Regine Isele/Soon-Ho Lee/Eberhard Nixdorf

Biomechanical Analysis of the Hammer Throw

13th IAAF World Championships in Athletics - Daegu - 29th August/4th September 2011

General

In this report, the results of biomechanical analyses of the two hammer throw competitions are presented. Through a cooperation between the OSP Hessen (Olympic Training Centre in Frankfurt/Hessen) with KISS (Korea Institute of Sport Science) the parameters describing hammer throw technique were recorded with video cameras and analysed using a three-dimensional kinematographic measurement method with the aim of obtaining the latest data and insight into the technical conditions of world's current best throwers. The intent was to analyse the best attempt of each of the top eight placers in the two competitions.

Hammer Throw Women

The women's hammer throw took place on Sunday, 4th September 2011 at 18:15 pm under warm and dry weather conditions (28° C and 54 % air humidity). In comparison, the relative quality of the performances in the women's competition lagged behind those at the Championships in Berlin two years before. Looking at the single performances and the average of the medal winners as well as the average of the final eight throwers, the women's hammer throw in Daegu was the second best competition in the history of European or World Championships or Olympic Games.

The average age of the top eight throwers was 25.8 ± 2.8 years. With Tatjana Lysenko, Betty Heidler, Wenxiu Zhang, Ypsi Moreno, Anita Wlodarczyk, Kathrin Klaas and Zalina Marghieva seven athletes in the final of the best were ranking among the top 8 of the world. Four athletes were throwing season's bests at that time. All the top eight placers were throwing from four turns. Since there were no obstructions through judges, photographers or others the best attempt of each of the top eight placers was analysed.

Hammer Throw Men

The men's hammer throw took place on Monday, 29th August 2011 at 19:15 pm under warm and dry weather conditions (31° C and 55 % air humidity). The average performance of the medal winners as well as of the eight top finalists shows a slightly upward trend after two years with weaker performances at European and World Championships.

The average age of the top eight throwers was 31.6 ± 4 years. From the current world's top twelve hammer throwers one did not compete in Daegu and two athletes did not make the final. But among the top eight finalists all athletes were ranking among the world's top twelve. The three medal winners all threw season's bests at that time. Seven of the top eight men threw from four turns. Vizzoni threw from three turns.

Koji Murofushi succeed in throwing his best performance of 81,24 m twice - in the third as well as in the fifth round. There were only 6 cm difference between the winner and the second placer Pars.

Since there were no obstructions through judges, photographers or others the best attempt of each of the top eight placers was analysed.

Regine Isele/Soon-Ho Lee/Eberhard Nixdorf

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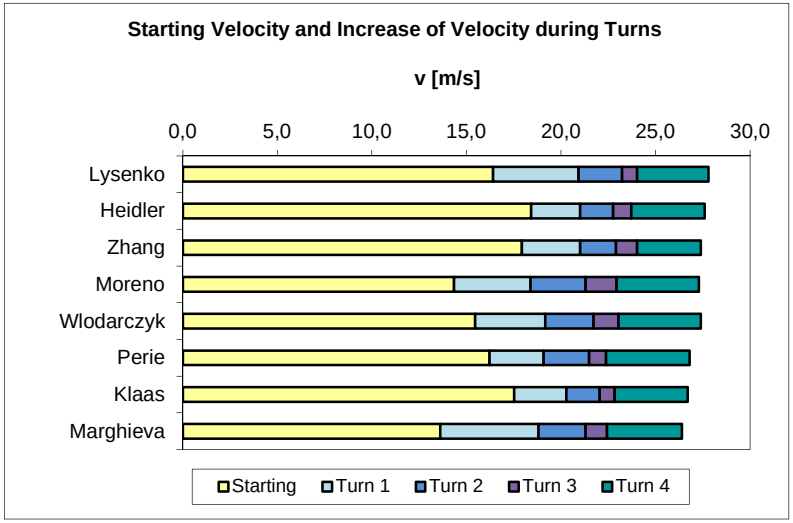
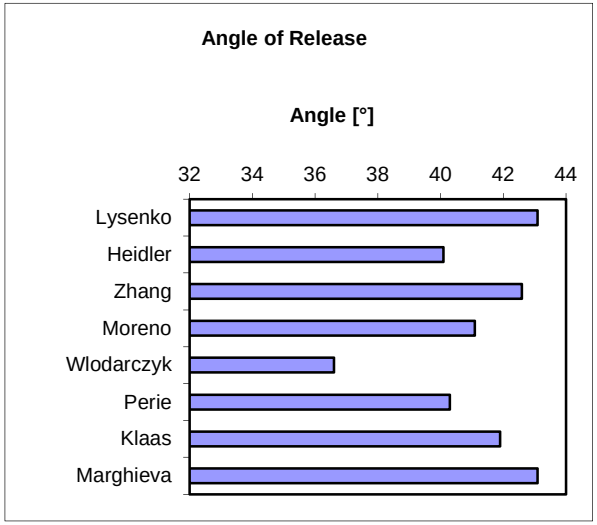
Biomechanical Analysis of the Hammer Throw Women Final

13th IAAF World Championships in Athletics - Daegu - 4 September 2011

Name	Attempt	Distance [m]	Starting Velocity [m/s]	Increase of Velocity				Velocity at Release [m/s]	Angle of Release [°]
				Turn 1 [m/s]	Turn 2 [m/s]	Turn 3 [m/s]	Turn 4 [m/s]		
Lysenko	3	77,13	16,4	4,5	2,3	0,8	3,8	27,8	43,1
Heidler	5	76,06	18,4	2,6	1,7	1,0	3,9	27,6	40,1
Zhang	1	75,03	17,9	3,1	1,9	1,1	3,4	27,4	42,6
Moreno	3	74,48	14,4	4,0	2,9	1,6	4,4	27,3	41,1
Wlodarczyk	1	73,56	15,5	3,7	2,6	1,3	4,4	27,4	36,6
Perie	6	72,04	16,2	2,9	2,4	0,9	4,4	26,8	40,3
Klaas	4	71,89	17,5	2,8	1,8	0,8	3,9	26,7	41,9
Marghieva	5	70,27	13,6	5,2	2,5	1,1	4,0	26,4	43,1





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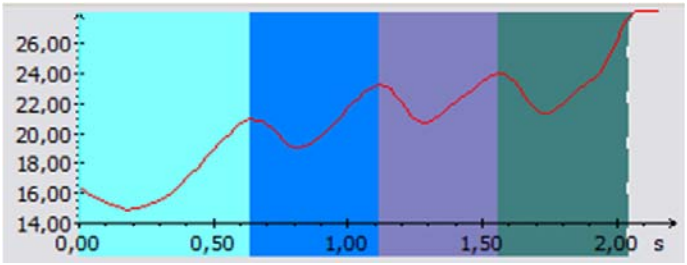
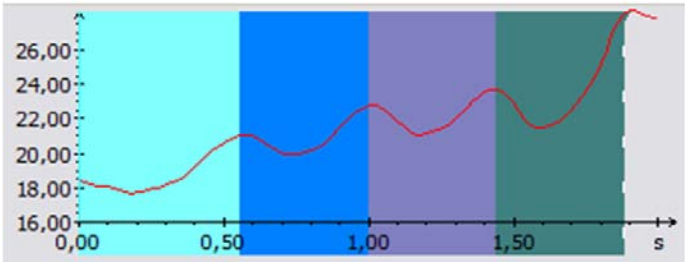
Biomechanical Analysis of the Hammer Throw Women Final

13th IAAF World Championships in Athletics - Daegu - 4 September 2011

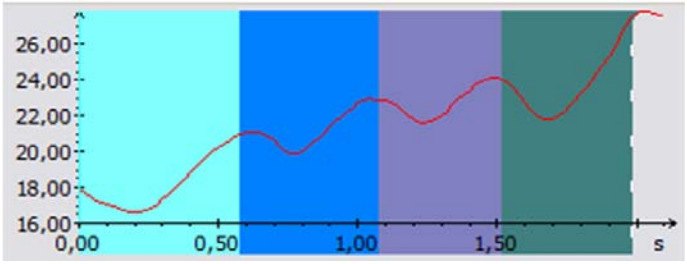
Velocity during turns:



Lysenko



Heidler



Zhang

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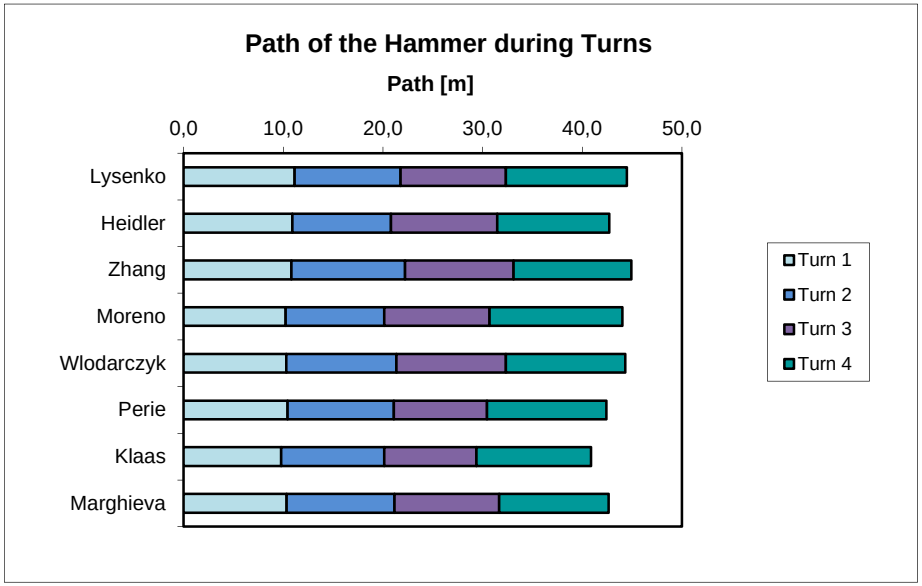
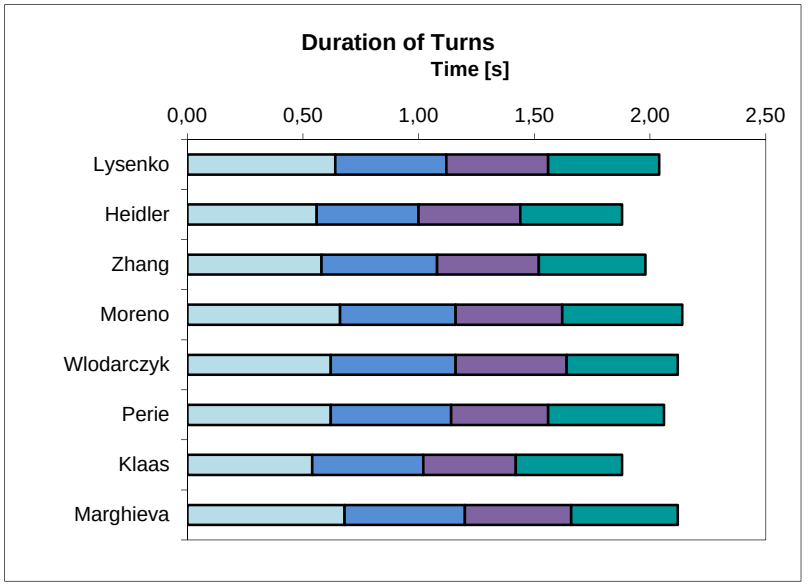
Biomechanical Analysis of the Hammer Throw Women Final

13th IAAF World Championships in Athletics - Daegu - 4 September 2011

Name	Path of the Hammer during Turns				
	Turn 1	Turn 2	Turn 3	Turn 4	Total
	[m]	[m]	[m]	[m]	[m]
Lysenko	11,1	10,6	10,6	12,1	44,5
Heidler	10,9	9,9	10,7	11,2	42,7
Zhang	10,8	11,4	10,9	11,8	44,9
Moreno	10,2	9,9	10,6	13,3	44,0
Wlodarczyk	10,3	11,1	11,0	12,0	44,3
Perie	10,4	10,7	9,4	12,0	42,4
Klaas	9,8	10,3	9,3	11,5	40,9
Marghieva	10,3	10,8	10,5	11,0	42,7

Name	Duration of Turns				
	Turn 1	Turn 2	Turn 3	Turn 4	Total
	[s]	[s]	[s]	[s]	[s]
Lysenko	0,64	0,48	0,44	0,48	2,04
Heidler	0,56	0,44	0,44	0,44	1,88
Zhang	0,58	0,50	0,44	0,46	1,98
Moreno	0,66	0,50	0,46	0,52	2,14
Wlodarczyk	0,62	0,54	0,48	0,48	2,12
Perie	0,62	0,52	0,42	0,50	2,06
Klaas	0,54	0,48	0,40	0,46	1,88
Marghieva	0,68	0,52	0,46	0,46	2,12





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Biomechanical Analysis of the Hammer Throw Women Final

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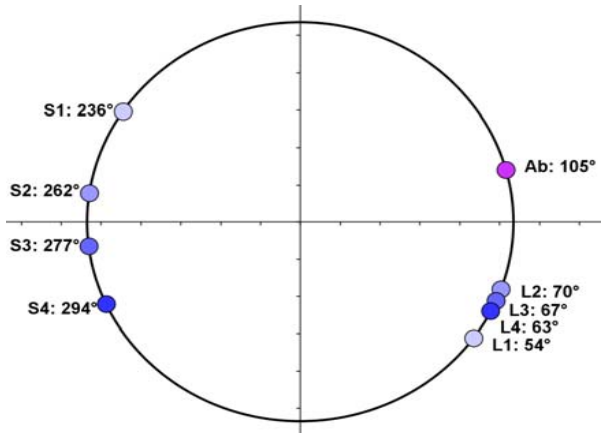
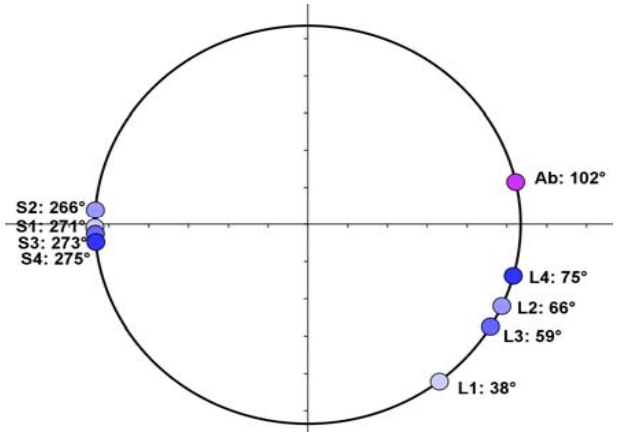
Name	Azimuthal angle								
	End of swings	end 1st ss	end 1 ds	end 2nd ss	end 2nd ds	end 3rd ss	end 3rd ds	end 4ss	release
	[Degrees]								
Lysenko	54	236	70	262	67	277	63	294	105
Heidler	38	271	66	266	59	273	75	275	102
Zhang	60	257	56	280	75	291	81	299	107
Moreno	52	230	36	239	6	244	4	255	109
Wlodarczyk	70	234	57	230	61	248	65	258	107
Perie	31	238	43	262	64	278	48	260	117
Klaas	46	232	42	253	60	244	39	251	89
Marghieva	49	189	43	233	59	269	72	278	97

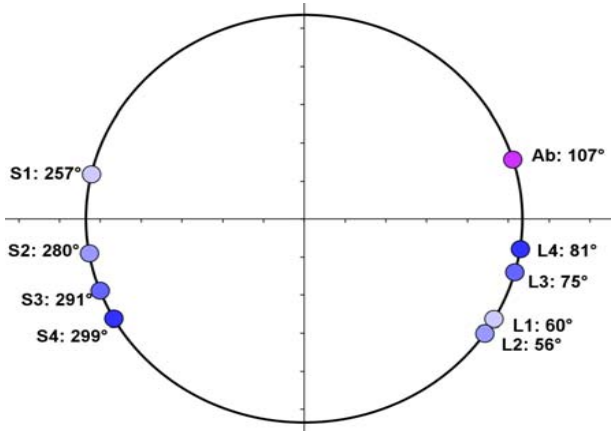
ss: single support, ds: double support



Lysenko



Heidler



Zhang

L1-L4: Leaving right foot from turn 1 to 4, S1-S4: Setting right foot from turn 1 to turn 4, Ab: Leaving the hand

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Biomechanical Analysis of the Hammer Throw Women Final

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Name	Angle of Twisting (between shoulder and hip axis)								
	End of swings	end 1st ss	end 1 ds	end 2nd ss	end 2nd ds	end 3rd ss	end 3rd ds	end 4ss	release
	[Degrees]								
Lysenko	14	26	12	26	11	7	2	47	3
Heidler	4	36	19	35	15	48	13	48	26
Zhang	2	41	6	28	21	23	10	5	47
Moreno	15	42	4	44	17	41	9	42	1
Wlodarczyk	2	54	24	53	11	33	12	68	5
Perie	4	32	7	19	7	32	22	20	15
Klaas	10	19	9	14	25	26	29	59	53
Marghieva	12	31	74	46	11	35	19	38	25

Name	Angle between shoulder axis and hammer wire								
	End of swings	end 1st ss	end 1 ds	end 2nd ss	end 2nd ds	end 3rd ss	end 3rd ds	end 4ss	release
	[Degrees]								
Lysenko	92	120	101	108	87	115	94	107	59
Heidler	88	93	75	103	78	84	84	86	87
Zhang	81	99	88	102	71	106	75	112	59
Moreno	88	122	102	107	98	101	104	100	55
Wlodarczyk	87	100	86	105	87	116	84	82	63
Perie	84	117	95	126	92	119	86	126	88
Klaas	99	133	89	120	80	112	81	92	123
Marghieva	94	123	179	103	83	112	73	108	89

This angle amounts to 90° when the hammer is directly in front of the body.
When trailing the hammer this angle increases, a "running ahead" of the hammer results in values under 90°.

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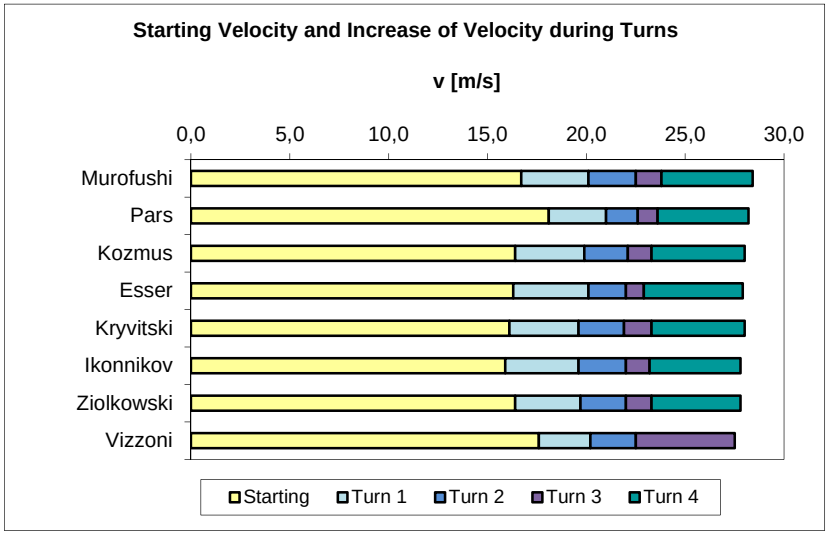
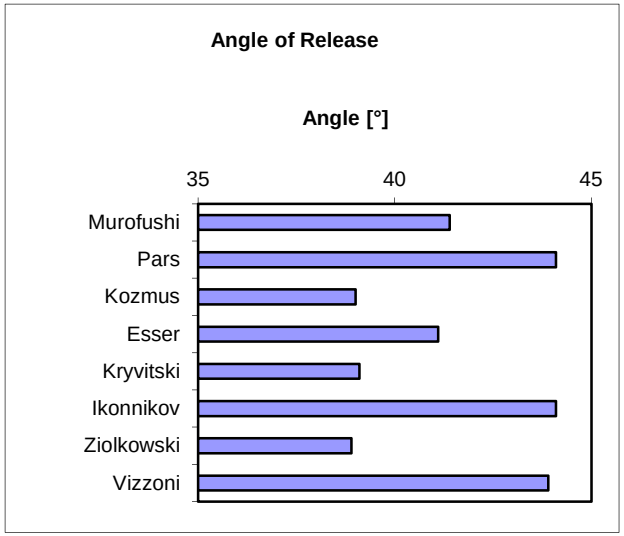
Biomechanical Analysis of the Hammer Throw Men Final

13th IAAF World Championships in Athletics - Daegu - 29 August 2011

Name	Attempt	Distance [m]	Starting Velocity [m/s]	Increase of Velocity				Velocity at Release [m/s]	Angle of Release [°]
				Turn 1 [m/s]	Turn 2 [m/s]	Turn 3 [m/s]	Turn 4 [m/s]		
Murofushi	3	81,24	16,7	3,4	2,4	1,3	4,6	28,3	41,4
Pars	6	81,18	18,1	2,9	1,6	1,0	4,6	28,2	44,1
Kozmus	2	79,39	16,4	3,5	2,2	1,2	4,7	28,1	39,0
Esser	5	79,12	16,3	3,8	1,9	0,9	5,0	27,9	41,1
Kryvitski	3	78,53	16,1	3,5	2,3	1,4	4,7	27,9	39,1
Ikonnikov	5	78,37	15,9	3,7	2,4	1,2	4,6	27,7	44,1
Ziolkowski	2	77,64	16,4	3,3	2,3	1,3	4,5	27,8	38,9
Vizzoni	1	77,04	17,6	2,6	2,3	5,0		27,4	43,9





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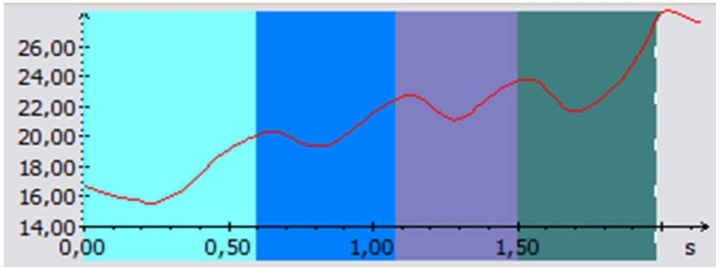
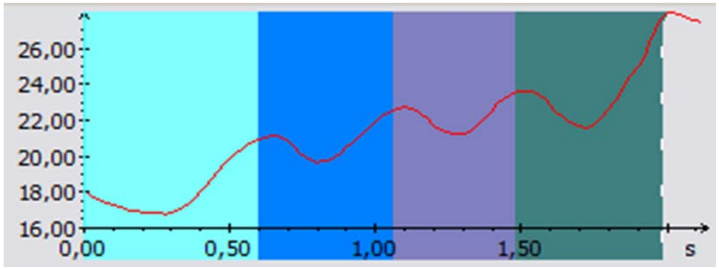
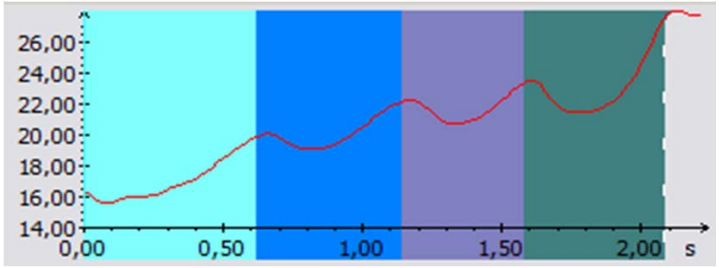
Velocity during turns:



Murofushi



Pars



Kozmus

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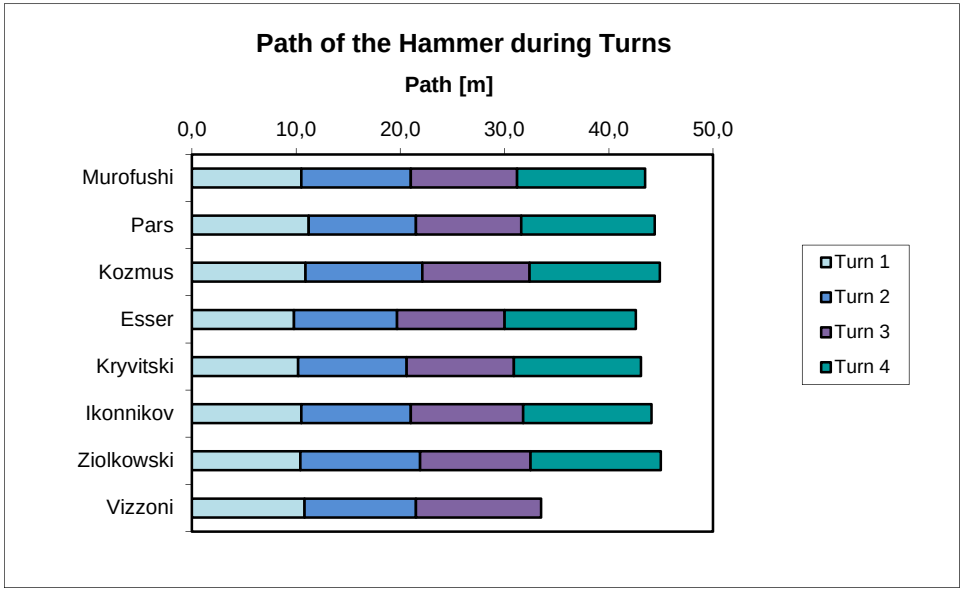
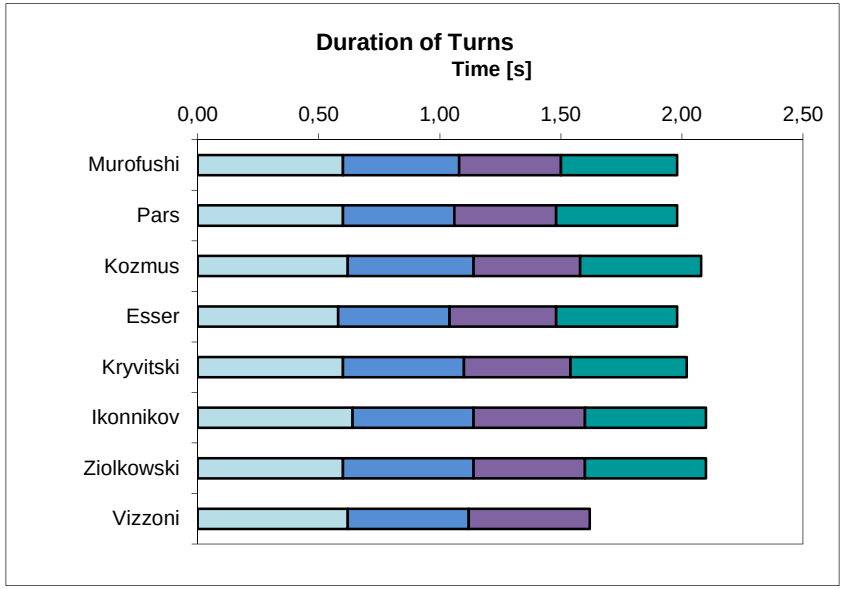
Name	Path of the Hammer during Turns				
	Turn 1	Turn 2	Turn 3	Turn 4	Total
	[m]	[m]	[m]	[m]	[m]
Murofushi	10,5	10,5	10,2	12,3	43,5
Pars	11,2	10,3	10,1	12,8	44,4
Kozmus	10,9	11,2	10,3	12,5	44,9
Esser	9,8	9,9	10,3	12,6	42,6
Kryvitski	10,2	10,4	10,3	12,2	43,1
Ikonnikov	10,5	10,5	10,8	12,3	44,1
Ziolkowski	10,4	11,5	10,6	12,5	45,0
Vizzoni	10,8	10,7	12,0		33,5

Name	Duration of Turns				
	Turn 1	Turn 2	Turn 3	Turn 4	Total
	[s]	[s]	[s]	[s]	[s]
Murofushi	0,60	0,48	0,42	0,48	1,98
Pars	0,60	0,46	0,42	0,50	1,98
Kozmus	0,62	0,52	0,44	0,50	2,08
Esser	0,58	0,46	0,44	0,50	1,98
Kryvitski	0,60	0,50	0,44	0,48	2,02
Ikonnikov	0,64	0,50	0,46	0,50	2,10
Ziolkowski	0,60	0,54	0,46	0,50	2,10
Vizzoni	0,62	0,50	0,50		1,62





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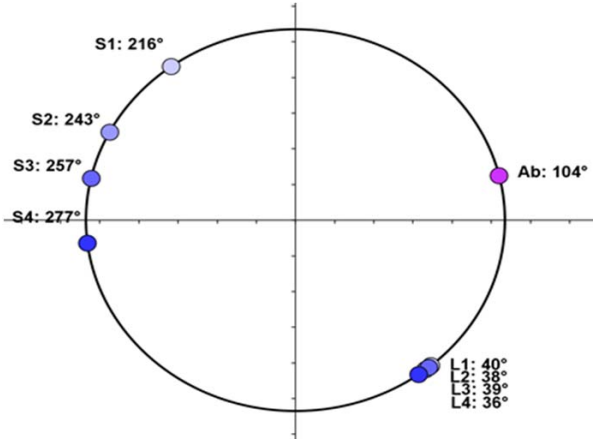
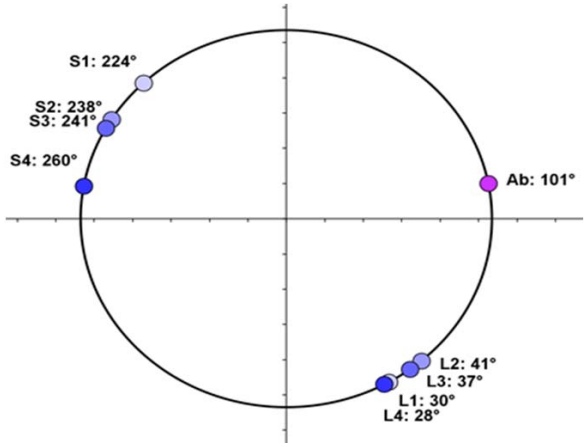
Name	Azimuthal angle								
	End of swings	end 1st ss	end 1st ds	end 2nd ss	end 2nd ds	end 3rd ss	end 3rd ds	end 4ss	release
	[Degrees]								
Murofushi	40	216	38	243	39	257	36	277	104
Pars	30	224	41	238	37	241	28	260	101
Kozmus	22	204	25	220	42	230	36	235	102
Esser	27	224	13	237	2	256	14	279	106
Kryvitski	95	245	76	234	64	252	56	276	107
Ikonnikov	15	199	18	228	22	233	40	236	96
Ziolkowski	21	193	6	243	38	255	44	260	107
Vizzoni	317	111	310	103	309	102	268		

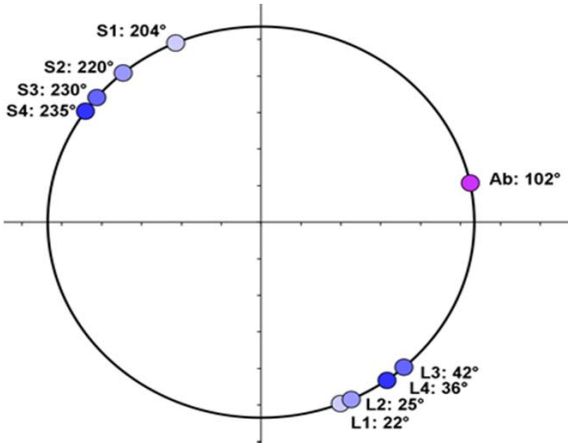
ss: single support, ds: double support



Murofushi



Pars



Kozmus

L1-L4: Leaving right foot from turn 1 to 4, S1-S4: Setting right foot from turn 1 to turn 4, Ab: Leaving the hand

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Biomechanical Analysis of the Hammer Throw Men Final

13th IAAF World Championships in Athletics - Daegu - 29 August 2011

Name	Angle of Twisting (between shoulder and hip axis)								
	End of swings	end 1st ss	end 1 ds	end 2nd ss	end 2nd ds	end 3rd ss	end 3rd ds	end 4ss	release
	[Degrees]								
Murofushi	2	60	18	40	9	43	15	21	27
Pars	11	45	1	57	12	41	12	45	2
Kozmus	6	65	6	63	23	48	25	58	24
Esser	7	65	12	50	16	37	4	43	19
Kryvitski	18	40	20	37	5	47	21	28	34
Ikonnikov	9	73	26	70	20	71	25	59	47
Ziolkowski	9	26	3	49	3	33	3	29	29
Vizzoni	14	43	20	32	20	49	14		

Name	Angle between shoulder axis and hammer wire								
	End of swings	end 1st ss	end 1 ds	end 2nd ss	end 2nd ds	end 3rd ss	end 3rd ds	end 4ss	release
	[Degrees]								
Murofushi	94	105	92	109	88	101	92	110	101
Pars	79	84	88	90	89	99	90	93	83
Kozmus	72	114	102	109	99	107	88	99	93
Esser	71	101	98	108	107	103	102	93	79
Kryvitski	91	102	106	102	87	98	79	111	94
Ikonnikov	68	115	97	102	105	95	96	97	105
Ziolkowski	86	98	79	107	97	110	94	116	78
Vizzoni	90	134	97	129	96	122	87		

This angle amounts to 90° when the hammer is directly in front of the body.
When trailing the hammer this angle increases, a "running ahead" of the hammer results in values under 90°.