Figure D63. Time History for PAEB Run 177, S1d, Daytime, 16 km/h

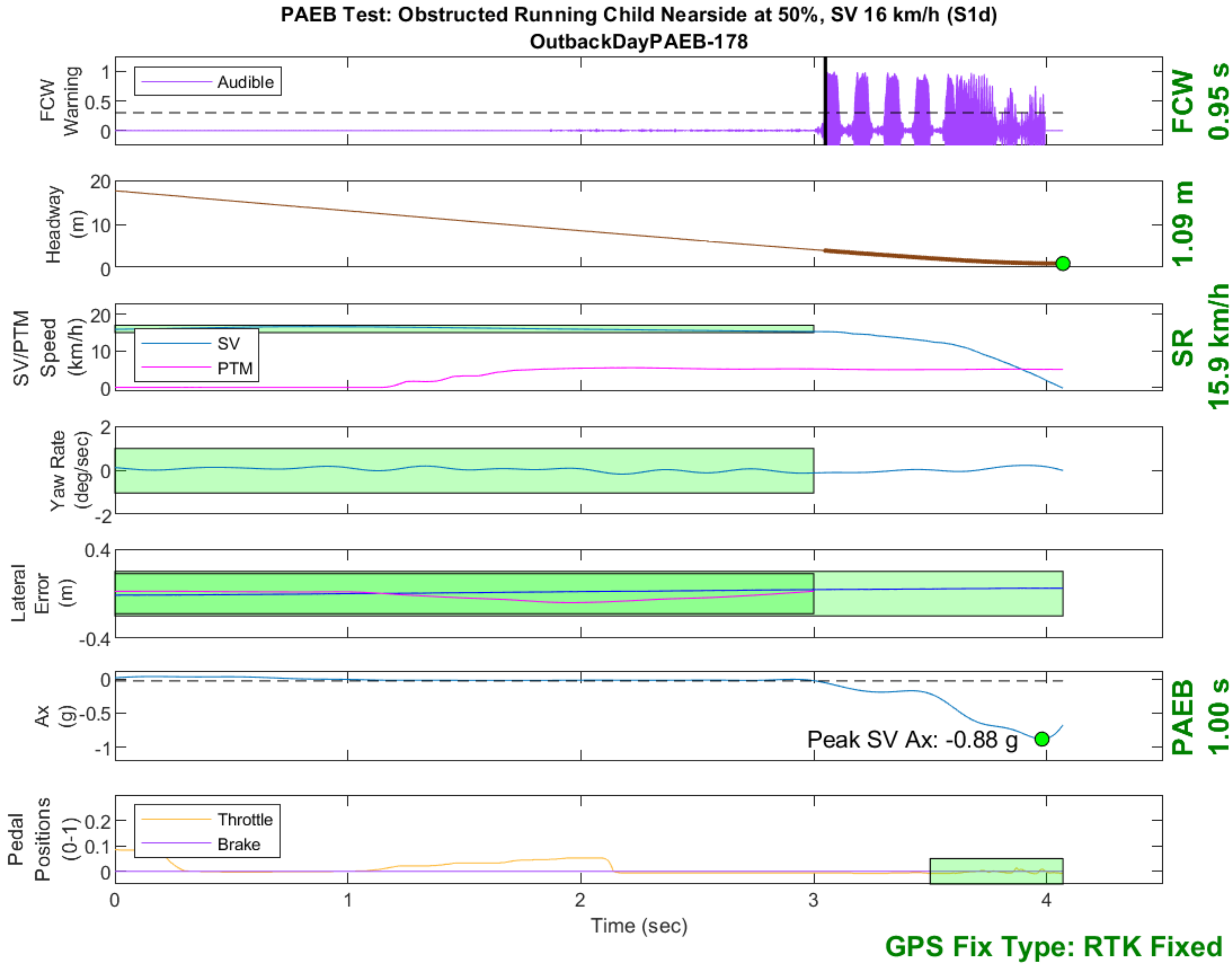


Figure D64. Time History for PAEB Run 178, S1d, Daytime, 16 km/h

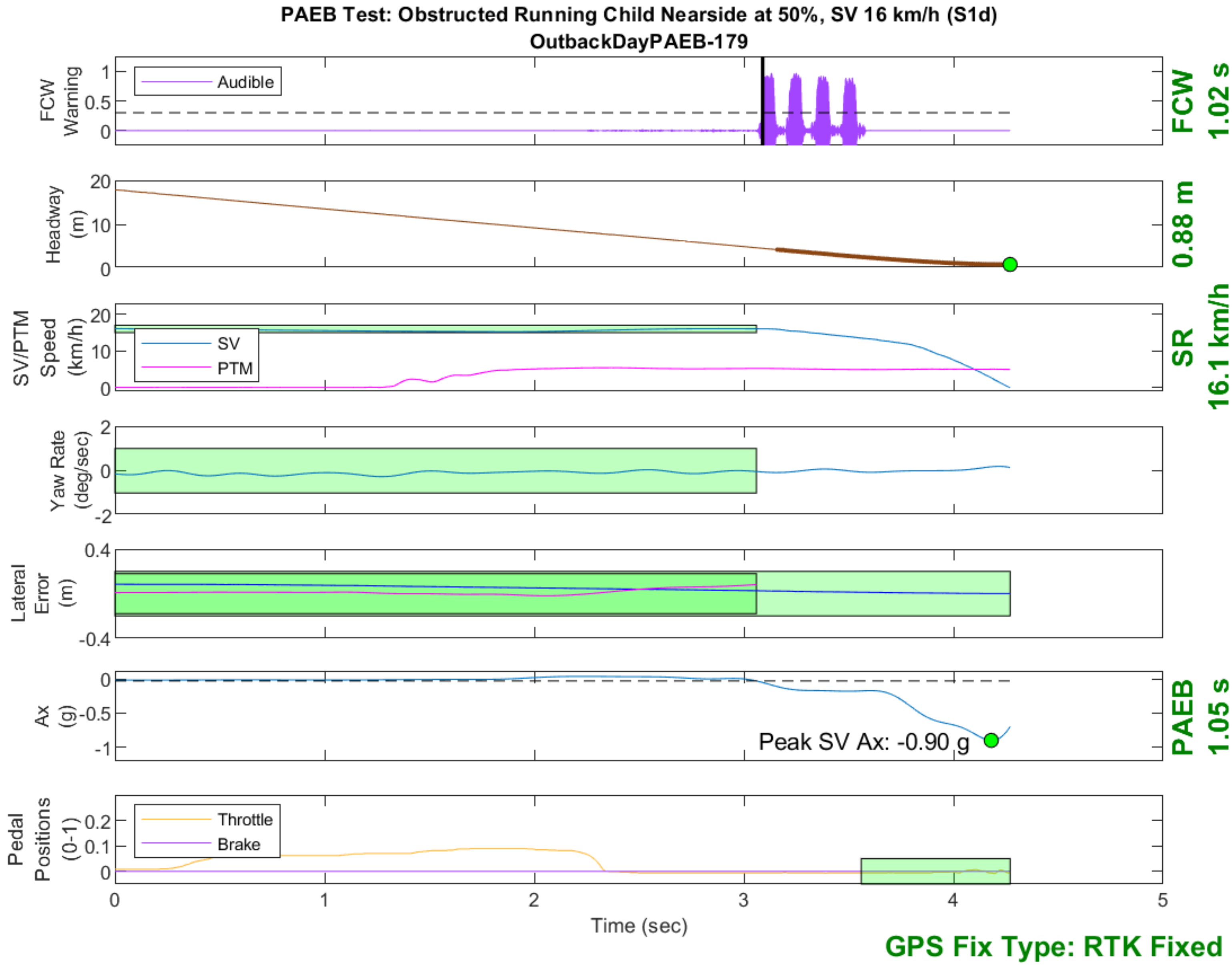


Figure D65. Time History for PAEB Run 179, S1d, Daytime, 16 km/h

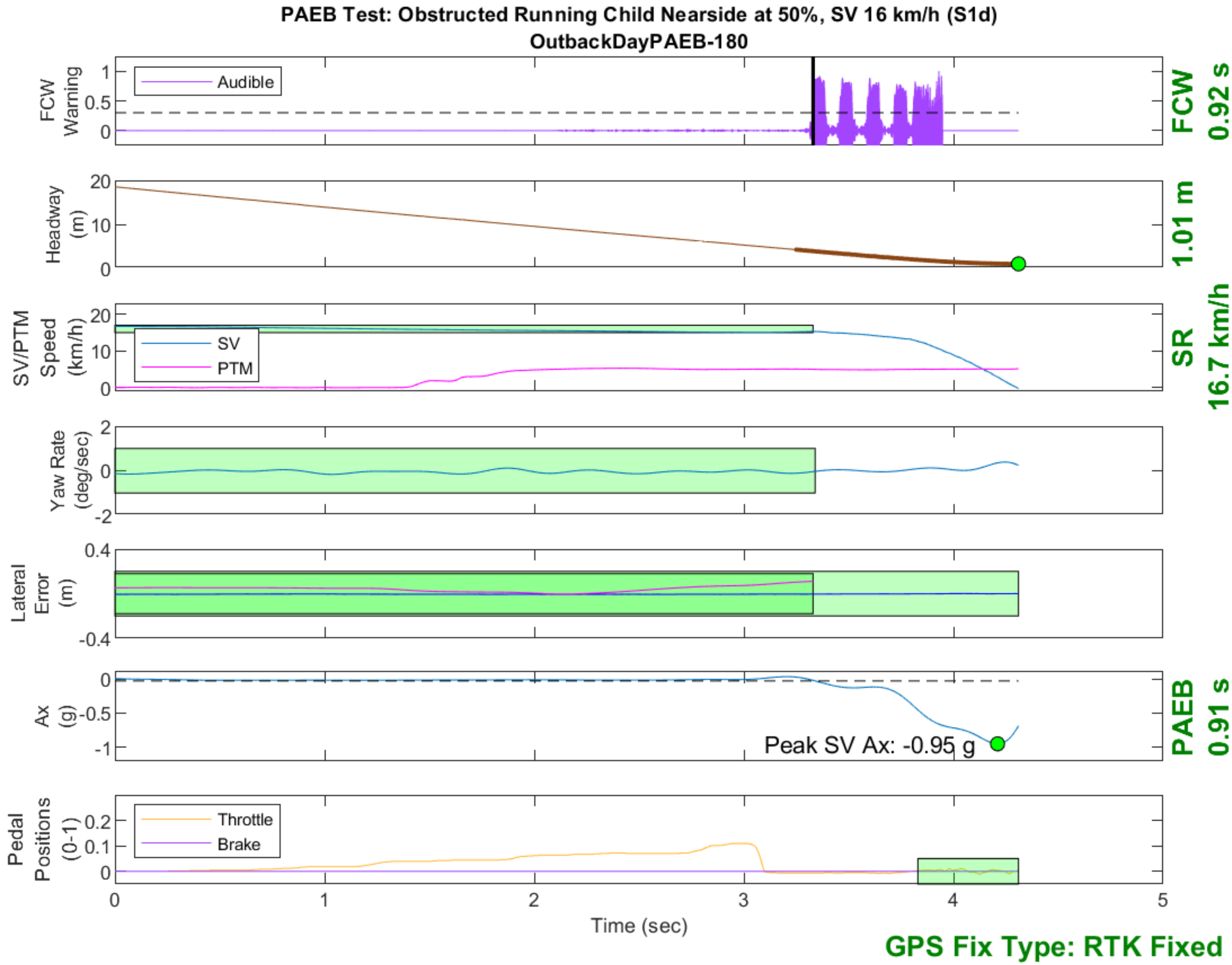


Figure D66. Time History for PAEB Run 180, S1d, Daytime, 16 km/h

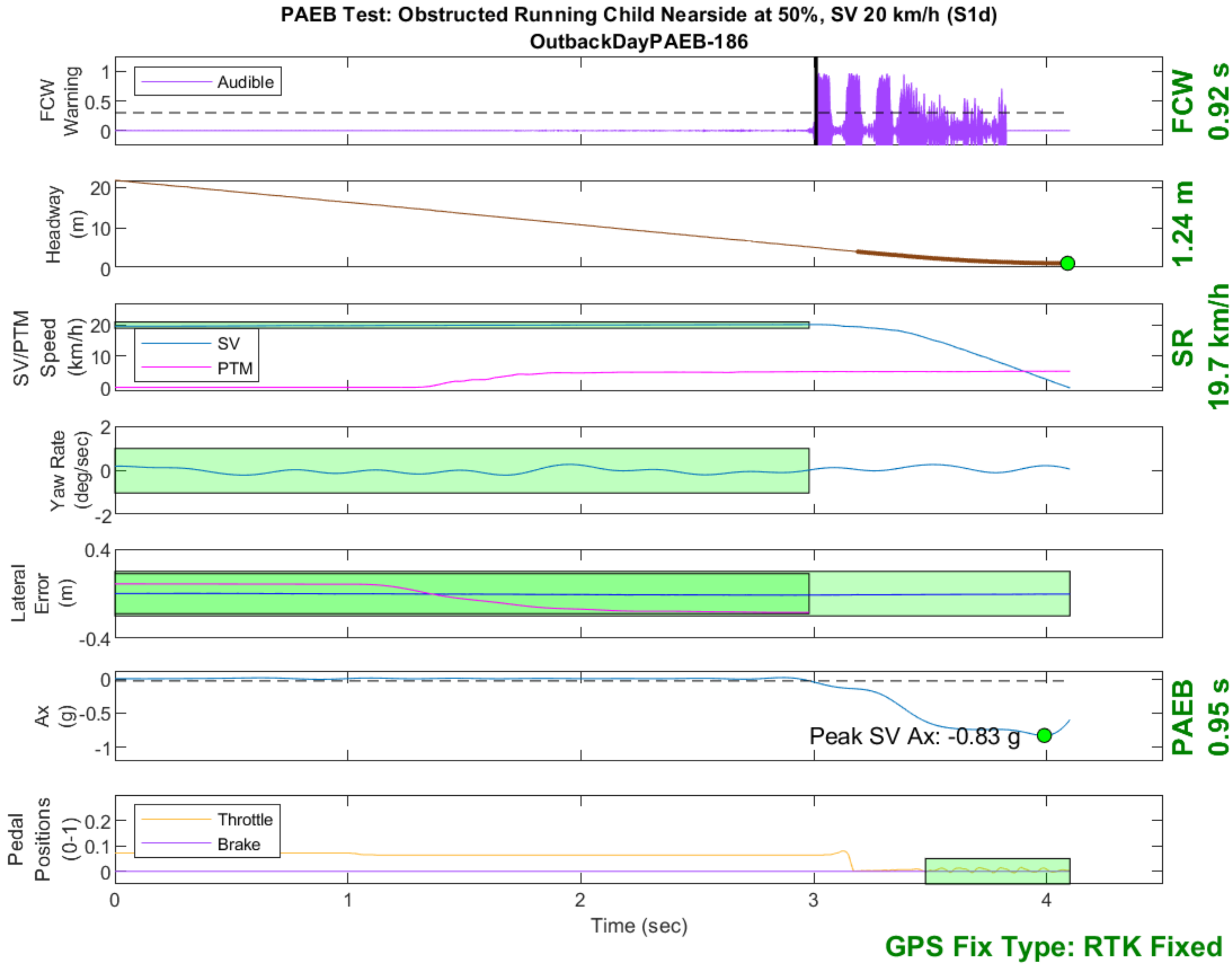


Figure D67. Time History for PAEB Run 186, S1d, Daytime, 20 km/h

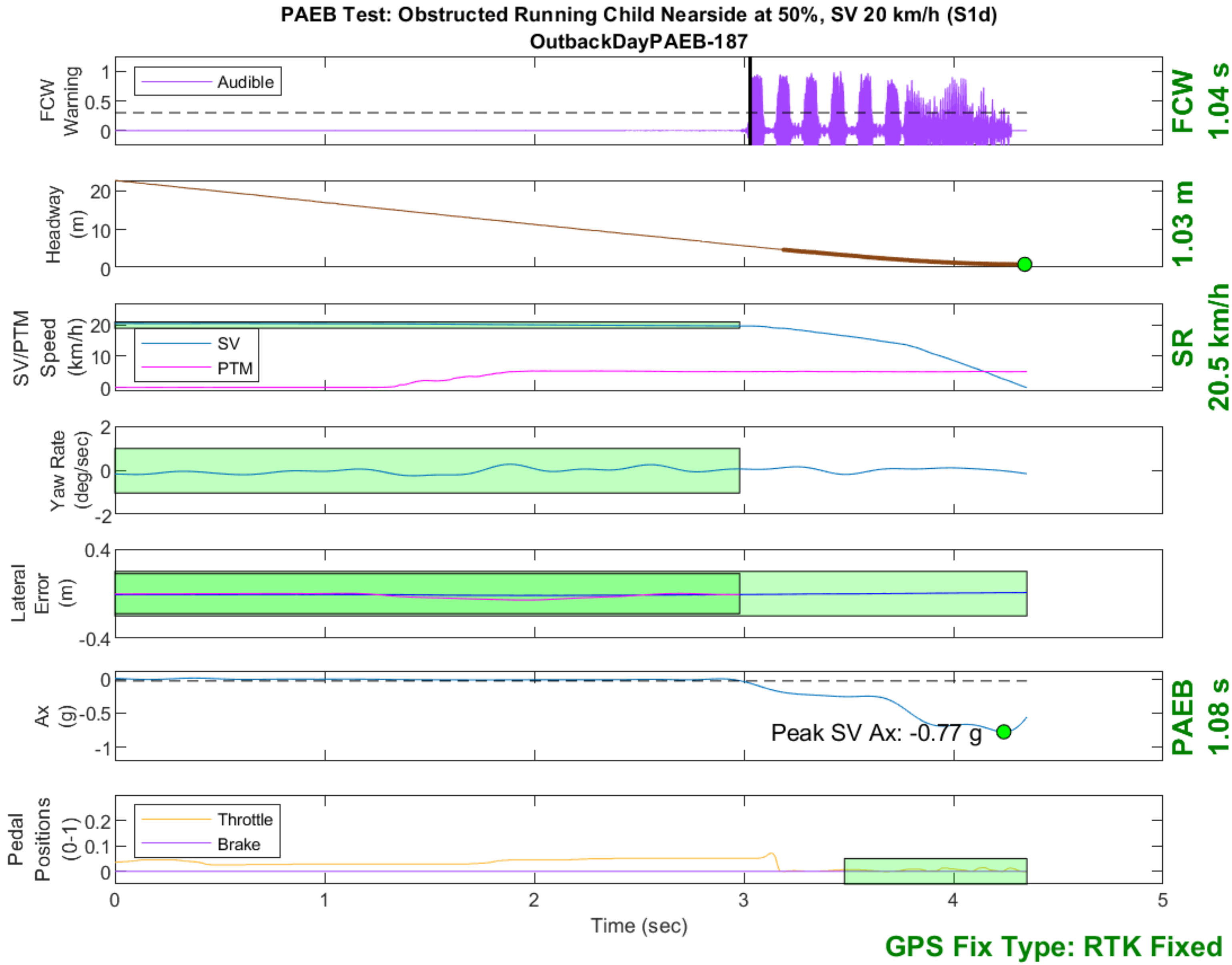


Figure D68. Time History for PAEB Run 187, S1d, Daytime, 20 km/h

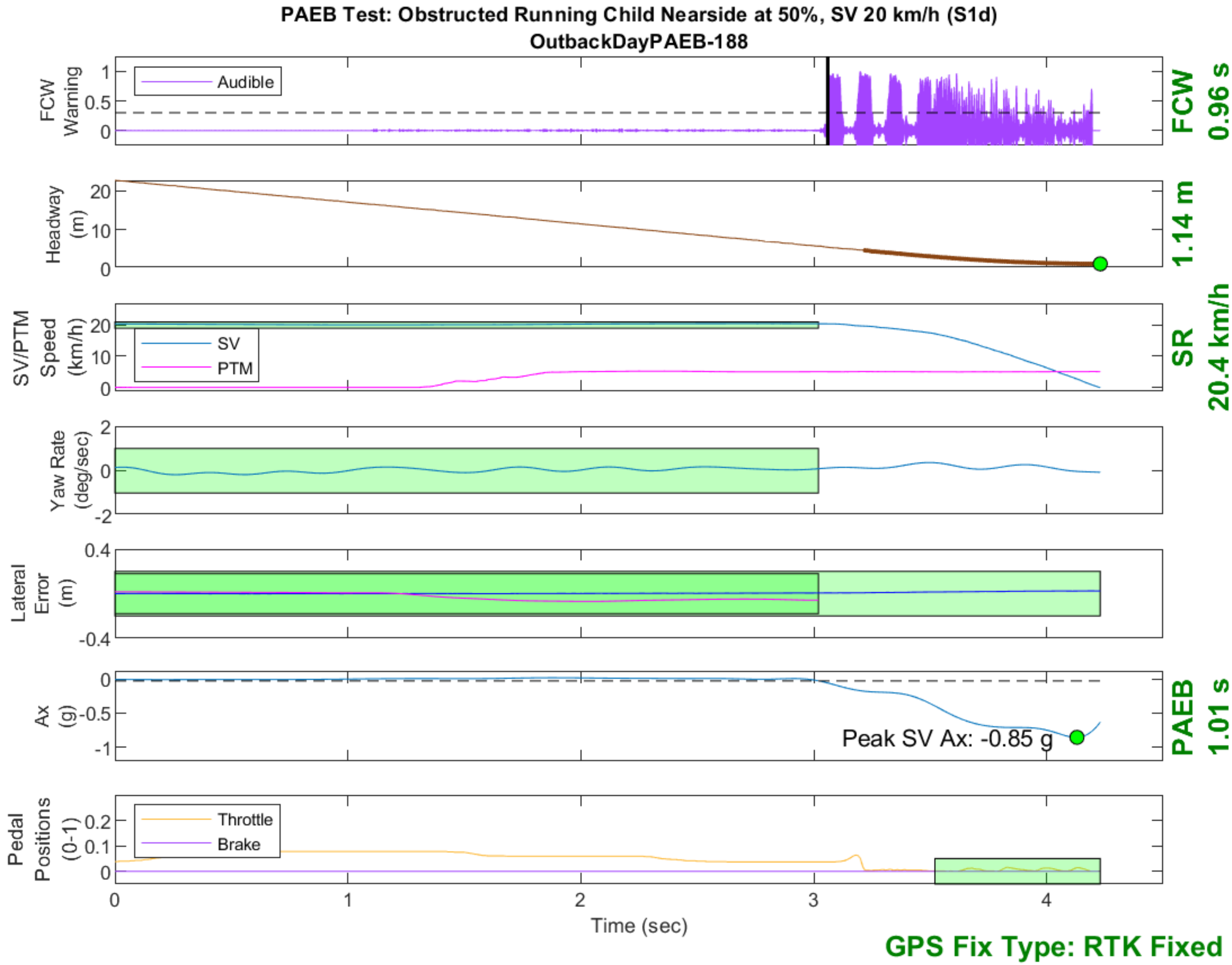


Figure D69. Time History for PAEB Run 188, S1d, Daytime, 20 km/h

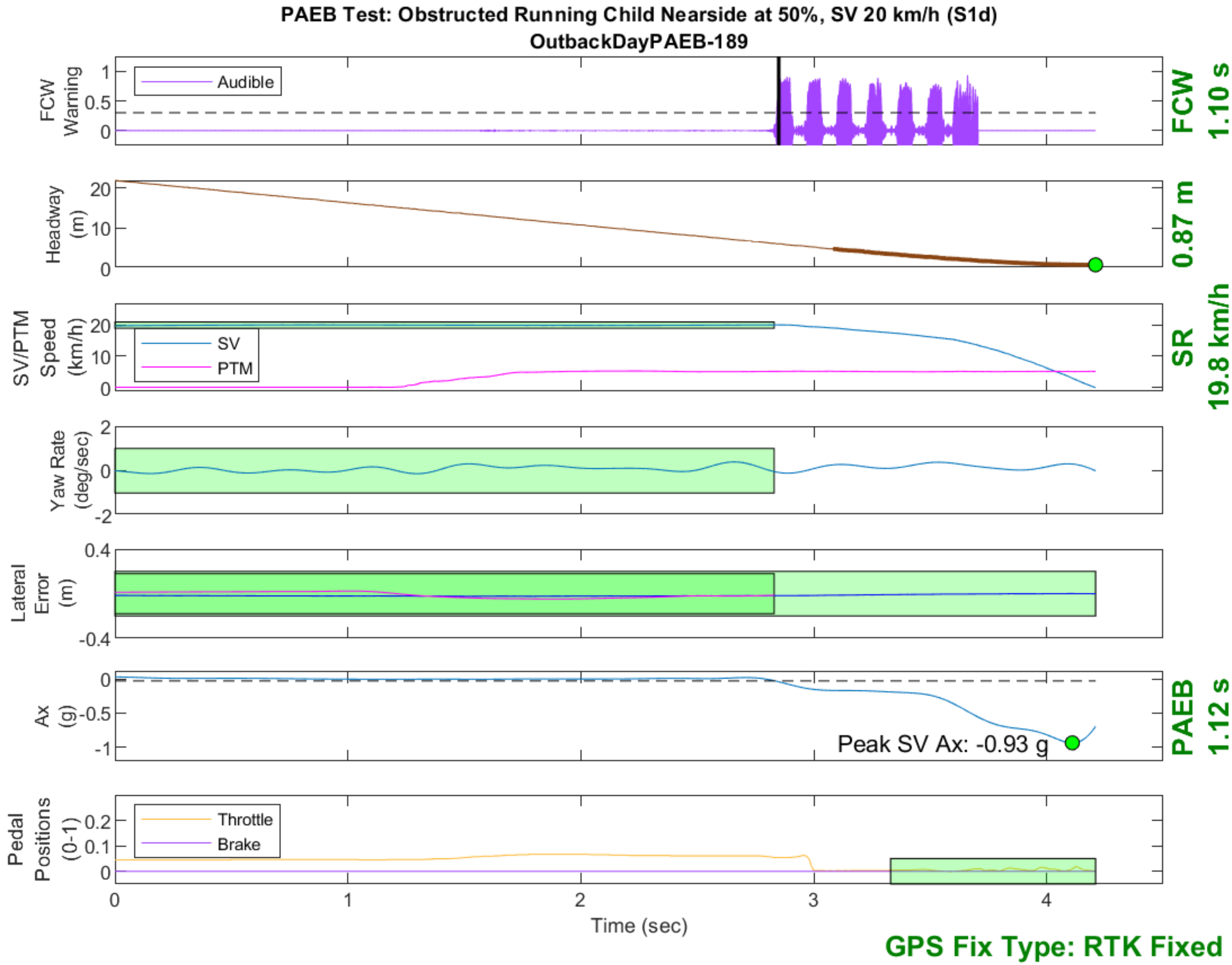


Figure D70. Time History for PAEB Run 189, S1d, Daytime, 20 km/h

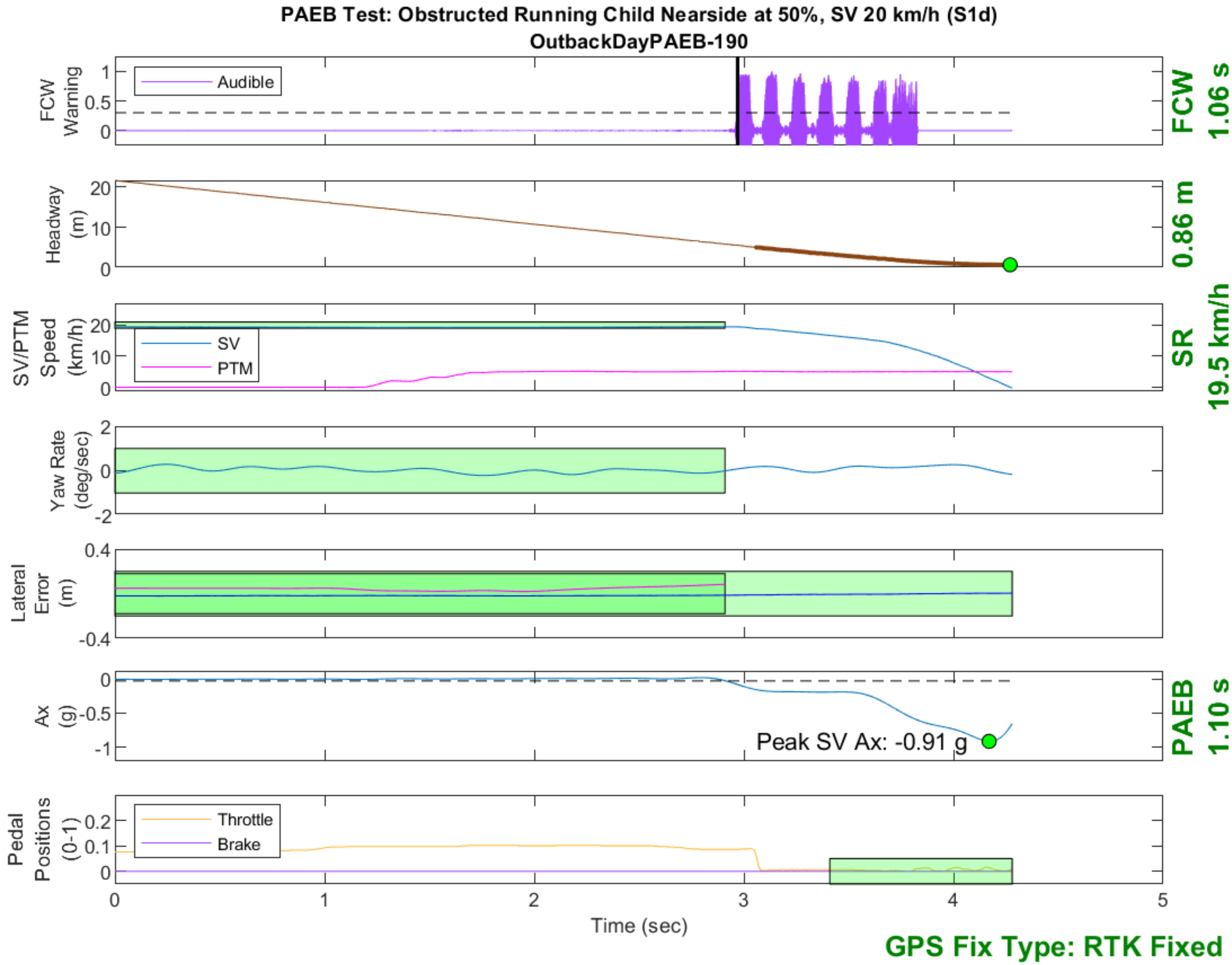


Figure D71. Time History for PAEB Run 190, S1d, Daytime, 20 km/h

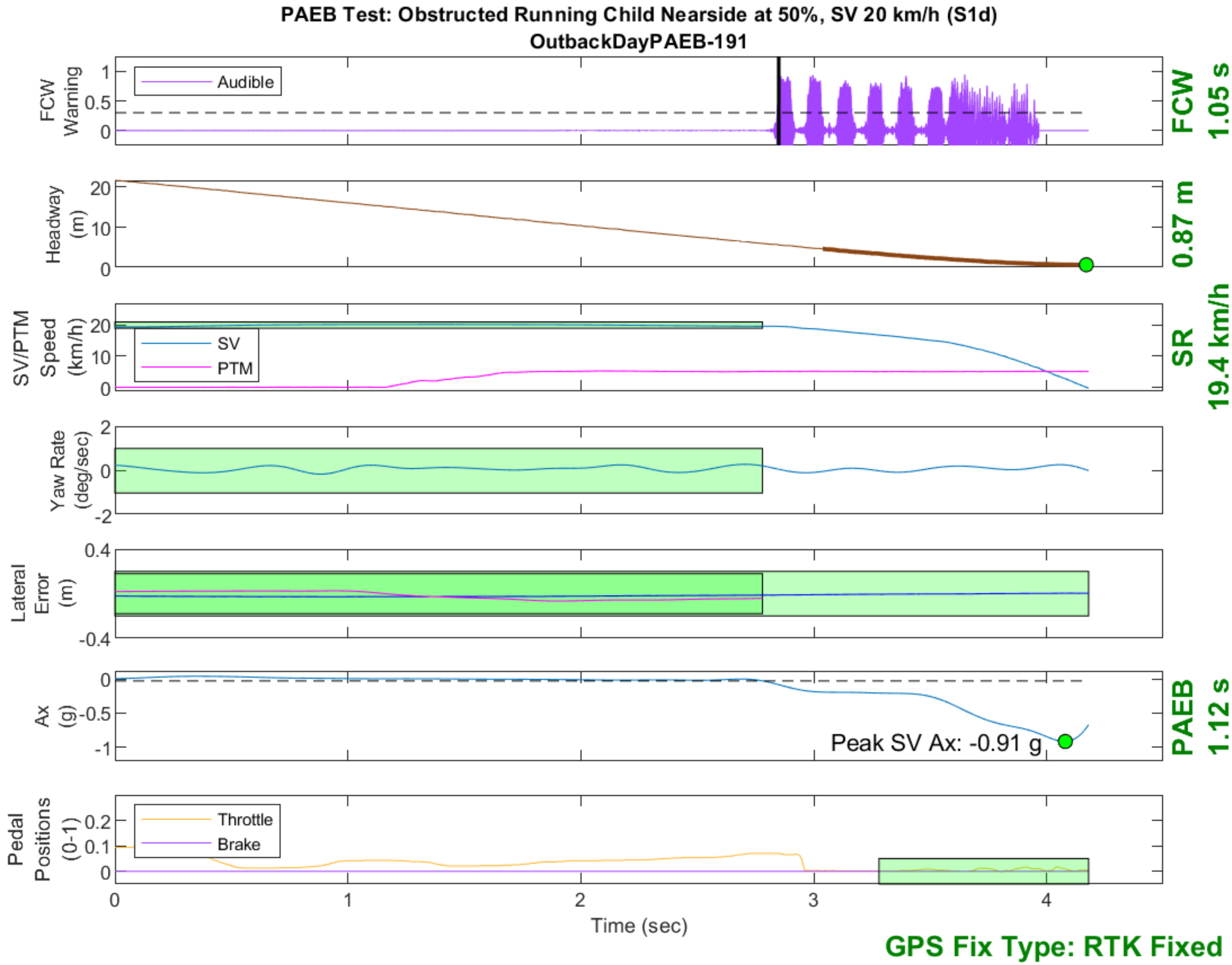


Figure D72. Time History for PAEB Run 191, S1d, Daytime, 20 km/h

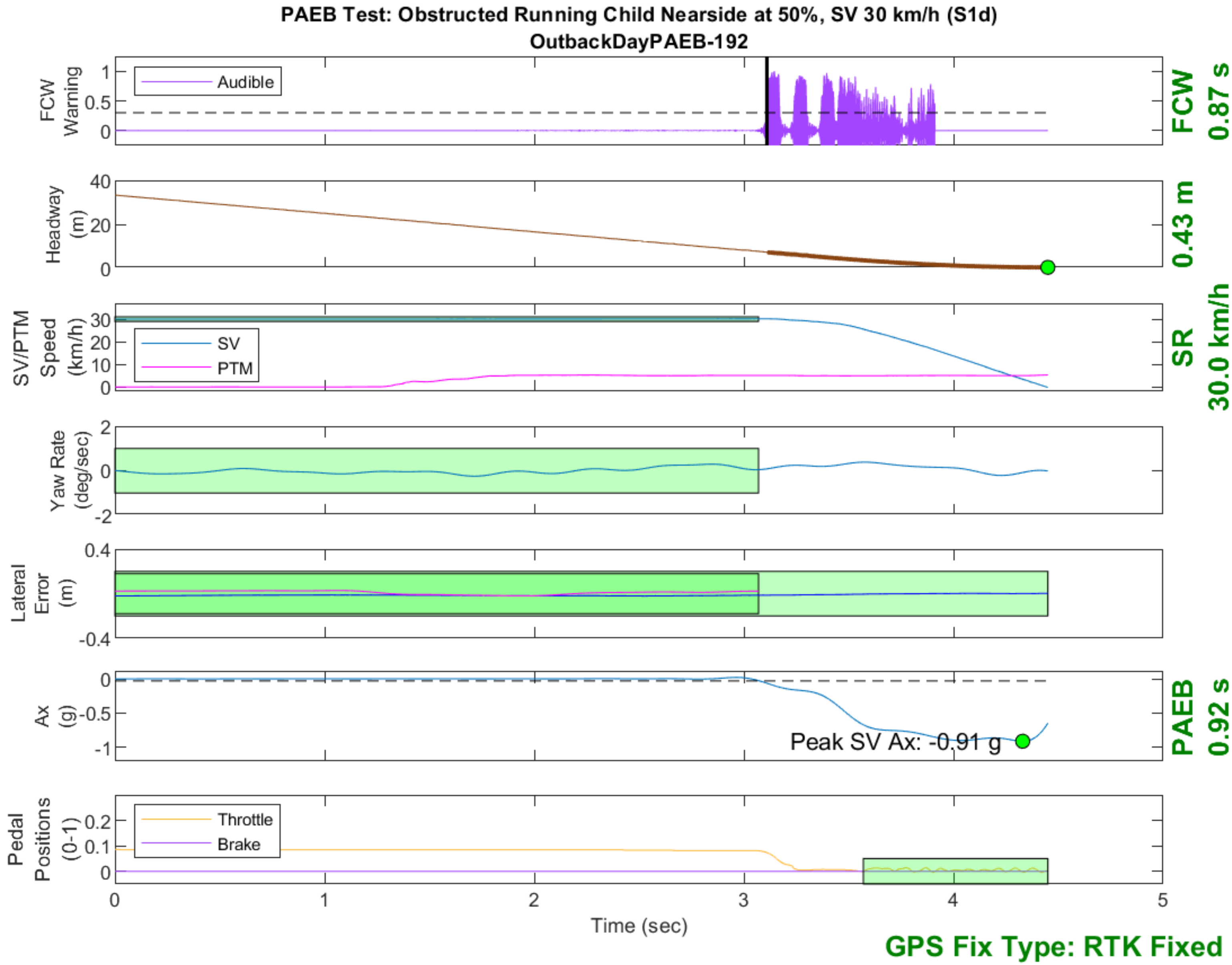


Figure D73. Time History for PAEB Run 192, S1d, Daytime, 30 km/h

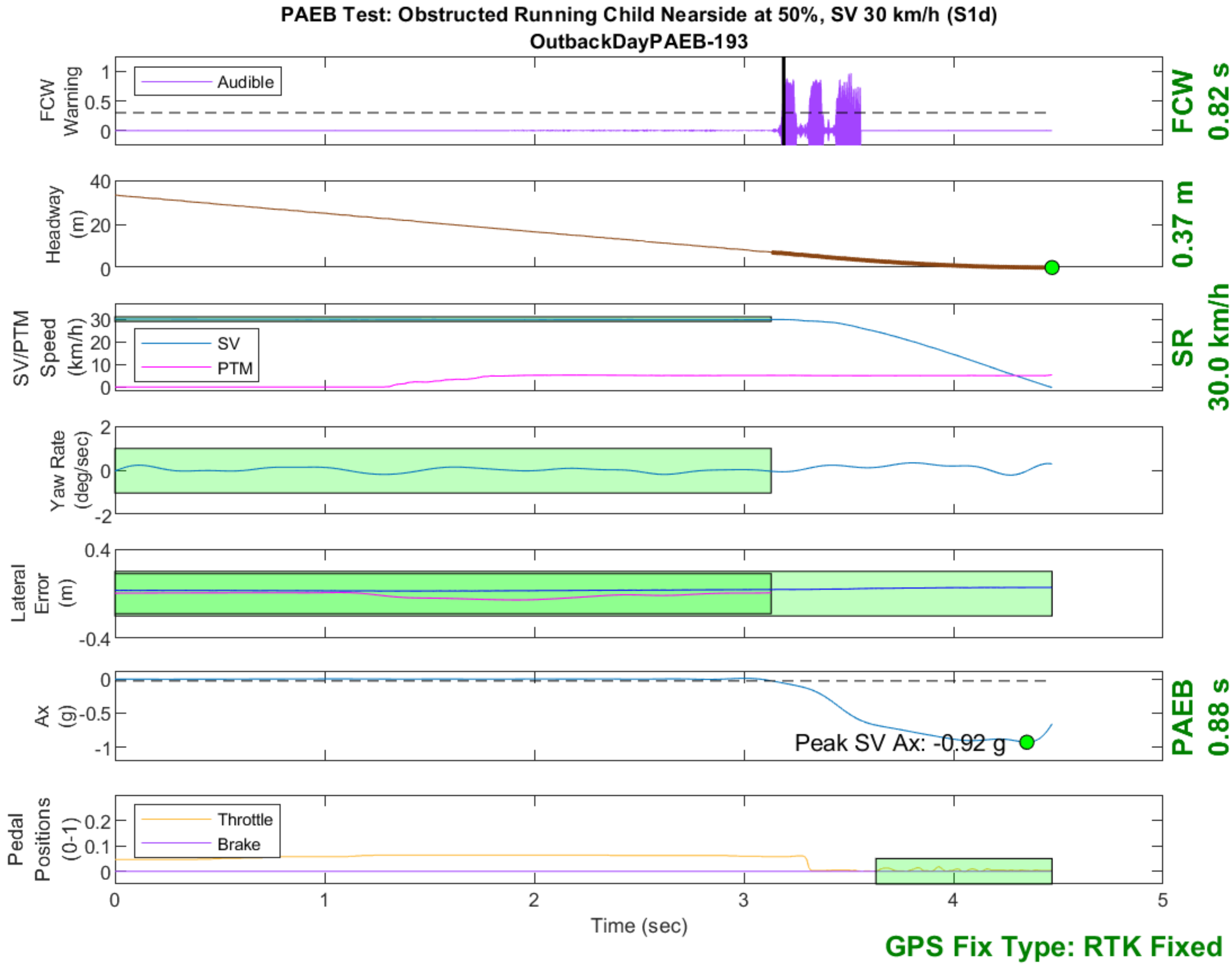


Figure D74. Time History for PAEB Run 193, S1d, Daytime, 30 km/h

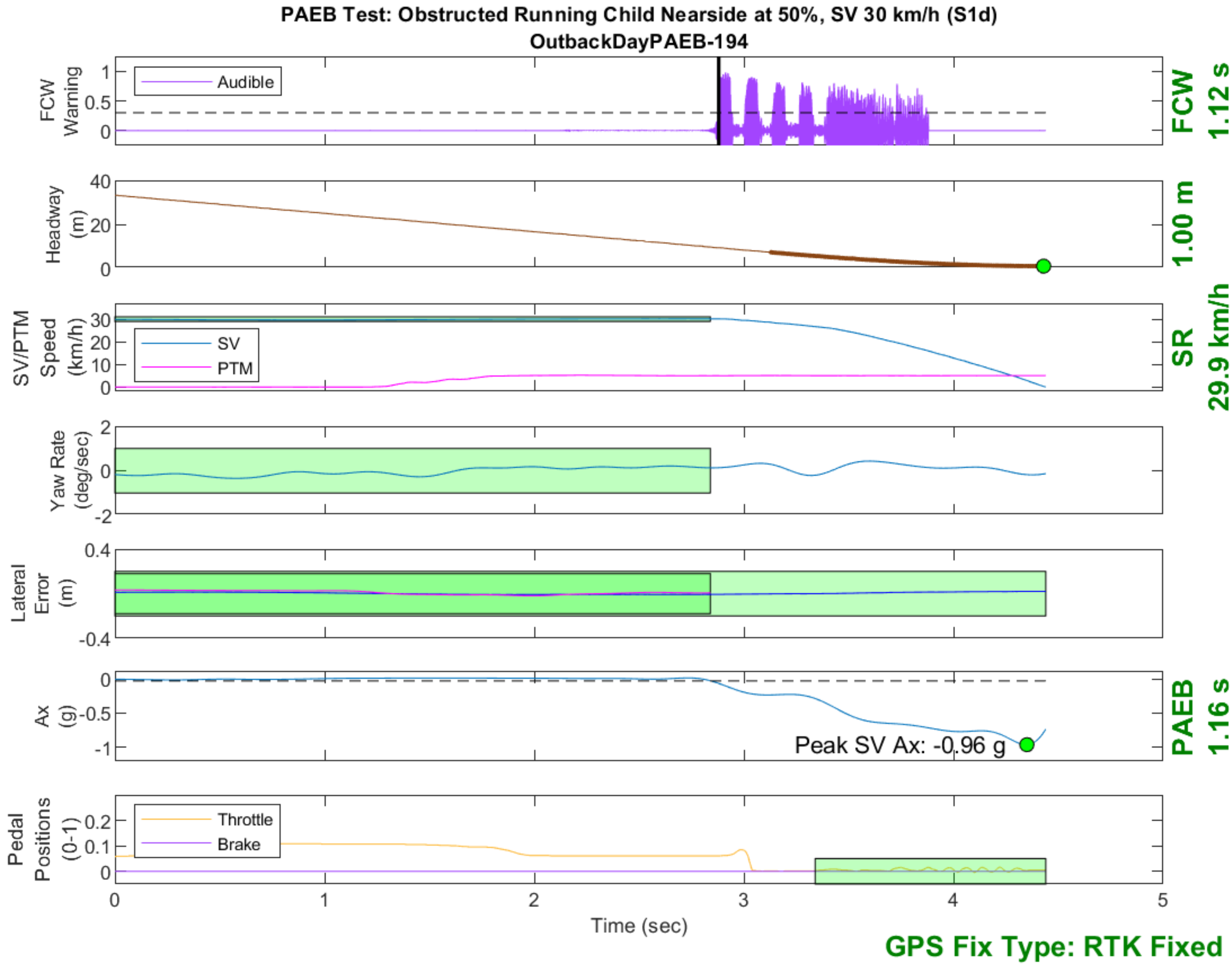


Figure D75. Time History for PAEB Run 194, S1d, Daytime, 30 km/h

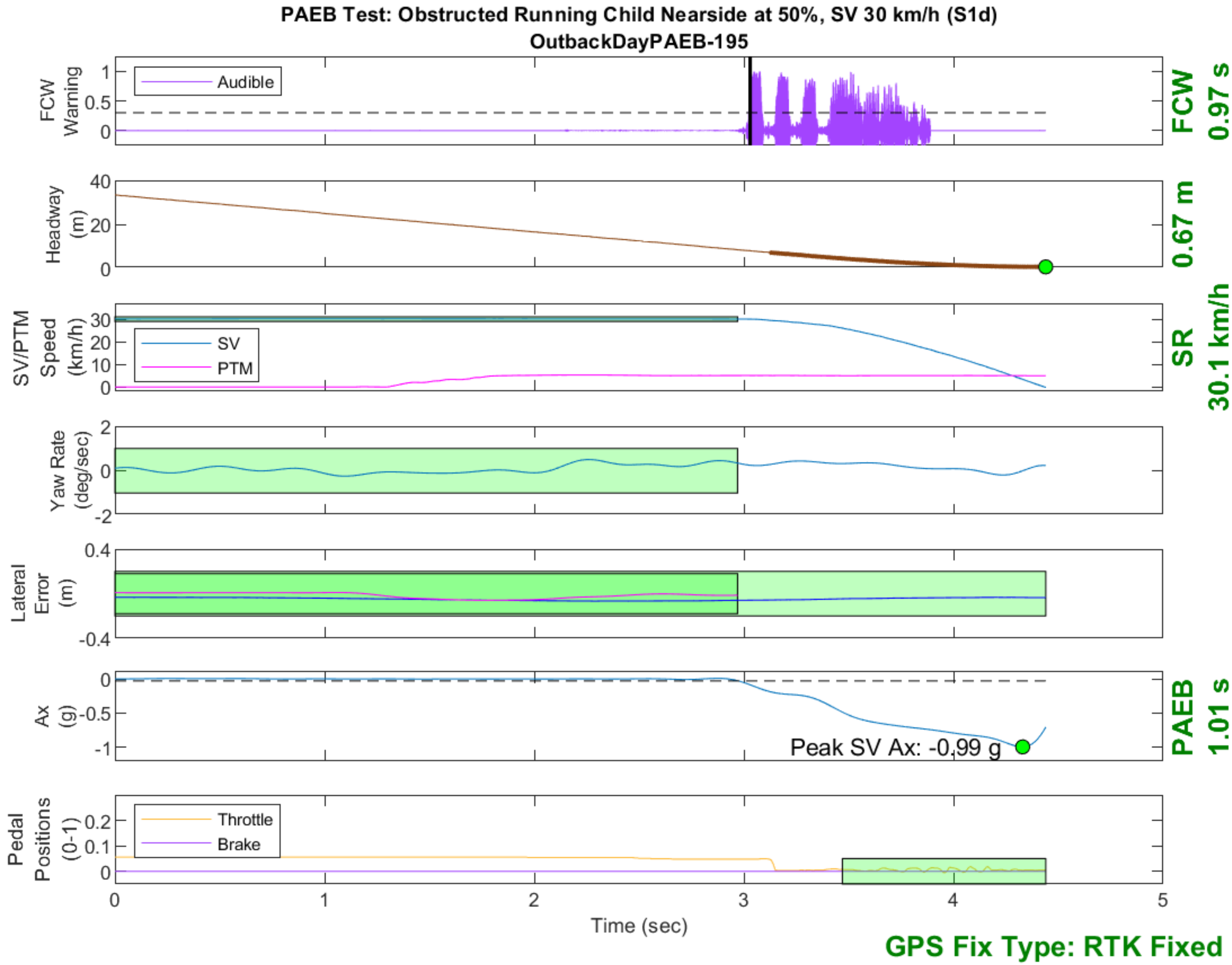


Figure D76. Time History for PAEB Run 195, S1d, Daytime, 30 km/h

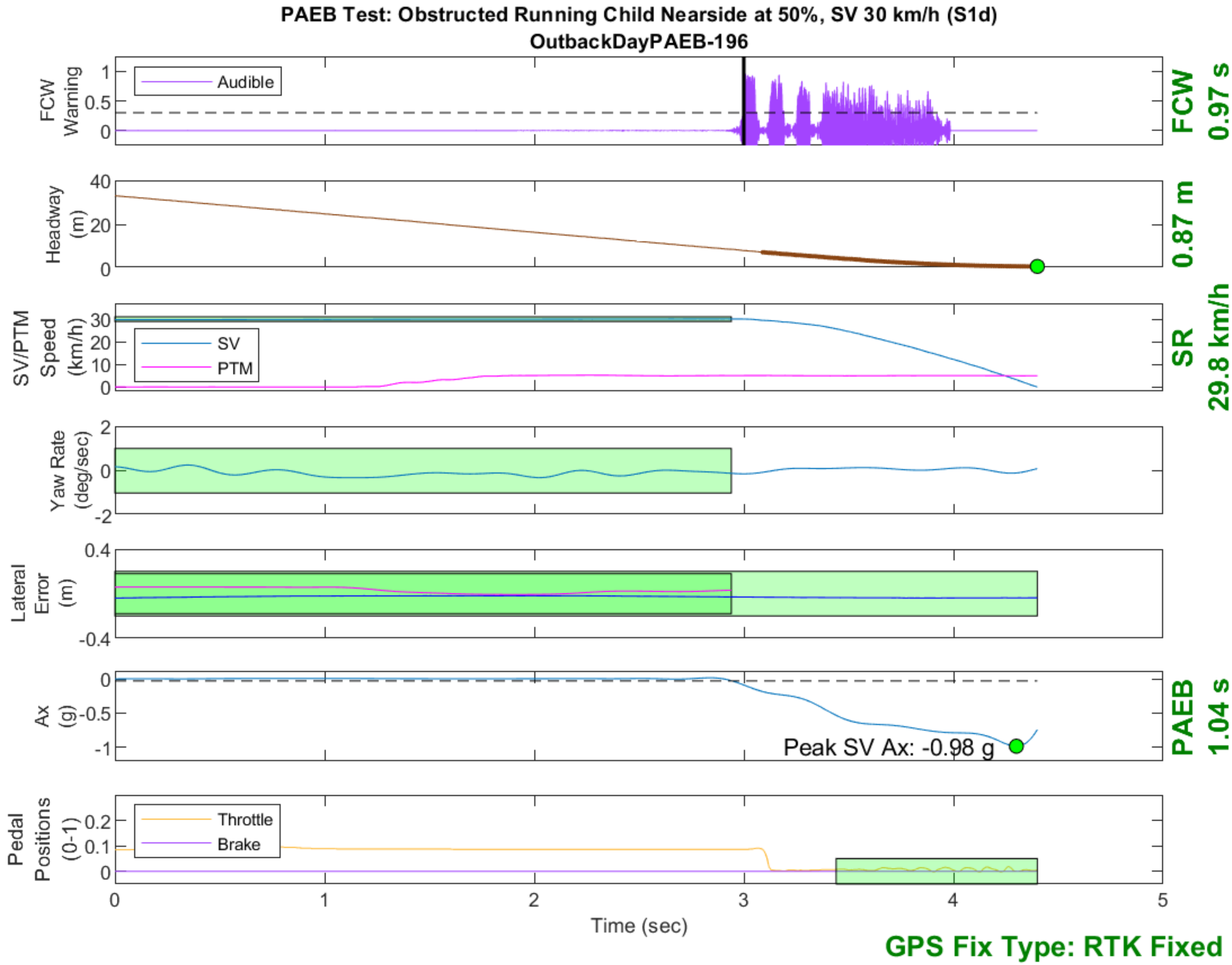


Figure D77. Time History for PAEB Run 196, S1d, Daytime, 30 km/h

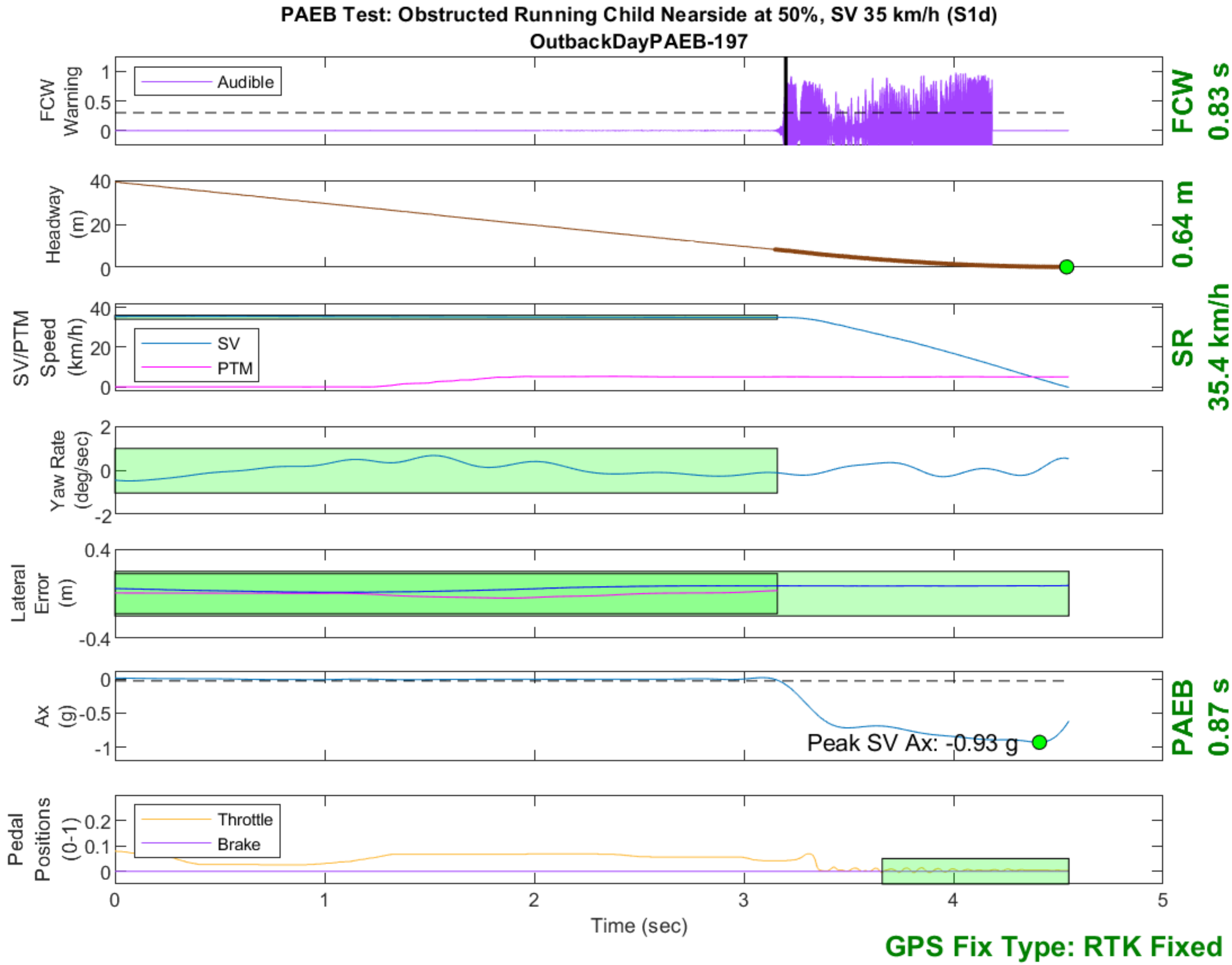


Figure D78. Time History for PAEB Run 197, S1d, Daytime, 35 km/h

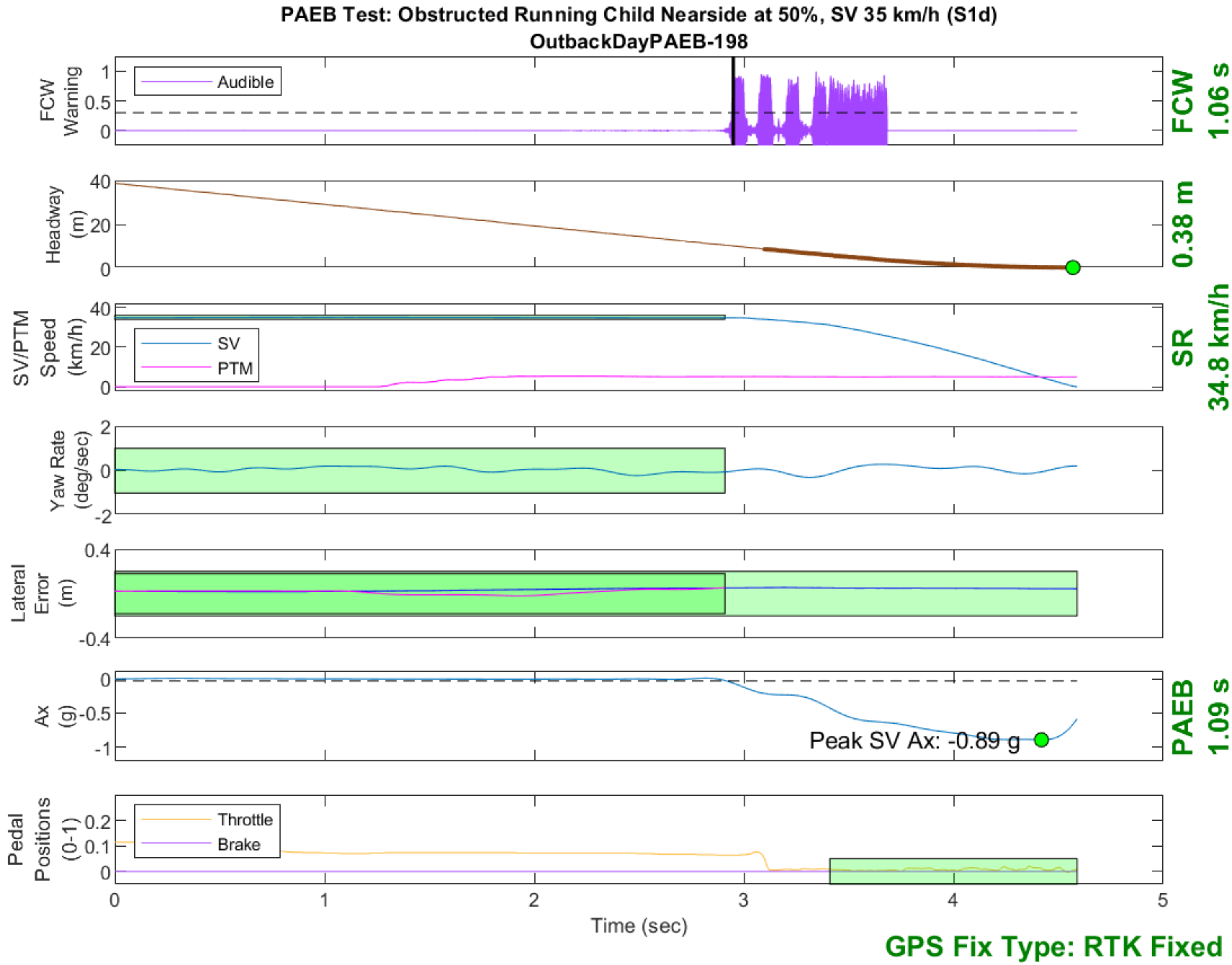


Figure D79. Time History for PAEB Run 198, S1d, Daytime, 35 km/h

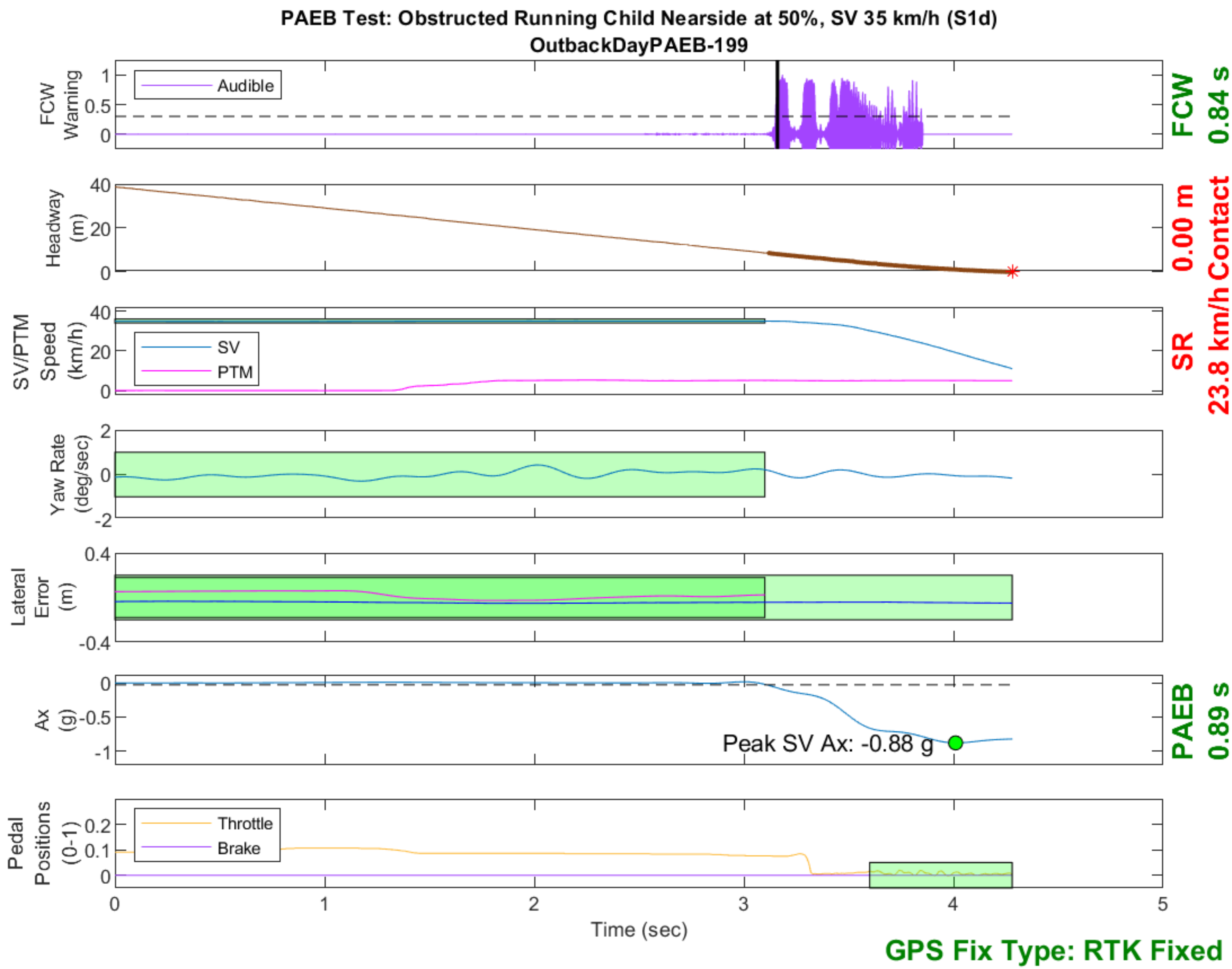


Figure D80. Time History for PAEB Run 199, S1d, Daytime, 35 km/h

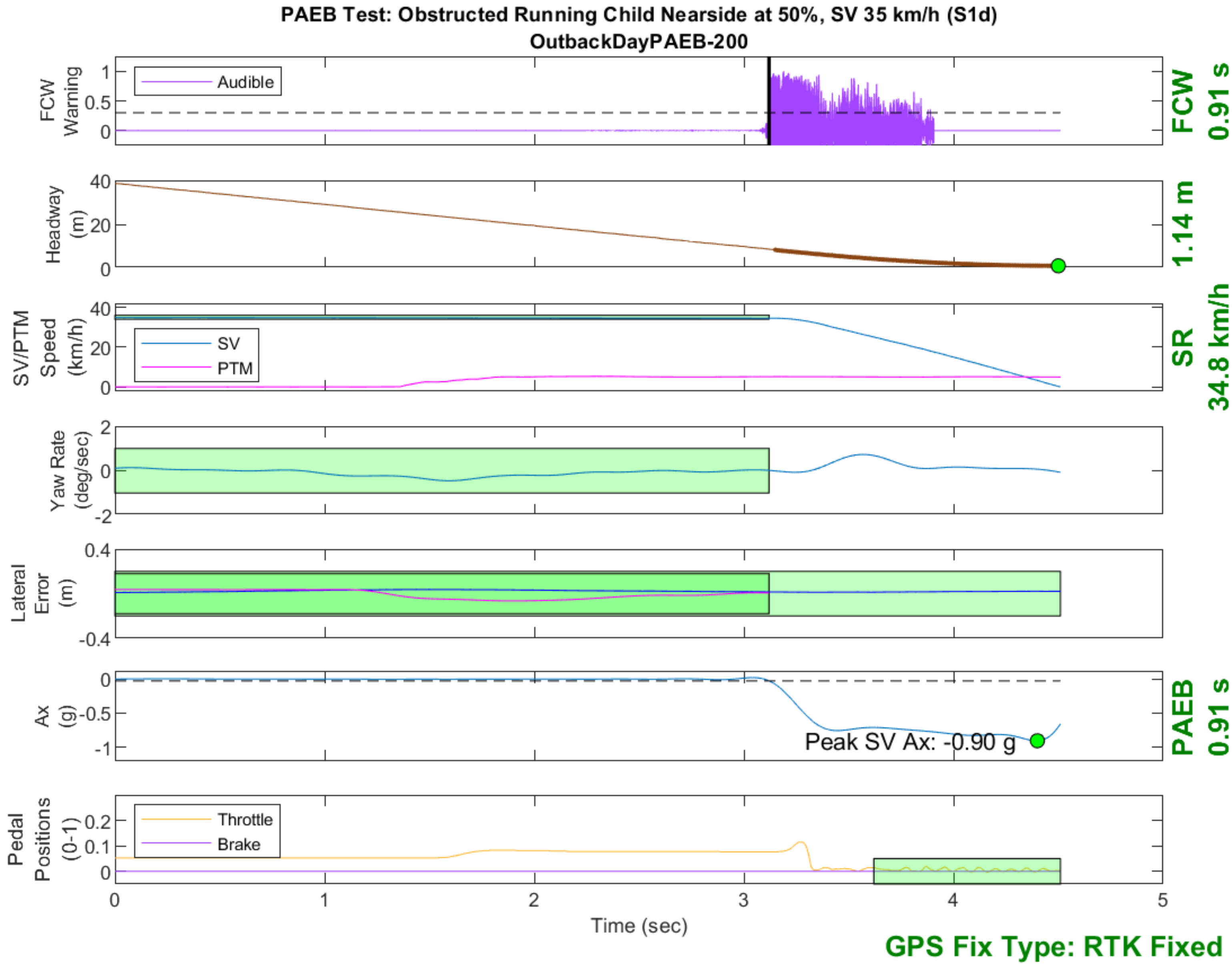


Figure D81. Time History for PAEB Run 200, S1d, Daytime, 35 km/h

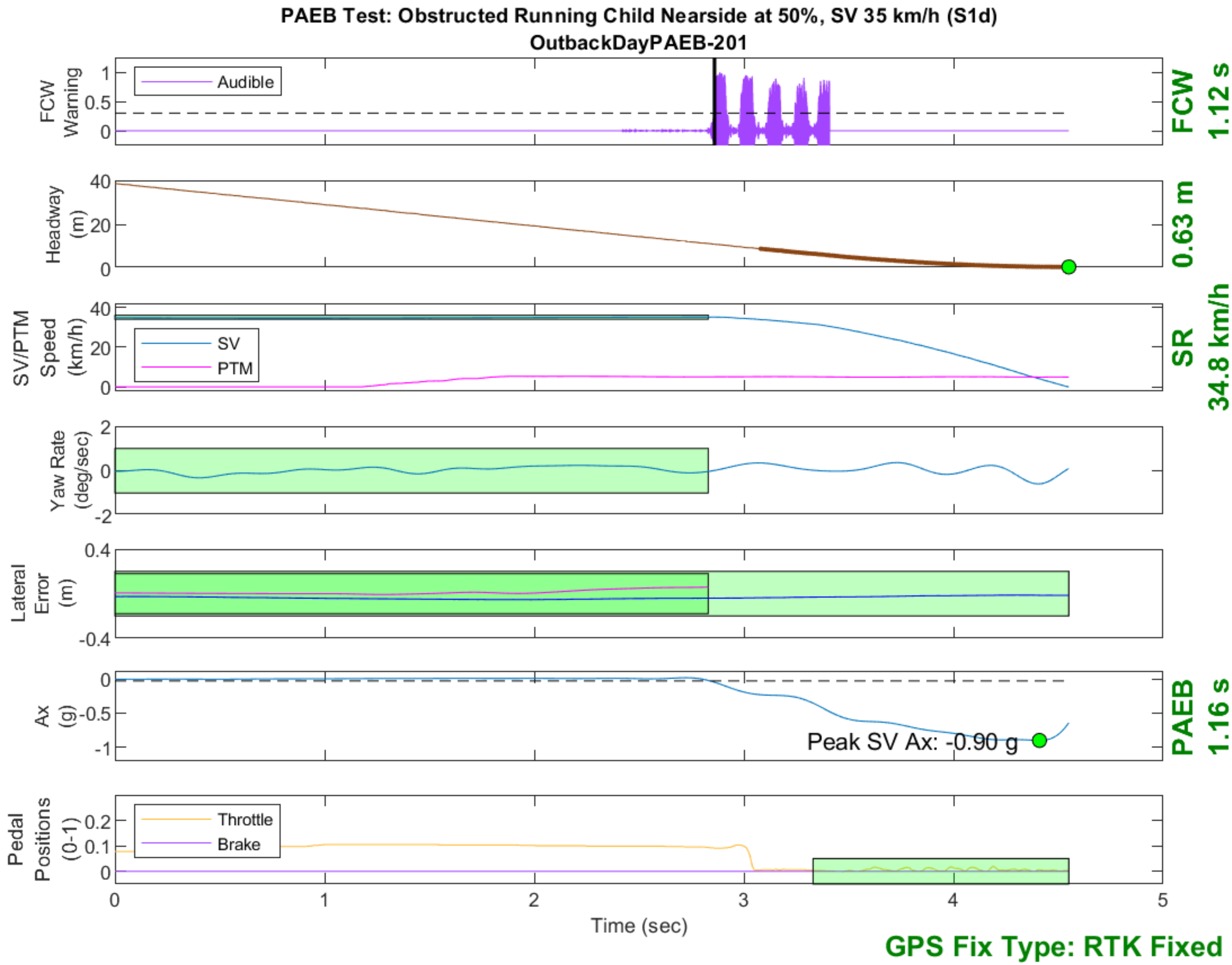


Figure D82. Time History for PAEB Run 201, S1d, Daytime, 35 km/h

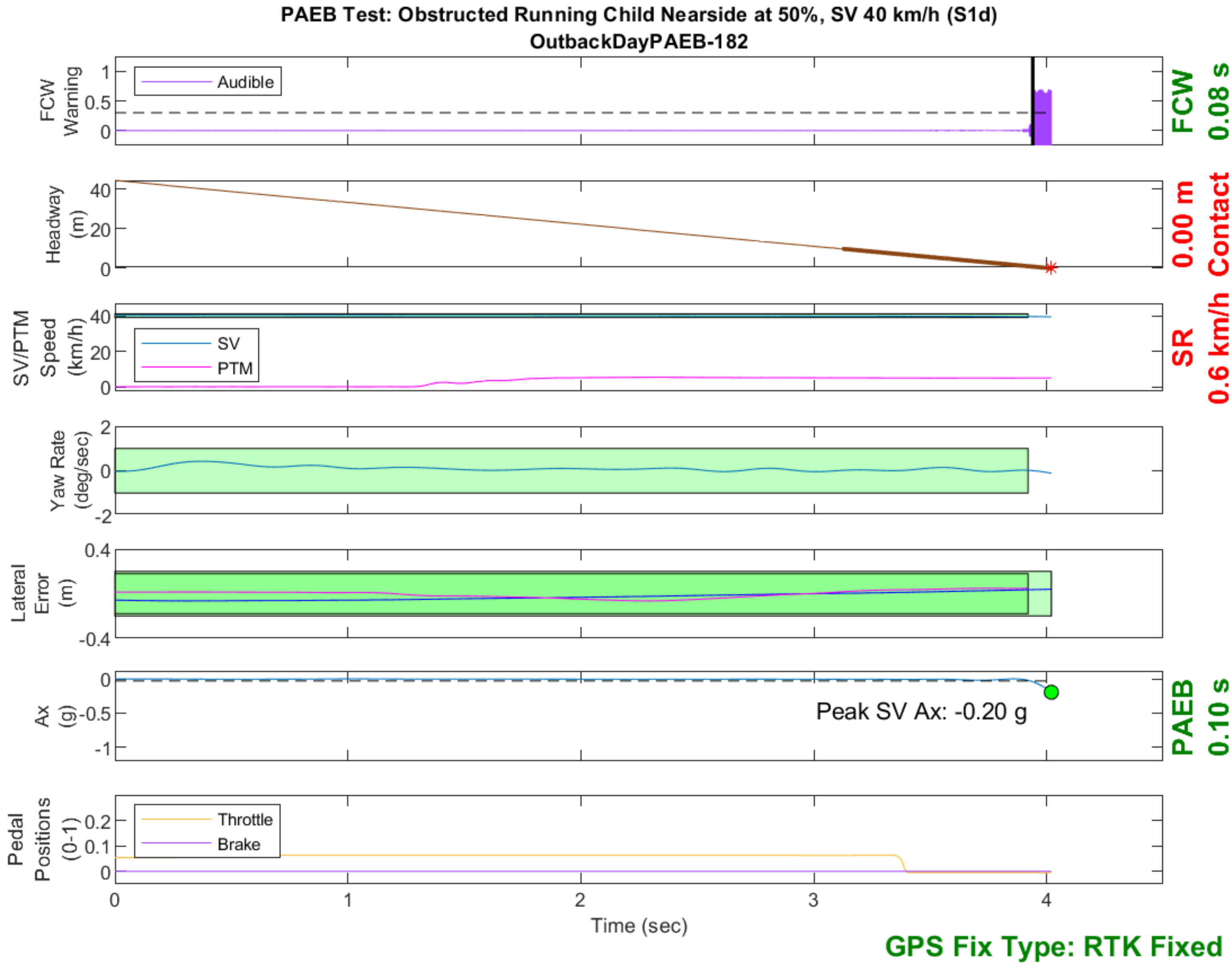


Figure D83. Time History for PAEB Run 182, S1d, Daytime, 40 km/h

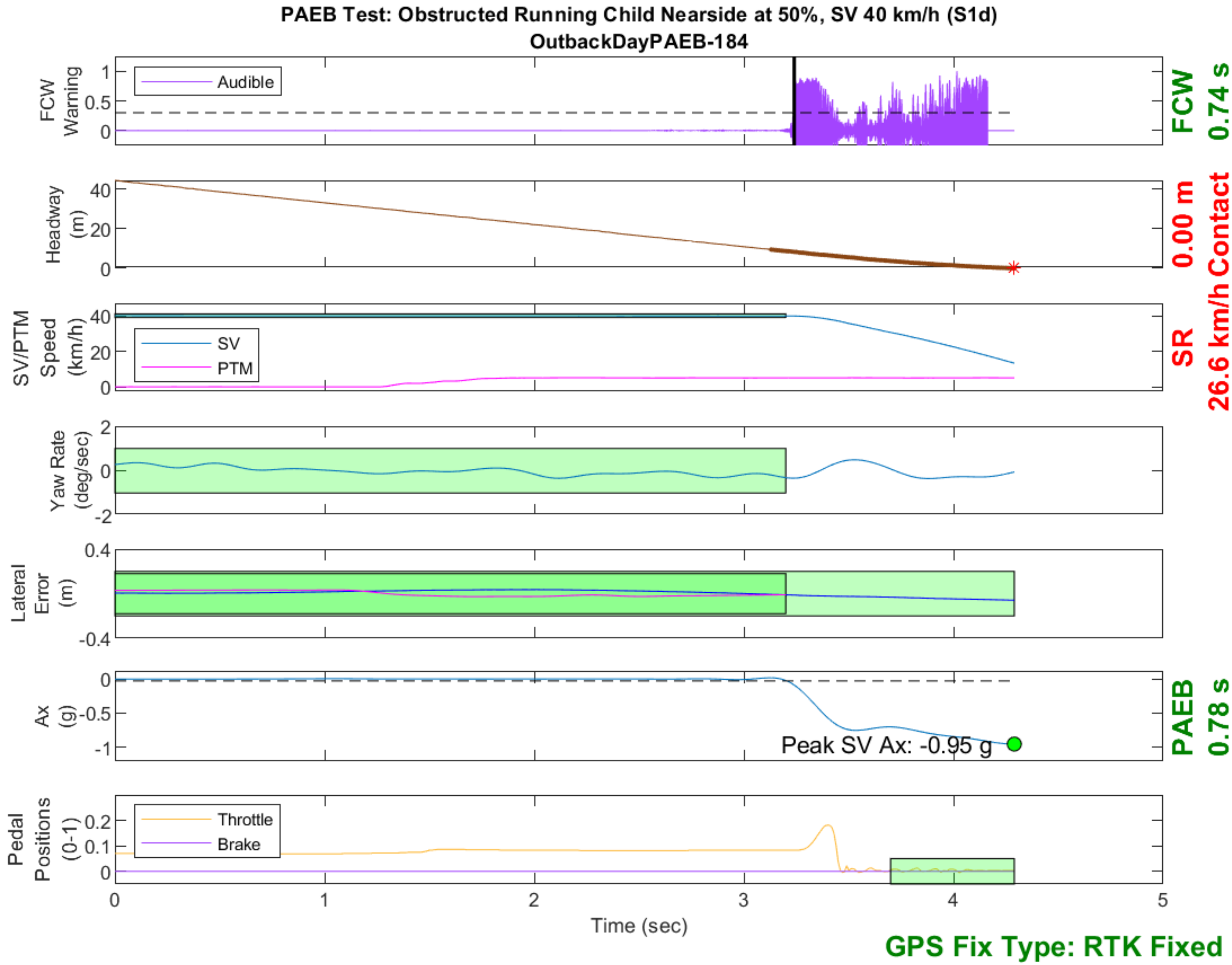


Figure D84. Time History for PAEB Run 184, S1d, Daytime, 40 km/h

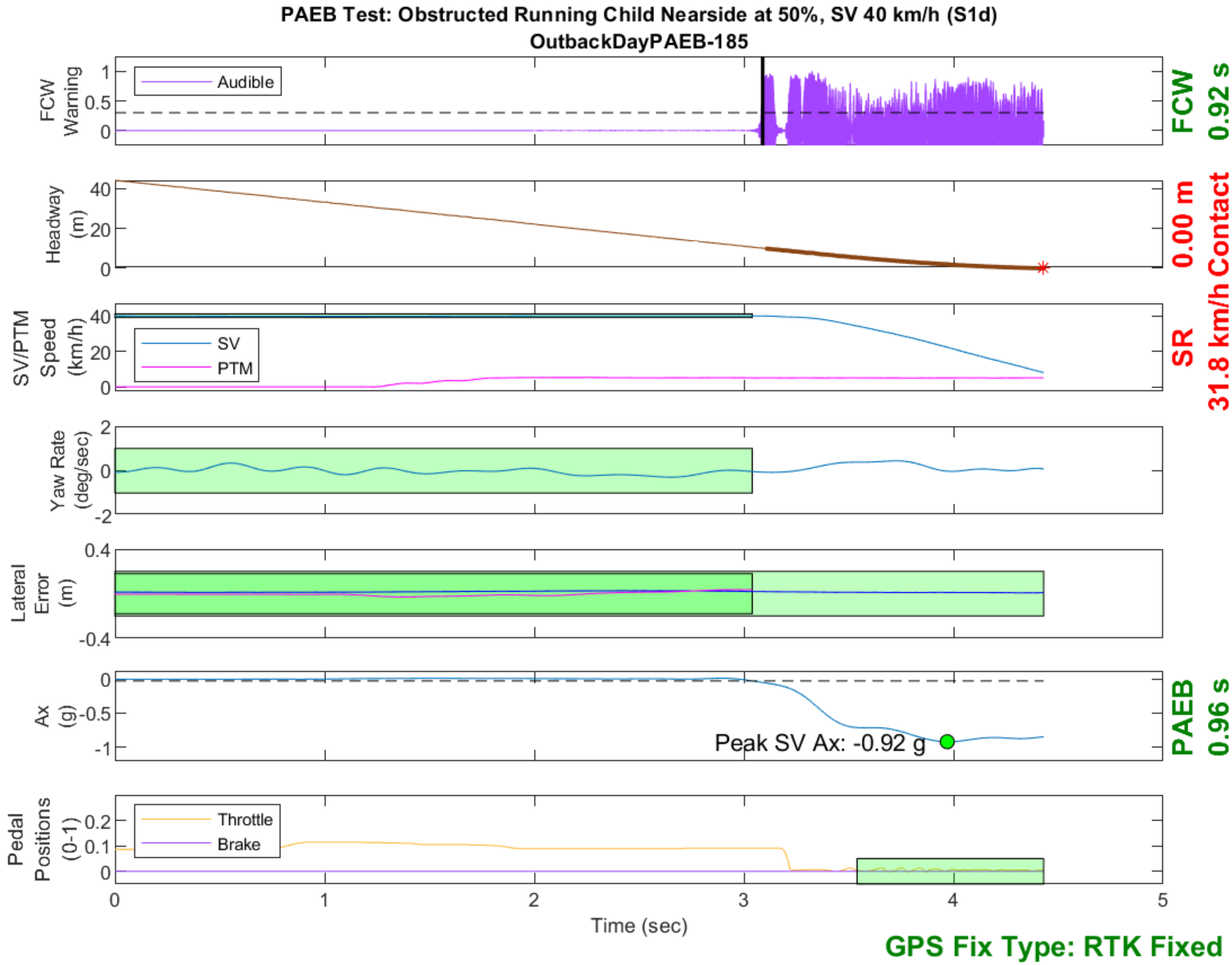


Figure D85. Time History for PAEB Run 185, S1d, Daytime, 40 km/h

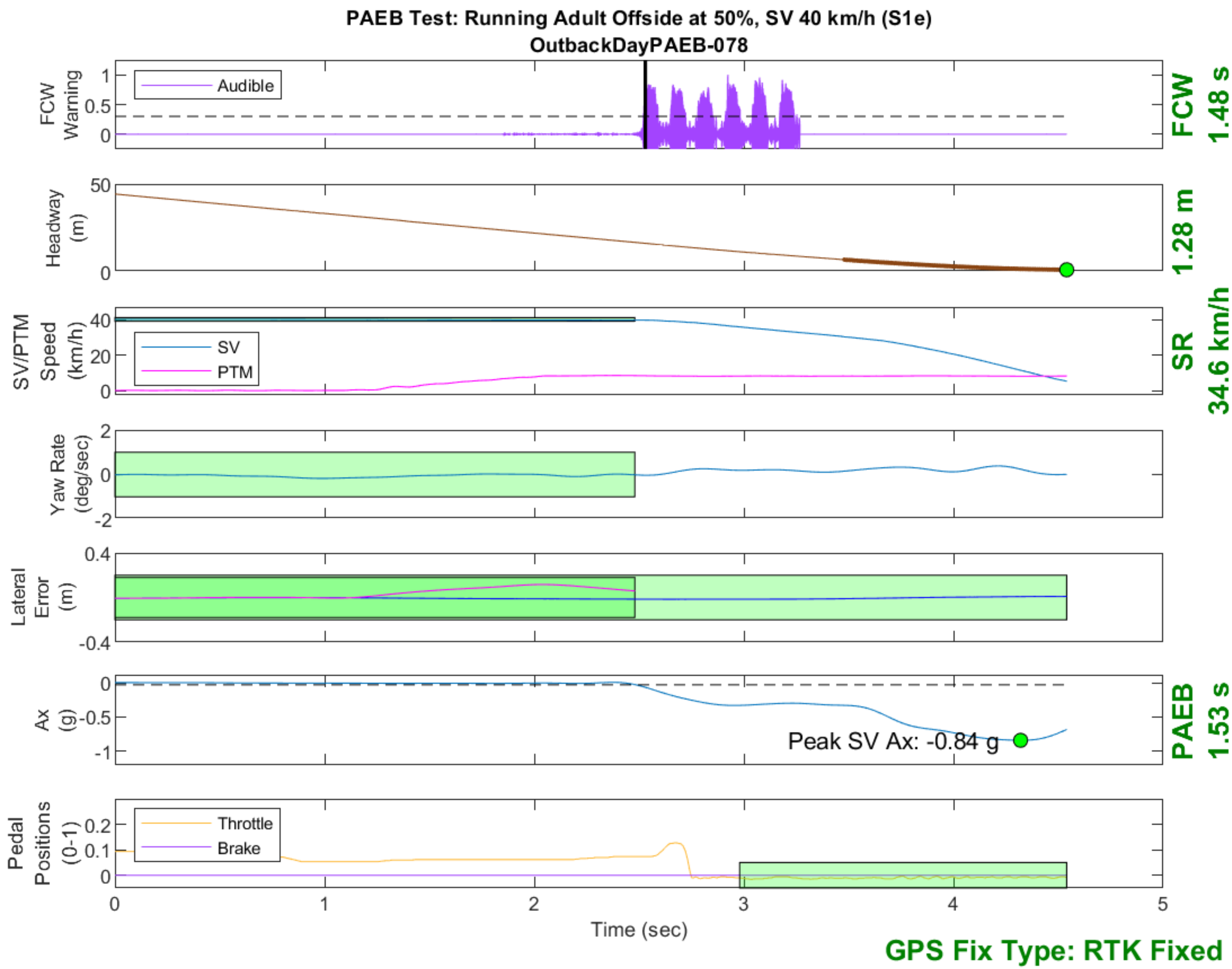


Figure D86. Time History for PAEB Run 78, S1e, Daytime, 40 km/h

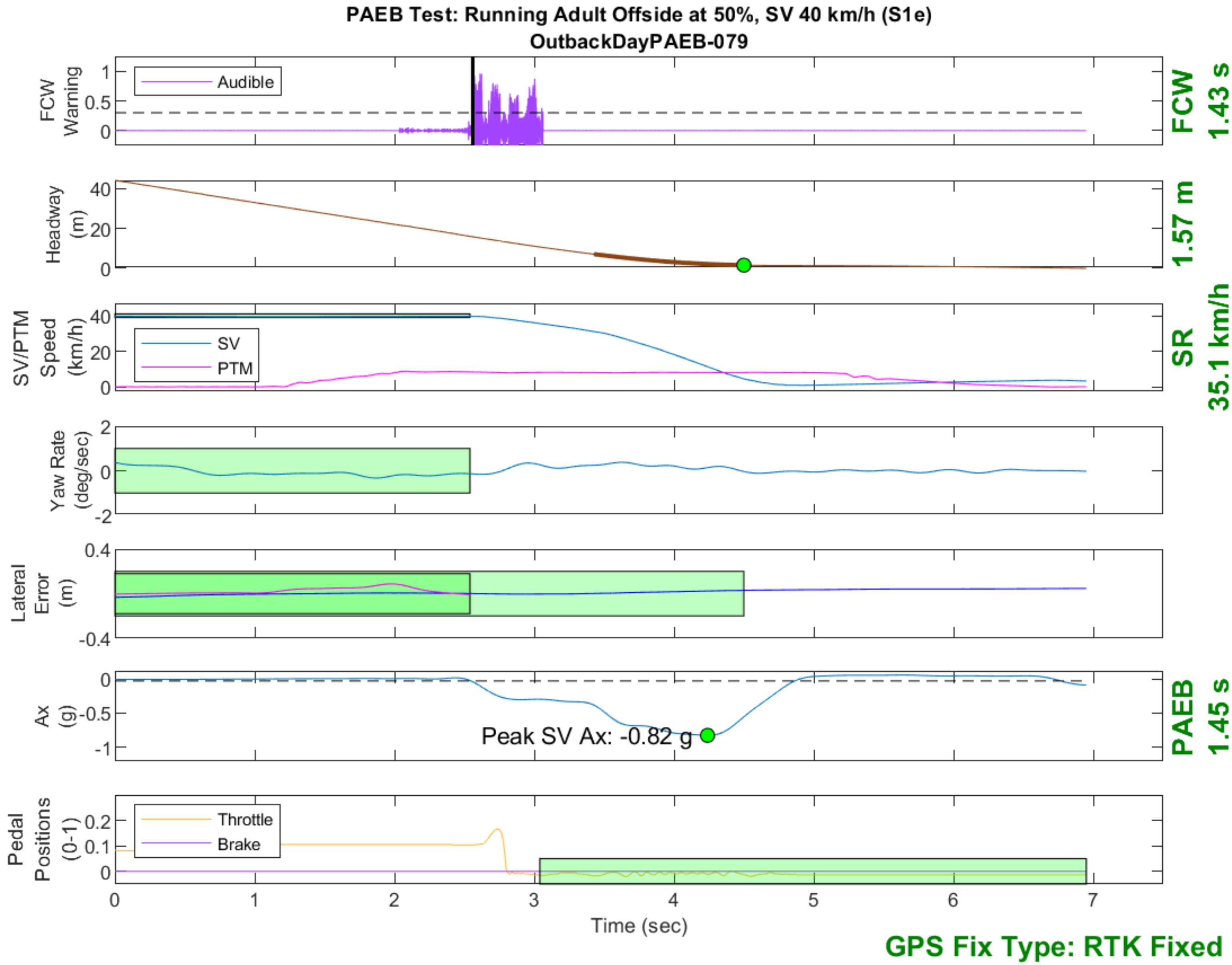


Figure D87. Time History for PAEB Run 79, S1e, Daytime, 40 km/h

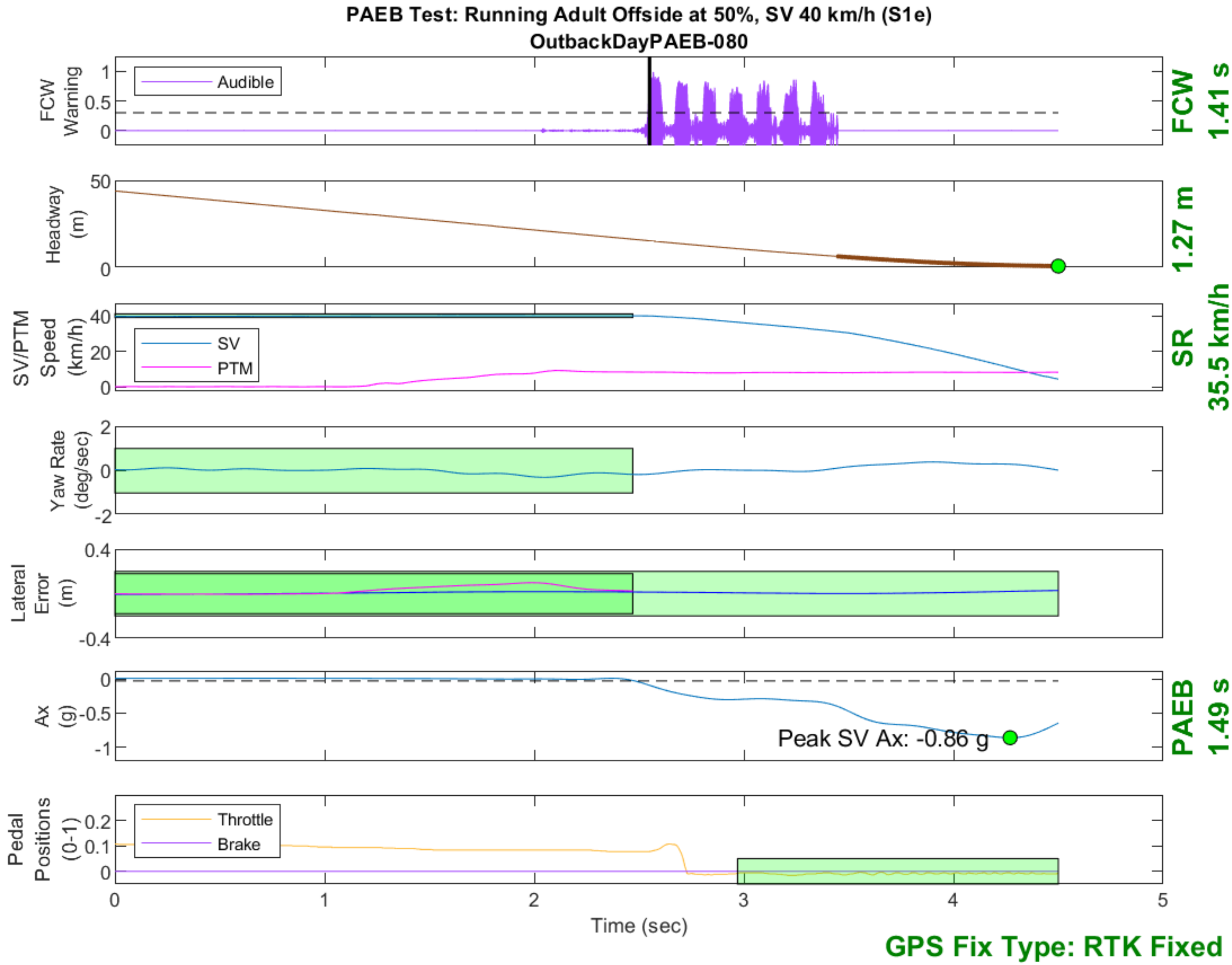


Figure D88. Time History for PAEB Run 80, S1e, Daytime, 40 km/h

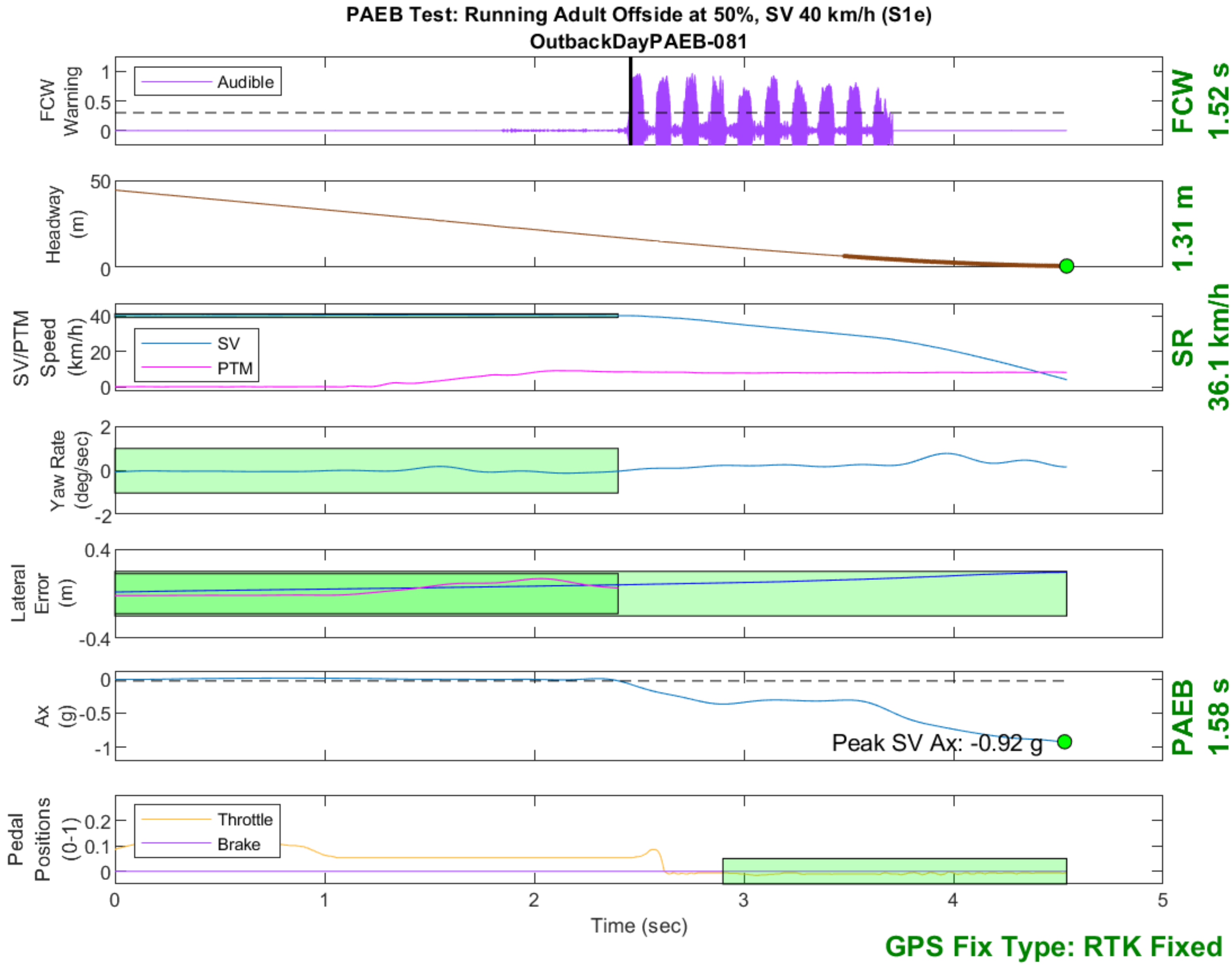


Figure D89. Time History for PAEB Run 81, S1e, Daytime, 40 km/h

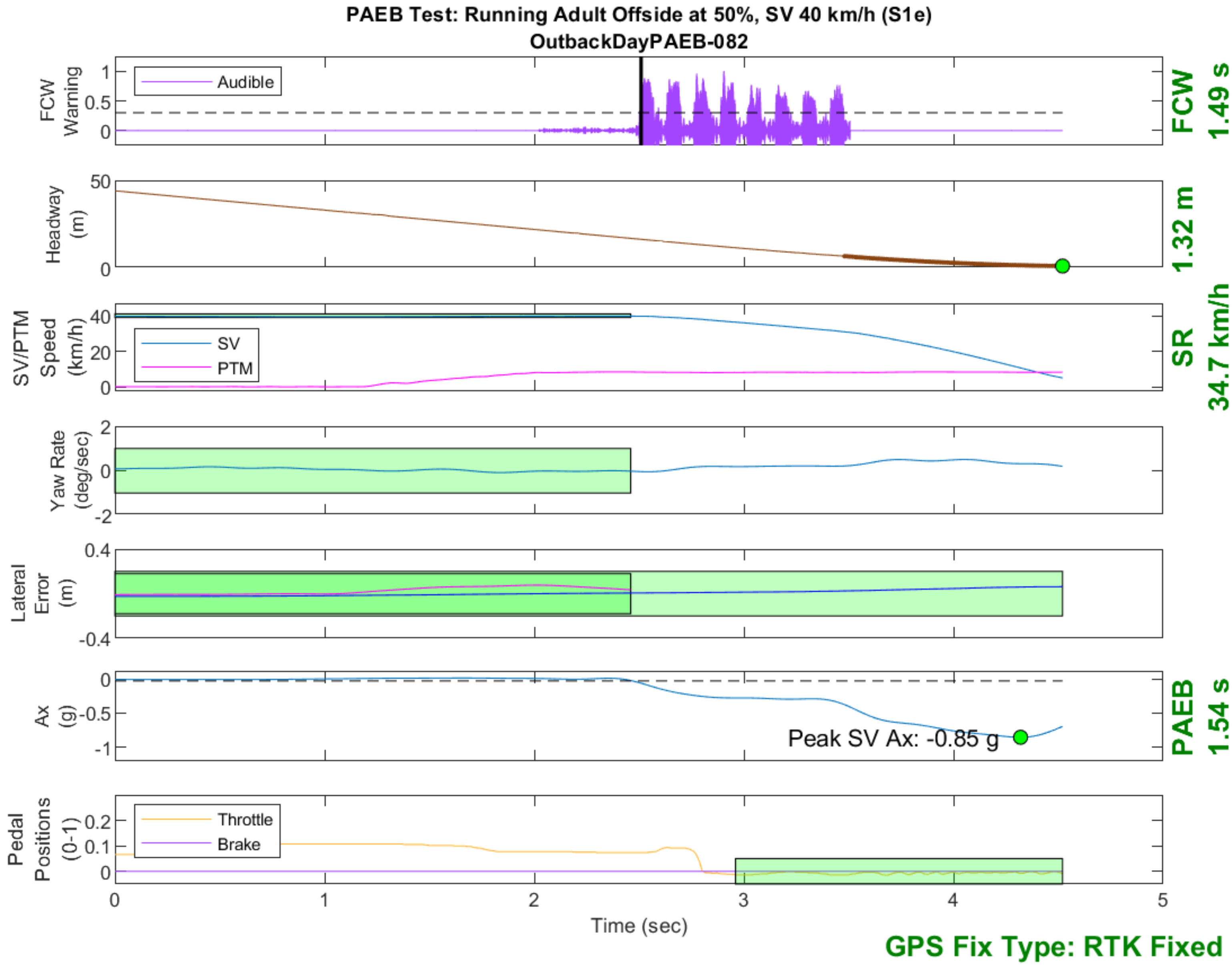


Figure D90. Time History for PAEB Run 82, S1e, Daytime, 40 km/h

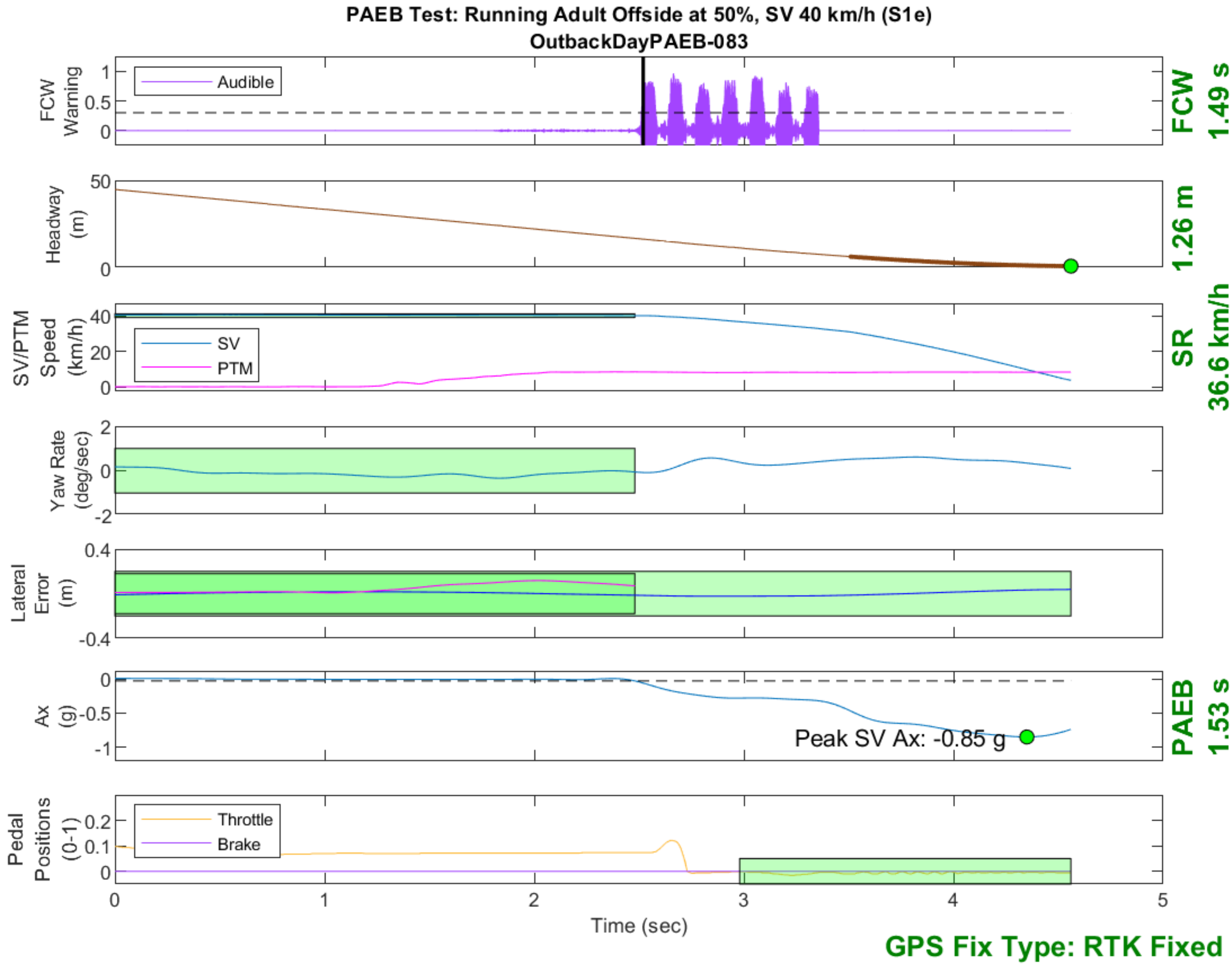


Figure D91. Time History for PAEB Run 83, S1e, Daytime, 40 km/h

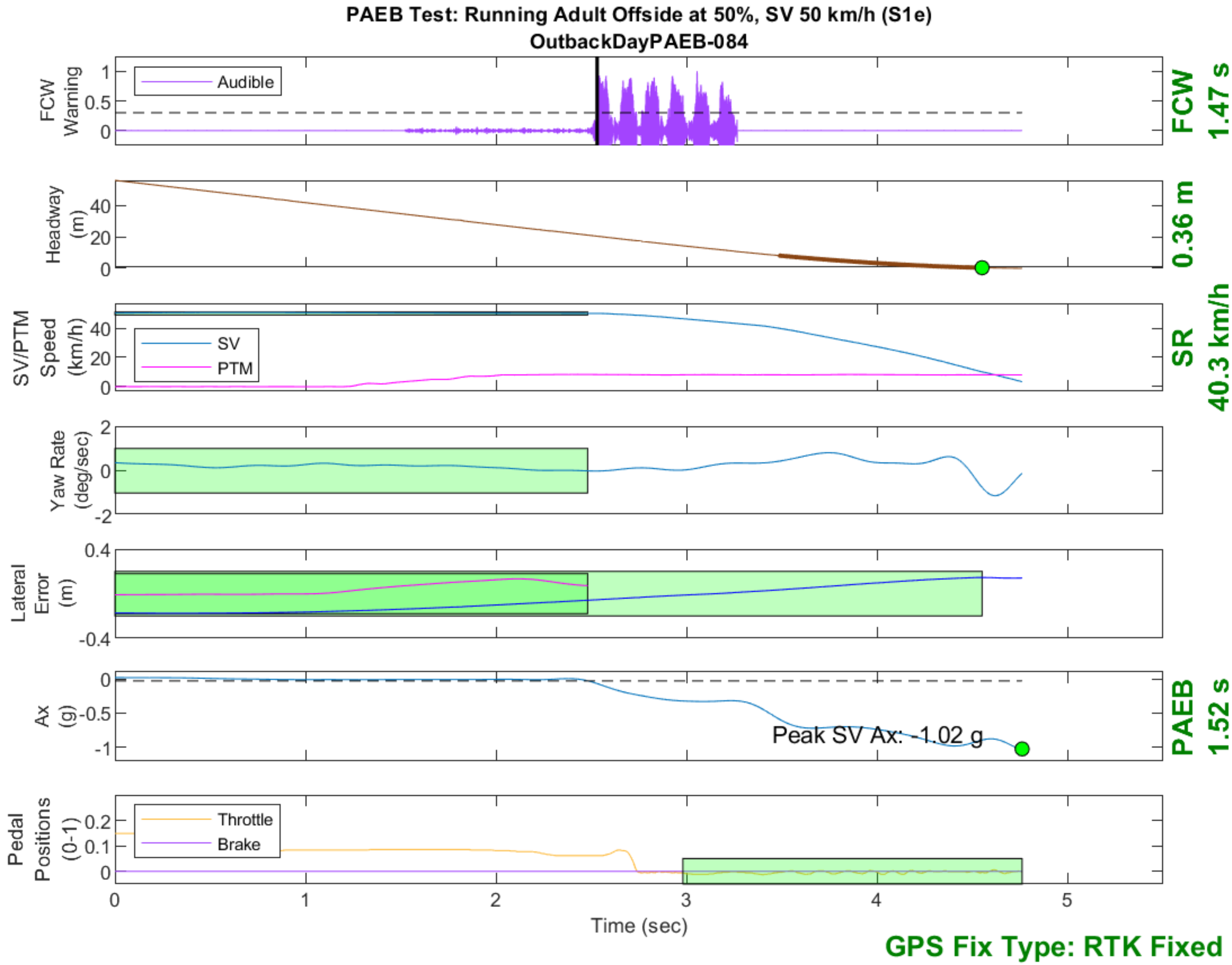


Figure D92. Time History for PAEB Run 84, S1e, Daytime, 50 km/h

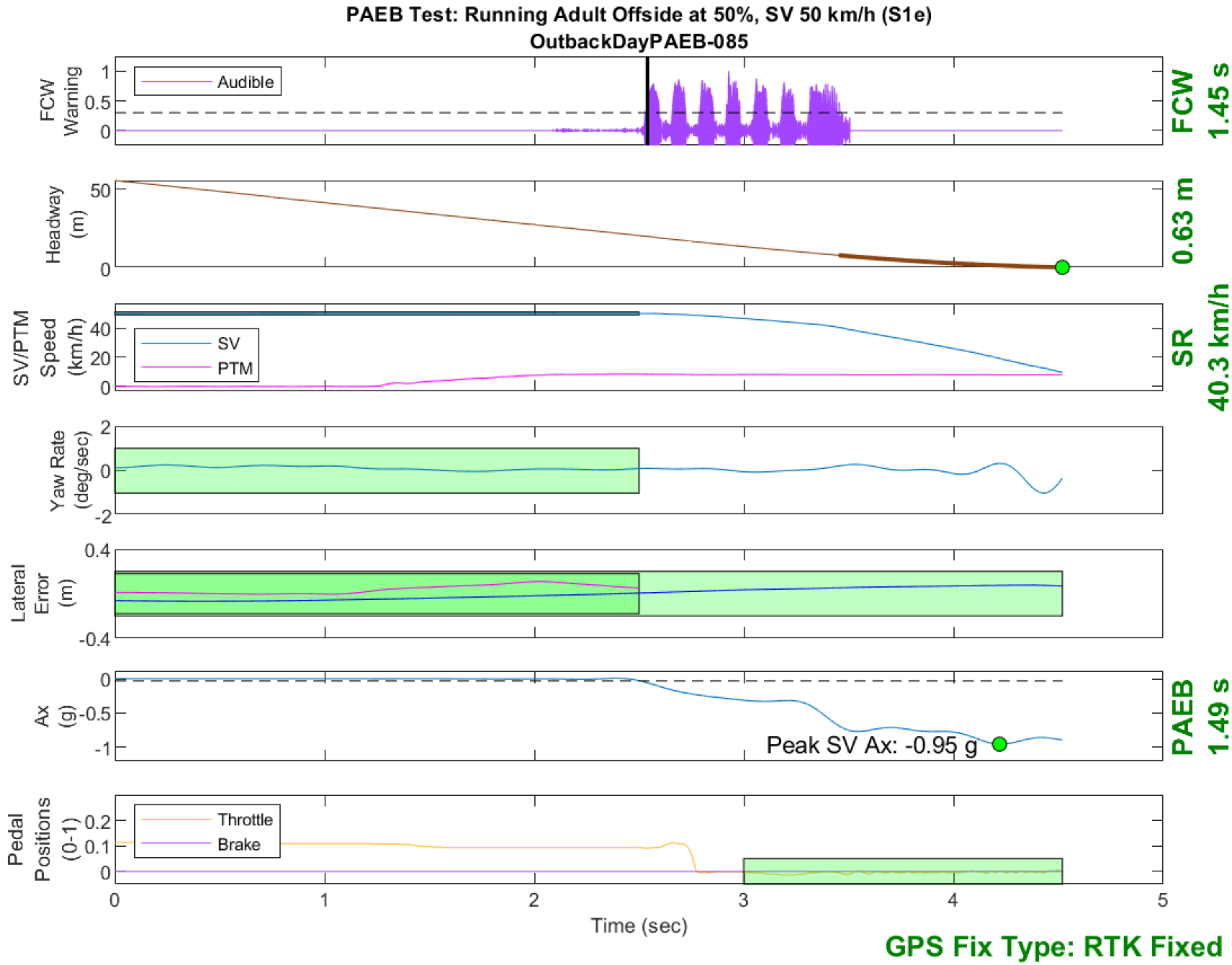


Figure D93. Time History for PAEB Run 85, S1e, Daytime, 50 km/h

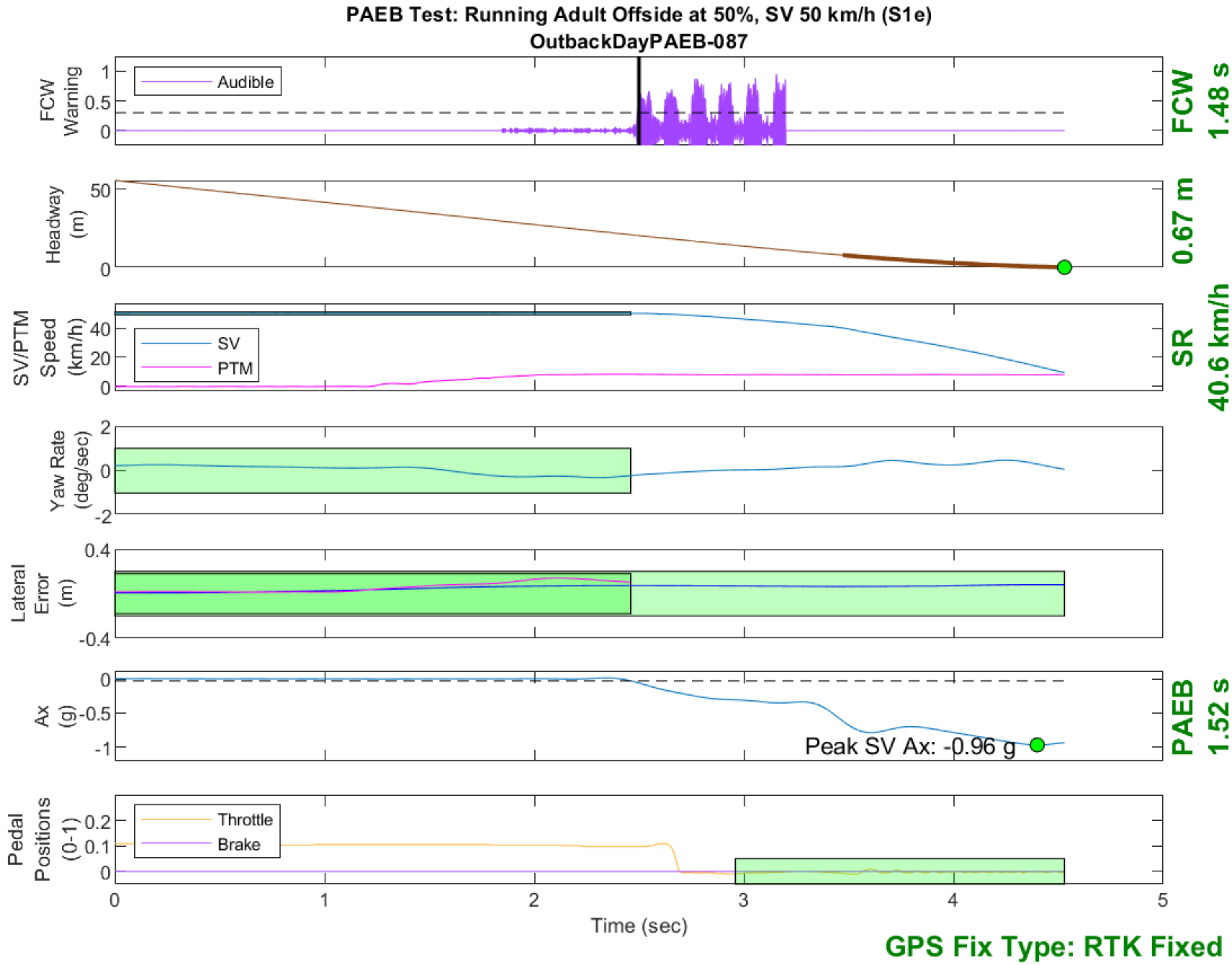


Figure D94. Time History for PAEB Run 87, S1e, Daytime, 50 km/h

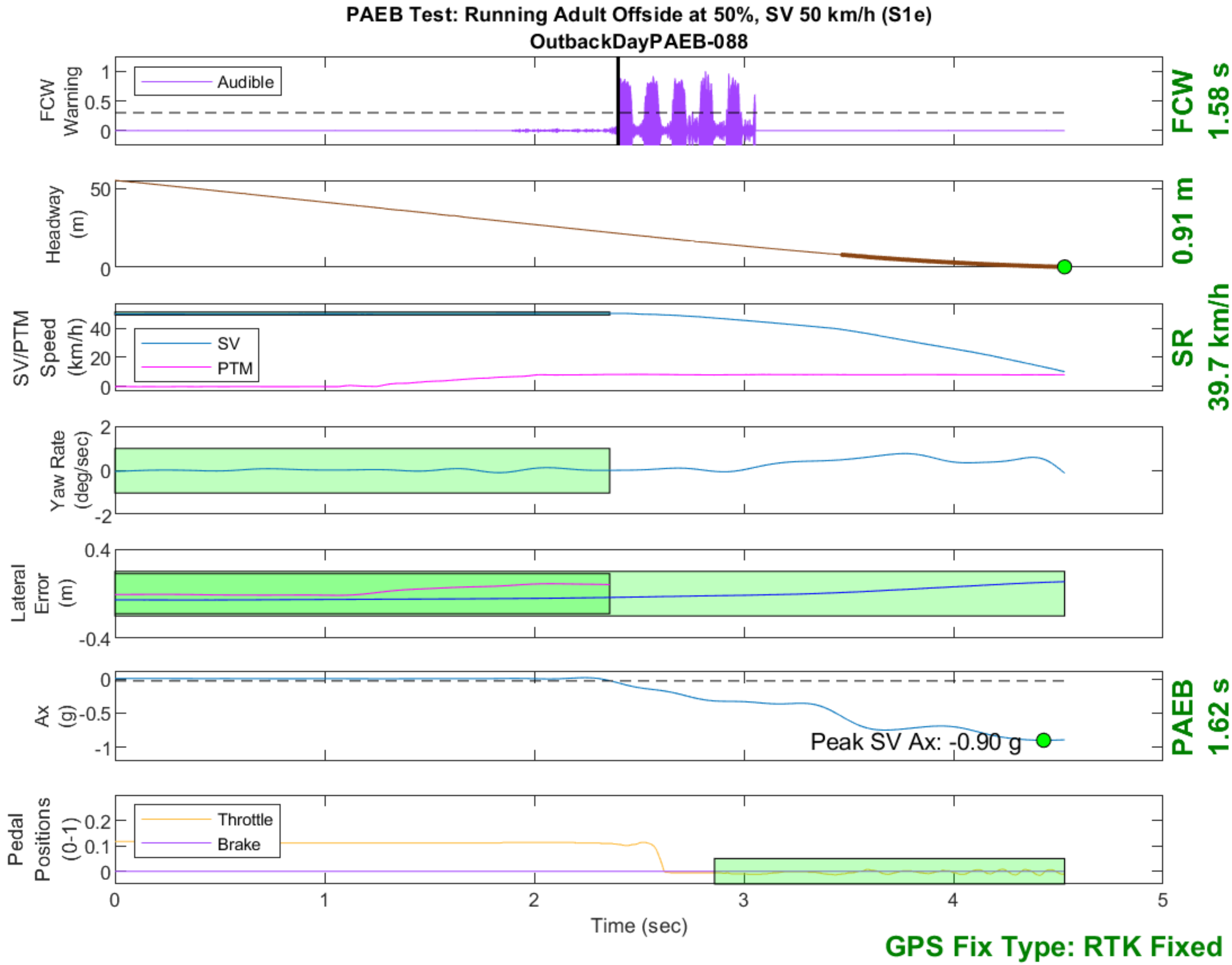


Figure D95. Time History for PAEB Run 88, S1e, Daytime, 50 km/h

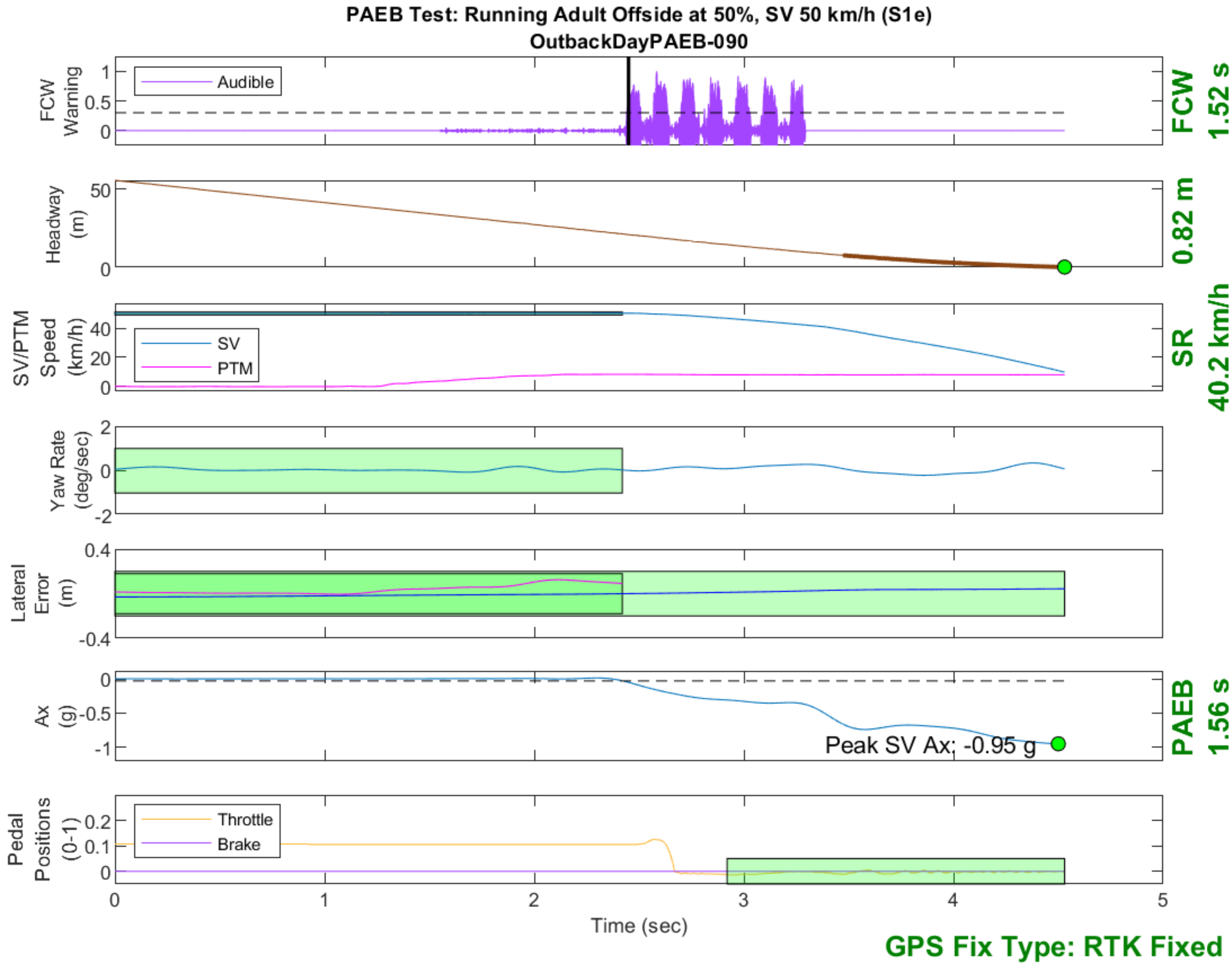


Figure D96. Time History for PAEB Run 90, S1e, Daytime, 50 km/h

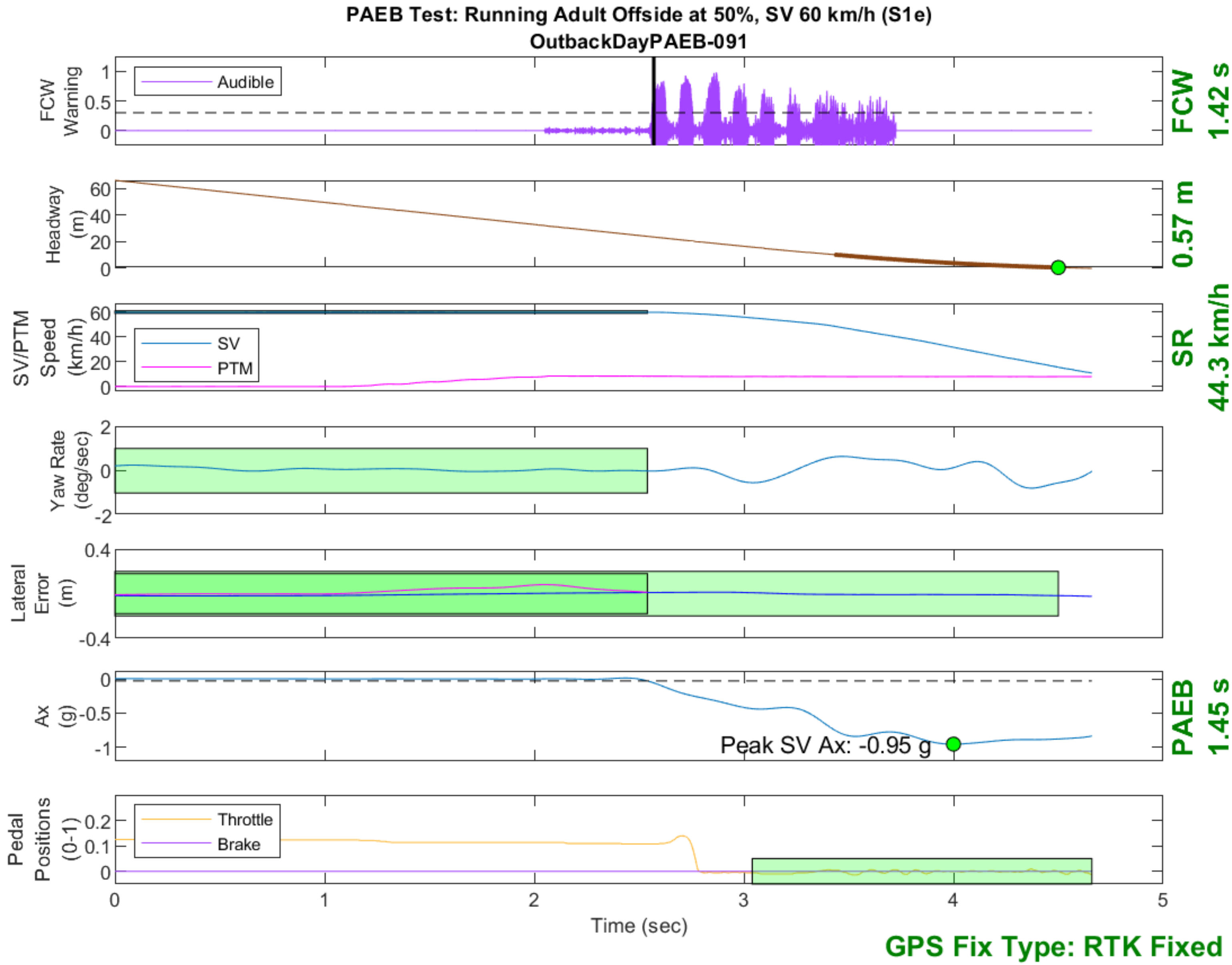


Figure D97. Time History for PAEB Run 91, S1e, Daytime, 60 km/h

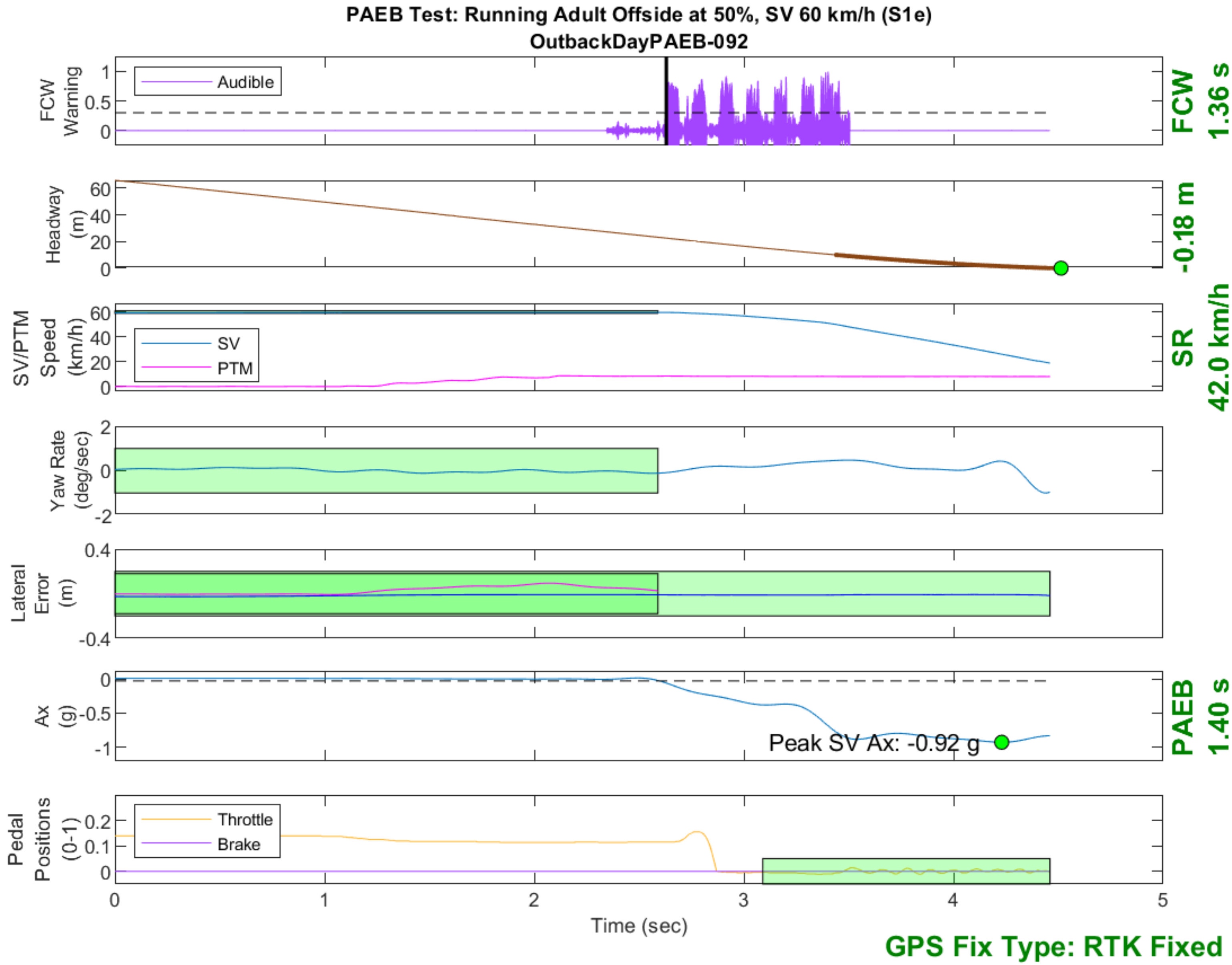


Figure D98. Time History for PAEB Run 92, S1e, Daytime, 60 km/h

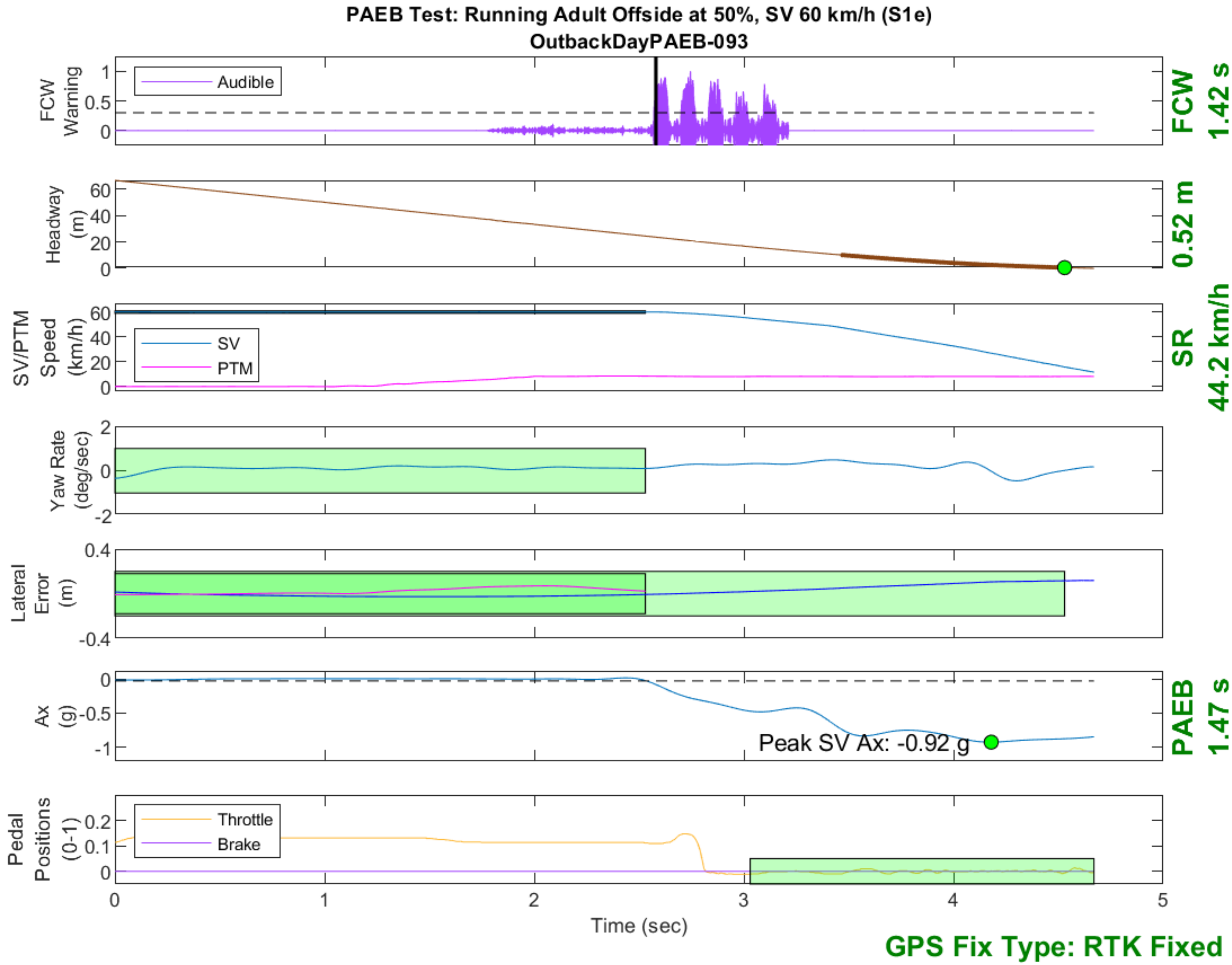


Figure D99. Time History for PAEB Run 93, S1e, Daytime, 60 km/h

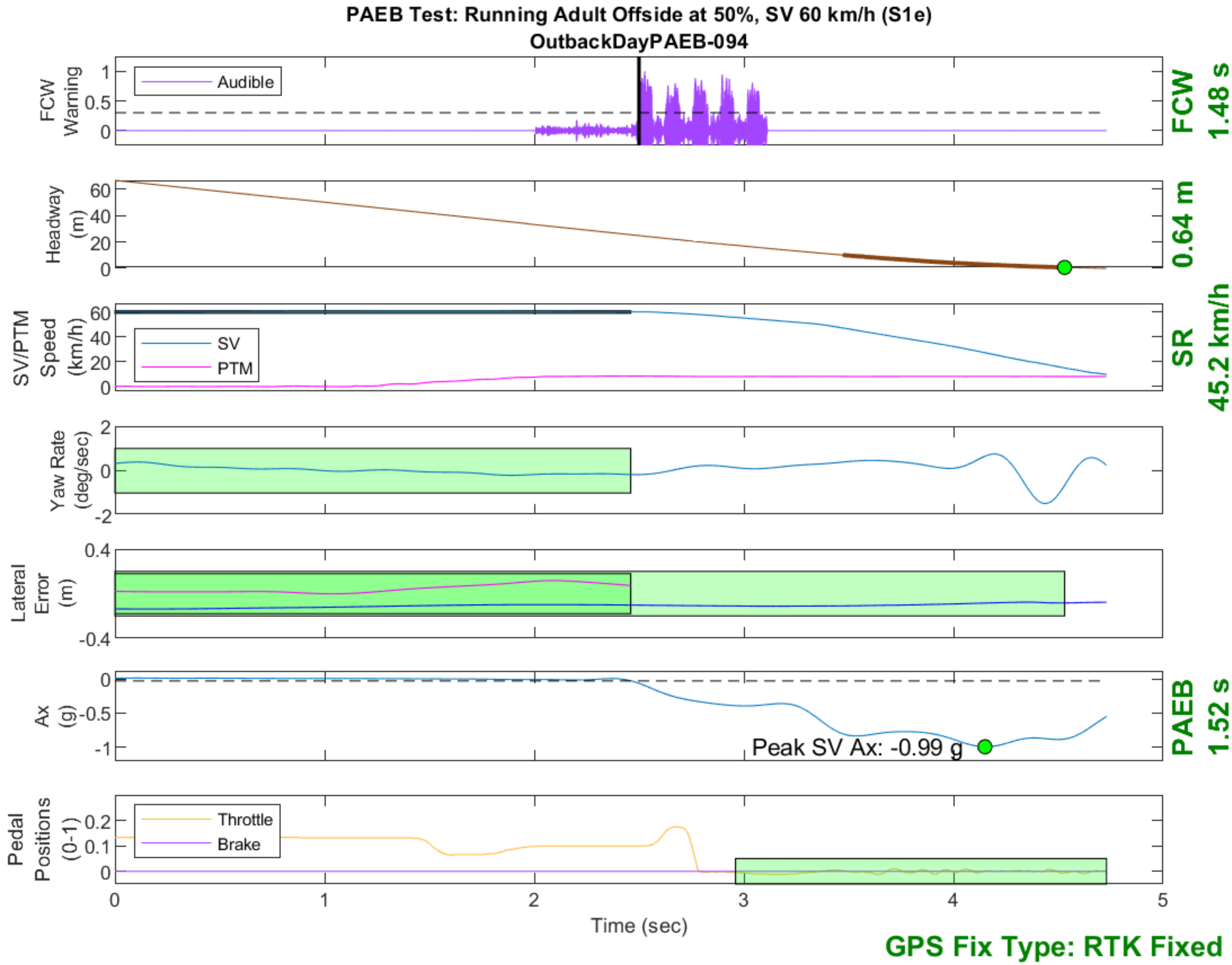


Figure D100. Time History for PAEB Run 94, S1e, Daytime, 60 km/h

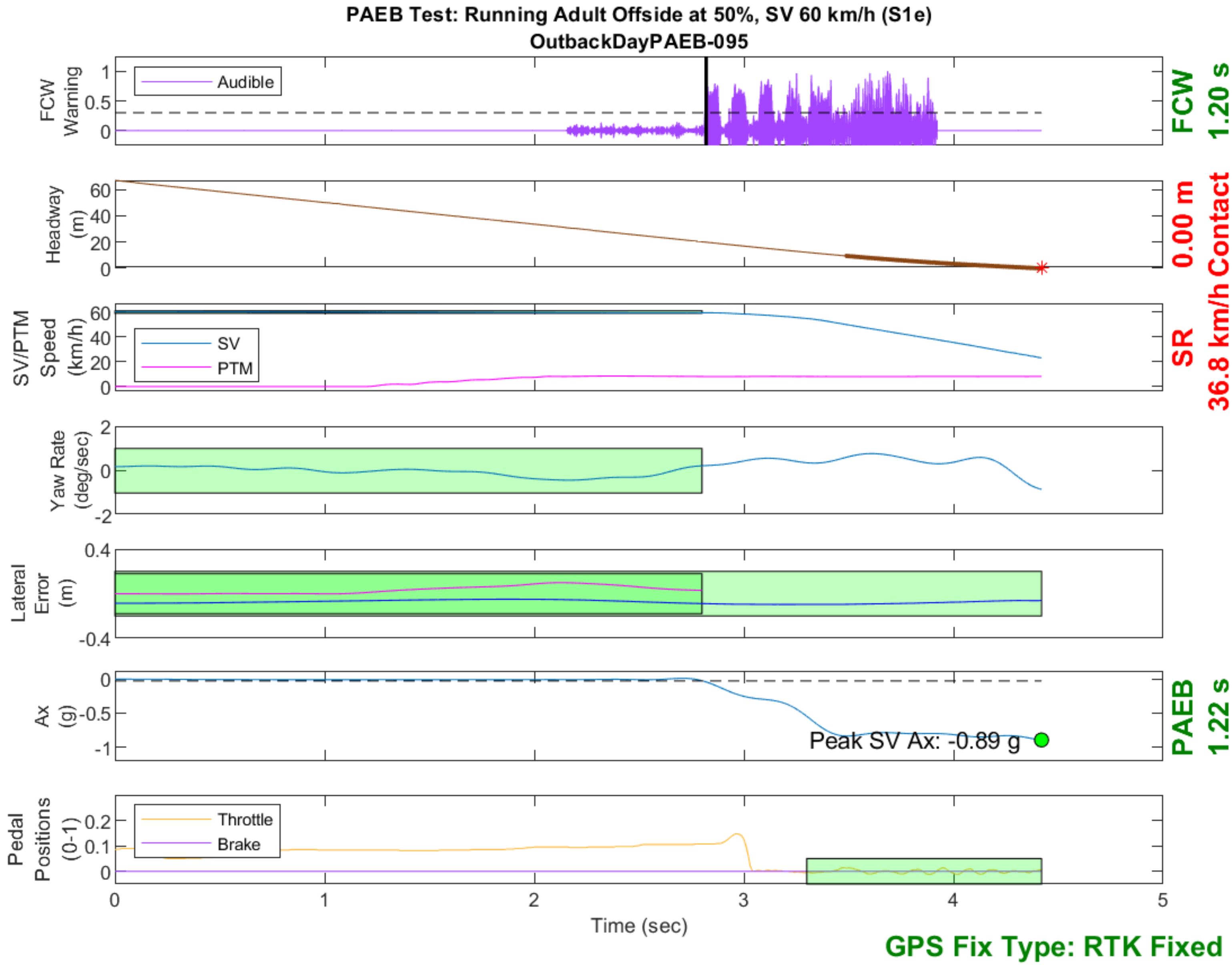


Figure D101. Time History for PAEB Run 95, S1e, Daytime, 60 km/h

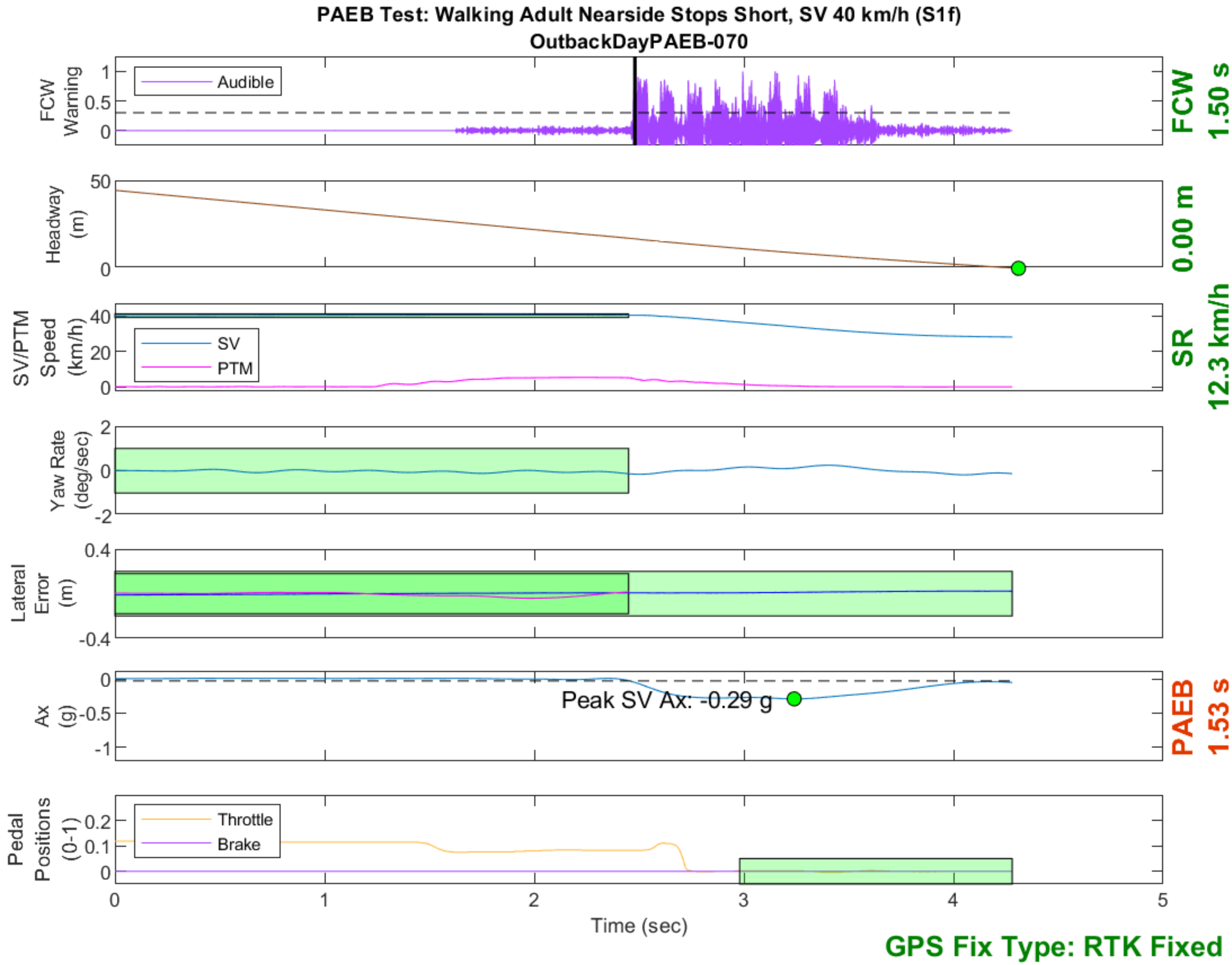


Figure D102. Time History for PAEB Run 70, S1f, Daytime, 40 km/h

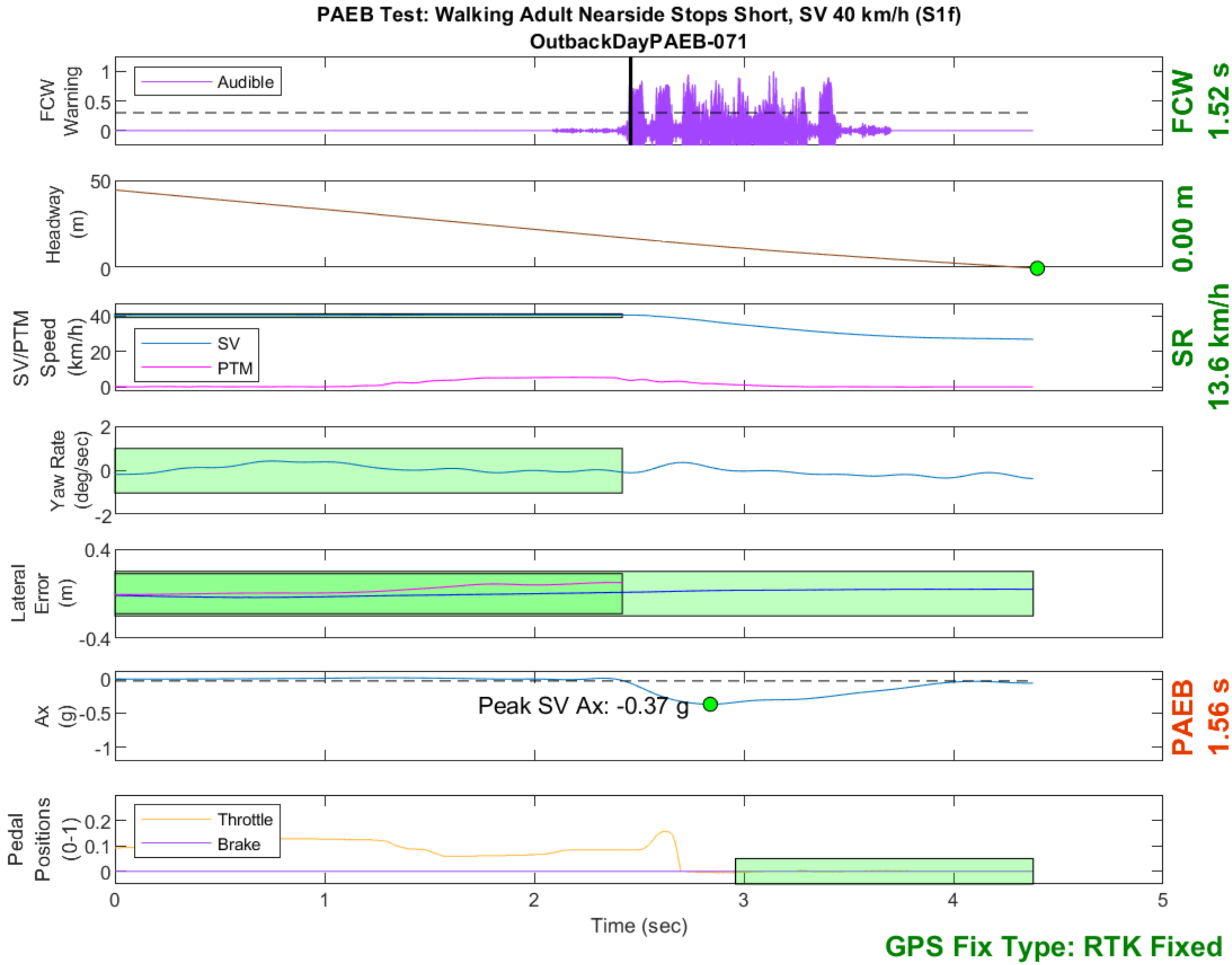


Figure D103. Time History for PAEB Run 71, S1f, Daytime, 40 km/h

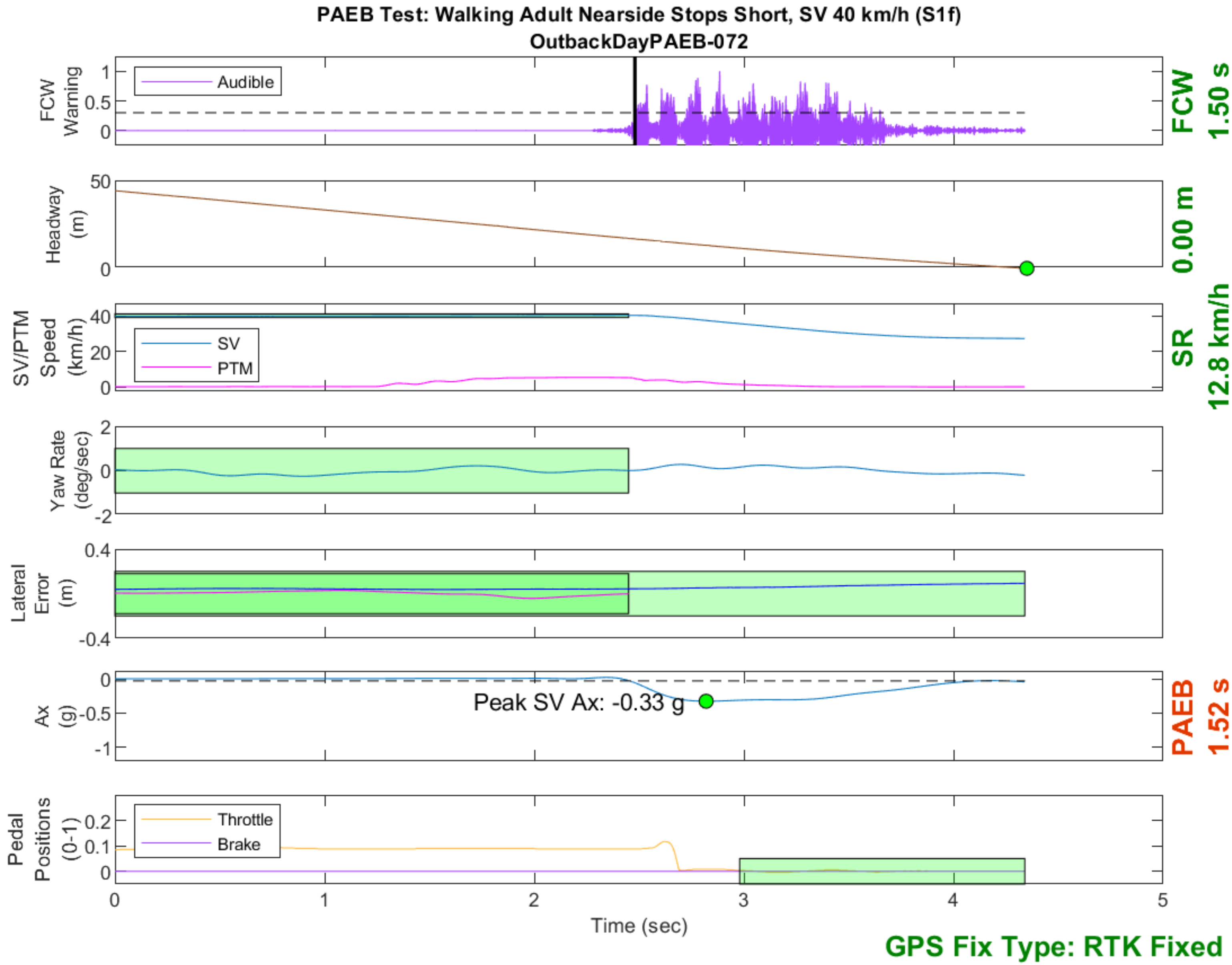


Figure D104. Time History for PAEB Run 72, S1f, Daytime, 40 km/h

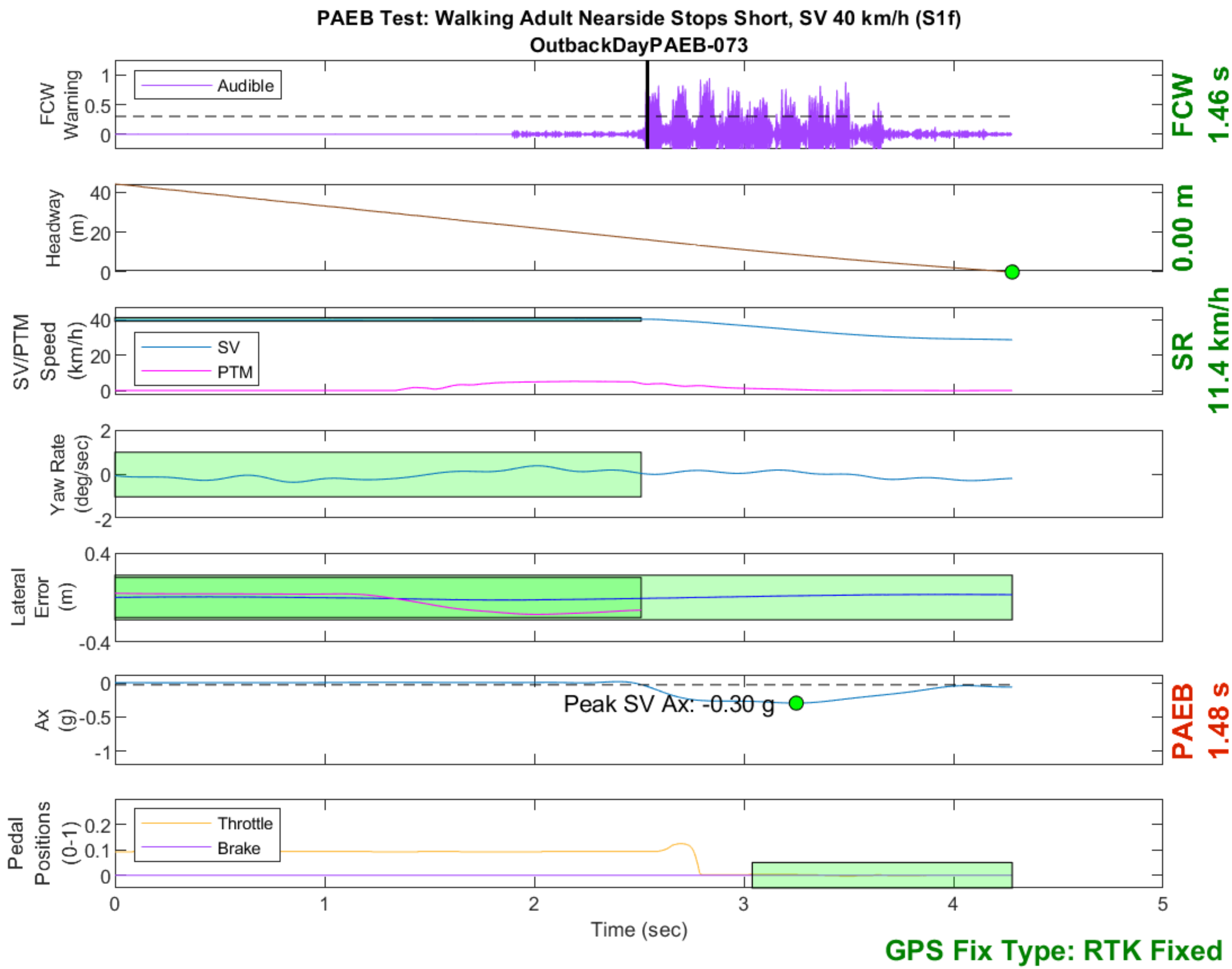


Figure D105. Time History for PAEB Run 73, S1f, Daytime, 40 km/h

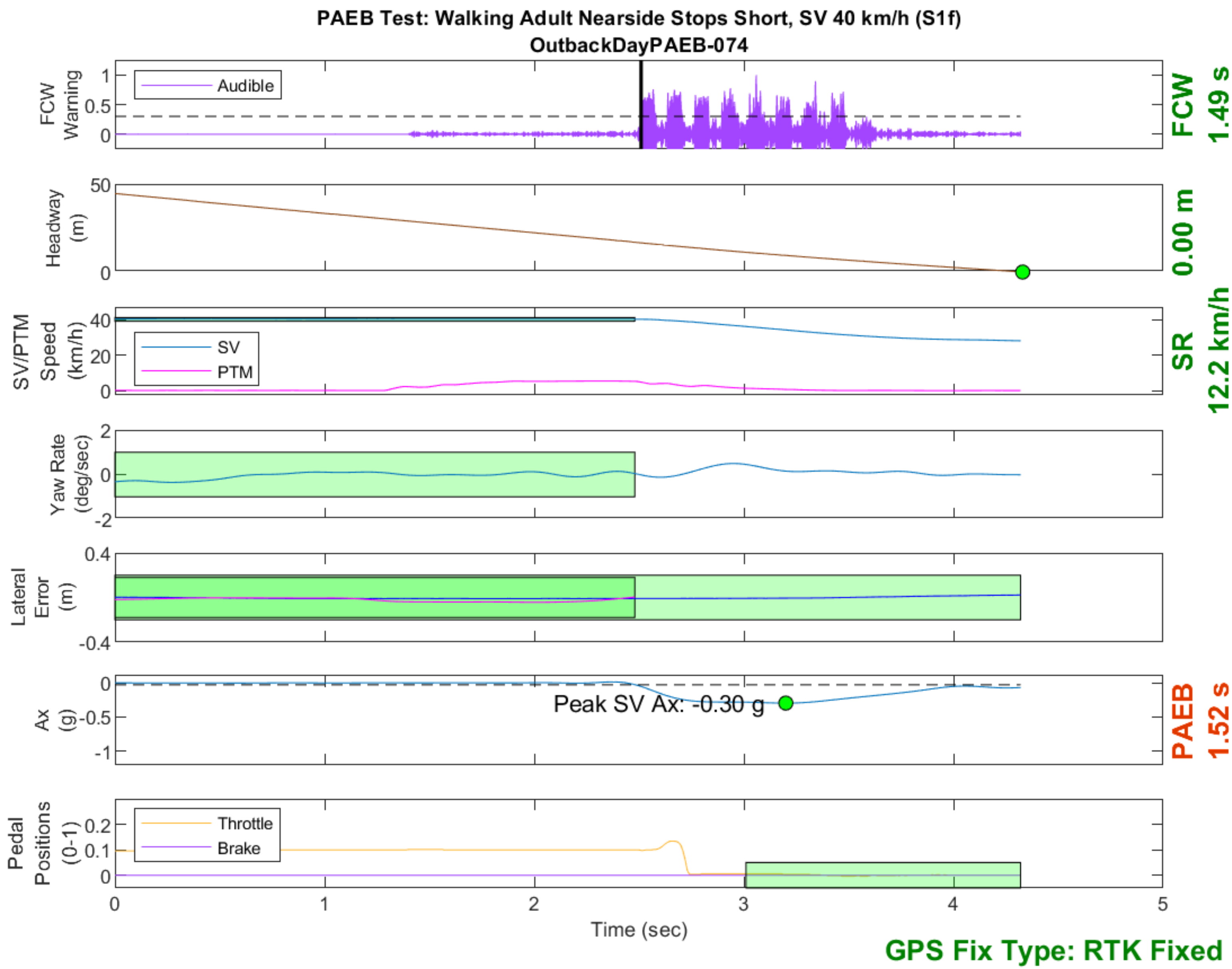


Figure D106. Time History for PAEB Run 74, S1f, Daytime, 40 km/h

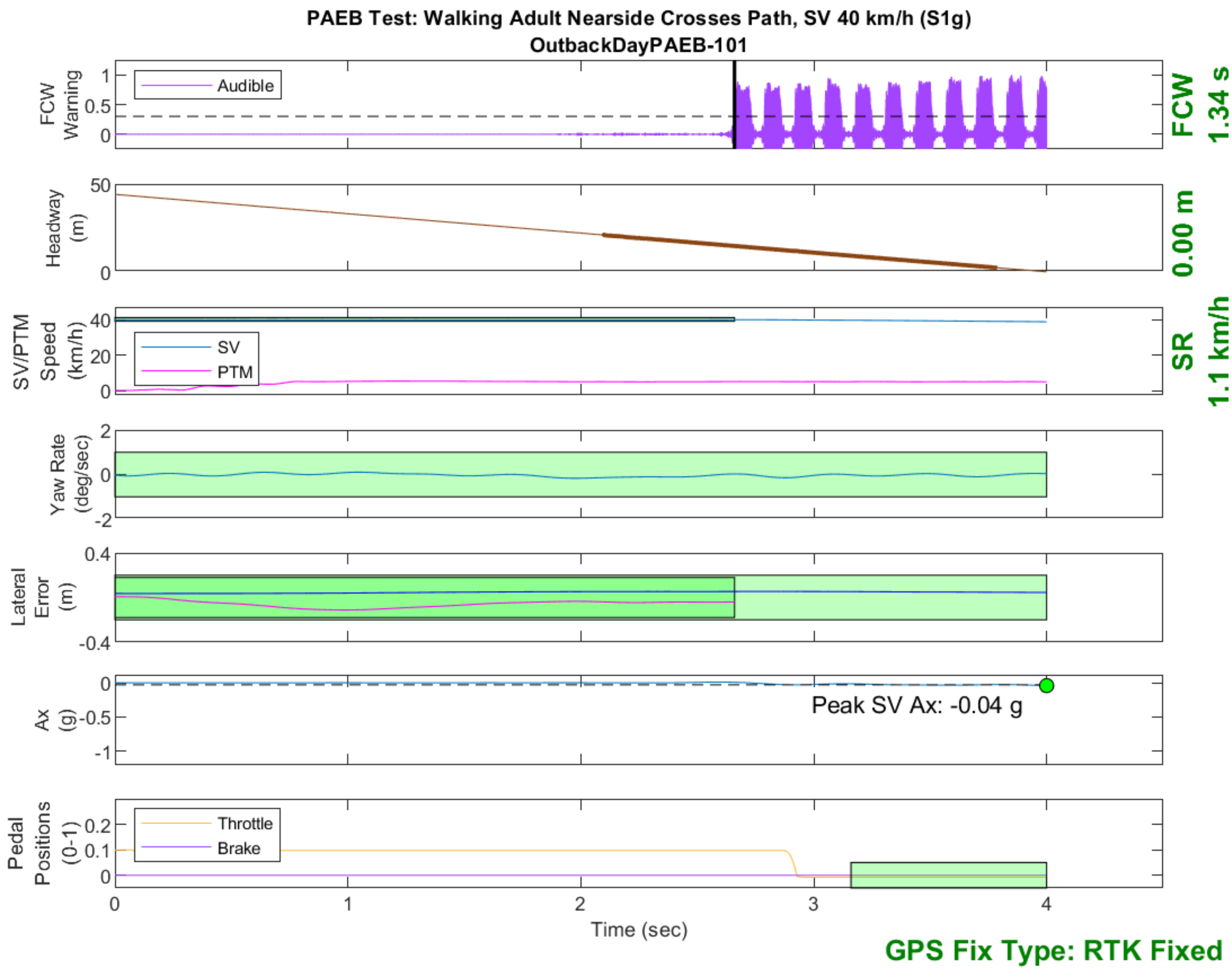


Figure D107. Time History for PAEB Run 101, S1g, Daytime, 40 km/h

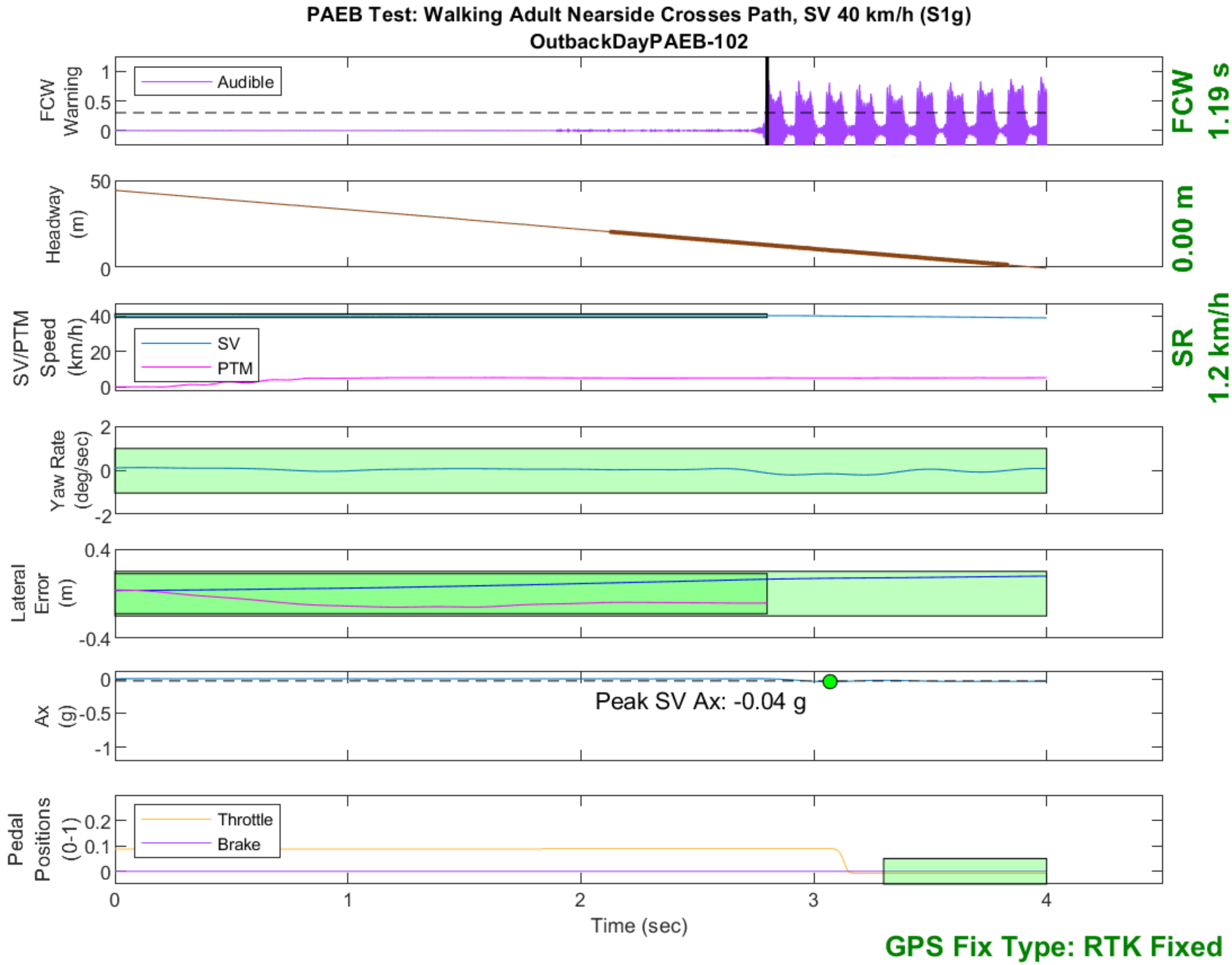


Figure D108. Time History for PAEB Run 102, S1g, Daytime, 40 km/h

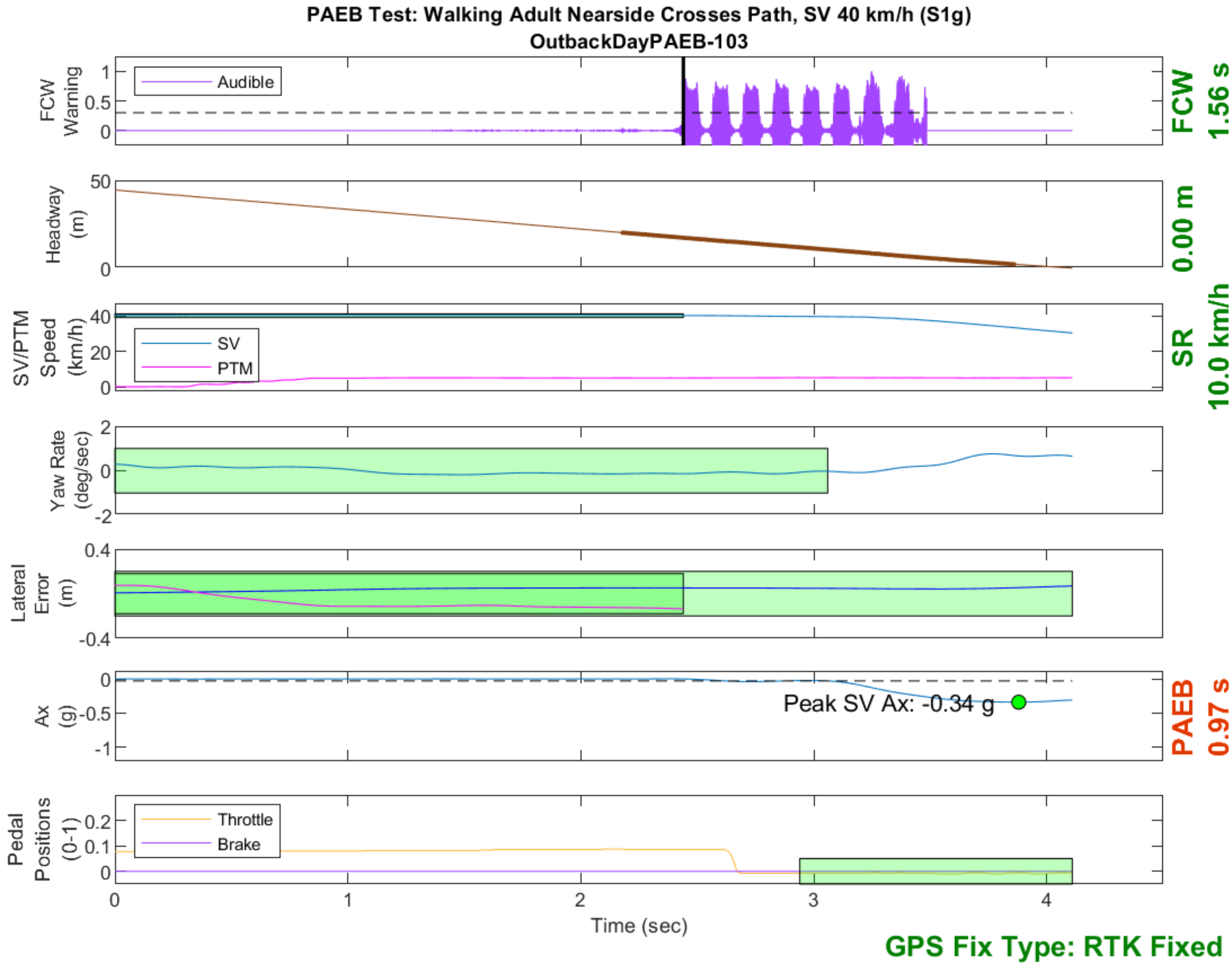


Figure D109. Time History for PAEB Run 103, S1g, Daytime, 40 km/h

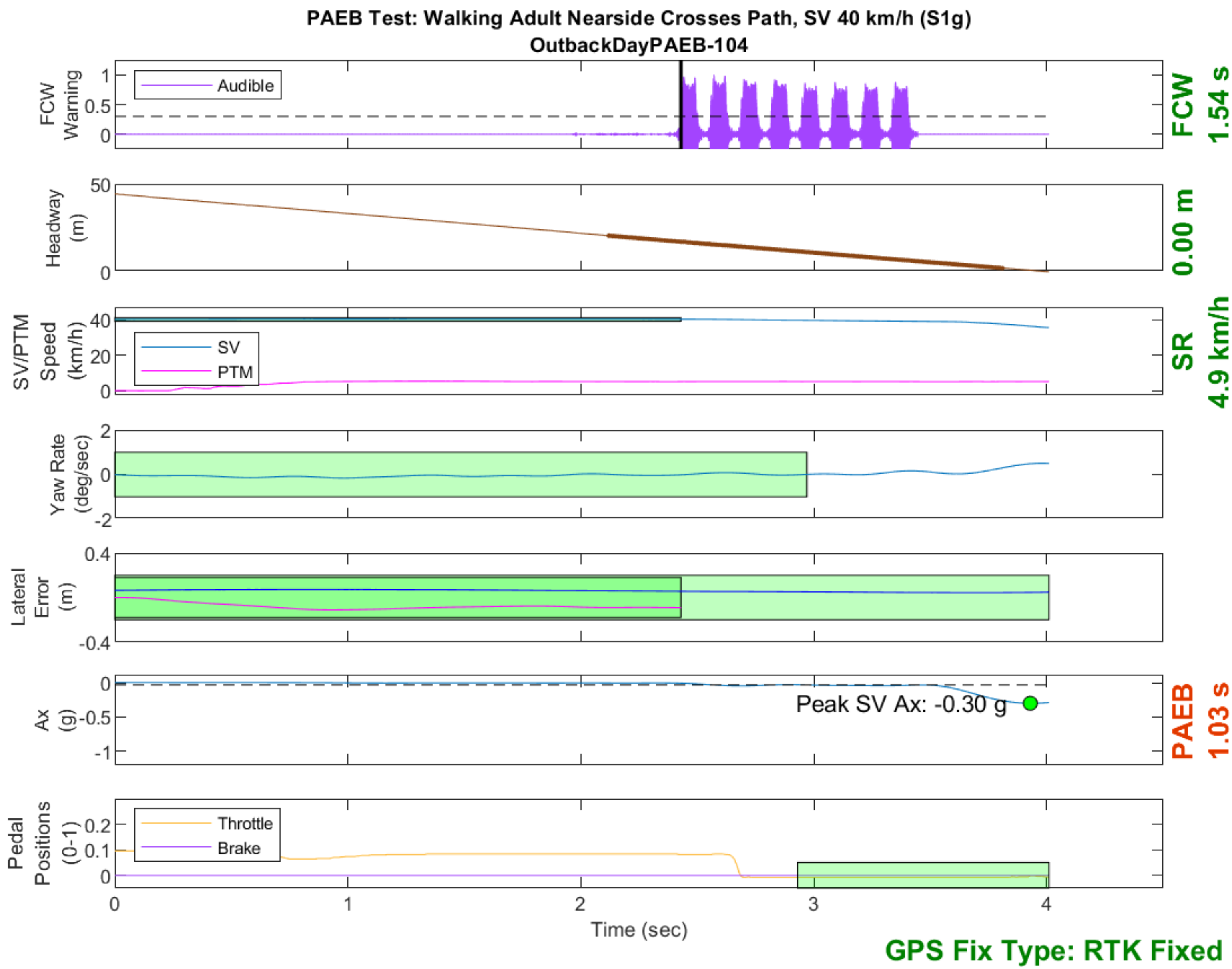


Figure D110. Time History for PAEB Run 104, S1g, Daytime, 40 km/h

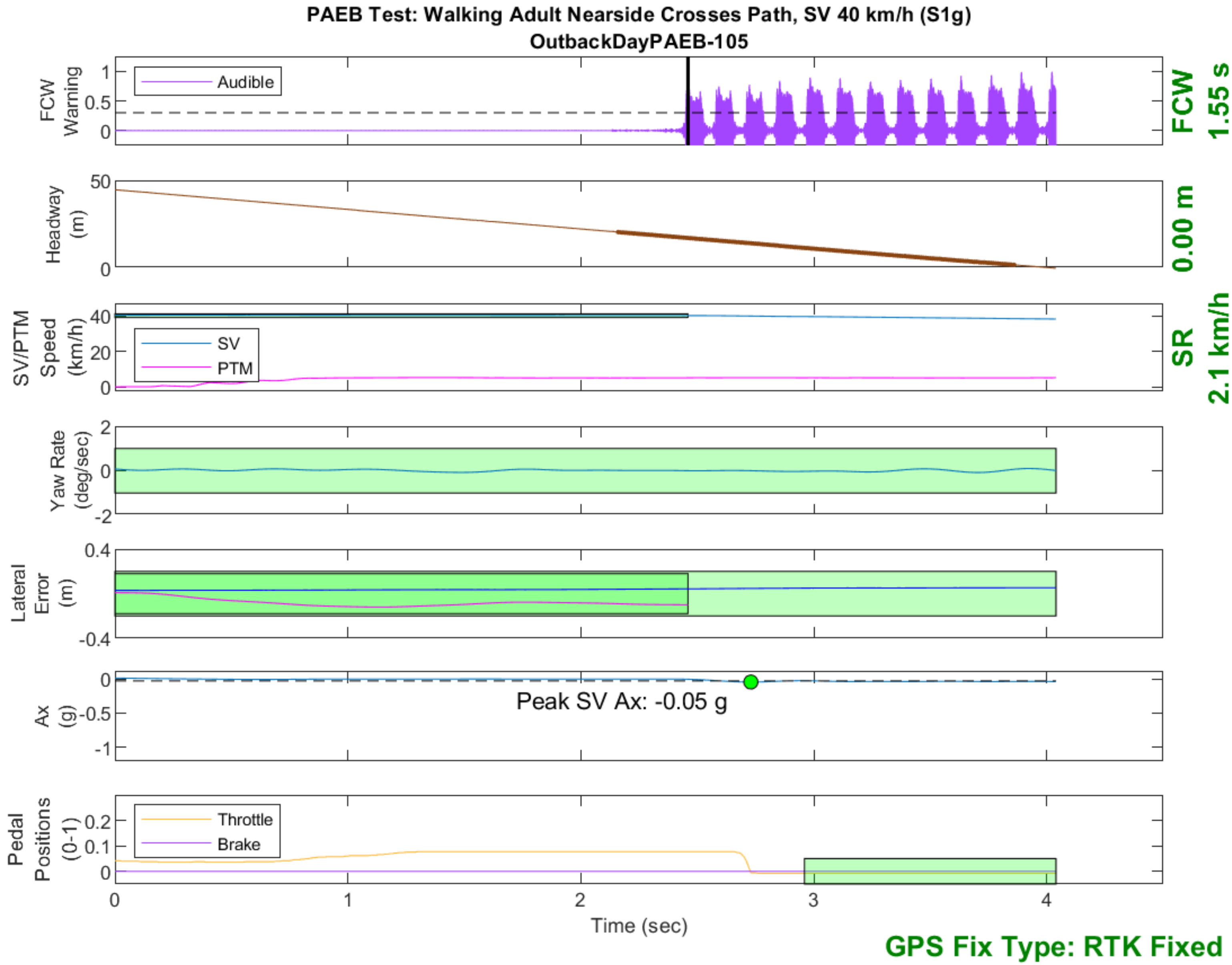


Figure D111. Time History for PAEB Run 105, S1g, Daytime, 40 km/h

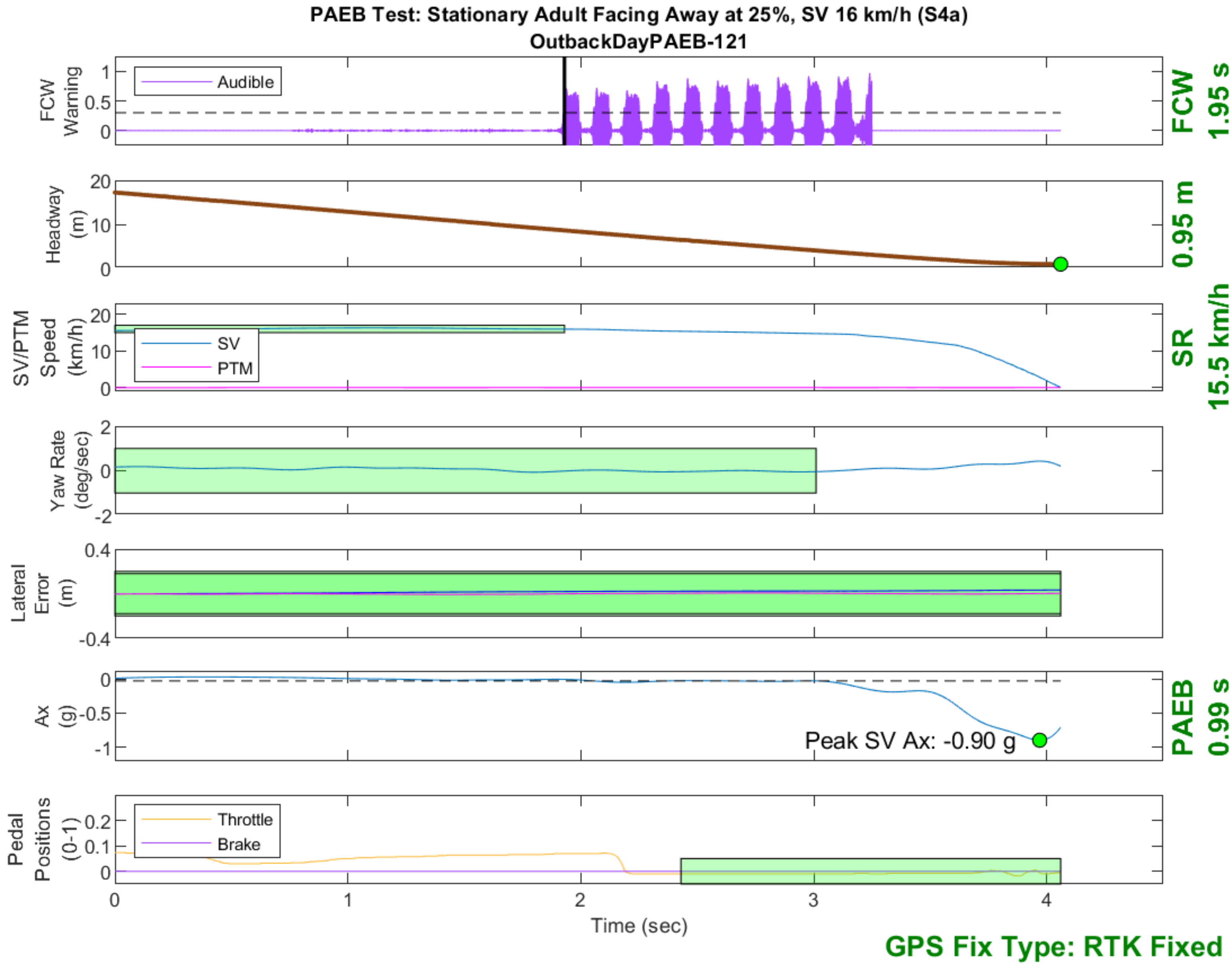


Figure D112. Time History for PAEB Run 121, S4a, Daytime, 16 km/h

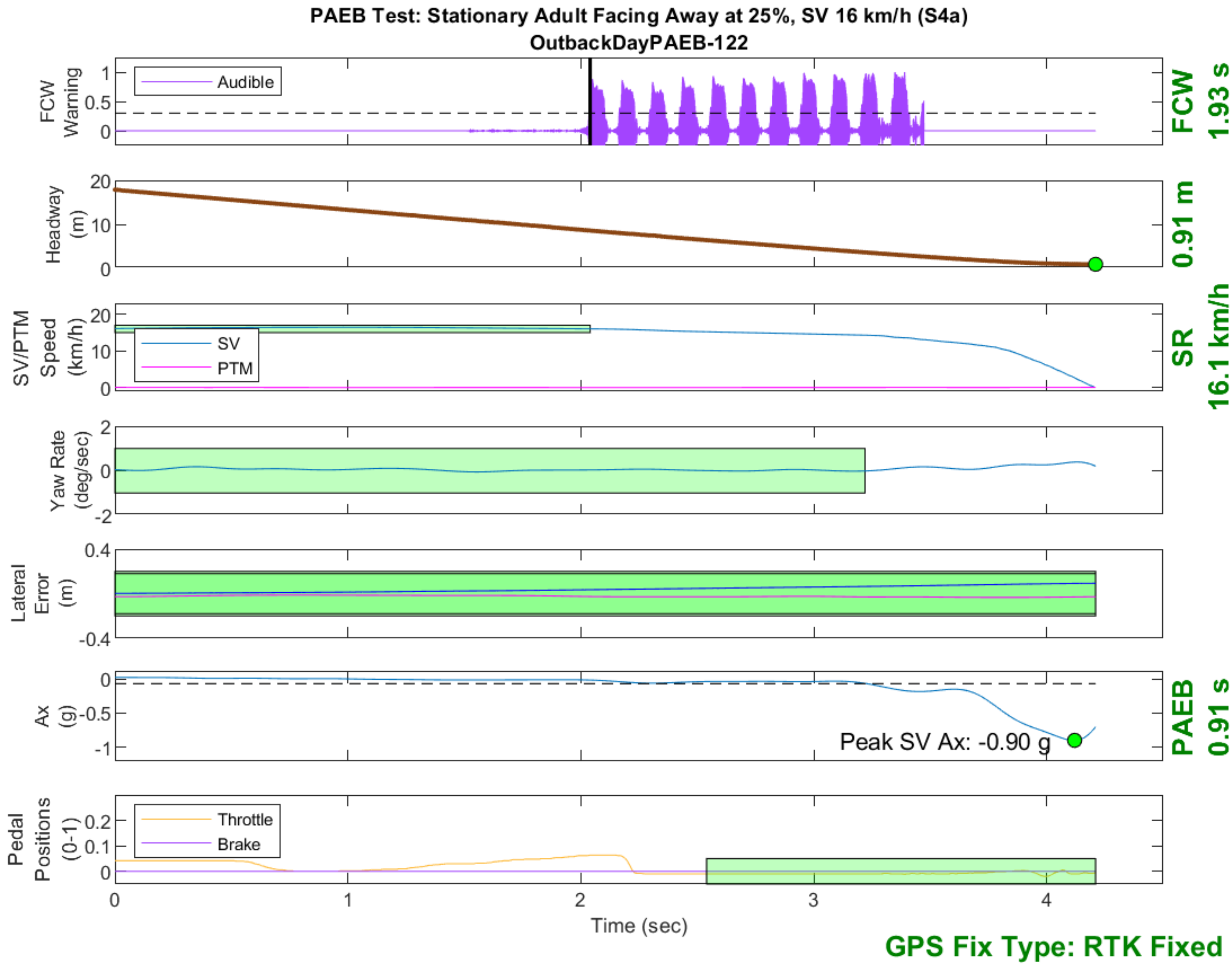


Figure D113. Time History for PAEB Run 122, S4a, Daytime, 16 km/h

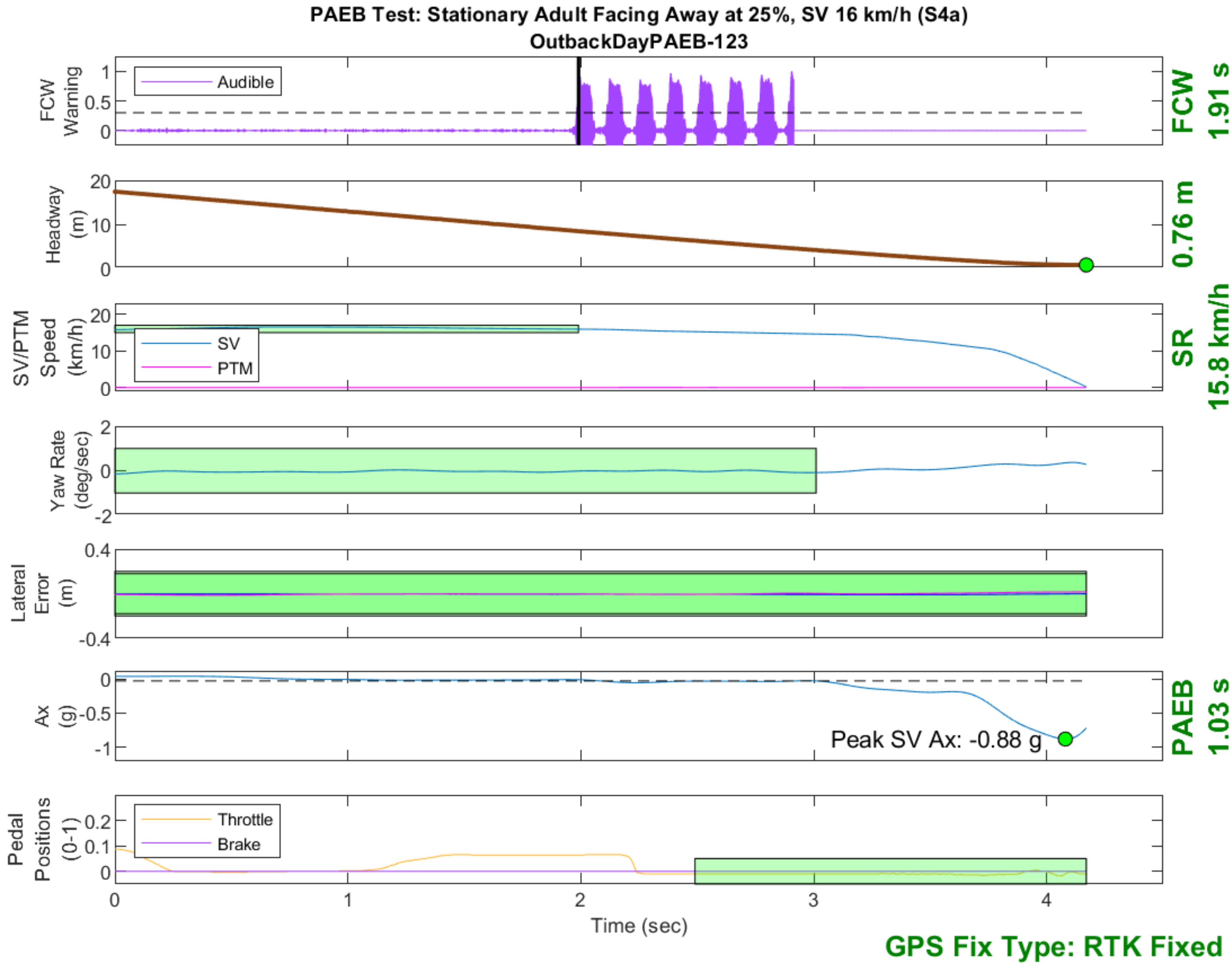


Figure D114. Time History for PAEB Run 123, S4a, Daytime, 16 km/h

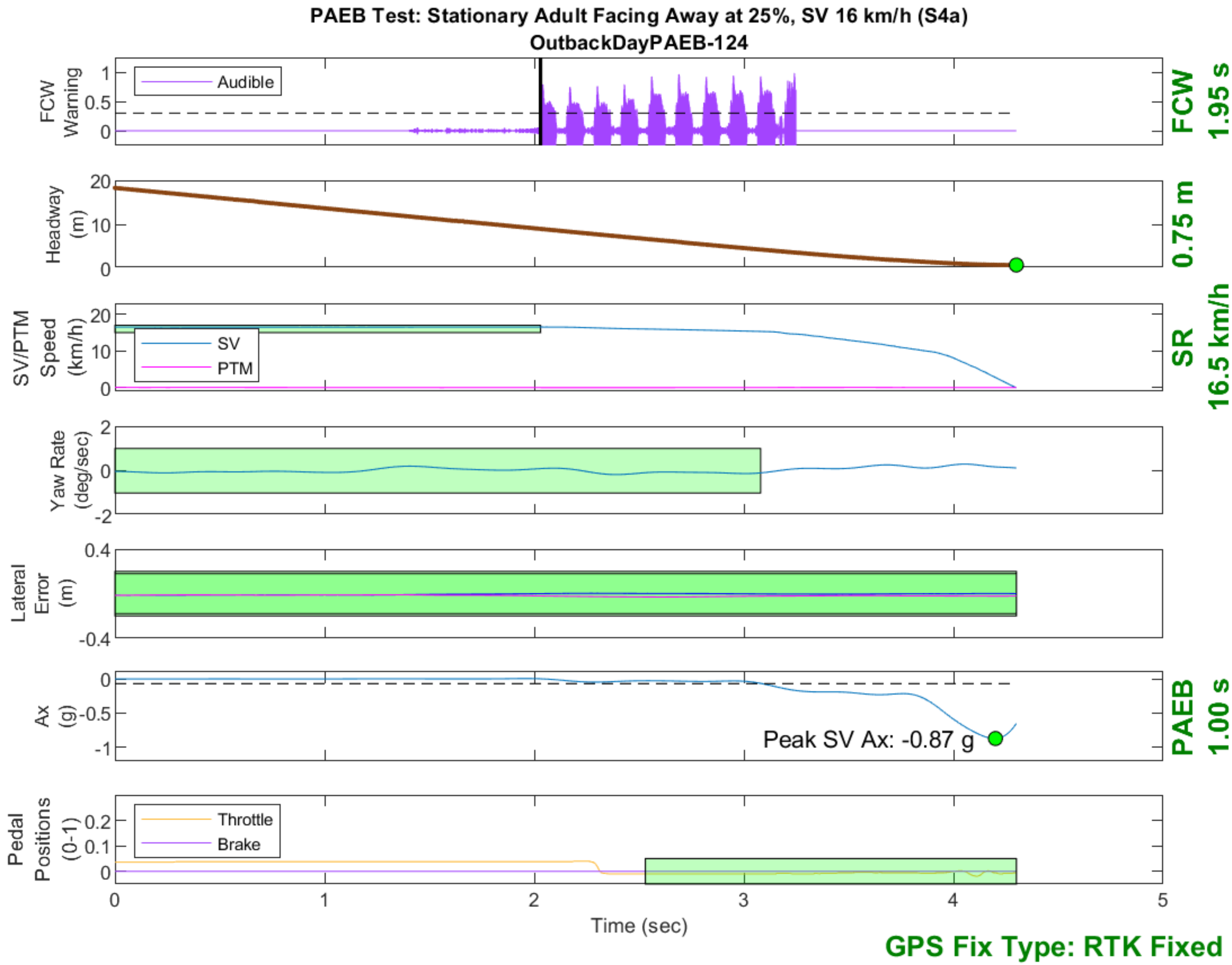


Figure D115. Time History for PAEB Run 124, S4a, Daytime, 16 km/h

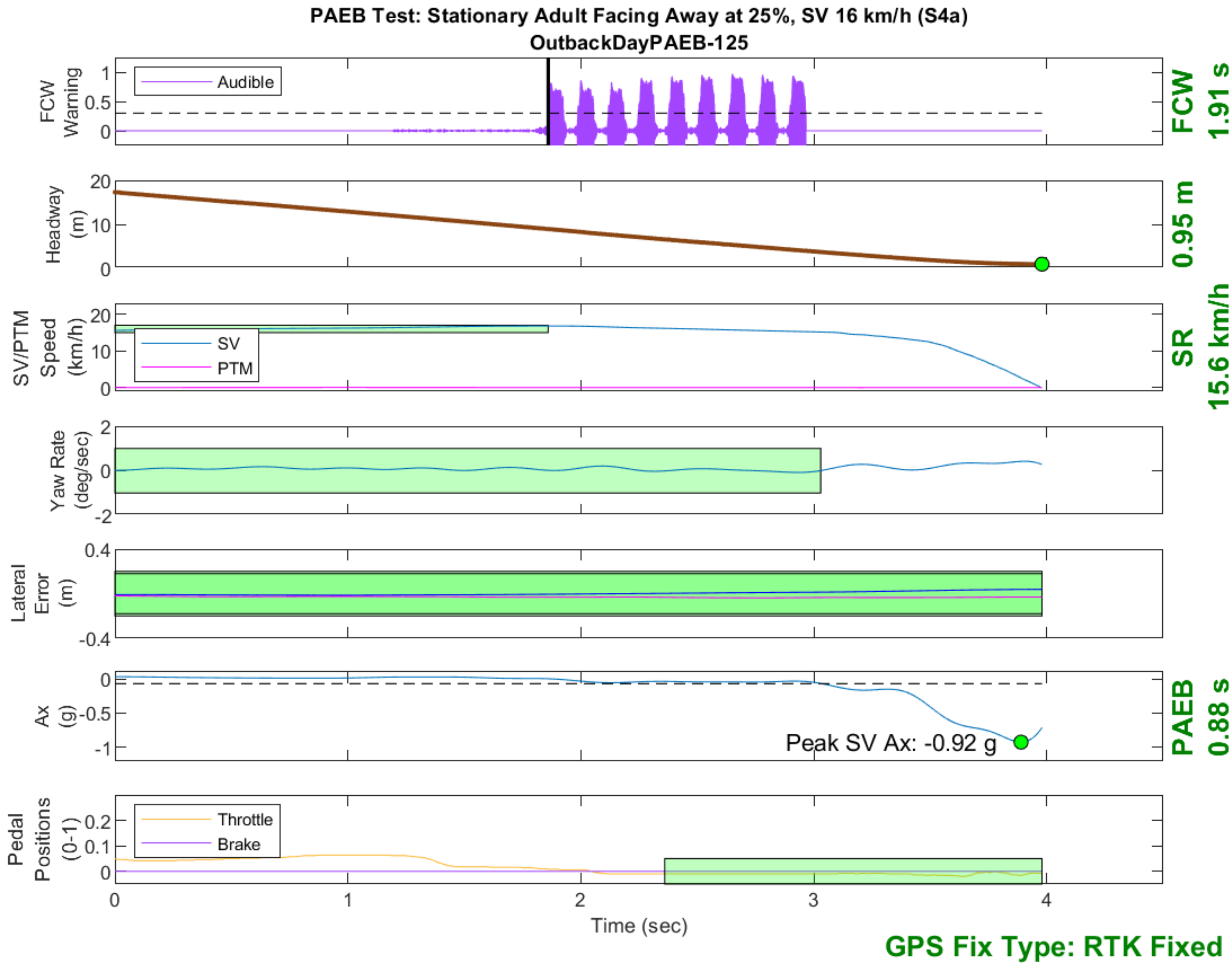


Figure D116. Time History for PAEB Run 125, S4a, Daytime, 16 km/h

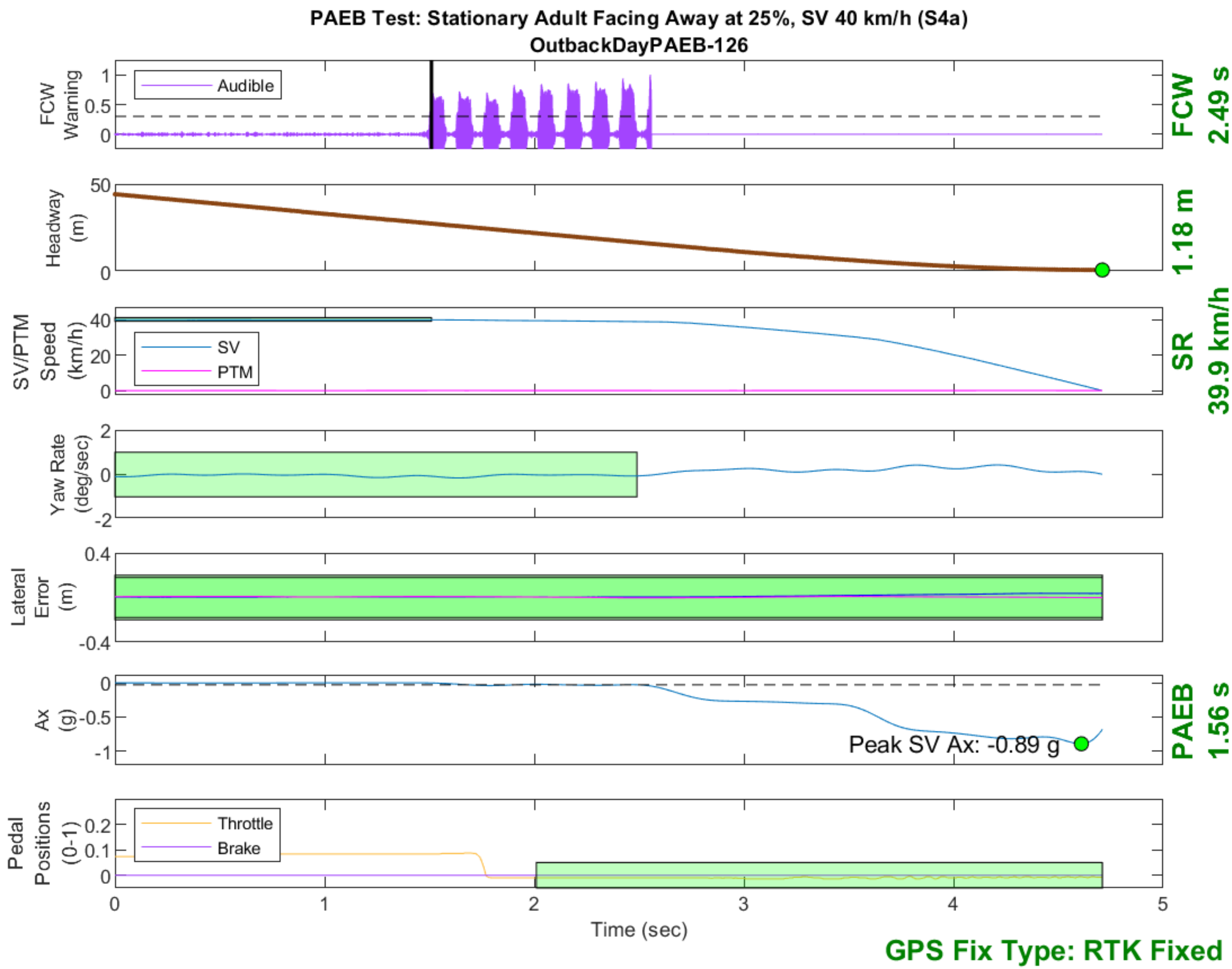


Figure D117. Time History for PAEB Run 126, S4a, Daytime, 40 km/h

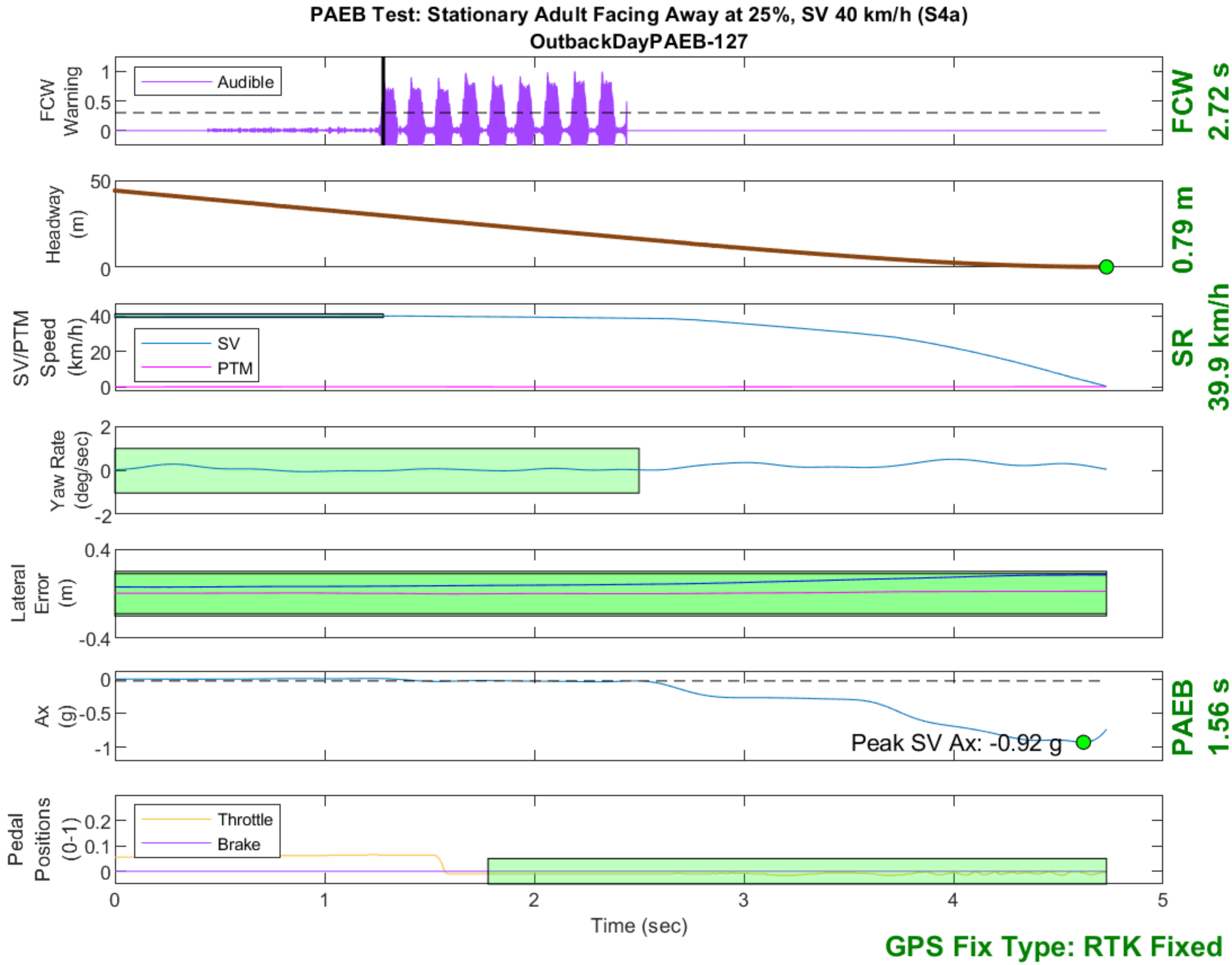


Figure D118. Time History for PAEB Run 127, S4a, Daytime, 40 km/h

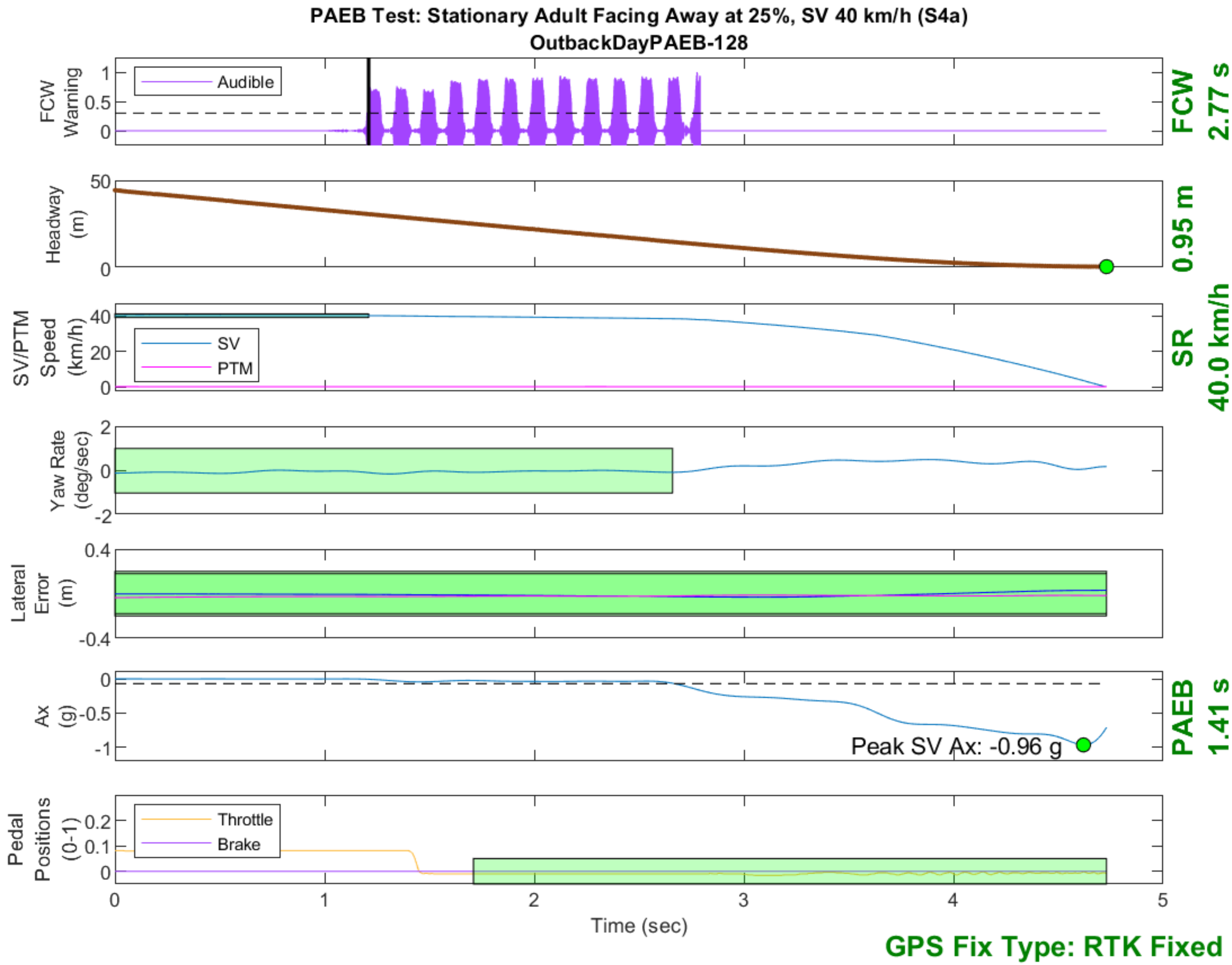


Figure D119. Time History for PAEB Run 128, S4a, Daytime, 40 km/h

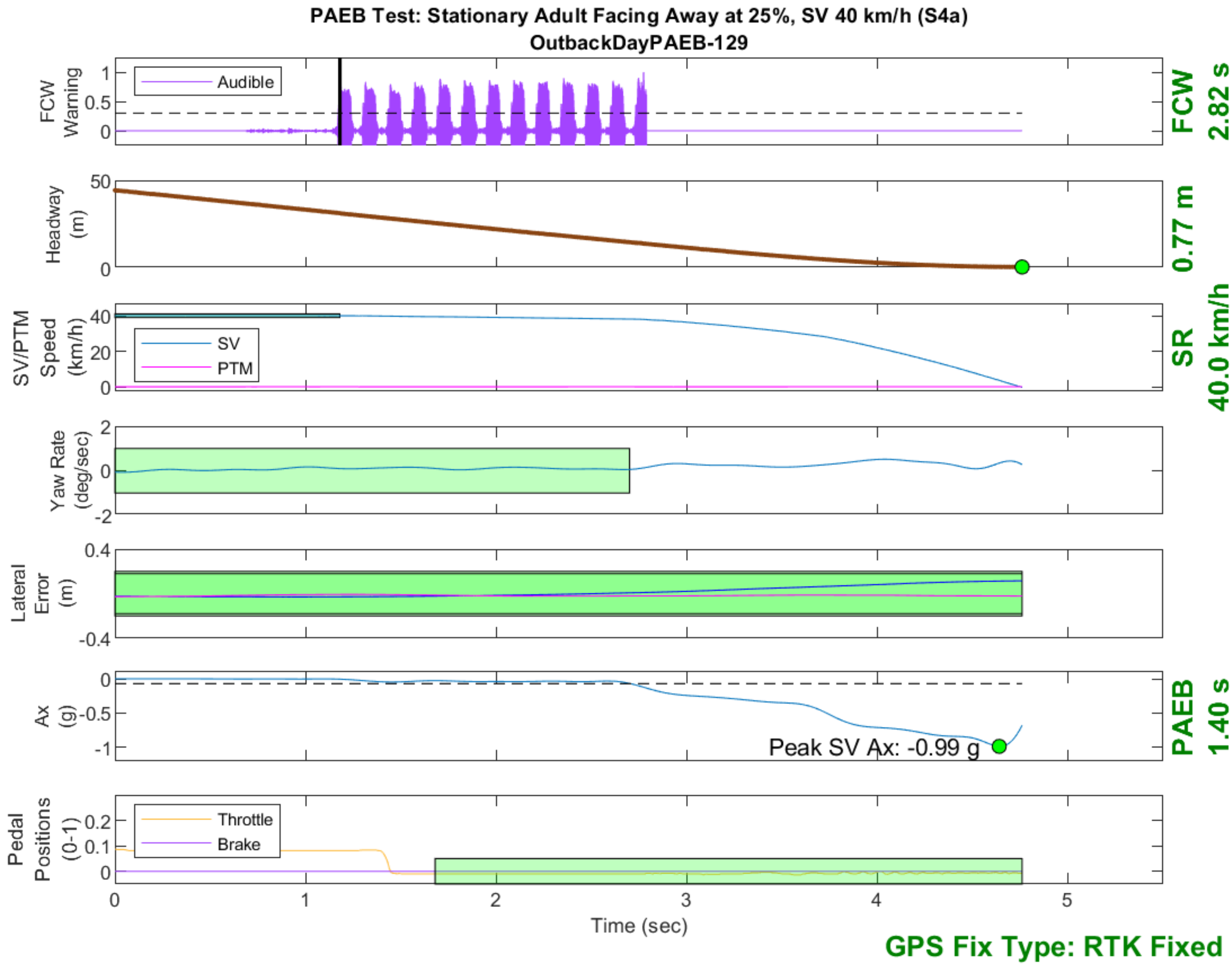


Figure D120. Time History for PAEB Run 129, S4a, Daytime, 40 km/h

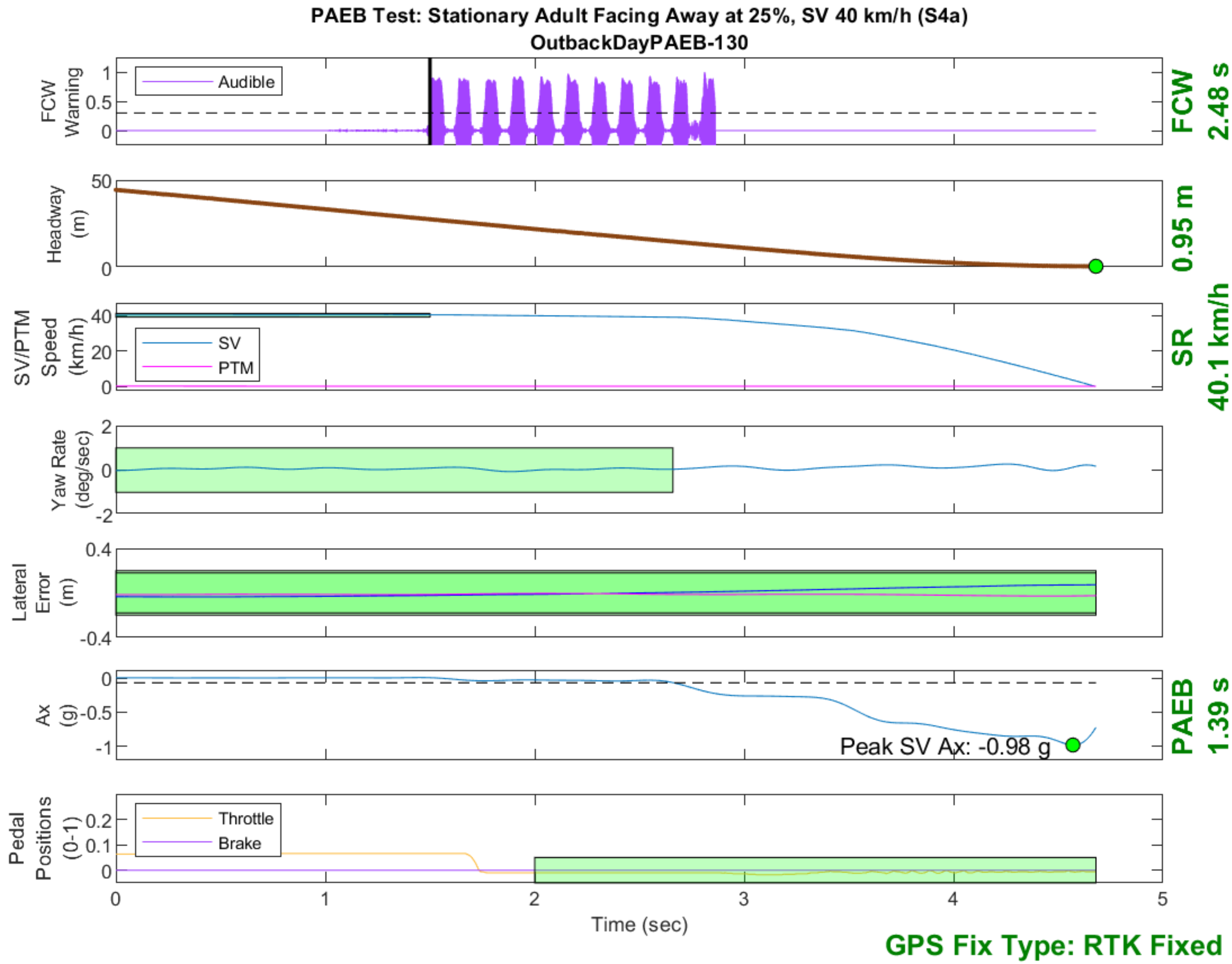


Figure D121. Time History for PAEB Run 130, S4a, Daytime, 40 km/h

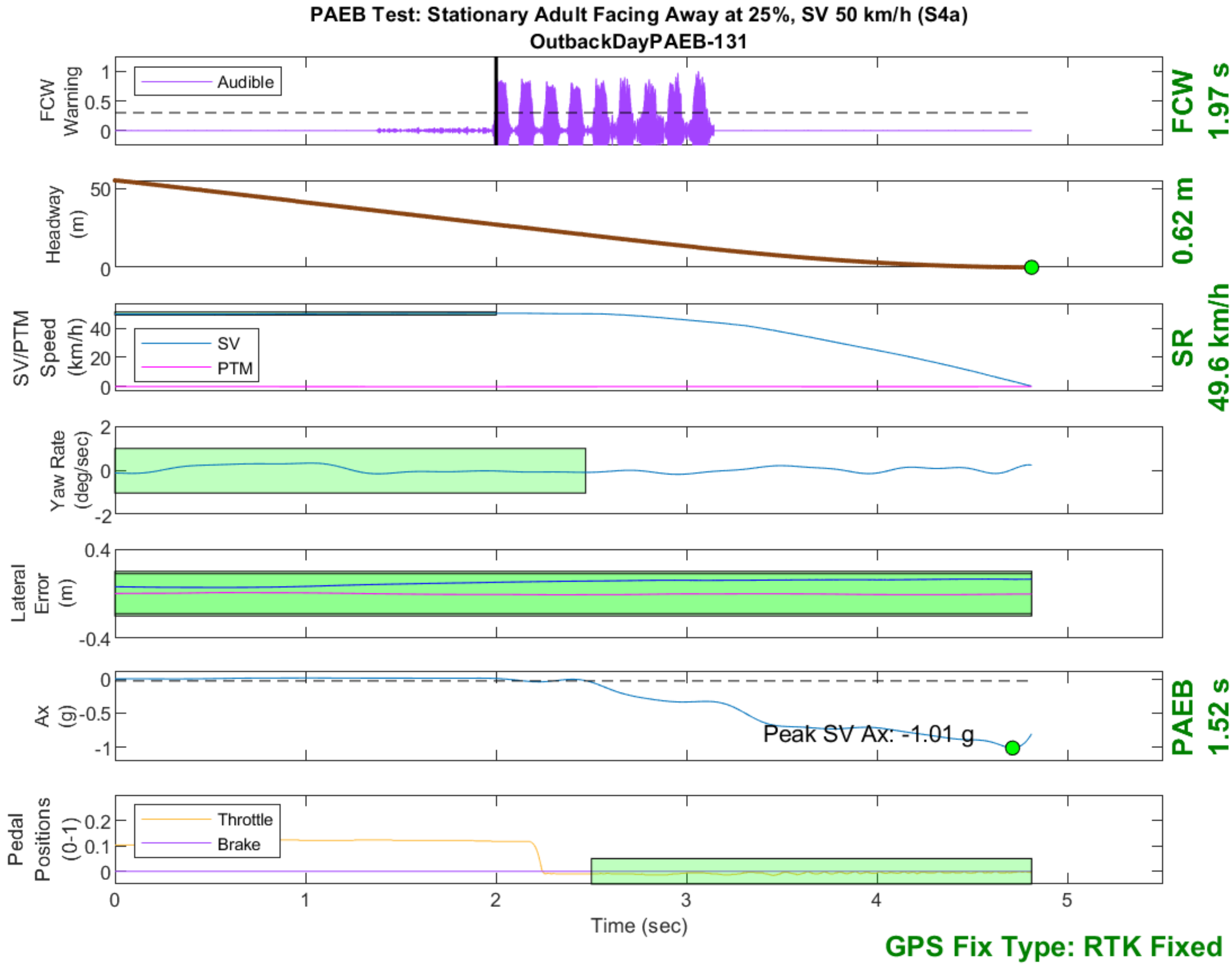


Figure D122. Time History for PAEB Run 131, S4a, Daytime, 50 km/h

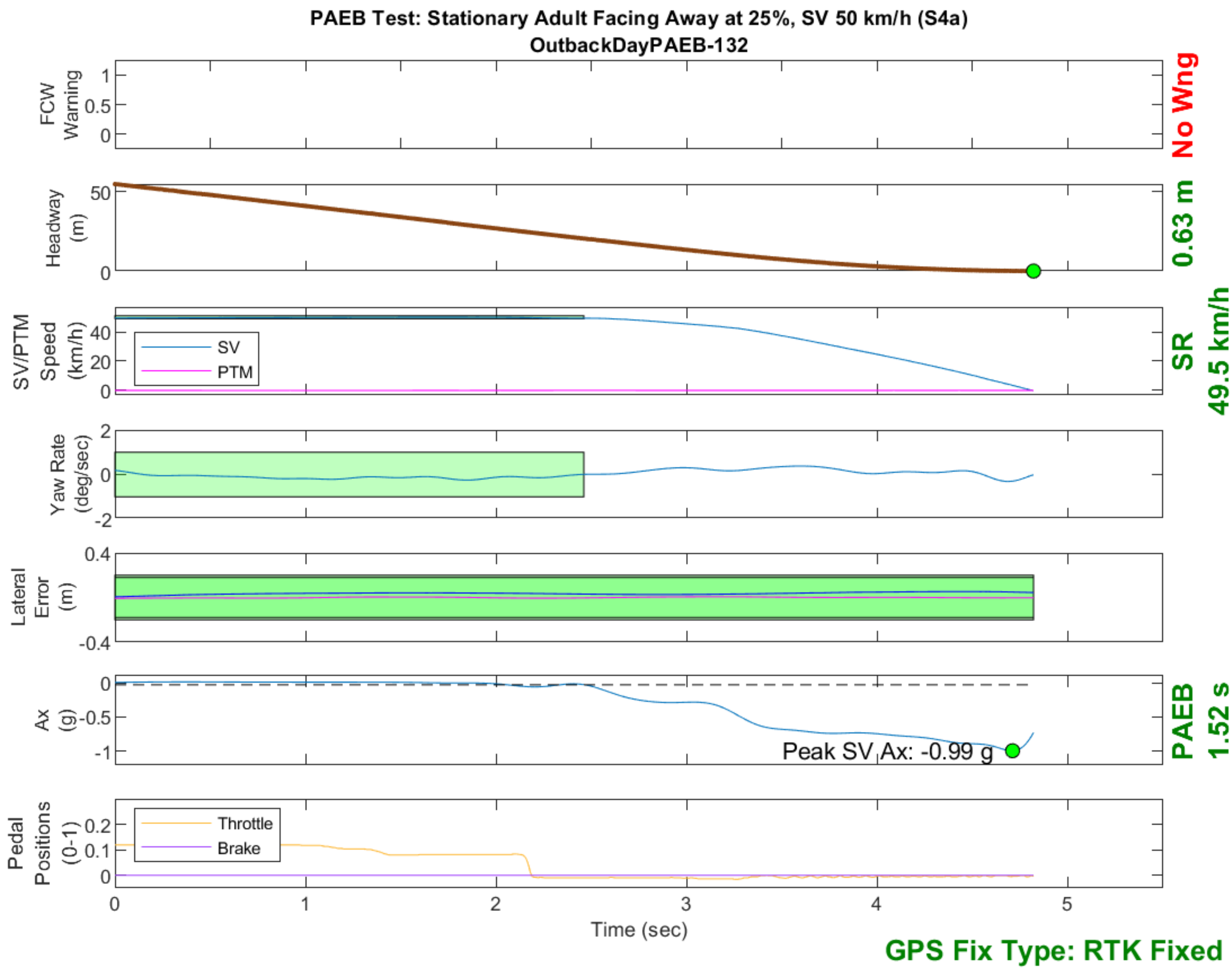


Figure D123. Time History for PAEB Run 132, S4a, Daytime, 50 km/h

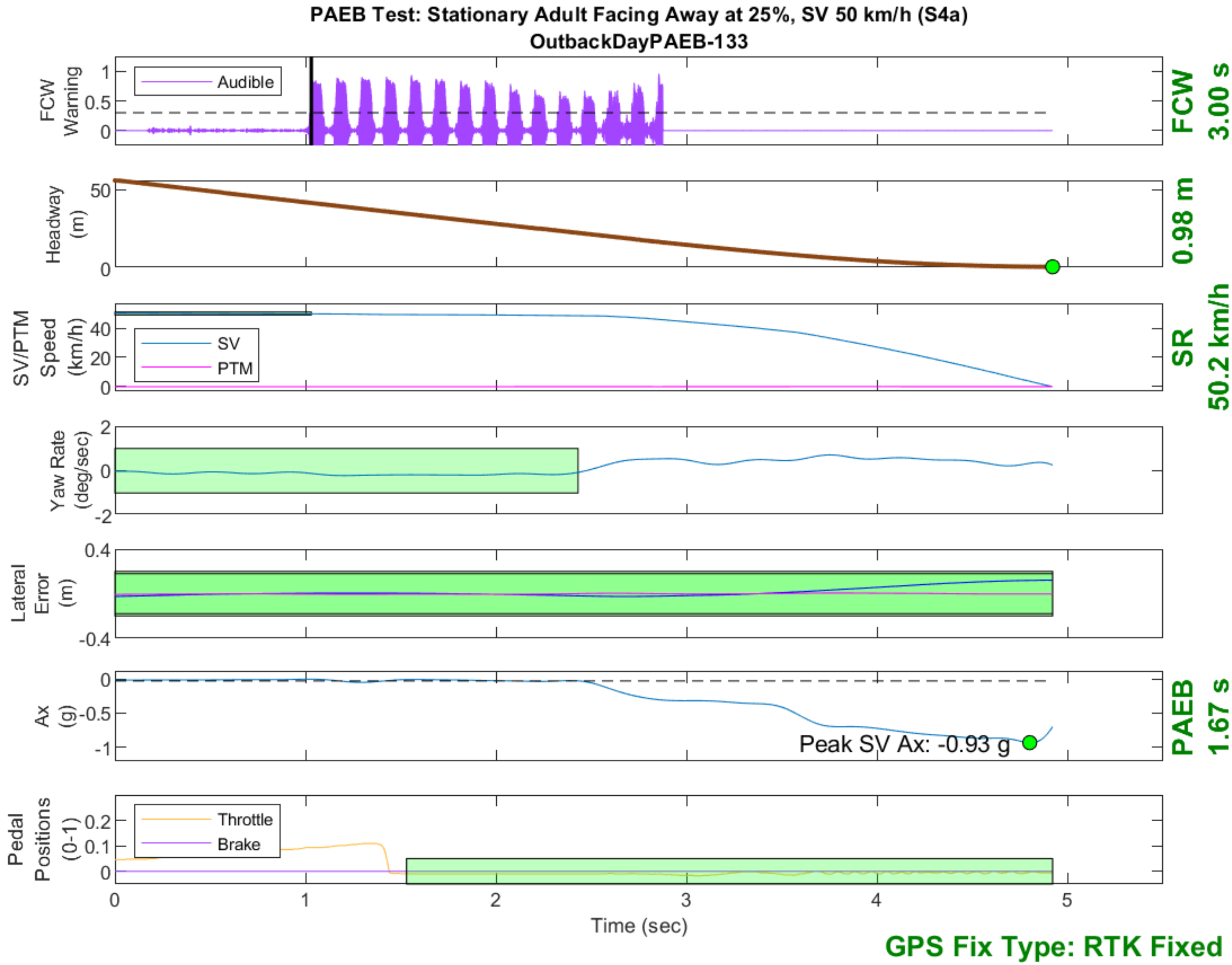


Figure D124. Time History for PAEB Run 133, S4a, Daytime, 50 km/h

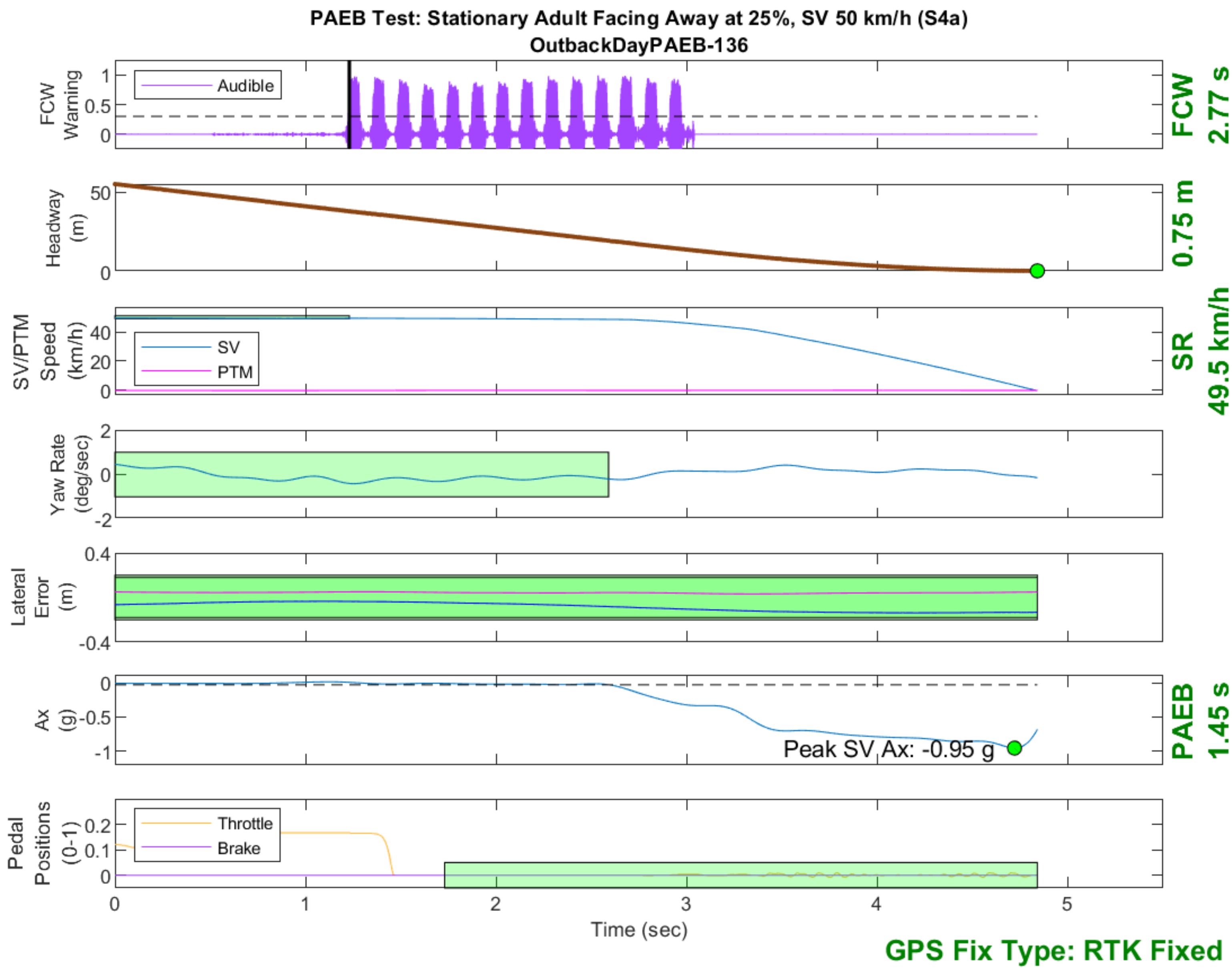


Figure D125. Time History for PAEB Run 136, S4a, Daytime, 50 km/h

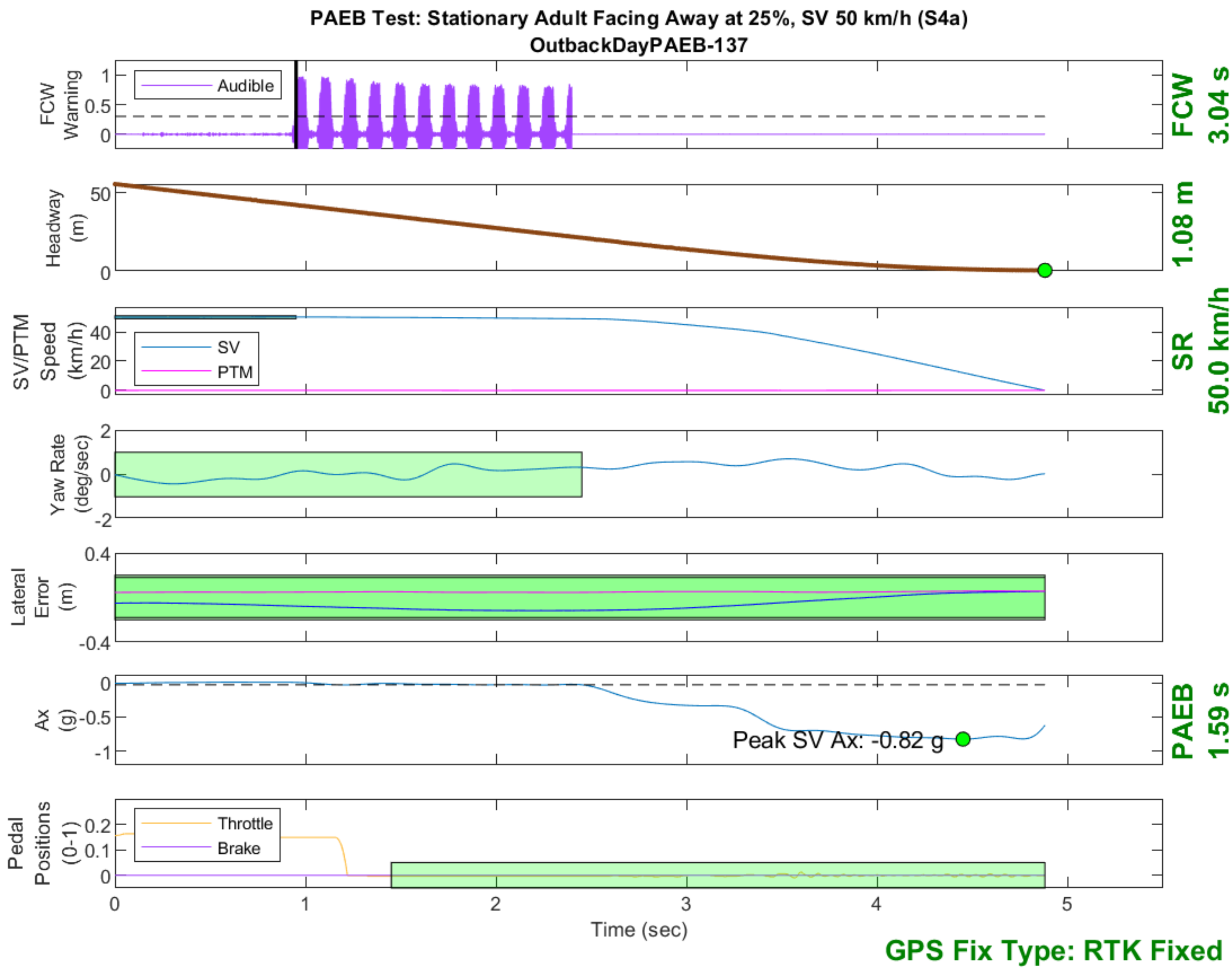


Figure D126. Time History for PAEB Run 137, S4a, Daytime, 50 km/h

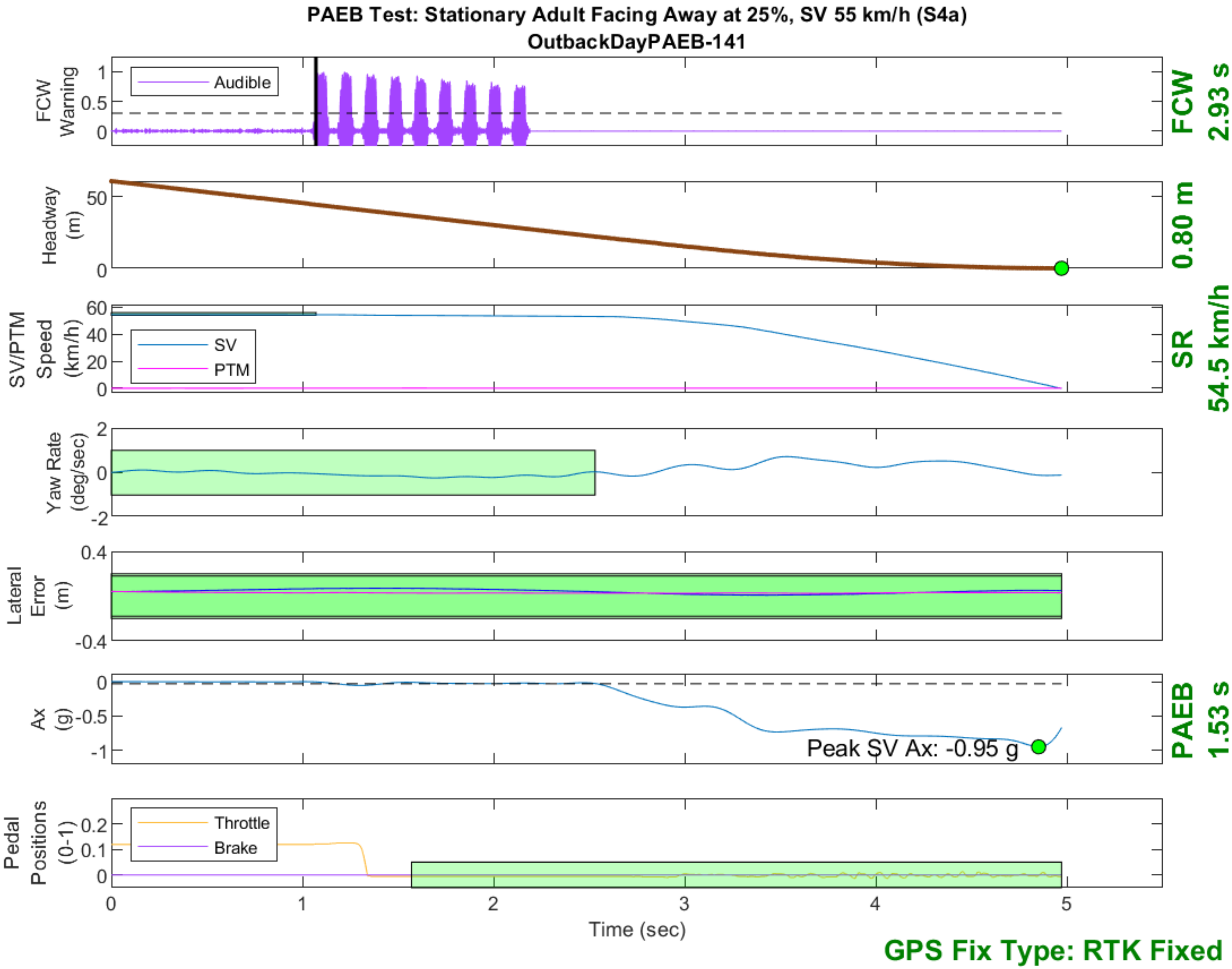


Figure D127. Time History for PAEB Run 141, S4a, Daytime, 55 km/h

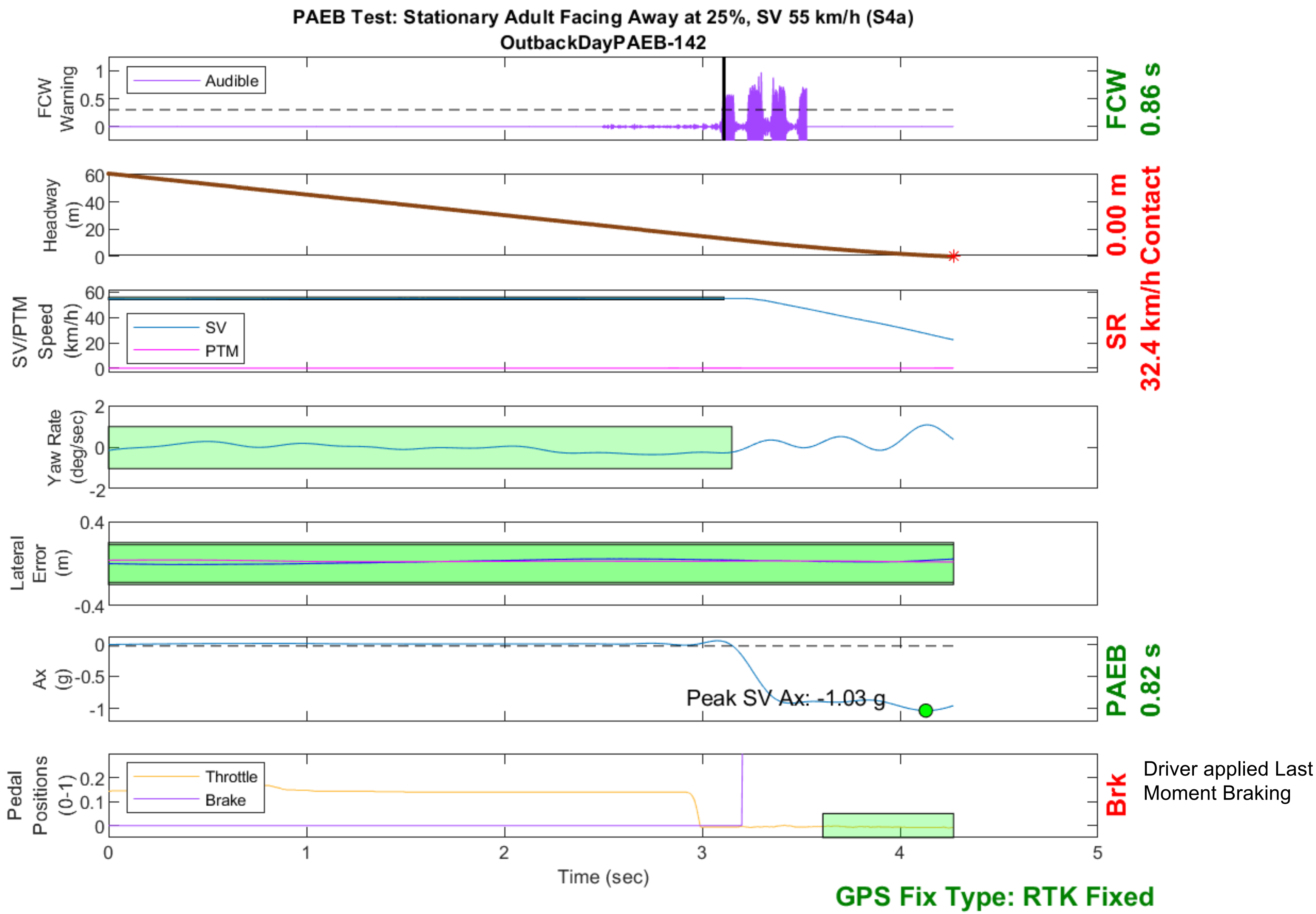


Figure D128. Time History for PAEB Run 142, S4a, Daytime, 55 km/h

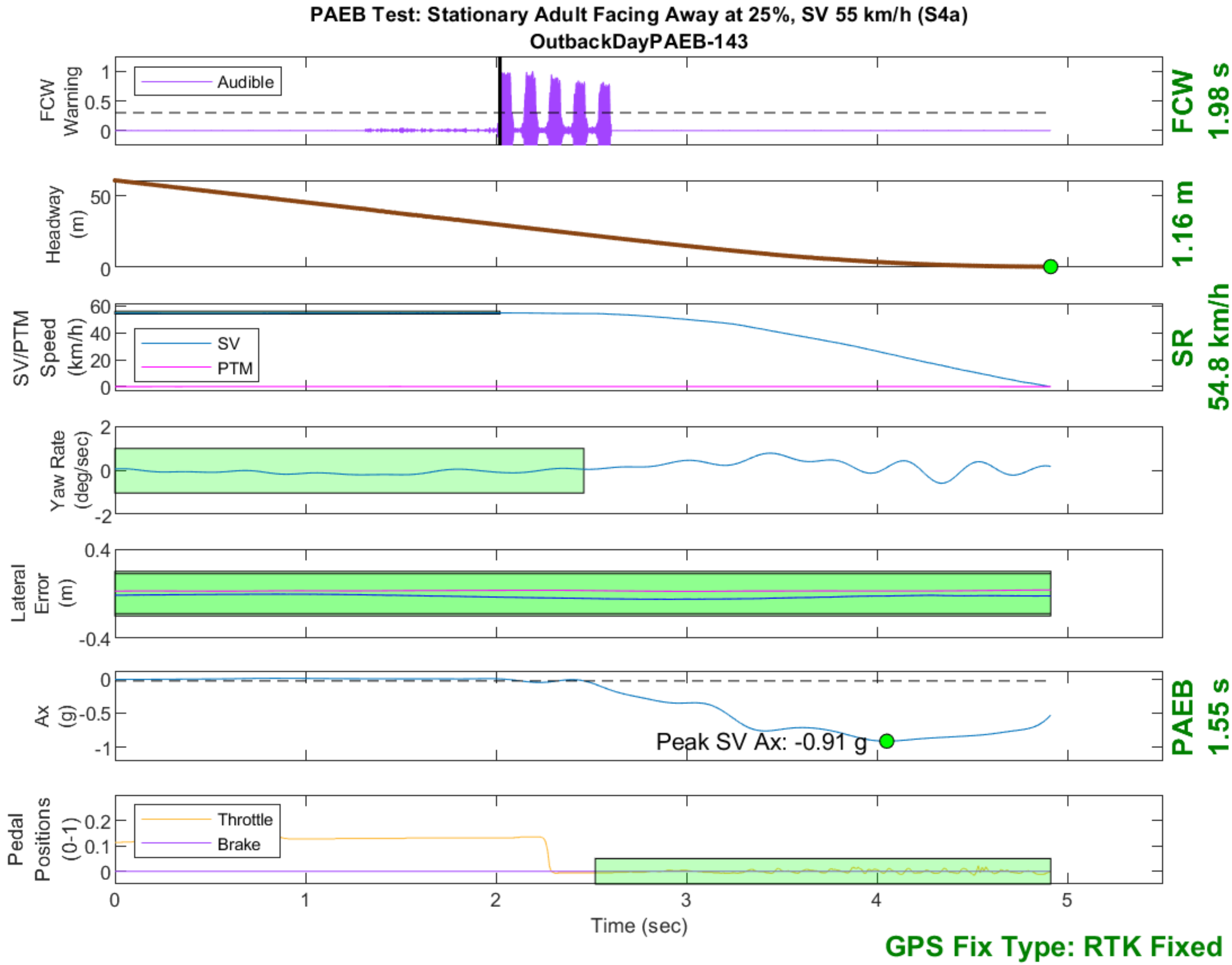


Figure D129. Time History for PAEB Run 143, S4a, Daytime, 55 km/h

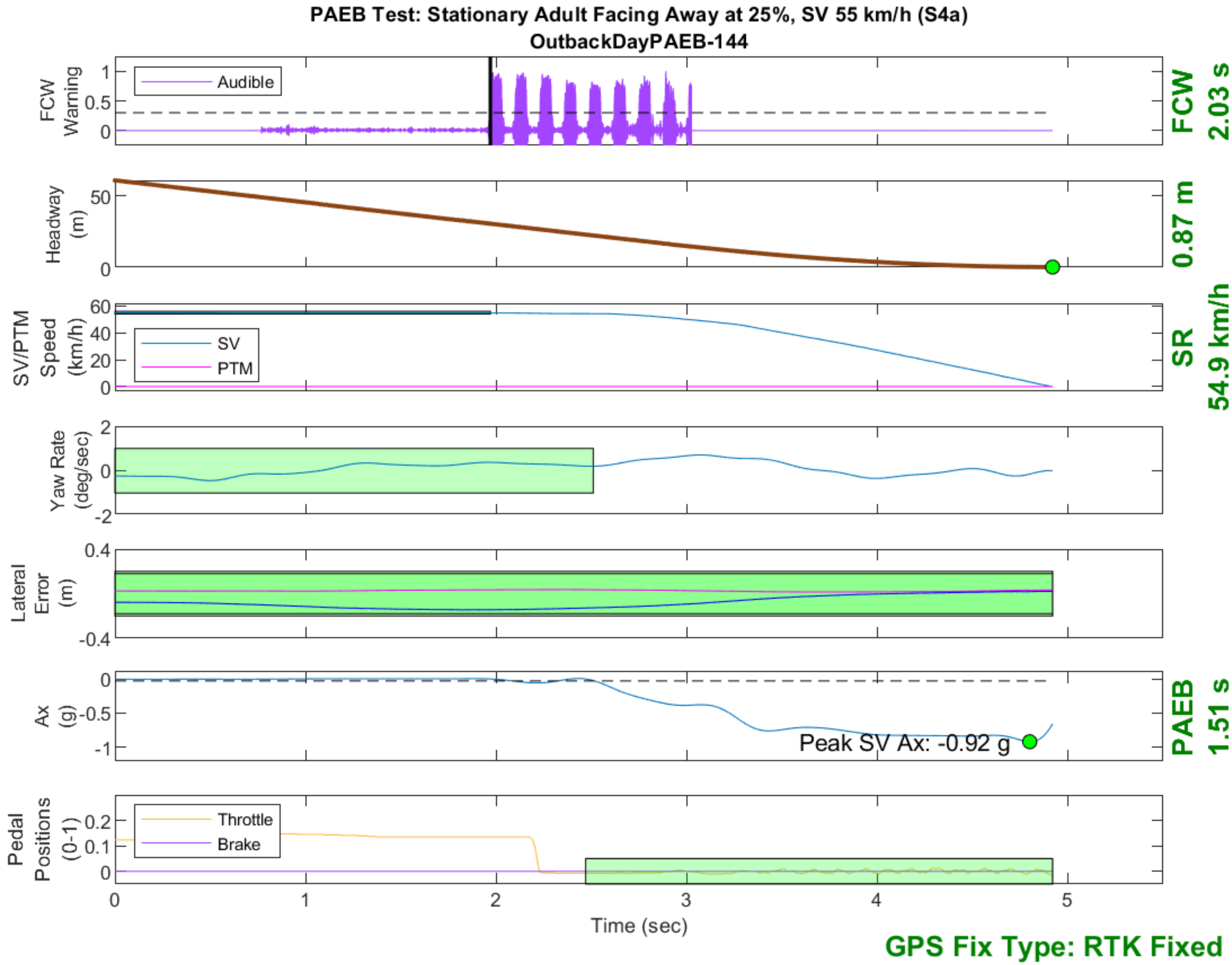


Figure D130. Time History for PAEB Run 144, S4a, Daytime, 55 km/h

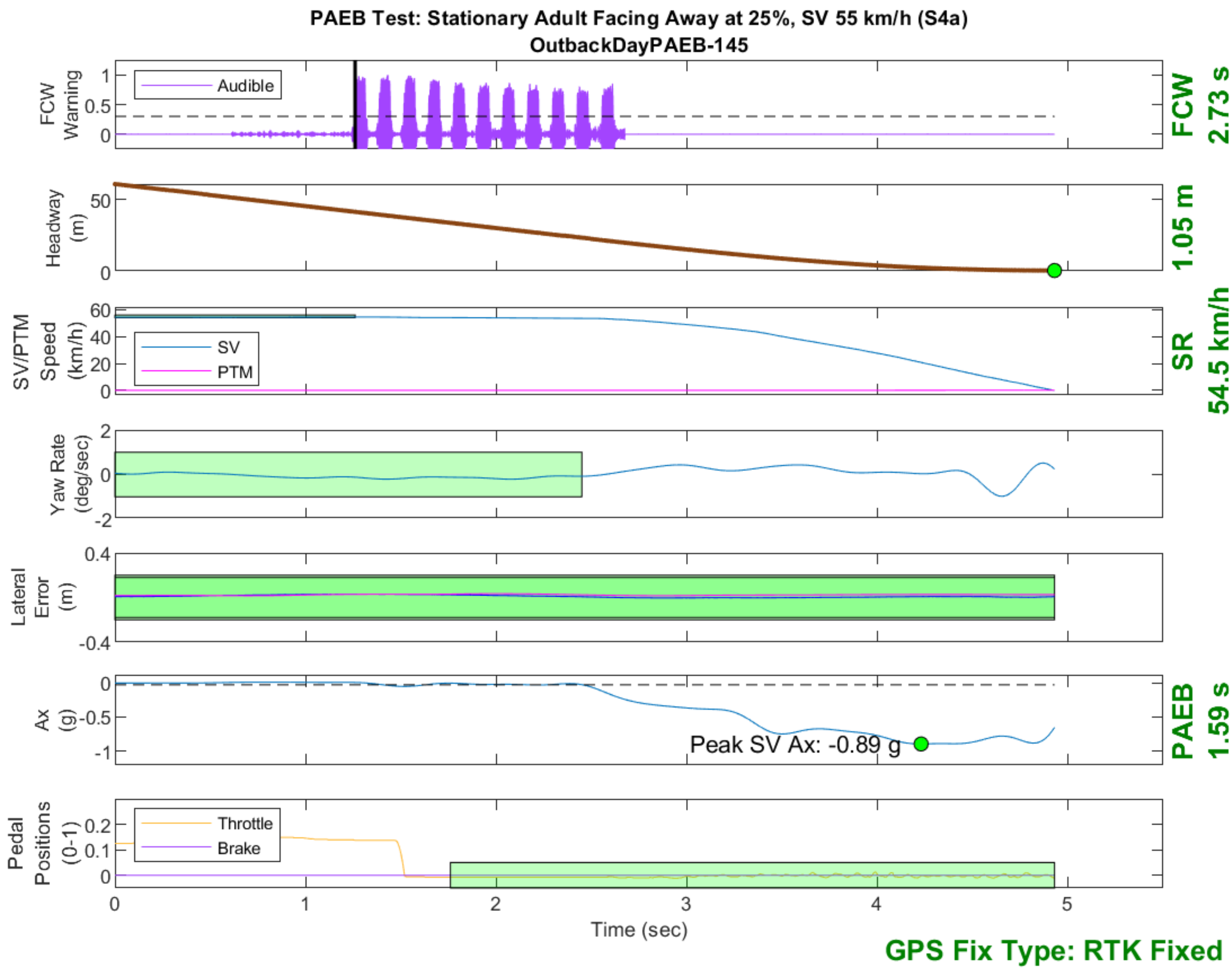


Figure D131. Time History for PAEB Run 145, S4a, Daytime, 55 km/h

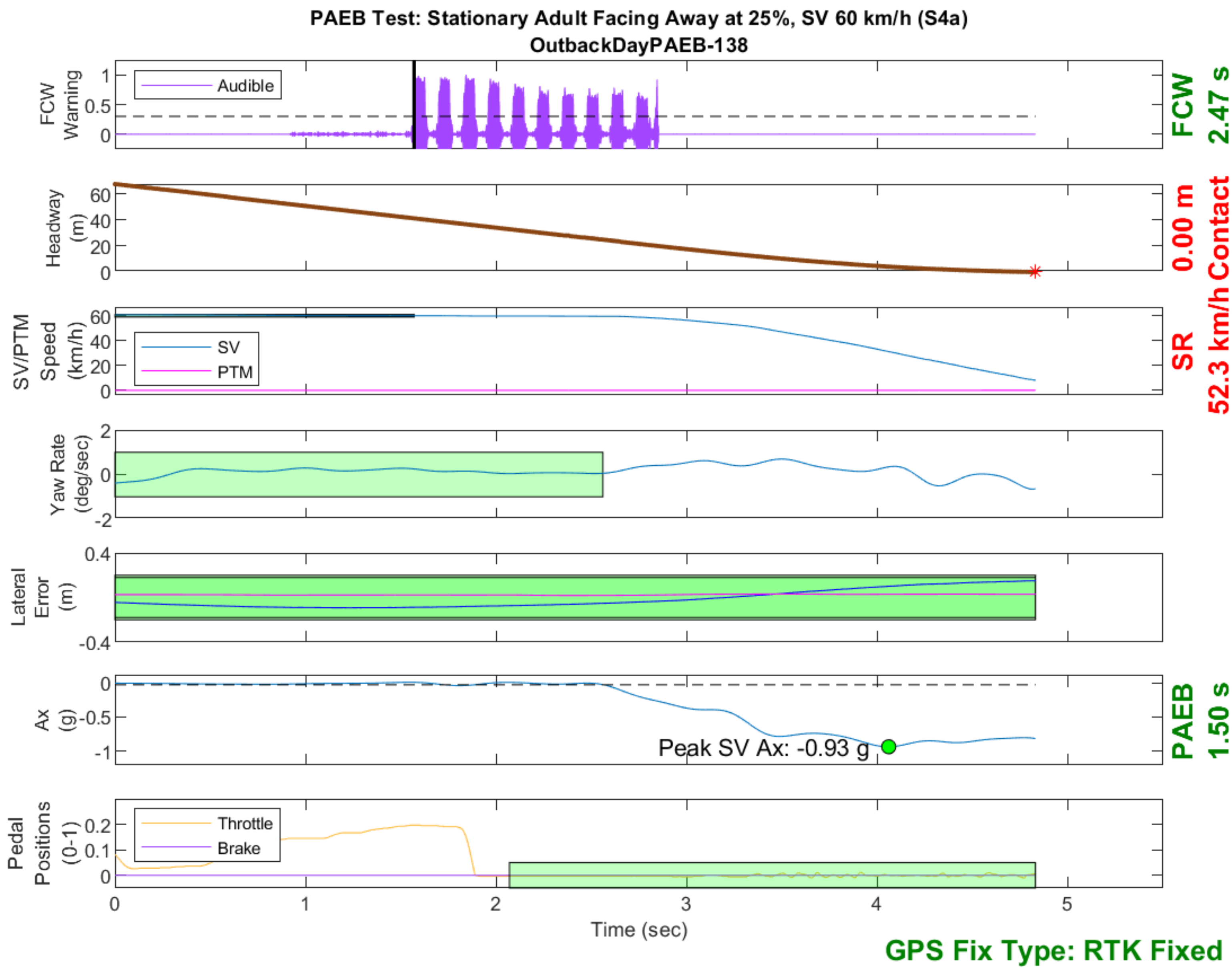


Figure D132. Time History for PAEB Run 138, S4a, Daytime, 60 km/h

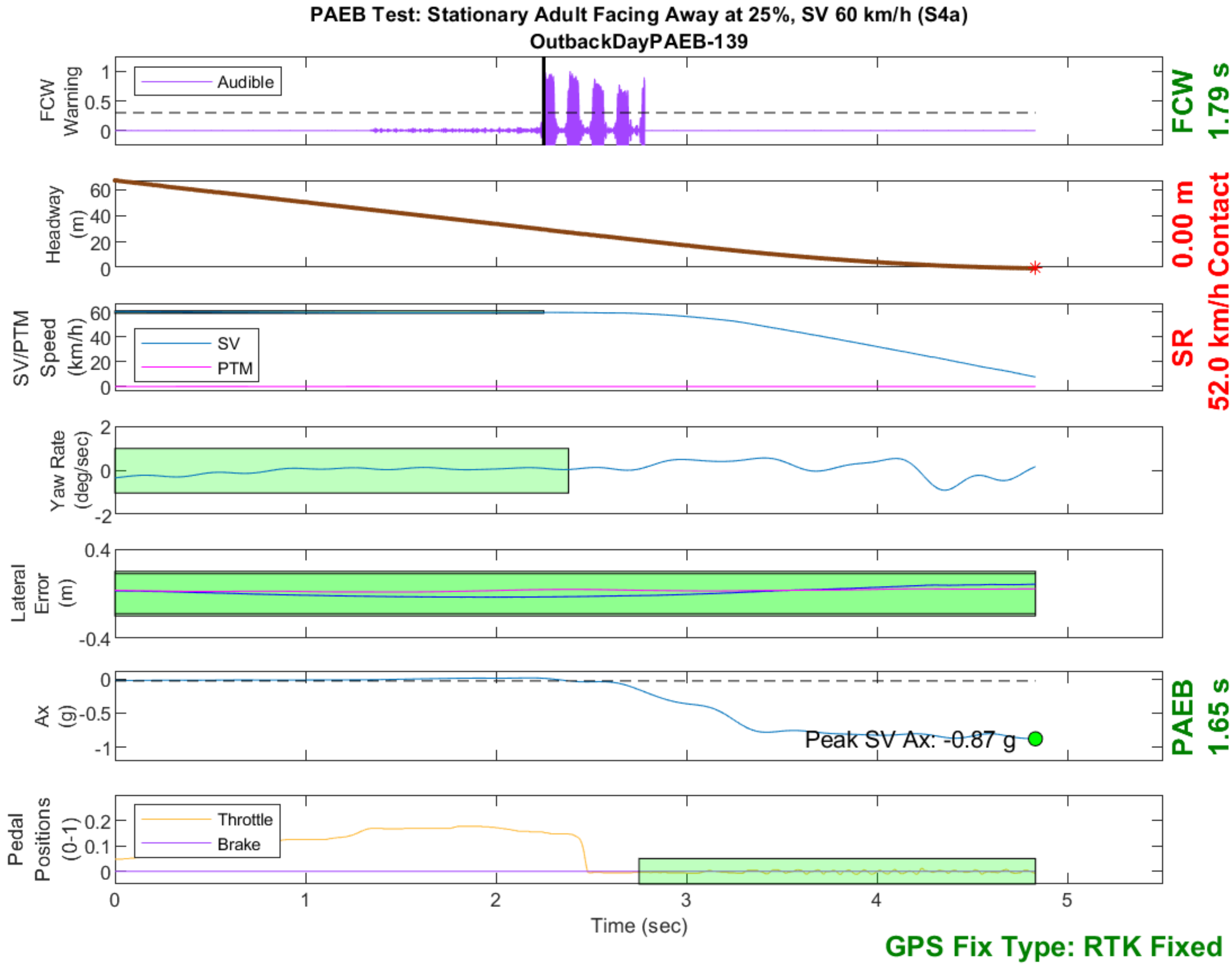


Figure D133. Time History for PAEB Run 139, S4a, Daytime, 60 km/h

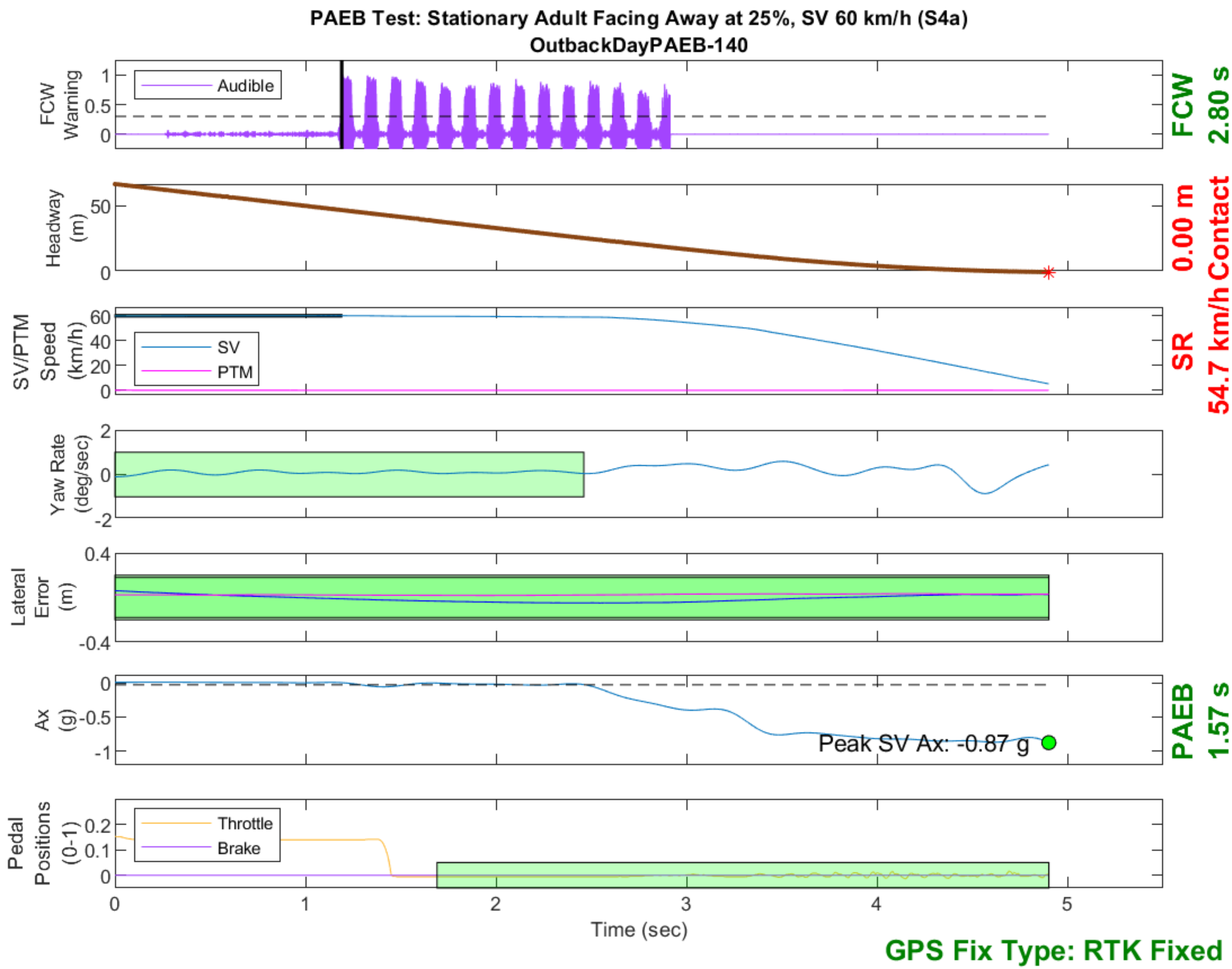


Figure D134. Time History for PAEB Run 140, S4a, Daytime, 60 km/h

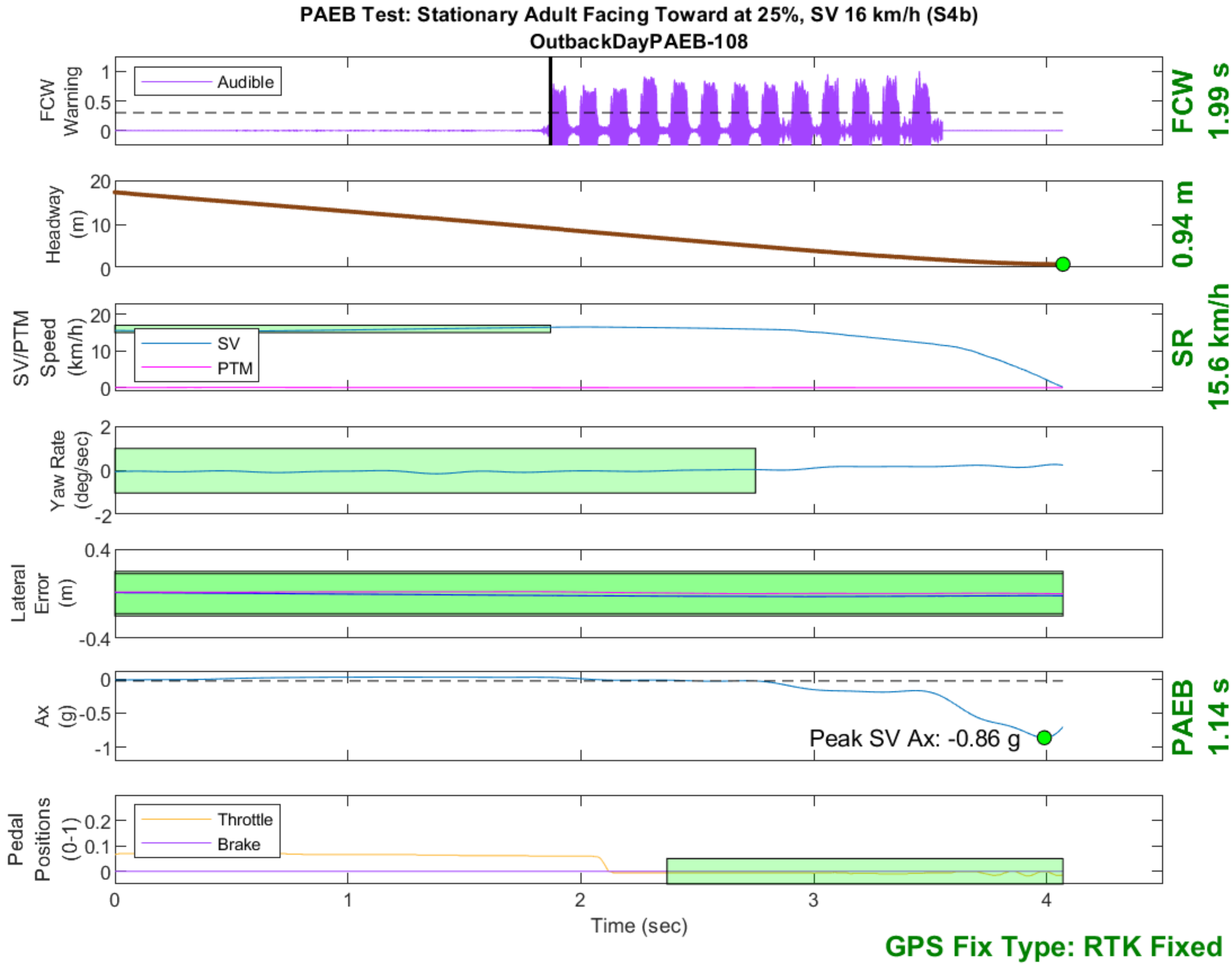


Figure D135. Time History for PAEB Run 108, S4b, Daytime, 16 km/h

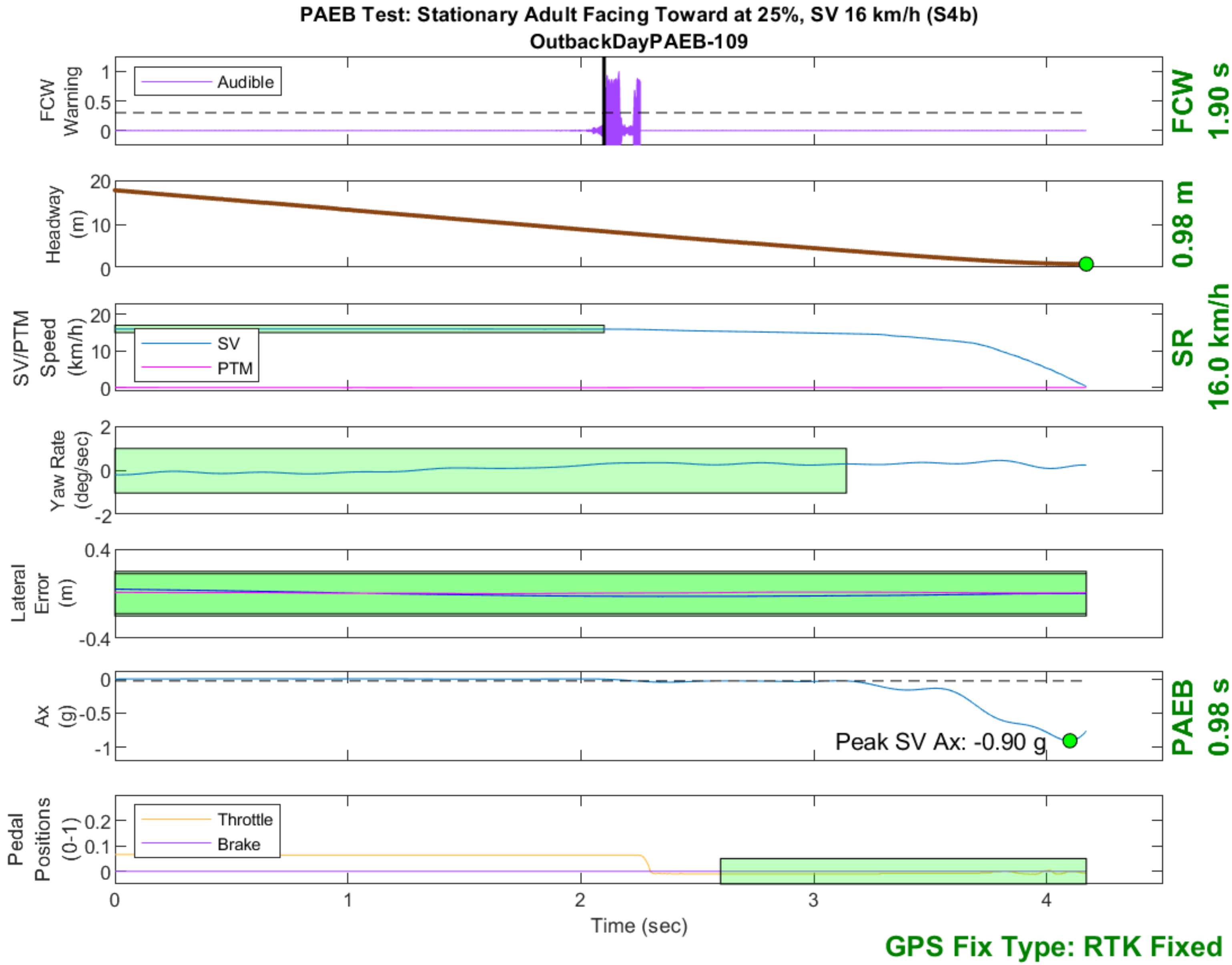


Figure D136. Time History for PAEB Run 109, S4b, Daytime, 16 km/h

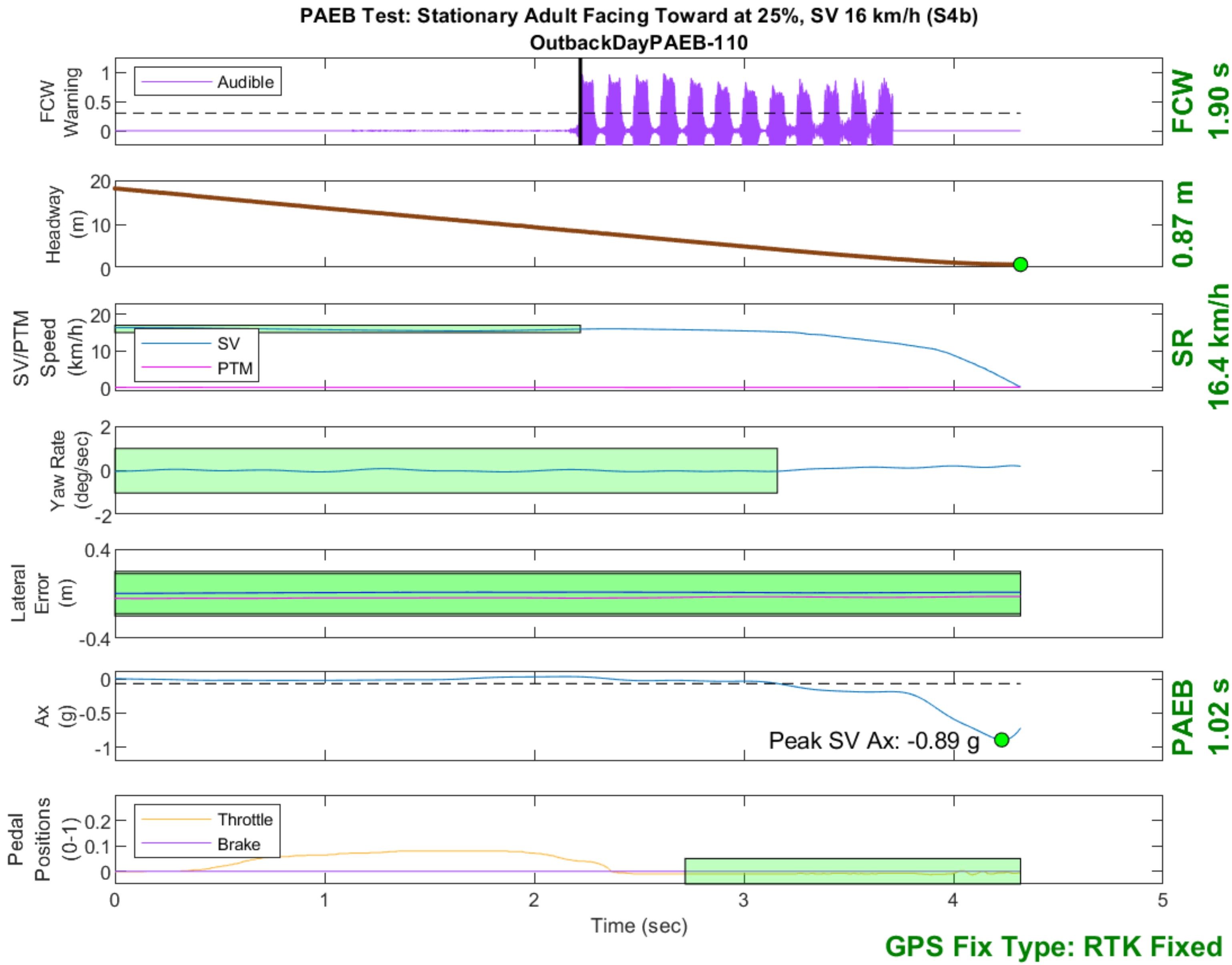


Figure D137. Time History for PAEB Run 110, S4b, Daytime, 16 km/h

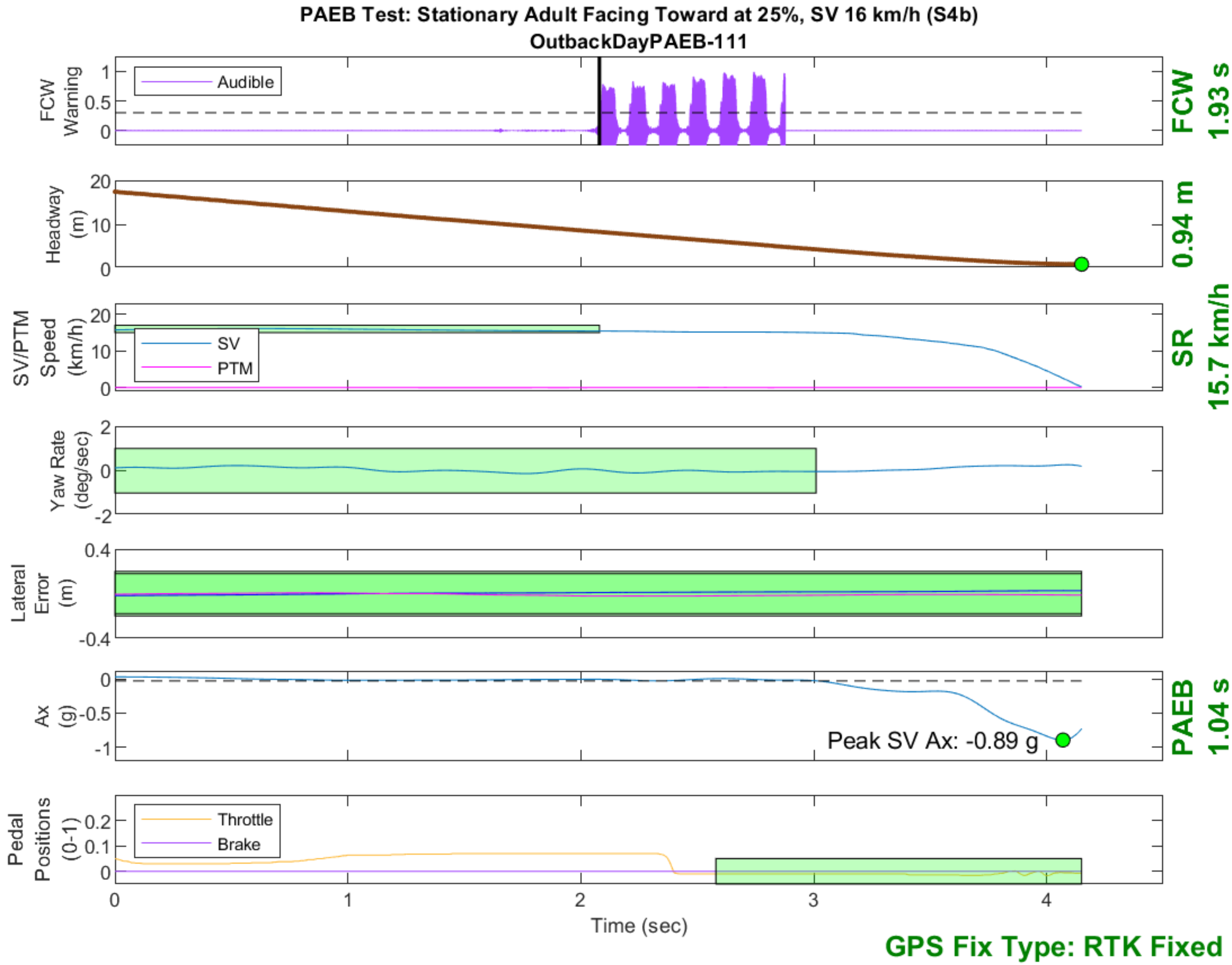


Figure D138. Time History for PAEB Run 111, S4b, Daytime, 16 km/h

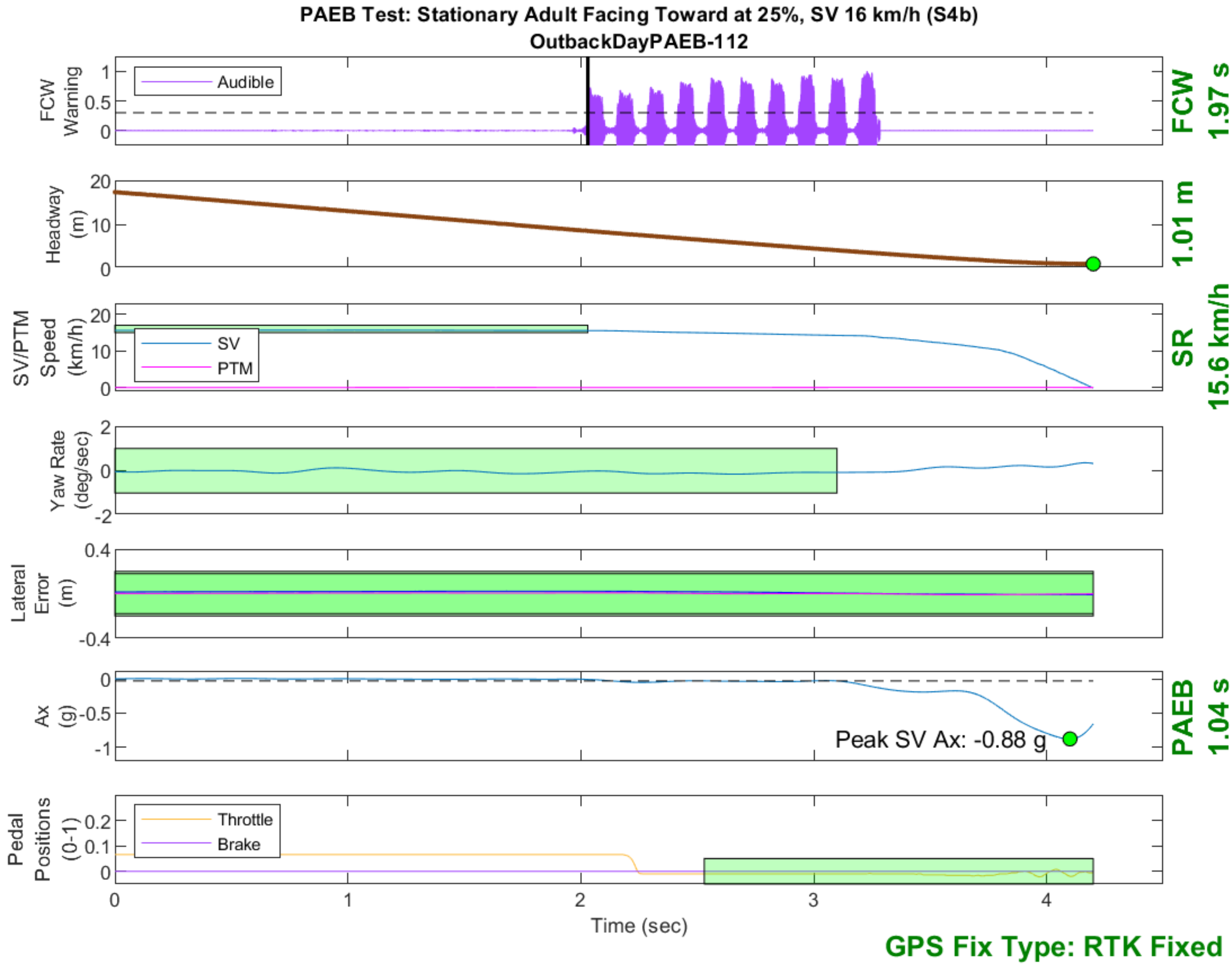


Figure D139. Time History for PAEB Run 112, S4b, Daytime, 16 km/h

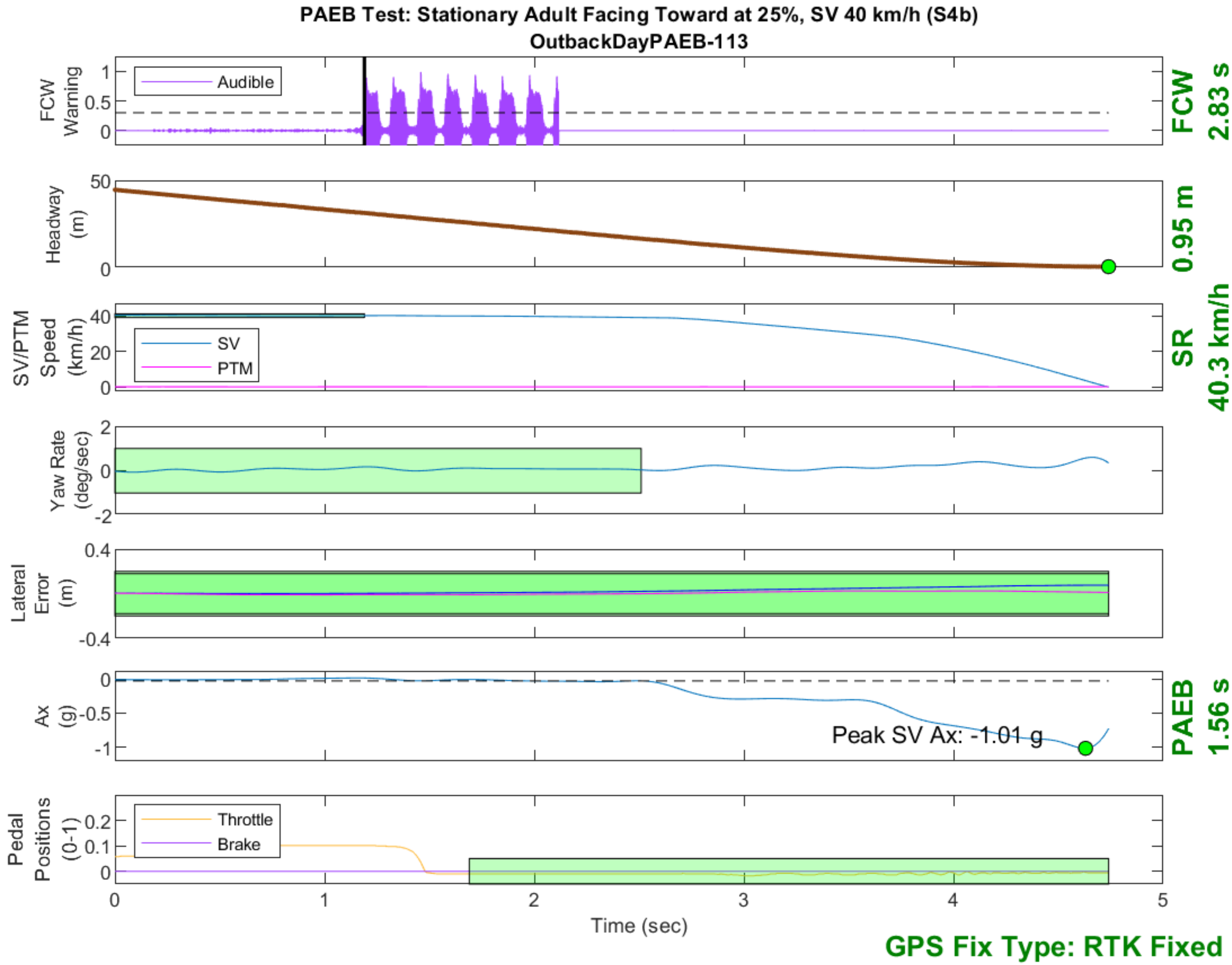


Figure D140. Time History for PAEB Run 113, S4b, Daytime, 40 km/h

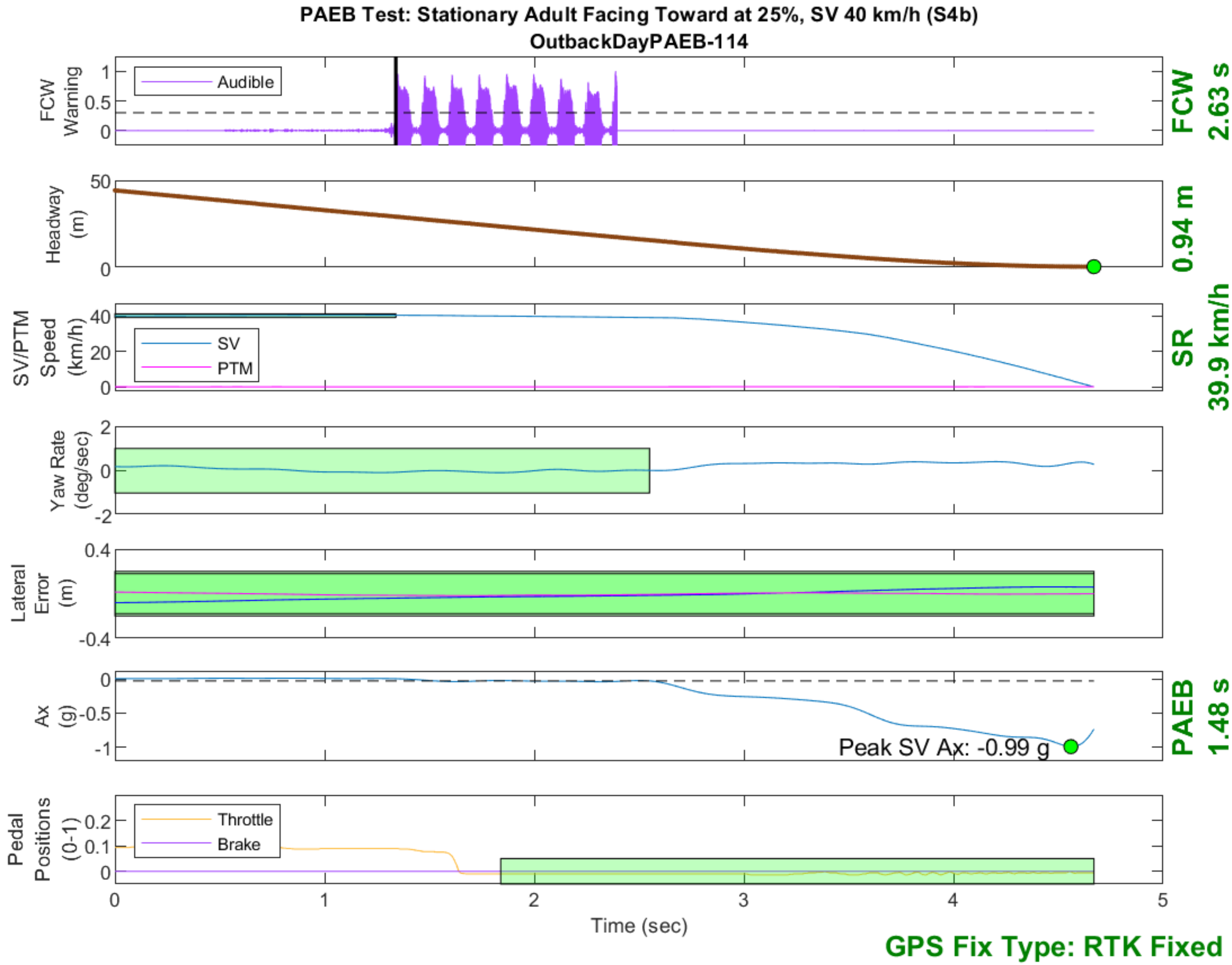


Figure D141. Time History for PAEB Run 114, S4b, Daytime, 40 km/h

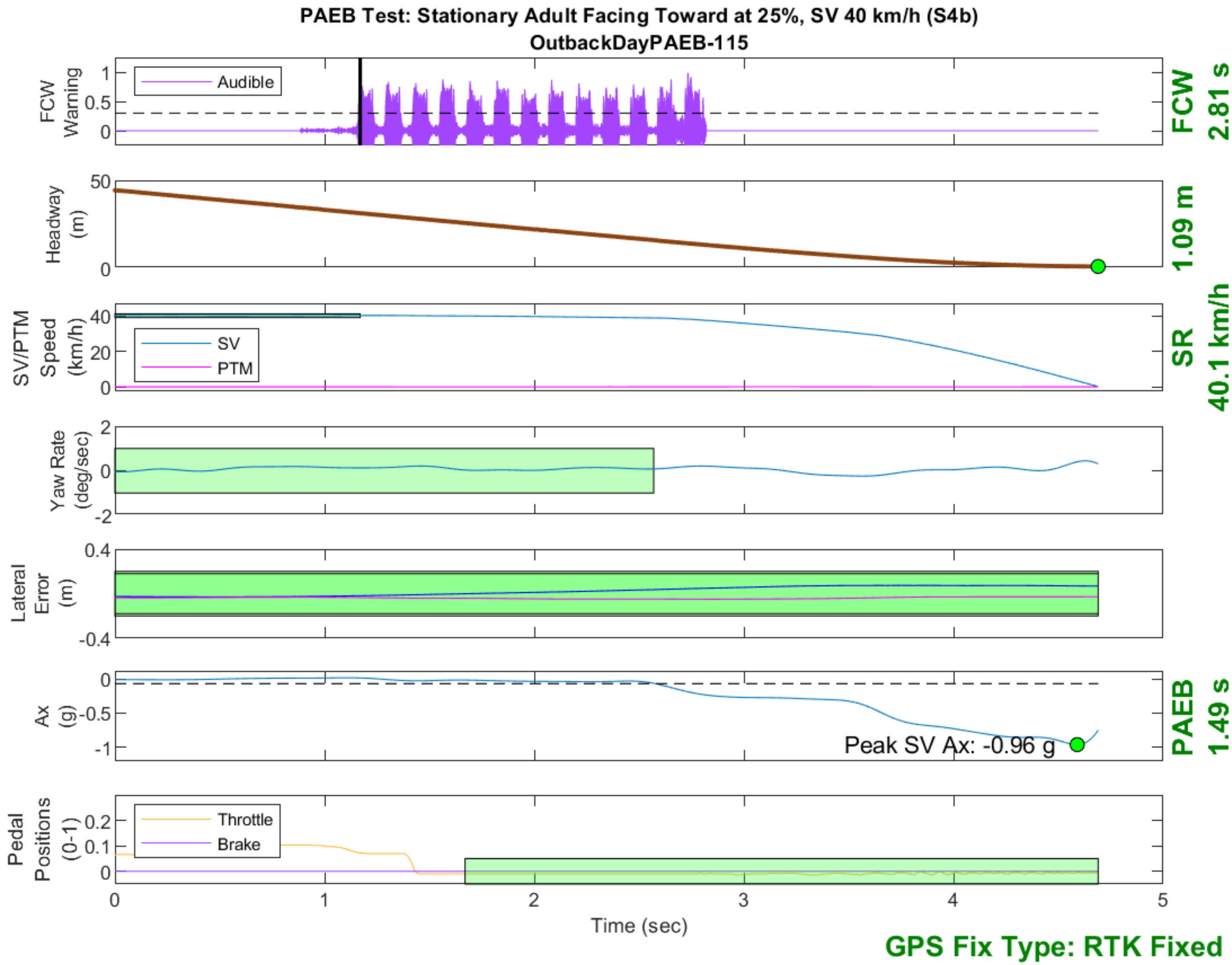


Figure D142. Time History for PAEB Run 115, S4b, Daytime, 40 km/h

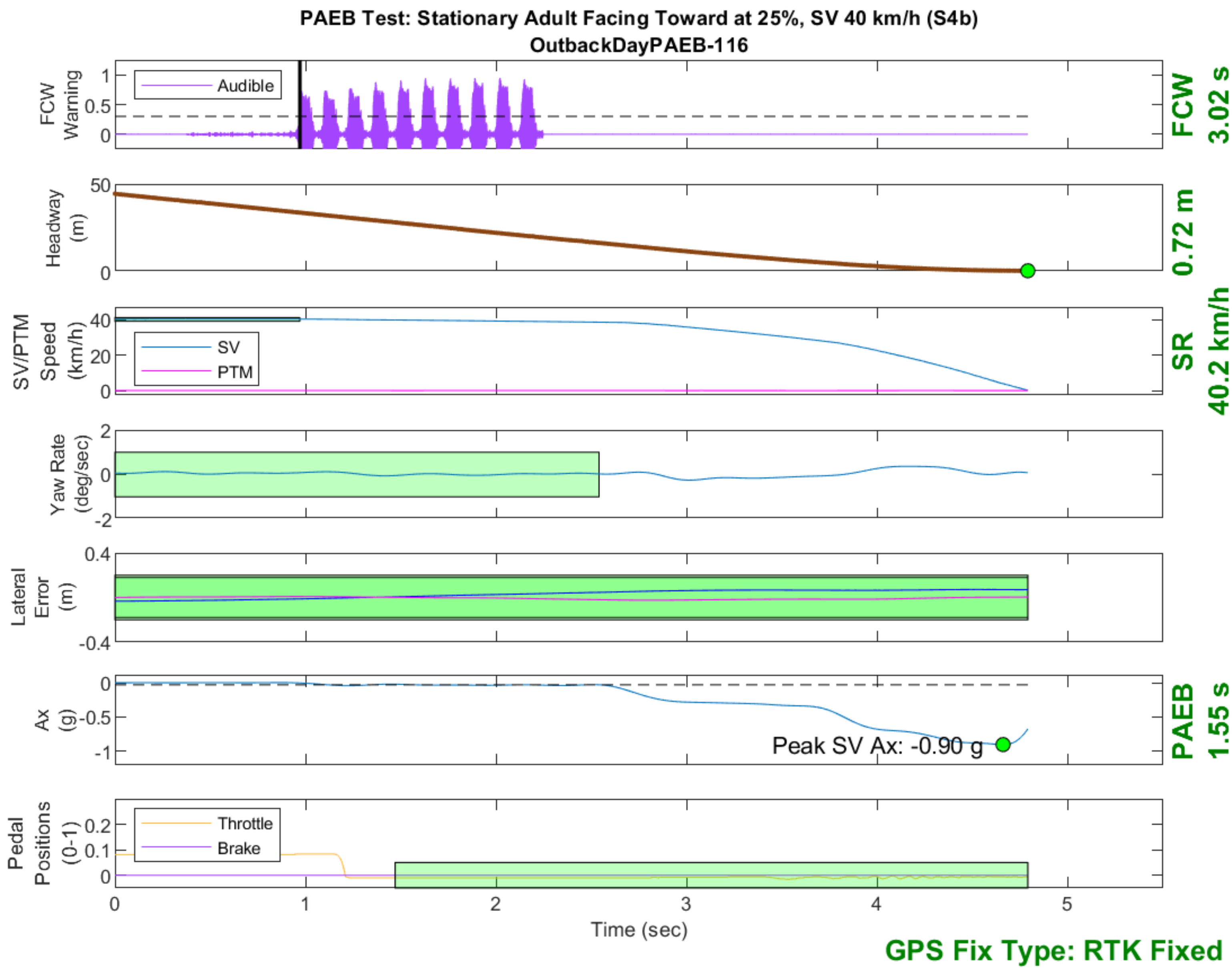


Figure D143. Time History for PAEB Run 116, S4b, Daytime, 40 km/h

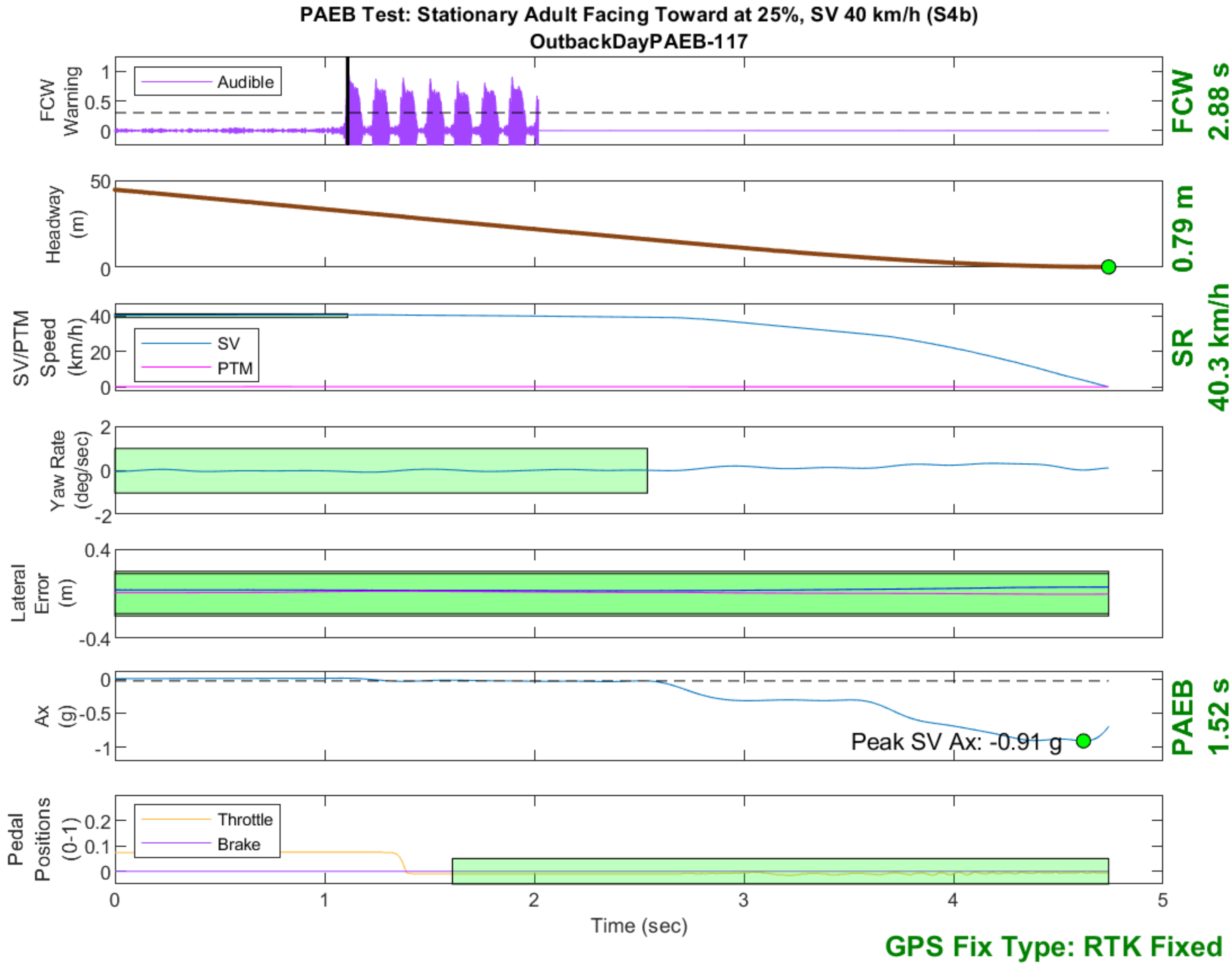


Figure D144. Time History for PAEB Run 117, S4b, Daytime, 40 km/h

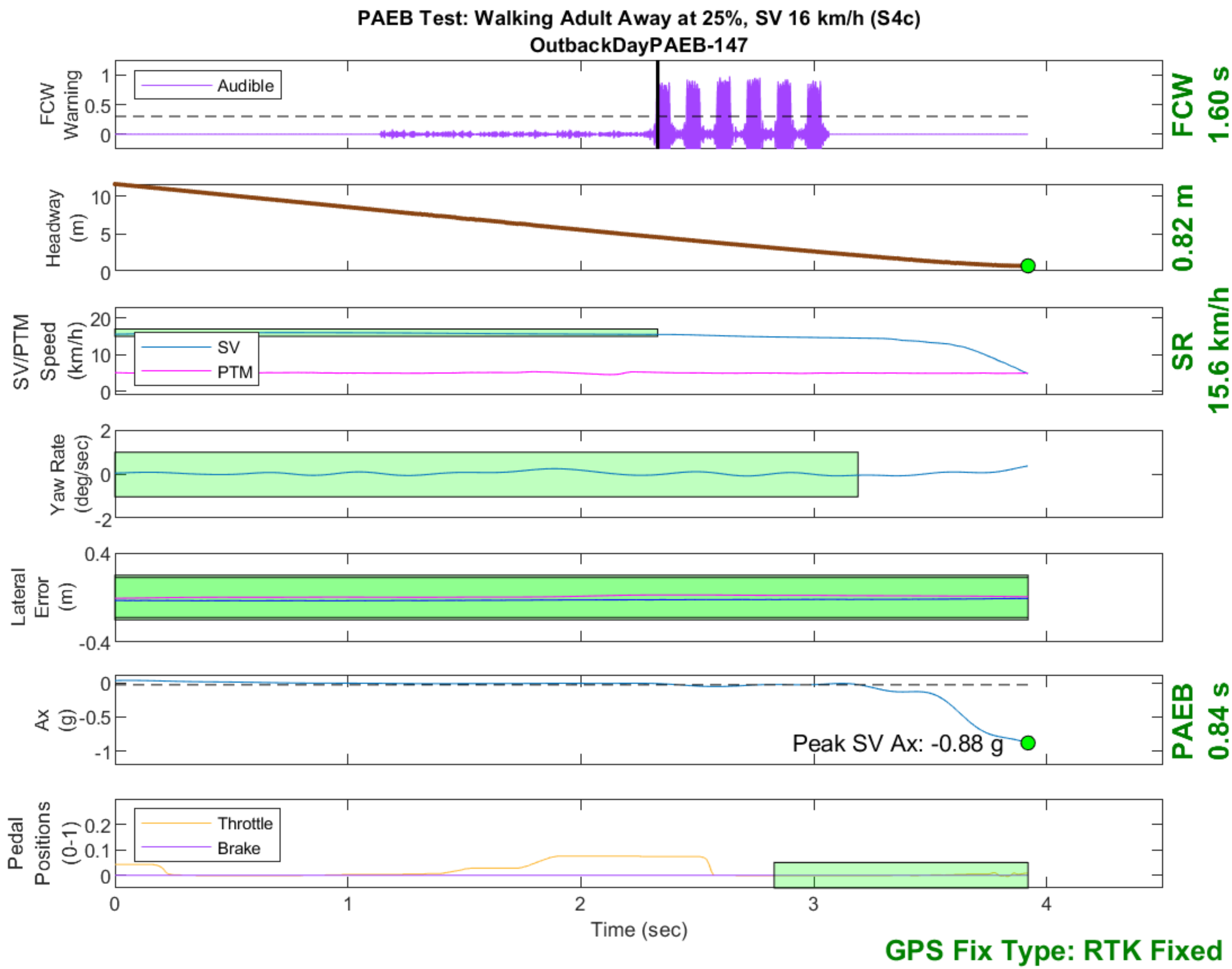


Figure D145. Time History for PAEB Run 147, S4c, Daytime, 16 km/h

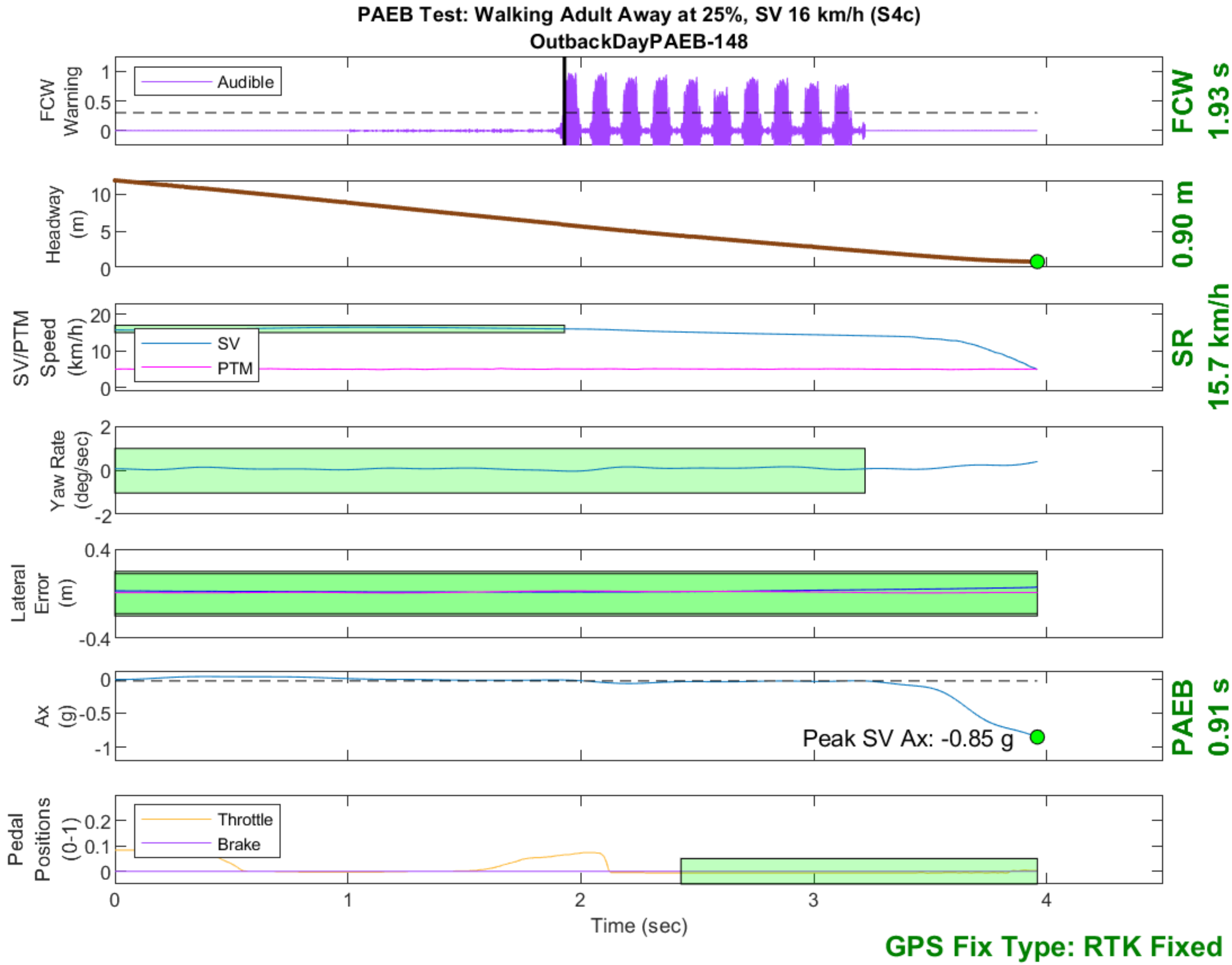


Figure D146. Time History for PAEB Run 148, S4c, Daytime, 16 km/h

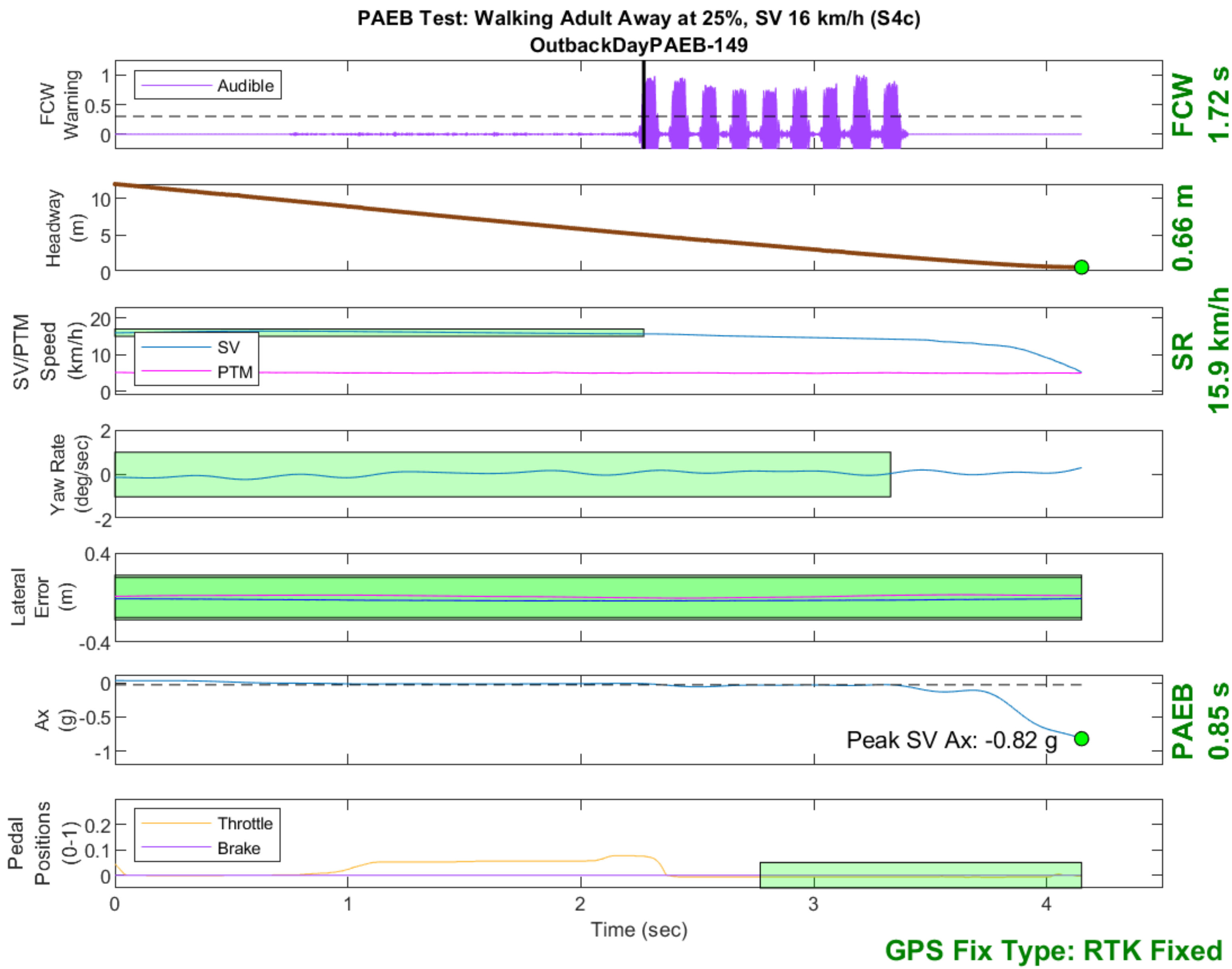


Figure D147. Time History for PAEB Run 149, S4c, Daytime, 16 km/h

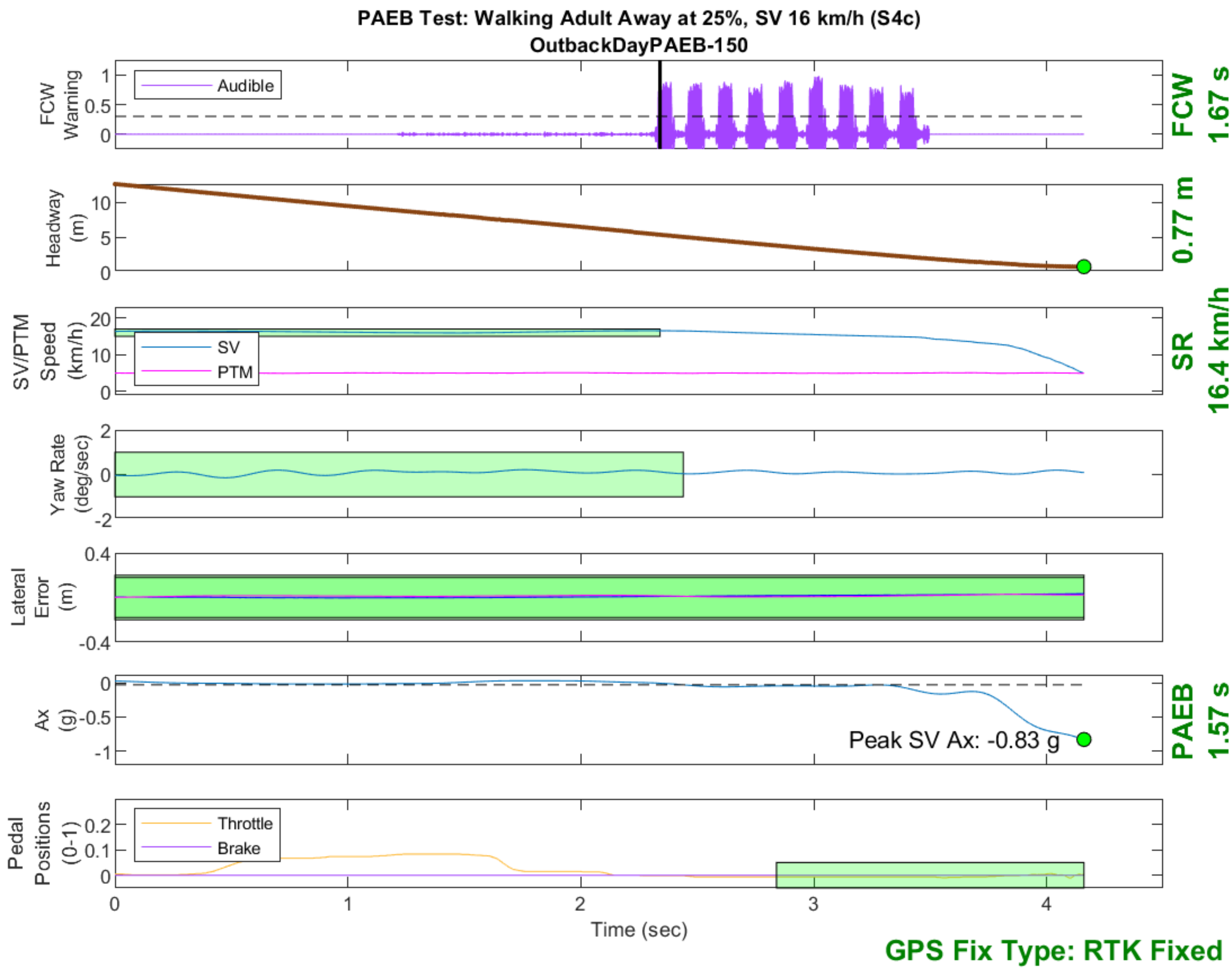


Figure D148. Time History for PAEB Run 150, S4c, Daytime, 16 km/h

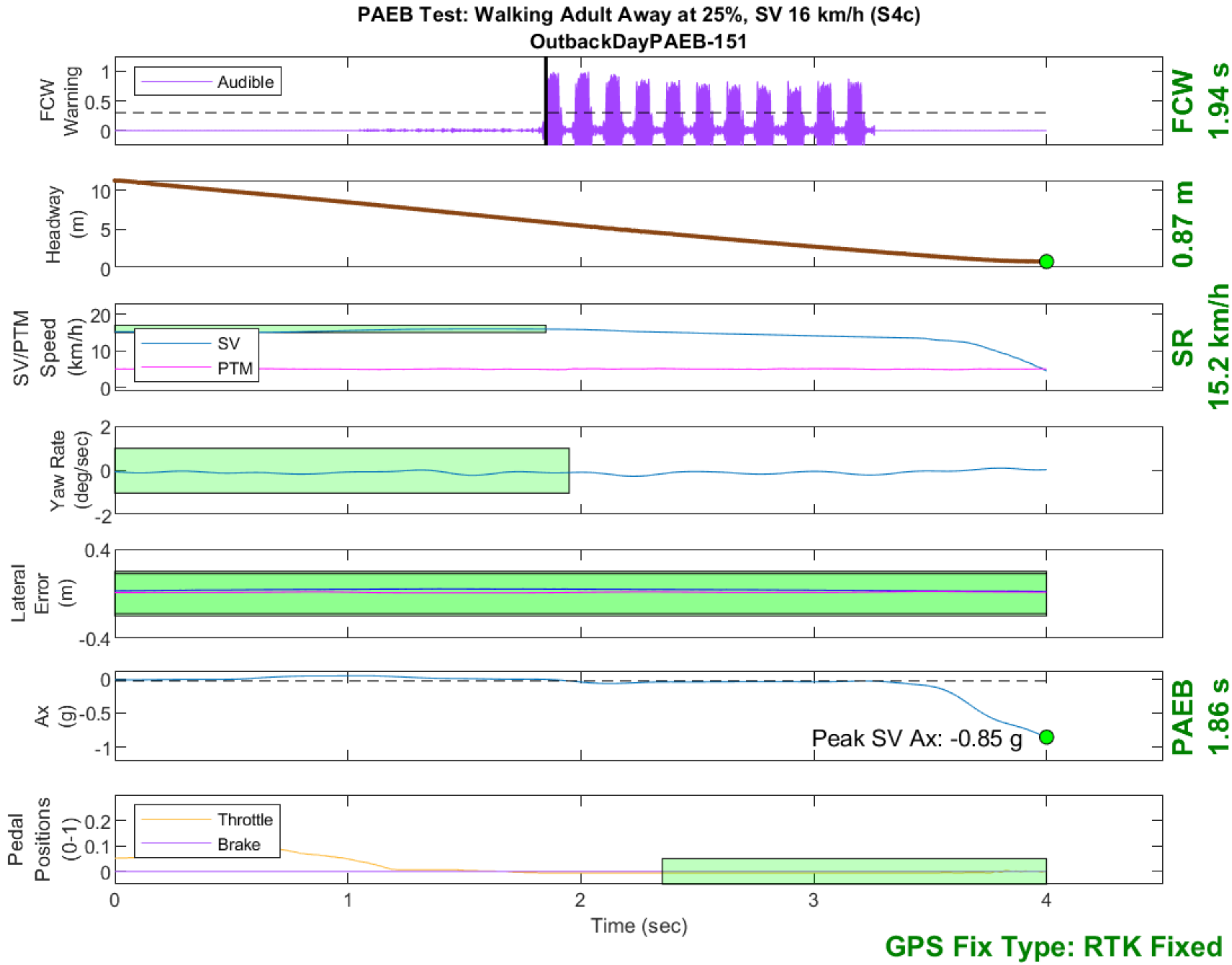


Figure D149. Time History for PAEB Run 151, S4c, Daytime, 16 km/h

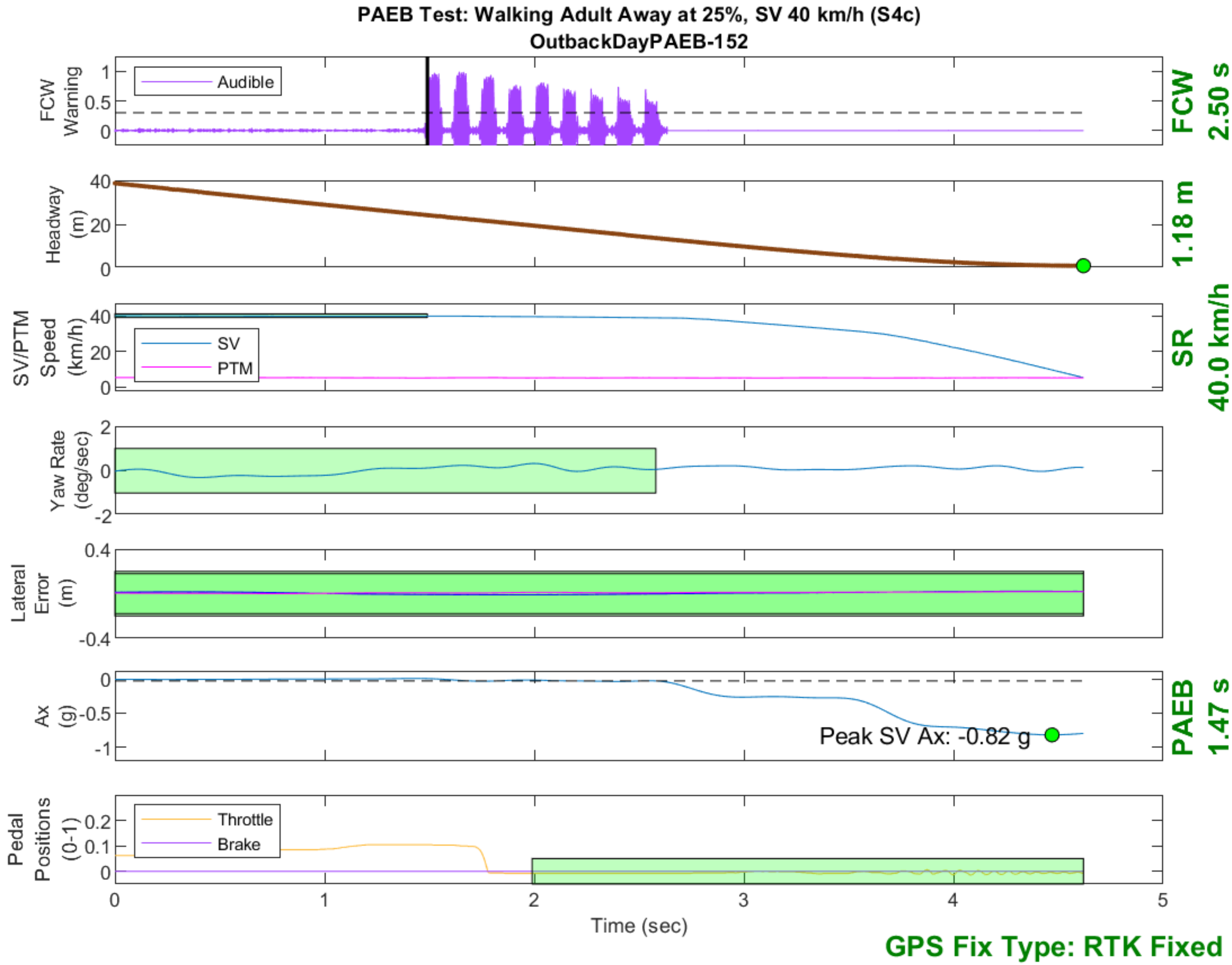


Figure D150. Time History for PAEB Run 152, S4c, Daytime, 40 km/h

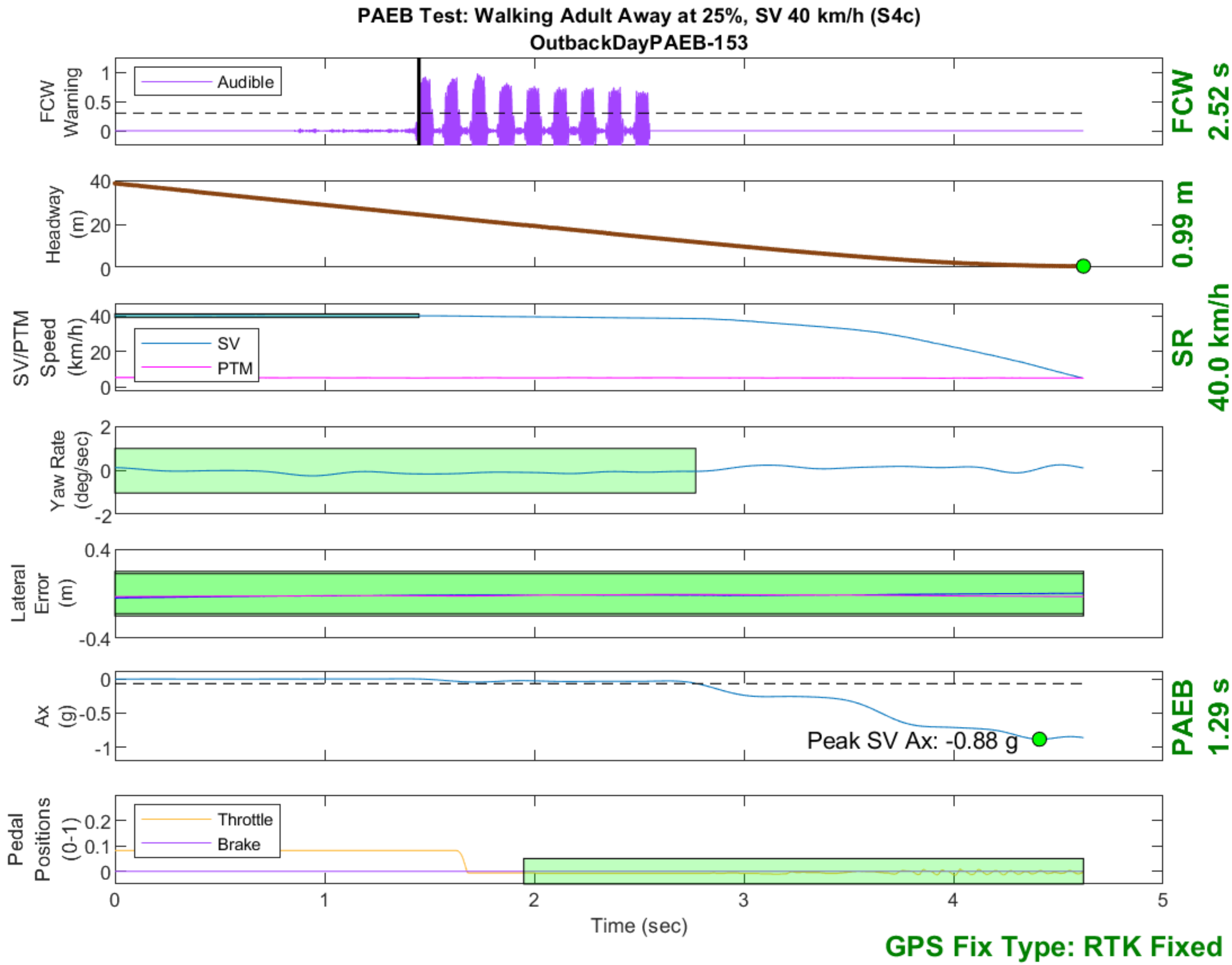


Figure D151. Time History for PAEB Run 153, S4c, Daytime, 40 km/h

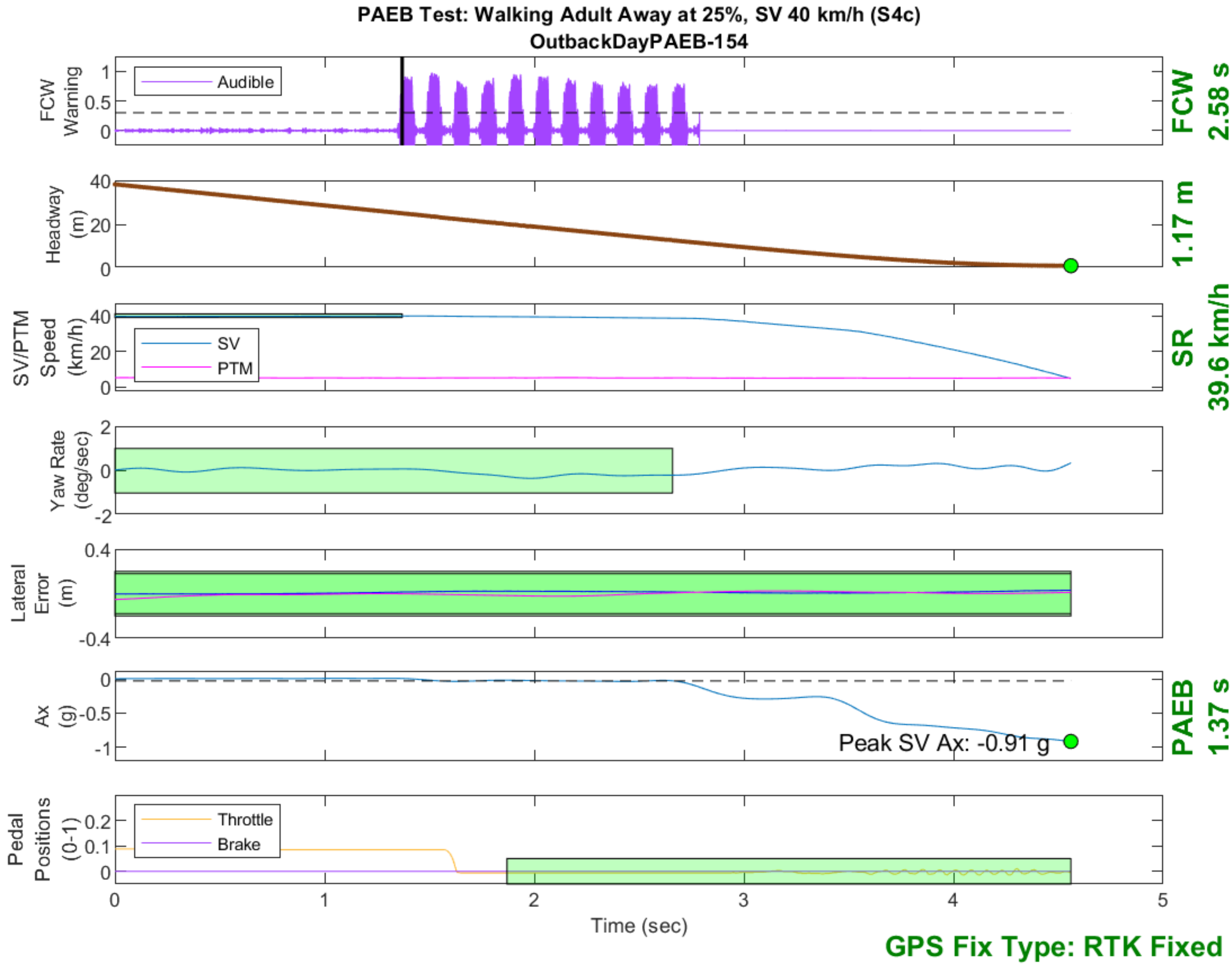


Figure D152. Time History for PAEB Run 154, S4c, Daytime, 40 km/h

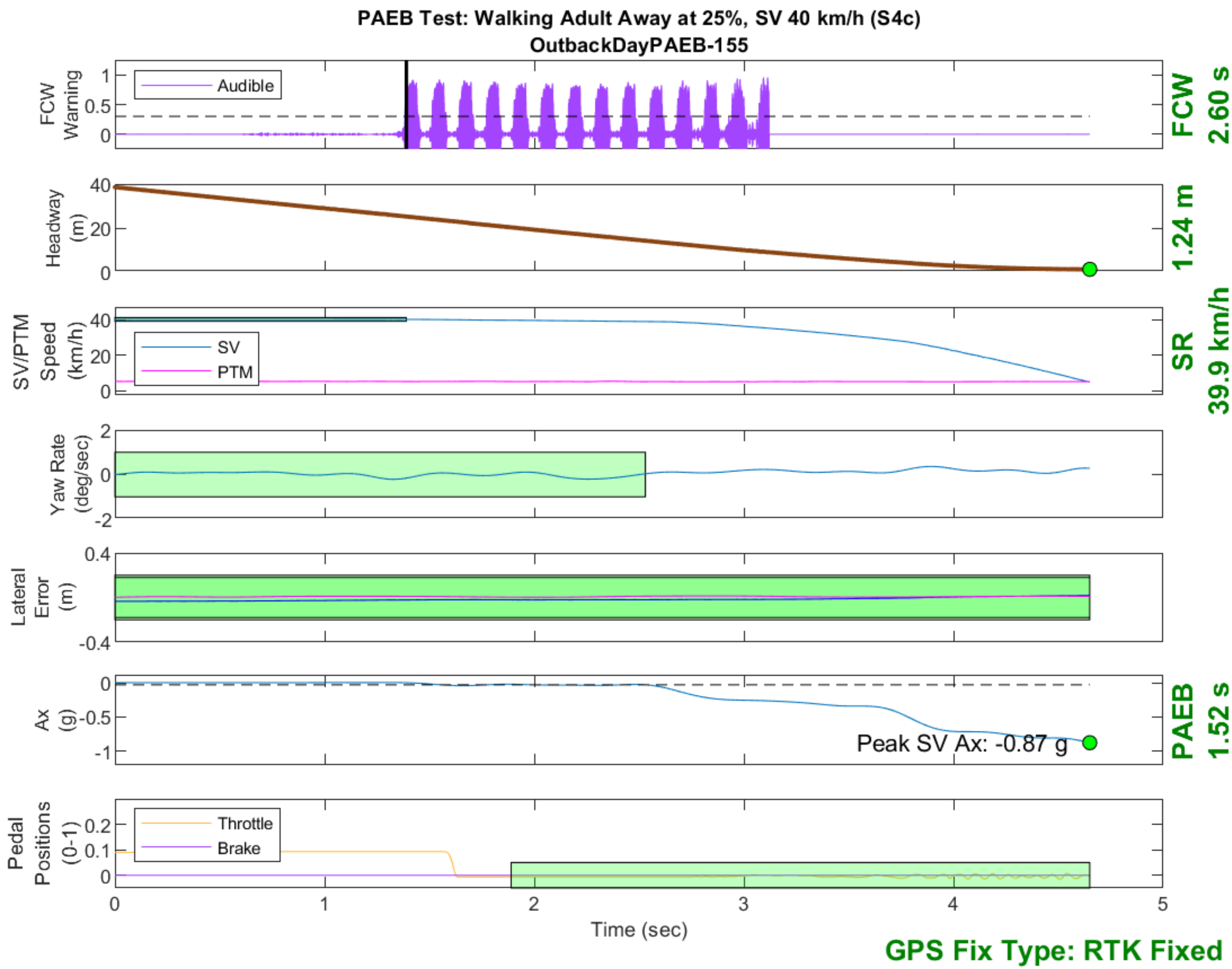


Figure D153. Time History for PAEB Run 155, S4c, Daytime, 40 km/h

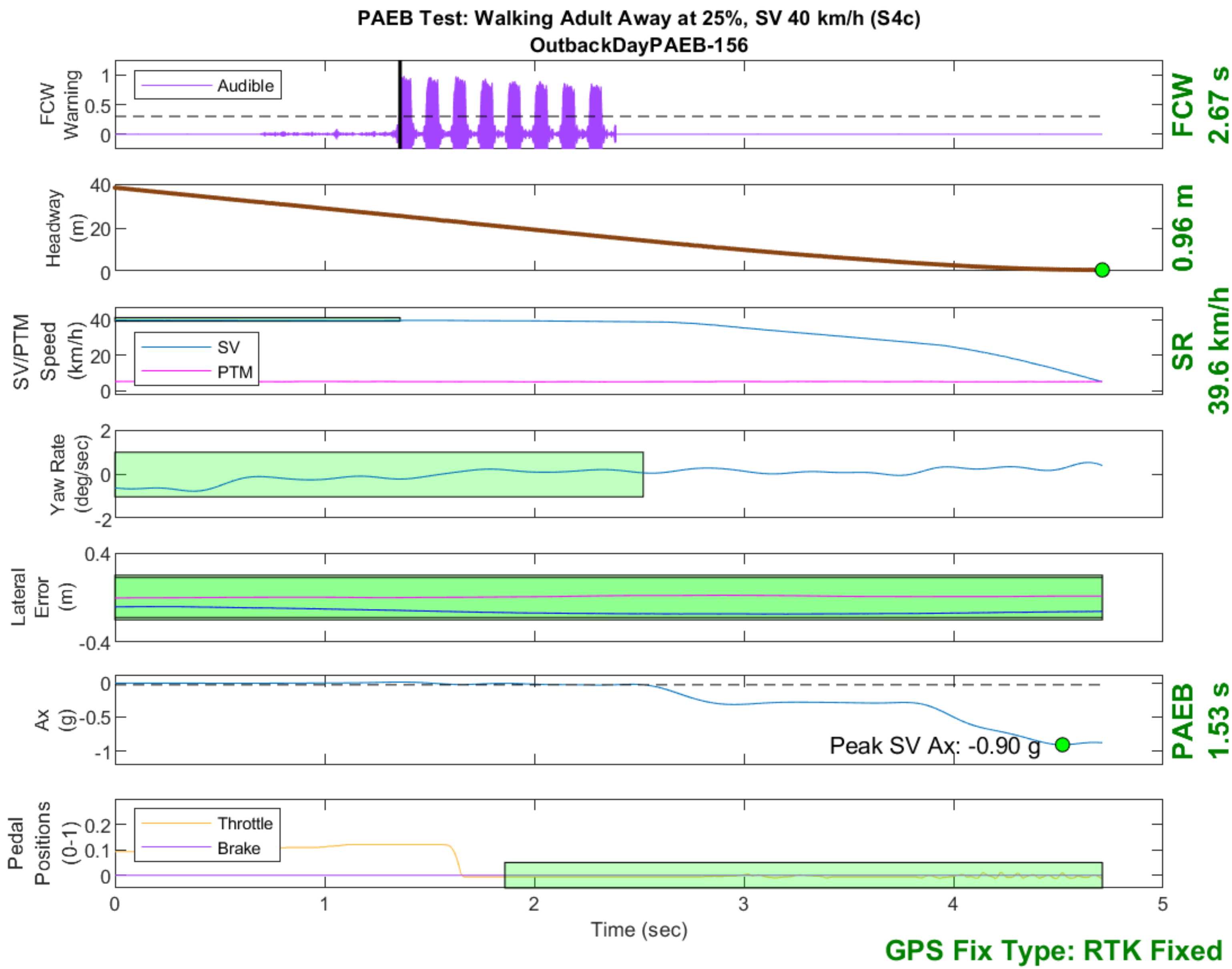


Figure D154. Time History for PAEB Run 156, S4c, Daytime, 40 km/h

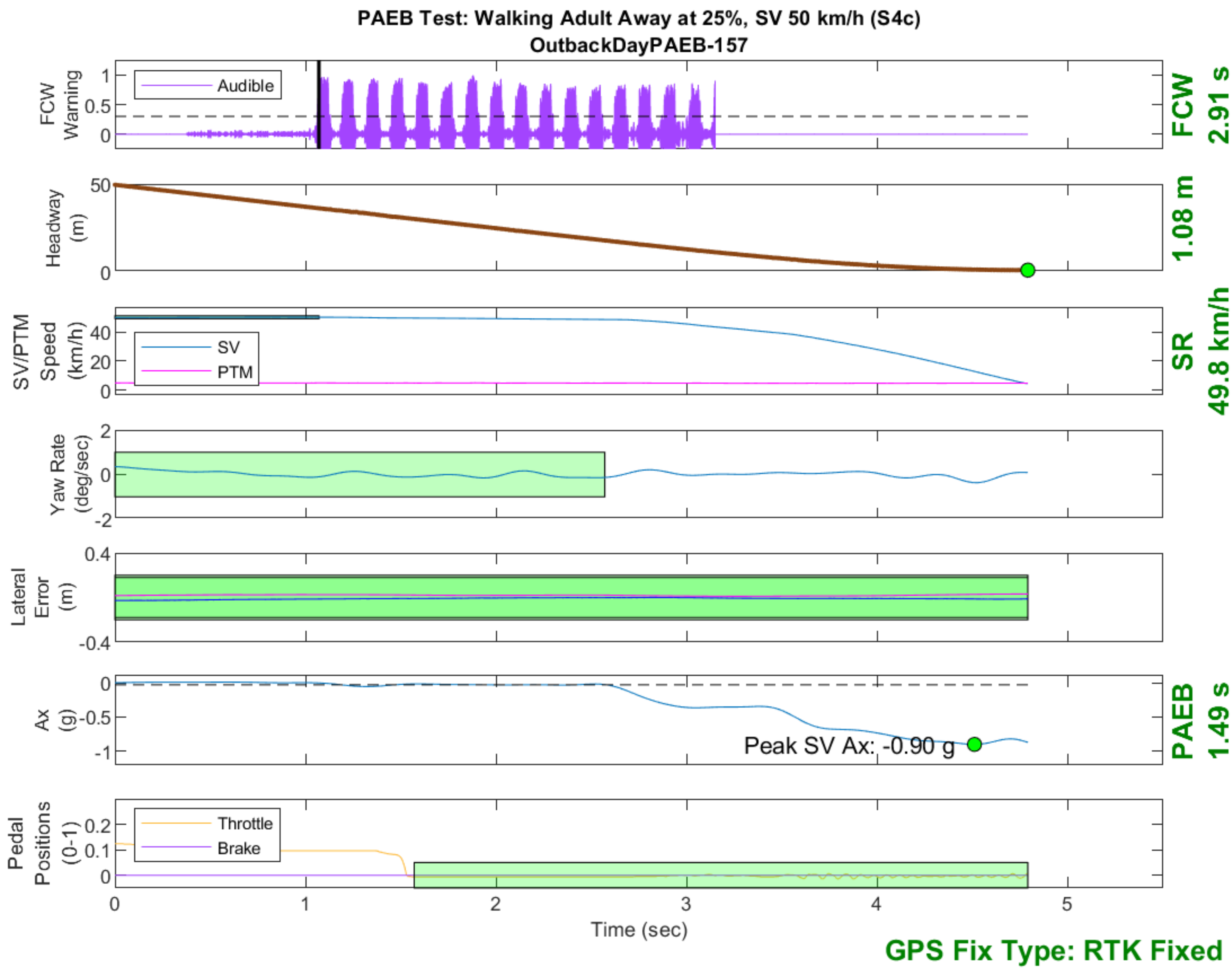


Figure D155. Time History for PAEB Run 157, S4c, Daytime, 50 km/h

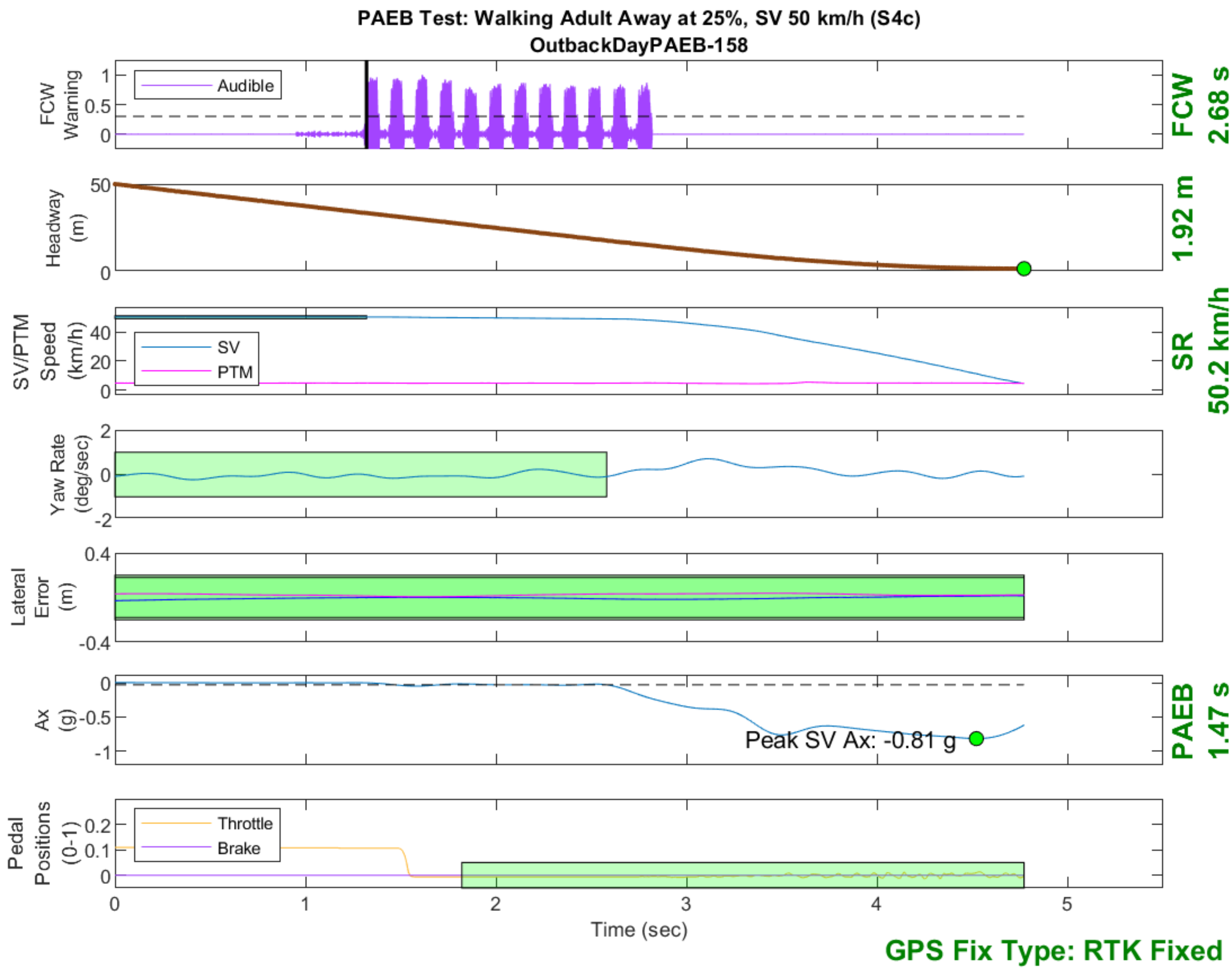


Figure D156. Time History for PAEB Run 158, S4c, Daytime, 50 km/h

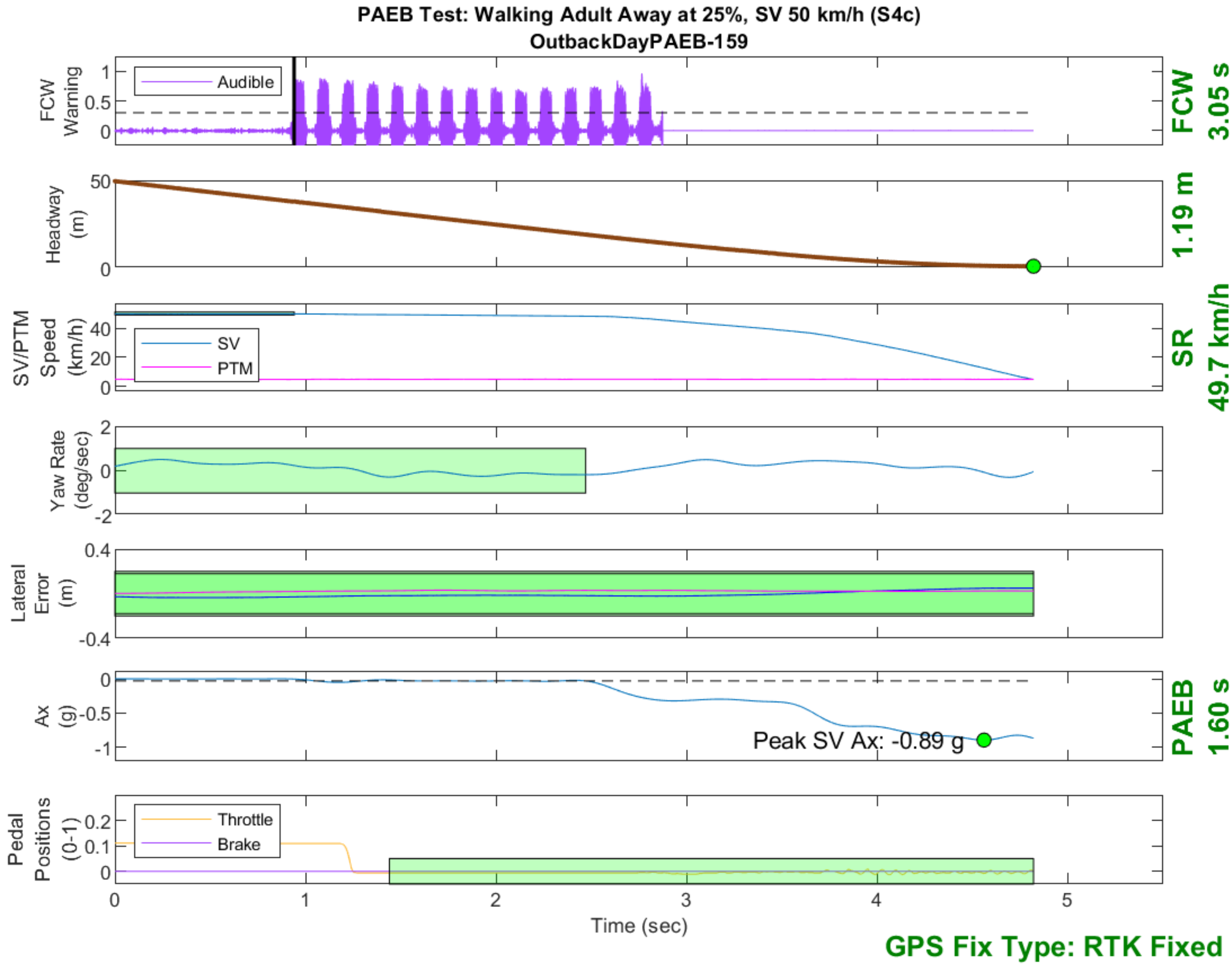


Figure D157. Time History for PAEB Run 159, S4c, Daytime, 50 km/h

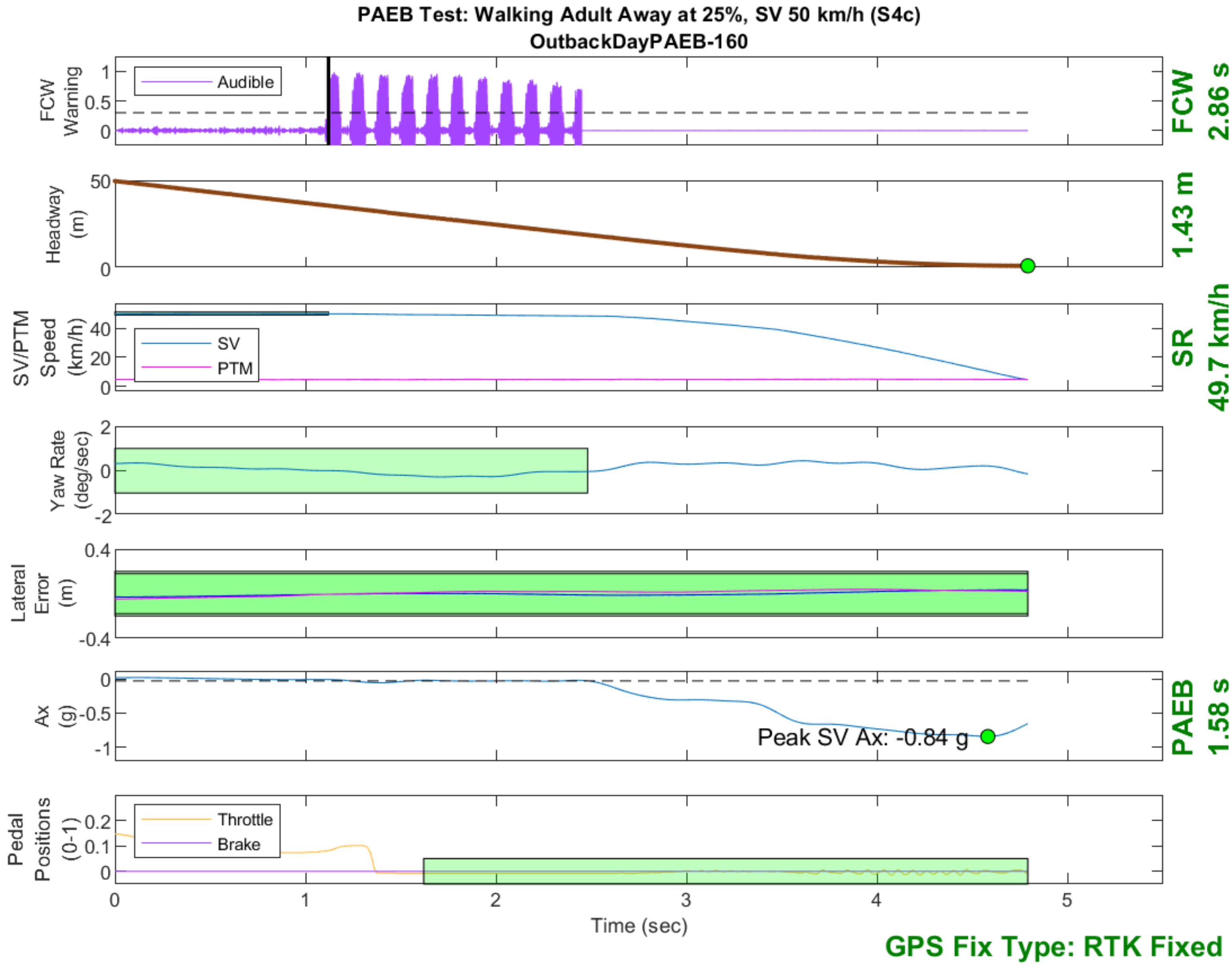


Figure D158. Time History for PAEB Run 160, S4c, Daytime, 50 km/h

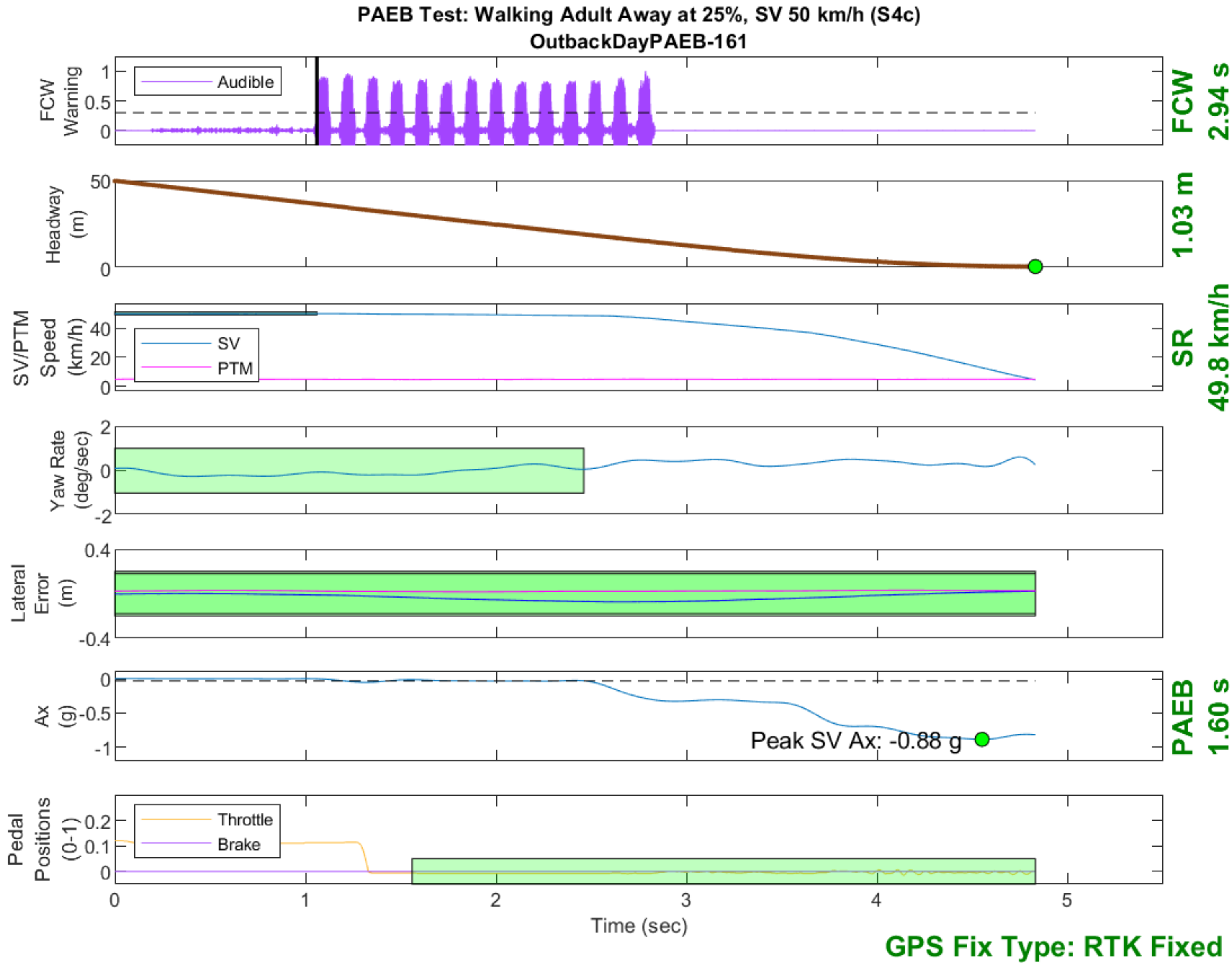


Figure D159. Time History for PAEB Run 161, S4c, Daytime, 50 km/h

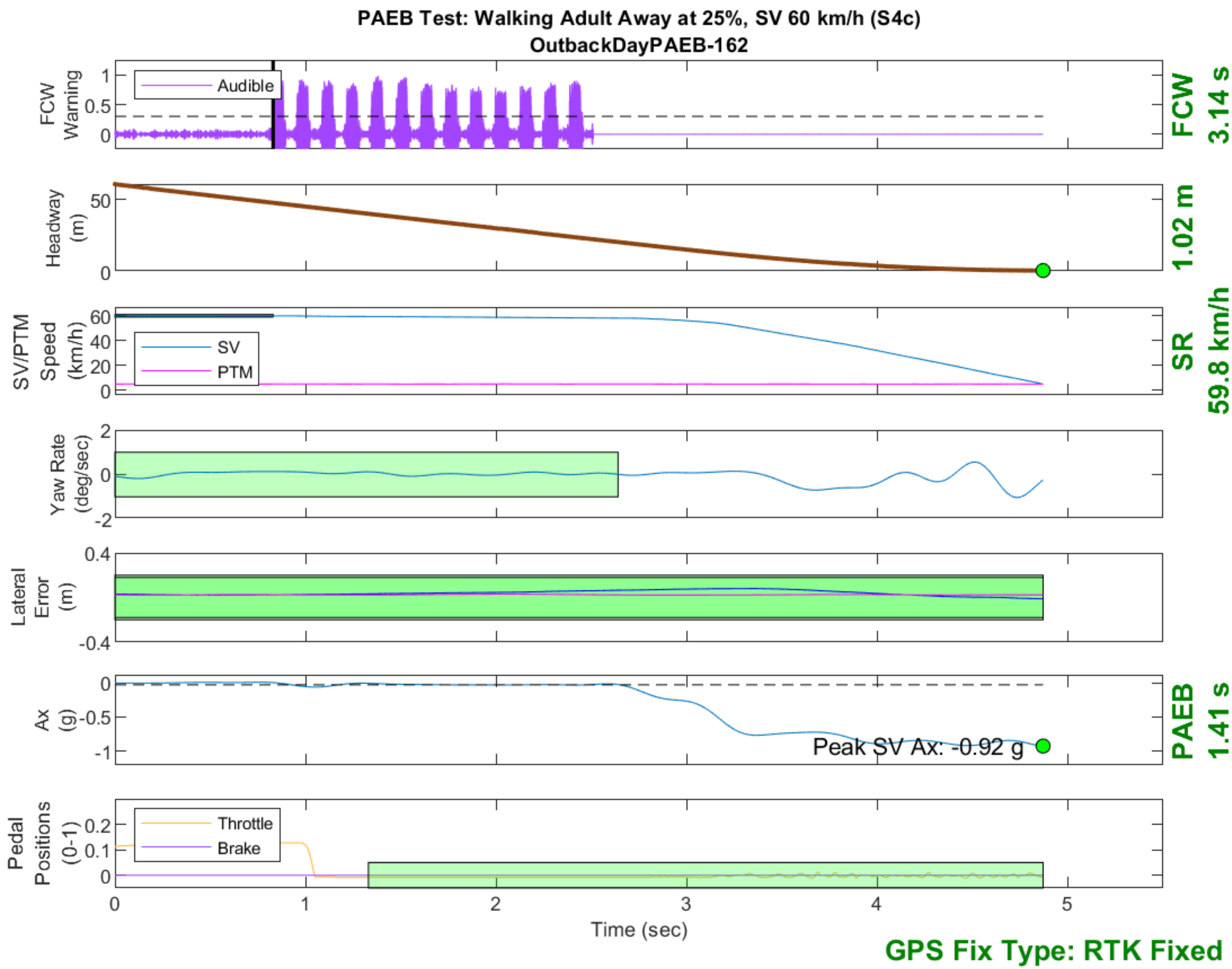


Figure D160. Time History for PAEB Run 162, S4c, Daytime, 60 km/h

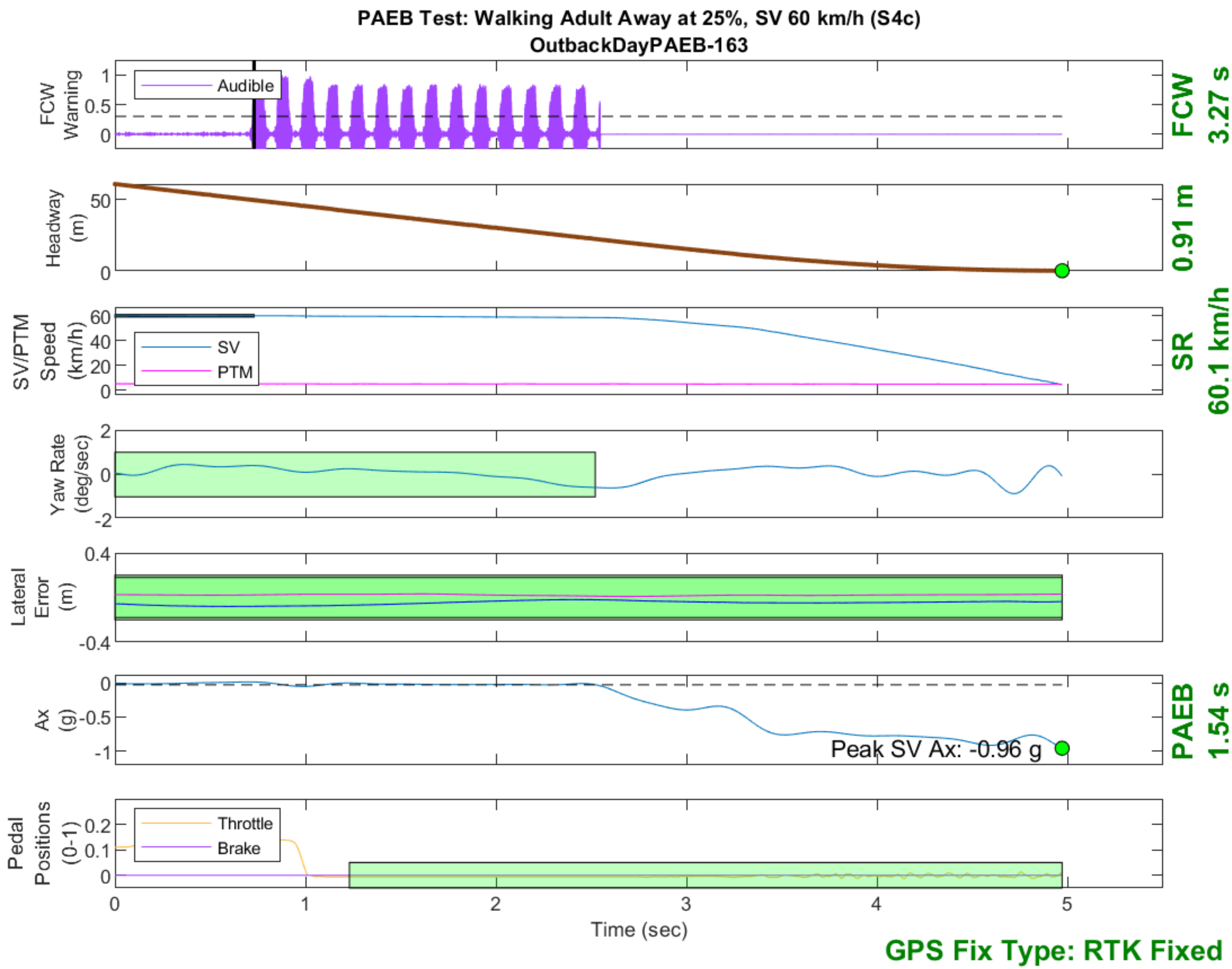


Figure D161. Time History for PAEB Run 163, S4c, Daytime, 60 km/h

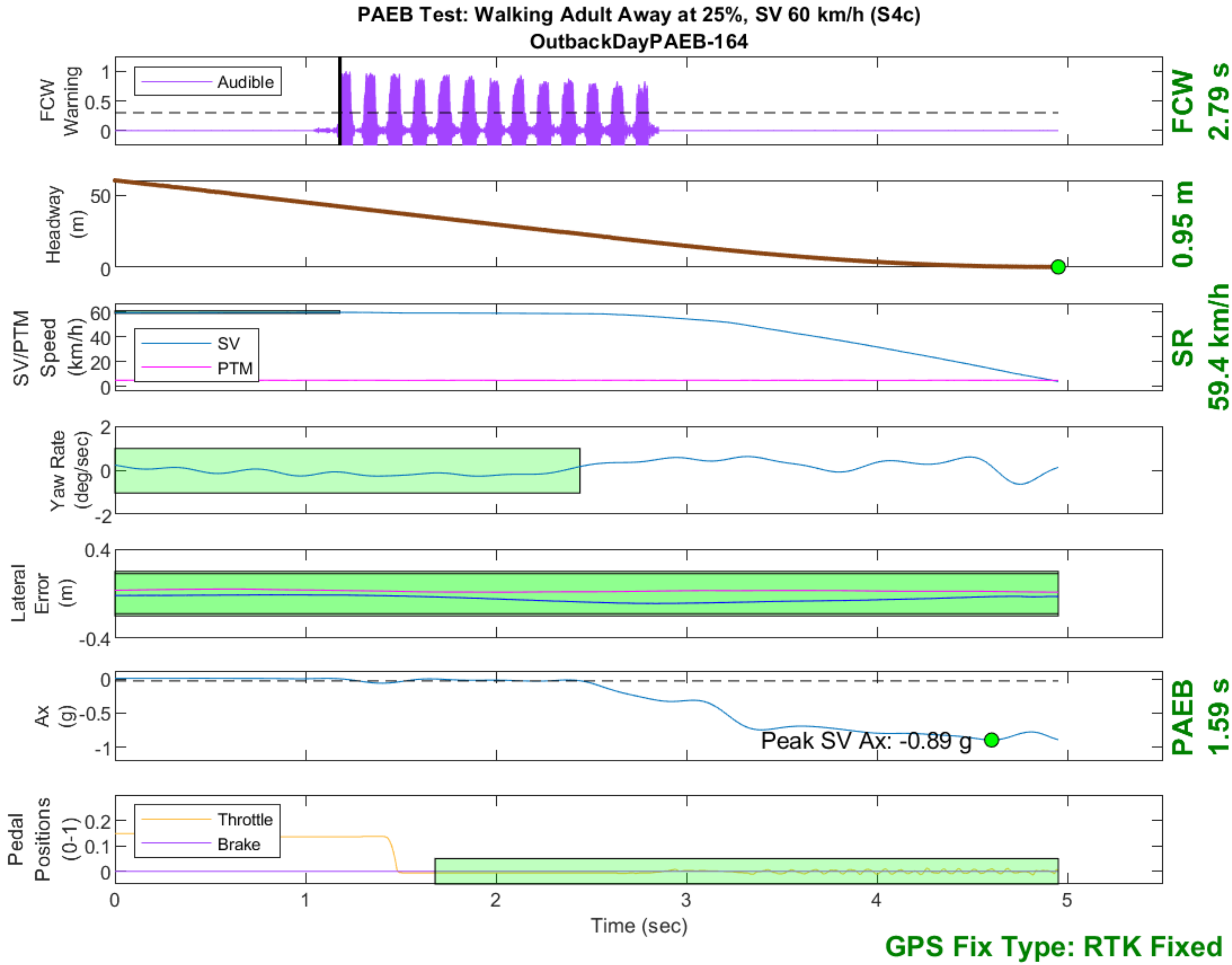


Figure D162. Time History for PAEB Run 164, S4c, Daytime, 60 km/h

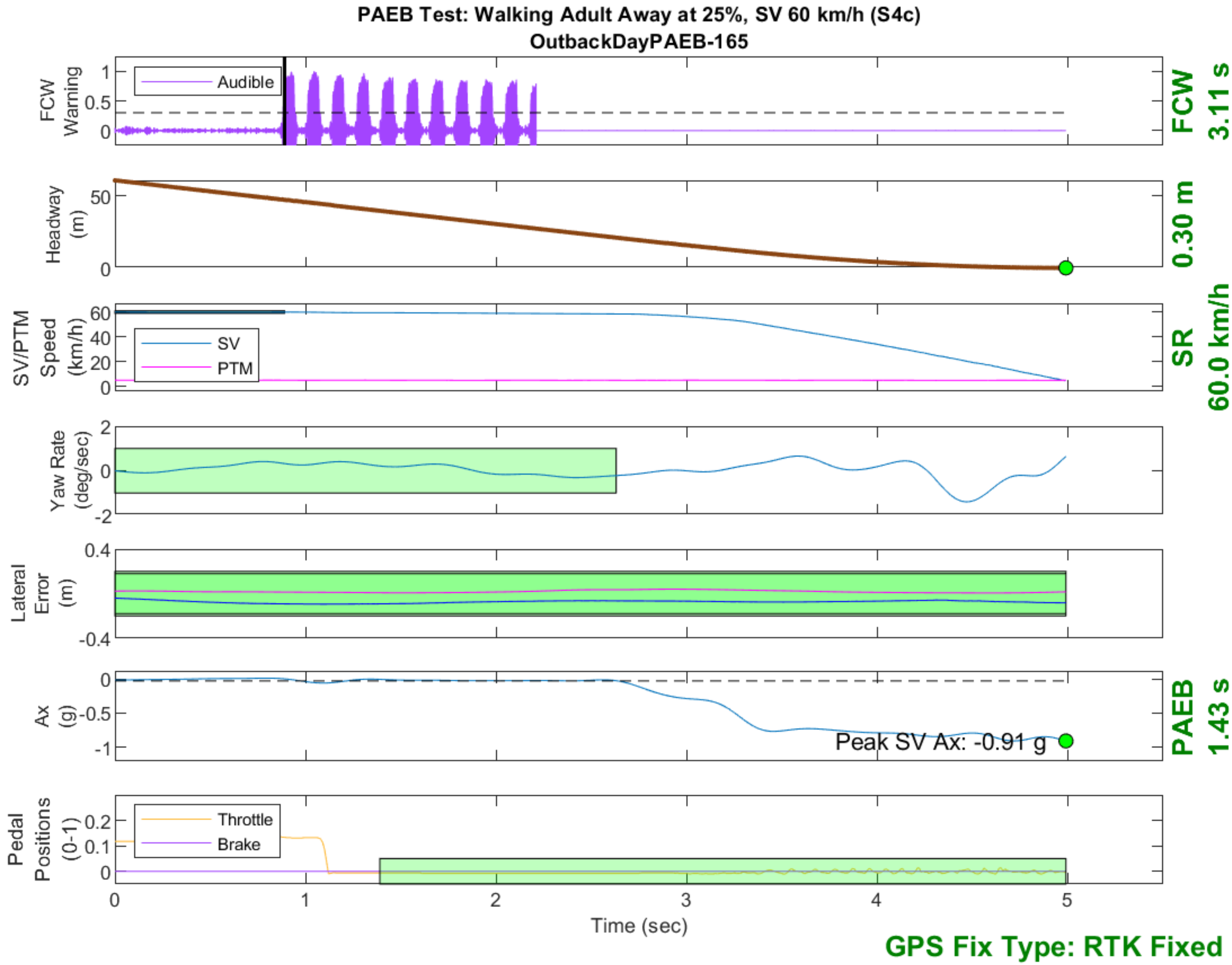


Figure D163. Time History for PAEB Run 165, S4c, Daytime, 60 km/h

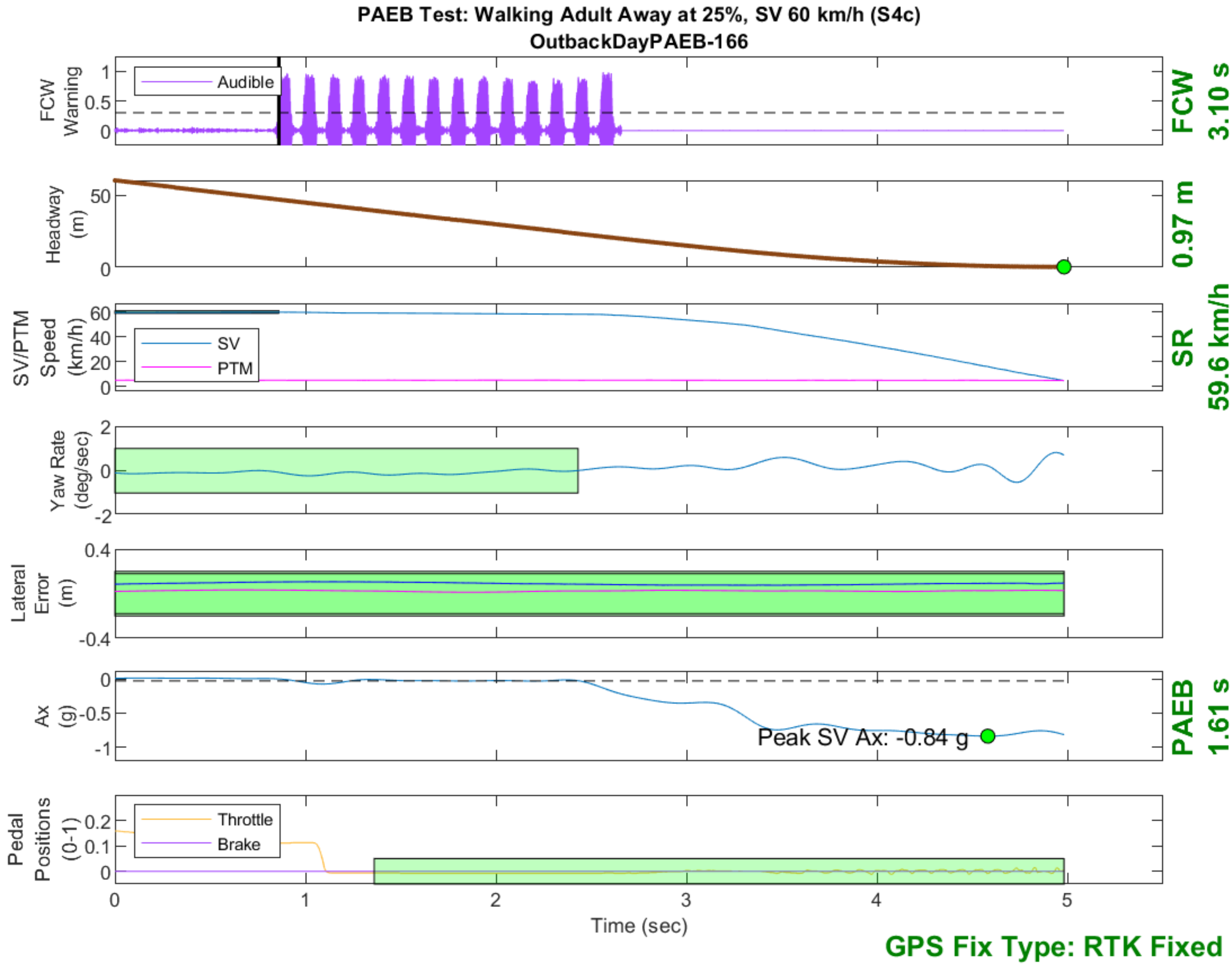


Figure D164. Time History for PAEB Run 166, S4c, Daytime, 60 km/h

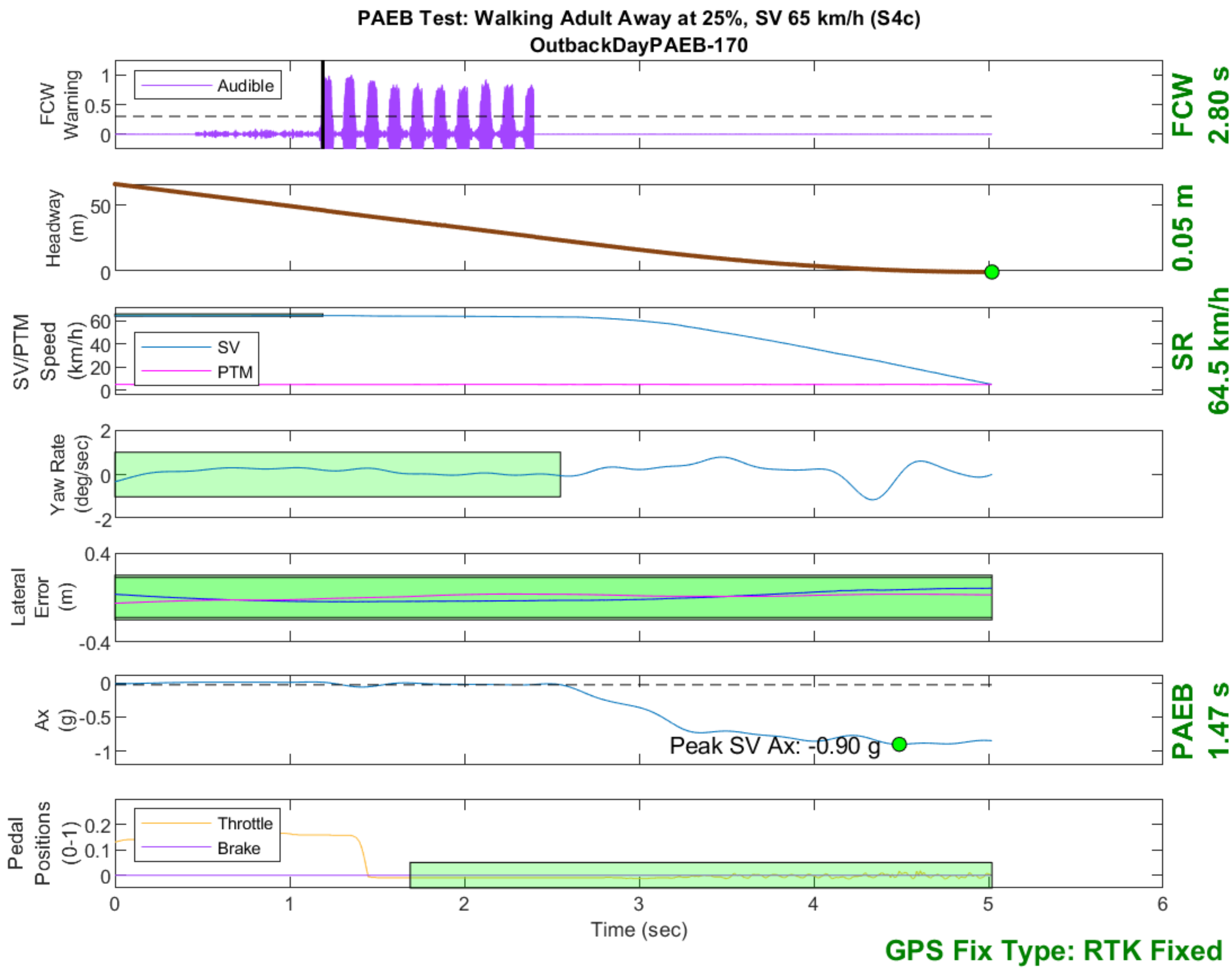


Figure D165. Time History for PAEB Run 170, S4c, Daytime, 65 km/h

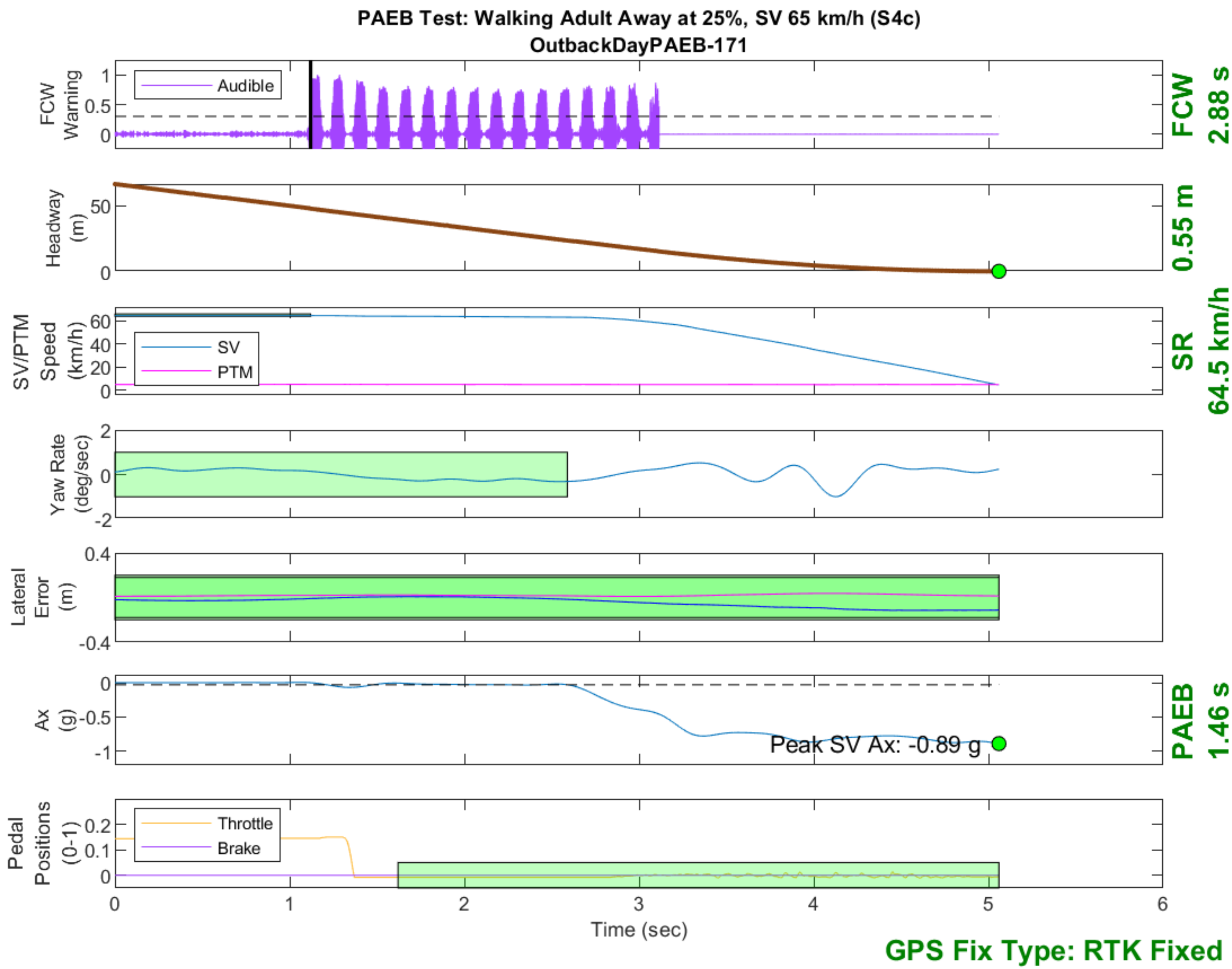


Figure D166. Time History for PAEB Run 171, S4c, Daytime, 65 km/h

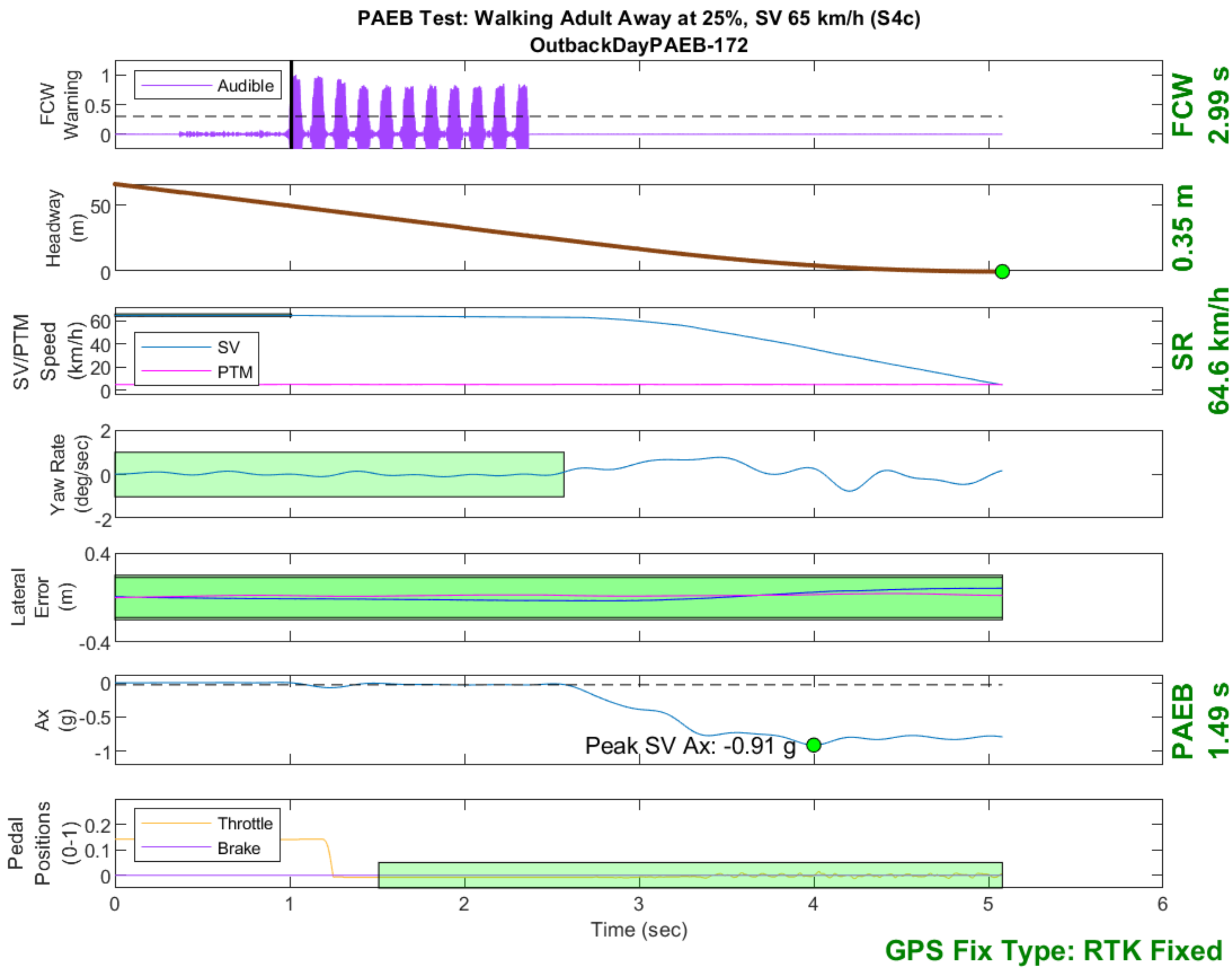


Figure D167. Time History for PAEB Run 172, S4c, Daytime, 65 km/h

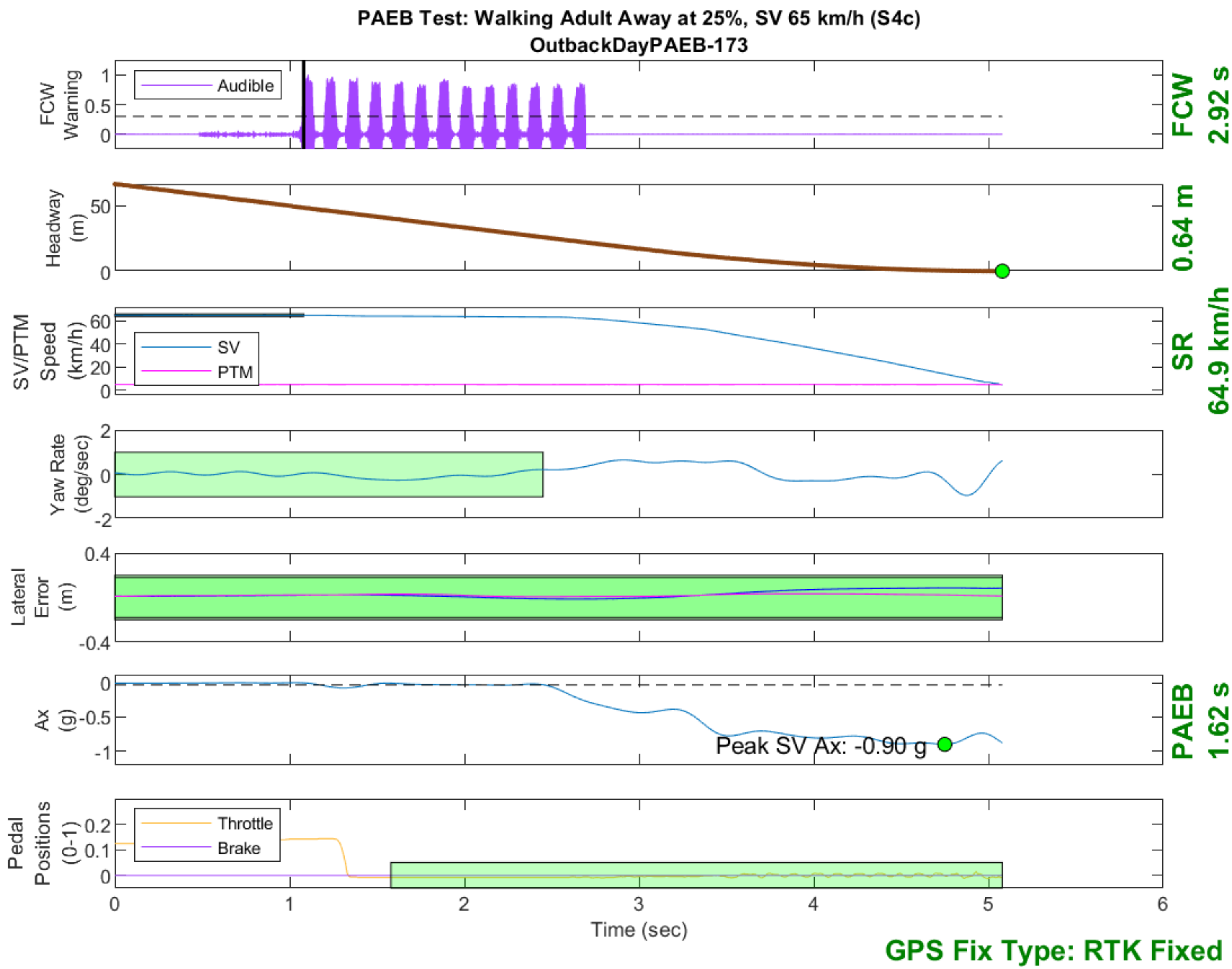


Figure D168. Time History for PAEB Run 173, S4c, Daytime, 65 km/h

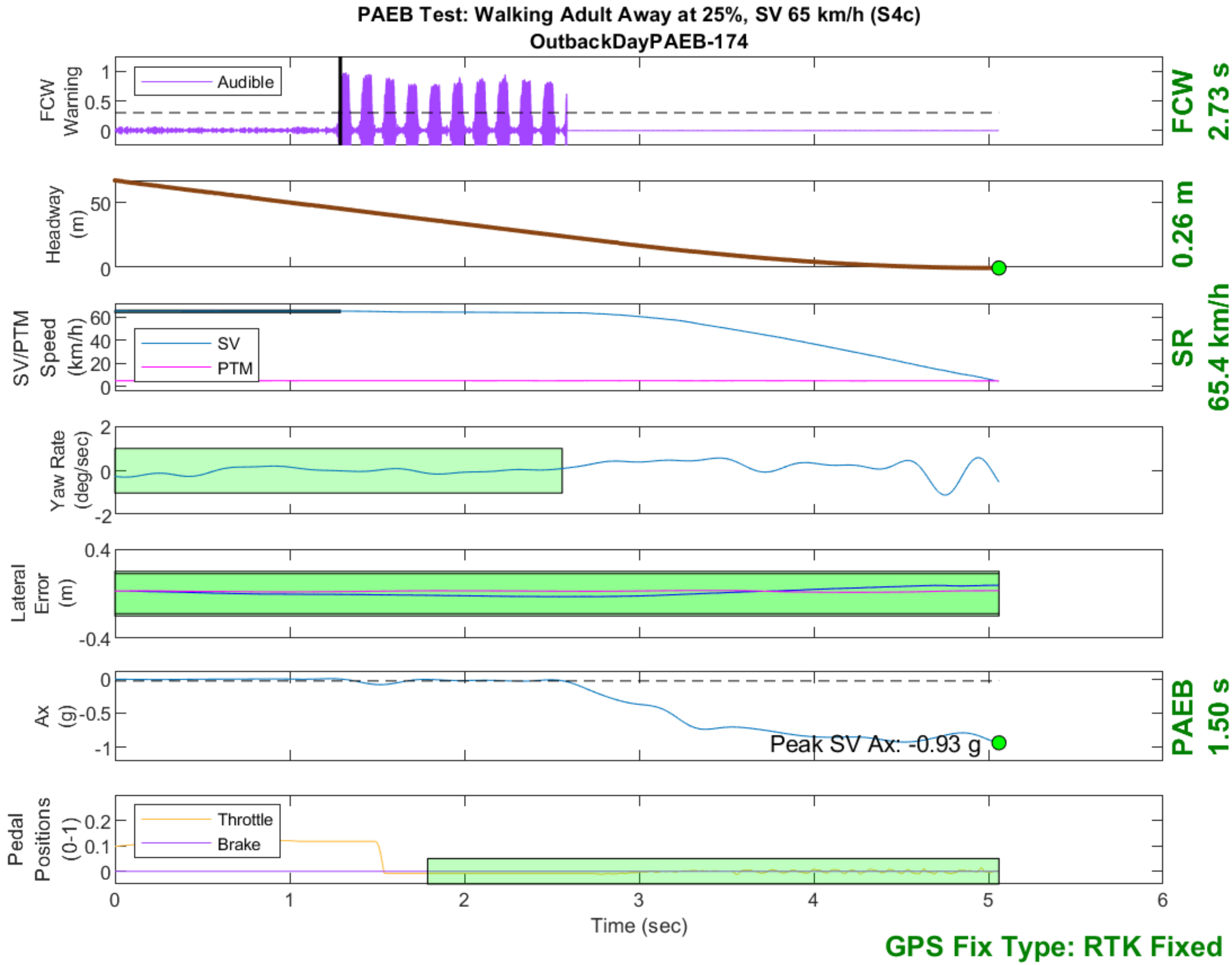


Figure D169. Time History for PAEB Run 174, S4c, Daytime, 65 km/h

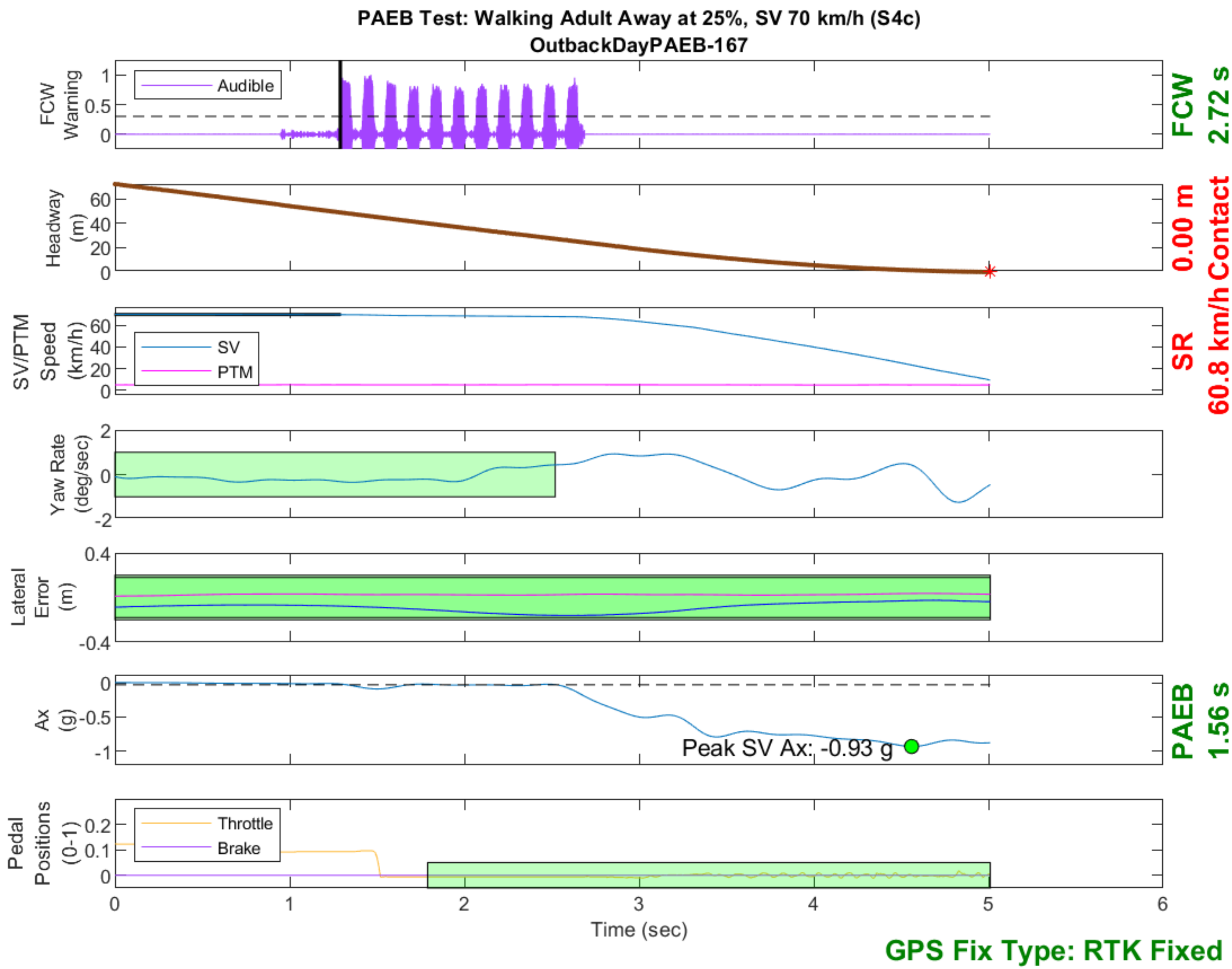


Figure D170. Time History for PAEB Run 167, S4c, Daytime, 70 km/h

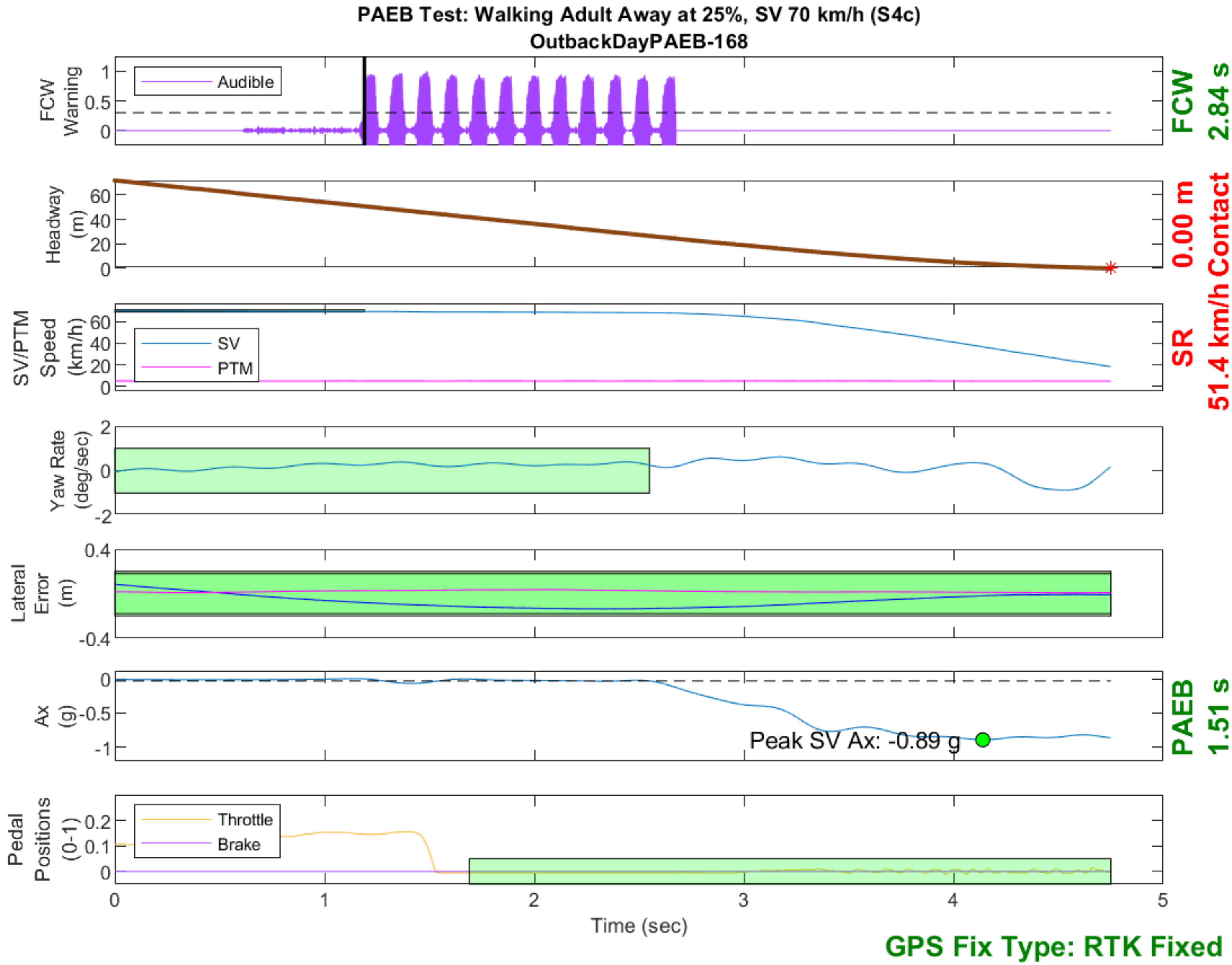


Figure D171. Time History for PAEB Run 168, S4c, Daytime, 70 km/h

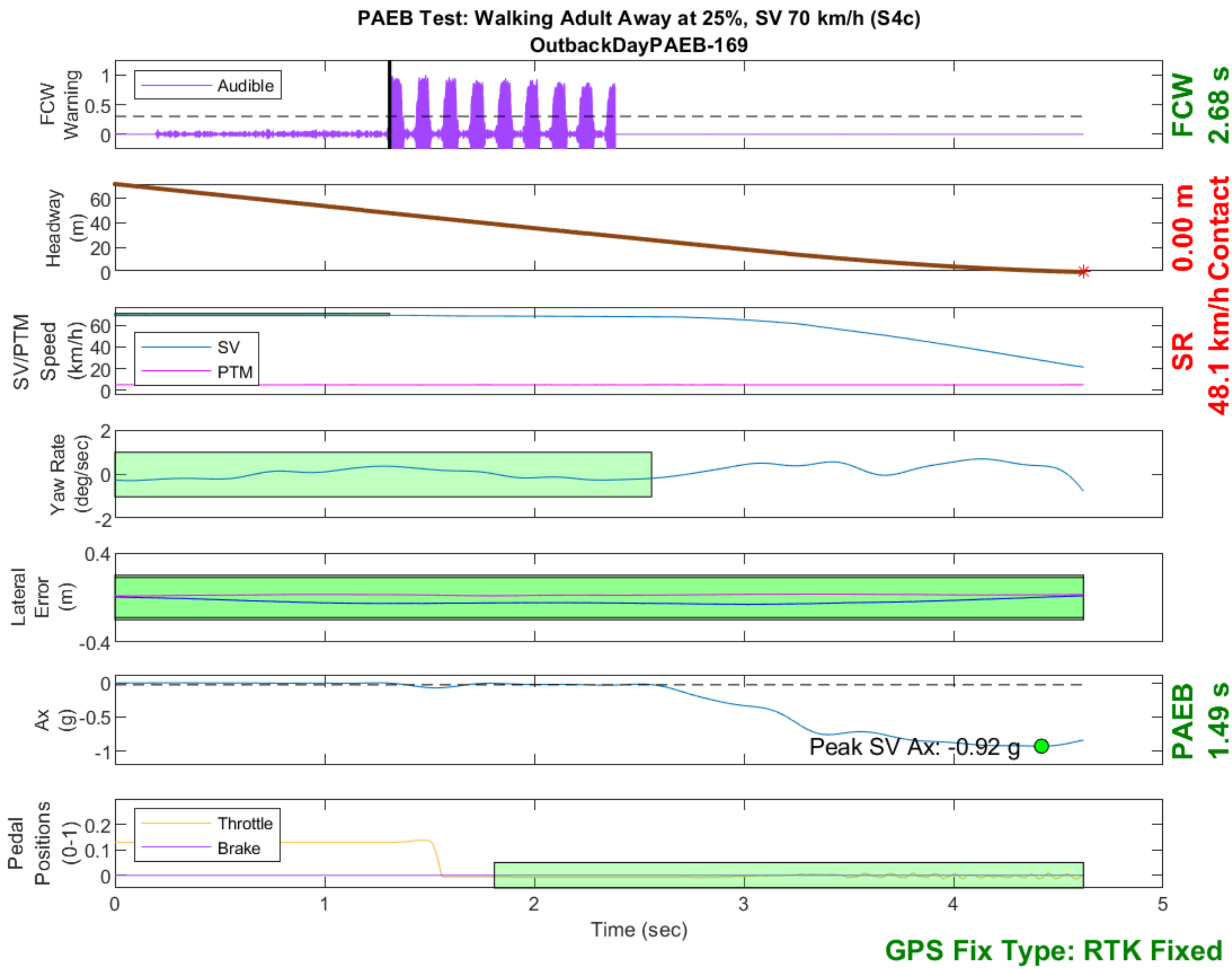


Figure D172. Time History for PAEB Run 169, S4c, Daytime, 70 km/h

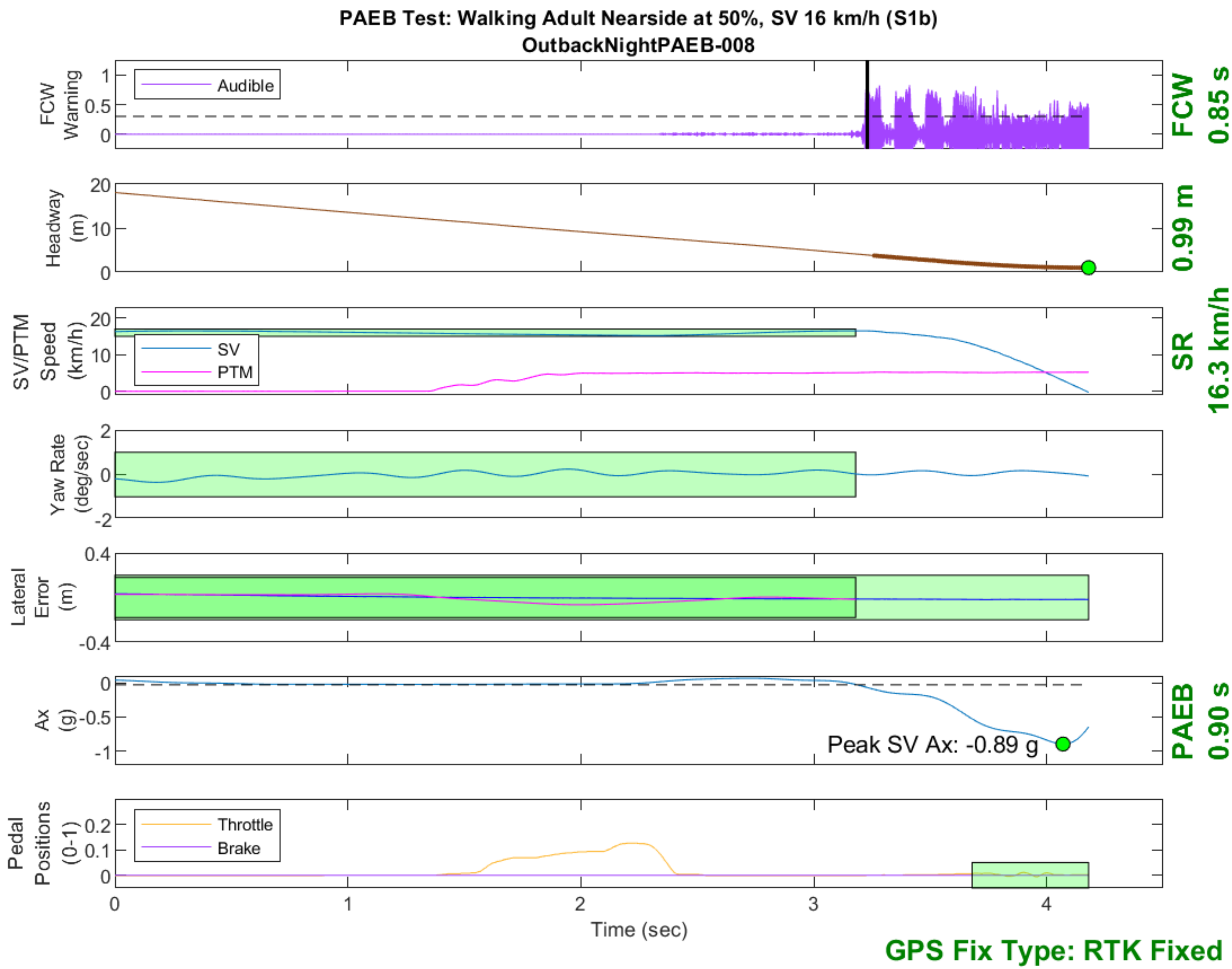


Figure D173. Time History for PAEB Run 8, S1b, Night, High Beam, 16 km/h

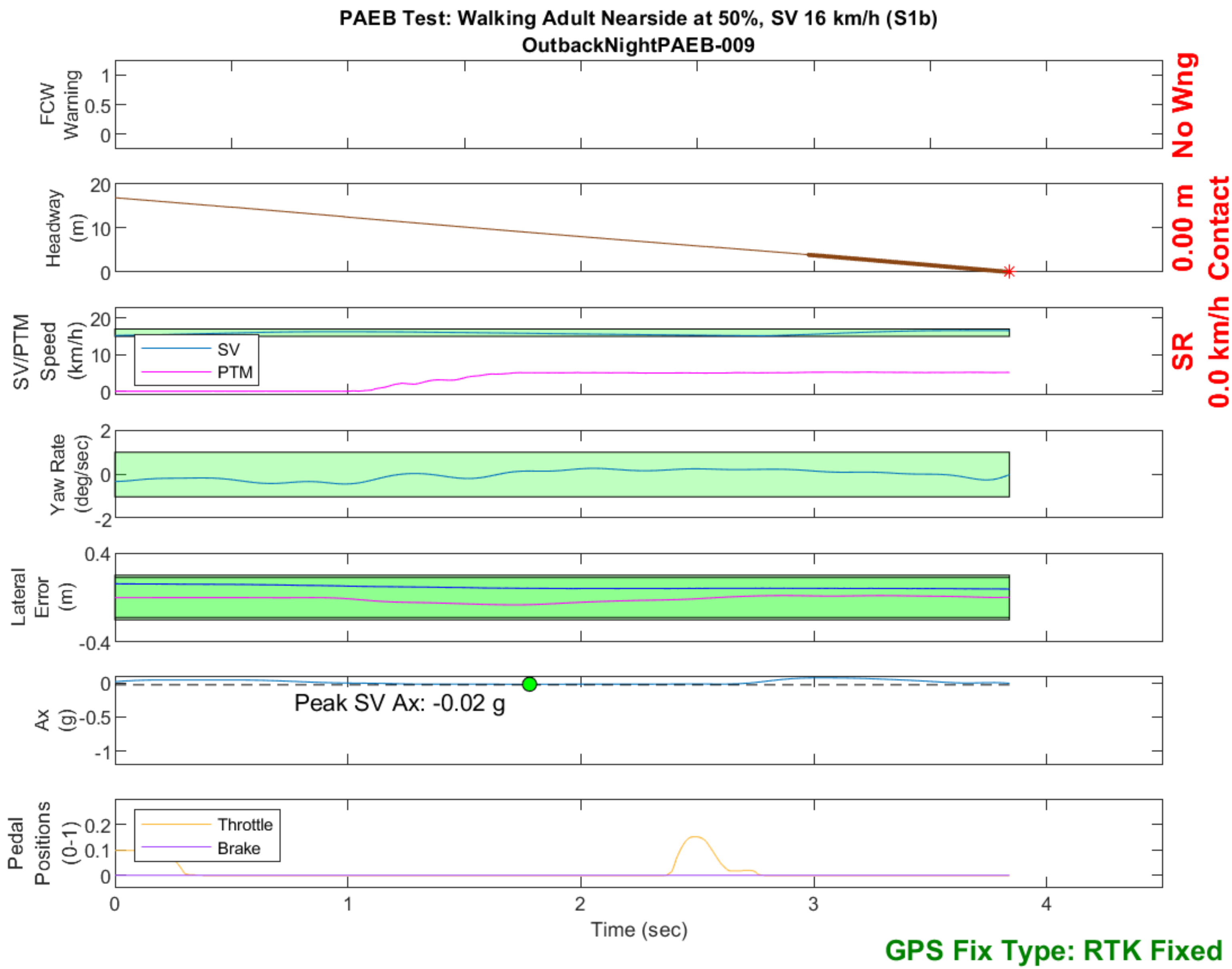


Figure D174. Time History for PAEB Run 9, S1b, Night, High Beam, 16 km/h

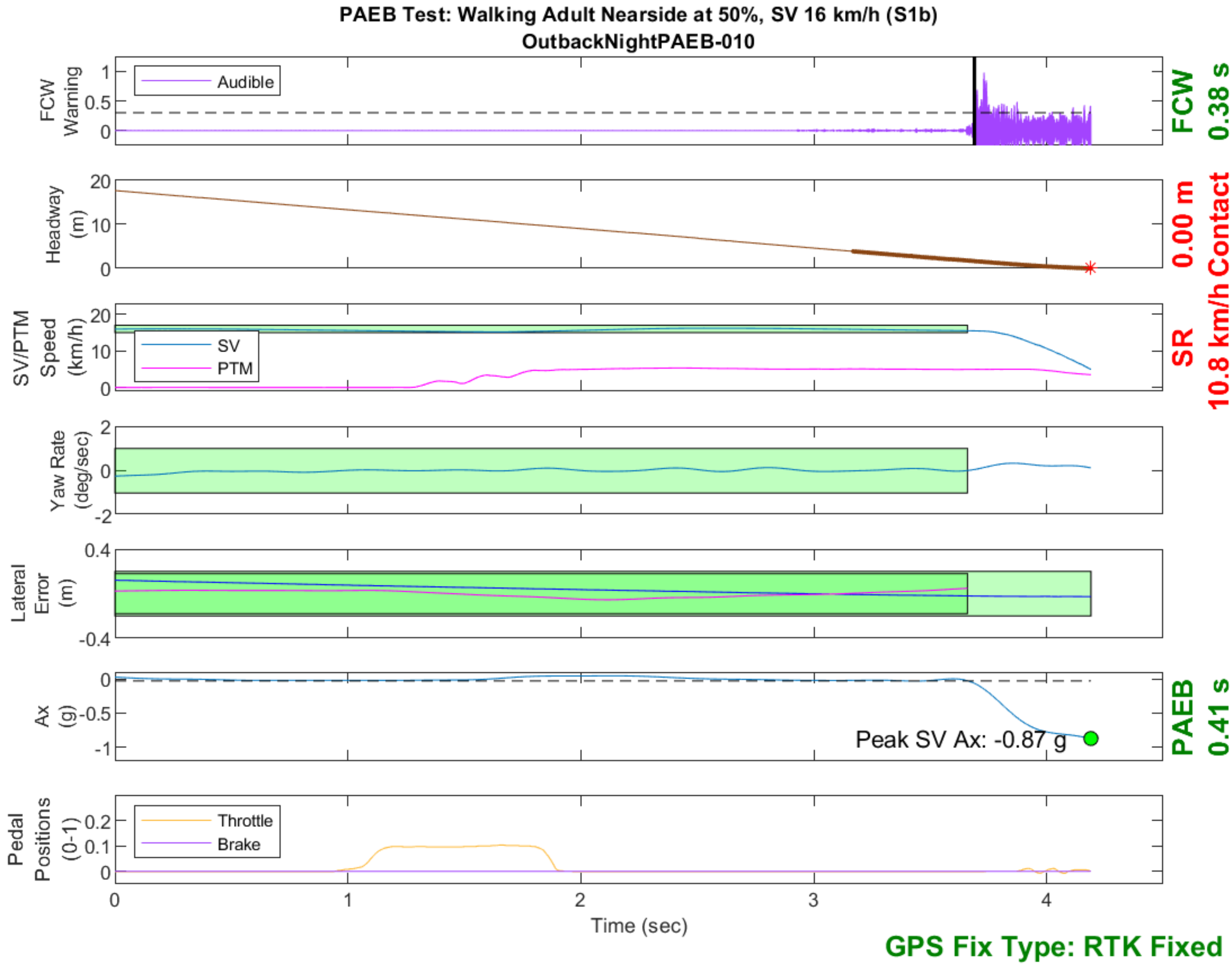


Figure D175. Time History for PAEB Run 10, S1b, Night, High Beam, 16 km/h

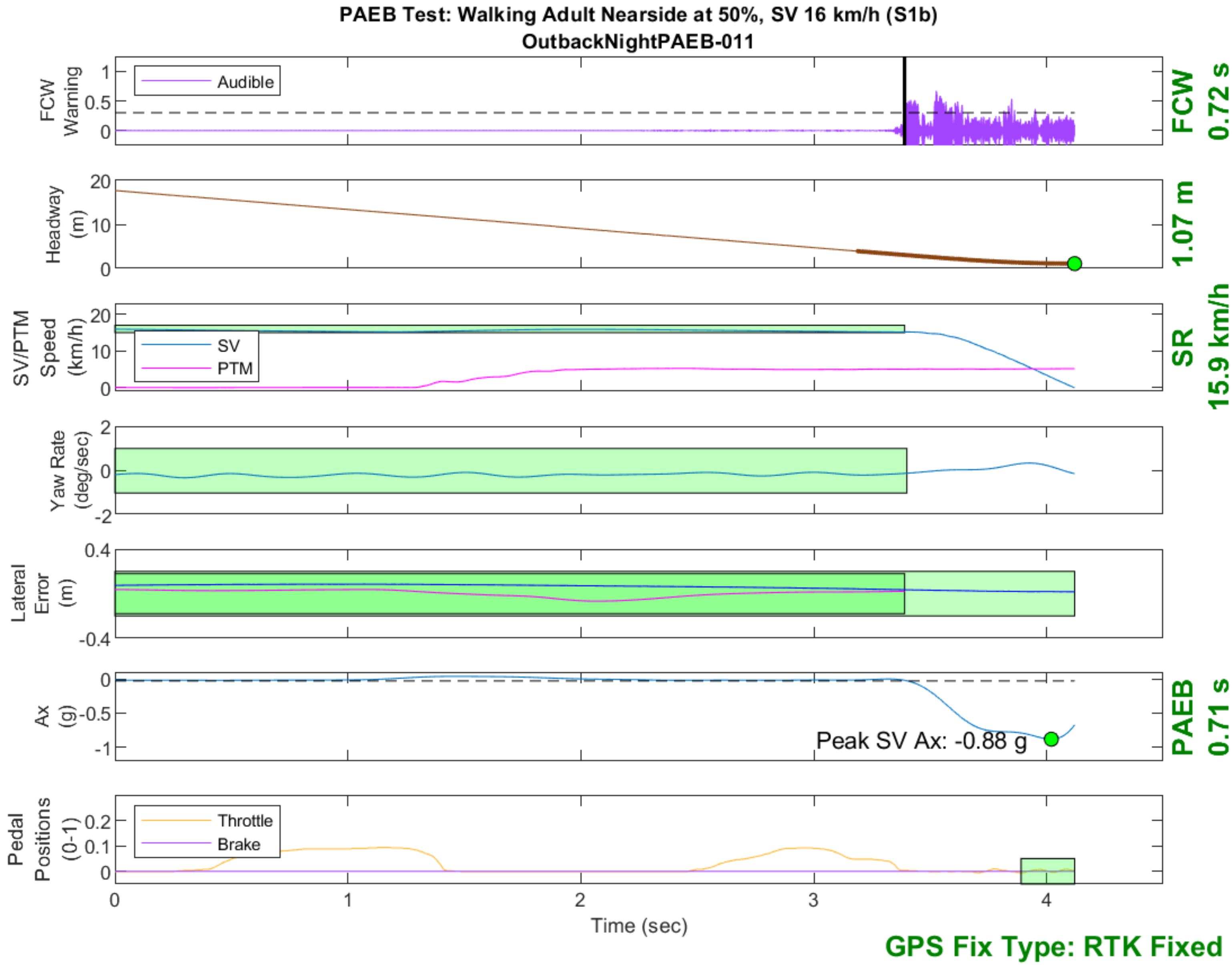


Figure D176. Time History for PAEB Run 11, S1b, Night, High Beam, 16 km/h

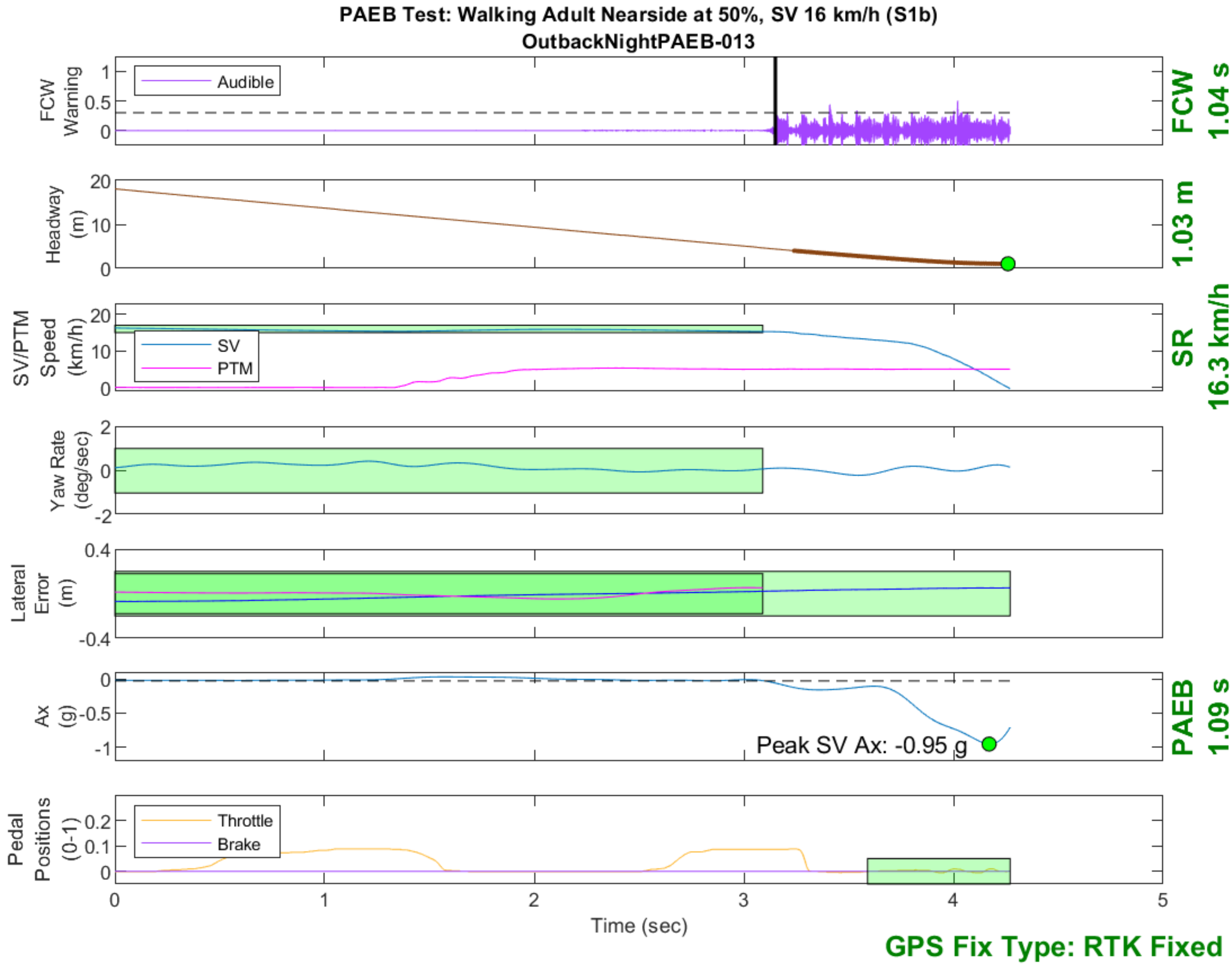


Figure D177. Time History for PAEB Run 13, S1b, Night, High Beam, 16 km/h

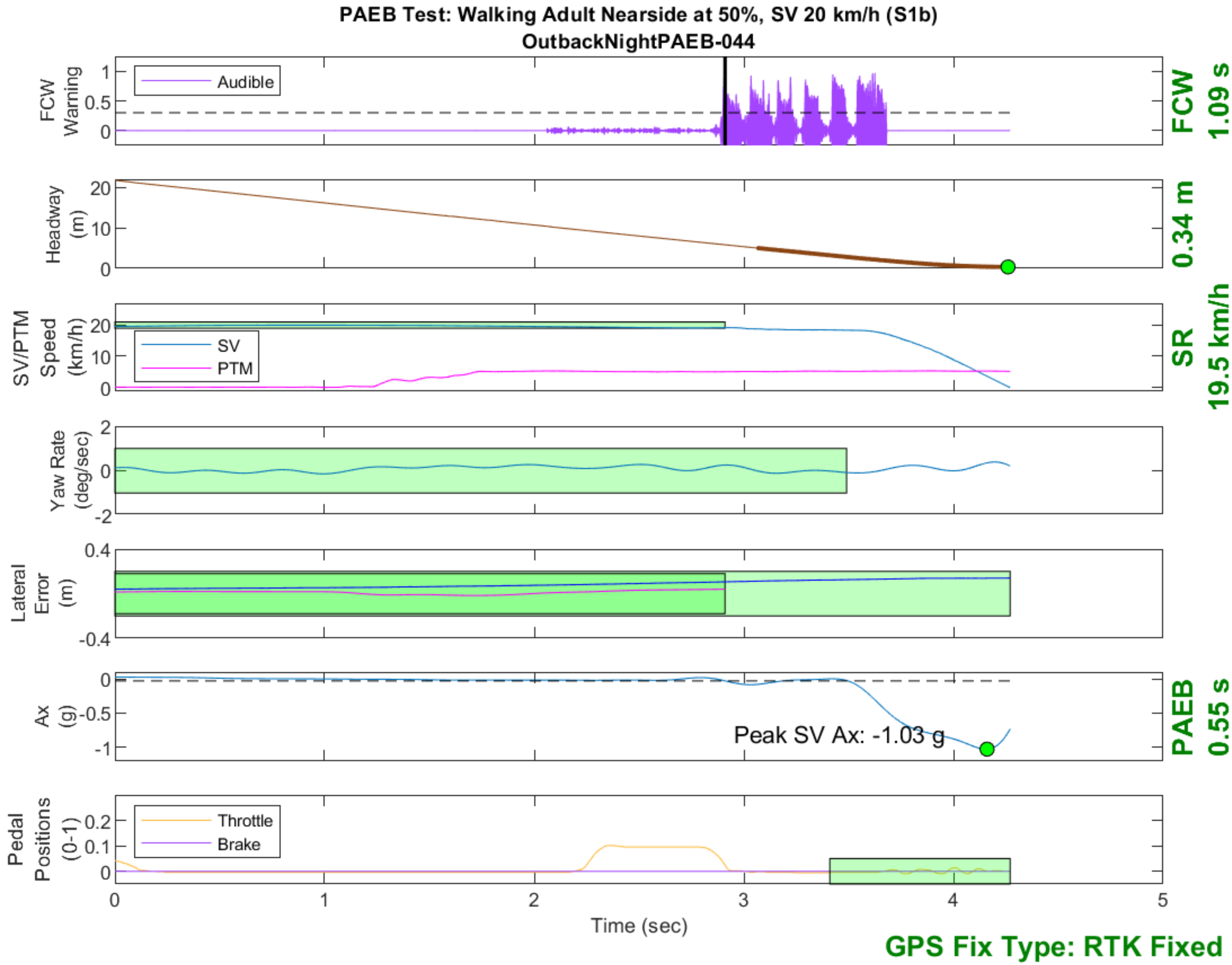


Figure D178. Time History for PAEB Run 44, S1b, Night, High Beam, 20 km/h

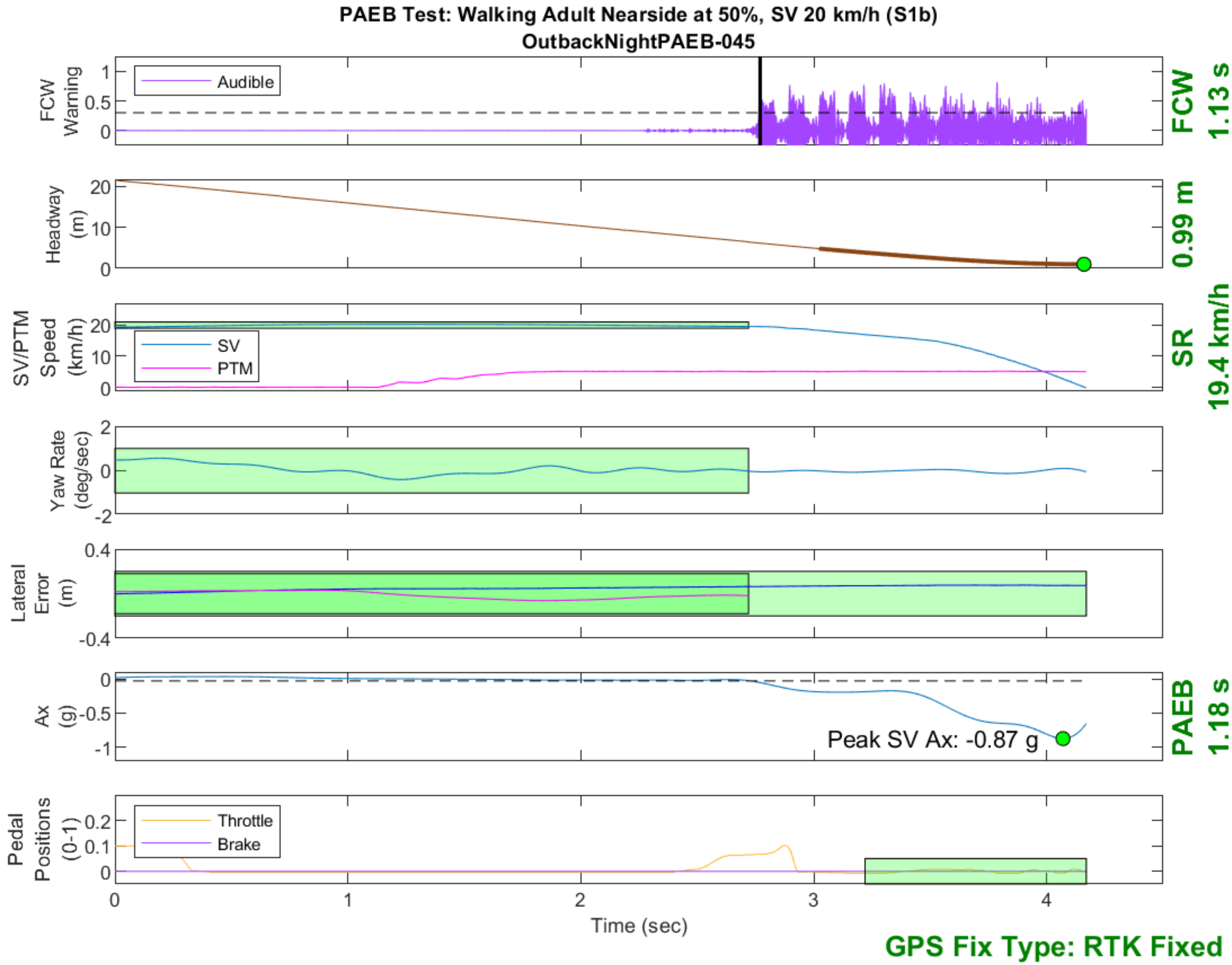


Figure D179. Time History for PAEB Run 45, S1b, Night, High Beam, 20 km/h

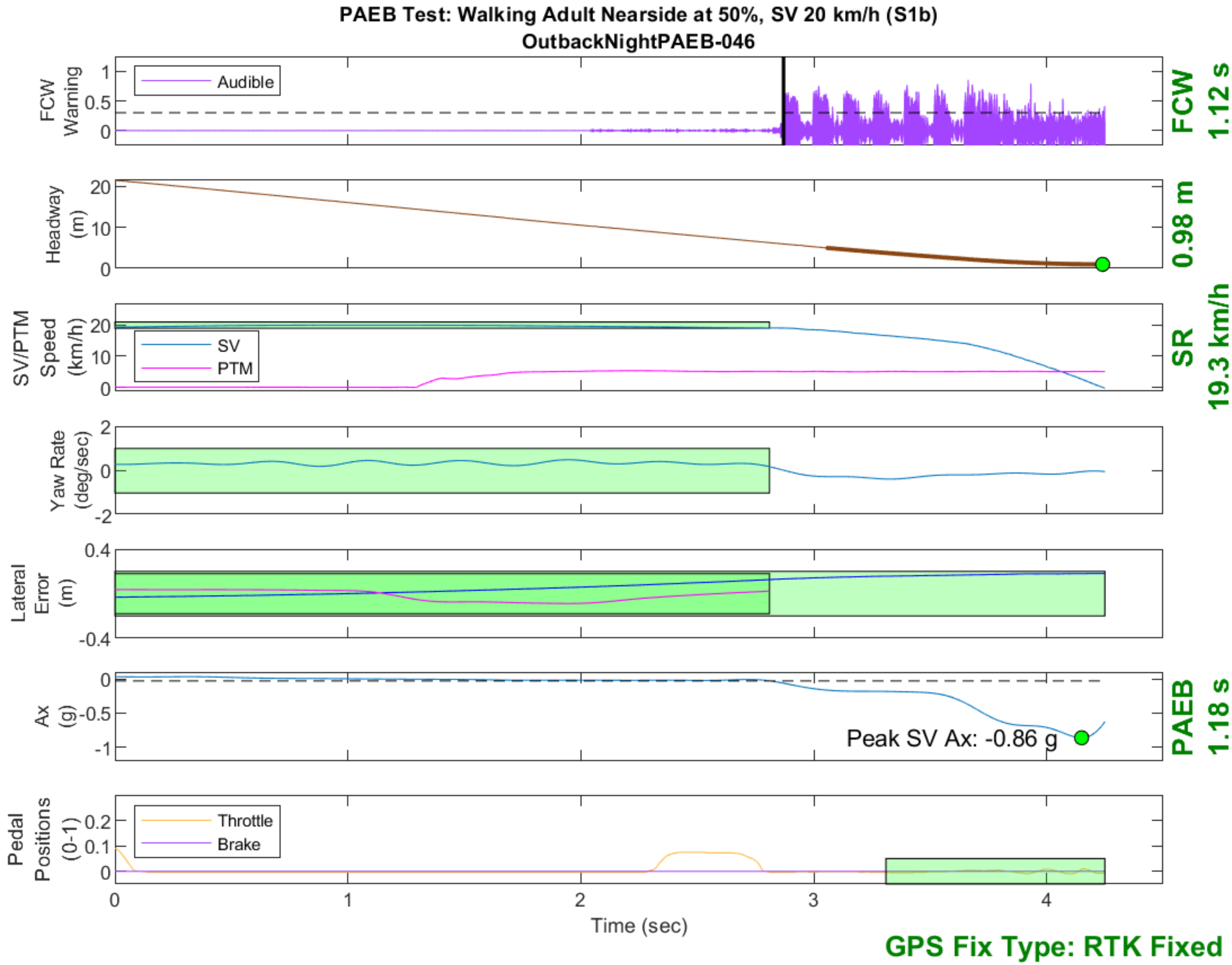


Figure D180. Time History for PAEB Run 46, S1b, Night, High Beam, 20 km/h

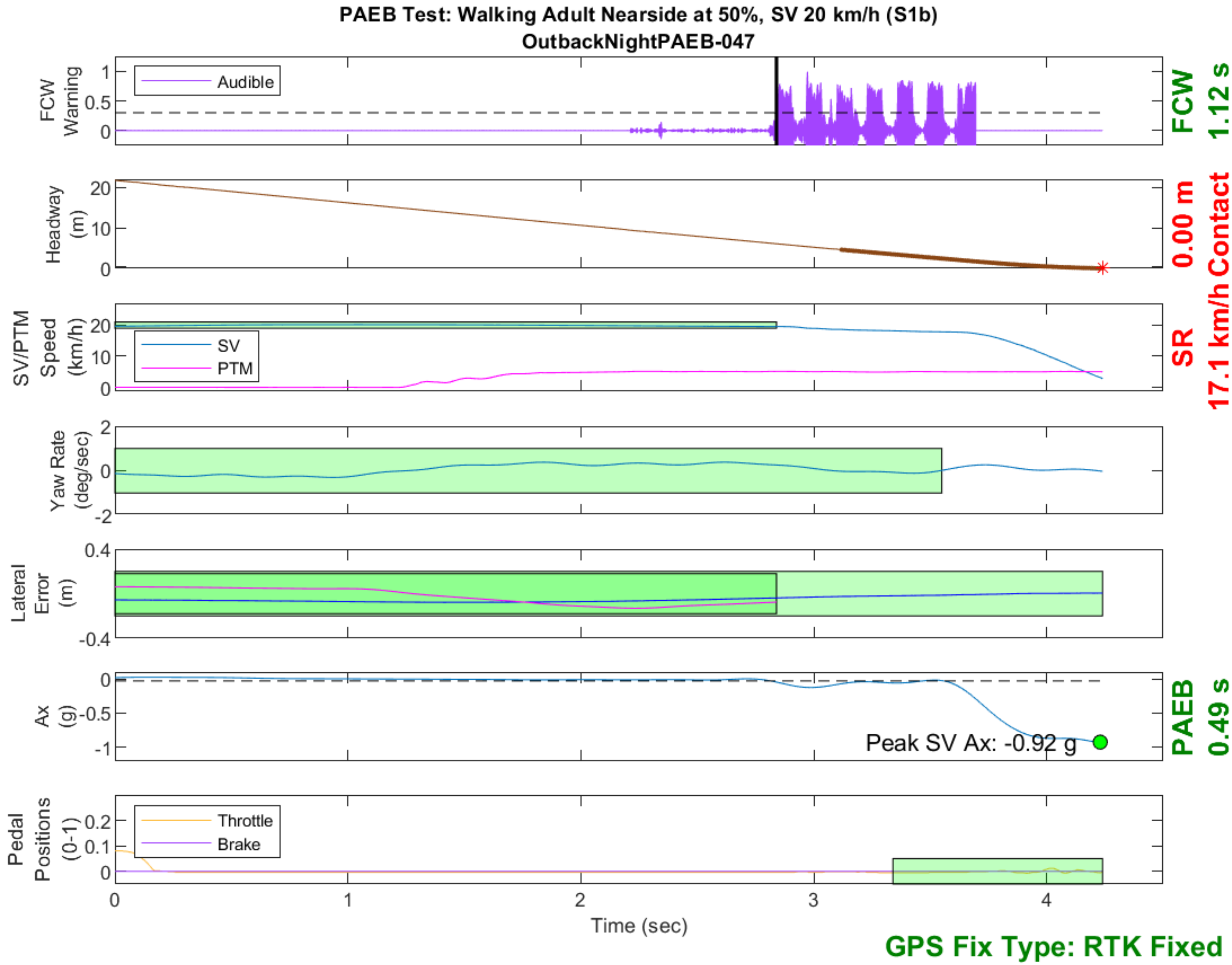


Figure D181. Time History for PAEB Run 47, S1b, Night, High Beam, 20 km/h

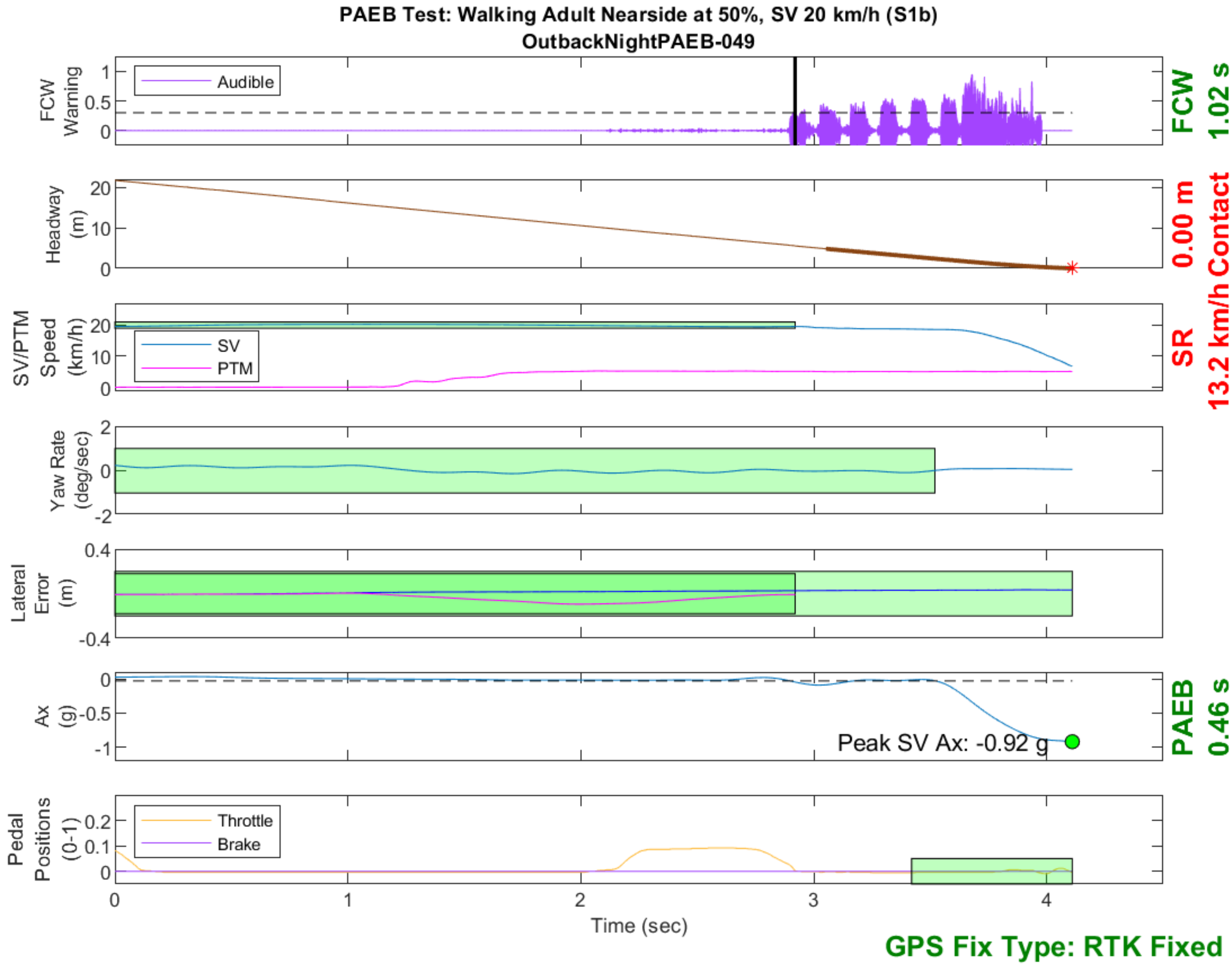


Figure D182. Time History for PAEB Run 49, S1b, Night, High Beam, 20 km/h

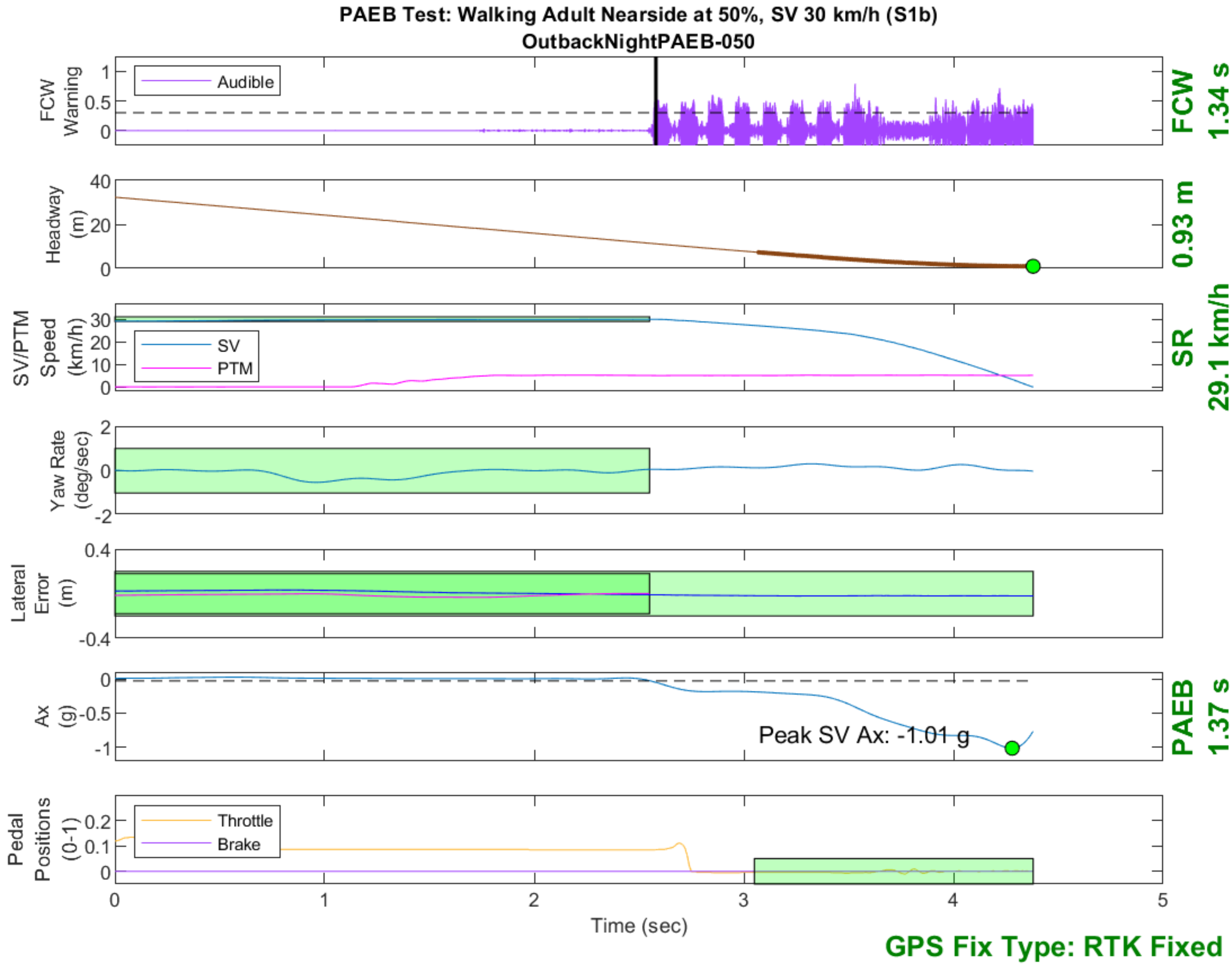


Figure D183. Time History for PAEB Run 50, S1b, Night, High Beam, 30 km/h

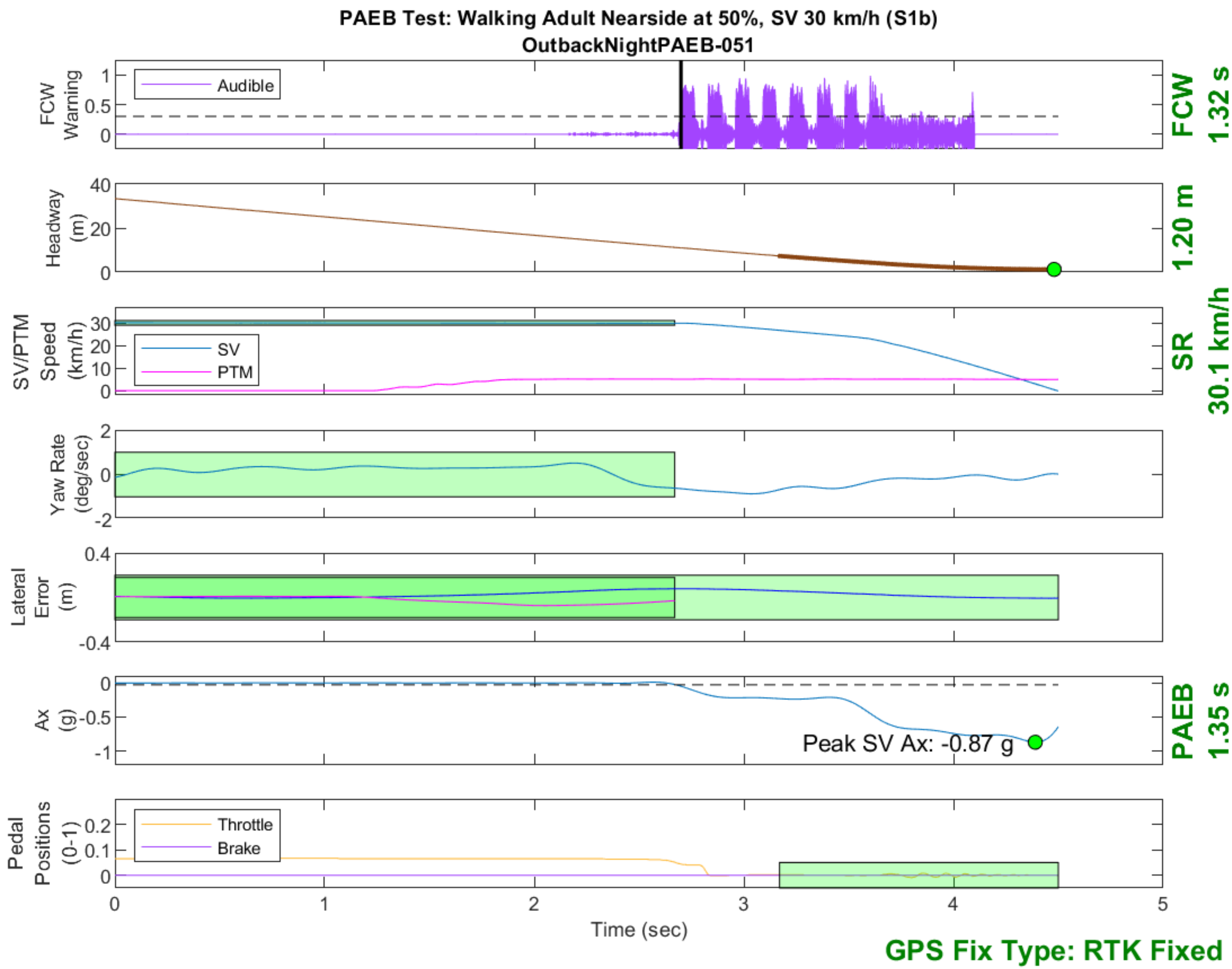


Figure D184. Time History for PAEB Run 51, S1b, Night, High Beam, 30 km/h

Figure D185. Time History for PAEB Run 52, S1b, Night, High Beam, 30 km/h

Figure D186. Time History for PAEB Run 53, S1b, Night, High Beam, 30 km/h

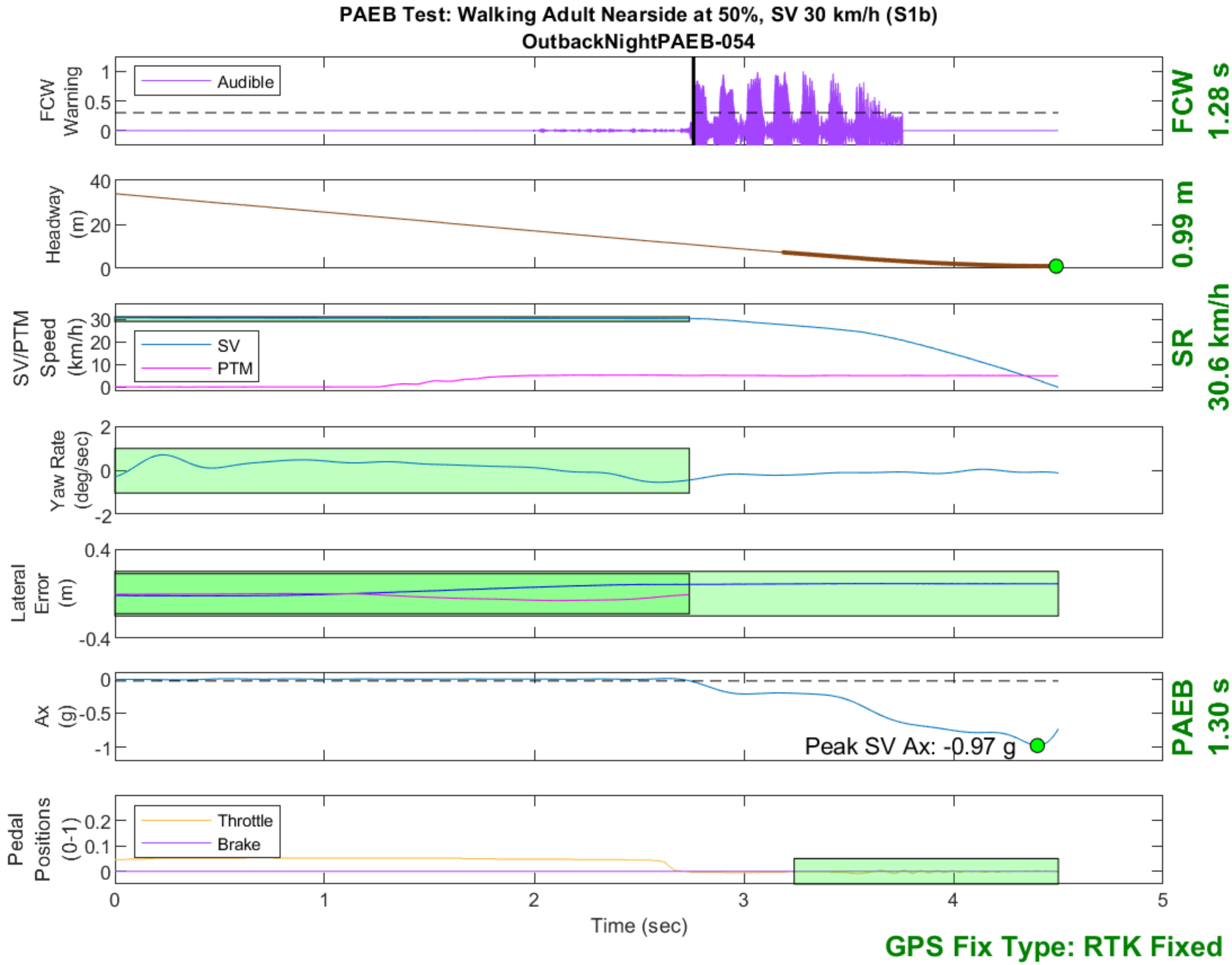


Figure D187. Time History for PAEB Run 54, S1b, Night, High Beam, 30 km/h

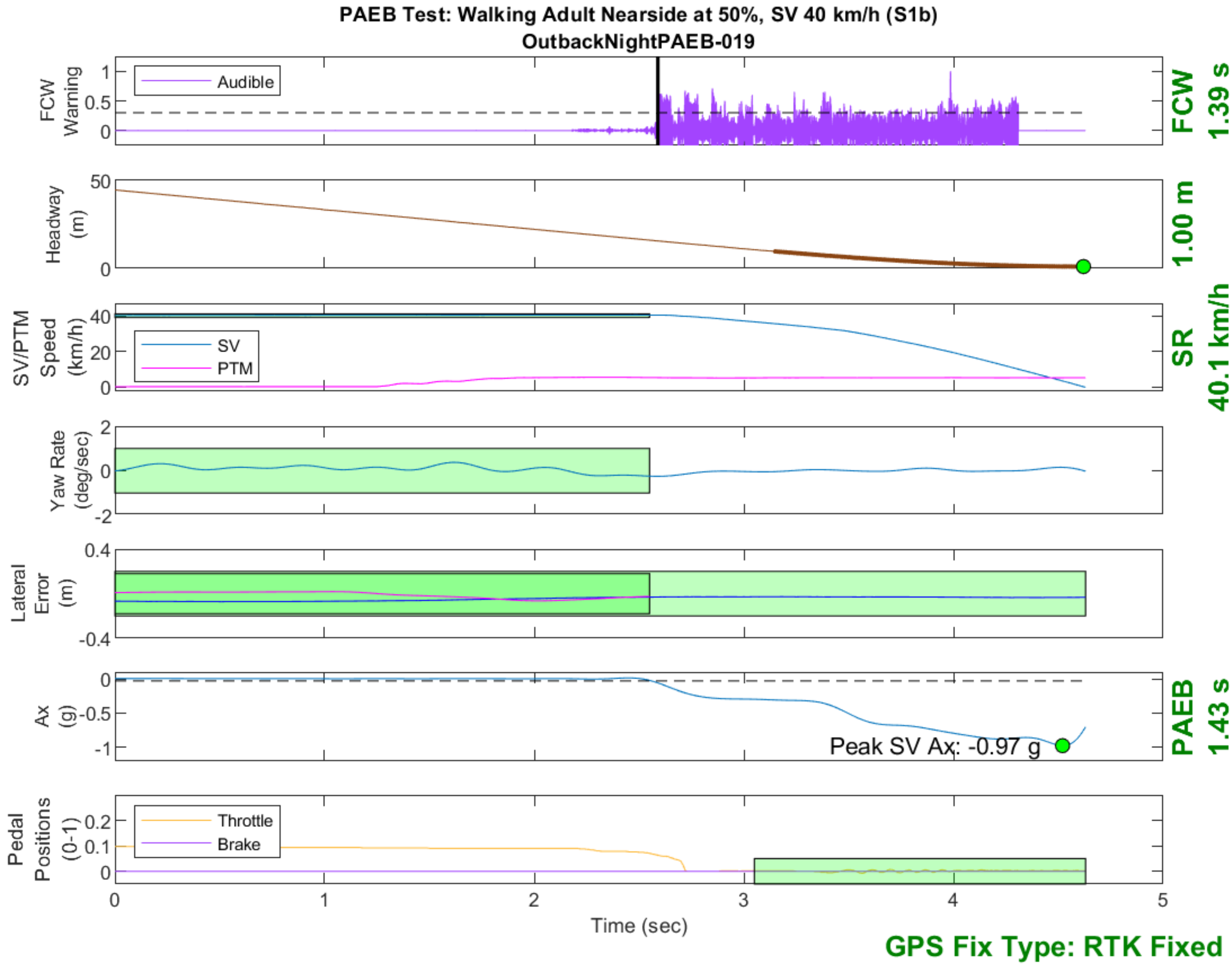


Figure D188. Time History for PAEB Run 19, S1b, Night, High Beam, 40 km/h

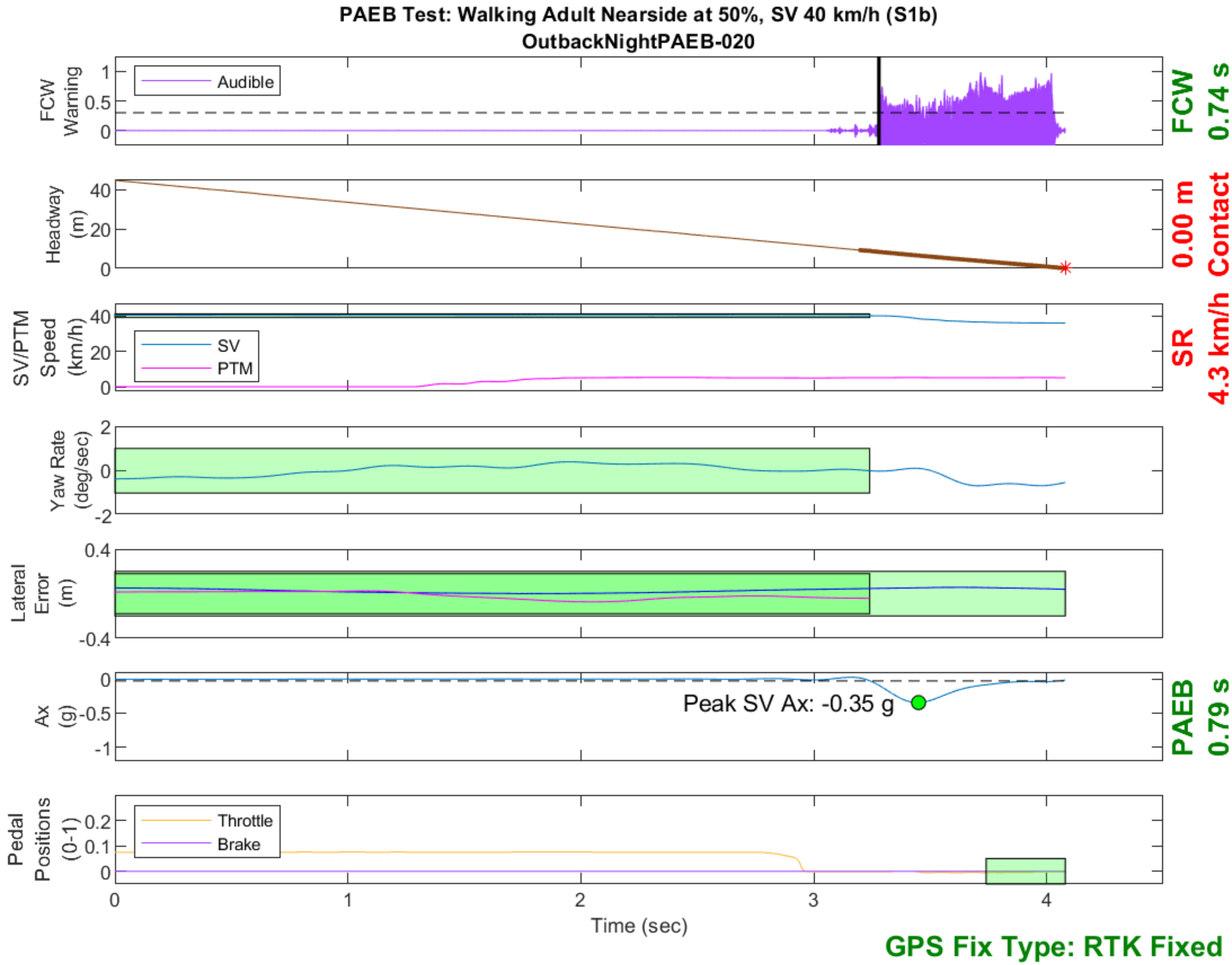


Figure D189. Time History for PAEB Run 20, S1b, Night, High Beam, 40 km/h

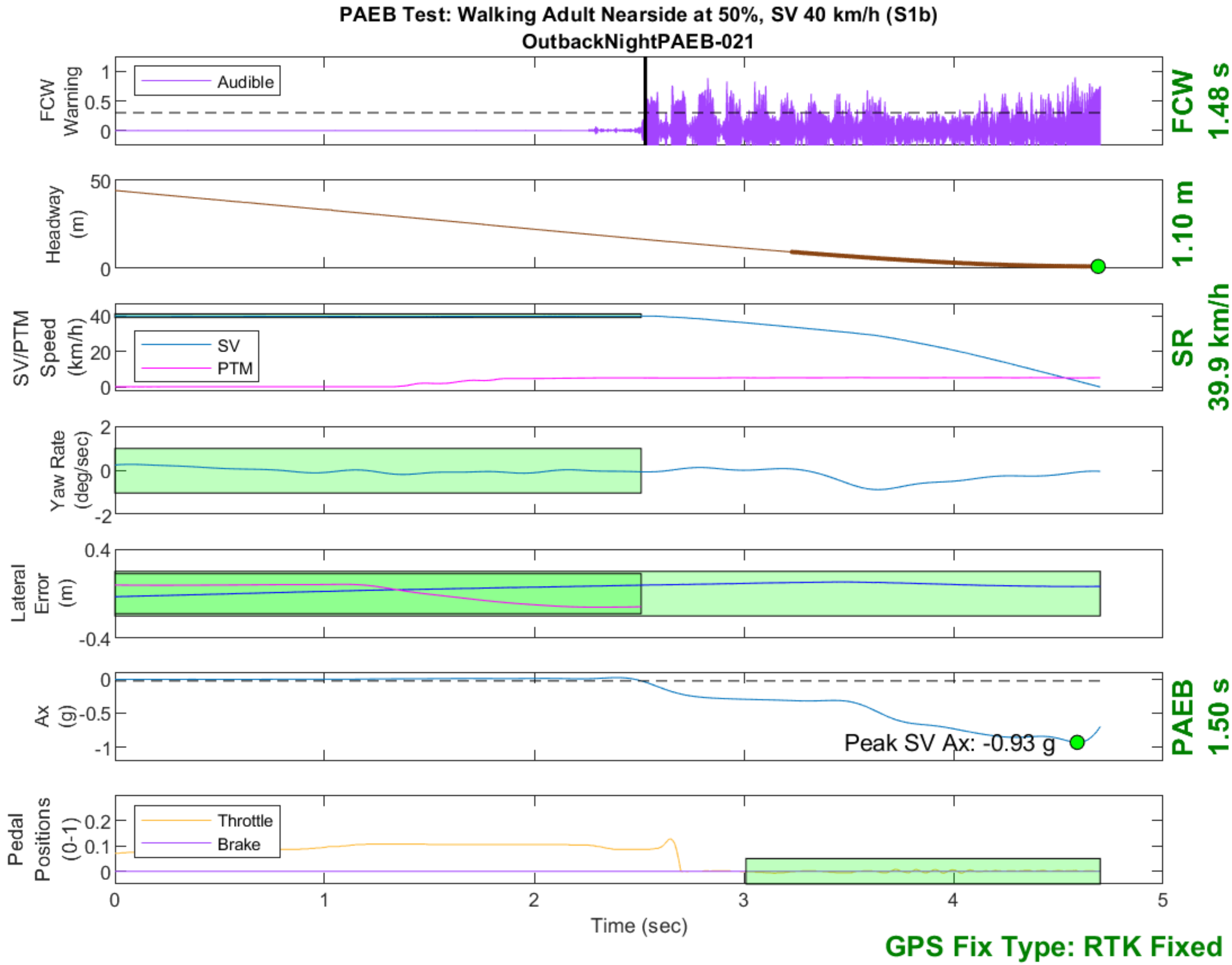


Figure D190. Time History for PAEB Run 21, S1b, Night, High Beam, 40 km/h

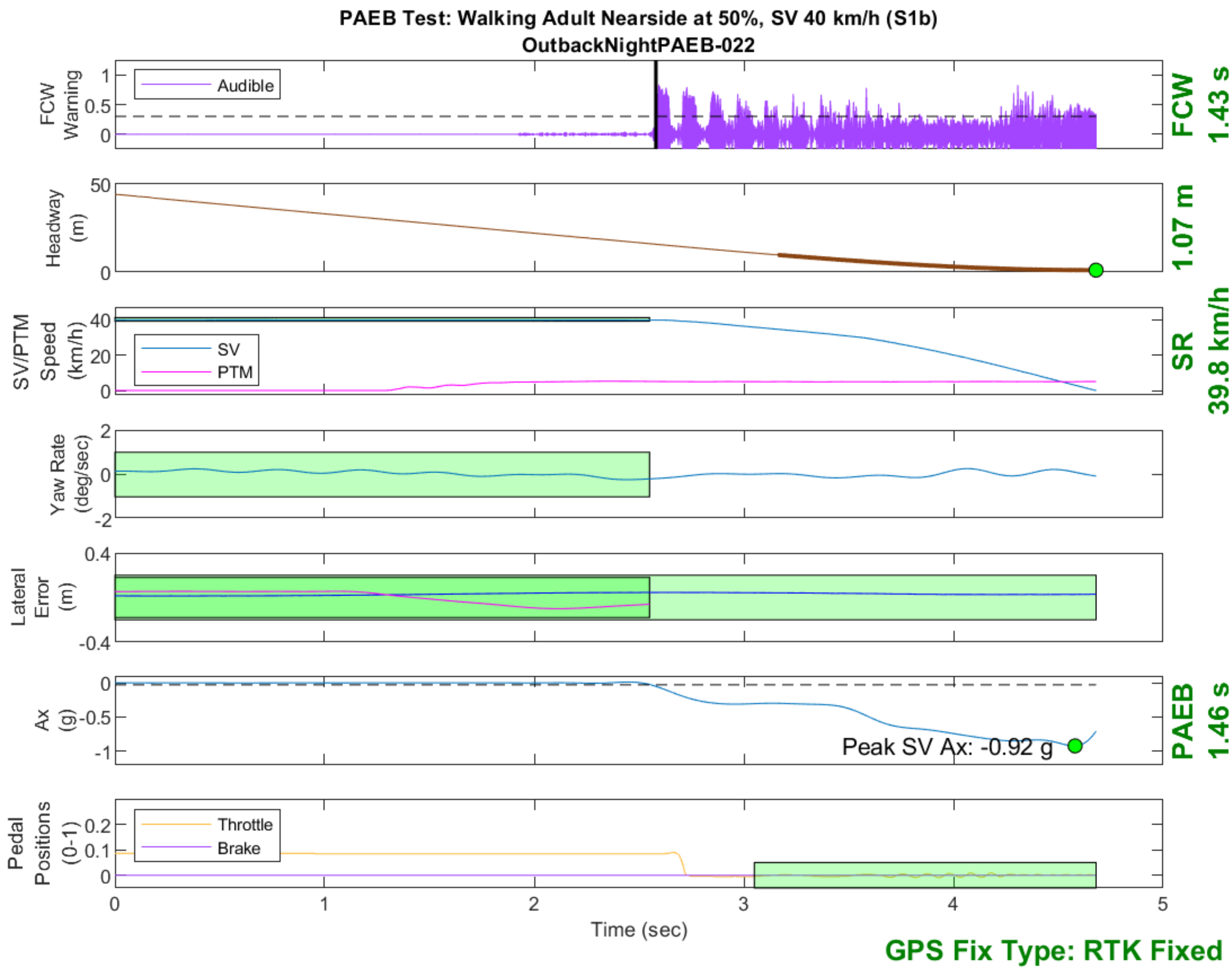


Figure D191. Time History for PAEB Run 22, S1b, Night, High Beam, 40 km/h

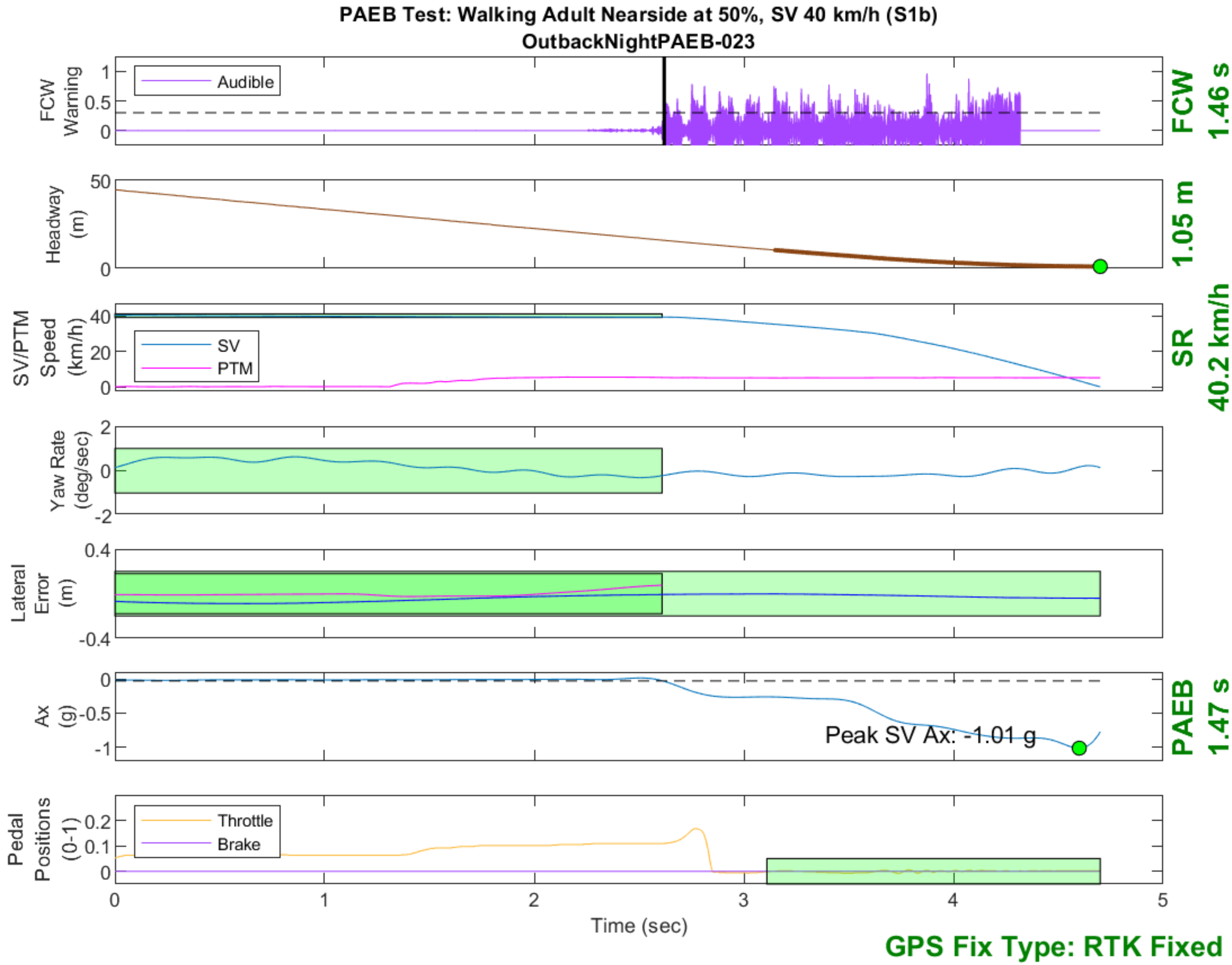


Figure D192. Time History for PAEB Run 23, S1b, Night, High Beam, 40 km/h

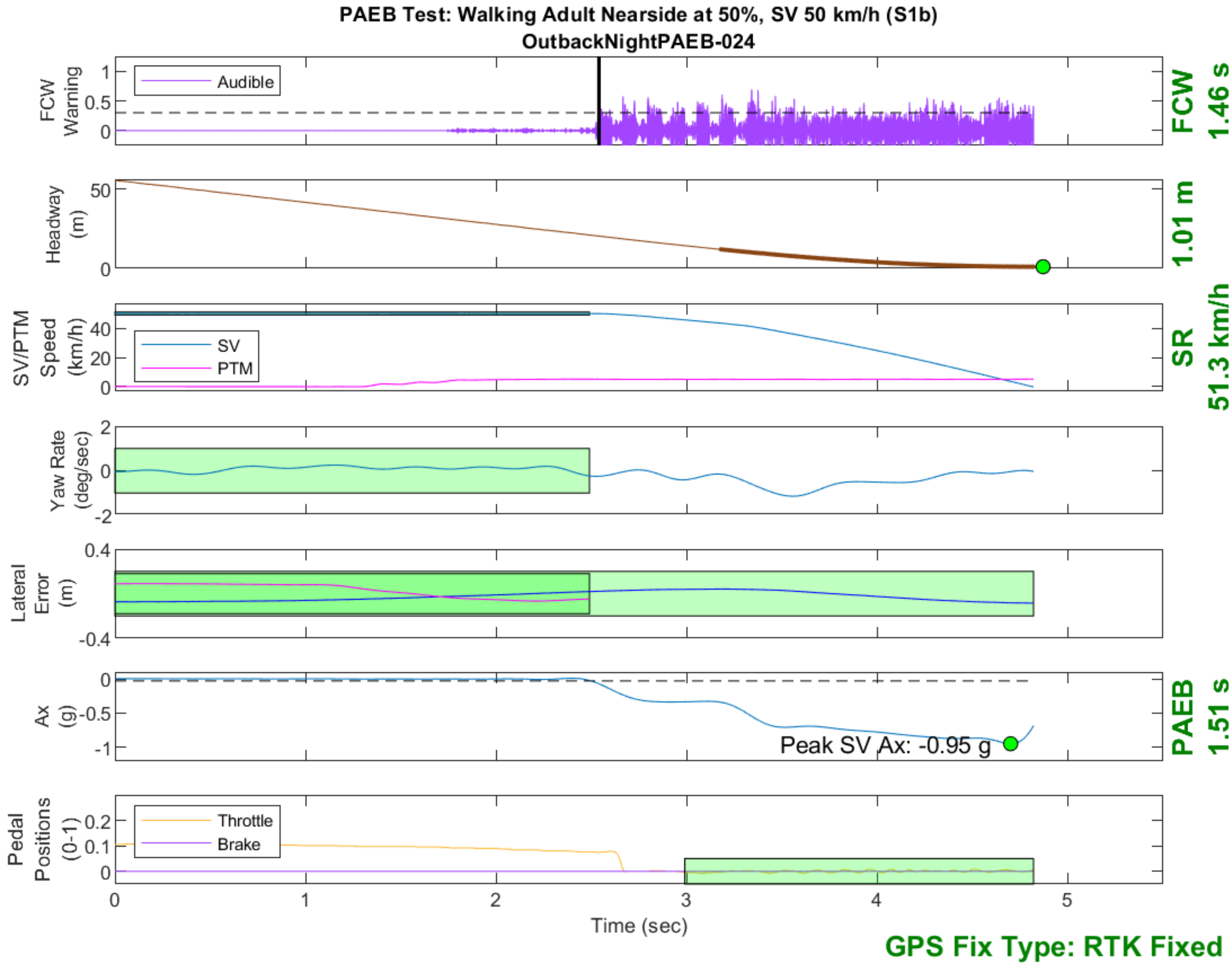


Figure D193. Time History for PAEB Run 24, S1b, Night, High Beam, 50 km/h

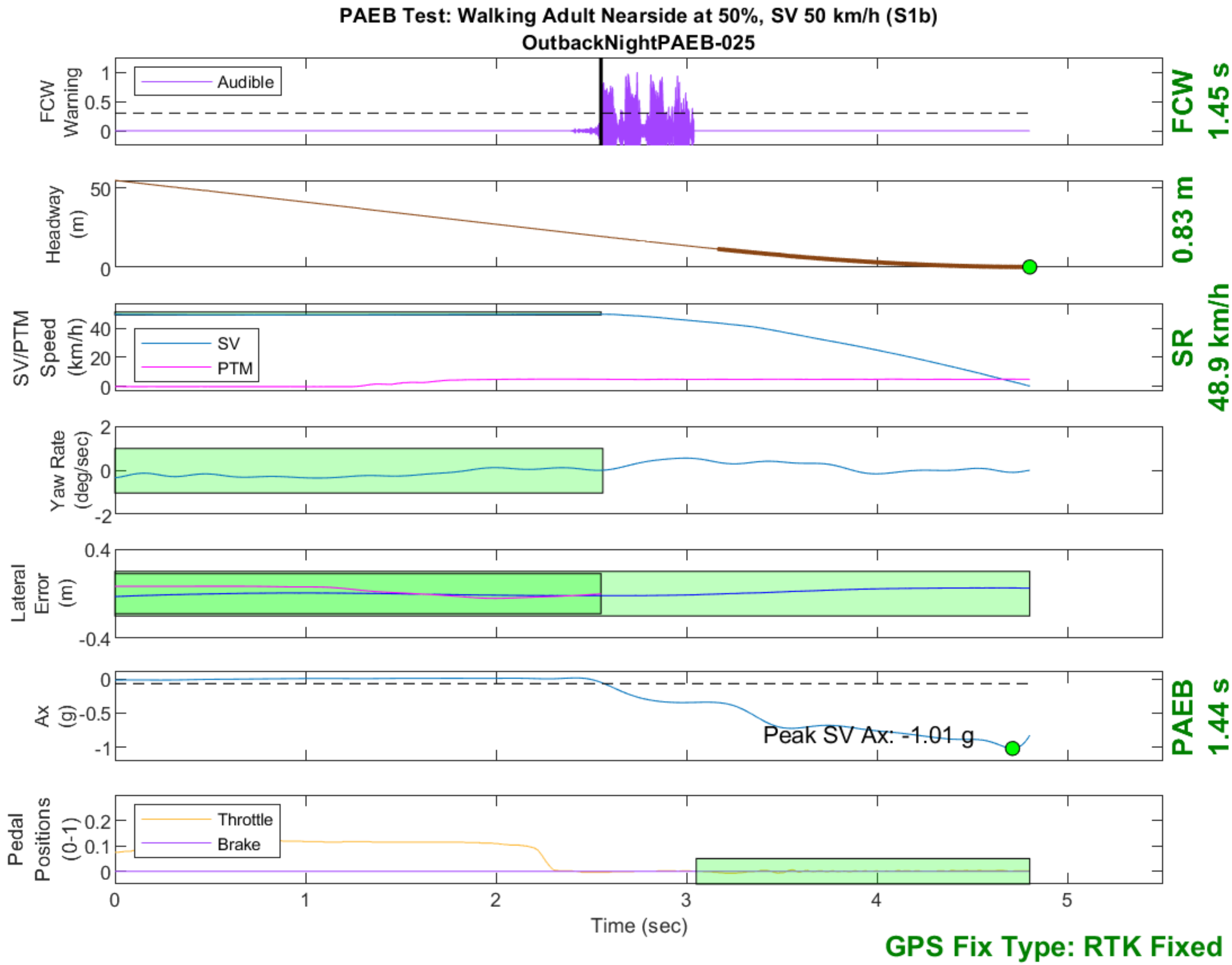


Figure D194. Time History for PAEB Run 25, S1b, Night, High Beam, 50 km/h

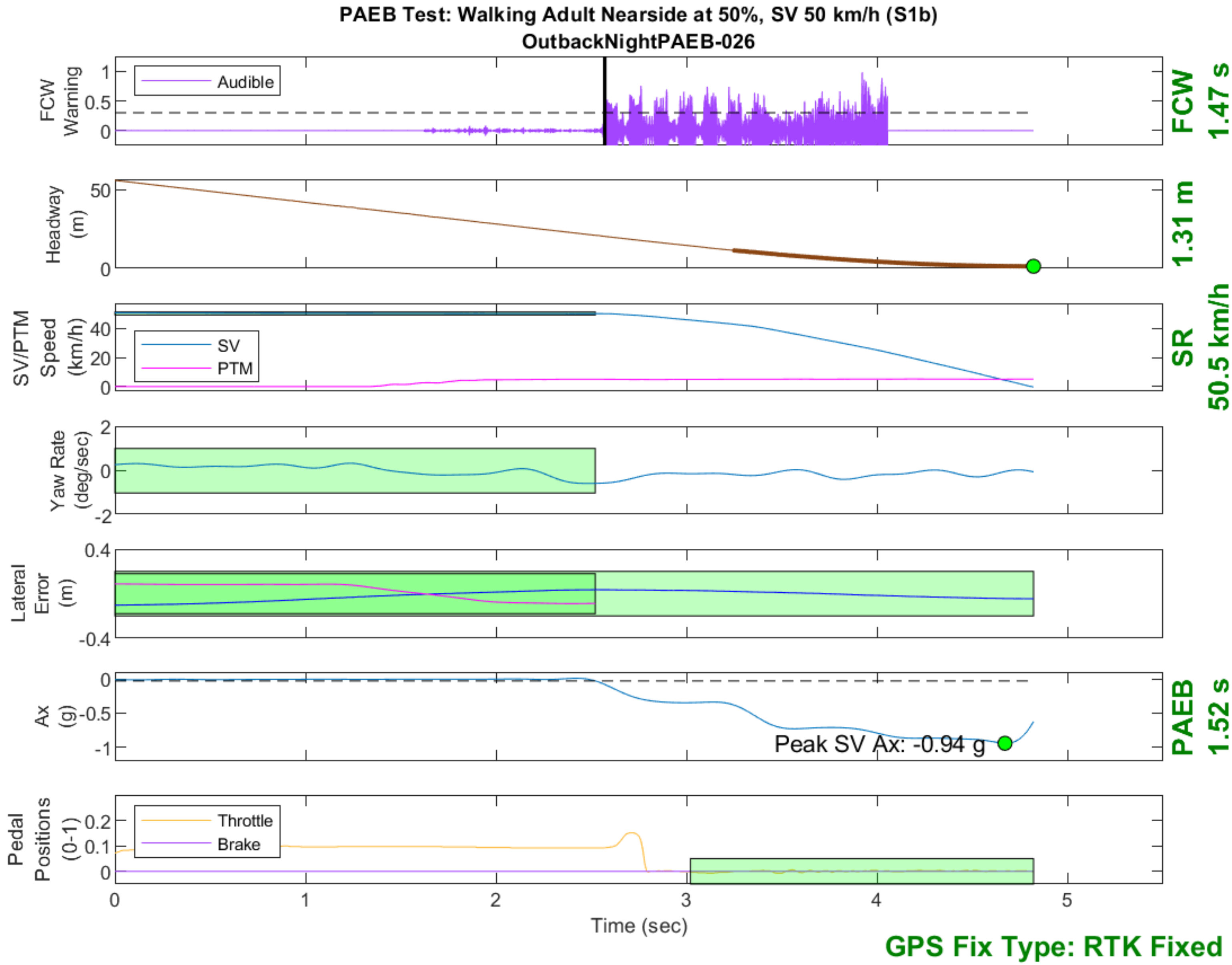


Figure D195. Time History for PAEB Run 26, S1b, Night, High Beam, 50 km/h

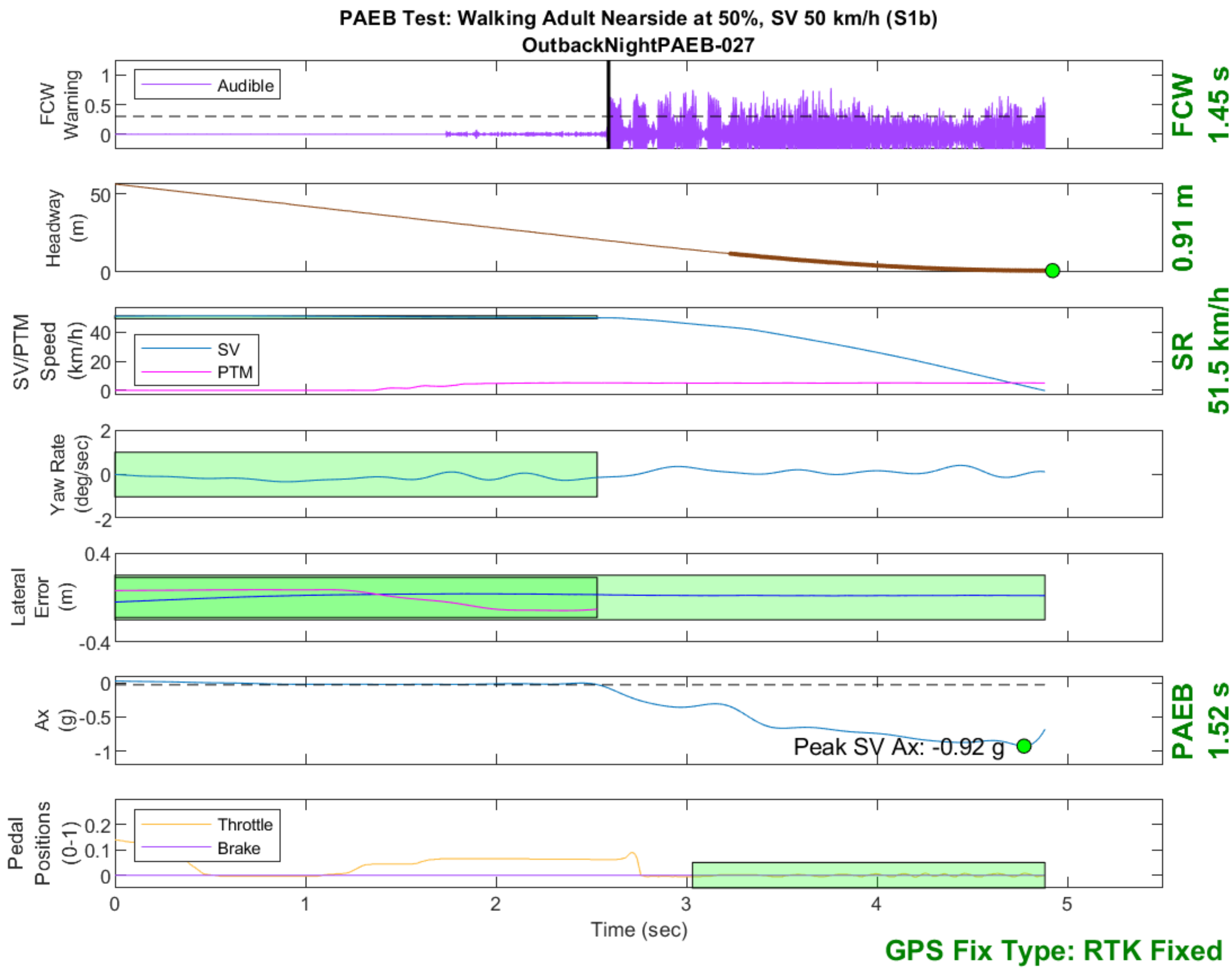


Figure D196. Time History for PAEB Run 27, S1b, Night, High Beam, 50 km/h

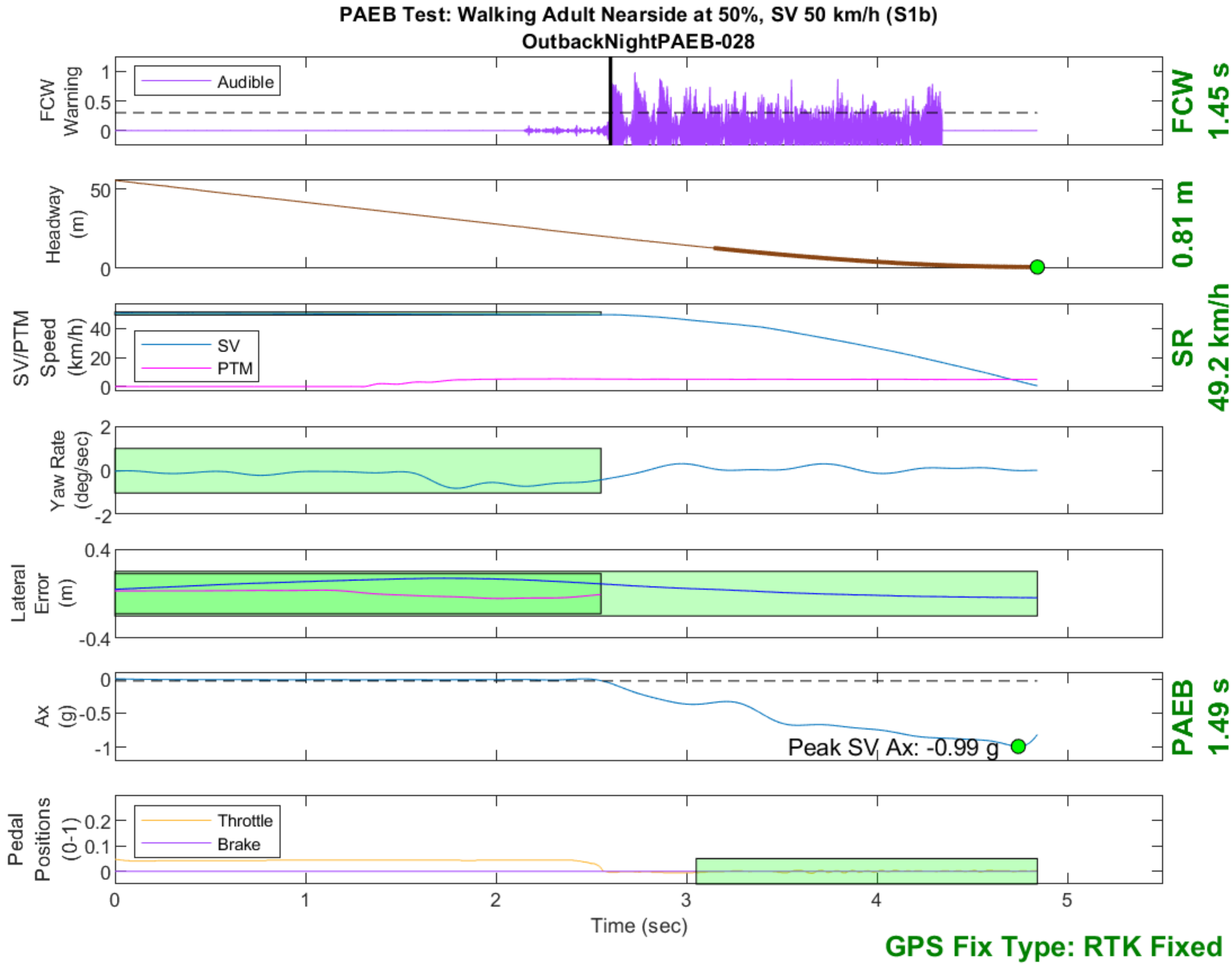


Figure D197. Time History for PAEB Run 28, S1b, Night, High Beam, 50 km/h

Figure D198. Time History for PAEB Run 29, S1b, Night, High Beam, 50 km/h

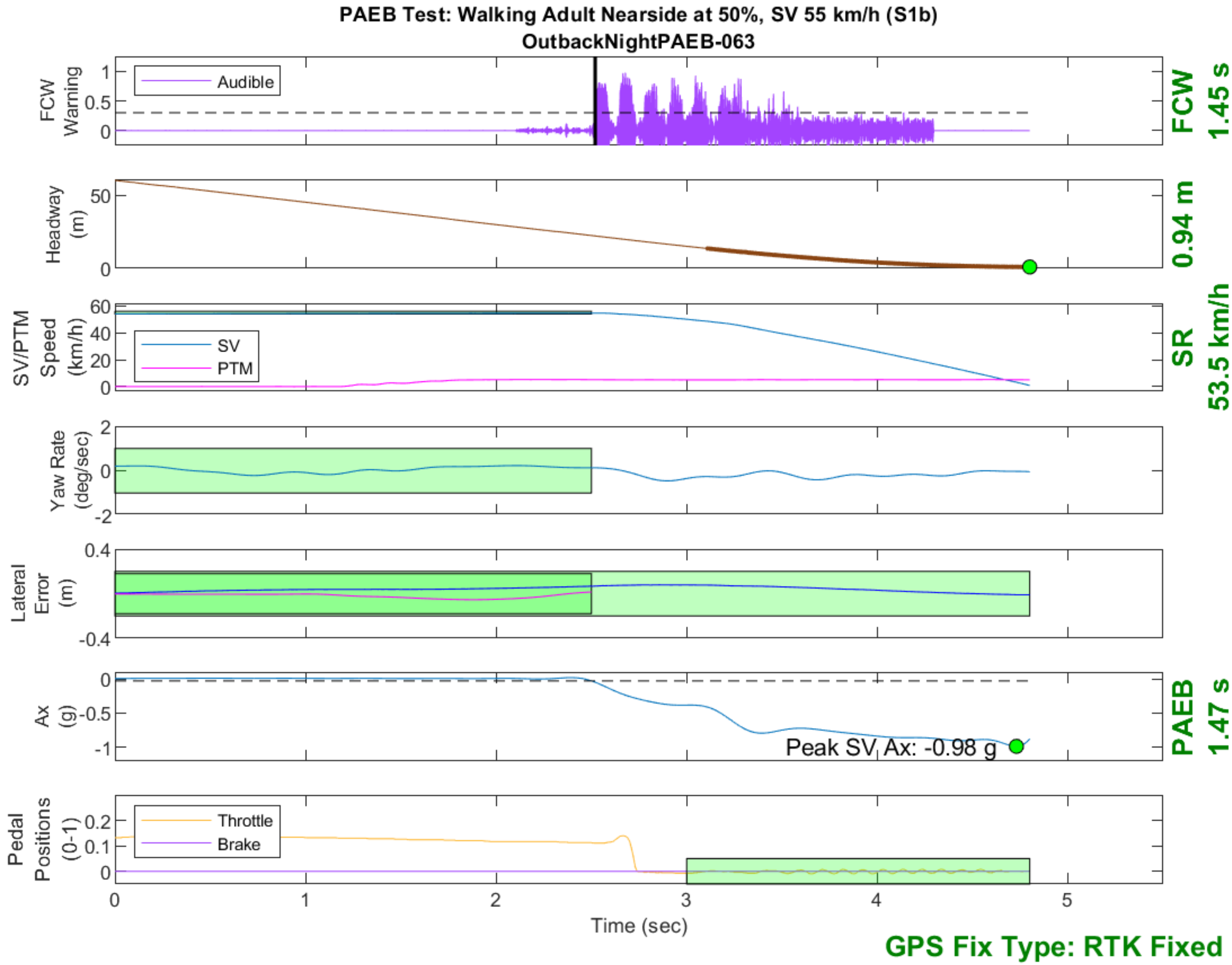


Figure D199. Time History for PAEB Run 63, S1b, Night, High Beam, 55 km/h

Figure D200. Time History for PAEB Run 64, S1b, Night, High Beam, 55 km/h

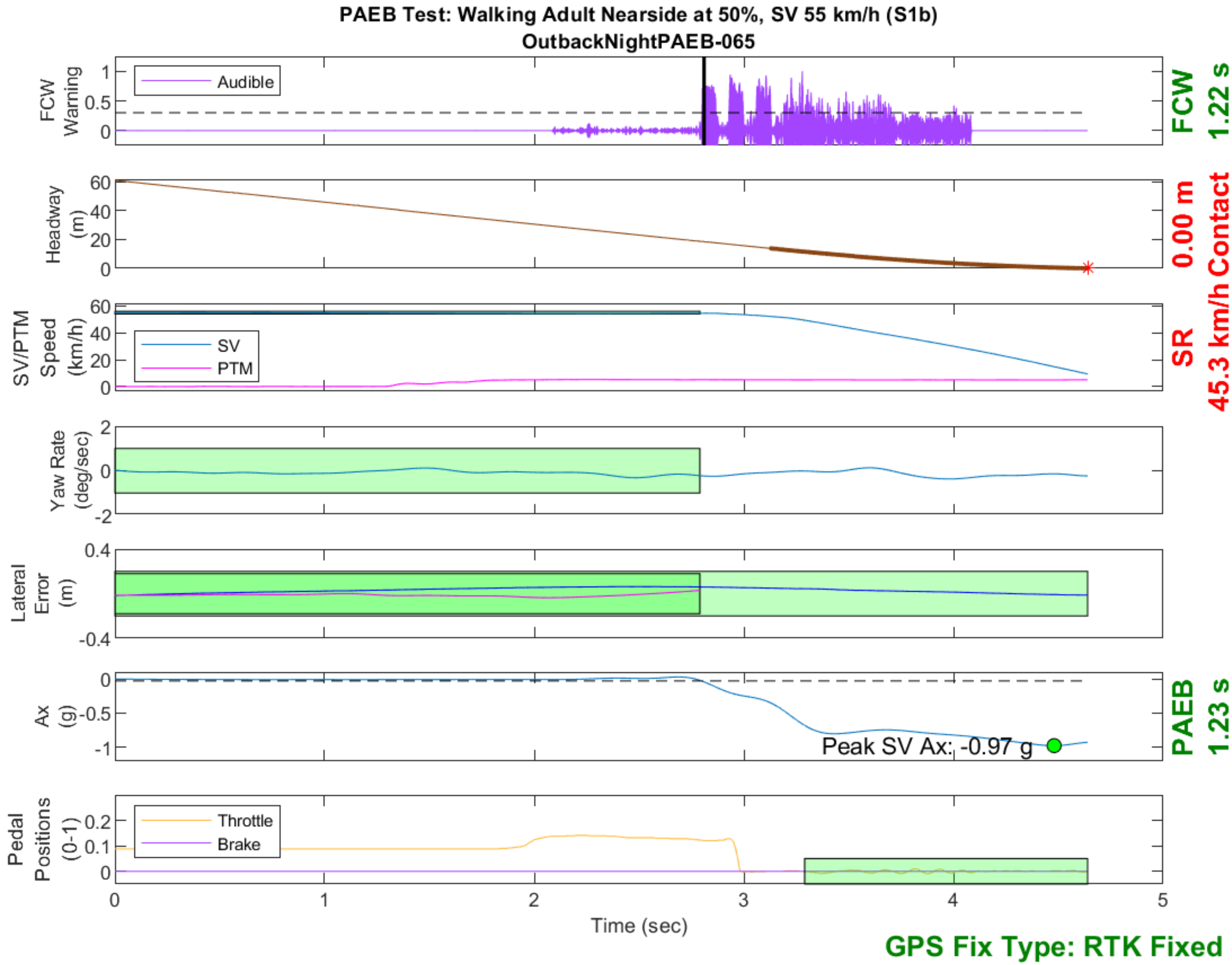


Figure D201. Time History for PAEB Run 65, S1b, Night, High Beam, 55 km/h

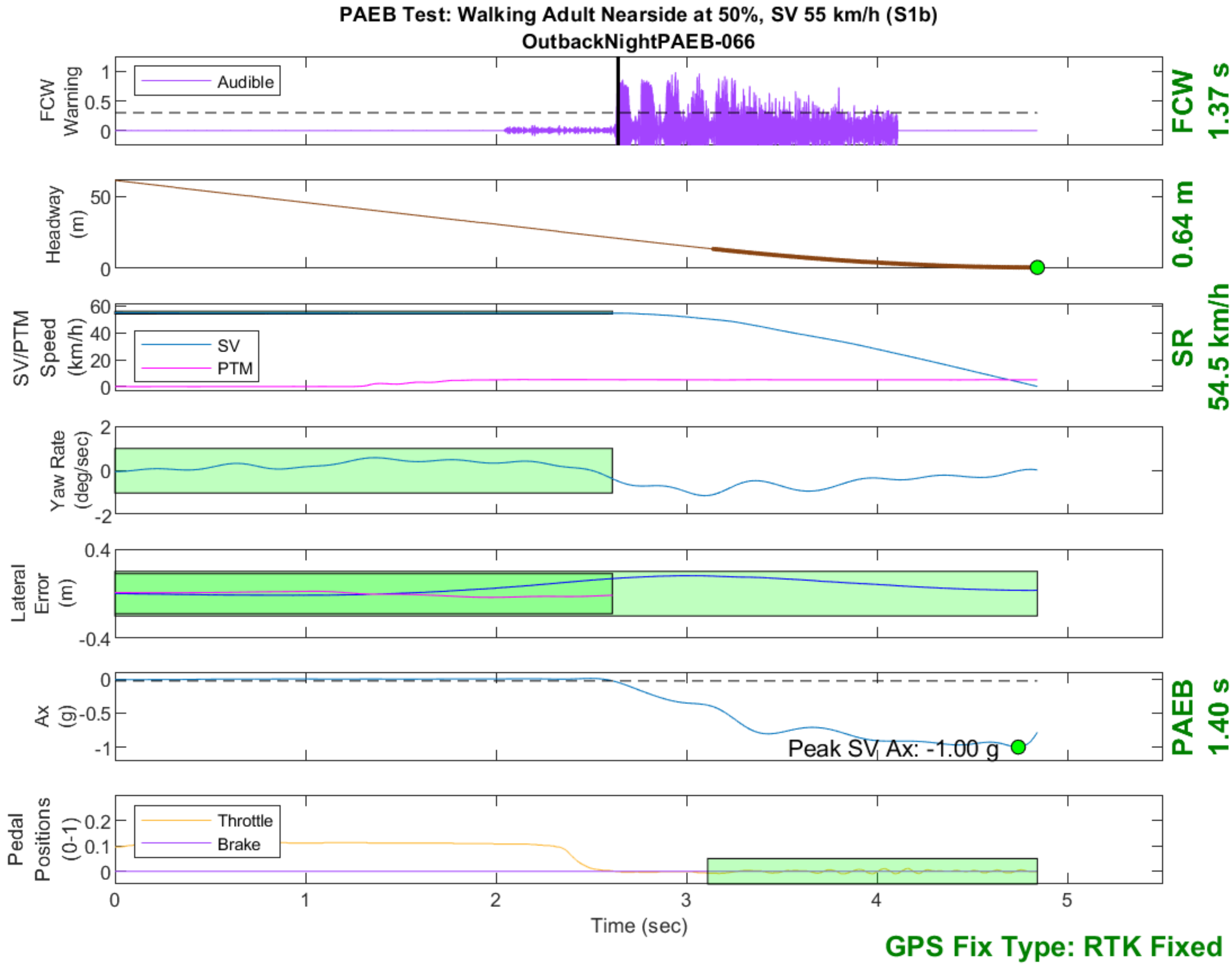


Figure D202. Time History for PAEB Run 66, S1b, Night, High Beam, 55 km/h

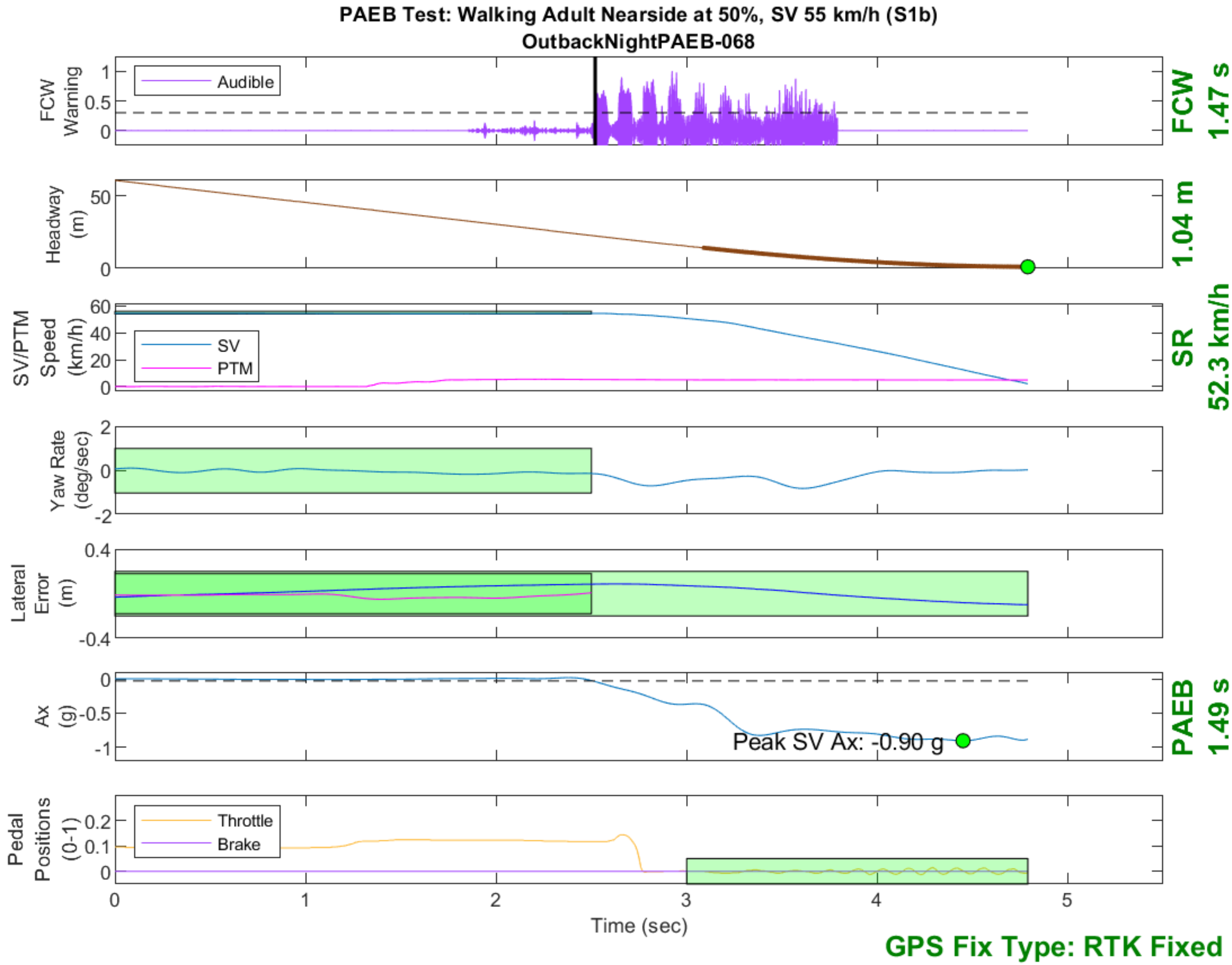


Figure D203. Time History for PAEB Run 68, S1b, Night, High Beam, 55 km/h

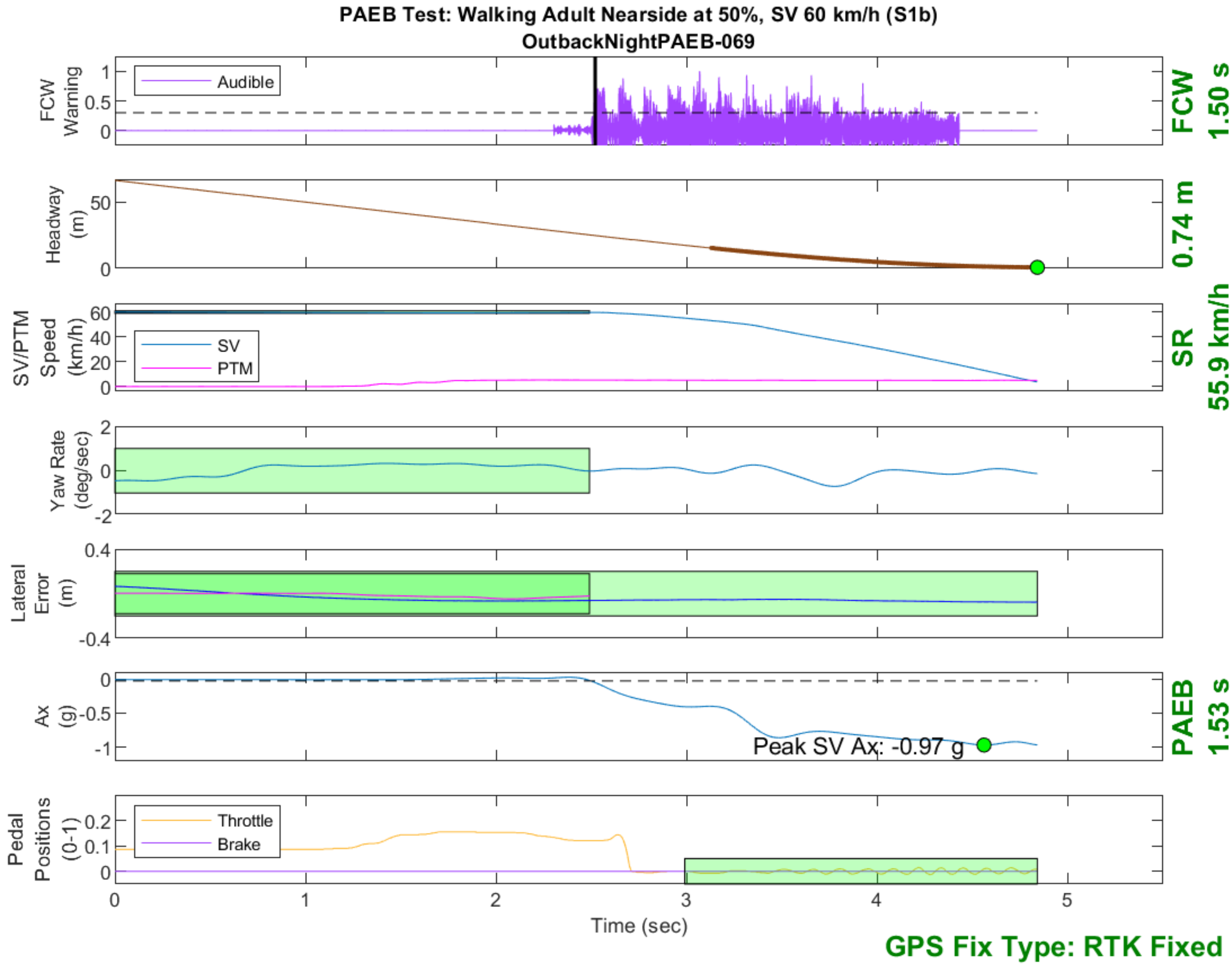


Figure D204. Time History for PAEB Run 69, S1b, Night, High Beam, 60 km/h

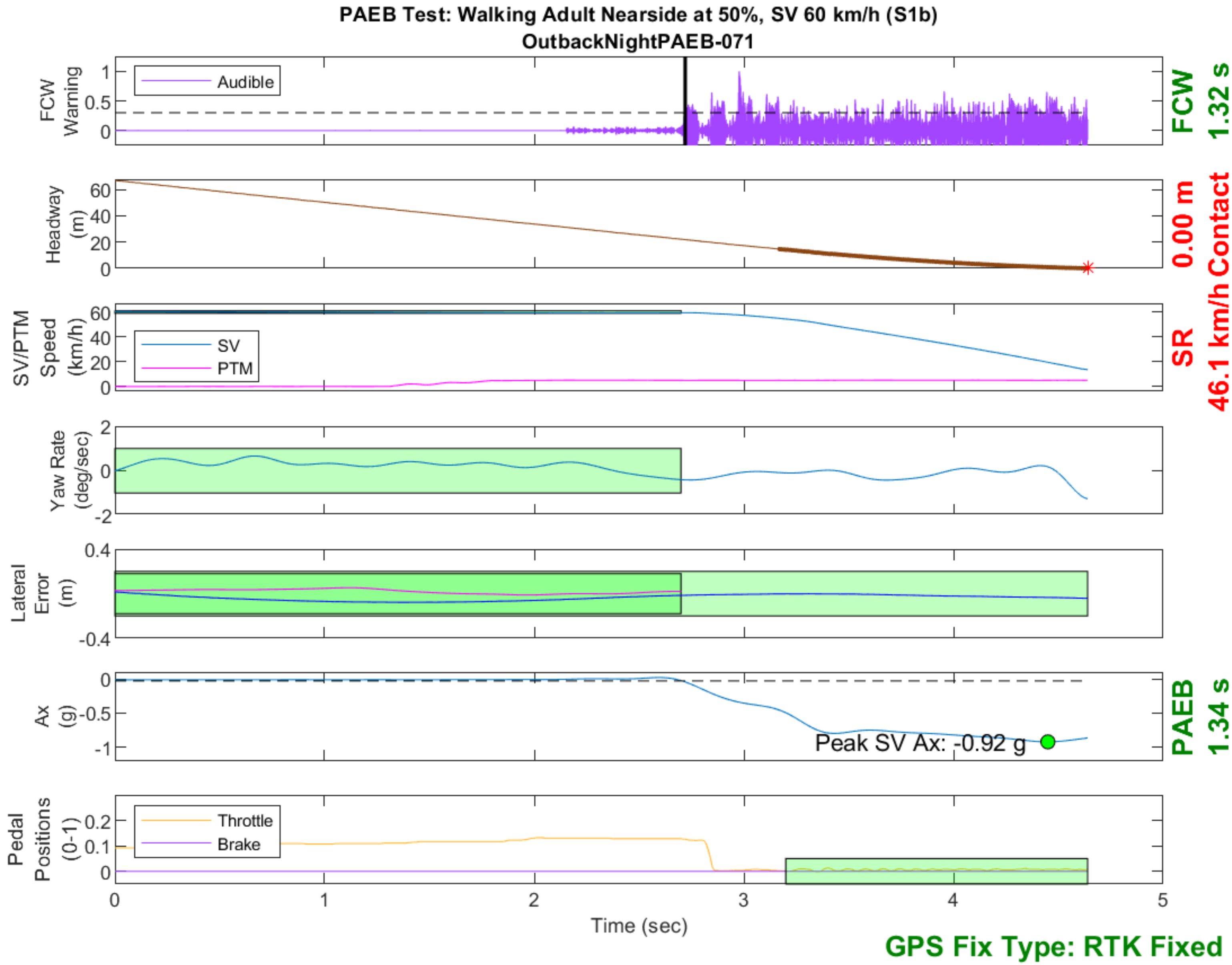


Figure D205. Time History for PAEB Run 71, S1b, Night, High Beam, 60 km/h

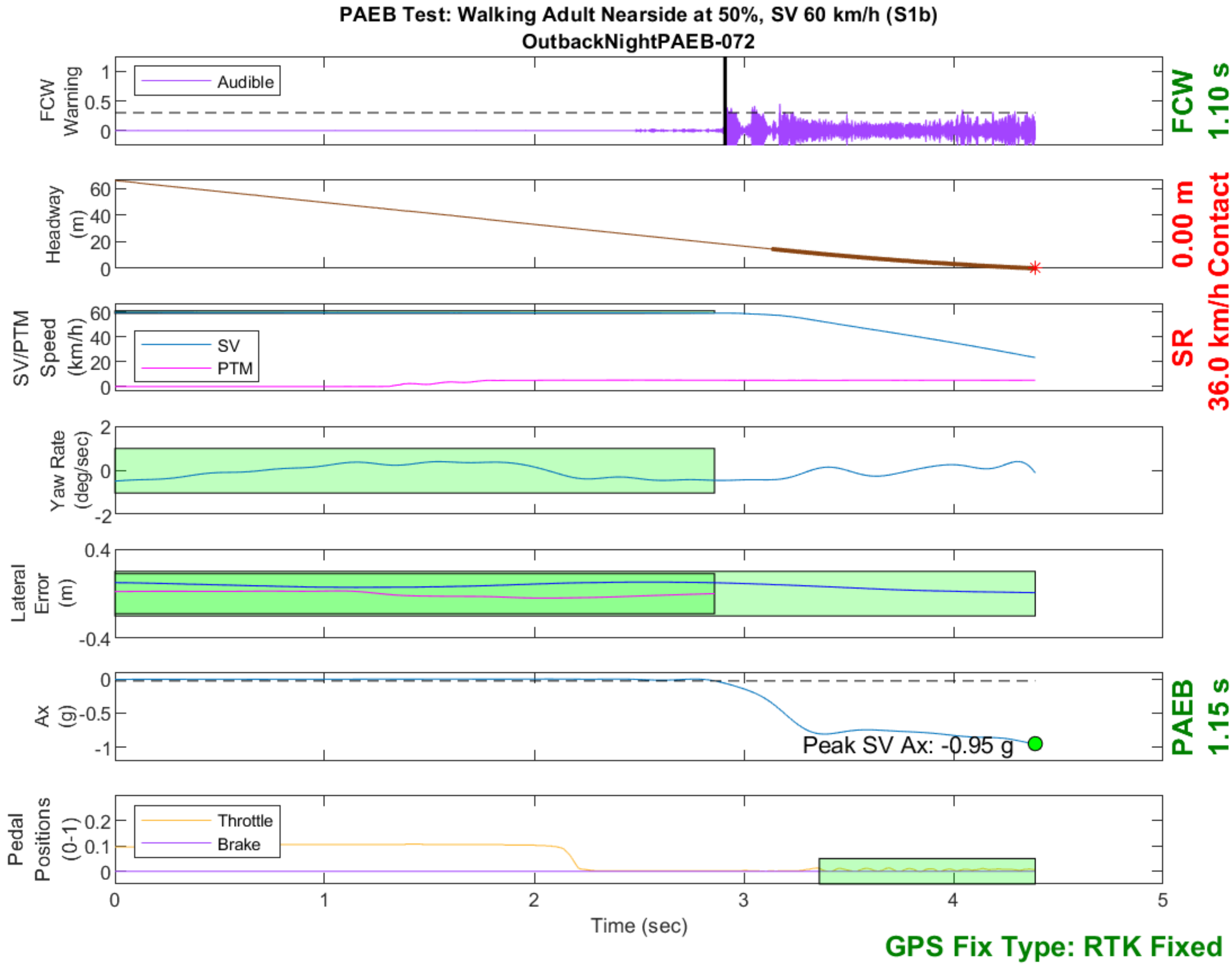


Figure D206. Time History for PAEB Run 72, S1b, Night, High Beam, 60 km/h

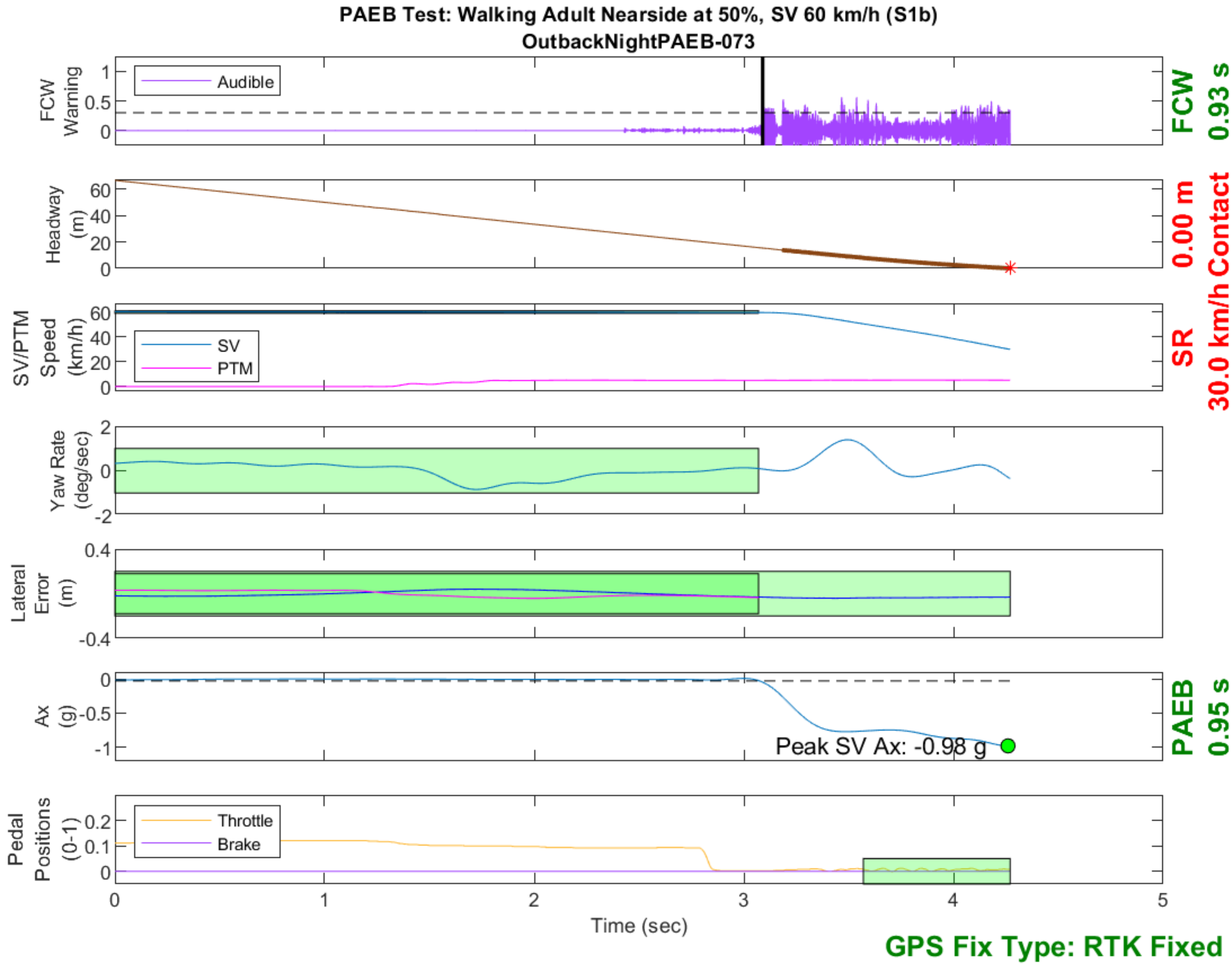


Figure D207. Time History for PAEB Run 73, S1b, Night, High Beam, 60 km/h

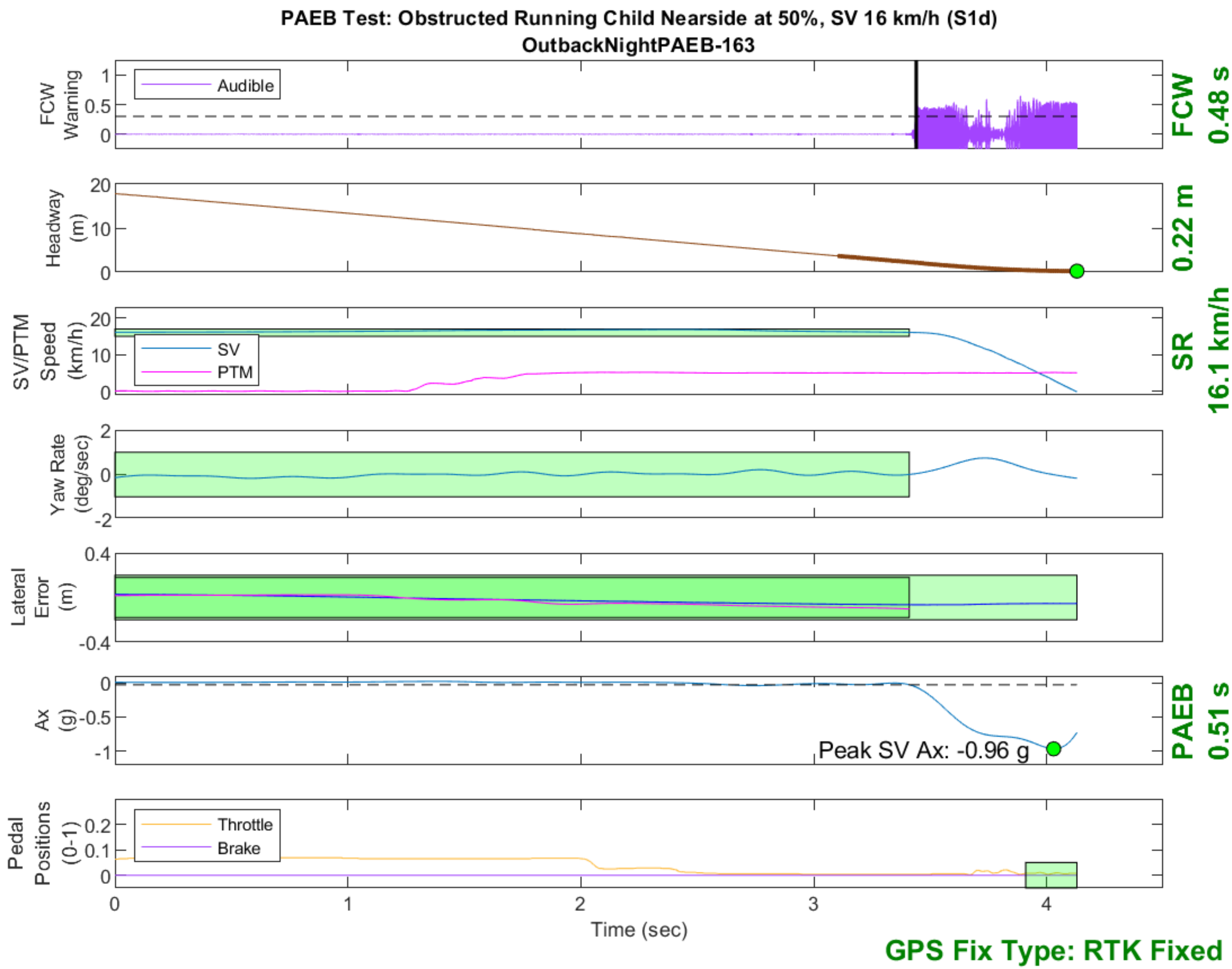


Figure D208. Time History for PAEB Run 163, S1d, Night, High Beam, 16 km/h

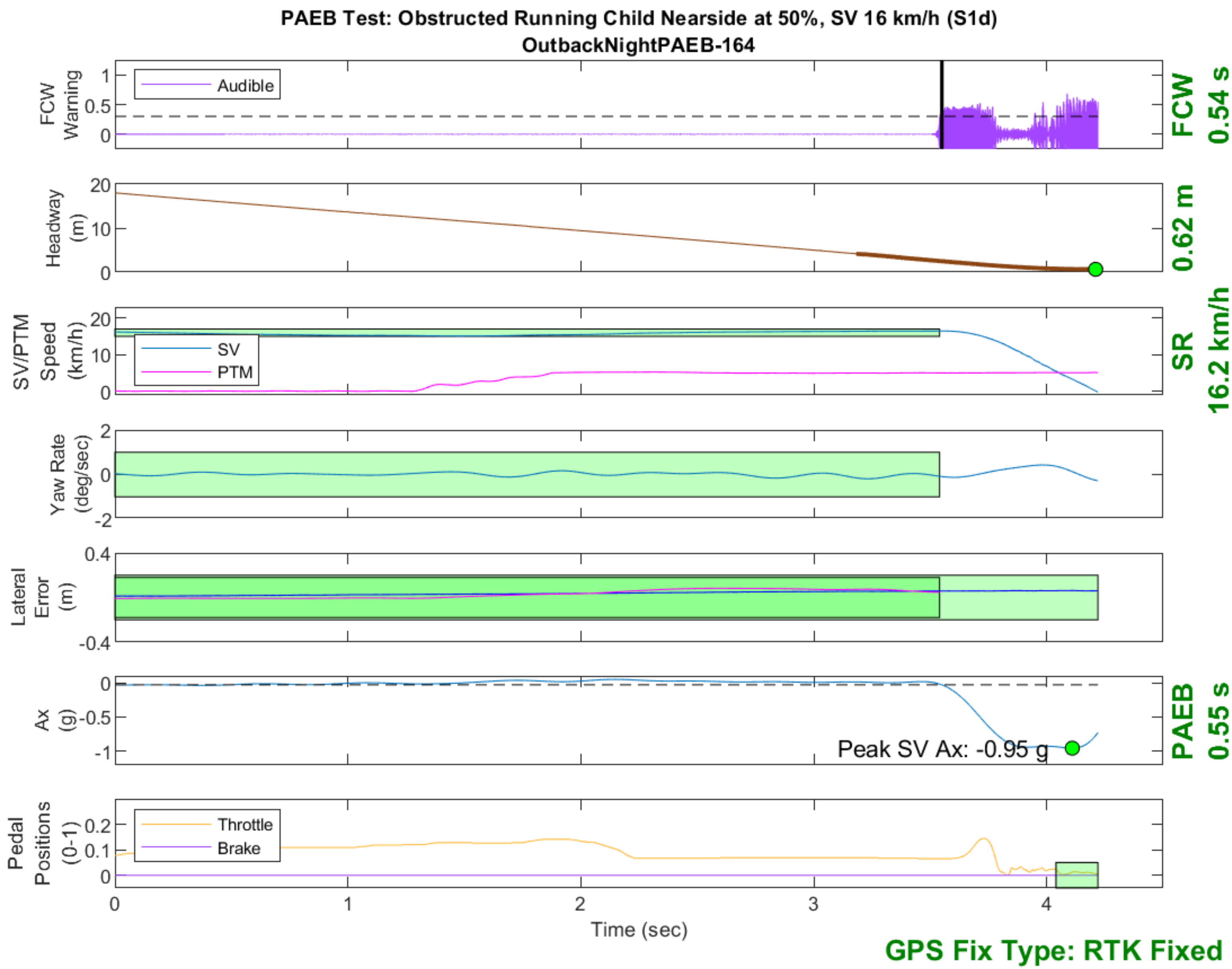


Figure D209. Time History for PAEB Run 164, S1d, Night, High Beam, 16 km/h

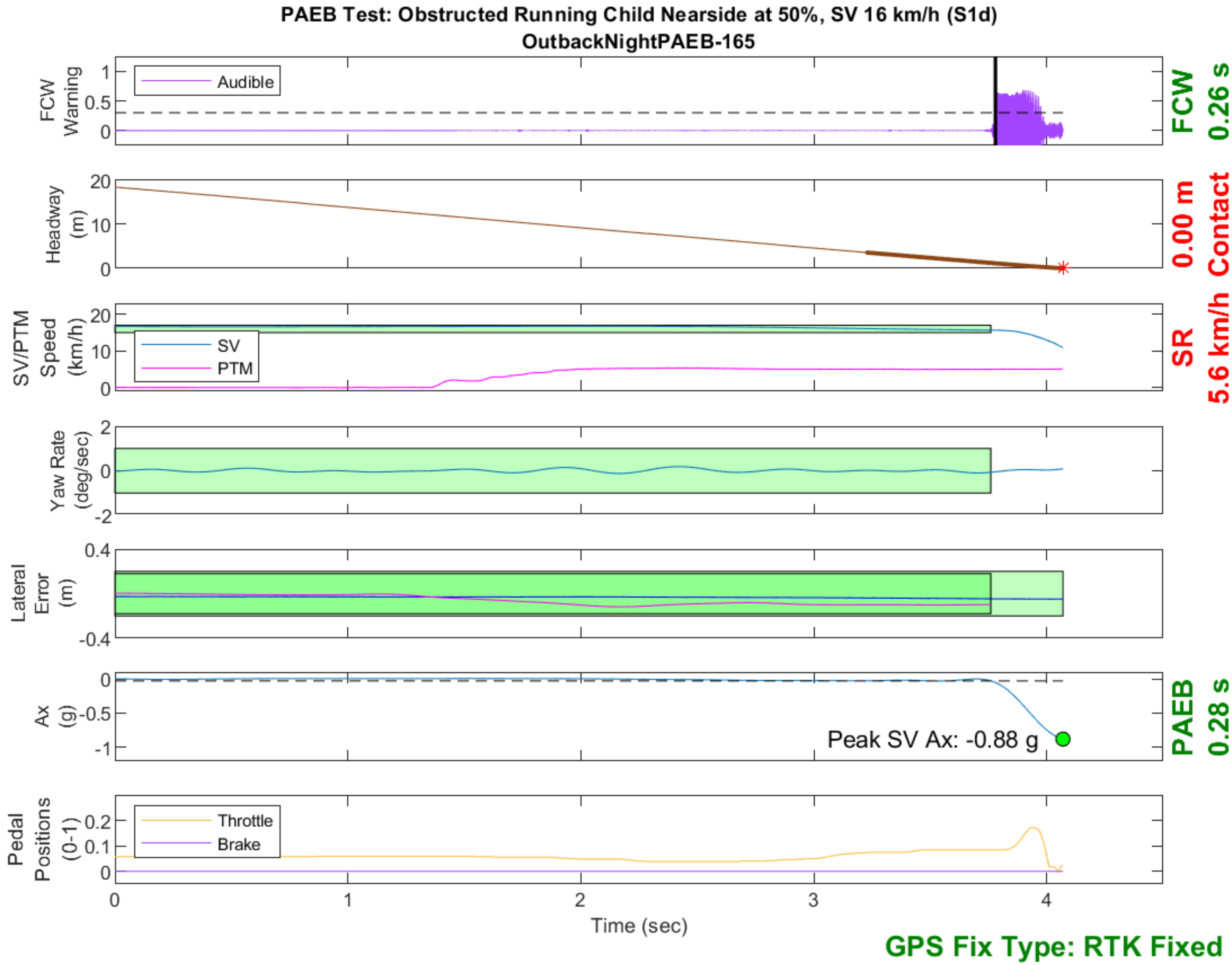


Figure D210. Time History for PAEB Run 165, S1d, Night, High Beam, 16 km/h

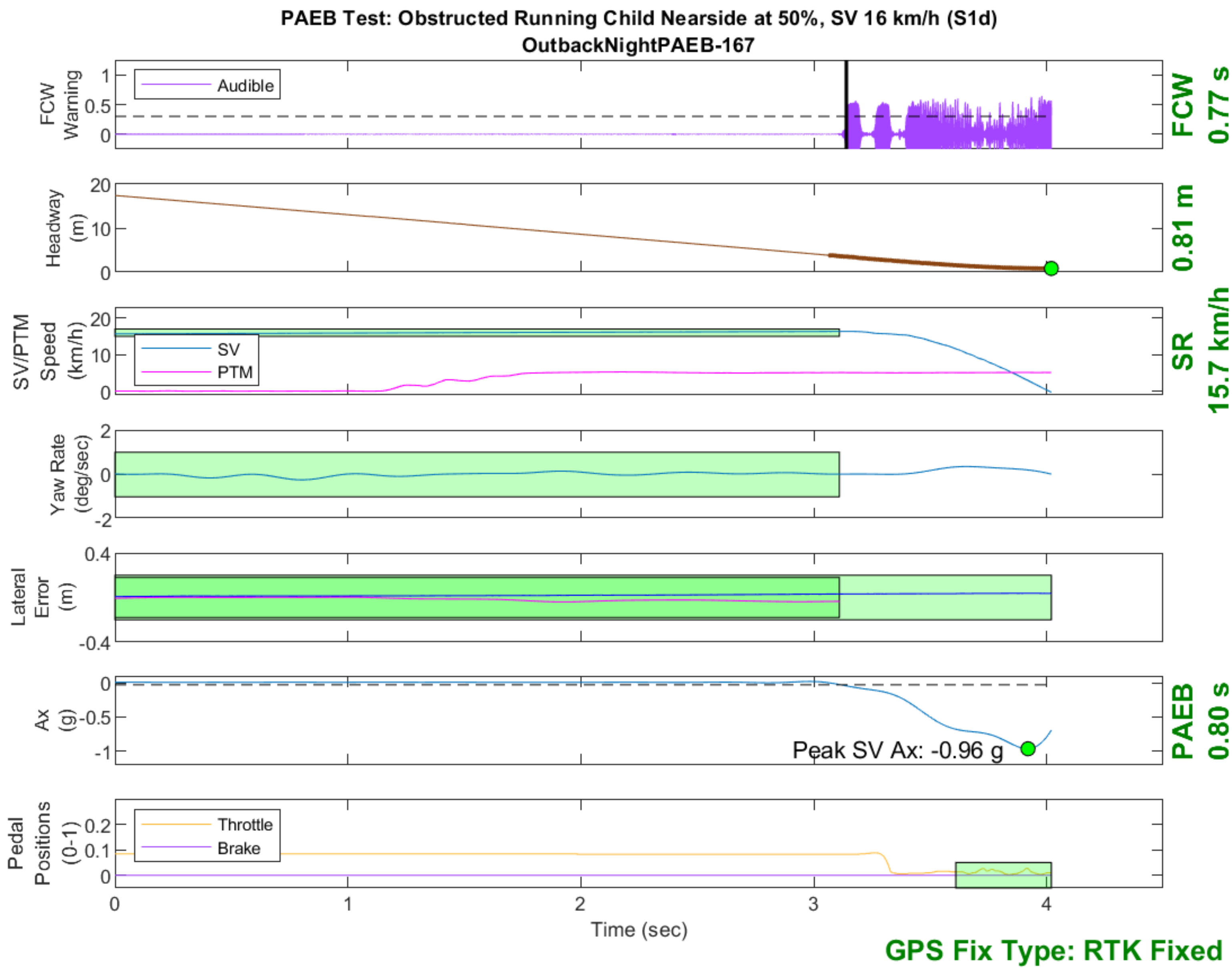


Figure D211. Time History for PAEB Run 167, S1d, Night, High Beam, 16 km/h

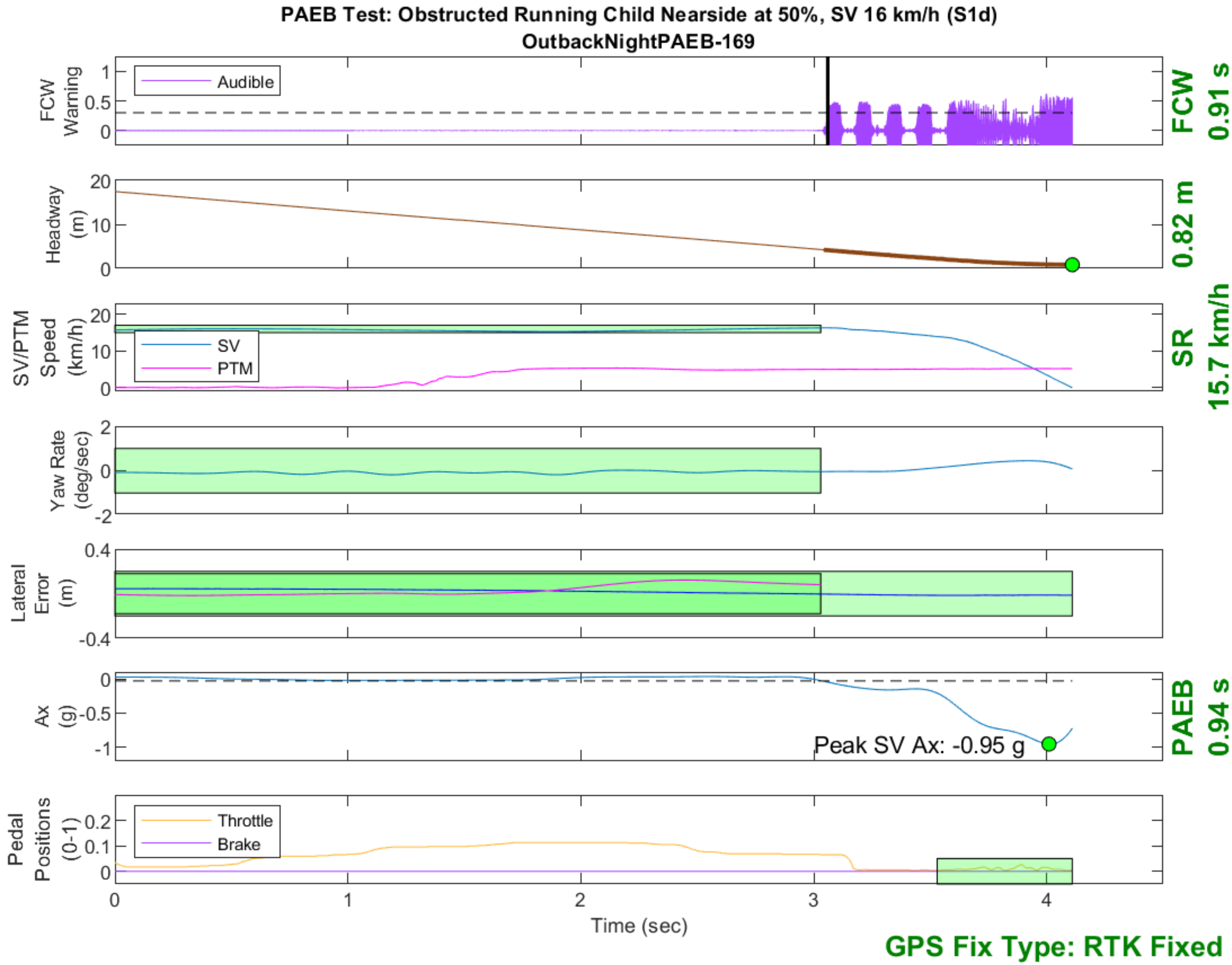


Figure D212. Time History for PAEB Run 169, S1d, Night, High Beam, 16 km/h

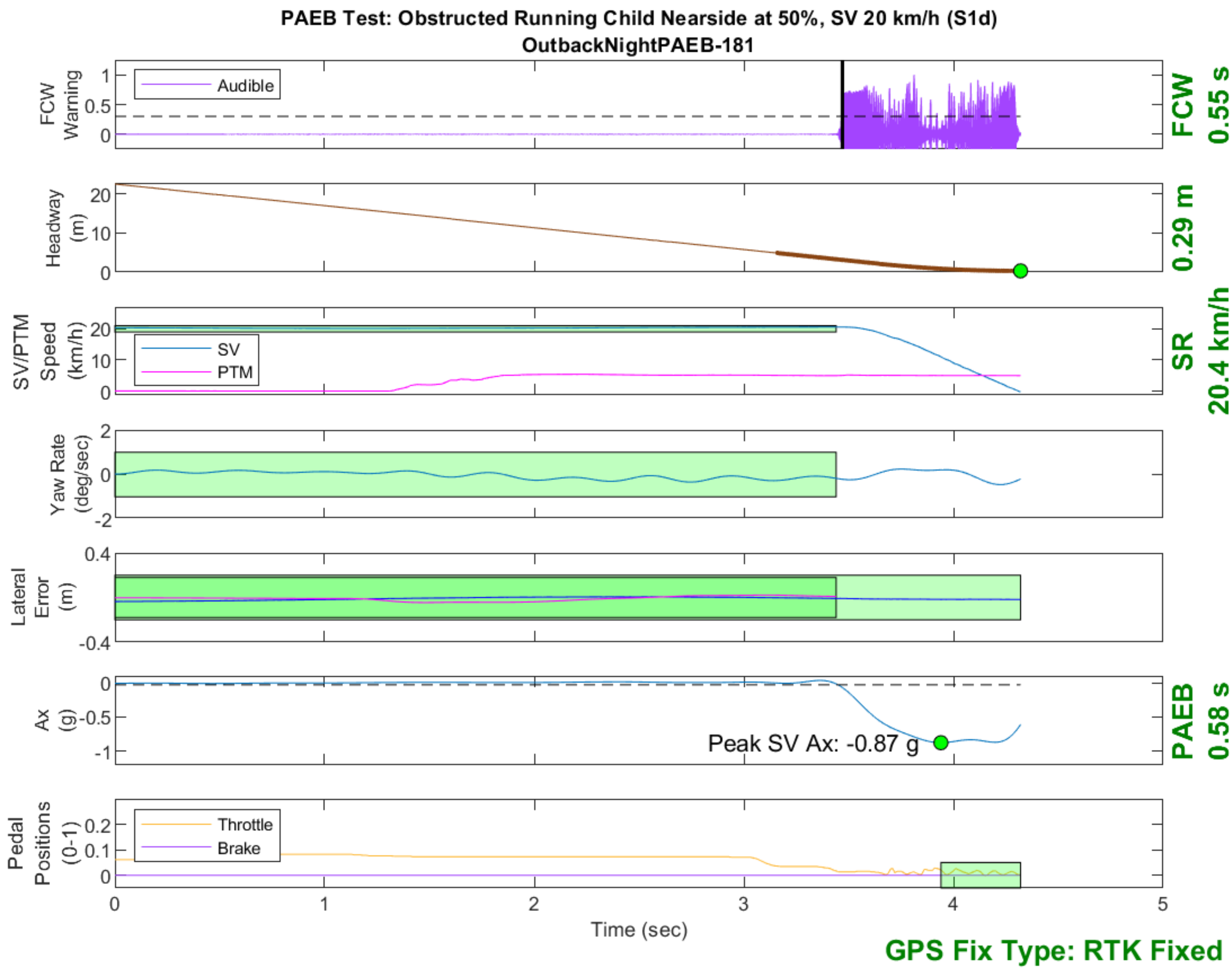


Figure D213. Time History for PAEB Run 181, S1d, Night, High Beam, 20 km/h

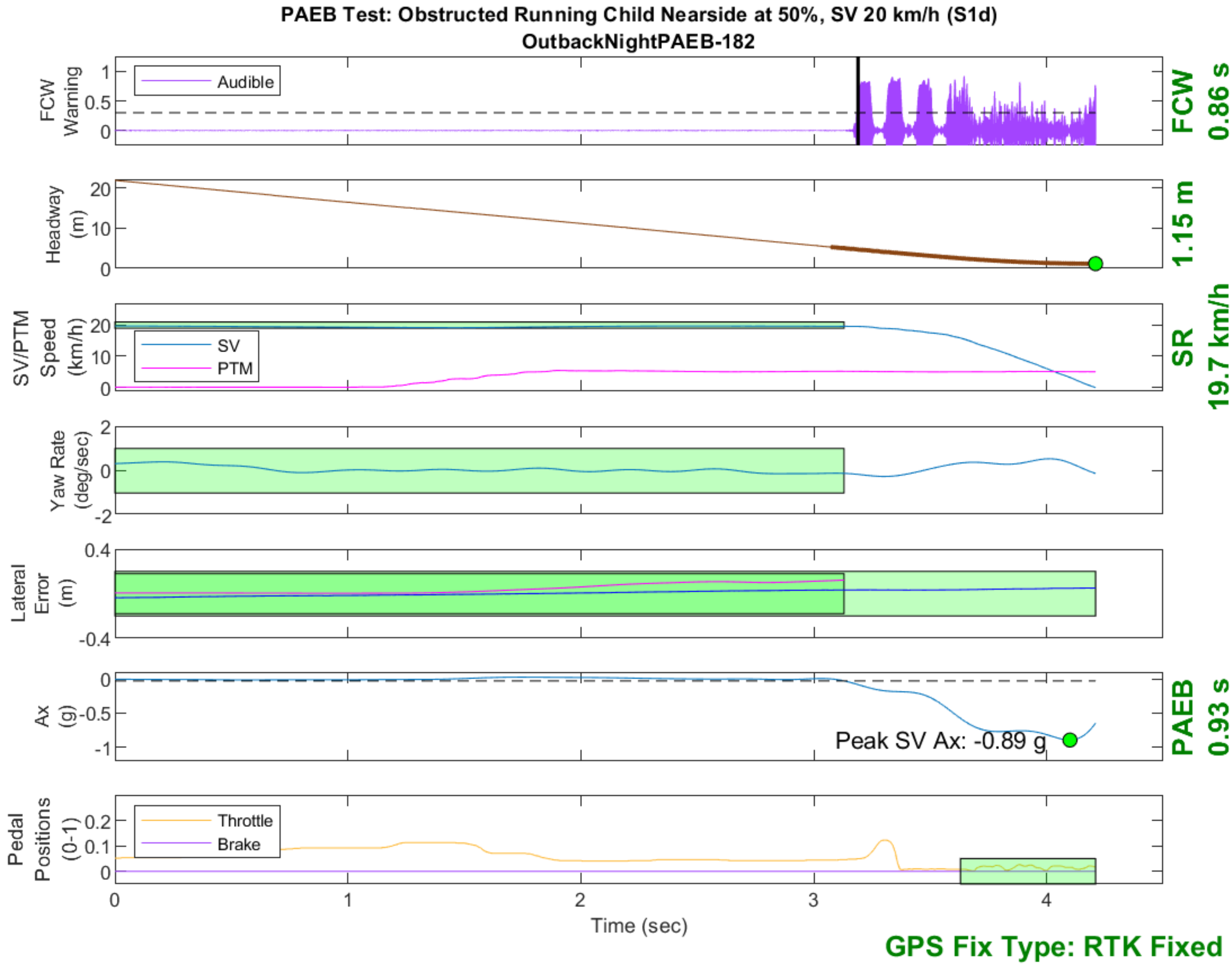


Figure D214. Time History for PAEB Run 182, S1d, Night, High Beam, 20 km/h

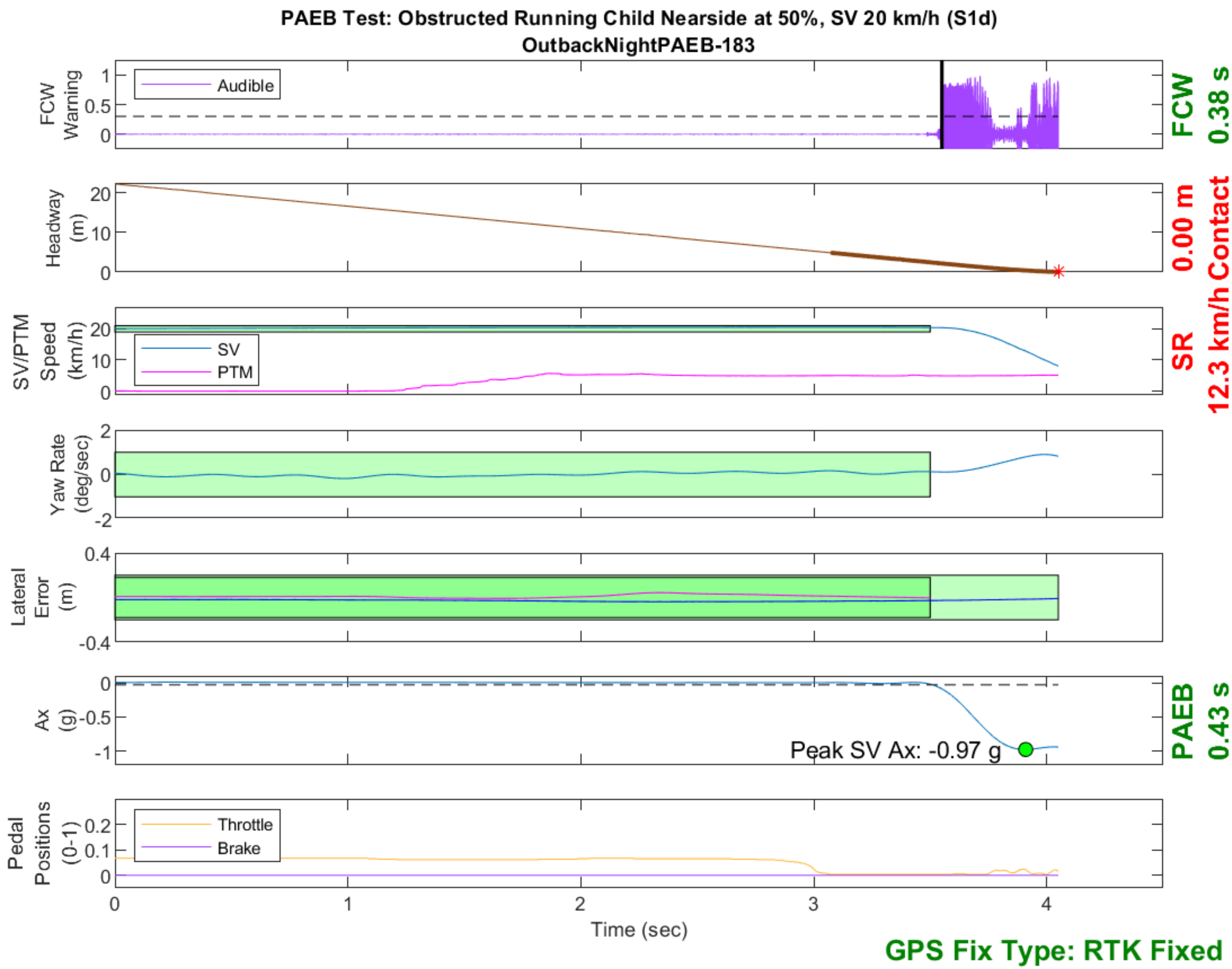


Figure D215. Time History for PAEB Run 183, S1d, Night, High Beam, 20 km/h

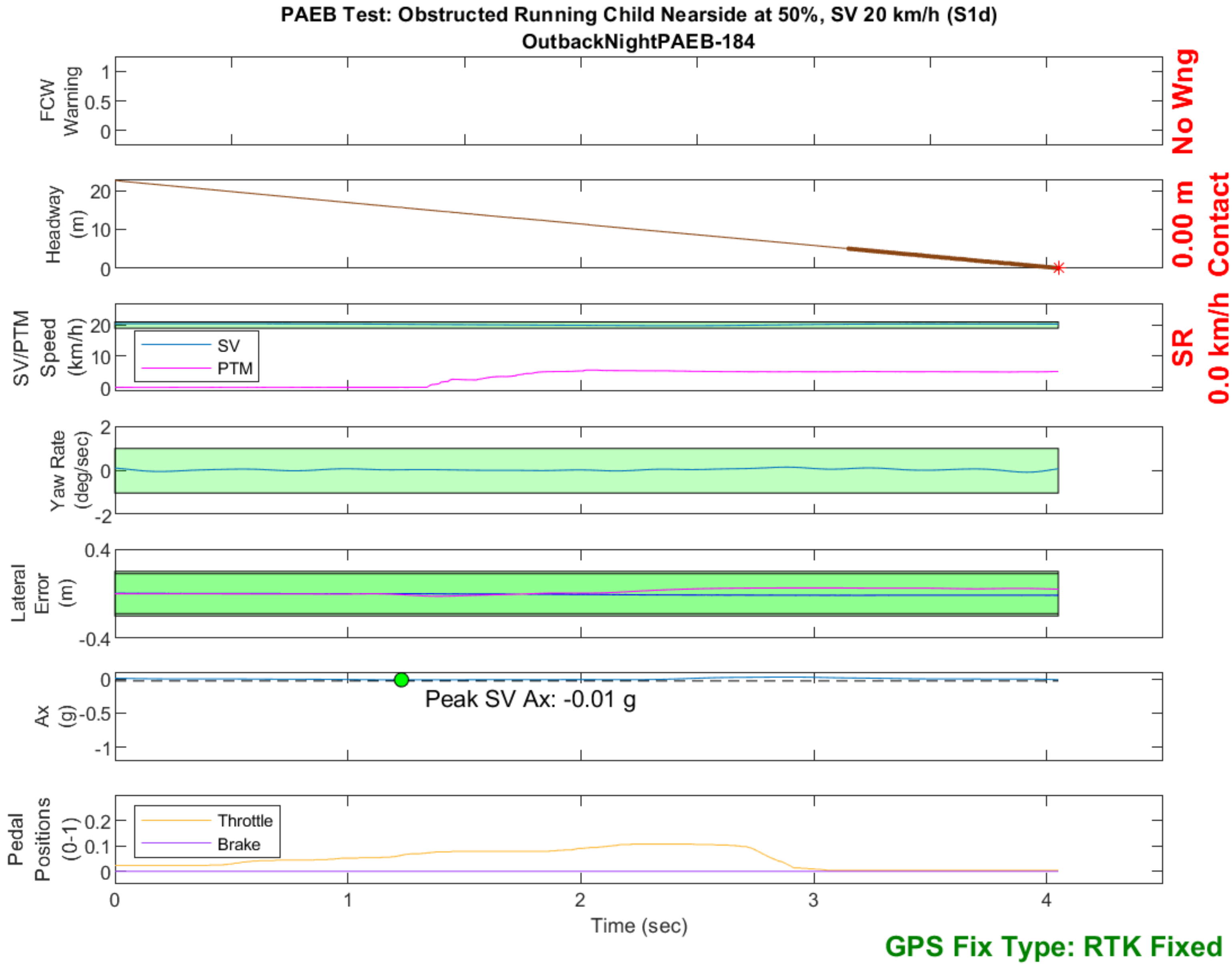


Figure D216. Time History for PAEB Run 184, S1d, Night, High Beam, 20 km/h

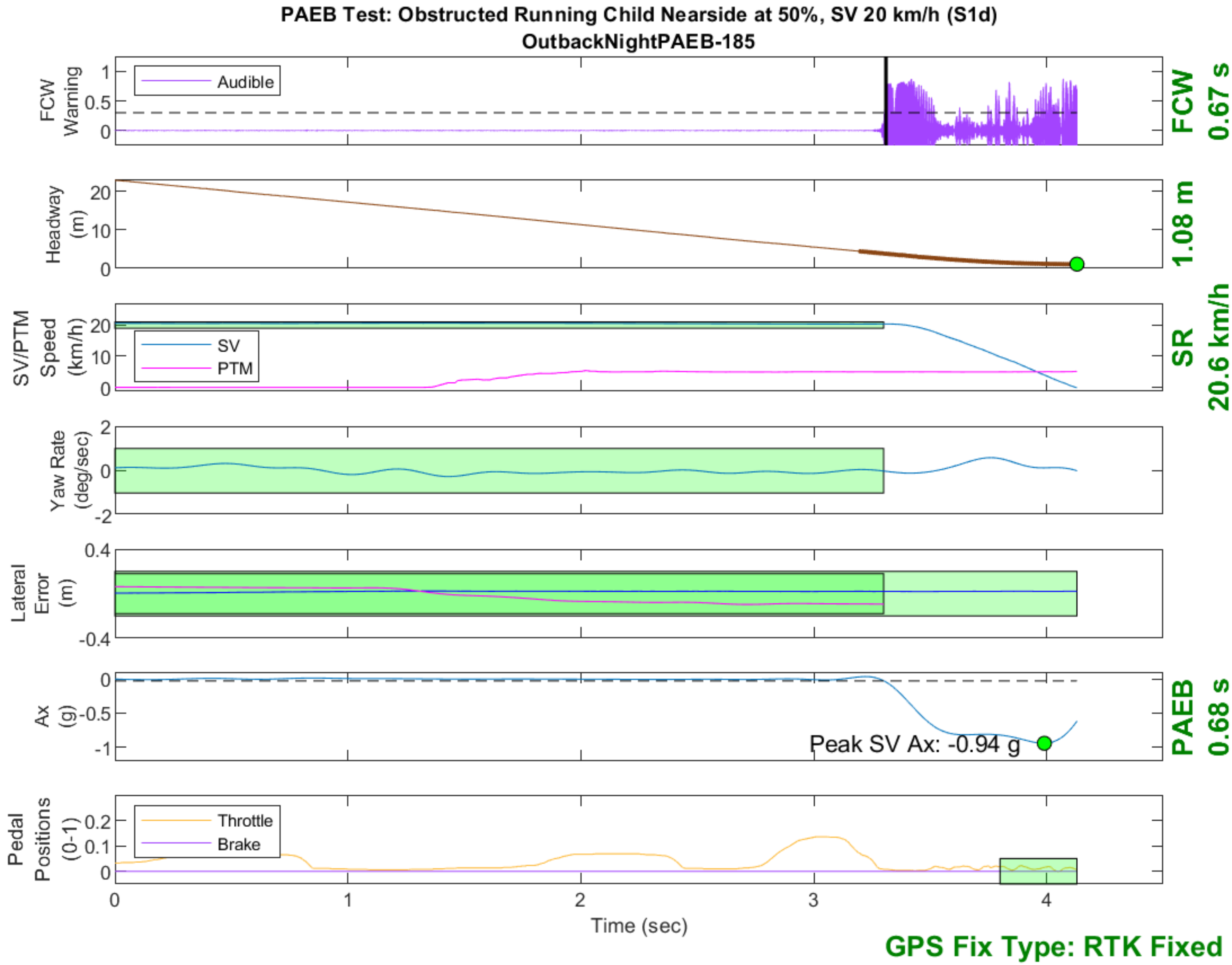


Figure D217. Time History for PAEB Run 185, S1d, Night, High Beam, 20 km/h

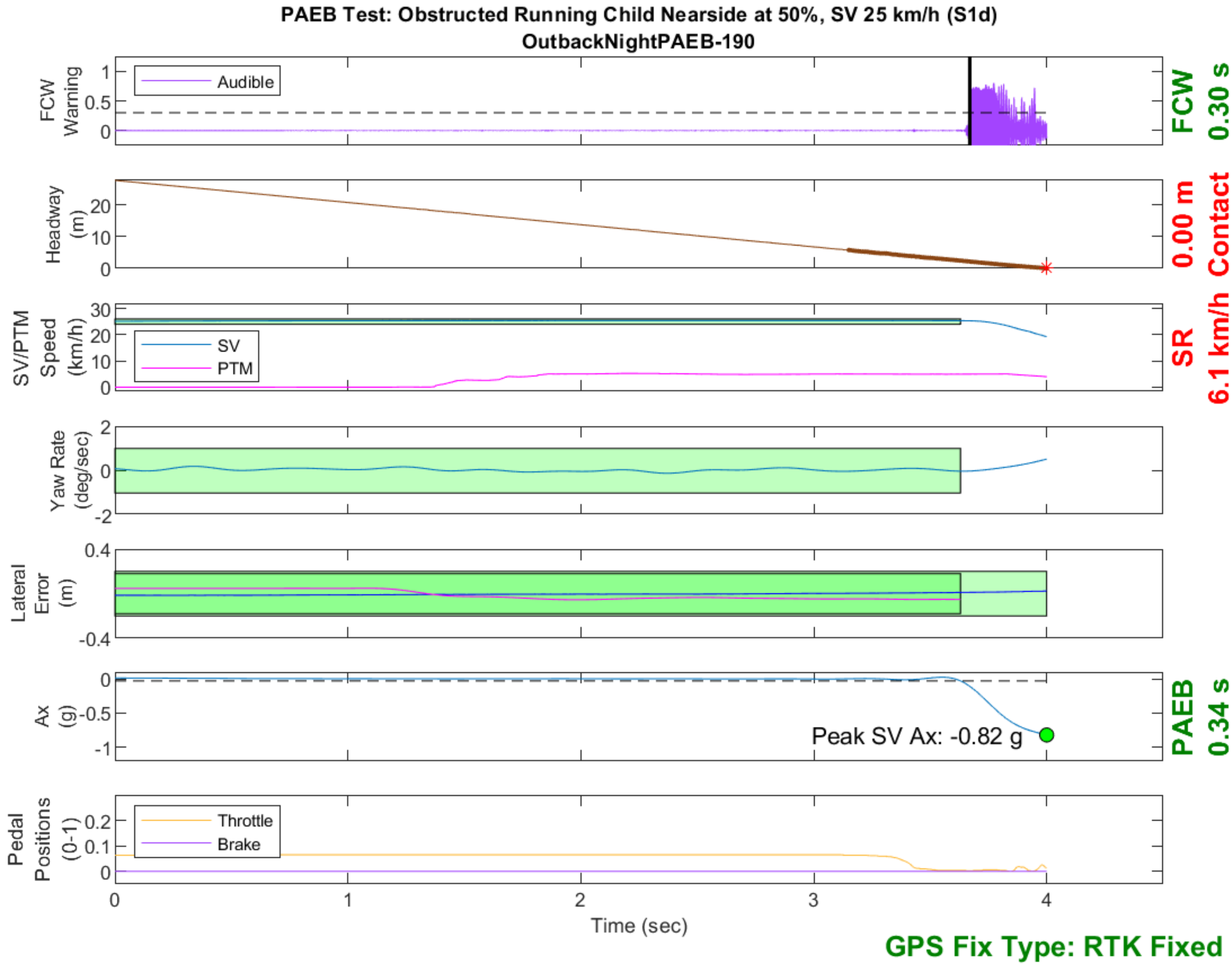


Figure D218. Time History for PAEB Run 190, S1d, Night, High Beam, 25 km/h

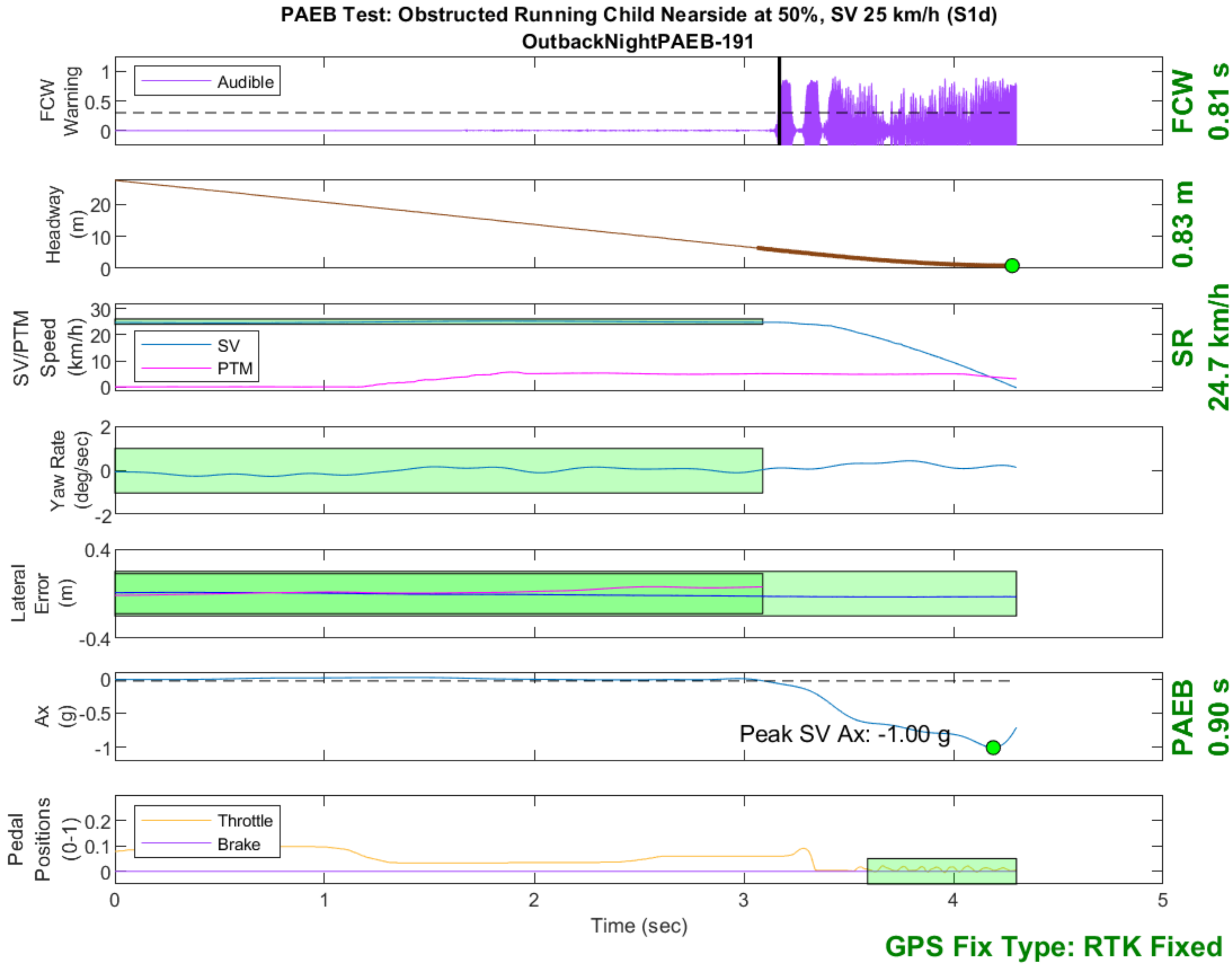


Figure D219. Time History for PAEB Run 191, S1d, Night, High Beam, 25 km/h

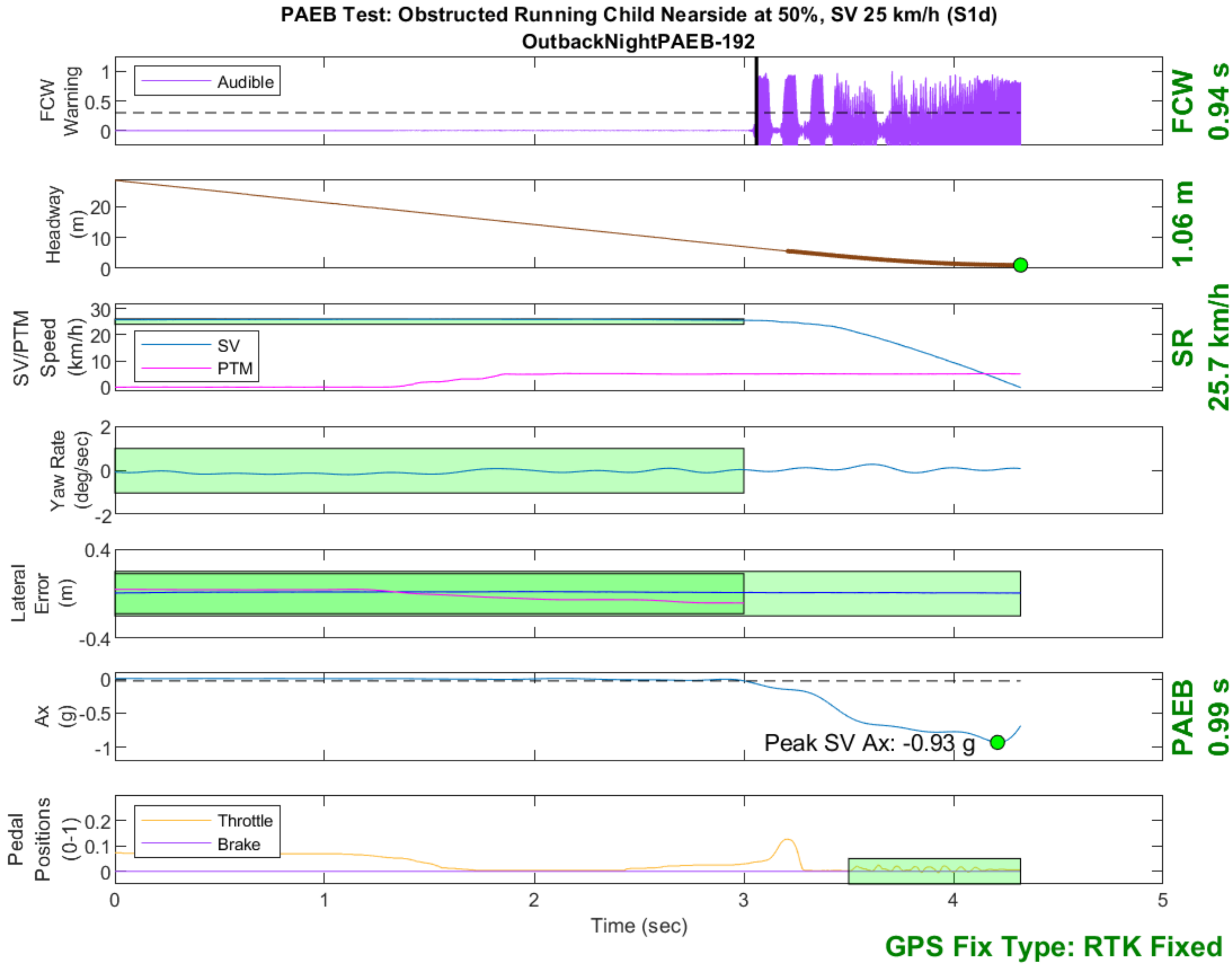


Figure D220. Time History for PAEB Run 192, S1d, Night, High Beam, 25 km/h

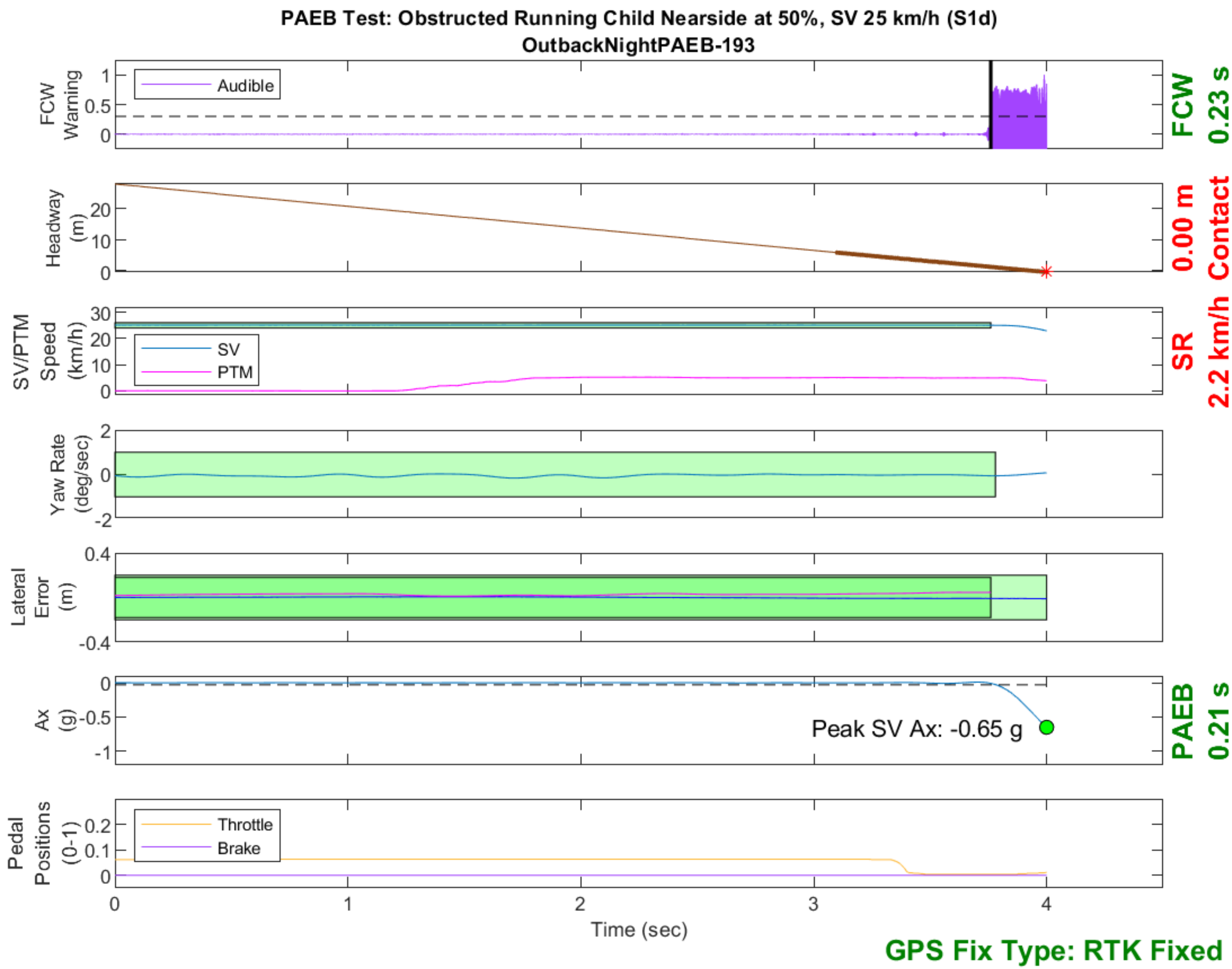


Figure D221. Time History for PAEB Run 193, S1d, Night, High Beam, 25 km/h

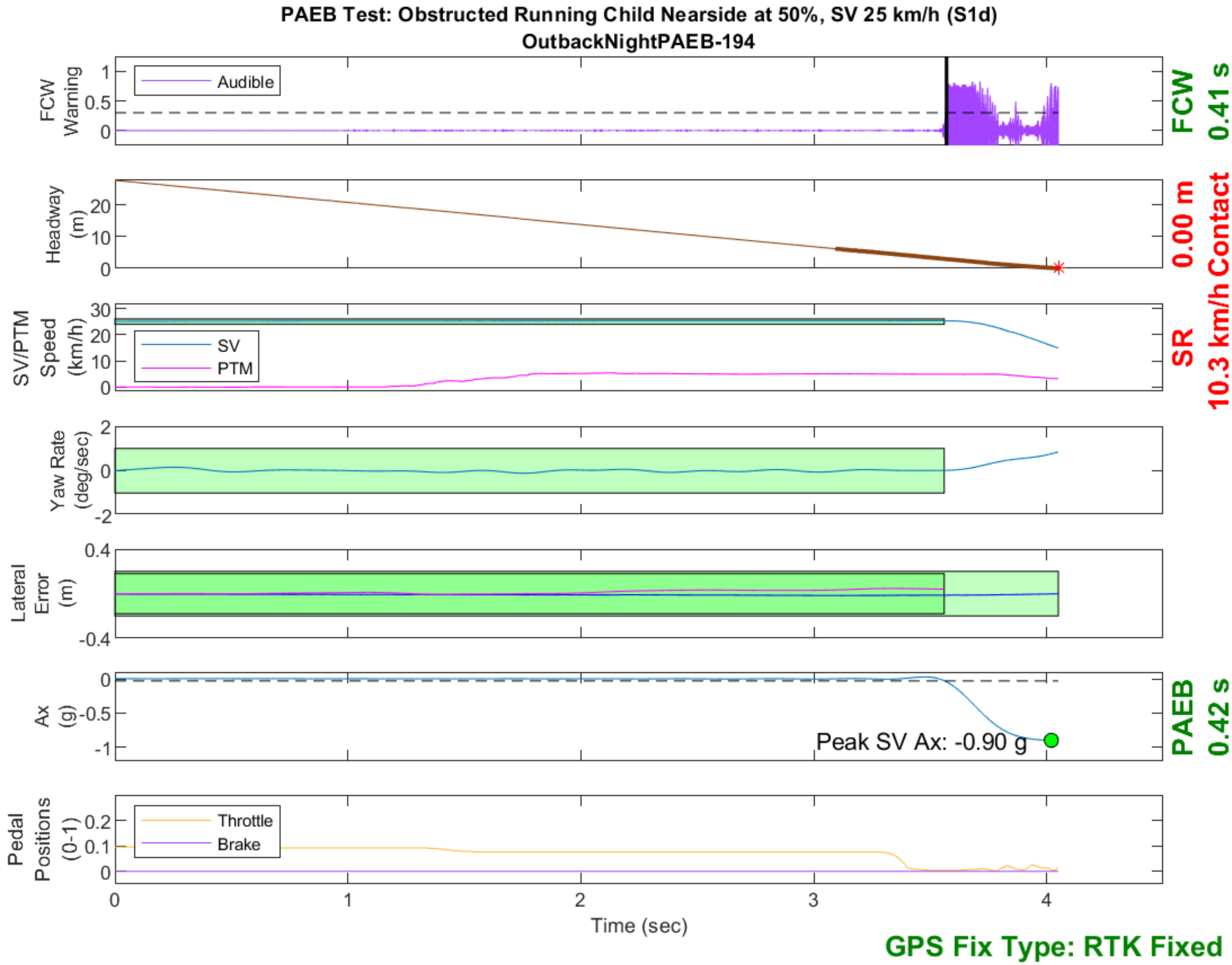


Figure D222. Time History for PAEB Run 194, S1d, Night, High Beam, 25 km/h

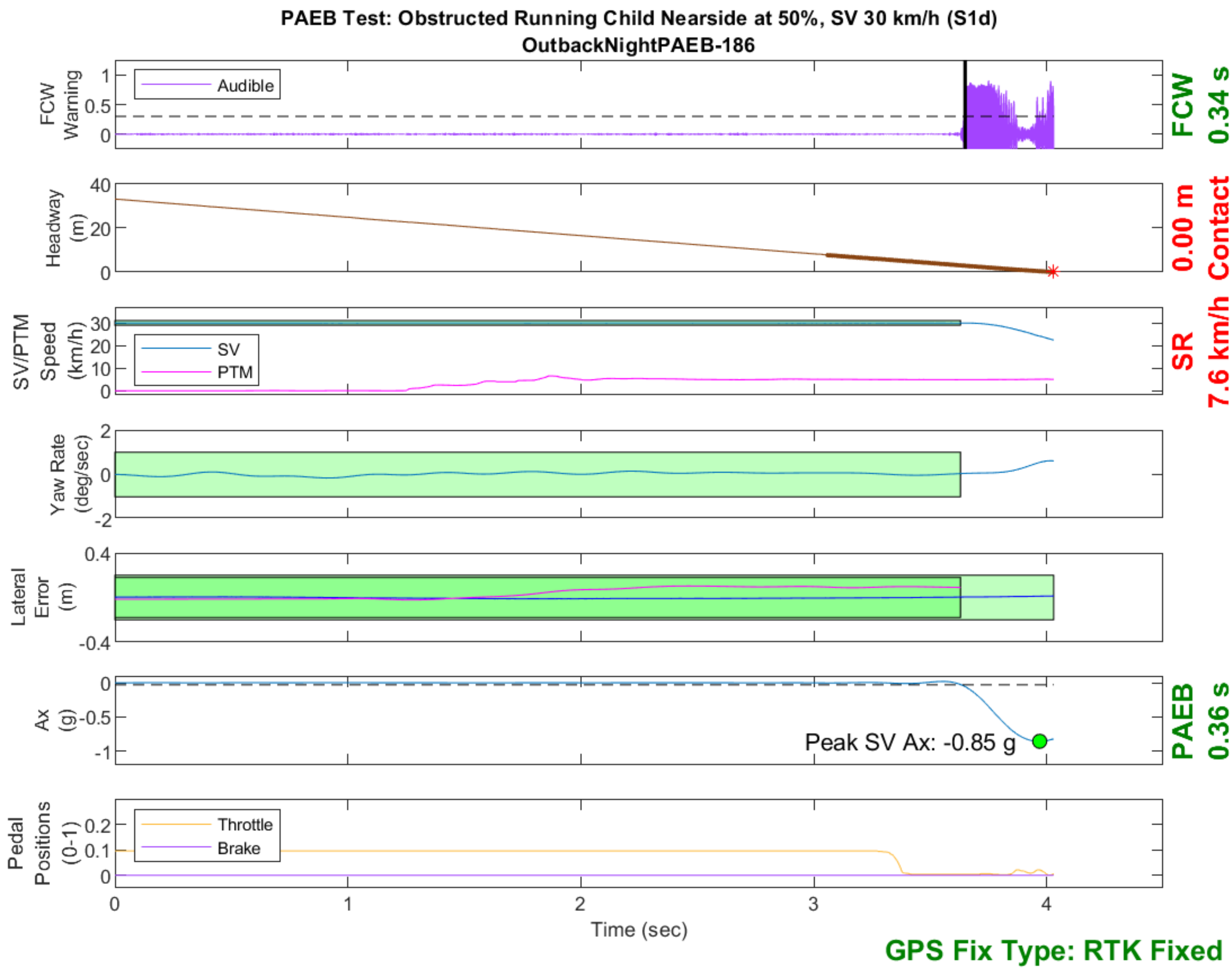


Figure D223. Time History for PAEB Run 186, S1d, Night, High Beam, 30 km/h

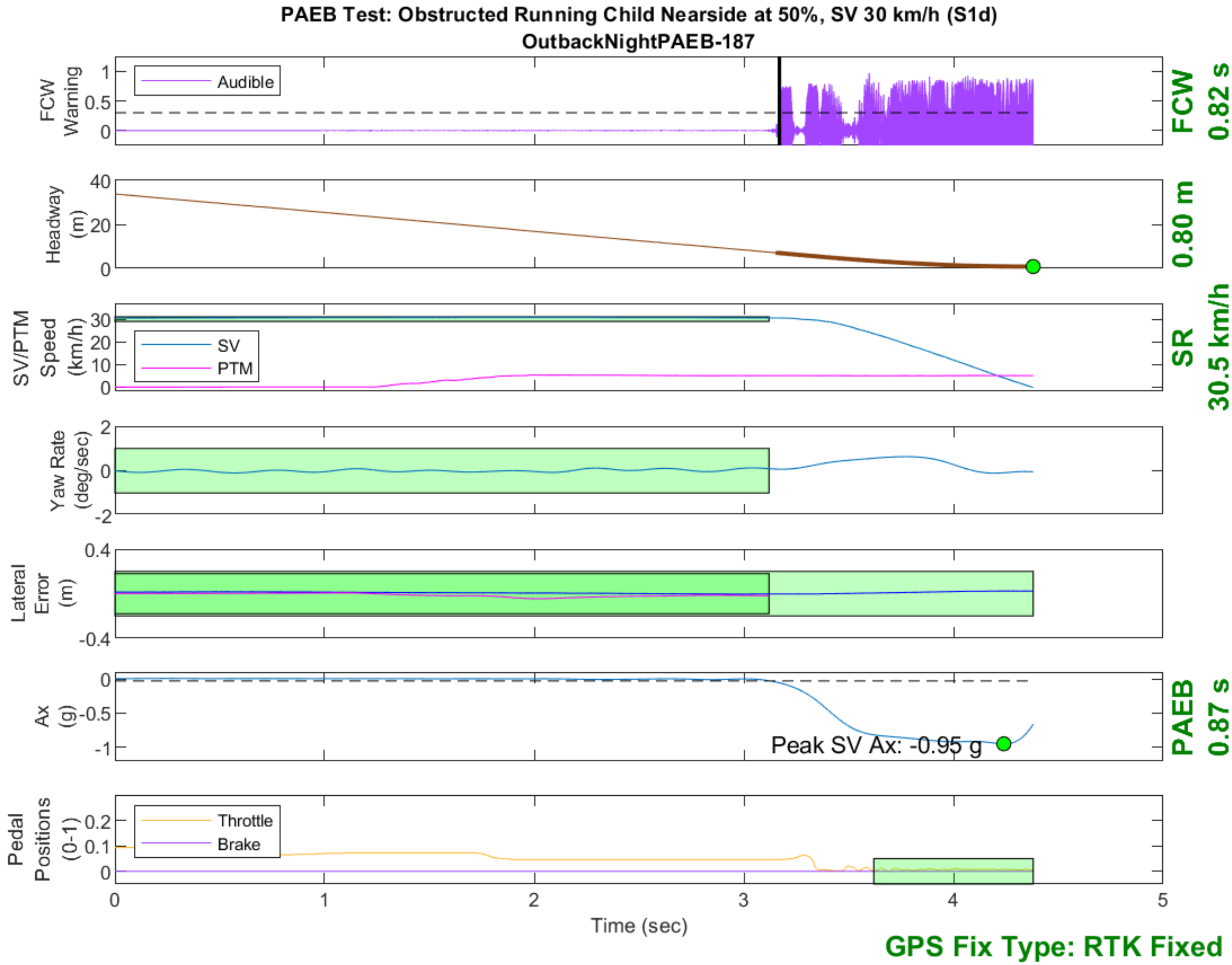


Figure D224. Time History for PAEB Run 187, S1d, Night, High Beam, 30 km/h

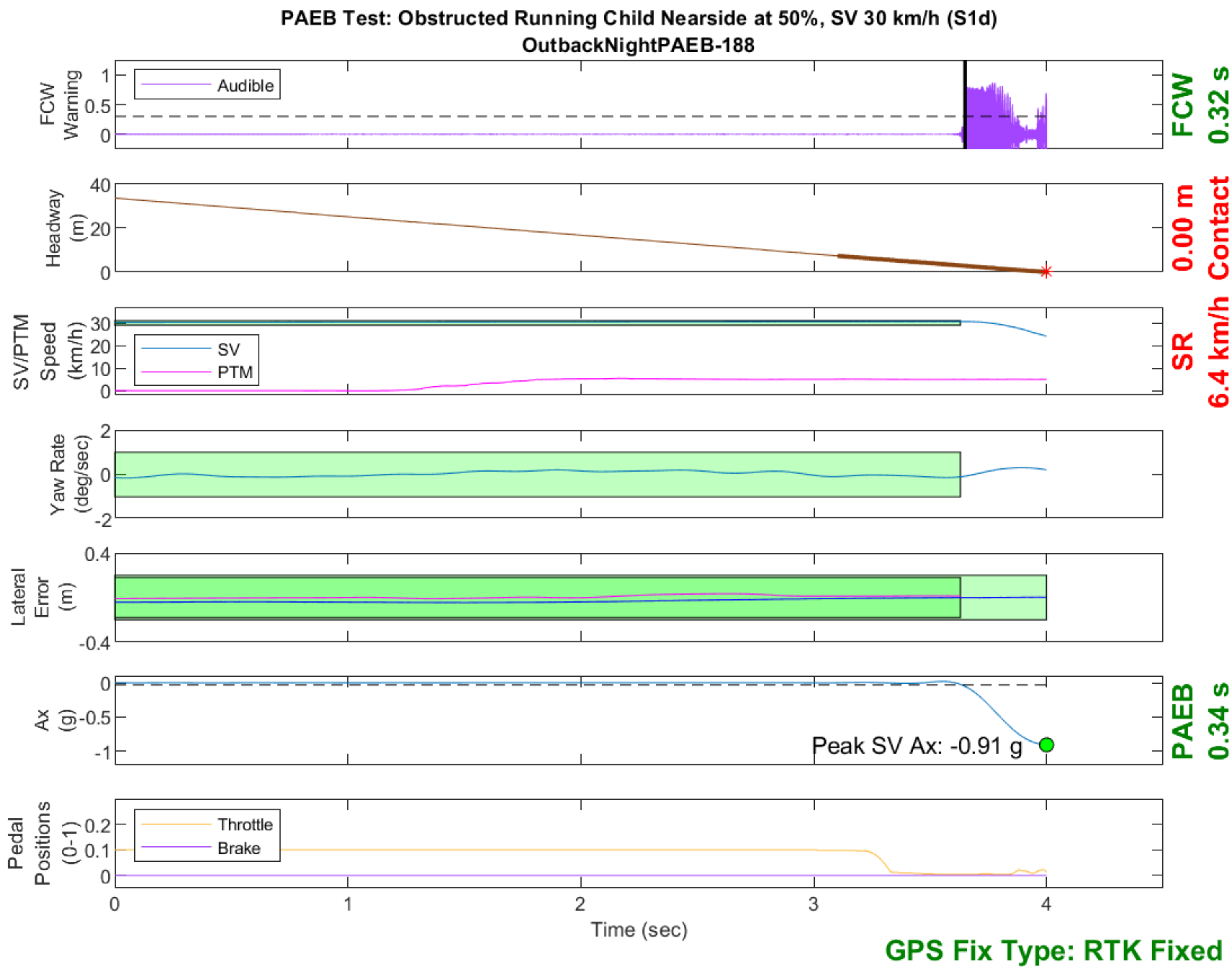


Figure D225. Time History for PAEB Run 188, S1d, Night, High Beam, 30 km/h

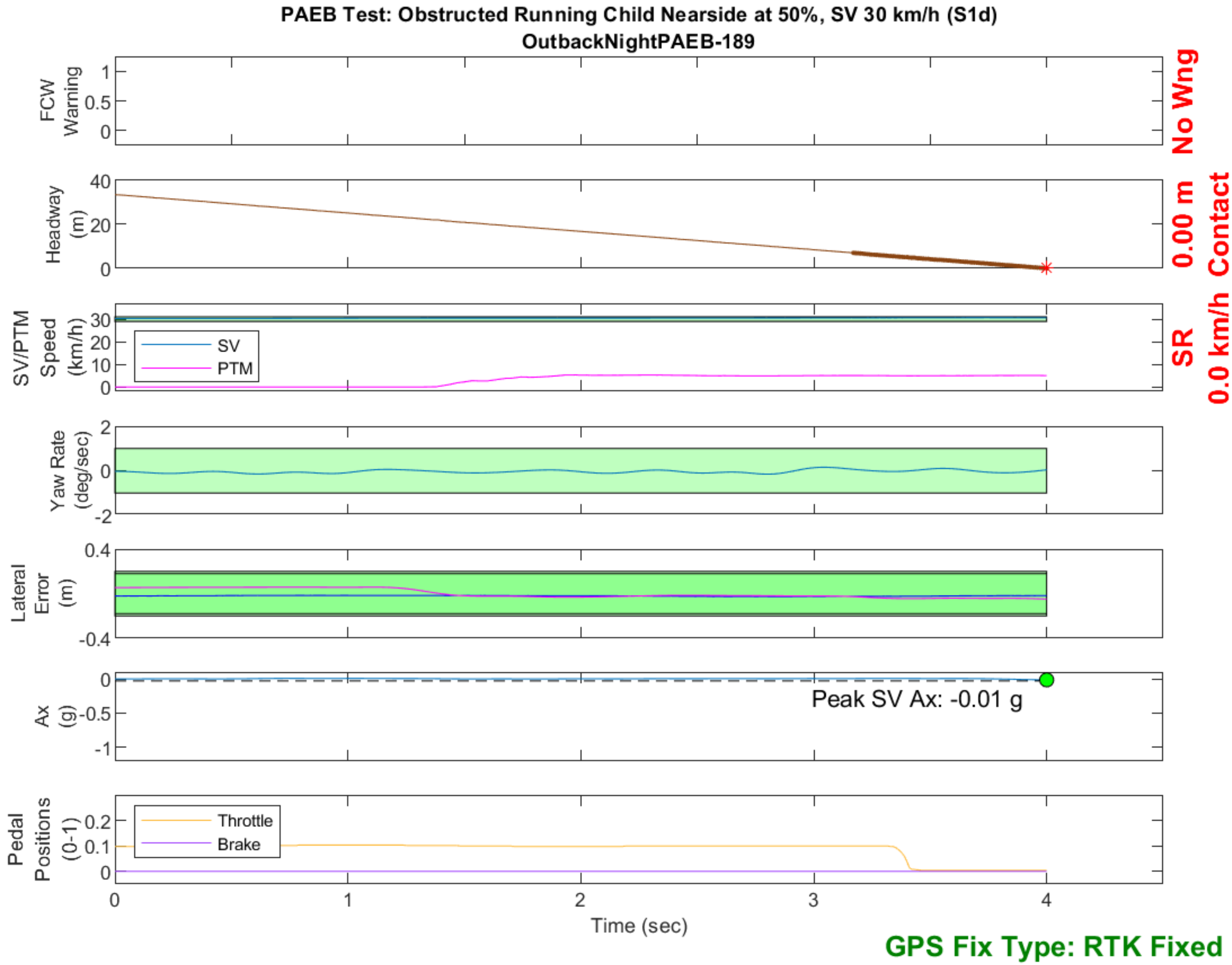


Figure D226. Time History for PAEB Run 189, S1d, Night, High Beam, 30 km/h

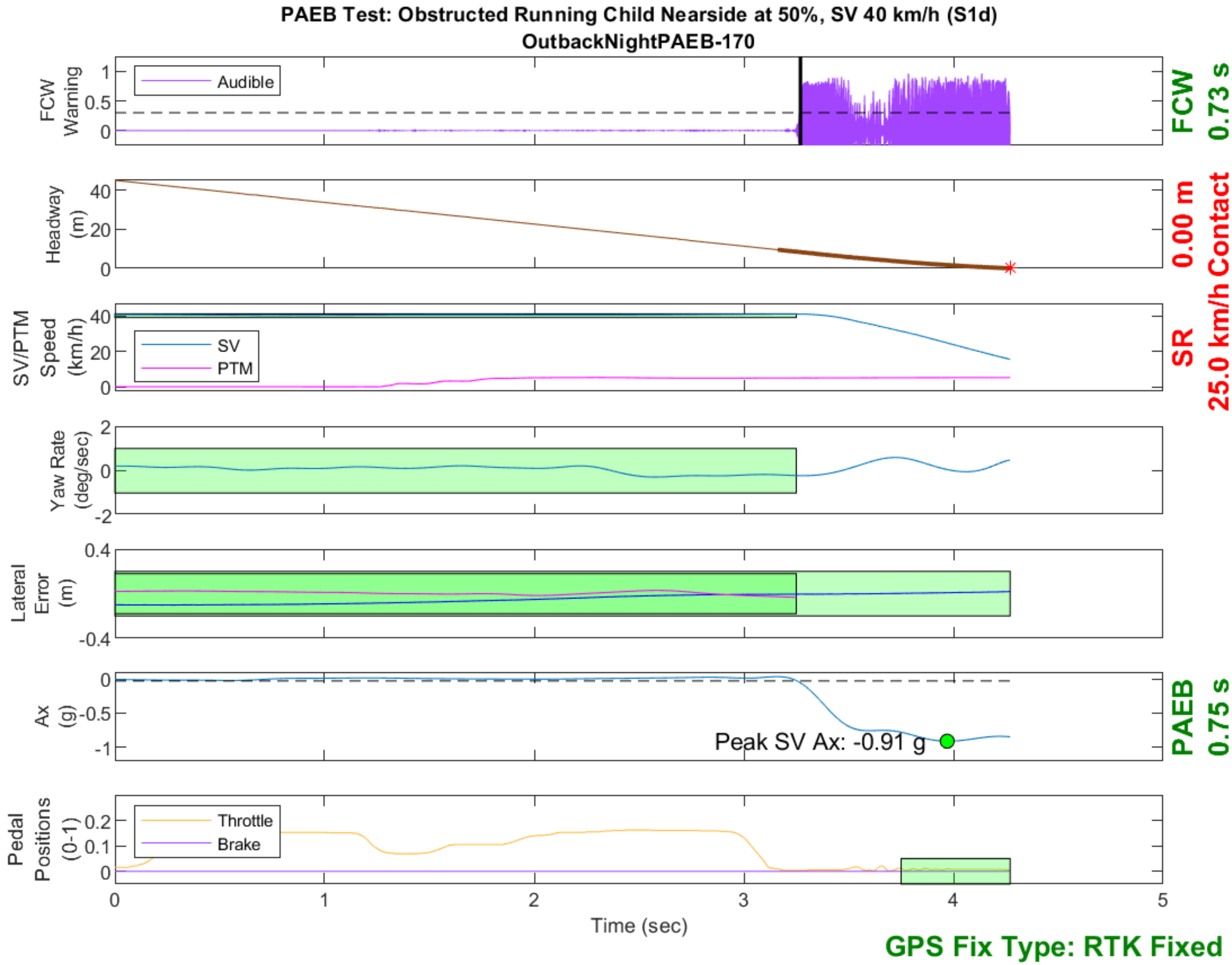


Figure D227. Time History for PAEB Run 170, S1d, Night, High Beam, 40 km/h

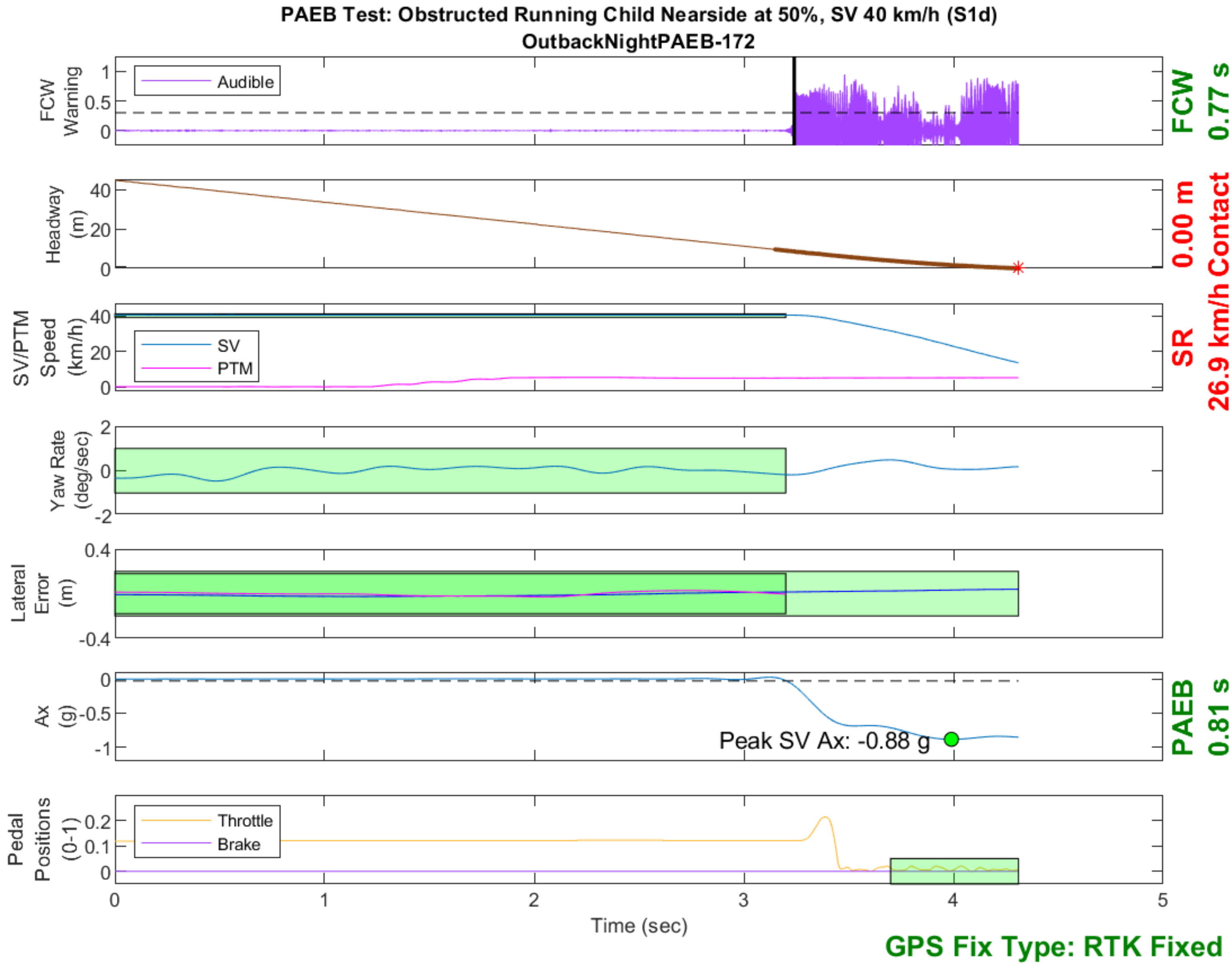


Figure D228. Time History for PAEB Run 172, S1d, Night, High Beam, 40 km/h

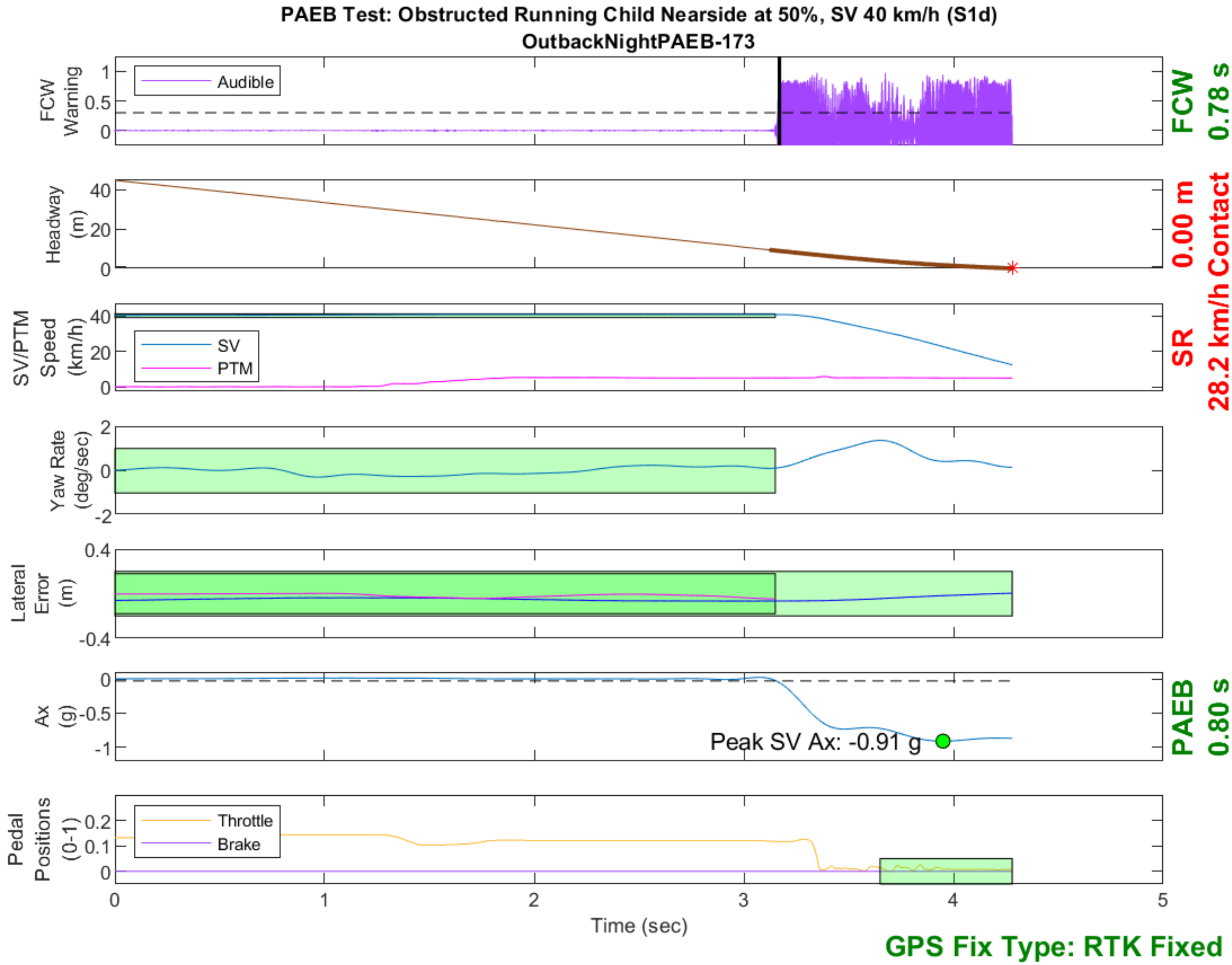


Figure D229. Time History for PAEB Run 173, S1d, Night, High Beam, 40 km/h

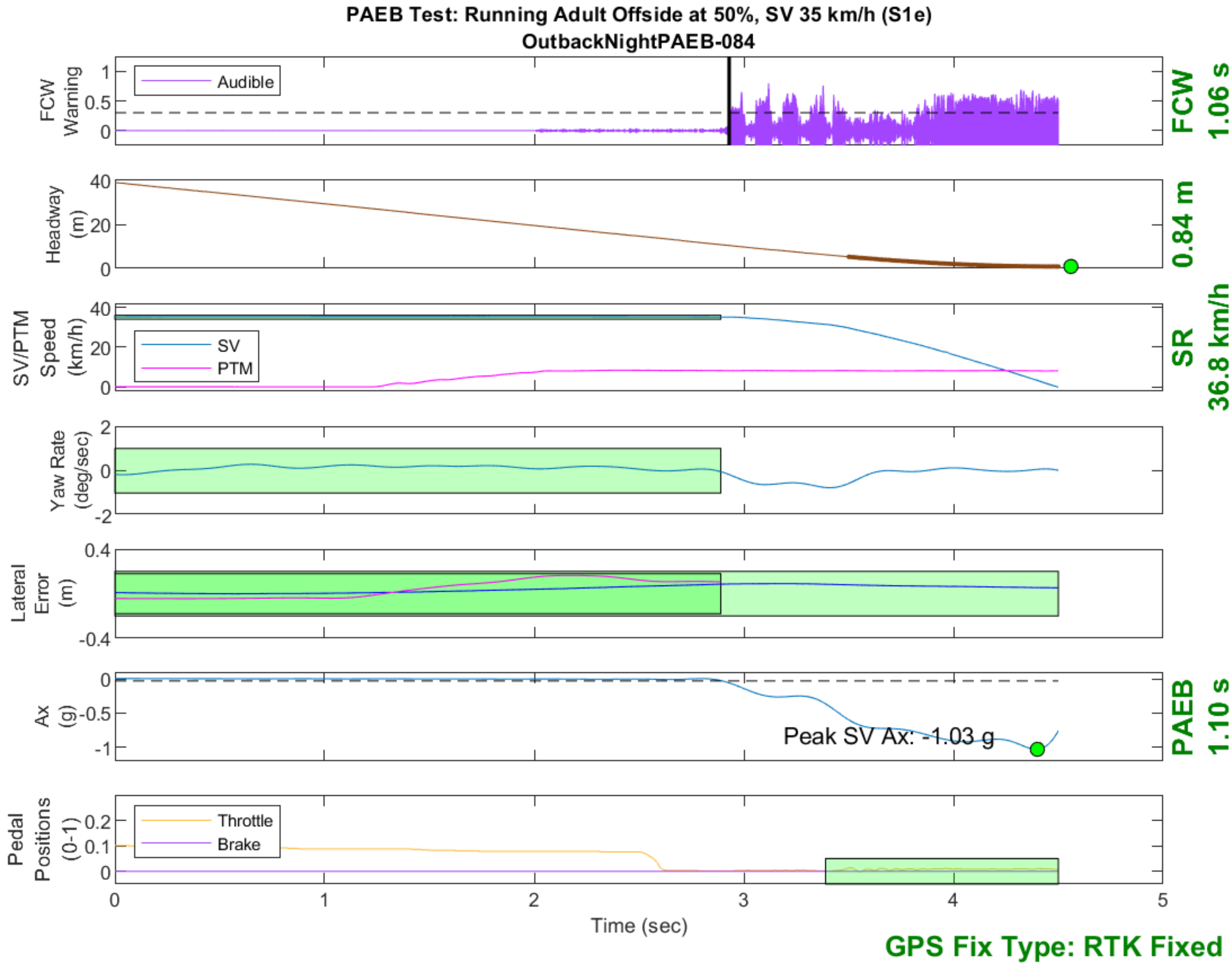


Figure D230. Time History for PAEB Run 84, S1e, Night, High Beam, 35 km/h

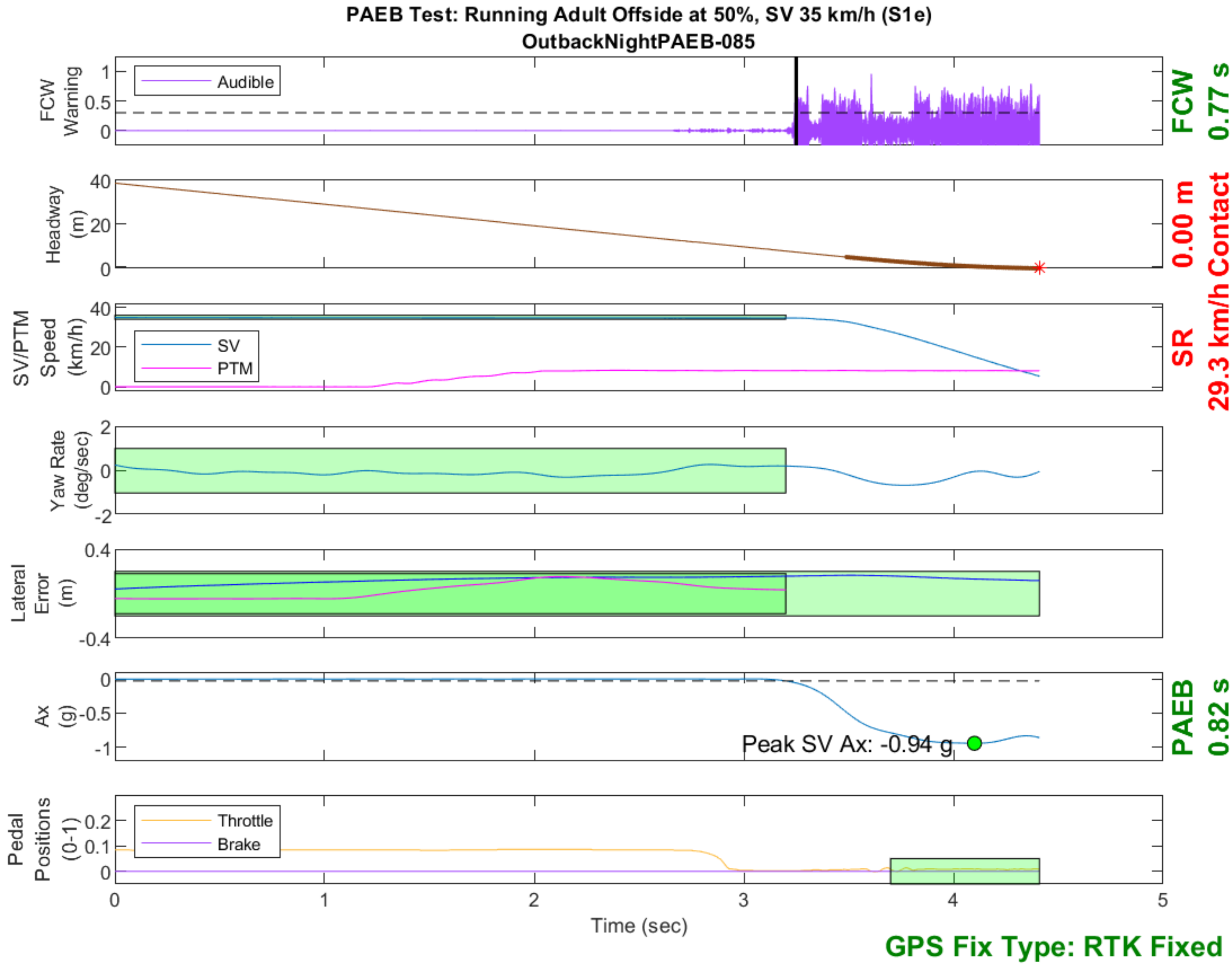


Figure D231. Time History for PAEB Run 85, S1e, Night, High Beam, 35 km/h

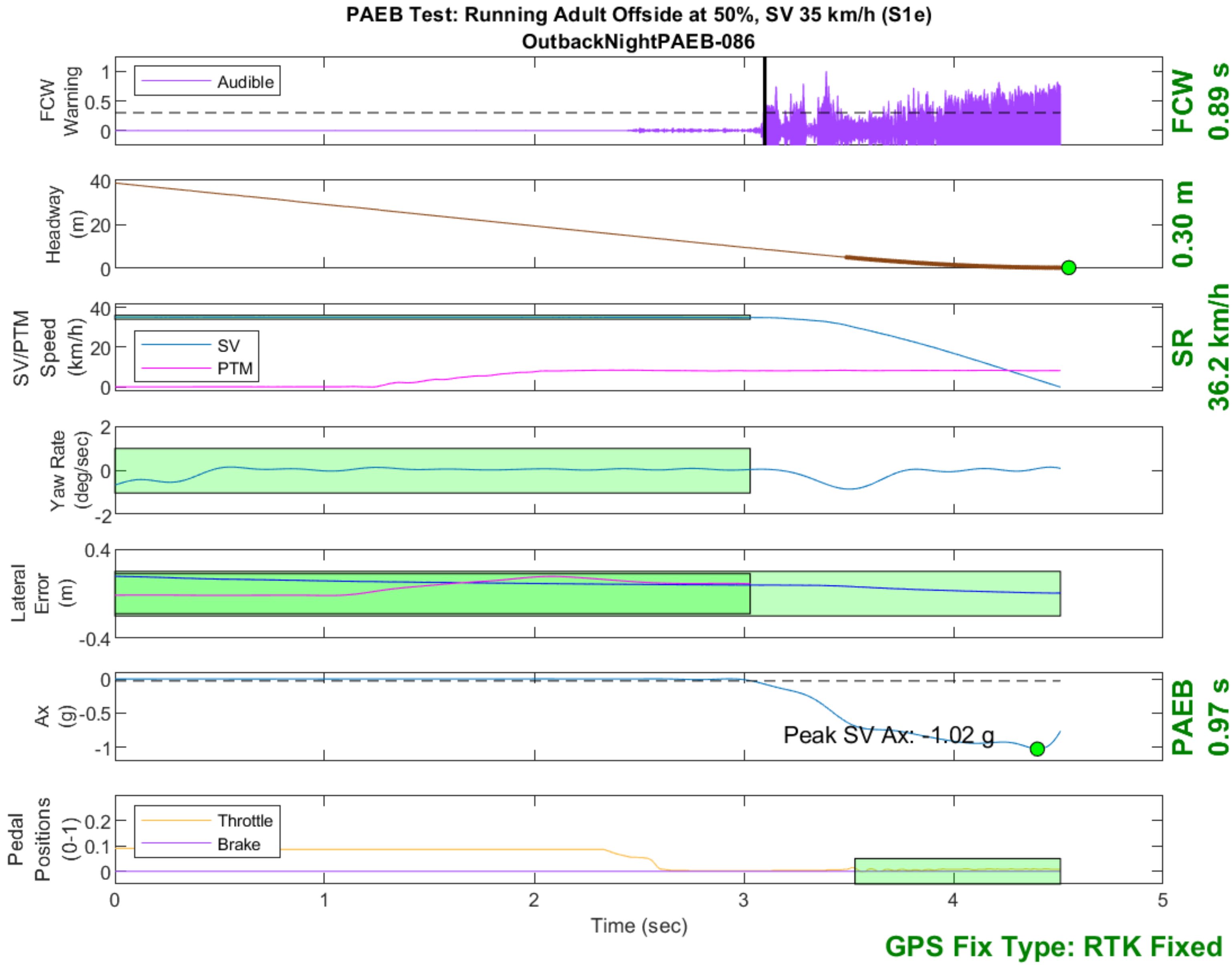


Figure D232. Time History for PAEB Run 86, S1e, Night, High Beam, 35 km/h

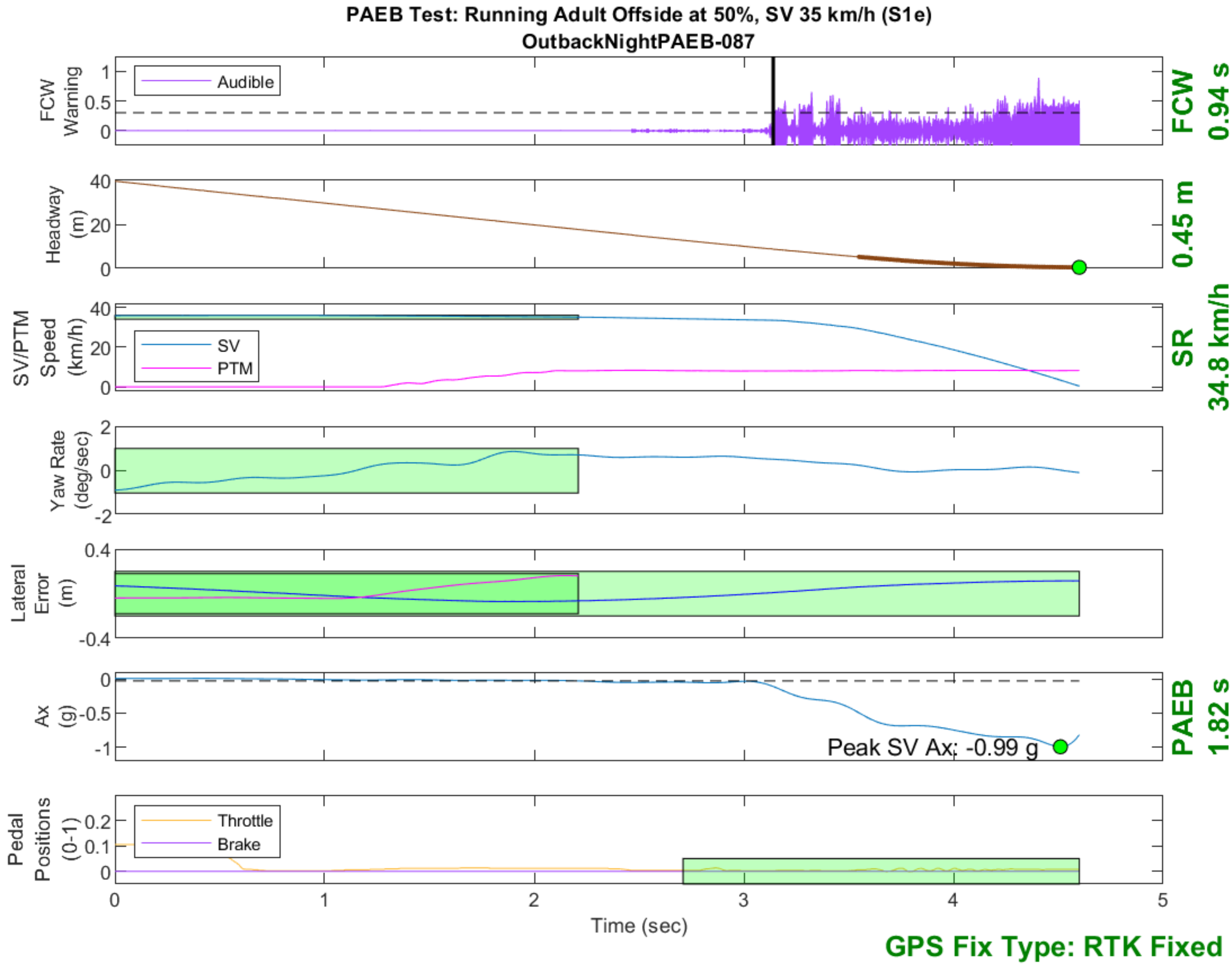


Figure D233. Time History for PAEB Run 87, S1e, Night, High Beam, 35 km/h

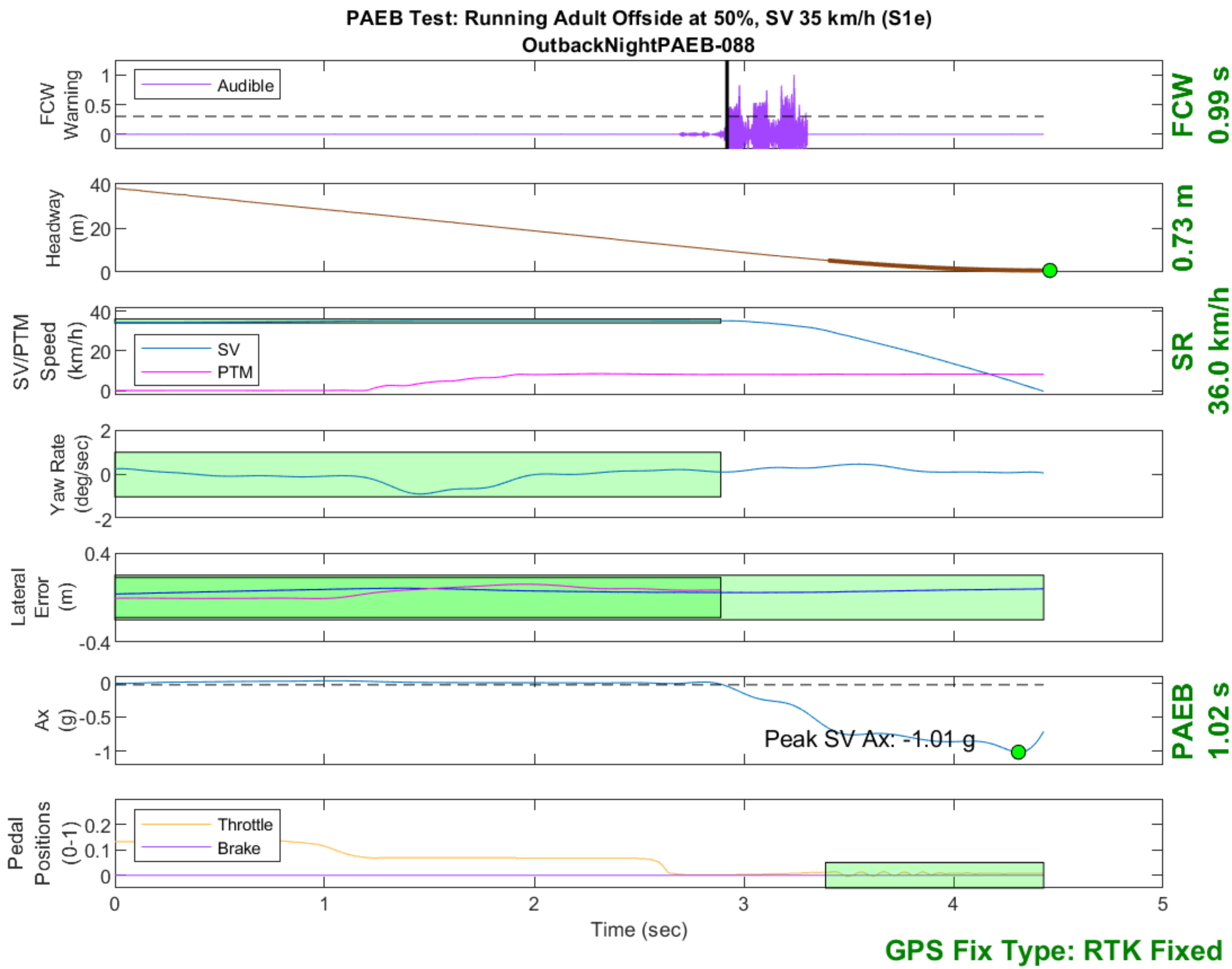


Figure D234. Time History for PAEB Run 88, S1e, Night, High Beam, 35 km/h

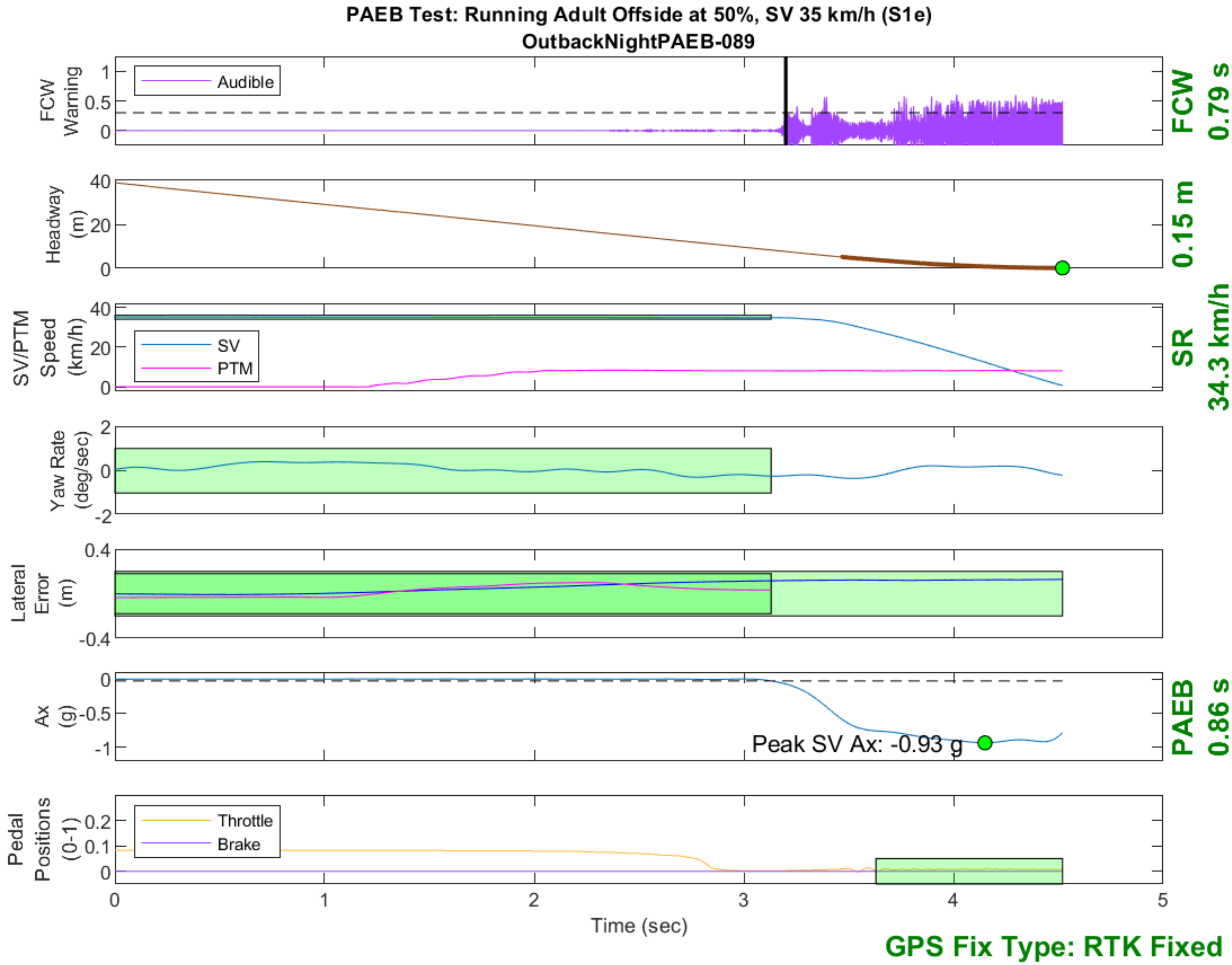


Figure D235. Time History for PAEB Run 89, S1e, Night, High Beam, 35 km/h

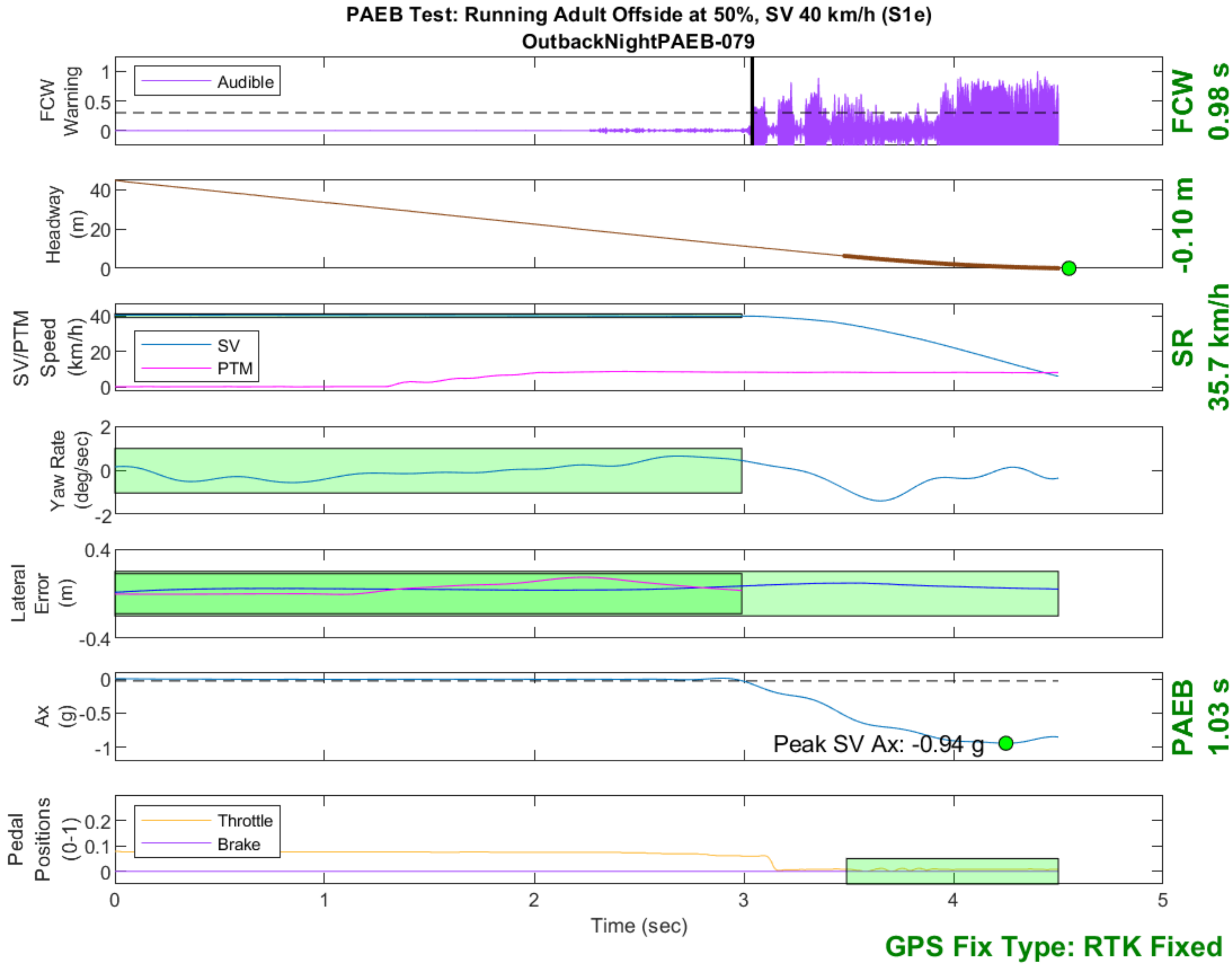


Figure D236. Time History for PAEB Run 79, S1e, Night, High Beam, 40 km/h

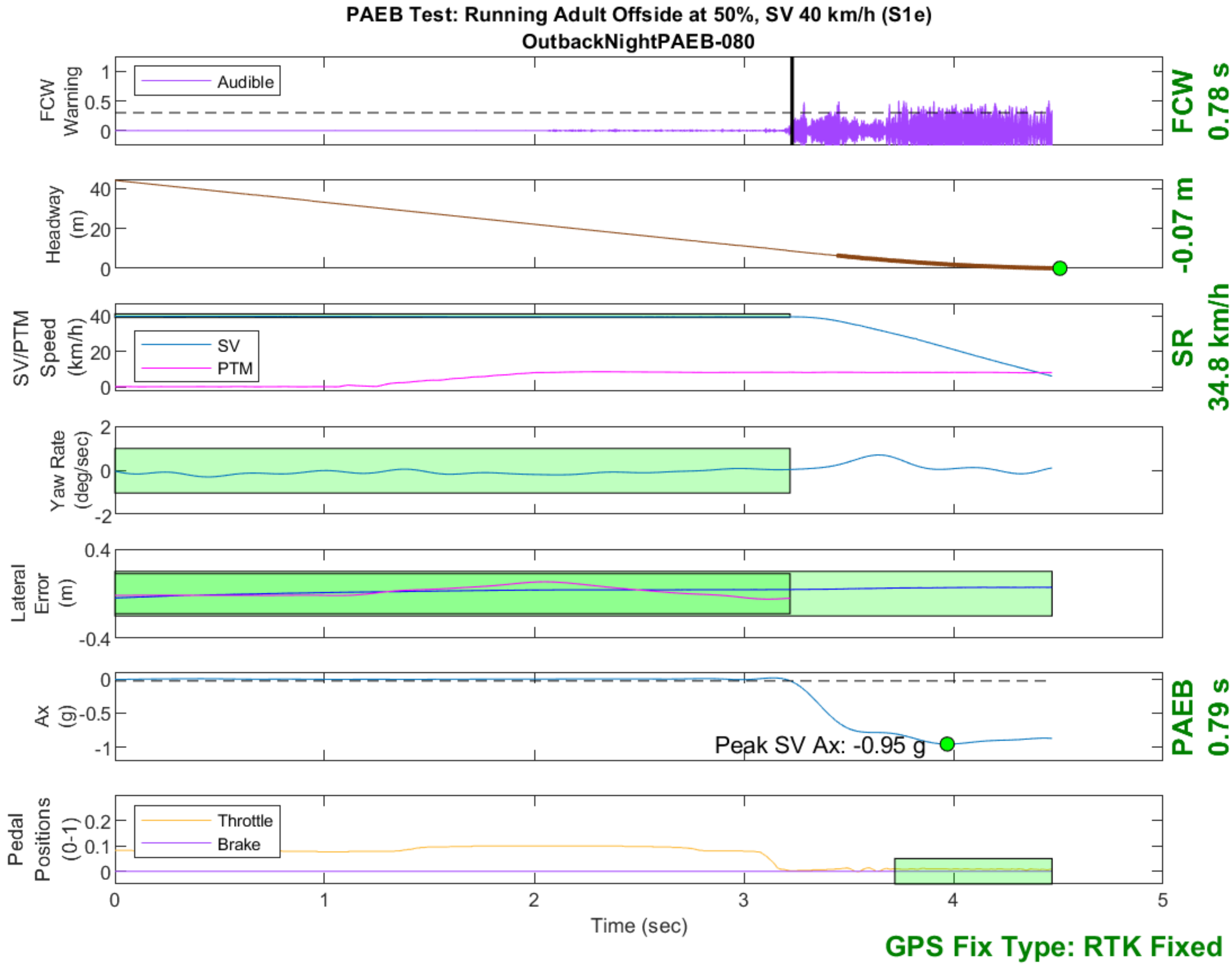


Figure D237. Time History for PAEB Run 80, S1e, Night, High Beam, 40 km/h

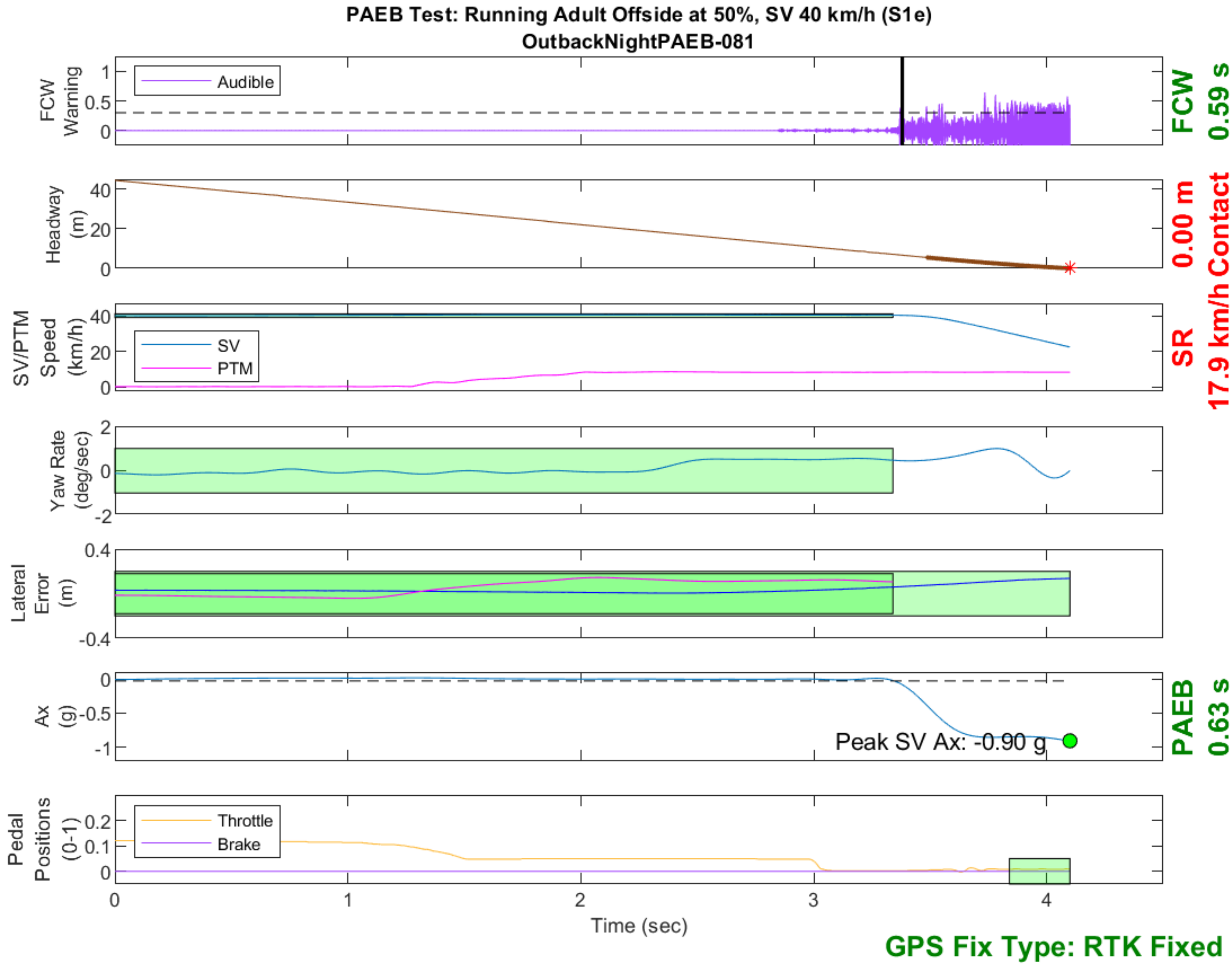


Figure D238. Time History for PAEB Run 81, S1e, Night, High Beam, 40 km/h

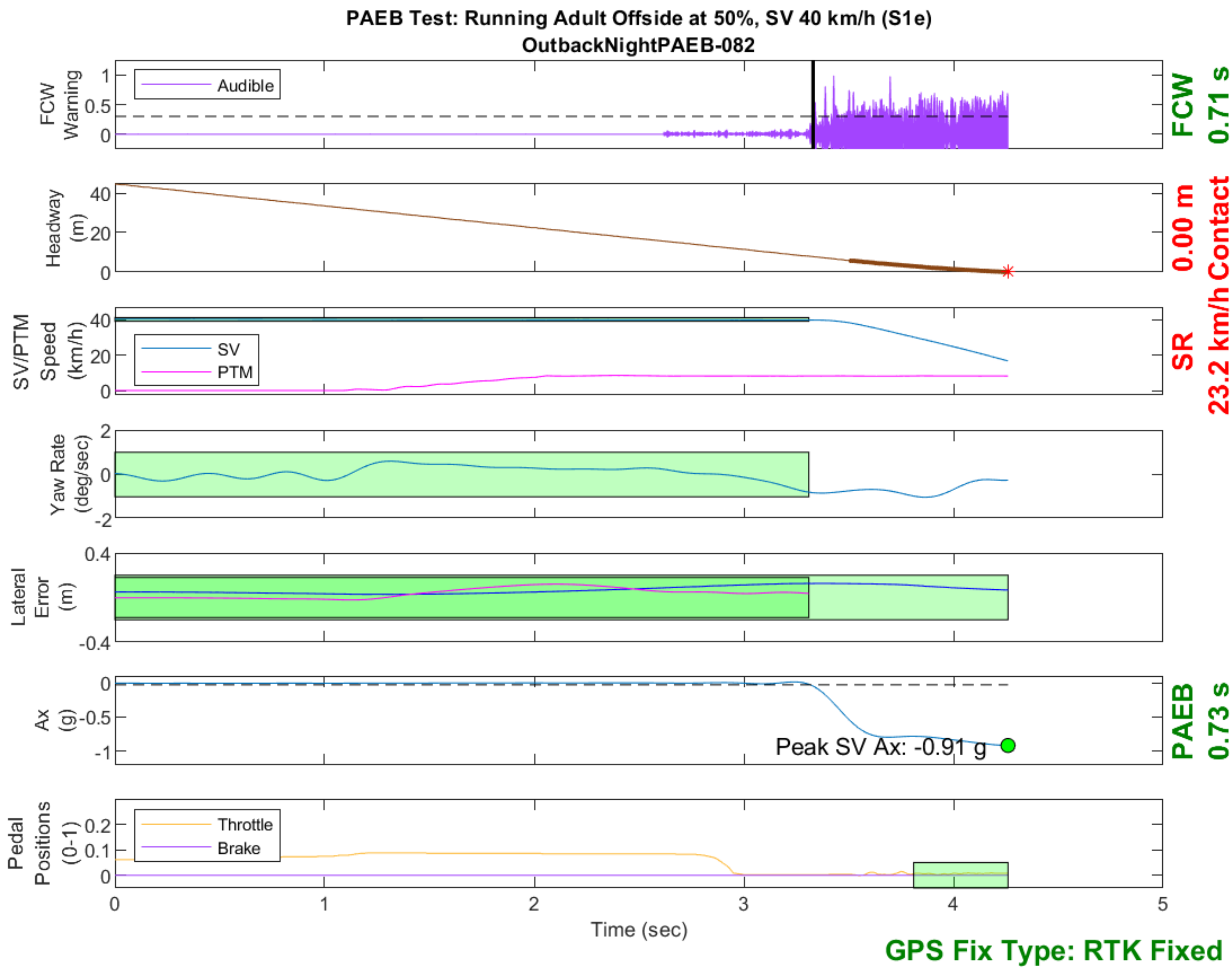


Figure D239. Time History for PAEB Run 82, S1e, Night, High Beam, 40 km/h

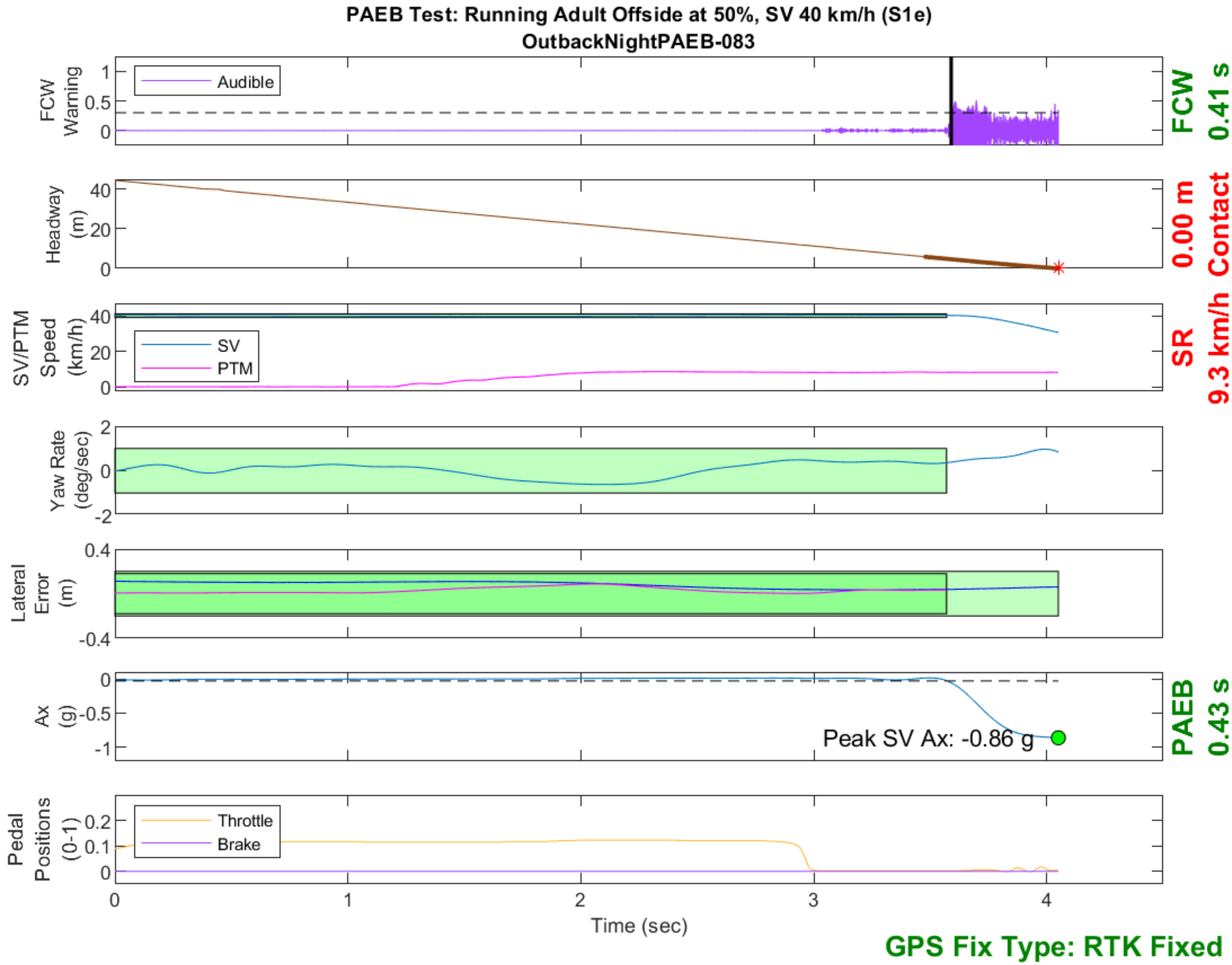


Figure D240. Time History for PAEB Run 83, S1e, Night, High Beam, 40 km/h

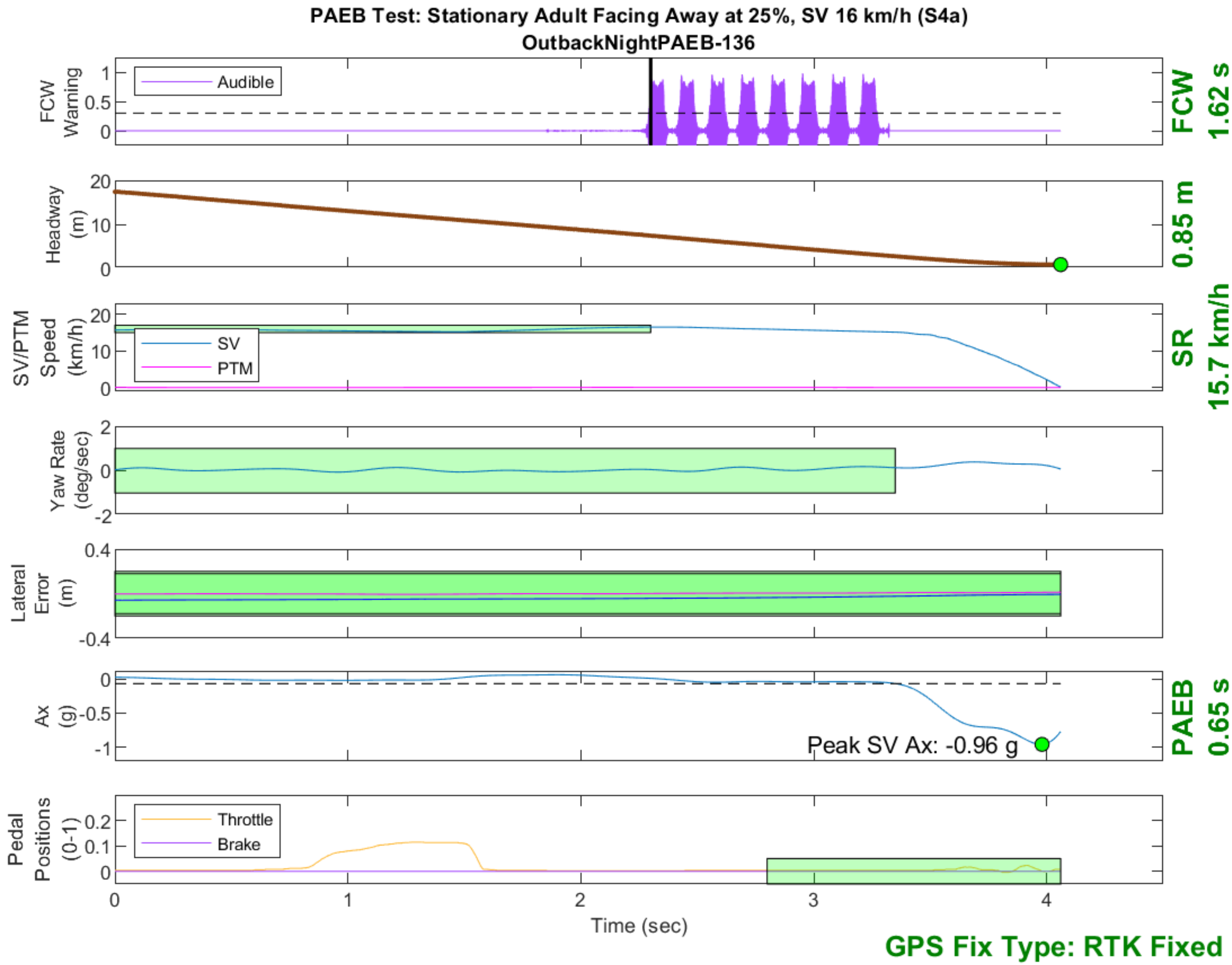


Figure D241. Time History for PAEB Run 136, S4a, Night, High Beam, 16 km/h

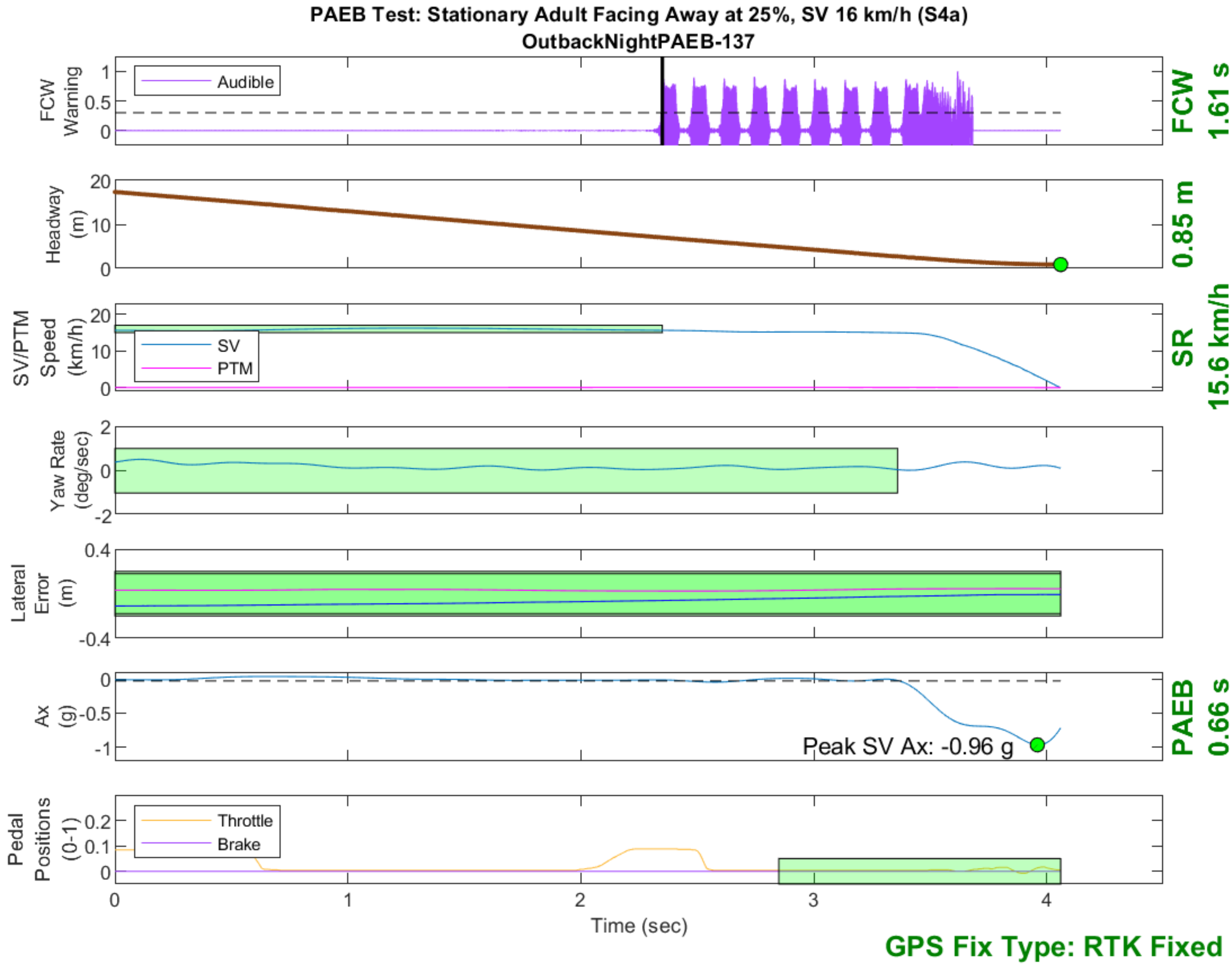


Figure D242. Time History for PAEB Run 137, S4a, Night, High Beam, 16 km/h

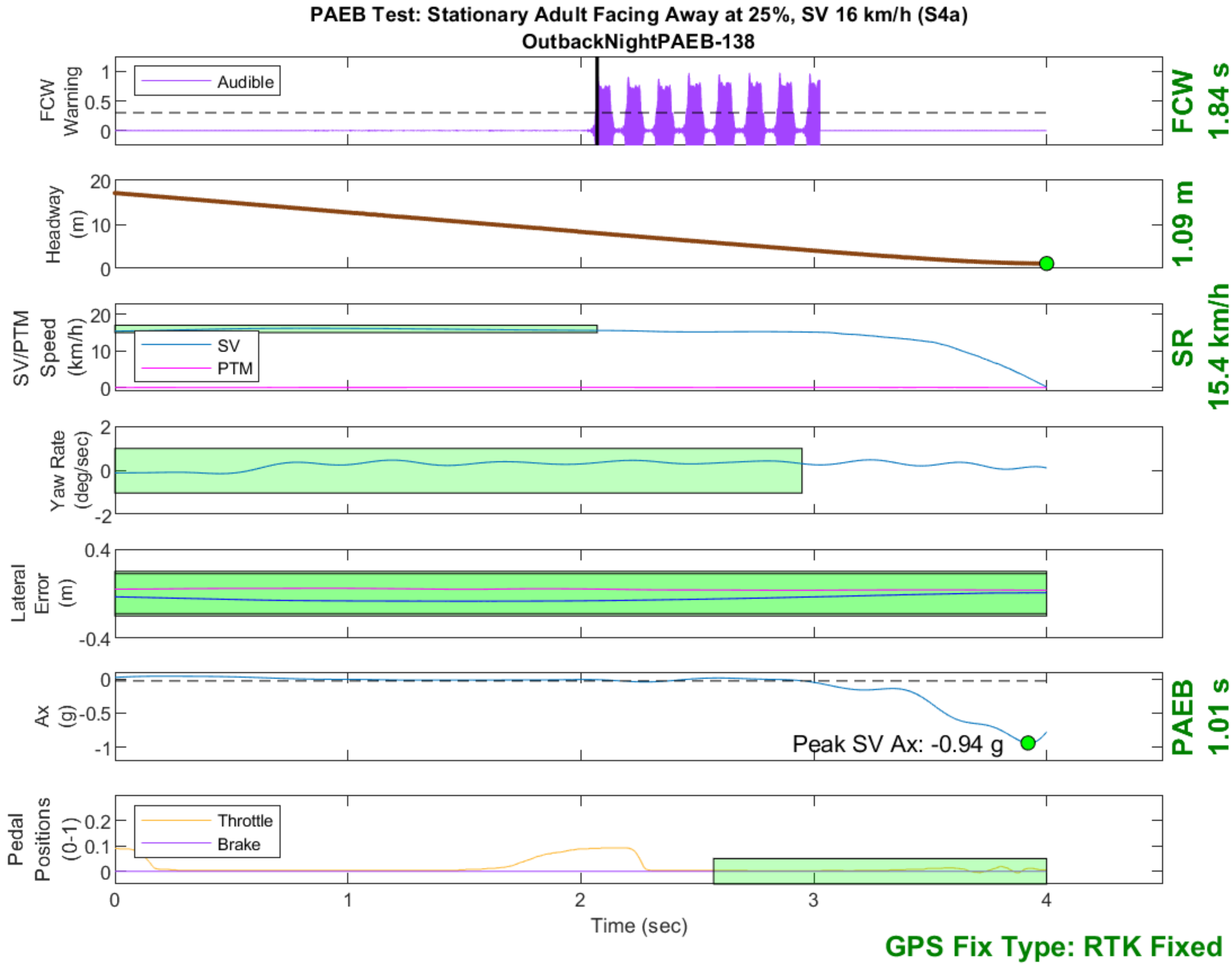


Figure D243. Time History for PAEB Run 138, S4a, Night, High Beam, 16 km/h

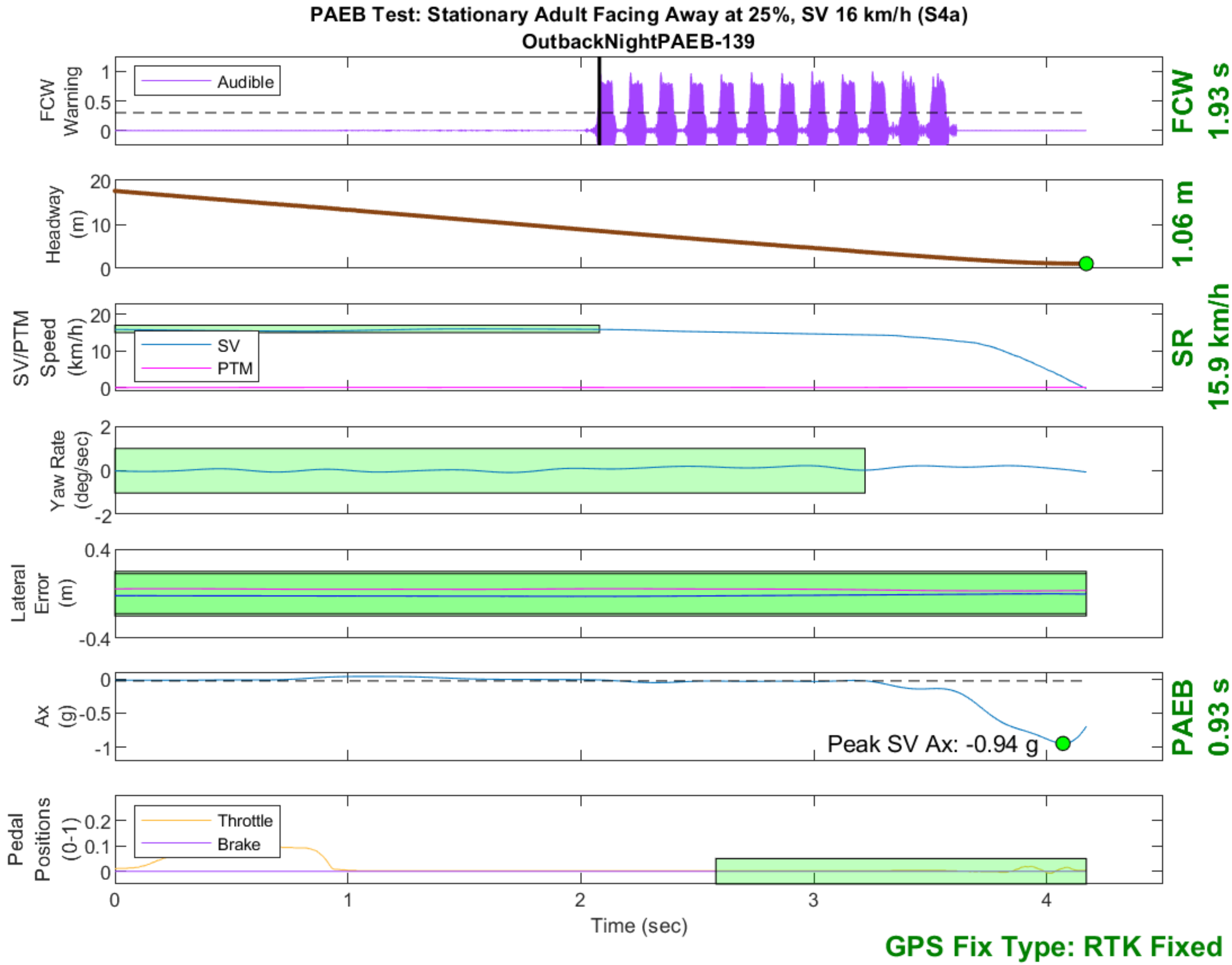


Figure D244. Time History for PAEB Run 139, S4a, Night, High Beam, 16 km/h

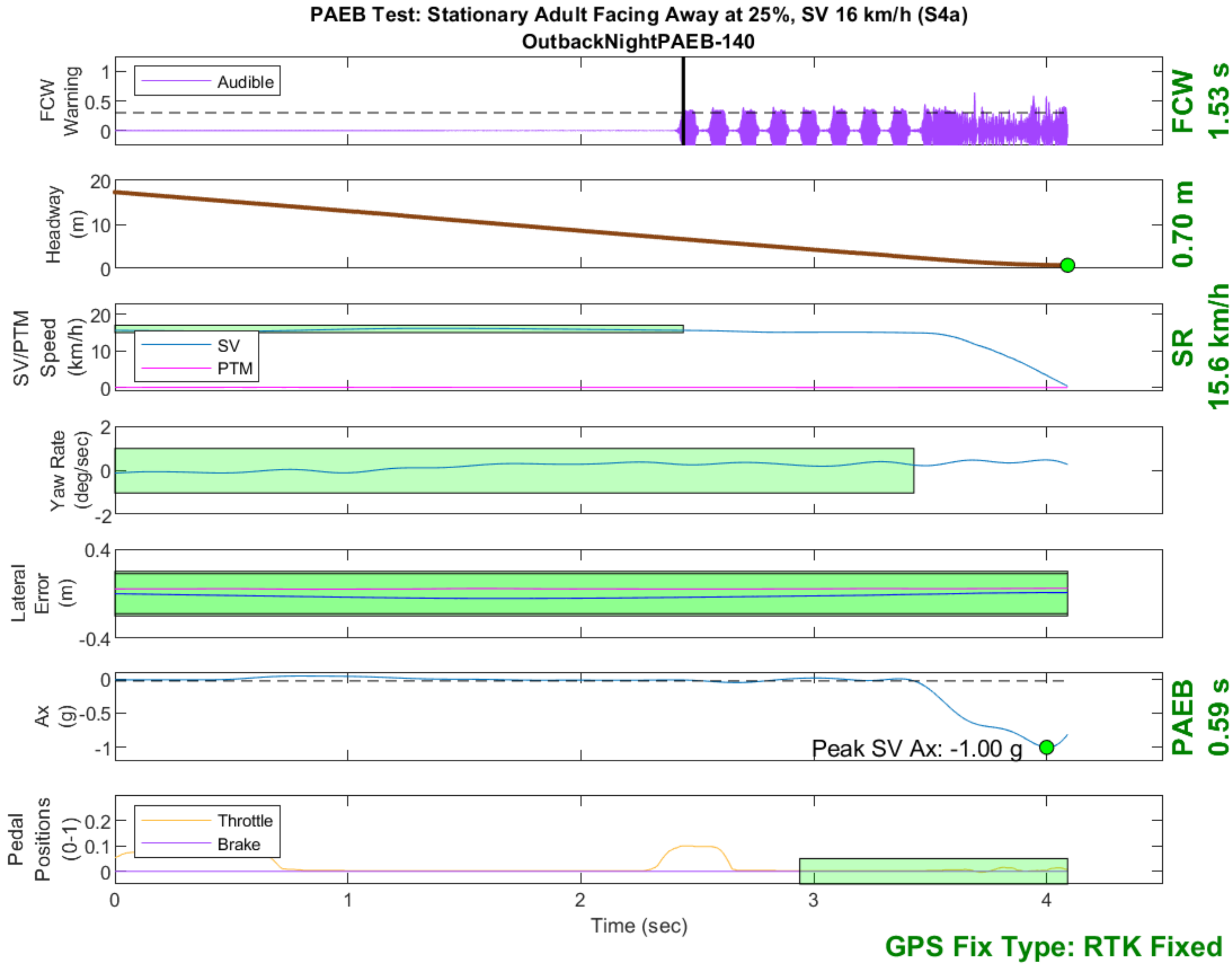


Figure D245. Time History for PAEB Run 140, S4a, Night, High Beam, 16 km/h

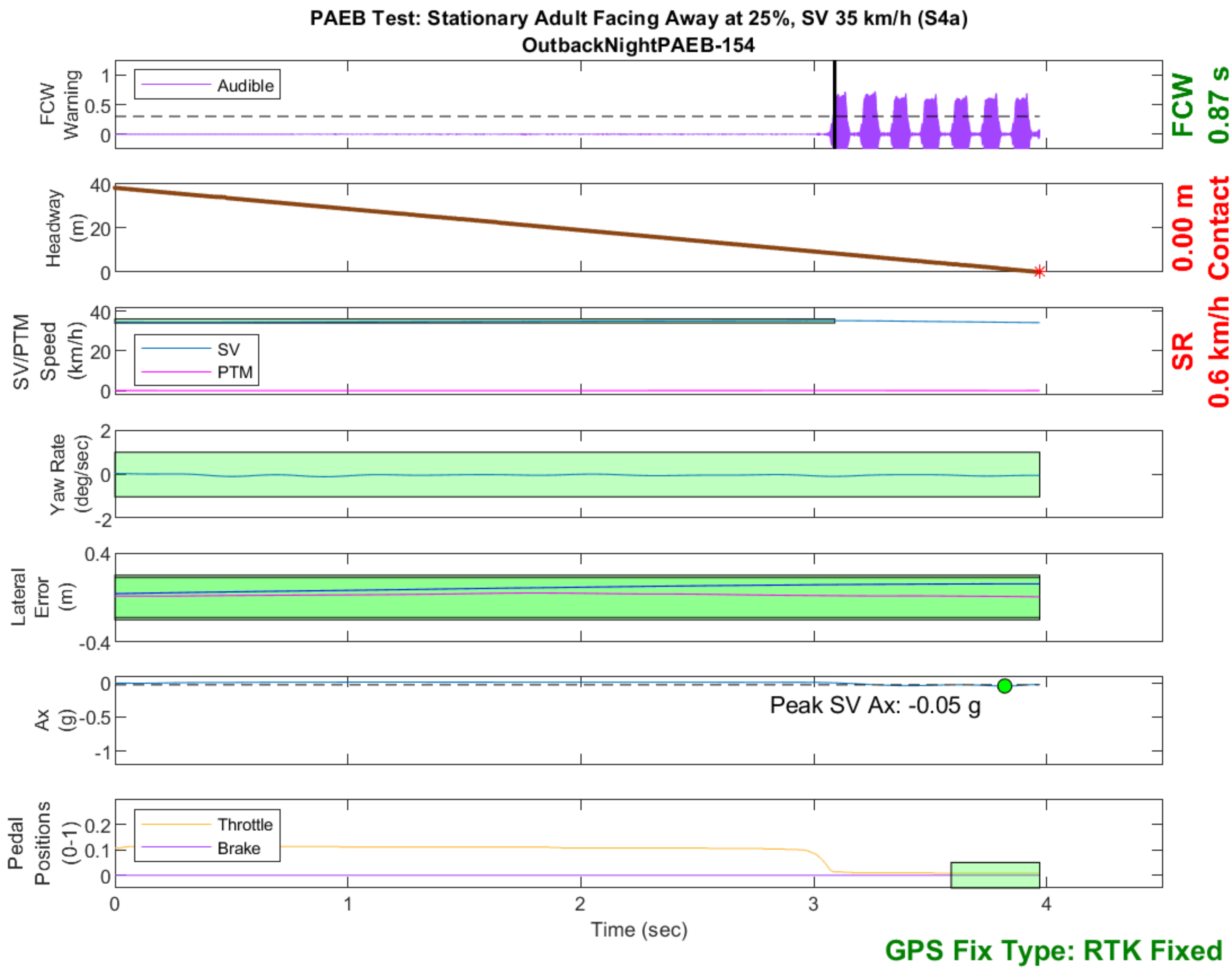


Figure D246. Time History for PAEB Run 154, S4a, Night, High Beam, 35 km/h

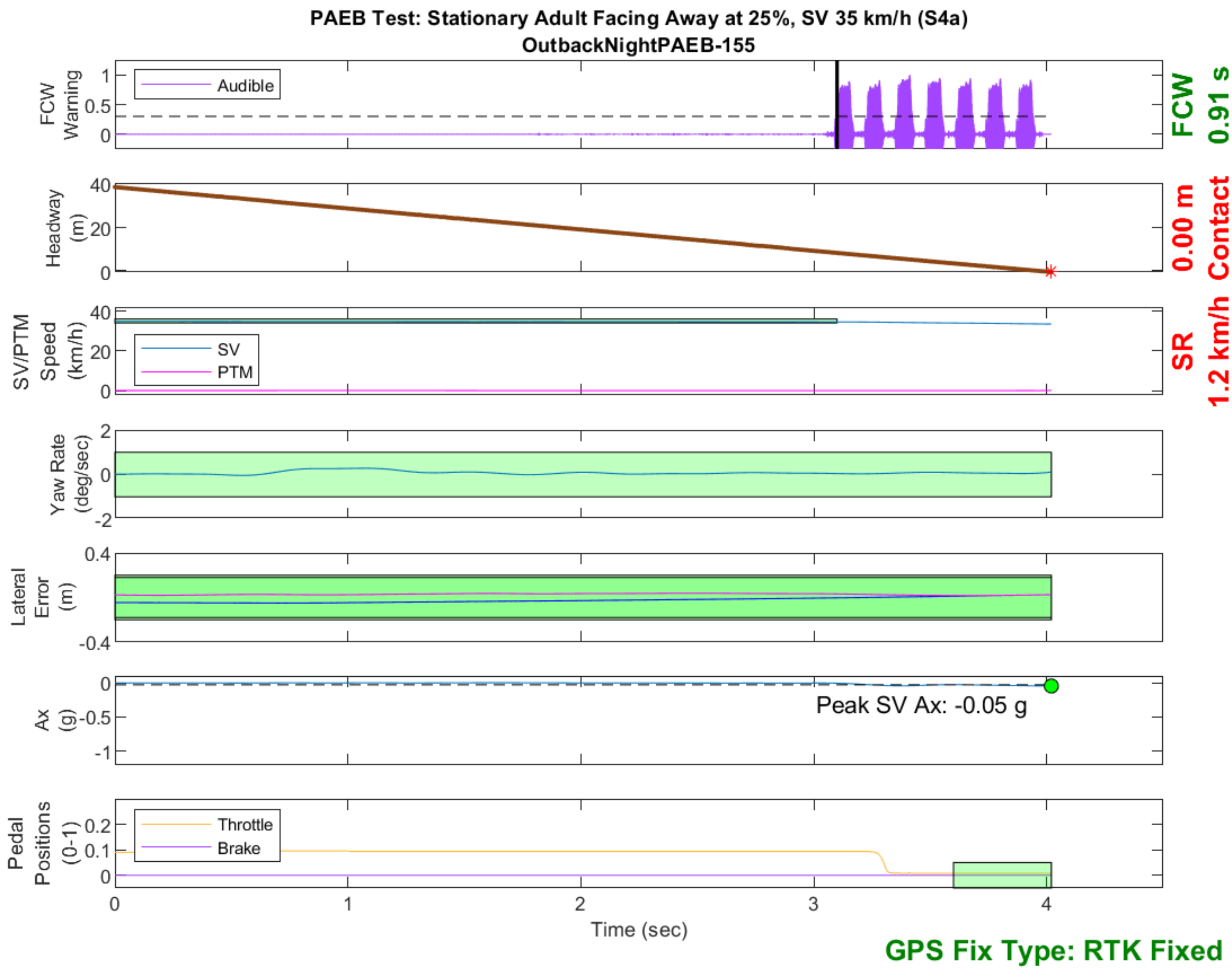


Figure D247. Time History for PAEB Run 155, S4a, Night, High Beam, 35 km/h

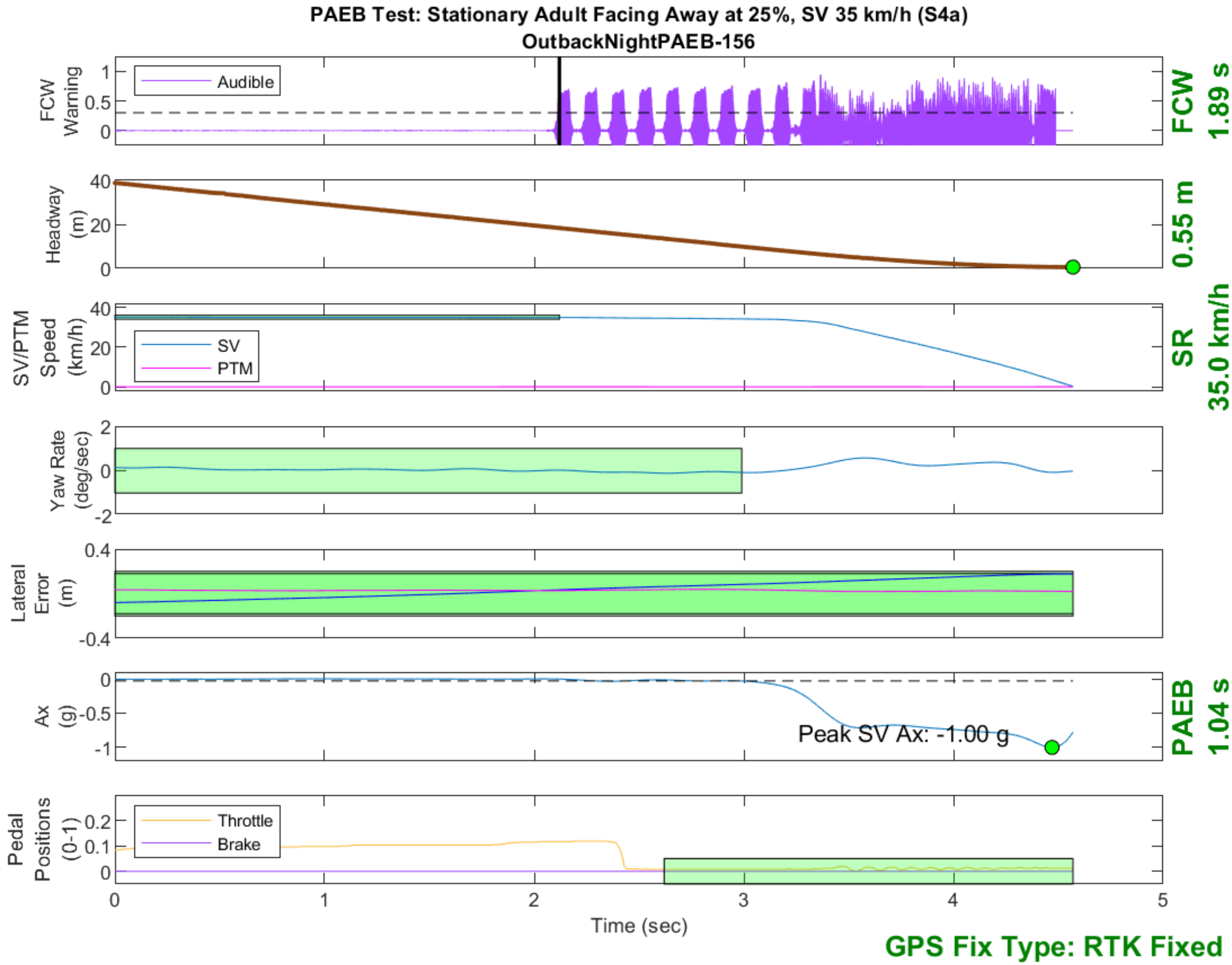


Figure D248. Time History for PAEB Run 156, S4a, Night, High Beam, 35 km/h

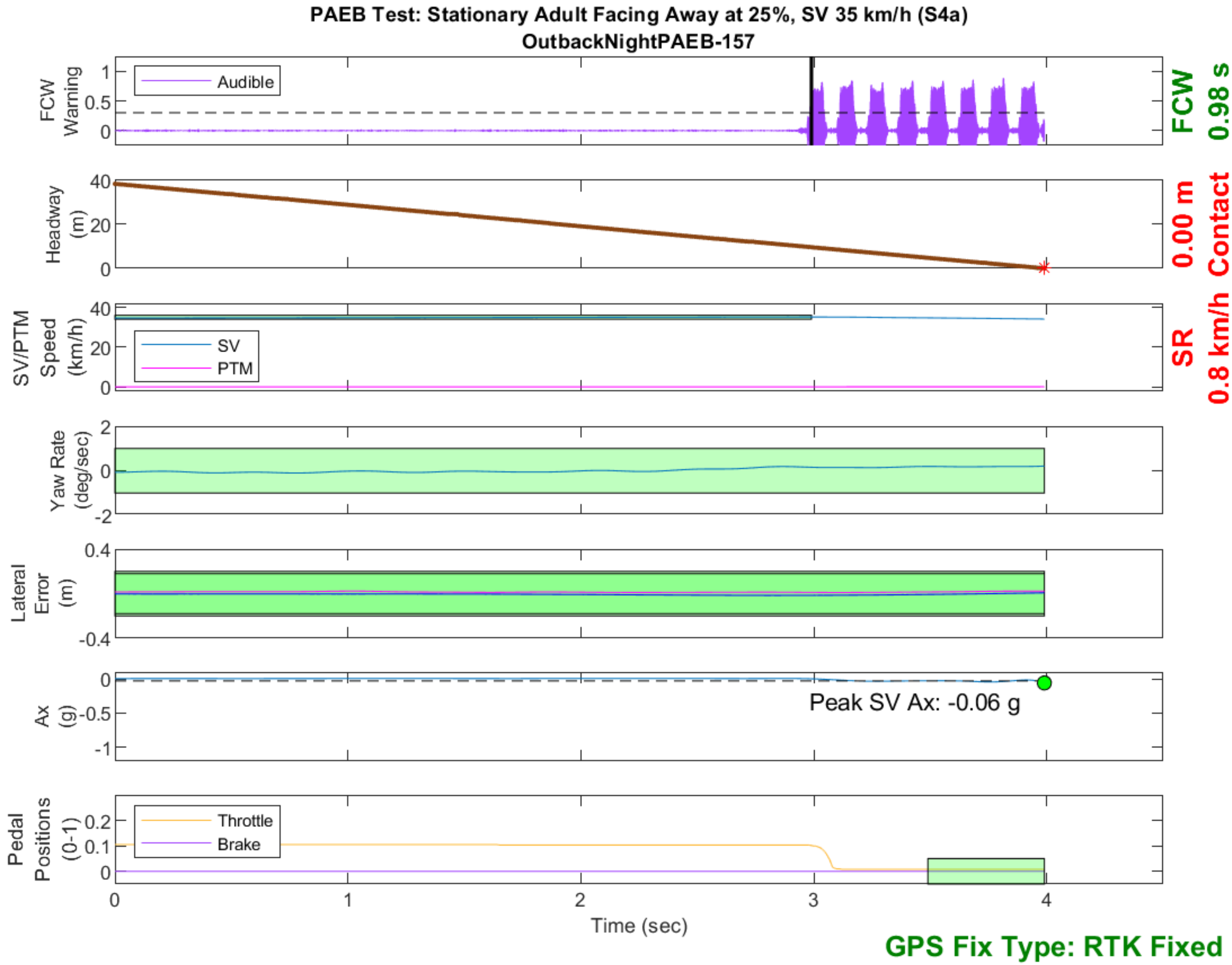


Figure D249. Time History for PAEB Run 157, S4a, Night, High Beam, 35 km/h

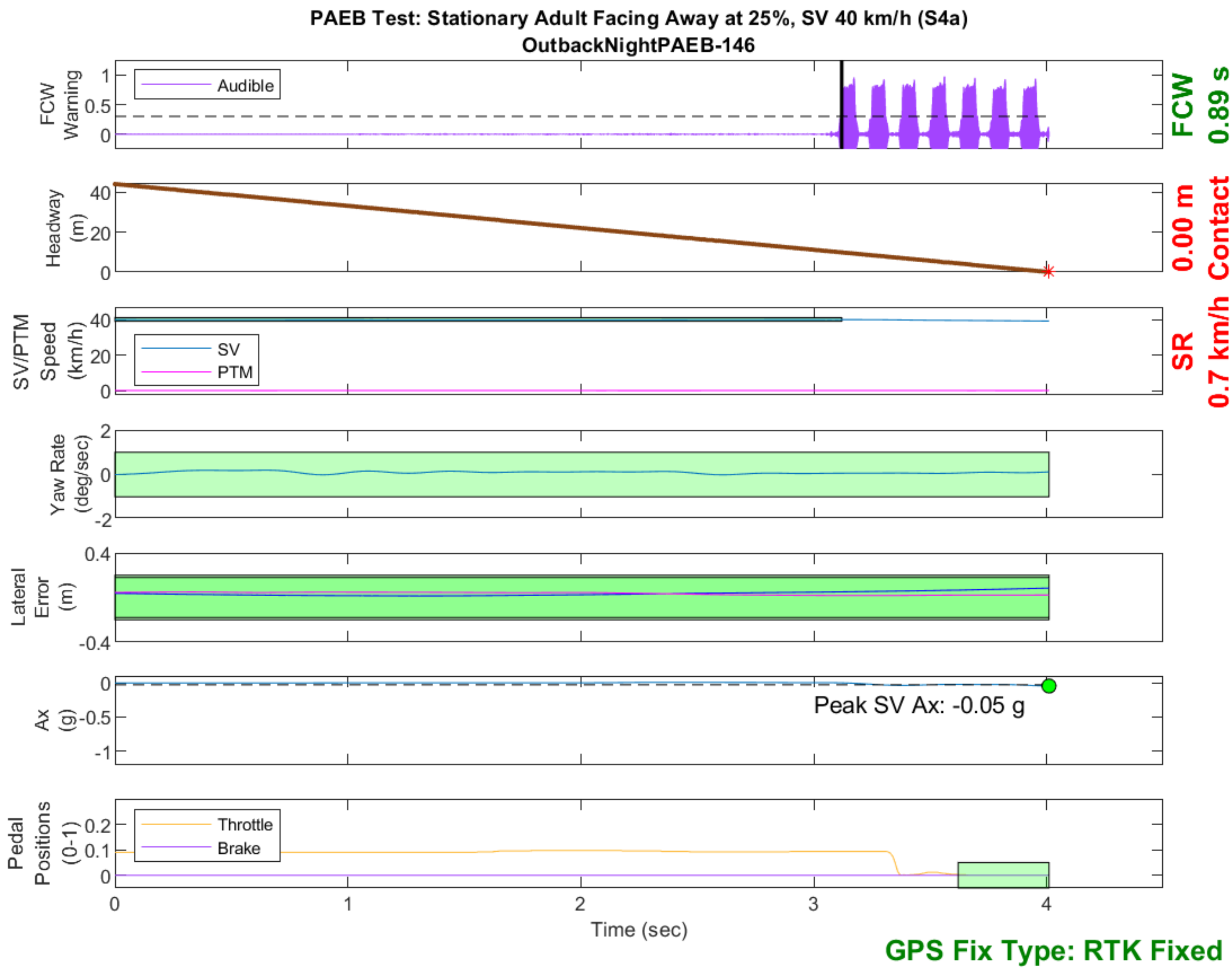


Figure D250. Time History for PAEB Run 146, S4a, Night, High Beam, 40 km/h

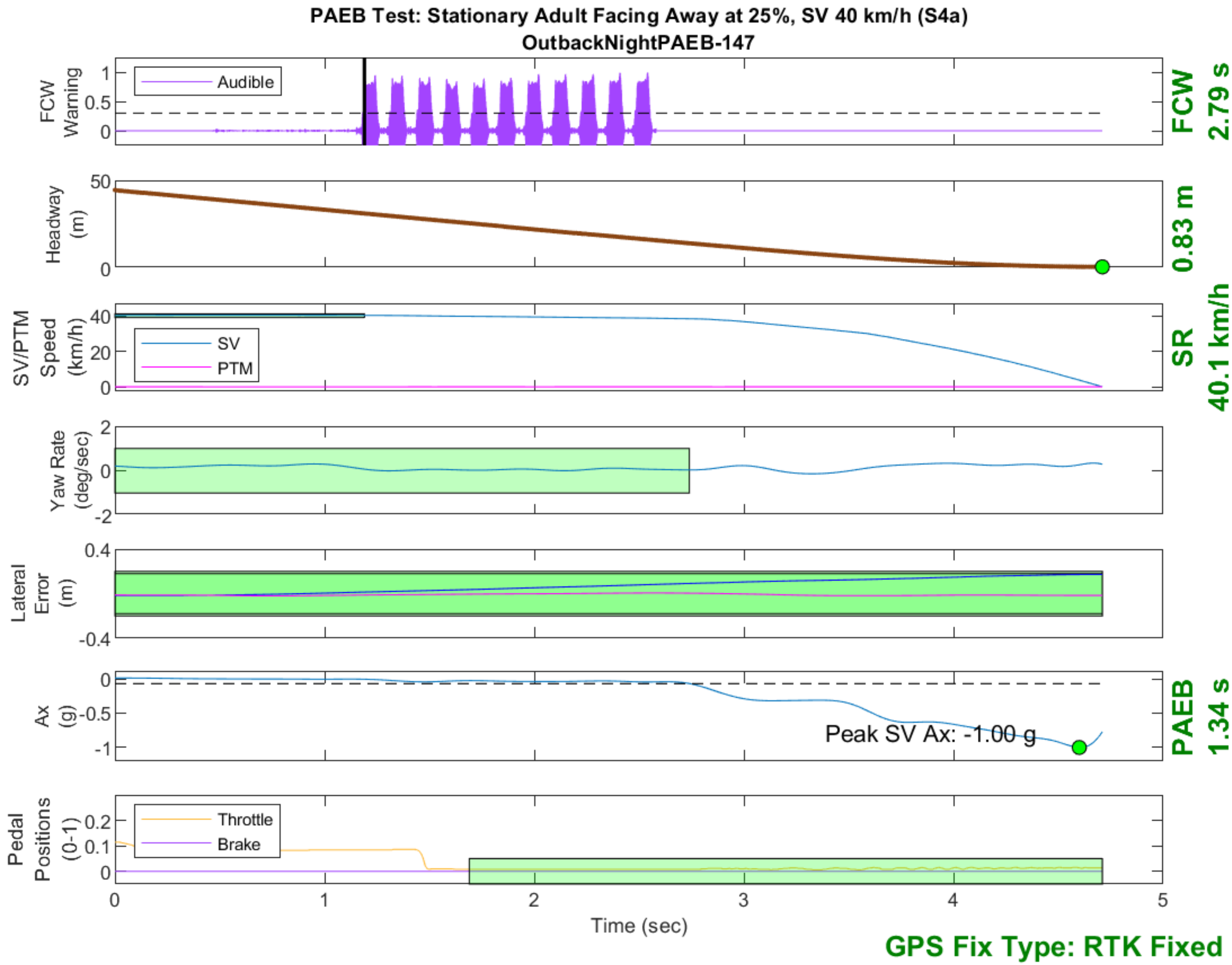


Figure D251. Time History for PAEB Run 147, S4a, Night, High Beam, 40 km/h

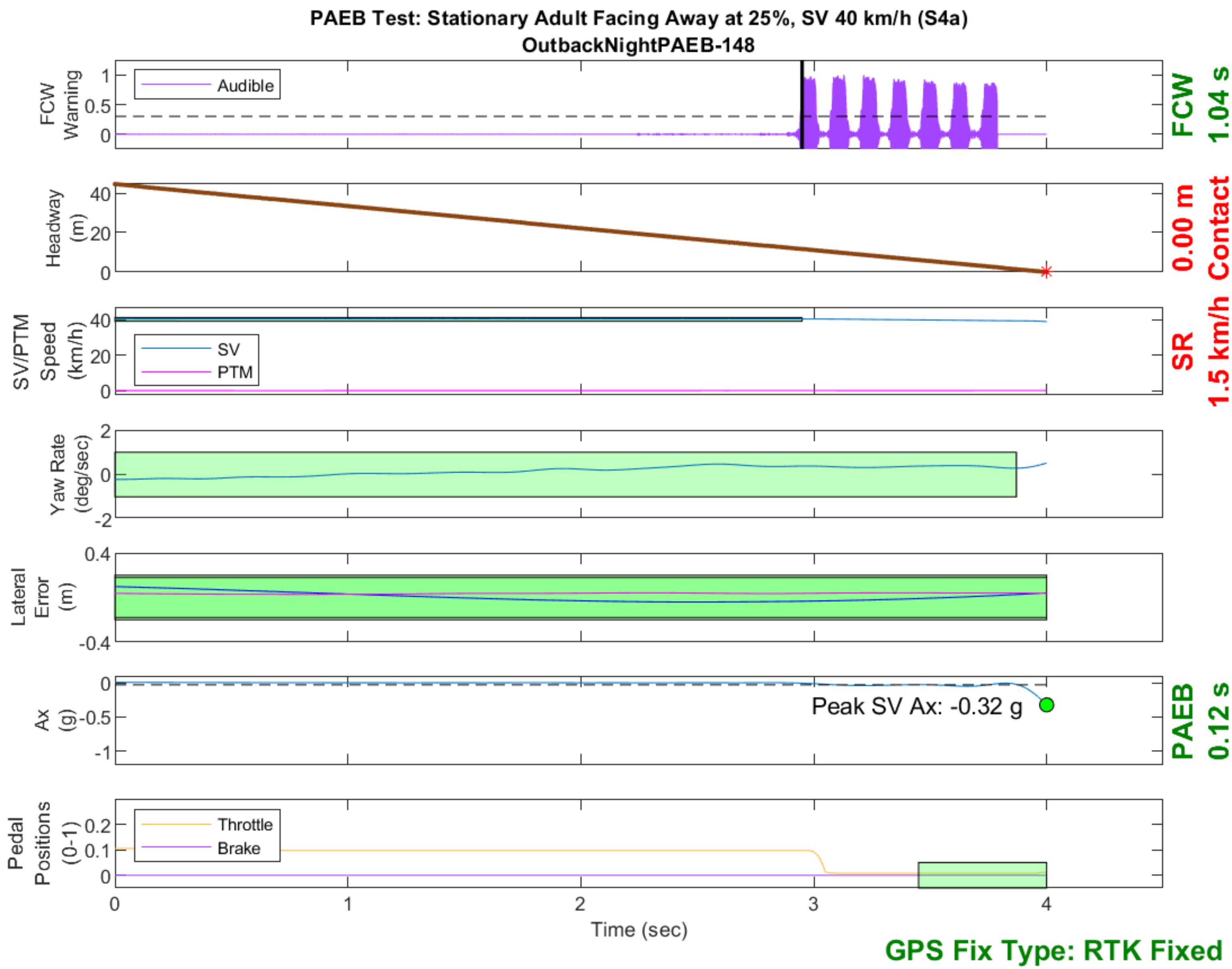


Figure D252. Time History for PAEB Run 148, S4a, Night, High Beam, 40 km/h

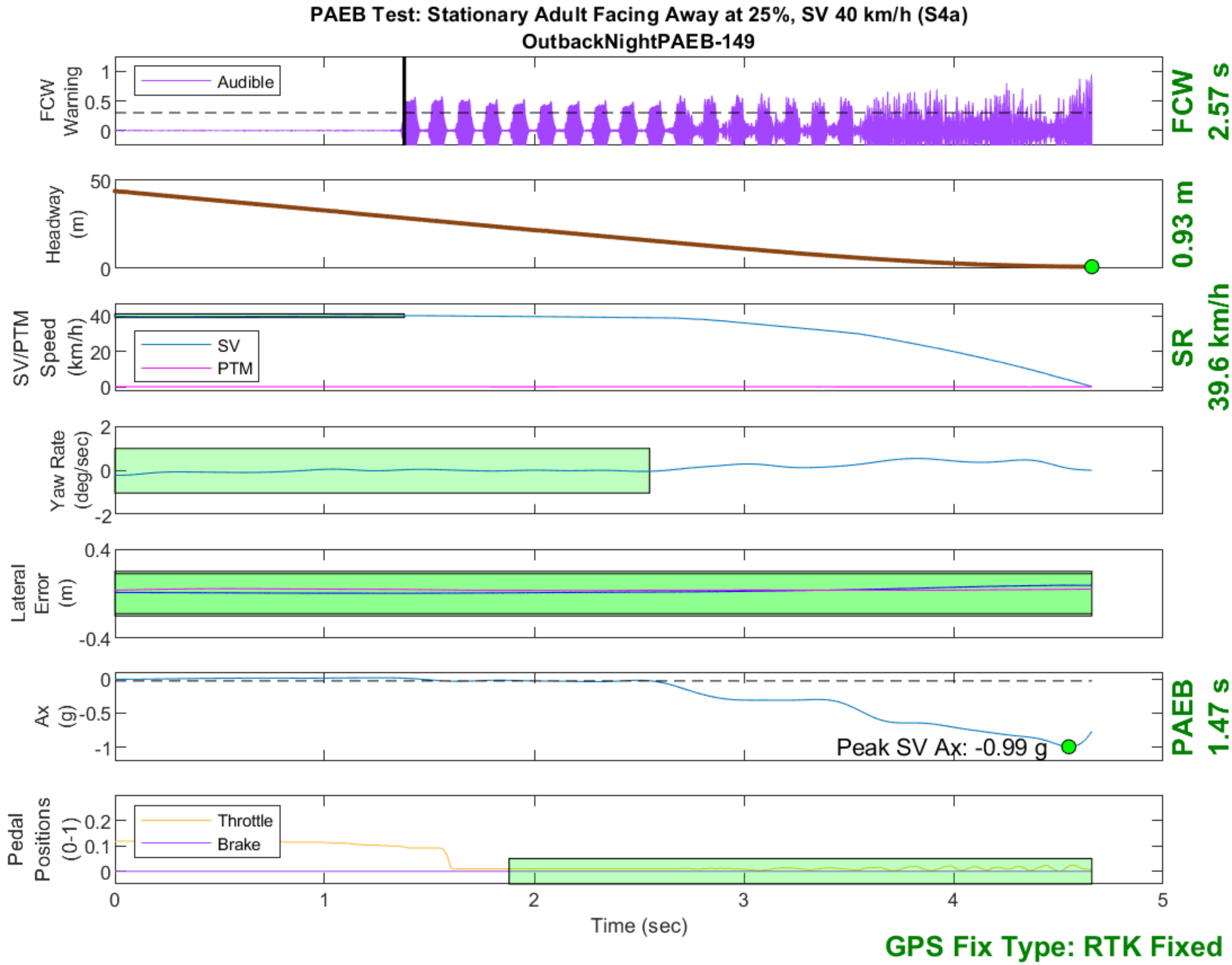


Figure D253. Time History for PAEB Run 149, S4a, Night, High Beam, 40 km/h

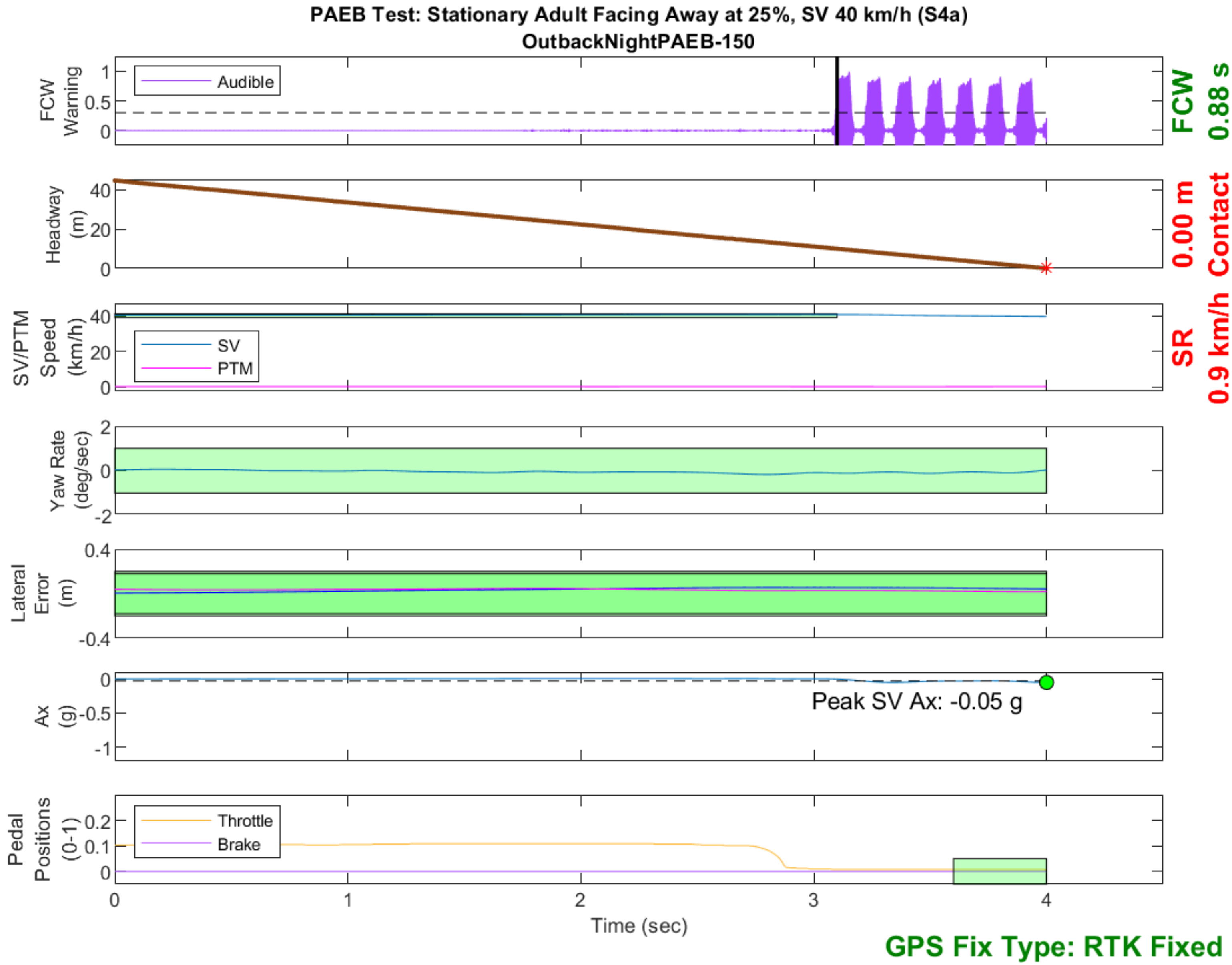


Figure D254. Time History for PAEB Run 150, S4a, Night, High Beam, 40 km/h

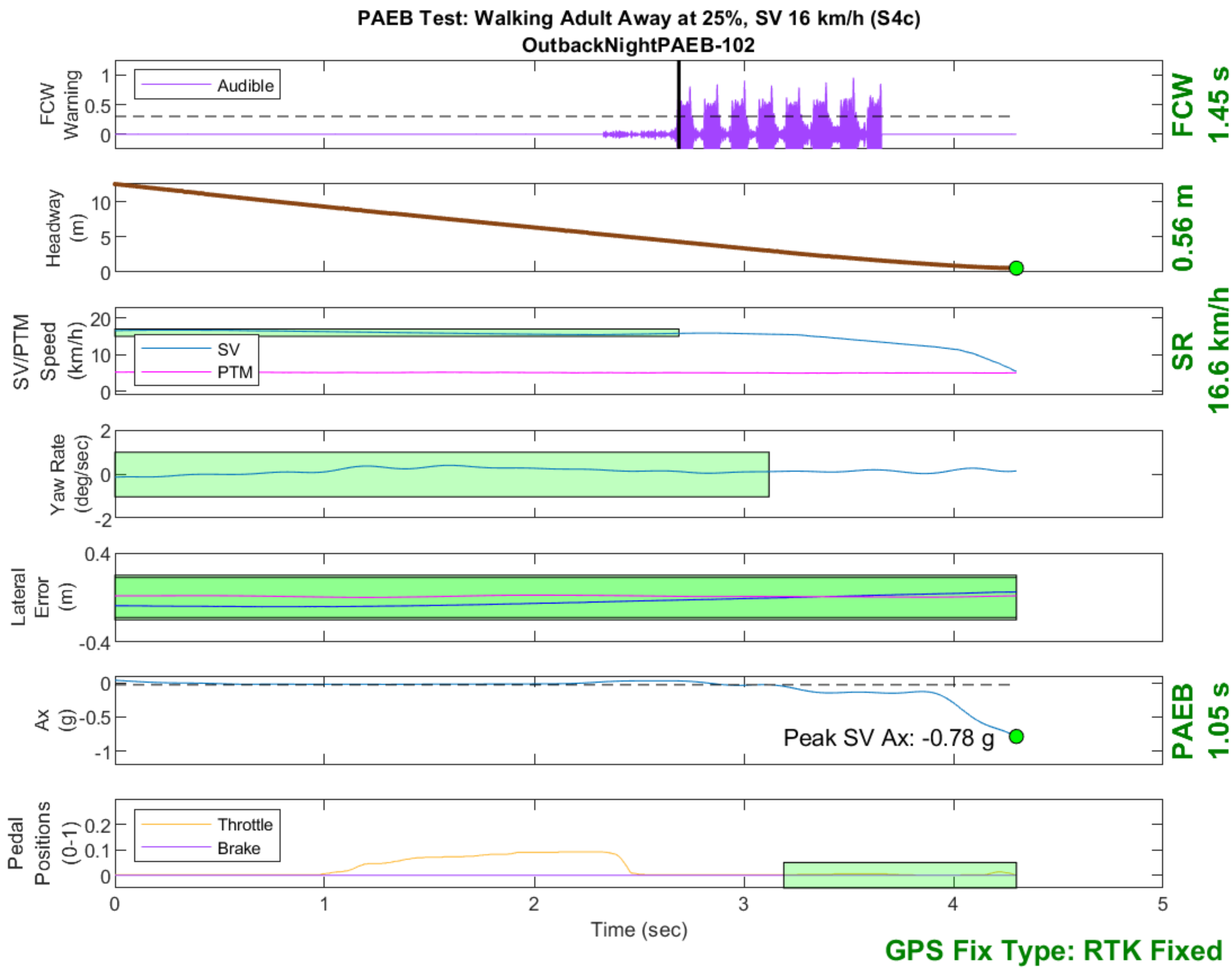


Figure D255. Time History for PAEB Run 102, S4c, Night, High Beam, 16 km/h

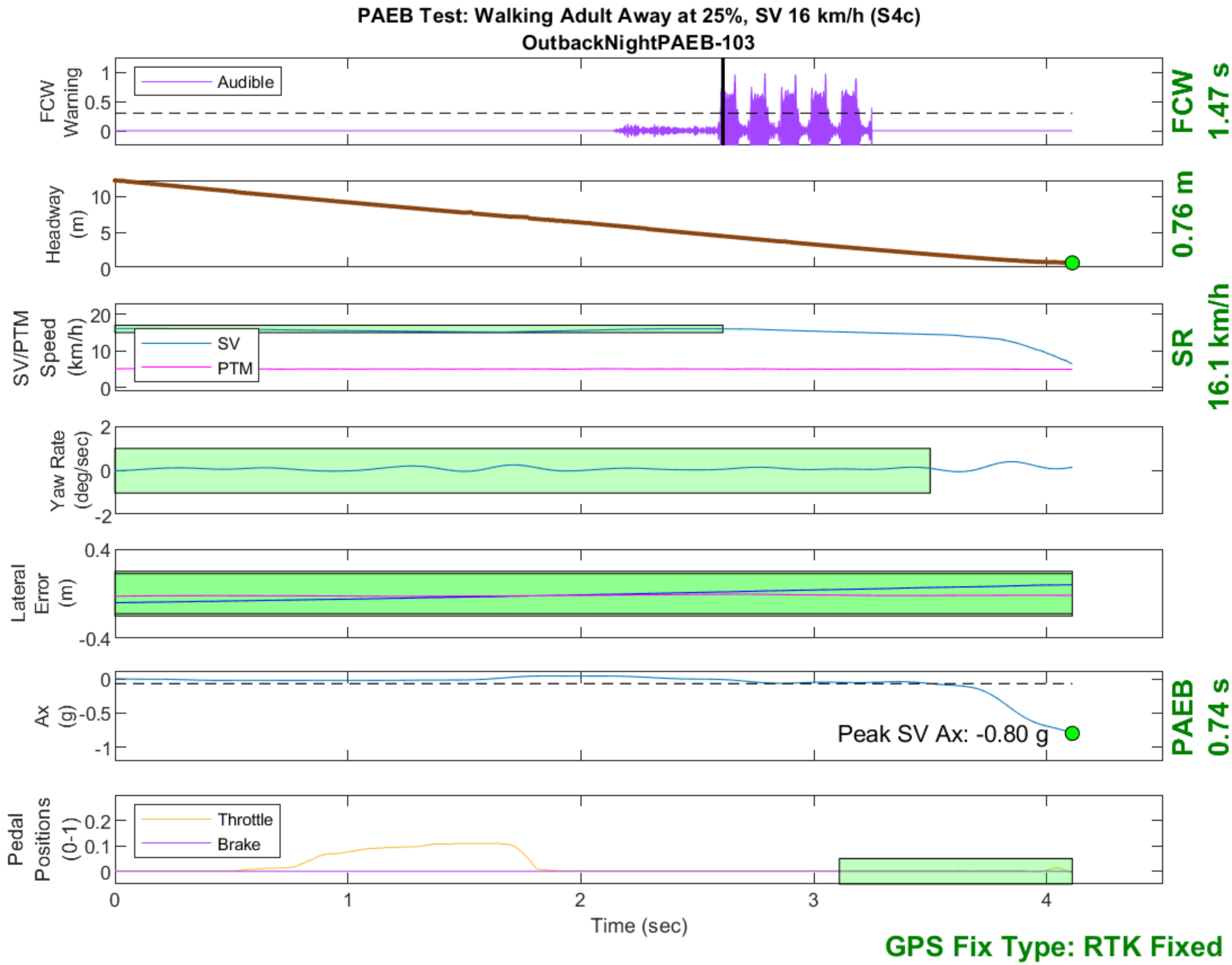


Figure D256. Time History for PAEB Run 103, S4c, Night, High Beam, 16 km/h

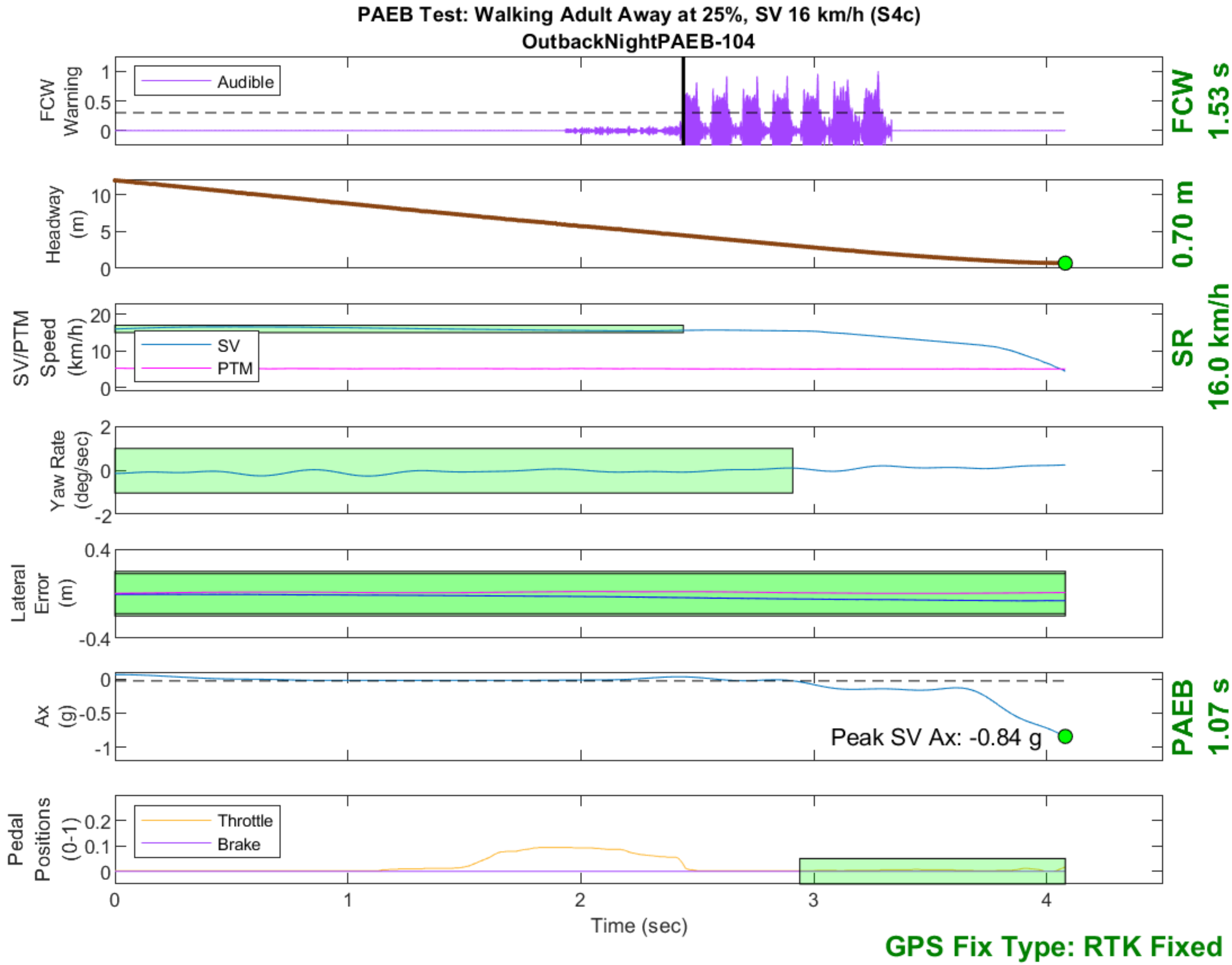


Figure D257. Time History for PAEB Run 104, S4c, Night, High Beam, 16 km/h

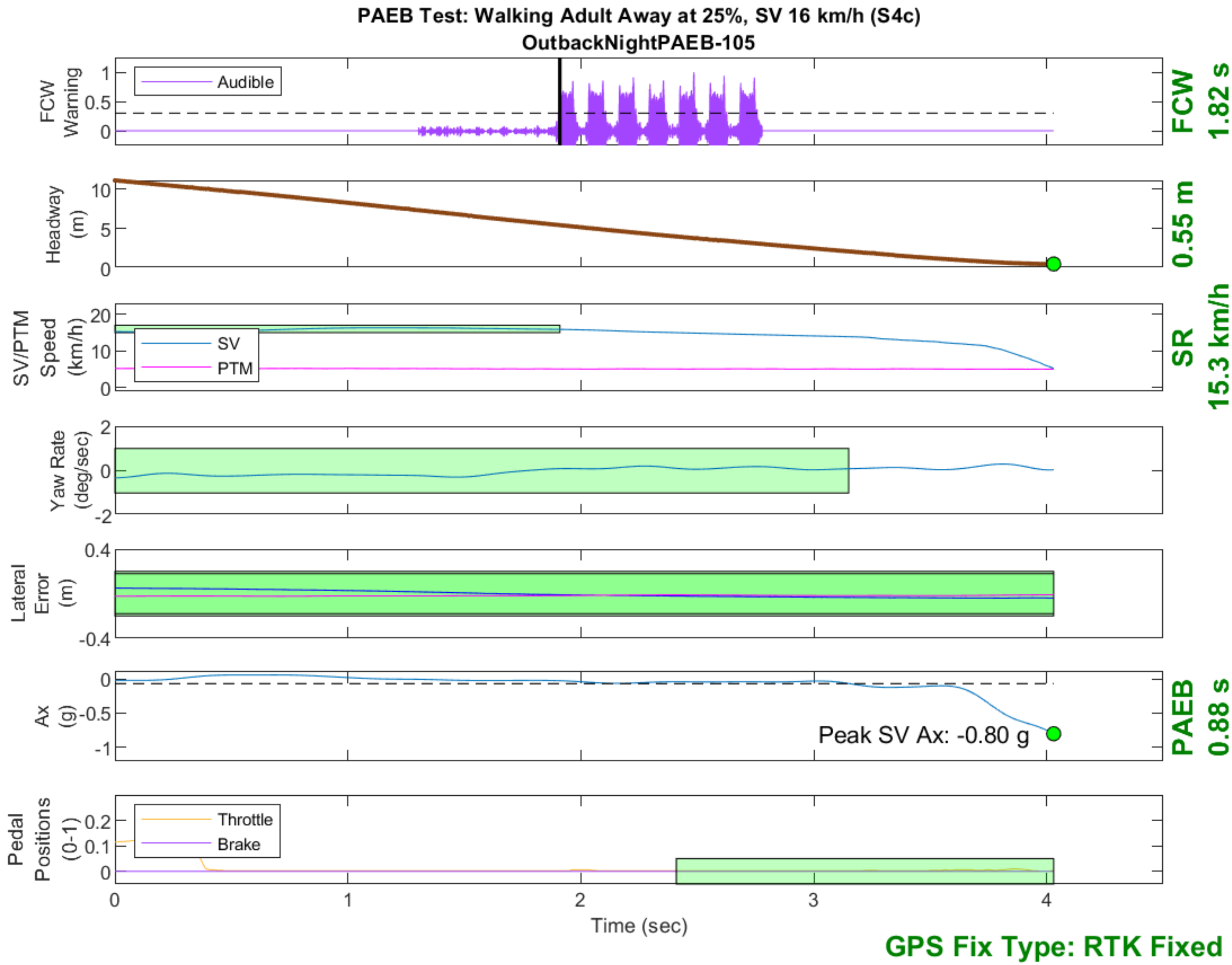


Figure D258. Time History for PAEB Run 105, S4c, Night, High Beam, 16 km/h

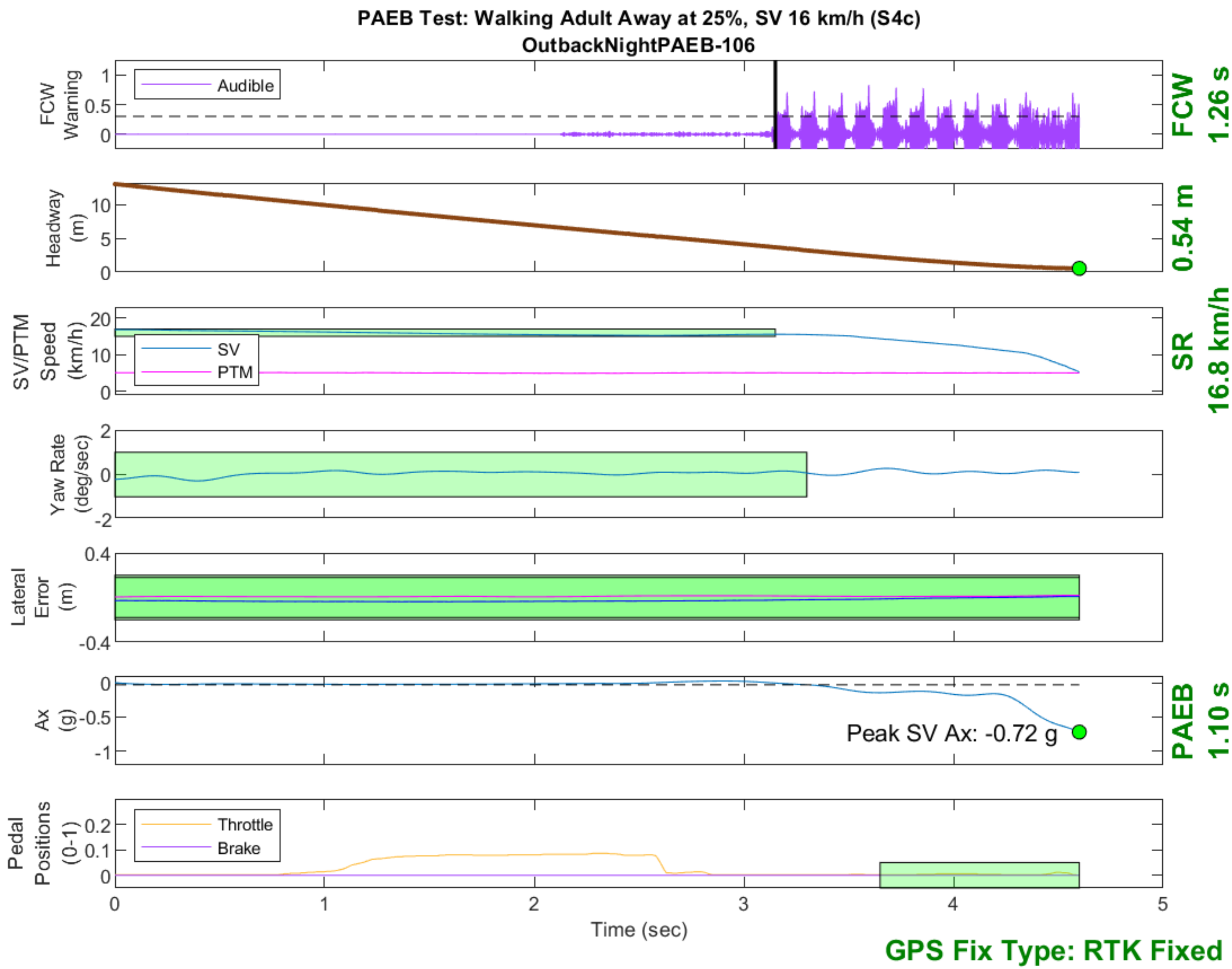


Figure D259. Time History for PAEB Run 106, S4c, Night, High Beam, 16 km/h

Figure D260. Time History for PAEB Run 111, S4c, Night, High Beam, 40 km/h

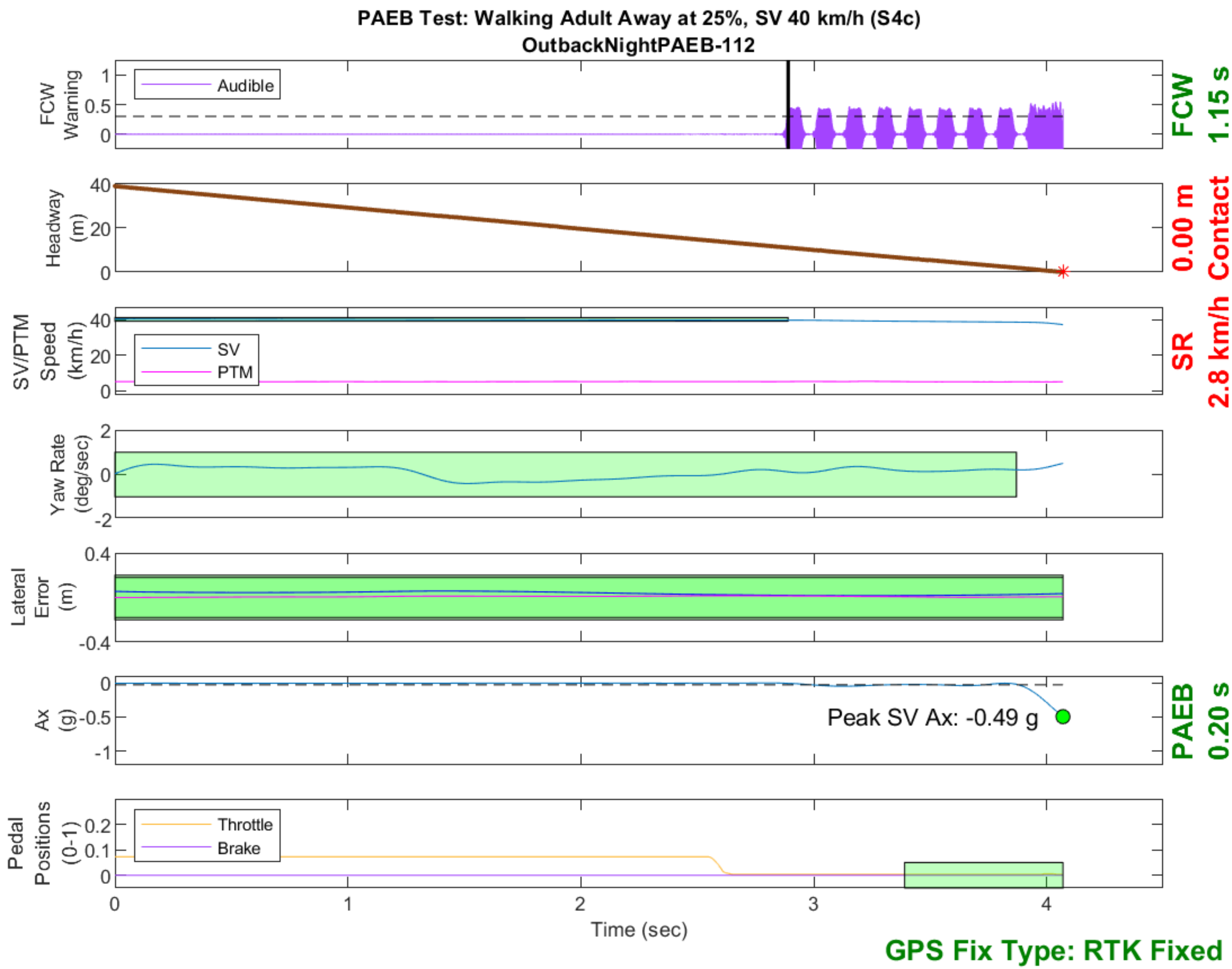


Figure D261. Time History for PAEB Run 112, S4c, Night, High Beam, 40 km/h

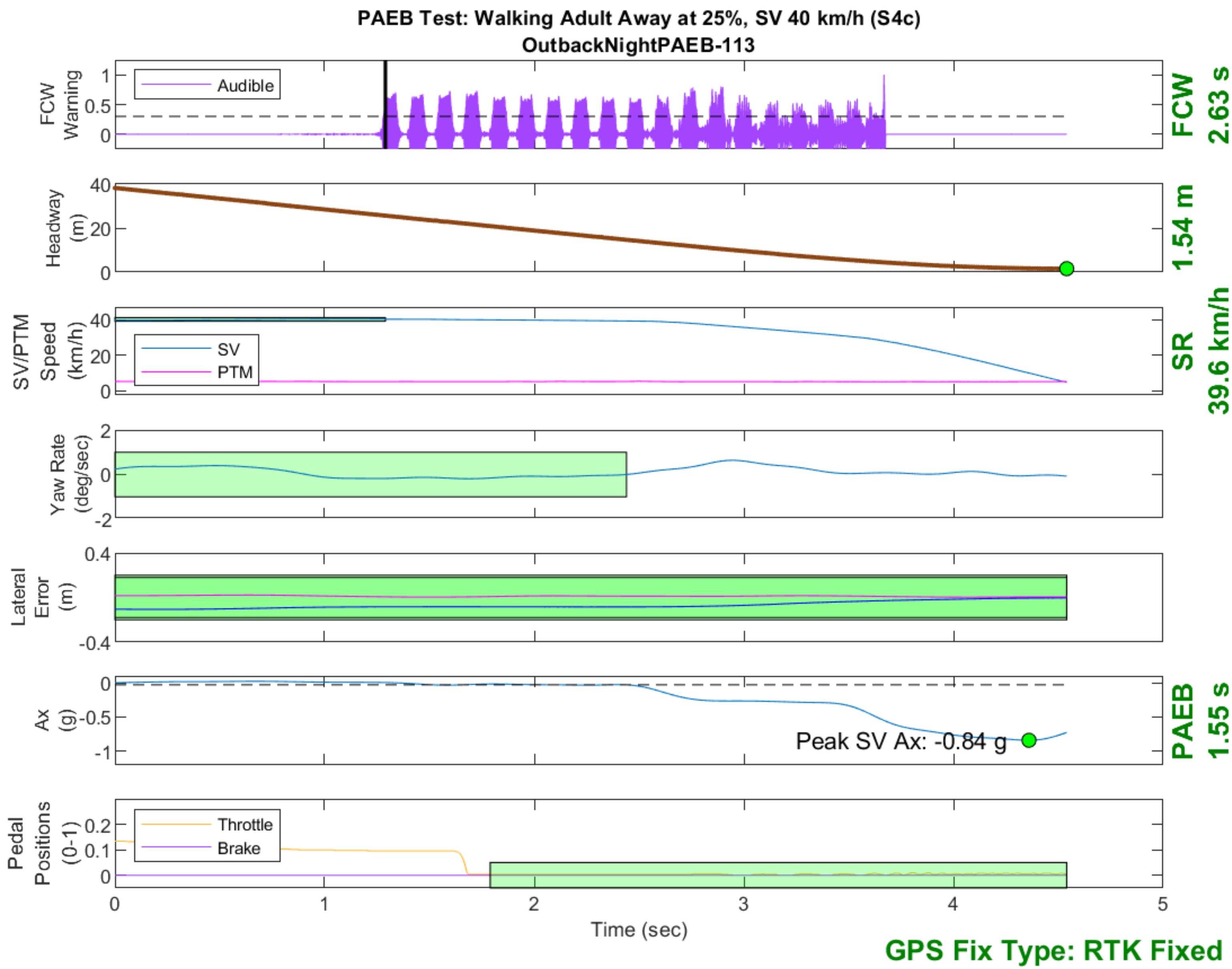


Figure D262. Time History for PAEB Run 113, S4c, Night, High Beam, 40 km/h

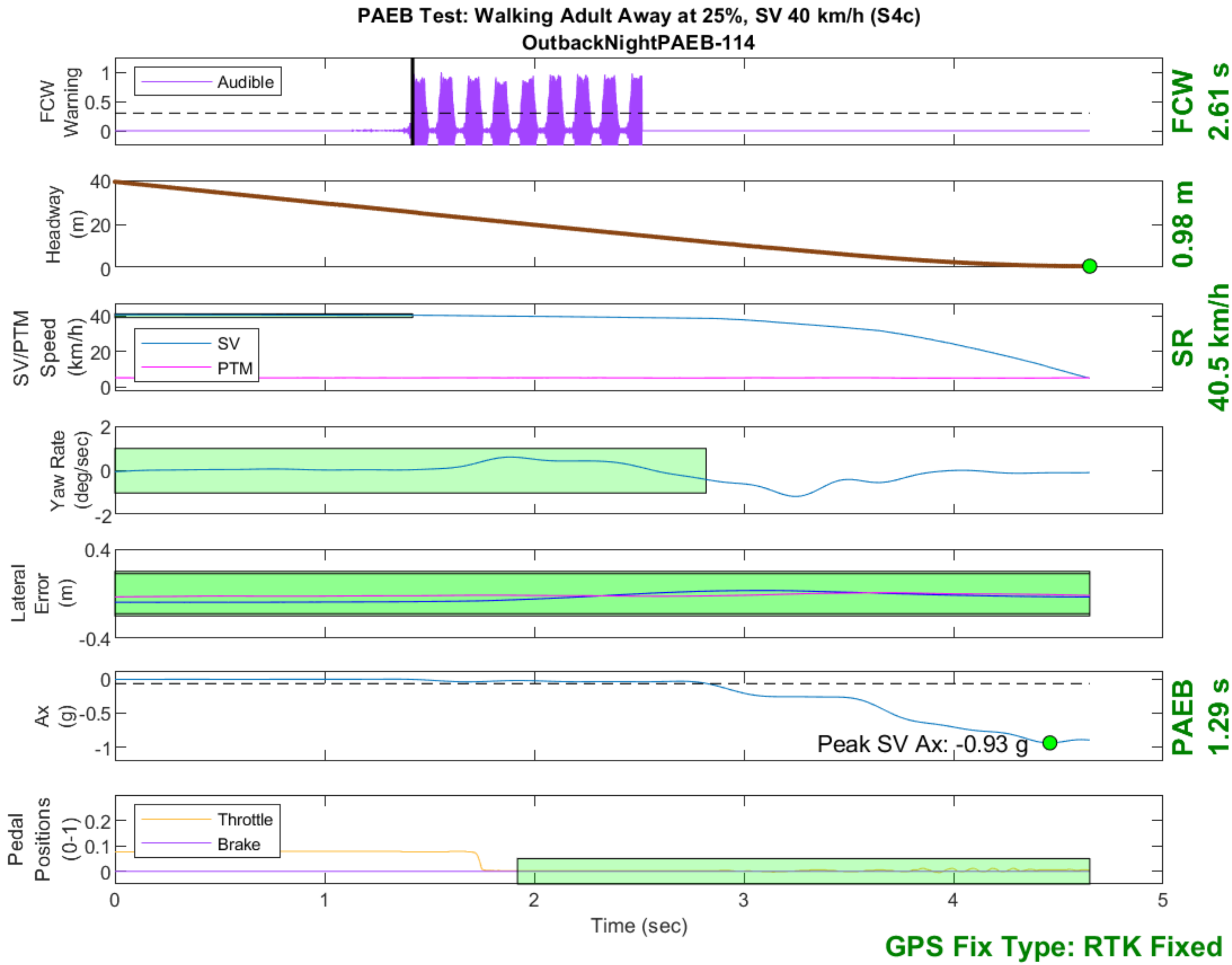


Figure D263. Time History for PAEB Run 114, S4c, Night, High Beam, 40 km/h

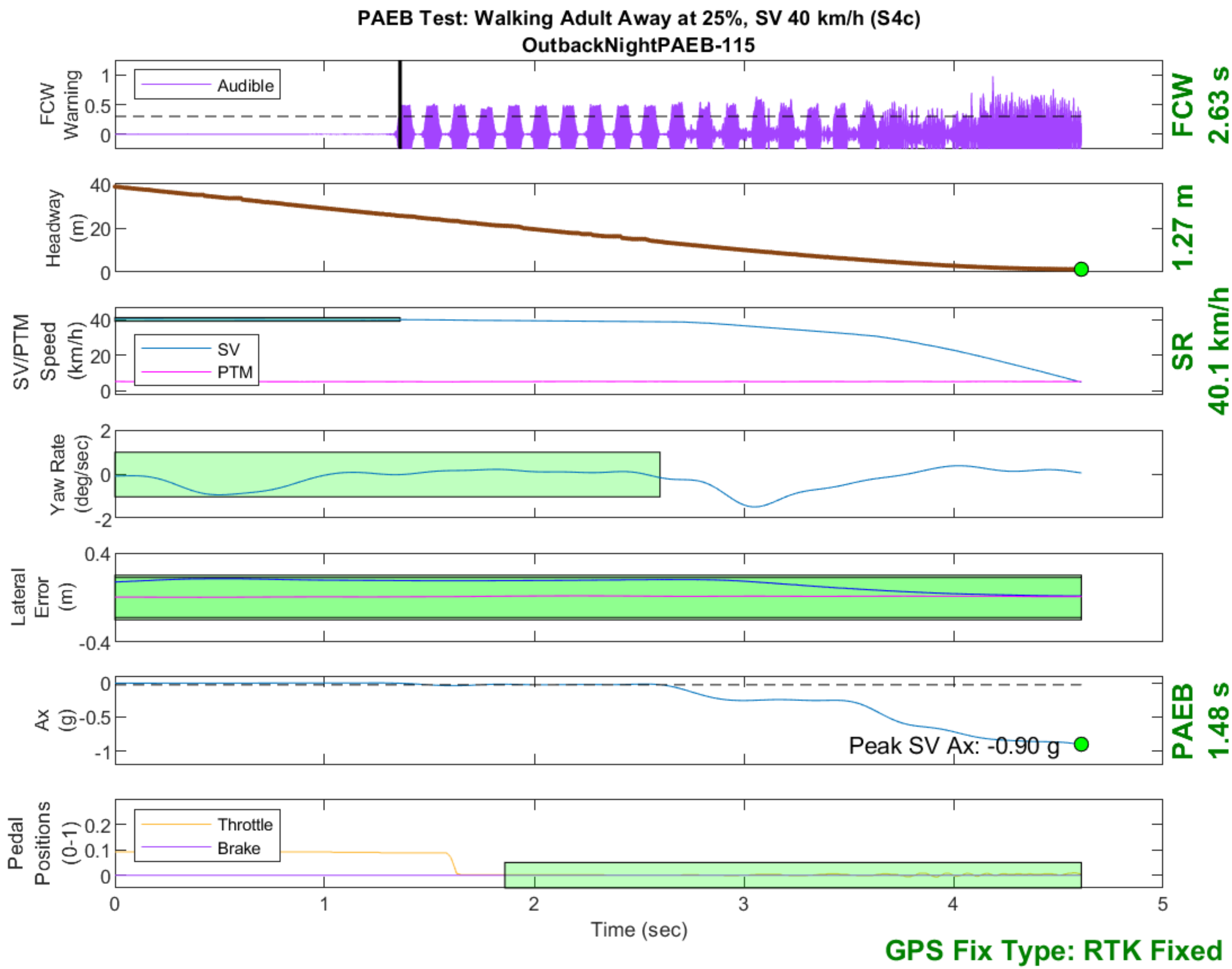


Figure D264. Time History for PAEB Run 115, S4c, Night, High Beam, 40 km/h

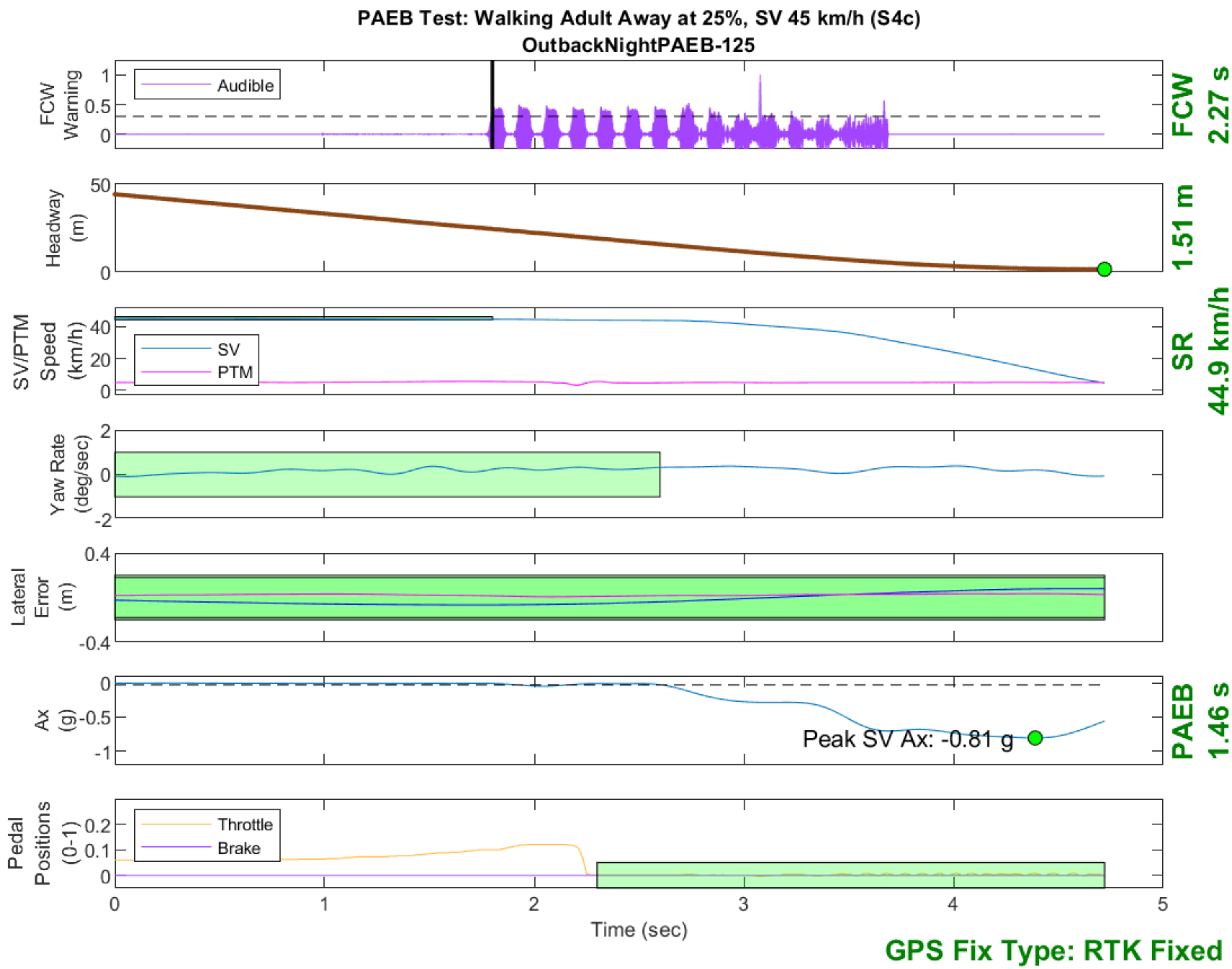


Figure D265. Time History for PAEB Run 125, S4c, Night, High Beam, 45 km/h

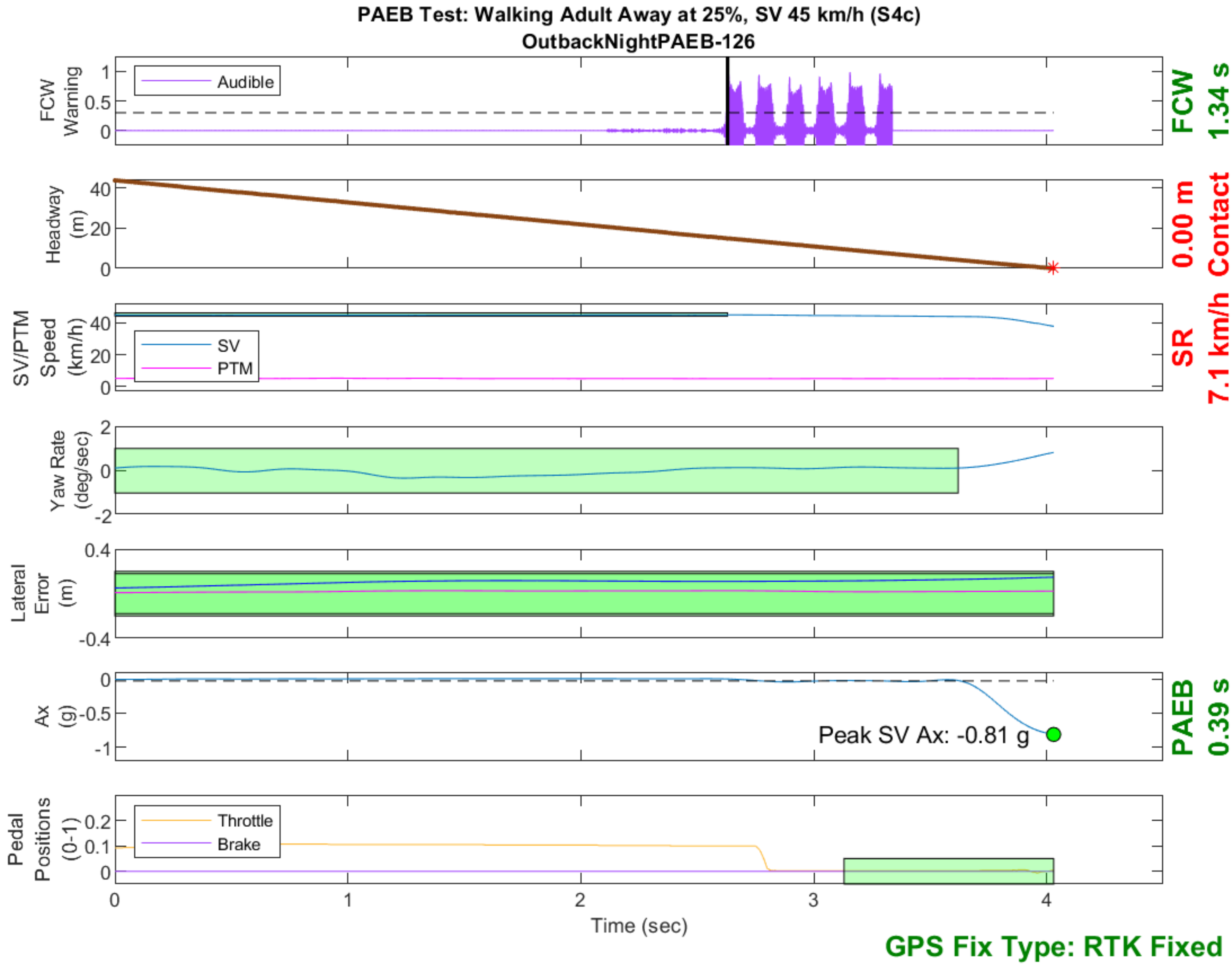


Figure D266. Time History for PAEB Run 126, S4c, Night, High Beam, 45 km/h

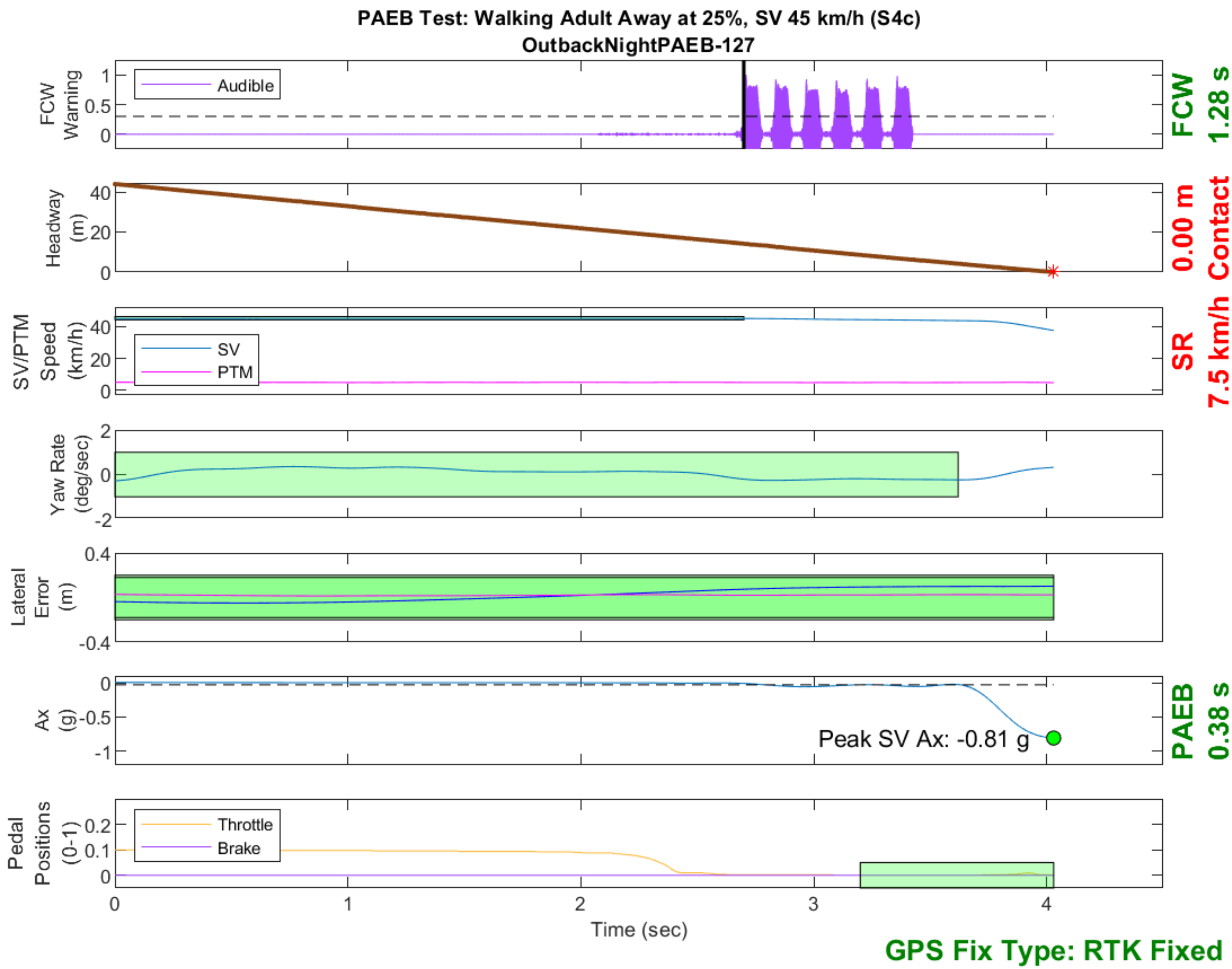


Figure D267. Time History for PAEB Run 127, S4c, Night, High Beam, 45 km/h

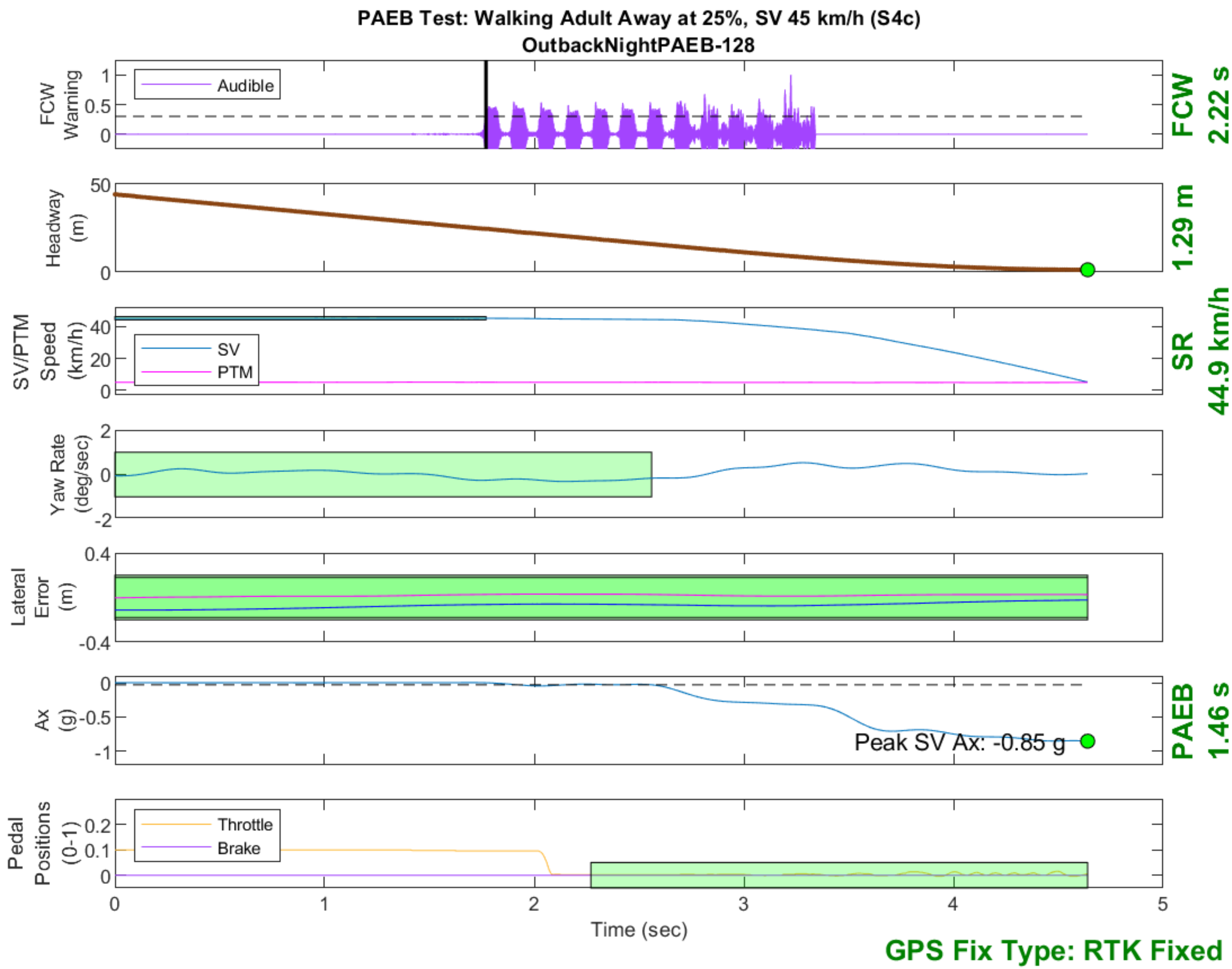


Figure D268. Time History for PAEB Run 128, S4c, Night, High Beam, 45 km/h

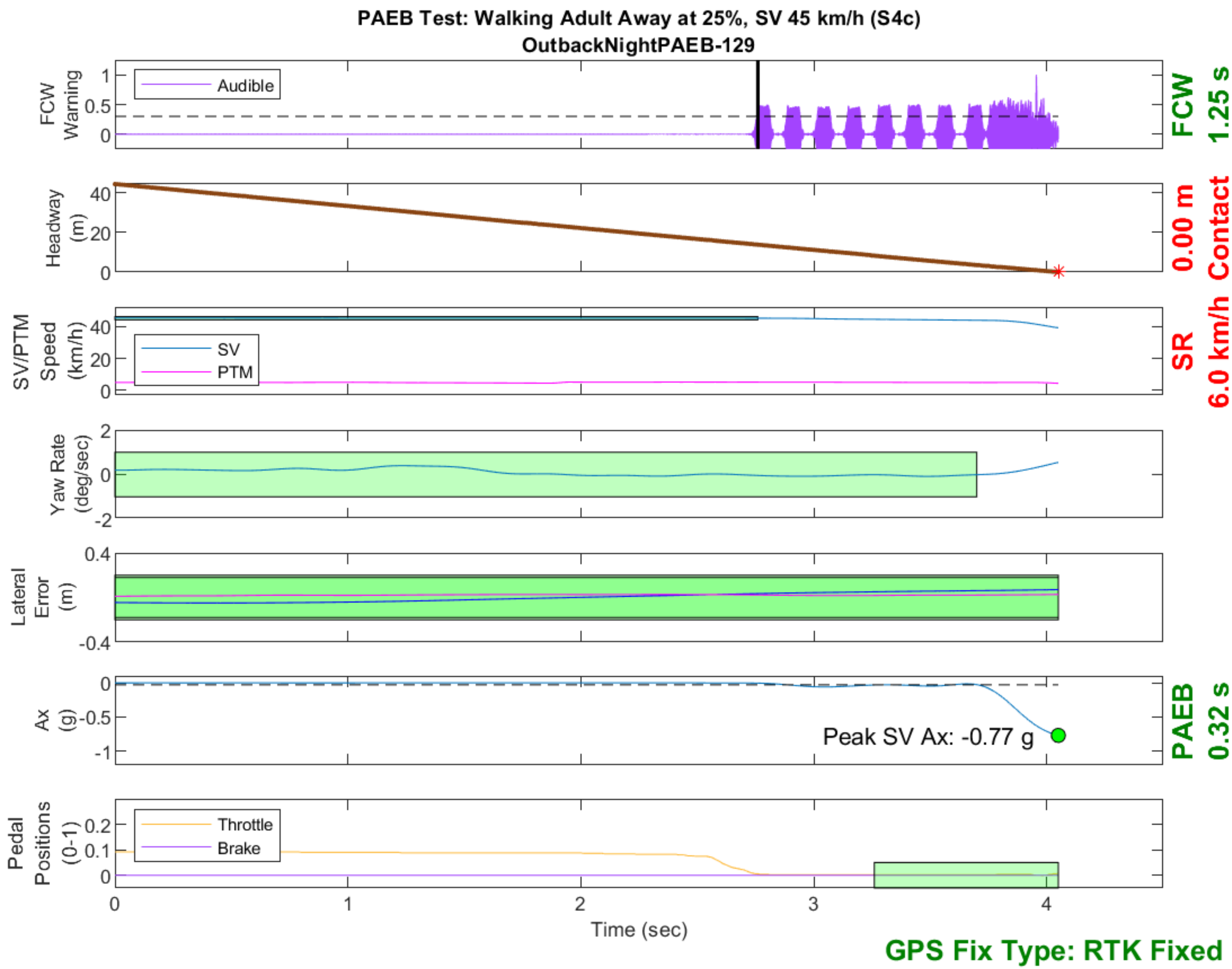


Figure D269. Time History for PAEB Run 129, S4c, Night, High Beam, 45 km/h

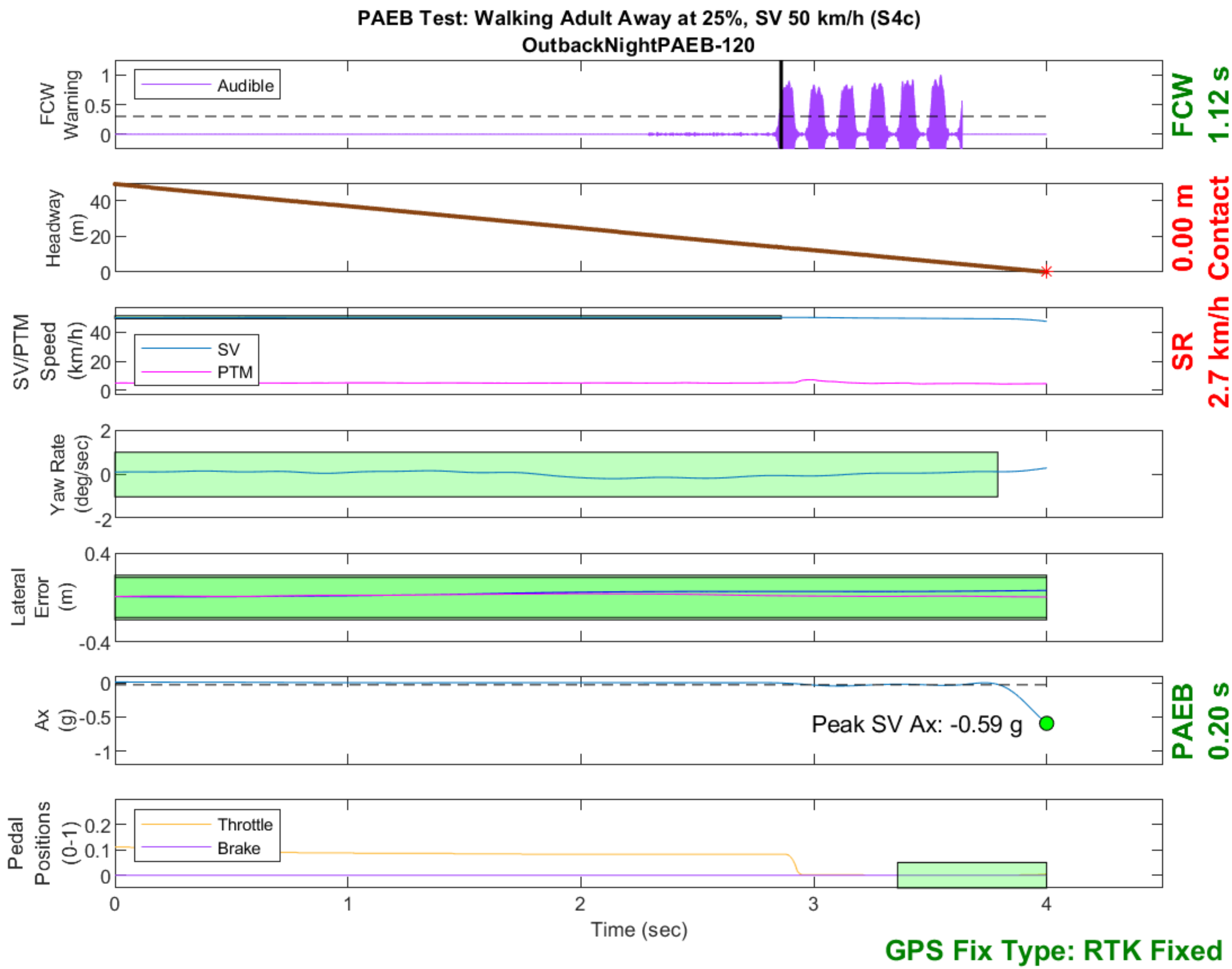


Figure D270. Time History for PAEB Run 120, S4c, Night, High Beam, 50 km/h

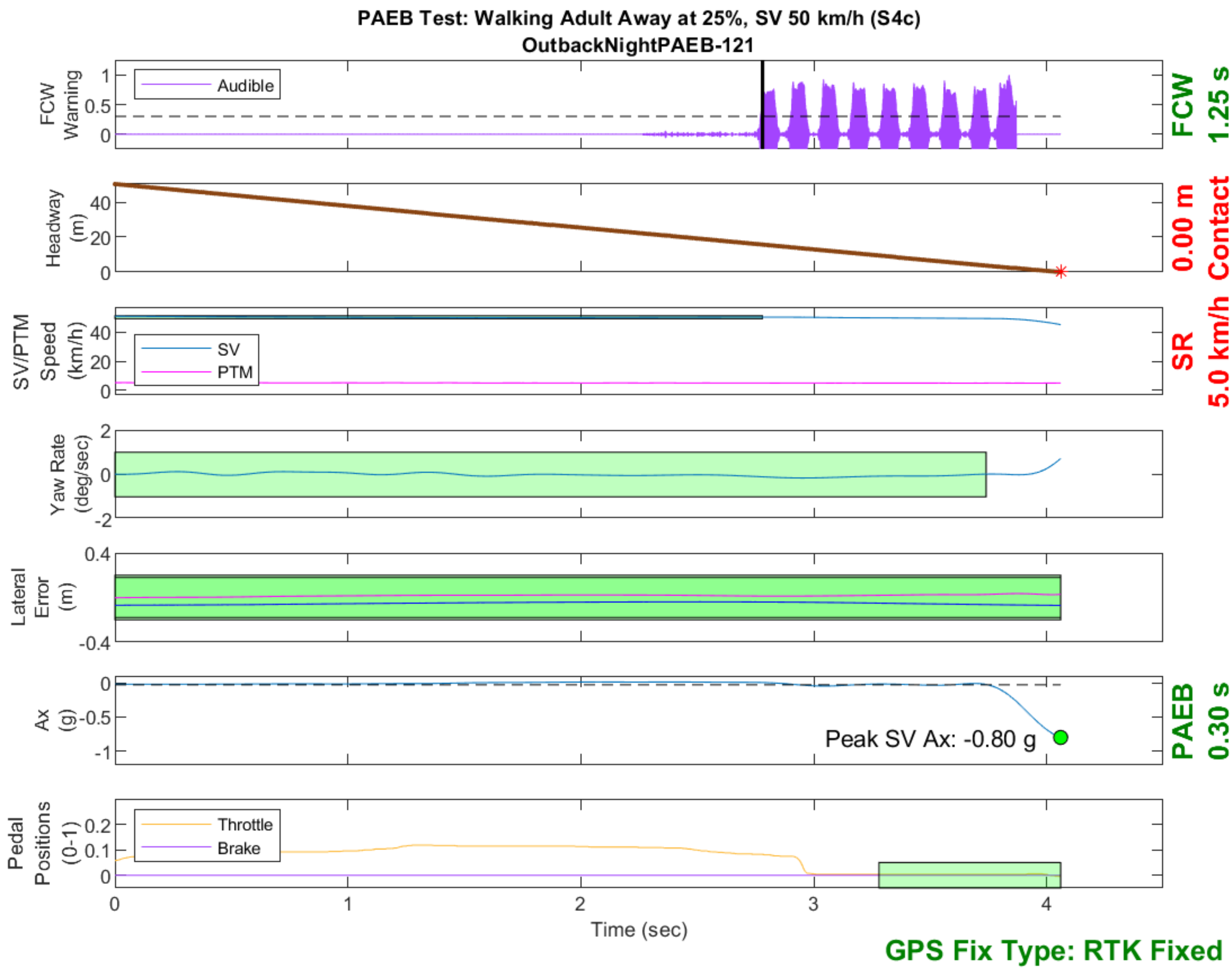


Figure D271. Time History for PAEB Run 121, S4c, Night, High Beam, 50 km/h

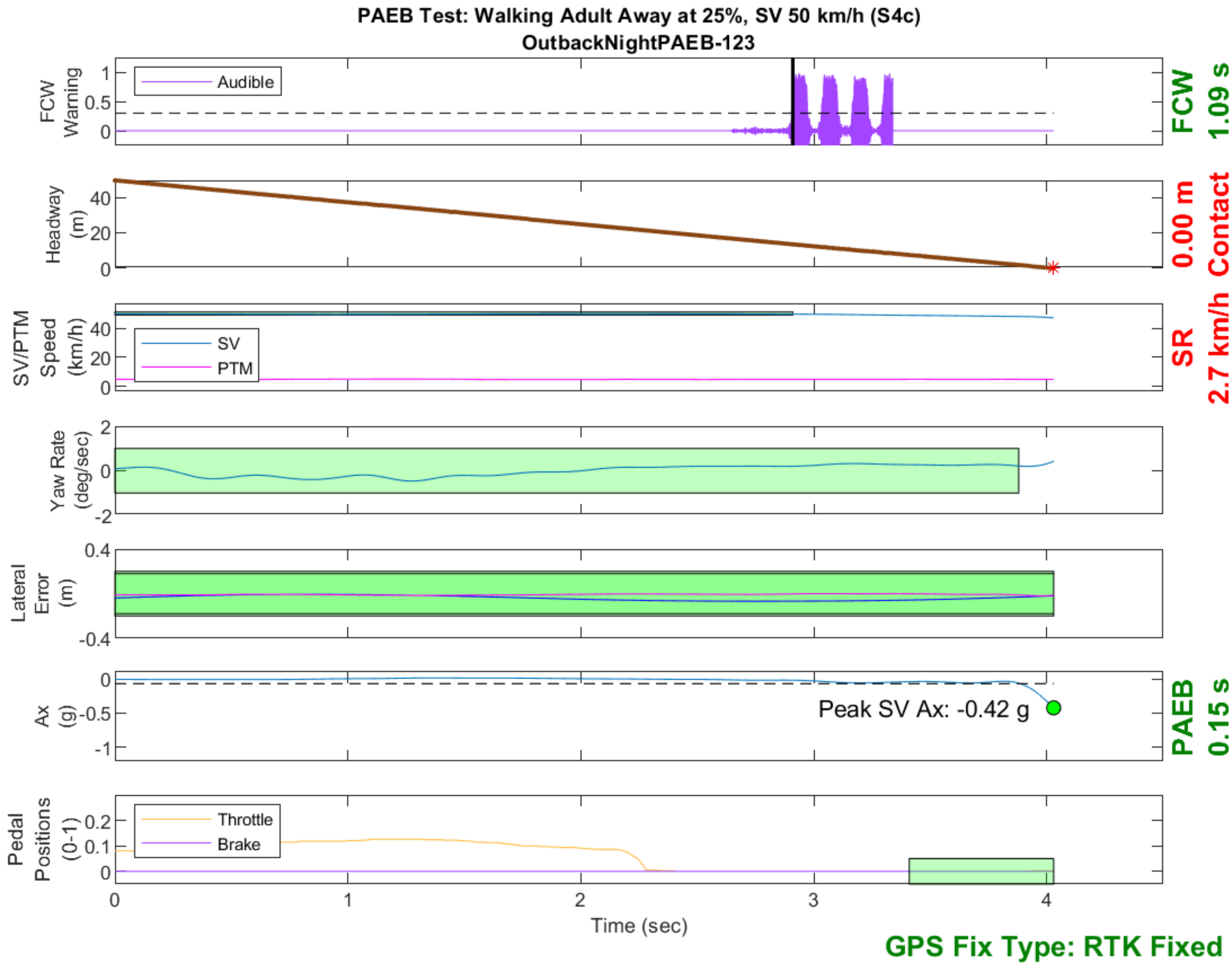


Figure D272. Time History for PAEB Run 123, S4c, Night, High Beam, 50 km/h

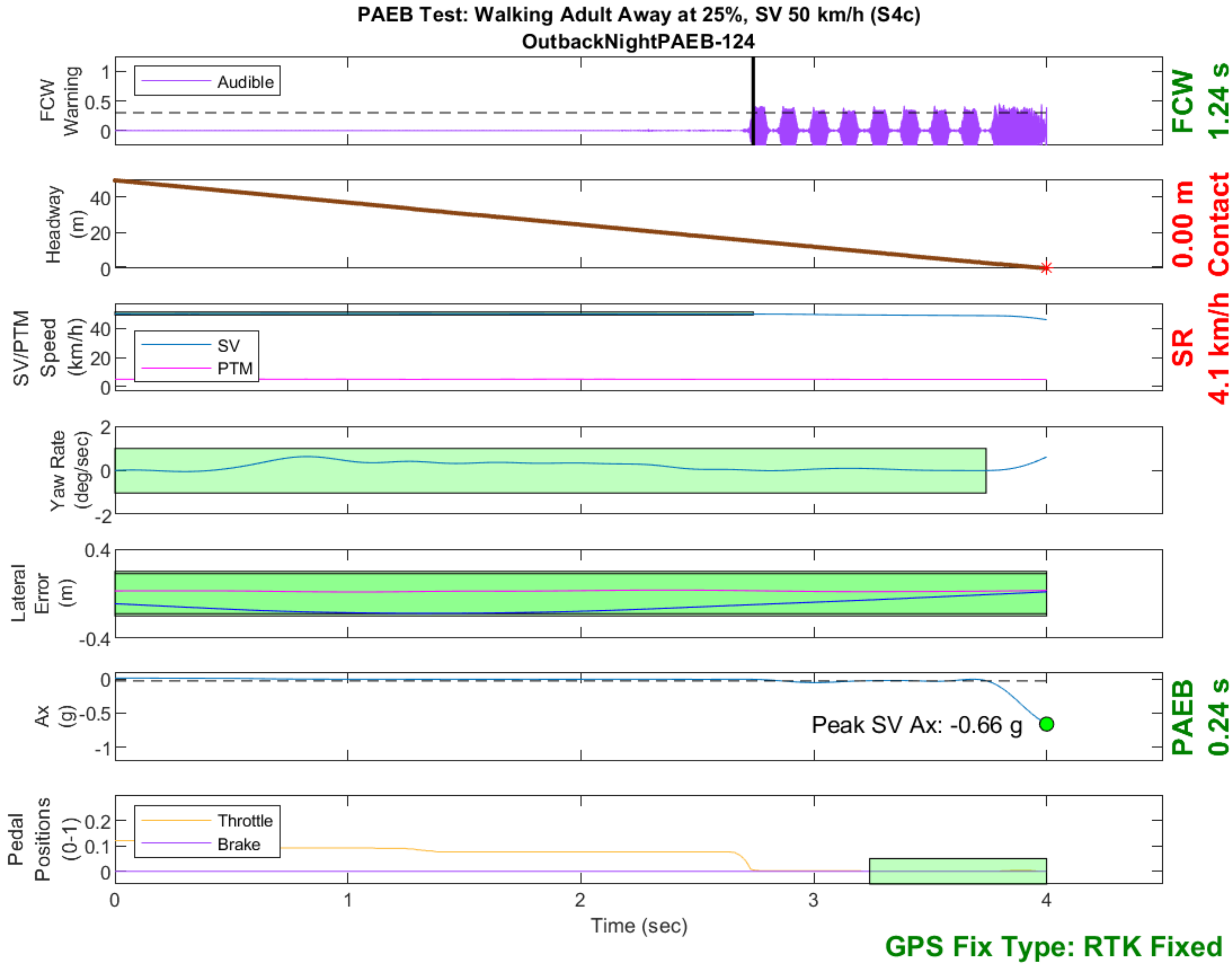


Figure D273. Time History for PAEB Run 124, S4c, Night, High Beam, 50 km/h

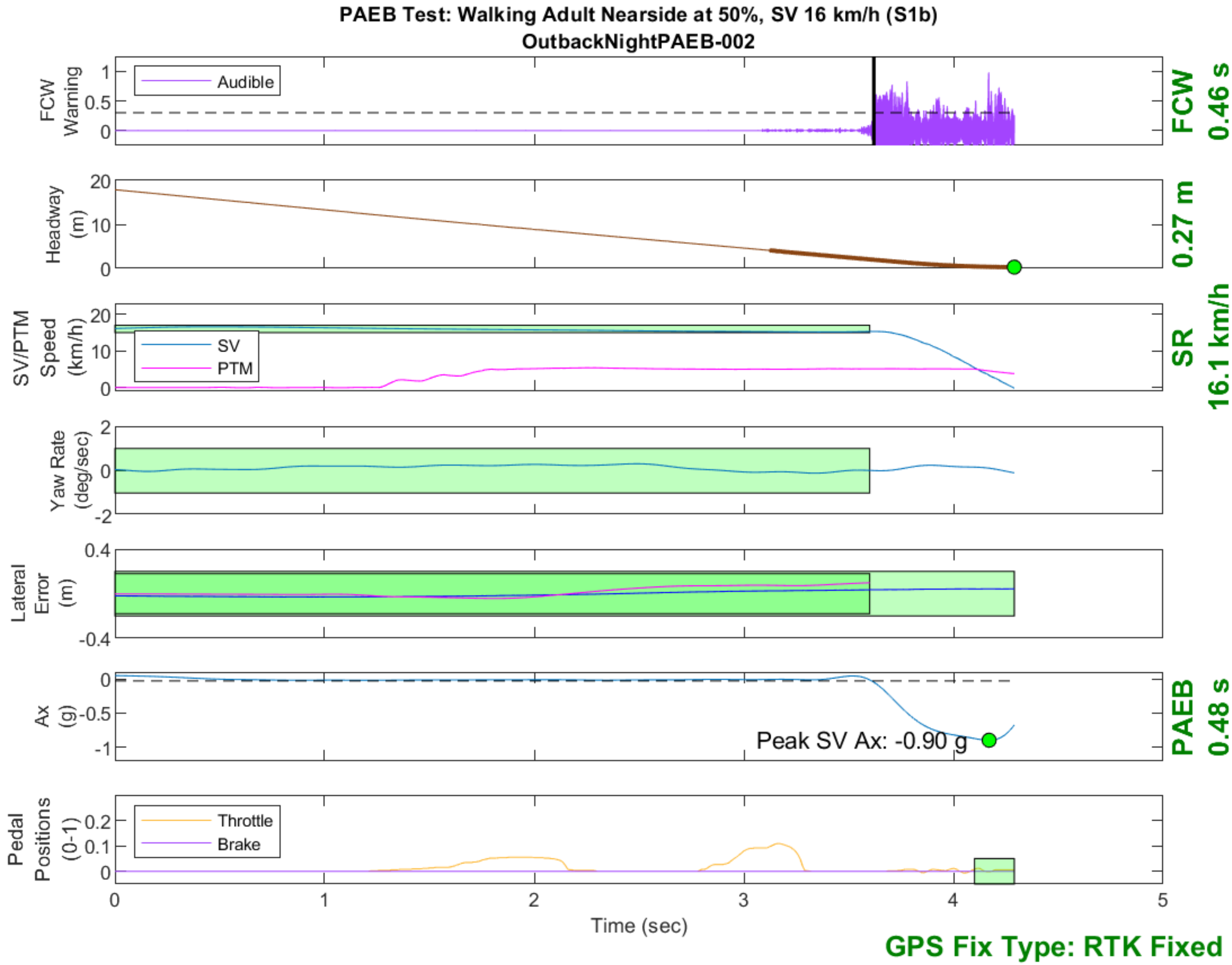


Figure D274. Time History for PAEB Run 2, S1b, Night, Low Beam, 16 km/h

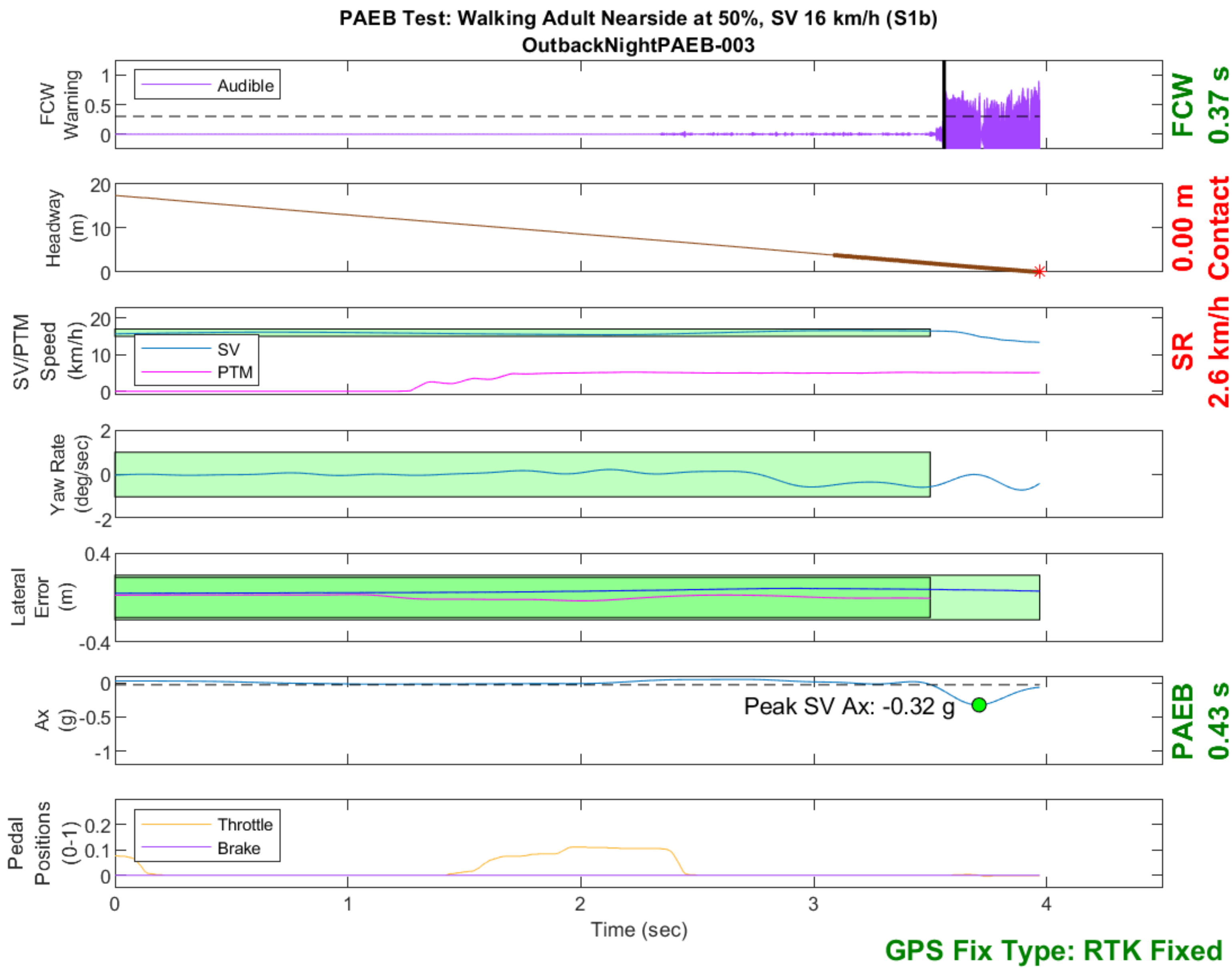


Figure D275. Time History for PAEB Run 3, S1b, Night, Low Beam, 16 km/h

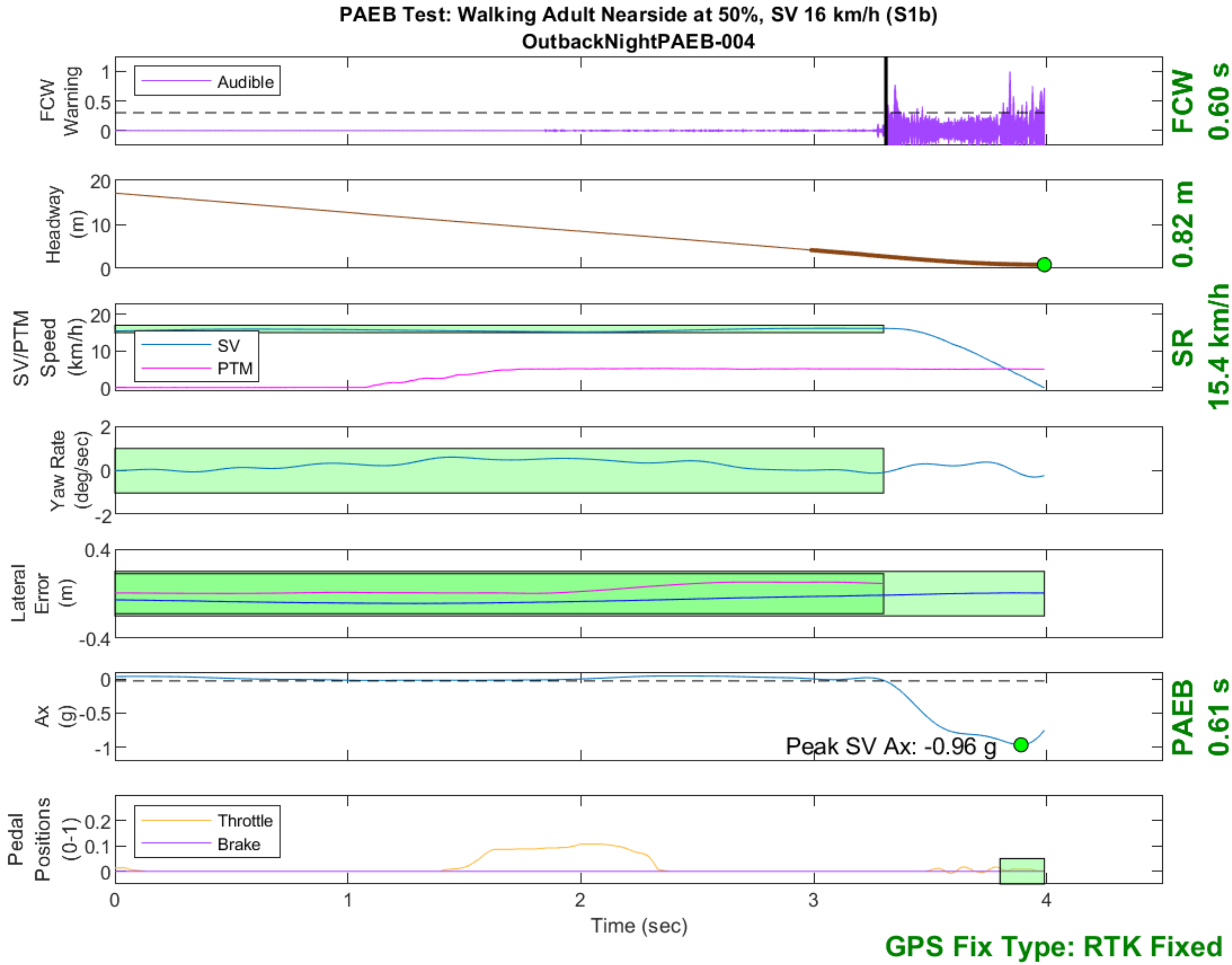


Figure D276. Time History for PAEB Run 4, S1b, Night, Low Beam, 16 km/h

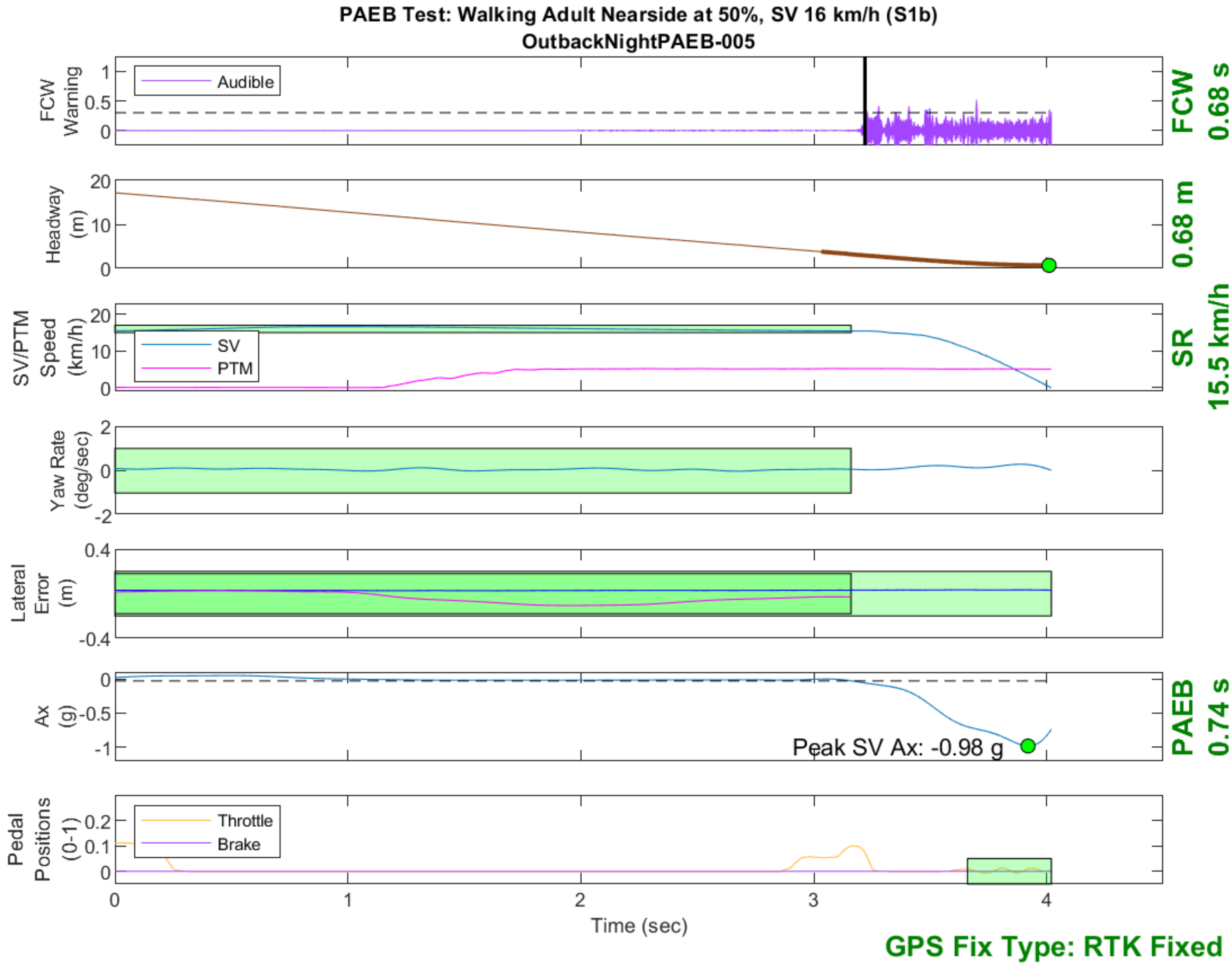


Figure D277. Time History for PAEB Run 5, S1b, Night, Low Beam, 16 km/h

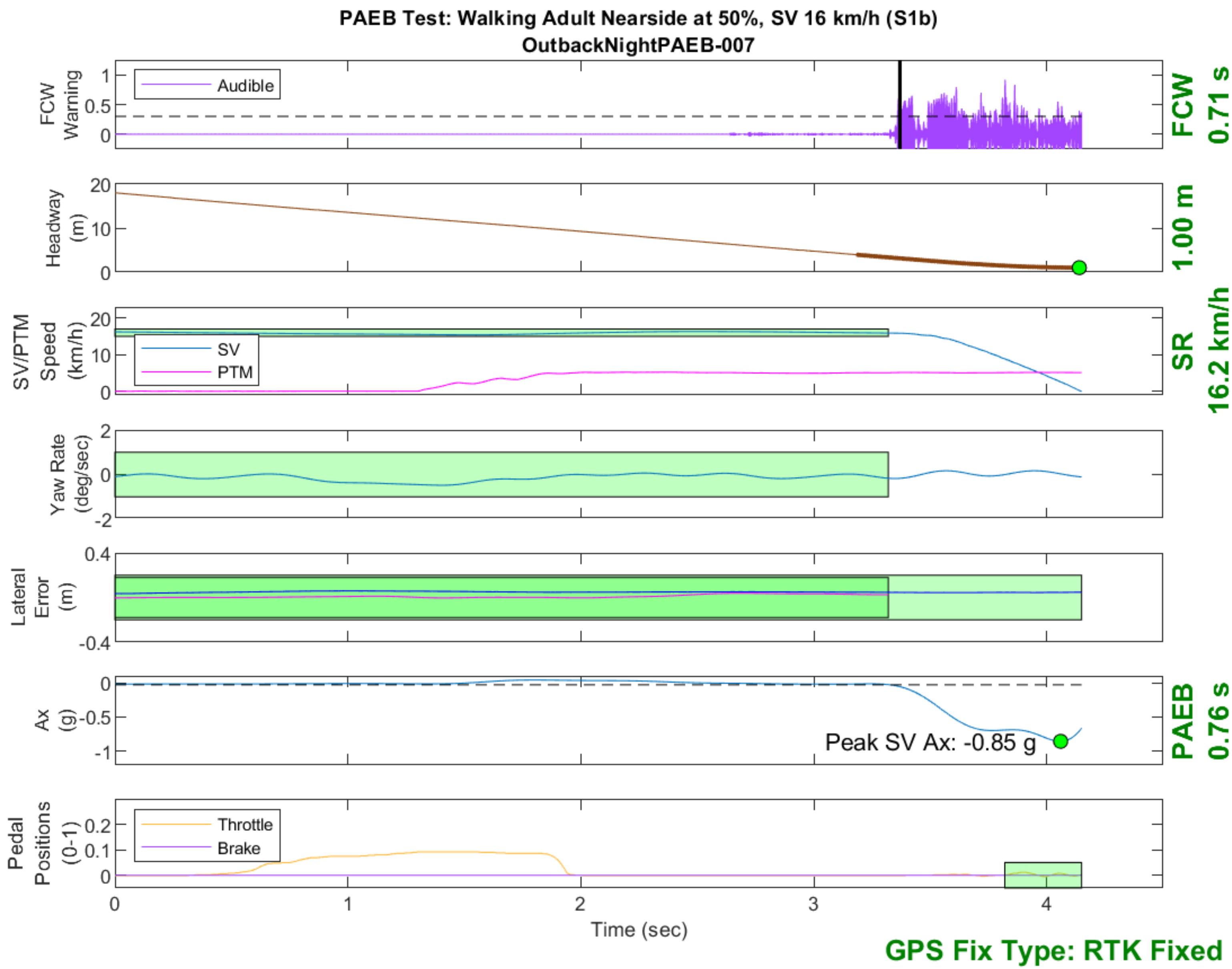


Figure D278. Time History for PAEB Run 7, S1b, Night, Low Beam, 16 km/h

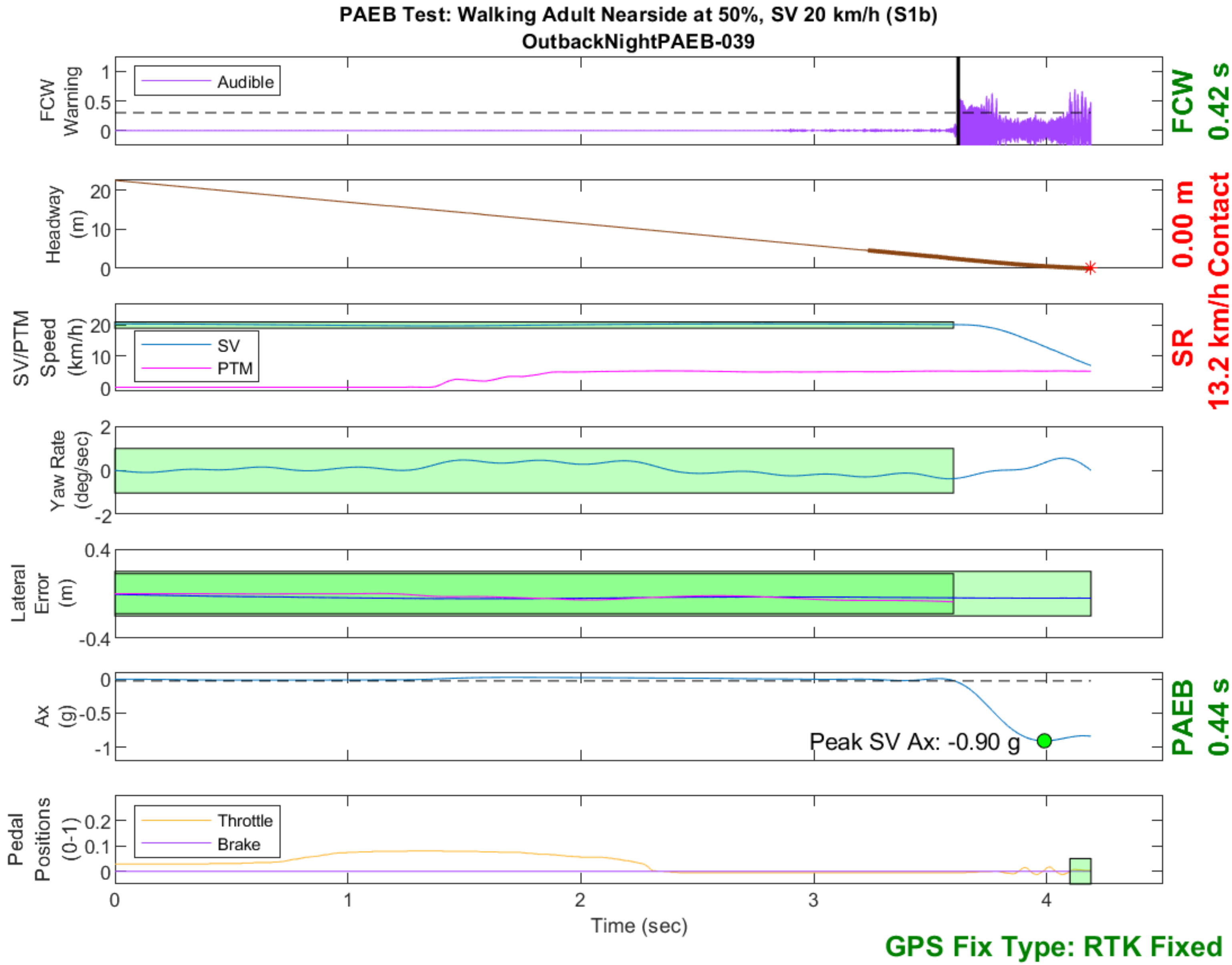


Figure D279. Time History for PAEB Run 39, S1b, Night, Low Beam, 20 km/h

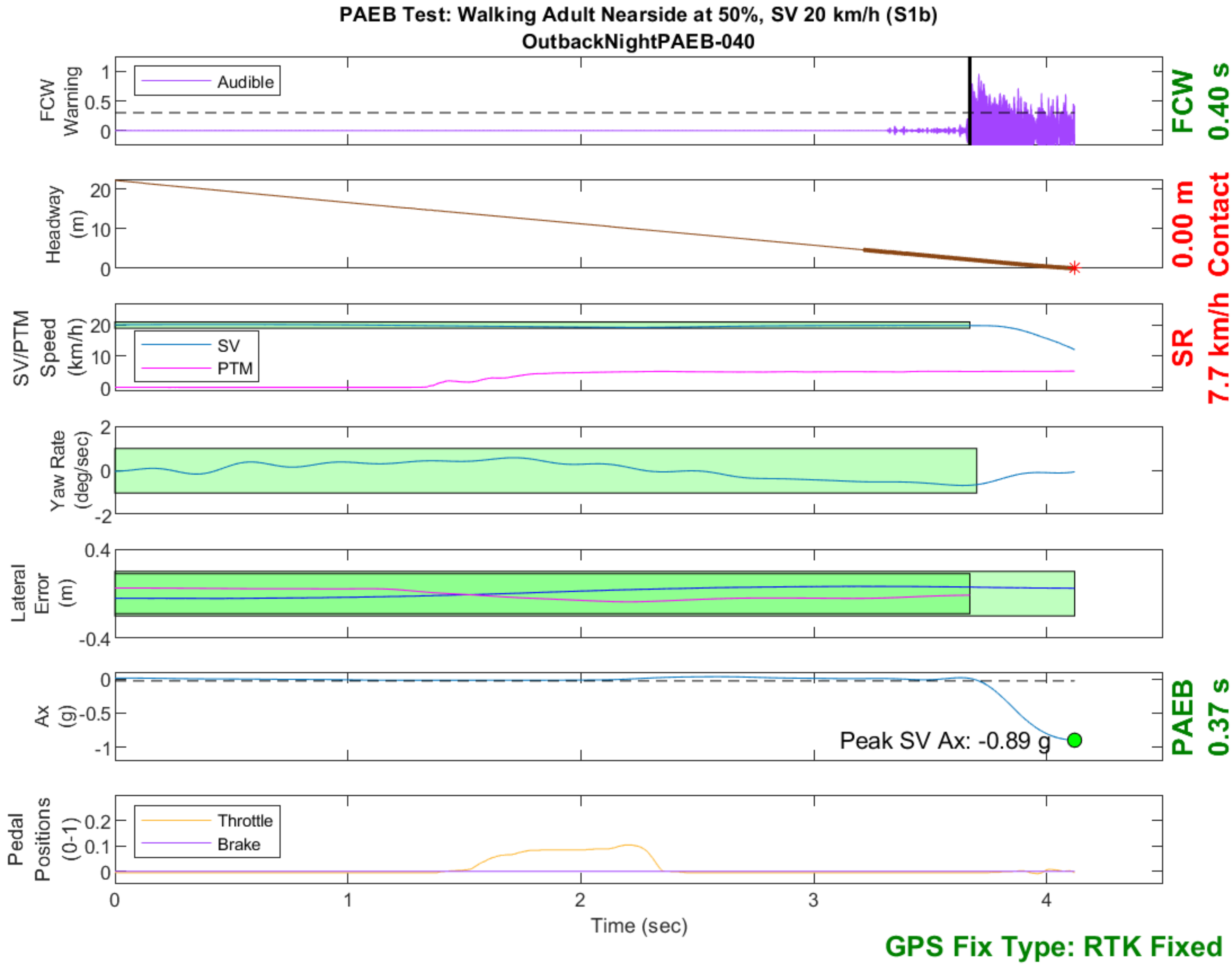


Figure D280. Time History for PAEB Run 40, S1b, Night, Low Beam, 20 km/h

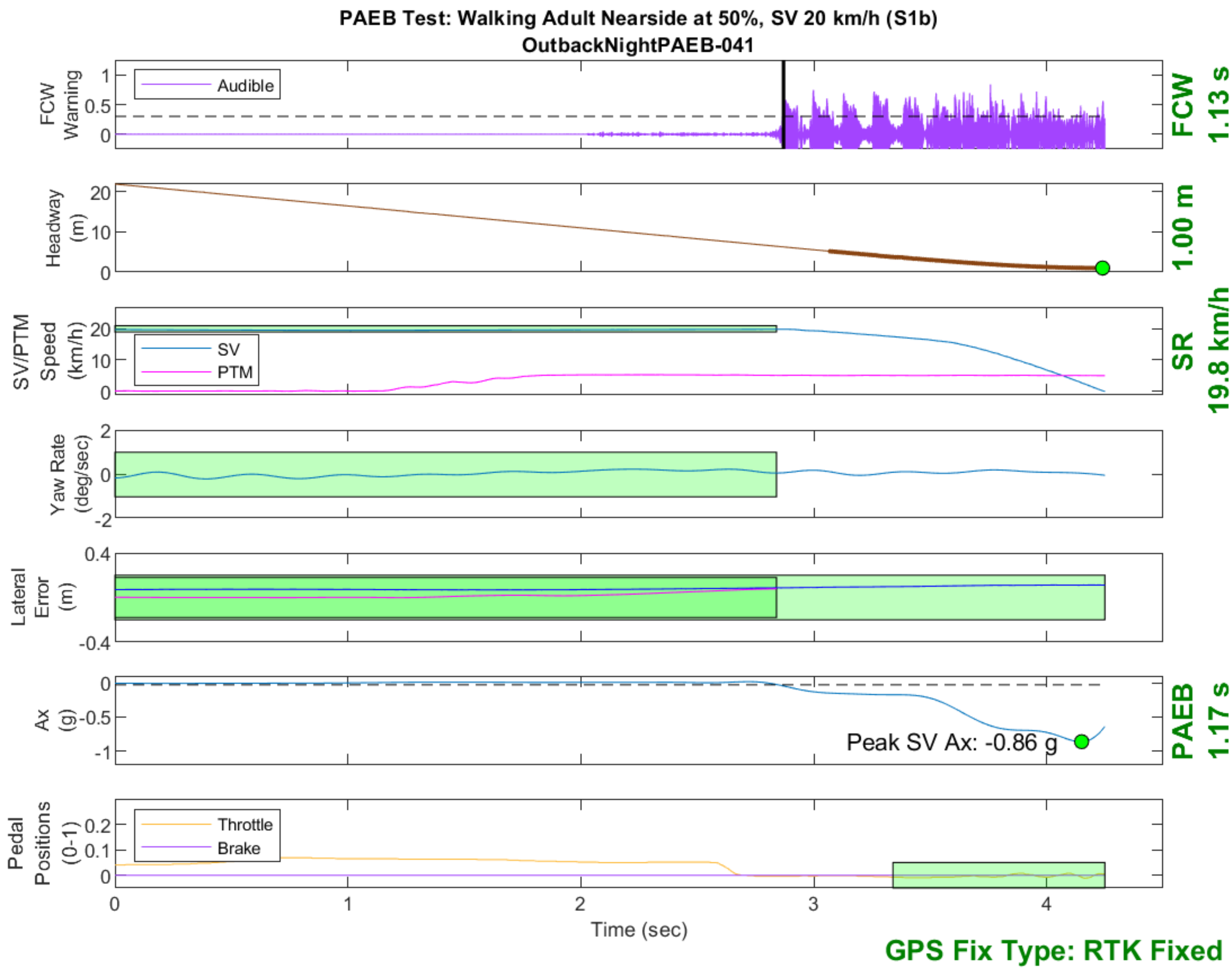


Figure D281. Time History for PAEB Run 41, S1b, Night, Low Beam, 20 km/h

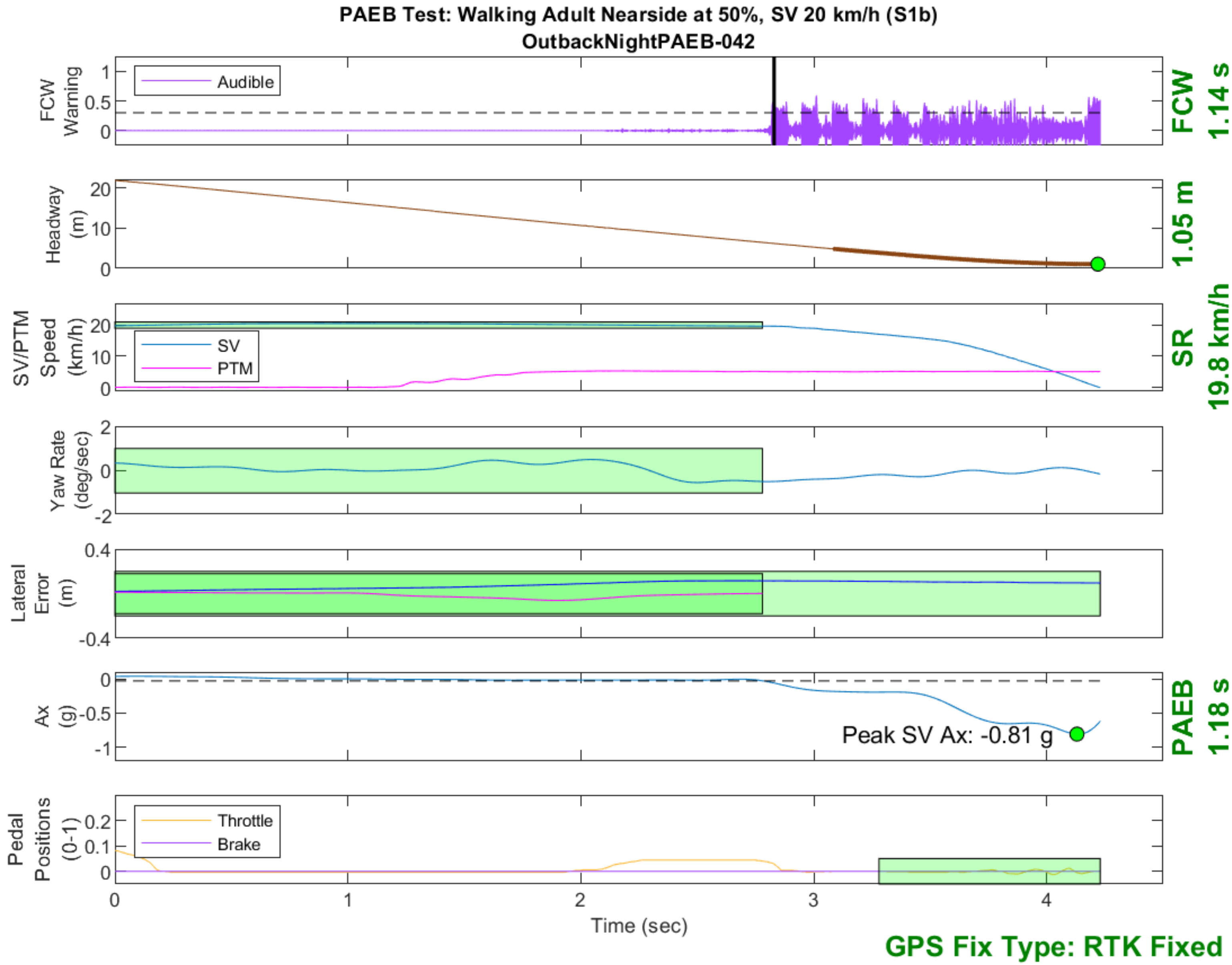


Figure D282. Time History for PAEB Run 42, S1b, Night, Low Beam, 20 km/h

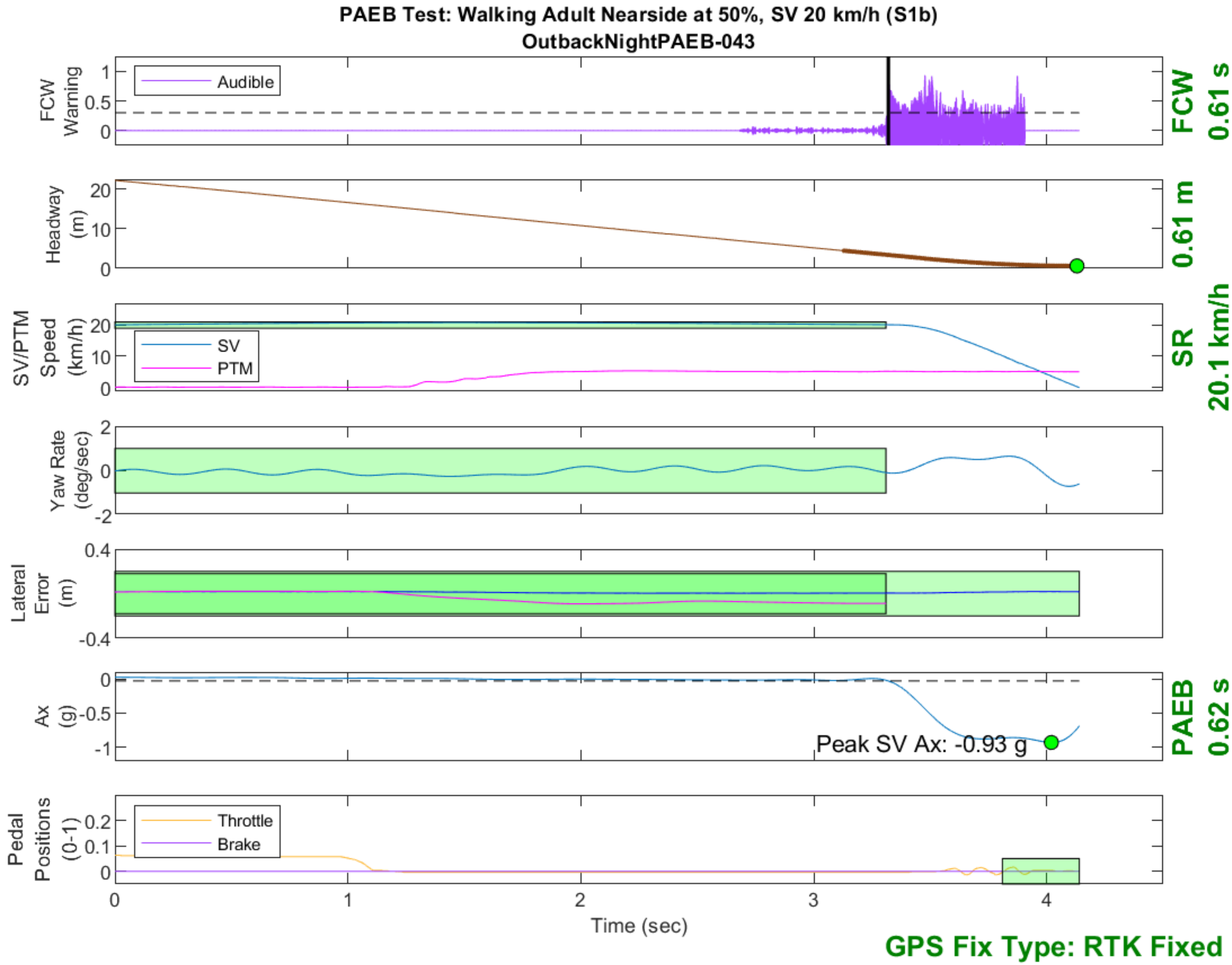


Figure D283. Time History for PAEB Run 43, S1b, Night, Low Beam, 20 km/h

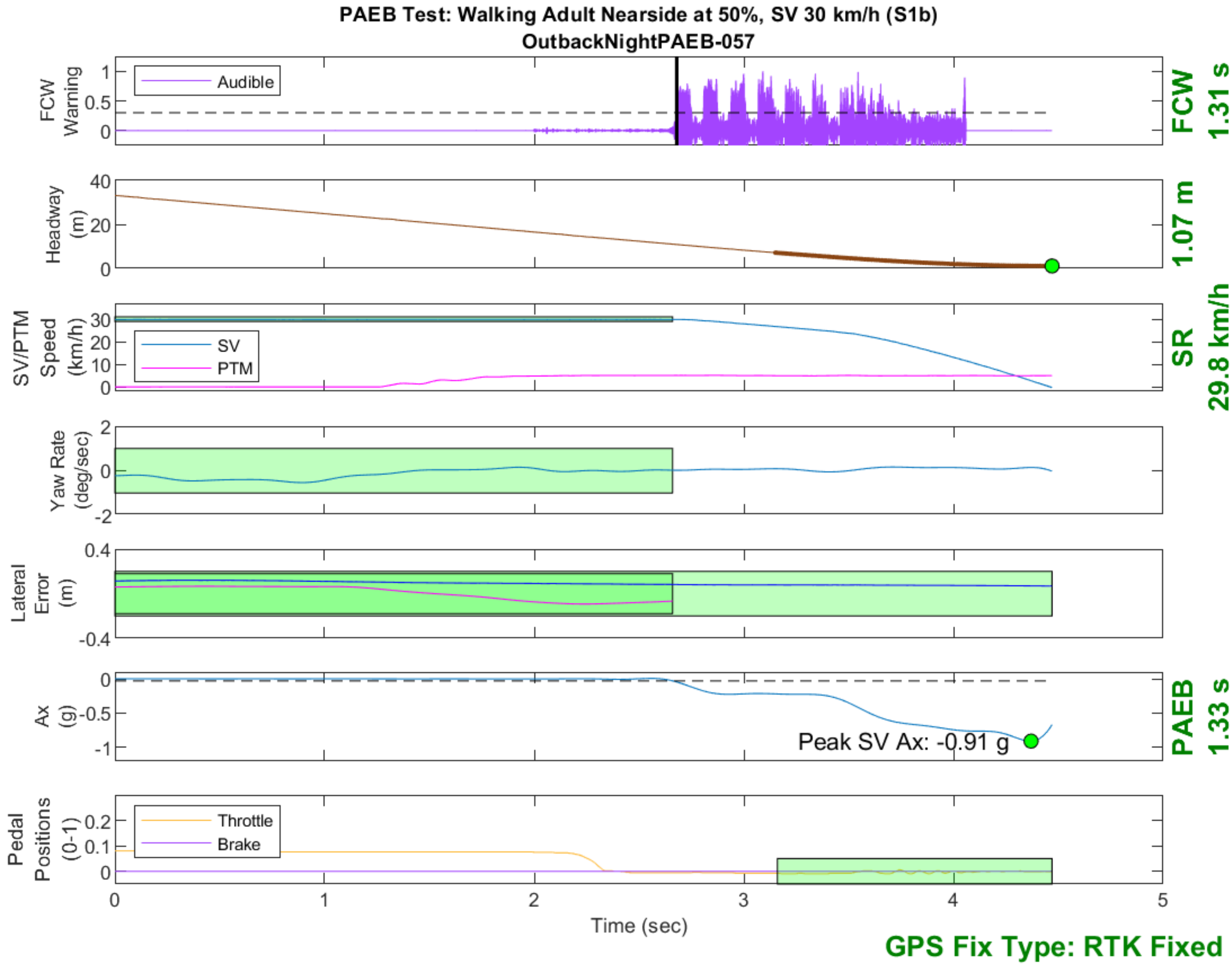


Figure D284. Time History for PAEB Run 57, S1b, Night, Low Beam, 30 km/h

Figure D285. Time History for PAEB Run 58, S1b, Night, Low Beam, 30 km/h

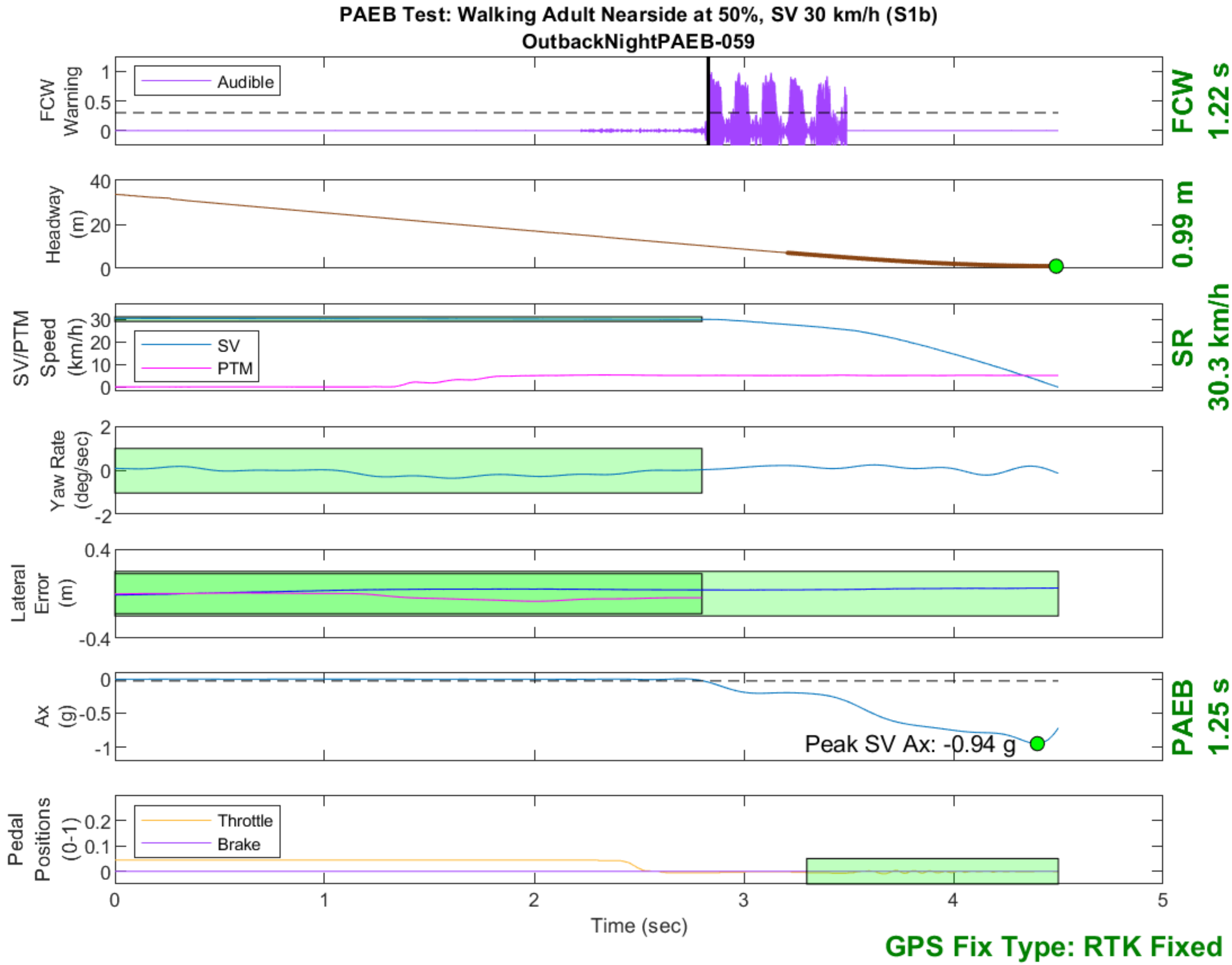


Figure D286. Time History for PAEB Run 59, S1b, Night, Low Beam, 30 km/h

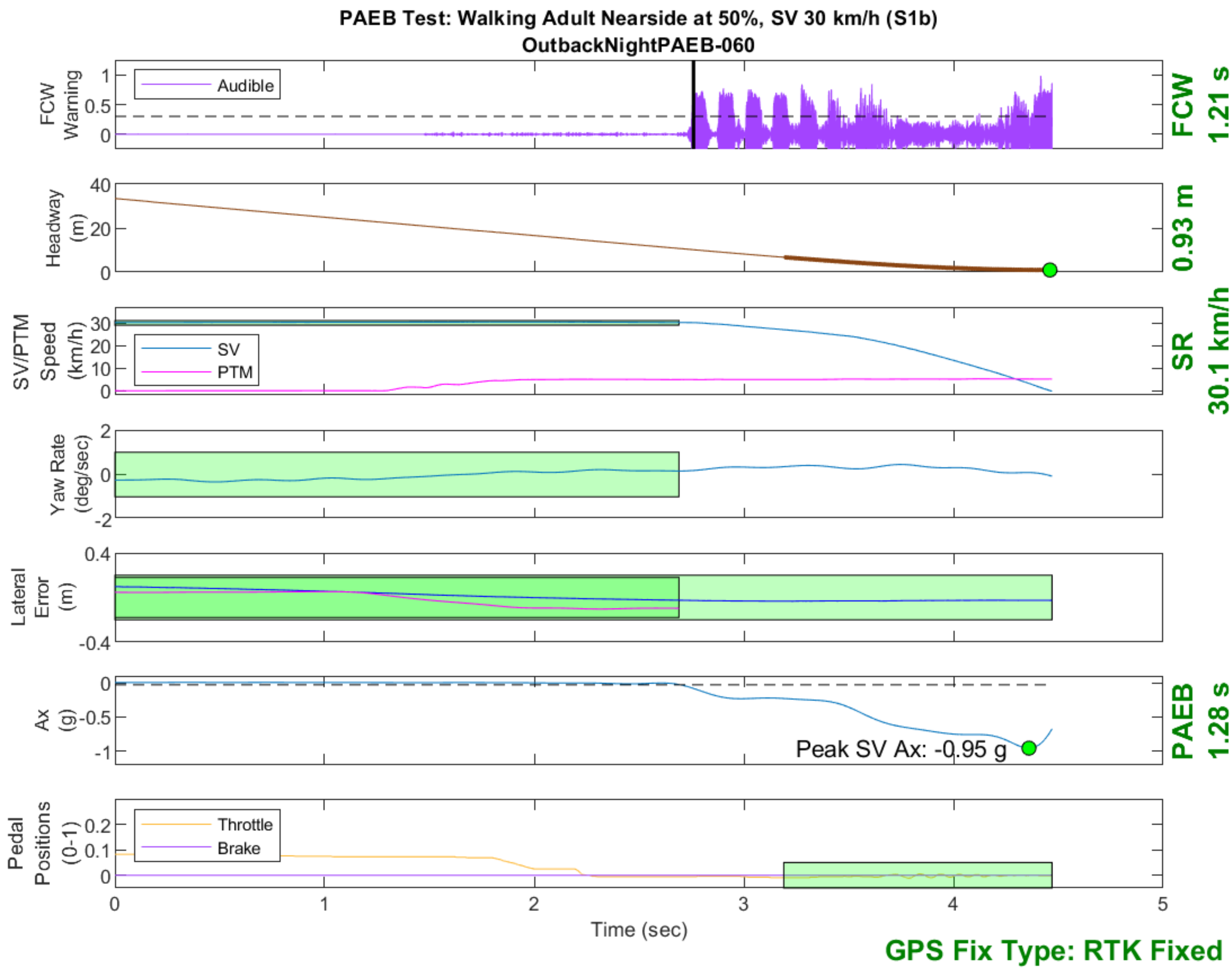


Figure D287. Time History for PAEB Run 60, S1b, Night, Low Beam, 30 km/h

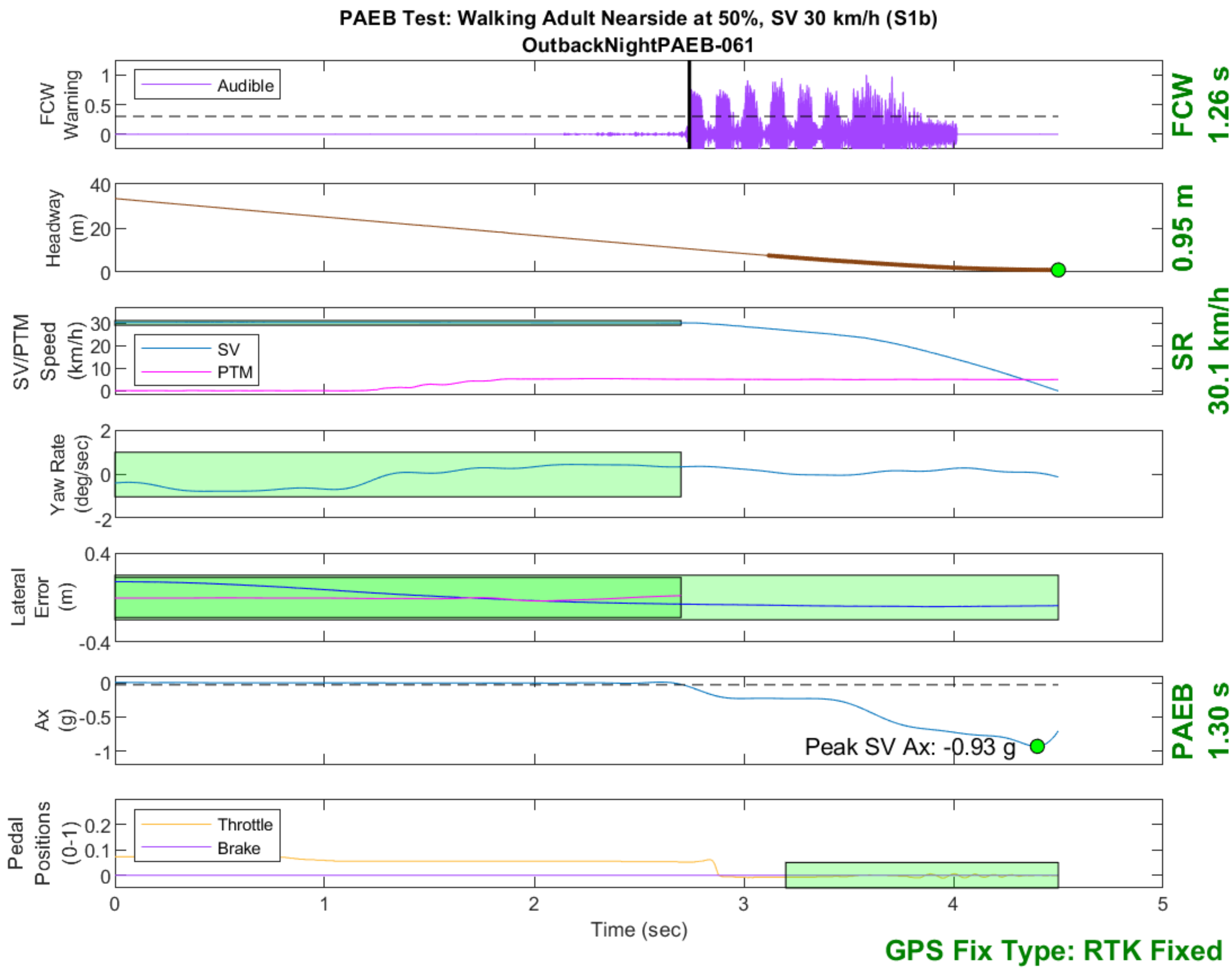


Figure D288. Time History for PAEB Run 61, S1b, Night, Low Beam, 30 km/h

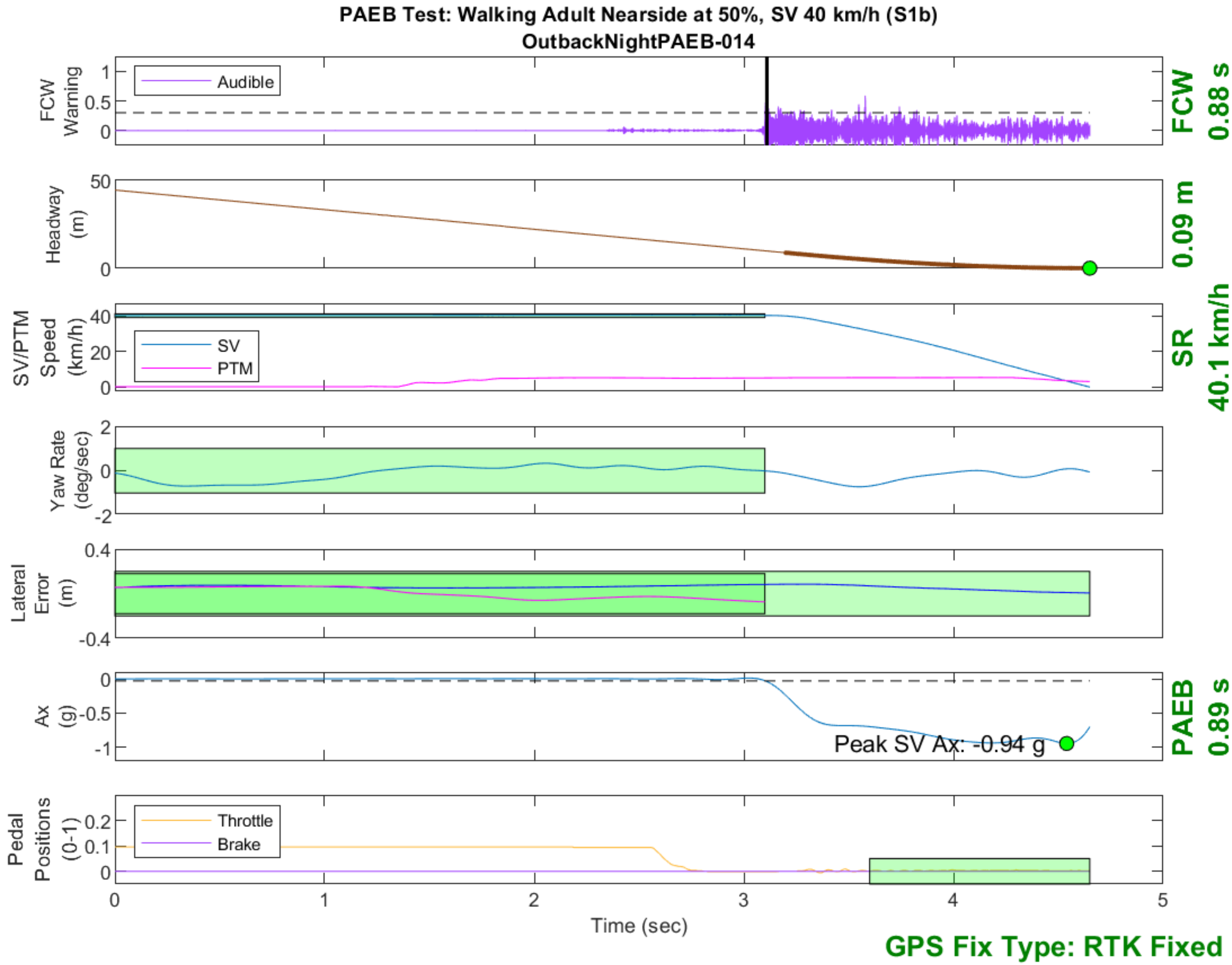


Figure D289. Time History for PAEB Run 14, S1b, Night, Low Beam, 40 km/h

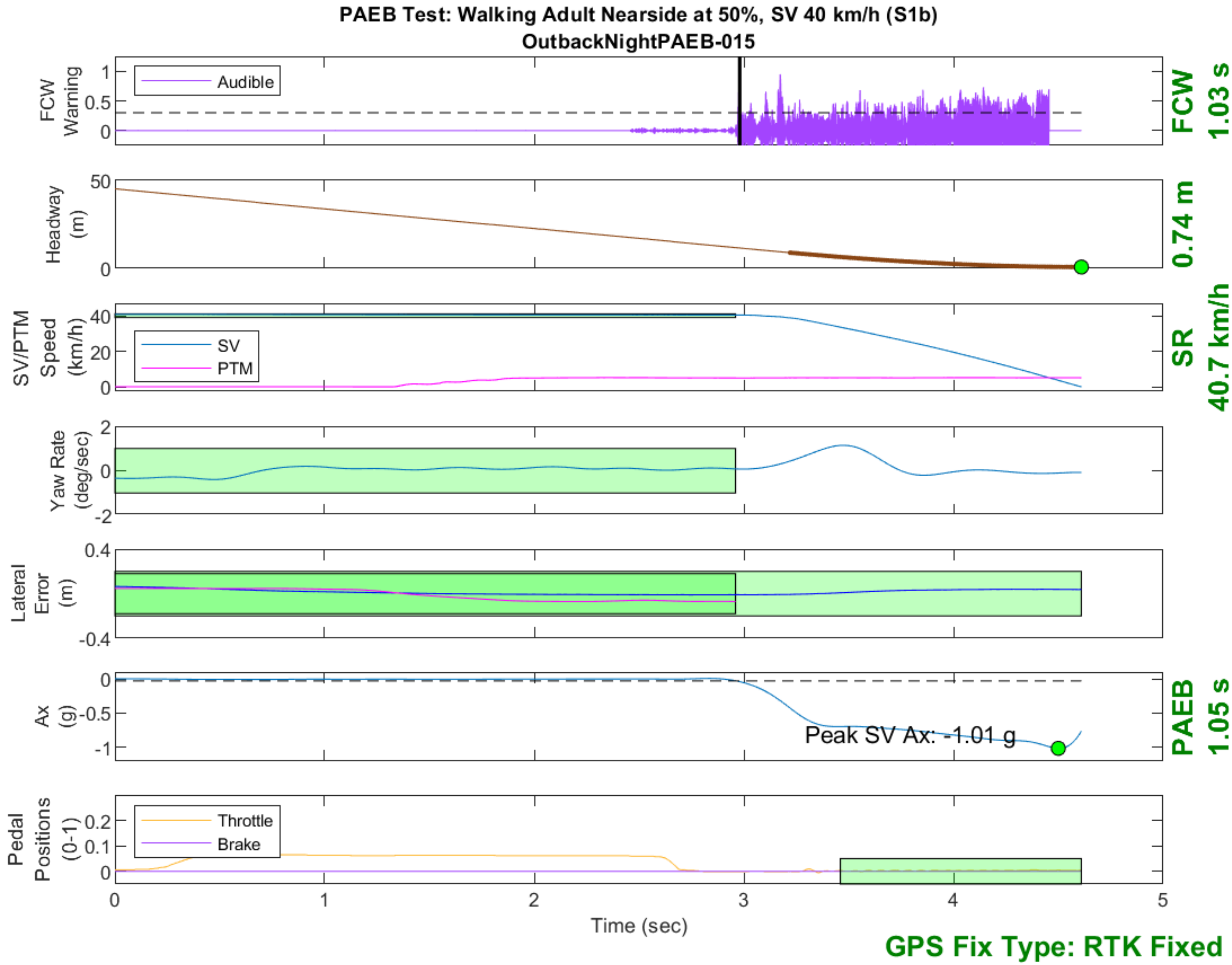


Figure D290. Time History for PAEB Run 15, S1b, Night, Low Beam, 40 km/h

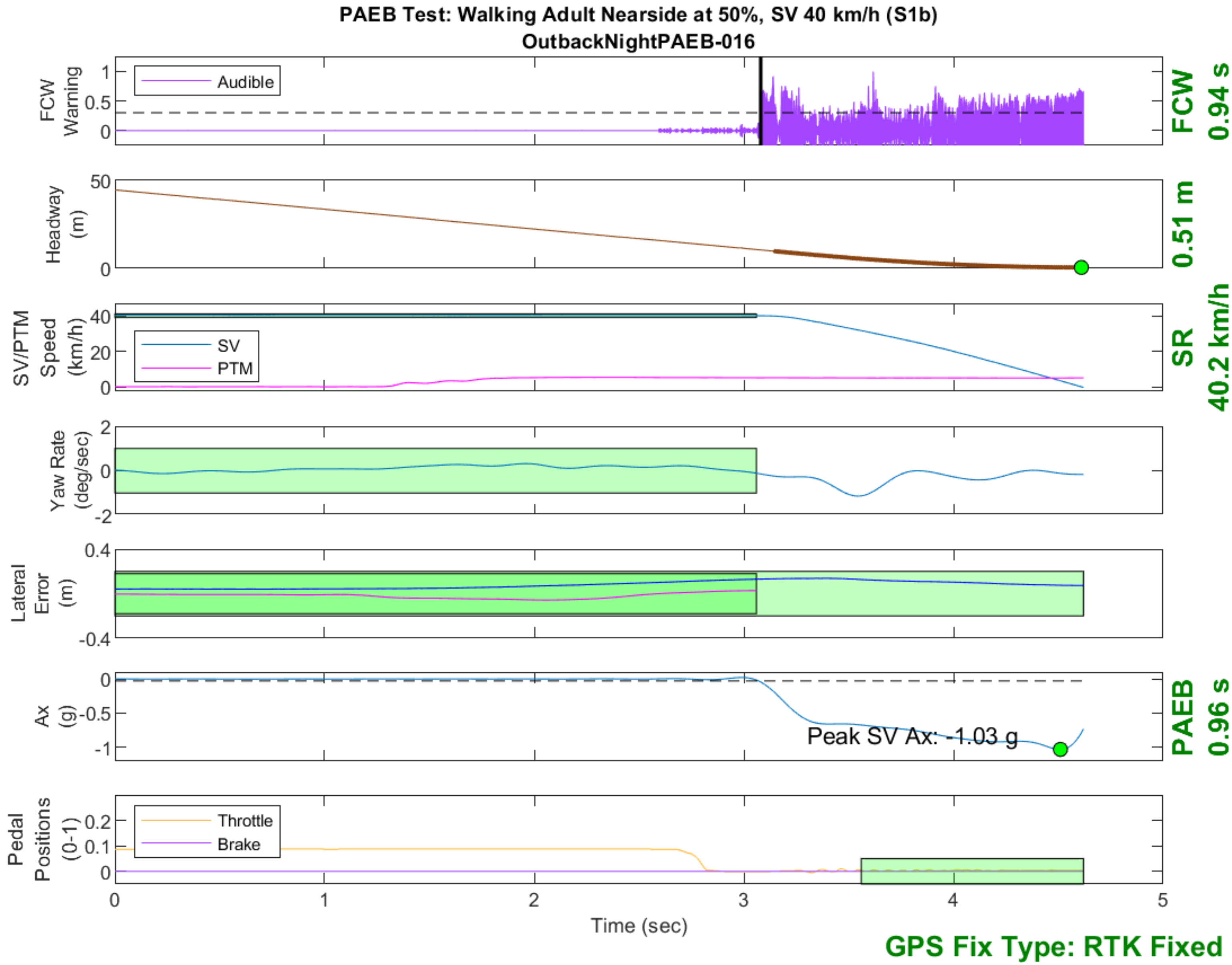


Figure D291. Time History for PAEB Run 16, S1b, Night, Low Beam, 40 km/h

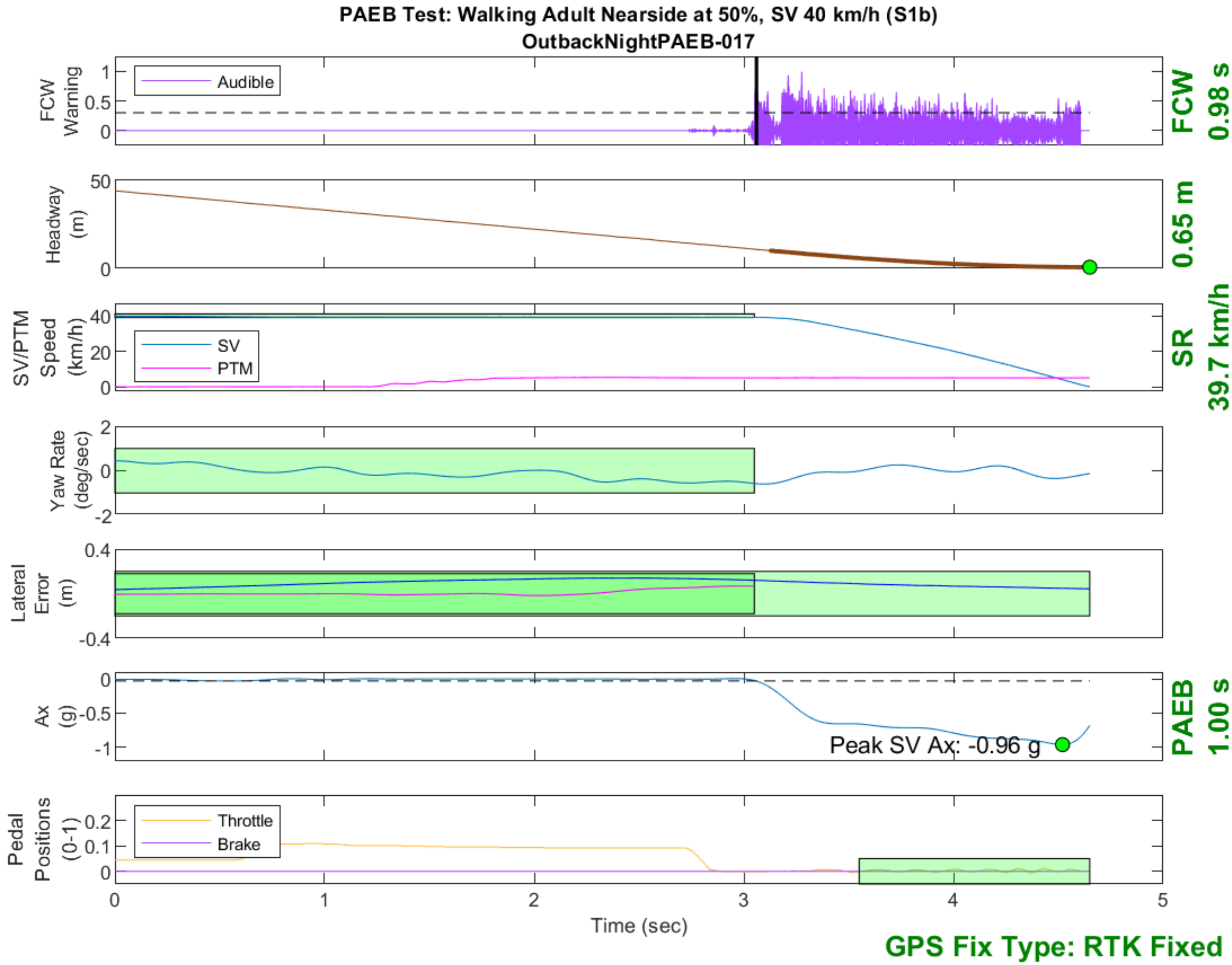


Figure D292. Time History for PAEB Run 17, S1b, Night, Low Beam, 40 km/h

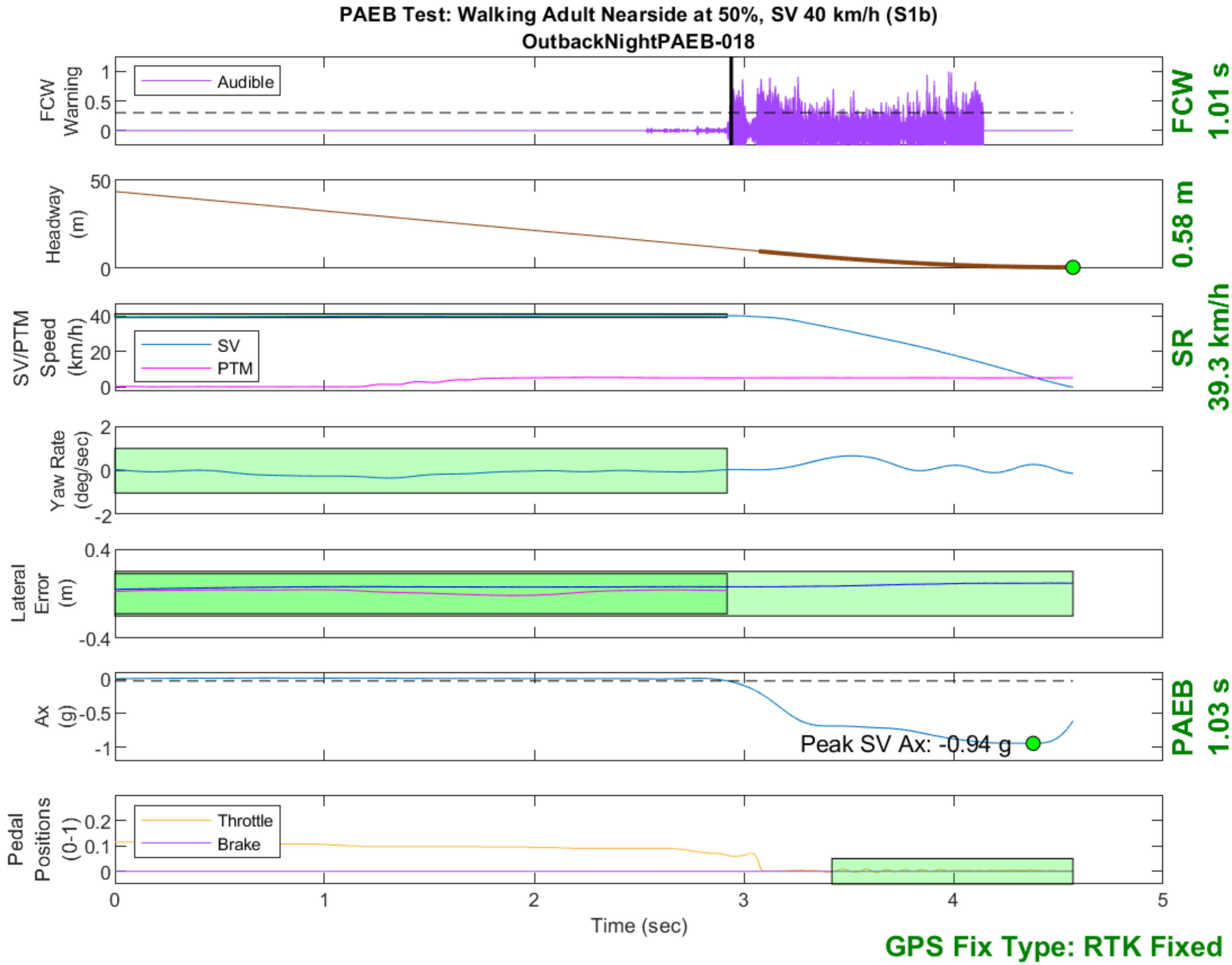


Figure D293. Time History for PAEB Run 18, S1b, Night, Low Beam, 40 km/h

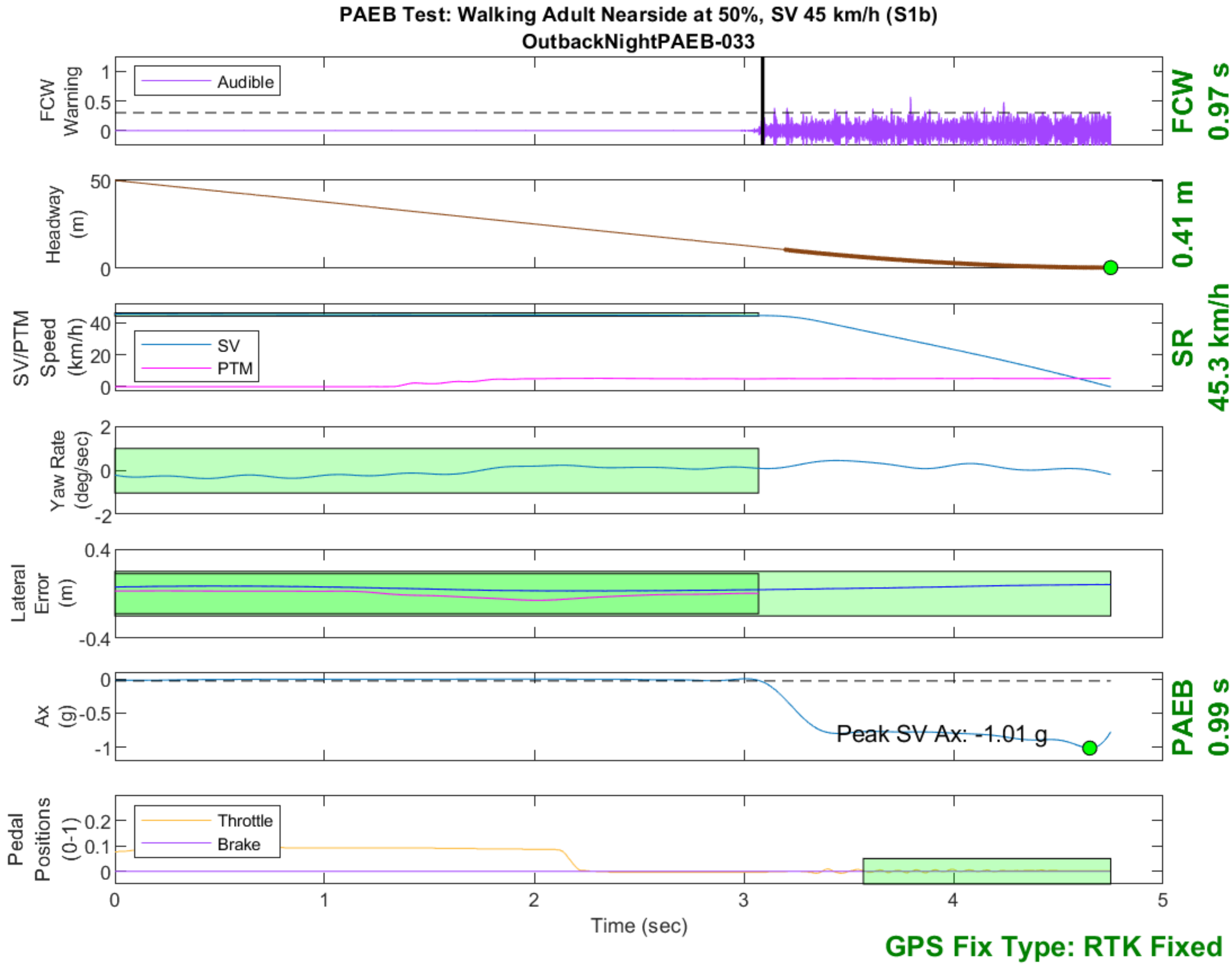


Figure D294. Time History for PAEB Run 33, S1b, Night, Low Beam, 45 km/h

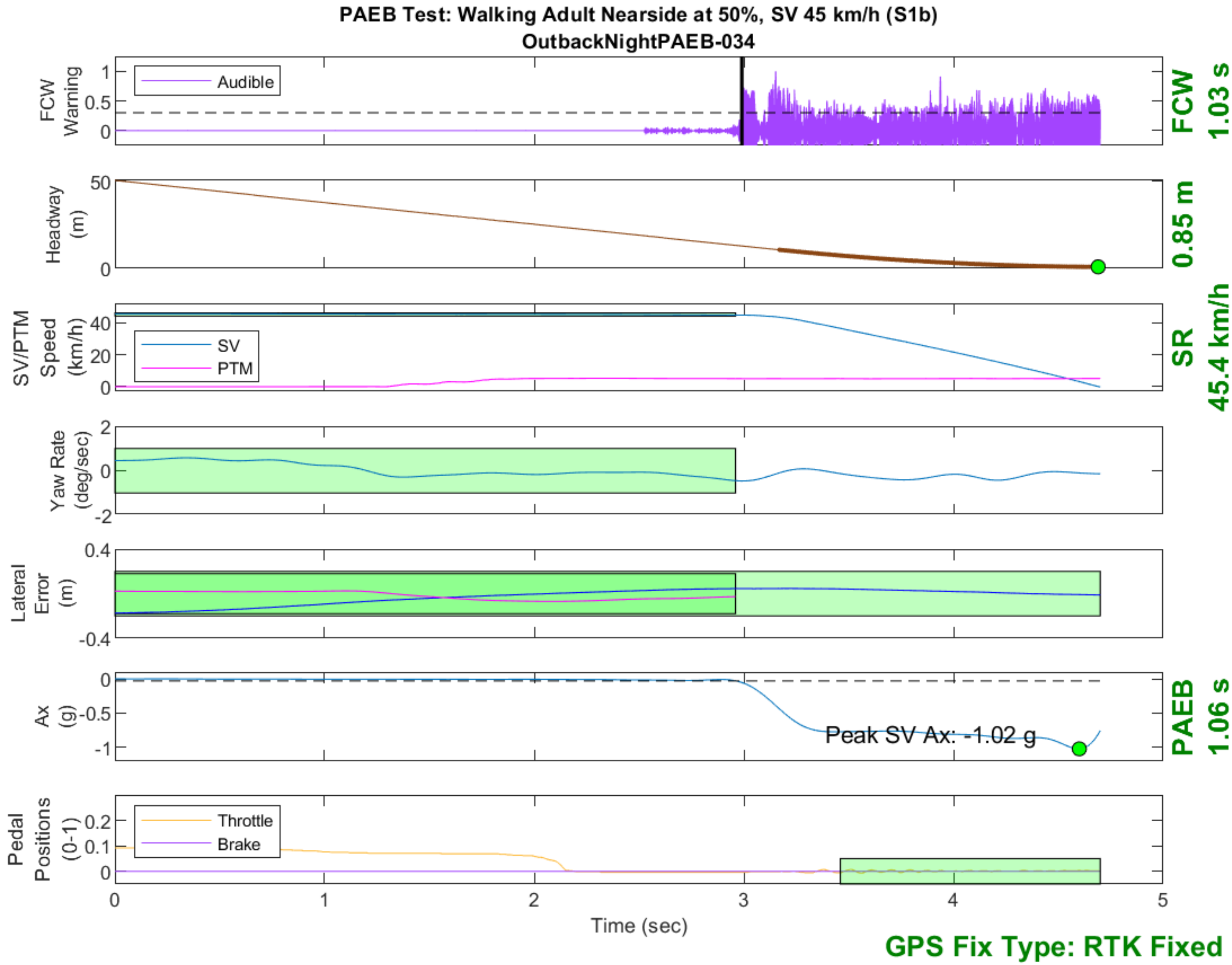


Figure D295. Time History for PAEB Run 34, S1b, Night, Low Beam, 45 km/h

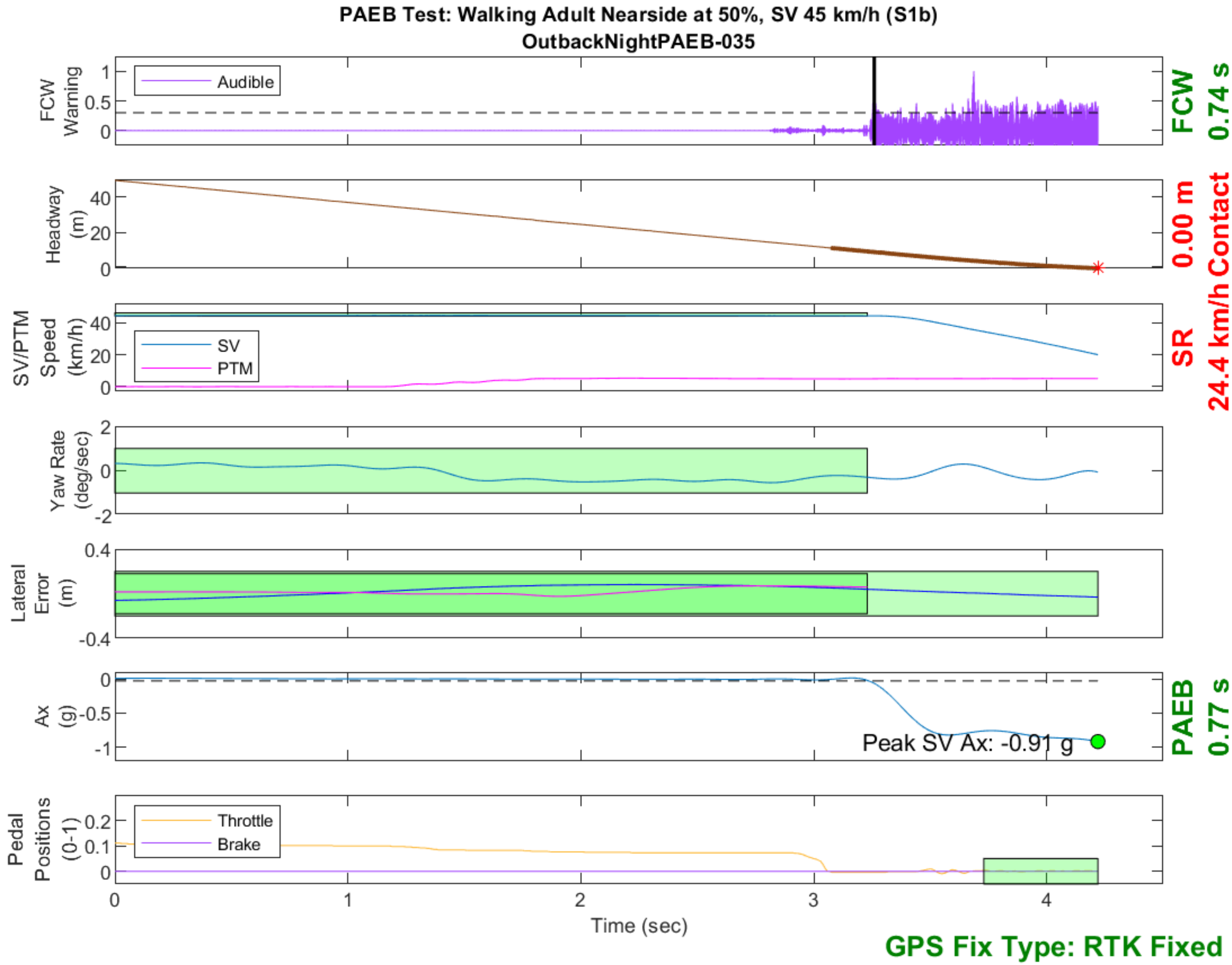


Figure D296. Time History for PAEB Run 35, S1b, Night, Low Beam, 45 km/h

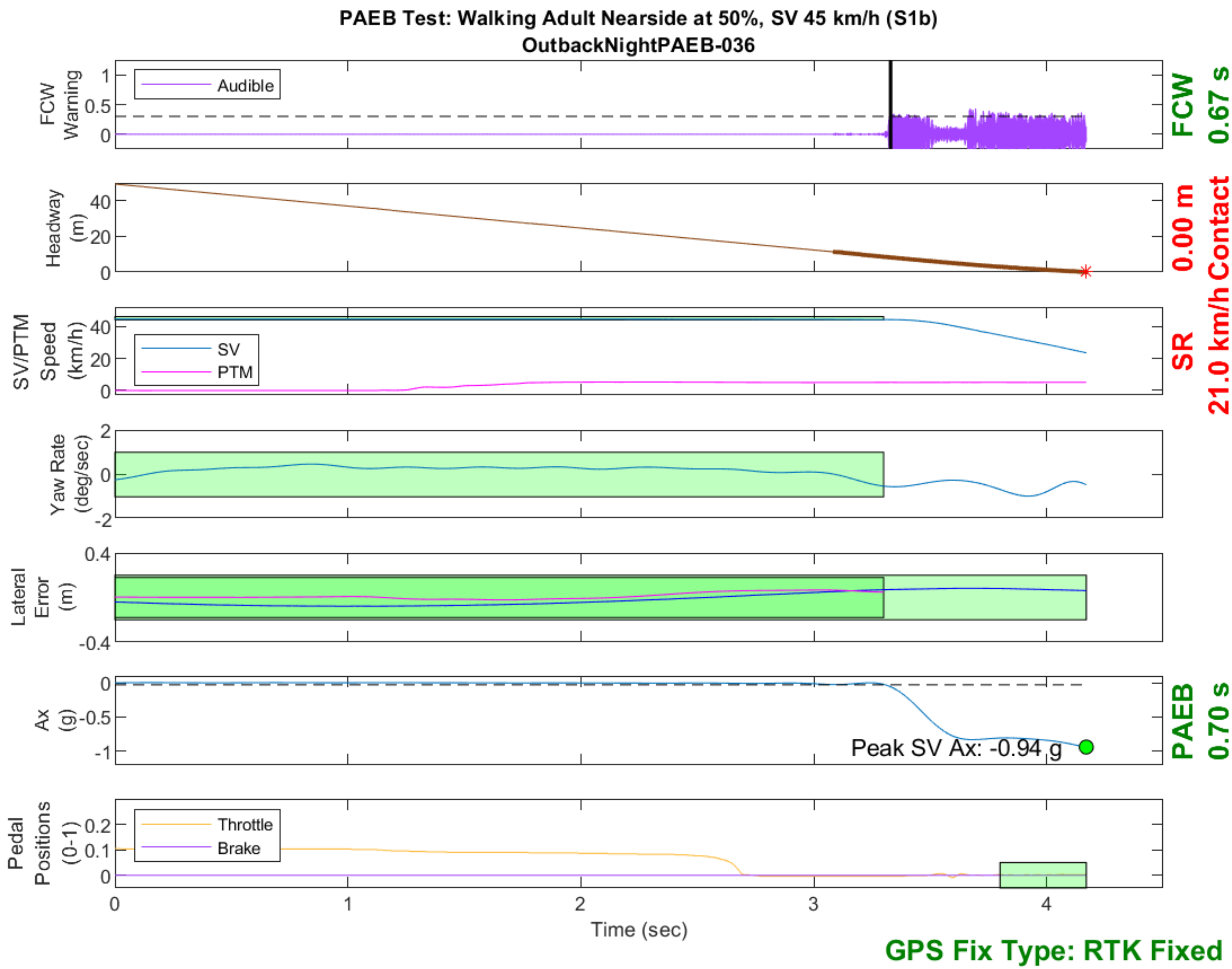


Figure D297. Time History for PAEB Run 36, S1b, Night, Low Beam, 45 km/h

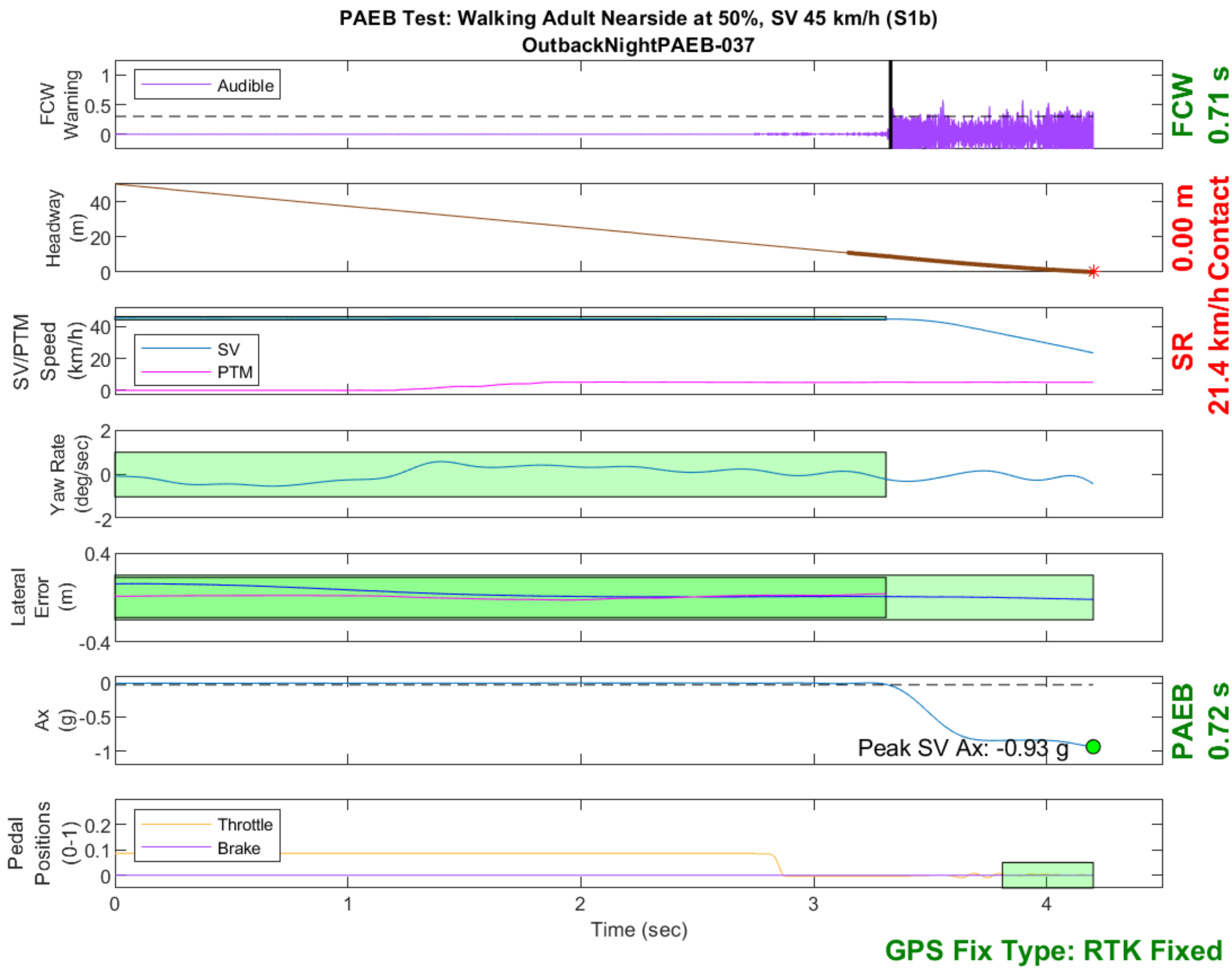


Figure D298. Time History for PAEB Run 37, S1b, Night, Low Beam, 45 km/h

Figure D299. Time History for PAEB Run 30, S1b, Night, Low Beam, 50 km/h

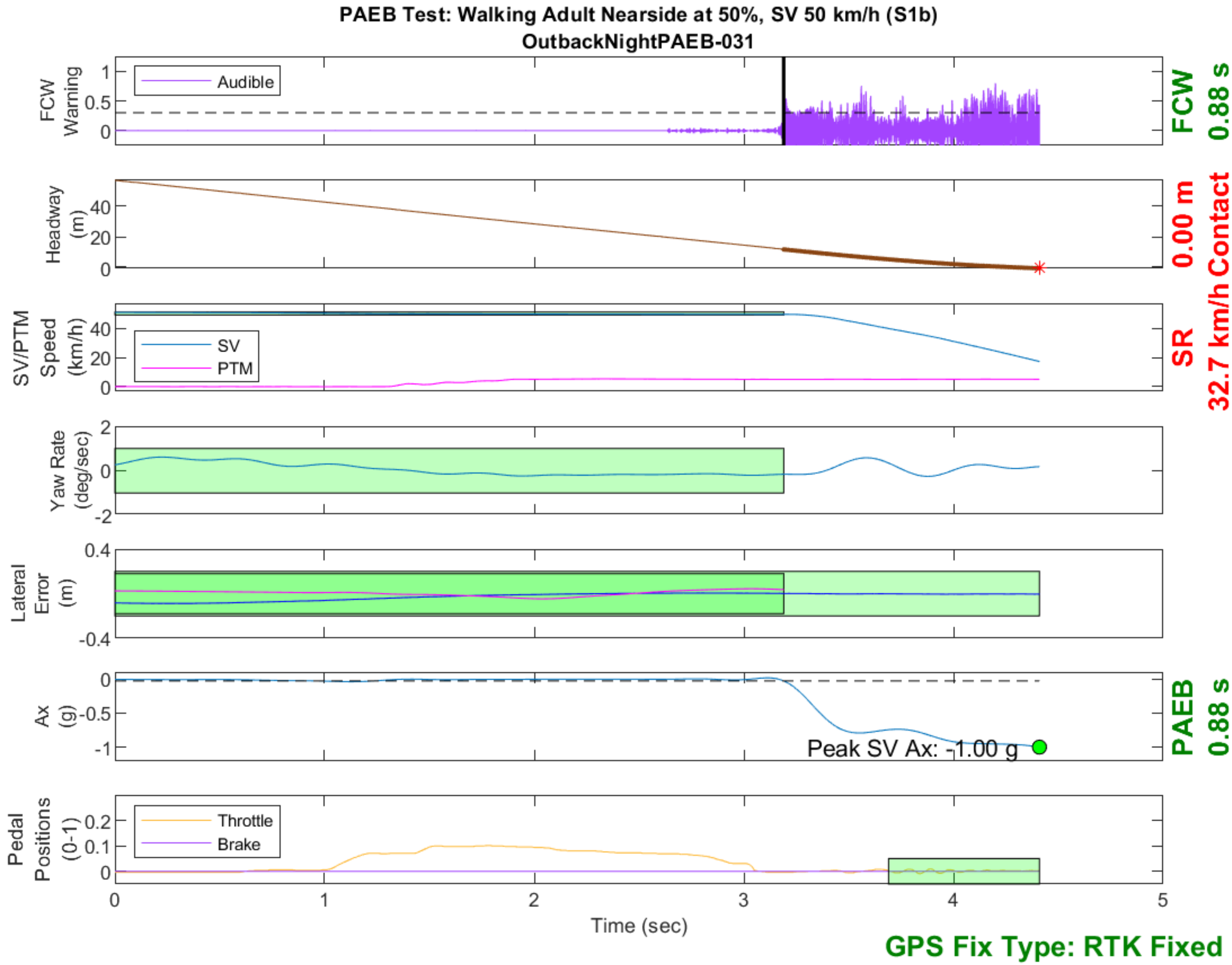


Figure D300. Time History for PAEB Run 31, S1b, Night, Low Beam, 50 km/h

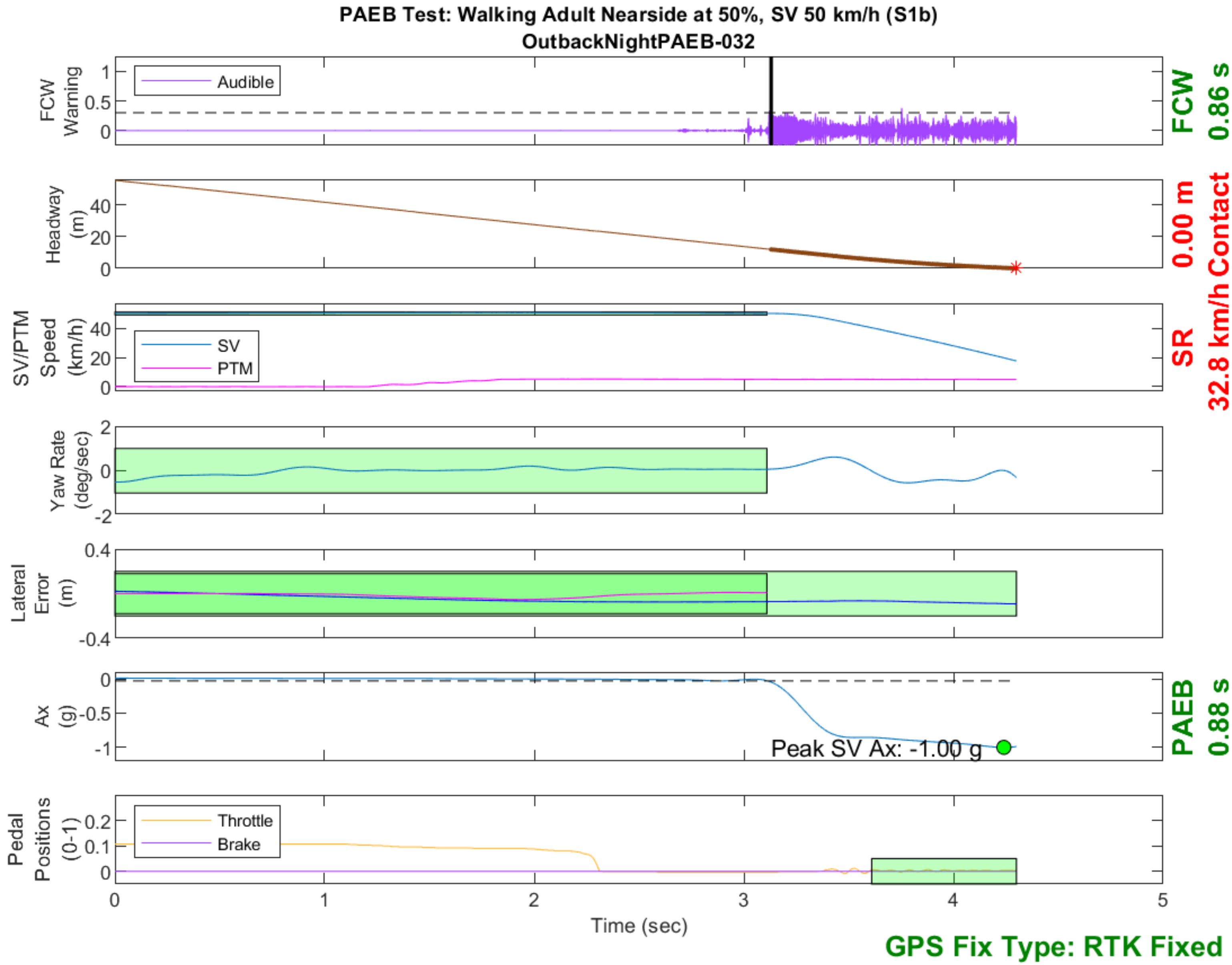


Figure D301. Time History for PAEB Run 32, S1b, Night, Low Beam, 50 km/h

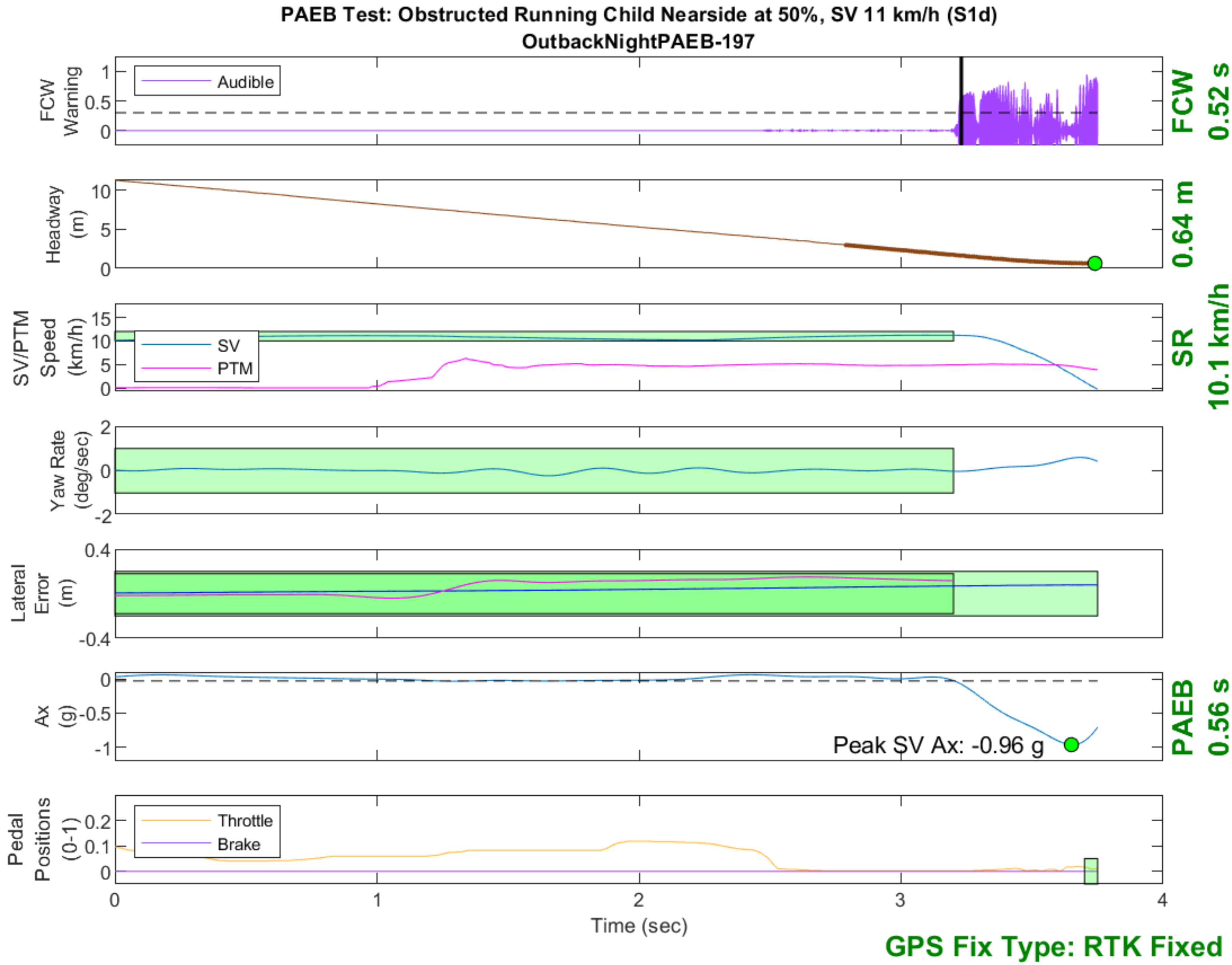


Figure D302. Time History for PAEB Run 197, S1d, Night, Low Beam, 11 km/h

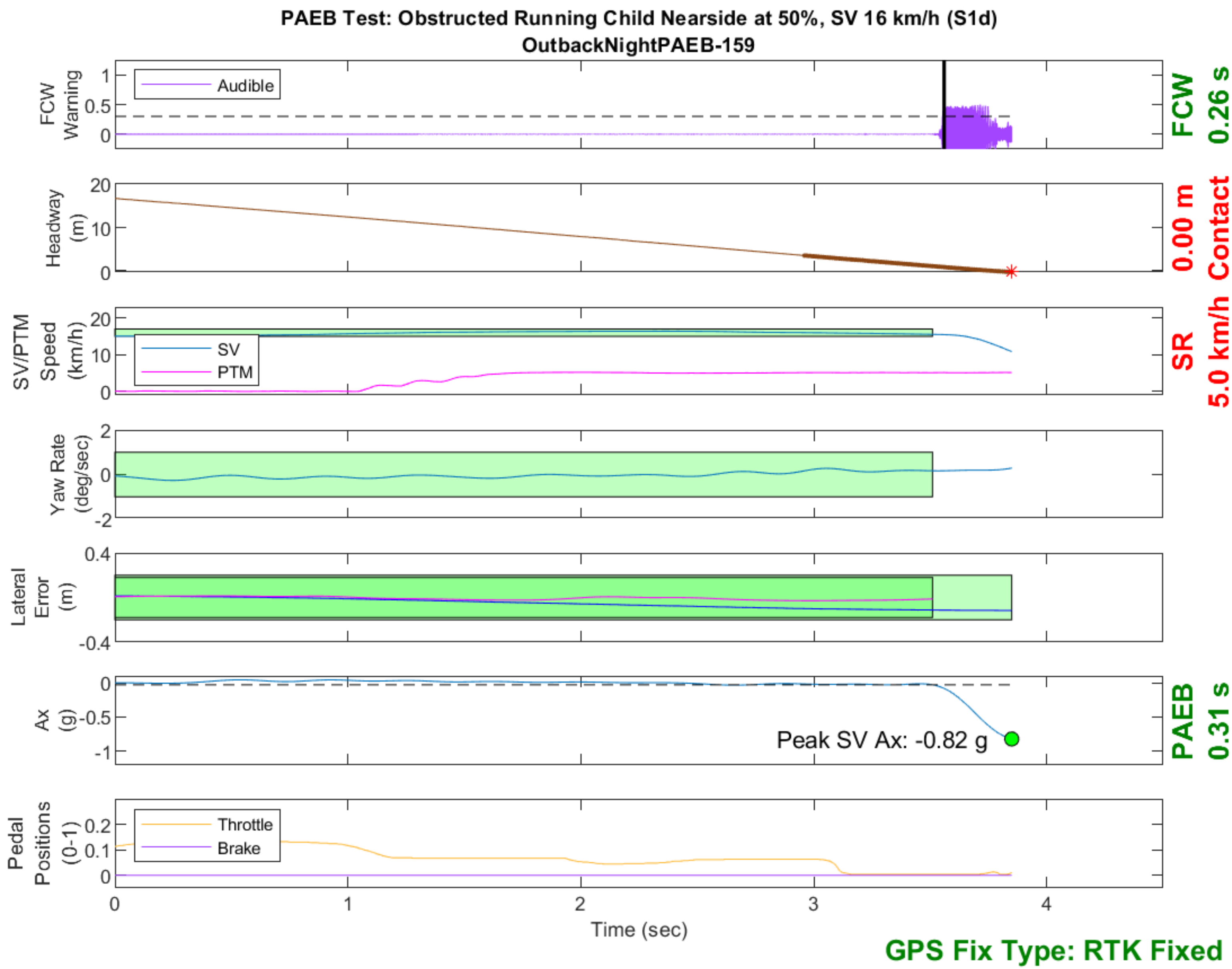


Figure D303. Time History for PAEB Run 159, S1d, Night, Low Beam, 16 km/h

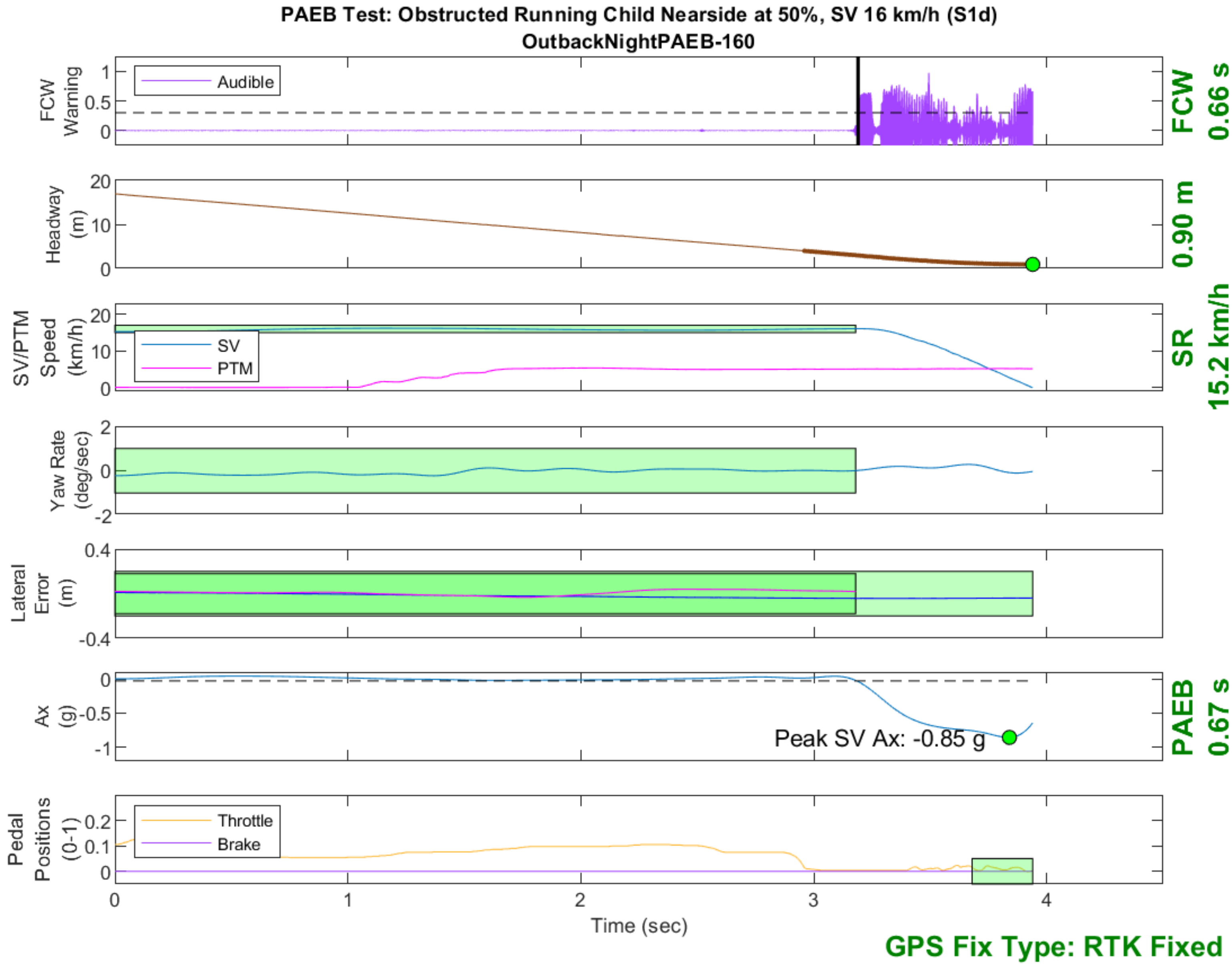


Figure D304. Time History for PAEB Run 160, S1d, Night, Low Beam, 16 km/h

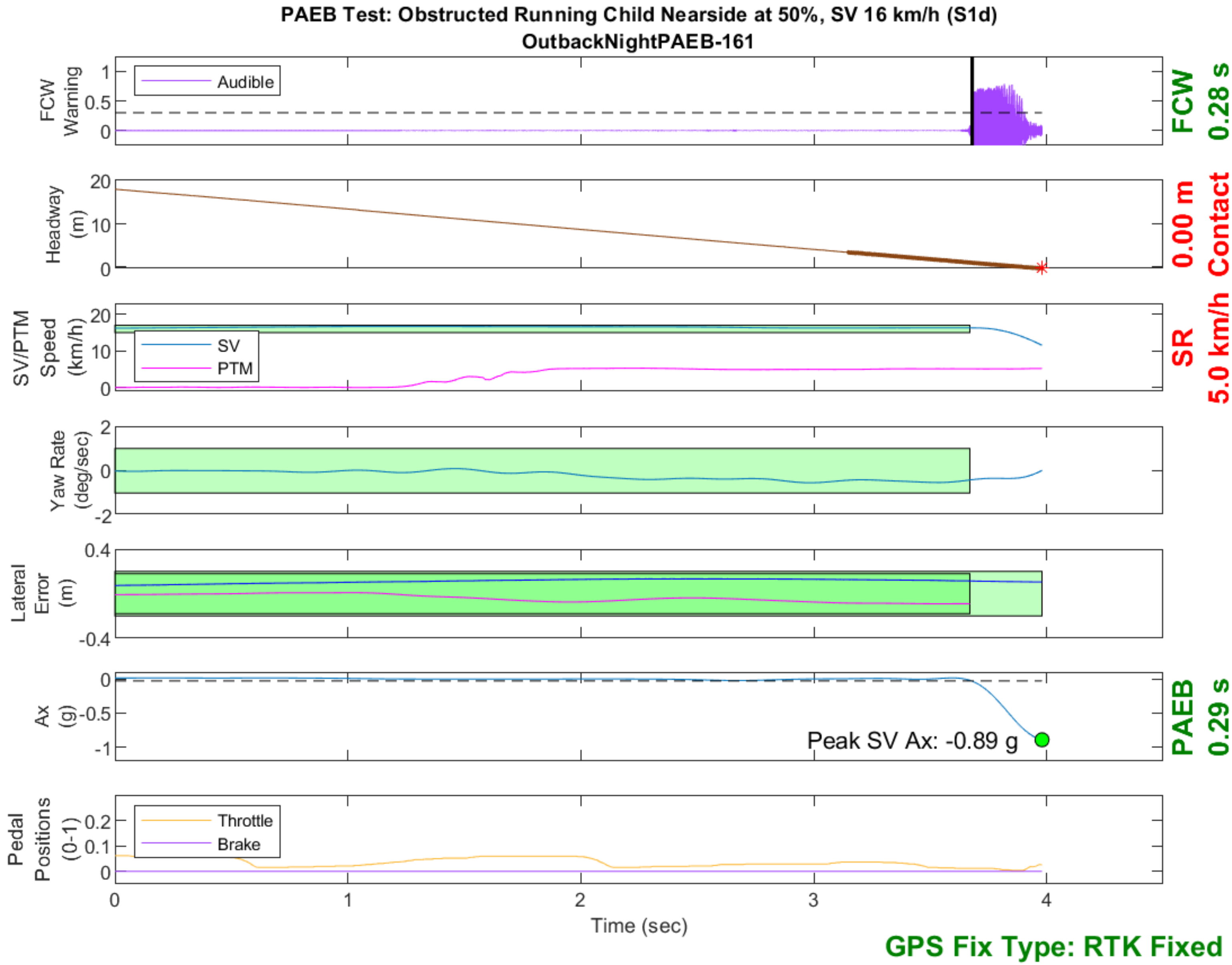


Figure D305. Time History for PAEB Run 161, S1d, Night, Low Beam, 16 km/h

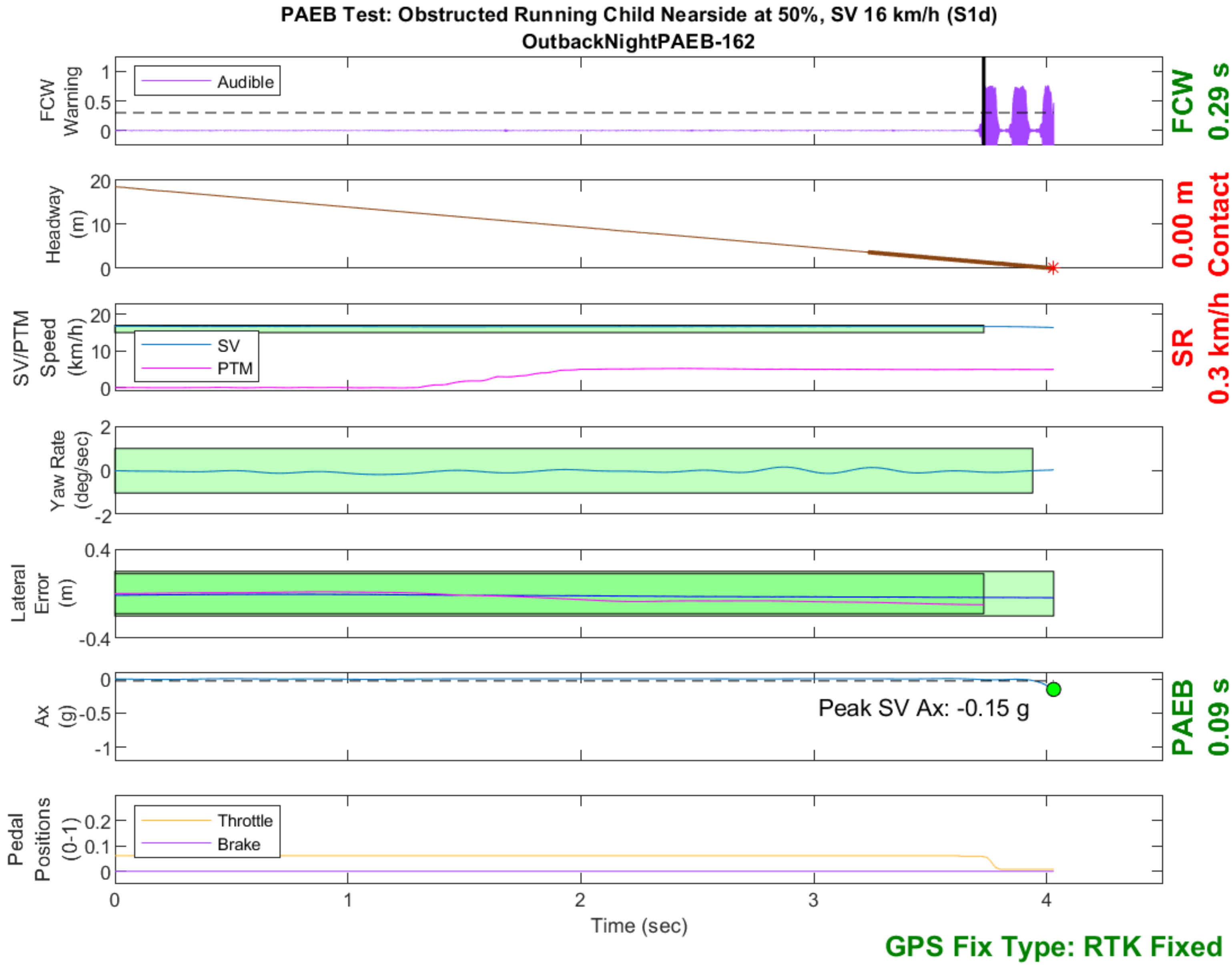


Figure D306. Time History for PAEB Run 162, S1d, Night, Low Beam, 16 km/h

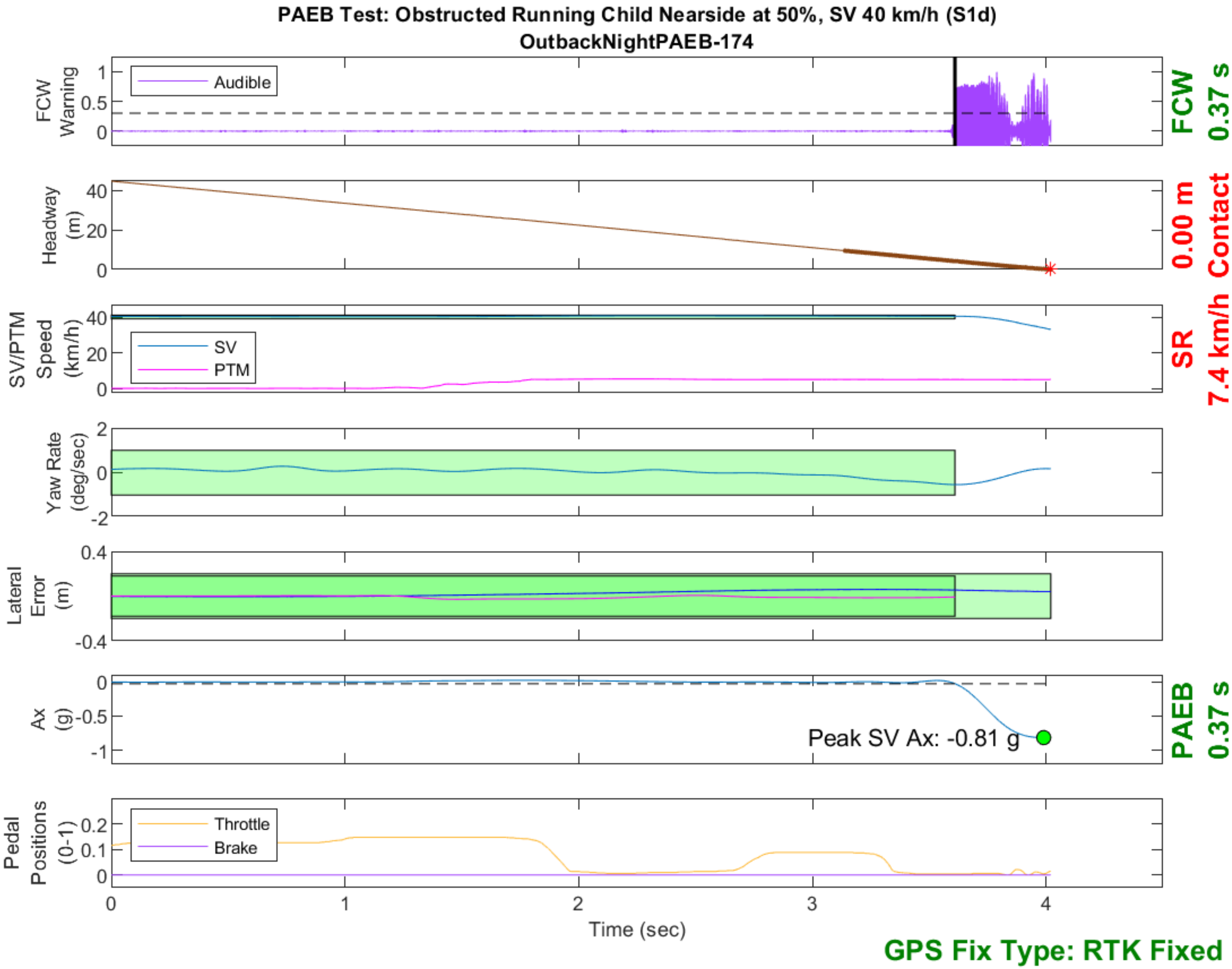


Figure D307. Time History for PAEB Run 174, S1d, Night, Low Beam, 40 km/h

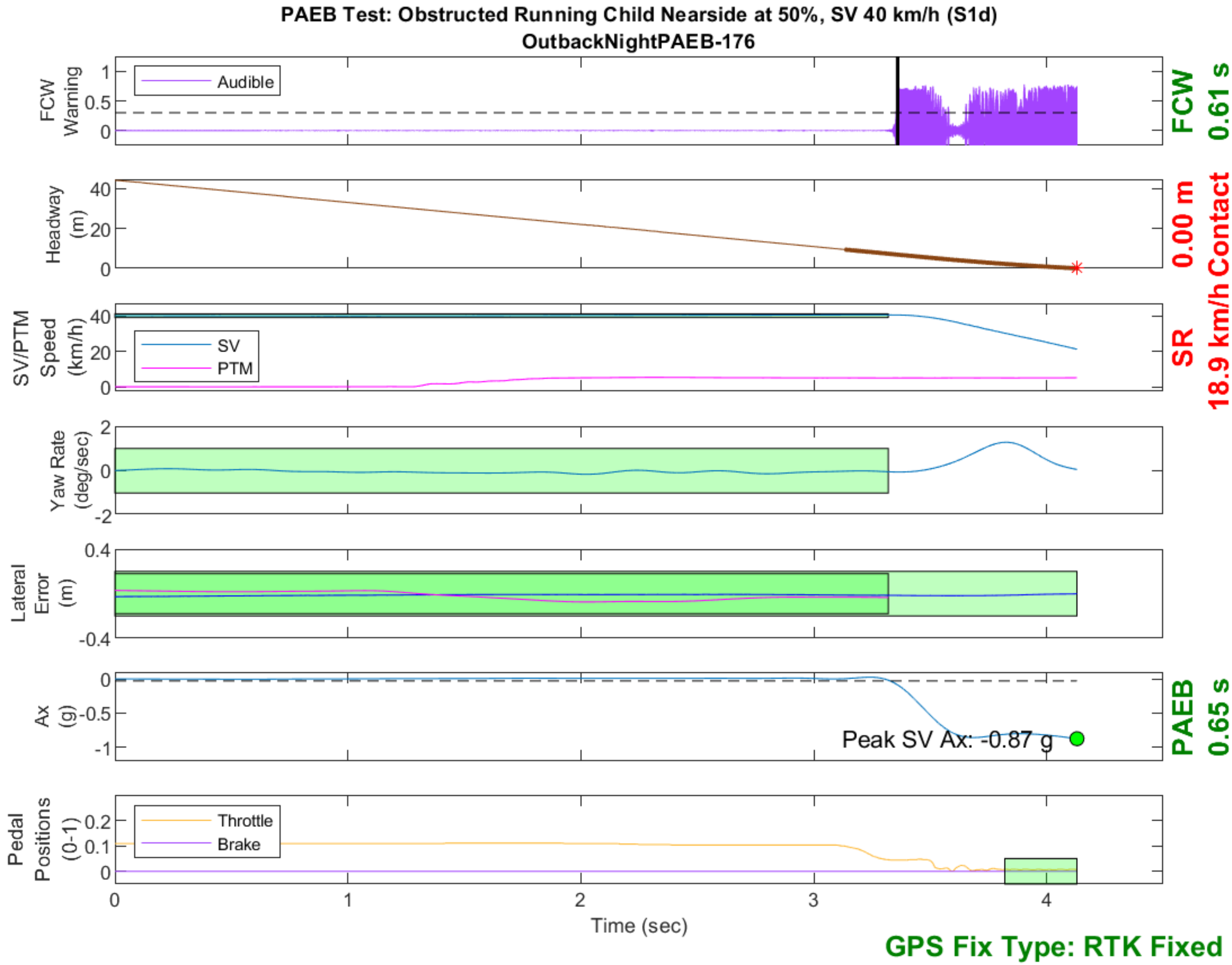


Figure D308. Time History for PAEB Run 176, S1d, Night, Low Beam, 40 km/h

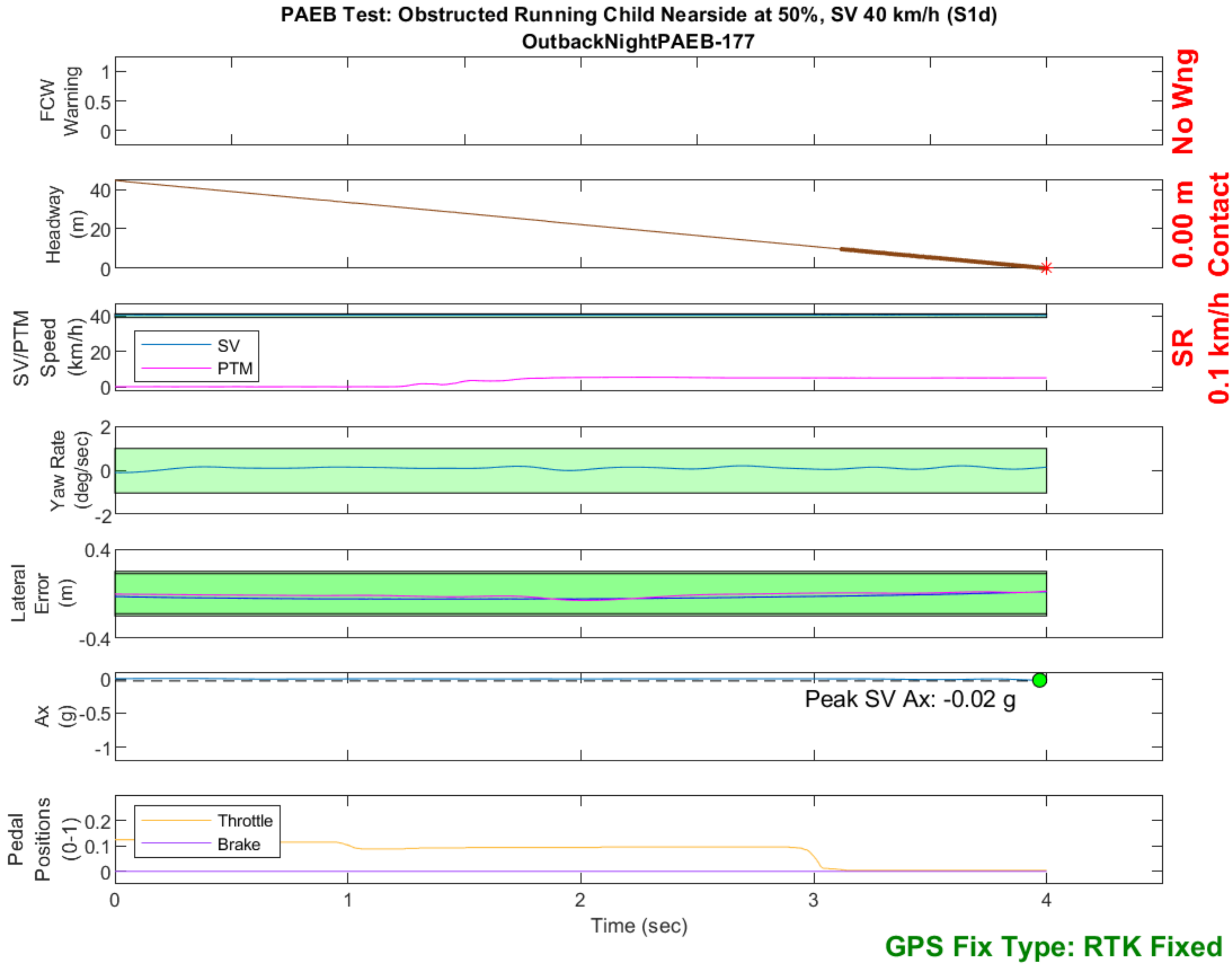


Figure D309. Time History for PAEB Run 177, S1d, Night, Low Beam, 40 km/h

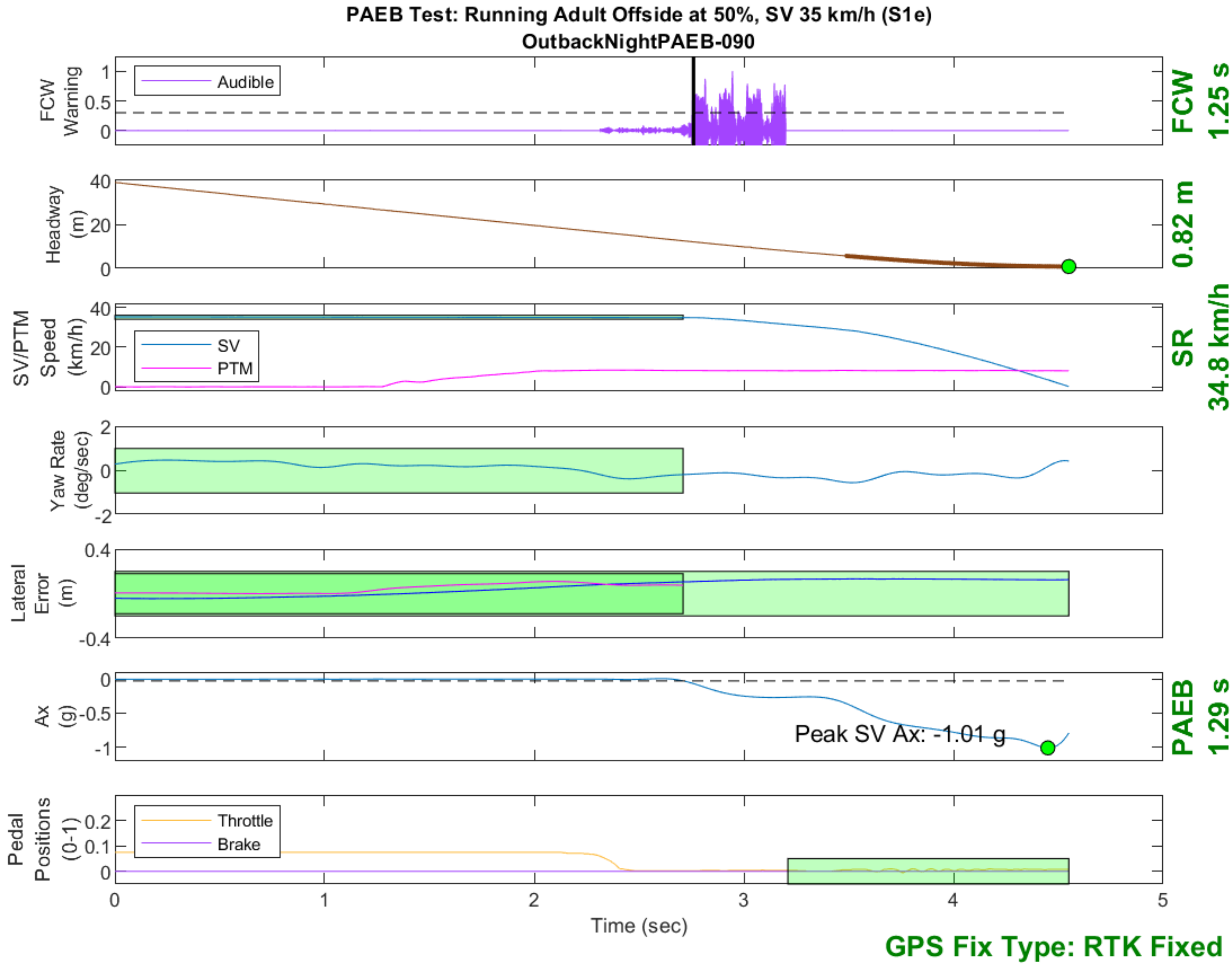


Figure D310. Time History for PAEB Run 90, S1e, Night, Low Beam, 35 km/h

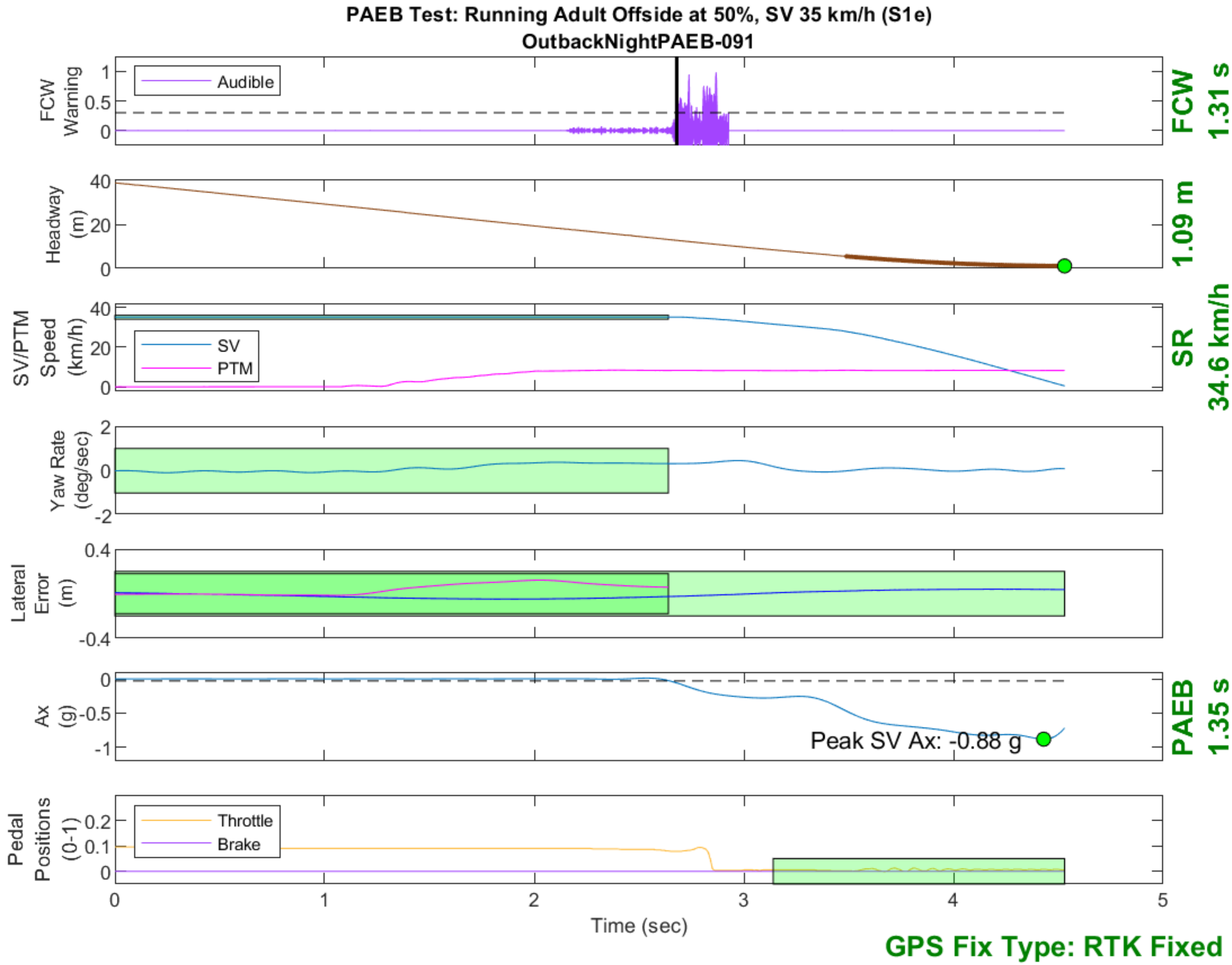


Figure D311. Time History for PAEB Run 91, S1e, Night, Low Beam, 35 km/h

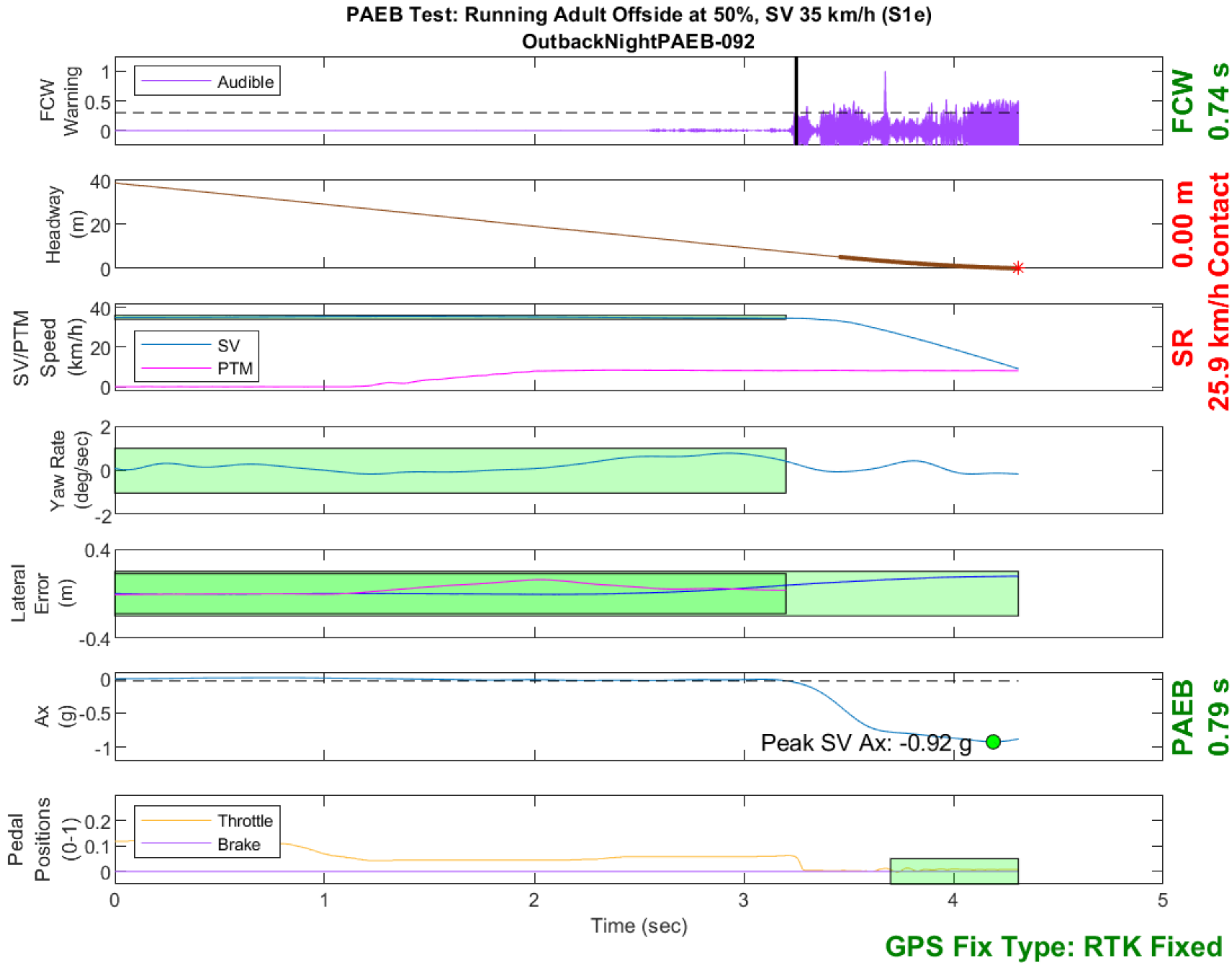


Figure D312. Time History for PAEB Run 92, S1e, Night, Low Beam, 35 km/h

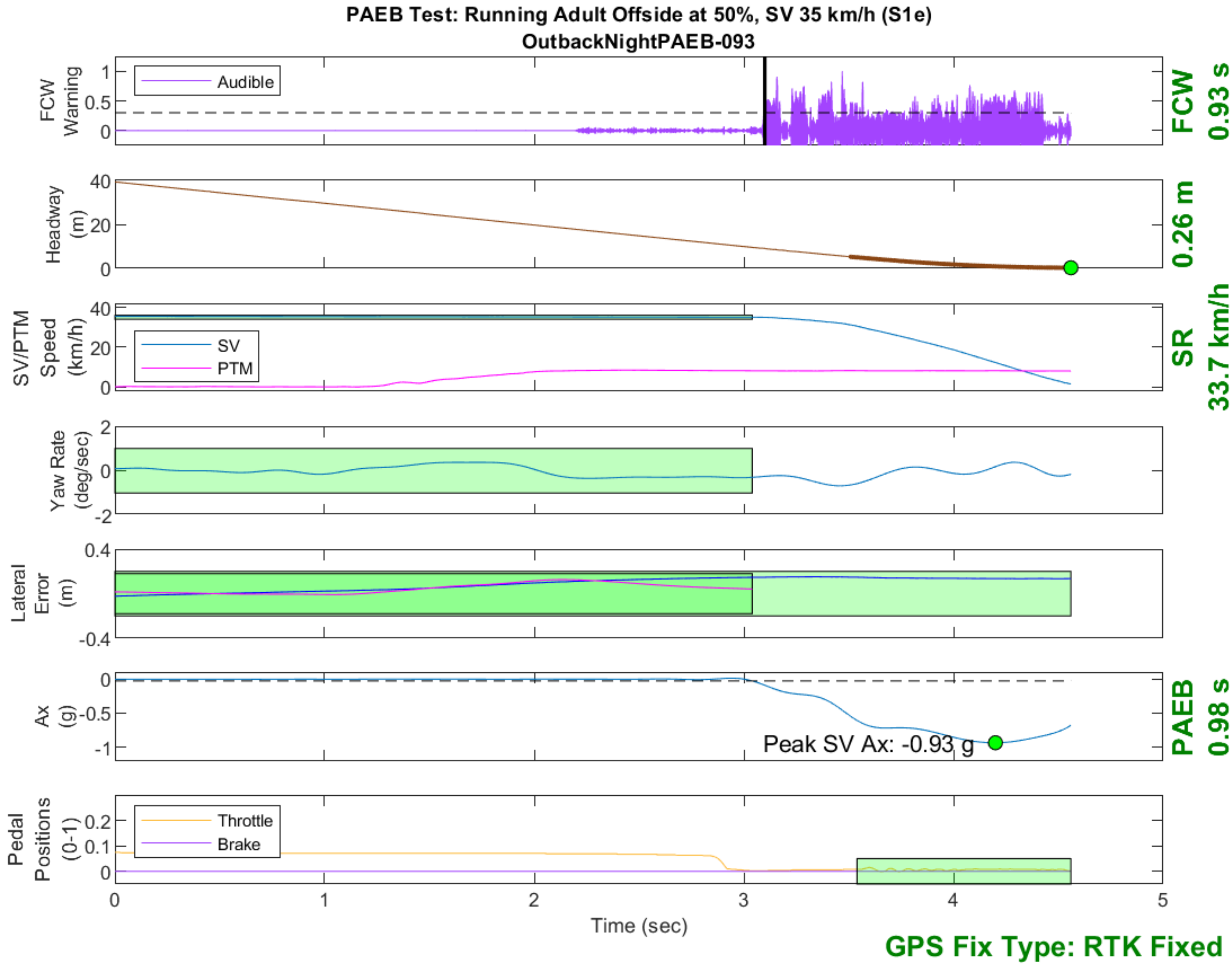


Figure D313. Time History for PAEB Run 93, S1e, Night, Low Beam, 35 km/h

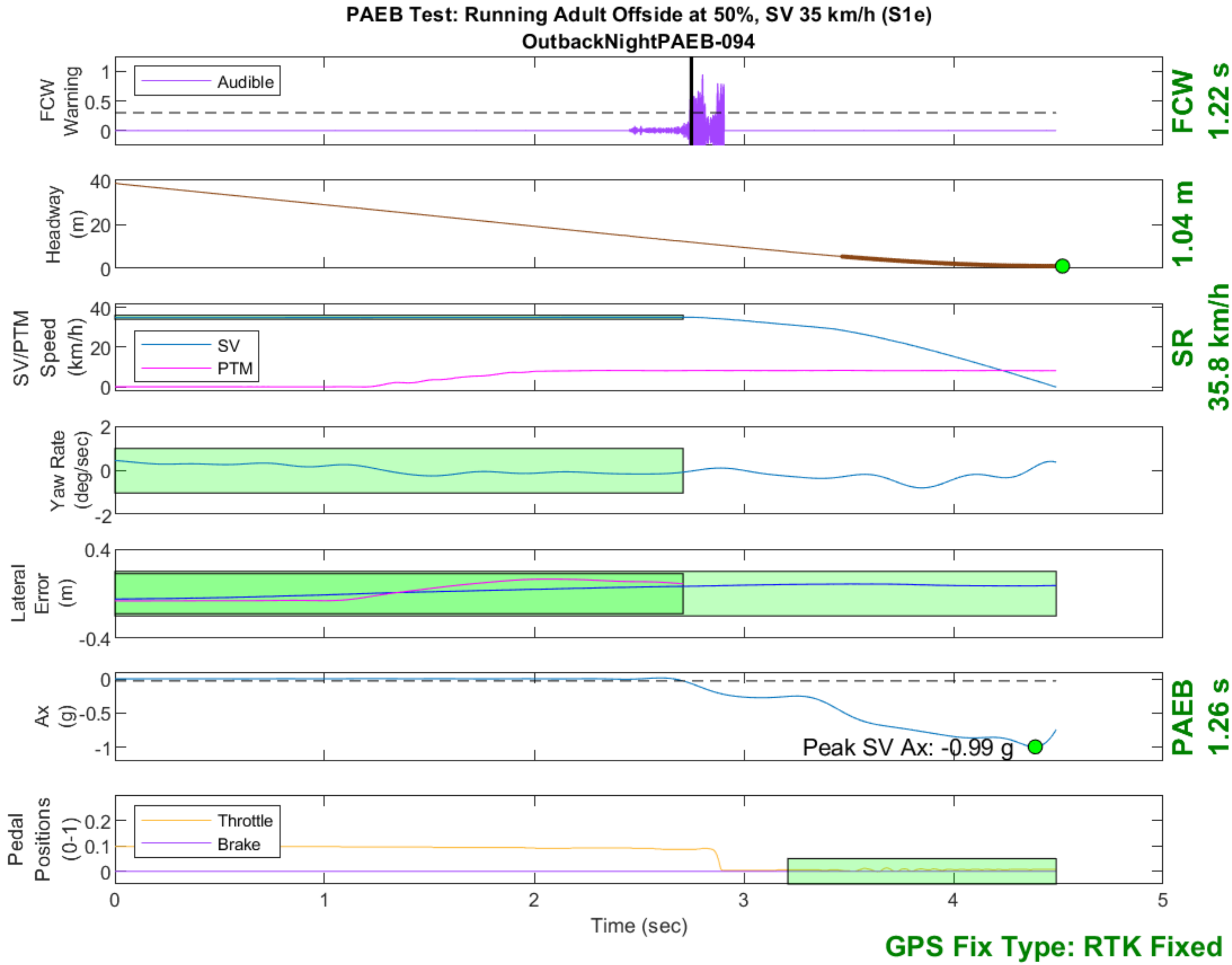


Figure D314. Time History for PAEB Run 94, S1e, Night, Low Beam, 35 km/h

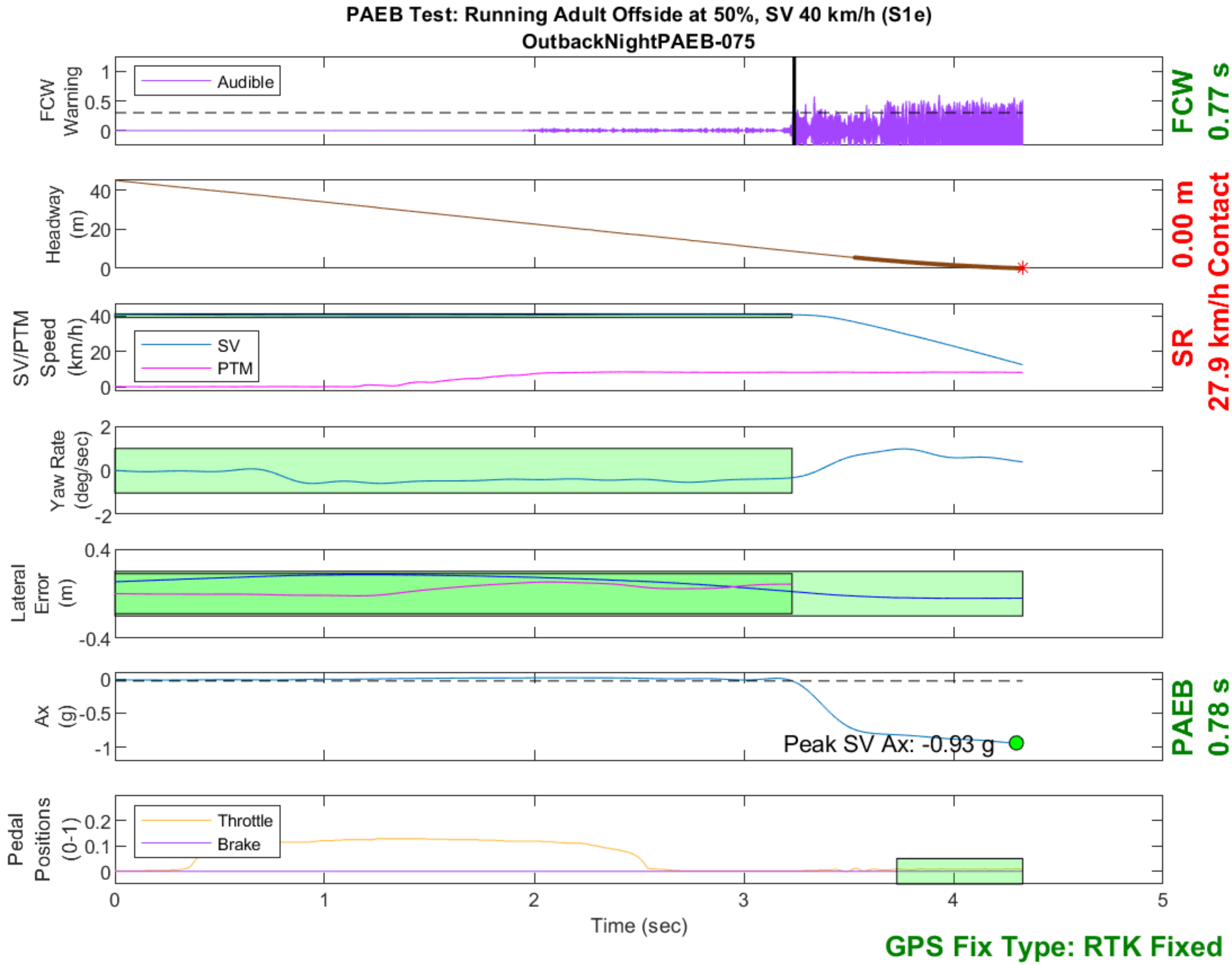


Figure D315. Time History for PAEB Run 75, S1e, Night, Low Beam, 40 km/h

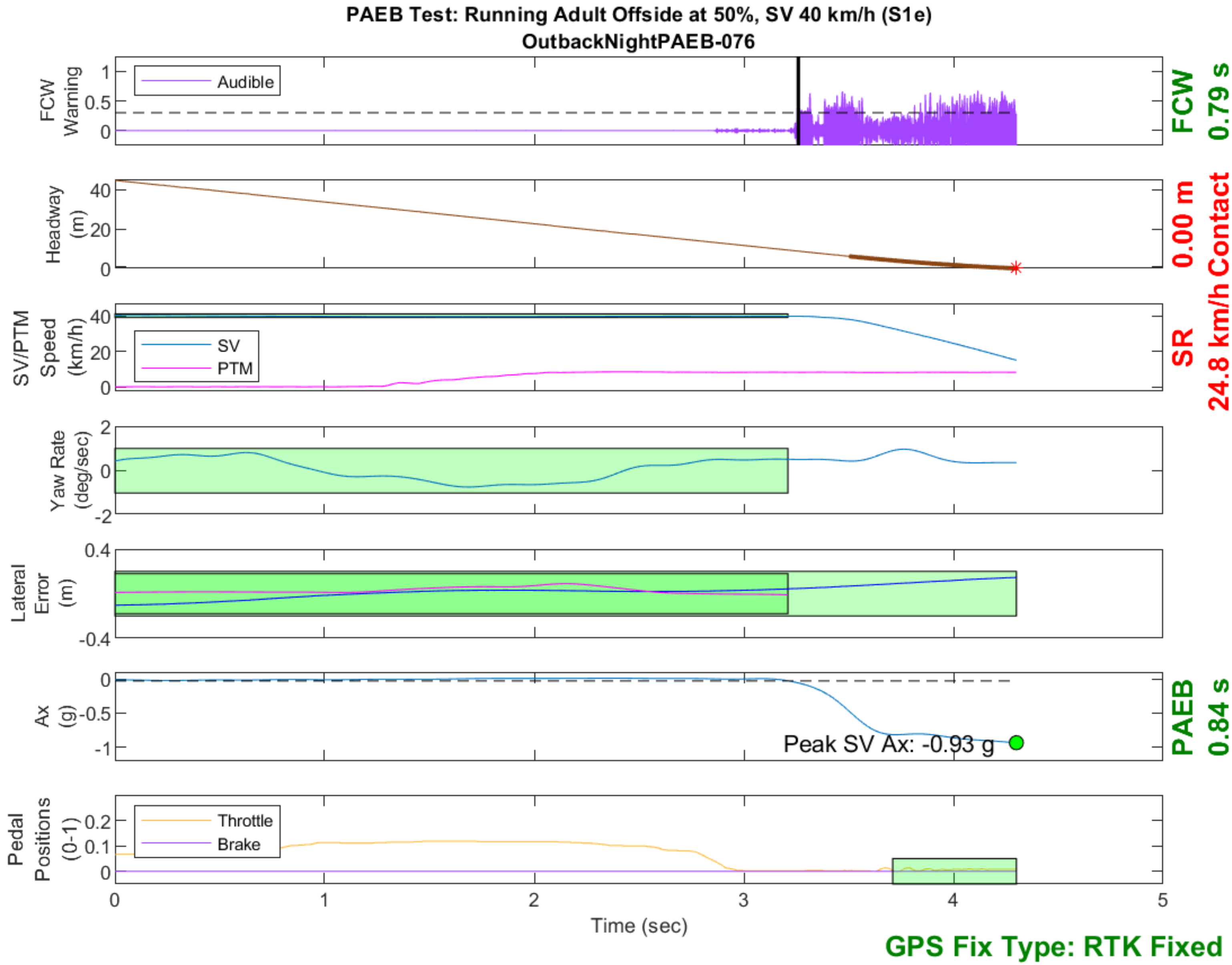


Figure D316. Time History for PAEB Run 76, S1e, Night, Low Beam, 40 km/h

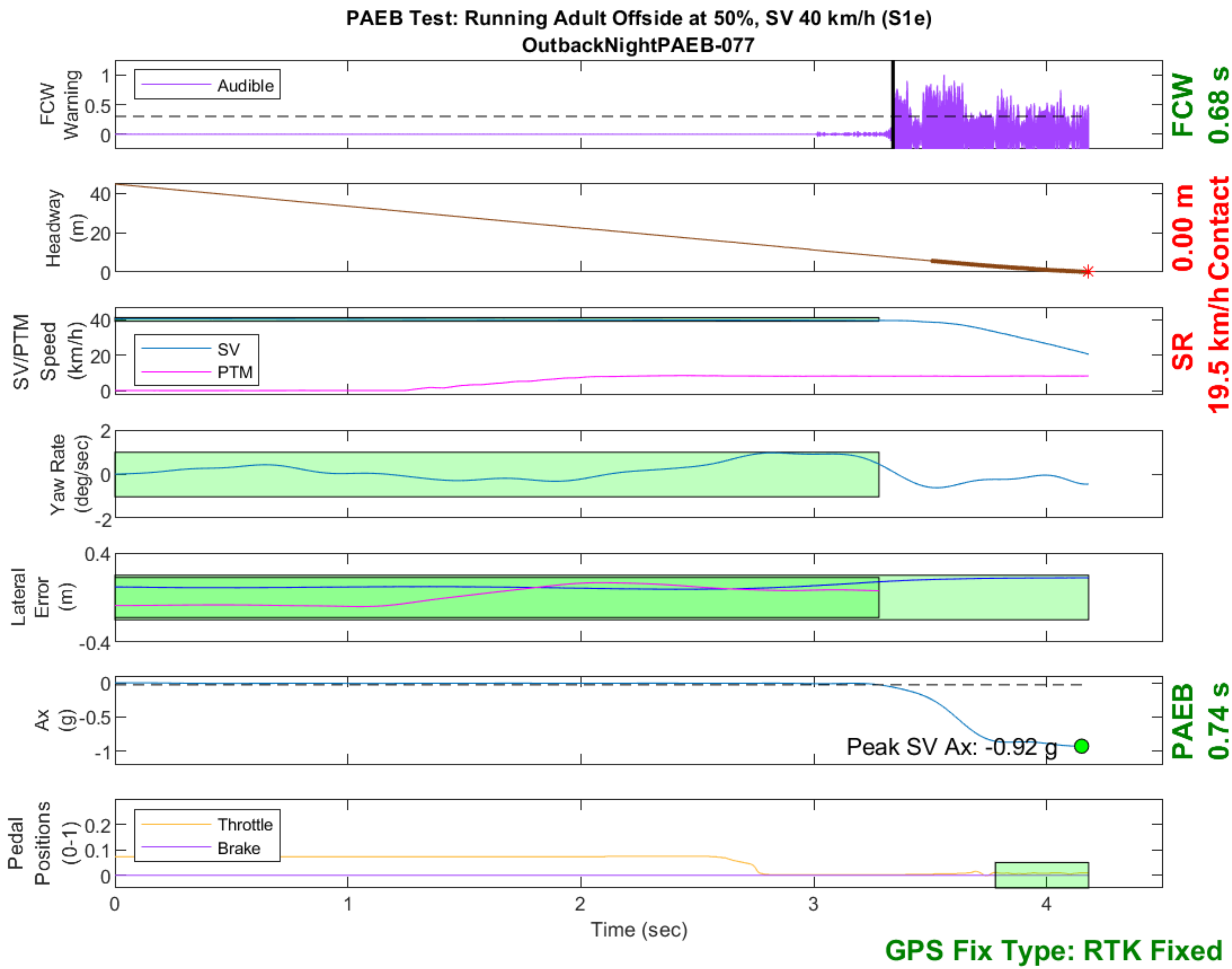


Figure D317. Time History for PAEB Run 77, S1e, Night, Low Beam, 40 km/h

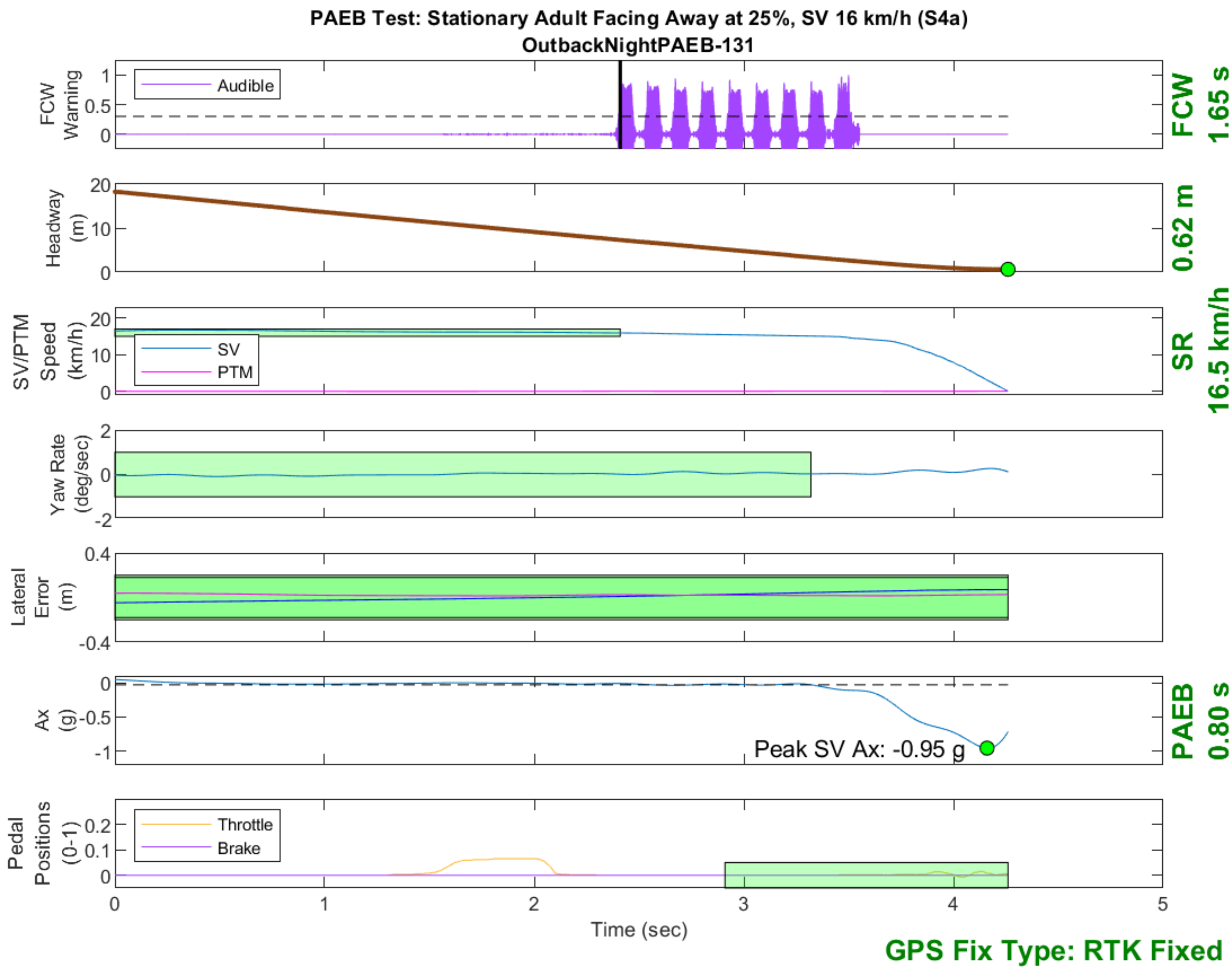


Figure D318. Time History for PAEB Run 131, S4a, Night, Low Beam, 16 km/h

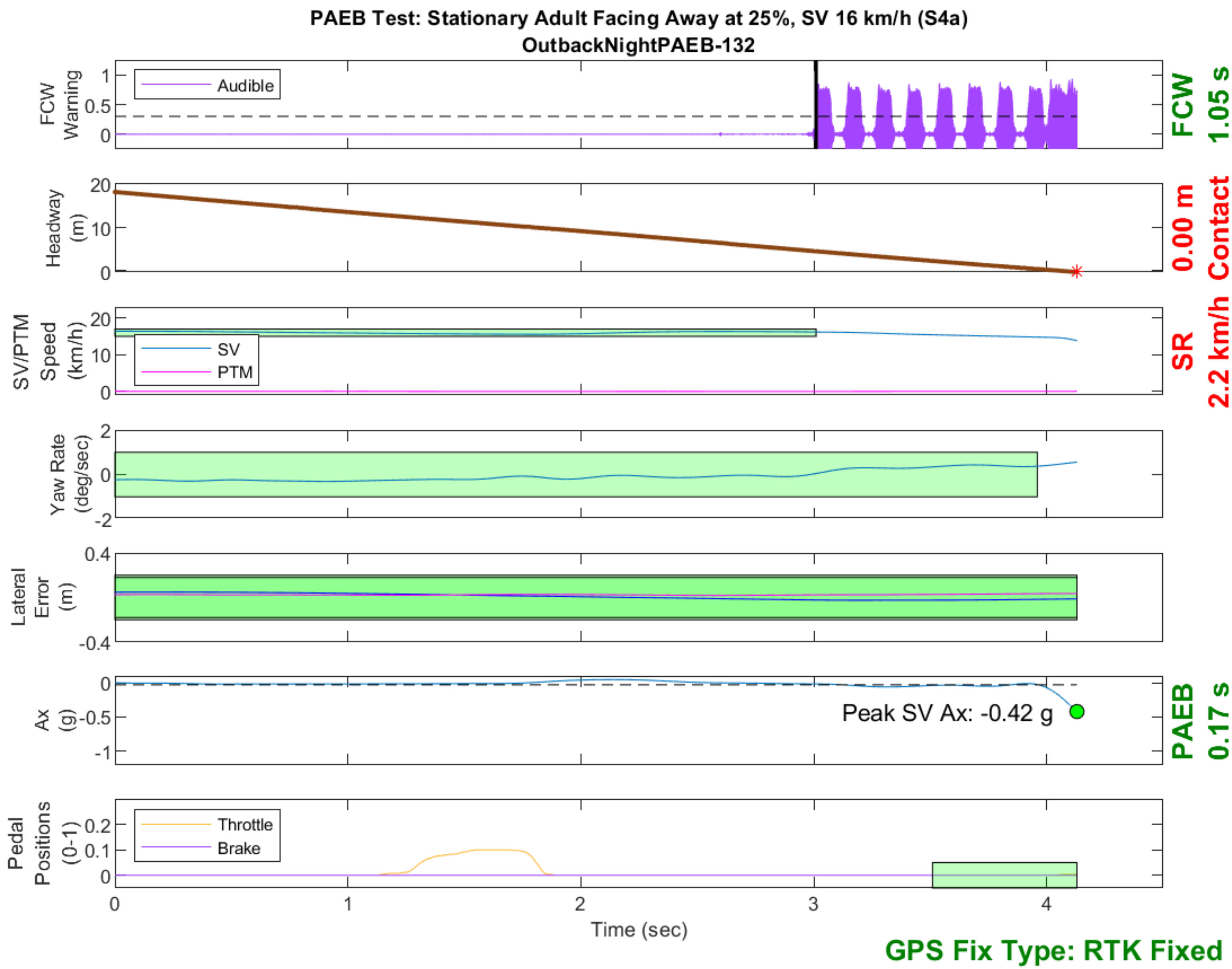


Figure D319. Time History for PAEB Run 132, S4a, Night, Low Beam, 16 km/h

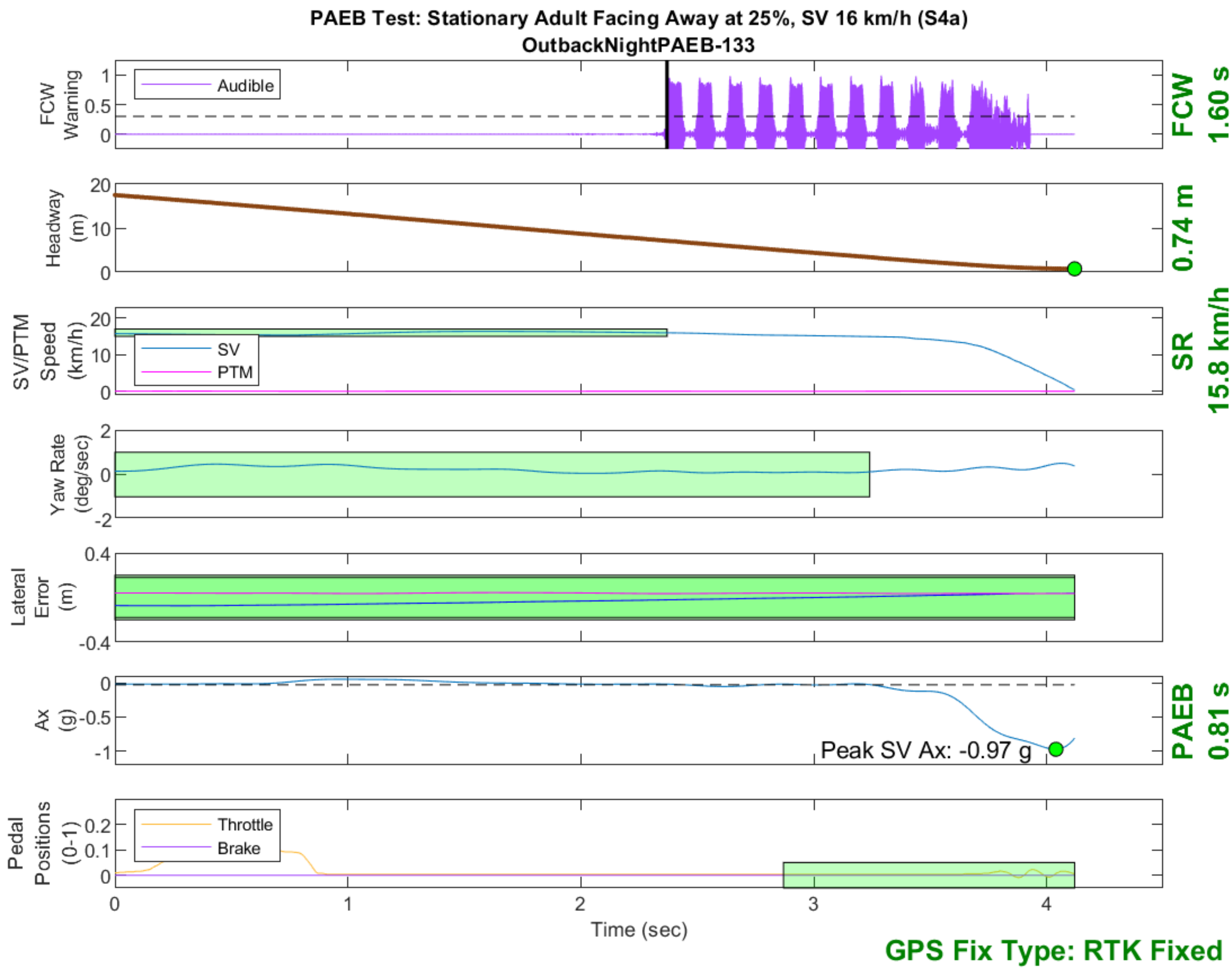


Figure D320. Time History for PAEB Run 133, S4a, Night, Low Beam, 16 km/h

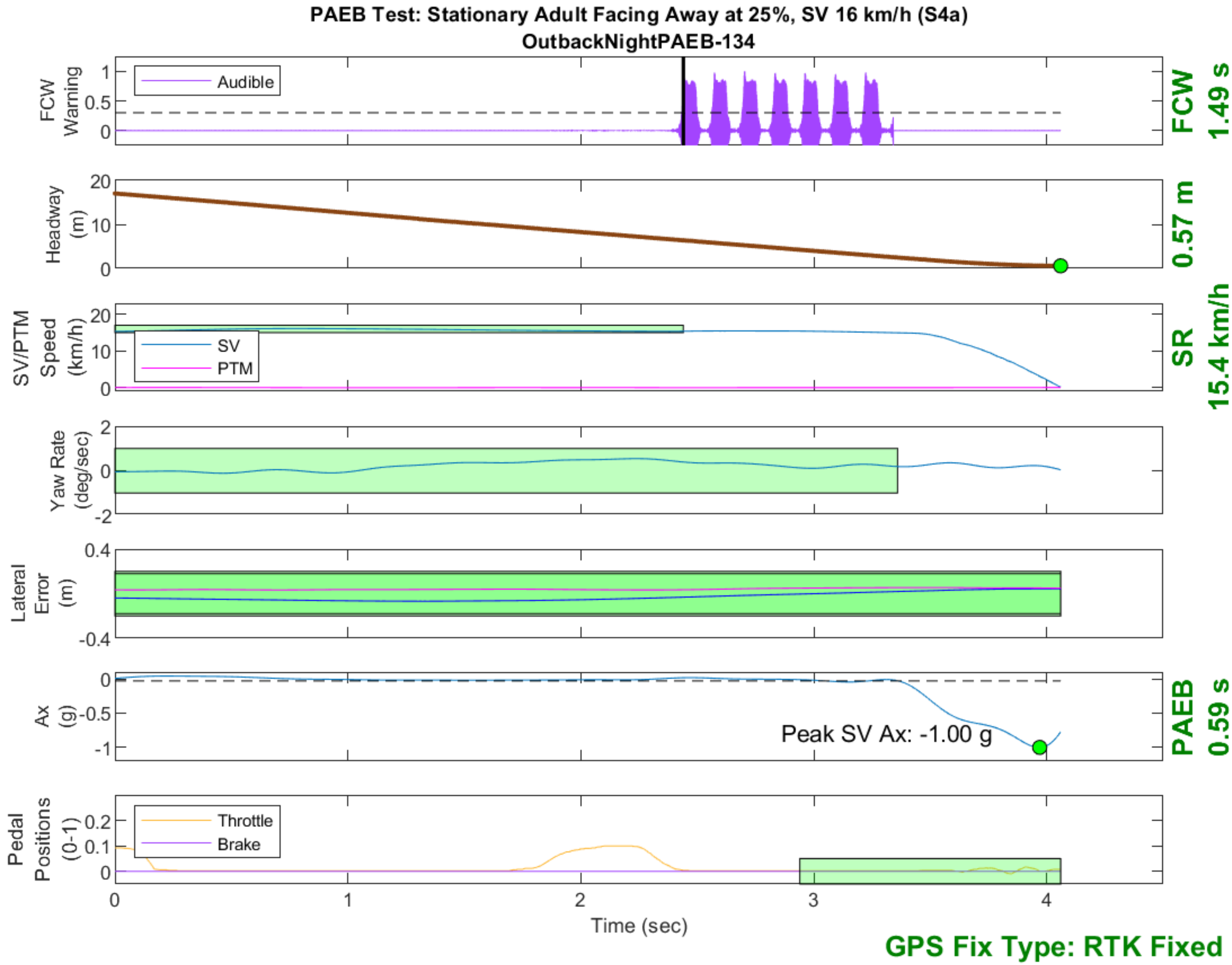


Figure D321. Time History for PAEB Run 134, S4a, Night, Low Beam, 16 km/h

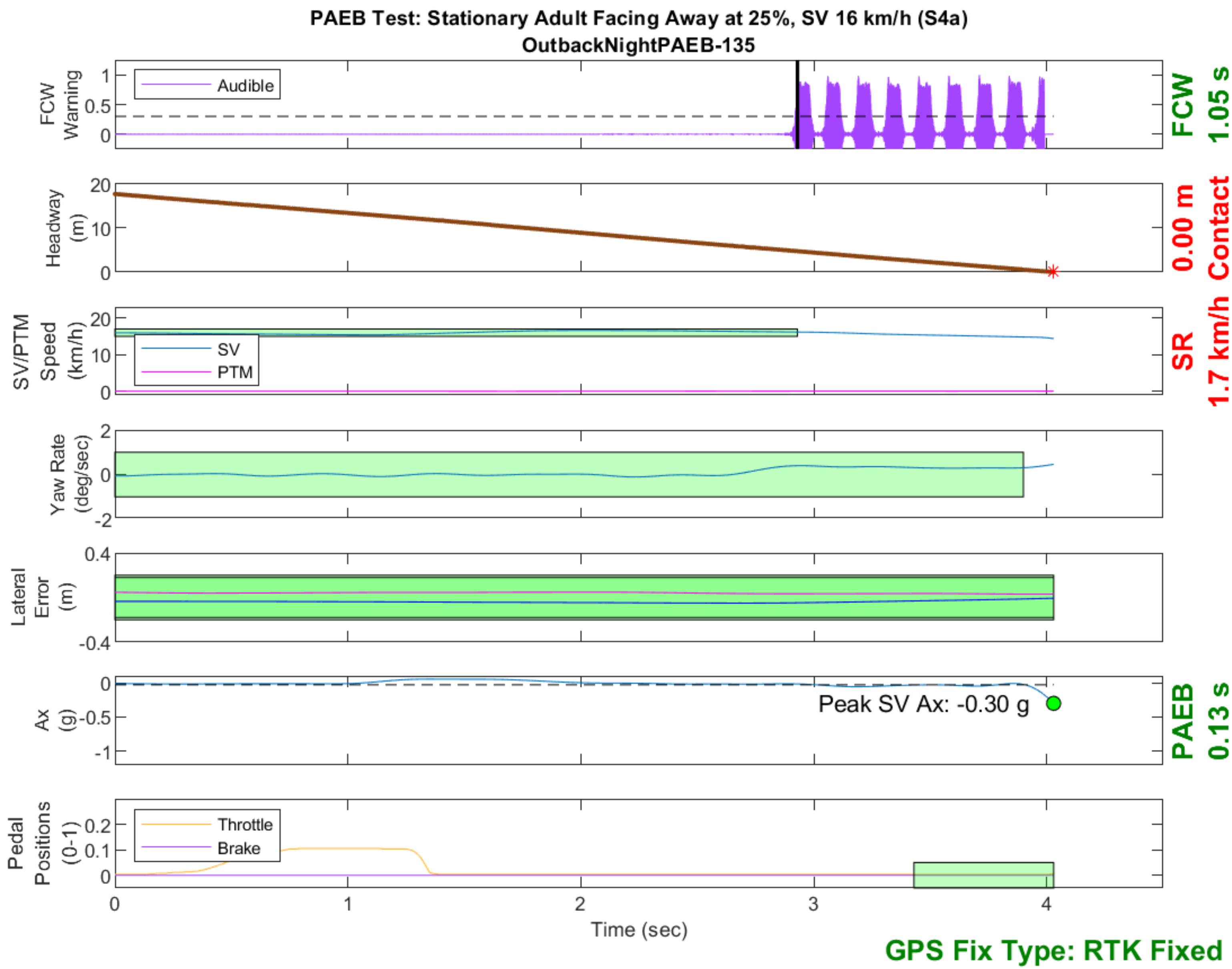


Figure D322. Time History for PAEB Run 135, S4a, Night, Low Beam, 16 km/h

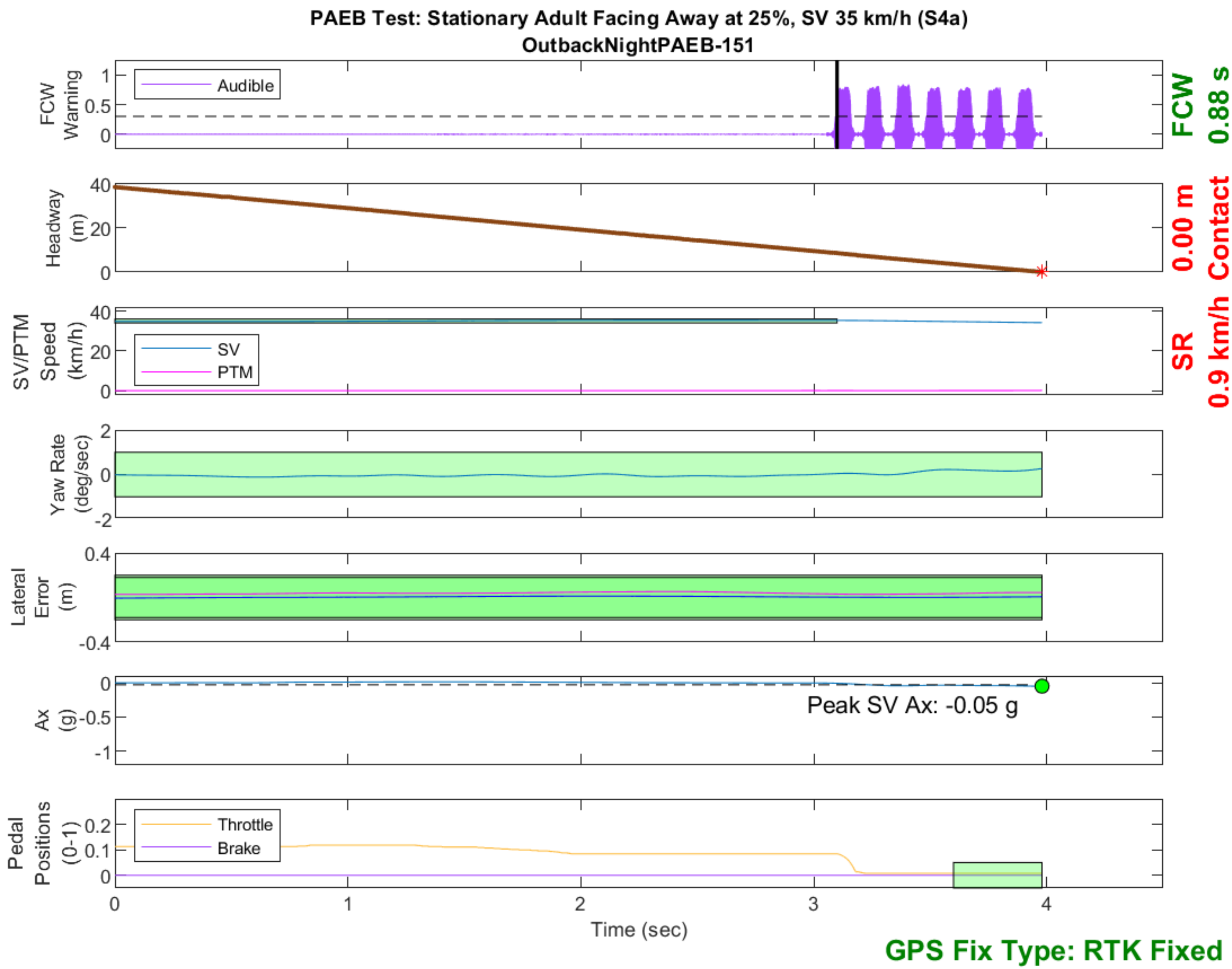


Figure D323. Time History for PAEB Run 151, S4a, Night, Low Beam, 35 km/h

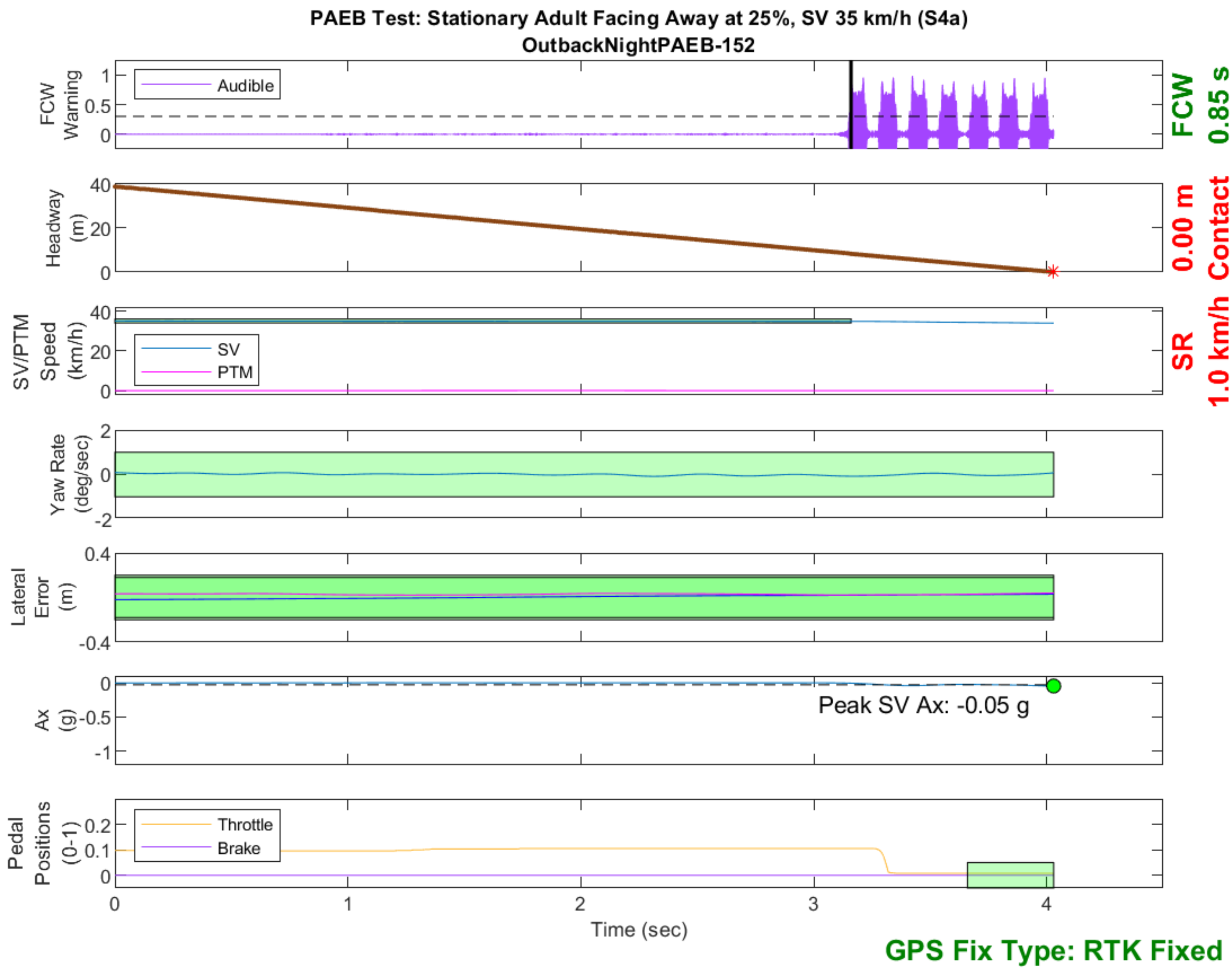


Figure D324. Time History for PAEB Run 152, S4a, Night, Low Beam, 35 km/h

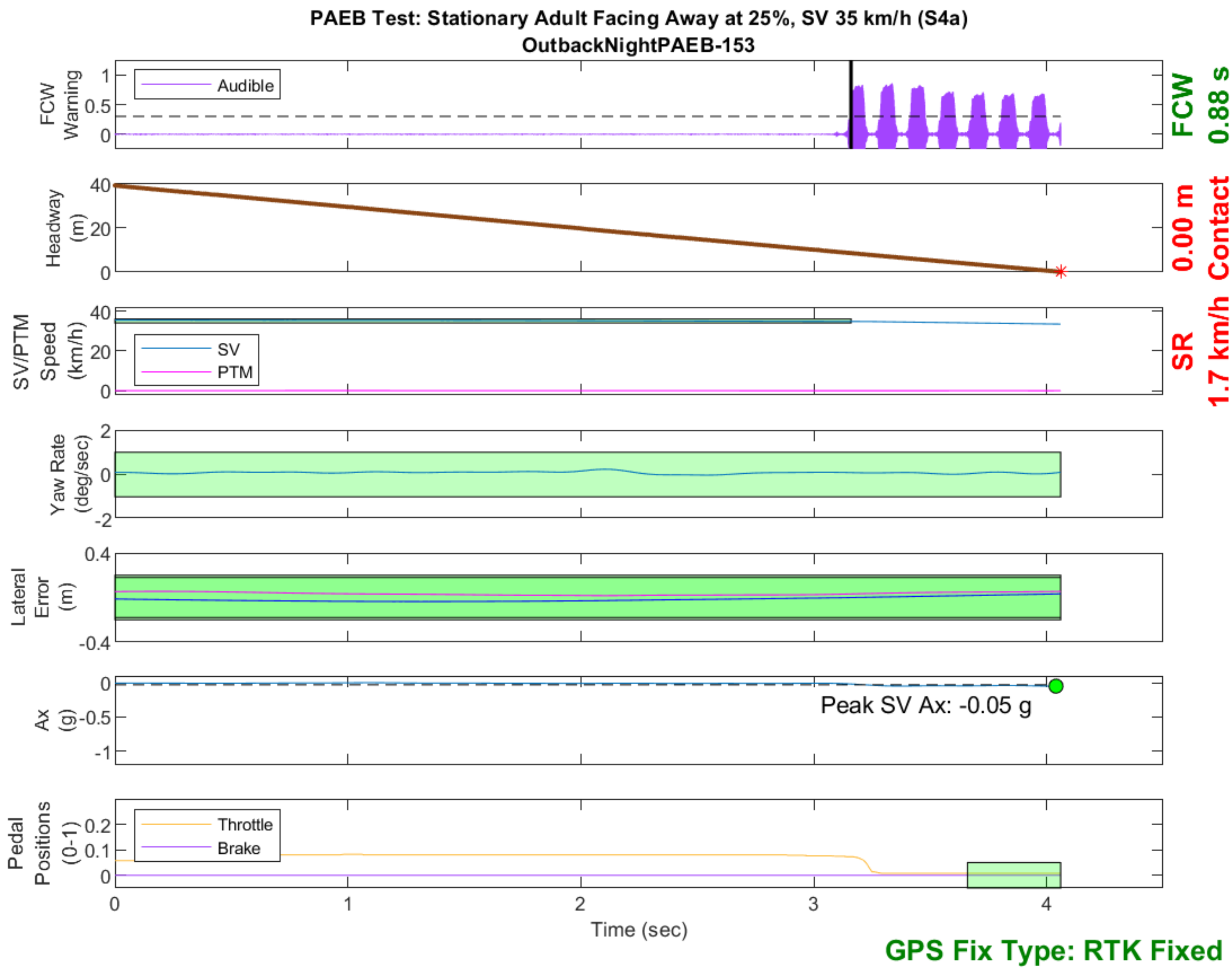


Figure D325. Time History for PAEB Run 153, S4a, Night, Low Beam, 35 km/h

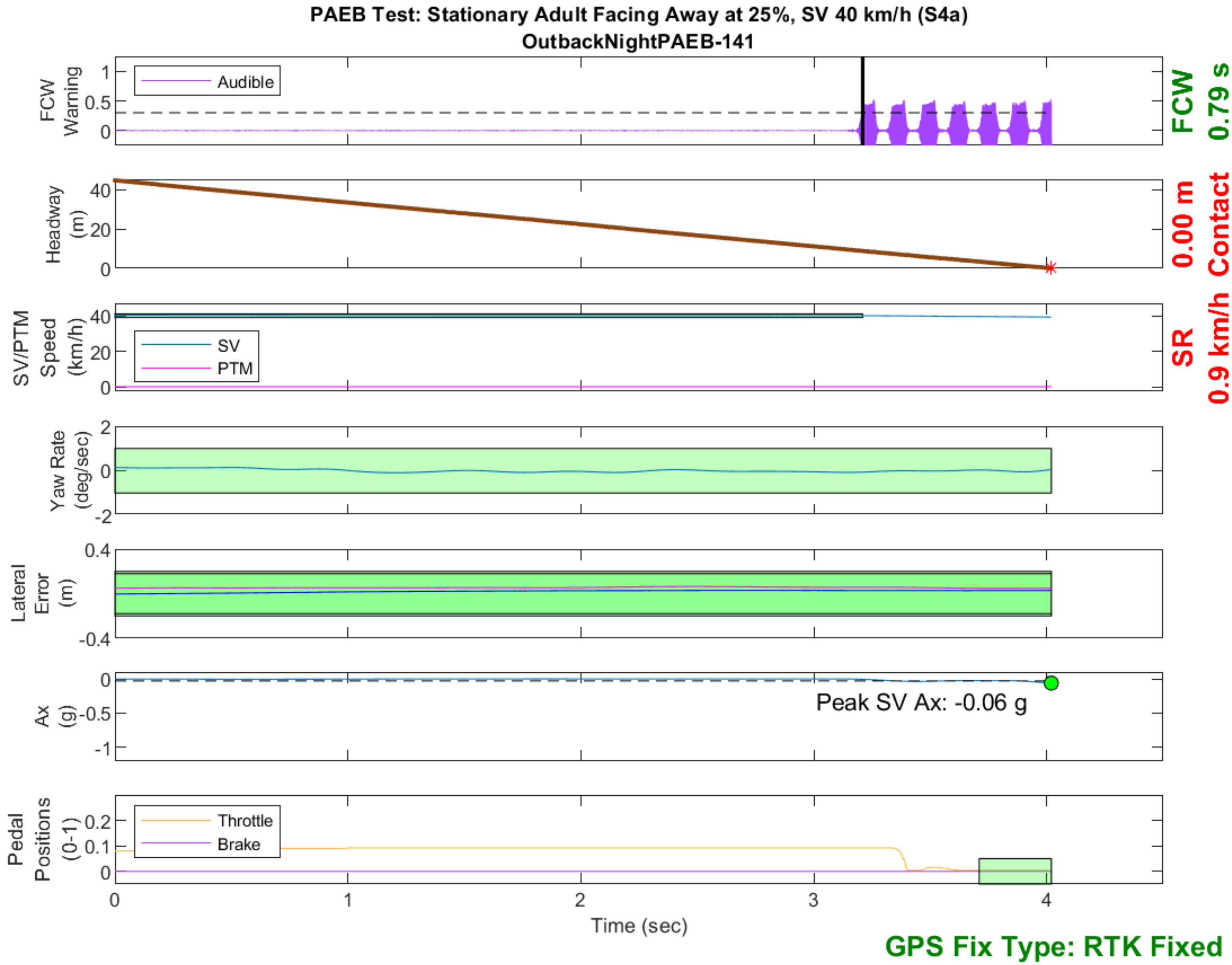


Figure D326. Time History for PAEB Run 141, S4a, Night, Low Beam, 40 km/h

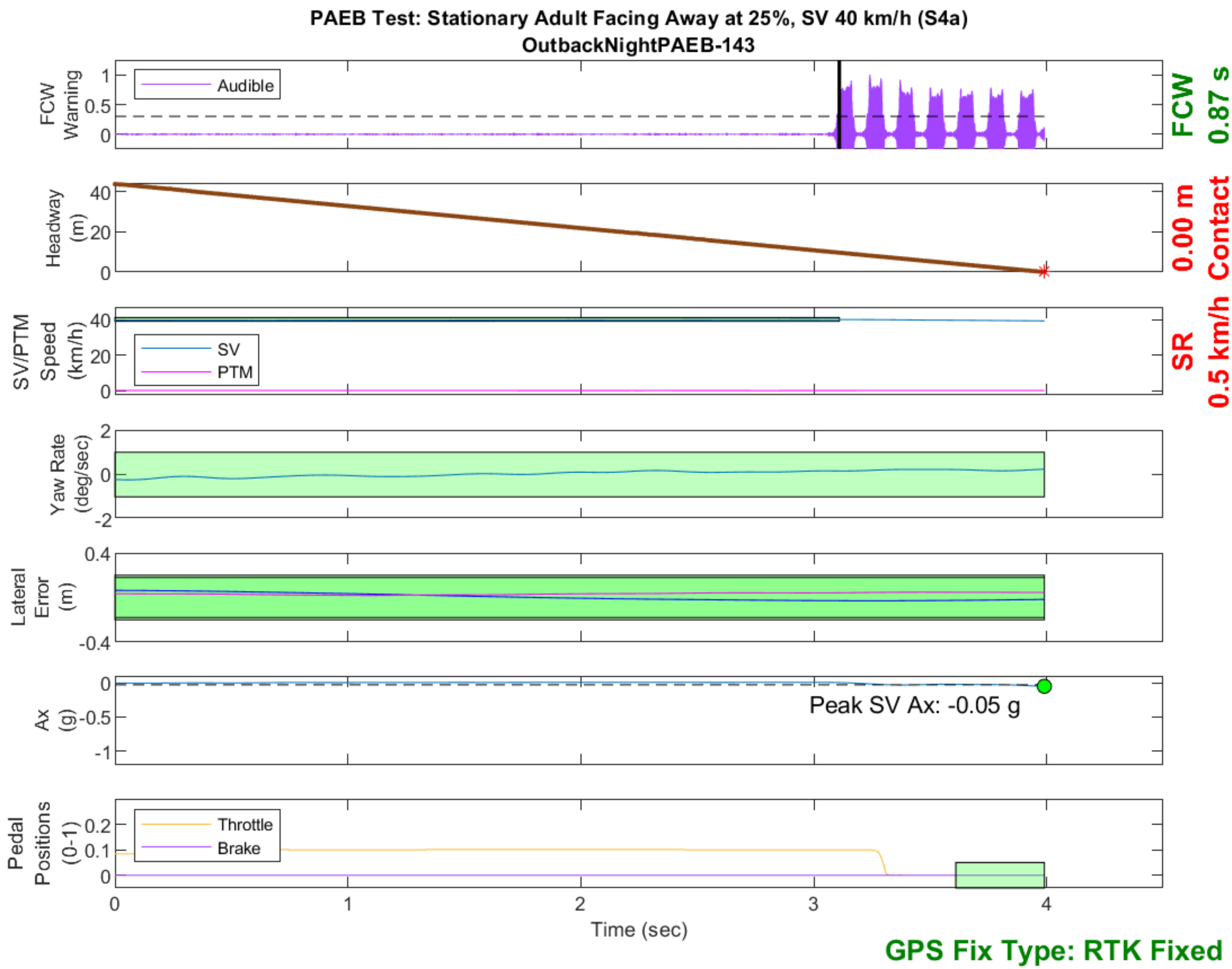


Figure D327. Time History for PAEB Run 143, S4a, Night, Low Beam, 40 km/h

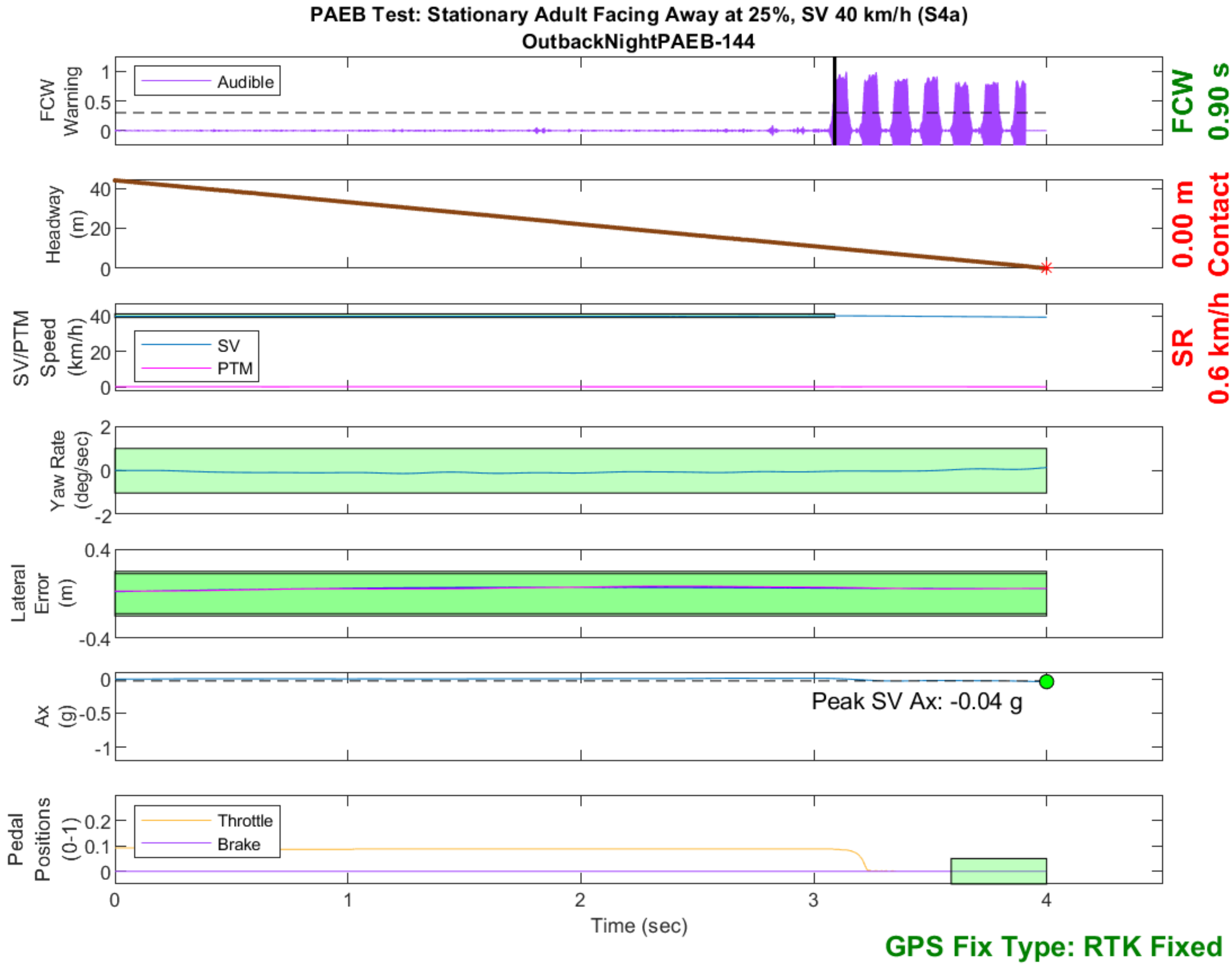


Figure D328. Time History for PAEB Run 144, S4a, Night, Low Beam, 40 km/h

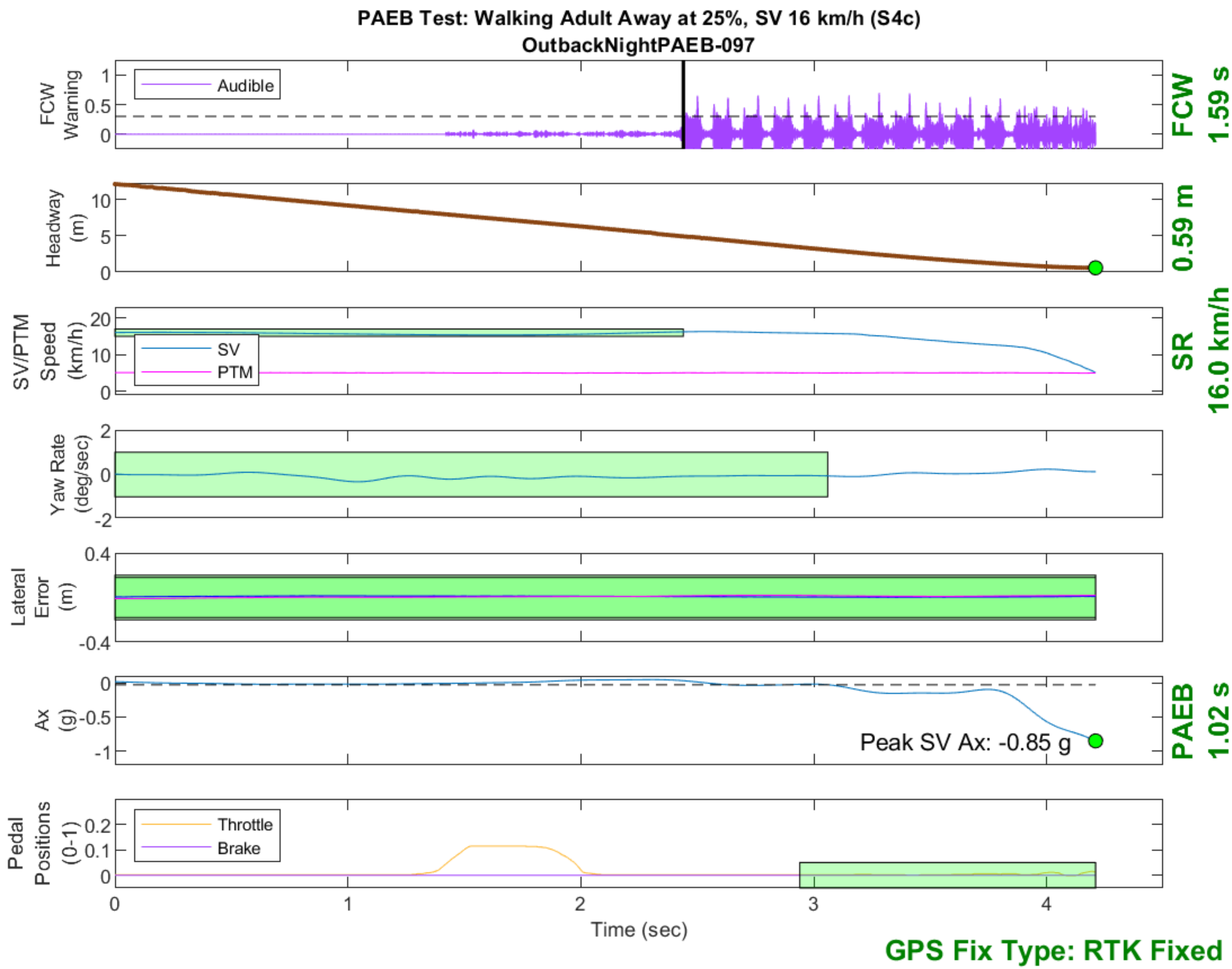


Figure D329. Time History for PAEB Run 97, S4c, Night, Low Beam, 16 km/h

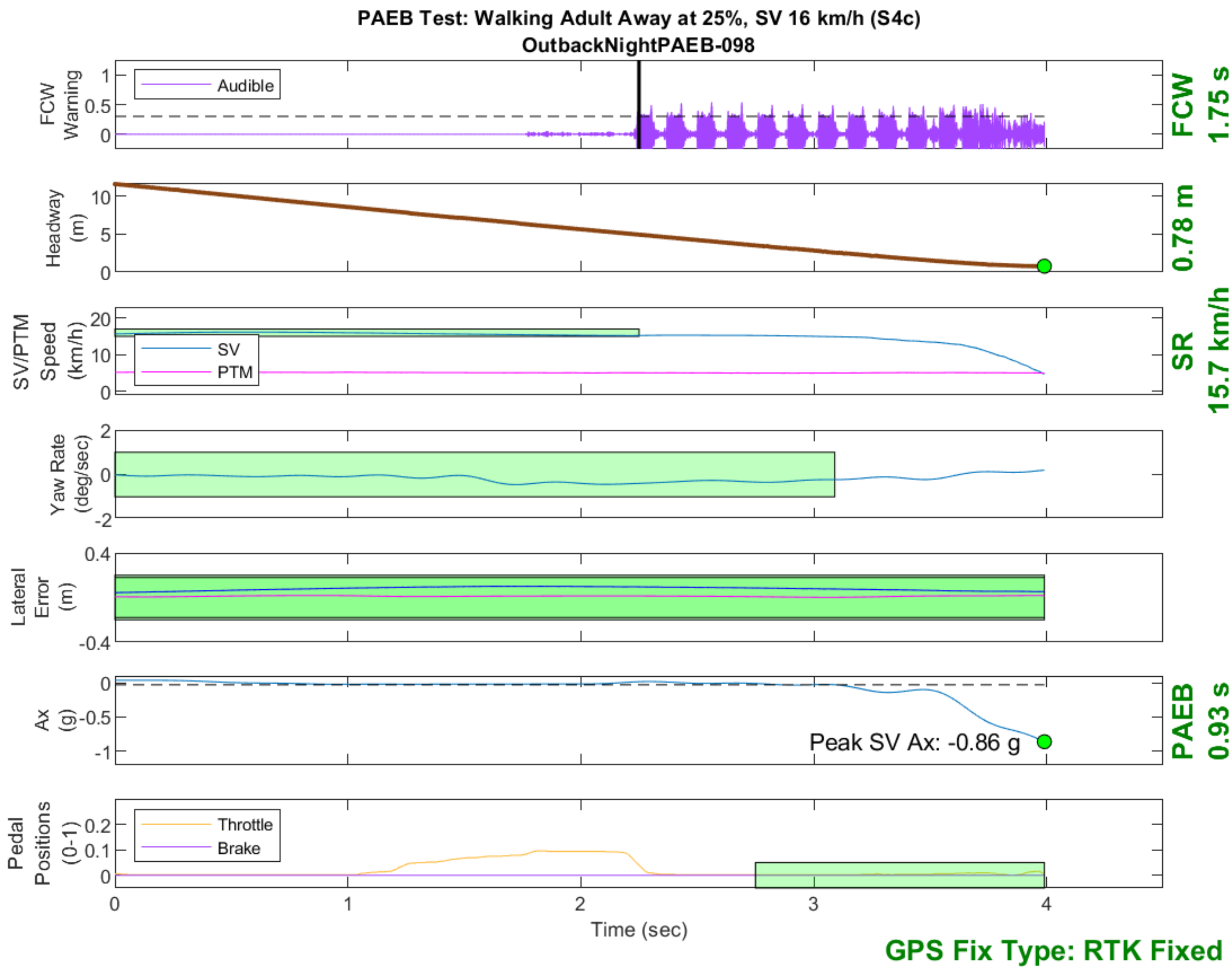


Figure D330. Time History for PAEB Run 98, S4c, Night, Low Beam, 16 km/h

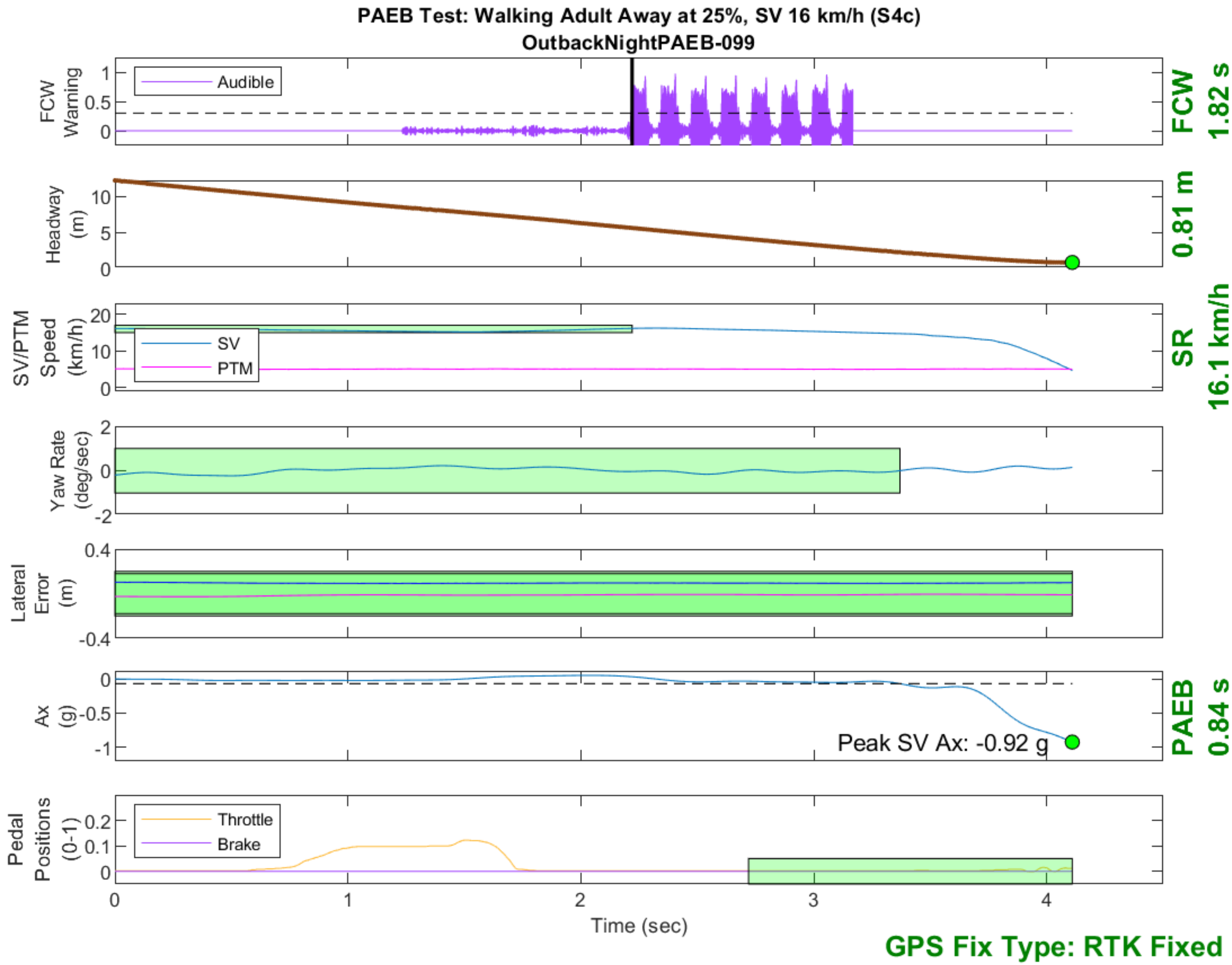


Figure D331. Time History for PAEB Run 99, S4c, Night, Low Beam, 16 km/h

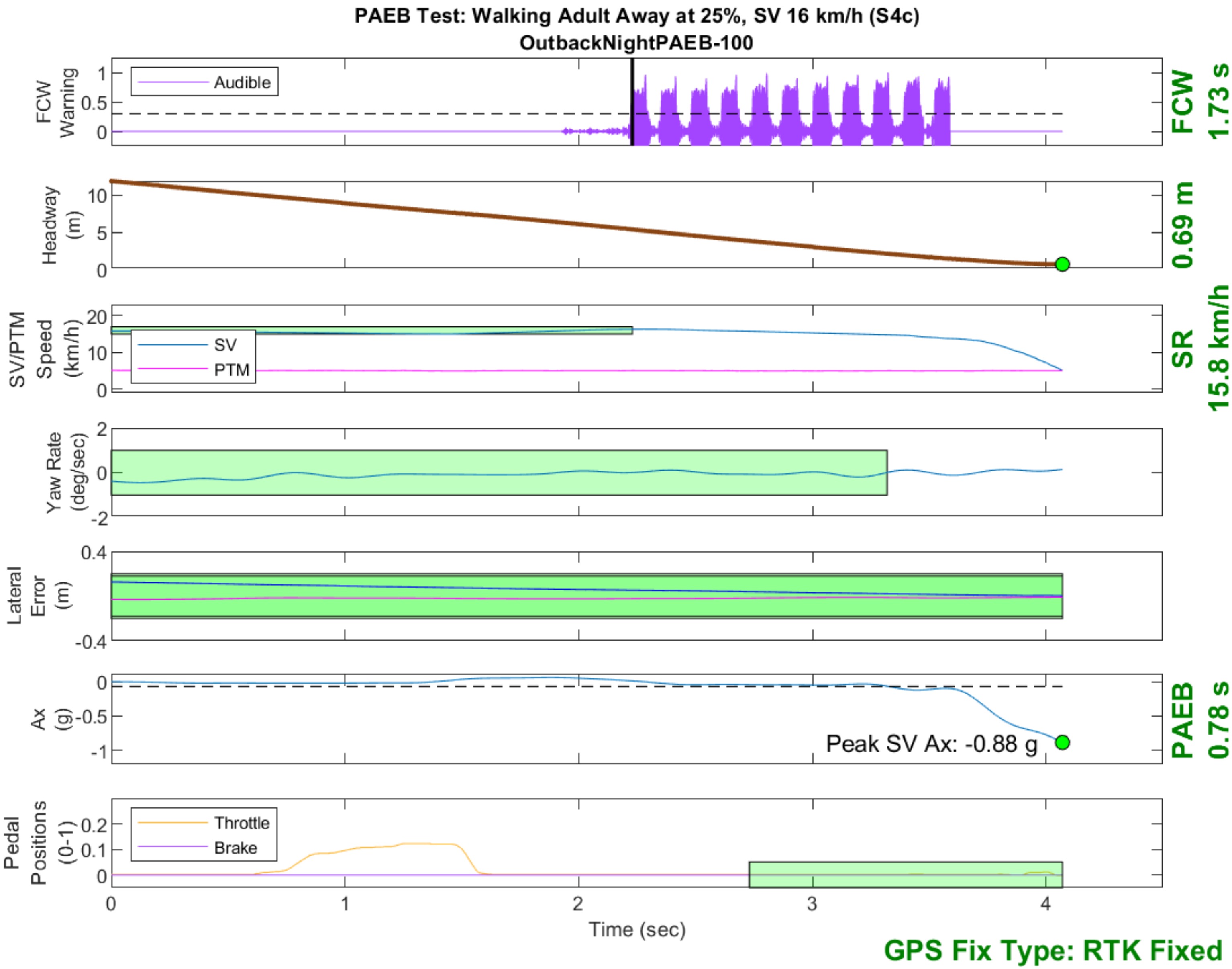


Figure D332. Time History for PAEB Run 100, S4c, Night, Low Beam, 16 km/h

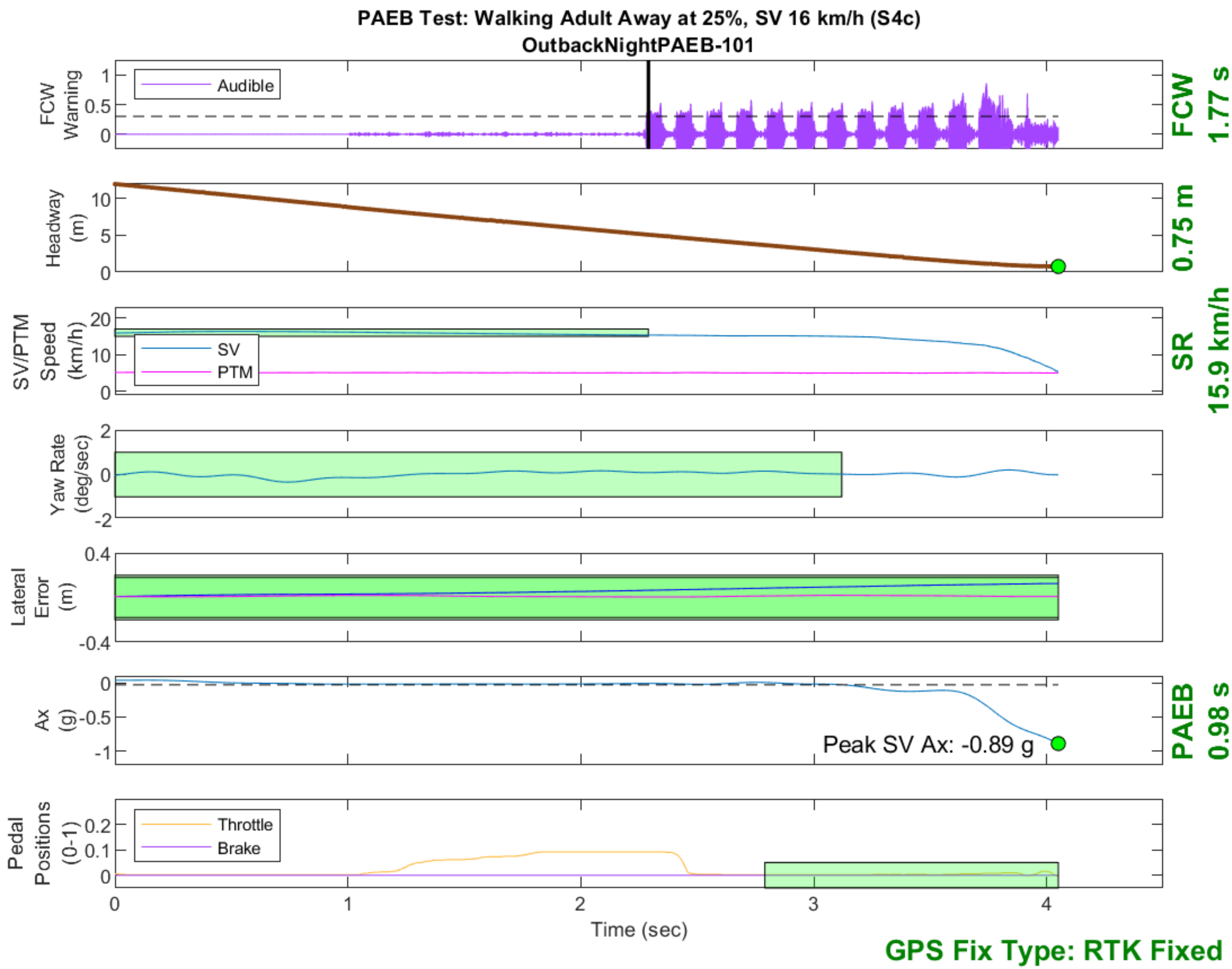


Figure D333. Time History for PAEB Run 101, S4c, Night, Low Beam, 16 km/h

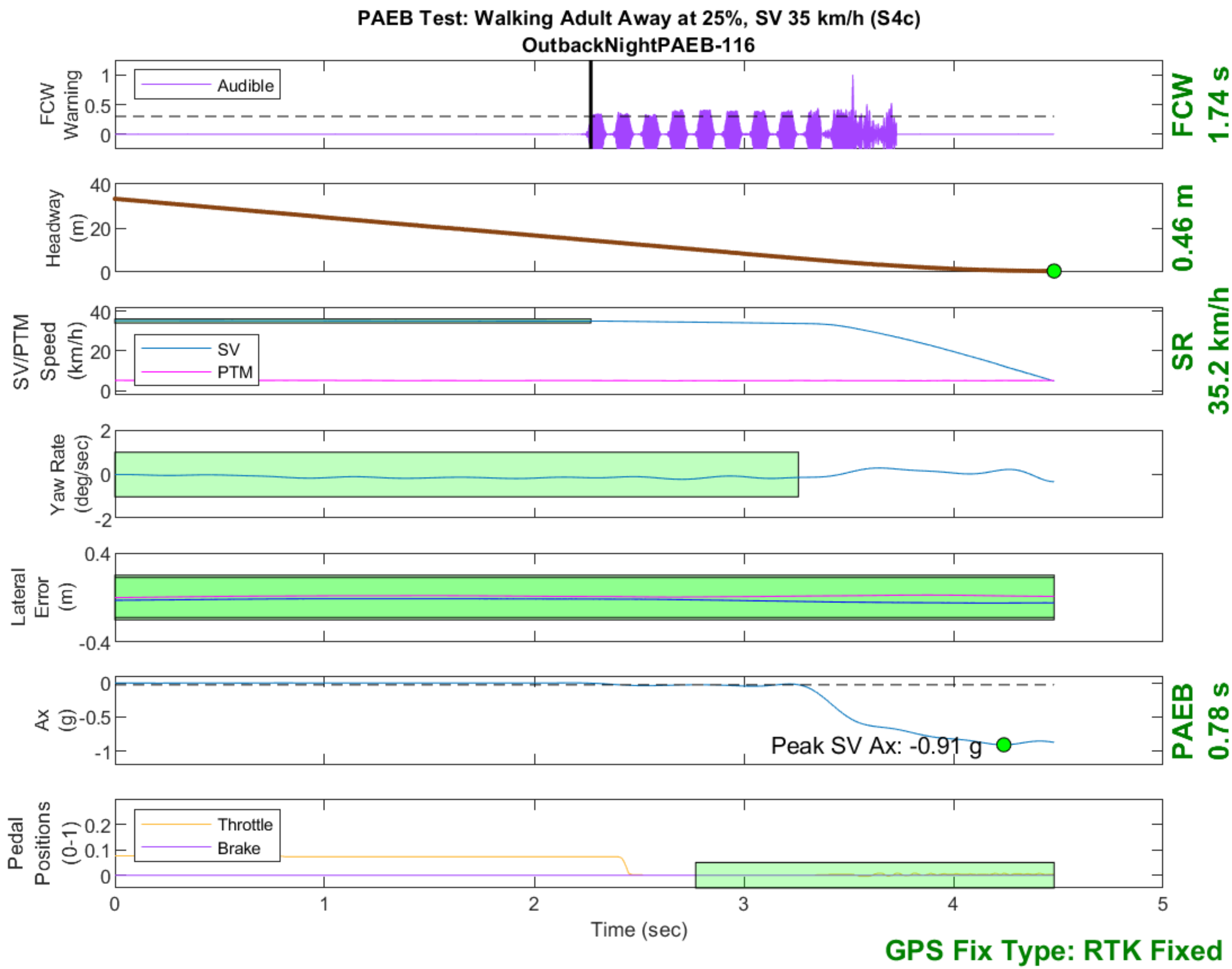


Figure D334. Time History for PAEB Run 116, S4c, Night, Low Beam, 35 km/h

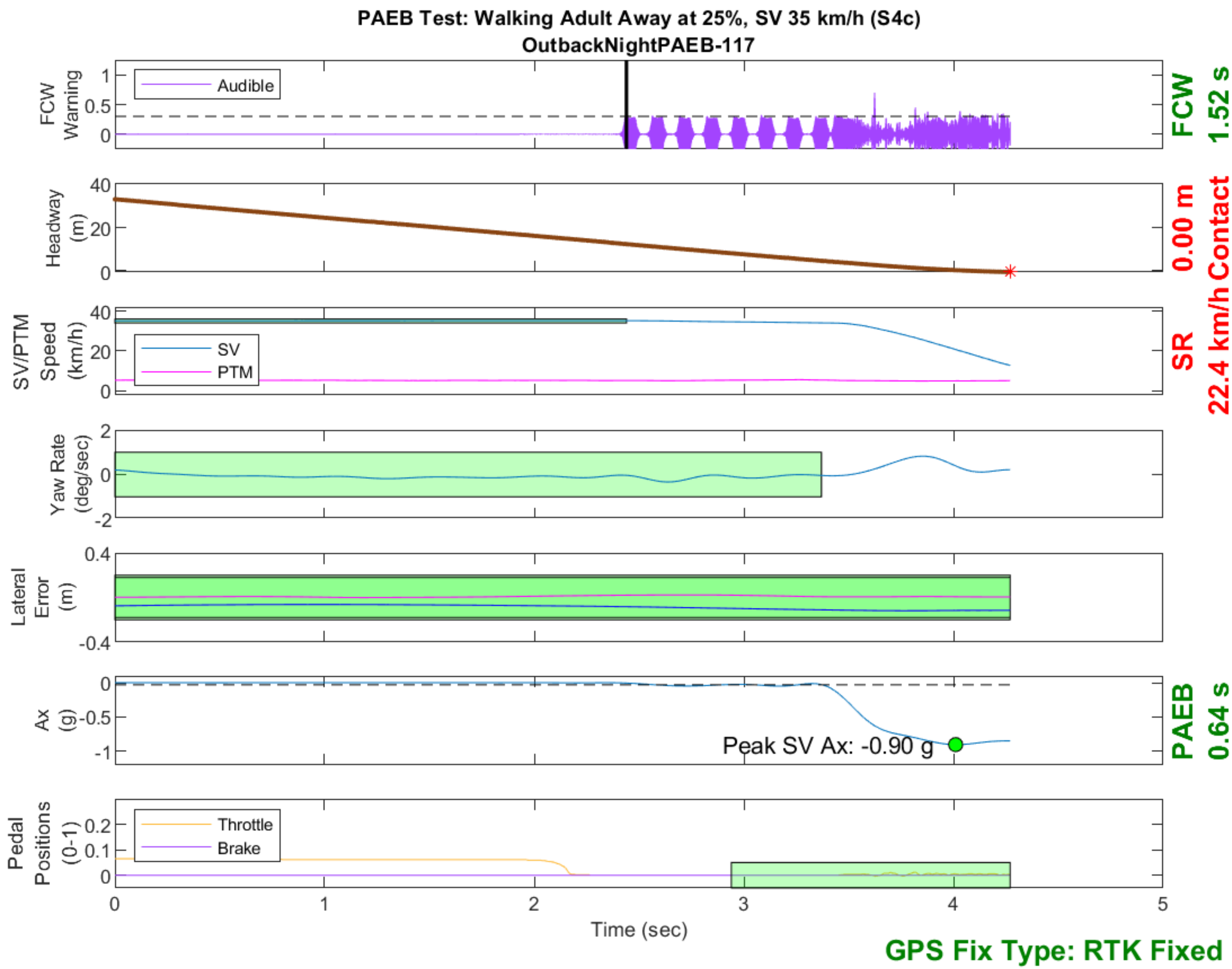


Figure D335. Time History for PAEB Run 117, S4c, Night, Low Beam, 35 km/h

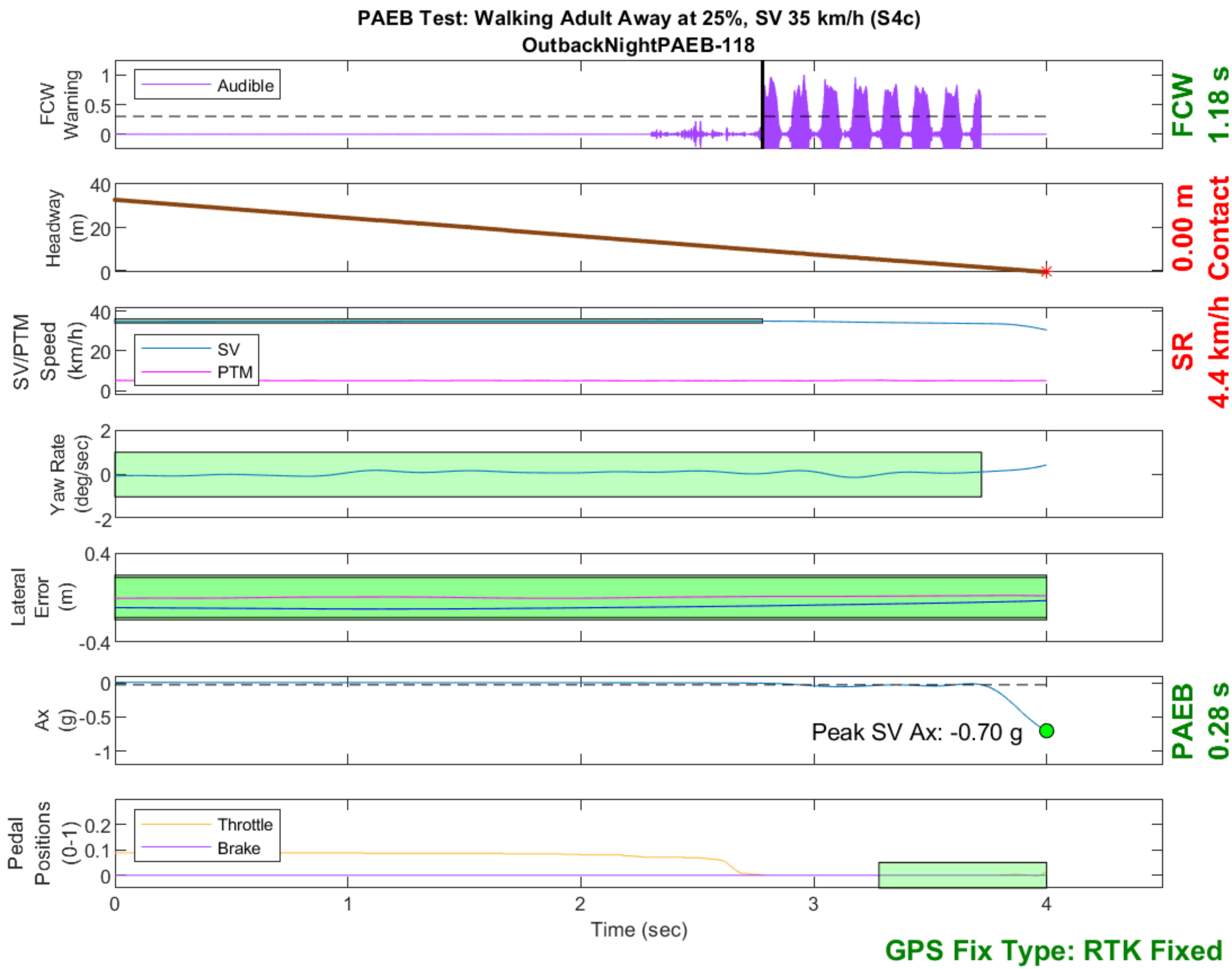


Figure D336. Time History for PAEB Run 118, S4c, Night, Low Beam, 35 km/h

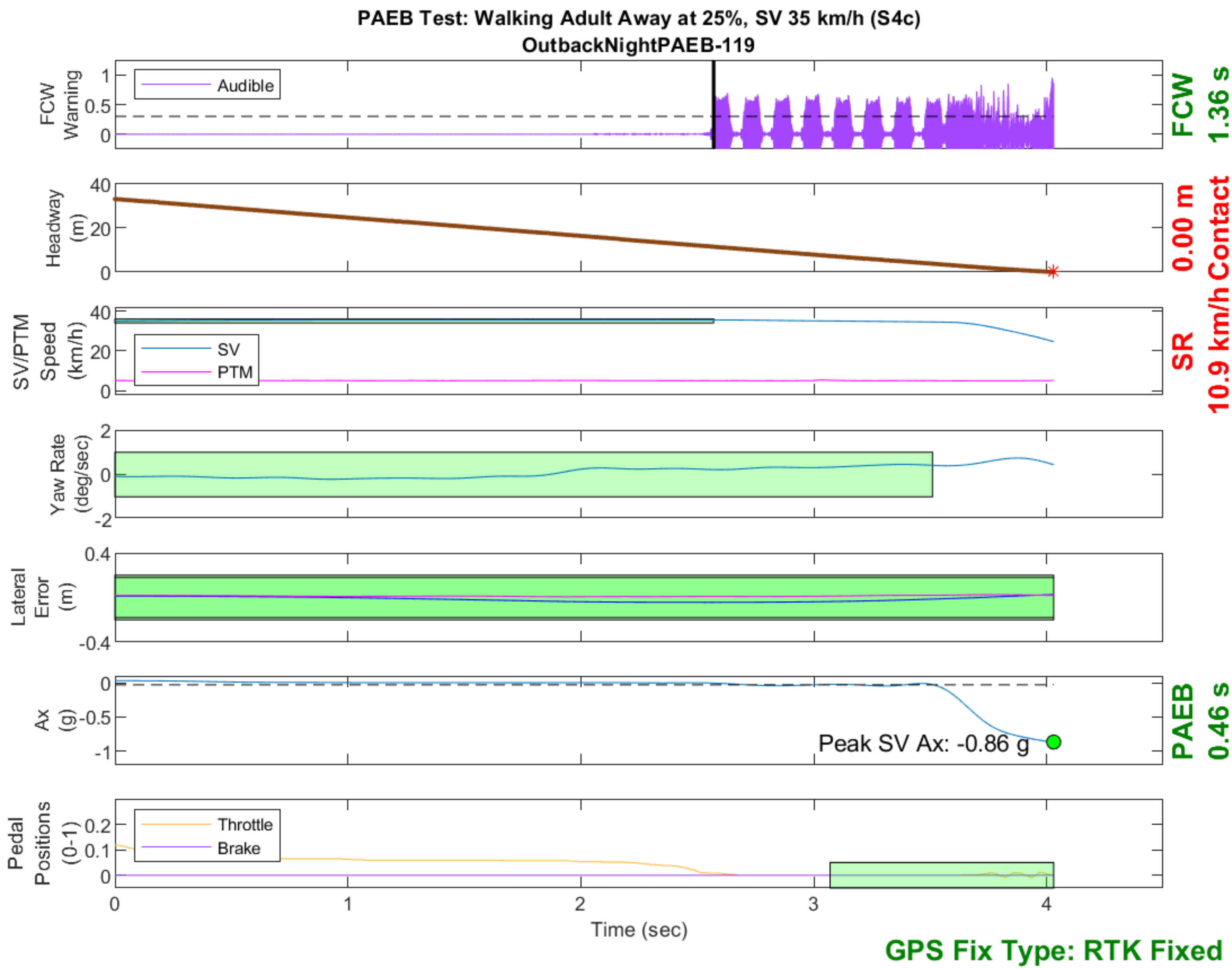


Figure D337. Time History for PAEB Run 119, S4c, Night, Low Beam, 35 km/h

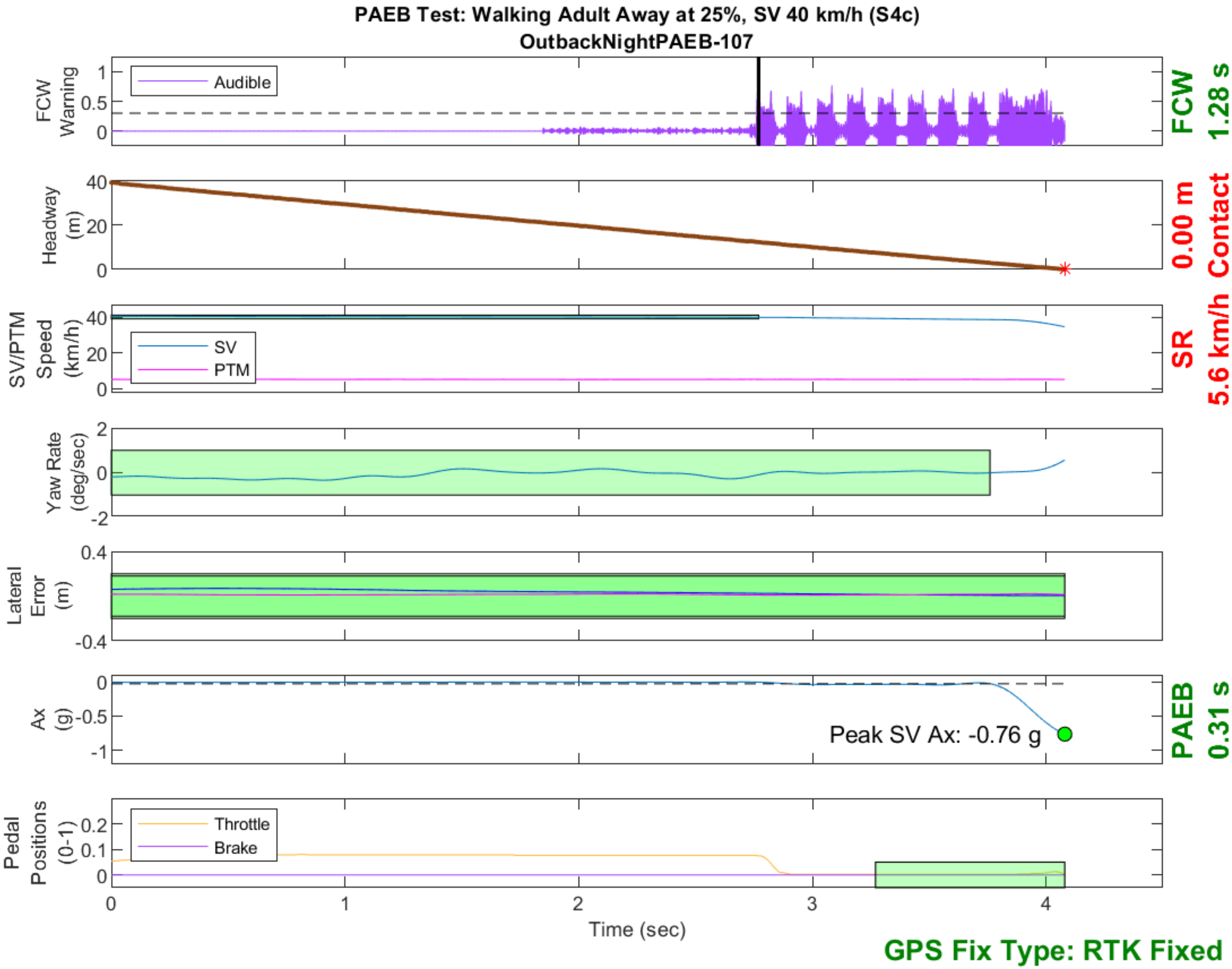


Figure D338. Time History for PAEB Run 107, S4c, Night, Low Beam, 40 km/h

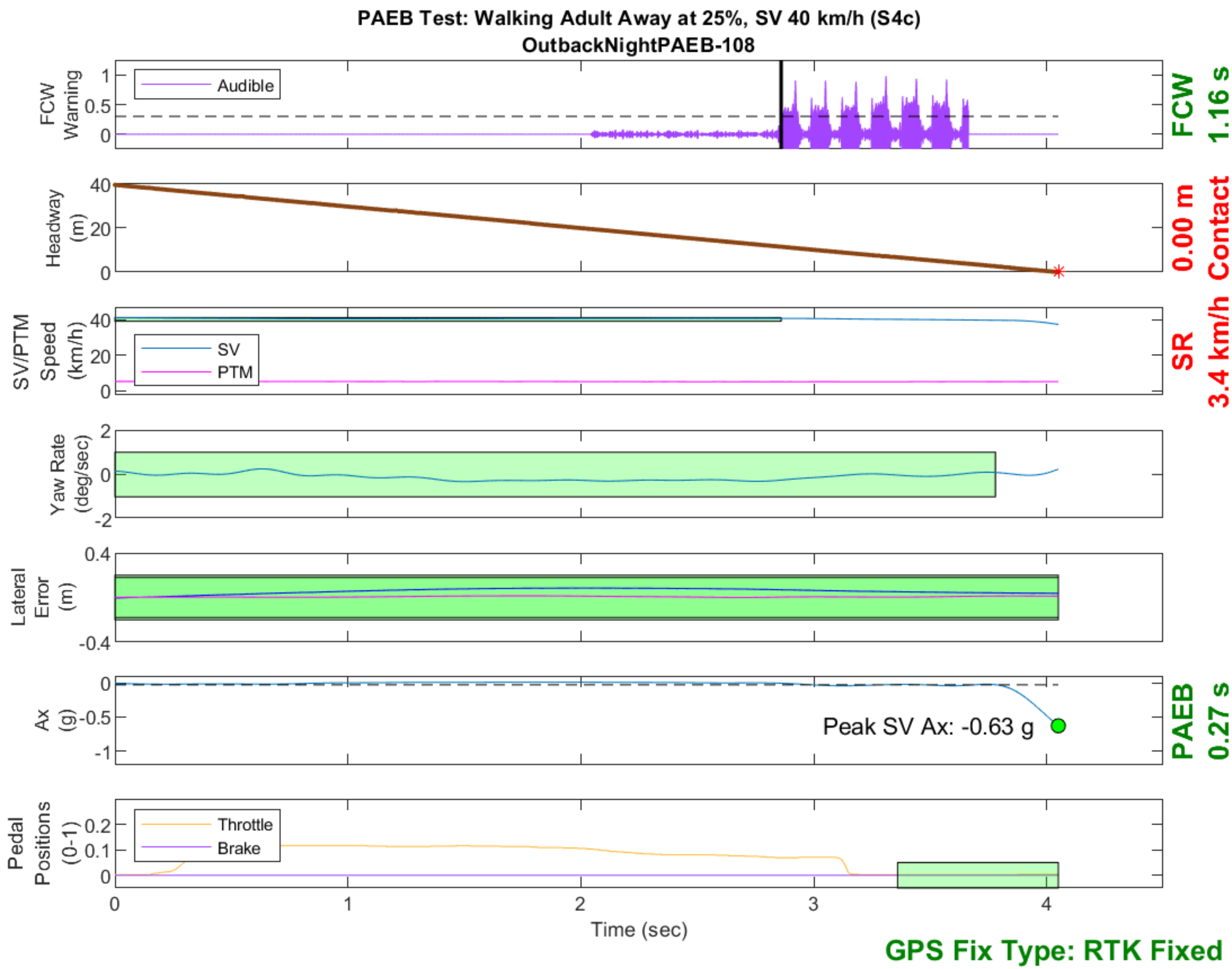


Figure D339. Time History for PAEB Run 108, S4c, Night, Low Beam, 40 km/h

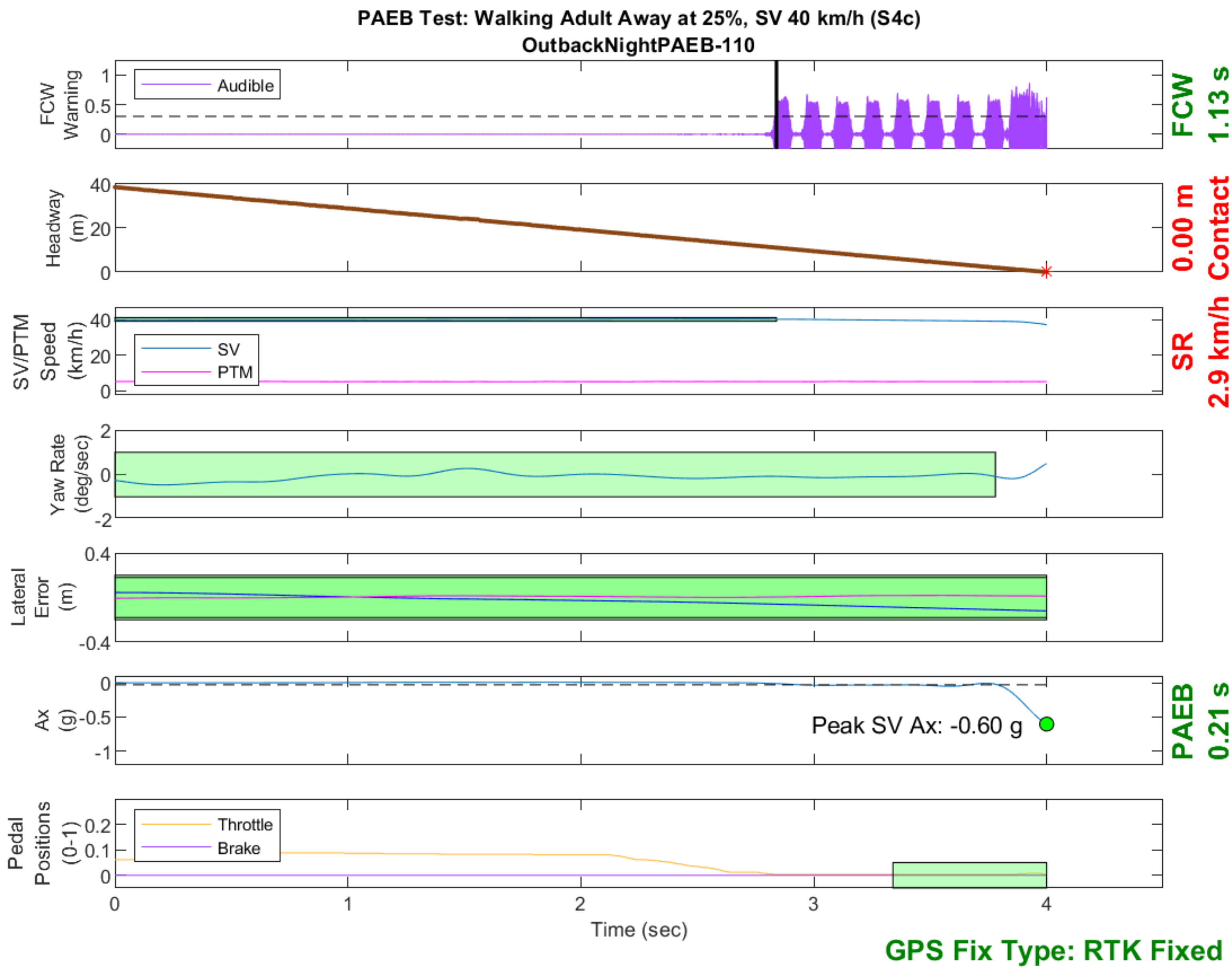


Figure D340. Time History for PAEB Run 110, S4c, Night, Low Beam, 40 km/h