NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

July 28, 2016

Cockpit Display – Recorded Flight Data

Specialist's Factual Report
By Bill Tuccio, Ph.D.

1. EVENT SUMMARY

Location: Abilene, Texas
Date: March 1, 2016
Aircraft: Vans Aircraft RV-6A
Registration: N419B
Operator: Private
NTSB Number: CEN16FA114

On March 1, 2016, about 0830 central standard time, an experimental amateur-built Ohlgren RV-6A airplane, N419B, impacted terrain during takeoff from runway 35 at the Elmdale Airpark (82TS), near Abilene, Texas. The airline transport pilot and his passenger were fatally injured. The impact with terrain destroyed the airplane. The airplane was registered to and operated by the pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Day visual meteorological conditions prevailed in area of the accident site about the time of the accident, and the flight was not operated on flight plan. The flight was destined for Henderson, Nevada, and was originating from 82TS at the time of the accident.

2. RECORDED FLIGHT DATA GROUP

A recorded flight data group was not convened.

3. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following electronic display capable of recording information to non-volatile memory:[1]

Recorder Manufacturer/Model: **Dynon SV-D700**
Recorder Serial Number: **2256**

3.1. Dynon SV-D700 Description

The Dynon SV-D700 is an uncertified screen display suitable for mounting in the cockpit of non type-certificated aircraft. Its capabilities include engine monitoring, synthetic vision, moving map, traffic, airport diagrams, autopilot control, and radio integration.

[1] Type of solid state memory that does not require electrical power to retain information.

The display receives input from multiple modules for flight instrumentation including modules for air data/attitude/heading (ADHARS), engine monitoring (EMS), GPS, transponder, radios, and intercoms.

Data is recorded on a Serial-ATA based Disk on Module (DOM) mounted to the main memory board. The DOM contains a user-configurable log file that can record between 2-150 hours of data at sampling rates ranging from 0.1-16 Hz. There is also an alert log file that is recorded whenever the device triggers any kind of alert and a “Black Box” recent flight data log file which contains the most recent 15 minutes of flight recorded at 16 Hz.

3.1.1. Dynon SV-D700 Data Recovery

The recorder was damaged in the event. The extent of the damage is shown in figure 1. An interior inspection revealed damage to the components, however, the DOM was not damaged, as shown in figure 2. The non-volatile memory chip on the DOM (Samsung K9WBG08U1M PCB0) was removed from the DOM. A raw-data binary readout of the chip was obtained using a Xeltek SP-6000u EEPROM programmer.

An attempt was made to read the binary readout of the chip as a Linux-based International Standards Organization (ISO) image, consistent with procedures used in other investigations; however, the binary readout would not mount. The header of the binary file was repaired and the binary readout did mount; however, the file system was corrupted. Figure 3 shows the expected file system representation from an exemplar and the corruption of the present case.

The binary readout was directly examined and fragments of text-based (ASCII) recordings were identified. The ASCII fragments contained areas of corrupted data interleaved with apparently uncorrupted data, as shown in figure 4. Valid data were manually carved out of the binary readout, corrupt data discarded, and the remaining data used in this report.

Figure 1. Damaged exterior of Dynon SV-D700.

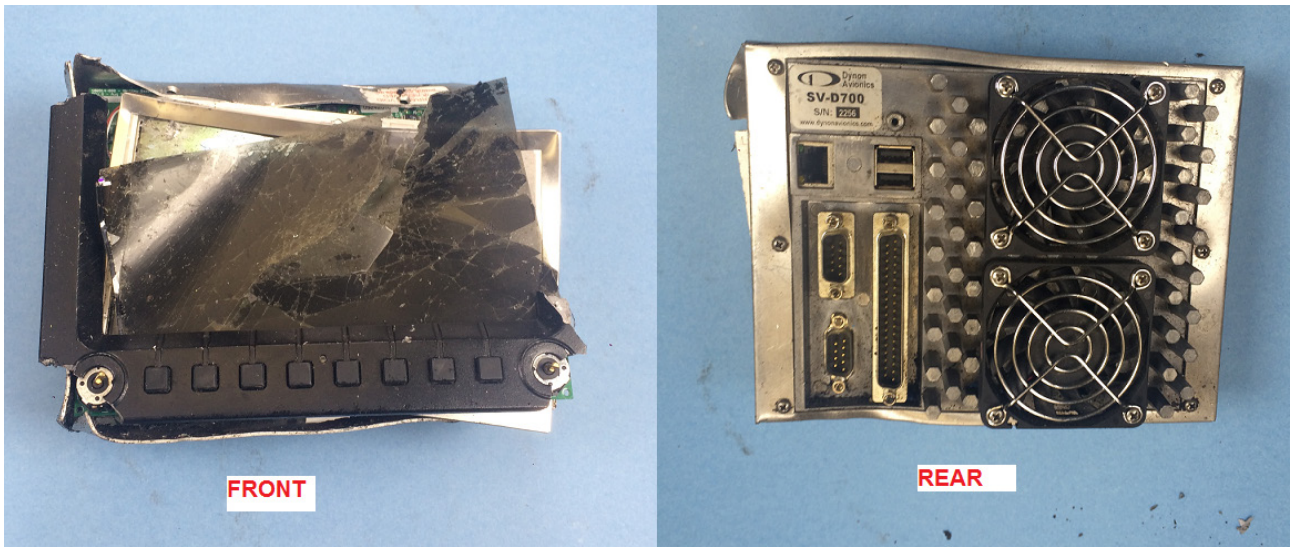


Figure 2. Internal memory board with DOM inset.

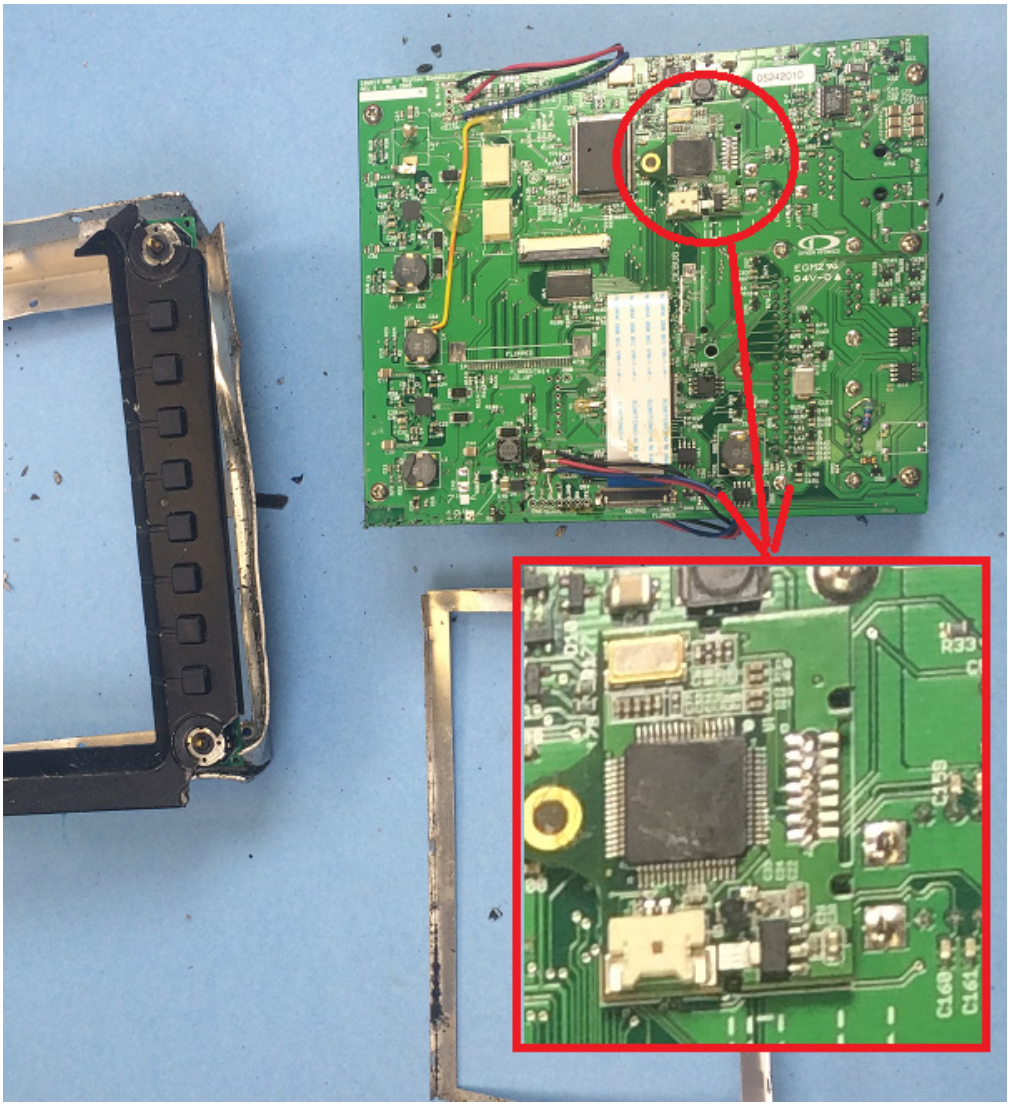


Figure 3. ISO image corruption.

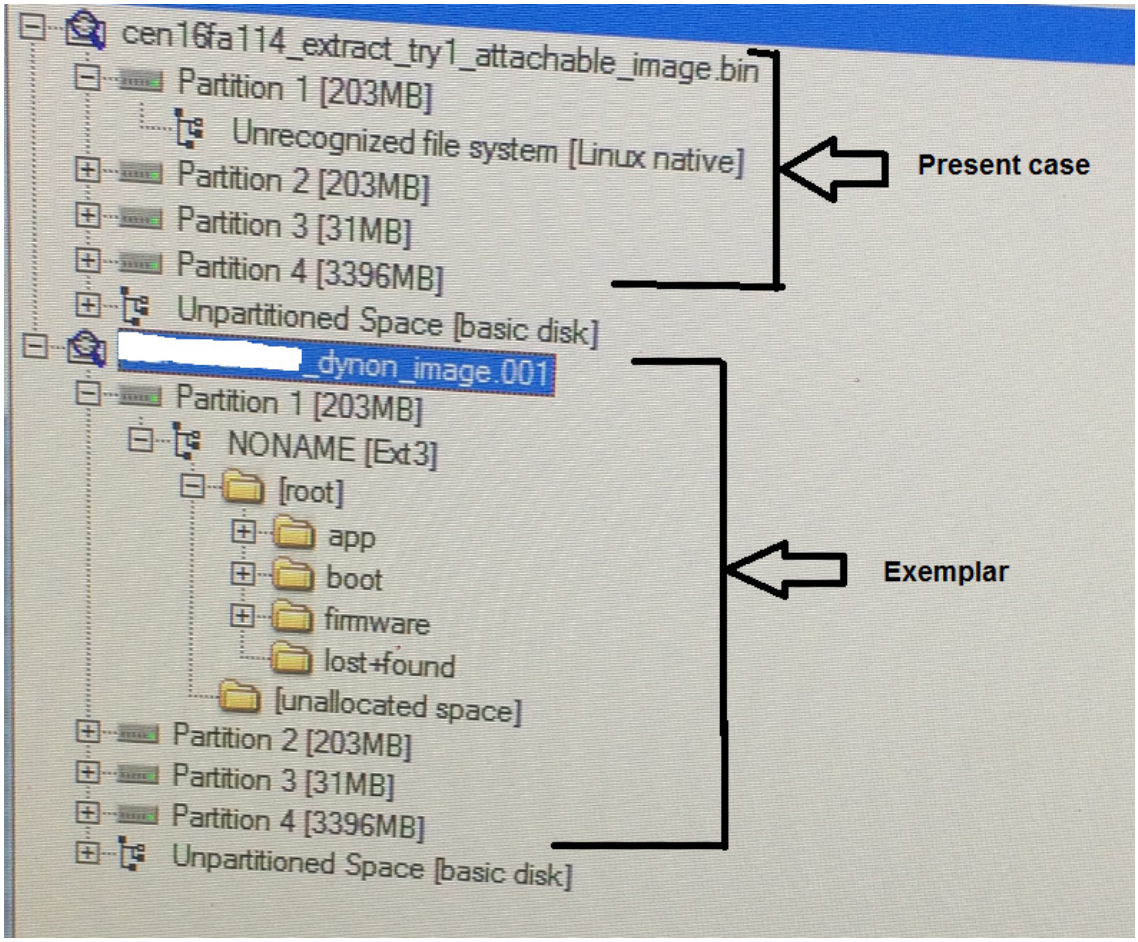
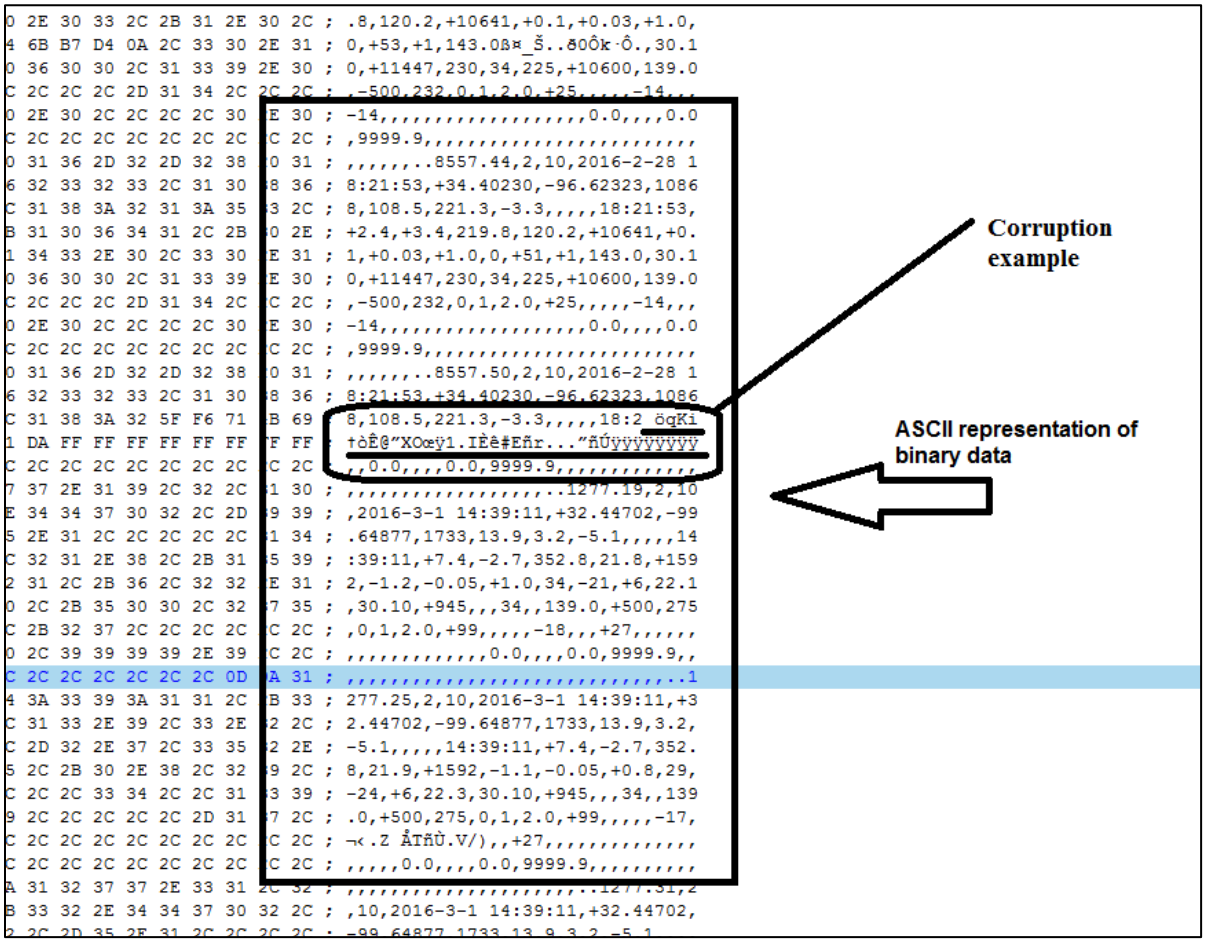


Figure 4. Valid and corrupted ASCII data.



3.1.2. Dynon SV-D700 Data Description

Two recording fragments pertinent to the investigation were identified: the accident flight on March 1, 2016, and a prior departure from Carroll County (4M1) airport in Berryville, Arkansas, on February 28, 2016. Due to data quality issues and investigative needs, fewer parameters were extracted from the 4M1 recording.

3.1.3. Dynon SV-D700 Engineering Units Conversions

Data in the ASCII fragments were expressed in engineering units and used as recorded.

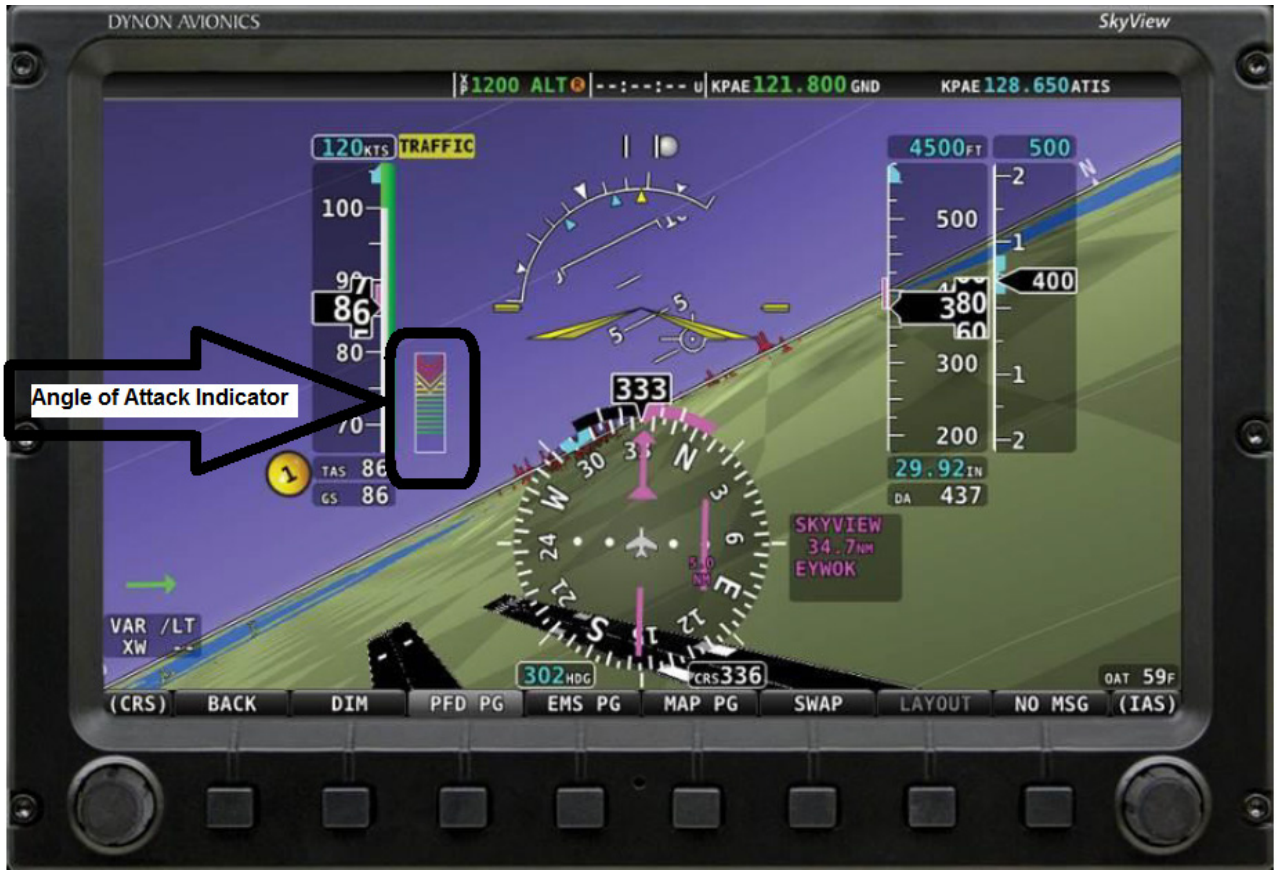
Where applicable, changes to the conversions have been made to ensure the parameters conform to the Safety Board's standard sign convention that climbing right turns are positive (CRT=+).[2]

APPENDIX A lists the SV-D700 parameters verified and provided in this report.

[2] CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Left Aileron Trailing Edge Down = -, Right Aileron Trailing Edge Up = +, Pitch Up = +, Elevator Trailing Edge Up = +.

The SV-D700 reports angle of attack in percent units. Angle of attack is calibrated through an inflight procedure and then electronically displayed to the pilot as shown in the exemplar display in figure 5.[3] The inflight calibration procedure is intended to determine the lowest angle of attack and critical angle of attack corresponding to 0% and 100%, respectively. For this report, the validity of the angle attack calibration was not determined.[4]

Figure 5. Angle of attack indicator in Dynon SV-D700.



3.1.4. Time Correlation

Times used in this report are those recorded by the Dynon unit. Based on a comparison to other investigative data, the times appeared to be recorded as UTC.

3.2. Plots and Corresponding Tabular Data

Overlays of satellite imagery shown in figures 5 and 8 were generated using Google Earth. The weather and lighting depicted in Google Earth are not necessarily representative of the weather and lighting conditions experienced during the accident flight.

[3] The display is an exemplar only, under certain conditions the angle of attack may not be displayed; for example, if angle of attack was not calibrated.
[4] For a full explanation of Dynon angle of attack see http://www.dynonavionics.com/docs/SkyView_AoA.html.

Figures 6 through 8 show the accident recording. The recovered recording began at 14:22:07 UTC on the ramp west of the runway. Due to non-recovered data between 14:22:07 UTC and 14:39:11 UTC, the taxi path to the end of runway 35 could not be determined. By 14:39:11 UTC, the aircraft began its takeoff roll on runway 35. Around 14:39:34 UTC, the aircraft began a climbing roll to the right. By 14:39:45 UTC, the aircraft began to roll left and track left. The last recovered point from the recording was at 14:39:49 UTC, and showed a pitch down attitude and left roll in excess of 60 degrees.

Figures 9 and 10 show the prior takeoff from 4M1 on February 28, 2016. The aircraft began a takeoff on runway 25 by 16:10:59 UTC at an initial GPS altitude of 1,201 feet. The aircraft climbed straight ahead until the end of the recovered data at 16:11:37 UTC at a GPS altitude of 1,829 feet. The indicated airspeed was in excess of groundspeed throughout the takeoff, consistent with a headwind; for example, at 16:11:30 UTC, the indicated airspeed was 80 knots and the groundspeed was 63 knots.

The corresponding tabular data used to create these five plots are provided in electronic (*.csv[5]) format as Attachment 1 to this report.

[5] Comma Separated Value format.

Figure 6. Satellite overlay of accident flight.

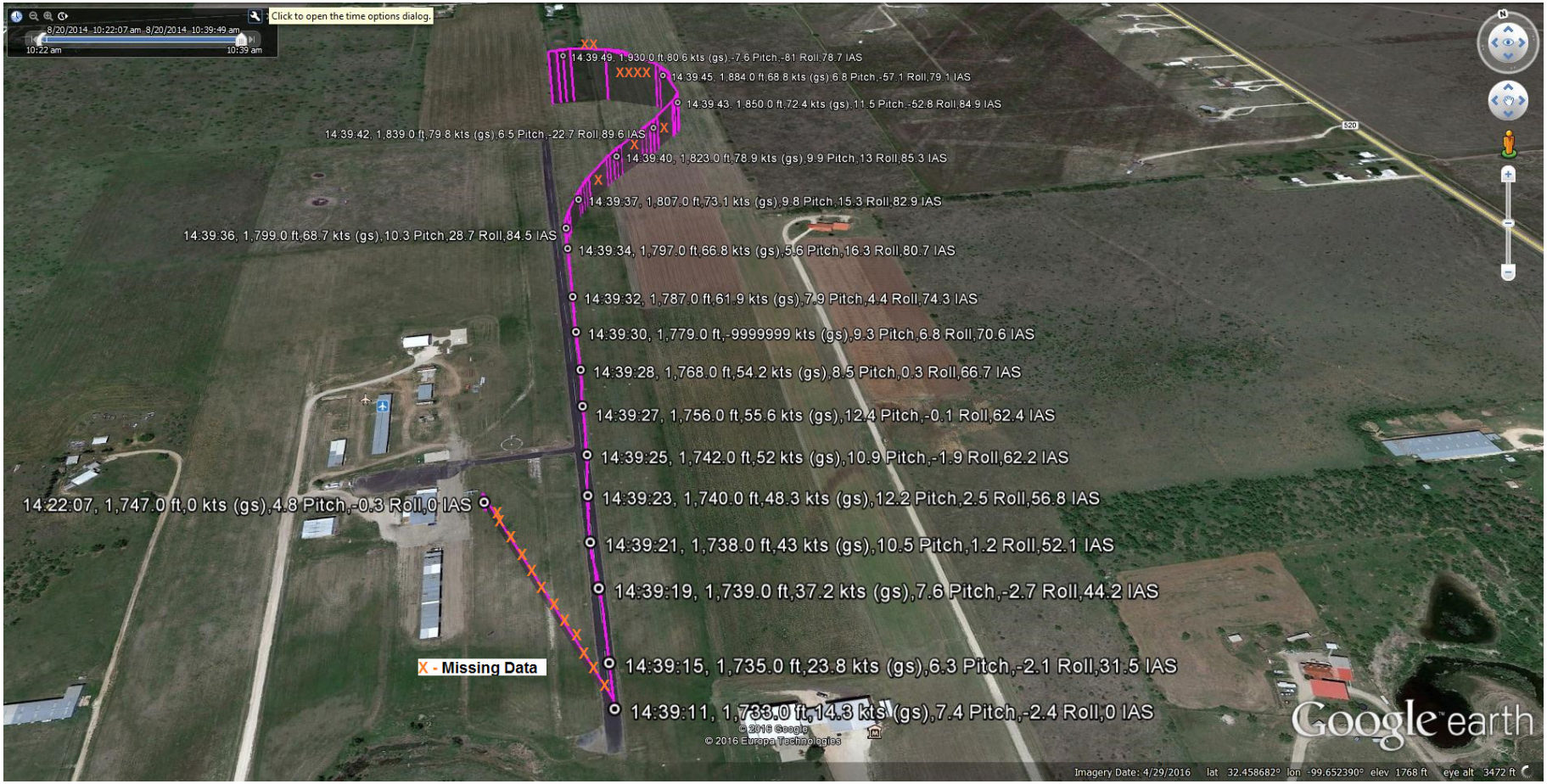


Figure 7. Plot of accident flight recording.

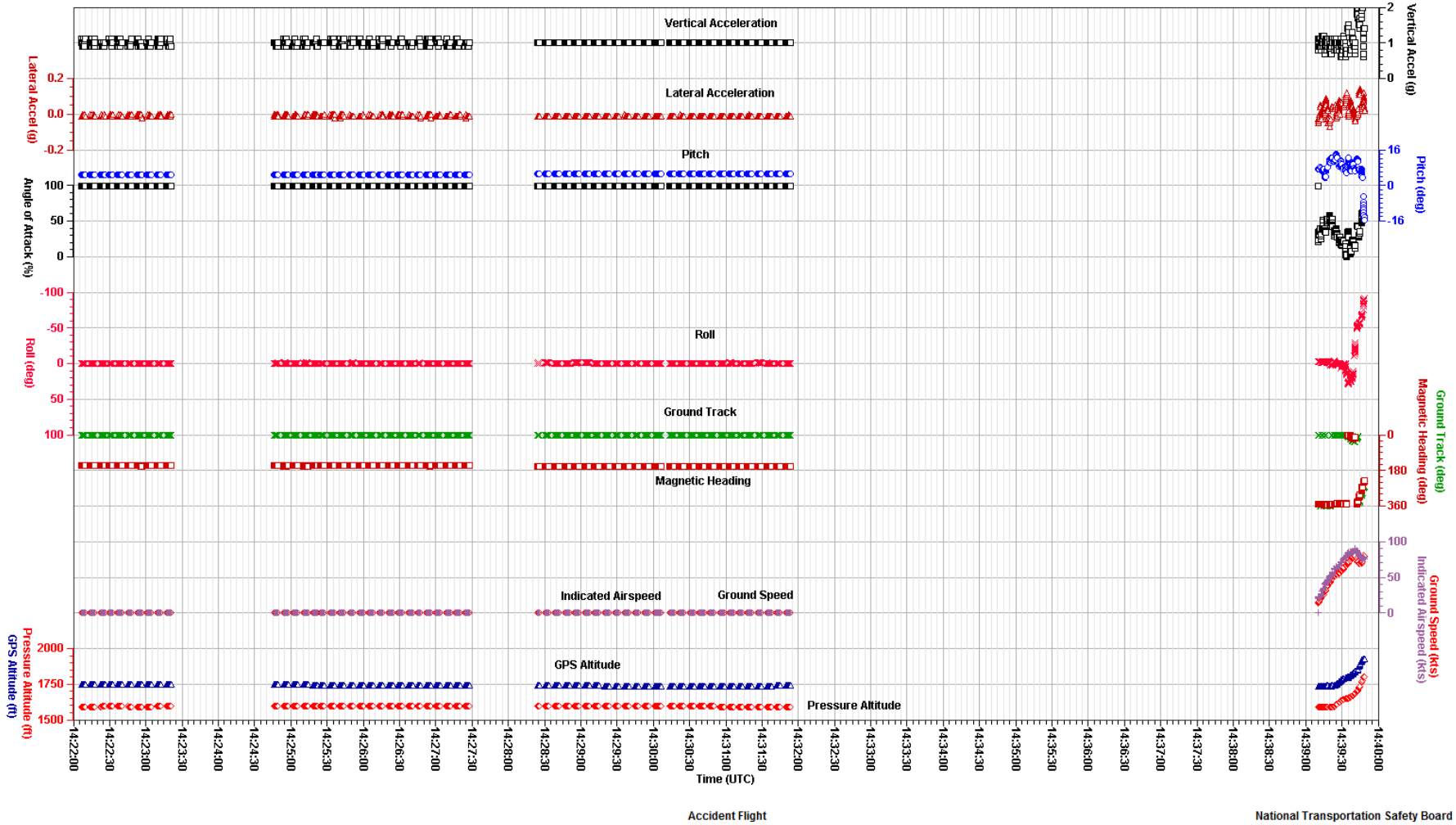


Figure 8. Plot of takeoff portion of accident flight until end of recording.

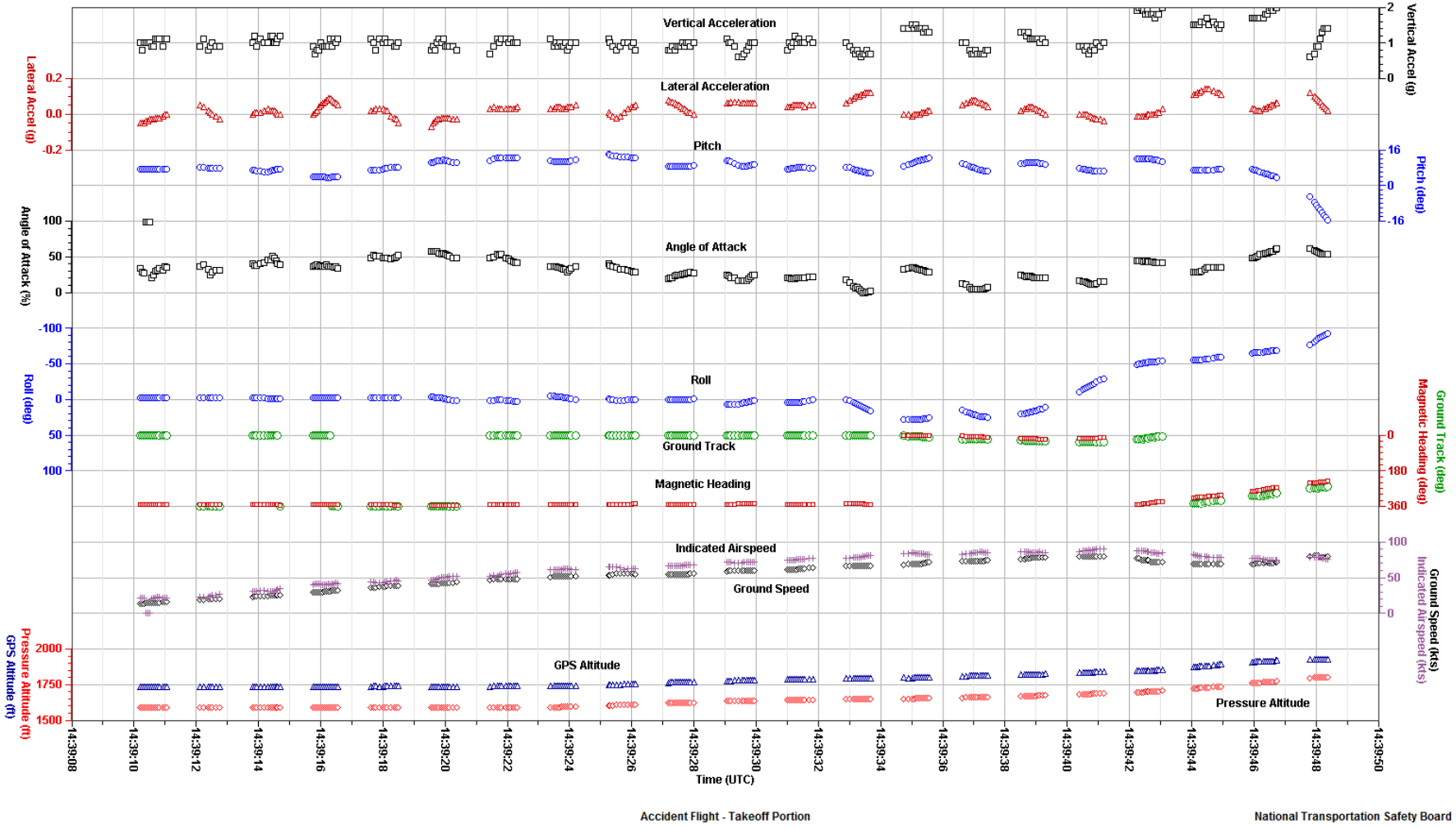


Figure 9. Satellite overlay of 4M1 takeoff.

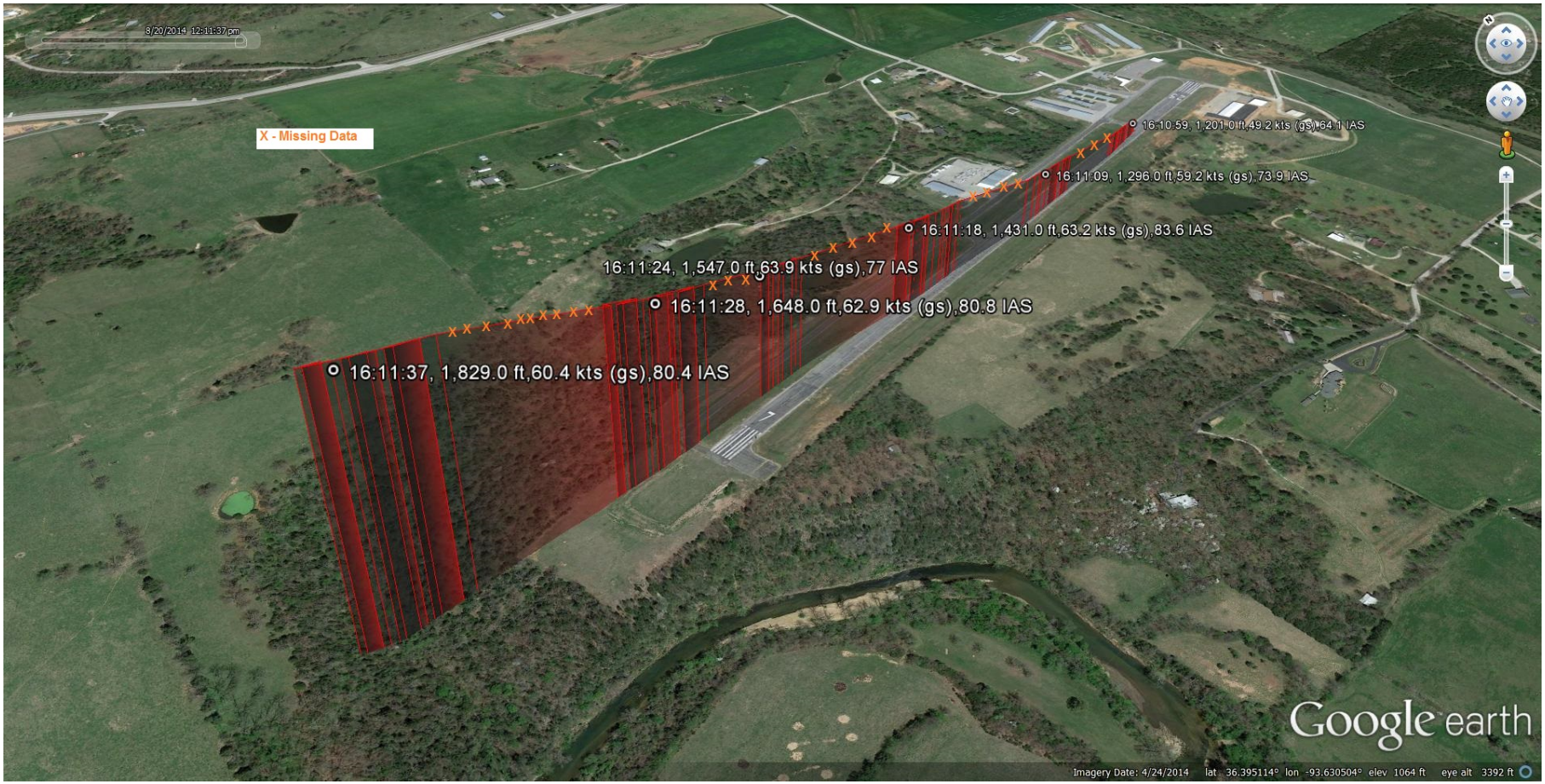
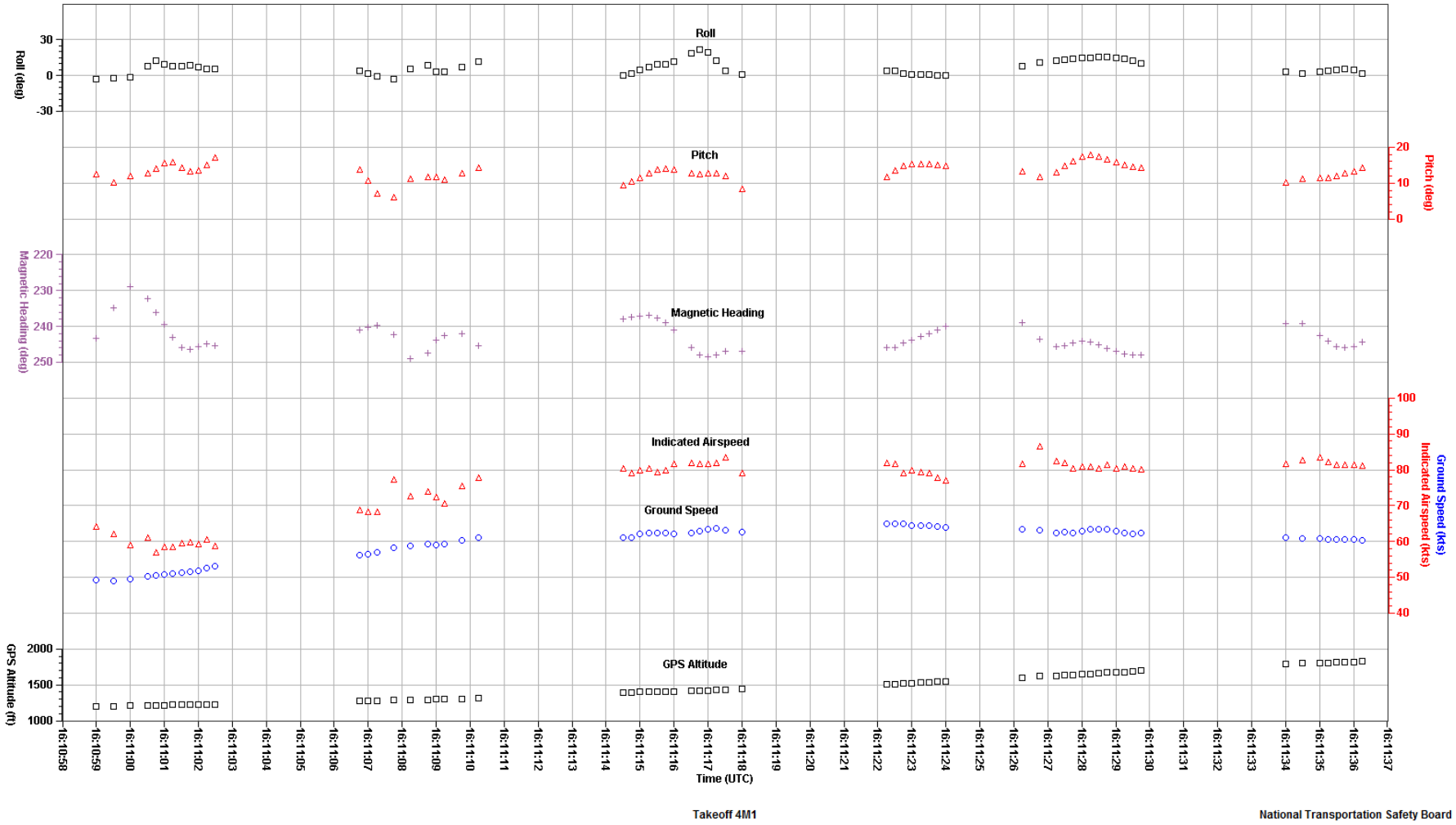


Figure 10. Plot of prior takeoff at 4M1.



APPENDIX A - Dynon Parameters

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameters and table A-2 describes the unit abbreviations used in this report.

Table A-1. Verified and provided parameters.

Parameter Name	Parameter Description
1. Angle of Attack (%)	Angle of Attack
2. Date/Time (mm/dd/yyyy hh:mm:ss)	UTC Date and Time
3. GPS Altitude (ft)	GPS Altitude
4. Ground Speed (kts)	Ground Speed
5. Ground Track (deg)	Track
6. Indicated Airspeed (kts)	Indicated Airspeed
7. Lateral Accel (g)	Lateral Acceleration
8. Latitude (deg)	Latitude
9. Longitude (deg)	Longitude
10. Magnetic Heading (deg)	Magnetic Heading
11. Pitch (deg)	Pitch
12. Pressure Altitude (ft)	Pressure Altitude
13. Roll (deg)	Roll
14. Vertical Accel (g)	Vertical Acceleration

Table A-2. Unit abbreviations.

Units Abbreviation	Description
%	percent
deg	degrees
ft	feet
kts	knots
g	g