

Wind Turbine Race Report 2010

Stauning, Denmark, Sep 24th-26th 2010



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Introduction

During the days 24-26 Sep. 2010 the Wind Turbine Race event, WTR2010, was held at Stauning airport, Denmark. The event was organized by Ringkøbing-Skjern municipal, the Danish Flight Museum, DTU-MEK, RISØ-DTU, Technical University of Denmark and Vestas Wind Systems A/S. The focus of the event is racing with specially designed wind powered vehicles against the wind by harvesting the wind using spinning blades. This report sums up racing results and measured wind conditions during the event. More details may be found at

www.windturbinerace.dk

www.windenergyevents.com

The present report finalizes the 2010 Wind Turbine Race event as we look forward to the 2011 edition to be held in Den Helder, Holland, more details at www.windenergyevents2011.com

Contestants WTR 2010



Figure 1 Hoogeschool van Amsterdam. Spirit of Amsterdam 1 (2009 race winner)



Figure 2 Hoogeschool van Amsterdam. Spirit of Amsterdam 2 (2010 race winner)



Figure 3 Team Anemo, InHolland, Delft, design winner 2010



Figure 4 Bristol University. Bristol (two rotors, electric transmission)



Figure 5 Technical University of Denmark. DTU2, winDTUrbineracer 2, design winner 2009



Figure 6 Technical University of Denmark. DTU1, winDTUrbineracer 1



Figure 7 Fachhochschule Flensburg, Gustav Winkler



Figure 8 Fachhochschule Kiel, Baltic Thunder III



Figure 9 University of Stuttgart, Team Inventus (2008 race winner)

Security check

Security checklist according to rules:

DESIGN

- A: The maximum length of the vehicle is: 4 meters
- B: The maximum width is: 2 meters
- C: The maximum height including rotor is: 3.5 meters.
- D: Vertical projection of all parts shall remain within the maximum length and width of the vehicle.
- E: Maximum rotor area 4m²

SAFETY

- F: 2 independently activated braking devices, one on the rotor and one on the wheel axis
- G: The rotor (blades) shall be contained inside a cage or net, made of steel wire of minimum 1 mm thickness, with a maximum mesh size of 0,1 m. The net shall be able to prevent broken blade (pieces) to be thrown off.
- H: The driver shall be able to vacate from inside without assistance
- I: Good visibility for the sector from -135 to 135 degrees with course
- J: Provided with two rear view mirrors, one on the left and one on the right side of the vehicle

SAFETY VALIDATION

- K: Brake capacity shall be demonstrated before the race

Car inspection table below: Fill out with OK or remark

Item	DTU1	Anemo	Stuttgart	Amster1	Kiel	DTU2	Bristol	Flensb	Amster2
A Length	3.50m	3.14m	3.95m	3.94m	2.99m	3.50m	3.40m	2.00m	2.60m
B Width Wheels	1.98m	1.99m	1.97m	1.92m	1.75m	1.98m	3.42m	1.76m	1.84m
C Height	3.17m	3.47m	3.50m	3.45m	3.00m	3.15m	3.42m	1.60	3.45m
D Inside box?	OK	>2.0m in yaw (Gurney)	>2.0m in yaw	> 2.0 in yaw (Triangles)	>2.0 in yaw	OK	OK	OK	>2.0m in yaw (Gurney)
E Rotor Shroud	D=1.88m S=1.96m	D=1.50m S=1.95m	D=1.90m S=1.99m	D=1.50m S=1.95m	D=1.79m S=1.98m	D=1.88m S=1.92m	D=1.60m S=1.66m	D=1.60m S=	S=2.07m D=1.51m
F Brakes?	OK	OK	OK	OK	OK	OK	OK	OK	OK
G Cage?	OK	OK	OK	OK	OK	OK	OK	OK	OK
H Self vacate?	OK	OK	OK	OK	OK	OK	OK	OK	OK
I Clear view?	OK	OK	OK	OK	OK	OK	OK	OK	OK
J Mirrors?	OK	OK	OK	OK	OK	OK	OK	OK	OK
K Brake test?	OK	OK	OK	OK	OK	OK	OK	OK	OK

All WPV's have been approved for racing.

Wind data overview

Wind data was measured at a height of 2.4m above ground using a Mitek sonic and Risø's in house WinDaq data acquisition software. Wind data is measured at 35Hz, but for all analysis presented here only the 1min min values were used. This is due to an unfortunate computer breakdown Friday, which resulted in only these being available throughout the event (It was very fortunate that we happened to bring a backup laptop just in case). The sonic measures the wind speed vector, so the figures below show wind speed vector magnitude (m/s) and direction (degrees) of the wind speed vector in the horizontal plane. The horizontal wind direction is defined as being zero when wind comes from north, 90 degrees when coming from east, 180 degrees when coming from south and 270 degrees when coming from west. For reference, the landing strip direction is very close to east-west, at an angle corresponding to 92.5 degrees (or 272.5 degrees). The figures below show the approximate wind measurement position and the measured wind data for the three days.



Figure 10 Approximate position of wind measurement device (red star). Note that the picture which is a screendumped google map, is not very recent, so things look a bit different now. Race track start and ends can be seen on the landing strip, 380m.

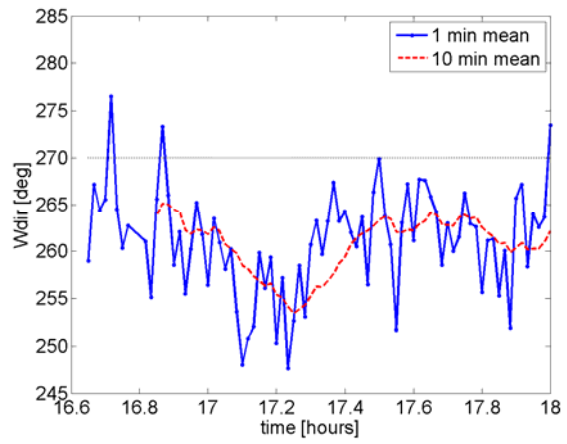
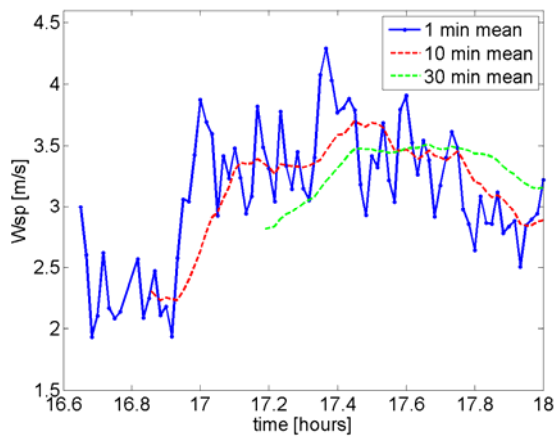


Figure 11 Wind data for Friday 24th of September 2010 at Stauning WTR. Left figure show wind speed (m/s) versus time (hours). Right figure show wind direction (degrees).

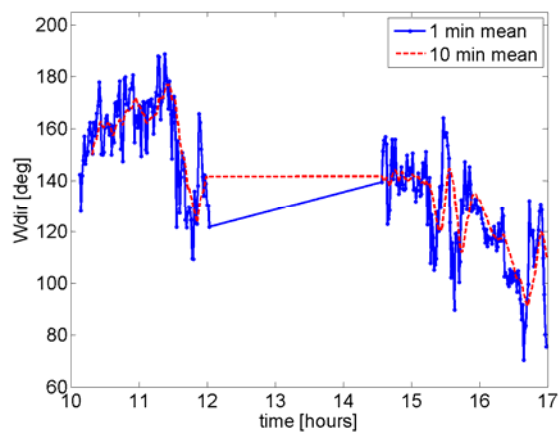
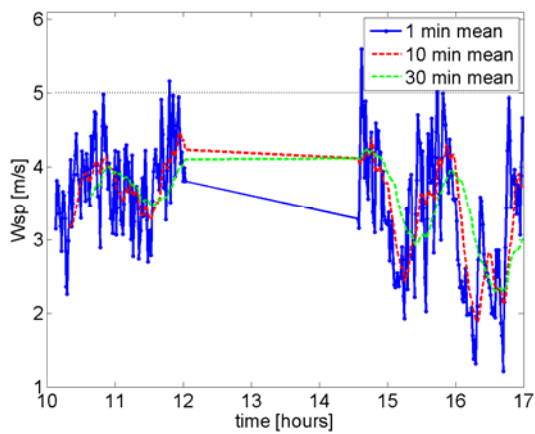


Figure 12 Wind data for Saturday 25th of September 2010 at Stauning WTR. Left figure show wind speed (m/s) versus time (hours). Right figure show wind direction (degrees).

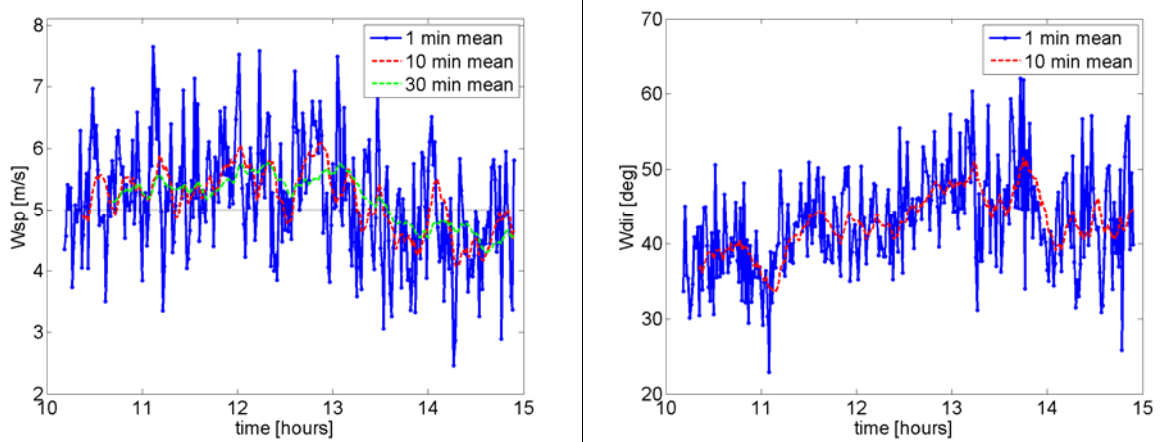


Figure 13 Wind data for Sunday 26th of September 2010 at Stauning WTR. Left figure show wind speed (m/s) versus time (hours). Right figure show wind direction (degrees).

As seen in the figures, the wind direction was “from west” on Friday, “from south east” on Saturday and “from north east” on Sunday. The latter two are quite atypical for the location, since wind is usually from west. Also the wind magnitude is not the usual 6-7 m/s, but rather much lower. Especially Friday and Saturday with wind speeds around 3 m/s. The only day with winds semi-consistently above the cut-in speed for the wind turbine race of 5 m/s was Saturday.

Along with this race report will be sent text files with the measured wind data for each day. The naming convention is easiest explained by an example: “WindData20100926.txt” contains measured wind data for year 2010 month 09 day 26 (So Sunday). The file is written from Matlab, so if it looks unreadable in notepad, try for instance wordpad. Matlab is doing some funny stuff with the end-of-line characters...

The contents of the files are that every measured (35Hz) minute of data (started exactly at the turn of the minute) has one line in the file. Each line has four numbers:

1:hour

2:minute

3:one minute mean wind speed for the minute starting hour:minute:00

4: one minute mean wind direction for the minute starting hour:minute:00

A note on how velocity ratio is determined

The velocity ratio for the vehicles given in this report is obtained by dividing the mean car speed with the mean measured wind velocity. The mean car speed is obtained from the race distance and the race time of the car, and the mean measured wind speed is obtained from the measured wind speed in time, making sure the time window over which the wind velocity mean is computed is the one where the car was actually racing:

$$|V_{wind}| = \frac{1}{T_{race}} \int_{t_{start}}^{t_{start}+T_{race}} V_{wind}(t) dt$$

The computations used for the numbers in this report are based on piecewise constant wind values (each minute) for $V_{wind}(t)$. Shifting to linearly changing wind velocities (between the points defined by hour:minute:30 points) only marginally change the numbers, probably far less than the influence of not measuring the reference wind velocity where the car is actually situated in space.

Fastest runs

Fastest (dimensional) speed measured: 11.0 km/h in 4.67 m/s wind by Amsterdam1 on Sunday 26th of September 2010.

The highest velocity ratio measured was the same run for the same vehicle. The maximum velocity ratio was 0.657. This was obtained at an angle between the wind and the race track of 45 degrees.

The highest velocity ratio measured for each of the vehicles are listed in the table below: (Further details can be found later in the report)

Vehicle	Velocity ratio [-]	@ reference wind speed [m/s]
Amsterdam2	0.657	4.67
Amsterdam1	0.495	4.65
Kiel	0.474	4.83
DTU1	0.427	3.60
Stuttgart	0.402	4.51
DTU2	0.249	4.67
Flensburg	0.161	5.47
Anemo	0.154	5.40
Bristol	0.049	4.31

Final Race Result (Sunday Results)

Due to the wind speeds being far below the race “cut-in” speed of 5 m/s both Friday and Saturday, only the race results from Sunday were used to determine the winner of the contest. For those interested, all measured data (including also time trials + 1km times from Sunday and all measured data from Friday and Saturday) is put at the end of this report.

Each heat of the races had three vehicles, such that all nine vehicles raced against all other vehicles (only once) in a total of twelve heats.

The points given to each contestant depend on what the ranking of the vehicle in the race was and how the race was completed for the vehicle. The winner got 3 points, second place got 2 points and third place 1 point. From this one point was subtracted if the vehicle didn't complete the race track with a minimum of 10% of the wind speed velocity (tow-away limit).

An overview of the specific race data is given in the table below

Race #	Vehicle1/Points/Ratio	Vehicle2/Points/Ratio	Vehicle3/Points/Ratio	Wind speed [m/s]
2	DTU1 2 0.234	Anemo 1 0.131	Stuttgart 3 0.281	5.9
3	Kiel 3 0.338	Amsterdam1 2 0.316	DTU2 1 0.152	6.0
1	Bristol 0 -	Amsterdam2 3 0.474	Flensburg 2 0.134	5.7
6	Amsterdam2 3 0.487	Stuttgart 2 0.251	DTU2 1 0.186	5.3
4	Bristol 0 -	DTU1 2 0.220	Amsterdam1 3 0.229	5.8
5	Flensburg 2 0.161	Anemo 1 0.154	Kiel 3 0.295	6.0
7	Bristol 0 -	Anemo 3 0.103	DTU2 1 (0.08)	4.5
8	Flensburg 0 -	Stuttgart 2 0.40	Amsterdam1 3 0.43	4.5
9	Amsterdam2 3 0.48	DTU1 1 0.39	Kiel 2 0.47	4.8
10	Bristol 0 (0.05)	Stuttgart 2 0.27	Kiel 3 0.34	4.4
11	Flensburg 0 -	DTU1 3 0.43	DTU2 2 0.25	3.7
12	Amsterdam2 3 0.66	Anemo 0 (0.096)	Amsterdam1 2 0.49	4.6

Based on the points above, the final result of the WTR 2010 is summarized below

Rank	Team	Points
1	Amsterdam2	12
2	Kiel	11
3	Amsterdam1	10
4	Stuttgart	9
5	DTU1	8
6	Anemo	5
7	DTU2	4 (Max vel ratio 0.25)
8	Flensburg	4 (Max vel ratio 0.16)
9	Bristol	0

Design Prize

The technical jury consisting of Thomas Buhl (Program leader, Wind Energy, Risø-DTU), Erik Grove Thomsen (SIEMENS, Project Manager, Blade Technology) and Birger Madsen (BTM Consult) awarded Team Anemo's vehicle the prestigious WTR design award 2010 for their beautiful chassis work and carefully consideration on using sustainable materials e.g. cork, bio resin, etc.

Wind Turbine Car Racing Association

At the event the Wind Turbine Car Association was founded with one member from each of the organizations racing. It is the idea that this organization should take care of anything concerning the technical part of the races: Specifications for wind measurements, Technical specifications for the vehicles, Race rules, Possibilities/procedures for speed record attempts, Possibilities for different vehicle classes in future renditions of the race (maybe a "home-built" class with requirements for max cost etc, along wind (propeller) cars, etc), race plan, Point rules, etc.

The persons elected for the association are listed below

Institution	Name	Email
Techn. Univ. Denmark (DTU)	Mac Gaunaa	macg@risoe.dtu.dk
Inholland hogeschool (ANEMO)	Martin Kampinga	martin.kampinga@inholland.nl
Hoogeschool van Amsterdam	Hugo Van Tienhoven	h.van.tienhoven@hva.nl
Fachhochschule Flensburg	Lennart Paape	lennart_paape@web.de
Fachhochschule Kiel	Alexander Dräger	Alexander.draeger@student.fh-kiel.de
University of Stuttgart	Daniel Kaufer	daniel.kaufer@ifb.uni-stuttgart.de
Bristol University	David Drury	david.drury@bristol.ac.uk

Pictures & Movies (accounts on Picasa and youtube)

Pictures from this year's race as well as from the previous races are available at the following address:

<http://picasaweb.google.com/Wind.Turbine.Races>

The web gallery presented at this address includes folders where each subfolder's name is as follows:

[year a particular race took place], [photographer's name], [photographer's e-mail address]

Ex: 2010, Witold Skrzypiński, wskrzyp@aol.com

All the pictures presented in the gallery are allowed for any sort of publishing in any media free of charge under the following conditions:

1. The photographer is informed about the publication (his e-mail address is mentioned in the respective folder's name).
2. The photographer's name is mentioned in the picture's caption

The pictures presented in the gallery may not be in the highest resolution due to limited storage space. However, high resolution pictures are available at a request from the photographers.

Movies are available at 'Wind Turbine Races' YouTube channel:

<http://www.youtube.com/user/WindTurbineRaces?feature=mhum>



Figure 14 Award lineup

Information for uploaders:

All are encouraged to upload all their best pictures. Please contact either one of the persons below to obtain the username and password of the Picasa site: Mac Gaunaa (macg@risoe.dtu.dk), Witold Skrzypiński (wisk@risoe.dtu.dk) or Robert Mikkelsen (rm@mek.dtu.dk)

Using this account we can upload pictures to a Picasa web gallery at the following address:

<http://picasaweb.google.com/Wind.Turbine.Races>

Please use the following scheme when setting up new folders:

[year a particular race took place], [photographer's name], [photographer's e-mail address]

Ex: 2010, Witold Skrzypiński, wskrzyp@aol.com

Pictures from all the races may be uploaded to this gallery. The year in a folder's name allows for easy distinction between different races. Due to limited storage space it is recommended that the pictures are not in their highest resolution. A recommended optimal resolution for web viewing is when the longer edge of the picture is 1024 px long. (But if somebody can't really decrease the pictures' size, please upload full size pictures). It would also be nice if high resolution pictures were available at a request from the uploaders. (But if, for some reason, they're not, it's also OK)

The uploaders agree to the following:

All the pictures presented in the gallery are allowed for any sort of publishing in any media free of charge under the following conditions: The photographer is informed about the publication (his e-mail address is mentioned in the respective folder's name). The photographer's name is mentioned in the picture's caption in the publication

Asking for a contact will help us keep a track of potential publications while it will not discourage anybody from publishing since it is clearly mentioned that it is free of charge.

Movies are available at 'Wind Turbine Races' YouTube channel:

<http://www.youtube.com/user/WindTurbineRaces?feature=mhum>

Movies can be uploaded using the same username and password. We haven't put any copyright info since we don't really know what to write...

But since you can't really copy a YouTube movie (unless you're an IT wiz) people can only put links to your YouTube movies on their web pages.



Figure 15 Race winners 2010, Spirit of Amsterdam

Race Times Friday (copied from analysis program used to determine velocity ratios during races)

```
Ltrack=380;%Track length in meters
%% Friday 24, 17:00 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Run 1
% DTU1, Anemo, Stuttgart
% DTU1 not working
StartTimeHours=17;%Starting time Hours
StartTimeMins=00;%Starting time Minutes
StartTimeSecs=50; %Start time seconds
%Stuttgart time
RaceDurationMin=21; %Race duration minute part
RaceDurationSec=20; %Race duration seconds part
% -----
% Mean wind speed 3.3755
% Mean wind direction 256.6841
% THE OFFICIAL SPEED RATIO IS 0.087949  !!!
% -----
%Anemo time
RaceDurationMin=26; %Race duration minute part
RaceDurationSec=20; %Race duration seconds part
% -----
% Mean wind speed 3.4826
% Mean wind direction 257.9498
% THE OFFICIAL SPEED RATIO IS 0.069059  !!!
% -----

% Run 2 - wind 3.5 m/s
% Amsterdam1, Kiel, DTU2
% DTU2 not working
StartTimeHours=17;%Starting time Hours
StartTimeMins=28;%Starting time Minutes
StartTimeSecs=20; %Start time seconds
%Kiel time
RaceDurationMin=15; %Race duration minute part
RaceDurationSec=26; %Race duration seconds part
% -----
% Mean wind speed 3.3587
% Mean wind direction 263.1318
% THE OFFICIAL SPEED RATIO IS 0.12218  !!!
% -----%
%Amsterdam1 time
RaceDurationMin=16; %Race duration minute part
RaceDurationSec=00; %Race duration seconds part
% -----
% Mean wind speed 3.3646
% Mean wind direction 263.0527
% THE OFFICIAL SPEED RATIO IS 0.11765  !!!
% -----

% Run 3
```

```
% Bristol, Flensburg, Amsterdam2
StartTimeHours=17;%Starting time Hours
StartTimeMins=49;%Starting time Minutes
StartTimeSecs=14; %Start time seconds
% NO time, had to break race prematurely due to end of racing time slot.
%Amsterdam2 went the furthest, Flensburg second, Bristol third
```

Race Times Saturday (copied from analysis program used to determine velocity ratios during races)

```
Ltrack=380;%Track length in meters
```

```
%% Saturday 25, 10:00 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Time trials & testing, DTU1
StartTimeHours=11;%Starting time Hours
StartTimeMins=44;%Starting time Minutes
StartTimeSecs=00; %Start time seconds
RaceDurationMin=8; %Race duration minute part
RaceDurationSec=3; %Race duration seconds part
% -----
% Mean wind speed 4.184
% Mean wind direction 123.3452 = 33 degrees off 'inland direction'
% THE OFFICIAL SPEED RATIO IS 0.18804  !!!
% -----
```

```
%% Saturday 25, 14:30 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Runs! Running EASTLY direction.
% Run#1: Bristol, Amsterdam2, Flensburg
StartTimeHours=14;%Starting time Hours
StartTimeMins=59;%Starting time Minutes
StartTimeSecs=08; %Start time seconds
% Flensburg: N/A
% Bristol: 80 m
% Amsterdam2:
RaceDurationMin=7; %Race duration minute part
RaceDurationSec=57; %Race duration seconds part
% -----
% Mean wind speed 2.9708
% Mean wind direction 140.1918
% THE OFFICIAL SPEED RATIO IS 0.26815  !!!
% -----
```

```
% Run#2: DTU1, Anemo, Stuttgart
StartTimeHours=15;%Starting time Hours
StartTimeMins=07;%Starting time Minutes
```

```

StartTimeSecs=30; %Start time seconds
% Stuttgart:
RaceDurationMin=18; %Race duration minute part
RaceDurationSec=58; %Race duration seconds part
% -----
% Mean wind speed 2.8224
% Mean wind direction 128.6534
% THE OFFICIAL SPEED RATIO IS 0.11831  !!!
% -----
% DTU1:
RaceDurationMin=19; %Race duration minute part
RaceDurationSec=39; %Race duration seconds part
% -----
% Mean wind speed 2.8639
% Mean wind direction 128.7472
% THE OFFICIAL SPEED RATIO IS 0.11254  !!!
% -----
% Anemo:
% 250m due to "tow away speed"

% Run#3: Amsterdam1, Kiel, DTU2
StartTimeHours=15;%Starting time Hours
StartTimeMins=28;%Starting time Minutes
StartTimeSecs=19; %Start time seconds
% Kiel:
RaceDurationMin=9; %Race duration minute part
RaceDurationSec=50; %Race duration seconds part
% -----
% Mean wind speed 3.5586
% Mean wind direction 136.9697
% THE OFFICIAL SPEED RATIO IS 0.18099  !!!
% -----
%Amsterdam1
RaceDurationMin=15; %Race duration minute part
RaceDurationSec=13; %Race duration seconds part
% -----
% Mean wind speed 3.6881
% Mean wind direction 127.19
% THE OFFICIAL SPEED RATIO IS 0.11285  !!!
% -----
% % DTU2: Not available

% Run#6: Amsterdam2, Stuttgart, DTU2
StartTimeHours=15;%Starting time Hours
StartTimeMins=51;%Starting time Minutes
StartTimeSecs=16; %Start time seconds
% Stuttgart:
RaceDurationMin=6; %Race duration minute part
RaceDurationSec=58; %Race duration seconds part
% -----
% Mean wind speed 4.0276
% Mean wind direction 133.0048

```

```

% THE OFFICIAL SPEED RATIO IS 0.22571  !!!
% -----
% Amsterdam2:
RaceDurationMin=7; %Race duration minute part
RaceDurationSec=41; %Race duration seconds part
% -----
% Mean wind speed 3.9843
% Mean wind direction 132.4469
% THE OFFICIAL SPEED RATIO IS 0.20689  !!!
% -----
% DTU2:
% Stopped after 30 m

% Run#4: Bristol, DTU1, Amsterdam1
StartTimeHours=16;%Starting time Hours
StartTimeMins=01;%Starting time Minutes
StartTimeSecs=26; %Start time seconds
% DTU1:
RaceDurationMin=28; %Race duration minute part
RaceDurationSec=27; %Race duration seconds part
% -----
% Mean wind speed 2.3868
% Mean wind direction 114.5778
% THE OFFICIAL SPEED RATIO IS 0.093267  !!!
% -----
% Amsterdam1:
RaceDurationMin=40; %Race duration minute part
RaceDurationSec=35; %Race duration seconds part
% -----
% Mean wind speed 2.3384
% Mean wind direction 108.2511
% THE OFFICIAL SPEED RATIO IS 0.066738  !!!
% -----
% Bristol: Stopped after 30 m

% Run#5: Anemo, Kiel, Flensburg
StartTimeHours=16;%Starting time Hours
StartTimeMins=25;%Starting time Minutes
StartTimeSecs=57; %Start time seconds
%Kiel
RaceDurationMin=16; %Race duration minute part
RaceDurationSec=37; %Race duration seconds part
% -----
% Mean wind speed 2.2647
% Mean wind direction 95.4728
% THE OFFICIAL SPEED RATIO IS 0.16829  !!!
% -----
%Anemo: 300m 32min
%Flensburg: 340m 32min (32 min corr to ratio 0.07)

```

Race Times Sunday (copied from analysis program used to determine velocity ratios during races)

Ltrack=380;%Track length in meters

%% Sunday 26th, 10:00 %%

%Testing

%DTU1 SELF START

StartTimeHours=10;%Starting time Hours

StartTimeMins=40;%Starting time Minutes

StartTimeSecs=00; %Start time seconds

RaceDurationMin=3; %Race duration minute part

RaceDurationSec=11; %Race duration seconds part

% -----

% Mean wind speed 5.3858

% Mean wind direction 38.923

% THE OFFICIAL SPEED RATIO IS 0.3694 !!!

% -----

%DTU1

StartTimeHours=10;%Starting time Hours

StartTimeMins=50;%Starting time Minutes

StartTimeSecs=00; %Start time seconds

RaceDurationMin=3; %Race duration minute part

RaceDurationSec=51; %Race duration seconds part

% -----

% Mean wind speed 5.1541

% Mean wind direction 35.2768

% THE OFFICIAL SPEED RATIO IS 0.31917 !!!

% -----

%DTU2

StartTimeHours=10;%Starting time Hours

StartTimeMins=51;%Starting time Minutes

StartTimeSecs=00; %Start time seconds

RaceDurationMin=9; %Race duration minute part

RaceDurationSec=45; %Race duration seconds part

% -----

% Mean wind speed 5.2623

% Mean wind direction 36.1662

% THE OFFICIAL SPEED RATIO IS 0.12344 !!!

% -----

%Amsterdam2

StartTimeHours=11;%Starting time Hours

StartTimeMins=03;%Starting time Minutes

StartTimeSecs=00; %Start time seconds

RaceDurationMin=3; %Race duration minute part

RaceDurationSec=16; %Race duration seconds part

% -----

```
% Mean wind speed 5.259
% Mean wind direction 30.6078
% THE OFFICIAL SPEED RATIO IS 0.36866  !!!
% -----
```

```
%DTU1
StartTimeHours=11;%Starting time Hours
StartTimeMins=03;%Starting time Minutes
StartTimeSecs=00; %Start time seconds
RaceDurationMin=4; %Race duration minute part
RaceDurationSec=43; %Race duration seconds part
% -----
% Mean wind speed 5.6934
% Mean wind direction 32.1296
% THE OFFICIAL SPEED RATIO IS 0.23584  !!!
% -----
```

```
% Racing-----
% Race#2: DTU1, Anemo, Stuttgart
StartTimeHours=11;%Starting time Hours
StartTimeMins=46;%Starting time Minutes
StartTimeSecs=55; %Start time seconds
% Stuttgart:
RaceDurationMin=3; %Race duration minute part
RaceDurationSec=49; %Race duration seconds part
% -----
% Mean wind speed 5.9028
% Mean wind direction 40.7458
% THE OFFICIAL SPEED RATIO IS 0.28112  !!!
% -----
% DTU1:
RaceDurationMin=4; %Race duration minute part
RaceDurationSec=36; %Race duration seconds part
% -----
% Mean wind speed 5.8835
% Mean wind direction 41.1391
% THE OFFICIAL SPEED RATIO IS 0.23401  !!!
% -----
% Anemo:
RaceDurationMin=8; %Race duration minute part
RaceDurationSec=8; %Race duration seconds part
% -----
% Mean wind speed 5.9348
% Mean wind direction 44.2338
% THE OFFICIAL SPEED RATIO IS 0.13121  !!!
% -----
```

```
% Race#3: Kiel, Amsterdam1, DTU2
StartTimeHours=11;%Starting time Hours
```

```

StartTimeMins=51;%Starting time Minutes
StartTimeSecs=30; %Start time seconds
% Kiel:
RaceDurationMin=3; %Race duration minute part
RaceDurationSec=07; %Race duration seconds part
% -----
% Mean wind speed 6.0127
% Mean wind direction 48.2758
% THE OFFICIAL SPEED RATIO IS 0.33796  !!!
% -----
% Amsterdam1:
RaceDurationMin=3; %Race duration minute part
RaceDurationSec=24; %Race duration seconds part
% -----
% Mean wind speed 6.0131
% Mean wind direction 48.2377
% THE OFFICIAL SPEED RATIO IS 0.30978  !!!
% -----
% DTU2:
RaceDurationMin=7; %Race duration minute part
RaceDurationSec=21; %Race duration seconds part
% -----
% Mean wind speed 5.6875
% Mean wind direction 44.6882
% THE OFFICIAL SPEED RATIO IS 0.1515  !!!
% -----

% Race#1: Bristol, Amsterdam2, Flensburg
StartTimeHours=11;%Starting time Hours
StartTimeMins=57;%Starting time Minutes
StartTimeSecs=14; %Start time seconds
% Amsterdam2:
RaceDurationMin=2; %Race duration minute part
RaceDurationSec=20; %Race duration seconds part
% -----
% Mean wind speed 5.7283
% Mean wind direction 40.9484
% THE OFFICIAL SPEED RATIO IS 0.47384  !!!
% -----
% Flensburg:
RaceDurationMin=7; %Race duration minute part
RaceDurationSec=57; %Race duration seconds part
% -----
% Mean wind speed 5.9381
% Mean wind direction 41.4212
% THE OFFICIAL SPEED RATIO IS 0.13416  !!!
% -----
% Bristol: Stopped after 30 m

% Race#6: Amsterdam2, Stuttgart, DTU2
StartTimeHours=12;%Starting time Hours
StartTimeMins=07;%Starting time Minutes

```

```
StartTimeSecs=25; %Start time seconds
% Amsterdam2:
RaceDurationMin=2; %Race duration minute part
RaceDurationSec=19; %Race duration seconds part
% -----
% Mean wind speed 5.6122
% Mean wind direction 42.9416
% THE OFFICIAL SPEED RATIO IS 0.48712 !!!
% -----
% Stuttgart:
RaceDurationMin=4; %Race duration minute part
RaceDurationSec=47; %Race duration seconds part
% -----
% Mean wind speed 5.2747
% Mean wind direction 44.396
% THE OFFICIAL SPEED RATIO IS 0.25102 !!!
% -----
% DTU2:
RaceDurationMin=6; %Race duration minute part
RaceDurationSec=24; %Race duration seconds part
% -----
% Mean wind speed 5.3137
% Mean wind direction 44.6372
% THE OFFICIAL SPEED RATIO IS 0.18623 !!!
% -----
```

```
% Race#4: Bristol, DTU1, Amsterdam1
StartTimeHours=12;%Starting time Hours
StartTimeMins=11;%Starting time Minutes
StartTimeSecs=45; %Start time seconds
% Amsterdam1:
RaceDurationMin=4; %Race duration minute part
RaceDurationSec=42; %Race duration seconds part
% -----
% Mean wind speed 5.8894
% Mean wind direction 42.5058
% THE OFFICIAL SPEED RATIO IS 0.22881 !!!
% -----
% DTU1:
RaceDurationMin=4; %Race duration minute part
RaceDurationSec=52; %Race duration seconds part
% -----
% Mean wind speed 5.8919
% Mean wind direction 42.397
% THE OFFICIAL SPEED RATIO IS 0.22088 !!!
% -----
% Bristol: Withdrawn
```

```
% Race#5: Flensburg, Anemo, Kiel
StartTimeHours=12;%Starting time Hours
```

```
StartTimeMins=16;%Starting time Minutes
StartTimeSecs=37; %Start time seconds
% Kiel
RaceDurationMin=3; %Race duration minute part
RaceDurationSec=34; %Race duration seconds part
% -----
% Mean wind speed 6.0166
% Mean wind direction 40.7895
% THE OFFICIAL SPEED RATIO IS 0.29514  !!!
% -----
% Flensburg
RaceDurationMin=7; %Race duration minute part
RaceDurationSec=12; %Race duration seconds part
% -----
% Mean wind speed 5.4733
% Mean wind direction 40.8254
% THE OFFICIAL SPEED RATIO IS 0.16071  !!!
% -----
% Anemo
RaceDurationMin=7; %Race duration minute part
RaceDurationSec=36; %Race duration seconds part
% -----
% Mean wind speed 5.4028
% Mean wind direction 40.7866
% THE OFFICIAL SPEED RATIO IS 0.15424  !!!
% -----
```

```
% Race#7: Bristol, Anemo, DTU2
StartTimeHours=13;%Starting time Hours
StartTimeMins=46;%Starting time Minutes
StartTimeSecs=45; %Start time seconds
%Anemo
RaceDurationMin=13; %Race duration minute part
RaceDurationSec=35; %Race duration seconds part
% -----
% Mean wind speed 4.5422
% Mean wind direction 44.6186
% THE OFFICIAL SPEED RATIO IS 0.10265  !!!
% -----
%DTU2
RaceDurationMin=16; %Race duration minute part
RaceDurationSec=15; %Race duration seconds part
% -----
% Mean wind speed 4.8052
% Mean wind direction 43.5068
% THE OFFICIAL SPEED RATIO IS 0.081109  !!!
% -----
%Bristol: Not available
```

```
% Race#8: Flensburg, Stuttgart, Amsterdam1
StartTimeHours=13;%Starting time Hours
StartTimeMins=51;%Starting time Minutes
StartTimeSecs=30; %Start time seconds
```

```
%Amsterdam1
RaceDurationMin=3; %Race duration minute part
RaceDurationSec=16; %Race duration seconds part
% -----
% Mean wind speed 4.4678
% Mean wind direction 45.2126
% THE OFFICIAL SPEED RATIO IS 0.43395  !!!
% -----
%Stuttgart
RaceDurationMin=3; %Race duration minute part
RaceDurationSec=30; %Race duration seconds part
% -----
% Mean wind speed 4.5058
% Mean wind direction 45.2382
% THE OFFICIAL SPEED RATIO IS 0.4016  !!!
% -----
%Flensburg: 100 m
```

```
% Race#9: Amsterdam2, DTU1, Kiel
StartTimeHours=13;%Starting time Hours
StartTimeMins=58;%Starting time Minutes
StartTimeSecs=11; %Start time seconds
% Amsterdam2
RaceDurationMin=2; %Race duration minute part
RaceDurationSec=45; %Race duration seconds part
% -----
% Mean wind speed 4.8262
% Mean wind direction 39.4175
% THE OFFICIAL SPEED RATIO IS 0.47719  !!!
% -----
% Kiel
RaceDurationMin=2; %Race duration minute part
RaceDurationSec=46; %Race duration seconds part
% -----
% Mean wind speed 4.8311
% Mean wind direction 39.3996
% THE OFFICIAL SPEED RATIO IS 0.47384  !!!
% -----
% DTU1
RaceDurationMin=3; %Race duration minute part
RaceDurationSec=16; %Race duration seconds part
% -----
% Mean wind speed 5.0195
% Mean wind direction 38.7502
% THE OFFICIAL SPEED RATIO IS 0.38625  !!!
% -----
```

```
% Race#10: Bristol, Stuttgart, Kiel
StartTimeHours=14;%Starting time Hours
StartTimeMins=10;%Starting time Minutes
```

```
StartTimeSecs=13; %Start time seconds
%Kiel
RaceDurationMin=4; %Race duration minute part
RaceDurationSec=19; %Race duration seconds part
% -----
% Mean wind speed 4.3609
% Mean wind direction 46.7443
% THE OFFICIAL SPEED RATIO IS 0.33644  !!!
% -----
%Stuttgart
RaceDurationMin=5; %Race duration minute part
RaceDurationSec=16; %Race duration seconds part
% -----
% Mean wind speed 4.3978
% Mean wind direction 45.8032
% THE OFFICIAL SPEED RATIO IS 0.27344  !!!
% -----
%Bristol
RaceDurationMin=29; %Race duration minute part
RaceDurationSec=40; %Race duration seconds part
% -----
% Mean wind speed 4.3131
% Mean wind direction 43.001
% THE OFFICIAL SPEED RATIO IS 0.049497  !!!
% -----
```

```
% Race#11: Flensburg, DTU1, DTU2
StartTimeHours=14;%Starting time Hours
StartTimeMins=14;%Starting time Minutes
StartTimeSecs=08; %Start time seconds
% DTU1
RaceDurationMin=4; %Race duration minute part
RaceDurationSec=7; %Race duration seconds part
% -----
% Mean wind speed 3.6003
% Mean wind direction 42.389
% THE OFFICIAL SPEED RATIO IS 0.42731  !!!
% -----
% DTU2
RaceDurationMin=6; %Race duration minute part
RaceDurationSec=24; %Race duration seconds part
% -----
% Mean wind speed 3.9776
% Mean wind direction 39.2053
% THE OFFICIAL SPEED RATIO IS 0.24879  !!!
% -----
% Flensburg: Not available
```

```
% Race#12: Amsterdam2, Anemo, Amsterdam1
StartTimeHours=14;%Starting time Hours
```

```

StartTimeMins=21;%Starting time Minutes
StartTimeSecs=42; %Start time seconds
% Amsterdam2
RaceDurationMin=2; %Race duration minute part
RaceDurationSec=4; %Race duration seconds part
% -----
% Mean wind speed 4.6651
% Mean wind direction 47.0451
% THE OFFICIAL SPEED RATIO IS 0.6569 !!!
% -----
% Amsterdam1
RaceDurationMin=2; %Race duration minute part
RaceDurationSec=45; %Race duration seconds part
% -----
% Mean wind speed 4.6533
% Mean wind direction 46.0759
% THE OFFICIAL SPEED RATIO IS 0.49492 !!!
% -----
% Anemo
RaceDurationMin=15; %Race duration minute part
RaceDurationSec=26; %Race duration seconds part
% -----
% Mean wind speed 4.2967
% Mean wind direction 42.9849
% THE OFFICIAL SPEED RATIO IS 0.095508 !!!
% -----

%%%%%%%%%%

% 1 KM TIME TRIALS
Ltrack=1000;%Track length in meters

StartTimeHours=14;%Starting time Hours
StartTimeMins=35;%Starting time Minutes
StartTimeSecs=30; %Start time seconds
%KIEL
RaceDurationMin=11; %Race duration minute part
RaceDurationSec=12; %Race duration seconds part
% -----
% Mean wind speed 4.8591
% Mean wind direction 42.8115
% THE OFFICIAL SPEED RATIO IS 0.30625 !!!
% -----
%DTU1
RaceDurationMin=13; %Race duration minute part
RaceDurationSec=15; %Race duration seconds part
% -----
% Mean wind speed 4.8176
% Mean wind direction 41.6291
% THE OFFICIAL SPEED RATIO IS 0.2611 !!!
% -----

```