Understanding the Zelocity PureLaunch launch monitor.

This paper has been written to explain the workings of the PureLaunch launch monitor. Its goal is to help PureLaunch owners understanding it and explaining some of the current problems with this launch monitor.

The trigger to this investigation was when I loaded a version 4.2 file in version 5 and noticed that almost all values where different then from what I remembered they where in version 4. I reloaded that same file in version 4 and again the displayed values where different than displayed in version 5.

I have a background in IT which allowed me to investigate this strange behavior in a bit more detail than normal. After the investigation I contacted Zelocity in August 2009 about my findings but I received no feedback/response or explication. Being unhappy about the lack of feedback/customer support I decided to write this paper.

SUMMARY

The PureLaunch application data displays values which are different than the values being sent to the PureLaunch software from the "data interface software".

It also displays values which can not be calculated based on the values that are sent to the PureLaunch software by the "data interface software". With only club speed, ball speed and launch angle it is impossible to calculate values for:

- Side-spin
- Face angle
- Azimuth
- Angle of attack.
- Azimuth
- Swing path

Versions higher then version 1 of the PureLaunch software will not longer indicate when spin is not measured but calculated. When not using the original striped ball the PureLaunch software will (as far as I can test) always produce calculated spin.

All above statements can be checked and reproduced using the software for which the link is included in this document. On request the sources of the software can be provided.

INTRODUCTION

To get a good understanding it must be made very clear that the PureLaunch has two major parts. **Hardware** and **Software**. This paper only discusses the software.

The hardware is the unit itself and the software (a part of it) is the software you received with your PureLaunch.
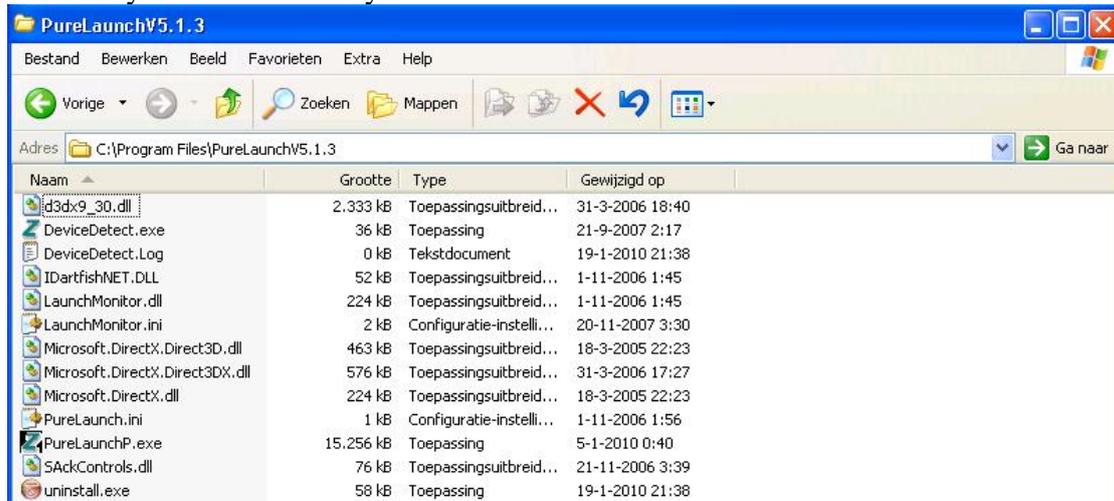
The hardware is connected to your pc and the PureLaunch software via an USB cable.

Normally the working of the PureLaunch system is as follows: You turn the PureLaunch on, start the PureLaunch software, **arm** the PureLaunch and **hit** a ball. After which the **results** appear on the screen of your pc.
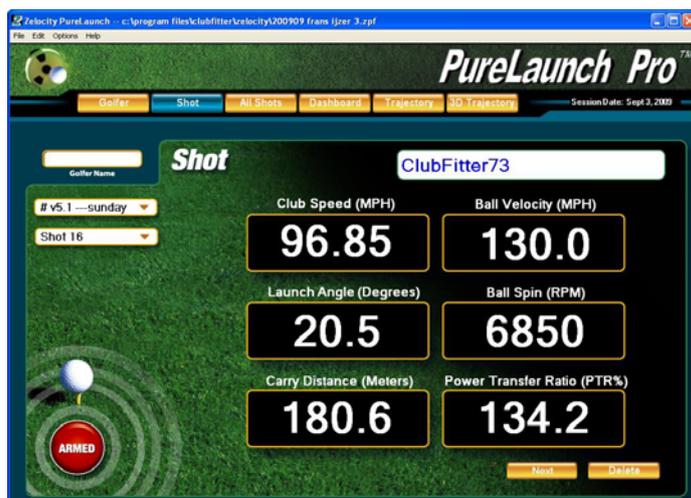
In short:
- **Arm**
- **Hit**
- **Results**

ARM

When the PureLaunch is armed it will start sending radar waves from the top and bottom pods. Some of those waves will bounce off the surface of the club or ball and will be received by those same two pods. The total amounts of waves/pulses sent and received are large. In fact the Zelocity website www.zelocity.com/golf/technology.shtml provides the following information:

<start website quote>

Doppler radar provides **Zelocity™ Golf Performance Monitors** the advantage of collecting hundreds of thousands of data points for ball flight and swing analysis. The radar "sees" the club and golf ball before, during, and after the moment of impact, and follows the ball as it flies down range. This allows *Zelocity™* to collect a stream of actual data points (100,000 per second) from the Doppler radar signal; see the radar data stream table below.

<end website quote>
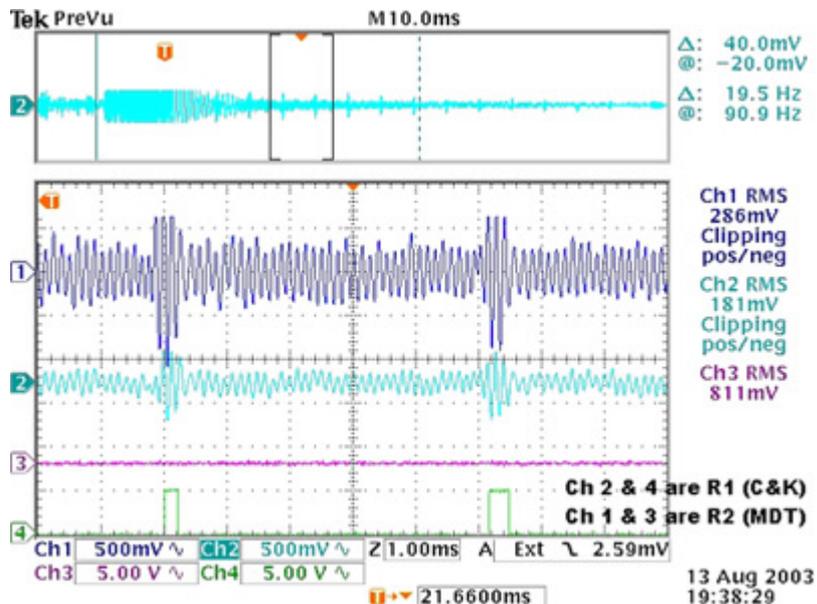
The term Doppler in the above statement refers to an effect on the radar waves. When the club or ball are moving the reflected radar waves do not have the same characteristics as when they where send. The difference between the waves sent and received is used to determine the speed of the club and/or the golf ball.

More information about Doppler: en.wikipedia.org/wiki/Doppler_effect

In order to handle the sending and receiving of the waves and the calculations of the differences between the sent/received waves there is a need for a central processing unit (CPU). The CPU for the PureLaunch is located between the two pods. It contains all the hardware and software required to generate, collect and process the radar waves. Software embedded in hardware is normally referred to as firmware.

So as soon as we **arm** the PureLaunch the sending and receiving of radar waves starts and the firmware will start storing large amount of calculated data.

HIT Part I

When the ball is struck by the club the sound of the impact is recorded by a microphone located in the PureLaunch. This sound will then trigger a process in the firmware to delete all already collected data except the last 15.000 microseconds of data and continue recording the newly received data as long as there is place in the memory banks of the central processing unit.

When the limits of storage are reached the firmware will then dump all collected data via the USB cable to the pc software and disarm the radar unit.

To save 15.000 microseconds of data before the sound of the impact is received by the microphone is important for a number of reasons.

First because the ball is place 60 inches in front of the unit so the sound of the ball being struck must travel those 60 inches before reaching to microphone. The sound of the impact travels at the speed of sound while the radar waves travel at the speed of light. As the sound reaches the PureLaunch unit later then the radar waves the data received before the sound of the impact is recorded must also be saved for processing.

Secondly the PureLaunch also would like to measure the speed of the moving club before it struck the ball, again for doing so it must "look back" in time.

The 15.000 microseconds therefore allows the PureLaunch both to record a moving club and start recording the ball at the correct moment.

HIT Part II

The firmware sends the data via the USB cable to the PureLaunch software that is installed on the PC.

The Zelocity website www.zelocity.com/golf/purelaunch.shtml provides the following information:

<start website quote>

Software:

• Compatible with Windows XP and Vista operating systems
• LaunchMonitor Data Interface software size ~ 8mb; PureLaunch™ application size ~ 8mb

<end website quote>

So the PureLaunch software consists of two parts. One part is the "data interface software" and a second part is the "PureLaunch application".

The desktop icon explains which part is the "PureLaunch application" because it will point to the following file "PurelaunchP.exe" (version 5.x) or "Purelaunch.exe" (version 4.x, 3.x, 1.x).

Running the PureLaunch application and then monitoring the additional applications it loads allowed me to determine what program the "data interface software" is. After some investigation it is clear that the application loads "Launchmonitor.dll".

So the firmware sends data to Launchmonitor.dll. Then the Launchmonitor.dll sends data to PurelaunchP.exe or Purelaunch.exe. Then the PureLaunch.exe displays the results.

BETWEEN HIT & RESULTS

Technically the fact that the data interface software seems to be a DLL (dynamically linked libary) is good news for the investigation. When software communicates with a DLL a programmer can create a so-called hook or "man in the middle". A hook can show what data and which requests are send between the launchmonitor.dll and PurelaunchP.exe.

This is the screenshot from the hook software made after a hit has been recorded.

From this screenshot it is clear that the following data is being sent to the Purelaunch.exe

- Ballspeed
- LaunchAngle
- TotalSpin
- Clubspeed
- Clubspeed prior to impact

Please note the following :
- Spin 9.005.139
- Pre-impact clubspeeds are all the same

SHOT RESULTS

These are screenshots from the PureLaunch software **version 4.2.3** for the above recorded shot.

NOTES:
- Spin was sent as 9.005.139 but is displayed as 8171.
- Face Angle was not sent but is shown.
- Side spin is not sent but is shown.

Below the same for PureLaunch **Version 3.0.3**

- Spin sent as 9.005.498

- spin displayed 5498 but sent as 9.005.498
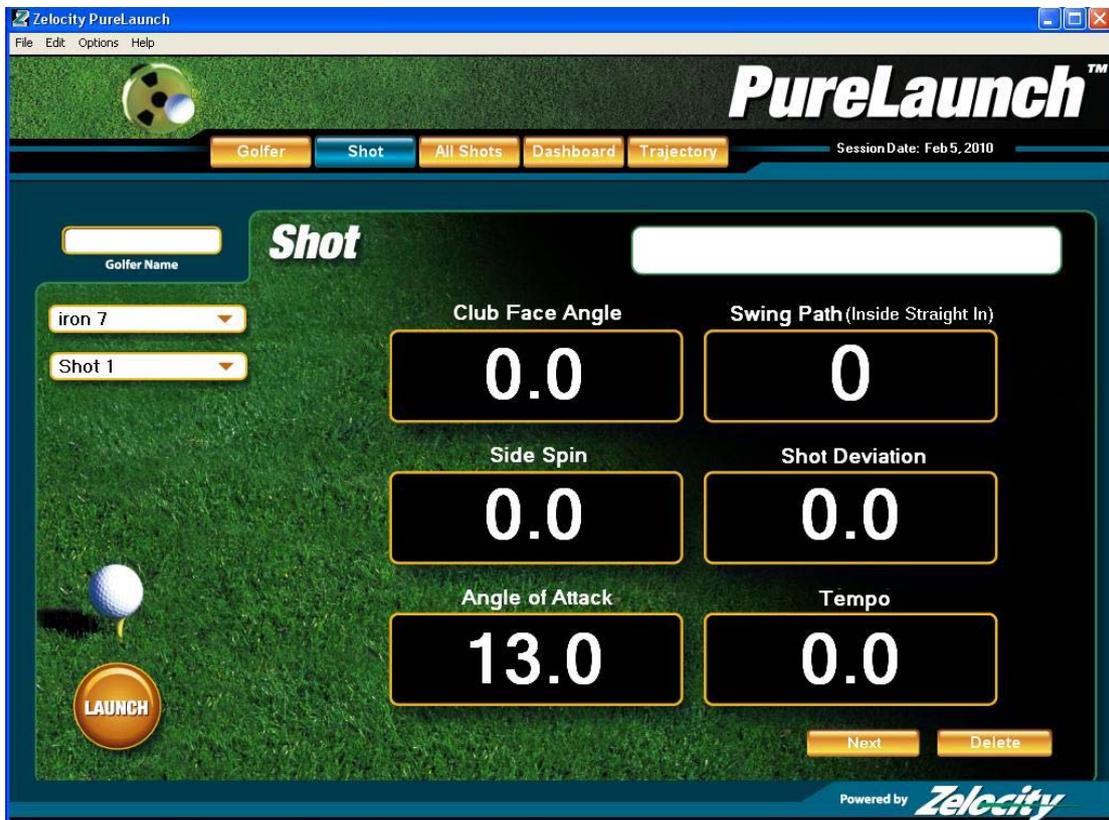
- Angle of Attack not sent but shown.
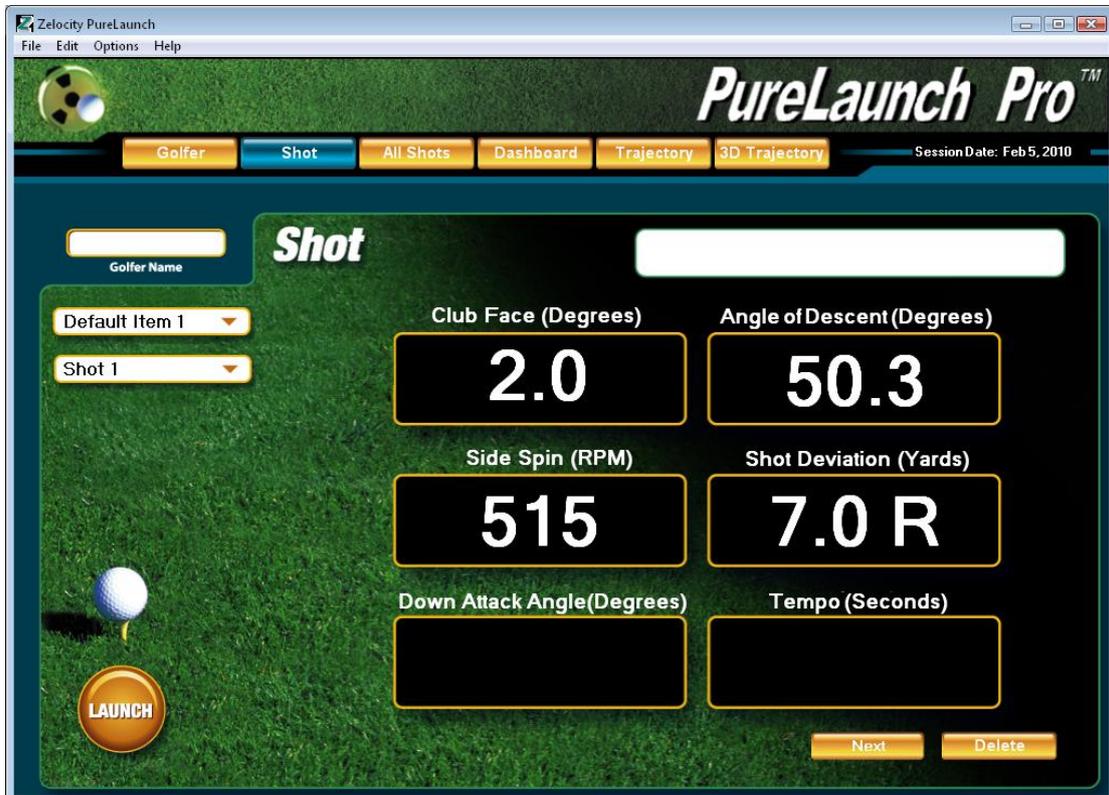
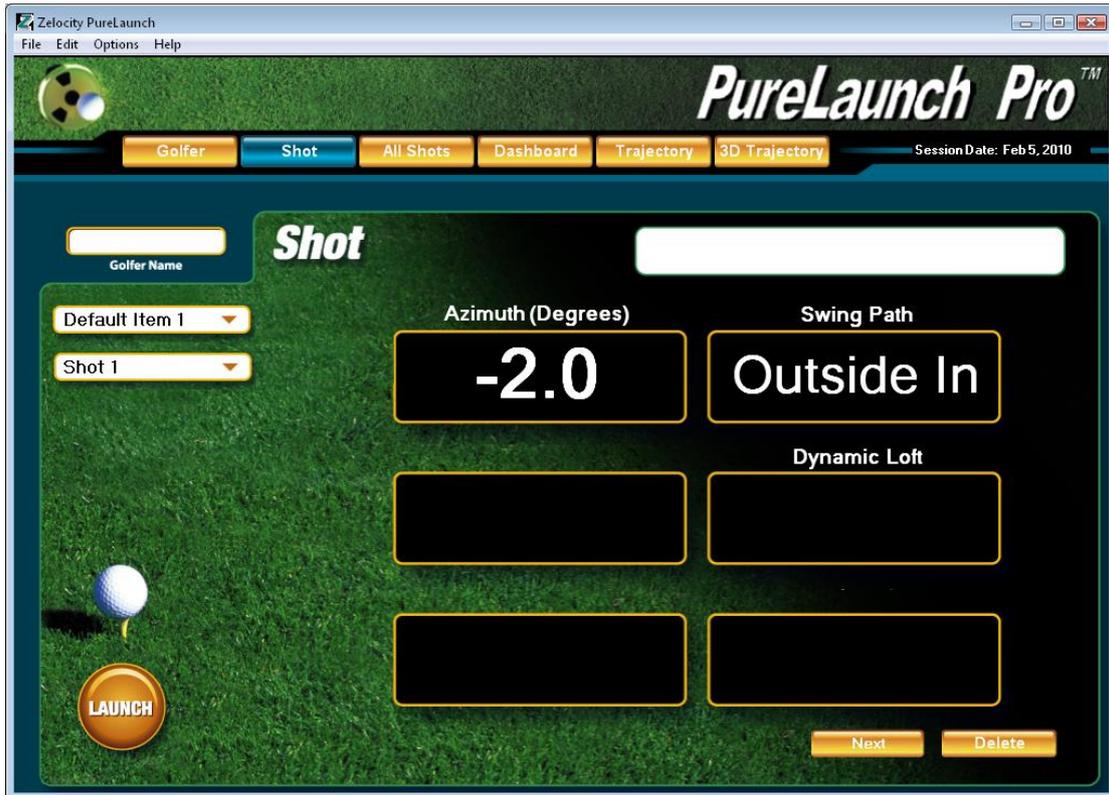Below the same for PureLaunch **Version 5.1.3**

- Spin sent as 9.004.660
- Pre impact clubspeeds are all the same

- spin displayed 6720 but sent as 9.004.660

- Face Angle displayed but not sent
- Side spin displayed but not sent

- Azimuth displayed but not sent
- Swing path displayed but not sent

- Pre impact speeds displayed as ascending speeds (late release) but sent as all being the same.

THE 9 MILLION RPM

As can be seen in the above screenshots the spin provided from the data processing software to the PureLaunch software always seems to be higher then 9.000.000. This seems to be a weird value for spin so extra investigation took place trying to understand the reason behind this high value.

I did remember that in the past the balls used for the PureLaunch had to have a reflective stripe. The old (2005) Zelocity website provide the following information

<start website quote>

Performance:

• For use with right-handed and left-handed golfers
• Indoor or outdoor use; No calibration required; Setup time less than 1 minute
• Spin measured using reflective-striped ball or calculated using non-striped ball
• Integrated microphone for club head speed measurement at impact

<end website quote>

This page can still be found via
http://web.archive.org/web/20050207122505/zelocity.com/purelaunch.shtml

So according to this quote from the website the reflective stripe would provide measured spin and non-striped balls would provide calculated spin.

Below two screenshots from PureLaunch version 1.2 using a striped-ball.

Looking at the two screenshots above it is clear that this version has a tick-box ("measured") that is un-ticked when the data processing software sends a spin higher than 9 million. It seems that this "calculated spin" indication is no longer present after version 1.

The screenshots also show several shots in the Zelocity monitor software. During the test it became clear that using a striped-ball would not always produce measured-spin. Is seems that the data processing software will try to measure the spin and when that is not possible due to whatever reason will automatically switch to calculated spin.

Below a screenshot using version 4.2.3 and a striped ball.
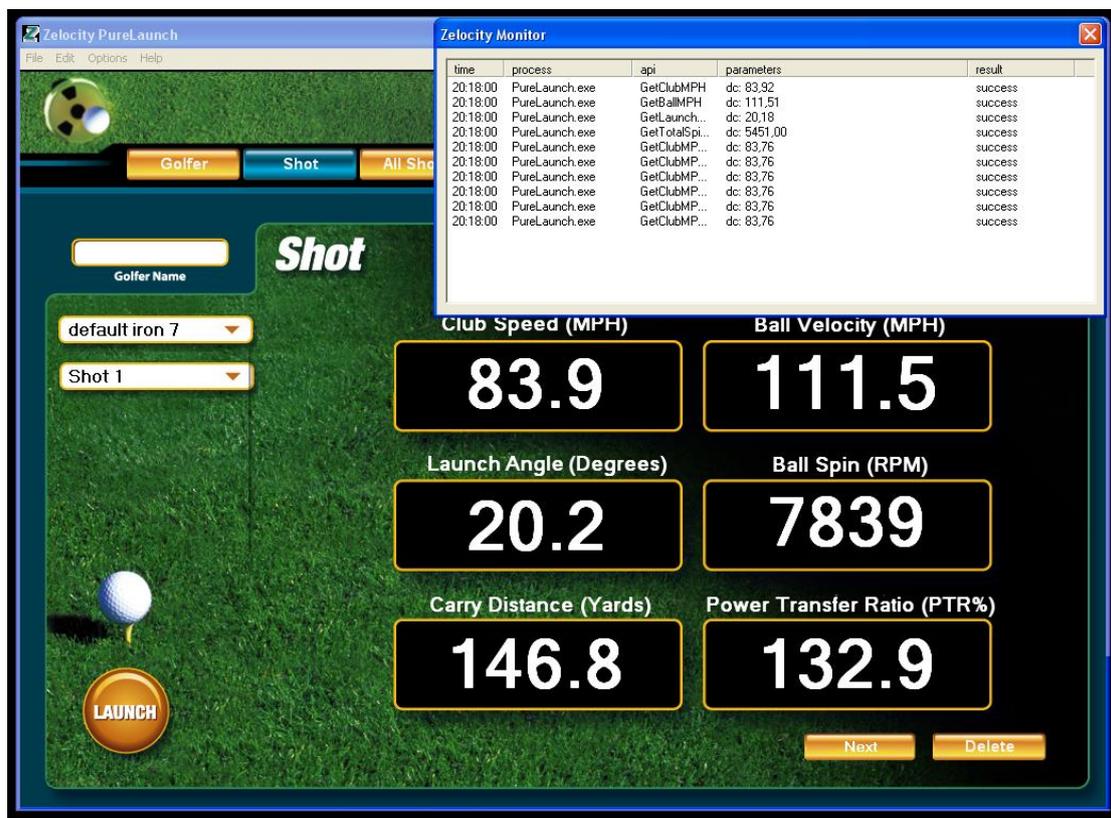
From the above screenshot it is clear that using a striped-ball with version 4.2.3 can sometimes generate measured spin. But the PureLaunch software chooses not to use the measured spin sent and displays something totally different.

CONCLUSION

The PureLaunch application data displays values which are different than the values being sent like pre-impact club speeds and spin.

While the particular software version determines which values will be displayed the PureLaunch software can display values for:
- azimuth
- face angle
- side spin
- shot deviation
- angle of attack
- swing path

These values can not be calculated based on the values that are sent to the application. With only club speed, ball speed and launch angle it is impossible to calculate the other values.

More recent versions of the PureLaunch software (higher than version 1) will no indicate whether or not the spin value is measured or calculated. When not using the original striped ball the PureLaunch software will (as far as I can test) always produces calculated spin. Furthermore several versions will, even when having a measured spin, display a spin value which value seem to have no relation to the value sent by the data processing software.

For those of you who would like to repeat this test. The software is available via www.clubfitter73.fr/PL.zip Unzip the two files to a folder and start the zelocitymonitor.exe before running the PureLaunch software. On request the sources of the software can be provided.

If there are any questions, remarks or errors found please contact me.