

PCAL End Station Measurement Trends

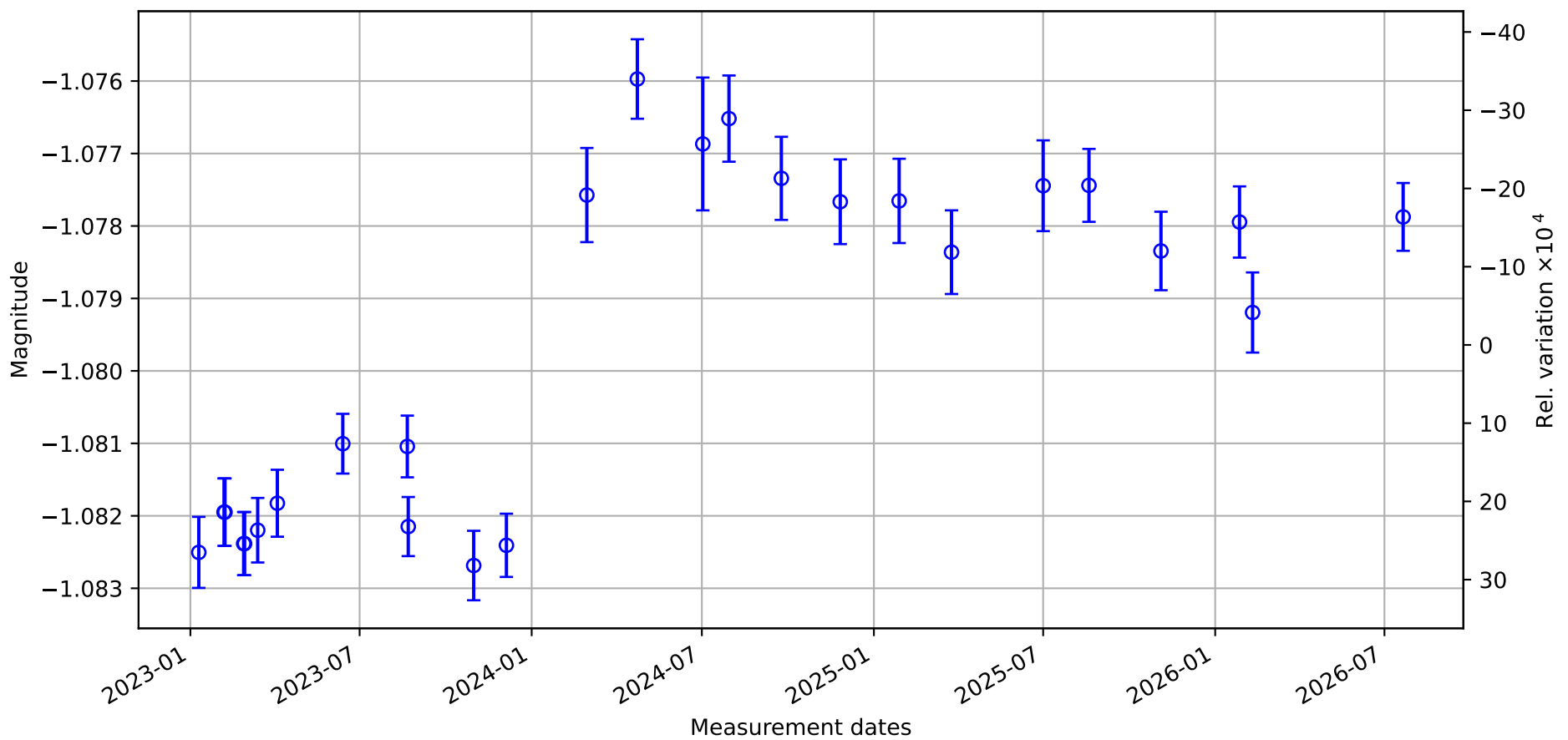
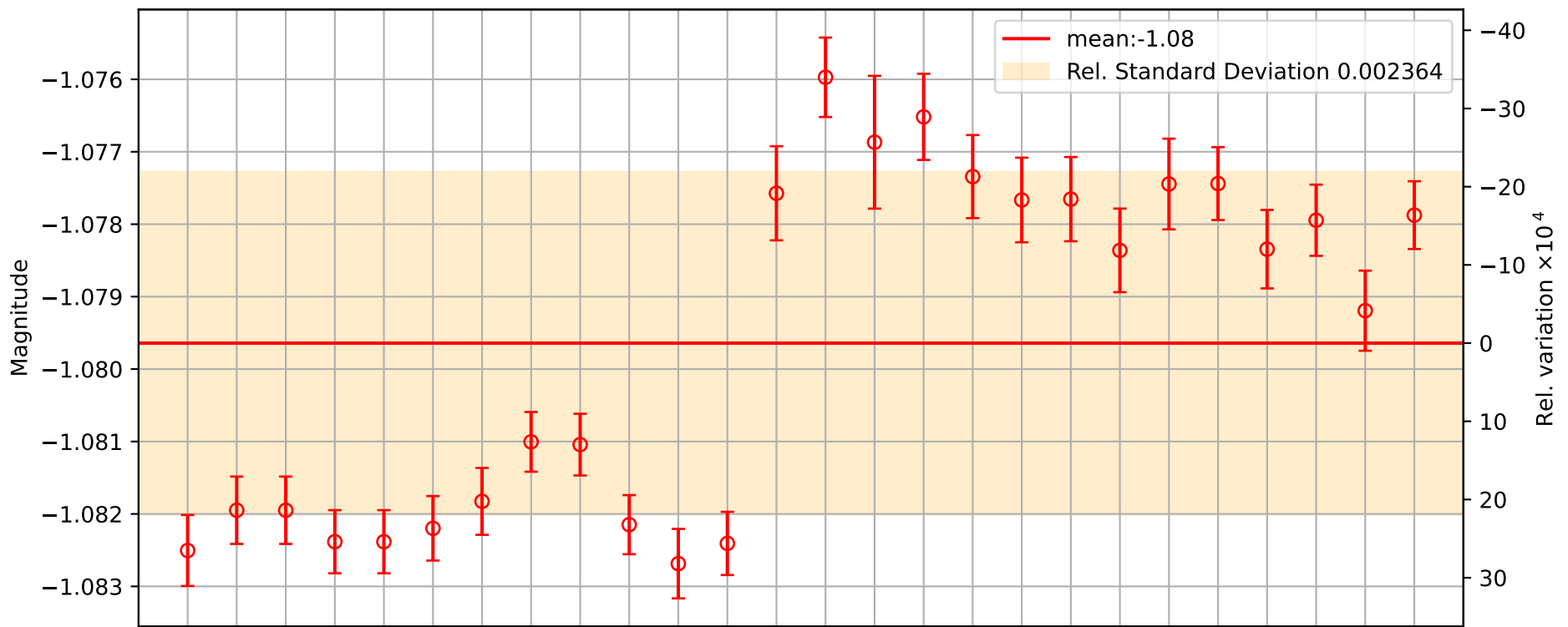
Description:

Tx/WS ratio: TXWS is the ratio of the TxPD responsivity to the Working Standard responsivity, and is dimensionless. It is measured at the end station by comparing the voltage output of the TxPD to that of the Working Standard with each beam exposed one at a time. This ratio is used in the Pcal chain to determine the responsivity of the TxPD from the known Working Standard responsivity. The plot shows two panels: the top panel displays the TXWS ratio against measurement number with a secondary axis showing relative variation $\times 10^4$ (which we call hop meaning hundredths of a percent); the bottom panel shows the same values plotted against measurement date. Error bars represent the measurement uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation of all measurements. This ratio, α_{TW} , is the Tx to Working Standard output with the backgrounds subtracted and is made using ES measurements M1 - M7

TXWS	
Date TXWS $\pm$ Rel.Uncertainty (epsilon)	
D20230110:	-1.082504 $\pm$ 0.000453
D20230206:	-1.081949 $\pm$ 0.000430
D20230207:	-1.081949 $\pm$ 0.000430
D20230227:	-1.082383 $\pm$ 0.000403
D20230228:	-1.082383 $\pm$ 0.000403
D20230314:	-1.082198 $\pm$ 0.000411
D20230404:	-1.081826 $\pm$ 0.000427
D20230613:	-1.081005 $\pm$ 0.000381
D20230821:	-1.081043 $\pm$ 0.000394
D20230822:	-1.082148 $\pm$ 0.000377
D20231031:	-1.082686 $\pm$ 0.000443
D20231205:	-1.082407 $\pm$ 0.000403
D20240229:	-1.077573 $\pm$ 0.000603
D20240423:	-1.075972 $\pm$ 0.000510
D20240702:	-1.076868 $\pm$ 0.000851
D20240730:	-1.076518 $\pm$ 0.000553
D20240924:	-1.077343 $\pm$ 0.000532
D20241126:	-1.077666 $\pm$ 0.000542
D20250128:	-1.077654 $\pm$ 0.000540
D20250325:	-1.078361 $\pm$ 0.000535
D20250701:	-1.077445 $\pm$ 0.000581
D20250819:	-1.077440 $\pm$ 0.000467
D20251104:	-1.078345 $\pm$ 0.000502
D20260127:	-1.077945 $\pm$ 0.000456
D20260210:	-1.079194 $\pm$ 0.000512
D20260721:	-1.077875 $\pm$ 0.000434

TXWS	
Summary of TS / WS ratio	
Mean value: -1.079642	
Standard deviation: 0.002364	
Standard error: -0.002233	
Relative Uncertainty: 0.002233	

TS / WS ratio



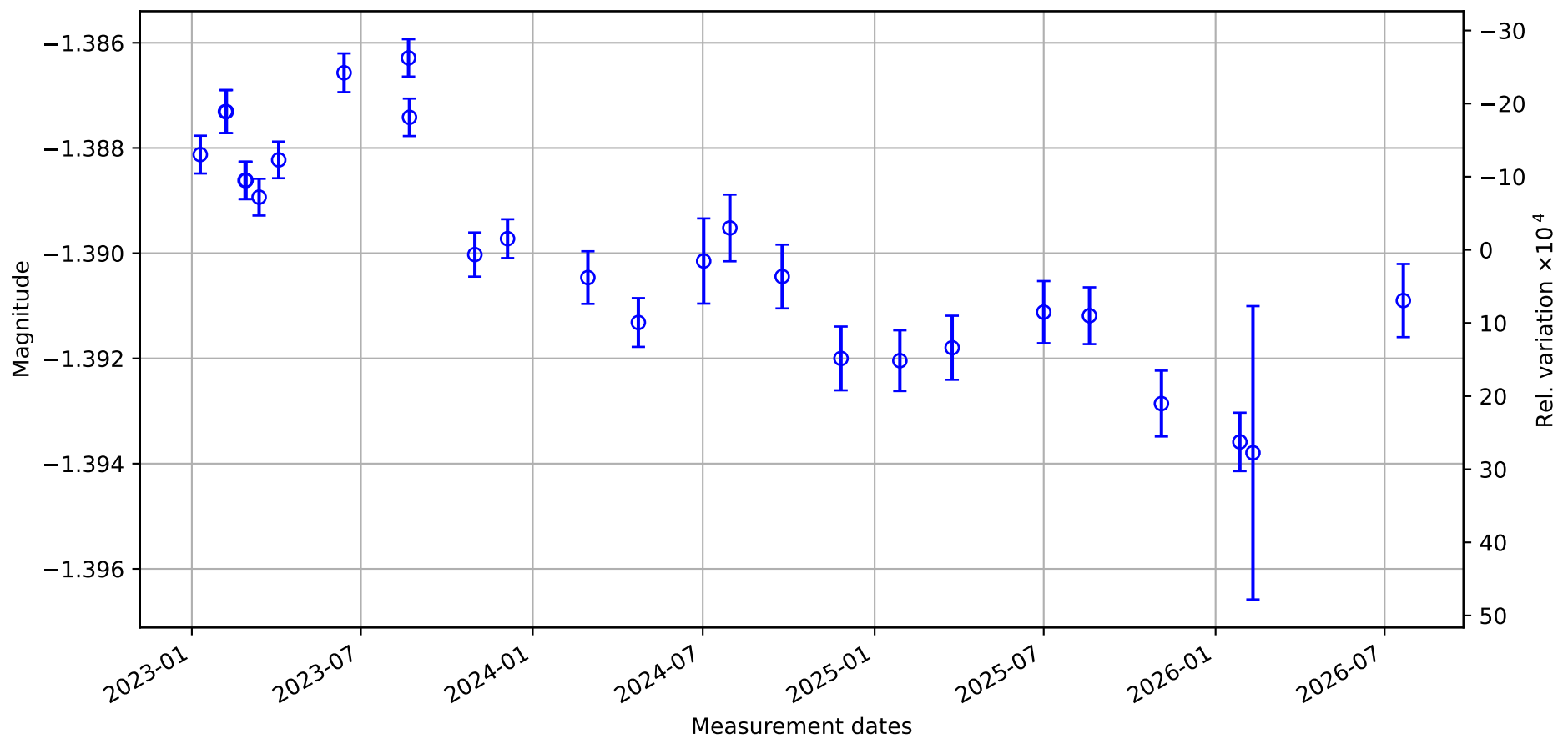
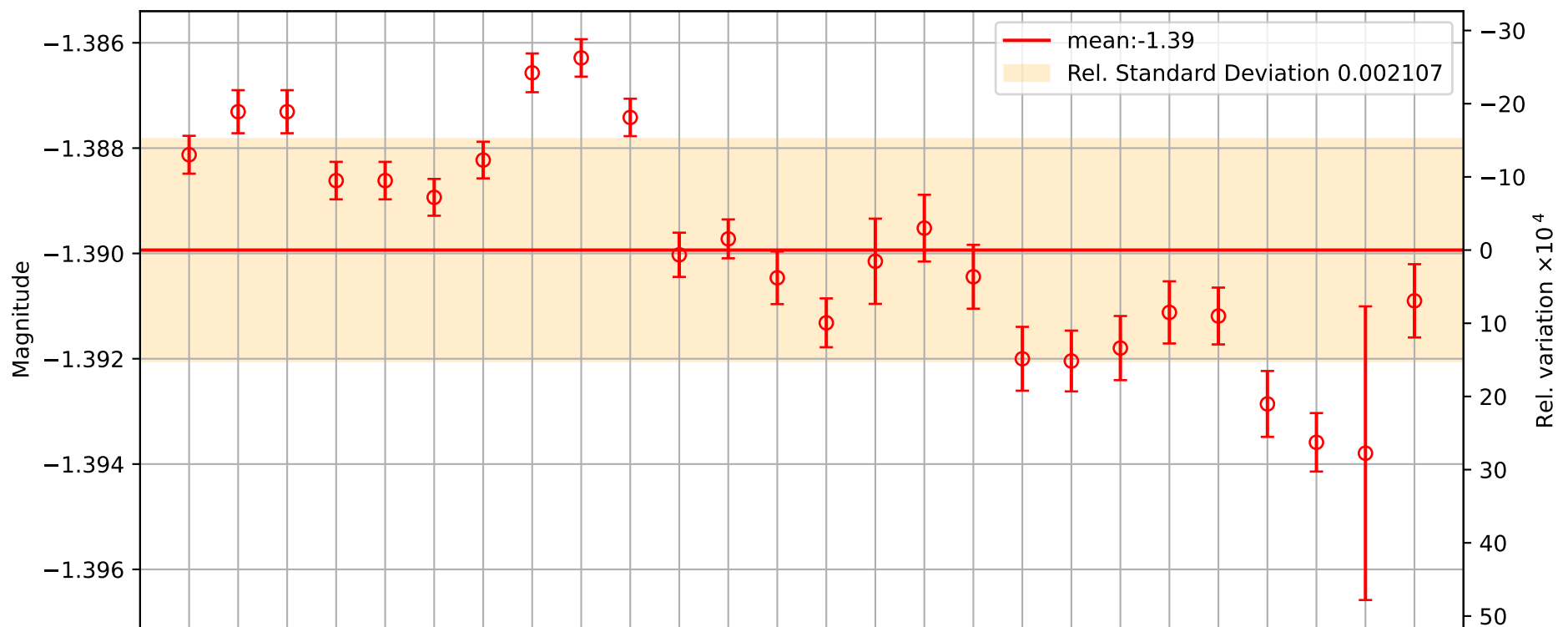
Description:

Rx/WS ratio RXWS is the ratio of the RxPD responsivity to the Working Standard responsivity, and is dimensionless. It is measured at the end station by comparing the voltage output of the RxPD to that of the Working Standard when both are exposed to the same laser beam. This ratio is used in the calibration chain to determine the absolute responsivity of the RxPD from the known Working Standard responsivity. The plot shows two panels: the top panel displays the RXWS ratio against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation. This ratio, α_{RW} , is the Rx to Working Standard output with the backgrounds subtracted and is made using M7 - M9 from the ES measurment process.

RXWS	
Date RXWS $\pm$ Rel.Uncertainty (epsilon)	
D20230110:	-1.388126 $\pm$ 0.000259
D20230206:	-1.387309 $\pm$ 0.000295
D20230207:	-1.387309 $\pm$ 0.000295
D20230227:	-1.388617 $\pm$ 0.000256
D20230228:	-1.388617 $\pm$ 0.000256
D20230314:	-1.388935 $\pm$ 0.000252
D20230404:	-1.388227 $\pm$ 0.000251
D20230613:	-1.386570 $\pm$ 0.000265
D20230821:	-1.386288 $\pm$ 0.000256
D20230822:	-1.387417 $\pm$ 0.000256
D20231031:	-1.390026 $\pm$ 0.000302
D20231205:	-1.389724 $\pm$ 0.000266
D20240229:	-1.390463 $\pm$ 0.000359
D20240423:	-1.391318 $\pm$ 0.000333
D20240702:	-1.390149 $\pm$ 0.000582
D20240730:	-1.389520 $\pm$ 0.000456
D20240924:	-1.390443 $\pm$ 0.000436
D20241126:	-1.392000 $\pm$ 0.000435
D20250128:	-1.392043 $\pm$ 0.000415
D20250325:	-1.391797 $\pm$ 0.000437
D20250701:	-1.391120 $\pm$ 0.000424
D20250819:	-1.391188 $\pm$ 0.000388
D20251104:	-1.392858 $\pm$ 0.000449
D20260127:	-1.393587 $\pm$ 0.000398
D20260210:	-1.393794 $\pm$ 0.002000
D20260721:	-1.390900 $\pm$ 0.000500

RXWS	
Summary of RX / WS ratio	
Mean value: -1.389936	
Standard deviation: 0.002107	
Standard error: -0.001546	
Relative Uncertainty: 0.001546	

RX / WS ratio



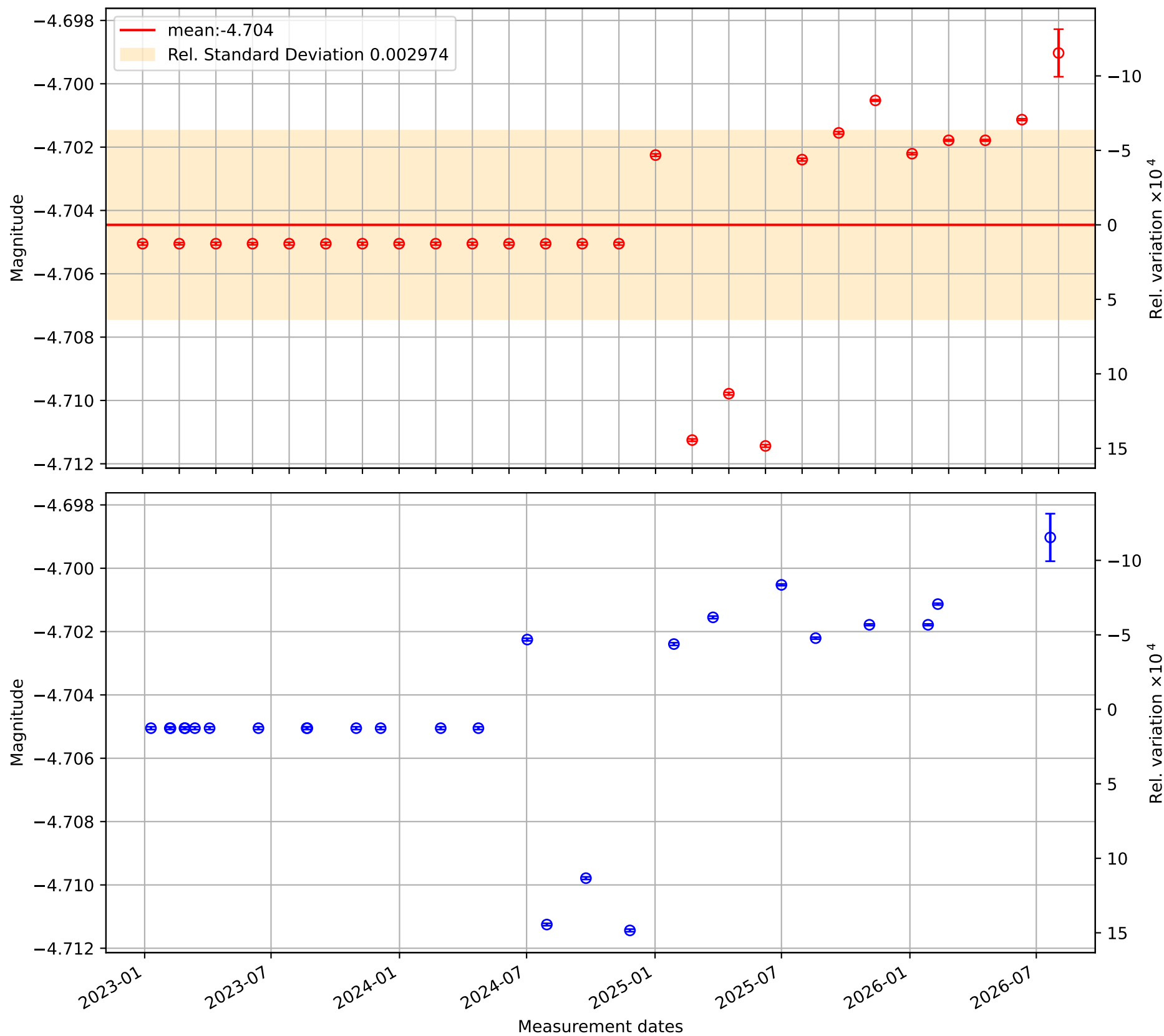
Description:

WS WS is the Working Standard Responsivity in units of V/W (Volts per Watt). It represents the sensitivity of the working standard photodetector, relating its electrical voltage output to the incident optical power. The working standard is used as a transfer reference to calibrate the end station TxPD and RxPD responsivities, and is itself calibrated against the Gold Standard in the PCAL lab, tracing back to absolute power standards at NIST and PTB. The plot shows two panels: the top panel displays the Working Standard Responsivity against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

WS	
Date WS $\pm$ Rel.Uncertainty (epsilon)	
D20230110:	-4.705050 $\pm$ 0.000009
D20230206:	-4.705050 $\pm$ 0.000008
D20230207:	-4.705050 $\pm$ 0.000009
D20230227:	-4.705050 $\pm$ 0.000008
D20230228:	-4.705050 $\pm$ 0.000009
D20230314:	-4.705050 $\pm$ 0.000009
D20230404:	-4.705050 $\pm$ 0.000009
D20230613:	-4.705050 $\pm$ 0.000009
D20230821:	-4.705050 $\pm$ 0.000009
D20230822:	-4.705050 $\pm$ 0.000009
D20231031:	-4.705050 $\pm$ 0.000009
D20231205:	-4.705050 $\pm$ 0.000009
D20240229:	-4.705050 $\pm$ 0.000009
D20240423:	-4.705050 $\pm$ 0.000009
D20240702:	-4.702252 $\pm$ 0.000009
D20240730:	-4.711251 $\pm$ 0.000008
D20240924:	-4.709787 $\pm$ 0.000009
D20241126:	-4.711436 $\pm$ 0.000009
D20250128:	-4.702395 $\pm$ 0.000009
D20250325:	-4.701551 $\pm$ 0.000009
D20250701:	-4.700525 $\pm$ 0.000006
D20250819:	-4.702207 $\pm$ 0.000007
D20251104:	-4.701786 $\pm$ 0.000006
D20260127:	-4.701786 $\pm$ 0.000006
D20260210:	-4.701132 $\pm$ 0.000006
D20260721:	-4.699027 $\pm$ 0.000160

WS	
Summary of Working Standard Responsivity	
rho_WS	
Mean value: -4.704455	
Standard deviation: 0.002974	
Standard error: -0.000126	
Relative Uncertainty: 0.000126	

Working Standard Responsivity rho_WS



Description:

Zeta is the ADC (Analog-to-Digital Converter) conversion factor, with units of counts per Volt (ct/V). It represents the gain of the digitization chain and is determined from the gradient of a linear fit between the raw ADC counts and the calibrated voltage signal, using the Martel individual method. Zeta is treated as a stationary quantity. The plot shows two panels: the top panel displays measured values against measurement number with a secondary axis showing relative variation \Uffffff0\u2074; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma). The mean value is shown as a horizontal red line.

zeta	
Date zeta ± Rel.Uncertainty (epsilon)	
D20230110:	1.6367e+03 ± 1.0000e-09
D20230206:	1.6368e+03 ± 1.0000e-09
D20230207:	1.6368e+03 ± 1.0000e-09
D20230227:	1.6367e+03 ± 1.0000e-09
D20230228:	1.6367e+03 ± 1.0000e-09
D20230314:	1.6369e+03 ± 1.0000e-09
D20230404:	1.6369e+03 ± 1.0000e-09
D20230613:	1.6369e+03 ± 1.0000e-09
D20230821:	1.6368e+03 ± 1.0000e-09
D20230822:	1.6368e+03 ± 1.0000e-09
D20231031:	1.6368e+03 ± 1.0000e-09
D20231205:	1.6369e+03 ± 1.0000e-09
D20240229:	1.6369e+03 ± 1.0000e-09
D20240423:	1.6369e+03 ± 1.0000e-09
D20240702:	1.6368e+03 ± 1.0000e-09
D20240730:	1.6368e+03 ± 1.0000e-09
D20240924:	1.6367e+03 ± 1.0000e-09
D20241126:	1.6368e+03 ± 1.0000e-09
D20250128:	1.6367e+03 ± 1.0000e-09
D20250325:	1.6368e+03 ± 1.0000e-09
D20250701:	1.6369e+03 ± 1.0000e-09
D20250819:	1.6371e+03 ± 1.0000e-09
D20251104:	1.6368e+03 ± 1.0000e-09
D20260127:	1.6370e+03 ± 1.0000e-09
D20260210:	1.6368e+03 ± 1.0000e-09
D20260721:	1.6369e+03 ± 1.0000e-09

zeta
Summary of ADC conversion factor (Zeta (ct/V))

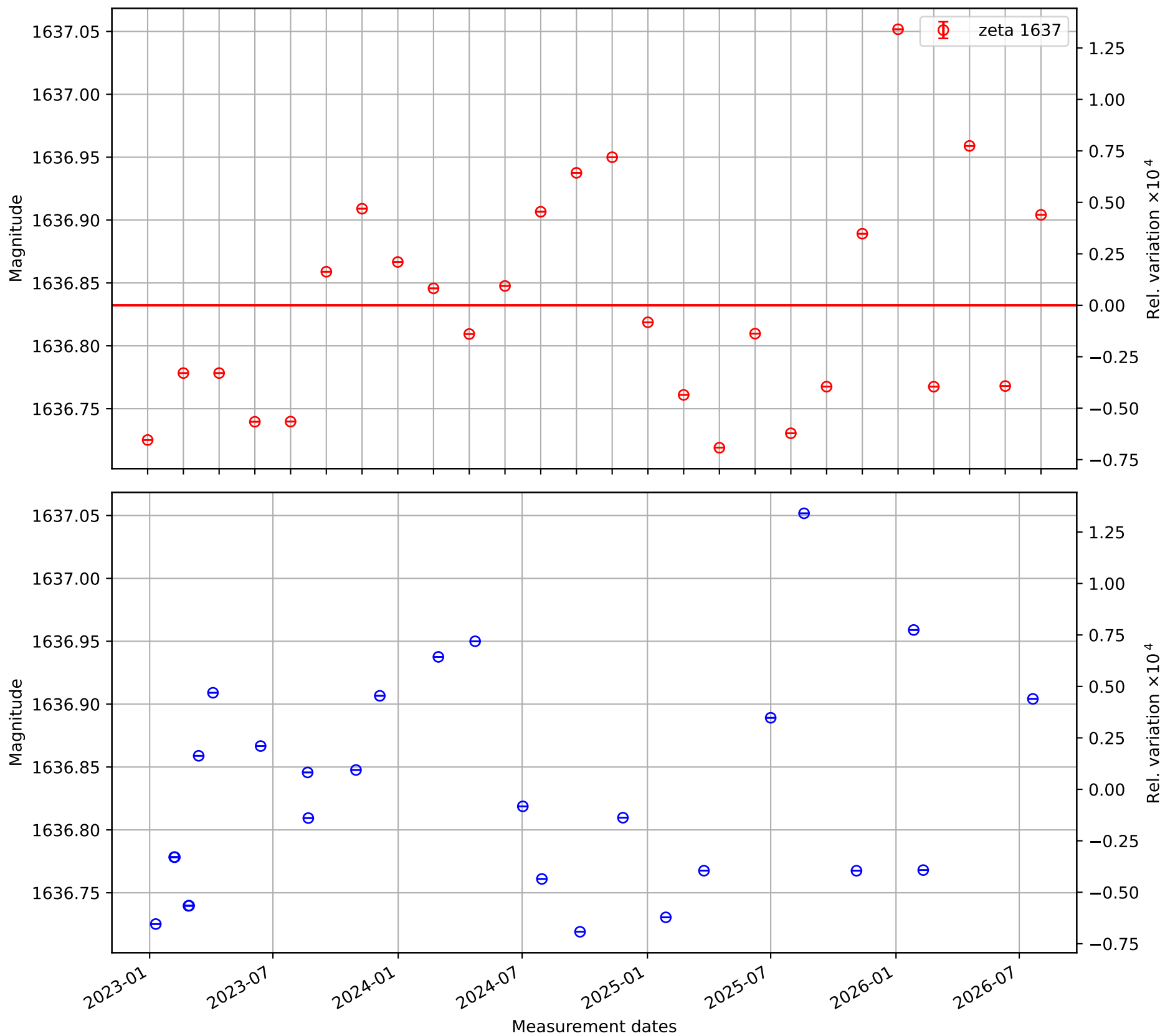
Mean value: 1636.832252

Standard deviation: 0.086660

Standard error: 0.000011

Relative Uncertainty: 0.000011

ADC conversion factor (Zeta (ct/V))



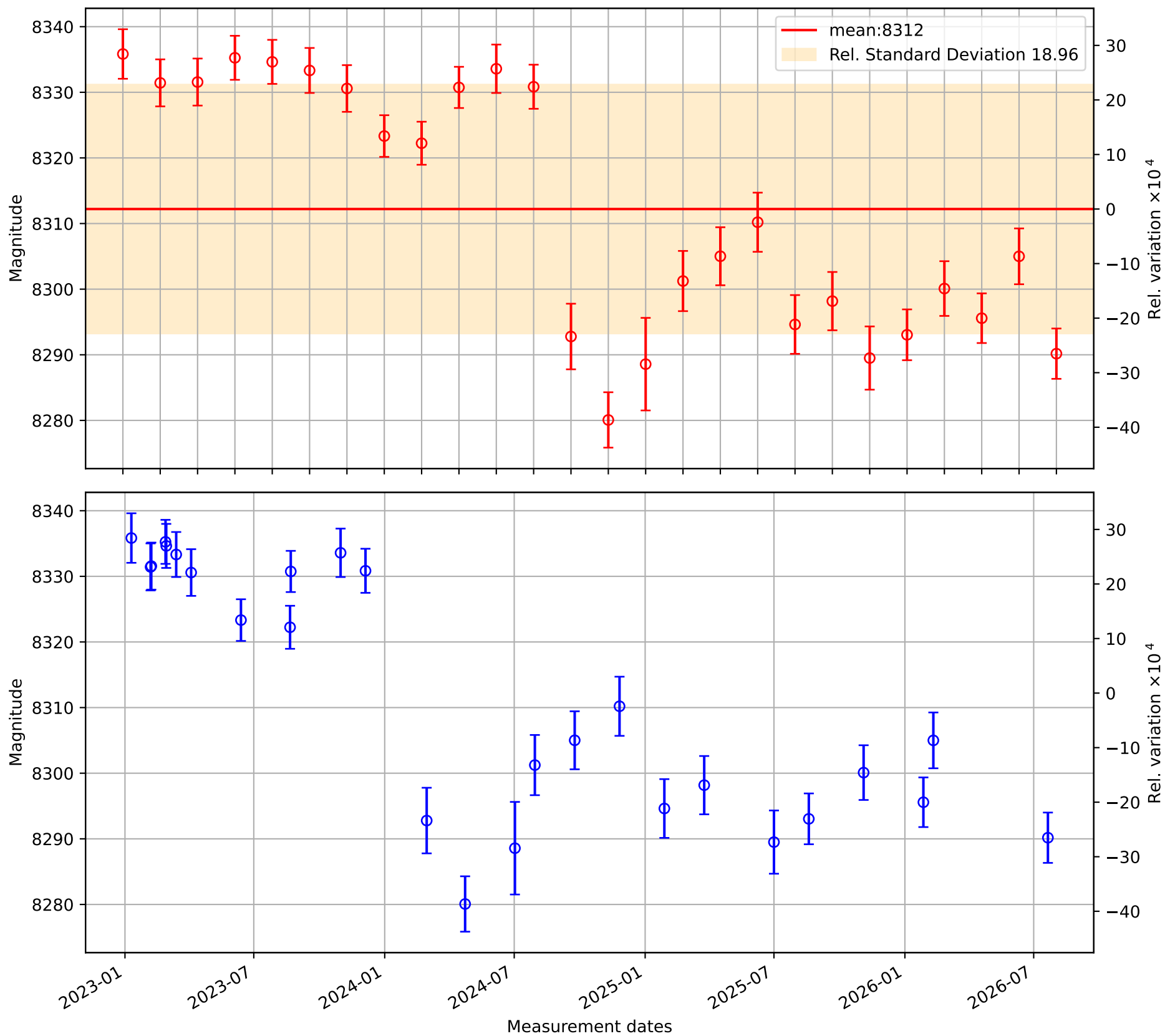
Description:

rho_T (rho_Tx) is the responsivity of the TxPD (Transmitter photodetector) in units of V/W, defined as $\rho_{Tx} = \alpha_{TW} * \rho_{WS}$, where α_{TW} is the ratio of the TxPD response to the Working Standard response and ρ_{WS} is the Working Standard responsivity. It relates the voltage output of the TxPD to the incident optical power and is used to estimate the laser power delivered to the test mass. Trending this parameter is useful for detecting changes in input laser power over time. The plot shows two panels: the top panel displays rho_T against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

rho_T	
Date	rho_T ± Rel.Uncertainty (epsilon)
D20230110:	8335.836288 ± 0.000453
D20230206:	8331.434558 ± 0.000430
D20230207:	8331.560758 ± 0.000430
D20230227:	8335.256514 ± 0.000403
D20230228:	8334.637130 ± 0.000403
D20230314:	8333.327226 ± 0.000411
D20230404:	8330.579600 ± 0.000427
D20230613:	8323.332802 ± 0.000381
D20230821:	8322.237755 ± 0.000394
D20230822:	8330.744766 ± 0.000377
D20231031:	8333.584723 ± 0.000443
D20231205:	8330.845836 ± 0.000403
D20240229:	8292.784108 ± 0.000603
D20240423:	8280.070091 ± 0.000510
D20240702:	8288.571727 ± 0.000851
D20240730:	8301.238569 ± 0.000553
D20240924:	8305.014575 ± 0.000532
D20241126:	8310.199441 ± 0.000542
D20250128:	8294.622892 ± 0.000540
D20250325:	8298.176715 ± 0.000536
D20250701:	8289.502545 ± 0.000581
D20250819:	8293.044565 ± 0.000467
D20251104:	8300.092018 ± 0.000502
D20260127:	8295.574935 ± 0.000456
D20260210:	8305.002279 ± 0.000512
D20260721:	8290.170030 ± 0.000462

rho_T	
Summary of TX Responsivity rho_T	
Mean value: 8312.209325	
Standard deviation: 18.960462	
Standard error: 0.002326	
Relative Uncertainty: 0.002326	

TX Responsivity ρ_T



Description:

rho_R (rho_Rx) is the responsivity of the RxPD (Receiver photodetector) in units of V/W, defined as $\rho_{Rx} = \alpha_{RW} * \rho_{WS}$, where α_{RW} is the ratio of the RxPD response to the Working Standard response and ρ_{WS} is the Working Standard responsivity. It relates the voltage output of the RxPD to the optical power it receives and is used to estimate the laser power returning from the test mass. Trending this parameter is useful for monitoring changes in the optical power incident on the ETM over time. The plot shows two panels: the top panel displays rho_R against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

rho_R
Date rho_R ± Rel.Uncertainty (epsilon)
D20230110: 10689.278561 ± 0.000259
D20230206: 10682.825334 ± 0.000295
D20230207: 10682.987152 ± 0.000295
D20230227: 10693.512463 ± 0.000256
D20230228: 10692.717839 ± 0.000256
D20230314: 10695.310902 ± 0.000252
D20230404: 10690.011970 ± 0.000251
D20230613: 10676.075302 ± 0.000265
D20230821: 10672.118836 ± 0.000256
D20230822: 10680.811596 ± 0.000256
D20231031: 10699.224210 ± 0.000302
D20231205: 10696.137078 ± 0.000266
D20240229: 10700.720462 ± 0.000359
D20240423: 10706.792370 ± 0.000333
D20240702: 10699.868997 ± 0.000582
D20240730: 10714.854654 ± 0.000456
D20240924: 10718.642376 ± 0.000436
D20241126: 10734.128811 ± 0.000436
D20250128: 10714.449733 ± 0.000415
D20250325: 10710.118688 ± 0.000437
D20250701: 10702.813484 ± 0.000424
D20250819: 10707.966967 ± 0.000388
D20251104: 10720.919880 ± 0.000449
D20260127: 10724.667200 ± 0.000398
D20260210: 10726.024181 ± 0.002000
D20260721: 10697.715774 ± 0.000525

rho_R

Summary of RX Responsivity rho_R

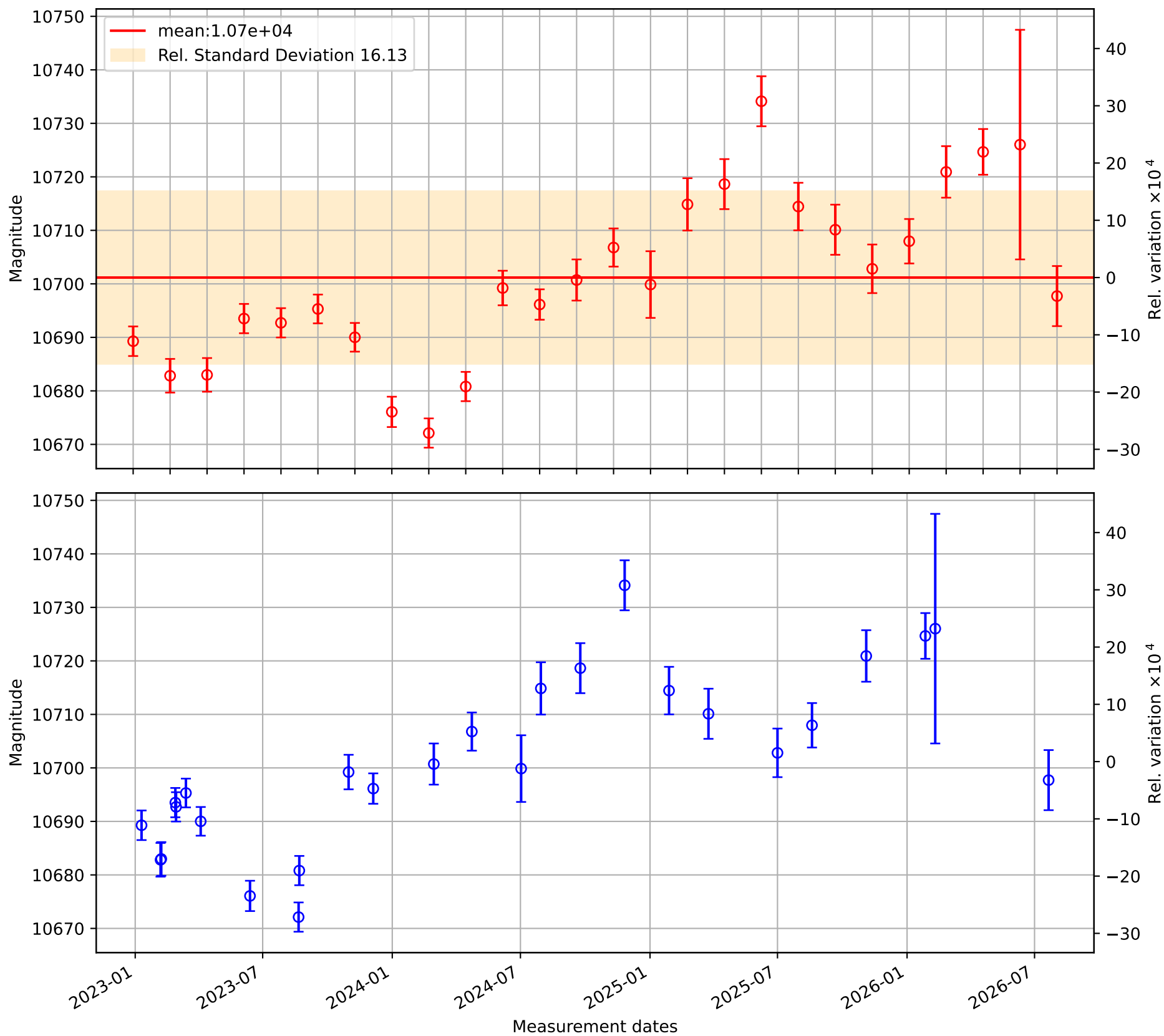
Mean value: 10701.180570

Standard deviation: 16.129798

Standard error: 0.001537

Relative Uncertainty: 0.001537

RX Responsivity rho_R



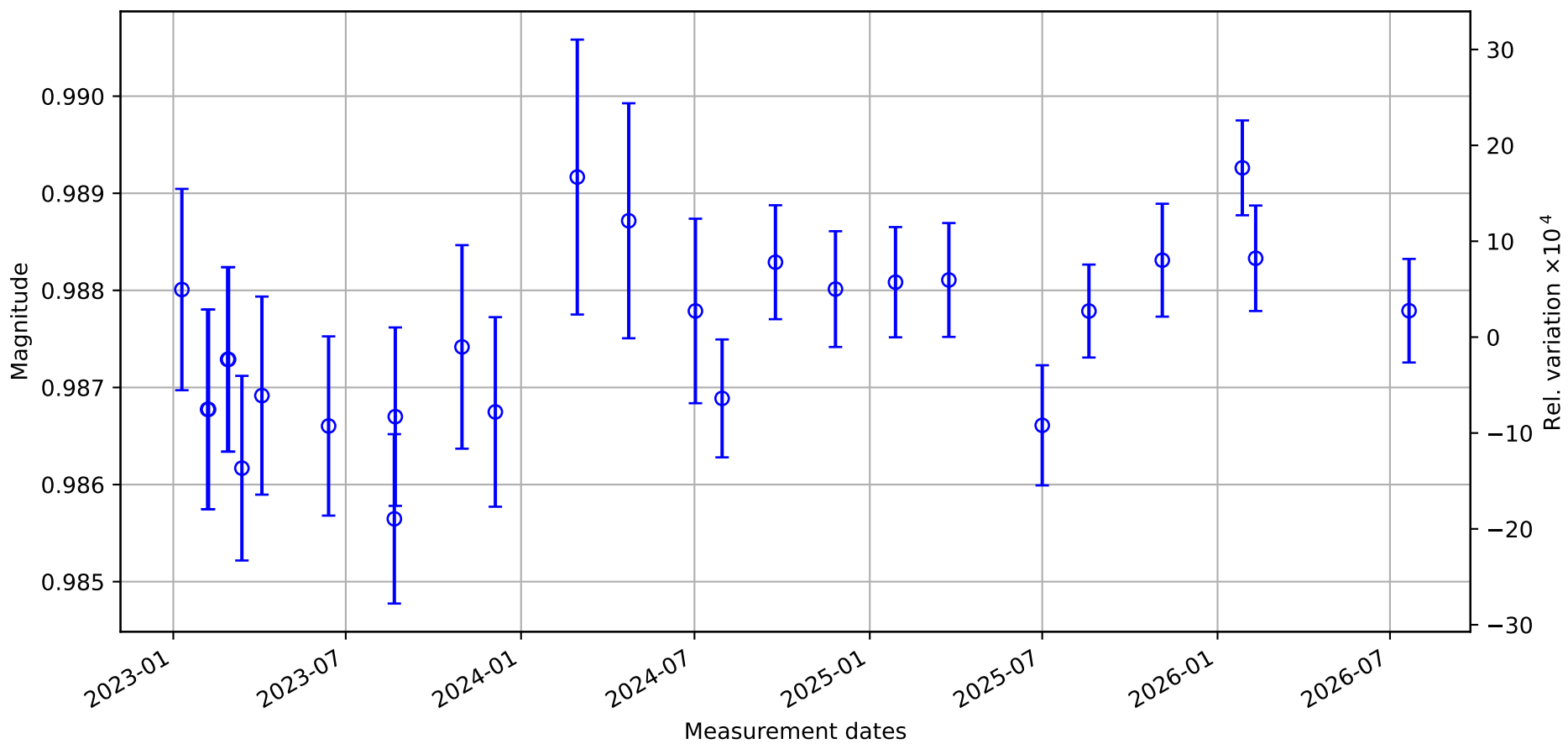
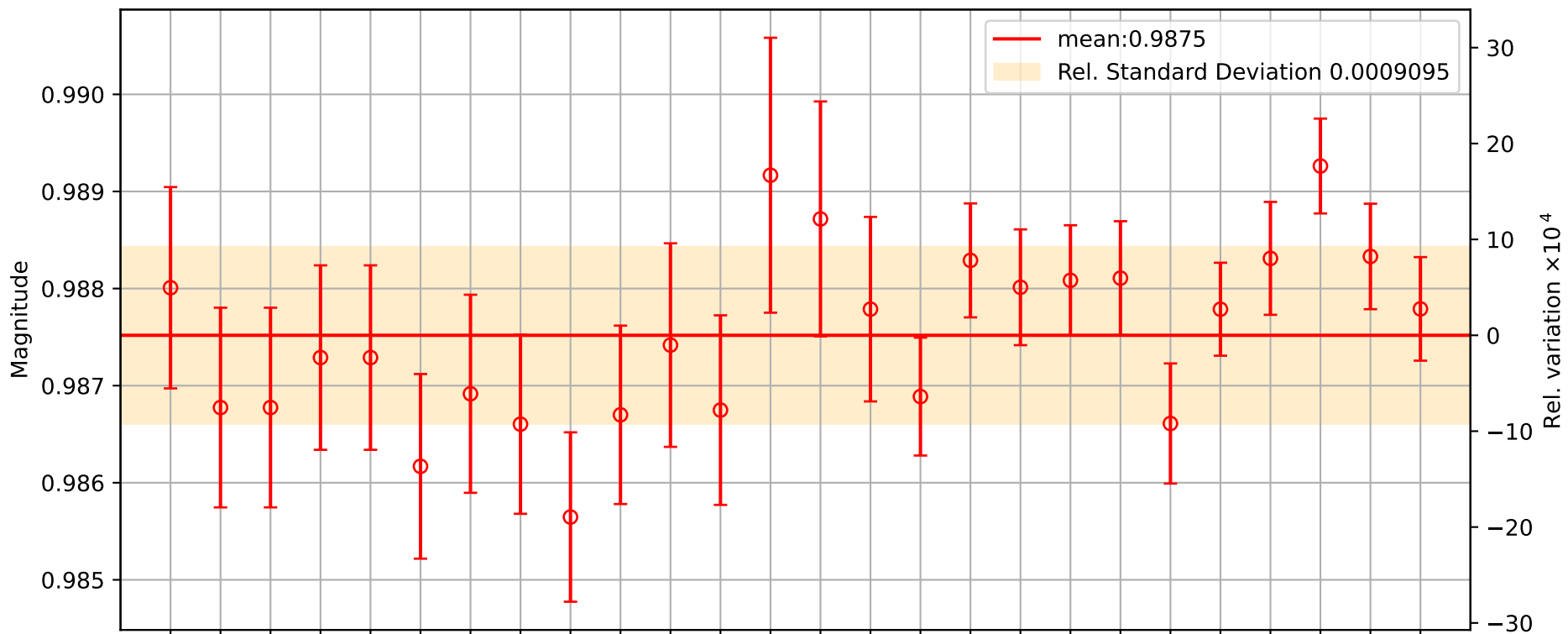
Description:

e_i is the Optical Efficiency of the inner beam, defined as $e_i = (W_{ri}/T_{ti}) / (W_{ti}/T_{ti})$, and is dimensionless. It is the ratio of the Working Standard output in the Rx module to the Working Standard output in the Tx module when only the inner beam is illuminating both, normalized by the Tx output. This measurement involves the inner beam ports M1 and M5 and characterizes how much of the inner beam power transmitted from the Tx side is received on the Rx side, accounting for optical losses along the inner beam path inside the vacuum chamber. The plot shows two panels: the top panel displays e_i against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

e_i	
Date	e_i ± Rel.Uncertainty (epsilon)
D20230110:	0.988008 ± 0.001049
D20230206:	0.986774 ± 0.001042
D20230207:	0.986774 ± 0.001042
D20230227:	0.987289 ± 0.000962
D20230228:	0.987289 ± 0.000962
D20230314:	0.986169 ± 0.000964
D20230404:	0.986916 ± 0.001034
D20230613:	0.986603 ± 0.000936
D20230821:	0.985647 ± 0.000885
D20230822:	0.986699 ± 0.000931
D20231031:	0.987418 ± 0.001061
D20231205:	0.986748 ± 0.000989
D20240229:	0.989167 ± 0.001431
D20240423:	0.988717 ± 0.001224
D20240702:	0.987788 ± 0.000962
D20240730:	0.986887 ± 0.000615
D20240924:	0.988290 ± 0.000594
D20241126:	0.988013 ± 0.000603
D20250128:	0.988084 ± 0.000574
D20250325:	0.988107 ± 0.000594
D20250701:	0.986610 ± 0.000627
D20250819:	0.987787 ± 0.000485
D20251104:	0.988311 ± 0.000588
D20260127:	0.989262 ± 0.000494
D20260210:	0.988331 ± 0.000550
D20260721:	0.987790 ± 0.000540

e_i	
Summary of Optical Efficiency (Inner Beam)	
Mean value: 0.987518	
Standard deviation: 0.000910	
Standard error: 0.000184	
Relative Uncertainty: 0.000184	

Optical Efficiency (Inner Beam)



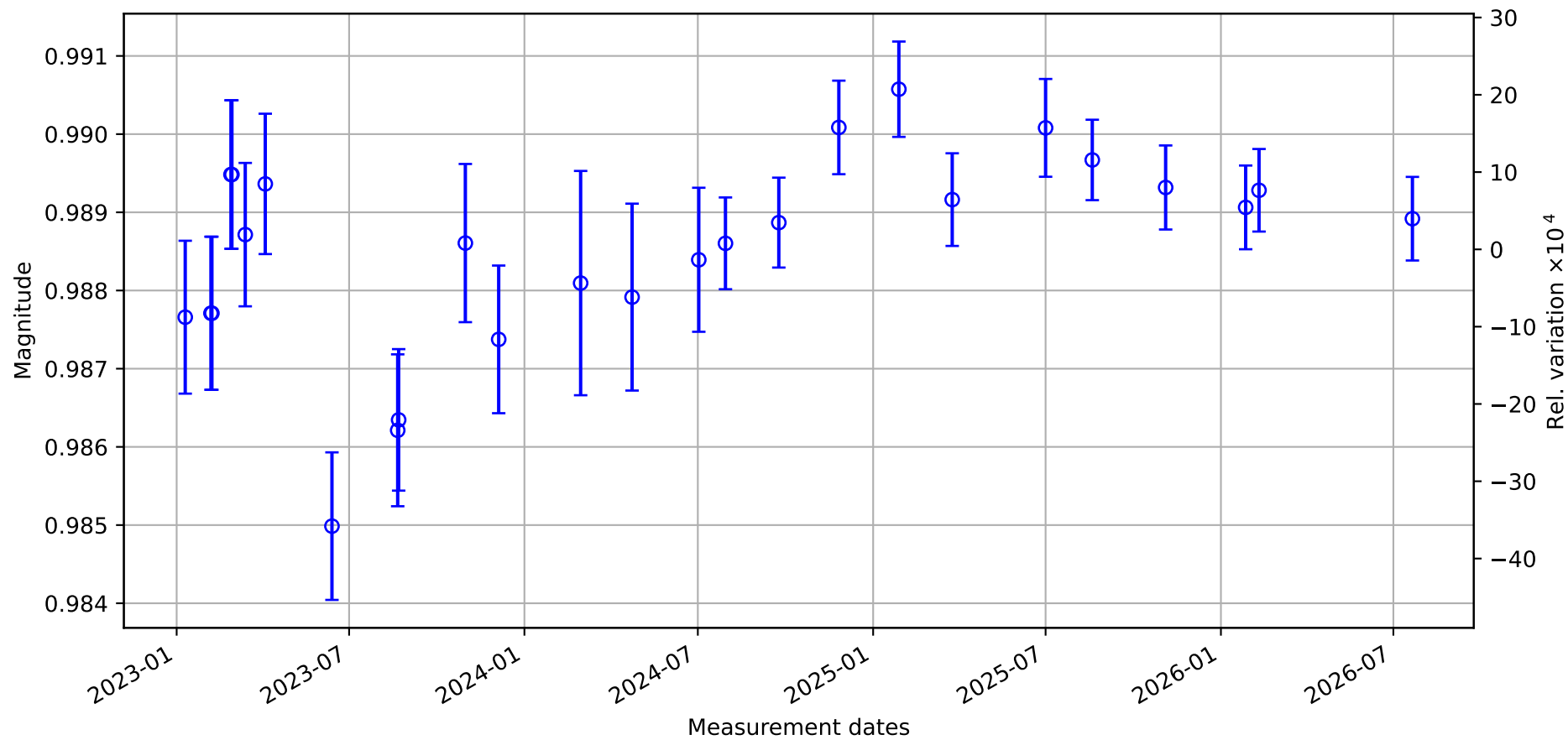
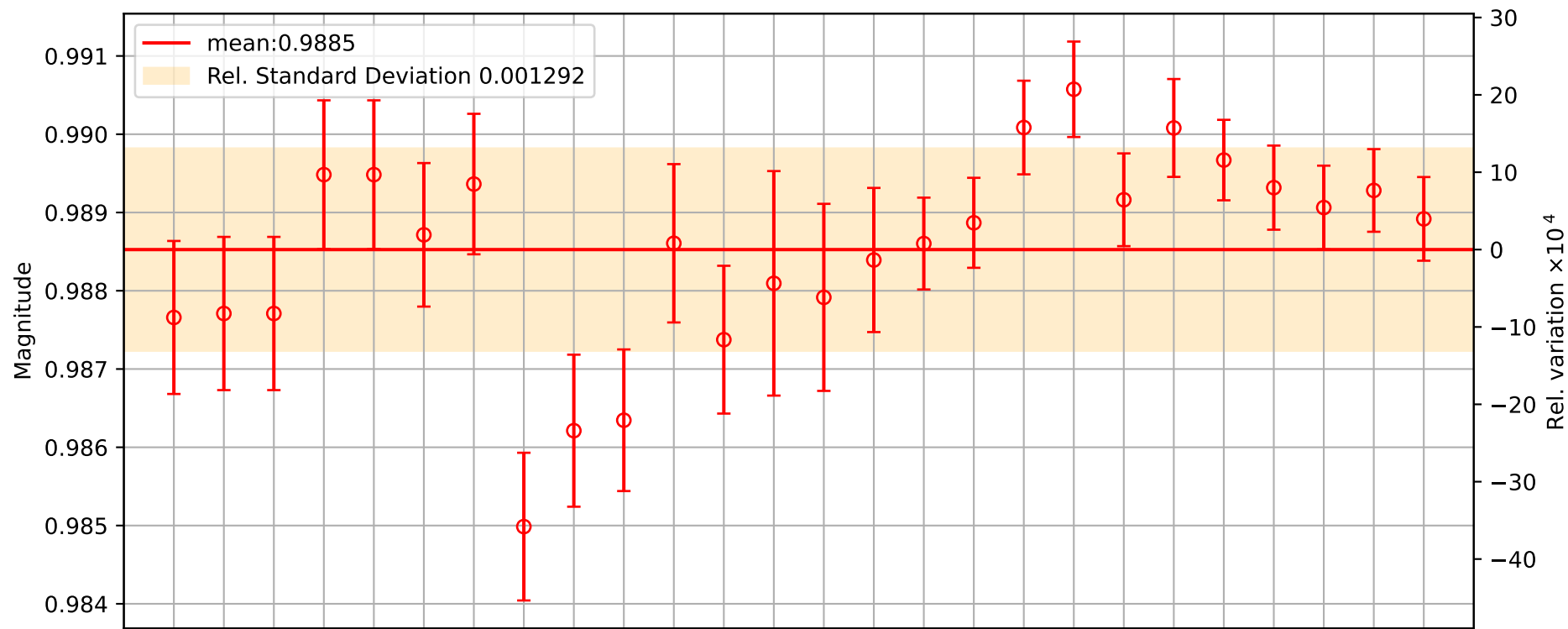
Description:

e_o is the Optical Efficiency of the outer beam, defined as $e_o = (W_{ro}/T_{to}) / (W_{to}/T_{to})$, and is dimensionless. It is the ratio of the Working Standard output in the Rx module to the Working Standard output in the Tx module when only the outer beam is illuminating both, normalized by the Tx output. This measurement involves the outer beam ports M2 and M4 and characterizes how much of the outer beam power transmitted from the Tx side is received on the Rx side, accounting for optical losses along the outer beam path inside the vacuum chamber. The plot shows two panels: the top panel displays e_o against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

e_o
Date e_o ± Rel.Uncertainty (epsilon)
D20230110: 0.987659 ± 0.000990
D20230206: 0.987709 ± 0.000991
D20230207: 0.987709 ± 0.000991
D20230227: 0.989483 ± 0.000960
D20230228: 0.989483 ± 0.000960
D20230314: 0.988715 ± 0.000927
D20230404: 0.989363 ± 0.000907
D20230613: 0.984986 ± 0.000958
D20230821: 0.986212 ± 0.000985
D20230822: 0.986345 ± 0.000917
D20231031: 0.988607 ± 0.001023
D20231205: 0.987375 ± 0.000956
D20240229: 0.988095 ± 0.001452
D20240423: 0.987915 ± 0.001210
D20240702: 0.988393 ± 0.000932
D20240730: 0.988603 ± 0.000594
D20240924: 0.988868 ± 0.000581
D20241126: 0.990086 ± 0.000604
D20250128: 0.990574 ± 0.000616
D20250325: 0.989162 ± 0.000599
D20250701: 0.990080 ± 0.000631
D20250819: 0.989670 ± 0.000520
D20251104: 0.989318 ± 0.000543
D20260127: 0.989063 ± 0.000541
D20260210: 0.989282 ± 0.000534
D20260721: 0.988918 ± 0.000541

e_o
Summary of Optical Efficiency (Outer Beam)
Mean value: 0.988526
Standard deviation: 0.001292
Standard error: 0.000261
Relative Uncertainty: 0.000261

Optical Efficiency (Outer Beam)



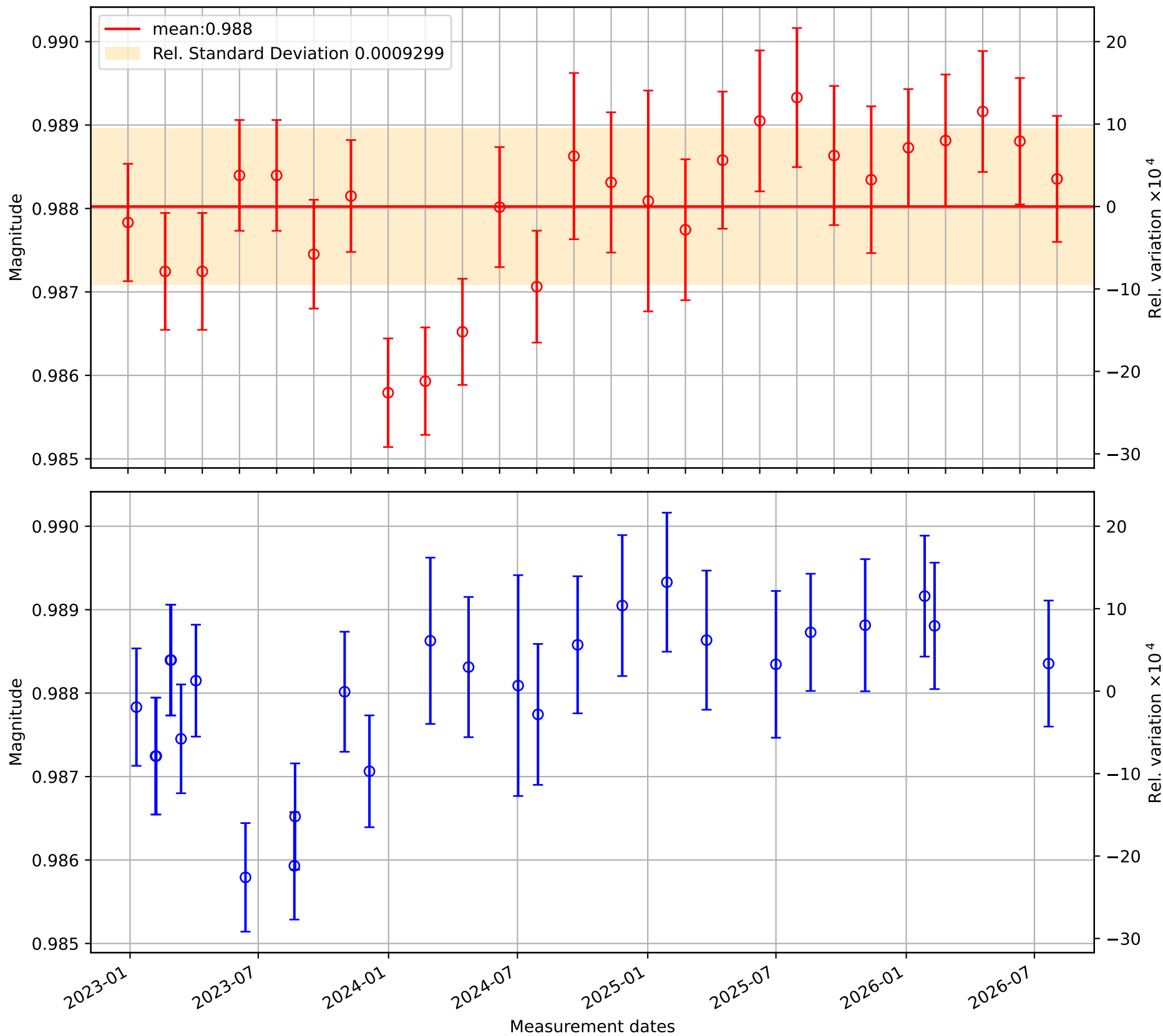
Description:

e is the Overall Optical Efficiency, defined as $e = (e_i + e_o) / 2$, and is dimensionless. It is the average of the inner beam and outer beam optical efficiencies, using measurements from ports M1, M2, M4, and M5. It represents the total fraction of laser power that survives transmission through the vacuum chamber from the Tx side to the Rx side, and is used in computing the optical efficiency correction factors E_T and E_R. Trending this parameter is useful for monitoring long-term degradation of the in-vacuum optics. The plot shows two panels: the top panel displays e against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

e
Date e ± Rel.Uncertainty (epsilon)
D20230110: 0.987832 ± 0.000712
D20230206: 0.987246 ± 0.000710
D20230207: 0.987246 ± 0.000710
D20230227: 0.988397 ± 0.000672
D20230228: 0.988397 ± 0.000672
D20230314: 0.987452 ± 0.000660
D20230404: 0.988149 ± 0.000679
D20230613: 0.985792 ± 0.000660
D20230821: 0.985931 ± 0.000653
D20230822: 0.986522 ± 0.000645
D20231031: 0.988017 ± 0.000728
D20231205: 0.987063 ± 0.000679
D20240229: 0.988627 ± 0.001008
D20240423: 0.988312 ± 0.000850
D20240702: 0.988090 ± 0.001339
D20240730: 0.987745 ± 0.000855
D20240924: 0.988579 ± 0.000831
D20241126: 0.989049 ± 0.000854
D20250128: 0.989329 ± 0.000842
D20250325: 0.988635 ± 0.000843
D20250701: 0.988345 ± 0.000890
D20250819: 0.988728 ± 0.000710
D20251104: 0.988814 ± 0.000801
D20260127: 0.989162 ± 0.000733
D20260210: 0.988806 ± 0.000766
D20260721: 0.988354 ± 0.000764

e
Summary of Overall Optical Efficiency
Mean value: 0.988024
Standard deviation: 0.000930
Standard error: 0.000188
Relative Uncertainty: 0.000188

Overall Optical Efficiency



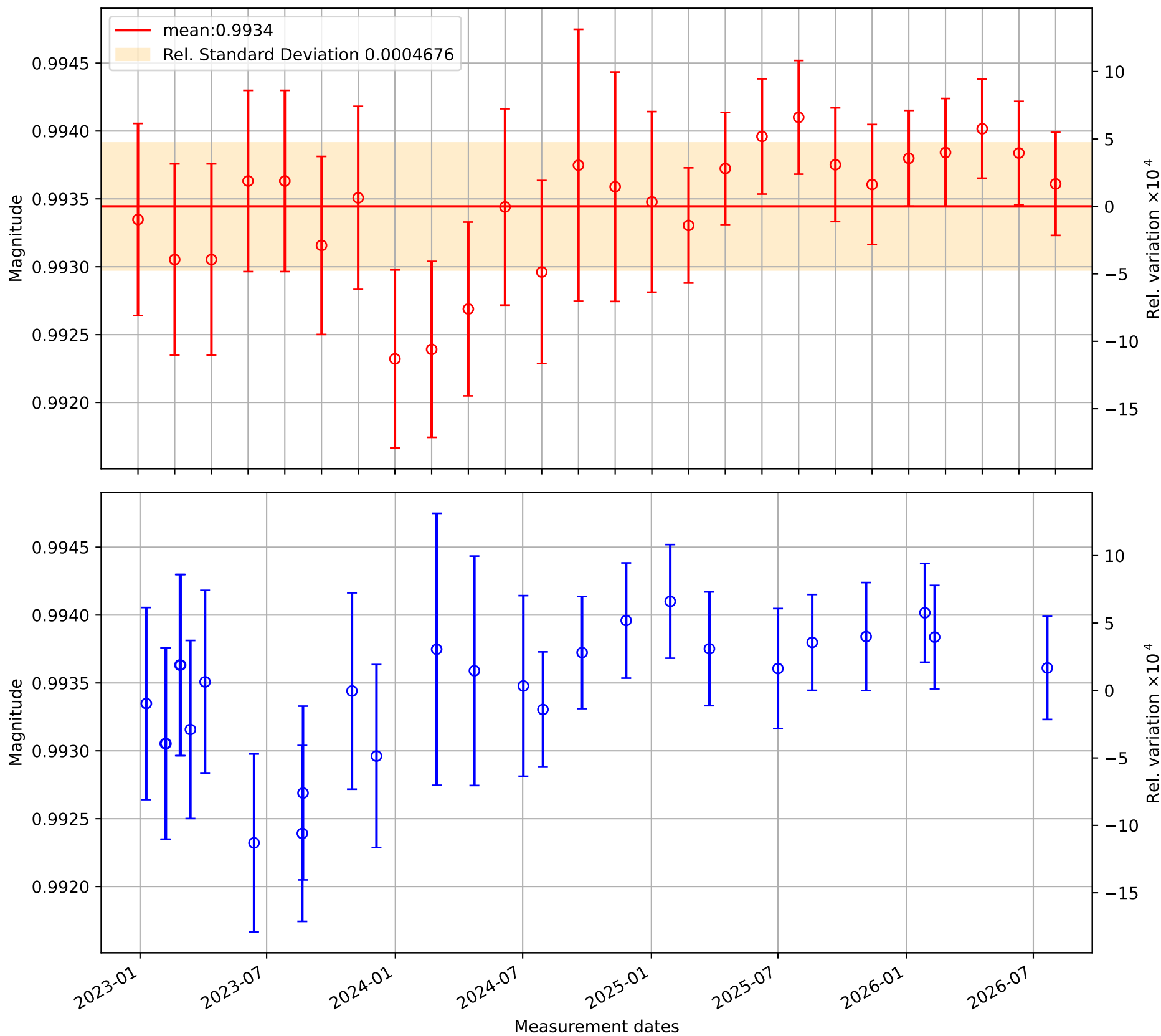
Description:

E_T is the Tx side Optical Efficiency Correction Factor, defined as $E_T = \sqrt{e \cdot \beta}$, and is dimensionless. It apportions the total optical loss inside the vacuum chamber between the Tx side and Rx side, using the overall optical efficiency (e) and the ratio of in-chamber optical efficiencies between the Tx and Rx sides (beta), measured during the last in-vacuum campaign (DCC T1800107). Beta is assumed to be stable over time. Applying E_T to the TxPD responsivity corrects for optical losses on the Tx side and yields the effective responsivity at the ETM. The plot shows two panels: the top panel displays E_T against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

E_T	
Date E_T ± Rel.Uncertainty (epsilon)	
D20230110:	0.993348 ± 0.000712
D20230206:	0.993053 ± 0.000710
D20230207:	0.993053 ± 0.000710
D20230227:	0.993632 ± 0.000672
D20230228:	0.993632 ± 0.000672
D20230314:	0.993157 ± 0.000660
D20230404:	0.993508 ± 0.000679
D20230613:	0.992322 ± 0.000660
D20230821:	0.992391 ± 0.000653
D20230822:	0.992689 ± 0.000645
D20231031:	0.993441 ± 0.000728
D20231205:	0.992961 ± 0.000679
D20240229:	0.993748 ± 0.001008
D20240423:	0.993589 ± 0.000850
D20240702:	0.993478 ± 0.000670
D20240730:	0.993304 ± 0.000427
D20240924:	0.993723 ± 0.000415
D20241126:	0.993960 ± 0.000427
D20250128:	0.994100 ± 0.000421
D20250325:	0.993751 ± 0.000422
D20250701:	0.993606 ± 0.000445
D20250819:	0.993799 ± 0.000355
D20251104:	0.993842 ± 0.000400
D20260127:	0.994017 ± 0.000366
D20260210:	0.993838 ± 0.000383
D20260721:	0.993611 ± 0.000382

E_T	
Summary of Input Side Optical Efficiency correction factor	
Mean value: 0.993444	
Standard deviation: 0.000468	
Standard error: 0.000094	
Relative Uncertainty: 0.000094	

Input Side Optical Efficiency correction factor



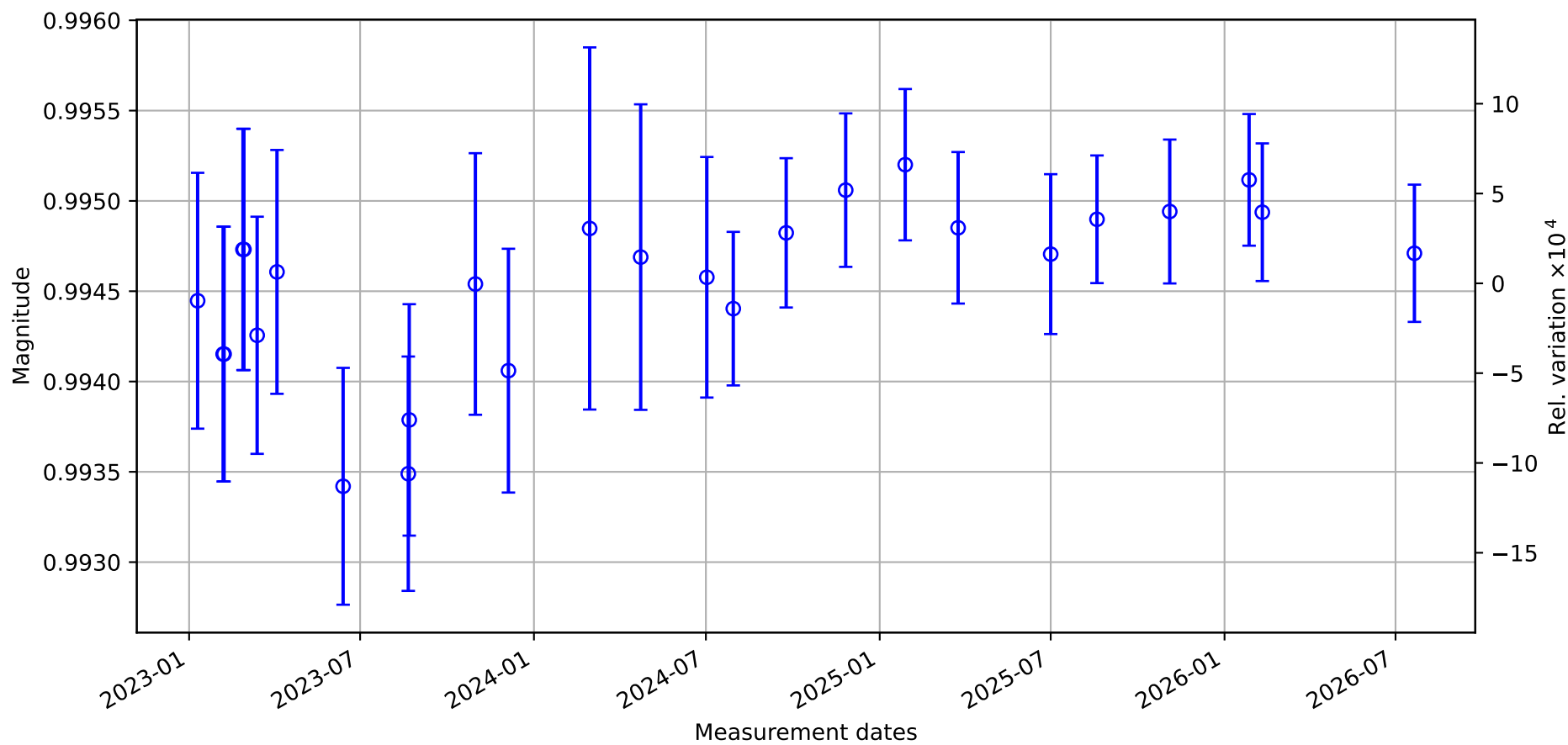
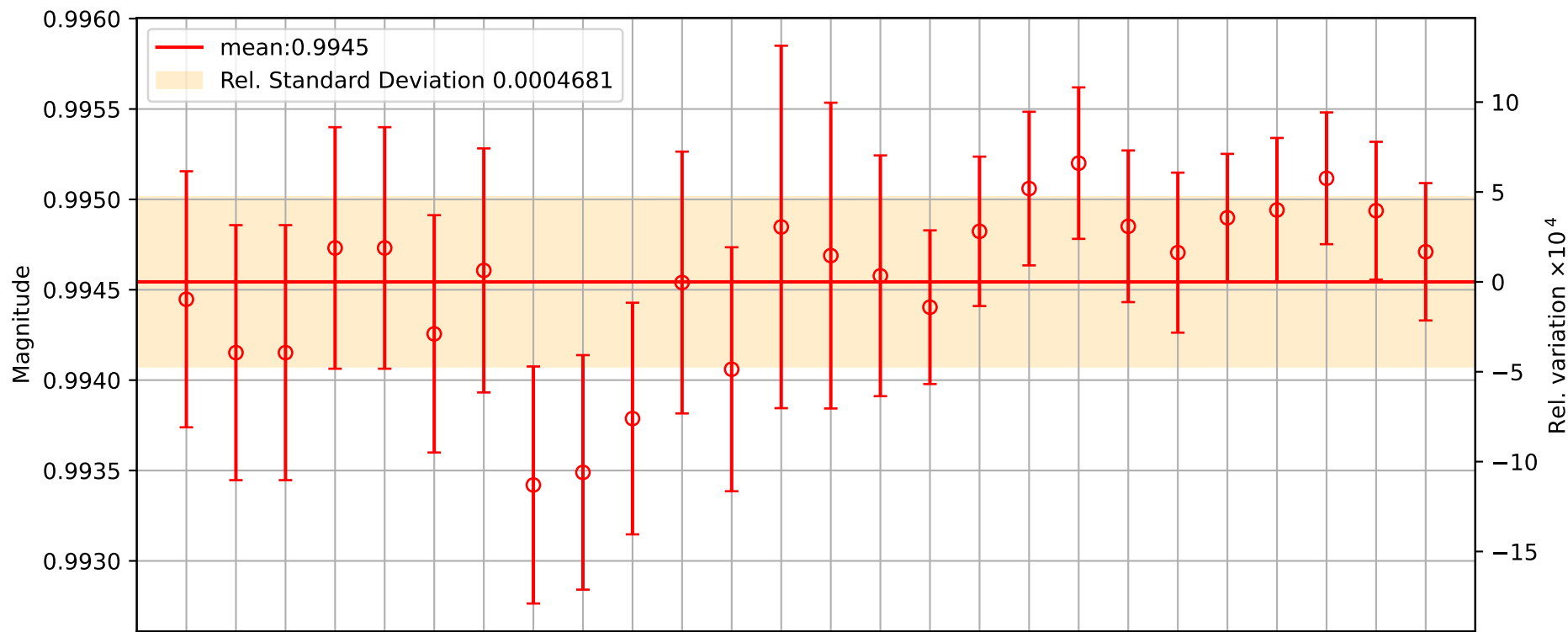
Description:

E_R is the Rx side Optical Efficiency Correction Factor, defined as $E_R = \sqrt{e / \beta}$, and is dimensionless. It apportions the total optical loss inside the vacuum chamber between the Rx side and Tx side, using the overall optical efficiency (e) and the ratio of in-chamber optical efficiencies between the Tx and Rx sides (beta), measured during the last in-vacuum campaign (DCC T1800107). Beta is assumed to be stable over time. Applying E_R to the RxPD responsivity corrects for optical losses on the Rx side and yields the effective responsivity at the ETM. The plot shows two panels: the top panel displays E_R against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

E_R	
Date E_R ± Rel.Uncertainty (epsilon)	
D20230110:	0.994447 ± 0.000712
D20230206:	0.994152 ± 0.000710
D20230207:	0.994152 ± 0.000710
D20230227:	0.994731 ± 0.000672
D20230228:	0.994731 ± 0.000672
D20230314:	0.994256 ± 0.000660
D20230404:	0.994607 ± 0.000679
D20230613:	0.993420 ± 0.000660
D20230821:	0.993490 ± 0.000653
D20230822:	0.993788 ± 0.000645
D20231031:	0.994540 ± 0.000728
D20231205:	0.994060 ± 0.000679
D20240229:	0.994847 ± 0.001008
D20240423:	0.994689 ± 0.000850
D20240702:	0.994577 ± 0.000670
D20240730:	0.994404 ± 0.000427
D20240924:	0.994823 ± 0.000415
D20241126:	0.995060 ± 0.000427
D20250128:	0.995201 ± 0.000421
D20250325:	0.994851 ± 0.000422
D20250701:	0.994705 ± 0.000445
D20250819:	0.994898 ± 0.000355
D20251104:	0.994941 ± 0.000400
D20260127:	0.995117 ± 0.000366
D20260210:	0.994937 ± 0.000383
D20260721:	0.994710 ± 0.000382

E_R	
Summary of Output Side Optical Efficiency correction factor	
Mean value: 0.994544	
Standard deviation: 0.000468	
Standard error: 0.000094	
Relative Uncertainty: 0.000094	

Output Side Optical Efficiency correction factor



Description:

rhoT_prime (rho_Tx') is the TxPD responsivity corrected for optical efficiency, defined as $\rho_{Tx'} = \rho_{Tx} * E_T$, with units of V/W. It represents the estimated responsivity of the Tx integrating sphere as if it were located at the test mass (ETM), accounting for optical losses between the Tx sphere and the ETM. This provides a useful sanity check against the RxPD measurement, which has historically been the primary sensor used for calibration. The plot shows two panels: the top panel displays rhoT_prime against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

rhoT_prime	
Date rhoT_prime ± Rel.Uncertainty (epsilon)	
D20230110:	8391.657415 ± 0.000844
D20230206:	8389.716851 ± 0.000830
D20230207:	8389.843934 ± 0.000830
D20230227:	8388.678261 ± 0.000783
D20230228:	8388.054907 ± 0.000783
D20230314:	8390.745367 ± 0.000778
D20230404:	8385.019277 ± 0.000802
D20230613:	8387.735856 ± 0.000762
D20230821:	8386.043678 ± 0.000763
D20230822:	8392.099802 ± 0.000747
D20231031:	8388.608335 ± 0.000852
D20231205:	8389.899580 ± 0.000790
D20240229:	8344.958864 ± 0.001174
D20240423:	8333.492357 ± 0.000991
D20240702:	8342.986209 ± 0.001083
D20240730:	8357.195971 ± 0.000699
D20240924:	8357.470375 ± 0.000675
D20241126:	8360.699967 ± 0.000690
D20250128:	8343.847866 ± 0.000684
D20250325:	8350.354471 ± 0.000682
D20250701:	8342.848209 ± 0.000732
D20250819:	8344.794689 ± 0.000587
D20251104:	8351.524162 ± 0.000642
D20260127:	8345.509419 ± 0.000585
D20260210:	8356.498578 ± 0.000640
D20260721:	8343.480446 ± 0.000600

rhoT_prime
Summary of Tx Responsivity Corrected for Optical Efficiency

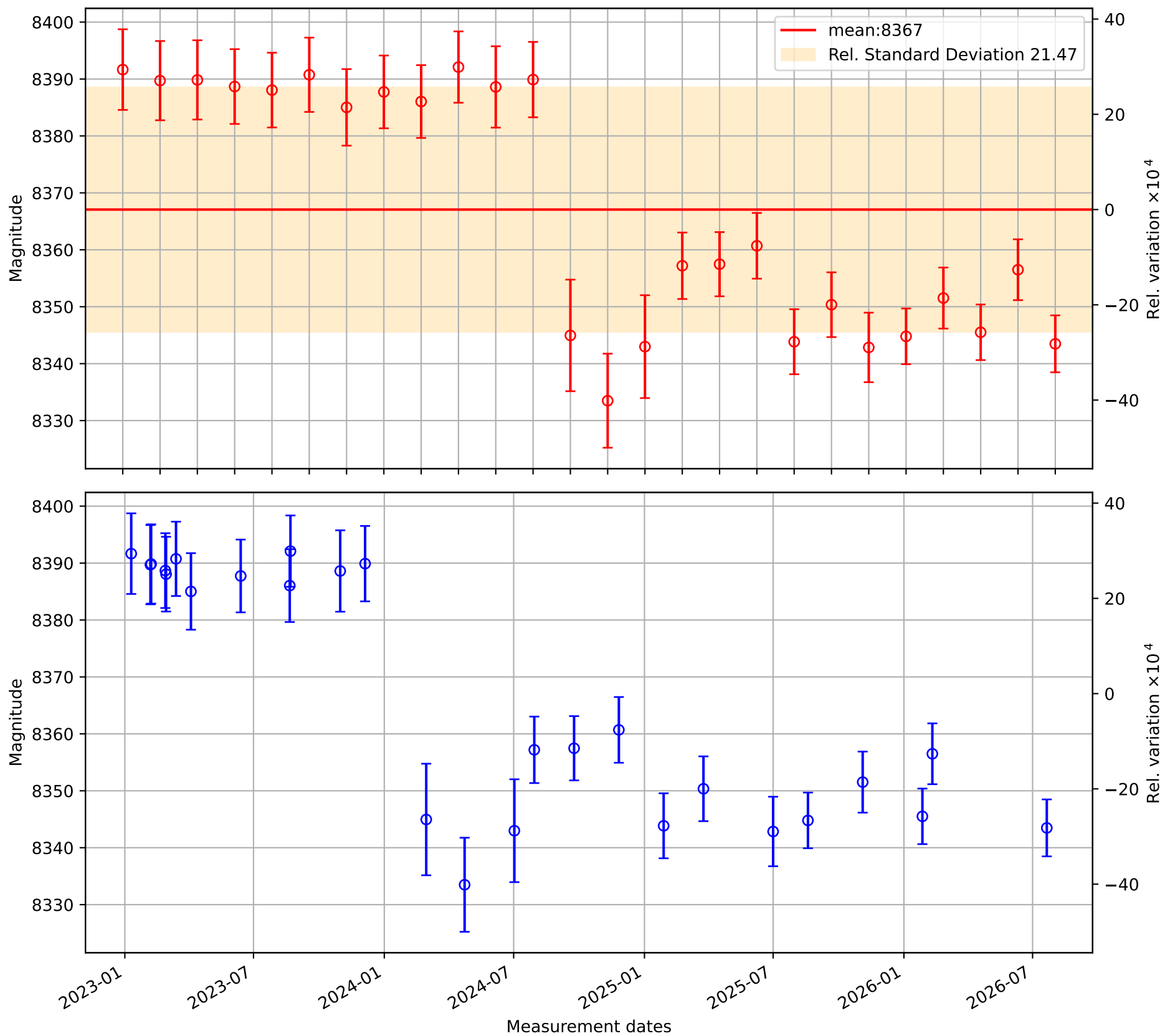
Mean value: 8367.067879

Standard deviation: 21.473374

Standard error: 0.002617

Relative Uncertainty: 0.002878

Tx Responsivity Corrected for Optical Efficiency



Description:

rhoR_prime (rho_Rx') is the RxPD responsivity corrected for optical efficiency, defined as $\rho_{Rx'} = \rho_{Rx} / E_R$, with units of V/W. It represents the estimated responsivity of the Rx integrating sphere as if it were located at the test mass (ETM), accounting for optical losses between the ETM and the Rx sphere. This is the primary quantity used in the PCAL calibration chain, as the RxPD has historically been the main sensor for determining the force applied to the test mass. The plot shows two panels: the top panel displays rhoR_prime against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

rhoR_prime	
Date rhoR_prime ± Rel.Uncertainty (epsilon)	
D20230110:	10629.924202 ± 0.000758
D20230206:	10620.353023 ± 0.000768
D20230207:	10620.513895 ± 0.000768
D20230227:	10637.171311 ± 0.000719
D20230228:	10636.380874 ± 0.000719
D20230314:	10633.877408 ± 0.000707
D20230404:	10632.360332 ± 0.000724
D20230613:	10605.825683 ± 0.000711
D20230821:	10602.639451 ± 0.000702
D20230822:	10614.457078 ± 0.000694
D20231031:	10640.807040 ± 0.000788
D20231205:	10632.603944 ± 0.000729
D20240229:	10645.584705 ± 0.001070
D20240423:	10649.928555 ± 0.000913
D20240702:	10641.846167 ± 0.000887
D20240730:	10654.889132 ± 0.000625
D20240924:	10663.153867 ± 0.000602
D20241126:	10681.099300 ± 0.000610
D20250128:	10663.026352 ± 0.000591
D20250325:	10654.973970 ± 0.000608
D20250701:	10646.146205 ± 0.000615
D20250819:	10653.338039 ± 0.000526
D20251104:	10666.687148 ± 0.000602
D20260127:	10672.294604 ± 0.000541
D20260210:	10671.722555 ± 0.002037
D20260721:	10641.125919 ± 0.000649

rhoR_prime
Summary of Rx Responsivity Corrected for
Optical Efficiency

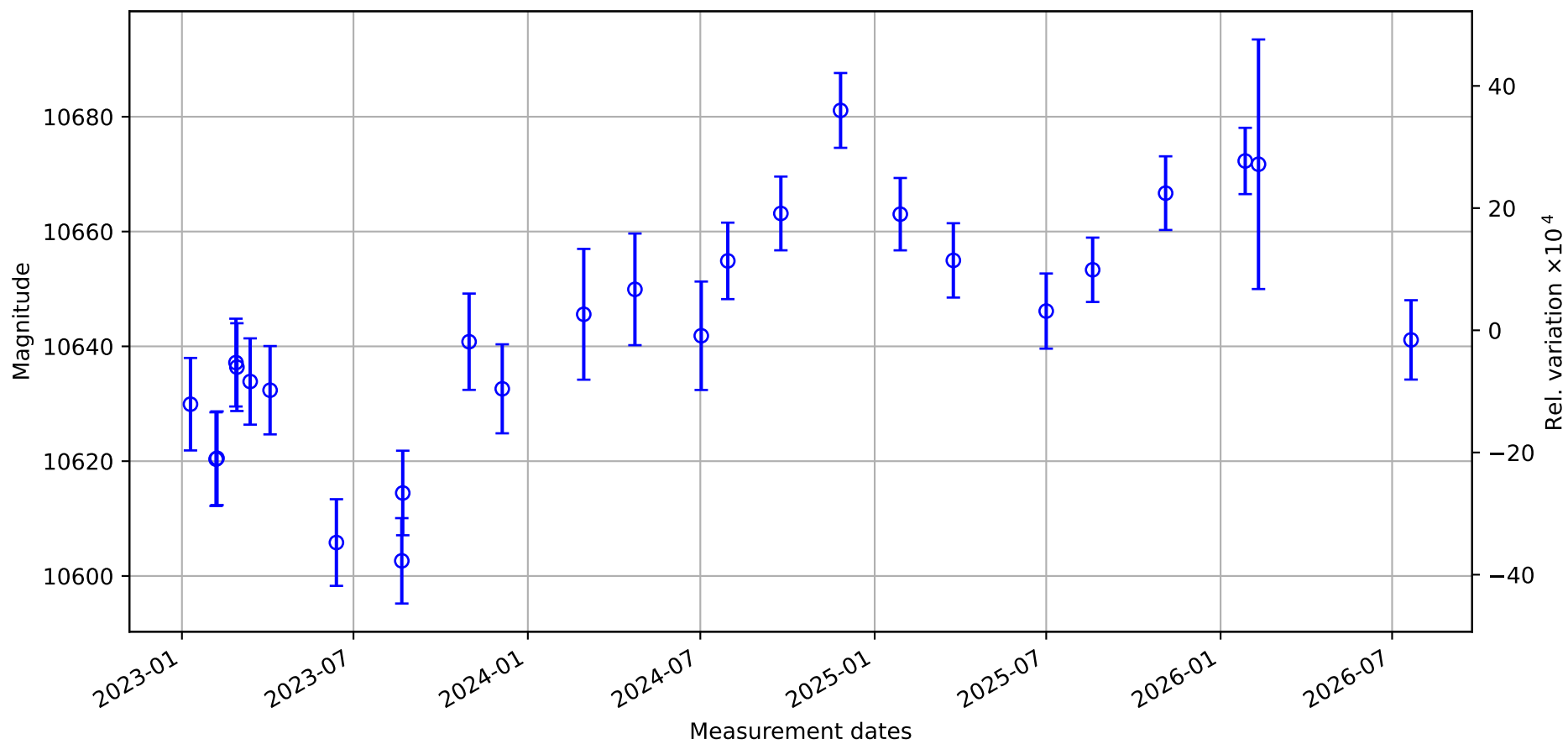
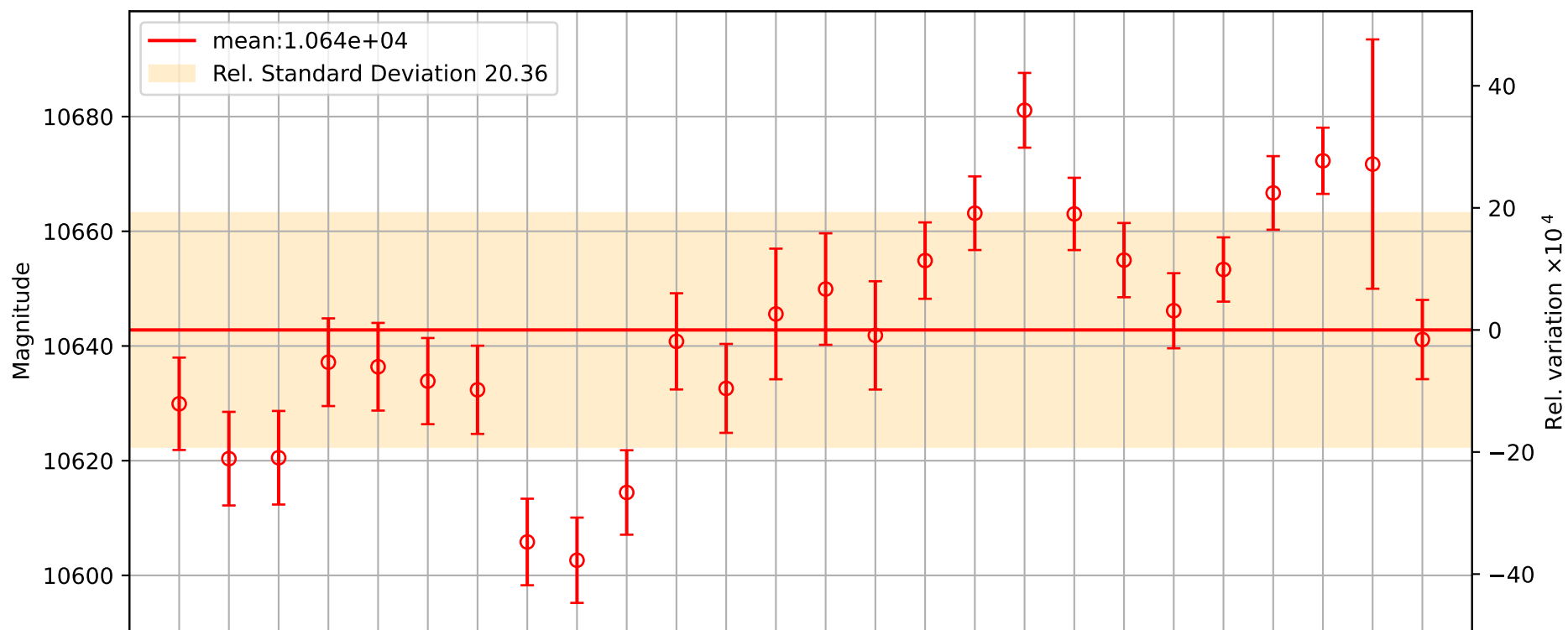
Mean value: 10642.797337

Standard deviation: 20.361905

Standard error: 0.001951

Relative Uncertainty: 0.002290

Rx Responsivity Corrected for Optical Efficiency



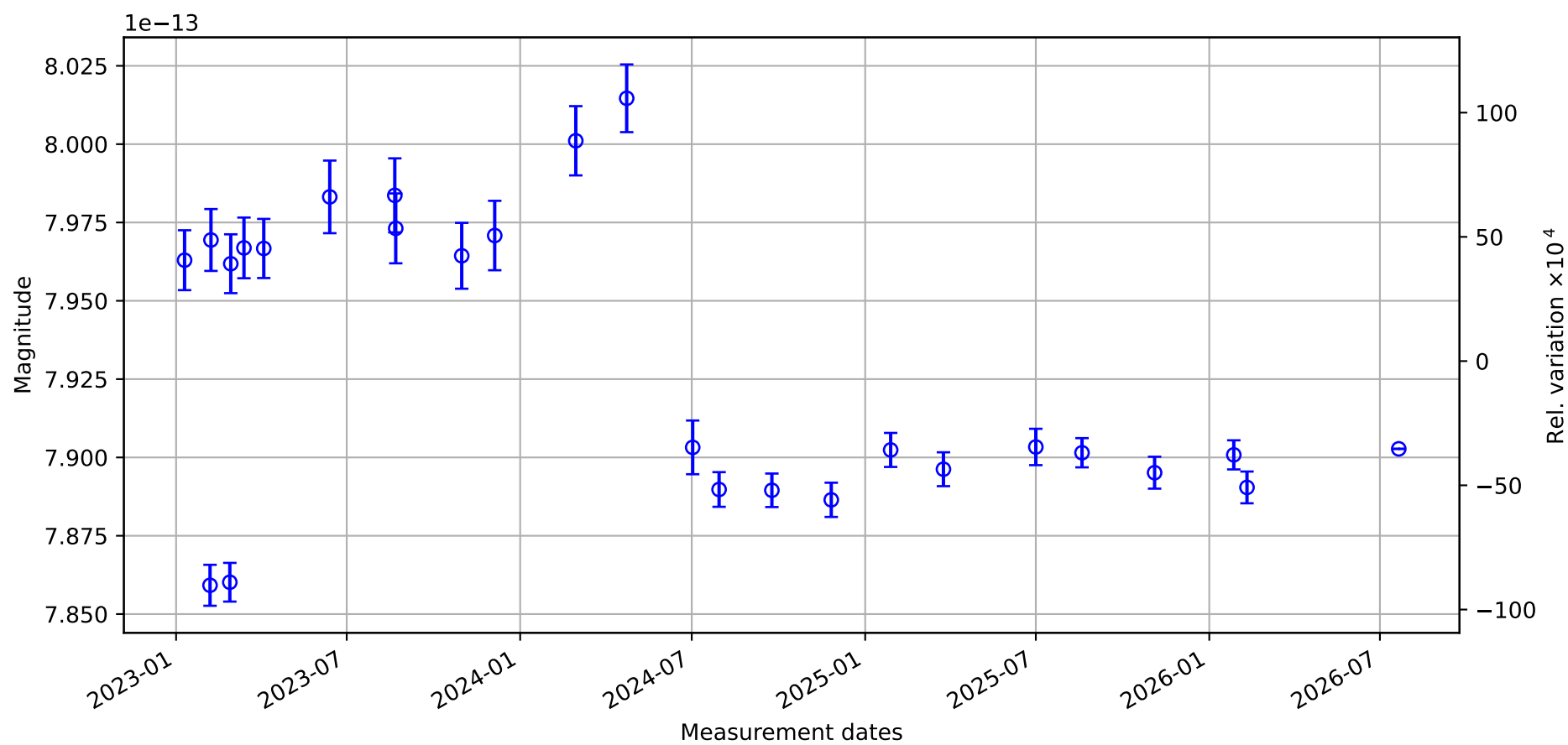
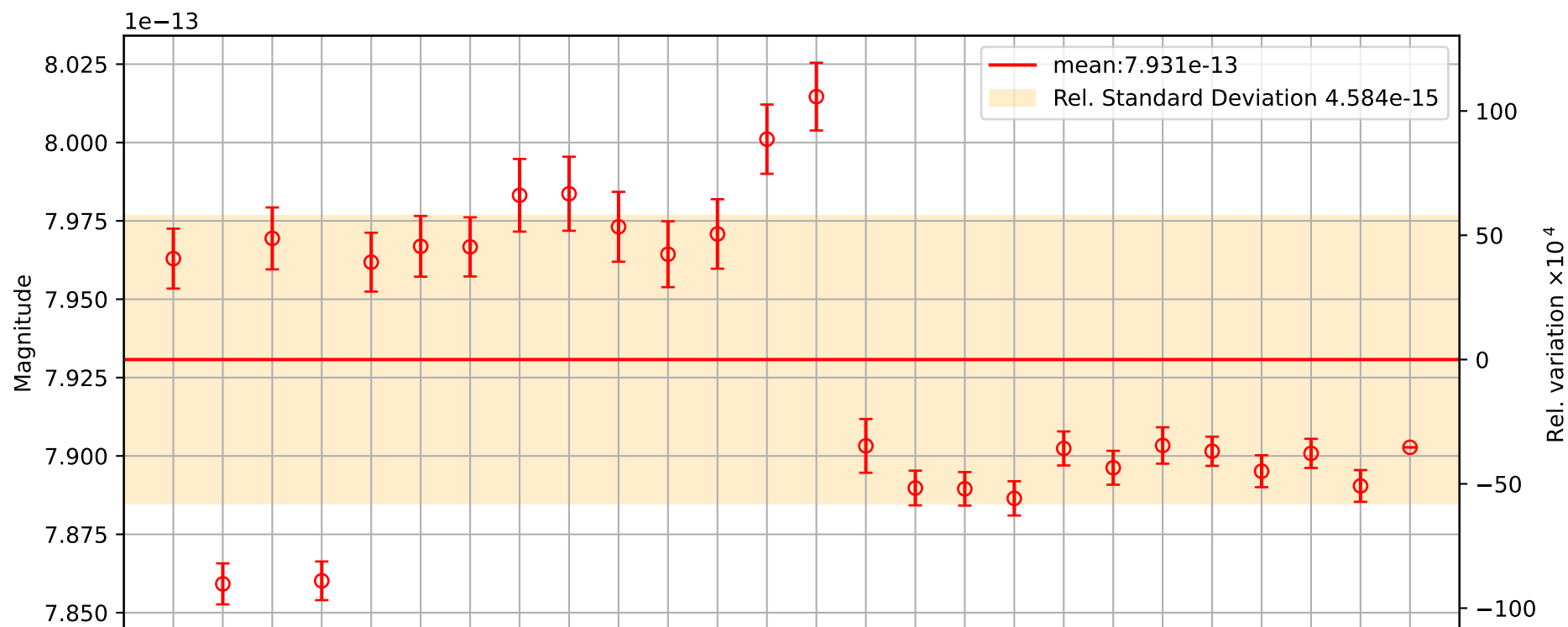
Description:

FC_TXPD is the Force Coefficient as measured by the TxPD, in units of N/W (Newtons per Watt). It relates the laser power measured by the TxPD to the radiation pressure force applied to the ETM, accounting for the angle of incidence and optical efficiency corrections. It is defined as $FC_TXPD = 2 * \cos(\theta) * E_T / (c * \rho_Tx')$, where c is the speed of light, $\cos(\theta)$ is the cosine of the angle of incidence, and E_T is the optical efficiency correction for the Tx side. Trending this parameter is important for monitoring the long-term stability of the PCAL force calibration as measured from the transmitter side. The plot shows two panels: the top panel displays FC_TXPD against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (σ) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

FC_TXPD	
Date FC_TXPD ± Rel.Uncertainty (epsilon)	
D20230110:	7.9630e-13 ± 1.2005e-03
D20230206:	7.8592e-13 ± 8.3195e-04
D20230207:	7.9694e-13 ± 1.2390e-03
D20230227:	7.8602e-13 ± 7.8541e-04
D20230228:	7.9618e-13 ± 1.1795e-03
D20230314:	7.9669e-13 ± 1.2158e-03
D20230404:	7.9667e-13 ± 1.1843e-03
D20230613:	7.9832e-13 ± 1.4520e-03
D20230821:	7.9837e-13 ± 1.4794e-03
D20230822:	7.9731e-13 ± 1.3987e-03
D20231031:	7.9644e-13 ± 1.3197e-03
D20231205:	7.9708e-13 ± 1.3903e-03
D20240229:	8.0011e-13 ± 1.3815e-03
D20240423:	8.0146e-13 ± 1.3483e-03
D20240702:	7.9032e-13 ± 1.0846e-03
D20240730:	7.8898e-13 ± 7.0134e-04
D20240924:	7.8895e-13 ± 6.7793e-04
D20241126:	7.8865e-13 ± 6.9295e-04
D20250128:	7.9024e-13 ± 6.8712e-04
D20250325:	7.8962e-13 ± 6.8429e-04
D20250701:	7.9033e-13 ± 7.3451e-04
D20250819:	7.9015e-13 ± 5.8989e-04
D20251104:	7.8951e-13 ± 6.4513e-04
D20260127:	7.9008e-13 ± 5.8808e-04
D20260210:	7.8904e-13 ± 6.4257e-04
D20260721:	7.9027e-13 ± 4.8099e-12

FC_TXPD	
Summary of TxPD Force Coefficient Corrected for Optical Efficiency	
Mean value: 7.930753e-13	
Standard deviation: 4.584254e-15	
Standard error: 5.893669e-03	
Relative Uncertainty: 5.893669e-03	

TxPD Force Coefficient Corrected for Optical Efficiency



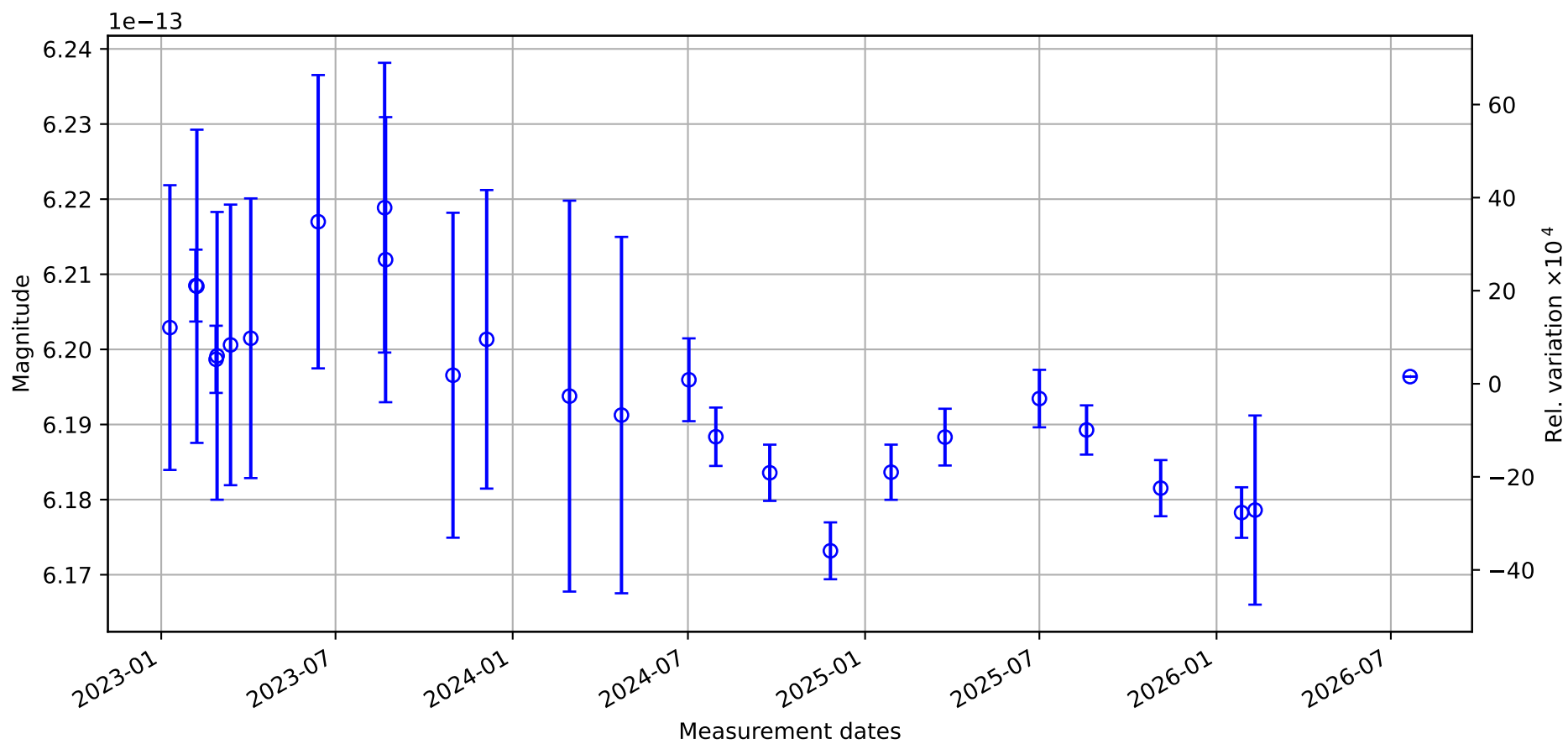
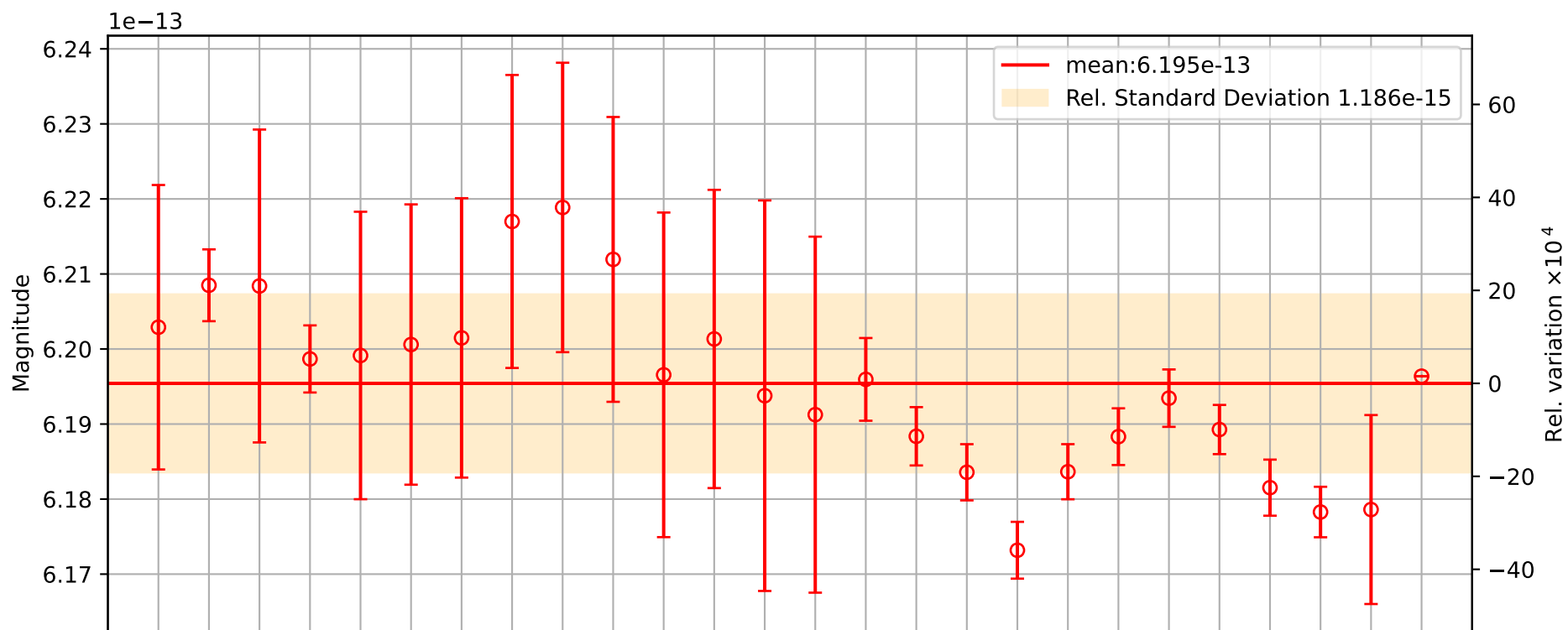
Description:

FC_RXPD is the Force Coefficient as measured by the RxPD, in units of N/ct (Newtons per counts). It relates the laser power measured by the RxPD to the radiation pressure force applied to the ETM, accounting for the angle of incidence and optical efficiency corrections. It is defined as $FC_RXPD = 2 * \cos(\theta) * E_R / (c * \rho_{Rx})$, where c is the speed of light, $\cos(\theta)$ is the cosine of the angle of incidence, and E_R is the optical efficiency correction for the Rx side. The RxPD force coefficient is the primary quantity used in the PCAL calibration chain. Trending this parameter is important for monitoring the long-term stability of the PCAL force calibration as measured from the receiver side. The plot shows two panels: the top panel displays FC_RXPD against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

FC_RXPD	
Date FC_RXPD ± Rel.Uncertainty (epsilon)	
D20230110:	6.2029e-13 ± 3.0557e-03
D20230206:	6.2085e-13 ± 7.7069e-04
D20230207:	6.2084e-13 ± 3.3581e-03
D20230227:	6.1987e-13 ± 7.2139e-04
D20230228:	6.1991e-13 ± 3.0899e-03
D20230314:	6.2006e-13 ± 3.0122e-03
D20230404:	6.2015e-13 ± 3.0021e-03
D20230613:	6.2170e-13 ± 3.1405e-03
D20230821:	6.2189e-13 ± 3.1011e-03
D20230822:	6.2119e-13 ± 3.0551e-03
D20231031:	6.1966e-13 ± 3.4904e-03
D20231205:	6.2013e-13 ± 3.2046e-03
D20240229:	6.1938e-13 ± 4.2012e-03
D20240423:	6.1913e-13 ± 3.8314e-03
D20240702:	6.1960e-13 ± 8.8952e-04
D20240730:	6.1884e-13 ± 6.2815e-04
D20240924:	6.1836e-13 ± 6.0549e-04
D20241126:	6.1732e-13 ± 6.1299e-04
D20250128:	6.1836e-13 ± 5.9402e-04
D20250325:	6.1883e-13 ± 6.1060e-04
D20250701:	6.1935e-13 ± 6.1779e-04
D20250819:	6.1893e-13 ± 5.2955e-04
D20251104:	6.1815e-13 ± 6.0474e-04
D20260127:	6.1783e-13 ± 5.4452e-04
D20260210:	6.1786e-13 ± 2.0377e-03
D20260721:	6.1964e-13 ± 5.0878e-12

FC_RXPD	
Summary of RxPD Force Coefficient Corrected for Optical Efficiency	
Mean value: 6.195421e-13	
Standard deviation: 1.185585e-15	
Standard error: 1.951162e-03	
Relative Uncertainty: 1.951162e-03	

RxPD Force Coefficient Corrected for Optical Efficiency



Description:

Chi_TXPD is the Displacement Coefficient as measured by the TxPD, defined as $\text{Chi_TXPD} = \text{FC_TXPD} / M$, where M is the mass of the test mass (ETM). It has units of m/cts (meters per count). It represents the acceleration of the ETM per unit of laser power as measured by the Tx sensor, and is frequency dependent, the actual displacement is Chi_TXPD divided by the angular frequency squared. Trending this parameter is useful for monitoring the long-term stability of the PCAL displacement calibration as measured from the transmitter side. The plot shows two panels: the top panel displays Chi_TXPD against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

Chi_TXPD	
Date Chi_TXPD ± Rel.Uncertainty (epsilon)	
D20230110:	2.0080e-14 ± 1.2005e-03
D20230206:	1.9818e-14 ± 8.3195e-04
D20230207:	2.0096e-14 ± 1.2390e-03
D20230227:	1.9820e-14 ± 7.8541e-04
D20230228:	2.0077e-14 ± 1.1795e-03
D20230314:	2.0089e-14 ± 1.2158e-03
D20230404:	2.0089e-14 ± 1.1843e-03
D20230613:	2.0131e-14 ± 1.4520e-03
D20230821:	2.0132e-14 ± 1.4794e-03
D20230822:	2.0105e-14 ± 1.3987e-03
D20231031:	2.0083e-14 ± 1.3197e-03
D20231205:	2.0099e-14 ± 1.3903e-03
D20240229:	2.0176e-14 ± 1.3815e-03
D20240423:	2.0210e-14 ± 1.3483e-03
D20240702:	1.9929e-14 ± 1.0846e-03
D20240730:	1.9895e-14 ± 7.0134e-04
D20240924:	1.9894e-14 ± 6.7793e-04
D20241126:	1.9887e-14 ± 6.9295e-04
D20250128:	1.9927e-14 ± 6.8712e-04
D20250325:	1.9911e-14 ± 6.8429e-04
D20250701:	1.9929e-14 ± 7.3451e-04
D20250819:	1.9925e-14 ± 5.8989e-04
D20251104:	1.9909e-14 ± 6.4513e-04
D20260127:	1.9923e-14 ± 5.8808e-04
D20260210:	1.9897e-14 ± 6.4257e-04
D20260721:	1.9928e-14 ± 4.8099e-12

Chi_TXPD
Summary of TxPD Displacement Coefficient
Corrected for Optical Efficiency

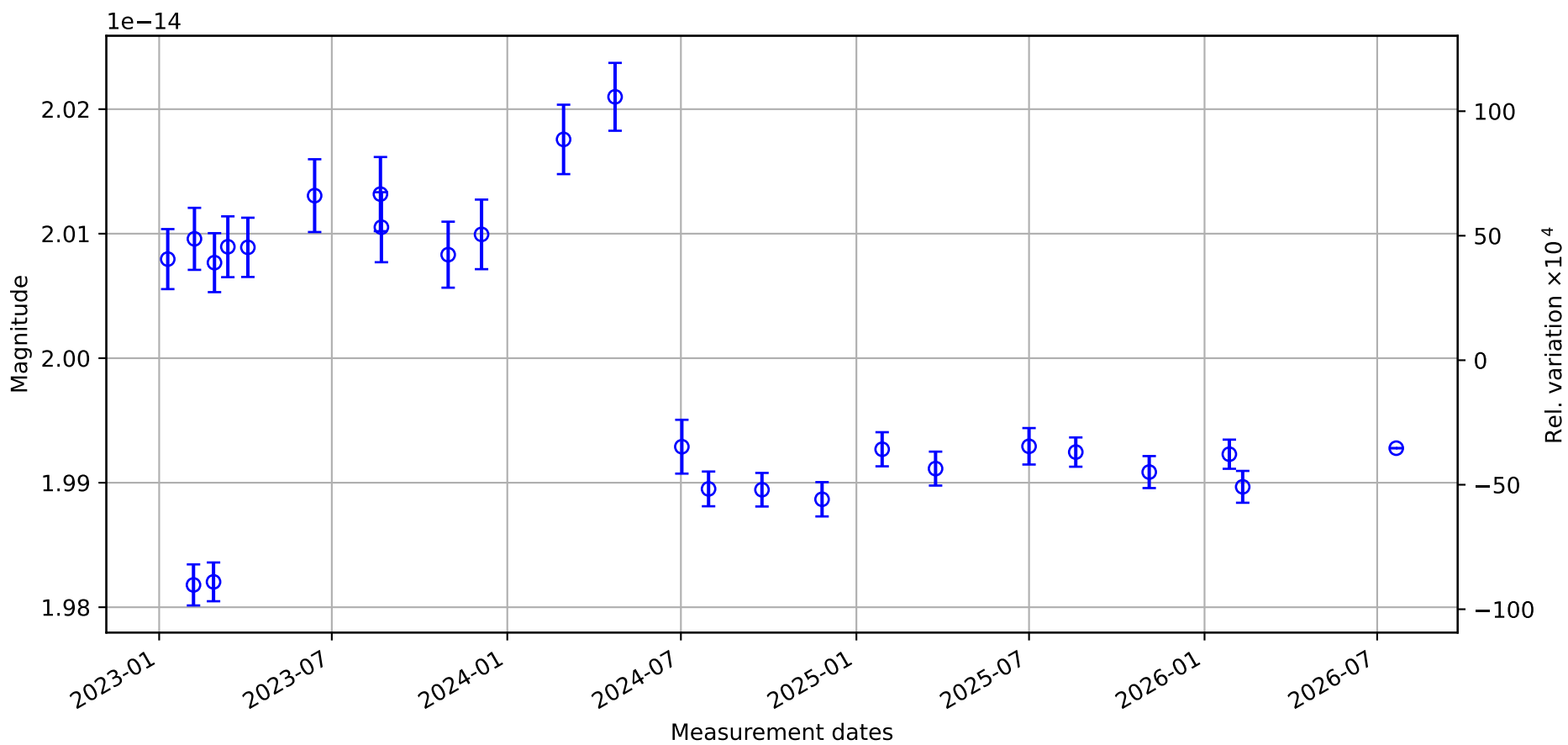
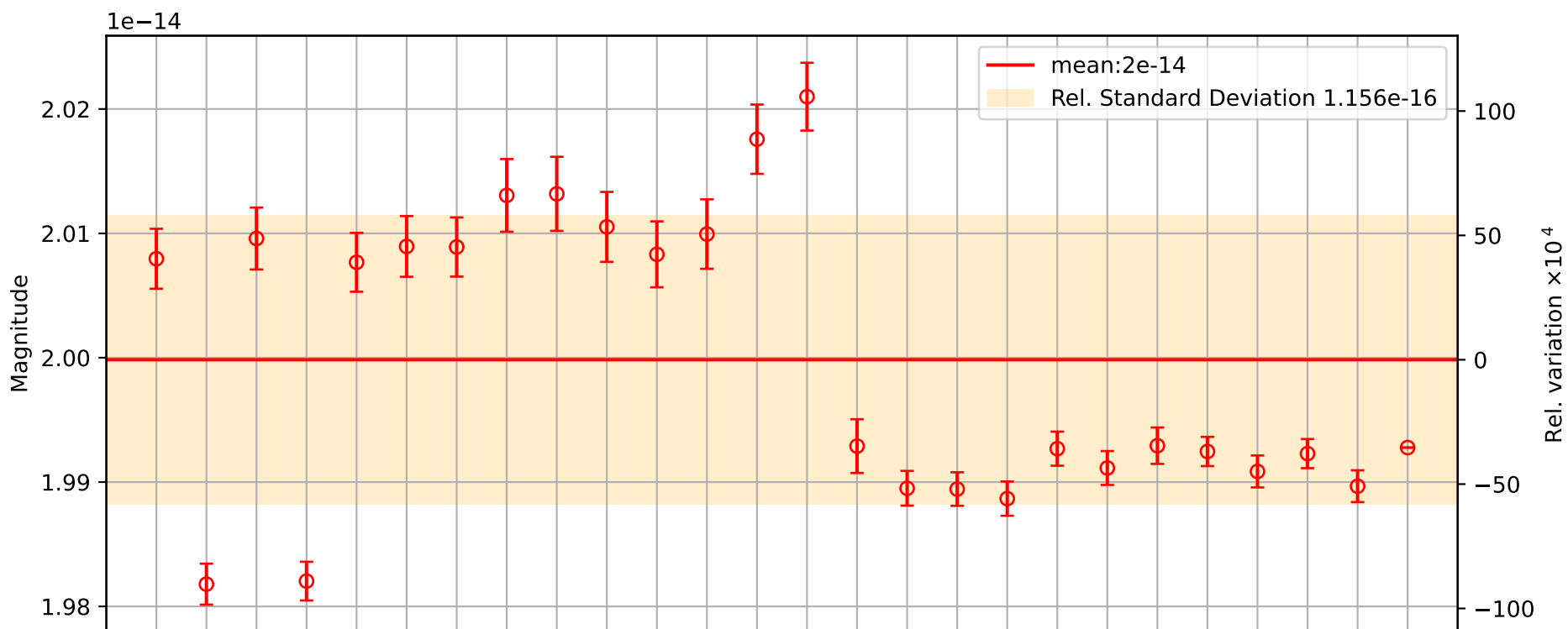
Mean value: 1.999837e-14

Standard deviation: 1.155976e-16

Standard error: 5.893669e-03

Relative Uncertainty: 5.893669e-03

TxPD Displacement Coefficient Corrected for Optical Efficiency



Description:

Chi_RXPD is the Displacement Coefficient as measured by the RxPD, defined as $\text{Chi_RXPD} = \text{FC_RXPD} / M$, where M is the mass of the test mass (ETM). It has units of m/cts (meters per count). It represents the acceleration of the ETM per unit of laser power as measured by the Tx sensor, and is frequency dependent, the actual displacement is Chi_TXPD divided by the angular frequency squared. Trending this parameter is useful for monitoring the long-term stability of the PCAL displacement calibration as measured from the transmitter side. The plot shows two panels: the top panel displays Chi_TXPD against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation.

Chi_RXPD	
Date Chi_RXPD ± Rel.Uncertainty (epsilon)	
D20230110:	1.5641e-14 ± 3.0557e-03
D20230206:	1.5655e-14 ± 7.7069e-04
D20230207:	1.5655e-14 ± 3.3581e-03
D20230227:	1.5631e-14 ± 7.2139e-04
D20230228:	1.5632e-14 ± 3.0899e-03
D20230314:	1.5636e-14 ± 3.0122e-03
D20230404:	1.5638e-14 ± 3.0021e-03
D20230613:	1.5677e-14 ± 3.1405e-03
D20230821:	1.5682e-14 ± 3.1011e-03
D20230822:	1.5664e-14 ± 3.0551e-03
D20231031:	1.5625e-14 ± 3.4904e-03
D20231205:	1.5637e-14 ± 3.2046e-03
D20240229:	1.5618e-14 ± 4.2012e-03
D20240423:	1.5612e-14 ± 3.8314e-03
D20240702:	1.5624e-14 ± 8.8952e-04
D20240730:	1.5605e-14 ± 6.2815e-04
D20240924:	1.5593e-14 ± 6.0549e-04
D20241126:	1.5566e-14 ± 6.1299e-04
D20250128:	1.5593e-14 ± 5.9402e-04
D20250325:	1.5605e-14 ± 6.1060e-04
D20250701:	1.5618e-14 ± 6.1779e-04
D20250819:	1.5607e-14 ± 5.2955e-04
D20251104:	1.5587e-14 ± 6.0474e-04
D20260127:	1.5579e-14 ± 5.4452e-04
D20260210:	1.5580e-14 ± 2.0377e-03
D20260721:	1.5625e-14 ± 5.0878e-12

Chi_RXPD
Summary of RxPD Displacement Coefficient
Corrected for Optical Efficiency

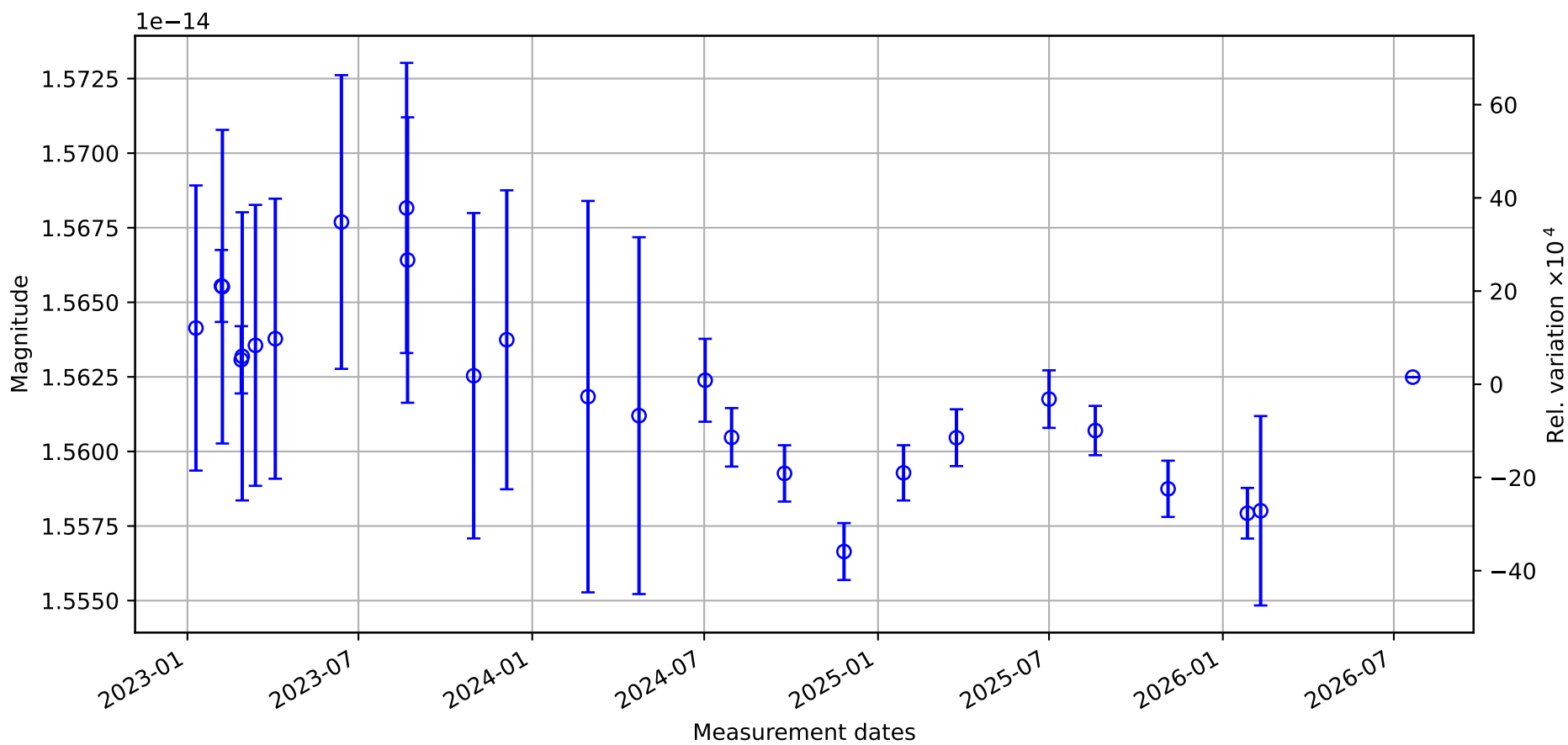
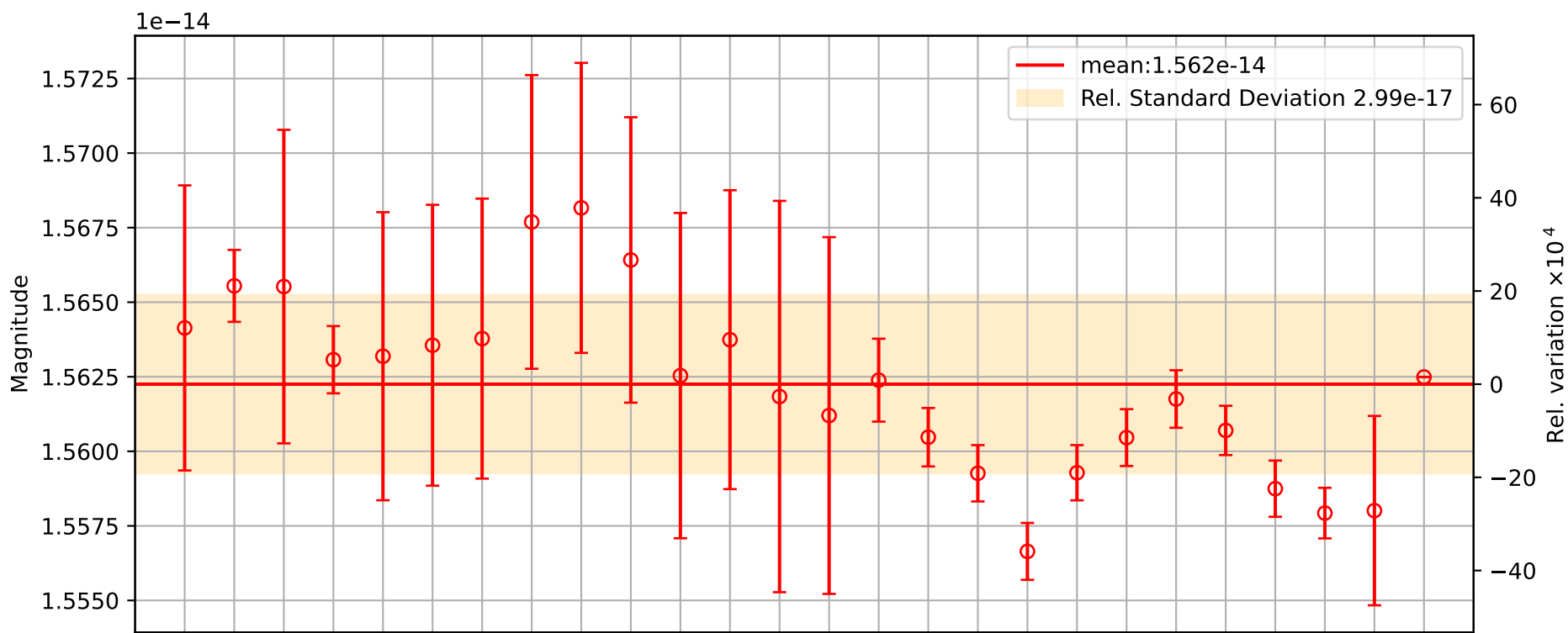
Mean value: 1.562252e-14

Standard deviation: 2.989598e-17

Standard error: 1.951162e-03

Relative Uncertainty: 1.951162e-03

RxPD Displacement Coefficient Corrected for Optical Efficiency



Description:

PowerImbalance is the ratio of the inner beam power to the outer beam power (M1/M2), as measured by the Working Standard inside the Tx module. It is a dimensionless quantity used to monitor the balance between the two PCAL beams that illuminate the test mass. Deviations from unity indicate an imbalance between the two beams, which can affect the accuracy of the force applied to the ETM. Trending this parameter is useful for detecting changes in the beam splitting optics or laser alignment over time. The plot shows two panels: the top panel displays the Power Imbalance against measurement number with a secondary axis showing relative variation $\times 10^4$; the bottom panel shows the same values plotted against measurement date. Error bars represent the absolute uncertainty (sigma) and the mean value is shown as a horizontal red line with a shaded orange band indicating one standard deviation. M1/M2.

PowerImbalance
Date PowerImbalance $\pm$ Rel.Uncertainty
(epsilon)

D20230110:	0.984969 $\pm$ 0.000496
D20230206:	0.983216 $\pm$ 0.000472
D20230207:	0.983216 $\pm$ 0.000472
D20230227:	0.981323 $\pm$ 0.000443
D20230228:	0.981323 $\pm$ 0.000443
D20230314:	0.983438 $\pm$ 0.000451
D20230404:	0.984300 $\pm$ 0.000468
D20230613:	0.993509 $\pm$ 0.000414
D20230821:	0.992181 $\pm$ 0.000428
D20230822:	0.994018 $\pm$ 0.000409
D20231031:	0.985309 $\pm$ 0.000485
D20231205:	0.988373 $\pm$ 0.000440
D20240229:	0.987016 $\pm$ 0.000656
D20240423:	0.981613 $\pm$ 0.000557
D20240702:	0.992450 $\pm$ 0.000921
D20240730:	0.992653 $\pm$ 0.000598
D20240924:	0.992467 $\pm$ 0.001221
D20241126:	0.989923 $\pm$ 0.001252
D20250128:	0.978635 $\pm$ 0.001253
D20250325:	0.989831 $\pm$ 0.001240
D20250701:	0.991154 $\pm$ 0.001341
D20250819:	0.989563 $\pm$ 0.001072
D20251104:	0.988718 $\pm$ 0.001165
D20260127:	0.978861 $\pm$ 0.001067
D20260210:	0.986647 $\pm$ 0.001185
D20260721:	0.990347 $\pm$ 0.001067

PowerImbalance
Summary of Power Imbalance
Mean value: 0.987117
Standard deviation: 0.004697
Standard error: 0.000951
Relative Uncertainty: 0.000951

Power Imbalance

