



Challenging wind and waves

Linking hydrodynamic research to the maritime industry

STAIMO TRAINING

Trial examples for STAIMO training

Date : September 30, 2013

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CONTENTS		Page
1	Training case 1	3
1.1	Ship data	3
1.2	Contract data	4
1.3	Model test data	4
1.3.1	Towing tank test data	4
1.3.2	Wind tunnel test.....	5
1.3.3	Sea keeping test.....	5
1.4	Trial data	5
2	Training case 2	7
2.1	Ship data	7
2.2	Contract data	8
2.3	Model test data	8
2.3.1	Towing tank test data	8
2.3.2	Wind tunnel test.....	9
2.3.3	Sea keeping test.....	10
2.4	Hydrostatic table	10
2.5	Trial data	11
3	Training case 3.....	12
3.1	Ship data	12
3.2	Contract data	13
3.3	Model test data	13
3.3.1	Towing tank test data	13
3.3.2	Wind tunnel test.....	13
3.3.3	Sea keeping test.....	14
3.4	Trial data	15

1 Training case 1

Case overview

Ship type	Bulk carrier
Trial in	Ballast condition
Model test data available?	Powering model tests at ballast, design and EEDI loading conditions
Corrections	Displacement, wind, waves, water depth, density, temperature
Trial runs	2x50%, 4x75%, 4x85%, 2x100% MCR

Objectives:

1. Determine the EEDI speed
2. Comment on the aspects that are not according to the ITTC procedure



1.1 Ship data

General ship data

Lpp [m]	205.5
B [m]	32.26
Maximum continuous rating [kW]	9500
RPM at MCR [RPM]	110.0
Bow length [m]	23.0
Propulsion configuration	Diesel direct
Shaft losses	1.0 %

1.2 Contract data

"The guaranteed speed of the vessel at the design draft of 11.5 m on even keel, shall be 14.2 knots with the main engine running at 90% MCR with 15% sea margin."

The speed trial is performed in ballast condition.

1.3 Model test data

1.3.1 Towing tank test data

The model tests for the ballast condition have been performed at a draft of $T_a/T_f = 7.3/4.8\text{m}$ (moulded draught at perpendiculars).

The corresponding moulded displacement volume is 35477 m³.

Speed-power relation at ballast loading condition

Vs [knots]	Ps [kW]	n [rpm]	etaD [-]
11.00	2313	66.3	0.726
12.00	3035	72.6	0.727
13.00	4018	79.6	0.725
14.00	5225	86.8	0.720
15.00	6728	94.3	0.716
16.00	8716	102.5	0.710
16.50	9987	107.1	0.705
17.00	11503	112.3	0.700

The model tests for the design condition have been performed at a draft of $T_a/T_f = 11.5/11.5\text{m}$ (moulded draught at perpendiculars).

The corresponding moulded displacement volume is 69822 m³.

Speed-power relation at design loading condition

Vs [knots]	Ps [kW]	n [rpm]	etaD [-]
11.00	3084	73.4	0.700
12.00	4068	80.4	0.694
13.00	5169	87.3	0.700
14.00	6527	94.5	0.700
14.50	7404	98.4	0.696
15.00	8451	102.6	0.691
16.00	10992	111.5	0.690

The model tests for the design condition have been performed at a draft of $T_a/T_f = 12.8/12.8\text{m}$ (moulded draught at perpendiculars).

The corresponding moulded displacement volume is 78803 m³.

Speed-power relation at EEDI loading condition

Vs [knots]	Ps [kW]	n [rpm]	etaD [-]
11.00	3259	74.9	0.683

12.00	4299	82.0	0.677
13.00	5462	89.1	0.683
14.00	6898	96.4	0.683
14.50	7824	100.4	0.679
15.00	8931	104.7	0.674
16.00	11616	113.7	0.673

The overload tests resulted in the following relations for all loading conditions:

20% increase of rpm at 100% power increase

33% increase of rpm at 100% speed increase

8% decrease of propulsive efficiency at 100% power increase

1.3.2 Wind tunnel test

There is no wind tunnel test data available for this specific ship. A Cx table from the STA dataset should be used.

1.3.3 Sea keeping test

No sea keeping tests have been performed for this vessel.

1.4 Trial data

The speed trial has been performed on May 29, 2013 in the Baltic Sea.

The measurement time of each run was 10 minutes.

Speed Trial log

Run	Time	Comment	Heading	Speed	Power	n
[-]	[-]	[-]	[deg]	[knots]	[kW]	[RPM]
1	06:21	50% with	170.0	14.01	5010	85.8
2	06:57	50% against	350.0	13.64	4958	85.8
3	07:54	75% with	170.0	15.42	7704	97.6
4	09:06	75% against	350.0	15.31	7571	97.6
5	10:21	75% with	170.0	15.35	7723	97.6
6	11:06	75% against	350.0	15.50	7354	97.6
7	12:16	85% with	170.0	15.78	9224	103.0
8	12:53	85% against	350.0	16.46	9049	103.0
9	13:35	85% with	170.0	15.49	9175	103.0
10	14:18	85% against	350.0	16.70	9083	103.0
11	15:05	100% with	170.0	15.89	10352	107.2
12	15:49	100% against	350.0	17.18	10119	107.2

Speed Trial log - environmental condition

Run	Relative wind direction	Relative wind speed	Significant wave height	Relative wave direction	Wave period	Water depth
[-]	[deg]	[kts]	[m]	[deg]	[s]	[m]
1	12.5	32.9	1.5	0	4.0	38
2	237.9	6.2	1.5	180	4.0	38
3	15.5	32.1	1.5	0	4.0	38
4	230.2	8.7	1.5	180	4.0	38

5	14.7	33.4	1.7	0	5.0	38
6	212.6	8.9	1.7	180	5.0	38
7	17.5	35.6	1.8	0	5.0	38
8	265.0	9.9	1.8	180	5.0	38
9	9.7	36.9	1.8	0	5.0	38
10	258.2	8.6	1.8	180	5.0	38
11	13.6	36.5	1.8	0	5.0	38
12	247.1	7.6	1.8	180	5.0	38

The air temperature during the trials was 25 degrees Celsius with an air pressure of 1012 mbar. The sea water temperature was 20 degrees Celsius, with a density of 1023 kg/m³.

The wind was measured by an anemometer on top of the wheelhouse, at 42.5m above sea level. There were no wave induced motions (roll/pitch) during the speed trials.

The draught reading prior to the speed trial showed that the draft is slightly less than during the model test.

Ship condition during speed trial

Moulded draught at FPP [m]	4.73
Moulded draught at APP [m]	7.28
Moulded displacement [m ³]	35040
Wetted surface of hull [m ²]	8318
Wetted surface of appendages [m ²]	108
Transverse wind area at trial condition [m ²]	925
Midship section area [m ²]	190

2 Training case 2

Case overview

Ship type	Container carrier
Trial in	Ballast condition
Model test data available?	Powering model tests at ballast, design and EEDI loading conditions. Wind tunnel tests at ballast and design condition.
Corrections	Displacement, wind, waves, water depth, density, temperature, BFT3 in contract conditions
Trial runs	2x50%, 2x75%, 4x90%, 2x100% MCR

Objectives:

1. Determine the EEDI speed
2. Comment on the aspects that are not according to the ITTC procedure



2.1 Ship data

General ship data

Lpp [m]	310
B [m]	44.5
Maximum continuous rating [kW]	58000 kW
RPM at MCR	104
RPM at contract power	100.4
Bow length [m]	112
Cm in actual trial condition	0.98
Transverse wind area at trial condition [m ²]	1737.4
Transverse wind area at design condition [m ²]	1476
Propulsion configuration	Diesel direct
Shaft losses	1.0 %

Distance between fore perpendicular and fore draught mark [m]	9.87 (marks is aft of perpendicular)
Distance between aft perpendicular and aft draught mark [m]	14.31 (mark is fore of perpendicular)
Hull thickness [mm]	19

2.2 Contract data

"The guaranteed speed of the vessel at the design draft of 13 m on even keel, is 24.1 knots with the main engine running at 85% MCR, including Beaufort 3, a sea water density of 1025 kg/m³ and a sea margin of 15%."

2.3 Model test data

2.3.1 Towing tank test data

The model tests for the ballast condition have been performed at a draft of $T_a/T_f = 9.2/4.5\text{m}$ (moulded draught at perpendiculars).

The corresponding moulded displacement volume is 51520 m³.

Speed-power relation at ballast condition

Vs [knots]	Ps [kW]	n [rpm]	etaD [-]
17.00	11280	66.5	0.797
18.00	13283	70.3	0.804
19.00	15643	74.3	0.805
20.00	18386	78.3	0.802
21.00	21609	82.6	0.793
22.00	25407	87.1	0.778
22.50	27511	89.4	0.771
23.00	29749	91.7	0.766
23.50	32141	94.0	0.760
24.00	34713	96.5	0.755
24.50	37483	98.9	0.751
25.00	40478	101.4	0.747
25.50	43737	104.0	0.744
26.00	47305	106.7	0.741
26.50	51238	109.4	0.738
27.00	55599	112.4	0.733
27.50	60466	115.5	0.726
28.00	65932	118.7	0.716

The model tests for the design condition have been performed at a draft of $T_a/T_f = 13.0/13.0\text{m}$ (moulded draught at perpendiculars).

The corresponding moulded displacement volume is 112080 m³.

Speed-power relation at design condition

Vs [knots]	Ps [kW]	n [rpm]	etaD [-]
17.00	14285	70.9	0.751
18.00	16524	74.8	0.748
19.00	19076	78.6	0.742
20.00	21974	82.5	0.736
21.00	25245	86.4	0.732

22.00	29057	90.5	0.734
22.50	31245	92.6	0.737
23.00	33676	94.8	0.740
23.50	36402	97.3	0.741
24.00	39482	99.7	0.739
24.50	42971	102.4	0.736
25.00	46935	105.2	0.731
25.50	51438	108.2	0.724
26.00	56535	111.4	0.714
26.50	62258	114.7	0.703
27.00	68612	118.2	0.692

The model test for the EEDI condition has been performed at a draft of $T_a/T_f = 14.0/14.0\text{m}$ (moulded draught at perpendiculars).

The corresponding moulded displacement volume is 123761 m³.

Speed-power relation at scantling condition

Vs [knots]	Ps [kW]	n [rpm]	etaD [-]
17.00	15261	71.0	0.711
18.00	17653	75.0	0.708
19.00	20379	78.8	0.702
20.00	23475	82.7	0.697
21.00	26970	86.6	0.693
22.00	31042	90.7	0.695
22.50	33380	92.8	0.698
23.00	35977	95.0	0.700
23.50	38889	97.5	0.701
24.00	42180	99.9	0.699
24.50	45907	102.6	0.697
25.00	50142	105.4	0.692
25.50	54953	108.4	0.685
26.00	60398	111.6	0.675
26.50	66512	114.9	0.665
27.00	73300	118.4	0.654

2.3.2 Wind tunnel test

Dedicated wind tunnel tests have been performed for this vessel. The results are presented in the table below.

Cx tables for ballast and design condition

Angle relative to the bow [deg]	Cx Ballast Condition	Cx Design Condition
0	-0.43	-0.49
10	-0.47	-0.53
20	-0.45	-0.51
30	-0.43	-0.49
40	-0.40	-0.46
50	-0.31	-0.37
60	-0.15	-0.21

70	-0.10	-0.16
80	-0.08	-0.14
90	0.05	-0.01
100	0.12	0.06
110	0.15	0.09
120	0.17	0.11
130	0.21	0.15
140	0.25	0.19
150	0.31	0.25
160	0.26	0.20
170	0.24	0.18
180	0.16	0.1

2.3.3 Sea keeping test

No sea keeping tests have been performed for this vessel.

2.4 Hydrostatic table

Hydrostatic table is valid for sea water with a density of 1.025 ton/m³.

Total displacement - tons

Tmean	Trim						
	4.80	4.75	4.70	4.65	4.60	4.55	4.50
6.70	50485	50381	50278	50176	50073	49971	49868
6.75	50899	50795	50692	50589	50487	50384	50282
6.80	51312	51209	51106	51003	50901	50798	50696
6.85	51726	51623	51520	51417	51315	51212	51110
6.90	52140	52037	51934	51831	51728	51626	51524
6.95	52554	52451	52348	52245	52142	52040	51938
7.00	52968	52865	52762	52659	52556	52454	52351
7.05	53382	53278	53175	53073	52970	52868	52765
7.10	53796	53692	53589	53486	53384	53281	53179
7.15	54209	54106	54003	53900	53798	53695	53593

2.5 Trial data

The speed trial has been performed on May 15, 2011 in the Mediterranean Sea. The measurement length of each run was 3 nautical miles.

Speed Trial log

Run	Time	Comment	Heading	Speed	Power	n
[-]	[-]	[-]	[deg]	[knots]	[kW]	[RPM]
1	20:30	50a	205.0	19.91	28712	85.7
2	21:50	50b	28.0	23.13	26812	85.7
3	23:12	75a	28.0	26.20	40858	99.2
4	23:57	75b	204.0	22.99	42188	98.4
5	01:29	90a	204.0	23.72	50569	104.3
6	02:41	90b	28.0	26.92	48022	104.3
7	04:22	90c	27.0	27.05	49364	105.3
8	05:16	90d	207.0	23.87	49804	103.9
9	06:08	100a	204.0	24.80	55781	107.7
10	06:58	100b	26.0	27.76	55813	109.1

Speed Trial log - environmental condition

Run	Relative wind direction	Relative wind speed	Significant swell height	Relative swell direction	Swell period	Water depth
[-]	[deg]	[m/s]	[m]	[deg]	[s]	[m]
1	-1.7	21.0	2.0	0	7.0	118
2	51.8	1.2	2.0	180	7.0	118
3	-10.8	3.7	1.8	180	6.0	118
4	-1.4	20.2	1.8	0	6.0	118
5	2.2	21.2	1.8	20	6.0	118
6	-21.7	3.9	1.8	200	6.0	118
7	-10.2	2.9	1.7	230	6.0	118
8	0.1	21.4	1.7	50	6.0	118
9	-2.1	22.5	1.7	60	6.0	118
10	-3.6	3.9	1.7	240	6.0	118

The air temperature during the trials was 11 degrees Celsius, with an air pressure of 1011 mbar. The sea water temperature was 6 degrees Celsius, with a density of 1022 kg/m³.

The wind was measured by an anemometer on top of the bridge, at 52m above sea level. The swell caused the vessel to roll and pitch during the speed trials.

Ship condition during speed trial

Draught at fore mark [m]	4.77
Draught at aft mark [m]	8.94
Wetted surface of hull [m ²]	11928
Wetted surface of appendages [m ²]	126

3 Training case 3

Case overview

Ship type	Supply vessel
Trial in	Design condition
Model test data available?	Powering model tests at design loading condition. Wind tunnel tests and seakeeping tests
Corrections	Displacement, wind, waves, density, temperature
Trial runs	4x60%, 2x85%, 2x100% MCR

Objectives:

1. Determine the EEDI speed
2. Comment on the aspects that are not according to the ITTC procedure



3.1 Ship data

General ship data

Lpp [m]	88
B [m]	18
Moulded draught at FPP [m]	5.0
Moulded draught at APP [m]	5.0
Moulded displacement [m3]	5830
Maximum continuous rating [kW]	4500 kW
RPM at MCR	210
RPM at contract power	180
Cm in actual trial condition	0.98
Shaft losses	4 %
Transverse wind area at trial condition [m2]	380

3.2 Contract data

“The guaranteed speed of the vessel at the design draft of 5.0 m on even keel, is 13.5 knots with the main engine running at 60% MCR in ideal conditions.

3.3 Model test data

3.3.1 Towing tank test data

The model tests for the design condition have been performed at a draft of $T_a/T_f = 5.0/5.0\text{m}$ (moulded draught at perpendiculars).

The corresponding moulded displacement volume is 5830 m³.

Speed-power relation at design condition

Vs [knots]	Ps [kW]	n [rpm]	etaD [-]
8.00	542	92.1	0.584
8.50	635	99.1	0.583
9.00	743	106.1	0.582
9.50	854	113.2	0.593
10.00	979	120.6	0.603
10.50	1132	127.6	0.606
11.00	1283	134.8	0.610
11.50	1483	142.7	0.603
12.00	1699	150.6	0.595
12.50	1896	157.0	0.594
13.00	2094	162.9	0.595
13.50	2296	169.5	0.597
14.00	2554	176.7	0.597
14.50	2939	185.9	0.584
15.00	3525	196.6	0.569
15.50	4304	209.3	0.552
16.00	5262	222.8	0.534

Overload tests have not been performed.

3.3.2 Wind tunnel test

Dedicated wind tunnel tests have been performed for this vessel. The results are presented in the table below. The C_x table is valid for 10 metres above the water level.

C_x tables for design condition

Angle relative to the bow [deg]	C _x
0.000	-0.540
10.000	-0.540
20.000	-0.500
30.000	-0.430
40.000	-0.360
50.000	-0.240
60.000	-0.240
70.000	-0.170
80.000	-0.120

90.000	-0.090
100.000	-0.060
110.000	0.080
120.000	0.370
130.000	0.590
140.000	0.720
150.000	0.810
160.000	0.770
170.000	0.810
180.000	0.790

3.3.3 Sea keeping test

Sea keeping tests have been performed for this vessel to determine the added wave resistance in head waves. The results are presented in the table below.

RAO for design condition at 10 knots

RAO [kN/m ²]	OMEGA [rad/s]
0.000	0.50000
0.000	0.53000
0.000	0.56000
0.405	0.59000
4.329	0.63000
6.003	0.66000
8.397	0.69000
13.599	0.72000
22.509	0.76000
36.252	0.79000
54.990	0.83000
76.779	0.86000
99.135	0.90000
122.544	0.93000
150.435	0.97000
184.221	1.01000
215.865	1.05000
228.960	1.08000
218.943	1.12000
199.107	1.16000
179.820	1.20000
161.865	1.24000
143.847	1.28000
126.738	1.33000
112.320	1.37000
100.836	1.41000
91.422	1.45000
83.394	1.50000
76.626	1.54000
71.055	1.58000
66.510	1.63000
62.757	1.67000

59.724	1.72000
57.285	1.77000
55.872	1.81000
55.323	1.86000
55.287	1.91000
55.683	1.96000
56.349	2.01000
57.213	2.06000
58.230	2.11000
59.346	2.16000
60.480	2.21000
61.551	2.26000
62.496	2.31000
63.297	2.36000
63.936	2.42000
64.404	2.47000
64.719	2.52000
64.926	2.58000
65.079	2.63000
65.259	2.69000
65.529	2.74000
65.961	2.80000
66.582	2.86000

3.4 Trial data

The speed trial has been performed on September 30, 2013 in the Barentz Sea. The measurement length of each run was 10 minutes.

Speed Trial log

Run	Time	Comment	Heading	Speed	PS Power	PS RPM	SB Power	SB RPM
[-]	[-]	[-]	[deg]	[knots]	[kW]	[RPM]	[kW]	[RPM]
1	15:21	60-1	90.0	12.57	1070	182.3	1183	182.3
2	15:55	60-2	269.2	13.22	1033	182.4	1150	182.4
3	16:23	60-3	92.0	12.63	1059	182.7	1195	182.4
4	16:51	60-4	270.2	13.16	1028	182.8	1171	182.5
5	17:17	85-1	91.8	14.37	1530	207.0	1711	206.8
6	17:43	85-2	268.8	14.90	1481	206.9	1674	206.7
7	18:09	100-1	93.5	14.99	1774	216.9	1960	216.3
8	18:35	100-2	269.8	15.52	1738	217.2	1954	217.2

Speed Trial log - environmental condition

Run	Relative wind direction	Relative wind speed	Water depth	Relative wave direction
[-]	[deg]	[knots]	[m]	[deg]
1	1.1	25.9	300	0
2	6.4	6.8	300	180
3	-0.9	25.5	300	0
4	7.9	6.0	300	180

5	0.2	27.6	300	0
6	13.2	8.6	300	180
7	-5.3	27.4	300	0
8	19.3	10.7	300	180

The air temperature during the trials was -5 degrees Celsius, with an air pressure of 1021 mbar. The sea water temperature was 6 degrees Celsius, with a density of 1024 kg/m³.

The wind was measured by an anemometer on top of the bridge, at 31m above sea level.

Ship condition during speed trial

Moulded draught at FPP [m]	5.0
Moulded draught at APP [m]	5.0
Moulded displacement [m ³]	5760
Wetted surface of hull [m ²]	2015
Wetted surface of appendages [m ²]	23

Measured wave spectrum data

Run 1/2		Run 3/4		Run 5/6		Run 7/8	
OMEGA [rad/s]	SPEC [m ² *s]	OMEGA [rad/s]	SPEC [m ² *s]	OMEGA [rad/s]	SPEC [m ² *s]	OMEGA [rad/s]	SPEC [m ² *s]
0	0	0	0	0	0	0	0
0.157079633	0.004854694	0.157079633	0.00492805	0.157079633	0.008044245	0.157079633	0.003421027
0.188495559	0.001072531	0.188495559	0.001768205	0.188495559	0.001886903	0.188495559	0.001221293
0.219911486	0.001491766	0.219911486	0.0012152	0.219911486	0.001607884	0.219911486	0.001191206
0.251327412	0.00130345	0.251327412	0.001025299	0.251327412	0.001648584	0.251327412	0.000810537
0.282743339	0.000814634	0.282743339	0.001759394	0.282743339	0.001499194	0.282743339	0.000980145
0.314159265	0.002281831	0.314159265	0.00220329	0.314159265	0.002800888	0.314159265	0.001296901
0.345575192	0.000307275	0.345575192	0.000882443	0.345575192	0.001110698	0.345575192	0.00059152
0.376991118	0.000612621	0.376991118	0.000382876	0.376991118	0.000918455	0.376991118	0.000366029
0.408407045	0.000540632	0.408407045	0.000640784	0.408407045	0.001264758	0.408407045	0.000201894
0.439822972	0.000296702	0.439822972	0.000494075	0.439822972	0.000600466	0.439822972	0.000479485
0.471238898	0.000477107	0.471238898	0.000355215	0.471238898	0.000465309	0.471238898	0.000394531
0.502654825	0.00223667	0.502654825	0.001576091	0.502654825	0.001040802	0.502654825	0.000729755
0.534070751	0.00578331	0.534070751	0.00397465	0.534070751	0.007134495	0.534070751	0.005285342
0.565486678	0.01113415	0.565486678	0.008801684	0.565486678	0.011302008	0.565486678	0.004854667
0.596902604	0.012060999	0.596902604	0.005473699	0.596902604	0.007098971	0.596902604	0.006520542
0.628318531	0.014954	0.628318531	0.008004009	0.628318531	0.004178453	0.628318531	0.004903566
0.691150384	0.012001034	0.691150384	0.006327722	0.691150384	0.009024456	0.691150384	0.006520542
0.753982237	0.010485147	0.753982237	0.017287003	0.753982237	0.011763	0.753982237	0.00592956
0.81681409	0.010175599	0.81681409	0.02049	0.81681409	0.008627455	0.81681409	0.003205839
0.879645943	0.006924001	0.879645943	0.011414979	0.879645943	0.008372551	0.879645943	0.004782439
0.942477796	0.006079848	0.942477796	0.007315135	0.942477796	0.007806397	0.942477796	0.004806365
1.005309649	0.00277307	1.005309649	0.005841289	1.005309649	0.006553167	1.005309649	0.007315198
1.068141502	0.001803901	1.068141502	0.00569704	1.068141502	0.006719143	1.068141502	0.005556458
1.130973355	0.001323085	1.130973355	0.004284254	1.130973355	0.006296146	1.130973355	0.002974052
1.193805208	0.000891393	1.193805208	0.003353933	1.193805208	0.005206657	1.193805208	0.004734735
1.256637061	0.000927761	1.256637061	0.002459415	1.256637061	0.002829119	1.256637061	0.008124957
1.319468915	0.000798484	1.319468915	0.001363405	1.319468915	0.002304725	1.319468915	0.014954
1.382300768	0.000826926	1.382300768	0.000895782	1.382300768	0.000913879	1.382300768	0.004617945
1.445132621	0.000818717	1.445132621	0.00094172	1.445132621	0.001491666	1.445132621	0.002814941
1.507964474	0.000657034	1.507964474	0.001560395	1.507964474	0.004503935	1.507964474	0.003724593
1.570796327	0.00057694	1.570796327	0.005419195	1.570796327	0.006202512	1.570796327	0.001632229
1.63362818	0.000406569	1.63362818	0.001759394	1.63362818	0.009346056	1.63362818	0.001599228
1.696460033	0.00033959	1.696460033	0.001020095	1.696460033	0.007767462	1.696460033	0.002064549
1.759291886	0.000647254	1.759291886	0.001127401	1.759291886	0.004549223	1.759291886	0.003403979
1.822123739	0.000287939	1.822123739	0.001370207	1.822123739	0.002731839	1.822123739	0.00564035
1.884955592	0.000433875	1.884955592	0.000989995	1.884955592	0.001303458	1.884955592	0.00592956
1.947787445	0.000995039	1.947787445	0.001185203	1.947787445	0.000562683	1.947787445	0.006110055
2.010619298	0.000666963	2.010619298	0.001009993	2.010619298	0.001009995	2.010619298	0.006423341
2.073451151	0.00038674	2.073451151	0.000733419	2.073451151	0.001584006	2.073451151	0.007884945
2.136283004	0.00021118	2.136283004	0.001072508	2.136283004	0.001632234	2.136283004	0.009923923
2.199114858	0.000261845	2.199114858	0.000618757	2.199114858	0.000904786	2.199114858	0.010858997
2.261946711	0.000329556	2.261946711	0.000479486	2.261946711	0.001035603	2.261946711	0.009727427

2.324778564	0.00059155	2.324778564	0.000618757	2.324778564	0.000767171	2.324778564	0.007134553
2.387610417	0.000562689	2.387610417	0.000433855	2.387610417	0.000551532	2.387610417	0.00323799
2.45044227	0.000203928	2.45044227	0.000442625	2.45044227	0.000535228	2.45044227	0.001794929
2.513274123	0.000548812	2.513274123	0.000324644	2.513274123	0.000715296	2.513274123	0.000904792
2.576105976	0.000951254	2.576105976	0.00033118	2.576105976	0.000790532	2.576105976	0.000469989
2.638937829	0.001072531	2.638937829	0.000287925	2.638937829	0.001040802	2.638937829	0.000708177
2.701769682	0.000726136	2.701769682	0.000494075	2.701769682	0.001121802	2.701769682	0.000941713
2.764601535	0.000463006	2.764601535	0.000562676	2.764601535	0.000814611	2.764601535	0.001144504
2.827433388	0.000358791	2.827433388	0.000733419	2.827433388	0.00069764	2.827433388	0.000951179
2.890265241	0.000436044	2.890265241	0.000644001	2.890265241	0.000806495	2.890265241	0.001138807
2.953097094	0.000748253	2.953097094	0.000571179	2.953097094	0.001284049	2.953097094	0.001963909
3.015928947	0.000790558	3.015928947	0.000644001	3.015928947	0.00167364	3.015928947	0.00304942
3.078760801	0.000650499	3.078760801	0.001083204	3.078760801	0.001426146	3.078760801	0.002651045
3.141592654	0.000594511	3.141592654	0.001491692	3.141592654	0.002731839	3.141592654	0.003303339
3.204424507	0.000663644	3.204424507	0.001521895	3.204424507	0.002677729	3.204424507	0.005841331