

Scientific Research Project Biomechanical Analyses

at the



Final Report

Long Jump

**Biomechanical analyses of selected events at the
12th IAAF World Championships in Athletics,
Berlin 15–23 August 2009**

A Project by the German Athletics Federation

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in co-operation with

IAT Leipzig

OSP Berlin

OSP Hessen

OSP Rheinland

Martin Luther-Universität Wittenberg-Halle



DLV Scientific Research Project

Deutscher
Leichtathletik-
Verband



IAT
Institut für Angewandte
Trainingswissenschaft



Olympiastützpunkte
Berlin
Hessen
Rheinland



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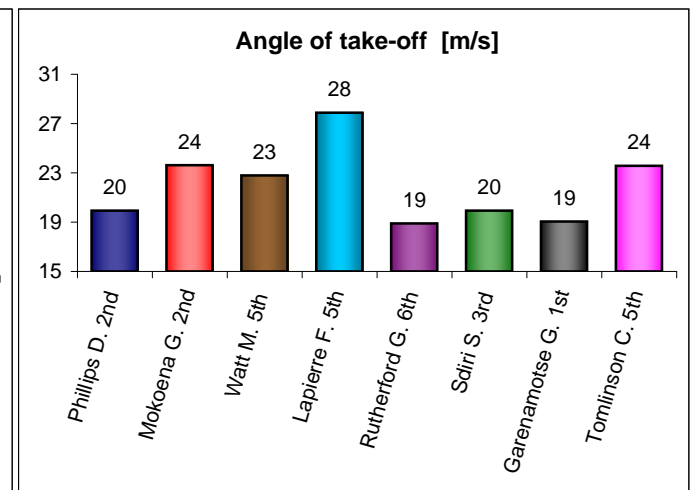
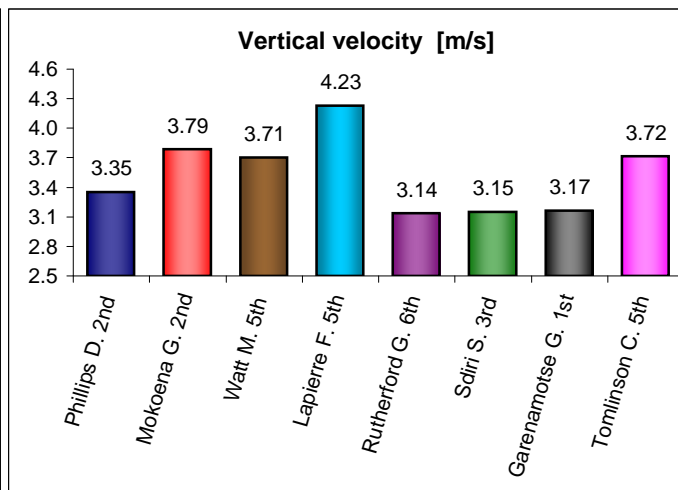
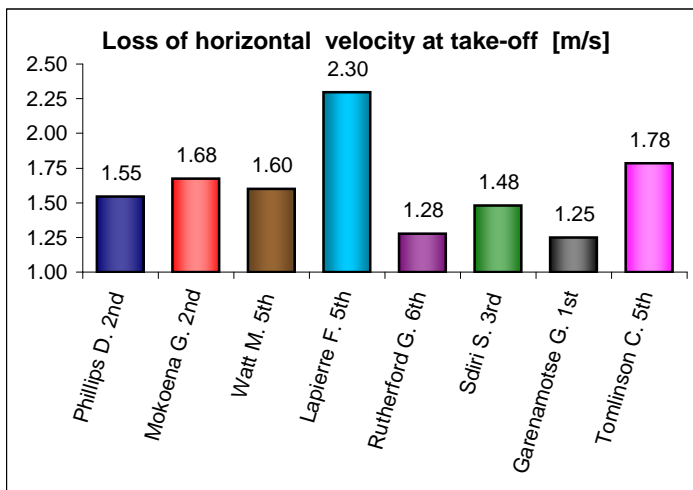
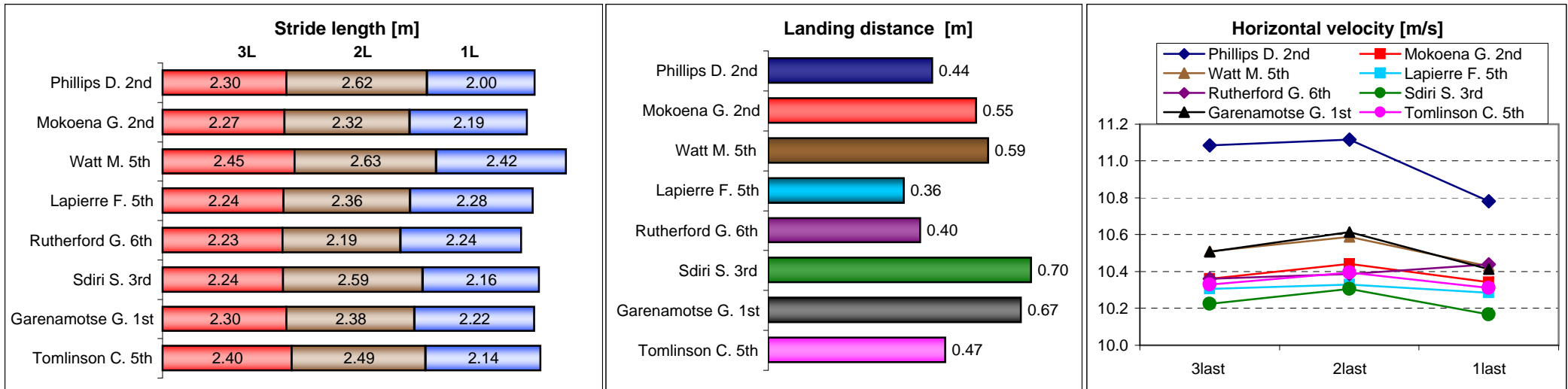
Biomechanical Analysis of the Long Jump Men Final

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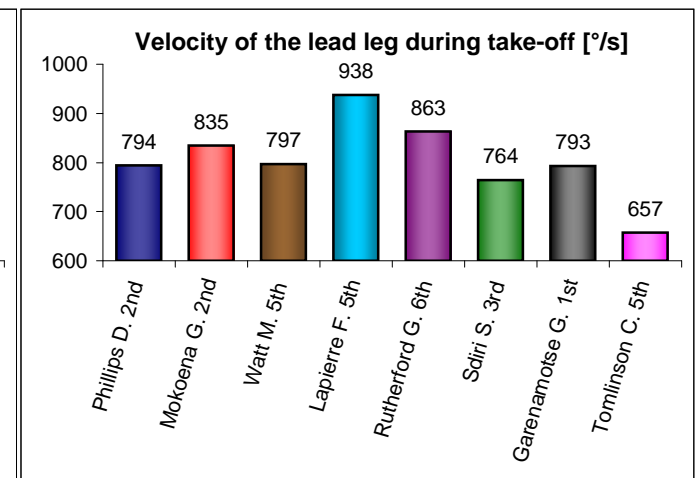
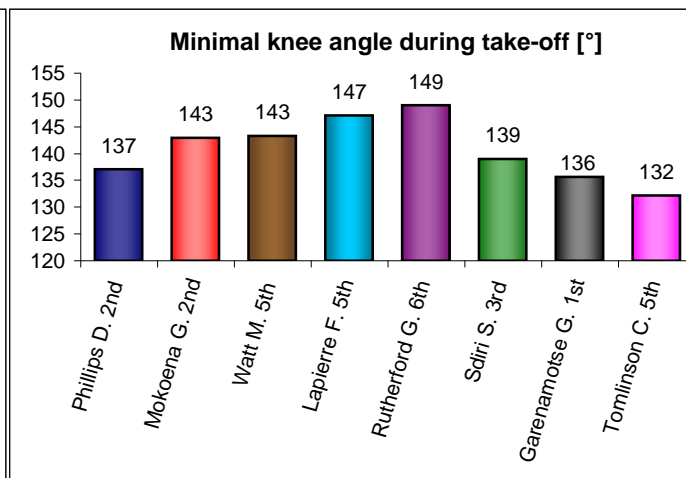
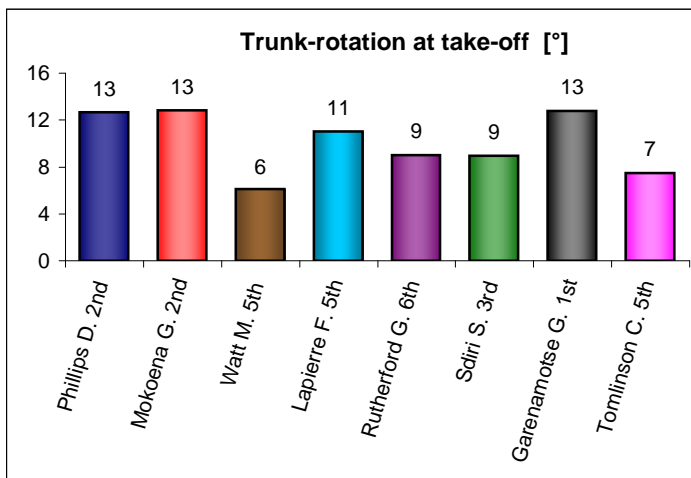
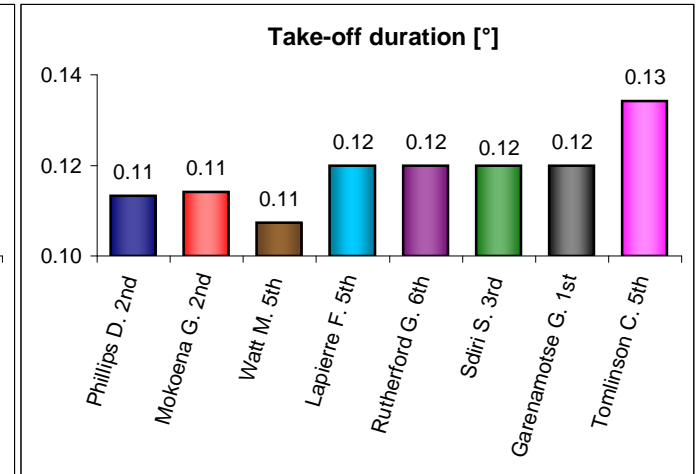
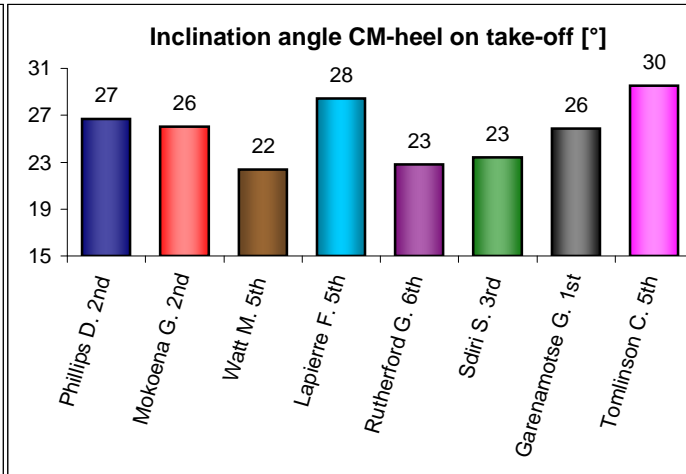
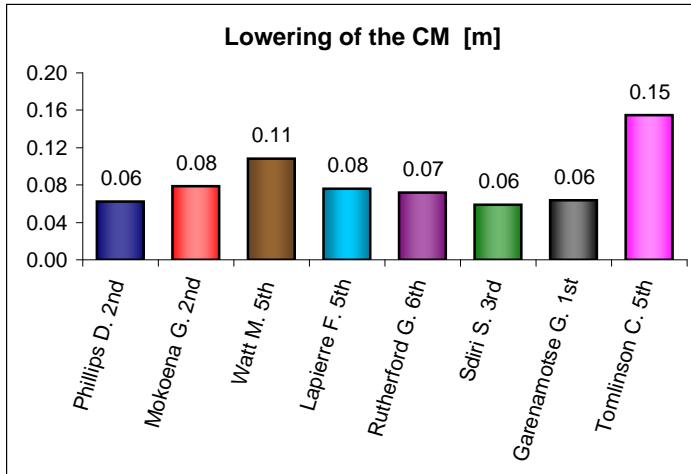
Name / Attempt	Distance [m]				Stride length [m]					lowering of CM	Velocity [m/s]					
	officially measured	real	loss at take-off (toe-to-board)	loss by landing	3last	2last	1last	relative length 2last / 3last [%]	relative length 1last / 2last [%]		3last	2last	1last	take-off instant	loss at take-off	vertical velocity at take-off
Phillips D. 2nd	8.54	8.59	0.05	0.00	2.30	2.62	2.00	114	77	0.06	11.08	11.12	10.78	9.23	1.55	3.35
Mokoena G. 2nd	8.47	8.48	0.01	0.00	2.27	2.32	2.19	102	94	0.08	10.36	10.44	10.34	8.67	1.68	3.79
Watt M. 5th	8.37	8.44	0.07	0.00	2.45	2.63	2.42	107	92	0.11	10.51	10.59	10.43	8.83	1.60	3.71
Lapierre F. 5th	8.21	8.33	0.12	0.00	2.24	2.36	2.28	105	97	0.08	10.30	10.33	10.28	7.99	2.30	4.23
Rutherford G. 6th	8.17	8.23	0.06	0.00	2.23	2.19	2.24	98	102	0.07	10.36	10.39	10.44	9.16	1.28	3.14
Sdiri S. 3rd	8.07	8.07	0.00	0.00	2.24	2.59	2.16	116	83	0.06	10.23	10.31	10.17	8.69	1.48	3.15
Garenamotse G. 1st	8.06	8.14	0.08	0.00	2.30	2.38	2.22	104	93	0.06	10.51	10.61	10.41	9.17	1.25	3.17
Tomlinson C. 5th	8.06	8.10	0.04	0.00	2.40	2.49	2.14	104	86	0.15	10.33	10.40	10.31	8.53	1.78	3.72

Name / Attempt	Take-off						Lead leg		Landing			
	duration [s]	inclination angle [°]	trunk-angle [°]	trunk rotation [°]	minimal knee-angle [°]	angle of take-off [°]	thigh-angle at take-off [°]	average velocity [°/s]	distance [m]	trunk angle [°]	knee angle [°]	hip angle [°]
Phillips D. 2nd	0.11	27	103	13	137	20.0	-9	794	0.44	51	129	55
Mokoena G. 2nd	0.11	26	99	13	143	23.6	-12	835	0.55	74	151	96
Watt M. 5th	0.11	22	97	6	143	22.8	-5	797	0.59	92	148	115
Lapierre F. 5th	0.12	28	102	11	147	27.9	15	938	0.36	61	143	92
Rutherford G. 6th	0.12	23	95	9	149	18.9	4	863	0.40	49	143	64
Sdiri S. 3rd	0.12	23	98	9	139	19.9	-9	764	0.70	108	127	106
Garenamotse G. 1st	0.12	26	99	13	136	19.1	-7	793	0.67	94	153	109
Tomlinson C. 5th	0.13	30	104	7	132	23.6	-17	657	0.47	76	133	94

Biomechanical Analysis of the Long Jump Men Final 12th IAAF World Championships in Athletics - Berlin 22. August 2009



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Phillips D. 2nd 8,59m



Mokoena G. 2nd 8,47m



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Watt M. 5th 8,37m



Lapierre F. 5th 8,21m



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Rutherford G. 6th 8,17m



Sdiri S. 3rd 8,07m



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Garenamotse G. 1st 8,06m



Tomlinson C. 5th 8,06m



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No.	Name	Att.	Distance [m]	Wind [m/s]	Run-Up-Velocity		
					11-6m [m/s]	6-1m from the Take-Off Board [m/s]	
1218	Phillips	2.A	8.54	+0.1	11.06	10.93	22. Aug 09 s18:30:38
1218	Phillips	3.A	8.37	+0.2	11.05	11.03	22. Aug 09 s18:53:18
1218	Phillips	4.A	8.25	+0.1	10.95	10.84	22. Aug 09 s19:26:21
1218	Phillips	6.A	x	-0.1	10.98	10.89	22. Aug 09 s19:53:29
966	Mokoena	1.A	x	-0.2	10.38	10.40	22. Aug 09 s18:15:10
966	Mokoena	2.A	8.47	+0.1	10.37	10.33	22. Aug 09 s18:34:29
966	Mokoena	3.A	8.31	-0.1	10.28	10.26	22. Aug 09 s18:57:17
966	Mokoena	4.A	8.19	+0.5	0.00	0.00	22. Aug 09 s19:25:14
966	Mokoena	5.A	x	+0.3	10.23	10.10	22. Aug 09 s19:38:18
966	Mokoena	6.A	x	+0.3	10.25	10.15	22. Aug 09 s19:51:39
149	Watt	1.A	8.28	-0.2	10.50	10.41	22. Aug 09 s18:23:06
149	Watt	2.A	x	+0.1	10.53	10.49	22. Aug 09 s18:41:45
149	Watt	3.A	x	+0.2	10.47	10.54	22. Aug 09 s19:05:01
149	Watt	4.A	x	+0.8	10.59	10.67	22. Aug 09 s19:23:44
149	Watt	5.A	8.37	-0.4	10.55	10.46	22. Aug 09 s19:36:56
149	Watt	6.A	x	+0.4	10.58	10.65	22. Aug 09 s19:50:08
140	Lapierre	1.A	8.21	+0.1	10.21	10.16	22. Aug 09 s18:08:51
140	Lapierre	2.A	7.77	-0.3	10.33	10.29	22. Aug 09 s18:27:43
140	Lapierre	3.A	8.19	+0.3	10.25	10.26	22. Aug 09 s18:50:08
140	Lapierre	4.A	x	+0.7	10.22	10.19	22. Aug 09 s19:22:22
140	Lapierre	5.A	8.21	-0.2	10.25	9.91	22. Aug 09 s19:35:18
140	Lapierre	6.A	8.20	-0.2	0.00	0.00	22. Aug 09 s19:49:23
517	Rutherford	1.A	7.83	+0.0	10.60	10.71	22. Aug 09 s18:07:30
517	Rutherford	2.A	7.96	+0.1	10.27	10.24	22. Aug 09 s18:25:59
517	Rutherford	3.A	x	+0.2	0.00	0.00	22. Aug 09 s18:46:27
517	Rutherford	4.A	8.05	+0.7	10.43	0.00	22. Aug 09 s19:14:45
517	Rutherford	5.A	8.15	+0.2	10.24	10.41	22. Aug 09 s19:28:55
517	Rutherford	6.A	8.17	+0.7	0.00	0.00	22. Aug 09 s19:47:38
477	Sdiri	1.A	7.78	-0.1	10.32	10.50	22. Aug 09 s18:10:22
477	Sdiri	2.A	x	+0.1	10.18	10.36	22. Aug 09 s18:28:53
477	Sdiri	3.A	7.99	-0.1	10.10	10.27	22. Aug 09 s18:51:52
477	Sdiri	4.A	8.07	+0.2	10.23	10.29	22. Aug 09 s19:15:54
477	Sdiri	5.A	7.92	+0.5	10.34	10.47	22. Aug 09 s19:30:44
477	Sdiri	6.A	7.83	-0.1	10.30	10.30	22. Aug 09 s19:46:14
206	Garenamotse	1.A	8.06	-0.2	10.41	10.49	22. Aug 09 s18:21:06
206	Garenamotse	2.A	8.04	-0.2	10.34	10.35	22. Aug 09 s18:40:28
206	Garenamotse	3.A	x	+0.3	10.36	10.36	22. Aug 09 s19:03:34
206	Garenamotse	4.A	7.77	+0.5	10.34	10.36	22. Aug 09 s19:19:02
206	Garenamotse	5.A	7.83	+0.4	10.24	0.00	22. Aug 09 s19:34:02
206	Garenamotse	6.A	7.69	+0.3	10.34	10.26	22. Aug 09 s19:45:07
519	Tomlinson	1.A	8.02	-0.4	10.55	10.40	22. Aug 09 s18:19:17
519	Tomlinson	2.A	7.93	+0.1	10.50	10.41	22. Aug 09 s18:38:47
519	Tomlinson	3.A	7.93	+0.2	10.16	10.36	22. Aug 09 s19:01:51
519	Tomlinson	4.A	7.66	+0.4	10.11	10.15	22. Aug 09 s19:17:26
519	Tomlinson	5.A	8.06	-0.2	10.23	10.32	22. Aug 09 s19:32:18
519	Tomlinson	6.A	8.02	+0.2	10.42	10.30	22. Aug 09 s19:43:12

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No.	Name	Att.	Distance [m]	Wind [m/s]	Run-Up-Velocity		
					11-6m [m/s]	6-1m from the Take-Off Board [m/s]	
1104	Johnson	1.A	6.30	-0.3	10.57	10.58	22. Aug 09 s18:16:39
1104	Johnson	2.A	x	-0.1	10.41	10.50	22. Aug 09 s18:35:28
1104	Johnson	3.A	7.86	+0.1	10.32	10.41	22. Aug 09 s18:58:55
801	Berrabah	1.A	5.91	-0.1	10.46	10.25	22. Aug 09 s18:17:51
801	Berrabah	2.A	x	-0.2	10.33	10.41	22. Aug 09 s18:36:56
801	Berrabah	3.A	7.83	+0.4	10.22	10.21	22. Aug 09 s19:00:18
587	Tsatsoumas	1.A	x	-0.1	0.00	0.00	22. Aug 09 s18:13:25
587	Tsatsoumas	2.A	7.59	+0.4	10.70	10.58	22. Aug 09 s18:32:42
587	Tsatsoumas	3.A	x	+0.8	0.00	0.00	22. Aug 09 s18:54:40
889	Saladino	1.A	x	-0.5	10.40	10.55	22. Aug 09 s18:24:14
889	Saladino	2.A	x	+0.1	10.39	10.28	22. Aug 09 s18:43:02
889	Saladino	3.A	x	+0.4	9.94	9.82	22. Aug 09 s19:06:16

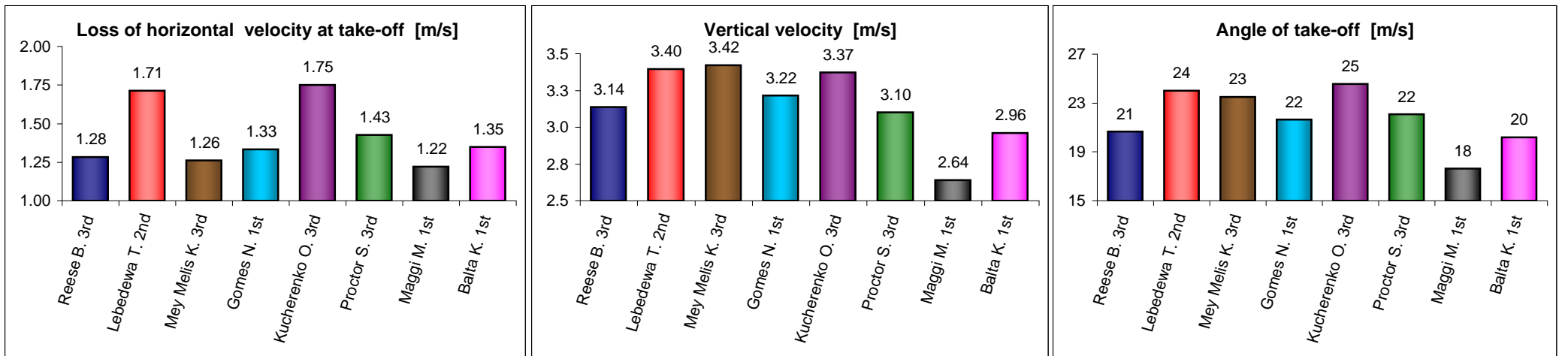
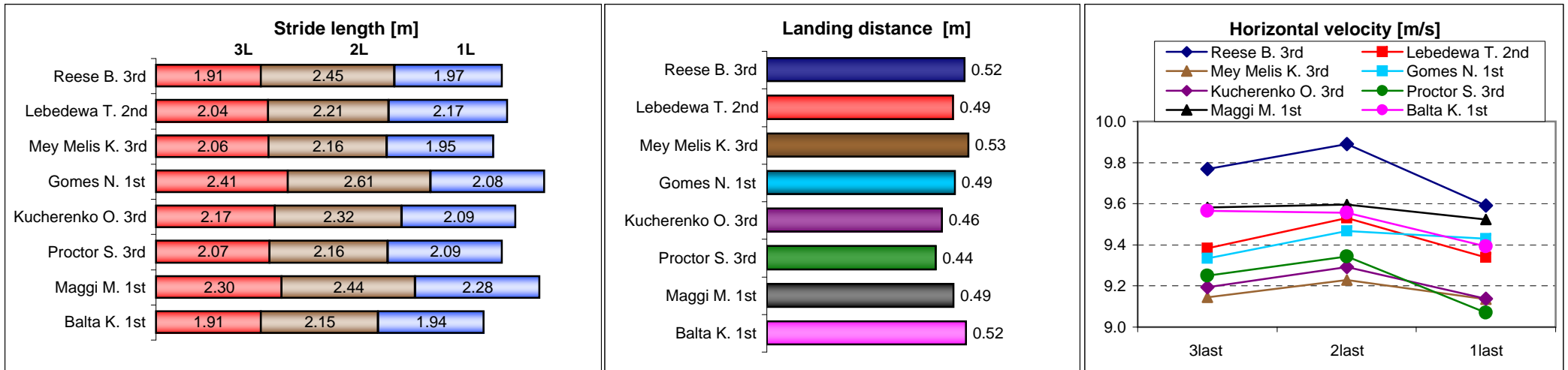
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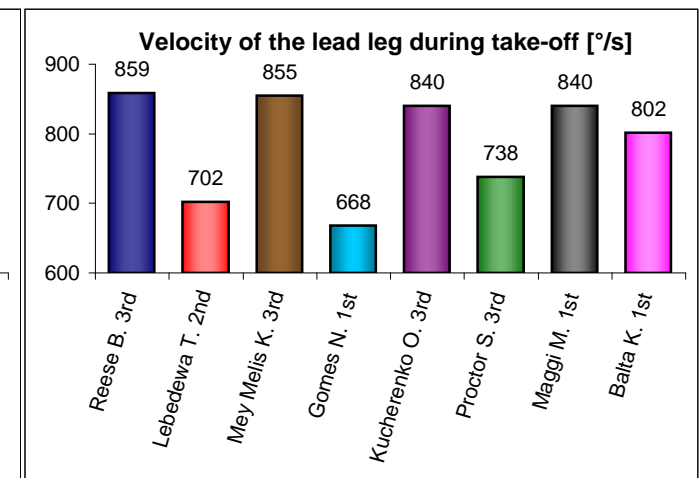
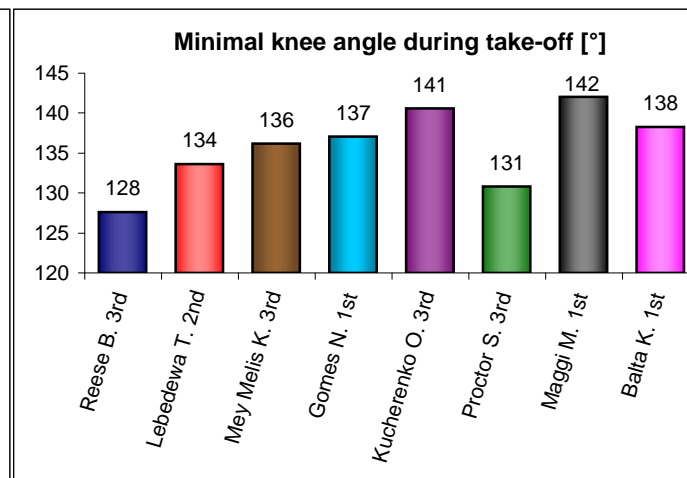
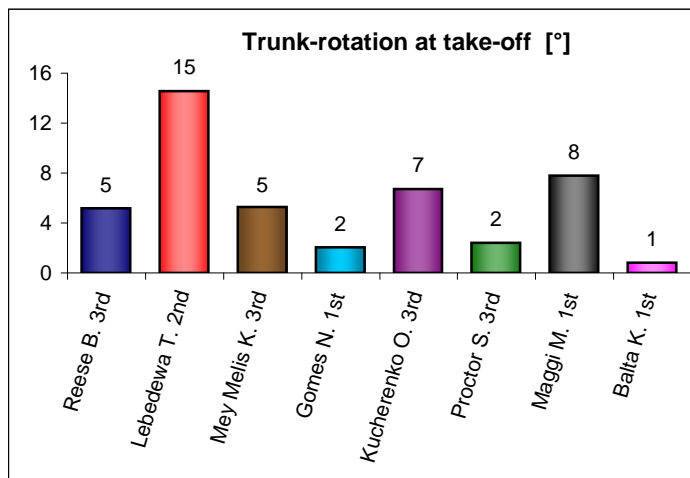
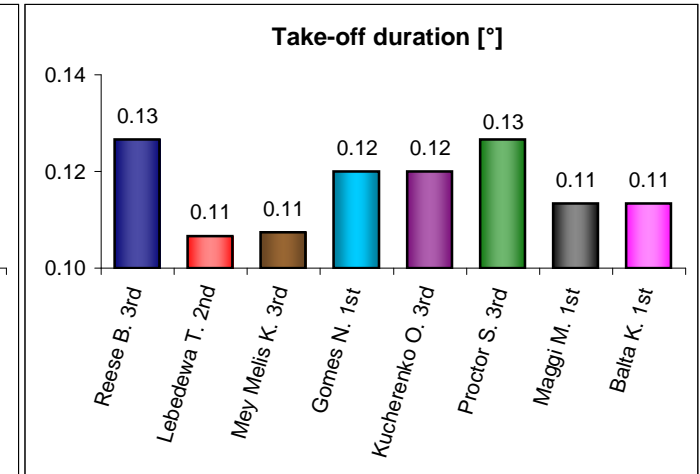
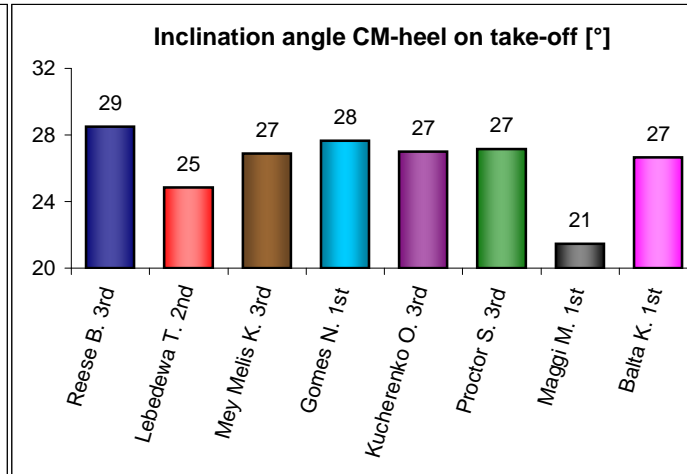
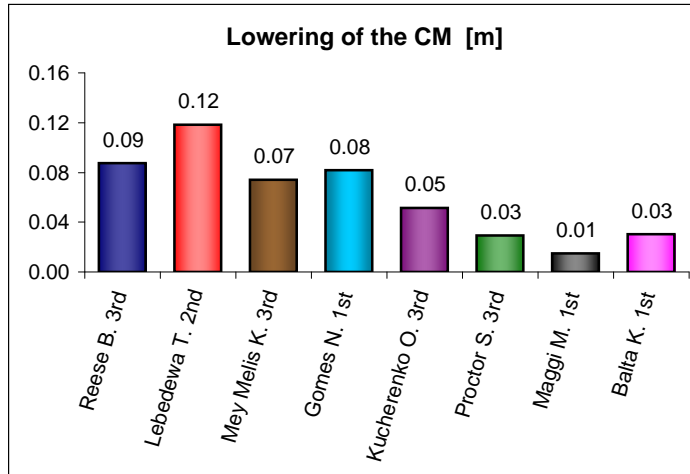
Name / Attempt	Distance [m]				Stride length [m]					lowering of CM	Velocity [m/s]					
	officially measured	real	loss at take-off (toe-to-board)	loss by landing	3last	2last	1last	relative length 2last / 3last [%]	relative length 1last / 2last [%]		3last	2last	1last	take-off instant	loss at take-off	vertical velocity at take-off
Reese B. 3rd	7.10	7.18	0.08	0.00	1.91	2.45	1.97	128	81	0.09	9.77	9.89	9.59	8.31	1.28	3.14
Lebedewa T. 2nd	6.97	6.97	0.00	0.00	2.04	2.21	2.17	108	98	0.12	9.38	9.53	9.34	7.62	1.71	3.40
Mey Melis K. 3rd	6.80	6.85	0.05	0.00	2.06	2.16	1.95	105	90	0.07	9.14	9.23	9.13	7.87	1.26	3.42
Gomes N. 1st	6.77	6.86	0.09	0.00	2.41	2.61	2.08	108	80	0.08	9.33	9.47	9.43	8.10	1.33	3.22
Kucherenko O. 3rd	6.77	6.77	0.00	0.00	2.17	2.32	2.09	107	90	0.05	9.19	9.29	9.14	7.39	1.75	3.37
Proctor S. 3rd	6.71	6.76	0.05	0.00	2.07	2.16	2.09	105	97	0.03	9.25	9.34	9.07	7.64	1.43	3.10
Maggi M. 1st	6.68	6.81	0.13	0.00	2.30	2.44	2.28	106	93	0.01	9.58	9.60	9.52	8.30	1.22	2.64
Balta K. 1st	6.62	6.64	0.02	0.13	1.91	2.15	1.94	112	90	0.03	9.57	9.55	9.39	8.04	1.35	2.96

Name / Attempt	Take-off						Lead leg		Landing			
	duration [s]	inclination angle [°]	trunk-angle [°]	trunk rotation [°]	minimal knee-angle [°]	angle of take-off [°]	thigh-angle at take-off [°]	average velocity [°/s]	distance [m]	trunk angle [°]	knee angle [°]	hip angle [°]
Reese B. 3rd	0.13	29	97	5	128	20.7	-1	859	0.52	68	150	83
Lebedewa T. 2nd	0.11	25	101	15	134	24.0	-12	702	0.49	70	148	84
Mey Melis K. 3rd	0.11	27	100	5	136	23.5	-8	855	0.53	87	158	106
Gomes N. 1st	0.12	28	99	2	137	21.7	-21	668	0.49	75	135	85
Kucherenko O. 3rd	0.12	27	98	7	141	24.5	-1	840	0.46	60	158	79
Proctor S. 3rd	0.13	27	96	2	131	22.1	-2	738	0.44	77	128	82
Maggi M. 1st	0.11	21	102	8	142	17.6	5	840	0.49	66	137	69
Balta K. 1st	0.11	27	97	1	138	20.2	-16	802	0.52	81	148	98

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Reese B. 3rd 7,10m



Lebedewa T. 2nd 6,97m

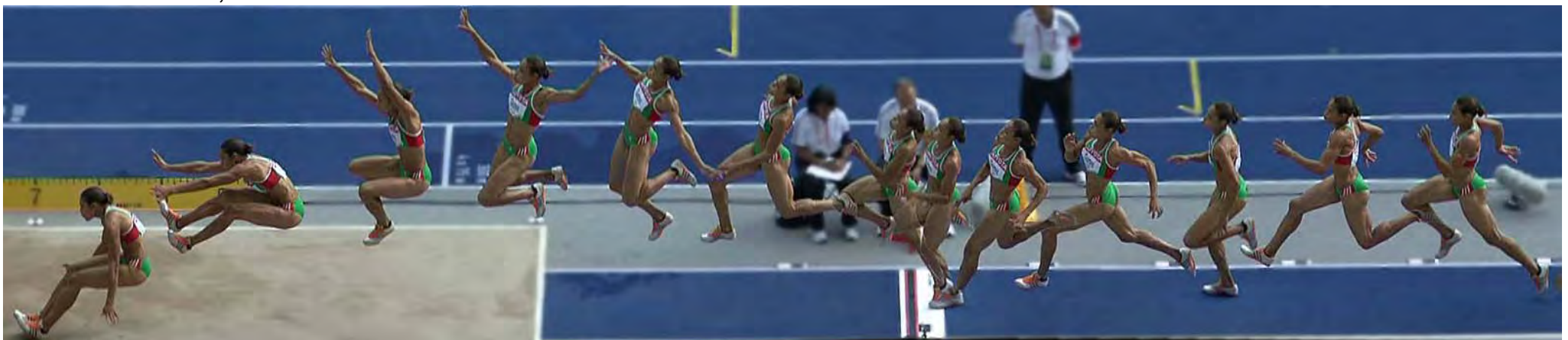


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Mey Melis K. 3rd 6,80m



Gomes N. 1st 6,77m



Biomechanical Analysis of the Long Jump Women Final 12th IAAF World Championships in Athletics - Berlin 23. August 2009

Kucherenko O. 3rd 6,77m



Proctor S. 3rd 6,71m



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Maggi M. 1st **6,68m**



Balta K. 1st **6,62m**



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No.	Name	Att.	Distance [m]	Wind [m/s]	Run-Up-Velocity		
					11-6m [m/s]	6-1m from the Take-Off Board [m/s]	
1020	Reese	1	6.92	+0.8	9.49	9.46	23. Aug 09 s16:27:02
1020	Reese	2	6.85	+0.5	9.50	9.47	23. Aug 09 s16:44:17
1020	Reese	3	7.10	+1.0	9.78	9.76	23. Aug 09 s17:03:54
1020	Reese	4	x	+0.1	9.54	9.37	23. Aug 09 s17:30:24
1020	Reese	5	x	-0.1	9.50	9.46	23. Aug 09 s17:42:34
1020	Reese	6	x	+0.2	9.71	9.56	23. Aug 09 s18:00:34
808	Lebedeva	1	6.78	+0.3	9.30	9.33	23. Aug 09 s16:34:55
808	Lebedeva	2	6.97	+1.0	9.26	9.40	23. Aug 09 s16:54:30
808	Lebedeva	3	x	-0.4	9.17	9.26	23. Aug 09 s17:12:09
808	Lebedeva	4	x	+0.8	9.29	9.37	23. Aug 09 s17:27:31
808	Lebedeva	5	x	+0.4	0.00	0.00	23. Aug 09 s17:41:31
808	Lebedeva	6	x	+0.4	9.19	9.31	23. Aug 09 s17:58:54
925	Melis	1	6.76	+0.8	9.17	9.01	23. Aug 09 s16:33:49
925	Melis	2	x	+0.8	9.18	9.11	23. Aug 09 s16:53:09
925	Melis	3	6.80	+0.4	9.19	9.09	23. Aug 09 s17:10:52
925	Melis	4	x	+0.2	9.08	9.10	23. Aug 09 s17:26:30
925	Melis	5	x	+1.0	9.17	9.03	23. Aug 09 s17:40:30
925	Melis	6	6.49	+0.1	8.98	8.96	23. Aug 09 s17:57:26
737	Gomes	1	6.77	+0.5	8.99	9.36	23. Aug 09 s16:28:14
737	Gomes	2	x	+0.6	9.04	9.41	23. Aug 09 s16:45:10
737	Gomes	3	6.52	+1.5	9.34	9.36	23. Aug 09 s17:04:57
737	Gomes	4	6.68	+0.6	9.10	9.30	23. Aug 09 s17:25:02
737	Gomes	5	6.69	+0.9	9.23	9.28	23. Aug 09 s17:39:04
737	Gomes	6	6.68	-0.4	9.19	9.30	23. Aug 09 s17:53:52
807	Kucherenko	1	x	+0.6	9.15	9.11	23. Aug 09 s16:21:40
807	Kucherenko	2	x	+0.6	9.14	9.16	23. Aug 09 s16:39:15
807	Kucherenko	3	6.77	+1.1	9.11	9.21	23. Aug 09 s16:58:40
807	Kucherenko	4	6.63	+0.4	9.08	9.11	23. Aug 09 s17:23:34
807	Kucherenko	5	x	+0.5	9.10	9.17	23. Aug 09 s17:35:35
807	Kucherenko	6	6.68	+1.3	0.00	0.00	23. Aug 09 s17:52:51
101	Proctor	1	x	+0.9	9.07	9.09	23. Aug 09 s16:29:20
101	Proctor	2	6.56	+1.6	9.24	9.11	23. Aug 09 s16:46:33
101	Proctor	3	6.71	+1.2	9.25	9.15	23. Aug 09 s17:06:10
101	Proctor	4	x	+0.1	0.00	9.03	23. Aug 09 s17:21:55
101	Proctor	5	x	-0.1	8.94	8.87	23. Aug 09 s17:34:19
101	Proctor	6	6.40	+0.5	9.08	8.93	23. Aug 09 s17:47:37
178	Maggi	1	6.68	+0.7	0.00	0.00	23. Aug 09 s16:20:22
178	Maggi	2	x	+0.8	9.71	9.65	23. Aug 09 s16:37:38
178	Maggi	3	x	+1.1	0.00	0.00	23. Aug 09 s16:57:10
178	Maggi	4	6.64	+0.0	9.46	9.49	23. Aug 09 s17:21:21
315	Balta	1	6.62	+0.3	9.44	9.53	23. Aug 09 s16:32:36
315	Balta	2	6.52	+0.1	9.31	9.52	23. Aug 09 s16:52:01
315	Balta	3	x	+0.1	9.33	9.41	23. Aug 09 s17:08:46
315	Balta	4	6.15	-0.3	9.23	9.42	23. Aug 09 s17:19:40
315	Balta	5	6.60	-0.5	9.19	9.37	23. Aug 09 s17:32:13
315	Balta	6	6.57	+0.3	9.28	9.37	23. Aug 09 s17:46:35



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No.	Name	Att.	Distance [m]	Wind [m/s]	Run-Up-Velocity		
					11-6m [m/s]	6-1m from the Take-Off Board [m/s]	
991	Glenn	1	x	+0.5	9.48	9.56	23. Aug 09 s16:30:46
991	Glenn	2	6.59	-0.1	9.51	9.53	23. Aug 09 s16:47:56
991	Glenn	3	x	+0.8	9.53	9.54	23. Aug 09 s17:07:37
708	Dobija	1	x	+0.4	8.70	8.68	23. Aug 09 s16:35:55
708	Dobija	2	6.58	+0.7	8.67	8.65	23. Aug 09 s16:55:45
708	Dobija	3	6.51	-0.1	8.61	8.74	23. Aug 09 s17:13:40
152	Mironchyk	1	x	+0.5	8.92	8.85	23. Aug 09 s16:24:34
152	Mironchyk	2	6.24	+0.8	8.44	8.59	23. Aug 09 s16:43:00
152	Mironchyk	3	6.29	+0.0	8.69	8.92	23. Aug 09 s17:02:31
174	Kosta	1	x	+0.3	9.20	9.23	23. Aug 09 s16:23:08
174	Kosta	2	x	+0.6	9.04	9.23	23. Aug 09 s16:40:44
174	Kosta	3	x	+1.1	9.25	9.24	23. Aug 09 s16:59:51