Report

Paraglider G-load measurement programme

Air Base De Peel Holland

9 februari 2008

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Distribution:

Test participants

KNVvL

Air base De Peel

NLR

Bräuniger

CML

DHV

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v5.2 editorial

Summary

This programme was initiated to gain objective data. The emphasis was on measuring the G-forces which occur during the spiral descent manoeuvre. Physiological data of the test-pilot were measured as well during the test.

Because it is not possible to make all information available in a written form, it will be possible to order a CD with all collected data, information, videos and photographs. Please send an e-mail to the author with your name and the address for delivery of the CD. To meet the costs please transfer Euro 10,- to the account below, mentioning 'G-load CD'.
It is also possible to obtain a printed and bounded report. Send an e-mail to the author with your name and the address for delivery of the report. To meet the costs please transfer Euro 10,- to the account below, mentioning 'G-load report.

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Abbreviations

AGSM	Anti-G Straining Manoeuvres
ASCII	American Standard Code for Information Interchange
BASI	Bureau of Air Safety Investigation
CD	Compact Disc
CML	Centrum voor Mens en Luchtvaart te Soesterberg (Centre for Human factors in Aviation)
DC	Direct Current
DHV	Deutscher Hangegleiter Verband (German Hangglider Association)
DNW	Duits Nederlandse Windtunnels (German Dutch Wind Tunnels)
EHBO	Eerste Hulp Bij Ongevallen (First Aid)
FAC	Forward Air Controller
G	acceleration of Gravity
G-LOC	G-load induced Loss Off Consiousness
GMT	Greenwich Mean Time
GPS	Global Positioning System
HEART	
Hz	Hertz
KNVvL	Koningklijke Nederlandse Vereniging voor Luchtvaart (Royal Netherlands Aeronautical Association)
LT	Local Time
LTF	LuftTuchtigkeitsForderungen (Airworthiness Criteria)
LST	Low Speed wind Tunnel
NLR	Nationaal Lucht en Ruimtevaart laboratorium (National Aerospace Laboratory)
NOTAM	NOtice To Air Man
OPS	OPerationS
PA	Pressure Altitude
SIV	Simulated Incidence in Flight
SLR	Single Lens Reflex
TAS	True Air Speed

1 Introduction

Lately, after a few incidents, there has been much to do around the steep spiral descent. This programme was initiated to deal with all rumours, speculations and half-truths by producing objective data.
This information can be used in discussions regarding existing safety issues.

In the trial we recorded G-forces, pressure altitude, air speed, descent rate and physiological data during spiral descents.
Afterwards it was to be determined if there is a relation between G-load and descent rate.

A report of the tests and the findings will be produced and published. This will be announced through the official KNVvL information channels and the various existing paraglider fora.
As it is not possible to make all information available in written form, a CD with all data collected can be ordered.

It was the intention that this report should be written in English to enable international distribution. However, a considerable amount of text was already written in Dutch. It was decided to translate those existing texts into English. Some of the referenced documents remain in Dutch.

This programme was initiated by Ronald ten Berge of Action Air Sports and Paul Blok, Senior Research Engineer at the Dutch Aerospace laboratory.

2 **Preparations**

A test plan was written prior to the trials, unfortunately in Dutch. The original version is available at http://www.actionairsports.nl/download/testplan-G-meting.doc
This plan was formulated to prepare as well as possible for the trials.
The test plan contained the following information:
- measurement plan, test matrix
- role allocation
- radio communication settings
- The equipment and its purpose
- registration parameters
- possible test locations
- airspace classification
- weather conditions
- preparations on the test day
- registration procedures
- safety precautions
- contact information

Relevant information is copied into Appendix A of this report.

To ensure safe operations without interfering traffic, a NOTAM was issued which guaranteed a free airspace within a radius of 2 nm up to 3000 ft (appendix E).

3 Test day

The day started at sunrise when we presented ourselves to the guards of Air Base De Peel. An agreement with the base commander was in place to use the air base for our test programme. See appendix B, C and D. After checking our passports we were allowed to enter the air base and we proceeded to the runway. When the group was complete and after checking the wind direction the position of the base camp was determined. The start position was at the head of runway 06 next to a small observation bunker, previously used by the Forward Air Controller for making a last visual check on incoming aircraft.

Next the group was split up for the specific tasks.

- A tent was set up to accommodate tables, computers, test equipment, sensors, measuring cables, paperwork and everything else that needed to remain dry and out of the wind. The tent was also used as a dressing room for the pilots. They had electrodes applied to their chests to measure heartbeats, and respiration sensors were also applied to their bodies. The temperature had become more comfortable, there was no wind and the tent provided some privacy.

- One of our military hosts from the base arranged for the provision of electricity for the electrical equipment. It was made available through the Forward Air Controller observation bunker.
- The cable was checked and rolled onto the winch. Because of the length of the track, with the winch

at a distance of 2300 meter from the start position, two cables were attached to each other and wound onto a single drum. During the winding process the cable was visually checked for defects which were cut out. The drum was large enough to contain this length of cable.

- The paragliders to be used during the test were collected and spread out on a groundsheet (appendix J). The pilots used their own personal harnesses.
- The Compeo vario was programmed to make sure the sample interval was set to the minimum of 1 second. The Total Energy Compensation was also set to zero.
- The Xciter propeller driven ultra light was assembled. During the trials this was used for photo and video recordings.

After the tent had been erected:

- The NLR data recording device, sensors and wirings were untangled and spread out on a table.
- The pilots were taped with electrodes for the heartbeat recordings (appendix F).
- The data recording device was checked for proper operation.
- A Yaesu VX-7R radio was attached to a computer to record all radio traffic.
- The blood pressure of the pilots was checked for any abnormalities.

The lower pressure of the pilots was between 75 and 85, and the upper pressure between 135 and 150. These were considered normal values.

Because early in the morning there was a slight cross-wind condition and there was no experience with the behaviour of the winch and cable over such a long distance, one of the pilots made a trial run. This gave confidence that a winch launch was possible without difficulties. In fact, because of the long cable, a more steady and uniform pull was obtained.

When everyone seemed to be ready a final briefing was held to make sure everyone understood their role in the trial. Also some safety issues were discussed like the danger of G-force induced loss of conscience (G-LOC), how to be aware of and avoid this situation. In short the characteristics of G-LOC were explained and the test-pilots were urged to abort the spiral manoeuvre as soon as they noticed any of the symptoms of an imminent G-LOC. Also the pilots were urged not to be over-confident or too eager to perform.

Before each test-flight, the pilot was weighed with his equipment to make sure the total weight was within the operating range of the paraglider.
The weighing data was written on the 'Test Registration Form'. (see appendix G)

Because the team members were all volunteers, and as this was the first time all were together to execute this trial, it took a while before we were ready to do the first run. Therefore it was decided to reduce the test matrix and also to adapt it further to the weight range of the test-pilots.

The resulting list of test runs can be found in Appendix G.

At the start of each run the pilots were winched in one pull to an altitude of approximately 850 meters. This was possible because of the distance of the winch from the start location, which was 2300 meters.
At first the pilots tried to maintain a descent rate of 14 m/s for at least 10 seconds. In case of sufficient available height a second attempt was made with a descent rate of 10 m/s. Although the pilots were asked (if safe) to maintain the spiral for at least 10 seconds, the recordings show a shorter time span. The 10 seconds were chosen to

obtain a stable situation. This was necessary for a better understanding of the recorded results.

In future it is recommended to concentrate on only one attempt each run.
A value of 10 m/s was chosen as a safe value to maintain the spiral. The value of 14 m/s is also used by the DHV during the certification tests for a new paraglider model.

Run 8 produced no useful data because of a cable failure at 350 m.
Run 11 failed because the harness carabiner was twisted. It was considered not safe to perform the test spiral and the run was aborted.

During the day a weather registration form was filled in at least once every half hour or whenever the conditions changed. (appendix H).

After the last run at 16:35 LT the sun stood too low and in the direction of the runway. The winch operator considered this condition unsafe because he did not have sufficient visual contact with the pilot. This resulted in the end of all flight activities.

The data was recovered from the Vitaport data recording device, the Compeo and the computer which recorded all radio traffic. All forms used were collected.

Camp was broken up, everything was packed and at sunset everyone made their way to the bar of the local glider association to celebrate the success of the day with a drink and something to eat.

4 Used registration devices

During the trial the main registration devices were a vitaport data recording device and a Compeo vario with recording capabilities. These made data available which could be processed by computer.
There were some additional devices, mainly for registration of the test environment.

4.1 Vitaport

A Vitaport 2 miniature data acquisition and recording system was made available by the Dutch Aerospace Laboratory NLR.
This device is capable of recording a number of parameters in high resolution and with a high update frequency.

The following parameters were recorded:	Recording frequency:
G-forces along the left riser	32 Hz
G-forces at chest level	32 Hz
static airpressure	32 Hz
testpilot heartbeat	256 Hz
testpilot respiration	16 Hz
event marker	16 Hz

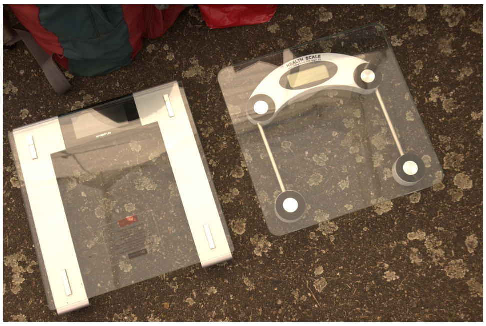
The data recorded by the Vitaport was extracted by a programme called Columbus, which established an RS232 connection with the unit. The output files were converted with the programme v2dbs to a format suitable for the NLR's data processing system HEART.
Because the intention was to merge the data with the Compeo data and also because of my inexperience with the HEART system, it was decided to convert the data to an ASCII format which is readable by Excel for further processing.
More information on the Vitaport can be found at
http://www.temec.com/portal2/index.php

The data retrieval procedure can be found in Appendix M, and the Vitaport settings can be found in Appendix N.

4.2 Compeo vario

The Compeo and speed probe were made available for the tests by Bräuniger. The compeo is capable of recording time, position, barometric altitude, GPS altitude and true air speed at a rate of 1 Hz. The data is downloadable with the Flychart programme and it is possible to read the produced datafile into Excel for further processing.
The user manual can be found at:
http://www.brauniger.com/download/Compeo_User_Manual_V224_Engl-corr.pdf
Appendix L shows the settings used during the experiment.

4.3 Weight



Two normal household balances were used for weighing the pilots and the equipment.
They were placed on a firm horizontal flat surface.
The value of both scales agreed very reasonably. We therefore decided to average both values.

4.4 Meteo

The meteo wind speed was recorded with a Conrad 3000 anemometer.
The specifications can be found at:

http://www2.produktinfo.conrad.com/datenblaetter/100000-124999/120435-an-01-nl-Handwindmesser_3000.pdf

It was held at 2 meters high straight into the wind. The wind speed appeared on the LCD window and the value was recorded on the meteo report form.

The temperature was read from a digital thermometer.

4.5 Radio telephony

A computer was connected through the line-in port with a Yaesu VX-7 radio. On the computer an audio registration programme was running. This was used to record all radio traffic during the experiment.

4.6 Health

There were two blood pressure measuring devices available. One professional device with a hand pump and stethoscope, and an automatic one of type 'OMRON MX3 Plus Digital Automatic Blood Pressure Monitor'.

4.7 Photo and video

Photo and video recordings were made with digital SLR and compact cameras. These will not be described in more detail.

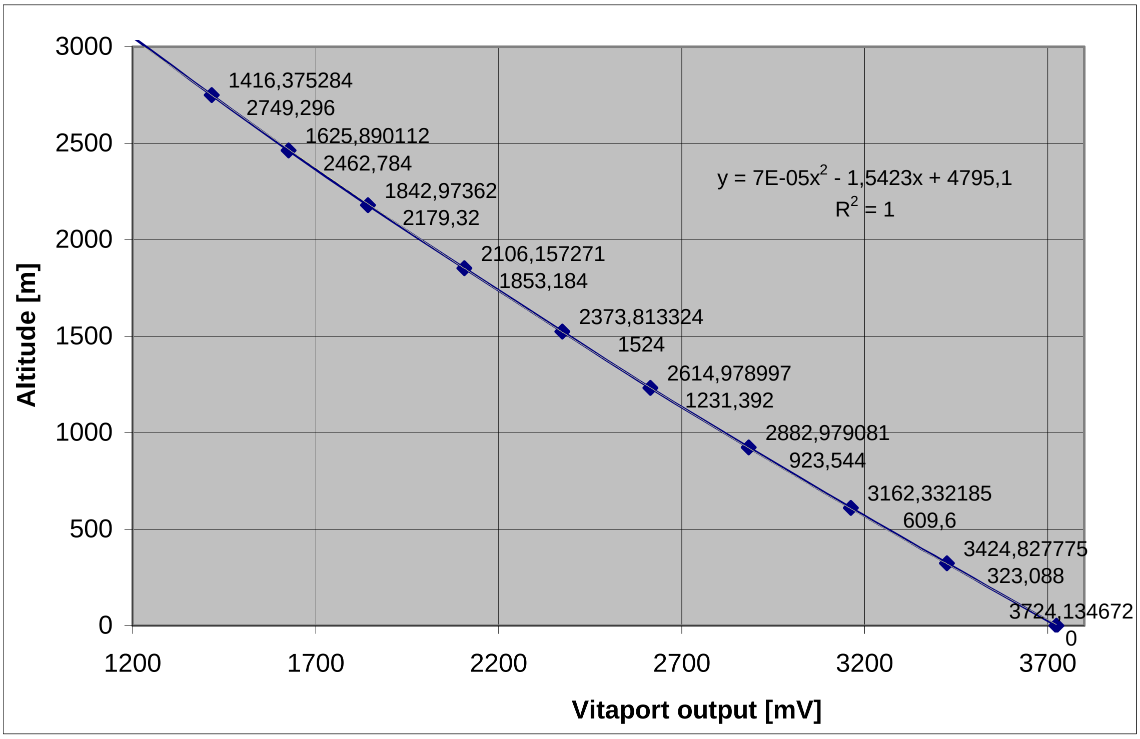
5 Sensor calibration

During the tests data was recorded with a set of measuring devices. As every device produces errors, special measures have to be taken. As far as practical the relevant devices were calibrated to produce the best possible measurements.

5.1 Pressure transducer

The pressure transducer was calibrated against a calibrated altimeter.
The local QNH was 1006.9 mbar. The altimeter was set to this value to obtain an altitude reading of 0 ft in normal atmospheric conditions.
The pressure transducer was connected to the Vitaport recording device. With a hand pump the pressure was reduced and at approximately every 1000 feet extra altitude, the altitude was recorded. After reading the recorded data it was fed into an Excel form to visualize the transfer function.
Excel also extracts a formula of the function.
y= 7E-05x2 – 1.5423x + 4795.1
y= altitude in feet
x= voltage provided by pressure transducer in mVolts
QNH = 1006.9 mBar
This function matches the recorded values very well. The R value is 1.0
(The true formula to transfer pressure into altitude is an exponential function instead of the quadratic one mentioned above. Up to 3000 ft the quadratic function is sufficiently accurate).

Vitaport [mV]	Altitude [ft]	Altitude [m]
34.92	10000	3048.00
41.17	9020	2749.30
47.26	8080	2462.78
53.57	7150	2179.32
61.22	6080	1853.18
69.00	5000	1524.00
76.01	4040	1231.39
83.80	3030	923.54
91.92	2000	609.60
99.55	1060	323.09
108.25	0	0.00

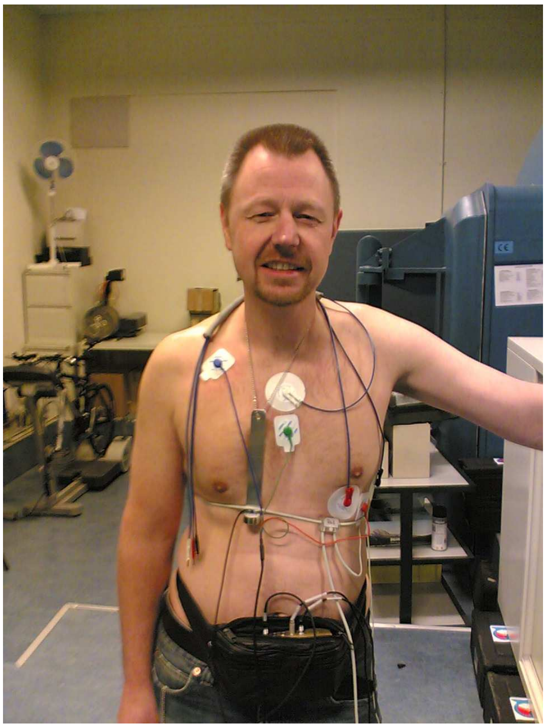


5.2 G-transducers

The G-transducers were calibrated by connecting them to the Vitaport recording device and positioning the sensors on a perfectly horizontal table.
Because the axis of measurement was horizontal, the recorded G-value had to be zero. By turning the sensor 180 degrees around the top-axis, the recorded value still had to be 0 G-s to confirm whether the table was horizontal.

Next the sensor was set in an upright position with the axis of measurement vertical. The recorded value had to be 1.
The sensor was calibrated by setting the offset and gain in the vitaport to make the sensor produce exactly 0 and 1 G in the mentioned positions.
The datasheets of the sensor can be found in appendix K.

5.2.1 Reliability of the G-transducers



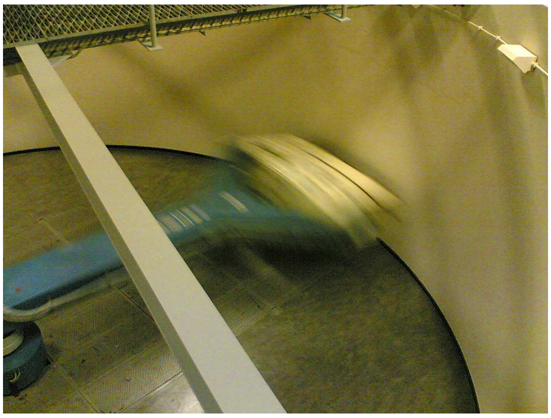
One day prior to the flight trials, two selected participants of the KNVvL winter meeting made a ride in the G-centrifuge of the "Centrum Mens en Luchtvaart" CML in Soesterberg. One of them was also taped with physiological sensors, and the G-load sensor used in the flight trials was hung around his neck.

He made a ride with a G-load of 6 G, next one with 4 G and finally one with 5 G.

The G-load sensor was attached to a long metal bar with an angle of 90 degrees at the end. This ensures that the G-load is measured along the length of the metal bar. Because the chair in the G-centrifuge resembles an F16 cockpit chair which is mounted at an angle of 30 degrees, the sensor should only record the fraction of Sqrt(3)/2 = 0.866 of the applied G-force.

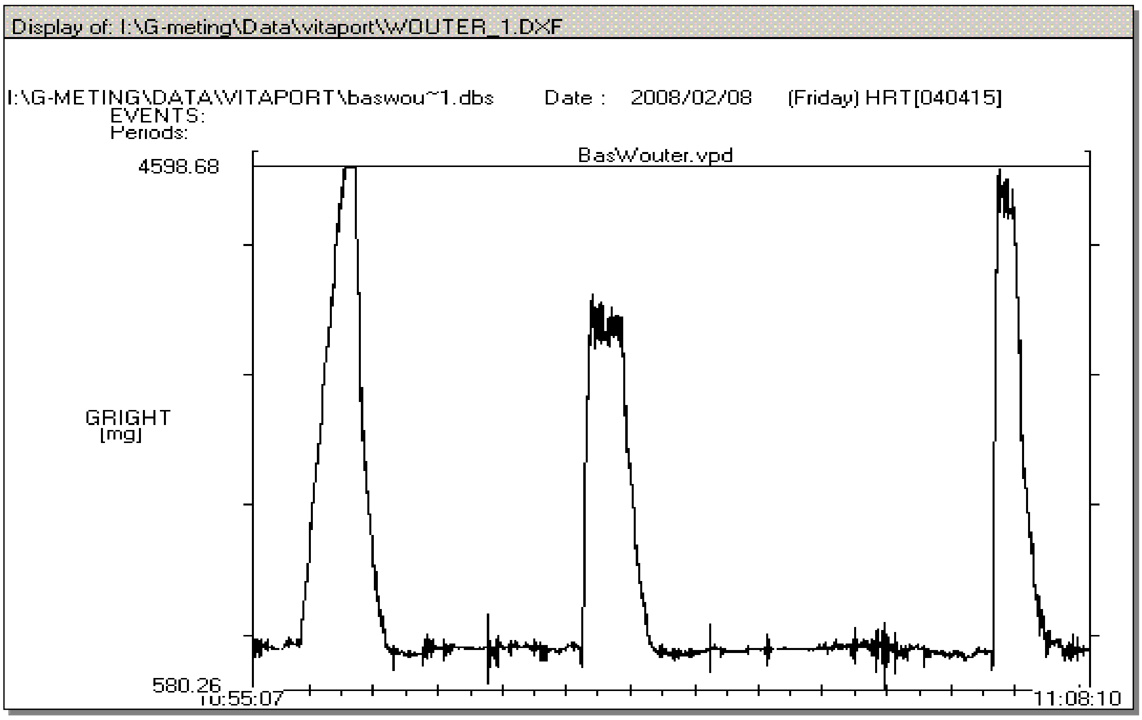
Because the sensor was hung around the neck of the test person, the angle of the strip relative to the normal is not reliably determined.

The recorded G-load values should be around 5.2, 3.4 and 4.3 G.



According to the registration plot, the first run ran out of range of the sensor, the second was 3.35 G and the third was 4.35 G.

These values correspond very well with the theoretical calculations based on the G-loads applied in the centrifuge.



The plot of the recording is a screendump of the NLR’s data acquisition system.

A full report of the G-centrifuge session at the CML can be found in the ‘B-lijn’.
http://www.knvvl.nl/uploads/aEk0kkrrHn4ZptW0k7YLGw/4grC0VGEpIUBTZ5XE5uX6g/Blijn32.pdf

5.3 Speed probe

The Compeo was sent to the DNW German Dutch Wind Tunnels in Marknesse, The Netherlands. There the Compeo speed probe was calibrated using the Low Speed wind tunnel LST, a continuous, atmospheric, low-speed wind tunnel with exchangeable test sections.

The DNW produced a calibration report together with photographs and video recordings of the test setting.

To protect the commercial value of the calibration of the speed probe it was requested to keep the results confidential.

The calibration data were used to calculate the correct speed. In the released results the originally measured speed will be removed to prevent reproduction of the calibration data.

6 Collected data

This chapter will describe the collected data of the trial.
Eleven runs were made and within each run one or more measurements were designated with an alphanumeric code. Run 8 and 11 failed because of a broken cable and a carabiner in an incorrect position. Run 1a is also removed from interpretation because the parameters did not reach a stable state.

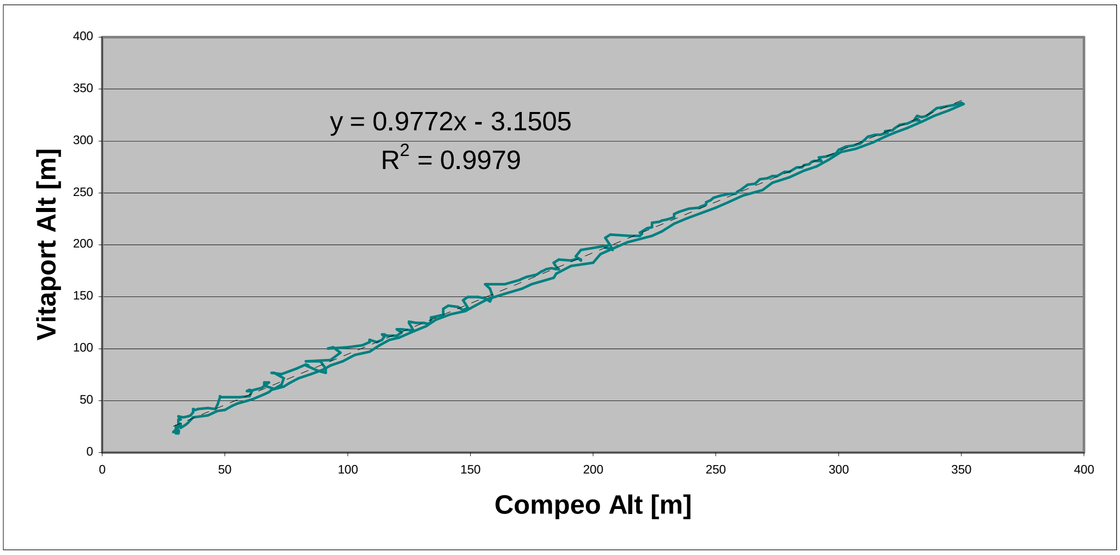
6.1 Vitaport and Compeo data

The Compeo has a recording rate of 1 second which is more than sufficient for the intended use. The Vitaport has a registration rate of 16- to 256 Hz. While processing the data it became clear that Excel is not capable of handling large amounts of data. The maximum data rate usable for processing is 4 Hz.

Each run is displayed in a graphical manner. The following plots were produced:

X-axis	range	unit	Y-axis	range	unit
Pressure Altitude		[m]	Time		[s]
GPS Altitude		[m]	Time		[s]
Vertical speed (Tau=1sec)	0-20	[m/s]	Time		[s]
Vertical speed (Tau=5sec)	0-20	[m/s]	Time		[s]
Speed [m/s]	0-30	[m/s]	Time		[s]
G-load	1-3.5	[G]	Time		[s]
Vertical speed (Tau=1sec)	0-20	[m/s]	G-load	1-3.5	[m/s2]
Position E		[m]	Position N		[m]

For the Altitude the Vitaport data was used because this was calibrated data with a higher update rate. This does not mean the Compeo is less accurate. In fact the next graph with a crossplot of Vitaport and Compeo Altitude (run 8) shows the output matches very well. There is a slight hysteresis which is caused by a small difference in time synchronization between the Compeo and Vitaport recording (less than 0.5 sec).



The vertical speed is differentiated from the altitude with a time constant of 1 second and 5 seconds to smooth out the measurement errors.

The speed information comes from the calibrated Compeo speed probe data.

'Position' is Compeo GPS data. Unfortunately the GPS receiver has a time lag of several seconds and is not capable of recording the exact position during a spiral descent. This is also illustrated by the next figure (run 7). The descent is shown as a vertical line.

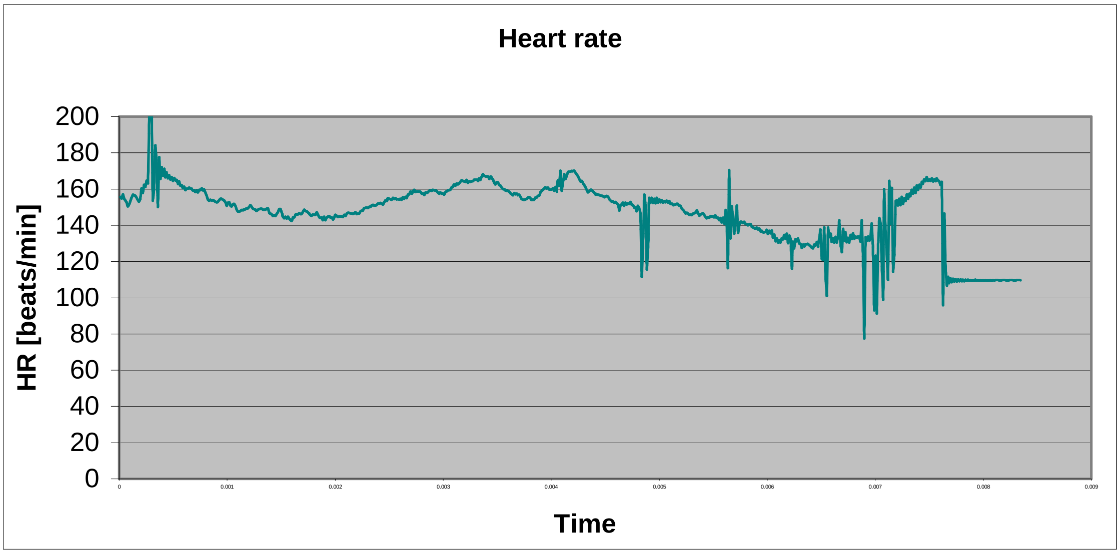
Although the position data is usable in the plots which show the complete cycle from start to landing, it is not usable for the rapid descent part.

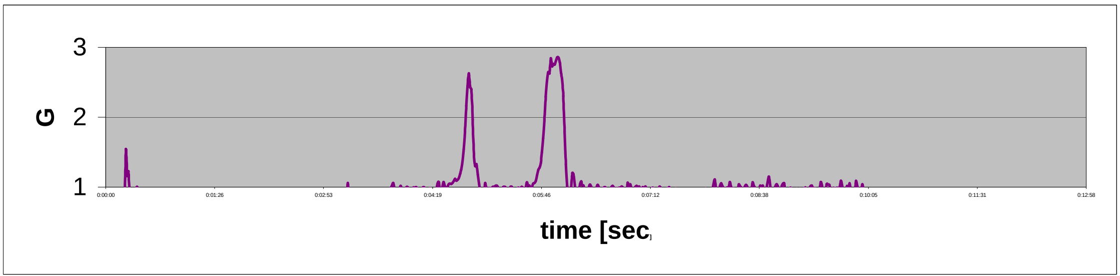
The data on heart rate and respiration are usable in a limited fashion. It appeared that the low pass filter gain was not set correctly which caused the signal to run out of boundaries.

Only the first run had usable data.

Please be aware of the artefacts in the recording. The vertical lines have to be disregarded because they are caused by temporarily invalid data.

It is interesting to see that the heart rate increases by 18 % during the spiral descent. You can see this when you put the G-load figure next to the heart rate figure. Take-off and landing also seem to be exciting activities.





The graphs are all included in Appendix O. Starting with an overview of each run followed by the detailed information.
The altitude figures contain the GPS altitude and pressure altitude. Of both lines the GPS altitude lags behind the pressure altitude.
The vertical speed figure is also a combined figure of V/S with Tau = 1 [sec] and Tau = 5 [sec]. The last line is the smoother one.
The detailed information is focussed on a period of 30 seconds. You can see the actual spiral descent takes a relatively short amount of time. Although the descent was intended to last for at least 10 seconds, it was very difficult for the pilots to keep track of time (this is actually normal human behaviour in stressed conditions). Because the time period is relatively short, the registered data tend to be unstable. The second order influences and harmonic fluctuations are not very well damped. Together with some noise jitter on the signal, this makes it hard to draw conclusions from the data.

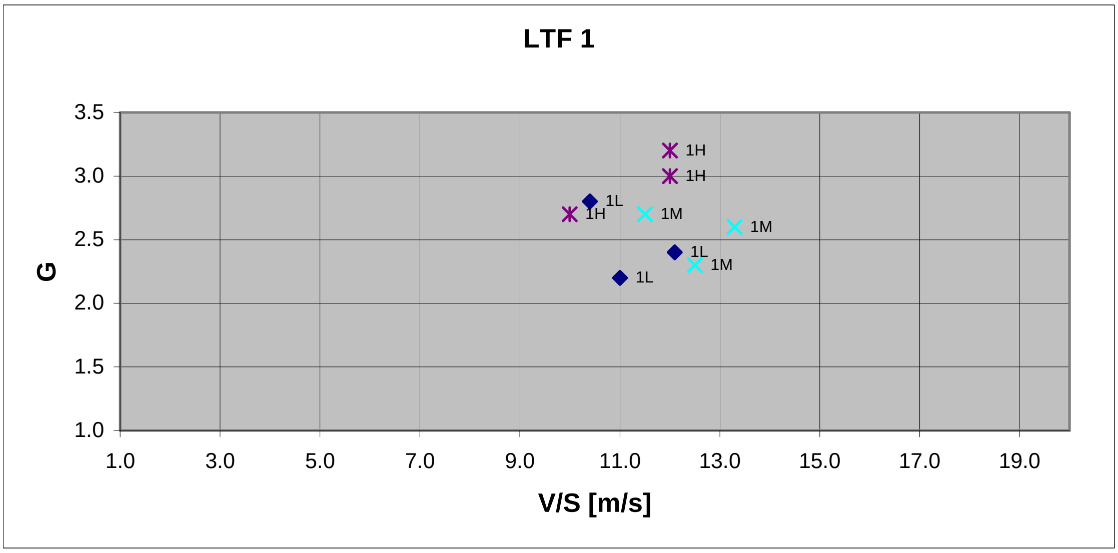
The next table shows a summary of the obtained results. You can see that the G-loads reached considerable values up to 3.2 Gs.

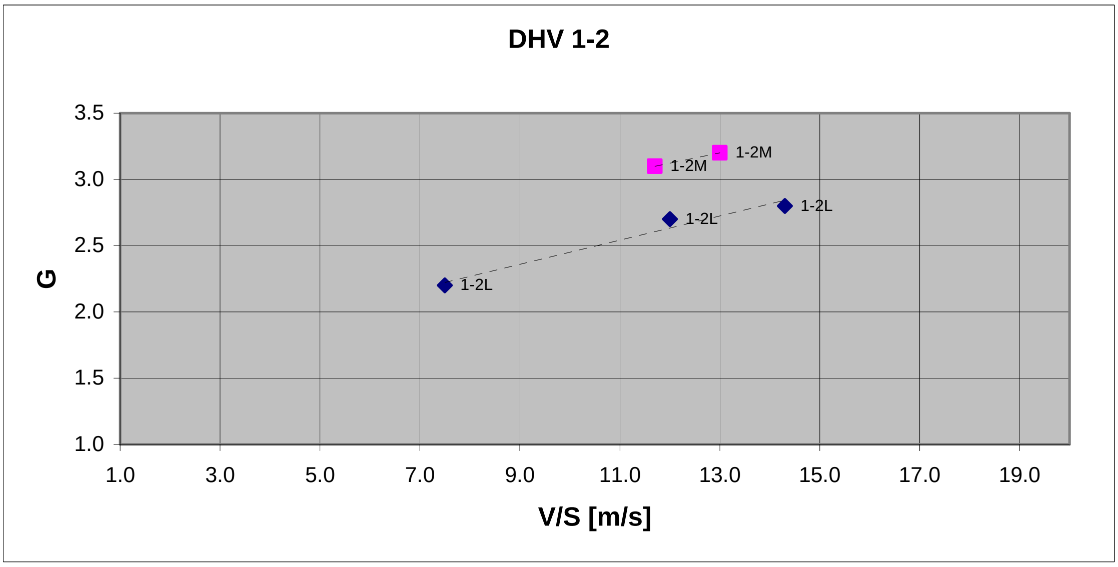
Run	Wing LTF	Weight L/M/H	avg.V/S [m/s]	Avg.G [G]	Comment
1a	1	L			Too short, not stable
1b	1	L	10.4	2.8	Fluctuating sink-rate
2a	1	L	11.0	2.2	First 15 sec usable
2b	1	L	12.1	2.4	Stable, good quality
3a	1	H	12.0	3.0	Usable for a short time
3b	1	H	12.0	3.2	Stable
3c	1	H	10.0	2.7	
4a	1-2	M	13	3.2	Stable, good quality
4b	1-2	M	11.7	3.1	
5a	2	M	14.0	3.1	Very long endurance, fluctuating
5b	2	M	13.1	3.1	Fluctuating
6a	2	M	9.0	2.5	Fluctuating, not stable
7a	2	H	12.0	2.7	Increasing
7b	2	H	11.7	2.7	Fluctuating
7c	2	H	11	2.7	
9a	1-2	L	12.0	2.7	
9b	1-2	L	14.3	2.8	
9c	1-2	L	7.5	2.2	Not stable
10a	1	M	12.5	2.3	Stable, good quality
10b	1	M	13.3	2.6	V/S fluctuating
10c	1	M	11.5	2.7	5 sec usable

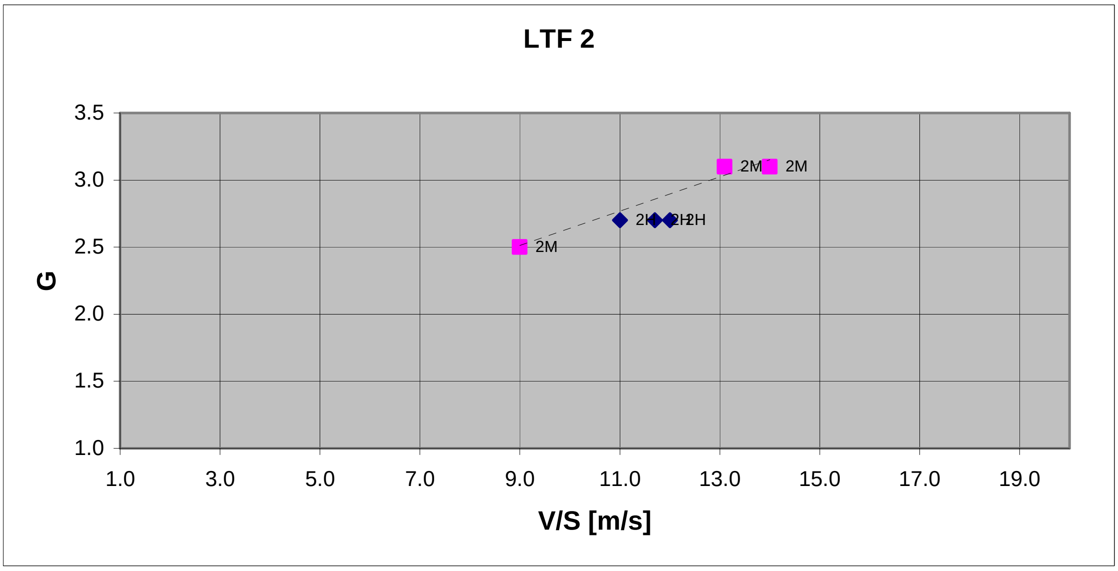
One of the questions was whether there is a relationship between the G-load and the rate of descent. Therefore the following graphs were produced. One for each LTF class of glider and each with different wing loadings. ‘L’ is on the lower edge of the weight envelope, ‘M’ is on the centre of the weight envelope and ‘H’ is on upper edge of the weight envelope.

As you can see in the table above, there are few really good quality stable descents.

The data-points in the next figures were determined by selecting a reasonably average value from the recorded data. Actually you should attach more weight to the good quality descent recordings. In the following figures this is not taken into account.
For interpreting these figures you should draw a line from the origin (1G, 1.2m/s) to the collection of points. Although the number of points is relatively small and not sufficient for drawing firm conclusions, you can best see especially in the figure of LTF 1-2 and LTF 2, there is a trend for a linear increase of G-forces with the descent rate. You can also see there is a trend that heavier pilots are subjected to a higher G-load for the same descent rate.



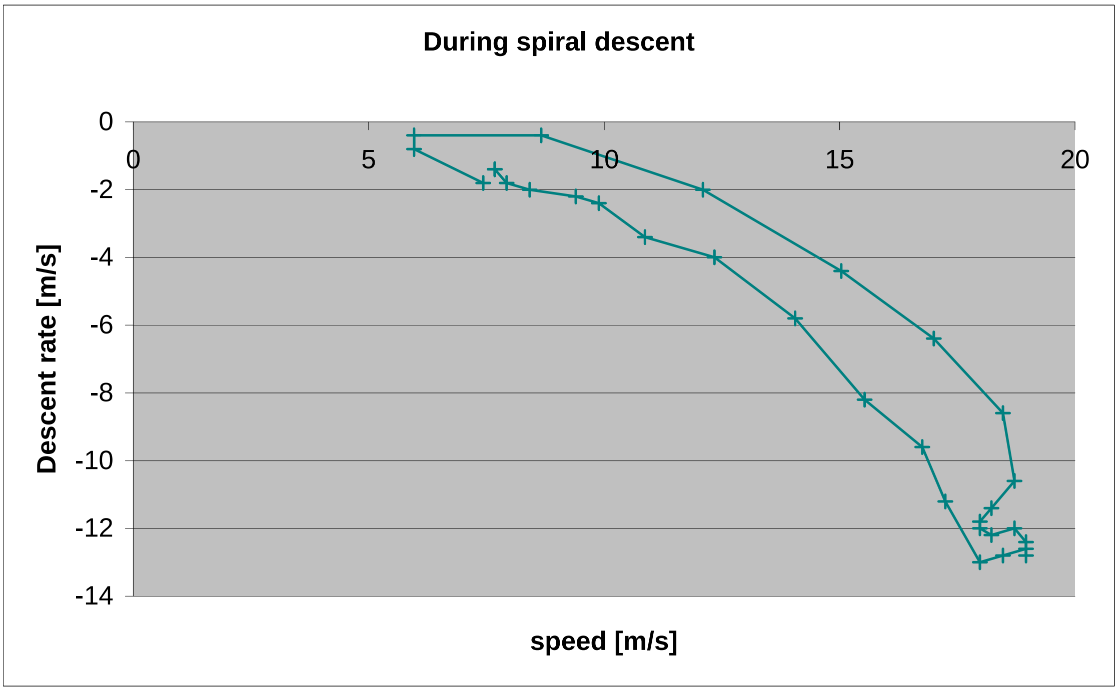




As an extra item I produced a Lift Drag curve from run 2b. I used the vertical speed data derived from the Compeo with Tau=5 [sec].

As the vertical speed increases during the spiral, the speed also increases.

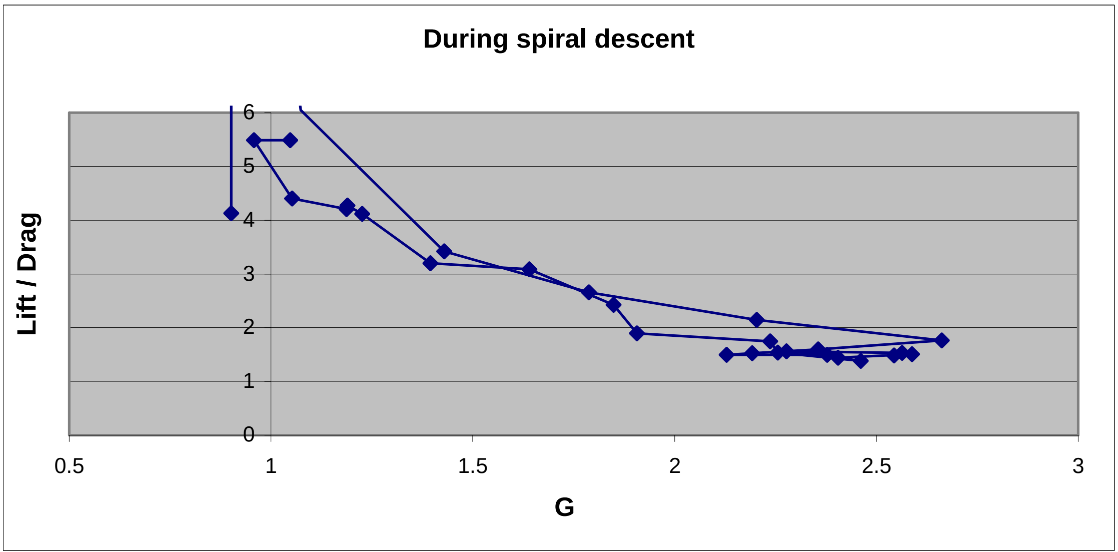
The L/D value is the angle from the originating point 0,0 to a point in the graph (speed / descent rate). You can see the drag is increasing rapidly with the increase in speed.



Next a graph is shown with the lift/drag coefficient plotted against the G-load. This also confirms that the lift/drag coefficient decreases to almost a value of 1 with an increasing G-load.

The hysteresis in the figure is caused by the rapid acceleration during initiation of the spiral descent and the rapid deceleration during the restoration to normal flight.

In reality this is an inappropriate way to produce a L/D curve. This one is produced during the acceleration of the spiral descent, while you should produce such a curve from data obtained during a straight level flight and a slow deceleration and acceleration using brakes and speedbar.



In fact the last graph is the best proof for the relationship between the G-load and the rate of descent. As the G-load increases, the L/D coefficient is decreasing. Because the speed is increasing during the spiral descent, the the sink-rate is increasing even more.

6.2 Observations by the KNVvL-Paragliding safety commission

During the tests there were two delegates from the KNVvL –paragliding safety commission present.
They were commissioned to observe the overall safety of all flights and other relevant activities during the day. They had the authority to break off any activity which could result in an unsafe situation.
They reported as follows:

Safety aspects of the measurements in De Peel.

"As 'observer safety aspects' I have seen to it that:
- The safety guidelines concerning the steep spirals in the test were correct: 'Do not engage in any spirals below a safe height, exit the

spirals correctly (i.e. not too abruptly), and if you don't succeed in the normal way, make sure you throw your reserve!'
- These guidelines have been followed by the pilots.

Also:
- In the case of a 'dubious situation' (a carabiner was not in its correct position), both the pilot and those on the ground took the proper decision: abort the test, no high-G manoeuvers. The safety people did not have to intervene to reach this decision."

Rogier Wolff

"I think the day went pretty well, especially because you and your son acted formally on the right moments (positively interpreted!). It is and will stay a serious matter and I think that message reached everybody involved."

Toon Westerburger

6.3 Photographs

Four photographers took photographs. All photographs taken were collected and synchronized in time. The pictures were renamed to "DePeel_080209_hhmmss_photographer_aa.jpg" in which:

DePeel	= the location of the experiment
080209	= year, month, day of the experiment (9th of February 2008)
hh	= hour in Local Time = GMT + 1 hour
mm	= min
ss	= sec
photographer	= the name of the photographer
aa	= an extra alphanumeric value starting with 'a' in case there was more than one picture taken in a single second.

All photos are grouped together in one directory with the result that a viewer steps through a sorted list of all pictures in chronological order.

Unfortunately both Rogier and Maaike switched the time code of their cameras during the trial from summer to wintertime (1 hour earlier). This was around 09:24 hours.
The first set of pictures was synchronized using pictures DePeel_080209_092252_Maaike.jpg and DePeel_080209_092252_ Rogier.jpg where they took a picture of each other.
The second set of pictures was synchronized using DePeel_080209_103625_Maaike.jpg and DePeel_080209_121330_Rogier.jpg where they both took a picture of a radiographic synchronized clock.

The pictures taken by Paul were synchronized using DePeel_080209_150739_Paul.jpg and DePeel_080209_150740_ Rogier.jpg where the car in the background passes the same bushes.

The pictures taken by Eric were synchronized using the red/white/orange paraglider in picture DePeel_080209_134416_Erik.jpg (from the air) and DePeel_080209_134701_Maaike.jpg (landing).

The second set of photographs taken by Rogier and Maaike and the Paul's pictures were synchronized to within 1 second. The first set of photos by Rogier and Maaike and those made by Eric are synchronized within 1 minute.

The pictures can be obtained by ordering the CD with all data produced during the tests.

6.4 Videos

The videos made during the day are very illustrative. They show the preparation, briefing, launch procedure and the runs from the ground and the air.
There are 5 .mpeg files

.mpg file name	duration [min:sec]	comment
ToonWesterburger	08:41	preparation, briefing, first launches from ground
XCiter_2	09:11	Start and winch location, winch procedure and

		test runs from the air
XCiter_Jacques	06:49	Test runs from the air
Stephan+Maarten_deel1	52:22	Winch preparation, test runs with time tags and comment
Stephan+Maarten_deel2	45:26	preparation, briefing,sensor application, first launches from ground

Most of the recordings had no recorded time tag. This made it difficult to link the recordings to a specific run.
The 'Stephan+Maarten_deel1' video contains recordings from the winch position upright with the camera supported by a tripod. During these recordings, at the start of each frame, a GPS with time reference was held in view of the camera.
During the run it proved hard to hold the paraglider within view of the camera.

6.5 RT recording

There were two frequencies used during the trial. One for air-ground communication and one for ground-ground communication. The purpose for using two separate frequencies is to prevent interference of the communication between pilot and ground team with non-flight test related communication.
A computer with a running audio registration programme was connected through the line-in port with a Yaesu VX-7 radio. This radio is capable of receiving 2 different frequencies simultaneously. This enabled the recording of all radio traffic during the experiment.
The recording has a duration of 4 hours, 42 minutes and 10 seconds. It started before the start of the first run at 12 hours 18 minutes and 47 seconds.

6.6 Pilot comments

Afterwards the pilots all wrote down their subjective opinion about their experiences during the trial. Their comments are written down in the next paragraphs.
The comments by Pilot 2 and Pilot 3 are translated from Dutch. The original lines of comment can be found in appendix I.

6.6.1 Pilot 1

"I was flying with to me unfamiliar gliders and in the lower end of the weight range. Because of not knowing the gliders and because of being light on them, it was difficult to understand their behaviour and act accordingly. (Also because I am used to flying in top of the weight range) I think it would have been better to do 1 or 2 test flights prior to the real testing, to get to know the gliders a bit better and figure out what works best to get them into a smooth spiral. Normally, at times, I do look at my vario during spirals but normally just to check my altitude, not to adjust the descent rate. It turned out to be very hard to adjust the descent rate during spiral, the glider tends to exit the spiral rather than descend less rapidly. Also, looking at the vario during spiralling the unfamiliar gliders made it harder to continue the spiral, so it might have been easier not having to check the vario.
All given information was sufficient in my opinion.
I had no problems with the measuring equipment on my body but I do think it would be better if a person on the ground could do the thinking when it comes to the actions that had to be taken prior to starting the spiral. (Like: Speed measurer out (I forgot to chuck it out a few times), press the event marker, start spiral, press the event marker again, and so on) It would make it easier and the chances to forget actions are less.
I normally fly a Skywalk Cayenne XS (LTF2) and I am in top weight range."

6.6.2 Pilot 2

(Translated from Dutch)
"During my first flight I found it troublesome to look at the vario because normally I watch the ground to check my altitude. Later things went better. After a spiral I felt a bit dizzy, but I think this is not different from normal.
I did not consider it a problem to spiral with a, to me, unfamiliar wing. I fly the Aspen myself but the testwing was the only wing which made it tricky to keep a spiral of 10 m/s. Either it wanted to dive in faster, or it wanted to stop spiralling altogether. My weight is just below the middle of the weight range.
Winching to this altitude is not abnormal for me, except that shifting the course to one side to be winched up straight into the wind was longer.
The sensors on my body did not interfere.
I think a pre-test day on our own field would have been of help, so that we could have tested the different gliders ourselves and would have known how things were

organized, because we probable lost some time there. But for a possible next event we gained some experience so that it will go more smoothly. By the way, the other preparations were very professional."

6.6.3 Pilot 3

(Translated from Dutch)
"It was pretty tough keeping an eye on the vario. I flew all my spirals to the right, and every time put my vario on my right leg. The problems encountered while reading my vario were: the screen reflects strongly in the sunlight. It was a sunny day so a quarter up to a half of every turn I was not able to read the screen due to the reflection. Also the numbers were small and rounded. With rounded I mean that a 3 and 8 looked pretty much alike, same for 10 and 13. The circle indicator for the vario was also unclear and only went to -8 m/s.

During my first spiral I only looked at the vario. Only now and then I scanned the area. This was rather unpleasant. The second flight I tried to take quick looks from the right tip of my wing to my vario. This gave, as described above, lots of problems. The last flight I trusted on my gut feeling, and only just before ending the spiral I checked whether it was close to -14 m/s. The last method was the most convenient, I just do not know whether it is the most accurate.

Especially when looking back from the vario to the wing I noticed that my body felt disorientated. That is the reason why I minimized this in the last flight.

I never flew the Aspen before; I had some trouble in feeling how fast you are going. I could have judged it easier with gliders familiar to me. I think that some pre-test flights with my own vario could have helped. Then we also could have trained listening to the correct bleep tone. I am still a supporter of listening to bleeps to judge the right speed. Apart from that you can always check the screen. Preferably my own digifly vario. I think that one is clearer, and has larger indications on the screen.

To keep a spiral stable in the air is manageable, but when you add the vario for this purpose it is another story. Normally I fly by feel for more than 90%. During the test day I was probably too much focussed on trying to do it correctly, and that is why I relied too much on the equipment. Of course the vario always lags behind, and before you have responded to that you probably have been spiralling for a few seconds already. Again, I think that a few test runs could have helped to overcome this.

Normally I look at my vario once or twice when I am spiralling, mostly at the screen, and then at the surroundings (is the airspace clear?) and to the ground.

It would have gone better if I had concentrated less on the vario, if I could have read it faster or if I had been supported by a familiar bleep.

I have been (step) winched to this altitude more often, so this did not make a difference to me.

The sensors on my body did not interfere with me, I was only reminded of them when I cleared my nose. 'Would they think that I was stressed or would they think that I had a cold?' But you will always have that sort of thing. As soon as I was released from the winch I forgot about the sensors and went for it. Of course I kept using the trigger.
It would have been nice if we had tested the trigger procedure the day before. I think I lost count sometimes. So this might be a good suggestion for the pre-test day.

I experienced the day as reasonably easy. I had read the test plan and had seen in the emails what had to be done. I had predicted to myself that we would be very lucky if we could do 10 test flights. That we did manage. The preparations on the day itself took as long as I had expected. Most people did not know in advance what the aim was and were not properly informed. After the briefing it all went better.

The flights themselves went faster than I had expected. I expected the test equipment to fail more often; cables broken, batteries empty, etc. The reason I expected this is that at school I run several demonstration projects and these always fail somewhere. But this went all very well; plenty of reserve equipment was available.

The radio communication was more then adequate.

As I wrote earlier concerning the information: a lot had been forwarded, but perhaps it had not been clear enough. In the beginning nobody knew what to do, except for Ronald, and he was doing everything."

7 **Conclusions**

Although the number of runs is not sufficient to draw firm conclusions on statistical grounds, you can see that during the runs a considerable level of G-loads, up to 3.2 G, is reached. The level of G-load is checked against data obtained in the G-centrifuge of the CML and seems reliable.
These G-loads were reached with a relatively mild spiral descent of 12 [m/s] where the LTF specifications mention a descent rate of 14m/s for their certification tests.
It may be assumed that much higher G-load values can be reached.

One of the questions was whether there is a relationship between the G-load and the rate of descent. Here you see a trend for a linear increase of G-load with the descent rate. You can also see a trend that heavier pilots endure a higher G-load for the same descent rate.

With the levels of G-load reached during the experiment, you can’t deny the risk of G-LOC. For a normal, healthy, person G-LOC tends to occur at a load around +4.5Gz but can occur anywhere between 2 and 6.5Gz. When the condition of the pilot deteriorates due to fatigue, use of alcohol in the last 24 hours, dehydration or a low nutrition level (typical paraglider circumstances), the resistence level for G-loads will decrease rapidly. This means that the resistance level for individual persons may be well below the G-load levels reachable in a spiral descent.
It may be assumed that the recent fatal incidents during a spiral descent were caused by G-LOC.

8 G-LOC explained

G-LOC is an abbreviated term meaning G-induced Loss of Consciousness. The character 'G' represents the acceleration being experienced. The 'G' that we discuss is technically termed '+Gz' and occurs when the body is accelerated in the headwards direction. Standing still on the ground causes our body to experience +1 Gz, due to the earth's gravitational attraction.

The basic mechanism of G-LOC is not too difficult to understand. The brain and eyes require oxygen and sugar (glucose) to function properly, they both have a very small store of sugar and virtually no stored oxygen. A constant supply of both these nutrients, via the bloodstream, is necessary for normal brain and eye function. Blood is constantly pumped to the head, against gravity, by the heart. This arrangement works well until the body is exposed to increased +Gz which forces the blood away from the head, no matter how hard the heart may work. If the +Gz is of sufficient intensity for a long enough time, little or no blood flow reaches the head. The eyes and brain exhaust their limited sugar and oxygen supplies and cease to function. Thus we suffer 'G Induced Loss of Consciousness'.

8.1 Symptoms

In short the symptoms are:

- Grey-out (loss of colour in vision)
- Tunnel vision (field of vision narrows)
- Blackout (no vision any more)
- Loss of conciousness
- Brain death

As you enter a spiral descent you will feel your weight increasing as the seat pushes up hard against your bottom. Head and arm movements will feel cumbersome and awkward due to the increased weight.

Vision is produced by cone and rod cells in the retina of the eye. The cone cells respond to different wavelengths and allow the perception of colour. The rods are responsible for the perception of light intensity. They are actually a hundred times

more sensitive to light than the cones. Because rods require less light to function than cones, they are therefore the primary source of visual information at night.
The increased force of gravity forces away the blood oxygen supply from brain and eyes. The eyes reacts to this loss of oxygen by a decrease in sensitivity of the cone and rod recipients.
At first the pilot's vision will change from full-colour to grey.

The next thing noticed will be a dulling of vision which may be more prominent at the periphery of the visual field, the so-called 'tunnel vision' phenomenon. The world really does look as if you are looking at it from the inside of a black tunnel. The pilot's peripheral vision actually starts to deteriorate as soon as you enter the spiral descent and by the time you notice any 'tunnelling', 75% of the visual field has already gone.

If the G-load continues to increase 'blackout' will follow. Blackout is a complete loss of vision due to no blood getting to the eye. The pilot is not unconscious at this time.

Should the G-load continue to increase and the pilot's tolerance be exceeded, loss of consciousness will promptly occur.

If the G-load remains high the pilot will remain unconscious and could, conceivably, suffer brain death.

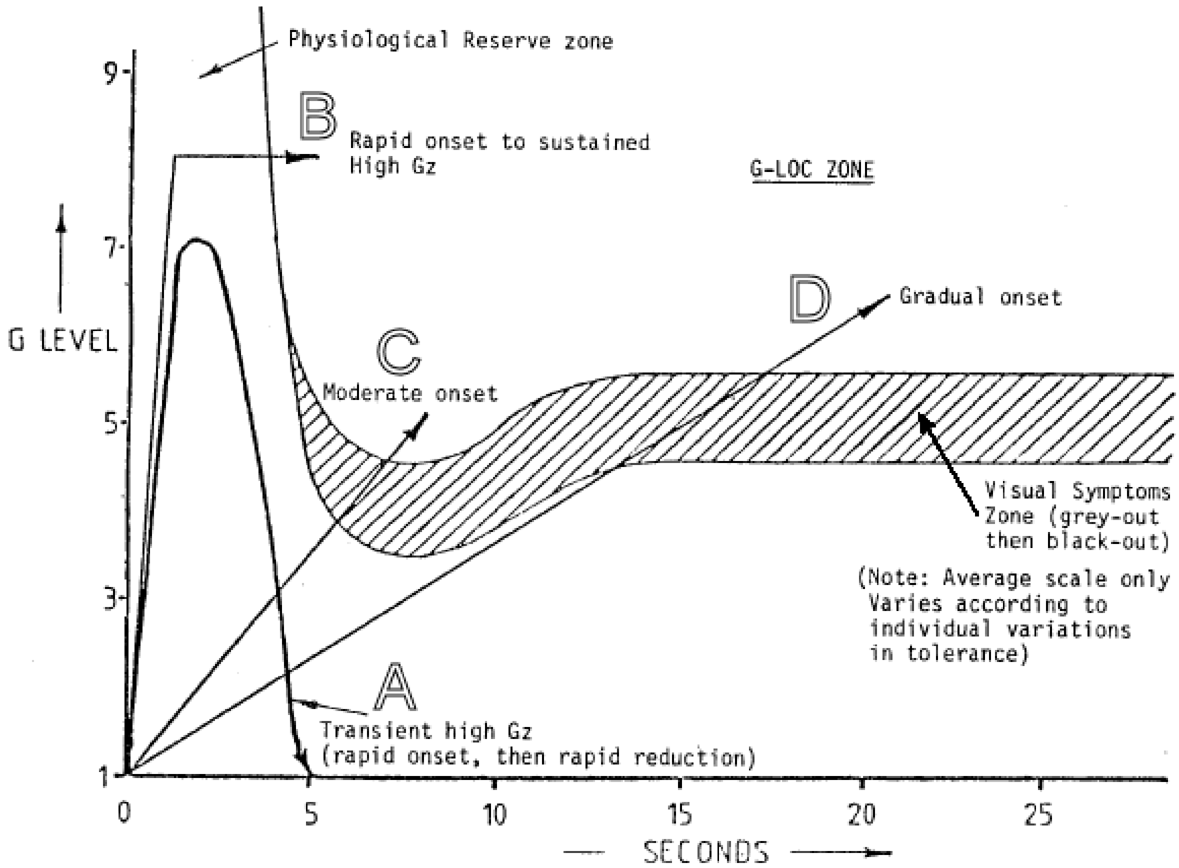
8.2 G-tolerance

Although various Centrifuge and Flying studies provide slightly different figures for G-LOC, most show that it tends to occur at around +4.5Gz in the unprotected individual, but may occur anywhere between +2Gz and +6.5Gz. **Aircrew have suffered G-LOC at +2Gz**. It is also important to note that although G-LOC is often preceded by visual symptoms, this is not always the case.

As it does with every aspect of aviation your general health plays an important role in your tolerance of +Gz. Factors which contribute to a decrease in G-tolerance are:
- any illness, even a minor 'cold',
- chronic or acute hypotension (low blood pressure),
- fatigue: sufficient rest is essential,

- most medicaments (when in doubt, consult your aeronautical medical officer for advice),
- non-illegal drugs such as alcohol and caffeine,
- dehydration,
- hypoglycemia (low blood sugar),
- self-imposed or environmental stress.

The next figure is a +Gz versus Time graph demonstrating the tolerance to +Gz of relaxed subjects.



The area above and to the right of the curve represents the +Gz and Time at which unconsciousness (generally) occurs. The shaded area is the region of visual disorders (grey-out, tunnel vision and blackout) without loss of consciousness. Below and to the left of the grey curve is the +Gz/Time zone where no visual symptoms or G-LOC occur in the average, unprotected person.

You can see a gradual increase of 1G in +Gz resistance after 10 seconds. This is due to cardiovascular reflexes which command more blood to be pumped to the brain.

In fact you can withstand a very high level of +Gz as long as the duration is very short, as when jumping off a wall. This is represented by line A.
A rapid onset of sustained +Gz, as shown in line B, will result in G-LOC after about 4 seconds, without any warning visual symptoms. This, however, is not expected paraglider behaviour.
The line 'C' represents a gradual onset of +Gz at a rate of around 0.6G per second and it shows that visual symptoms are likely after about 5 seconds, and loss of consciousness about 1 second later at +4Gz.
The measured G-onset with a paraglider is lower and in the range of 0.2 and 0.35 G/s. This is better represented with line D which means there is some more time to recognize and respond to the symptoms of an impending G-LOC.

There are a number of Anti-G Straining Manoeuvres (AGSM) that can be used to increase your G-tolerance. Most of the AGSMs involve isometric muscle contraction and regulated breathing routines. Correct instruction, training, and lots of practice are essential for the correct performance of an AGSM. **An incorrectly performed AGSM is useless and may provide a false sense of safety.**

The loss of memory that often occurs during G-LOC is particularly concerning as it leaves the pilots totally unaware that they have been unconscious and may provide them with a false perception of how well they can cope with G.

9 Recommendations

After analyzing the results of the trial the following recommendations can be made for the improvement of safety and for achieving better results in a next trial.
A further trial would be useful for cross-checking the results gained and for focussing on a more limited set of test conditions.

9.1 Safety

As a consequence of the investigation, The KNVvL has been recommended to organize a general safety education programme on G-LOC, targeted at paraglider instructors as well as the pilots. It is a lack of knowledge which results in G-LOC-related accidents. By adjusting the pilots' training, new accidents should easily be prevented from happening.

This education programme should contain at least the following three activities:

1. Instructors should be trained on this subject to make sure they can relay the knowledge to their students.
2. Pilots should receive information on this subject to make sure they are aware of the dangers and recognize the symptoms of G-LOC in order to abort a spiral descent in time.
3. This subject should be included in the knowledge required to pass the paraglider licence examinations. During the examinations questions should be asked on this subject.

And the most important one, pilots are urged to abort the spiral manoeuvre as soon as they notice any of the symptoms of an imminent G-LOC.

9.2 Next trial

To improve the data collection during a future trial the following recommendations are made:

- The use of the event marker is not required. The recorded altitude and computed vertical speed information was sufficient to discriminate between the runs. Not using the event markers will also reduce the work-load for the pilots.

- Unless there is more knowledge available on interpreting physiological data, there is no need to record these parameters. This will save a considerable amount of time during preparation and pilot change.
- More attention should be paid to the static pressure sensor. A free flying probe should be considered.
- During each run, the pilots tried to maintain a descent rate of 10 m/s and also one of 14 m/s for at least 10 seconds. It is advised to concentrate on only one value during the entire run.
- The pilots should not fly on instruments but fly visually as they are used to while listening to the vario-tone. The most important goal is to have a stable spiral descent for a prolonged time. Afterwards the data will be analysed and categorized according to the descent rate reached.
- The pilots should use also their own varios.
- Concentrate on only one type of paraglider to produce more comparable data.
- After 284.698 mouse-clicks I know for sure that Excel is not suitable for analysing large amounts of data. Unless the next analyst is familiar with Excel macros and can solve the problems encountered, a better data-analysis process should be used.
- The photographers should take a picture of a radio controlled clock and not change any time setting during the trial.
- The video cameras should have a time tag recorded in the picture to enable identification of recorded video clips and corresponding runs.
- After each run the the pilot comment should be recorded on video.
- The briefing should be completely recorded on video.
- To shorten the preparation time in the morning before the first run, the preparation tasks to be performed should be more clearly defined and firmly assigned in advance of the test day.
- All preparations that can be carried out before the day of tests, like checking the cable, should not be carried out on the morning of the test day.
- Prepare a dry run with the recording devices in advance to check for proper functioning for an extended length of time.
- Check all recording device readings during the test for valid data.
- It should be considered to organize a pre-run day, to practise all procedures to be used during the real tests and to have the pilots get used to the unfamiliar wings.

This might sound as criticism on a fantastic team. This is not true. In fact it is incredible what was achieved during this experiment which for all participants was the first time they ever did such a task.
The recommendations are meant to improve the quality of the results even more.

10 Acknowledgement

First I wish to thank the commander of Air Base De Peel for his kindness in allowing the test team to use the airfield for the test operations. This enabled a safe and efficient execution of the trials.

Next I wish to thank the NLR and Bräuniger for unselfishly putting the recording devices at our disposal: NLR for the Vitaport 2 with G-sensor, pressure transducer and physiological sensors and Bräuniger for the Compeo vario with speed probe.

And of course I thank all the team members who made the day possible with their cooperation. These are the pilots, the winch operators, the observers, the cable runners, the photographers, the caterers, the ……..

Last but not least, the reviewing team and the translator who translated relevant parts of the test plan and the pilot comments.

Participants:

Aart van den Hoek	winch operator
Andre Bongers	De Peel, Press officer
Angélique Lormans	coordinator
Berrie Vlietstra	test pilot
Bert Viersma	De Peel, CEAD
Charles Pellens	supervisor
Coos Meester	First Aid
Eric Wierenga	XCitor ULM / video
Frank Blok	adjudant, cable runner
Hans Brugman	NLR, recording devices
Harry Bakker	observer weight
Henny Arendsen	winch operator
Isabel Puts	NLR publications
Jaap Crezee	photographer
Jacques Bechthold	XCitor ULM / video
Jaques van Muijen	translator
Jan Takens	DNW, speed probe calibration
Joop de Hoog	Compeo registration observer

Jos Mientjes	test pilot
José Mulder	weight observer
Luke Lemmen	test pilot
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Maarten Vogelaar	video
Marcel Olsman	video
Marieke Six Dijkstra	test pilot
Marten Kommer	winch operator
Martin Joosse	NLR , data acquisition system
Mike Wierenga	XCitor ULM / video
Monique Smith	professional English translator
Nuria Vico	start controller
Outger Commandeur	NLR, recording devices
Paul Blok	NLR, Project leader
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P. W. W. Wijninga. Colonel	De Peel, Base Commander Group Guided Missiles
Richard Meerkerk	winch operator
Rob van den Eijnden	cable runner
Robert Beukers	coordinator
Rogier Wolff	safety, photographer, reviewer
Ronald ten Berge	Flight operations coordinator
Stephan de Jong	photographer
Tjebbe Haringa	De Peel, LtKol H-AORE
Toon Westerburger	safety, meteo observer
William Mans	winch operator
Wim Ruck	NLR reproduction
Wolf Willershausen	Bräuniger

I do already apologize in case I forgot to mention someone. There were so many people involved……

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KNVvL afdeling Schermvliegen

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Appendix A Test plan

Because of the time scale and the tremendous efforts involved, things will be arranged to be redundant whenever possible. This is to prevent having to cancel the whole test operation because of illness or mechanical breakdown. So we have two winches, several winch operators and tandem pilots, two side releases (Zwiep release) and at least two test pilots.

While executing the test, several variables are deemed relevant:
These are:

- Glider type
- Wing loading
- Spiral dive form
- Pilot performing the test

Several glider types will be tested.
To determine the effects between the different classes, LTF1, LTF1-2, and LTF2 class gliders will be tested.
With the different sizes of the gliders we will ensure that the test pilot will be within the weight range for that glider.

Water ballast will be used, if possible, to test at the lower and upper end of the weight range.

The spiral speed will be varied, as indicated in the table below with Low, Medium and High. This will be linked to the rate of descent because this value normally can be read from the vario. The exact rate of descent values or sink rate are not yet set, this will be done prior to testing.
The set values can be, for example, -6, followed by -10 and -14 [m/s]. The DHV normally tests with -14 [m/s].

More than one pilot will perform the test.

Preferably each test pilot will repeat the same manoeuvre several times in order to collect reliable data.

This gives the following combinations:

Glider type	LTF 1 L	LTF 1-2 L	LTF 2 L	
Wing loading	Low	Mid	High	
Sink rate	Low	Medium	DHV -14 [m/s]	High
Pilot	1	2	3	
Run	1	2		

If each combination has to be tested, 216 runs will be necessary. Because this is very impractical, a selection of these 216 tests needs to be made. The idea is that we set a 'baseline' test, and then vary only one parameter from there.

An order of testing can be:

No.	**Glider type**	**Wing loading**	**Sink rate**	**Pilot**	**Run**
1	LTF 1-2 M	Mid	Medium	1	1
2	LTF 1 M	Mid	Medium	1	1
3	LTF 2 M	Mid	Medium	1	1
4	LTF 1-2 M	Low	Medium	1	1
5	LTF 1-2 M	High	Medium	1	1
6	LTF 1-2 M	Mid	DHV -14 [m/s]	1	1
7	LTF 1 M	Mid	DHV -14 [m/s]	1	1
8	LTF 2 M	Mid	DHV -14 [m/s]	1	1
9	LTF 1-2 M	Low	DHV -14 [m/s]	1	1

10	LTF 1-2 M	High	DHV -14 [m/s]	1	1
11	LTF 1-2 M	Mid	Low	1	1
12	LTF 1-2 M	Mid	High	1	1

The above-mentioned order does not take into account the repetition of runs by several pilots. This will be decided upon on the day of testing, depending on how the tests progress.

Appendix A.1 Tasks

A lot of people will be involved in the tests . These people will be assigned specific tasks to prevent any miscommunications during the actual testing.

- Test Officer
- Safety Officer
- Winch Operator
- Start Leader
- Test Pilot
- Wingman
- Wingman passenger
- Assistant
- Winch Engineer
- Observer 1
- Observer 2
- Weather Officer
- Photographer
- Security Officer
- Bystanders

Together with the test pilot the Test Officer decides on the execution of the experiments. He communicates with all the participants. He starts or stops the experiment. His decision is binding.

The Safety Officer is primarily responsible for the safe execution of the experiment. He can communicate with everybody he deems necessary to carry out his task. He consults the Test Officer. Only in case of uncontrolled unsafe situations he will communicate directly with the pilot.

The Winch Operator takes care of the proper winch procedure. He stays in contact with the pilot for as long as the pilot is connected to the winch cable.

The Start Leader controls the take-off of the pilots. He stays in contact with the pilots untill the winch operator takes over.

The test pilot listens to the Test Officer and executes his orders. Manoeuvres will not be started on own initiatives. From a safety point of view, manoeuvres can be stopped on own initiative.

The Wingman will take off before the test pilot. His passenger will film the test pilot while executing the manoeuvres. Whenever possible the Paramotor will be used so filming will minimize the interference on the test.

The Assistant assists the Test Officer in executing the tasks.

In case of mechanical failure of a winch, the second winch will be used. The Winch Engineer will try to fix the problem instantly to get it operational again. When necessary, the winch engineer will repair a broken down motor or quad.

While executing the experiments only the Test Officer and the Safety Officer communicate with the test pilot.

The Observers monitor all activities and will report separately.

The Weatherman or Weathergirl observes the weather and keeps an hourly weather log and records any changes in the weather.

The Photographer captures the execution of the experiments on digital photos and video. He assists with the preparation of the air shots and shoots from the ground. He is responsible for changing the batteries and recording media in time.

The Security Officer takes care that the bystanders do not interfere with the experiment.

Bystanders, as far as not being assigned a specific task, should not interfere with the testing process.

It is possible that a person is assigned several tasks.

Appendix A.2 Radio communication

Two separate communication systems will be used.
Radio 1 (ground): everybody except the test pilot is tuned to this frequency. PMR is used, with sufficient power to cover the distance between winch and take-off area.
Radio 2 (operations): for dedicated use in executing the test flights and measurements by the test pilot. This frequency will be used by:
- Test Officer
- Safety Officer
- Winch Operator
- Start Leader
- Test Pilot
- Wingman
- Wingman passenger
- Security Officer

LPD will be used, with CTSS (Tone Squelch) to reduce the risk of receiving jamming stations by the test pilot and wingman.

Appendix A.3 Equipment

The following equipment is needed to perform the measurement flights:
- Paraglider LTF 1
- Paraglider LTF 1-2,
- Paraglider LTF 2,
- Winch 1
- Winch 2
- release 1

- release 2
- harness test pilot 1
- harness test pilot 2
- reserve chute test pilot 1
- reserve chute test pilot 2
- vario 1 (GPS with logging possibilities)
- vario 2 (GPS met logging possibilities)
- radio winchman 1
- radio winchman 2
- radio 1 test officer
- radio 2 test officer
- radio 1 safety officer
- radio 2 safety officer
- radio test pilot 1
- radio test pilot 2
- radio wingman
- radio wingman passenger
- radio assistant
- radio observer 1
- radio observer 2
- radio photographer
- radio security officer
- radio PC
- weight balance
- plank-bridge, to support the balance
- vitaport 2, equipment to log G-forces and physiological data.
- probe for measuring static and dynamic pressure
- professional video recorder on tripod
- wireless video under canopy
- knee-supported camera
- helm camera
- camera for tandem
- picture camera
- Laptop
- generator
- power extension cord
- swing

- table
- chairs
- tent
- terrace heater
- batteries
- charge equipment
- recording media
- thermometer
- stopwatch
- water ballast bottles
- water
- timer
- blood pressure meter

Whenever relevant the brand, type and other specifications of every piece of equipment will be recorded.
The vario will be used by the pilots to read the height above ground and the sink rate.
The weight balance will be used to weigh the pilot and his/her equipment.
The PC will be used to record the radio communication. The radio will be tuned to the predetermined frequencies and will be connected via audio line-in.

The generator is necessary to guarantee power for the laptop and other equipment.
The swing will be used to adjust the harnesses and to determine the position and attachment location of the measuring equipment.

The thermometer, together with the pressure on the ground, will be used to determine, the air density.

Appendix A.4 Recordings

For recording data the Dutch National Aerospace Laboratory kindly lend out some of their measuring equipment.
The equipment on loan is a Vitaport 2 recording device; a miniature device that can record data with high resolution and data rate.

With the Vitaport 2 the following data will be recorded:
- G-force parallel to the left riser

- G-force parallel to the right riser
- dynamic air pressure
- static air pressure
- heartbeat rate of the test pilot
- respiration of the test pilot
- event marker

A laptop will be prepared to record the communication to and from the test pilot.

The GPS varios will be used for additional records. The GPS records position which can be used to calculate altitude and sink rate. Because of the measurement inaccuracies of the satellite signal the altitude data based on the satelite positioning are less accurate than those based on pressure measurements.

The event marker is a pressure switch to record a marker pulse.
This pulse can be used to record the moment in time. This can be used to synchronize the time between Vitaport and laptop recordings at specific moments during the manoeuvres.

The manoeuvres will be recorded with several video cameras. On the ground the cameras will be placed on tripods.
The test pilots carry 3 cameras. One camera under the canopy facing the pilot, one on a knee support and facing the pilot, and one on the helmet recording the pilots view.
The tandem (paramotor or glider) will function as wingman with the passenger filming the test pilot.

Appendix A.5 Test locations

Because the sink rates can be very high during the execution of the tests, the terrain for the tests is preferable one where the test pilot can be winched to a minimum altitude of 2500 ft. The length of the winch cable and the safety of the test pilot should be taken into account. The test pilot will be focussed on the experiment and not on other air traffic.

One of the possible locations was Airforce base De Peel 51°31’ N, 5°51’ E

This location is in the centre of De Peel CTR with classification C from ground to 3000 ft. Above the field there is an ATZ with a radius of 2 nm from ground to 1500 ft.
The advantage of this location is that the tests can be performed fully within the controlled airspace while the location can easily be identified from large distances by other air traffic.
Because of the length of the field it will be possible to winch the gliders to sufficient height in one step, without step winching. This will reduce the time needed to reach the minimum test altitude.

The tests will be conducted within a radius of 2 nm above the airfield.

As this is a military airfield we had to prepare a list of participants for security reasons. This list had to contain the personal identification and passport numbers of all team members and it had to be handed over to the head of security of the base prior to the tests.

Appendix A.6 Airspace classification

<table>
<tr><td rowspan="3">Airspace class</td><td rowspan="3">C</td><td rowspan="3">E</td><td colspan="2">G</td></tr>
<tr><td>above</td><td>at or below</td></tr>
<tr><td colspan="2">3000 ft</td></tr>
<tr><td>Distance to cloud</td><td colspan="3">1500 m horizontally, 1000 ft vertically</td><td>Free of cloud with the surface in sight ground visual</td></tr>
<tr><td>Flight visibility</td><td>5 km</td><td>8 km 1)</td><td>8 km</td><td>1.5 km</td></tr>
<tr><td>Radio contact</td><td>Continues two-way</td><td>Not required</td><td>Not required</td><td>Not required</td></tr>
</table>

1) from Friday 16:00 till Sunday 23:00 hours (winter time) and during legal holydays 5 km in Nieuw Millegen TMAs

In the TMZ the use of an activated SSR-transponder is mandatory for all aircraft (including balloons, gliders, hanggliders and paragliders). Permission for flights through the TMZ without activated SSR-transponder can be given or rejected by the air traffic controller by radio (Dutch Mil Info, frequency 132.350 MHz).

Appendix A.7 Weather conditions

The cloud base should be at least 3000 ft and flight visibility at least 5 km.
Winds at ground level should not exceed 10 kts and winds at 3000 ft altitude should not exceed 15 kts.
Wind direction will determine the choice of test location

Weather conditions can be checked via:
http://www.knmi.nl/actueel/metar.html
The METAR from Eindhoven and Volkel generates the most reliable information. De Peel does not generate a METAR.

An example of a METAR is:
ZCZC
SA152025 EHVK
METAR EHVK 152025Z AUTO 19020G30KT 9999NDV –RA SCT020/// BKN024/// OVC028/// 08/05 Q0987 REDZ
WHT=

It is also possible to consult the TAF of the mentioned airfield, or the Low Level Forecast-FIR 3 from this airfield.

Appendix A.8 Preparation on the day of testing

Several tasks can be identified:

- organization
- measuring crew
- winch crew
- quartermasters
- camera crew

The weather will be monitored to see if the conditions are good enough for the tests to be performed.
A telephone chain will be used to inform all team members about the go-ahead of the test day.

The formal contact persons from surrounding airfield will be informed about the intended activities:

- airport Eindhoven
- airfield Budel
- airforce base Volkel
- airforce base de Peel
- airforce base Kleine Brogel

Every crew member will be briefed about his or her task.
The time on the GPS is the true local time.
The time on the laptop will be synchronized with the local time.
The time of the Vitaport will be synchronized with the local time.

The G-force sensors will be placed parallel to the left and right riser at chest height.
The blood pressure of the test pilot will be measured before the test.
The respiration sensors will be placed around the chest.
The heartbeat sensor, electrodes, will be placed on the chest as described in figure 1.
The event marker will be placed at one of the brake toggles.
When the Vitaport and the sound recording of the laptop have been started, the event marker will be pressed at the moment of saying “Now”. The time of pressing the event marker will be recorded. This way the time of the Vitaport is synchronized with the other equipment.
The video camera will be synchronized with local time. Images should be recorded including time.

To allow for extraction of extra information from photo and video images, two streamers will be placed in the middle left and right B-line, 1 meter apart.

Appendix A.9 Execution

A weather condition form will be filled in at least once every hour and with changing conditions.
Prior to every run, a run registration form will be filled in.
Prior to the winch procedure it will be communicated which runs can be performed during this flight.

The start leader and the winch man are responsible for a safe winch operation.
The test pilot will be towed to a safe altitude.
After release the test pilot signals that he is ready to execute the experiments.
The test officer announces which run will be executed at which sink rate.
The test pilot will start the manoeuvre. If the sink rate is stable he will press the event marker and inform the test officer.
The test officer starts the stopwatch and waits 10-20 seconds.
The test officer announces that the manoeuvre can be stopped, or that another sink rate can be started.
If a second manoeuvre can be started in the same run, the event marker will be pressed twice.
The minimum safety altitude on which a manoeuvre can be stopped is 200 meters.
The test pilot will also check the minimum safety altitude.

During one run with a sink rate of 15 m/s at least 150 meters altitude will be lost.

A number of tests will be recorded on video from a supporting tandem flight.
A Paramotor will be used for this task in order not to interfere with the test sequence.
The advantage of using a Paramotor is that it can execute longer flights and can circle at a constant altitude.
As the tests are possibly performed above a nature reserve, the paramotor will first be towed to a height of at least 1000 ft before starting its engine.

After the first run it will be checked whether the measured data are recorded correctly. The memory card of the Vitaport will be read and the data processed to obtain visual results.

Appendix A.10 Safety precautions

The test pilot has to be aware that the steep spiral is potentially dangerous. The aim of the measurements and the amount of preparation can cause stress during the performance. Despite this level of stress the pilot has to keep his safety a top priority.

The G-tolerance differs from person to person and depends on the physical condition of the person.
Circumstances that can influence the G-tolerance negatively are:

- fatigue
- use of alcohol
- use of medication
- illness
- dehydration

It can be expected of the test pilot that he is fit, did not use any alcohol in the last 24 hours and that he does not take any medicine that can potentially influence his airworthiness. When in doubt, advice can be obtained from the medical team of the Centrum Mens en Luchtvaart (CML).

The test pilot has licence III and, preferably, has extended experience with aerobatics and extreme manoeuvres. A recently attended SIV course (safety course) is mandatory.

It is the intention that the test pilot will not have to fly four runs in succession. He will be relieved by another test pilot to allow for a break.

The wings to be used for the tests will be flown within the weight ranges given by the manufacturer.

The tests will be performed with recently checked flight gear, step winches with Zwiep releases and recently vented and packed reserve chutes.

For the test day a release will be requested from IVW / LVNL to allow for winching up to 3000 ft.

A NOTAM will be issued.

Communications will be in place with the formal ATS-unit.
If runway 04 at Eindhoven Airport is in use it is possible that air traffic already has clearance to descend to 2000 AMSL above Sterksel.

The airfield administration in Budel will be informed about the intended activities.

Airforce base Volkel has an QRA task this year and will be informed about the intended activities.

In case video shots from a tandem or Paramotor are necessary, the pilot of this aircraft has to realize that the test pilot is mainly focussed on the performance of the test manoeuvre. The camera crew is obliged not to cross the flight path of the test pilot.

Appendix A.11 Contact information

Air Traffic Information Services		
Aeronautical Information Service	Tel:	020-406 3521
	Fax:	020-406 3532
	E-mail:	AIS@lvnl.nl
International NOTAM Office	Tel:	020-406 2315
	Fax:	020-406 2316
	E-mail:	fsc@lvnl.nl

Air Base de Peel EHDP		
Operational Control Centre	Tel:	0493 – 59 8083
	Fax:	
	E-mail:	GGWOCC.GGW.CLSK@mindef.nl

Air Base Volkel EHVK		
Operational Control Centre	Tel :	
	Fax :	
	E-mail :	
	Post :	Air Base Volkel attn Chief Air Traffic Control PO Box 10150 5408 ZW Volkel

Airport Eindhoven EHEH		
AD-administration	Tel:	040-291 9823
	Fax:	040-291 9833
	E-mail:	operations@eindhovenairport.nl
Eindhoven TWR		131.000

Air Base Budel EHBD

AD-administration	Tel:	0495-697 949
	Fax:	0495-697 940
	E-mail:	
Budel radio		122.150

Airport Kleine Brogel

AD-administration	Tel:	
	Fax:	
	E-mail:	
Kleine Brogel TWR		122.100

Appendix B De Peel air base usage agreement

Koninklijke Luchtmacht

Ministerie van Defensie

Commando
Luchtstrijdkrachten
Groep Geleide Wapens
Commando

Bezoekadres:
Luchtmachtbasis de Peel
Ripseweg 3, Vredepeel
Postadres:
MPC 88 A
Postbus 5034
5800 GA Venray
www.luchtmacht.nl

Steller:
Kap P.J. Geurts
Telefoon (0493) 59 80 83
Fax (0493) 59 87 35
Intern (494) 80 83
E-mail:
PJ.Geurts@mindef.nl

Intern memorandum

Aan Zie verzendlijst

Datum

Ons kenmerk GGW/08.

Onderwerp G-kracht metingen t.b.v. parapenten

C-LMB De Peel heeft toestemming gegeven voor een tweetal testdagen voor het doen van G-kracht metingen ten behoeve van de parapentsport. De metingen worden verricht door een medewerker van het NLR en zijn onder auspiciën van de KNVvL afdeling Schermvliegen.

De eerste testdag zal plaatsvinden op zaterdag 9 februari, mits het weer de testen toestaat, de tweede testdag is nog niet bekend. Het opbouwen, de testvluchten en het afbreken zal plaatsvinden tussen 0800LT en SUNSET. De project-leider zal zich aan- en afmelden bij de wachtcommandant.

De volgende afspraken zijn in overleg met het OCC gemaakt:

- Er mag gebruikt worden gemaakt van de landingsbaan en de oefenvelden gelegen tussen de landingsbaan en de parallelbaan;
- Afhankelijk van de windrichting wordt aan een van de twee verste zijden een kleine partytent geplaatst t.b.v. de test- en analyseapparatuur;
- Er mag gebruikt worden gemaakt van de zweefvlieghangaar t.b.v. toilet- en koffiefaciliteiten, hieronder genoemde personen zullen tijdelijk op de sleutellijst worden geplaatst;
- De testlocatie is bereikbaar via mobiel nummer:
  - Dhr. Paul Blok 06 42 ......
  - Dhr. Ronald ten Berge 06 51 ......
- Wanneer door kabelbreuk een deel van de lierkabel op een van de OPS-locaties terecht komt wordt direct contact opgenomen met de wachtcommandant. Men zal zelf geen actie ondernemen.
- Alle schade aan infrastructuur van LMB De Peel wordt direct gemeld aan de wachtcommandant en op de eerstvolgende werkdag telefonisch aan het OCC.
- Na overleg met HSVo is besloten dat er geen media-aandacht zal zijn voor dit evenement.
- HBIV heeft toestemming gegeven voor fotograferen en filmen t.b.v. analyse.

Actie OCC

- Aanvraag NOTAM; is aangevraagd en goedgekeurd door ATC.

Actie HBIV

- Sleutellijst zweefvlieghangaar, gebouw 379, tijdelijk aanvullen. Namen worden aangeleverd via de mail.

Ministerie van Defensie

Commando Luchtstrijdkrachten
Groep Geleide Wapens
Commando

Datum

Ons kenmerk GGW/08.

Actie Wachtcommandant

- In het kader van (vlieg)veiligheid het gebied rondom de landings- en parallelbaan vrijhouden van personen die niet tot het onderzoekteam behoren.
- In geval van kabelbreuk de organisatie ondersteunen bij het verwijderen van de kabel indien deze gevallen is op een van de OPS-locaties.

Officier OPS

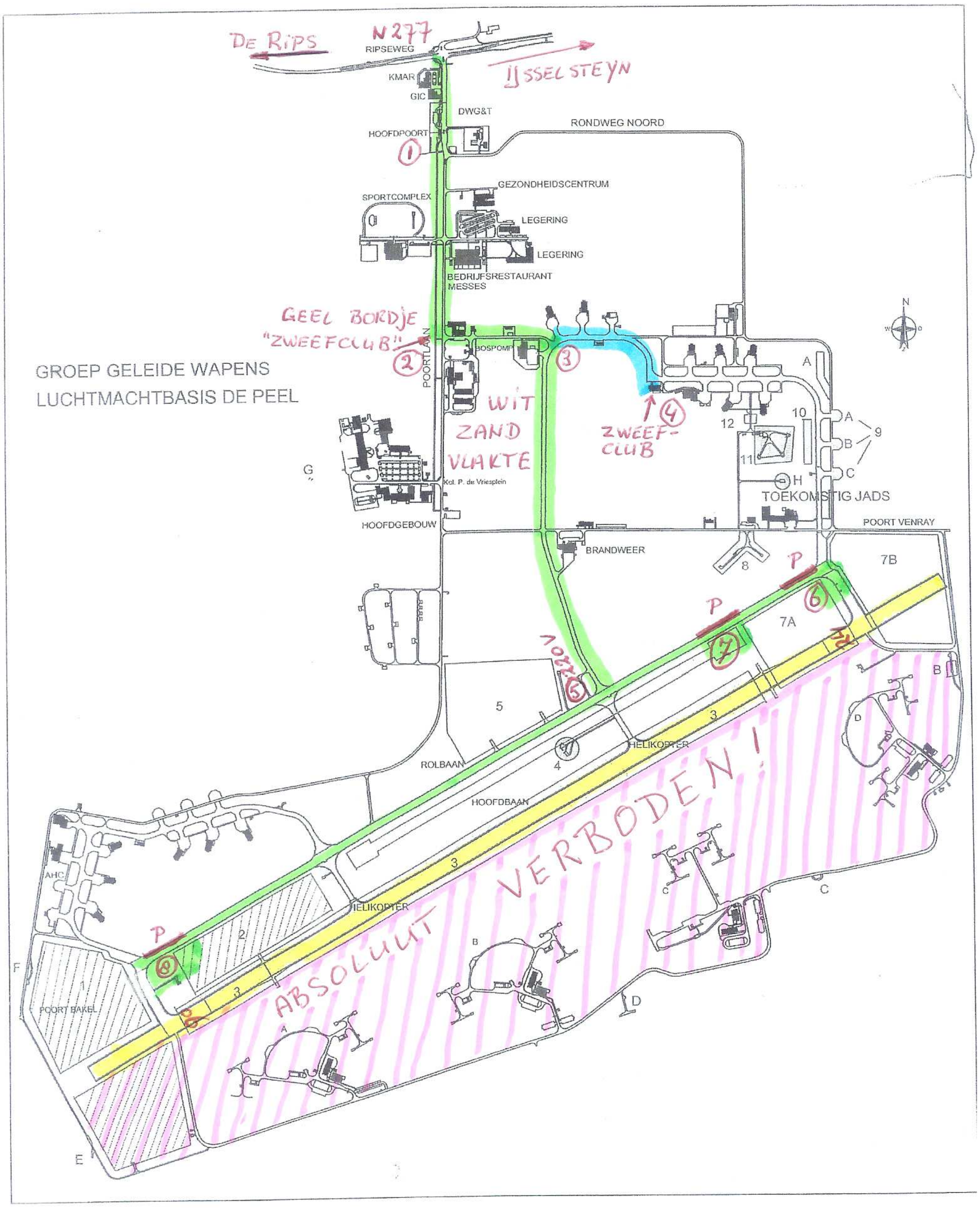
P.J. Geurts
Kapitein

Verzendlijst

C-LMB De Peel
HSOOD
HOCC
C-650 t.b.v. Wachtcommandant
HBIB
HBIV
HSVo
HBA t.b.v. OBD
KMar Venlo

Appendix C Map of the air base De Peel

This map shows the restricted areas and roads to be used by the team.



Appendix D House rules air base De Peel

Adres:
Luchtmachtbasis De Peel
Ripseweg 1
5816 AC Vredepeel
Tel: 0493 598911

Coördinaten ingang: N51° 32' 14.5" E005° 51' 09.7"

Op de basis gelden dezelfde regels als op de openbare weg. Er geldt een maximum snelheid van 50 km/u. Op de taxibaan en de lierstrip die we gaan gebruiken kan het zijn dat harder gereden wordt, dus kijk daar bijzonder goed uit!

Roken is niet verboden, maar:
1. na het doven van een peuk moet je deze meenemen (niet op de grond laten liggen dus). Als één van de rokers een emmertje met zand meeneemt, dan kunnen daarin alle sigaretten gedoofd worden. We willen die peuken in ieder geval niet bij het overige afval hebben. Aan het einde van de dag dienen de rokers zelf zorg te dragen voor het opruimen van de emmer.
2. roken mag zoals bekend niet in de buurt van paragliders, maar ook niet op de startplaats waar de schermen uitgelegd worden om te starten.

Huisdieren (zoals honden) zijn niet toegestaan i.v.m. de honden van de bewakingsdienst.

Route: Om bij de runway te komen mogen we uitsluitend de route gebruiken die op het kaartje met groen is aangegeven (route van poort naar runway) en om naar de kantine van de zweefclub te gaan gebruiken we de blauwe route. We mogen niet op andere plaatsen komen.
1. vanaf de hoofdpoort rij je ongeveer 600 meter tot een afslag naar links; daar staat met een geel bordje aan de rechtse kant van de weg "zweefclub" aangegeven. Deze afslag neem je.
2. vervolgens kom je uit in een bocht van een taxibaan. Linksaf ga je richting de zweefclub, rechtsaf ga je naar de runway.
3. bij de runway kom je eerst op een parallelle taxibaan. Die gebruik je om naar de startplaats of de lier te rijden.

Verboden gebied: ten zuidoosten van de runway mogen we absoluut niet komen! Loop je daar enkele meters het gras in, dan wordt je opgemerkt door sensoren en gaan gaan de alarmbellen af. Moeten we daar toch zijn om wat voor reden dan ook, dan moet ik eerst de bewaking bellen.

Met de volgende link kun je in een Windows omgeving MS Virtual Earth opstarten:
http://maps.live.nl/?cp=51.53811432122892~5.853095054626473&style=h&lvl=14&dir=0&tilt=-90&alt=-1000

Kies linksboven voor "Aerial". Daarna kun je kiezen voor "Zoom to: street".
De runway is in de richting van 06/24 en ligt ongeveer op 88 feet AMSL.

Appendix E Notam EHDP

NOTAM Processing			**System - NOTAM**	
NOF: EHMC	**Priority:**		**Reception:**	
	Originator:	EUECYIYN	**Operator:**	INO_eh_JCuppen
	Filing Time:	221449	**Last Stordate:**	08-01-22 14:49
Type: Origination			**Grid:** No	On Pib: Yes

System NOTAM

M0078/08 NOTAMN

Q) EHAA/QFALT/IV/NBO/AW/000/030/5131N00551E005
A) EHDP B) 0802090638 C) 0802091712
D) SR-SS
E) EHDP ATZ RAD 2NM AVOID AREA BLW 3000FT AGL, DUE TO PARAPENT TESTS

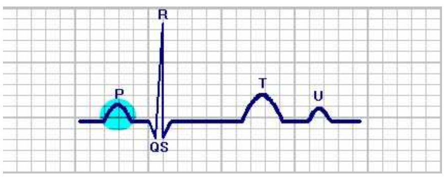
Original Message

(M0078/08 NOTAMN
Q) EHAA/QFALT/IV/NBO/AW/000/030/5131N00551E005
A) EHDP B) 0802090638 C) 0802091712
D) SR-SS
E) EHDP ATZ RAD 2NM AVOID AREA BLW 3000FT AGL, DUE TO PARAPENT TESTS)

End of Report

Appendix F ECG electrode colour and position for the Vitaport II

The skin is cleaned with a preparation cream at the indicated places. The preparation with this cream is especially important for field experiments during which the test person moves and transpires a lot. Three already gelled electrodes are stuck to the derivation points.



Appendix G Test registration form

Tijd	run	manoeuvre	piloot	scherm	TOW	L/M/H	Max v/s [m/s]	opmerkingen
12:24	1	Steil spiraal	Pilot 1	Bright 26	78.5	L	10	2e poging stabiel
12:50	2	Steil spiraal	Pilot 1	Bright 26	78.5	L	14	2 pogingen. kwaliteit van de spiraal? Daalde niet snel
13:24	3	Steil spiraal	Pilot 2	Bright 26	92	H	10	3 pogingen
13:47	4	Steil spiraal	Pilot 2	Golden 26	92.1	M	14	2 pogingen
14:04	5	Steil spiraal	Pilot 2	Aspen 26	91.7	M	14 10+	2 pogingen 2e niet stabiel -> herh
14:20	6	Steil spiraal	Pilot 2	Aspen 26	91.7	M	10	
14:51	7	Steil spiraal	Pilot 3	Aspen 26	100	H	14 10	1e niet stabiel

Tijd	run	manoeuvre	piloot	scherm	TOW	L/M/H	Max v/s [m/s]	Opmerkingen
15:14	8	Steil spiraal	Pilot 3	Golden 26	100.4	H		Kabelbreuk, geen meting
15:29	9	Steil Spiral	Pilot 3	Golden 26	100.4	H	14	3 pogingen
16:10	10	Steil spiraal	Pilot 1	Aspen 26	82.7	L	14 10	2 pogingen met 4.5 kg ballast
16:35	11	Steil Spiraal	Pilot 1	Bright 26	85	M		Gedraaide karibiner Geen test

Meetplan v0.7
G-kracht meting Steilspiraal
Paul M. Blok

KNVvL Schermvliegen

Test registratie formulier

gewicht piloot " scherm } = TOW

klok v.d. datalogger = +26 s.

op Compeo UTC

tijd UT	run	manoeuvre	piloot	scherm	TOW	L/M/H	Max v/s [m/s]	opmerkingen
12.24	1	SP	1	Bright 26	(72.9) + 5.6 ~~+ scherm~~	L	10	2e poging stabiel
12.50	2	SP	1	"	" + 5.6 ~~+ scherm~~	"	poging 14	2 pogingen kwaliteit v.d. spiraal? daalde niet snel
13.24	3	SP	2	"	86.4 + 5.6 ~~+ scherm~~	H	10	3 pogingen
13.47	4	SP	2	Golden 26	86.4 5.7 } 92.1	M	14	2 pogingen
14.~~00~~ 04	5	SP	2	Aspen 26	86.4 5.3 } 91.7	M	14 10+	2 pogingen ε niet stabiel → hesh.
14.20	6	SP	2	~~Bright~~ Aspen 26	incl. niet 91.7	M	10	
14.51	7	SP	3	Aspen 26	94.7 5.3 } 100	H	14 10	1e niet stabiel
15.29 15.14	8	SP	3	Golden 26	94.7 5.7 } 100.4	H	14	15.14 = kabelbreuk 3 pogingen = 15.29u
±16:10	9	SP	1	~~Golden~~ Aspen 26	72.9 5.3 } 78.6 +4.5 H2O	$\boxed{TOW = 82.7}$ L	14. 10.	2 pogingen
16:35	10	SP	1	Bright 26	72.9 5.3 + 6.8 H2O	M		gedraaide carabiner geen test!

86.4 +

72.9 +
91.7
~~100.6~~ + 8.8

81.3

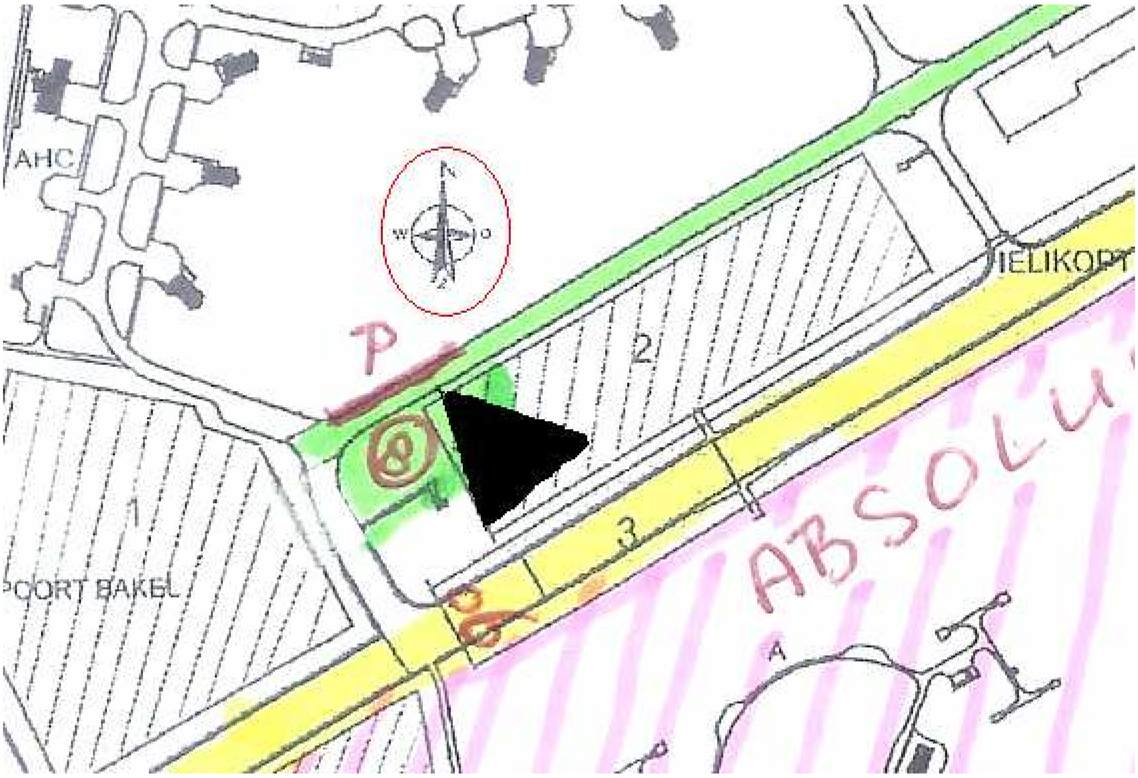
- 8.8
- 96.7
- 95

Appendix H Weather registration form

Local time	Temp [°C]	QFE [mbar]	Cloud base [ft]	coverage	Wind [km/h]
11:30	15	1022	-	0/8	5
11:50	15	1022	-	0/8	6
12:05	15	1022	-	0/8	5-6
12:15	15	1022	-	0/8	7
12:32	15	1022	-	0/8	8
12:50	16	1022	-	0/8	5-6
13:20	15	1022	-	0/8	6-7
13:30	15	1022	-	0/8	6
13:45	15	1022	-	0/8	5-6
13:55	15	1022	-	0/8	3-4
14:05	15	1022	-	0/8	4
14:10	15	1022	-	0/8	4
14:21	15	1022	-	0/8	6
14:35	15	1022	-	0/8	4
14:45	15	1022	-	0/8	7-8
15:15	15	1022	-	0/8	7
15:35	14	1022	-	0/8	6
15:50	14	1022	-	0/8	5
16:10	15	1022	-	0/8	6
16:45	15	1022	-	0/8	1,5-2

Unfortunately the values for the direction of the wind are unreliable due to the presence of a magnetic object in the vicinity of the compass used to determine the direction.

The black triangle in the next diagram shows the direction of the wind as encountered during the experiment. At the start of the first run there was a small tailwind component. Later in the afternoon the wind direction shifted more towards the East. The most important point is that the physical conditions during the day were stable.



Meetplan v0.7
G-kracht meting Steilspiraal
Paul M. Blok

KNVvL Schermvliegen V

~~[illegible]~~ LET OP 0

Weer registratie formulier

T. Westerburger

Grondniveau

	Lokale tijd	Temp [°C]	QFE [mbar]	Wolken basis [ft]	bedekking	~~Wind~~ [kts]/[deg]	
	~~[illegible]~~		~~[illegible]~~			~~[illegible]~~ km/uur	
	1130	15°	1022	—	0/8	5	180°
	1150	15°	1022	—	0/8	6	160°
	1205	14°	1022	—	0/8	5-6	160°
Mareke 1	1215	15°	1022	—	0/8	7	180°
	12.32	15°	1022	—	0/8	8	160°
Mareke 2	1250	16°	1022	—	0/8	5-6	180°
Jos 1	1320	15°	1022	—	0/8	6-7	180°
	1330	15°	1022	—	0/8	6	180°
Jos 2	1345	15°	1022	—	0/8	5-6	150°
	1355	15°	1022	—	0/8	3-4	160°
Jos 3	1405	15°	1022	—	0/8	4	160°
	1410	15°	1022	—	0/8	4	160°
Jos 4	1421	15°	1022	—	0/8	6	160°
Luke 1	1435	15°	1022	—	0/8	4	160°
	14.45	15°	1022	—	0/8	7-8	140°
Luke 2	1515	15°	1022	—	0/8	7	140°
Luke 3	1535	14°	1022	—	0/8	6	130°
	1550	14°	1022	—	0/8	5	130°
Mareke 3	1610	15°	1022	—	0/8	6	130°
Mareke 4	1645	15°	1022	—	0/8	1,5-2	130°

17 / 24
7-2-2008

Appendix I Original (Dutch) pilot comments

Pilot 2

Bij de eerste vlucht vond ik het wat lastig om naar de vario te kijken omdat ik normaal meer naar de grond kijk om mijn hoogte in de gaten te houden. Later ging het beter.
Ik was best even duizelig na een spiraal maar denk niet dat het normaal anders is.
Ik vond het geen probleem de spiralen op een onbekend scherm uit te voeren. Zelf vlieg ik op de Aspen waarbij dit (het testscherm) het enige scherm was waarbij het lastig was deze in een spiraal van 10 m/s te houden, hij wilde er graag dieper induiken of er mee ophouden. Mijn gewicht ligt hierbij net onder het midden.
Het lieren op deze hoogte vond ik niet anders dan normaal buiten dat het opzij laten zetten om recht tegen de wind in opgelierd te kunnen worden een veel langere weg was.
De meetapparatuur zat mij niet in de weg.
Ik denk dat we misschien beter een oefendag hadden kunnen hebben op een eigen lierveld, zodat we ook allemaal de verschillende schermen hadden kunnen testen en we vooral organisatorisch zouden weten hoe het zou gaan lopen, misschien hebben we hierin wat tijd verloren. Maar voor een evt. volgende testdag hebben we nu dan wel al die ervaring en zal het waarschijnlijk iets soepeler kunnen verlopen. Overigens vond ik de verdere voorbereidingen wel erg professioneel.

Pilot 3

Het in de gaten houden van de vario vond ik erg lastig. Ik heb al mijn spiralen naar rechts gemaakt, en telkens de vario op mijn rechter been geplaatst. Problemen die ik vooral ondervond tijdens het aflezen van die vario waren. Het scherm spiegelde sterk in het zonlicht. Het was een erg heldere dag, dus een kwart tot de helft van een rondje was het scherm niet te zien door de spiegeling. Dan was het vario getal erg klein en rond afgewerkt. Met rond afgewerkt bedoel ik dat een 3 en een 8 erg veel van elkaar weg hadden, en 10 en 13 bijvoorbeeld ook. De cirkel die ook de vario aangaf was onduidelijk en ging maar tot -8 m/s.

Tijdens mijn eerst spiraal heb ik alleen maar op de vario gekeken. Alleen heel soms met een scheef oog naar de omgeving. Dit vond ik niet erg prettig. De tweede vlucht heb ik van de rechter tip van het scherm steeds geprobeerd kort naar de vario te kijken. Dit gaf echter zoals hierboven beschreven veel problemen. De laatste vlucht ben ik op mijn gevoel afgegaan en heb ik alleen op het einde, voor het uitleiden even op de vario gekeken of de spiraal tegen de 14 m/s aan was. Die laatste manier vond ik ook het meest prettig, ik weet alleen niet of deze ook het meest accuraat is.

Vooral bij het van de vario terug kijken in het scherm merkte ik dat mijn lichaam niet helemaal doorhad wat er gebeurde. Vandaar dat ik dit in de laatste vlucht ook tot een minimum heb beperkt.

Ik had nog nooit met de Aspen gevlogen, ik vond het ook wel lastig om dan meteen aan te voelen hoe snel je gaat. Ik zou het met mij bekende schermen wel sneller in kunnen schatten. Ik denk dat wat test rondjes vooraf met mijn eigen vario veel geholpen zouden kunnen hebben. Dan hadden we ook met de fluit toon van de vario ons oor kunnen trainen op welke geluiden we moesten letten. Ik ben nog steeds voorstander van via piepjes laten horen wanneer de juiste snelheid is bereikt. Daar naast kun je altijd nog op een scherm kijken. Bij voorkeur mijn eigen digifly flyer vario. Deze vind ik persoonlijk duidelijker, en heeft grotere aanduidingen op het scherm.

De spiraal stabiel houden in de lucht gaat opzich goed, maar wanneer je daar de vario bij gaat gebruiken wordt het een ander verhaal. Normaal vlieg ik voor 90% (of meer) op gevoel. Tijdens de testdag was ik misschien teveel gefocust op het goed doen en ben daardoor misschien teveel op de apparatuur gaan vertrouwen. De vario loopt natuurlijk altijd achter en voordat je dat "geregeld" hebt ben je al een paar seconden aan het spiralen. Ik denk wederom dat een paar oefenrondjes hier veel geholpen zouden hebben.

Normaal kijk ik tijdens het spiralen 1 of 2 keer op mijn vario ter controle, het meeste kijk ik naar het scherm, dan naar de omging (is het vrij) en naar de grond.

Het was zeker beter gegaan wanneer ik minder geconcentreerd zou zijn op de vario, als ik het sneller kon zien of werd ondersteund door een bekende piep.

Lieren tot deze hoogte had ik al vaker gedaan met trappen en geeft voor mij geen verschil.

De meet apparatuur heeft mij in geen geval gehinderd, alleen dat ik tijdens het lieren dacht als ik mijn neus ophaalde. Zouden ze nu denken dat ik het spannend vind of zouden ze weten dat ik verkouden ben. Maar dat soort dingen blijf je houden. Zodra ik van de lier los was "vergat" ik alle apparatuur en ging ik ervoor. Ik ben natuurlijk wel de trigger blijven gebruiken.

Het was overigens ook wel prettig geweest als we misschien een dag eerder al met bijvoorbeeld die trigger de procedure hadden getest. Ik denk namelijk dat ik soms wel eens de tel kwijt was etc. Dus dat is misschien een mooie voor de oefendag.

Hoe de dag op me overkwam is eigenlijk redelijk simpel. Ik had het testplan gelezen en gezien in de mails wat er allemaal gedaan moest worden. Ik had voor mijzelf de voorspelling gemaakt dat we in onze handen konden klappen als er 10 testvluchten werden gemaakt. En dat is gelukt. Het opstarten had wel ongeveer zolang geduurd als ik had verwacht. Meeste mensen wisten van tevoren nog niet wat de bedoeling was en was van tevoren niet echt goed ingelicht. Na de briefing ging het wel goed.

De vluchten op zichzelf gingen wat mij betreft sneller dan verwacht. Ik had verwacht dat de apparatuur meer zou haperen; kabels kapot, batterijen leeg, etc. De reden dat ik zulke dingen verwacht is omdat ik regelmatig op school project demo's geef en het gaat altijd fout. Er gaat altijd iets kapot. Maar dat ging allemaal hartstikke goed, er was ook voldoende reserve apparatuur.

Radio communicatie was meer dan voldoende.

Ja wat informatie betreft, wat ik eerder al schreef. Er is heel veel rondgestuurd, maar misschien niet concreet genoeg. Eigenlijk wist niemand nog wat hij moest doen behalve Ronald en die was alles aan het doen.

Appendix J Paragliders used

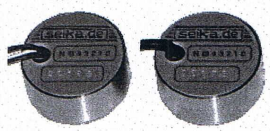
Gradient Type		BRIGHT III	GOLDEN II	ASPEN II
		26	26	26
Production date		13-03-06	01-03-07	06-06-06
Serial-number		G20262 602023	G21262 702208	G17262 605304
Colour		blue/green	green/blue	red/yellow
Latest check		25-03-07	n.v.t.	15-12-07
Length B-line nr. 1 GRADIENT	[mm]	6945	7365	7540
Length B-line nr. 1	[mm]	6928	7427	7535
Length B-riser	[mm]	470	500	500
		The following data is derived from the producers' datasheets		
Flat Area	[m^2]	26.98	26.56	26.36
Projected area	[m^2]	23.51	23.34	23.22
Span	[m]	11.35	11.91	12.25
Projected span	[m]	9.59	10.07	10.31
Aspect ratio	-	4.78	5.35	5.69
Projected aspect ratio	-	3.91	4.35	4.58
Max. chord	[m]	2.94	2.76	2.67
Min. chord	[m]	0.66	0.63	0.57
Number of cells	-	40	50	53
Line consumption	[m]	310.7	345.0	353.8
Weight of the glider	[kg]	5.4	5.4	5.4
Take-off weight range	[kg]	75 - 95	80 - 100	80 - 100
Certification		LTF 1	LTF 1-2	LTF 2
Basic speed *	km/h	36	37	38
Max. speed *	km/h	47	50+	50+
Min. sink rate *	m/s	1.15	1.1	1.0
Gliding ratio *	-	7,5+	8+	8.5+

*These data are valid at the mid-point of weight range.

Note: performance data are dependent upon the wing loading, type of harness and position of the pilot.

Appendix K Datasheet Seika B1 accelerometer

seika.de® B1, B2, B3



Accelerometers of high overload resistance with integrated electronics for measurement of acceleration in the frequency range 0 to several 100 Hz

Features

- very high overload resistance
- insensitive to interference by magnetic and electric fields
- lower cut-off frequency is zero, hence suitable for measuring static acceleration, such as gravity (inclinations) or radial acceleration (centrifugal force)
- linear frequency response with little or no resonant peak at upper cut-off frequency
- low non-linearity
- high signal-to-noise ratio
- no measurable hysteresis of signal
- hermetically sealed
- high long-term stability
- small temperature drift
- integrated sensor electronics
- low power consumption
- very short on-transition delay
- multiple housing options

Description

The sensors B1, B2 and B3 are capacitive spring-mass accelerometers with integrated electronics. Resonant peaks are minimized by special gas-dynamic damping in the primary transformer.
The sensors are manufactured with an analog DC output. The sensor electronics require only small amounts of power and are in conjunction with the capacitive primary transformer characterized by low error and high long-term stability.

Application

The accelerometers B1, B2 and B3 are used for applications requiring high overload tolerance, high long-term stability, small lower cut-off frequency down to measurement of static acceleration, very short on-transition delay and low power consumption. Typical applications include:

- measurements on vehicles, machinery, buildings and plants for process control and error diagnosis
- seismic measurements
- inclination measurements
- safety engineering
- dynamic measurement of position and velocity

Technical Specifications

Type:	B1	B2	B3
Measuring range	$\pm3g$ (ca. $\pm30 m/s^2$)	$\pm10g$ (ca. $\pm100 m/s^2$)	$\pm50g$ (ca. $\pm500 m/s^2$)
Resolution	$<10^{-3}g$	$<5\cdot10^{-3}g$	$<2\cdot10^{-2}g$
Frequency range	0...160Hz	0...350Hz	0...550Hz
Linearity deviation	<0,5%		
Transverse sensitivity	<1%		

SEIKA Mikrosystemtechnik GmbH - Ellharter Str.10 - D-87435 Kempten - Tel: 0831-25532 Fax: 0831-25534
Internet: http://www.seika.de - http://www.seika.net - Email: seika@seika.de

1 / 2

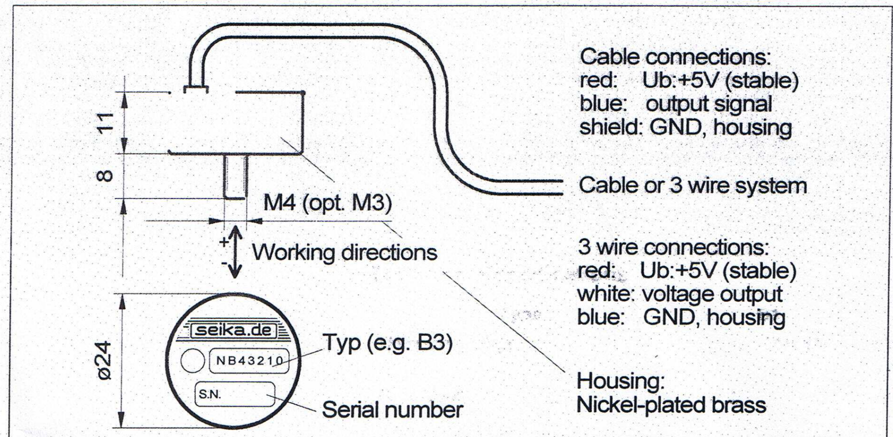
seika.de®

B1, B2, B3

Mechanical overload resistance in direction of measurement	10 000 g (approx. 100 000 m/s²)		
Nominal supply voltage (regulated)	5Volt		
Permissible range of supply voltage	3Volt ... 6Volt		
Current drawn at U_b = 5V	approx.1mA		
Degree of protection	IP65		
Operating temperature	-40°C to +85°C (optional 125°C)		
Storage temperature	-45°C to +90°C (optional 125°C)		
Weight (in metal housing without cable)	approx. 23 grams		
Standard electrical connection	3 highly flexible, color-coded wires ø1mm, length approx. 18 cm (special lengths on request)		
Alternative electrical connection	0.5m strong, flexible, shielded cable ø2.1mm (special lengths on request) 3 flexible, color-coded wires with Teflon insulation for extended temperature range		
Sensitivity*	approx.140mV/g	approx.30mV/g	approx.7.5mV/g
Temperature drift of sensitivity	$<+6\cdot10^{-2}$ % / K		
Temperature drift of zero point	<±0.1mV/K		
Zero offset at Ub=5V	(2.5±0.1)Volt - generally: 0.5Ub±4%		
Output impedance	10 kΩ		

* Each sensor will be delivery with individual calibration dates (offset and sensitivity) *on request: PWM-output

Dimensions (in mm) and Connections



Attention! The supply voltage must not exceed 6 Volt and the polarity must not be reversed.

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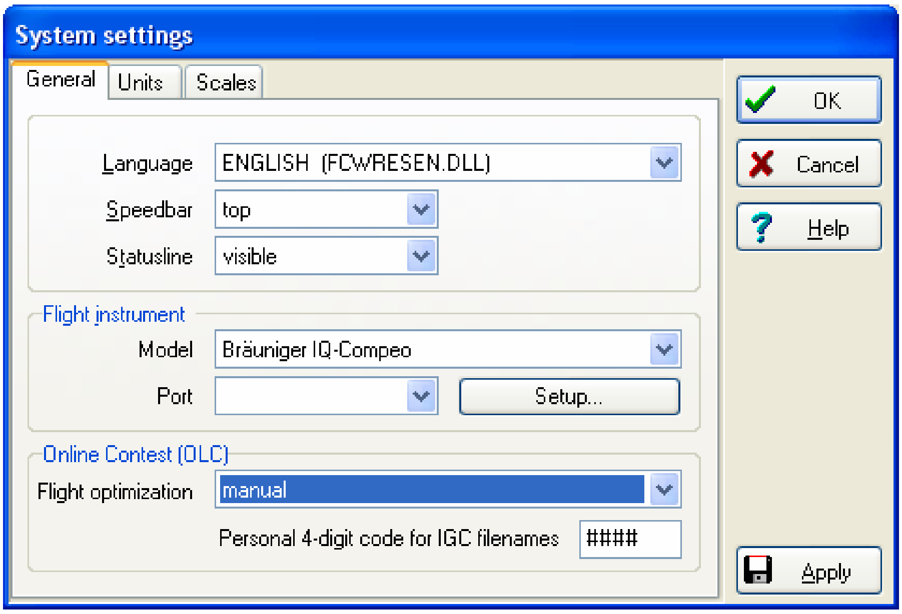
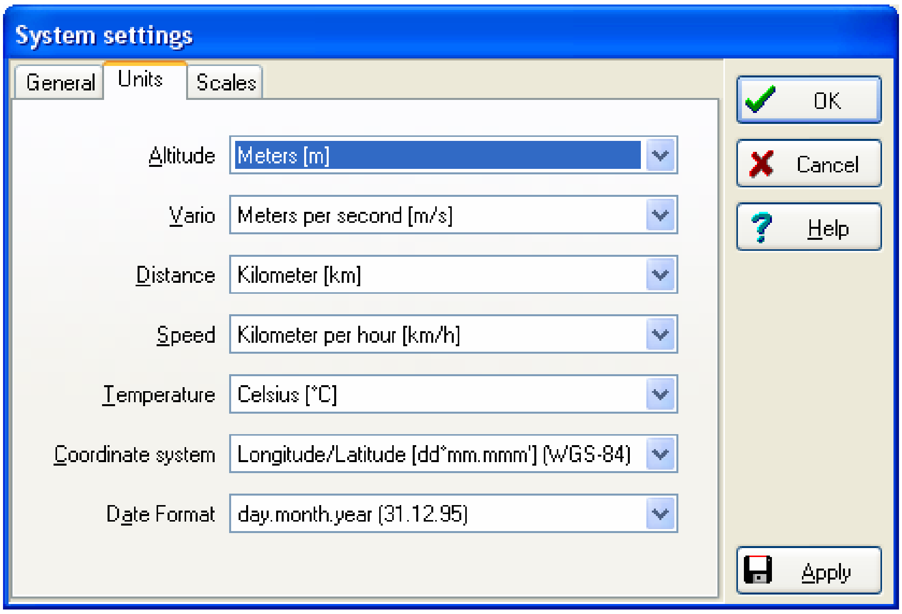
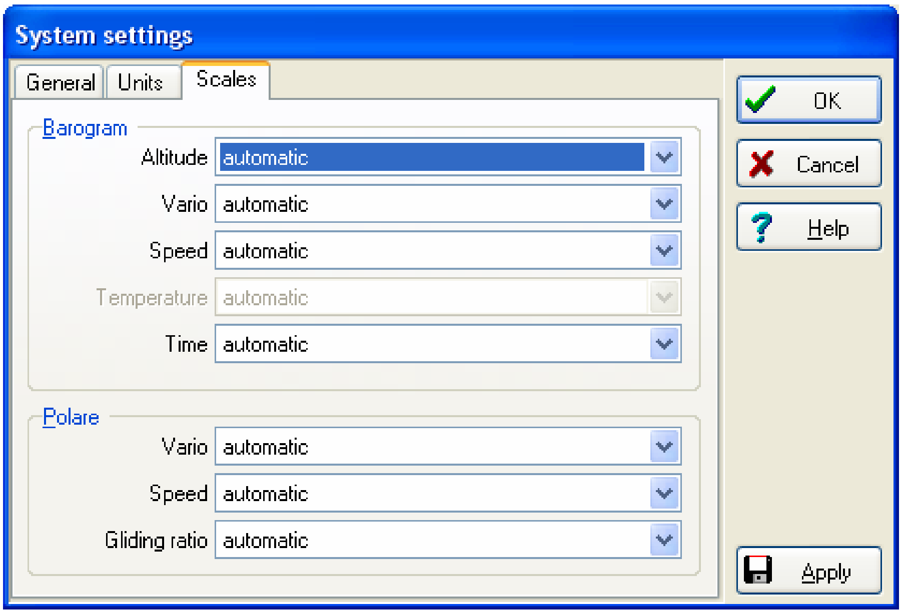
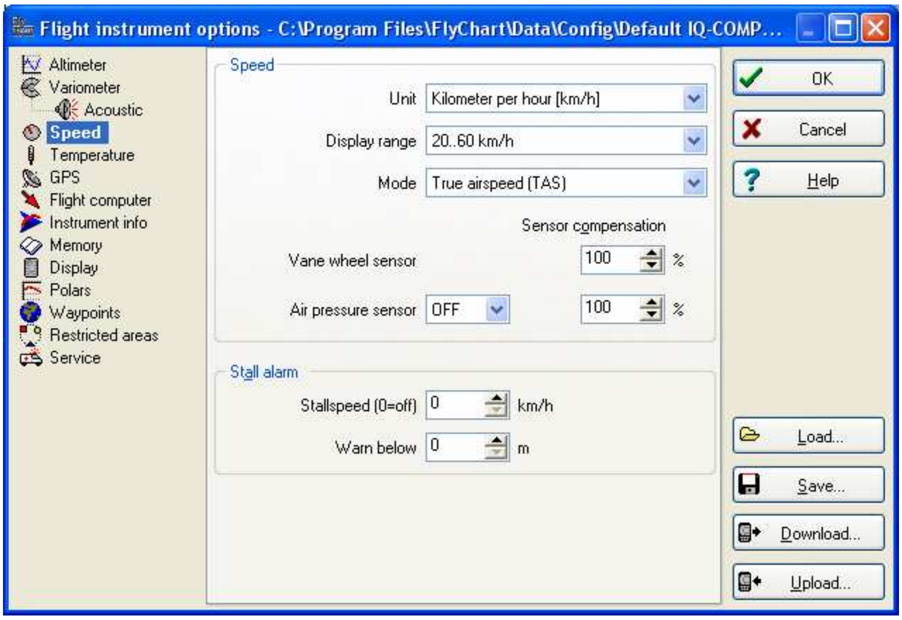
Internet: http://www.seika.de - http://www.seika.net - Email: seika@seika.de

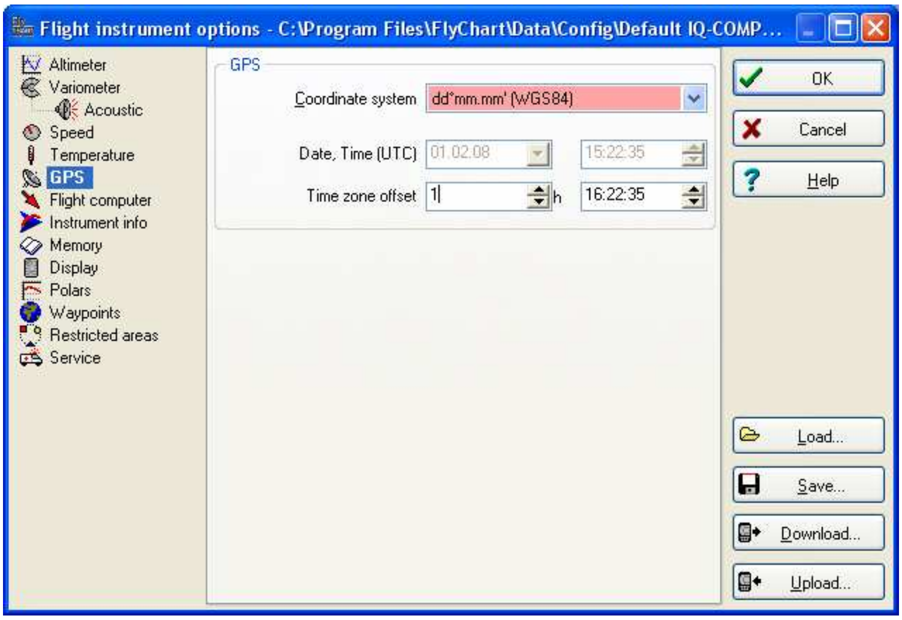
Appendix L Compeo settings via Flychart

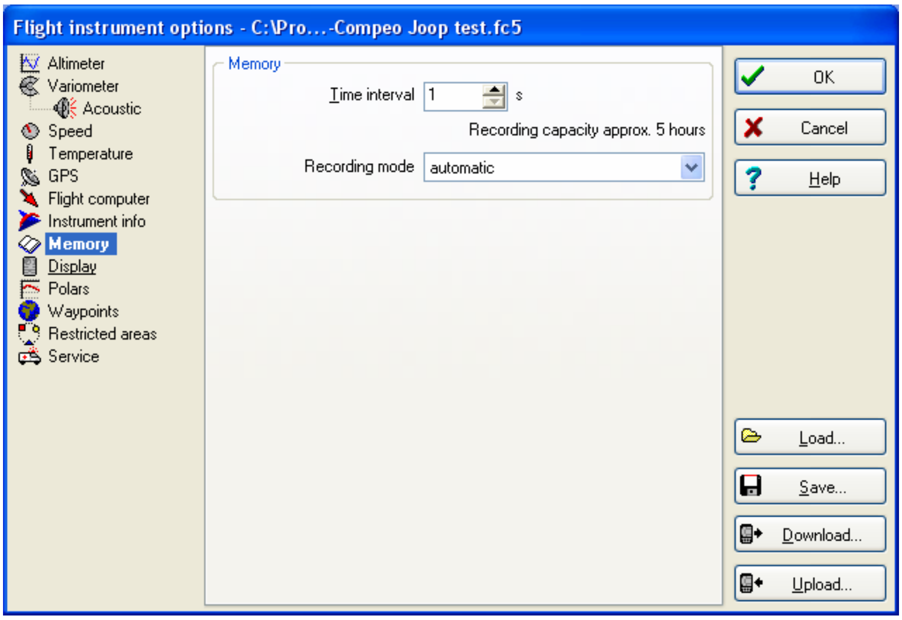


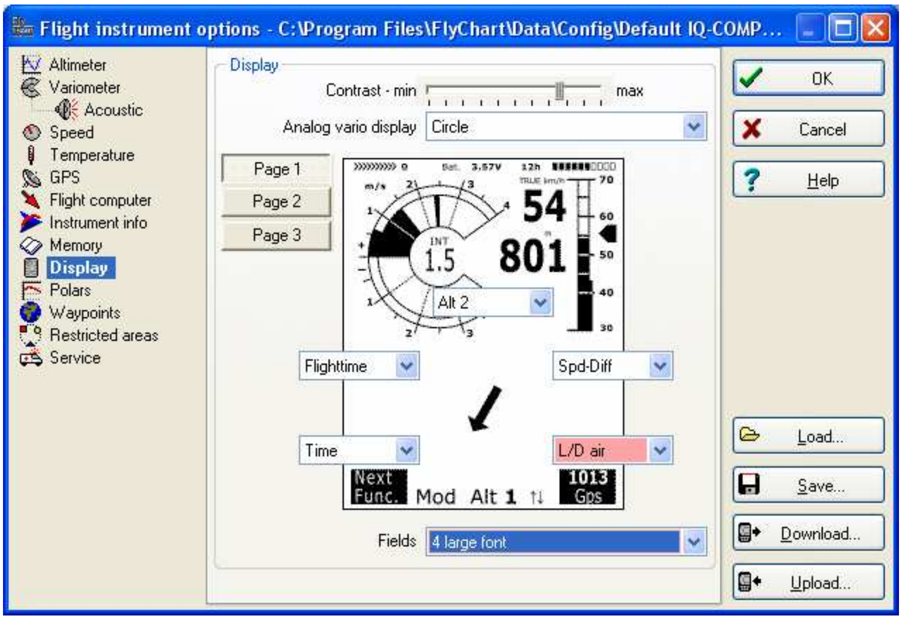



System settings
General
Units
Scales
Barogram
Altitude
automatic
Vario
automatic
Speed
automatic
Temperature
automatic
Time
automatic
Polare
Vario
automatic
Speed
automatic
Gliding ratio
automatic
OK
Cancel
Help
Apply


Flight instrument options - C:\Program Files\FlyChart\Data\Config\Default IQ-COMP...
Altimeter
Variometer
Acoustic
Speed
Temperature
GPS
Flight computer
Instrument info
Memory
Display
Polars
Waypoints
Restricted areas
Service
Speed
Unit
Kilometer per hour [km/h]
Display range
20..60 km/h
Mode
True airspeed (TAS)
Sensor compensation
Vane wheel sensor
100
%
Air pressure sensor
OFF
100
%
Stall alarm
Stallspeed (0=off)
0
km/h
Warn below
0
m
OK
Cancel
Help
Load...
Save...
Download...
Upload...


Flight instrument options - C:\Program Files\FlyChart\Data\Config\Default IQ-COMP...
Altimeter
Variometer
Acoustic
Speed
Temperature
GPS
Flight computer
Instrument info
Memory
Display
Polars
Waypoints
Restricted areas
Service
GPS
Coordinate system
dd°mm.mm' (WGS84)
Date, Time (UTC)
01.02.08
15:22:35
Time zone offset
1
h
16:22:35
OK
Cancel
Help
Load...
Save...
Download...
Upload...


Flight instrument options - C:\Pro...-Compeo Joop test.fc5
Altimeter
Variometer
Acoustic
Speed
Temperature
GPS
Flight computer
Instrument info
Memory
Display
Polars
Waypoints
Restricted areas
Service
Memory
Time interval
1
s
Recording capacity approx. 5 hours
Recording mode
automatic
OK
Cancel
Help
Load...
Save...
Download...
Upload...


Flight instrument options - C:\Program Files\FlyChart\Data\Config\Default IQ-COMP...
Altimeter
Variometer
Acoustic
Speed
Temperature
GPS
Flight computer
Instrument info
Memory
Display
Polars
Waypoints
Restricted areas
Service
Display
Contrast - min
max
Analog vario display
Circle
Page 1
Page 2
Page 3
Alt 2
Flighttime
Spd-Diff
Time
L/D air
Fields
4 large font
OK
Cancel
Help
Load...
Save...
Download...
Upload...

Appendix M Data retrieval

Start Laptop op.

SafeBoot Security System V4.2 vraagt om identificatie

Username: blok

Password: XXXX

Windows start op

Start Columbus

File | Raw-recorded data | Read card in recorder

Reconstruct card entry

Klik Read...

Save reconstructed entry as (vul geschikte filenaam in)

Save

Kaartlezen begint

check 'Action completed succesfully'

Klik OK

Sluit Columbus

Er is nu een *.vpd datafile aangemaakt welke door het Heart systeem kan worden ingelezen.

Eerst moet deze datafile nog geconverteerd en de data in een database geplaatst.

Start v2dbs

Add

Select the VitaPort data files “dePeel.vpd” | Open

Alleen het vinkje “Use the year of the datafile” mag zijn gezet.

Convert

Select a database (geef een passende naam) | Open

Hiermee is een *.dbs file aangemaakt die de database voor het data aquisitiesysteem vormt.

De dbs file moet in dezelfde directory staan als Heart.exe

Start Heart

Scherm met bet beschikbare databases worden getoond

Klik de gewenste database “DEPEEL.DBS” aan met een muis of via pijltoetsen en Enter toets.
Klik de gewenste configuratiefile “PLOT2.HCF” aan welke de weergave op het scherm bepaald.
Hak de totale run op in deelstukjes met TOOLS -> Add Period en aanwijzen in plotweergave. Wijs periodes aan van 15 min. zodat de hoeveelheid data telkens gelijk is en alle runs er volledig invallen.
Exporteer de geselecteerde data naar ASCII format met FILE -> EXPORT -> EXPORT TO SAMPLED DATAFILE
Selecteer GLEFT, GRIGHT, HR_[HR1], HR_ANALOG, PA, RESP1.
Selecteer alle periodes
Geef de sample rate aan en activeer “EXPORT”.
Er zijn nu leesbare ASCII files met de naam HRT___[runno.].DAT files aangemaakt.

Appendix N Vitaport Settings

Channel settings: UNI-module: Channel 01

General:	Name:	Resp1
	Data format:	WORD
	State:	On
	Sampling rate:	16.000 Hz
	Storage rate:	16.000 Hz
Preprocess:	Mode:	No preprocessing
	No parameter	
Filters:	Lowpass (Frequency):	4.8 Hz
	Highpass (Time constant):	D.C.
	Nulling of DC-signal:	Normal nulling
Range:	Display unit:	adc
	Amplification:	50.0
	Full scale:	49.965mV
	Max./ Min.:	4095.0 adc / 0.0000 adc
	Full scale / Offset:	4095.0 adc / 0.0000 adc
Scaling:	Vertical scaling:	Automatic
	MUL-factor:	1
	DIV-factor:	1
	Offset (in adc):	0
Excitation:	Excitation:	On
	Voltage:	4.2 Volt
	Current:	1.5 mA

Channel settings: UNI-module: Channel 02

General:	Name:	Gleft
	Data format:	WORD
	State:	On
	Sampling rate:	32.000 Hz
	Storage rate:	32.000 Hz
Preprocess:	Mode:	No preprocessing
	No parameter	

Filters:	Lowpass (Frequency):	16.6 Hz
	Highpass (Time constant):	D.C.
	Nulling of DC-signal:	Normal nulling
Range:	Display unit:	mG
	Sensitivity:	0.0000 V/mG
	Amplification:	20.0
	Full scale:	125.00mV
	Max./ Min.:	4590.1 mG / -510.70 mG
	Full scale / Offset:	5100.8 mG / 510.70 mG
Scaling:	Vertical scaling:	Manual set
	MUL-factor:	71
	DIV-factor:	57
	Offset (in adc):	410
Excitation:	Excitation:	On
	Voltage:	4.2 Volt
	Current:	1.5 mA

Channel settings: UNI-module: Channel 03

General:	Name:	HR1
	Data format:	WORD
	State:	On
	Sampling rate:	256.00 Hz
	Storage rate:	256.00 Hz
Preprocess:	Mode:	No preprocessing
	No parameter	
Filters:	Lowpass (Frequency):	127.8 Hz
	Highpass (Time constant):	D.C.
	Nulling of DC-signal:	Adjust DC-offset
Range:	Display unit:	mV
	Amplification:	250.1
	Full scale:	9.9958mV
	Max./ Min.:	9.9963 mV / 0.0000 mV
	Full scale / Offset:	9.9963 mV / 0.0000 mV
Scaling:	Vertical scaling:	Automatic
	MUL-factor:	20
	DIV-factor:	8193

	Offset (in adc):	0
Excitation:	Excitation:	Off
	Voltage:	4.2 Volt
	Current:	1.5 mA

Channel settings: UNI-module: Channel 04

General:	Name:	PA
	Data format:	WORD
	State:	On
	Sampling rate:	32.000 Hz
	Storage rate:	32.000 Hz
Preprocess:	Mode:	No preprocessing
	No parameter	
Filters:	Lowpass (Frequency):	16.0 Hz
	Highpass (Time constant):	D.C.
	Nulling of DC-signal:	Normal nulling
Range:	Display unit:	mV
	Amplification:	100.0
	Full scale:	24.991mV
	Max./ Min.:	4095.0 mV / 0.0000 mV
	Full scale / Offset:	4095.0 mV / 0.0000 mV
Scaling:	Vertical scaling:	Manual set
	MUL-factor:	1
	DIV-factor:	1
	Offset (in adc):	0
Excitation:	Excitation:	On
	Voltage:	4.2 Volt
	Current:	1.5 mA

Channel settings: UNI-module: Channel 05

General:	Name:	Gright
	Data format:	WORD
	State:	On
	Sampling rate:	32.000 Hz
	Storage rate:	32.000 Hz

Preprocess:	Mode:	No preprocessing
	No parameter	
Filters:	Lowpass (Frequency):	16.0 Hz
	Highpass (Time constant):	D.C.
	Nulling of DC-signal:	Normal nulling
Range:	Display unit:	mg
	Sensitivity:	0.0000 V/mg
	Amplification:	21.0
	Full scale:	119.03mV
	Max./ Min.:	4485.4 mg / -830.88 mg
	Full scale / Offset:	5316.3 mg / 830.88 mg
Scaling:	Vertical scaling:	Manual set
	MUL-factor:	74
	DIV-factor:	57
	Offset (in adc):	640
Excitation:	Excitation:	On
	Voltage:	4.2 Volt
	Current:	1.5 mA

Appendix O Graphical representation

Testmatrix	**Piloot**	**Scherm**	**Gewichtsklasse**
	Pilot 1	Bright 26	Low
	Pilot 2	Golden 26	Medium
	Pilot 3	Aspen 26	High

	N		**E**		**Alt**	**Alt**
	deg	**min**	**deg**	**min**	**ft**	**m**
De Peel ref pos	51	30.8	5	50.3	88	26.8
	51.5133					

	N		**E**		**N**	**E**
	deg	**min**	**deg**	**min**	**m**	**m**
Start Position	51	30.8	5	50.45	0.00	172.88
Winch Position	51	31.4	5	52.2	1111.20	2189.86

Distance	2302.82	m
Direction	61.1	deg

Run	**pilot**	**glider**	**T/O weight**	**weight**	**start time**	**start A**	**start B**	**start C**
			[kg]					
1	1	Bright 26	78.5	Low	12:25:44	12:30:18	12:31:25	
2	1	Bright 26	78.5	Low	12:50:35	12:55:08	12:56:57	
3	2	Bright 26	92.0	High	13:26:03	13:30:20	13:31:06	13:32:11
4	2	Golden 26	92.1	Medium	13:47:51	13:52:11	13:53:10	

5	2	Aspen 26	91.7	Medium	14:05:46	14:09:45	14:10:42	
6	2	Aspen 26	91.7	Medium	14:20:30	14:24:55		
7	3	Aspen 26	100.0	High	14:52:20	14:56:22	14:57:29	14:58:09
8	3	Golden 26	100.0	High	15:14:49			
9	3	Golden 26	100.0	High	15:29:46	15:33:55	15:34:53	15:35:41
10	1	Aspen 26	82.7	Low	16:07:34	16:11:55	16:13:11	16:14:43
11	1	Bright 26	85.0	Medium	16:43:53			

Vitaport time offset	0:00:31
Vitaport Alt offset	40.0

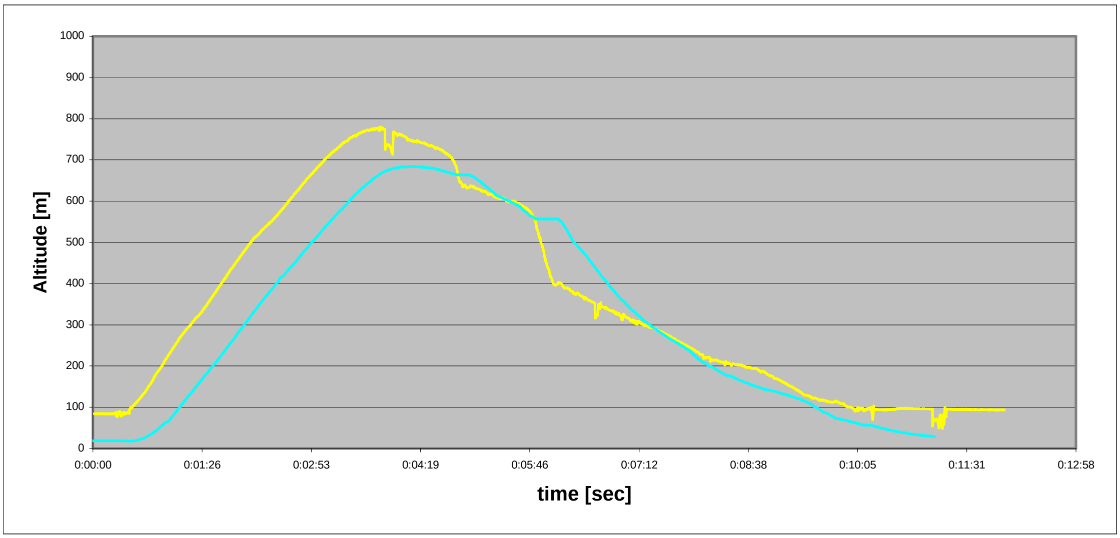
Run 1

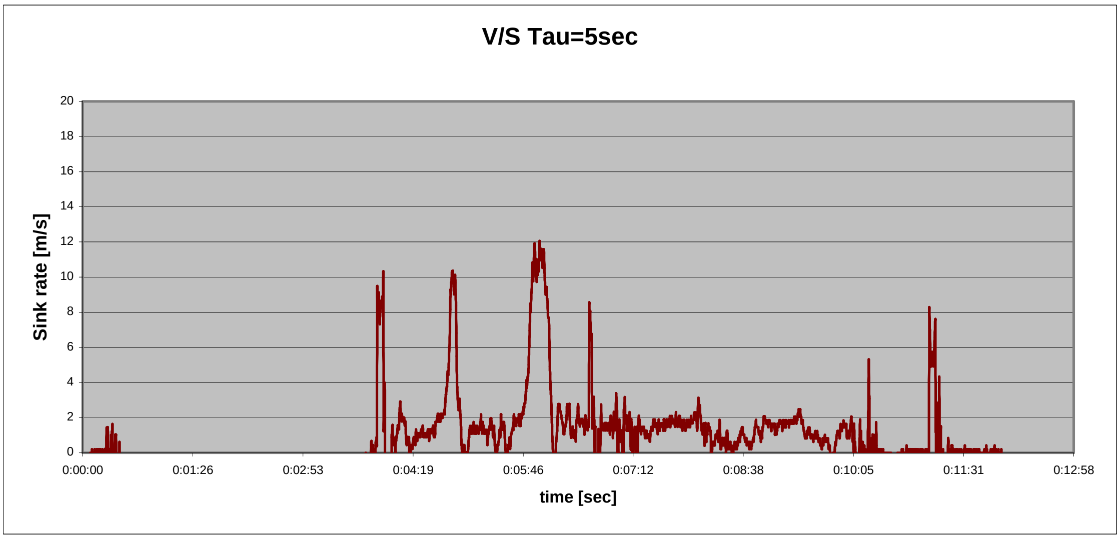
Pilot 1

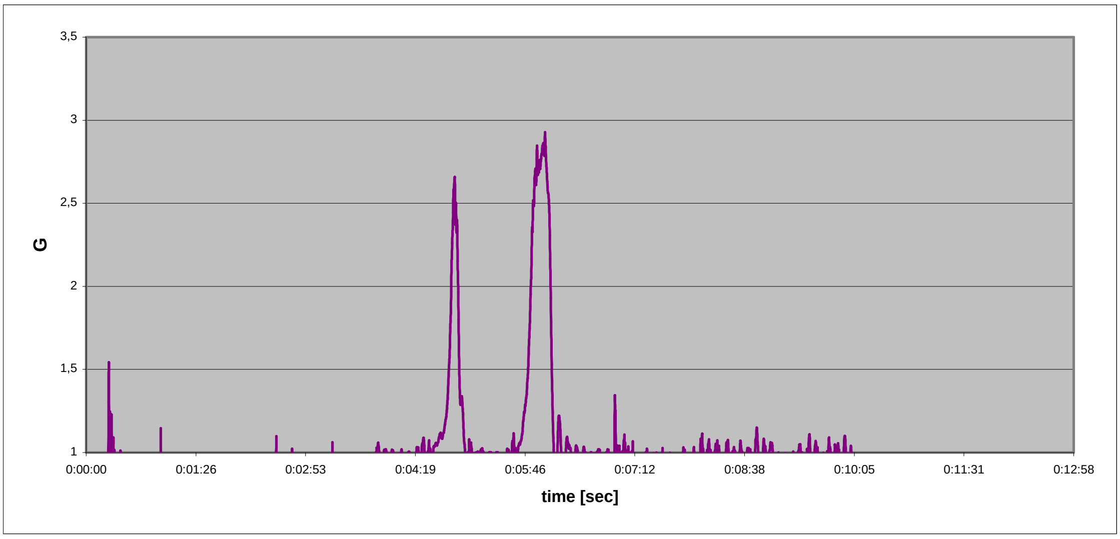
Wing LTF 1

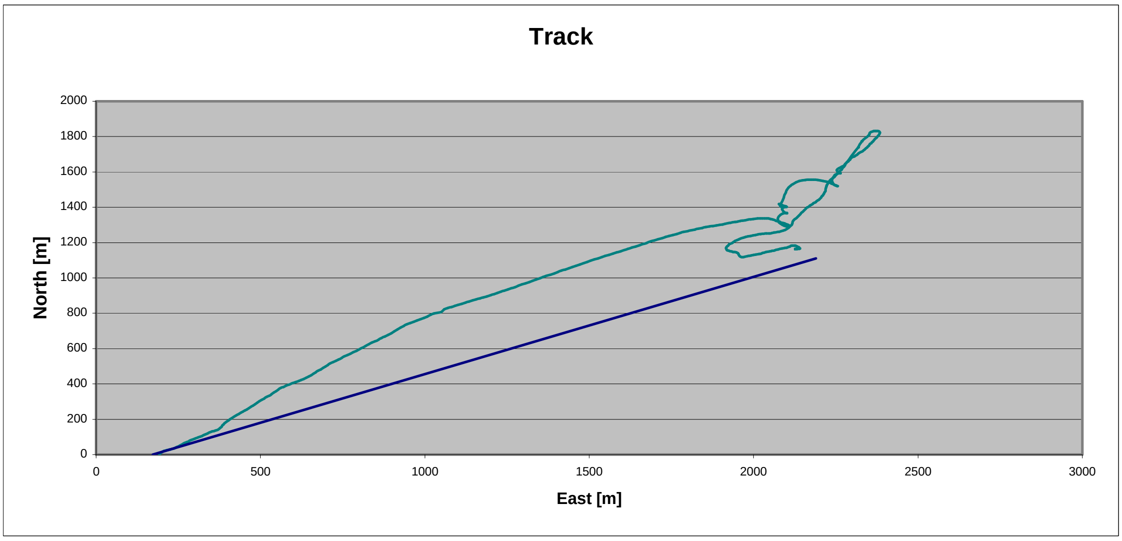
Weight Low

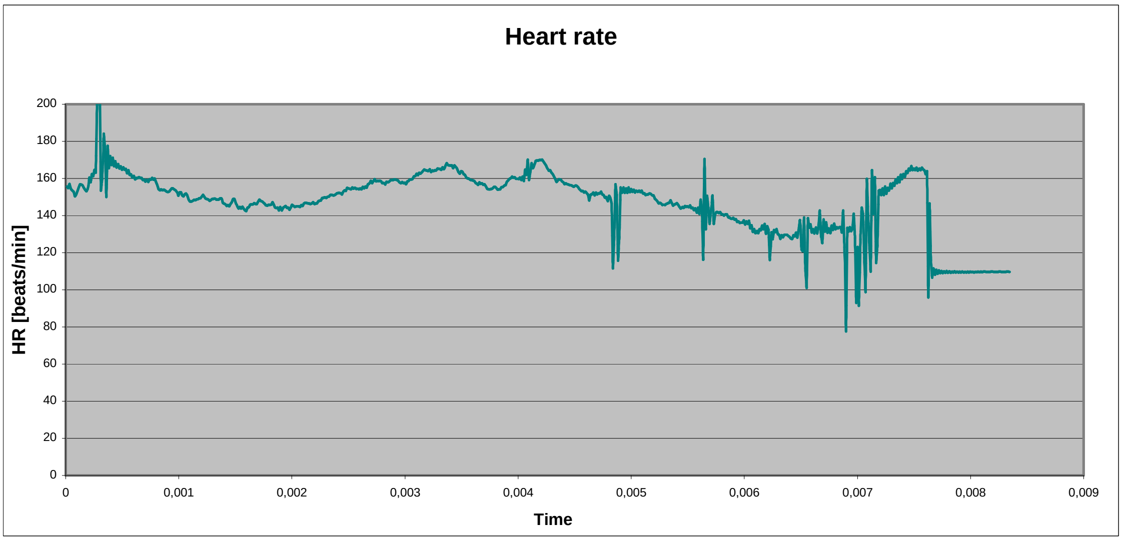
(no speed data)






3,5
3
2,5
2
1,5
1
G
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
0:12:58
time [sec]


Track
2000
1800
1600
1400
1200
1000
800
600
400
200
0
North [m]
0
500
1000
1500
2000
2500
3000
East [m]


Heart rate
200
180
160
140
120
100
80
60
40
20
0
HR [beats/min]
0
0,001
0,002
0,003
0,004
0,005
0,006
0,007
0,008
0,009
Time

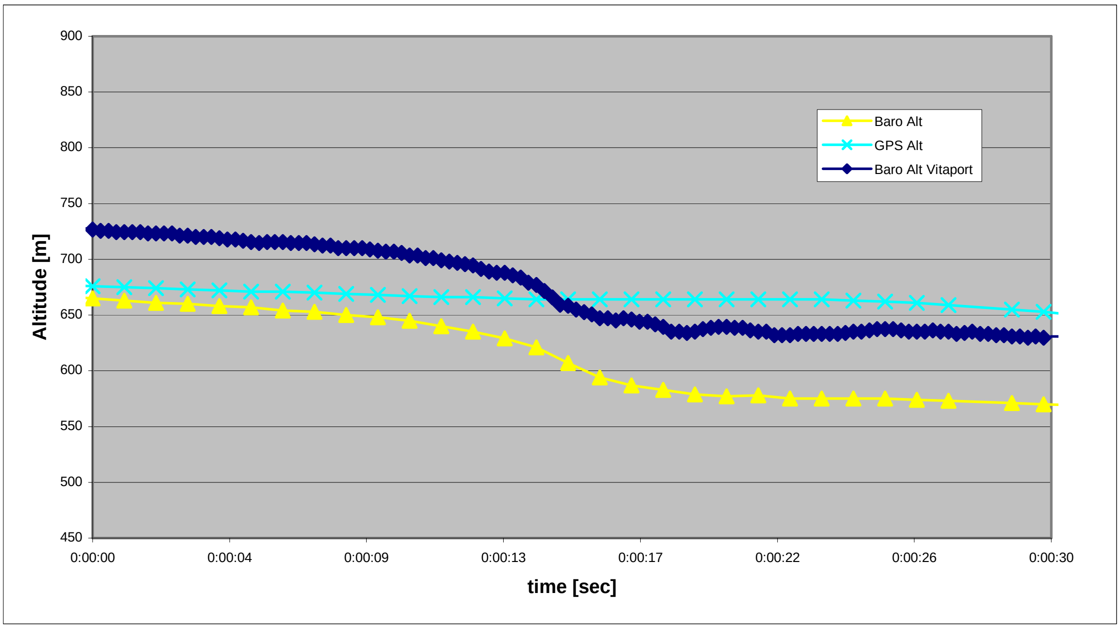
Run 1A

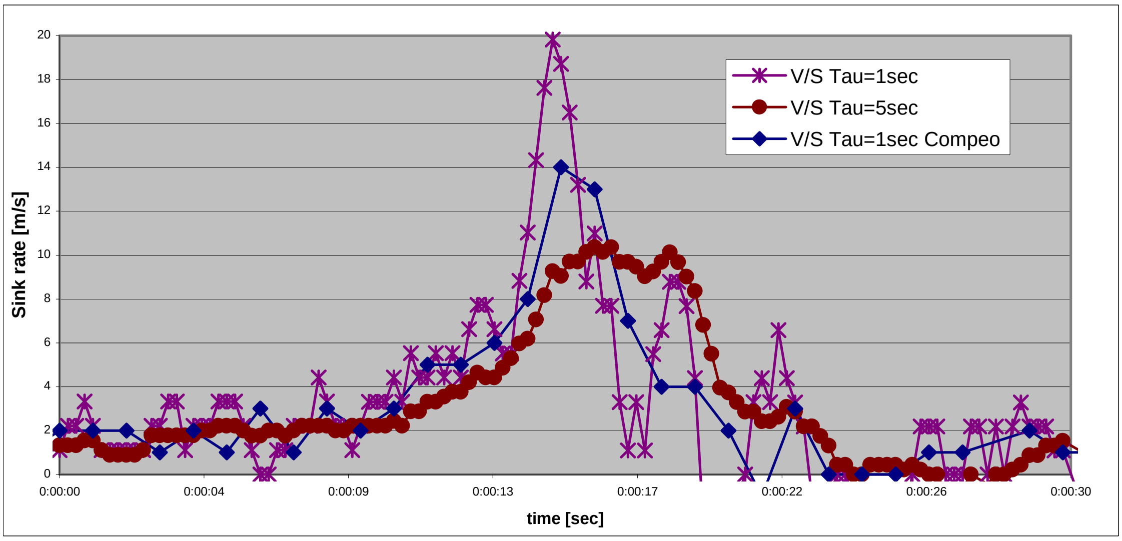
Pilot 1

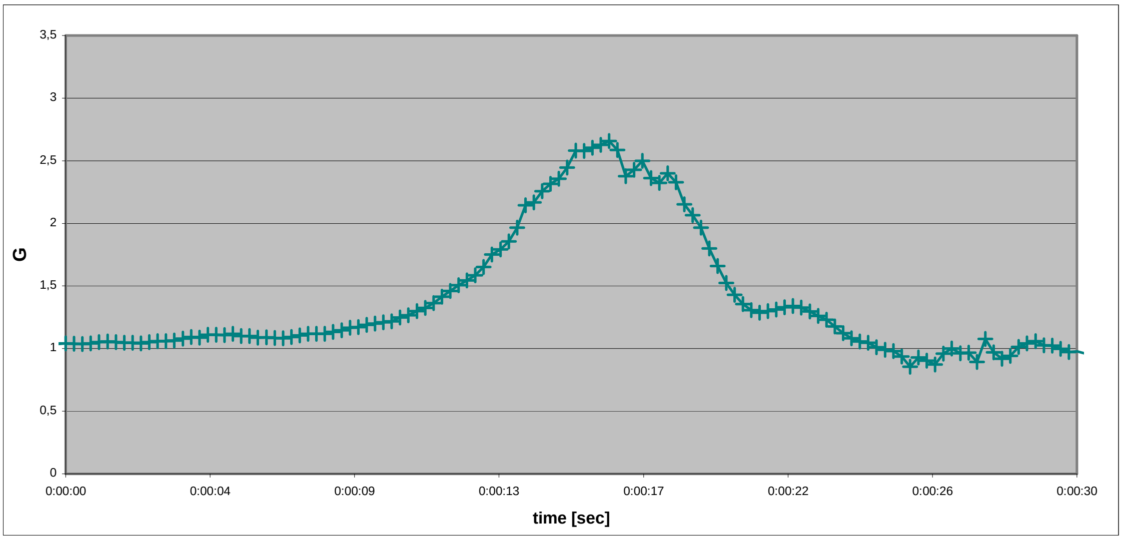
Wing LTF 1

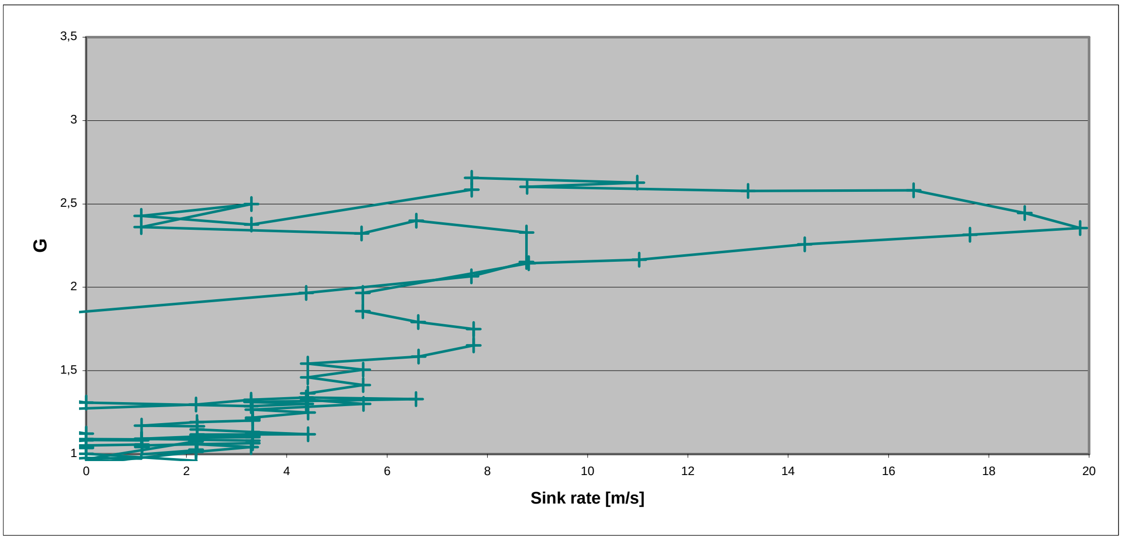
Weight Low

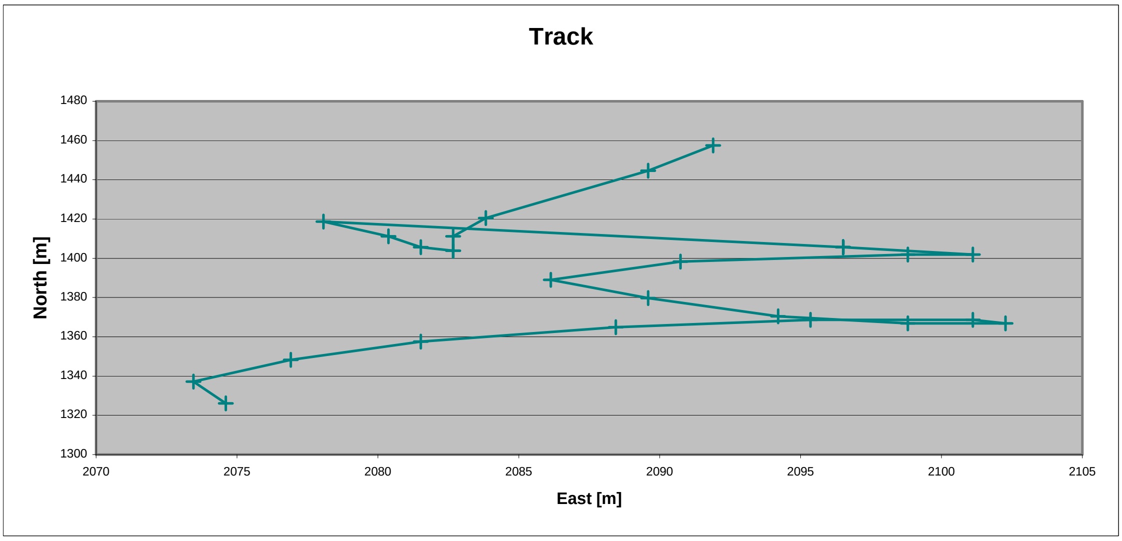
(no speed data)






G
time [sec]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
3,5
3
2,5
2
1,5
1
0,5
0


G
Sink rate [m/s]
3,5
3
2,5
2
1,5
1
0
2
4
6
8
10
12
14
16
18
20


Track
North [m]
East [m]
1480
1460
1440
1420
1400
1380
1360
1340
1320
1300
2070
2075
2080
2085
2090
2095
2100
2105

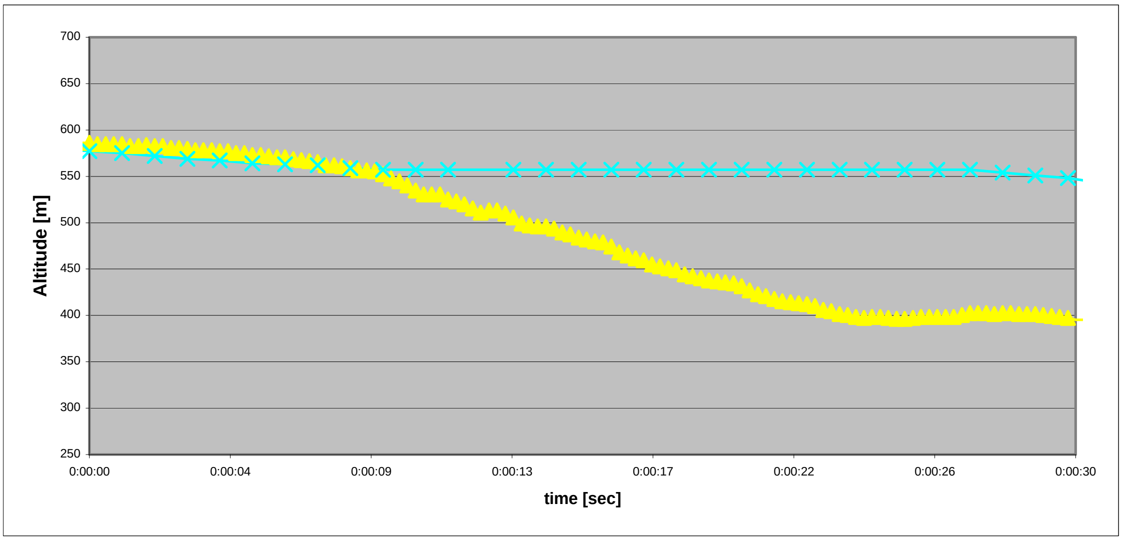
Run 1B

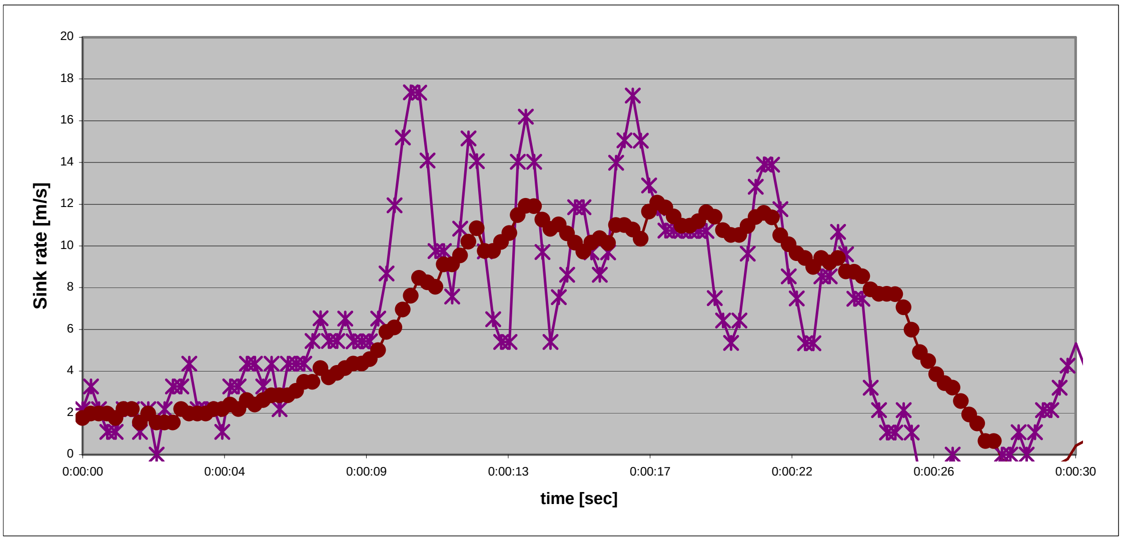
Pilot 1

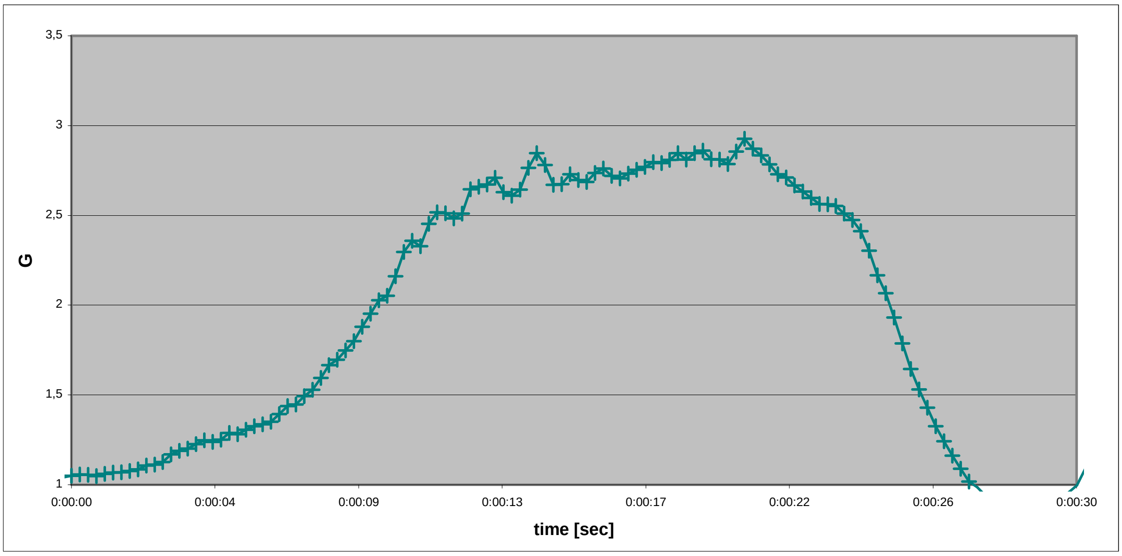
Wing LTF 1

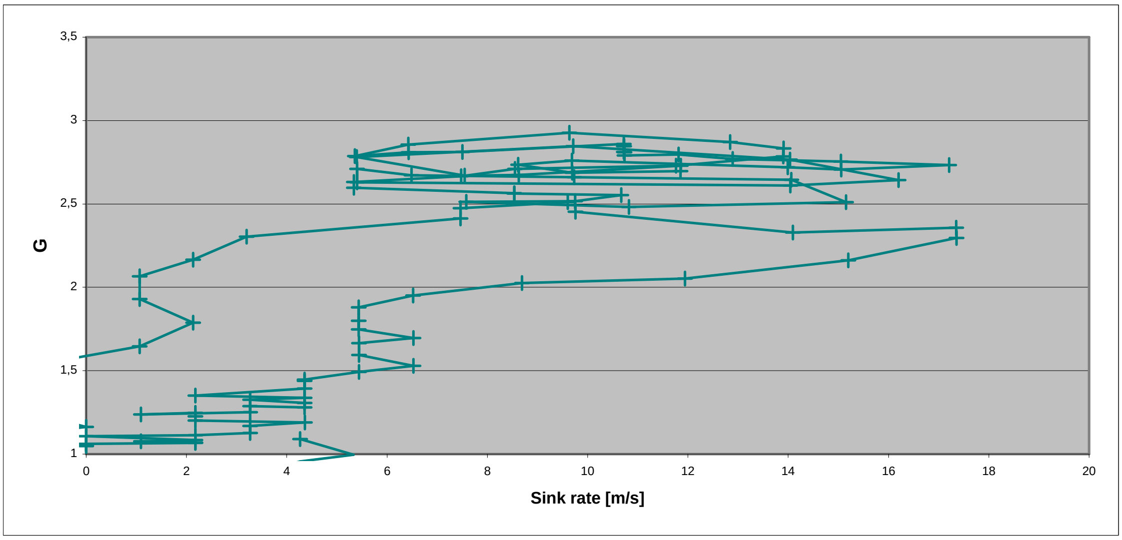
Weight Low

(no speed data)






3,5
3
2,5
2
1,5
1
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

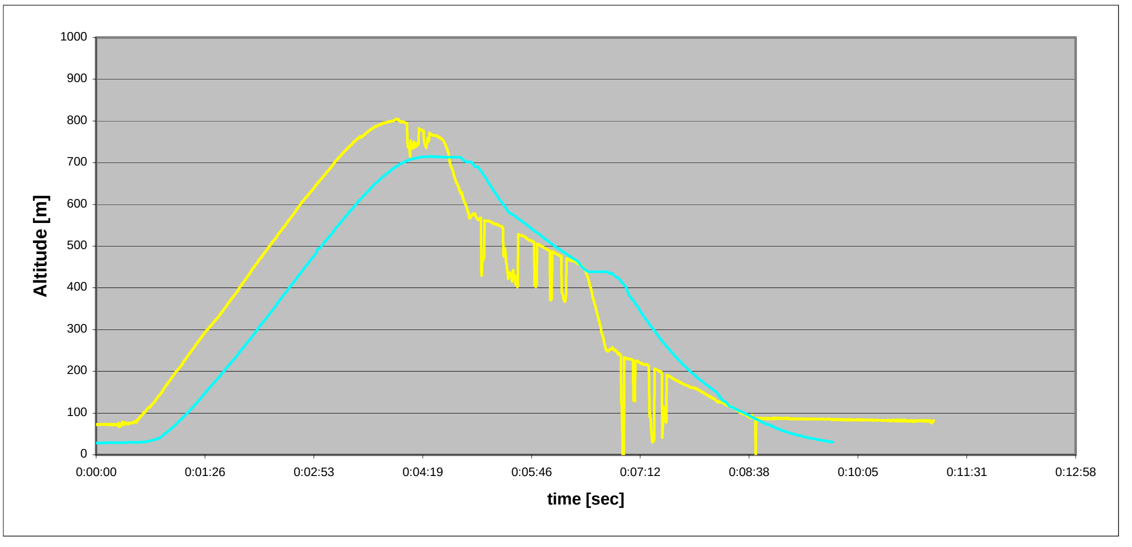

3,5
3
2,5
2
1,5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

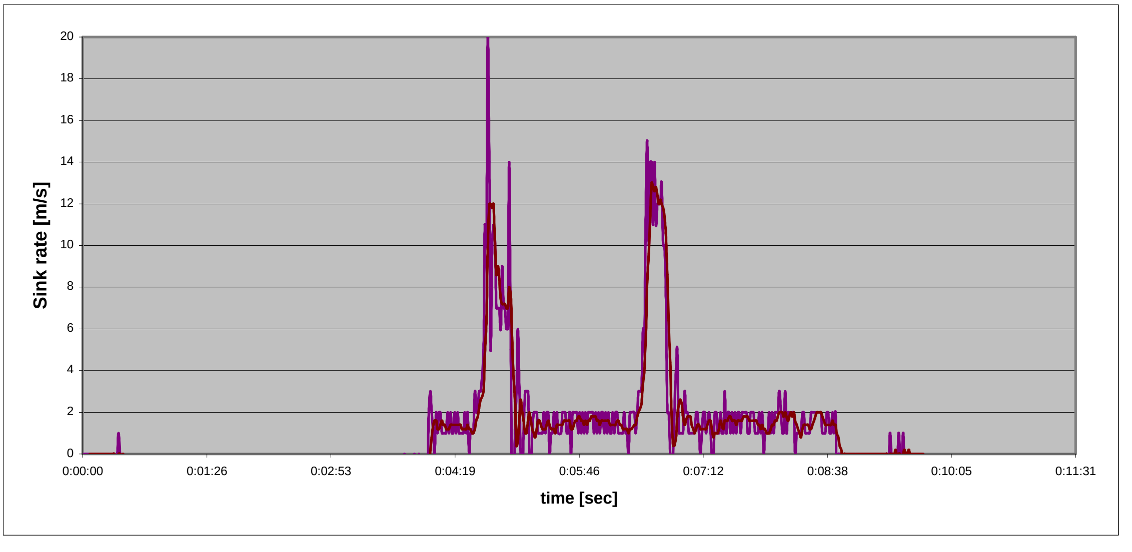
Run 2

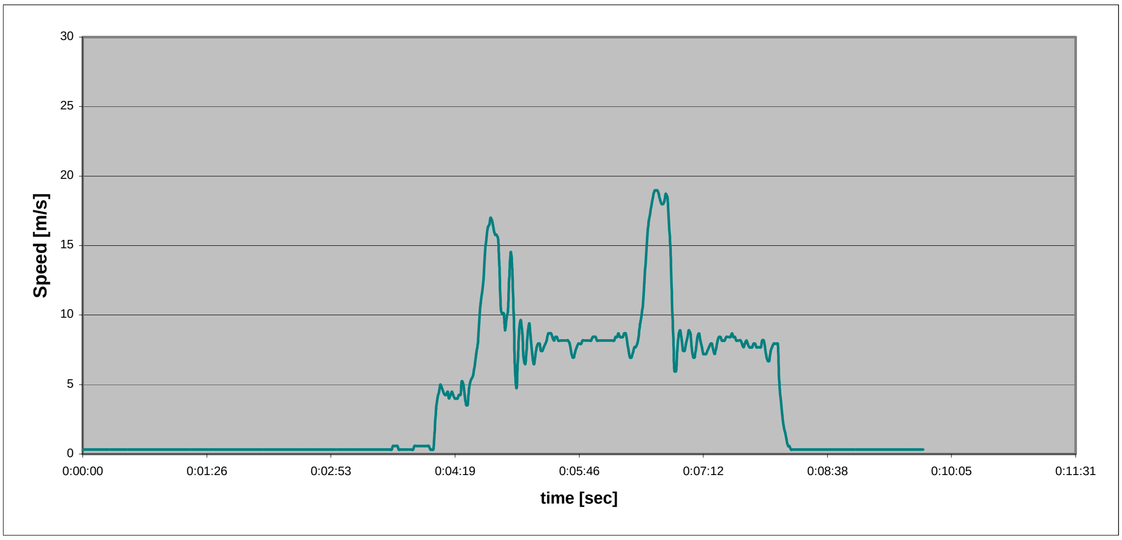
Pilot 1

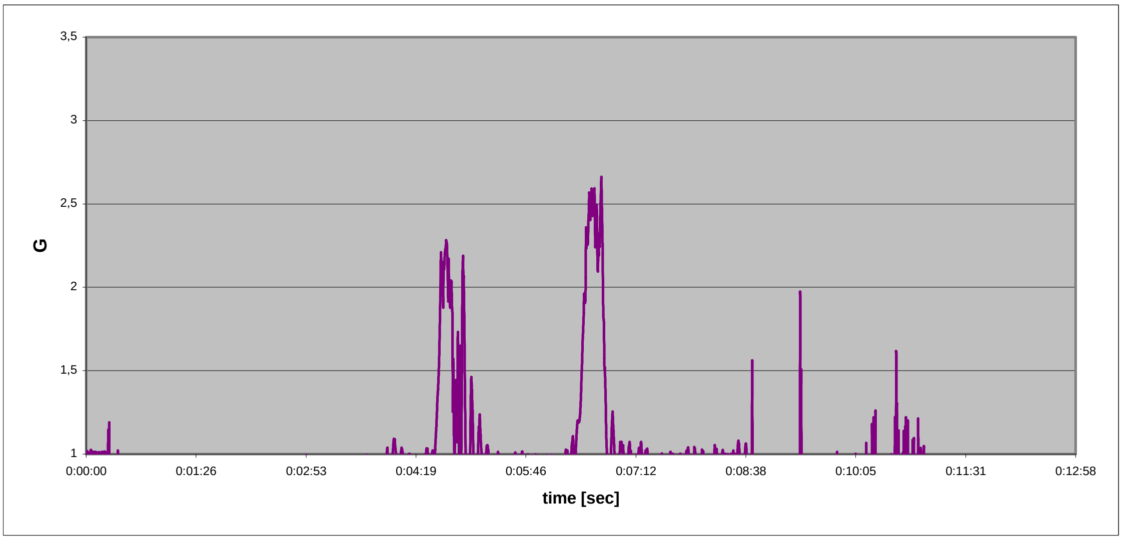
Wing LTF 1

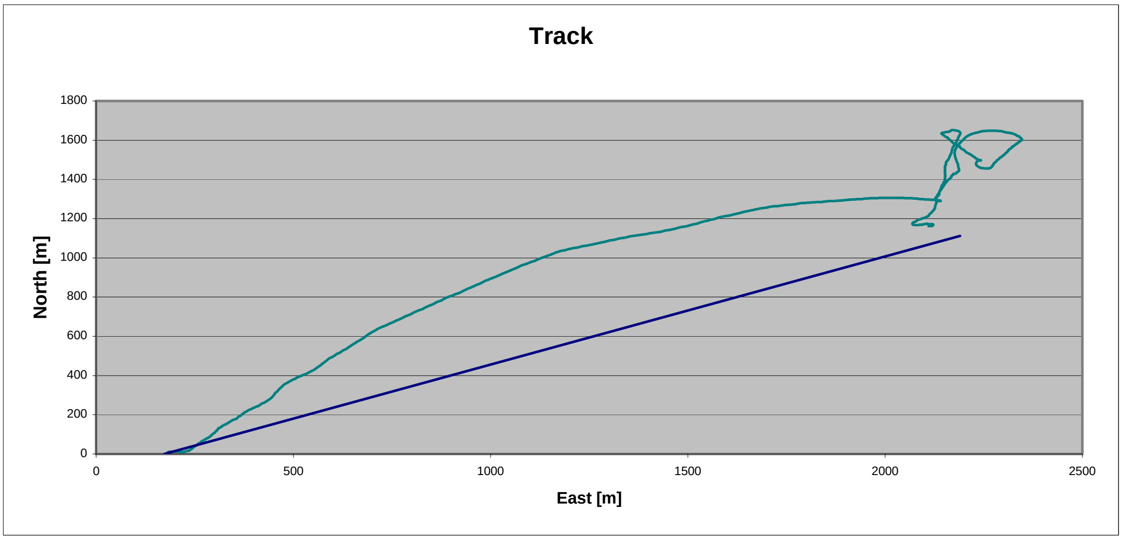
Weight Low






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
time [sec]


3,5
3
2,5
2
1,5
1
G
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
0:12:58
time [sec]

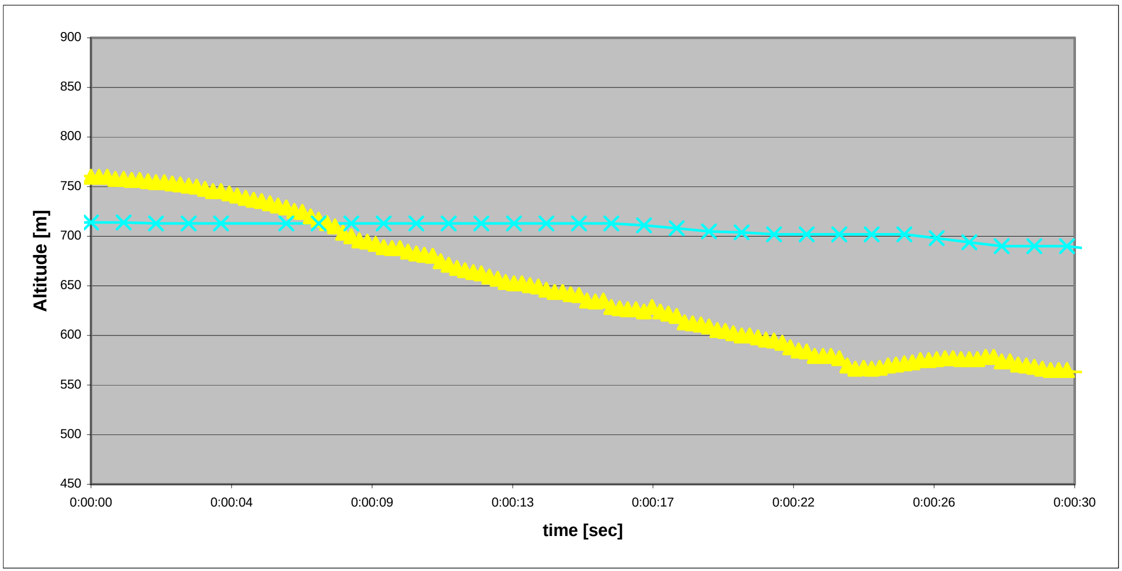

Track
1800
1600
1400
1200
1000
800
600
400
200
0
North [m]
0
500
1000
1500
2000
2500
East [m]

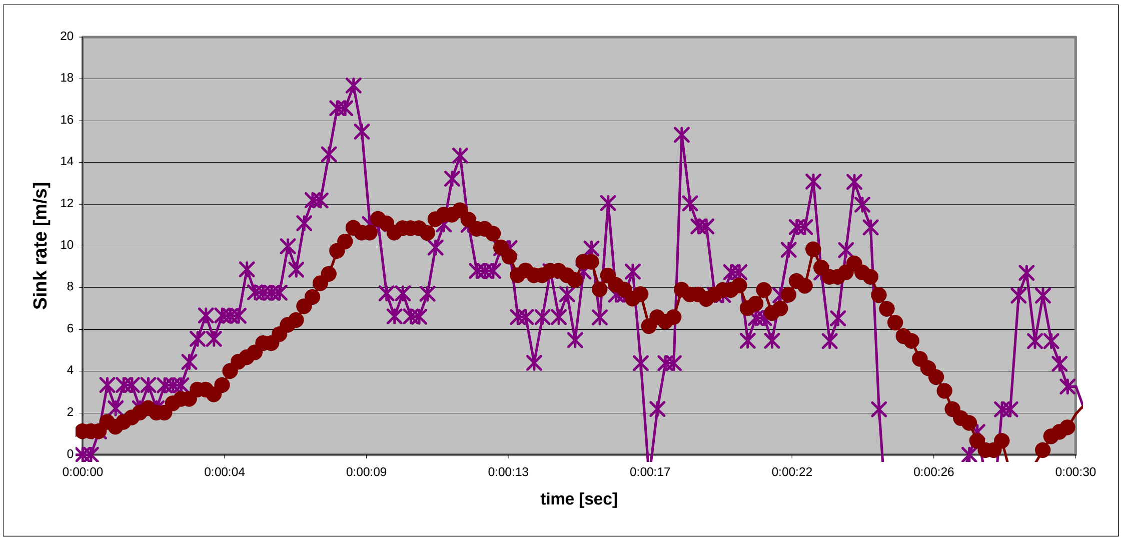
Run 2A

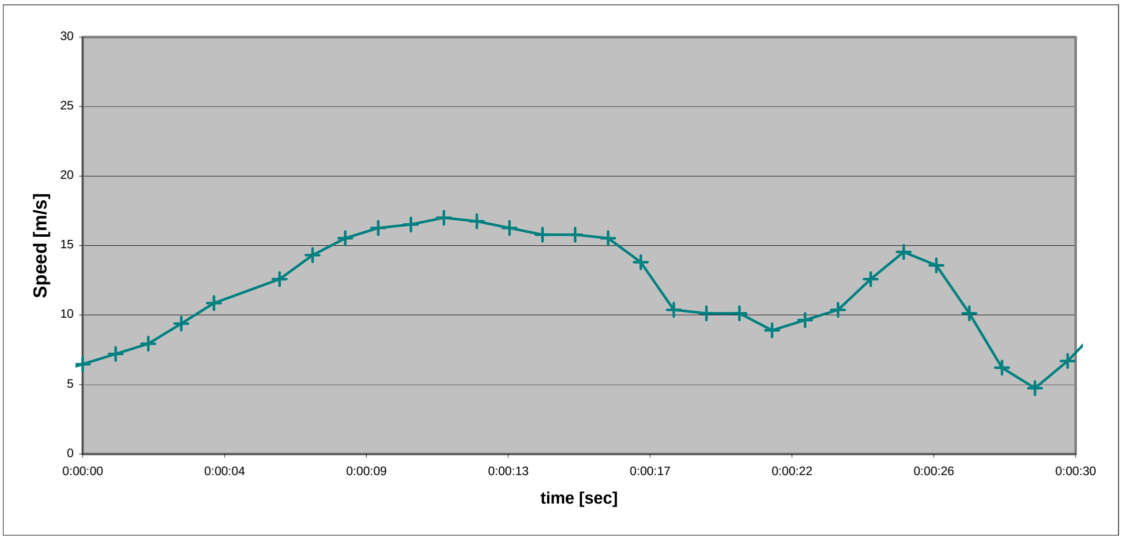
Pilot 1

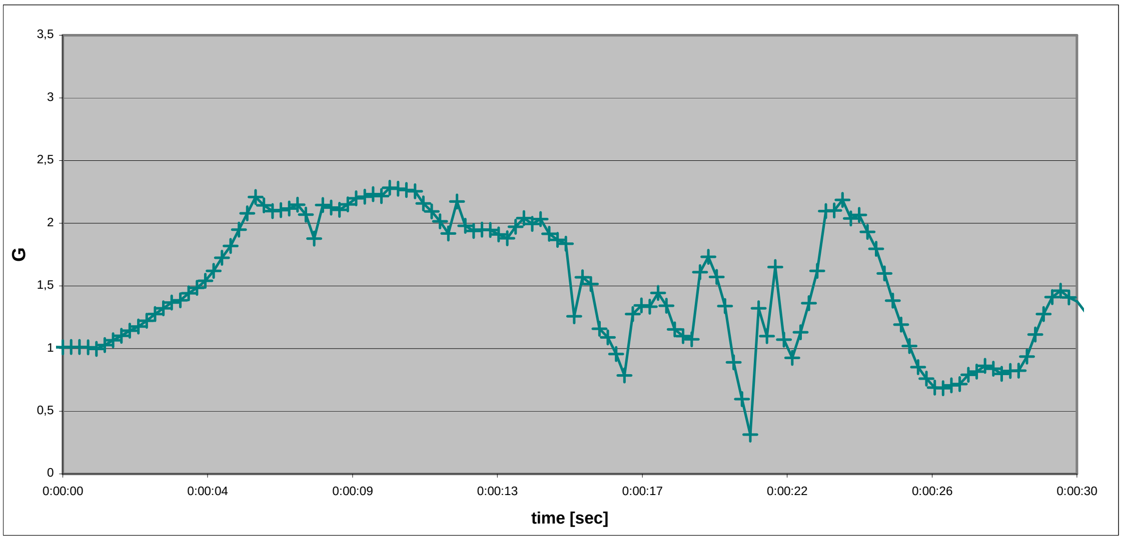
Wing LTF 1

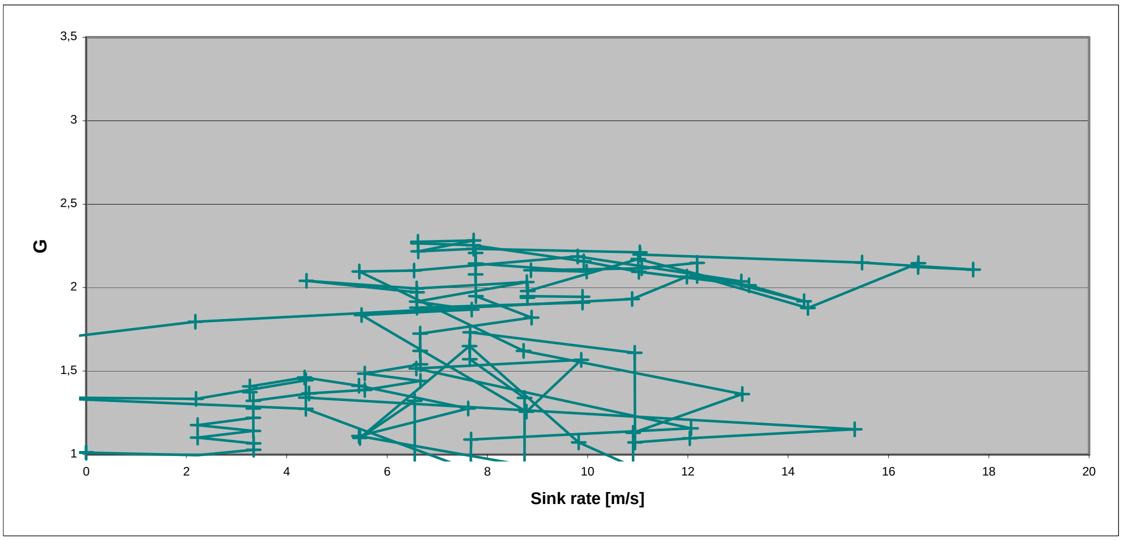
Weight Low






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


G
3,5
3
2,5
2
1,5
1
0,5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

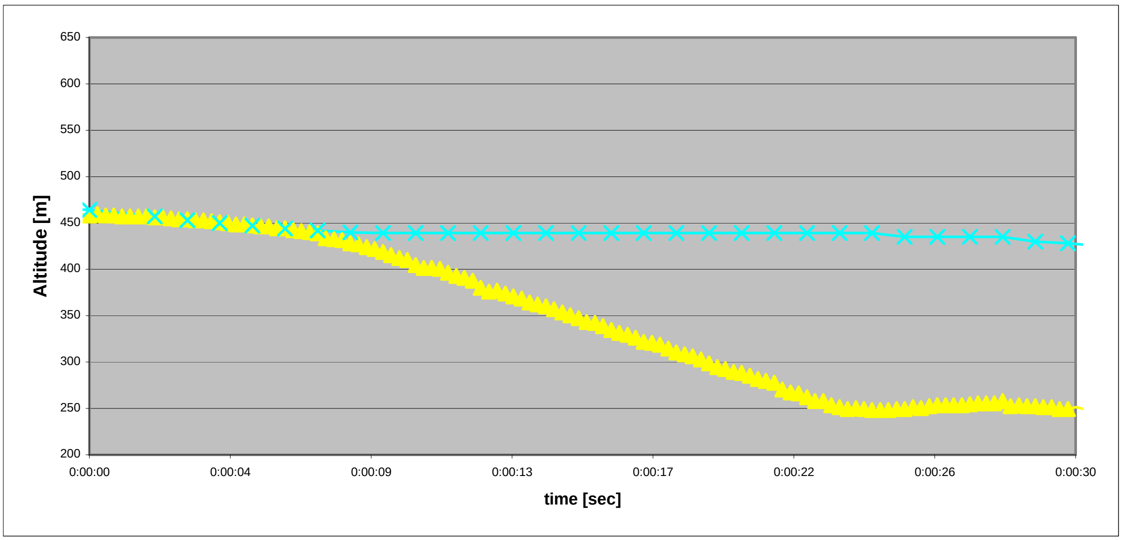

G
3,5
3
2,5
2
1,5
1
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

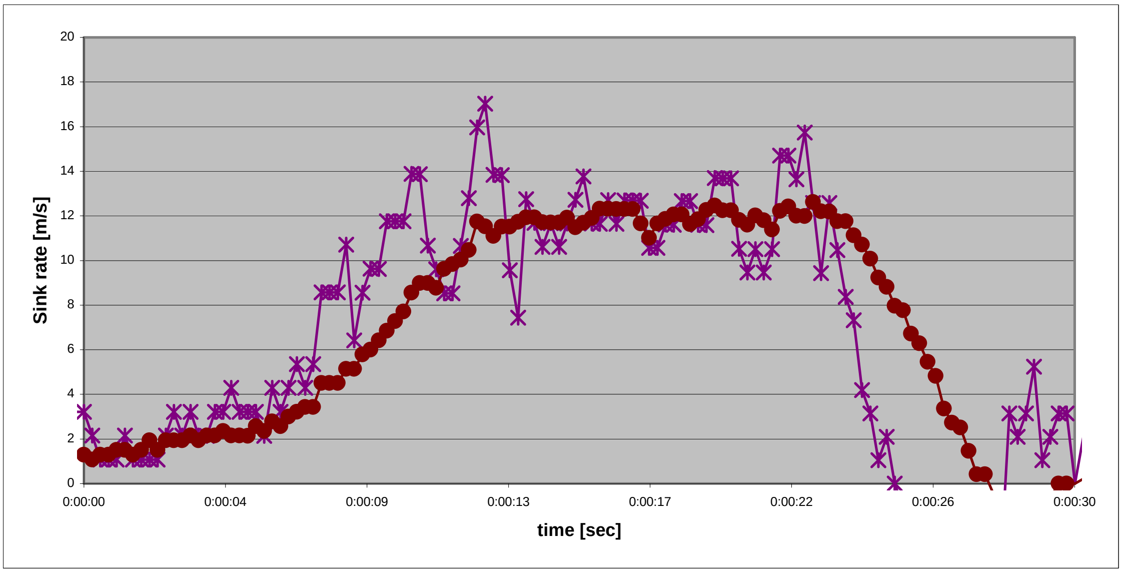
Run 2B

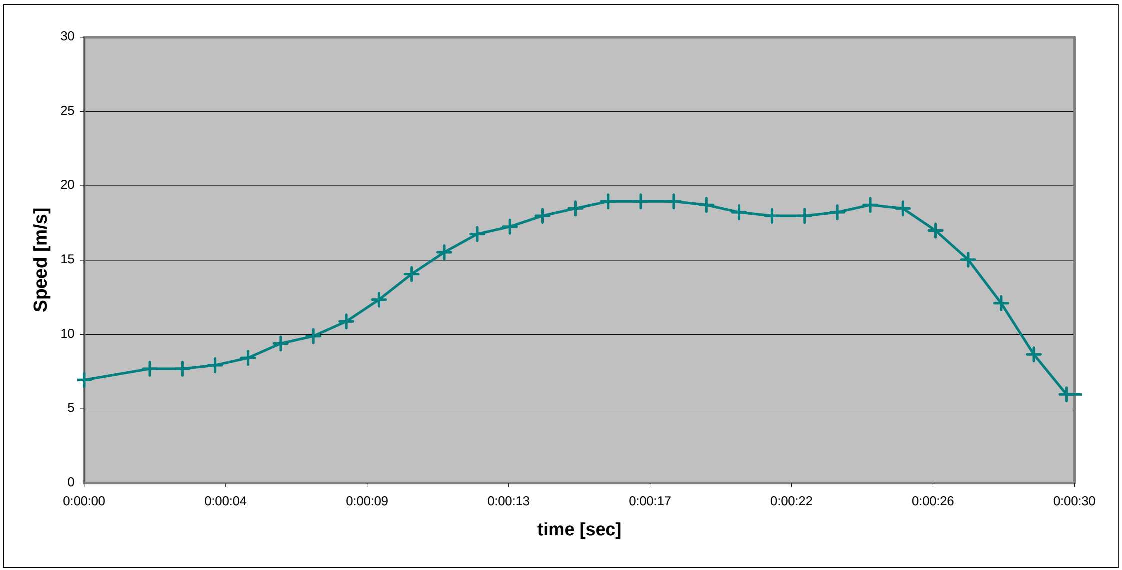
Pilot 1

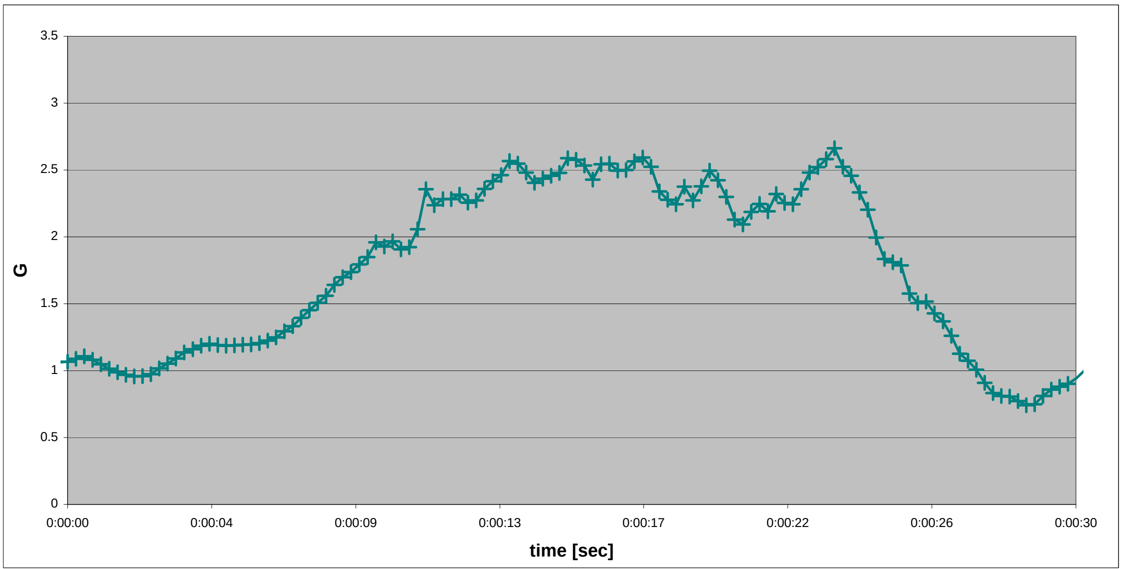
Wing LTF 1

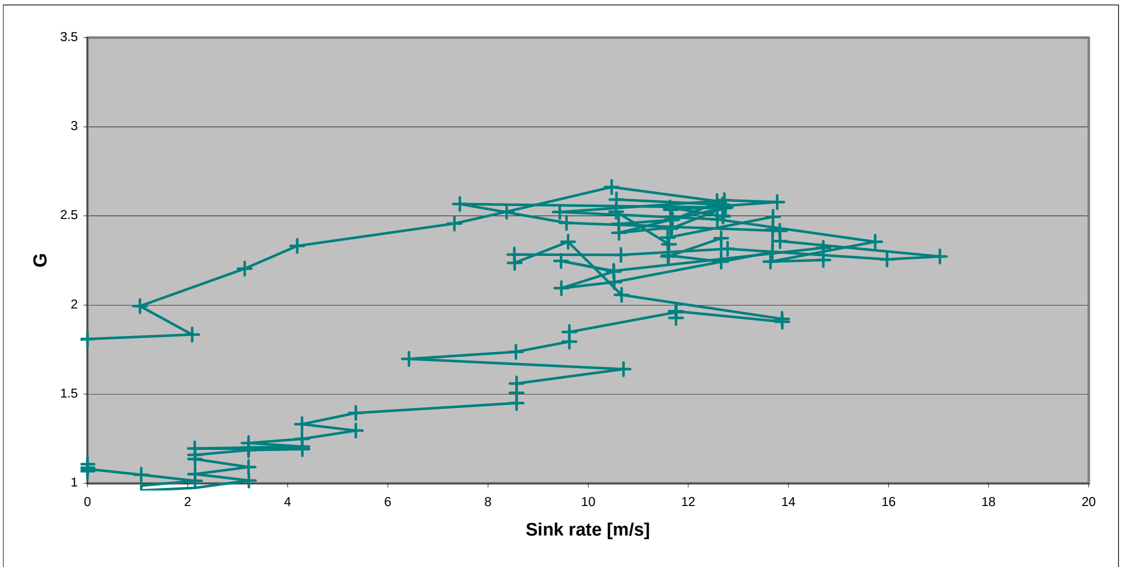
Weight Low






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

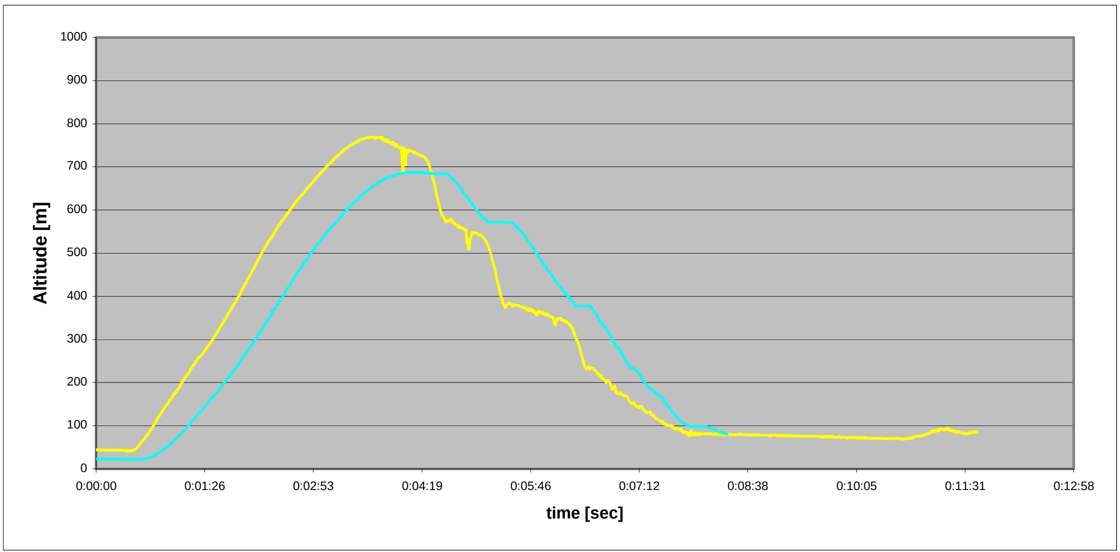

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

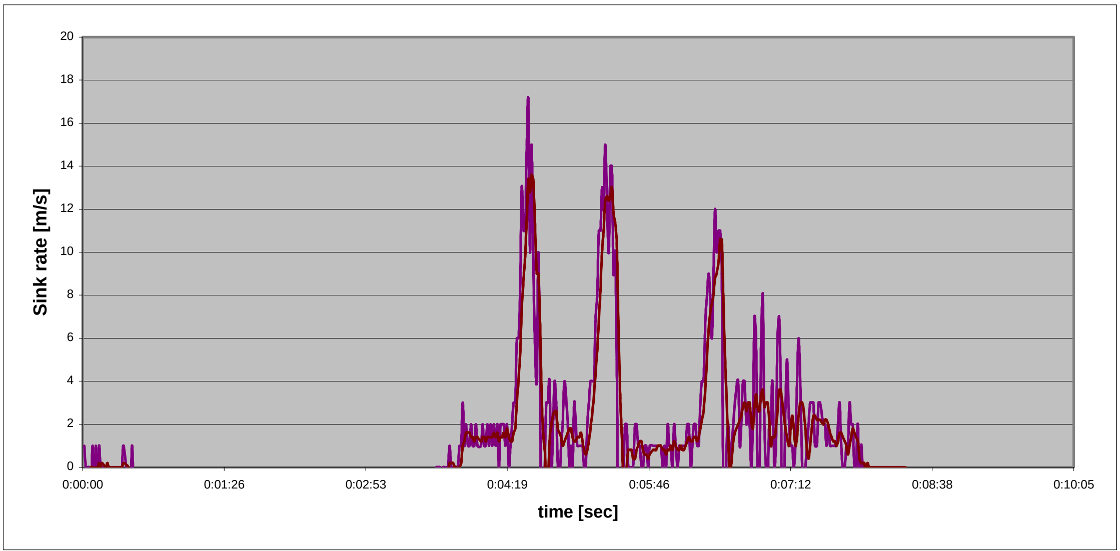
Run 3

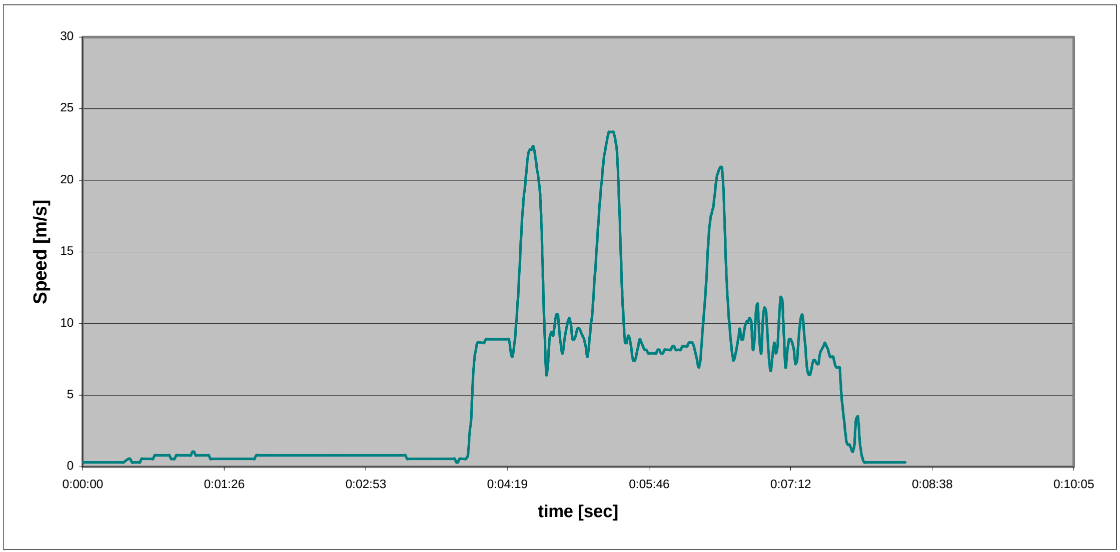
Pilot 2

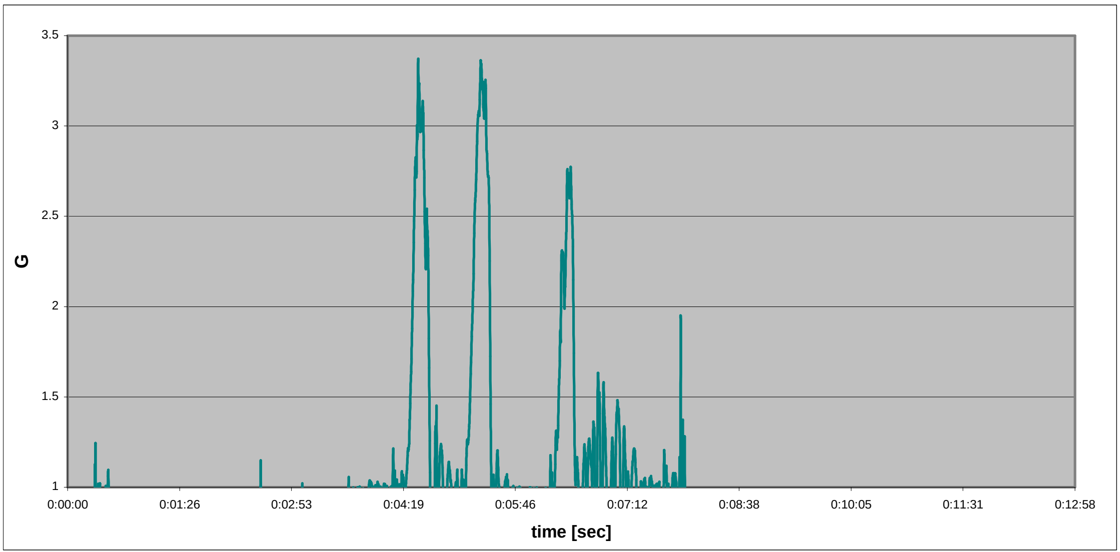
Wing LTF 1

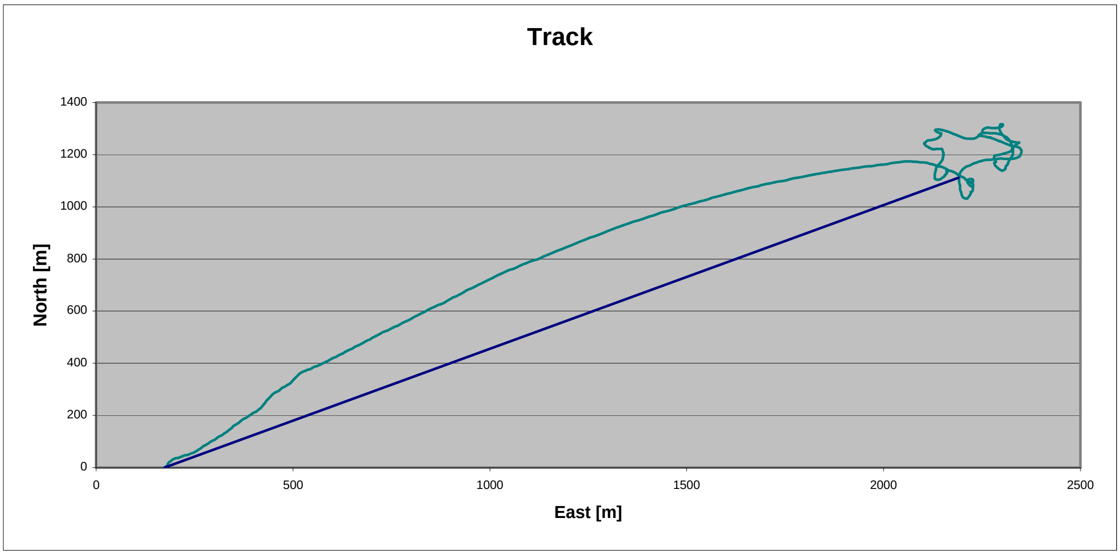
Weight Low






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
time [sec]


3.5
3
2.5
2
1.5
1
G
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
0:12:58
time [sec]

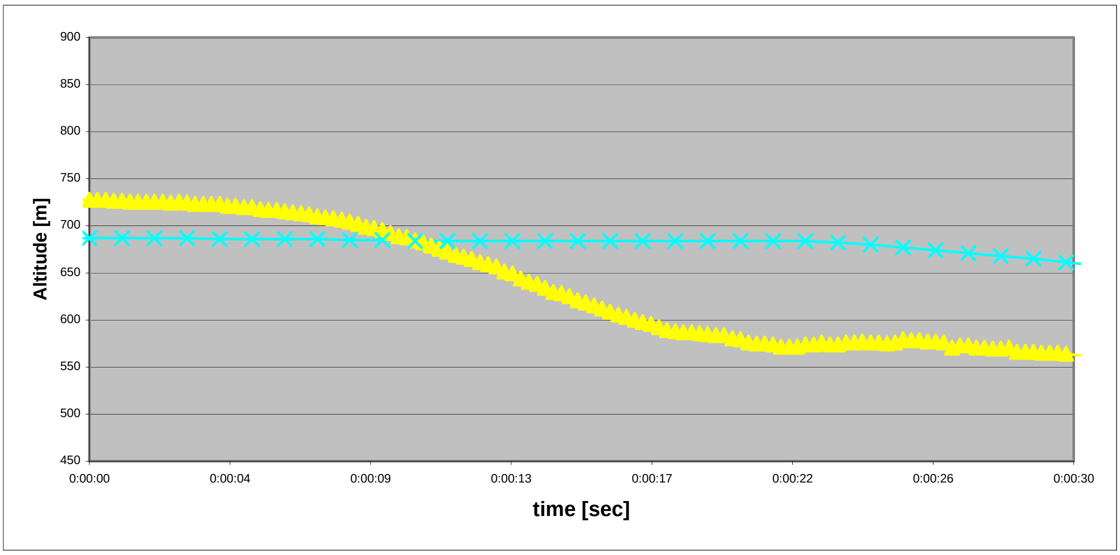

Track
1400
1200
1000
800
600
400
200
0
North [m]
0
500
1000
1500
2000
2500
East [m]

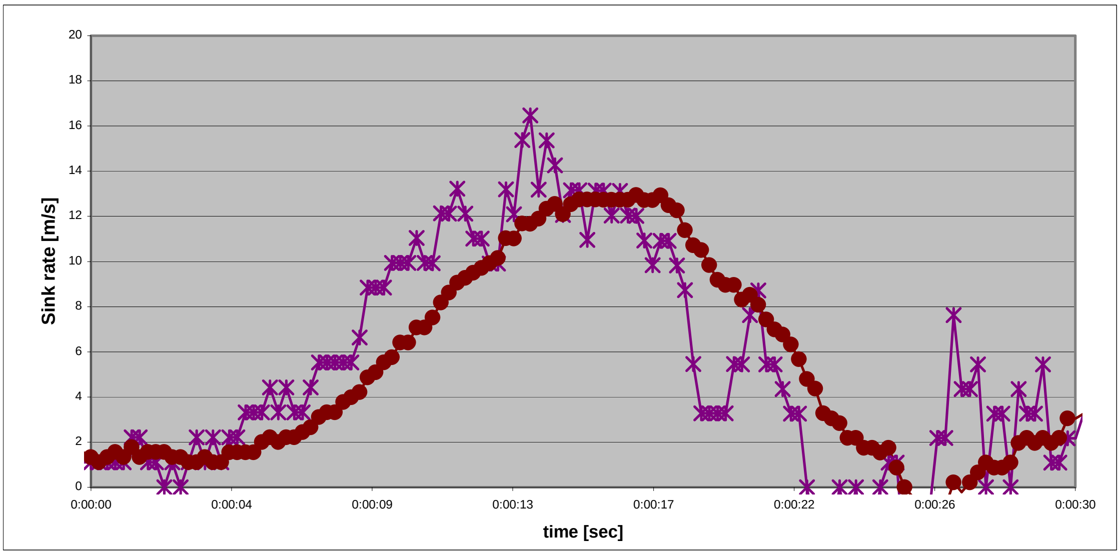
Run 3A

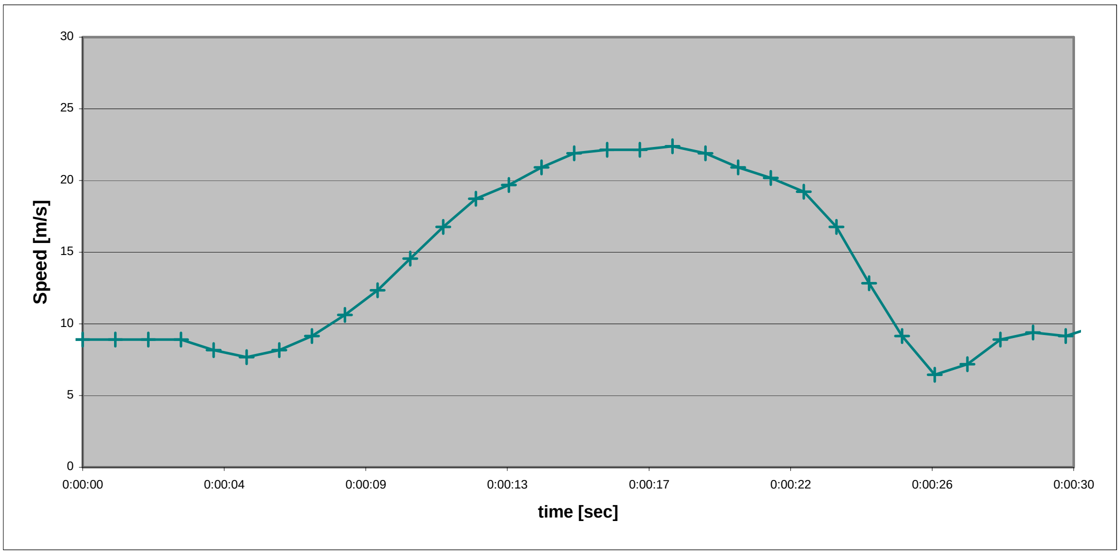
Pilot 2

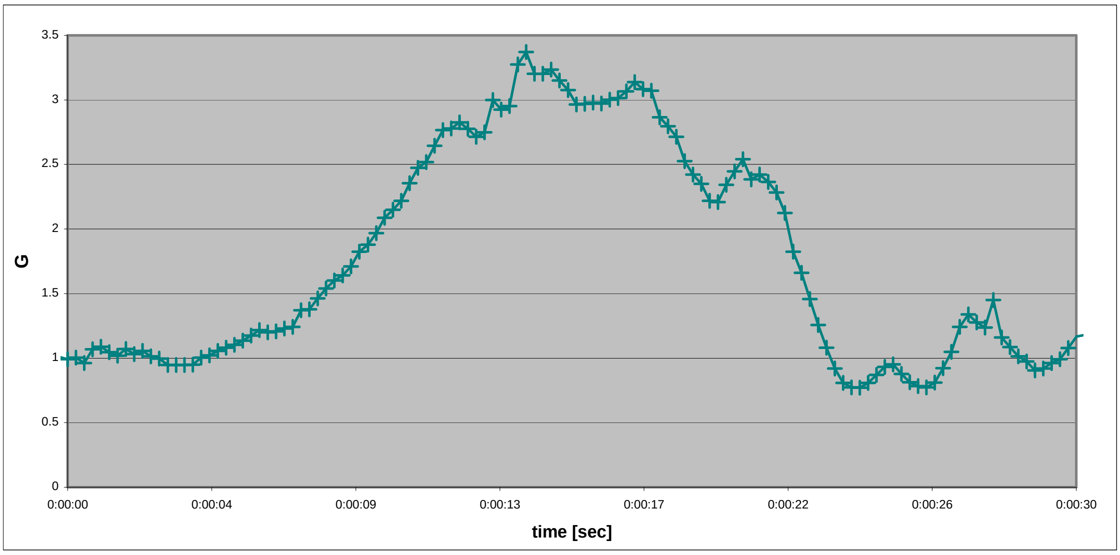
Wing LTF 1

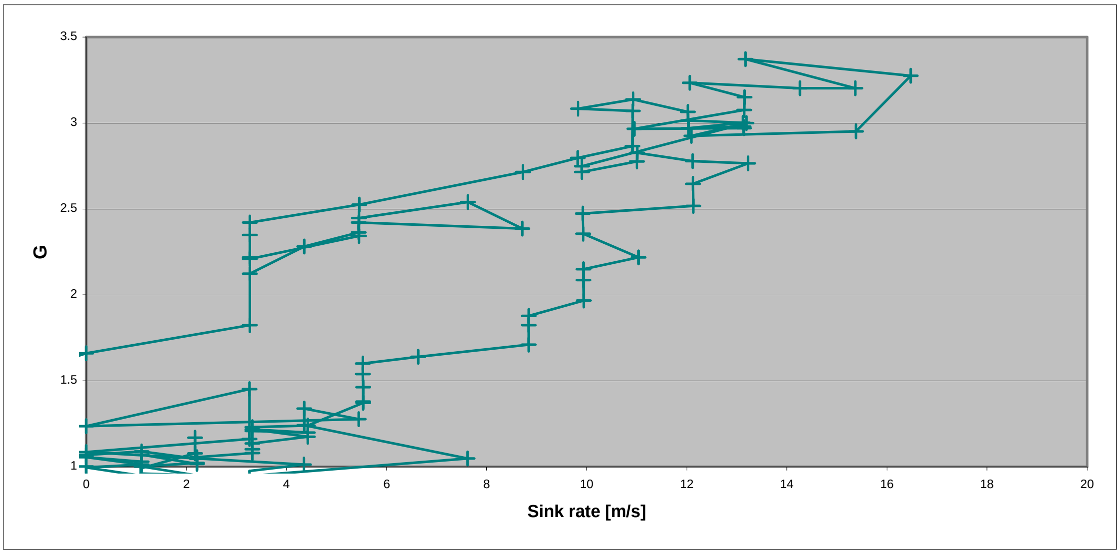
Weight Low






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

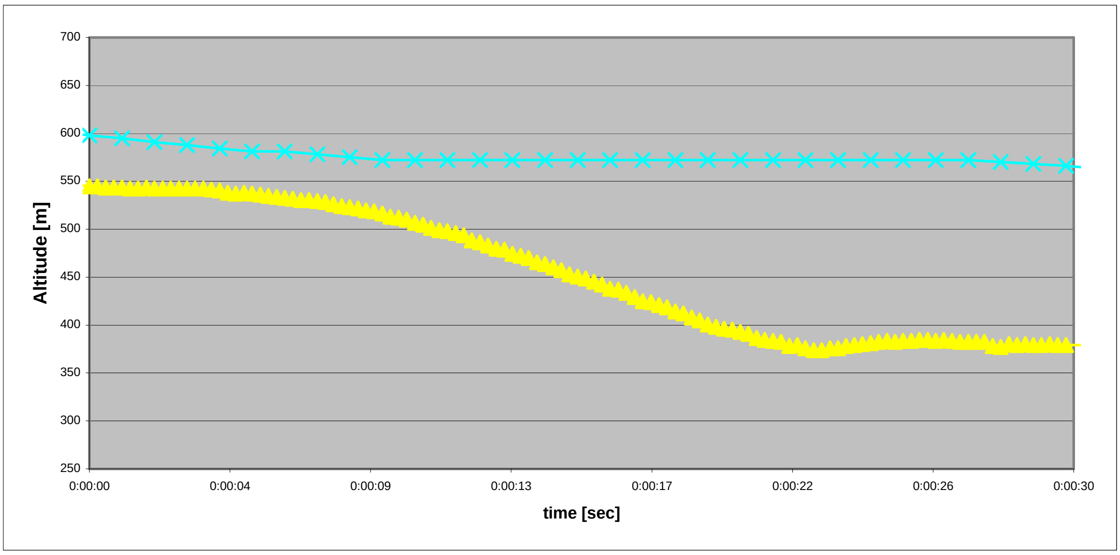

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

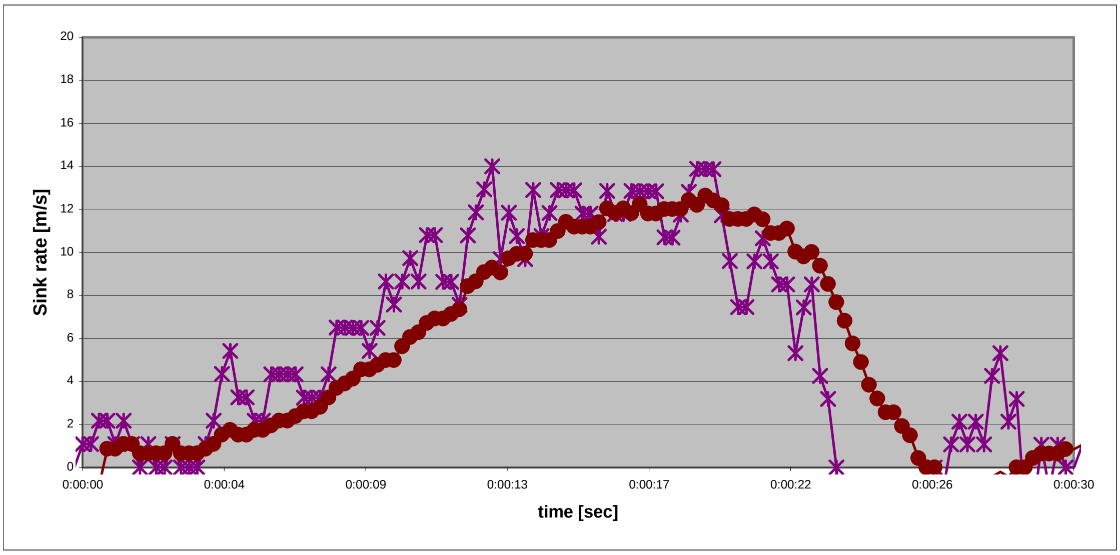
Run 3B

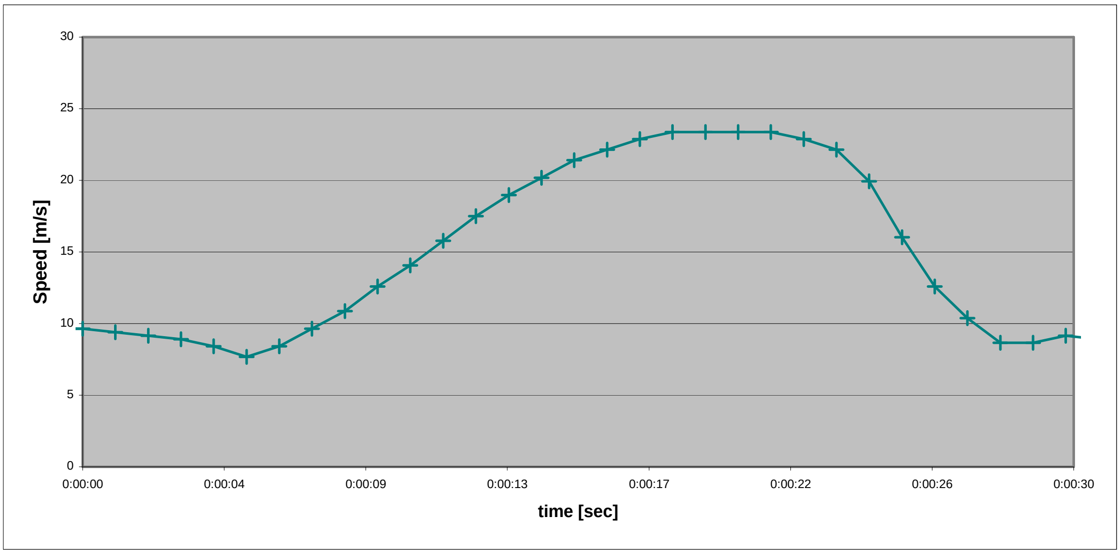
Pilot 2

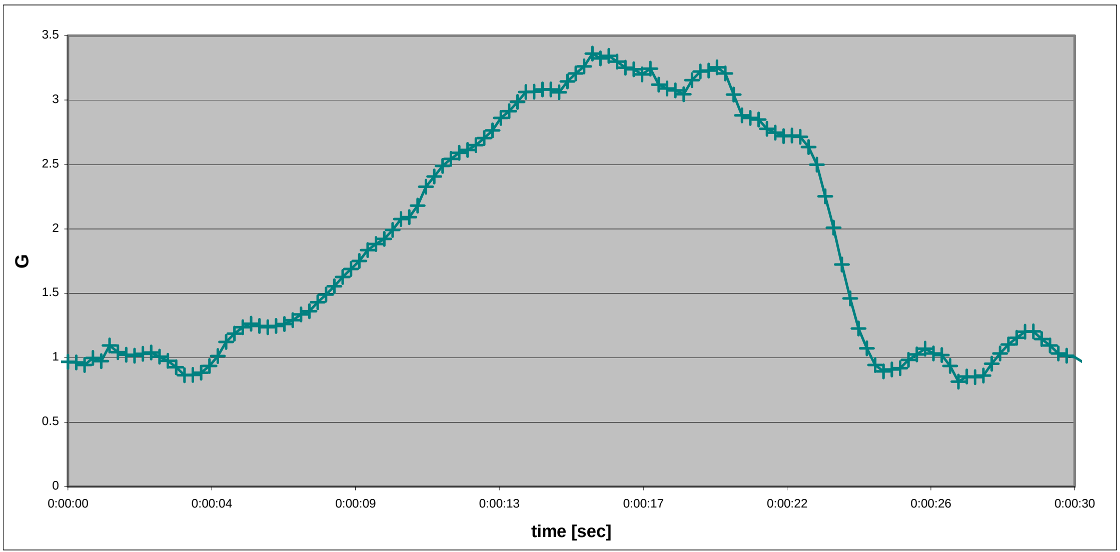
Wing LTF 1

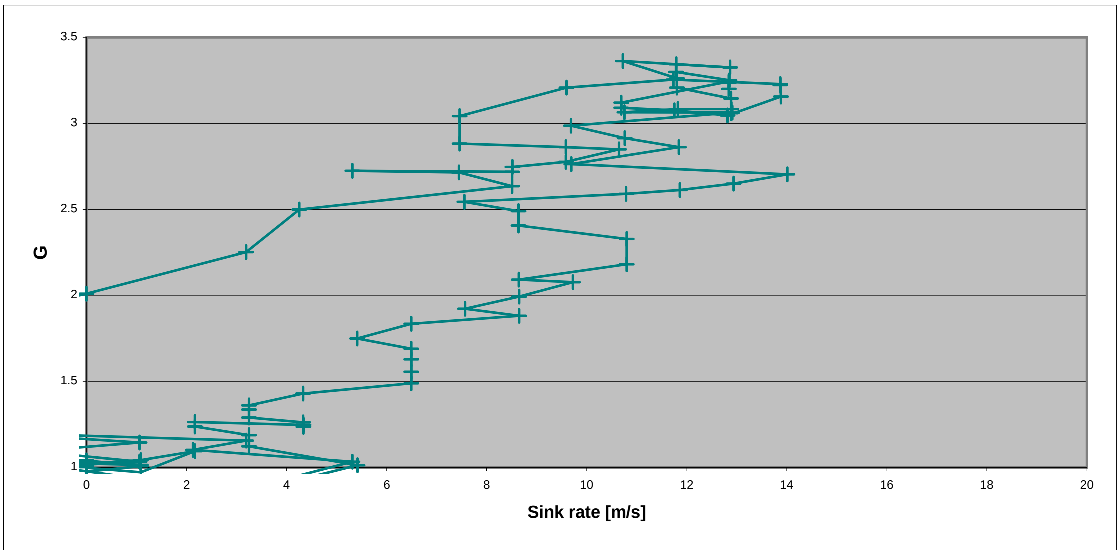
Weight Low






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

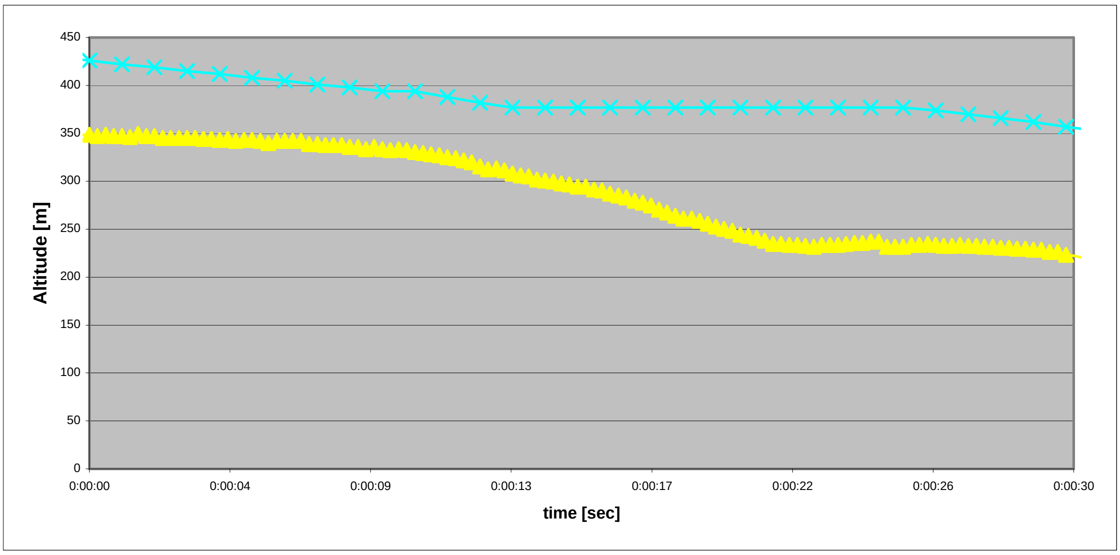

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

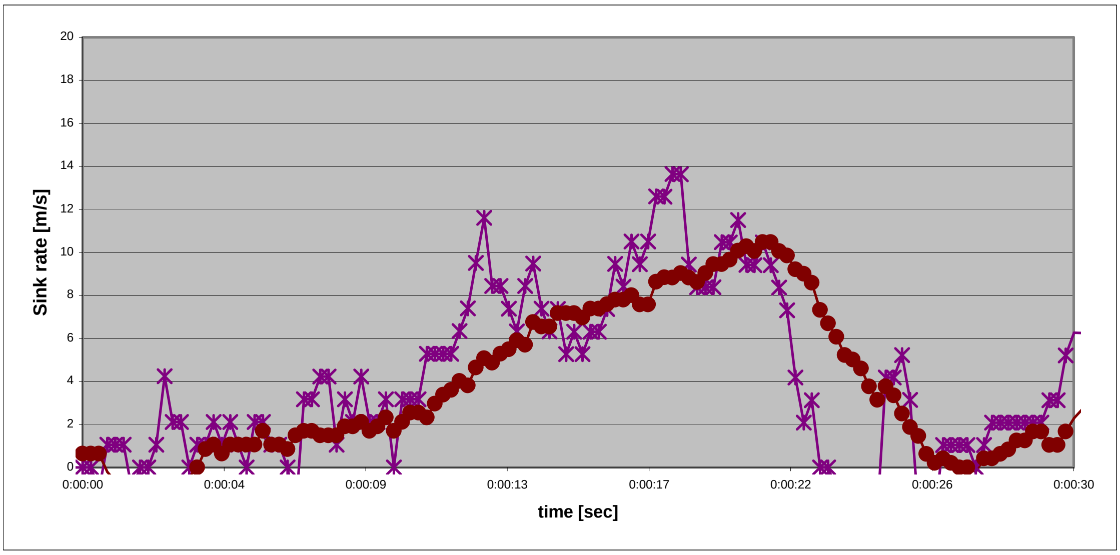
Run 3C

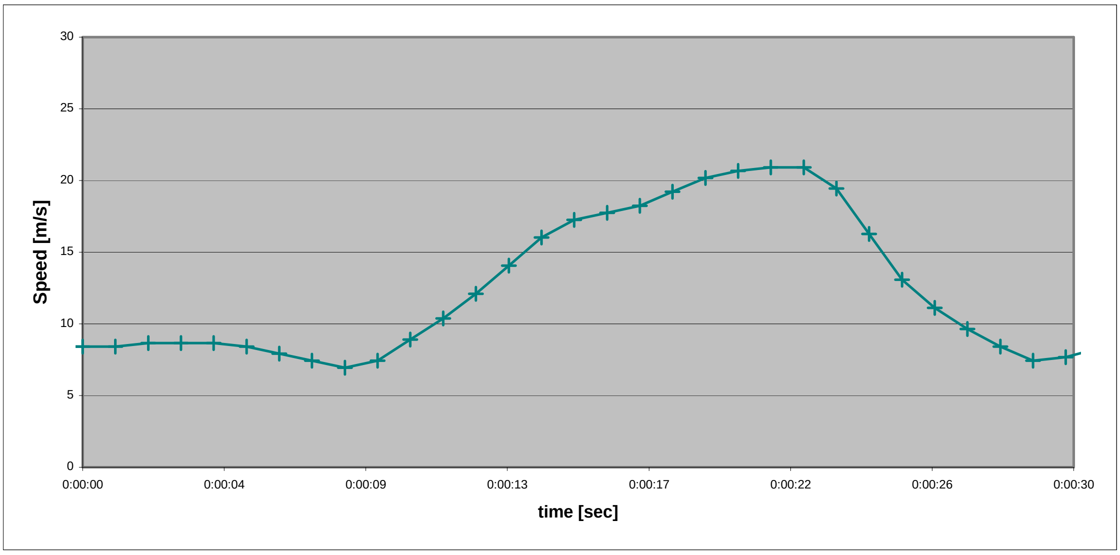
Pilot 2

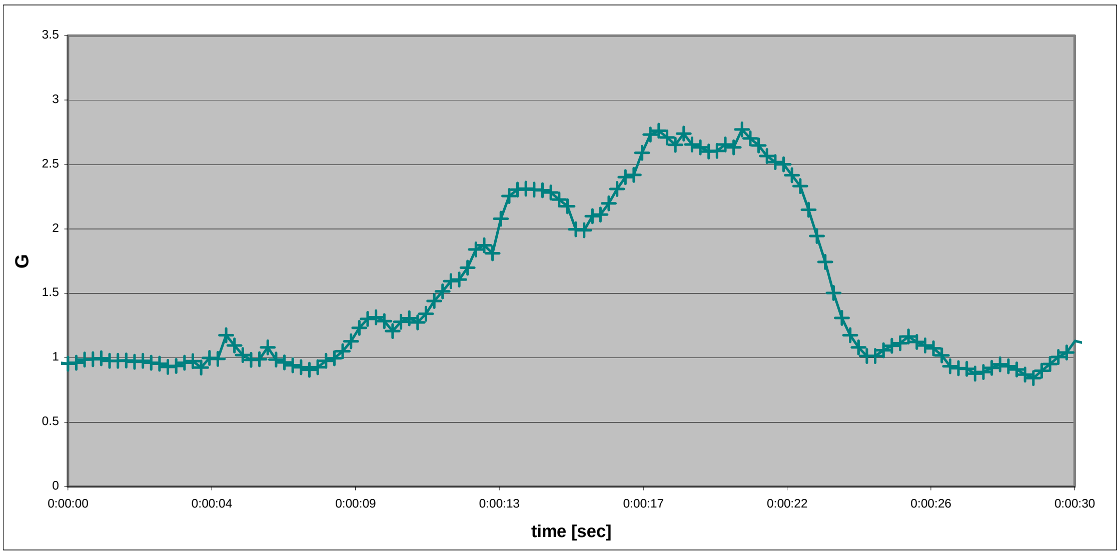
Wing LTF 1

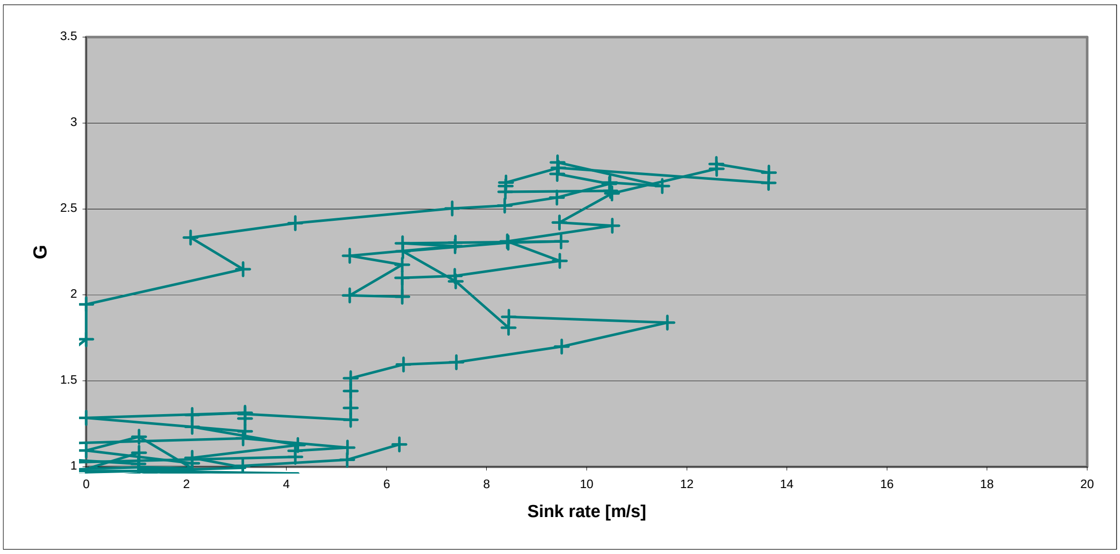
Weight Low






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


G
3.5
3
2.5
2
1.5
1
0.5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

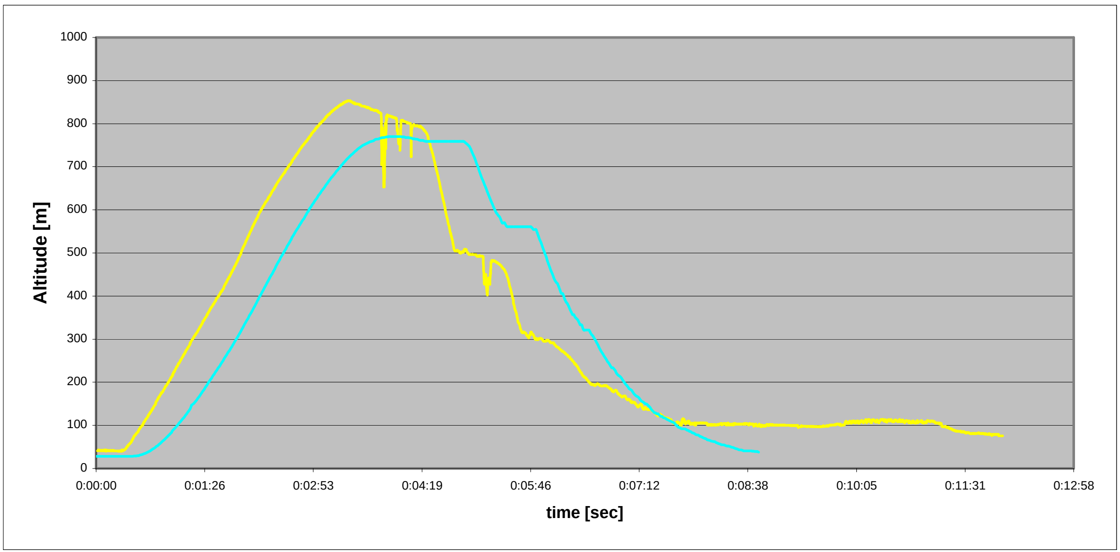

G
3.5
3
2.5
2
1.5
1
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

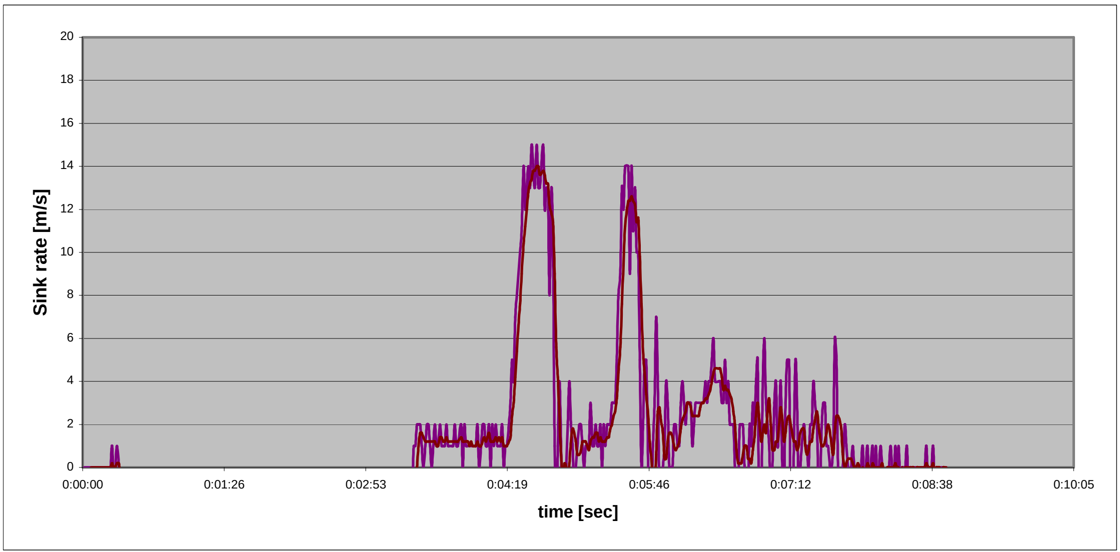
Run 4

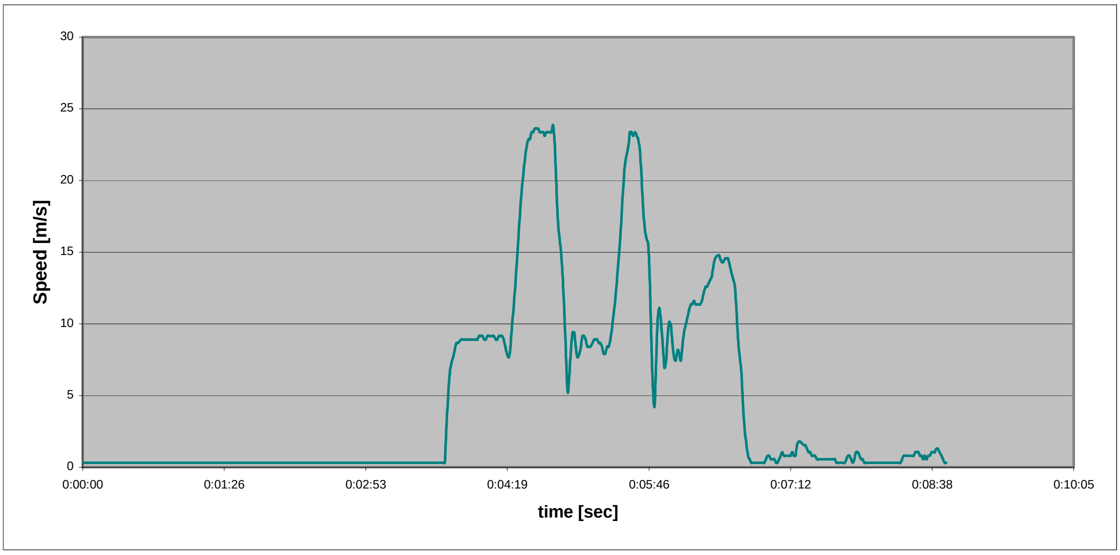
Pilot 2

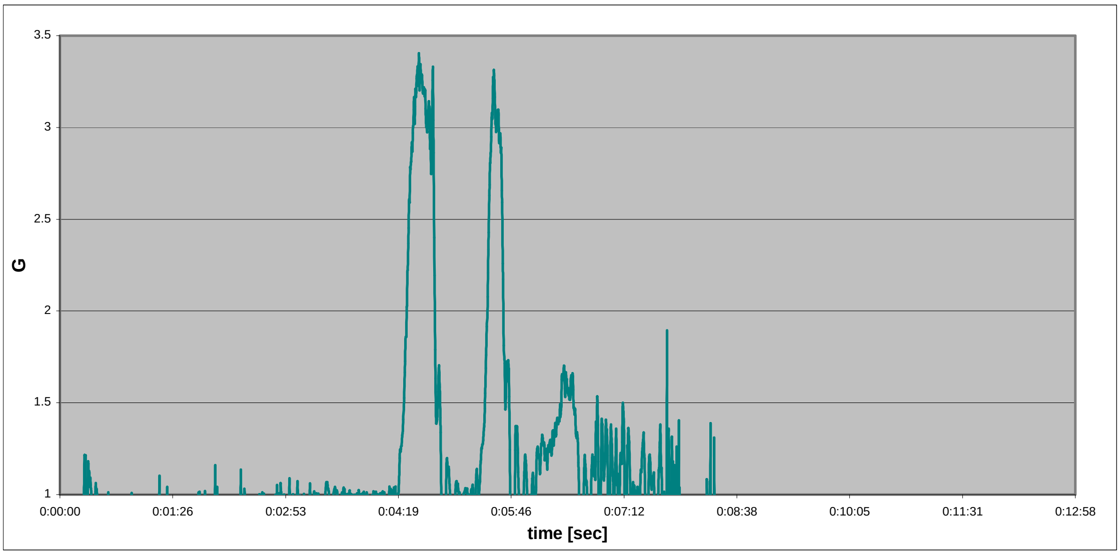
Wing LTF 1-2

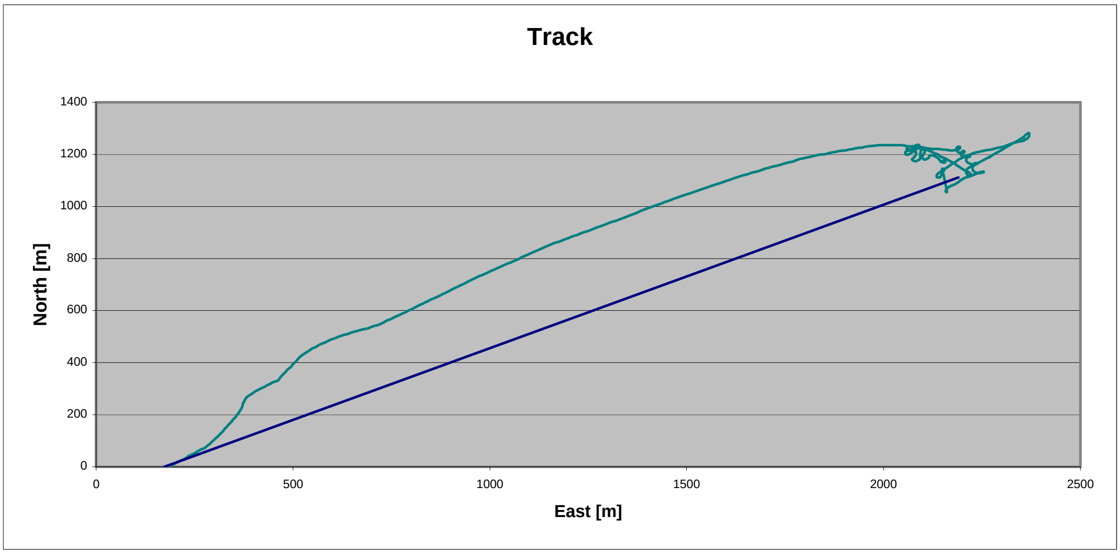
Weight Medium






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
time [sec]


3.5
3
2.5
2
1.5
1
G
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
0:12:58
time [sec]

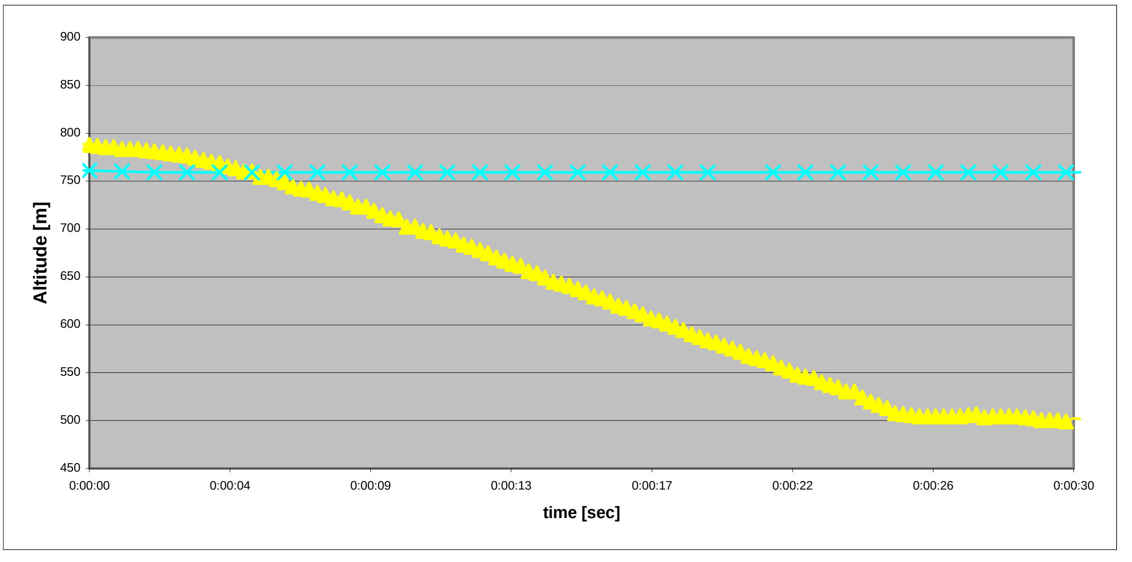

Track
1400
1200
1000
800
600
400
200
0
North [m]
0
500
1000
1500
2000
2500
East [m]

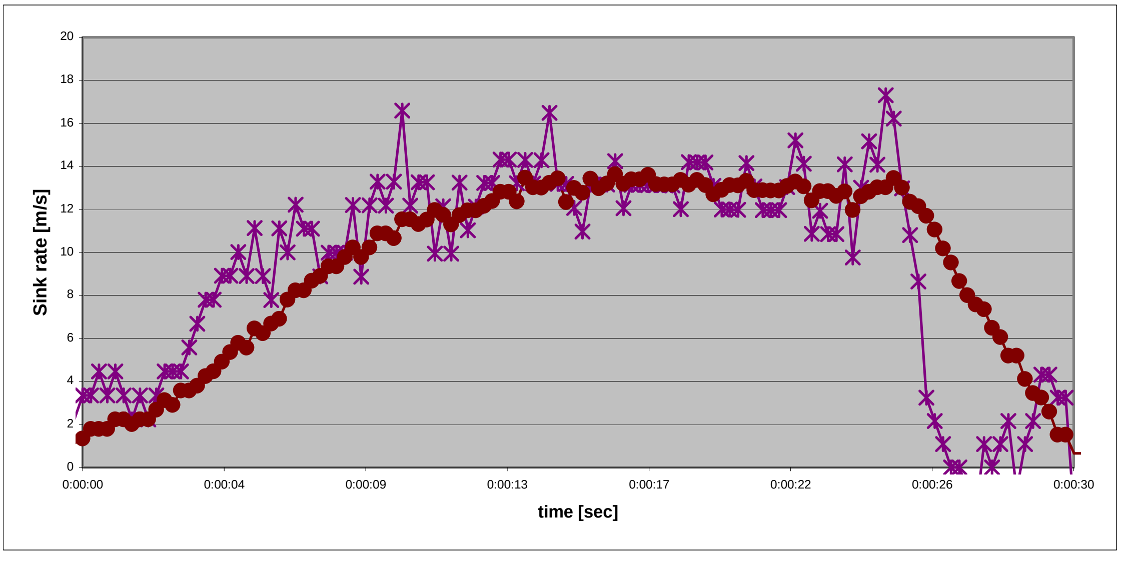
Run 4A

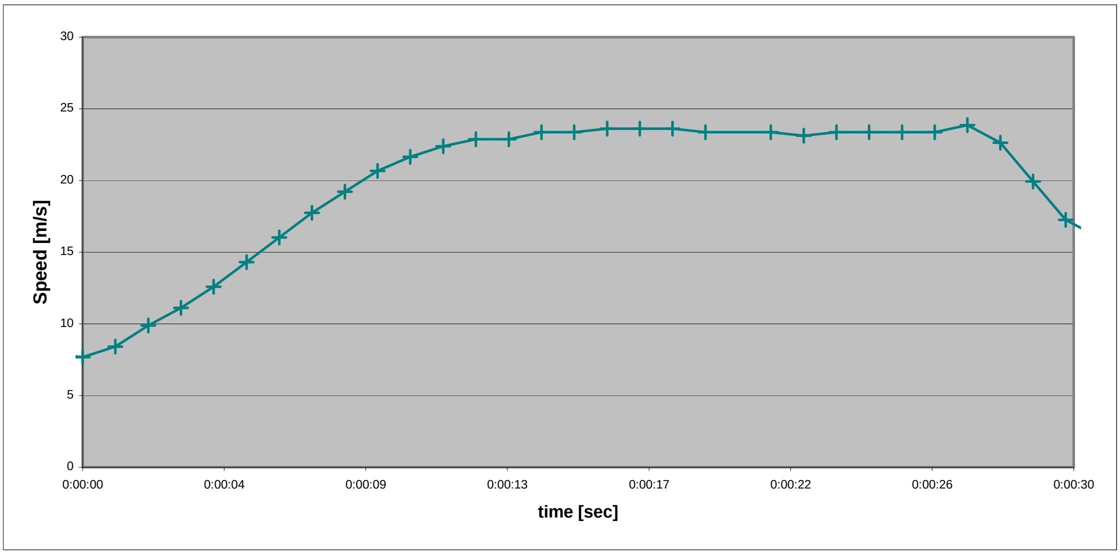
Pilot 2

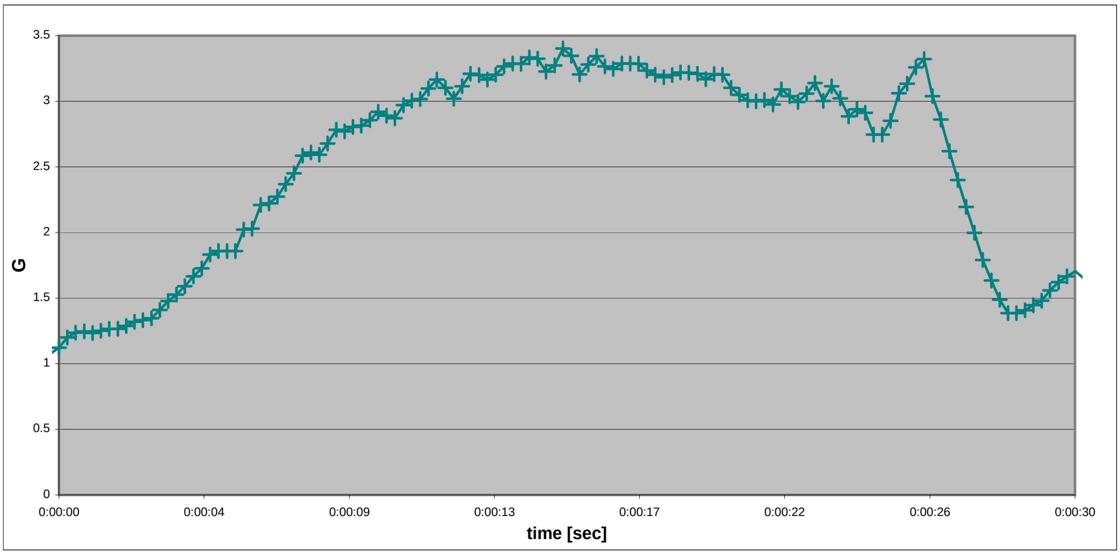
Wing LTF 1-2

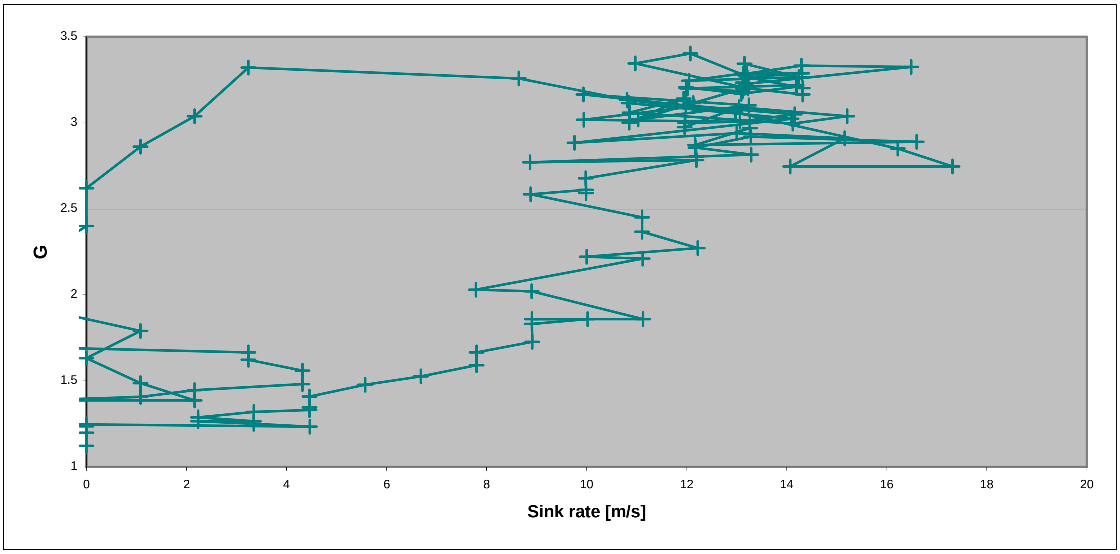
Weight Medium






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

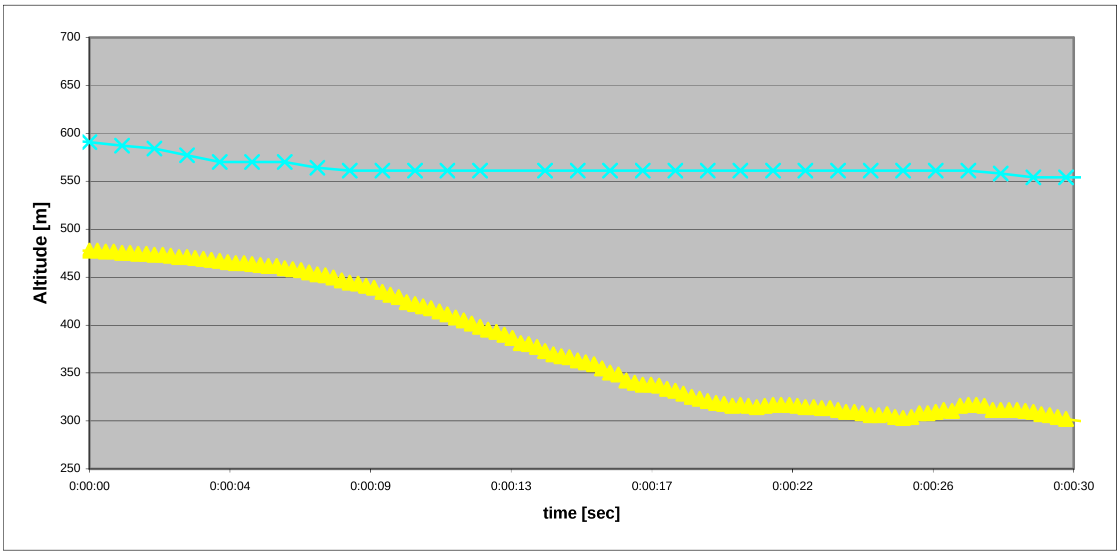

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

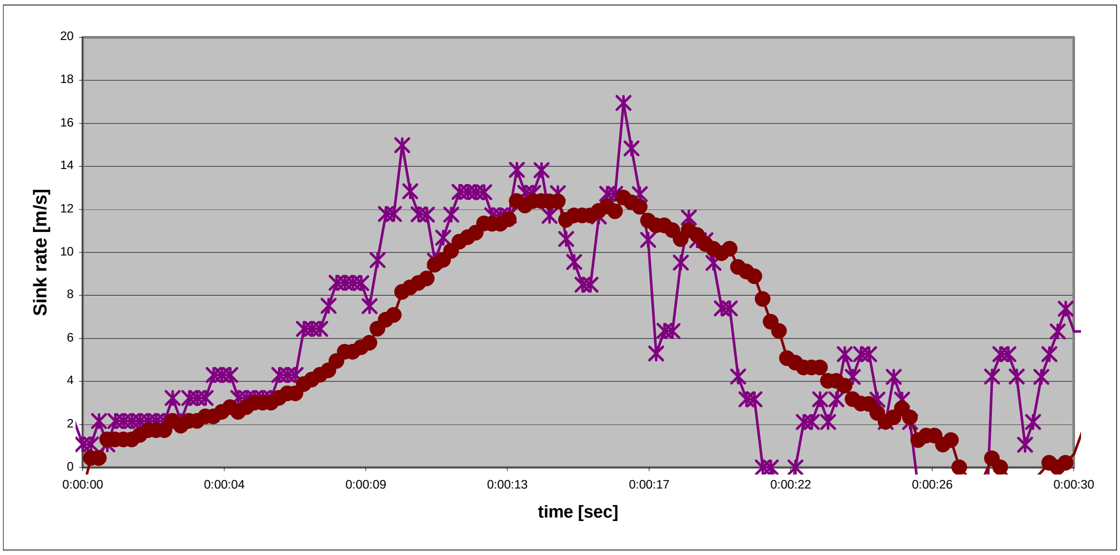
Run 4B

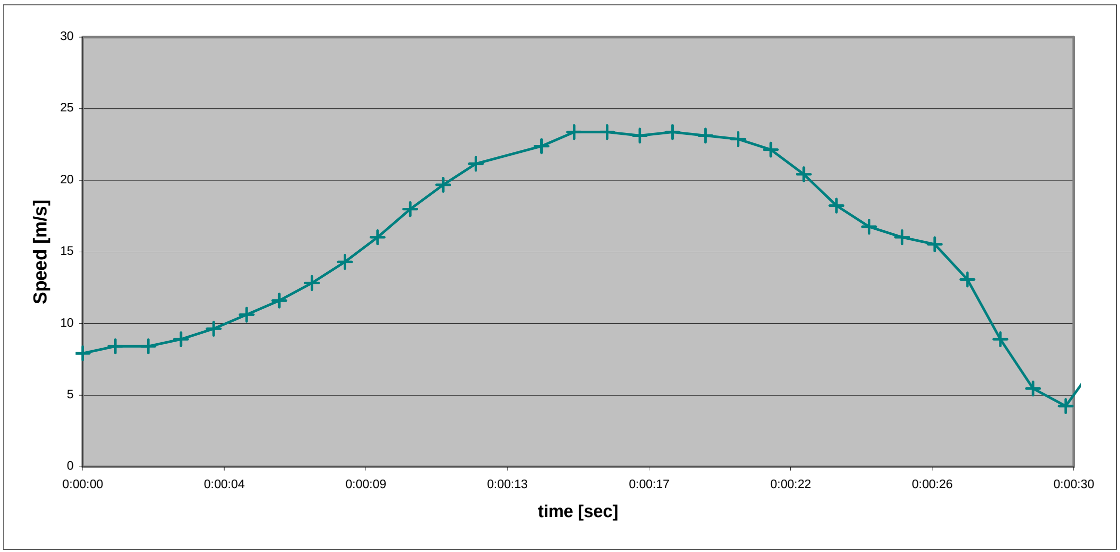
Pilot 2

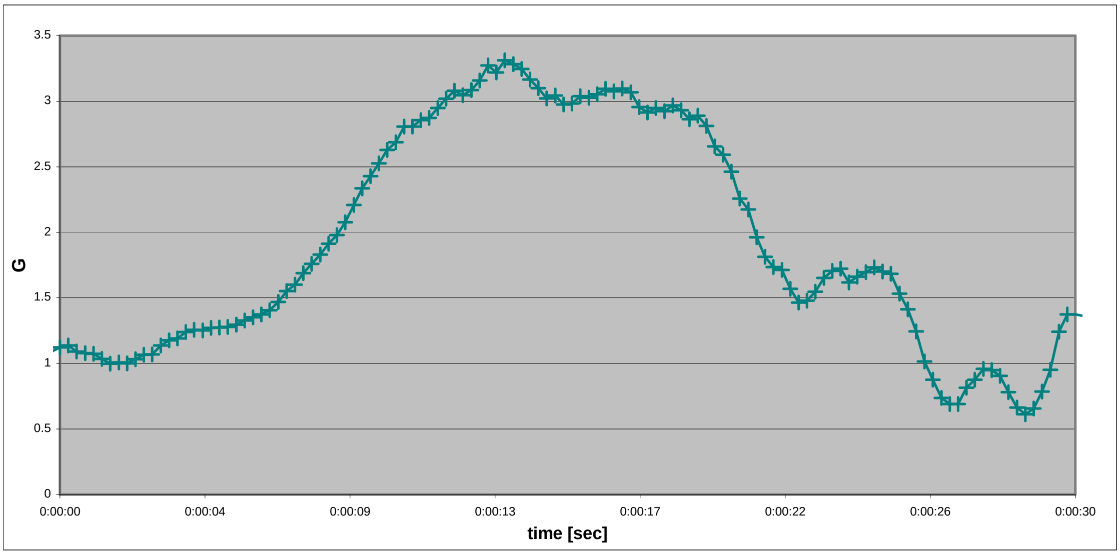
Wing LTF 1-2

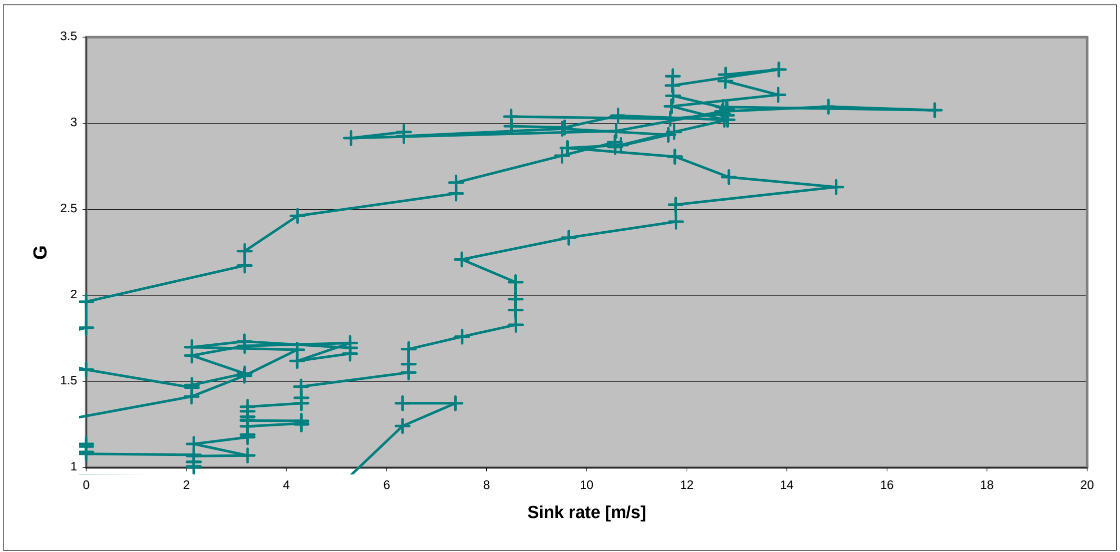
Weight Medium






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

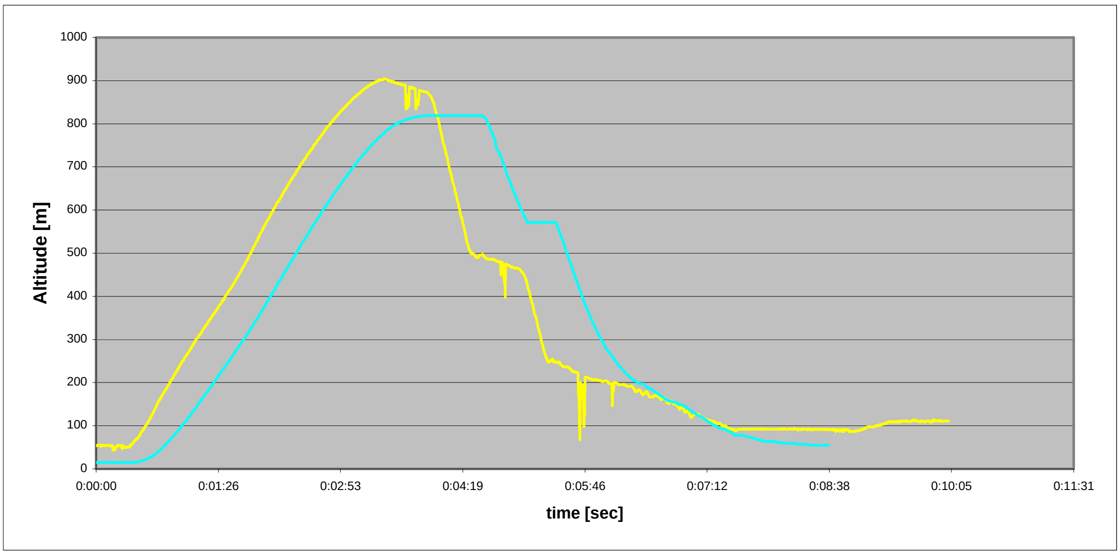

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

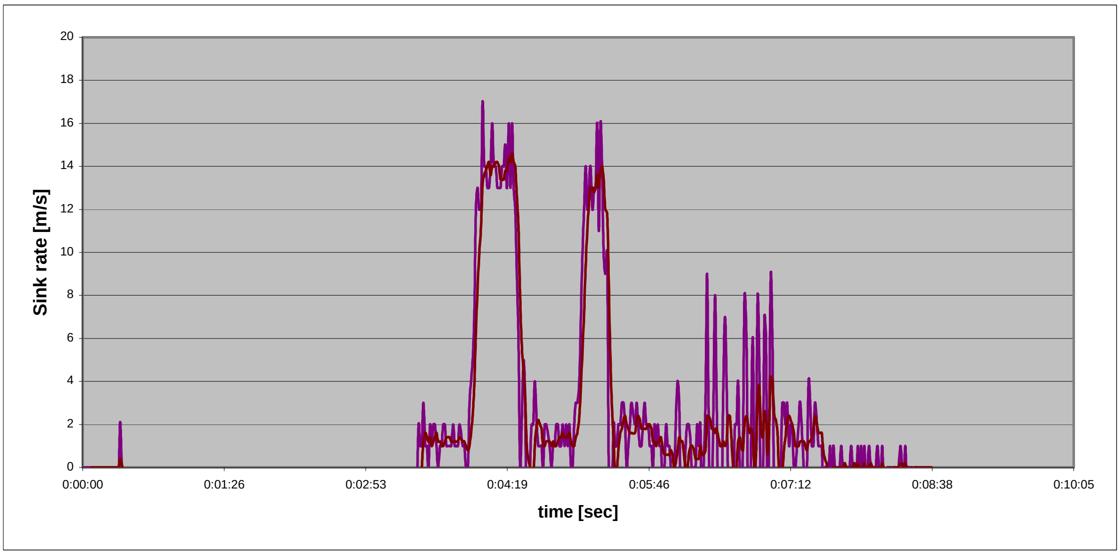
Run 5

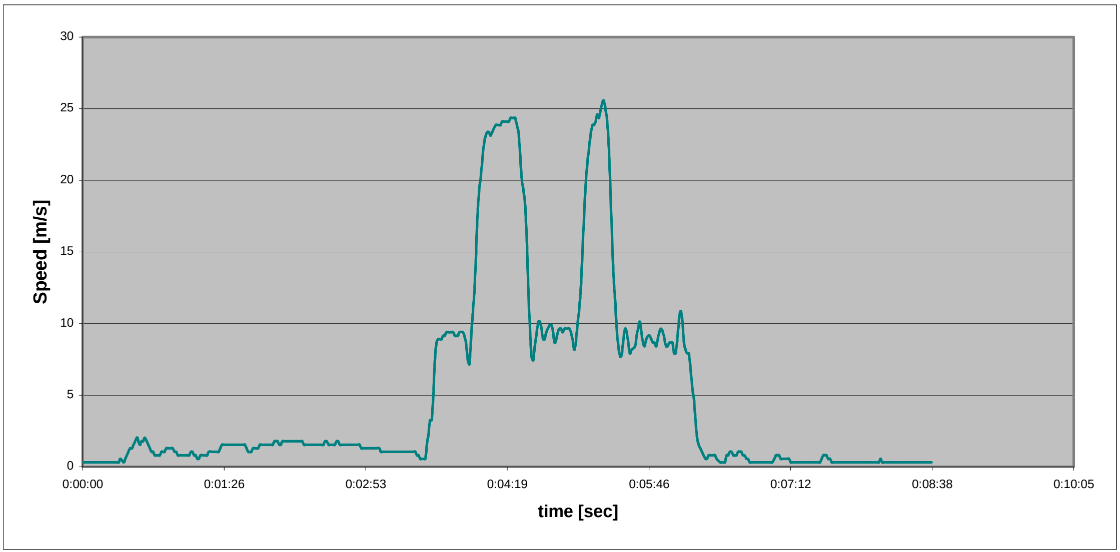
Pilot 2

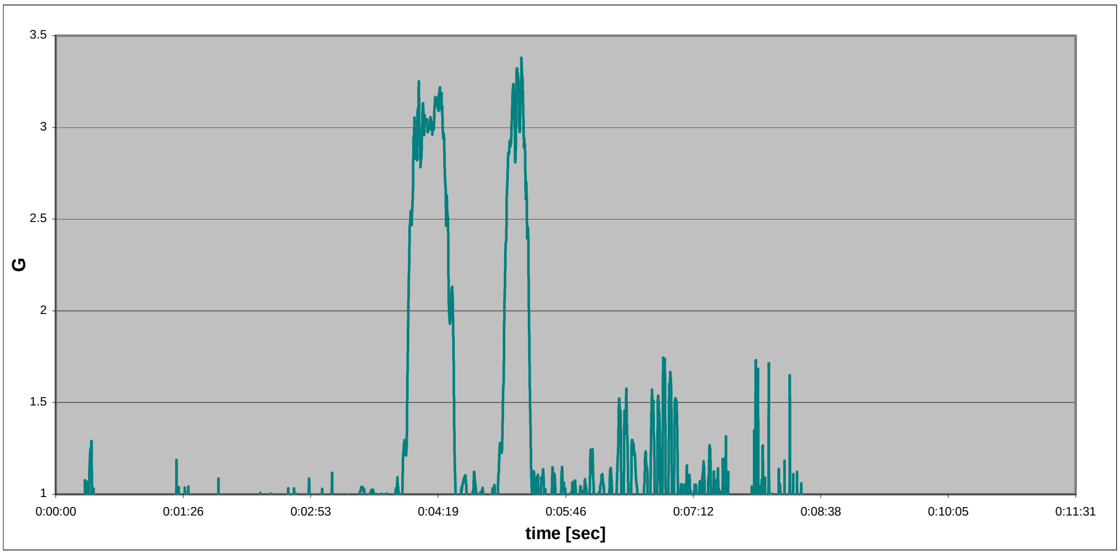
Wing LTF 2

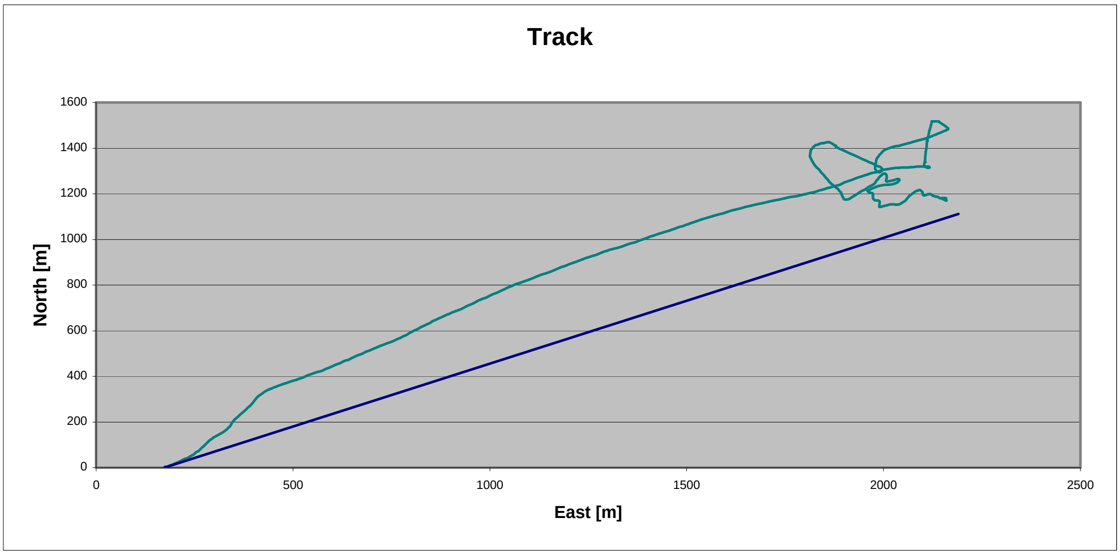
Weight Medium






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
time [sec]


G
3.5
3
2.5
2
1.5
1
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
time [sec]

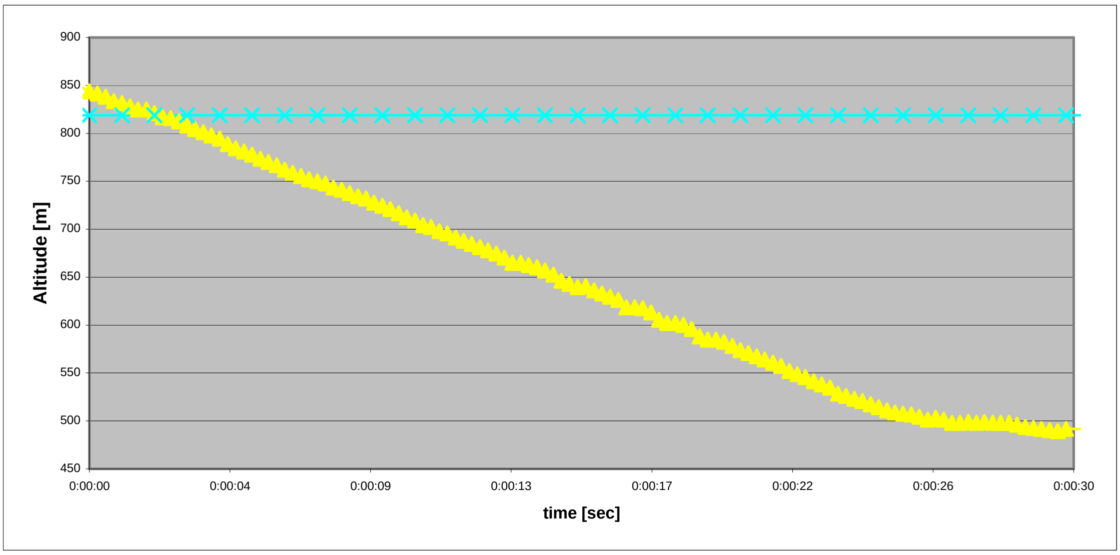

Track
North [m]
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
East [m]

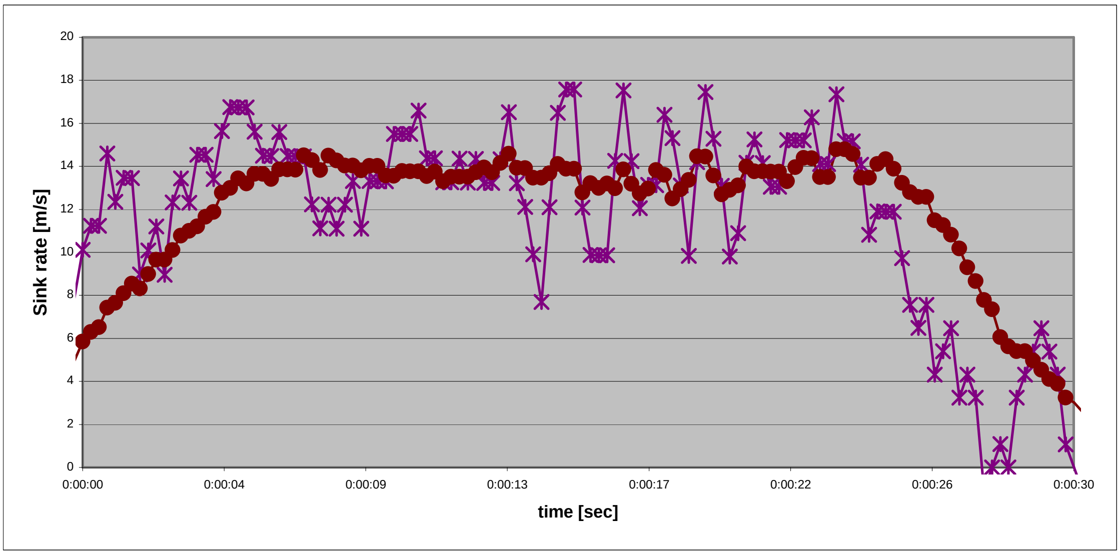
Run 5A

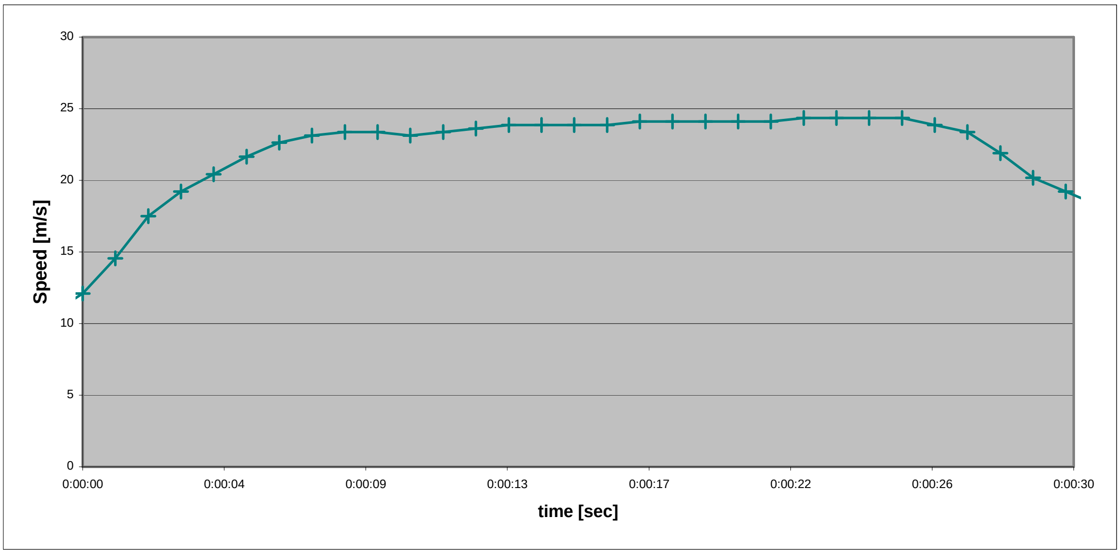
Pilot 2

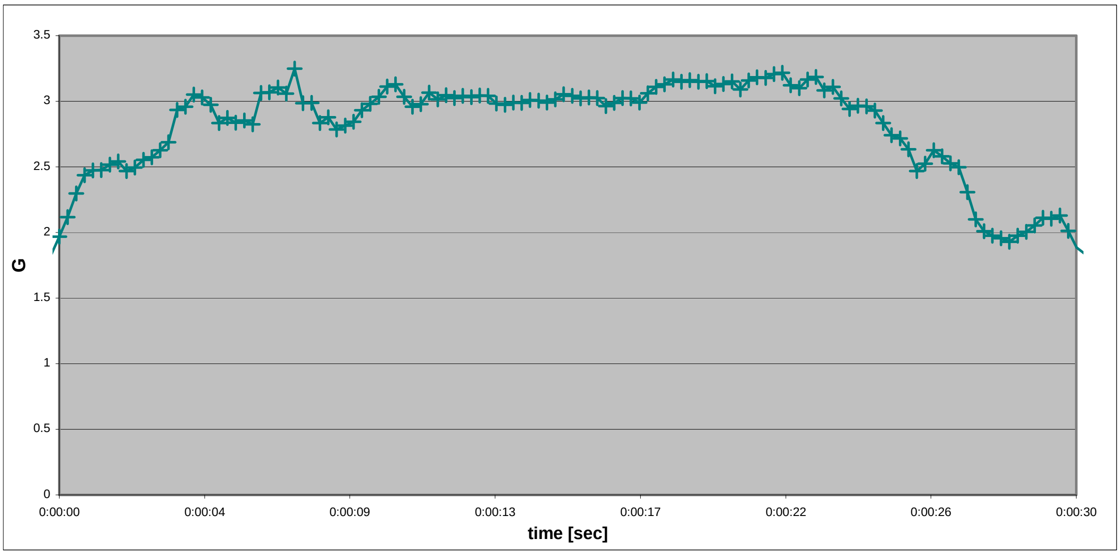
Wing LTF 2

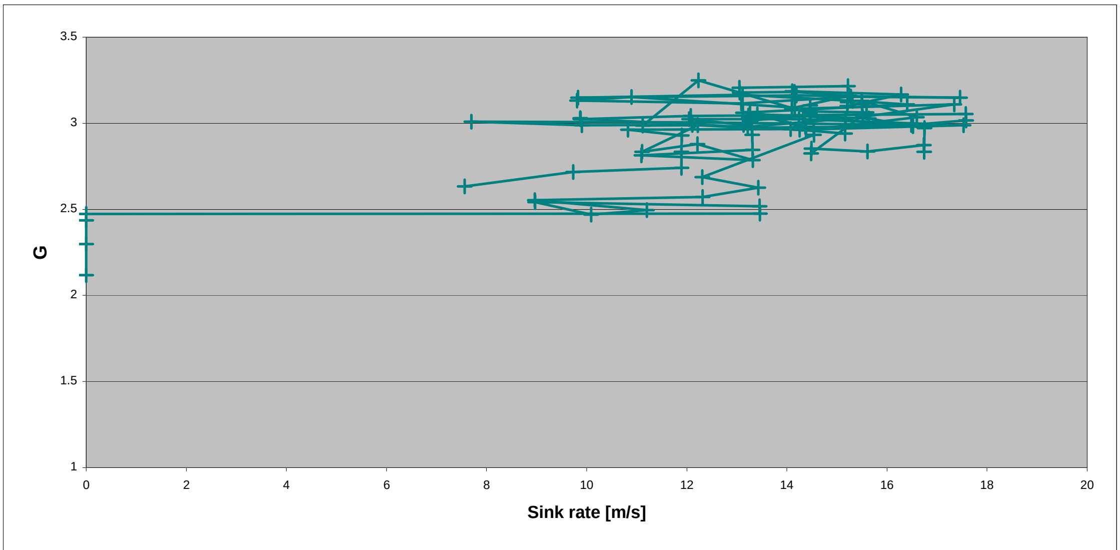
Weight Medium






Speed [m/s]
time [sec]
30
25
20
15
10
5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30


G
time [sec]
3.5
3
2.5
2
1.5
1
0.5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30

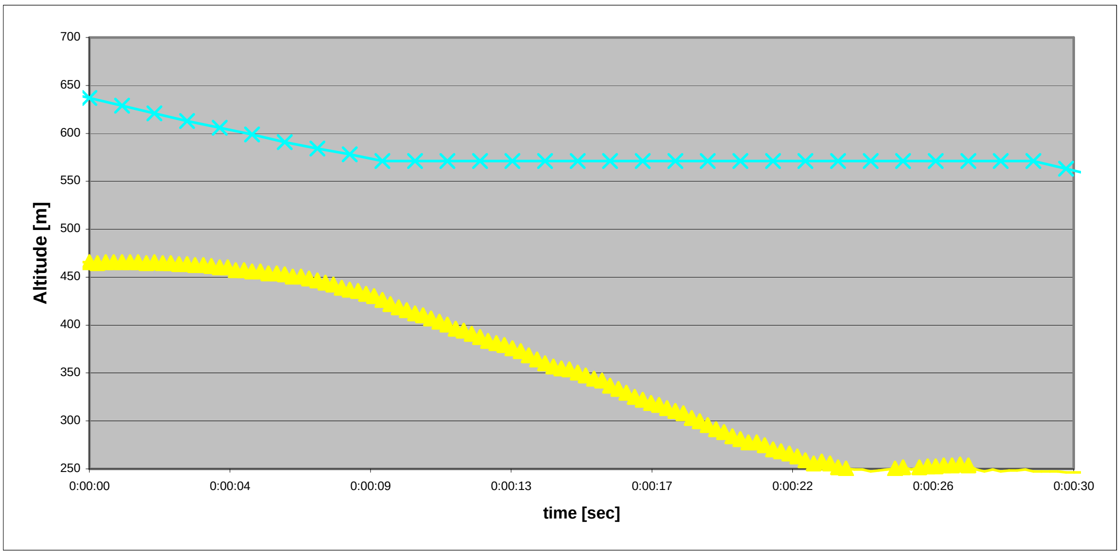

G
Sink rate [m/s]
3.5
3
2.5
2
1.5
1
0
2
4
6
8
10
12
14
16
18
20

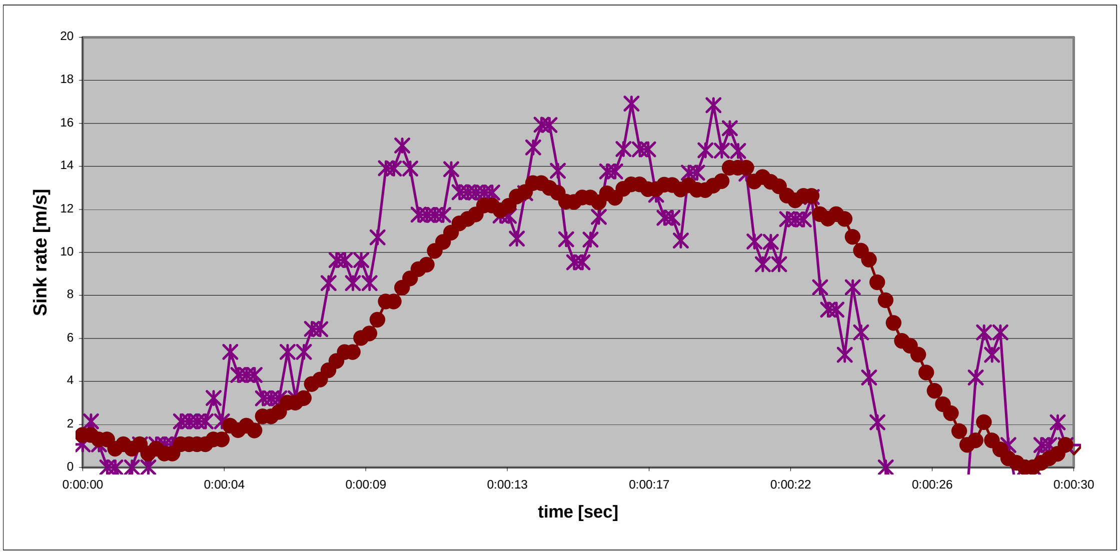
Run 5B

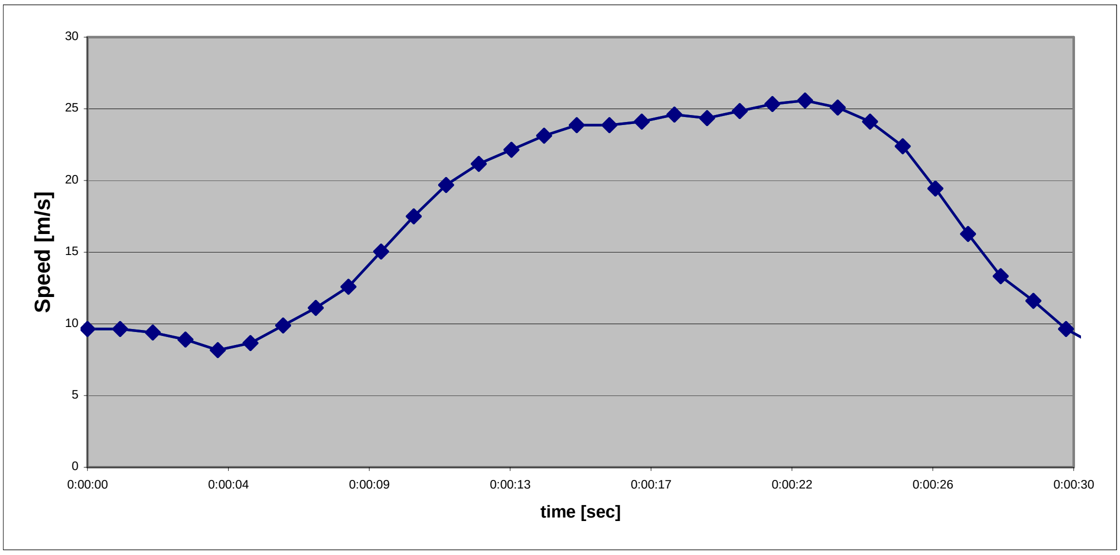
Pilot 2

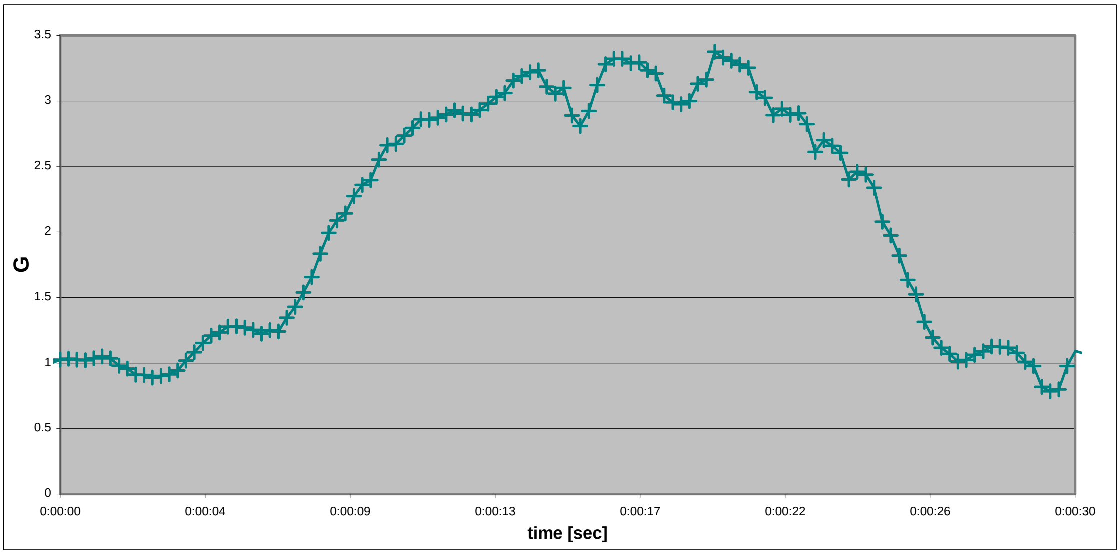
Wing LTF 2

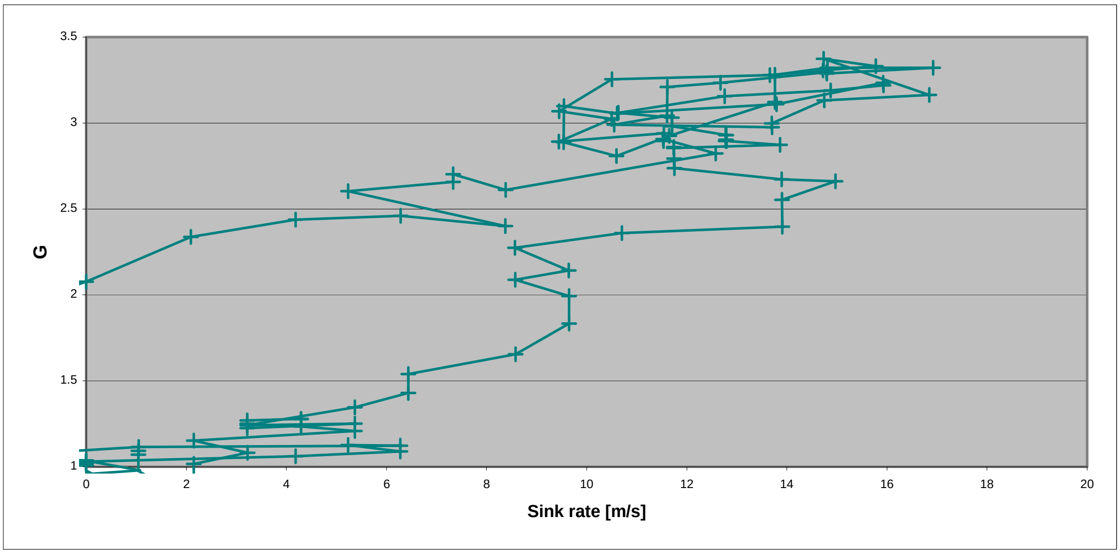
Weight Medium






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

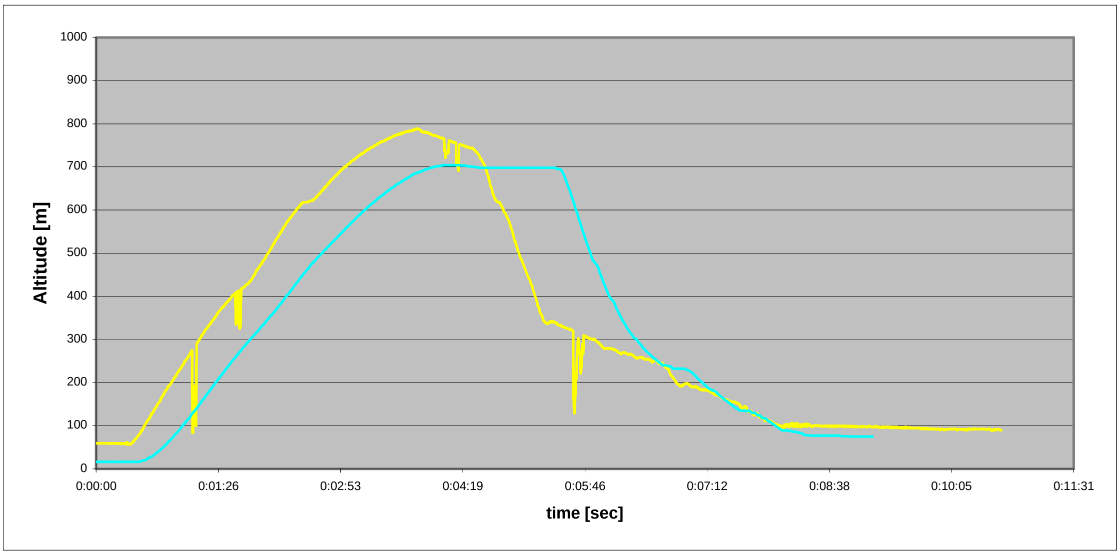

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

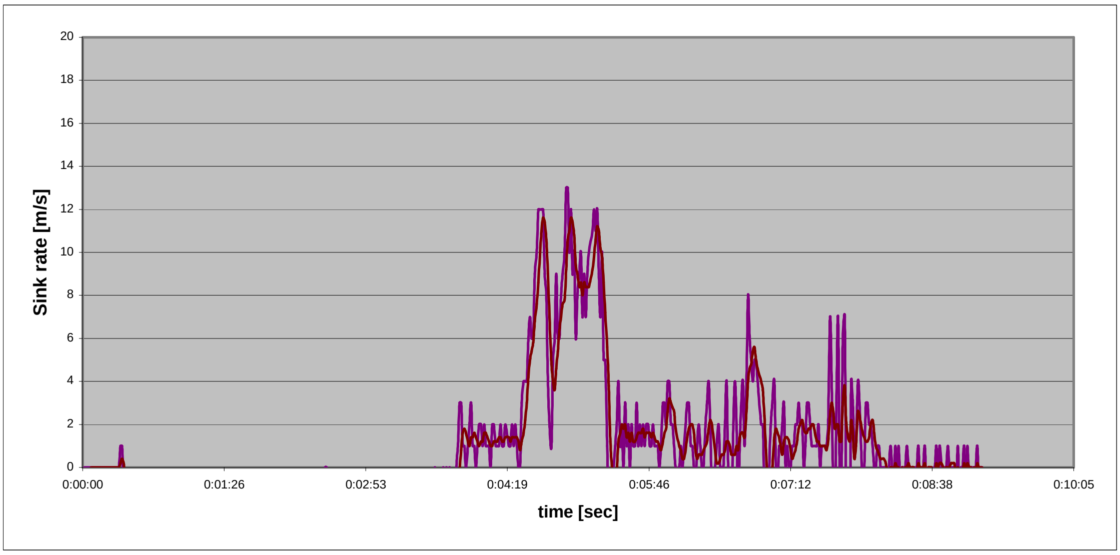
Run 6

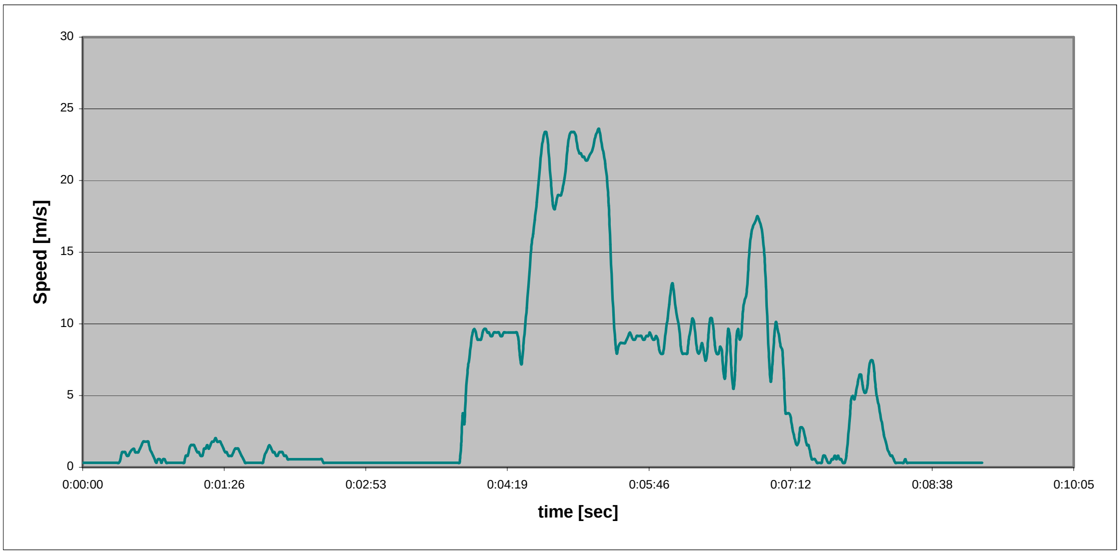
Pilot 2

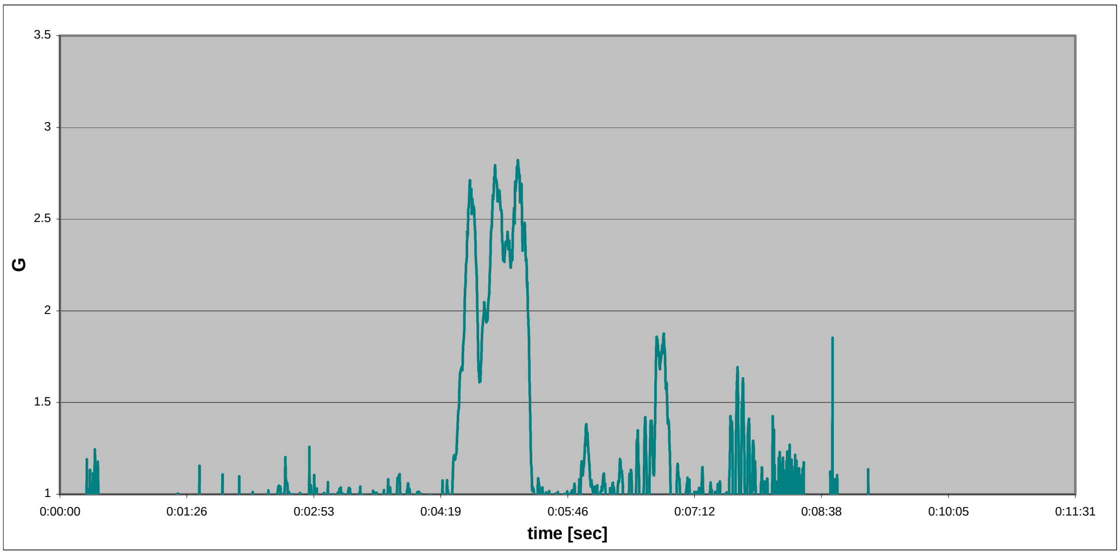
Wing LTF 2

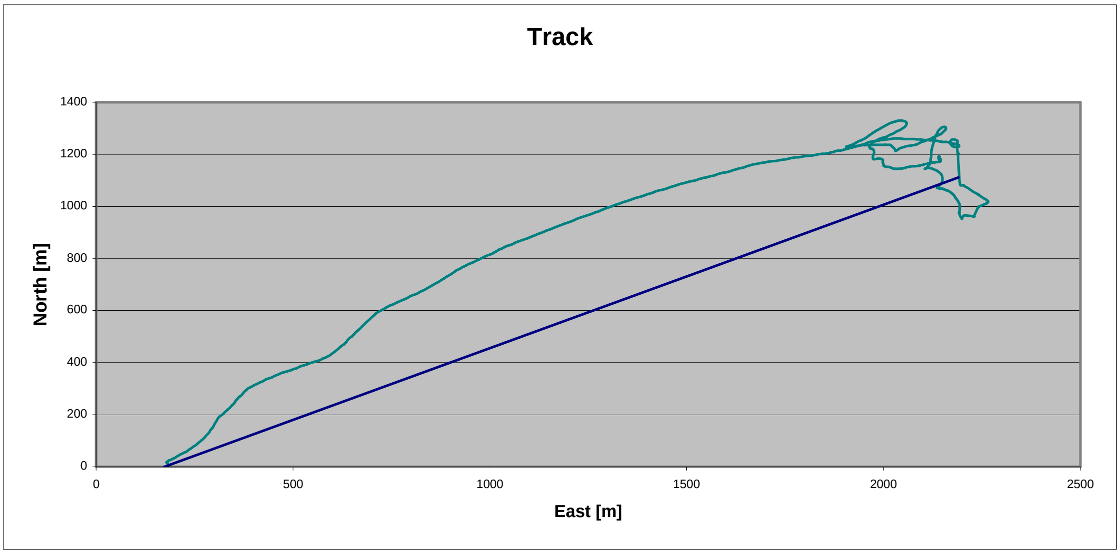
Weight Medium






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
time [sec]


G
3.5
3
2.5
2
1.5
1
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
time [sec]

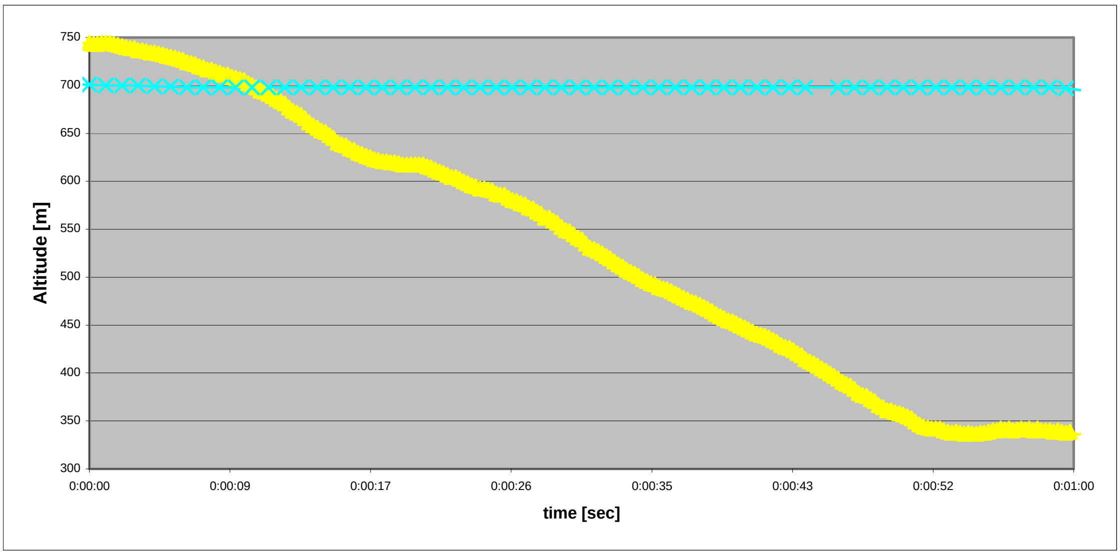

Track
North [m]
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
East [m]

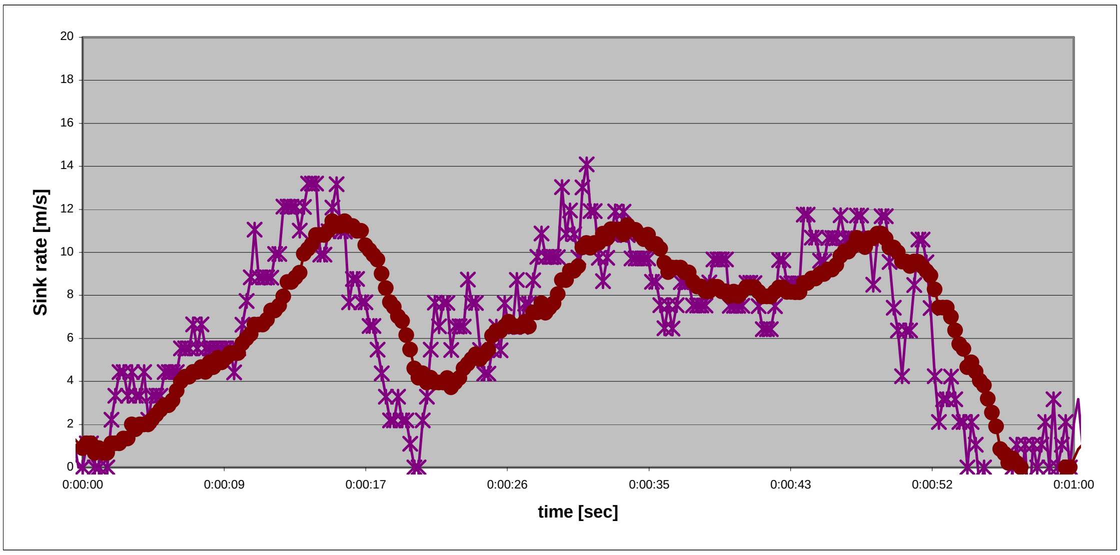
Run 6A

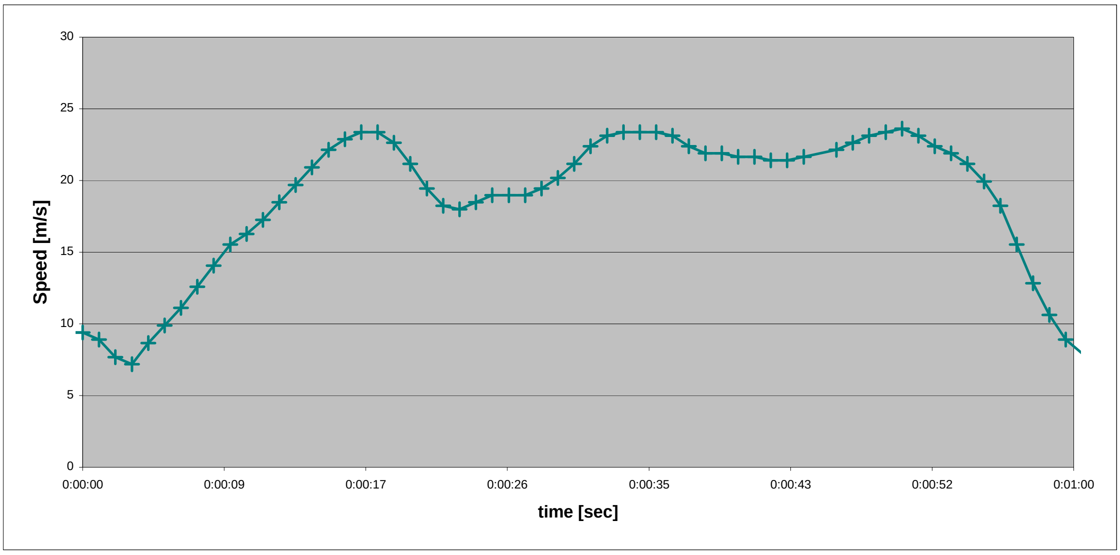
Pilot 2

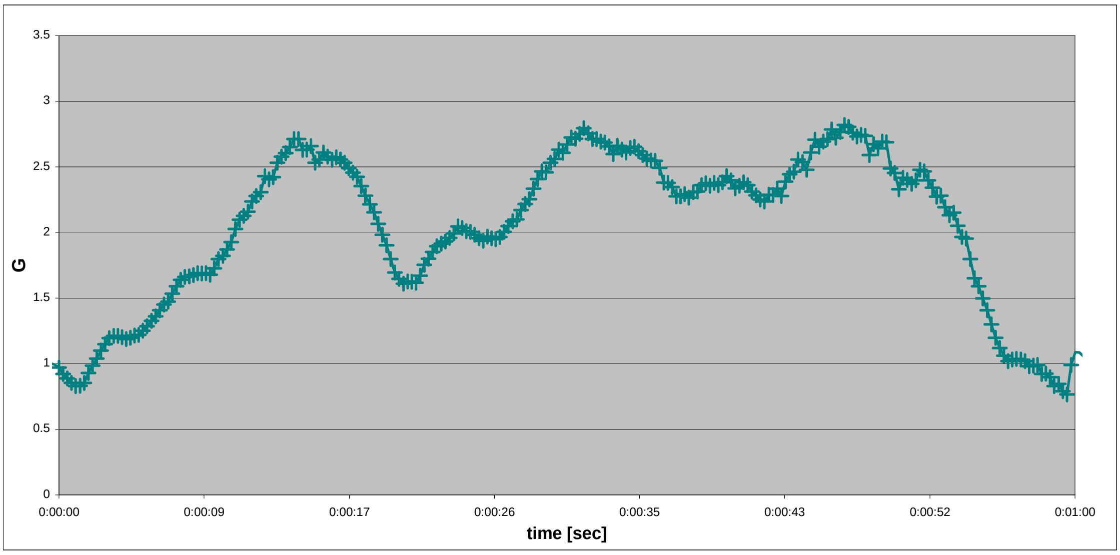
Wing LTF 2

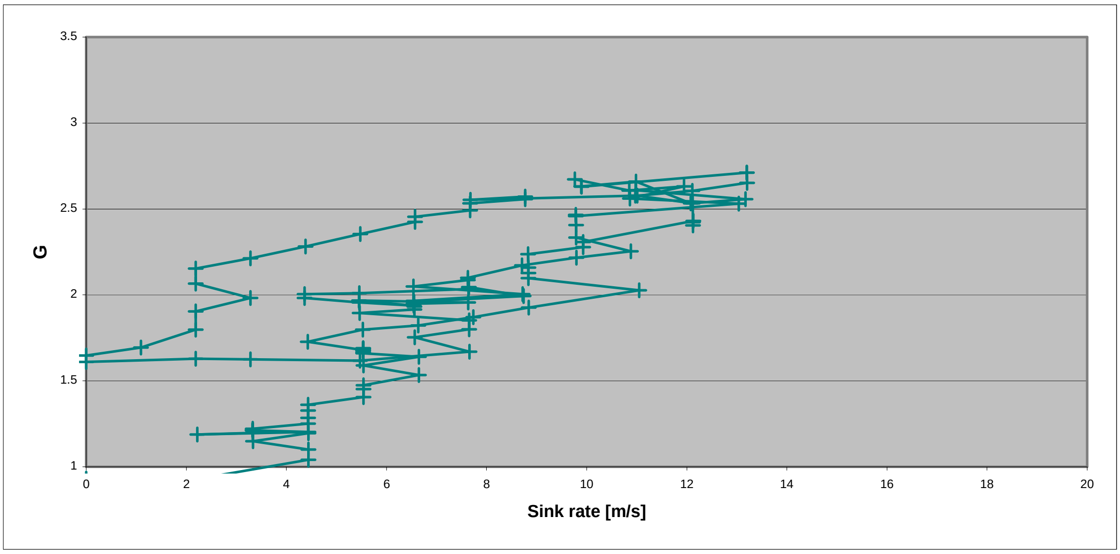
Weight Medium






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:00:09
0:00:17
0:00:26
0:00:35
0:00:43
0:00:52
0:01:00
time [sec]


G
3.5
3
2.5
2
1.5
1
0.5
0
0:00:00
0:00:09
0:00:17
0:00:26
0:00:35
0:00:43
0:00:52
0:01:00
time [sec]

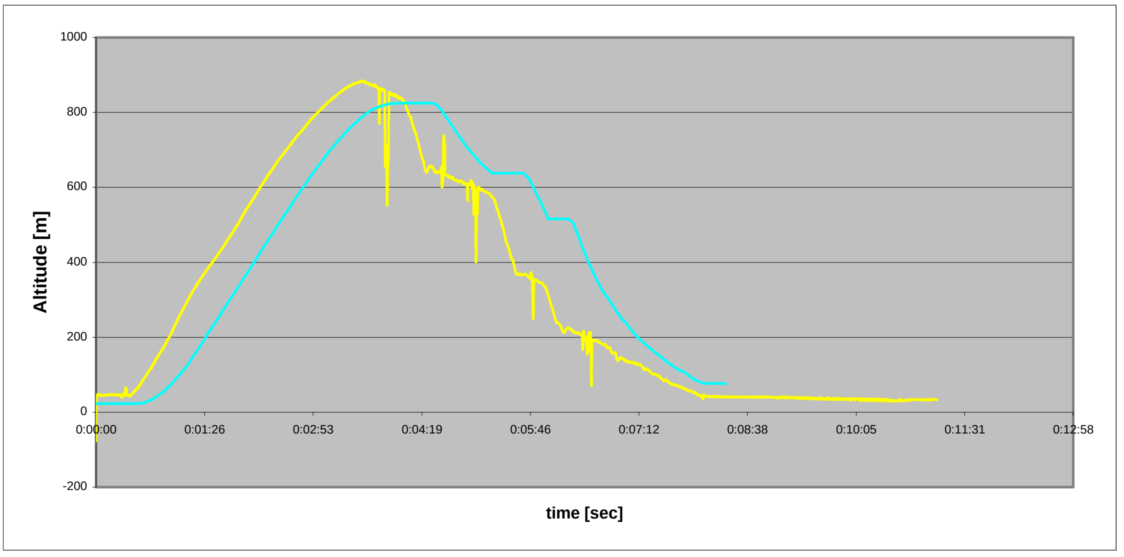

G
3.5
3
2.5
2
1.5
1
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

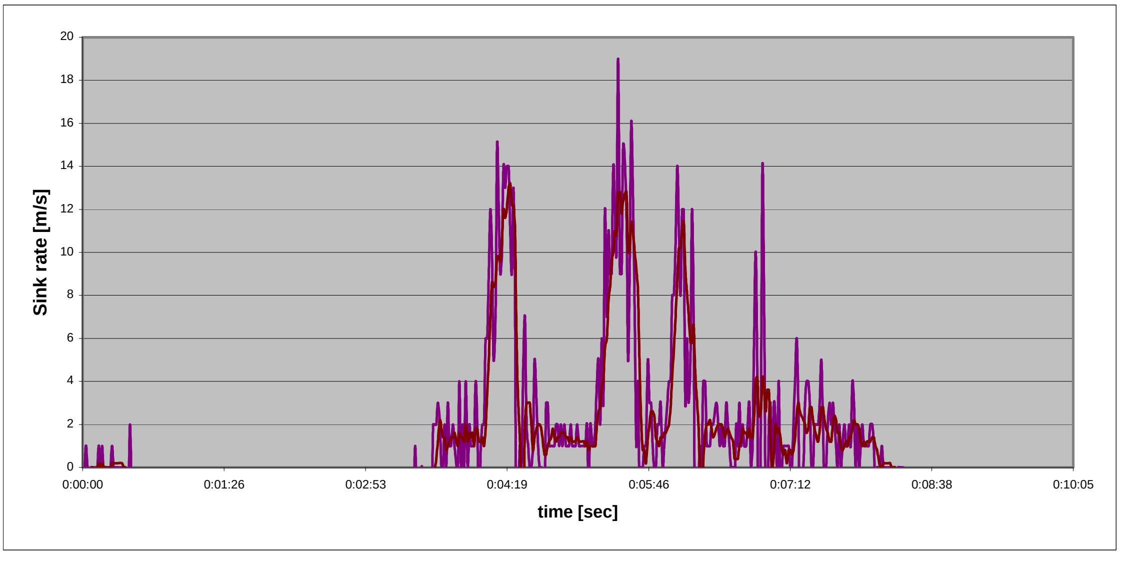
Run 7

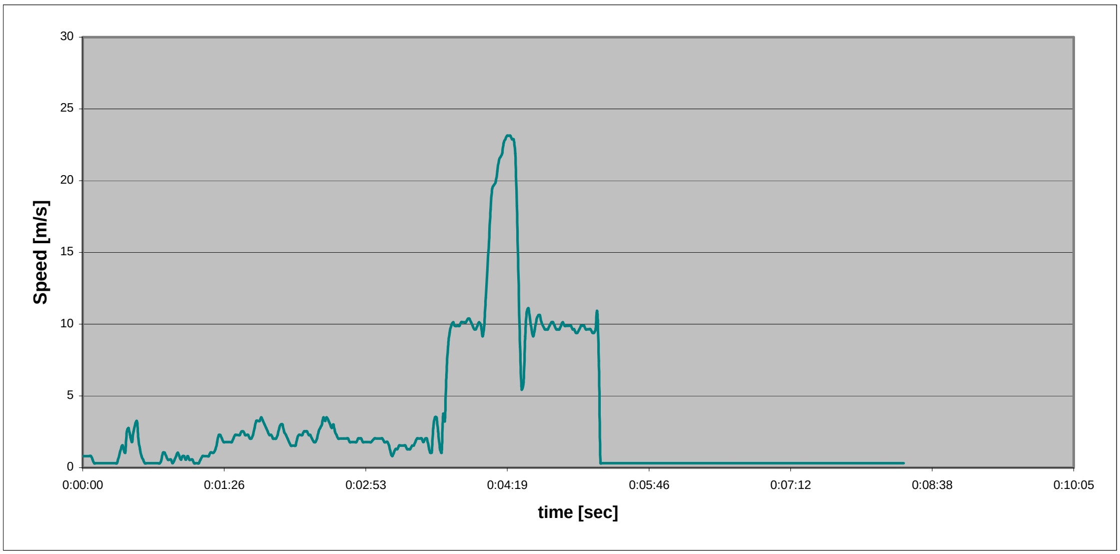
Pilot 3

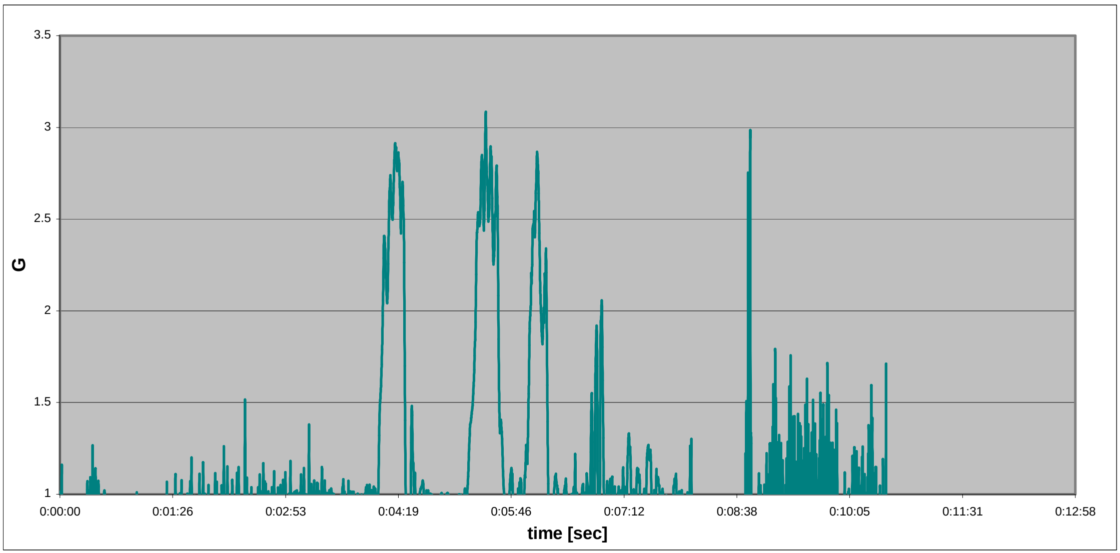
Wing LTF 2

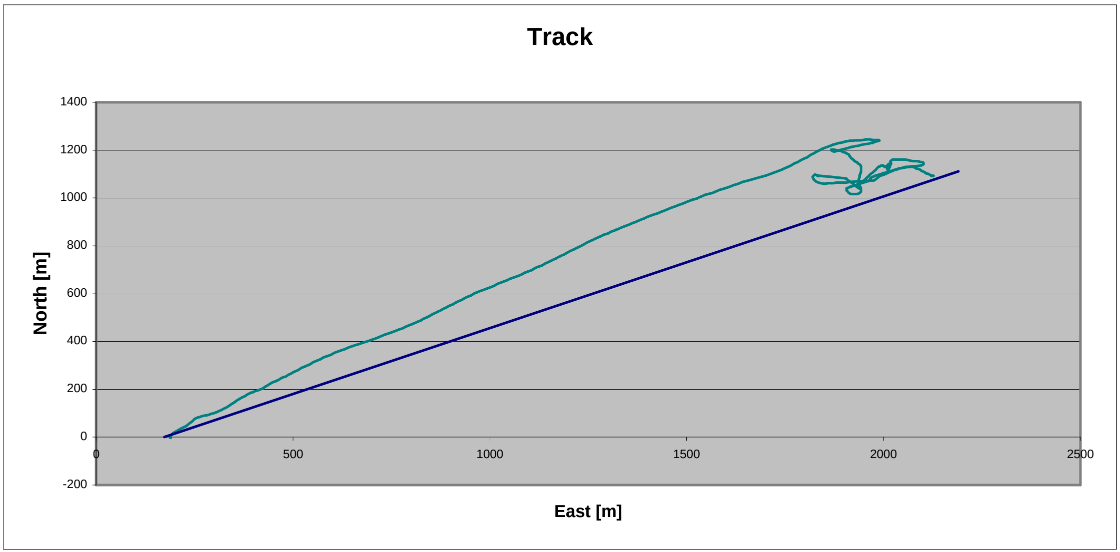
Weight High






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
time [sec]


G
3.5
3
2.5
2
1.5
1
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
0:12:58
time [sec]

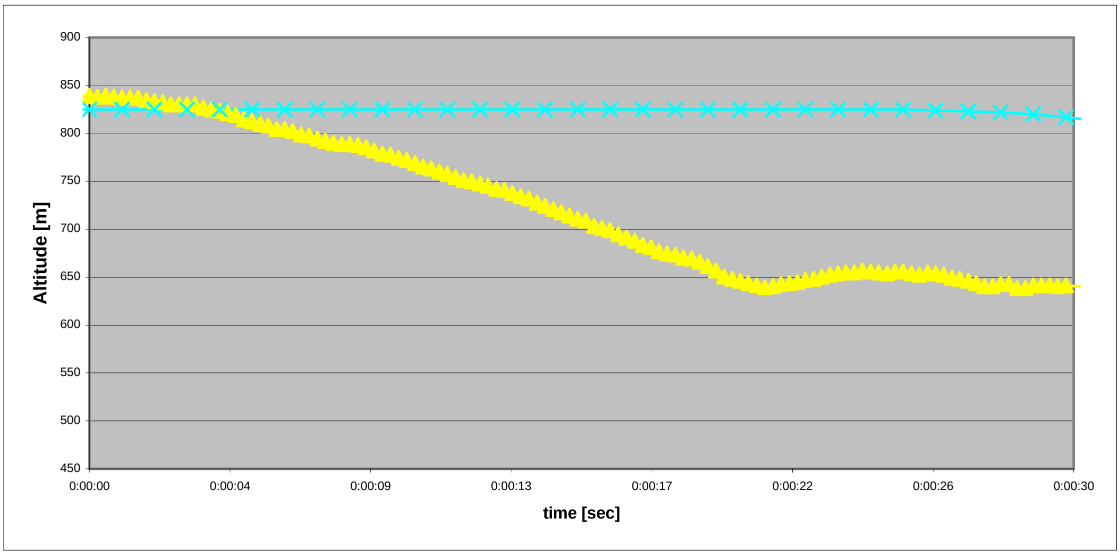

Track
North [m]
1400
1200
1000
800
600
400
200
0
-200
0
500
1000
1500
2000
2500
East [m]

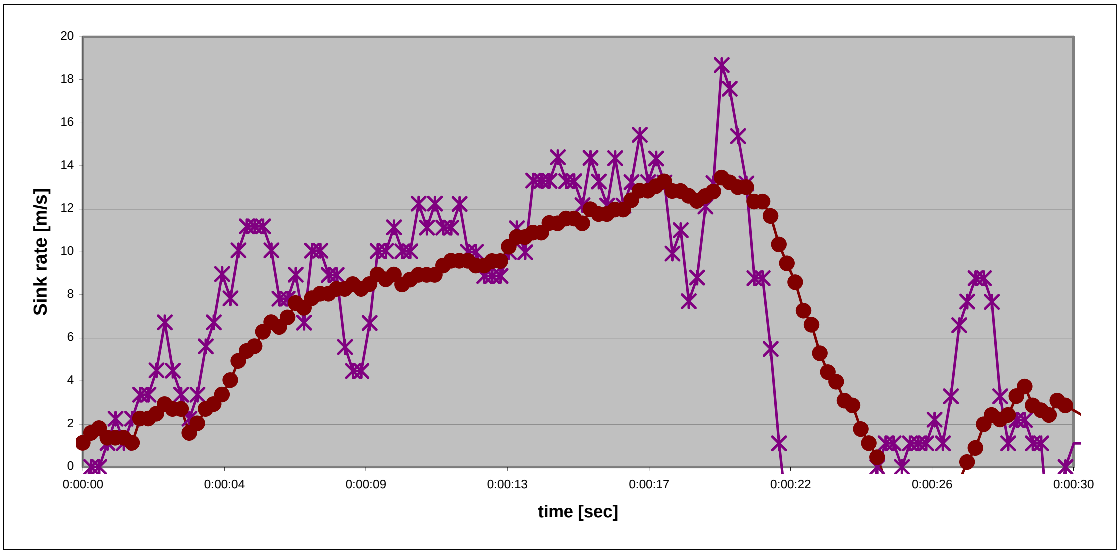
Run 7A

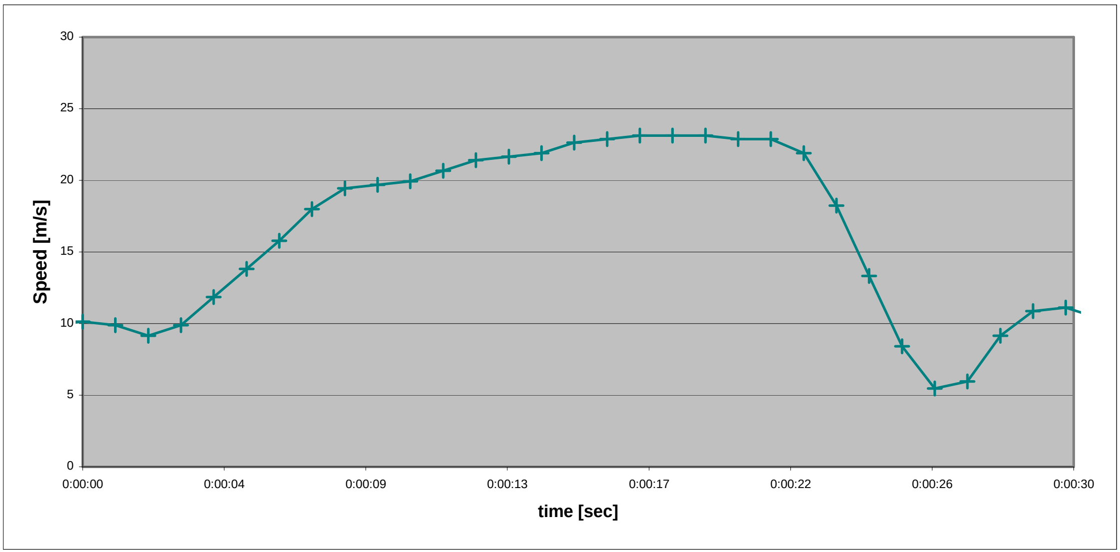
Pilot 3

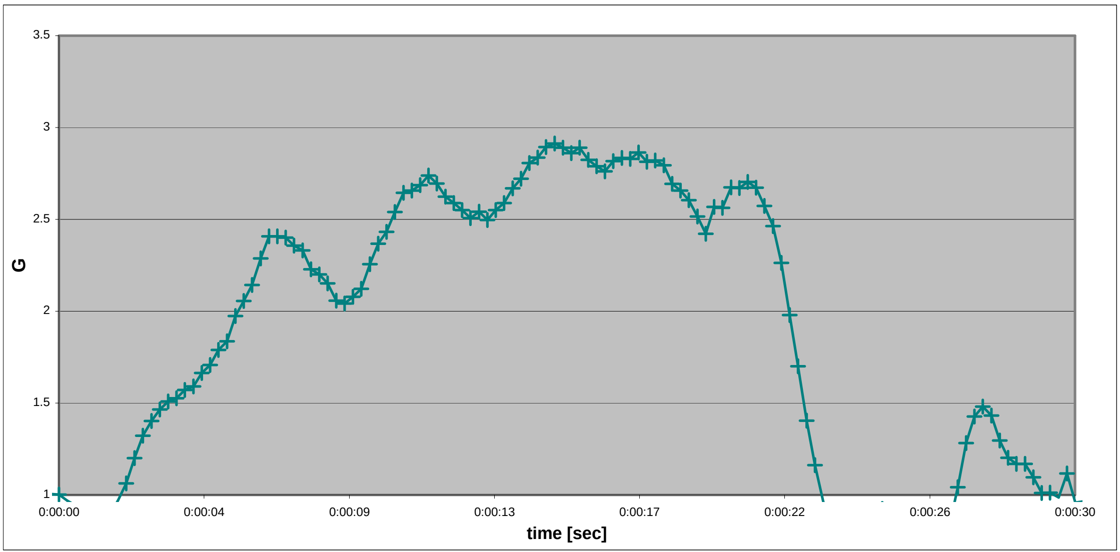
Wing LTF 2

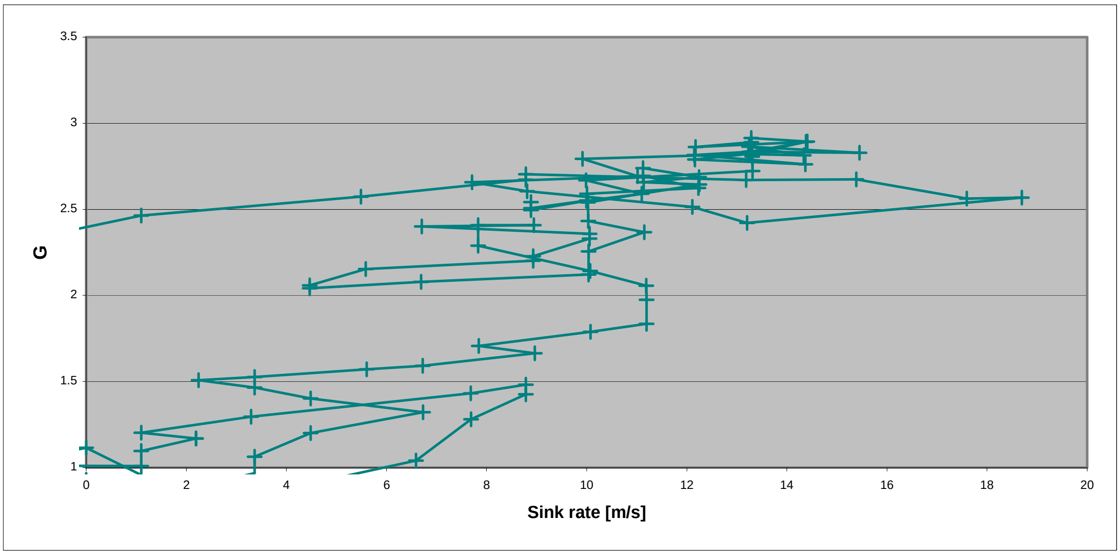
Weight High






Speed [m/s]
time [sec]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30


G
time [sec]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30

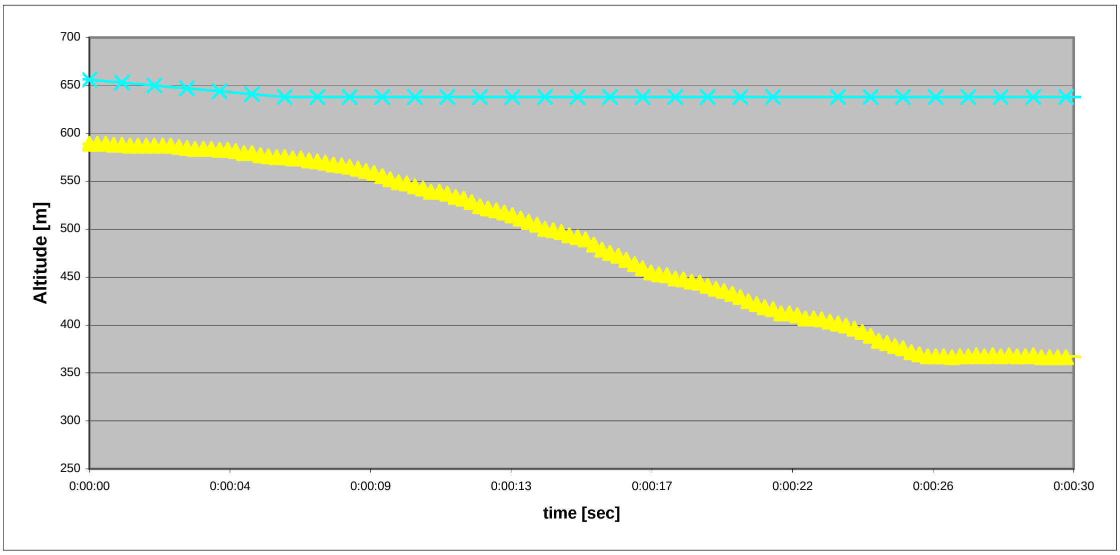

G
Sink rate [m/s]

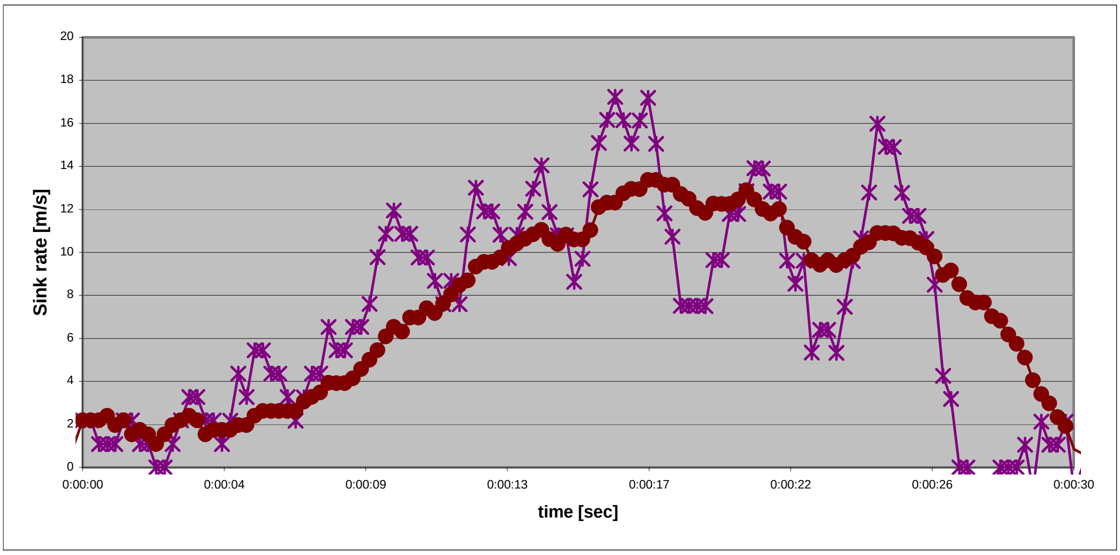
Run 7B

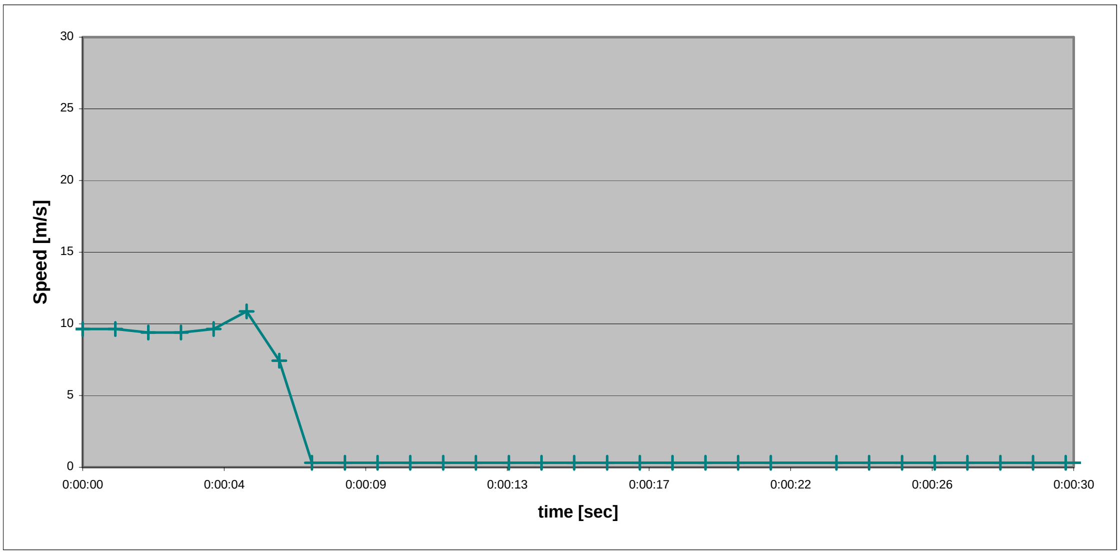
Pilot 3

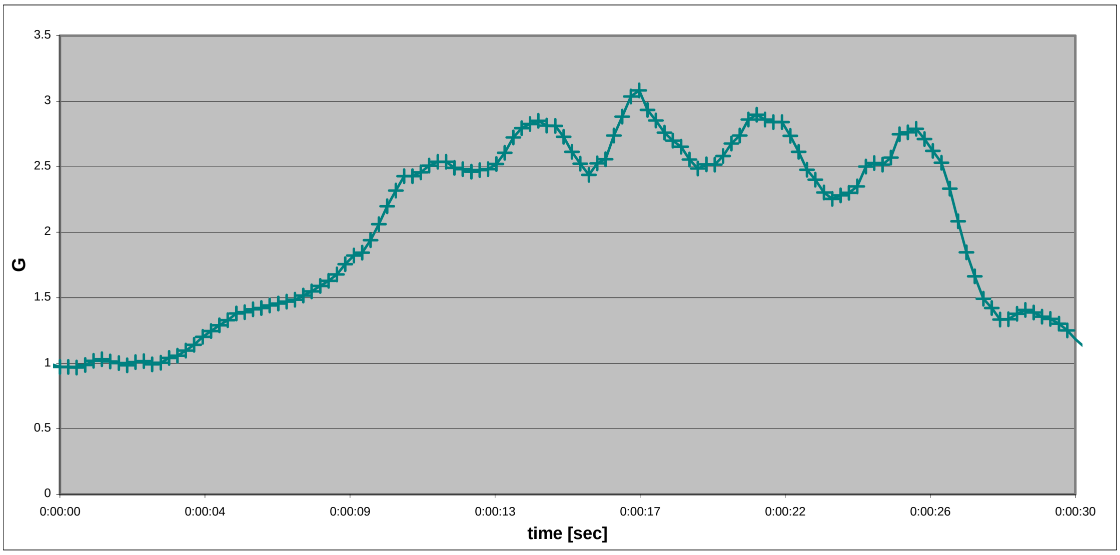
Wing LTF 2

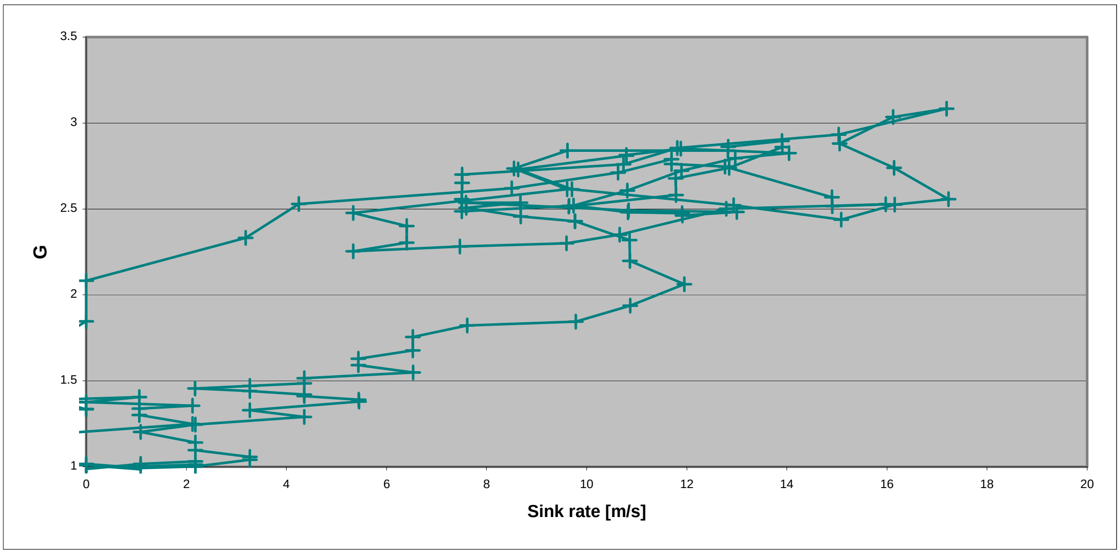
Weight High






Speed [m/s]
time [sec]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30


G
time [sec]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30


G
Sink rate [m/s]

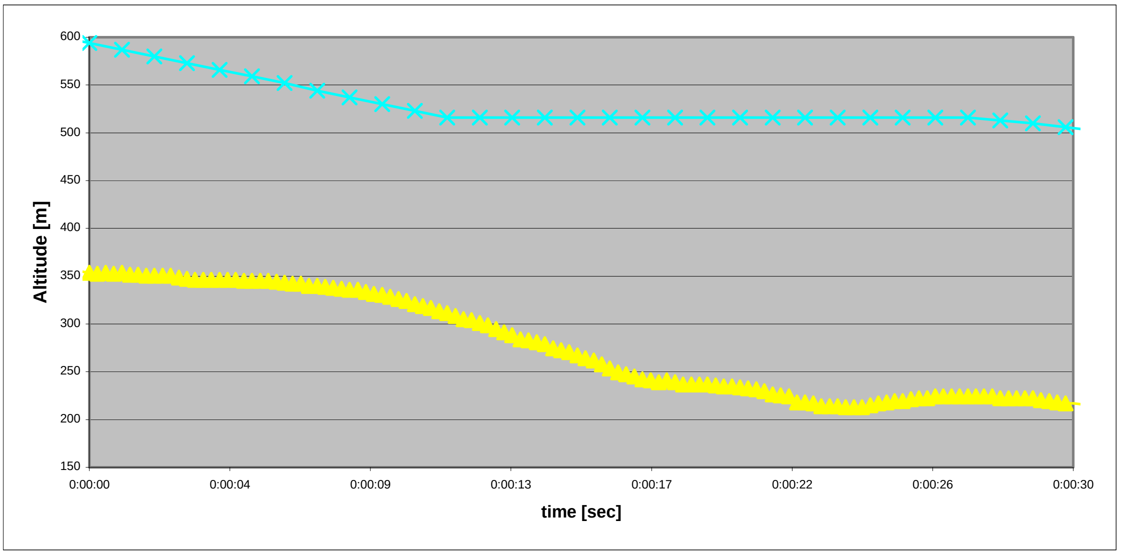
Run 7C

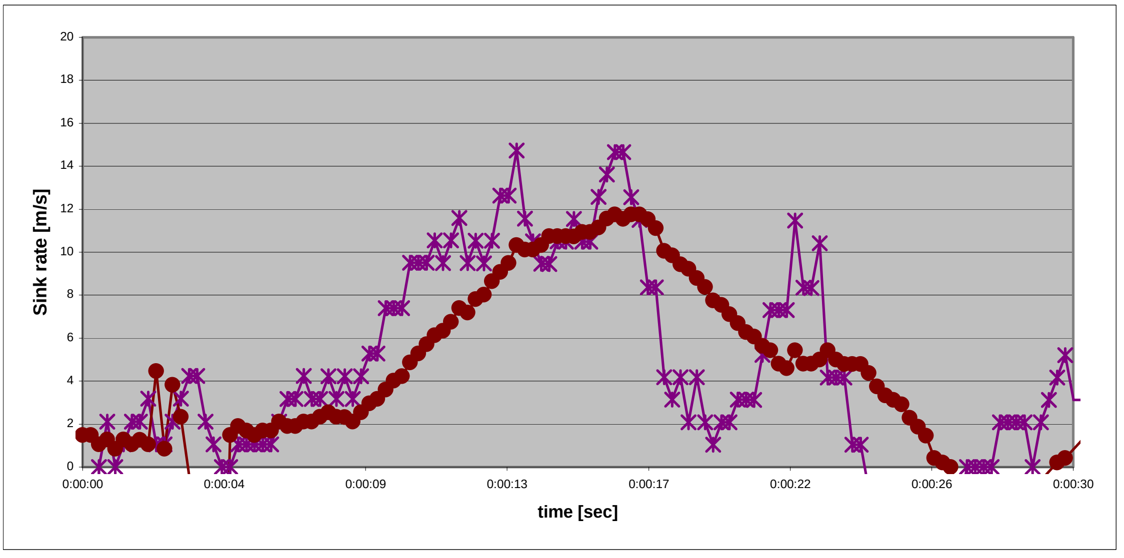
Pilot 3

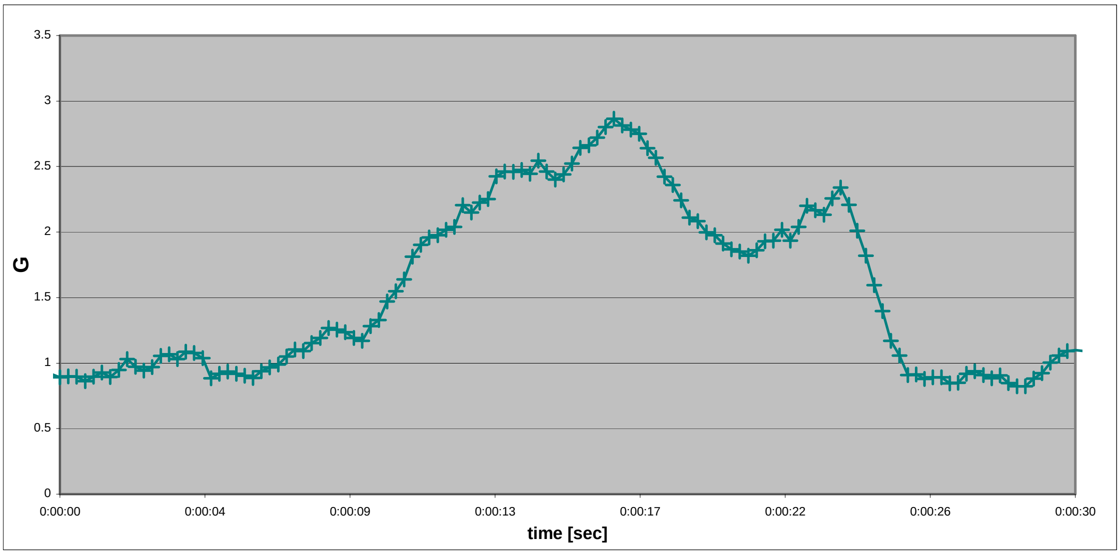
Wing LTF 2

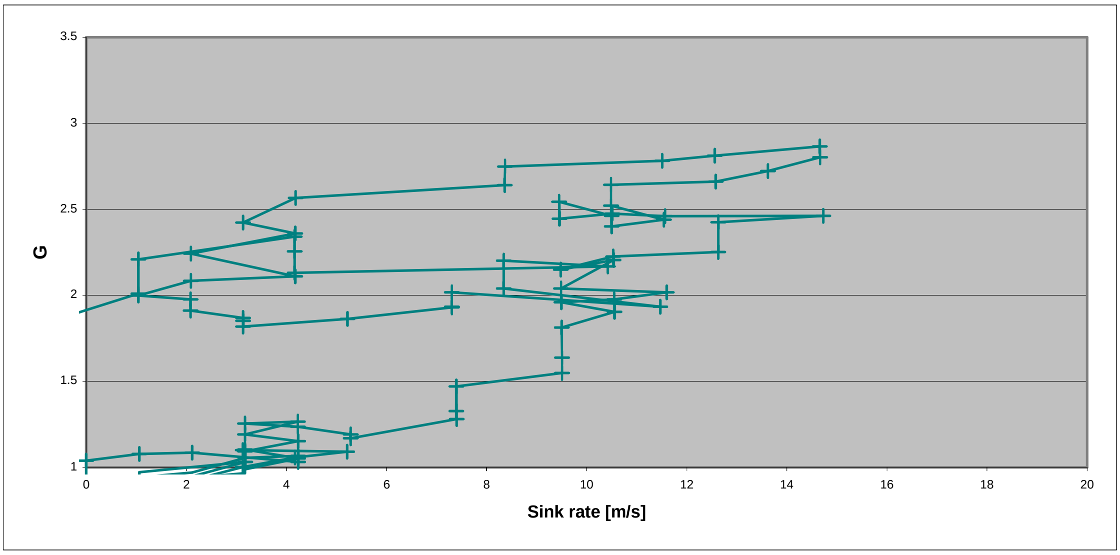
Weight High

(no speed data)






3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

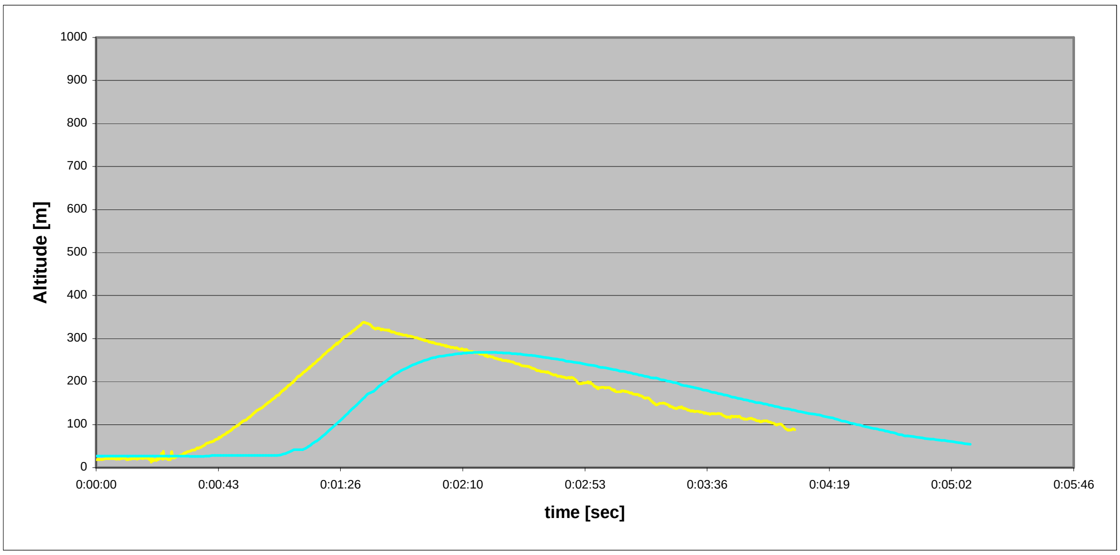

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

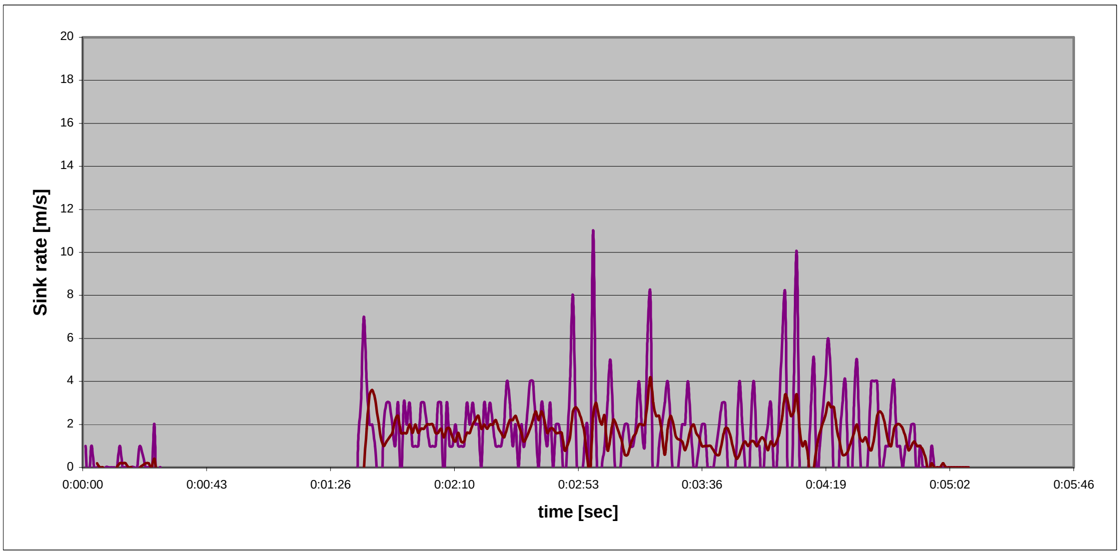
Run 8

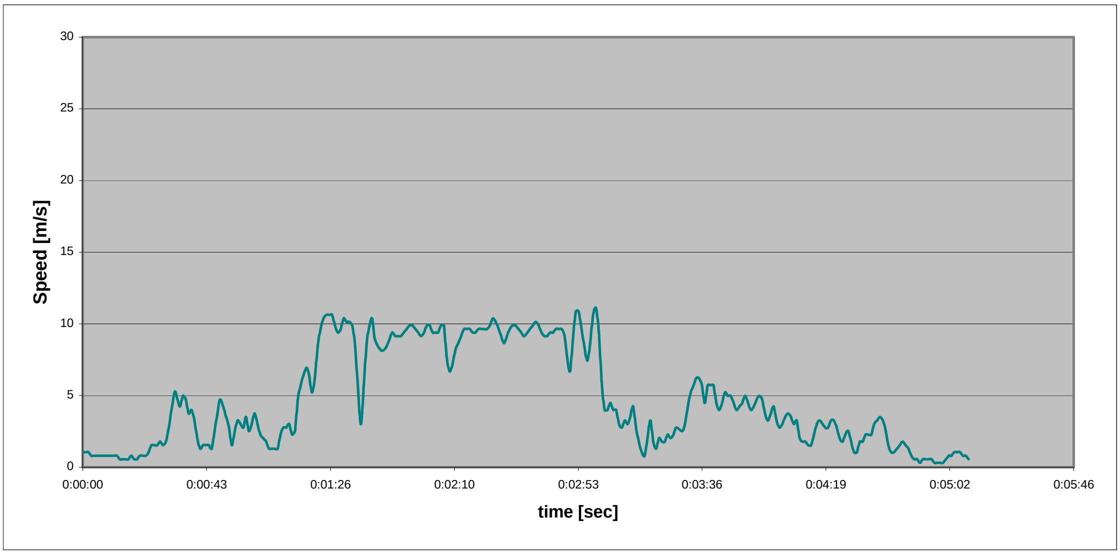
Pilot 3

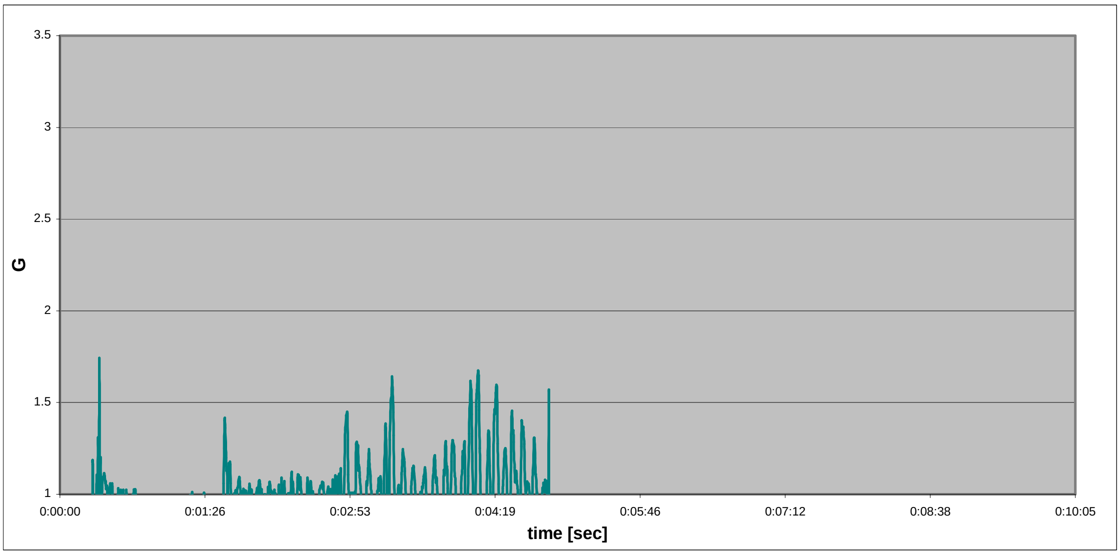
Wing LTF 1-2

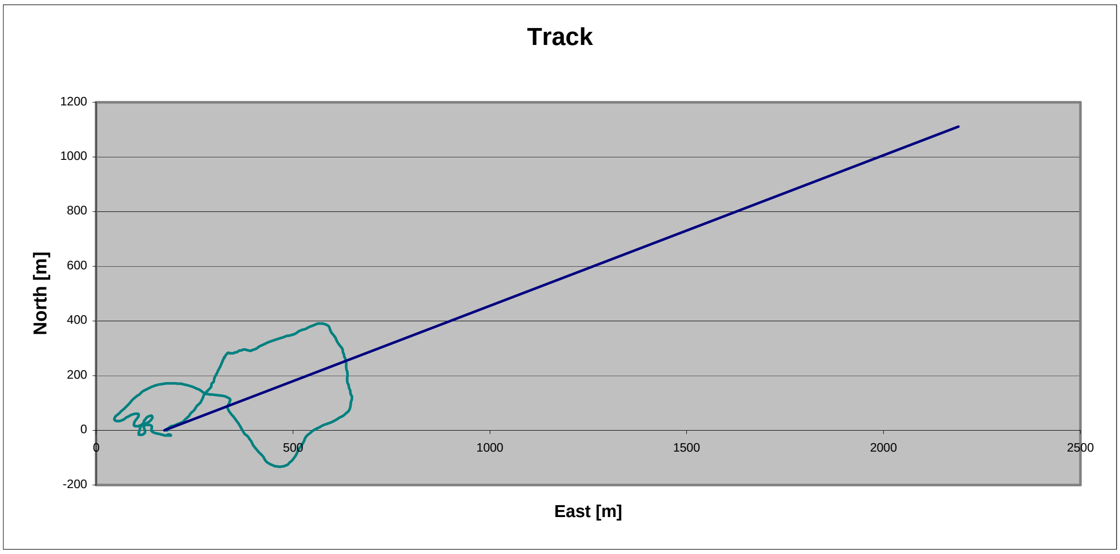
Weight Low






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:43
0:01:26
0:02:10
0:02:53
0:03:36
0:04:19
0:05:02
0:05:46
time [sec]


3.5
3
2.5
2
1.5
1
G
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
time [sec]

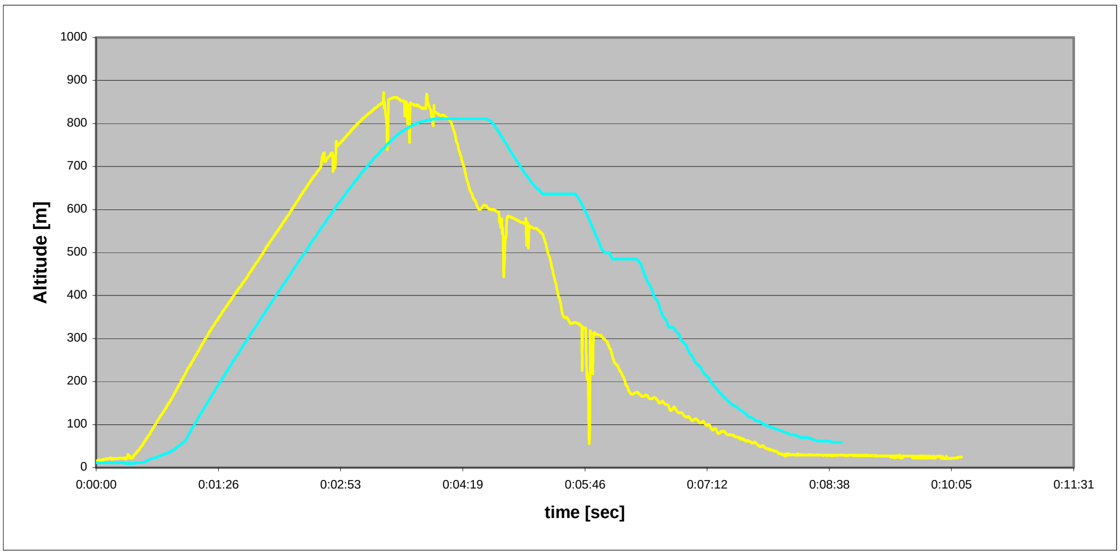

Track
1200
1000
800
600
400
200
0
-200
North [m]
0
500
1000
1500
2000
2500
East [m]

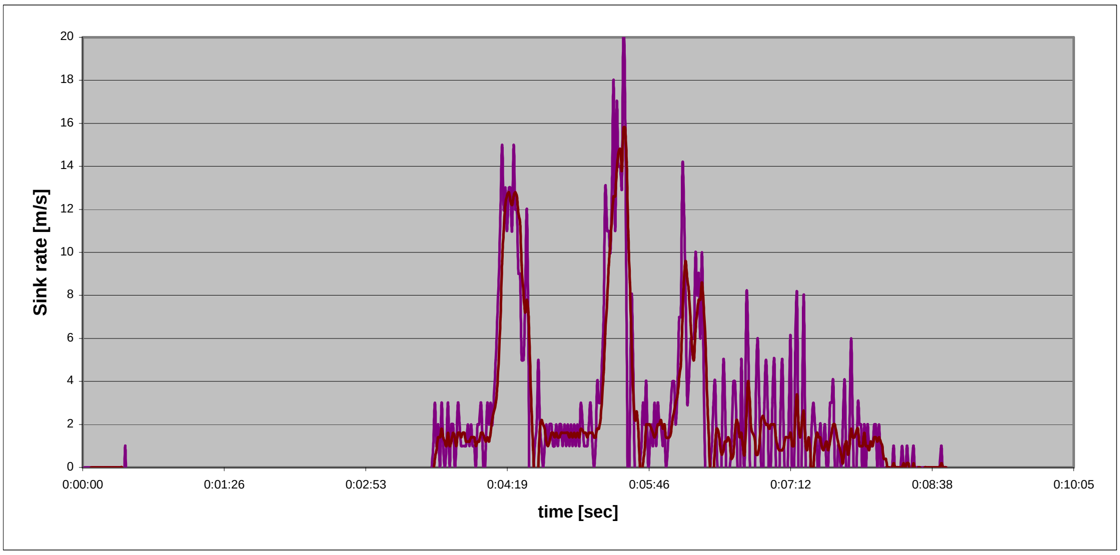
Run 9

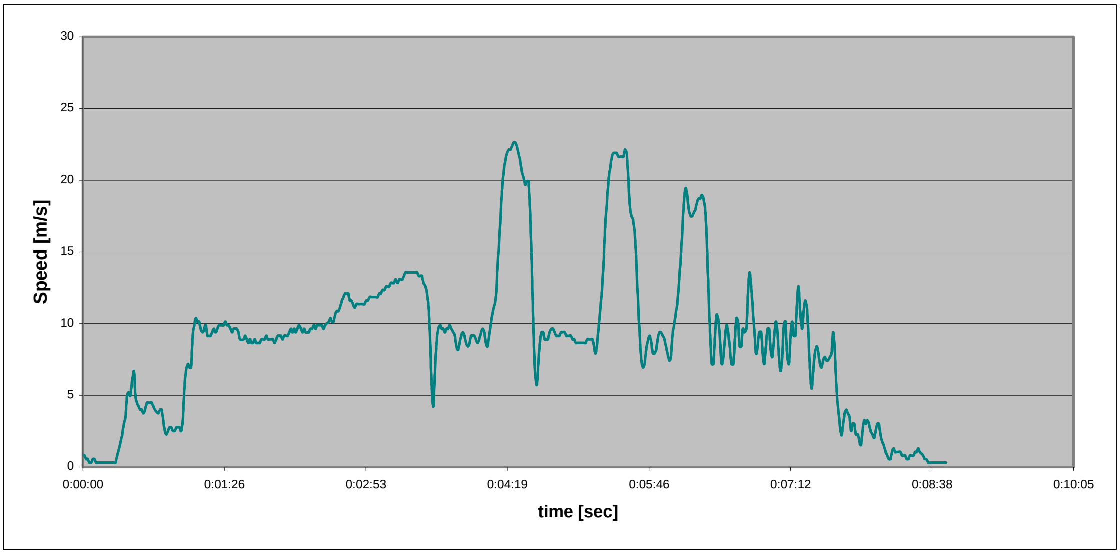
Pilot 3

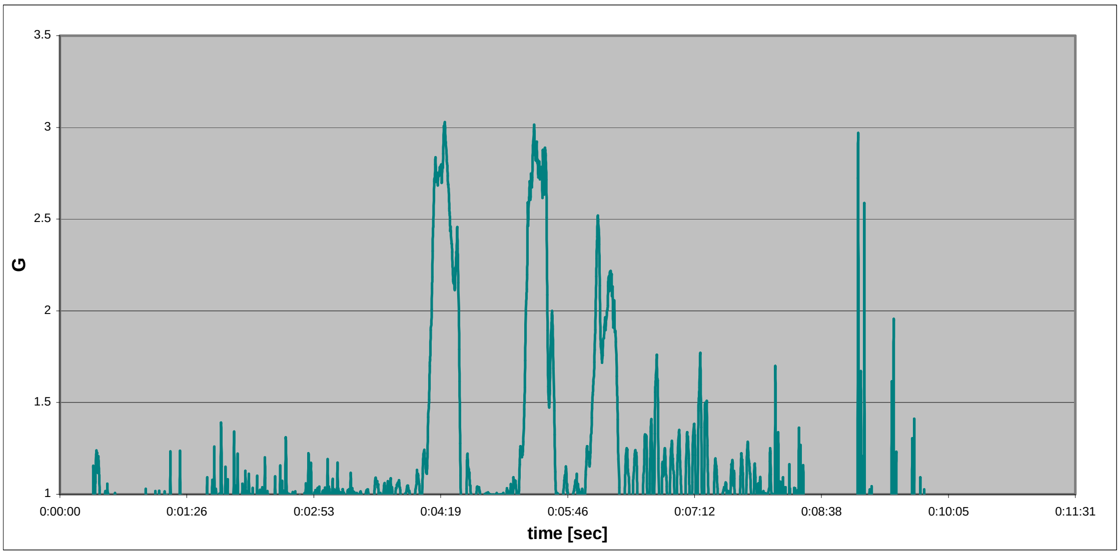
Wing LTF 1-2

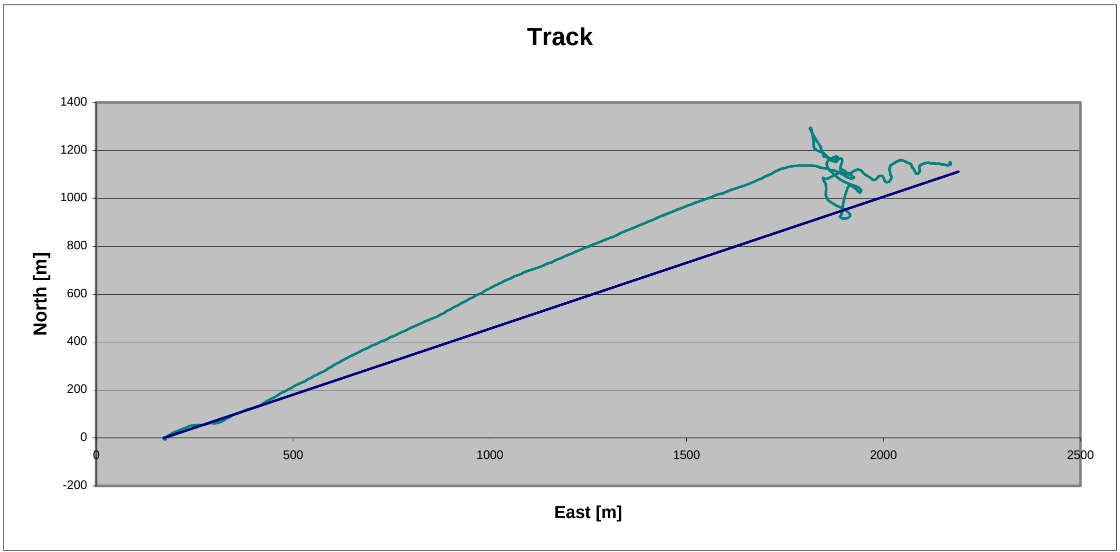
Weight Low






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
time [sec]


G
3.5
3
2.5
2
1.5
1
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
time [sec]

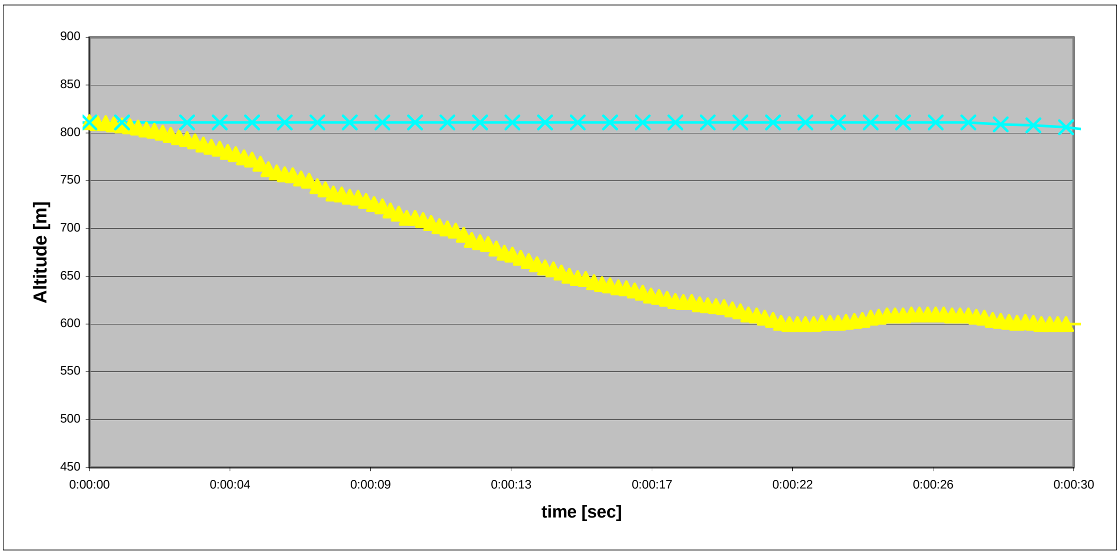

Track
North [m]
1400
1200
1000
800
600
400
200
0
-200
0
500
1000
1500
2000
2500
East [m]

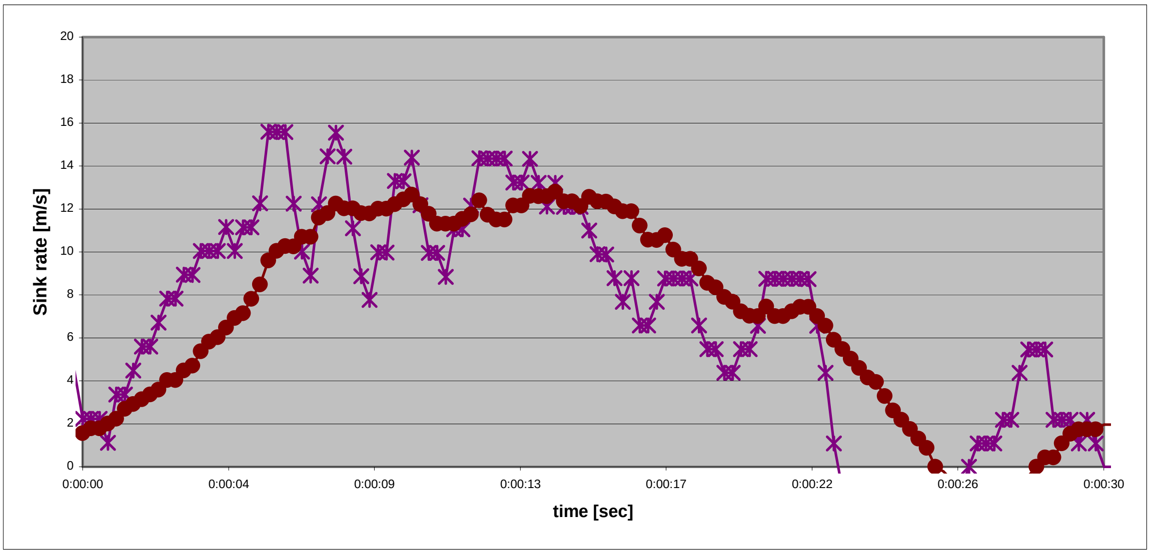
Run 9A

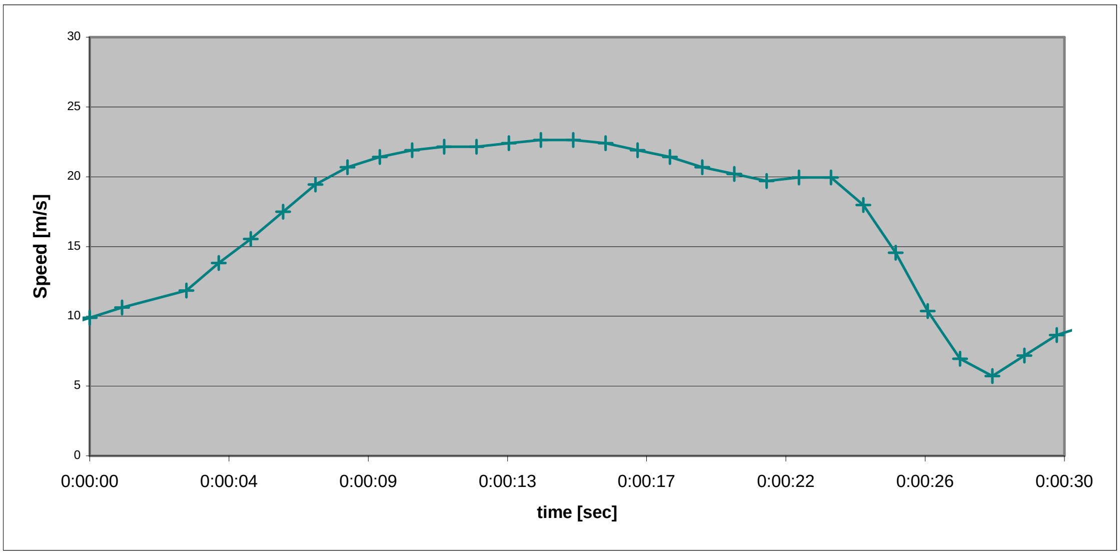
Pilot 3

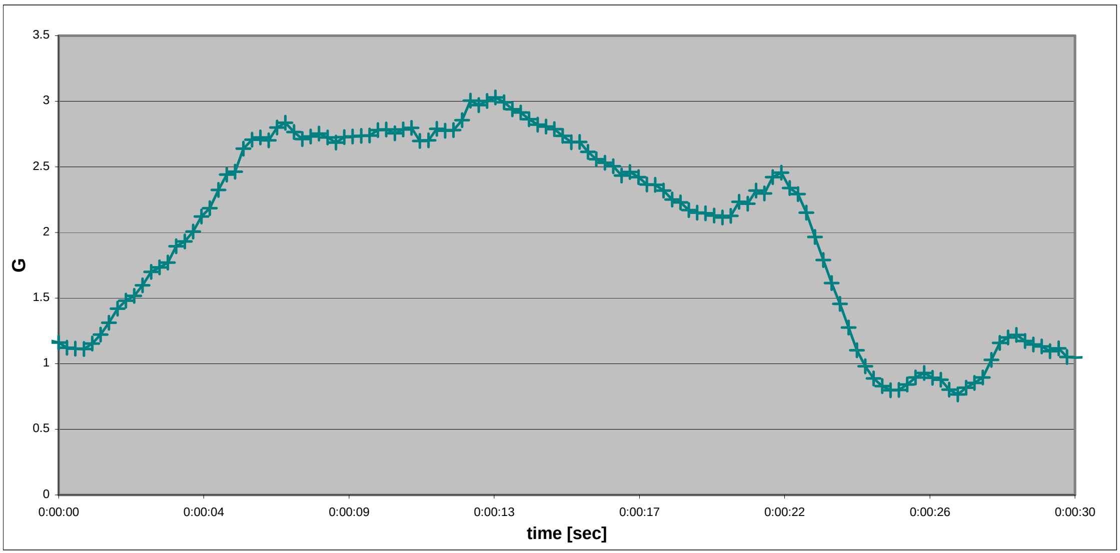
Wing LTF 1-2

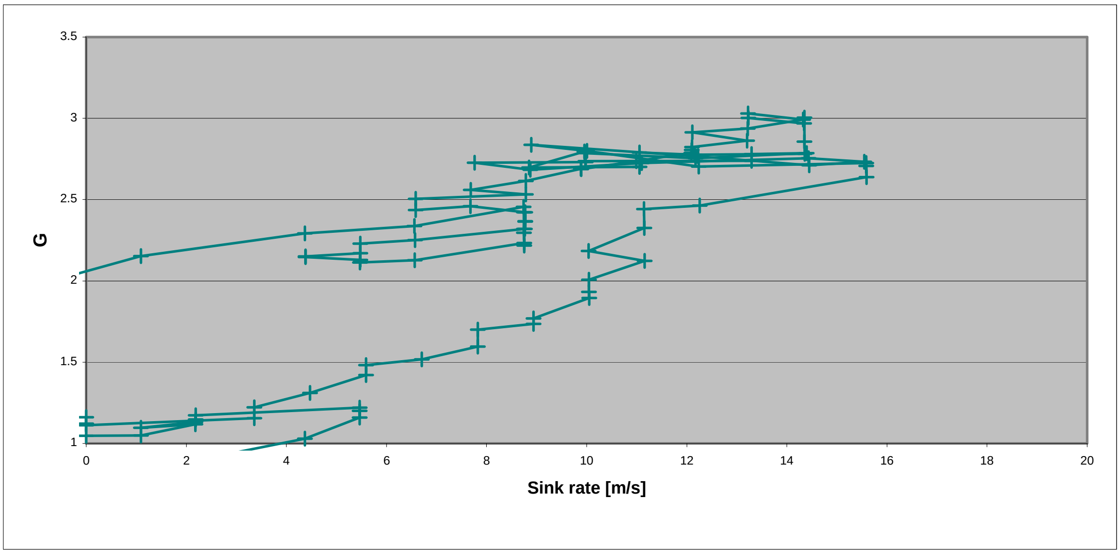
Weight Low






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


G
3.5
3
2.5
2
1.5
1
0.5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

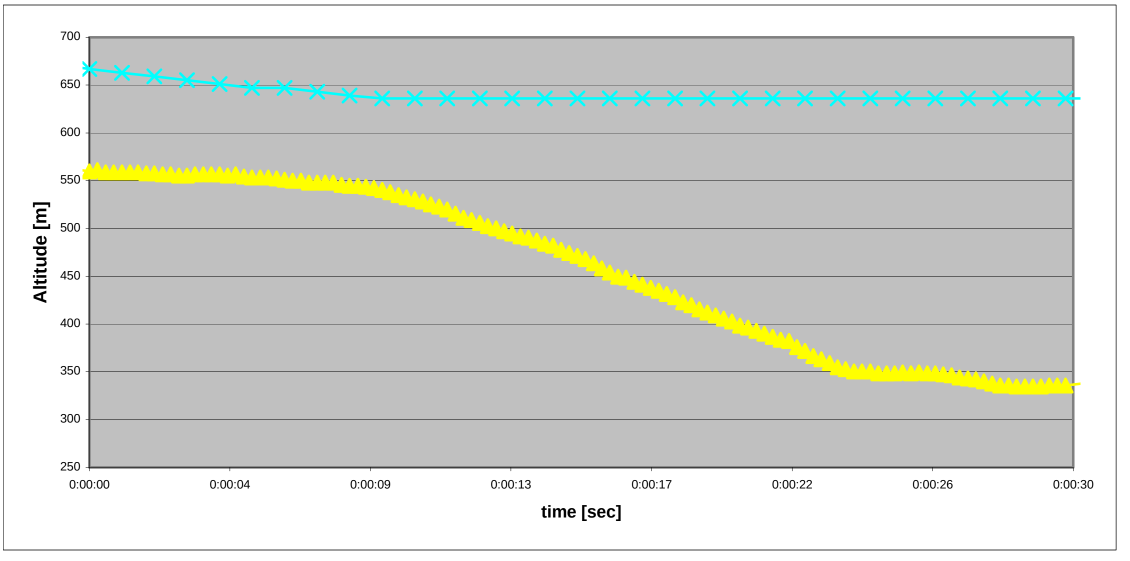

G
3.5
3
2.5
2
1.5
1
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

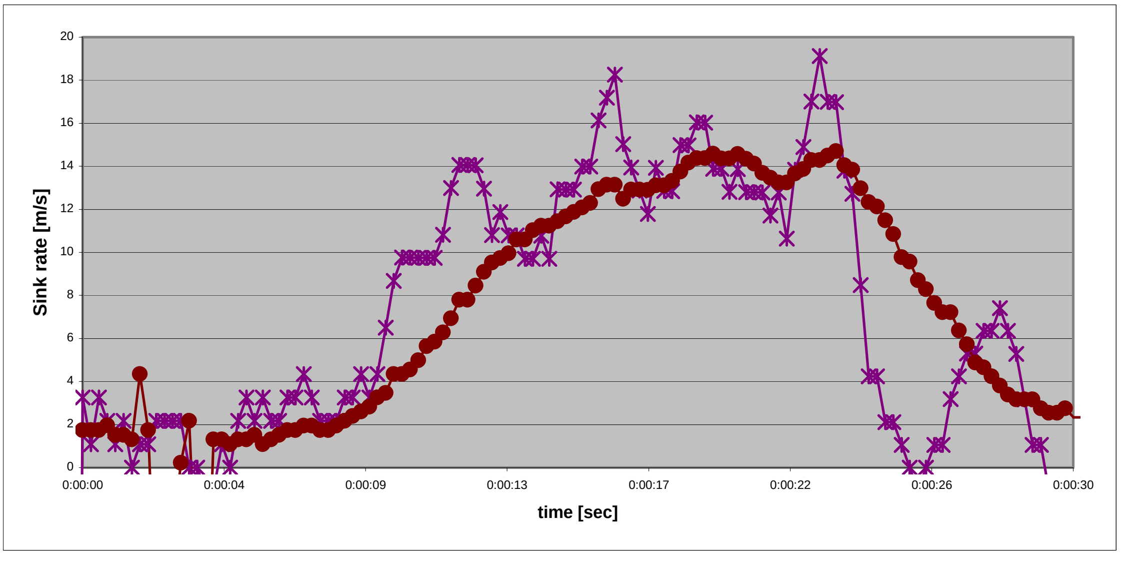
Run 9B

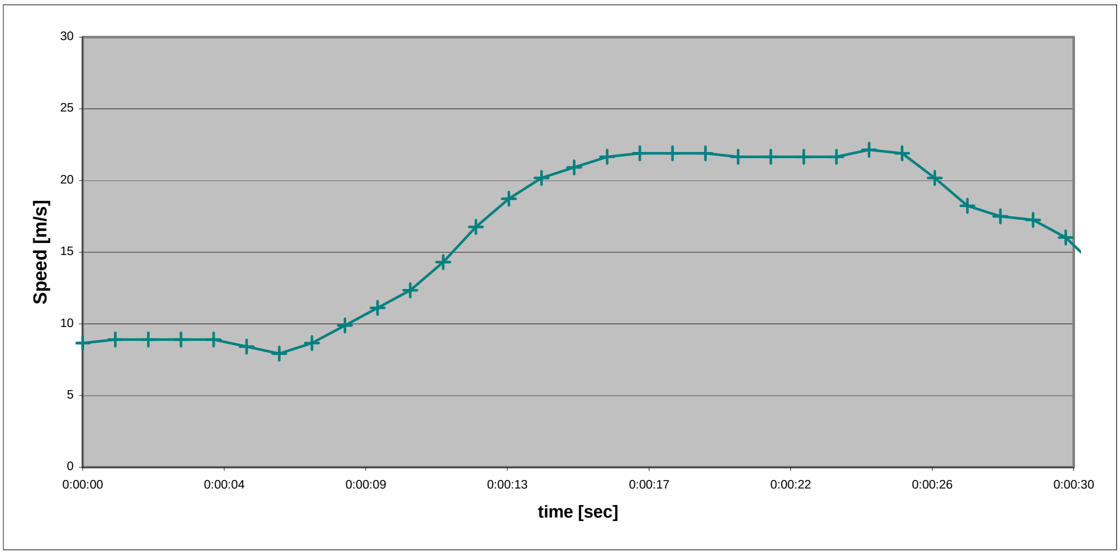
Pilot 3

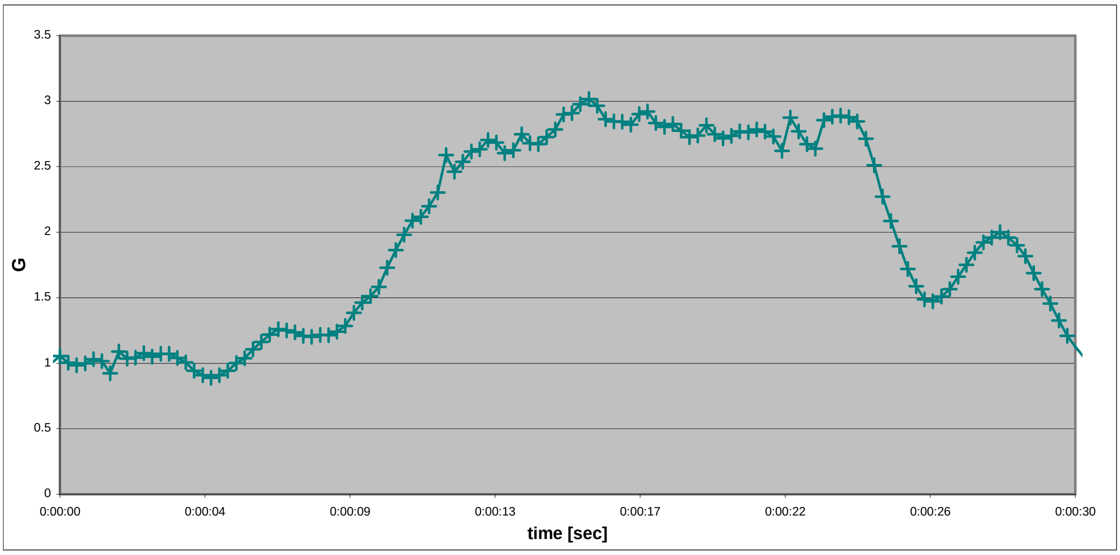
Wing LTF 1-2

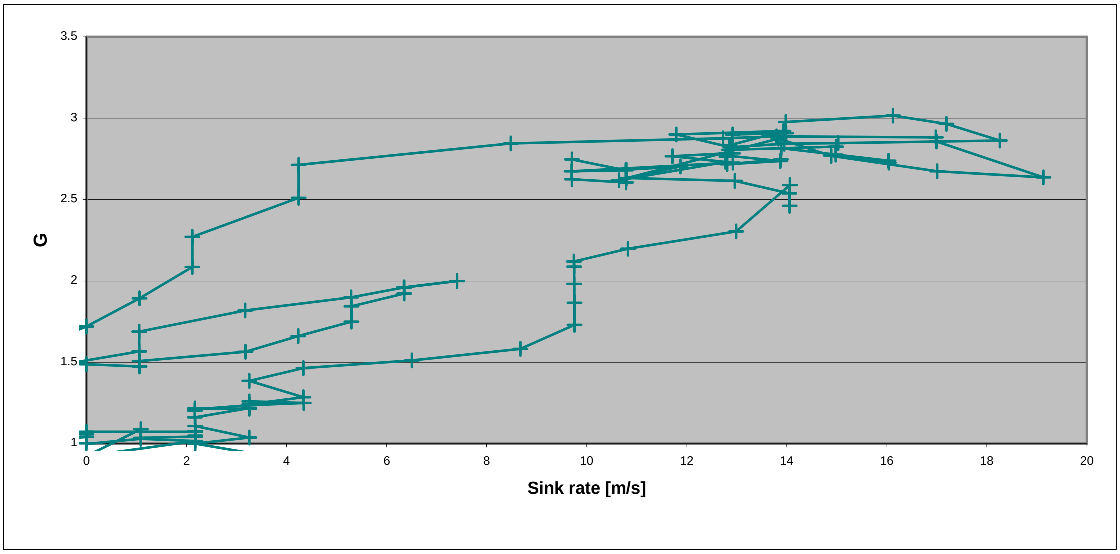
Weight Low






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

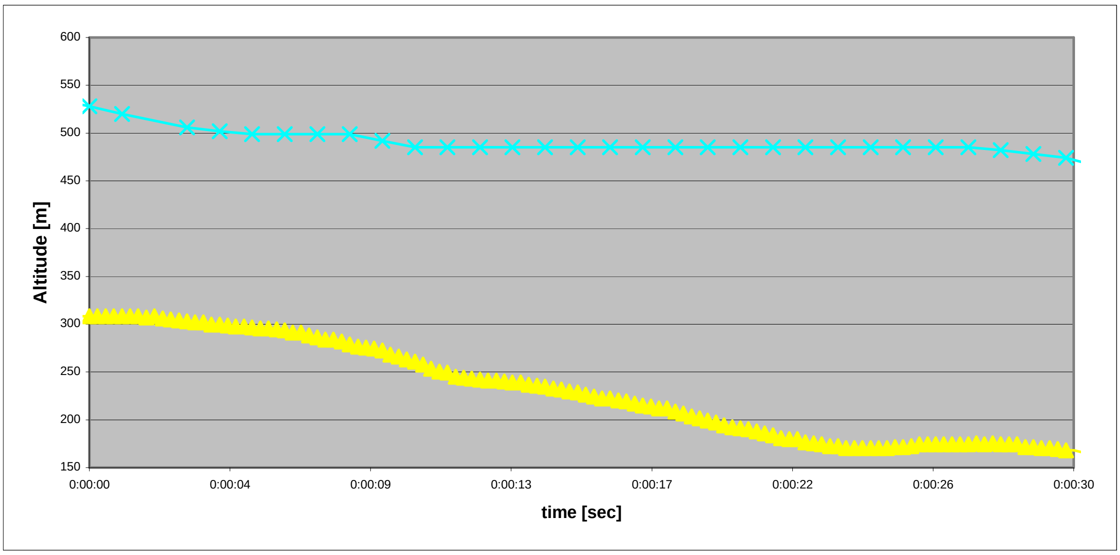

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

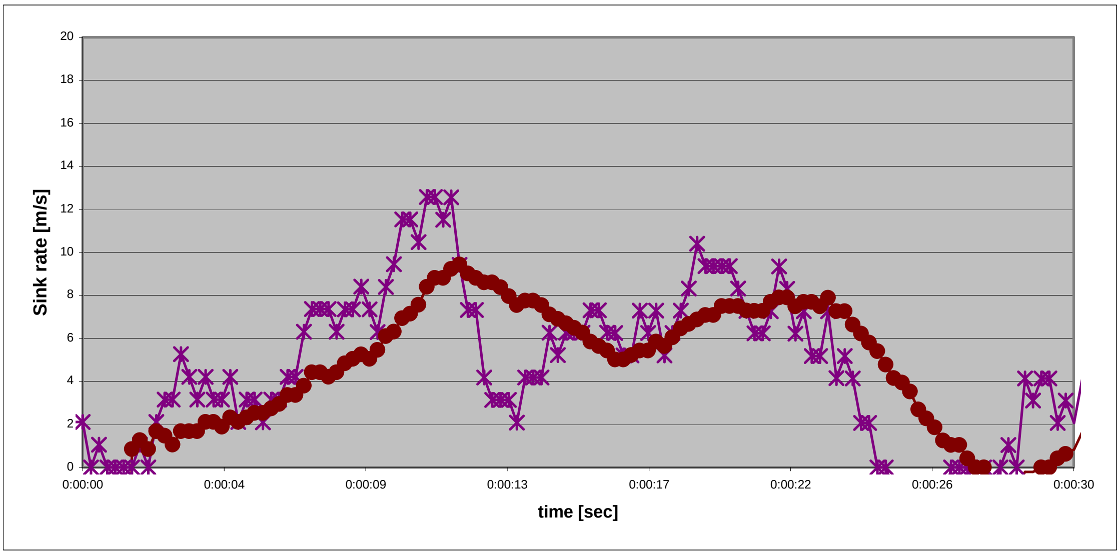
Run 9C

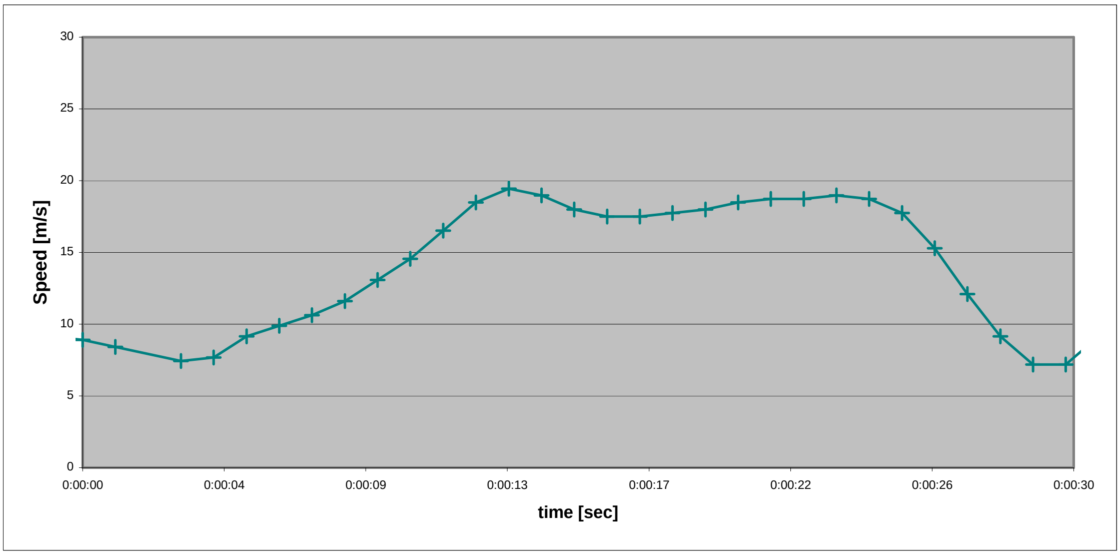
Pilot 3

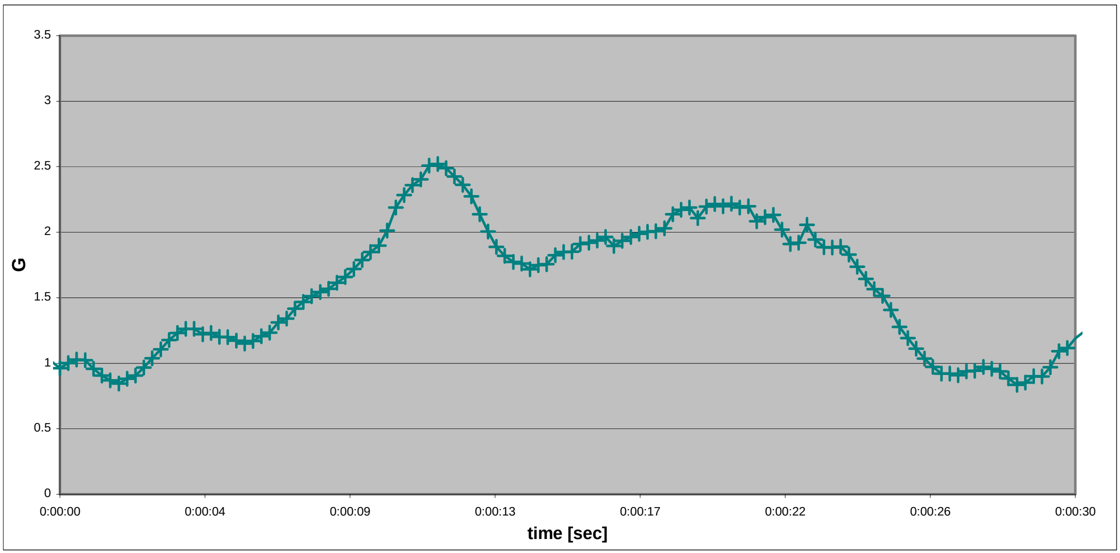
Wing LTF 1-2

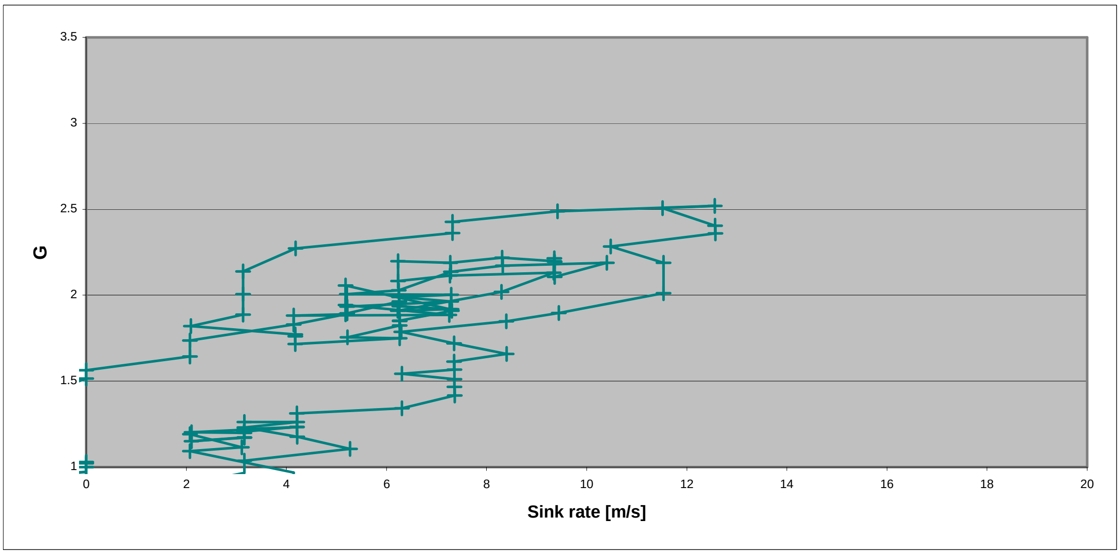
Weight Low






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


G
3.5
3
2.5
2
1.5
1
0.5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

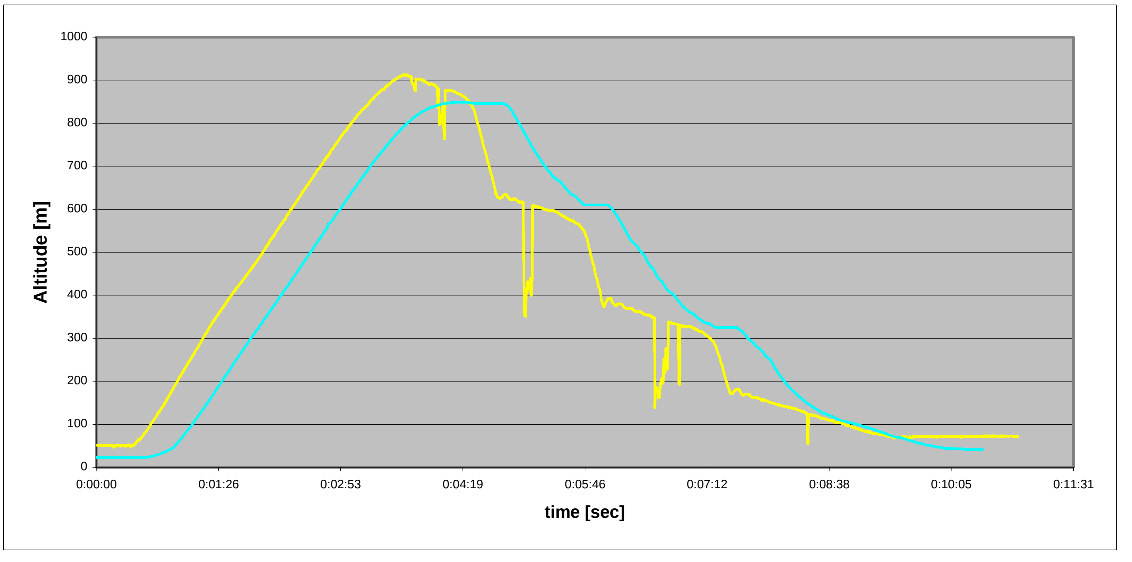

G
3.5
3
2.5
2
1.5
1
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

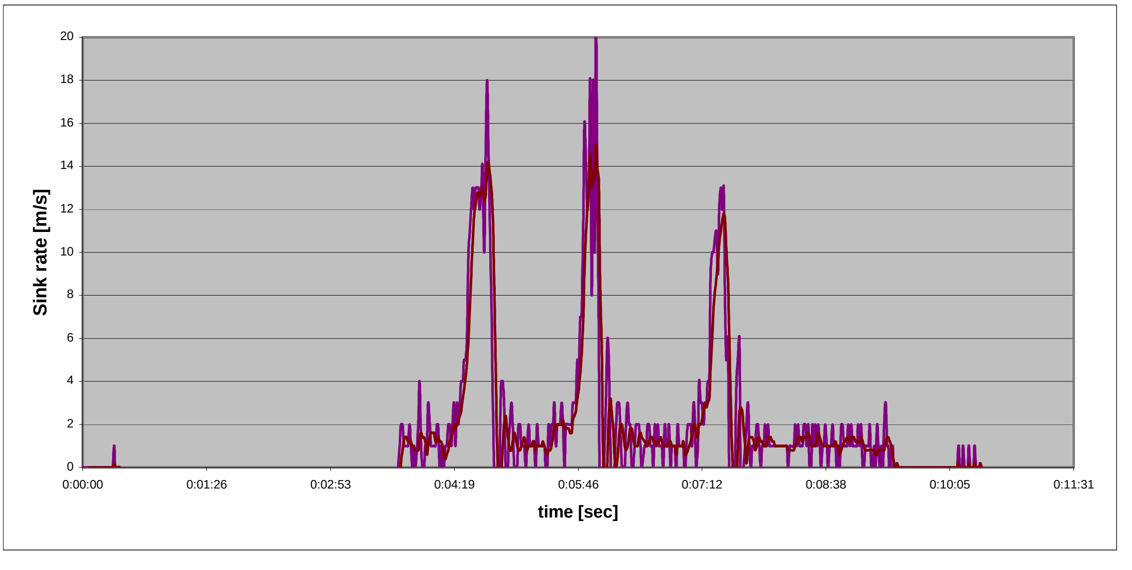
Run 10

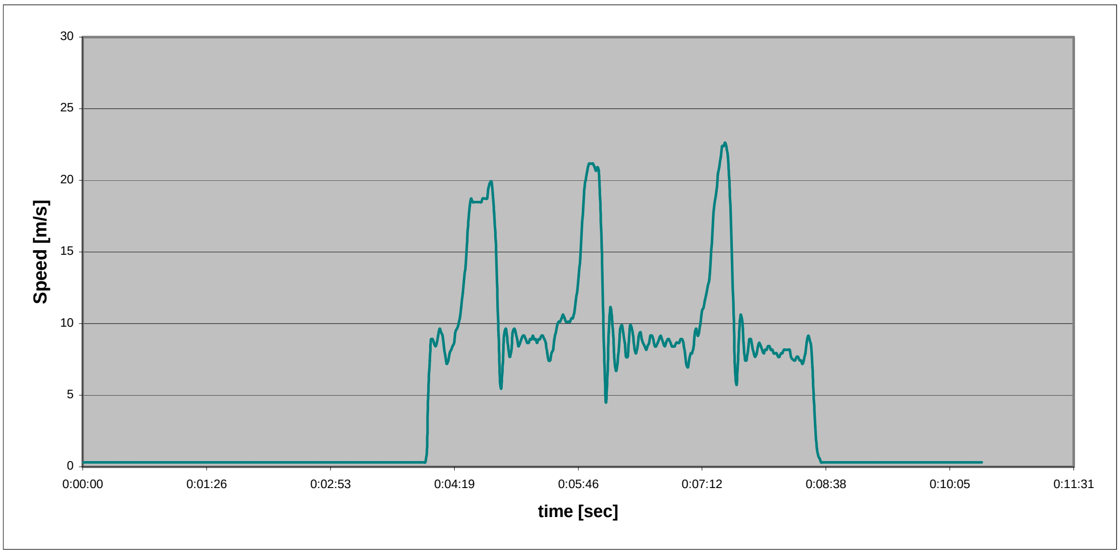
Pilot 1

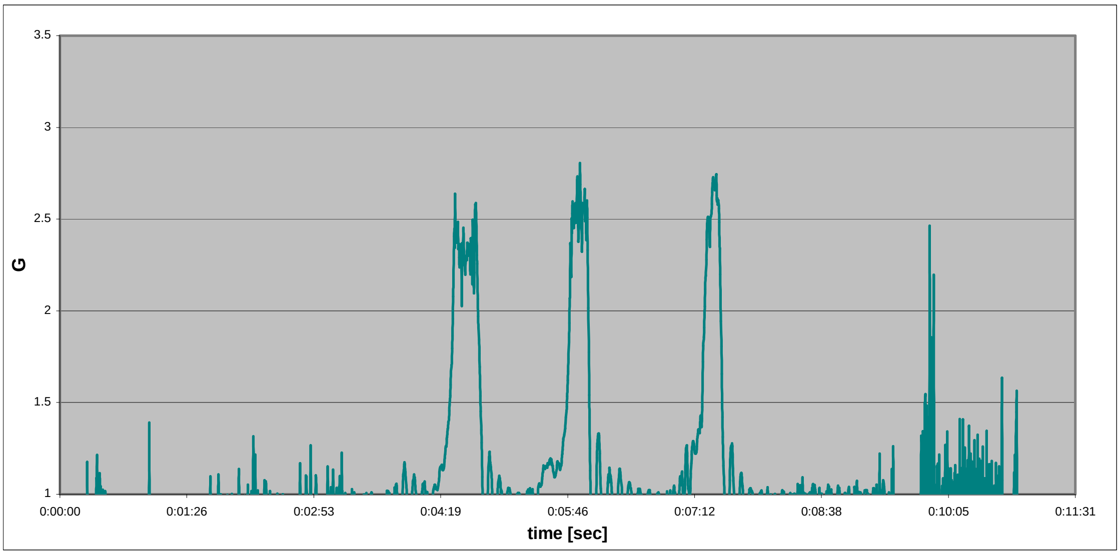
Wing LTF 1

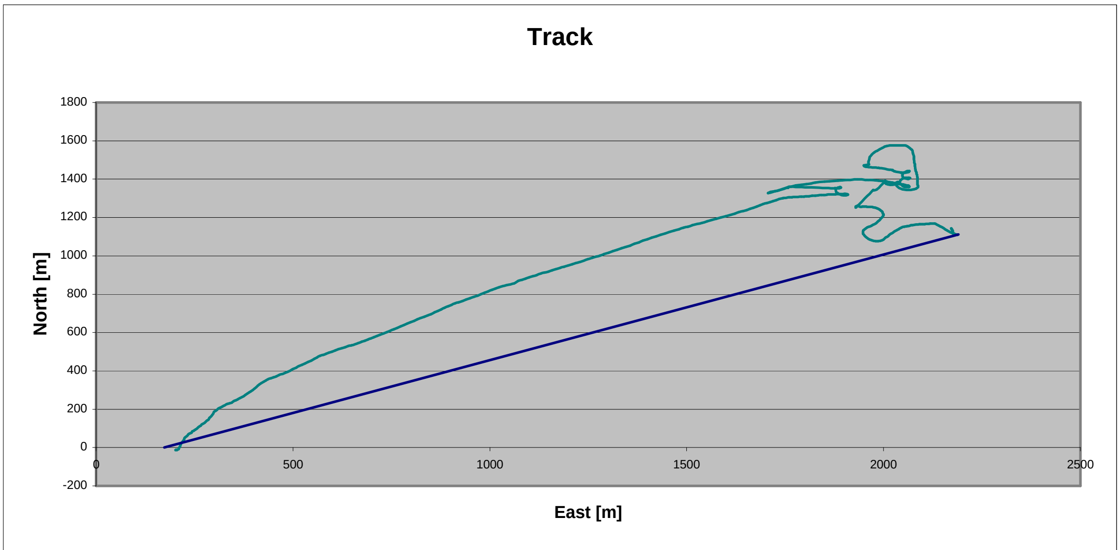
Weight Medium






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
time [sec]


G
3.5
3
2.5
2
1.5
1
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
time [sec]

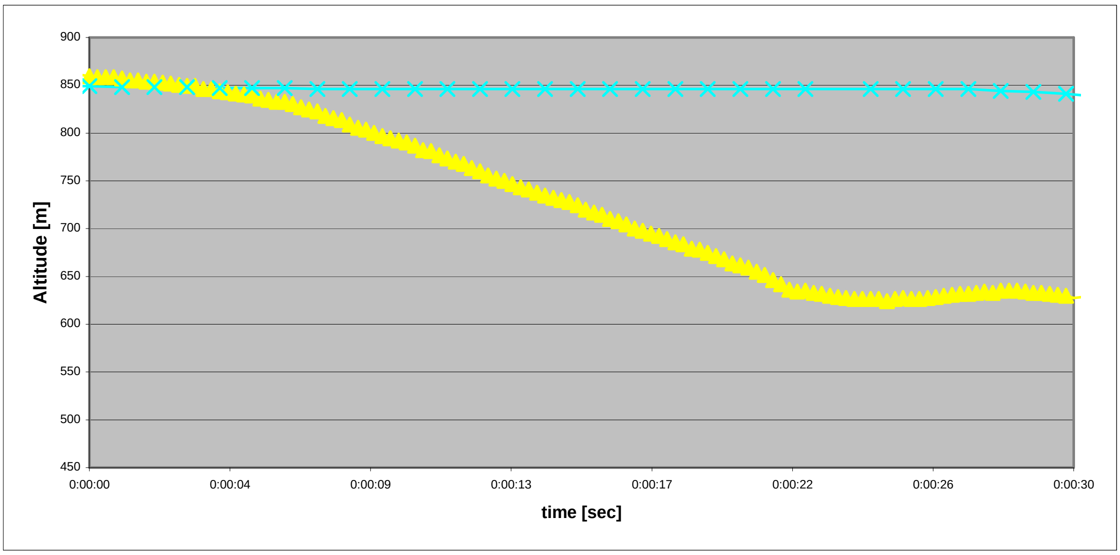

Track
North [m]
1800
1600
1400
1200
1000
800
600
400
200
0
-200
0
500
1000
1500
2000
2500
East [m]

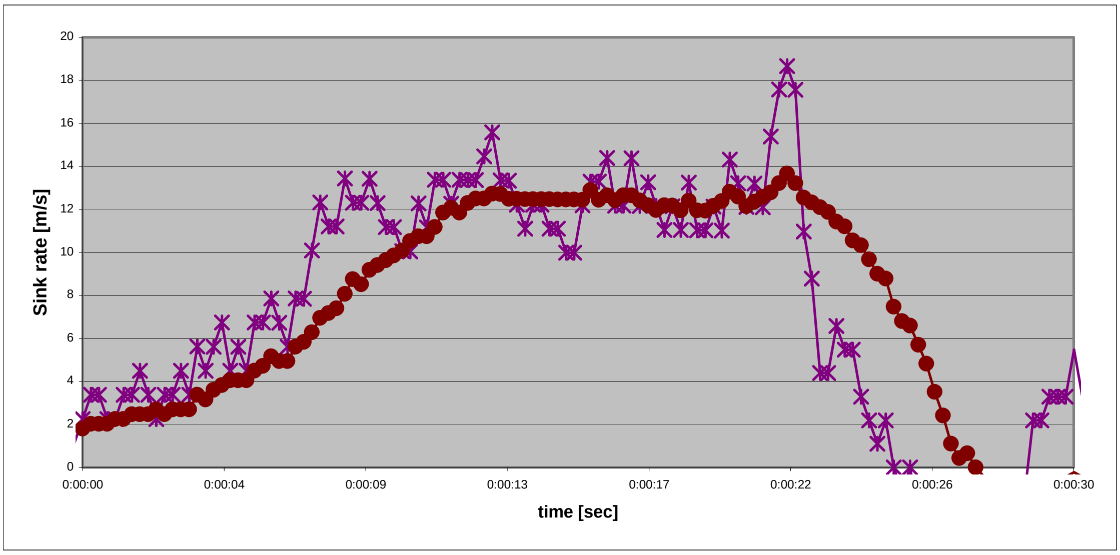
Run 10A

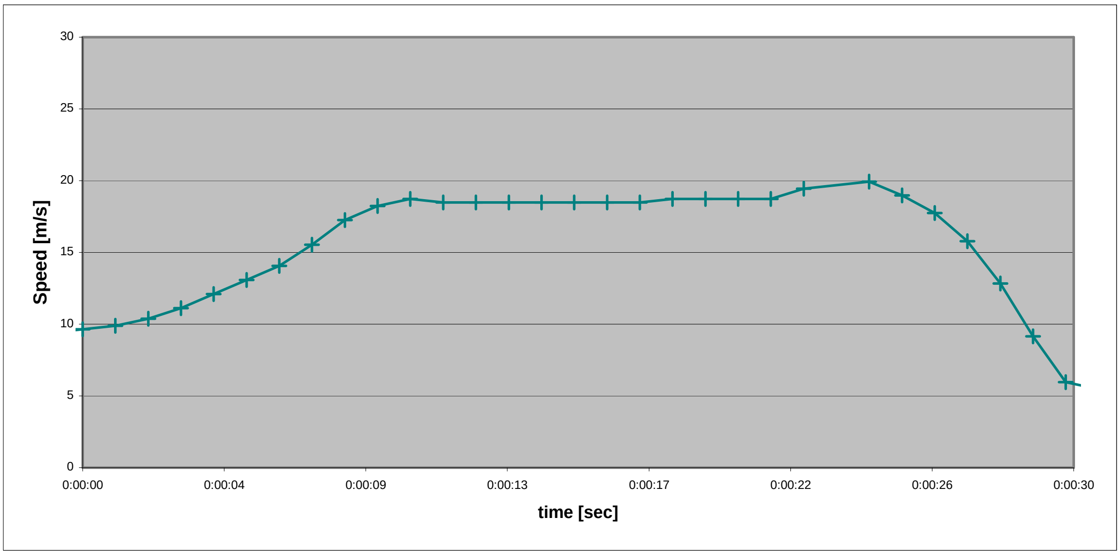
Pilot 1

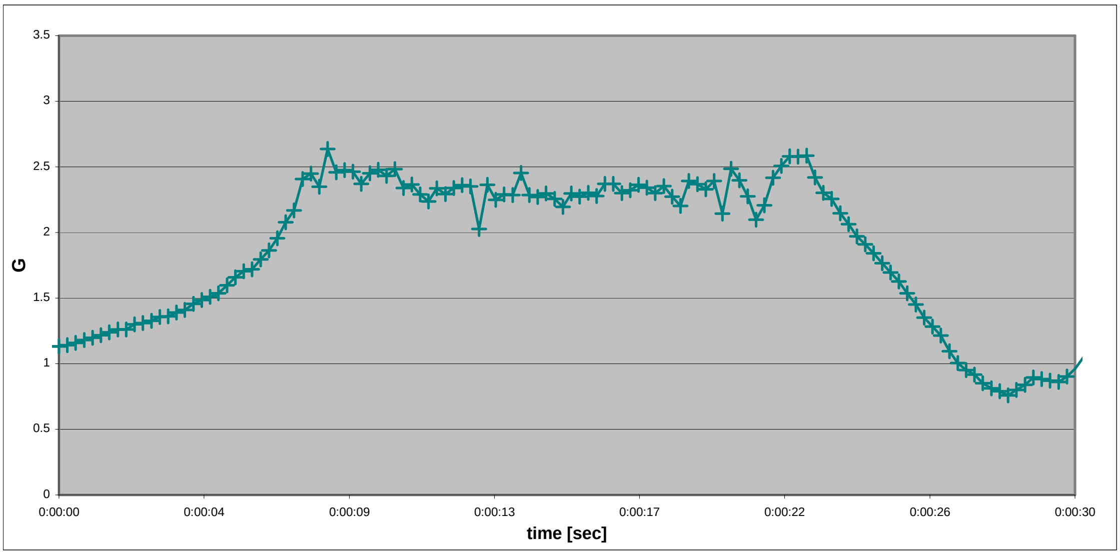
Wing LTF 1

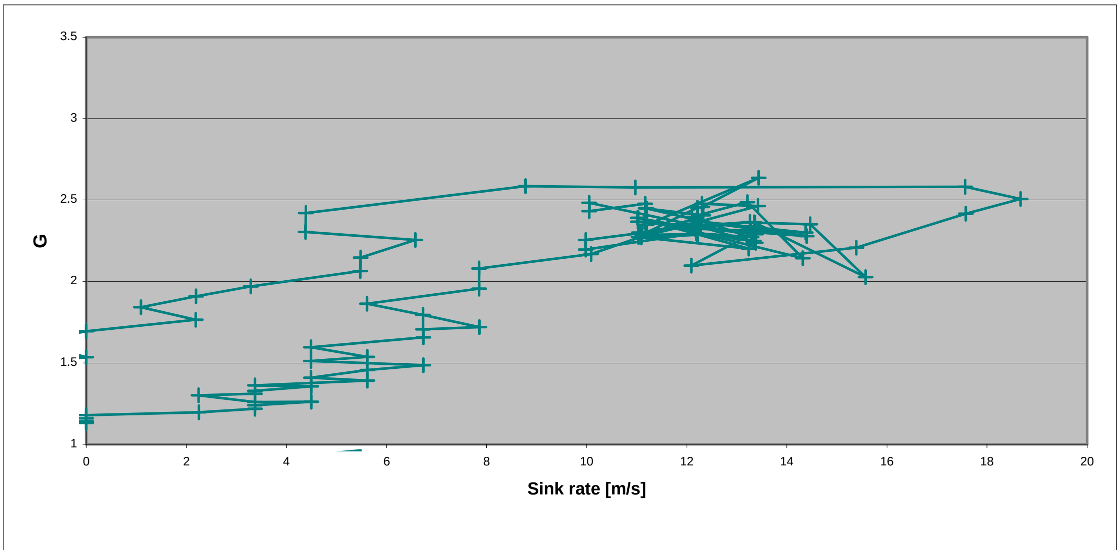
Weight Medium






Speed [m/s]
30
25
20
15
10
5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


G
3.5
3
2.5
2
1.5
1
0.5
0
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

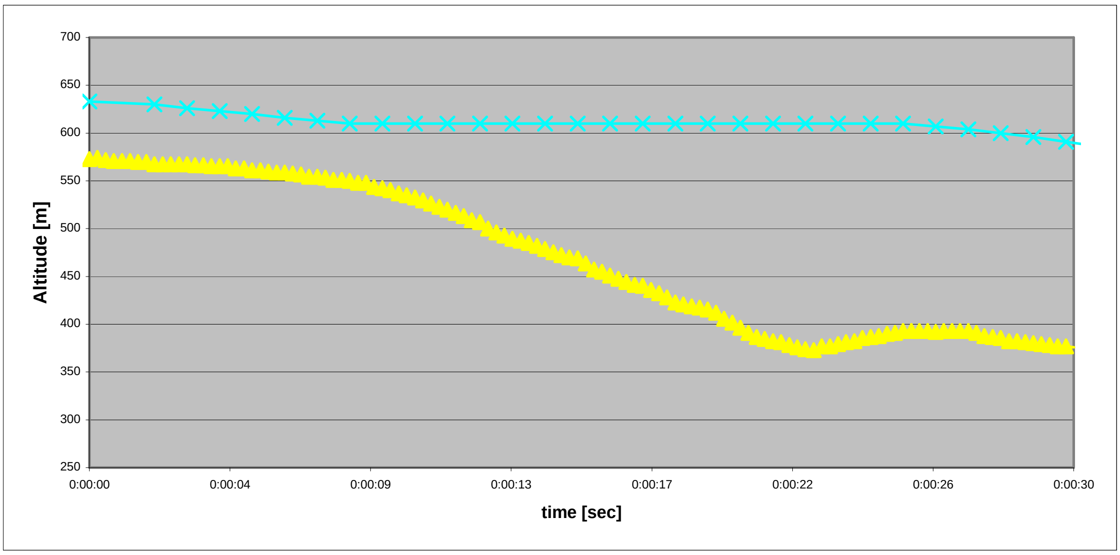

G
3.5
3
2.5
2
1.5
1
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

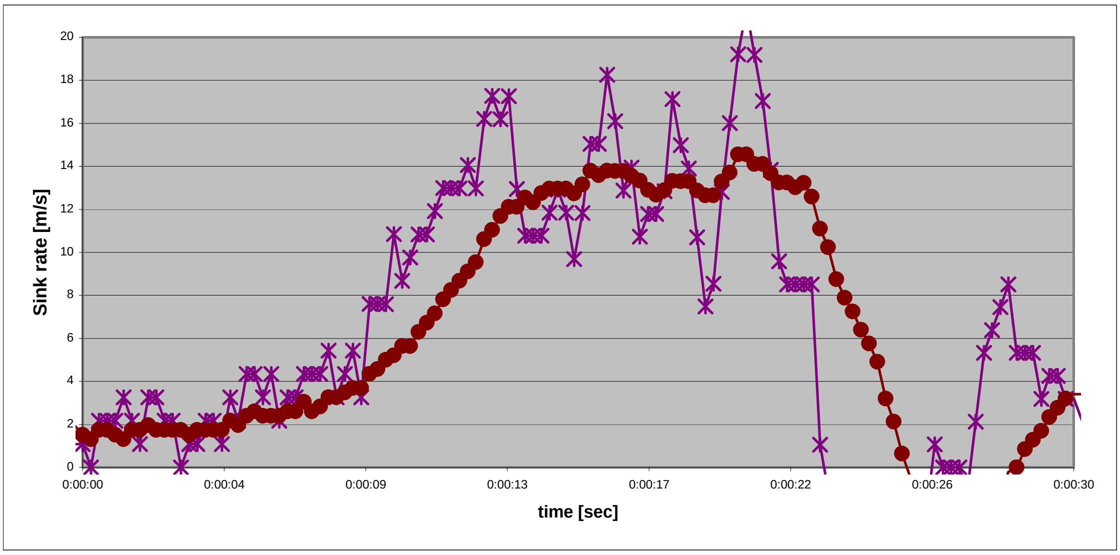
Run 10B

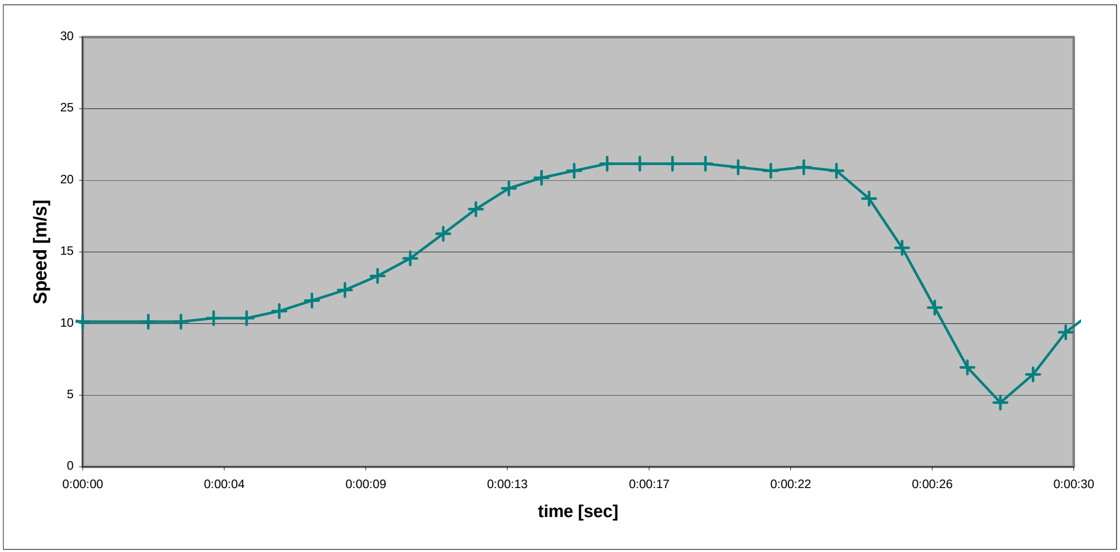
Pilot 1

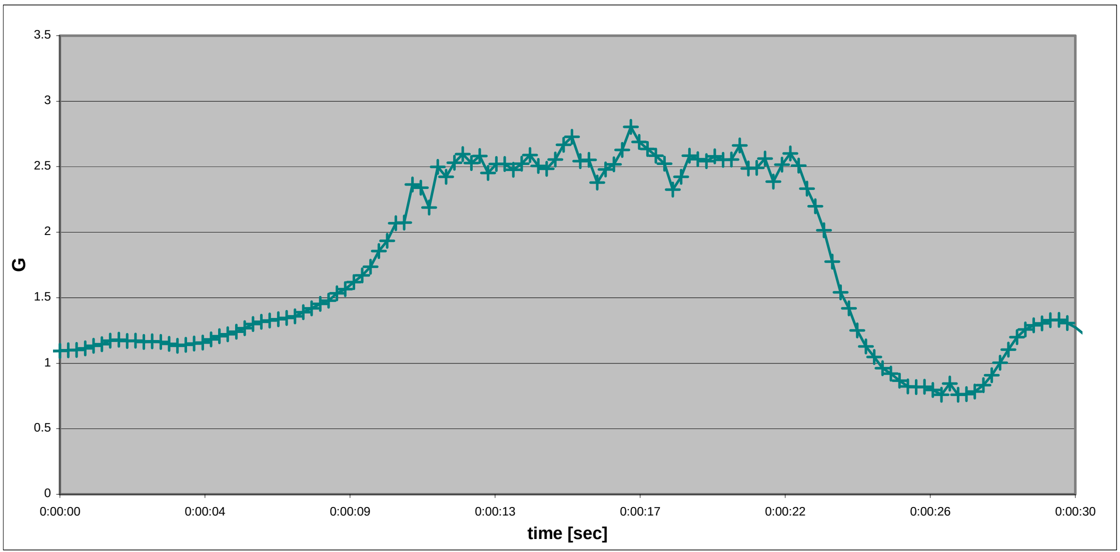
Wing LTF 1

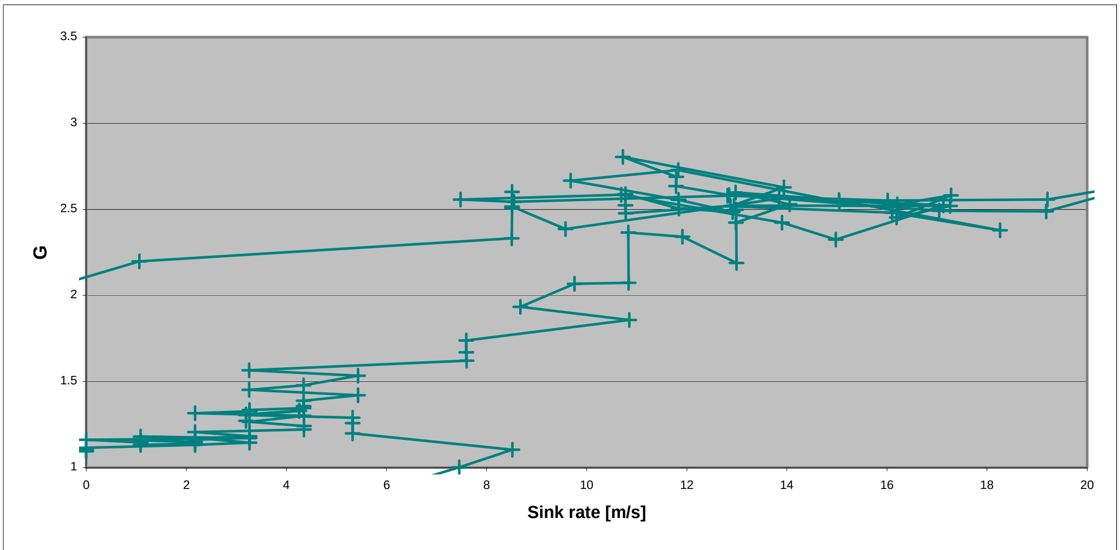
Weight Medium






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

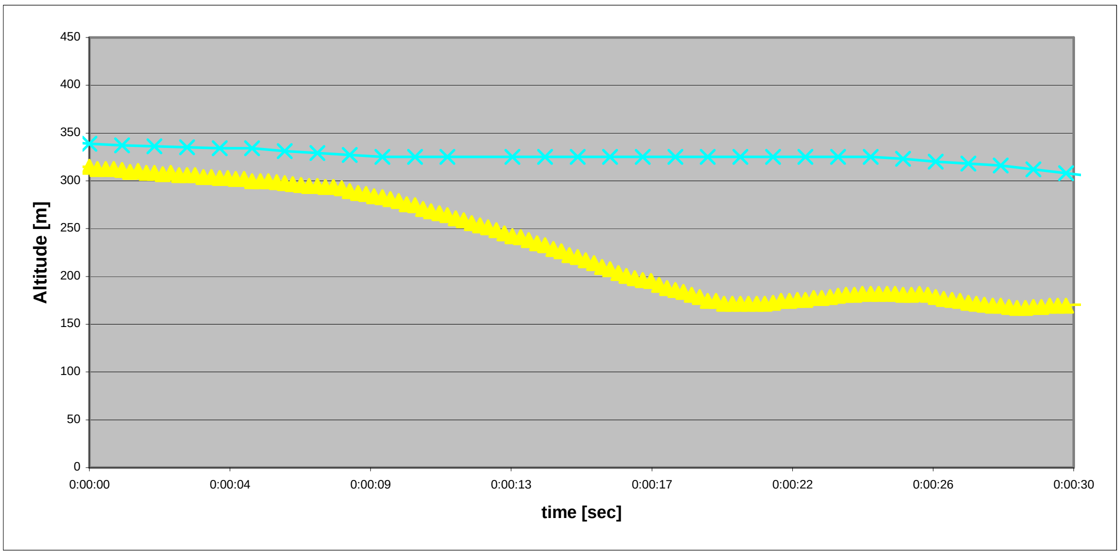

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

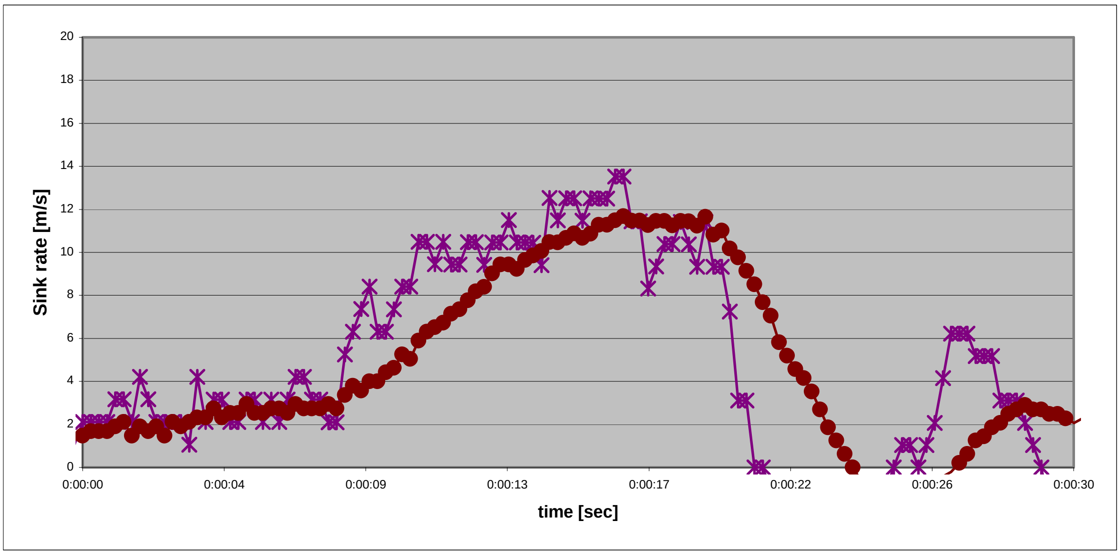
Run 10C

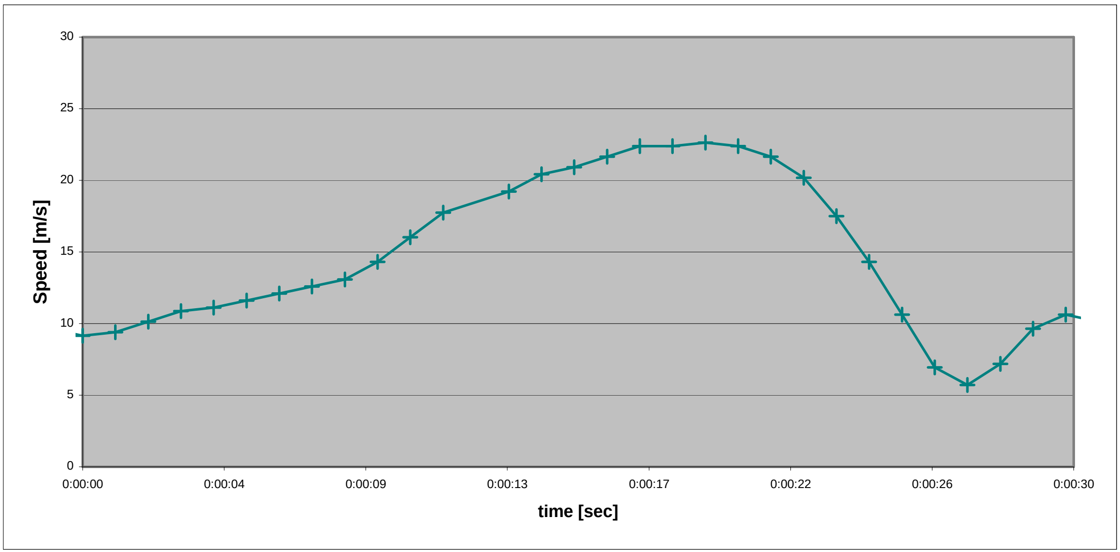
Pilot 1

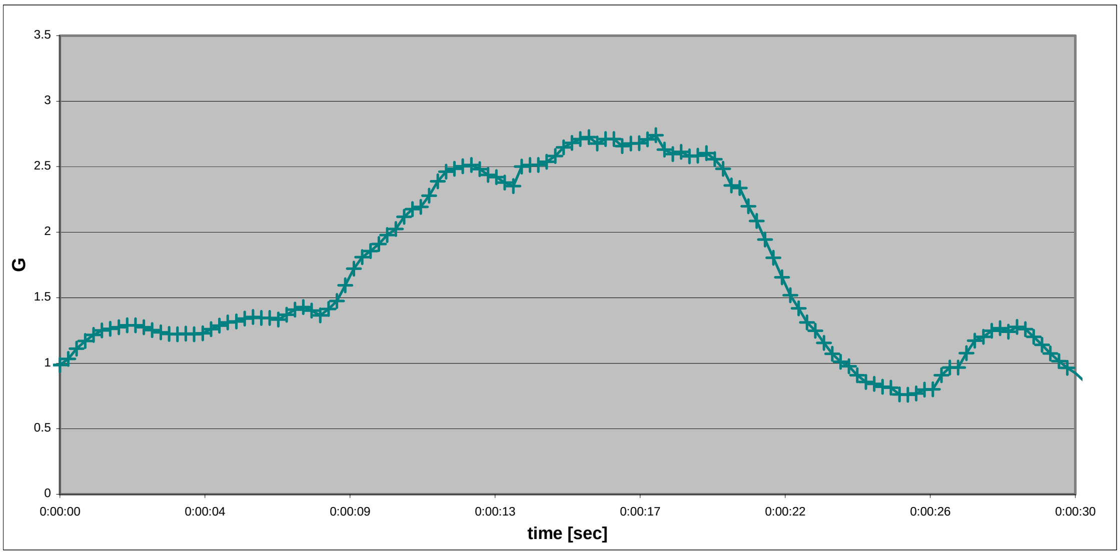
Wing LTF 1

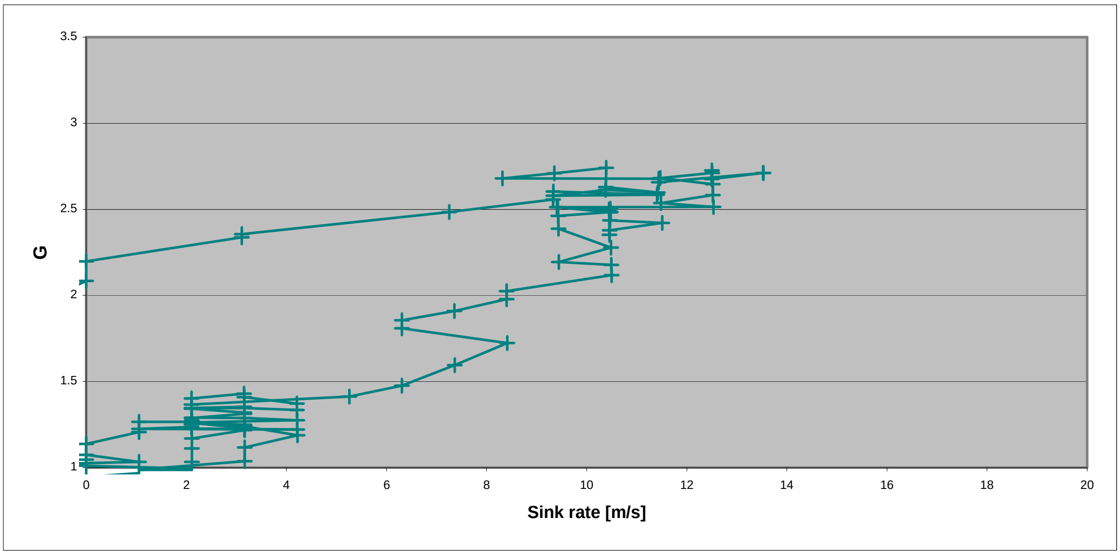
Weight Medium






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]


3.5
3
2.5
2
1.5
1
0.5
0
G
0:00:00
0:00:04
0:00:09
0:00:13
0:00:17
0:00:22
0:00:26
0:00:30
time [sec]

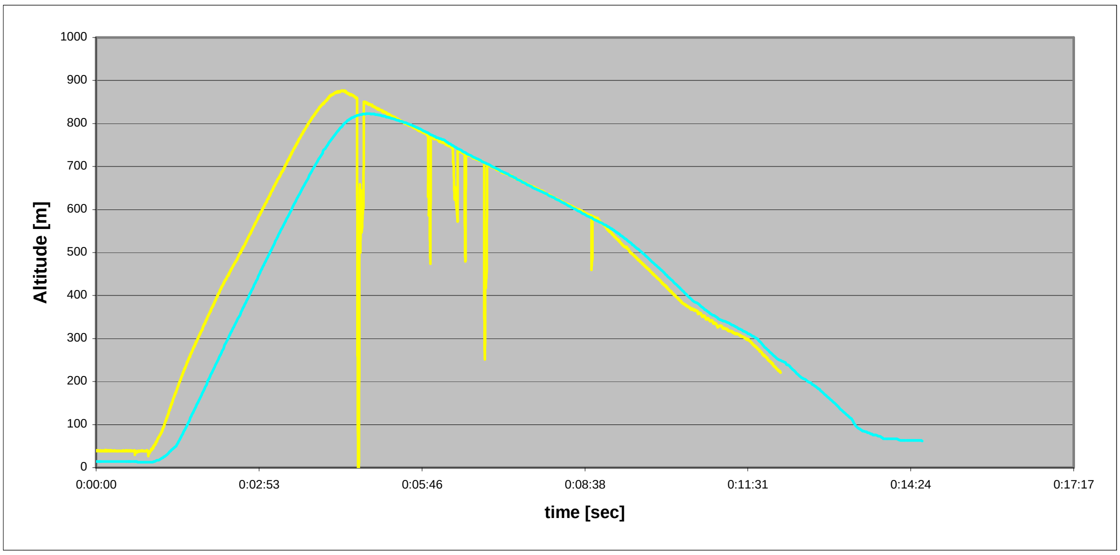

3.5
3
2.5
2
1.5
1
G
0
2
4
6
8
10
12
14
16
18
20
Sink rate [m/s]

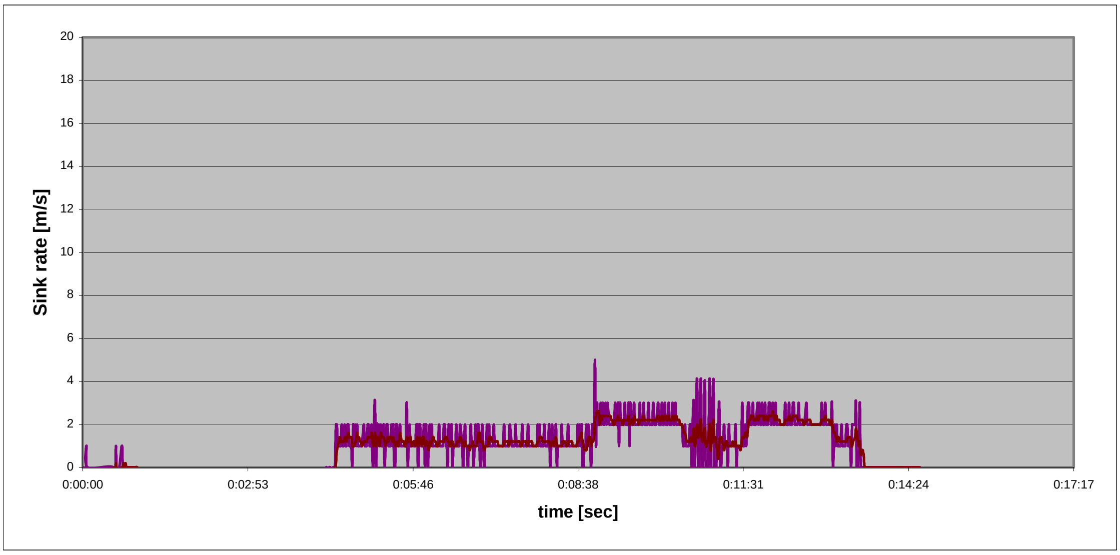
Run 11

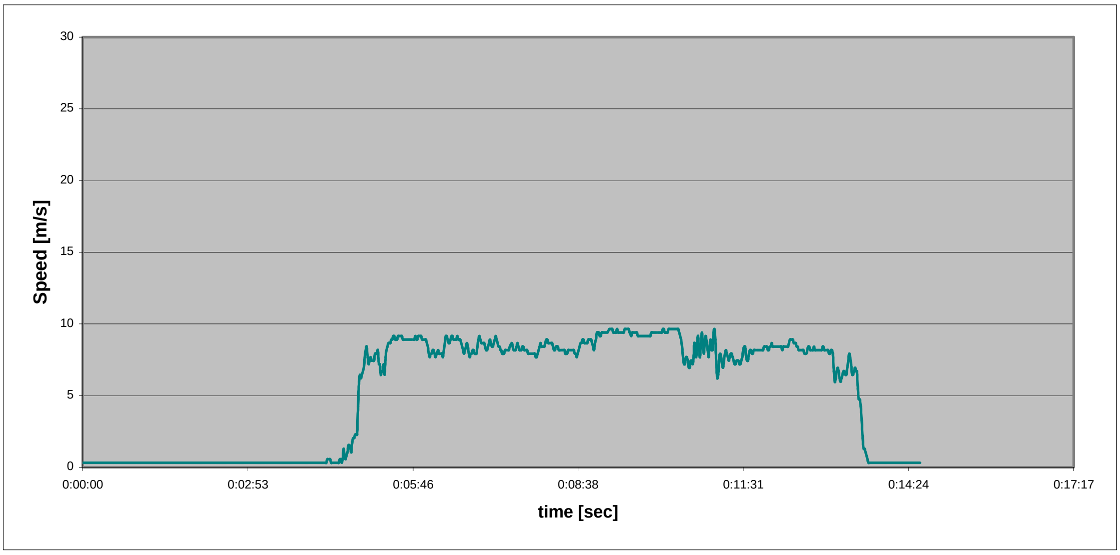
Pilot 1

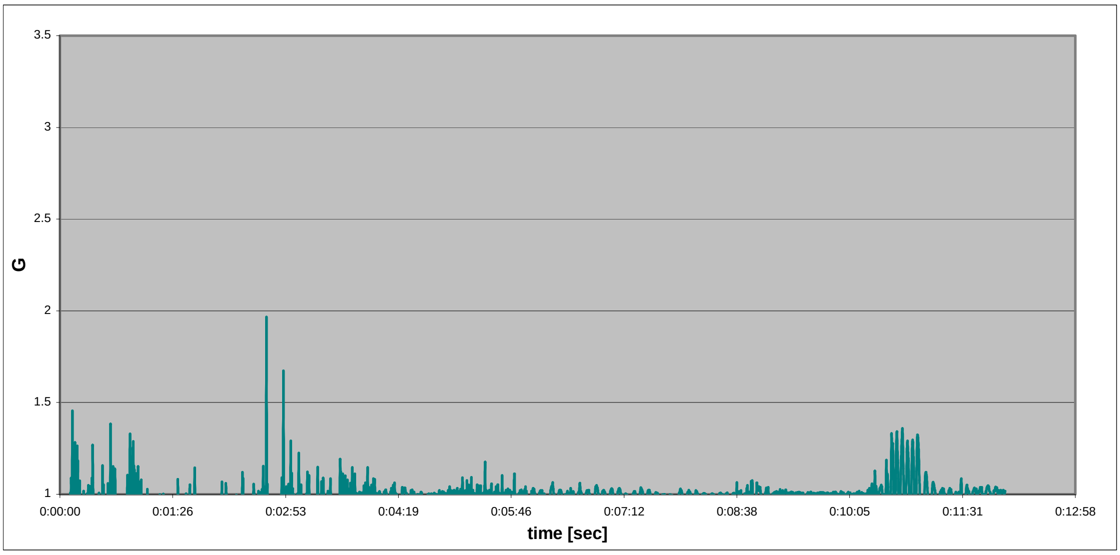
Wing LTF 1

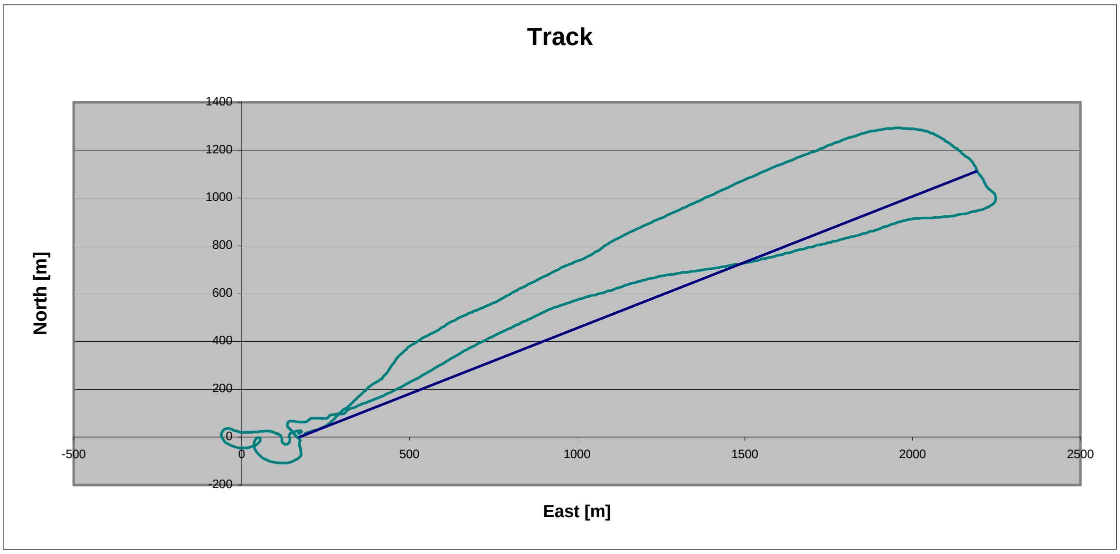
Weight Medium






30
25
20
15
10
5
0
Speed [m/s]
0:00:00
0:02:53
0:05:46
0:08:38
0:11:31
0:14:24
0:17:17
time [sec]


3.5
3
2.5
2
1.5
1
G
0:00:00
0:01:26
0:02:53
0:04:19
0:05:46
0:07:12
0:08:38
0:10:05
0:11:31
0:12:58
time [sec]


Track
1400
1200
1000
800
600
400
200
0
-200
North [m]
-500
0
500
1000
1500
2000
2500
East [m]