

Extra Material

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1 Introduction

This document serves as an extra material for my PhD thesis. Meant to be a storage for raw material. For theory, methods, etc. see the thesis.

2 Data that is constant for all cases

plate size	287x150x0.2mm
emissivity down	1
emissivity up	0
convective heat transfer coefficient down	5
plate material	18Cr 19Ni

Part I Collections

3 Stagnation Point

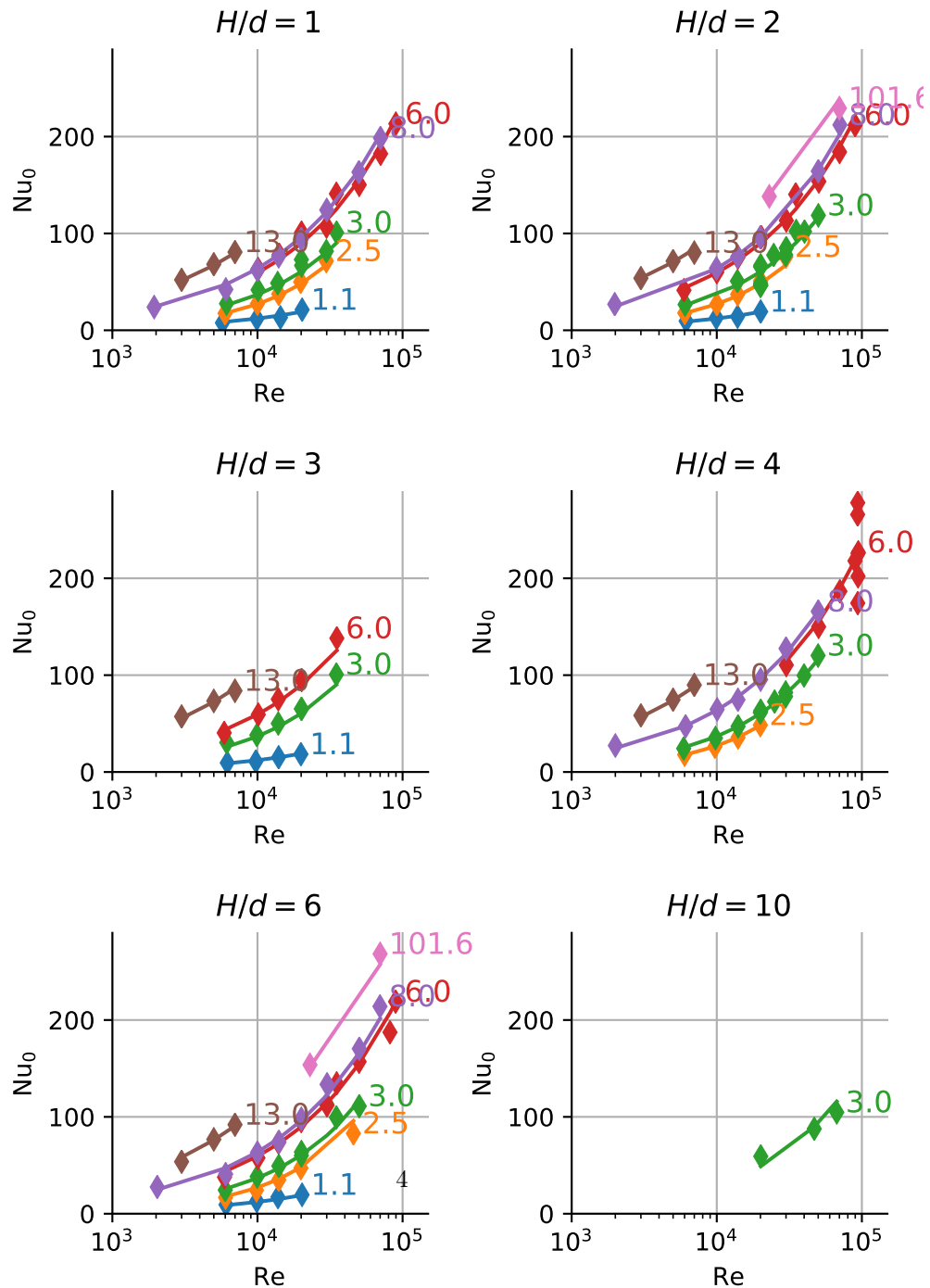


Figure 1: Stagnation point Nusselt numbers for different H/d . The number next to a line represents nozzle diameter in millimeters. The line represents a

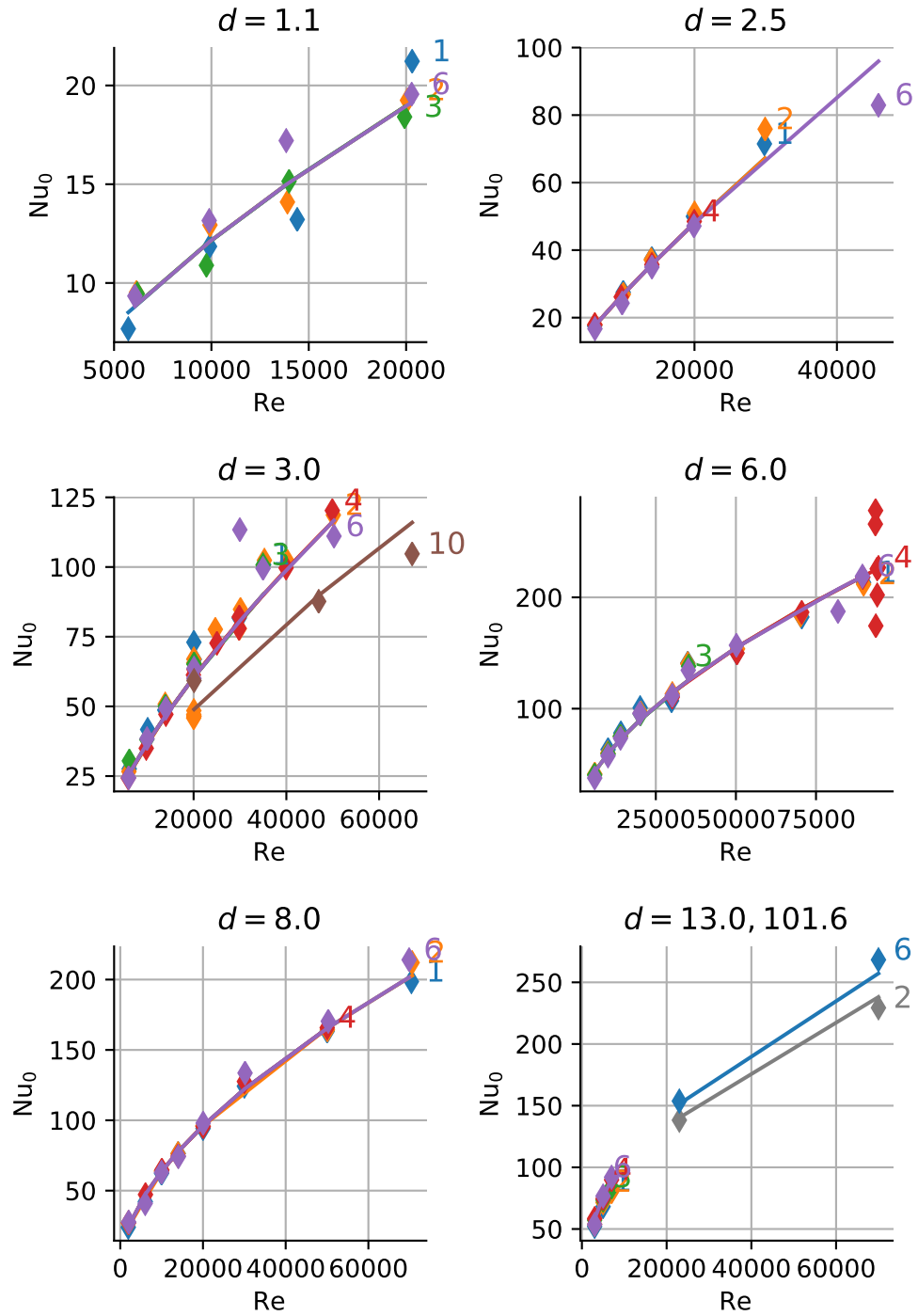


Figure 2: Stagnation point Nusselt numbers for different nozzle diameters. The number next to a line represents H/d . The line represents a novel correlation.

Part II

Data

Case id: mikkonen_000

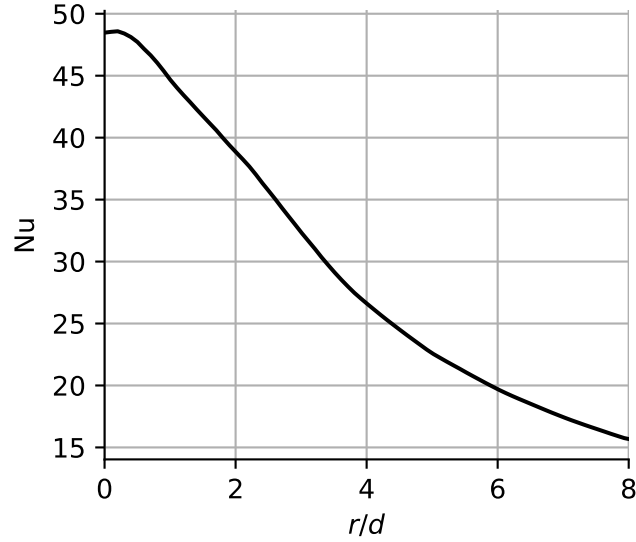


Figure 3: Nu, mikkonen_000

path	2017_02_16_Tsarja_6mm_36-61C/6mm_36C
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-02-16 16:12:46

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20052	0.30	2	0.71	3.0	6.0	20.3	20.1	0.861	102.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.5	190.6	3.24	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.58	35.82	36.86	38.01	39.30	40.93	43.02	45.41	47.73
Nu	48.47	47.73	44.69	41.75	38.86	35.74	32.37	29.19	26.62
h (W/m²K)	418.42	411.98	385.79	360.36	335.46	308.47	279.41	251.98	229.81
q (kW/m²)	6.50	6.50	6.48	6.47	6.46	6.44	6.42	6.39	6.36

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.73	49.98	52.36	54.51	56.81	58.97	61.19	63.34	65.42
Nu	26.62	24.52	22.61	21.11	19.70	18.53	17.45	16.51	15.68
h (W/m²K)	229.81	211.68	195.14	182.22	170.07	159.92	150.60	142.50	135.34
q (kW/m²)	6.36	6.33	6.30	6.28	6.25	6.22	6.20	6.17	6.14

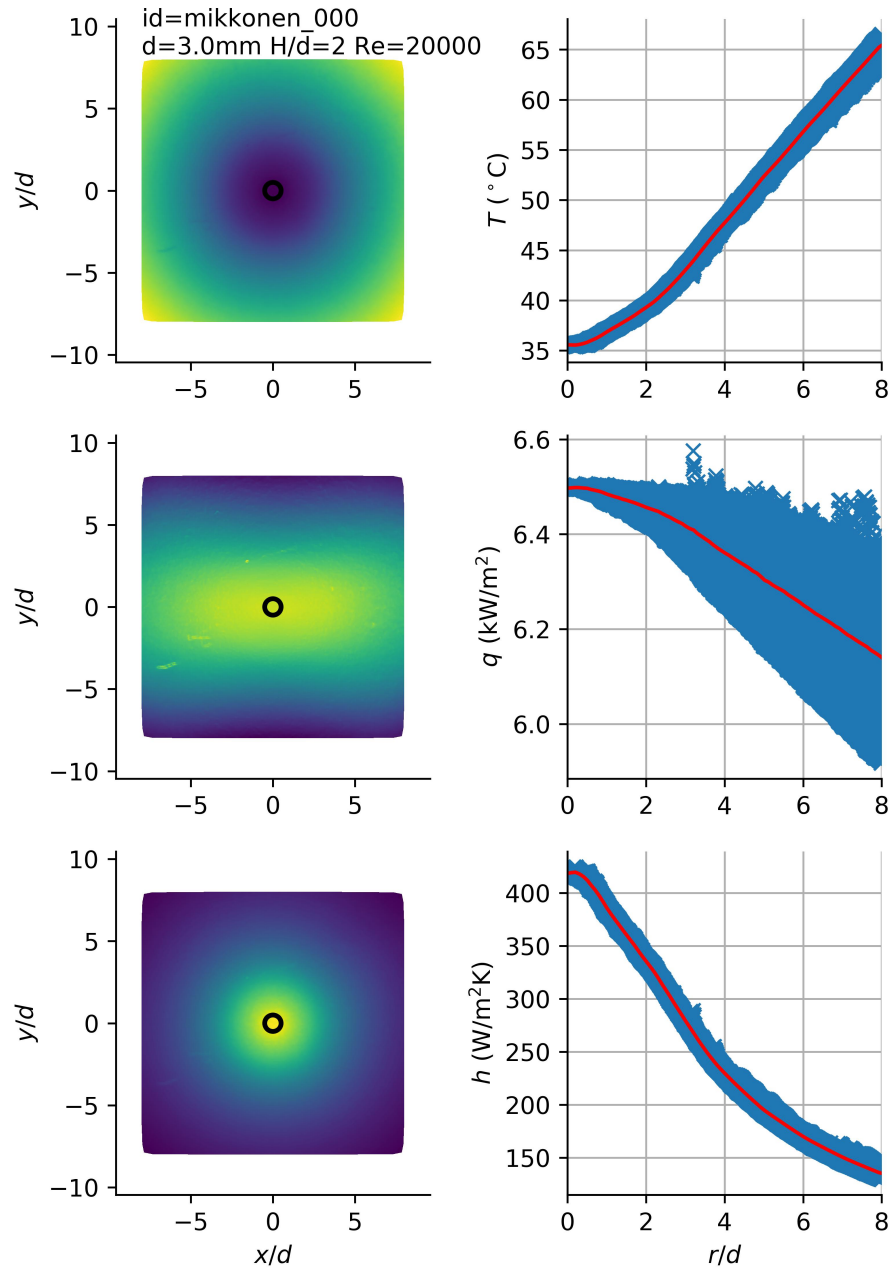


Figure 4: Results, mikkonen_000

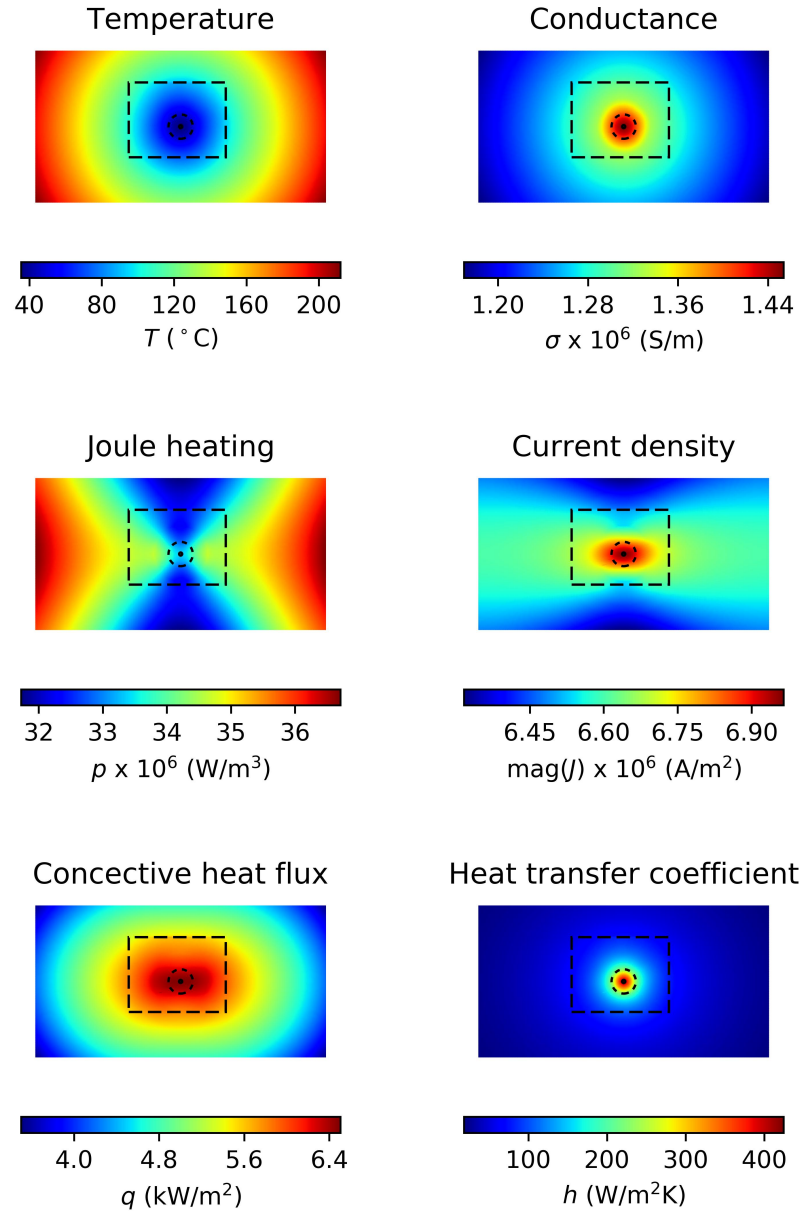


Figure 5: Convection calculation, mikkonen_000

Case id: mikkonen_001

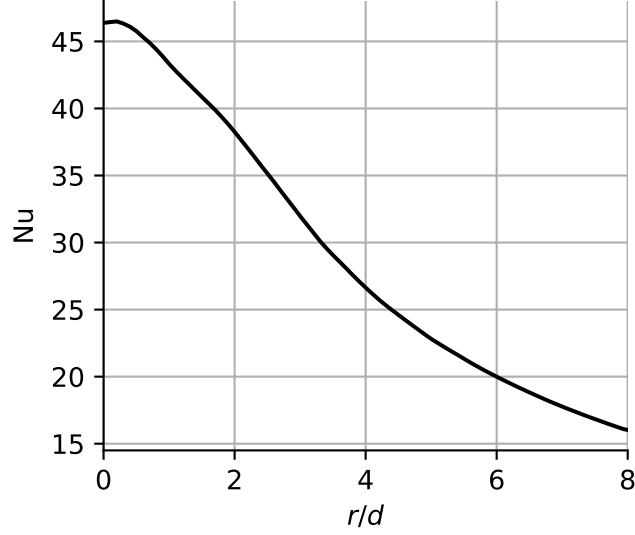


Figure 6: Nu, mikkonen_001

path	2017_02_16_Tsarja_6mm_36-61C/6mm_41C
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-02-16 16:25:53

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20077	0.30	2	0.71	3.0	6.0	20.7	20.1	0.863	102.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.7	214.0	3.96	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.15	41.43	42.60	43.92	45.50	47.66	50.31	53.19	56.06
Nu	46.38	45.77	43.33	40.86	38.26	35.16	31.98	29.07	26.64
h (W/m²K)	400.82	395.54	374.44	353.13	330.61	303.81	276.34	251.23	230.24
q (kW/m²)	8.46	8.46	8.44	8.43	8.41	8.39	8.36	8.32	8.29

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	56.06	58.87	61.72	64.45	67.21	69.92	72.62	75.29	77.80
Nu	26.64	24.61	22.82	21.34	20.00	18.83	17.77	16.84	16.02
h (W/m²K)	230.24	212.64	197.23	184.41	172.81	162.69	153.56	145.49	138.48
q (kW/m²)	8.29	8.26	8.22	8.19	8.15	8.11	8.07	8.04	8.00

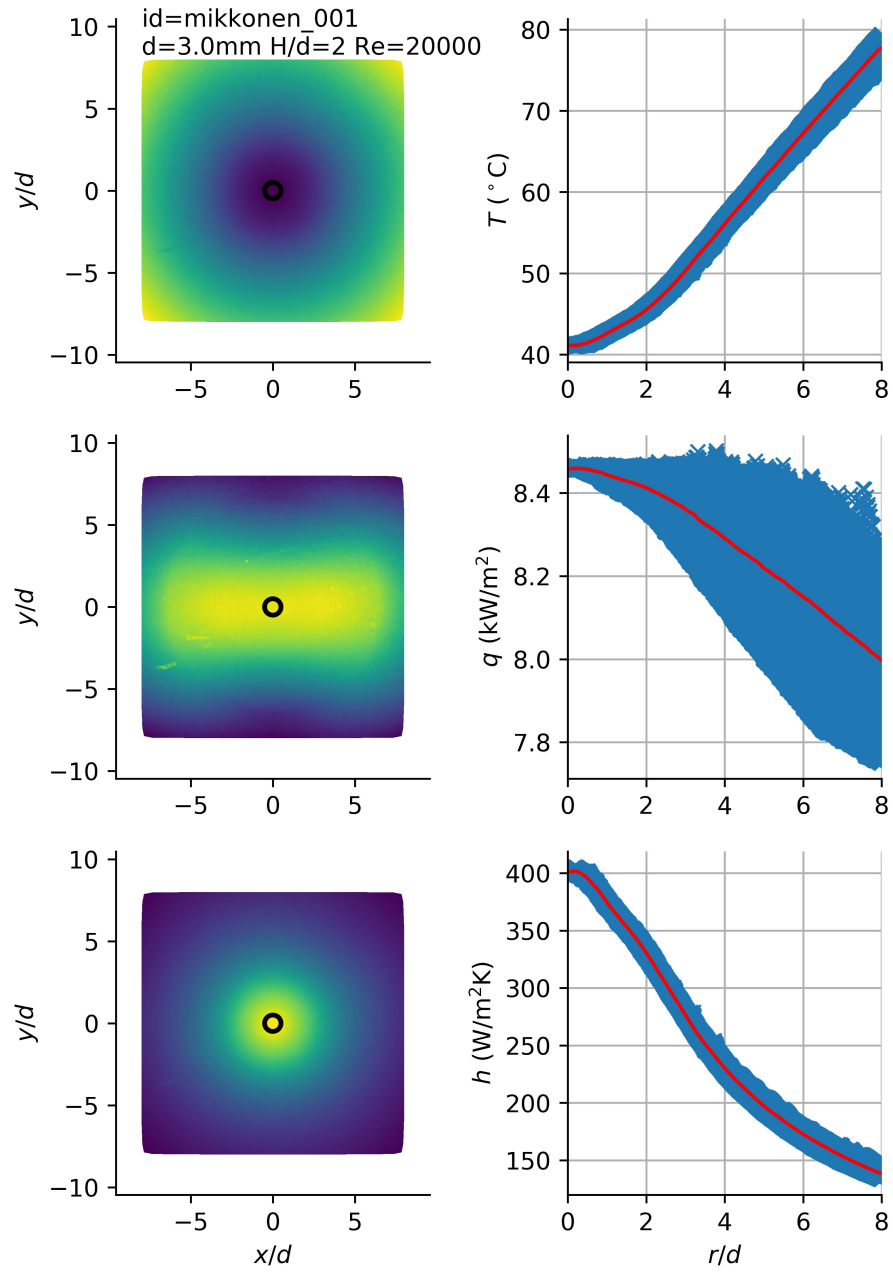


Figure 7: Results, mikkonen_001

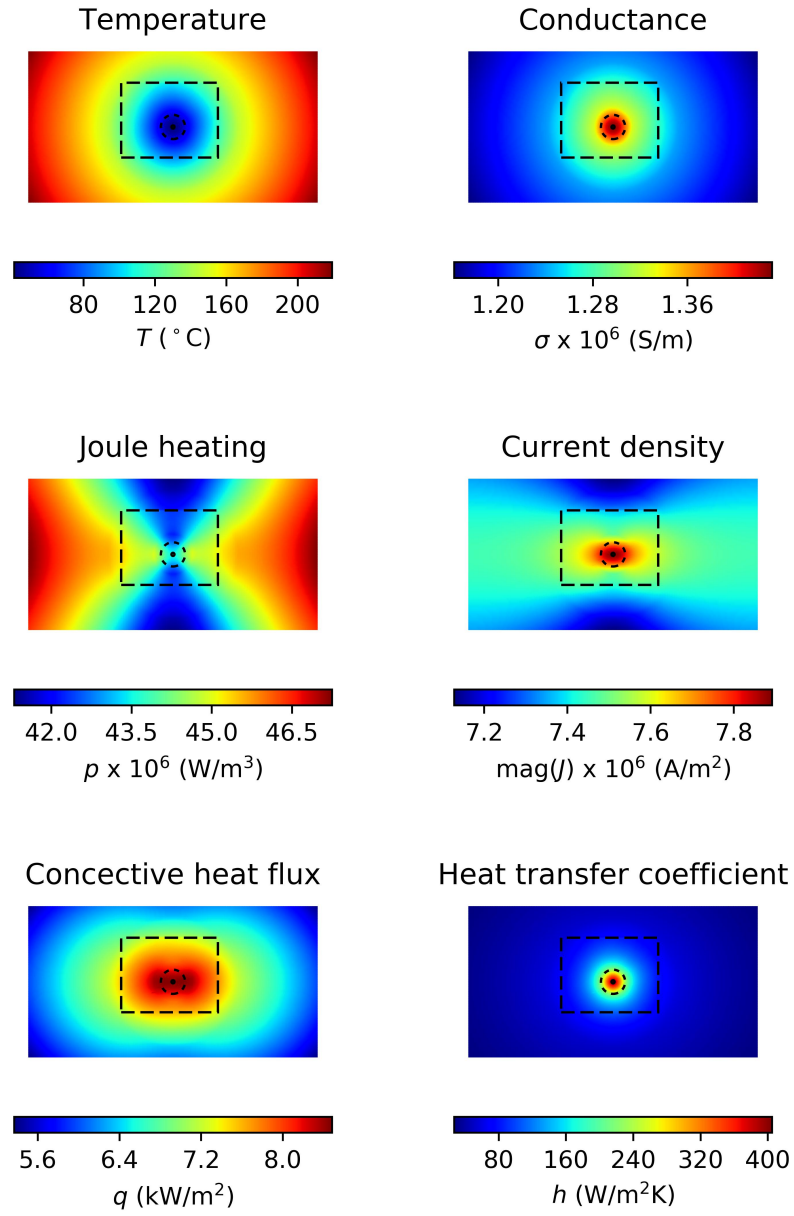


Figure 8: Convection calculation, mikkonen_001

Case id: mikkonen_002

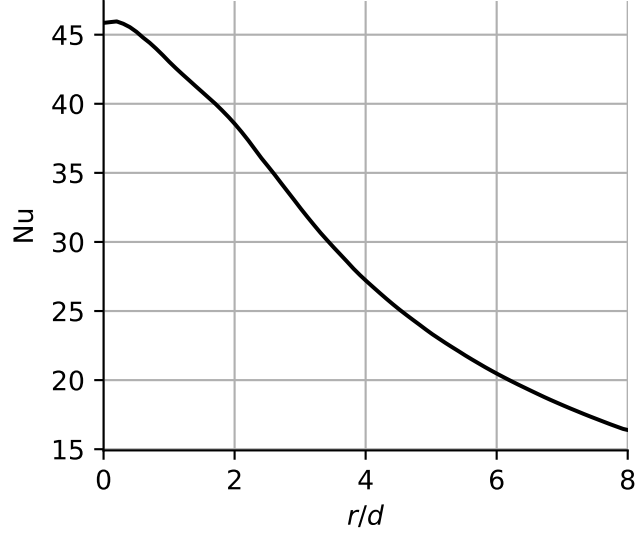


Figure 9: Nu, mikkonen_002

path	2017_02_16_Tsarja_6mm_36-61C/6mm_46C
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-02-16 16:32:11

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20015	0.30	2	0.71	3.0	6.0	21.0	20.1	0.861	102.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.9	230.4	5.70	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	45.80	46.16	47.44	48.85	50.53	53.03	56.03	59.28	62.63
Nu	45.85	45.21	43.05	40.88	38.56	35.53	32.47	29.67	27.22
h (W/m ² K)	396.61	391.07	372.35	353.54	333.50	307.36	280.88	256.62	235.43
q (kW/m ²)	10.21	10.21	10.20	10.18	10.16	10.14	10.11	10.07	10.02

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	62.63	65.92	69.20	72.42	75.65	78.82	82.03	85.21	88.21
Nu	27.22	25.17	23.38	21.85	20.48	19.29	18.20	17.23	16.39
h (W/m ² K)	235.43	217.69	202.26	188.98	177.11	166.81	157.43	149.06	141.78
q (kW/m ²)	10.02	9.98	9.94	9.90	9.85	9.80	9.76	9.71	9.66

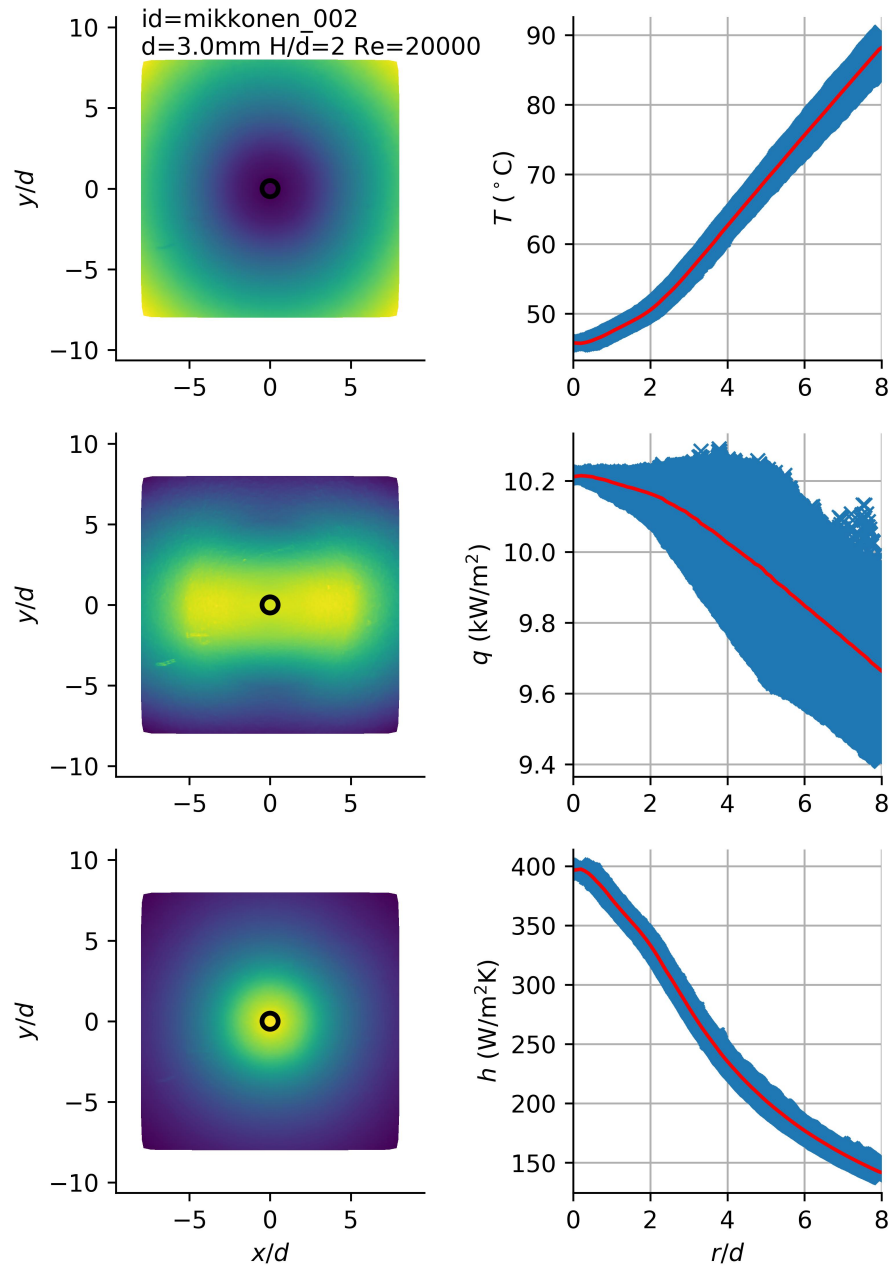


Figure 10: Results, mikkonen_002

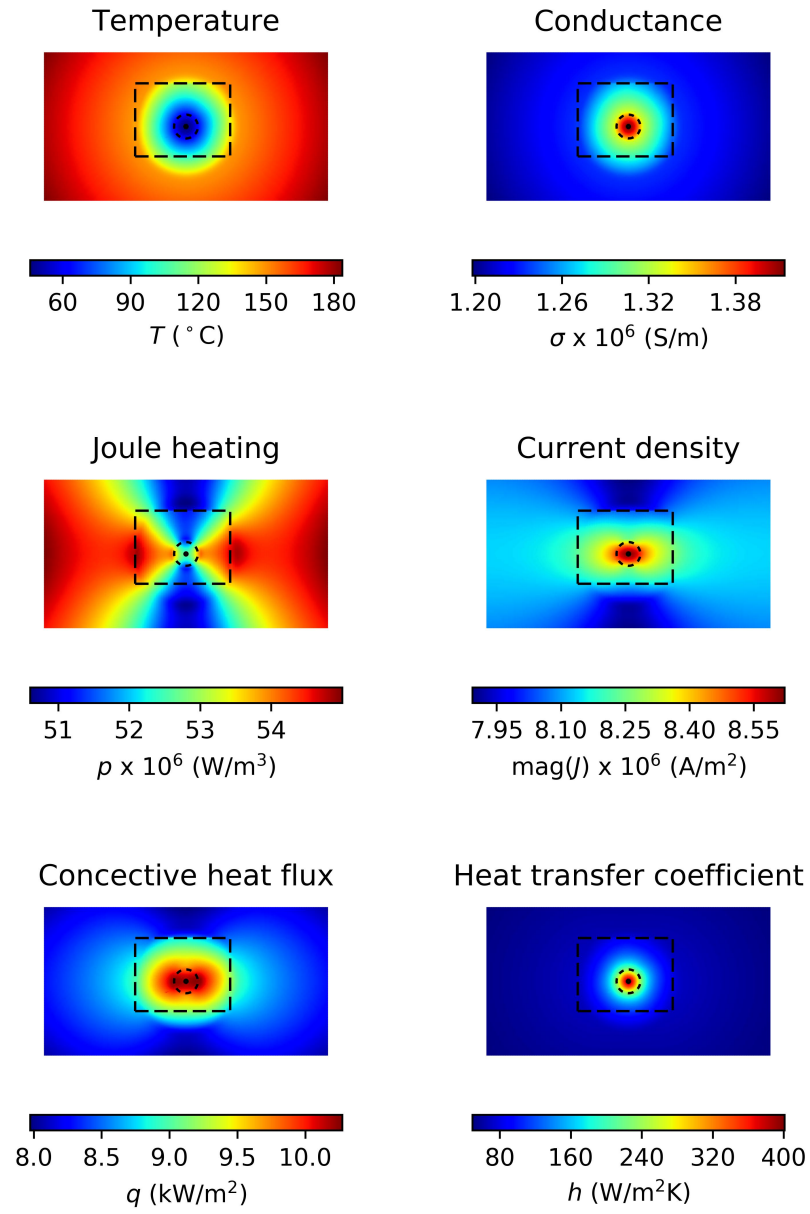


Figure 11: Convection calculation, mikkonen_002

Case id: mikkonen_003

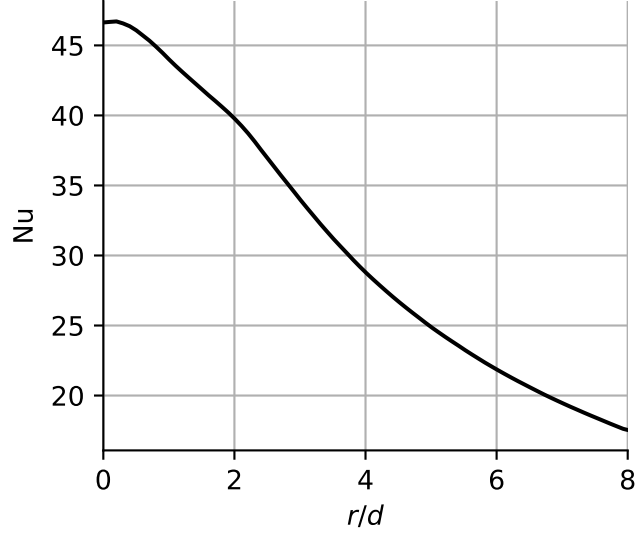


Figure 12: Nu, mikkonen_003

path	2017_02_16_Tsarja_6mm_36-61C/6mm_52C
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-02-16 16:41:30

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20050	0.30	2	0.71	3.0	6.0	21.2	20.1	0.863	103.1

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.2	254.2	8.74	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	52.85	53.25	54.77	56.48	58.34	61.17	64.62	68.40	72.27
Nu	46.64	46.08	44.01	41.88	39.78	36.98	34.01	31.25	28.80
h (W/m²K)	403.62	398.83	380.88	362.44	344.29	320.00	294.35	270.42	249.28
q (kW/m²)	13.24	13.24	13.22	13.20	13.18	13.16	13.12	13.07	13.02

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	72.27	76.10	79.95	83.79	87.66	91.48	95.31	99.10	102.78
Nu	28.80	26.72	24.90	23.30	21.87	20.61	19.47	18.45	17.54
h (W/m²K)	249.28	231.28	215.47	201.68	189.24	178.35	168.48	159.65	151.81
q (kW/m²)	13.02	12.96	12.91	12.85	12.79	12.74	12.68	12.62	12.56

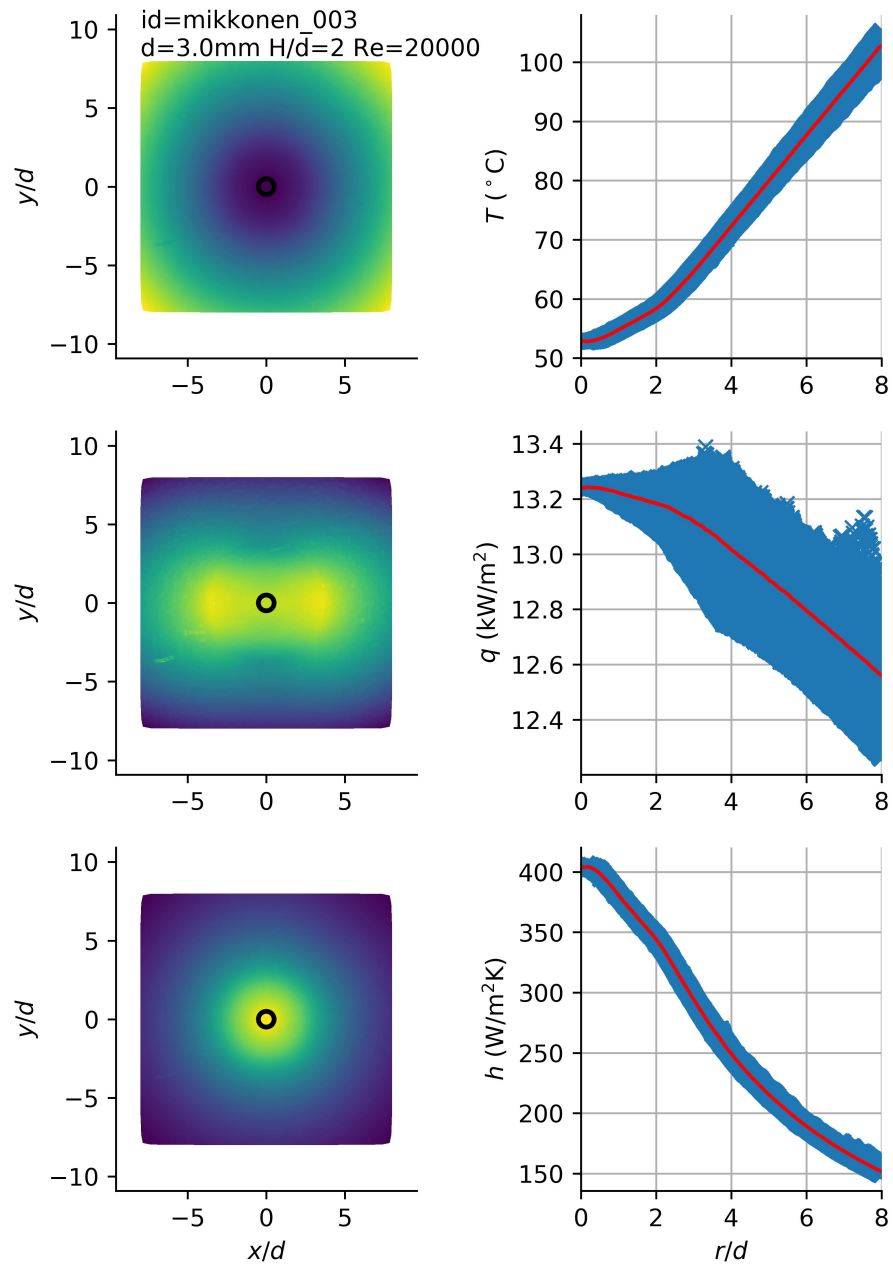


Figure 13: Results, mikkonen_003

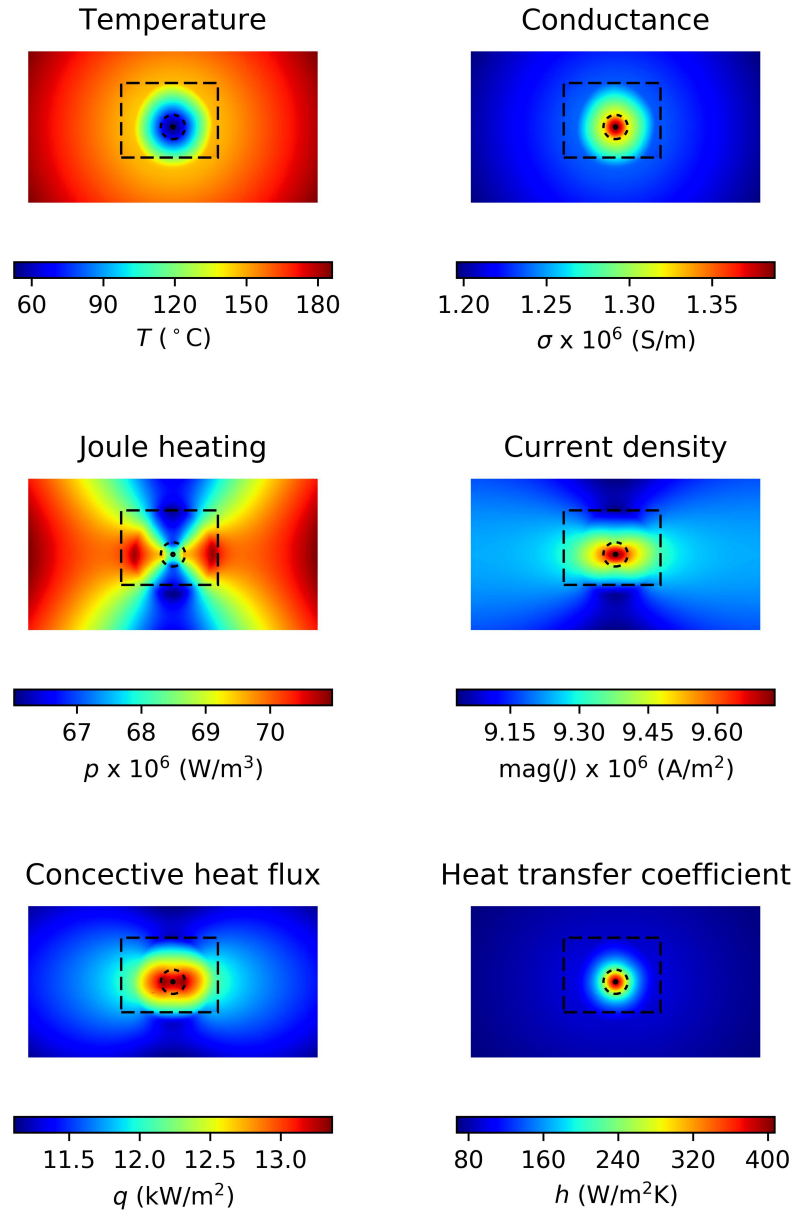


Figure 14: Convection calculation, mikkonen_003

Case id: mikkonen_004

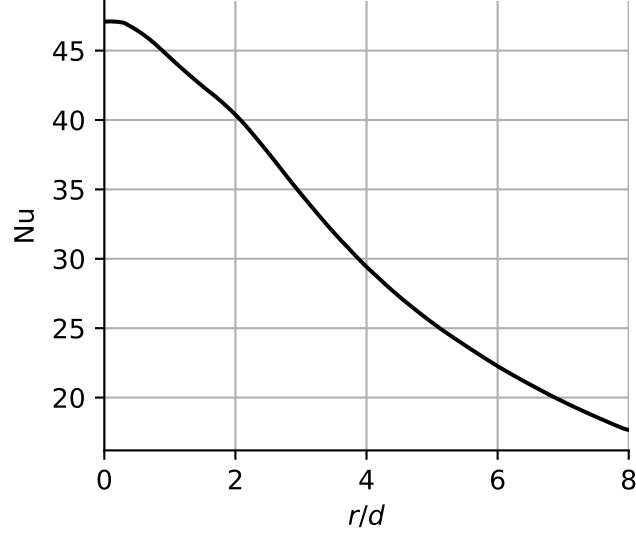


Figure 15: Nu, mikkonen_004

path	2017_02_16_Tsarja_6mm_36-61C/6mm_61C
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-02-16 16:45:44

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20034	0.30	2	0.71	3.0	6.0	21.5	20.1	0.863	103.2

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.4	279.8	10.81	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	61.04	61.58	63.37	65.42	67.66	71.01	75.21	79.79	84.55
Nu	47.09	46.46	44.50	42.43	40.38	37.64	34.67	31.90	29.42
h (W/m ² K)	407.89	402.46	385.46	367.52	349.80	326.05	300.32	276.29	254.84
q (kW/m ²)	16.72	16.71	16.70	16.67	16.65	16.61	16.56	16.50	16.44

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	84.55	89.32	94.08	98.84	103.77	108.68	113.68	118.67	123.43
Nu	29.42	27.28	25.41	23.77	22.27	20.93	19.71	18.61	17.67
h (W/m ² K)	254.84	236.29	220.08	205.92	192.86	181.29	170.72	161.23	153.01
q (kW/m ²)	16.44	16.36	16.29	16.22	16.14	16.06	15.98	15.90	15.81

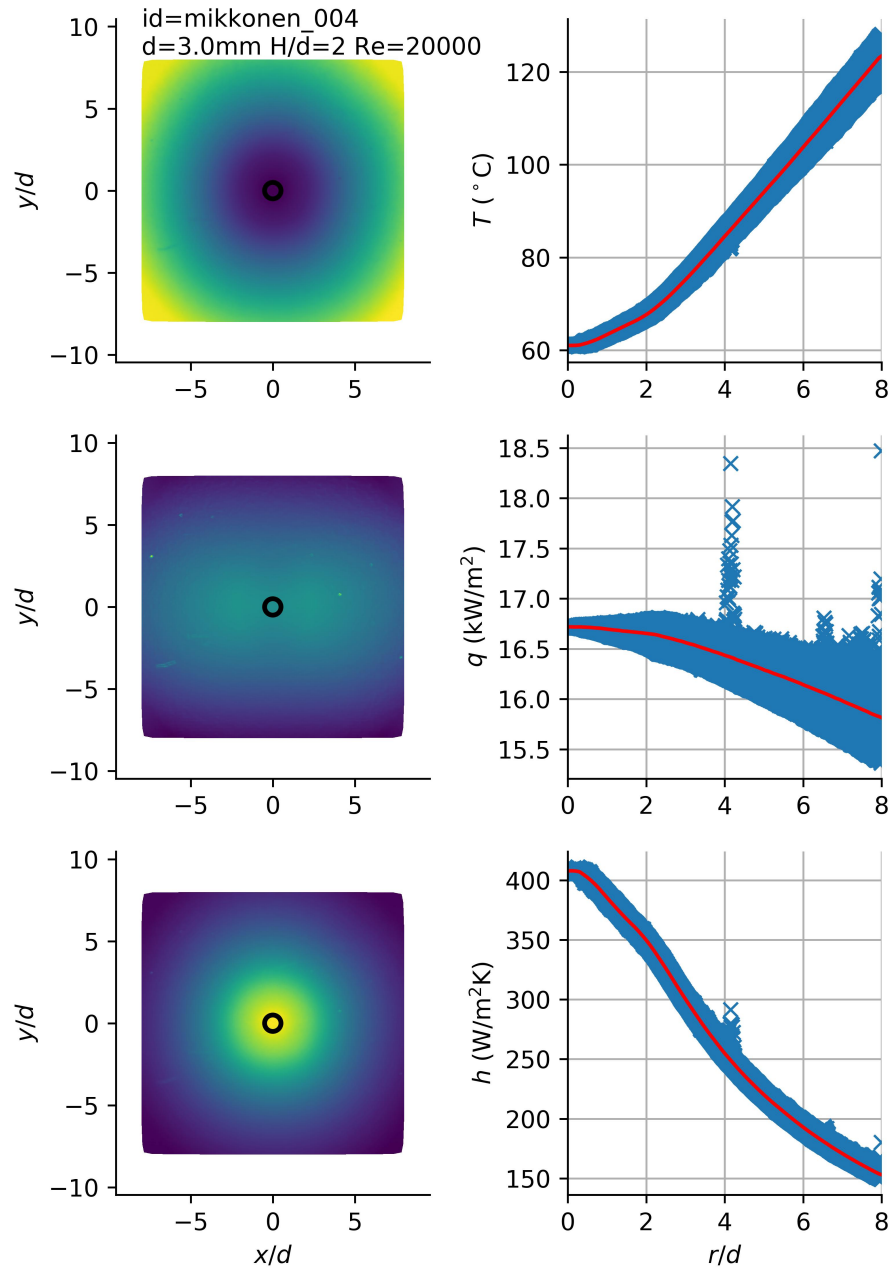


Figure 16: Results, mikkonen_004

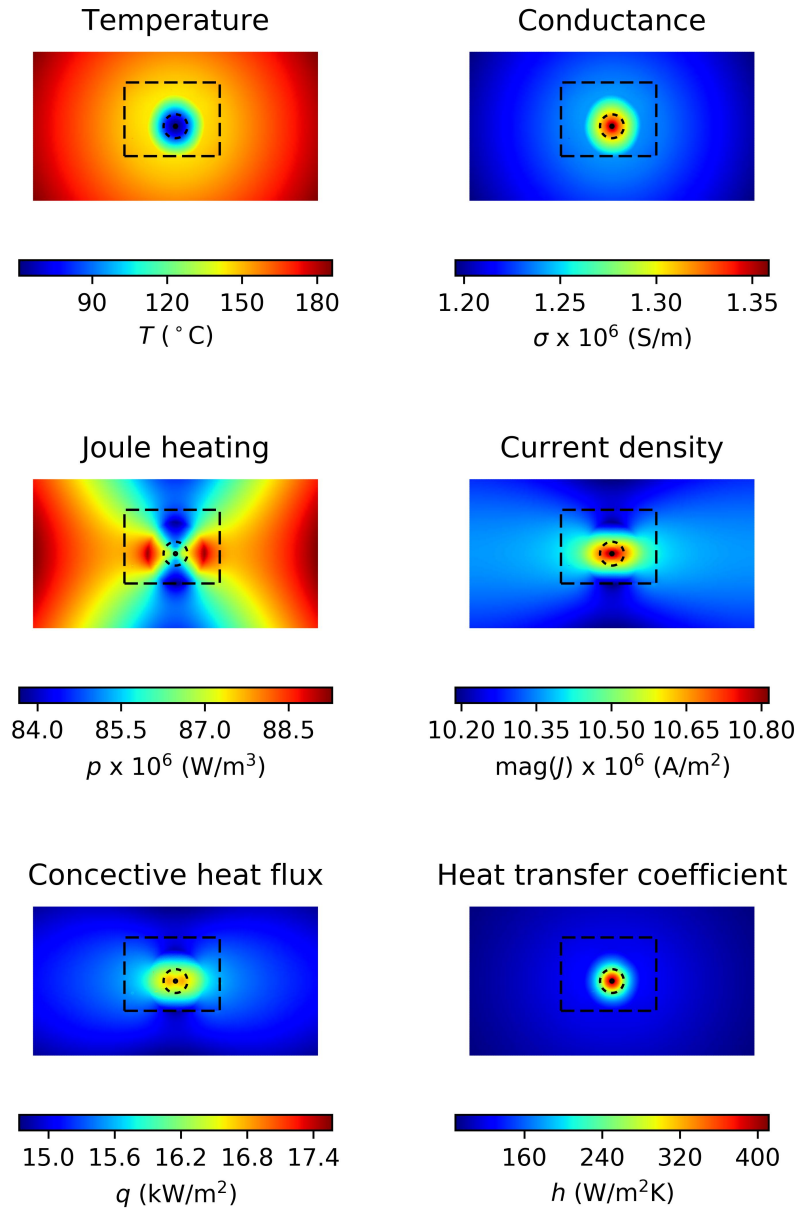


Figure 17: Convection calculation, mikkonen_004

Case id: mikkonen_005

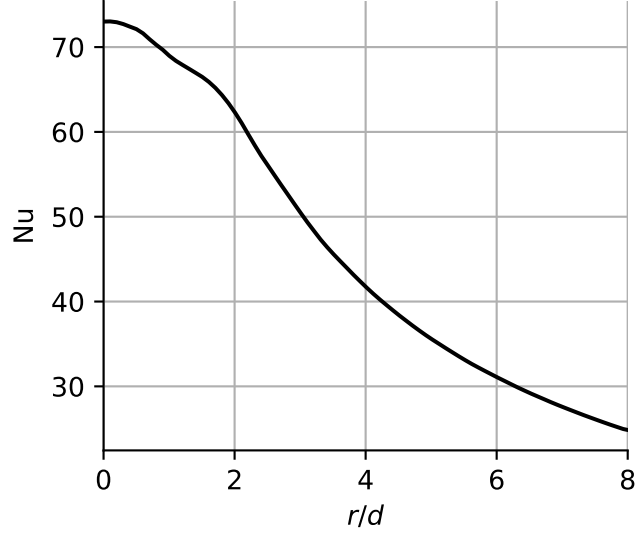


Figure 18: Nu, mikkonen_005

path		2017_02_20_HDsarja_3mm_DH1-10/DH_1_T_41							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 13:46:05							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20060	0.30	1	0.71	3.0	3.0	19.5	20.0	0.859	102.1
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.1	259.8	6.14				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.95	41.20	42.15	42.96	44.47	47.12	50.05	53.16	56.17
Nu	73.01	72.12	69.00	66.51	62.35	56.13	50.54	45.67	41.76
h (W/m ² K)	628.75	621.11	594.19	572.81	536.95	483.41	435.26	393.30	359.62
q (kW/m ²)	13.16	13.16	13.15	13.14	13.13	13.10	13.07	13.03	13.00
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	56.17	59.17	62.16	65.14	68.01	70.91	73.76	76.61	79.30
Nu	41.76	38.45	35.61	33.18	31.10	29.23	27.59	26.12	24.86
h (W/m ² K)	359.62	331.09	306.69	285.76	267.83	251.76	237.64	224.98	214.07
q (kW/m ²)	13.00	12.96	12.92	12.89	12.85	12.81	12.77	12.73	12.69

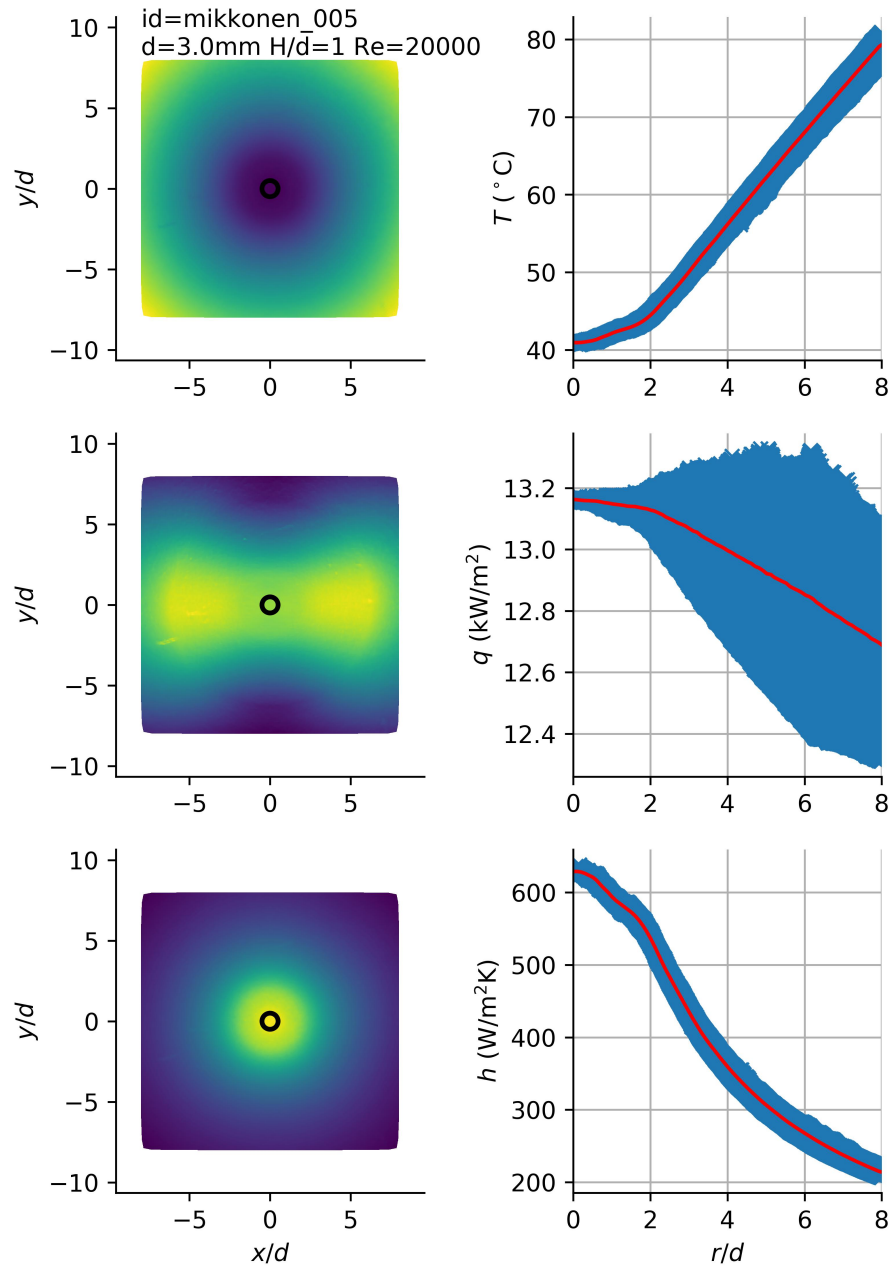


Figure 19: Results, mikkonen_005

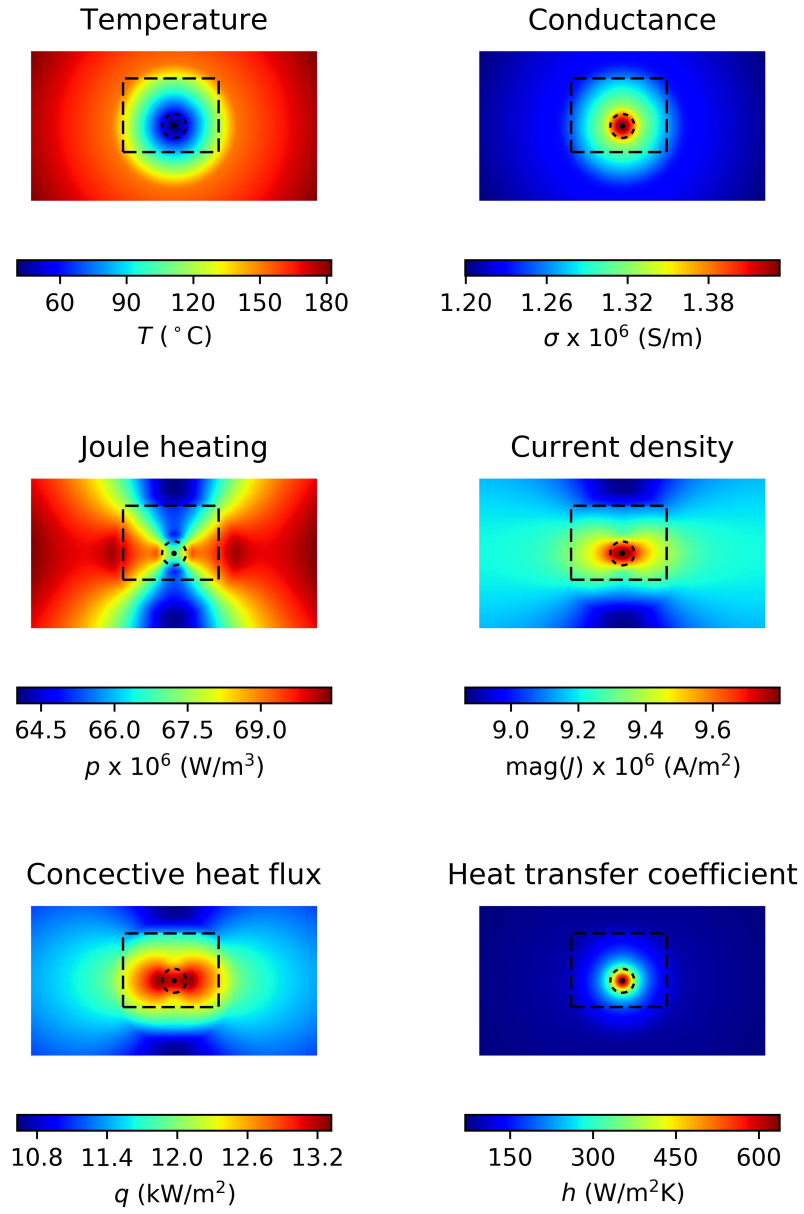


Figure 20: Convection calculation, mikkonen_005

Case id: mikkonen_006

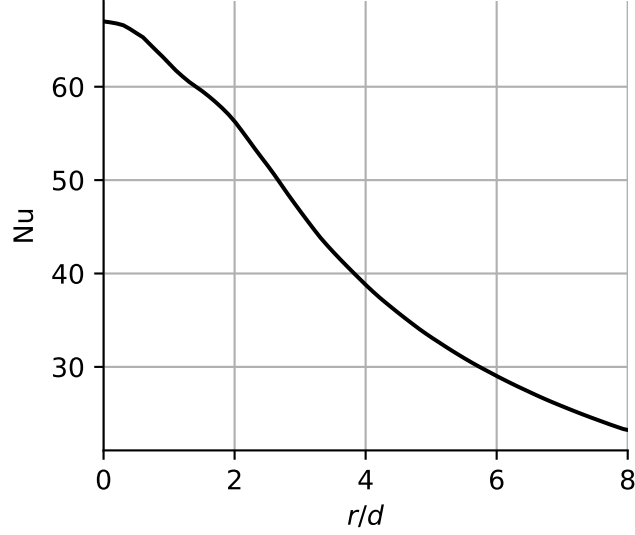


Figure 21: Nu, mikkonen_006

path		2017_02_20_HDsarja_3mm_DH1-10/DH_2_T_41							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 13:59:20							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20057	0.30	2	0.71	3.0	6.0	19.9	20.0	0.860	102.3
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.1	252.5	5.73				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.33	41.72	42.83	43.94	45.30	47.55	50.37	53.38	56.34
Nu	66.99	65.75	62.50	59.56	56.29	51.60	46.69	42.35	38.80
h (W/m ² K)	577.62	566.86	538.83	513.52	485.29	444.86	402.55	365.13	334.50
q (kW/m ²)	12.31	12.30	12.29	12.28	12.27	12.25	12.22	12.18	12.15
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	56.34	59.29	62.24	65.16	68.01	70.83	73.66	76.47	79.13
Nu	38.80	35.78	33.18	30.95	29.03	27.32	25.79	24.42	23.25
h (W/m ² K)	334.50	308.47	286.05	266.89	250.26	235.51	222.33	210.59	200.42
q (kW/m ²)	12.15	12.11	12.08	12.05	12.01	11.97	11.93	11.89	11.85

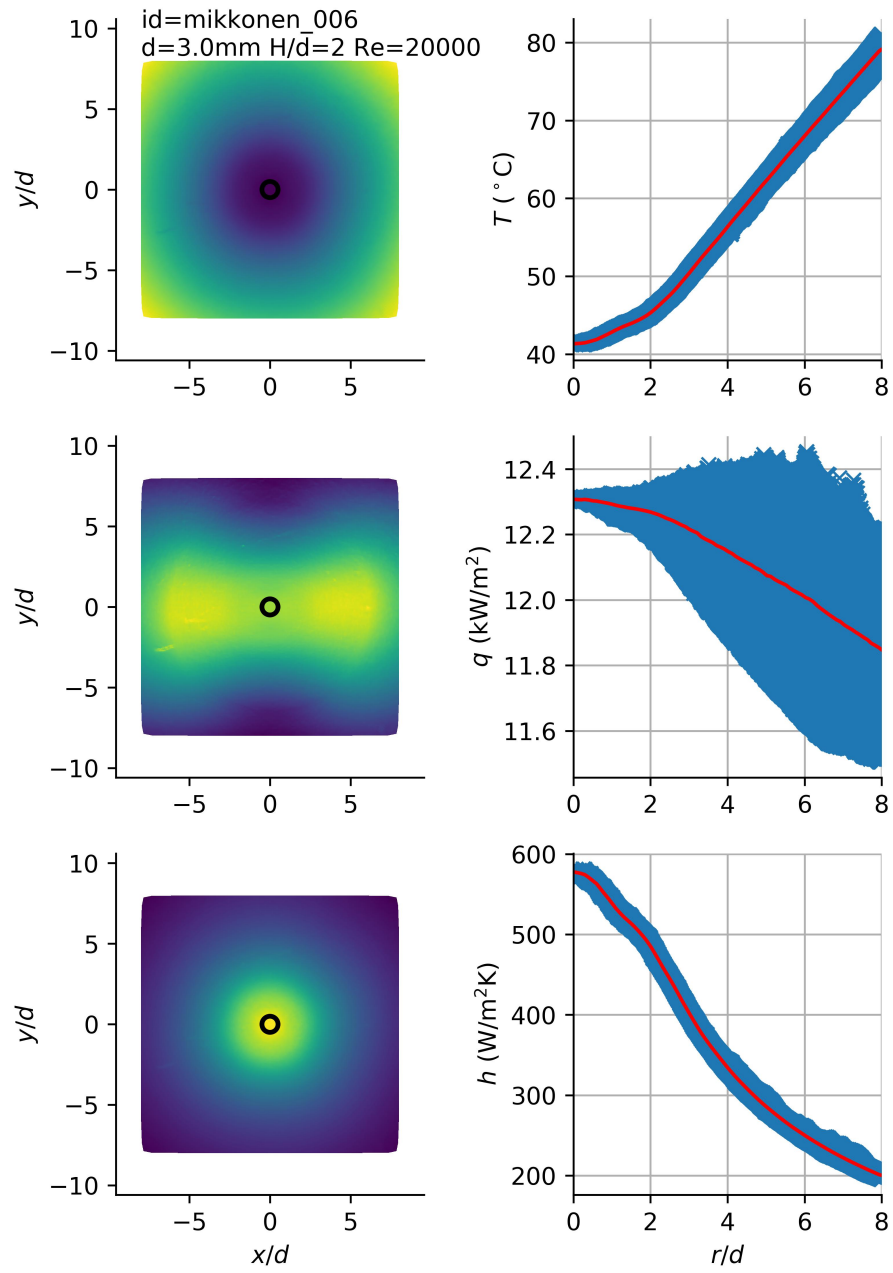


Figure 22: Results, mikkonen_006

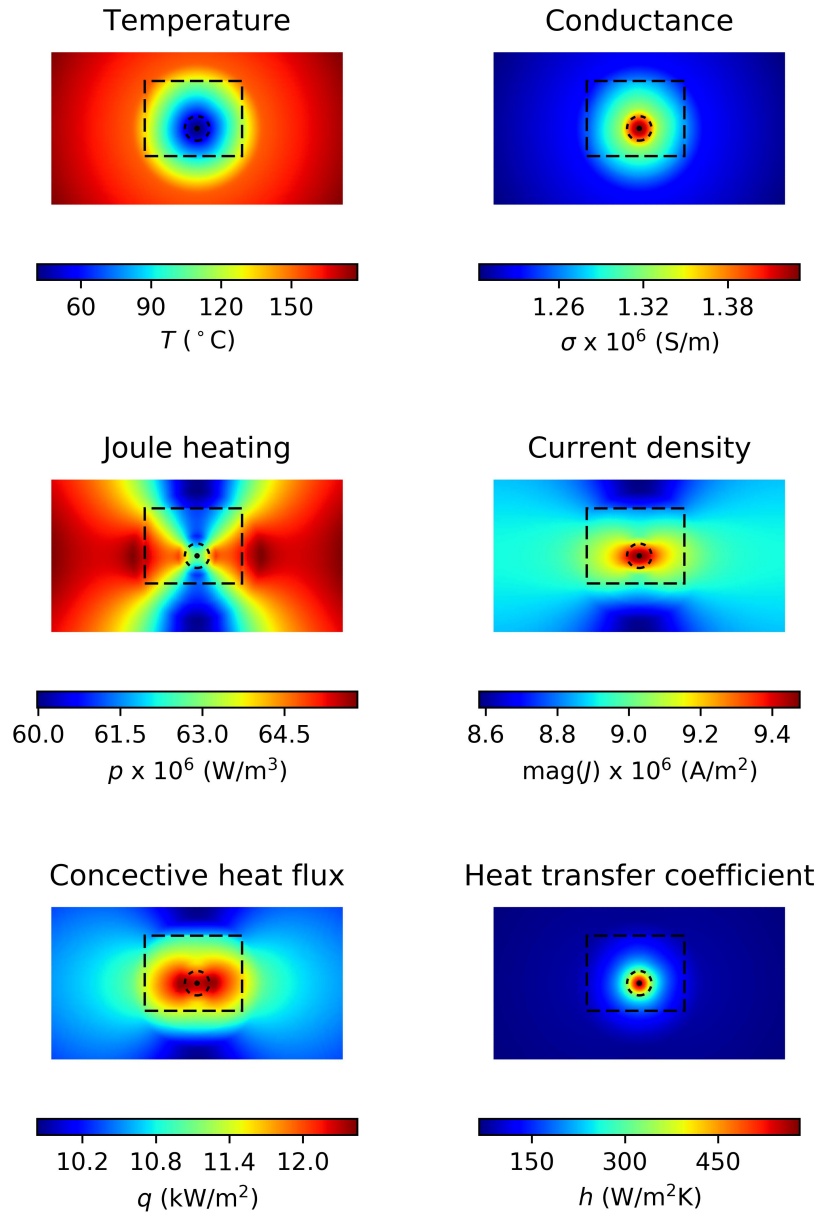


Figure 23: Convection calculation, mikkonen_006

Case id: mikkonen_007

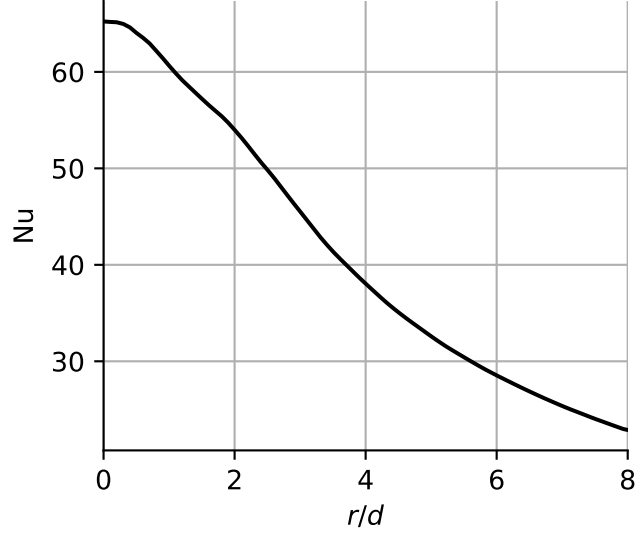


Figure 24: Nu, mikkonen_007

path	2017_02_20_HDsarja_3mm_DH1-10/DH_3_T_41								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-20 14:09:47								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20119	0.30	3	0.71	3.0	9.0	20.1	20.0	0.863	102.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.0	249.1	4.45			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.76	41.14	42.30	43.61	44.99	47.01	49.51	52.37	55.12
Nu	65.23	64.05	60.64	57.22	53.99	49.85	45.53	41.39	38.05
h (W/m ² K)	562.75	552.57	523.18	493.62	465.78	430.08	392.77	357.09	328.27
q (kW/m ²)	11.67	11.67	11.66	11.64	11.63	11.61	11.58	11.55	11.52
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	55.12	57.98	60.76	63.53	66.27	68.99	71.70	74.39	76.94
Nu	38.05	35.08	32.59	30.43	28.54	26.88	25.37	24.04	22.88
h (W/m ² K)	328.27	302.65	281.17	262.51	246.21	231.88	218.86	207.38	197.38
q (kW/m ²)	11.52	11.49	11.45	11.42	11.39	11.36	11.31	11.27	11.24

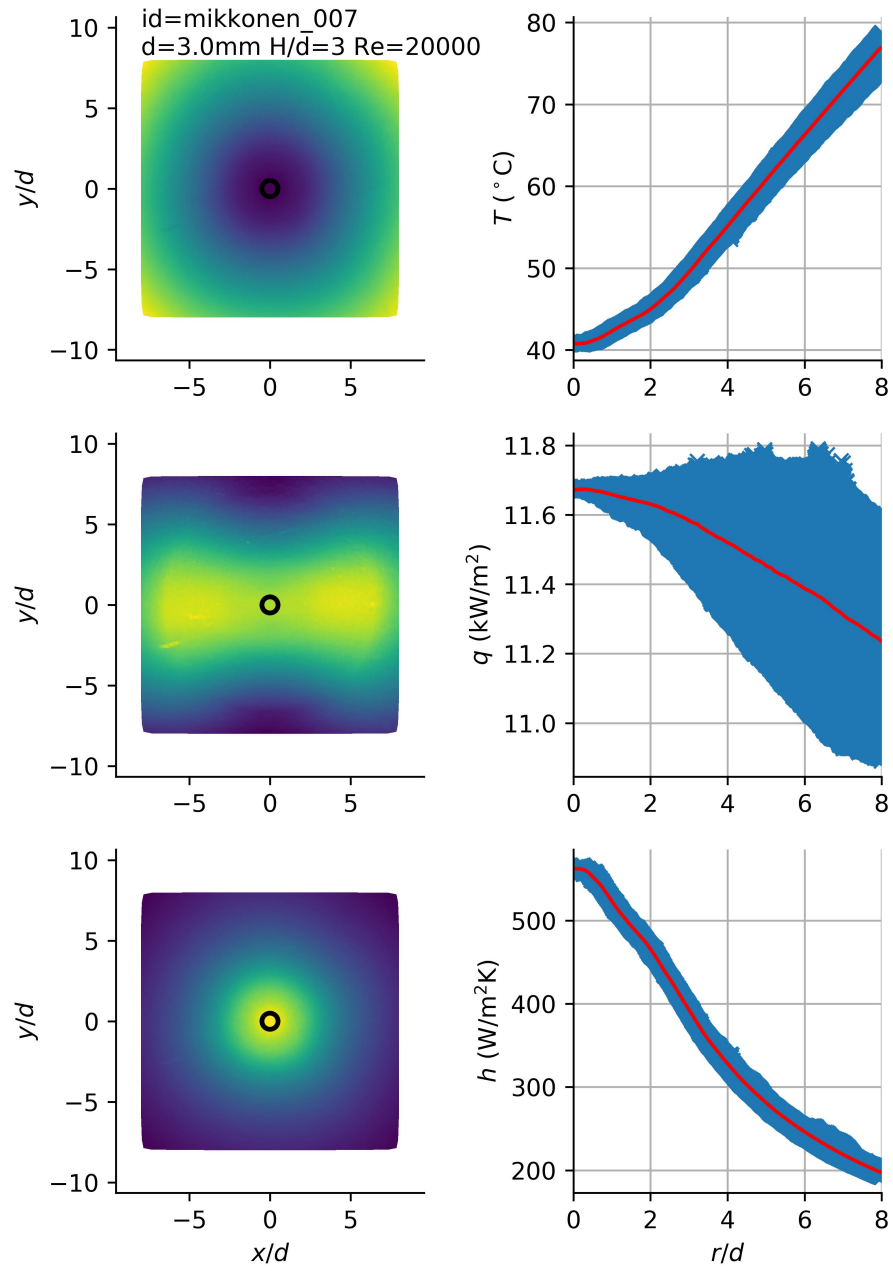


Figure 25: Results, mikkonen_007

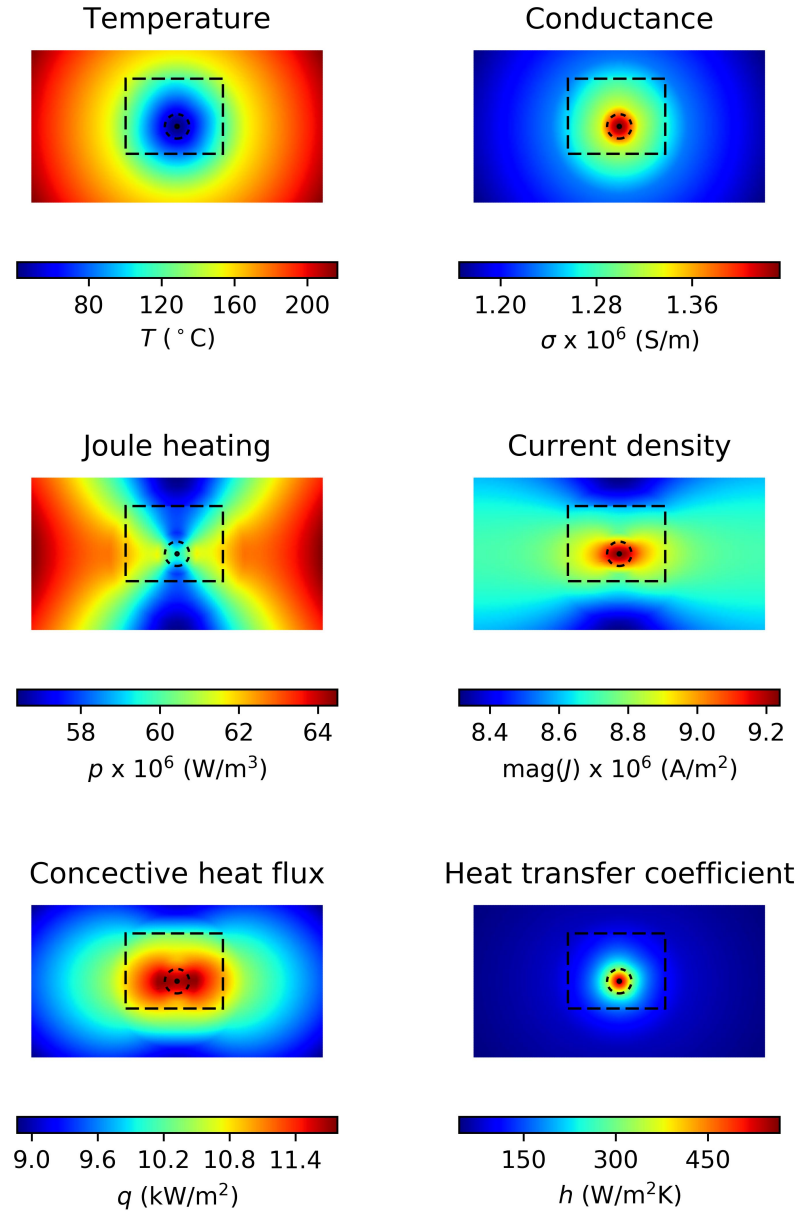


Figure 26: Convection calculation, mikkonen_007

Case id: mikkonen_008

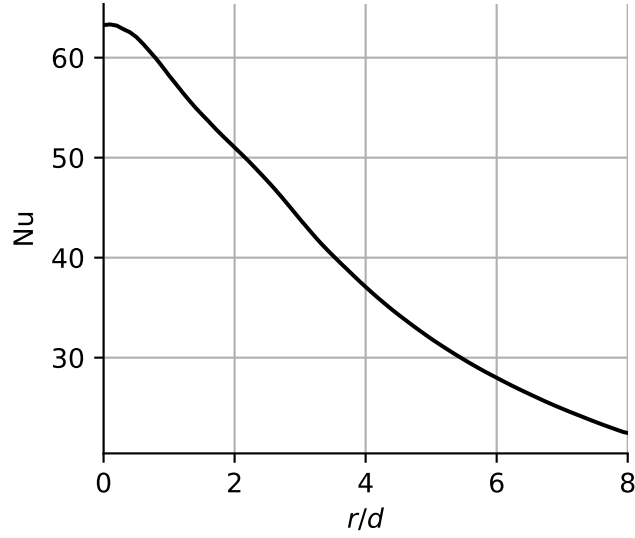


Figure 27: Nu, mikkonen_008

path		2017_02_20_HDsarja_3mm_DH1-10/DH_4_T_41							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 14:22:41							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20085	0.30	4	0.71	3.0	12.0	20.2	20.0	0.862	102.7
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.0	247.3	5.04			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.31	41.71	43.12	44.73	46.30	48.09	50.49	53.15	55.86
Nu	63.26	62.06	58.21	54.33	51.02	47.68	43.83	40.21	37.07
h (W/m ² K)	545.88	535.56	502.35	468.81	440.27	411.44	378.26	347.01	319.93
q (kW/m ²)	11.62	11.62	11.60	11.58	11.57	11.55	11.52	11.50	11.47
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	55.86	58.65	61.44	64.23	66.96	69.69	72.42	75.14	77.69
Nu	37.07	34.30	31.89	29.81	27.99	26.36	24.90	23.59	22.47
h (W/m ² K)	319.93	296.00	275.21	257.21	241.51	227.48	214.85	203.59	193.88
q (kW/m ²)	11.47	11.43	11.40	11.37	11.34	11.30	11.26	11.22	11.18

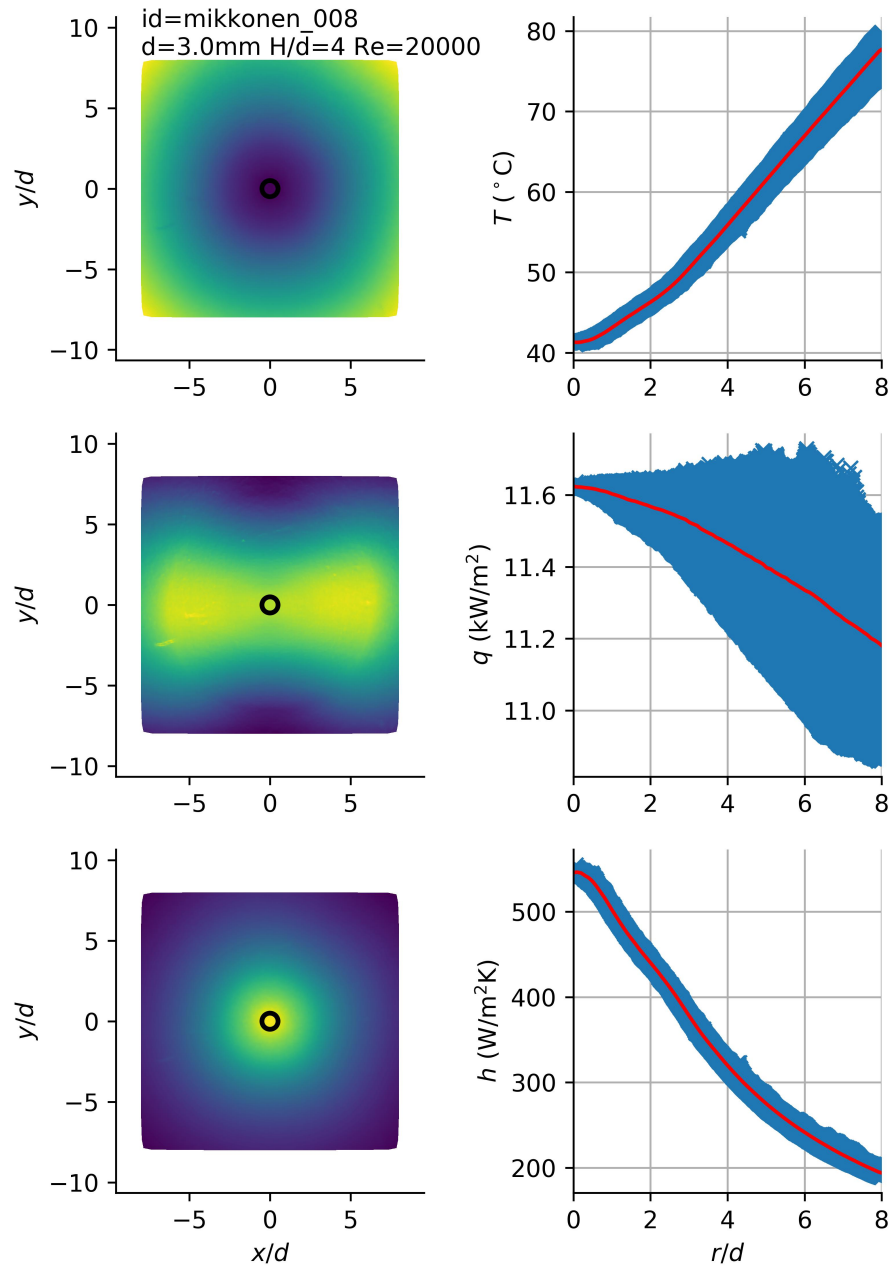


Figure 28: Results, mikkonen_008

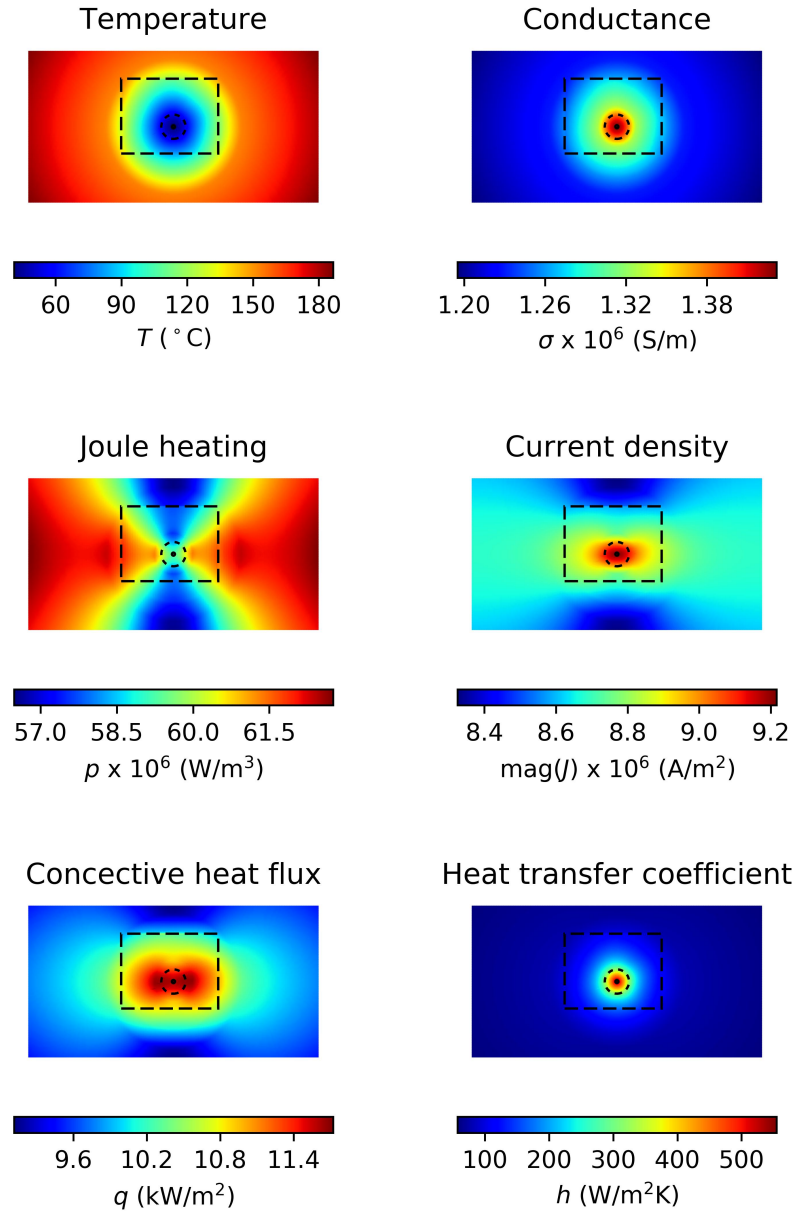


Figure 29: Convection calculation, mikkonen_008

Case id: mikkonen_009

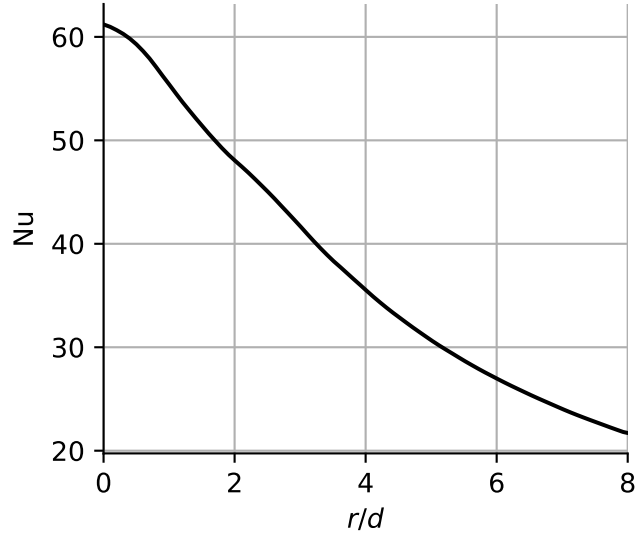


Figure 30: Nu, mikkonen_009

path		2017_02_20_HDsarja_3mm_DH1-10/DH_5_T_41							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 14:29:07							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20041	0.30	5	0.71	3.0	15.0	20.2	20.0	0.860	102.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.0	243.4	3.89				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.86	41.52	42.99	44.72	46.40	48.11	50.32	52.85	55.40
Nu	61.20	59.29	55.42	51.44	48.07	45.08	41.71	38.39	35.55
h (W/m ² K)	528.16	511.66	478.23	443.88	414.82	388.99	359.95	331.27	306.74
q (kW/m ²)	11.00	11.00	10.98	10.96	10.94	10.93	10.90	10.88	10.85
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	55.40	58.07	60.76	63.44	66.09	68.73	71.37	73.98	76.48
Nu	35.55	32.95	30.68	28.72	26.98	25.44	24.04	22.80	21.71
h (W/m ² K)	306.74	284.31	264.78	247.80	232.83	219.54	207.46	196.73	187.38
q (kW/m ²)	10.85	10.82	10.79	10.76	10.72	10.69	10.65	10.61	10.58

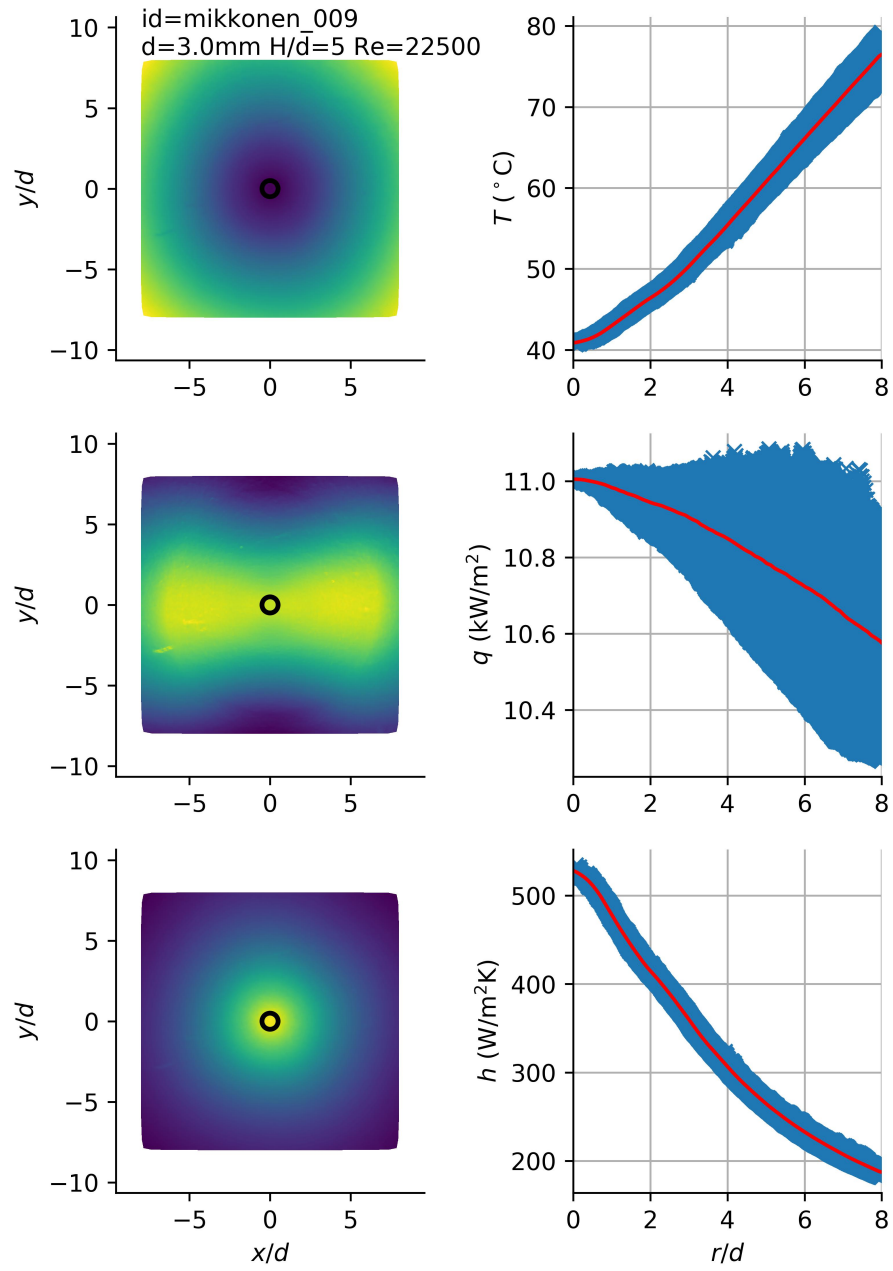


Figure 31: Results, mikkonen_009

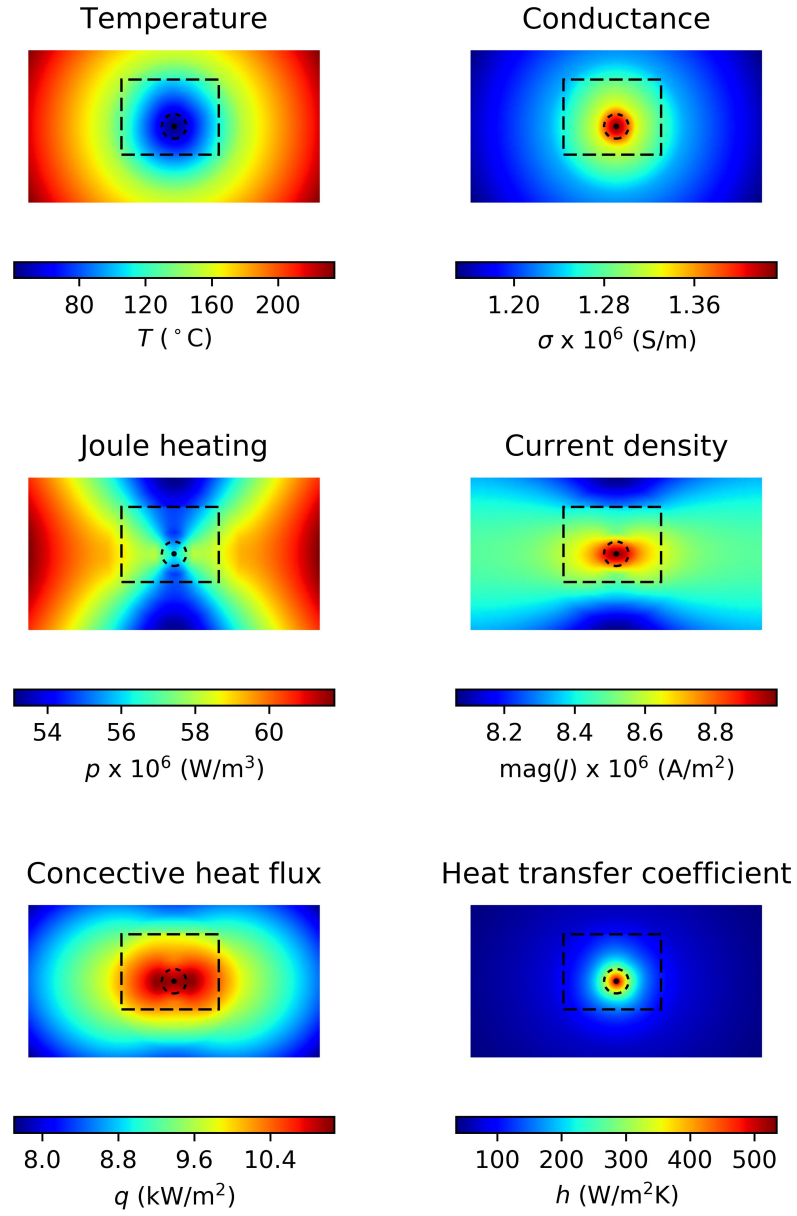


Figure 32: Convection calculation, mikkonen_009

Case id: mikkonen_010

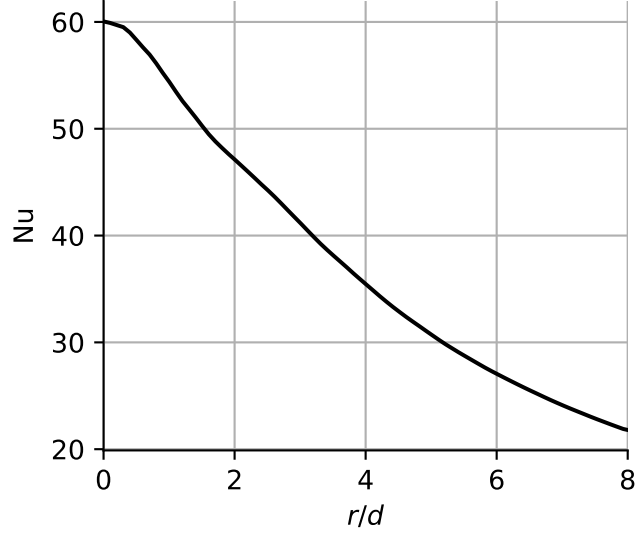


Figure 33: Nu, mikkonen_010

path		2017_02_20_HDsarja_3mm_DH1-10/DH_6_T_41							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 14:41:03							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20062	0.30	6	0.71	3.0	18.0	20.2	20.0	0.861	102.5
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.0	242.8	4.05				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.19	41.81	43.34	45.20	46.84	48.52	50.59	52.93	55.36
Nu	60.05	58.33	54.41	50.30	47.13	44.28	41.20	38.17	35.47
h (W/m ² K)	518.18	503.35	469.57	434.08	406.68	382.13	355.50	329.42	306.06
q (kW/m ²)	10.97	10.97	10.95	10.93	10.91	10.89	10.87	10.84	10.82
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	55.36	57.98	60.57	63.21	65.82	68.43	71.04	73.64	76.11
Nu	35.47	32.93	30.74	28.78	27.06	25.53	24.13	22.88	21.80
h (W/m ² K)	306.06	284.16	265.28	248.35	233.51	220.31	208.21	197.45	188.11
q (kW/m ²)	10.82	10.79	10.76	10.73	10.69	10.66	10.62	10.59	10.55

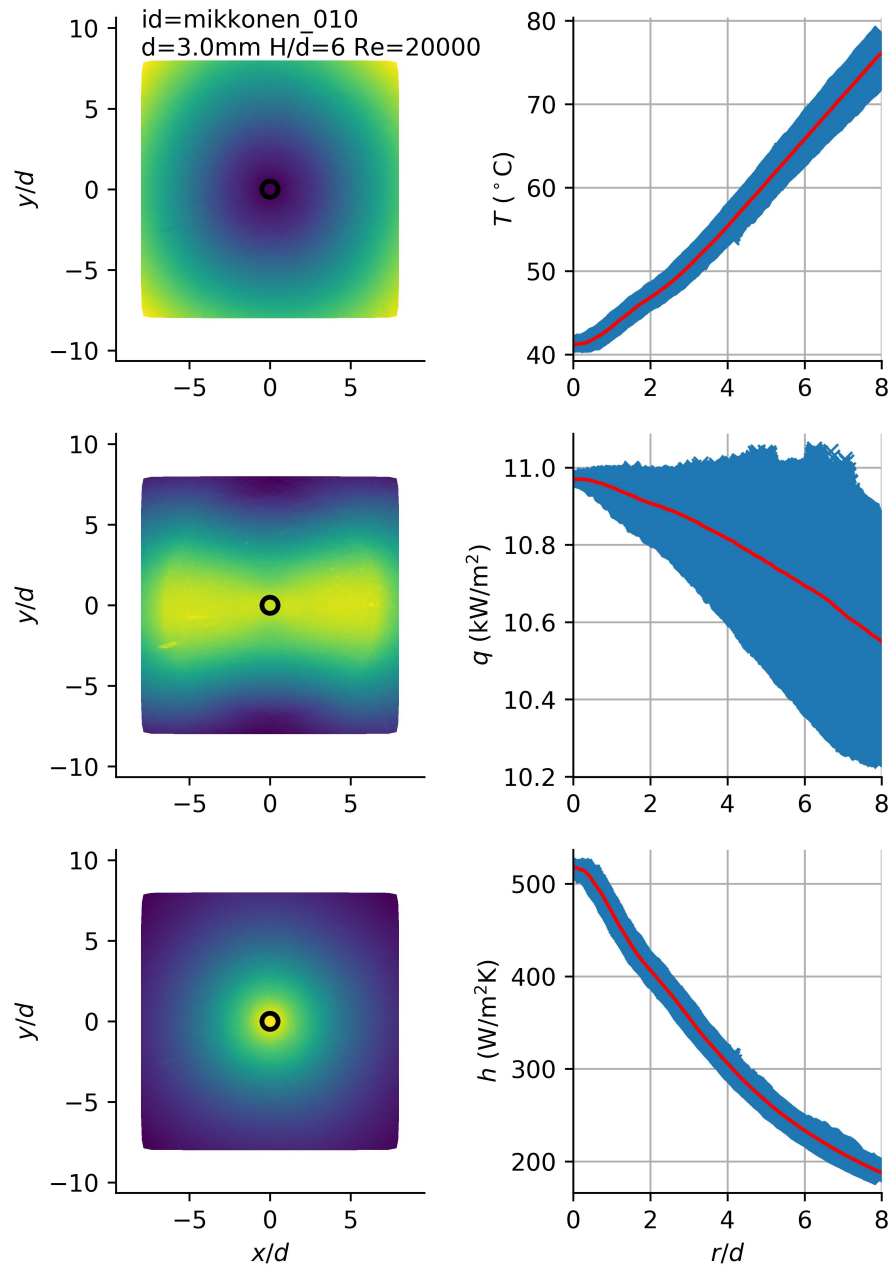


Figure 34: Results, mikkonen_010

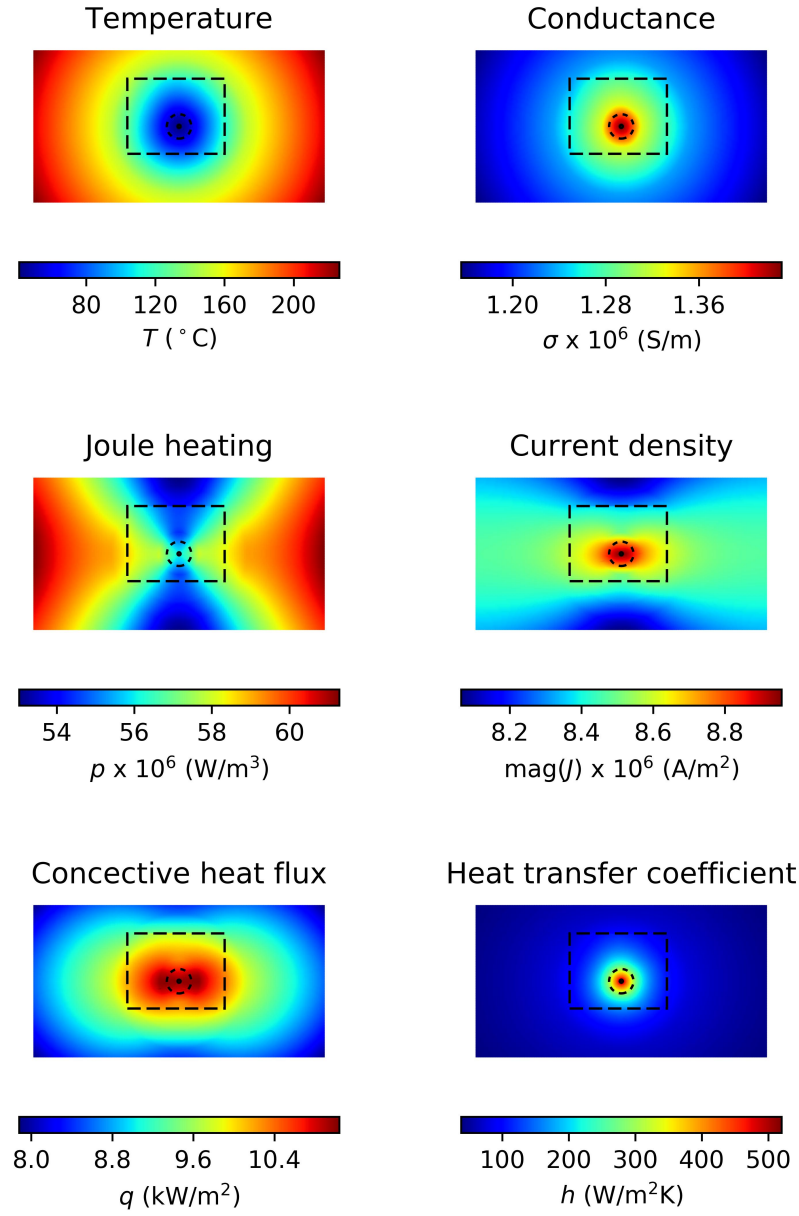


Figure 35: Convection calculation, mikkonen_010

Case id: mikkonen_011

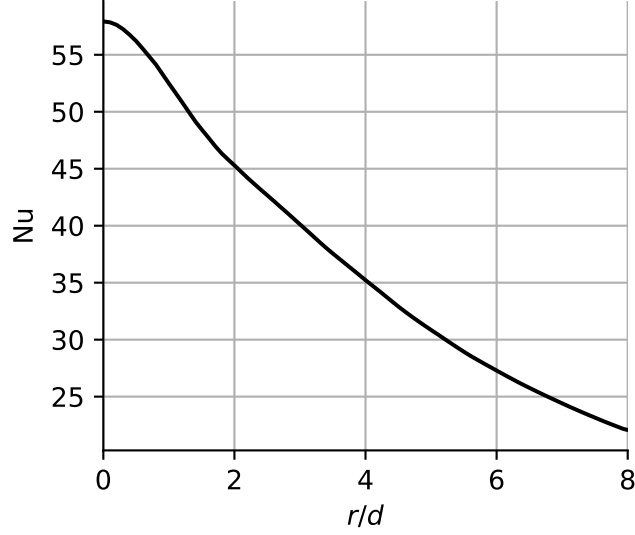


Figure 36: Nu, mikkonen_011

path		2017_02_20_HDsarja_3mm_DH1-10/DH_8_T_41							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 14:51:37							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20057	0.30	8	0.71	3.0	24.0	20.3	20.0	0.861	102.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.9	236.8	4.99			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.12	41.75	43.26	45.14	46.84	48.43	50.19	52.17	54.24
Nu	57.93	56.20	52.49	48.45	45.30	42.68	40.12	37.57	35.22
h (W/m ² K)	500.02	485.15	453.09	418.24	391.00	368.37	346.32	324.27	304.05
q (kW/m ²)	10.55	10.54	10.53	10.51	10.48	10.47	10.45	10.43	10.40
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	54.24	56.56	58.89	61.35	63.73	66.17	68.62	71.05	73.36
Nu	35.22	32.91	30.85	28.94	27.29	25.77	24.41	23.16	22.07
h (W/m ² K)	304.05	284.09	266.31	249.82	235.56	222.45	210.69	199.89	190.55
q (kW/m ²)	10.40	10.38	10.35	10.32	10.30	10.27	10.24	10.20	10.16

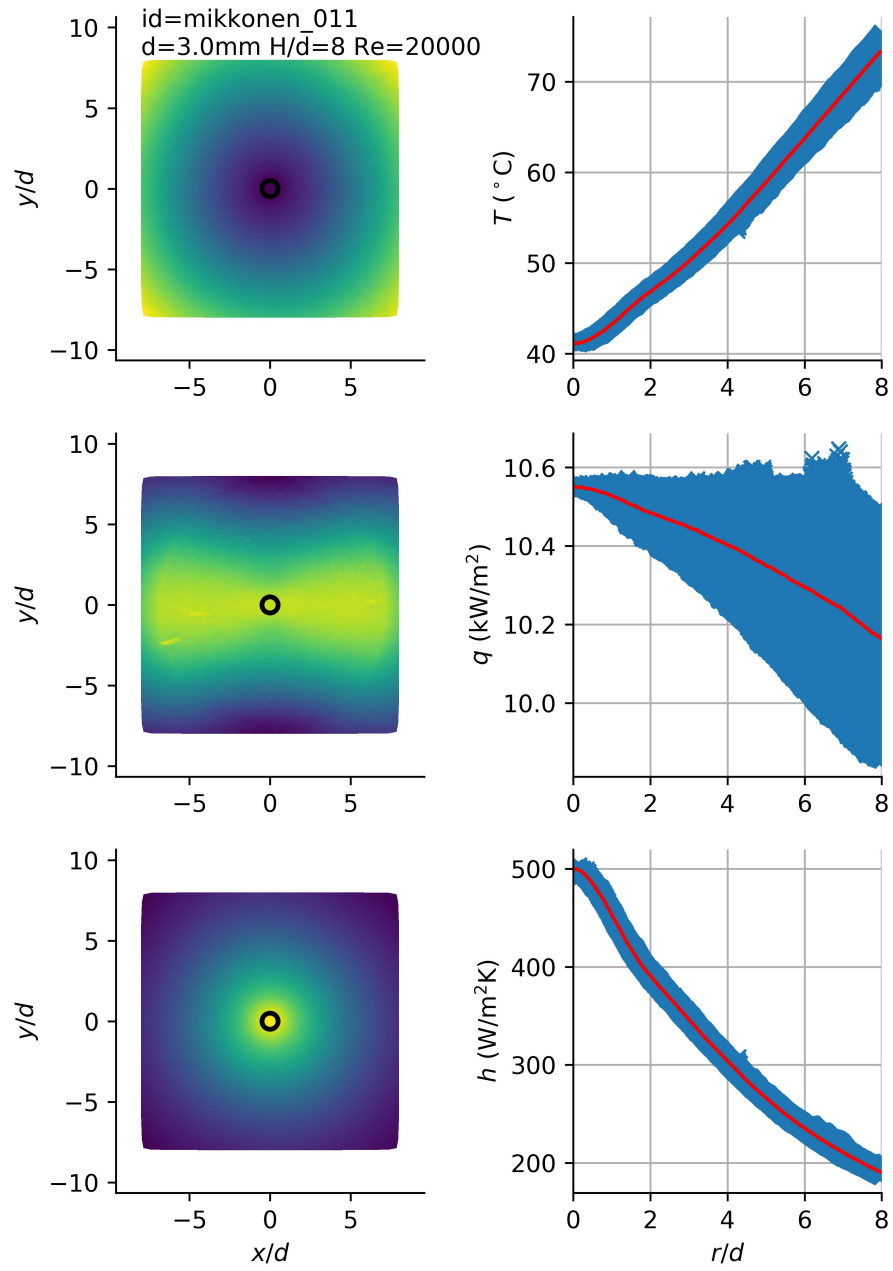


Figure 37: Results, mikkonen_011

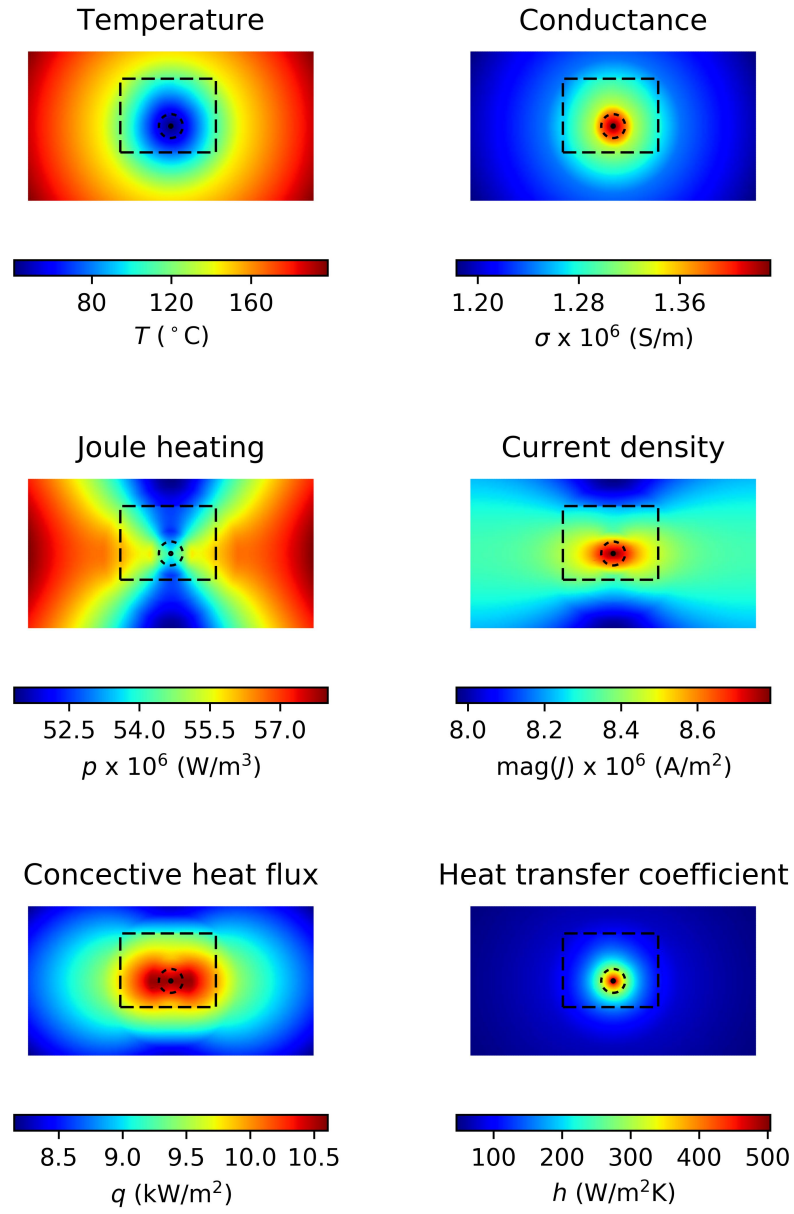


Figure 38: Convection calculation, mikkonen_011

Case id: mikkonen_012

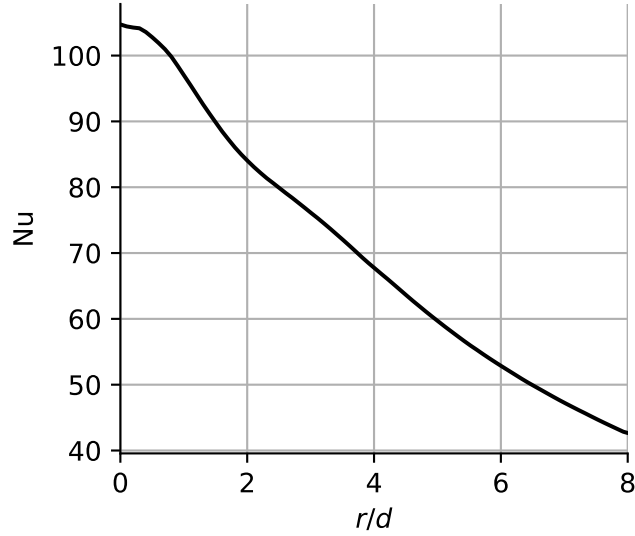


Figure 39: Nu, mikkonen_012

path		2017_02_20_HDsarja_3mm_DH1-10/DH_10_T_41_Lstdmin_140							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 16:06:13							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
67119	0.99	10	0.71	3.0	30.0	19.0	20.0	2.871	340.5
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.6	319.3	4.52				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.35	41.75	43.02	44.83	46.53	47.88	49.25	50.88	52.82
Nu	104.73	102.80	97.04	89.89	84.06	79.94	76.15	72.09	67.77
h (W/m ² K)	900.64	884.03	834.51	772.98	722.92	687.40	654.84	619.90	582.79
q (kW/m ²)	19.21	19.21	19.19	19.18	19.16	19.15	19.14	19.13	19.11
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	52.82	54.91	57.19	59.55	61.91	64.34	66.79	69.27	71.63
Nu	67.77	63.66	59.71	56.09	52.87	49.93	47.26	44.82	42.66
h (W/m ² K)	582.79	547.46	513.48	482.35	454.68	429.38	406.43	385.44	366.90
q (kW/m ²)	19.11	19.10	19.07	19.06	19.04	19.02	19.00	18.97	18.92

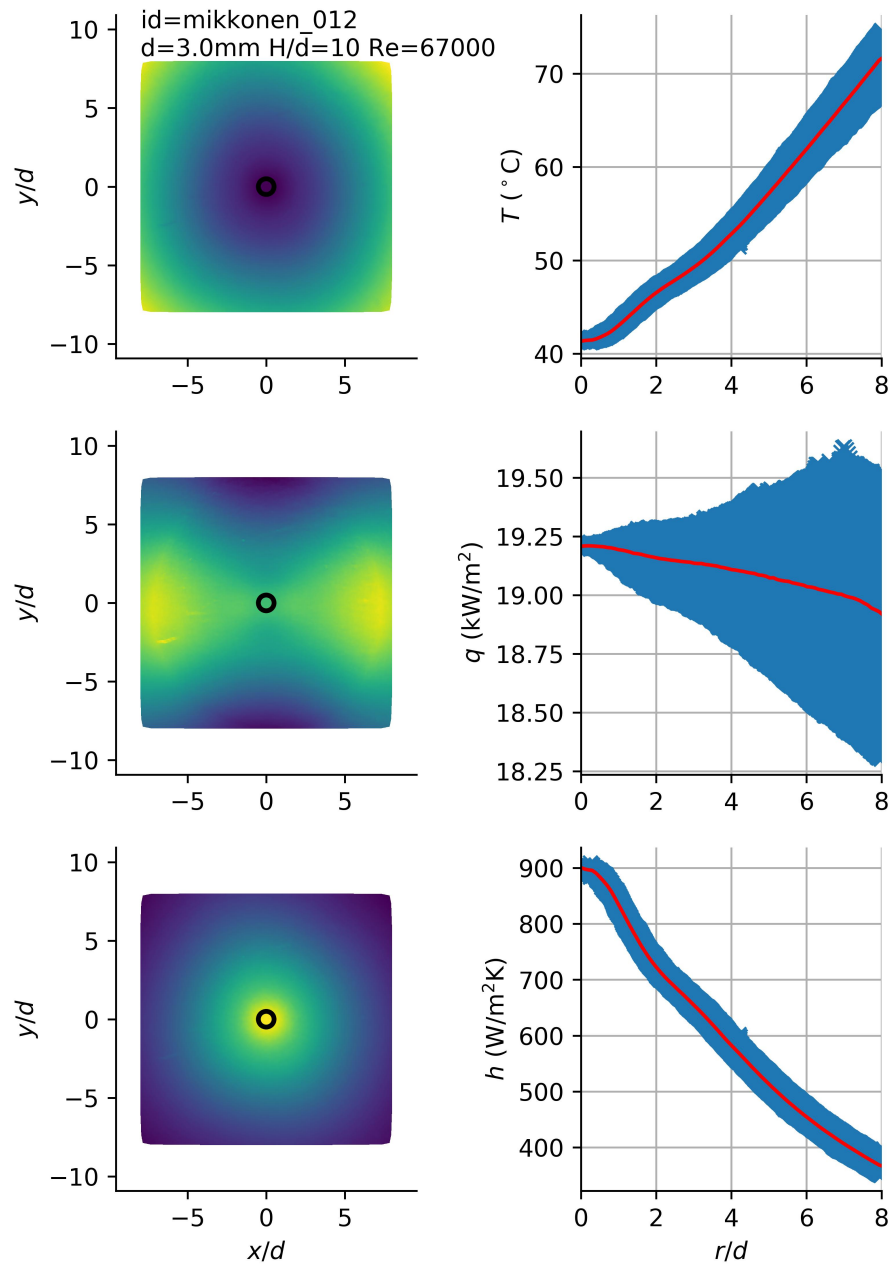


Figure 40: Results, mikkonen_012

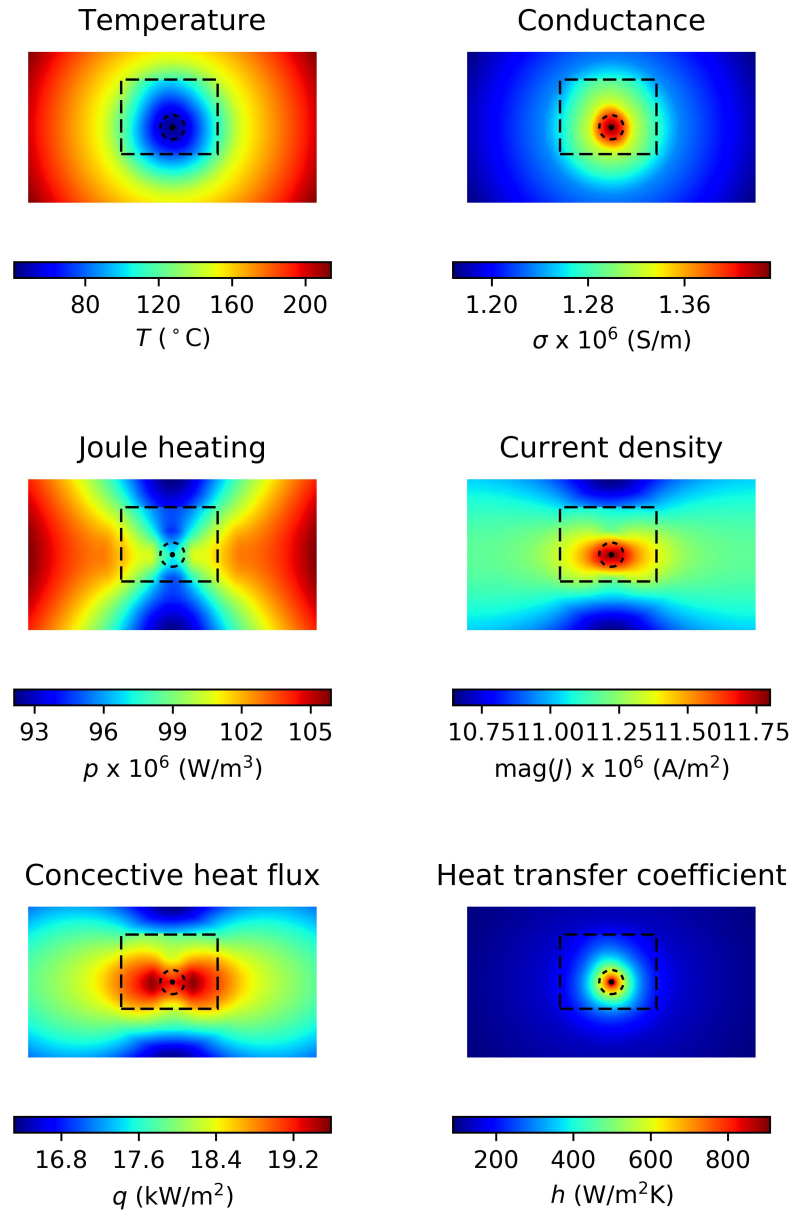


Figure 41: Convection calculation, mikkonen_012

Case id: mikkonen_013

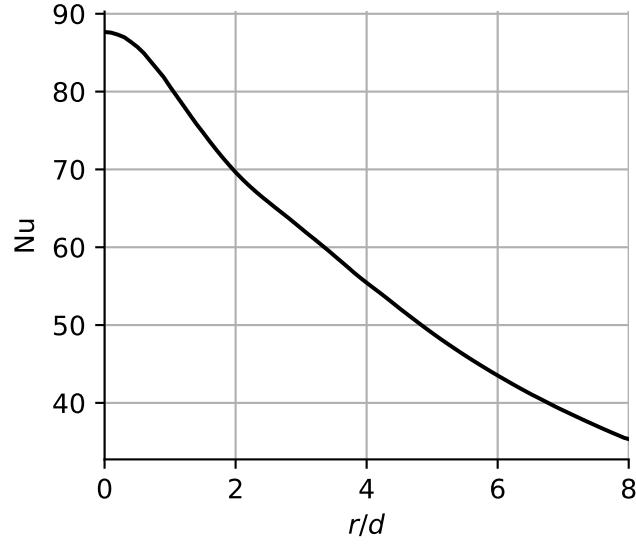


Figure 42: Nu, mikkonen_013

path		2017_02_20_HDsarja_3mm_DH1-10/DH_10_T_41_Lstdmin_100							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 16:10:07							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
46974	0.70	10	0.71	3.0	30.0	19.0	20.0	2.010	238.3
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.4	277.6	8.99				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.87	41.32	42.66	44.40	46.16	47.65	49.13	50.81	52.72
Nu	87.66	85.75	80.62	74.77	69.64	65.81	62.42	58.96	55.44
h (W/m ² K)	753.86	737.37	693.29	643.00	598.83	565.96	536.82	507.05	476.74
q (kW/m ²)	15.72	15.71	15.69	15.67	15.65	15.64	15.62	15.61	15.59
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	52.72	54.74	56.94	59.19	61.46	63.78	66.09	68.45	70.67
Nu	55.44	52.17	48.99	46.11	43.52	41.16	39.04	37.08	35.35
h (W/m ² K)	476.74	448.60	421.27	396.52	374.24	353.98	335.69	318.91	304.03
q (kW/m ²)	15.59	15.57	15.55	15.53	15.51	15.48	15.46	15.44	15.40

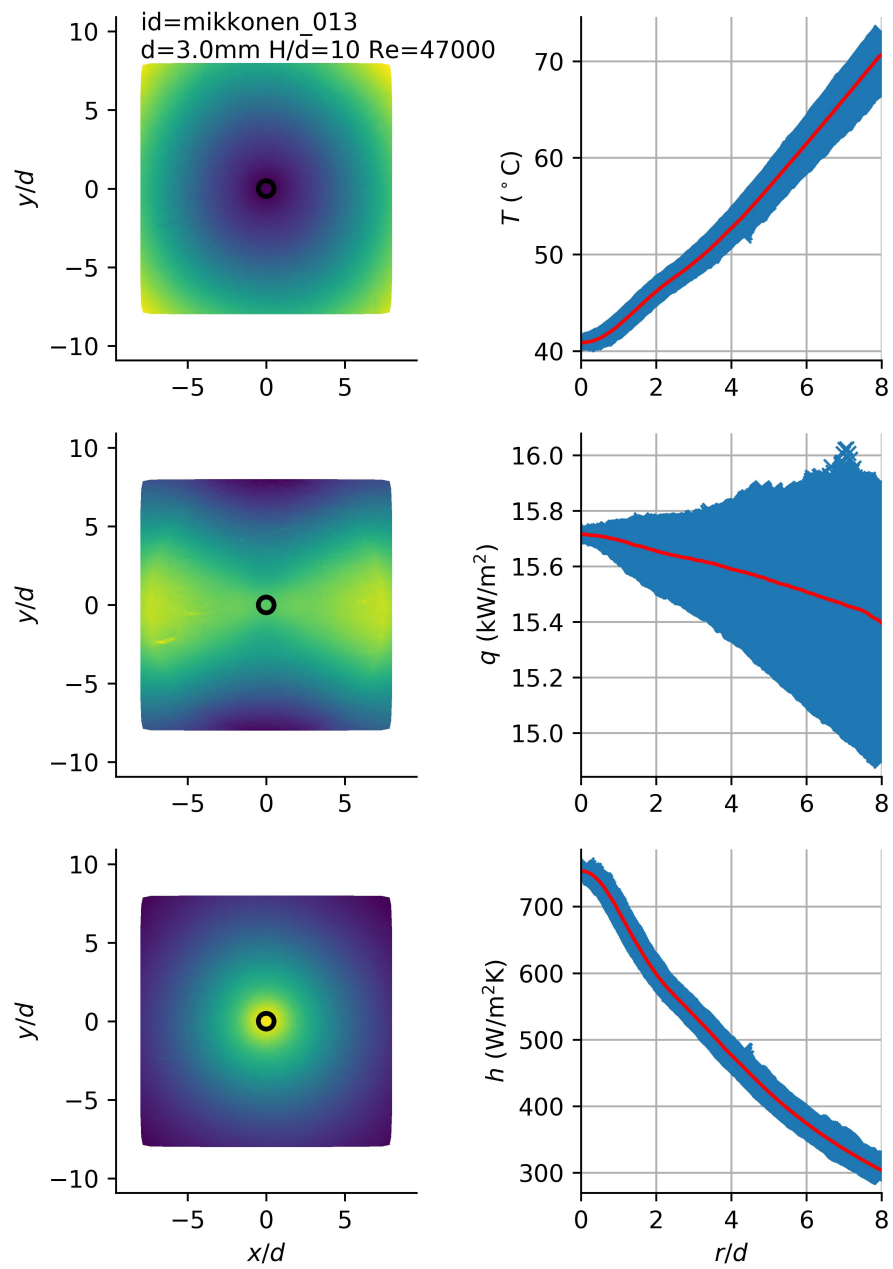


Figure 43: Results, mikkonen_013

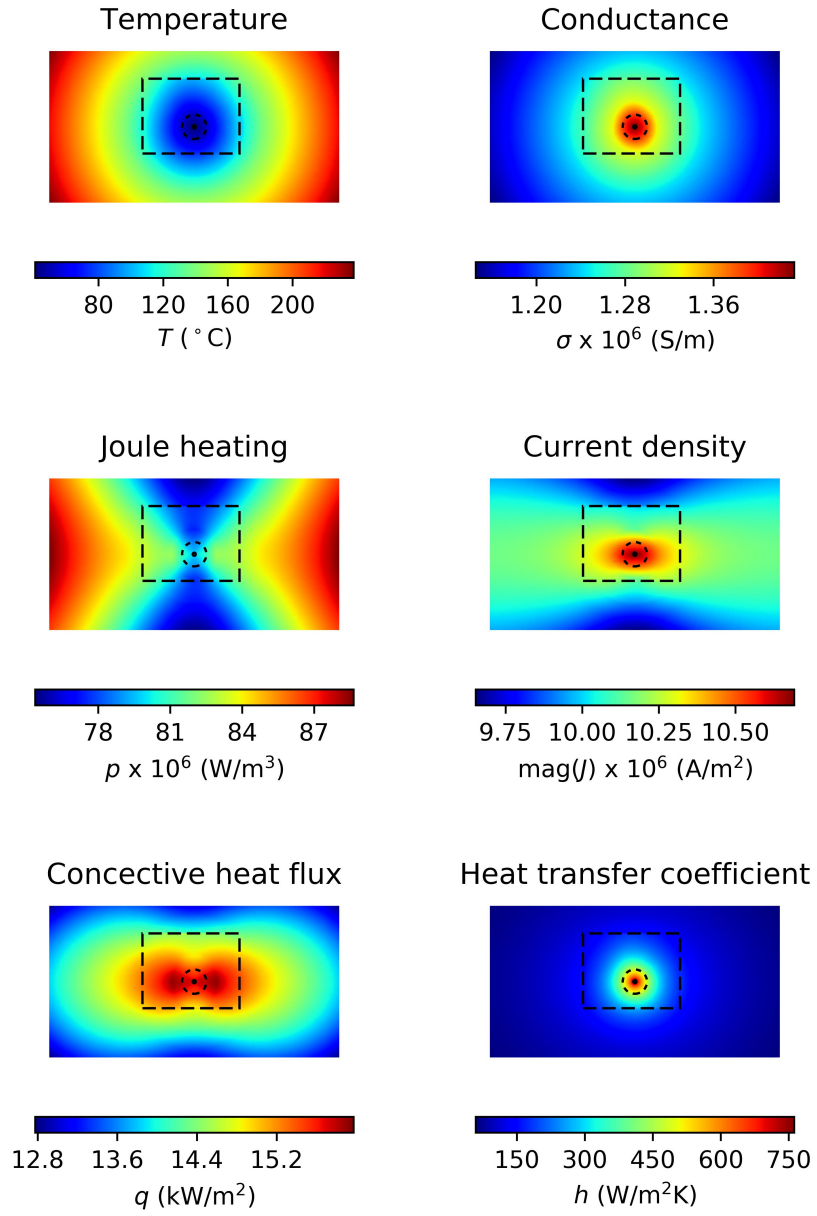


Figure 44: Convection calculation, mikkonen_013

Case id: mikkonen_014

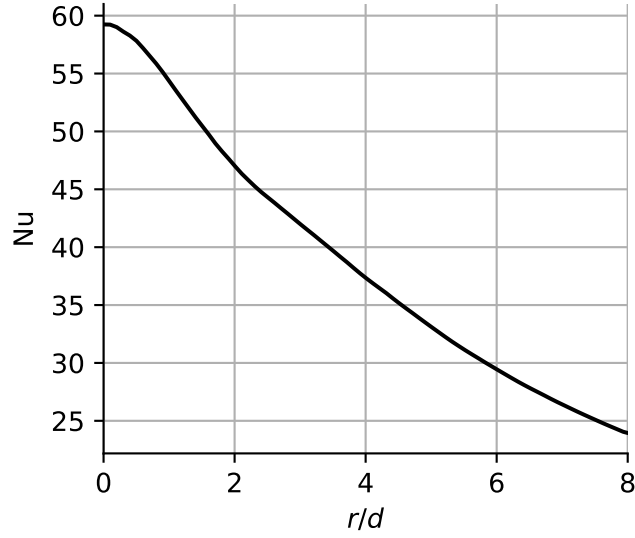


Figure 45: Nu, mikkonen_014

path		2017_02_20_HDsarja_3mm_DH1-10/DH_10_T_41							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-20 15:01:00							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20094	0.30	10	0.71	3.0	30.0	20.3	20.0	0.863	102.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.9	227.8	9.02				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.49	40.98	42.29	43.94	45.66	47.17	48.63	50.25	52.08
Nu	59.24	57.83	54.36	50.51	47.04	44.33	42.01	39.70	37.36
h (W/m ² K)	511.38	499.21	469.21	436.00	406.04	382.67	362.59	342.71	322.46
q (kW/m ²)	10.47	10.46	10.45	10.43	10.41	10.39	10.37	10.36	10.34
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	52.08	53.97	56.02	58.19	60.32	62.53	64.73	66.96	69.07
Nu	37.36	35.21	33.12	31.17	29.45	27.85	26.42	25.10	23.95
h (W/m ² K)	322.46	303.93	285.92	269.07	254.22	240.41	228.04	216.68	206.73
q (kW/m ²)	10.34	10.32	10.29	10.27	10.24	10.22	10.19	10.17	10.14

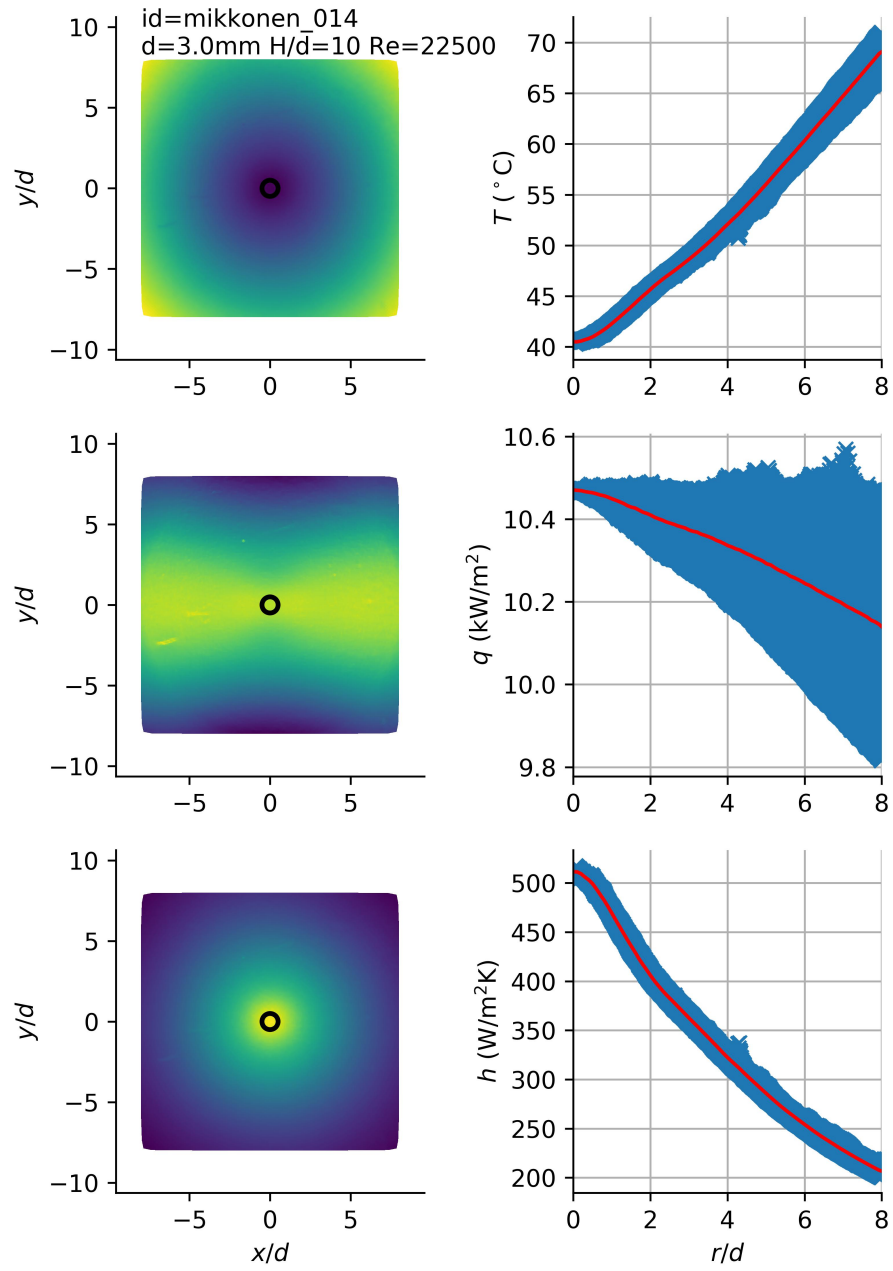


Figure 46: Results, mikkonen_014

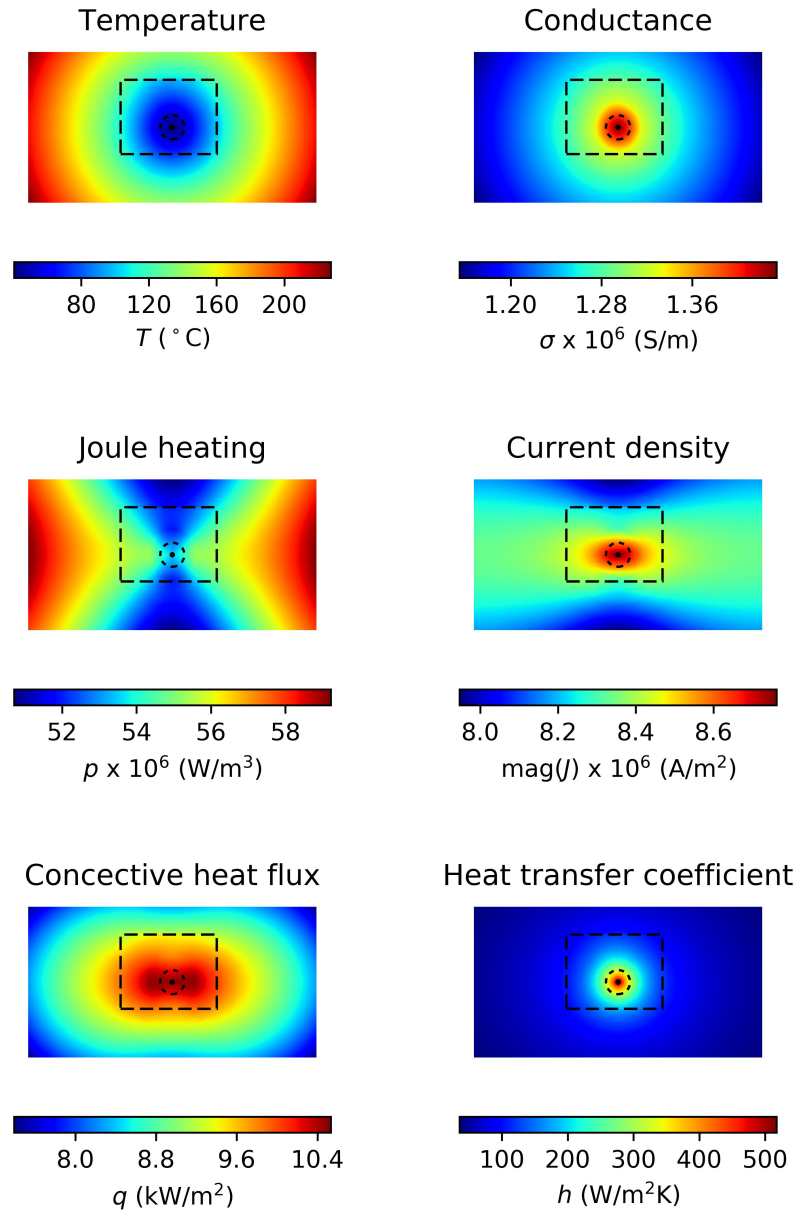


Figure 47: Convection calculation, mikkonen_014

Case id: mikkonen_015

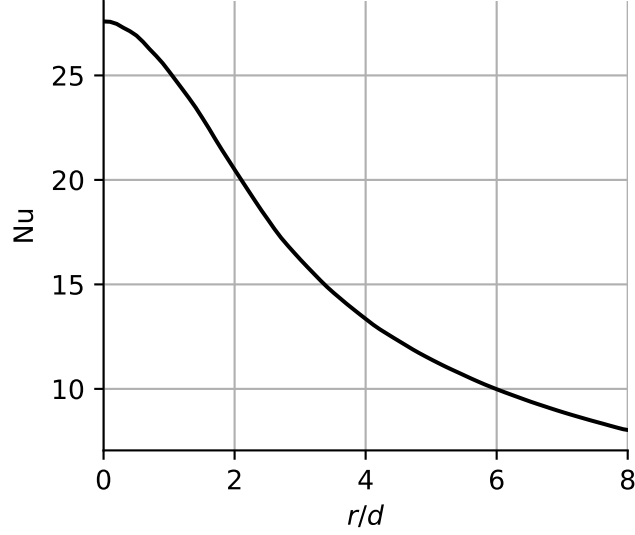


Figure 48: Nu, mikkonen_015

path	2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_1_Lstd_12								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-21 14:36:37								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6118	0.09	1	0.71	3.0	3.0	20.6	20.4	0.263	31.3
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.3	166.1	3.11			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.01	41.50	42.88	44.91	47.74	51.06	54.41	57.73	60.95
Nu	27.58	26.91	25.19	23.00	20.49	18.14	16.20	14.63	13.35
h (W/m ² K)	238.31	232.50	217.62	198.75	177.05	156.72	139.97	126.39	115.34
q (kW/m ²)	4.91	4.91	4.89	4.87	4.84	4.80	4.76	4.72	4.68
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	60.95	64.00	67.00	69.88	72.71	75.44	78.11	80.71	83.18
Nu	13.35	12.30	11.41	10.66	9.98	9.41	8.89	8.44	8.03
h (W/m ² K)	115.34	106.30	98.58	92.06	86.26	81.27	76.84	72.90	69.41
q (kW/m ²)	4.68	4.63	4.59	4.56	4.51	4.47	4.43	4.40	4.36

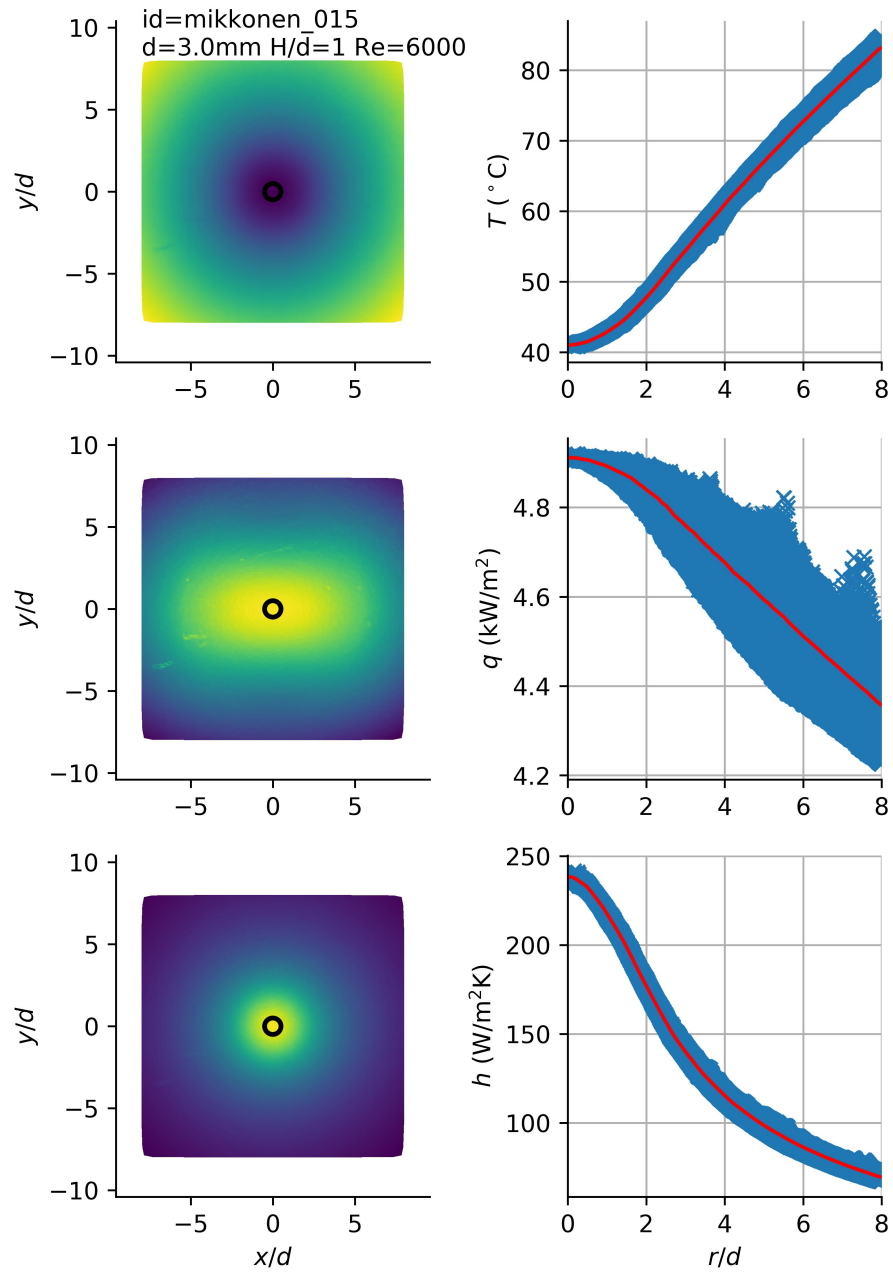


Figure 49: Results, mikkonen_015

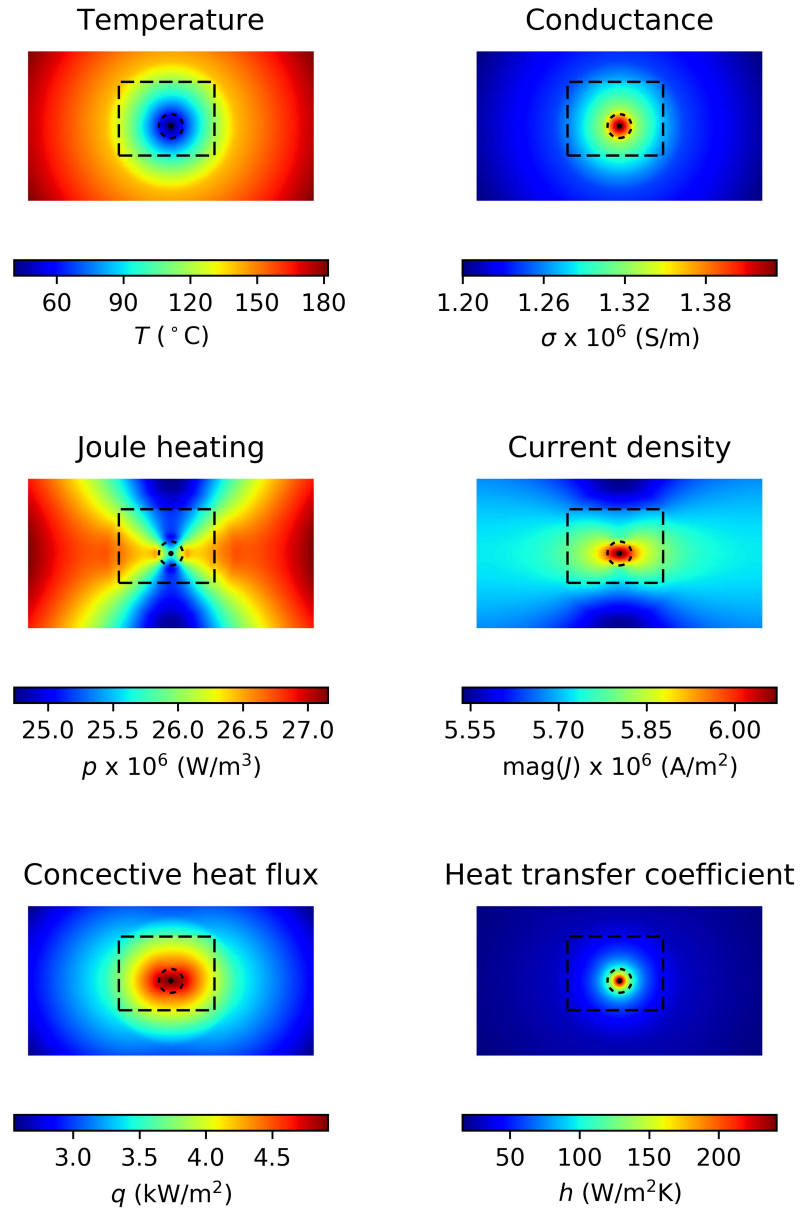


Figure 50: Convection calculation, mikkonen_015

Case id: mikkonen_016

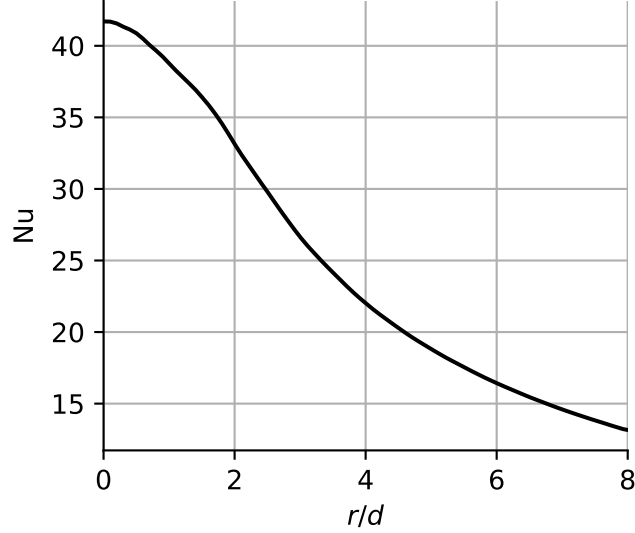


Figure 51: Nu, mikkonen_016

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_1_Lstd_21							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 14:43:05							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
10097	0.15	1	0.71	3.0	3.0	20.7	20.4	0.434	51.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.6	199.8	3.84				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.76	41.16	42.26	43.62	45.84	48.57	51.75	54.79	57.93
Nu	41.70	40.88	38.77	36.42	33.15	29.81	26.65	24.16	22.02
h (W/m ² K)	360.40	353.27	335.05	314.78	286.44	257.60	230.28	208.83	190.32
q (kW/m ²)	7.34	7.33	7.32	7.31	7.29	7.26	7.22	7.18	7.14
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	57.93	60.92	63.86	66.75	69.62	72.41	75.18	77.88	80.47
Nu	22.02	20.29	18.82	17.55	16.43	15.46	14.60	13.83	13.16
h (W/m ² K)	190.32	175.34	162.61	151.70	142.01	133.60	126.13	119.53	113.71
q (kW/m ²)	7.14	7.10	7.07	7.03	6.99	6.95	6.91	6.87	6.83

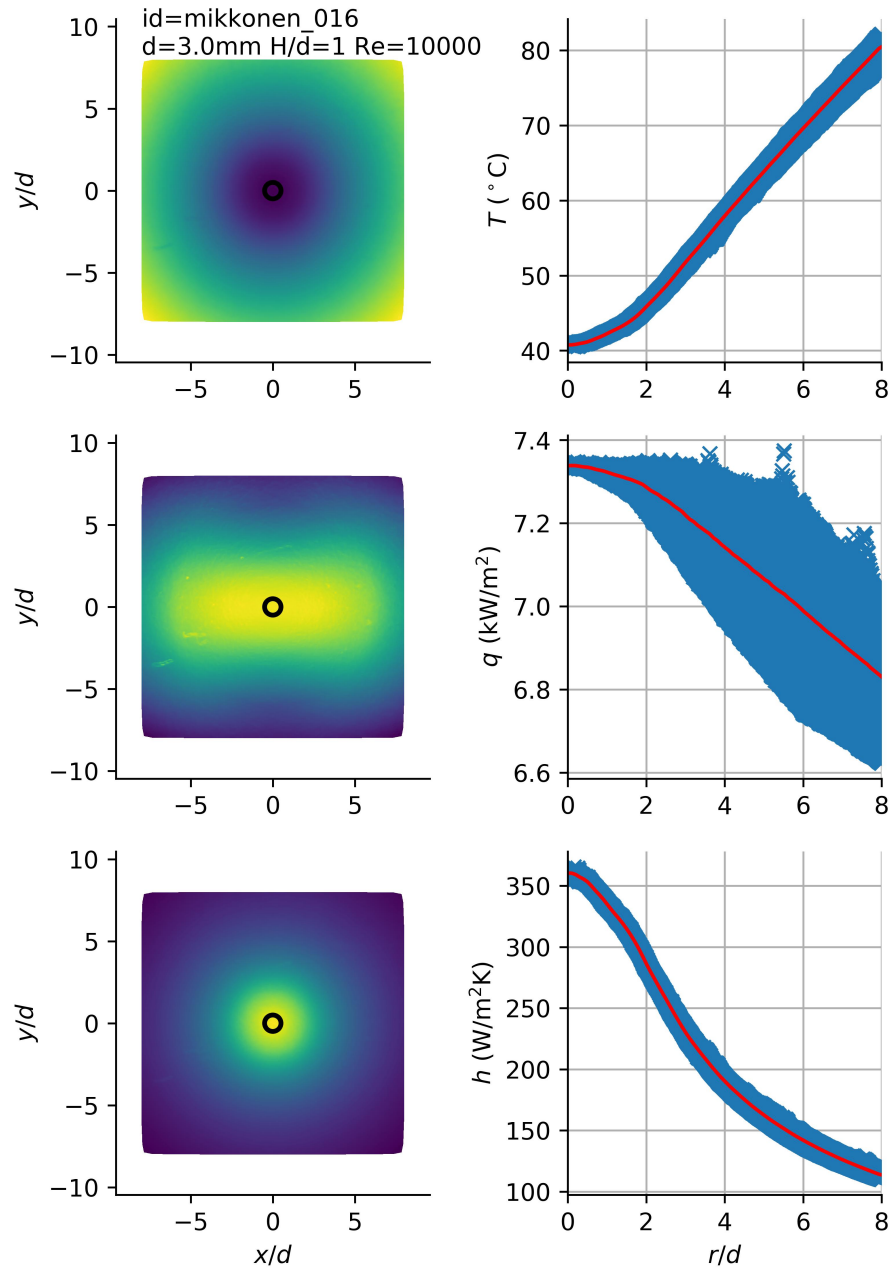


Figure 52: Results, mikkonen_016

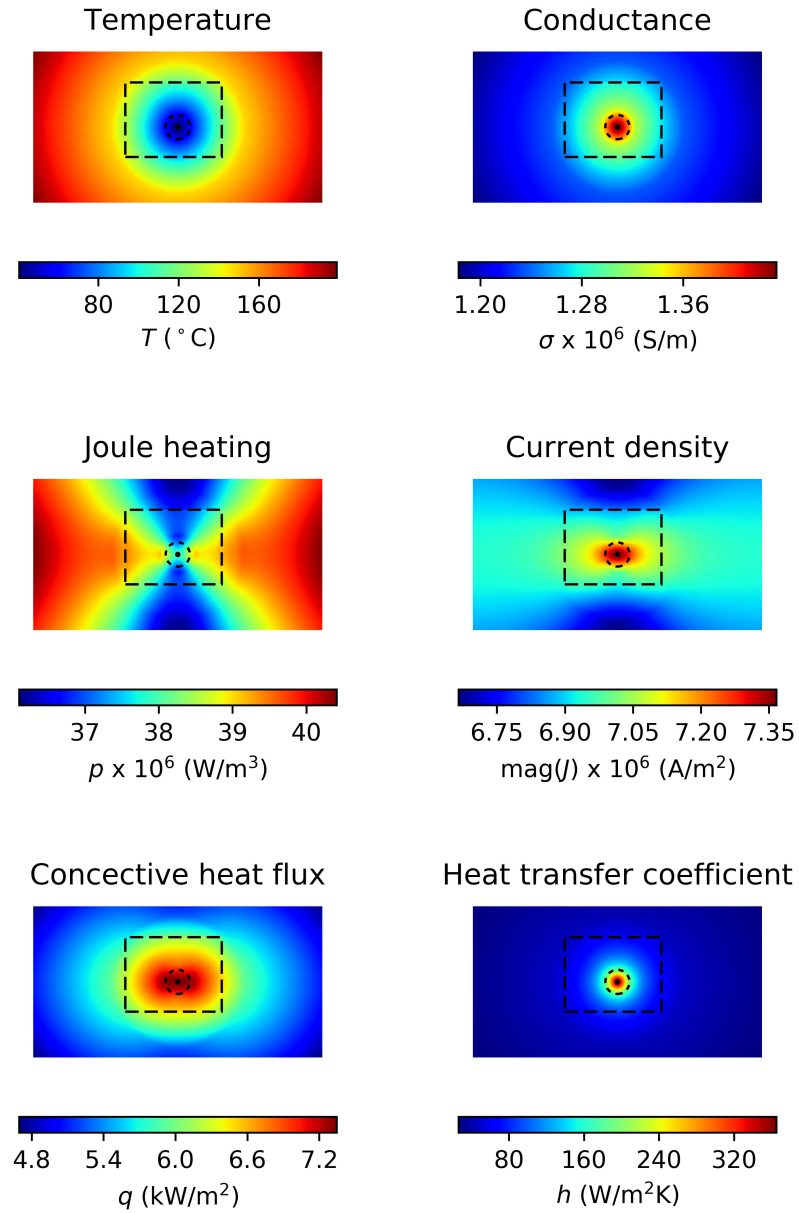


Figure 53: Convection calculation, mikkonen_016

Case id: mikkonen_017

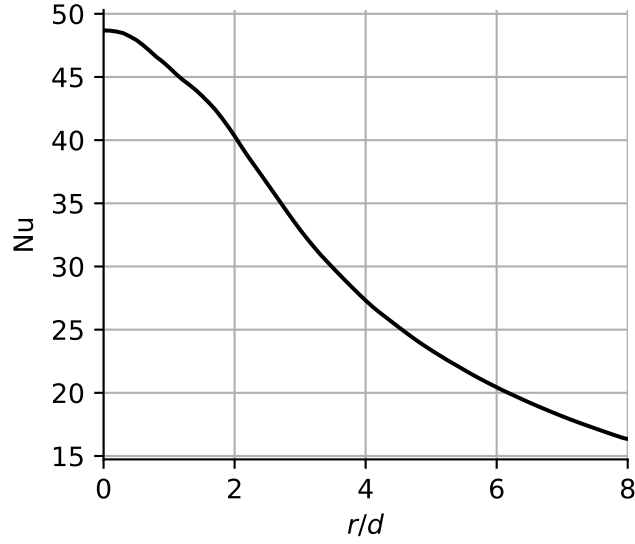


Figure 54: Nu, mikkonen_017

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_1_Lstd_30							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 14:49:23							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13779	0.21	1	0.71	3.0	3.0	20.7	20.4	0.592	70.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.8	220.0	2.98			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.35	41.68	42.66	43.77	45.58	48.09	51.04	53.98	57.00
Nu	48.68	47.93	45.76	43.52	40.33	36.55	32.91	29.90	27.31
h (W/m ² K)	420.73	414.17	395.44	376.11	348.49	315.86	284.39	258.39	236.04
q (kW/m ²)	8.82	8.81	8.80	8.79	8.77	8.74	8.71	8.67	8.64
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	57.00	59.87	62.78	65.63	68.47	71.25	74.04	76.76	79.38
Nu	27.31	25.22	23.38	21.82	20.44	19.23	18.15	17.19	16.35
h (W/m ² K)	236.04	217.92	202.06	188.61	176.62	166.18	156.82	148.55	141.27
q (kW/m ²)	8.64	8.60	8.56	8.53	8.49	8.45	8.41	8.37	8.33

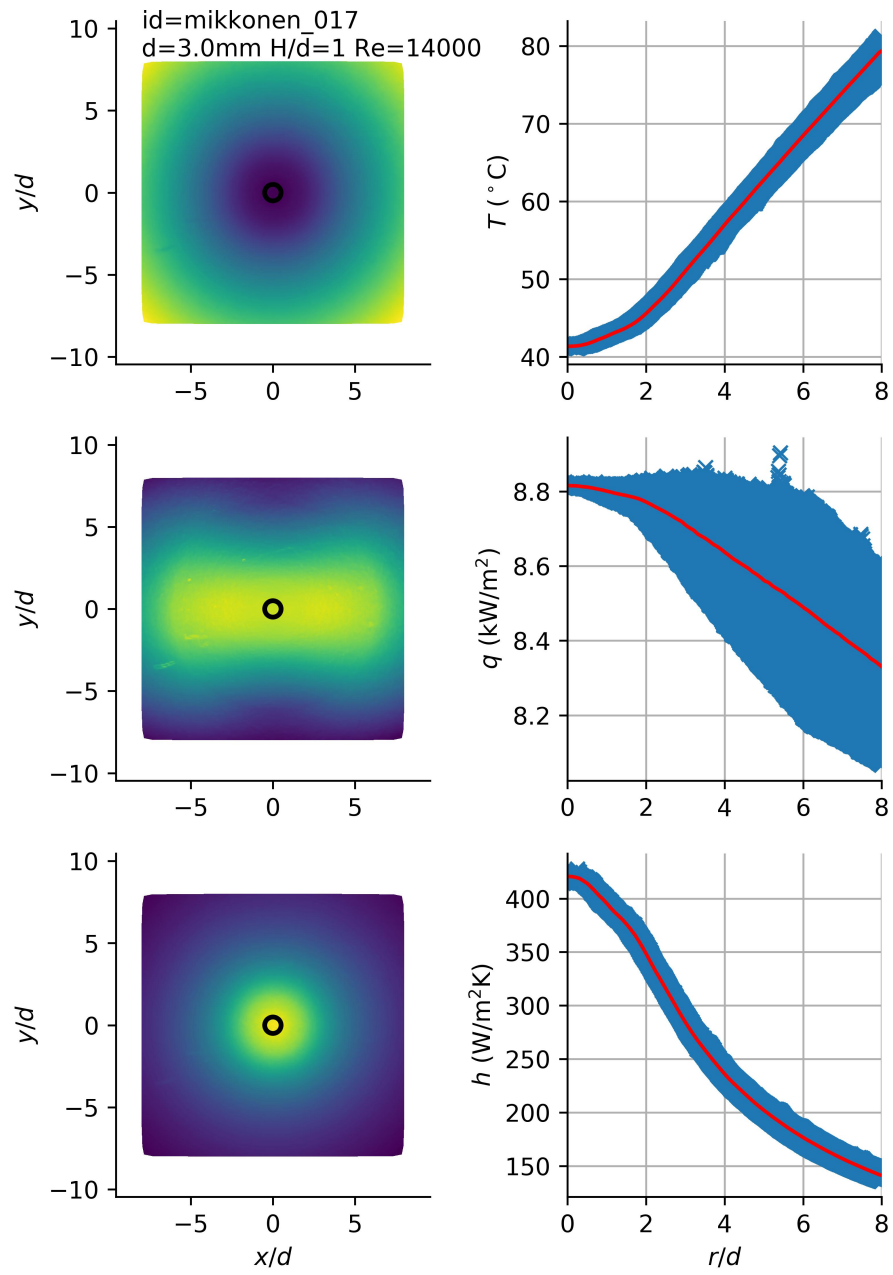


Figure 55: Results, mikkonen_017

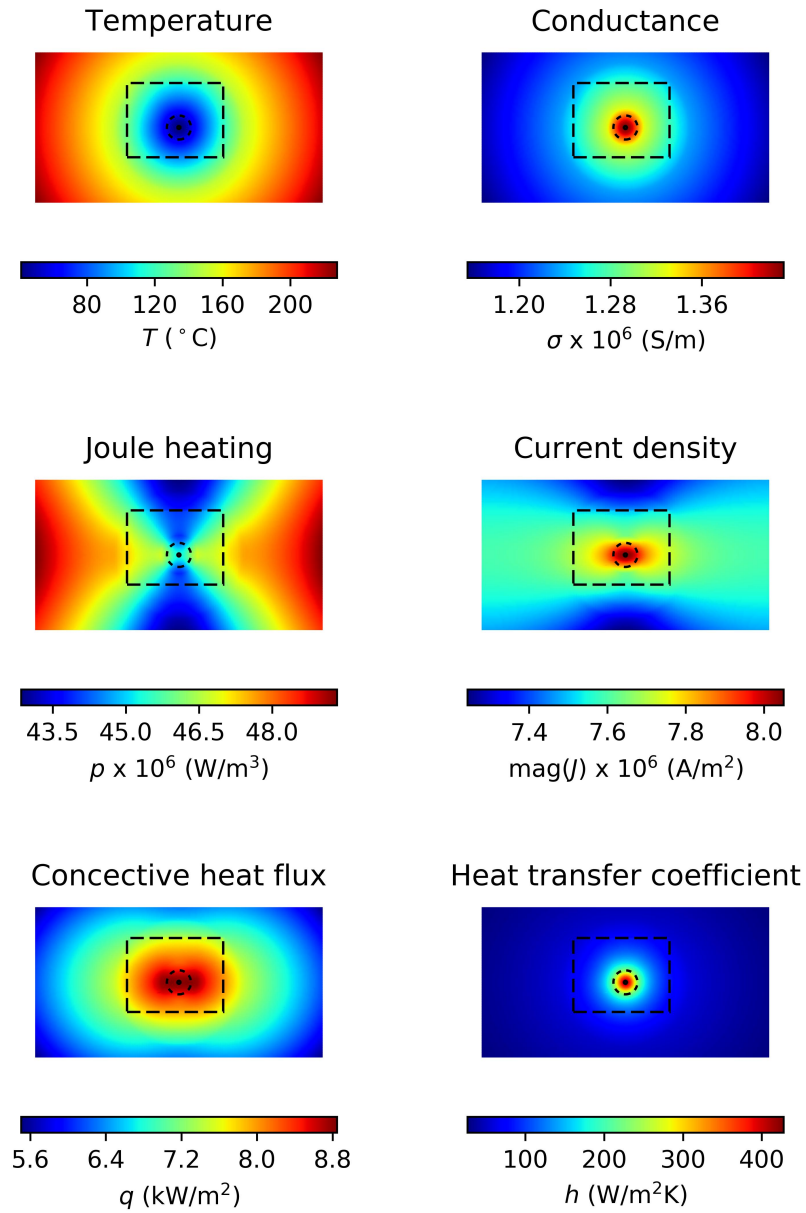


Figure 56: Convection calculation, mikkonen_017

Case id: mikkonen_018

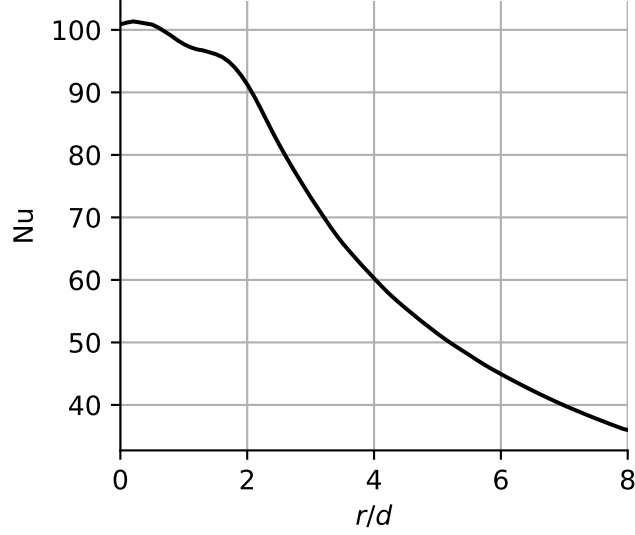


Figure 57: Nu, mikkonen_018

path	2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_1_Lstd_75								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-21 15:01:04								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
35102	0.52	1	0.71	3.0	3.0	20.0	20.4	1.506	179.2
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.5	306.3	5.68			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.34	41.34	42.01	42.37	43.53	46.19	49.14	52.25	55.18
Nu	100.88	100.85	97.72	96.12	91.28	81.74	73.23	65.94	60.27
h (W/m ² K)	870.00	869.77	842.80	829.00	787.22	704.93	631.55	568.70	519.79
q (kW/m ²)	18.22	18.22	18.21	18.21	18.20	18.18	18.14	18.11	18.08
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	55.18	58.12	61.01	63.83	66.68	69.48	72.29	75.05	77.69
Nu	60.27	55.46	51.42	48.00	44.95	42.30	39.92	37.82	36.00
h (W/m ² K)	519.79	478.28	443.43	413.98	387.65	364.84	344.29	326.20	310.46
q (kW/m ²)	18.08	18.04	18.01	17.98	17.94	17.91	17.86	17.83	17.78

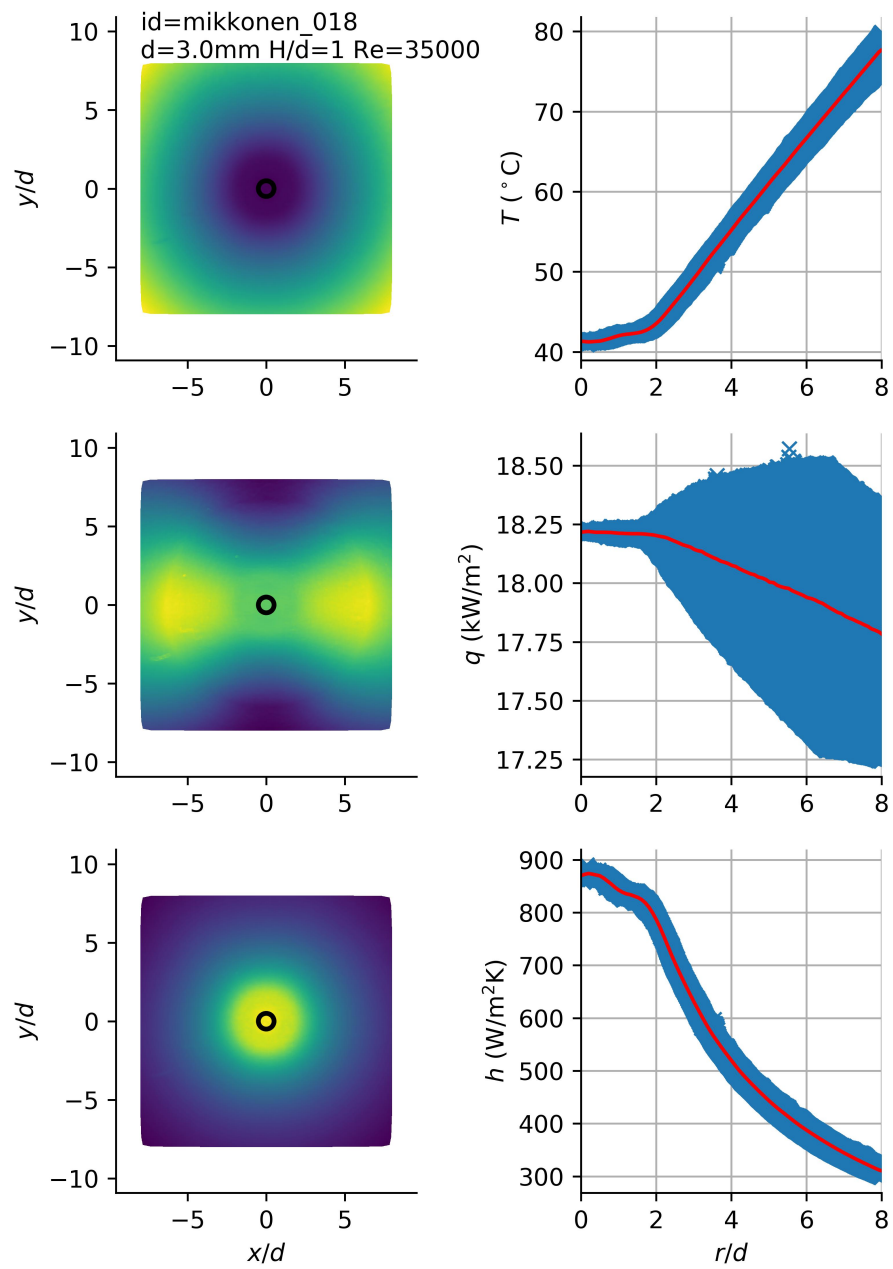


Figure 58: Results, mikkonen_018

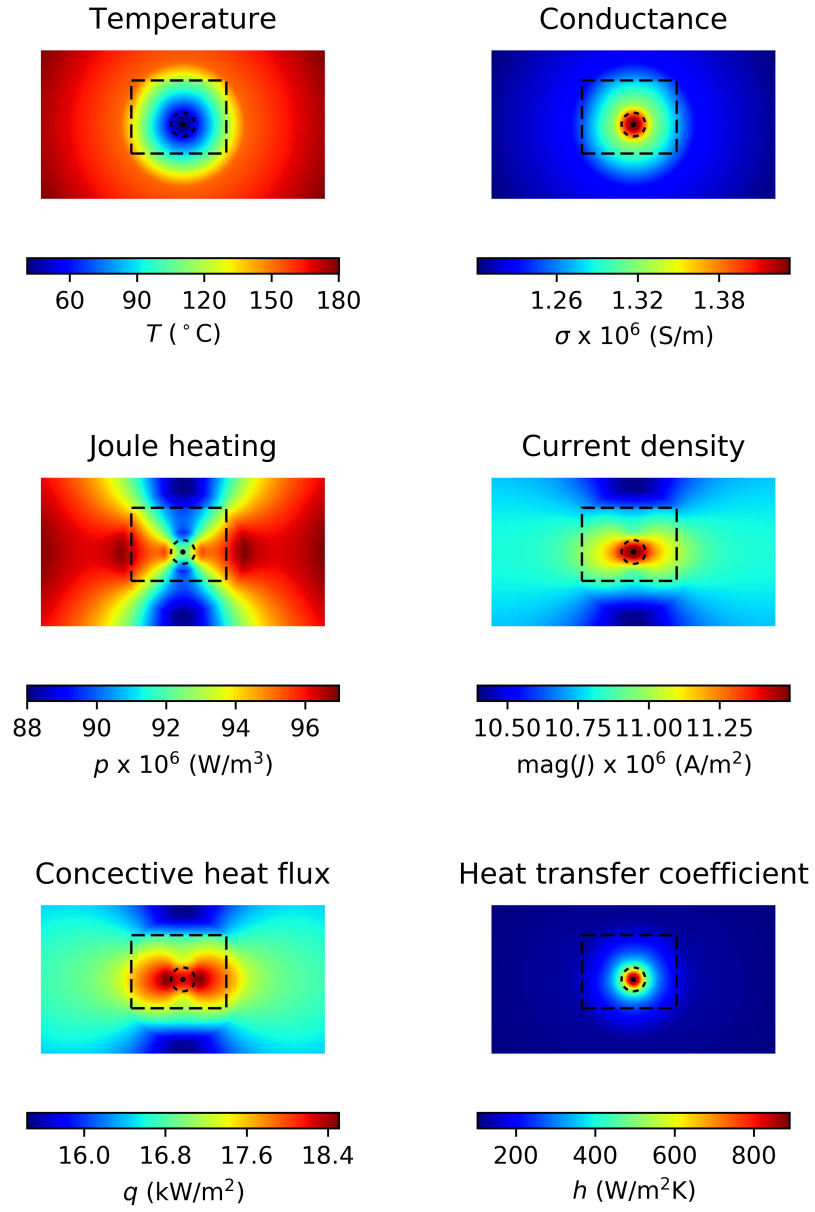


Figure 59: Convection calculation, mikkonen_018

Case id: mikkonen_019

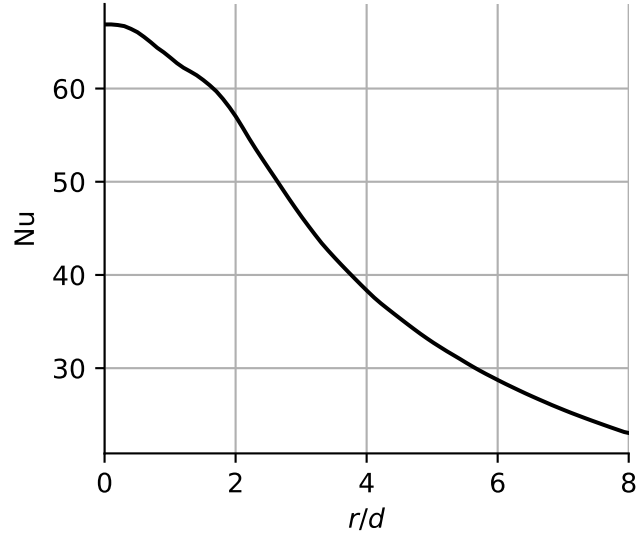


Figure 60: Nu, mikkonen_019

path	2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_1_Lstd_43								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-21 14:55:53								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20135	0.30	1	0.71	3.0	3.0	20.4	20.4	0.865	103.0
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.0	251.2	5.14			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.27	41.52	42.41	43.26	44.80	47.38	50.30	53.31	56.30
Nu	66.87	66.05	63.34	60.94	57.03	51.47	46.32	41.95	38.34
h (W/m ² K)	577.42	570.32	546.90	526.22	492.43	444.43	399.91	362.17	331.08
q (kW/m ²)	12.05	12.04	12.04	12.03	12.01	11.99	11.95	11.92	11.88
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	56.30	59.17	62.08	64.89	67.72	70.49	73.27	76.00	78.61
Nu	38.34	35.39	32.82	30.66	28.74	27.05	25.55	24.21	23.05
h (W/m ² K)	331.08	305.56	283.36	264.75	248.12	233.59	220.58	209.08	198.99
q (kW/m ²)	11.88	11.85	11.81	11.78	11.74	11.70	11.66	11.62	11.58

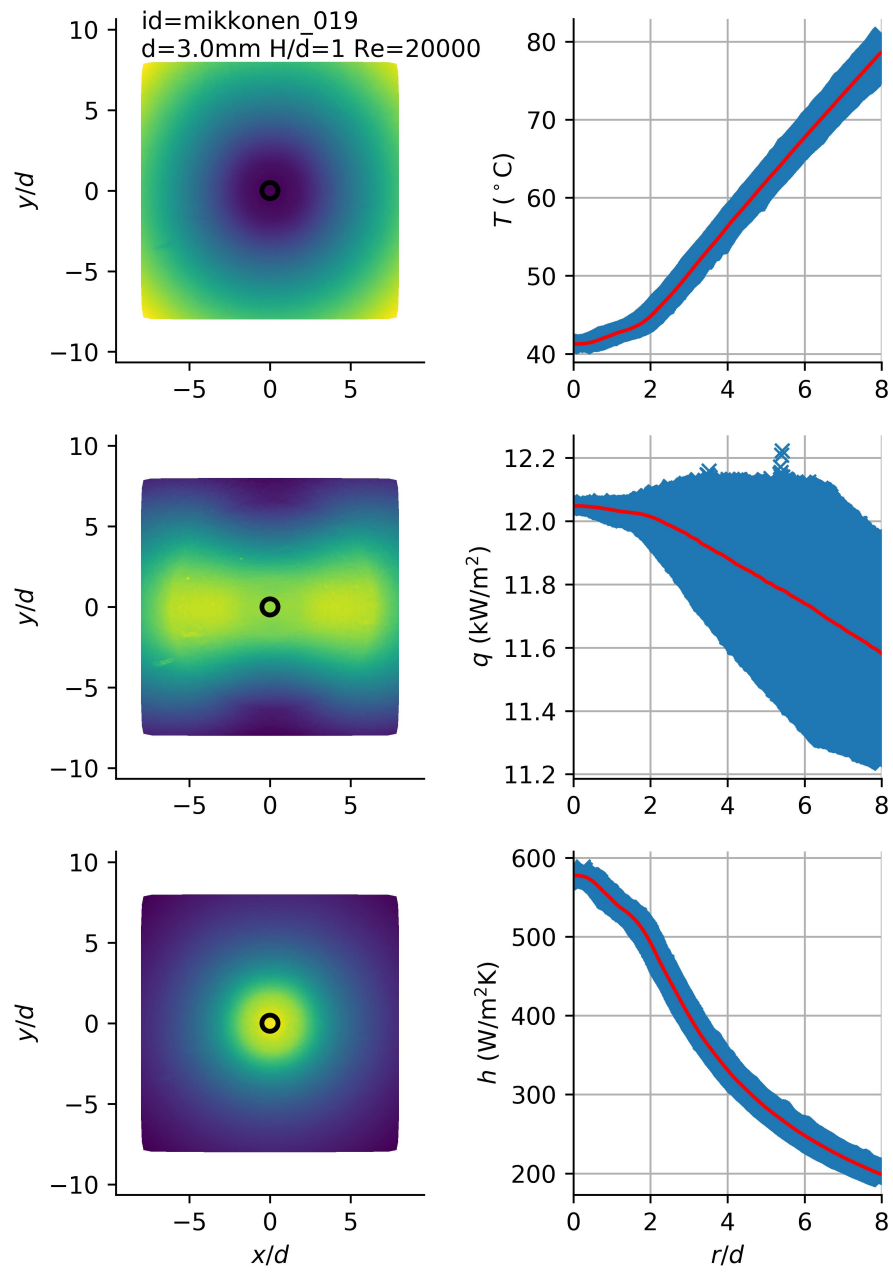


Figure 61: Results, mikkonen_019

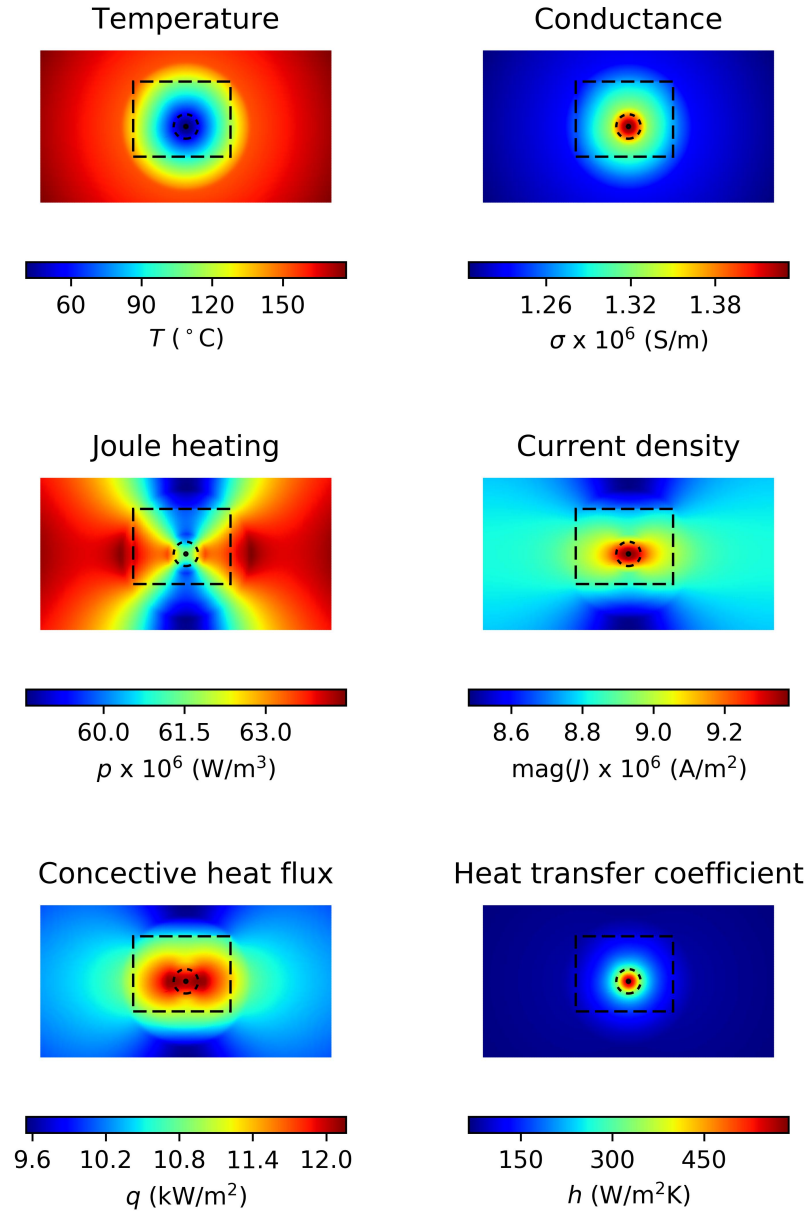


Figure 62: Convection calculation, mikkonen_019

Case id: mikkonen_020

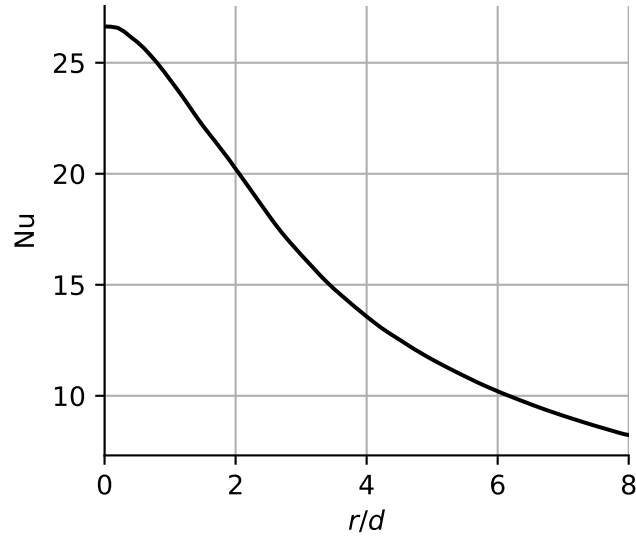


Figure 63: Nu, mikkonen_020

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_2_Lstd_12							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 15:25:24							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6048	0.09	2	0.71	3.0	6.0	21.2	20.4	0.260	31.1
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.3	165.5	4.02				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.88	42.43	43.90	45.97	48.28	51.25	54.36	57.55	60.65
Nu	26.64	25.93	24.23	22.16	20.22	18.15	16.35	14.82	13.57
h (W/m ² K)	230.52	224.42	209.73	191.82	175.03	157.10	141.51	128.28	117.46
q (kW/m ²)	4.95	4.94	4.93	4.90	4.88	4.85	4.81	4.77	4.73
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	60.65	63.62	66.54	69.37	72.13	74.79	77.42	79.98	82.38
Nu	13.57	12.53	11.64	10.88	10.20	9.62	9.10	8.64	8.24
h (W/m ² K)	117.46	108.44	100.70	94.13	88.29	83.28	78.78	74.77	71.27
q (kW/m ²)	4.73	4.69	4.65	4.61	4.57	4.53	4.49	4.45	4.42

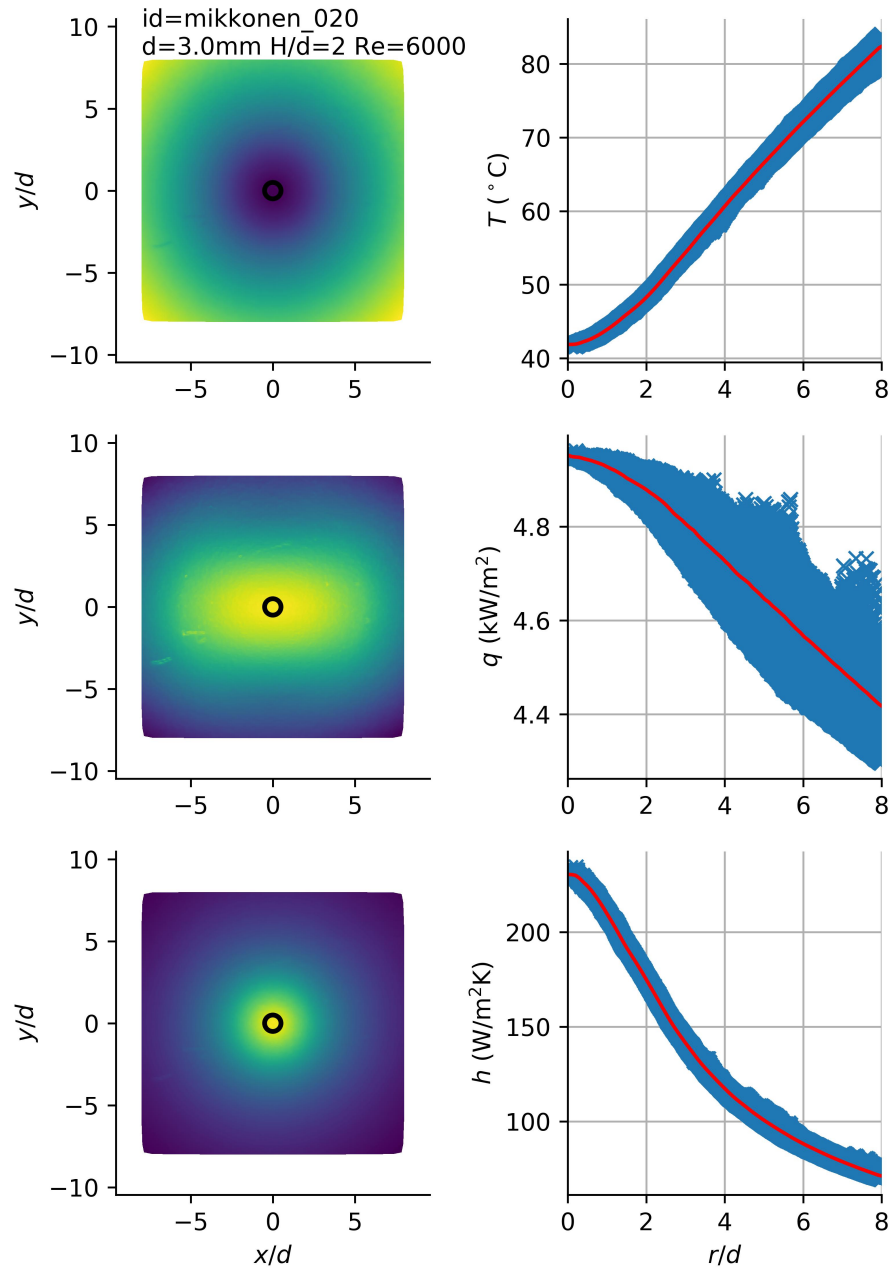


Figure 64: Results, mikkonen_020

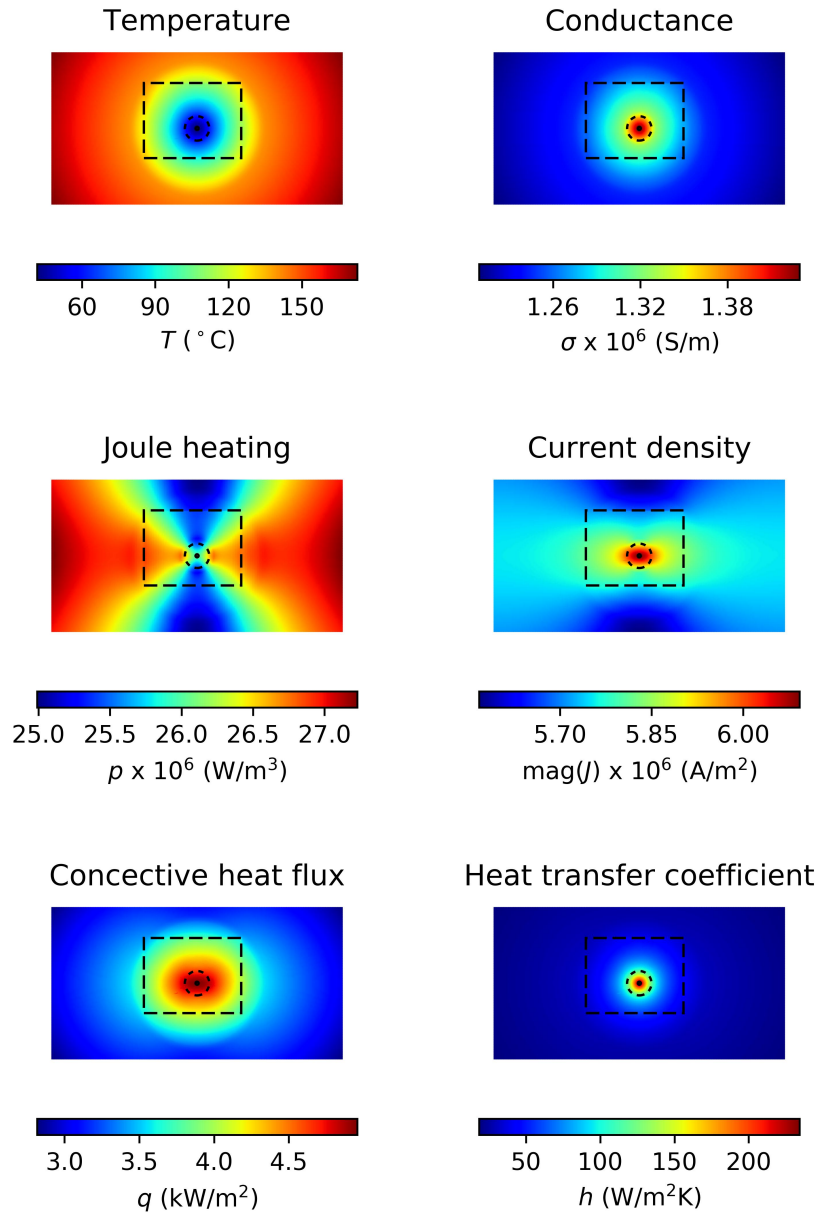


Figure 65: Convection calculation, mikkonen_020

Case id: mikkonen_021

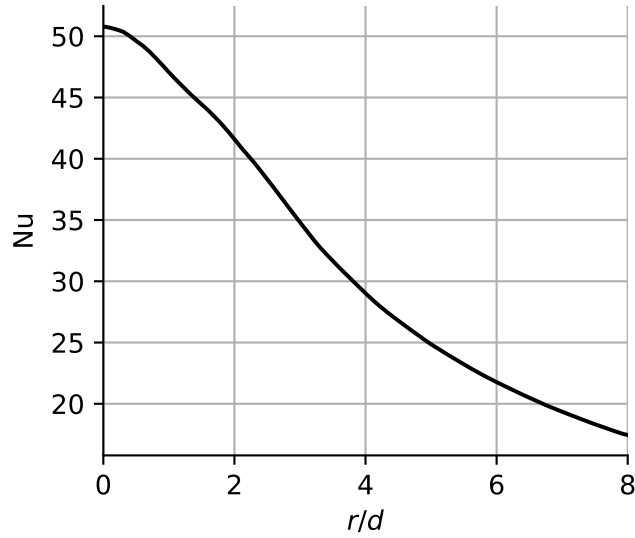


Figure 66: Nu, mikkonen_021

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_2_Lstd_30							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 15:20:03							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13879	0.21	2	0.71	3.0	6.0	20.6	20.4	0.596	71.1
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.8	220.2	4.71				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.18	41.66	42.79	44.07	45.64	47.73	50.38	53.24	56.10
Nu	50.80	49.62	47.06	44.44	41.60	38.33	34.82	31.67	29.02
h (W/m ² K)	438.90	428.70	406.56	383.94	359.40	331.14	300.83	273.60	250.74
q (kW/m ²)	9.12	9.11	9.10	9.09	9.07	9.05	9.02	8.98	8.95
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	56.10	58.92	61.73	64.48	67.22	69.93	72.62	75.29	77.79
Nu	29.02	26.79	24.86	23.22	21.77	20.49	19.35	18.33	17.45
h (W/m ² K)	250.74	231.41	214.78	200.64	188.08	177.06	167.19	158.38	150.80
q (kW/m ²)	8.95	8.91	8.87	8.84	8.80	8.77	8.73	8.69	8.65

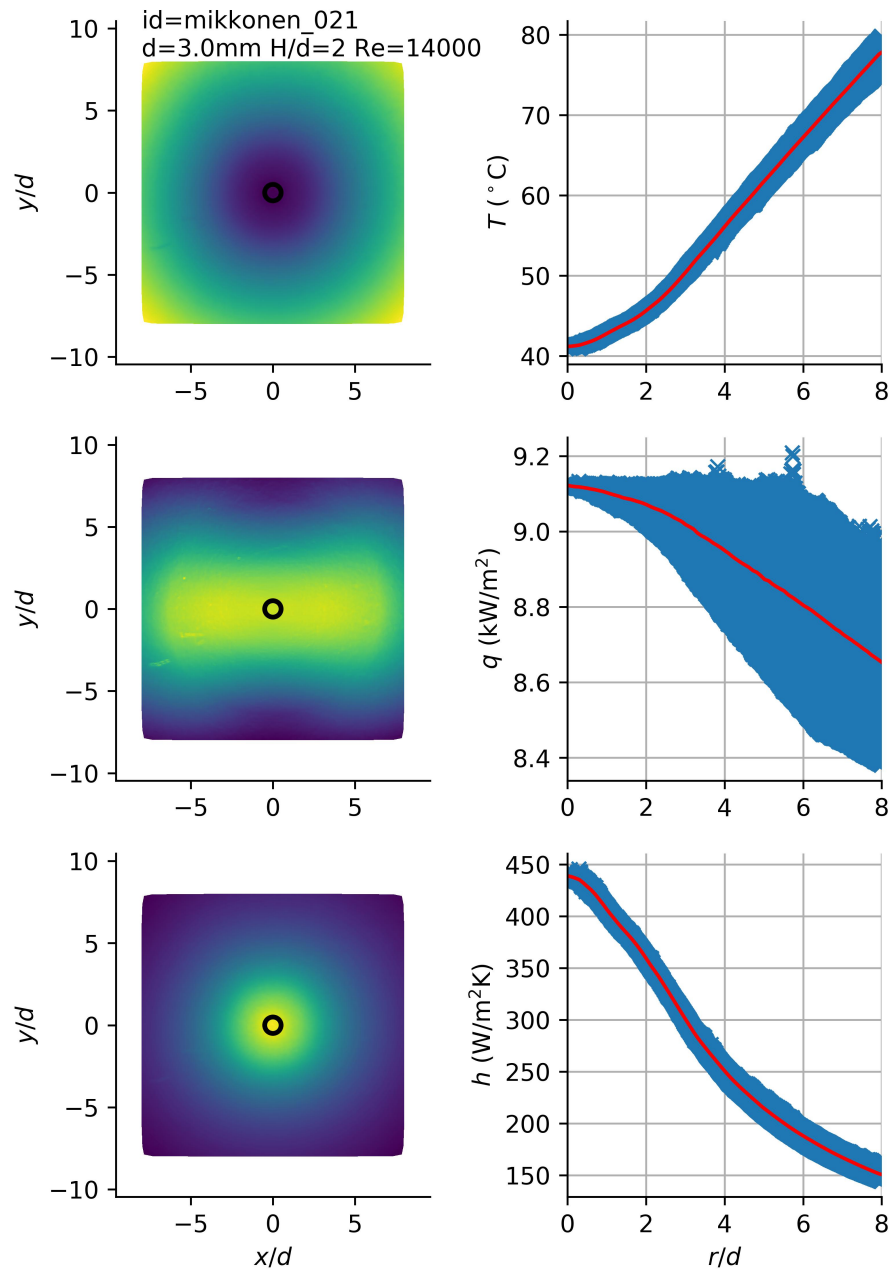


Figure 67: Results, mikkonen_021

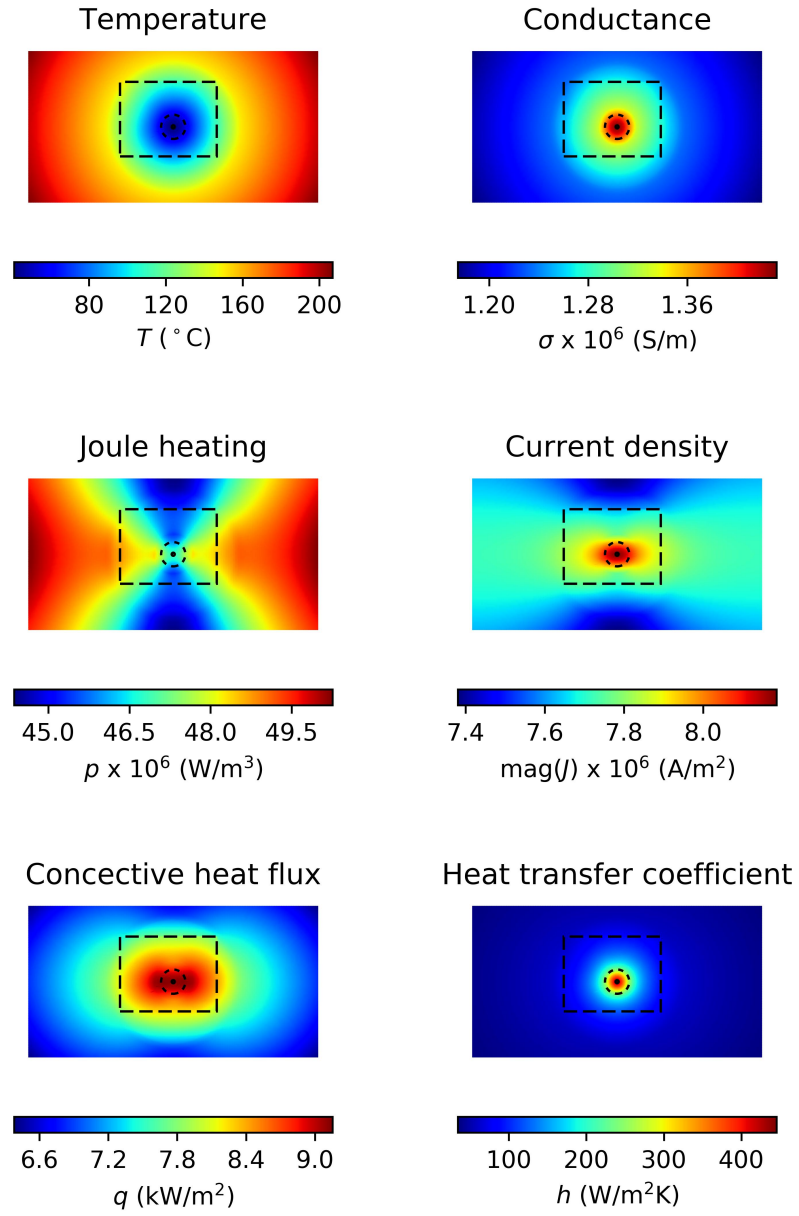


Figure 68: Convection calculation, mikkonen_021

Case id: mikkonen_022

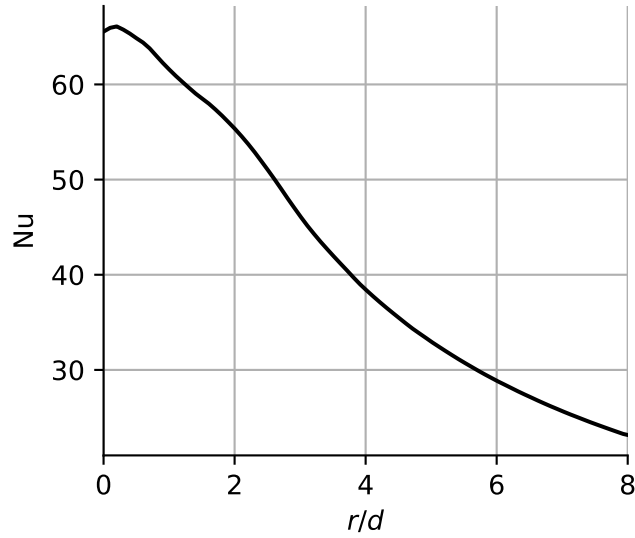


Figure 69: Nu, mikkonen_022

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_2_Lstd_43							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 15:14:42							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20029	0.30	2	0.71	3.0	6.0	20.2	20.4	0.860	102.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.1	254.5	5.25			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	42.33	42.56	43.72	44.91	46.28	48.41	51.31	54.25	57.30
Nu	65.55	64.86	61.59	58.54	55.37	51.08	46.18	42.03	38.45
h (W/m ² K)	565.67	559.75	531.45	505.14	477.79	440.78	398.48	362.73	331.81
q (kW/m ²)	12.41	12.40	12.39	12.38	12.37	12.35	12.31	12.28	12.24
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	57.30	60.23	63.16	66.07	68.95	71.78	74.63	77.44	80.10
Nu	38.45	35.51	32.98	30.79	28.87	27.19	25.67	24.33	23.16
h (W/m ² K)	331.81	306.47	284.58	265.72	249.12	234.62	221.55	209.95	199.90
q (kW/m ²)	12.24	12.20	12.17	12.13	12.09	12.05	12.01	11.97	11.93

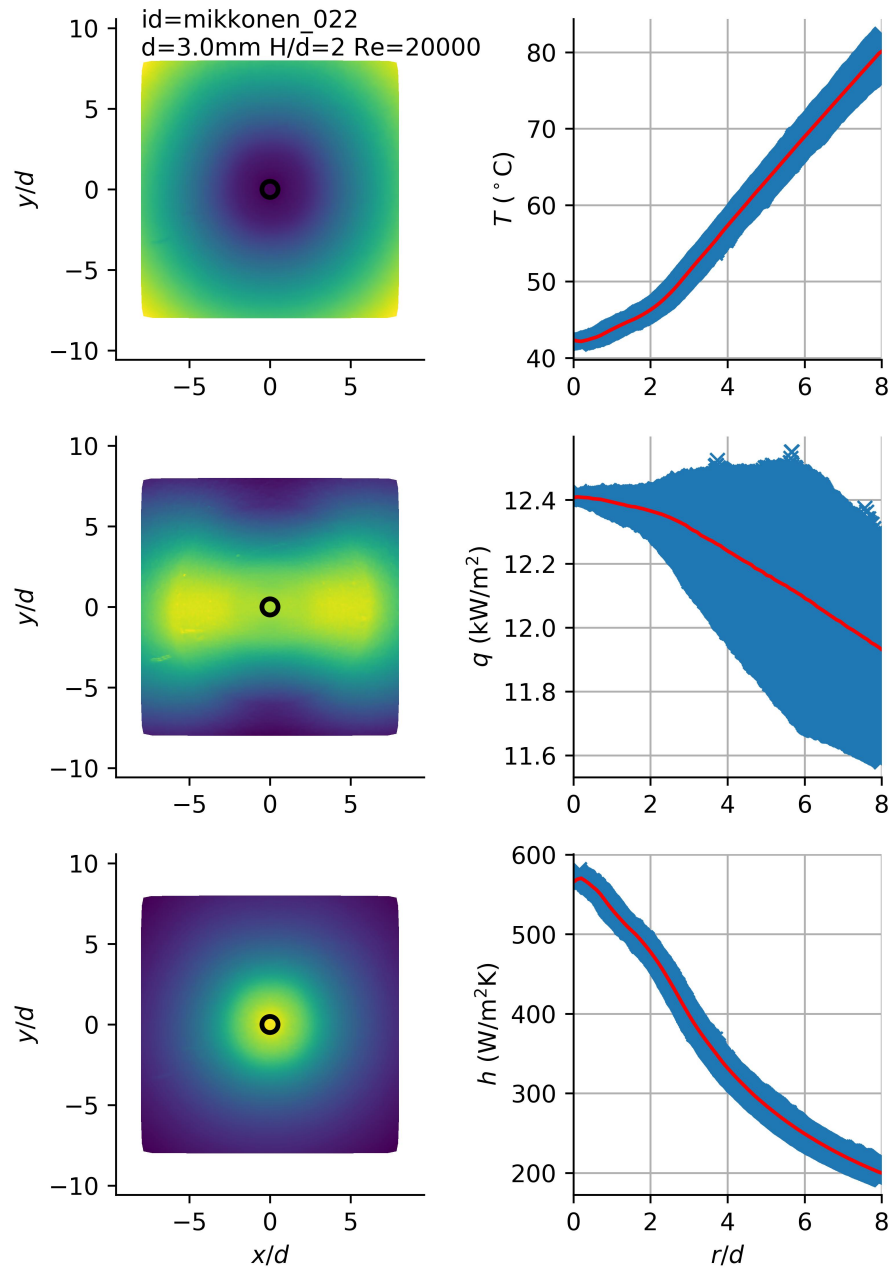


Figure 70: Results, mikkonen_022

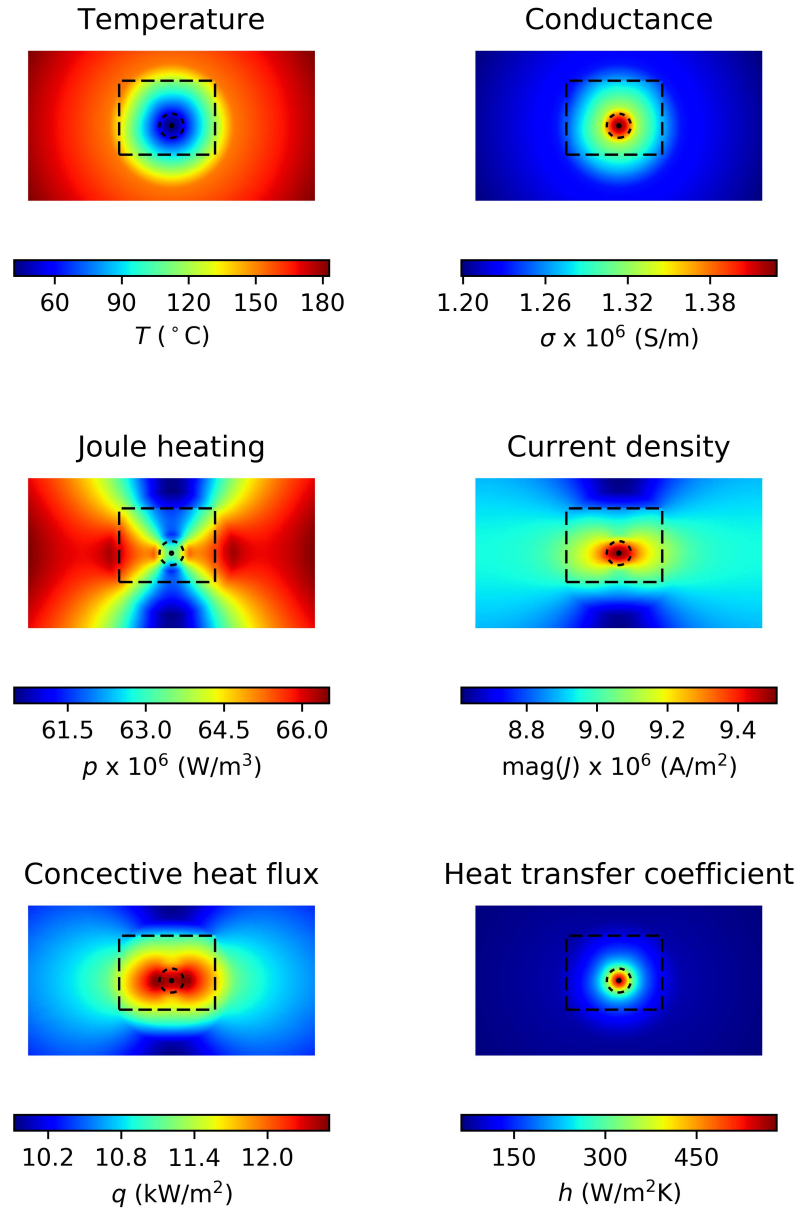


Figure 71: Convection calculation, mikkonen_022

Case id: mikkonen_023

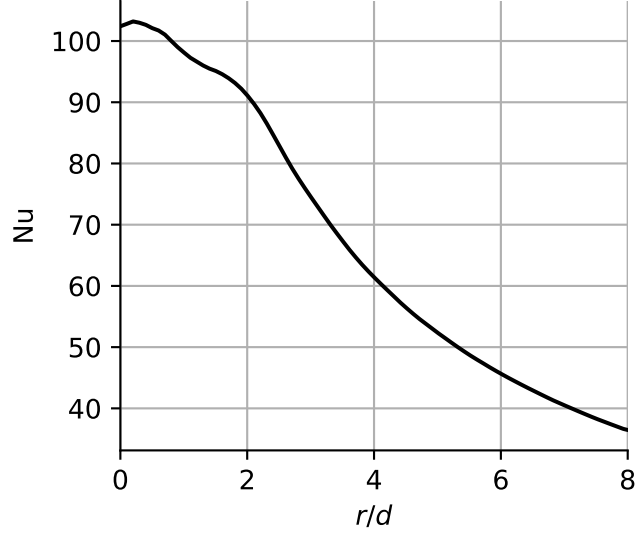


Figure 72: Nu, mikkonen_023

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_2_Lstd_75							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 15:07:25							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
35265	0.52	2	0.71	3.0	6.0	20.0	20.4	1.513	180.0
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.5	302.1	5.48				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.35	40.41	41.21	41.86	42.79	44.96	47.68	50.54	53.40
Nu	102.41	102.12	98.15	95.13	91.14	83.01	74.59	67.41	61.44
h (W/m ² K)	883.23	880.73	846.48	820.41	786.00	715.89	643.32	581.37	529.85
q (kW/m ²)	17.62	17.62	17.61	17.61	17.60	17.58	17.55	17.52	17.48
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	53.40	56.22	58.96	61.75	64.46	67.17	69.87	72.58	75.11
Nu	61.44	56.50	52.38	48.76	45.67	42.95	40.51	38.33	36.47
h (W/m ² K)	529.85	487.28	451.74	420.56	393.85	370.45	349.41	330.59	314.54
q (kW/m ²)	17.48	17.45	17.42	17.39	17.35	17.32	17.28	17.24	17.20

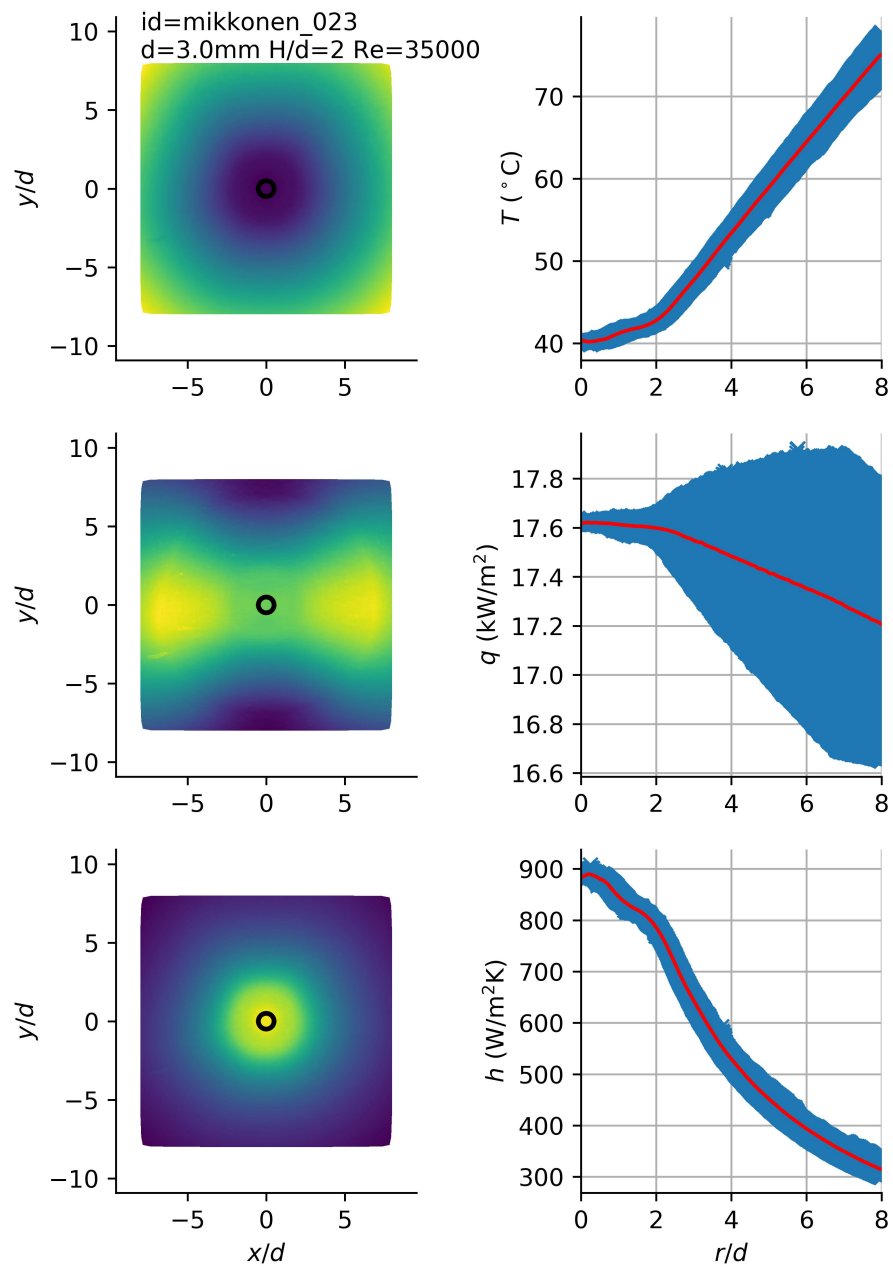


Figure 73: Results, mikkonen_023

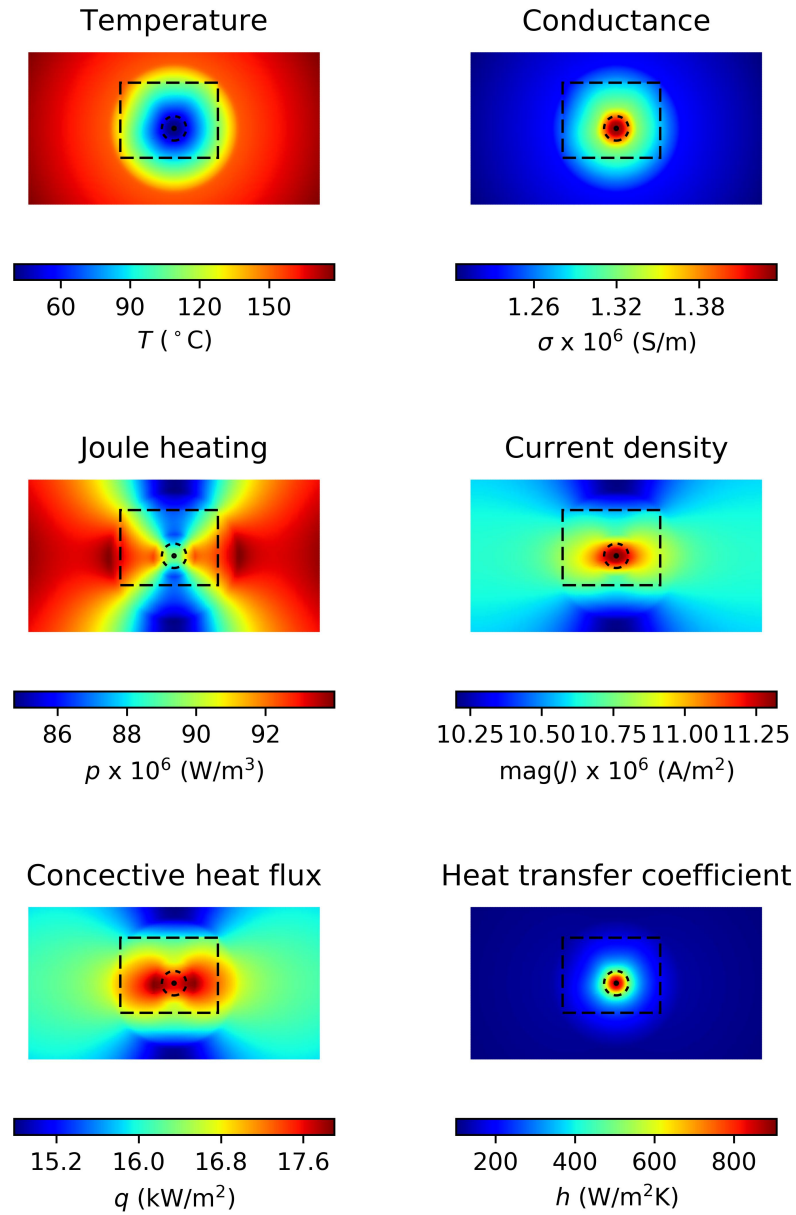


Figure 74: Convection calculation, mikkonen_023

Case id: mikkonen_024

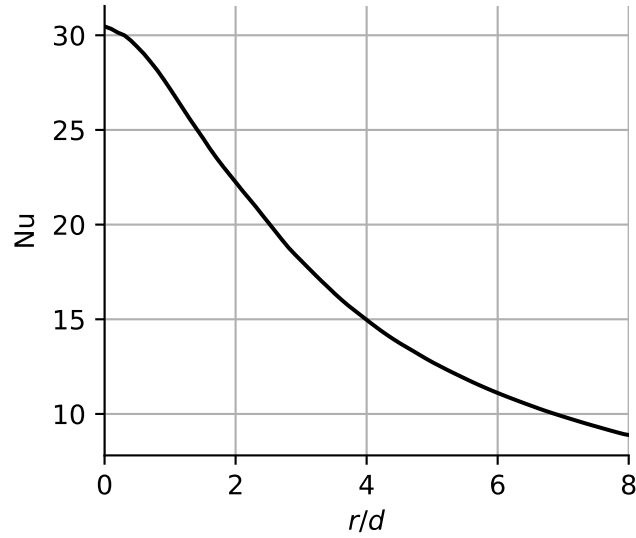


Figure 75: Nu, mikkonen_024

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_3_Lstd_12							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 15:40:32							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6141	0.09	3	0.71	3.0	9.0	21.2	20.4	0.264	31.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.4	169.8	4.39				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.43	41.14	42.76	45.00	47.43	50.13	53.19	56.33	59.44
Nu	30.47	29.38	27.17	24.58	22.24	20.11	18.10	16.40	14.97
h (W/m ² K)	263.67	254.29	235.13	212.71	192.51	174.02	156.62	141.91	129.55
q (kW/m ²)	5.28	5.27	5.26	5.23	5.20	5.17	5.13	5.10	5.06
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	59.44	62.55	65.53	68.46	71.32	74.11	76.83	79.49	82.00
Nu	14.97	13.75	12.74	11.87	11.11	10.45	9.86	9.34	8.89
h (W/m ² K)	129.55	119.01	110.26	102.76	96.14	90.42	85.34	80.85	76.94
q (kW/m ²)	5.06	5.02	4.98	4.94	4.90	4.86	4.82	4.78	4.74

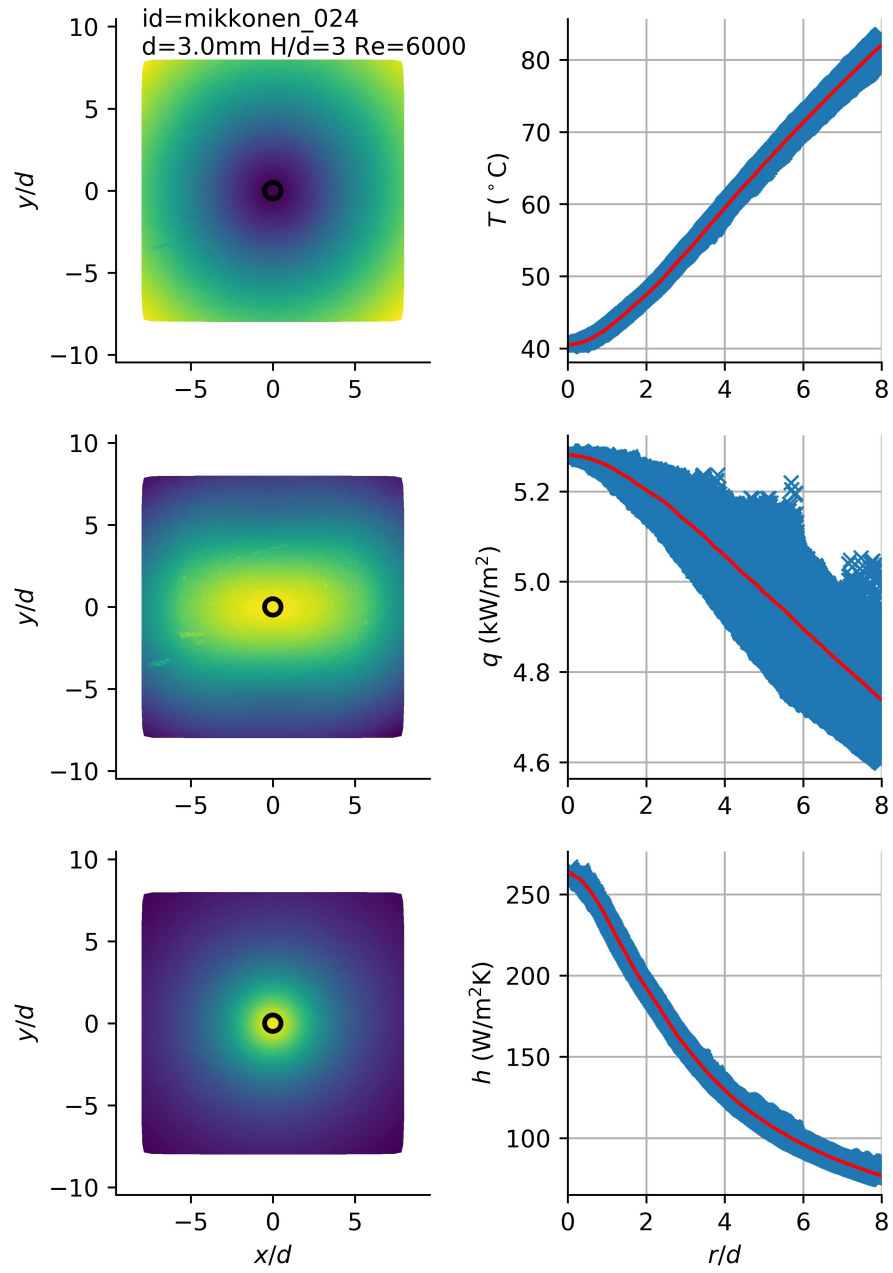


Figure 76: Results, mikkonen_024

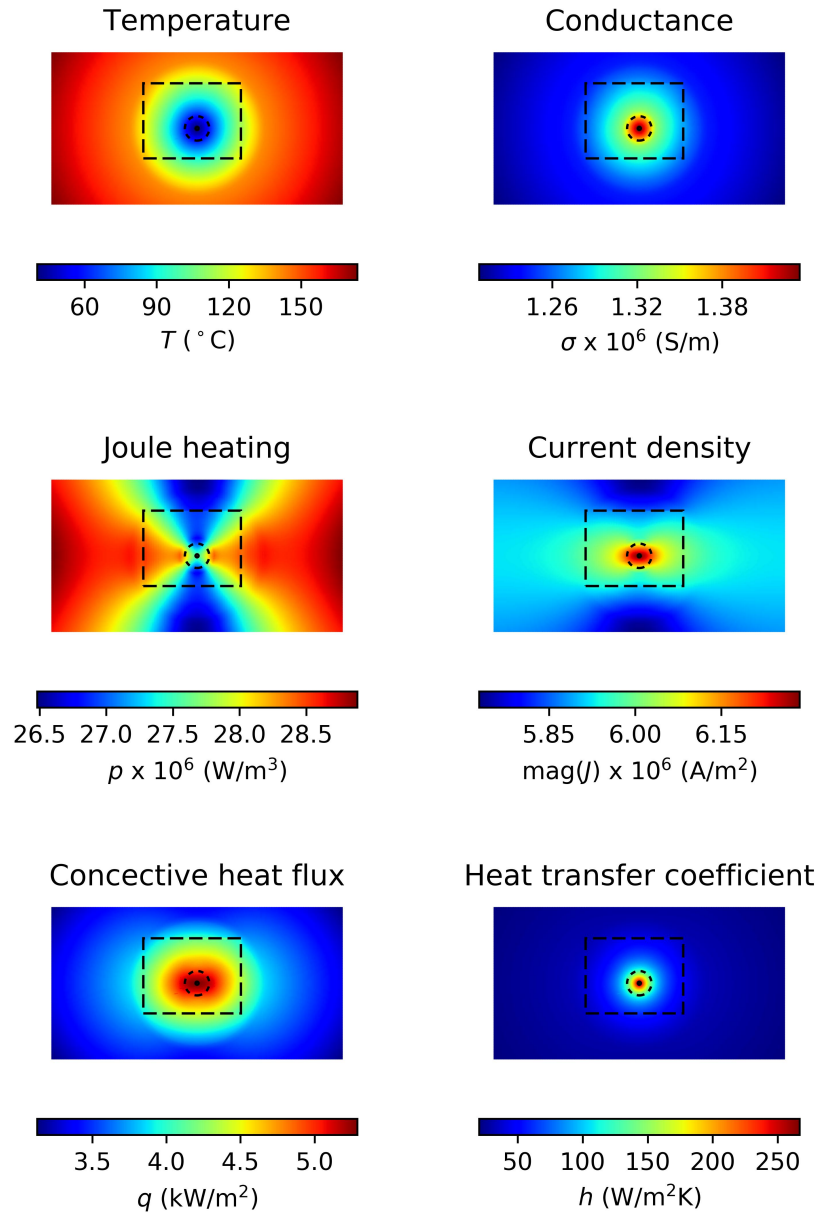


Figure 77: Convection calculation, mikkonen_024

Case id: mikkonen_025

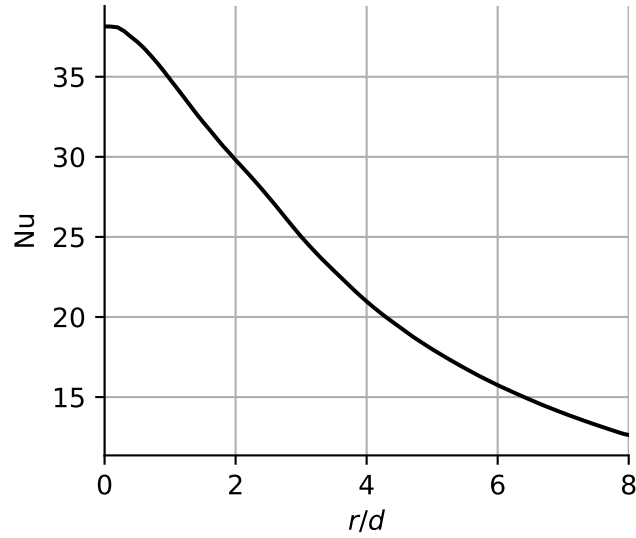


Figure 78: Nu, mikkonen_025

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_3_Lstd_21							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 15:45:45							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9900	0.15	3	0.71	3.0	9.0	21.0	20.4	0.426	50.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.6	194.0	3.62				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.19	41.70	43.09	44.88	46.75	48.86	51.54	54.28	57.18
Nu	38.14	37.18	34.84	32.19	29.80	27.51	25.02	22.89	20.97
h (W/m ² K)	329.91	321.59	301.34	278.45	257.78	237.90	216.43	197.99	181.40
q (kW/m ²)	6.86	6.85	6.84	6.81	6.79	6.77	6.74	6.71	6.67
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	57.18	59.98	62.80	65.56	68.31	70.98	73.65	76.27	78.73
Nu	20.97	19.38	17.99	16.80	15.75	14.83	14.00	13.27	12.63
h (W/m ² K)	181.40	167.66	155.62	145.33	136.20	128.26	121.11	114.77	109.28
q (kW/m ²)	6.67	6.63	6.60	6.56	6.52	6.49	6.45	6.41	6.37

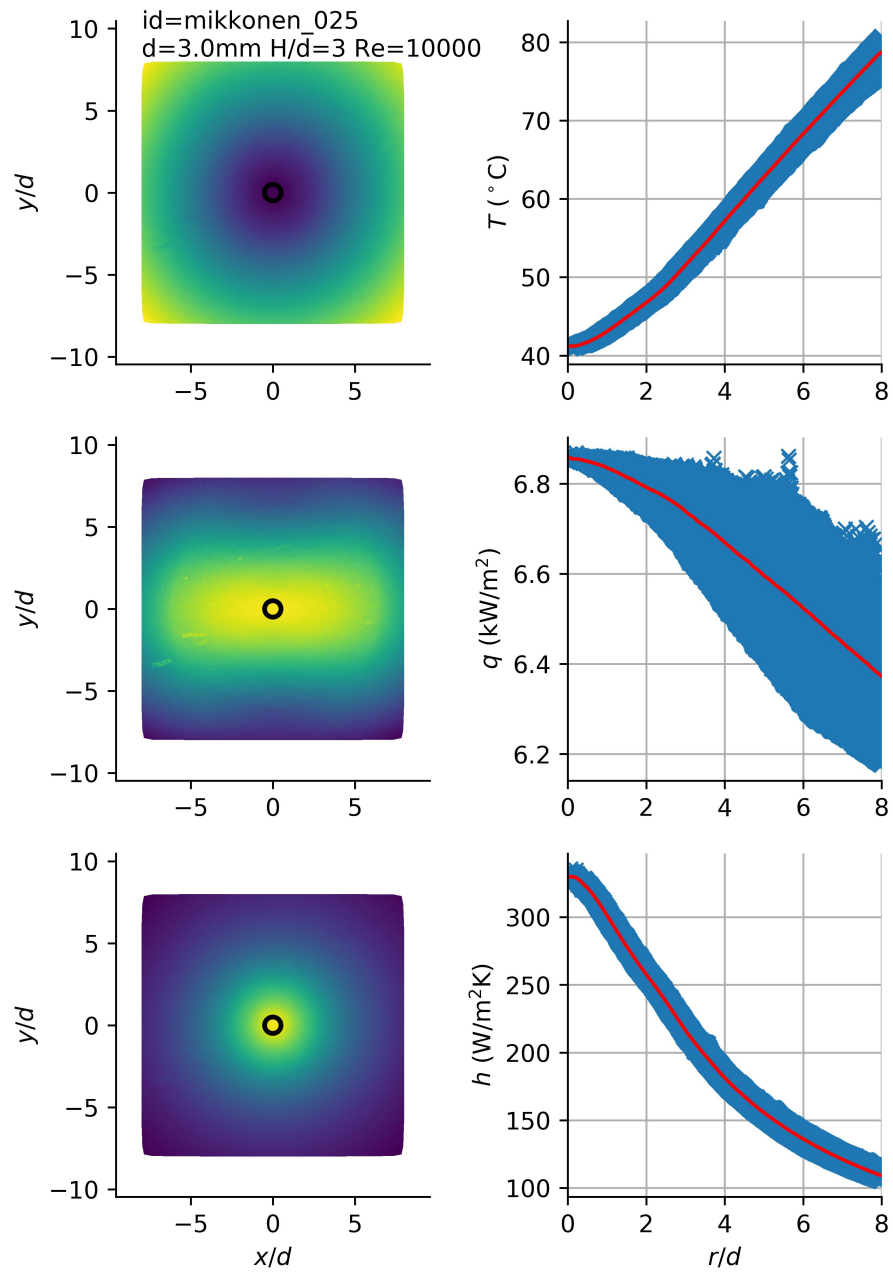


Figure 79: Results, mikkonen_025

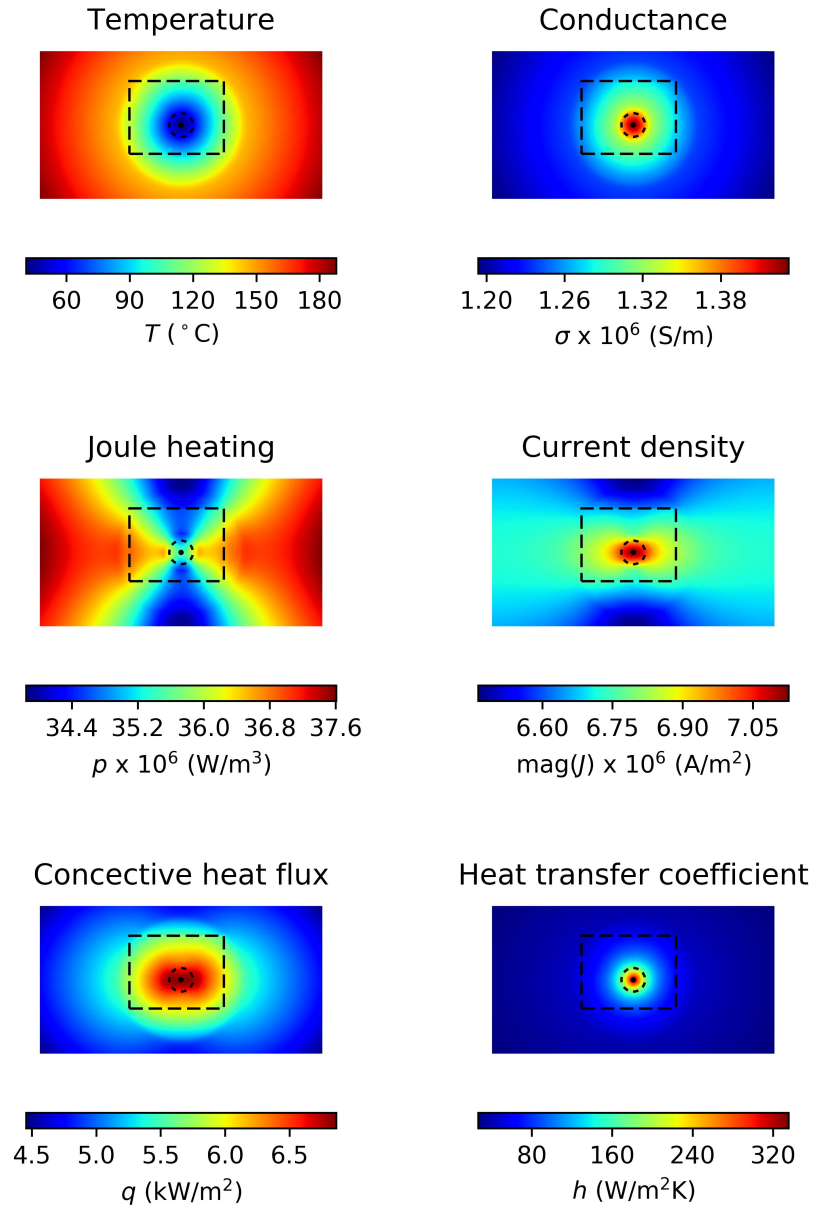


Figure 80: Convection calculation, mikkonen_025

Case id: mikkonen_026

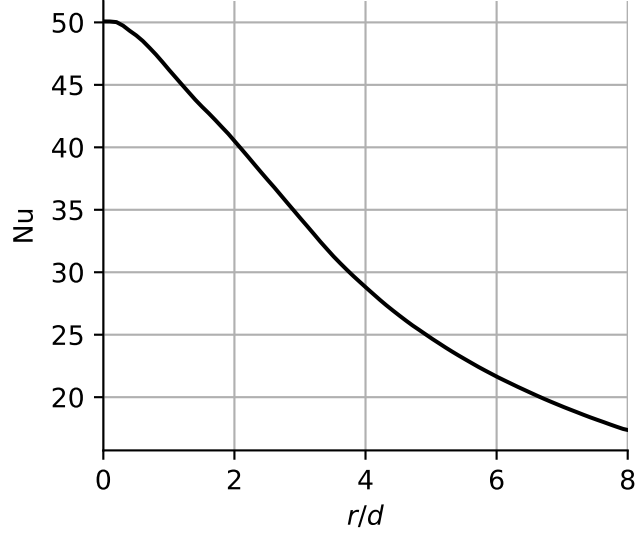


Figure 81: Nu, mikkonen_026

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_3_Lstd_30							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 15:50:57							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13909	0.21	3	0.71	3.0	9.0	20.9	20.4	0.598	71.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.7	214.8	4.32			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.19	40.62	41.79	43.20	44.71	46.64	48.91	51.54	54.14
Nu	50.08	48.97	46.22	43.28	40.51	37.43	34.36	31.34	28.81
h (W/m ² K)	433.01	423.40	399.63	374.26	350.30	323.70	297.09	271.00	249.14
q (kW/m ²)	8.57	8.56	8.55	8.53	8.51	8.49	8.47	8.44	8.40
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	54.14	56.80	59.39	62.00	64.59	67.12	69.66	72.16	74.54
Nu	28.81	26.60	24.73	23.09	21.65	20.40	19.26	18.25	17.37
h (W/m ² K)	249.14	230.00	213.85	199.68	187.21	176.38	166.56	157.82	150.24
q (kW/m ²)	8.40	8.37	8.34	8.30	8.27	8.24	8.20	8.17	8.13

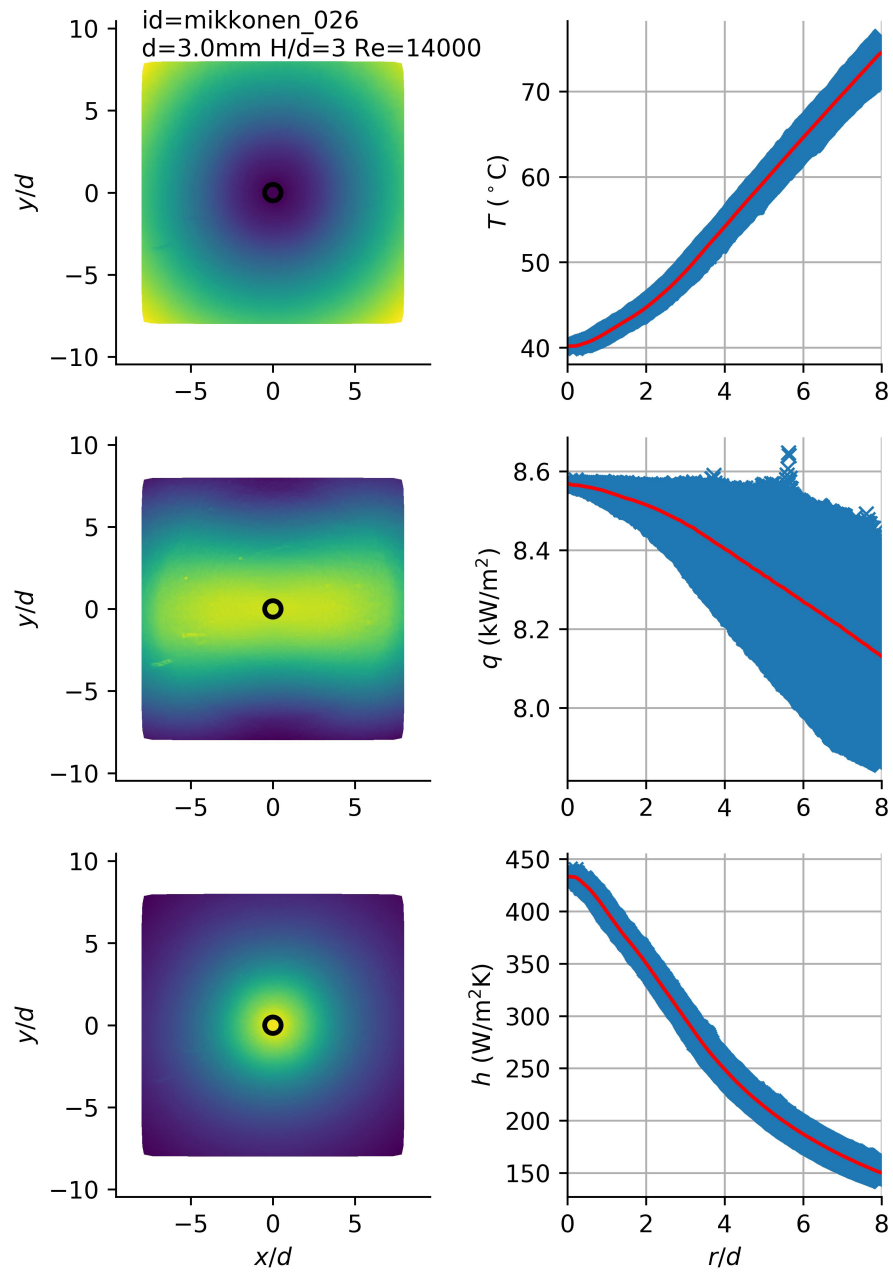


Figure 82: Results, mikkonen_026

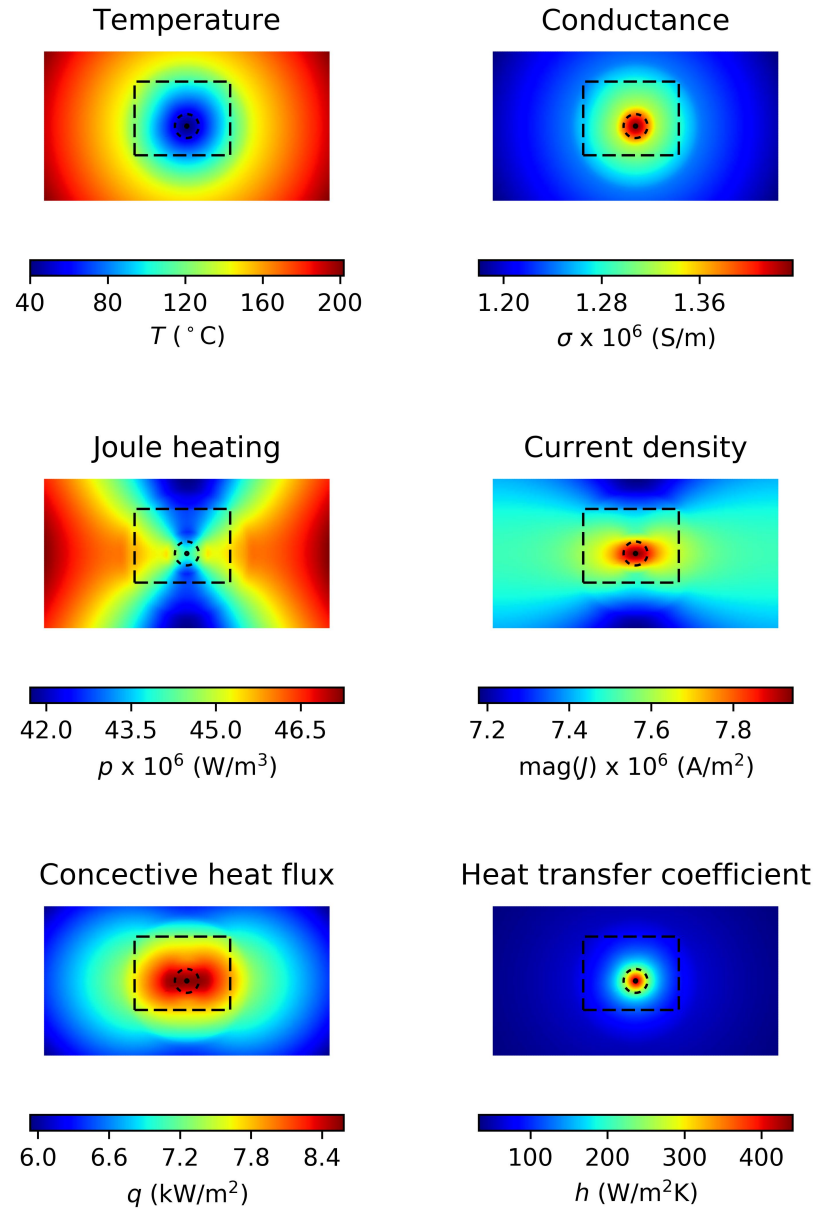


Figure 83: Convection calculation, mikkonen_026

Case id: mikkonen_027

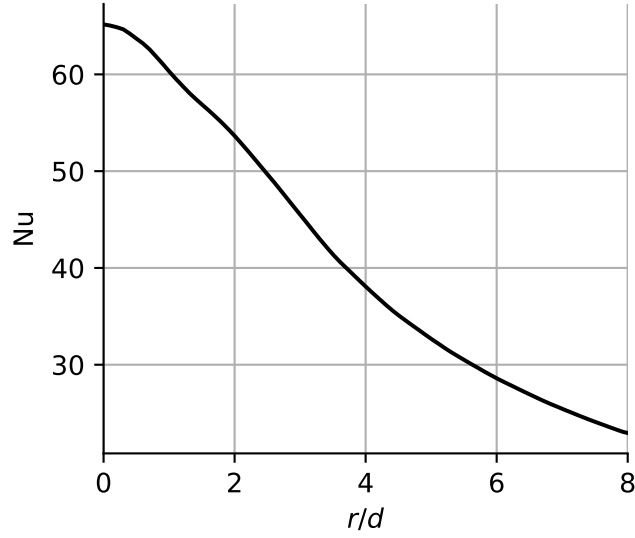


Figure 84: Nu, mikkonen_027

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_3_Lstd_43							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 15:56:27							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20082	0.30	3	0.71	3.0	9.0	20.6	20.4	0.863	102.9
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.0	247.3	4.04				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.69	41.15	42.29	43.57	44.94	46.86	49.22	51.98	54.64
Nu	65.16	63.70	60.31	56.90	53.65	49.68	45.51	41.41	38.09
h (W/m ² K)	562.95	550.34	521.07	491.55	463.51	429.21	393.17	357.74	329.04
q (kW/m ²)	11.42	11.42	11.41	11.39	11.38	11.36	11.33	11.30	11.26
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	54.64	57.41	60.06	62.75	65.44	68.06	70.70	73.33	75.80
Nu	38.09	35.12	32.68	30.51	28.60	26.95	25.45	24.10	22.95
h (W/m ² K)	329.04	303.43	282.33	263.60	247.11	232.81	219.84	208.25	198.27
q (kW/m ²)	11.26	11.23	11.19	11.16	11.13	11.10	11.06	11.02	10.98

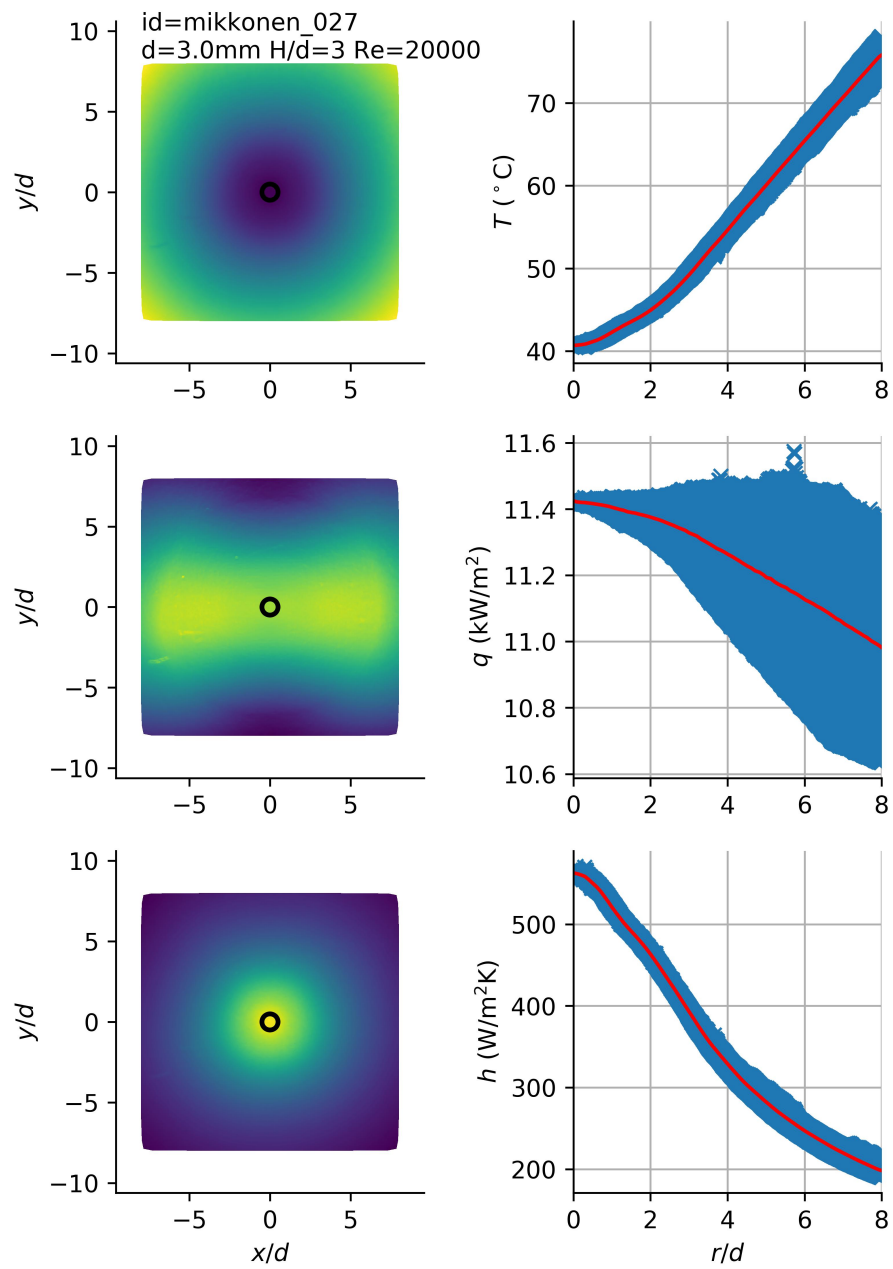


Figure 85: Results, mikkonen_027

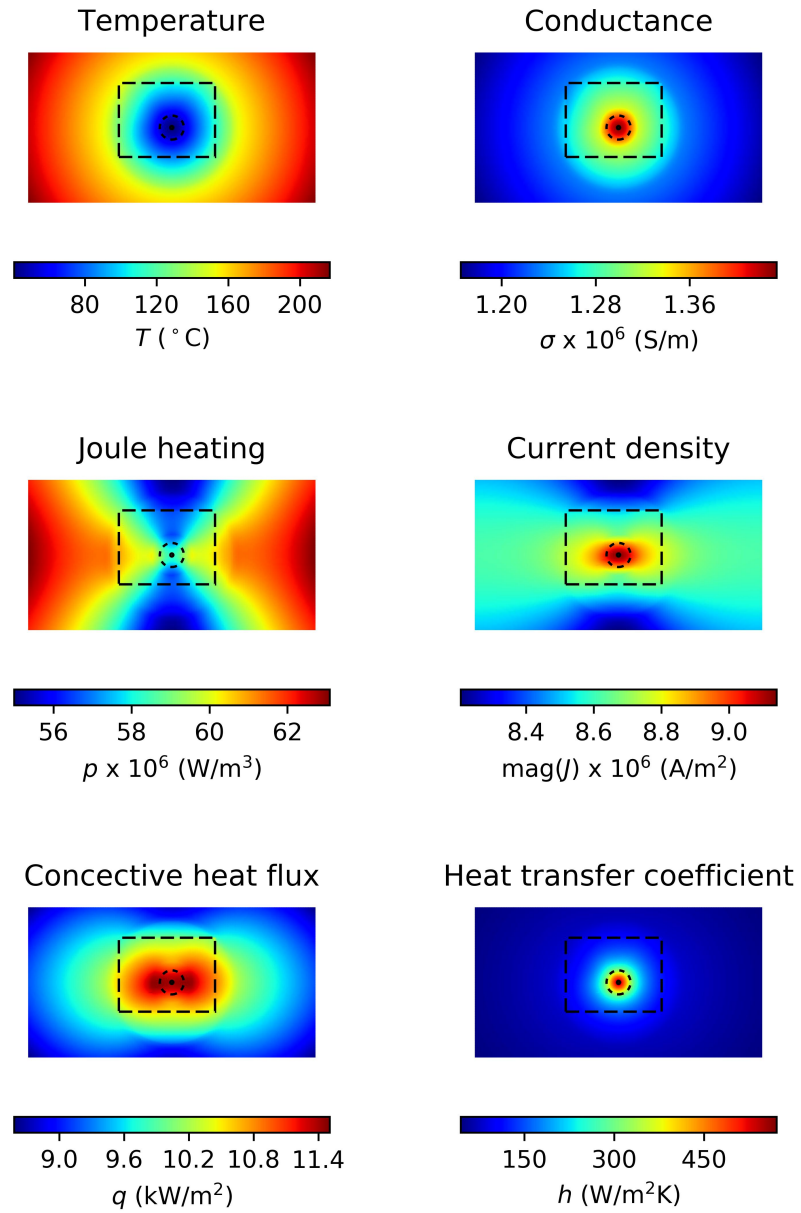


Figure 86: Convection calculation, mikkonen_027

Case id: mikkonen_028

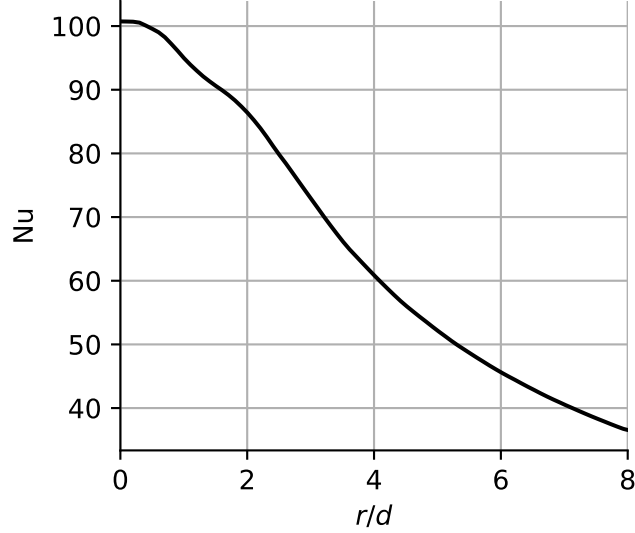


Figure 87: Nu, mikkonen_028

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_3_Lstd_75							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 16:02:04							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
34973	0.52	3	0.71	3.0	9.0	20.2	20.4	1.501	178.7
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.5	304.2	5.99				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.19	41.42	42.43	43.47	44.58	46.54	48.97	51.80	54.52
Nu	100.73	99.58	95.00	90.64	86.43	79.87	72.98	66.28	60.88
h (W/m ² K)	869.23	859.35	819.81	782.17	745.81	689.28	629.76	571.94	525.38
q (kW/m ²)	18.07	18.07	18.06	18.04	18.04	18.02	17.99	17.96	17.92
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	54.52	57.35	60.06	62.83	65.59	68.31	71.03	73.76	76.33
Nu	60.88	56.12	52.18	48.70	45.63	42.97	40.56	38.41	36.56
h (W/m ² K)	525.38	484.27	450.30	420.24	393.78	370.80	350.02	331.50	315.51
q (kW/m ²)	17.92	17.89	17.86	17.83	17.79	17.76	17.72	17.68	17.64

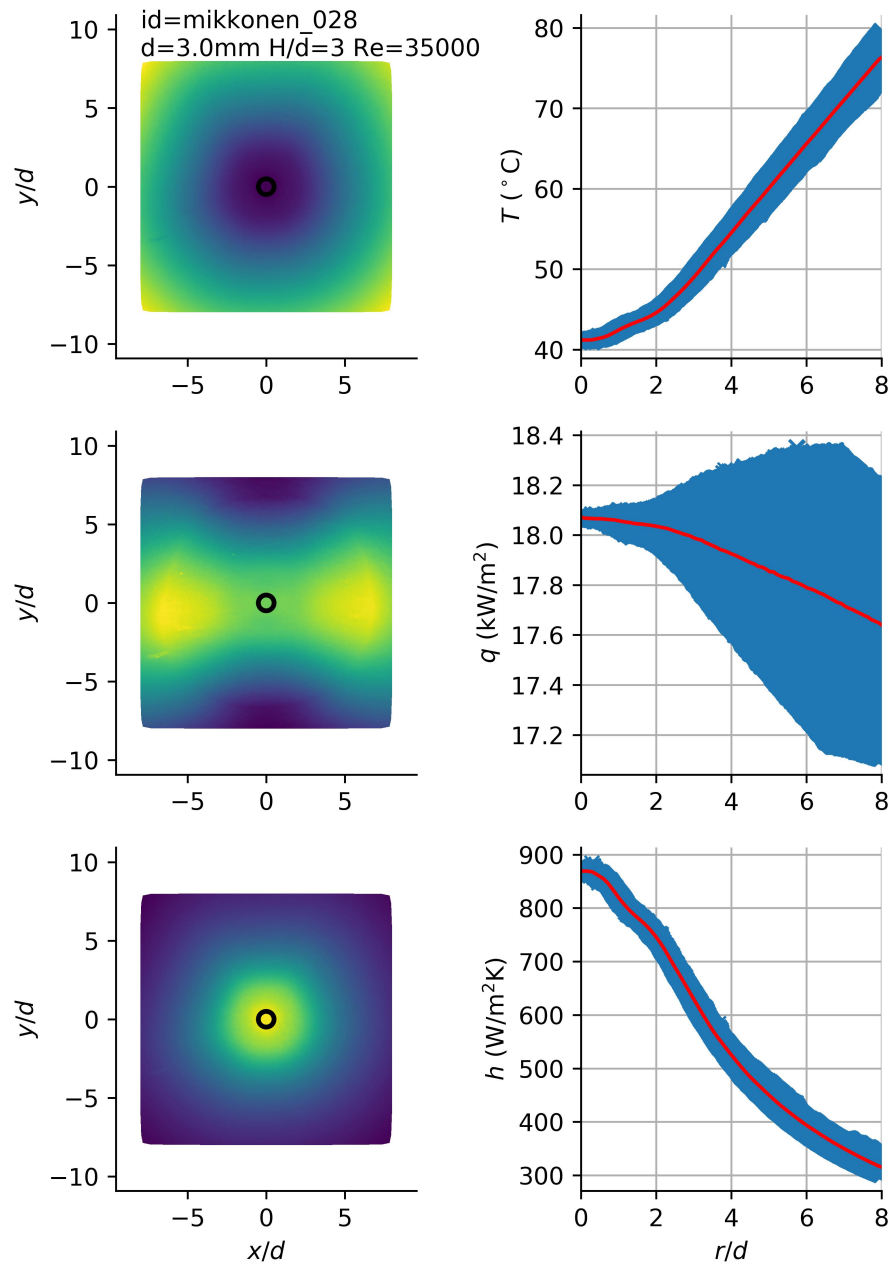


Figure 88: Results, mikkonen_028

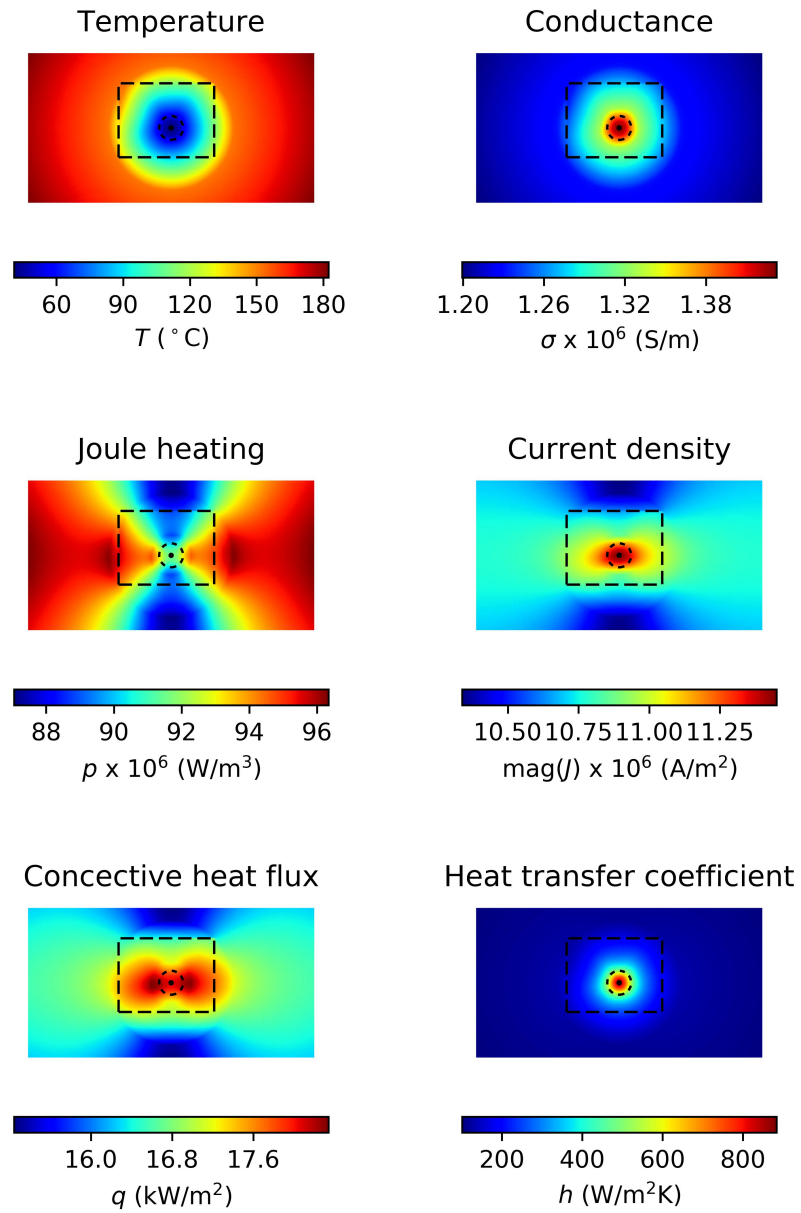


Figure 89: Convection calculation, mikkonen_028

Case id: mikkonen_029

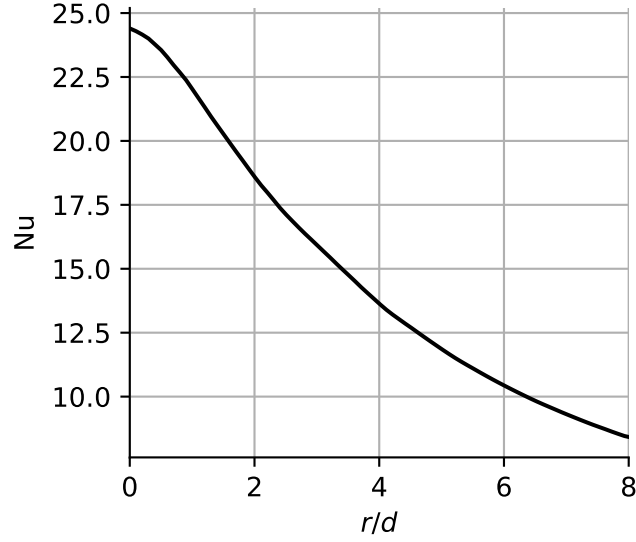


Figure 90: Nu, mikkonen_029

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_6_Lstd_12							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 16:31:05							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
5996	0.09	6	0.71	3.0	18.0	21.4	21.4	0.258	30.9
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.1	146.8	3.36				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	39.15	39.75	40.95	42.54	44.31	46.12	47.84	49.75	51.88
Nu	24.40	23.56	22.04	20.28	18.60	17.14	15.93	14.77	13.64
h (W/m ² K)	211.28	204.02	190.83	175.60	161.09	148.40	137.96	127.90	118.10
q (kW/m ²)	3.75	3.74	3.73	3.71	3.69	3.67	3.65	3.63	3.60
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	51.88	53.87	55.95	58.02	60.07	62.11	64.10	66.06	67.91
Nu	13.64	12.71	11.86	11.11	10.44	9.84	9.31	8.84	8.42
h (W/m ² K)	118.10	110.10	102.70	96.18	90.39	85.20	80.65	76.51	72.93
q (kW/m ²)	3.60	3.57	3.55	3.52	3.50	3.47	3.44	3.42	3.39

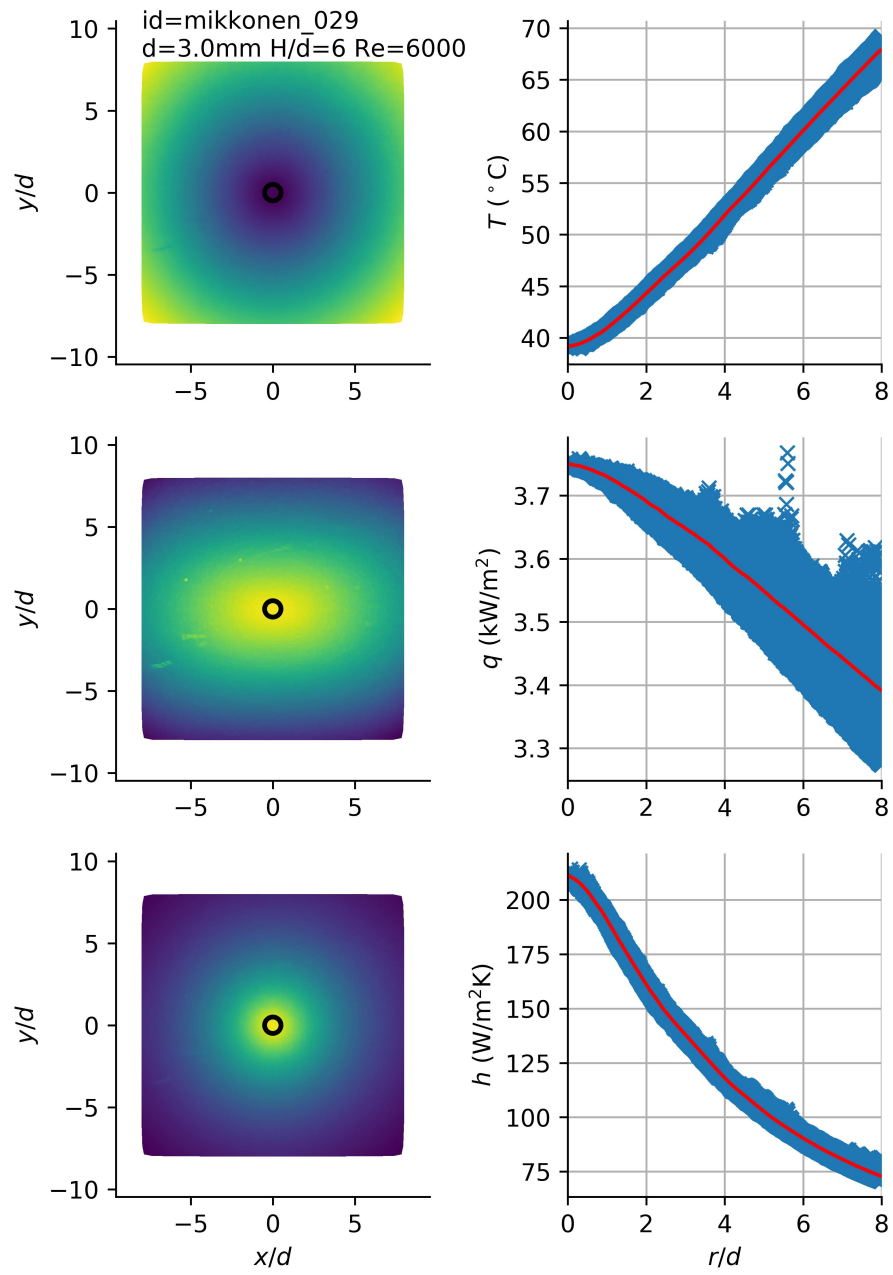


Figure 91: Results, mikkonen_029

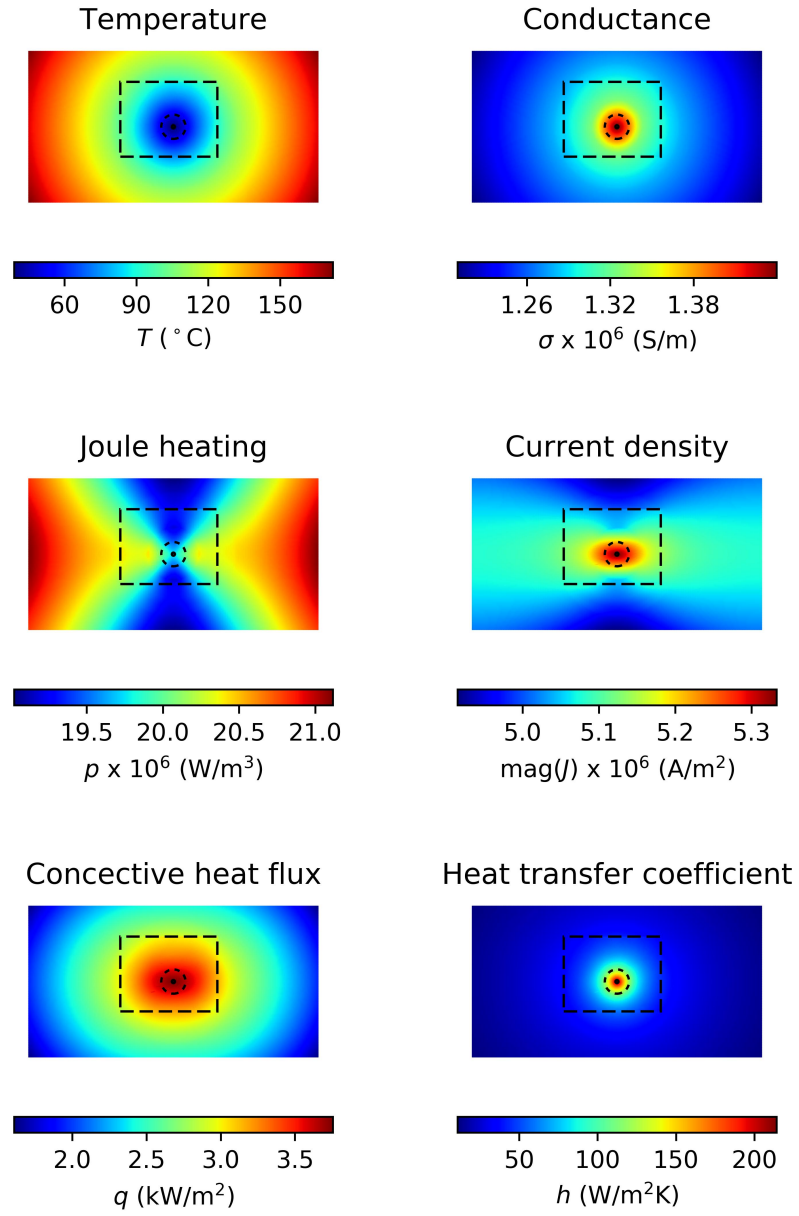


Figure 92: Convection calculation, mikkonen_029

Case id: mikkonen_030

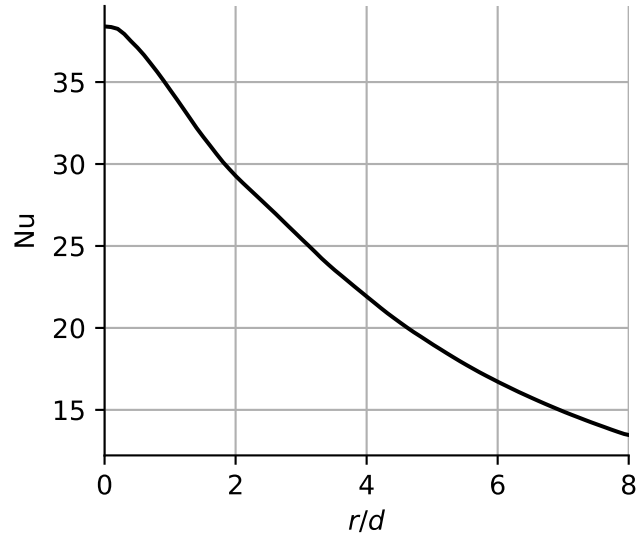


Figure 93: Nu, mikkonen_030

path	2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_6_Lstd_21
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-02-21 16:26:21

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9953	0.15	6	0.71	3.0	18.0	21.1	21.4	0.428	51.2

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.5	187.7	4.17	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.79	41.43	42.88	44.72	46.55	48.21	50.14	52.30	54.49
Nu	38.39	37.11	34.53	31.69	29.28	27.38	25.45	23.57	21.92
h (W/m ² K)	332.18	321.04	298.72	274.18	253.33	236.90	220.21	203.94	189.65
q (kW/m ²)	6.44	6.43	6.41	6.39	6.37	6.35	6.33	6.30	6.27

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	54.49	56.86	59.18	61.58	63.94	66.28	68.64	70.94	73.11
Nu	21.92	20.36	19.01	17.79	16.72	15.77	14.91	14.14	13.47
h (W/m ² K)	189.65	176.15	164.51	153.95	144.66	136.41	128.96	122.31	116.53
q (kW/m ²)	6.27	6.24	6.21	6.18	6.15	6.12	6.09	6.06	6.03

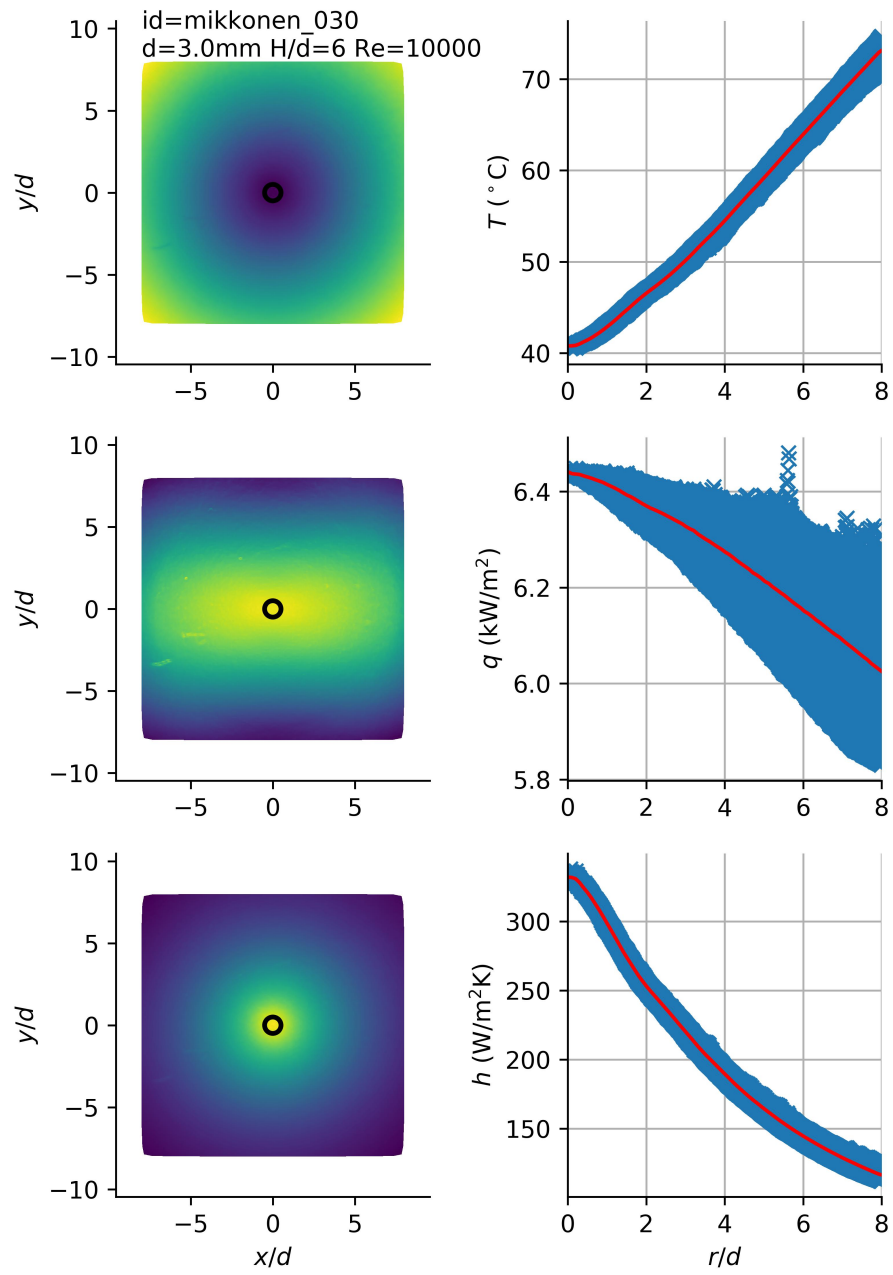


Figure 94: Results, mikkonen_030

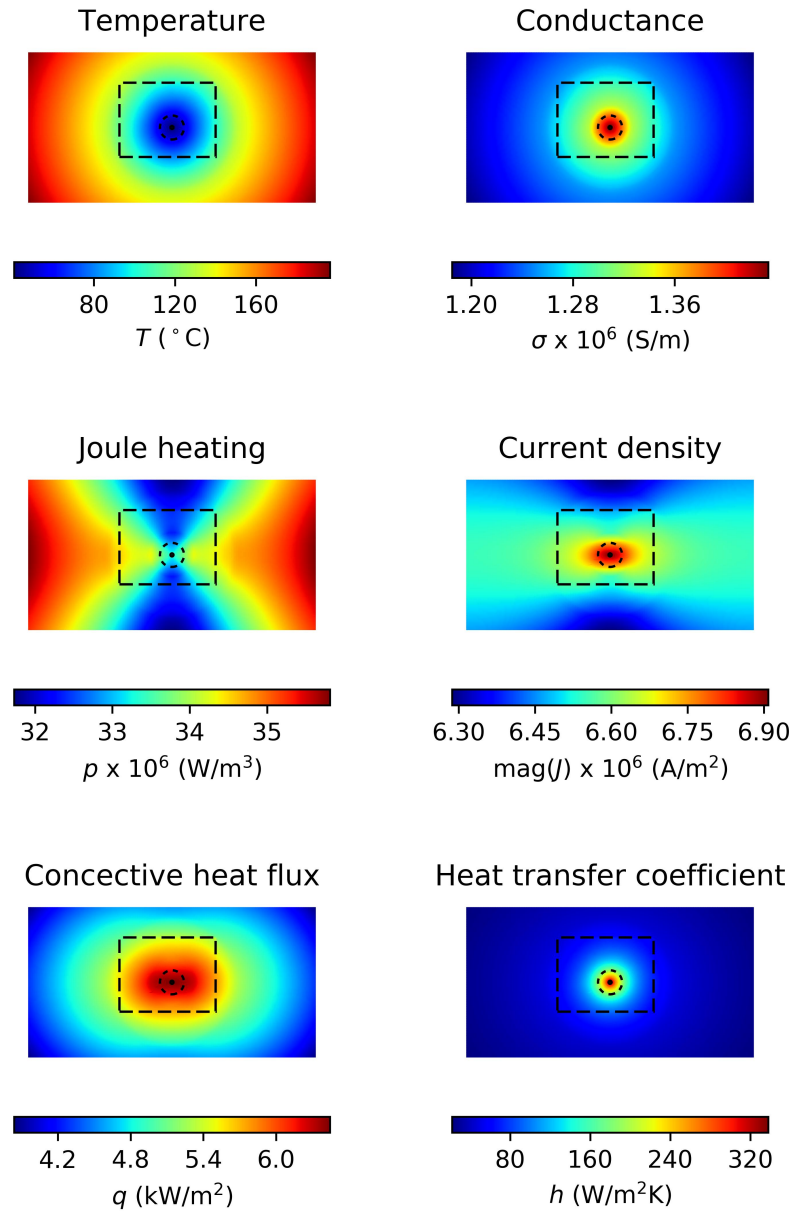


Figure 95: Convection calculation, mikkonen_030

Case id: mikkonen_031

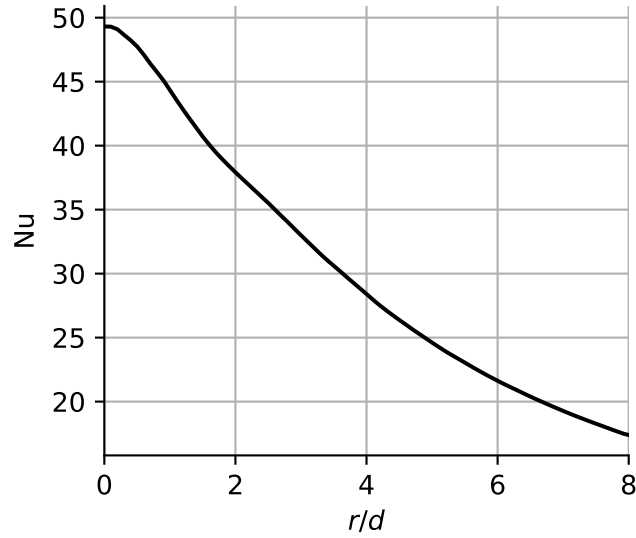


Figure 96: Nu, mikkonen_031

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_6_Lstd_30							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 16:21:37							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14036	0.21	6	0.71	3.0	18.0	20.8	21.4	0.603	72.0
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.7	214.7	3.81			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.30	41.94	43.47	45.37	47.08	48.75	50.76	52.94	55.28
Nu	49.32	47.75	44.35	40.72	37.92	35.52	33.00	30.61	28.41
h (W/m ² K)	426.30	412.77	383.35	351.99	327.78	307.09	285.26	264.63	245.55
q (kW/m ²)	8.48	8.48	8.46	8.44	8.42	8.40	8.37	8.35	8.32
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	55.28	57.74	60.21	62.69	65.22	67.69	70.18	72.62	74.97
Nu	28.41	26.38	24.61	23.05	21.63	20.39	19.27	18.27	17.39
h (W/m ² K)	245.55	228.05	212.75	199.22	186.94	176.28	166.59	157.97	150.35
q (kW/m ²)	8.32	8.29	8.25	8.22	8.19	8.16	8.12	8.09	8.05

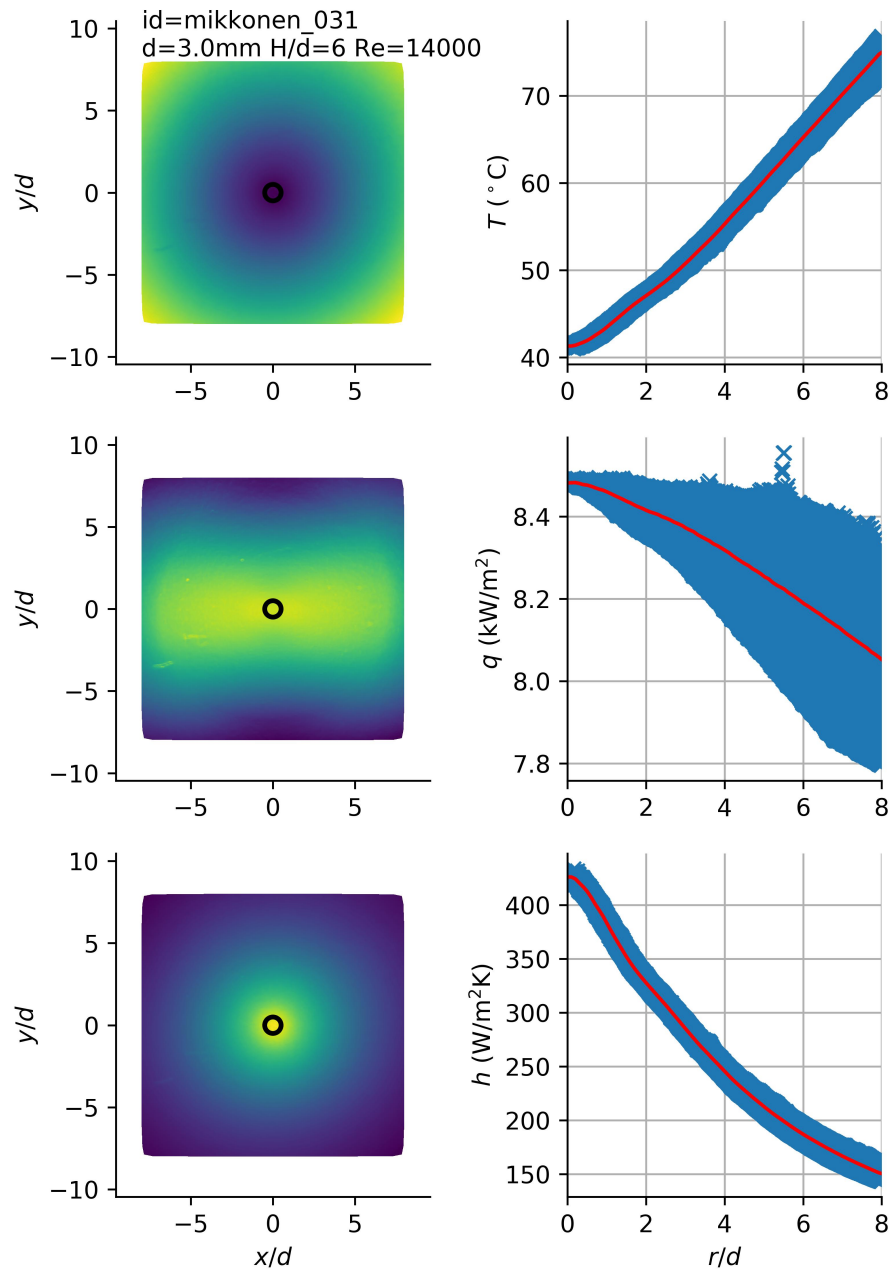


Figure 97: Results, mikkonen_031

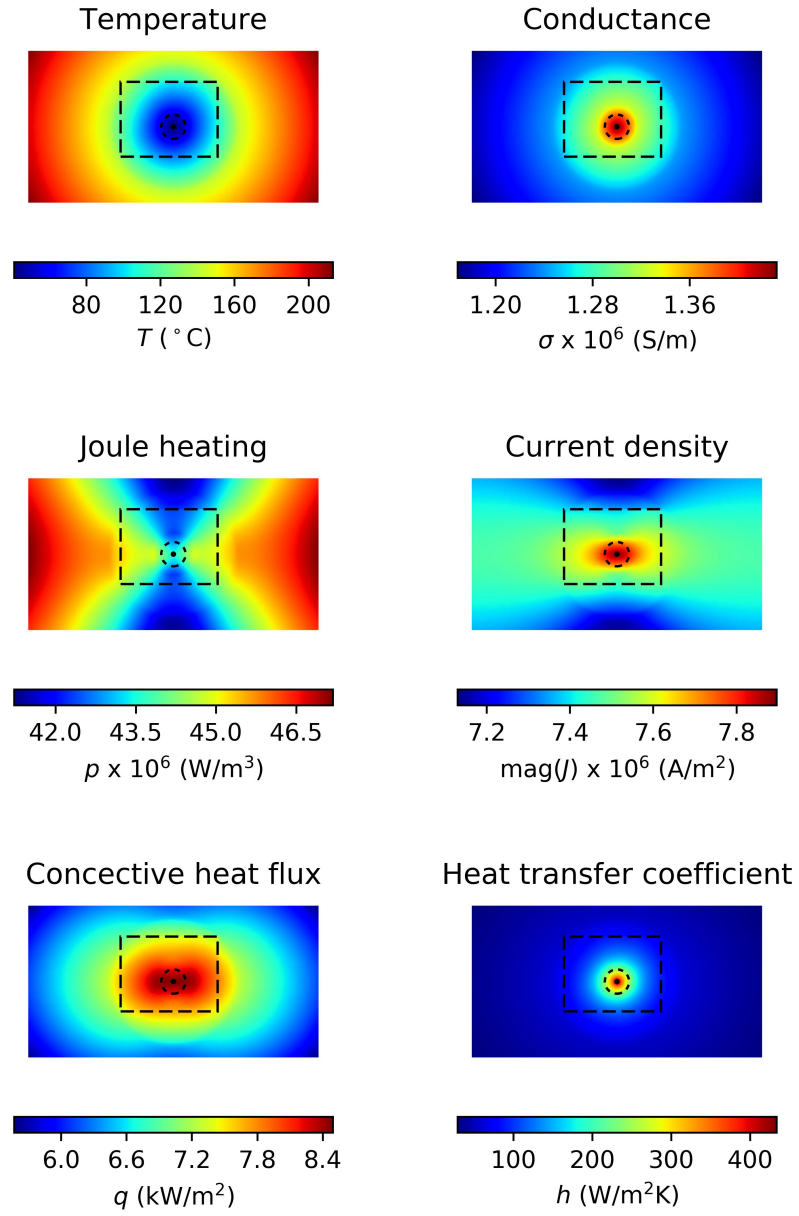


Figure 98: Convection calculation, mikkonen_031

Case id: mikkonen_032

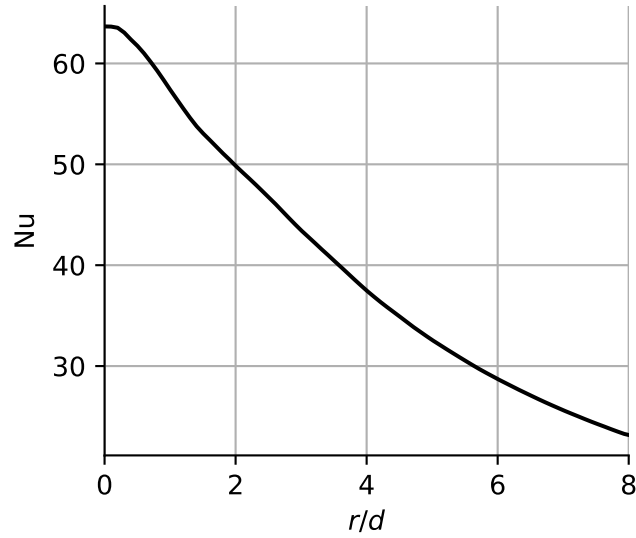


Figure 99: Nu, mikkonen_032

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_6_Lstd_43							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 16:15:55							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20086	0.30	6	0.71	3.0	18.0	20.4	20.4	0.863	102.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.0	253.5	4.09				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	42.28	42.94	44.61	46.52	48.17	49.96	52.14	54.42	57.02
Nu	63.67	61.75	57.41	53.09	49.86	46.76	43.46	40.46	37.49
h (W/m ² K)	549.75	533.21	495.68	458.44	430.51	403.74	375.28	349.38	323.70
q (kW/m ²)	12.03	12.02	12.00	11.98	11.96	11.94	11.91	11.88	11.85
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	57.02	59.59	62.28	64.96	67.65	70.32	73.02	75.69	78.22
Nu	37.49	34.93	32.59	30.55	28.72	27.10	25.63	24.31	23.17
h (W/m ² K)	323.70	301.60	281.37	263.81	247.96	233.98	221.27	209.93	200.06
q (kW/m ²)	11.85	11.82	11.78	11.75	11.71	11.68	11.64	11.60	11.56

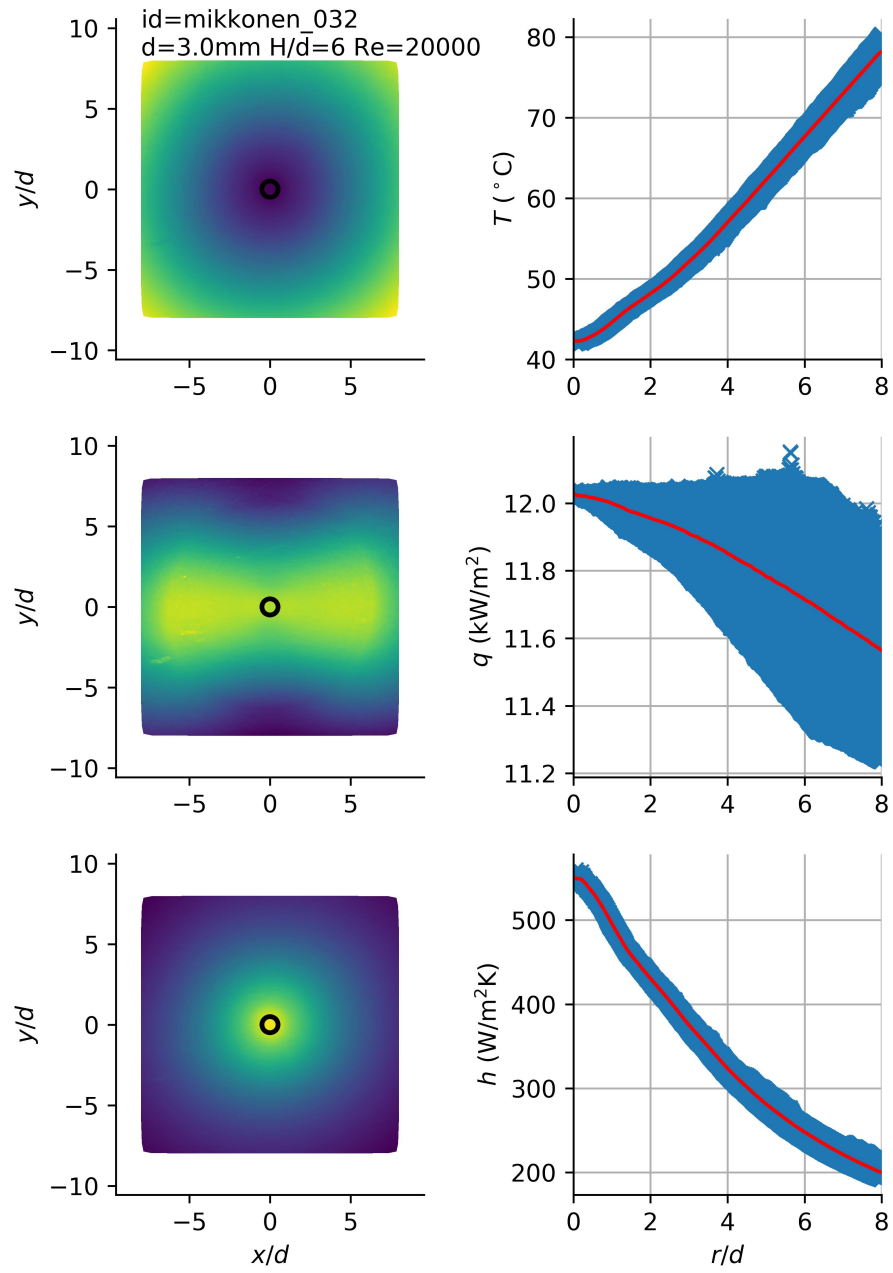


Figure 100: Results, mikkonen_032

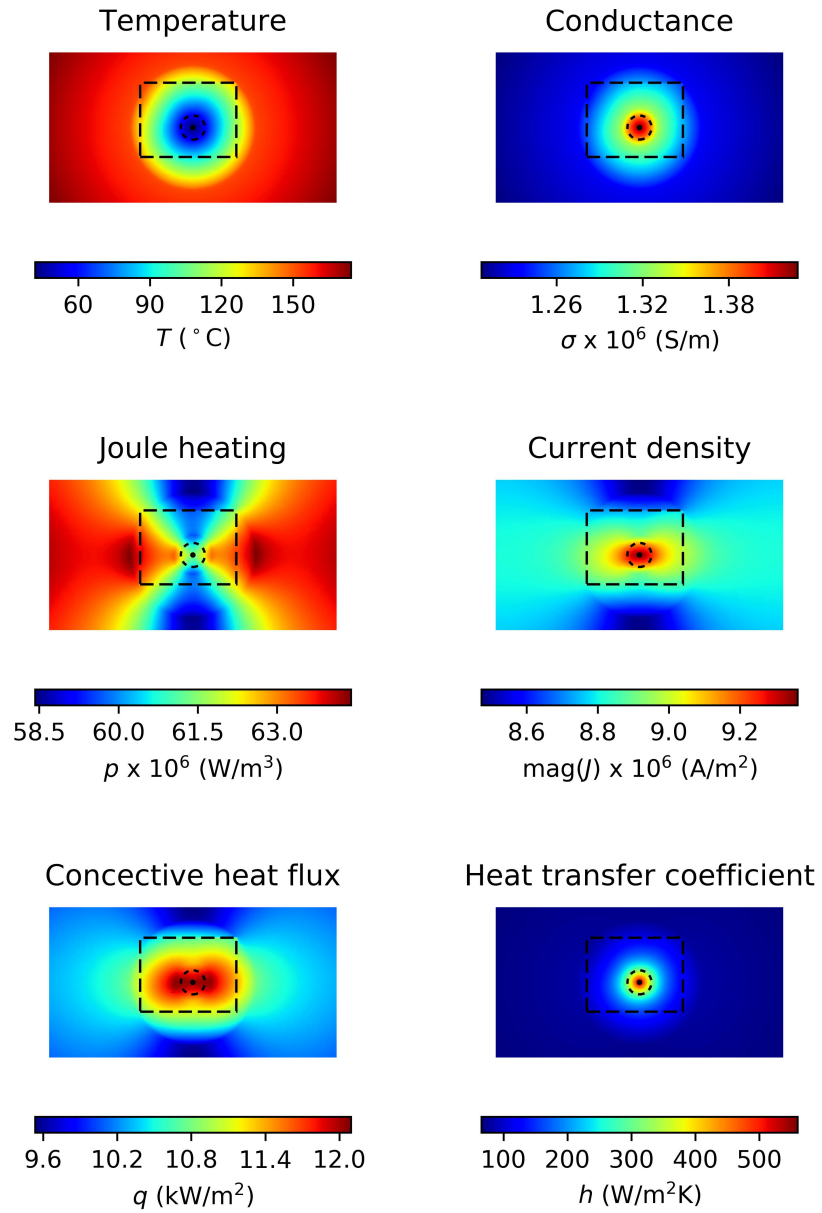


Figure 101: Convection calculation, mikkonen_032

Case id: mikkonen_033

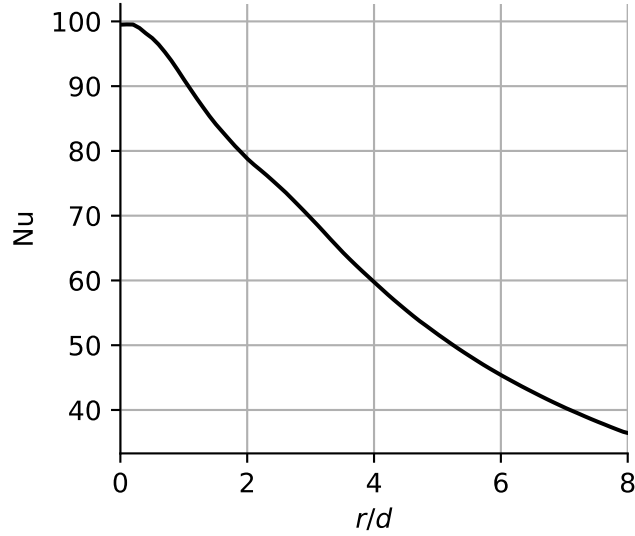


Figure 102: Nu, mikkonen_033

path		2017_02_21_hidasSarja_3mm_HD1,2,3,6/3mm_Hd_6_Lstd_75							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-21 16:10:50							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
34973	0.52	6	0.71	3.0	18.0	20.2	20.4	1.501	178.7
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.4	299.2	6.02				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.76	41.17	42.61	44.40	46.00	47.45	49.31	51.62	54.00
Nu	99.49	97.44	91.06	84.19	78.83	74.54	69.66	64.43	59.76
h (W/m ² K)	858.57	840.84	785.83	726.53	680.22	643.27	601.14	555.97	515.70
q (kW/m ²)	17.48	17.47	17.45	17.43	17.41	17.40	17.38	17.35	17.32
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	54.00	56.54	59.08	61.69	64.30	66.90	69.55	72.16	74.64
Nu	59.76	55.47	51.72	48.38	45.40	42.79	40.40	38.29	36.45
h (W/m ² K)	515.70	478.64	446.32	417.47	391.80	369.23	348.66	330.43	314.54
q (kW/m ²)	17.32	17.29	17.26	17.23	17.19	17.16	17.12	17.09	17.05

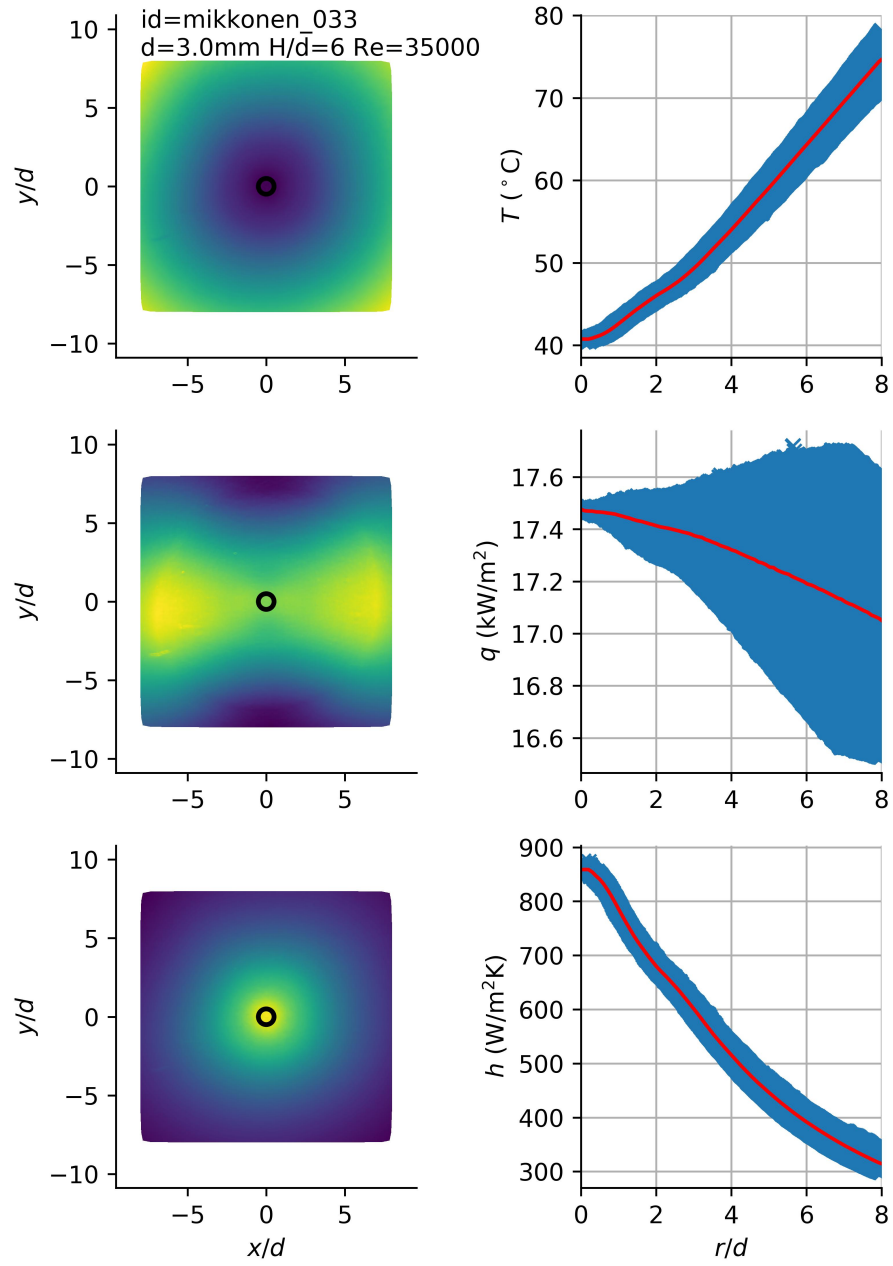


Figure 103: Results, mikkonen_033

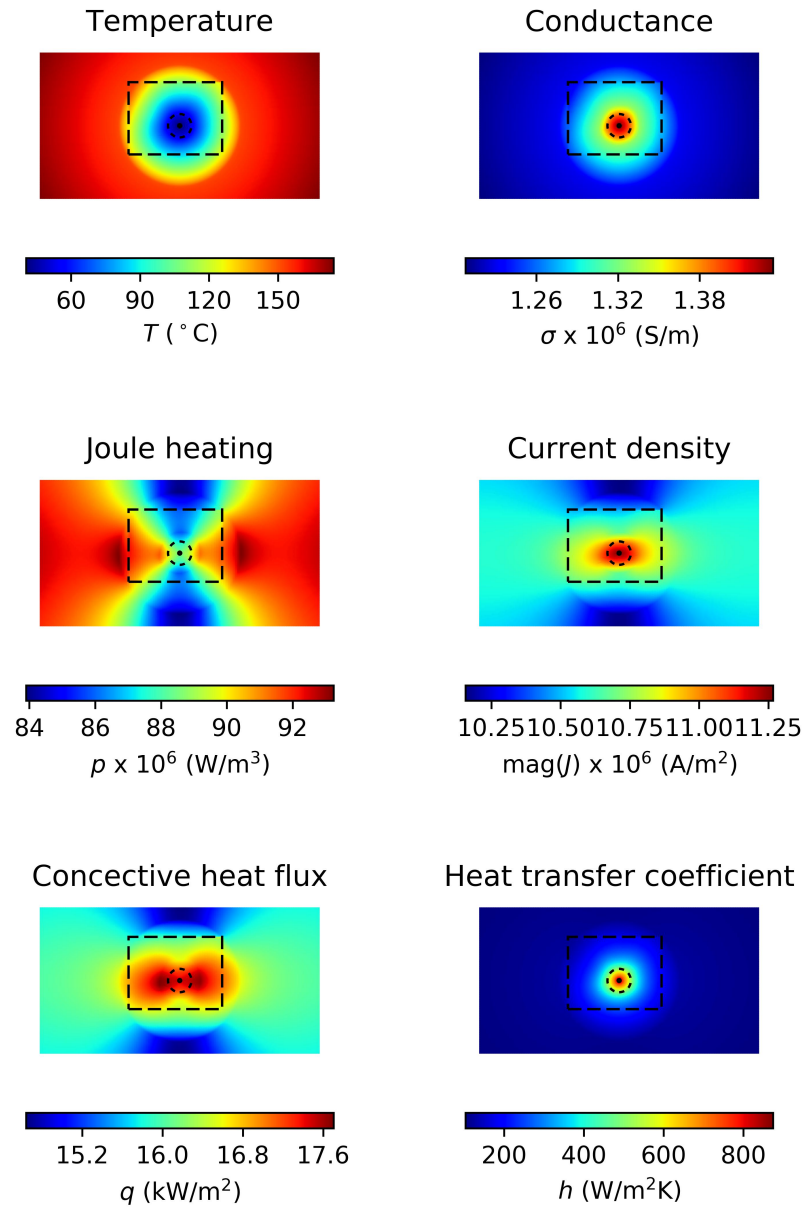


Figure 104: Convection calculation, mikkonen_033

Case id: mikkonen_034

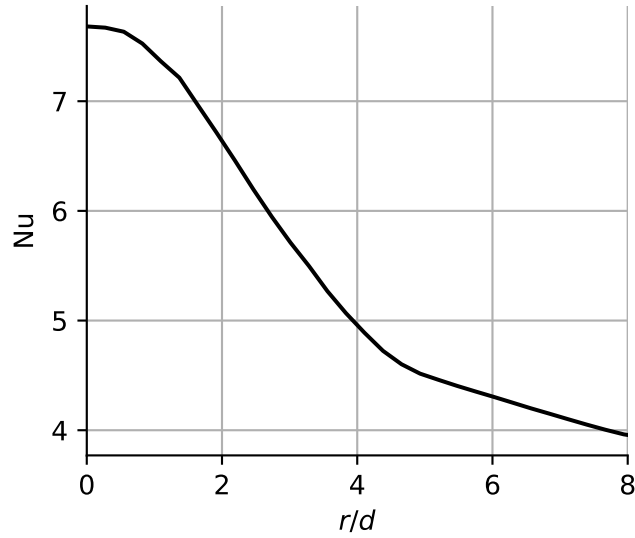


Figure 105: Nu, mikkonen_034

path	2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_1_Lstd_4
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-02-22 12:36:01

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
5731	0.23	1	0.71	1.1	1.1	21.4	20.4	0.090	80.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.3	165.3	-0.01	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	45.88	46.03	46.77	48.00	49.81	51.92	54.15	56.55	58.83
Nu	7.68	7.64	7.42	7.09	6.64	6.16	5.72	5.32	4.96
h (W/m ² K)	181.42	180.43	175.24	167.56	156.76	145.55	135.12	125.58	117.11
q (kW/m ²)	4.62	4.62	4.62	4.62	4.60	4.58	4.55	4.53	4.50

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	58.83	60.73	61.91	62.74	63.56	64.41	65.27	66.13	66.90
Nu	4.96	4.67	4.50	4.40	4.31	4.21	4.12	4.03	3.96
h (W/m ² K)	117.11	110.31	106.30	103.91	101.73	99.49	97.35	95.25	93.44
q (kW/m ²)	4.50	4.45	4.41	4.40	4.39	4.38	4.37	4.36	4.34

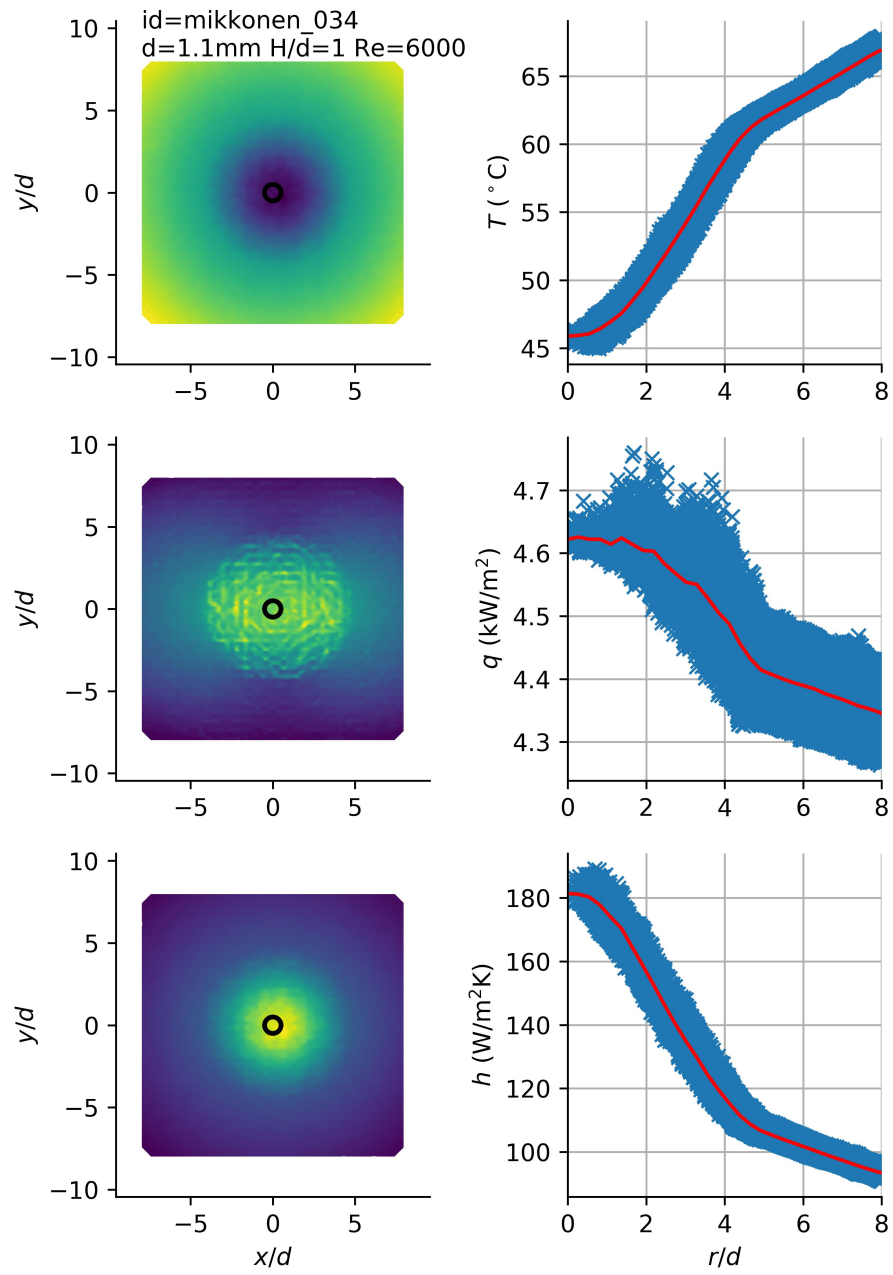


Figure 106: Results, mikkonen_034

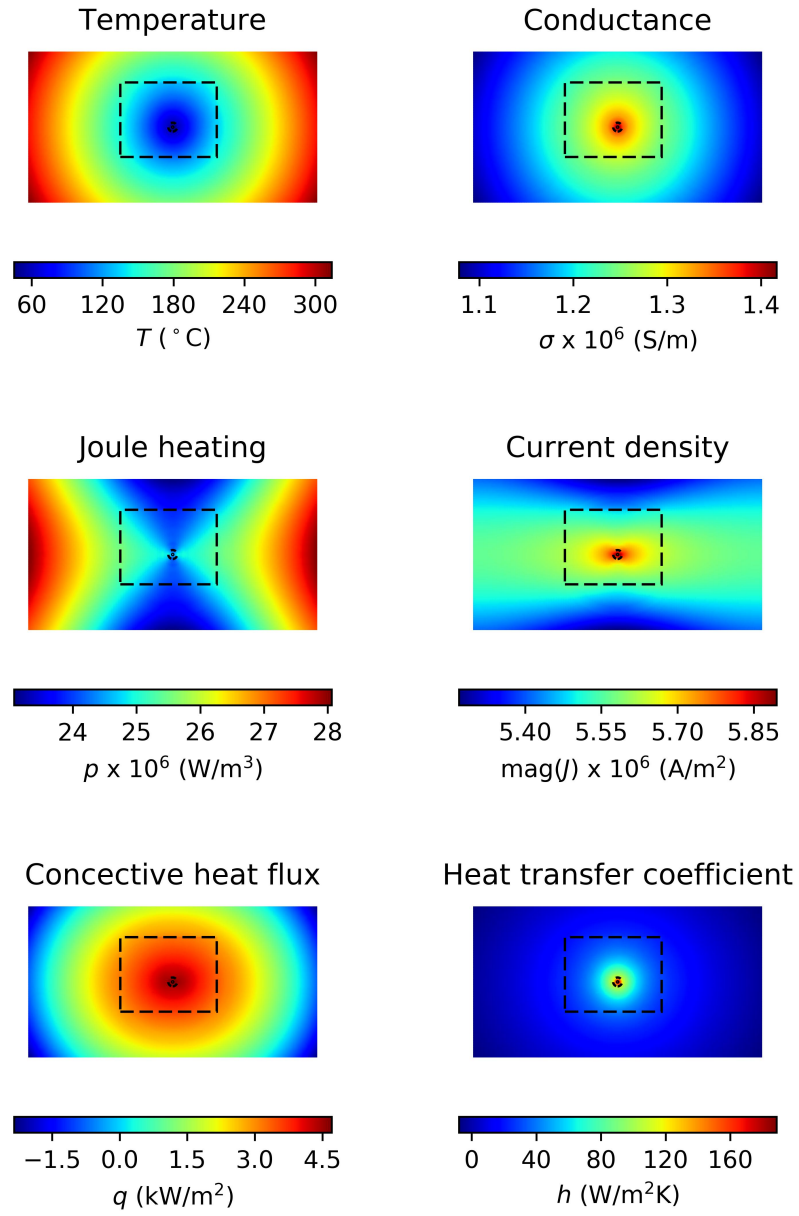


Figure 107: Convection calculation, mikkonen_034

Case id: mikkonen_035

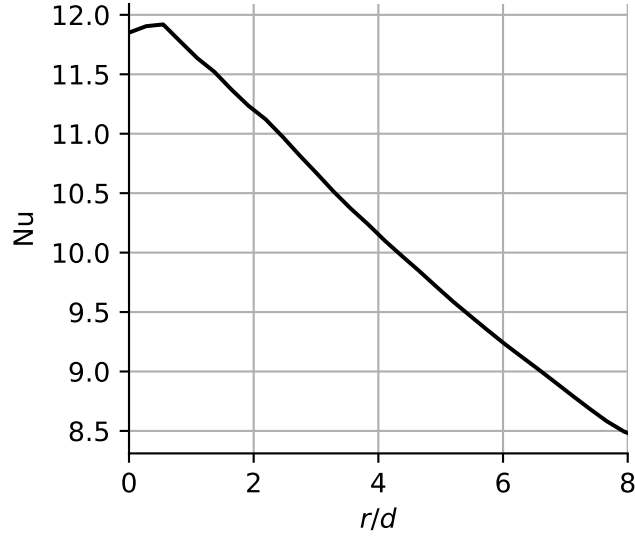


Figure 108: Nu, mikkonen_035

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_1_Lstd_7							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 12:56:47							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9905	0.40	1	0.71	1.1	1.1	21.4	20.4	0.156	139.1
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.5	174.6	11.06				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	43.06	42.92	43.33	43.78	44.27	44.78	45.39	46.02	46.61
Nu	11.85	11.92	11.68	11.45	11.20	10.95	10.67	10.40	10.15
h (W/m ² K)	279.86	281.43	275.95	270.40	264.52	258.69	252.06	245.61	239.79
q (kW/m ²)	6.34	6.34	6.33	6.32	6.31	6.31	6.30	6.29	6.28
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.61	47.20	47.82	48.44	49.05	49.65	50.28	50.92	51.46
Nu	10.15	9.92	9.68	9.46	9.24	9.04	8.84	8.64	8.48
h (W/m ² K)	239.79	234.18	228.64	223.33	218.28	213.60	208.83	204.15	200.33
q (kW/m ²)	6.28	6.28	6.27	6.26	6.25	6.25	6.24	6.23	6.22

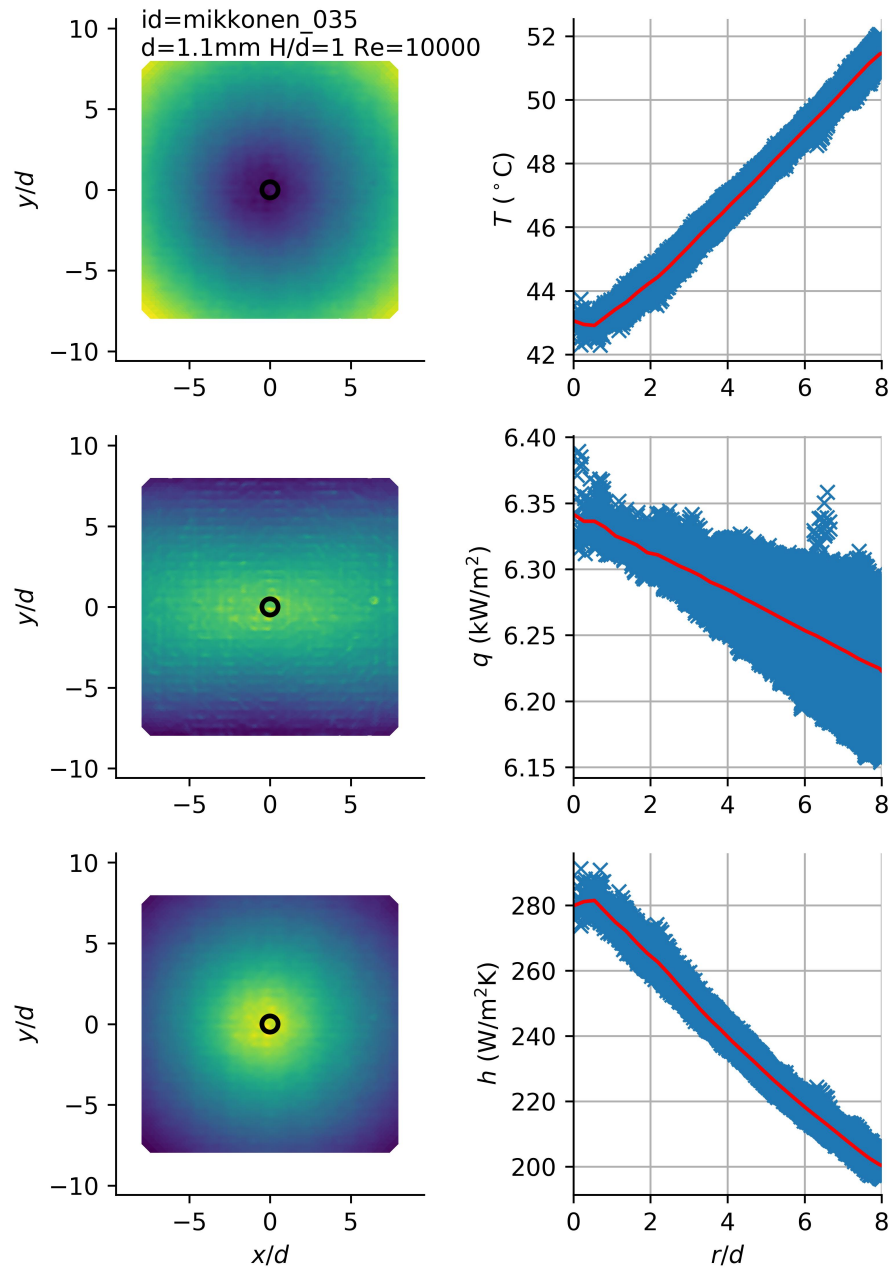


Figure 109: Results, mikkonen_035

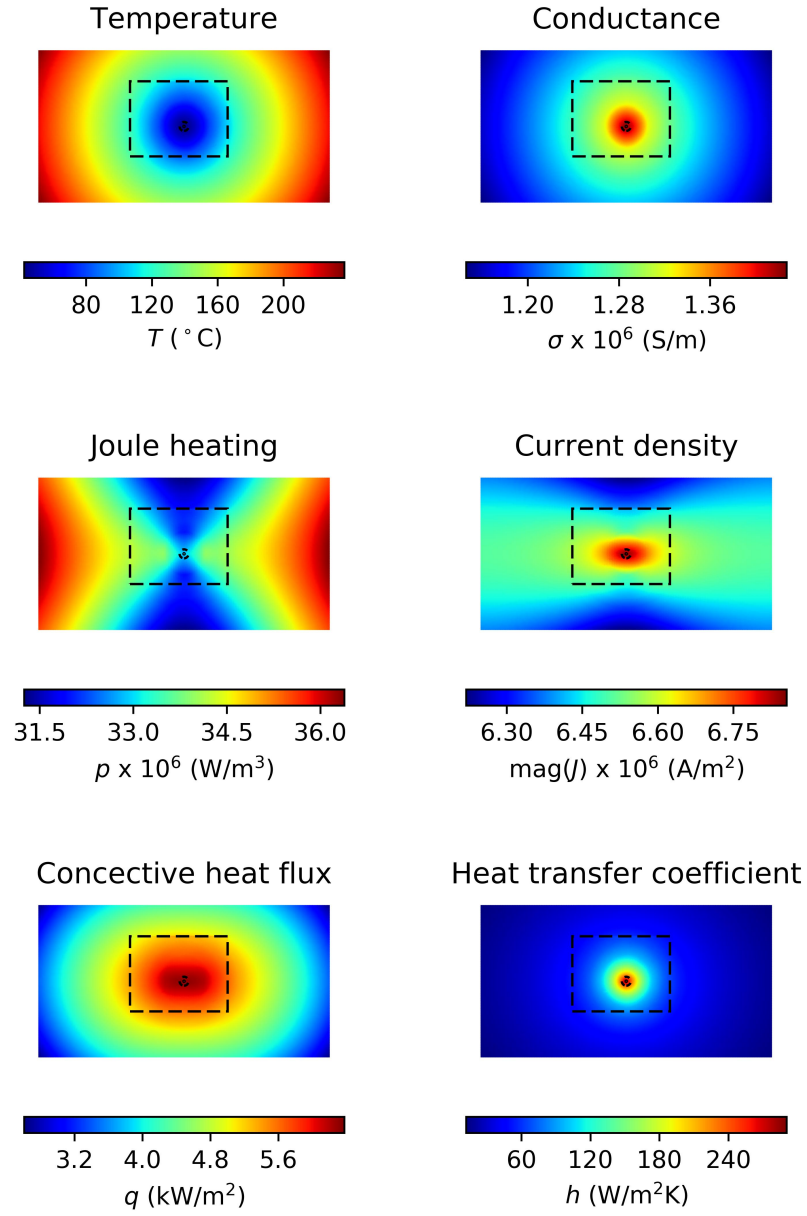


Figure 110: Convection calculation, mikkonen_035

Case id: mikkonen_036

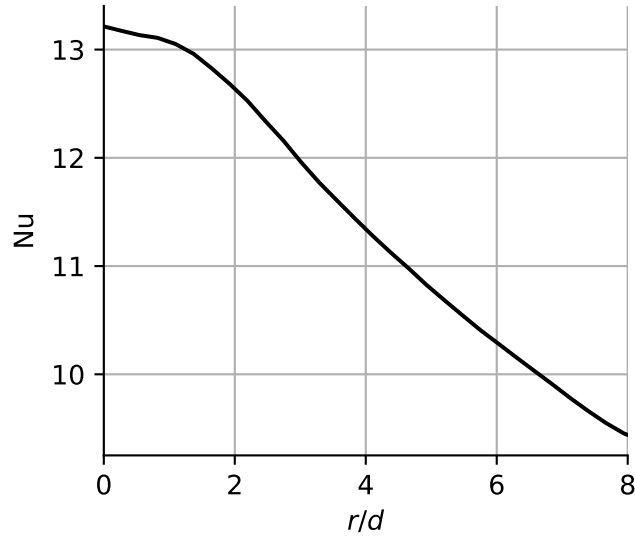


Figure 111: Nu, mikkonen_036

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_1_Lstd_11							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 13:03:53							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14408	0.59	1	0.71	1.1	1.1	21.4	20.4	0.227	202.3
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.6	196.5	1.13			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.77	41.89	42.00	42.28	42.72	43.27	43.92	44.55	45.16
Nu	13.21	13.14	13.07	12.90	12.64	12.32	11.97	11.64	11.34
h (W/m ² K)	312.07	310.32	308.70	304.60	298.46	290.90	282.67	274.96	267.85
q (kW/m ²)	6.67	6.67	6.67	6.66	6.66	6.65	6.65	6.64	6.63
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.16	45.76	46.37	46.97	47.56	48.14	48.76	49.37	49.88
Nu	11.34	11.06	10.79	10.53	10.29	10.07	9.84	9.62	9.44
h (W/m ² K)	267.85	261.23	254.78	248.76	243.12	237.70	232.33	227.16	222.93
q (kW/m ²)	6.63	6.62	6.62	6.61	6.60	6.59	6.59	6.58	6.57

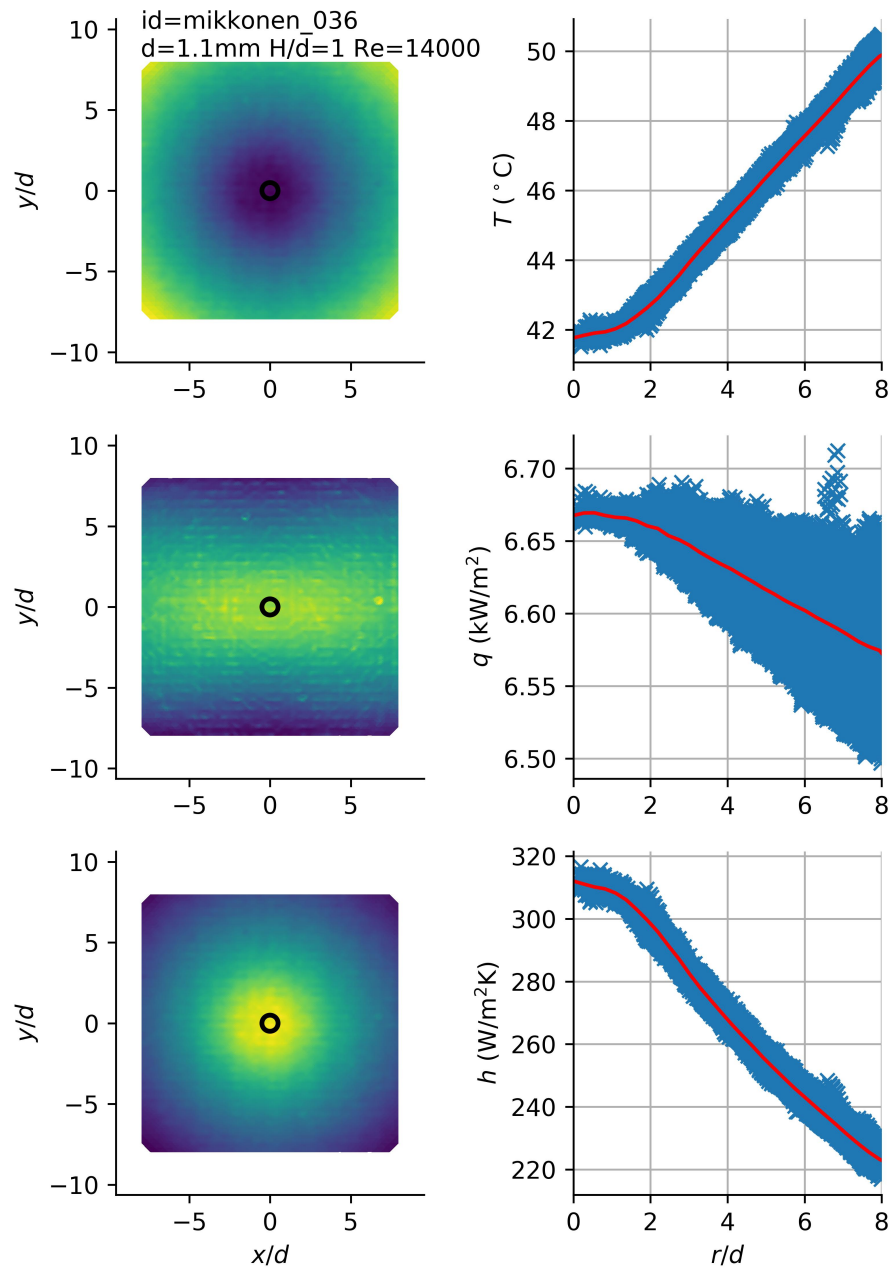


Figure 112: Results, mikkonen_036

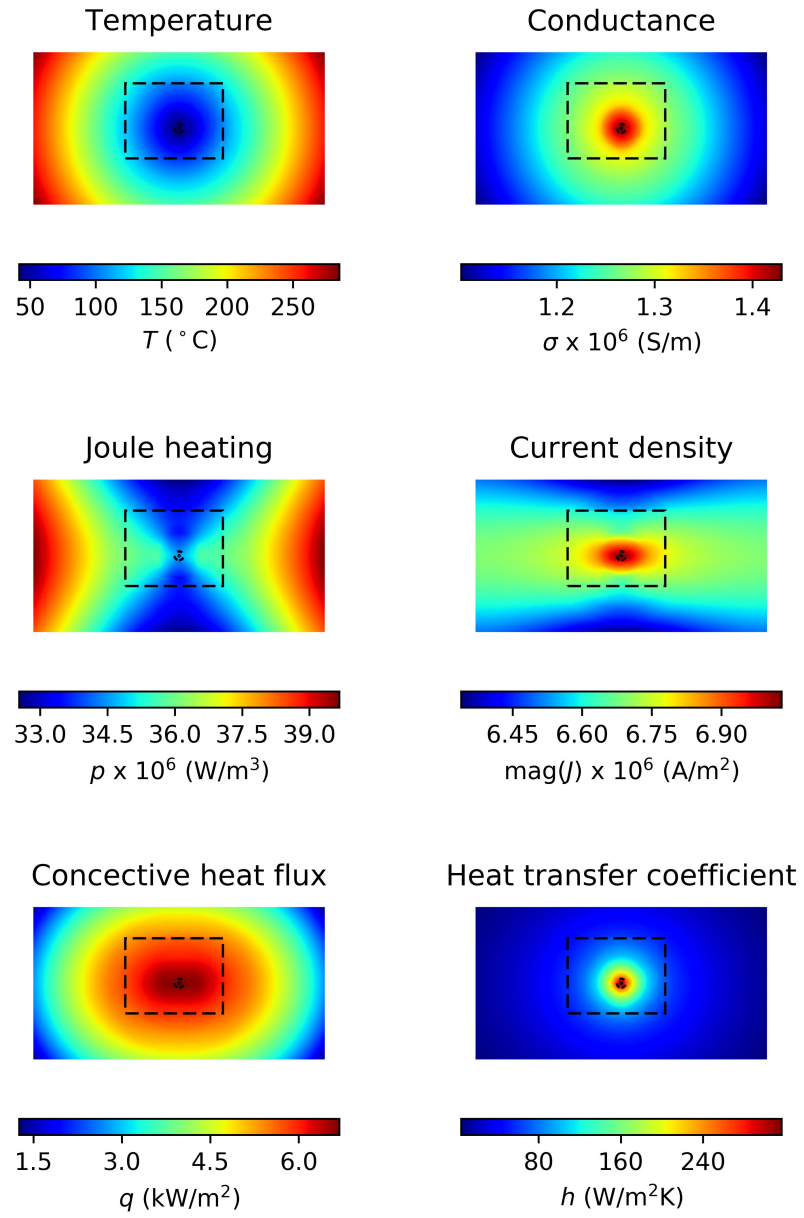


Figure 113: Convection calculation, mikkonen_036

Case id: mikkonen_037

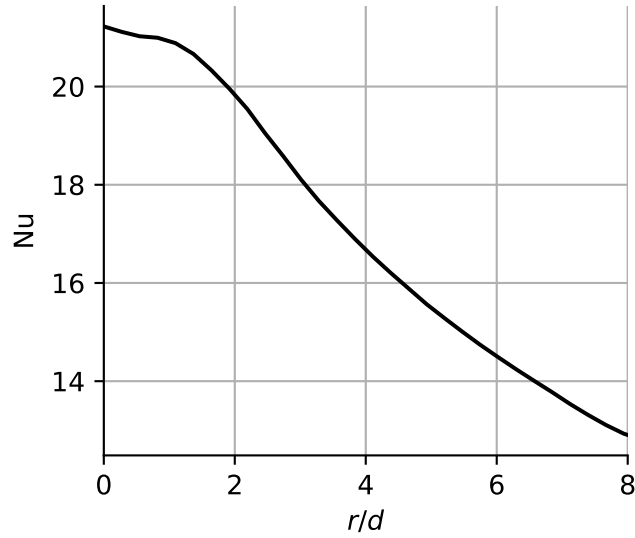


Figure 114: Nu, mikkonen_037

path	2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_1_Lstd_15								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-22 13:11:25								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20309	0.83	1	0.71	1.1	1.1	21.3	20.4	0.321	285.0
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.8	218.5	1.94			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	37.45	37.60	37.69	38.04	38.63	39.42	40.30	41.15	41.98
Nu	21.22	21.04	20.92	20.50	19.83	18.99	18.13	17.36	16.68
h (W/m ² K)	501.10	496.74	493.97	484.11	468.23	448.27	427.95	409.91	393.80
q (kW/m ²)	8.54	8.54	8.54	8.54	8.53	8.52	8.52	8.50	8.50
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	41.98	42.77	43.57	44.33	45.09	45.84	46.61	47.38	48.04
Nu	16.68	16.07	15.49	14.98	14.51	14.07	13.64	13.23	12.90
h (W/m ² K)	393.80	379.34	365.82	353.74	342.55	332.15	322.04	312.45	304.67
q (kW/m ²)	8.50	8.49	8.48	8.47	8.46	8.45	8.44	8.43	8.42

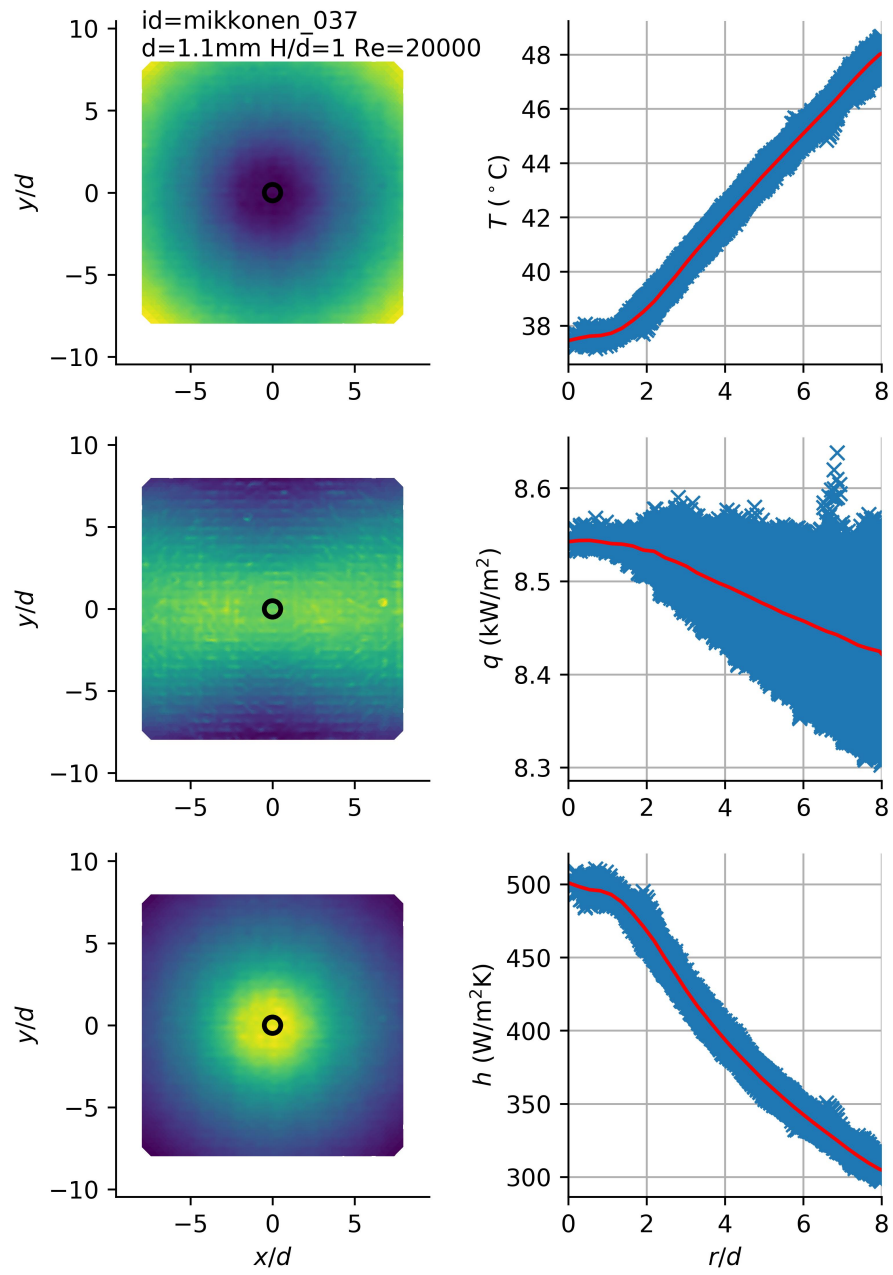


Figure 115: Results, mikkonen_037

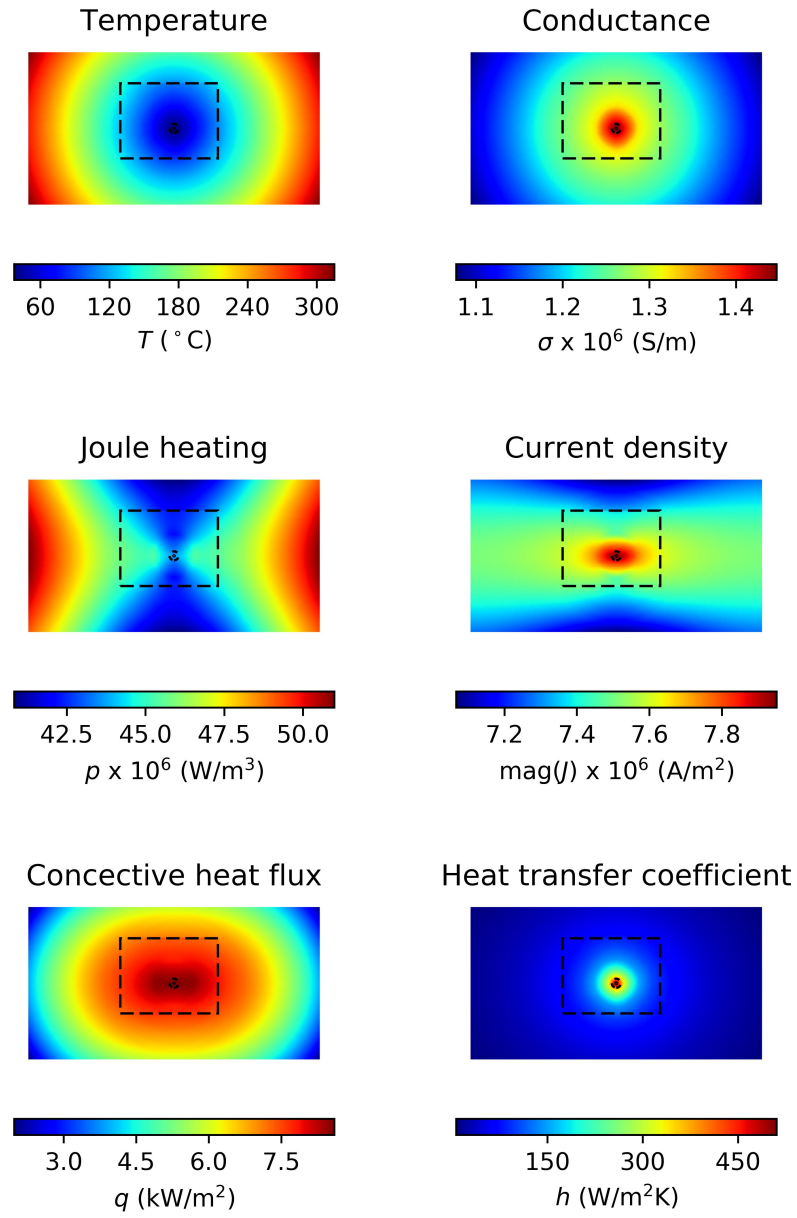


Figure 116: Convection calculation, mikkonen_037

Case id: mikkonen_038

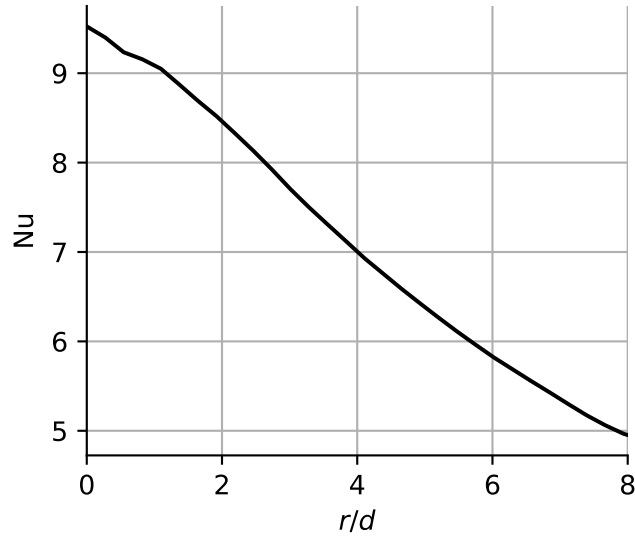


Figure 117: Nu, mikkonen_038

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_2_Lstd_4							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 13:38:23							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6152	0.25	2	0.71	1.1	2.2	22.4	20.4	0.097	86.9
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.3	162.5	1.47				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.74	41.33	41.70	42.39	43.21	44.16	45.30	46.45	47.66
Nu	9.52	9.26	9.09	8.79	8.46	8.10	7.71	7.35	7.01
h (W/m ² K)	225.55	219.38	215.22	208.09	200.42	191.95	182.68	174.11	165.91
q (kW/m ²)	4.59	4.59	4.58	4.58	4.57	4.56	4.55	4.53	4.52
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.66	48.87	50.12	51.41	52.70	53.98	55.33	56.72	57.90
Nu	7.01	6.68	6.38	6.10	5.83	5.59	5.36	5.13	4.95
h (W/m ² K)	165.91	158.33	151.20	144.42	138.11	132.41	126.86	121.50	117.31
q (kW/m ²)	4.52	4.51	4.49	4.48	4.46	4.44	4.43	4.41	4.40

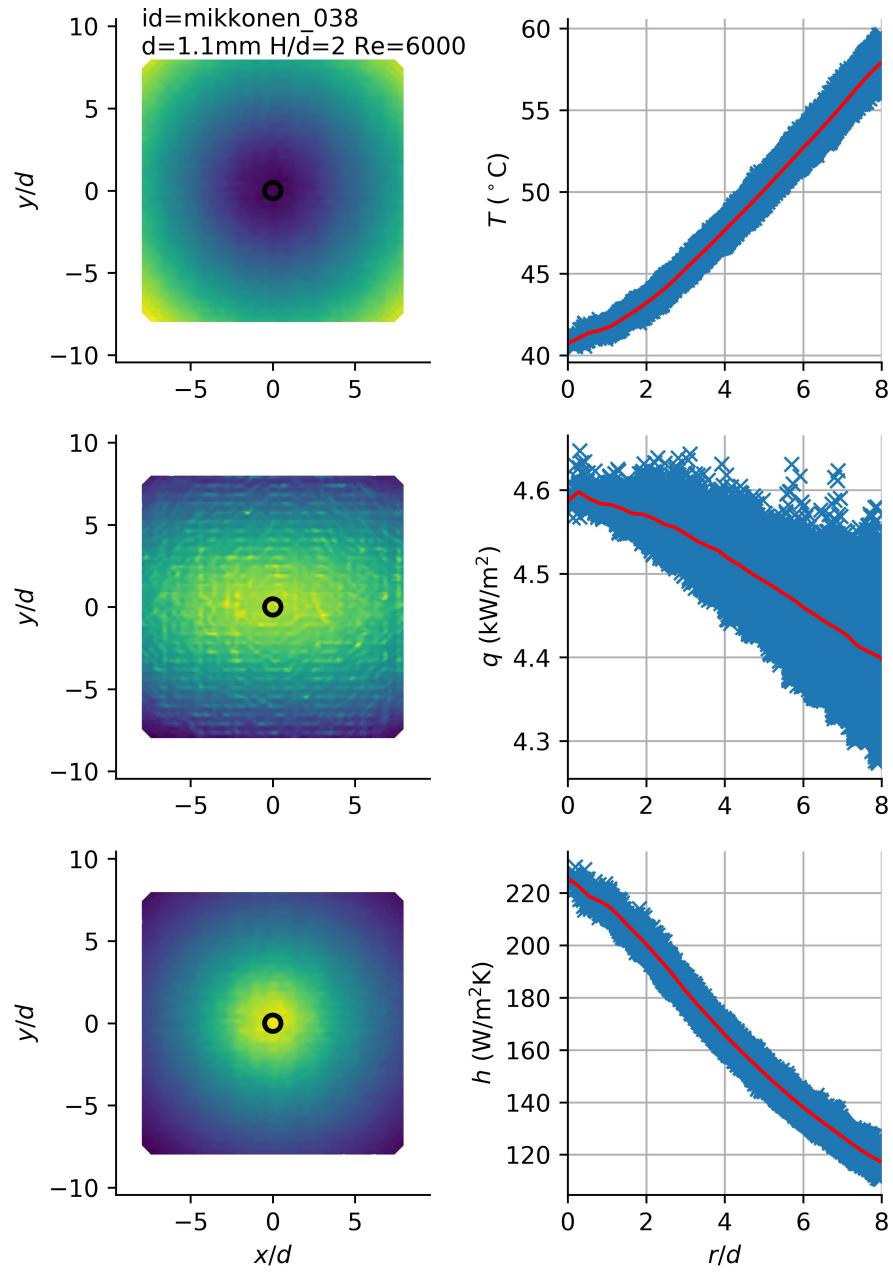


Figure 118: Results, mikkonen_038

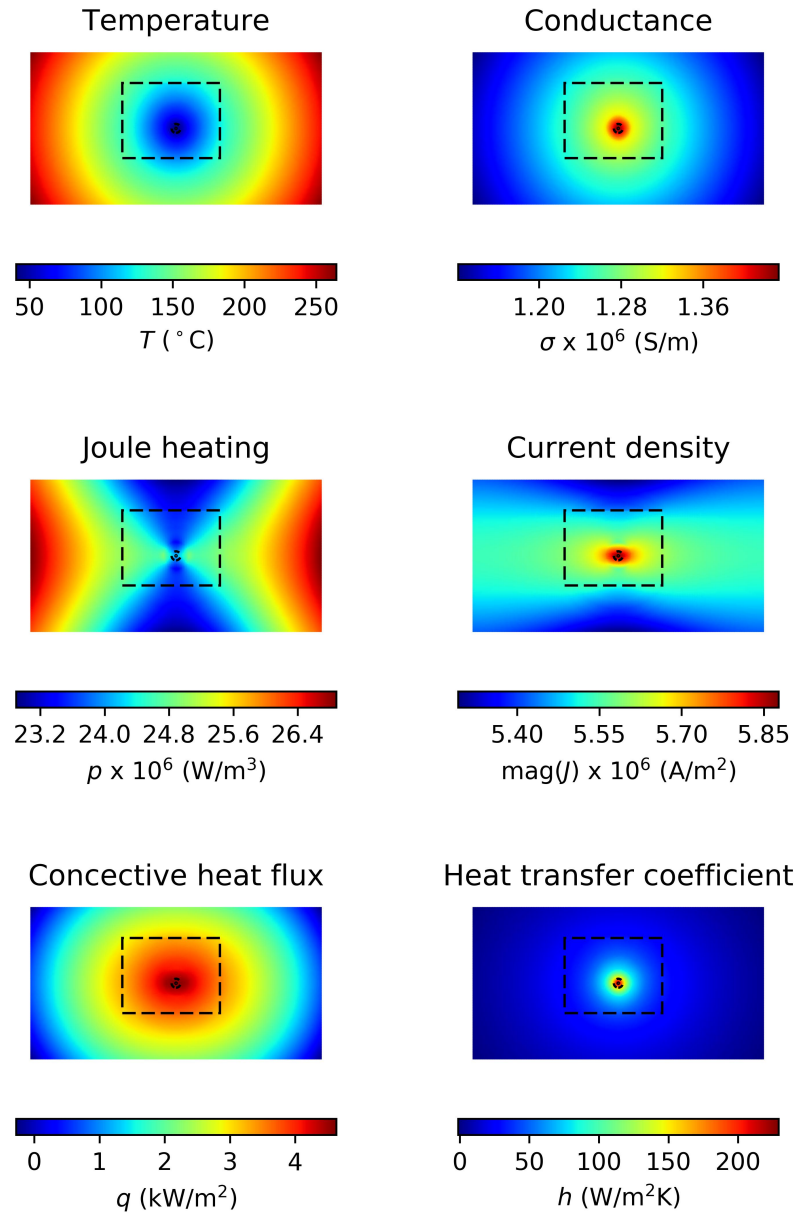


Figure 119: Convection calculation, mikkonen_038

Case id: mikkonen_039

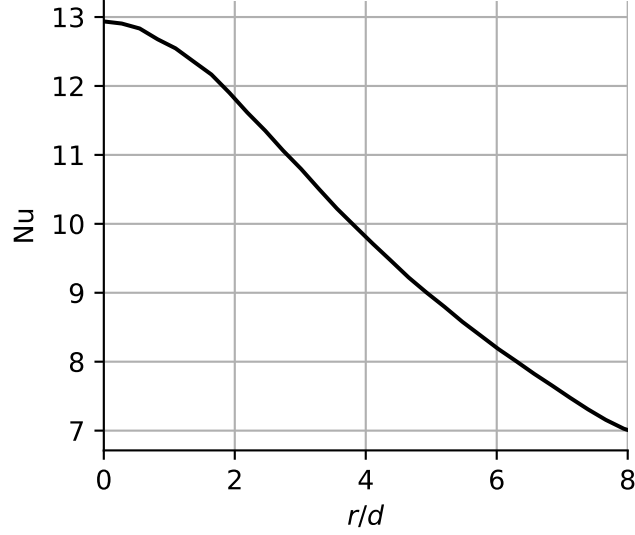


Figure 120: Nu, mikkonen_039

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_2_Lstd_7							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 13:31:50							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9926	0.41	2	0.71	1.1	2.2	21.8	20.4	0.157	139.7
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.6	195.6	2.11				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	42.97	43.05	43.48	44.07	44.95	46.00	47.15	48.46	49.75
Nu	12.94	12.85	12.59	12.27	11.82	11.31	10.81	10.28	9.81
h (W/m ² K)	305.86	303.73	297.71	289.99	279.35	267.51	255.55	243.13	231.97
q (kW/m ²)	6.90	6.88	6.87	6.86	6.86	6.85	6.83	6.82	6.81
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	49.75	51.10	52.43	53.79	55.17	56.56	57.99	59.46	60.70
Nu	9.81	9.36	8.95	8.56	8.20	7.87	7.55	7.25	7.01
h (W/m ² K)	231.97	221.33	211.58	202.42	193.92	186.12	178.61	171.40	165.73
q (kW/m ²)	6.81	6.79	6.77	6.76	6.74	6.72	6.71	6.69	6.67

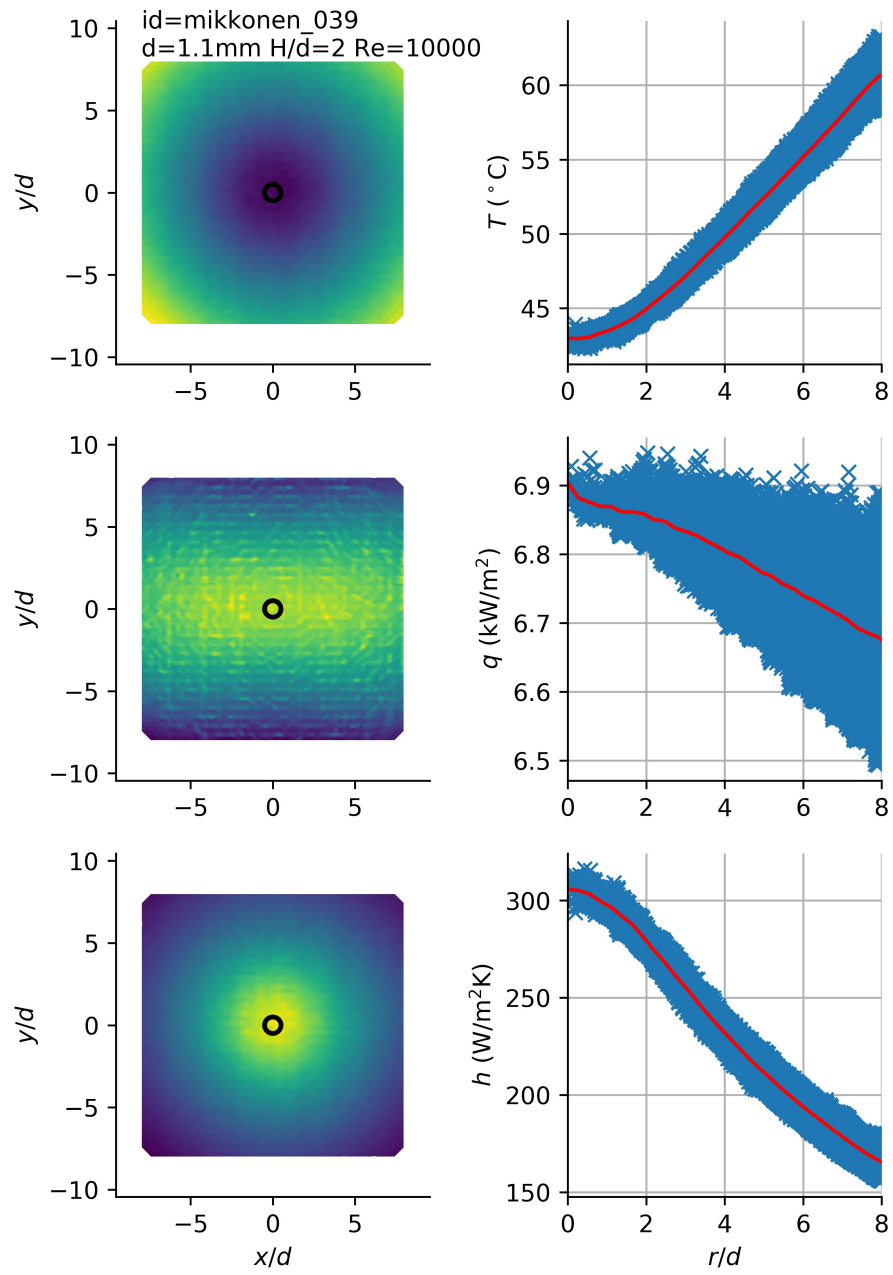


Figure 121: Results, mikkonen_039

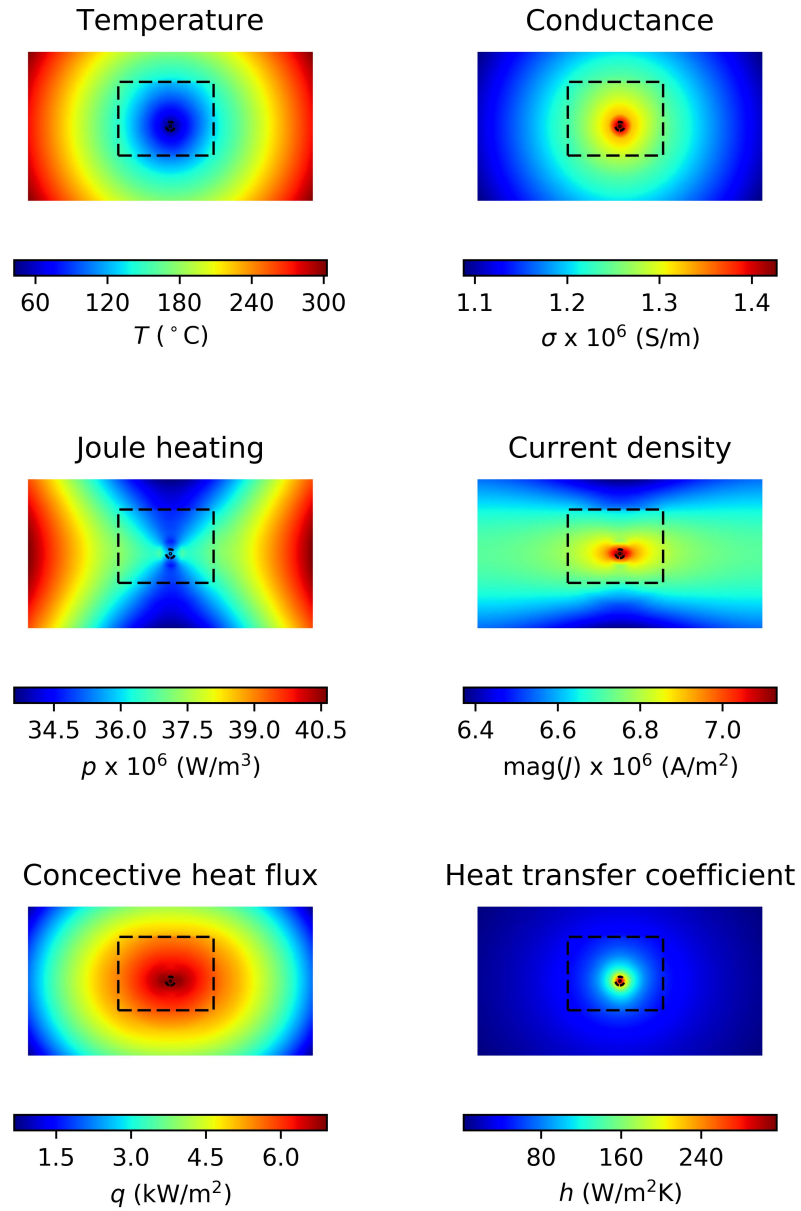


Figure 122: Convection calculation, mikkonen_039

Case id: mikkonen_040

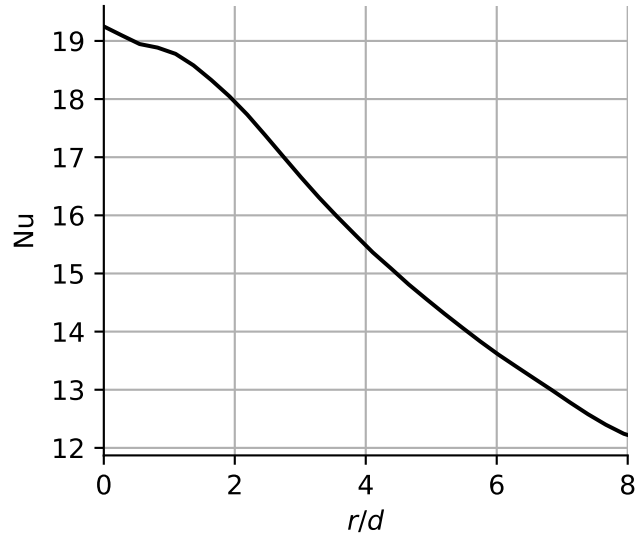


Figure 123: Nu, mikkonen_040

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_2_Lstd_15							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 13:16:49							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20067	0.82	2	0.71	1.1	2.2	21.2	20.4	0.317	281.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.8	222.6	3.10			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.30	40.60	40.76	41.15	41.72	42.47	43.32	44.18	45.02
Nu	19.25	18.97	18.82	18.46	17.95	17.33	16.67	16.05	15.48
h (W/m ² K)	454.34	447.80	444.09	435.68	423.73	409.06	393.45	378.89	365.45
q (kW/m ²)	9.04	9.05	9.04	9.04	9.03	9.03	9.02	9.01	9.00
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.02	45.84	46.65	47.45	48.26	49.02	49.83	50.65	51.33
Nu	15.48	14.97	14.49	14.05	13.63	13.25	12.87	12.51	12.22
h (W/m ² K)	365.45	353.34	342.04	331.51	321.60	312.68	303.83	295.24	288.47
q (kW/m ²)	9.00	8.99	8.98	8.97	8.96	8.95	8.94	8.93	8.92

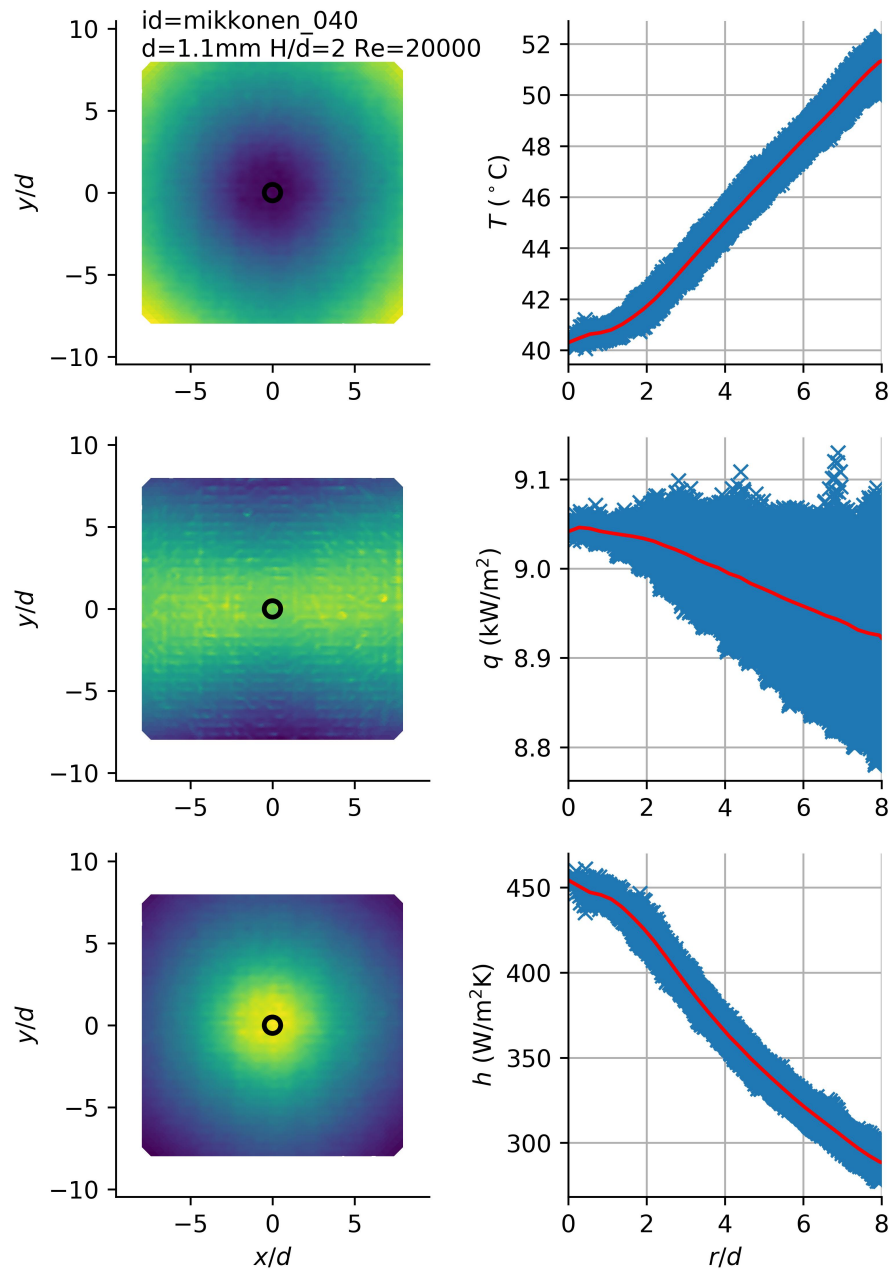


Figure 124: Results, mikkonen_040

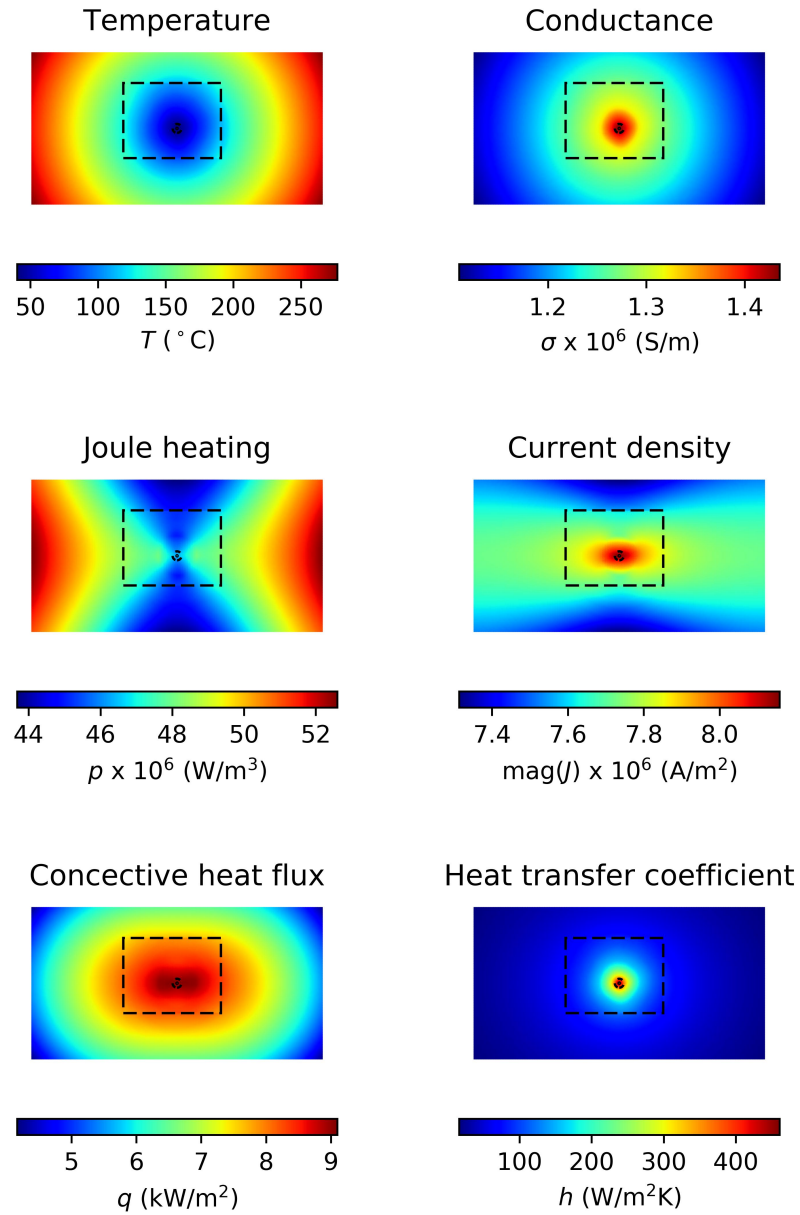


Figure 125: Convection calculation, mikkonen_040

Case id: mikkonen_041

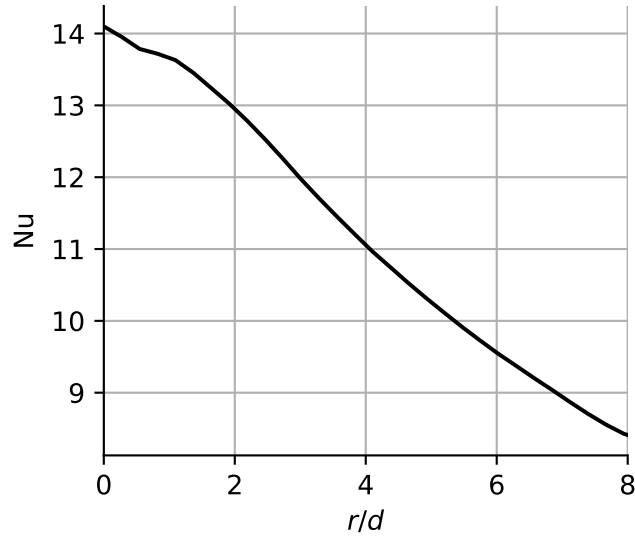


Figure 126: Nu, mikkonen_041

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_2_Lstd_11							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 13:23:11							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13905	0.57	2	0.71	1.1	2.2	21.3	20.4	0.219	195.1
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.5	202.5	-4.69				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	39.47	39.87	40.07	40.52	41.13	41.86	42.74	43.63	44.54
Nu	14.10	13.81	13.66	13.35	12.95	12.49	11.98	11.51	11.06
h (W/m ² K)	332.87	326.15	322.51	315.18	305.74	294.90	282.95	271.69	261.05
q (kW/m ²)	6.35	6.35	6.34	6.34	6.34	6.33	6.32	6.31	6.30
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.54	45.42	46.32	47.23	48.13	49.01	49.94	50.89	51.70
Nu	11.06	10.65	10.26	9.90	9.56	9.25	8.94	8.65	8.41
h (W/m ² K)	261.05	251.37	242.24	233.64	225.65	218.33	211.14	204.17	198.59
q (kW/m ²)	6.30	6.29	6.28	6.27	6.26	6.24	6.23	6.22	6.21

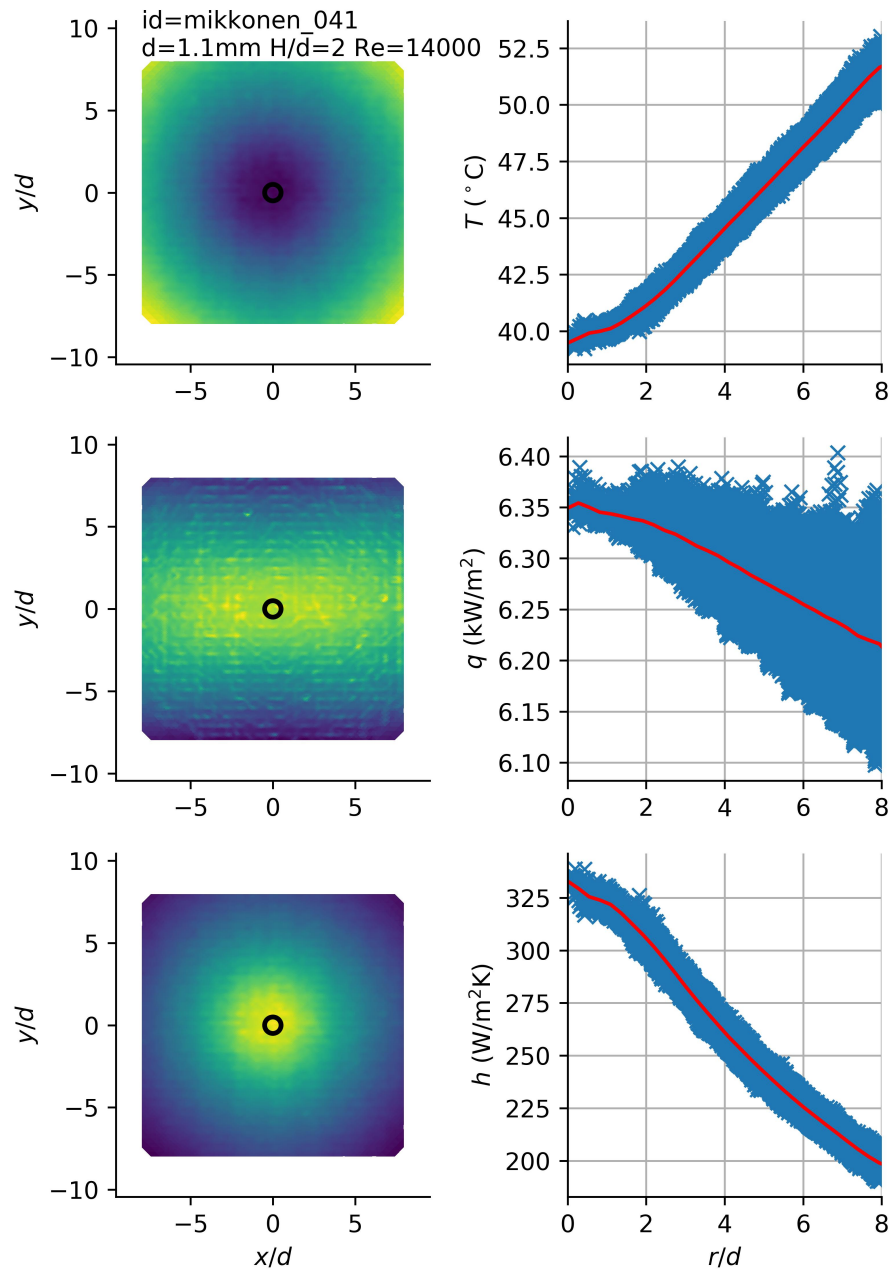


Figure 127: Results, mikkonen_041

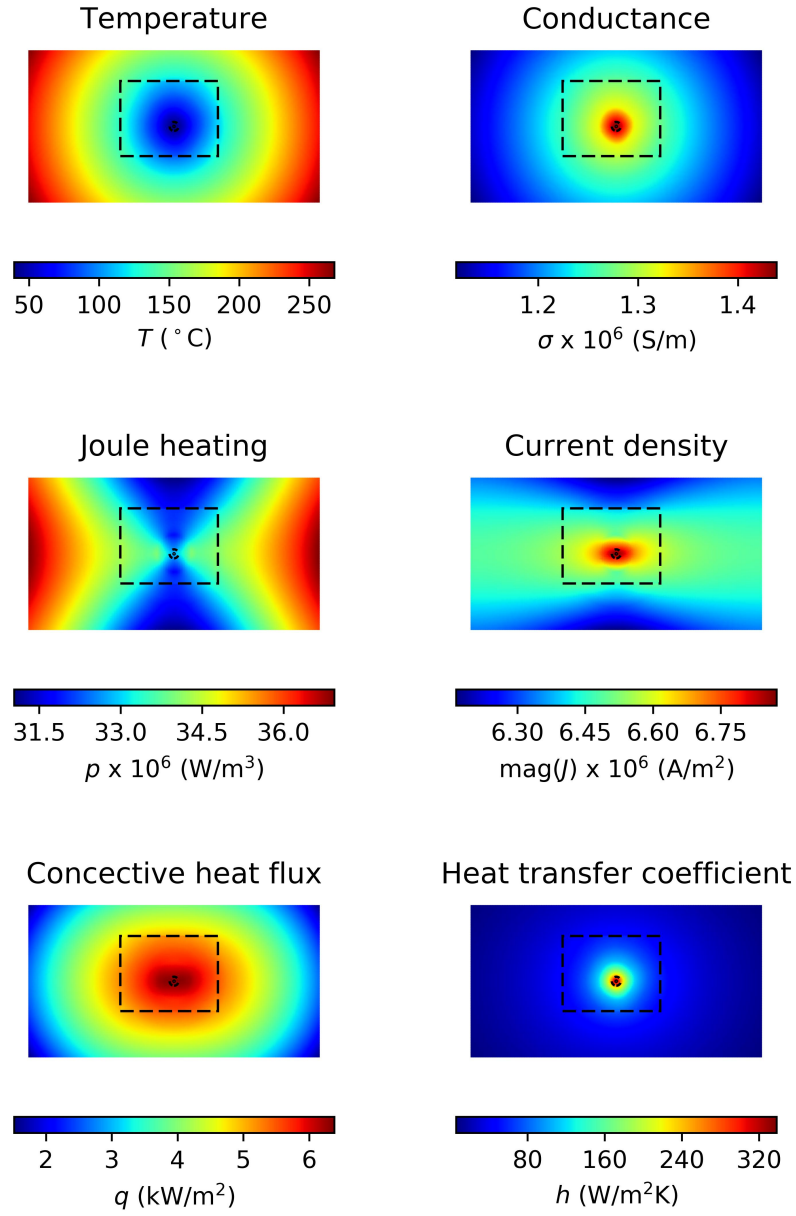


Figure 128: Convection calculation, mikkonen_041

Case id: mikkonen_042

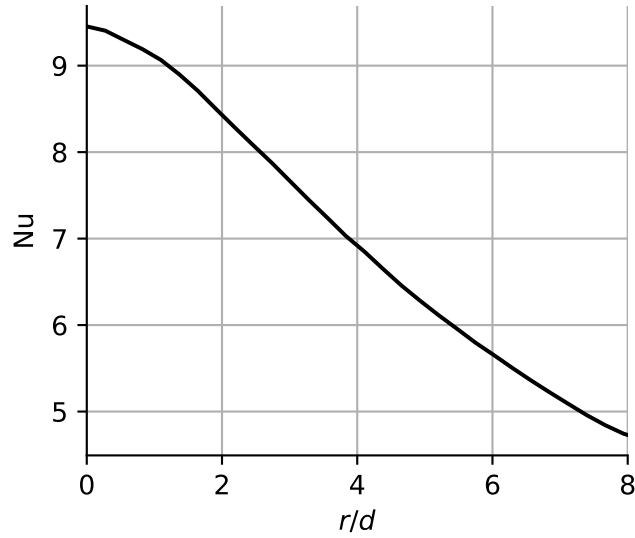


Figure 129: Nu, mikkonen_042

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_3_Lstd_4							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 13:52:12							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6192	0.25	3	0.71	1.1	3.3	22.3	20.4	0.098	87.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.4	170.0	0.63				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	42.73	42.98	43.46	44.22	45.24	46.34	47.58	48.95	50.35
Nu	9.45	9.32	9.11	8.81	8.43	8.05	7.67	7.28	6.92
h (W/m ² K)	223.84	220.58	215.70	208.55	199.61	190.63	181.58	172.48	163.84
q (kW/m ²)	5.00	4.98	4.97	4.97	4.96	4.94	4.93	4.92	4.90
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	50.35	51.86	53.38	54.89	56.46	58.09	59.75	61.43	62.89
Nu	6.92	6.57	6.24	5.94	5.66	5.40	5.15	4.91	4.73
h (W/m ² K)	163.84	155.47	147.72	140.71	134.10	127.78	121.88	116.34	111.97
q (kW/m ²)	4.90	4.89	4.87	4.85	4.83	4.81	4.79	4.77	4.75

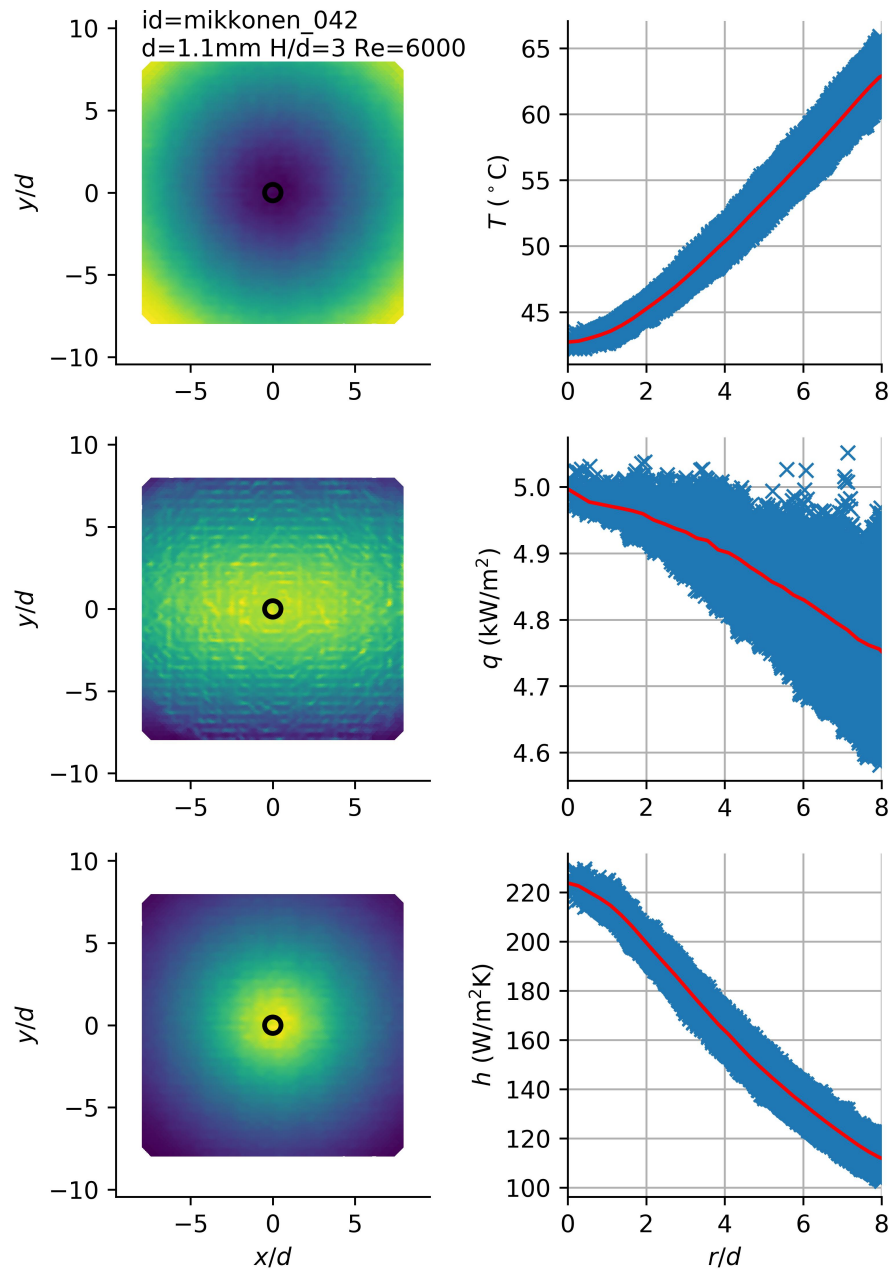


Figure 130: Results, mikkonen_042

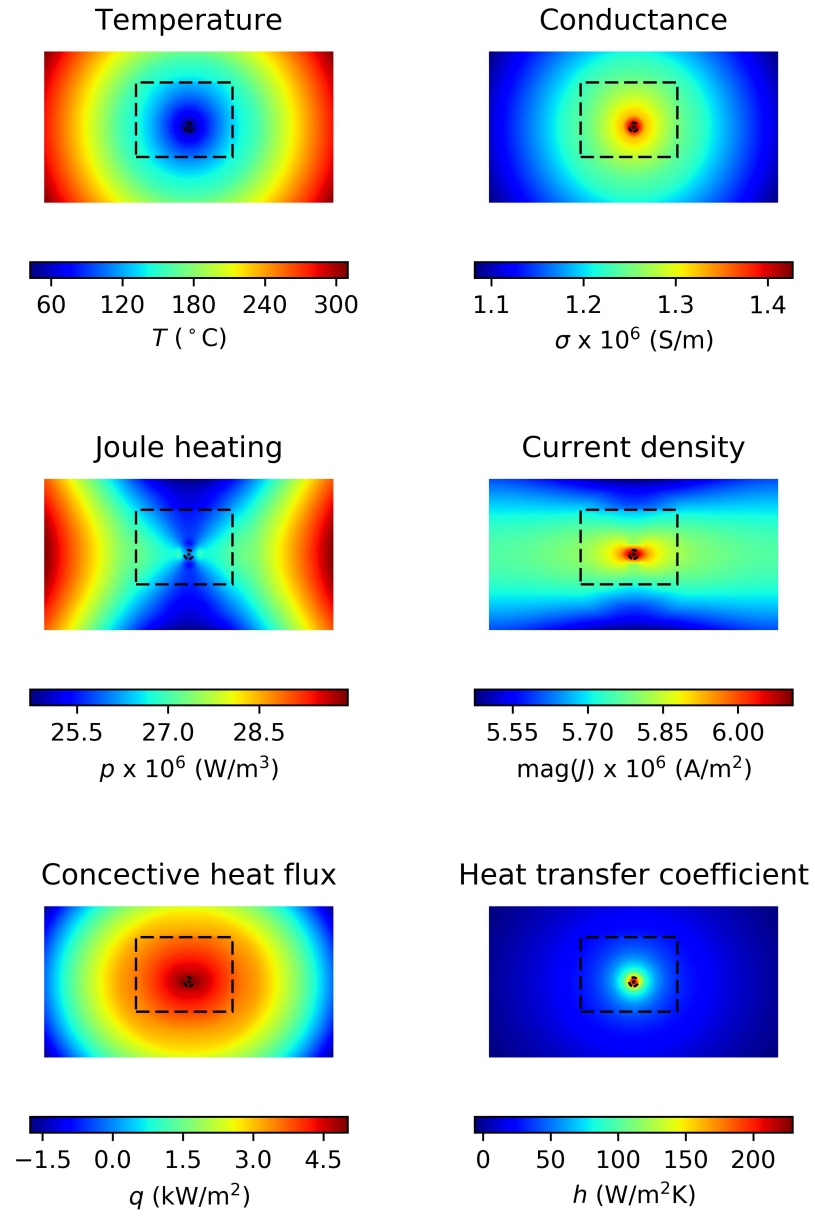


Figure 131: Convection calculation, mikkonen_042

Case id: mikkonen_043

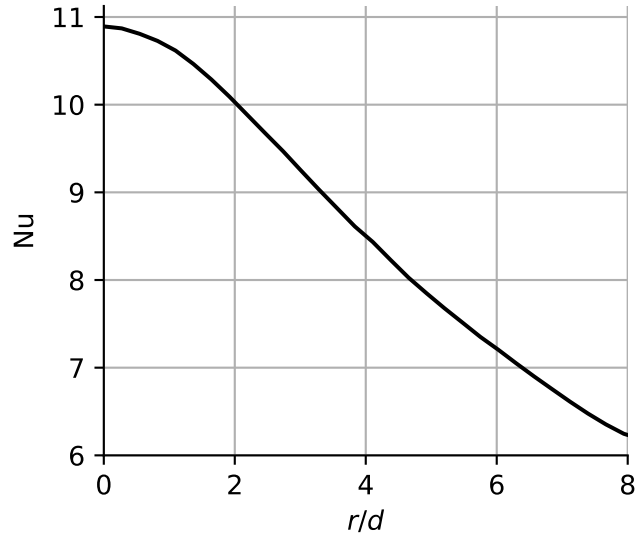


Figure 132: Nu, mikkonen_043

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_3_Lstd_7							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 14:00:44							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9744	0.40	3	0.71	1.1	3.3	22.0	20.4	0.154	137.3
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.4	185.7	-3.87				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.43	41.53	41.83	42.38	43.12	43.97	44.92	45.96	46.99
Nu	10.89	10.82	10.66	10.38	10.03	9.65	9.26	8.87	8.50
h (W/m ² K)	257.69	255.94	252.08	245.54	237.26	228.24	219.01	209.76	201.17
q (kW/m ²)	5.42	5.41	5.40	5.39	5.39	5.38	5.37	5.36	5.35
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.99	48.11	49.23	50.32	51.42	52.58	53.77	54.95	55.96
Nu	8.50	8.14	7.80	7.50	7.22	6.94	6.67	6.43	6.23
h (W/m ² K)	201.17	192.57	184.62	177.44	170.74	164.15	157.90	152.08	147.44
q (kW/m ²)	5.35	5.33	5.32	5.31	5.30	5.28	5.27	5.25	5.24

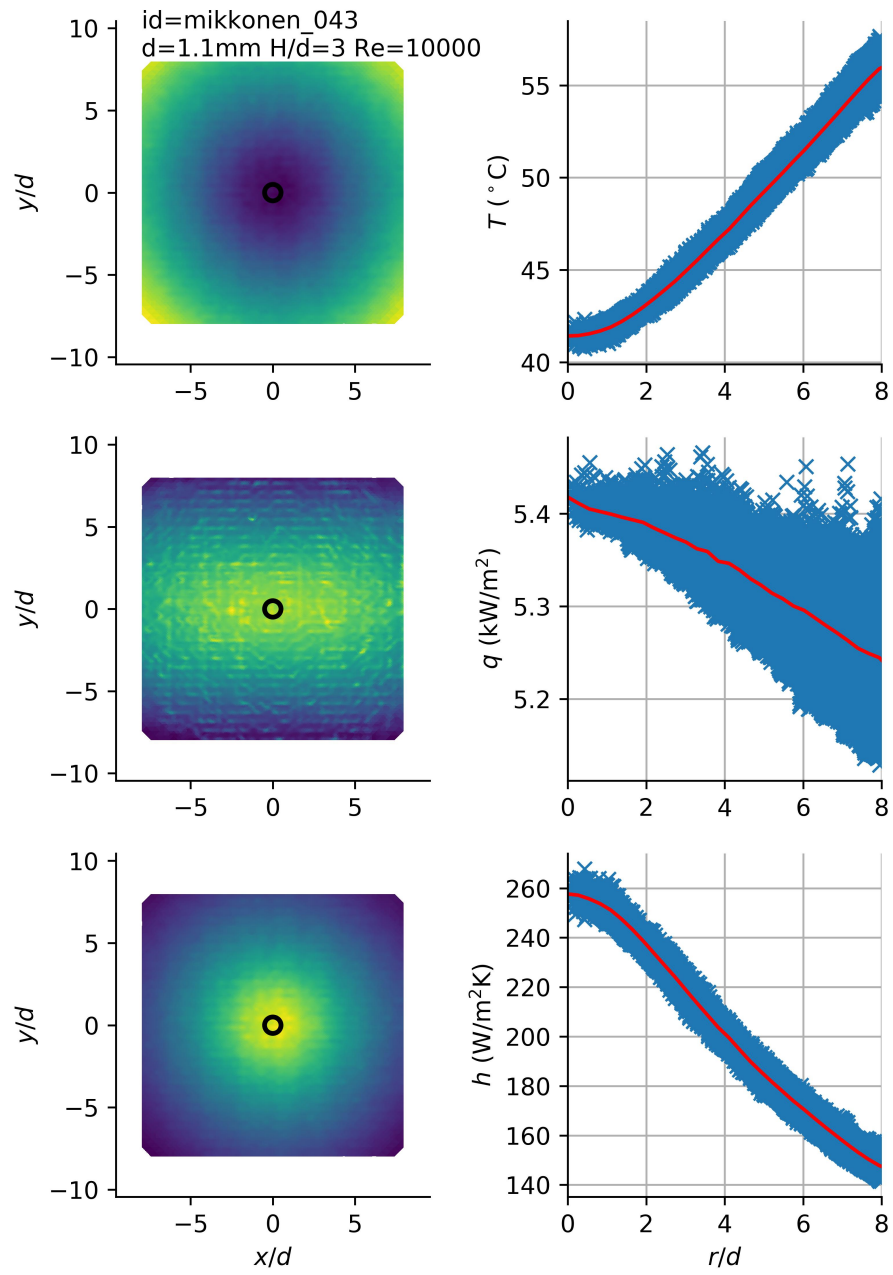


Figure 133: Results, mikkonen_043

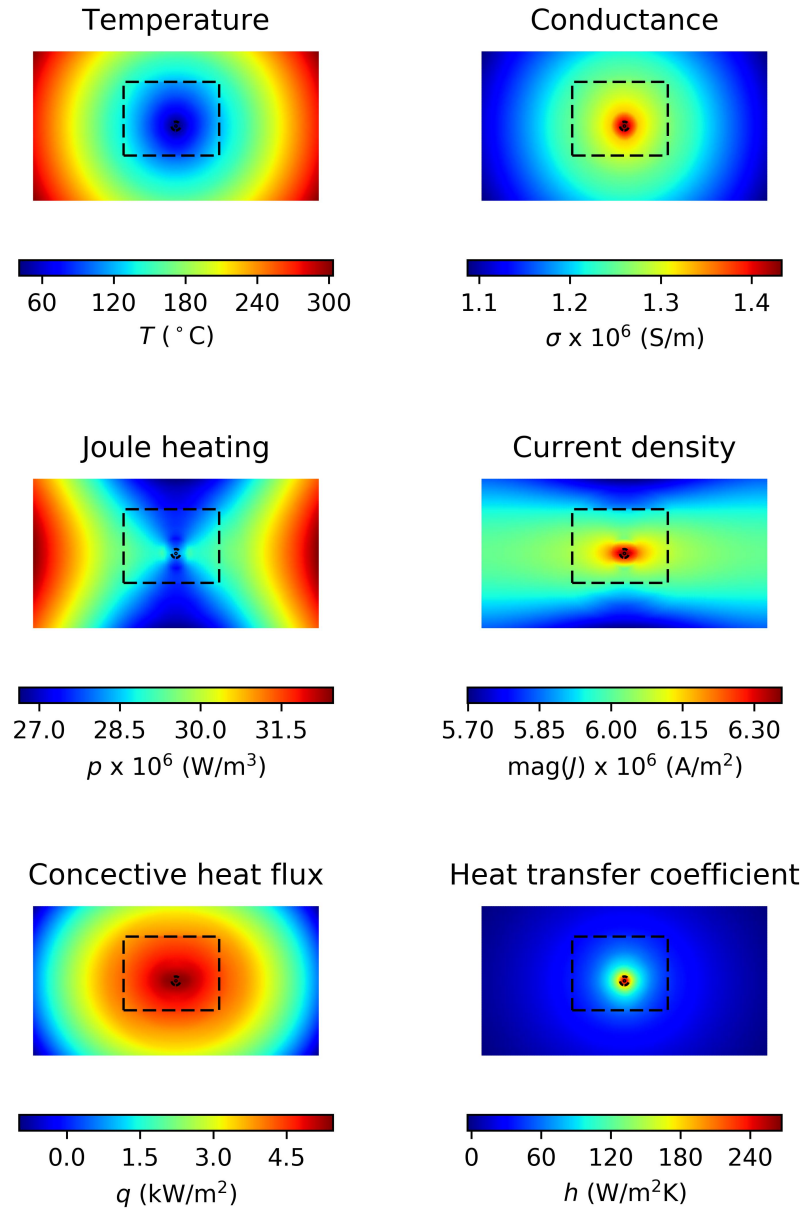


Figure 134: Convection calculation, mikkonen_043

Case id: mikkonen_044

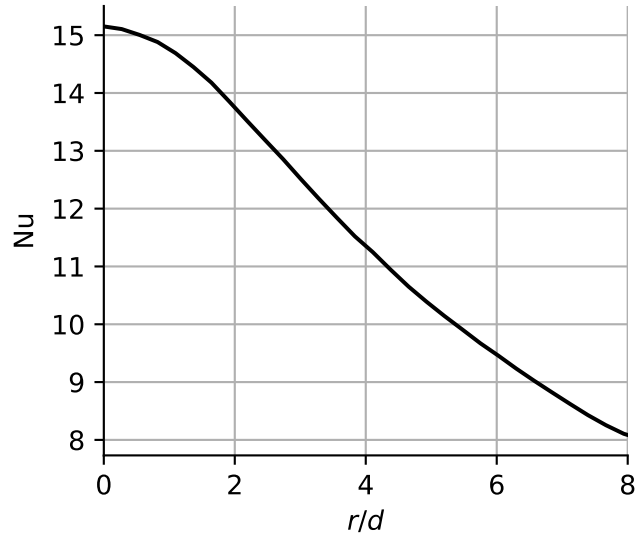


Figure 135: Nu, mikkonen_044

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_3_Lstd_11							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 14:08:54							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13987	0.57	3	0.71	1.1	3.3	21.8	20.4	0.221	196.9
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.7	212.8	0.44			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	42.58	42.71	43.09	43.77	44.72	45.81	47.02	48.35	49.66
Nu	15.15	15.02	14.76	14.32	13.75	13.14	12.52	11.91	11.35
h (W/m ² K)	358.23	355.16	348.89	338.58	325.08	310.70	296.08	281.67	268.47
q (kW/m ²)	7.95	7.92	7.92	7.91	7.90	7.89	7.88	7.87	7.85
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	49.66	51.07	52.45	53.79	55.18	56.63	58.08	59.56	60.82
Nu	11.35	10.82	10.32	9.89	9.48	9.08	8.71	8.36	8.09
h (W/m ² K)	268.47	255.72	244.11	233.78	224.05	214.64	205.90	197.68	191.16
q (kW/m ²)	7.85	7.84	7.82	7.80	7.79	7.77	7.75	7.73	7.72

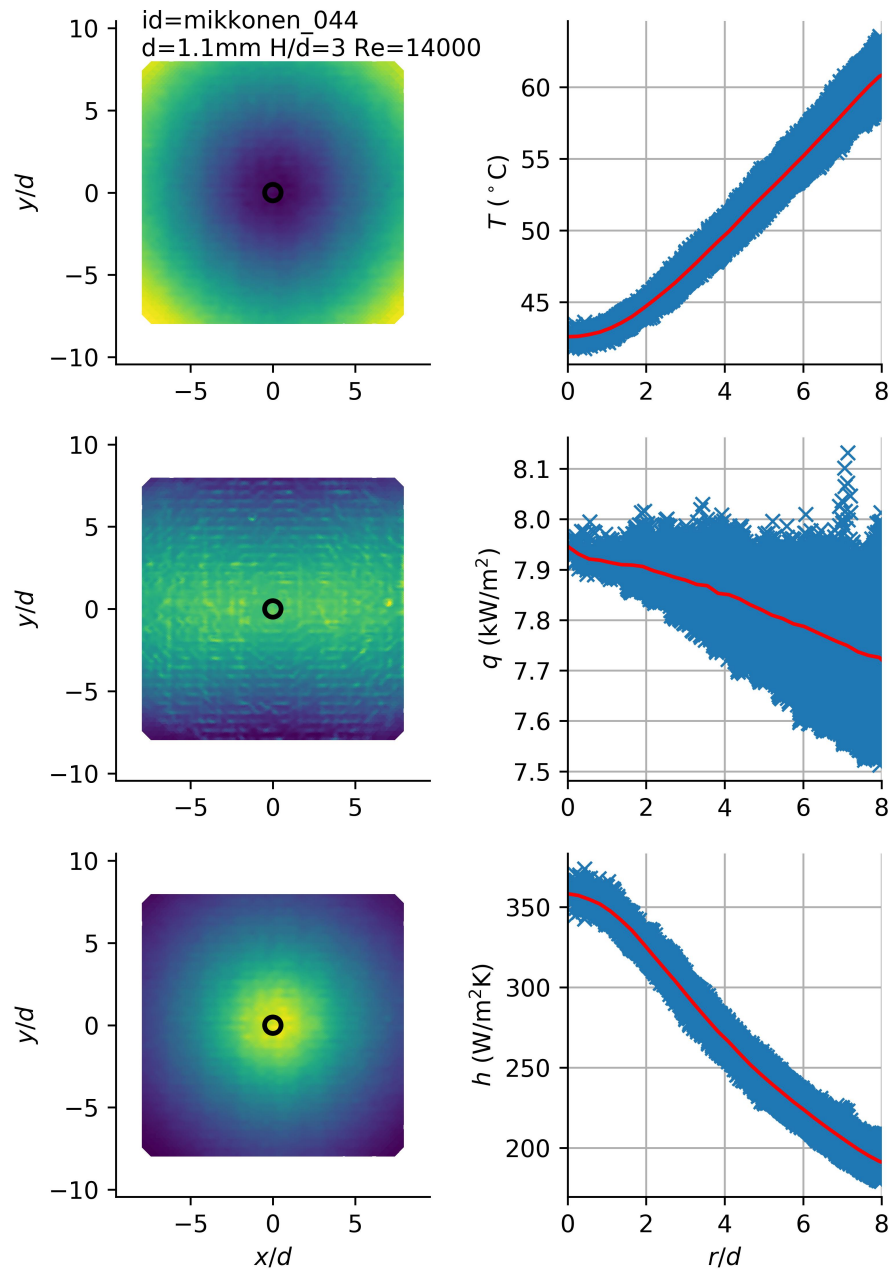


Figure 136: Results, mikkonen_044

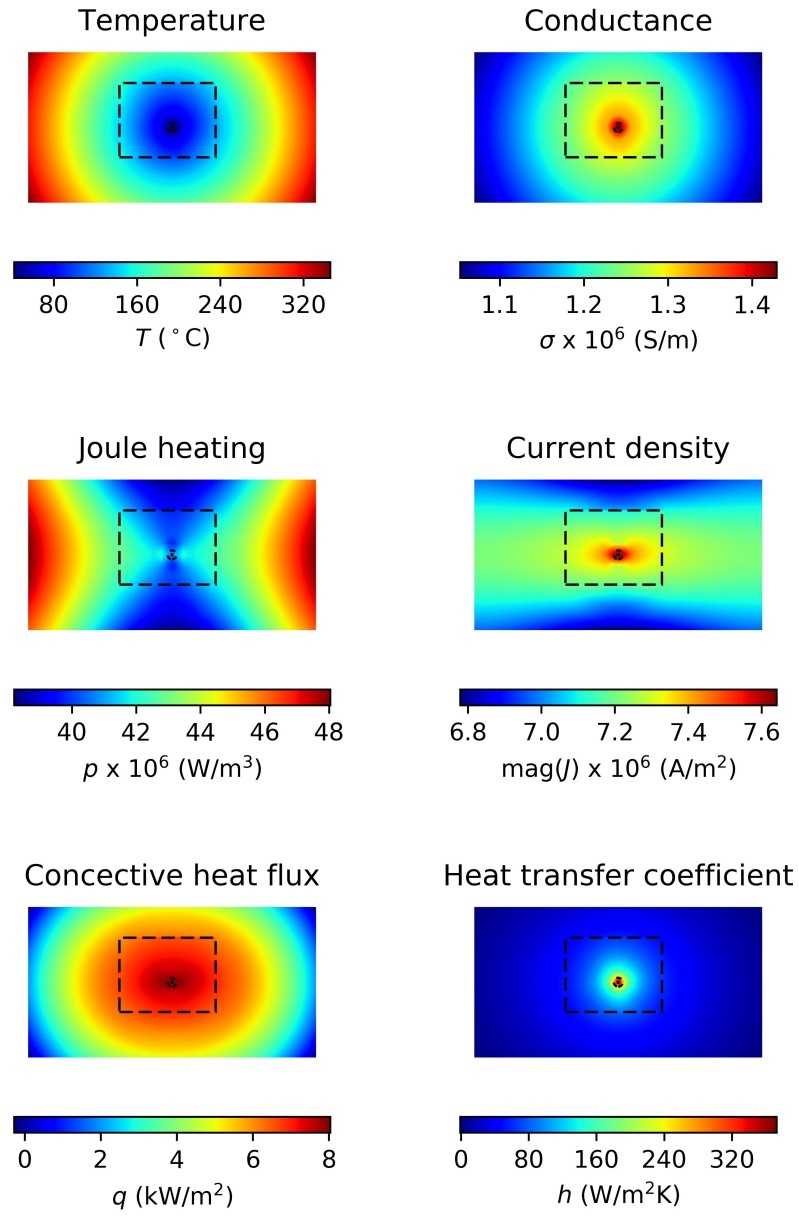


Figure 137: Convection calculation, mikkonen_044

Case id: mikkonen_045

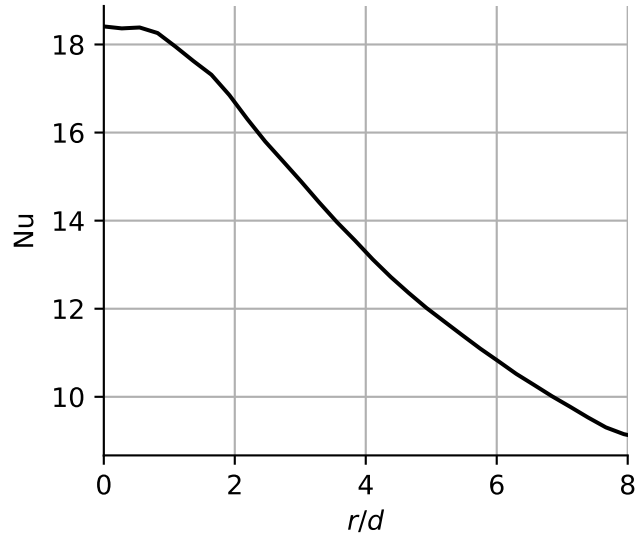


Figure 138: Nu, mikkonen_045

path	2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_3_Lstd_15								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-22 14:19:32								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
19921	0.81	3	0.71	1.1	3.3	21.8	20.4	0.315	280.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.0	243.5	-0.36			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	44.28	44.22	44.63	45.42	46.61	48.14	49.64	51.36	53.11
Nu	18.41	18.38	18.06	17.48	16.69	15.74	14.91	14.07	13.29
h (W/m ² K)	435.28	434.62	426.96	413.17	394.52	372.13	352.54	332.55	314.21
q (kW/m ²)	10.39	10.35	10.34	10.33	10.33	10.31	10.30	10.29	10.27
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	53.11	54.93	56.67	58.39	60.21	62.06	63.89	65.77	67.14
Nu	13.29	12.56	11.94	11.37	10.83	10.33	9.88	9.44	9.13
h (W/m ² K)	314.21	297.08	282.19	268.84	256.16	244.34	233.56	223.28	215.95
q (kW/m ²)	10.27	10.25	10.23	10.20	10.19	10.17	10.15	10.12	10.09

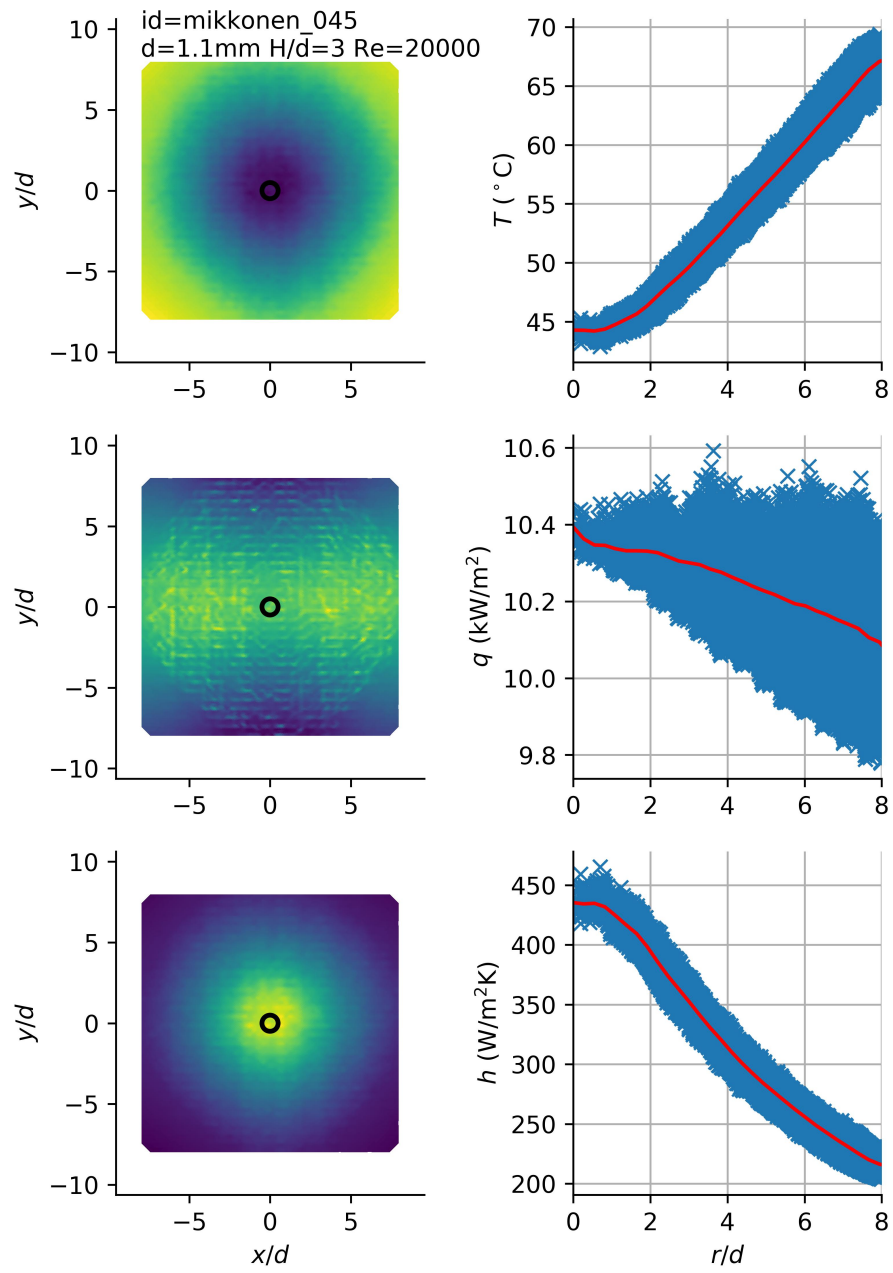


Figure 139: Results, mikkonen_045

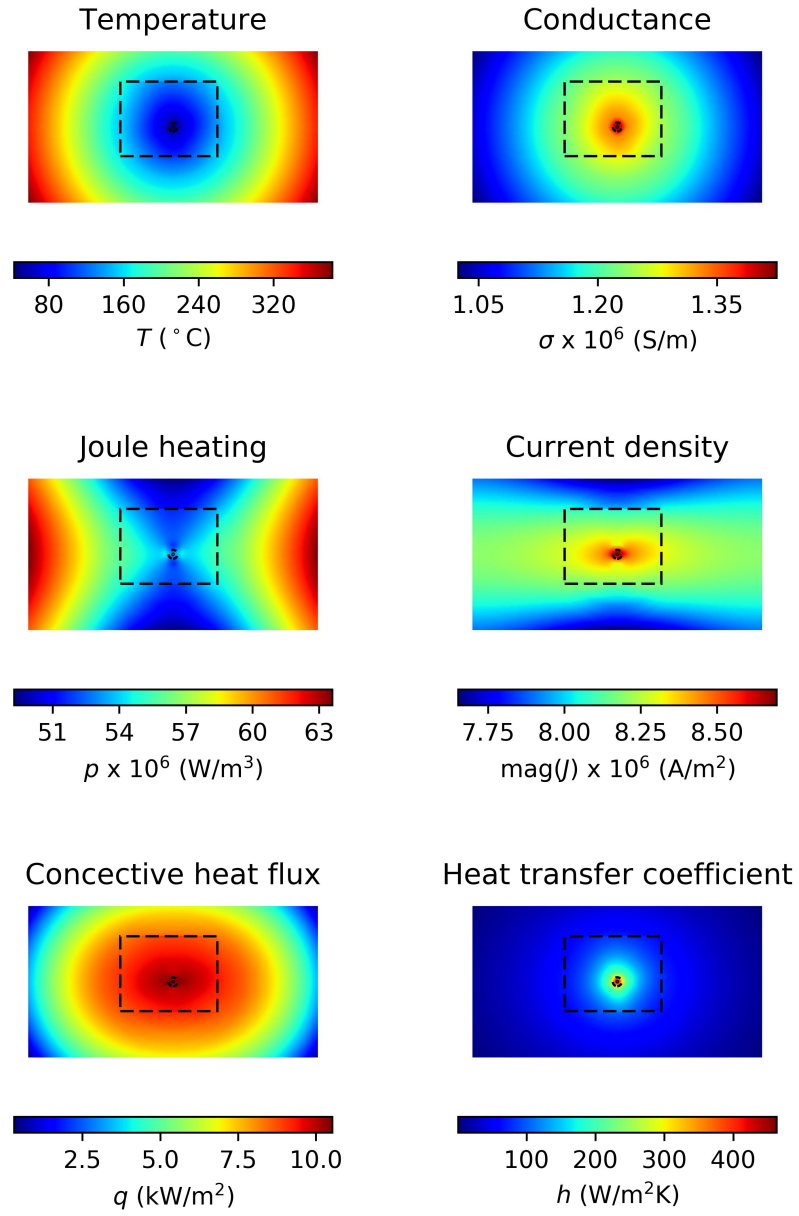


Figure 140: Convection calculation, mikkonen_045

Case id: mikkonen_046

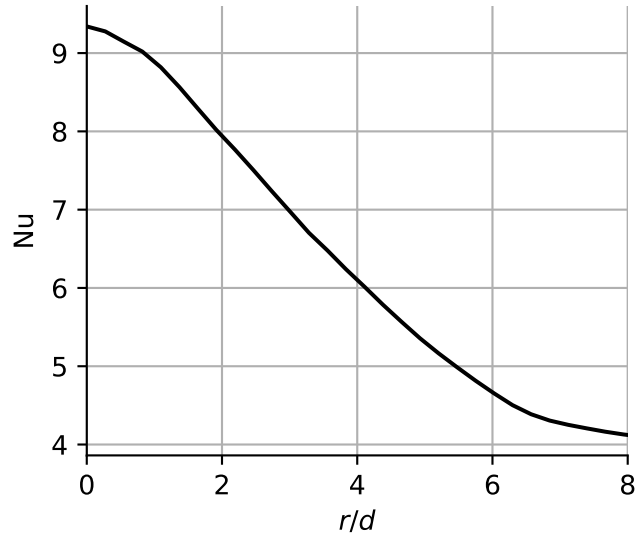


Figure 141: Nu, mikkonen_046

path	2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_6_Lstd_4
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-02-22 14:48:42

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6068	0.25	6	0.71	1.1	6.6	22.1	20.4	0.096	85.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.4	173.6	-1.19	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	43.18	43.61	44.35	45.61	47.08	48.70	50.58	52.53	54.63
Nu	9.34	9.17	8.89	8.43	7.94	7.47	6.98	6.53	6.10
h (W/m ² K)	221.03	216.98	210.34	199.59	187.94	176.77	165.22	154.48	144.42
q (kW/m ²)	5.03	5.03	5.03	5.03	5.01	5.00	4.98	4.96	4.94

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	54.63	56.95	59.35	61.71	64.10	66.04	67.20	68.02	68.69
Nu	6.10	5.69	5.31	4.97	4.67	4.42	4.28	4.19	4.12
h (W/m ² K)	144.42	134.67	125.58	117.67	110.45	104.53	101.17	99.15	97.54
q (kW/m ²)	4.94	4.91	4.89	4.85	4.82	4.77	4.73	4.72	4.71

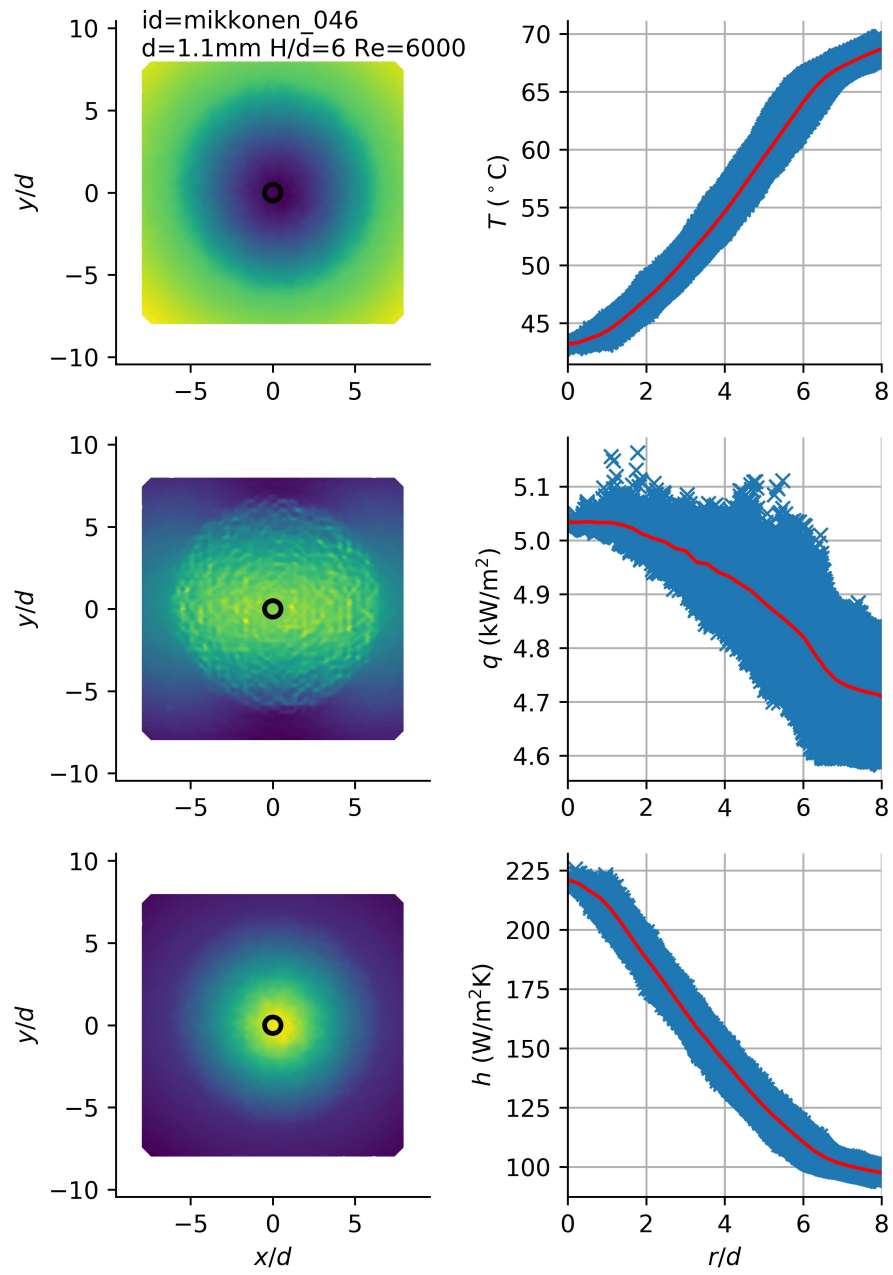


Figure 142: Results, mikkonen_046

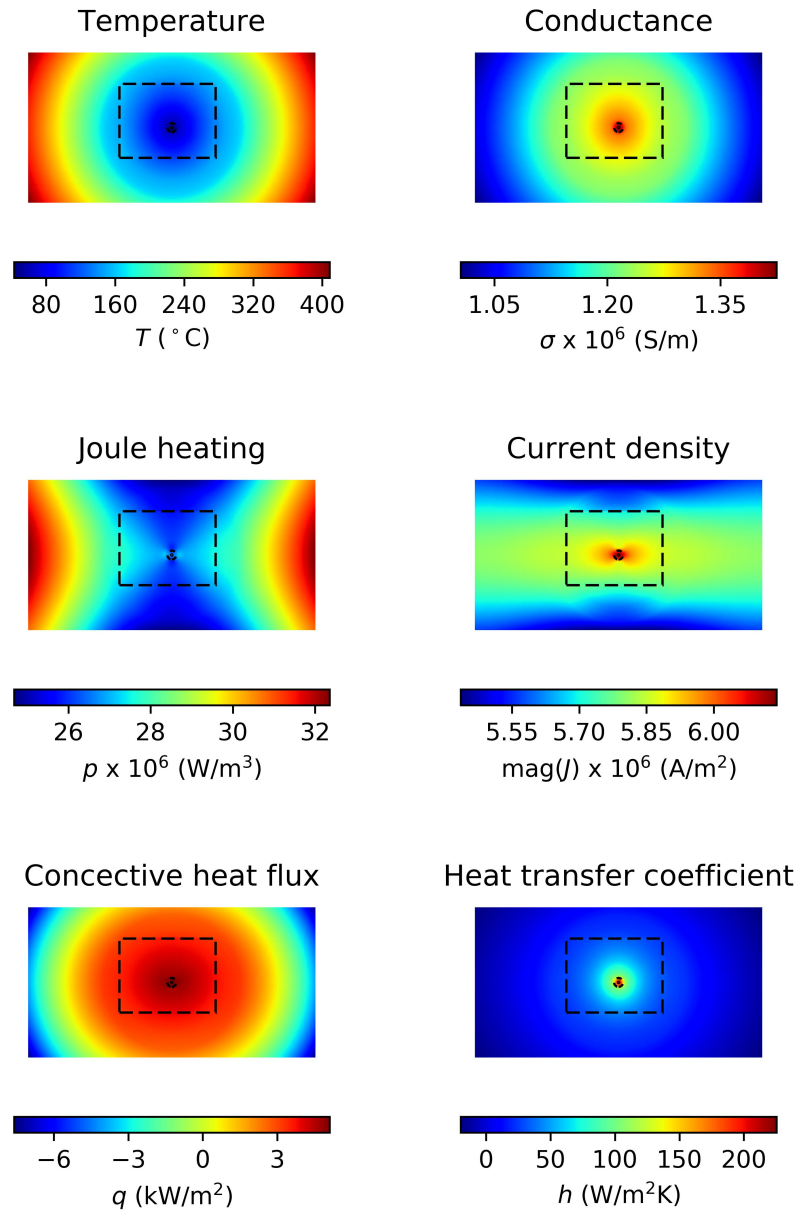


Figure 143: Convection calculation, mikkonen_046

Case id: mikkonen_047

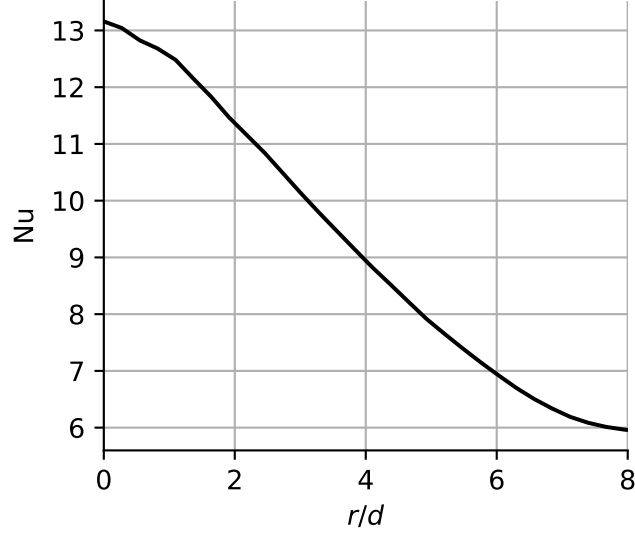


Figure 144: Nu, mikkonen_047

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_6_Lstd_7							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 14:45:00							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9886	0.40	6	0.71	1.1	6.6	22.1	20.4	0.156	139.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.6	201.4	-0.25				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	42.88	43.38	43.97	45.05	46.36	47.72	49.39	51.18	53.14
Nu	13.16	12.86	12.55	12.00	11.37	10.79	10.14	9.54	8.94
h (W/m ² K)	311.39	304.42	297.02	283.85	268.99	255.26	240.05	225.64	211.63
q (kW/m ²)	7.00	6.99	7.00	6.99	6.97	6.96	6.95	6.93	6.91
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	53.14	55.23	57.49	59.70	62.01	64.20	66.00	67.21	67.89
Nu	8.94	8.39	7.85	7.38	6.94	6.56	6.25	6.06	5.96
h (W/m ² K)	211.63	198.47	185.70	174.61	164.33	155.15	148.01	143.36	141.01
q (kW/m ²)	6.91	6.90	6.87	6.85	6.82	6.79	6.74	6.71	6.70

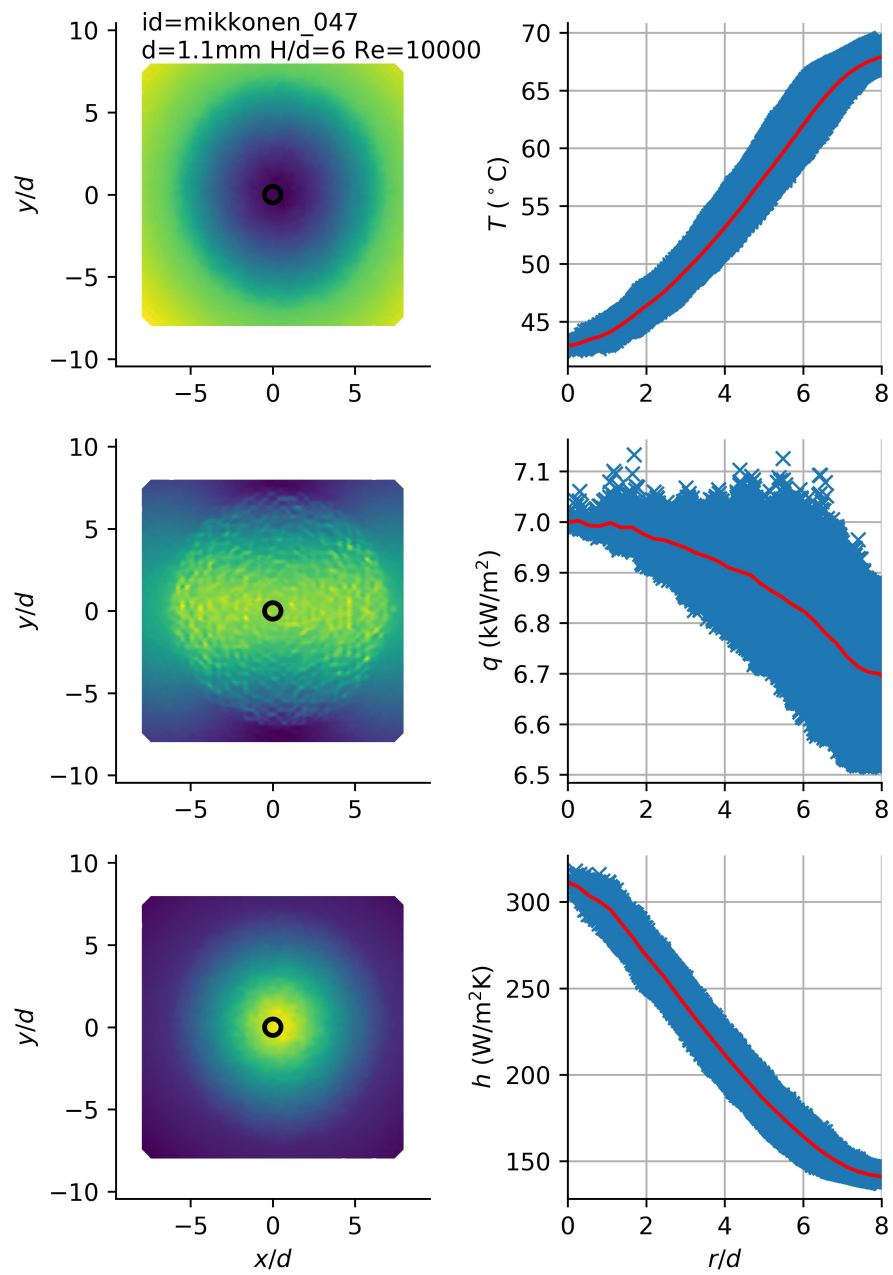


Figure 145: Results, mikkonen_047

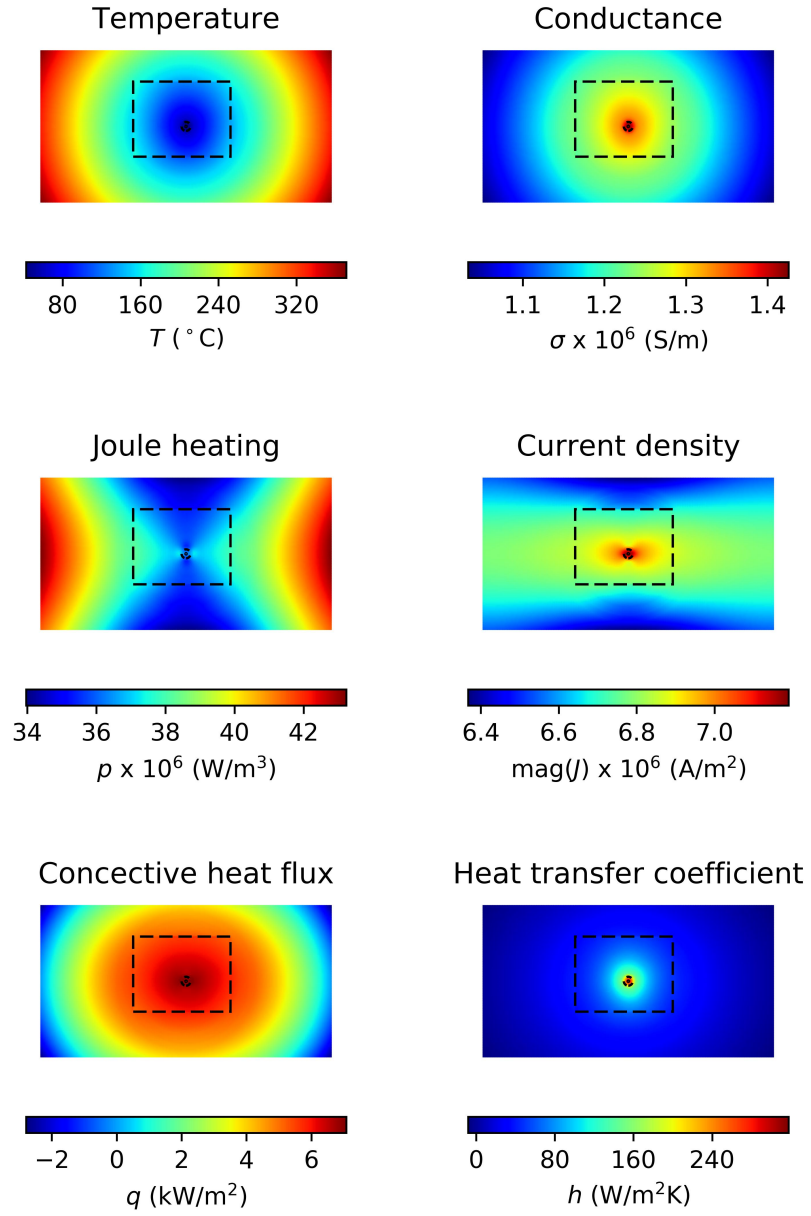


Figure 146: Convection calculation, mikkonen_047

Case id: mikkonen_048

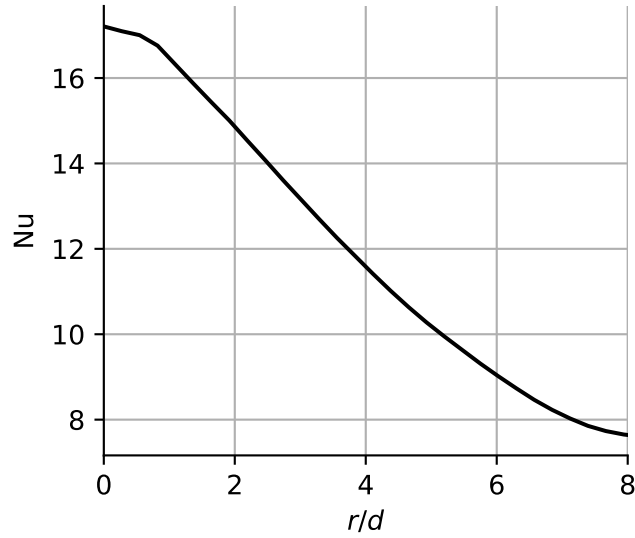


Figure 147: Nu, mikkonen_048

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_6_Lstd_11							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 14:38:03							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13842	0.57	6	0.71	1.1	6.6	21.8	20.4	0.219	194.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.8	221.0	1.53			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.94	42.17	42.93	44.05	45.30	46.77	48.40	50.21	52.14
Nu	17.21	17.02	16.47	15.66	14.86	14.02	13.17	12.35	11.58
h (W/m ² K)	406.87	402.40	389.36	370.28	351.41	331.38	311.48	292.10	273.87
q (kW/m ²)	8.76	8.76	8.77	8.75	8.75	8.73	8.72	8.70	8.69
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	52.14	54.22	56.31	58.43	60.67	62.94	64.92	66.44	67.28
Nu	11.58	10.85	10.19	9.60	9.04	8.54	8.12	7.81	7.64
h (W/m ² K)	273.87	256.54	240.93	227.00	213.80	201.81	191.89	184.58	180.66
q (kW/m ²)	8.69	8.67	8.65	8.63	8.60	8.58	8.54	8.50	8.47

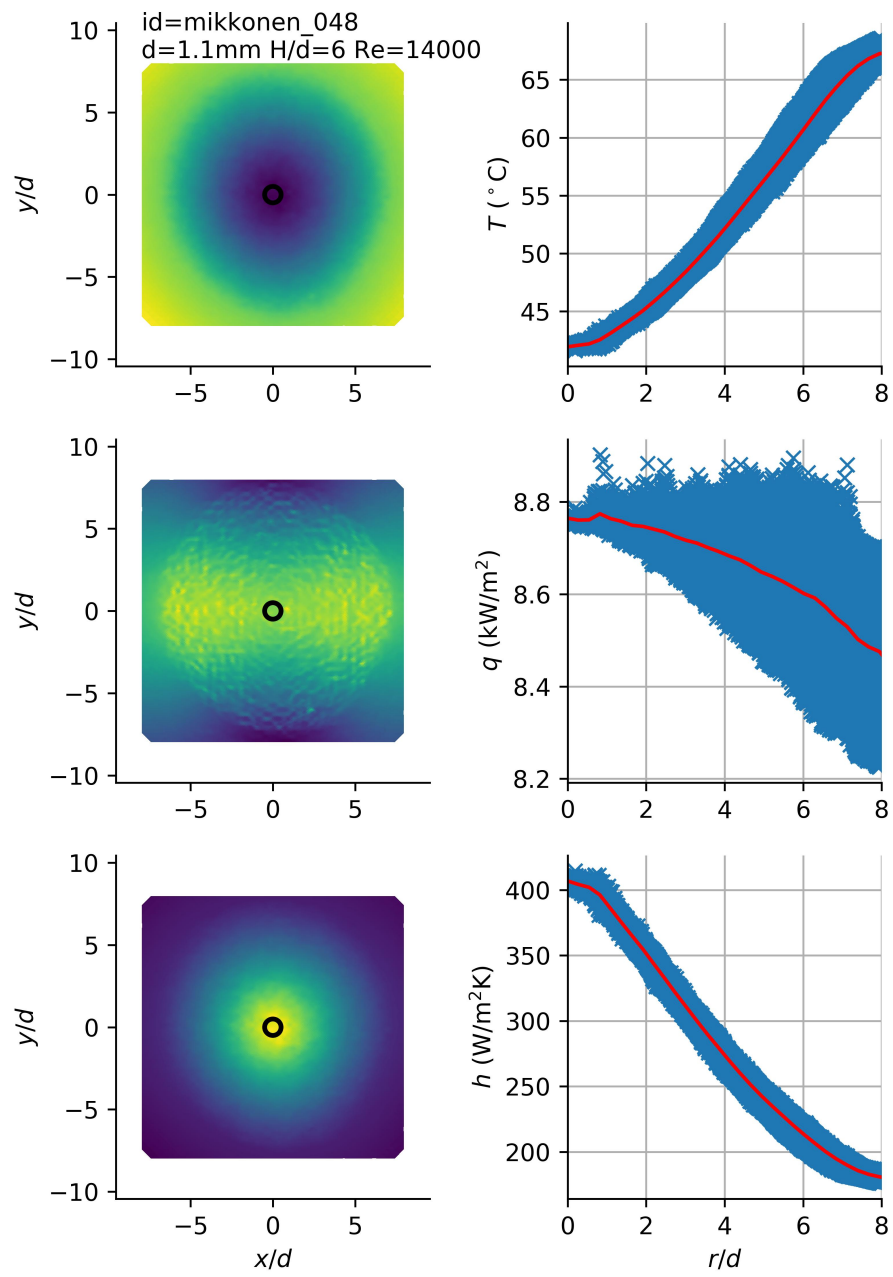


Figure 148: Results, mikkonen_048

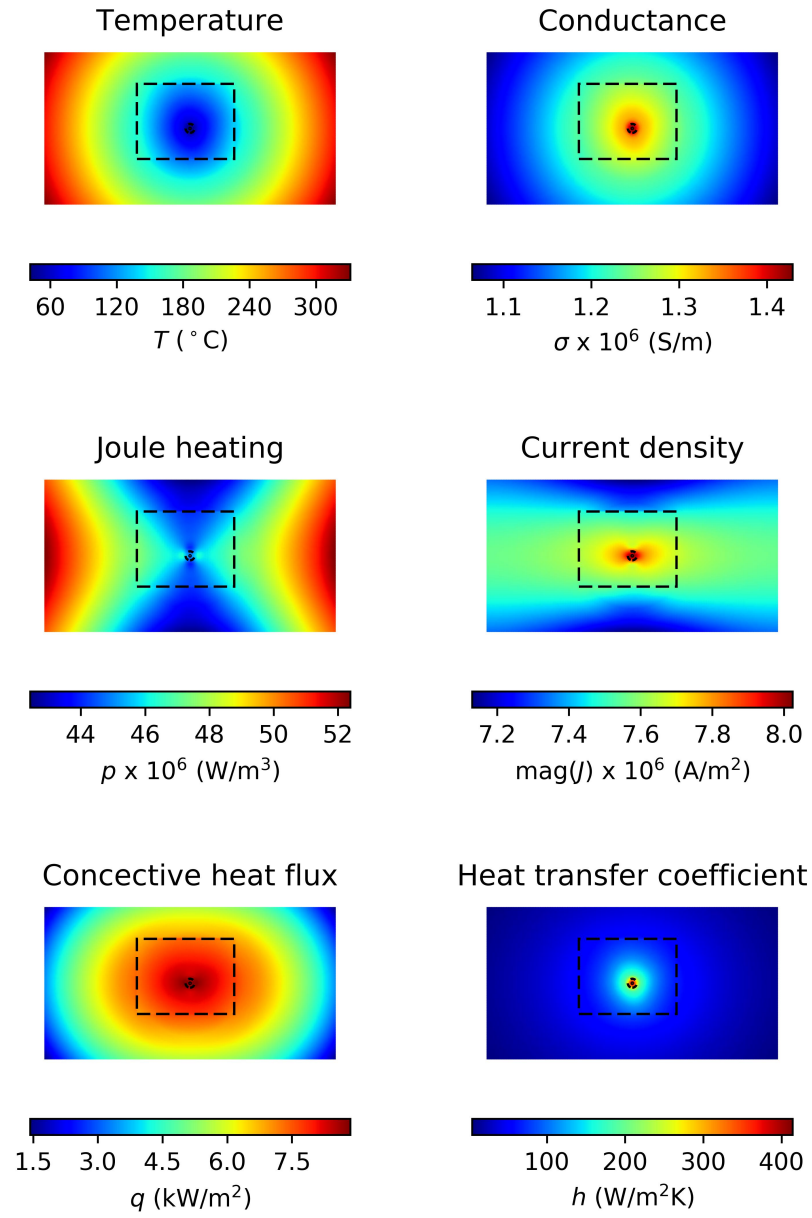


Figure 149: Convection calculation, mikkonen_048

Case id: mikkonen_049

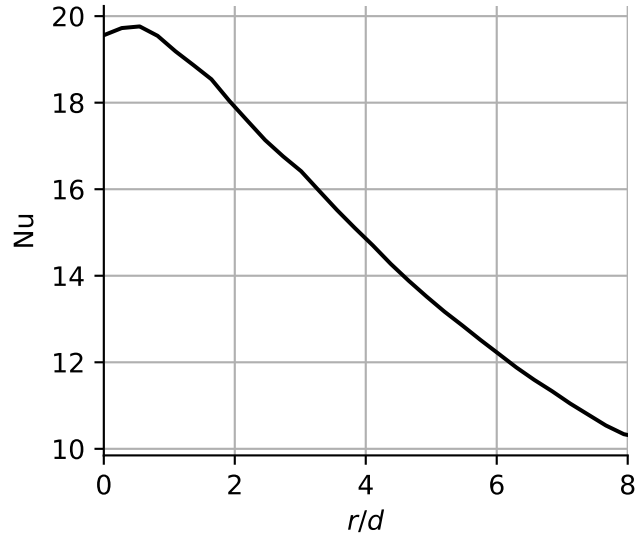


Figure 150: Nu, mikkonen_049

path		2017_02_22_hidasSarja_1mm_HD1,2,3,6/1mm_Hd_6_Lstd_15							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-22 14:32:29							
Re	Ma	H/d	Pr	d (mm)	H (mm)	T _{n,t} (°C)	T _∞ (°C)	$\dot{m}$ (g/s)	V _n (m/s)
20286	0.83	6	0.71	1.1	6.6	21.6	20.4	0.320	285.2
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.9	234.0	0.73			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.32	41.11	41.58	42.25	43.21	44.28	45.21	46.49	47.79
Nu	19.56	19.76	19.31	18.71	17.90	17.09	16.43	15.62	14.86
h (W/m ² K)	462.18	466.83	456.32	442.16	423.06	403.73	388.30	369.05	351.13
q (kW/m ²)	9.67	9.67	9.66	9.65	9.64	9.64	9.63	9.62	9.61
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.79	49.22	50.63	52.02	53.51	55.04	56.54	58.09	59.41
Nu	14.86	14.11	13.43	12.82	12.23	11.67	11.17	10.69	10.32
h (W/m ² K)	351.13	333.32	317.31	302.95	288.98	275.77	263.99	252.71	243.87
q (kW/m ²)	9.61	9.59	9.58	9.57	9.55	9.53	9.52	9.50	9.49

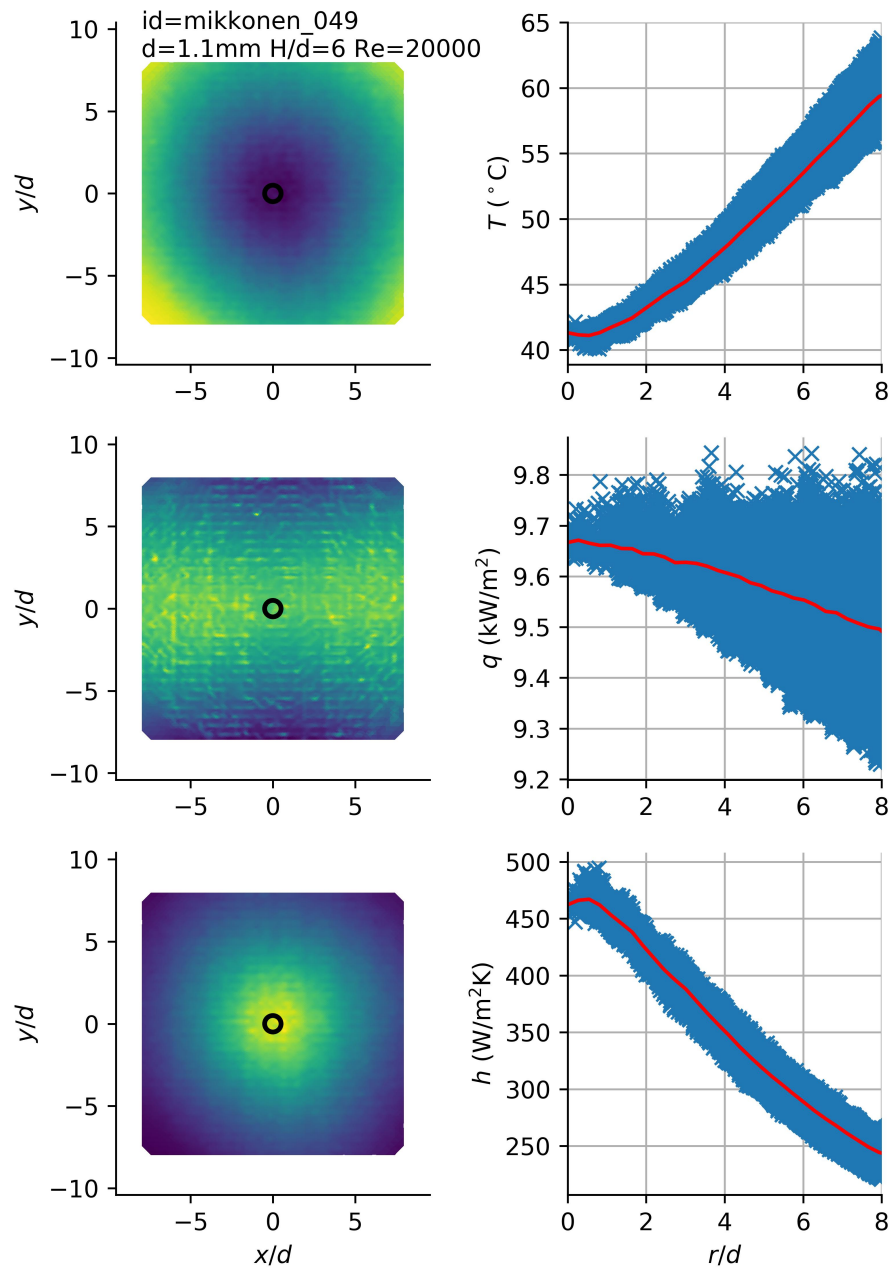


Figure 151: Results, mikkonen_049

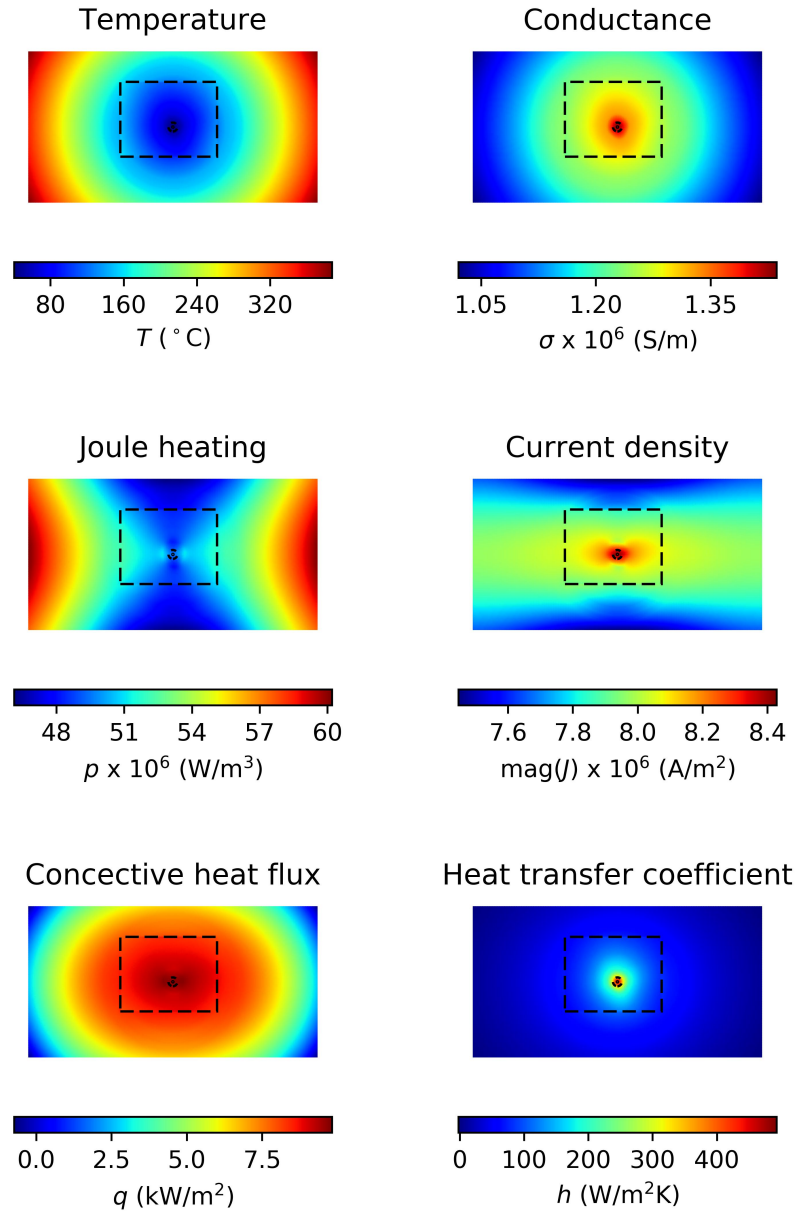


Figure 152: Convection calculation, mikkonen_049

Case id: mikkonen_050

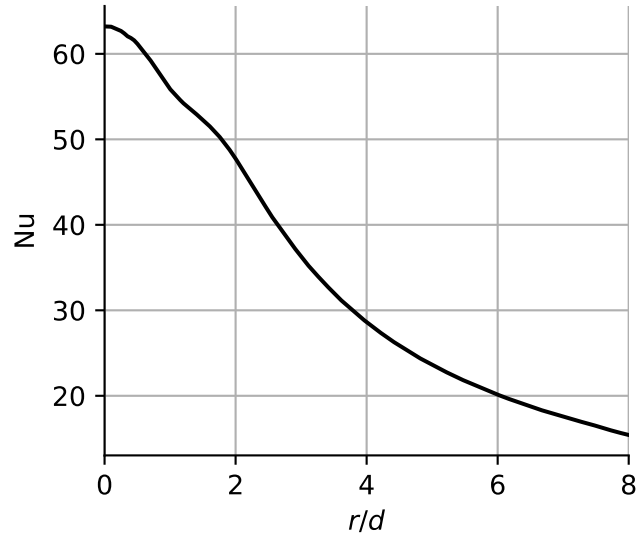


Figure 153: Nu, mikkonen_050

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_1_Lstd_43							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 13:58:46							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
10096	0.08	1	0.71	6.0	6.0	20.0	20.1	0.866	25.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.4	182.1	3.40			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.61	42.30	44.30	45.88	48.21	52.11	56.44	60.88	65.27
Nu	63.21	61.18	55.89	52.29	47.74	41.59	36.29	32.01	28.62
h (W/m ² K)	272.57	263.83	241.00	225.49	205.88	179.32	156.50	138.02	123.40
q (kW/m ²)	5.86	5.86	5.83	5.81	5.79	5.74	5.69	5.63	5.57
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	65.27	69.52	73.67	77.66	81.61	85.43	89.15	92.88	96.82
Nu	28.62	25.87	23.61	21.74	20.13	18.75	17.55	16.48	15.42
h (W/m ² K)	123.40	111.57	101.83	93.75	86.80	80.83	75.67	71.07	66.48
q (kW/m ²)	5.57	5.51	5.45	5.40	5.34	5.28	5.22	5.17	5.10

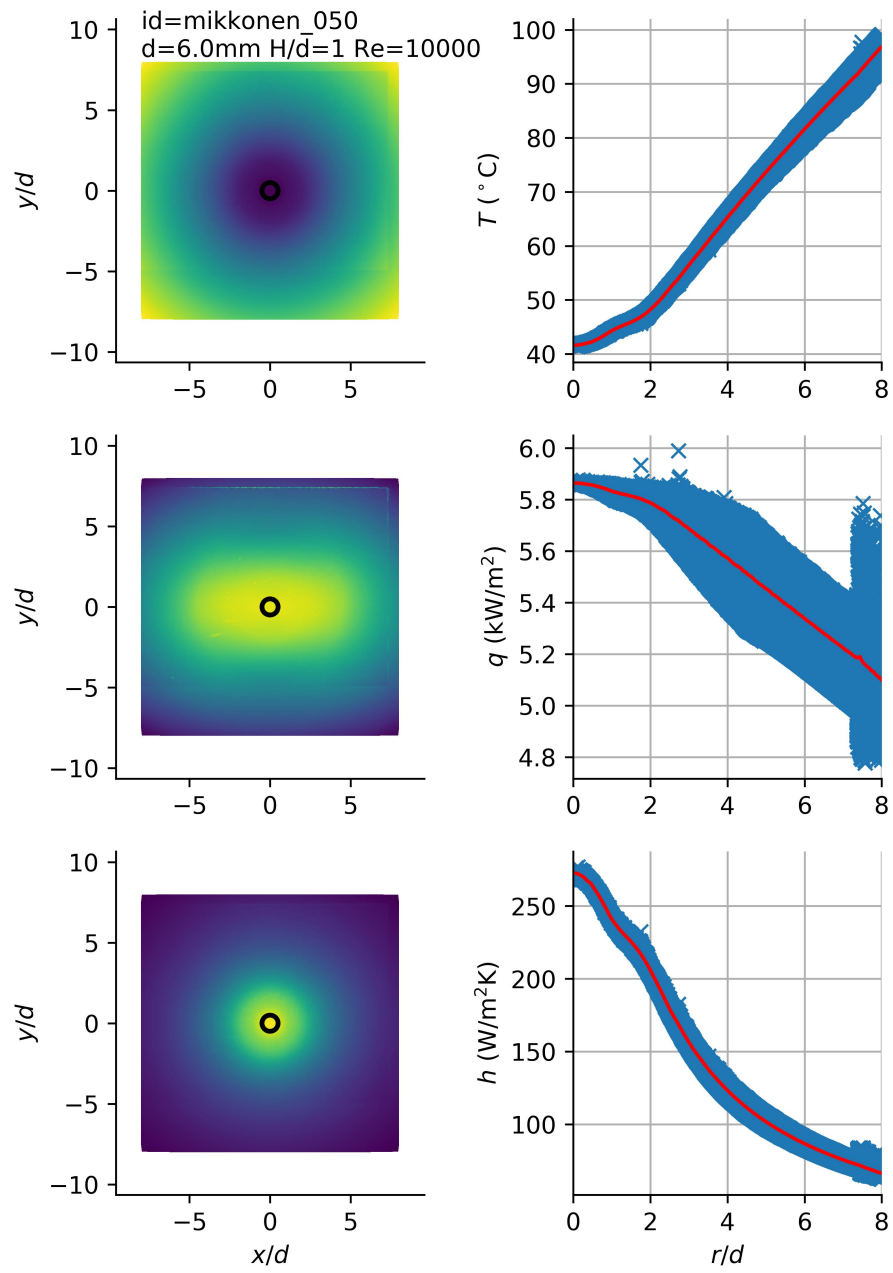


Figure 154: Results, mikkonen_050

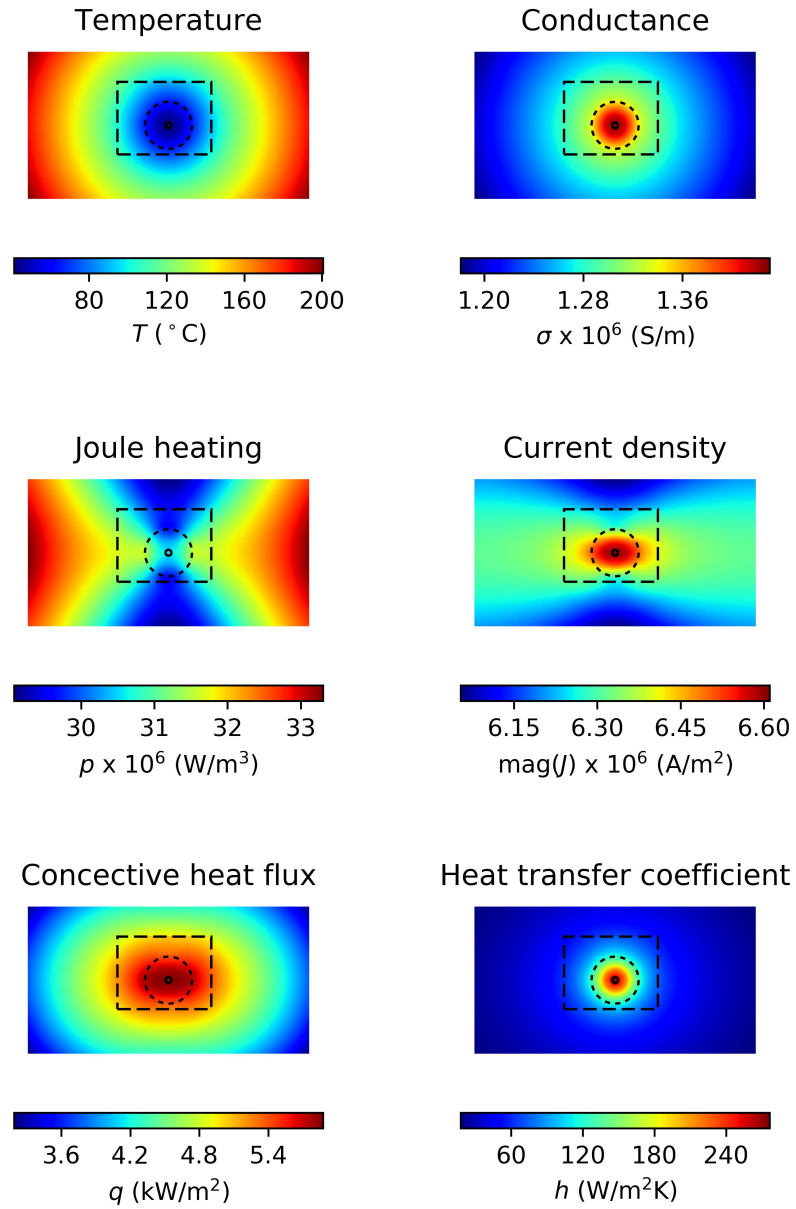


Figure 155: Convection calculation, mikkonen_050

Case id: mikkonen_051

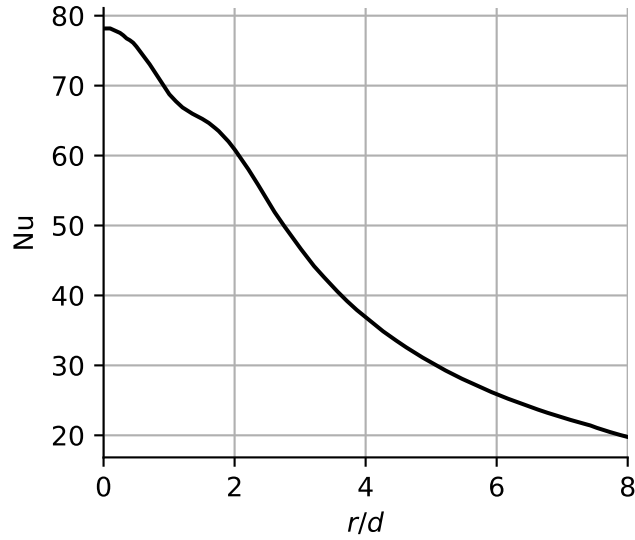


Figure 156: Nu, mikkonen_051

path	2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_1_Lstd_60								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-27 14:05:57								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14097	0.10	1	0.71	6.0	6.0	19.8	20.1	1.209	35.9
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.6	202.5	3.13			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.68	42.38	44.50	45.77	47.55	51.09	55.36	59.77	64.15
Nu	78.17	75.61	68.81	65.28	60.88	53.61	46.78	41.24	36.86
h (W/m ² K)	336.88	325.84	296.54	281.32	262.37	231.05	201.63	177.74	158.87
q (kW/m ²)	7.27	7.26	7.24	7.22	7.20	7.16	7.11	7.05	7.00
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	64.15	68.42	72.63	76.71	80.74	84.67	88.49	92.41	96.61
Nu	36.86	33.33	30.39	27.96	25.88	24.09	22.55	21.16	19.76
h (W/m ² K)	158.87	143.63	130.99	120.48	111.52	103.84	97.20	91.18	85.17
q (kW/m ²)	7.00	6.94	6.88	6.82	6.76	6.70	6.65	6.59	6.52

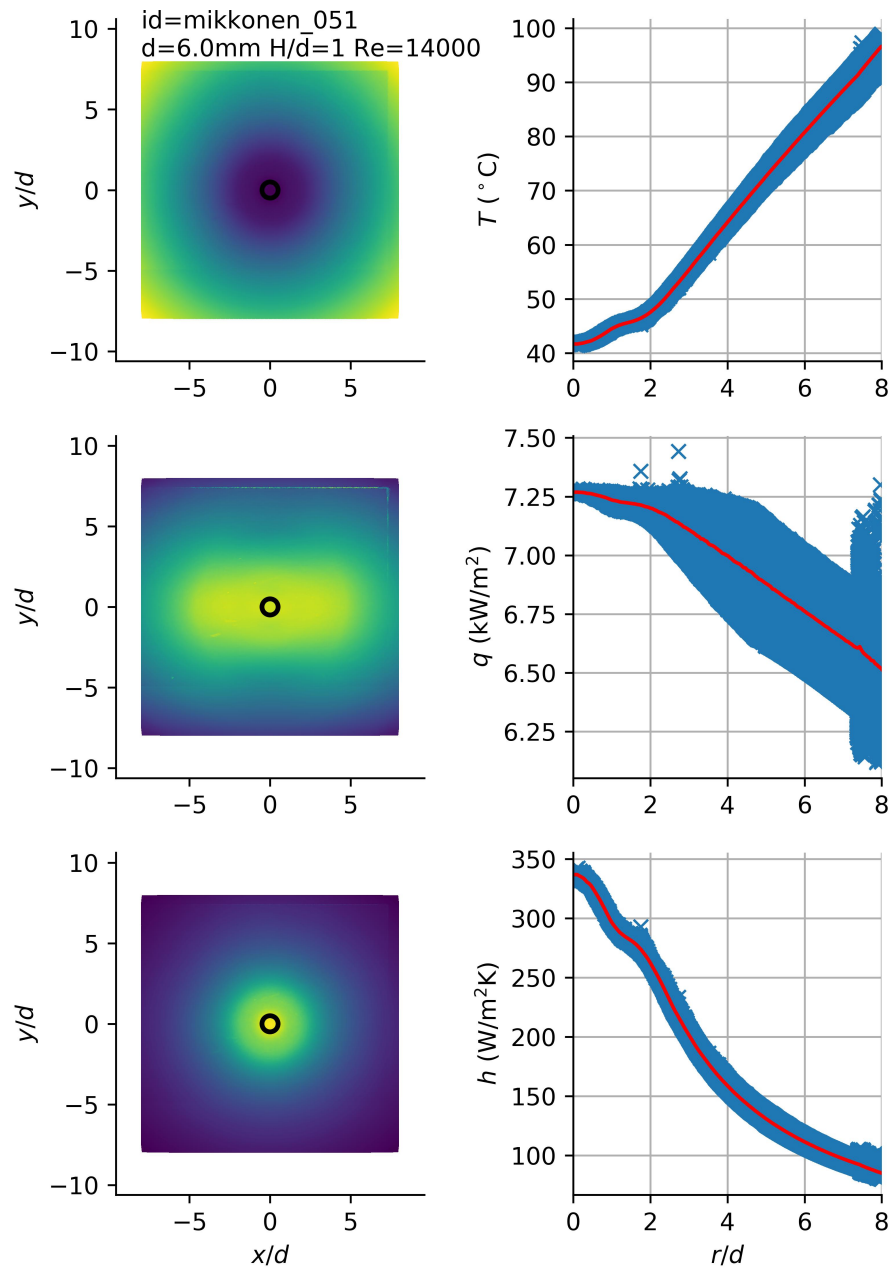


Figure 157: Results, mikkonen_051

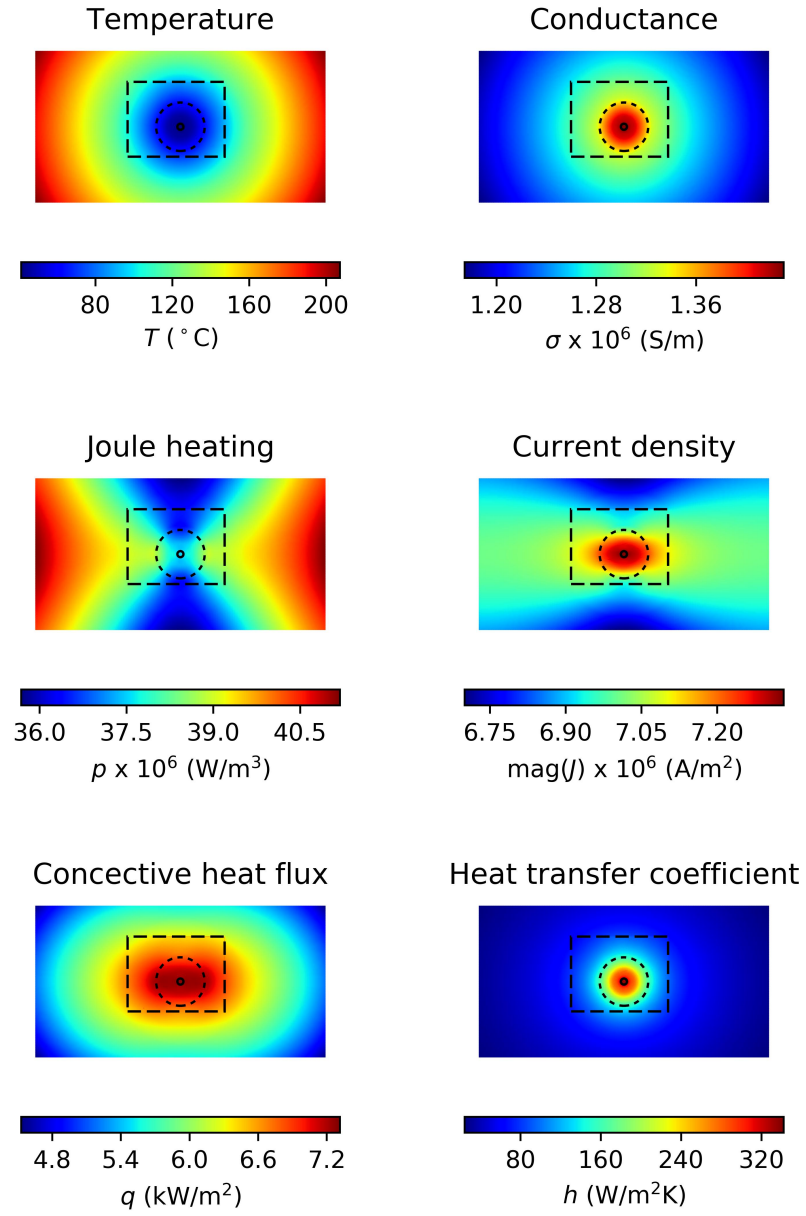


Figure 158: Convection calculation, mikkonen_051

Case id: mikkonen_052

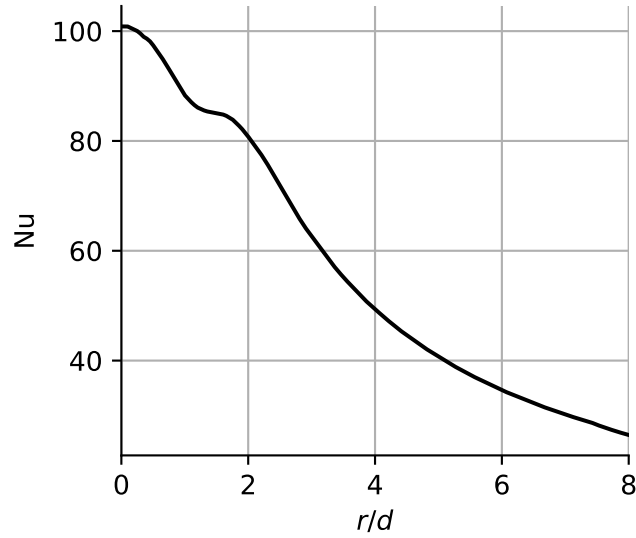


Figure 159: Nu, mikkonen_052

path	2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_1_Lstd_86								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-27 14:13:18								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20109	0.15	1	0.71	6.0	6.0	19.5	20.1	1.723	51.2
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.8	225.3	4.12			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.34	42.07	44.26	45.16	46.45	49.59	53.78	58.09	62.36
Nu	100.86	97.44	88.34	85.08	80.78	71.91	62.64	55.19	49.35
h (W/m ² K)	434.28	419.58	380.40	366.36	347.86	309.64	269.71	237.67	212.48
q (kW/m ²)	9.23	9.22	9.19	9.18	9.17	9.13	9.08	9.03	8.98
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	62.36	66.53	70.69	74.76	78.79	82.71	86.56	90.52	94.75
Nu	49.35	44.63	40.70	37.41	34.62	32.24	30.18	28.30	26.45
h (W/m ² K)	212.48	192.16	175.25	161.11	149.09	138.83	129.95	121.87	113.91
q (kW/m ²)	8.98	8.92	8.87	8.81	8.75	8.69	8.64	8.58	8.50

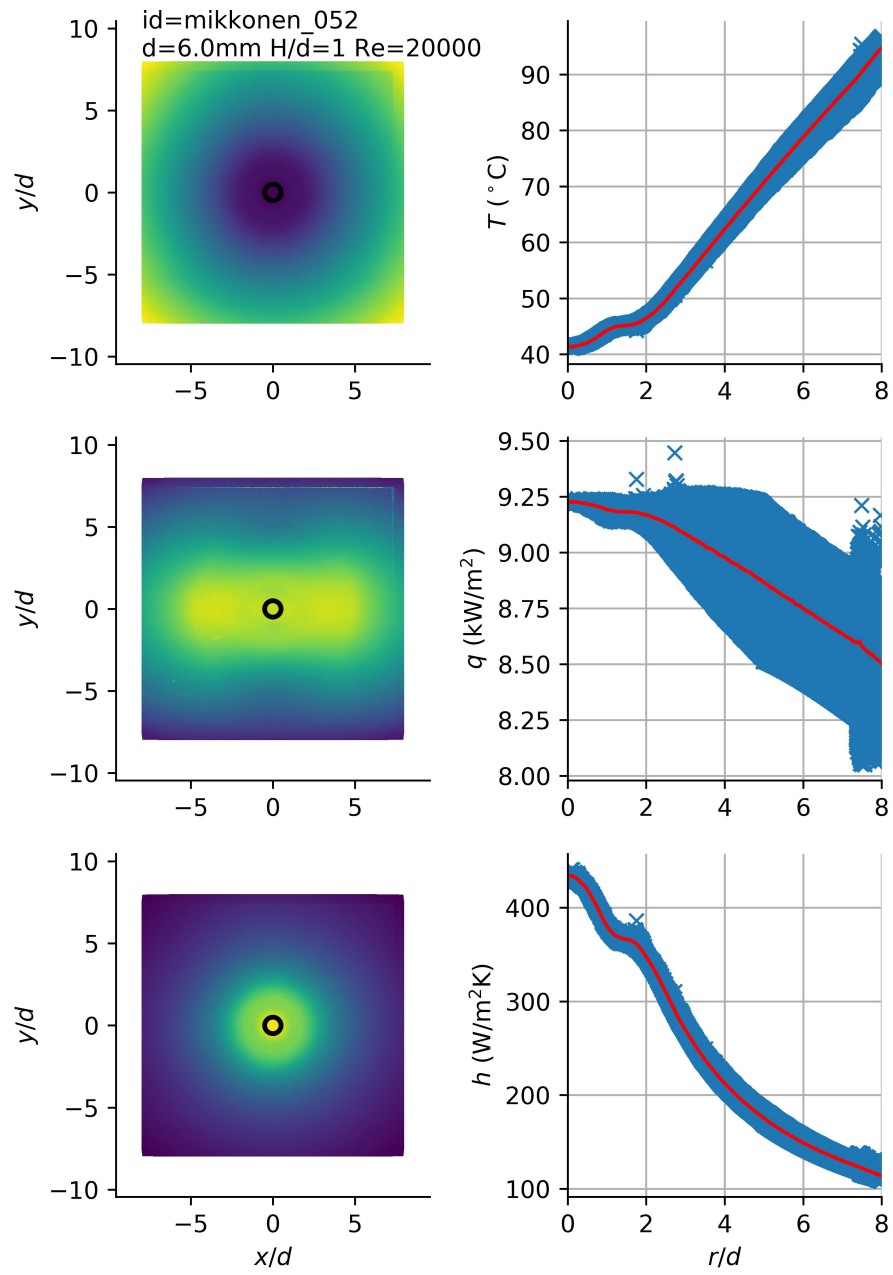


Figure 160: Results, mikkonen_052

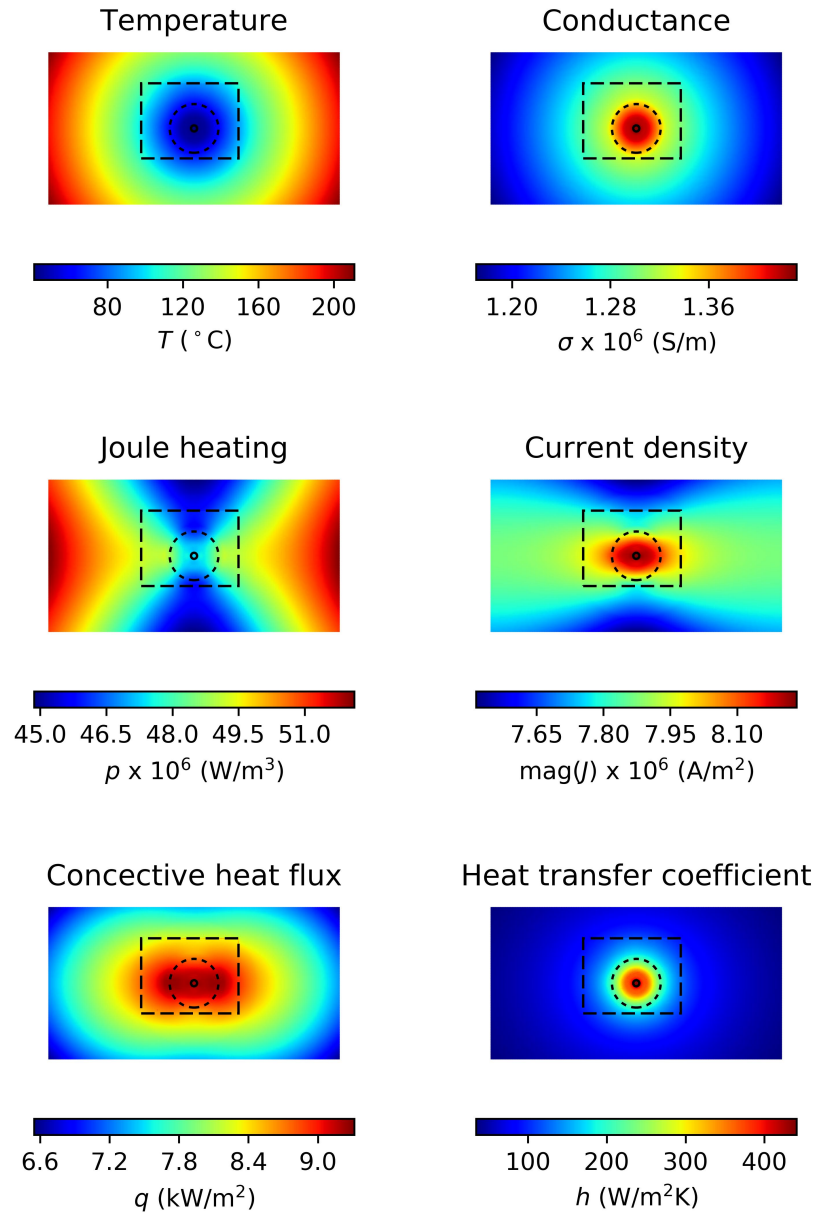


Figure 161: Convection calculation, mikkonen_052

Case id: mikkonen_053

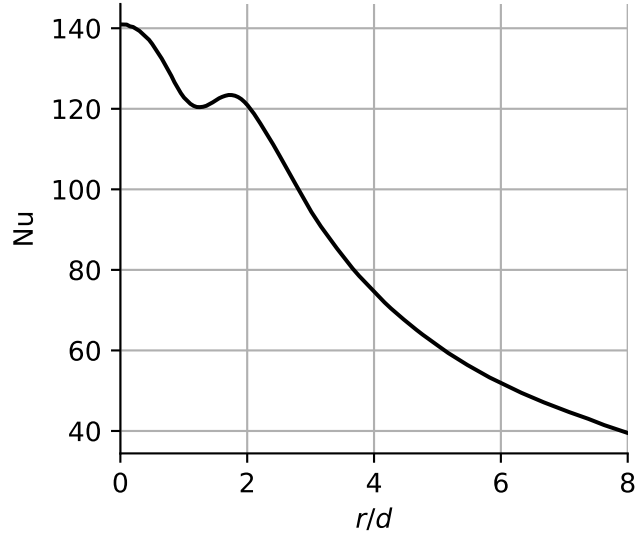


Figure 162: Nu, mikkonen_053

path	2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_1_Lstd_150								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-27 14:17:54								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
34981	0.26	1	0.71	6.0	6.0	19.3	20.1	2.995	88.9
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.1	269.5	3.18			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.60	42.35	44.71	44.87	45.09	47.85	51.83	55.94	60.10
Nu	140.95	136.14	122.86	122.05	120.97	108.66	94.70	83.52	74.56
h (W/m ² K)	606.58	585.86	528.74	525.23	520.58	467.62	407.56	359.43	320.87
q (kW/m ²)	13.04	13.04	13.01	13.01	13.01	12.97	12.93	12.88	12.83
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	60.10	64.25	68.39	72.53	76.59	80.53	84.44	88.54	92.81
Nu	74.56	67.27	61.27	56.14	51.88	48.27	45.14	42.23	39.50
h (W/m ² K)	320.87	289.48	263.67	241.60	223.26	207.73	194.25	181.76	170.01
q (kW/m ²)	12.83	12.78	12.73	12.67	12.61	12.55	12.50	12.44	12.36

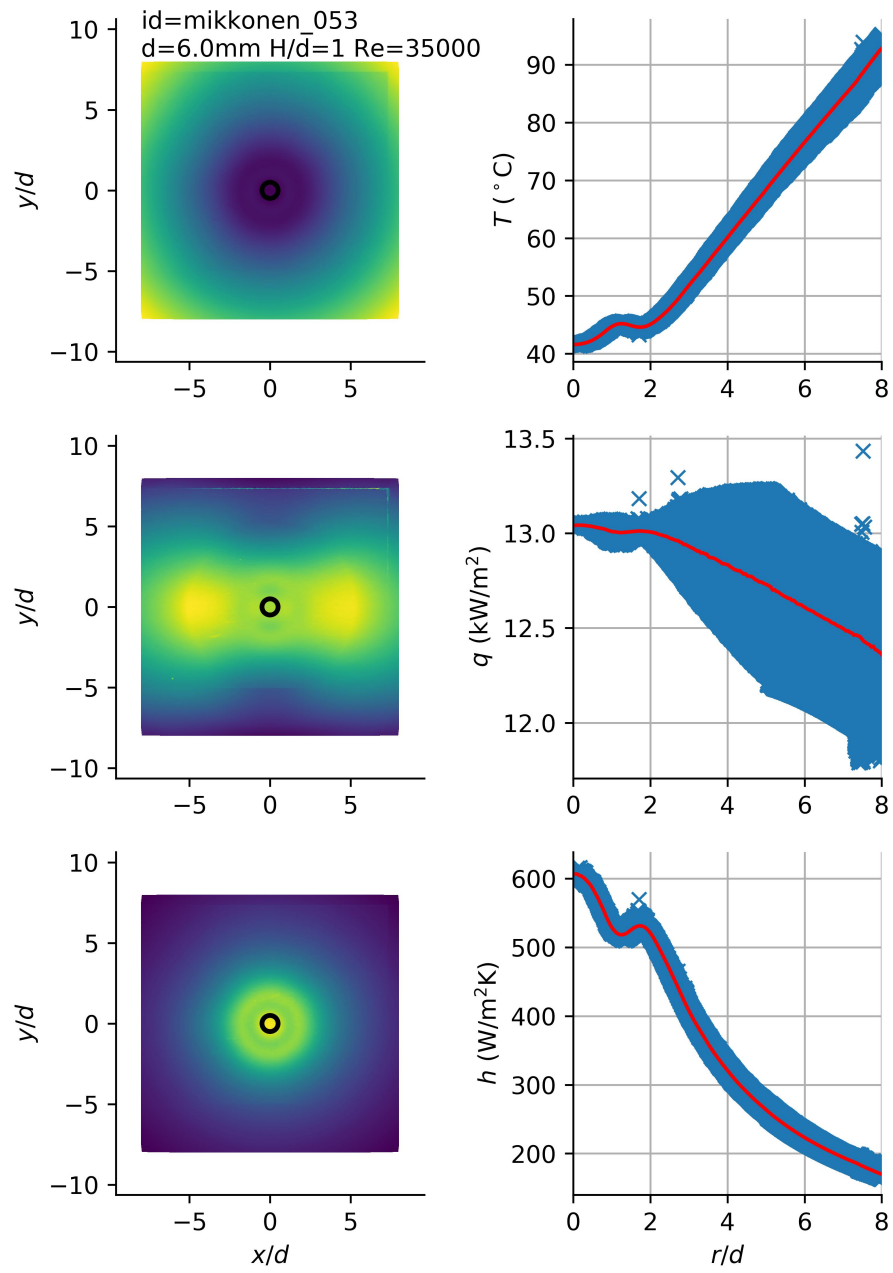


Figure 163: Results, mikkonen_053

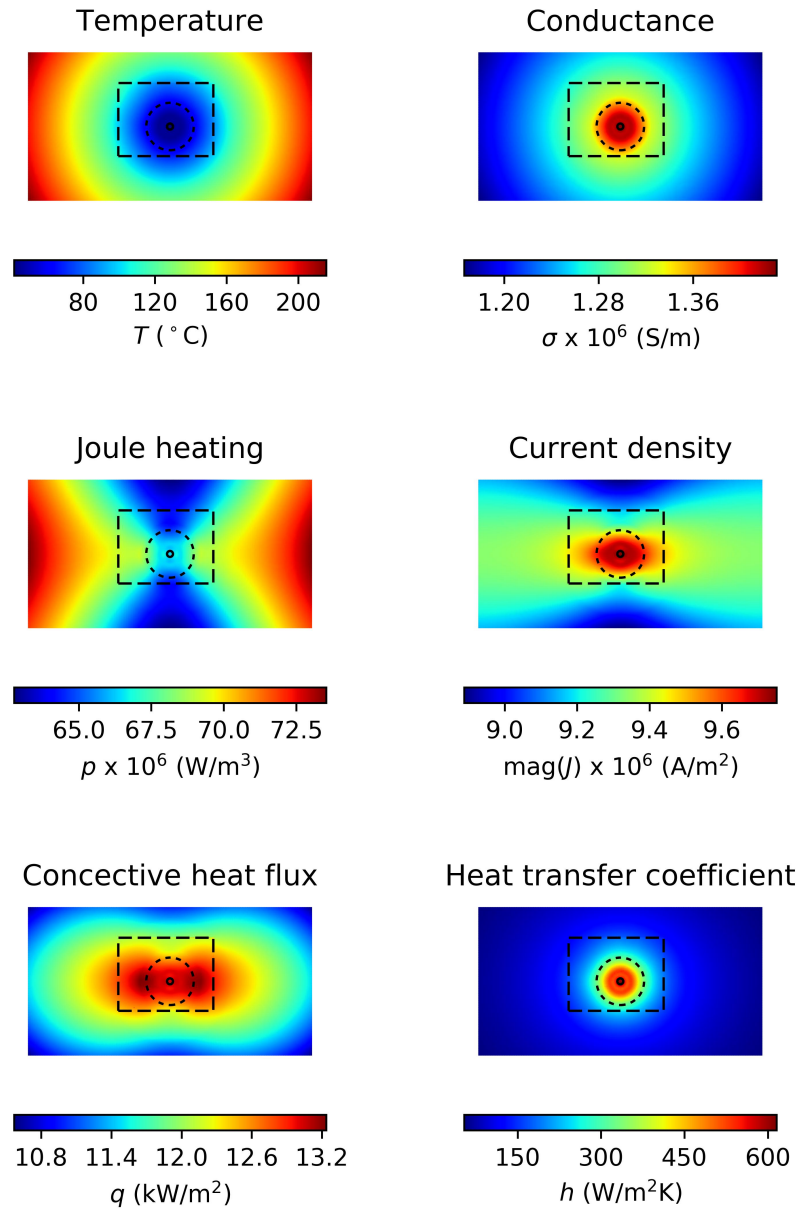


Figure 164: Convection calculation, mikkonen_053

Case id: mikkonen_054

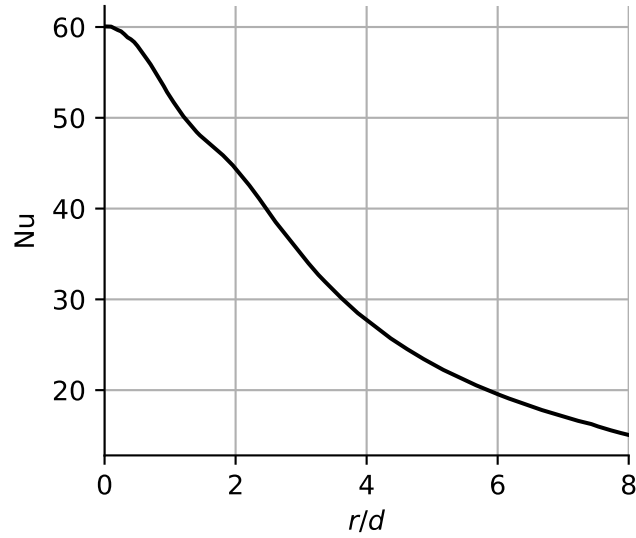


Figure 165: Nu, mikkonen_054

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_2_Lstd_43							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 14:39:58							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
10008	0.07	2	0.71	6.0	12.0	20.3	20.1	0.859	25.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.4	176.0	3.66			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.20	41.95	44.19	46.33	48.22	51.38	55.24	59.39	63.55
Nu	60.06	57.93	52.29	47.79	44.40	39.64	34.97	30.95	27.71
h (W/m ² K)	259.24	250.04	225.68	206.28	191.63	171.07	150.91	133.59	119.61
q (kW/m ²)	5.47	5.46	5.44	5.41	5.39	5.35	5.30	5.25	5.20
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	63.55	67.61	71.57	75.36	79.08	82.68	86.17	89.65	93.30
Nu	27.71	25.07	22.89	21.09	19.55	18.23	17.09	16.07	15.06
h (W/m ² K)	119.61	108.21	98.81	91.04	84.39	78.68	73.74	69.37	65.01
q (kW/m ²)	5.20	5.14	5.09	5.03	4.98	4.92	4.87	4.82	4.76

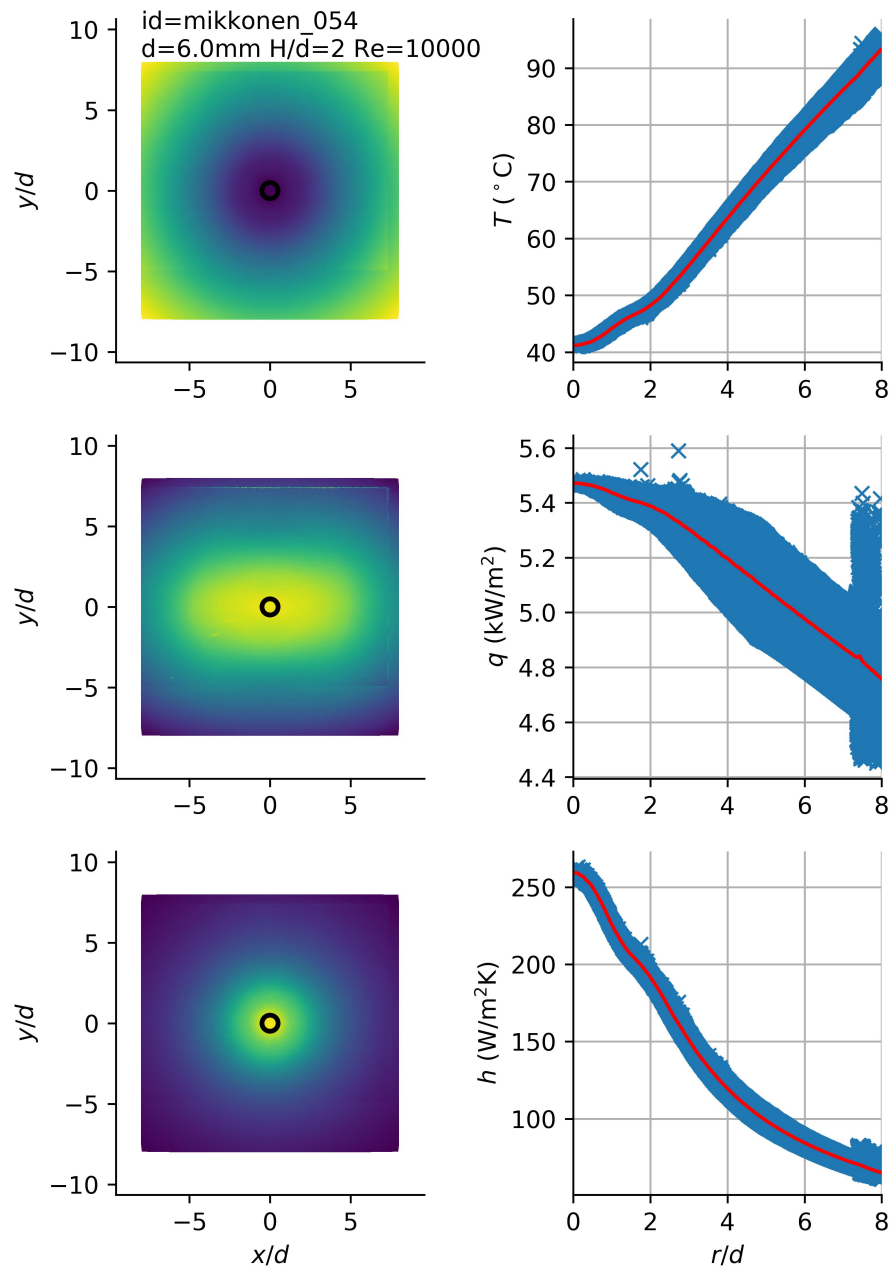


Figure 166: Results, mikkonen_054

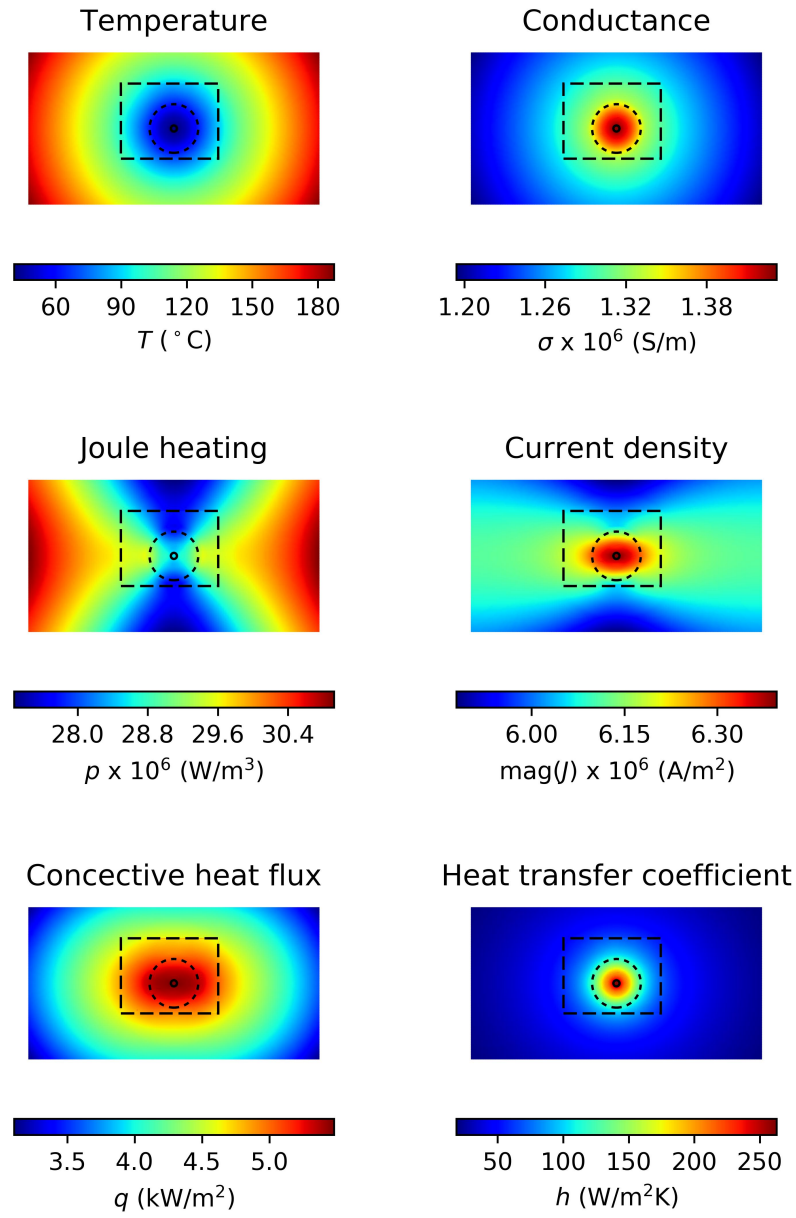


Figure 167: Convection calculation, mikkonen_054

Case id: mikkonen_055

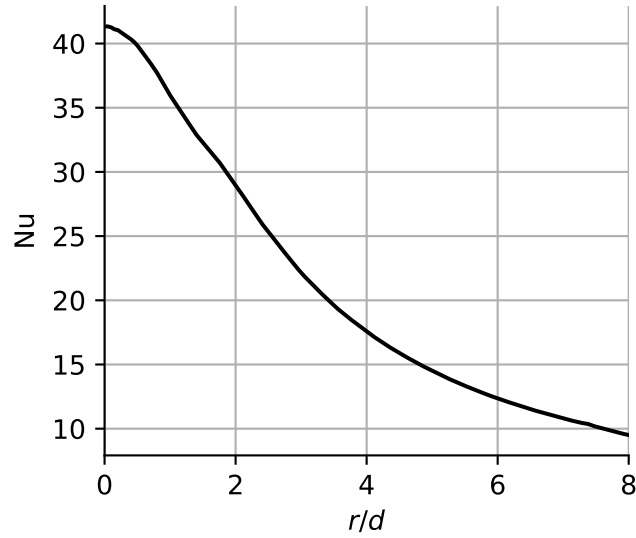


Figure 168: Nu, mikkonen_055

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_2_Lstd_25							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 14:46:28							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
5944	0.04	2	0.71	6.0	12.0	20.7	20.1	0.511	15.2
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.1	148.3	2.73				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.04	41.77	43.94	46.44	49.19	52.98	57.14	61.31	65.40
Nu	41.33	39.85	35.98	32.29	28.99	25.31	22.15	19.60	17.56
h (W/m ² K)	178.60	172.18	155.45	139.53	125.27	109.38	95.70	84.71	75.89
q (kW/m ²)	3.74	3.73	3.71	3.68	3.64	3.60	3.54	3.49	3.44
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	65.40	69.36	73.18	76.88	80.43	83.80	87.01	90.23	93.57
Nu	17.56	15.89	14.51	13.34	12.36	11.52	10.80	10.16	9.51
h (W/m ² K)	75.89	68.67	62.69	57.64	53.39	49.78	46.67	43.89	41.09
q (kW/m ²)	3.44	3.38	3.33	3.27	3.22	3.17	3.12	3.08	3.02

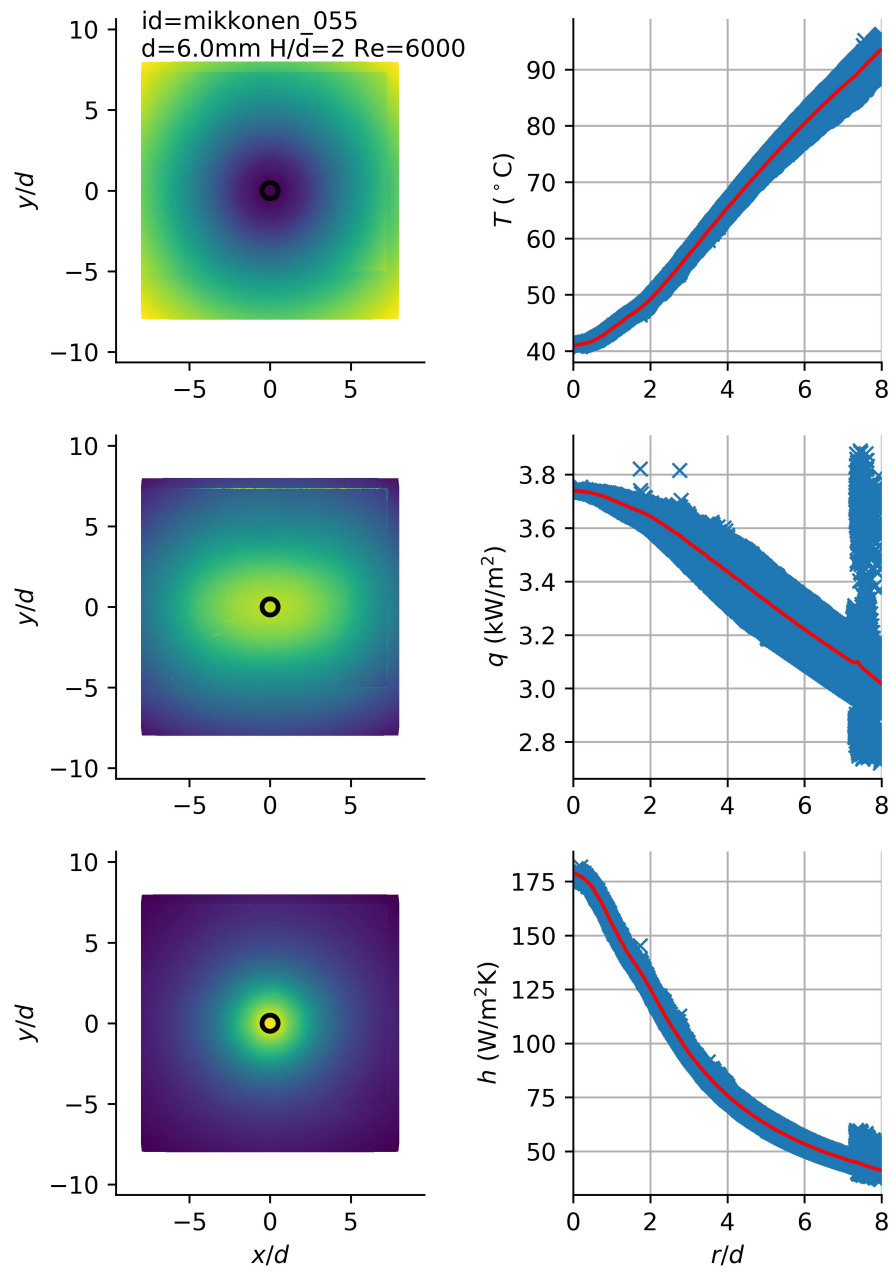


Figure 169: Results, mikkonen_055

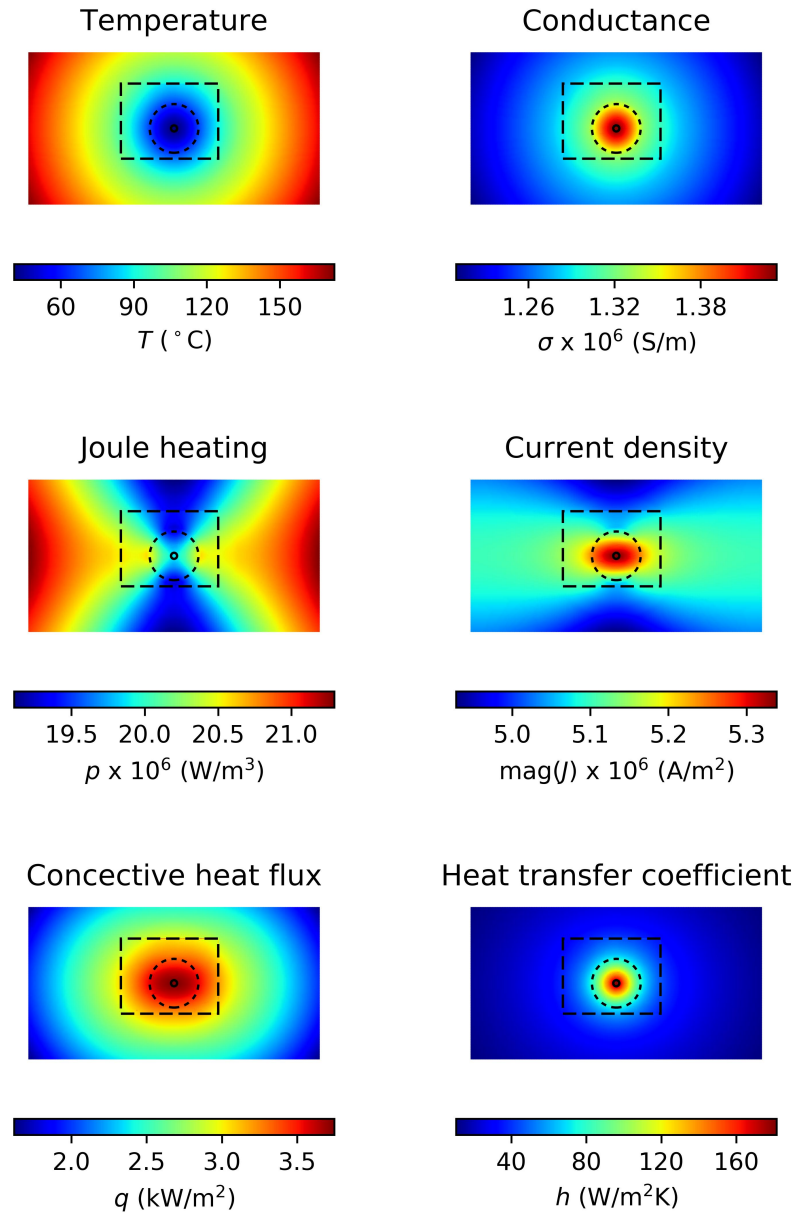


Figure 170: Convection calculation, mikkonen_055

Case id: mikkonen_056

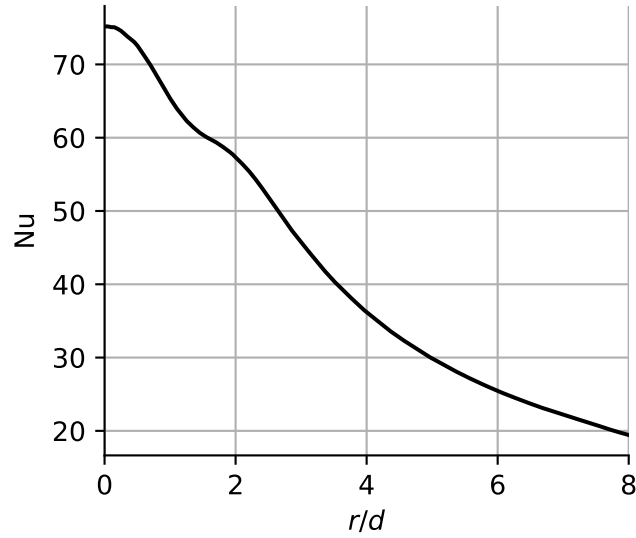


Figure 171: Nu, mikkonen_056

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_2_Lstd_60							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 14:35:34							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13981	0.10	2	0.71	6.0	12.0	20.1	20.1	1.200	35.7
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.5	197.4	2.73				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.15	41.88	44.19	46.08	47.40	50.11	53.93	58.05	62.19
Nu	75.18	72.57	65.36	60.39	57.34	51.91	45.75	40.45	36.19
h (W/m ² K)	324.29	313.03	281.94	260.47	247.35	223.93	197.35	174.48	156.12
q (kW/m ²)	6.83	6.82	6.79	6.77	6.75	6.72	6.67	6.62	6.57
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	62.19	66.24	70.24	74.12	77.95	81.67	85.33	89.08	93.09
Nu	36.19	32.74	29.88	27.49	25.46	23.71	22.19	20.81	19.44
h (W/m ² K)	156.12	141.22	128.87	118.59	109.80	102.27	95.72	89.76	83.85
q (kW/m ²)	6.57	6.52	6.46	6.40	6.35	6.30	6.24	6.19	6.12

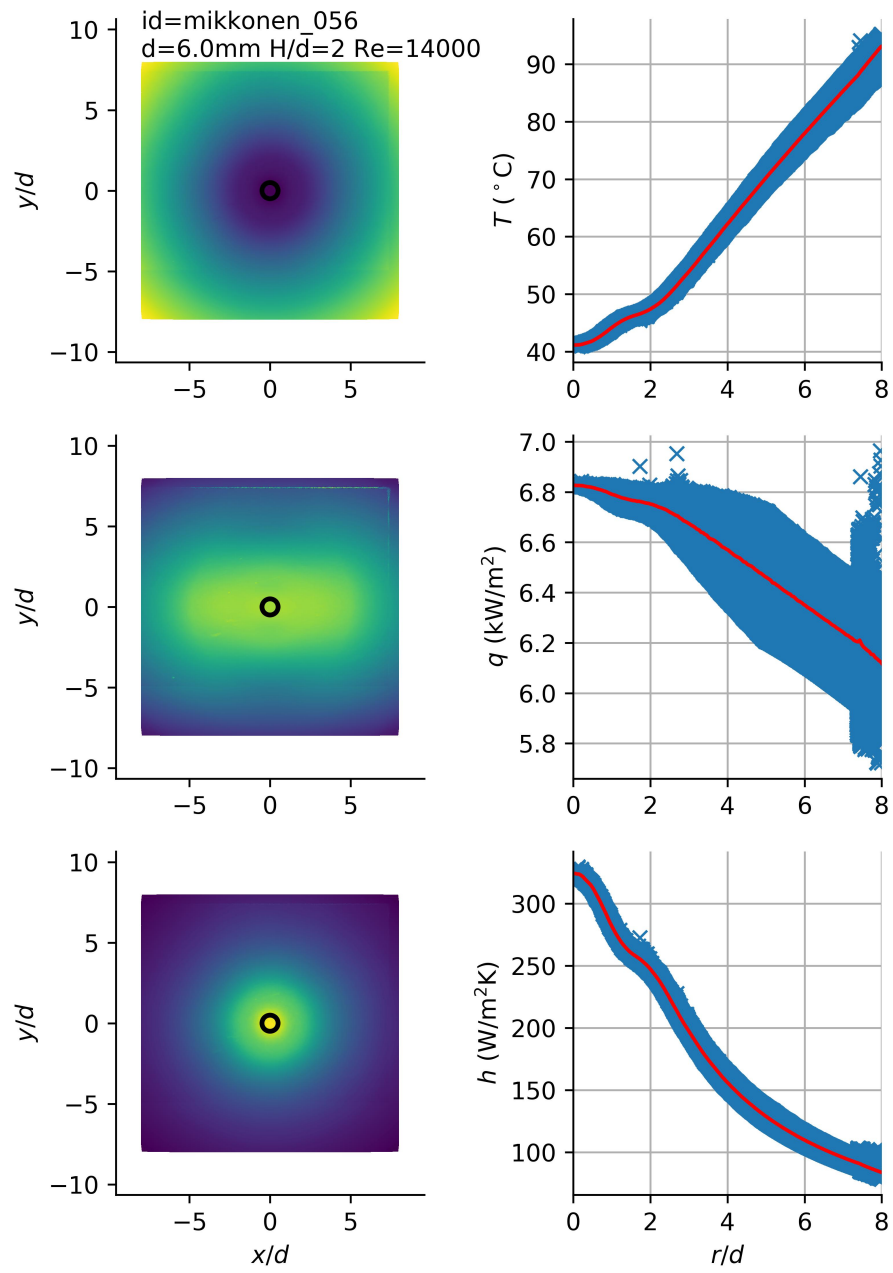


Figure 172: Results, mikkonen_056

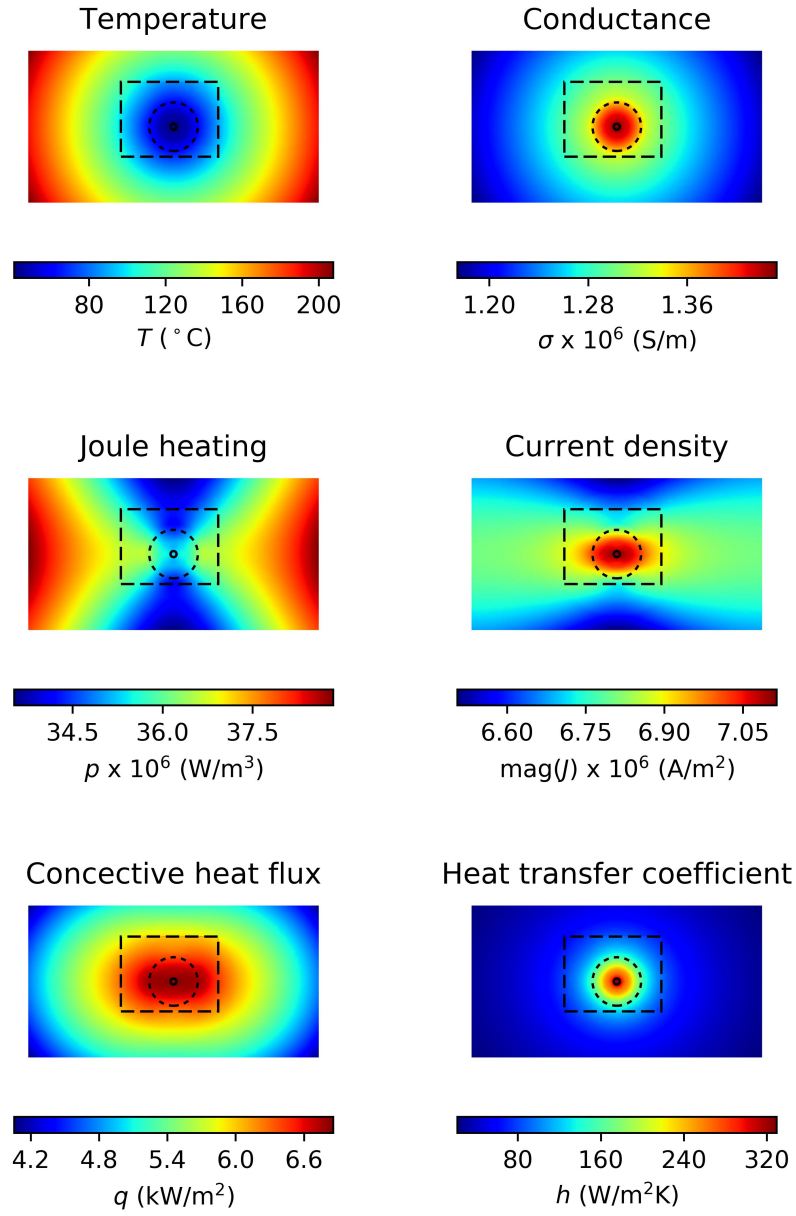


Figure 173: Convection calculation, mikkonen_056

Case id: mikkonen_057

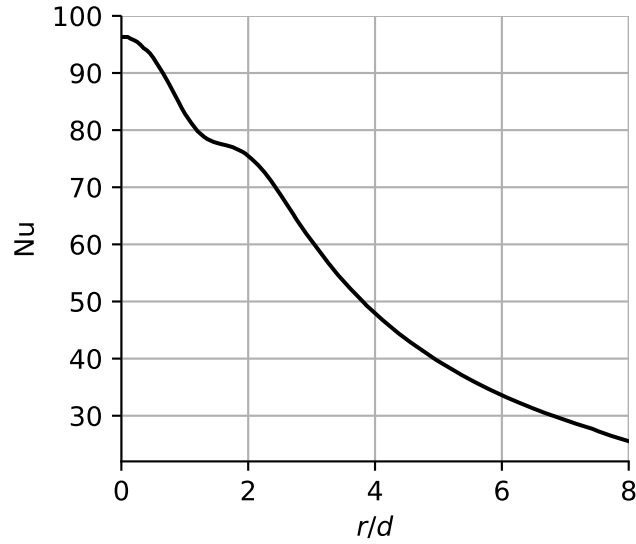


Figure 174: Nu, mikkonen_057

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_2_Lstd_86							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 14:28:08							
Re	Ma	H/d	Pr	d (mm)	H (mm)	T _{n,t} (°C)	T _∞ (°C)	$\dot{m}$ (g/s)	V _n (m/s)
20247	0.15	2	0.71	6.0	12.0	19.7	20.1	1.736	51.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.8	224.7	2.82			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.65	42.47	45.03	46.62	47.39	49.93	53.80	58.01	62.23
Nu	96.31	92.71	82.92	77.78	75.49	68.86	60.63	53.57	47.93
h (W/m ² K)	414.96	399.42	357.26	335.09	325.26	296.66	261.22	230.80	206.49
q (kW/m ²)	8.94	8.94	8.91	8.89	8.88	8.85	8.80	8.75	8.70
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	62.23	66.39	70.53	74.59	78.63	82.59	86.48	90.51	94.80
Nu	47.93	43.34	39.53	36.33	33.59	31.25	29.22	27.37	25.55
h (W/m ² K)	206.49	186.74	170.30	156.52	144.74	134.65	125.90	117.90	110.06
q (kW/m ²)	8.70	8.64	8.59	8.53	8.47	8.41	8.35	8.30	8.22

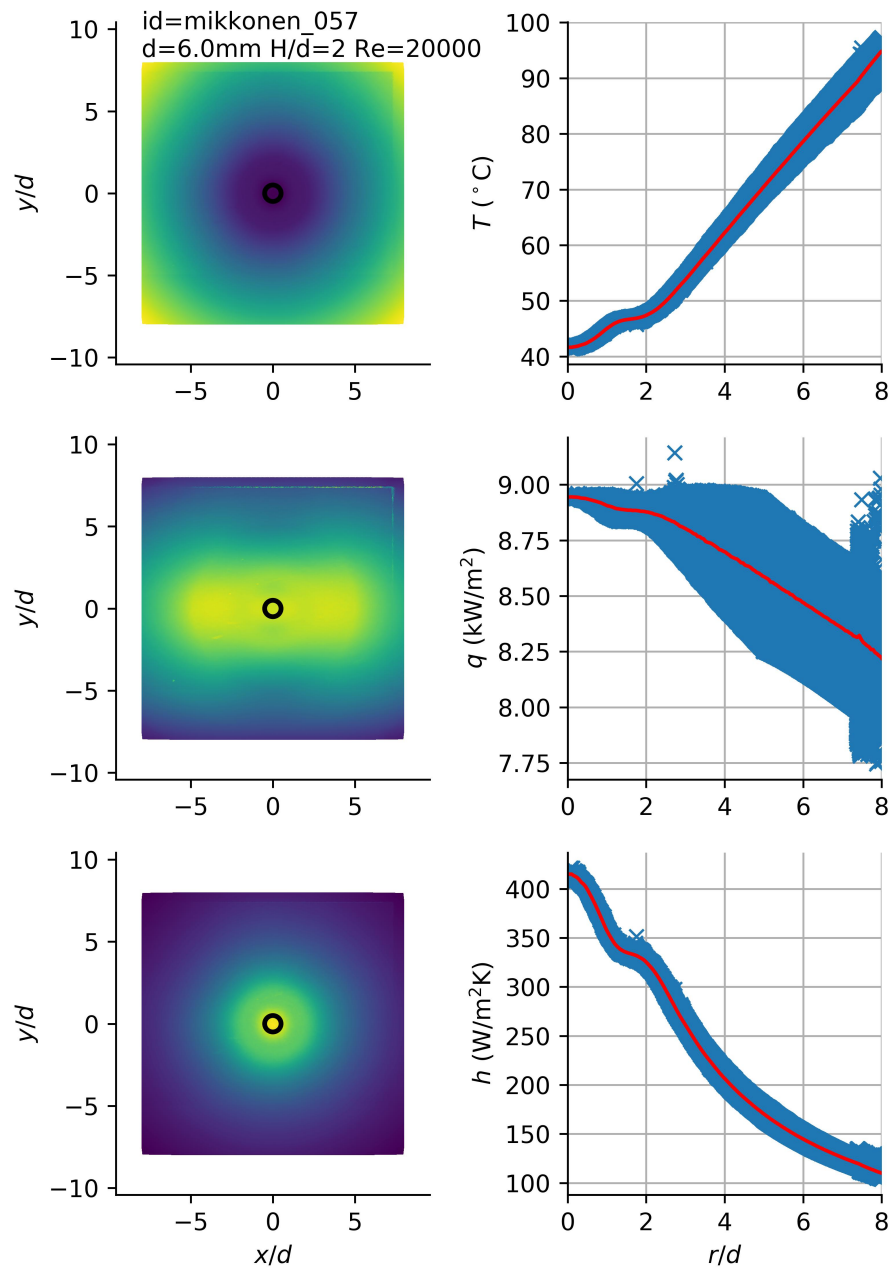


Figure 175: Results, mikkonen_057

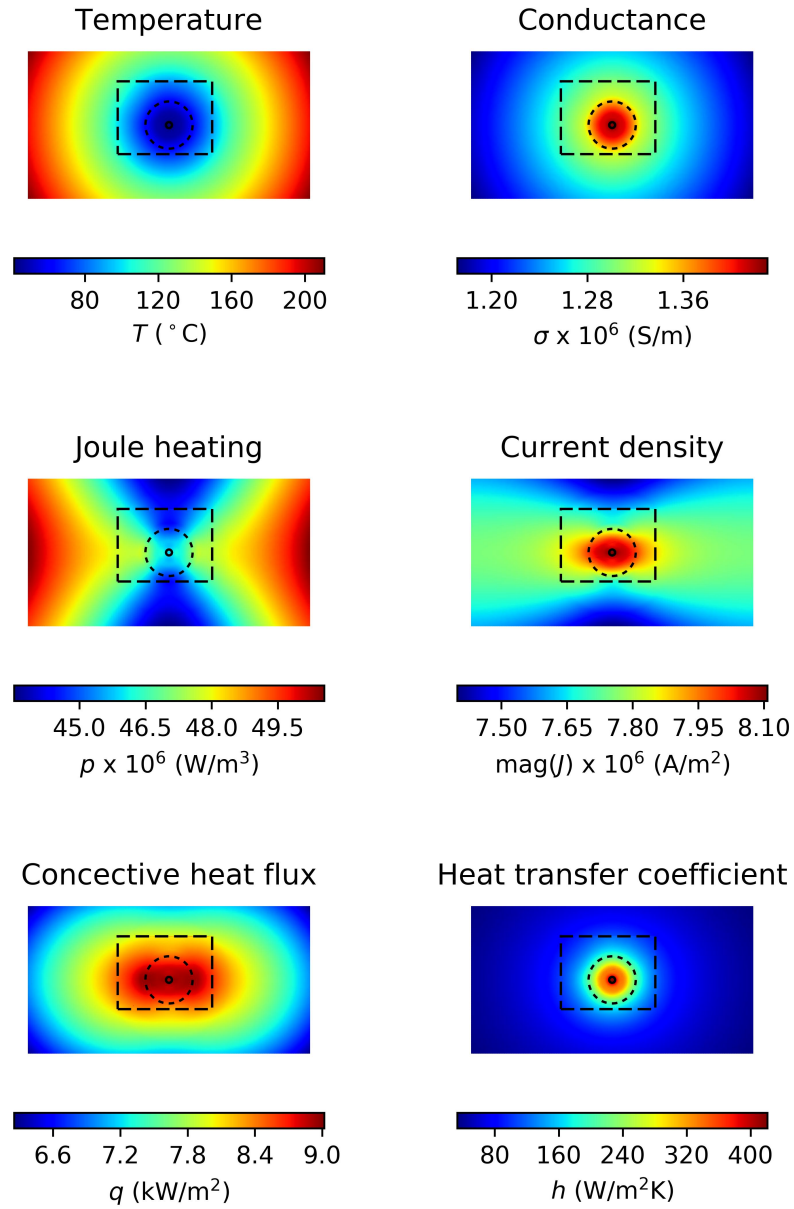


Figure 176: Convection calculation, mikkonen_057

Case id: mikkonen_058

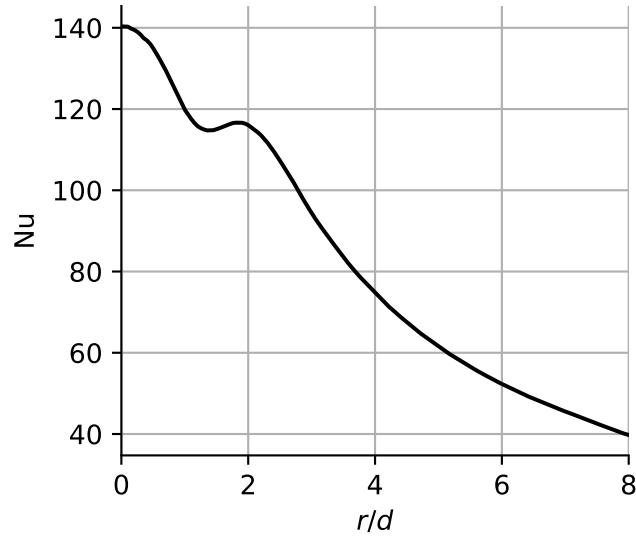


Figure 177: Nu, mikkonen_058

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_2_Lstd_150							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 14:23:36							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
34981	0.26	2	0.71	6.0	12.0	19.3	20.1	2.995	88.9
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.1	269.3	3.13			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.65	42.49	45.25	46.29	46.07	48.13	51.87	55.83	59.91
Nu	140.34	135.01	119.87	115.01	116.03	107.31	94.38	83.58	74.77
h (W/m ² K)	603.94	581.01	515.87	494.94	499.32	461.81	406.14	359.68	321.76
q (kW/m ²)	13.01	13.01	12.98	12.96	12.97	12.94	12.90	12.85	12.81
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	59.91	63.97	68.04	72.04	76.02	79.93	83.80	87.87	92.22
Nu	74.77	67.55	61.58	56.57	52.32	48.69	45.53	42.60	39.76
h (W/m ² K)	321.76	290.70	265.01	243.46	225.15	209.52	195.93	183.34	171.12
q (kW/m ²)	12.81	12.75	12.70	12.64	12.59	12.53	12.48	12.42	12.34

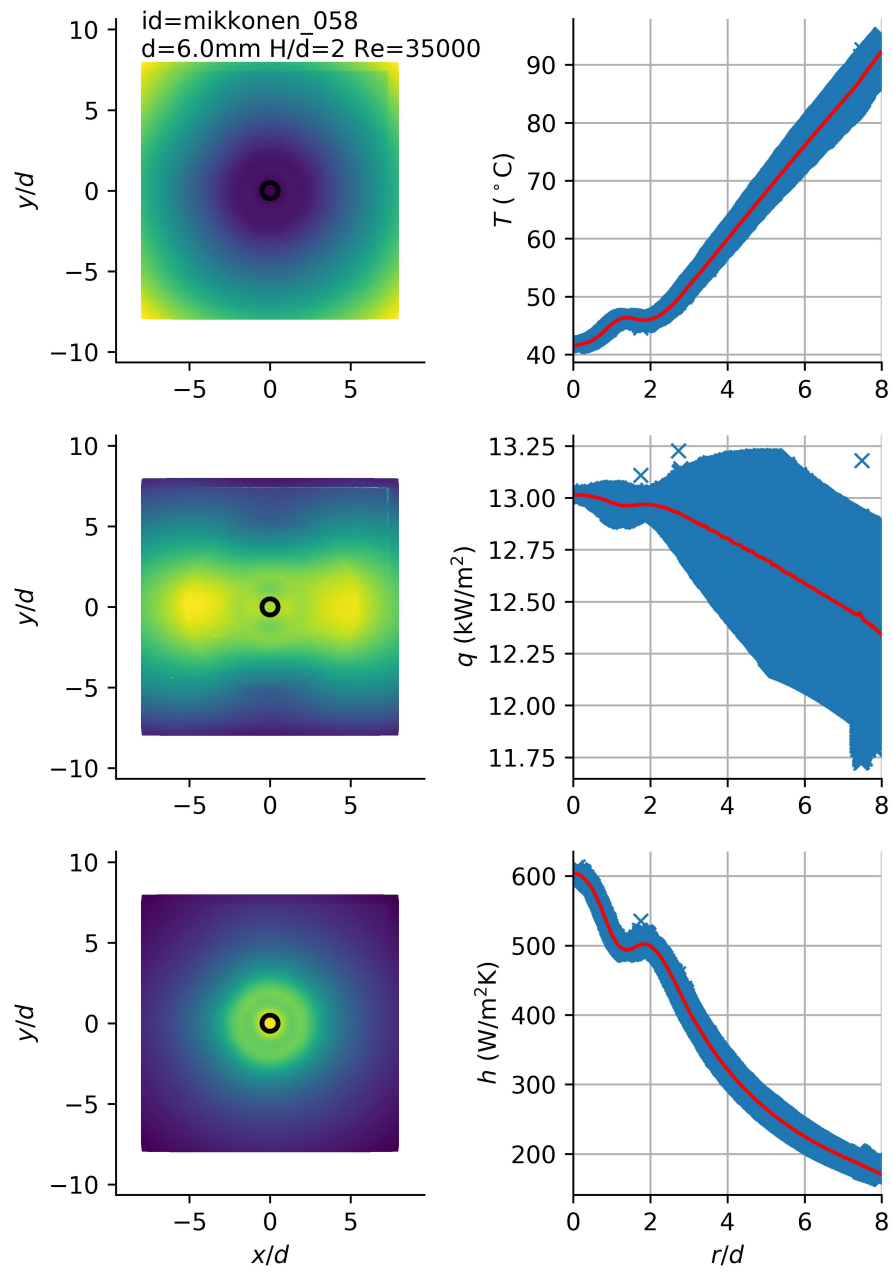


Figure 178: Results, mikkonen_058

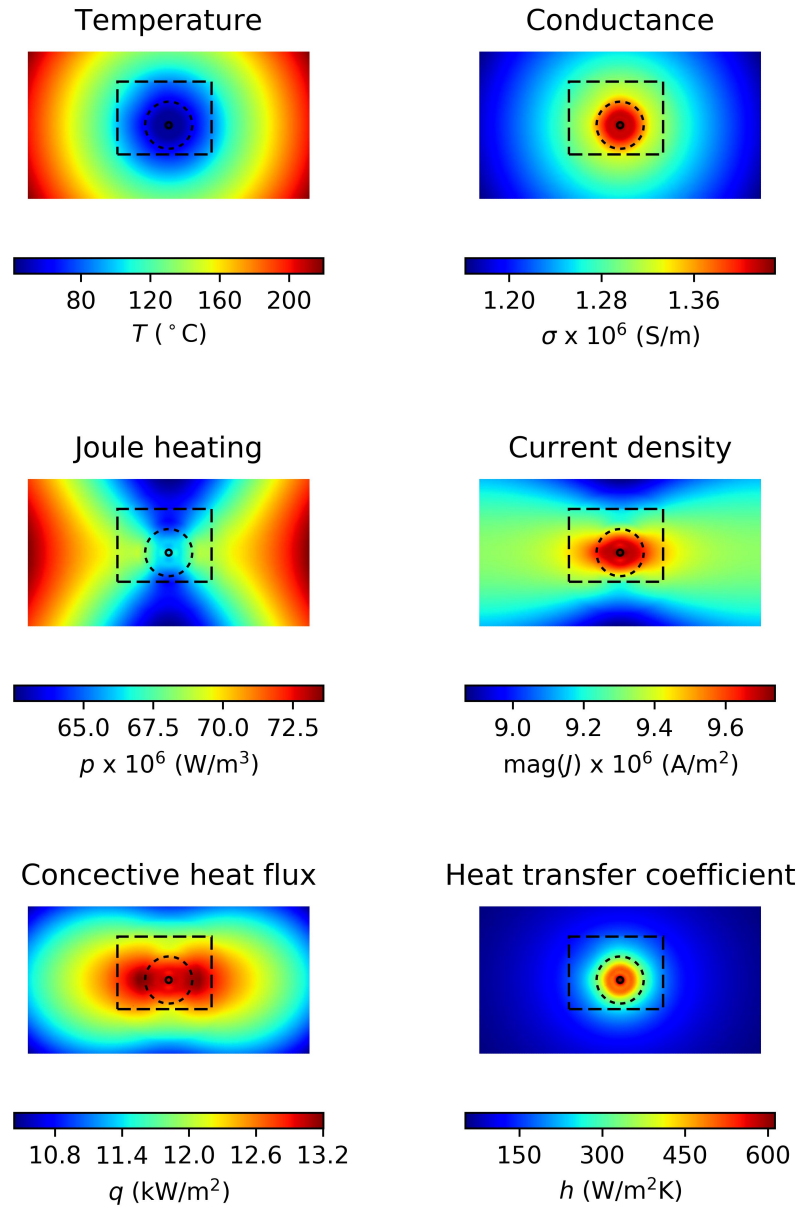


Figure 179: Convection calculation, mikkonen_058

Case id: mikkonen_059

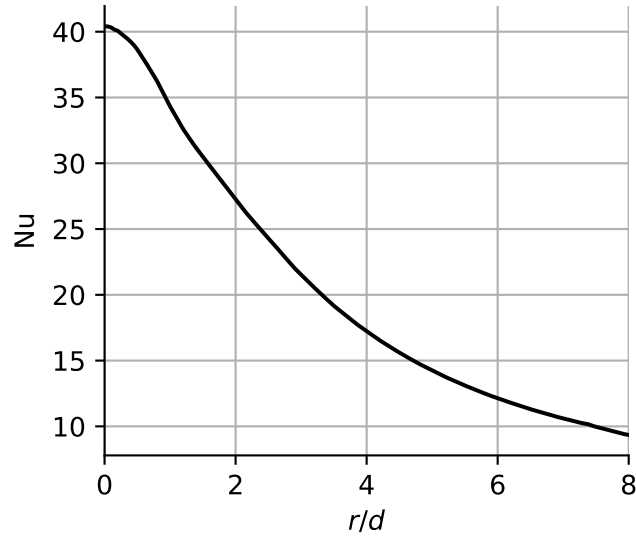


Figure 180: Nu, mikkonen_059

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_3_Lstd_25							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 14:50:14							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
5899	0.04	3	0.71	6.0	18.0	20.7	20.1	0.507	15.1
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.1	148.3	2.68				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.49	42.40	45.01	47.88	50.86	54.21	58.08	62.11	66.14
Nu	40.40	38.64	34.32	30.49	27.26	24.30	21.52	19.17	17.23
h (W/m ² K)	174.57	166.98	148.30	131.74	117.79	104.99	93.00	82.83	74.45
q (kW/m ²)	3.73	3.72	3.69	3.66	3.62	3.58	3.53	3.48	3.43
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	66.14	70.10	73.96	77.69	81.28	84.70	87.94	91.18	94.47
Nu	17.23	15.60	14.25	13.10	12.14	11.31	10.60	9.97	9.35
h (W/m ² K)	74.45	67.43	61.57	56.62	52.44	48.86	45.80	43.06	40.38
q (kW/m ²)	3.43	3.37	3.32	3.26	3.21	3.16	3.11	3.06	3.00

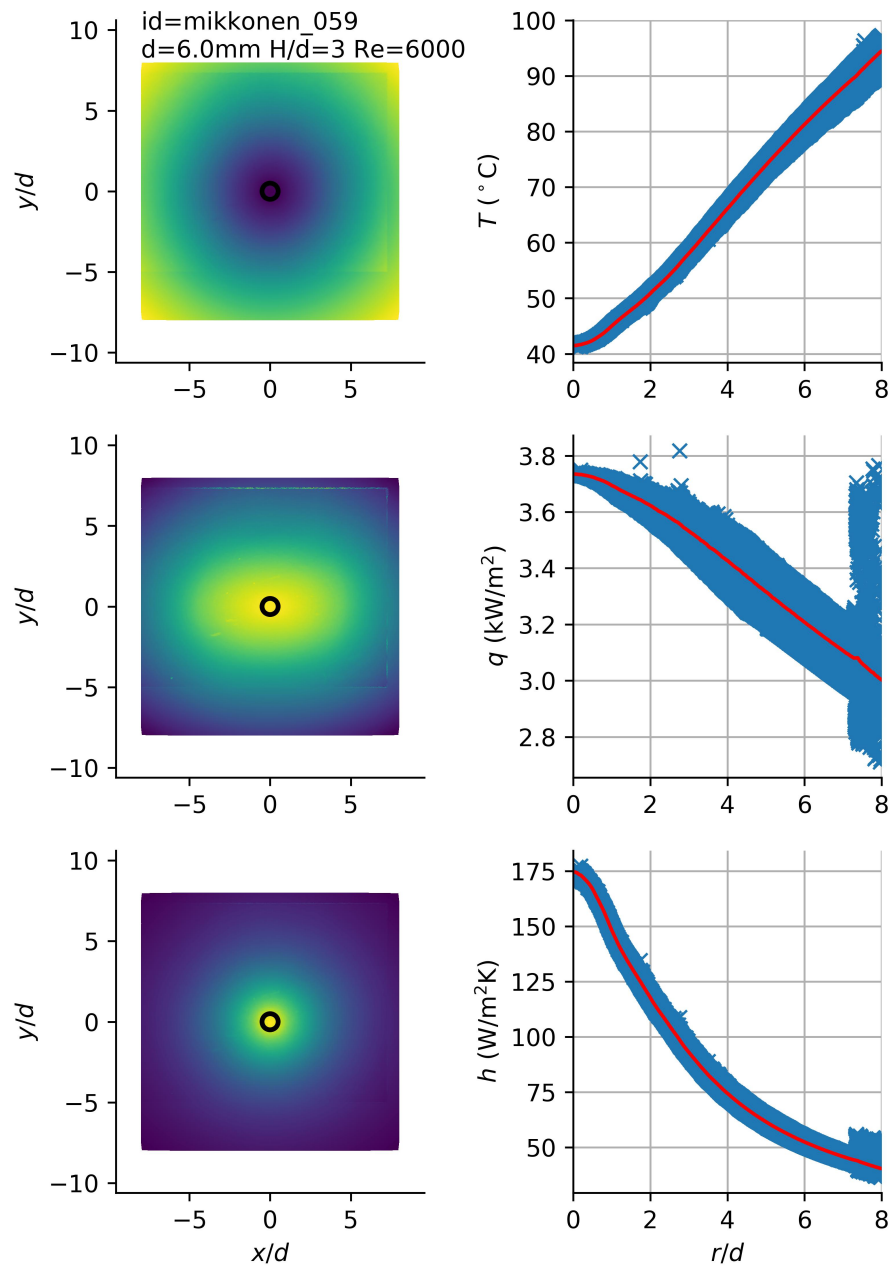


Figure 181: Results, mikkonen_059

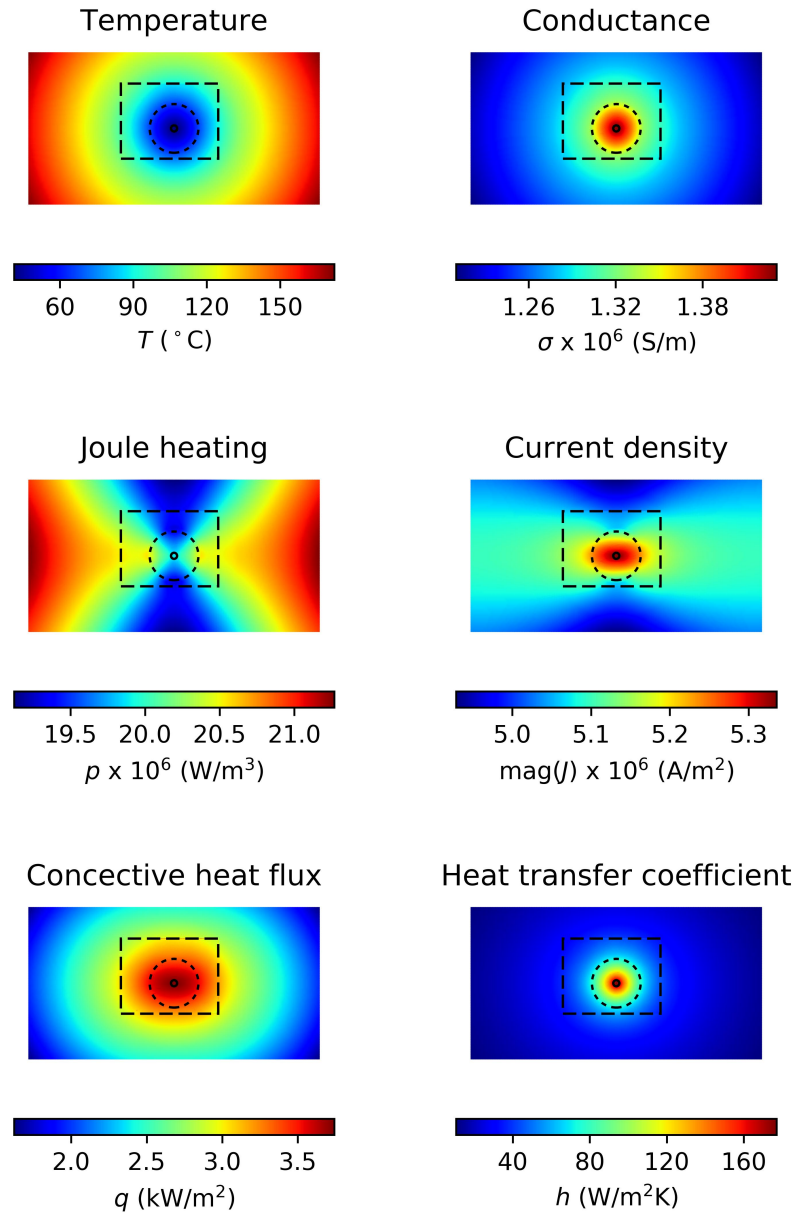


Figure 182: Convection calculation, mikkonen_059

Case id: mikkonen_060

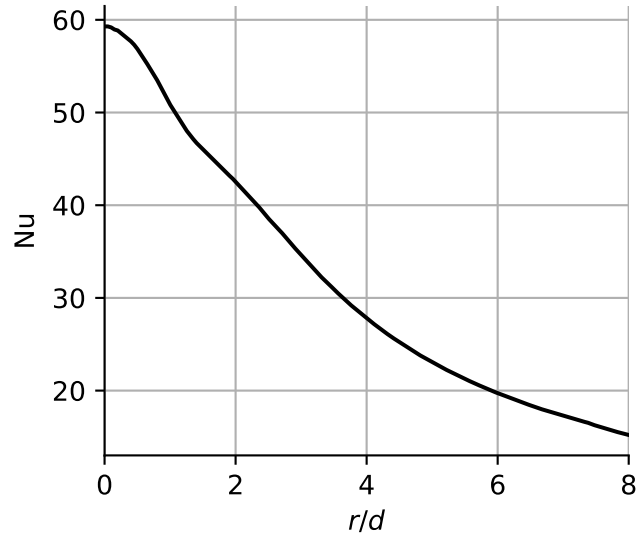


Figure 183: Nu, mikkonen_060

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_3_Lstd_43							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 14:56:25							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
10129	0.08	3	0.71	6.0	18.0	20.7	20.1	0.871	26.0
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.4	177.5	2.82			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.46	42.32	44.82	47.27	49.36	52.14	55.54	59.40	63.37
Nu	59.29	56.87	50.87	46.02	42.53	38.59	34.62	30.93	27.82
h (W/m ² K)	256.18	245.73	219.80	198.83	183.76	166.74	149.58	133.64	120.21
q (kW/m ²)	5.47	5.46	5.43	5.40	5.38	5.34	5.30	5.25	5.20
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	63.37	67.32	71.21	74.95	78.60	82.14	85.58	89.08	92.68
Nu	27.82	25.23	23.06	21.26	19.73	18.41	17.26	16.22	15.21
h (W/m ² K)	120.21	109.00	99.66	91.88	85.24	79.53	74.59	70.09	65.74
q (kW/m ²)	5.20	5.15	5.09	5.04	4.99	4.93	4.88	4.83	4.77

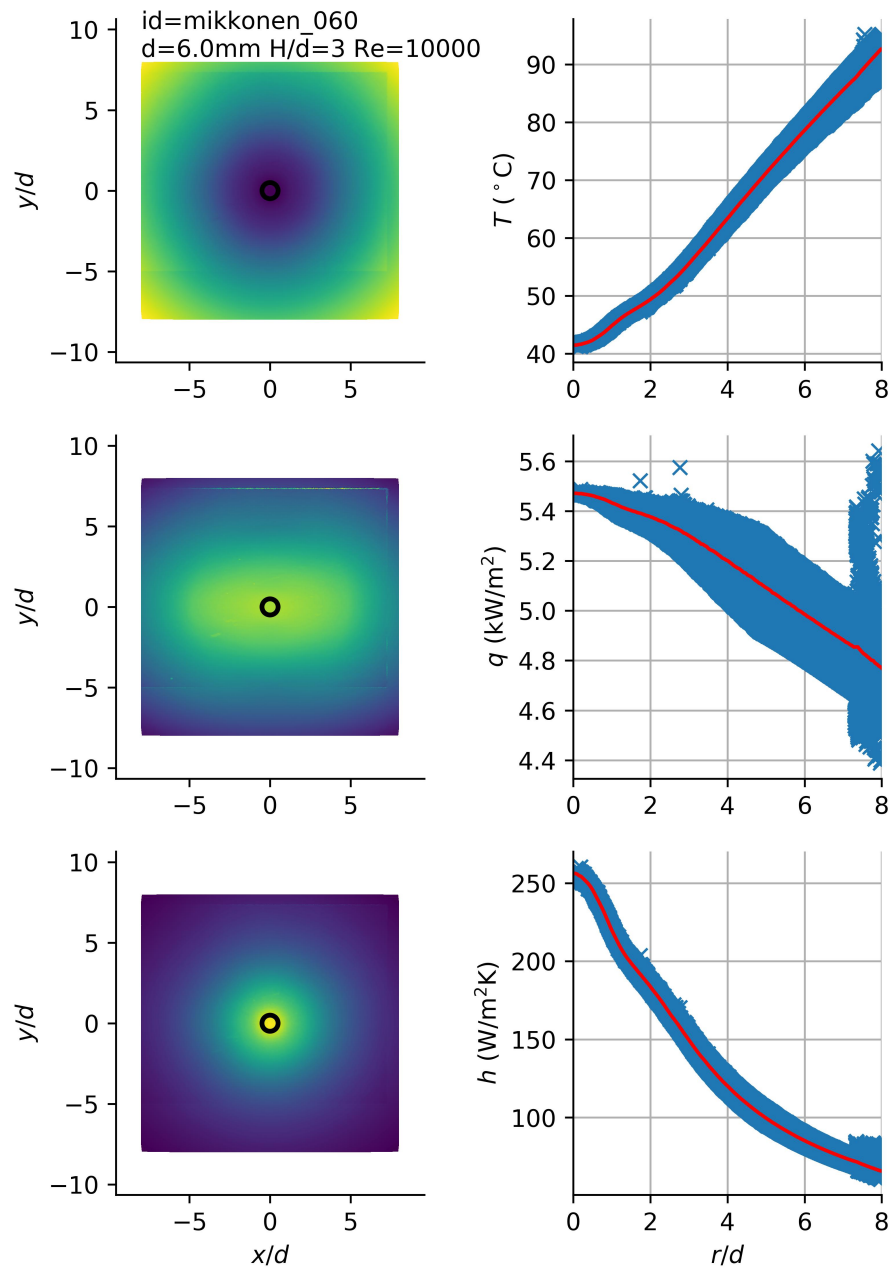


Figure 184: Results, mikkonen_060

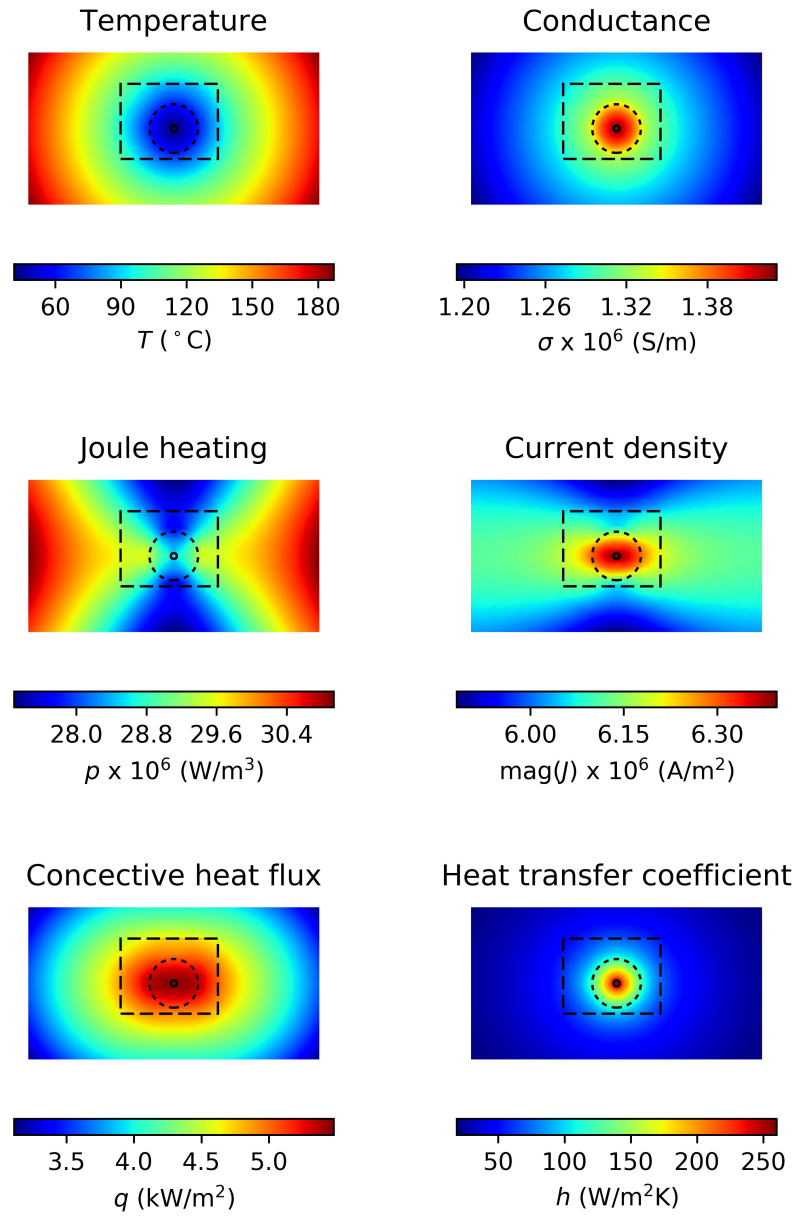


Figure 185: Convection calculation, mikkonen_060

Case id: mikkonen_061

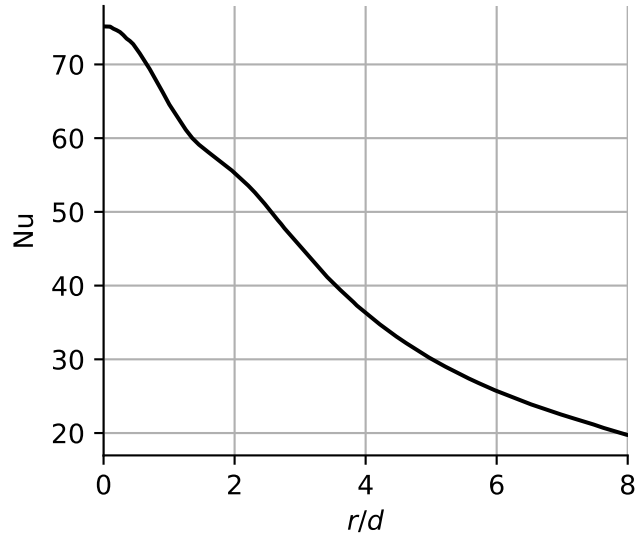


Figure 186: Nu, mikkonen_061

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_3_Lstd_60							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 15:00:37							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13912	0.10	3	0.71	6.0	18.0	20.7	20.1	1.196	35.7
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.5	195.0	3.87				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.04	41.88	44.33	46.62	48.22	50.67	54.05	57.91	61.87
Nu	75.15	72.18	64.62	58.79	55.27	50.64	45.31	40.38	36.29
h (W/m ² K)	324.74	311.91	279.23	254.04	238.83	218.80	195.77	174.47	156.79
q (kW/m ²)	6.80	6.79	6.76	6.74	6.72	6.69	6.65	6.60	6.55
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	61.87	65.79	69.68	73.43	77.16	80.76	84.31	87.94	91.77
Nu	36.29	32.90	30.08	27.73	25.70	23.97	22.46	21.09	19.74
h (W/m ² K)	156.79	142.17	129.99	119.80	111.07	103.59	97.06	91.14	85.29
q (kW/m ²)	6.55	6.49	6.44	6.39	6.34	6.28	6.23	6.18	6.11

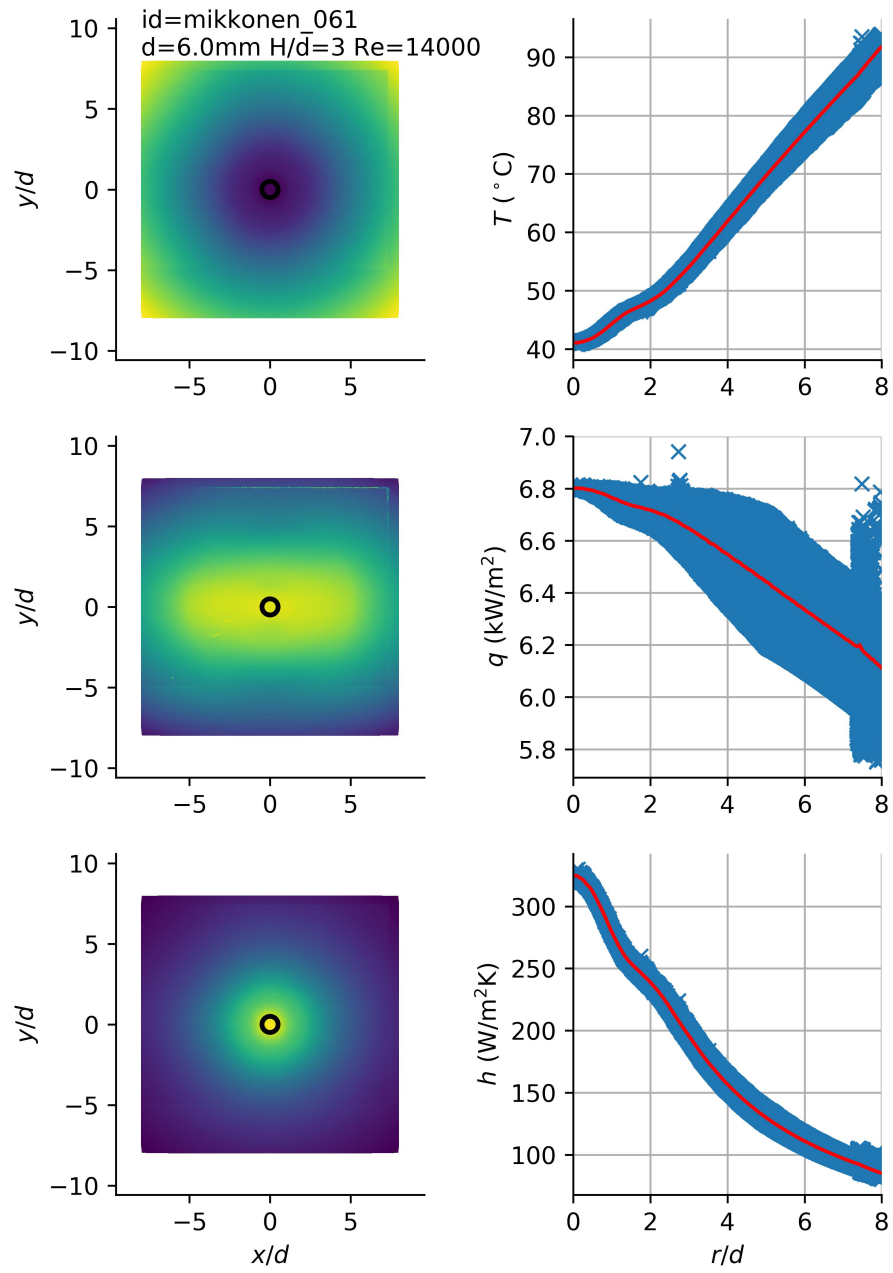


Figure 187: Results, mikkonen_061

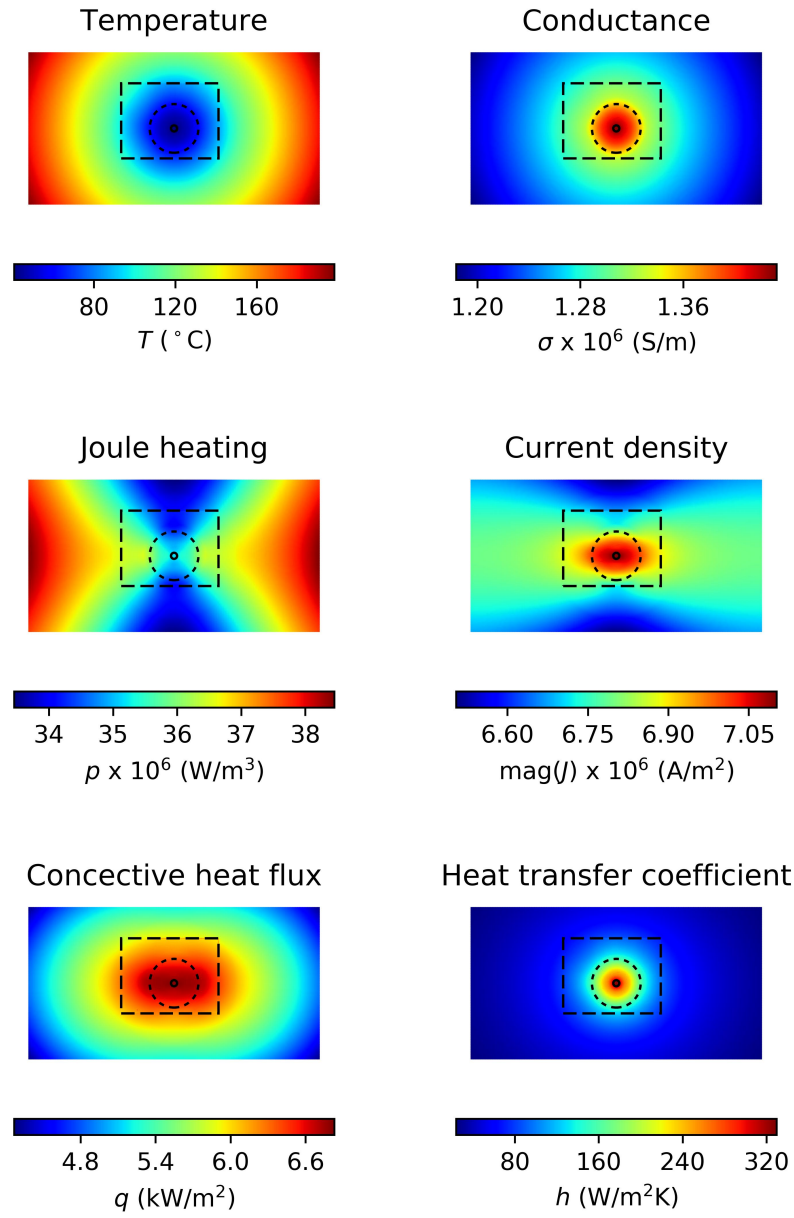


Figure 188: Convection calculation, mikkonen_061

Case id: mikkonen_062

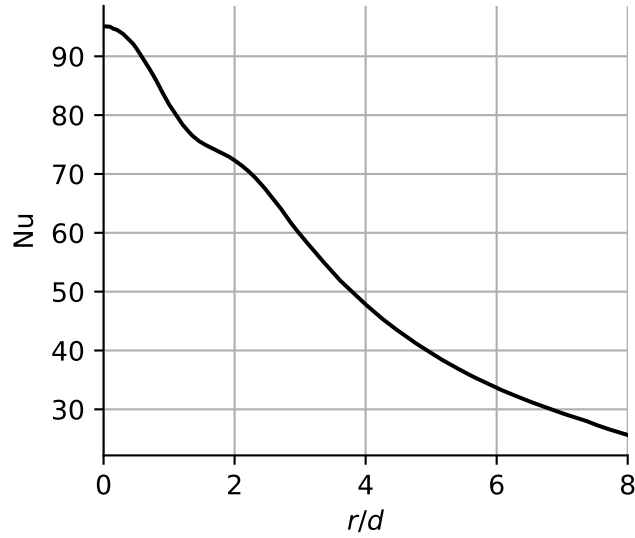


Figure 189: Nu, mikkonen_062

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_3_Lstd_86							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 15:05:05							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20159	0.15	3	0.71	6.0	18.0	20.0	20.1	1.729	51.5
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.7	218.8	3.14			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.84	41.66	44.10	46.11	47.14	49.21	52.60	56.36	60.23
Nu	95.08	91.38	81.82	75.29	72.30	66.99	59.71	53.23	47.82
h (W/m ² K)	409.99	394.03	352.85	324.65	311.79	288.87	257.49	229.52	206.22
q (kW/m ²)	8.51	8.50	8.47	8.44	8.43	8.41	8.37	8.32	8.27
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	60.23	64.12	68.01	71.85	75.65	79.35	83.00	86.90	90.92
Nu	47.82	43.32	39.57	36.37	33.67	31.35	29.34	27.44	25.64
h (W/m ² K)	206.22	186.79	170.63	156.85	145.17	135.19	126.52	118.32	110.57
q (kW/m ²)	8.27	8.22	8.17	8.12	8.06	8.01	7.96	7.90	7.83

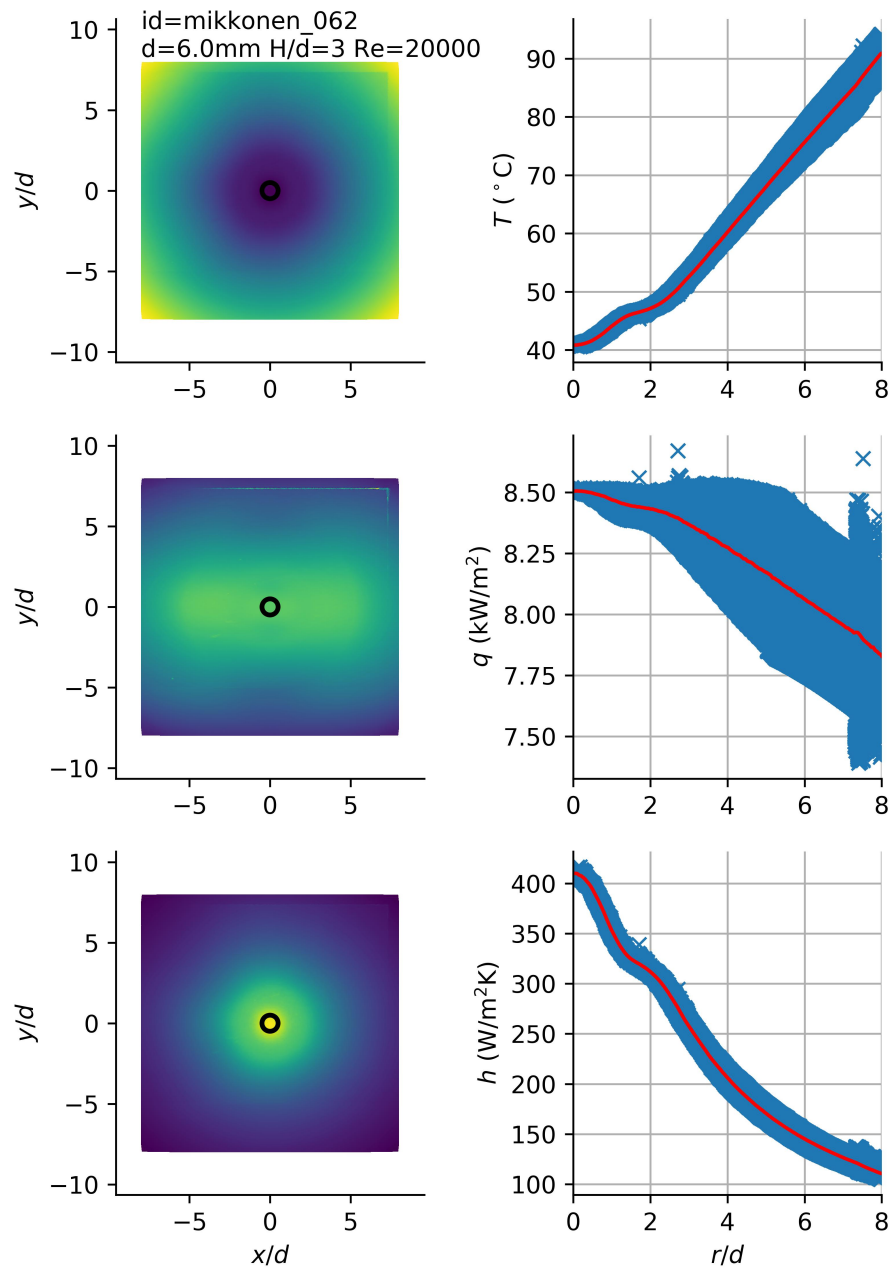


Figure 190: Results, mikkonen_062

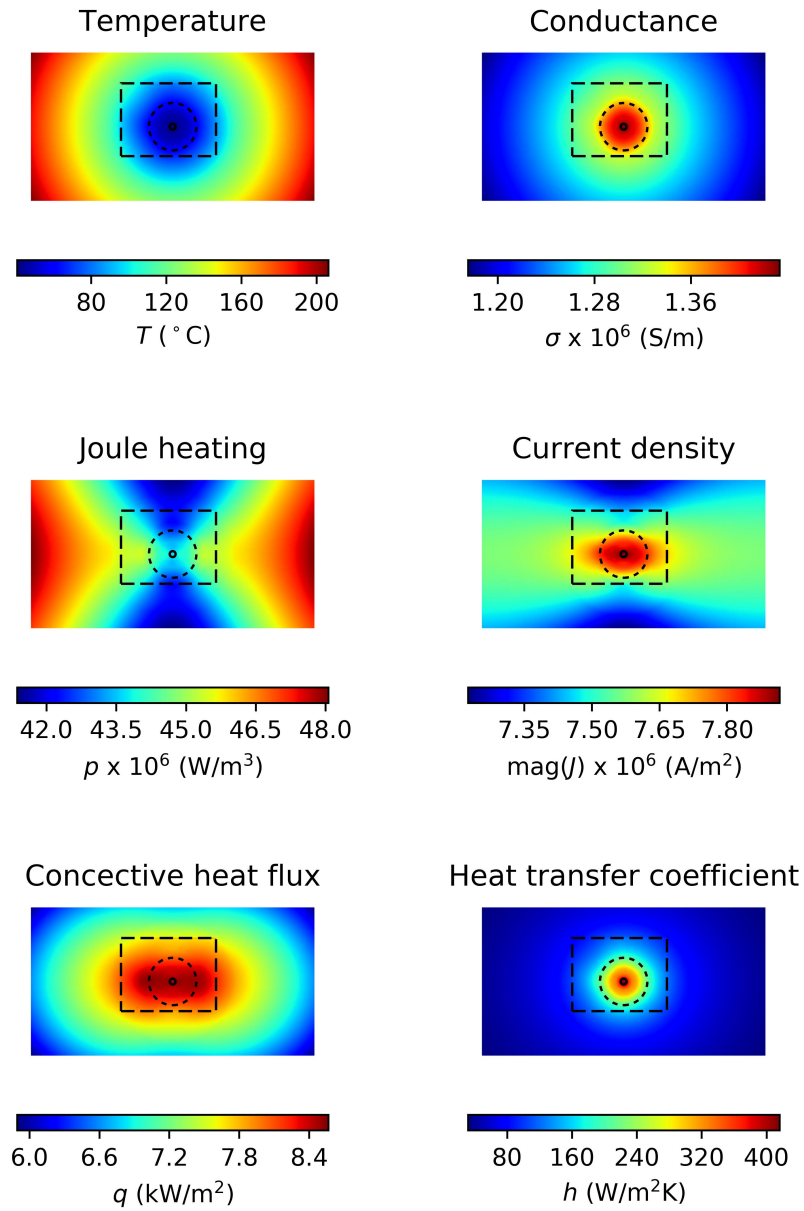


Figure 191: Convection calculation, mikkonen_062

Case id: mikkonen_063

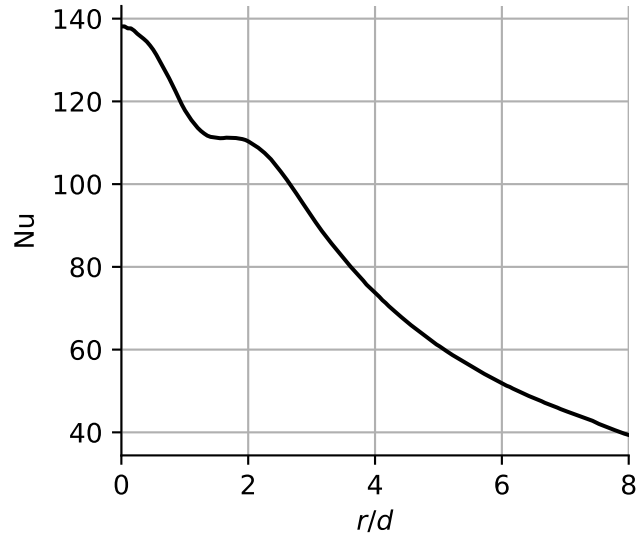


Figure 192: Nu, mikkonen_063

path	2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_3_Lstd_150								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-02-27 15:10:01								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
35230	0.26	3	0.71	6.0	18.0	19.5	20.1	3.018	89.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.1	264.5	2.40			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.88	41.74	44.36	45.80	45.99	47.71	50.95	54.60	58.40
Nu	138.12	132.53	117.92	111.18	110.34	103.31	92.19	82.13	73.73
h (W/m ² K)	594.74	570.68	507.76	478.73	475.13	444.84	396.98	353.64	317.46
q (kW/m ²)	12.36	12.35	12.32	12.30	12.30	12.28	12.24	12.20	12.15
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	58.40	62.23	66.05	69.84	73.61	77.33	80.99	84.97	89.24
Nu	73.73	66.75	60.96	56.08	51.90	48.31	45.21	42.25	39.37
h (W/m ² K)	317.46	287.43	262.48	241.47	223.47	208.03	194.68	181.94	169.51
q (kW/m ²)	12.15	12.10	12.05	12.00	11.95	11.90	11.85	11.79	11.71

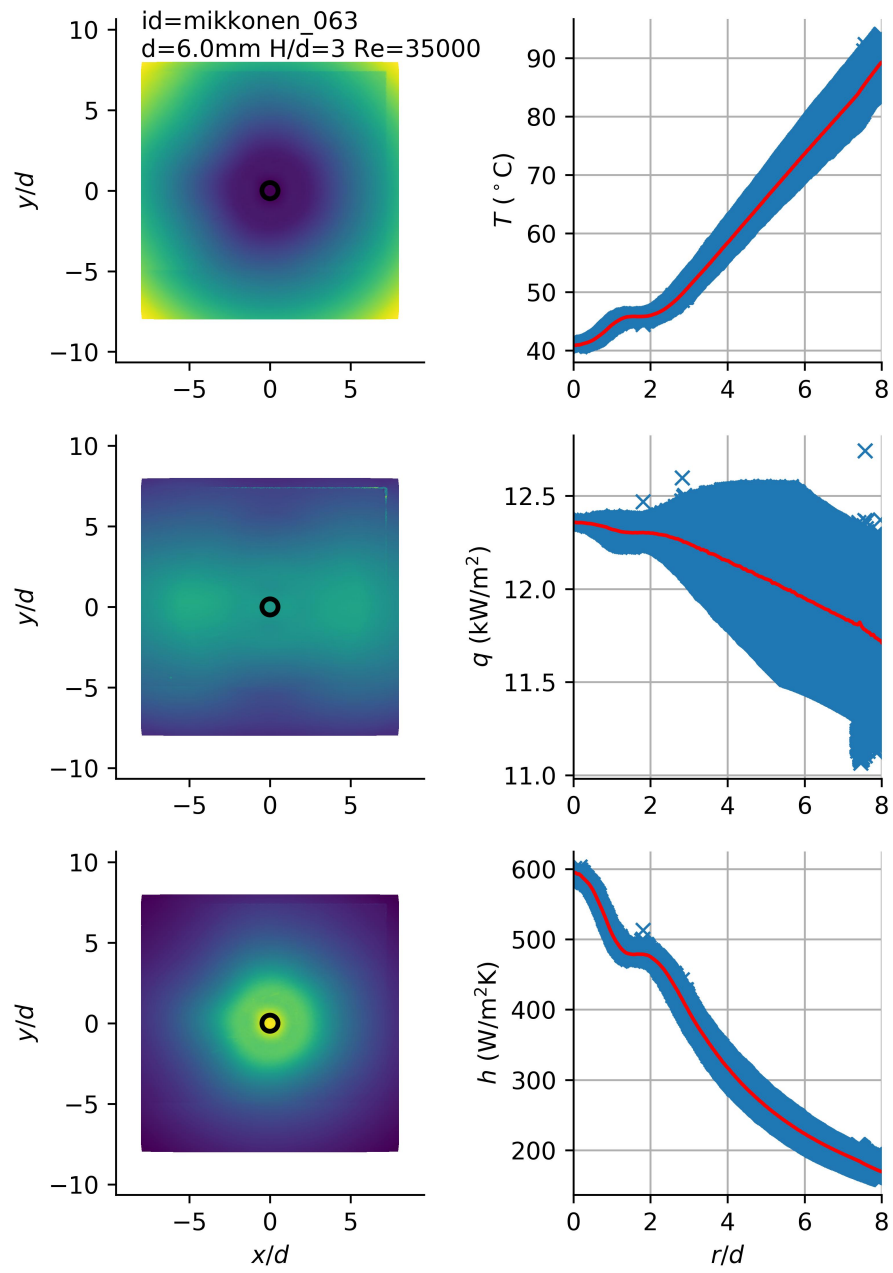


Figure 193: Results, mikkonen_063

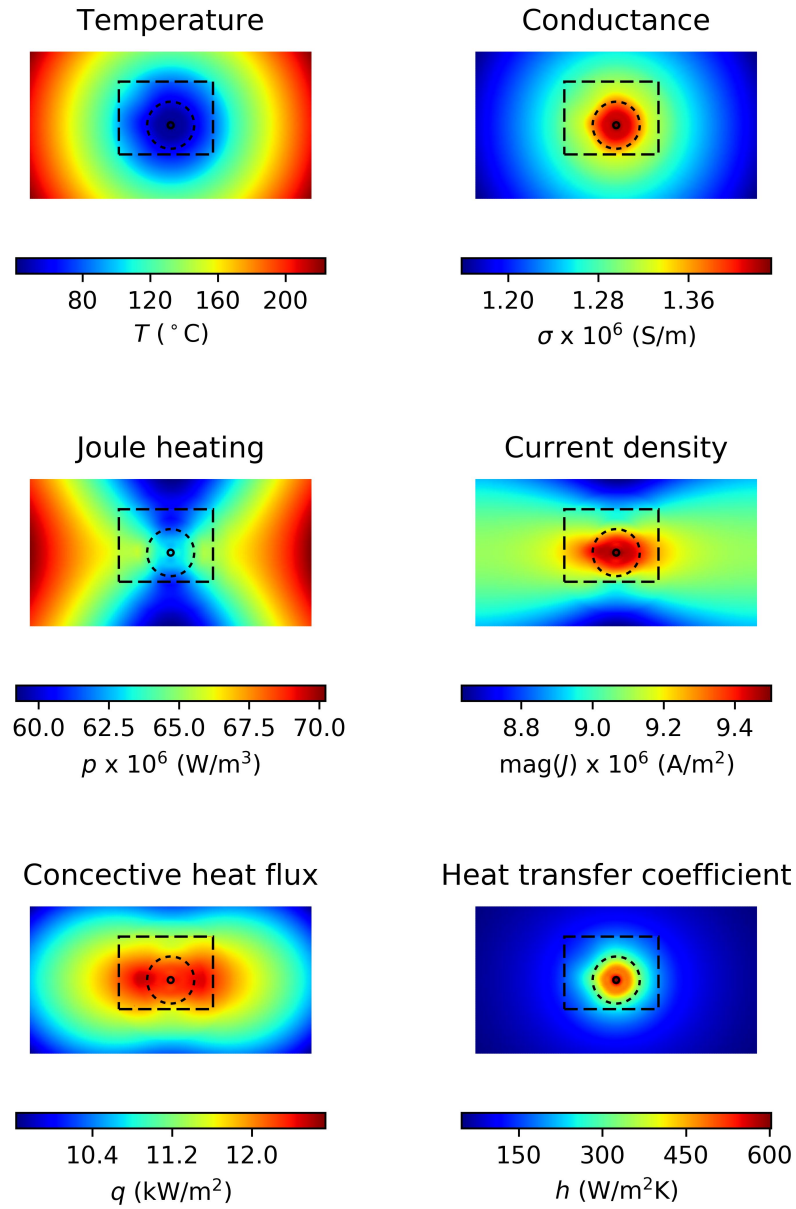


Figure 194: Convection calculation, mikkonen_063

Case id: mikkonen_064

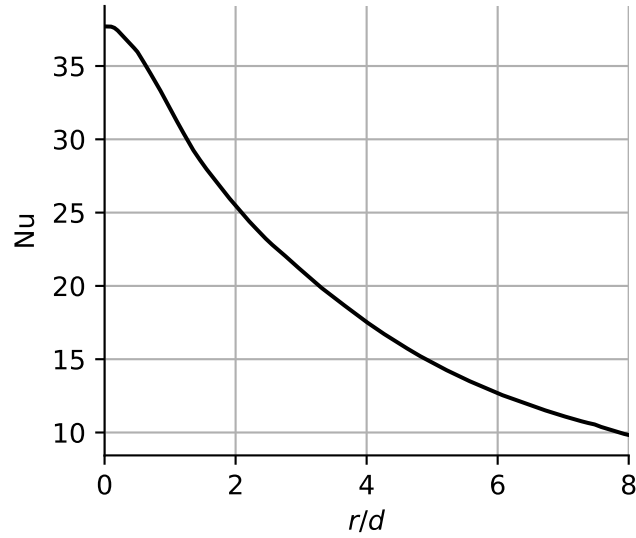


Figure 195: Nu, mikkonen_064

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_6_Lstd_25							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 15:38:04							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
5925	0.04	6	0.71	6.0	36.0	20.8	20.1	0.509	15.2
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.1	139.4	4.18				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.66	41.58	43.97	46.87	49.57	52.30	54.96	57.90	60.99
Nu	37.70	35.97	32.10	28.31	25.46	23.05	21.07	19.20	17.53
h (W/m ² K)	162.95	155.48	138.73	122.37	110.05	99.62	91.09	82.98	75.78
q (kW/m ²)	3.35	3.34	3.31	3.28	3.24	3.21	3.17	3.14	3.10
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	60.99	64.13	67.33	70.43	73.50	76.42	79.23	81.96	84.97
Nu	17.53	16.06	14.76	13.65	12.68	11.85	11.13	10.51	9.83
h (W/m ² K)	75.78	69.41	63.81	59.00	54.80	51.20	48.09	45.44	42.50
q (kW/m ²)	3.10	3.06	3.01	2.97	2.93	2.88	2.84	2.81	2.76

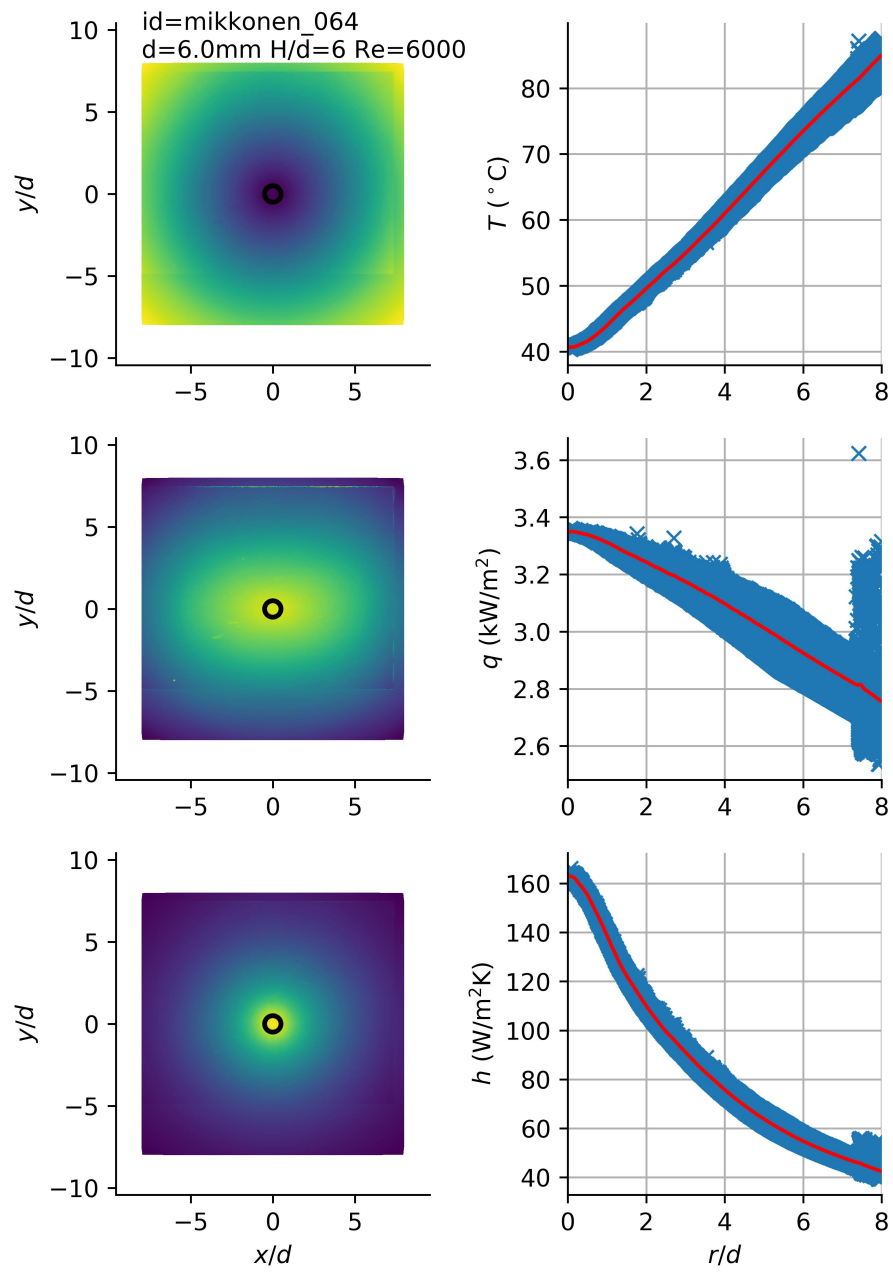


Figure 196: Results, mikkonen_064

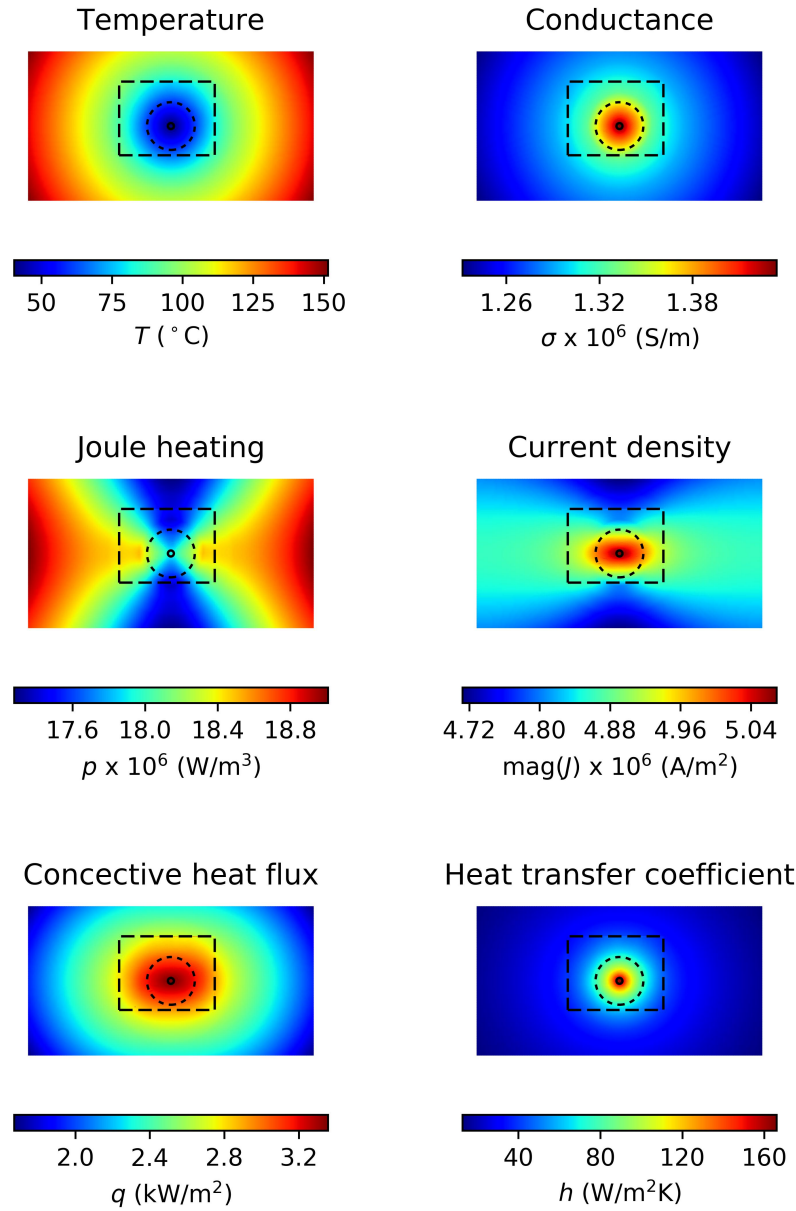


Figure 197: Convection calculation, mikkonen_064

Case id: mikkonen_065

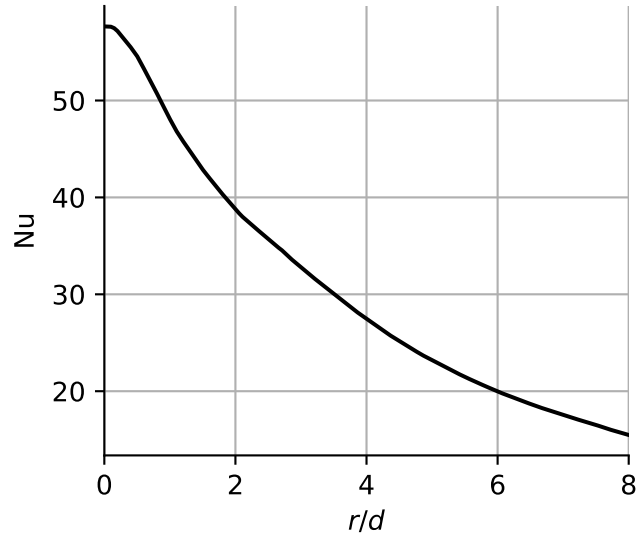


Figure 198: Nu, mikkonen_065

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_6_Lstd_43							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 15:34:38							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
10075	0.08	6	0.71	6.0	36.0	20.5	20.1	0.866	25.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.4	175.0	3.27				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.59	42.74	45.63	48.54	51.33	53.82	56.60	59.61	62.95
Nu	57.65	54.58	48.09	42.89	38.79	35.70	32.77	30.04	27.47
h (W/m ² K)	248.94	235.69	207.69	185.21	167.53	154.19	141.53	129.73	118.65
q (kW/m ²)	5.35	5.34	5.30	5.27	5.23	5.20	5.17	5.13	5.08
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	62.95	66.42	69.92	73.34	76.78	80.11	83.38	86.65	90.21
Nu	27.47	25.18	23.19	21.48	19.98	18.68	17.54	16.53	15.48
h (W/m ² K)	118.65	108.72	100.13	92.77	86.29	80.68	75.76	71.40	66.86
q (kW/m ²)	5.08	5.04	4.99	4.94	4.89	4.84	4.79	4.75	4.69

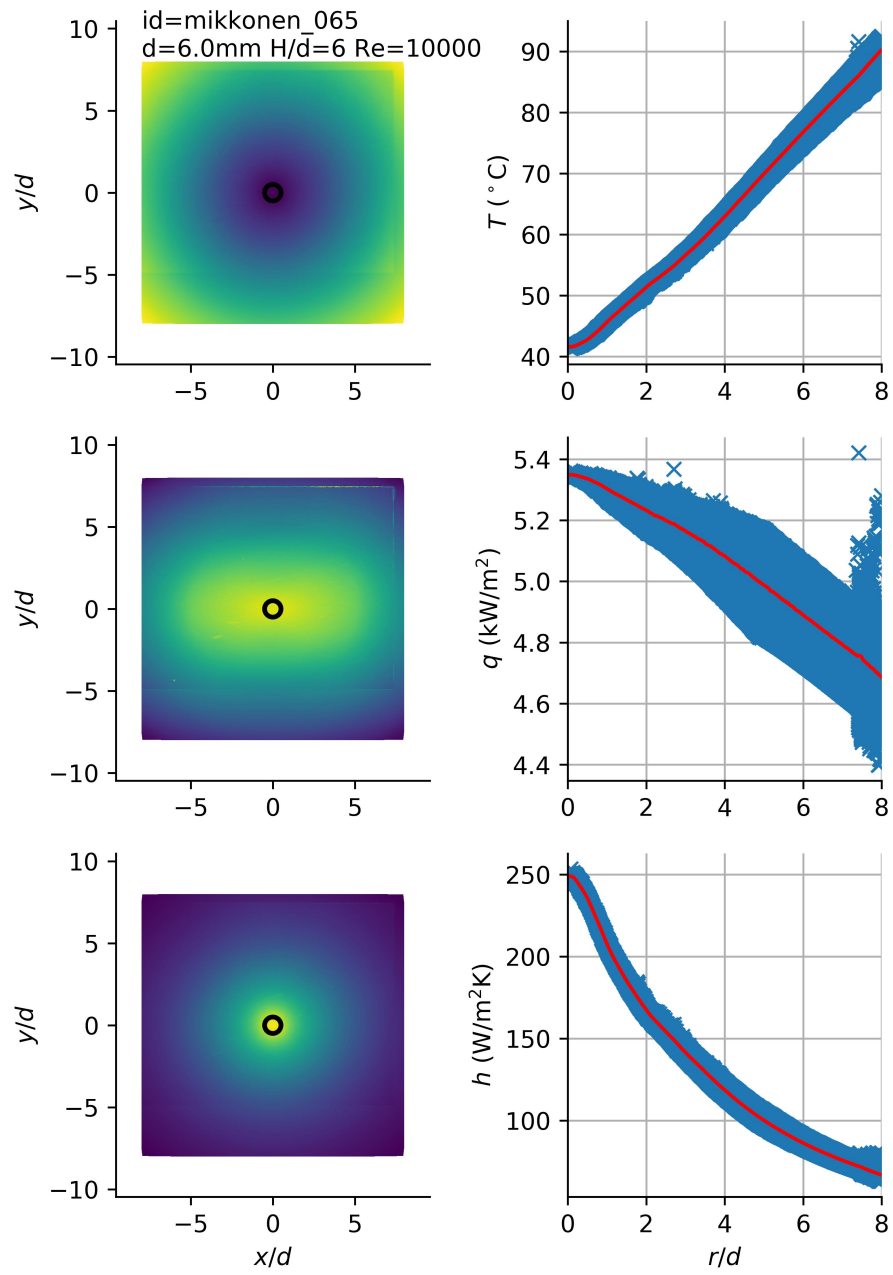


Figure 199: Results, mikkonen_065

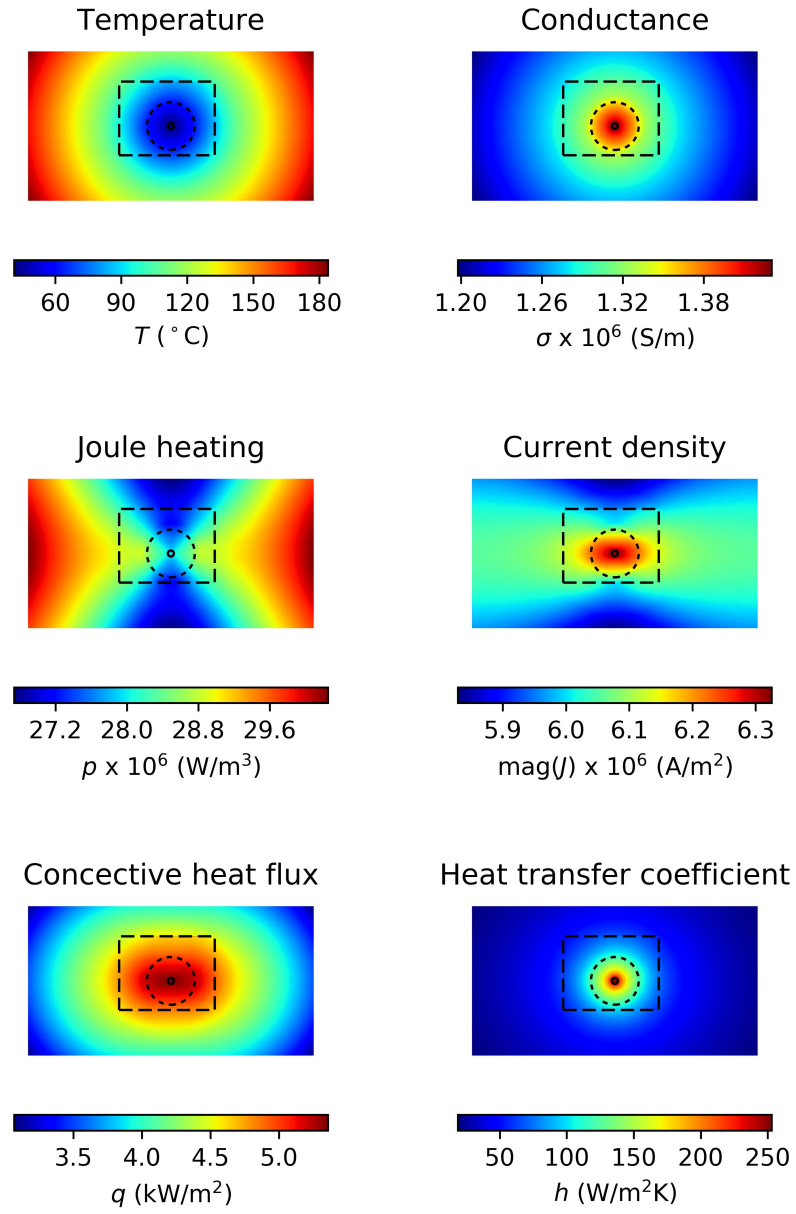


Figure 200: Convection calculation, mikkonen_065

Case id: mikkonen_066

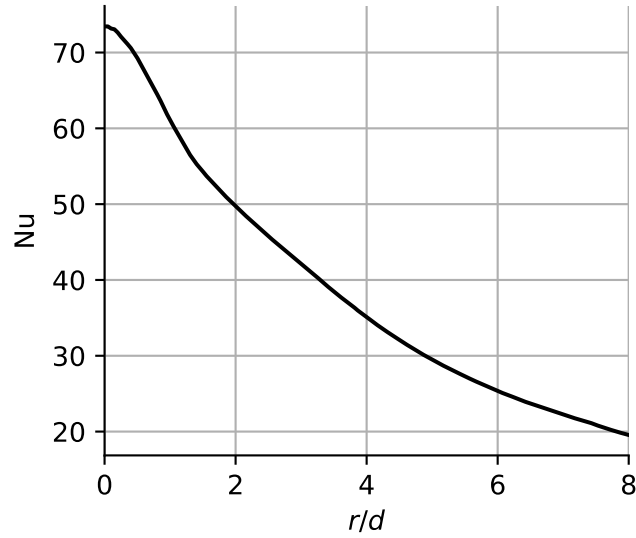


Figure 201: Nu, mikkonen_066

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_6_Lstd_60							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 15:27:54							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13977	0.10	6	0.71	6.0	36.0	20.2	20.1	1.200	35.7
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.5	191.1	2.70				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	40.17	41.34	44.07	46.91	49.25	51.61	54.14	57.19	60.46
Nu	73.44	69.28	61.09	54.31	49.72	45.78	42.16	38.45	35.10
h (W/m ² K)	316.89	298.91	263.59	234.33	214.54	197.51	181.93	165.89	151.46
q (kW/m ²)	6.36	6.35	6.32	6.28	6.25	6.22	6.19	6.15	6.11
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	60.46	63.91	67.40	70.81	74.23	77.58	80.87	84.28	87.89
Nu	35.10	32.09	29.50	27.30	25.37	23.69	22.23	20.88	19.55
h (W/m ² K)	151.46	138.46	127.27	117.78	109.45	102.23	95.92	90.08	84.36
q (kW/m ²)	6.11	6.06	6.02	5.97	5.92	5.87	5.83	5.78	5.72

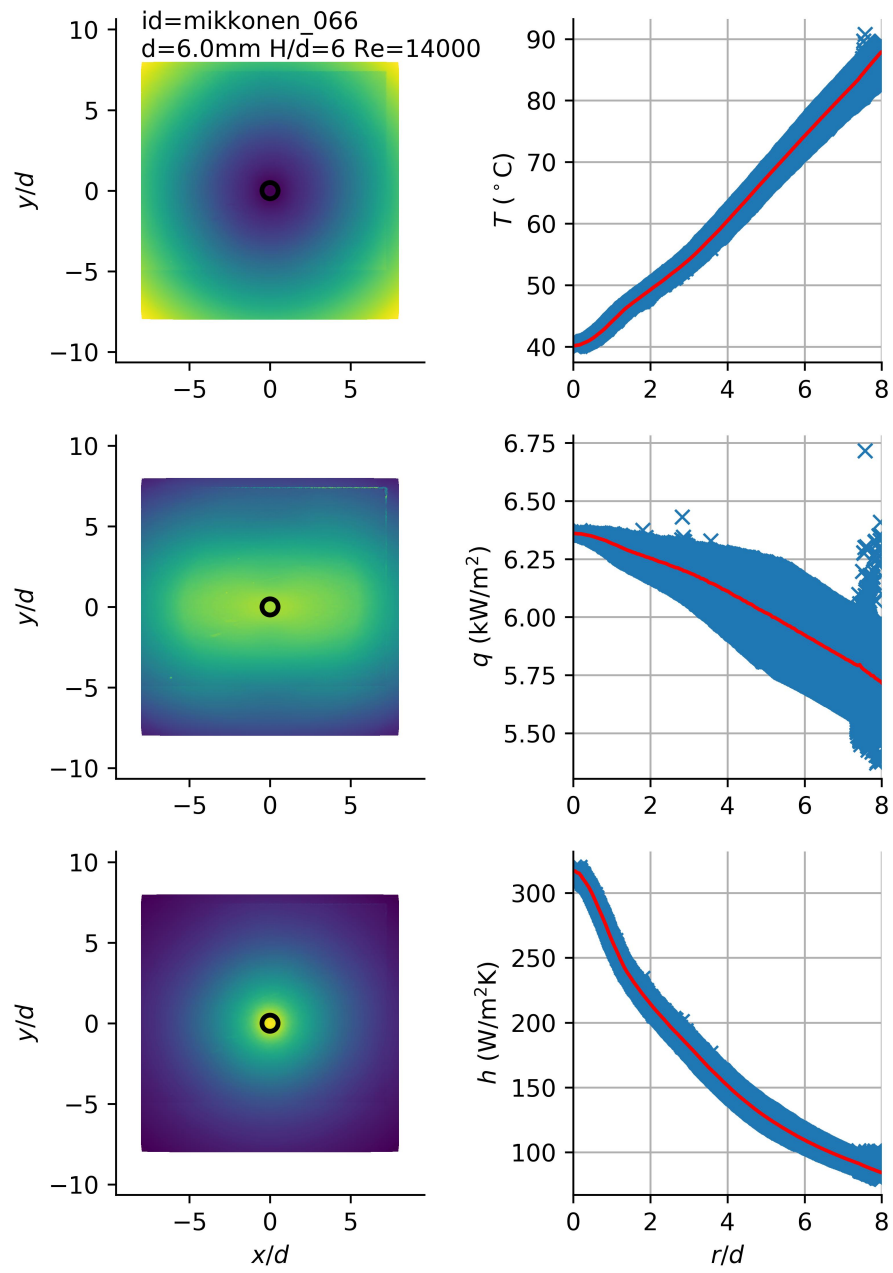


Figure 202: Results, mikkonen_066

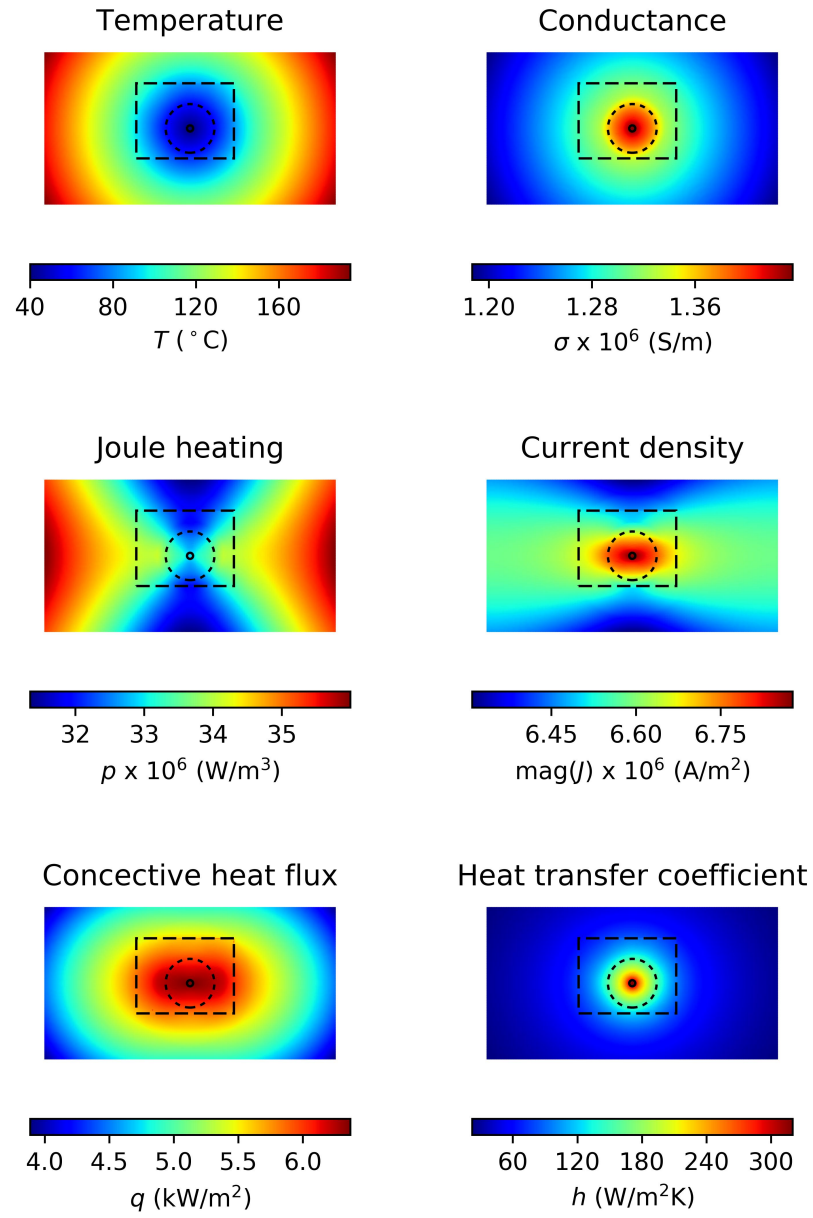


Figure 203: Convection calculation, mikkonen_066

Case id: mikkonen_067

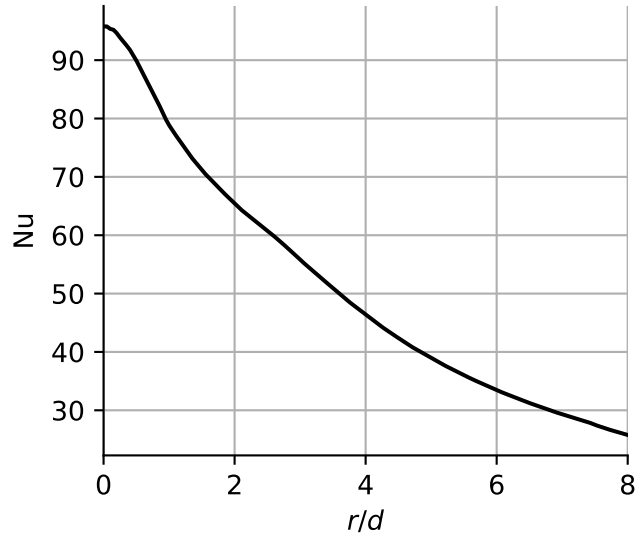


Figure 204: Nu, mikkonen_067

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_6_Lstd_86							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 15:22:58							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20021	0.15	6	0.71	6.0	36.0	20.0	20.1	1.718	51.1
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.8	223.4	3.28				1.0		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.71	43.08	46.20	48.90	51.33	53.61	56.46	59.76	63.41
Nu	95.78	89.94	78.87	71.21	65.45	60.78	55.81	50.92	46.39
h (W/m ² K)	413.03	387.84	340.10	307.08	282.26	262.11	240.68	219.56	200.02
q (kW/m ²)	8.93	8.91	8.88	8.84	8.81	8.78	8.75	8.71	8.66
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	63.41	67.22	71.07	74.85	78.64	82.39	86.08	89.95	94.00
Nu	46.39	42.38	38.94	36.02	33.48	31.26	29.31	27.51	25.77
h (W/m ² K)	200.02	182.74	167.93	155.34	144.36	134.78	126.41	118.64	111.13
q (kW/m ²)	8.66	8.61	8.56	8.50	8.45	8.39	8.34	8.28	8.21

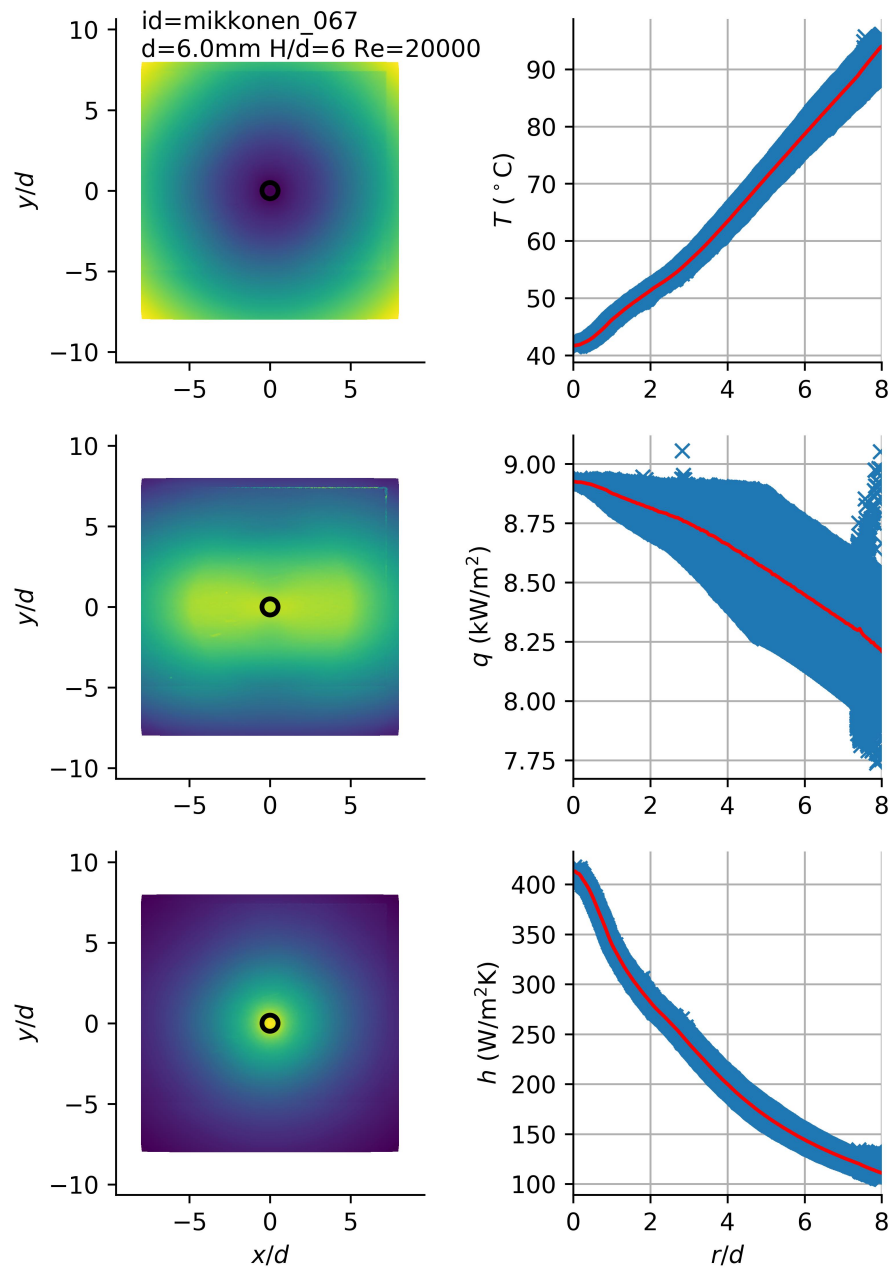


Figure 205: Results, mikkonen_067

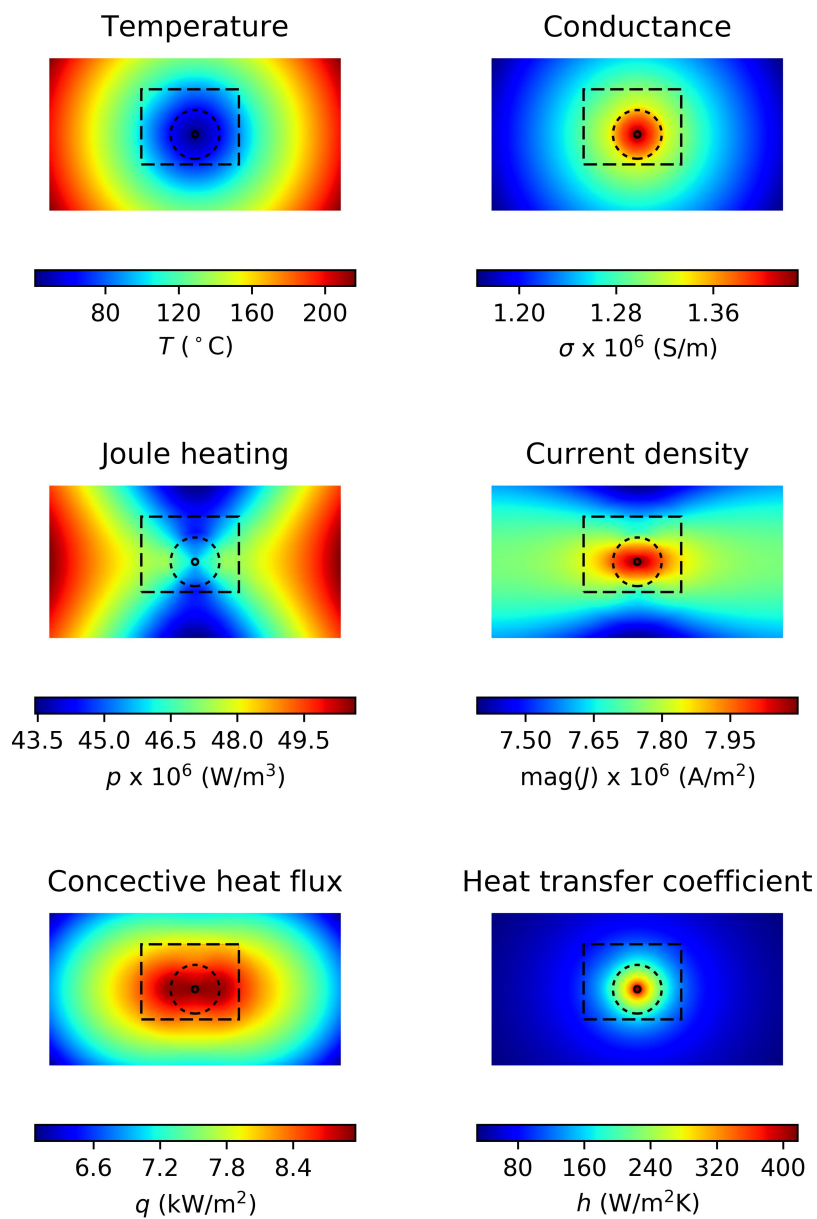


Figure 206: Convection calculation, mikkonen_067

Case id: mikkonen_068

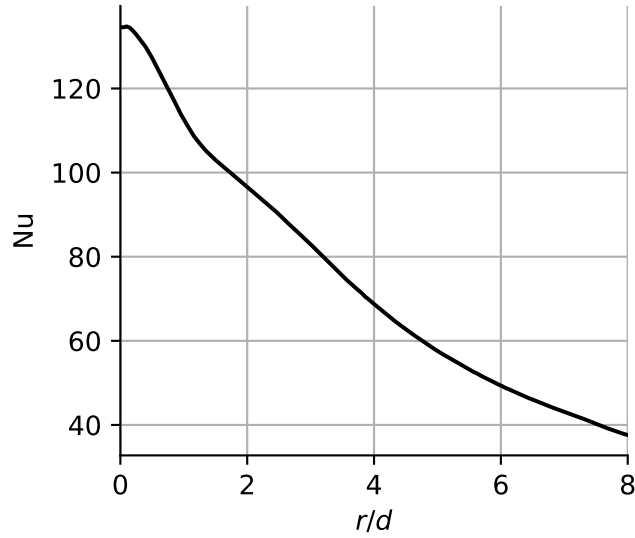


Figure 207: Nu, mikkonen_068

path		2017_02_27_hidasSarja_6mm_HD1,2,3,6/6mm_Hd_6_Lstd_150							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-02-27 15:17:18							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
35125	0.26	6	0.71	6.0	36.0	19.5	20.1	3.009	89.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	2.1	263.4	1.89			1.0			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	41.07	42.25	45.07	47.35	49.10	51.14	53.72	56.93	60.38
Nu	134.55	127.27	112.63	103.00	96.59	90.05	82.94	75.45	68.75
h (W/m ² K)	579.37	548.02	484.97	443.52	415.91	387.75	357.15	324.87	296.03
q (kW/m ²)	12.15	12.14	12.11	12.08	12.06	12.03	12.00	11.96	11.92
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	60.38	64.04	67.77	71.50	75.26	78.99	82.70	86.82	90.98
Nu	68.75	62.76	57.61	53.20	49.37	46.02	43.10	40.23	37.62
h (W/m ² K)	296.03	270.24	248.09	229.09	212.57	198.16	185.57	173.21	161.98
q (kW/m ²)	11.92	11.87	11.82	11.77	11.72	11.66	11.61	11.55	11.48

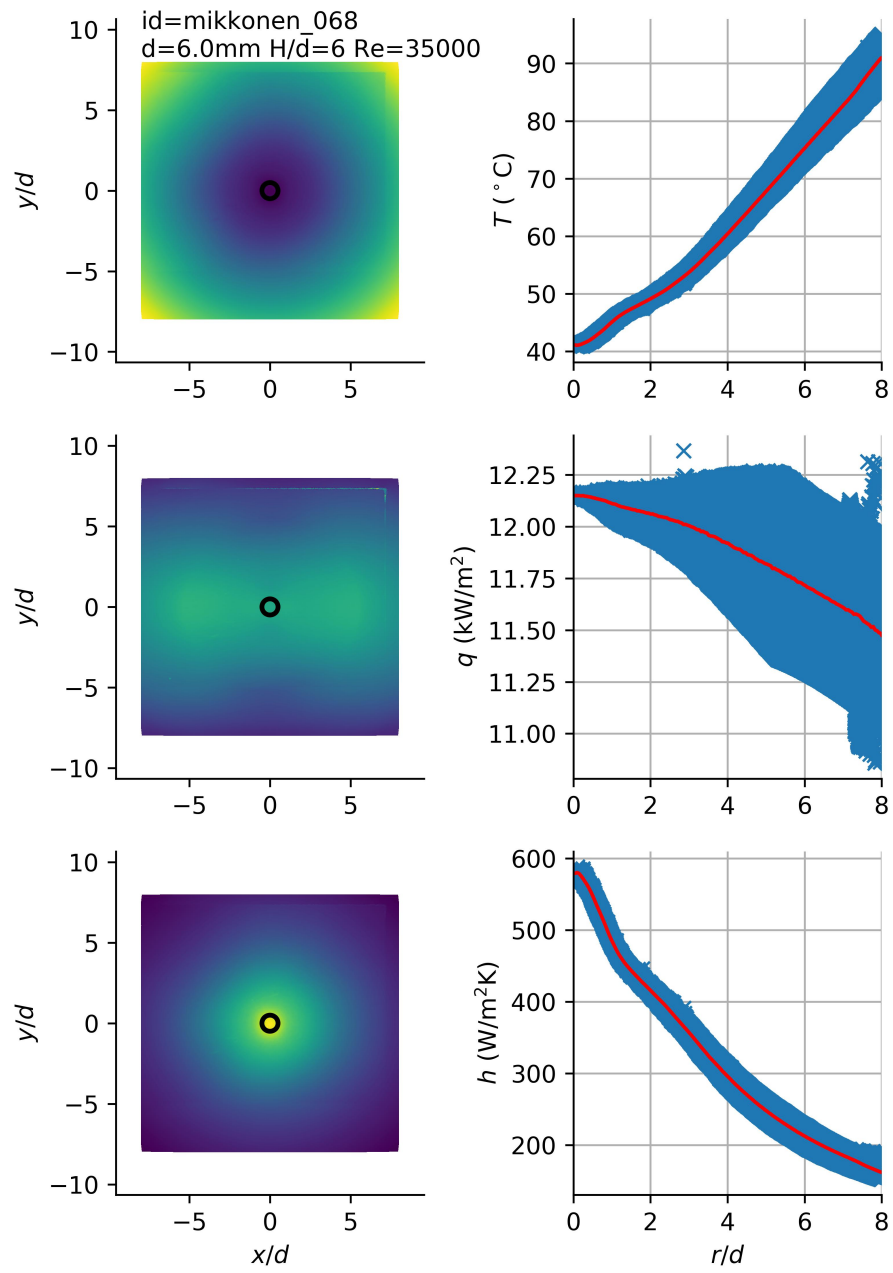


Figure 208: Results, mikkonen_068

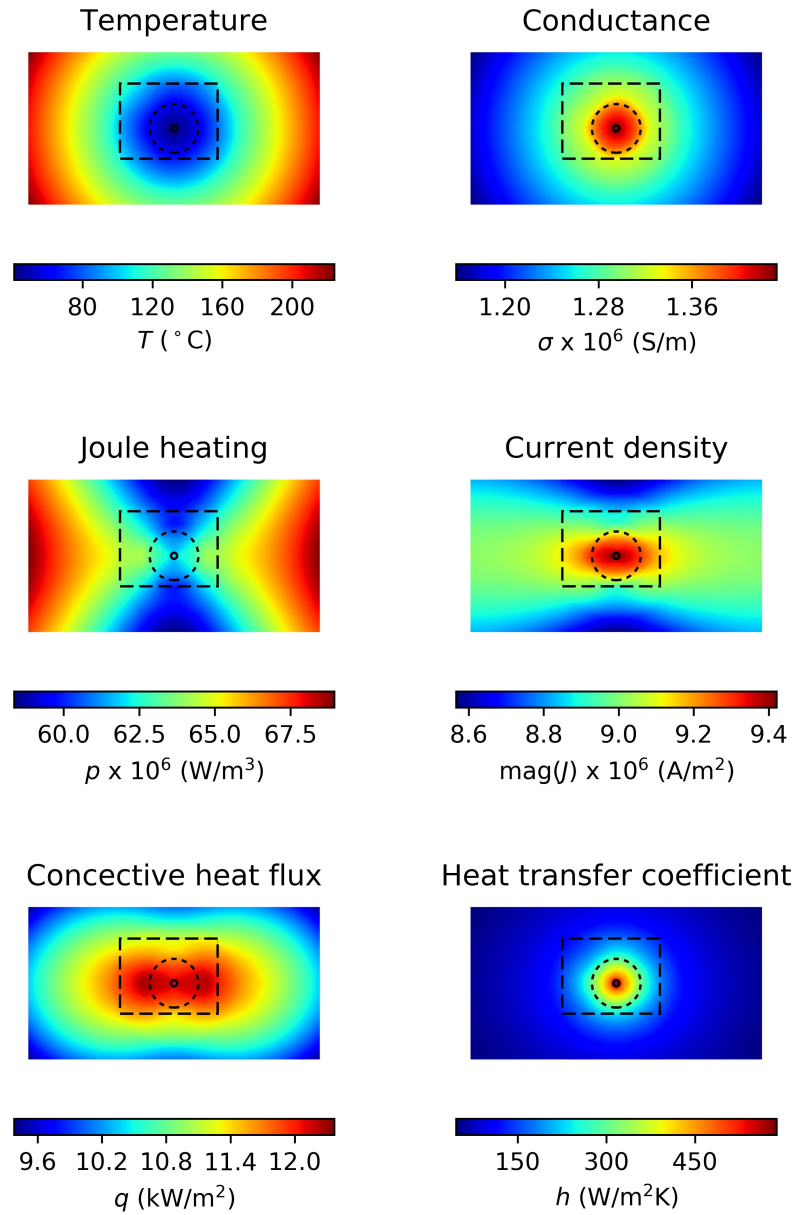


Figure 209: Convection calculation, mikkonen_068

Case id: mikkonen_069

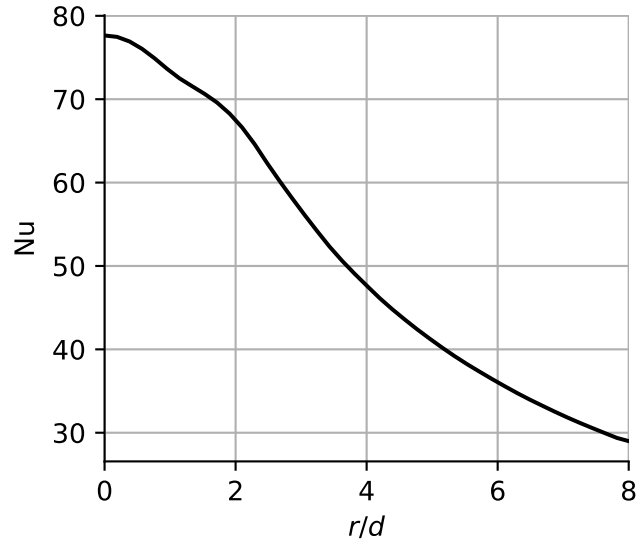


Figure 210: Nu, mikkonen_069

path		2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd2_Re25000							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=25mm							
measurement time		2017-03-06 13:54:38							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
24686	0.37	2	0.71	3.0	6.0	20.2	20.5	1.059	126.2
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.6	2.3	280.6	8.45				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	44.45	44.85	45.83	46.74	48.01	50.35	53.15	56.19	59.16
Nu	77.64	76.37	73.37	70.77	67.47	62.12	56.68	51.73	47.65
h (W/m ² K)	670.01	659.04	633.11	610.67	582.27	536.10	489.12	446.43	411.22
q (kW/m ²)	16.05	16.04	16.03	16.02	16.01	15.99	15.96	15.92	15.89
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	59.16	62.16	65.14	68.14	71.09	74.09	77.09	80.04	82.74
Nu	47.65	44.11	41.07	38.39	36.06	33.94	32.06	30.39	28.99
h (W/m ² K)	411.22	380.62	354.40	331.28	311.15	292.84	276.66	262.22	250.21
q (kW/m ²)	15.89	15.85	15.81	15.77	15.73	15.69	15.65	15.61	15.57

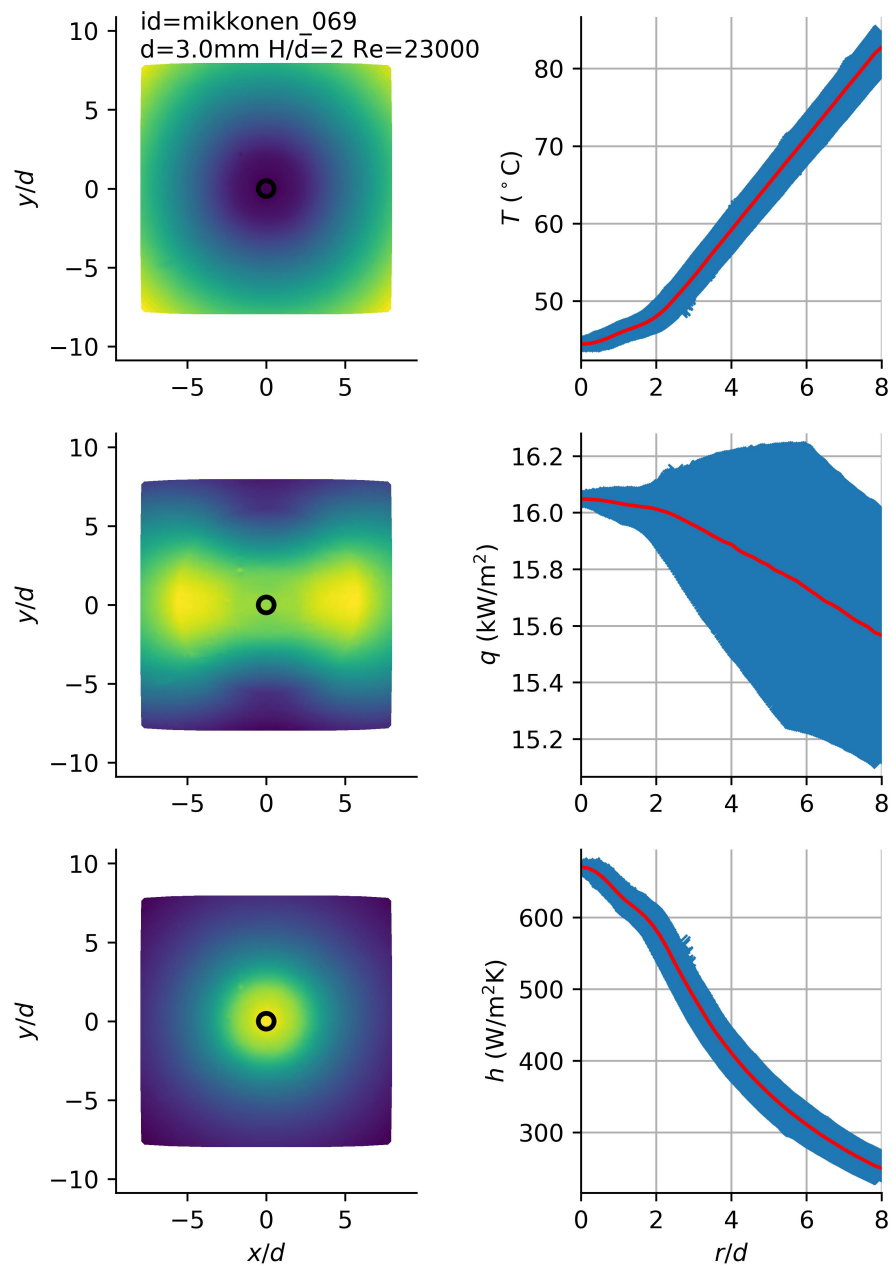


Figure 211: Results, mikkonen_069

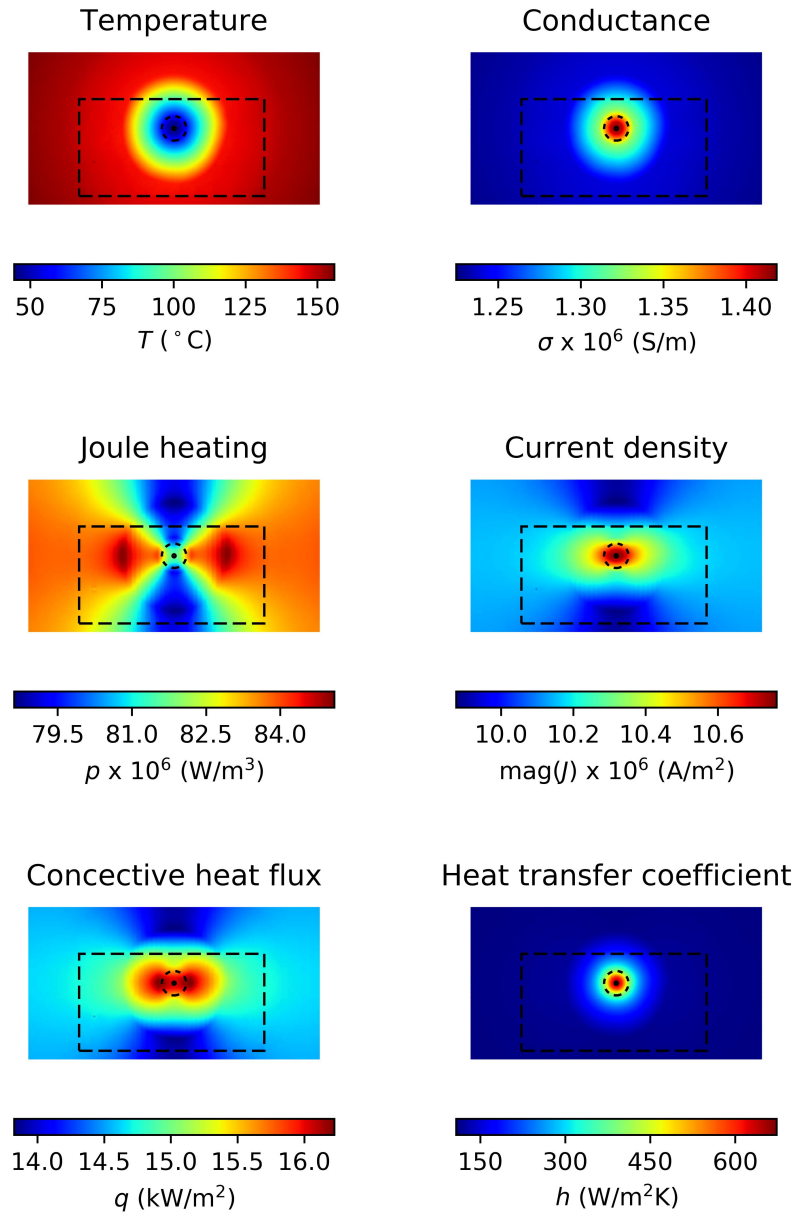


Figure 212: Convection calculation, mikkonen_069

Case id: mikkonen_070

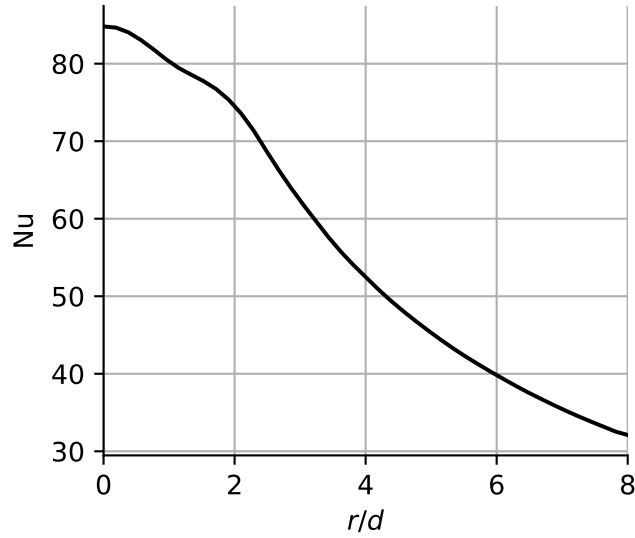


Figure 213: Nu, mikkonen_070

path		2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd2_Re30000							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=25mm							
measurement time		2017-03-06 14:00:39							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
30106	0.45	2	0.71	3.0	6.0	20.5	20.5	1.293	154.1
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.6	2.4	295.0	6.18				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	43.71	44.09	45.00	45.75	46.88	49.14	51.92	54.84	57.68
Nu	84.81	83.42	80.30	77.86	74.51	68.56	62.37	56.95	52.49
h (W/m ² K)	732.46	720.46	693.53	672.48	643.53	592.14	538.68	491.91	453.32
q (kW/m ²)	17.00	17.00	16.99	16.98	16.97	16.95	16.91	16.88	16.85
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	57.68	60.57	63.41	66.27	69.09	71.95	74.82	77.63	80.19
Nu	52.49	48.60	45.29	42.37	39.83	37.51	35.45	33.62	32.10
h (W/m ² K)	453.32	419.77	391.20	365.92	343.98	323.93	306.19	290.40	277.29
q (kW/m ²)	16.85	16.81	16.78	16.74	16.71	16.66	16.62	16.58	16.55

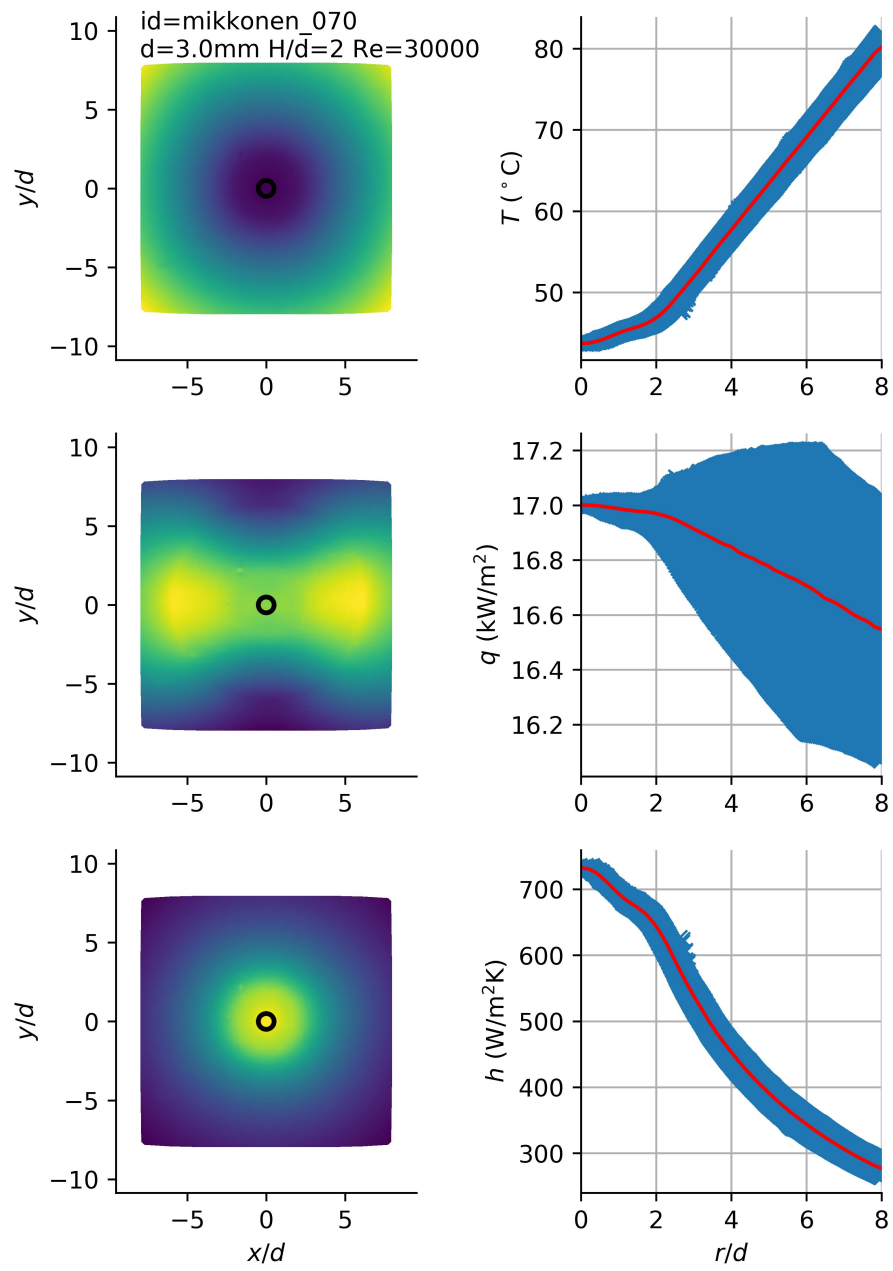


Figure 214: Results, mikkonen_070

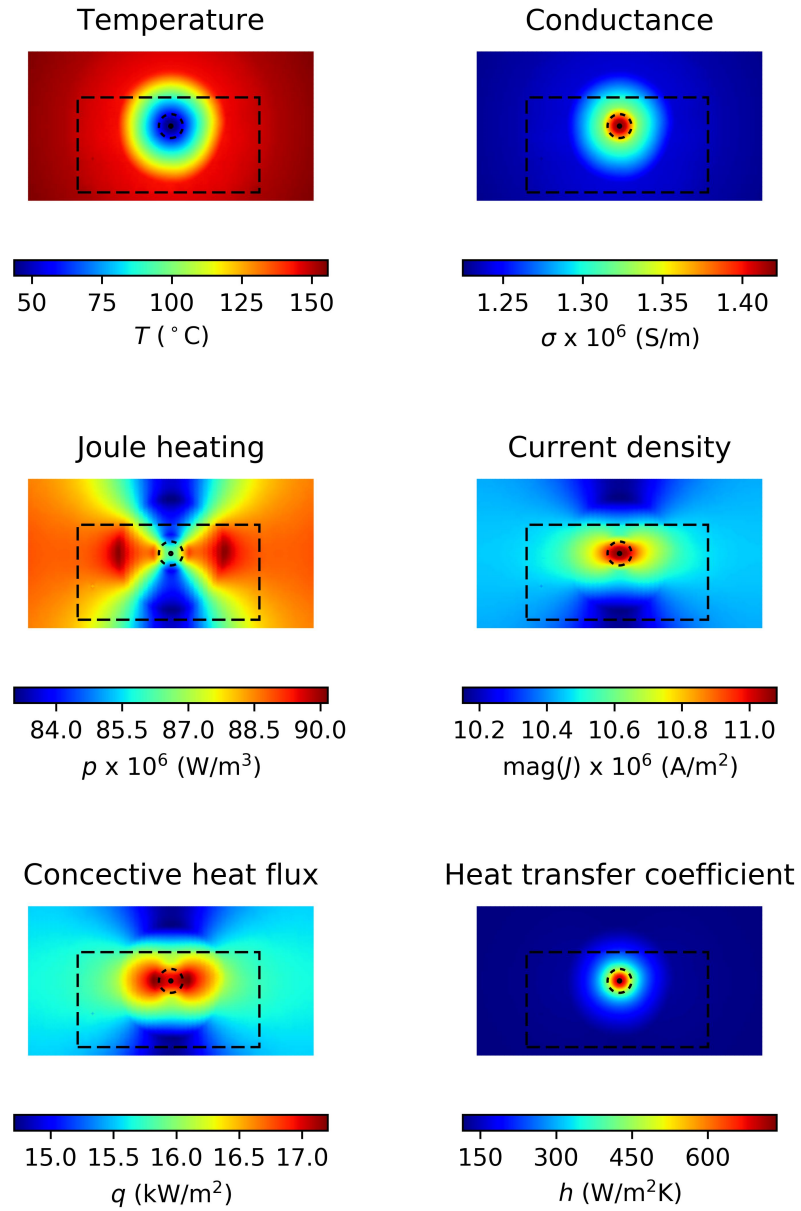


Figure 215: Convection calculation, mikkonen_070

Case id: mikkonen_071

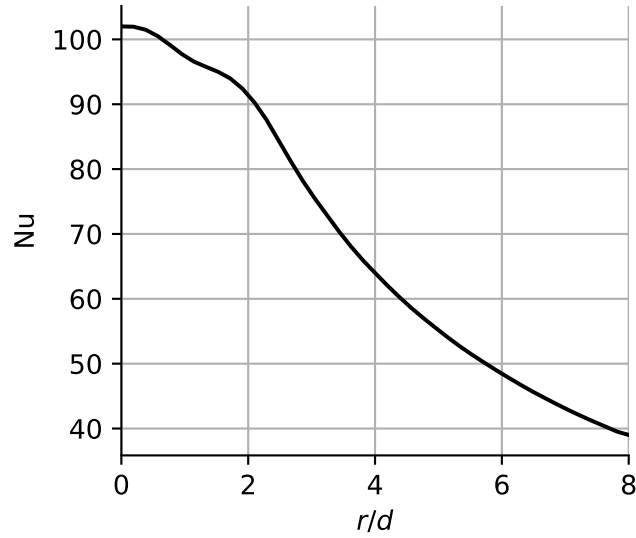


Figure 216: Nu, mikkonen_071

path		2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd2_Re40000							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=25mm							
measurement time		2017-03-06 14:07:30							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
40236	0.60	2	0.71	3.0	6.0	20.8	20.5	1.730	206.4
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.6	2.6	319.5	6.89			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	43.47	43.72	44.53	45.11	46.11	48.32	51.14	54.01	56.86
Nu	102.00	100.88	97.45	95.10	91.38	84.06	76.19	69.55	64.00
h (W/m ² K)	881.70	872.06	842.40	822.07	789.93	726.64	658.62	601.20	553.25
q (kW/m ²)	20.25	20.25	20.24	20.23	20.23	20.21	20.17	20.14	20.11
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	56.86	59.71	62.53	65.38	68.19	71.05	73.91	76.73	79.28
Nu	64.00	59.24	55.18	51.58	48.46	45.62	43.10	40.86	39.01
h (W/m ² K)	553.25	512.07	476.99	445.89	418.93	394.32	372.56	353.17	337.19
q (kW/m ²)	20.11	20.07	20.04	20.01	19.97	19.93	19.89	19.85	19.82

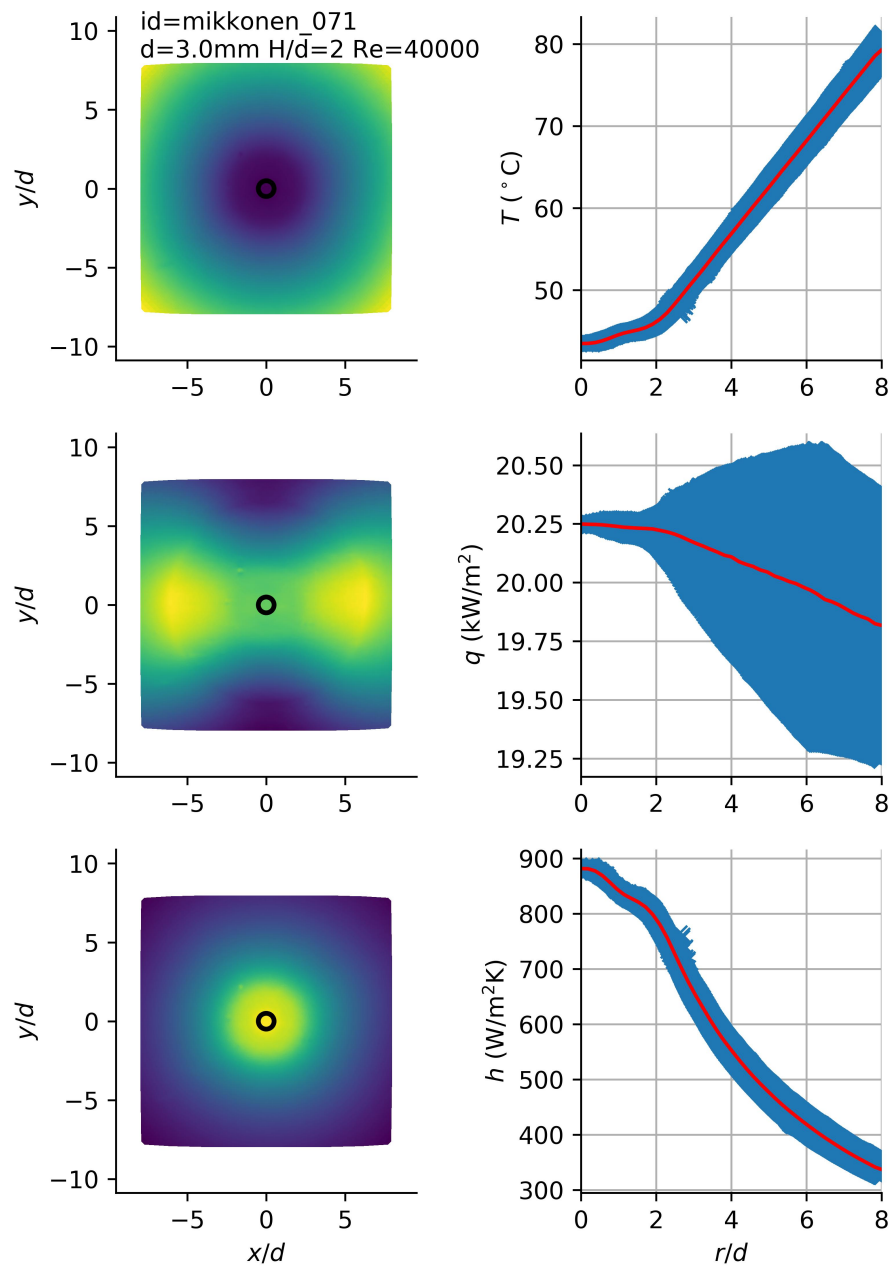


Figure 217: Results, mikkonen_071

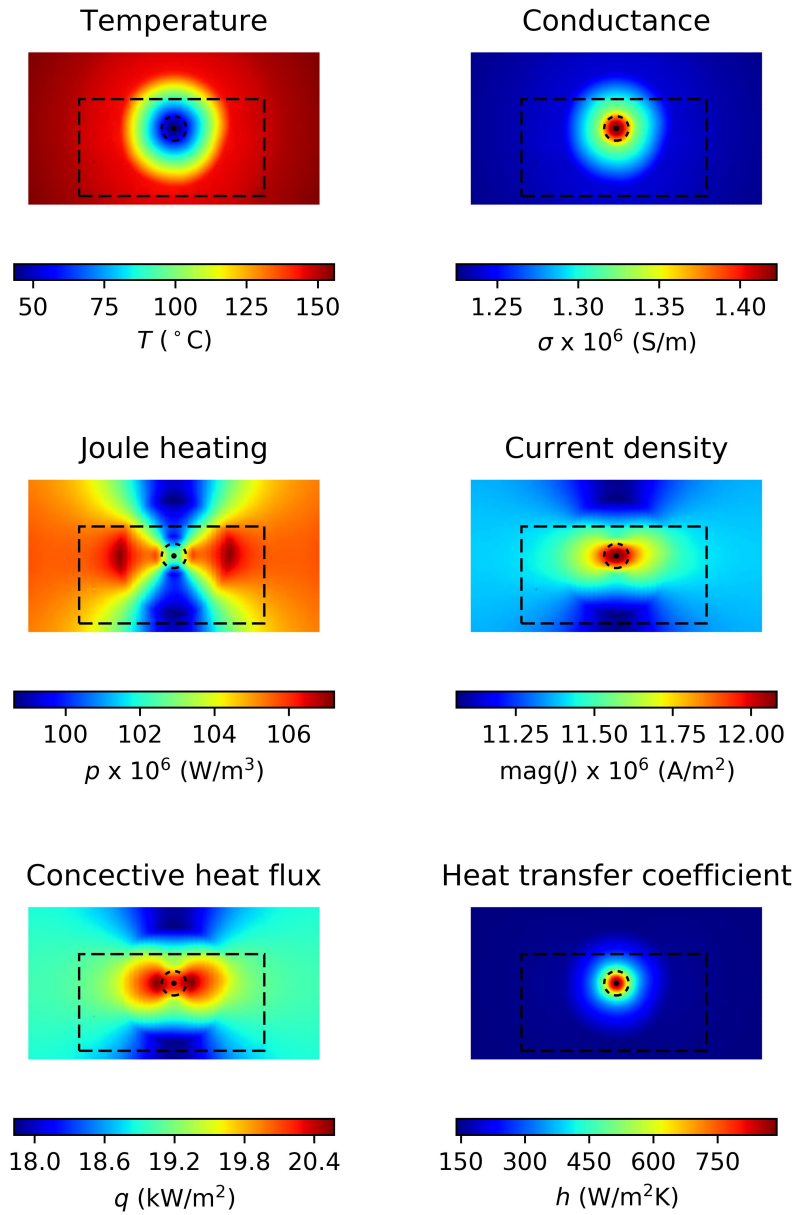


Figure 218: Convection calculation, mikkonen_071

Case id: mikkonen_072

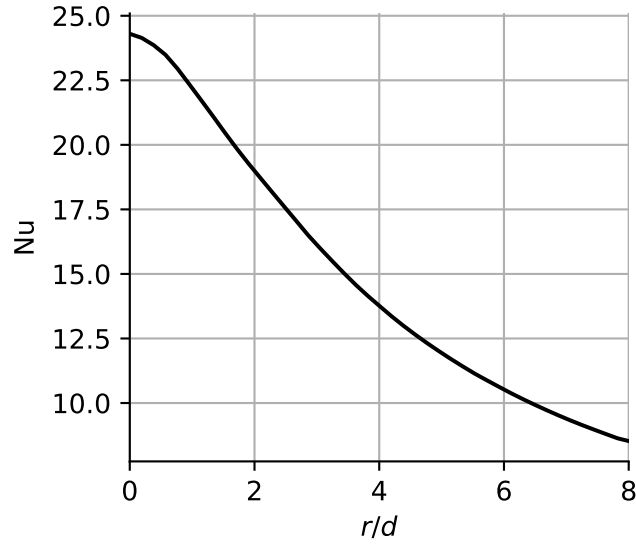


Figure 219: Nu, mikkonen_072

path	2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd4_Re6000
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=25mm
measurement time	2017-03-06 14:47:06

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
5917	0.09	4	0.71	3.0	12.0	21.7	20.5	0.255	30.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.6	1.3	165.4	4.38	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	44.04	44.69	46.18	48.10	50.23	52.51	55.08	57.75	60.45
Nu	24.30	23.63	22.20	20.56	18.99	17.54	16.13	14.87	13.77
h (W/m ² K)	210.62	204.81	192.40	178.16	164.62	152.02	139.81	128.91	119.33
q (kW/m ²)	4.96	4.95	4.94	4.91	4.89	4.86	4.83	4.80	4.76

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	60.45	63.17	65.86	68.55	71.16	73.76	76.33	78.82	81.05
Nu	13.77	12.79	11.94	11.18	10.53	9.93	9.39	8.92	8.53
h (W/m ² K)	119.33	110.85	103.49	96.93	91.22	86.03	81.41	77.31	73.91
q (kW/m ²)	4.76	4.72	4.69	4.65	4.62	4.58	4.54	4.50	4.47

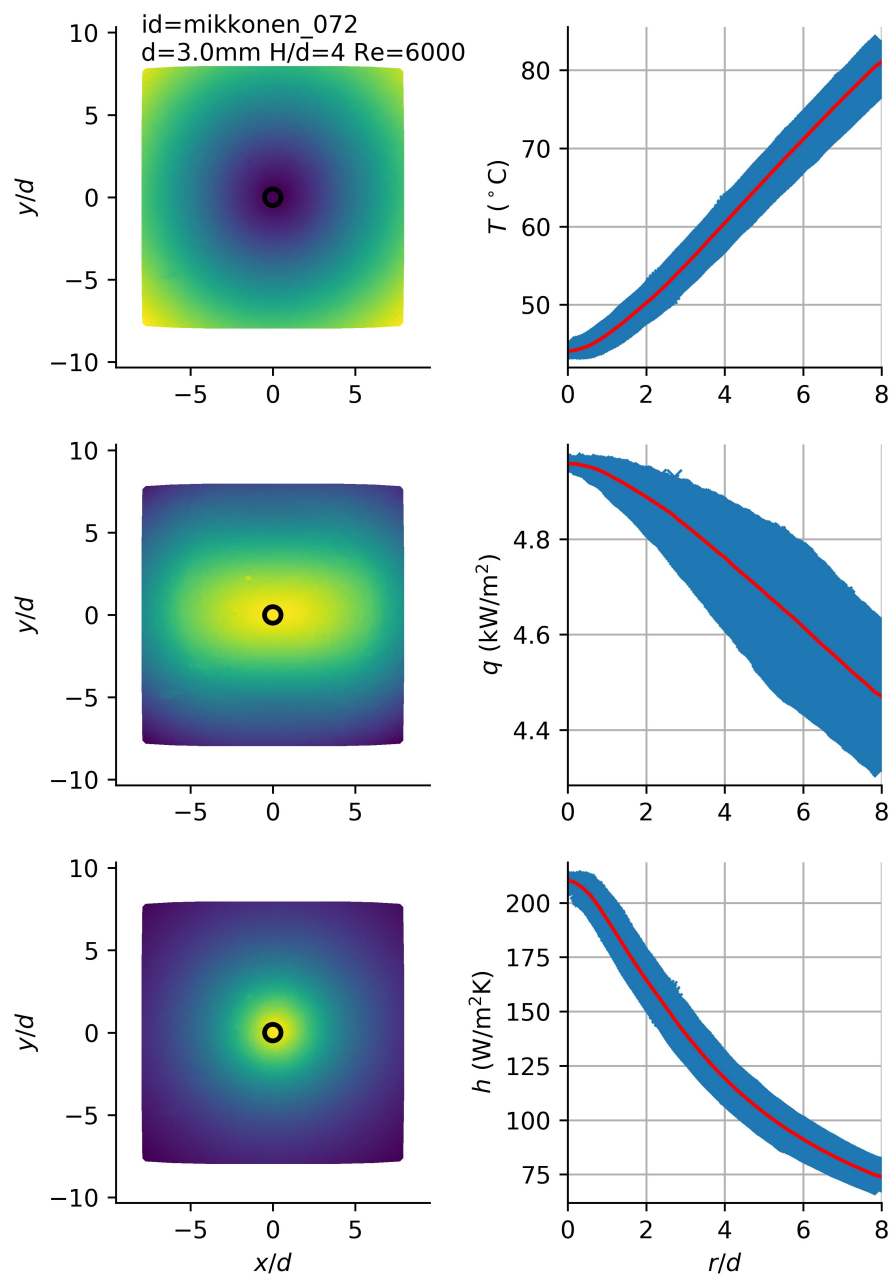


Figure 220: Results, mikkonen_072

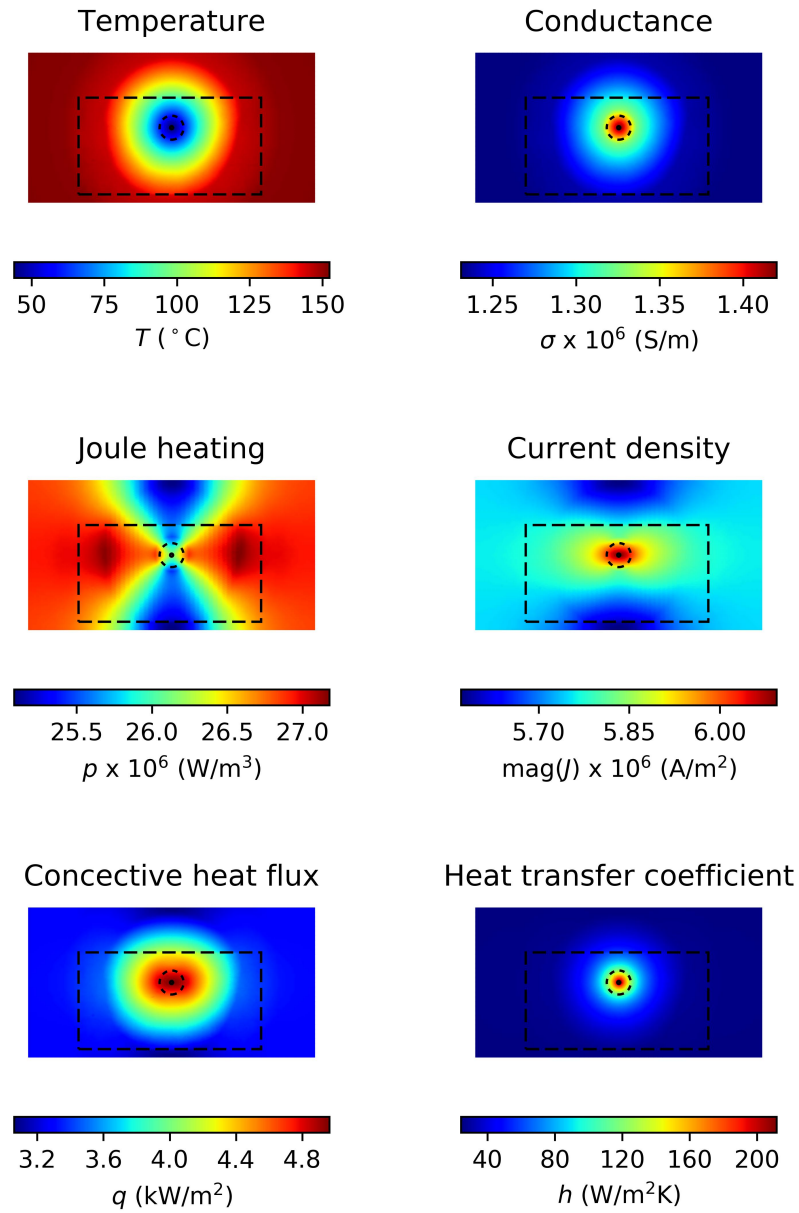


Figure 221: Convection calculation, mikkonen_072

Case id: mikkonen_073

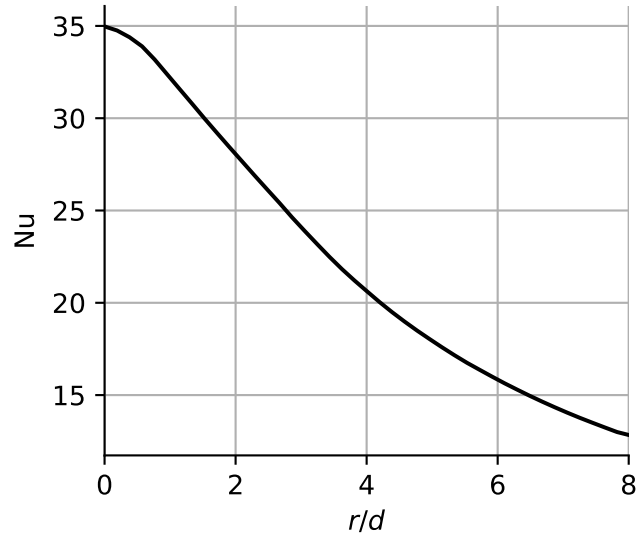


Figure 222: Nu, mikkonen_073

path		2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd4_Re10000							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=25mm							
measurement time		2017-03-06 14:43:32							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9791	0.15	4	0.71	3.0	12.0	21.7	20.5	0.422	50.5
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.6	1.6	193.9	4.93				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	43.59	44.18	45.53	47.20	49.05	51.12	53.49	56.06	58.67
Nu	34.97	34.08	32.19	30.09	28.06	26.07	24.10	22.25	20.64
h (W/m ² K)	303.10	295.37	278.98	260.80	243.16	225.95	208.87	192.88	178.87
q (kW/m ²)	7.00	6.99	6.98	6.96	6.94	6.91	6.88	6.85	6.82
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	58.67	61.32	63.95	66.61	69.21	71.82	74.43	76.97	79.26
Nu	20.64	19.19	17.94	16.82	15.84	14.94	14.14	13.43	12.84
h (W/m ² K)	178.87	166.35	155.51	145.75	137.27	129.51	122.58	116.39	111.27
q (kW/m ²)	6.82	6.78	6.75	6.71	6.68	6.64	6.60	6.57	6.53

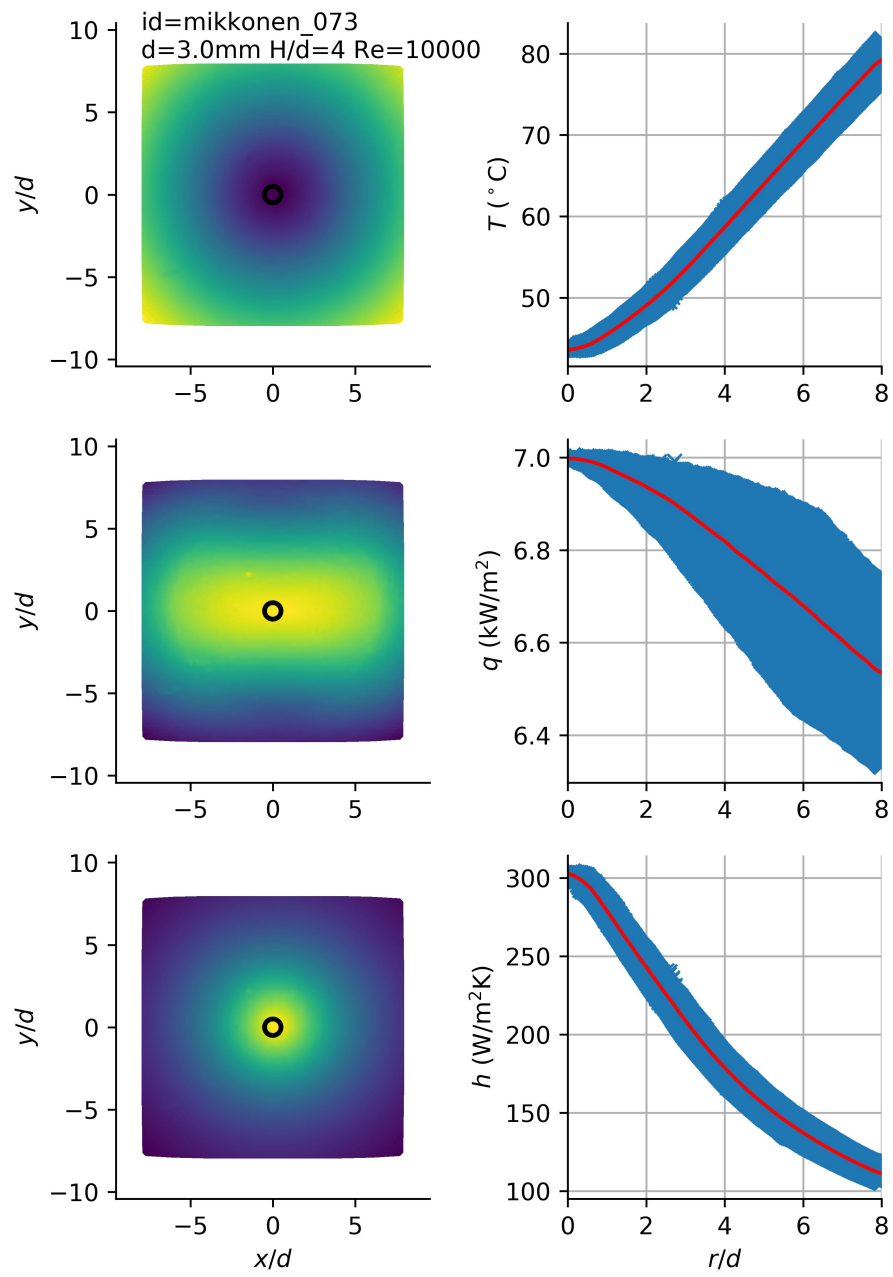


Figure 223: Results, mikkonen_073

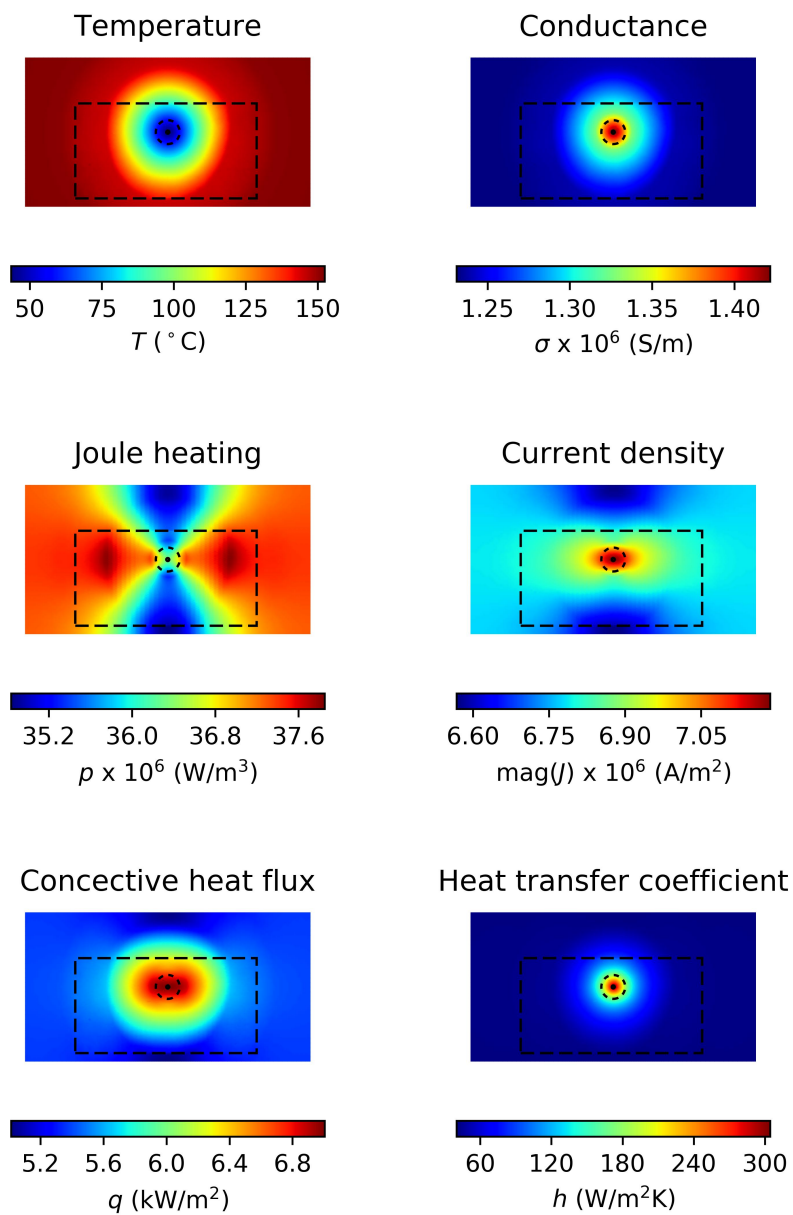


Figure 224: Convection calculation, mikkonen_073

Case id: mikkonen_074

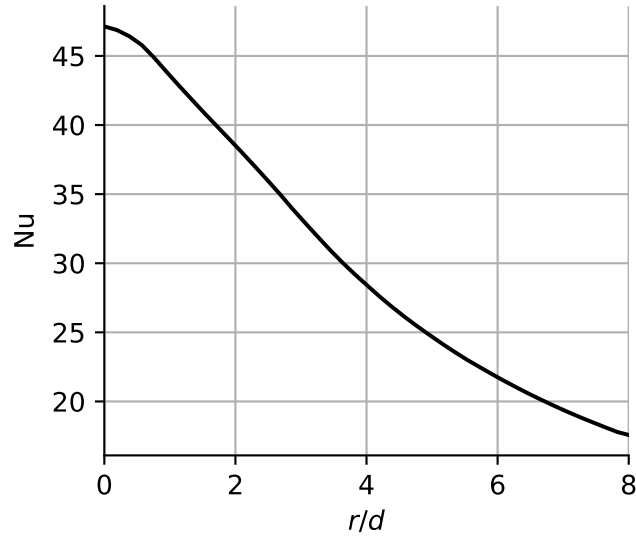


Figure 225: Nu, mikkonen_074

path		2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd4_Re14000							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=25mm							
measurement time		2017-03-06 14:38:49							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14025	0.21	4	0.71	3.0	12.0	21.4	20.5	0.604	72.2
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.6	1.8	224.1	5.79				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	44.06	44.63	45.95	47.50	49.19	51.17	53.57	56.20	58.90
Nu	47.13	46.03	43.58	41.00	38.51	35.95	33.25	30.69	28.44
h (W/m ² K)	408.15	398.56	377.40	355.02	333.50	311.28	287.94	265.76	246.25
q (kW/m ²)	9.62	9.61	9.60	9.58	9.56	9.54	9.51	9.48	9.45
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	58.90	61.66	64.41	67.20	69.94	72.70	75.47	78.19	80.65
Nu	28.44	26.43	24.68	23.12	21.75	20.50	19.39	18.40	17.58
h (W/m ² K)	246.25	228.83	213.74	200.17	188.36	177.54	167.91	159.31	152.19
q (kW/m ²)	9.45	9.41	9.37	9.34	9.30	9.26	9.22	9.18	9.15

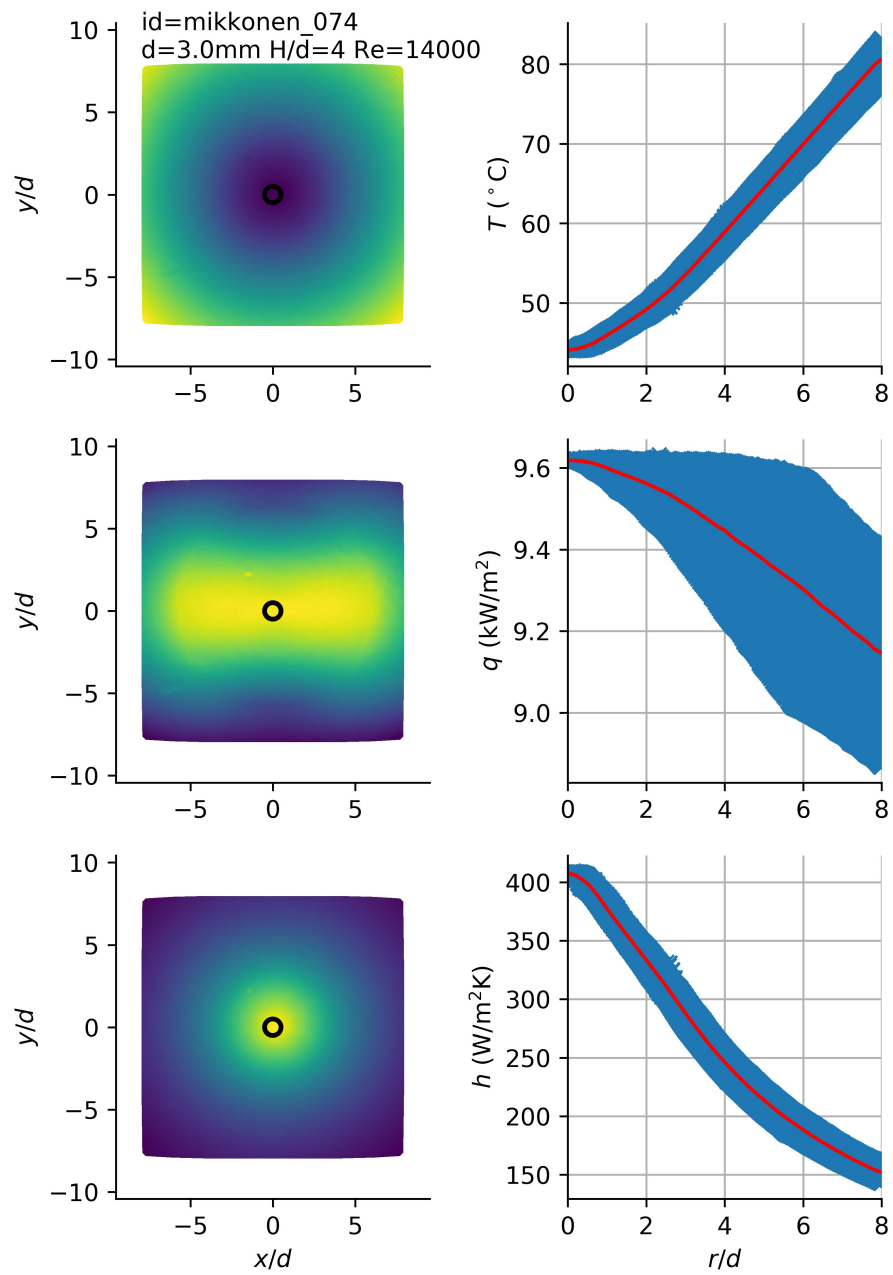


Figure 226: Results, mikkonen_074

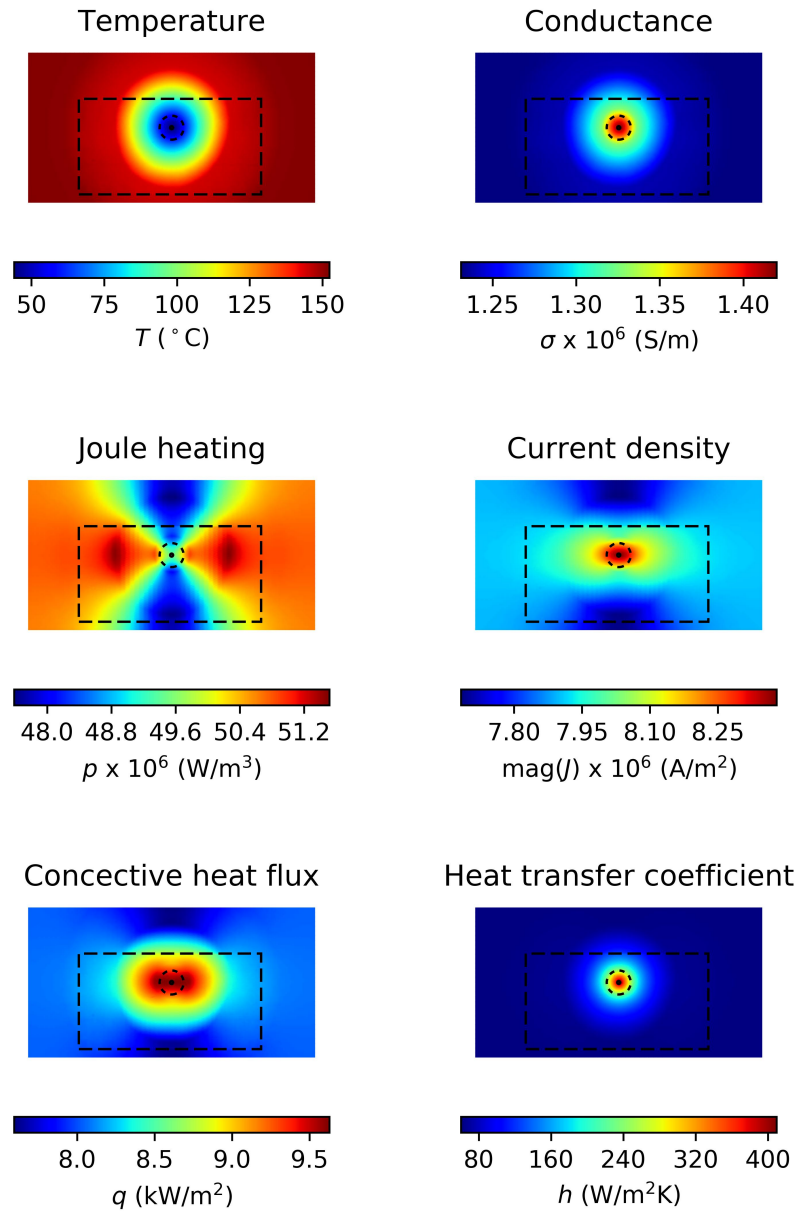


Figure 227: Convection calculation, mikkonen_074

Case id: mikkonen_075

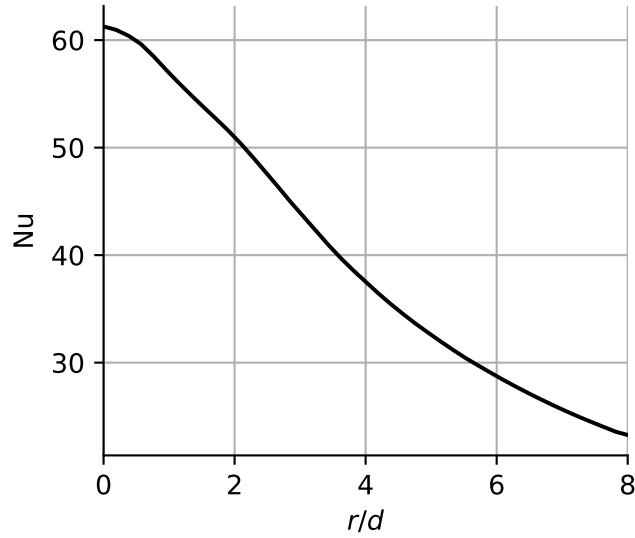


Figure 228: Nu, mikkonen_075

path	2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd4_Re20000								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=25mm								
measurement time	2017-03-06 14:33:14								
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
19954	0.30	4	0.71	3.0	12.0	21.4	20.5	0.859	102.7
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.6	2.0	249.6	6.69			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	43.49	44.01	45.21	46.56	48.05	49.99	52.33	54.94	57.58
Nu	61.27	59.92	56.95	53.92	50.97	47.53	43.94	40.51	37.53
h (W/m ² K)	530.59	518.87	493.17	466.93	441.37	411.57	380.51	350.78	324.98
q (kW/m ²)	12.20	12.19	12.18	12.16	12.15	12.13	12.10	12.07	12.04
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	57.58	60.28	62.95	65.68	68.35	71.05	73.77	76.44	78.84
Nu	37.53	34.88	32.59	30.53	28.75	27.11	25.65	24.35	23.27
h (W/m ² K)	324.98	302.02	282.20	264.38	248.93	234.78	222.12	210.84	201.54
q (kW/m ²)	12.04	12.00	11.97	11.93	11.90	11.86	11.82	11.78	11.75

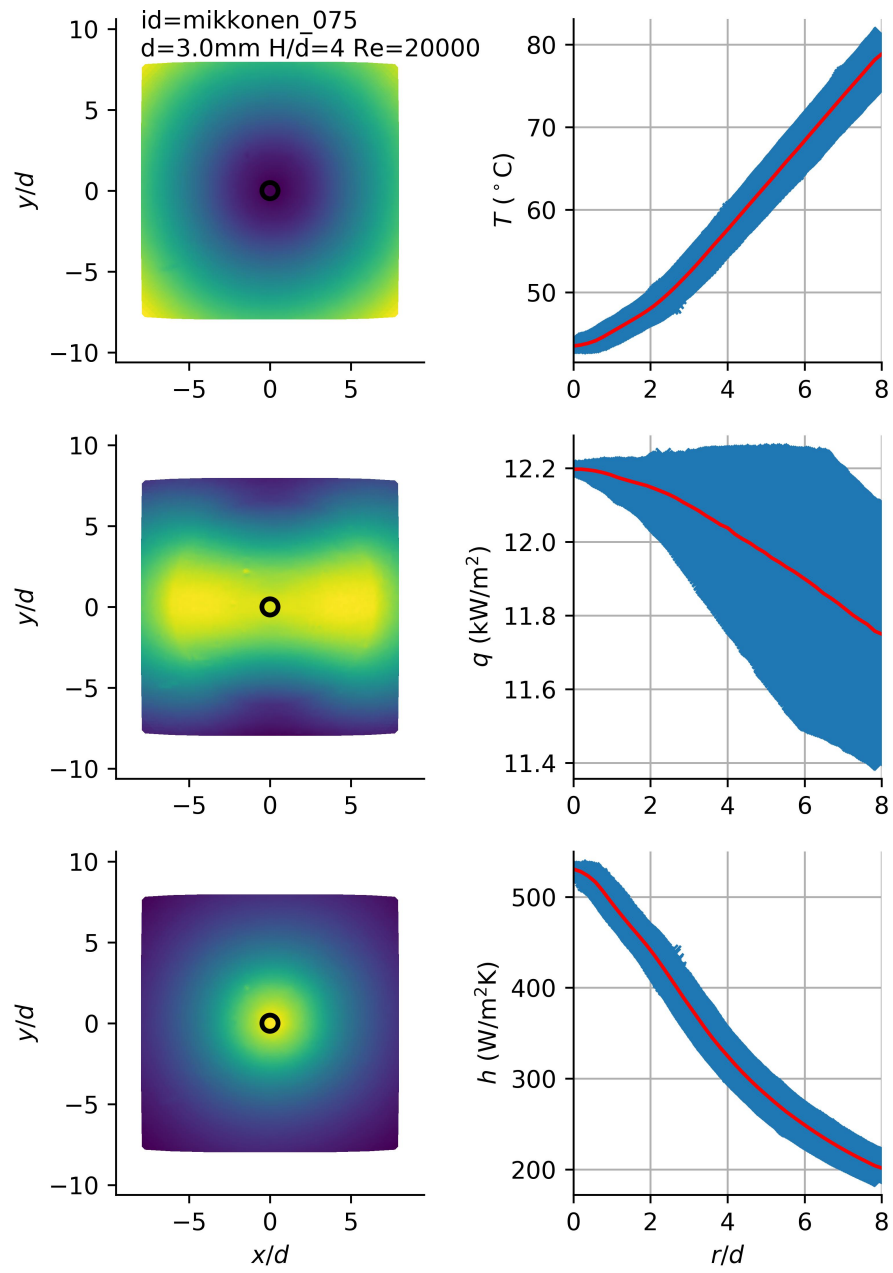


Figure 229: Results, mikkonen_075

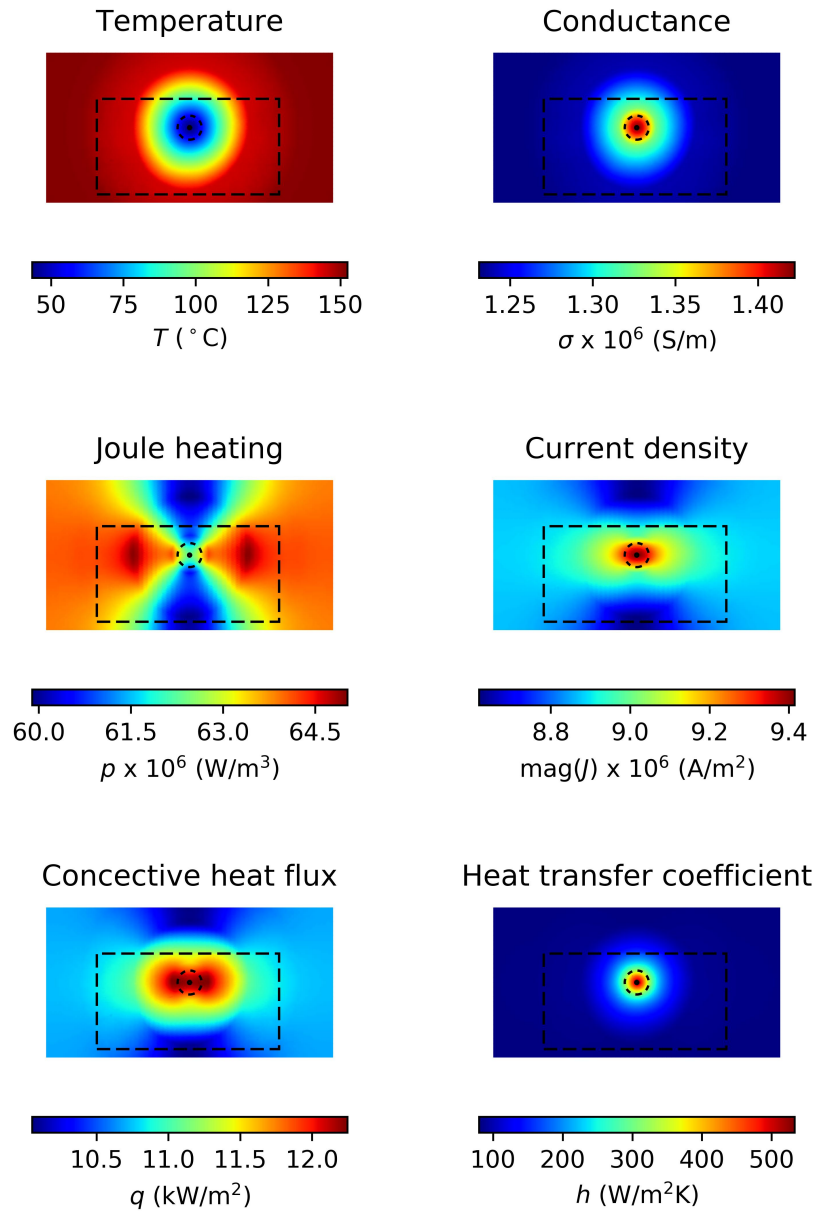


Figure 230: Convection calculation, mikkonen_075

Case id: mikkonen_076

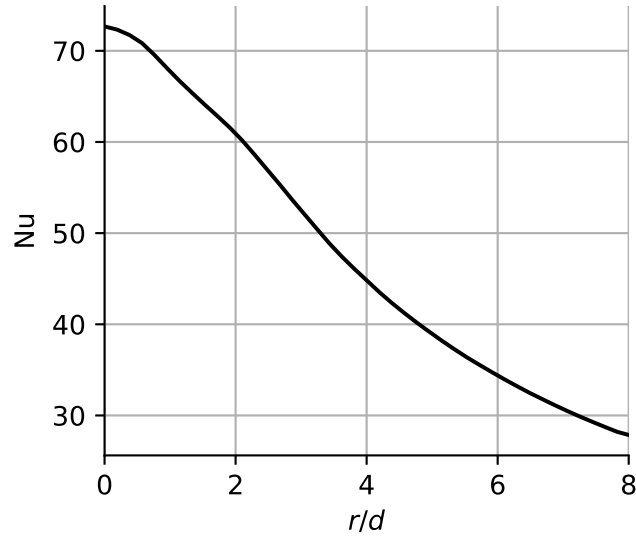


Figure 231: Nu, mikkonen_076

path		2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd4_Re25000							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=25mm							
measurement time		2017-03-06 14:29:21							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
25032	0.37	4	0.71	3.0	12.0	21.4	20.5	1.078	128.9
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.6	2.2	274.3	6.53			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	43.93	44.42	45.61	46.94	48.38	50.35	52.74	55.43	58.10
Nu	72.68	71.18	67.75	64.29	60.92	56.81	52.51	48.35	44.83
h (W/m ² K)	629.33	616.35	586.71	556.70	527.50	491.98	454.67	418.68	388.18
q (kW/m ²)	14.75	14.74	14.73	14.71	14.70	14.68	14.65	14.62	14.59
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	58.10	60.84	63.56	66.32	69.04	71.81	74.58	77.31	79.78
Nu	44.83	41.67	38.96	36.52	34.39	32.43	30.70	29.14	27.86
h (W/m ² K)	388.18	360.86	337.35	316.21	297.77	280.84	265.83	252.34	241.24
q (kW/m ²)	14.59	14.55	14.52	14.48	14.45	14.41	14.37	14.33	14.30

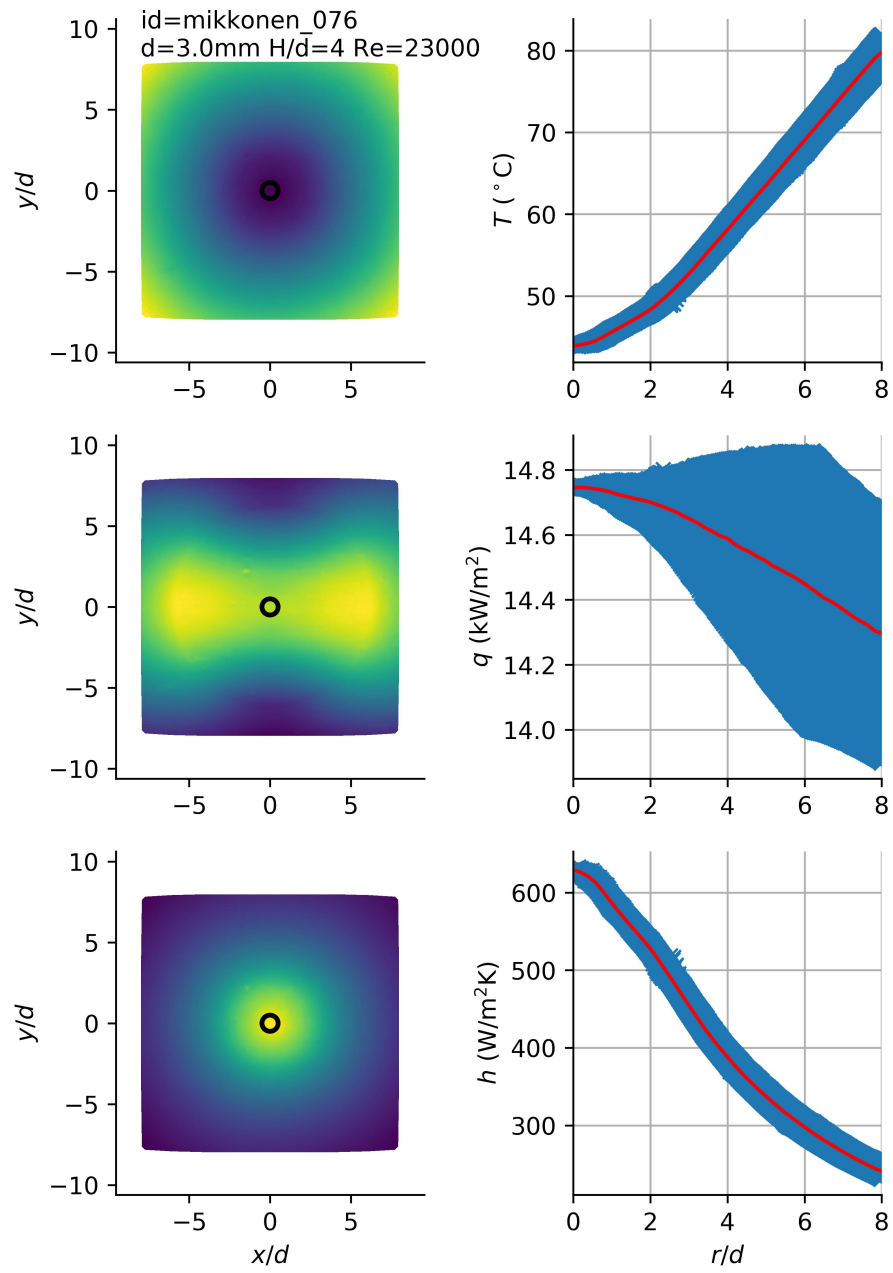


Figure 232: Results, mikkonen_076

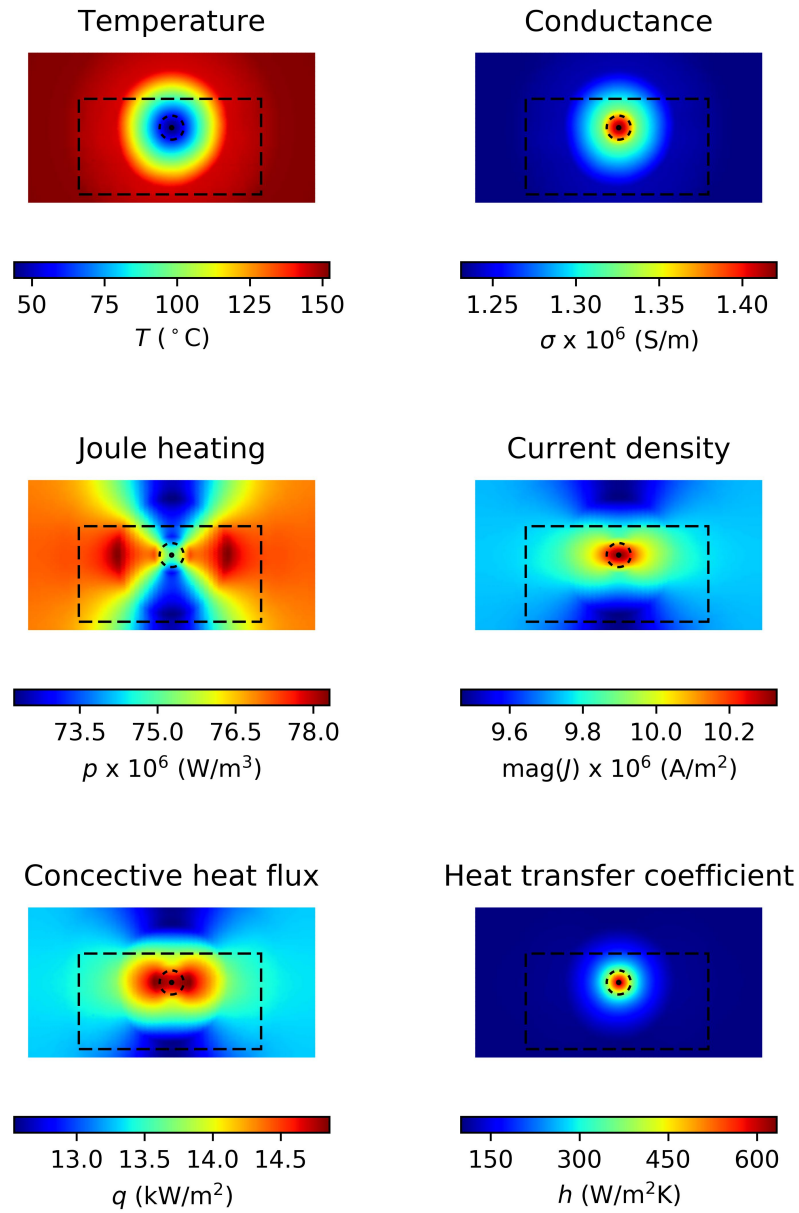


Figure 233: Convection calculation, mikkonen_076

Case id: mikkonen_077

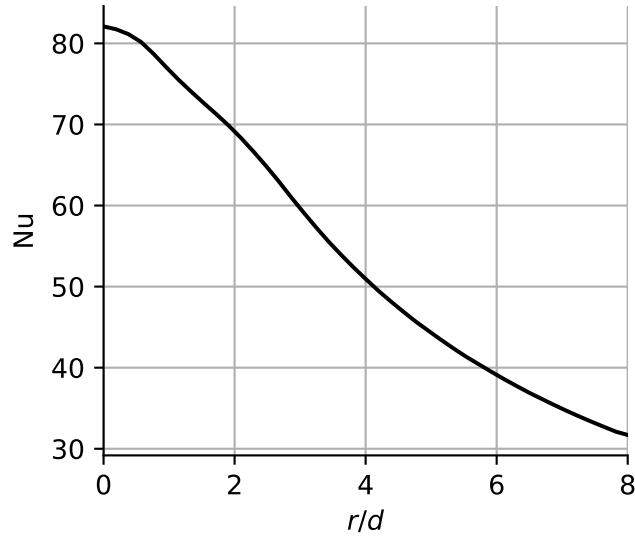


Figure 234: Nu, mikkonen_077

path		2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd4_Re30000							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=25mm							
measurement time		2017-03-06 14:25:15							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
29839	0.45	4	0.71	3.0	12.0	21.4	20.5	1.285	153.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.6	2.4	296.8	6.56			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	44.89	45.36	46.59	47.94	49.40	51.35	53.89	56.65	59.45
Nu	82.09	80.53	76.70	72.85	69.13	64.68	59.67	54.99	50.95
h (W/m ² K)	710.84	697.35	664.20	630.83	598.58	560.10	516.69	476.20	441.20
q (kW/m ²)	17.34	17.34	17.32	17.31	17.29	17.27	17.24	17.21	17.18
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	59.45	62.27	65.10	67.98	70.80	73.68	76.55	79.40	81.98
Nu	50.95	47.40	44.31	41.53	39.12	36.90	34.93	33.16	31.70
h (W/m ² K)	441.20	410.50	383.69	359.66	338.72	319.52	302.51	287.17	274.51
q (kW/m ²)	17.18	17.14	17.11	17.07	17.03	16.99	16.95	16.91	16.87

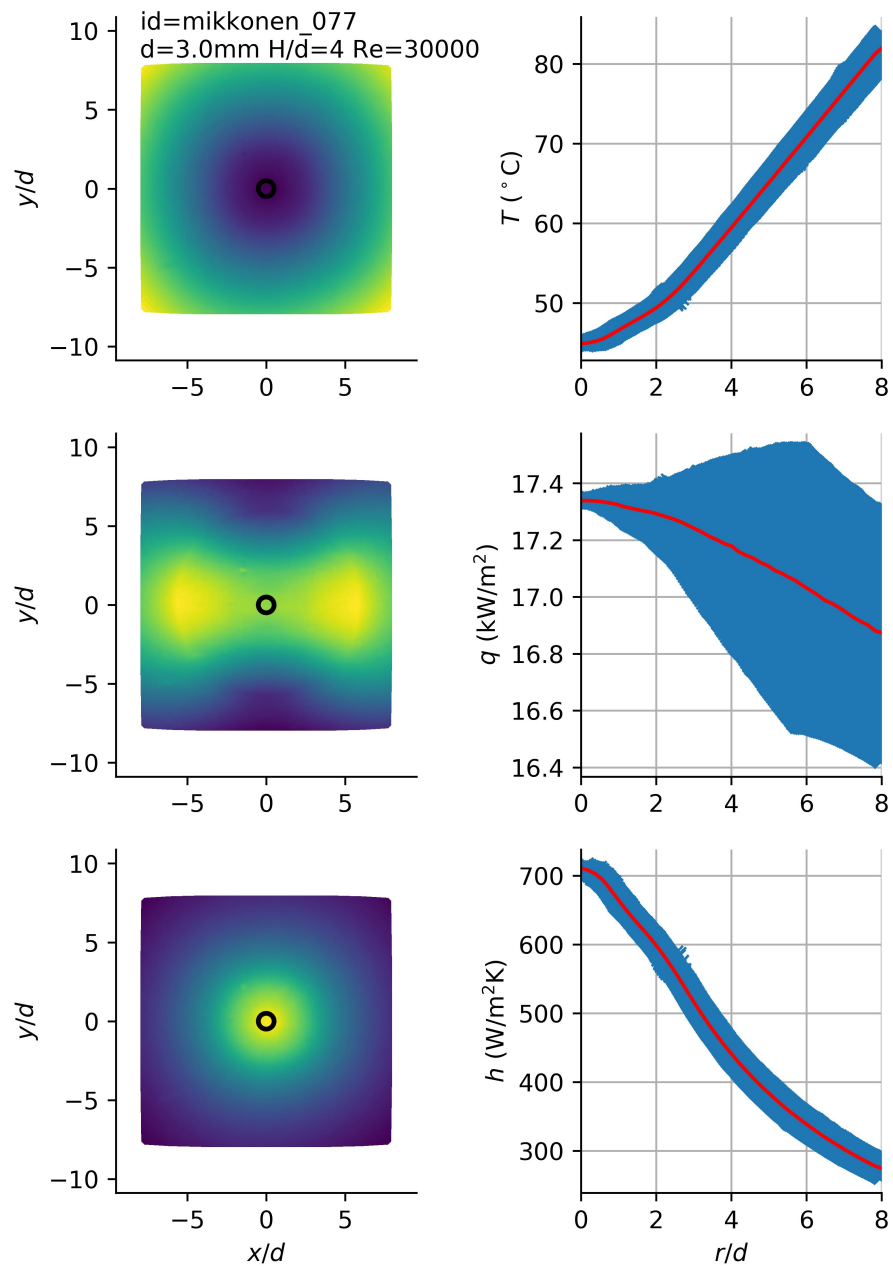


Figure 235: Results, mikkonen_077

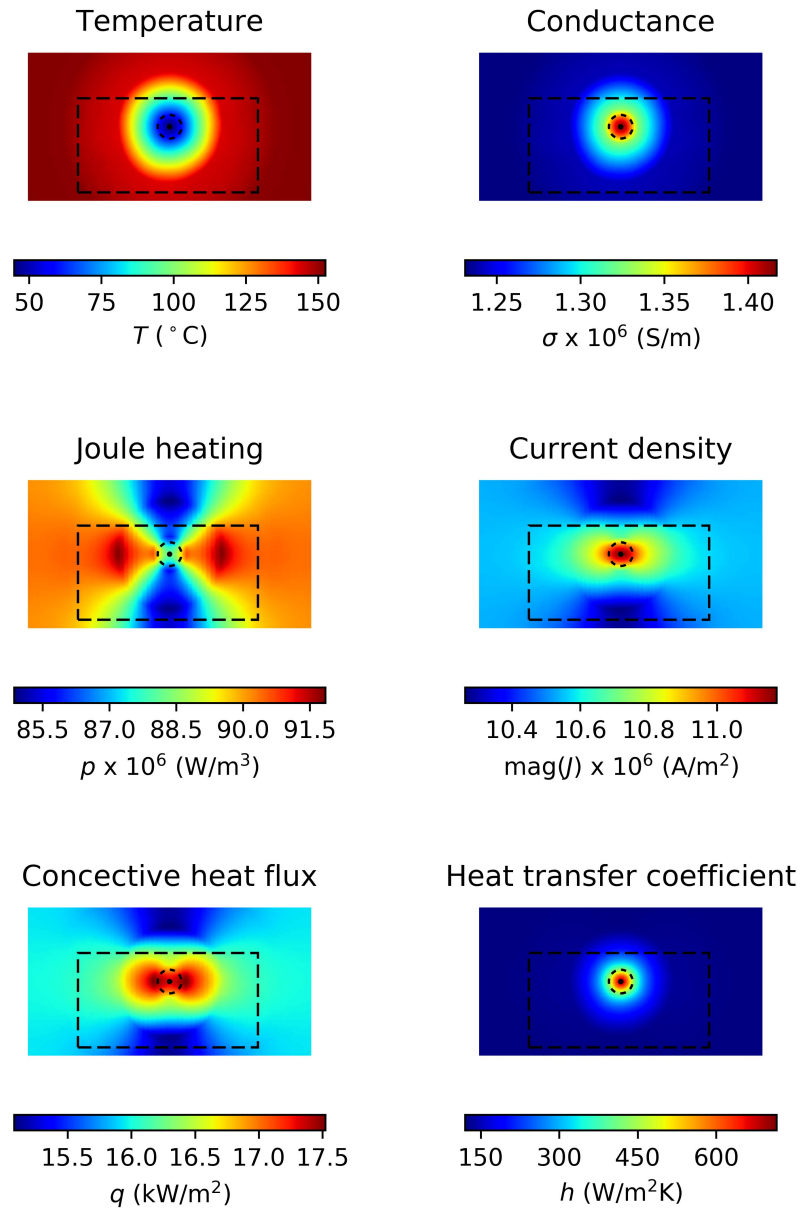


Figure 236: Convection calculation, mikkonen_077

Case id: mikkonen_078

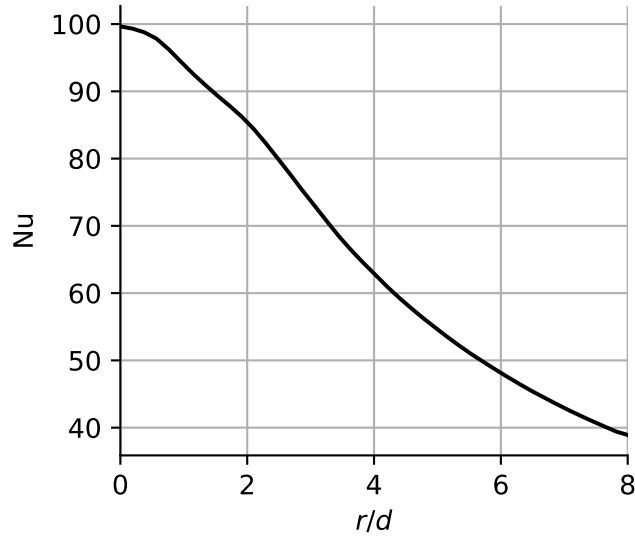


Figure 237: Nu, mikkonen_078

path		2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd4_Re40000							
this case measured by		Mikko Pirttiniemi							
lens		MWIR_f/2.0_f=25mm							
measurement time		2017-03-06 14:21:53							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
39940	0.60	4	0.71	3.0	12.0	21.4	20.5	1.720	205.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.6	2.6	321.4	7.21			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	44.40	44.76	45.83	47.05	48.34	50.27	52.68	55.40	58.10
Nu	99.65	98.17	93.98	89.61	85.40	79.80	73.73	67.88	62.92
h (W/m ² K)	862.89	850.10	813.78	775.96	739.50	691.06	638.49	587.81	544.83
q (kW/m ²)	20.62	20.62	20.61	20.60	20.58	20.56	20.54	20.50	20.48
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	58.10	60.90	63.67	66.51	69.30	72.16	75.01	77.85	80.41
Nu	62.92	58.46	54.62	51.16	48.15	45.38	42.93	40.73	38.91
h (W/m ² K)	544.83	506.24	472.98	443.04	416.93	392.96	371.76	352.68	336.96
q (kW/m ²)	20.48	20.44	20.41	20.37	20.34	20.29	20.26	20.22	20.18

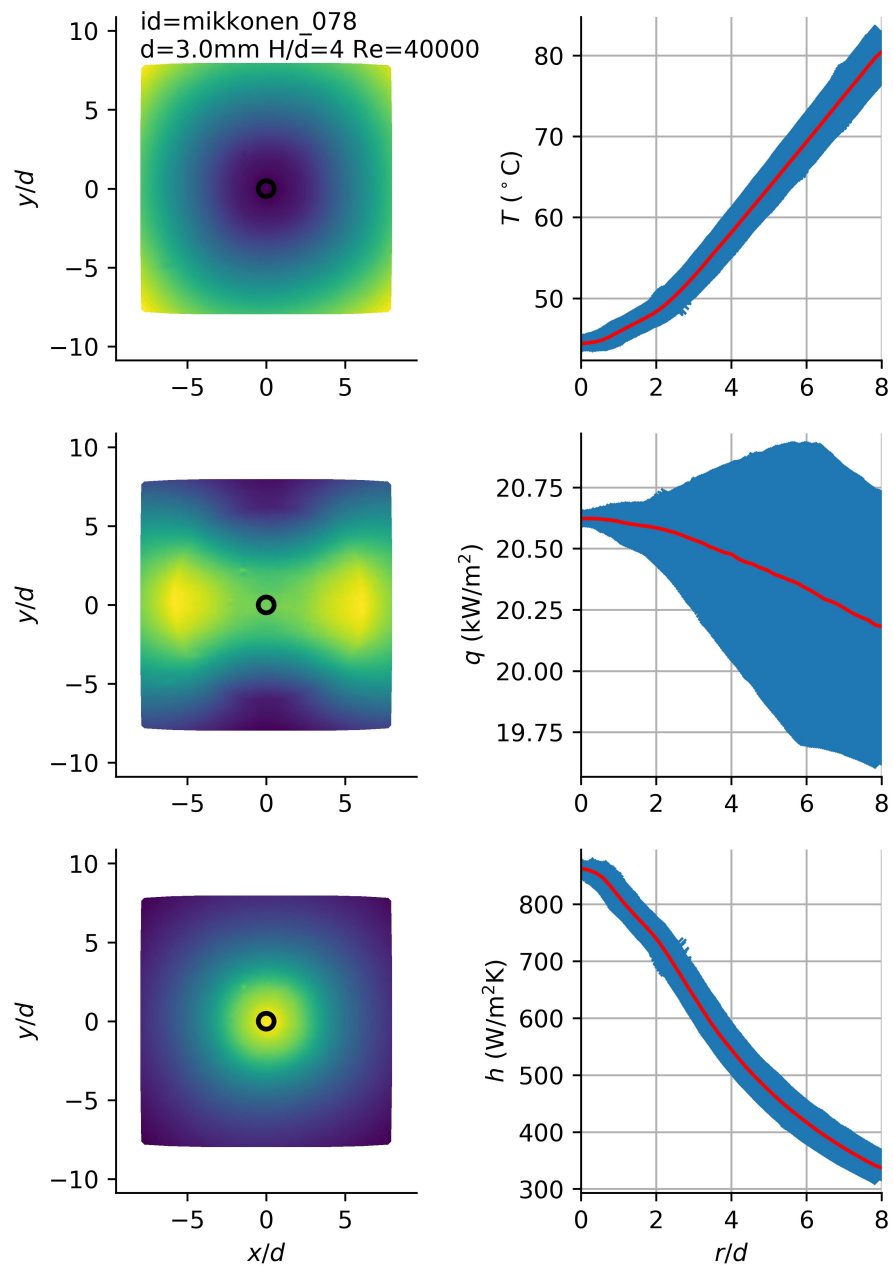


Figure 238: Results, mikkonen_078

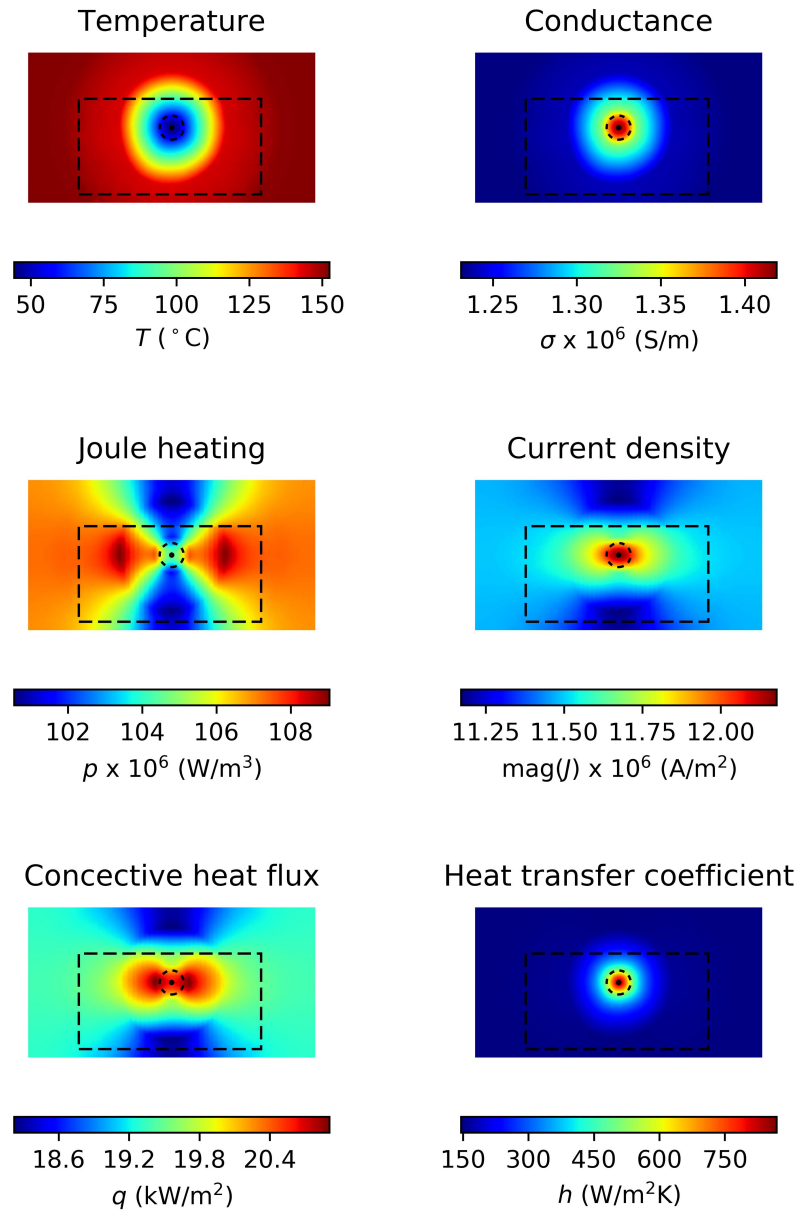


Figure 239: Convection calculation, mikkonen_078

Case id: mikkonen_079

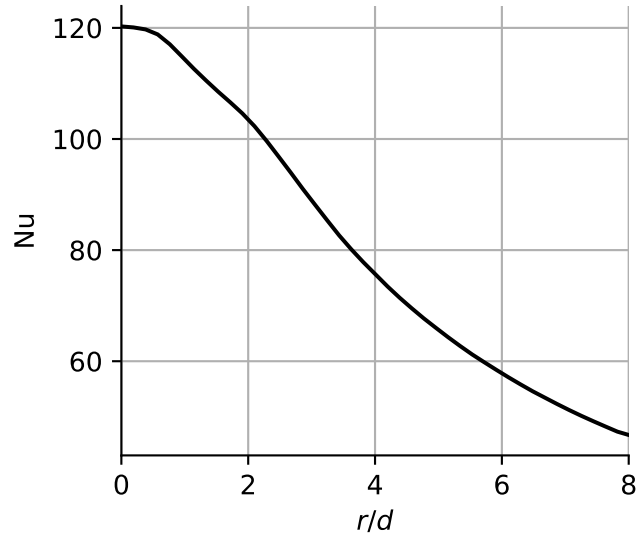


Figure 240: Nu, mikkonen_079

path	2017_03_06_d3mm_Hd2_4_Re_pitka/d3_hd4_Re50000								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=25mm								
measurement time	2017-03-06 14:17:38								

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
49909	0.75	4	0.71	3.0	12.0	21.0	20.5	2.147	256.3

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.6	2.9	351.9	7.51	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	44.46	44.68	45.70	46.97	48.31	50.30	52.80	55.59	58.36
Nu	120.26	119.17	114.32	108.79	103.50	96.53	88.97	81.79	75.71
h (W/m ² K)	1040.20	1030.73	988.77	940.98	895.20	834.91	769.50	707.42	654.89
q (kW/m ²)	24.92	24.92	24.91	24.90	24.89	24.87	24.84	24.81	24.78

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	58.36	61.22	64.05	66.94	69.79	72.70	75.61	78.50	81.12
Nu	75.71	70.31	65.66	61.47	57.84	54.50	51.56	48.91	46.73
h (W/m ² K)	654.89	608.15	567.88	531.71	500.24	471.40	445.96	423.04	404.14
q (kW/m ²)	24.78	24.74	24.71	24.68	24.64	24.60	24.56	24.52	24.49

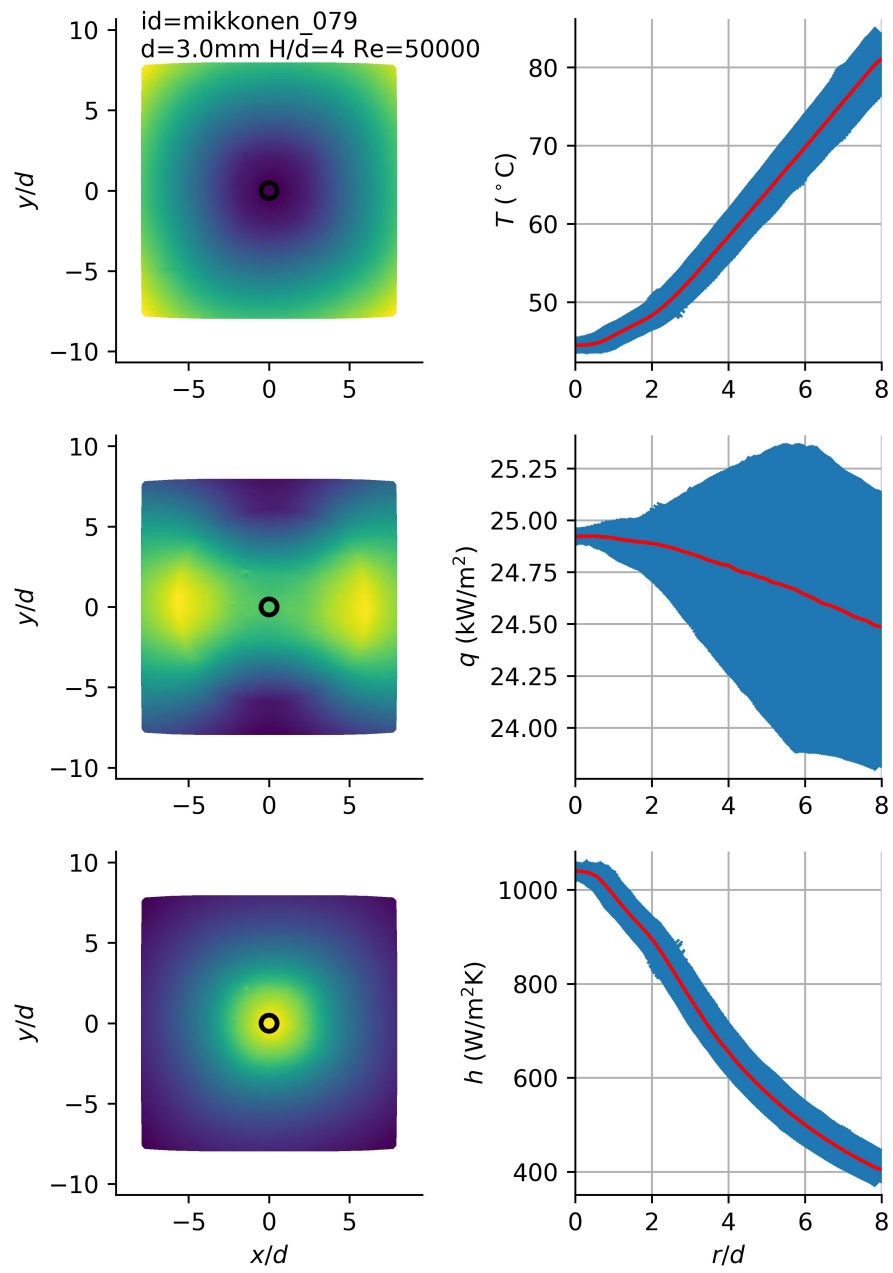


Figure 241: Results, mikkonen_079

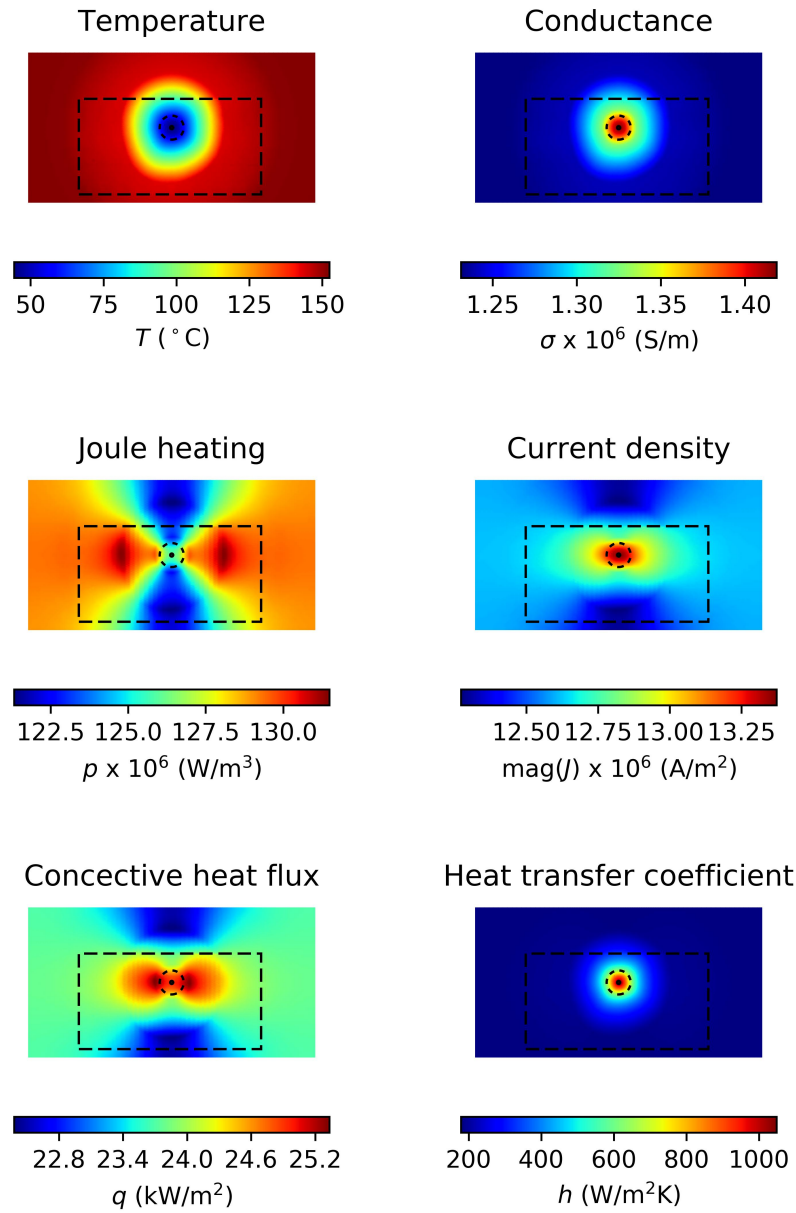


Figure 242: Convection calculation, mikkonen_079

Case id: mikkonen_080

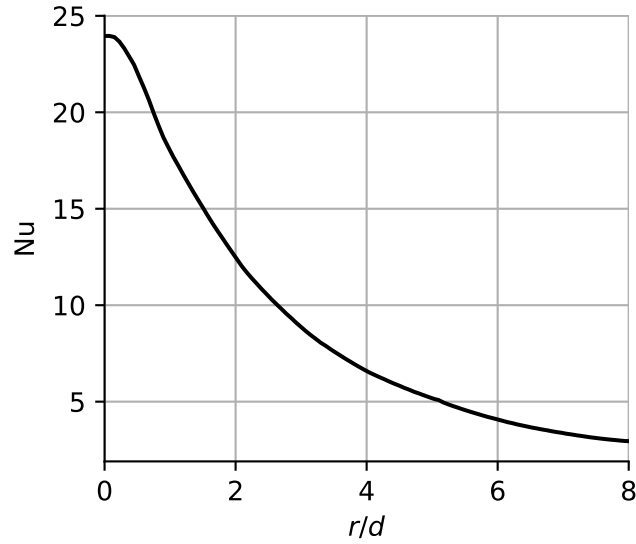


Figure 243: Nu, mikkonen_080

path	2017_03_07_8mm_HD1,2,3,6/8d_11Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 12:16:46

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
1941	0.01	1	0.71	8.0	8.0	20.8	20.6	0.222	3.7

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	0.6	82.9	1.57	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	33.83	34.82	37.48	40.15	43.29	46.47	49.76	52.95	56.06
Nu	23.96	22.07	18.01	15.06	12.48	10.48	8.87	7.61	6.59
h (W/m ² K)	77.66	71.53	58.40	48.83	40.47	33.96	28.75	24.65	21.36
q (kW/m ²)	1.03	1.02	0.99	0.95	0.92	0.88	0.84	0.80	0.76

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	56.06	58.83	61.49	64.36	66.92	69.21	71.08	72.75	73.92
Nu	6.59	5.83	5.18	4.57	4.08	3.67	3.37	3.12	2.95
h (W/m ² K)	21.36	18.89	16.78	14.80	13.21	11.91	10.92	10.10	9.57
q (kW/m ²)	0.76	0.72	0.69	0.65	0.61	0.58	0.55	0.53	0.51

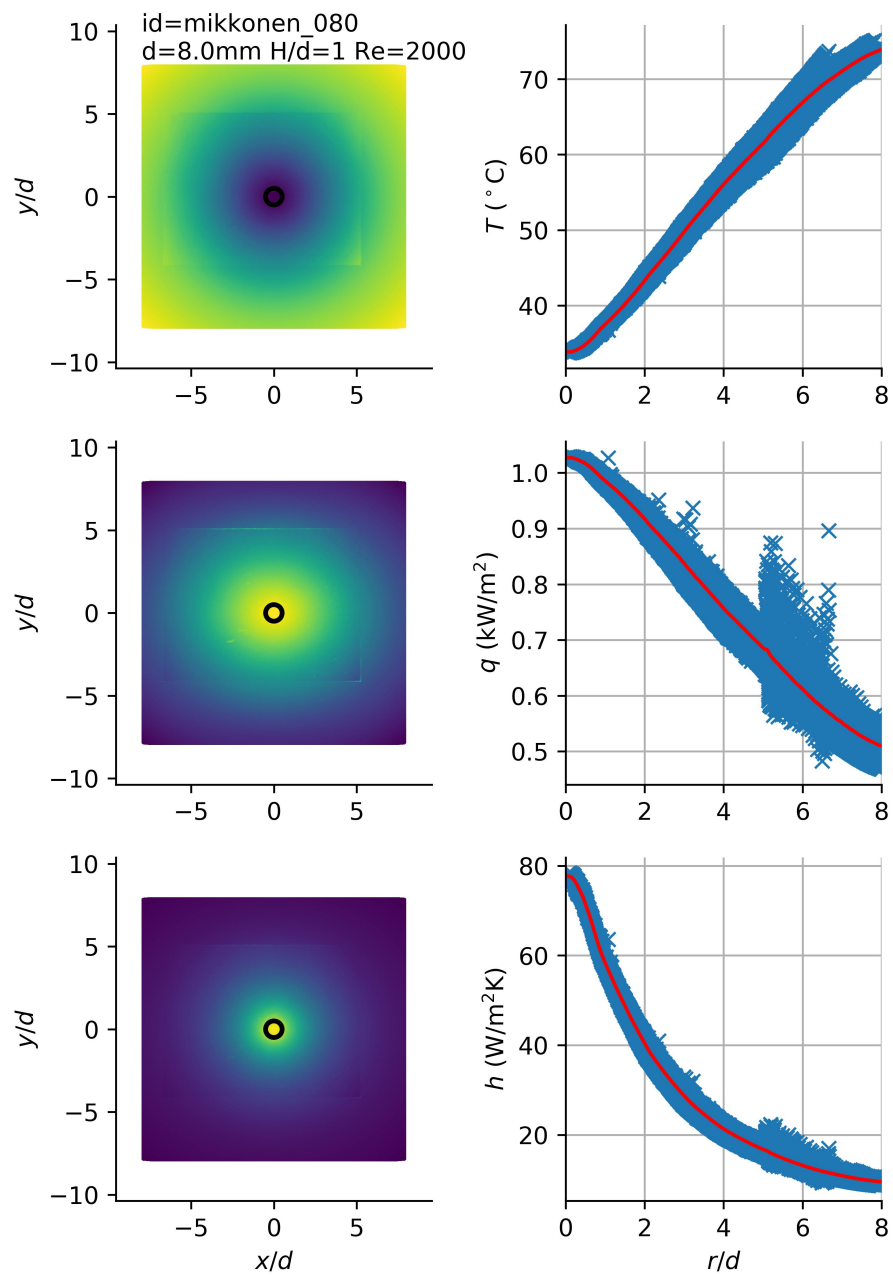


Figure 244: Results, mikkonen_080

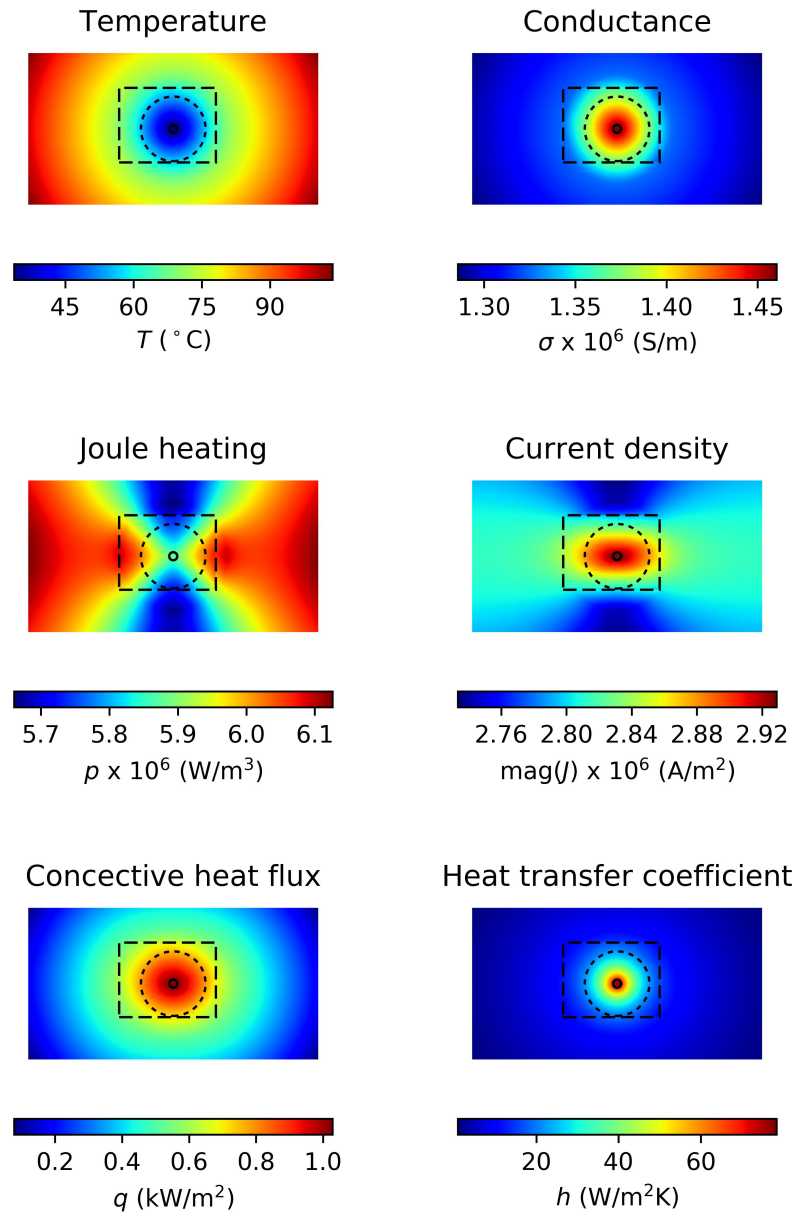


Figure 245: Convection calculation, mikkonen_080

Case id: mikkonen_081

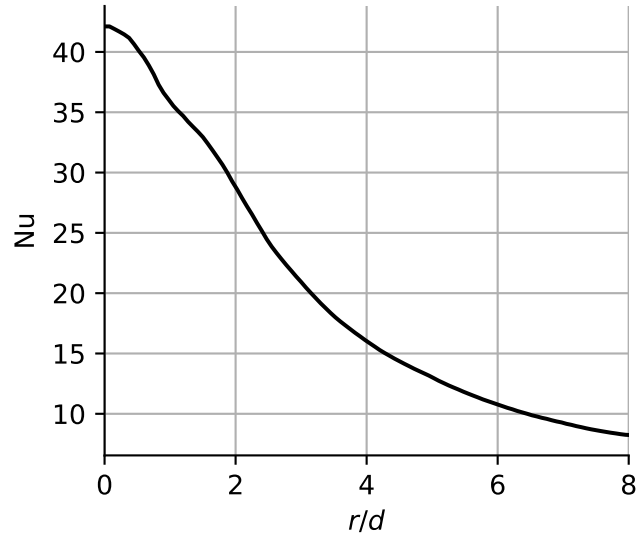


Figure 246: Nu, mikkonen_081

path	2017_03_07_8mm_HD1,2,3,6/8d_34Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 12:22:42

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6053	0.03	1	0.71	8.0	8.0	20.8	20.6	0.694	11.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	0.8	112.6	0.35	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.91	35.52	37.17	38.50	40.79	44.07	47.24	50.67	53.82
Nu	42.12	40.27	35.89	32.95	28.81	24.27	20.93	18.11	16.03
h (W/m ² K)	136.52	130.53	116.35	106.80	93.39	78.68	67.86	58.71	51.95
q (kW/m ²)	1.95	1.95	1.93	1.91	1.89	1.85	1.81	1.77	1.73

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	53.82	56.84	59.72	62.73	65.57	68.26	70.61	72.90	74.56
Nu	16.03	14.36	13.03	11.78	10.77	9.92	9.25	8.64	8.24
h (W/m ² K)	51.95	46.56	42.23	38.19	34.92	32.15	29.97	28.02	26.73
q (kW/m ²)	1.73	1.69	1.65	1.61	1.57	1.53	1.50	1.47	1.44

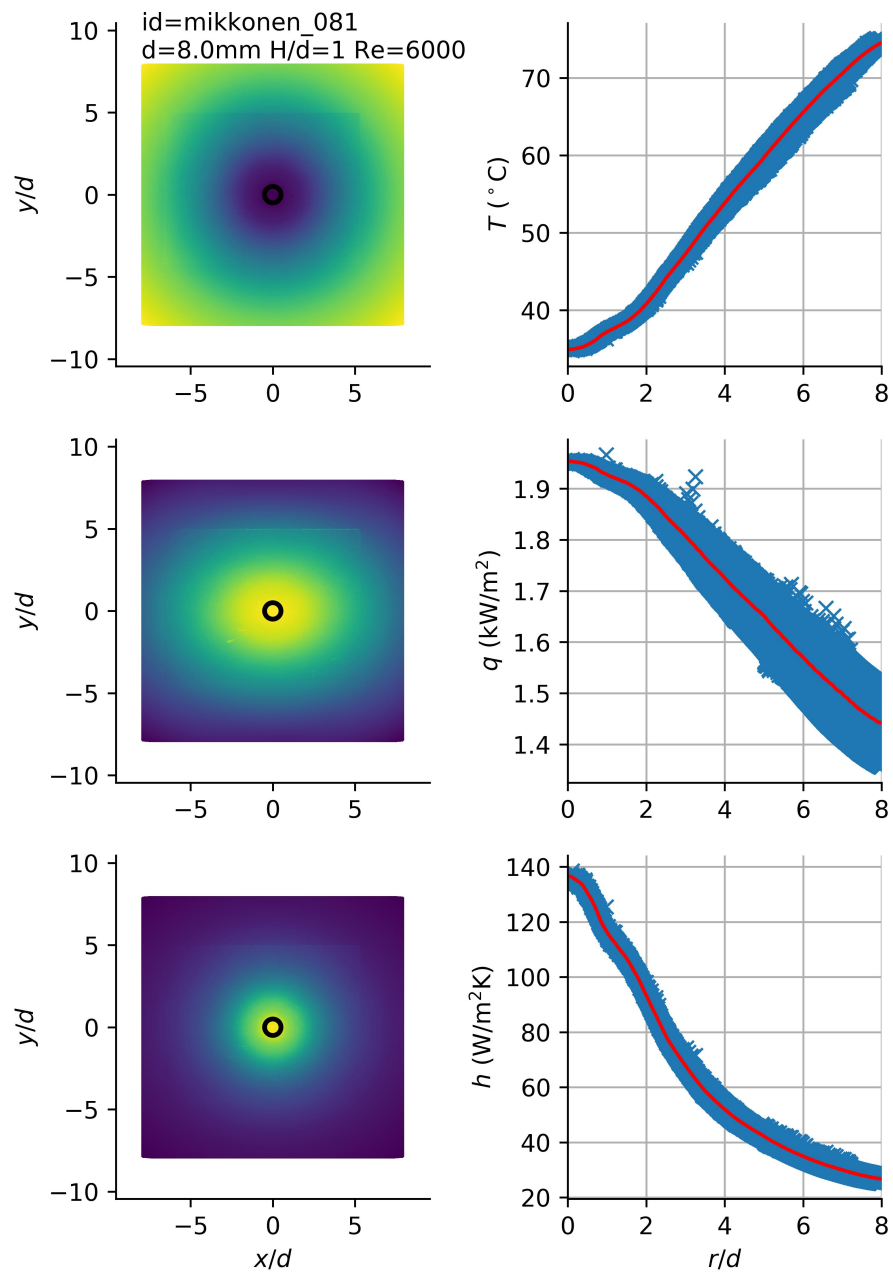


Figure 247: Results, mikkonen_081

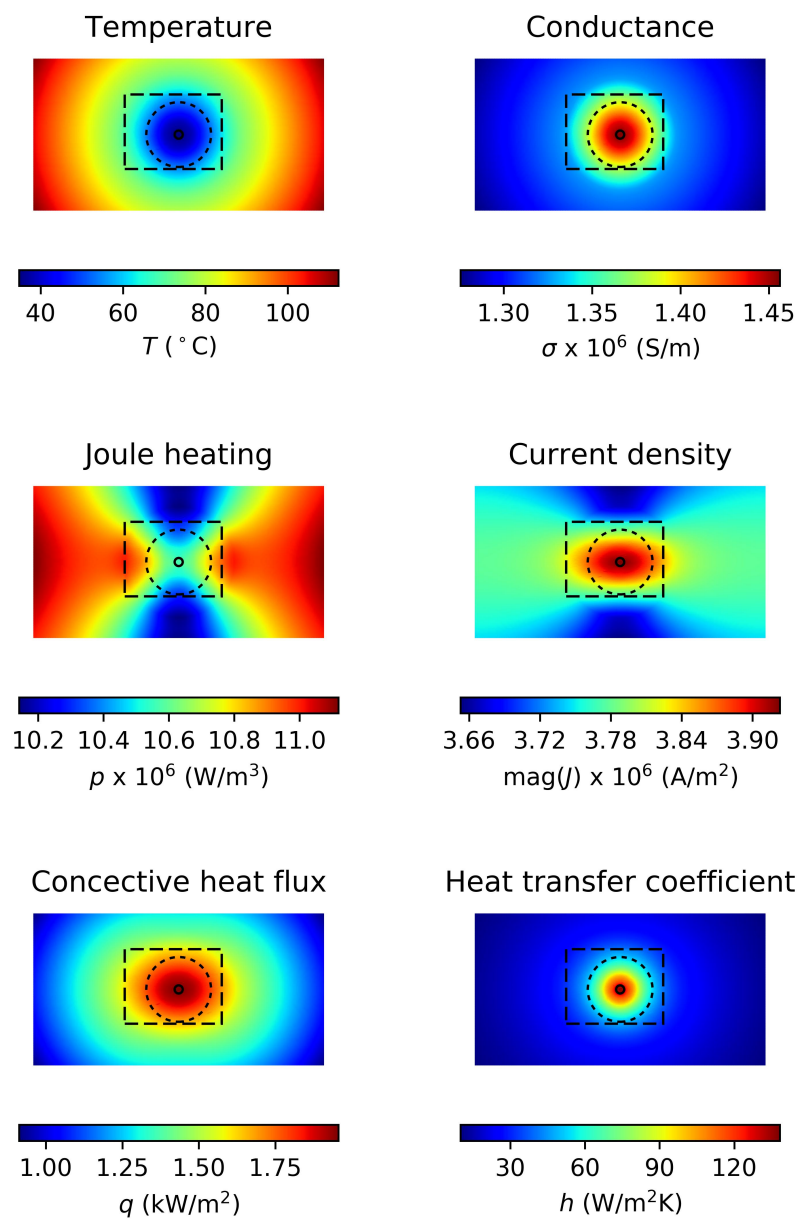


Figure 248: Convection calculation, mikkonen_081

Case id: mikkonen_082

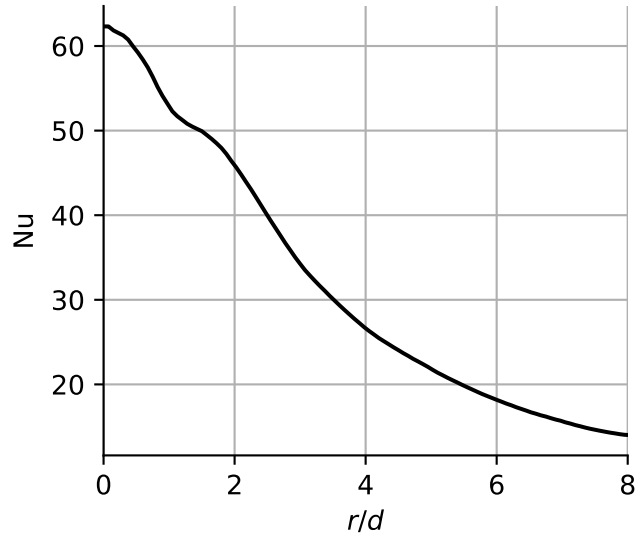


Figure 249: Nu, mikkonen_082

path	2017_03_07_8mm_HD1,2,3,6/8d_57Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 12:27:38

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9986	0.06	1	0.71	8.0	8.0	20.8	20.6	1.145	19.2

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.0	127.4	3.73	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.07	34.68	36.32	37.18	38.53	40.97	44.05	46.92	49.93
Nu	62.31	59.47	52.88	49.93	45.91	39.98	34.25	30.11	26.63
h (W/m ² K)	202.00	192.77	171.42	161.87	148.81	129.60	111.03	97.59	86.33
q (kW/m ²)	2.72	2.71	2.69	2.68	2.67	2.64	2.60	2.57	2.53

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	49.93	52.65	55.43	58.30	61.13	63.86	66.31	68.70	70.35
Nu	26.63	24.05	21.83	19.85	18.17	16.76	15.64	14.64	14.02
h (W/m ² K)	86.33	77.96	70.78	64.33	58.92	54.35	50.71	47.46	45.45
q (kW/m ²)	2.53	2.50	2.46	2.43	2.39	2.35	2.32	2.28	2.26

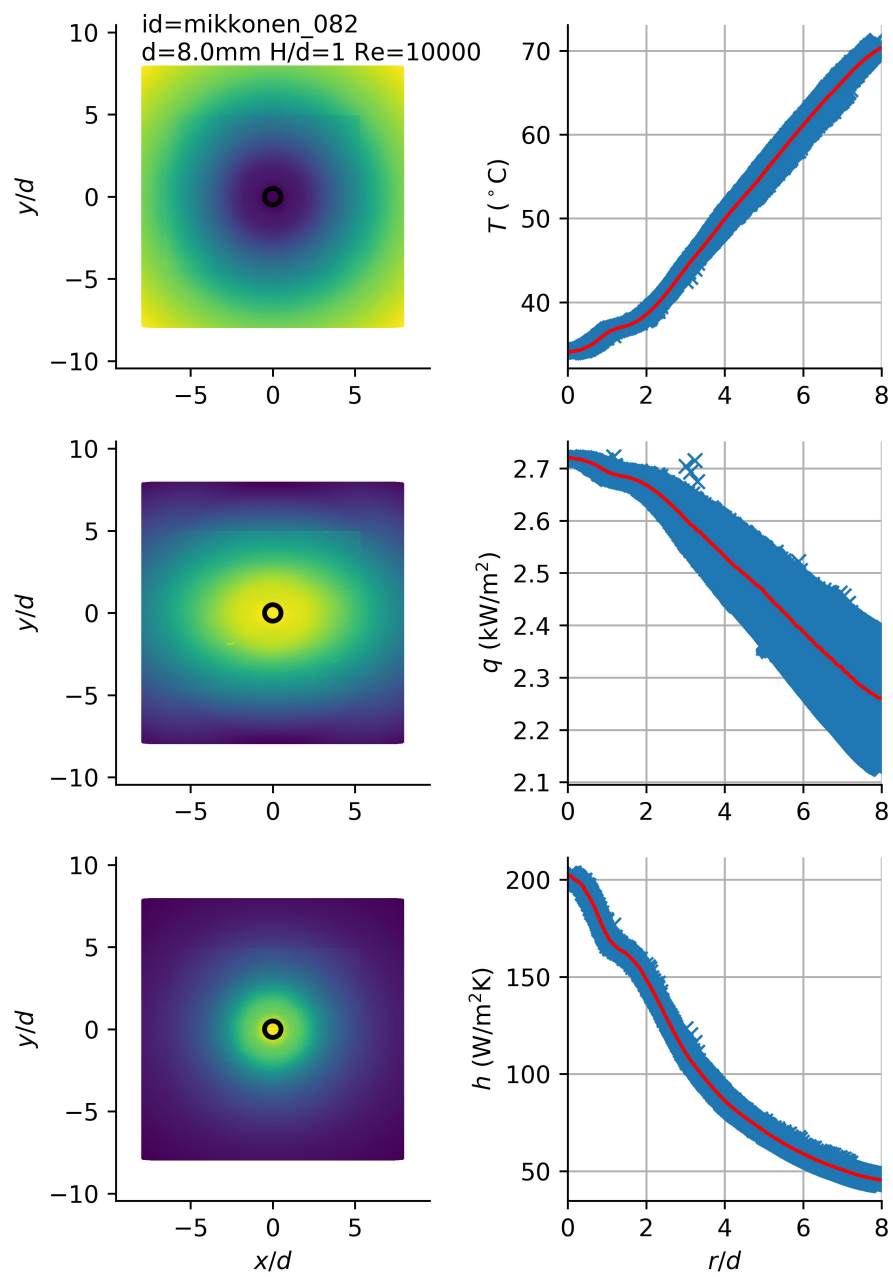


Figure 250: Results, mikkonen_082

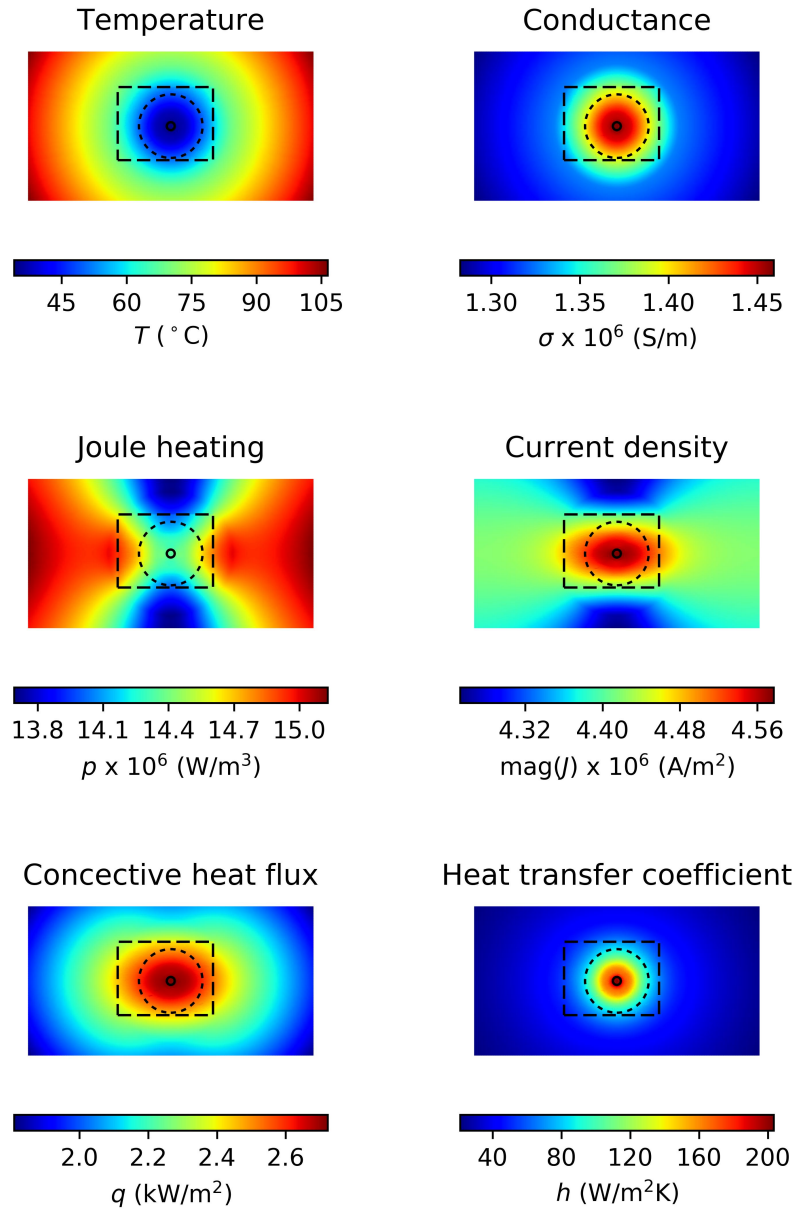


Figure 251: Convection calculation, mikkonen_082

Case id: mikkonen_083

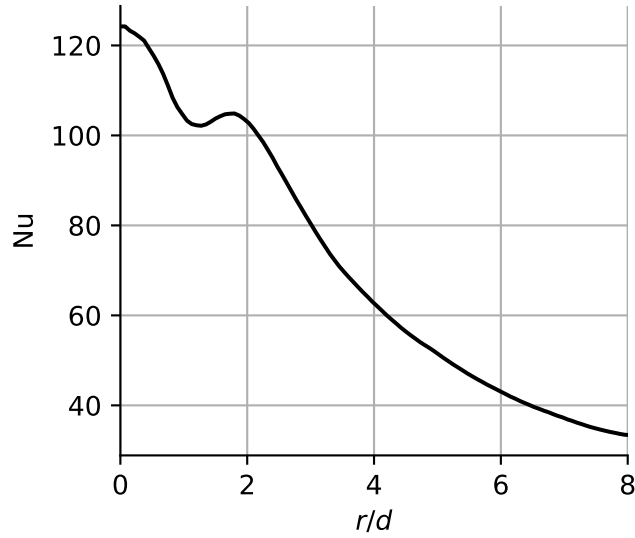


Figure 252: Nu, mikkonen_083

path	2017_03_07_8mm_HD1,2,3,6/8d_172Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 12:36:52

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
30015	0.17	1	0.71	8.0	8.0	20.0	20.6	3.433	57.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.3	180.1	3.86	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.47	35.15	37.04	37.12	37.23	39.06	41.71	44.65	47.34
Nu	124.23	118.25	104.27	103.75	103.05	92.47	80.40	70.11	62.69
h (W/m ² K)	401.77	382.46	337.22	335.53	333.27	299.06	260.03	226.76	202.77
q (kW/m ²)	5.57	5.57	5.54	5.54	5.54	5.52	5.49	5.45	5.42
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.34	50.14	52.76	55.70	58.55	61.37	63.95	66.49	68.28
Nu	62.69	56.42	51.52	46.86	43.04	39.78	37.17	34.86	33.42
h (W/m ² K)	202.77	182.48	166.62	151.55	139.21	128.65	120.22	112.76	108.08
q (kW/m ²)	5.42	5.39	5.36	5.32	5.28	5.24	5.21	5.17	5.15

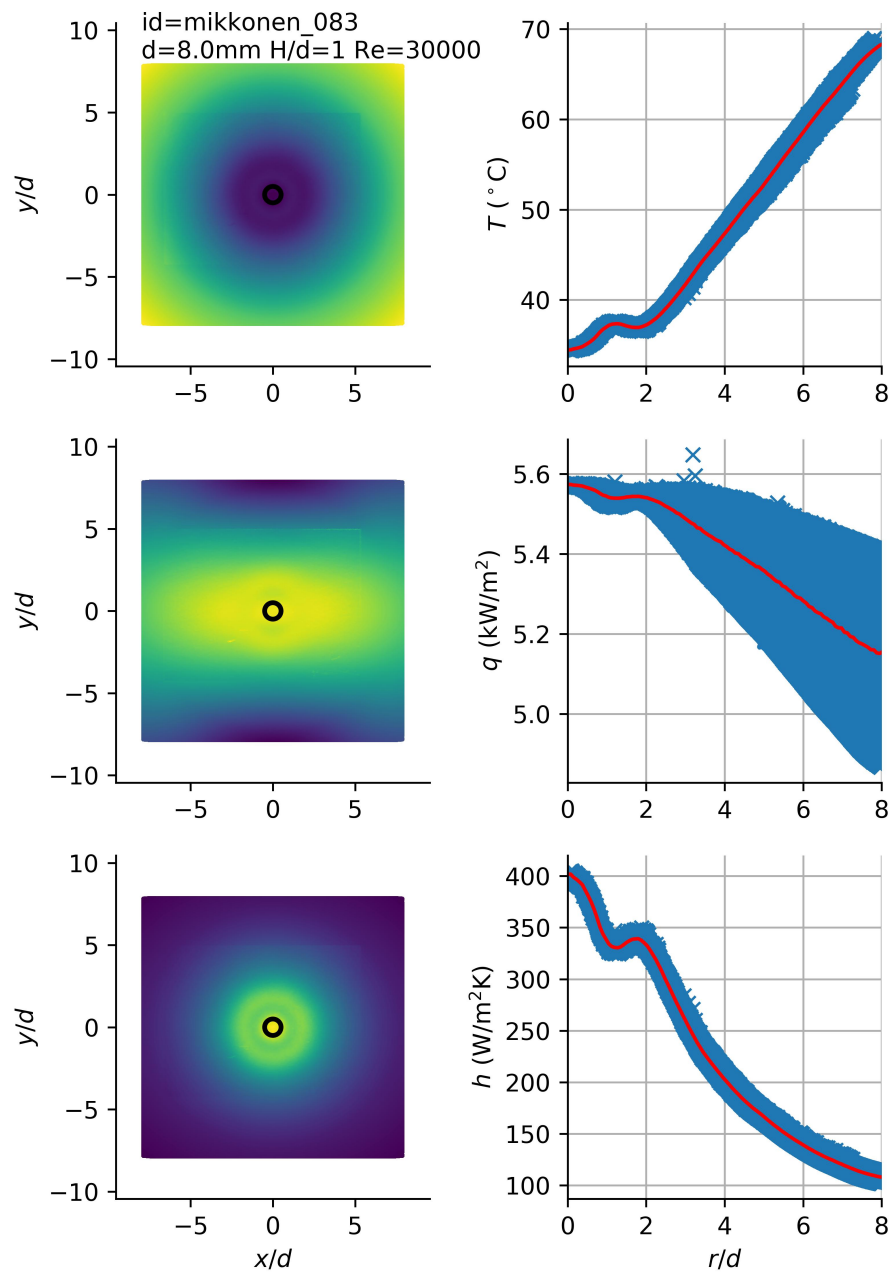


Figure 253: Results, mikkonen_083

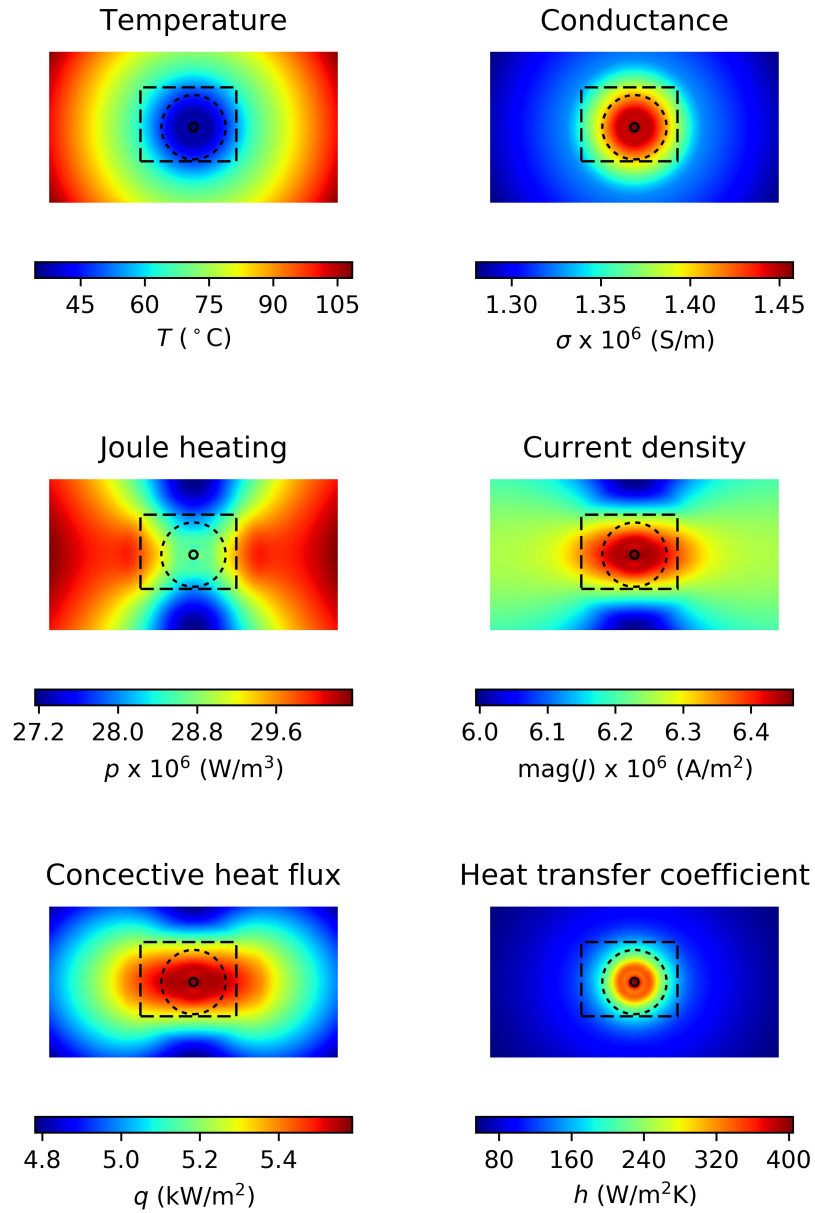


Figure 254: Convection calculation, mikkonen_083

Case id: mikkonen_084

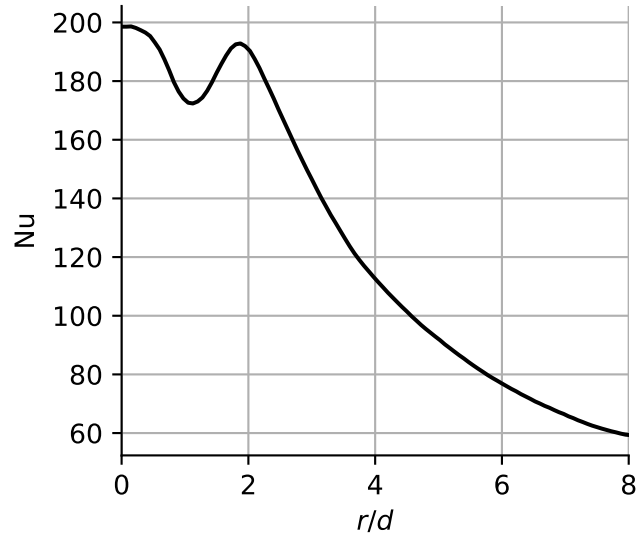


Figure 255: Nu, mikkonen_084

path	2017_03_07_8mm_HD1,2,3,6/8d_430Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 12:41:09

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
70404	0.39	1	0.71	8.0	8.0	20.0	20.6	8.053	134.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.7	231.5	3.73	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.00	35.35	37.03	36.22	35.58	37.45	39.99	42.87	45.65
Nu	198.56	193.89	173.59	182.86	190.81	169.18	146.56	127.17	112.64
h (W/m ² K)	642.16	627.07	561.43	591.40	617.11	547.16	474.01	411.29	364.28
q (kW/m ²)	9.25	9.25	9.23	9.24	9.24	9.22	9.19	9.16	9.12
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.65	48.33	51.05	53.91	56.75	59.57	62.25	64.89	66.79
Nu	112.64	101.45	92.06	83.81	76.90	71.06	66.24	62.03	59.35
h (W/m ² K)	364.28	328.12	297.74	271.04	248.72	229.82	214.25	200.61	191.95
q (kW/m ²)	9.12	9.10	9.07	9.03	8.99	8.96	8.92	8.88	8.87

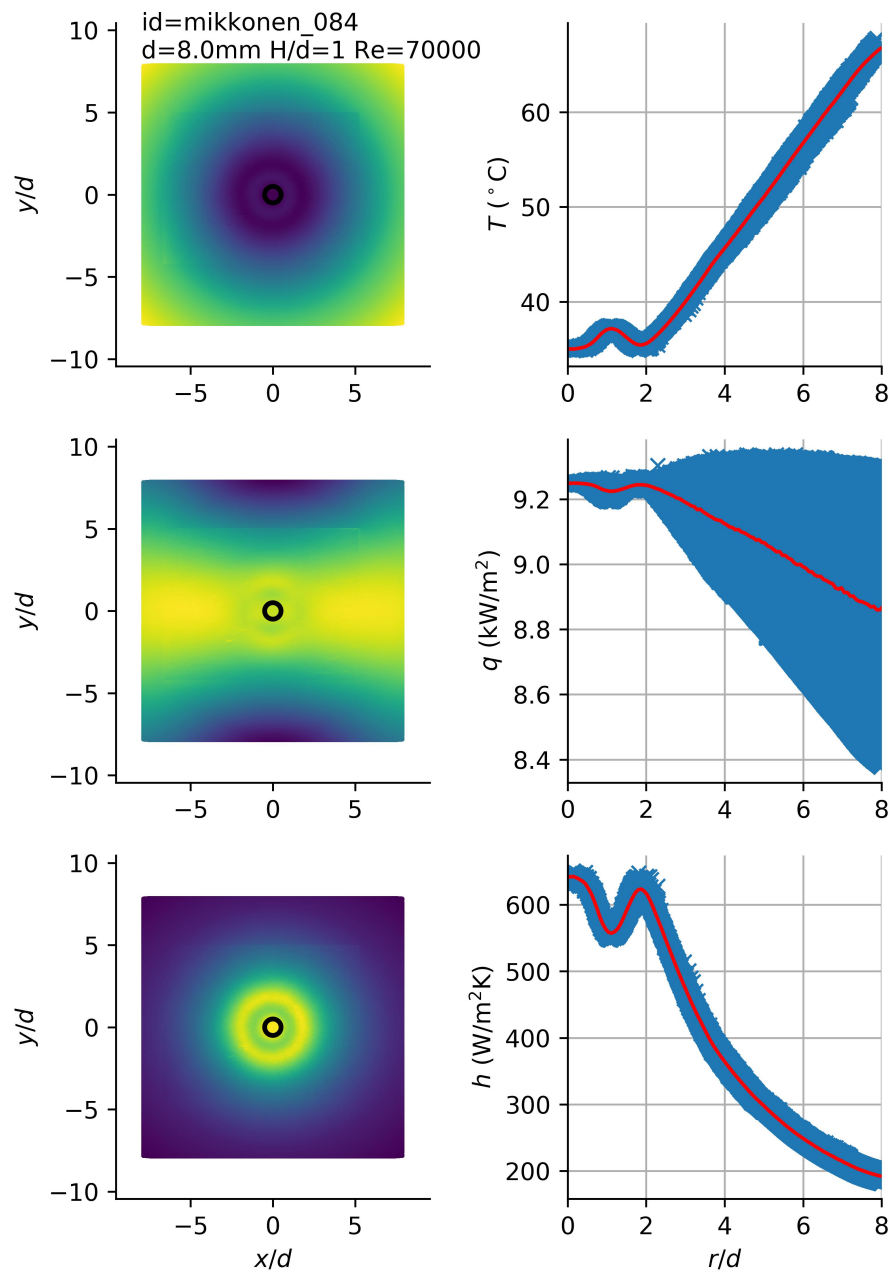


Figure 256: Results, mikkonen_084

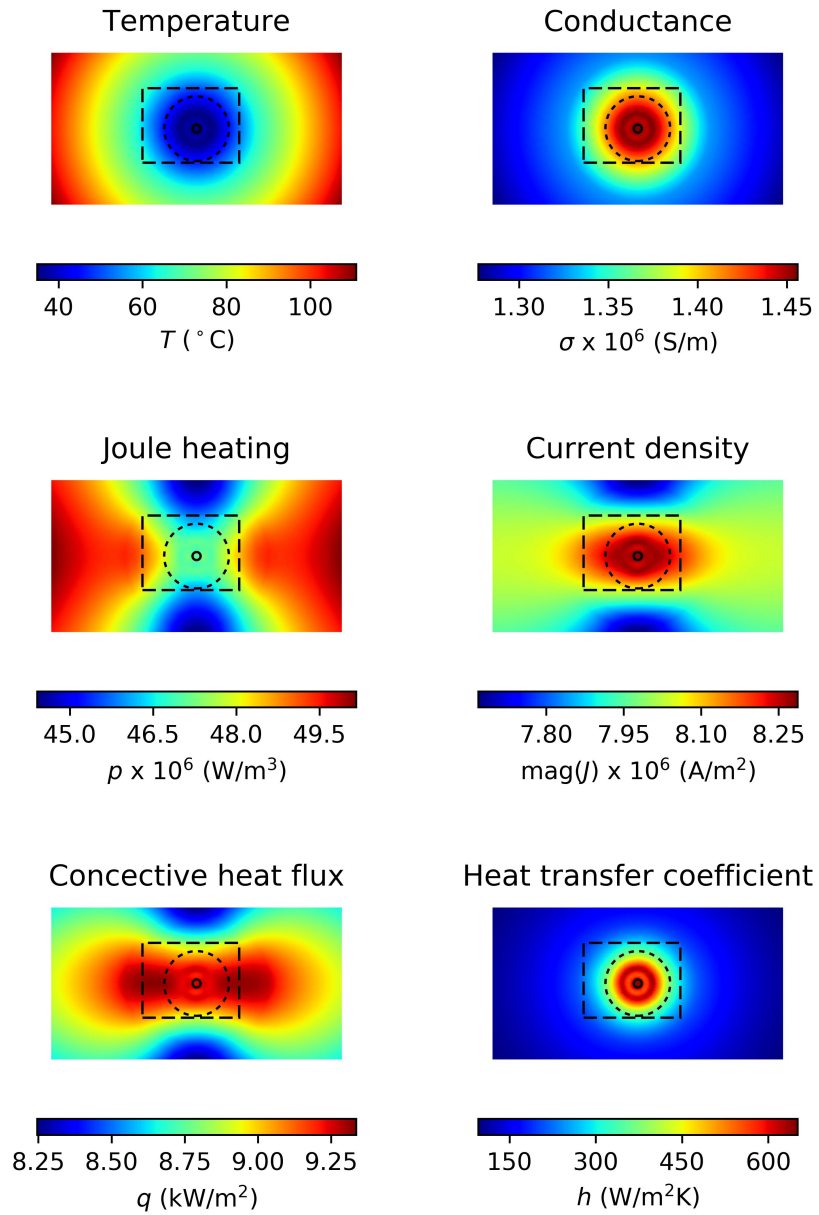


Figure 257: Convection calculation, mikkonen_084

Case id: mikkonen_085

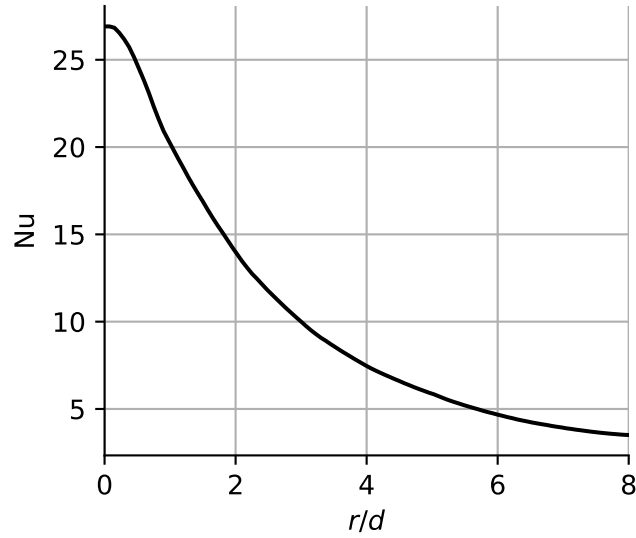


Figure 258: Nu, mikkonen_085

path	2017_03_07_8mm_HD1,2,3,6/8d_11Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 13:31:03

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
1982	0.01	2	0.71	8.0	16.0	21.3	20.6	0.227	3.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	0.6	83.0	4.07	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	33.13	34.12	36.67	39.28	42.35	45.46	48.64	51.80	54.90
Nu	26.91	24.71	20.21	16.89	13.99	11.76	10.00	8.59	7.46
h (W/m²K)	87.36	80.22	65.61	54.82	45.42	38.18	32.47	27.90	24.22
q (kW/m²)	1.09	1.08	1.05	1.02	0.99	0.95	0.91	0.87	0.83

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	54.90	57.70	60.44	63.27	65.78	68.04	69.85	71.40	72.43
Nu	7.46	6.60	5.87	5.20	4.67	4.24	3.93	3.67	3.51
h (W/m²K)	24.22	21.42	19.06	16.89	15.17	13.78	12.74	11.91	11.40
q (kW/m²)	0.83	0.79	0.76	0.72	0.69	0.65	0.63	0.60	0.59

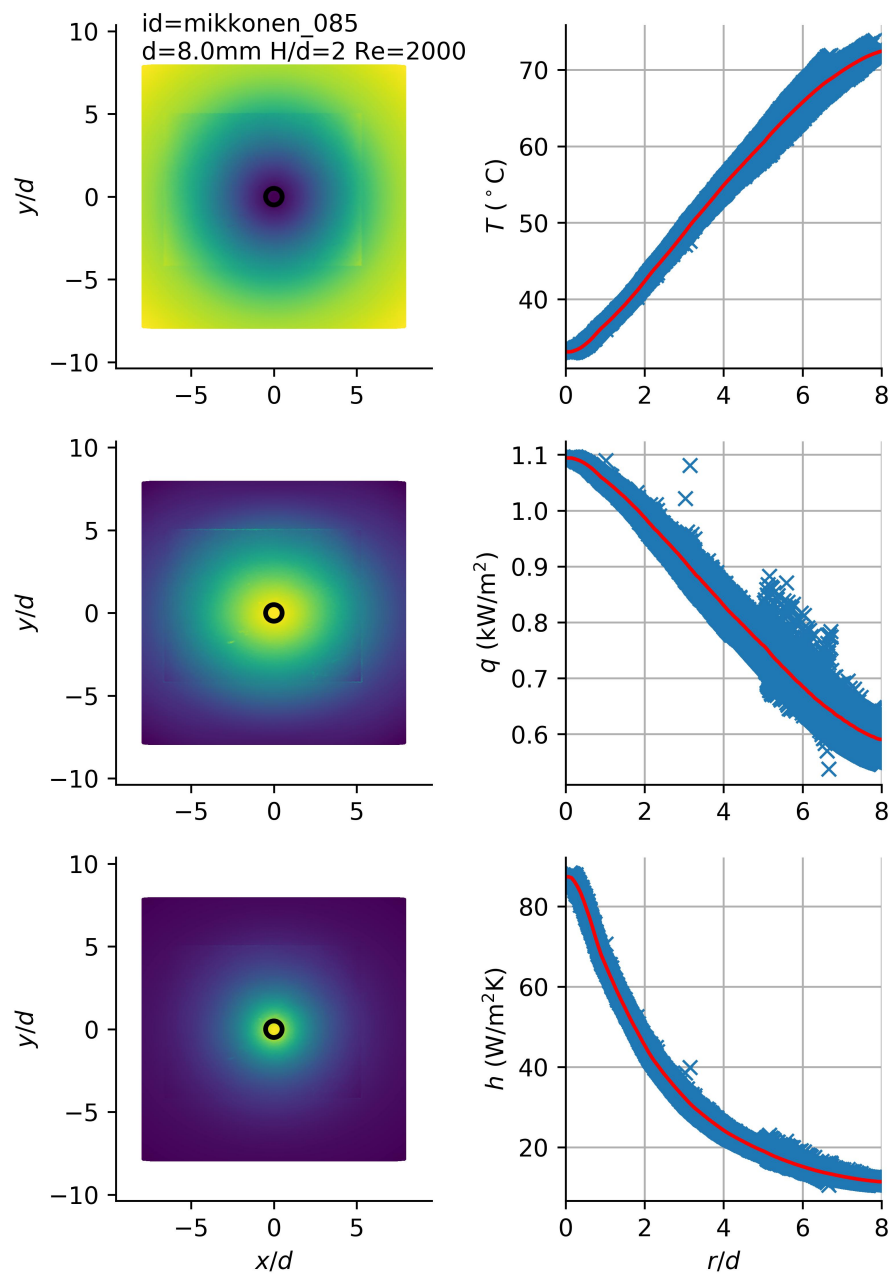


Figure 259: Results, mikkonen_085

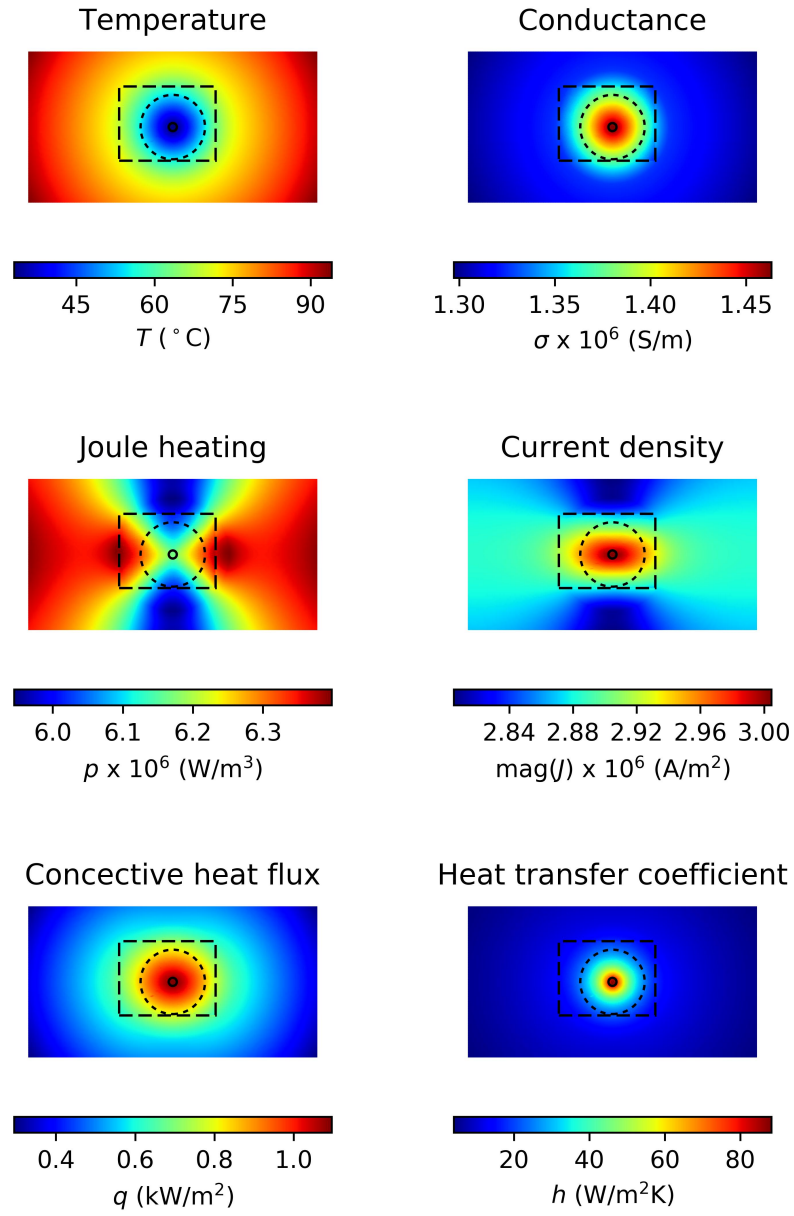


Figure 260: Convection calculation, mikkonen_085

Case id: mikkonen_086

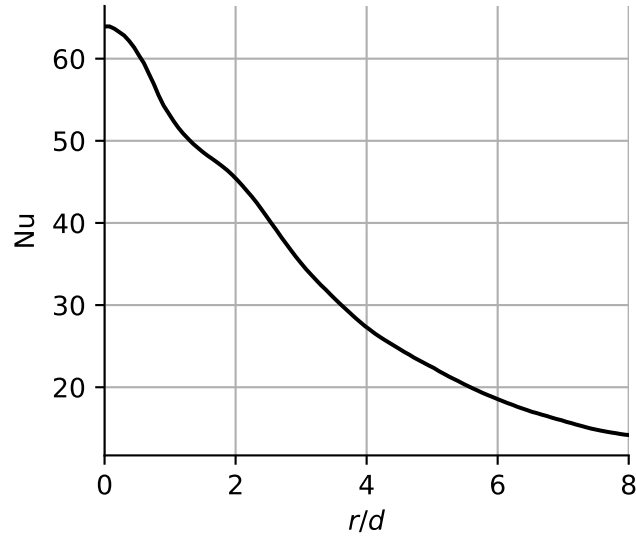


Figure 261: Nu, mikkonen_086

path	2017_03_07_8mm_HD1,2,3,6/8d_57Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 13:07:21

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9953	0.06	2	0.71	8.0	16.0	20.1	20.6	1.139	19.1

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.0	128.9	3.42	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.01	34.68	36.59	37.94	39.07	41.15	44.00	46.86	49.89
Nu	63.93	60.72	53.07	48.63	45.43	40.49	35.10	30.88	27.29
h (W/m ² K)	206.80	196.45	171.68	157.34	146.98	130.98	113.54	99.90	88.30
q (kW/m ²)	2.77	2.77	2.74	2.73	2.71	2.69	2.66	2.62	2.58

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	49.89	52.59	55.30	58.30	61.25	64.07	66.57	69.12	70.86
Nu	27.29	24.67	22.45	20.32	18.55	17.07	15.91	14.84	14.19
h (W/m ² K)	88.30	79.79	72.62	65.75	60.01	55.23	51.49	48.02	45.90
q (kW/m ²)	2.58	2.55	2.52	2.48	2.44	2.40	2.37	2.33	2.31

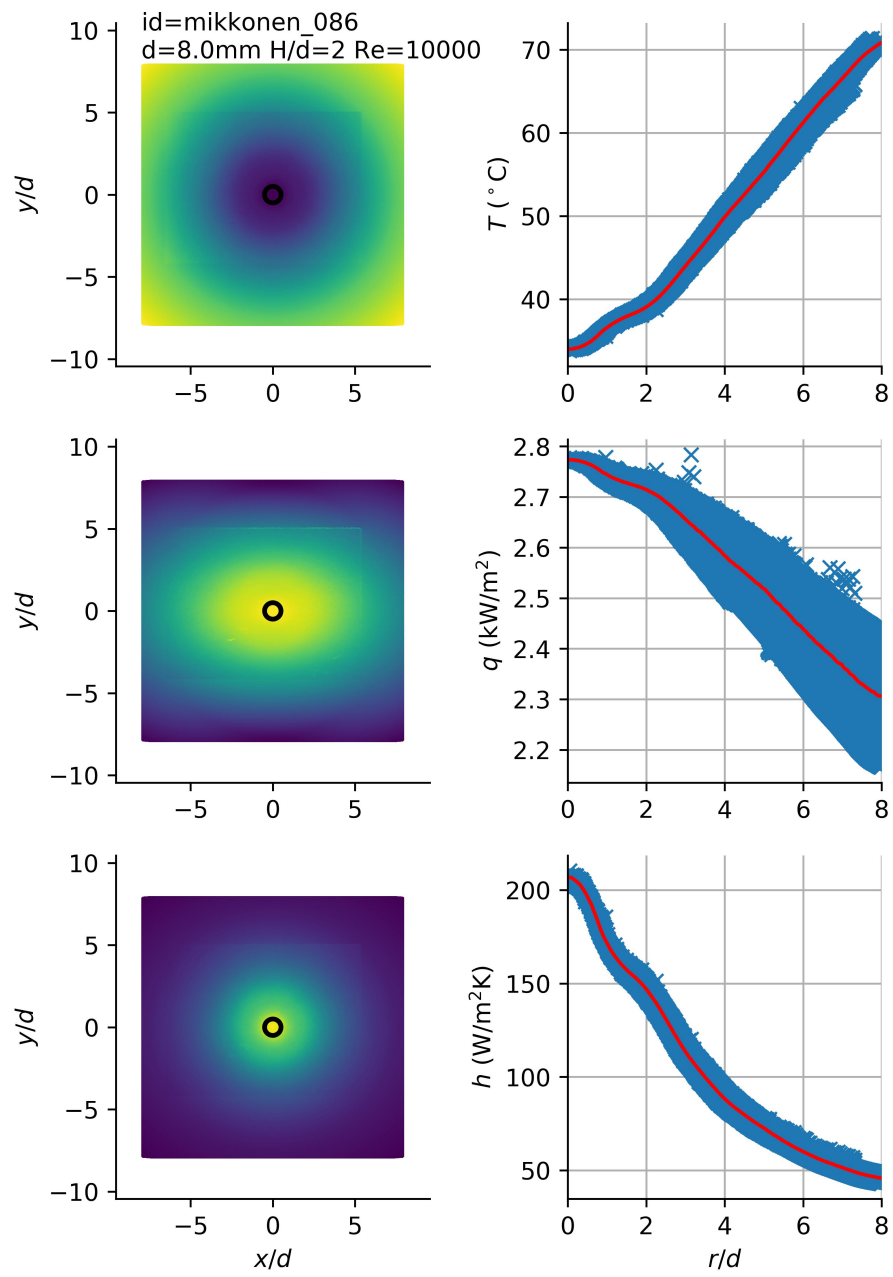


Figure 262: Results, mikkonen_086

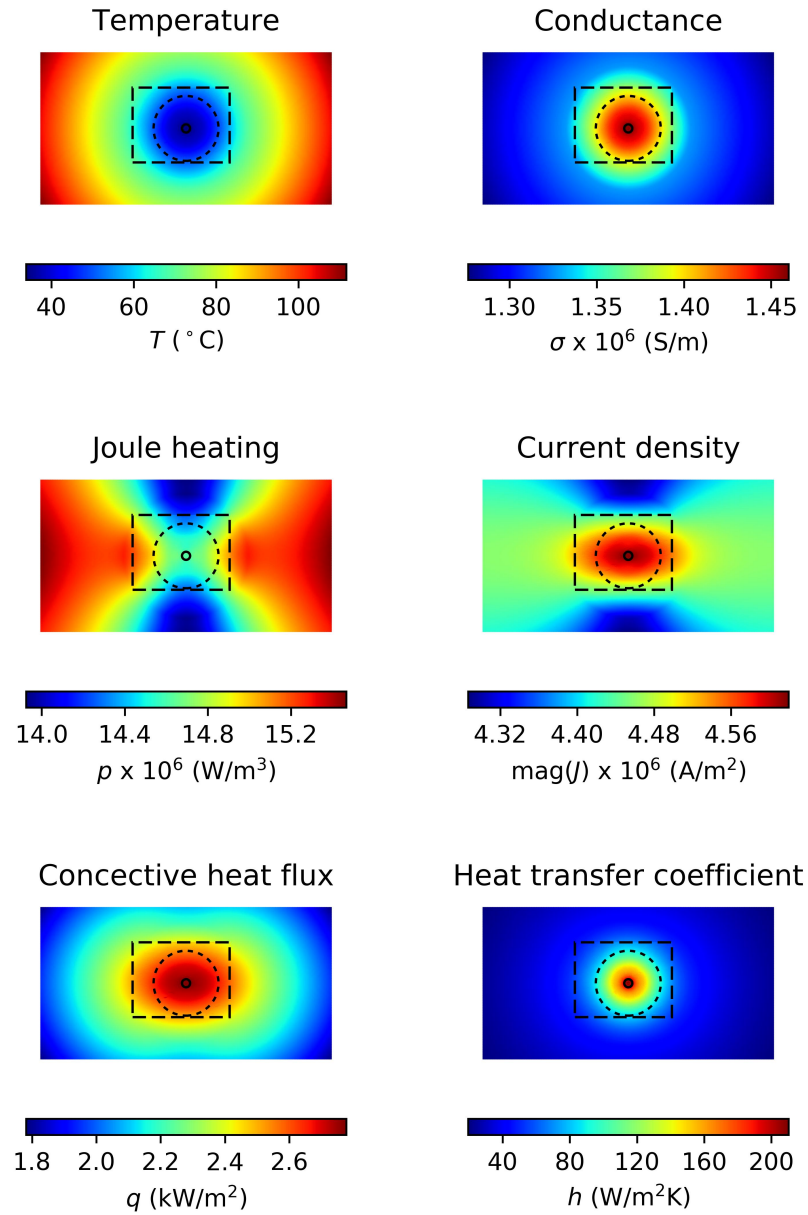


Figure 263: Convection calculation, mikkonen_086

Case id: mikkonen_087

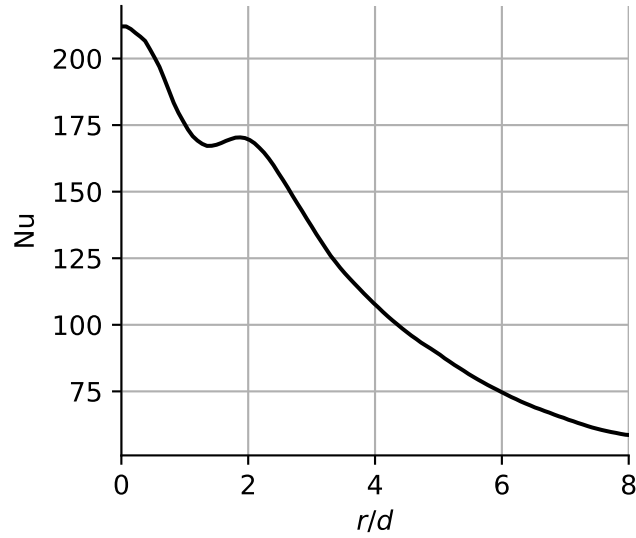


Figure 264: Nu, mikkonen_087

path	2017_03_07_8mm_HD1,2,3,6/8d_172Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 12:54:37

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
70579	0.39	2	0.71	8.0	16.0	20.0	20.6	8.073	135.1

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.7	233.5	3.37	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.28	34.99	37.08	37.83	37.62	39.06	41.58	44.46	47.11
Nu	212.06	201.37	175.40	167.61	169.63	156.14	136.98	120.01	107.65
h (W/m ² K)	685.83	651.28	567.28	542.08	548.62	505.00	443.01	388.13	348.17
q (kW/m ²)	9.38	9.37	9.35	9.34	9.34	9.32	9.29	9.26	9.23
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.11	49.85	52.42	55.39	58.26	61.08	63.65	66.18	67.91
Nu	107.65	97.29	89.14	81.17	74.67	69.19	64.83	60.97	58.63
h (W/m ² K)	348.17	314.64	288.28	262.52	241.50	223.76	209.66	197.19	189.61
q (kW/m ²)	9.23	9.20	9.17	9.13	9.09	9.06	9.02	8.99	8.97

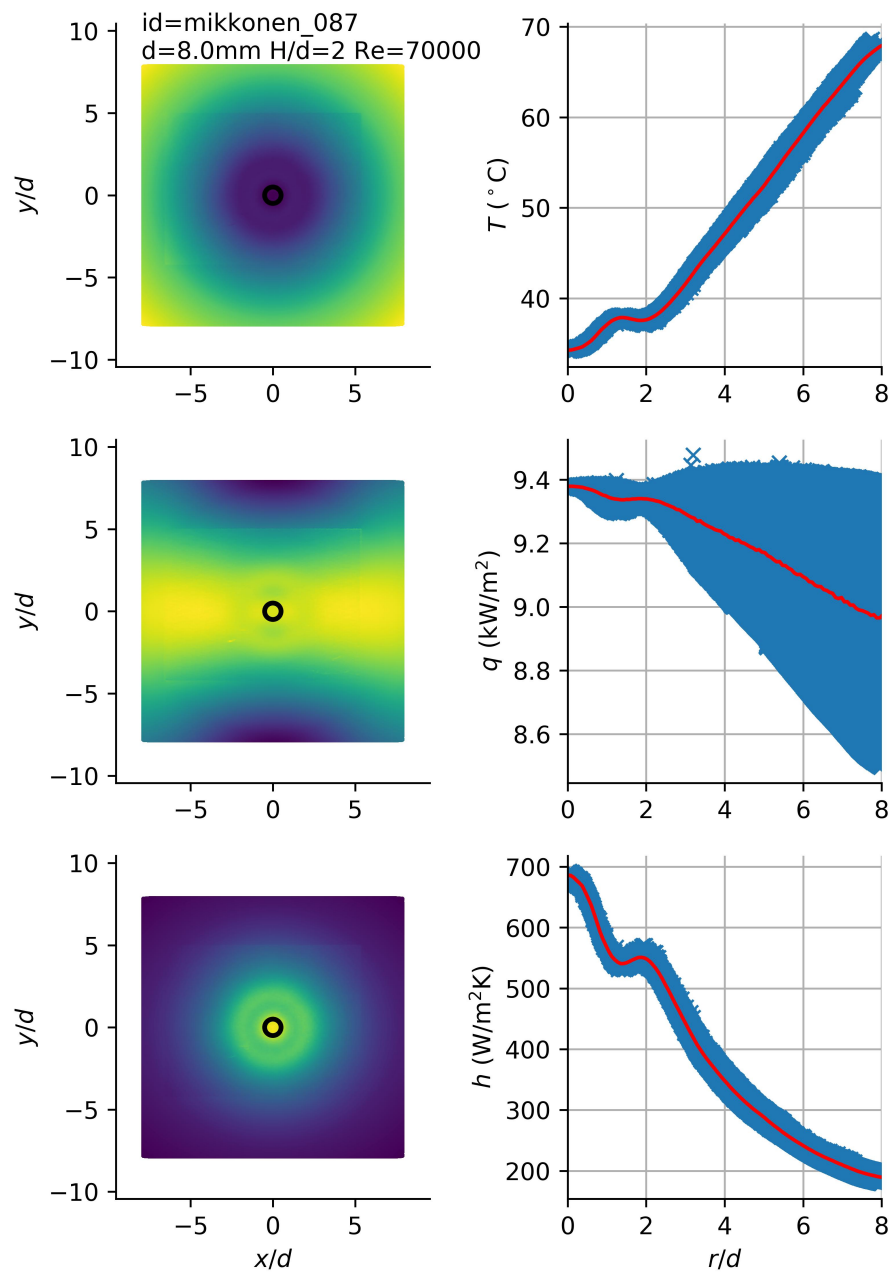


Figure 265: Results, mikkonen_087

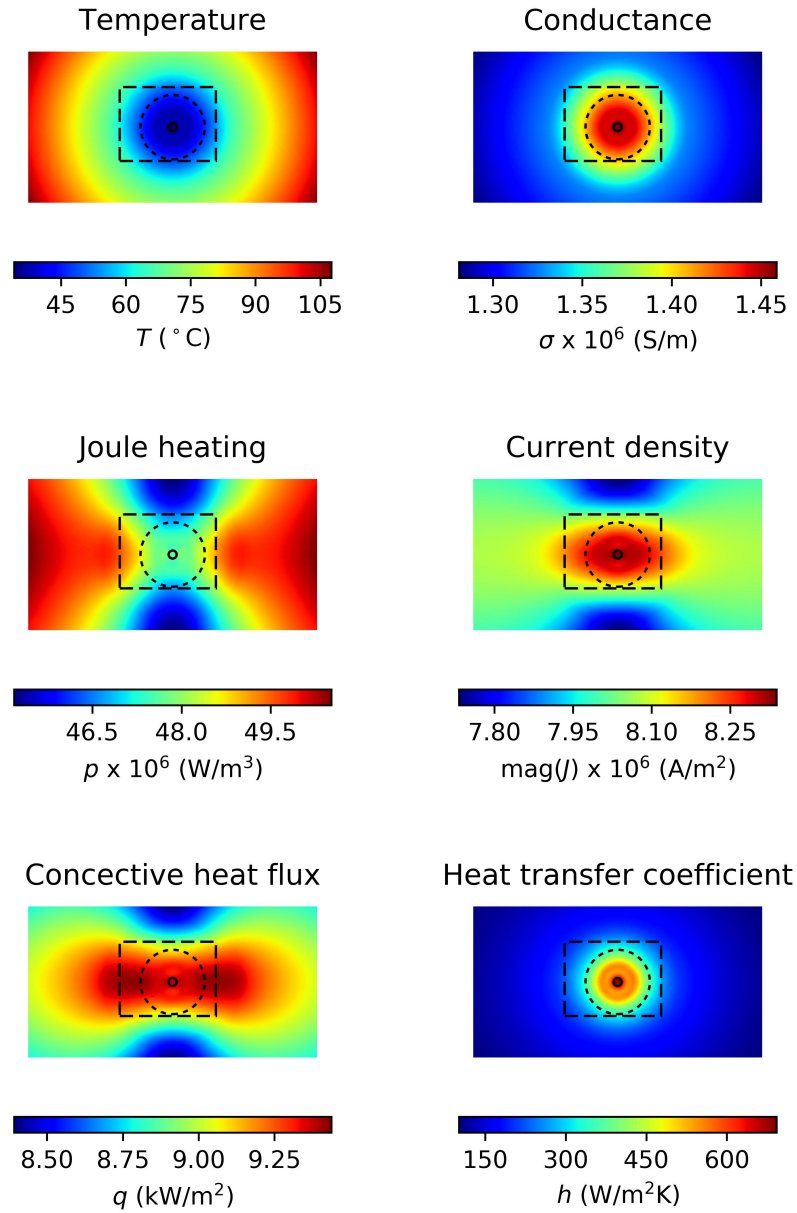


Figure 266: Convection calculation, mikkonen_087

Case id: mikkonen_088

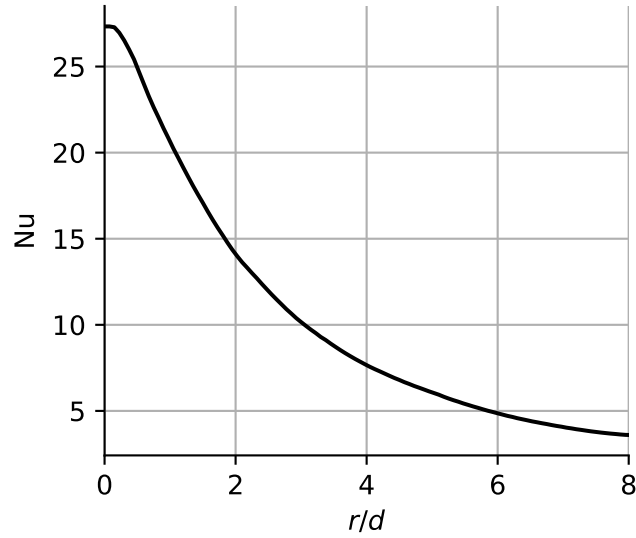


Figure 267: Nu, mikkonen_088

path	2017_03_07_8mm_HD1,2,3,6/8d_11Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 13:52:31

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
2000	0.01	4	0.71	8.0	32.0	21.2	20.6	0.230	3.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	0.7	86.9	3.07	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	33.95	35.09	37.66	40.58	43.92	47.09	50.50	53.74	56.93
Nu	27.33	24.94	20.64	17.09	14.11	11.97	10.16	8.78	7.66
h (W/m ² K)	88.70	80.93	66.98	55.45	45.80	38.84	32.97	28.50	24.86
q (kW/m ²)	1.18	1.17	1.14	1.11	1.07	1.03	0.99	0.94	0.90

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	56.93	59.83	62.61	65.53	68.20	70.61	72.64	74.43	75.61
Nu	7.66	6.80	6.07	5.41	4.86	4.41	4.06	3.78	3.60
h (W/m ² K)	24.86	22.06	19.71	17.55	15.78	14.33	13.19	12.26	11.69
q (kW/m ²)	0.90	0.87	0.83	0.79	0.75	0.72	0.69	0.66	0.64

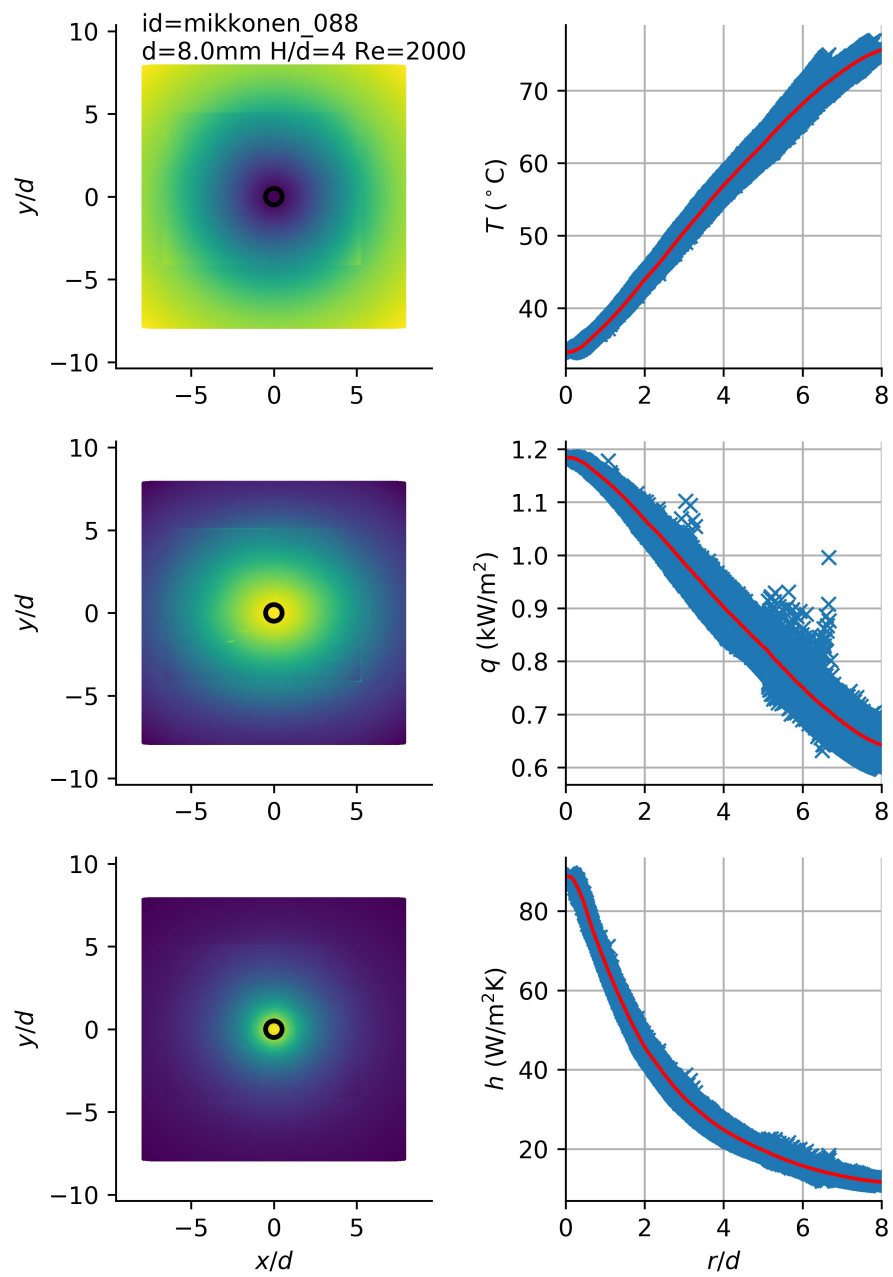


Figure 268: Results, mikkonen_088

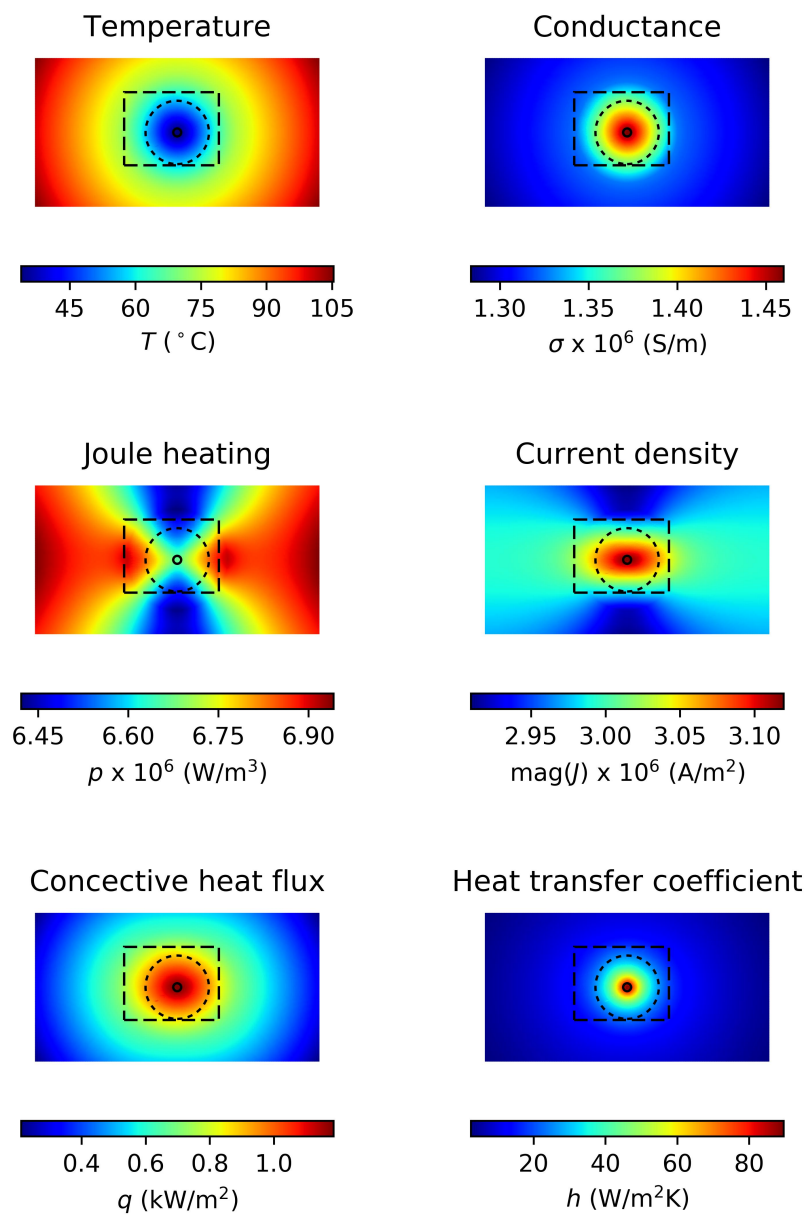


Figure 269: Convection calculation, mikkonen_088

Case id: mikkonen_089

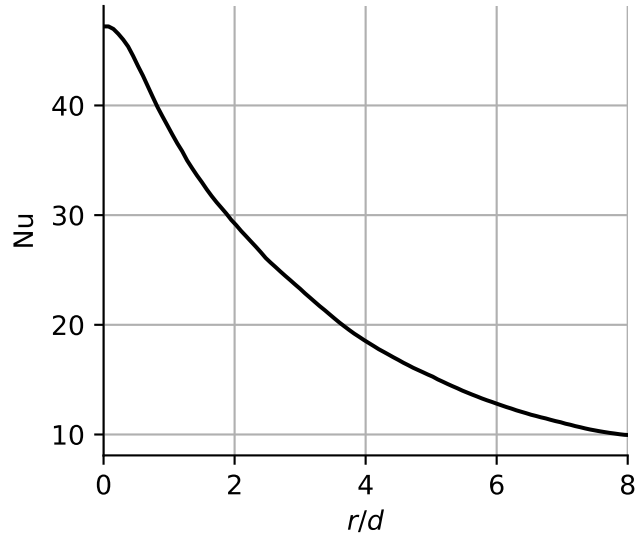


Figure 270: Nu, mikkonen_089

path	2017_03_07_8mm_HD1,2,3,6/8d_34Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 13:56:18

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6098	0.03	4	0.71	8.0	32.0	20.7	20.6	0.699	11.7

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	0.8	111.8	3.43	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.01	34.95	37.03	39.22	41.35	43.64	45.91	48.59	51.32
Nu	47.20	43.91	37.89	33.00	29.24	25.95	23.29	20.70	18.52
h (W/m ² K)	152.98	142.29	122.81	106.96	94.75	84.10	75.46	67.09	60.01
q (kW/m ²)	2.05	2.04	2.02	1.99	1.97	1.94	1.91	1.88	1.84

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	51.32	53.88	56.42	59.16	61.74	64.20	66.40	68.58	70.00
Nu	18.52	16.80	15.34	13.94	12.81	11.85	11.08	10.37	9.96
h (W/m ² K)	60.01	54.43	49.70	45.19	41.52	38.40	35.89	33.62	32.27
q (kW/m ²)	1.84	1.81	1.78	1.74	1.71	1.67	1.64	1.61	1.59

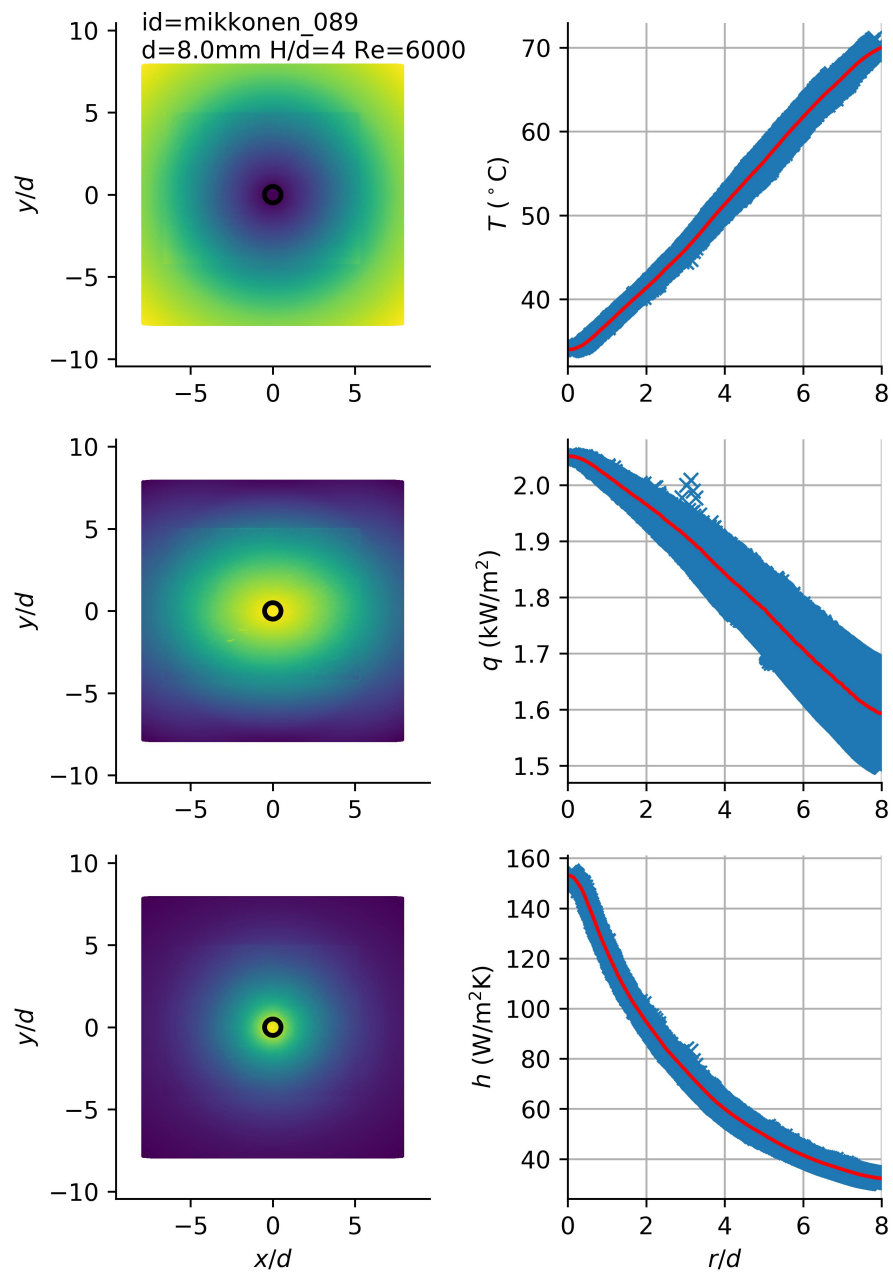


Figure 271: Results, mikkonen_089

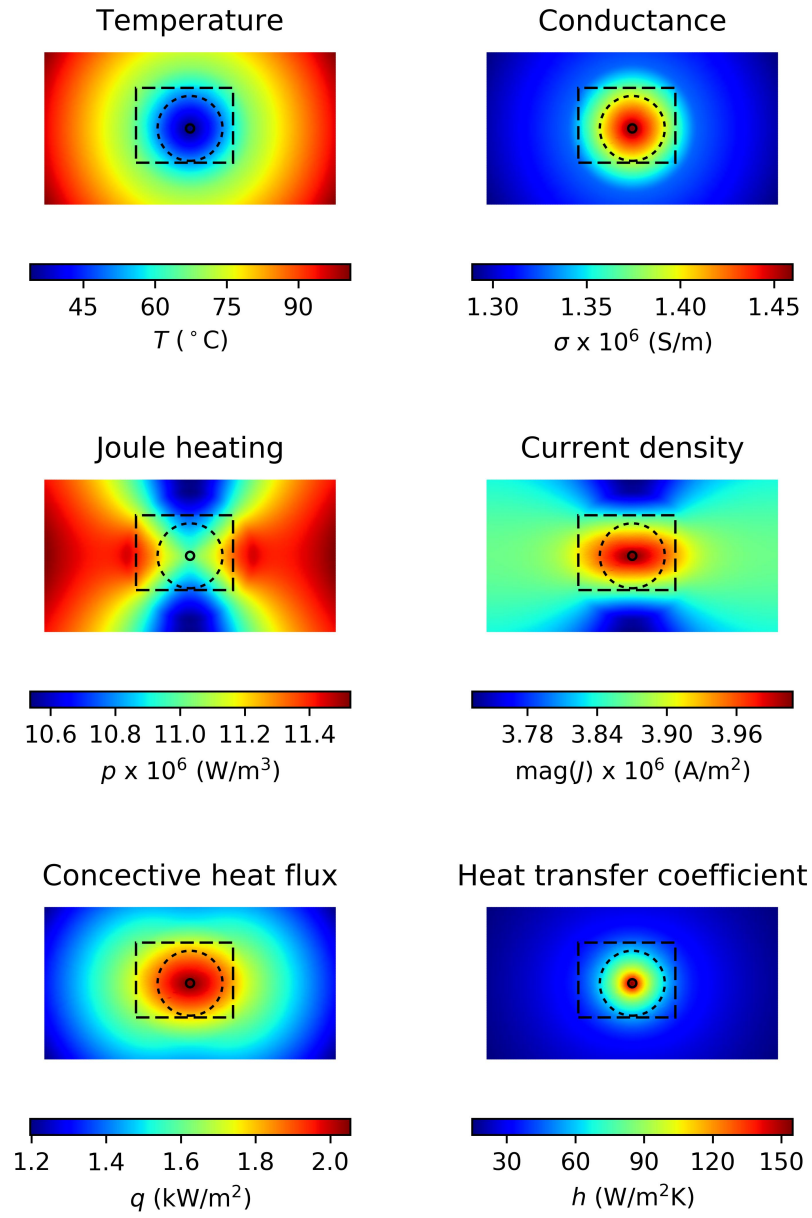


Figure 272: Convection calculation, mikkonen_089

Case id: mikkonen_090

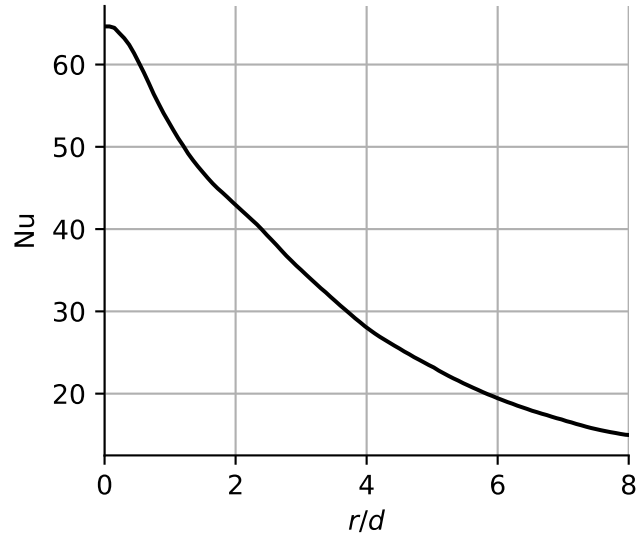


Figure 273: Nu, mikkonen_090

path	2017_03_07_8mm_HD1,2,3,6/8d_57Q_4HD								
this case measured by	Mikko Pirttiniemi								
lens	MWIR_f/2.0_f=50mm								
measurement time	2017-03-08 14:00:11								

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
10058	0.06	4	0.71	8.0	32.0	20.4	20.6	1.152	19.3

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.0	128.9	4.26	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.06	34.91	36.91	38.79	40.34	42.11	44.36	46.82	49.60
Nu	64.63	60.60	52.72	46.91	42.94	39.09	35.04	31.41	28.03
h (W/m ² K)	209.27	196.21	170.70	151.88	139.03	126.58	113.44	101.70	90.77
q (kW/m ²)	2.82	2.81	2.78	2.76	2.74	2.72	2.69	2.67	2.63

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	49.60	52.12	54.70	57.52	60.24	62.83	65.24	67.69	69.47
Nu	28.03	25.49	23.28	21.18	19.44	18.00	16.80	15.69	14.98
h (W/m ² K)	90.77	82.53	75.37	68.57	62.95	58.27	54.39	50.81	48.50
q (kW/m ²)	2.63	2.60	2.57	2.53	2.50	2.46	2.43	2.39	2.37

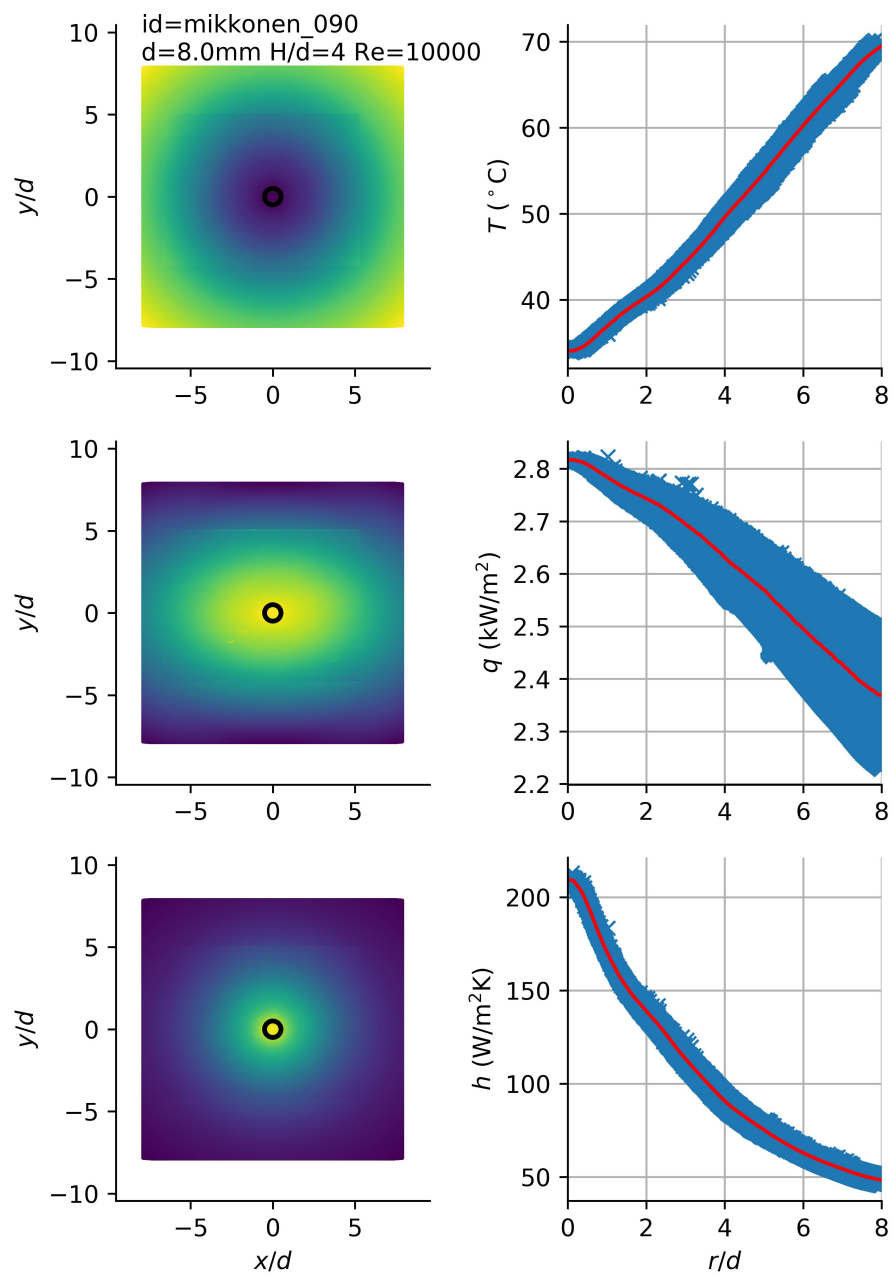


Figure 274: Results, mikkonen_090

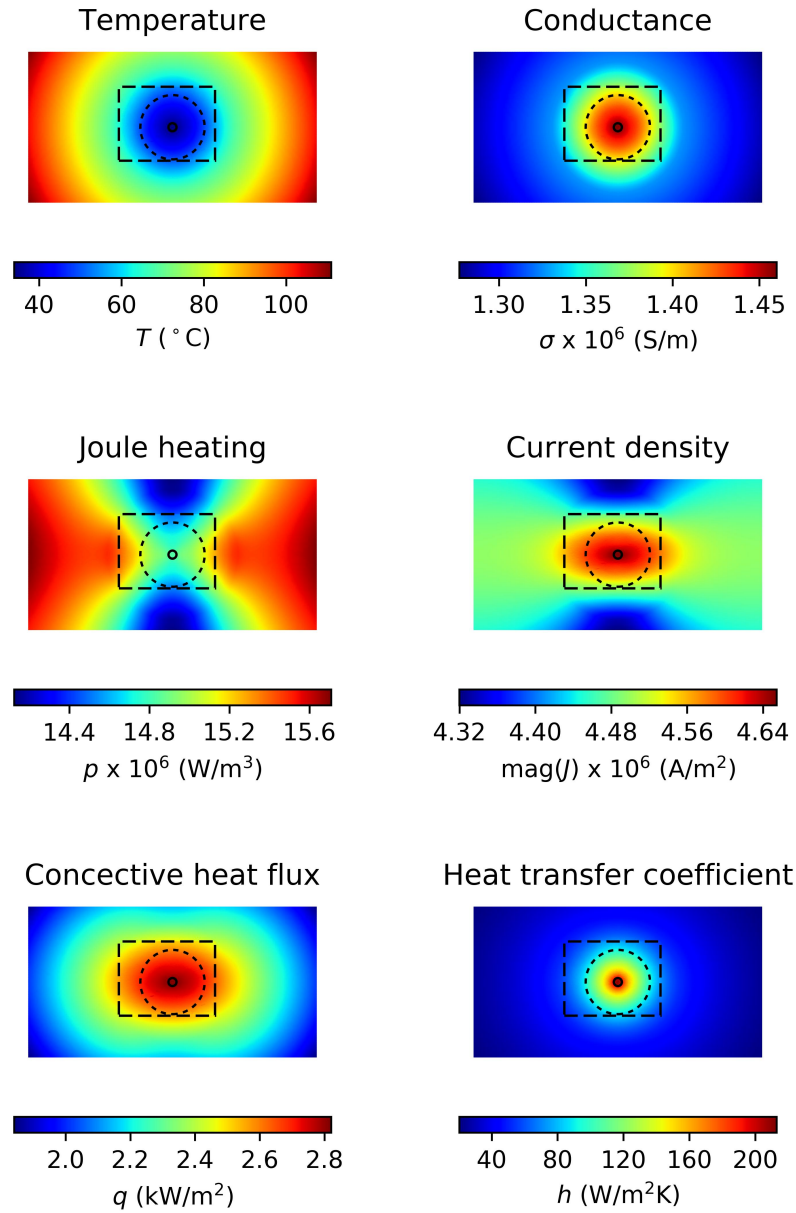


Figure 275: Convection calculation, mikkonen_090

Case id: mikkonen_091

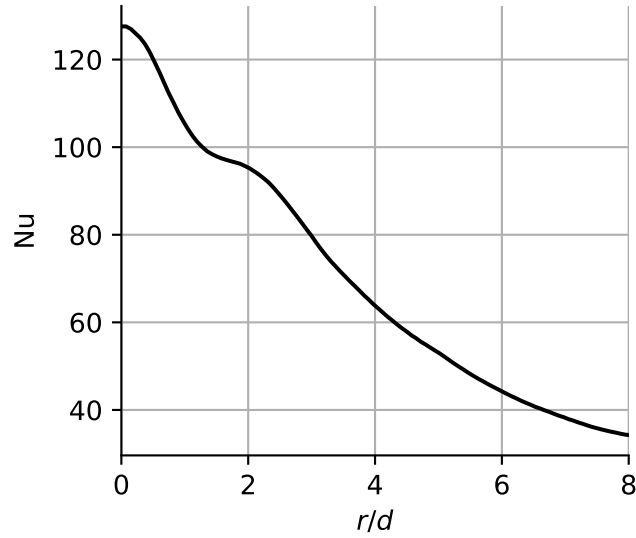


Figure 276: Nu, mikkonen_091

path	2017_03_07_8mm_HD1,2,3,6/8d_172Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 14:04:10

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
30014	0.17	4	0.71	8.0	32.0	19.9	20.6	3.432	57.4

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.4	181.8	3.81	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.37	35.20	37.18	38.39	38.85	40.09	42.28	44.83	47.39
Nu	127.57	120.13	105.35	97.90	95.33	89.06	79.72	70.92	63.81
h (W/m ² K)	412.45	388.42	340.63	316.54	308.21	287.97	257.75	229.31	206.32
q (kW/m ²)	5.68	5.67	5.65	5.63	5.63	5.61	5.58	5.55	5.52

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.39	49.98	52.46	55.41	58.28	61.09	63.67	66.21	68.06
Nu	63.81	57.88	53.08	48.23	44.25	40.89	38.20	35.83	34.29
h (W/m ² K)	206.32	187.14	171.63	155.93	143.07	132.19	123.52	115.84	110.86
q (kW/m ²)	5.52	5.50	5.47	5.43	5.39	5.35	5.32	5.28	5.26

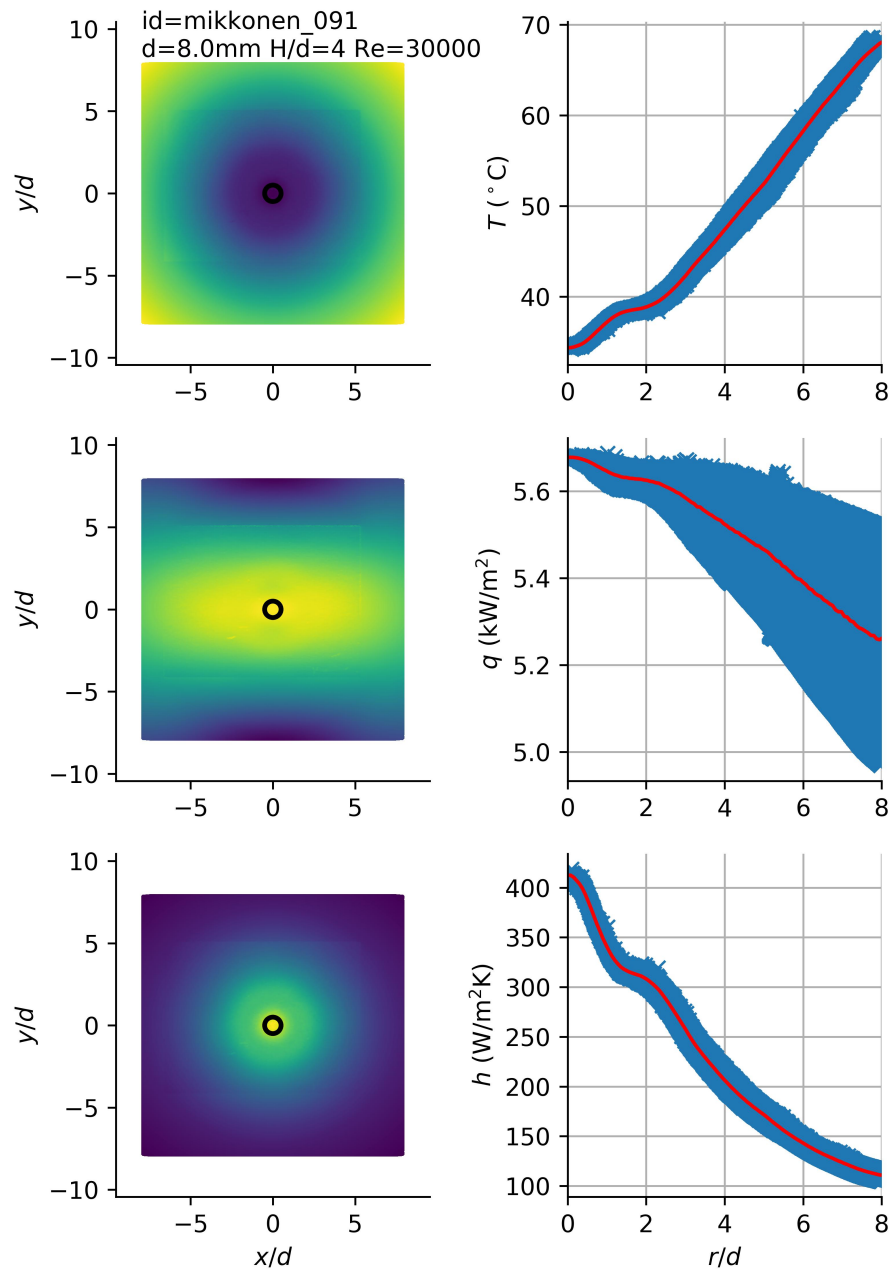


Figure 277: Results, mikkonen_091

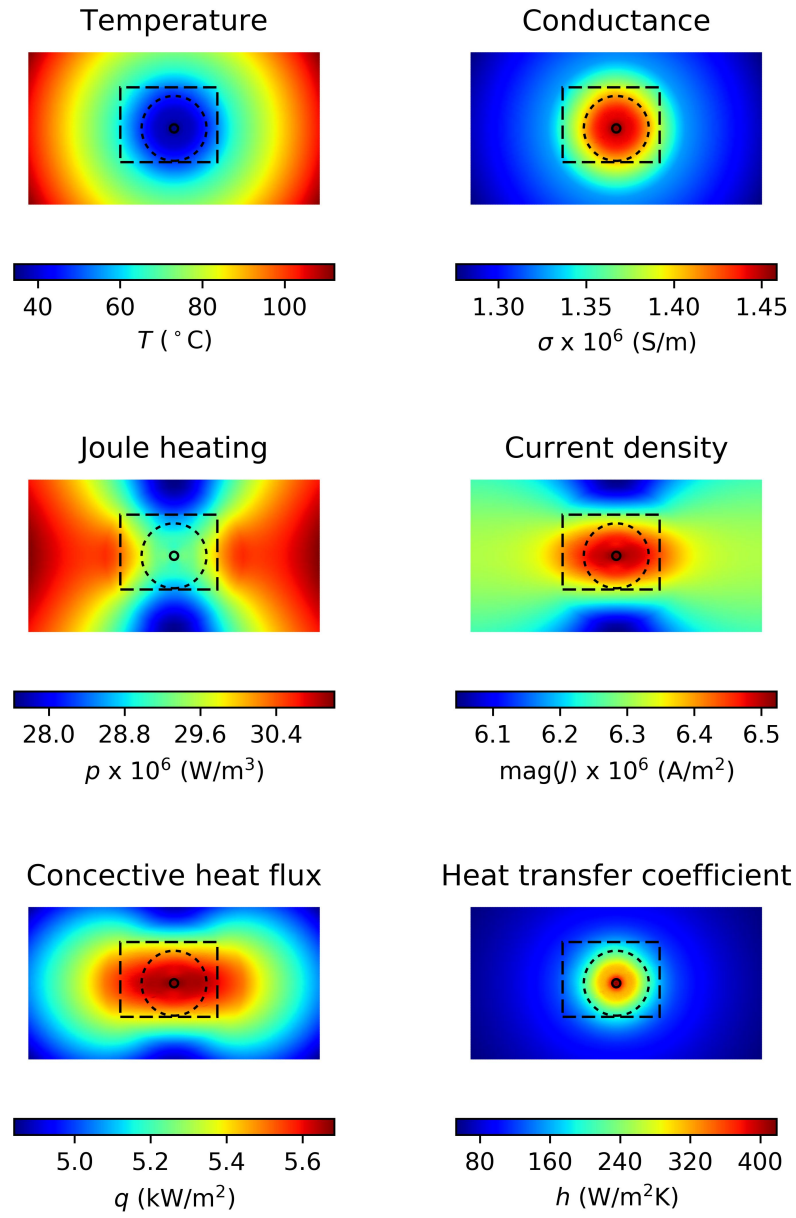


Figure 278: Convection calculation, mikkonen_091

Case id: mikkonen_092

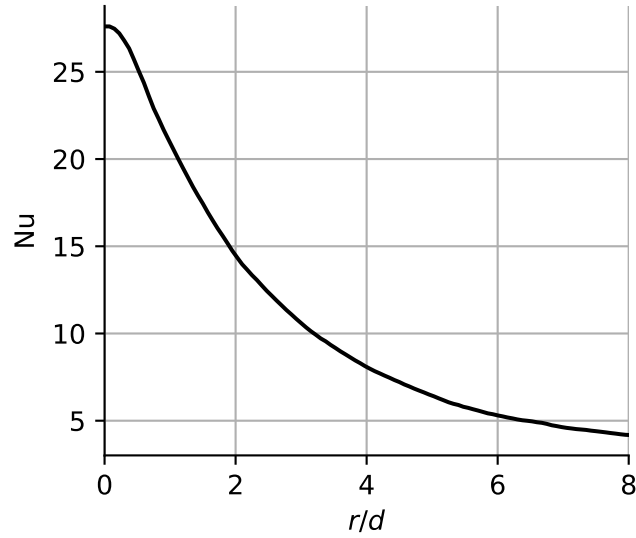


Figure 279: Nu, mikkonen_092

path	2017_03_07_8mm_HD1,2,3,6/8d_11Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 14:25:35

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
2039	0.01	6	0.71	8.0	48.0	21.1	20.6	0.234	3.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	0.6	86.0	3.49	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	33.63	34.71	37.19	39.93	43.09	46.04	49.14	52.10	55.09
Nu	27.60	25.24	20.93	17.45	14.48	12.35	10.60	9.23	8.08
h (W/m ² K)	89.55	81.91	67.92	56.61	46.98	40.08	34.38	29.94	26.22
q (kW/m ²)	1.17	1.16	1.13	1.09	1.06	1.02	0.98	0.94	0.90

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	55.09	57.77	60.54	63.23	65.38	67.00	68.71	69.84	71.11
Nu	8.08	7.22	6.44	5.78	5.30	4.97	4.62	4.40	4.18
h (W/m ² K)	26.22	23.41	20.88	18.75	17.21	16.14	14.99	14.27	13.57
q (kW/m ²)	0.90	0.87	0.83	0.80	0.77	0.75	0.72	0.70	0.69

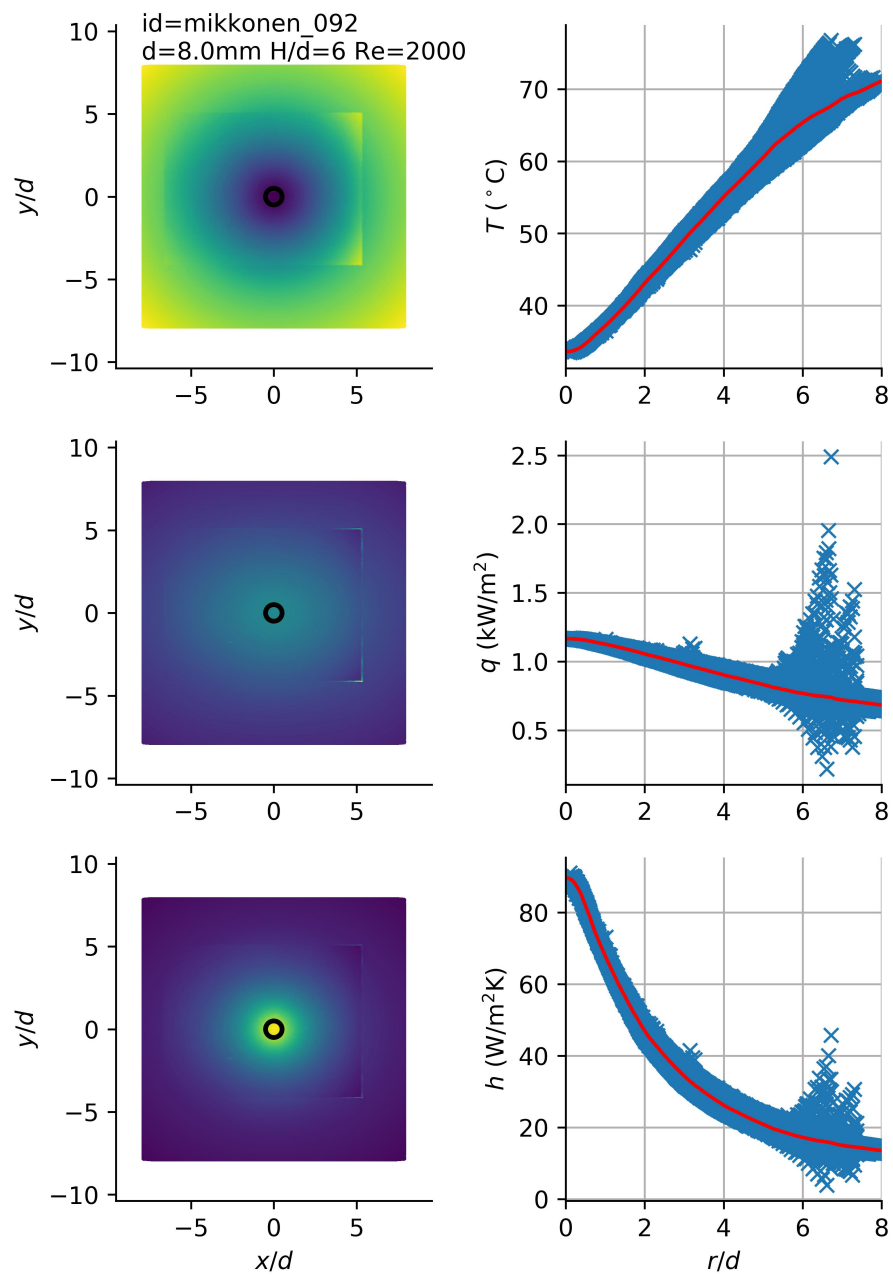


Figure 280: Results, mikkonen_092

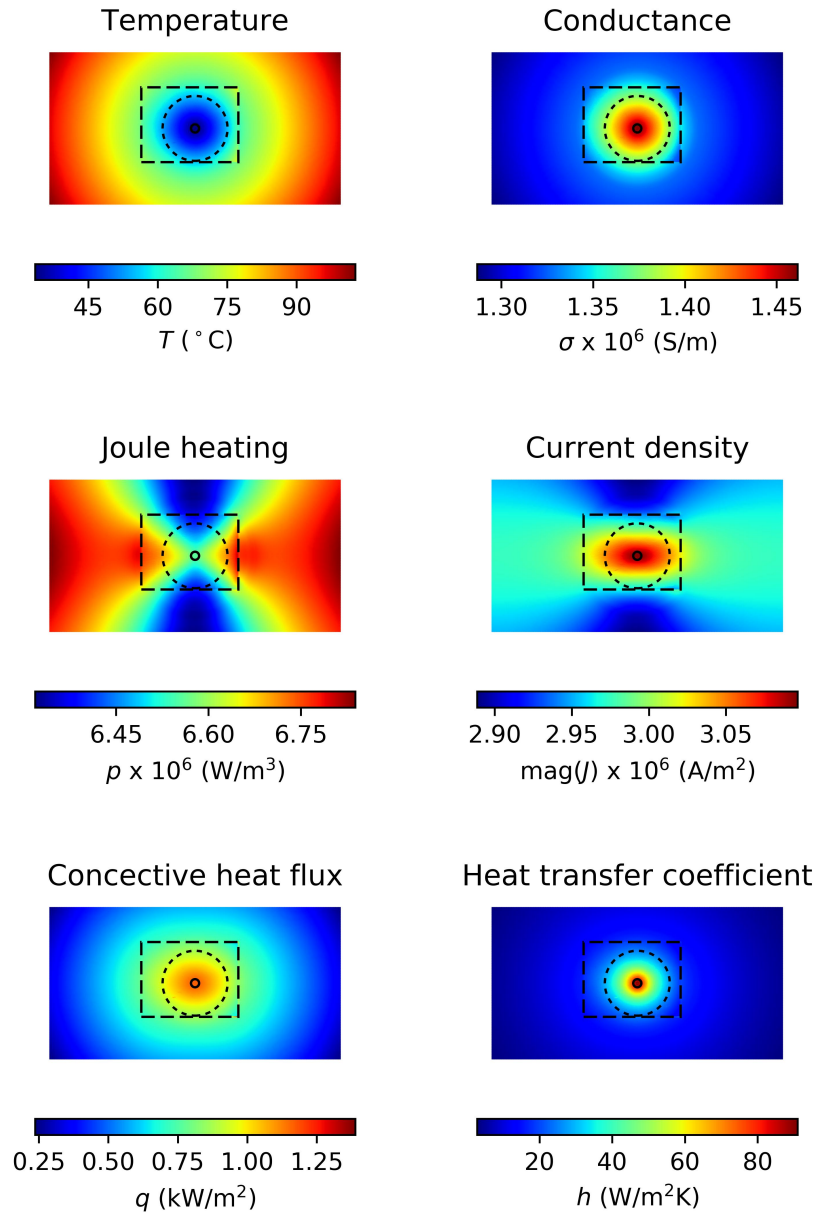


Figure 281: Convection calculation, mikkonen_092

Case id: mikkonen_093

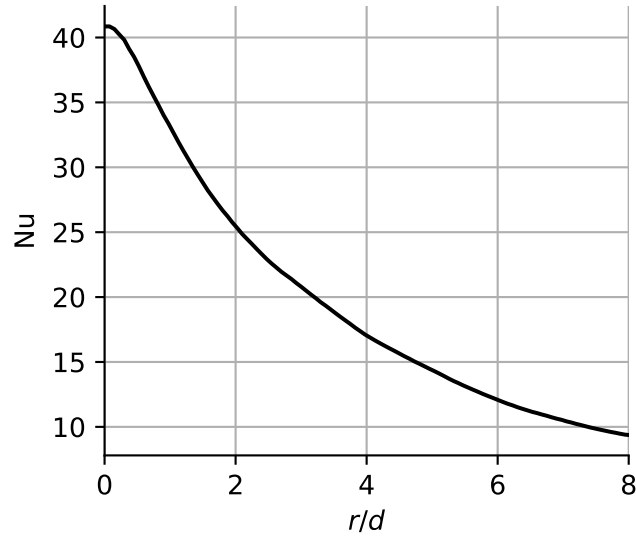


Figure 282: Nu, mikkonen_093

path	2017_03_07_8mm_HD1,2,3,6/8d_34Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 14:22:05

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6033	0.03	6	0.71	8.0	48.0	20.4	20.6	0.691	11.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	0.8	106.6	2.61	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.26	35.20	37.14	39.35	41.50	43.59	45.47	47.61	49.95
Nu	40.85	38.02	33.14	28.82	25.47	22.81	20.80	18.86	17.04
h (W/m ² K)	132.28	123.10	107.31	93.30	82.46	73.87	67.35	61.06	55.18
q (kW/m ²)	1.81	1.80	1.77	1.75	1.72	1.70	1.67	1.65	1.62

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	49.95	52.05	54.26	56.67	59.02	61.22	63.15	65.09	66.68
Nu	17.04	15.65	14.38	13.14	12.08	11.20	10.50	9.86	9.38
h (W/m ² K)	55.18	50.68	46.55	42.54	39.12	36.26	34.01	31.92	30.36
q (kW/m ²)	1.62	1.59	1.57	1.53	1.50	1.47	1.45	1.42	1.40

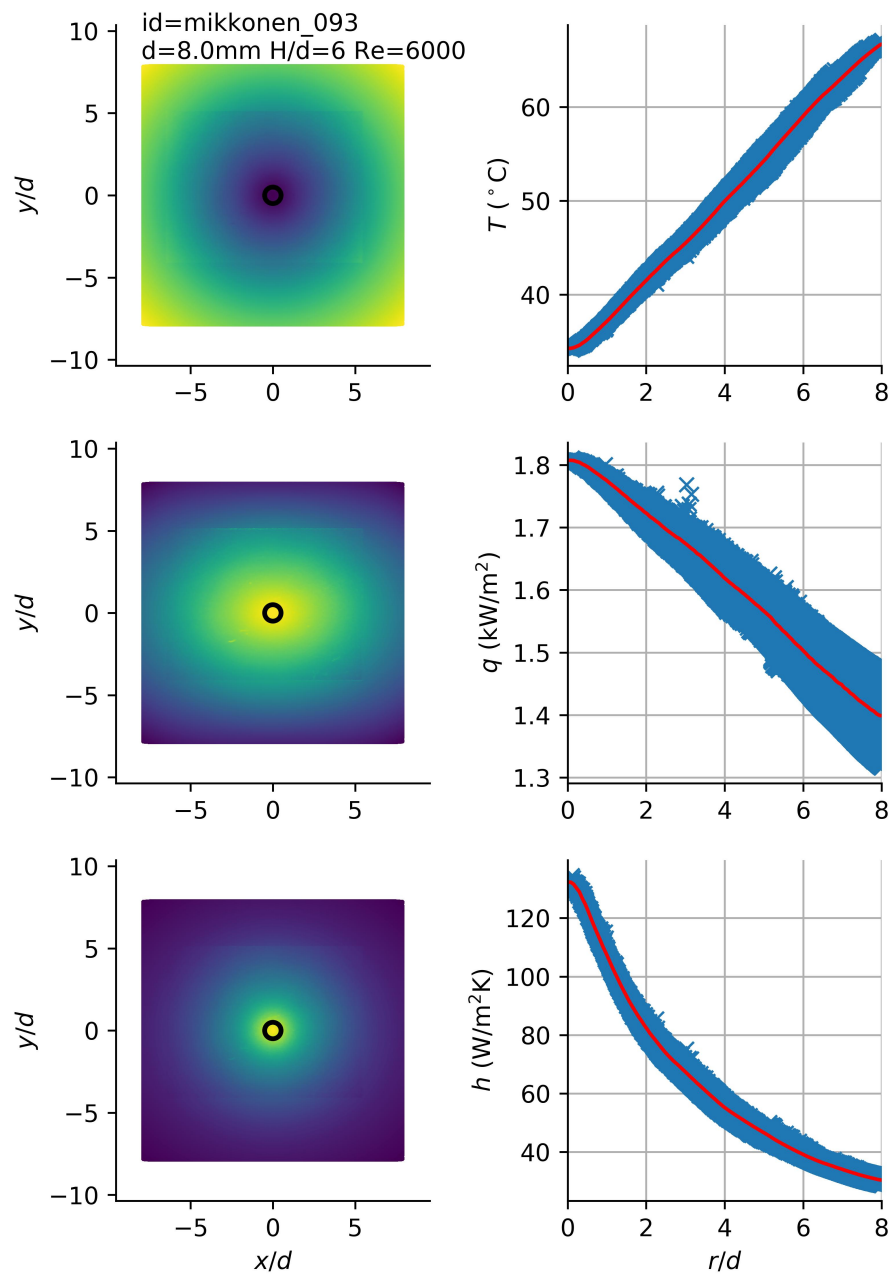


Figure 283: Results, mikkonen_093

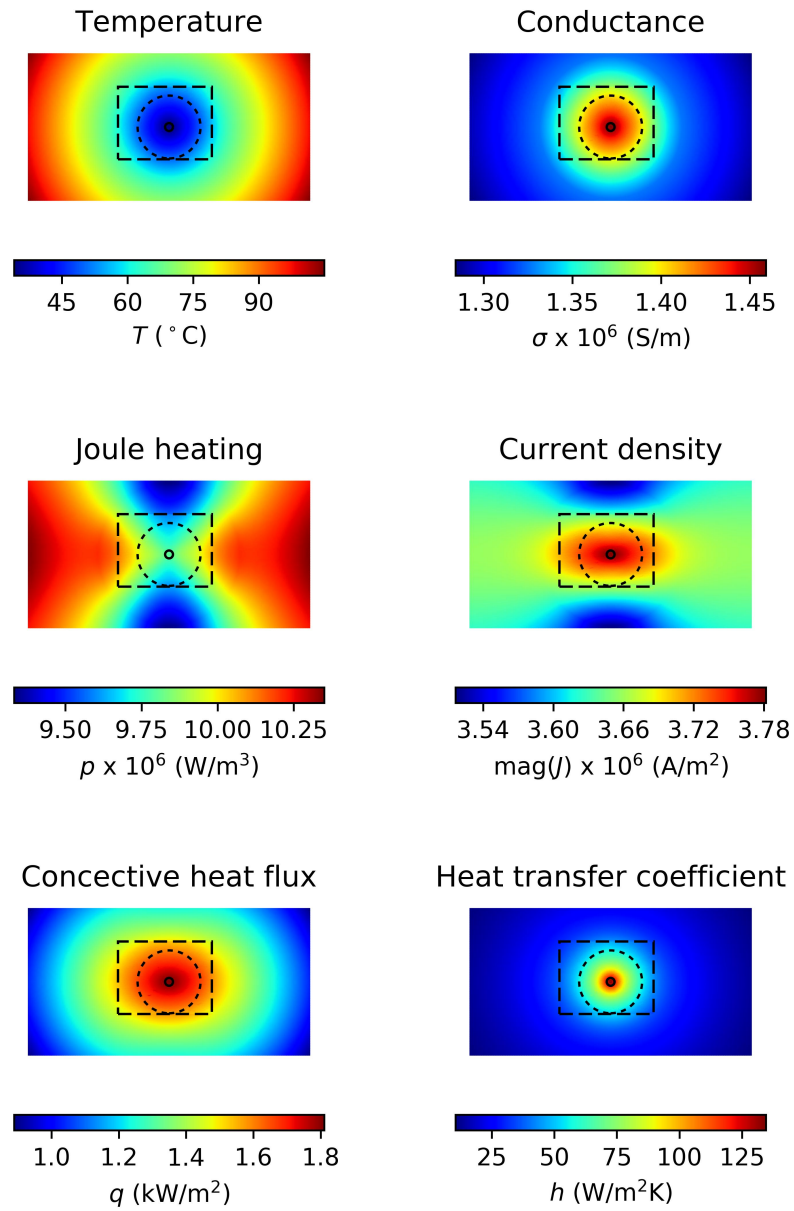


Figure 284: Convection calculation, mikkonen_093

Case id: mikkonen_094

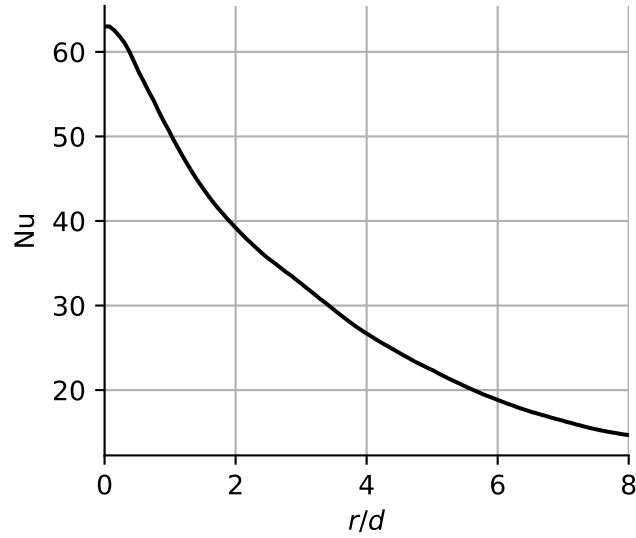


Figure 285: Nu, mikkonen_094

path	2017_03_07_8mm_HD1,2,3,6/8d_57Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 14:18:43

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9990	0.06	6	0.71	8.0	48.0	20.0	20.6	1.143	19.1

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.0	129.1	3.96	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.40	35.53	37.62	39.96	42.07	44.05	45.96	48.32	50.88
Nu	63.01	57.99	50.41	43.89	39.20	35.57	32.61	29.51	26.69
h (W/m ² K)	203.79	187.56	163.04	141.93	126.79	115.04	105.46	95.45	86.33
q (kW/m ²)	2.81	2.80	2.77	2.75	2.72	2.70	2.67	2.65	2.61

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	50.88	53.35	55.87	58.62	61.30	63.89	66.19	68.50	70.21
Nu	26.69	24.40	22.37	20.46	18.83	17.46	16.37	15.36	14.69
h (W/m ² K)	86.33	78.90	72.36	66.17	60.91	56.46	52.93	49.68	47.52
q (kW/m ²)	2.61	2.58	2.55	2.51	2.48	2.44	2.41	2.38	2.36

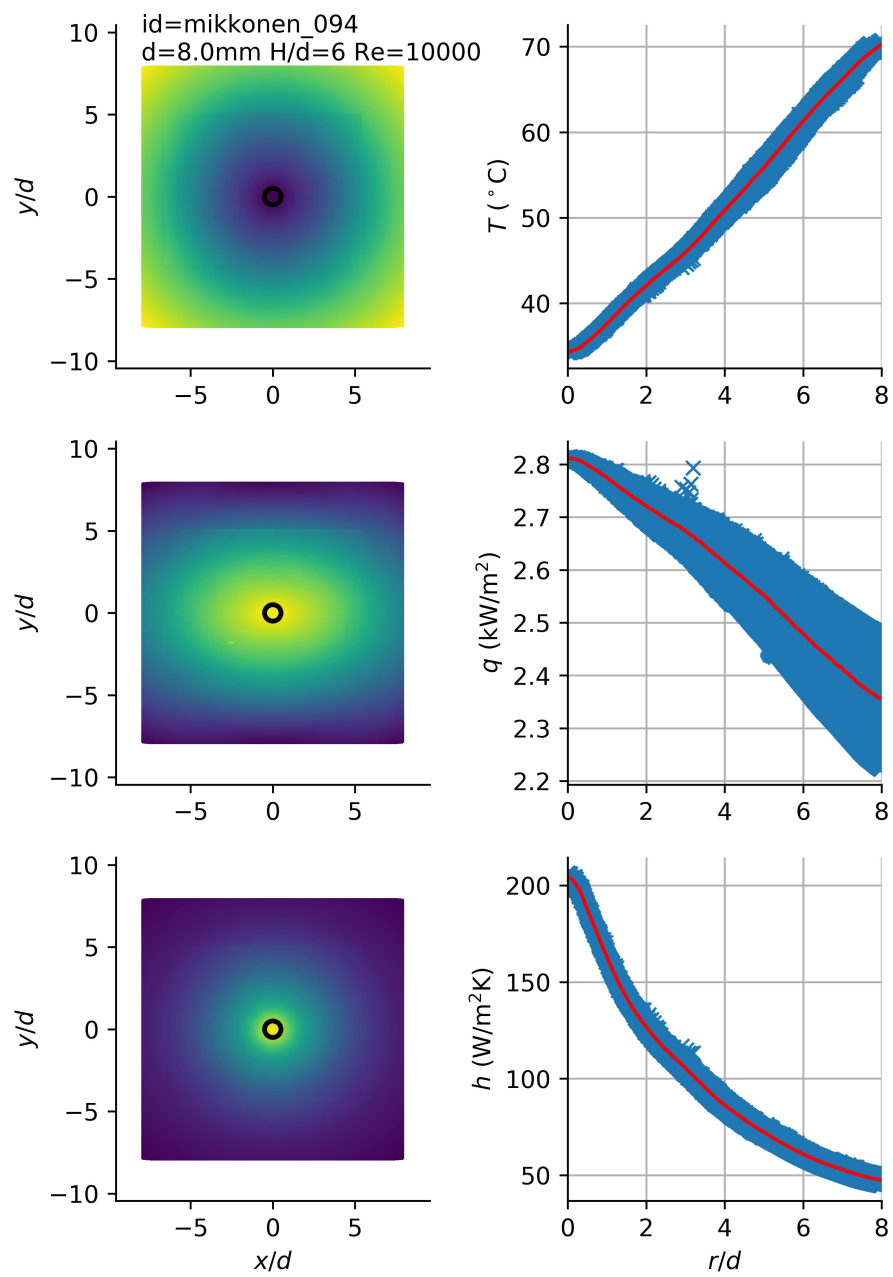


Figure 286: Results, mikkonen_094

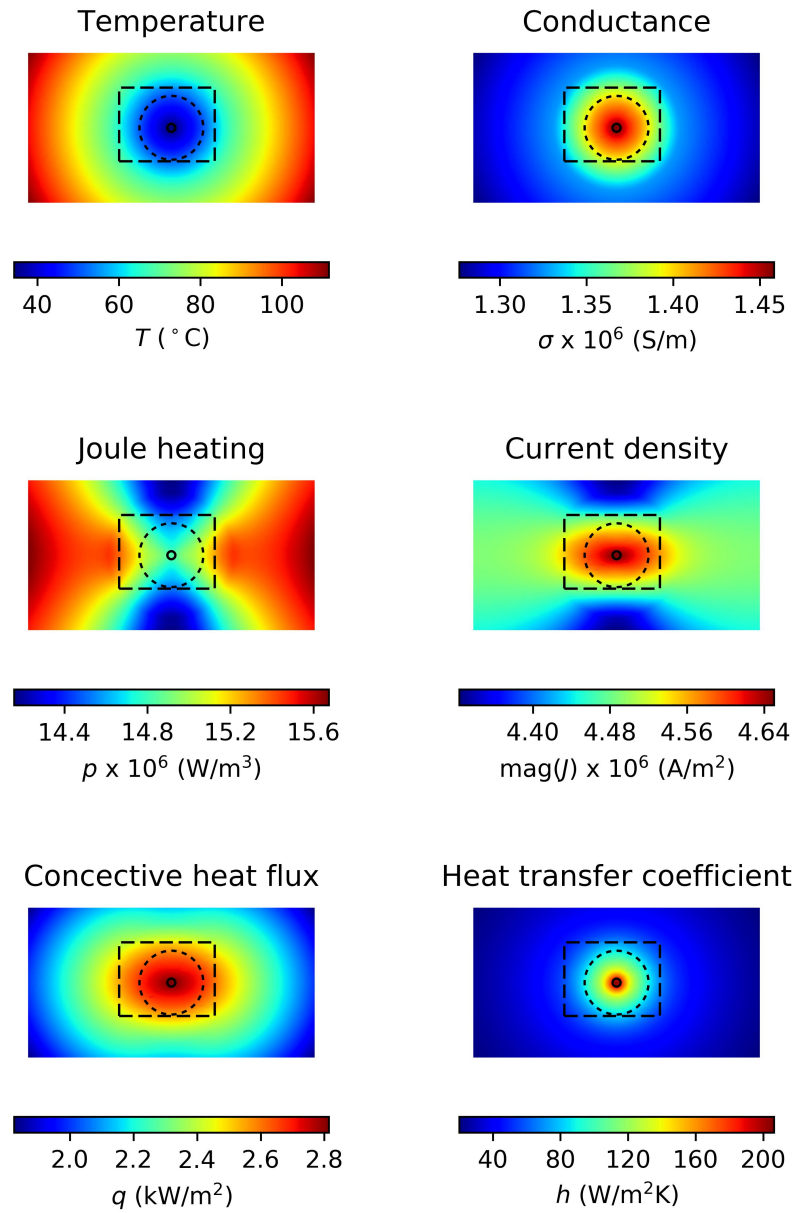


Figure 287: Convection calculation, mikkonen_094

Case id: mikkonen_095

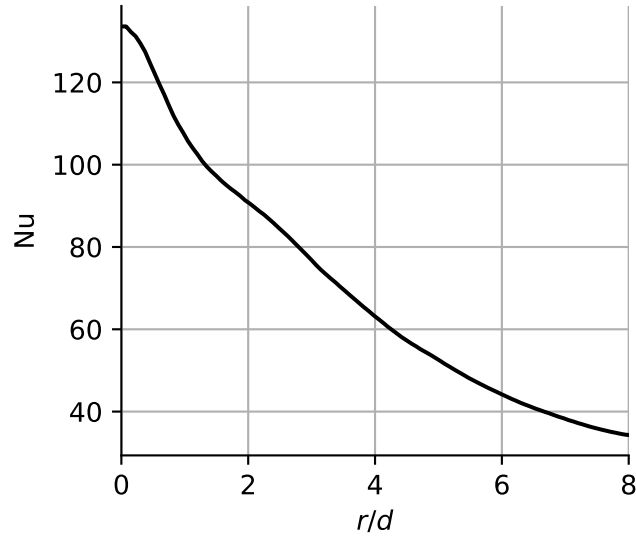


Figure 288: Nu, mikkonen_095

path	2017_03_07_8mm_HD1,2,3,6/8d_172Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 14:14:58

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
30170	0.17	6	0.71	8.0	48.0	19.7	20.6	3.448	57.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.4	181.1	4.22	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	33.78	34.89	36.94	38.53	39.75	41.14	43.08	45.26	47.68
Nu	133.60	123.03	107.09	97.25	90.82	84.39	76.80	69.69	63.13
h (W/m ² K)	431.71	397.57	346.05	314.25	293.47	272.69	248.17	225.19	203.99
q (kW/m ²)	5.69	5.68	5.65	5.63	5.62	5.60	5.58	5.55	5.52
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.68	50.28	52.75	55.59	58.36	61.11	63.67	66.17	68.06
Nu	63.13	57.29	52.59	47.99	44.18	40.91	38.23	35.90	34.32
h (W/m ² K)	203.99	185.11	169.93	155.08	142.76	132.18	123.53	115.99	110.89
q (kW/m ²)	5.52	5.49	5.46	5.43	5.39	5.35	5.32	5.29	5.26

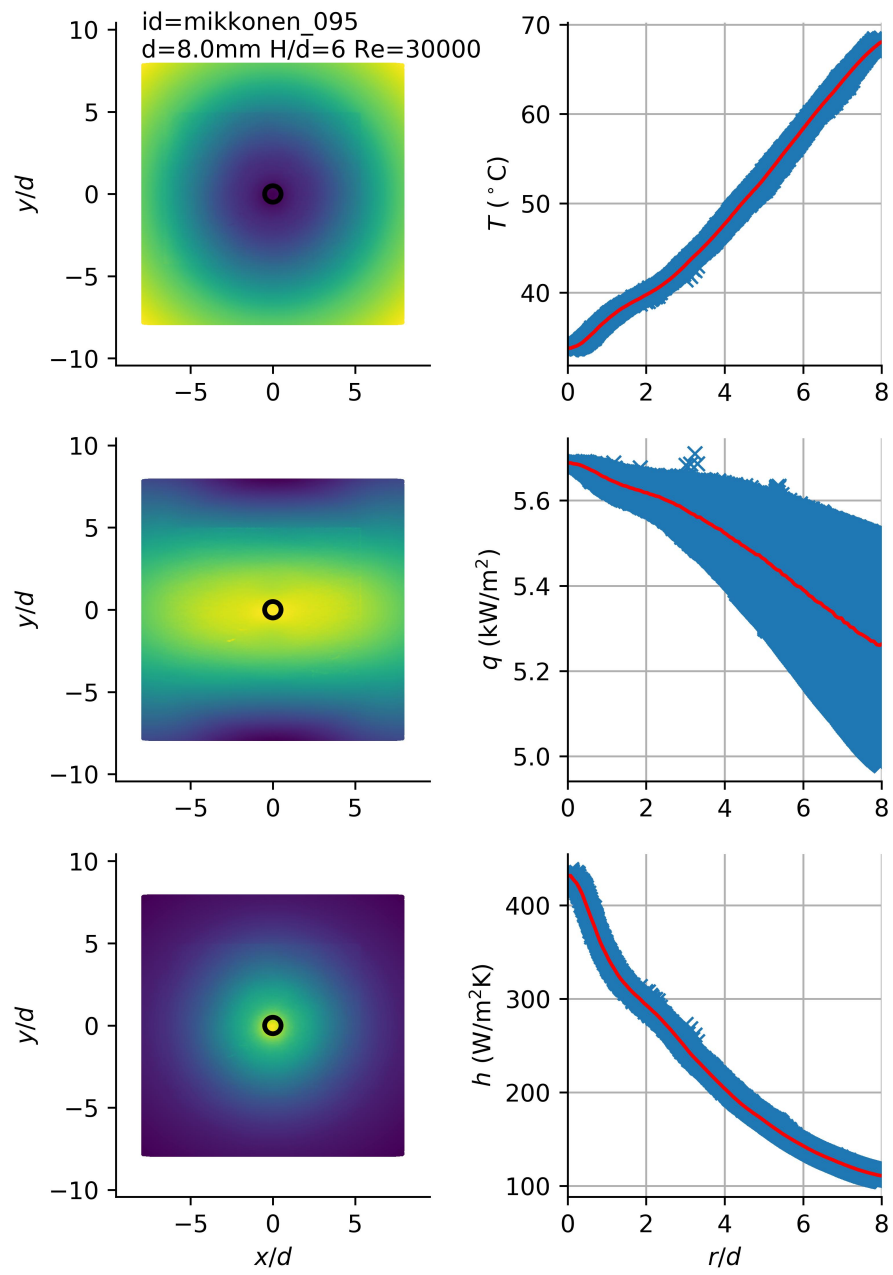


Figure 289: Results, mikkonen_095

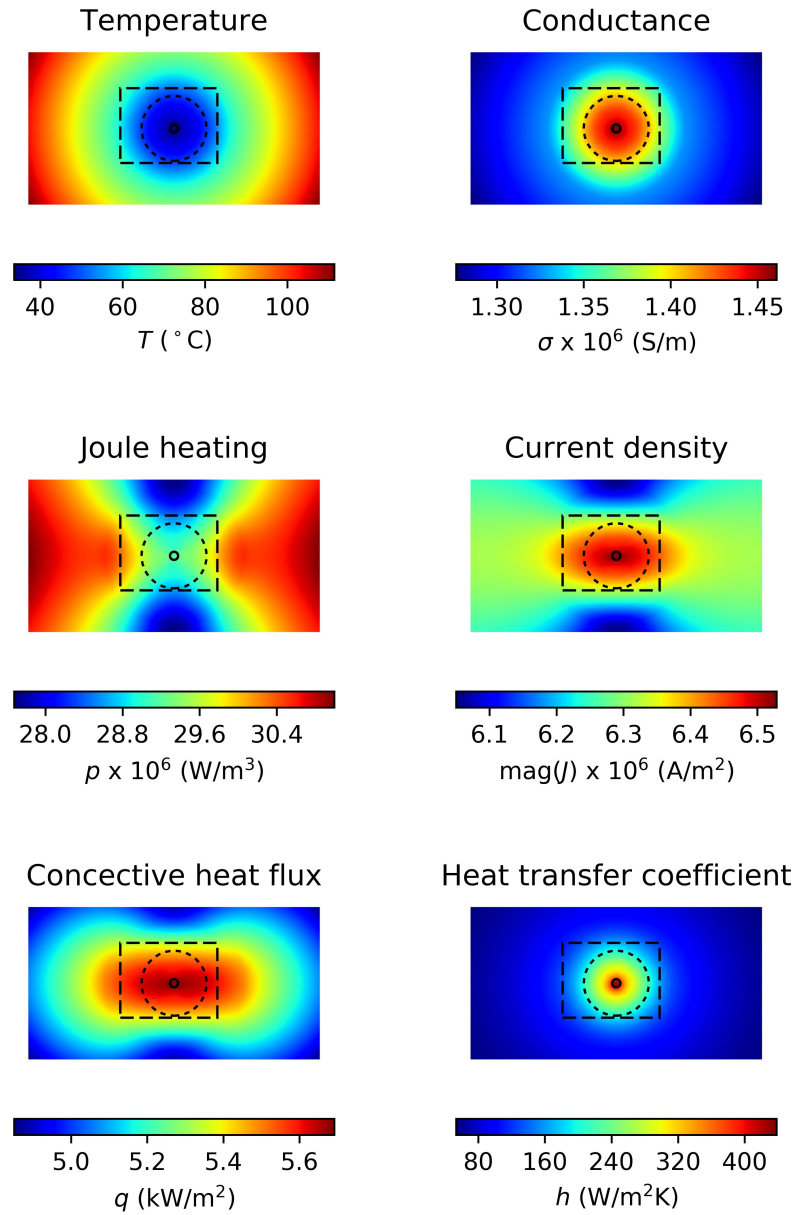


Figure 290: Convection calculation, mikkonen_095

Case id: mikkonen_096

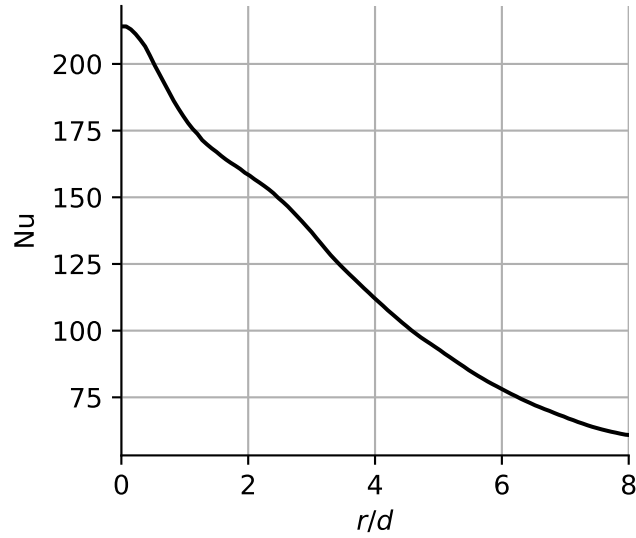


Figure 291: Nu, mikkonen_096

path	2017_03_07_8mm_HD1,2,3,6/8d_430Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-08 14:11:25

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
69851	0.39	6	0.71	8.0	48.0	19.5	20.6	7.979	133.3

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.8	233.3	4.32	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.38	35.29	36.98	38.18	39.11	40.22	41.94	44.22	46.54
Nu	214.06	200.72	179.63	167.03	158.46	149.24	136.96	123.38	112.02
h (W/m ² K)	691.31	648.24	580.11	539.41	511.74	481.98	442.30	398.46	361.75
q (kW/m ²)	9.53	9.52	9.50	9.48	9.47	9.46	9.44	9.41	9.38
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.54	49.11	51.63	54.49	57.29	60.09	62.69	65.24	67.03
Nu	112.02	101.61	93.06	84.88	78.09	72.27	67.57	63.46	60.89
h (W/m ² K)	361.75	328.15	300.54	274.12	252.20	233.41	218.21	204.94	196.63
q (kW/m ²)	9.38	9.35	9.32	9.29	9.25	9.22	9.18	9.15	9.13

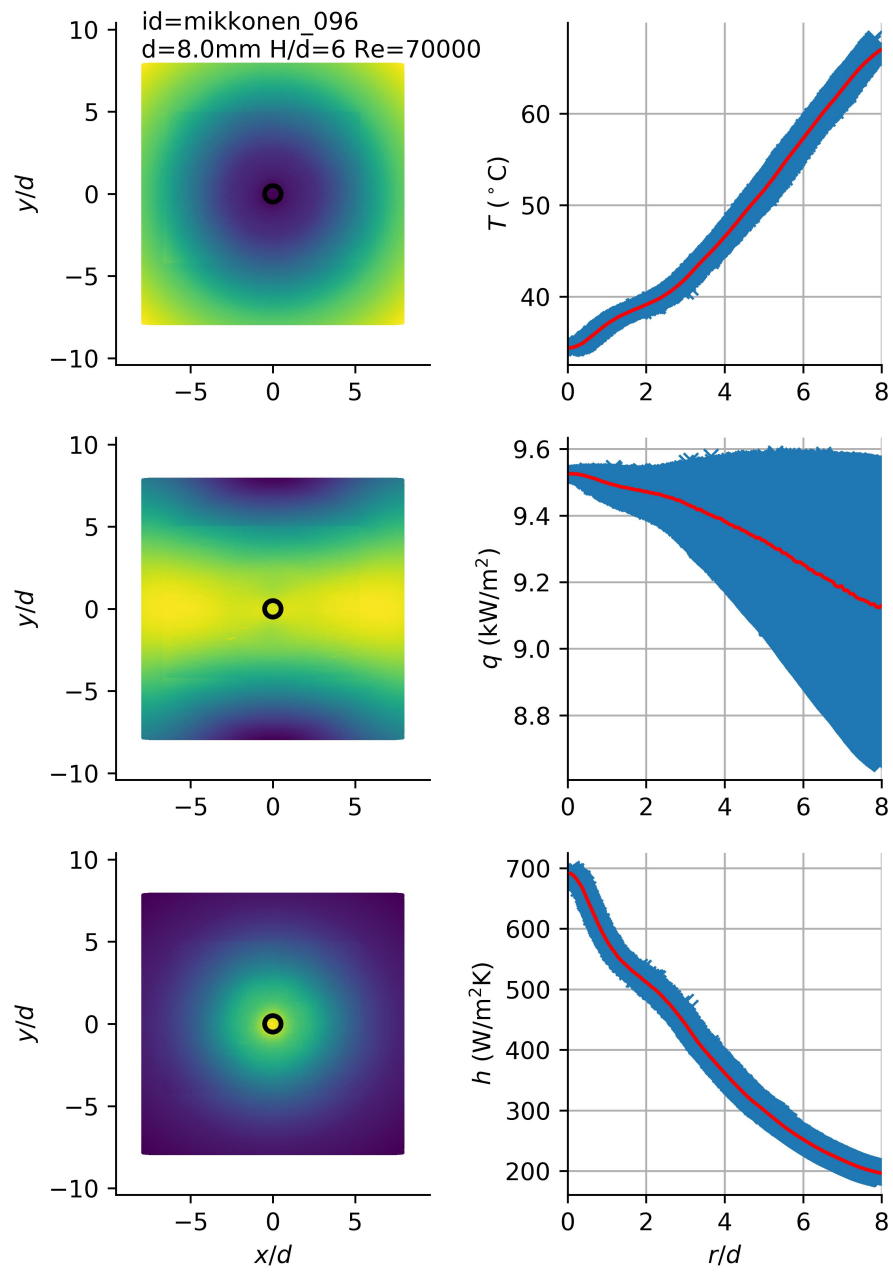


Figure 292: Results, mikkonen_096

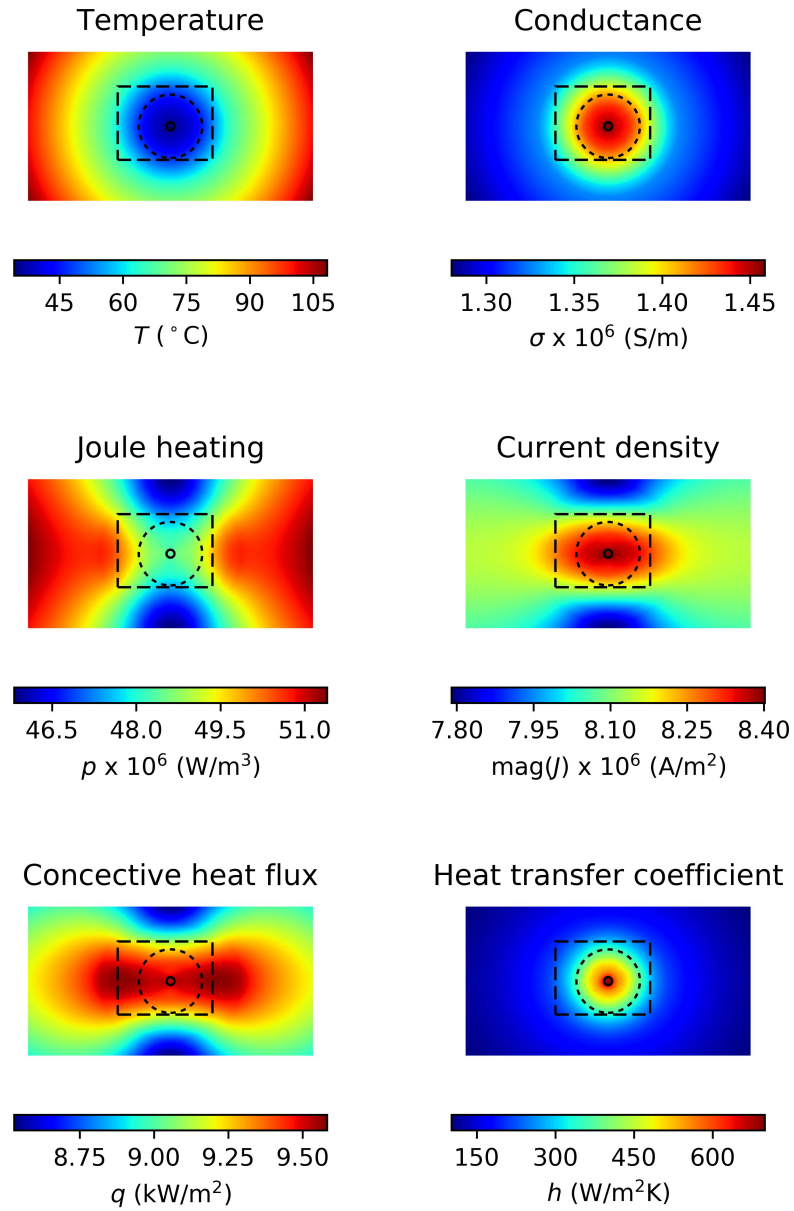


Figure 293: Convection calculation, mikkonen_096

Case id: mikkonen_097

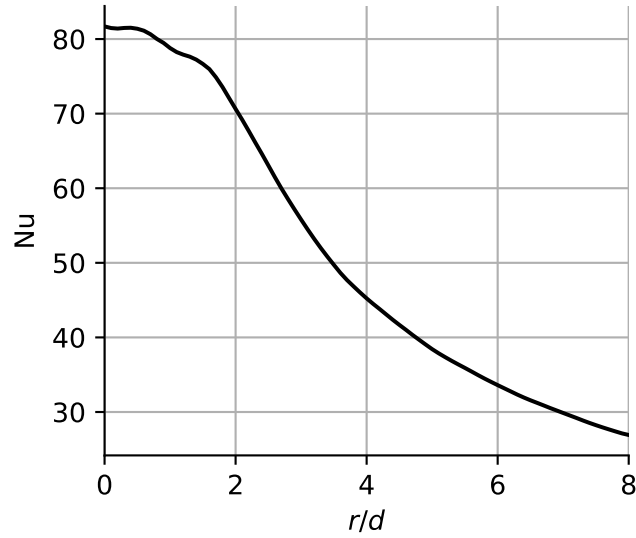


Figure 294: Nu, mikkonen_097

path	2017_03_09_mikko/3d_64Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 15:10:27

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
29841	0.44	1	0.71	3.0	3.0	20.2	20.2	1.281	152.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.9	238.1	2.44	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.47	34.52	34.99	35.39	36.67	38.62	40.96	43.43	45.66
Nu	81.69	81.38	78.79	76.67	70.63	63.05	55.80	49.73	45.23
h (W/m ² K)	704.96	702.29	679.92	661.58	609.50	544.11	481.49	429.13	390.34
q (kW/m ²)	10.06	10.06	10.06	10.05	10.04	10.02	9.99	9.97	9.94

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.66	47.77	50.02	52.03	54.13	56.21	58.17	60.26	62.12
Nu	45.23	41.67	38.43	35.91	33.60	31.57	29.87	28.24	26.92
h (W/m ² K)	390.34	359.63	331.60	309.88	289.97	272.46	257.76	243.65	232.31
q (kW/m ²)	9.94	9.91	9.89	9.86	9.84	9.81	9.79	9.76	9.74

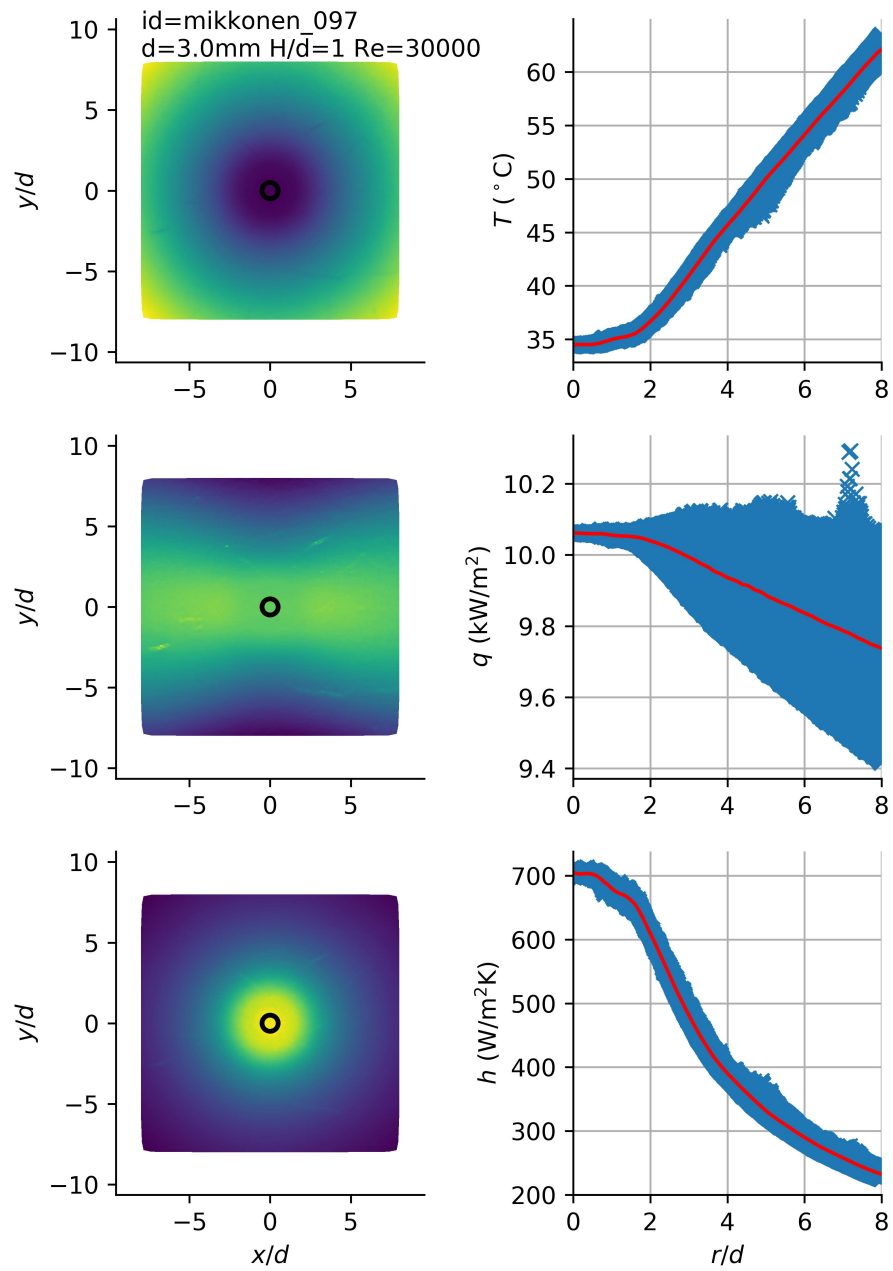


Figure 295: Results, mikkonen_097

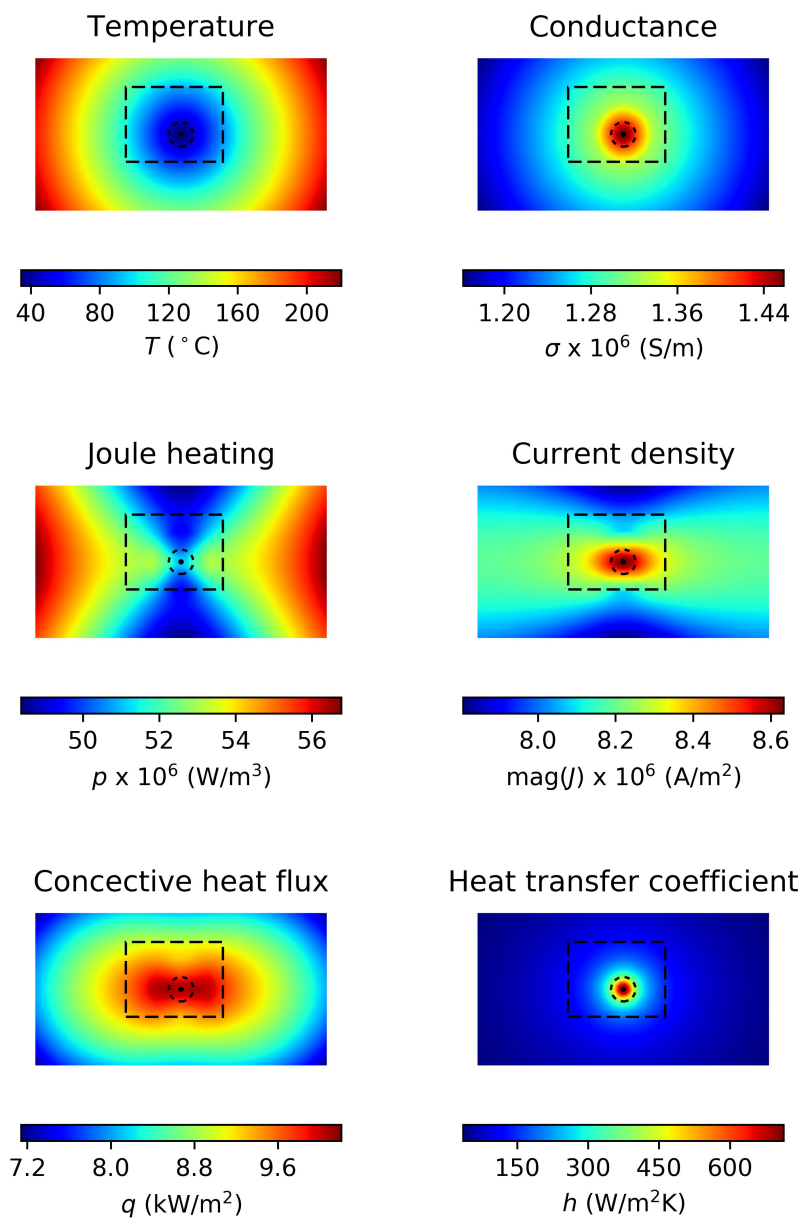


Figure 296: Convection calculation, mikkonen_097

Case id: mikkonen_098

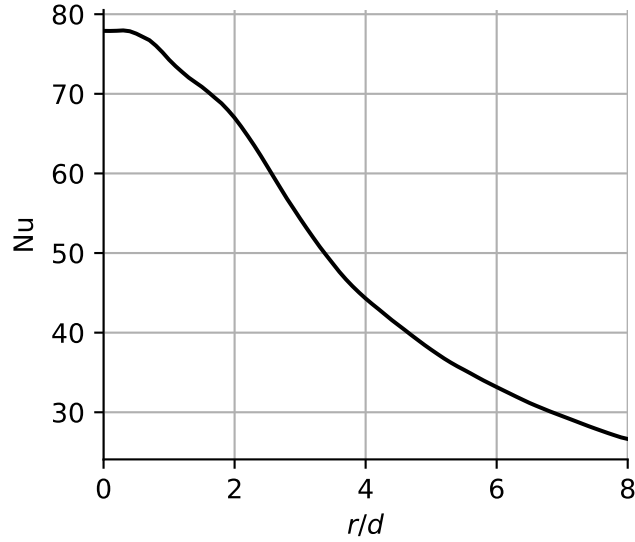


Figure 297: Nu, mikkonen_098

path	2017_03_09_mikko/3d_64Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 15:26:41

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
29840	0.45	2	0.71	3.0	6.0	20.8	20.2	1.283	153.1

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.8	232.3	2.76	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.45	34.51	35.13	35.83	36.73	38.36	40.50	42.79	44.95
Nu	77.91	77.56	74.28	70.88	66.99	60.87	54.32	48.67	44.29
h (W/m ² K)	673.44	670.43	642.11	612.68	579.06	526.14	469.59	420.73	382.87
q (kW/m ²)	9.59	9.59	9.59	9.58	9.57	9.55	9.53	9.50	9.48
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.95	46.91	49.01	50.99	52.92	54.92	56.78	58.72	60.52
Nu	44.29	40.95	37.86	35.34	33.17	31.18	29.52	27.96	26.65
h (W/m ² K)	382.87	353.98	327.28	305.47	286.69	269.50	255.18	241.73	230.34
q (kW/m ²)	9.48	9.46	9.43	9.40	9.38	9.36	9.33	9.31	9.29

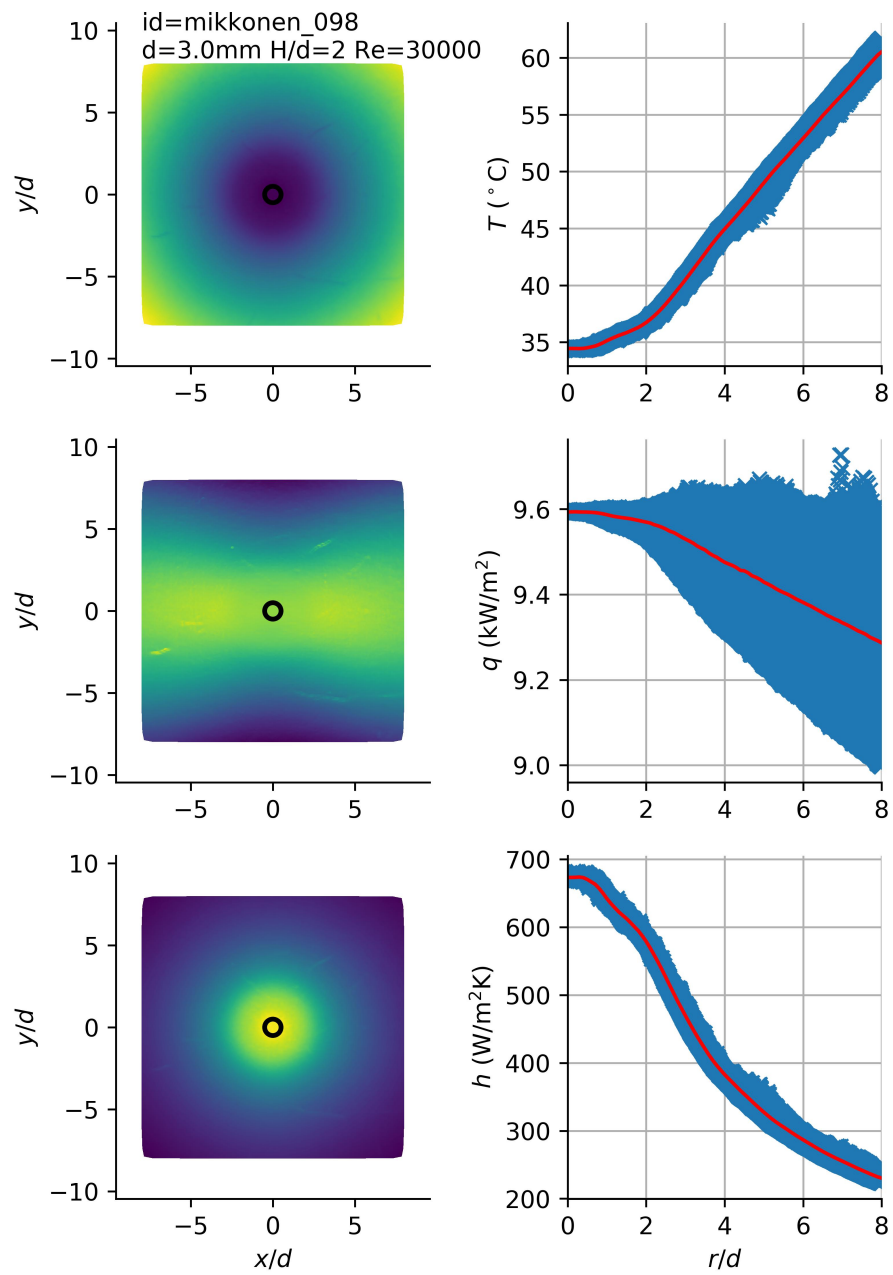


Figure 298: Results, mikkonen_098

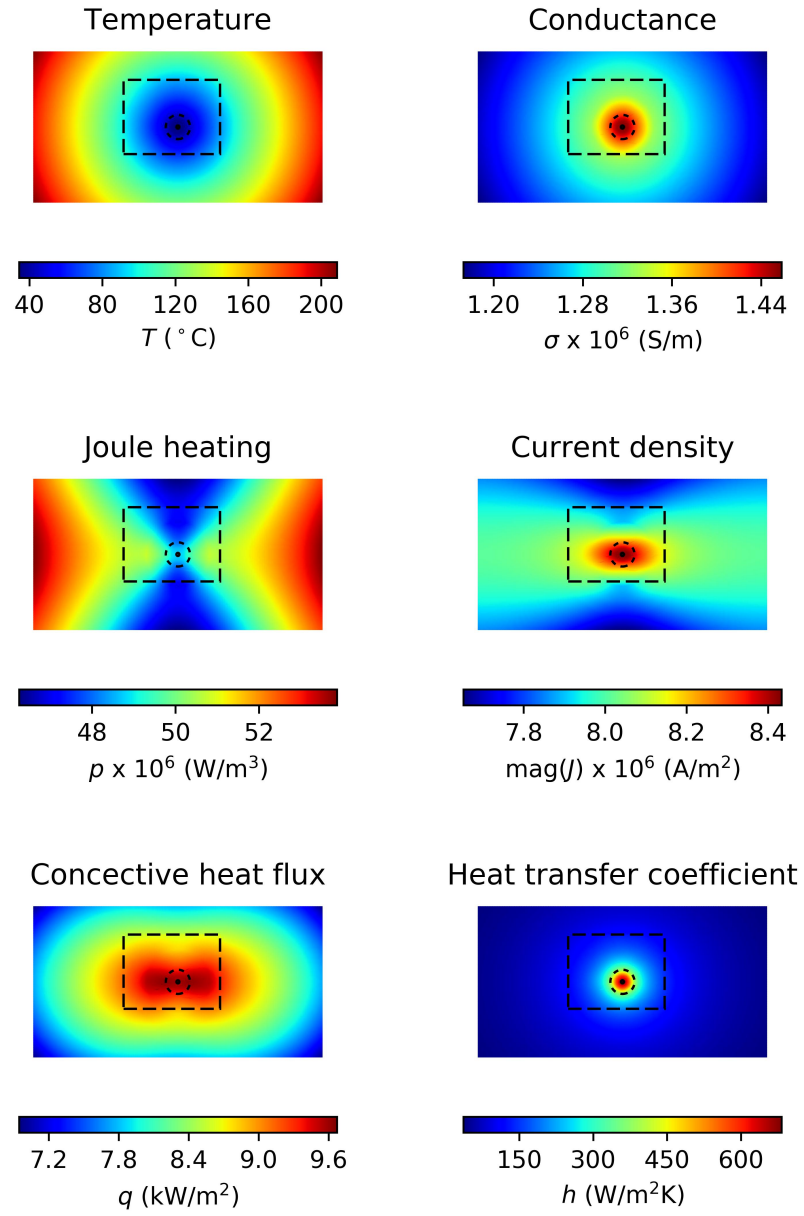


Figure 299: Convection calculation, mikkonen_098

Case id: mikkonen_099

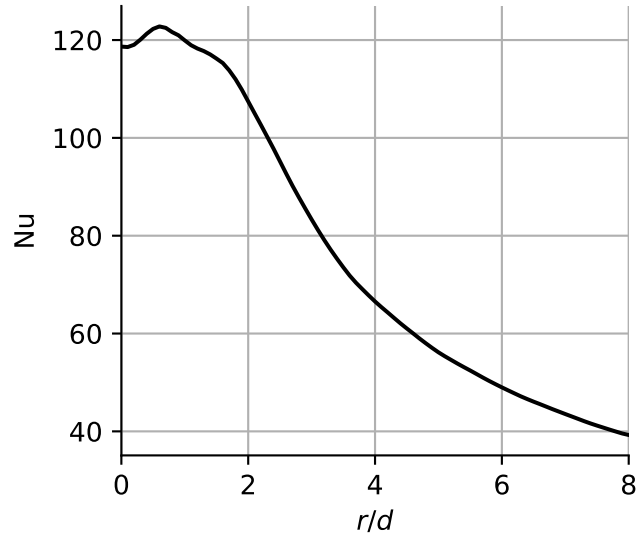


Figure 300: Nu, mikkonen_099

path	2017_03_09_mikko/3d_107Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 15:21:07

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50128	0.75	2	0.71	3.0	6.0	20.4	20.2	2.153	256.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.3	287.1	2.39	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.58	34.16	34.43	34.88	36.07	38.08	40.60	43.27	45.63
Nu	118.66	122.28	119.93	116.21	107.44	95.22	83.32	73.53	66.55
h (W/m ² K)	1024.57	1055.81	1035.49	1003.40	927.73	822.21	719.44	634.88	574.64
q (kW/m ²)	14.73	14.73	14.73	14.73	14.72	14.70	14.67	14.64	14.61

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.63	47.88	50.23	52.30	54.50	56.61	58.66	60.79	62.71
Nu	66.55	61.04	56.16	52.45	48.99	46.07	43.54	41.18	39.26
h (W/m ² K)	574.64	527.09	484.90	452.86	423.04	397.82	375.95	355.57	339.01
q (kW/m ²)	14.61	14.59	14.56	14.53	14.51	14.48	14.46	14.43	14.41

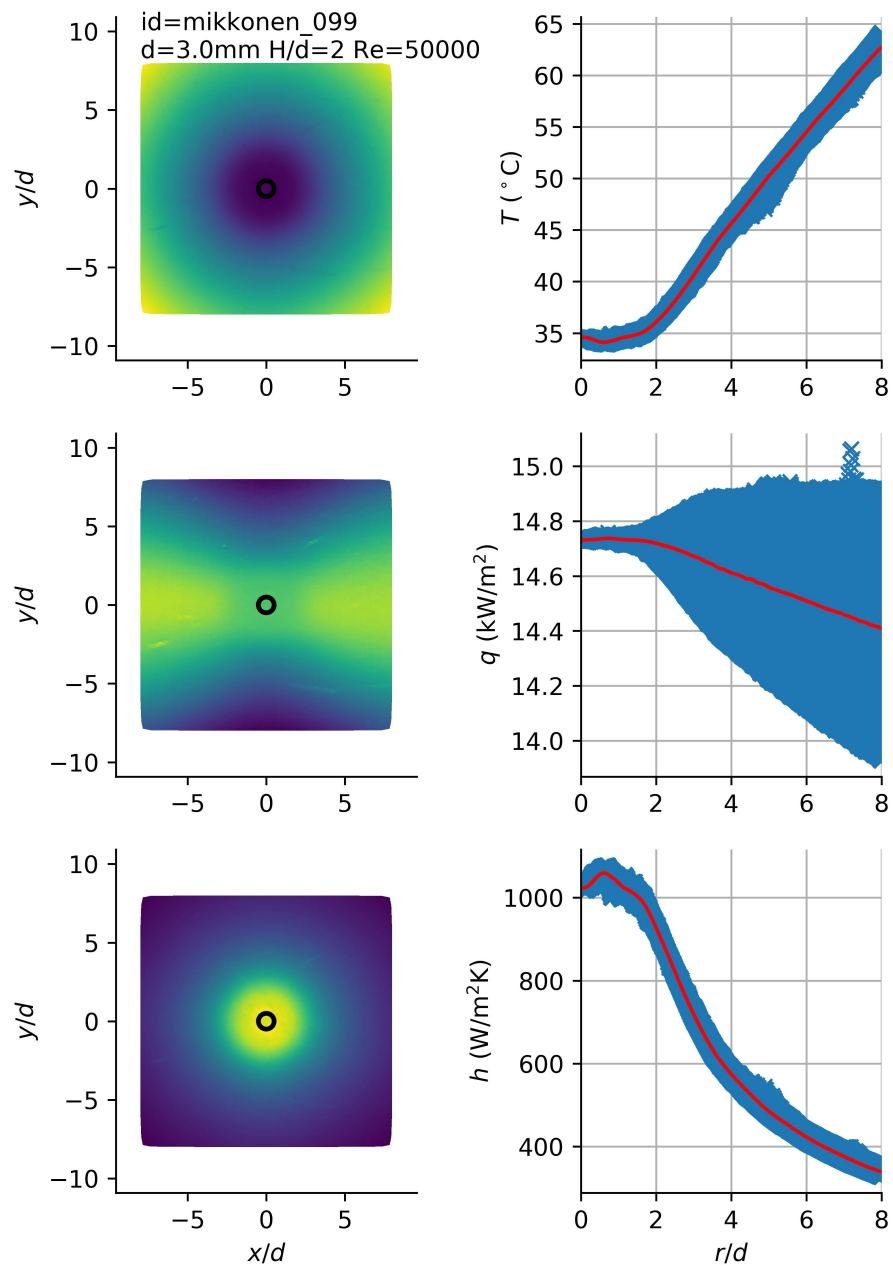


Figure 301: Results, mikkonen_099

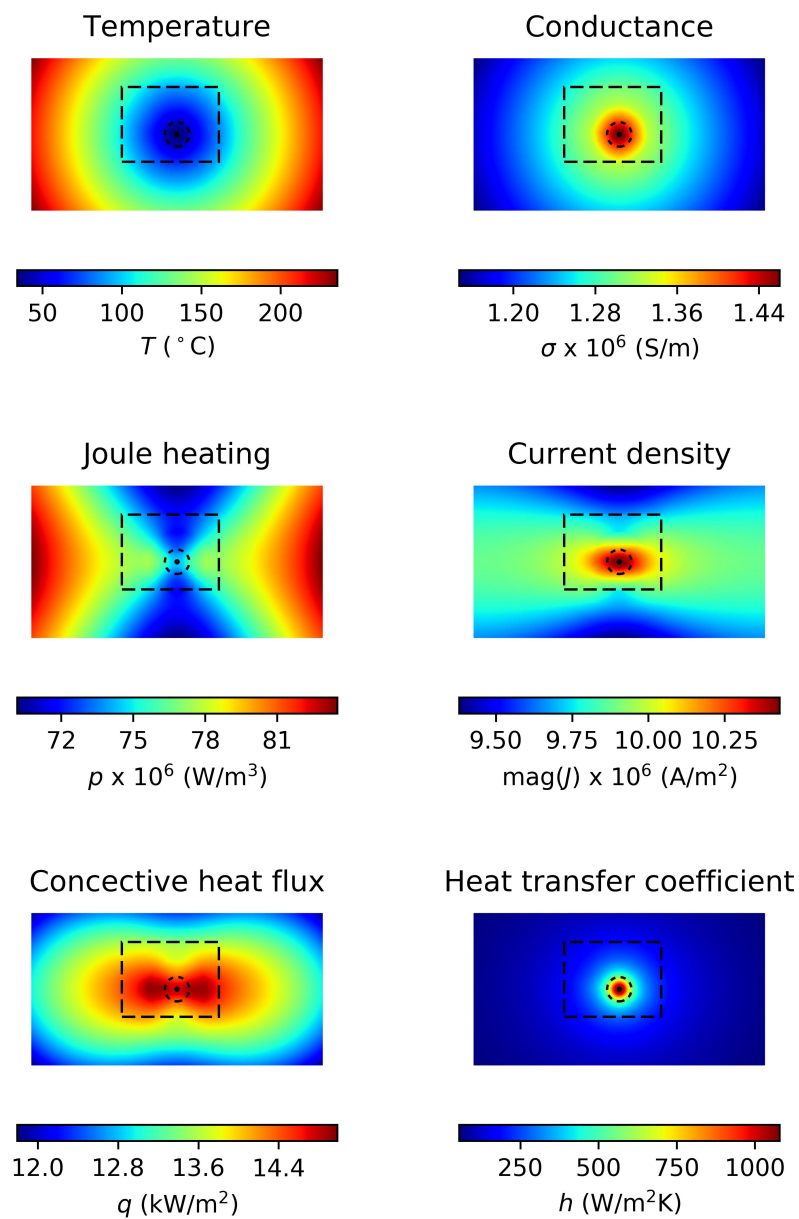


Figure 302: Convection calculation, mikkonen_099

Case id: mikkonen_100

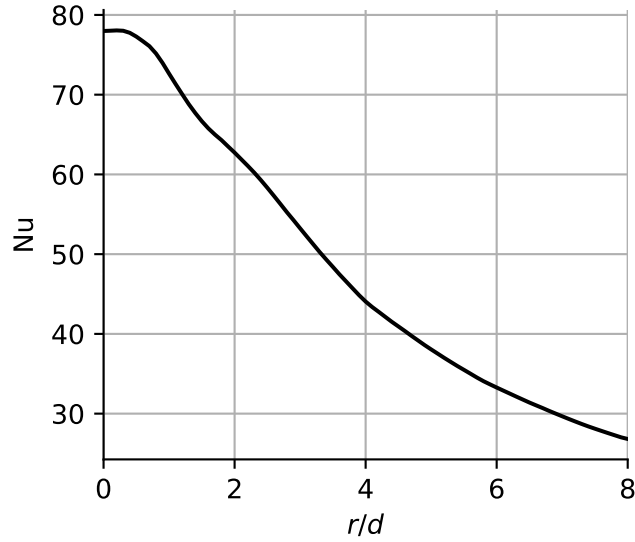


Figure 303: Nu, mikkonen_100

path	2017_03_09_mikko/3d_64Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 15:38:50

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
29794	0.44	4	0.71	3.0	12.0	20.8	20.2	1.281	152.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.8	224.8	3.39	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	33.62	33.74	34.60	35.86	36.82	38.05	39.72	41.62	43.66
Nu	77.99	77.28	72.63	66.67	62.73	58.32	53.24	48.40	44.06
h (W/m²K)	674.16	668.08	627.87	576.34	542.30	504.15	460.22	418.41	380.84
q (kW/m²)	9.05	9.05	9.04	9.02	9.01	9.00	8.98	8.96	8.94

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	43.66	45.40	47.24	49.12	50.96	52.73	54.53	56.34	57.99
Nu	44.06	40.93	38.05	35.49	33.27	31.39	29.67	28.11	26.82
h (W/m²K)	380.84	353.86	328.95	306.81	287.63	271.35	256.47	242.99	231.87
q (kW/m²)	8.94	8.92	8.89	8.87	8.85	8.83	8.80	8.78	8.76

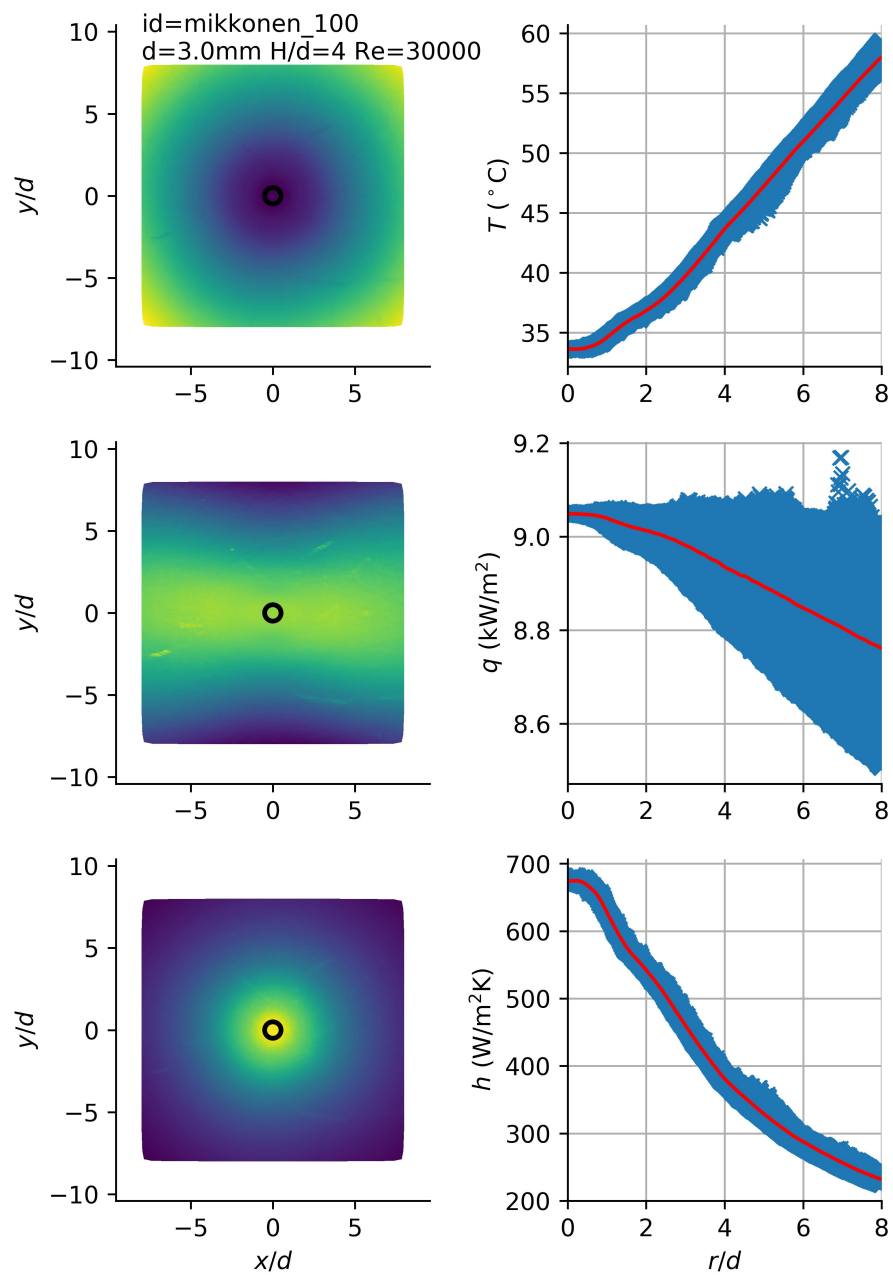


Figure 304: Results, mikkonen_100

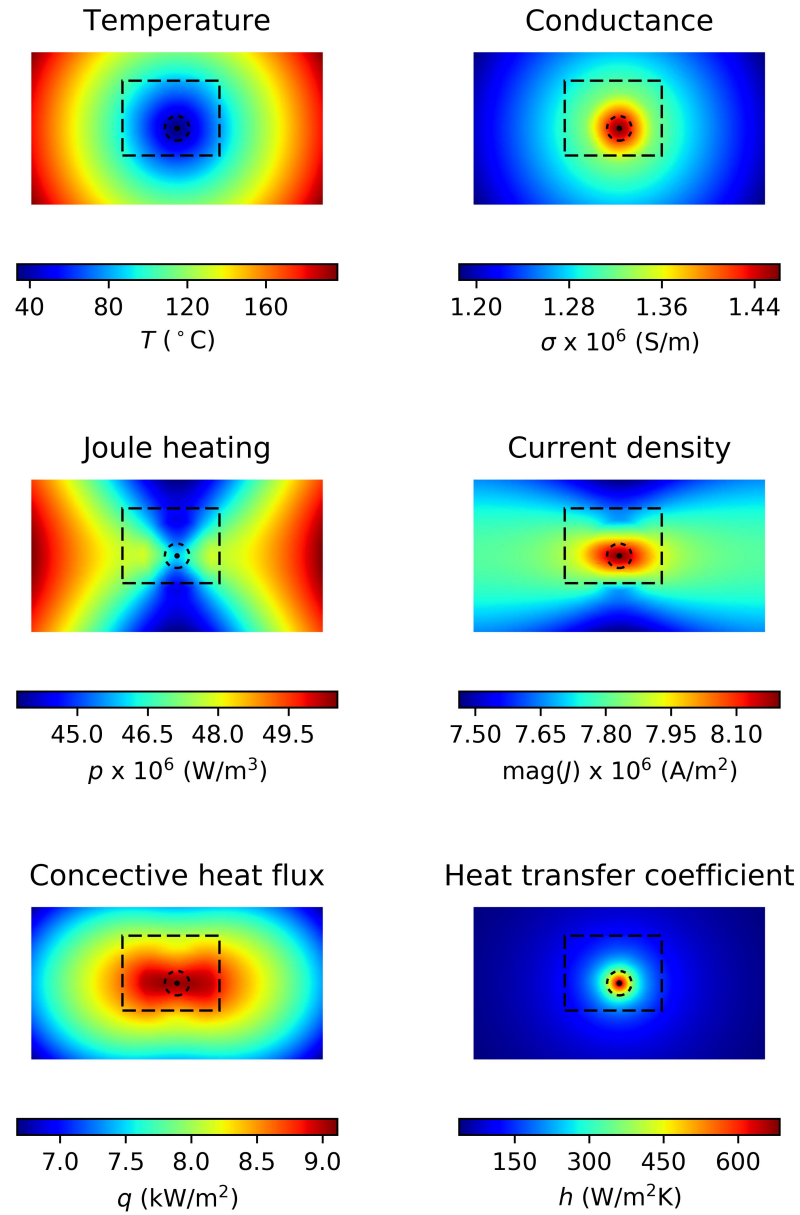


Figure 305: Convection calculation, mikkonen_100

Case id: mikkonen_102

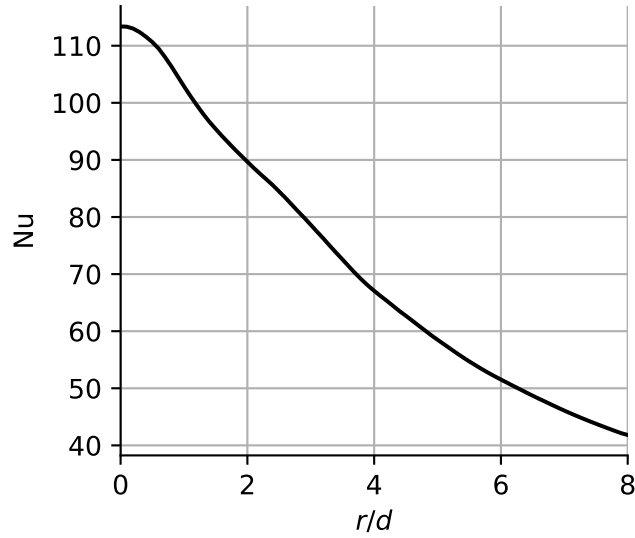


Figure 306: Nu, mikkonen_102

path	2017_03_09_mikko/3d_64Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 15:51:48

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
29964	0.45	6	0.71	3.0	18.0	21.0	20.2	1.289	153.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.2	275.5	4.74	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.50	34.85	35.94	37.16	38.23	39.32	40.73	42.41	44.19
Nu	113.38	110.64	102.89	95.42	89.69	84.47	78.63	72.57	67.07
h (W/m²K)	980.67	957.00	889.96	825.29	775.73	730.63	680.06	627.69	580.10
q (kW/m²)	14.02	14.02	14.01	14.00	13.98	13.97	13.96	13.94	13.92

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.19	45.83	47.63	49.49	51.24	52.99	54.80	56.56	58.21
Nu	67.07	62.70	58.50	54.71	51.53	48.70	46.09	43.79	41.82
h (W/m²K)	580.10	542.34	505.95	473.18	445.71	421.24	398.66	378.72	361.74
q (kW/m²)	13.92	13.90	13.88	13.86	13.83	13.81	13.79	13.77	13.75

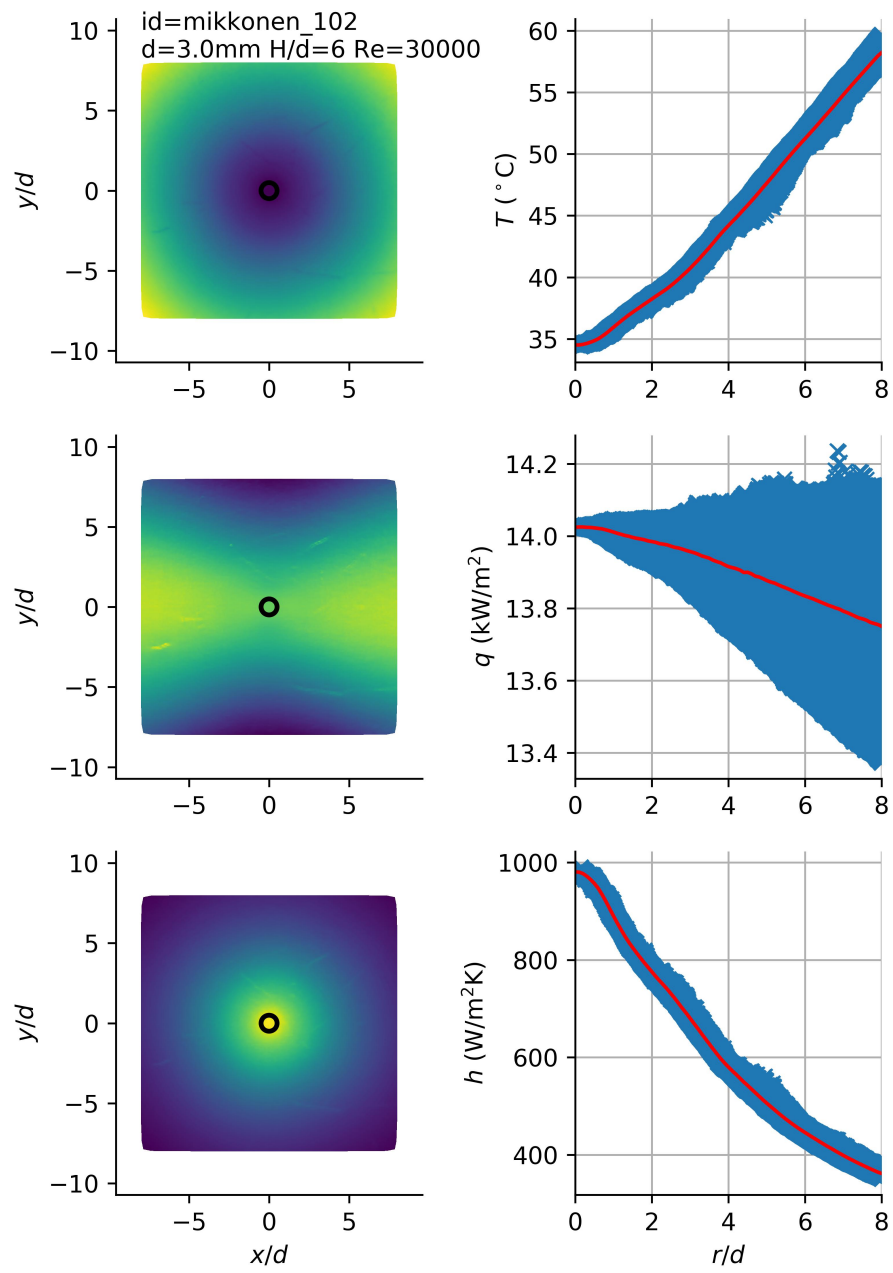


Figure 307: Results, mikkonen_102

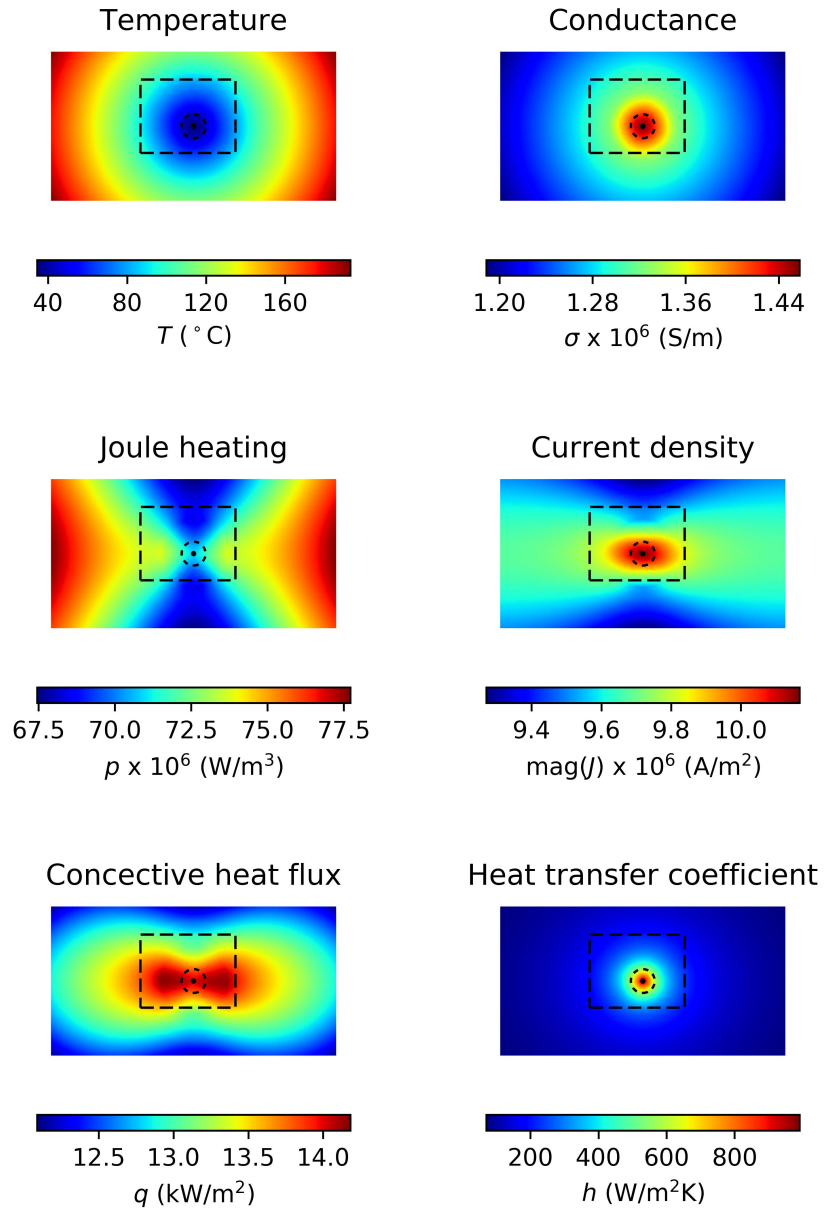


Figure 308: Convection calculation, mikkonen_102

Case id: mikkonen_103

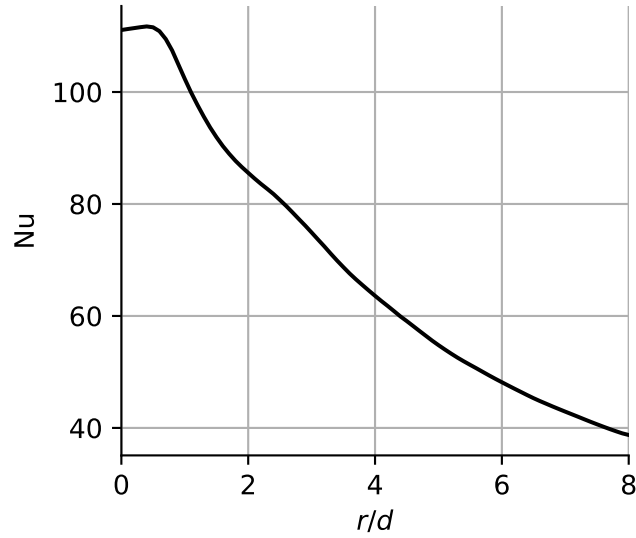


Figure 309: Nu, mikkonen_103

path	2017_03_09_mikko/3d_107Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 15:48:38

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50271	0.75	6	0.71	3.0	18.0	20.9	20.2	2.162	258.0

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.2	275.5	3.82	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.64	34.58	35.86	37.61	38.88	39.98	41.50	43.37	45.20
Nu	111.07	111.56	102.33	91.92	85.56	80.71	74.90	68.73	63.60
h (W/m ² K)	960.44	964.62	884.88	794.87	739.85	697.91	647.69	594.28	549.93
q (kW/m ²)	13.87	13.87	13.86	13.83	13.82	13.81	13.79	13.77	13.75
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.20	47.08	49.13	51.07	53.00	55.00	56.89	58.85	60.69
Nu	63.60	59.08	54.79	51.26	48.16	45.31	42.91	40.65	38.74
h (W/m ² K)	549.93	510.90	473.76	443.24	416.45	391.79	371.00	351.50	334.99
q (kW/m ²)	13.75	13.73	13.70	13.68	13.65	13.63	13.61	13.58	13.56

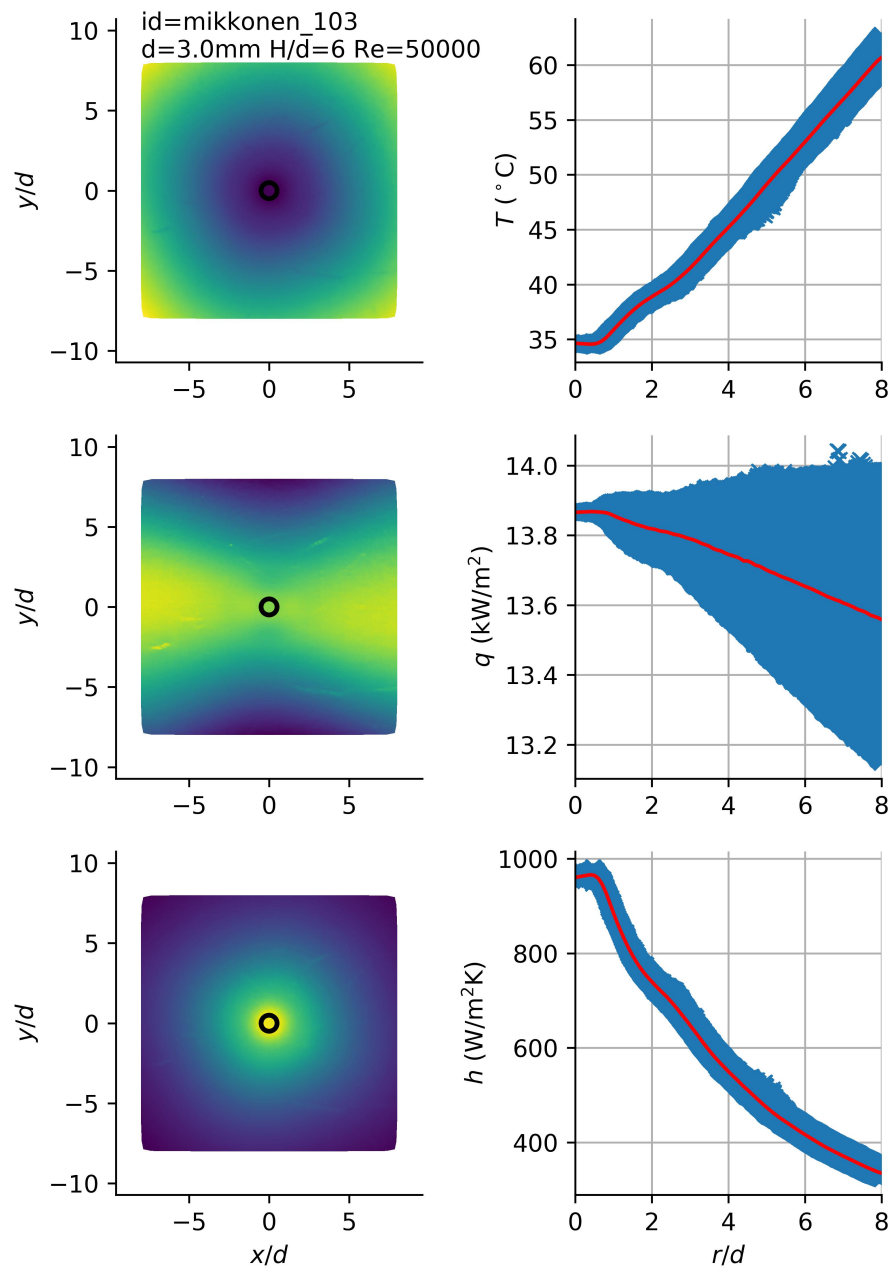


Figure 310: Results, mikkonen_103

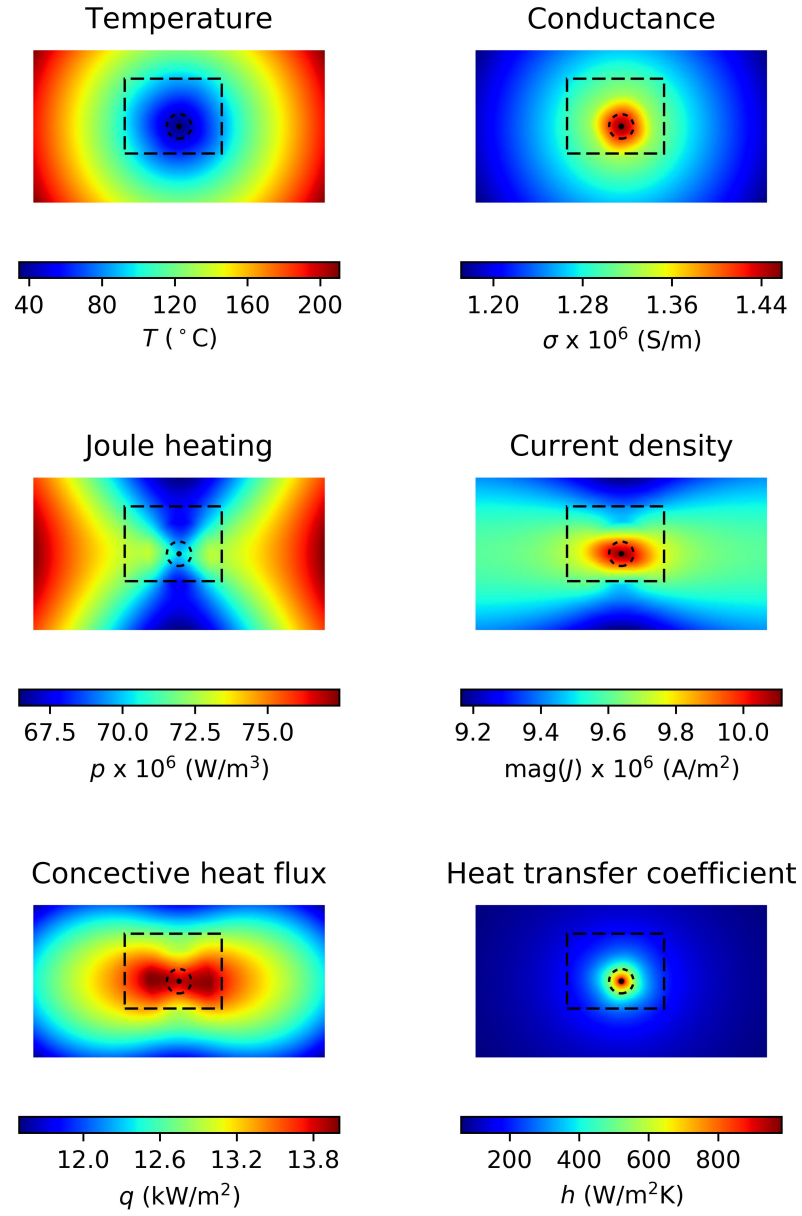


Figure 311: Convection calculation, mikkonen_103

Case id: mikkonen_104

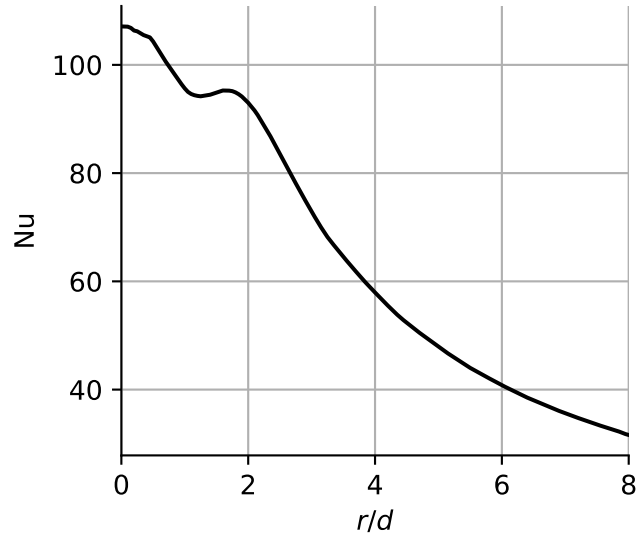


Figure 312: Nu, mikkonen_104

path	2017_03_09_mikko/6d_129Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:16:44

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
29911	0.22	1	0.71	6.0	6.0	20.5	20.2	2.569	76.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.5	200.5	3.63	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.40	35.80	37.17	37.30	37.64	39.56	42.28	45.02	47.72
Nu	107.10	104.33	95.65	94.91	93.00	83.54	72.91	64.54	57.95
h (W/m ² K)	462.53	450.56	413.05	409.87	401.61	360.74	314.86	278.73	250.24
q (kW/m ²)	7.03	7.03	7.01	7.01	7.00	6.98	6.95	6.92	6.89
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.72	50.51	53.16	55.89	58.50	61.14	63.67	66.15	68.69
Nu	57.95	52.34	47.90	44.01	40.82	38.02	35.62	33.54	31.62
h (W/m ² K)	250.24	226.05	206.87	190.07	176.30	164.17	153.83	144.84	136.53
q (kW/m ²)	6.89	6.85	6.82	6.78	6.75	6.72	6.69	6.65	6.62

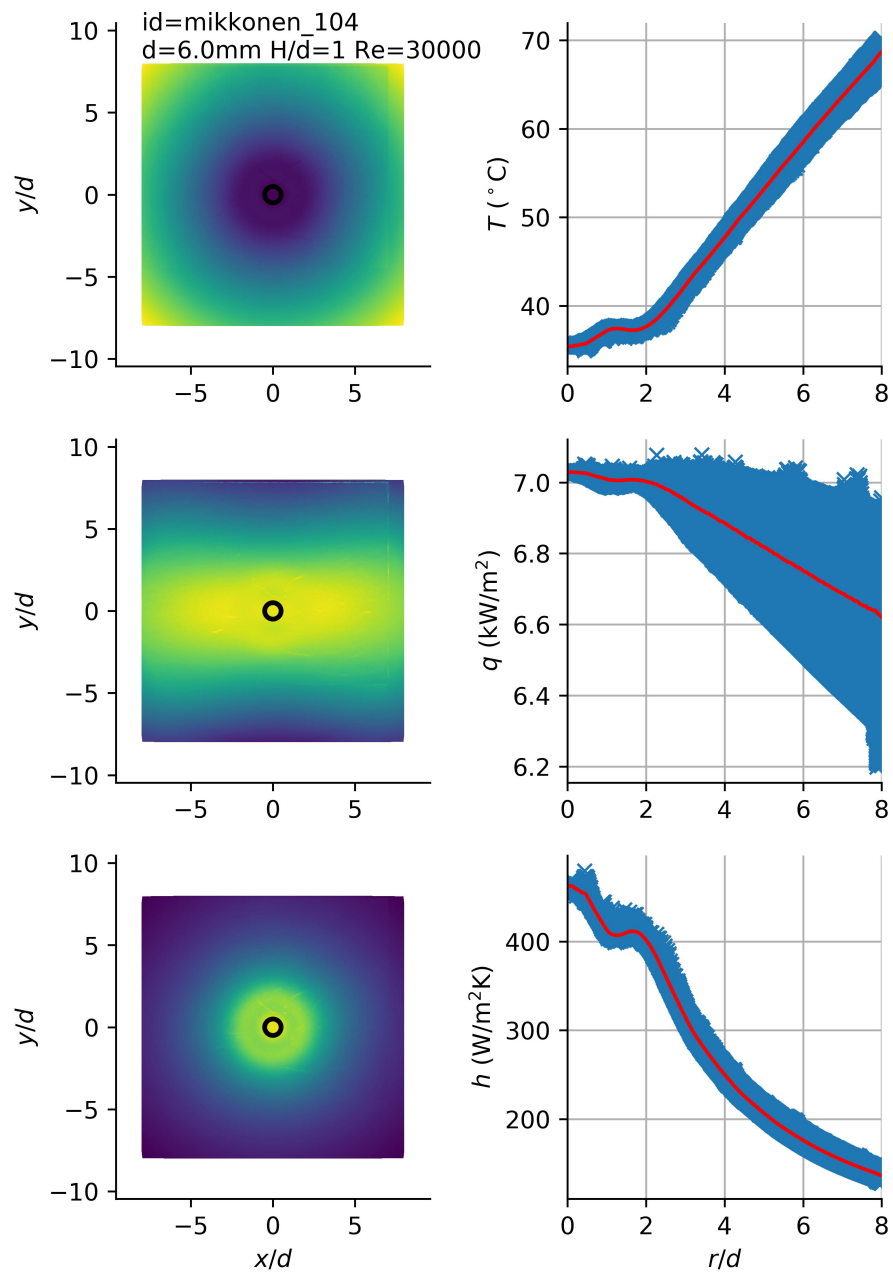


Figure 313: Results, mikkonen_104

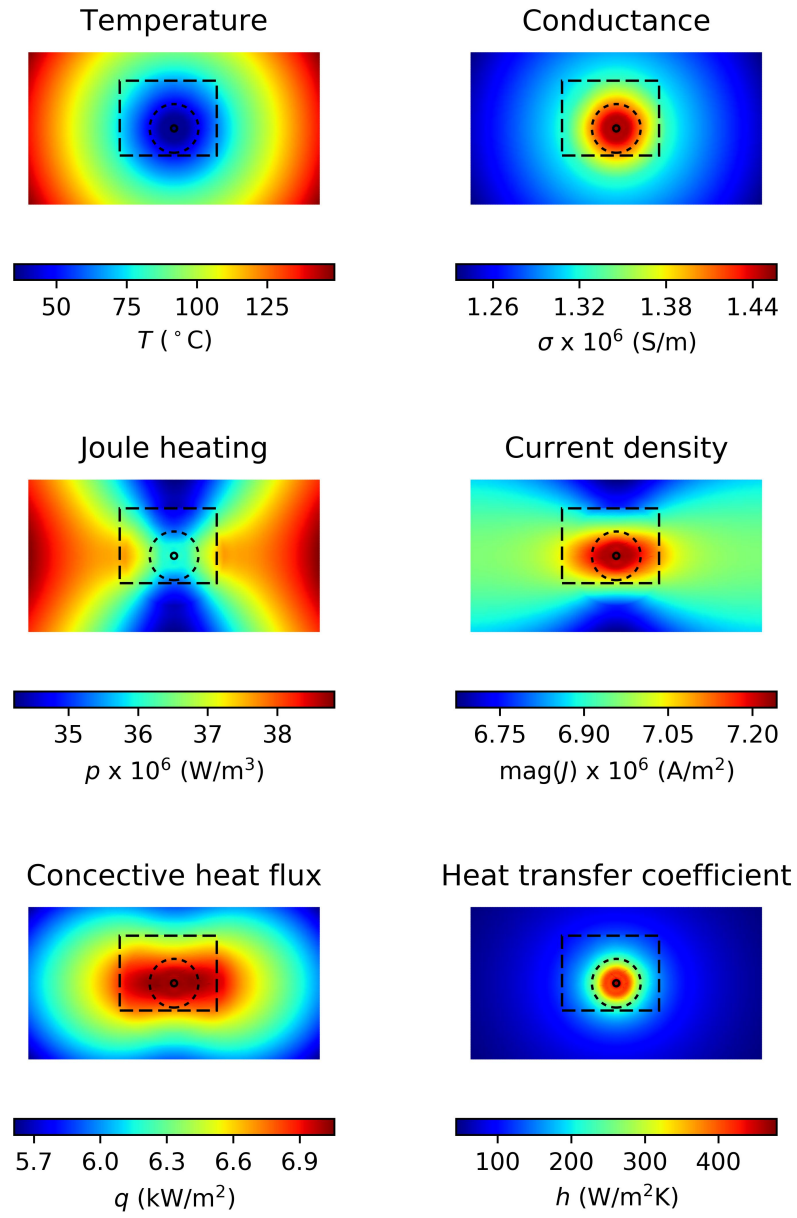


Figure 314: Convection calculation, mikkonen_104

Case id: mikkonen_105

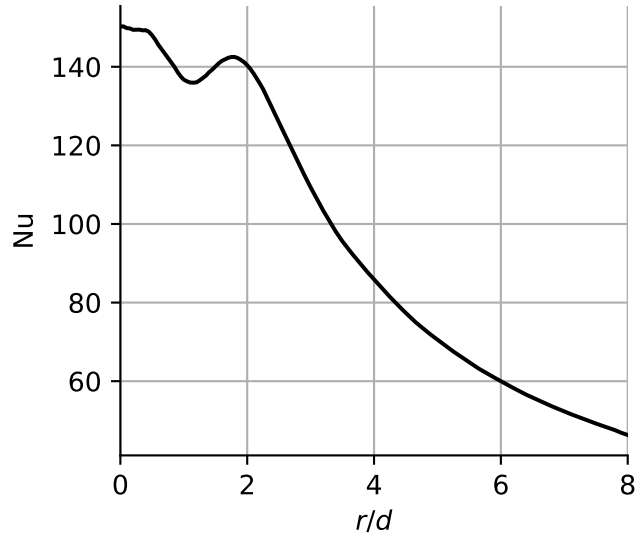


Figure 315: Nu, mikkonen_105

path	2017_03_09_mikko/6d_215Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:20:46

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50258	0.37	1	0.71	6.0	6.0	20.3	20.2	4.315	128.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.8	237.7	3.34	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.43	35.66	36.91	36.52	36.48	38.31	41.00	43.90	46.51
Nu	150.27	148.03	136.71	140.08	140.40	125.91	109.33	95.62	85.86
h (W/m ² K)	648.54	638.88	590.04	604.58	605.97	543.42	471.85	412.70	370.55
q (kW/m ²)	9.88	9.87	9.86	9.86	9.86	9.84	9.81	9.78	9.75
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.51	49.30	52.00	54.74	57.34	60.00	62.53	65.03	67.64
Nu	85.86	77.36	70.54	64.71	59.98	55.81	52.29	49.21	46.31
h (W/m ² K)	370.55	333.90	304.43	279.27	258.89	240.85	225.69	212.39	199.88
q (kW/m ²)	9.75	9.72	9.68	9.64	9.61	9.58	9.55	9.52	9.48

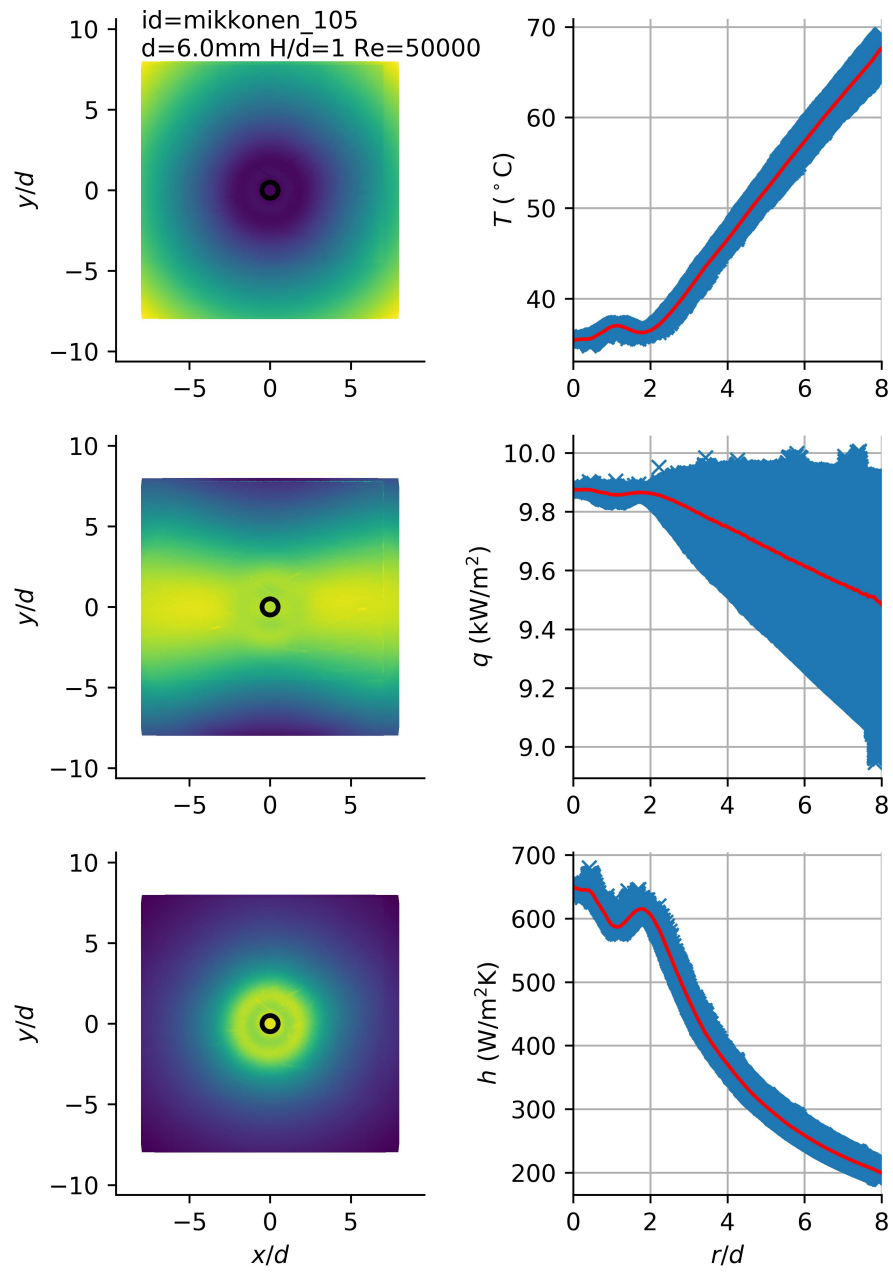


Figure 316: Results, mikkonen_105

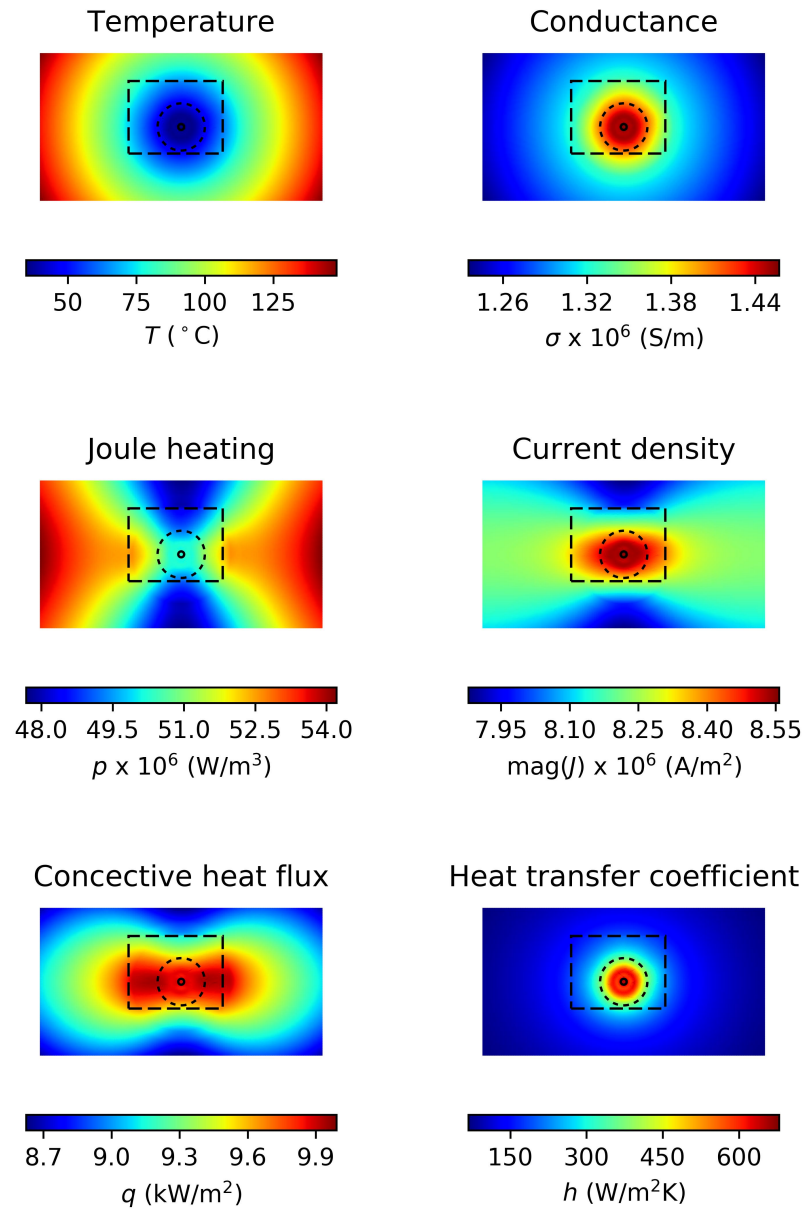


Figure 317: Convection calculation, mikkonen_105

Case id: mikkonen_106

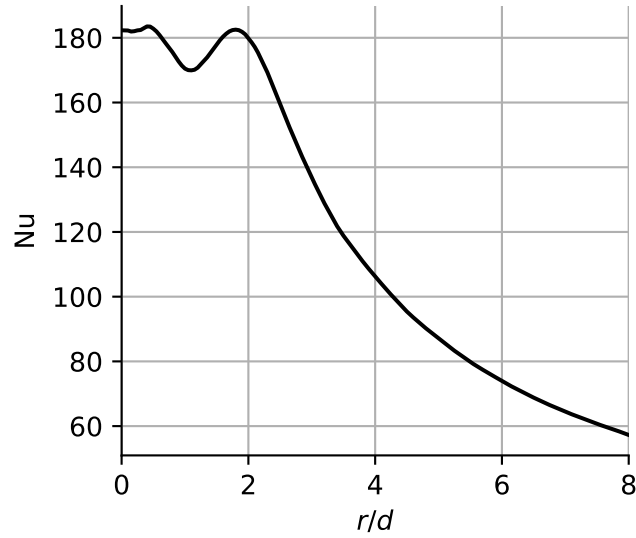


Figure 318: Nu, mikkonen_106

path	2017_03_09_mikko/6d_301Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:28:49

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
70566	0.53	1	0.71	6.0	6.0	20.3	20.2	6.059	180.4

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.0	265.5	3.13	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.86	35.82	36.94	36.25	36.07	38.06	40.98	44.05	46.80
Nu	182.32	182.82	170.47	177.94	179.90	159.55	136.79	118.83	106.29
h (W/m ² K)	786.88	789.03	735.74	767.97	776.46	688.62	590.36	512.86	458.74
q (kW/m ²)	12.32	12.32	12.31	12.32	12.32	12.30	12.27	12.23	12.20

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.80	49.75	52.49	55.33	58.01	60.73	63.35	65.90	68.49
Nu	106.29	95.41	87.06	79.78	73.95	68.81	64.45	60.70	57.26
h (W/m ² K)	458.74	411.80	375.75	344.34	319.15	296.97	278.16	261.98	247.14
q (kW/m ²)	12.20	12.17	12.13	12.09	12.06	12.03	12.00	11.97	11.93

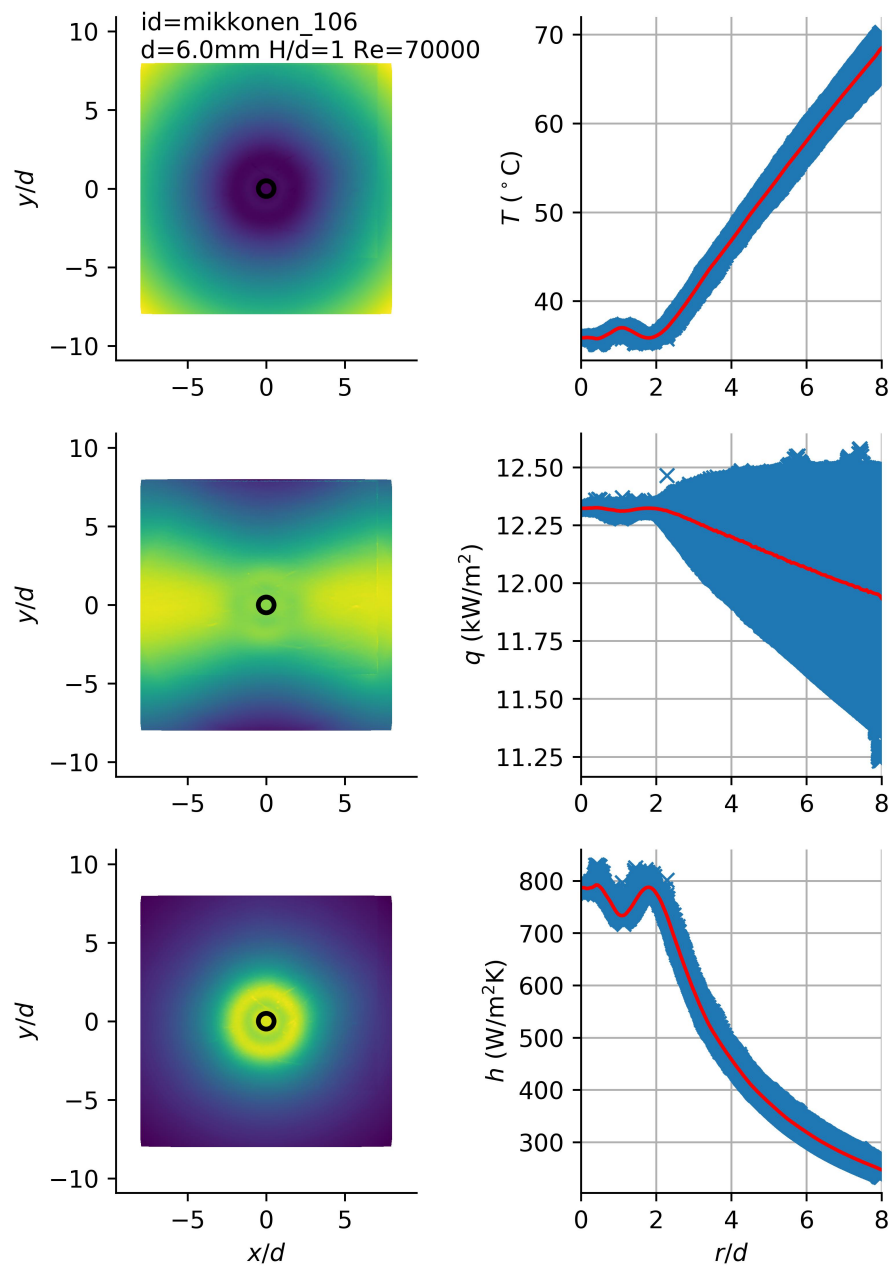


Figure 319: Results, mikkonen_106

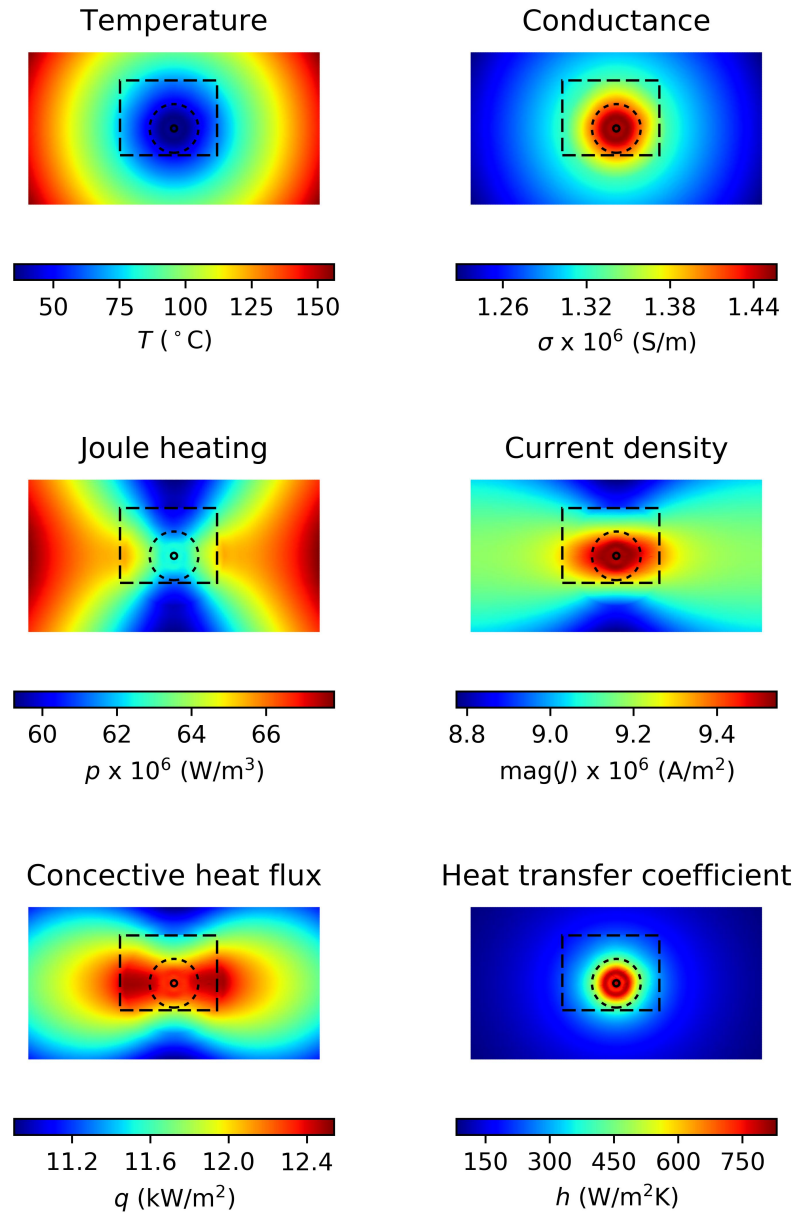


Figure 320: Convection calculation, mikkonen_106

Case id: mikkonen_107

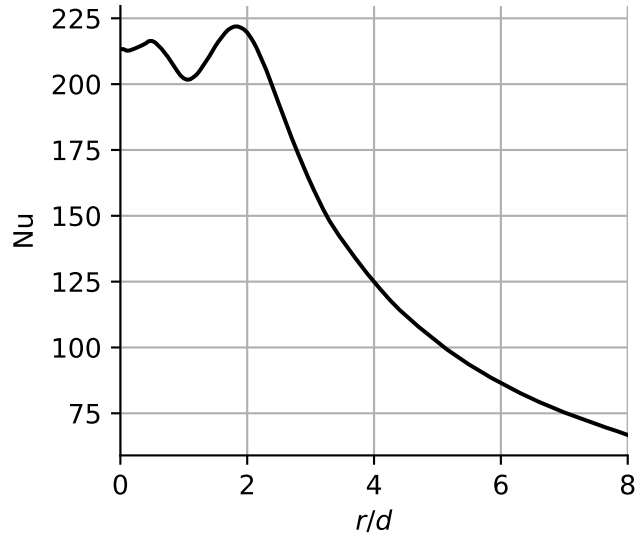


Figure 321: Nu, mikkonen_107

path	2017_03_09_mikko/6d_387Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:31:41

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
89849	0.67	1	0.71	6.0	6.0	20.3	20.2	7.714	229.7

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.2	291.4	3.42	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	36.50	36.28	37.39	36.42	36.04	38.25	41.54	44.77	47.80
Nu	213.29	216.39	202.18	214.53	219.60	192.45	162.45	140.70	124.99
h (W/m ² K)	920.55	933.95	872.59	925.92	947.78	830.60	701.15	607.27	539.44
q (kW/m ²)	15.01	15.01	15.00	15.01	15.02	14.99	14.96	14.92	14.88
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.80	50.88	53.86	56.82	59.72	62.58	65.36	68.08	70.86
Nu	124.99	112.14	101.97	93.49	86.45	80.45	75.32	70.88	66.77
h (W/m ² K)	539.44	484.00	440.08	403.51	373.10	347.24	325.08	305.90	288.18
q (kW/m ²)	14.88	14.85	14.81	14.77	14.74	14.71	14.68	14.65	14.60

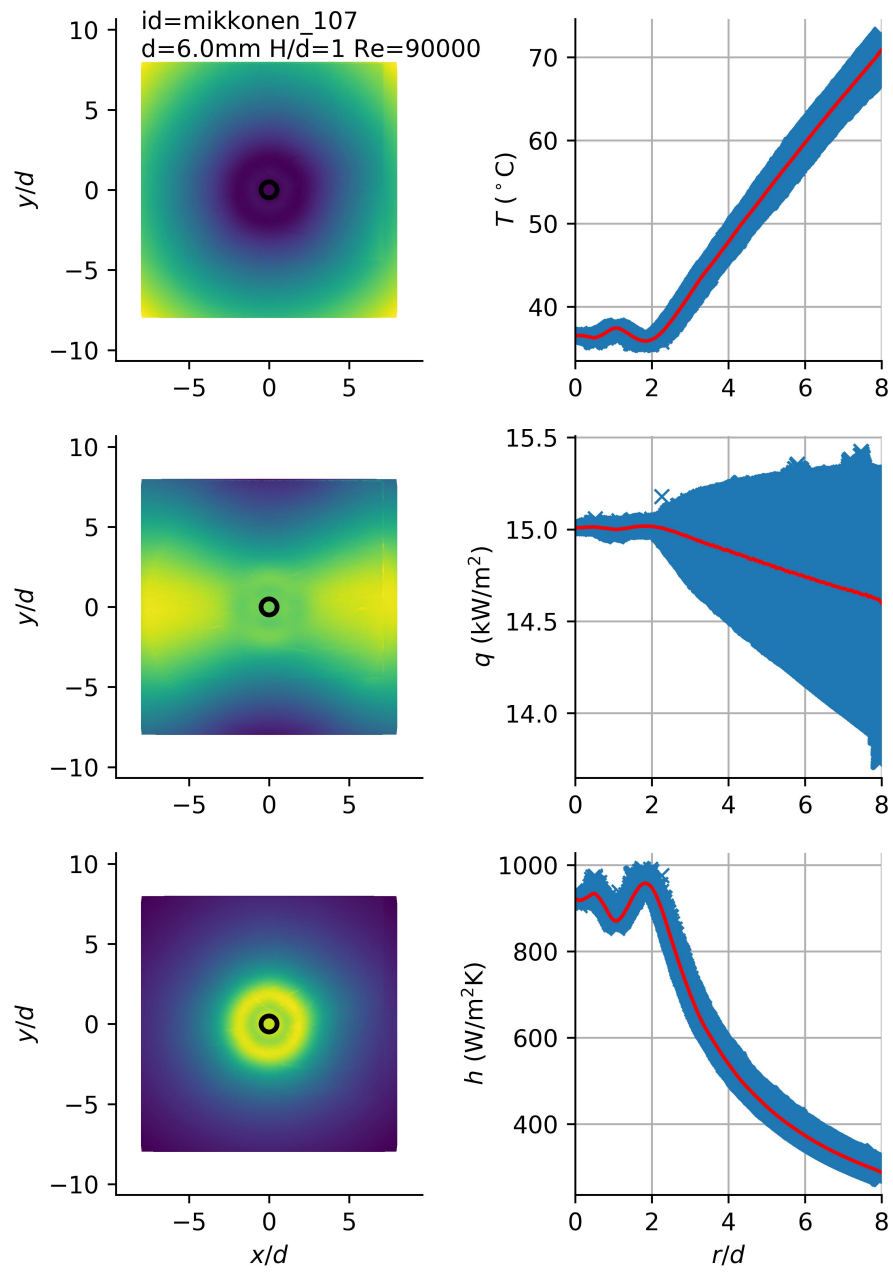


Figure 322: Results, mikkonen_107

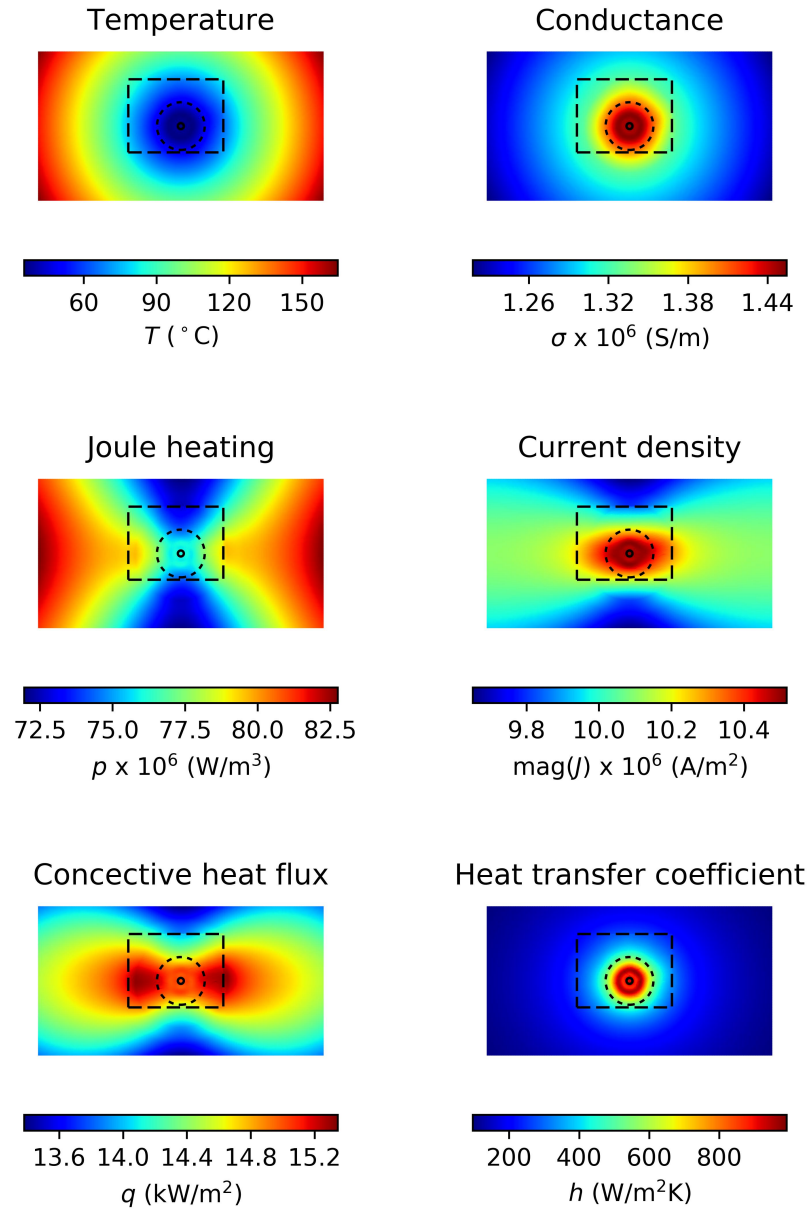


Figure 323: Convection calculation, mikkonen_107

Case id: mikkonen_108

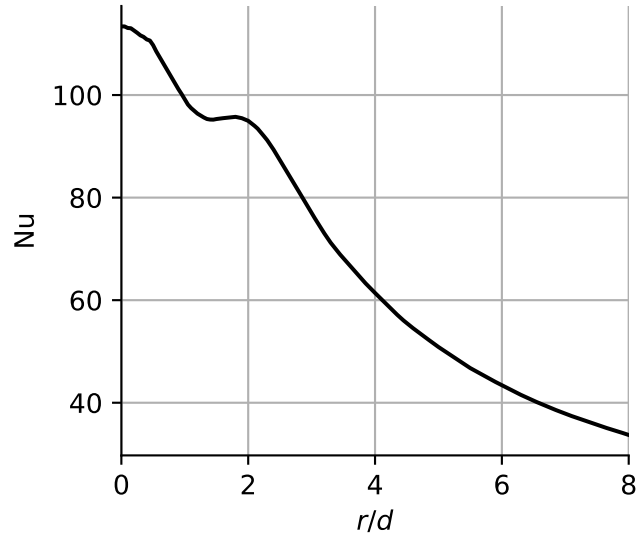


Figure 324: Nu, mikkonen_108

path	2017_03_09_mikko/6d_129Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:47:12

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
30149	0.22	2	0.71	6.0	12.0	20.0	20.2	2.586	76.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.6	201.8	4.85	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.11	35.60	37.20	37.85	37.92	39.42	41.93	44.61	47.20
Nu	113.38	109.74	99.12	95.32	94.97	87.33	76.97	68.18	61.41
h (W/m ² K)	488.92	473.21	427.41	411.05	409.53	376.58	331.92	294.02	264.81
q (kW/m ²)	7.29	7.28	7.27	7.26	7.26	7.24	7.21	7.18	7.15
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.20	49.93	52.50	55.16	57.71	60.31	62.81	65.20	67.62
Nu	61.41	55.51	50.87	46.77	43.40	40.41	37.86	35.69	33.72
h (W/m ² K)	264.81	239.39	219.37	201.68	187.14	174.26	163.27	153.91	145.39
q (kW/m ²)	7.15	7.12	7.08	7.05	7.02	6.99	6.96	6.92	6.89

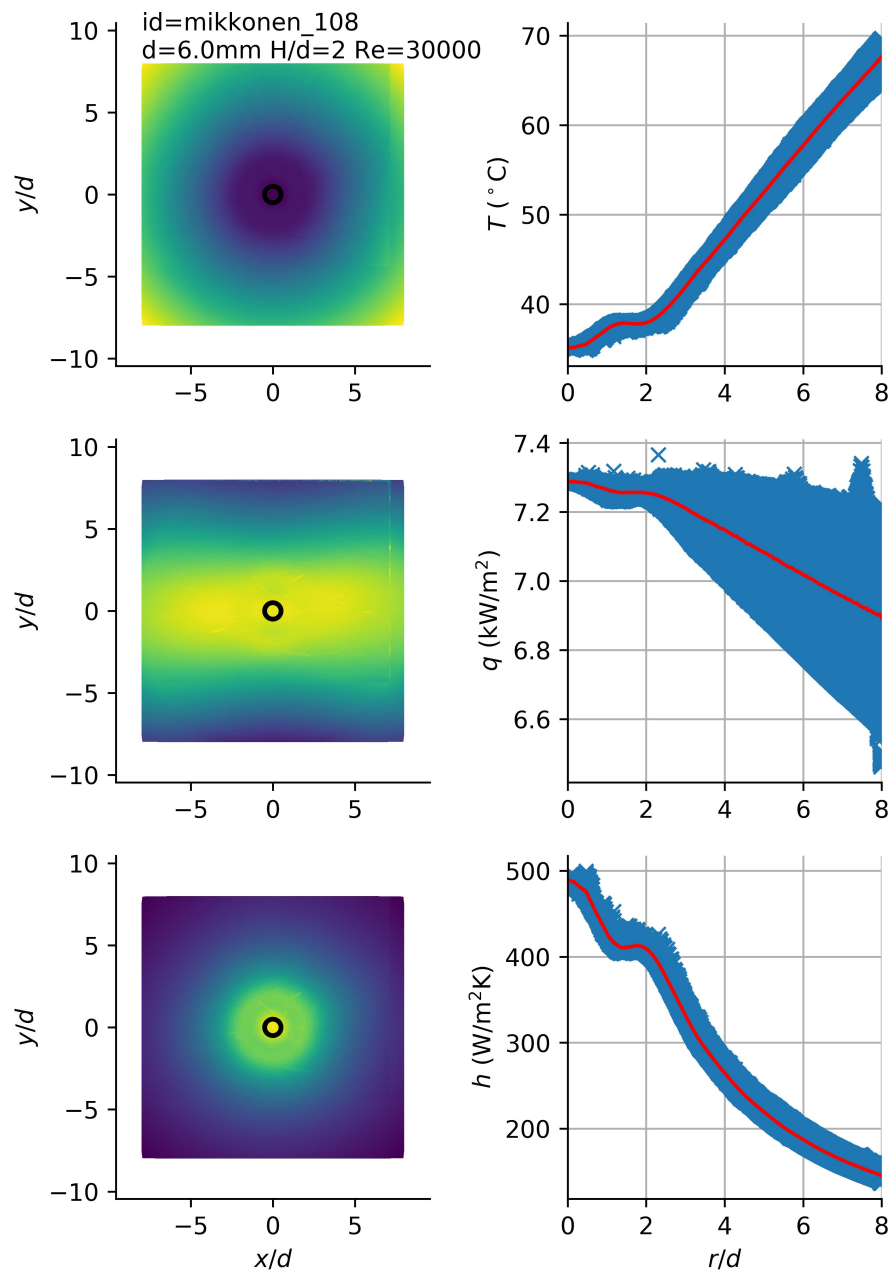


Figure 325: Results, mikkonen_108

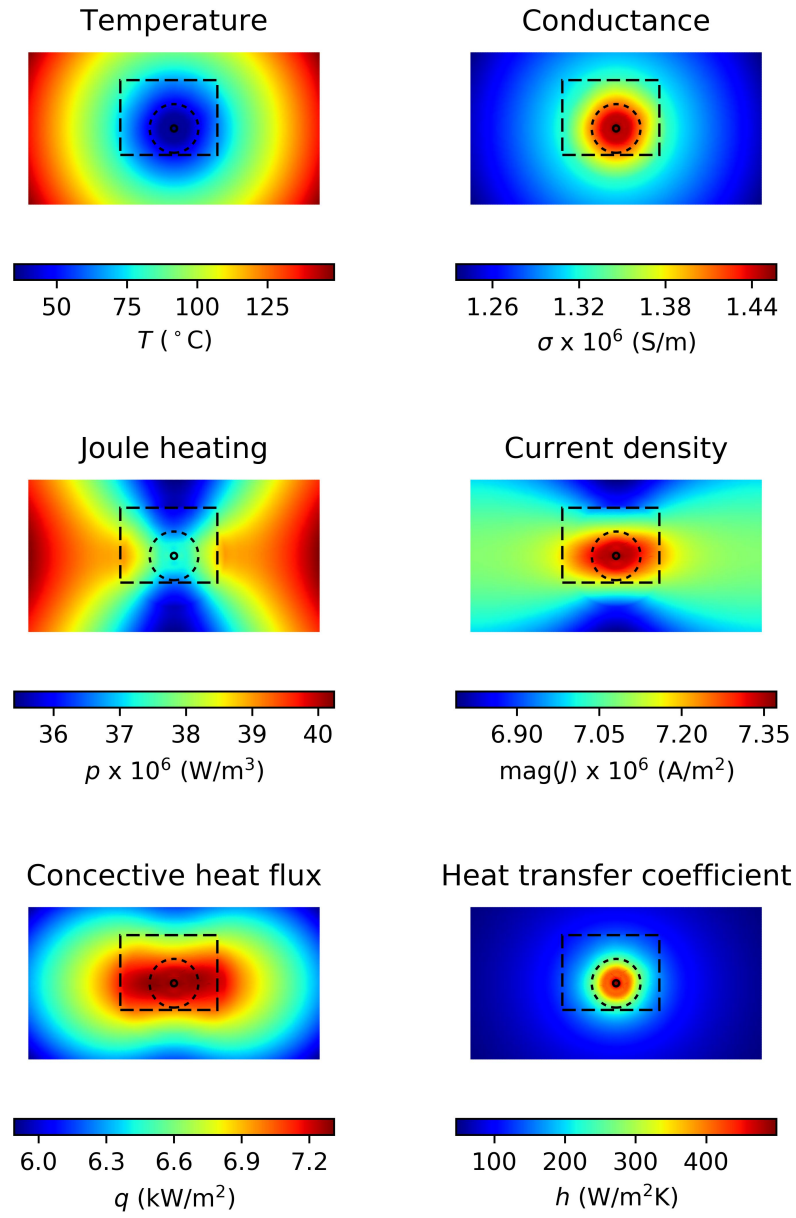


Figure 326: Convection calculation, mikkonen_108

Case id: mikkonen_109

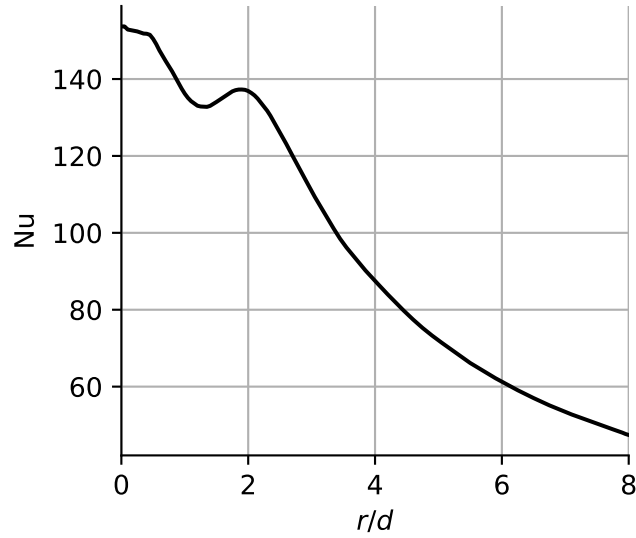


Figure 327: Nu, mikkonen_109

path	2017_03_09_mikko/6d_215Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:42:26

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50508	0.38	2	0.71	6.0	12.0	20.0	20.2	4.333	128.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.8	237.0	3.80	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.14	35.46	37.03	37.29	36.94	38.35	40.79	43.58	46.11
Nu	153.68	150.45	136.19	134.05	136.88	126.10	110.83	97.27	87.52
h (W/m ² K)	662.71	648.78	587.28	578.04	590.26	543.79	477.93	419.44	377.41
q (kW/m ²)	9.90	9.90	9.88	9.88	9.88	9.87	9.84	9.81	9.78
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.11	48.82	51.48	54.14	56.74	59.33	61.84	64.25	66.76
Nu	87.52	79.00	72.02	66.15	61.25	57.02	53.41	50.32	47.43
h (W/m ² K)	377.41	340.67	310.57	285.26	264.14	245.90	230.30	217.00	204.52
q (kW/m ²)	9.78	9.75	9.71	9.68	9.65	9.62	9.59	9.56	9.52

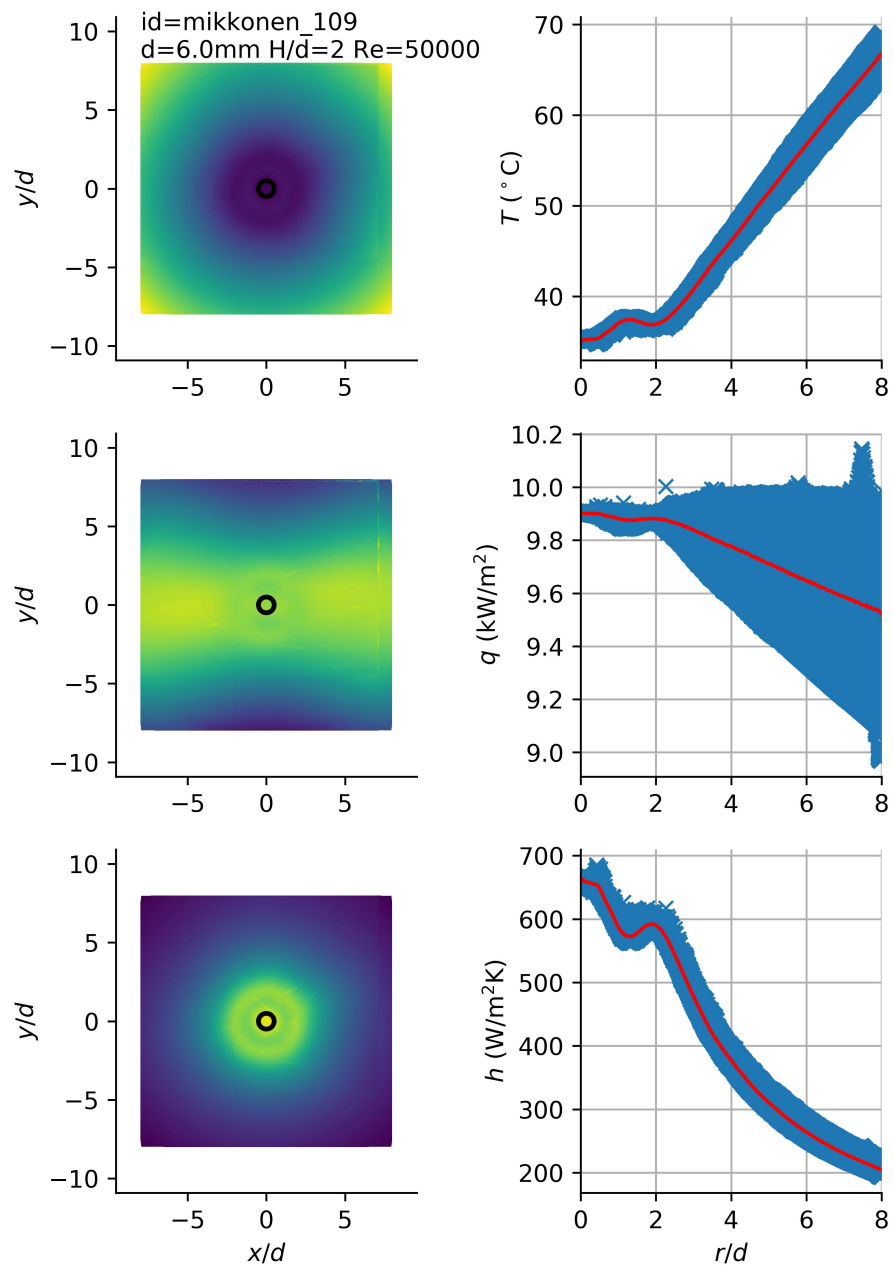


Figure 328: Results, mikkonen_109

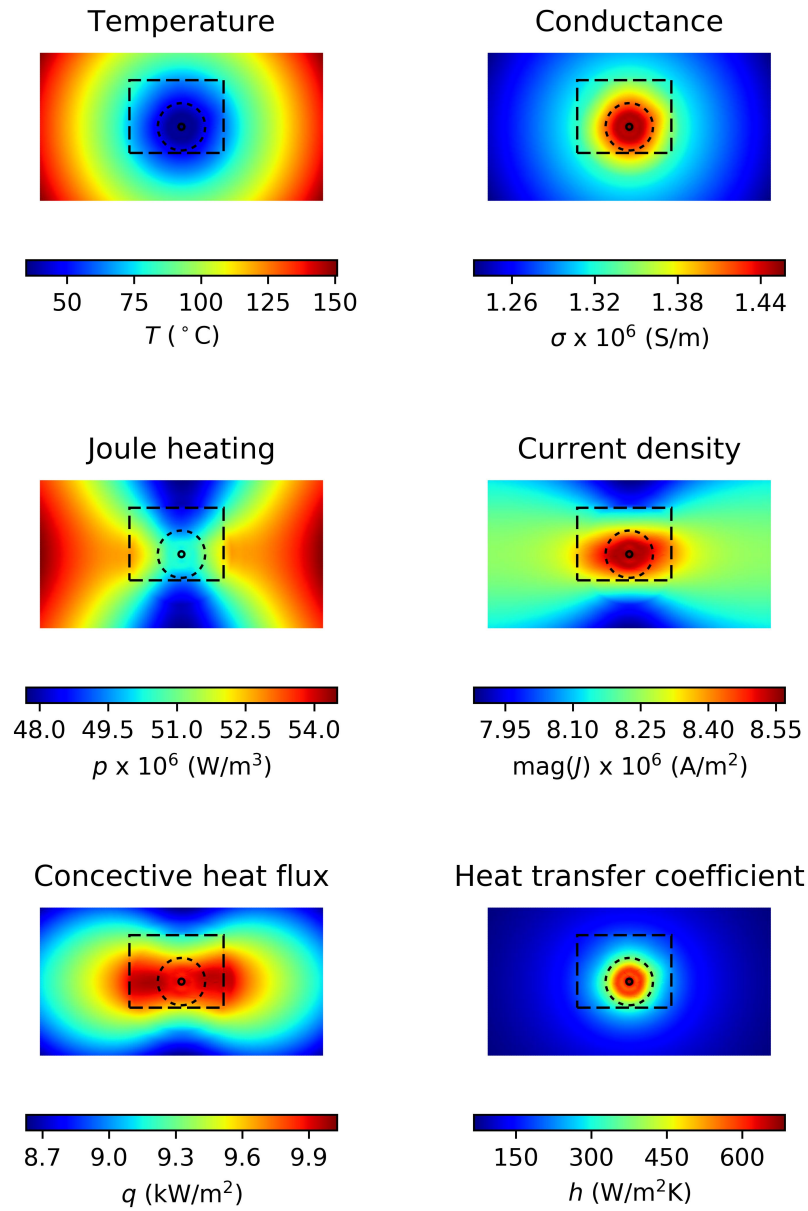


Figure 329: Convection calculation, mikkonen_109

Case id: mikkonen_110

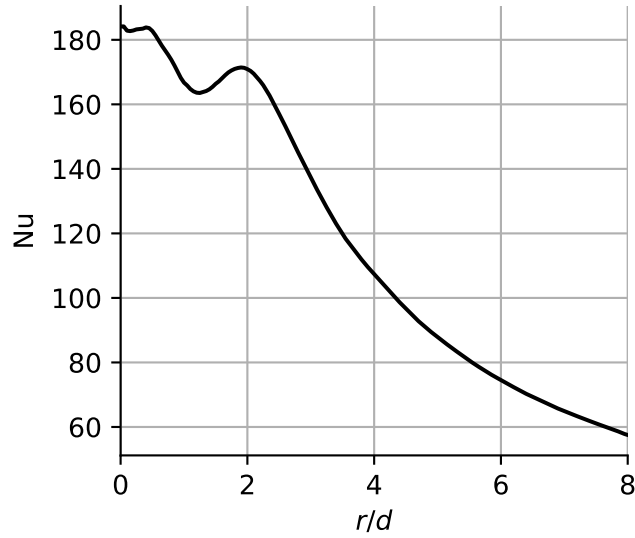


Figure 330: Nu, mikkonen_110

path	2017_03_09_mikko/6d_301Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:39:15

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
70191	0.52	2	0.71	6.0	12.0	20.0	20.2	6.022	179.2

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.0	261.7	3.54	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.39	35.50	36.95	36.99	36.54	37.97	40.49	43.38	46.01
Nu	184.15	182.75	166.74	166.36	170.91	157.05	137.27	119.81	107.32
h (W/m ² K)	794.10	788.08	719.01	717.40	737.01	677.25	591.93	516.66	462.79
q (kW/m ²)	12.06	12.06	12.04	12.04	12.04	12.03	12.00	11.97	11.94
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.01	48.78	51.54	54.28	56.95	59.62	62.19	64.67	67.27
Nu	107.32	96.68	87.87	80.56	74.52	69.31	64.88	61.09	57.52
h (W/m ² K)	462.79	416.89	378.91	347.39	321.34	298.87	279.79	263.43	248.04
q (kW/m ²)	11.94	11.91	11.87	11.83	11.80	11.77	11.74	11.71	11.67

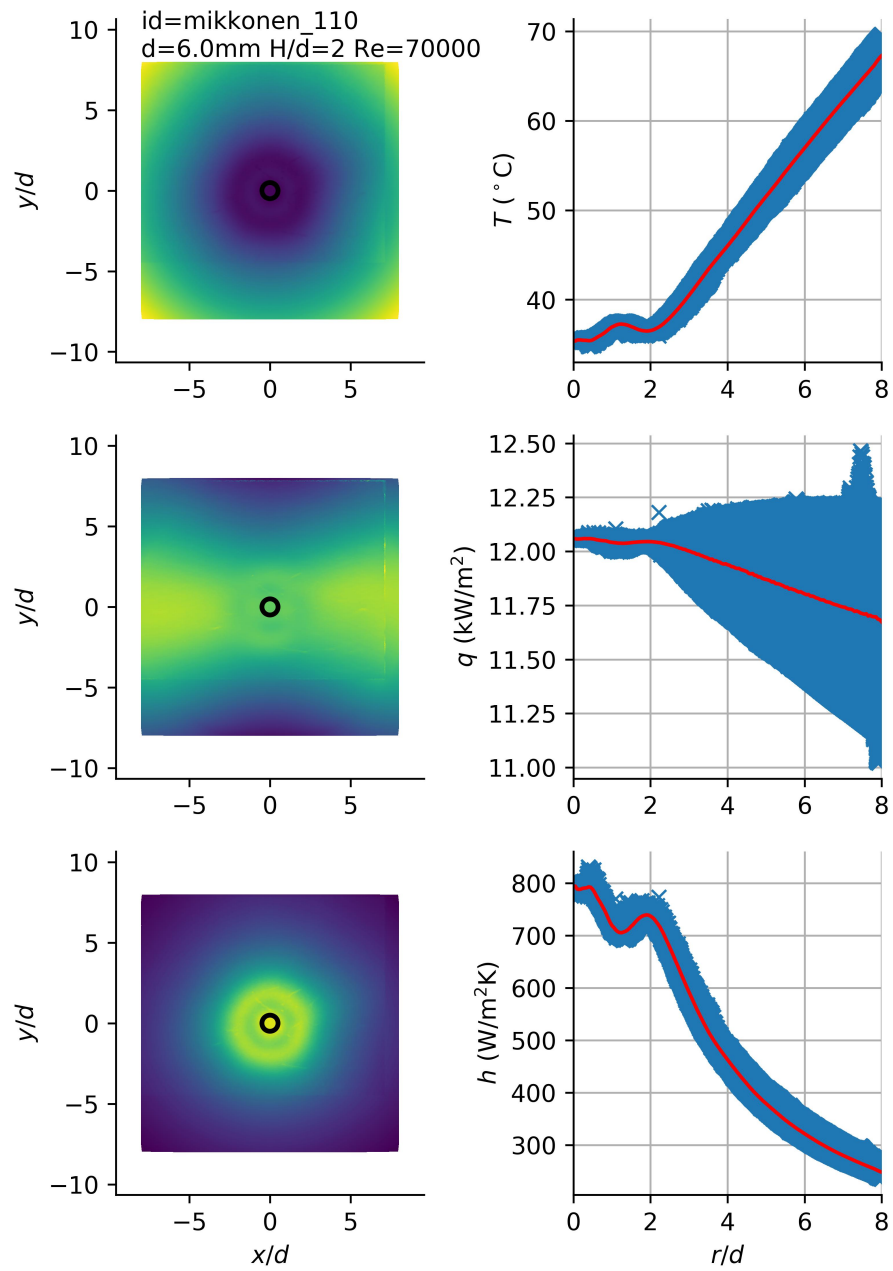


Figure 331: Results, mikkonen_110

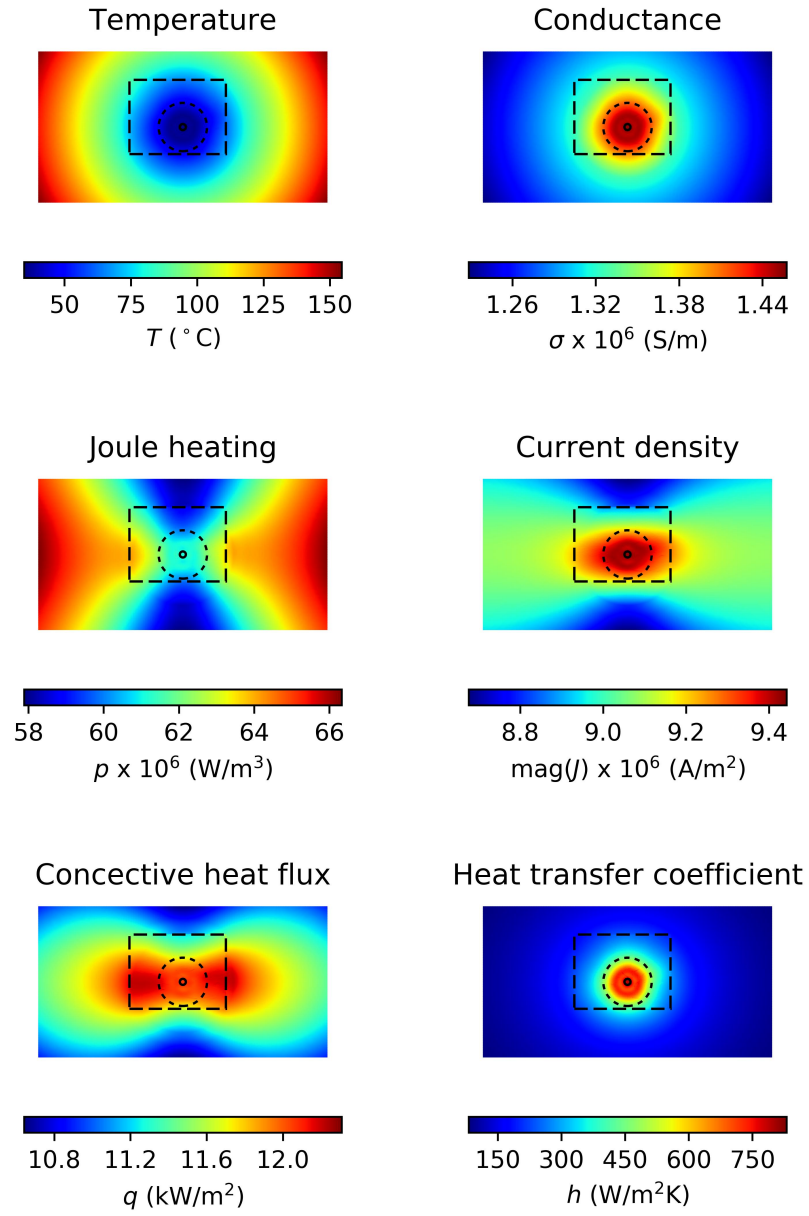


Figure 332: Convection calculation, mikkonen_110

Case id: mikkonen_111

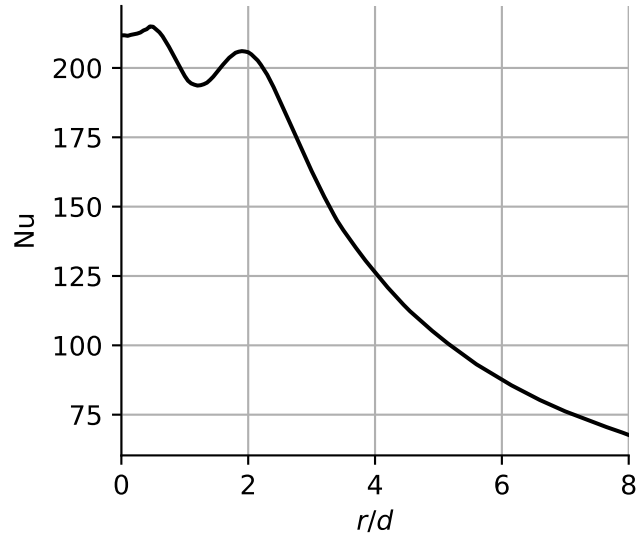


Figure 333: Nu, mikkonen_111

path	2017_03_09_mikko/6d_387Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:35:32

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
89849	0.67	2	0.71	6.0	12.0	20.3	20.2	7.714	229.7

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.2	288.2	3.30	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	36.19	35.97	37.38	37.27	36.66	38.18	40.93	44.00	46.80
Nu	211.77	214.85	197.08	198.34	205.66	188.14	162.86	141.52	126.36
h (W/m ² K)	913.98	927.27	850.57	856.02	887.64	812.02	702.88	610.81	545.34
q (kW/m ²)	14.62	14.62	14.61	14.61	14.61	14.60	14.57	14.53	14.50

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.80	49.76	52.58	55.47	58.24	61.04	63.73	66.30	68.95
Nu	126.36	113.47	103.35	94.64	87.55	81.39	76.18	71.77	67.68
h (W/m ² K)	545.34	489.72	446.05	408.45	377.86	351.30	328.79	309.75	292.12
q (kW/m ²)	14.50	14.47	14.43	14.40	14.37	14.34	14.30	14.27	14.24

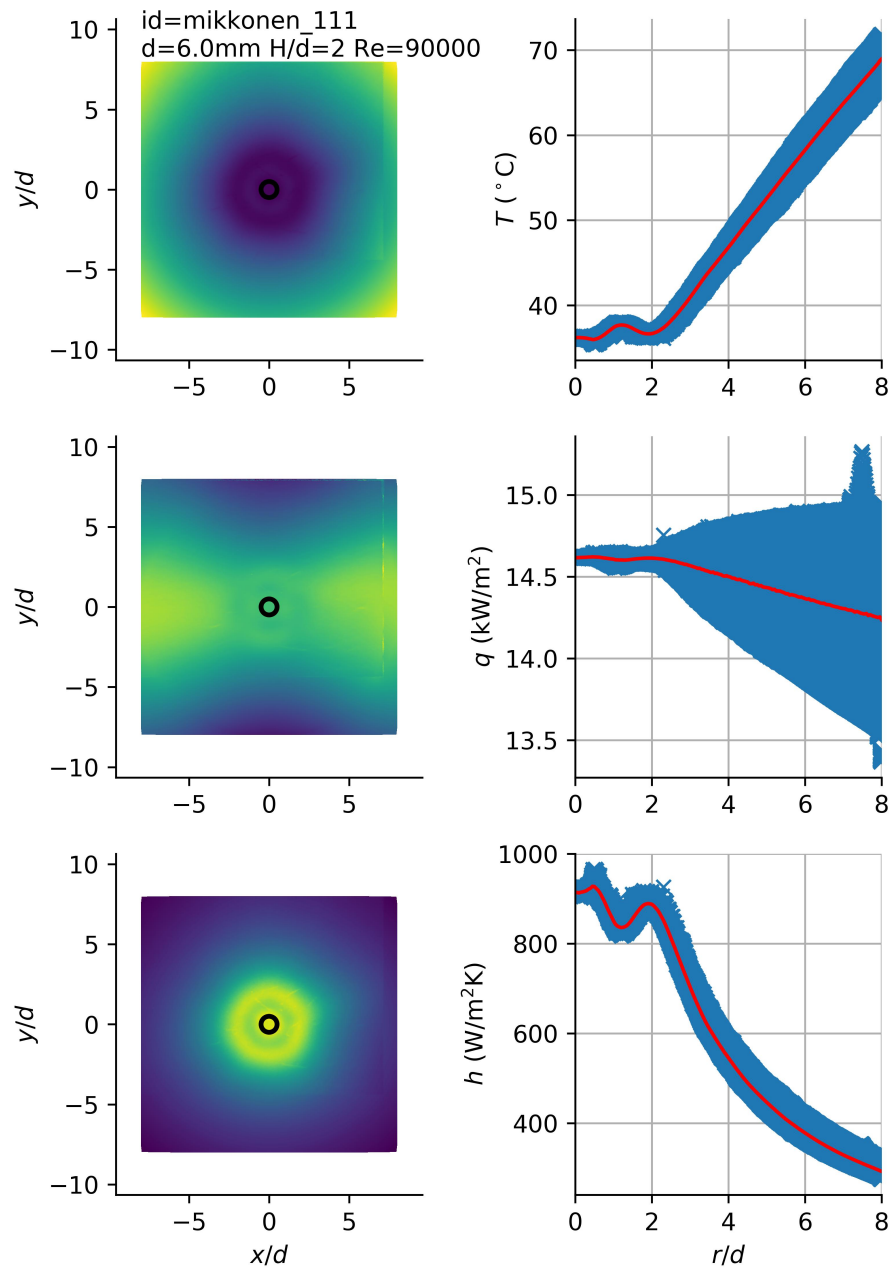


Figure 334: Results, mikkonen_111

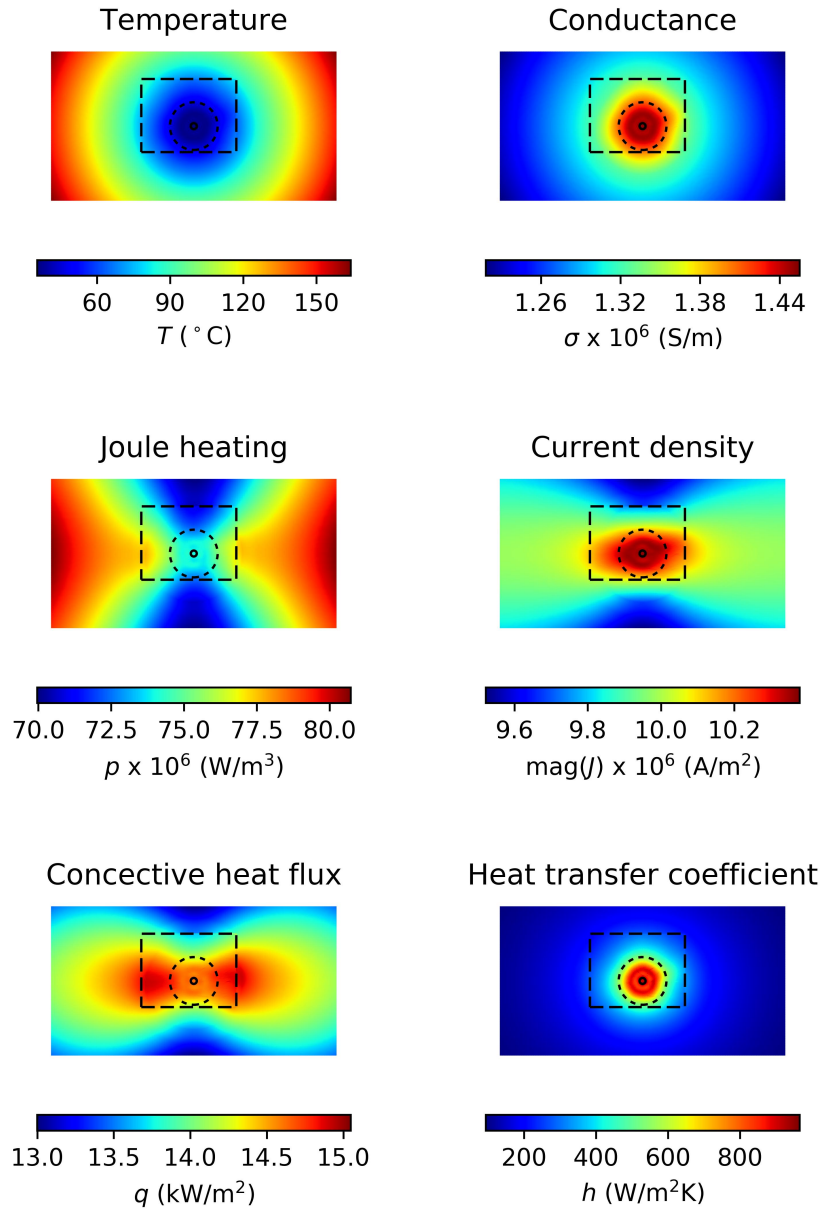


Figure 335: Convection calculation, mikkonen_111

Case id: mikkonen_112

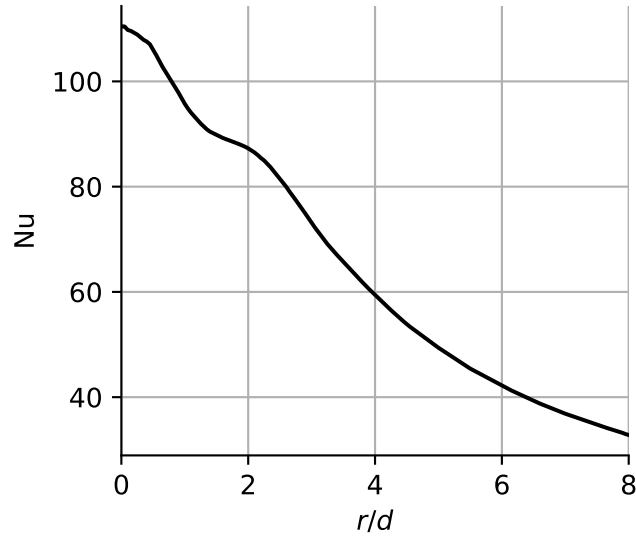


Figure 336: Nu, mikkonen_112

path	2017_03_09_mikko/6d_129Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:51:08

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
30149	0.22	4	0.71	6.0	24.0	20.0	20.2	2.586	76.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.5	200.7	4.40	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.22	35.83	37.46	38.56	39.08	40.38	42.61	45.04	47.54
Nu	110.44	106.06	95.74	89.84	87.27	81.50	73.14	65.72	59.46
h (W/m ² K)	476.26	457.36	412.86	387.42	376.32	351.44	315.38	283.38	256.39
q (kW/m ²)	7.15	7.15	7.13	7.11	7.11	7.09	7.07	7.04	7.01
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.54	50.23	52.81	55.47	58.02	60.61	63.09	65.49	67.91
Nu	59.46	53.88	49.39	45.44	42.19	39.31	36.86	34.75	32.82
h (W/m ² K)	256.39	232.34	212.99	195.93	181.92	169.50	158.93	149.84	141.51
q (kW/m ²)	7.01	6.98	6.94	6.91	6.88	6.85	6.81	6.78	6.75

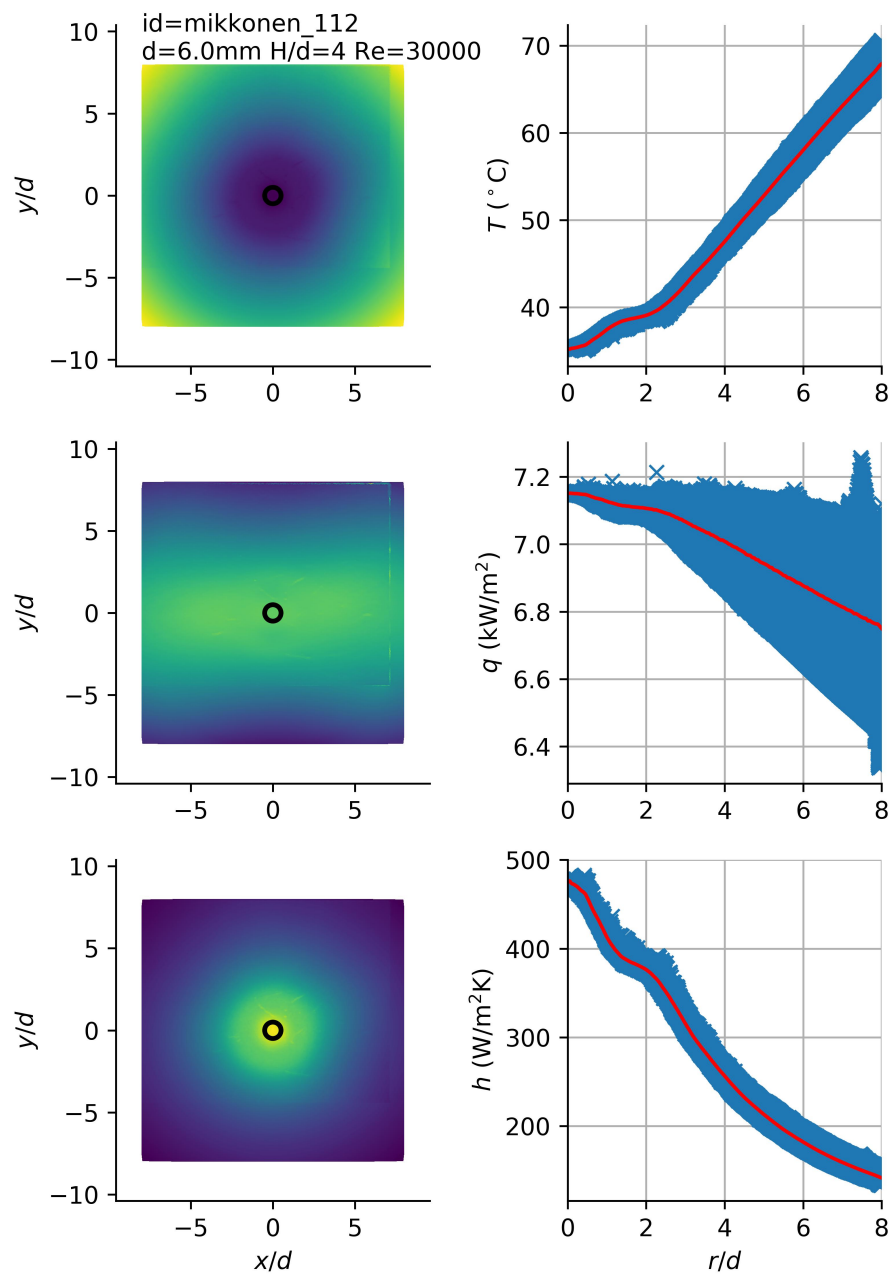


Figure 337: Results, mikkonen_112

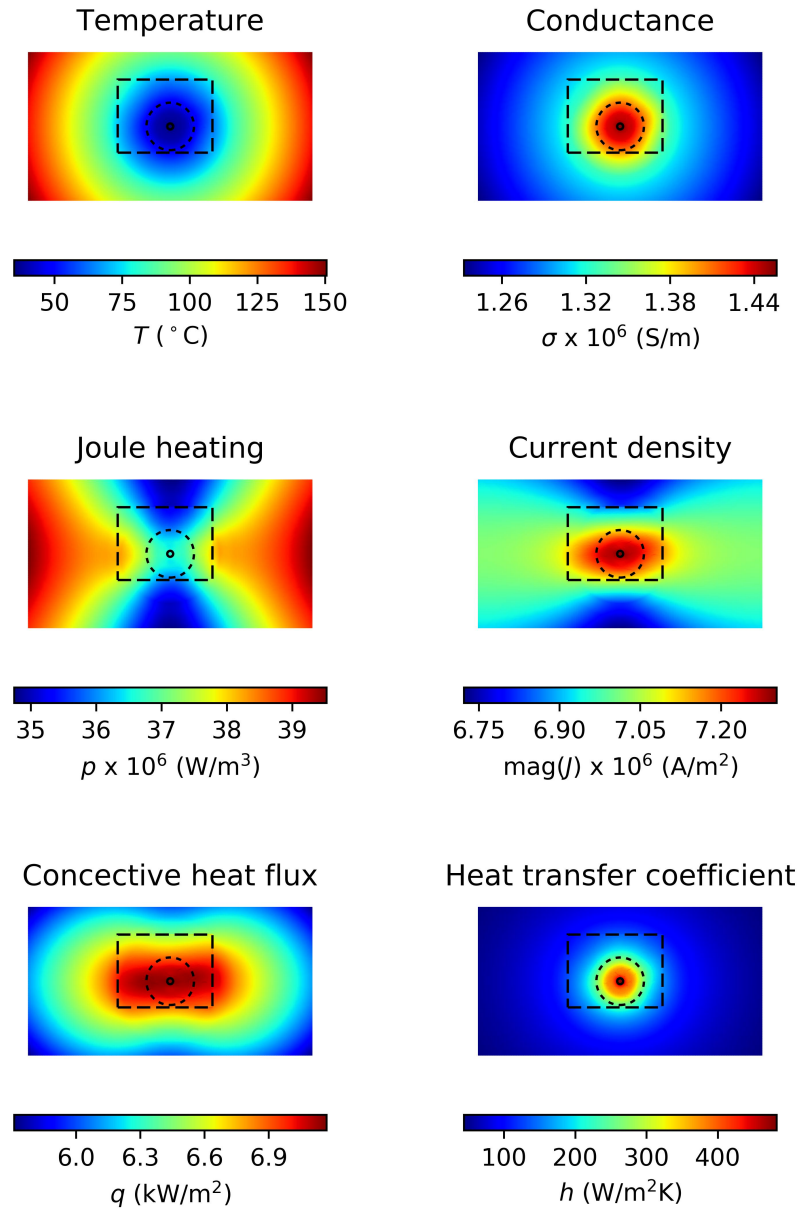


Figure 338: Convection calculation, mikkonen_112

Case id: mikkonen_113

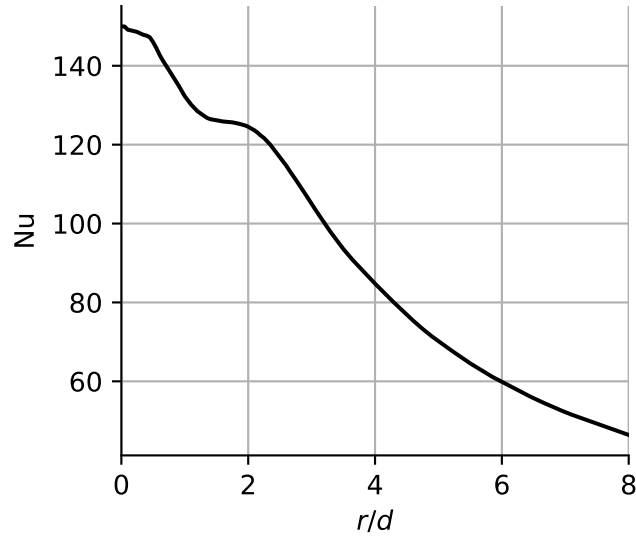


Figure 339: Nu, mikkonen_113

path	2017_03_09_mikko/6d_215Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 16:55:47

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50333	0.37	4	0.71	6.0	24.0	20.0	20.2	4.318	128.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.8	236.3	2.66	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.09	35.50	37.05	37.85	38.07	39.22	41.32	43.83	46.21
Nu	149.97	145.99	132.28	126.17	124.53	116.85	105.00	93.55	84.77
h (W/m ² K)	646.72	629.53	570.40	544.06	537.02	503.89	452.80	403.39	365.55
q (kW/m ²)	9.63	9.63	9.61	9.60	9.60	9.58	9.56	9.53	9.50

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.21	48.81	51.42	54.01	56.58	59.13	61.63	64.01	66.45
Nu	84.77	76.85	70.16	64.56	59.80	55.72	52.17	49.18	46.40
h (W/m ² K)	365.55	331.39	302.56	278.38	257.87	240.27	224.98	212.09	200.09
q (kW/m ²)	9.50	9.47	9.44	9.40	9.37	9.35	9.31	9.29	9.25

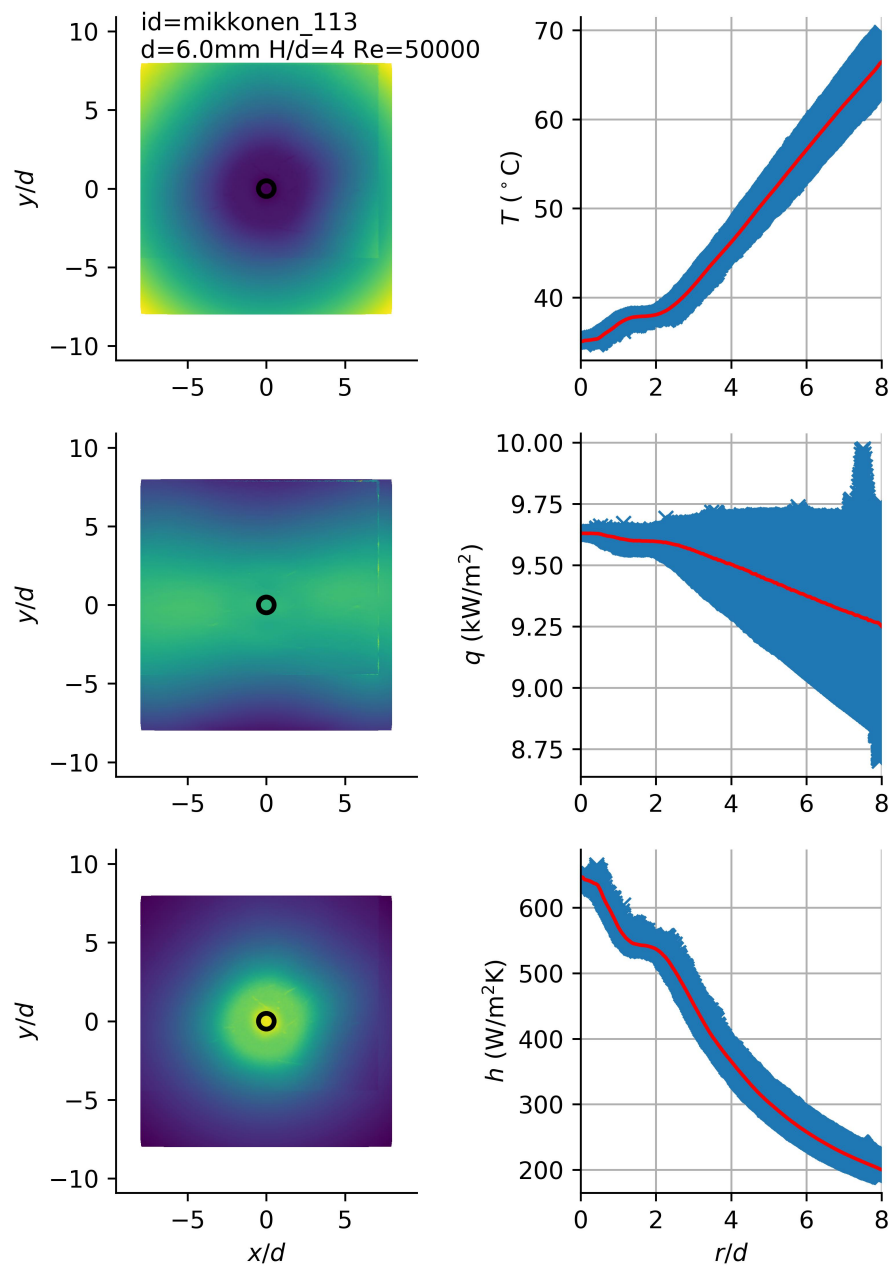


Figure 340: Results, mikkonen_113

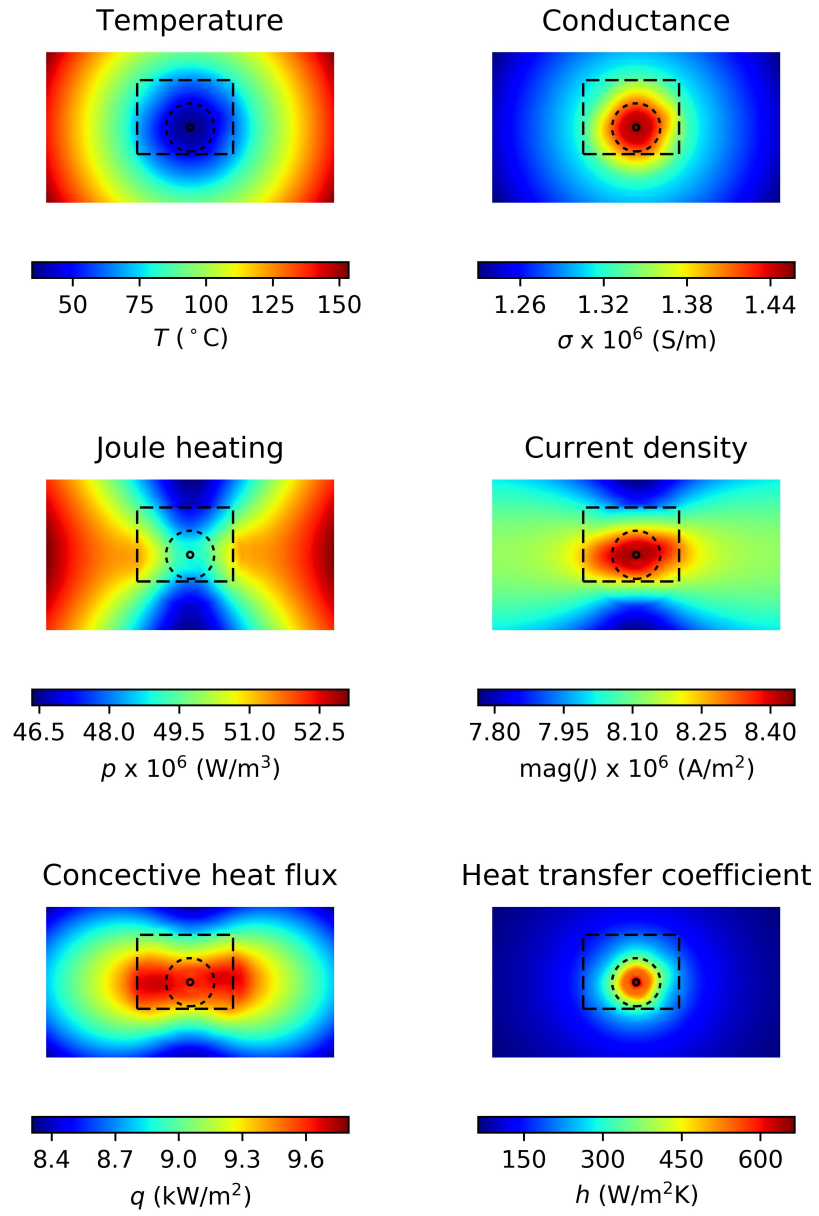


Figure 341: Convection calculation, mikkonen_113

Case id: mikkonen_114

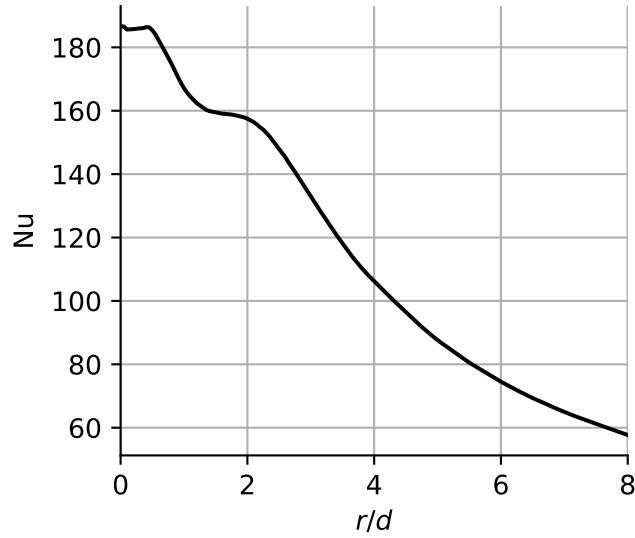


Figure 342: Nu, mikkonen_114

path	2017_03_09_mikko/6d_301Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 17:06:38

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
70541	0.52	4	0.71	6.0	24.0	20.0	20.2	6.052	180.0

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.9	256.0	3.59	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.52	34.61	36.17	36.92	37.12	38.19	40.19	42.65	45.11
Nu	186.60	185.42	167.11	159.48	157.50	148.02	133.02	118.15	106.25
h (W/m ² K)	804.67	799.57	720.61	687.74	679.16	638.30	573.60	509.48	458.17
q (kW/m ²)	11.52	11.52	11.51	11.50	11.49	11.48	11.46	11.43	11.40
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.11	47.60	50.25	52.79	55.34	57.86	60.32	62.65	65.07
Nu	106.25	96.38	87.62	80.56	74.52	69.37	64.94	61.21	57.71
h (W/m ² K)	458.17	415.63	377.82	347.37	321.35	299.12	280.04	263.93	248.85
q (kW/m ²)	11.40	11.38	11.34	11.31	11.28	11.25	11.22	11.19	11.16

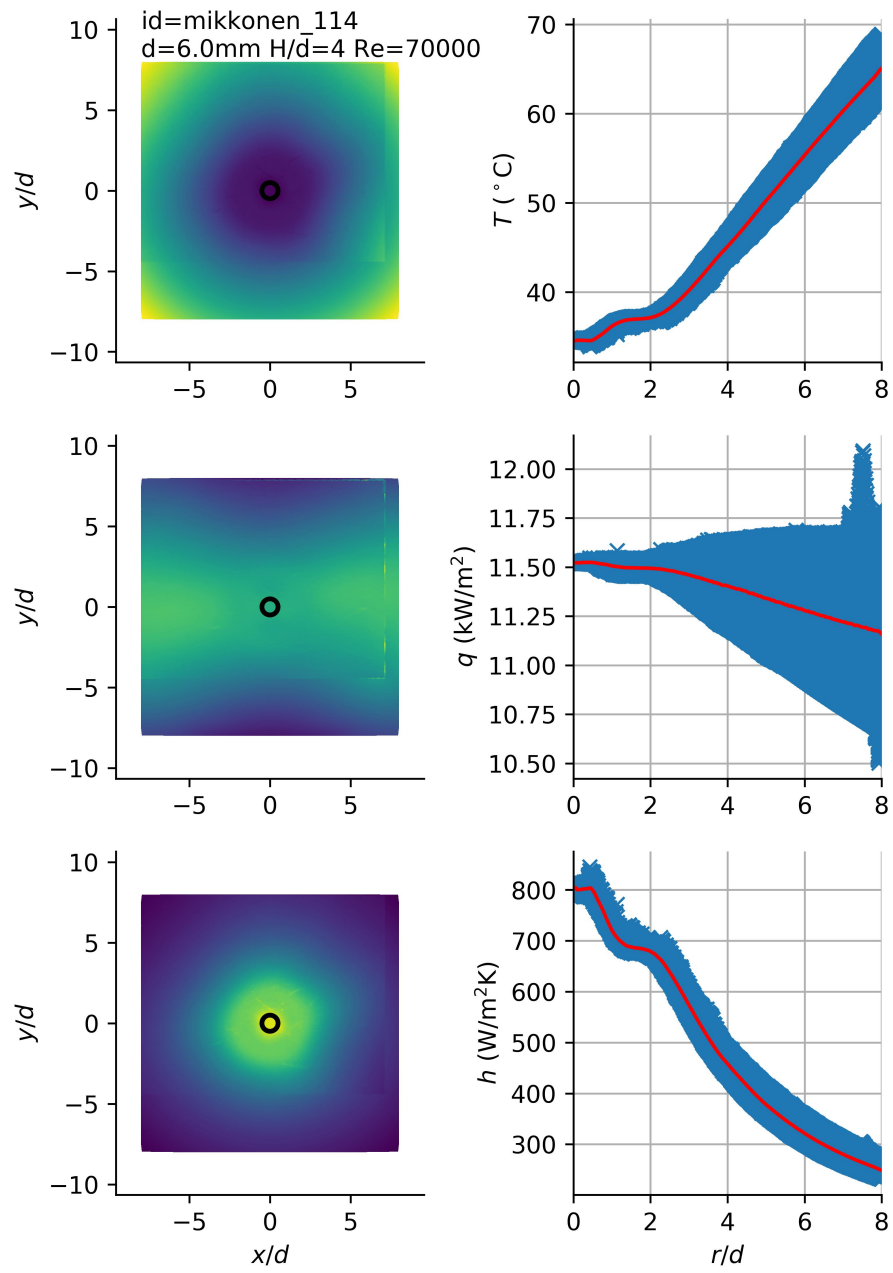


Figure 343: Results, mikkonen_114

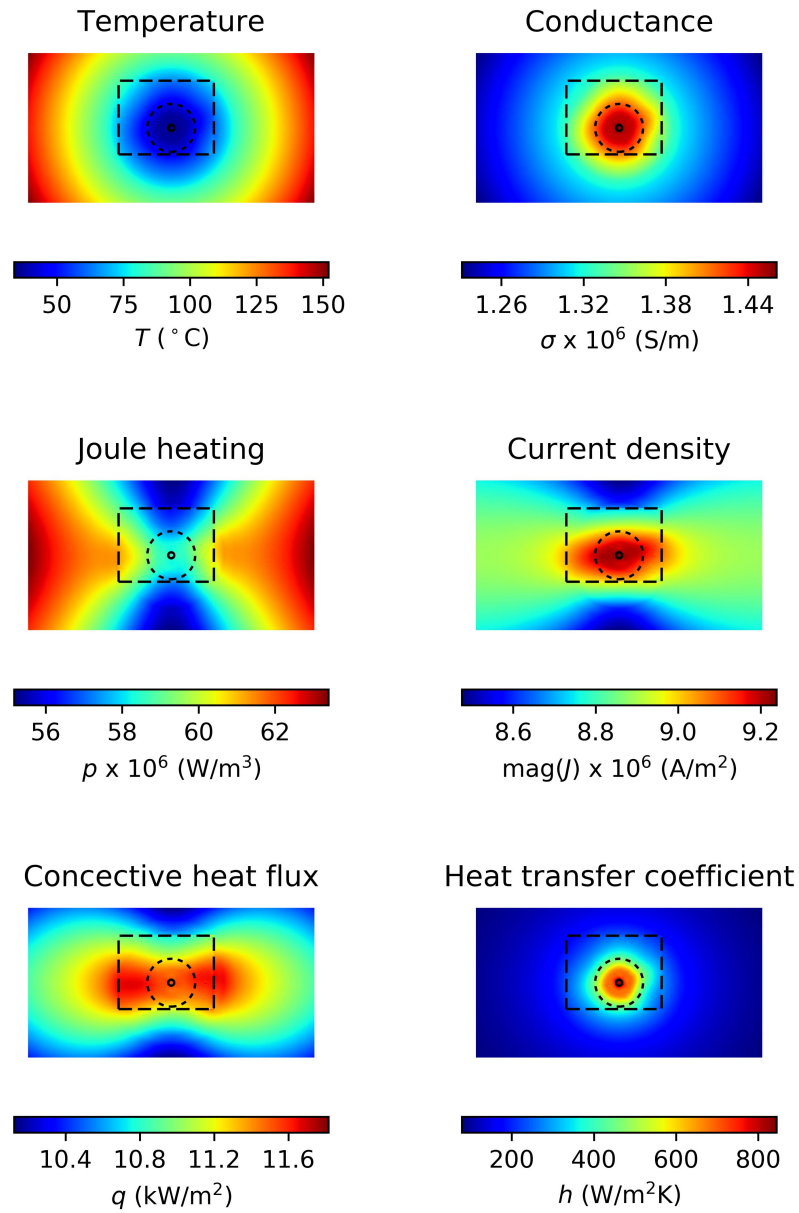


Figure 344: Convection calculation, mikkonen_114

Case id: mikkonen_115

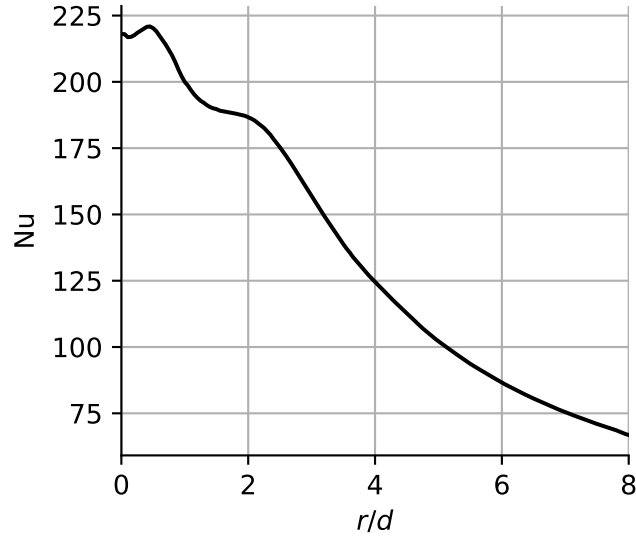


Figure 345: Nu, mikkonen_115

path	2017_03_09_mikko/6d_387Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 17:11:10

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
89607	0.67	4	0.71	6.0	24.0	20.0	20.2	7.687	228.7

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.1	278.8	3.54	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.79	34.65	36.10	36.94	37.21	38.30	40.39	42.99	45.54
Nu	218.01	220.26	199.96	189.71	186.68	175.33	157.02	138.80	124.57
h (W/m ² K)	940.12	949.81	862.27	818.07	805.02	756.08	677.10	598.56	537.18
q (kW/m ²)	13.72	13.72	13.70	13.69	13.69	13.68	13.66	13.62	13.60

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.54	48.18	50.96	53.65	56.32	58.93	61.50	63.95	66.51
Nu	124.57	112.62	102.13	93.69	86.57	80.57	75.38	70.99	66.83
h (W/m ² K)	537.18	485.65	440.43	404.00	373.31	347.42	325.06	306.14	288.20
q (kW/m ²)	13.60	13.57	13.53	13.49	13.46	13.44	13.40	13.38	13.34

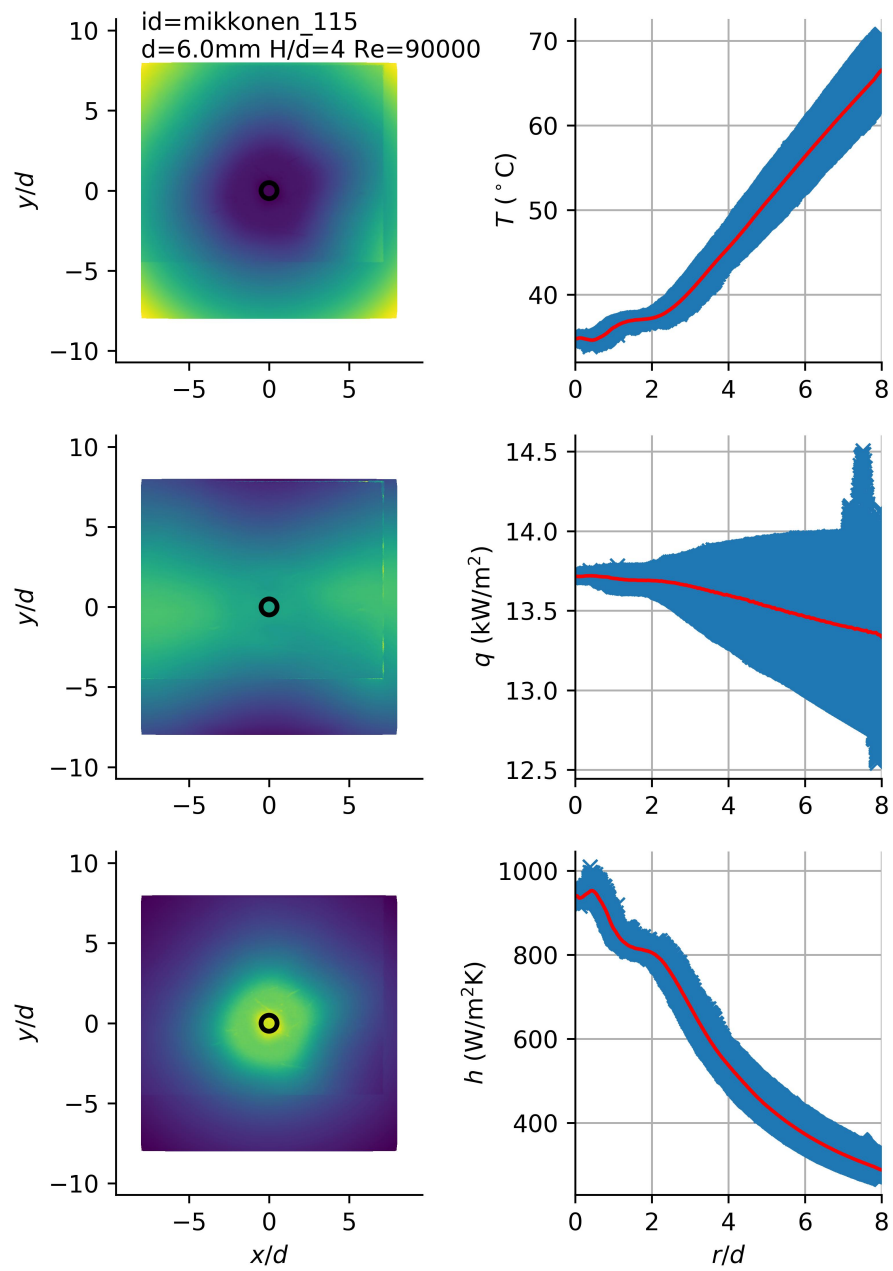


Figure 346: Results, mikkonen_115

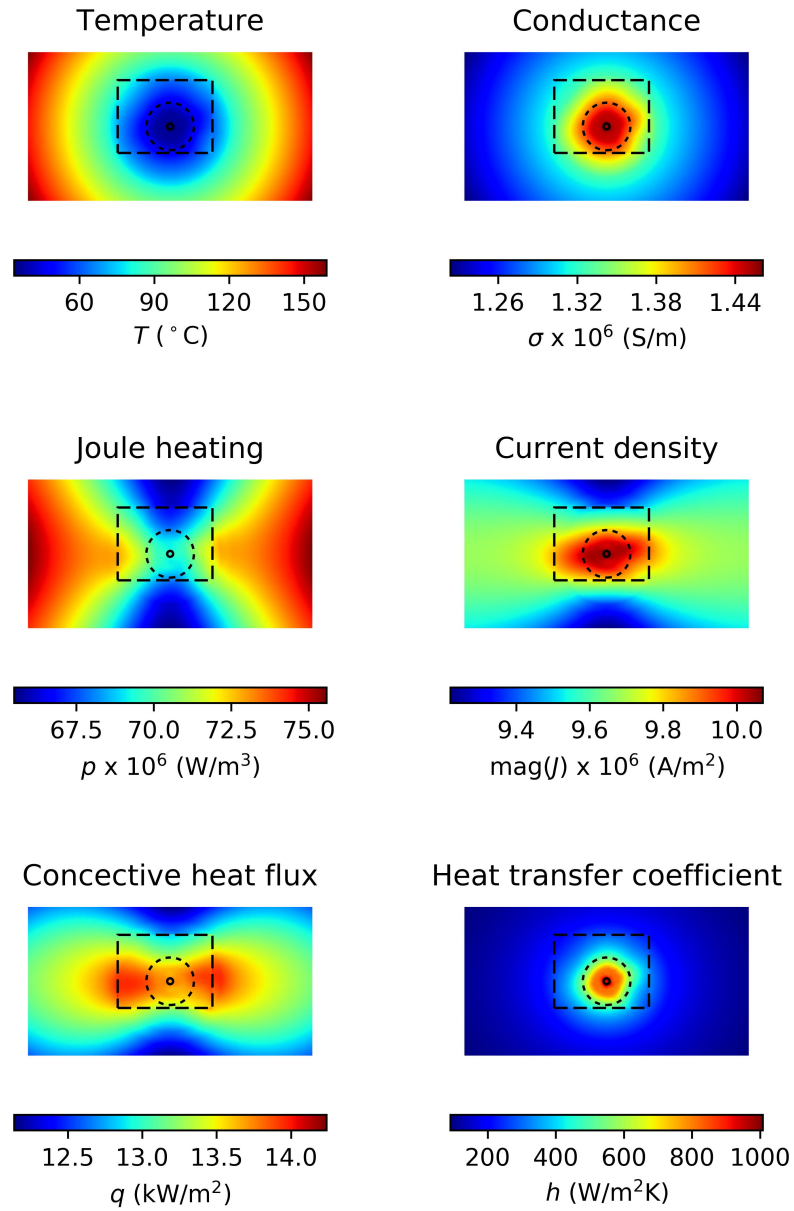


Figure 347: Convection calculation, mikkonen_115

Case id: mikkonen_116

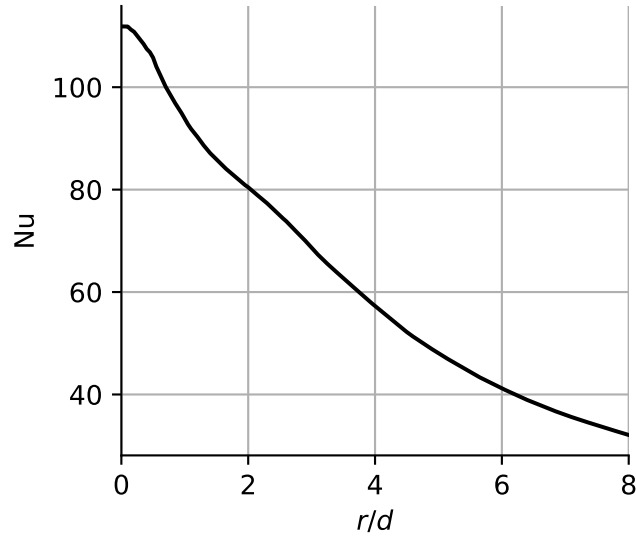


Figure 348: Nu, mikkonen_116

path	2017_03_09_mikko/6d_129Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 17:33:34

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
30138	0.22	6	0.71	6.0	36.0	19.7	20.2	2.583	76.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.5	198.3	3.28	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.36	35.17	37.02	38.50	39.71	41.09	42.95	45.00	47.25
Nu	111.86	105.77	93.81	85.94	80.46	74.96	68.64	62.71	57.28
h (W/m ² K)	481.97	455.70	404.16	370.28	346.64	322.96	295.75	270.19	246.80
q (kW/m ²)	6.82	6.82	6.80	6.78	6.76	6.75	6.73	6.70	6.67

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.25	49.75	52.17	54.68	57.14	59.63	62.06	64.37	66.73
Nu	57.28	52.20	48.04	44.33	41.20	38.42	36.02	33.97	32.09
h (W/m ² K)	246.80	224.91	206.99	191.00	177.49	165.52	155.18	146.36	138.27
q (kW/m ²)	6.67	6.64	6.61	6.58	6.55	6.52	6.49	6.46	6.43

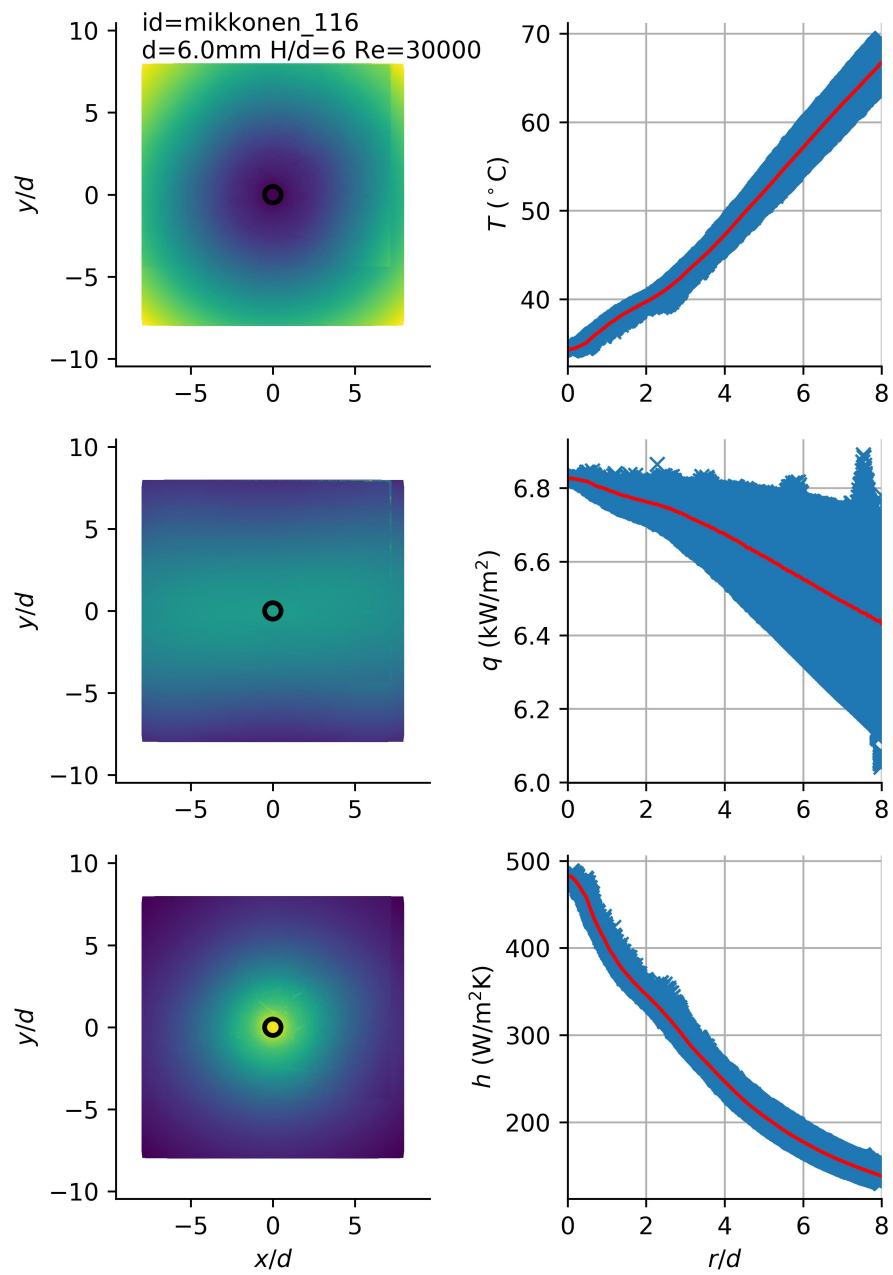


Figure 349: Results, mikkonen_116

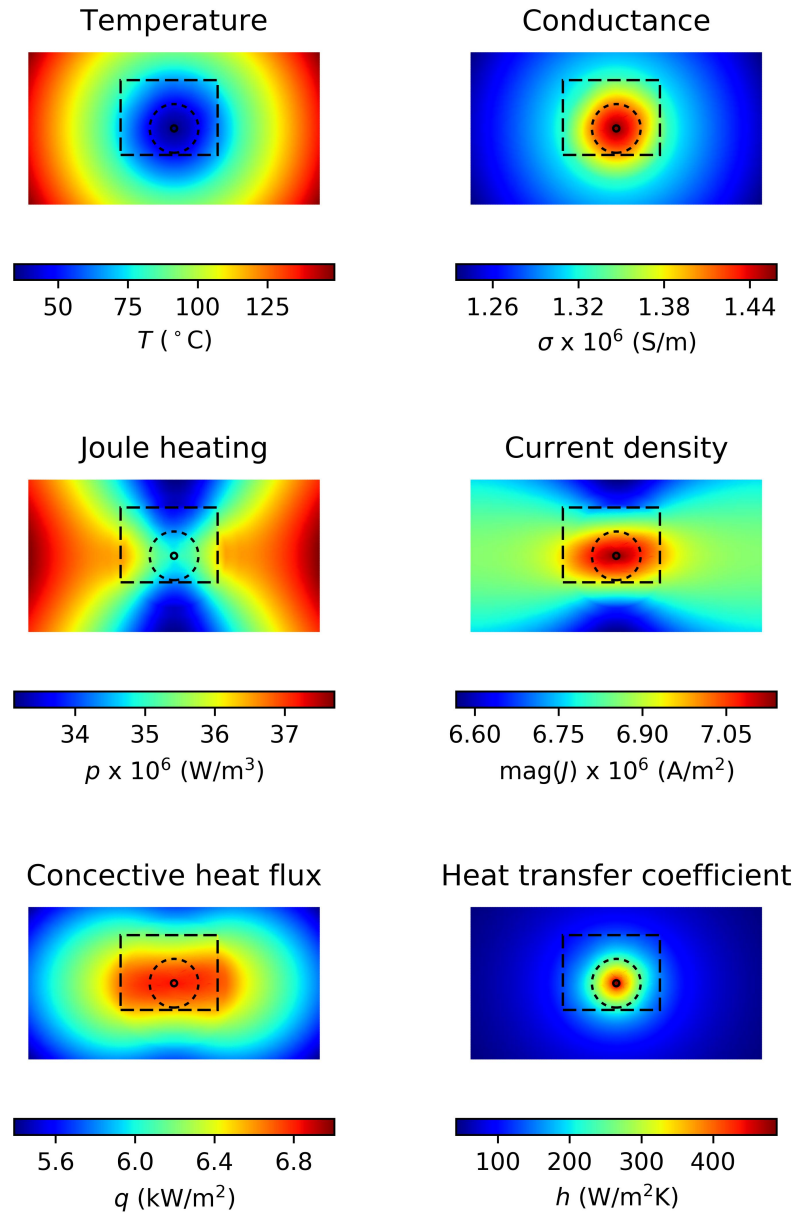


Figure 350: Convection calculation, mikkonen_116

Case id: mikkonen_117

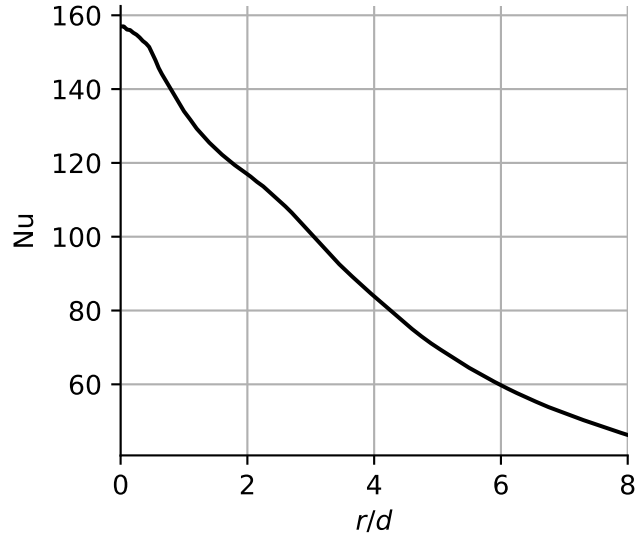


Figure 351: Nu, mikkonen_117

path	2017_03_09_mikko/6d_215Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 17:30:17

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50152	0.37	6	0.71	6.0	36.0	19.7	20.2	4.299	127.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.8	234.5	3.24	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.40	35.08	36.79	38.11	39.14	40.35	42.09	44.22	46.41
Nu	156.98	149.70	133.99	123.89	116.97	109.80	100.93	91.70	83.84
h (W/m²K)	676.35	644.97	577.28	533.78	503.95	473.08	434.87	395.10	361.23
q (kW/m²)	9.60	9.60	9.58	9.56	9.55	9.53	9.51	9.49	9.46

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.41	48.88	51.43	53.96	56.51	59.04	61.53	63.91	66.44
Nu	83.84	76.43	69.92	64.46	59.74	55.69	52.16	49.15	46.28
h (W/m²K)	361.23	329.31	301.23	277.73	257.40	239.95	224.71	211.76	199.39
q (kW/m²)	9.46	9.44	9.40	9.37	9.34	9.31	9.28	9.25	9.21

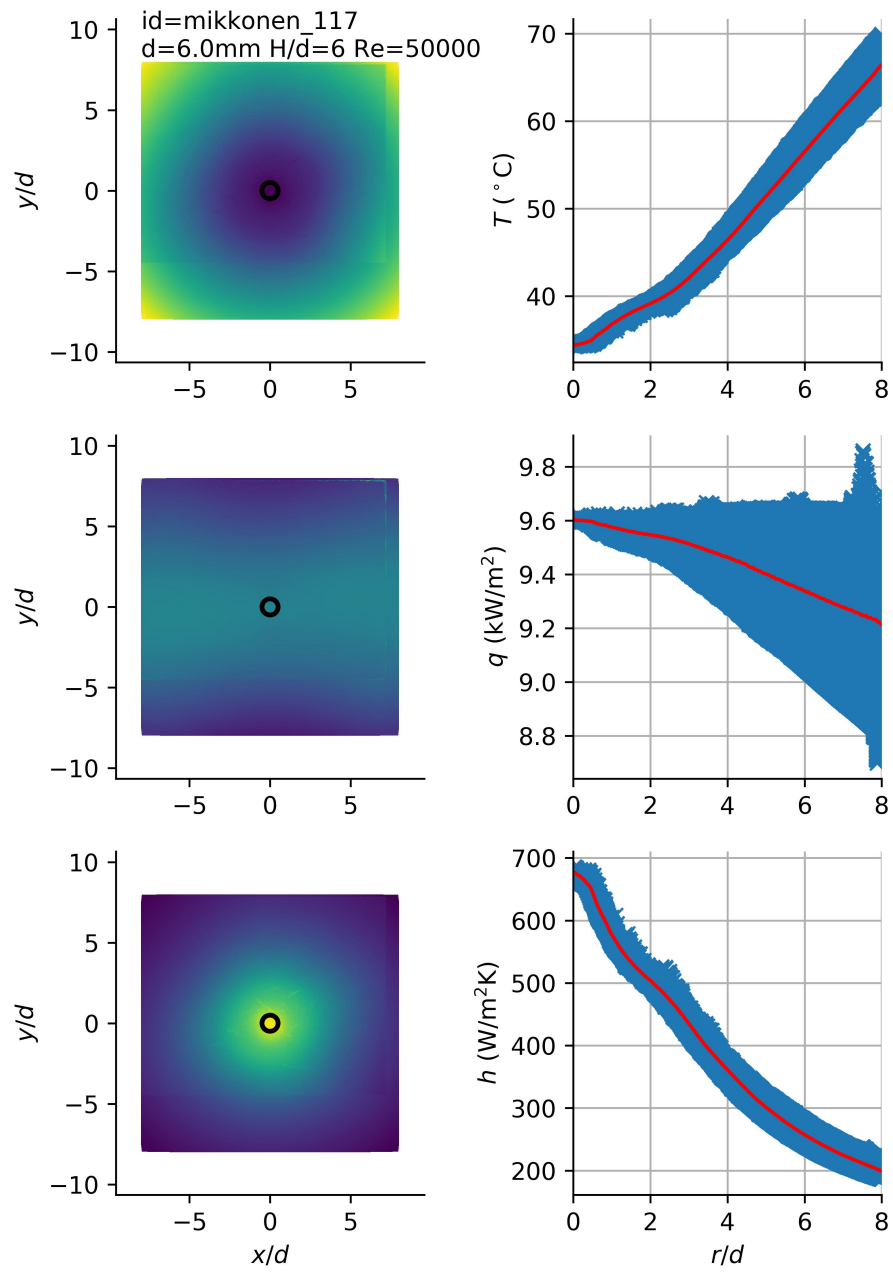


Figure 352: Results, mikkonen_117

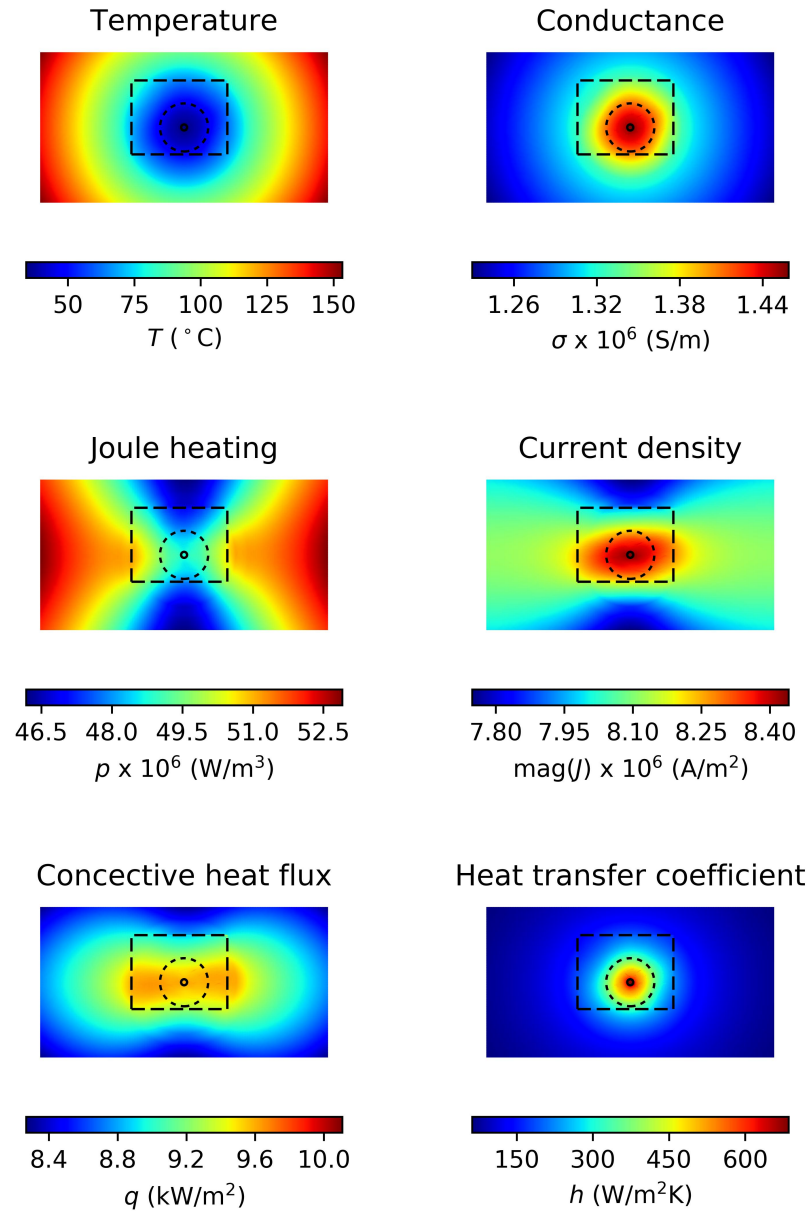


Figure 353: Convection calculation, mikkonen_117

Case id: mikkonen_118

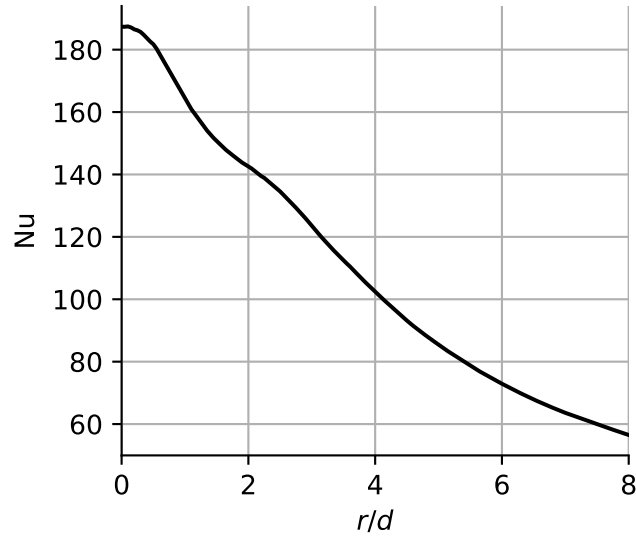


Figure 354: Nu, mikkonen_118

path	2017_03_09_mikko/6d_301Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 17:25:59

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
81863	0.61	6	0.71	6.0	36.0	19.6	20.2	7.016	208.4

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.0	261.9	3.43	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.18	35.64	37.23	38.75	39.79	40.94	42.76	44.93	47.29
Nu	187.33	181.75	164.47	150.79	142.62	134.57	123.56	112.49	102.46
h (W/m ² K)	806.90	782.82	708.42	649.47	614.29	579.62	532.20	484.51	441.32
q (kW/m ²)	12.09	12.08	12.06	12.04	12.03	12.02	12.00	11.97	11.95

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.29	49.92	52.53	55.23	57.88	60.58	63.18	65.72	68.29
Nu	102.46	93.18	85.43	78.64	72.93	67.89	63.60	59.89	56.51
h (W/m ² K)	441.32	401.34	367.97	338.73	314.11	292.44	273.94	257.96	243.39
q (kW/m ²)	11.95	11.92	11.89	11.85	11.82	11.79	11.76	11.73	11.69

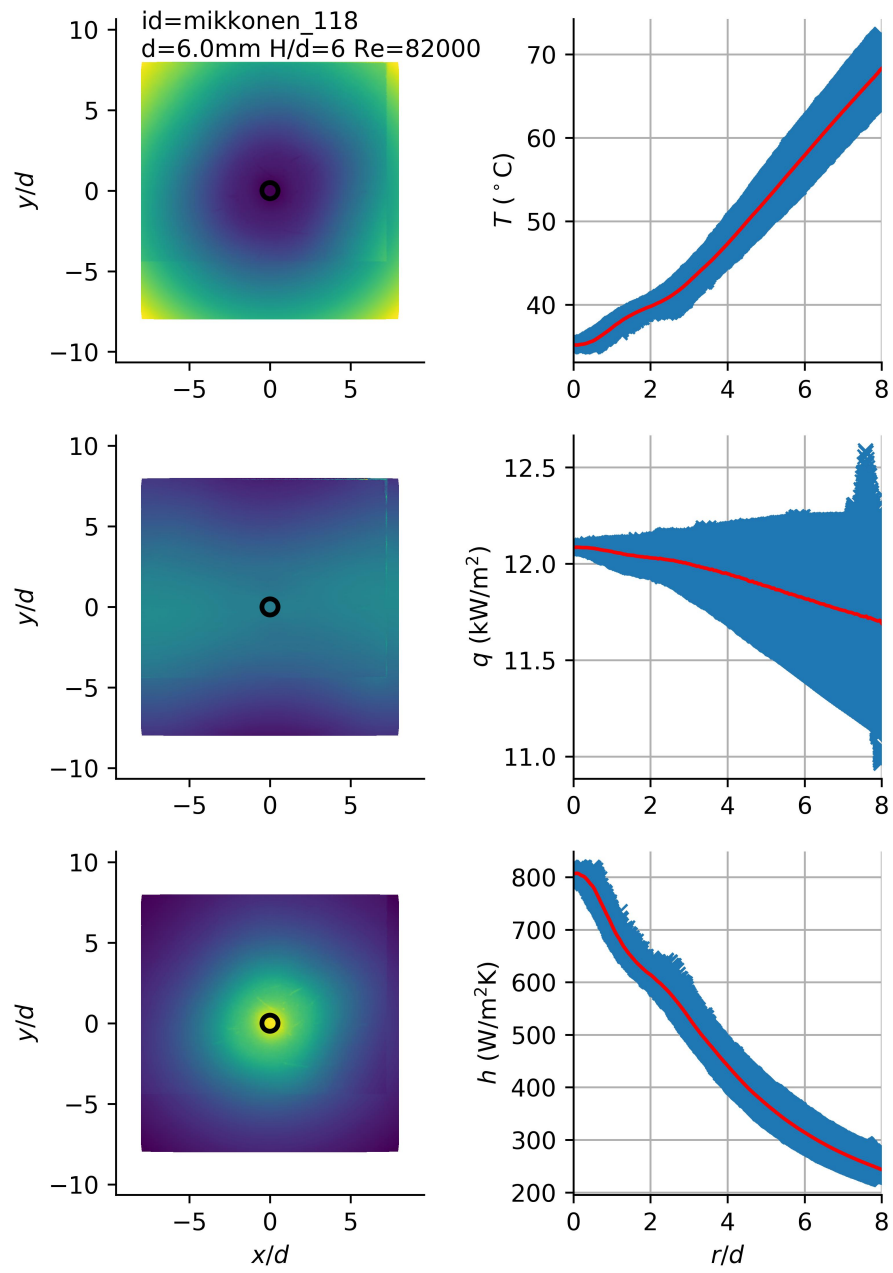


Figure 355: Results, mikkonen_118

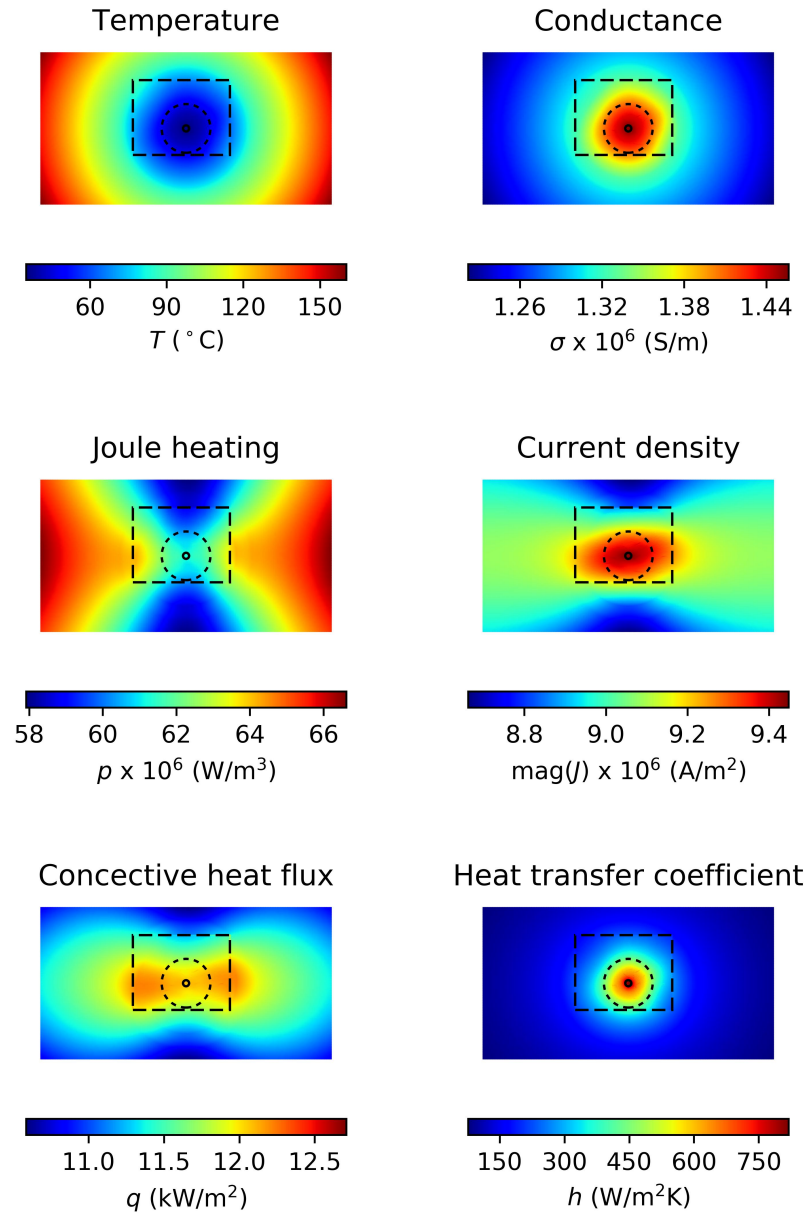


Figure 356: Convection calculation, mikkonen_118

Case id: mikkonen_119

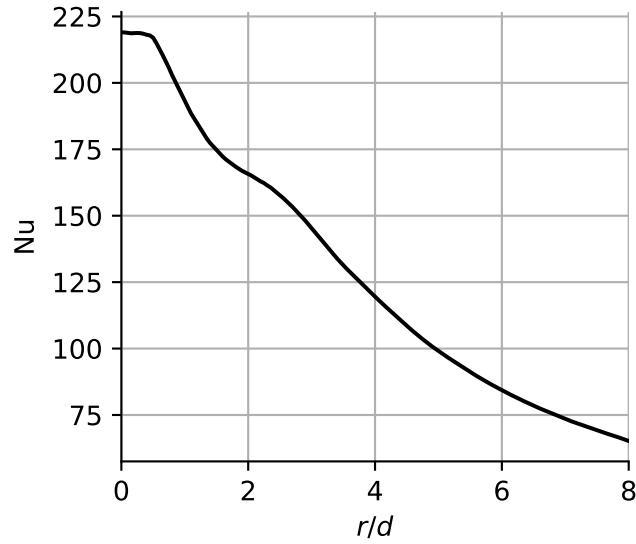


Figure 357: Nu, mikkonen_119

path	2017_03_09_mikko/6d_387Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 17:21:09

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
89490	0.67	6	0.71	6.0	36.0	20.0	20.2	7.677	228.4

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.1	277.9	3.26	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.57	34.70	36.49	38.15	39.10	40.06	41.74	43.99	46.29
Nu	218.99	217.02	192.89	174.78	165.84	157.75	145.28	131.34	119.55
h (W/m ² K)	944.33	935.86	831.80	753.70	715.13	680.24	626.47	566.39	515.52
q (kW/m ²)	13.57	13.57	13.55	13.53	13.52	13.51	13.49	13.46	13.44
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.29	48.88	51.55	54.20	56.86	59.50	62.09	64.56	67.14
Nu	119.55	108.57	99.07	91.13	84.34	78.52	73.48	69.23	65.22
h (W/m ² K)	515.52	468.17	427.19	392.98	363.68	338.59	316.86	298.54	281.24
q (kW/m ²)	13.44	13.41	13.37	13.34	13.31	13.28	13.25	13.22	13.18

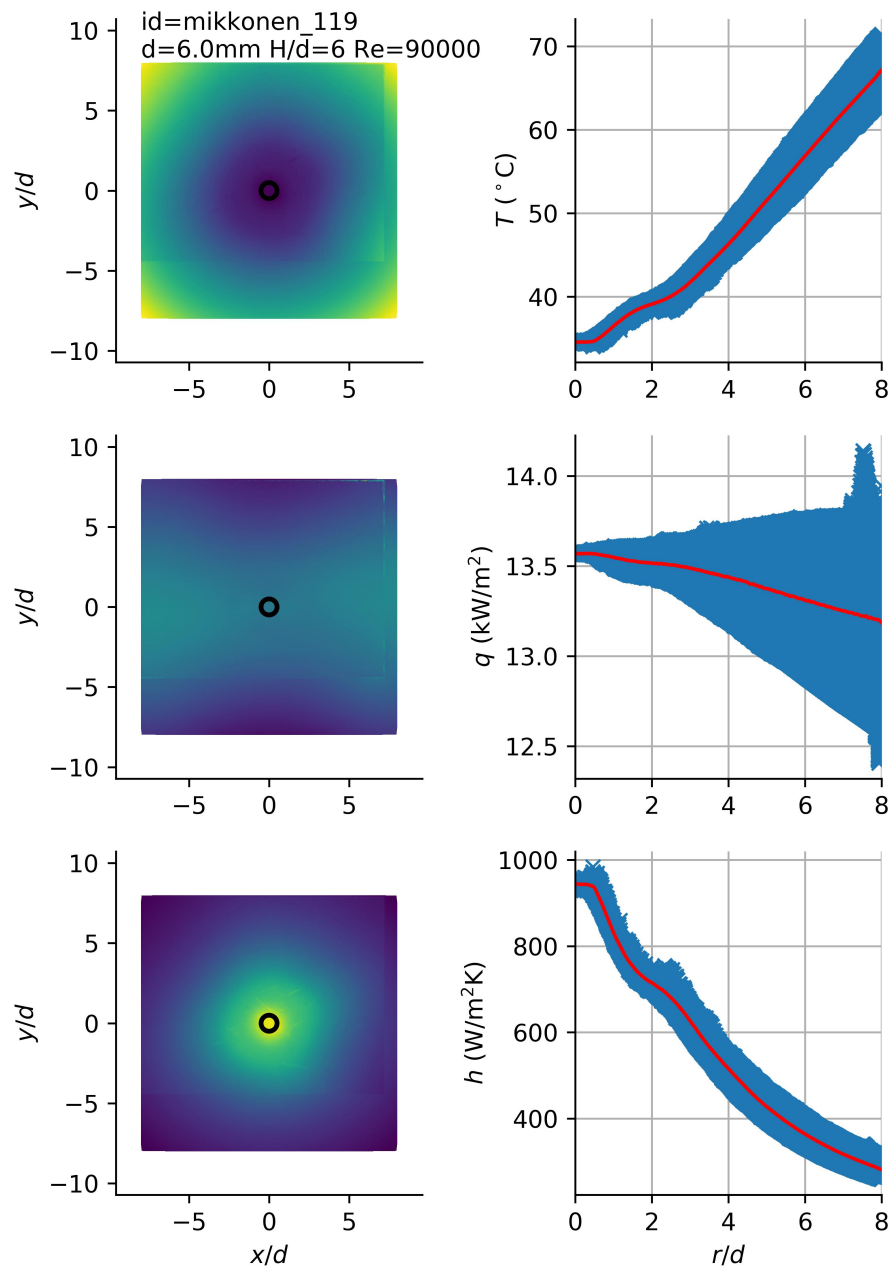


Figure 358: Results, mikkonen_119

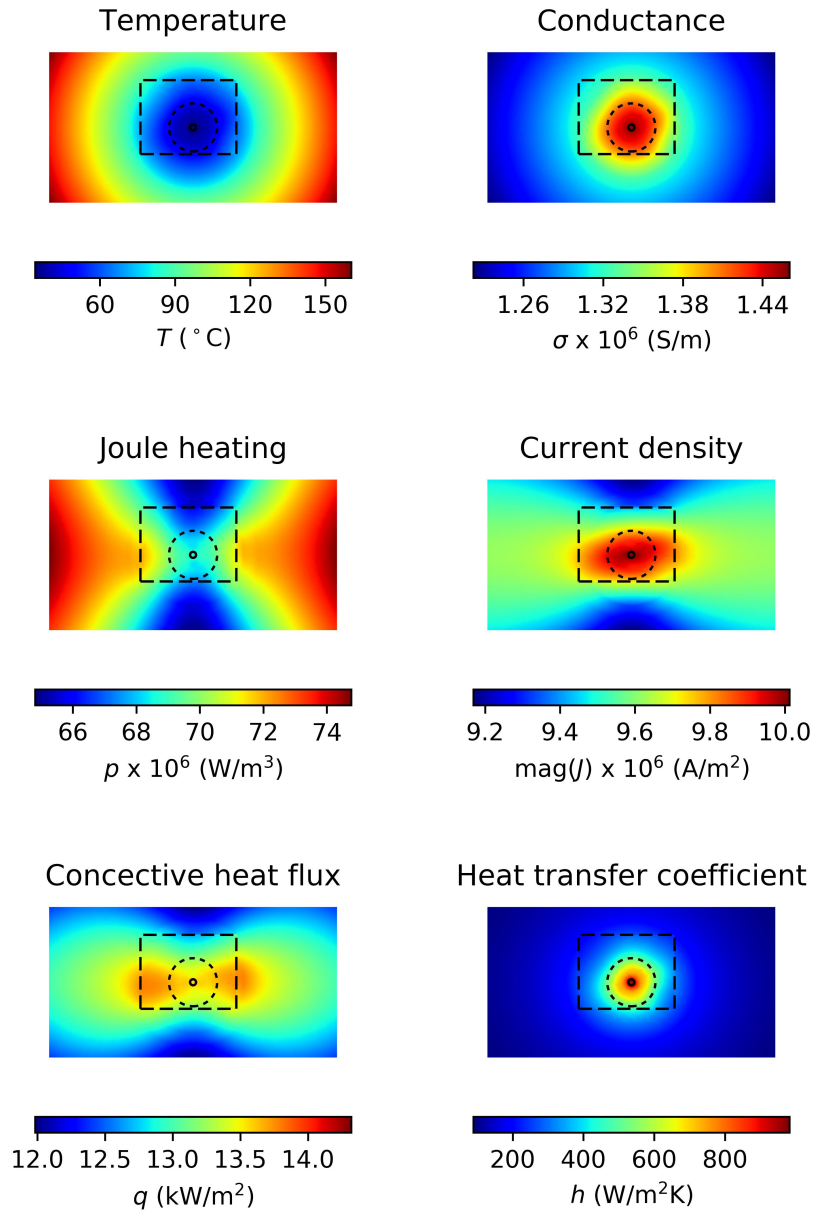


Figure 359: Convection calculation, mikkonen_119

Case id: mikkonen_120

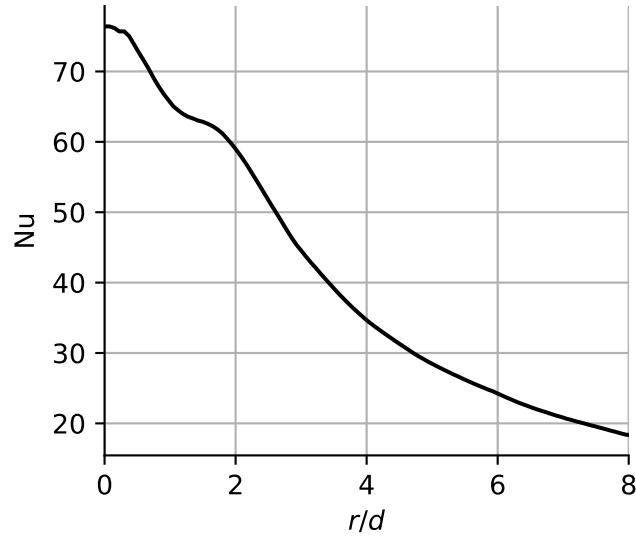


Figure 360: Nu, mikkonen_120

path	2017_03_09_mikko/8d_80Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:21:13

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14003	0.08	1	0.71	8.0	8.0	20.2	20.2	1.603	26.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.1	144.0	4.39	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.61	35.24	36.85	37.54	38.62	41.03	44.12	47.13	50.28
Nu	76.40	73.05	65.64	62.85	58.98	51.73	44.56	39.18	34.67
h (W/m ² K)	247.23	236.41	212.40	203.40	190.86	167.40	144.21	126.77	112.19
q (kW/m ²)	3.56	3.55	3.54	3.53	3.51	3.49	3.45	3.41	3.37

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	50.28	53.15	56.05	58.73	61.43	64.40	67.05	69.54	72.16
Nu	34.67	31.31	28.46	26.21	24.24	22.32	20.82	19.55	18.35
h (W/m ² K)	112.19	101.33	92.11	84.82	78.44	72.23	67.37	63.25	59.39
q (kW/m ²)	3.37	3.34	3.30	3.27	3.23	3.19	3.16	3.12	3.09

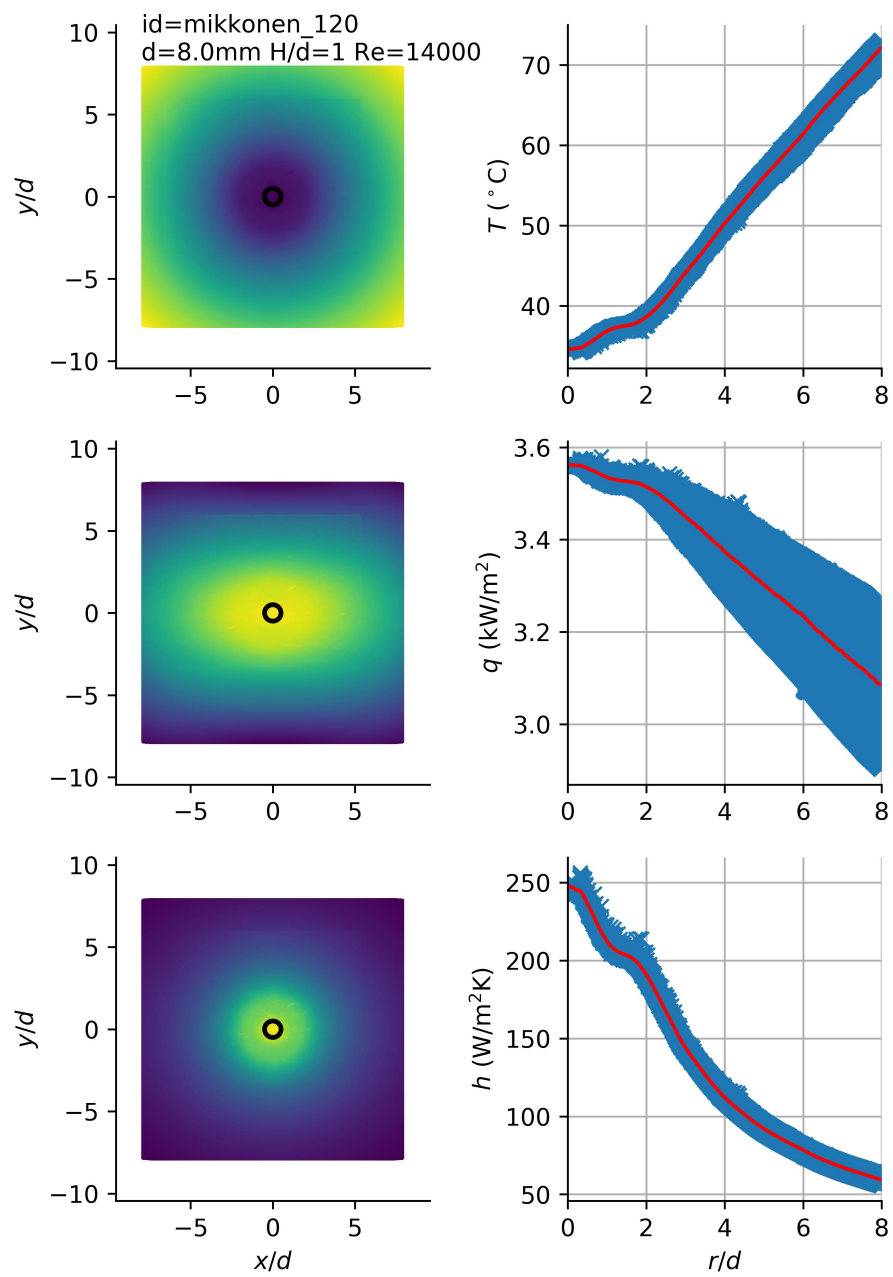


Figure 361: Results, mikkonen_120

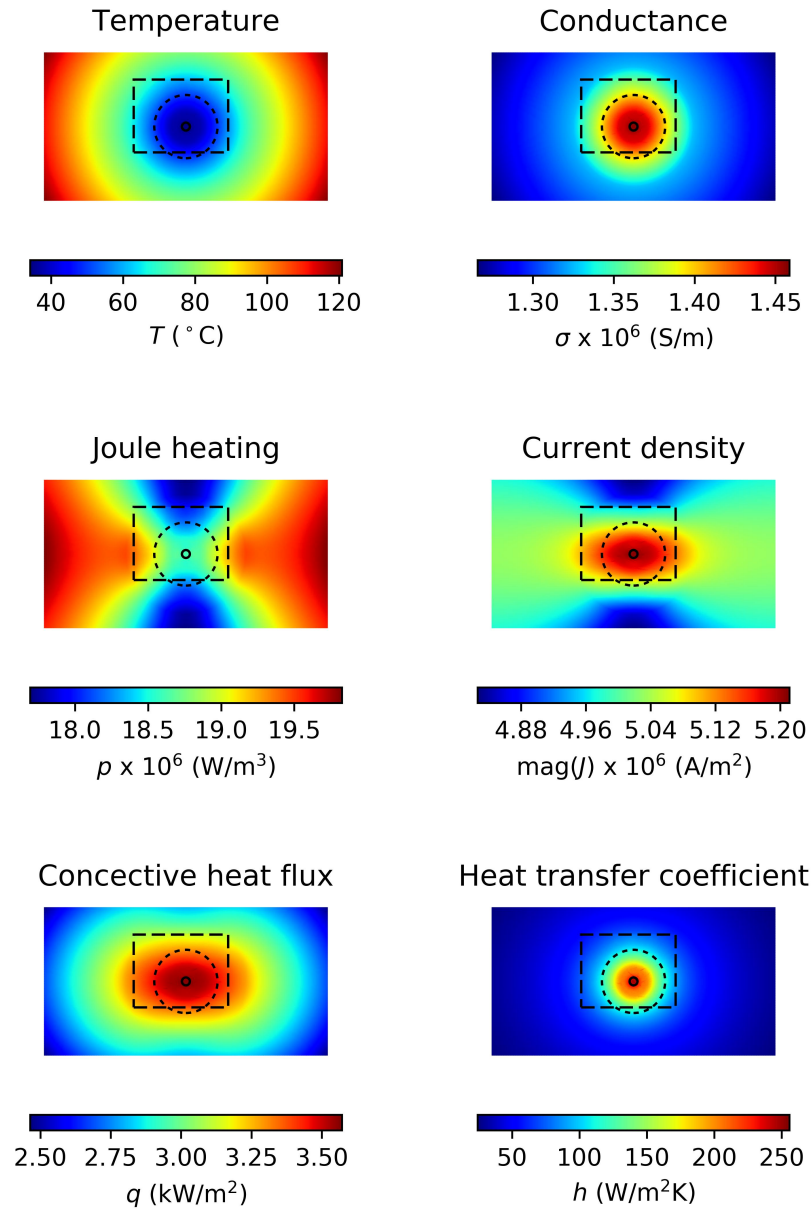


Figure 362: Convection calculation, mikkonen_120

Case id: mikkonen_121

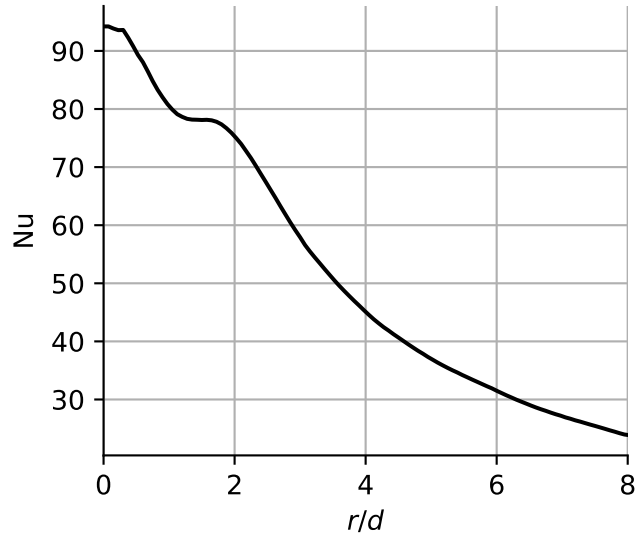


Figure 363: Nu, mikkonen_121

path	2017_03_09_mikko/8d_114Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:24:13

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20016	0.11	1	0.71	8.0	8.0	20.0	20.2	2.290	38.3

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.2	159.8	3.75	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.51	35.18	36.83	37.32	37.93	40.02	42.94	45.90	48.90
Nu	94.22	89.81	80.53	78.11	75.30	67.00	57.93	50.81	45.09
h (W/m ² K)	304.71	290.48	260.46	252.62	243.54	216.69	187.34	164.32	145.84
q (kW/m ²)	4.36	4.35	4.33	4.32	4.32	4.29	4.26	4.22	4.19

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	48.90	51.76	54.59	57.23	59.94	62.85	65.50	68.03	70.71
Nu	45.09	40.67	37.00	34.09	31.50	29.06	27.12	25.45	23.89
h (W/m ² K)	145.84	131.53	119.67	110.24	101.89	94.00	87.70	82.32	77.27
q (kW/m ²)	4.19	4.15	4.12	4.08	4.05	4.01	3.97	3.94	3.90

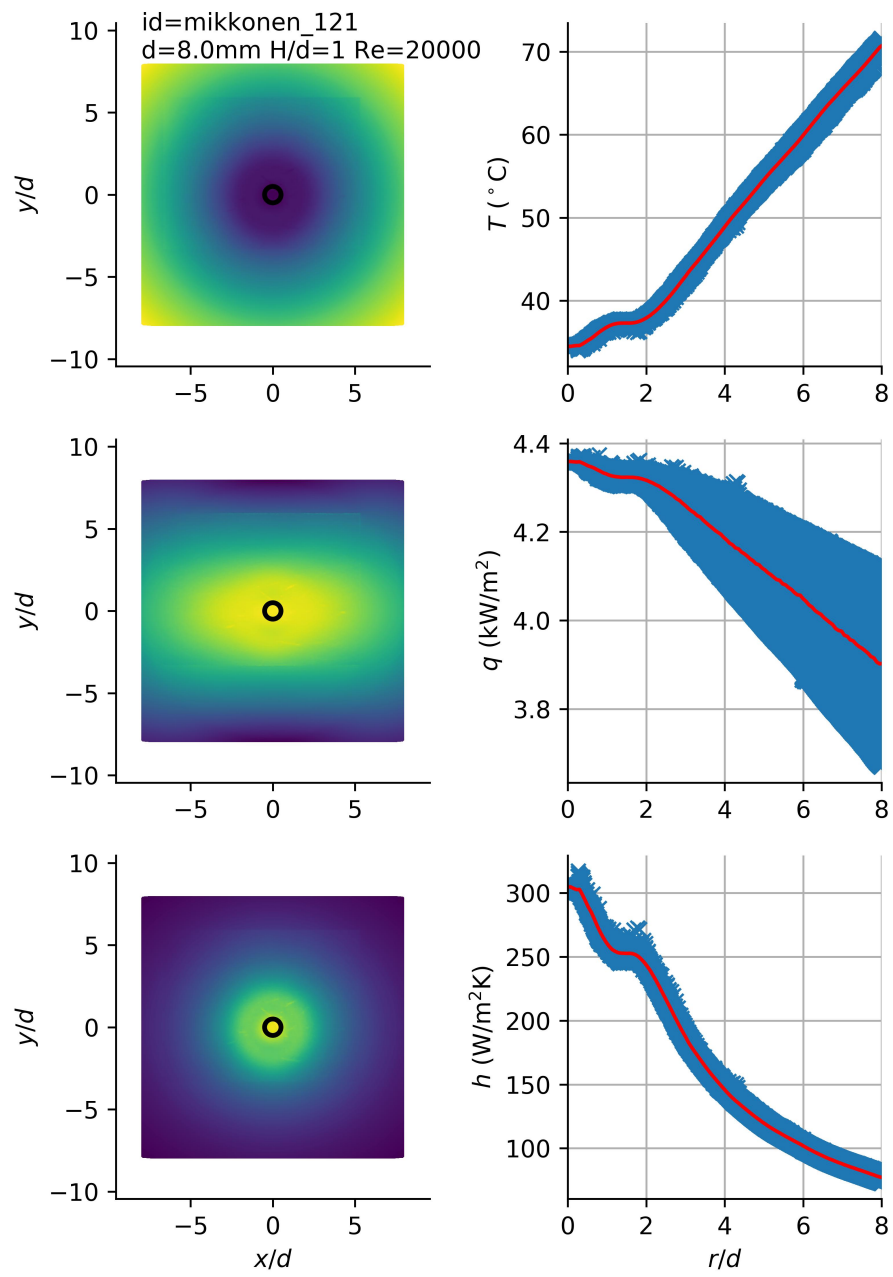


Figure 364: Results, mikkonen_121

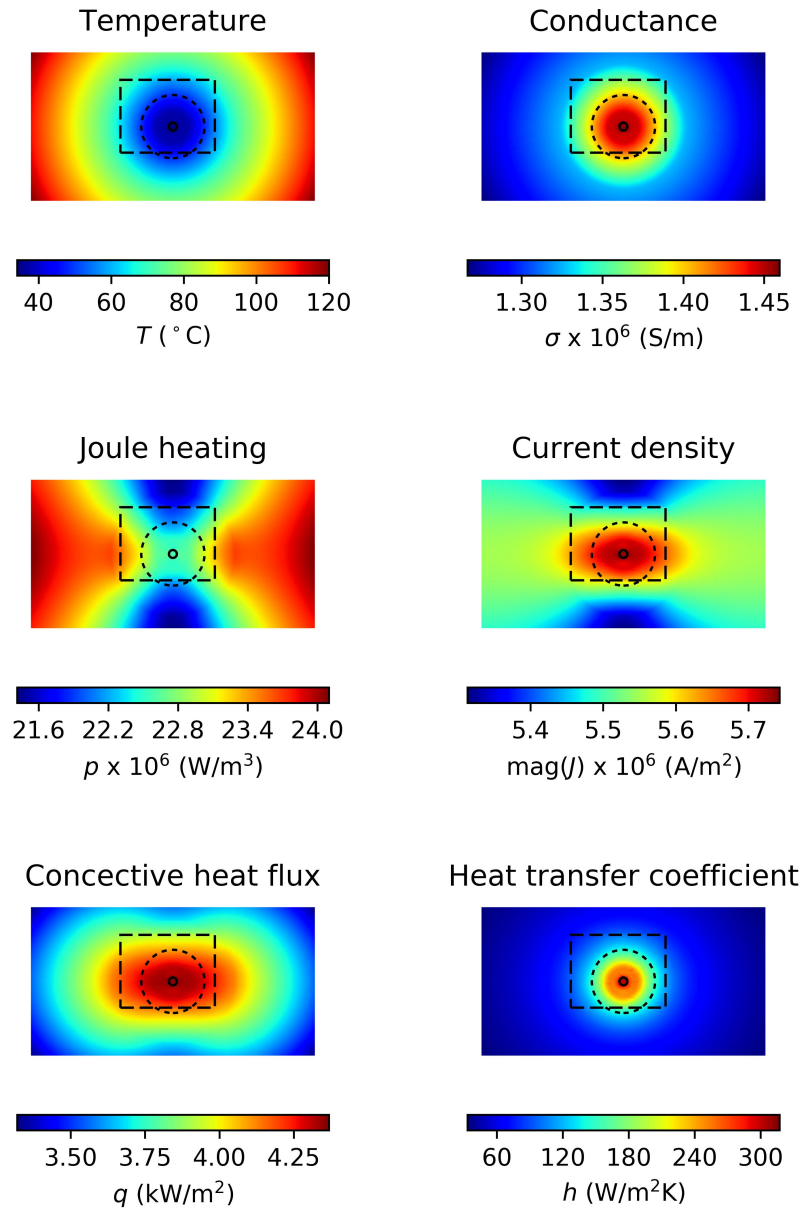


Figure 365: Convection calculation, mikkonen_121

Case id: mikkonen_122

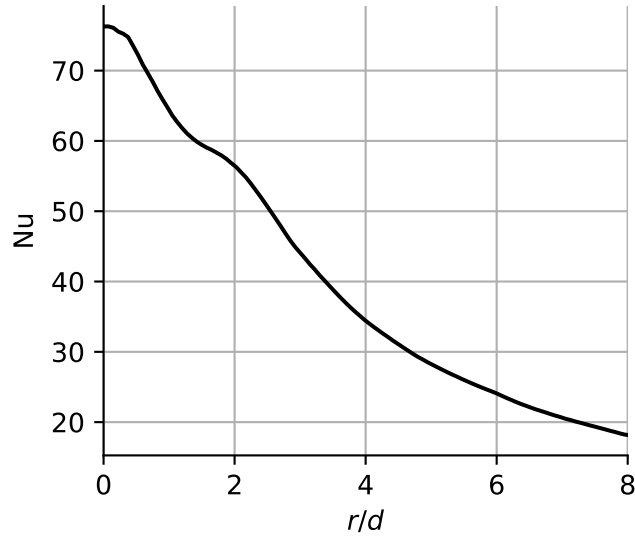


Figure 366: Nu, mikkonen_122

path	2017_03_09_mikko/8d_80Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:39:06

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13966	0.08	2	0.71	8.0	16.0	19.8	20.2	1.597	26.7

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.1	144.8	3.75	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.64	35.32	37.16	38.49	39.40	41.45	44.36	47.34	50.48
Nu	76.28	72.68	64.38	59.44	56.47	50.67	44.10	38.86	34.43
h (W/m²K)	246.57	234.92	208.11	192.12	182.51	163.78	142.55	125.60	111.28
q (kW/m²)	3.56	3.55	3.53	3.51	3.50	3.48	3.44	3.41	3.37

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	50.48	53.39	56.29	59.01	61.69	64.72	67.41	69.96	72.60
Nu	34.43	31.08	28.26	26.01	24.09	22.14	20.64	19.36	18.18
h (W/m²K)	111.28	100.47	91.35	84.07	77.85	71.58	66.71	62.56	58.75
q (kW/m²)	3.37	3.33	3.30	3.26	3.23	3.19	3.15	3.11	3.08

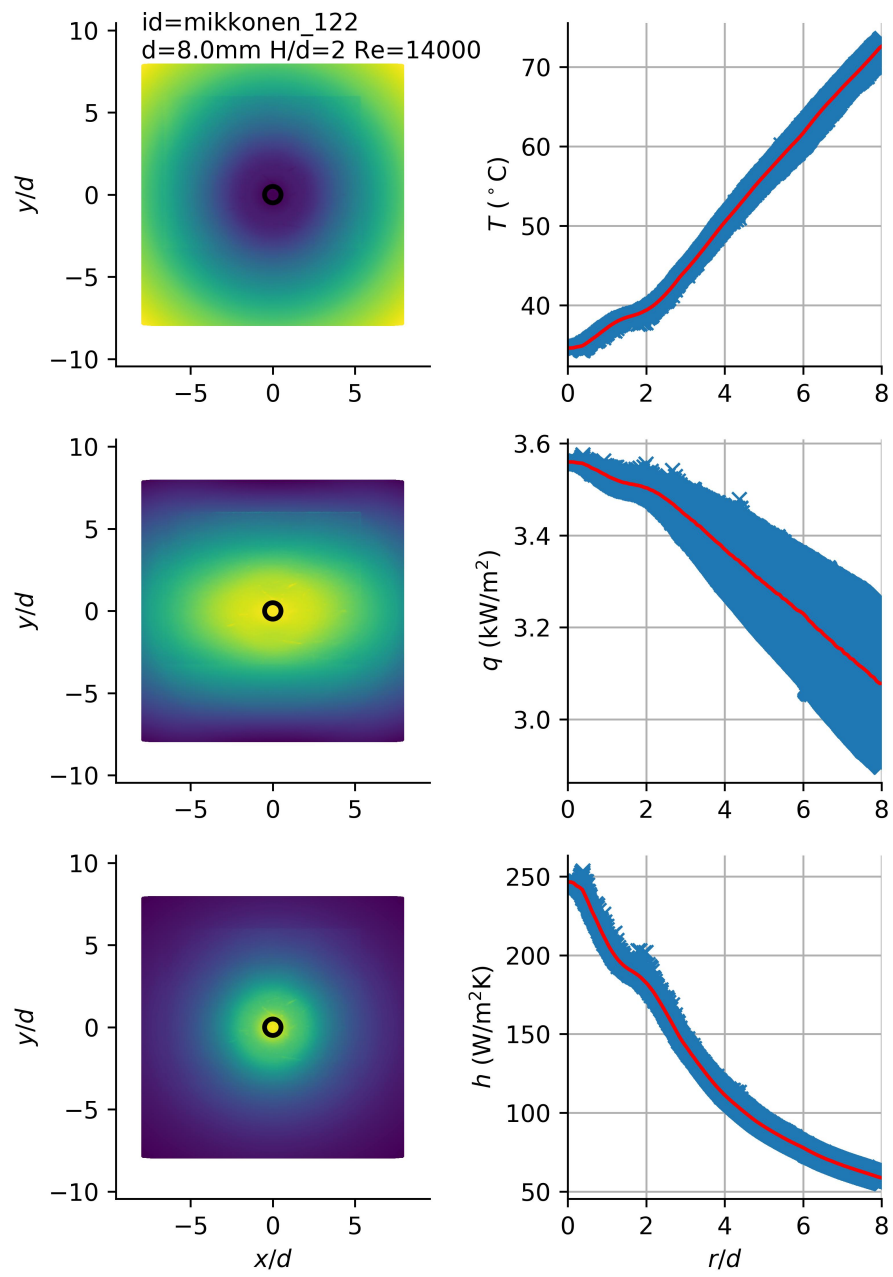


Figure 367: Results, mikkonen_122

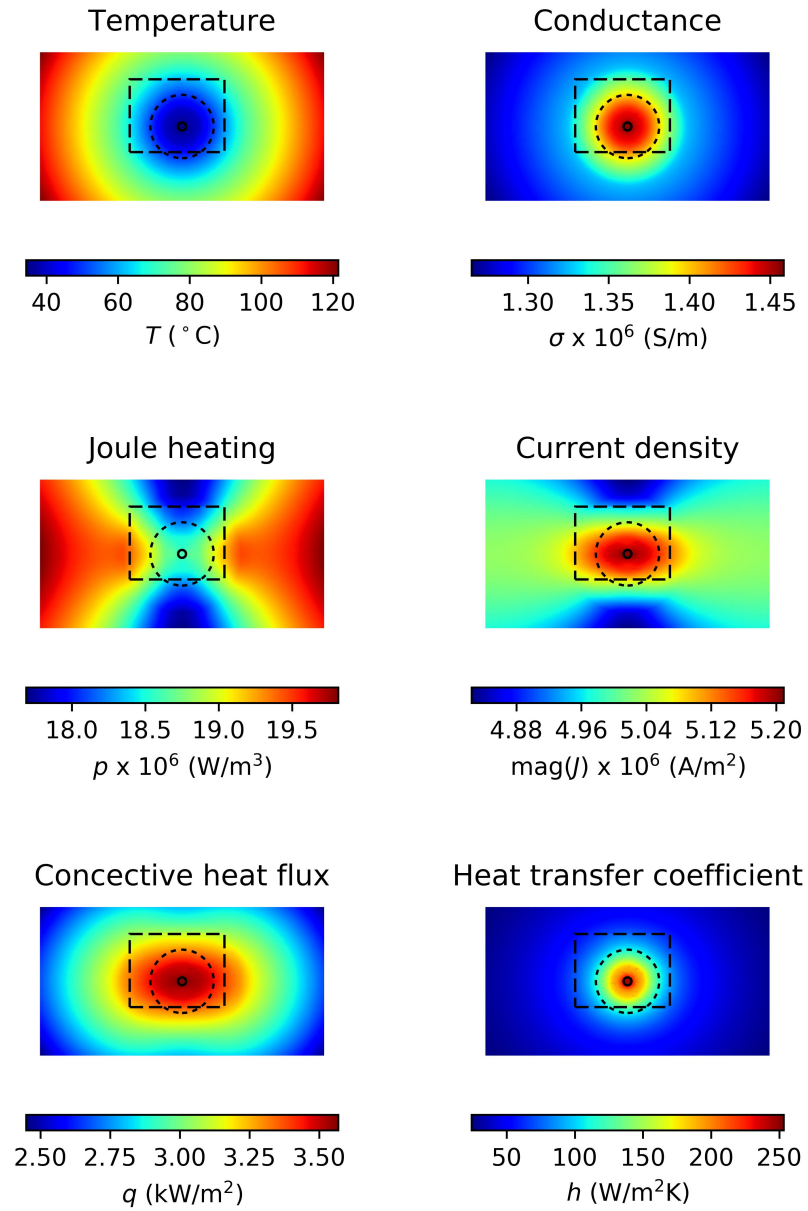


Figure 368: Convection calculation, mikkonen_122

Case id: mikkonen_123

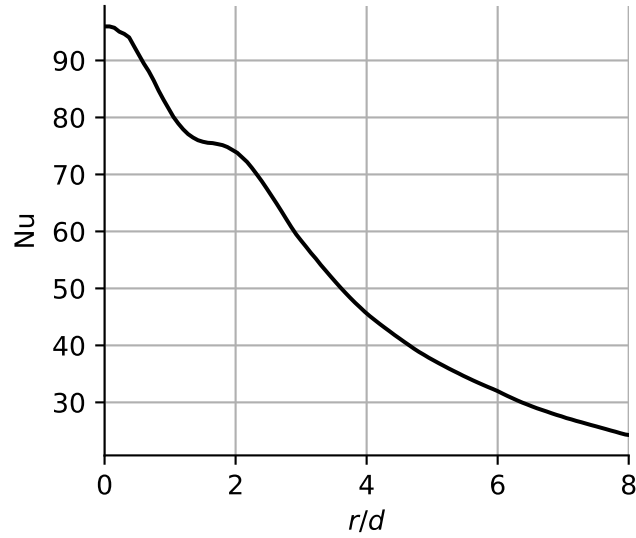


Figure 369: Nu, mikkonen_123

path	2017_03_09_mikko/8d_114Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:35:59

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
19957	0.11	2	0.71	8.0	16.0	19.3	20.2	2.279	38.0

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.2	164.7	3.40	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.11	35.81	37.72	38.90	39.33	41.19	44.13	47.14	50.32
Nu	95.97	91.47	81.11	75.74	73.96	67.09	58.38	51.46	45.61
h (W/m ² K)	309.76	295.24	261.81	244.45	238.72	216.54	188.44	166.09	147.22
q (kW/m ²)	4.62	4.61	4.59	4.57	4.57	4.54	4.51	4.47	4.43

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	50.32	53.26	56.22	59.02	61.80	64.96	67.72	70.30	72.99
Nu	45.61	41.22	37.51	34.53	31.98	29.41	27.44	25.80	24.28
h (W/m ² K)	147.22	133.05	121.07	111.45	103.21	94.91	88.58	83.27	78.37
q (kW/m ²)	4.43	4.40	4.36	4.33	4.29	4.25	4.21	4.17	4.14

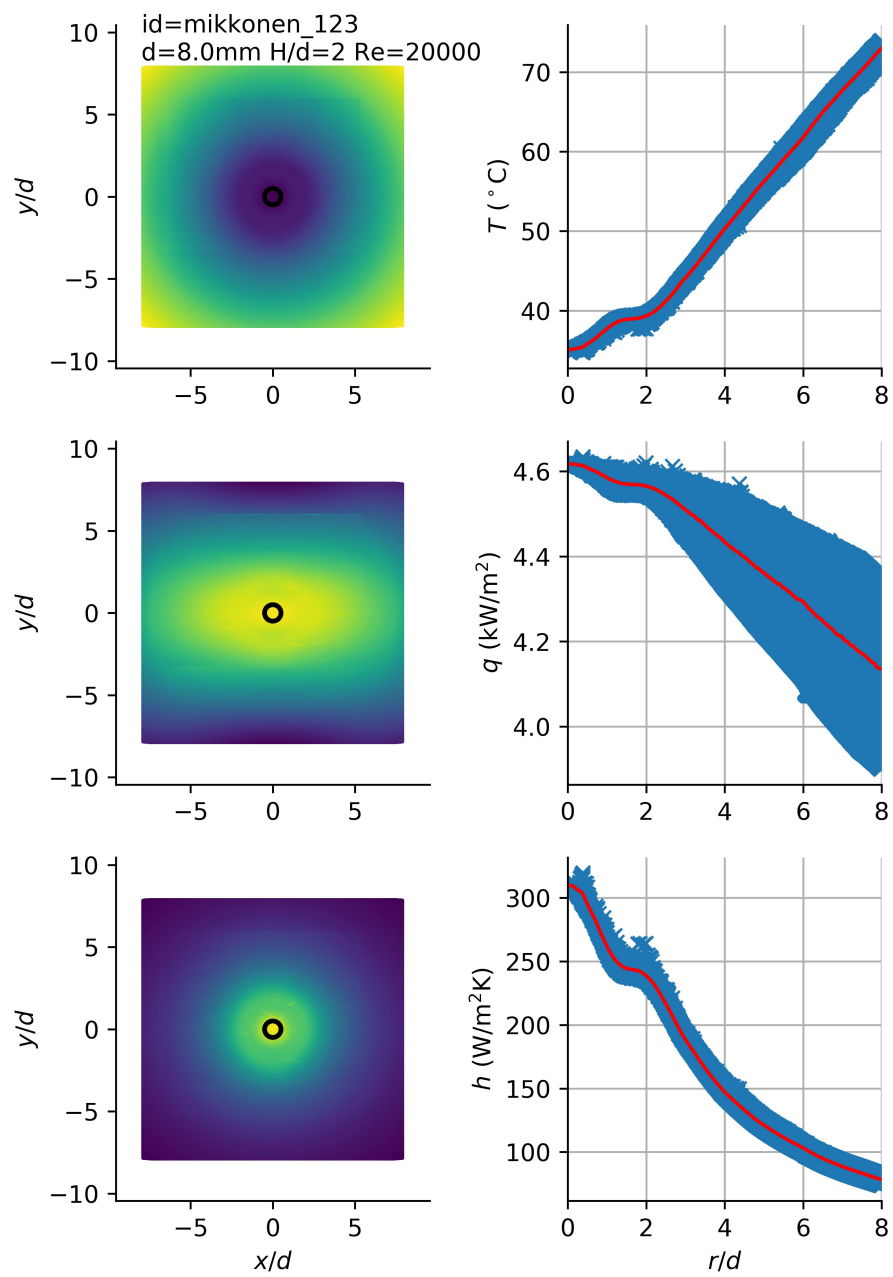


Figure 370: Results, mikkonen_123

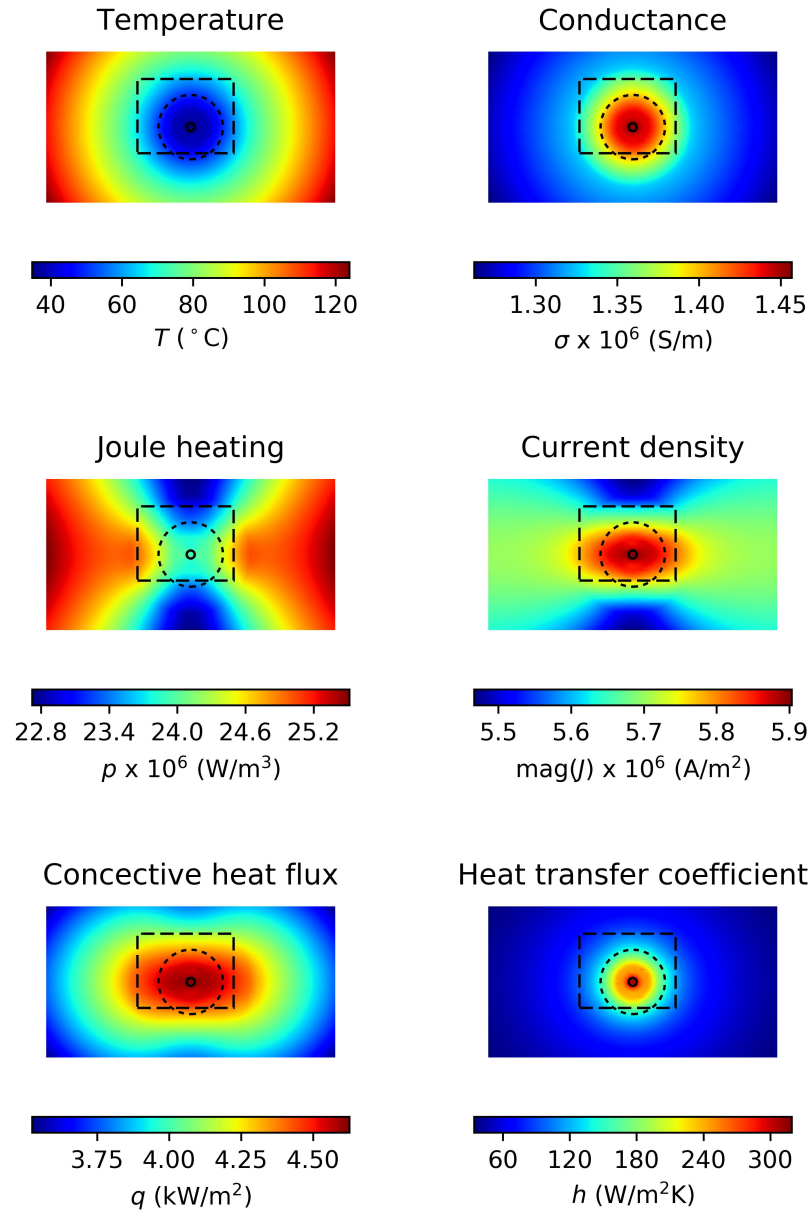


Figure 371: Convection calculation, mikkonen_123

Case id: mikkonen_124

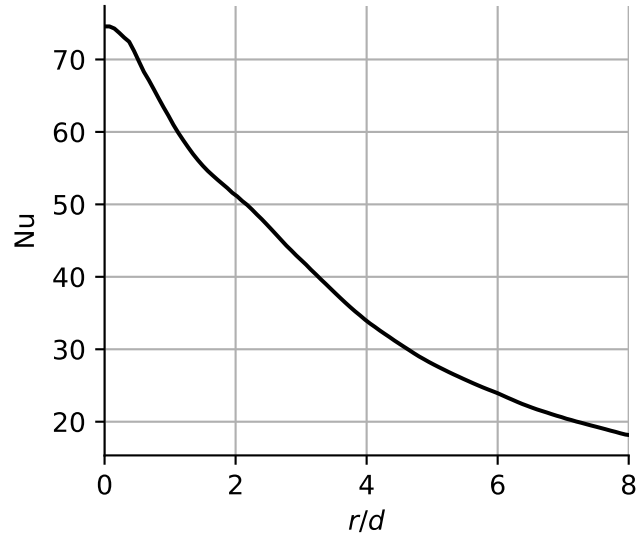


Figure 372: Nu, mikkonen_124

path	2017_03_09_mikko/8d_80Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:42:11

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13997	0.08	4	0.71	8.0	32.0	19.9	20.2	1.601	26.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.1	144.4	3.14	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.69	35.55	37.51	39.42	40.84	42.58	44.84	47.45	50.35
Nu	74.56	70.20	61.82	55.33	51.27	47.00	42.33	37.93	33.92
h (W/m ² K)	241.07	226.98	199.89	178.89	165.76	151.95	136.85	122.64	109.66
q (kW/m ²)	3.49	3.48	3.46	3.44	3.42	3.40	3.37	3.34	3.31

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	50.35	53.10	55.93	58.56	61.16	64.13	66.72	69.17	71.68
Nu	33.92	30.76	28.01	25.82	23.94	22.03	20.56	19.31	18.17
h (W/m ² K)	109.66	99.44	90.56	83.48	77.39	71.22	66.48	62.44	58.75
q (kW/m ²)	3.31	3.27	3.24	3.20	3.17	3.13	3.09	3.06	3.02

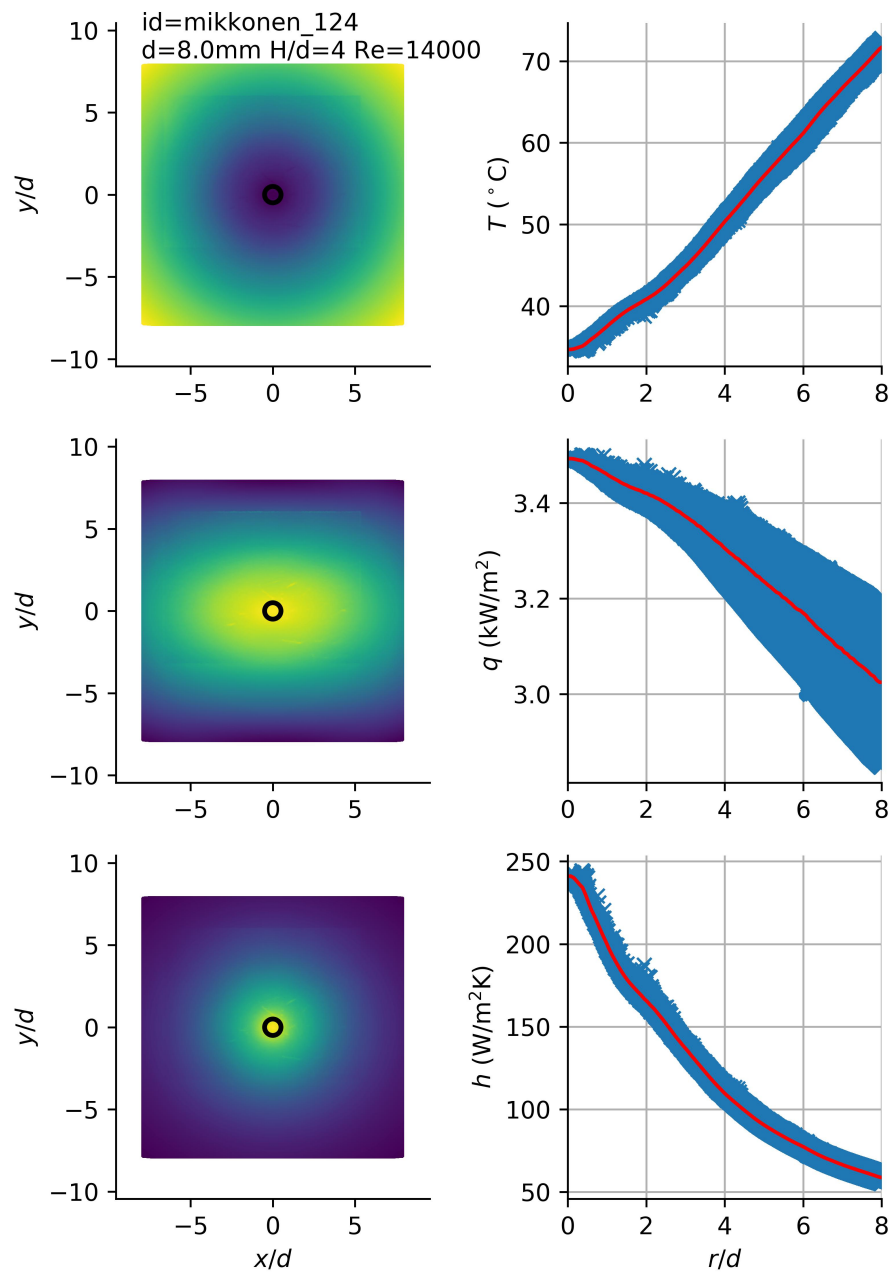


Figure 373: Results, mikkonen_124

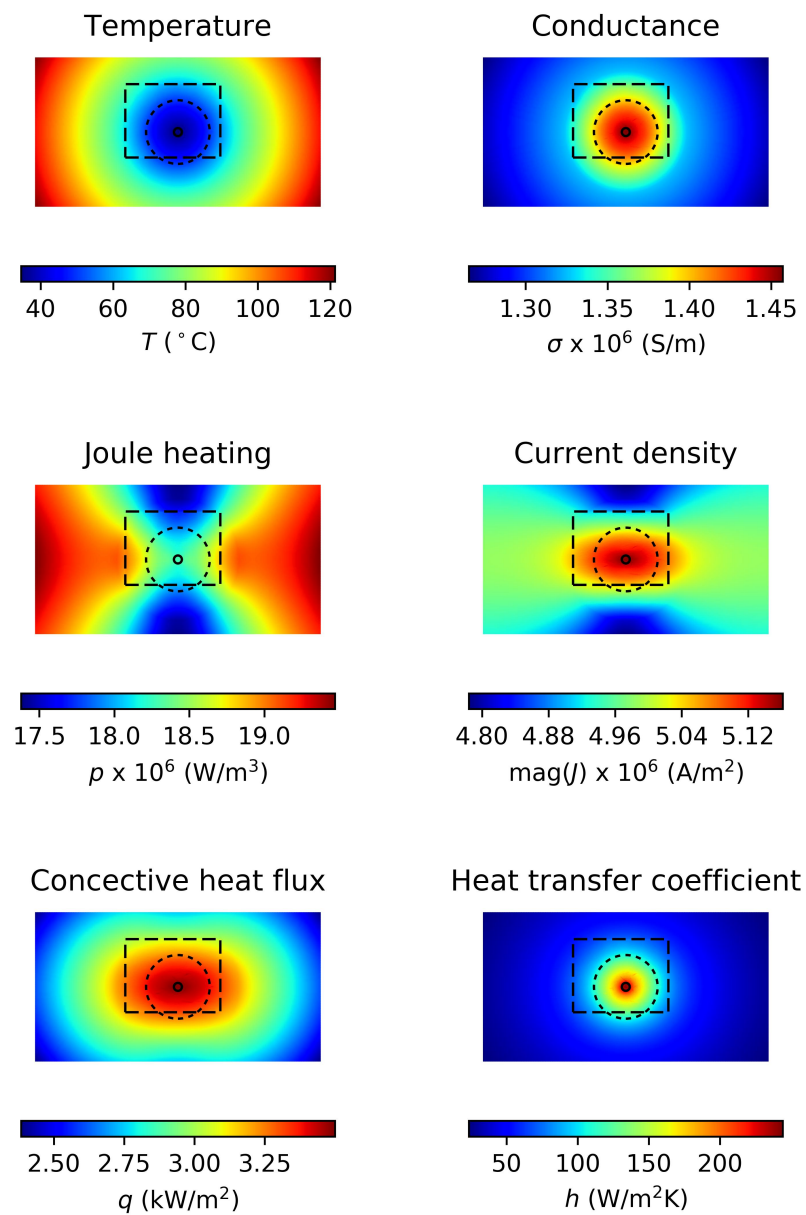


Figure 374: Convection calculation, mikkonen_124

Case id: mikkonen_125

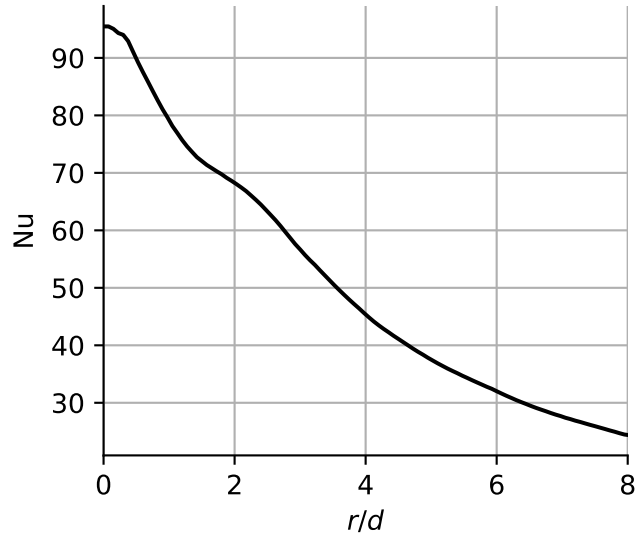


Figure 375: Nu, mikkonen_125

path	2017_03_09_mikko/8d_114Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:46:18

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20058	0.11	4	0.71	8.0	32.0	19.7	20.2	2.293	38.3

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.2	160.2	3.84	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.43	35.29	37.23	38.83	39.81	41.27	43.58	46.13	48.96
Nu	95.48	89.85	79.16	72.05	68.26	63.29	56.68	50.72	45.37
h (W/m²K)	308.52	290.35	255.80	232.83	220.57	204.52	183.16	163.91	146.61
q (kW/m²)	4.39	4.38	4.36	4.34	4.33	4.31	4.28	4.25	4.22

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	48.96	51.68	54.42	57.02	59.67	62.54	65.15	67.61	70.18
Nu	45.37	41.11	37.51	34.59	32.01	29.56	27.59	25.93	24.40
h (W/m²K)	146.61	132.83	121.21	111.76	103.45	95.50	89.16	83.80	78.85
q (kW/m²)	4.22	4.18	4.15	4.11	4.08	4.04	4.01	3.97	3.94

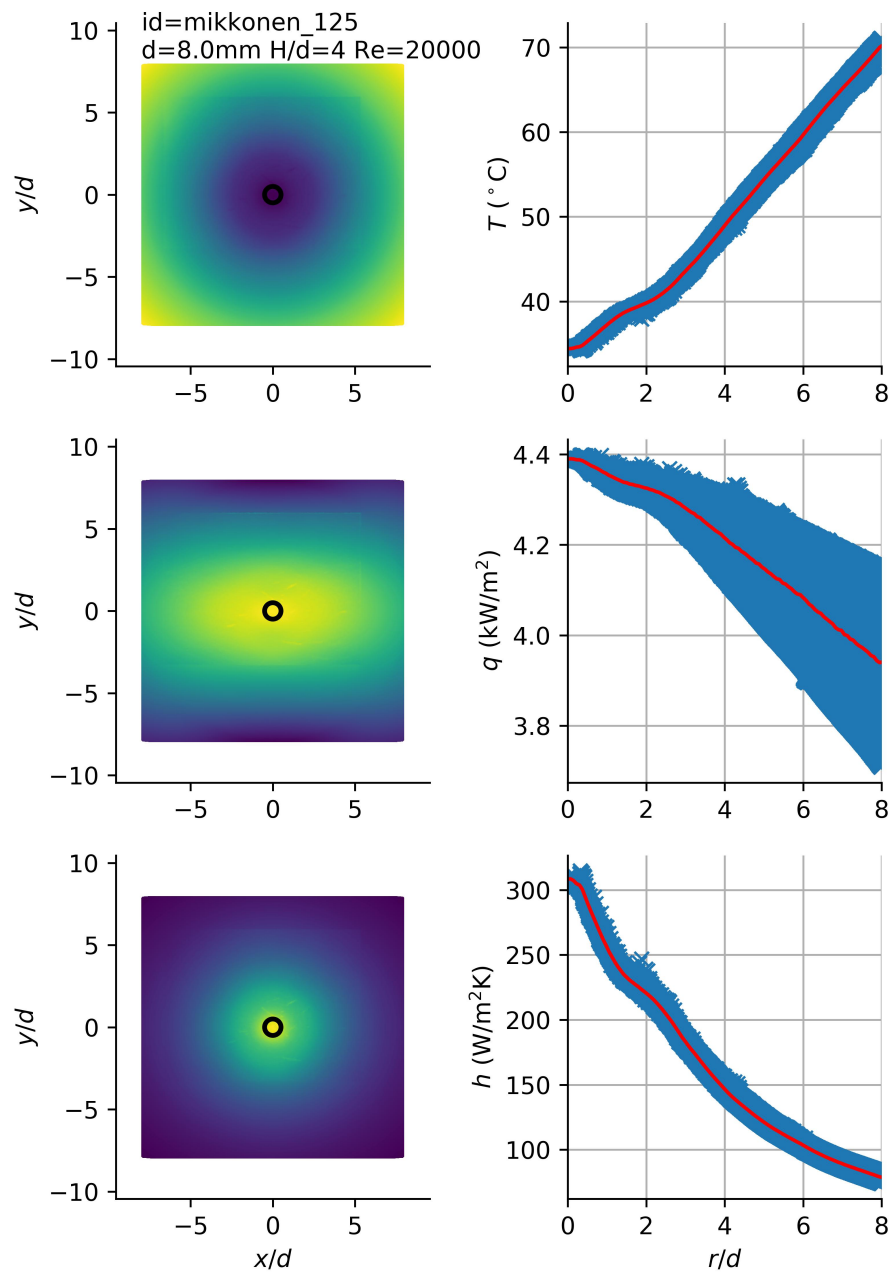


Figure 376: Results, mikkonen_125

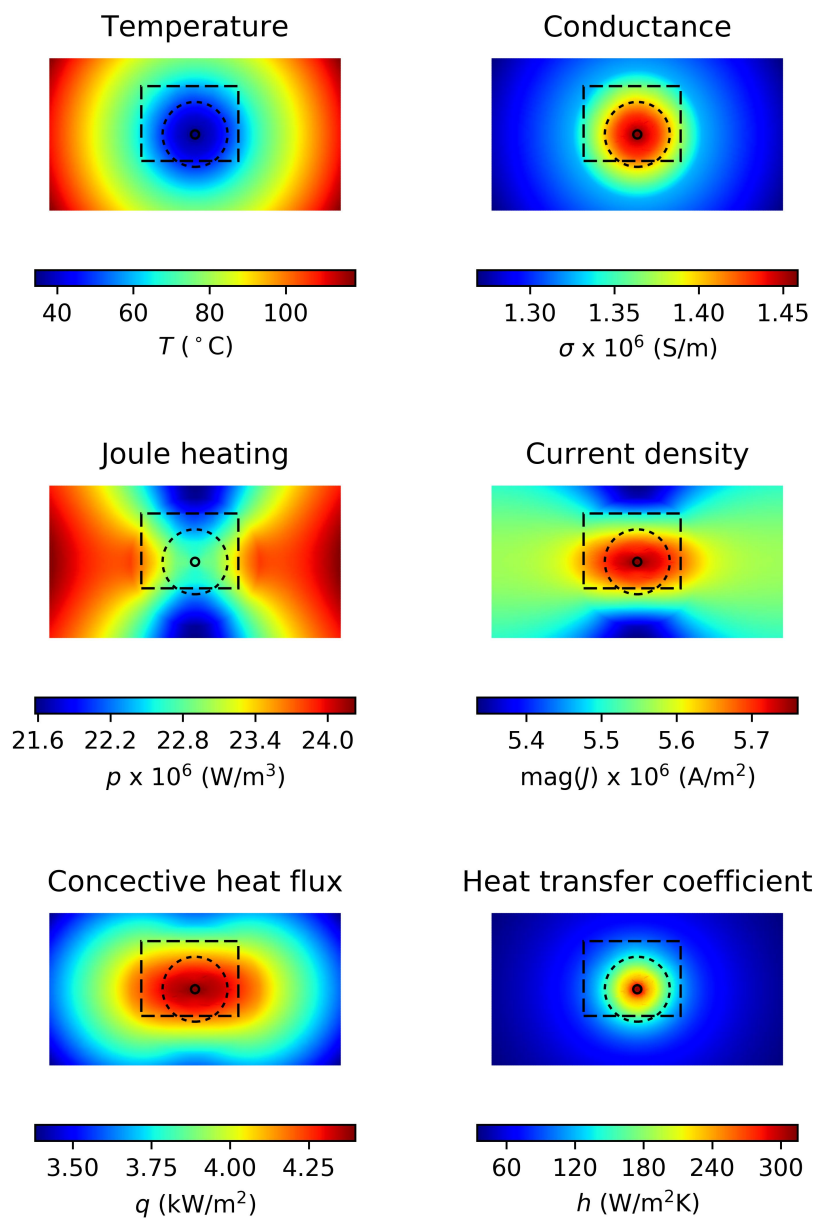


Figure 377: Convection calculation, mikkonen_125

Case id: mikkonen_126

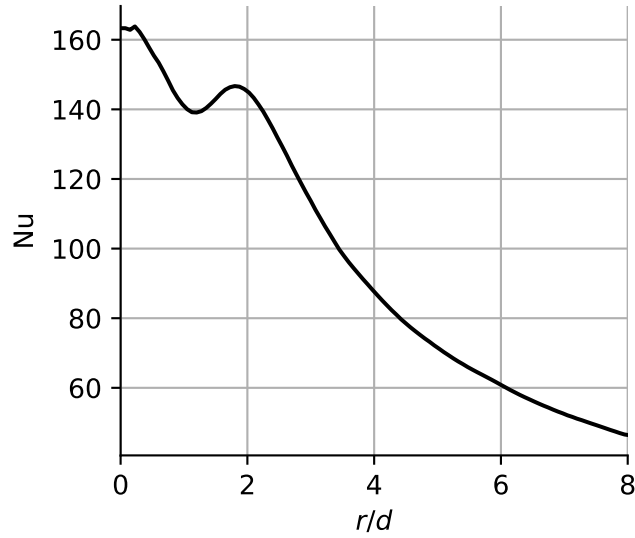


Figure 378: Nu, mikkonen_126

path	2017_03_09_mikko/8d_287Q_1HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:27:43

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50028	0.28	1	0.71	8.0	8.0	19.3	20.2	5.712	95.4

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.6	212.4	3.61	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.96	35.61	37.23	37.00	36.74	38.49	41.19	44.31	47.17
Nu	163.31	156.21	140.98	142.98	145.17	131.02	113.70	98.49	87.63
h (W/m ² K)	527.12	504.18	455.04	461.48	468.54	422.89	366.98	317.89	282.84
q (kW/m ²)	7.78	7.77	7.75	7.75	7.75	7.73	7.70	7.66	7.63
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.17	50.16	52.93	55.67	58.35	61.24	63.99	66.57	69.22
Nu	87.63	78.52	71.54	65.73	60.85	56.27	52.48	49.31	46.46
h (W/m ² K)	282.84	253.42	230.91	212.14	196.40	181.61	169.39	159.16	149.94
q (kW/m ²)	7.63	7.59	7.56	7.52	7.49	7.45	7.42	7.38	7.35

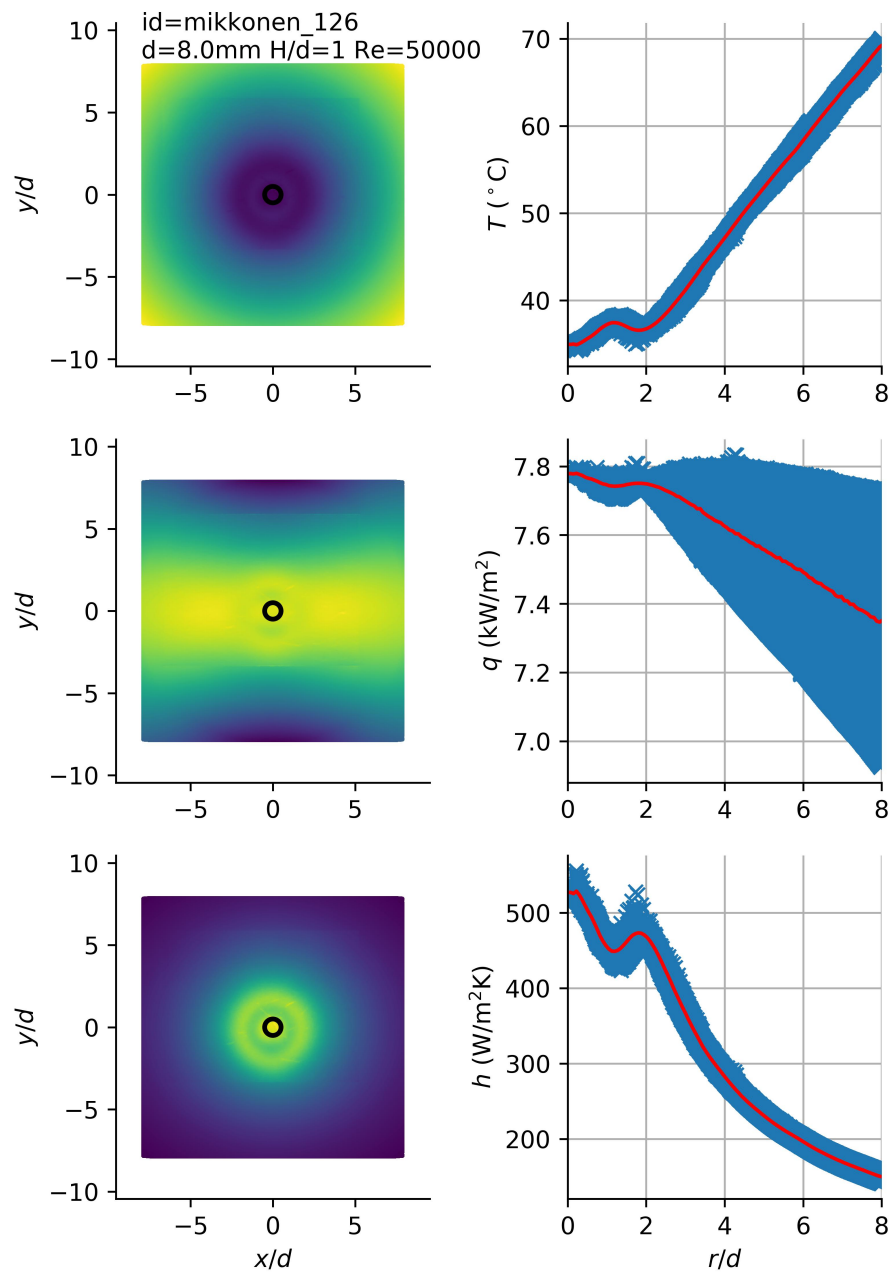


Figure 379: Results, mikkonen_126

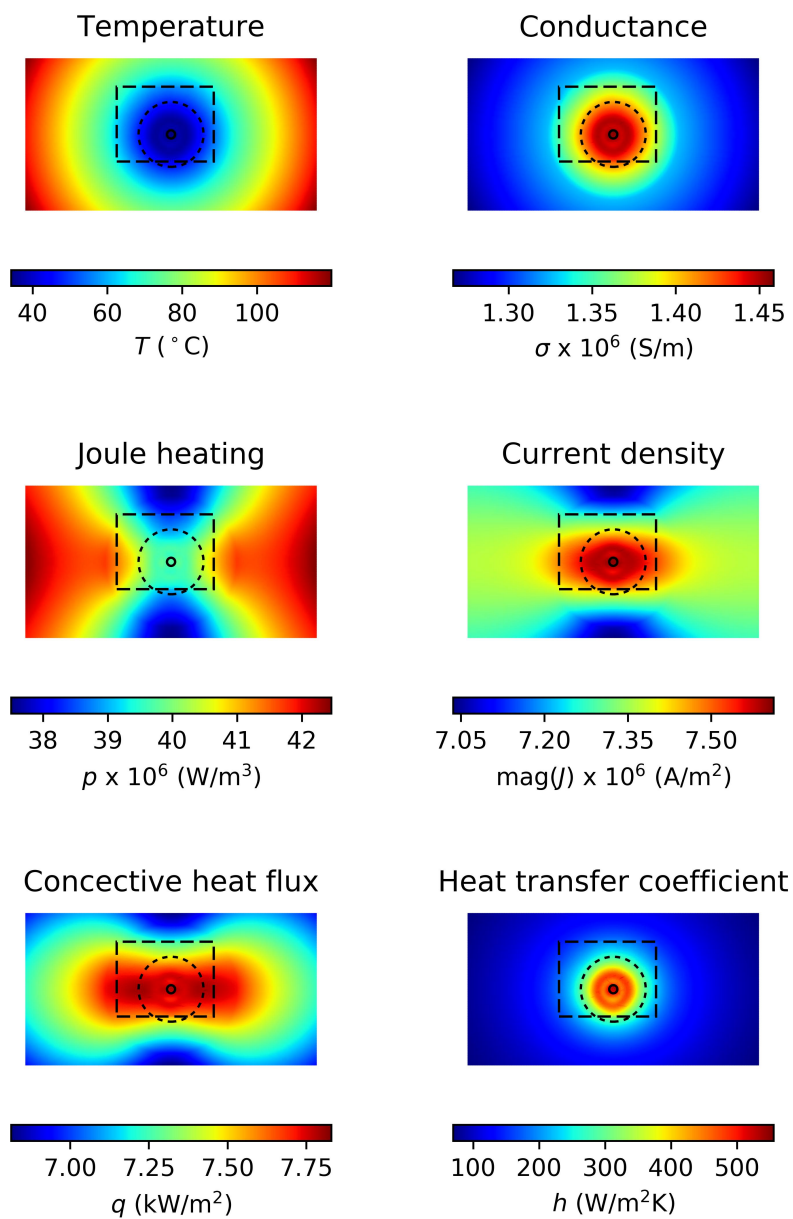


Figure 380: Convection calculation, mikkonen_126

Case id: mikkonen_127

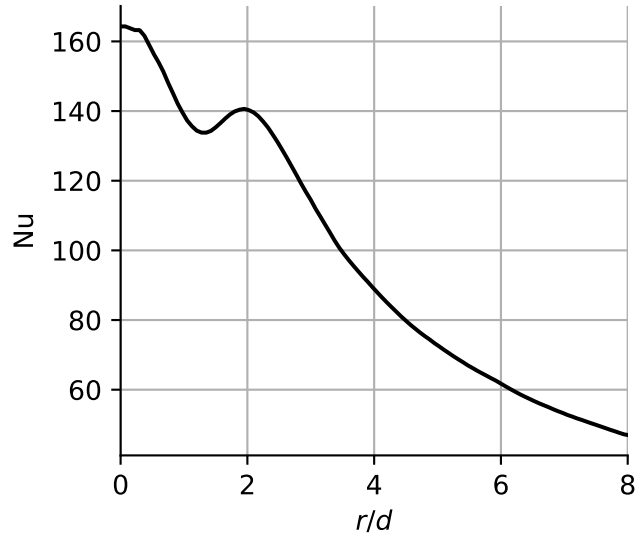


Figure 381: Nu, mikkonen_127

path	2017_03_09_mikko/8d_287Q_2HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:32:23

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50080	0.28	2	0.71	8.0	16.0	19.3	20.2	5.718	95.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.6	212.3	3.71	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.87	35.51	37.48	37.92	37.29	38.58	41.05	44.07	46.80
Nu	164.30	157.22	138.85	135.34	140.38	130.37	114.51	99.53	88.91
h (W/m ² K)	530.31	507.46	448.15	436.81	453.10	420.79	369.58	321.25	286.97
q (kW/m ²)	7.78	7.77	7.74	7.74	7.74	7.73	7.70	7.67	7.63
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.80	49.70	52.42	55.16	57.85	60.80	63.51	66.08	68.72
Nu	88.91	79.81	72.75	66.76	61.74	56.94	53.13	49.90	47.00
h (W/m ² K)	286.97	257.61	234.82	215.48	199.26	183.78	171.48	161.07	151.70
q (kW/m ²)	7.63	7.60	7.57	7.53	7.50	7.46	7.43	7.39	7.36

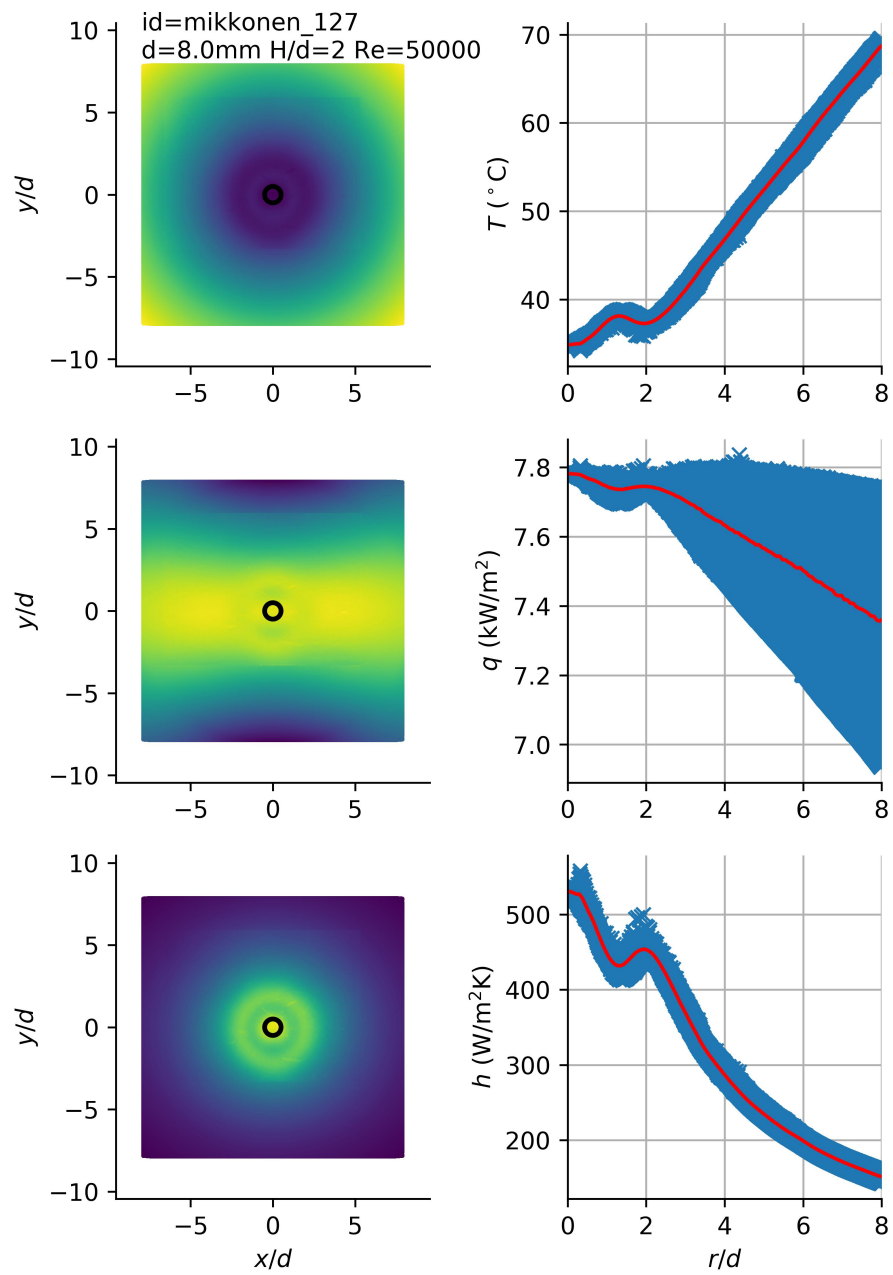


Figure 382: Results, mikkonen_127

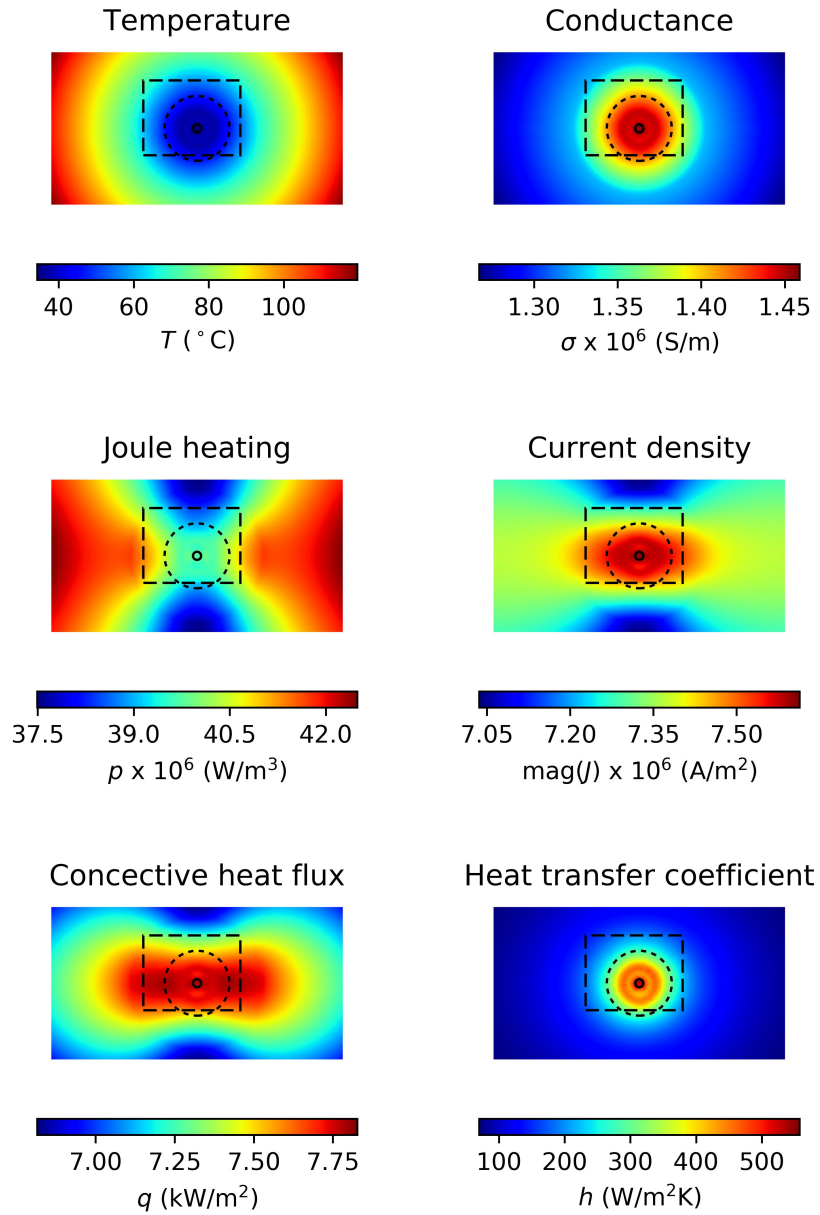


Figure 383: Convection calculation, mikkonen_127

Case id: mikkonen_128

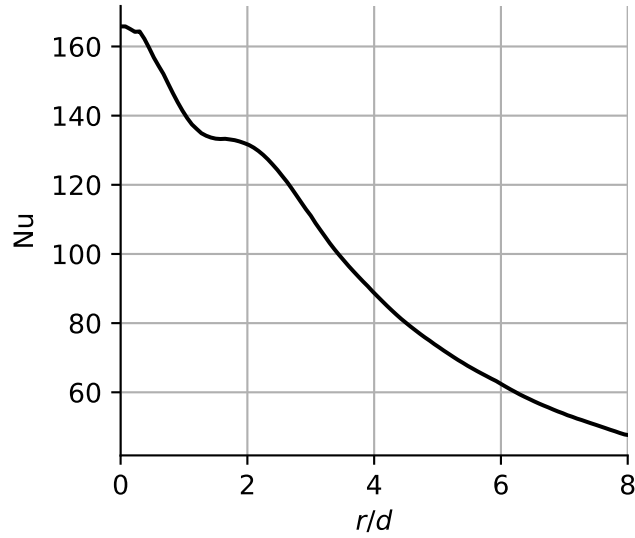


Figure 384: Nu, mikkonen_128

path	2017_03_09_mikko/8d_287Q_4HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:49:23

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50036	0.28	4	0.71	8.0	32.0	19.3	20.2	5.713	95.4

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.6	213.5	4.13	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.04	35.78	37.61	38.54	38.77	39.93	42.11	44.78	47.41
Nu	165.80	157.71	140.75	133.35	131.70	123.70	111.09	98.59	88.70
h (W/m ² K)	535.13	509.02	454.29	430.39	425.06	399.27	358.55	318.21	286.31
q (kW/m ²)	7.94	7.93	7.91	7.89	7.89	7.88	7.85	7.82	7.79

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	47.41	50.20	52.85	55.56	58.22	61.19	63.91	66.44	69.08
Nu	88.70	80.12	73.30	67.40	62.43	57.60	53.76	50.57	47.66
h (W/m ² K)	286.31	258.60	236.60	217.55	201.51	185.90	173.52	163.23	153.83
q (kW/m ²)	7.79	7.76	7.72	7.69	7.66	7.62	7.58	7.55	7.52

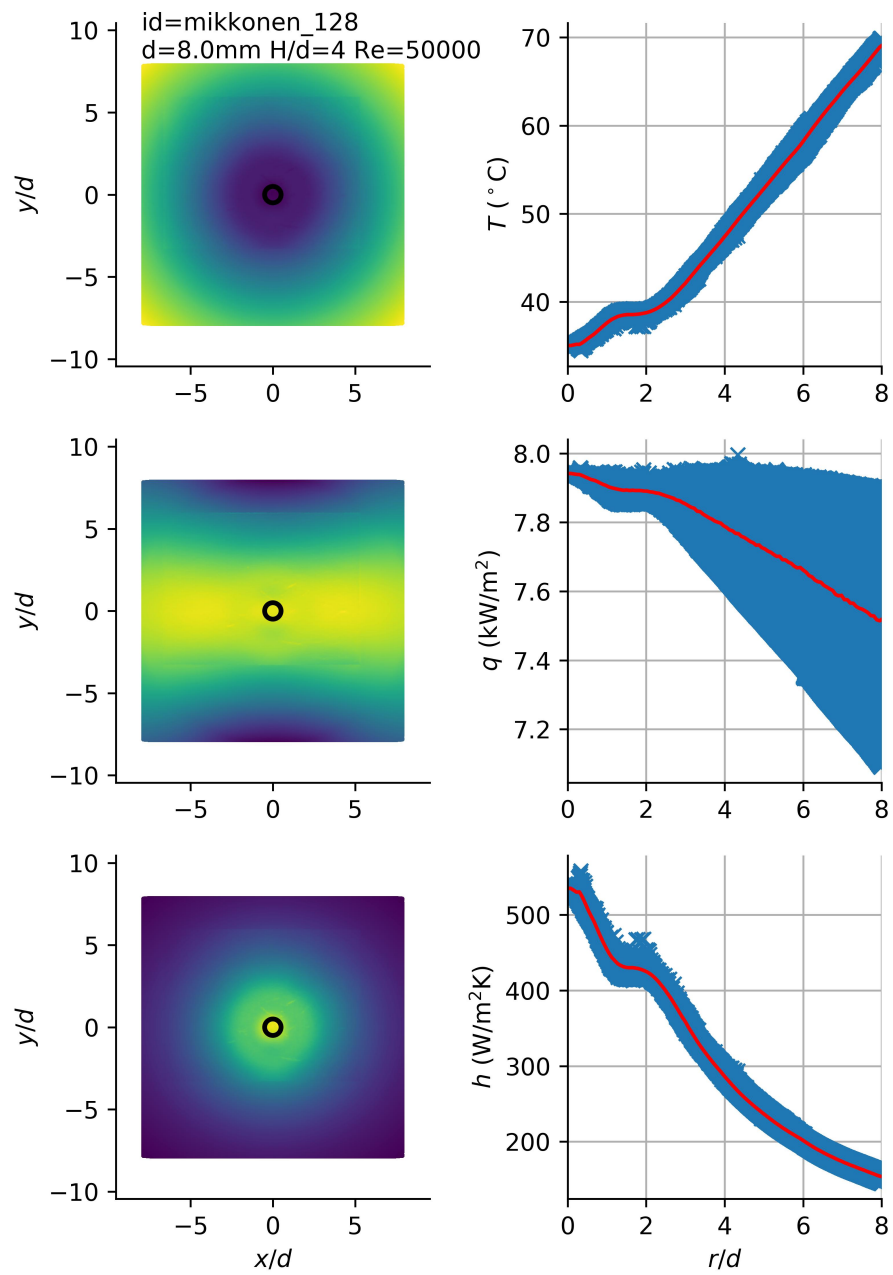


Figure 385: Results, mikkonen_128

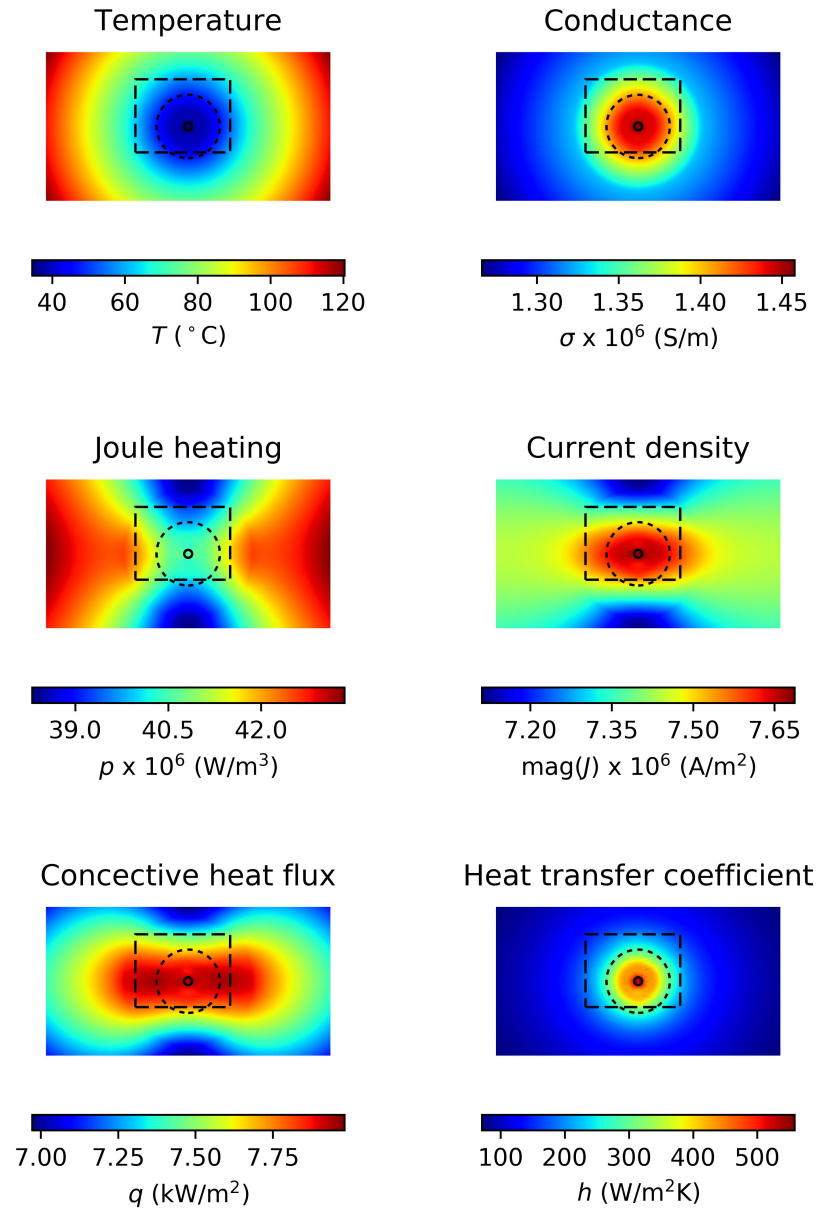


Figure 386: Convection calculation, mikkonen_128

Case id: mikkonen_129

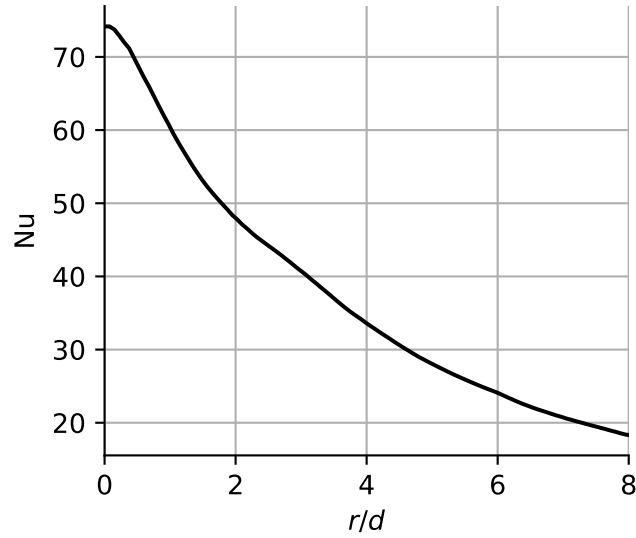


Figure 387: Nu, mikkonen_129

path	2017_03_09_mikko/8d_80Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:58:40

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14053	0.08	6	0.71	8.0	48.0	19.8	20.2	1.607	26.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.1	145.4	3.56	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.11	36.18	38.33	40.66	42.68	44.44	46.33	48.73	51.33
Nu	74.17	68.98	60.39	53.07	47.98	44.20	40.73	37.01	33.60
h (W/m²K)	239.73	222.98	195.19	171.53	155.09	142.88	131.67	119.62	108.59
q (kW/m²)	3.57	3.56	3.54	3.51	3.49	3.46	3.44	3.41	3.38

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	51.33	54.02	56.74	59.35	61.90	64.90	67.51	69.97	72.52
Nu	33.60	30.62	28.05	25.91	24.09	22.19	20.73	19.48	18.33
h (W/m²K)	108.59	98.98	90.65	83.75	77.87	71.71	66.99	62.96	59.25
q (kW/m²)	3.38	3.35	3.31	3.28	3.25	3.21	3.17	3.13	3.10

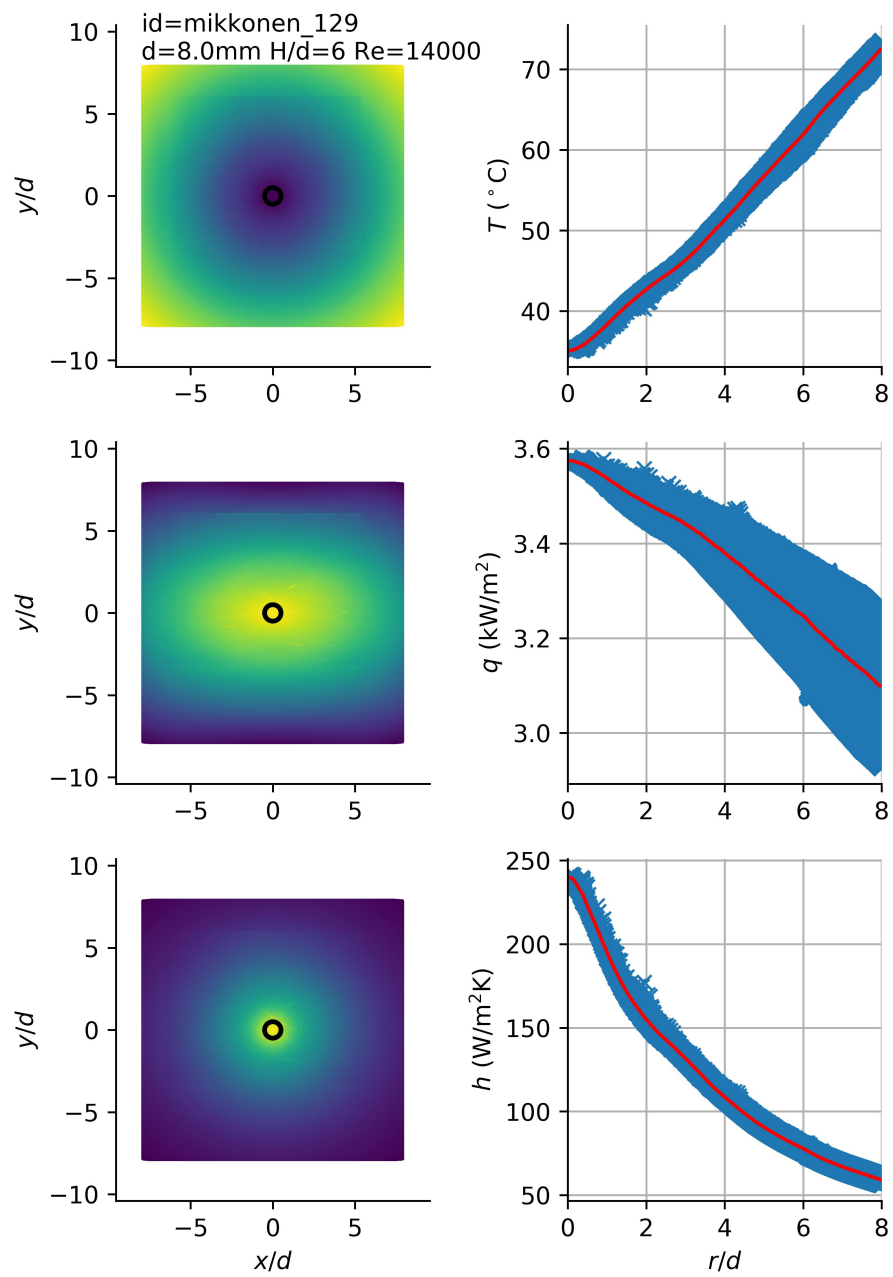


Figure 388: Results, mikkonen_129

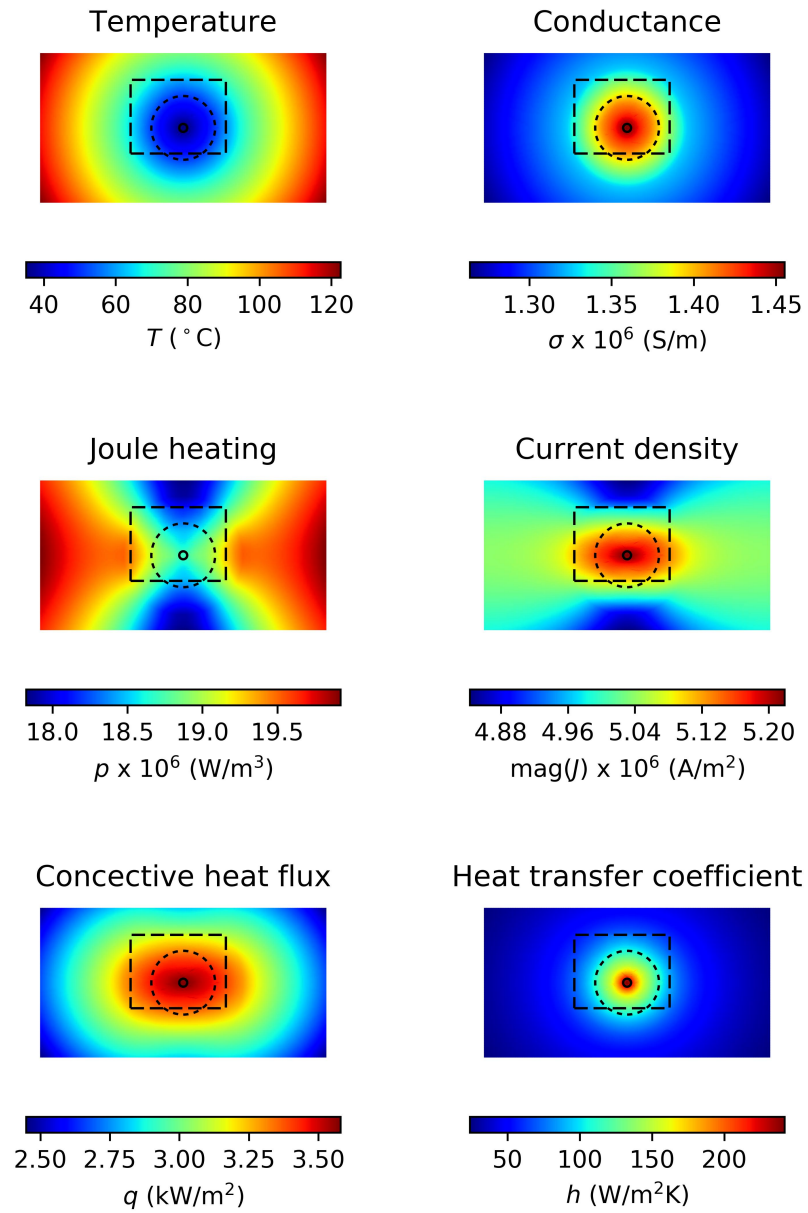


Figure 389: Convection calculation, mikkonen_129

Case id: mikkonen_130

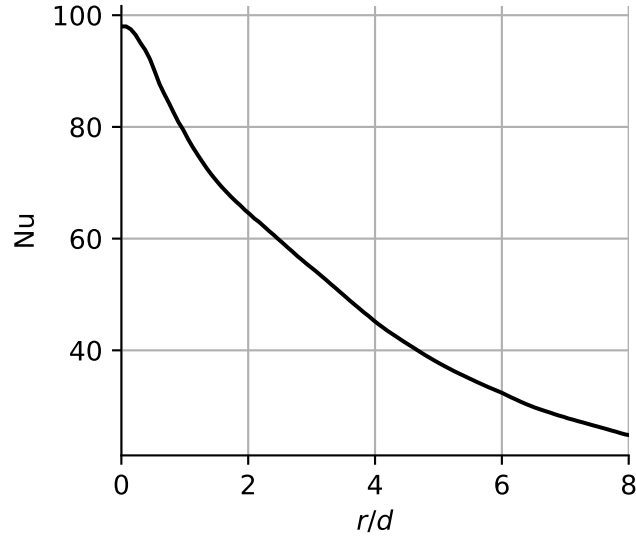


Figure 390: Nu, mikkonen_130

path	2017_03_09_mikko/8d_114Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:55:17

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20046	0.11	6	0.71	8.0	48.0	19.6	20.2	2.291	38.3

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.2	160.8	4.01	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.23	35.32	37.47	39.47	41.09	42.72	44.60	46.81	49.41
Nu	97.99	90.71	78.94	70.35	64.62	59.66	54.77	49.94	45.16
h (W/m ² K)	316.55	293.03	255.02	227.26	208.75	192.72	176.94	161.32	145.90
q (kW/m ²)	4.44	4.43	4.40	4.38	4.36	4.34	4.32	4.29	4.26

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	49.41	51.96	54.61	57.14	59.71	62.66	65.10	67.44	69.96
Nu	45.16	41.23	37.77	34.90	32.40	29.85	27.99	26.38	24.85
h (W/m ² K)	145.90	133.18	122.00	112.75	104.66	96.41	90.41	85.23	80.27
q (kW/m ²)	4.26	4.23	4.20	4.16	4.13	4.09	4.06	4.03	3.99

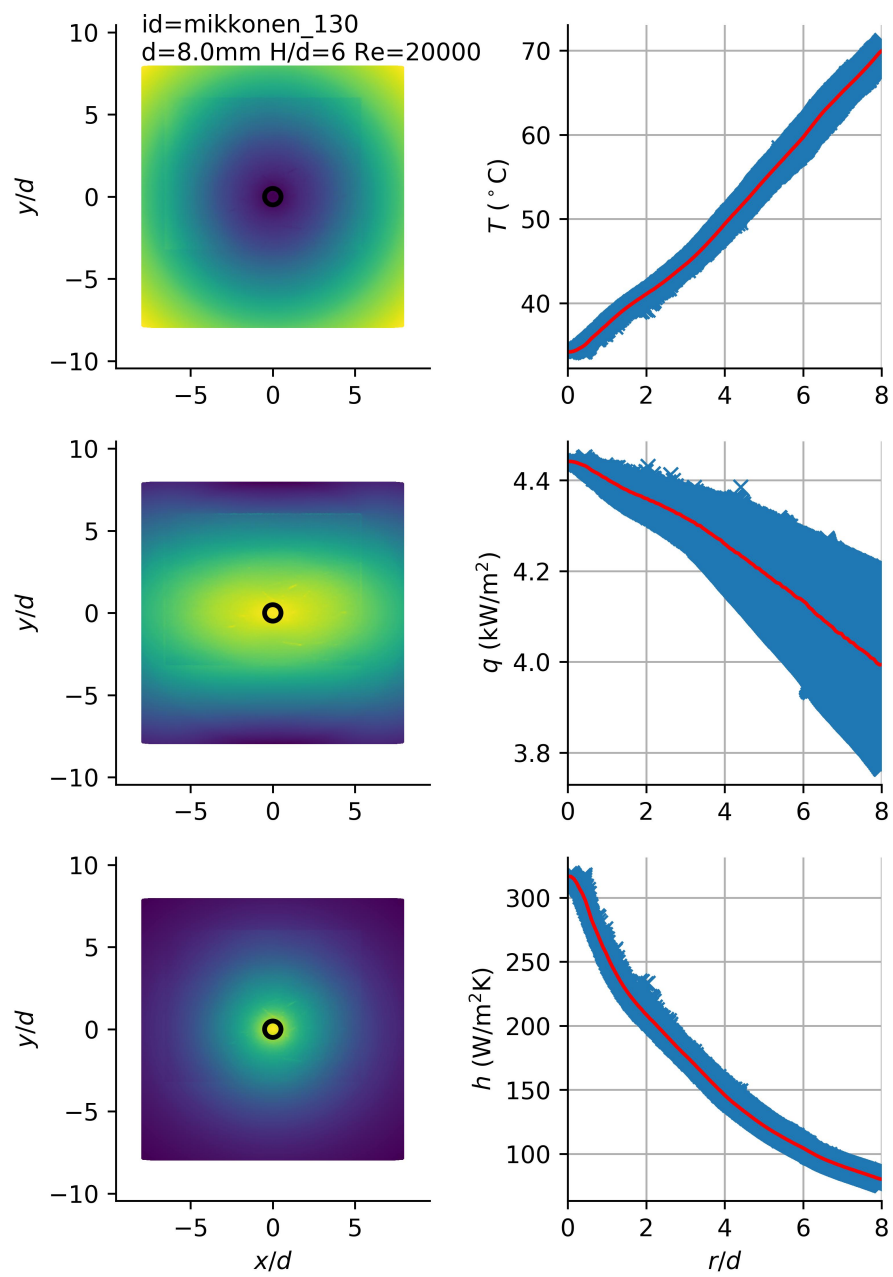


Figure 391: Results, mikkonen_130

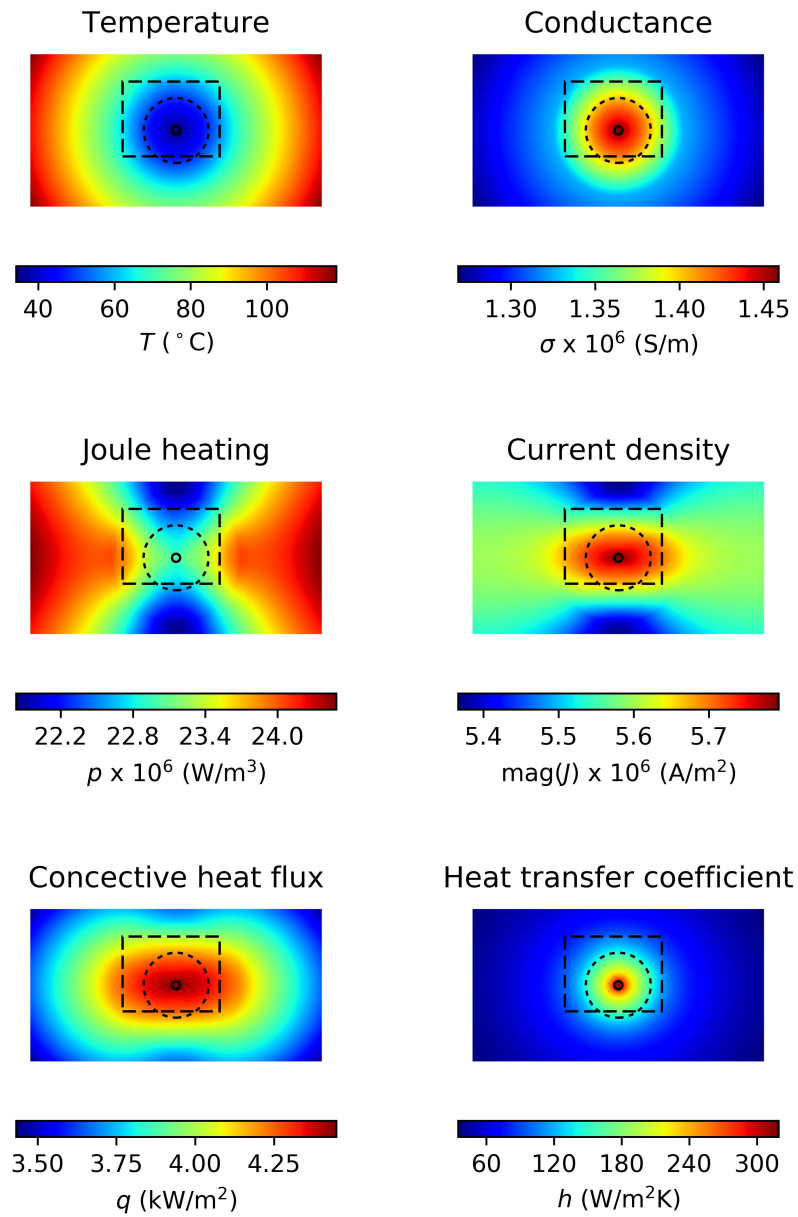


Figure 392: Convection calculation, mikkonen_130

Case id: mikkonen_131

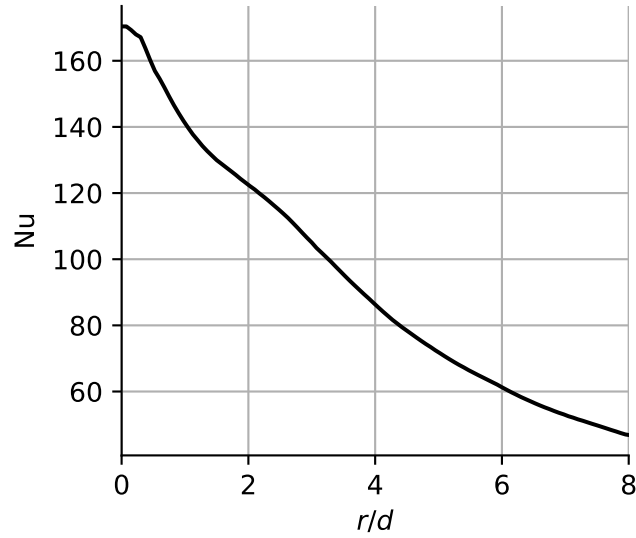


Figure 393: Nu, mikkonen_131

path	2017_03_09_mikko/8d_287Q_6HD
this case measured by	Mikko Pirttiniemi
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-09 18:51:53

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
50299	0.28	6	0.71	8.0	48.0	19.3	20.2	5.743	95.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.6	213.4	4.07	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.64	35.74	37.54	38.99	40.11	41.42	43.31	45.55	48.11
Nu	170.38	158.03	141.16	129.96	122.48	114.67	105.04	95.39	86.32
h (W/m ² K)	549.94	510.07	455.61	419.46	395.32	370.11	339.04	307.89	278.62
q (kW/m ²)	7.94	7.92	7.90	7.88	7.87	7.85	7.83	7.81	7.77

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	48.11	50.80	53.45	56.14	58.86	61.82	64.54	67.10	69.80
Nu	86.32	78.40	71.85	66.20	61.28	56.62	52.90	49.77	46.86
h (W/m ² K)	278.62	253.05	231.92	213.67	197.80	182.75	170.74	160.65	151.25
q (kW/m ²)	7.77	7.74	7.71	7.68	7.65	7.61	7.57	7.53	7.50

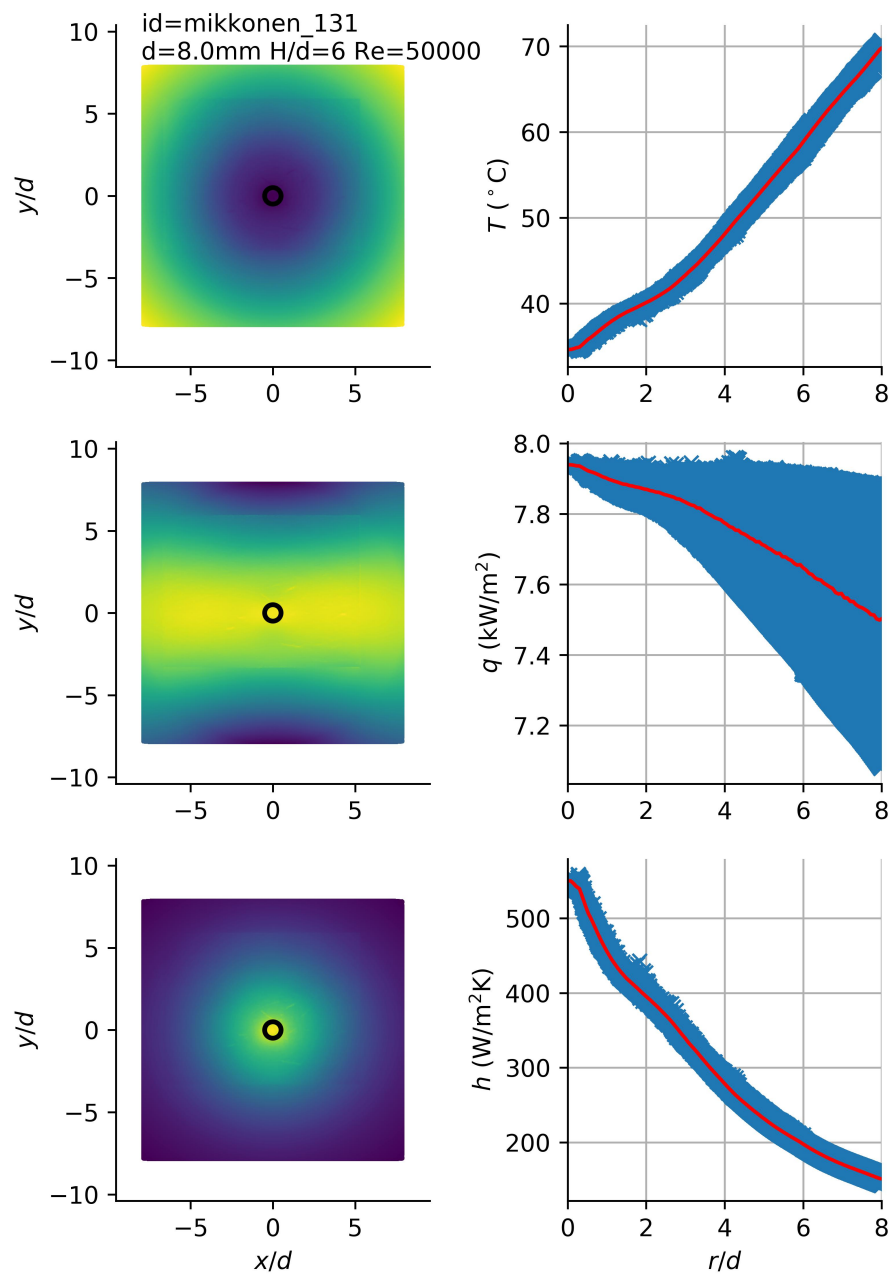


Figure 394: Results, mikkonen_131

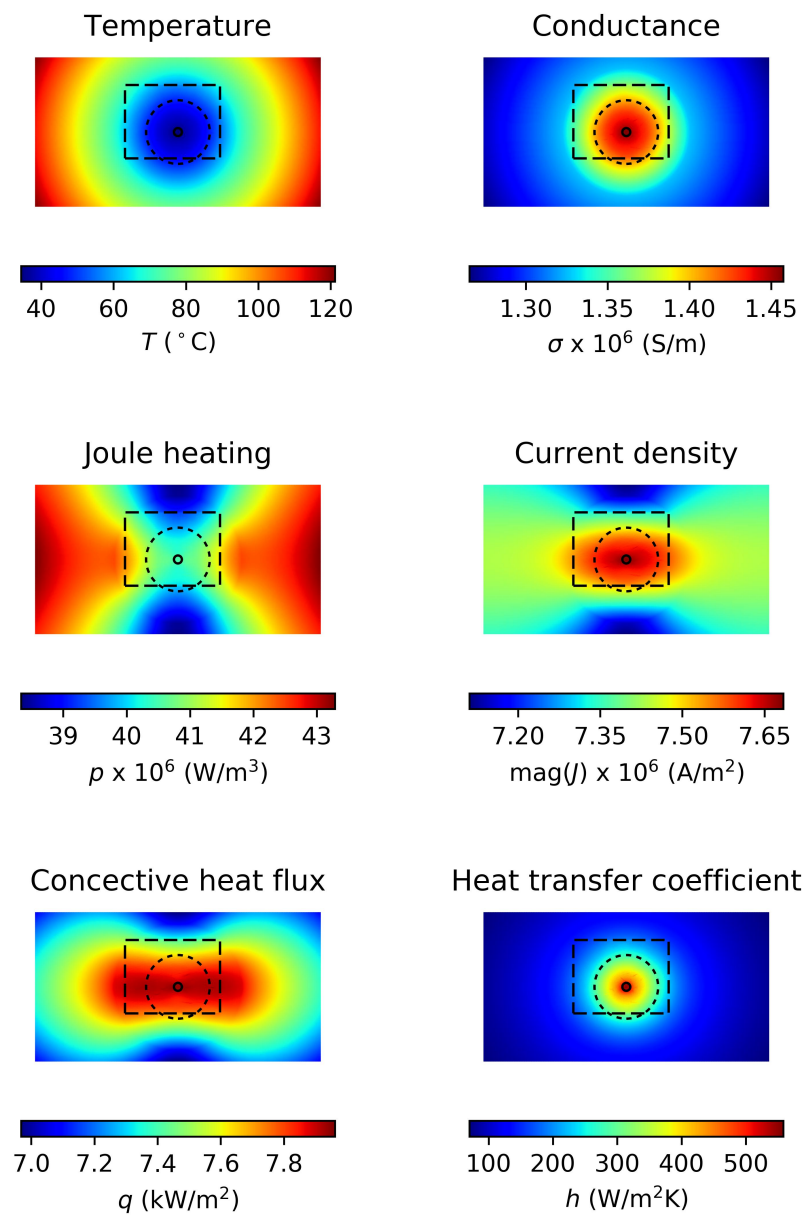


Figure 395: Convection calculation, mikkonen_131

Case id: mikkonen_132

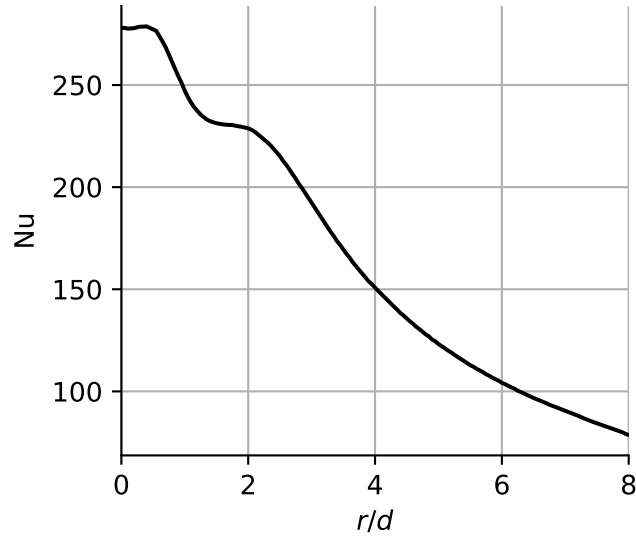


Figure 396: Nu, mikkonen_132

path	2017_03_10_Tsarja/6mm_Q392_Hd4_T34
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 10:51:46

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
93596	0.70	4	0.71	6.0	24.0	19.8	20.5	8.025	238.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.5	317.2	3.65	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.53	35.58	37.41	38.54	38.74	39.89	42.17	45.07	48.06
Nu	277.97	277.30	247.16	231.28	228.78	215.18	192.42	169.42	150.75
h (W/m ² K)	1197.98	1195.07	1065.21	996.77	986.00	927.36	829.27	730.15	649.70
q (kW/m ²)	18.01	18.01	18.00	17.98	17.98	17.96	17.94	17.90	17.87

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	48.06	51.08	54.11	57.11	60.07	63.05	65.94	69.11	72.46
Nu	150.75	135.65	123.17	112.86	104.23	96.78	90.42	84.33	78.67
h (W/m ² K)	649.70	584.62	530.83	486.42	449.22	417.11	389.68	363.45	339.03
q (kW/m ²)	17.87	17.83	17.80	17.76	17.73	17.70	17.66	17.63	17.59

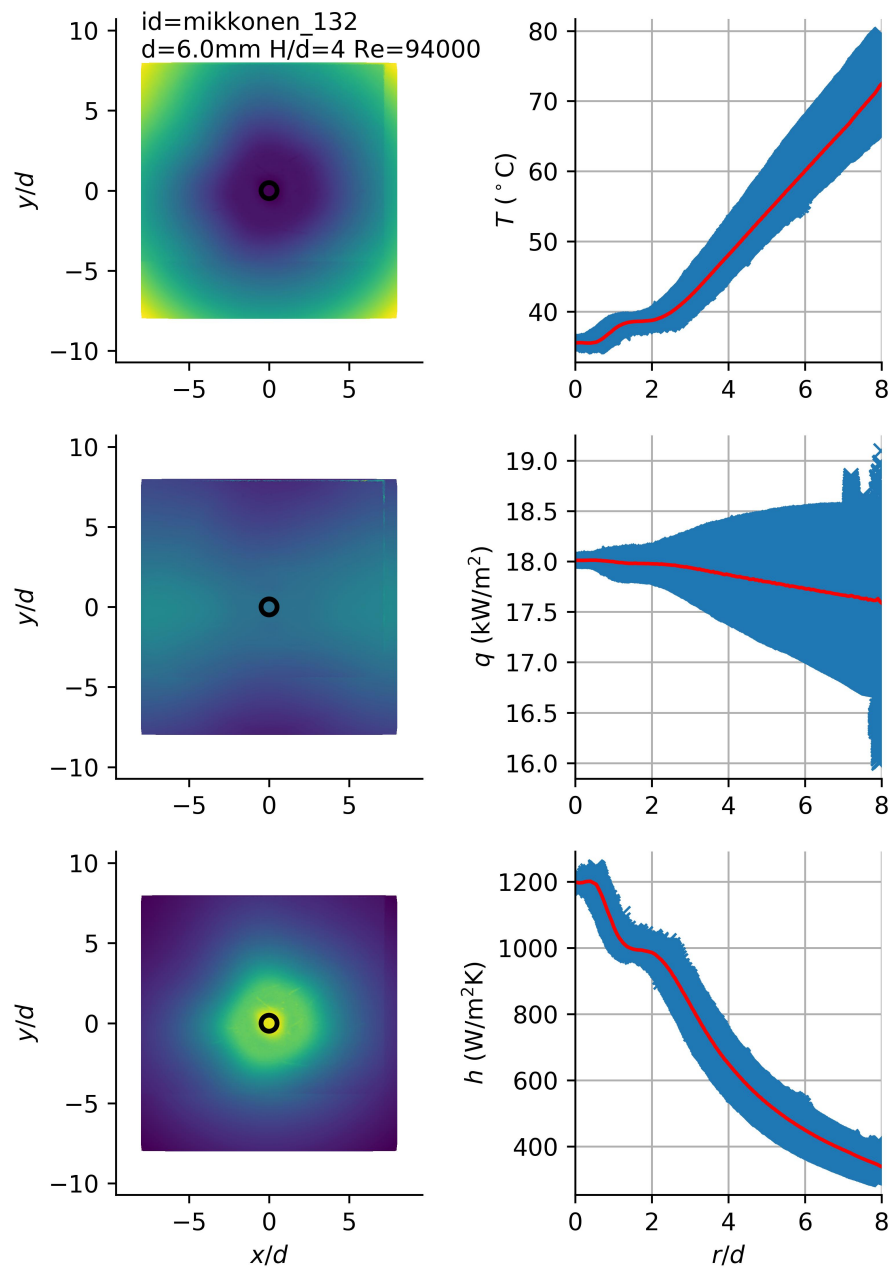


Figure 397: Results, mikkonen_132

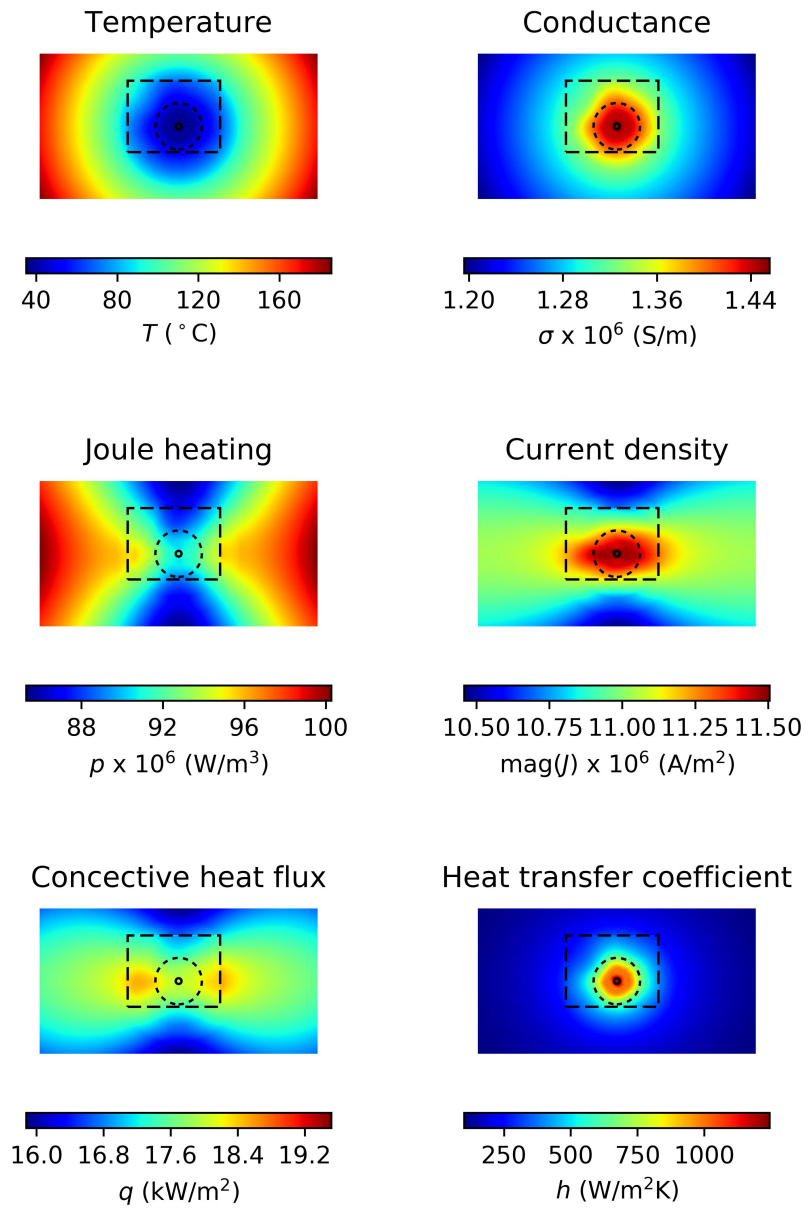


Figure 398: Convection calculation, mikkonen_132

Case id: mikkonen_133

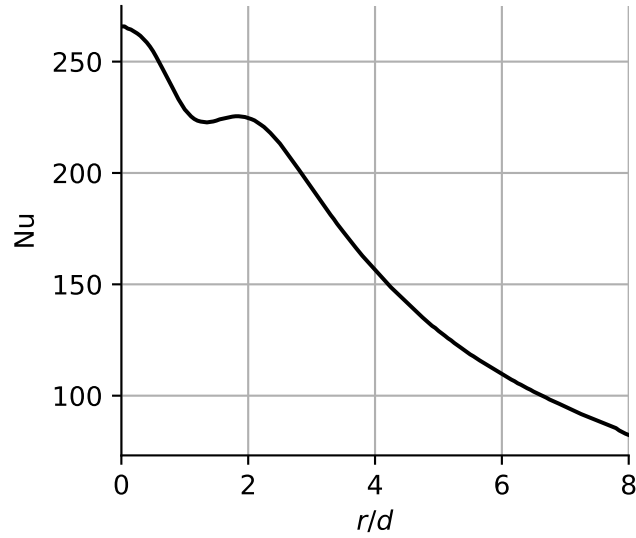


Figure 399: Nu, mikkonen_133

path	2017_03_10_Tsarja/6mm_Q392_Hd4_T50
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 10:56:19

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
93536	0.70	4	0.71	6.0	24.0	19.9	20.7	8.022	238.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	3.5	421.8	5.90	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	51.00	52.33	55.94	56.71	56.53	58.44	62.32	66.96	72.00
Nu	265.80	254.66	228.51	223.53	224.67	213.22	193.19	173.56	156.29
h (W/m ² K)	1145.86	1097.84	985.12	963.64	968.57	919.18	832.86	748.21	673.76
q (kW/m ²)	34.72	34.72	34.71	34.70	34.70	34.69	34.65	34.59	34.53

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	72.00	77.16	82.55	87.91	93.23	98.62	104.01	109.67	116.25
Nu	156.29	141.76	129.11	118.54	109.62	101.84	95.02	88.75	82.36
h (W/m ² K)	673.76	611.11	556.59	511.02	472.56	439.02	409.62	382.60	355.06
q (kW/m ²)	34.53	34.46	34.38	34.29	34.22	34.15	34.07	33.98	33.88

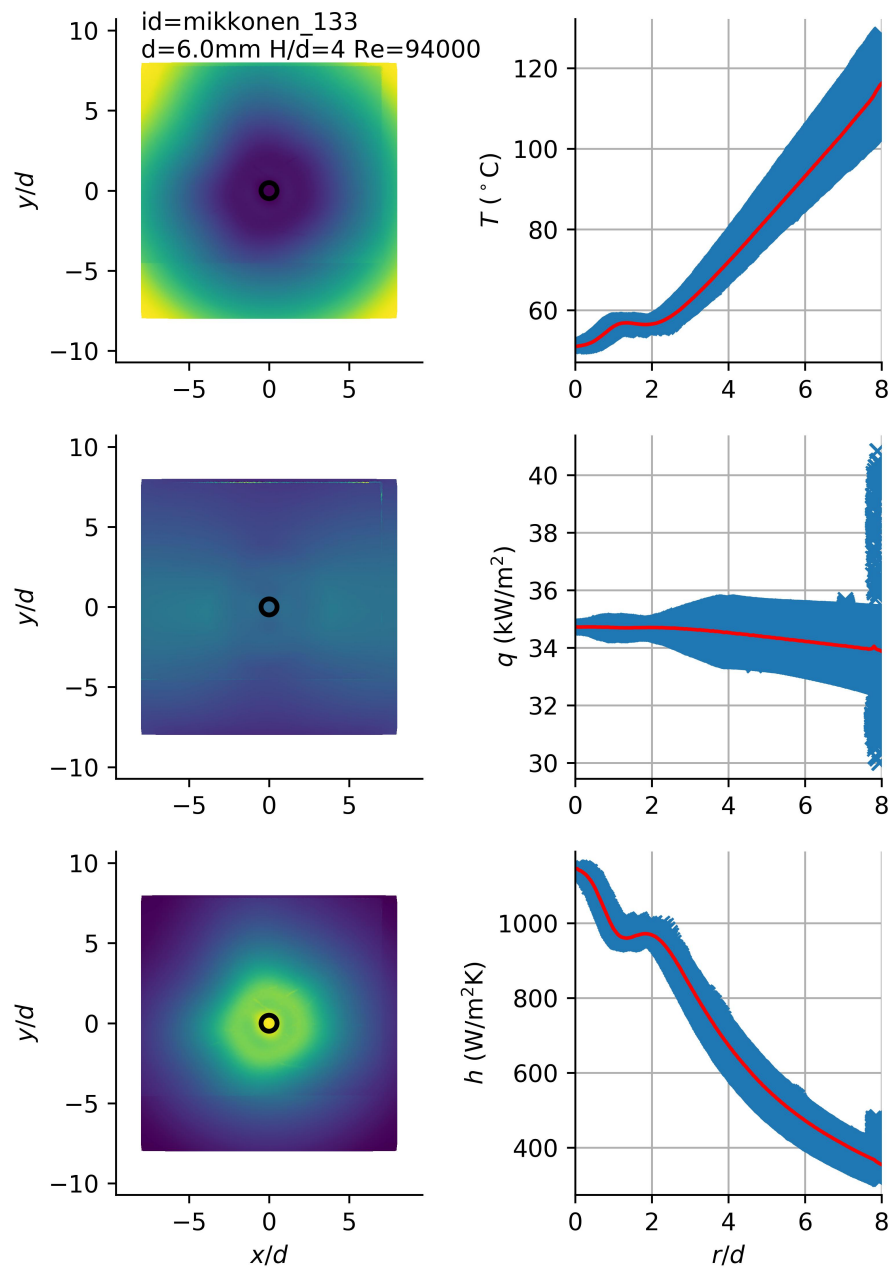


Figure 400: Results, mikkonen_133

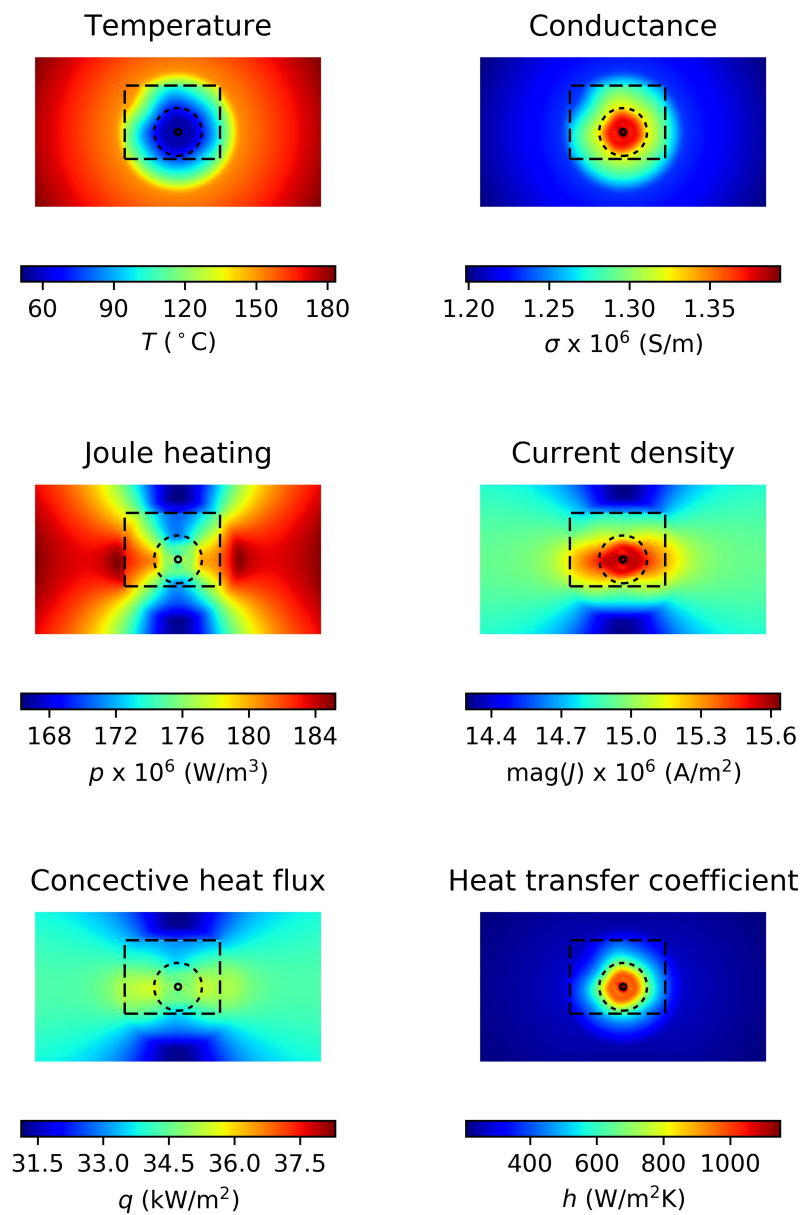


Figure 401: Convection calculation, mikkonen_133

Case id: mikkonen_134

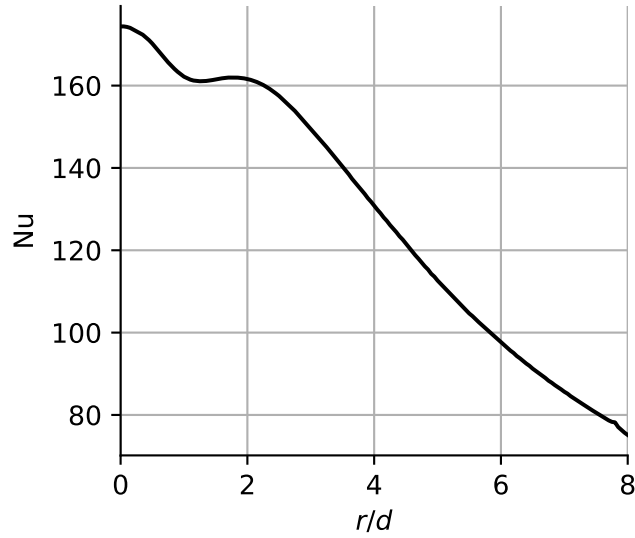


Figure 402: Nu, mikkonen_134

path	2017_03_10_Tsarja/6mm_Q392_Hd4_T114
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 11:01:06

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
93669	0.70	4	0.71	6.0	24.0	20.3	20.4	8.042	239.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	5.3	584.8	3.98	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	114.33	116.60	121.28	121.67	121.61	124.21	129.66	136.60	144.86
Nu	174.37	170.21	162.16	161.50	161.61	157.49	149.48	140.33	130.79
h (W/m ² K)	752.59	734.63	699.89	697.05	697.51	679.72	645.14	605.66	564.51
q (kW/m ²)	70.69	70.67	70.60	70.59	70.60	70.56	70.48	70.35	70.22
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	144.86	153.97	164.18	174.64	185.30	196.18	206.98	217.91	231.10
Nu	130.79	121.64	112.65	104.65	97.58	91.25	85.63	80.56	75.14
h (W/m ² K)	564.51	524.98	486.20	451.67	421.16	393.83	369.60	347.69	324.28
q (kW/m ²)	70.22	70.07	69.84	69.59	69.37	69.14	68.87	68.58	68.25

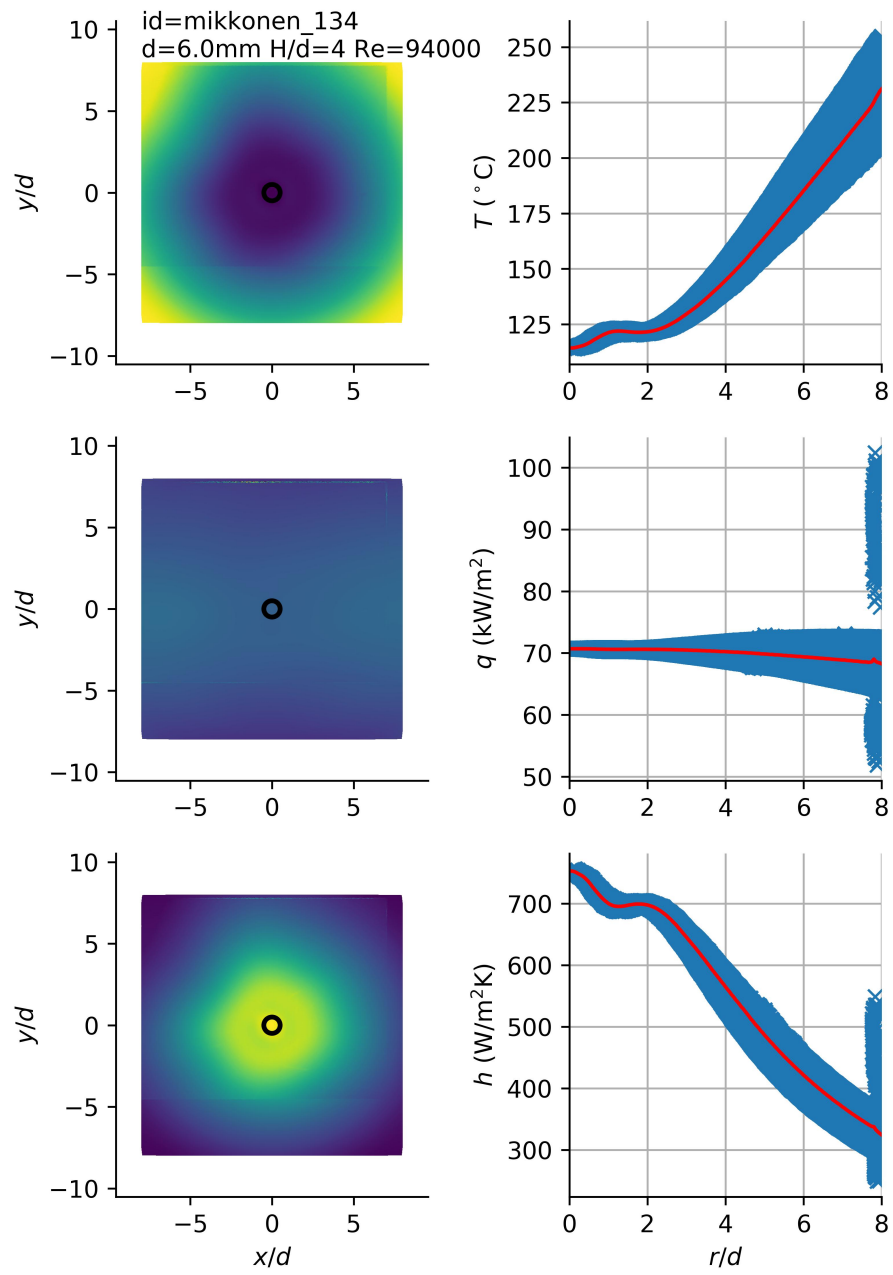


Figure 403: Results, mikkonen_134

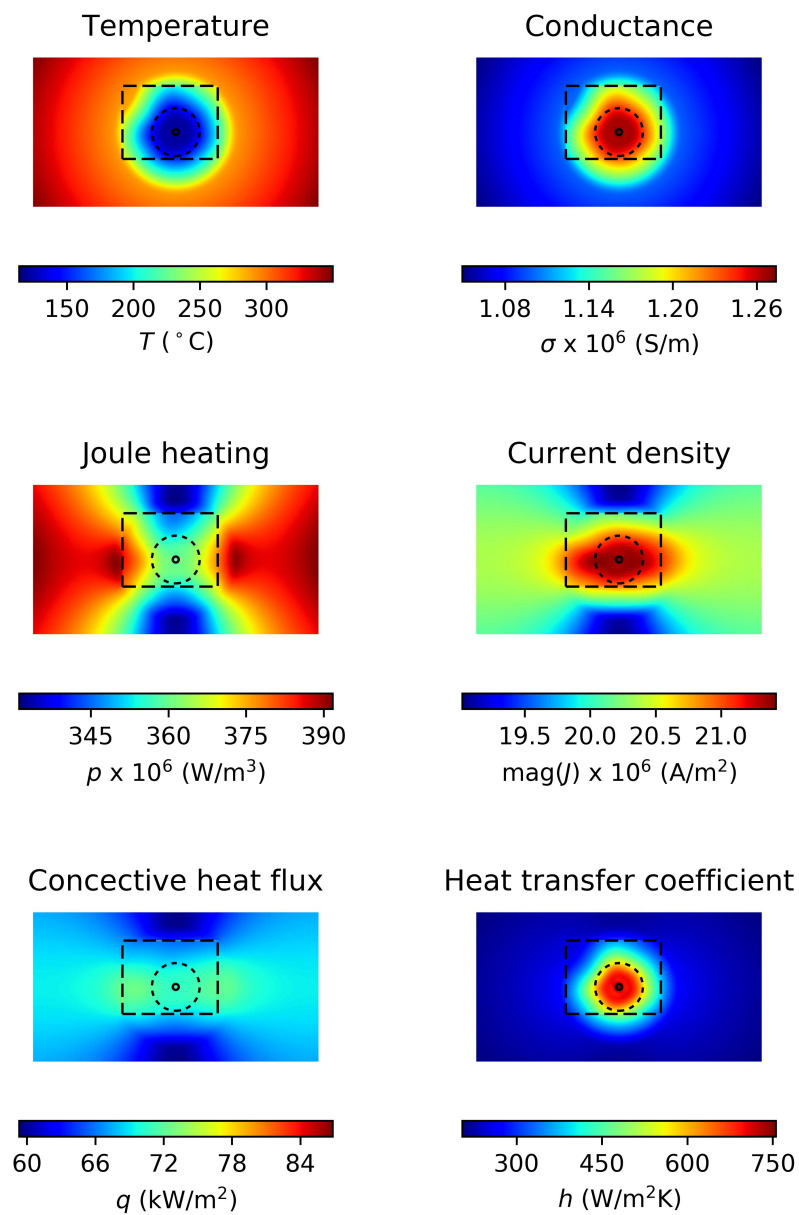


Figure 404: Convection calculation, mikkonen_134

Case id: mikkonen_135

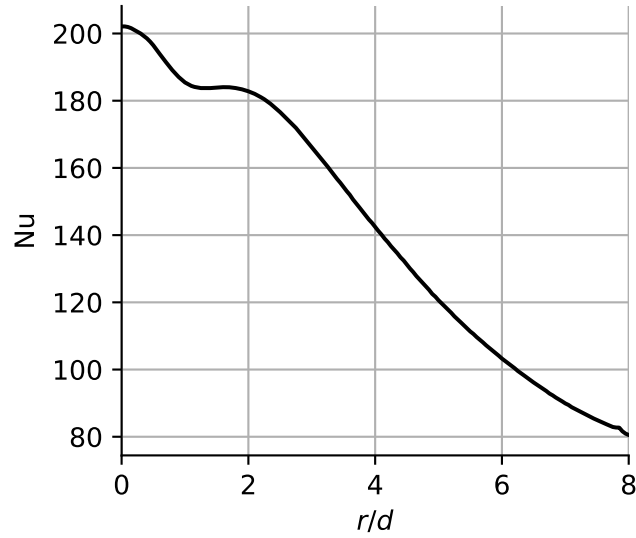


Figure 405: Nu, mikkonen_135

path	2017_03_10_Tsarja/6mm_Q392_Hd4_T150
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 11:07:39

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
94111	0.70	4	0.71	6.0	24.0	21.6	22.4	8.108	242.5

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	6.8	704.0	6.23	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	151.10	154.76	162.53	163.63	164.49	169.36	178.28	190.01	203.69
Nu	202.10	196.49	185.43	183.92	182.79	176.60	166.30	154.34	142.39
h (W/m ² K)	875.55	851.23	803.33	796.79	791.90	765.08	720.45	668.62	616.84
q (kW/m ²)	112.68	112.66	112.56	112.53	112.52	112.44	112.28	112.03	111.75

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	203.69	218.67	234.96	251.55	268.33	285.24	301.76	316.11	330.81
Nu	142.39	131.21	120.60	111.34	103.26	96.15	89.92	84.97	80.53
h (W/m ² K)	616.84	568.40	522.46	482.33	447.36	416.53	389.55	368.09	348.87
q (kW/m ²)	111.75	111.45	110.93	110.39	109.87	109.32	108.67	108.04	107.57

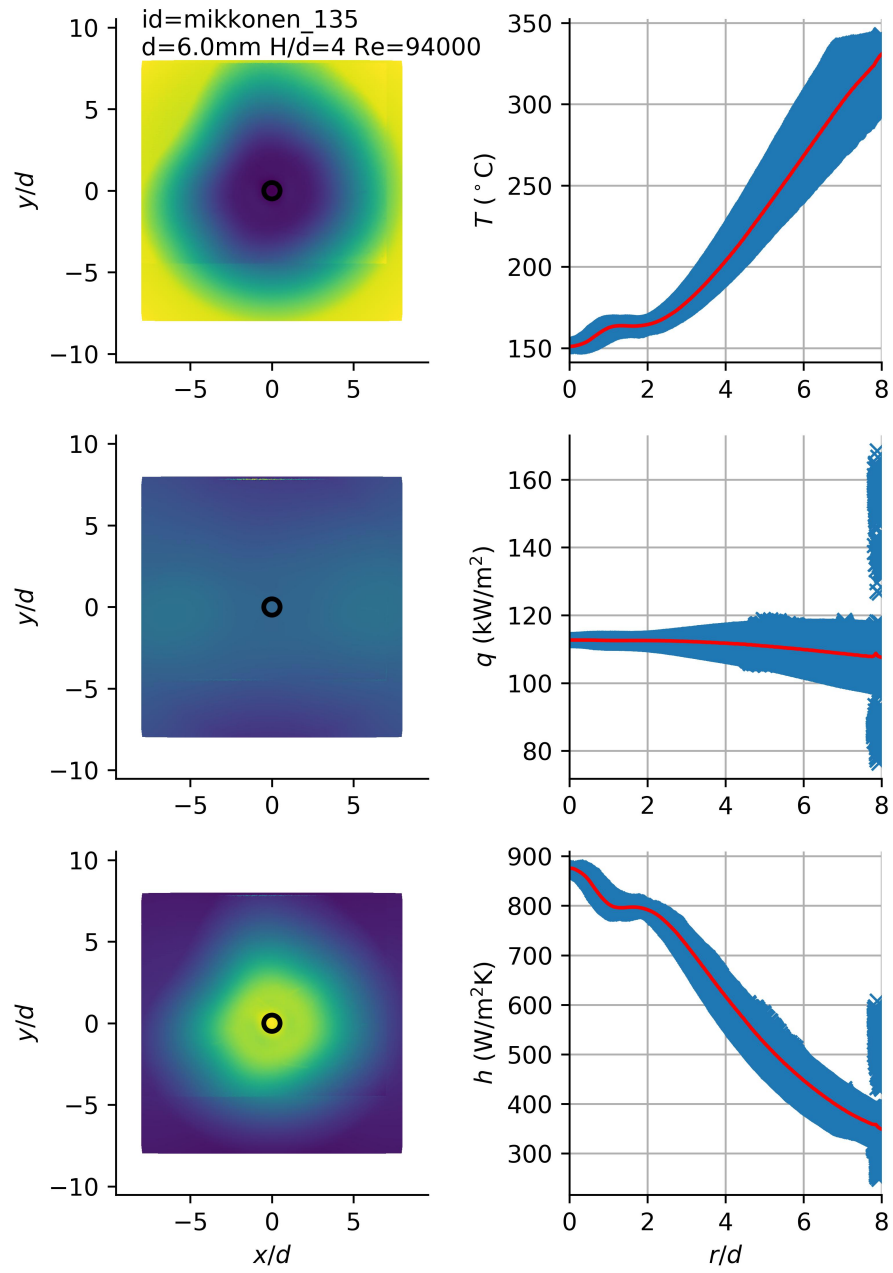


Figure 406: Results, mikkonen_135

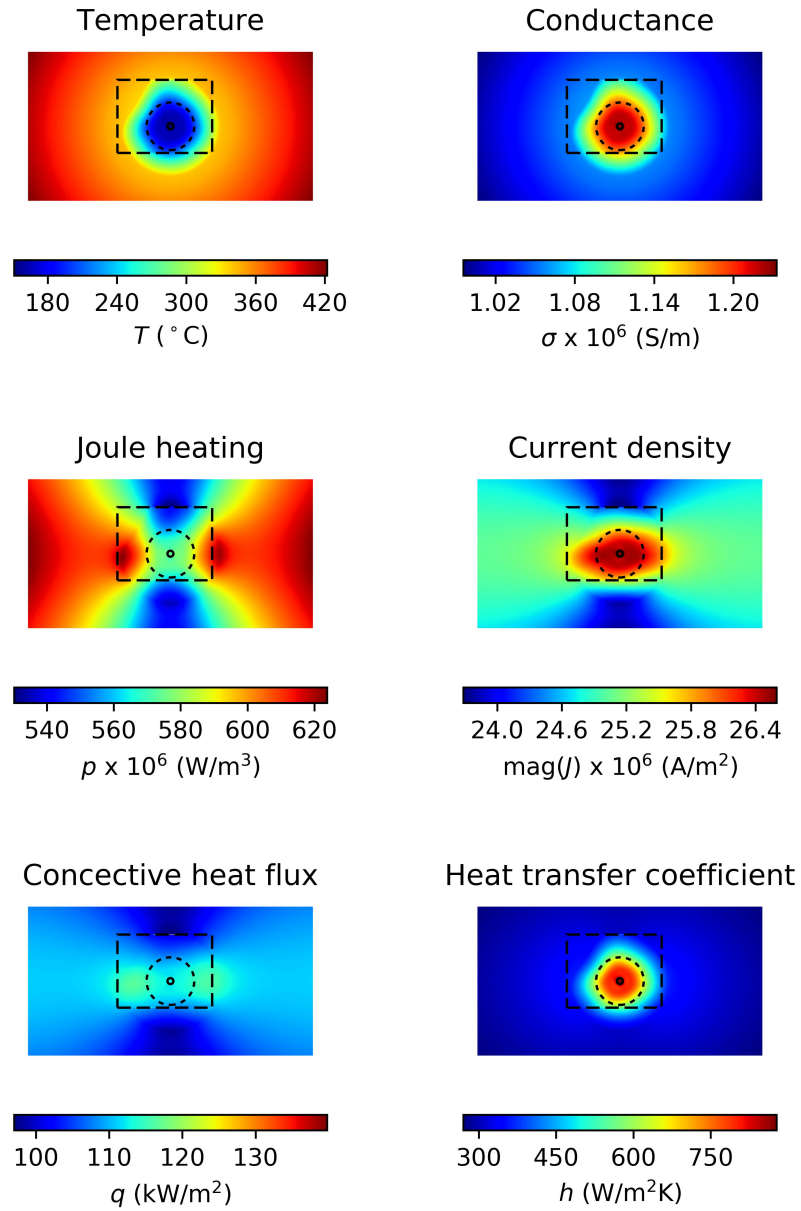


Figure 407: Convection calculation, mikkonen_135

Case id: mikkonen_136

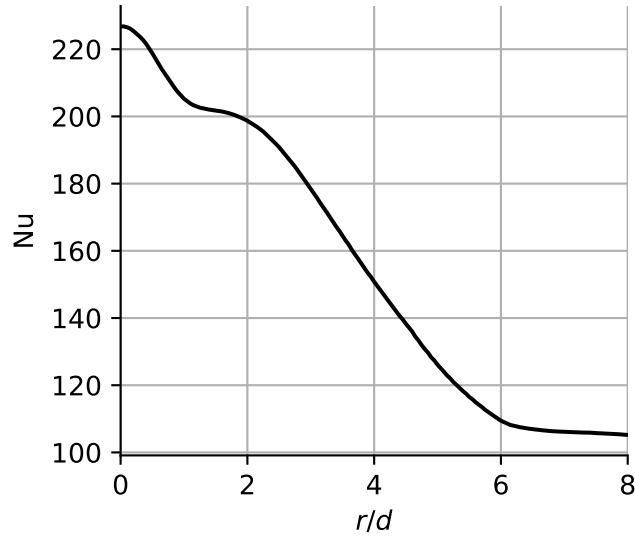


Figure 408: Nu, mikkonen_136

path	2017_03_10_Tsarja/6mm_Q392_Hd4_T175
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 11:13:57

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
94491	0.71	4	0.71	6.0	24.0	23.0	23.2	8.171	245.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	7.9	785.0	9.32	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	175.48	181.00	191.28	194.09	196.68	203.67	215.93	231.84	250.20
Nu	226.78	218.81	205.26	201.76	198.69	190.84	178.49	164.49	150.79
h (W/m ² K)	986.42	951.73	892.79	877.55	864.22	830.09	776.34	715.46	655.89
q (kW/m ²)	150.21	150.17	150.04	149.95	149.92	149.79	149.58	149.19	148.75

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	250.20	269.91	292.23	312.38	329.24	335.39	337.33	338.19	339.48
Nu	150.79	138.30	126.09	116.51	109.44	106.95	106.14	105.75	105.20
h (W/m ² K)	655.89	601.57	548.46	506.78	476.03	465.19	461.65	459.99	457.56
q (kW/m ²)	148.75	148.23	147.35	146.44	145.68	145.24	145.02	144.89	144.72

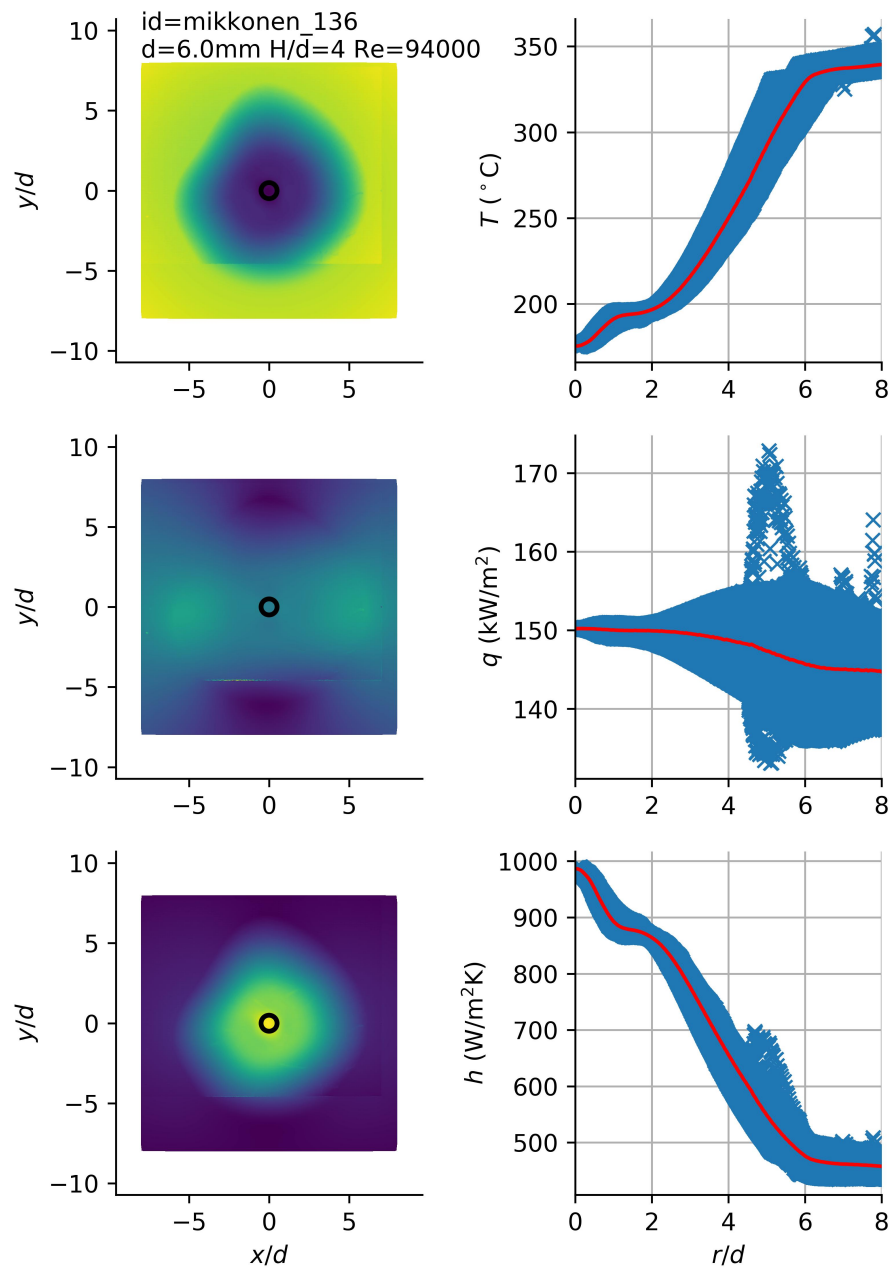


Figure 409: Results, mikkonen_136

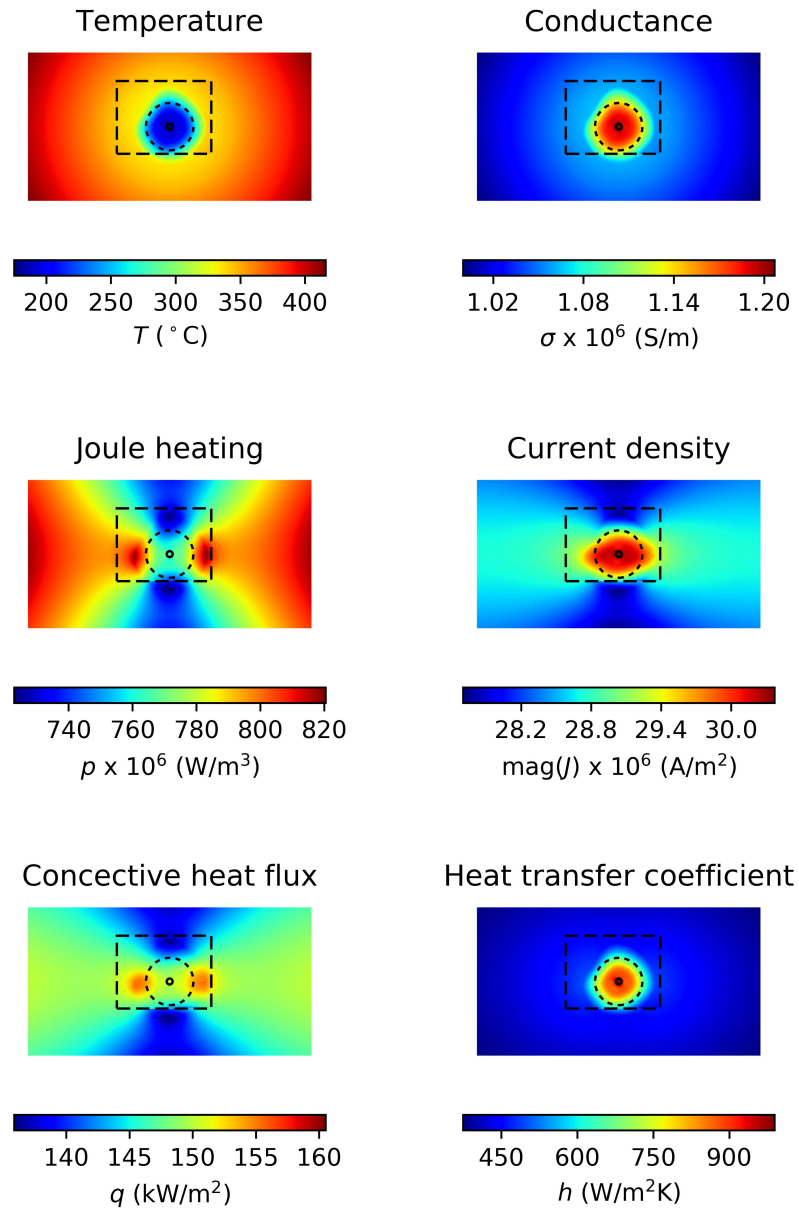


Figure 410: Convection calculation, mikkonen_136

Case id: mikkonen_137

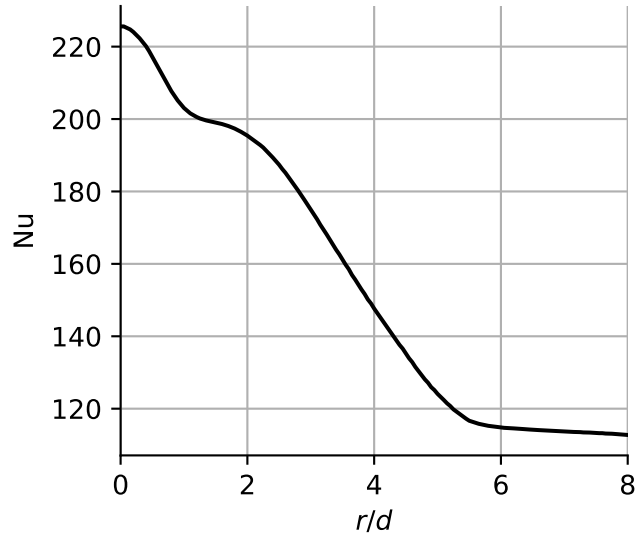


Figure 411: Nu, mikkonen_137

path	2017_03_10_Tsarja/6mm_Q392_Hd4_T185
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 11:21:16

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
94101	0.71	4	0.71	6.0	24.0	24.2	21.4	8.163	246.4

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	8.2	812.0	9.34	1.0

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	185.01	191.34	202.95	206.47	209.84	217.72	231.22	248.67	268.75
Nu	225.58	217.15	203.05	199.04	195.41	187.38	175.05	161.17	147.65
h (W/m ² K)	984.54	947.74	886.21	868.70	852.88	817.83	764.01	703.42	644.41
q (kW/m ²)	161.08	161.04	160.87	160.76	160.71	160.55	160.28	159.80	159.29

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	268.75	290.60	312.67	329.24	333.49	334.96	336.24	337.08	338.27
Nu	147.65	135.23	124.10	116.67	114.78	114.22	113.68	113.28	112.74
h (W/m ² K)	644.41	590.20	541.63	509.20	500.95	498.49	496.17	494.42	492.05
q (kW/m ²)	159.29	158.72	157.65	156.76	156.35	156.31	156.22	156.08	155.91

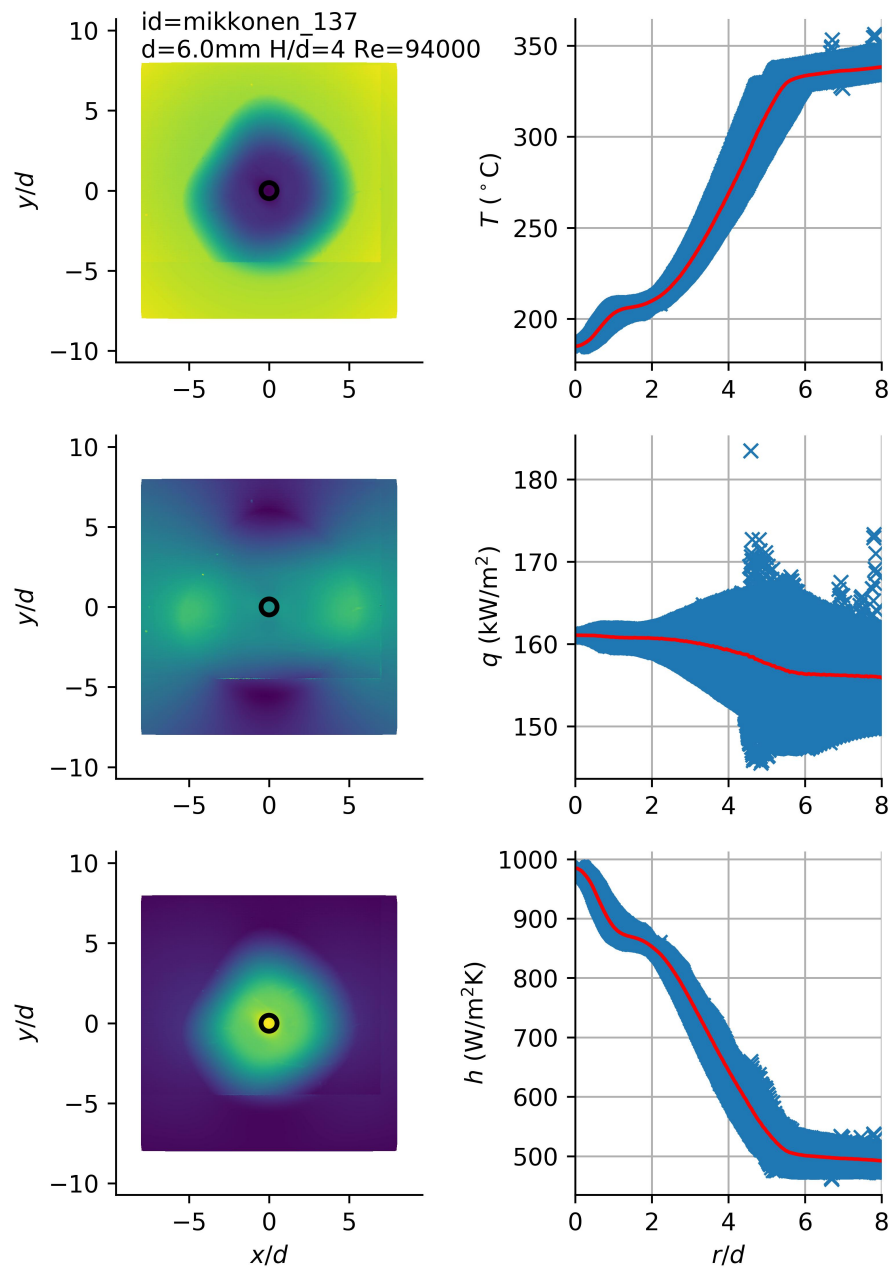


Figure 412: Results, mikkonen_137

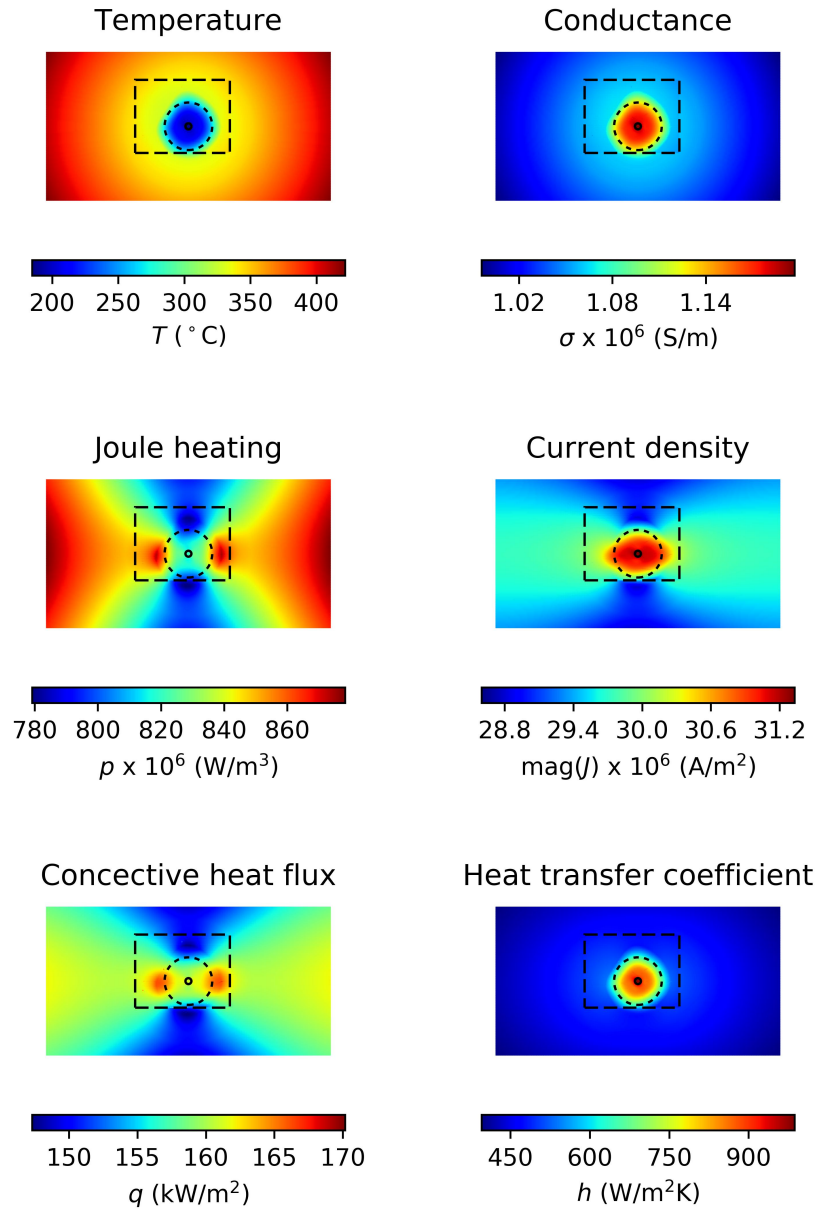


Figure 413: Convection calculation, mikkonen_137

Case id: mikkonen_138

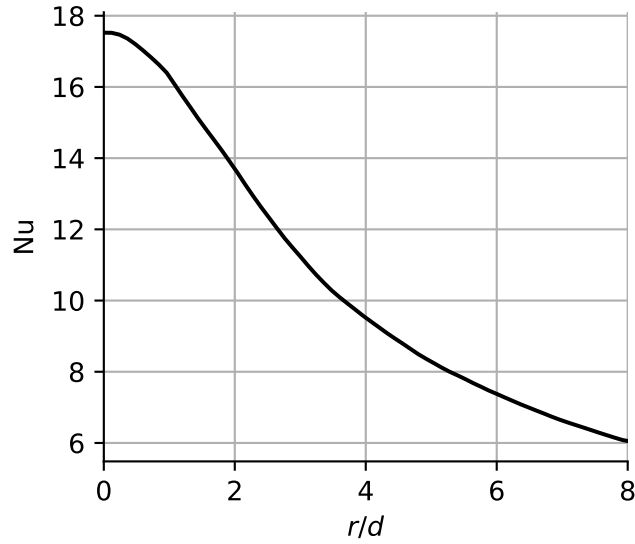


Figure 414: Nu, mikkonen_138

path	2017_03_10_viimeinen/2.5mm_Q10.7_Hd1
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 07:22:46

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
5979	0.11	1	0.71	2.5	2.5	20.4	19.4	0.214	36.7

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.0	129.4	2.67	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.03	35.33	36.16	37.53	39.10	41.03	43.02	45.06	46.81
Nu	17.52	17.17	16.29	14.96	13.70	12.38	11.24	10.25	9.52
h (W/m ² K)	181.57	177.95	168.81	155.05	141.93	128.31	116.45	106.23	98.62
q (kW/m ²)	2.84	2.83	2.83	2.81	2.80	2.77	2.75	2.72	2.70

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.81	48.58	50.38	52.02	53.65	55.28	56.89	58.39	59.84
Nu	9.52	8.87	8.28	7.81	7.38	6.99	6.63	6.33	6.06
h (W/m ² K)	98.62	91.89	85.83	80.94	76.44	72.39	68.69	65.55	62.74
q (kW/m ²)	2.70	2.68	2.66	2.64	2.62	2.60	2.57	2.56	2.54

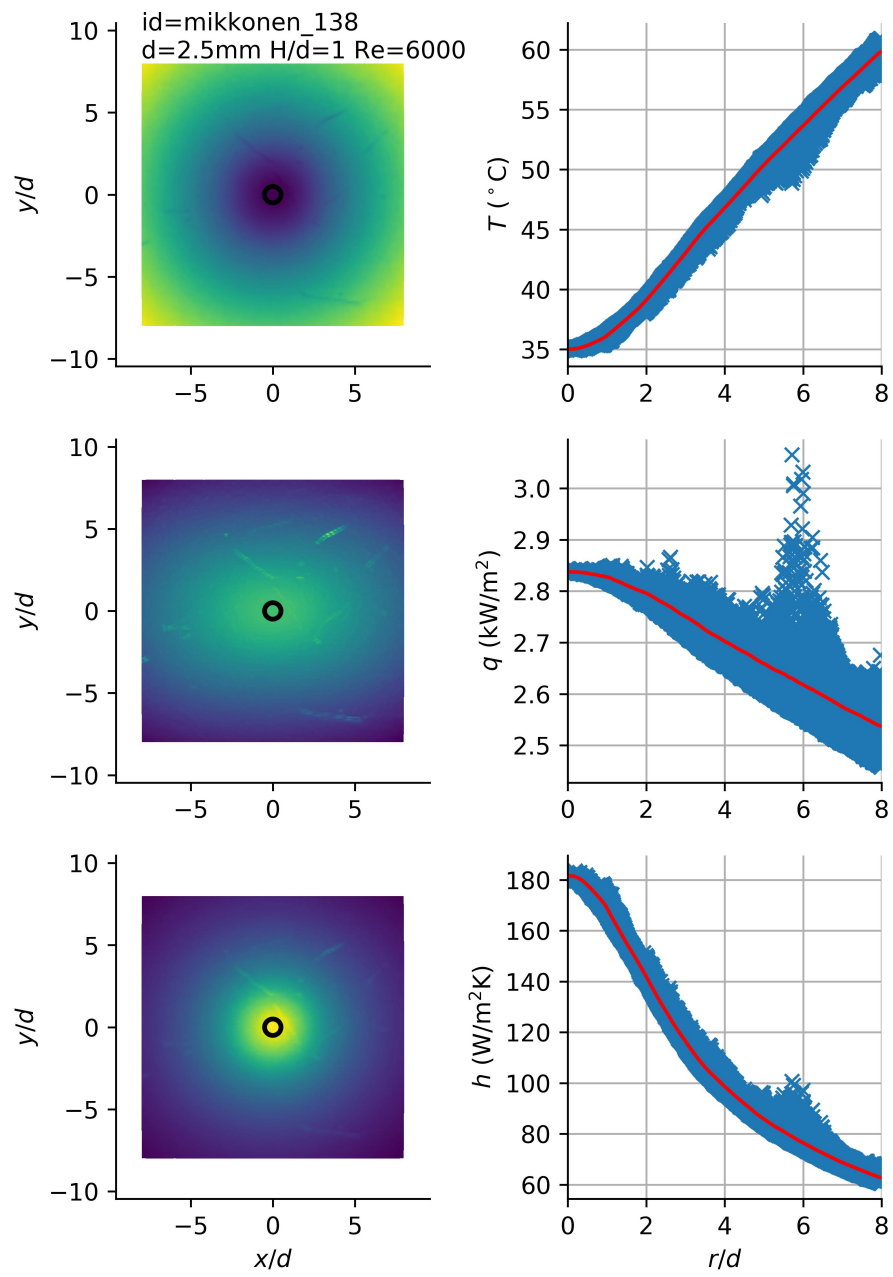


Figure 415: Results, mikkonen_138

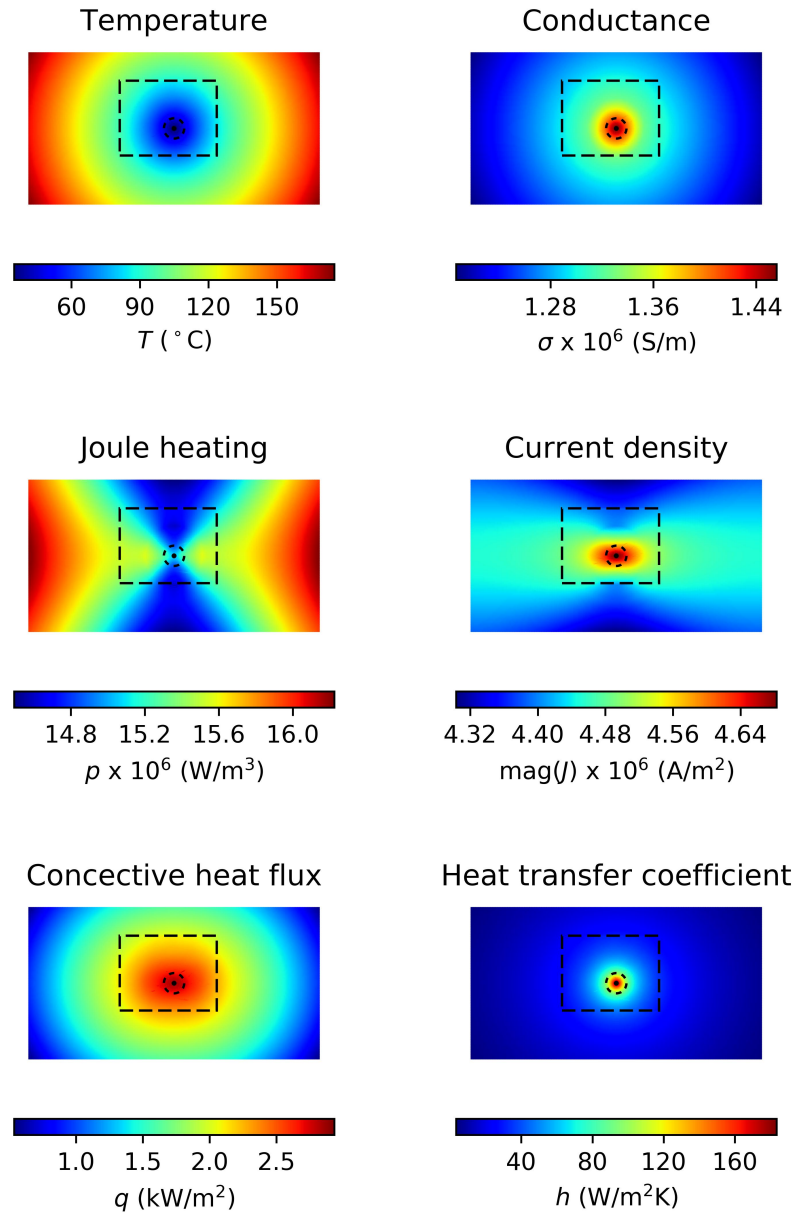


Figure 416: Convection calculation, mikkonen_138

Case id: mikkonen_139

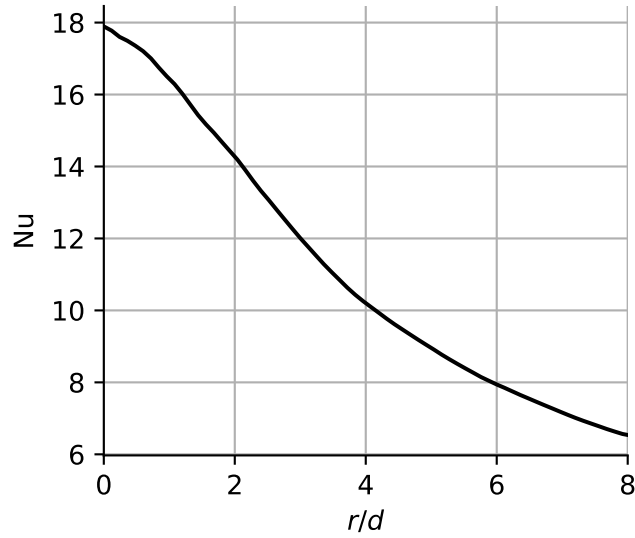


Figure 417: Nu, mikkonen_139

path	2017_03_10_viimeinen/2.5mm_Q10.7_Hd2
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 07:31:21

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6016	0.11	2	0.71	2.5	5.0	20.9	19.4	0.216	37.1

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.0	129.5	3.08	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.78	35.26	36.08	37.23	38.43	39.99	41.71	43.53	45.25
Nu	17.89	17.33	16.44	15.30	14.27	13.11	12.01	11.03	10.20
h (W/m ² K)	185.66	179.85	170.55	158.75	148.11	136.01	124.62	114.41	105.87
q (kW/m ²)	2.86	2.85	2.84	2.83	2.82	2.80	2.78	2.76	2.74

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.25	46.84	48.44	50.09	51.65	53.13	54.66	56.15	57.47
Nu	10.20	9.54	8.96	8.41	7.94	7.54	7.16	6.82	6.54
h (W/m ² K)	105.87	99.01	92.94	87.27	82.40	78.26	74.30	70.75	67.84
q (kW/m ²)	2.74	2.72	2.70	2.68	2.66	2.64	2.62	2.60	2.58

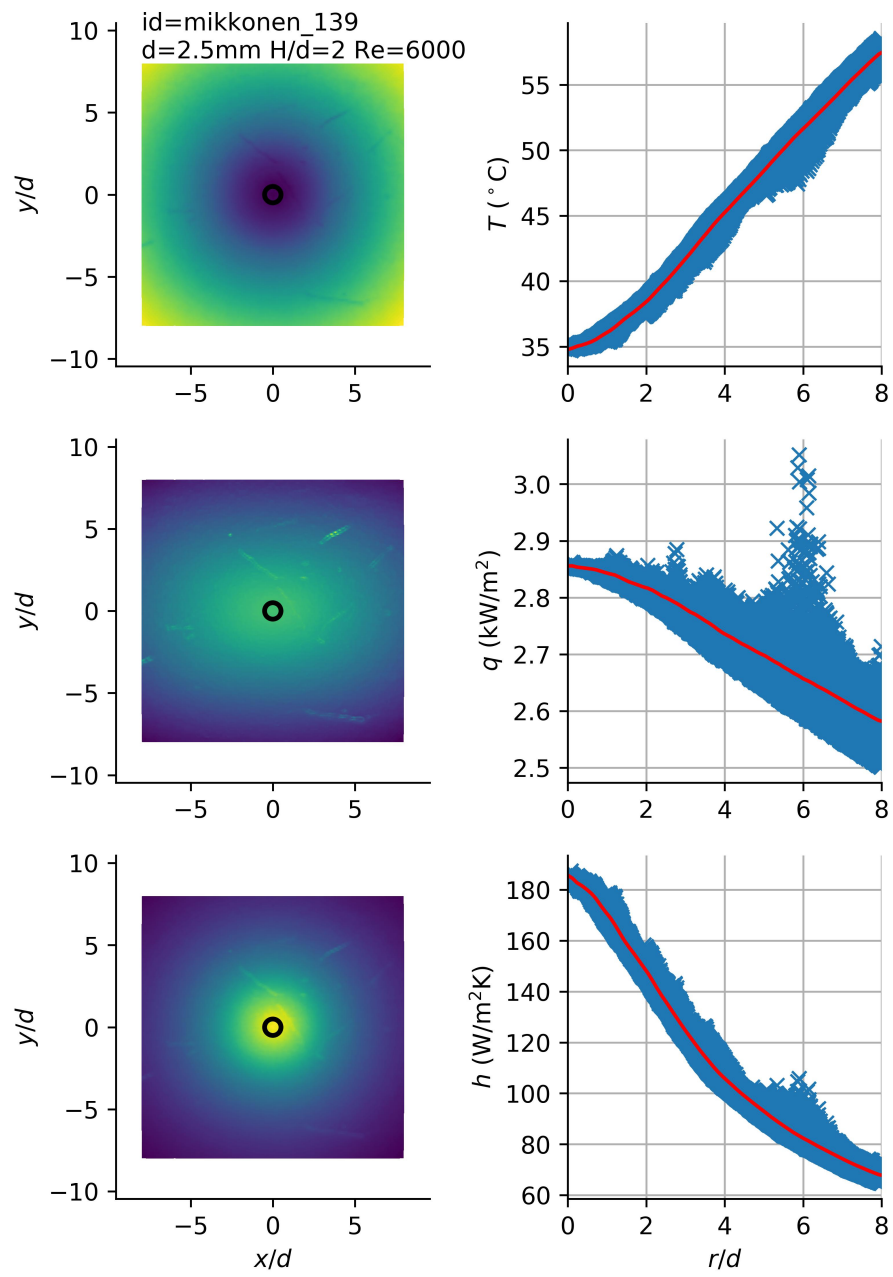


Figure 418: Results, mikkonen_139

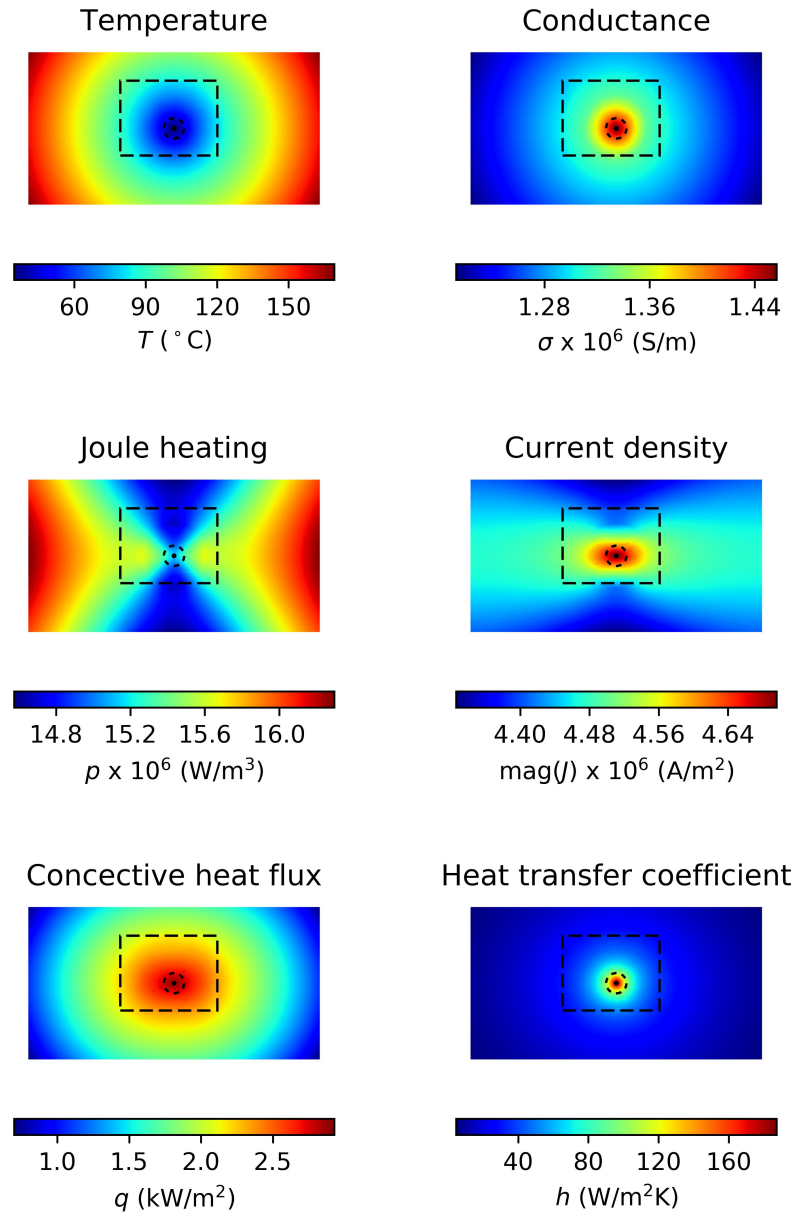


Figure 419: Convection calculation, mikkonen_139

Case id: mikkonen_140

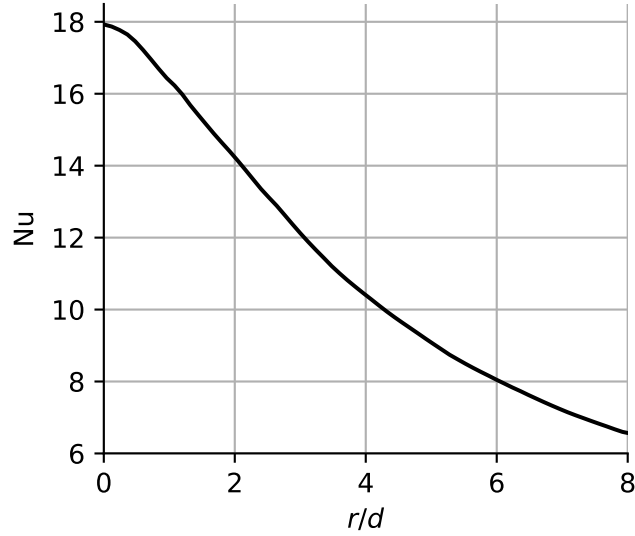


Figure 420: Nu, mikkonen_140

path	2017_03_10_viimeinen/2.5mm_Q10.7_Hd4
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 07:40:12

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6004	0.11	4	0.71	2.5	10.0	21.1	19.8	0.215	37.0

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.0	132.8	1.65	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.57	36.00	36.97	38.11	39.37	40.84	42.49	44.24	45.85
Nu	17.93	17.42	16.37	15.29	14.24	13.16	12.12	11.18	10.40
h (W/m ² K)	186.12	180.82	169.94	158.70	147.80	136.59	125.88	116.03	108.01
q (kW/m ²)	2.93	2.93	2.92	2.90	2.89	2.87	2.86	2.83	2.81

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.85	47.51	49.22	50.93	52.51	54.12	55.75	57.26	58.69
Nu	10.40	9.71	9.08	8.52	8.05	7.61	7.21	6.87	6.57
h (W/m ² K)	108.01	100.81	94.32	88.42	83.53	79.03	74.84	71.28	68.20
q (kW/m ²)	2.81	2.79	2.77	2.75	2.73	2.71	2.69	2.67	2.65

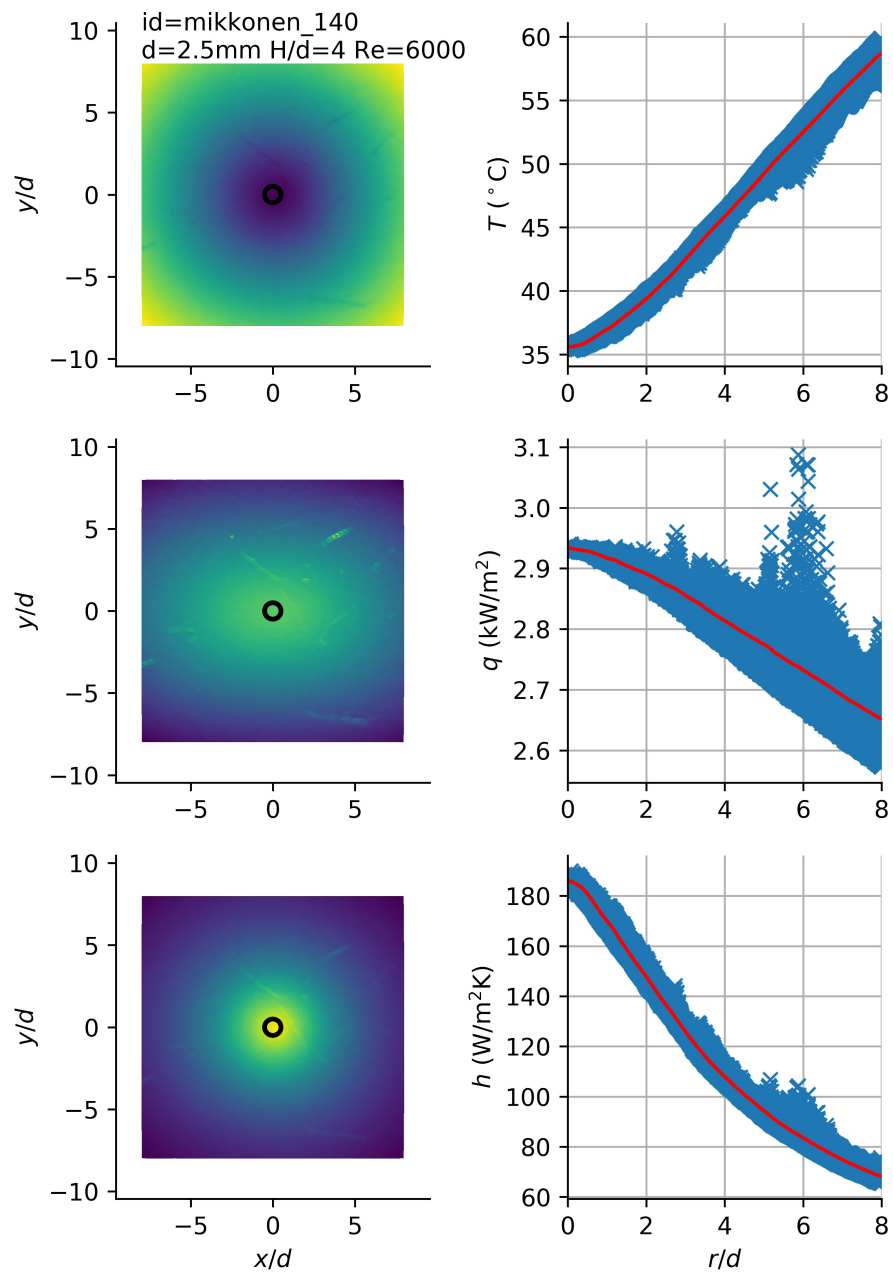


Figure 421: Results, mikkonen_140

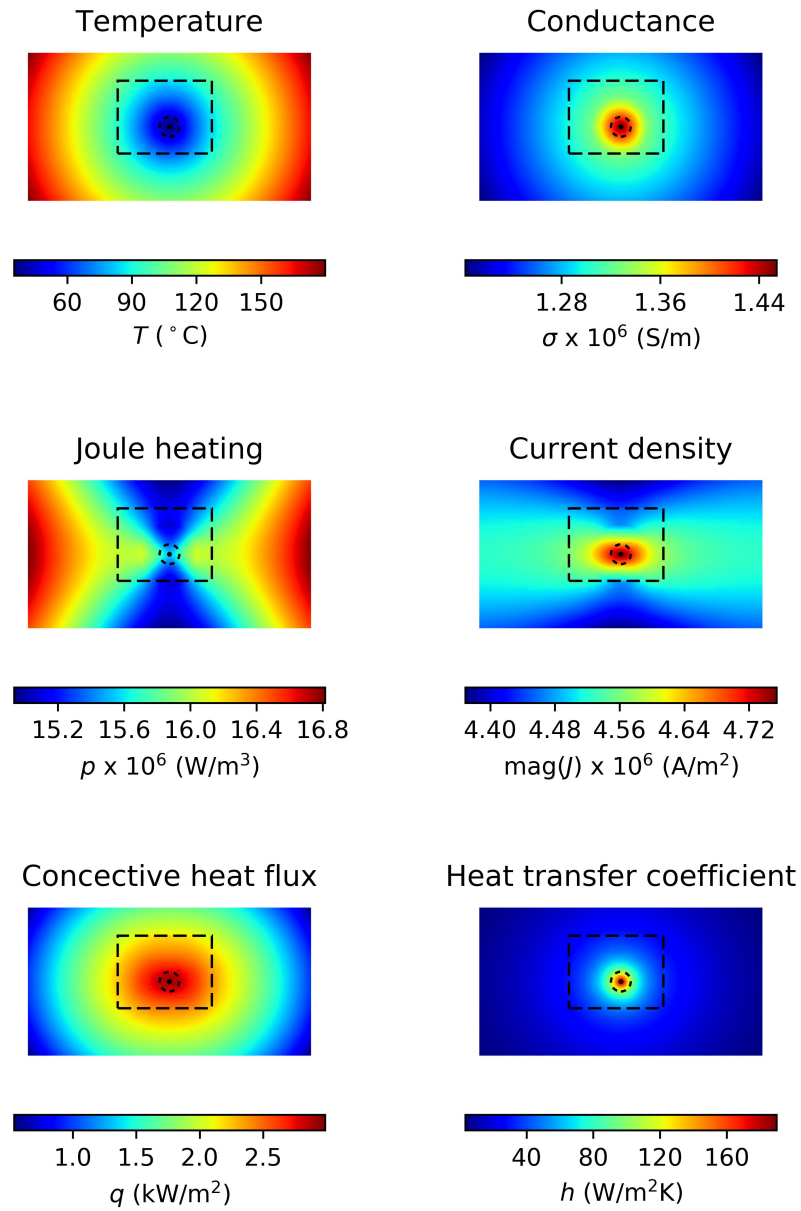


Figure 422: Convection calculation, mikkonen_140

Case id: mikkonen_141

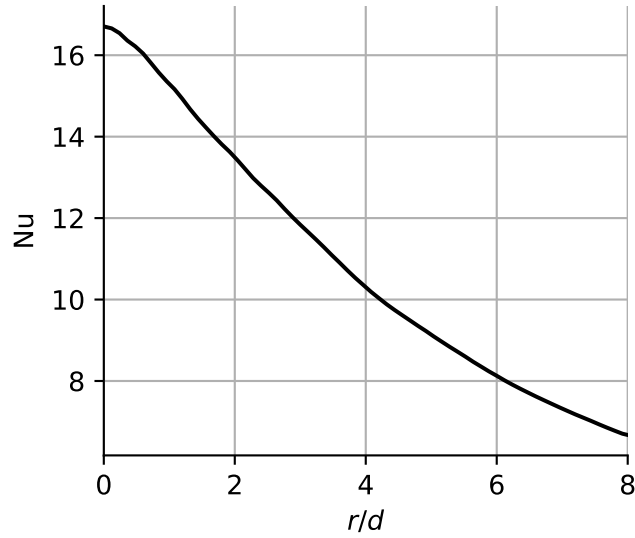


Figure 423: Nu, mikkonen_141

path	2017_03_10_viimeinen/2.5mm_Q10.7_Hd6
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 07:46:34

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
6025	0.11	6	0.71	2.5	15.0	21.2	19.8	0.216	37.2

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.0	126.2	2.73	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.21	35.66	36.53	37.57	38.60	39.75	41.00	42.36	43.85
Nu	16.71	16.19	15.29	14.33	13.49	12.65	11.84	11.06	10.30
h (W/m ² K)	173.51	168.13	158.84	148.83	140.13	131.38	122.94	114.88	107.01
q (kW/m ²)	2.67	2.67	2.66	2.64	2.63	2.62	2.61	2.59	2.57

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	43.85	45.23	46.58	47.99	49.49	50.91	52.27	53.64	54.93
Nu	10.30	9.68	9.14	8.62	8.13	7.70	7.32	6.98	6.67
h (W/m ² K)	107.01	100.51	94.88	89.52	84.41	79.94	76.04	72.47	69.31
q (kW/m ²)	2.57	2.55	2.54	2.52	2.50	2.49	2.47	2.45	2.43

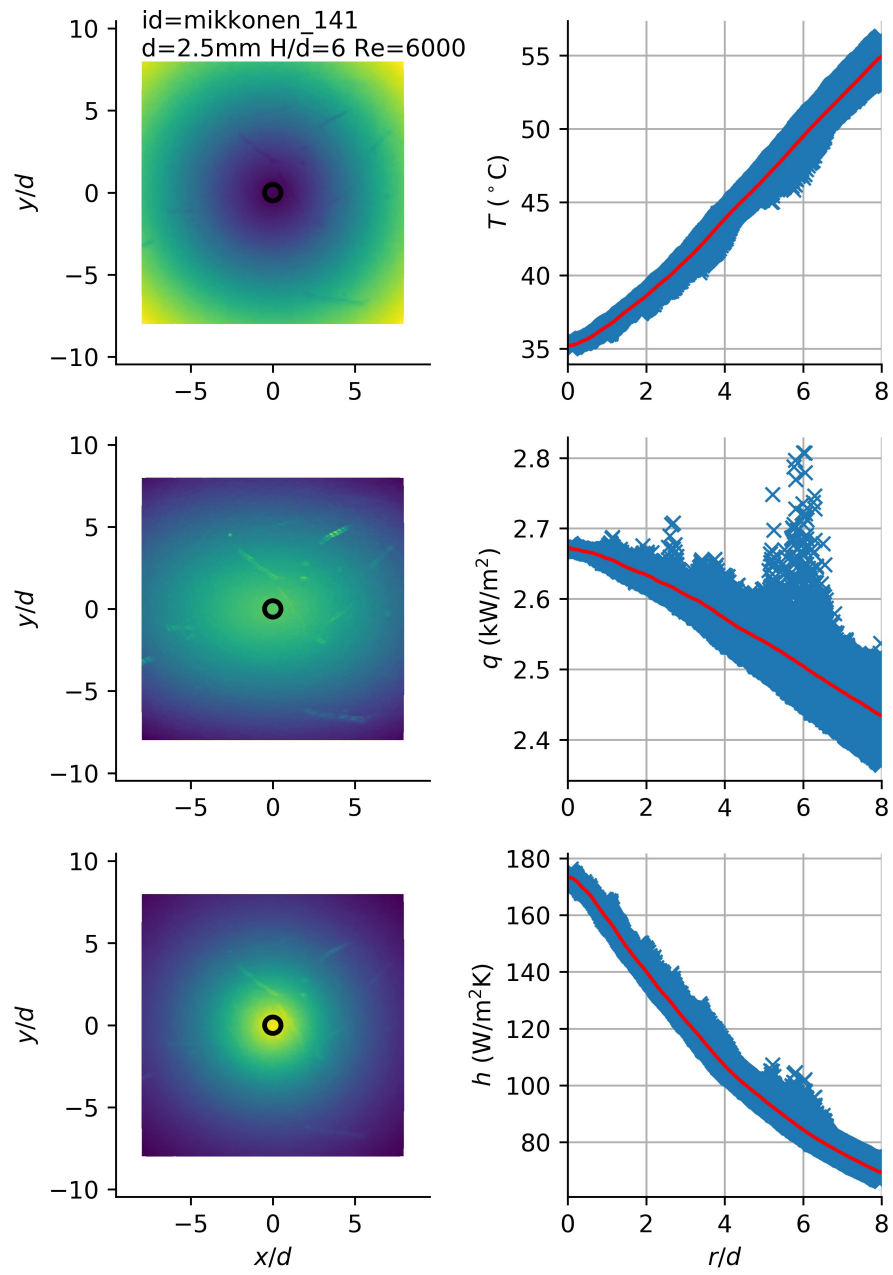


Figure 424: Results, mikkonen_141

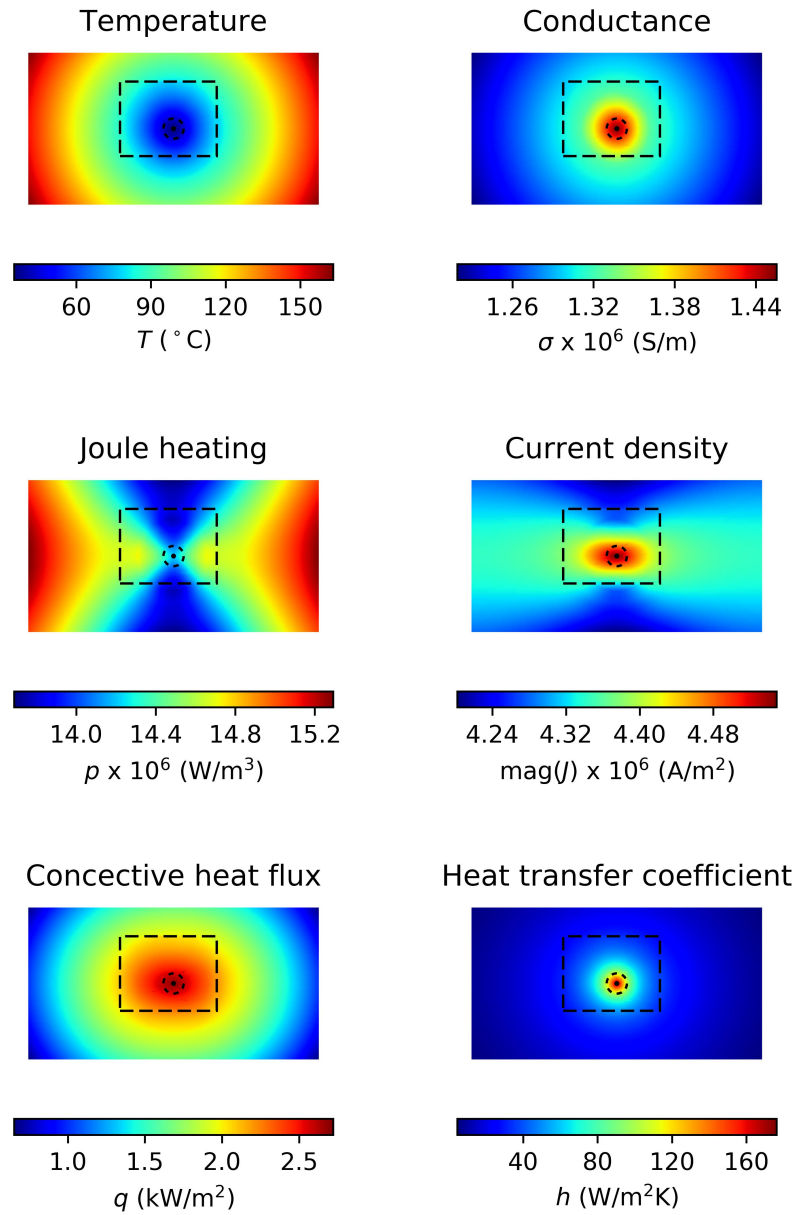


Figure 425: Convection calculation, mikkonen_141

Case id: mikkonen_142

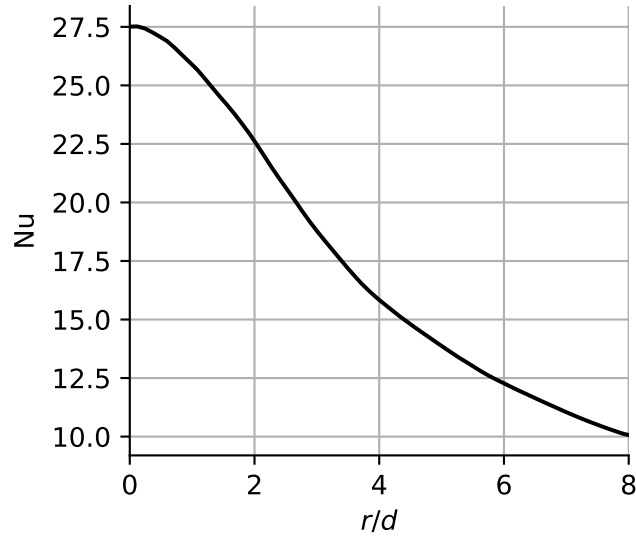


Figure 426: Nu, mikkonen_142

path	2017_03_10_viimeinen/2.5mm_Q17.9_Hd1
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 09:08:59

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9995	0.18	1	0.71	2.5	2.5	21.3	19.7	0.359	61.7

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.2	154.8	3.21	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.38	34.62	35.27	36.21	37.42	39.04	40.84	42.70	44.49
Nu	27.51	27.05	25.89	24.35	22.62	20.64	18.78	17.18	15.84
h (W/m ² K)	285.78	281.01	268.91	252.97	234.96	214.41	195.13	178.46	164.55
q (kW/m ²)	4.19	4.19	4.19	4.17	4.16	4.15	4.12	4.10	4.08

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.49	46.10	47.75	49.45	51.07	52.61	54.22	55.80	57.19
Nu	15.84	14.80	13.87	13.01	12.27	11.64	11.04	10.51	10.07
h (W/m ² K)	164.55	153.78	144.09	135.15	127.51	120.94	114.71	109.13	104.60
q (kW/m ²)	4.08	4.06	4.04	4.02	4.00	3.98	3.96	3.94	3.92

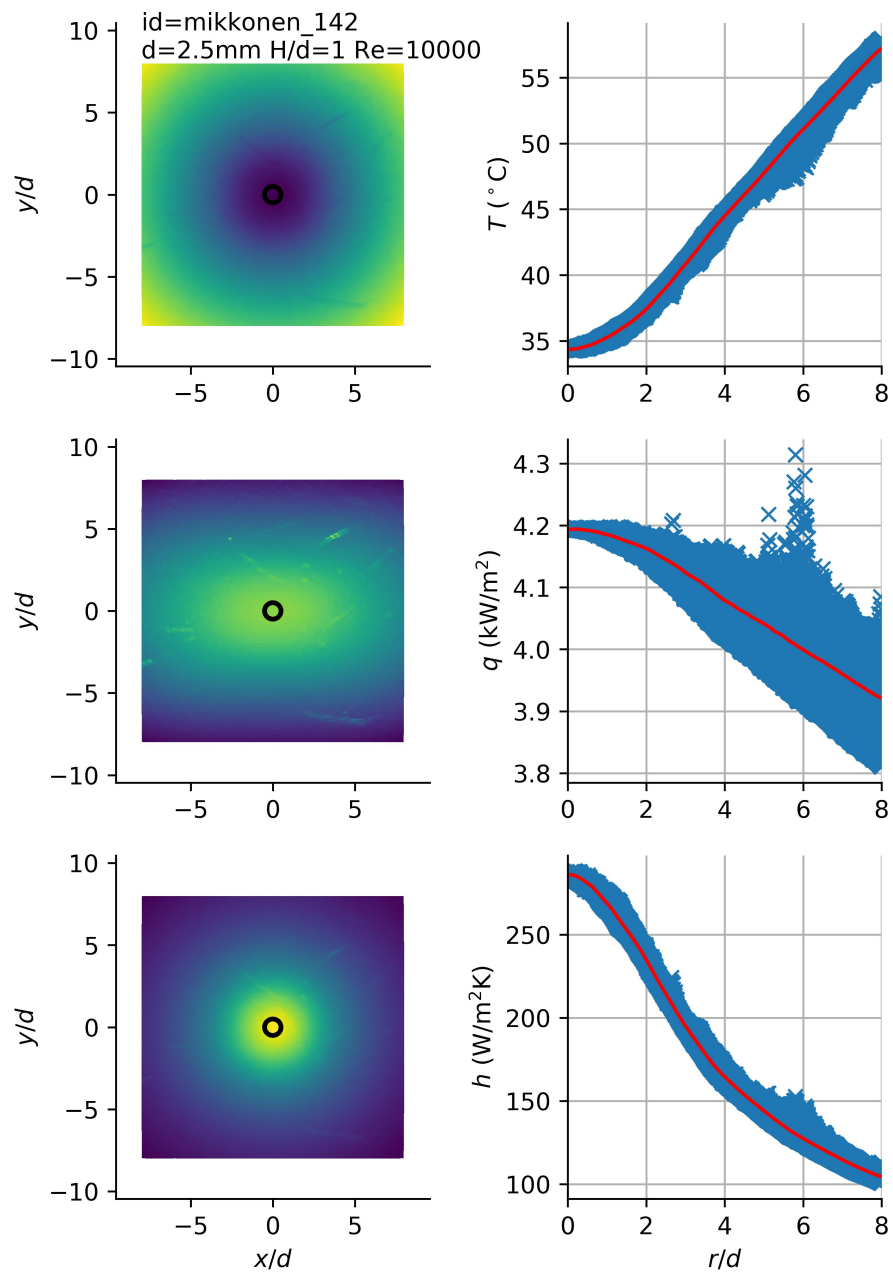


Figure 427: Results, mikkonen_142

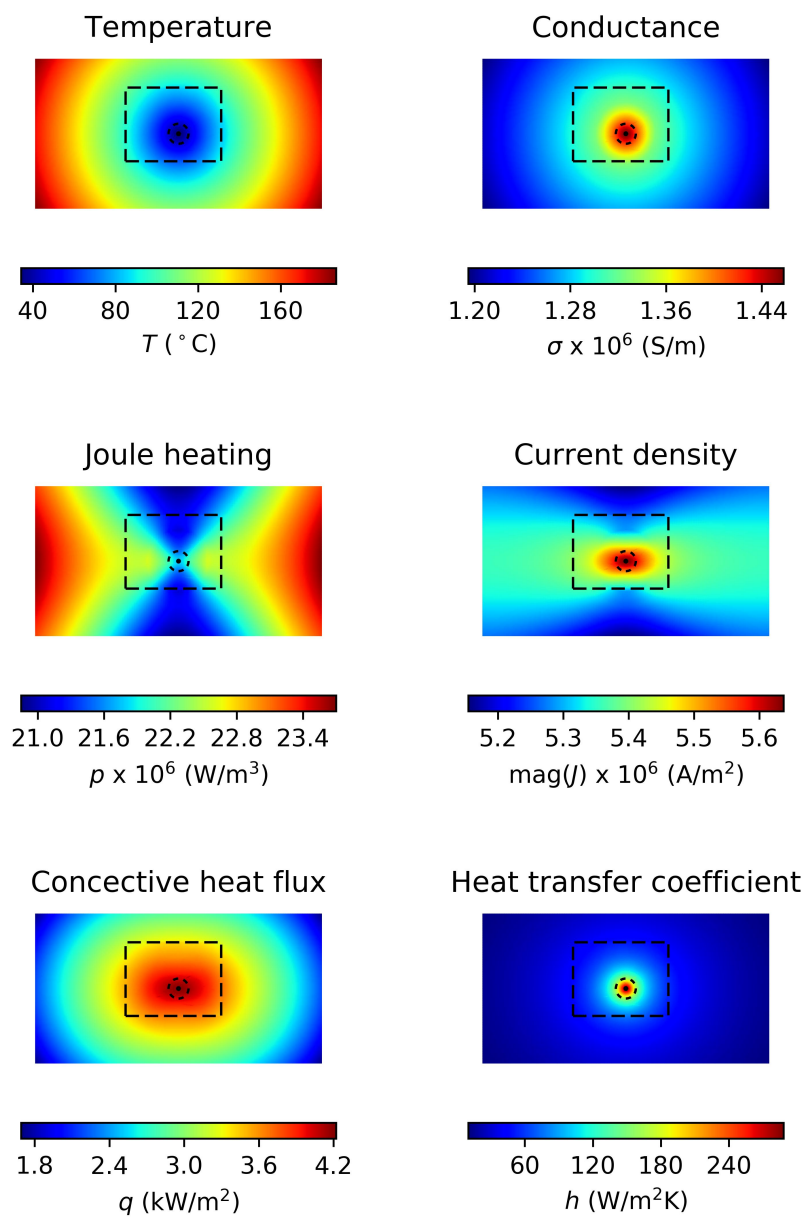


Figure 428: Convection calculation, mikkonen_142

Case id: mikkonen_143

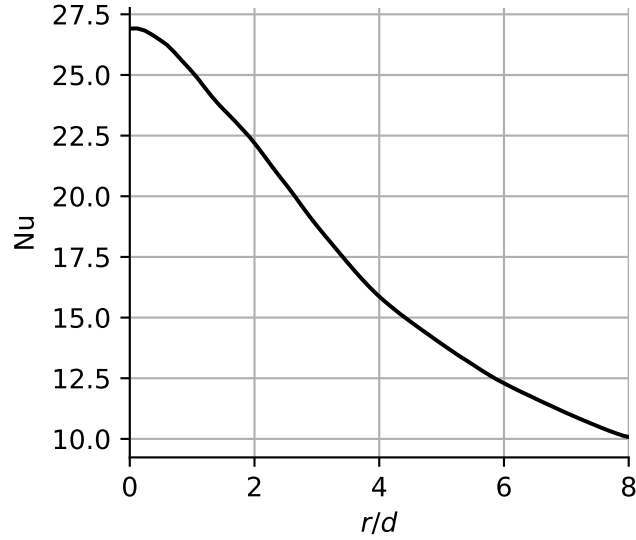


Figure 429: Nu, mikkonen_143

path		2017_03_10_viimeinen/2.5mm_Q17.9_Hd2							
this case measured by		Antti Mikkonen							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-03-10 09:04:58							
Re	Ma	H/d	Pr	d (mm)	H (mm)	T _{n,t} (°C)	T _∞ (°C)	$\dot{m}$ (g/s)	V _n (m/s)
10012	0.18	2	0.71	2.5	5.0	21.3	19.7	0.359	61.8
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.2	154.4	2.76				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.46	34.73	35.48	36.46	37.47	38.87	40.52	42.28	44.08
Nu	26.91	26.42	25.13	23.59	22.19	20.50	18.79	17.24	15.87
h (W/m ² K)	279.58	274.42	261.05	245.05	230.49	212.95	195.14	179.09	164.86
q (kW/m ²)	4.13	4.13	4.12	4.11	4.10	4.08	4.06	4.04	4.02
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.08	45.66	47.24	48.90	50.55	52.06	53.62	55.20	56.60
Nu	15.87	14.83	13.92	13.06	12.29	11.67	11.07	10.53	10.08
h (W/m ² K)	164.86	154.10	144.56	135.71	127.72	121.19	115.01	109.34	104.70
q (kW/m ²)	4.02	4.00	3.98	3.96	3.94	3.92	3.90	3.88	3.86

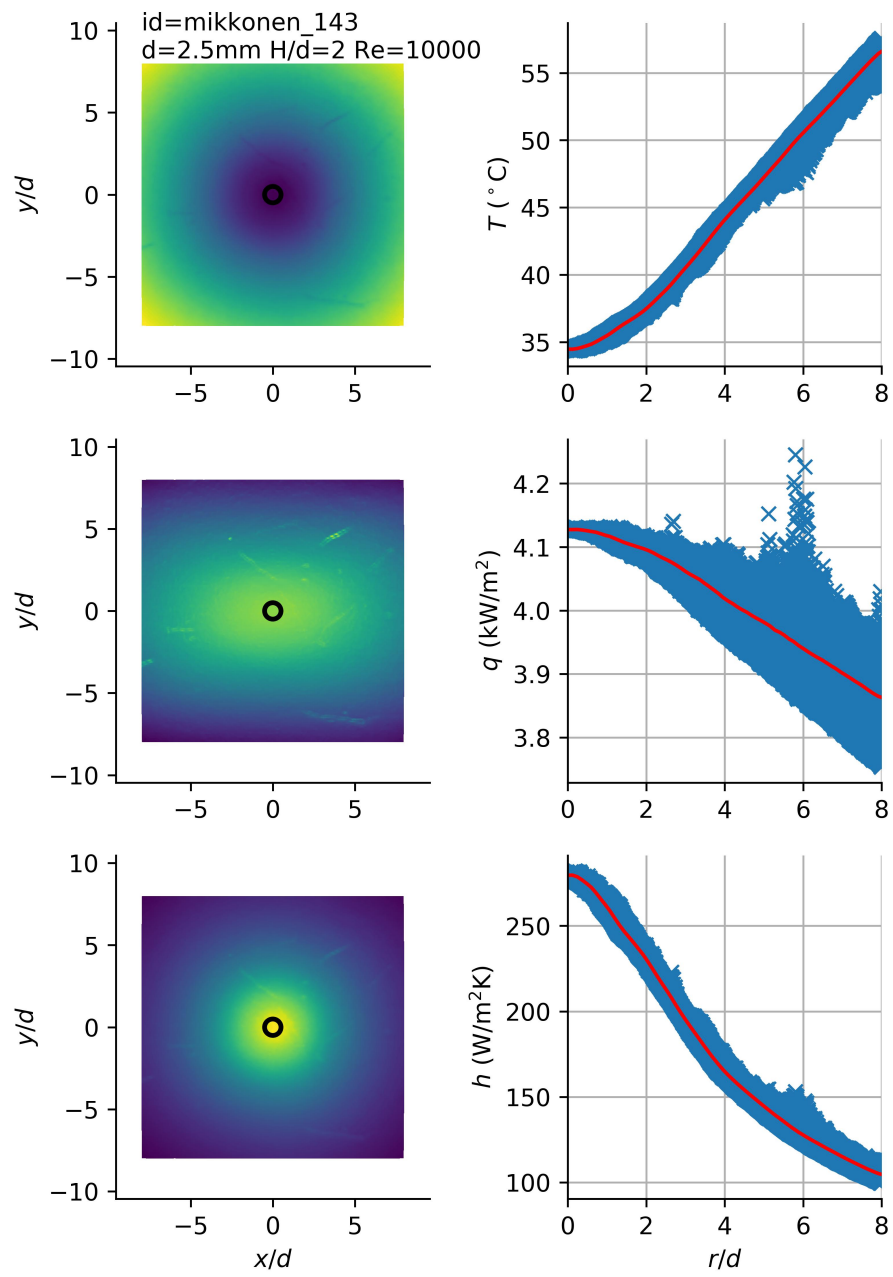


Figure 430: Results, mikkonen_143

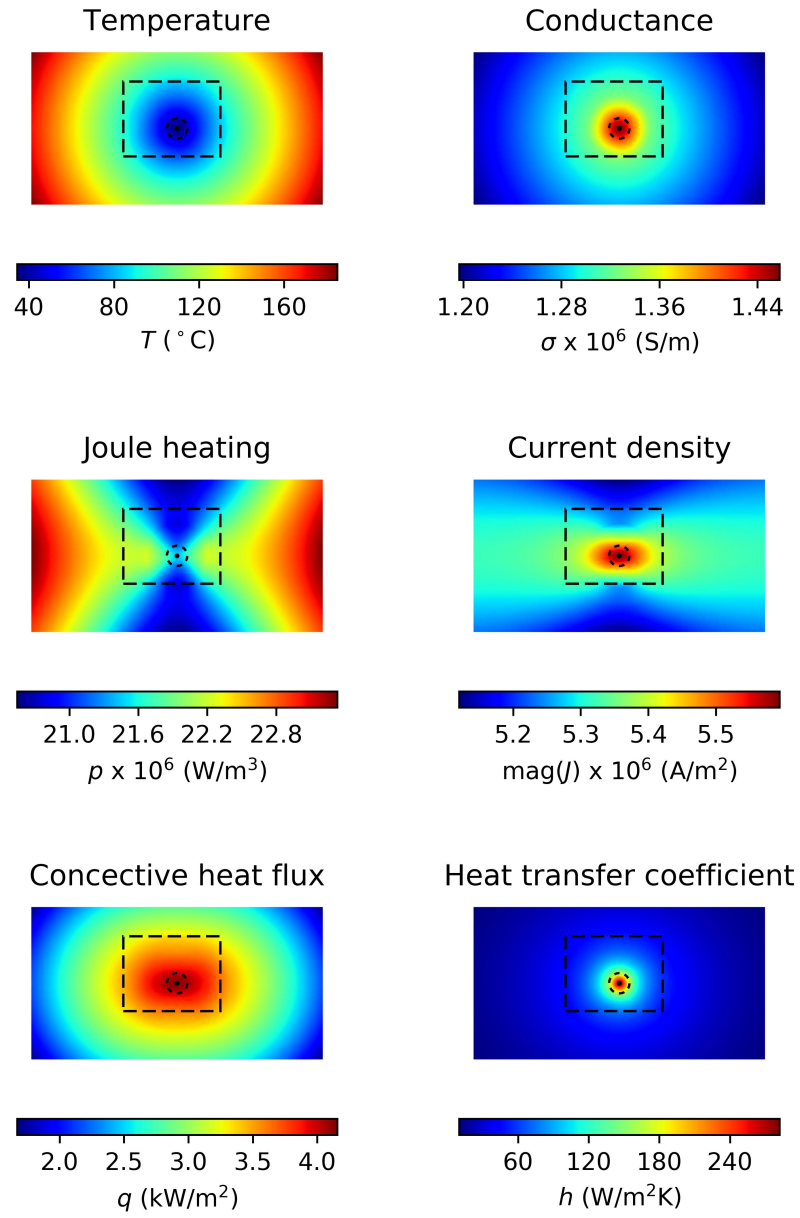


Figure 431: Convection calculation, mikkonen_143

Case id: mikkonen_144

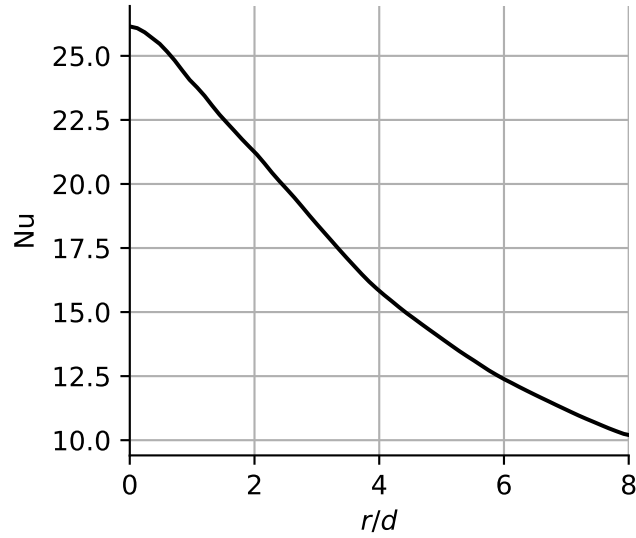


Figure 432: Nu, mikkonen_144

path	2017_03_10_viimeinen/2.5mm_Q17.9_Hd4
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 08:59:34

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9710	0.17	4	0.71	2.5	10.0	21.1	19.7	0.348	59.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.2	154.3	3.44	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.06	35.49	36.41	37.41	38.44	39.70	41.15	42.77	44.43
Nu	26.15	25.42	23.96	22.54	21.25	19.84	18.43	17.06	15.83
h (W/m ² K)	271.48	263.90	248.81	234.04	220.57	206.02	191.35	177.10	164.37
q (kW/m ²)	4.17	4.17	4.16	4.15	4.13	4.12	4.10	4.09	4.06

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.43	45.94	47.48	49.10	50.71	52.19	53.71	55.26	56.63
Nu	15.83	14.85	13.97	13.14	12.39	11.77	11.19	10.65	10.20
h (W/m ² K)	164.37	154.19	145.02	136.38	128.59	122.19	116.15	110.56	105.94
q (kW/m ²)	4.06	4.05	4.03	4.01	3.99	3.97	3.95	3.93	3.91

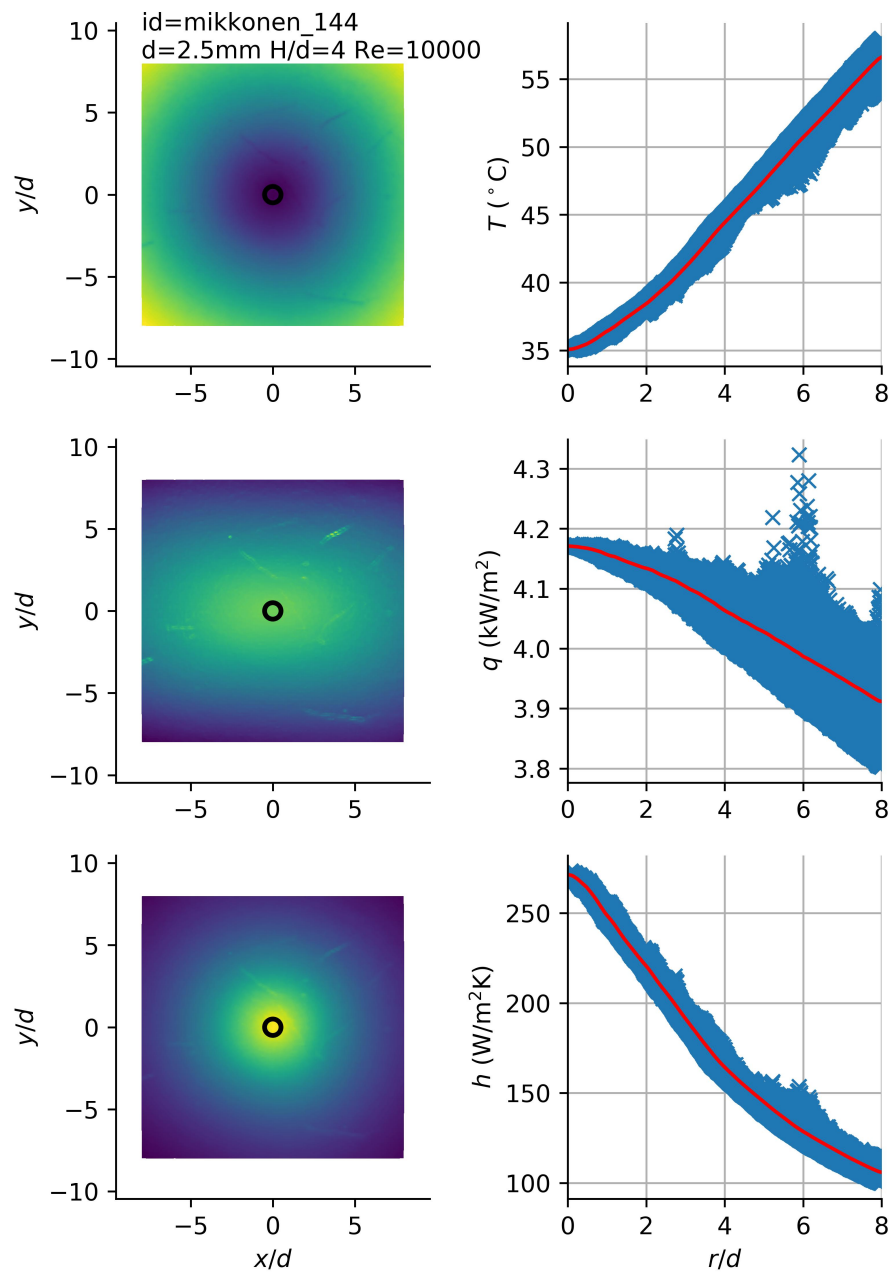


Figure 433: Results, mikkonen_144

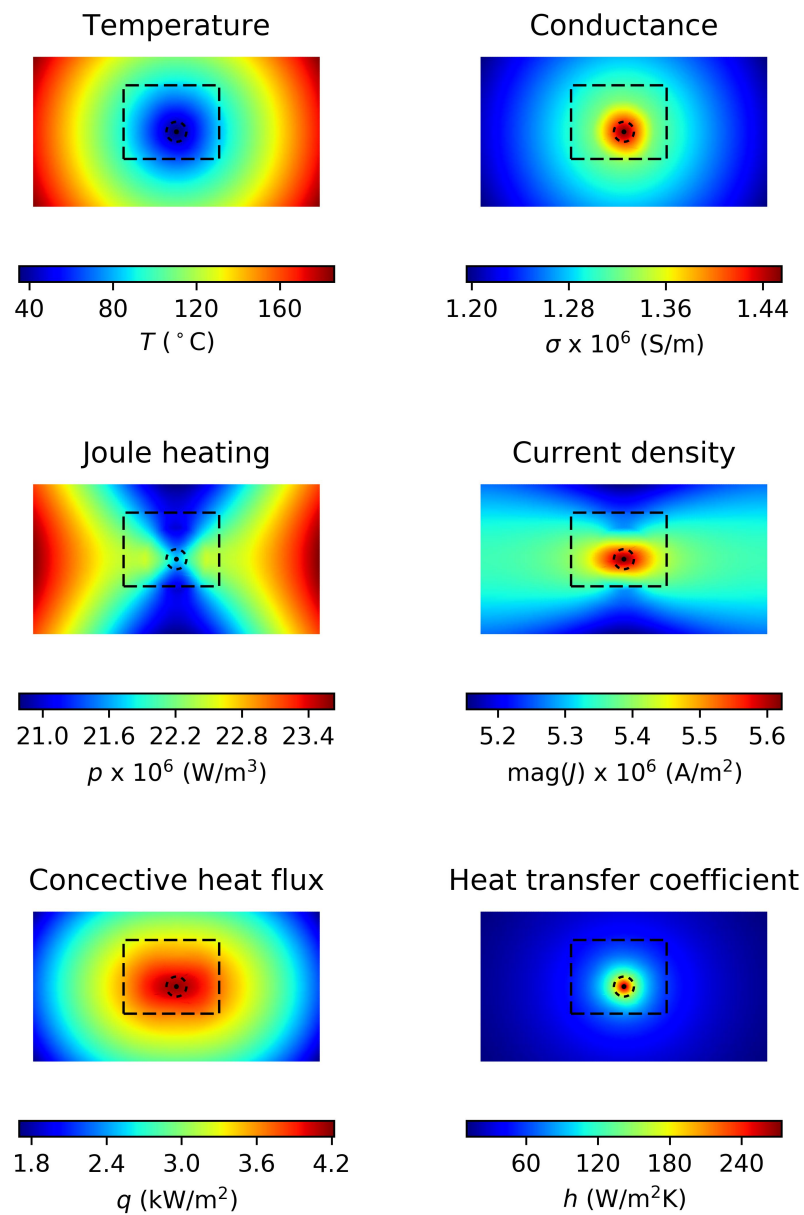


Figure 434: Convection calculation, mikkonen_144

Case id: mikkonen_145

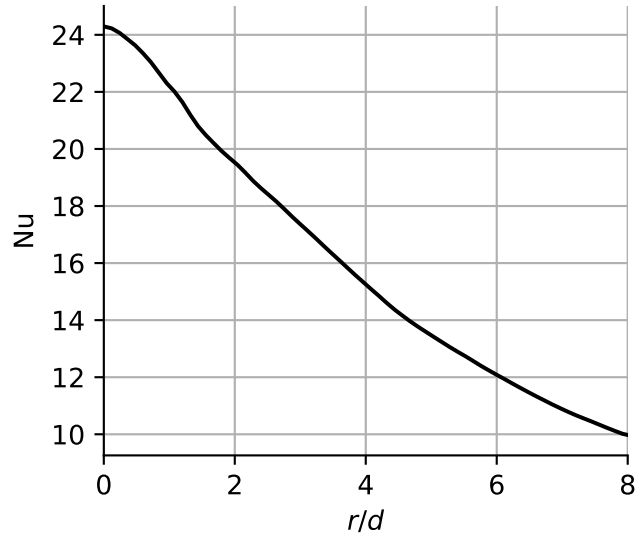


Figure 435: Nu, mikkonen_145

path	2017_03_10_viimeinen/2.5mm_Q17.9_Hd6
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 08:46:09

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
9841	0.18	6	0.71	2.5	15.0	20.9	19.5	0.353	60.6

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.1	147.2	2.78	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.21	34.64	35.54	36.70	37.62	38.64	39.74	40.98	42.35
Nu	24.29	23.58	22.21	20.64	19.52	18.43	17.36	16.30	15.25
h (W/m ² K)	252.08	244.71	230.43	214.15	202.59	191.19	180.17	169.14	158.28
q (kW/m ²)	3.71	3.71	3.70	3.68	3.67	3.66	3.65	3.63	3.62

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	42.35	43.82	45.14	46.44	47.82	49.23	50.64	51.93	53.16
Nu	15.25	14.26	13.47	12.76	12.08	11.46	10.88	10.40	9.98
h (W/m ² K)	158.28	148.02	139.77	132.44	125.37	118.86	112.91	107.91	103.51
q (kW/m ²)	3.62	3.60	3.58	3.57	3.55	3.53	3.51	3.50	3.48

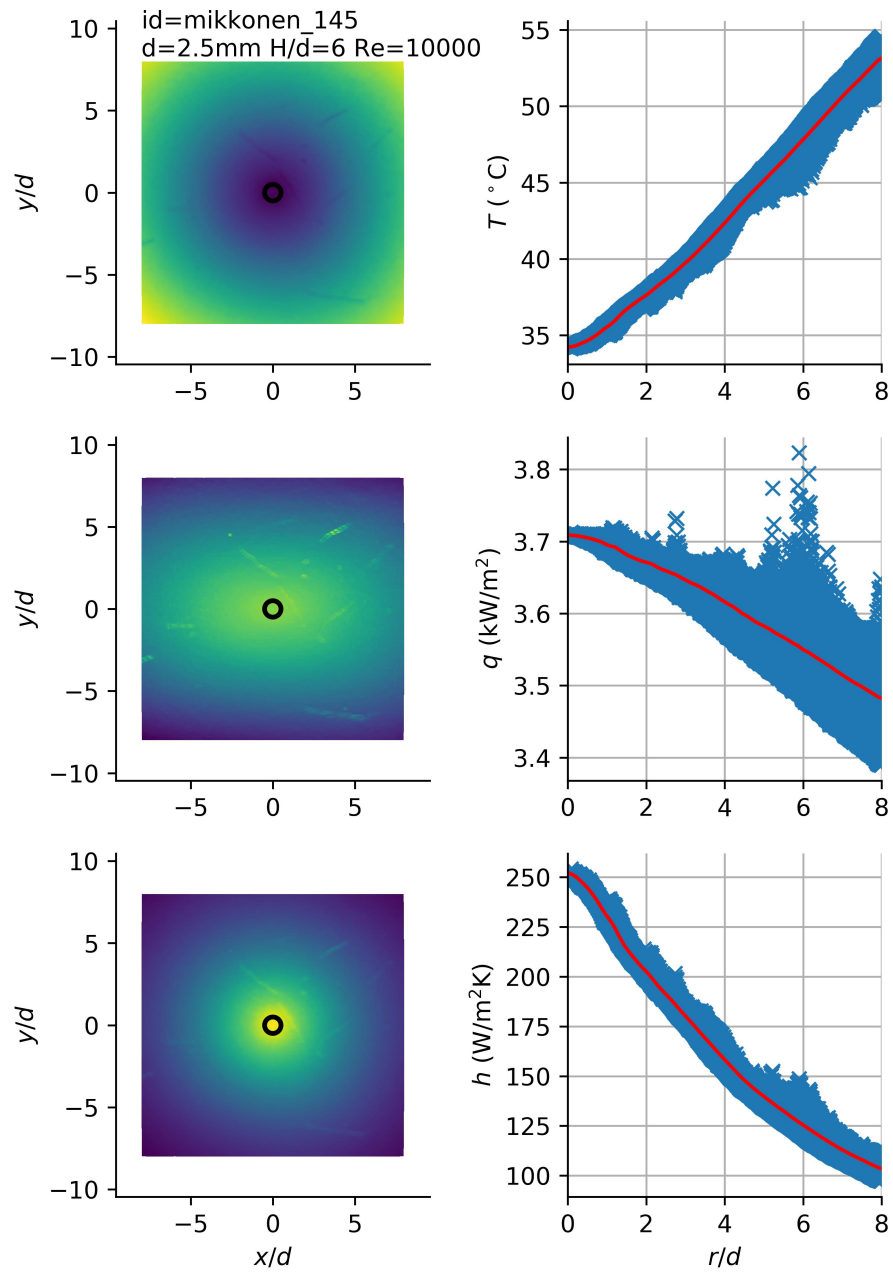


Figure 436: Results, mikkonen_145

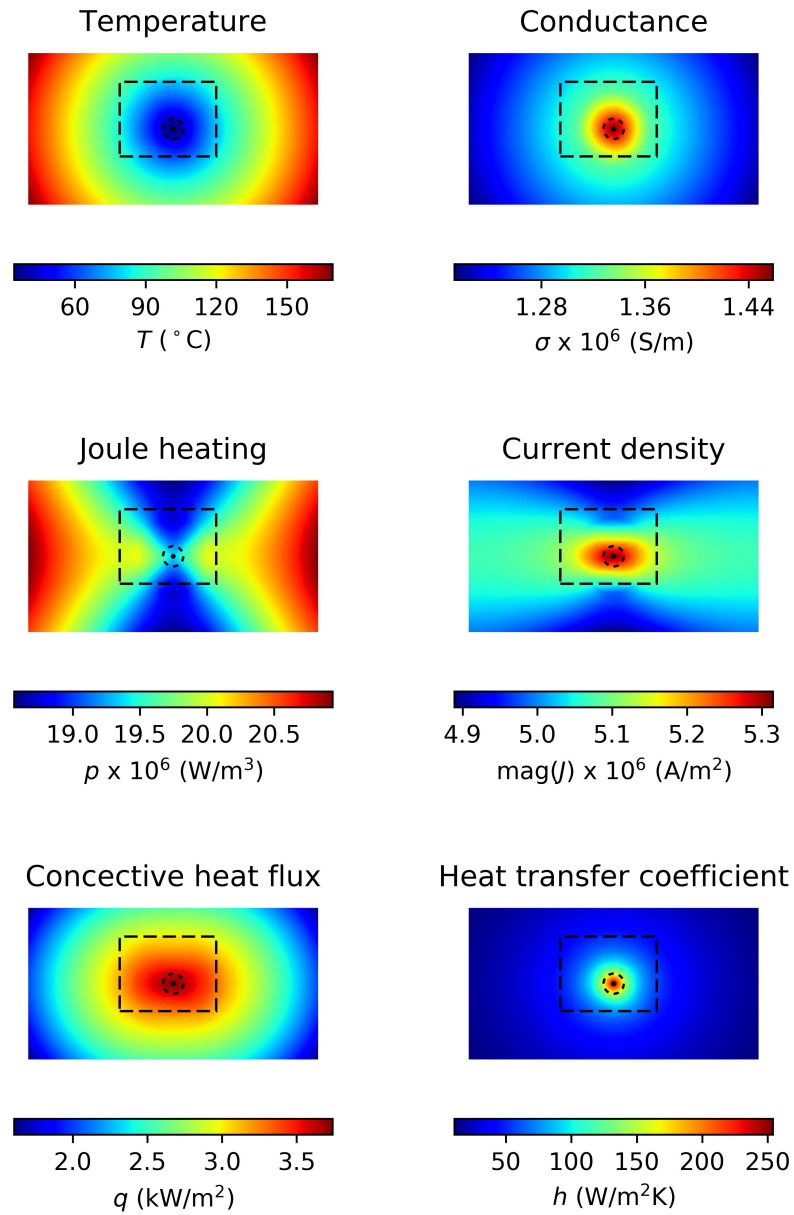


Figure 437: Convection calculation, mikkonen_145

Case id: mikkonen_146

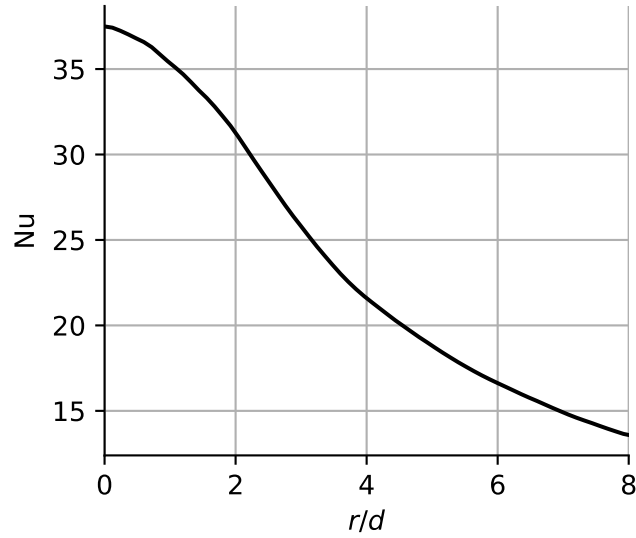


Figure 438: Nu, mikkonen_146

path		2017_03_10_viimeinen/2.5mm_Q25.1_Hd1							
this case measured by		Antti Mikkonen							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-03-10 09:24:11							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14009	0.25	1	0.71	2.5	2.5	21.3	19.7	0.503	86.5
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.4	179.7	2.96				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.34	34.63	35.22	36.03	37.18	38.85	40.74	42.75	44.62
Nu	37.49	36.76	35.34	33.53	31.26	28.44	25.80	23.45	21.60
h (W/m ² K)	389.50	381.91	367.14	348.32	324.74	295.48	268.00	243.65	224.34
q (kW/m ²)	5.70	5.70	5.70	5.69	5.68	5.66	5.64	5.61	5.59
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.62	46.34	48.10	49.90	51.58	53.24	54.97	56.60	58.12
Nu	21.60	20.13	18.81	17.62	16.62	15.74	14.91	14.20	13.59
h (W/m ² K)	224.34	209.09	195.40	183.03	172.69	163.52	154.89	147.50	141.17
q (kW/m ²)	5.59	5.57	5.55	5.53	5.50	5.48	5.46	5.44	5.42

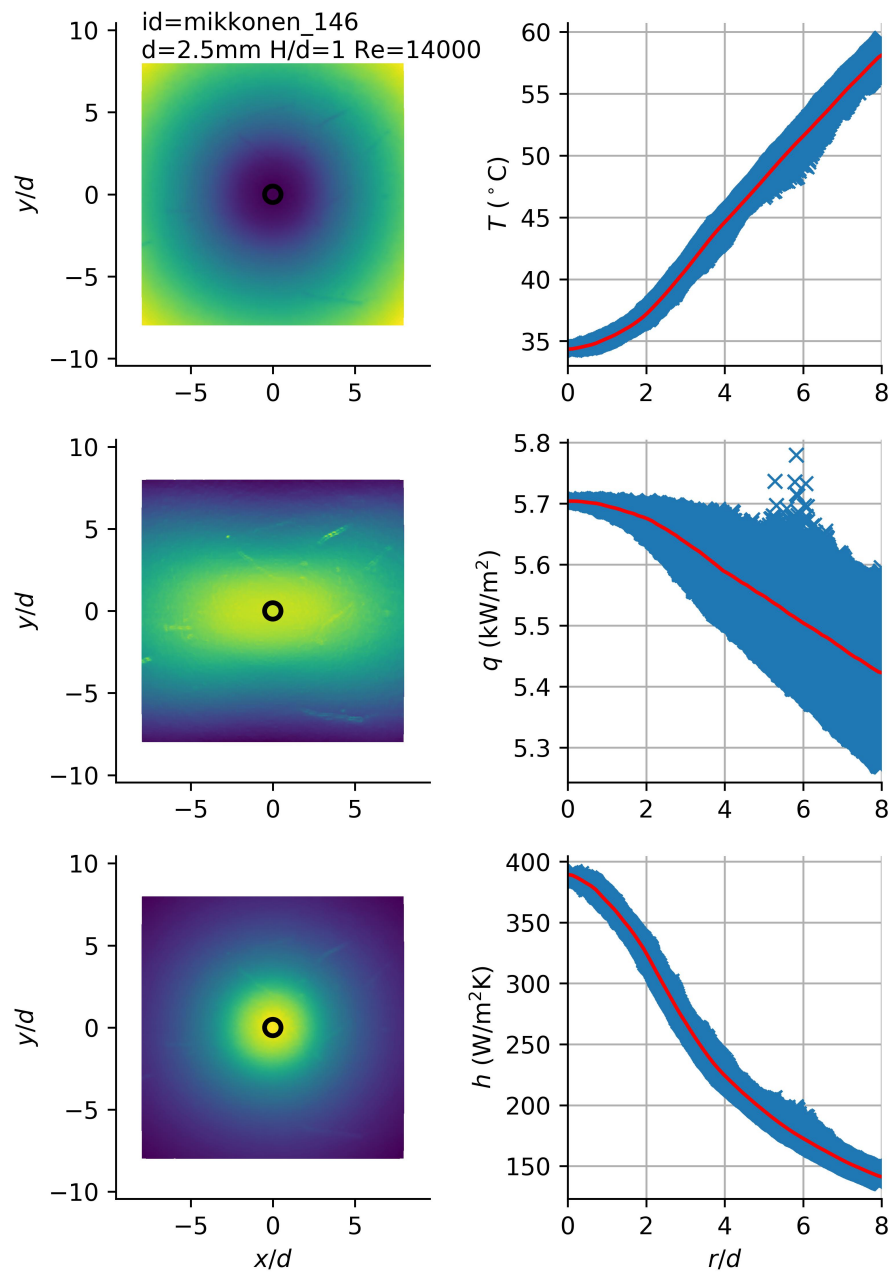


Figure 439: Results, mikkonen_146

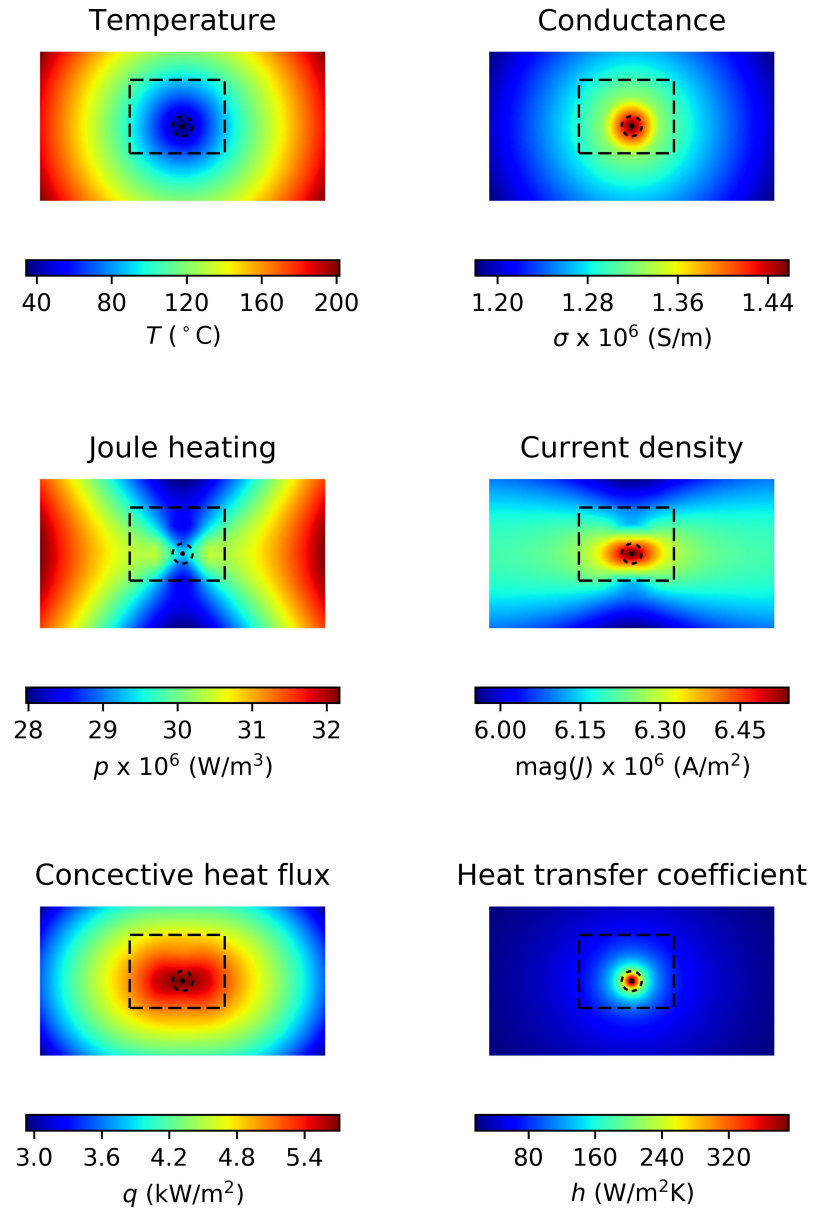


Figure 440: Convection calculation, mikkonen_146

Case id: mikkonen_147

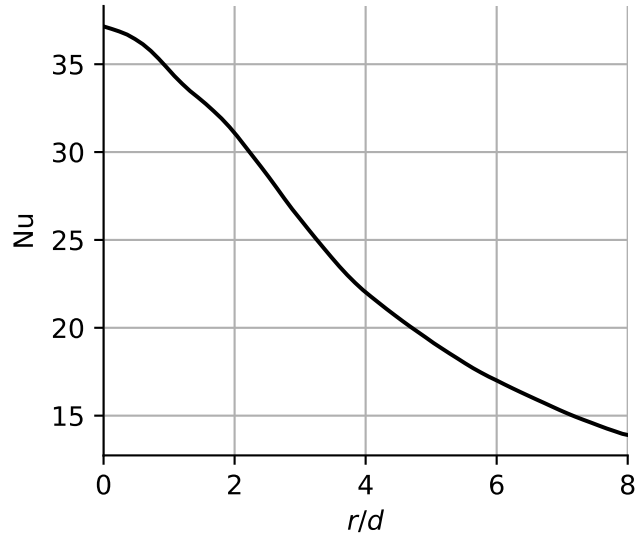


Figure 441: Nu, mikkonen_147

path	2017_03_10_viimeinen/2.5mm_Q25.1_Hd2
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 09:29:31

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
13923	0.25	2	0.71	2.5	5.0	21.2	19.7	0.499	85.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.4	180.0	3.27	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.62	34.93	35.66	36.47	37.44	38.88	40.63	42.53	44.39
Nu	37.15	36.38	34.67	32.93	31.08	28.69	26.19	23.92	22.02
h (W/m ² K)	385.81	377.85	360.02	341.98	322.78	297.91	272.01	248.39	228.72
q (kW/m ²)	5.76	5.75	5.75	5.74	5.73	5.71	5.69	5.67	5.65

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.39	46.05	47.77	49.54	51.21	52.84	54.55	56.18	57.67
Nu	22.02	20.56	19.23	18.02	17.00	16.11	15.26	14.52	13.90
h (W/m ² K)	228.72	213.53	199.73	187.18	176.58	167.25	158.44	150.79	144.36
q (kW/m ²)	5.65	5.63	5.61	5.58	5.56	5.54	5.52	5.50	5.48

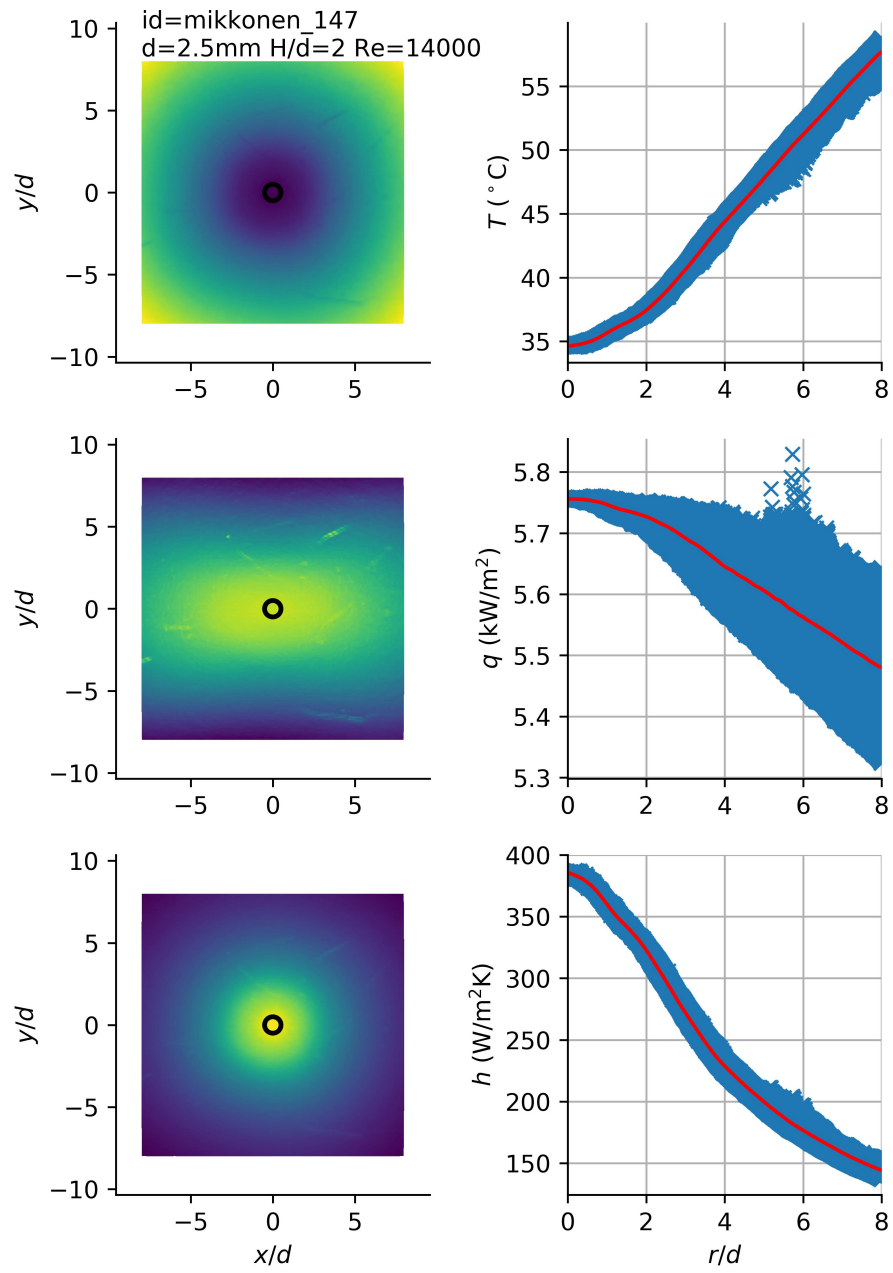


Figure 442: Results, mikkonen_147

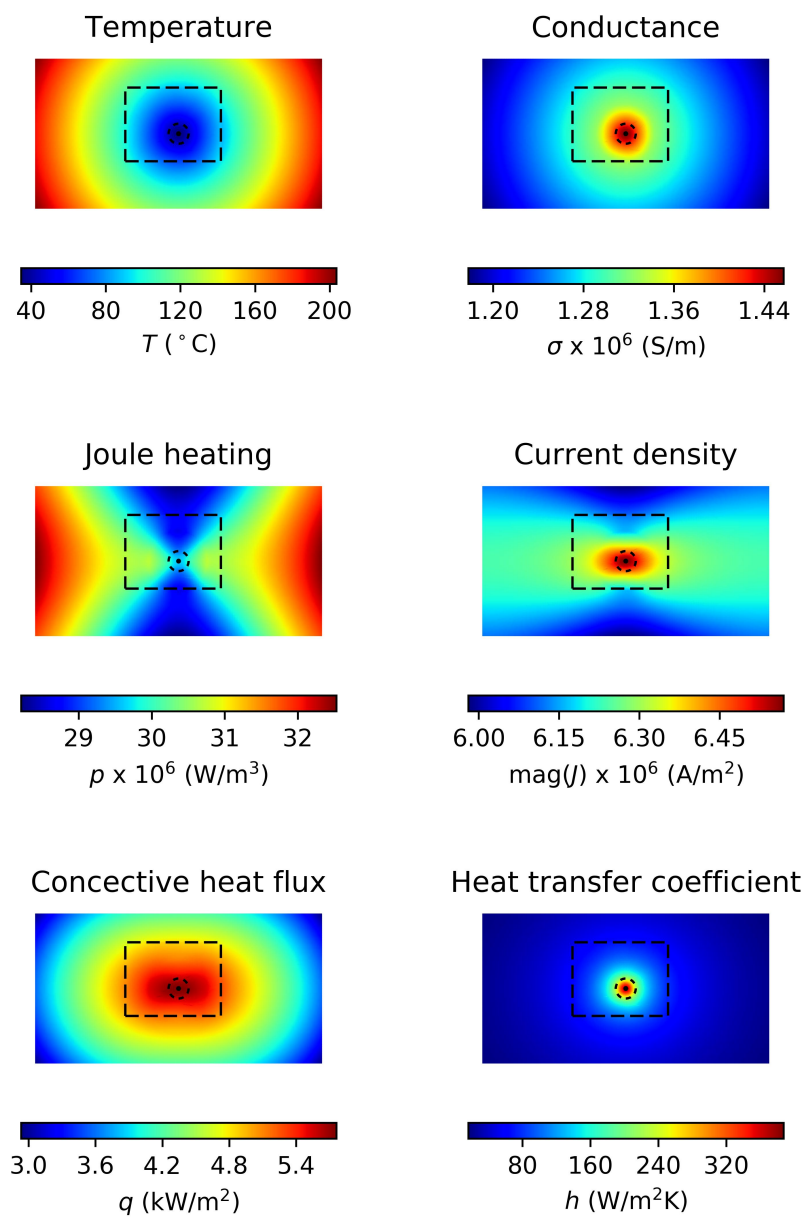


Figure 443: Convection calculation, mikkonen_147

Case id: mikkonen_148

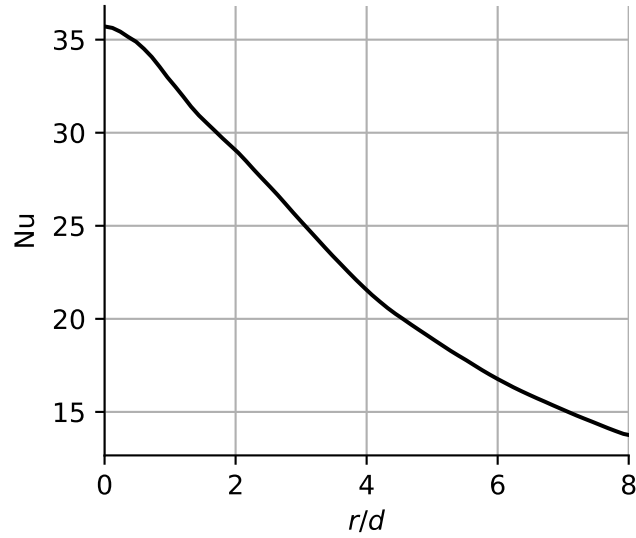


Figure 444: Nu, mikkonen_148

path		2017_03_10_viimeinen/2.5mm_Q25.1_Hd4							
this case measured by		Antti Mikkonen							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-03-10 09:34:28							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14017	0.25	4	0.71	2.5	10.0	21.3	19.6	0.503	86.5
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)			t (mm)			
0.3	1.4	173.5	3.88			0.5			
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.09	34.45	35.34	36.36	37.29	38.46	39.86	41.46	43.16
Nu	35.71	34.83	32.81	30.72	29.06	27.19	25.23	23.32	21.55
h (W/m ² K)	370.98	361.81	340.84	319.18	301.85	282.45	262.14	242.26	223.90
q (kW/m ²)	5.38	5.37	5.36	5.35	5.34	5.33	5.31	5.29	5.27
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	43.16	44.73	46.22	47.79	49.44	50.97	52.46	53.99	55.43
Nu	21.55	20.13	18.94	17.82	16.77	15.89	15.12	14.39	13.76
h (W/m ² K)	223.90	209.08	196.72	185.12	174.19	165.09	157.03	149.49	142.95
q (kW/m ²)	5.27	5.25	5.24	5.22	5.20	5.18	5.16	5.14	5.12

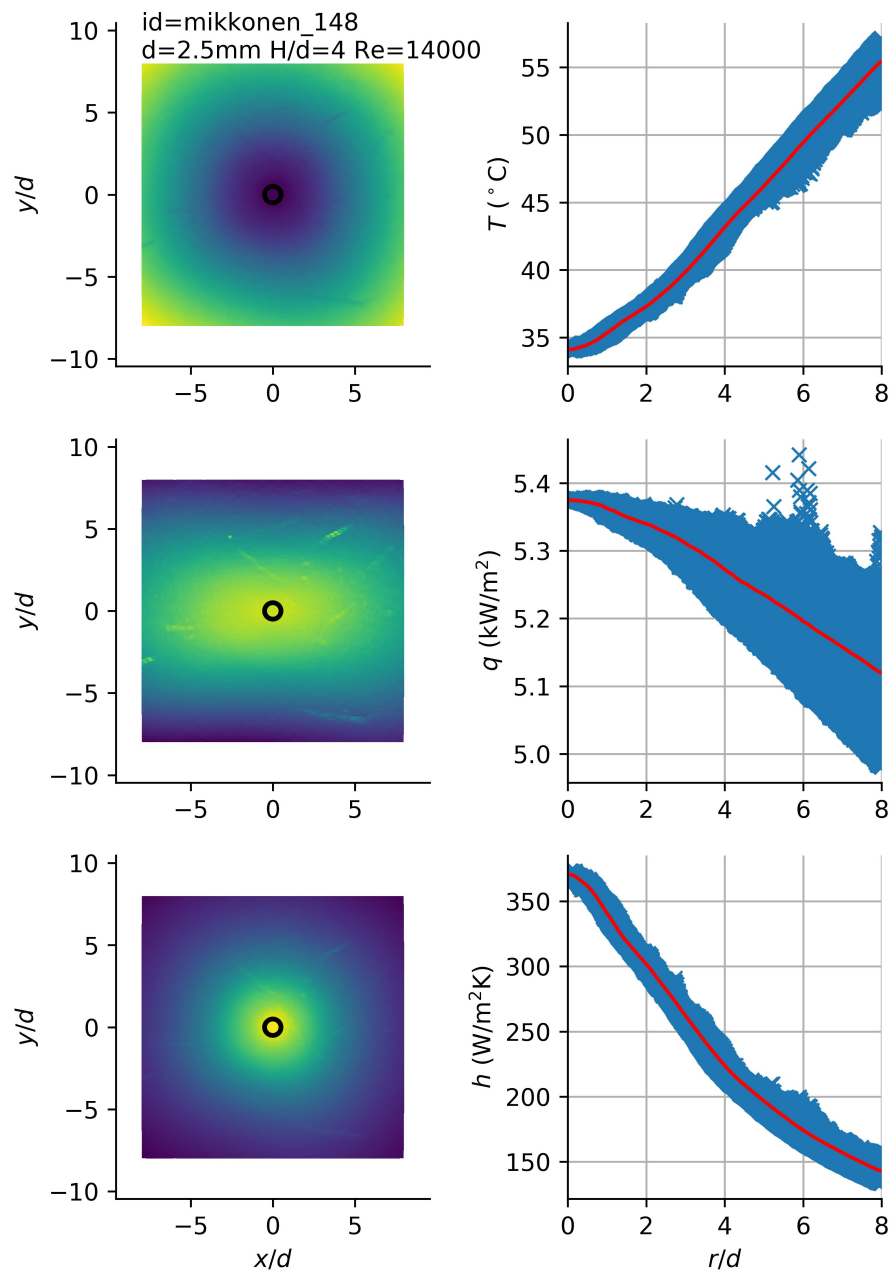


Figure 445: Results, mikkonen_148

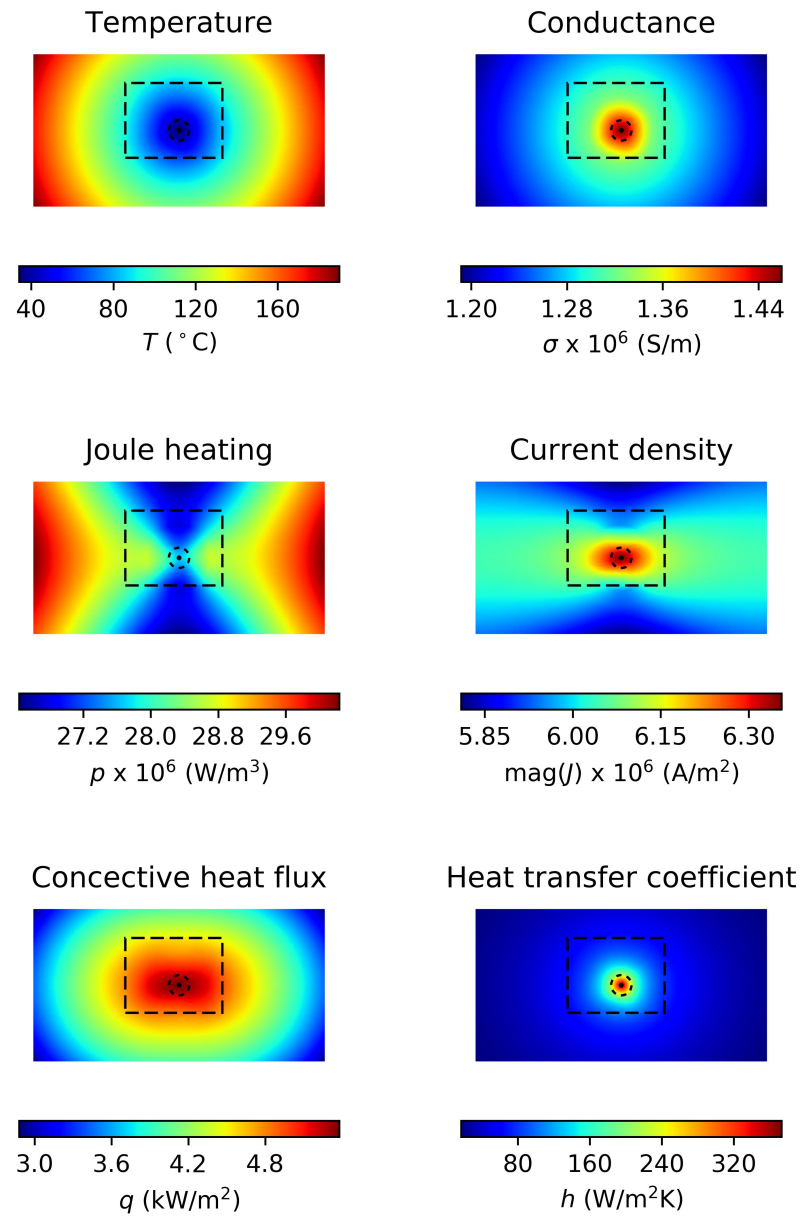


Figure 446: Convection calculation, mikkonen_148

Case id: mikkonen_149

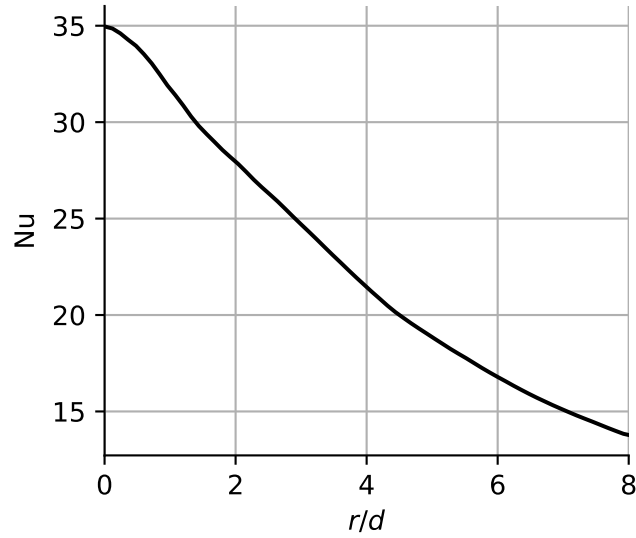


Figure 447: Nu, mikkonen_149

path		2017_03_10_viimeinen/2.5mm_Q25.1_Hd6							
this case measured by		Antti Mikkonen							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-03-10 09:38:12							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
14023	0.25	6	0.71	2.5	15.0	21.3	20.0	0.503	86.6
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	1.3	168.6	3.88				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	33.90	34.33	35.27	36.34	37.26	38.29	39.44	40.77	42.24
Nu	34.96	33.89	31.74	29.59	27.95	26.32	24.70	23.05	21.45
h (W/m ² K)	363.21	352.02	329.69	307.34	290.36	273.45	256.58	239.48	222.84
q (kW/m ²)	5.05	5.05	5.04	5.02	5.01	5.00	4.99	4.97	4.95
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	42.24	43.76	45.12	46.52	48.02	49.52	50.94	52.31	53.64
Nu	21.45	20.00	18.85	17.80	16.79	15.88	15.09	14.40	13.78
h (W/m ² K)	222.84	207.79	195.87	184.90	174.40	164.93	156.75	149.55	143.15
q (kW/m ²)	4.95	4.94	4.92	4.90	4.88	4.87	4.85	4.83	4.81

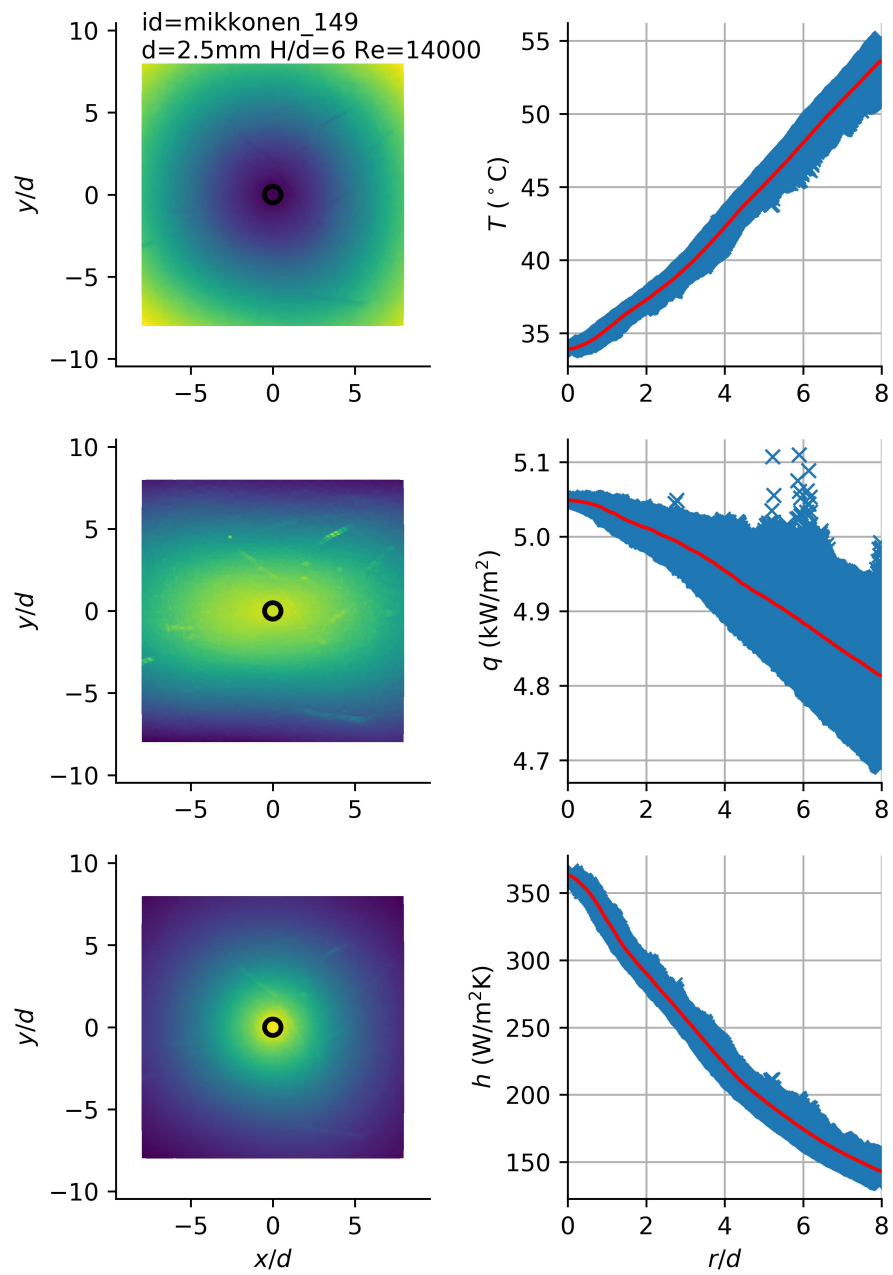


Figure 448: Results, mikkonen_149

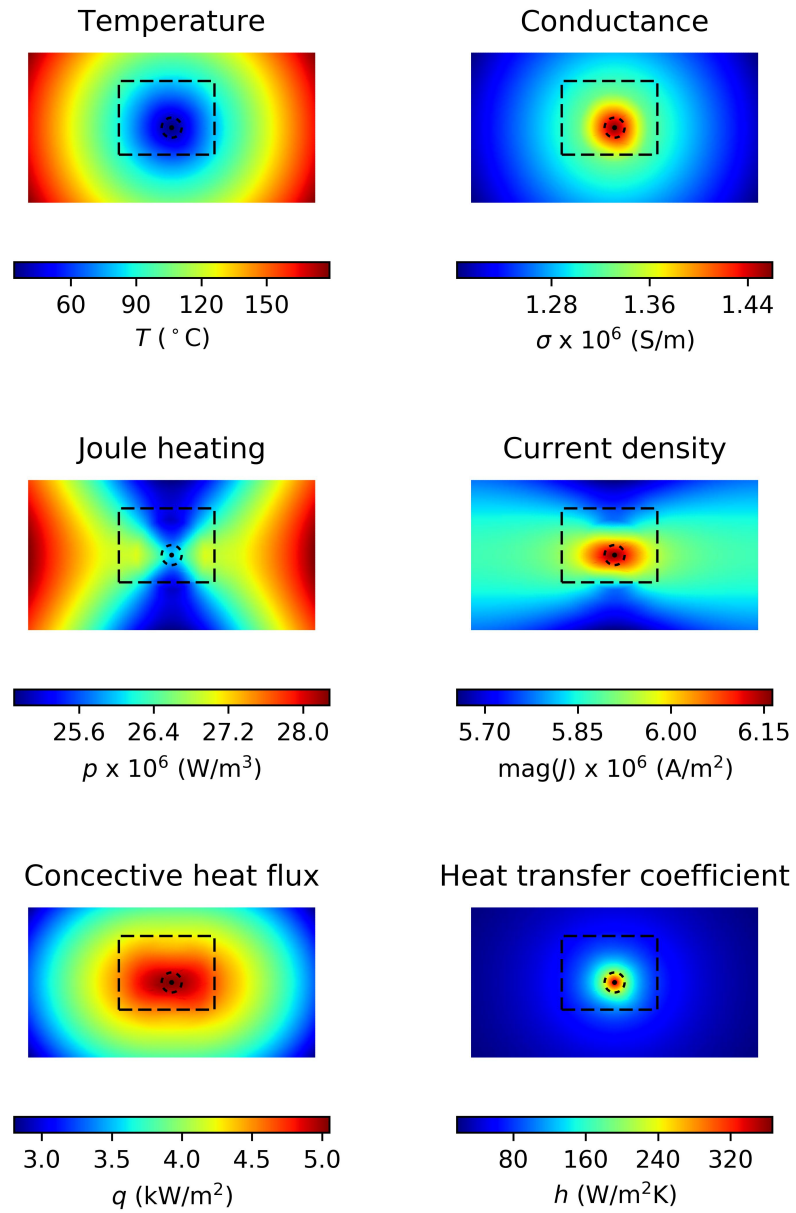


Figure 449: Convection calculation, mikkonen_149

Case id: mikkonen_150

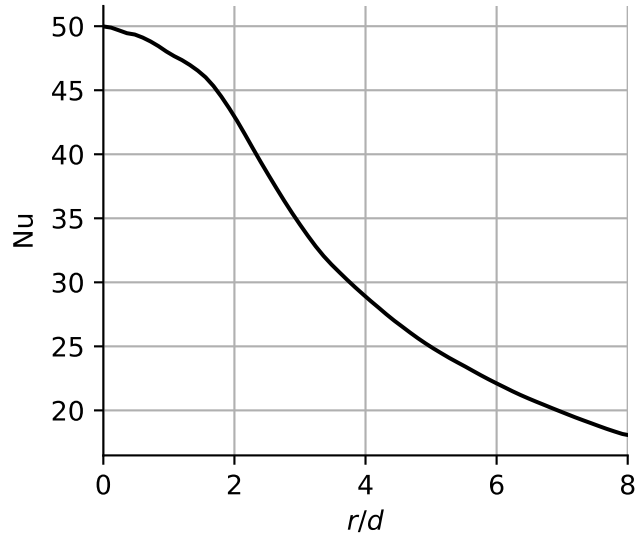


Figure 450: Nu, mikkonen_150

path	2017_03_10_viimeinen/2.5mm_Q35.8_Hd1
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 09:54:55

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
19847	0.36	1	0.71	2.5	2.5	20.9	19.9	0.711	122.2

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.7	210.5	3.41	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.34	35.55	36.00	36.56	37.83	39.82	42.08	44.26	46.21
Nu	49.98	49.31	47.91	46.27	42.94	38.55	34.51	31.30	28.89
h (W/m ² K)	518.64	511.66	497.12	480.15	445.57	399.97	358.07	324.73	299.81
q (kW/m ²)	8.01	8.01	8.00	8.00	7.99	7.97	7.94	7.91	7.89

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.21	48.21	50.18	51.99	53.87	55.73	57.50	59.32	60.96
Nu	28.89	26.77	24.95	23.48	22.11	20.90	19.86	18.89	18.08
h (W/m ² K)	299.81	277.77	258.93	243.65	229.39	216.88	206.08	196.01	187.61
q (kW/m ²)	7.89	7.86	7.84	7.82	7.79	7.77	7.75	7.73	7.70

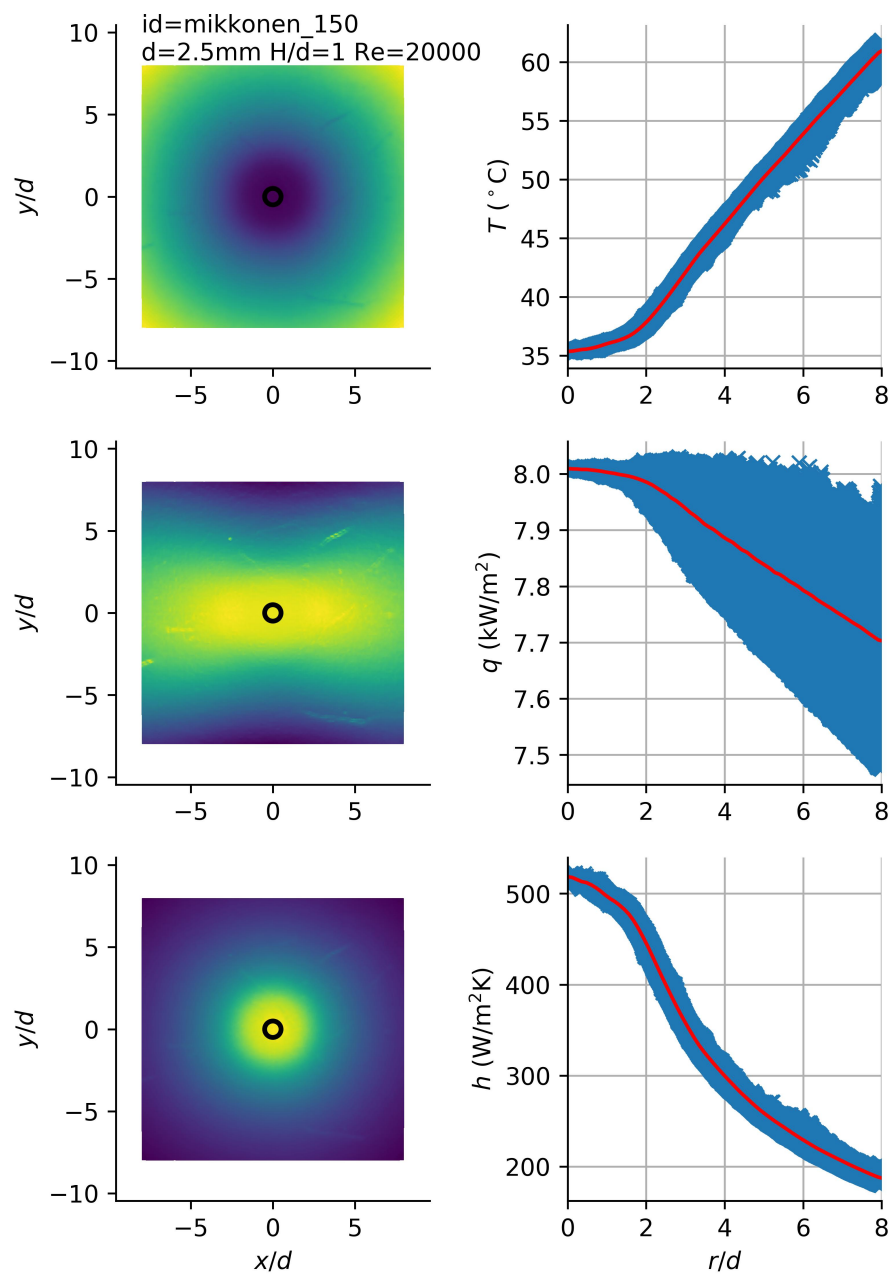


Figure 451: Results, mikkonen_150

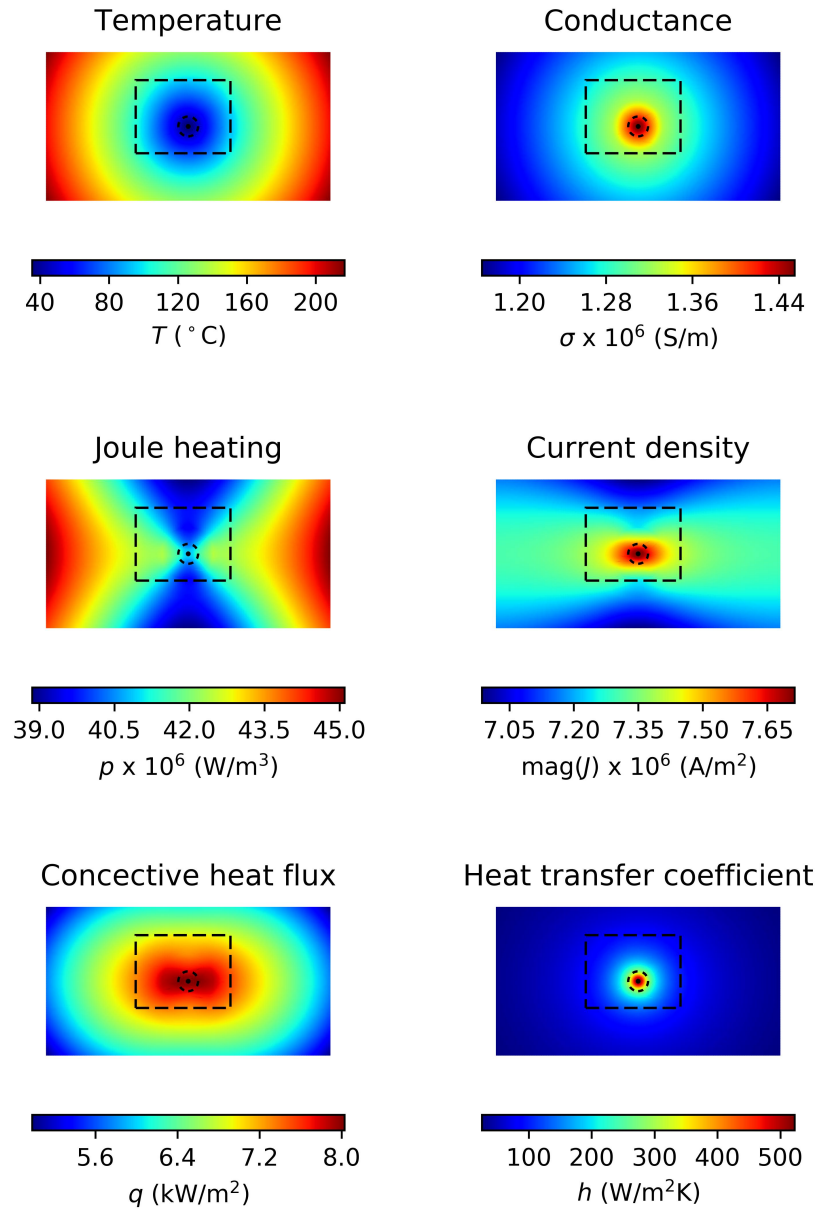


Figure 452: Convection calculation, mikkonen_150

Case id: mikkonen_151

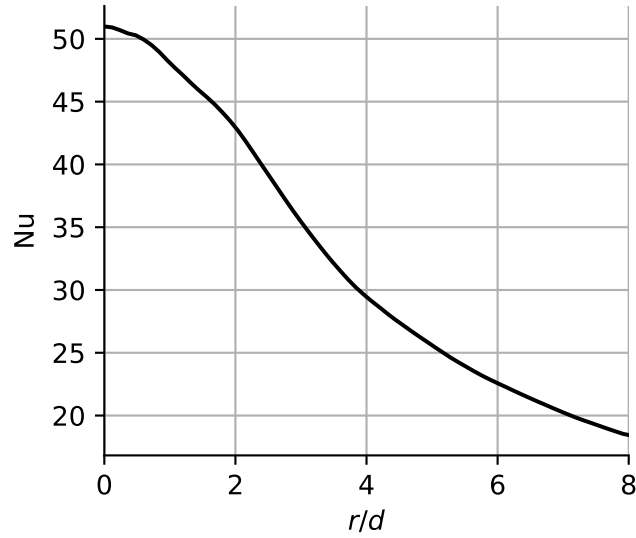


Figure 453: Nu, mikkonen_151

path	2017_03_10_viimeinen/2.5mm_Q35.8_Hd2
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 09:51:23

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
20012	0.36	2	0.71	2.5	5.0	20.9	20.0	0.717	123.3

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.6	203.7	3.83	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.20	34.42	35.05	35.83	36.81	38.37	40.26	42.29	44.22
Nu	50.99	50.23	48.09	45.65	42.95	39.20	35.44	32.12	29.45
h (W/m²K)	529.08	521.18	498.95	473.63	445.62	406.78	367.75	333.27	305.61
q (kW/m²)	7.52	7.51	7.51	7.50	7.49	7.47	7.45	7.43	7.40

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.22	45.95	47.72	49.53	51.24	52.90	54.63	56.27	57.79
Nu	29.45	27.41	25.60	23.95	22.57	21.37	20.25	19.28	18.45
h (W/m²K)	305.61	284.41	265.61	248.52	234.22	221.76	210.10	200.02	191.47
q (kW/m²)	7.40	7.38	7.36	7.34	7.31	7.30	7.27	7.25	7.23

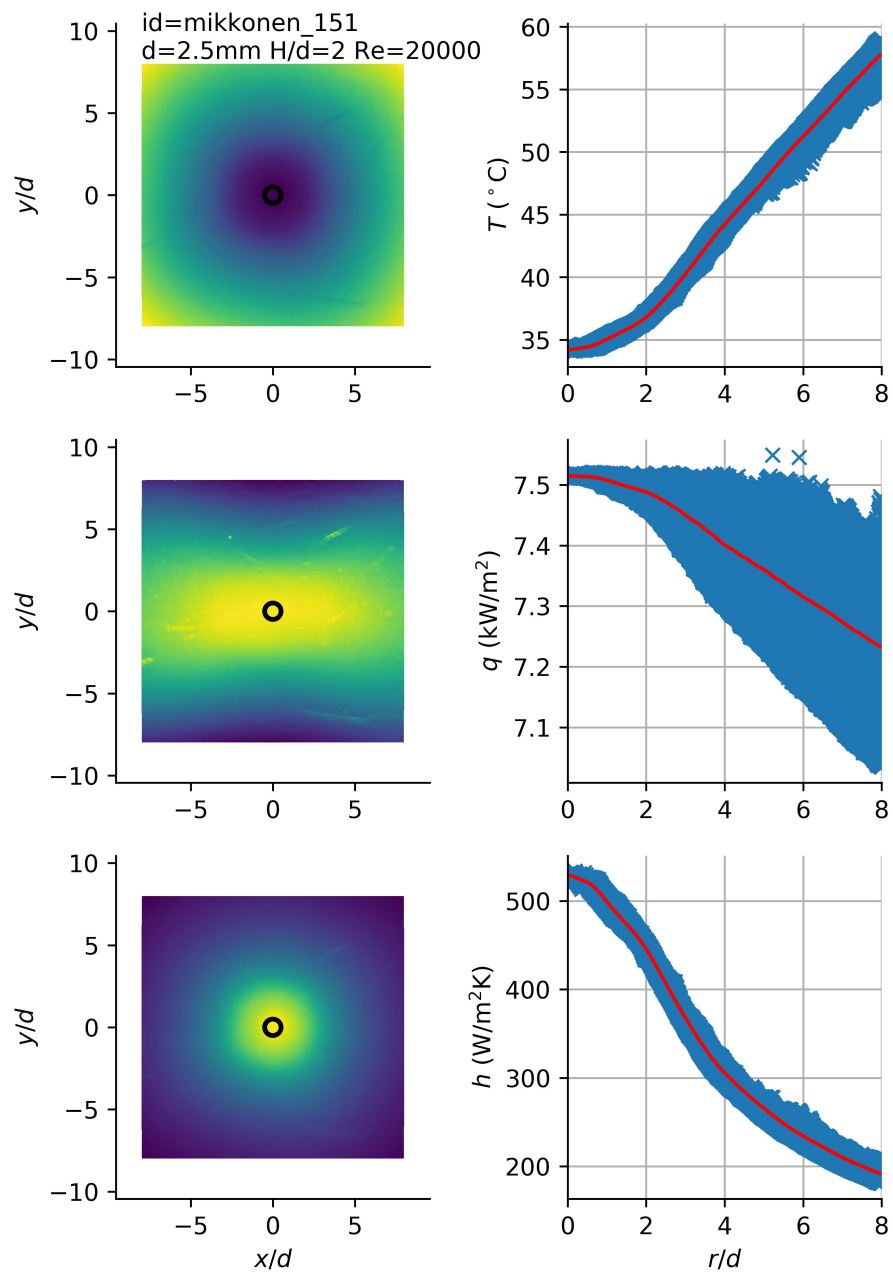


Figure 454: Results, mikkonen_151

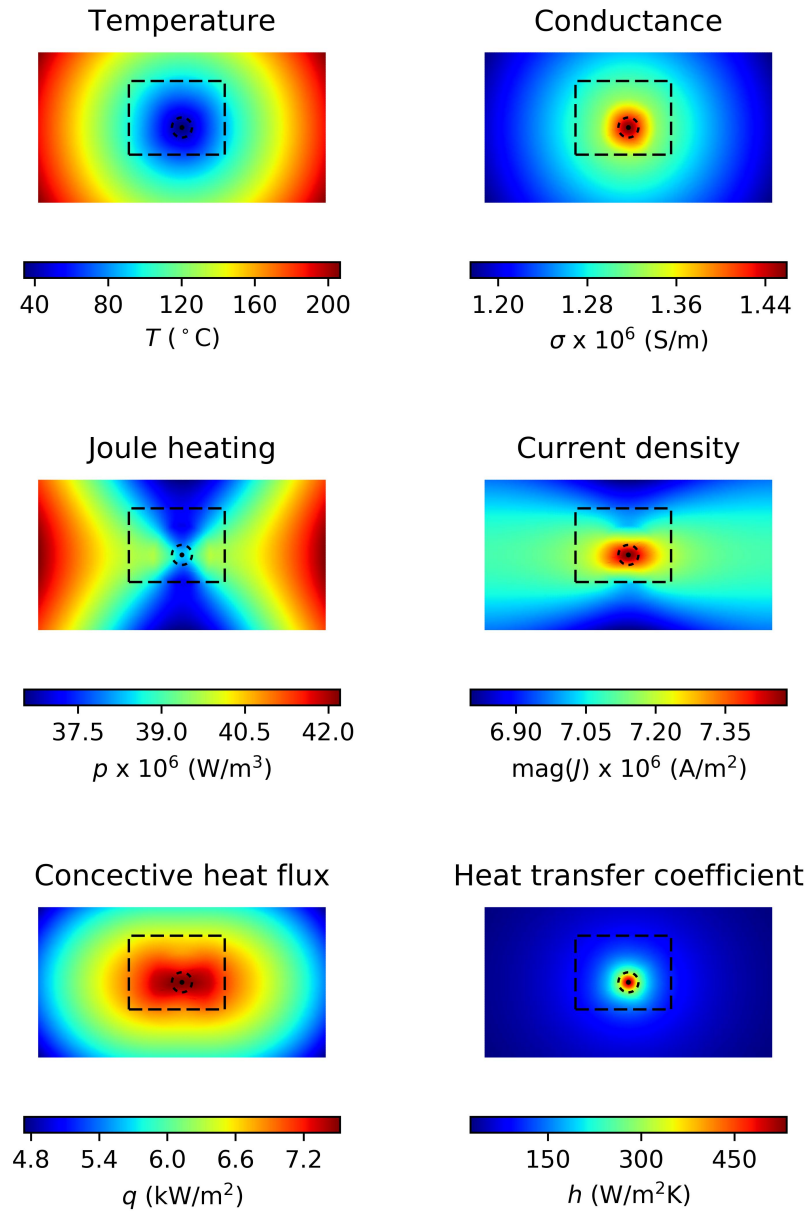


Figure 455: Convection calculation, mikkonen_151

Case id: mikkonen_152

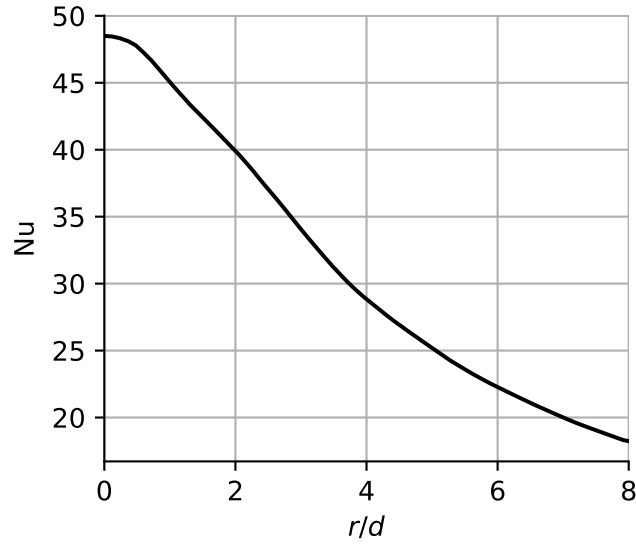


Figure 456: Nu, mikkonen_152

path	2017_03_10_viimeinen/2.5mm_Q35.8_Hd4
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 09:48:16

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
19972	0.36	4	0.71	2.5	10.0	20.9	19.9	0.716	123.0

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.6	203.5	3.54	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.70	34.95	35.82	36.78	37.81	39.16	40.79	42.64	44.43
Nu	48.50	47.70	45.06	42.42	39.91	37.05	34.07	31.21	28.84
h (W/m ² K)	503.29	495.00	467.53	440.12	414.09	384.45	353.47	323.82	299.24
q (kW/m ²)	7.45	7.45	7.44	7.43	7.42	7.40	7.38	7.36	7.34
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.43	46.10	47.83	49.62	51.30	52.96	54.66	56.30	57.82
Nu	28.84	26.92	25.20	23.60	22.27	21.10	20.00	19.05	18.24
h (W/m ² K)	299.24	279.35	261.43	244.89	231.12	218.90	207.58	197.65	189.22
q (kW/m ²)	7.34	7.32	7.30	7.28	7.25	7.23	7.21	7.19	7.17

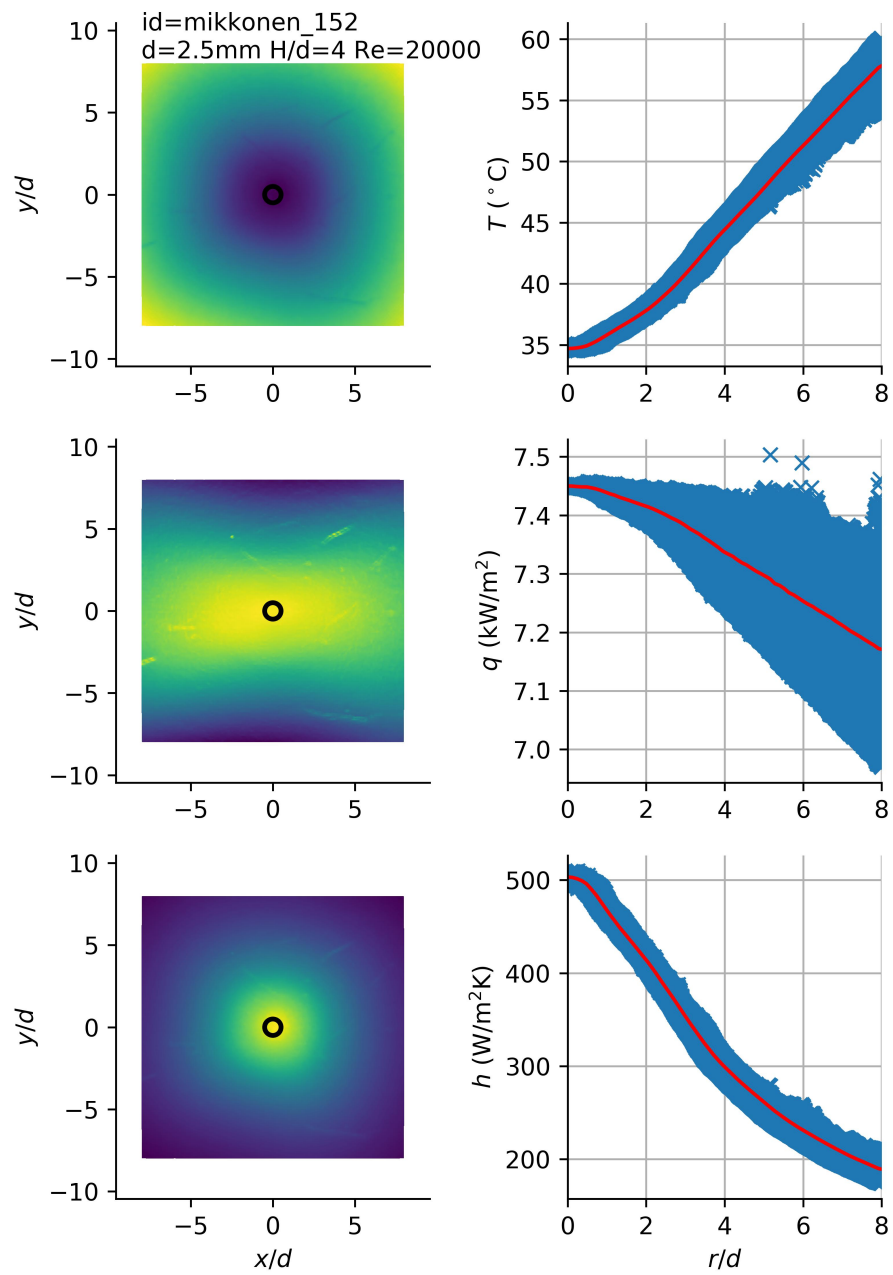


Figure 457: Results, mikkonen_152

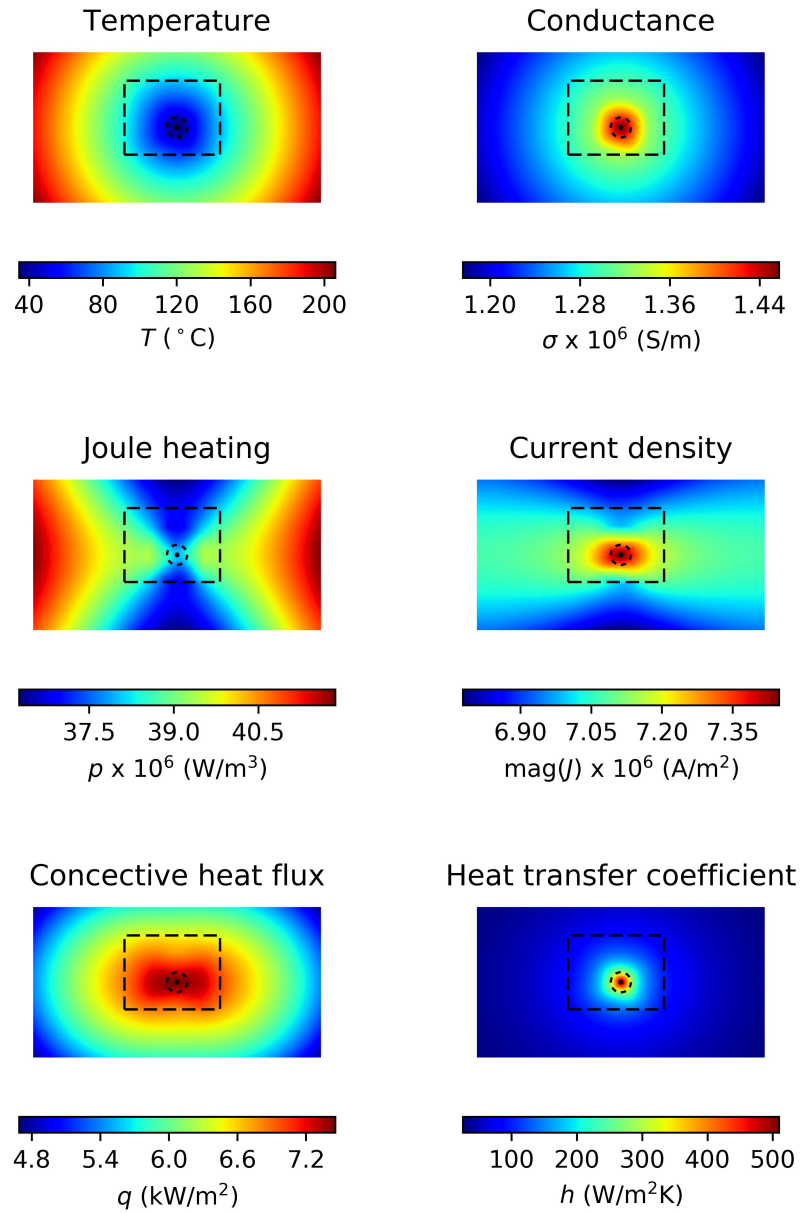


Figure 458: Convection calculation, mikkonen_152

Case id: mikkonen_153

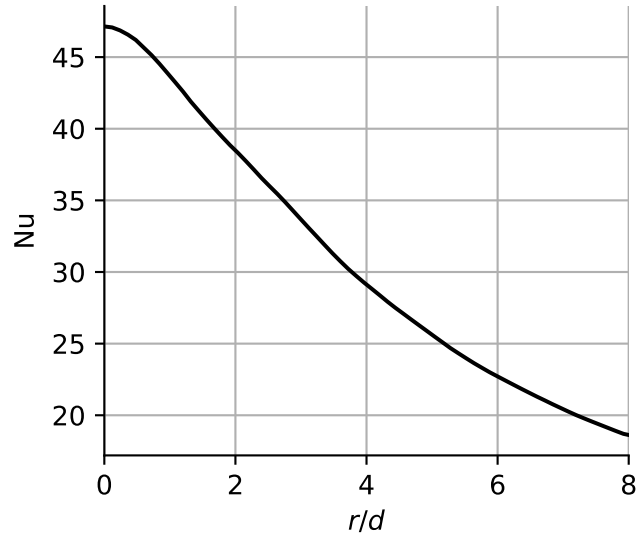


Figure 459: Nu, mikkonen_153

path	2017_03_10_viimeinen/2.5mm_Q35.8_Hd6
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 09:44:43

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
19925	0.36	6	0.71	2.5	15.0	21.0	20.3	0.714	122.8

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	1.6	203.3	3.84	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.56	35.89	36.74	37.81	38.90	40.10	41.48	43.09	44.65
Nu	47.14	46.11	43.68	40.94	38.49	36.09	33.67	31.22	29.12
h (W/m ² K)	489.30	478.57	453.41	424.93	399.46	374.56	349.46	324.00	302.27
q (kW/m ²)	7.47	7.46	7.45	7.44	7.43	7.41	7.40	7.38	7.36

r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.65	46.22	47.85	49.58	51.20	52.81	54.47	56.09	57.58
Nu	29.12	27.30	25.62	24.04	22.71	21.53	20.43	19.45	18.62
h (W/m ² K)	302.27	283.34	265.91	249.51	235.71	223.46	212.01	201.88	193.31
q (kW/m ²)	7.36	7.34	7.32	7.30	7.28	7.26	7.24	7.22	7.20

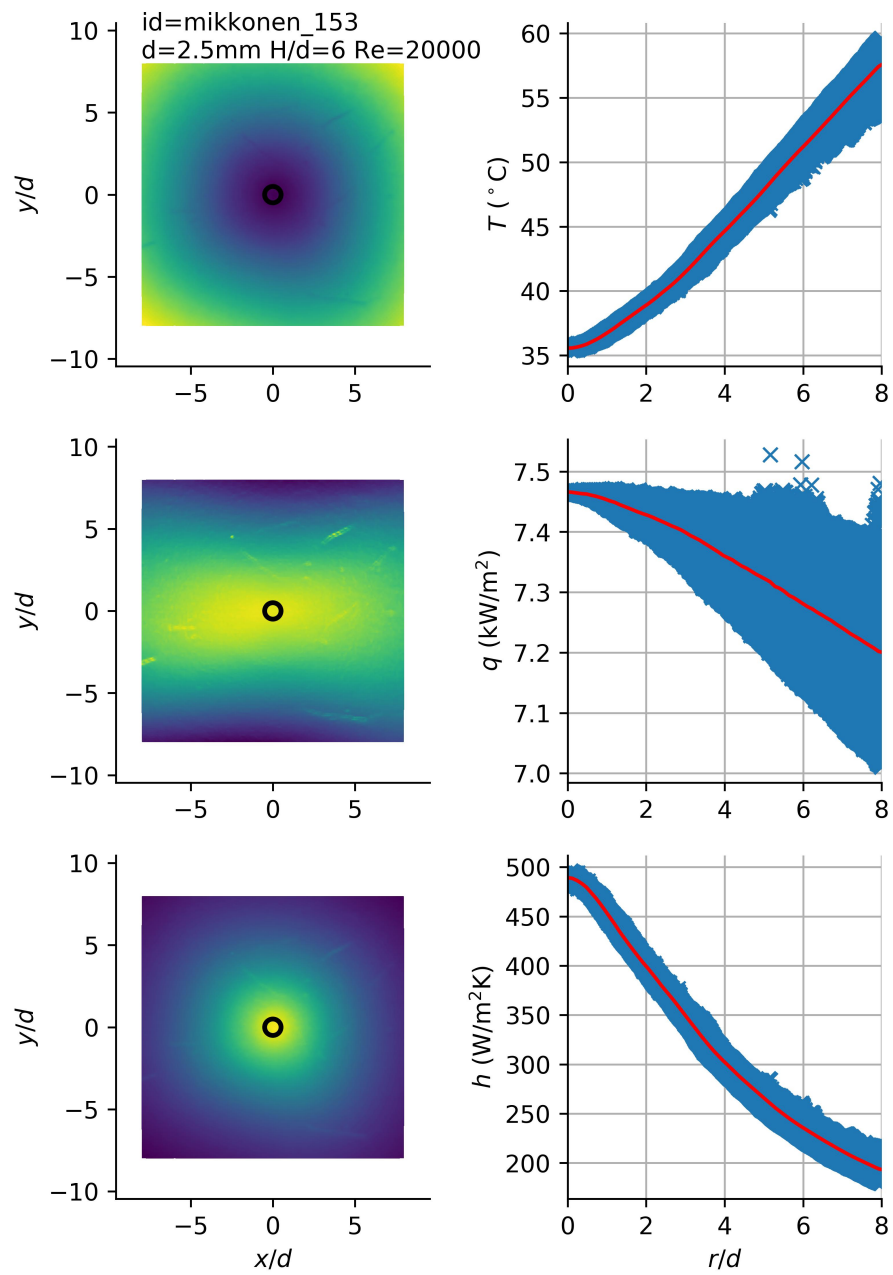


Figure 460: Results, mikkonen_153

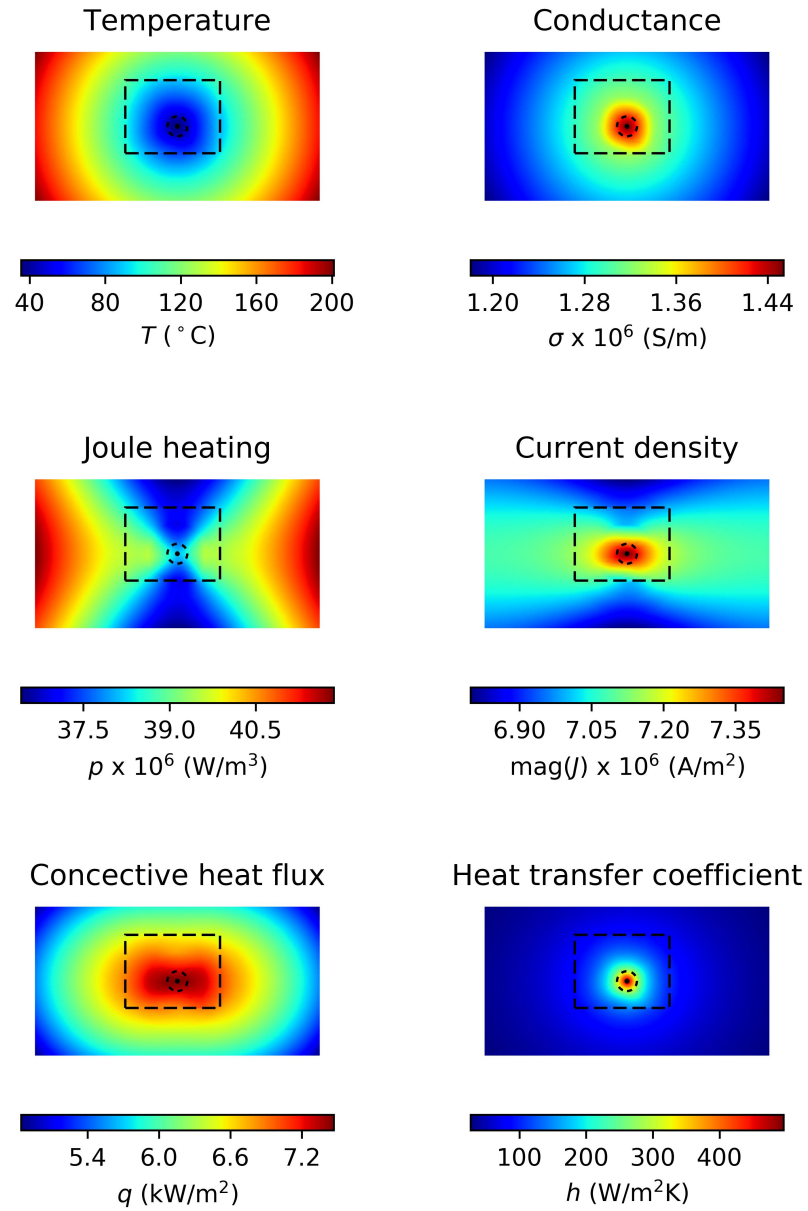


Figure 461: Convection calculation, mikkonen_153

Case id: mikkonen_154

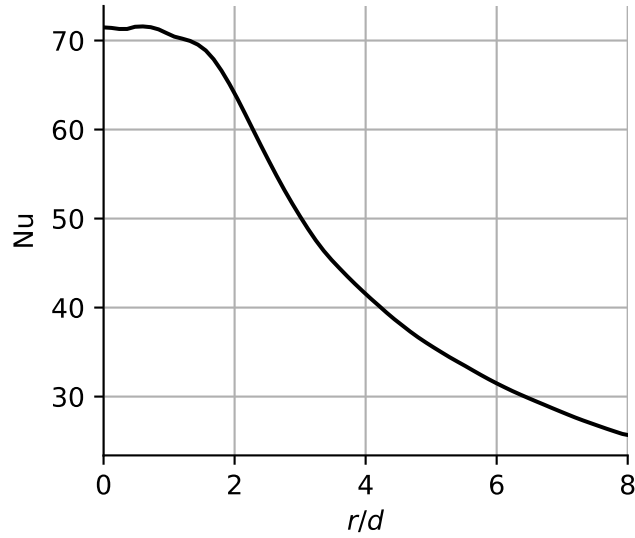


Figure 462: Nu, mikkonen_154

path		2017_03_10_viimeinen/2.5mm_Q53.7_Hd1							
this case measured by		Antti Mikkonen							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-03-10 10:05:11							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
29824	0.53	1	0.71	2.5	2.5	20.7	19.9	1.068	183.5
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.0	249.5	4.21				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.49	35.47	35.66	36.00	37.28	39.47	41.96	44.35	46.44
Nu	71.48	71.55	70.71	69.21	64.05	56.80	50.23	45.20	41.54
h (W/m ² K)	741.22	742.02	733.24	717.72	664.21	588.99	520.93	468.75	430.76
q (kW/m ²)	11.55	11.55	11.55	11.55	11.54	11.52	11.49	11.46	11.43
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	46.44	48.60	50.65	52.58	54.61	56.52	58.44	60.35	62.10
Nu	41.54	38.34	35.70	33.52	31.49	29.78	28.24	26.85	25.69
h (W/m ² K)	430.76	397.59	370.21	347.64	326.52	308.86	292.89	278.41	266.40
q (kW/m ²)	11.43	11.41	11.38	11.36	11.33	11.31	11.29	11.26	11.24

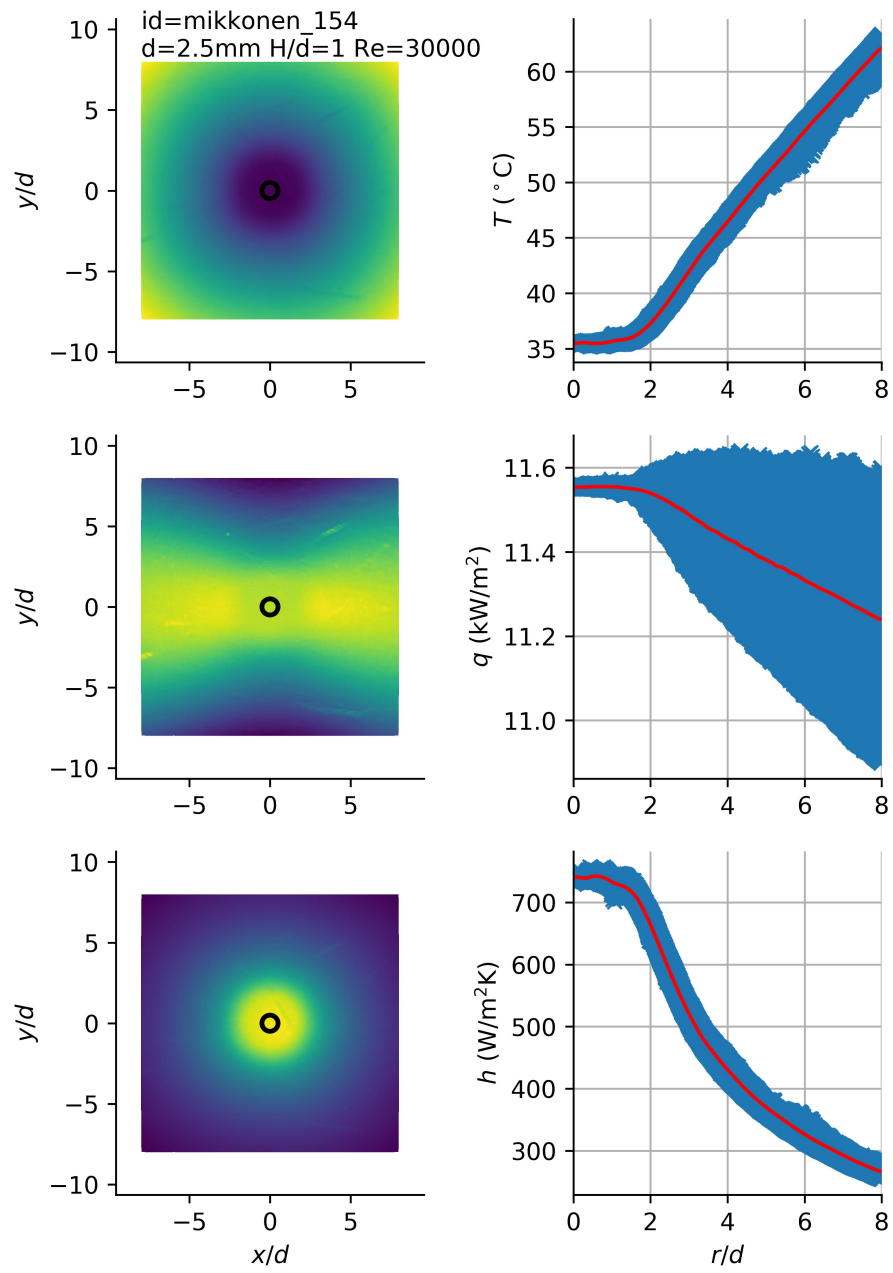


Figure 463: Results, mikkonen_154

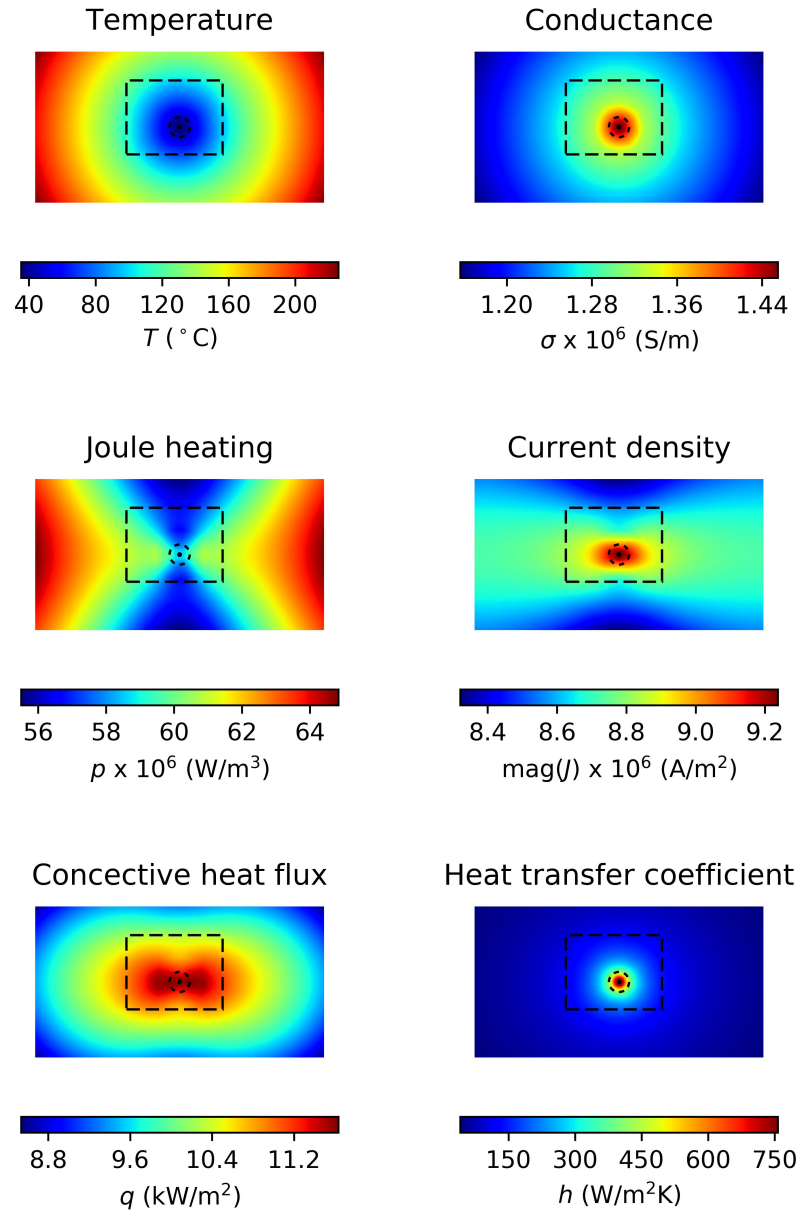


Figure 464: Convection calculation, mikkonen_154

Case id: mikkonen_155

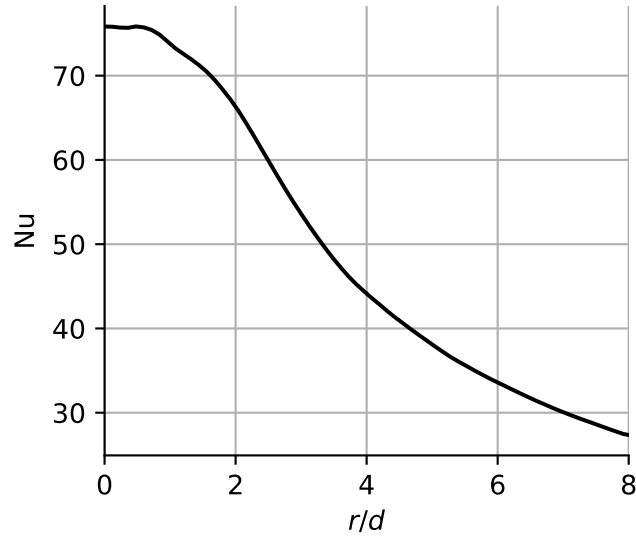


Figure 465: Nu, mikkonen_155

path	2017_03_10_viimeinen/2.5mm_Q53.7_Hd2
this case measured by	Antti Mikkonen
lens	MWIR_f/2.0_f=50mm
measurement time	2017-03-10 10:10:59

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
29918	0.54	2	0.71	2.5	5.0	20.6	19.8	1.071	183.9

Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)	t (mm)
0.3	2.0	240.4	7.93	0.5

r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	34.36	34.36	34.76	35.37	36.42	38.17	40.29	42.53	44.56
Nu	75.83	75.82	73.79	70.86	66.31	59.92	53.61	48.21	44.14
h (W/m ² K)	786.16	786.10	764.99	734.63	687.43	621.23	555.74	499.83	457.62
q (kW/m ²)	11.44	11.45	11.44	11.44	11.42	11.41	11.38	11.36	11.33
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	44.56	46.45	48.38	50.28	52.08	53.91	55.72	57.46	59.13
Nu	44.14	40.93	38.11	35.64	33.59	31.73	30.06	28.63	27.36
h (W/m ² K)	457.62	424.38	395.05	369.53	348.23	328.96	311.69	296.77	283.64
q (kW/m ²)	11.33	11.31	11.28	11.26	11.24	11.22	11.19	11.17	11.15

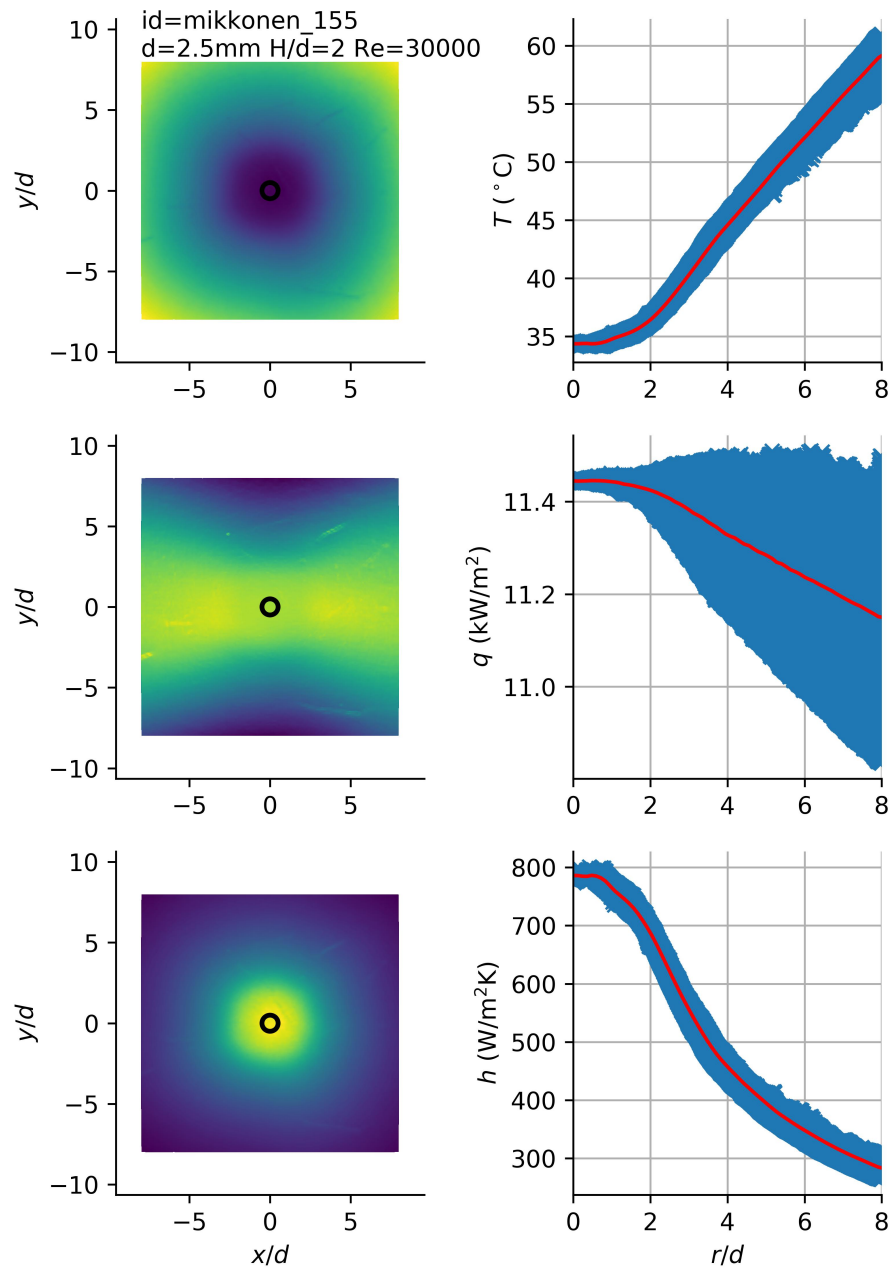


Figure 466: Results, mikkonen_155

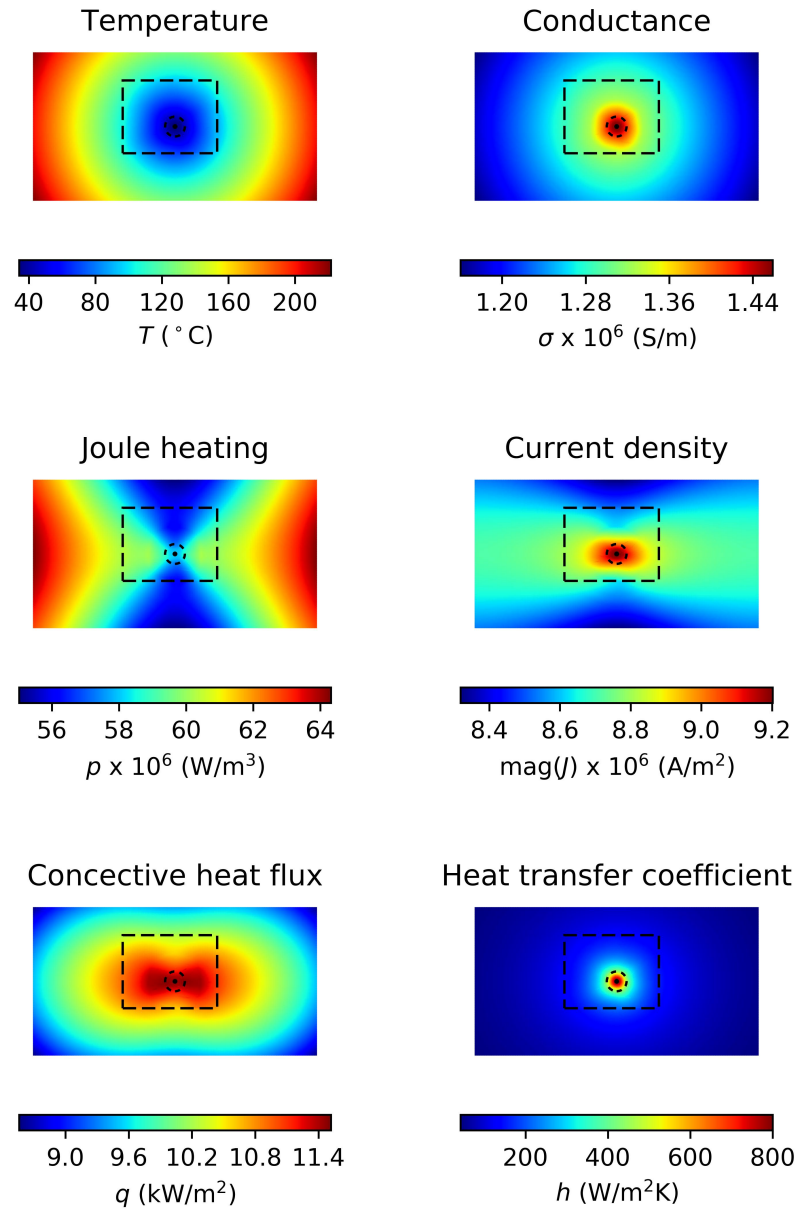


Figure 467: Convection calculation, mikkonen_155

Case id: mikkonen_156

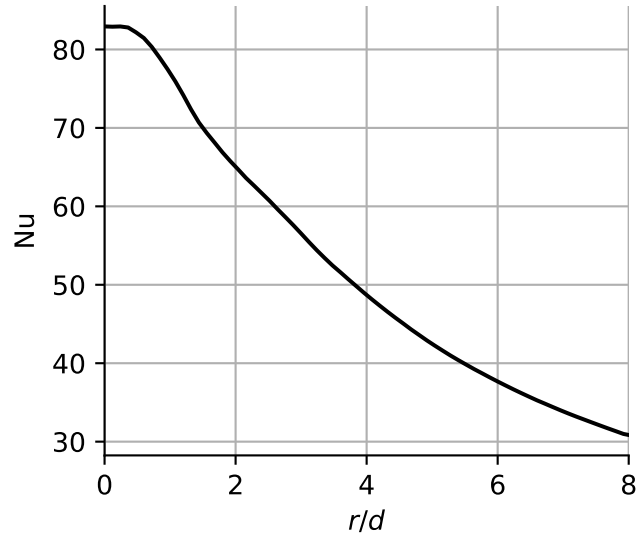


Figure 468: Nu, mikkonen_156

path		2017_03_10_viimeinen/2.5mm_Q81.8_Hd6_extra							
this case measured by		Antti Mikkonen							
lens		MWIR_f/2.0_f=50mm							
measurement time		2017-03-10 10:28:31							
Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (g/s)	V_n (m/s)
45833	0.82	6	0.71	2.5	15.0	20.3	20.0	1.640	281.3
Δx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		
0.3	2.1	276.1	0.52				0.5		
r/d	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00
T (°C)	35.24	35.41	36.44	38.05	39.39	40.70	42.26	44.02	45.76
Nu	82.94	82.06	76.98	70.02	65.05	60.86	56.54	52.31	48.70
h (W/m ² K)	859.10	850.03	797.36	725.28	673.81	630.36	585.64	541.87	504.44
q (kW/m ²)	13.09	13.10	13.09	13.07	13.05	13.04	13.02	13.00	12.98
r/d	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50	8.00
T (°C)	45.76	47.59	49.47	51.30	53.12	54.94	56.74	58.51	60.21
Nu	48.70	45.42	42.46	39.91	37.67	35.65	33.86	32.26	30.85
h (W/m ² K)	504.44	470.49	439.85	413.44	390.18	369.30	350.71	334.11	319.58
q (kW/m ²)	12.98	12.96	12.94	12.92	12.89	12.88	12.85	12.84	12.82

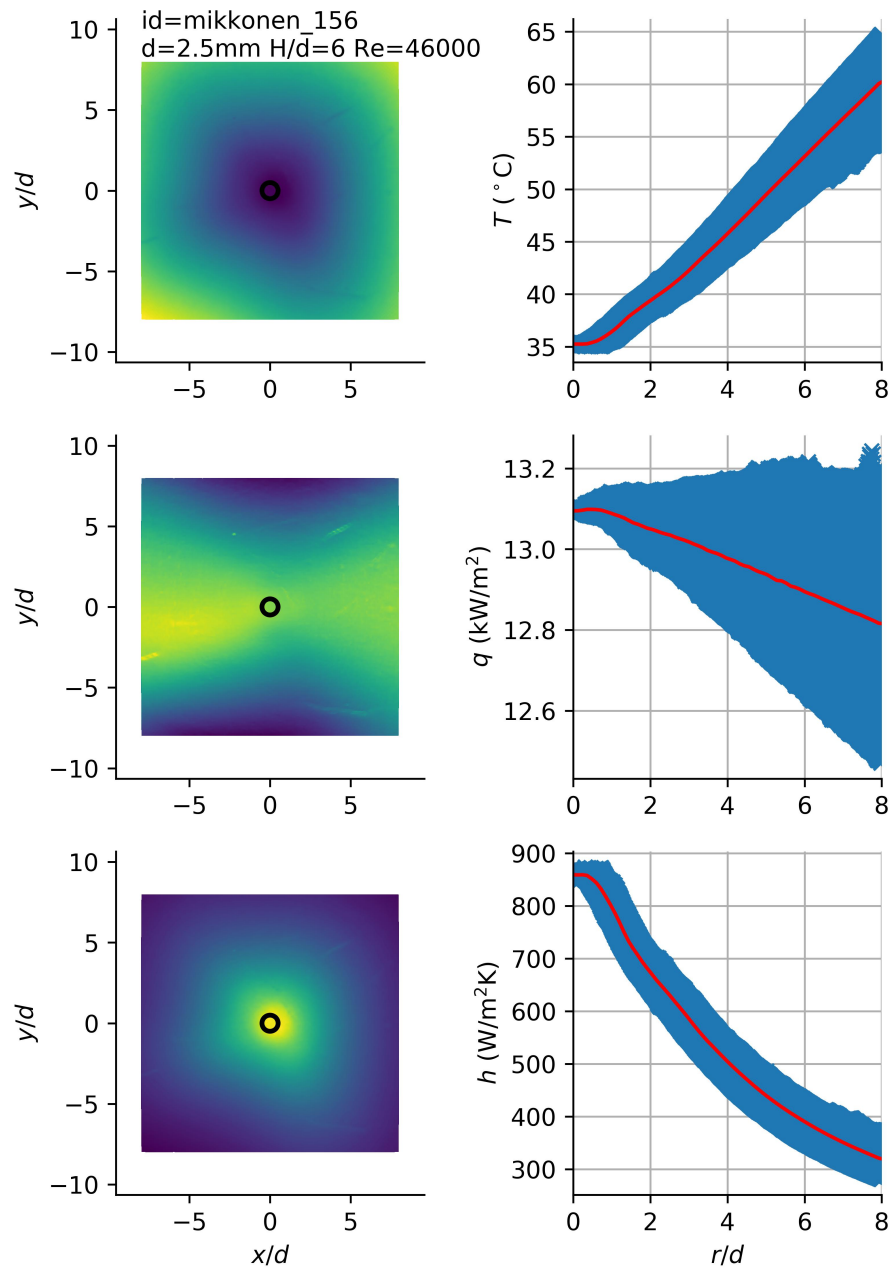


Figure 469: Results, mikkonen_156

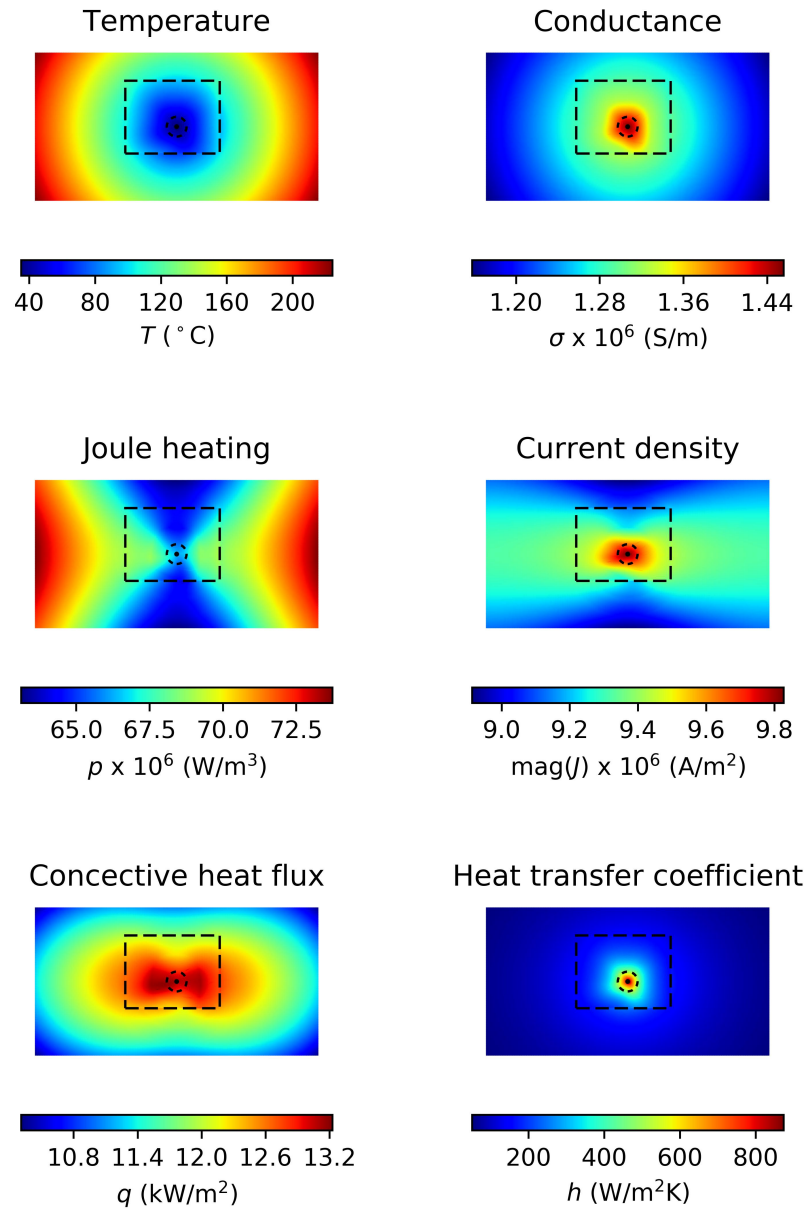


Figure 470: Convection calculation, mikkonen_156

4 Test

path	
this case measured by	
lens	
measurement date	

Re	Ma	H/d	Pr	d (mm)	H (mm)	$T_{n,t}$ (°C)	T_{∞} (°C)	$\dot{m}$ (kg/s)	V_n (m/s)
dx (mm)	V (V)	I (A)	$\frac{P_{measured}-P_{calculated}}{P_{calculated}}$ (%)				t (mm)		

r/d																			
T																			
Nu																			
q																			
h																			

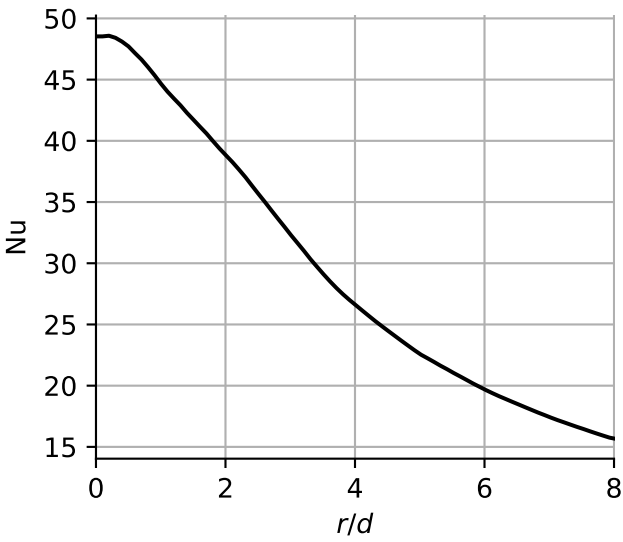


Figure 471: mikkone_000