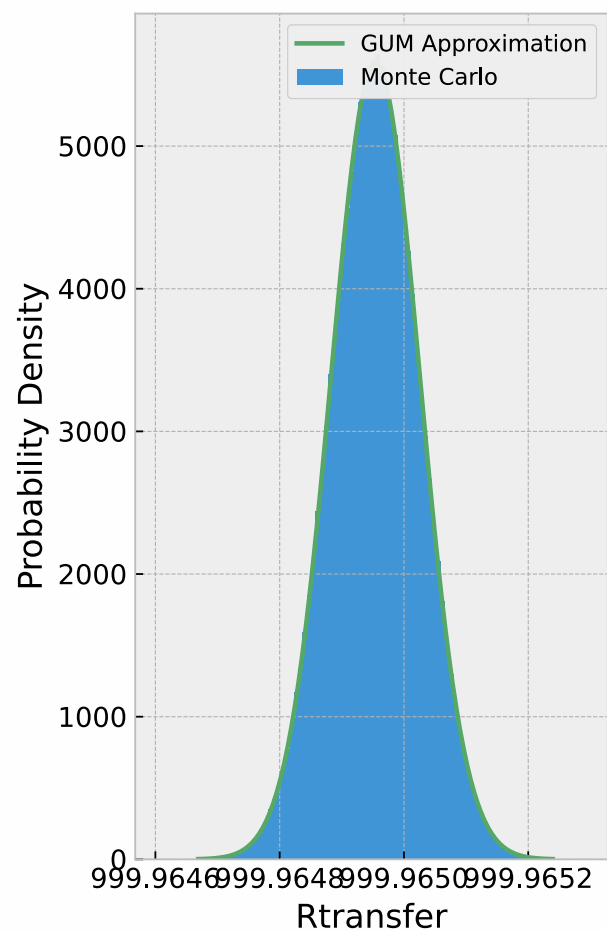
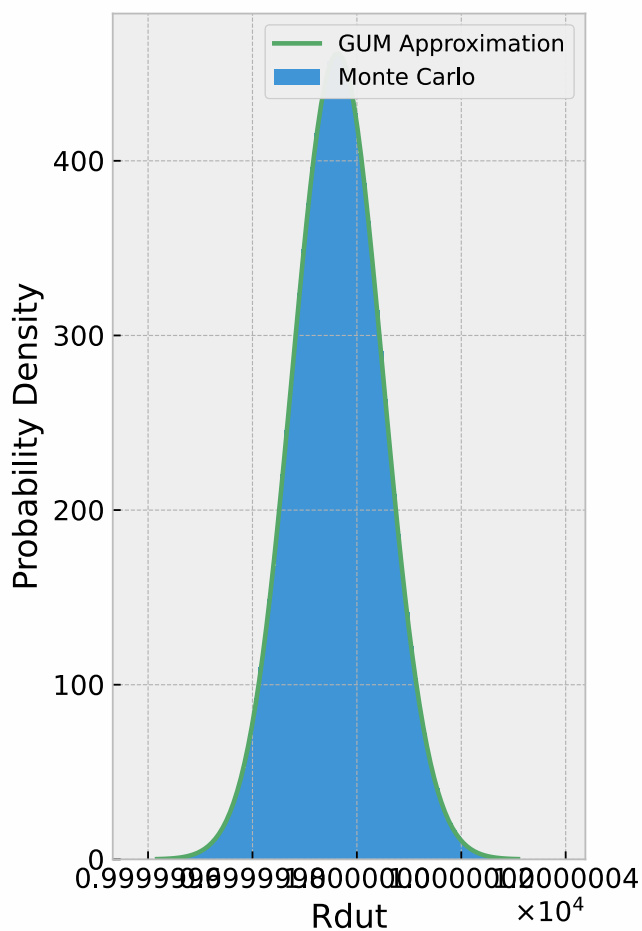


uncertainty

Summary

Function	Method	Nominal	Std. Uncertainty	95% Coverage	k	Deg. Freedom
Rdut	GUM	9999.999629	0.00086419	± 0.0016938	1.960	395856.5
Rdut	Monte Carlo	9999.999630	0.00086370	(9999.997938 , 10000.00132)	1.958	-
Rtransfer	GUM	999.9649541	0.000071335	± 0.00013982	1.960	241053.7
Rtransfer	Monte Carlo	999.9649542	0.000071281	(999.9648147 , 999.9650938)	1.958	-



Standardized Input Values

Variable	Mean	Std. Uncertainty	Deg. Freedom	Description
A ₁	10.00032667	7.1340e-07	2.4e+05	Measurement Rref -> Rtransfer
A ₂	10.00035010	4.8778e-07	1.7e+05	Measurement Rtransfer -> Rdut

Uncertainty Budget

Variable	Component	Standard Uncertainty	Deg. Freedom	Description
A ₁	-	-	-	Measurement Rref -> Rtransfer
-	u6(A1)	3.5001e-07	inf	Temperature coefficient
-	u5(A1)	5.0002e-08	inf	DCC linearity
-	u4(A1)	5.0002e-08	inf	DCC leakage
-	u3(A1)	2.8868e-09	inf	DCC resolution
-	u2(A1)	1.5000e-07	inf	Long term drift
-	u1(A1)	5.0002e-07	inf	Reference standard uncertainty from MI
-	u(A1)	3.3001e-07	11038	Transfer from Rref to Rtransfer
A ₂	-	-	-	Measurement Rtransfer -> Rdut
-	u4(A2)	5.0002e-08	inf	DCC linearity
-	u3(A2)	2.8869e-09	inf	DCC Resolution
-	u2(A2)	4.0001e-07	inf	Temperature coefficient
-	u1(A2)	5.0002e-08	inf	DCC Leakage
-	u(A2)	2.7001e-07	15886	Transfer from Rtransfer to DUT

Sensitivity Coefficients

Rdut

Variable	GUM Sensitivity	GUM Proportion	MC Sensitivity	MC Proportion
A ₁	-999.97	68.14%	999.20	68.12%
A ₂	999.96	31.86%	999.74	31.88%

Rtransfer

Variable	GUM Sensitivity	GUM Proportion	MC Sensitivity	MC Proportion
A ₁	-99.993	100.00%	99.917	100.00%
A ₂	0.0000	0.00%	3.4961e-06	0.00%

Expanded Uncertainties

GUM Approximation

Function	Level of Confidence	Minimum	Maximum	k	Deg. Freedom	Expanded Uncertainty
Rdut	95.00%	9999.997935	10000.00132	1.960	395856.50	0.0016938
Rtransfer	95.00%	999.9648143	999.9650940	1.960	241053.67	0.00013982

Monte Carlo

Symmetric Coverage Intervals

Function	Level of Confidence	Minimum	Maximum	Coverage Factor
Rdut	95.00%	9999.997938	10000.00132	1.958
Rtransfer	95.00%	999.9648147	999.9650938	1.958

GUM Derivation

Measurement Model:

$$R_{dut} = A_2 R_{transfer}$$

$$R_{transfer} = \frac{9999.9762}{A_1}$$

Input Covariance Matrix [U_x]:

-	A1	A2
A1	u_{A1}^2	0
A2	0	u_{A2}^2

Sensitivity Matrix [C_x]:

Partial Derivatives:

-	A1	A2
Rdut	$\frac{\partial}{\partial A_1} R_{dut}$	$\frac{\partial}{\partial A_2} R_{dut}$
Rtransfer	$\frac{\partial}{\partial A_1} R_{transfer}$	$\frac{\partial}{\partial A_2} R_{transfer}$

Computed Partial Derivatives:

-	A1	A2
Rdut	$-\frac{9999.9762 A_2}{A_1^2}$	$\frac{9999.9762}{A_1}$
Rtransfer	$-\frac{9999.9762}{A_1^2}$	0

Combined Covariance [U_y]:

$$U_y = C_x \cdot U_x \cdot C_x^T$$

Uncertainties ($\sqrt{\text{diag}(U_y)}$):

$$u_{R_{dut}} = 9999.9762 \sqrt{\frac{u_{A2}^2}{A_1^2} + \frac{A_2^2 u_{A1}^2}{A_1^4}}$$

$$u_{Rtransfer} = 9999.9762 \sqrt{\frac{u_{A1}^2}{A_1^4}}$$

Effective degrees of freedom:

$$v_{Rdut} = \frac{u_{Rdut}^4}{\frac{9.99990480033986 \cdot 10^{15} u_{A2}^4}{A_1^4 v_{A2}} + \frac{9.99990480033986 \cdot 10^{15} A_2^4 u_{A1}^4}{A_1^8 v_{A1}}}$$

$$v_{Rtransfer} = \frac{1.00000952005664 \cdot 10^{-16} A_1^8 v_{A1} u_{Rtransfer}^4}{u_{A1}^4}$$

GUM Validity

Comparison to Monte Carlo 95.00% Coverage

1 significant digit. $\delta = 0.000050$.

Rdut

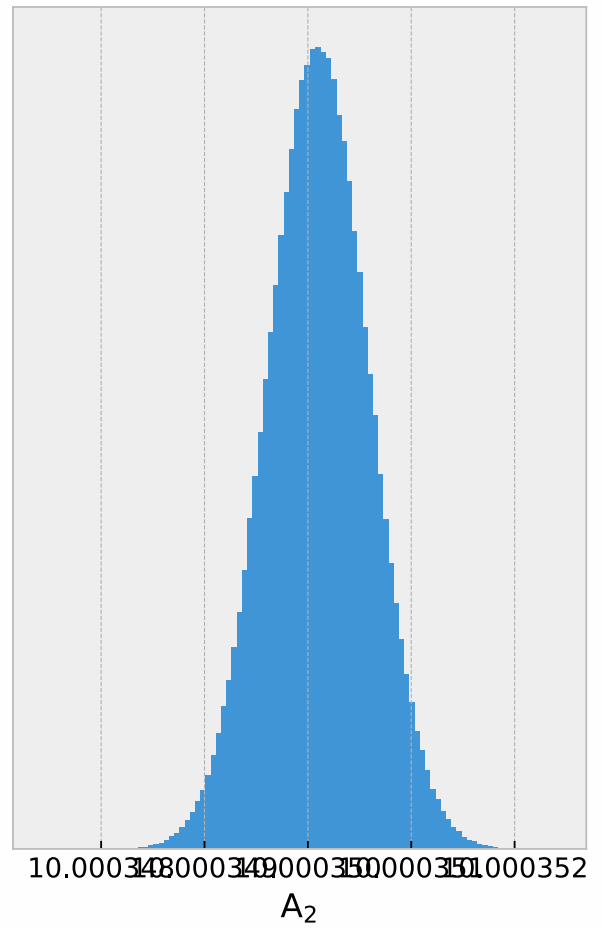
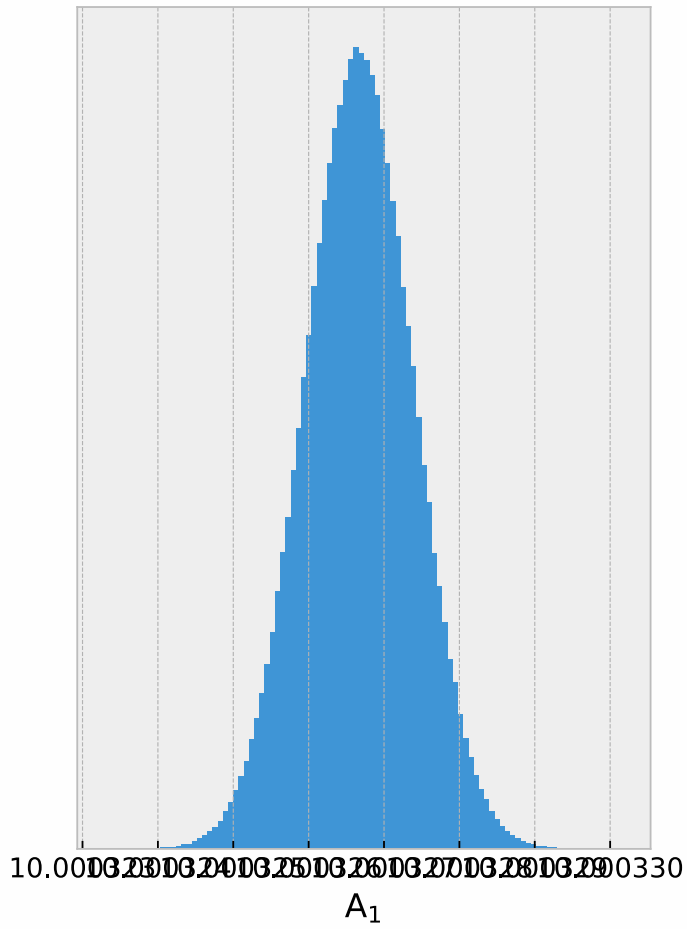
95.00% Coverage	Lower Limit	Upper Limit
GUM	9999.997935	10000.00132
MC	9999.997938	10000.00132
abs(GUM - MC)	2.8109e-06	2.0971e-06
abs(GUM - MC) < δ	PASS	PASS

1 significant digit. $\delta = 5.0e-06$.

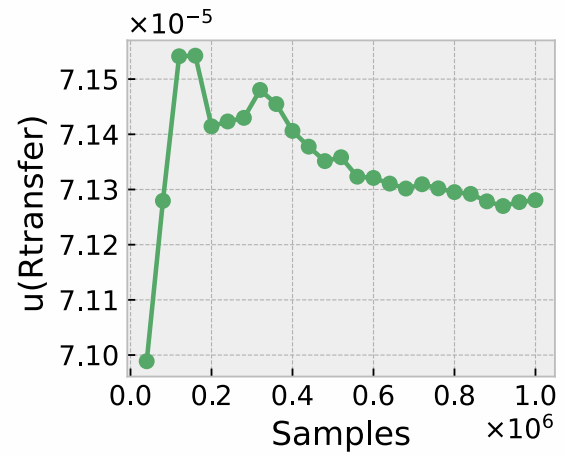
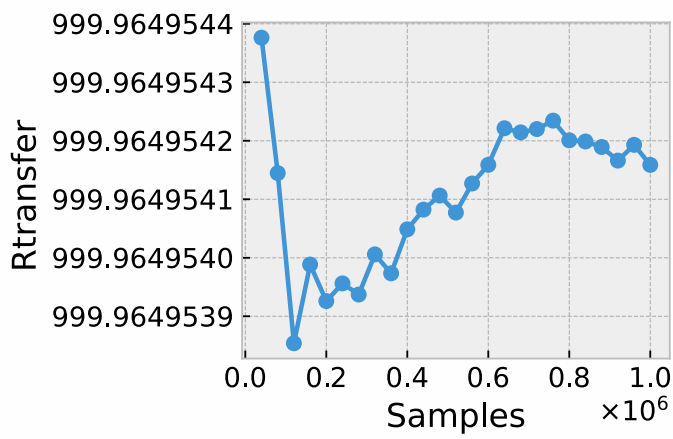
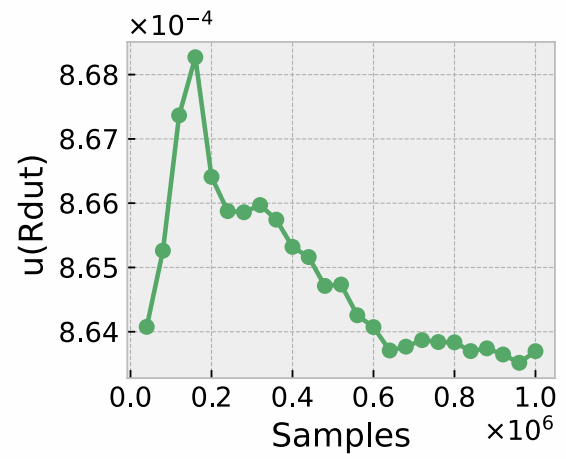
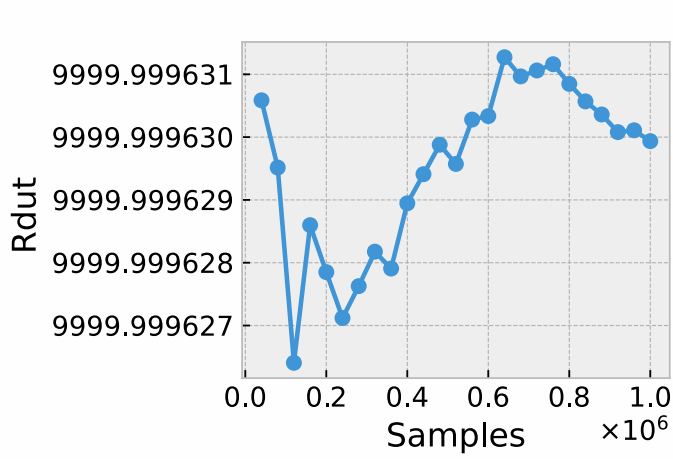
Rtransfer

95.00% Coverage	Lower Limit	Upper Limit
GUM	999.9648143	999.9650940
MC	999.9648147	999.9650938
abs(GUM - MC)	3.3237e-07	1.4080e-07
abs(GUM - MC) < δ	PASS	PASS

Monte Carlo Inputs



Monte Carlo Convergence



Uncertainty calculated by [Suncal](#)