

PCAL End Station Measurement Trends

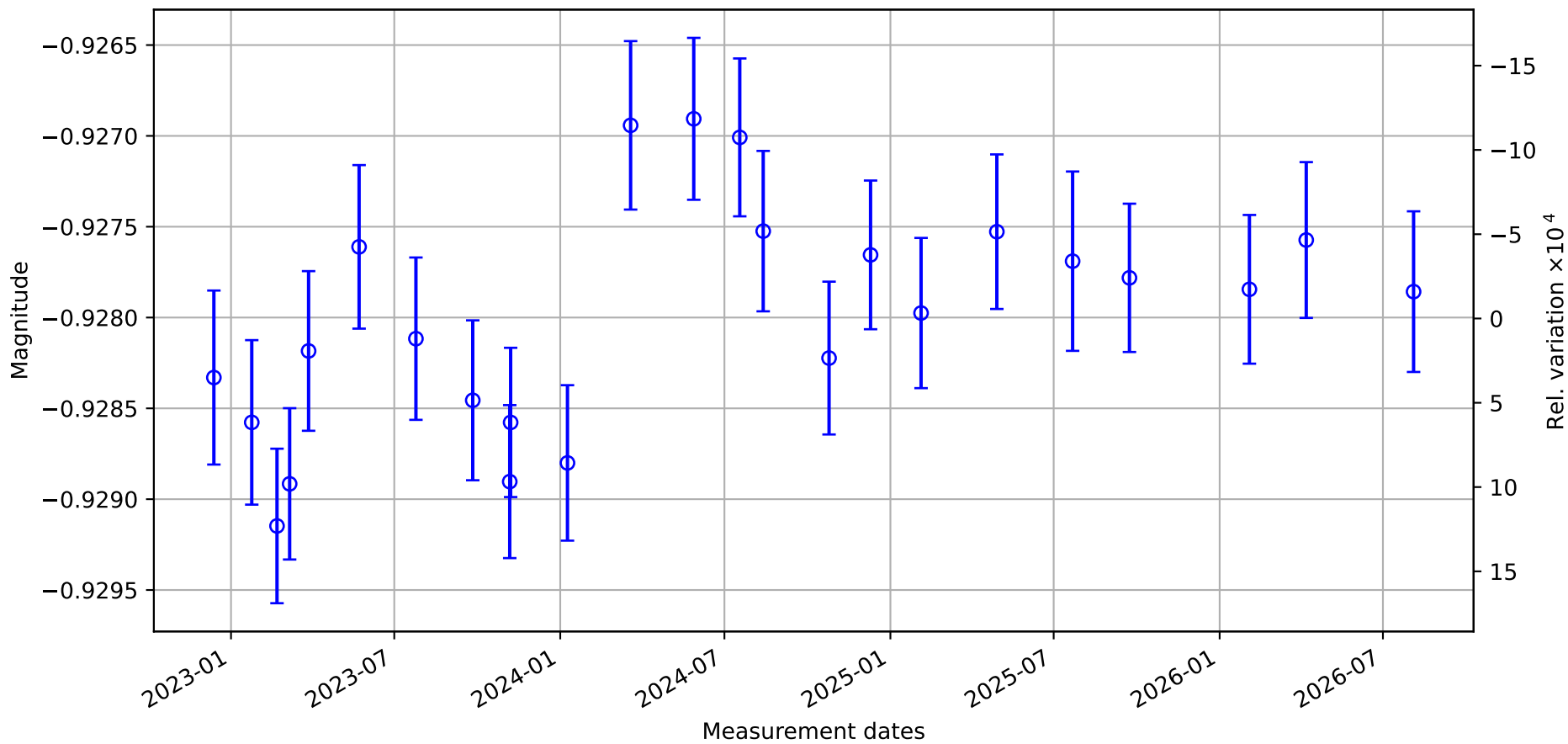
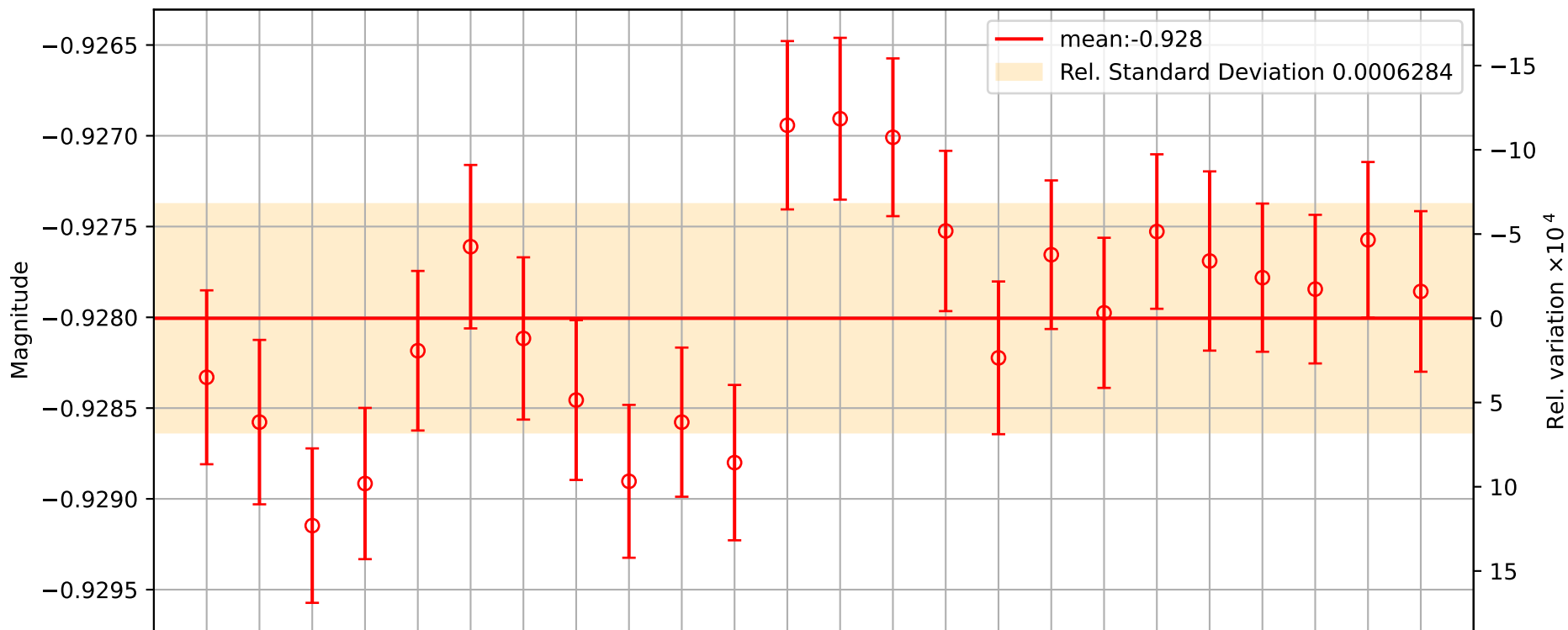
Description:

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)	
D20221213:	-0.928330 $\pm$ 0.000516
D20230124:	-0.928577 $\pm$ 0.000488
D20230221:	-0.929147 $\pm$ 0.000458
D20230307:	-0.928916 $\pm$ 0.000448
D20230328:	-0.928184 $\pm$ 0.000473
D20230523:	-0.927611 $\pm$ 0.000485
D20230725:	-0.928116 $\pm$ 0.000481
D20230926:	-0.928456 $\pm$ 0.000474
D20231106:	-0.928903 $\pm$ 0.000453
D20231107:	-0.928577 $\pm$ 0.000442
D20240109:	-0.928800 $\pm$ 0.000461
D20240319:	-0.926942 $\pm$ 0.000500
D20240528:	-0.926906 $\pm$ 0.000481
D20240718:	-0.927008 $\pm$ 0.000469
D20240813:	-0.927524 $\pm$ 0.000476
D20241025:	-0.928223 $\pm$ 0.000453
D20241210:	-0.927655 $\pm$ 0.000441
D20250204:	-0.927975 $\pm$ 0.000446
D20250429:	-0.927527 $\pm$ 0.000459
D20250722:	-0.927690 $\pm$ 0.000532
D20250923:	-0.927782 $\pm$ 0.000440
D20260203:	-0.927845 $\pm$ 0.000441
D20260407:	-0.927573 $\pm$ 0.000462
D20260804:	-0.927858 $\pm$ 0.000477

TXWS	
Summary of TS / WS ratio	
Mean value:	-0.928005
Standard deviation:	0.000628
Standard error:	-0.000692
Relative Uncertainty:	0.000692

TS / WS ratio



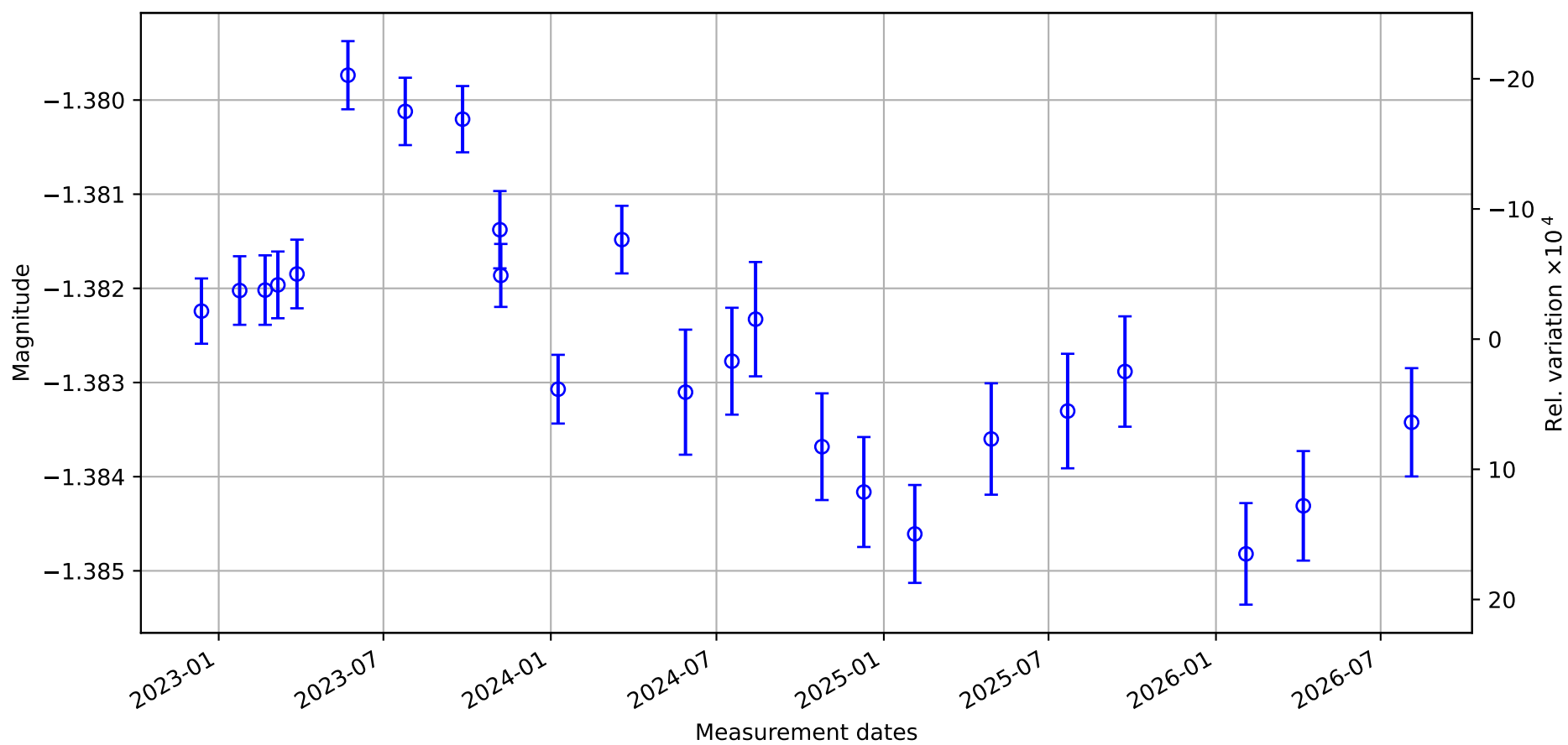
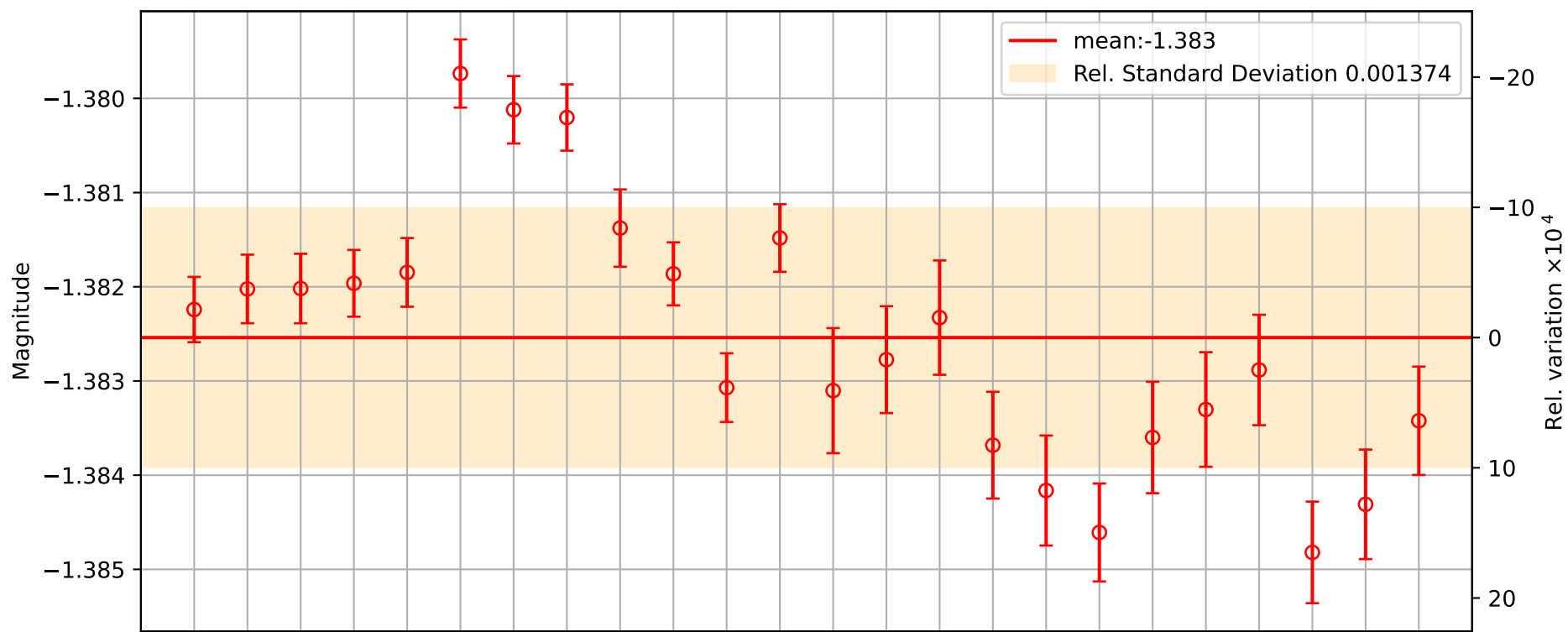
Description:

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)	
D20221213:	-1.382242 $\pm$ 0.000251
D20230124:	-1.382023 $\pm$ 0.000263
D20230221:	-1.382018 $\pm$ 0.000267
D20230307:	-1.381963 $\pm$ 0.000256
D20230328:	-1.381847 $\pm$ 0.000264
D20230523:	-1.379736 $\pm$ 0.000262
D20230725:	-1.380121 $\pm$ 0.000259
D20230926:	-1.380203 $\pm$ 0.000255
D20231106:	-1.381377 $\pm$ 0.000297
D20231107:	-1.381863 $\pm$ 0.000242
D20240109:	-1.383071 $\pm$ 0.000264
D20240319:	-1.381482 $\pm$ 0.000260
D20240528:	-1.383103 $\pm$ 0.000480
D20240718:	-1.382774 $\pm$ 0.000410
D20240813:	-1.382327 $\pm$ 0.000439
D20241025:	-1.383682 $\pm$ 0.000409
D20241210:	-1.384163 $\pm$ 0.000422
D20250204:	-1.384608 $\pm$ 0.000375
D20250429:	-1.383600 $\pm$ 0.000428
D20250722:	-1.383303 $\pm$ 0.000440
D20250923:	-1.382883 $\pm$ 0.000424
D20260203:	-1.384820 $\pm$ 0.000389
D20260407:	-1.384310 $\pm$ 0.000420
D20260804:	-1.383422 $\pm$ 0.000416

RXWS	
Summary of RX / WS ratio	
Mean value: -1.382539	
Standard deviation: 0.001374	
Standard error: -0.001015	
Relative Uncertainty: 0.001015	

RX / WS ratio



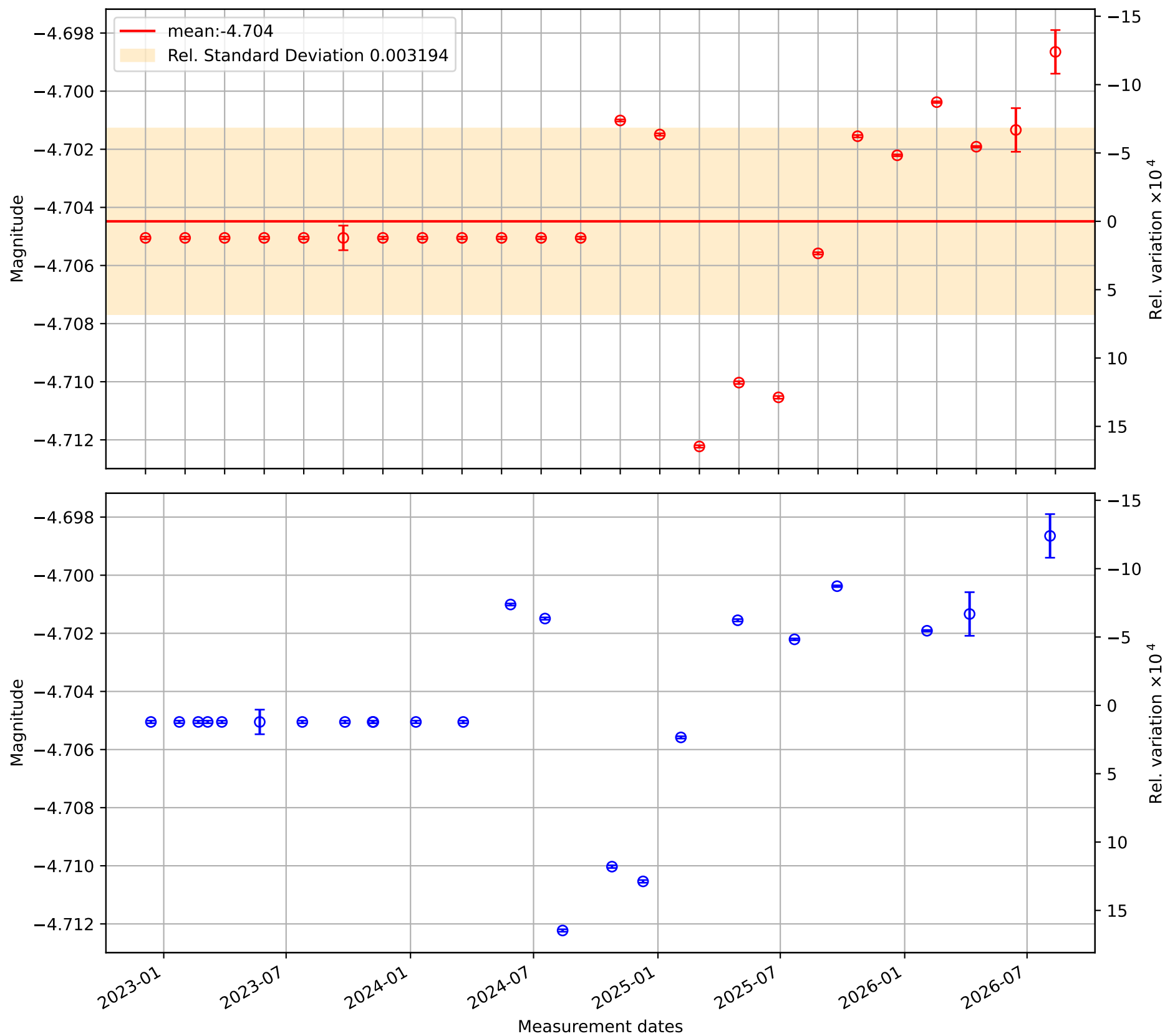
Description:

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)	
D20221213:	-4.705050 $\pm$ 0.000009
D20230124:	-4.705050 $\pm$ 0.000009
D20230221:	-4.705050 $\pm$ 0.000009
D20230307:	-4.705050 $\pm$ 0.000009
D20230328:	-4.705050 $\pm$ 0.000009
D20230523:	-4.705050 $\pm$ 0.000090
D20230725:	-4.705050 $\pm$ 0.000009
D20230926:	-4.705050 $\pm$ 0.000009
D20231106:	-4.705050 $\pm$ 0.000009
D20231107:	-4.705050 $\pm$ 0.000009
D20240109:	-4.705050 $\pm$ 0.000009
D20240319:	-4.705050 $\pm$ 0.000009
D20240528:	-4.701009 $\pm$ 0.000008
D20240718:	-4.701492 $\pm$ 0.000009
D20240813:	-4.712227 $\pm$ 0.000009
D20241025:	-4.710030 $\pm$ 0.000010
D20241210:	-4.710537 $\pm$ 0.000010
D20250204:	-4.705582 $\pm$ 0.000008
D20250429:	-4.701551 $\pm$ 0.000009
D20250722:	-4.702207 $\pm$ 0.000007
D20250923:	-4.700378 $\pm$ 0.000006
D20260203:	-4.701912 $\pm$ 0.000006
D20260407:	-4.701335 $\pm$ 0.000160
D20260804:	-4.698648 $\pm$ 0.000160

WS	
Summary of Working Standard Responsivity	
rho_WS	
Mean value: -4.704480	
Standard deviation: 0.003194	
Standard error: -0.000142	
Relative Uncertainty: 0.000142	

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 $\frac{\Delta \text{Zeta}}{\text{Zeta}}$; 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)	
D20221213:	1.6379e+03 ± 1.0000e-09
D20230124:	1.6382e+03 ± 1.0000e-09
D20230221:	1.6379e+03 ± 1.0000e-09
D20230307:	1.6378e+03 ± 1.0000e-09
D20230328:	1.6377e+03 ± 1.0000e-09
D20230523:	1.6378e+03 ± 1.0000e-09
D20230725:	1.6379e+03 ± 1.0000e-09
D20230926:	1.6378e+03 ± 1.0000e-09
D20231106:	1.6379e+03 ± 1.0000e-09
D20231107:	1.6379e+03 ± 1.0000e-09
D20240109:	1.6379e+03 ± 1.0000e-09
D20240319:	1.6378e+03 ± 1.0000e-09
D20240528:	1.6378e+03 ± 1.0000e-09
D20240718:	1.6379e+03 ± 1.0000e-09
D20240813:	1.6379e+03 ± 1.0000e-09
D20241025:	1.6379e+03 ± 1.0000e-09
D20241210:	1.6379e+03 ± 1.0000e-09
D20250204:	1.6379e+03 ± 1.0000e-09
D20250429:	1.6379e+03 ± 1.0000e-09
D20250722:	1.6379e+03 ± 1.0000e-09
D20250923:	1.6379e+03 ± 1.0000e-09
D20260203:	1.6379e+03 ± 1.0000e-09
D20260407:	1.6379e+03 ± 1.0000e-09
D20260804:	1.6380e+03 ± 1.0000e-09

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

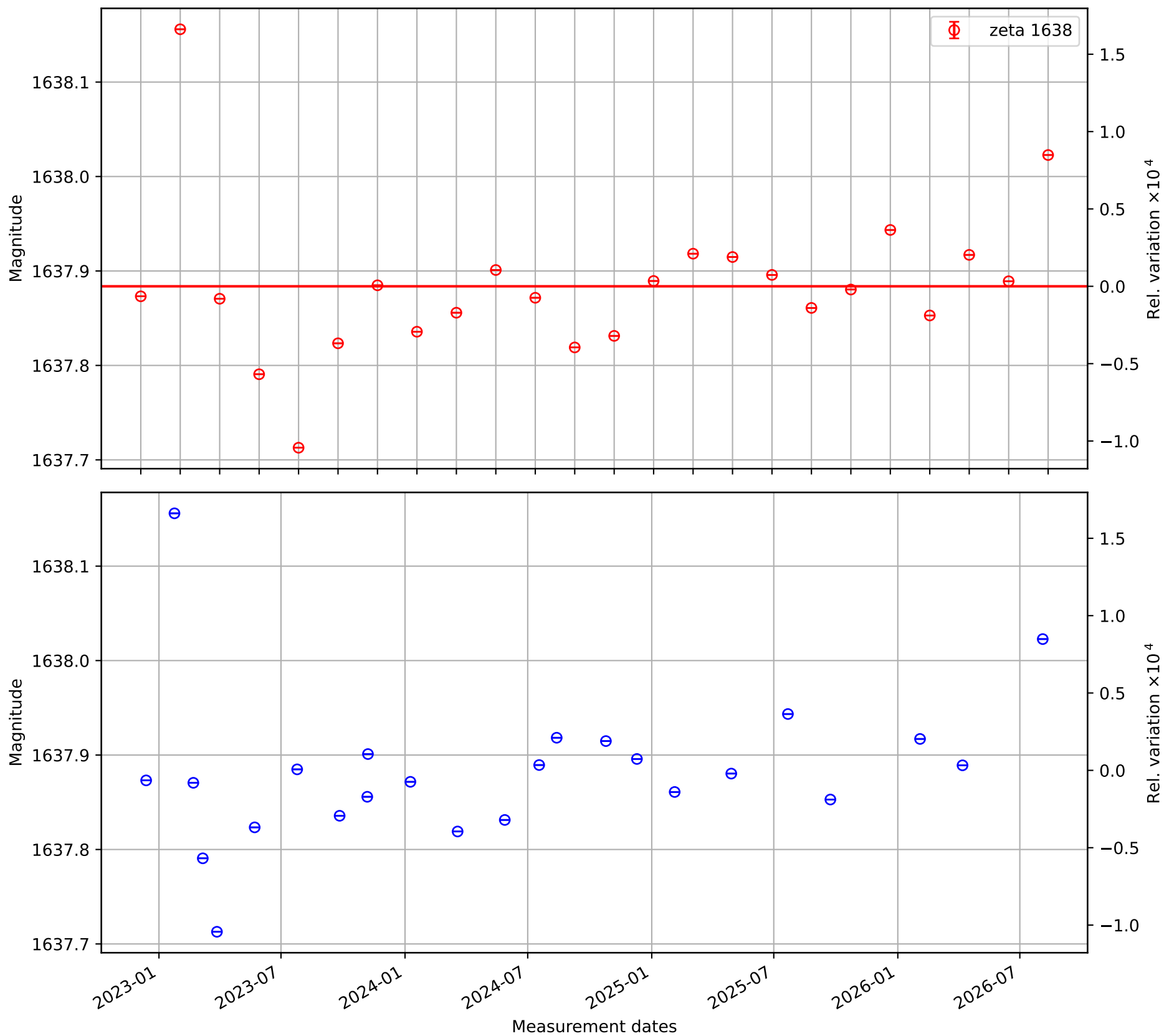
Mean value: 1637.883774

Standard deviation: 0.081871

Standard error: 0.000010

Relative Uncertainty: 0.000010

ADC conversion factor (Zeta (ct/V))



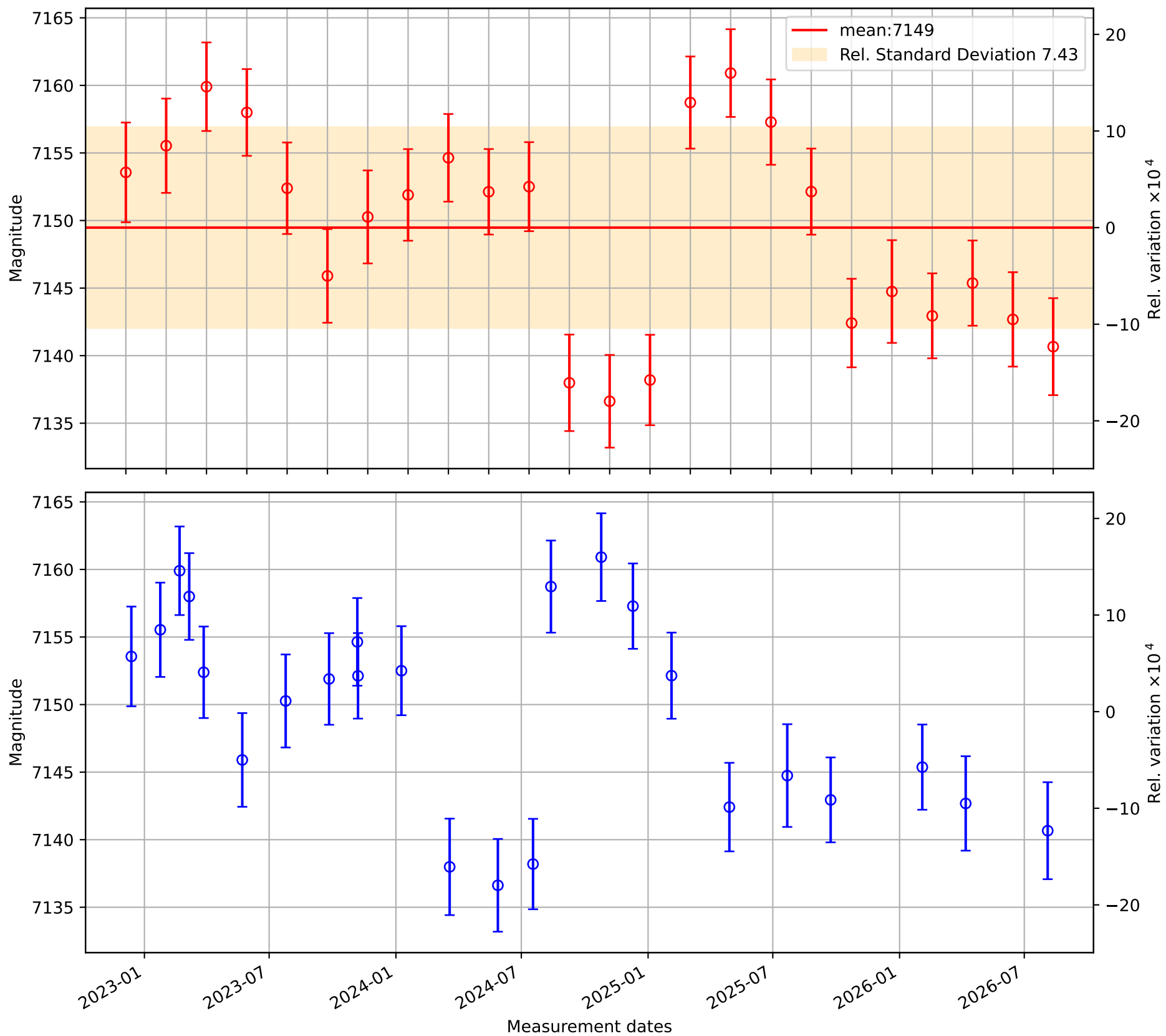
Description:

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)
D20221213: 7153.562223 ± 0.000516
D20230124: 7155.535171 ± 0.000488
D20230221: 7159.902744 ± 0.000458
D20230307: 7157.997893 ± 0.000448
D20230328: 7152.388875 ± 0.000473
D20230523: 7145.902737 ± 0.000485
D20230725: 7150.267299 ± 0.000481
D20230926: 7151.895574 ± 0.000474
D20231106: 7154.640027 ± 0.000453
D20231107: 7152.126675 ± 0.000442
D20240109: 7152.504950 ± 0.000461
D20240319: 7137.989008 ± 0.000500
D20240528: 7136.622441 ± 0.000481
D20240718: 7138.196545 ± 0.000469
D20240813: 7158.731980 ± 0.000476
D20241025: 7160.911552 ± 0.000453
D20241210: 7157.284786 ± 0.000441
D20250204: 7152.140281 ± 0.000446
D20250429: 7142.412496 ± 0.000459
D20250722: 7144.745021 ± 0.000532
D20250923: 7142.946485 ± 0.000440
D20260203: 7145.369650 ± 0.000441
D20260407: 7142.682342 ± 0.000489
D20260804: 7140.664931 ± 0.000503

rho_T
Summary of TX Responsivity rho_T
Mean value: 7149.475904
Standard deviation: 7.430326
Standard error: 0.001061
Relative Uncertainty: 0.001061

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)
D20221213: 10651.327811 ± 0.000251
D20230124: 10649.748717 ± 0.000263
D20230221: 10649.673834 ± 0.000267
D20230307: 10649.072590 ± 0.000256
D20230328: 10648.221570 ± 0.000264
D20230523: 10628.873902 ± 0.000262
D20230725: 10632.538207 ± 0.000259
D20230926: 10631.706744 ± 0.000255
D20231106: 10639.703231 ± 0.000297
D20231107: 10643.438558 ± 0.000242
D20240109: 10650.750768 ± 0.000264
D20240319: 10638.211861 ± 0.000260
D20240528: 10649.062793 ± 0.000480
D20240718: 10647.703764 ± 0.000411
D20240813: 10668.950020 ± 0.000439
D20241025: 10674.611242 ± 0.000410
D20241210: 10679.451206 ± 0.000422
D20250204: 10671.526305 ± 0.000376
D20250429: 10654.391401 ± 0.000428
D20250722: 10653.719446 ± 0.000440
D20250923: 10646.753271 ± 0.000424
D20260203: 10664.554730 ± 0.000389
D20260407: 10659.734323 ± 0.000449
D20260804: 10646.630522 ± 0.000445

rho_R

Summary of RX Responsivity rho_R

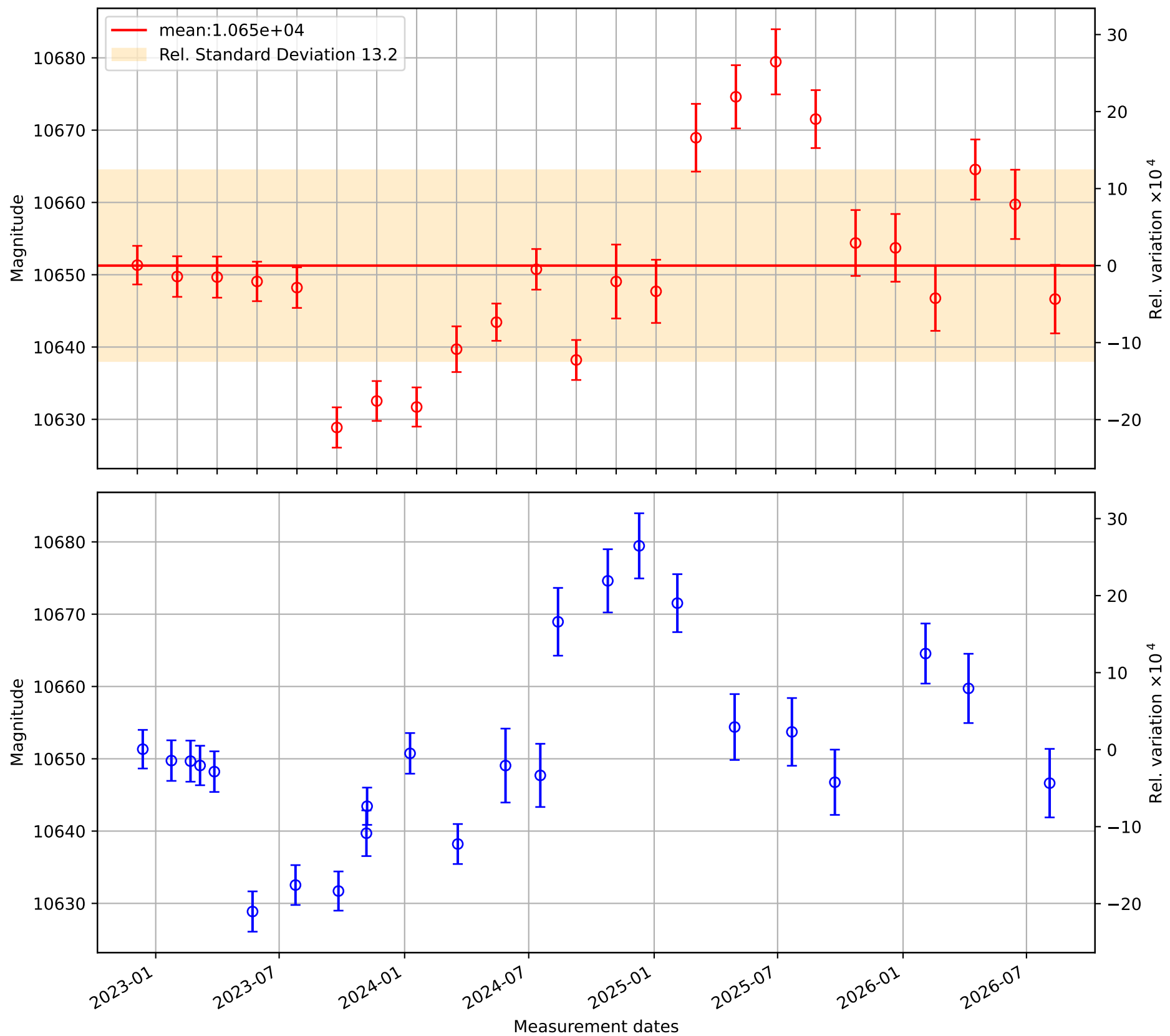
Mean value: 10651.264867

Standard deviation: 13.196444

Standard error: 0.001265

Relative Uncertainty: 0.001265

RX Responsivity ρ_R



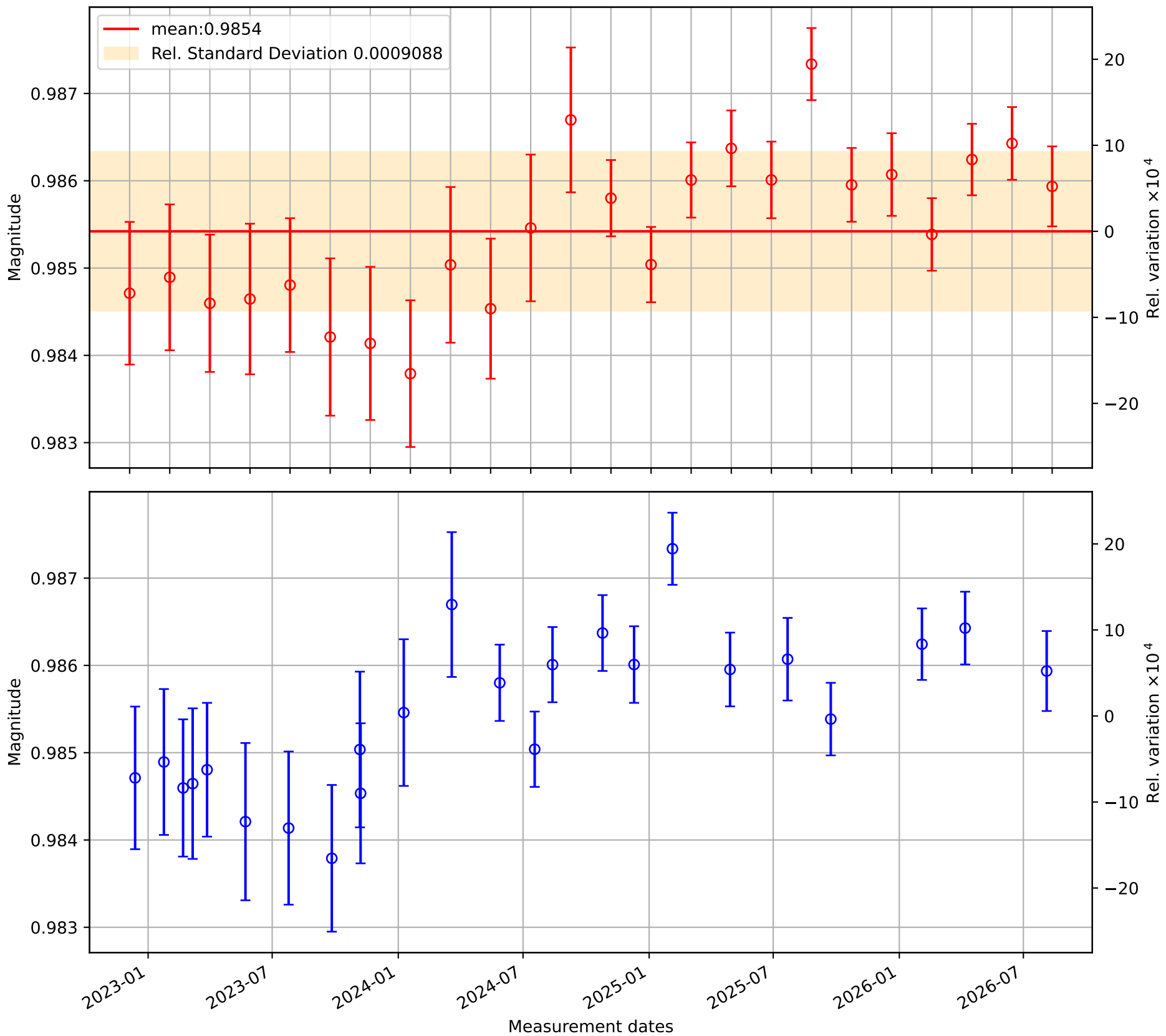
Description:

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)	
D20221213: 0.984711 ± 0.000830	
D20230124: 0.984894 ± 0.000848	
D20230221: 0.984596 ± 0.000798	
D20230307: 0.984646 ± 0.000876	
D20230328: 0.984805 ± 0.000778	
D20230523: 0.984210 ± 0.000915	
D20230725: 0.984137 ± 0.000891	
D20230926: 0.983790 ± 0.000854	
D20231106: 0.985037 ± 0.000905	
D20231107: 0.984535 ± 0.000815	
D20240109: 0.985460 ± 0.000852	
D20240319: 0.986697 ± 0.000841	
D20240528: 0.985801 ± 0.000443	
D20240718: 0.985040 ± 0.000438	
D20240813: 0.986009 ± 0.000437	
D20241025: 0.986371 ± 0.000441	
D20241210: 0.986010 ± 0.000445	
D20250204: 0.987336 ± 0.000418	
D20250429: 0.985953 ± 0.000429	
D20250722: 0.986071 ± 0.000480	
D20250923: 0.985385 ± 0.000422	
D20260203: 0.986243 ± 0.000415	
D20260407: 0.986428 ± 0.000422	
D20260804: 0.985936 ± 0.000465	

e_i	
Summary of Optical Efficiency (Inner Beam)	
Mean value: 0.985421	
Standard deviation: 0.000909	
Standard error: 0.000192	
Relative Uncertainty: 0.000192	

Optical Efficiency (Inner Beam)



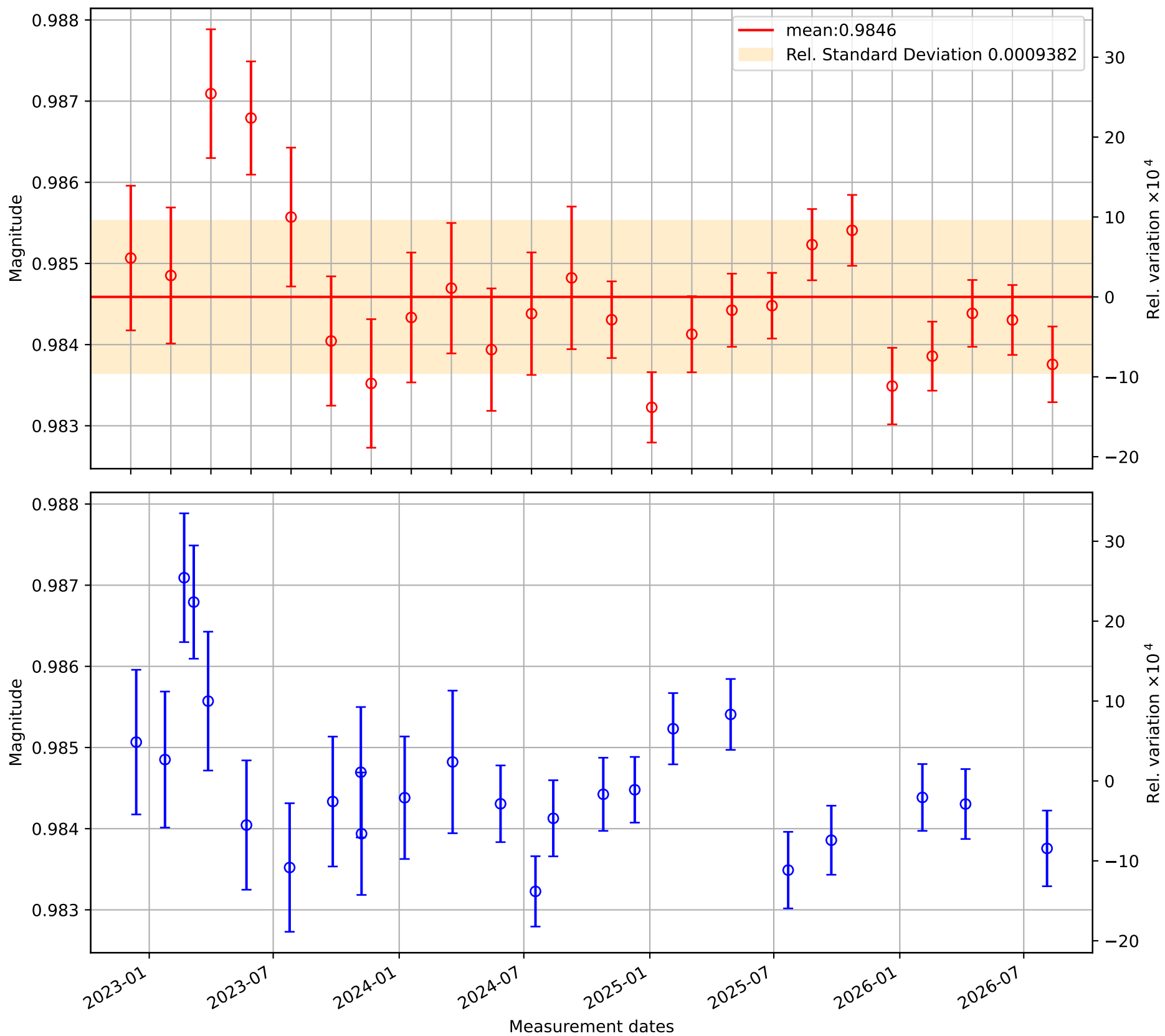
Description:

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)	
D20221213:	0.985067 ± 0.000905
D20230124:	0.984851 ± 0.000851
D20230221:	0.987092 ± 0.000804
D20230307:	0.986792 ± 0.000707
D20230328:	0.985572 ± 0.000868
D20230523:	0.984045 ± 0.000810
D20230725:	0.983521 ± 0.000805
D20230926:	0.984334 ± 0.000813
D20231106:	0.984695 ± 0.000816
D20231107:	0.983938 ± 0.000767
D20240109:	0.984381 ± 0.000767
D20240319:	0.984822 ± 0.000892
D20240528:	0.984307 ± 0.000480
D20240718:	0.983227 ± 0.000441
D20240813:	0.984128 ± 0.000477
D20241025:	0.984424 ± 0.000458
D20241210:	0.984479 ± 0.000411
D20250204:	0.985232 ± 0.000446
D20250429:	0.985408 ± 0.000443
D20250722:	0.983489 ± 0.000480
D20250923:	0.983858 ± 0.000432
D20260203:	0.984385 ± 0.000418
D20260407:	0.984304 ± 0.000438
D20260804:	0.983757 ± 0.000474

e_o	
Summary of Optical Efficiency (Outer Beam)	
Mean value: 0.984588	
Standard deviation: 0.000938	
Standard error: 0.000199	
Relative Uncertainty: 0.000199	

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)

D20221213: 0.984890 ± 0.000605

D20230124: 0.984872 ± 0.000592

D20230221: 0.985851 ± 0.000559

D20230307: 0.985725 ± 0.000554

D20230328: 0.985191 ± 0.000575

D20230523: 0.984127 ± 0.000601

D20230725: 0.983827 ± 0.000591

D20230926: 0.984064 ± 0.000580

D20231106: 0.984865 ± 0.000600

D20231107: 0.984234 ± 0.000550

D20240109: 0.984917 ± 0.000564

D20240319: 0.985754 ± 0.000604

D20240528: 0.985054 ± 0.000653

D20240718: 0.984133 ± 0.000621

D20240813: 0.985068 ± 0.000646

D20241025: 0.985397 ± 0.000635

D20241210: 0.985245 ± 0.000606

D20250204: 0.986284 ± 0.000611

D20250429: 0.985681 ± 0.000617

D20250722: 0.984780 ± 0.000679

D20250923: 0.984621 ± 0.000604

D20260203: 0.985314 ± 0.000589

D20260407: 0.985366 ± 0.000608

D20260804: 0.984846 ± 0.000664

e

Summary of Overall Optical Efficiency

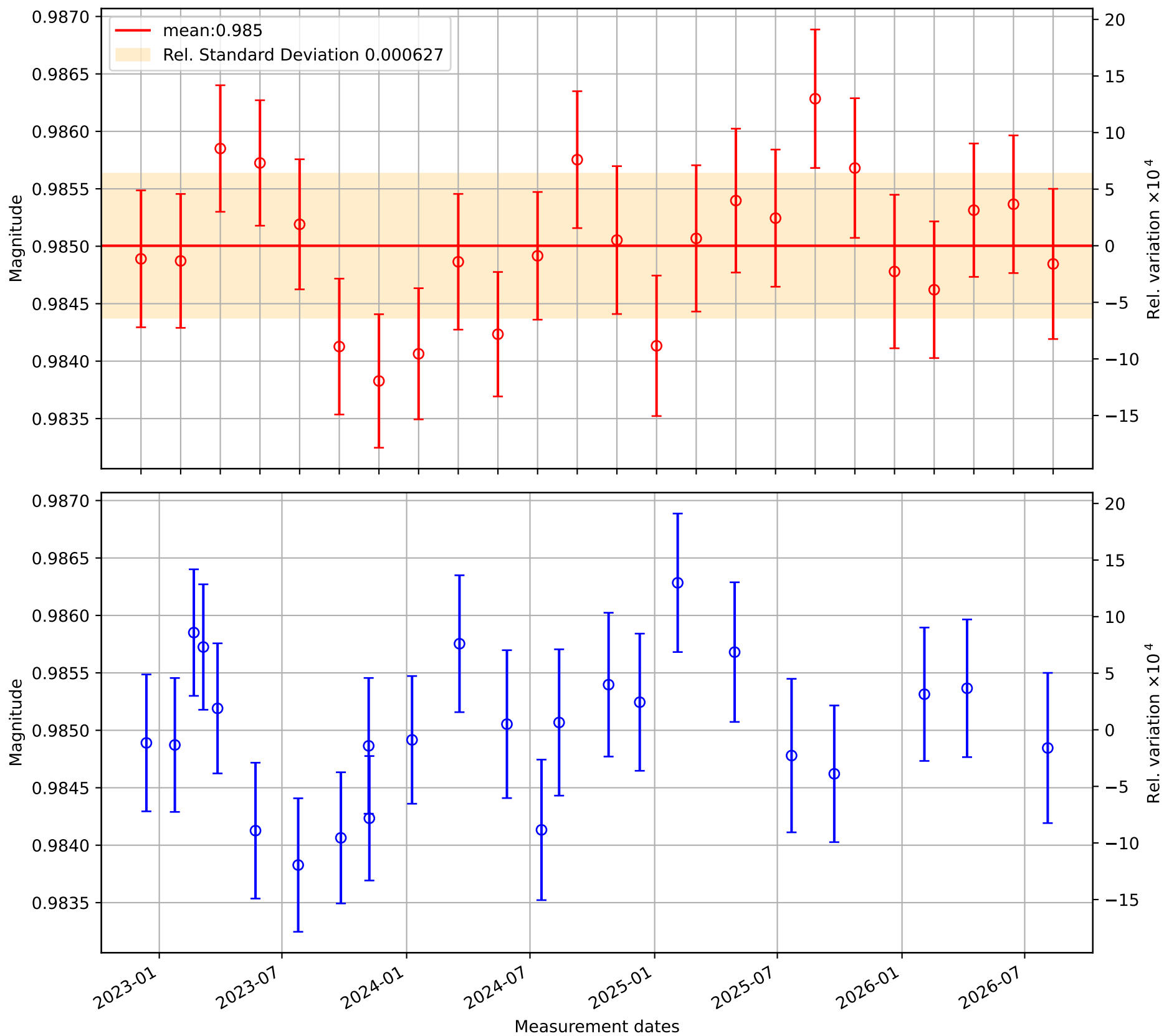
Mean value: 0.985004

Standard deviation: 0.000627

Standard error: 0.000133

Relative Uncertainty: 0.000133

Overall Optical Efficiency



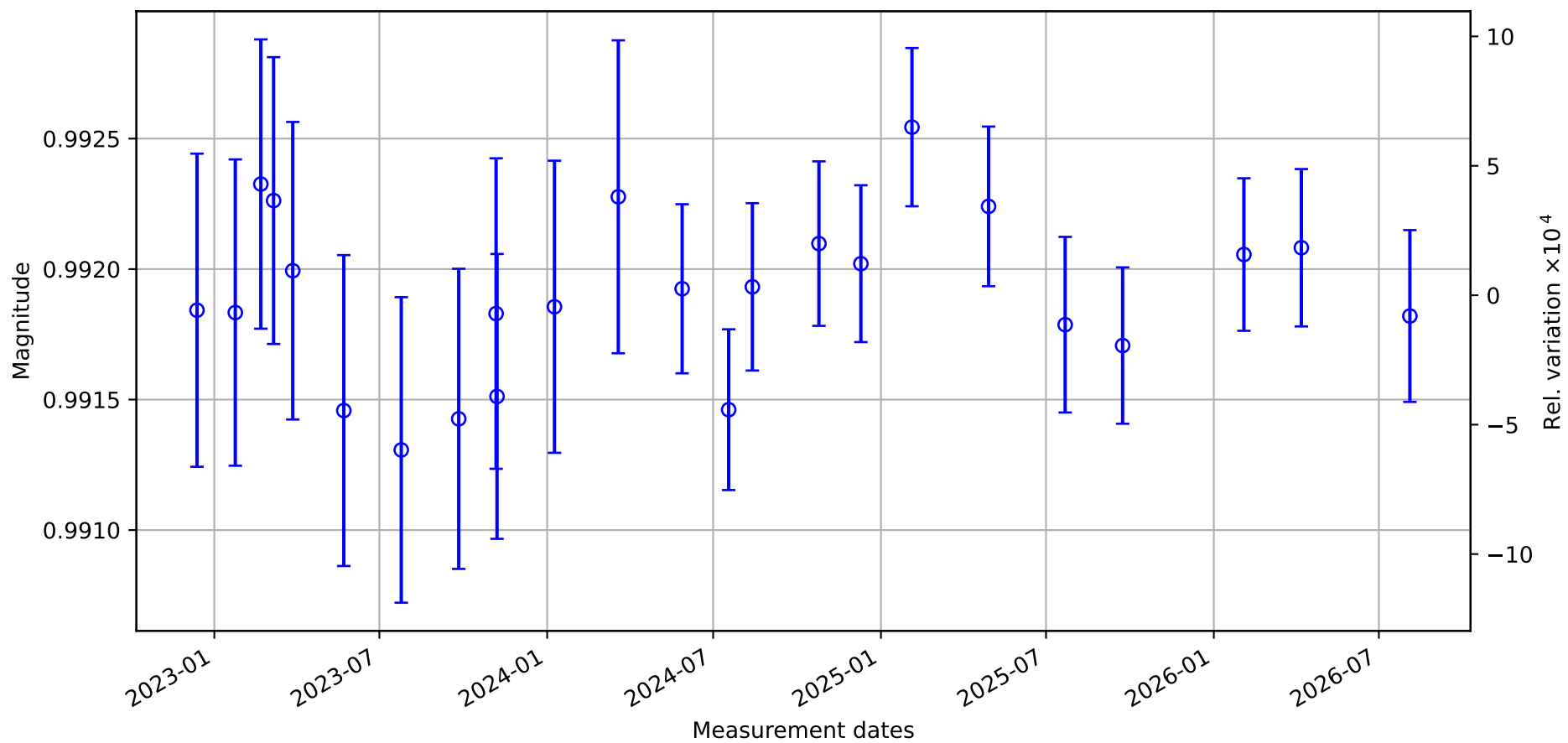
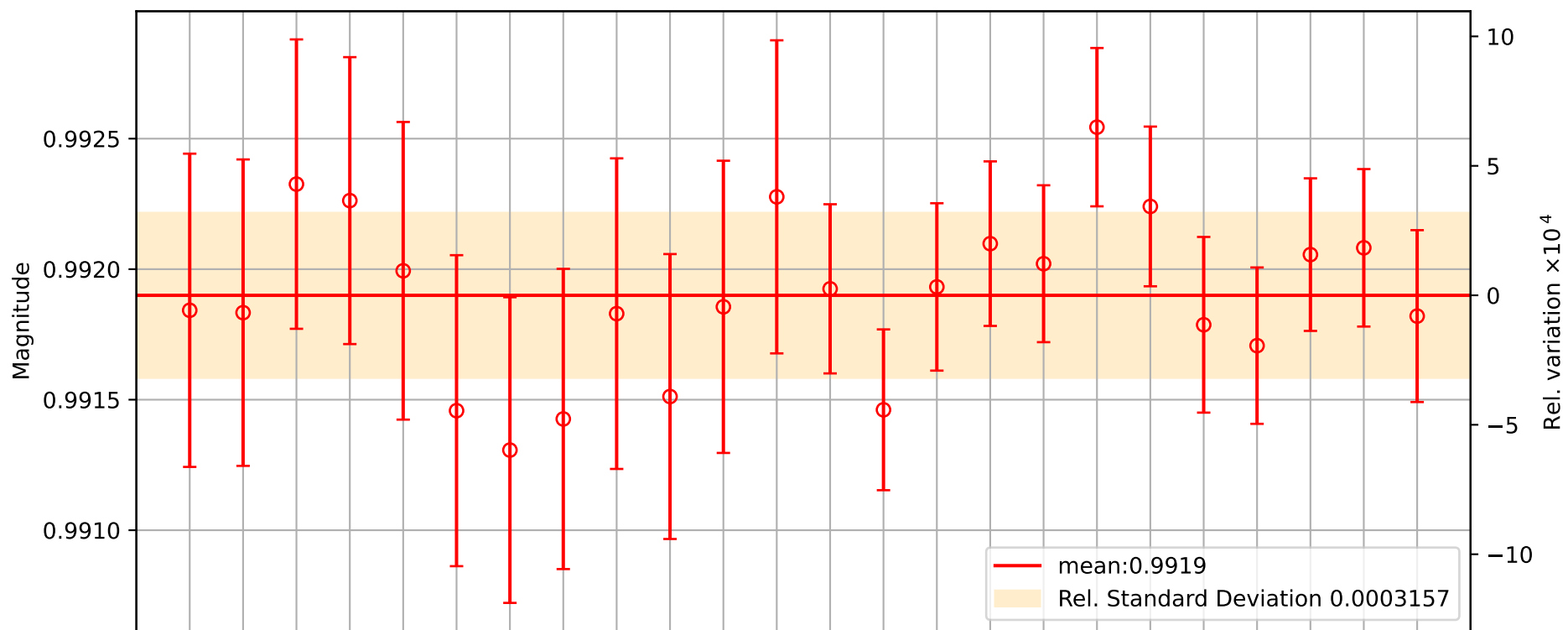
Description:

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)	
D20221213:	0.991842 ± 0.000605
D20230124:	0.991833 ± 0.000592
D20230221:	0.992326 ± 0.000559
D20230307:	0.992263 ± 0.000554
D20230328:	0.991994 ± 0.000575
D20230523:	0.991458 ± 0.000601
D20230725:	0.991307 ± 0.000591
D20230926:	0.991426 ± 0.000580
D20231106:	0.991830 ± 0.000600
D20231107:	0.991512 ± 0.000550
D20240109:	0.991856 ± 0.000564
D20240319:	0.992277 ± 0.000604
D20240528:	0.991925 ± 0.000327
D20240718:	0.991461 ± 0.000311
D20240813:	0.991932 ± 0.000323
D20241025:	0.992098 ± 0.000318
D20241210:	0.992021 ± 0.000303
D20250204:	0.992544 ± 0.000306
D20250429:	0.992240 ± 0.000308
D20250722:	0.991787 ± 0.000339
D20250923:	0.991707 ± 0.000302
D20260203:	0.992056 ± 0.000295
D20260407:	0.992082 ± 0.000304
D20260804:	0.991820 ± 0.000332

E_T	
Summary of Input Side Optical Efficiency correction factor	
Mean value: 0.991900	
Standard deviation: 0.000316	
Standard error: 0.000066	
Relative Uncertainty: 0.000066	

Input Side Optical Efficiency correction factor



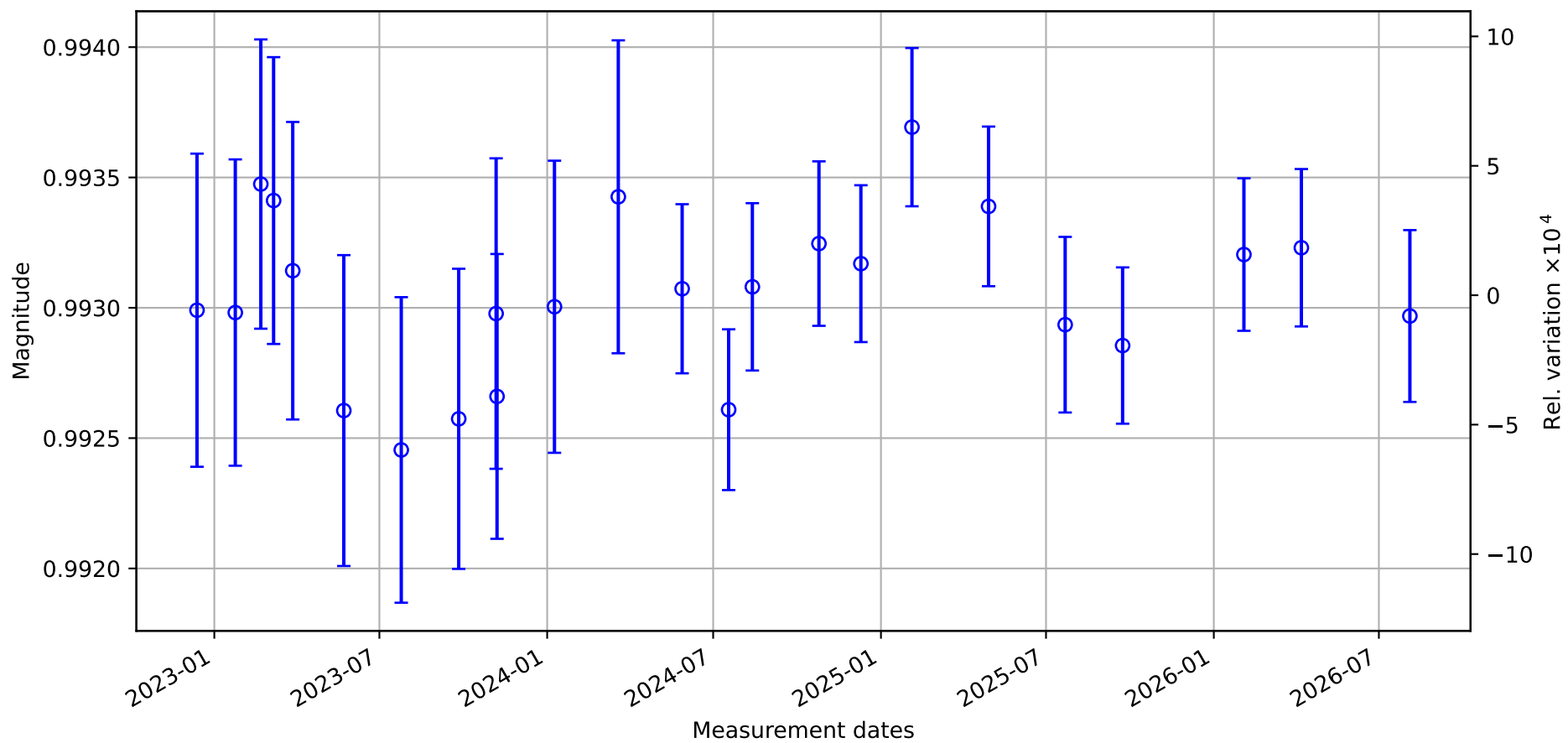
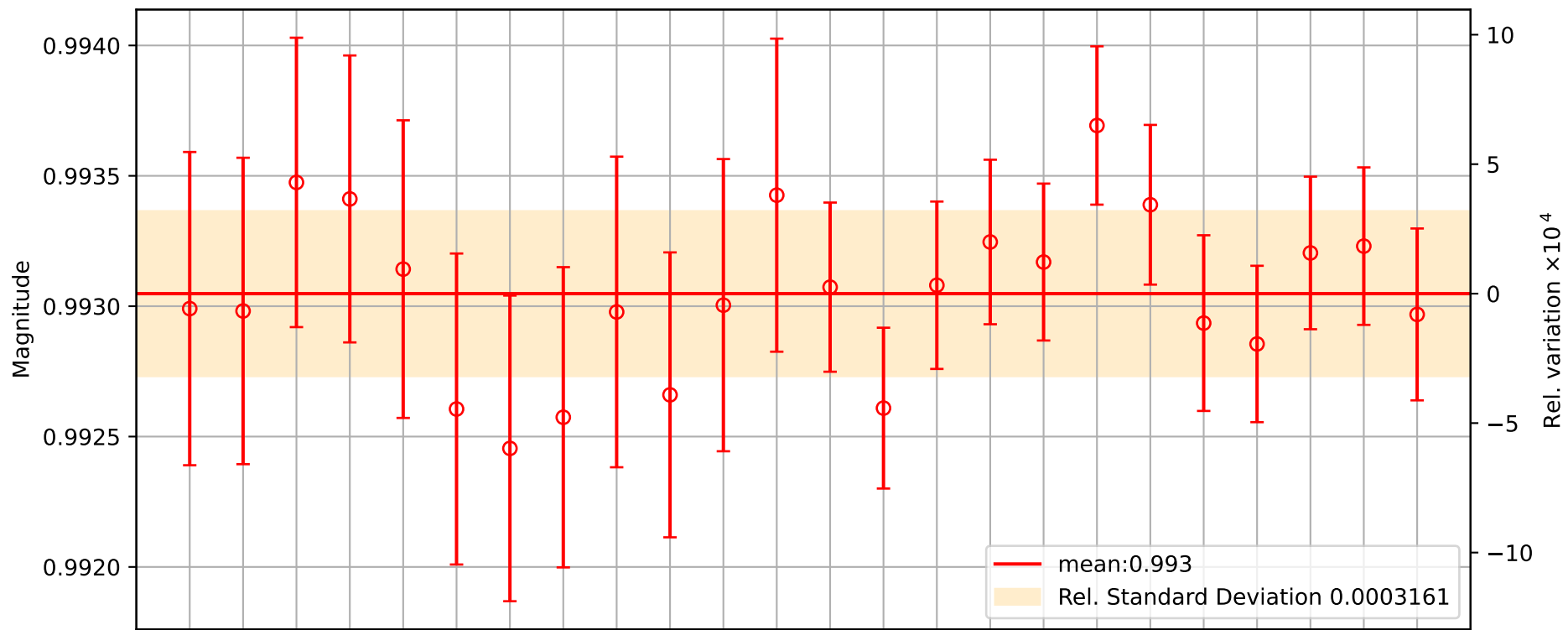
Description:

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)	
D20221213:	0.992991 ± 0.000605
D20230124:	0.992982 ± 0.000592
D20230221:	0.993475 ± 0.000559
D20230307:	0.993411 ± 0.000554
D20230328:	0.993142 ± 0.000575
D20230523:	0.992606 ± 0.000601
D20230725:	0.992455 ± 0.000591
D20230926:	0.992574 ± 0.000580
D20231106:	0.992978 ± 0.000600
D20231107:	0.992660 ± 0.000550
D20240109:	0.993004 ± 0.000564
D20240319:	0.993426 ± 0.000604
D20240528:	0.993073 ± 0.000327
D20240718:	0.992609 ± 0.000311
D20240813:	0.993080 ± 0.000323
D20241025:	0.993246 ± 0.000318
D20241210:	0.993169 ± 0.000303
D20250204:	0.993693 ± 0.000306
D20250429:	0.993389 ± 0.000308
D20250722:	0.992935 ± 0.000339
D20250923:	0.992855 ± 0.000302
D20260203:	0.993204 ± 0.000295
D20260407:	0.993230 ± 0.000304
D20260804:	0.992968 ± 0.000332

E_R	
Summary of Output Side Optical Efficiency correction factor	
Mean value: 0.993048	
Standard deviation: 0.000316	
Standard error: 0.000066	
Relative Uncertainty: 0.000066	

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)	
D20221213:	7212.397526 ± 0.000795
D20230124:	7214.452449 ± 0.000767
D20230221:	7215.273577 ± 0.000722
D20230307:	7213.813867 ± 0.000713
D20230328:	7210.114627 ± 0.000745
D20230523:	7207.469593 ± 0.000772
D20230725:	7212.969539 ± 0.000762
D20230926:	7213.744566 ± 0.000749
D20231106:	7213.577544 ± 0.000752
D20231107:	7213.352735 ± 0.000706
D20240109:	7211.235248 ± 0.000728
D20240319:	7193.544215 ± 0.000784
D20240528:	7194.721895 ± 0.000581
D20240718:	7199.672540 ± 0.000562
D20240813:	7216.958246 ± 0.000575
D20241025:	7217.949666 ± 0.000553
D20241210:	7214.853234 ± 0.000535
D20250204:	7205.867282 ± 0.000540
D20250429:	7198.268742 ± 0.000553
D20250722:	7203.910847 ± 0.000631
D20250923:	7202.677875 ± 0.000534
D20260203:	7202.588673 ± 0.000531
D20260407:	7199.690744 ± 0.000576
D20260804:	7199.555564 ± 0.000602

rhoT_prime
Summary of Tx Responsivity Corrected for
Optical Efficiency

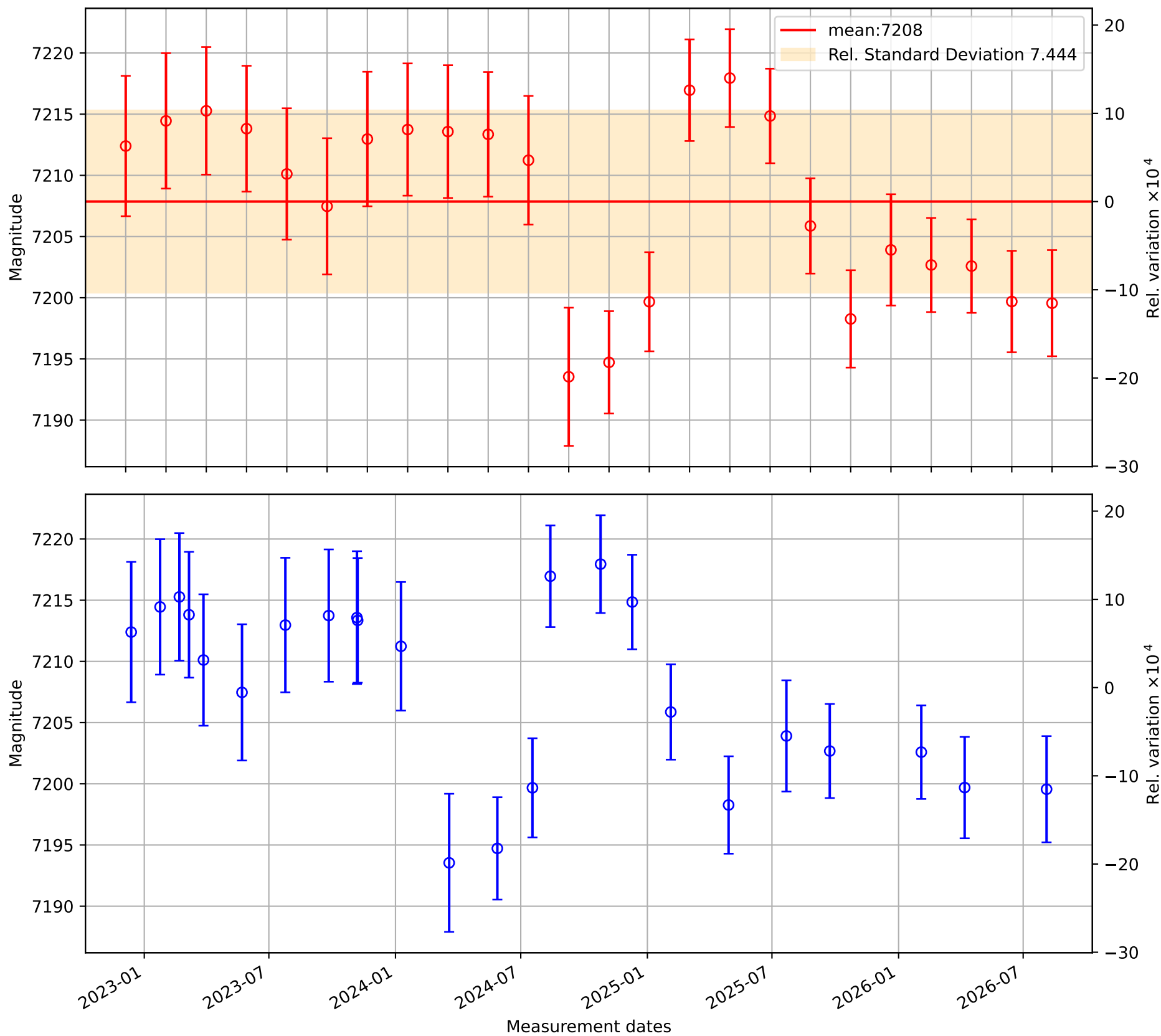
Mean value: 7207.860866

Standard deviation: 7.444445

Standard error: 0.001055

Relative Uncertainty: 0.001538

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)	
D20221213:	10576.669791 ± 0.000655
D20230124:	10575.005390 ± 0.000648
D20230221:	10580.181519 ± 0.000619
D20230307:	10578.909763 ± 0.000610
D20230328:	10575.198319 ± 0.000632
D20230523:	10550.281025 ± 0.000656
D20230725:	10552.311978 ± 0.000645
D20230926:	10552.755712 ± 0.000634
D20231106:	10564.989969 ± 0.000669
D20231107:	10565.315655 ± 0.000601
D20240109:	10576.238042 ± 0.000623
D20240319:	10568.274471 ± 0.000658
D20240528:	10575.297390 ± 0.000581
D20240718:	10569.007570 ± 0.000515
D20240813:	10595.124936 ± 0.000545
D20241025:	10602.518017 ± 0.000518
D20241210:	10606.503121 ± 0.000519
D20250204:	10604.221621 ± 0.000484
D20250429:	10583.955621 ± 0.000527
D20250722:	10578.452789 ± 0.000555
D20250923:	10570.683879 ± 0.000520
D20260203:	10592.081311 ± 0.000488
D20260407:	10587.571739 ± 0.000543
D20260804:	10571.768415 ± 0.000555

rhoR_prime
Summary of Rx Responsivity Corrected for
Optical Efficiency

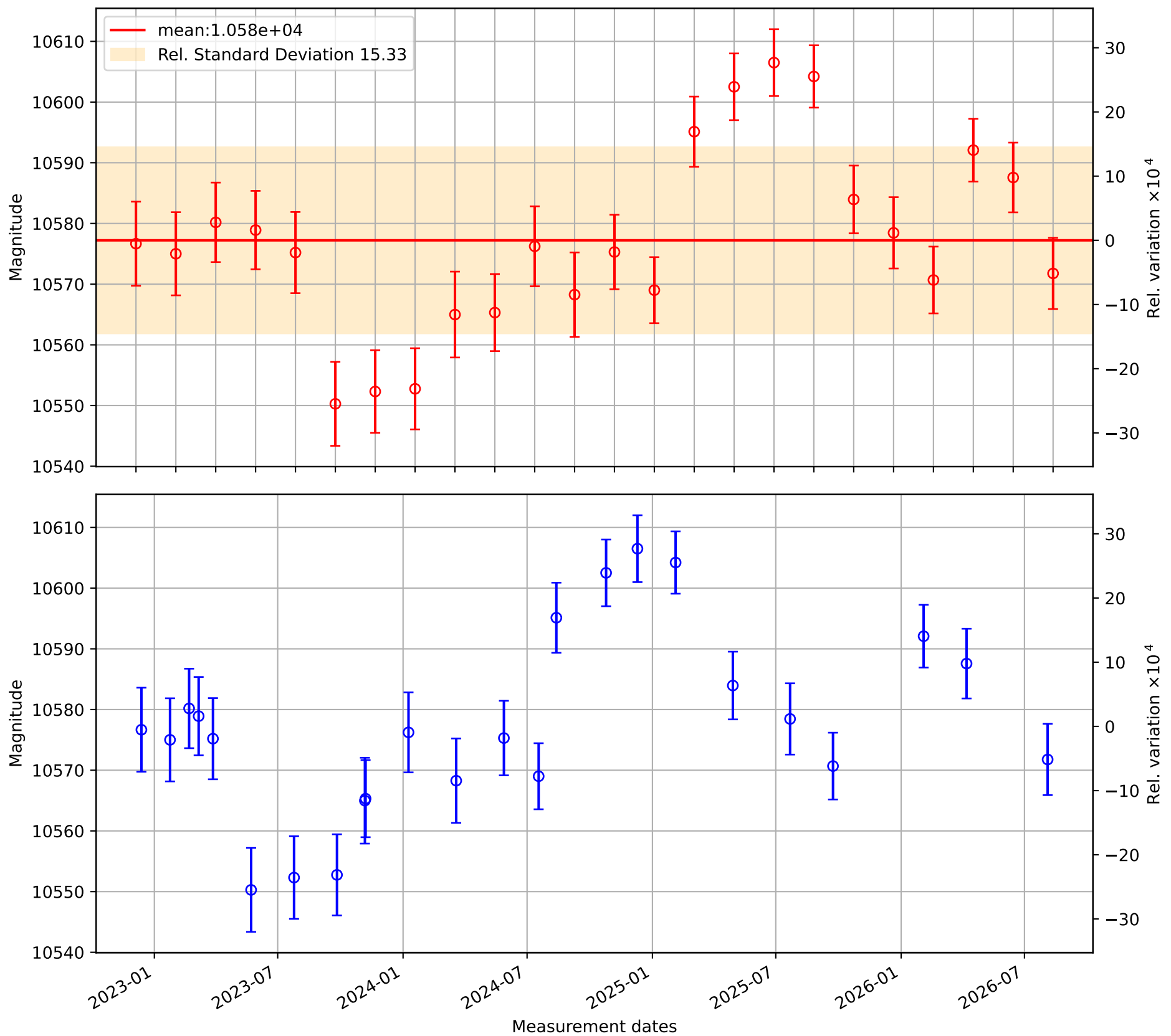
Mean value: 10577.221585

Standard deviation: 15.327533

Standard error: 0.001480

Relative Uncertainty: 0.001830

Rx Responsivity Corrected for Optical Efficiency



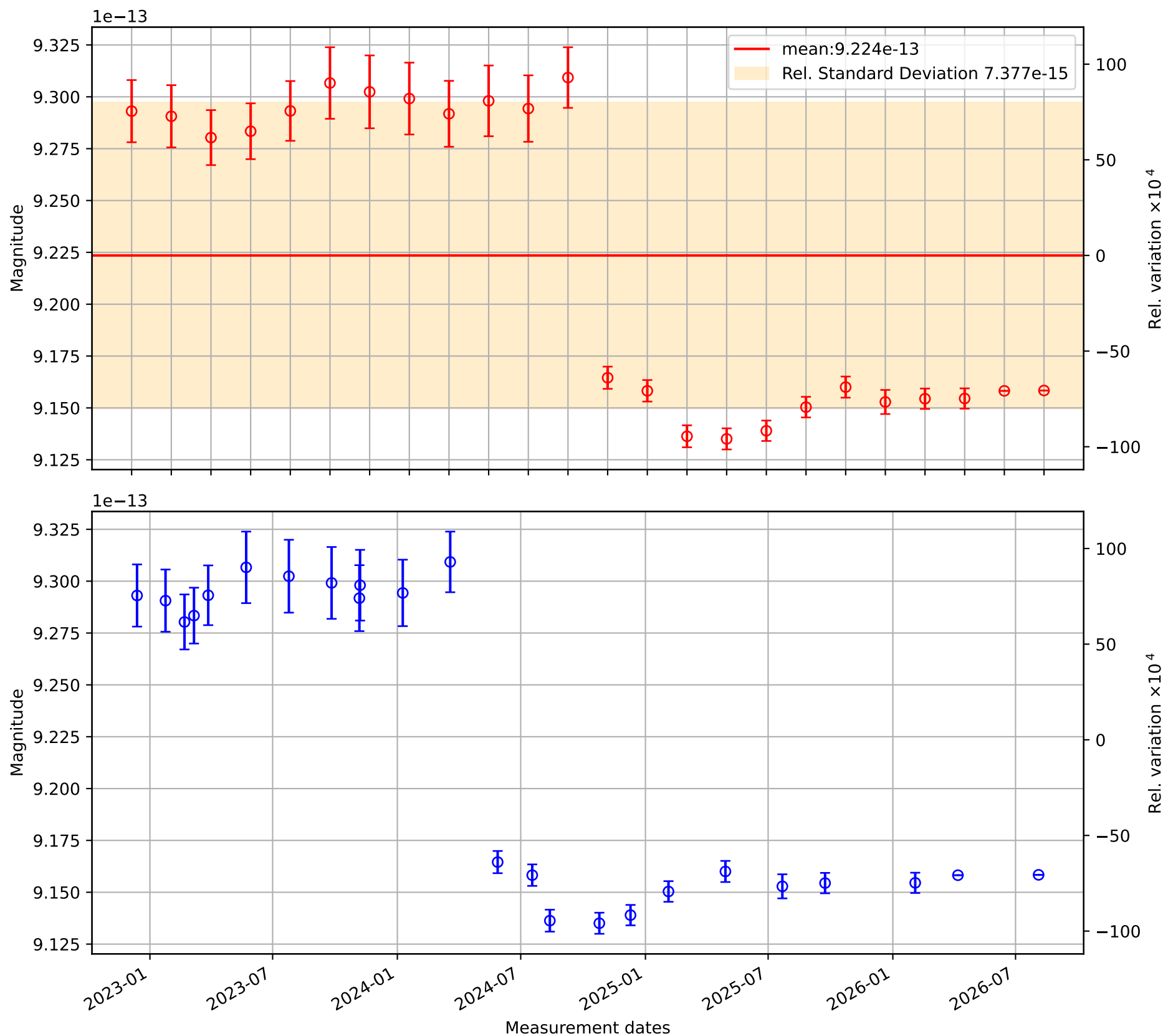
Description:

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)	
D20221213:	9.2931e-13 ± 1.6128e-03
D20230124:	9.2906e-13 ± 1.6152e-03
D20230221:	9.2803e-13 ± 1.4285e-03
D20230307:	9.2834e-13 ± 1.4498e-03
D20230328:	9.2932e-13 ± 1.5504e-03
D20230523:	9.3067e-13 ± 1.8535e-03
D20230725:	9.3024e-13 ± 1.8883e-03
D20230926:	9.2992e-13 ± 1.8626e-03
D20231106:	9.2918e-13 ± 1.7113e-03
D20231107:	9.2981e-13 ± 1.8340e-03
D20240109:	9.2943e-13 ± 1.7238e-03
D20240319:	9.3093e-13 ± 1.5699e-03
D20240528:	9.1645e-13 ± 5.8447e-04
D20240718:	9.1582e-13 ± 5.6571e-04
D20240813:	9.1363e-13 ± 5.7864e-04
D20241025:	9.1351e-13 ± 5.5682e-04
D20241210:	9.1390e-13 ± 5.3875e-04
D20250204:	9.1504e-13 ± 5.4373e-04
D20250429:	9.1600e-13 ± 5.5609e-04
D20250722:	9.1529e-13 ± 6.3402e-04
D20250923:	9.1544e-13 ± 5.3716e-04
D20260203:	9.1545e-13 ± 5.3400e-04
D20260407:	9.1582e-13 ± 4.6780e-12
D20260804:	9.1584e-13 ± 4.8238e-12

FC_TXPD	
Summary of TxPD Force Coefficient Corrected for Optical Efficiency	
Mean value: 9.223513e-13	
Standard deviation: 7.377345e-15	
Standard error: 8.168553e-03	
Relative Uncertainty: 8.168553e-03	

TxPD Force Coefficient Corrected for Optical Efficiency



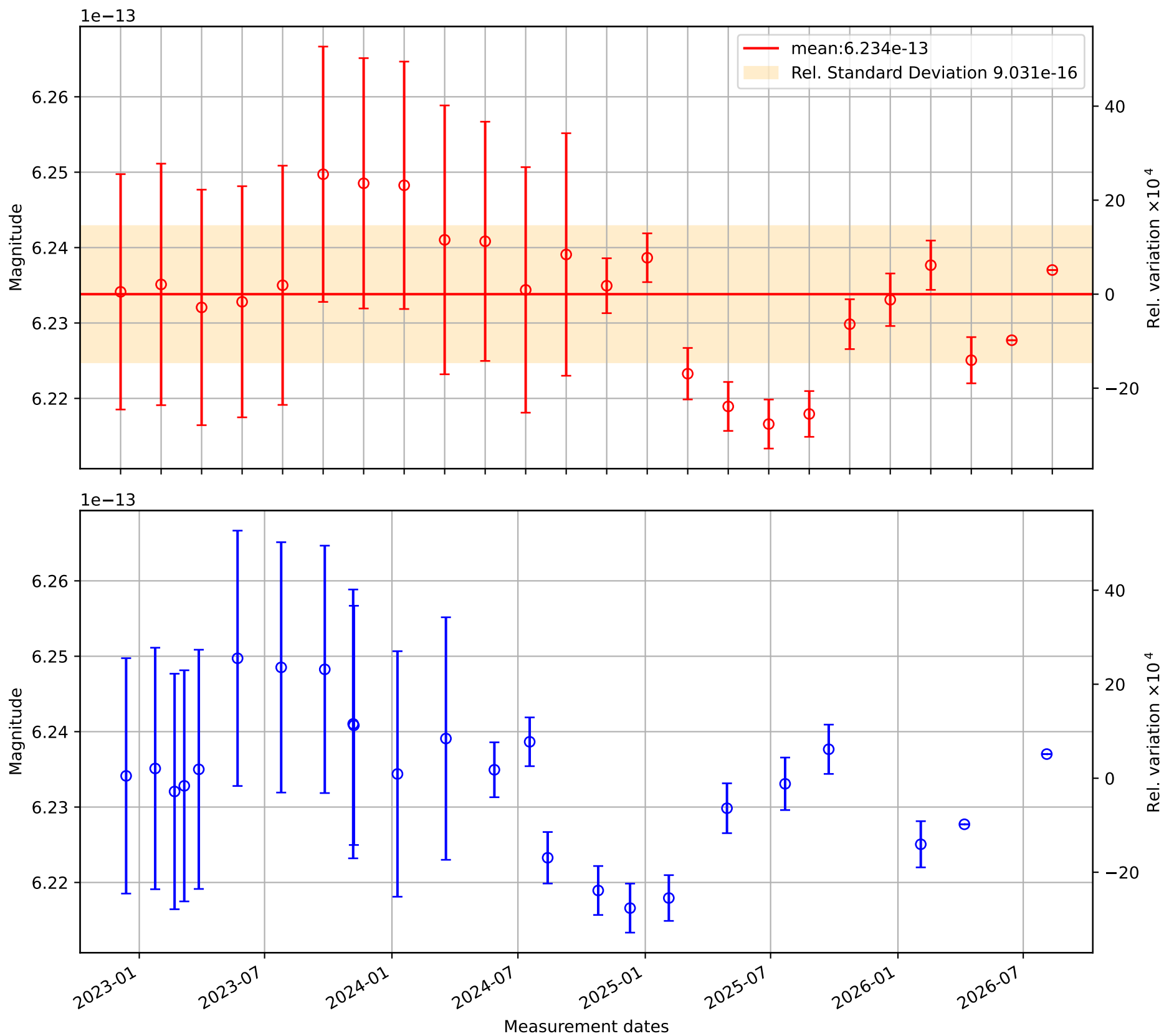
Description:

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)
D20221213: 6.2341e-13 ± 2.5037e-03
D20230124: 6.2351e-13 ± 2.5685e-03
D20230221: 6.2321e-13 ± 2.5062e-03
D20230307: 6.2328e-13 ± 2.4590e-03
D20230328: 6.2350e-13 ± 2.5442e-03
D20230523: 6.2497e-13 ± 2.7091e-03
D20230725: 6.2485e-13 ± 2.6567e-03
D20230926: 6.2483e-13 ± 2.6256e-03
D20231106: 6.2410e-13 ± 2.8565e-03
D20231107: 6.2408e-13 ± 2.5418e-03
D20240109: 6.2344e-13 ± 2.6114e-03
D20240319: 6.2391e-13 ± 2.5776e-03
D20240528: 6.2349e-13 ± 5.8395e-04
D20240718: 6.2387e-13 ± 5.1842e-04
D20240813: 6.2233e-13 ± 5.4875e-04
D20241025: 6.2189e-13 ± 5.2191e-04
D20241210: 6.2166e-13 ± 5.2294e-04
D20250204: 6.2179e-13 ± 4.8798e-04
D20250429: 6.2298e-13 ± 5.3066e-04
D20250722: 6.2331e-13 ± 5.5868e-04
D20250923: 6.2377e-13 ± 5.2404e-04
D20260203: 6.2251e-13 ± 4.9214e-04
D20260407: 6.2277e-13 ± 4.4973e-12
D20260804: 6.2370e-13 ± 4.5661e-12

FC_RXPD
Summary of RxPD Force Coefficient Corrected for Optical Efficiency
Mean value: 6.233822e-13
Standard deviation: 9.030909e-16
Standard error: 1.479512e-03
Relative Uncertainty: 1.479512e-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)	
D20221213:	2.3477e-14 ± 1.6128e-03
D20230124:	2.3471e-14 ± 1.6152e-03
D20230221:	2.3445e-14 ± 1.4285e-03
D20230307:	2.3452e-14 ± 1.4498e-03
D20230328:	2.3477e-14 ± 1.5504e-03
D20230523:	2.3511e-14 ± 1.8535e-03
D20230725:	2.3500e-14 ± 1.8883e-03
D20230926:	2.3492e-14 ± 1.8626e-03
D20231106:	2.3474e-14 ± 1.7113e-03
D20231107:	2.3489e-14 ± 1.8340e-03
D20240109:	2.3480e-14 ± 1.7238e-03
D20240319:	2.3518e-14 ± 1.5699e-03
D20240528:	2.3152e-14 ± 5.8447e-04
D20240718:	2.3136e-14 ± 5.6571e-04
D20240813:	2.3081e-14 ± 5.7864e-04
D20241025:	2.3078e-14 ± 5.5682e-04
D20241210:	2.3088e-14 ± 5.3875e-04
D20250204:	2.3116e-14 ± 5.4373e-04
D20250429:	2.3141e-14 ± 5.5609e-04
D20250722:	2.3123e-14 ± 6.3402e-04
D20250923:	2.3127e-14 ± 5.3716e-04
D20260203:	2.3127e-14 ± 5.3400e-04
D20260407:	2.3136e-14 ± 4.6780e-12
D20260804:	2.3137e-14 ± 4.8238e-12

Chi_TXPD
Summary of TxPD Displacement Coefficient
Corrected for Optical Efficiency

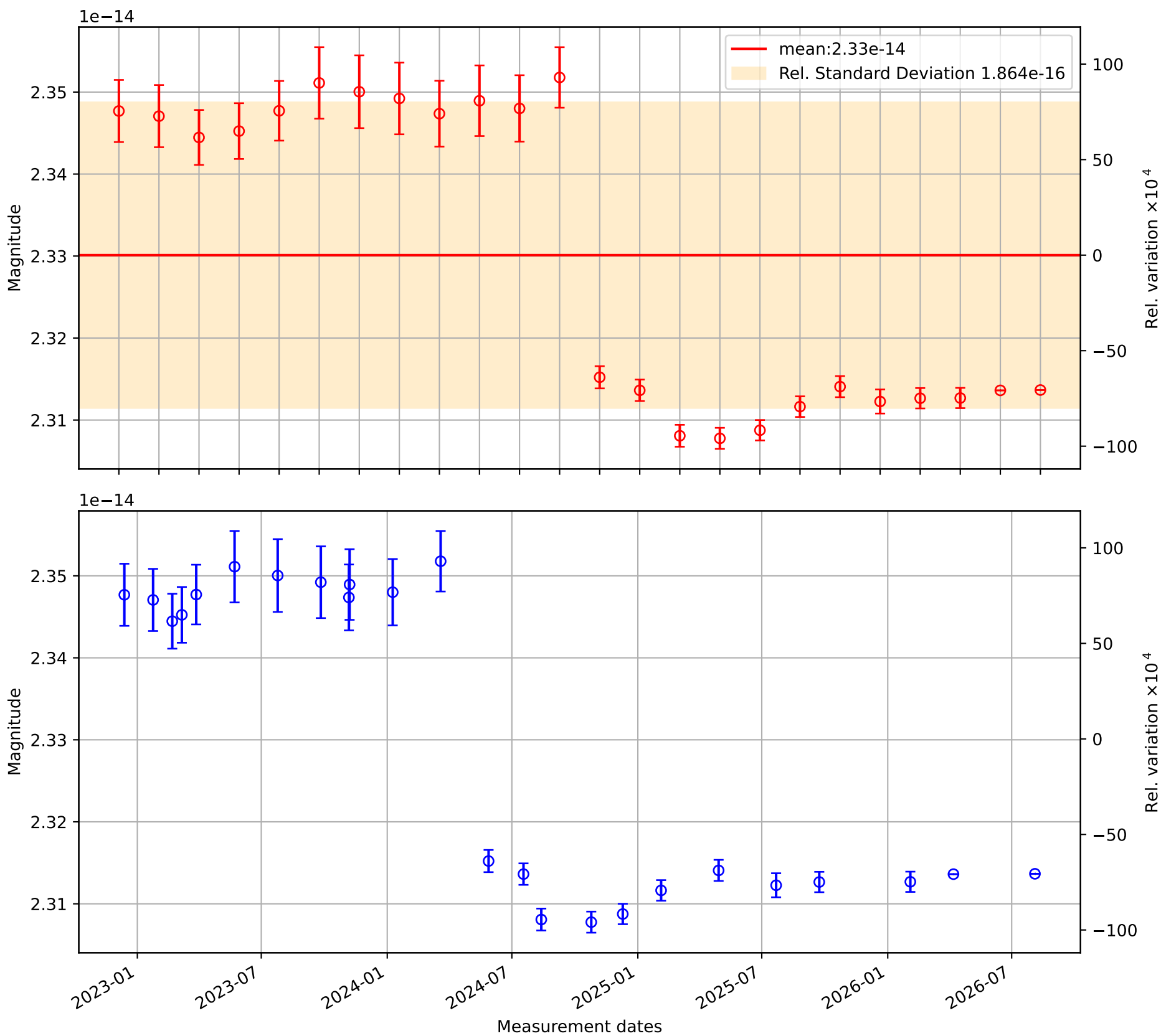
Mean value: 2.330111e-14

Standard deviation: 1.863719e-16

Standard error: 8.168553e-03

Relative Uncertainty: 8.168553e-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)	
D20221213:	1.5749e-14 ± 2.5037e-03
D20230124:	1.5752e-14 ± 2.5685e-03
D20230221:	1.5744e-14 ± 2.5062e-03
D20230307:	1.5746e-14 ± 2.4590e-03
D20230328:	1.5751e-14 ± 2.5442e-03
D20230523:	1.5789e-14 ± 2.7091e-03
D20230725:	1.5785e-14 ± 2.6567e-03
D20230926:	1.5785e-14 ± 2.6256e-03
D20231106:	1.5767e-14 ± 2.8565e-03
D20231107:	1.5766e-14 ± 2.5418e-03
D20240109:	1.5750e-14 ± 2.6114e-03
D20240319:	1.5762e-14 ± 2.5776e-03
D20240528:	1.5751e-14 ± 5.8395e-04
D20240718:	1.5761e-14 ± 5.1842e-04
D20240813:	1.5722e-14 ± 5.4875e-04
D20241025:	1.5711e-14 ± 5.2191e-04
D20241210:	1.5705e-14 ± 5.2294e-04
D20250204:	1.5708e-14 ± 4.8798e-04
D20250429:	1.5738e-14 ± 5.3066e-04
D20250722:	1.5746e-14 ± 5.5868e-04
D20250923:	1.5758e-14 ± 5.2404e-04
D20260203:	1.5726e-14 ± 4.9214e-04
D20260407:	1.5733e-14 ± 4.4973e-12
D20260804:	1.5756e-14 ± 4.5661e-12

Chi_RXPD
Summary of RxPD Displacement Coefficient
Corrected for Optical Efficiency

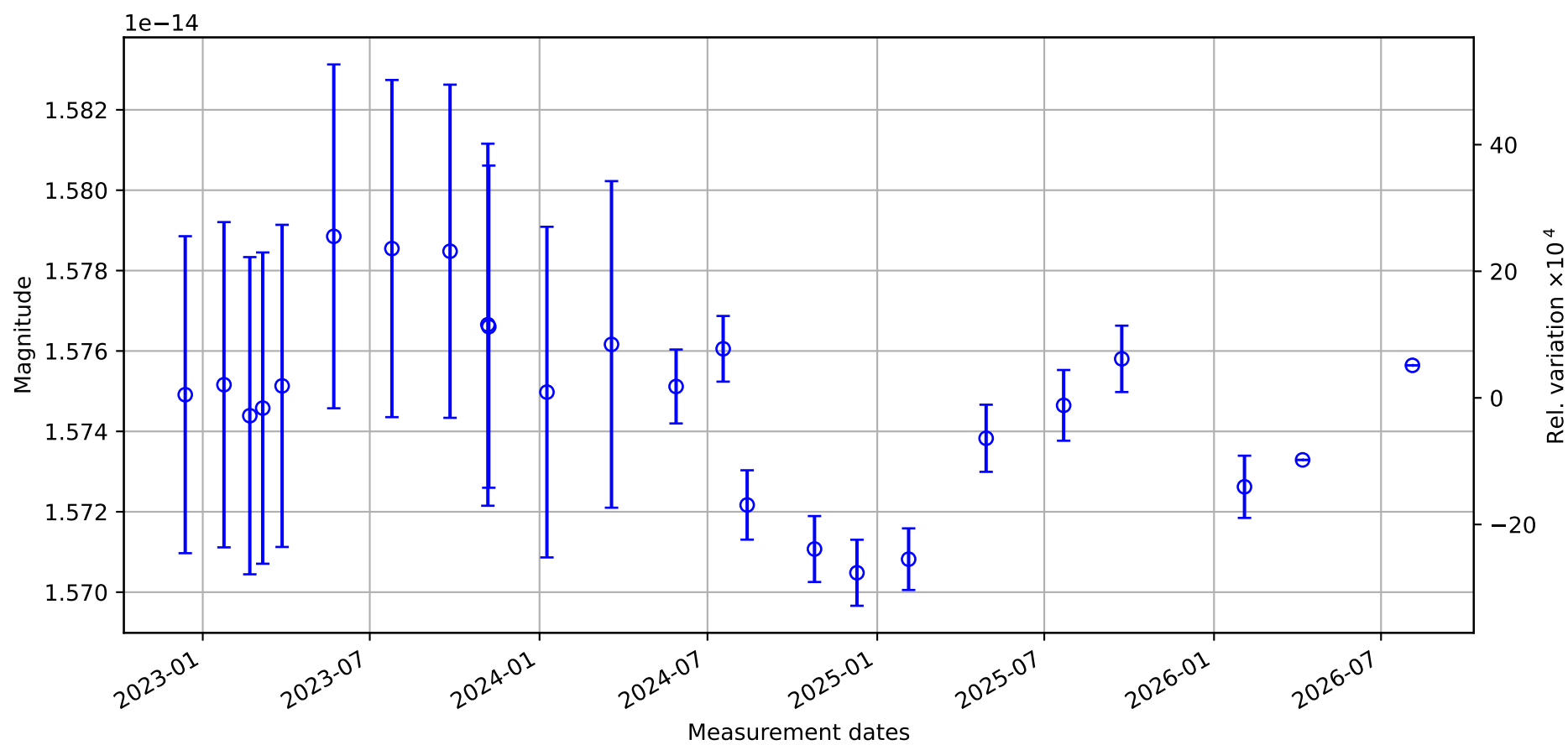
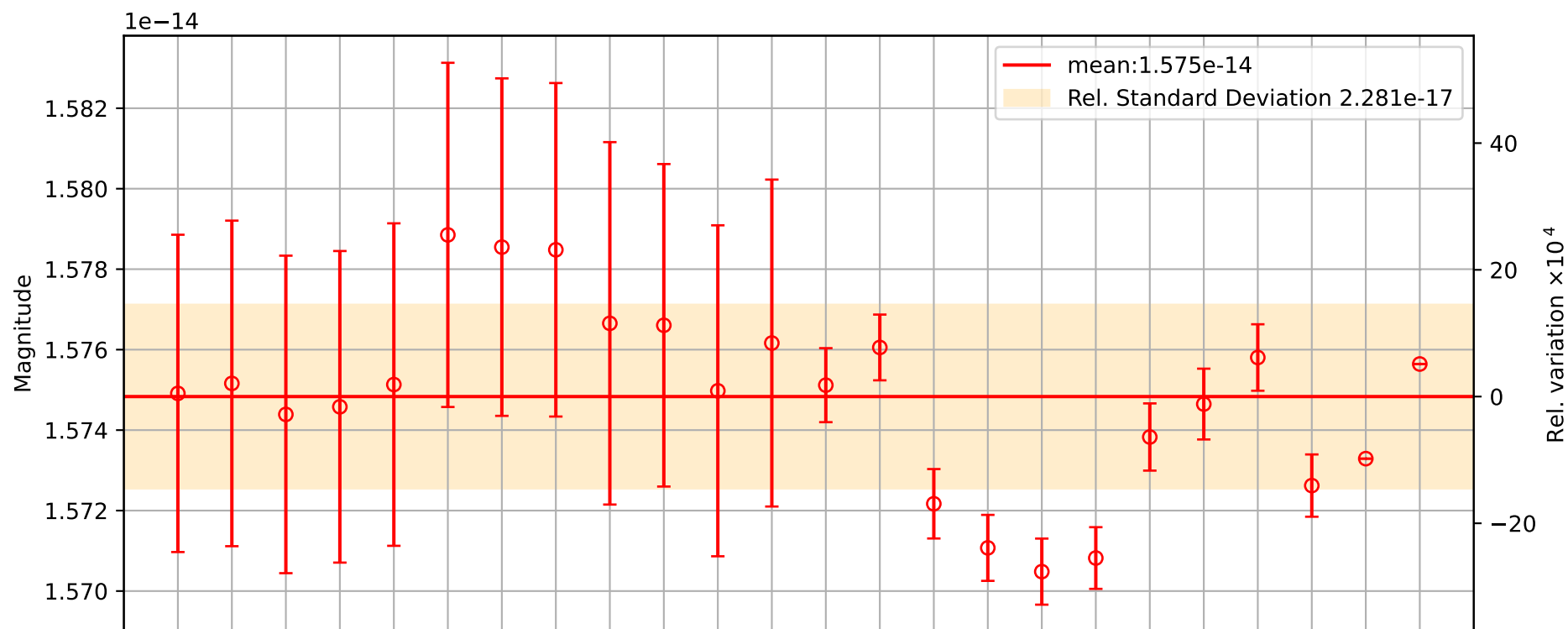
Mean value: 1.574834e-14

Standard deviation: 2.281454e-17

Standard error: 1.479512e-03

Relative Uncertainty: 1.479512e-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)

D20221213:	0.985549 $\pm$ 0.000491
D20230124:	0.986959 $\pm$ 0.000463
D20230221:	0.989722 $\pm$ 0.000432
D20230307:	0.988612 $\pm$ 0.000425
D20230328:	0.986163 $\pm$ 0.000450
D20230523:	0.985812 $\pm$ 0.000461
D20230725:	0.988268 $\pm$ 0.000456
D20230926:	0.987966 $\pm$ 0.000449
D20231106:	0.986664 $\pm$ 0.000431
D20231107:	0.986688 $\pm$ 0.000420
D20240109:	0.986184 $\pm$ 0.000438
D20240319:	0.987011 $\pm$ 0.000474
D20240528:	0.985520 $\pm$ 0.000457
D20240718:	0.985794 $\pm$ 0.000445
D20240813:	0.986034 $\pm$ 0.000452
D20241025:	0.983952 $\pm$ 0.000772
D20241210:	0.984123 $\pm$ 0.000761
D20250204:	0.981114 $\pm$ 0.000770
D20250429:	0.984776 $\pm$ 0.000795
D20250722:	0.984192 $\pm$ 0.000903
D20250923:	0.984059 $\pm$ 0.000756
D20260203:	0.982524 $\pm$ 0.000757
D20260407:	0.981895 $\pm$ 0.000801
D20260804:	0.982015 $\pm$ 0.000829

PowerImbalance
Summary of Power Imbalance
Mean value: 0.985483
Standard deviation: 0.002203
Standard error: 0.000466
Relative Uncertainty: 0.000466

Power Imbalance

