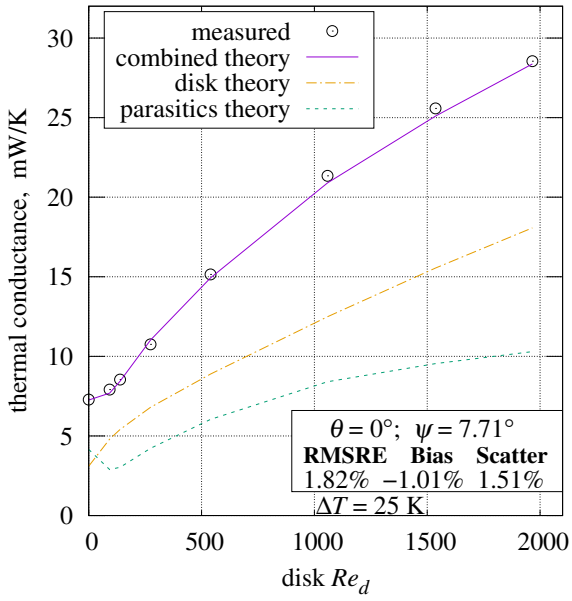
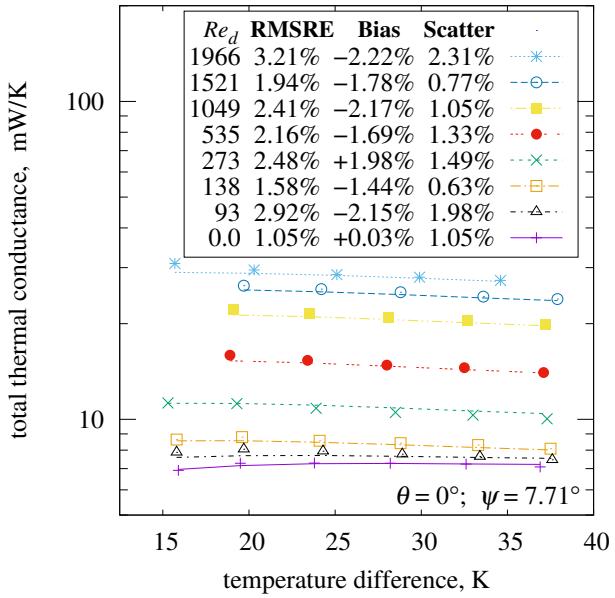
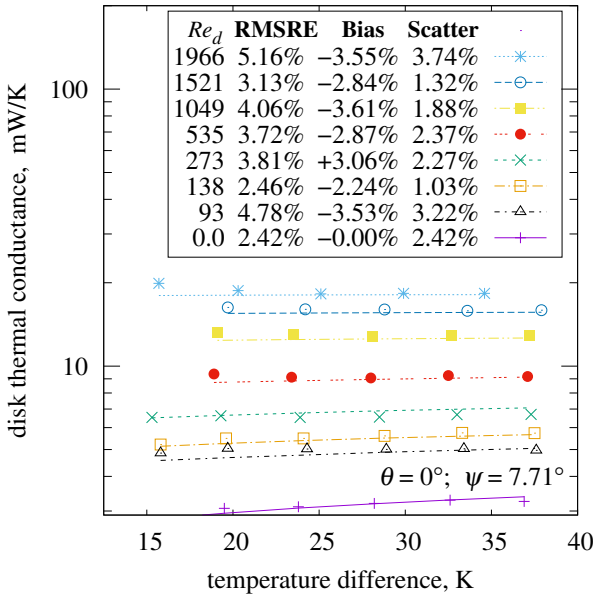
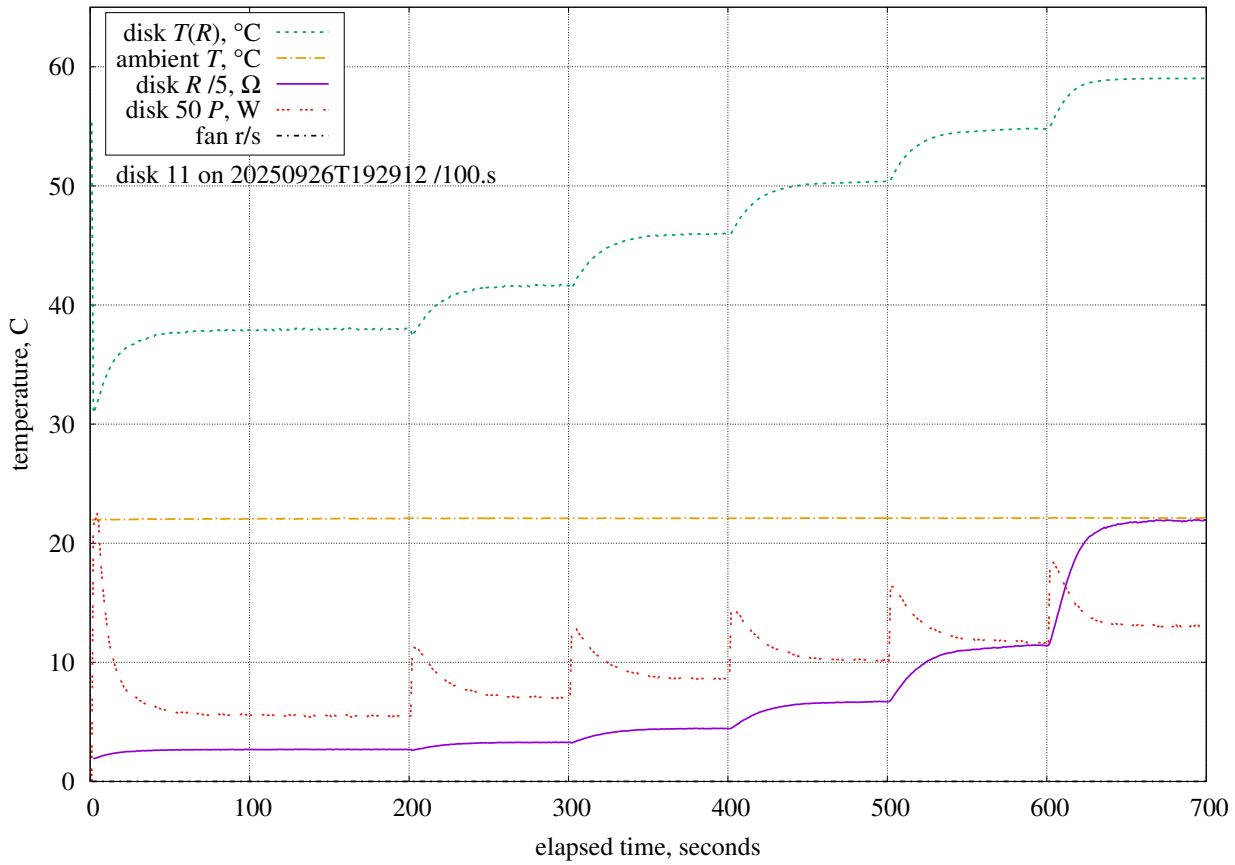

measured
combined theory
disk theory
parasitics theory
thermal conductance, mW/K
disk Re_d
$\theta = 0°;\ \psi = 7.71°$
RMSRE Bias Scatter
1.82% −1.01% 1.51%
ΔT = 25 K


Re_d RMSRE Bias Scatter
1966 3.21% −2.22% 2.31%
1521 1.94% −1.78% 0.77%
1049 2.41% −2.17% 1.05%
535 2.16% −1.69% 1.33%
273 2.48% +1.98% 1.49%
138 1.58% −1.44% 0.63%
93 2.92% −2.15% 1.98%
0.0 1.05% +0.03% 1.05%
total thermal conductance, mW/K
temperature difference, K
$\theta = 0°;\ \psi = 7.71°$

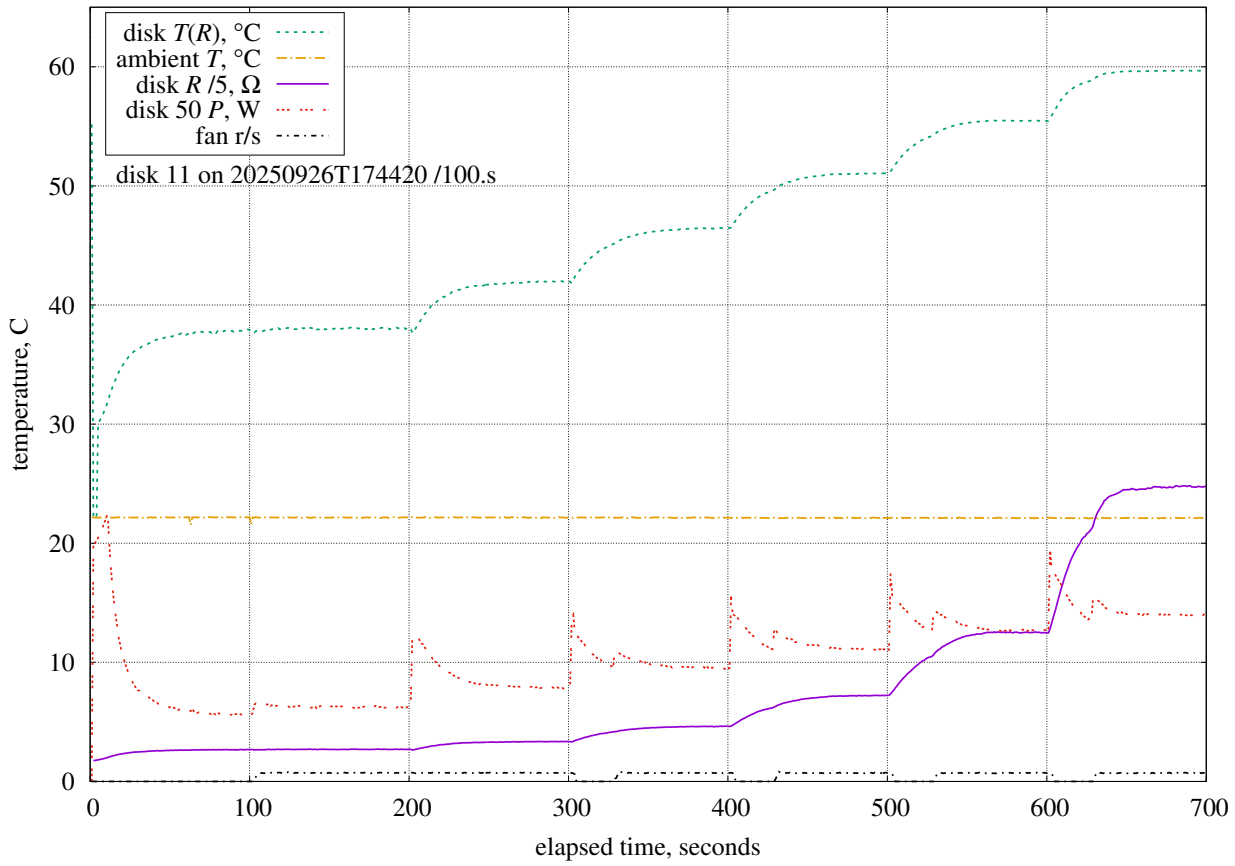

Re_d RMSRE Bias Scatter
1966 5.16% −3.55% 3.74%
1521 3.13% −2.84% 1.32%
1049 4.06% −3.61% 1.88%
535 3.72% −2.87% 2.37%
273 3.81% +3.06% 2.27%
138 2.46% −2.24% 1.03%
93 4.78% −3.53% 3.22%
0.0 2.42% −0.00% 2.42%
disk thermal conductance, mW/K
temperature difference, K
$\theta = 0°;\ \psi = 7.71°$



$\theta = 0.0°;\ \psi = 7.7°;\ V = 0.000$ **m/s (0 r/min)**

Estimated measurement uncertainties of natural convection at $\theta = 0.0$.

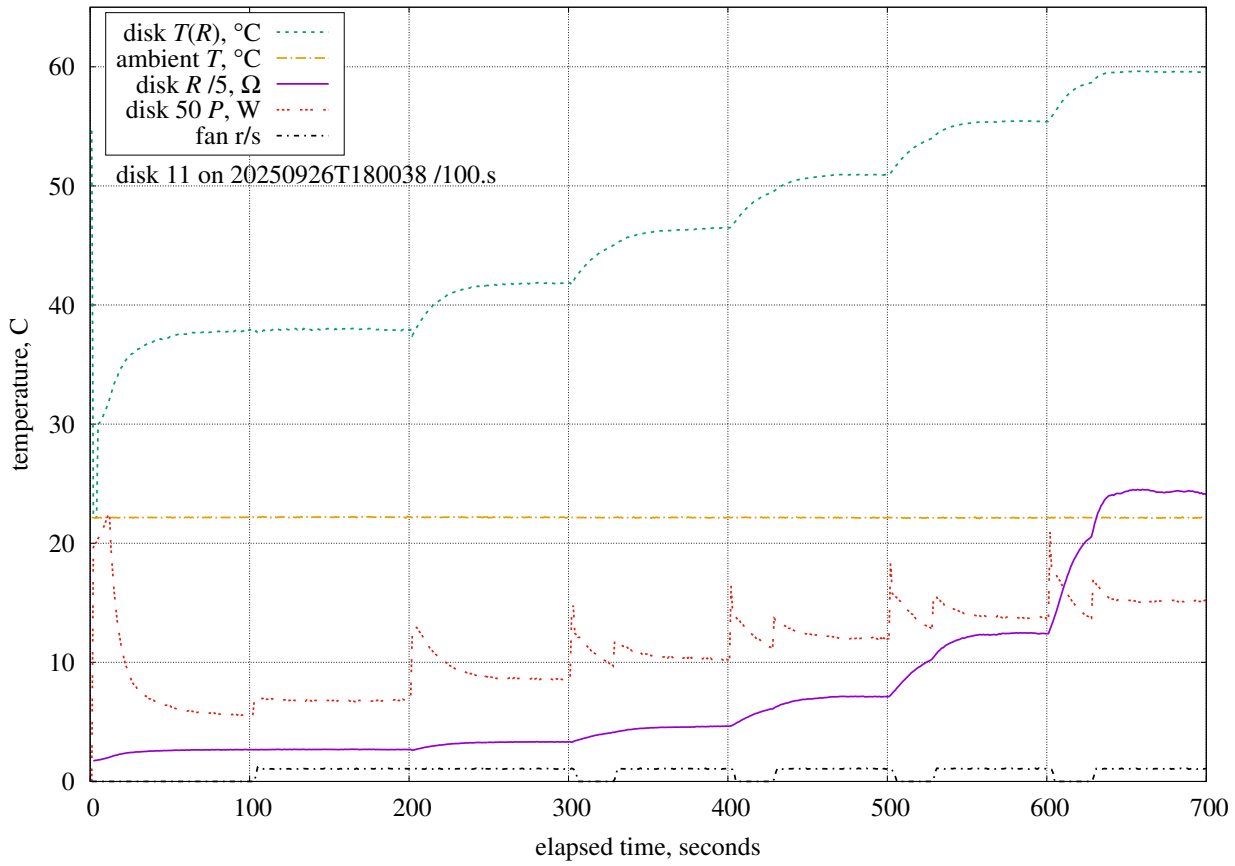
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.43%/K	0.10.K	0.44%	LM35C differential
P	99.7.kPa	+0.0002%/Pa	1.5.kPa	0.30%	MPXH6115A6U air pressure
Re_0	600	+0.0051%	60	0.30%	integration lower-bound
D_o	2.81.mm	+3621%/m	500.um	1.81%	tube outer diameter
D_i	1.11.mm	+3807%/m	200.um	0.76%	tube inner diameter
D_g	166.um	−960%/m	750.um	0.72%	tube air gap
L_{wire}	38.0.mm	+842%/m	500.um	0.42%	wire length
k_{ABS}	179.$\frac{\text{mW}}{\text{K·m}}$	+0.111%/$\frac{\text{mW}}{\text{K·m}}$	9.0.$\frac{\text{mW}}{\text{K·m}}$	0.99%	ABS thermal conductivity
d	12.0.mm	+5322%/m	100.um	0.53%	disk diameter
θ	50.0.m°	+3.29%/°	0.20.°	0.66%	plate angle
				2.58%	combined bias uncertainty



$\theta = 0.0°;\ \psi = 7.7°;\ V = 0.128$ **m/s (43 r/min)**

Estimated measurement uncertainties at $Re = 92$**.**

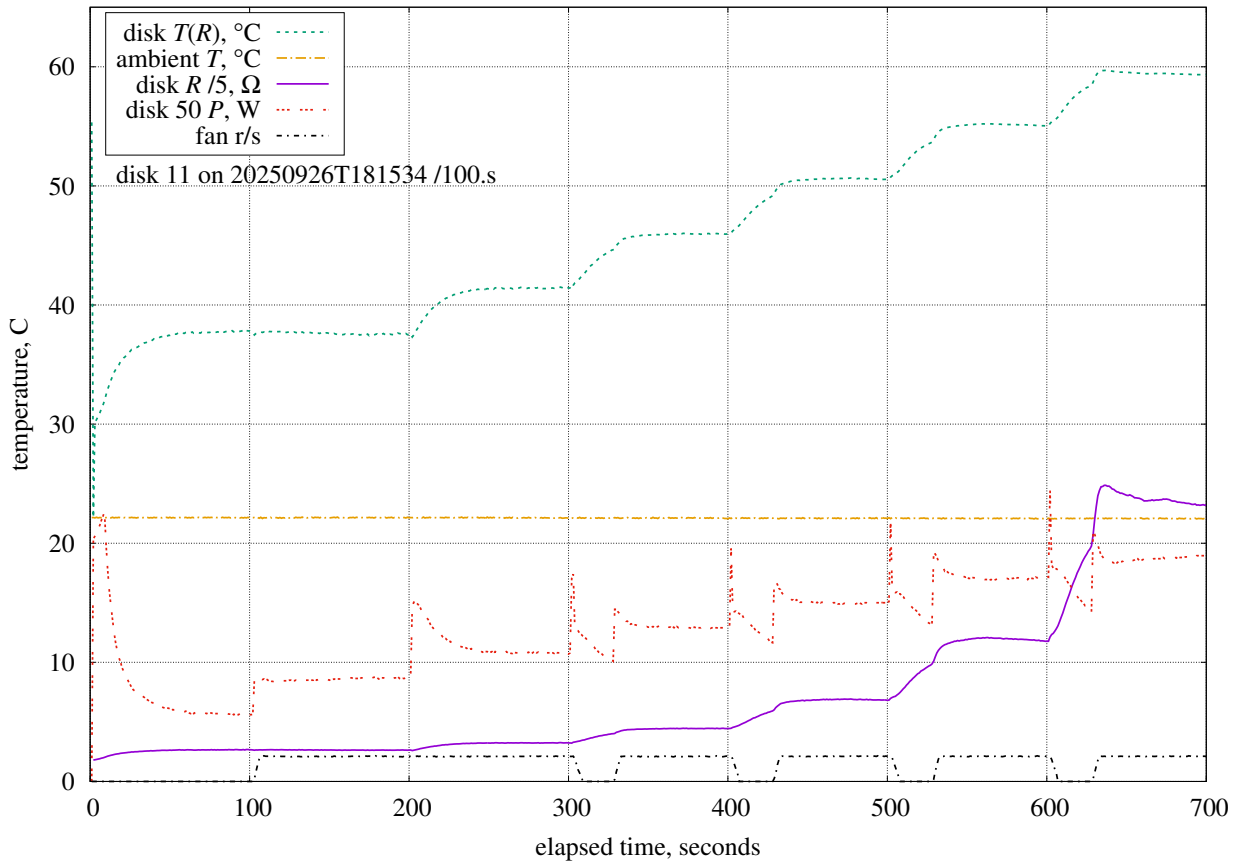
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.34%/K	0.10.K	0.43%	LM35C differential
P	99.7.kPa	+0.0002%/Pa	1.5.kPa	0.35%	MPXH6115A6U air pressure
η	0.340	+29.6%	0.007	0.20%	anemometer calibration
Re_0	600	+0.0095%	60	0.57%	integration lower-bound
C_B	0.541	−4.28%	0.100	0.43%	bypass coefficient
D_o	2.81.mm	+1124%/m	500.um	0.56%	tube outer diameter
D_i	1.11.mm	+3090%/m	200.um	0.62%	tube inner diameter
D_g	166.um	−946%/m	750.um	0.71%	tube air gap
L_{wire}	38.0.mm	+830%/m	500.um	0.42%	wire length
k_{ABS}	179.$\frac{\text{mW}}{\text{K·m}}$	+0.116%/$\frac{\text{mW}}{\text{K·m}}$	9.0.$\frac{\text{mW}}{\text{K·m}}$	1.04%	ABS thermal conductivity
d	12.0.mm	+5622%/m	100.um	0.56%	disk diameter
θ	50.0.m°	−1.57%/°	0.20.°	0.31%	plate angle
				1.94%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	42.6.r/min	+0.236%/(r/min)	1.5.r/min	0.36%	fan rotation rate
				2.06%	RSS combined uncertainty



$\theta = 0.0°;\ \psi = 7.7°;\ V = 0.193$ **m/s (64 r/min)**

Estimated measurement uncertainties at $Re = 139$**.**

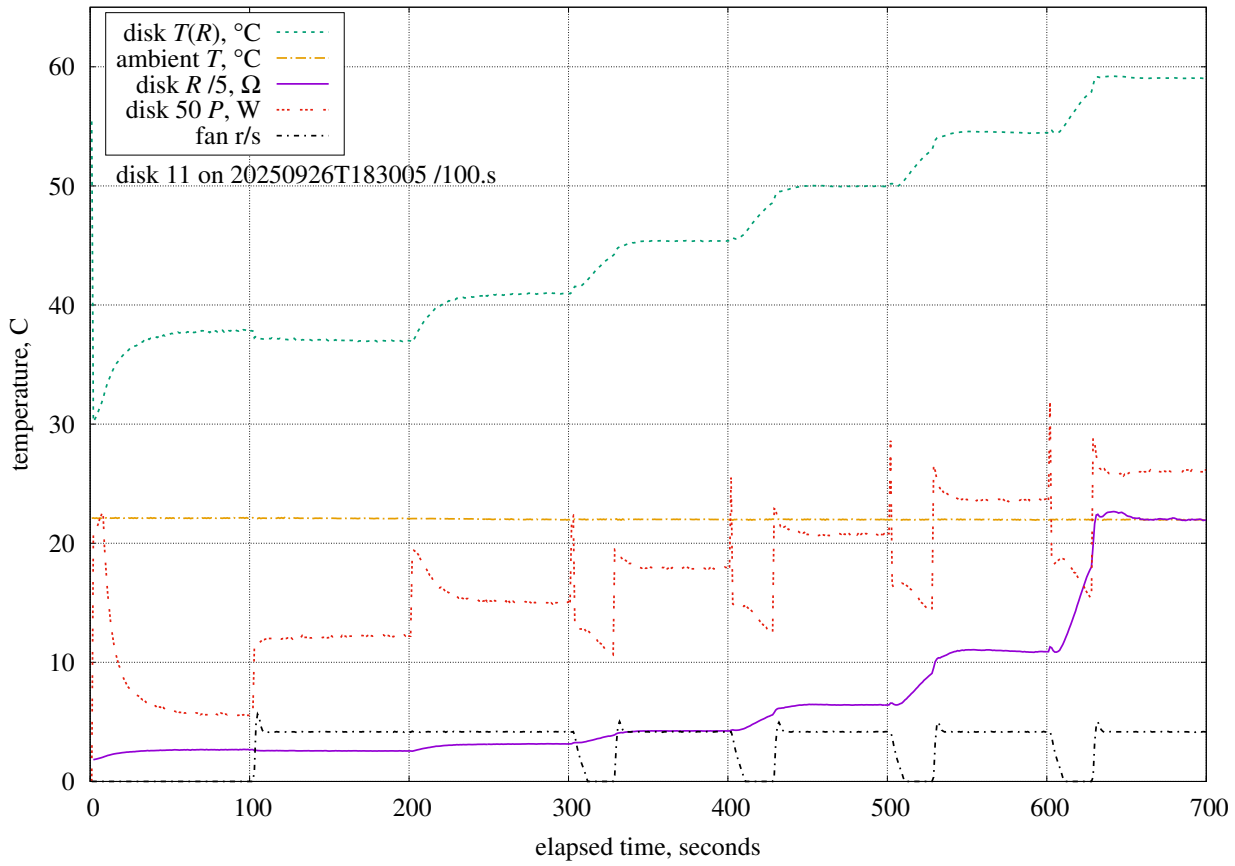
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.05%/K	0.10.K	0.41%	LM35C differential
P	99.7.kPa	+0.0003%/Pa	1.5.kPa	0.52%	MPXH6115A6U air pressure
η	0.340	+96.4%	0.007	0.66%	anemometer calibration
D_i	1.11.mm	+4521%/m	200.um	0.90%	tube inner diameter
D_g	166.um	−1144%/m	750.um	0.86%	tube air gap
L_{wire}	38.0.mm	+1004%/m	500.um	0.50%	wire length
k_{ABS}	179.$\frac{\text{mW}}{\text{K·m}}$	+0.128%/$\frac{\text{mW}}{\text{K·m}}$	9.0.$\frac{\text{mW}}{\text{K·m}}$	1.14%	ABS thermal conductivity
d	12.0.mm	+5442%/m	100.um	0.54%	disk diameter
θ	50.0.m°	−1.36%/°	0.20.°	0.27%	plate angle
				2.09%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	64.0.r/min	+0.512%/(r/min)	1.3.r/min	0.67%	fan rotation rate
				2.49%	RSS combined uncertainty



$\theta = 0.0°;\ \psi = 7.7°;\ V = 0.380$ **m/s (126 r/min)**

Estimated measurement uncertainties at $Re = 274$**.**

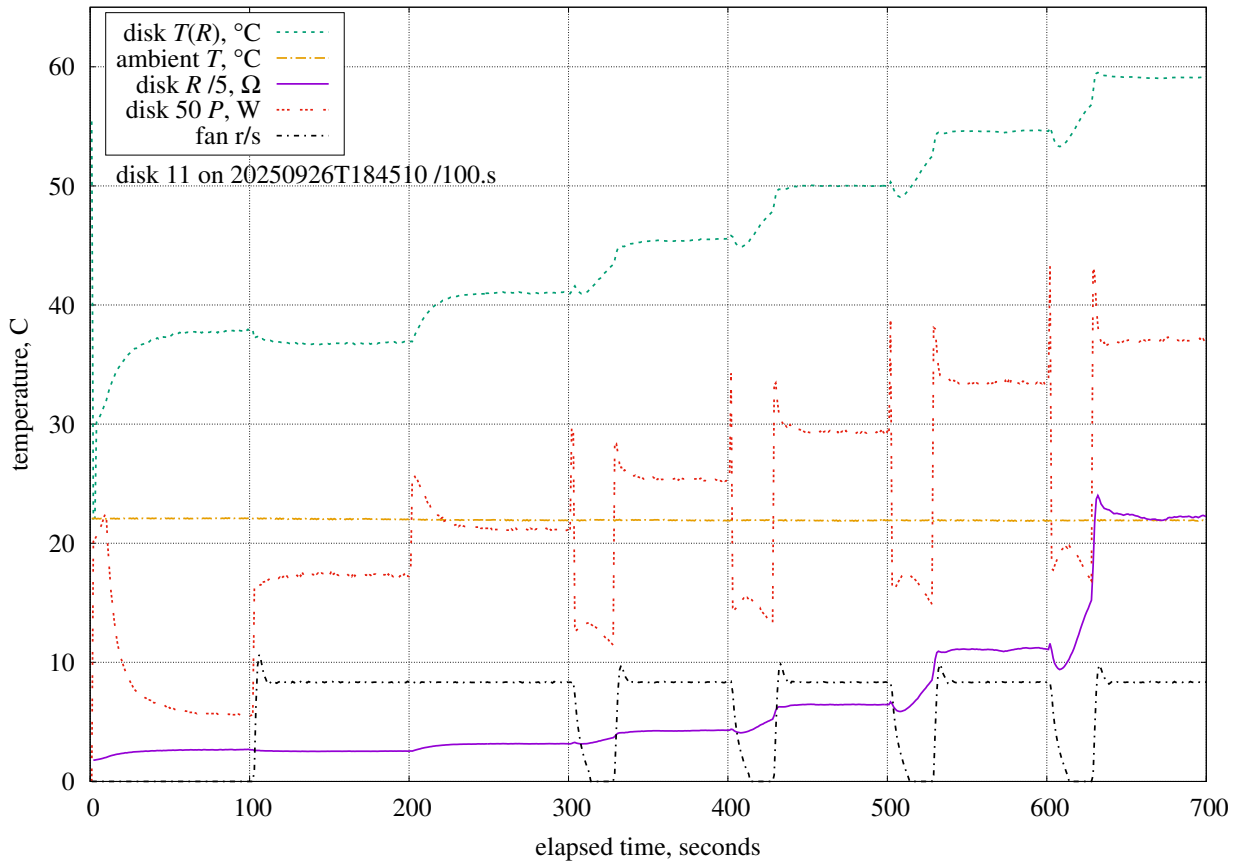
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+3.97%/K	0.10.K	0.40%	LM35C differential
P	99.7.kPa	+0.0003%/Pa	1.5.kPa	0.38%	MPXH6115A6U air pressure
η	0.340	+81.4%	0.007	0.55%	anemometer calibration
Re_0	600	−0.0035%	60	0.21%	integration lower-bound
C_B	0.541	+2.78%	0.100	0.28%	bypass coefficient
D_o	2.81.mm	−5550%/m	500.um	2.77%	tube outer diameter
D_i	1.11.mm	+6311%/m	200.um	1.26%	tube inner diameter
D_g	166.um	−1366%/m	750.um	1.02%	tube air gap
L_{wire}	38.0.mm	+1199%/m	500.um	0.60%	wire length
k_{ABS}	179. $\frac{\text{mW}}{\text{K·m}}$	+0.131%/$\frac{\text{mW}}{\text{K·m}}$	9.0. $\frac{\text{mW}}{\text{K·m}}$	1.18%	ABS thermal conductivity
d	12.0.mm	+5826%/m	100.um	0.58%	disk diameter
				3.63%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	126.r/min	+0.219%/(r/min)	0.98.r/min	0.21%	fan rotation rate
				3.66%	RSS combined uncertainty



$\theta = 0.0°;\ \psi = 7.7°;\ V = 0.748$ **m/s (250 r/min)**

Estimated measurement uncertainties at $Re = 540$**.**

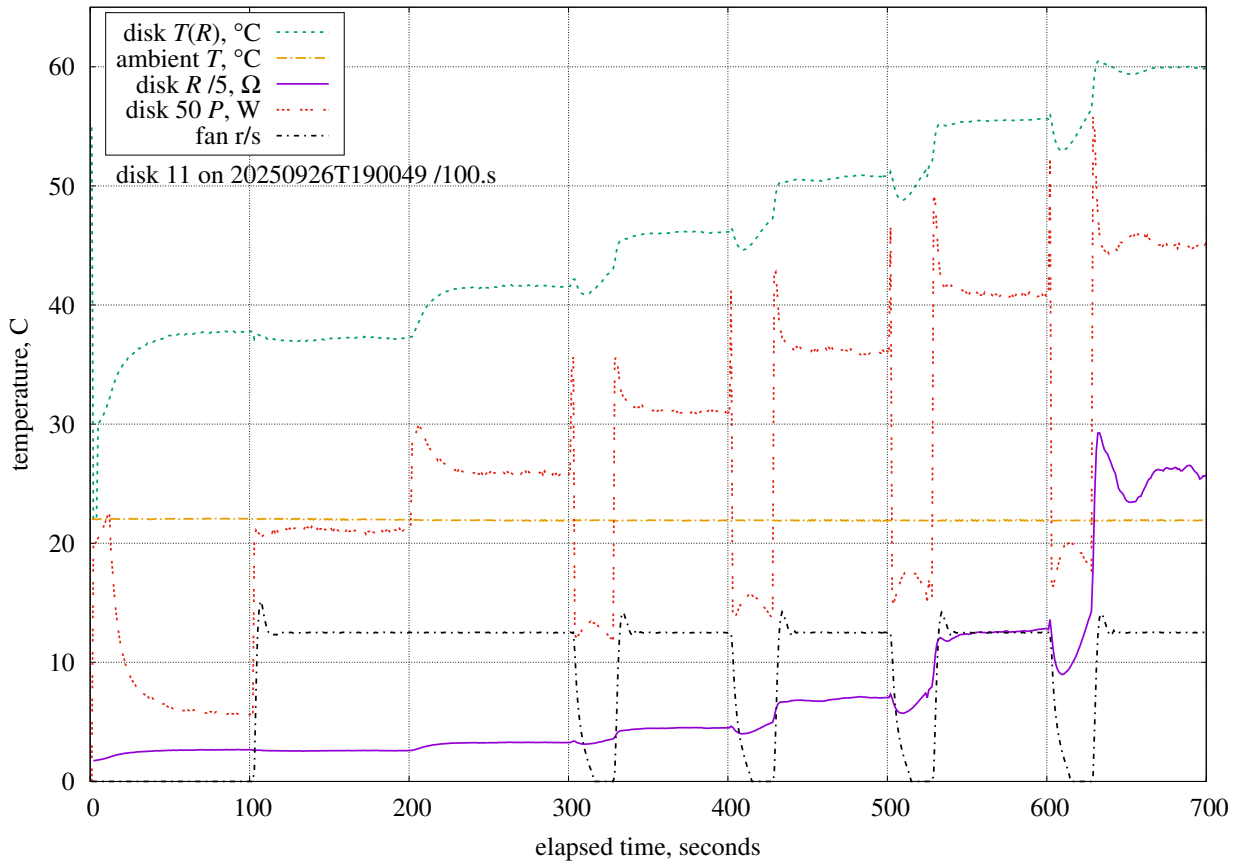
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+3.97%/K	0.10.K	0.40%	LM35C differential
P	99.7.kPa	+0.0005%/Pa	1.5.kPa	0.75%	MPXH6115A6U air pressure
η	0.340	+152%	0.007	1.03%	anemometer calibration
Re_0	600	−0.0047%	60	0.28%	integration lower-bound
C_B	0.541	+4.87%	0.100	0.49%	bypass coefficient
D_o	2.81.mm	+1253%/m	500.um	0.63%	tube outer diameter
D_i	1.11.mm	+8346%/m	200.um	1.67%	tube inner diameter
D_g	166.um	−1657%/m	750.um	1.24%	tube air gap
L_{wire}	38.0.mm	+1454%/m	500.um	0.73%	wire length
k_{ABS}	179. $\frac{\text{mW}}{\text{K·m}}$	+0.135%/$\frac{\text{mW}}{\text{K·m}}$	9.0. $\frac{\text{mW}}{\text{K·m}}$	1.21%	ABS thermal conductivity
d	12.0.mm	+6252%/m	100.um	0.63%	disk diameter
				3.04%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	250.r/min	+0.207%/(r/min)	0.97.r/min	0.20%	fan rotation rate
				3.07%	RSS combined uncertainty



$\theta = 0.0°;\ \psi = 7.7°;\ V = 1.467$ **m/s (500 r/min)**

Estimated measurement uncertainties at $Re = 1058$**.**

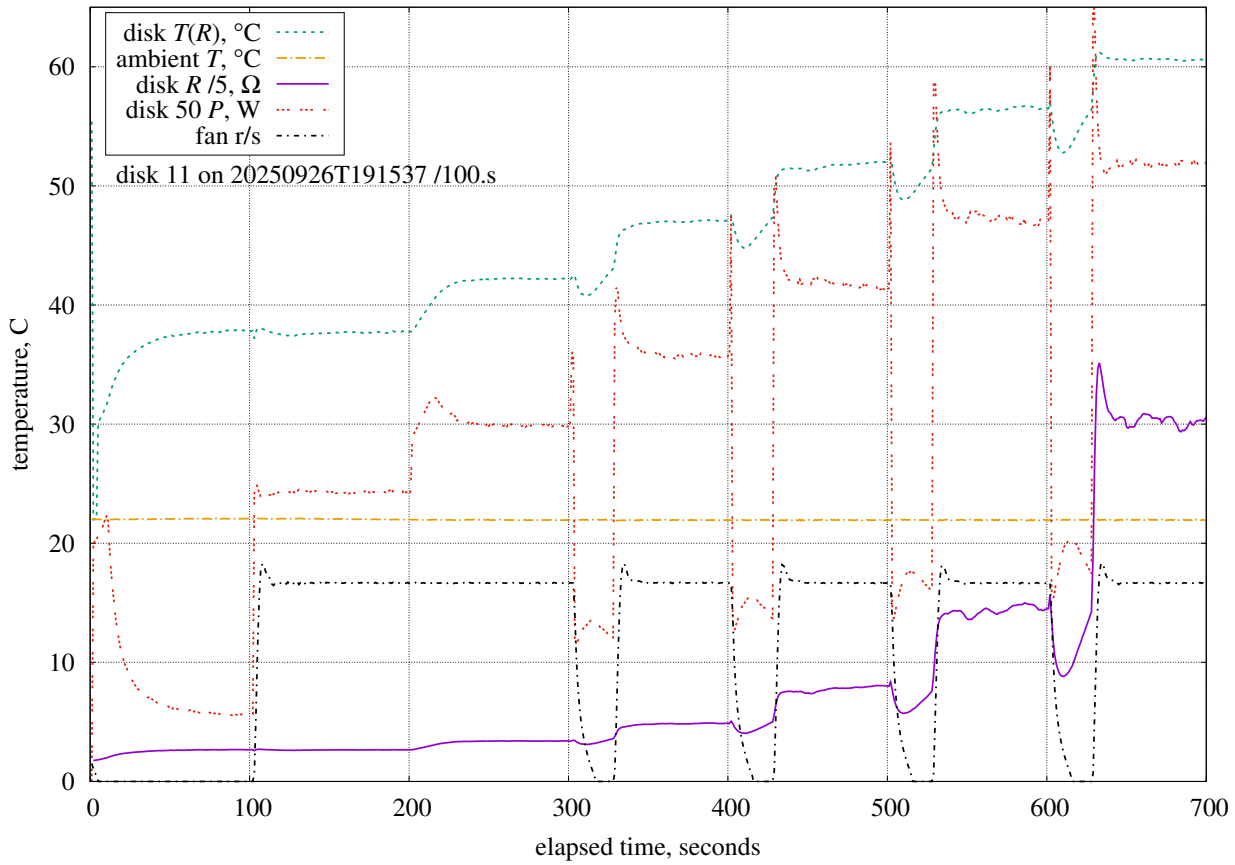
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+3.96%/K	0.10.K	0.40%	LM35C differential
P	99.7.kPa	+0.0004%/Pa	1.5.kPa	0.63%	MPXH6115A6U air pressure
η	0.340	+126%	0.007	0.86%	anemometer calibration
Re_0	600	−0.0079%	60	0.47%	integration lower-bound
C_B	0.541	+7.01%	0.100	0.70%	bypass coefficient
D_o	2.81.mm	−4118%/m	500.um	2.06%	tube outer diameter
D_i	1.11.mm	+10461%/m	200.um	2.09%	tube inner diameter
D_g	166.um	−1945%/m	750.um	1.46%	tube air gap
L_{wire}	38.0.mm	+1706%/m	500.um	0.85%	wire length
k_{ABS}	179. $\frac{\text{mW}}{\text{K·m}}$	+0.136%/$\frac{\text{mW}}{\text{K·m}}$	9.0. $\frac{\text{mW}}{\text{K·m}}$	1.22%	ABS thermal conductivity
d	12.0.mm	+6969%/m	100.um	0.70%	disk diameter
				3.93%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	500.r/min	+0.086%/(r/min)	1.6.r/min	0.14%	fan rotation rate
				3.94%	RSS combined uncertainty



$\theta = 0.0°;\ \psi = 7.7°;\ V = 2.130$ **m/s (750 r/min)**

Estimated measurement uncertainties at $Re = 1537$**.**

Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+3.96%/K	0.10.K	0.40%	LM35C differential
P	99.7.kPa	+0.0004%/Pa	1.5.kPa	0.65%	MPXH6115A6U air pressure
η	0.340	+122%	0.007	0.83%	anemometer calibration
Re_0	600	−0.0086%	60	0.51%	integration lower-bound
C_B	0.541	+8.11%	0.100	0.81%	bypass coefficient
D_o	2.81.mm	−4624%/m	500.um	2.31%	tube outer diameter
D_i	1.11.mm	+10715%/m	200.um	2.14%	tube inner diameter
D_g	166.um	−1986%/m	750.um	1.49%	tube air gap
L_{wire}	38.0.mm	+1743%/m	500.um	0.87%	wire length
k_{ABS}	179. $\frac{\text{mW}}{\text{K·m}}$	+0.131%/ $\frac{\text{mW}}{\text{K·m}}$	9.0. $\frac{\text{mW}}{\text{K·m}}$	1.17%	ABS thermal conductivity
d	12.0.mm	+7522%/m	100.um	0.75%	disk diameter
				4.13%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	750.r/min	+0.055%/(r/min)	0.96.r/min	0.05%	fan rotation rate
				4.13%	RSS combined uncertainty



$\theta = 0.0°;\ \psi = 7.7°;\ V = 2.726$ **m/s (1000 r/min)**

Estimated measurement uncertainties at $Re = 1966$**.**

Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+3.96%/K	0.10.K	0.40%	LM35C differential
P	99.7.kPa	+0.0004%/Pa	1.5.kPa	0.66%	MPXH6115A6U air pressure
η	0.340	+114%	0.007	0.77%	anemometer calibration
Re_0	600	−0.0086%	60	0.52%	integration lower-bound
C_B	0.541	+8.82%	0.100	0.88%	bypass coefficient
D_o	2.81.mm	−4798%/m	500.um	2.40%	tube outer diameter
D_i	1.11.mm	+10743%/m	200.um	2.15%	tube inner diameter
D_g	166.um	−1989%/m	750.um	1.49%	tube air gap
L_{wire}	38.0.mm	+1745%/m	500.um	0.87%	wire length
k_{ABS}	179. $\frac{\text{mW}}{\text{K·m}}$	+0.126%/ $\frac{\text{mW}}{\text{K·m}}$	9.0. $\frac{\text{mW}}{\text{K·m}}$	1.13%	ABS thermal conductivity
d	12.0.mm	+7892%/m	100.um	0.79%	disk diameter
				4.19%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	1.00.kr/min	+0.039%/(r/min)	1.6.r/min	0.06%	fan rotation rate
				4.19%	RSS combined uncertainty