

PCAL End Station Measurement Trends

TXWS

Date None $\pm$ SD_None

D20230110	-1.0825 $\pm$ 0.0005
D20230206	-1.0819 $\pm$ 0.0005
D20230207	-1.0819 $\pm$ 0.0005
D20230227	-1.0824 $\pm$ 0.0004
D20230228	-1.0824 $\pm$ 0.0004
D20230314	-1.0822 $\pm$ 0.0004
D20230404	-1.0818 $\pm$ 0.0005
D20230613	-1.0810 $\pm$ 0.0004
D20230821	-1.0810 $\pm$ 0.0004
D20230822	-1.0821 $\pm$ 0.0004
D20231031	-1.0827 $\pm$ 0.0005
D20231205	-1.0824 $\pm$ 0.0004
D20240229	-1.0776 $\pm$ 0.0006
D20240423	-1.0760 $\pm$ 0.0005
D20240702	-1.0769 $\pm$ 0.0009
D20240730	-1.0765 $\pm$ 0.0006
D20240924	-1.0773 $\pm$ 0.0006
D20241126	-1.0777 $\pm$ 0.0006
D20250128	-1.0777 $\pm$ 0.0006
D20250325	-1.0784 $\pm$ 0.0006
D20250701	-1.0774 $\pm$ 0.0006
D20250819	-1.0774 $\pm$ 0.0005
D20251104	-1.0783 $\pm$ 0.0005
D20260127	-1.0779 $\pm$ 0.0005
D20260210	-1.0792 $\pm$ 0.0006

Description:

Tx/WS ratio:

This ratio, α TW, is the Tx to Working Standard output with the backgrounds subtracted and is made using M1 - M7

TXWS

Summary of TS / WS ratio

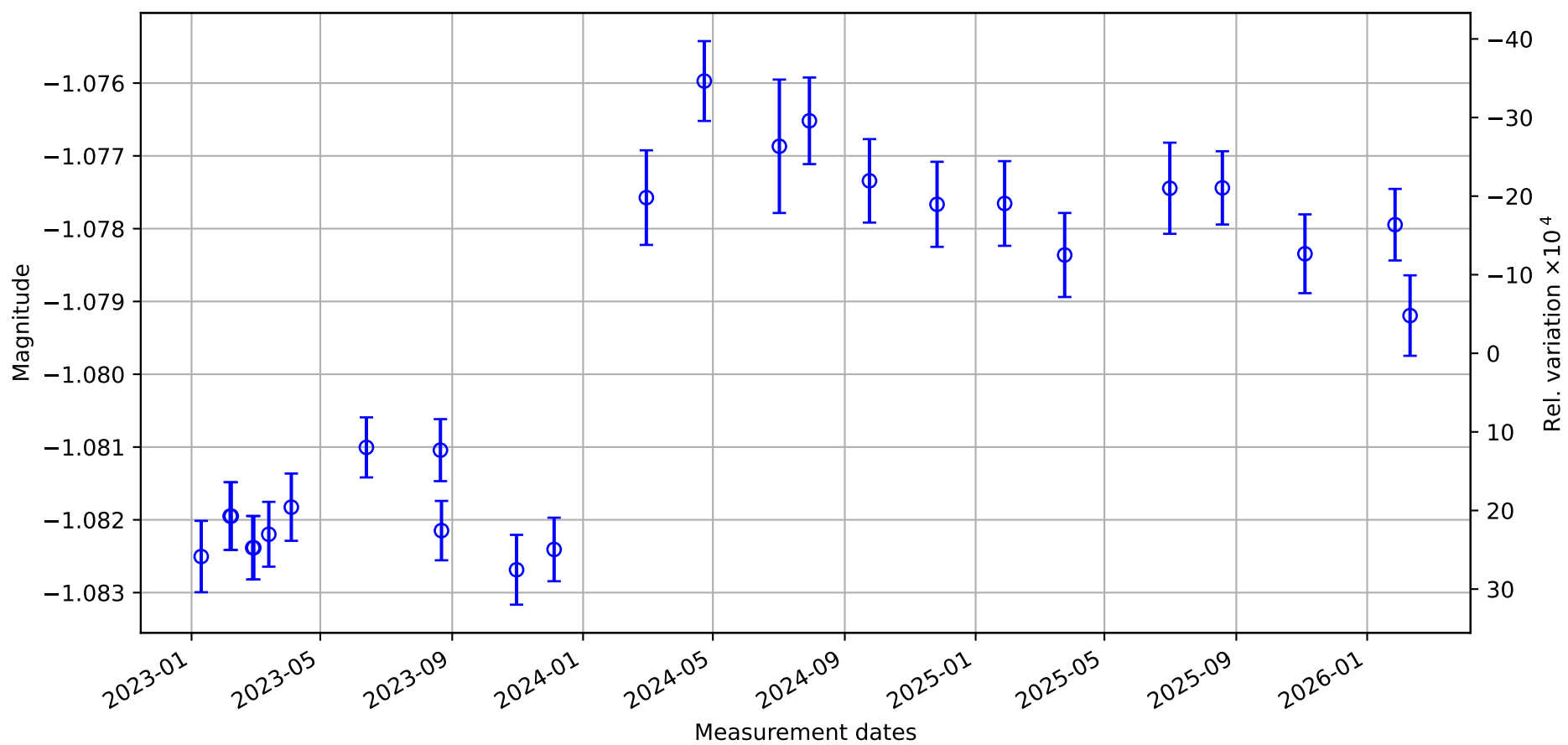
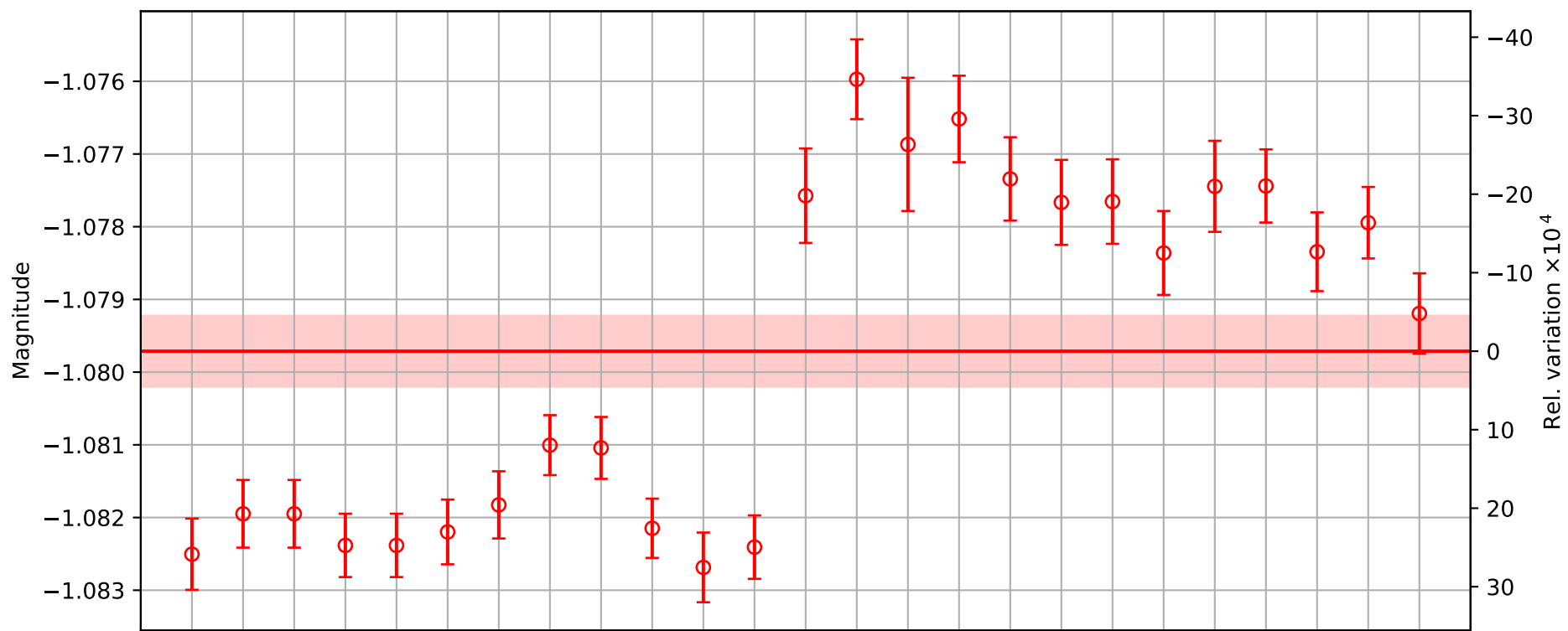
Mean value: -1.079712

Standard deviation: 0.002385

Standard error: 0.000487

Relative Standard error: -0.000451

TS / WS ratio



RXWS

Date None ± SD_None

D20230110	-1.3881 ± 0.0004
D20230206	-1.3873 ± 0.0004
D20230207	-1.3873 ± 0.0004
D20230227	-1.3886 ± 0.0004
D20230228	-1.3886 ± 0.0004
D20230314	-1.3889 ± 0.0003
D20230404	-1.3882 ± 0.0003
D20230613	-1.3866 ± 0.0004
D20230821	-1.3863 ± 0.0004
D20230822	-1.3874 ± 0.0004
D20231031	-1.3900 ± 0.0004
D20231205	-1.3897 ± 0.0004
D20240229	-1.3905 ± 0.0005
D20240423	-1.3913 ± 0.0005
D20240702	-1.3901 ± 0.0008
D20240730	-1.3895 ± 0.0006
D20240924	-1.3904 ± 0.0006
D20241126	-1.3920 ± 0.0006
D20250128	-1.3920 ± 0.0006
D20250325	-1.3918 ± 0.0006
D20250701	-1.3911 ± 0.0006
D20250819	-1.3912 ± 0.0005
D20251104	-1.3929 ± 0.0006
D20260127	-1.3936 ± 0.0006
D20260210	-1.3938 ± 0.0028

Description:

Rx/WS ratio

This ratio, α_{RW} , is the Rx to Working Standard output with the backgrounds subtracted and is made using M7 - M9.

RXWS

Summary of RX / WS ratio

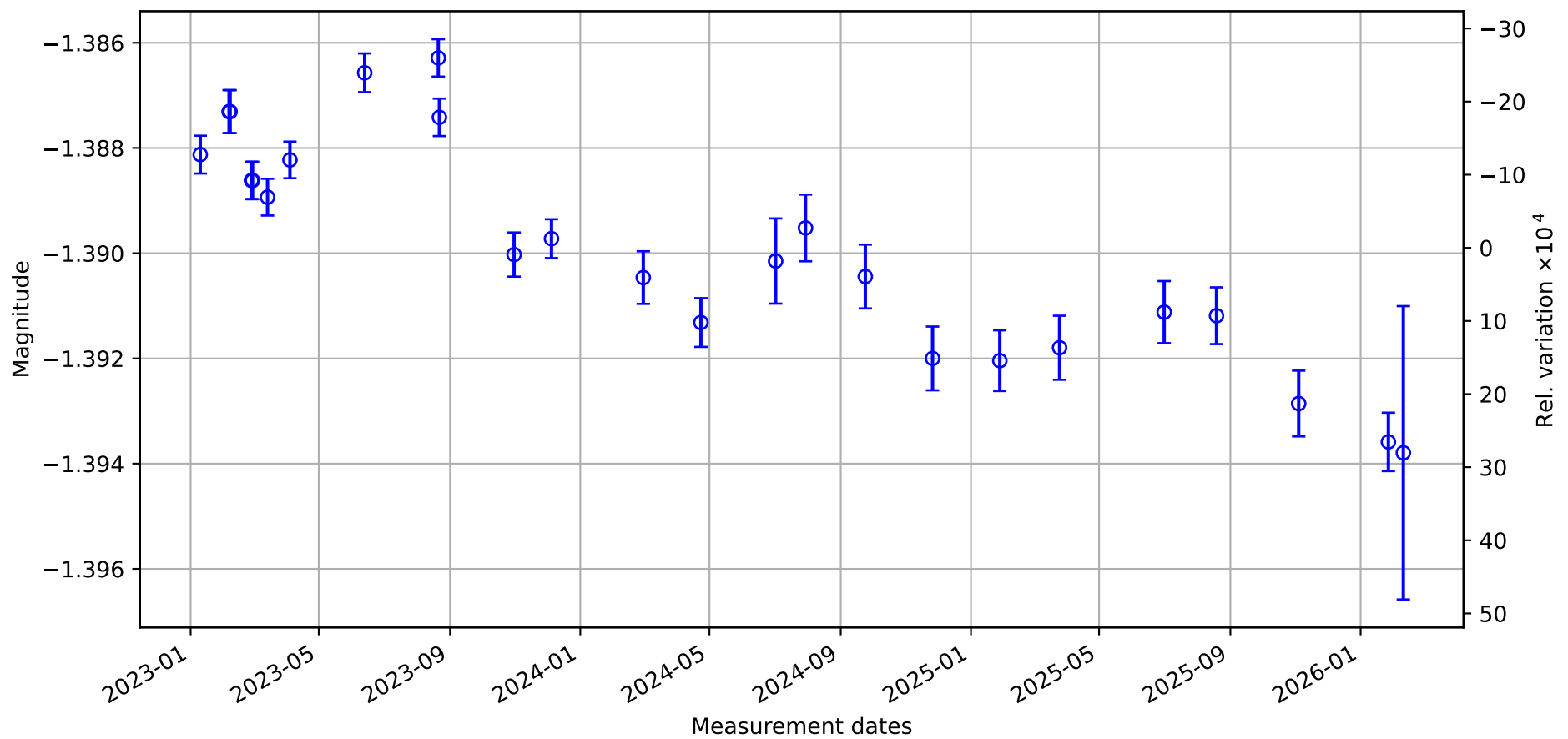
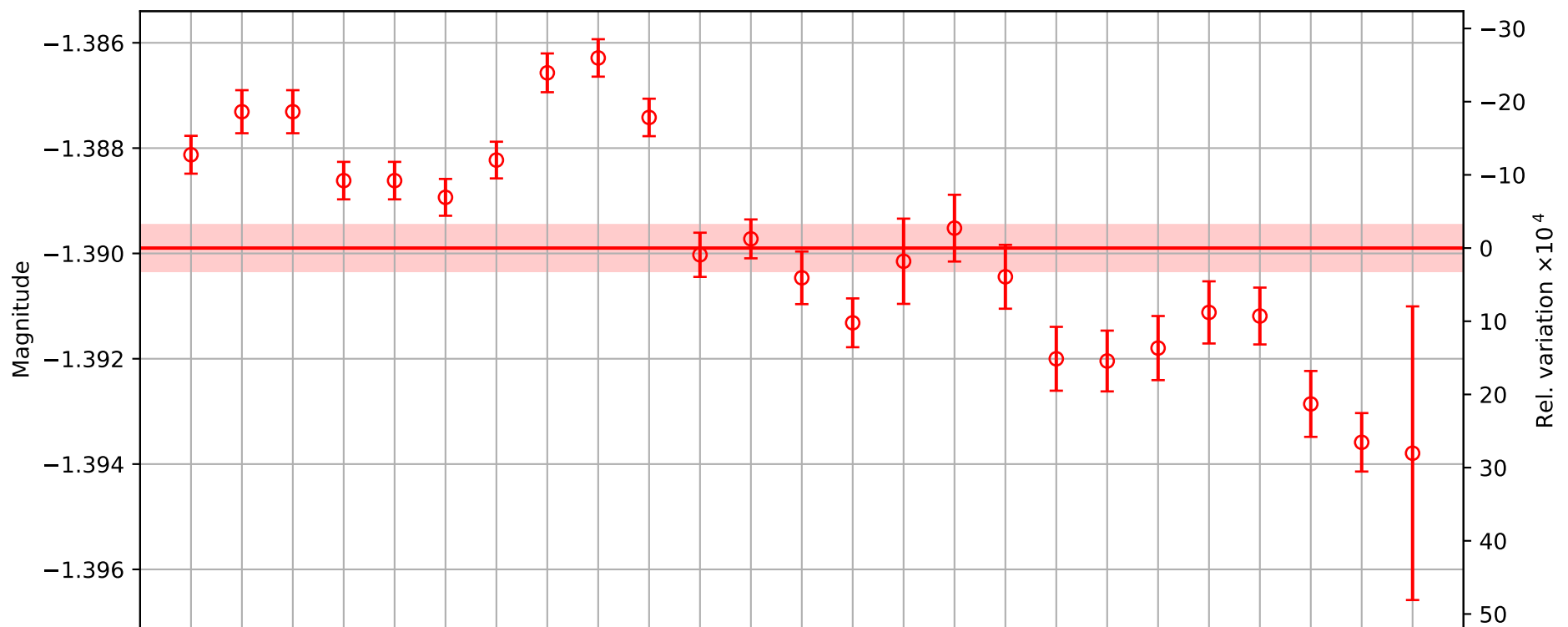
Mean value: -1.389898

Standard deviation: 0.002141

Standard error: 0.000437

Relative Standard error: -0.000314

RX / WS ratio



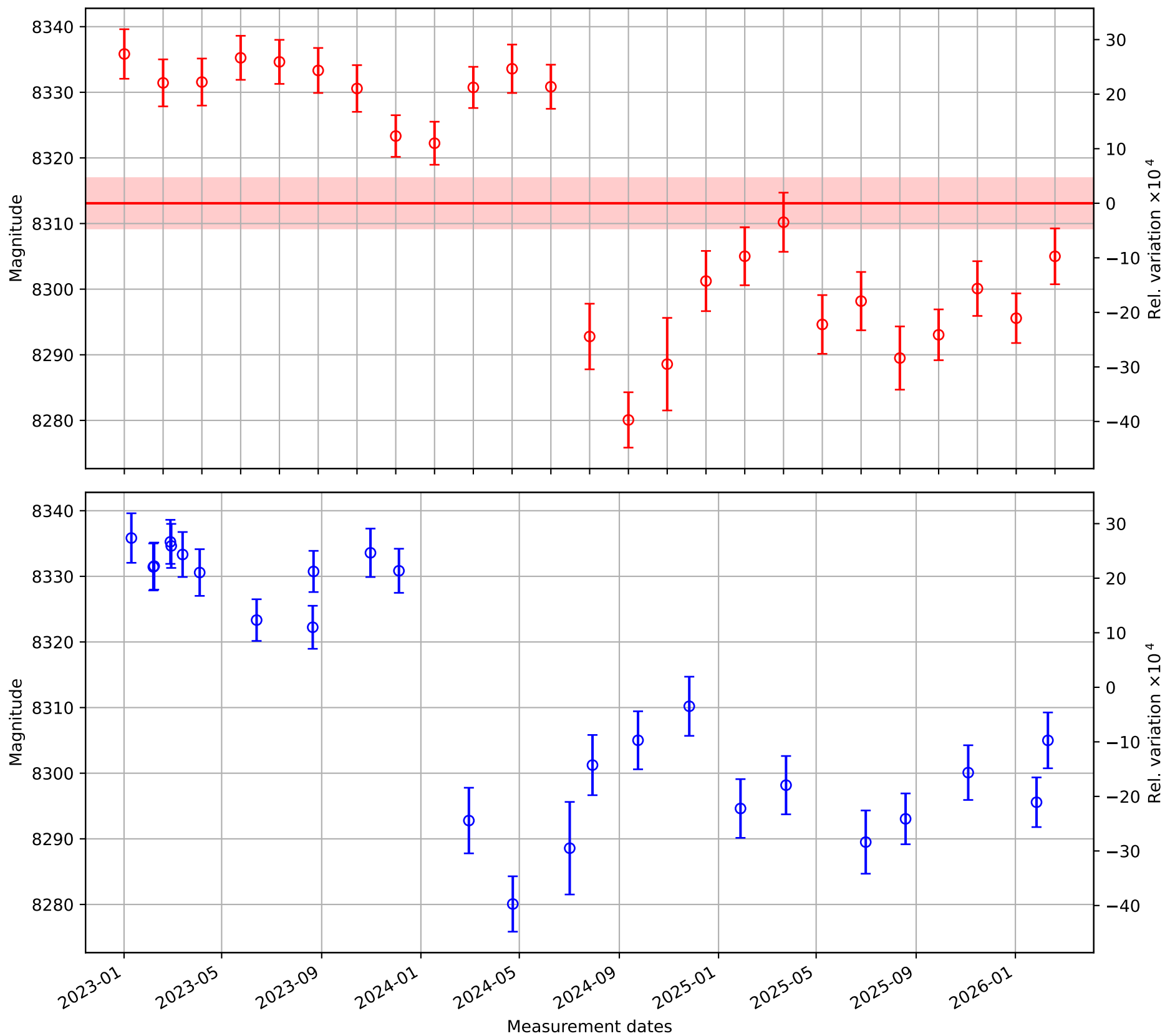
	rho_T
Date m5 ± SD_m5	
D20230110	8335.8363 ± 3.7737
D20230206	8331.4346 ± 3.5832
D20230207	8331.5608 ± 3.5832
D20230227	8335.2565 ± 3.3557
D20230228	8334.6371 ± 3.3555
D20230314	8333.3272 ± 3.4285
D20230404	8330.5796 ± 3.5576
D20230613	8323.3328 ± 3.1747
D20230821	8322.2378 ± 3.2788
D20230822	8330.7448 ± 3.1393
D20231031	8333.5847 ± 3.6905
D20231205	8330.8458 ± 3.3593
D20240229	8292.7841 ± 4.9992
D20240423	8280.0701 ± 4.2208
D20240702	8288.5717 ± 7.0540
D20240730	8301.2386 ± 4.5879
D20240924	8305.0146 ± 4.4201
D20241126	8310.1994 ± 4.5070
D20250128	8294.6229 ± 4.4760
D20250325	8298.1767 ± 4.4438
D20250701	8289.5025 ± 4.8182
D20250819	8293.0446 ± 3.8730
D20251104	8300.0920 ± 4.1682
D20260127	8295.5749 ± 3.7830
D20260210	8305.0023 ± 4.2548

Description:

TX Responsivity rho_T: $\rho_{Tx} = \alpha_{TW} * \rho_{WS}$ The responsivity of the TxPD, calculated using ρ_{WS} . Trending this parameter is useful in determining if there has been a change in the input Laser Power and for estimating how much power is incident on the ETM once corrected for optical losses inside the vacuum chamber.

rho_T
Summary of TX Responsivity rho_T
Mean value: 8313.090897
Standard deviation: 18.799732
Standard error: 3.836664
Relative Standard error: 0.000462

TX Responsivity ρ_T



	rho_R
Date	None ± SD_None
D20230110	10689.2786 ± 2.7664
D20230206	10682.8253 ± 3.1470
D20230207	10682.9872 ± 3.1471
D20230227	10693.5125 ± 2.7393
D20230228	10692.7178 ± 2.7391
D20230314	10695.3109 ± 2.6911
D20230404	10690.0120 ± 2.6817
D20230613	10676.0753 ± 2.8342
D20230821	10672.1188 ± 2.7358
D20230822	10680.8116 ± 2.7371
D20231031	10699.2242 ± 3.2295
D20231205	10696.1371 ± 2.8415
D20240229	10700.7205 ± 3.8462
D20240423	10706.7924 ± 3.5673
D20240702	10699.8690 ± 6.2313
D20240730	10714.8547 ± 4.8884
D20240924	10718.6424 ± 4.6756
D20241126	10734.1288 ± 4.6754
D20250128	10714.4497 ± 4.4426
D20250325	10710.1187 ± 4.6850
D20250701	10702.8135 ± 4.5407
D20250819	10707.9670 ± 4.1548
D20251104	10720.9199 ± 4.8150
D20260127	10724.6672 ± 4.2715
D20260210	10726.0242 ± 21.4567

Description:

RX Responsivity rho_R: $p_{Rx} = \alpha_{RW} * p_{WS}$ The responsivity of the RxPD, calculated using pWS. Trending this parameter is useful in estimating how much power is incident on the ETM once corrected for optical losses inside the vacuum chamber.

rho_R

Summary of RX Responsivity rho_R

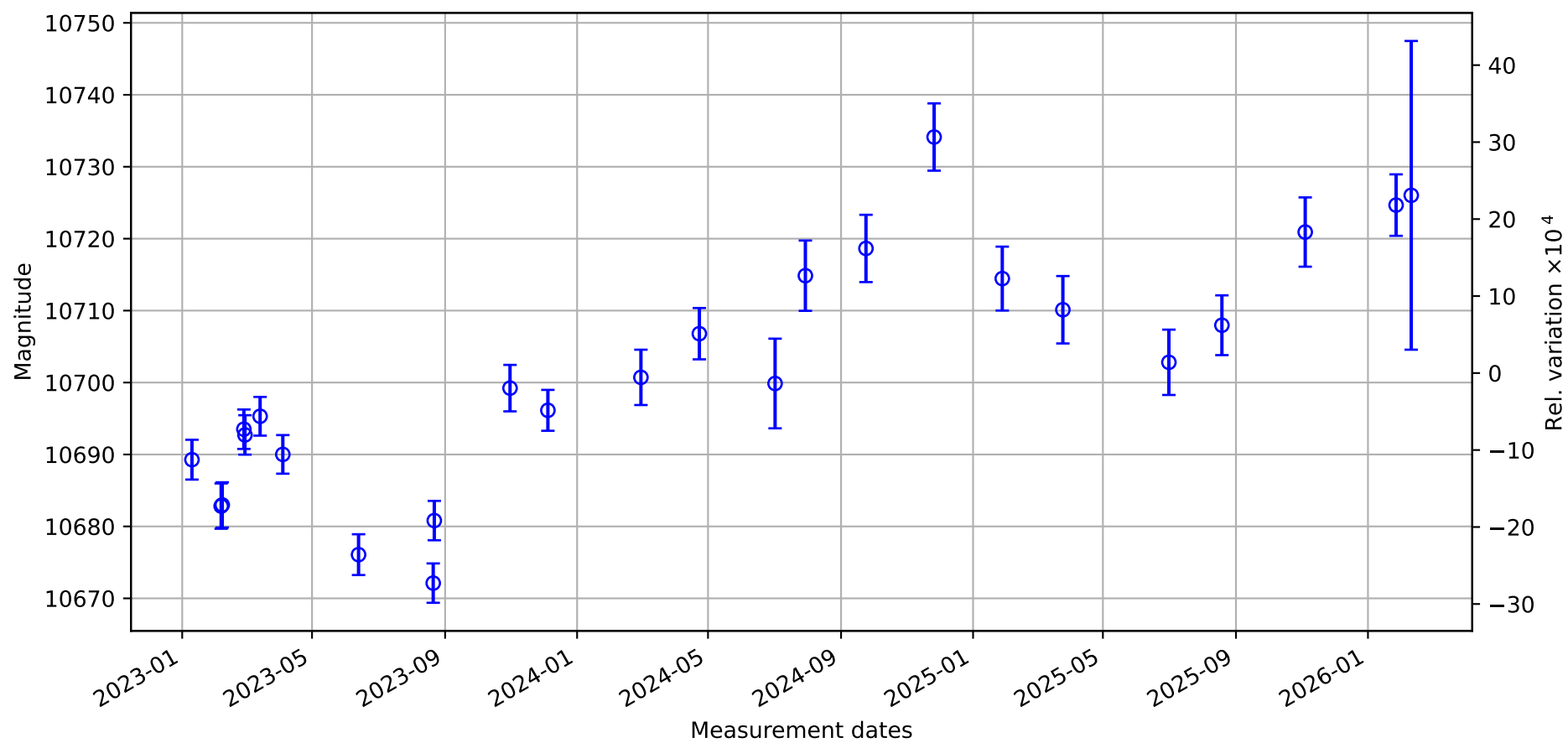
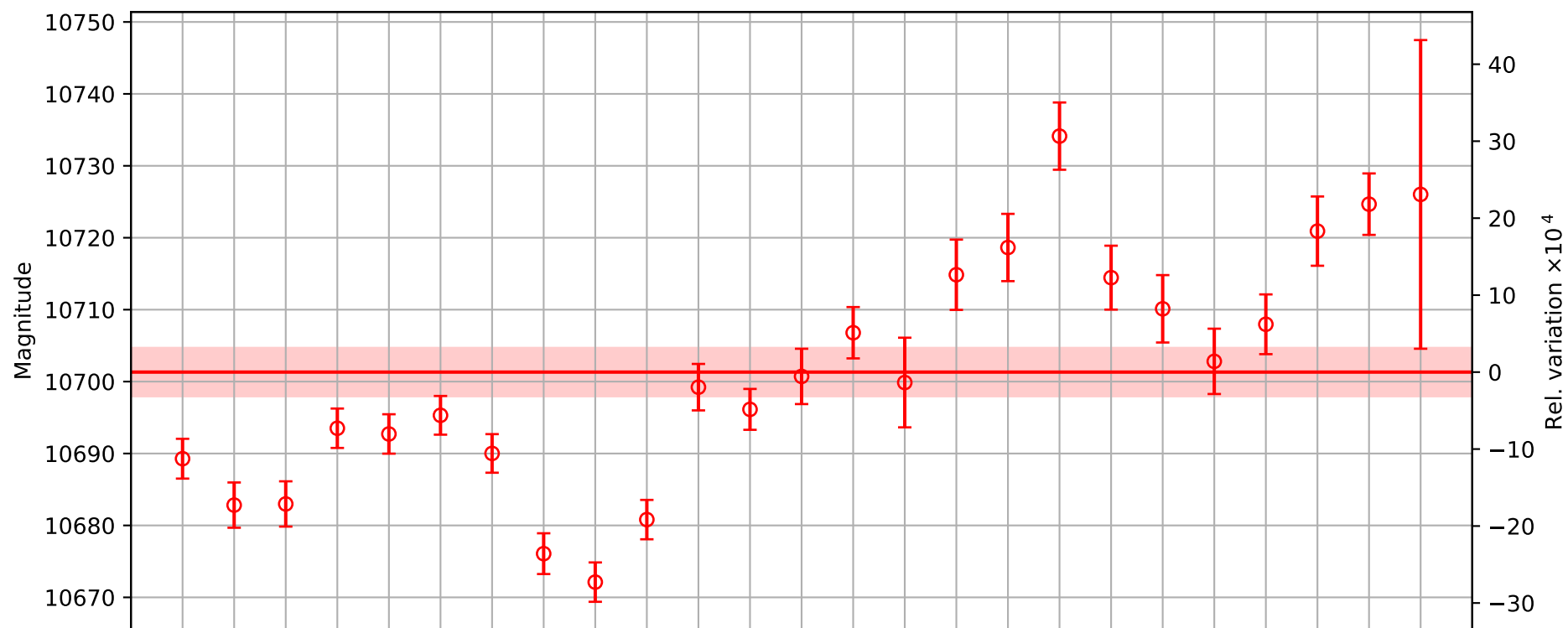
Mean value: 10701.319162

Standard deviation: 16.446599

Standard error: 3.356435

Relative Standard error: 0.000314

RX Responsivity rho_R



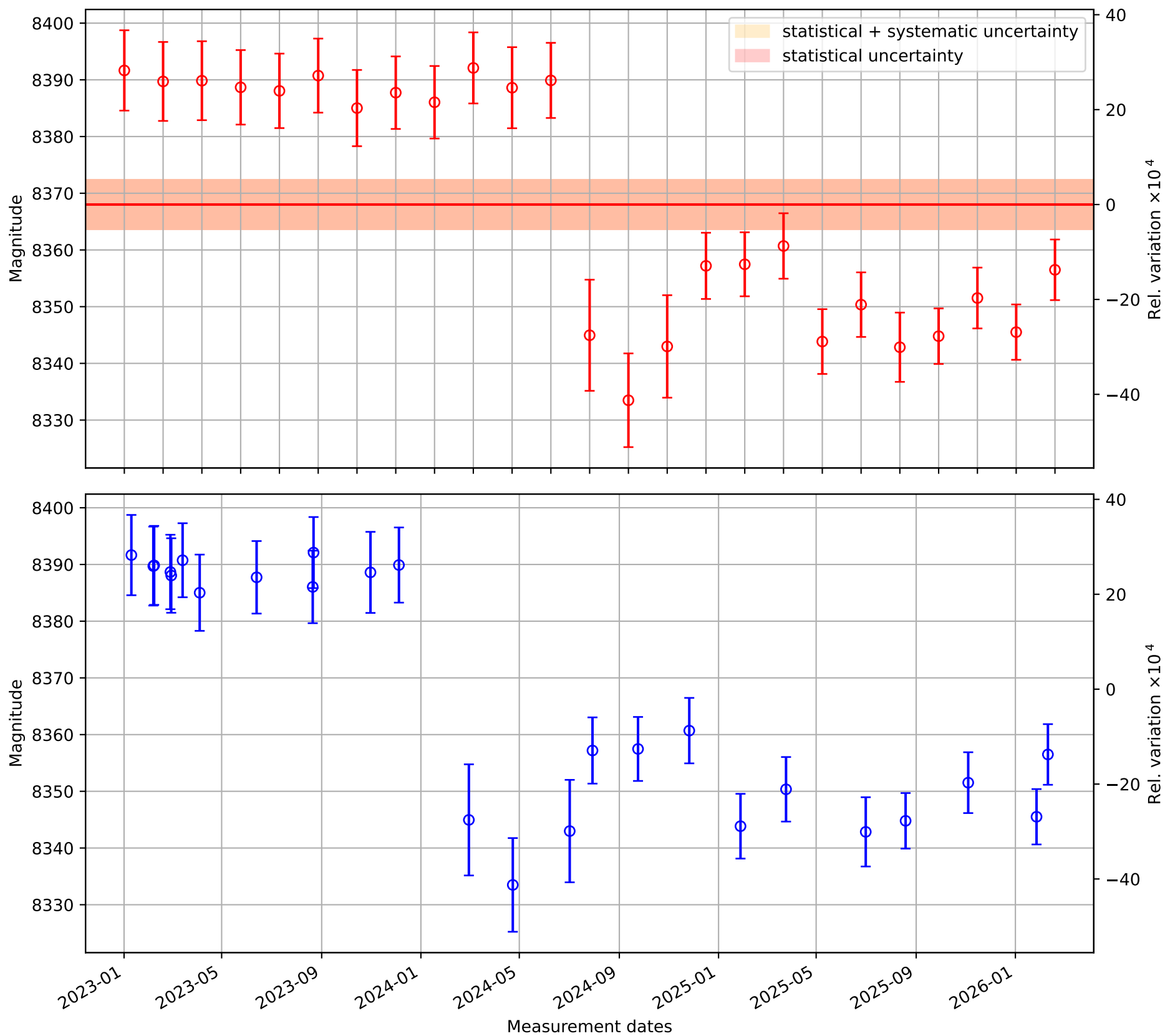
	rhoT_prime
Date	None ± SD_None
D20230110	8391.6574 ± 7.0818
D20230206	8389.7169 ± 6.9611
D20230207	8389.8439 ± 6.9612
D20230227	8388.6783 ± 6.5688
D20230228	8388.0549 ± 6.5683
D20230314	8390.7454 ± 6.5279
D20230404	8385.0193 ± 6.7238
D20230613	8387.7359 ± 6.3941
D20230821	8386.0437 ± 6.3956
D20230822	8392.0998 ± 6.2670
D20231031	8388.6083 ± 7.1489
D20231205	8389.8996 ± 6.6251
D20240229	8344.9589 ± 9.7997
D20240423	8333.4924 ± 8.2620
D20240702	8342.9862 ± 9.0346
D20240730	8357.1960 ± 5.8391
D20240924	8357.4704 ± 5.6429
D20241126	8360.7000 ± 5.7712
D20250128	8343.8479 ± 5.7107
D20250325	8350.3545 ± 5.6914
D20250701	8342.8482 ± 6.1068
D20250819	8344.7947 ± 4.8963
D20251104	8351.5242 ± 5.3638
D20260127	8345.5094 ± 4.8815
D20260210	8356.4986 ± 5.3455

Description:

Tx Responsivity Corrected for Optical Efficiency:
 $\rho_{Tx}' = \rho_{Tx} * ET$
 Rho_Tx^Prime is the estimated responsivity of the Tx integrating sphere if the Tx Sphere were to be located at ETM. This provides a nice sanity check for the Rx Sphere, which historically has been the main sensor for calibration.

 Summary of Tx Responsivity Corrected
 for Optical Efficiency
 Mean value: 8368.011376
 Standard deviation: 21.359057
 Standard error: 4.358973
 Relative Standard error: 0.000521

Tx Responsivity Corrected for Optical Efficiency



	rhoR_prime
Date	None ± SD_None
D20230110	10629.9242 ± 8.0551
D20230206	10620.3530 ± 8.1594
D20230207	10620.5139 ± 8.1595
D20230227	10637.1713 ± 7.6462
D20230228	10636.3809 ± 7.6456
D20230314	10633.8774 ± 7.5141
D20230404	10632.3603 ± 7.6934
D20230613	10605.8257 ± 7.5452
D20230821	10602.6395 ± 7.4380
D20230822	10614.4571 ± 7.3641
D20231031	10640.8070 ± 8.3872
D20231205	10632.6039 ± 7.7518
D20240229	10645.5847 ± 11.3904
D20240423	10649.9286 ± 9.7264
D20240702	10641.8462 ± 9.4440
D20240730	10654.8891 ± 6.6613
D20240924	10663.1539 ± 6.4237
D20241126	10681.0993 ± 6.5151
D20250128	10663.0264 ± 6.3007
D20250325	10654.9740 ± 6.4735
D20250701	10646.1462 ± 6.5451
D20250819	10653.3380 ± 5.6041
D20251104	10666.6871 ± 6.4178
D20260127	10672.2946 ± 5.7749
D20260210	10671.7226 ± 21.7359

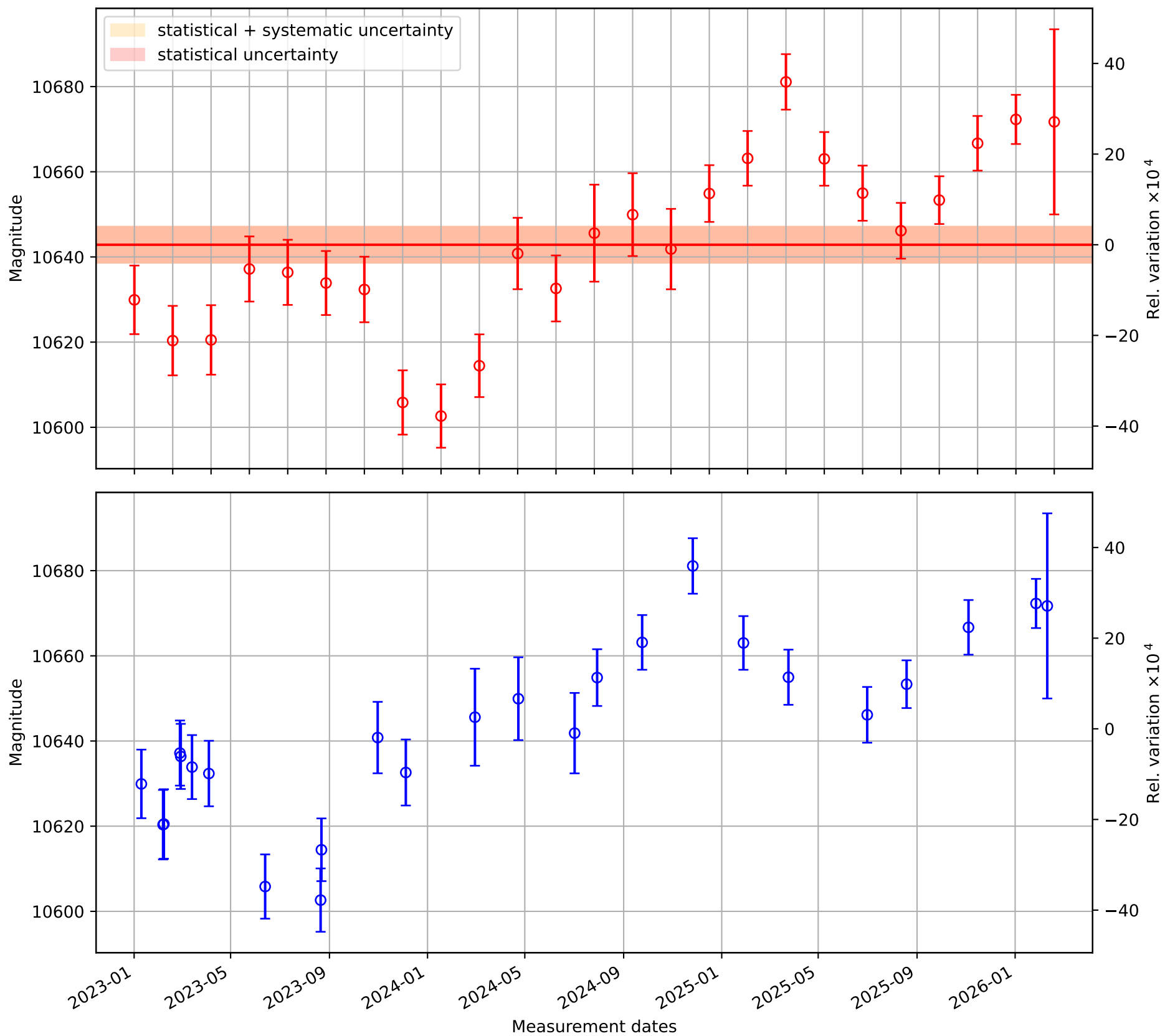
Description:

Rx Responsivity Corrected for Optical Efficiency:
 $\rho_{Rx}' = \rho_{Rx} / ER$
 Rho_Rx^Prime is the estimated responsivity of the Rx integrating sphere if the Rx Sphere were to be located at ETM.

Summary of Rx Responsivity Corrected for Optical Efficiency

Mean value: 10642.864194
 Standard deviation: 20.778869
 Standard error: 4.240568
 Relative Standard error: 0.000398

Rx Responsivity Corrected for Optical Efficiency



	WS
Date	WS $\pm$ SD_WS
D20230110	-4.7051 $\pm$ 0.0000
D20230206	-4.7051 $\pm$ 0.0000
D20230207	-4.7051 $\pm$ 0.0000
D20230227	-4.7051 $\pm$ 0.0000
D20230228	-4.7051 $\pm$ 0.0000
D20230314	-4.7051 $\pm$ 0.0000
D20230404	-4.7051 $\pm$ 0.0000
D20230613	-4.7051 $\pm$ 0.0000
D20230821	-4.7051 $\pm$ 0.0000
D20230822	-4.7051 $\pm$ 0.0000
D20231031	-4.7051 $\pm$ 0.0000
D20231205	-4.7051 $\pm$ 0.0000
D20240229	-4.7051 $\pm$ 0.0000
D20240423	-4.7051 $\pm$ 0.0000
D20240702	-4.7023 $\pm$ 0.0000
D20240730	-4.7113 $\pm$ 0.0000
D20240924	-4.7098 $\pm$ 0.0000
D20241126	-4.7114 $\pm$ 0.0000
D20250128	-4.7024 $\pm$ 0.0000
D20250325	-4.7016 $\pm$ 0.0000
D20250701	-4.7005 $\pm$ 0.0000
D20250819	-4.7022 $\pm$ 0.0000
D20251104	-4.7018 $\pm$ 0.0000
D20260127	-4.7018 $\pm$ 0.0000
D20260210	-4.7011 $\pm$ 0.0000

Description:

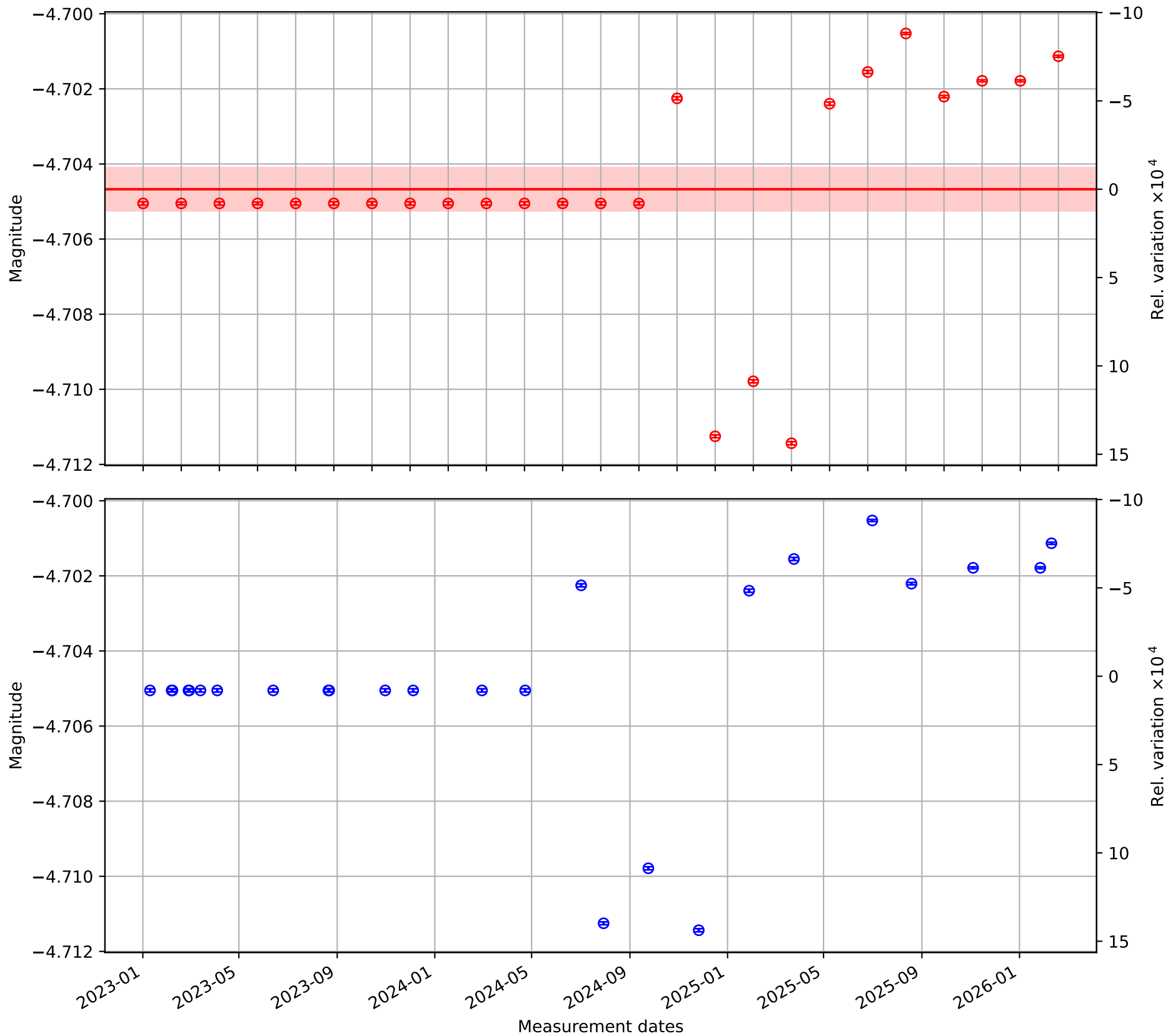
WS

WS is the Working standard Responsivity as measured from the Gold standard in the lab.

Summary of Working Standard Responsivity rho_WS

Mean value: -4.704672
Standard deviation: 0.002817
Standard error: 0.000575
Relative Standard error: -0.000122

Working Standard Responsivity rho_WS



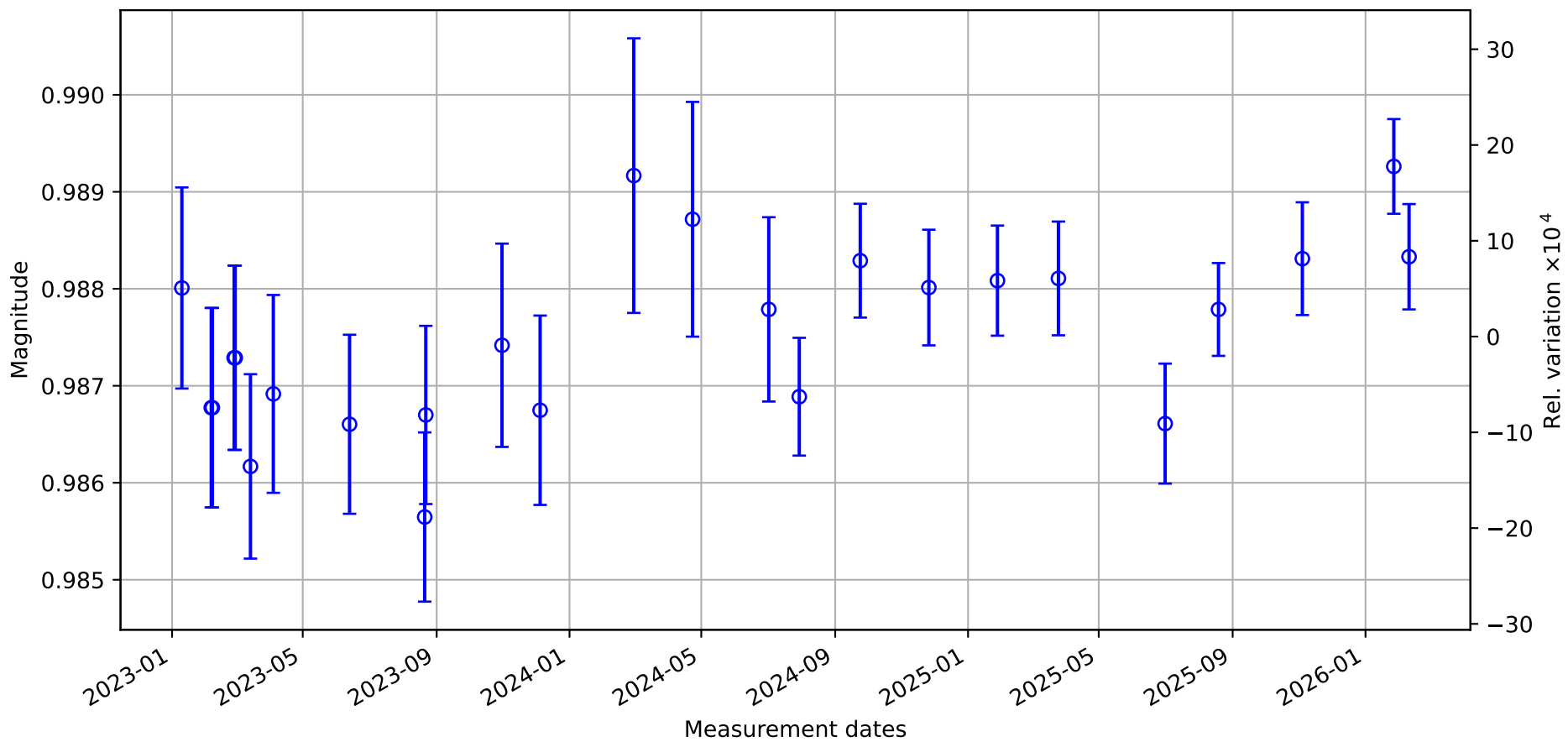
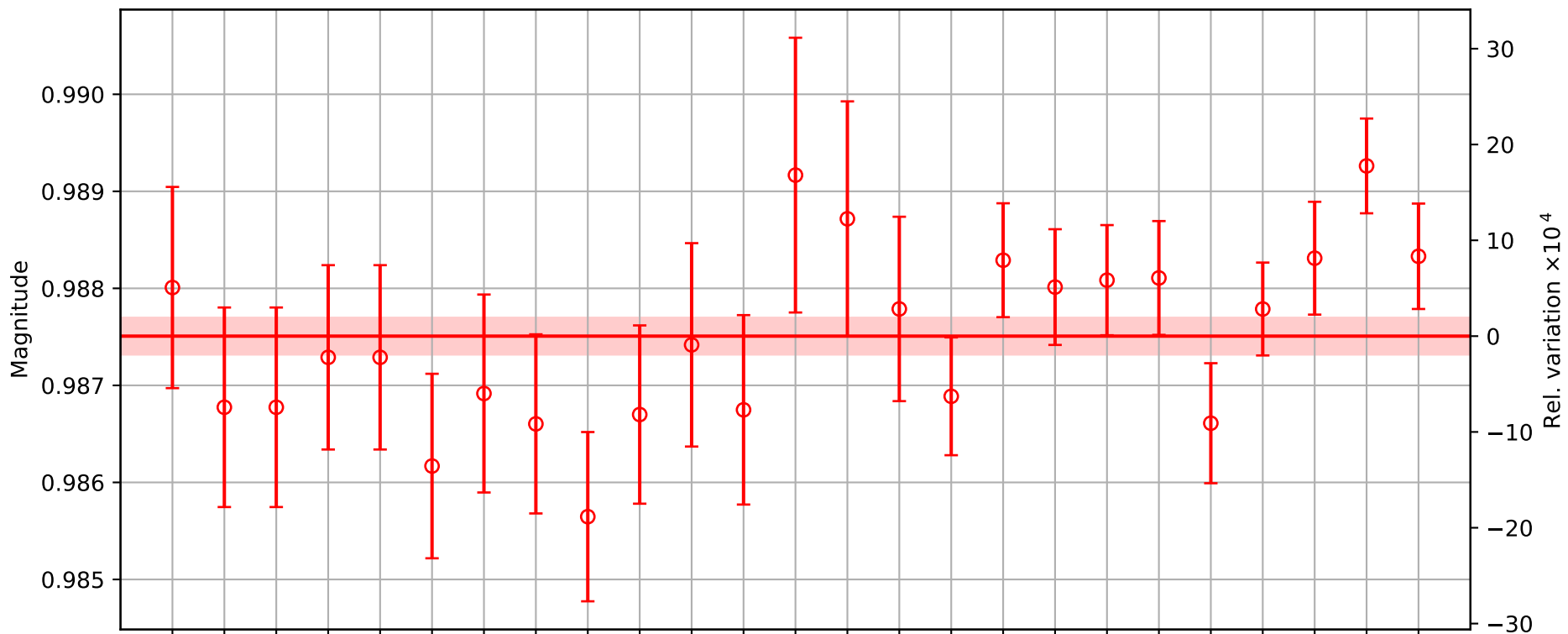
	Date	$e_i \pm SD_{e_i}$
D20230110		0.9880 ± 0.0010
D20230206		0.9868 ± 0.0010
D20230207		0.9868 ± 0.0010
D20230227		0.9873 ± 0.0009
D20230228		0.9873 ± 0.0009
D20230314		0.9862 ± 0.0010
D20230404		0.9869 ± 0.0010
D20230613		0.9866 ± 0.0009
D20230821		0.9856 ± 0.0009
D20230822		0.9867 ± 0.0009
D20231031		0.9874 ± 0.0010
D20231205		0.9867 ± 0.0010
D20240229		0.9892 ± 0.0014
D20240423		0.9887 ± 0.0012
D20240702		0.9878 ± 0.0010
D20240730		0.9869 ± 0.0006
D20240924		0.9883 ± 0.0006
D20241126		0.9880 ± 0.0006
D20250128		0.9881 ± 0.0006
D20250325		0.9881 ± 0.0006
D20250701		0.9866 ± 0.0006
D20250819		0.9878 ± 0.0005
D20251104		0.9883 ± 0.0006
D20260127		0.9893 ± 0.0005
D20260210		0.9883 ± 0.0005

Description:

Optical Efficiency (Inner beam): $e_i = (W_{ri}/T_{ti}) / (W_{ti}/T_{ti})$
 This parameter is the ratio of the Working Standard (WS) output in both the Rx module and Tx module with only the inner beam on it, normalized by the Tx Output. This parameter involves M1 and M5 and is useful for determining overall optical Efficiency.

Summary of Optical Efficiency (Inner Beam)		
Mean value:	0.987508	
Standard deviation:	0.000927	
Standard error:	0.000189	
Relative Standard error:	0.000191	

Optical Efficiency (Inner Beam)



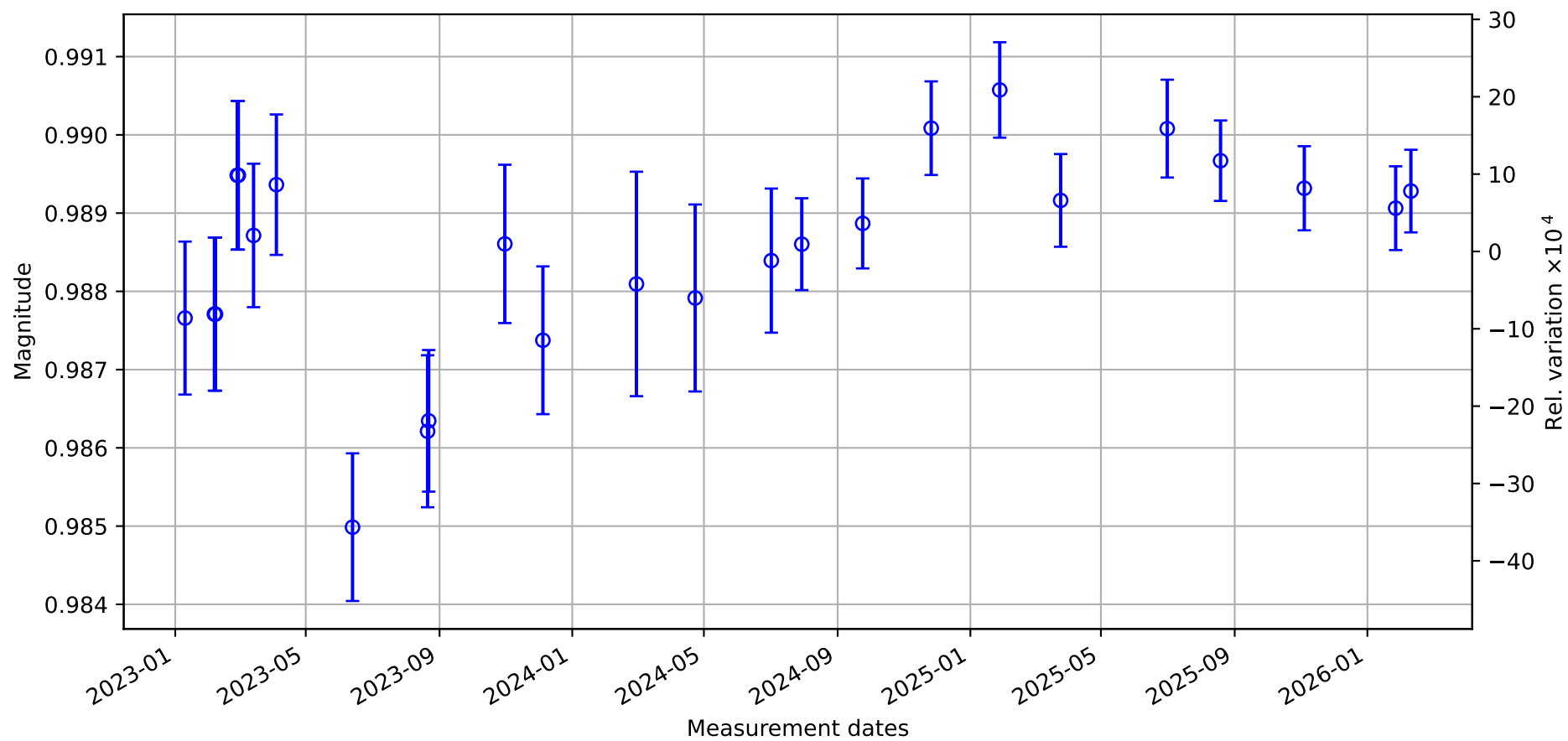
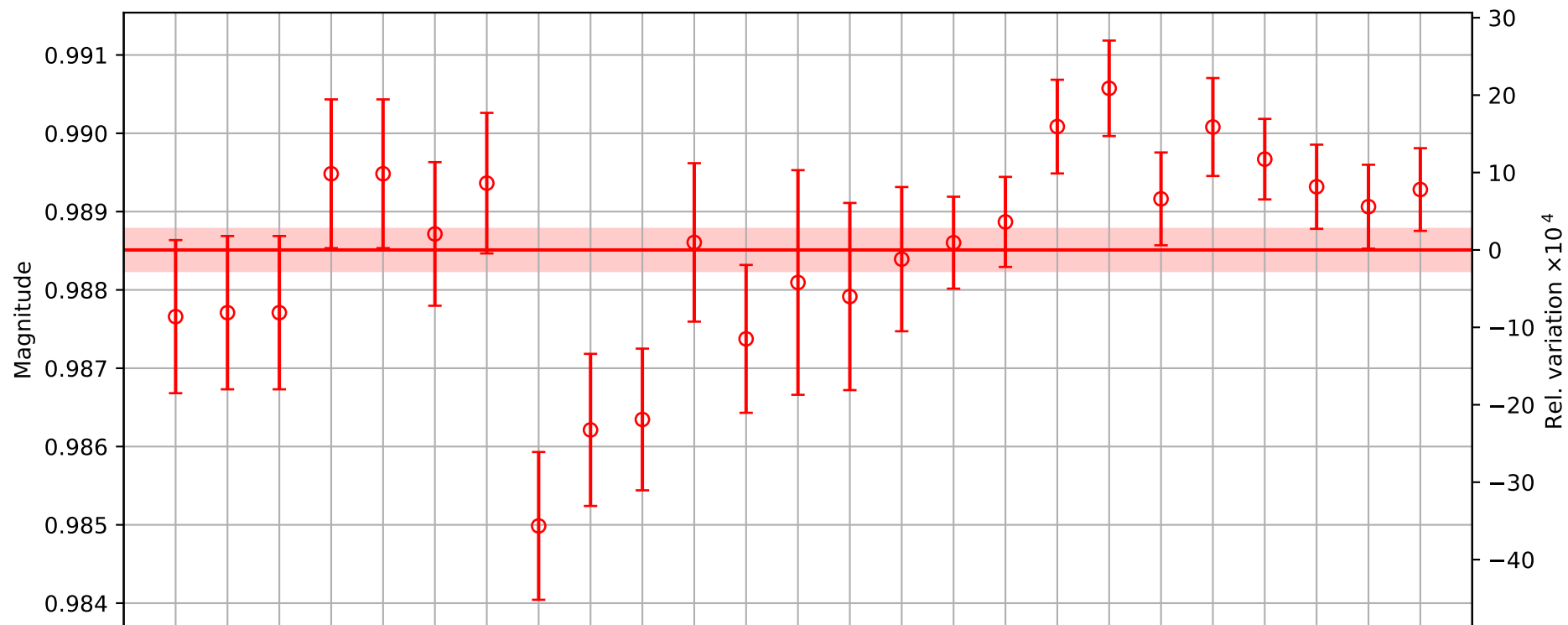
	e_o
Date	e_o ± SD_e_o
D20230110	0.9877 ± 0.0010
D20230206	0.9877 ± 0.0010
D20230207	0.9877 ± 0.0010
D20230227	0.9895 ± 0.0009
D20230228	0.9895 ± 0.0009
D20230314	0.9887 ± 0.0009
D20230404	0.9894 ± 0.0009
D20230613	0.9850 ± 0.0009
D20230821	0.9862 ± 0.0010
D20230822	0.9863 ± 0.0009
D20231031	0.9886 ± 0.0010
D20231205	0.9874 ± 0.0009
D20240229	0.9881 ± 0.0014
D20240423	0.9879 ± 0.0012
D20240702	0.9884 ± 0.0009
D20240730	0.9886 ± 0.0006
D20240924	0.9889 ± 0.0006
D20241126	0.9901 ± 0.0006
D20250128	0.9906 ± 0.0006
D20250325	0.9892 ± 0.0006
D20250701	0.9901 ± 0.0006
D20250819	0.9897 ± 0.0005
D20251104	0.9893 ± 0.0005
D20260127	0.9891 ± 0.0005
D20260210	0.9893 ± 0.0005

Description:

Optical Efficiency (Outer beam): e_o = (Wro/Tto) / (Wto/Tto)
 This parameter is the ratio of the Working Standard (WS) output in both the Rx module and Tx module with only the outer beam on it, normalized by the Tx Output. This parameter involves M2 and M4 and is useful for determining overall optical Efficiency.

Summary of Optical Efficiency (Outer Beam)	
Mean value:	0.988510
Standard deviation:	0.001316
Standard error:	0.000269
Relative Standard error:	0.000272

Optical Efficiency (Outer Beam)



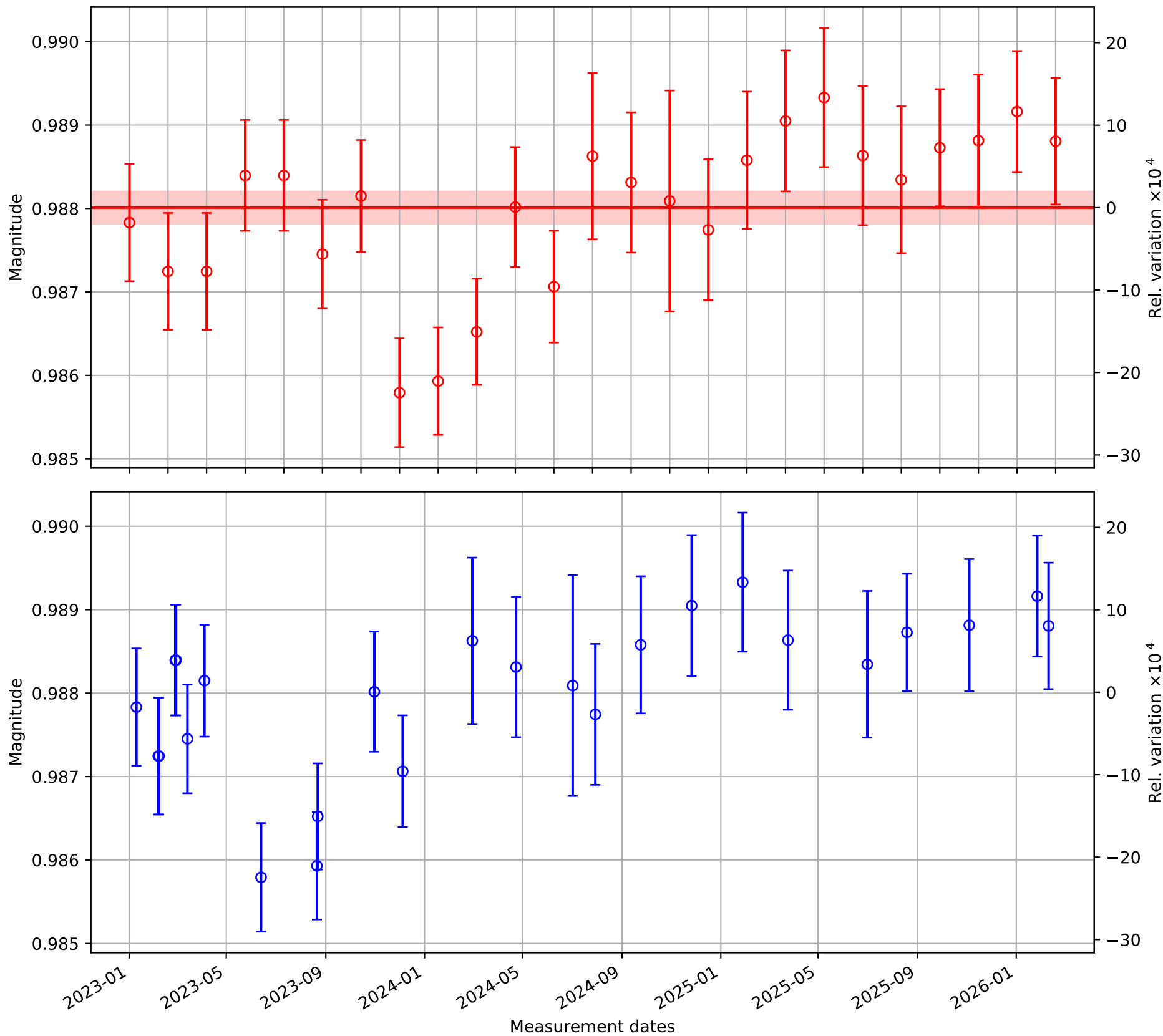
	e
Date	None $\pm$ SD_None
D20230110	0.9878 $\pm$ 0.0007
D20230206	0.9872 $\pm$ 0.0007
D20230207	0.9872 $\pm$ 0.0007
D20230227	0.9884 $\pm$ 0.0007
D20230228	0.9884 $\pm$ 0.0007
D20230314	0.9875 $\pm$ 0.0007
D20230404	0.9881 $\pm$ 0.0007
D20230613	0.9858 $\pm$ 0.0007
D20230821	0.9859 $\pm$ 0.0006
D20230822	0.9865 $\pm$ 0.0006
D20231031	0.9880 $\pm$ 0.0007
D20231205	0.9871 $\pm$ 0.0007
D20240229	0.9886 $\pm$ 0.0010
D20240423	0.9883 $\pm$ 0.0008
D20240702	0.9881 $\pm$ 0.0013
D20240730	0.9877 $\pm$ 0.0008
D20240924	0.9886 $\pm$ 0.0008
D20241126	0.9890 $\pm$ 0.0008
D20250128	0.9893 $\pm$ 0.0008
D20250325	0.9886 $\pm$ 0.0008
D20250701	0.9883 $\pm$ 0.0009
D20250819	0.9887 $\pm$ 0.0007
D20251104	0.9888 $\pm$ 0.0008
D20260127	0.9892 $\pm$ 0.0007
D20260210	0.9888 $\pm$ 0.0008

Description:

Overall Optical Efficiency: $e = (e_o + e_i)/2$
 This parameter is just the average efficiency of both the inner and outer beams. This uses M1 ,M2, M4, & M5 and is used to determine how much power is lost inside the vacuum chamber.

	e
Summary of Overall Optical Efficiency	
Mean value:	0.988011
Standard deviation:	0.000947
Standard error:	0.000193
Relative Standard error:	0.000196

Overall Optical Efficiency



	E_T
Date	E_T ± SD_E_T
D20230110	0.9933 ± 0.0007
D20230206	0.9931 ± 0.0007
D20230207	0.9931 ± 0.0007
D20230227	0.9936 ± 0.0007
D20230228	0.9936 ± 0.0007
D20230314	0.9932 ± 0.0007
D20230404	0.9935 ± 0.0007
D20230613	0.9923 ± 0.0007
D20230821	0.9924 ± 0.0006
D20230822	0.9927 ± 0.0006
D20231031	0.9934 ± 0.0007
D20231205	0.9930 ± 0.0007
D20240229	0.9937 ± 0.0010
D20240423	0.9936 ± 0.0008
D20240702	0.9935 ± 0.0007
D20240730	0.9933 ± 0.0004
D20240924	0.9937 ± 0.0004
D20241126	0.9940 ± 0.0004
D20250128	0.9941 ± 0.0004
D20250325	0.9938 ± 0.0004
D20250701	0.9936 ± 0.0004
D20250819	0.9938 ± 0.0004
D20251104	0.9938 ± 0.0004
D20260127	0.9940 ± 0.0004
D20260210	0.9938 ± 0.0004

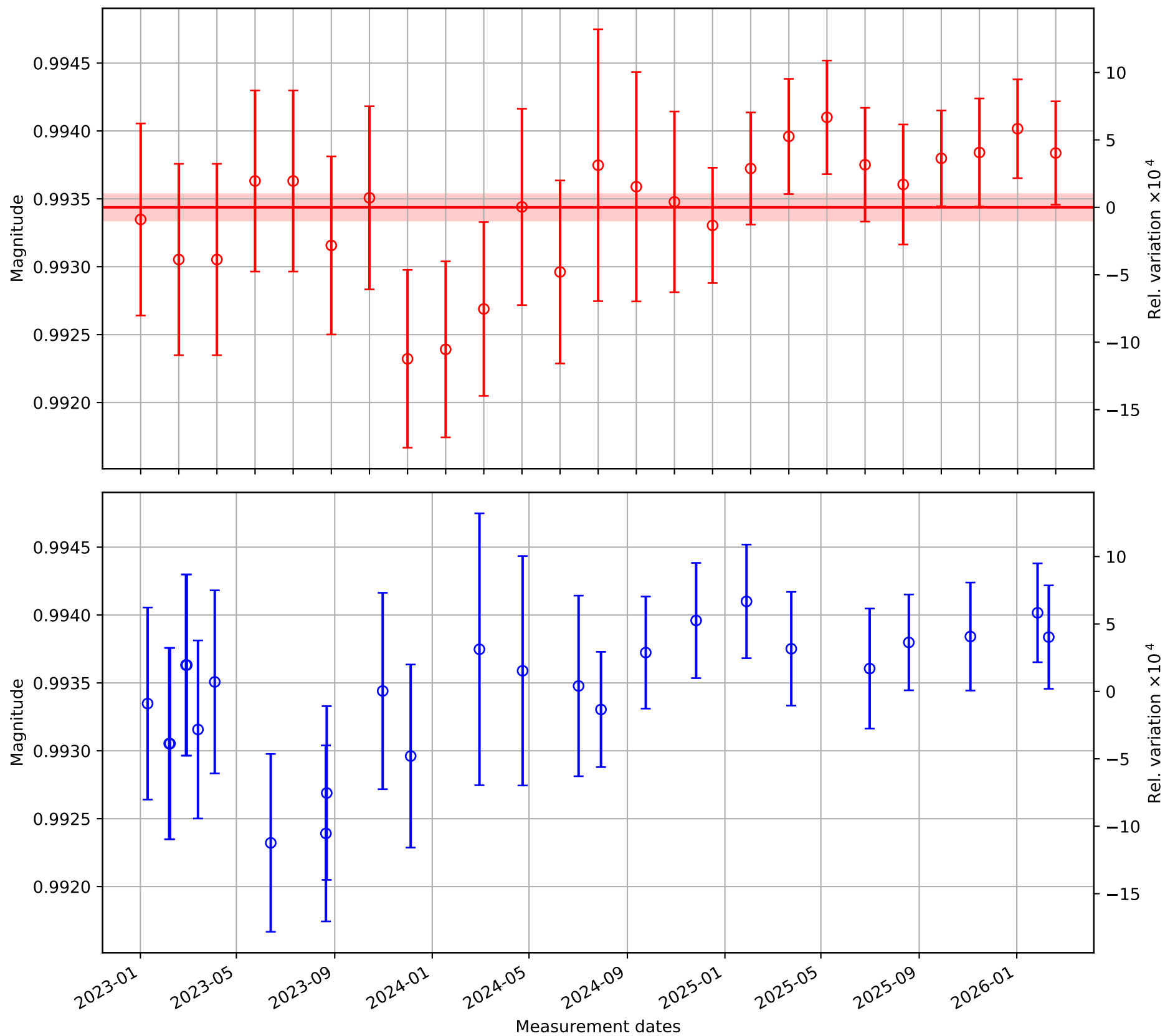
Description:

Tx side Optical Efficiency Correction Factor: $E_T = \sqrt{e \cdot \beta}$

This parameter is used to apportion the optical loss inside the vacuum chamber to before the ETM and after the ETM, and uses the Optical Efficiency (e) along with the last in-chamber measurements (DCC- T1800107). The in-chamber measurements yield a ratio of optical efficiencies between the Tx side and Rx side, referred to as β , which we assume have not changed. Applying this correction factor corrects for the optical loss on the Tx side, providing the Rx and Tx responsivities at the ETM.

Summary of Input Side Optical Efficiency	E_T
	correction factor
Mean value:	0.993438
Standard deviation:	0.000476
Standard error:	0.000097
Relative Standard error:	0.000098

Input Side Optical Efficiency correction factor



	E_R
Date	None $\pm$ SD_None
D20230110	0.9944 $\pm$ 0.0007
D20230206	0.9942 $\pm$ 0.0007
D20230207	0.9942 $\pm$ 0.0007
D20230227	0.9947 $\pm$ 0.0007
D20230228	0.9947 $\pm$ 0.0007
D20230314	0.9943 $\pm$ 0.0007
D20230404	0.9946 $\pm$ 0.0007
D20230613	0.9934 $\pm$ 0.0007
D20230821	0.9935 $\pm$ 0.0006
D20230822	0.9938 $\pm$ 0.0006
D20231031	0.9945 $\pm$ 0.0007
D20231205	0.9941 $\pm$ 0.0007
D20240229	0.9948 $\pm$ 0.0010
D20240423	0.9947 $\pm$ 0.0008
D20240702	0.9946 $\pm$ 0.0007
D20240730	0.9944 $\pm$ 0.0004
D20240924	0.9948 $\pm$ 0.0004
D20241126	0.9951 $\pm$ 0.0004
D20250128	0.9952 $\pm$ 0.0004
D20250325	0.9949 $\pm$ 0.0004
D20250701	0.9947 $\pm$ 0.0004
D20250819	0.9949 $\pm$ 0.0004
D20251104	0.9949 $\pm$ 0.0004
D20260127	0.9951 $\pm$ 0.0004
D20260210	0.9949 $\pm$ 0.0004

Summary of Output Side Optical Efficiency correction factor

Mean value: 0.994537

Standard deviation: 0.000477

Standard error: 0.000097

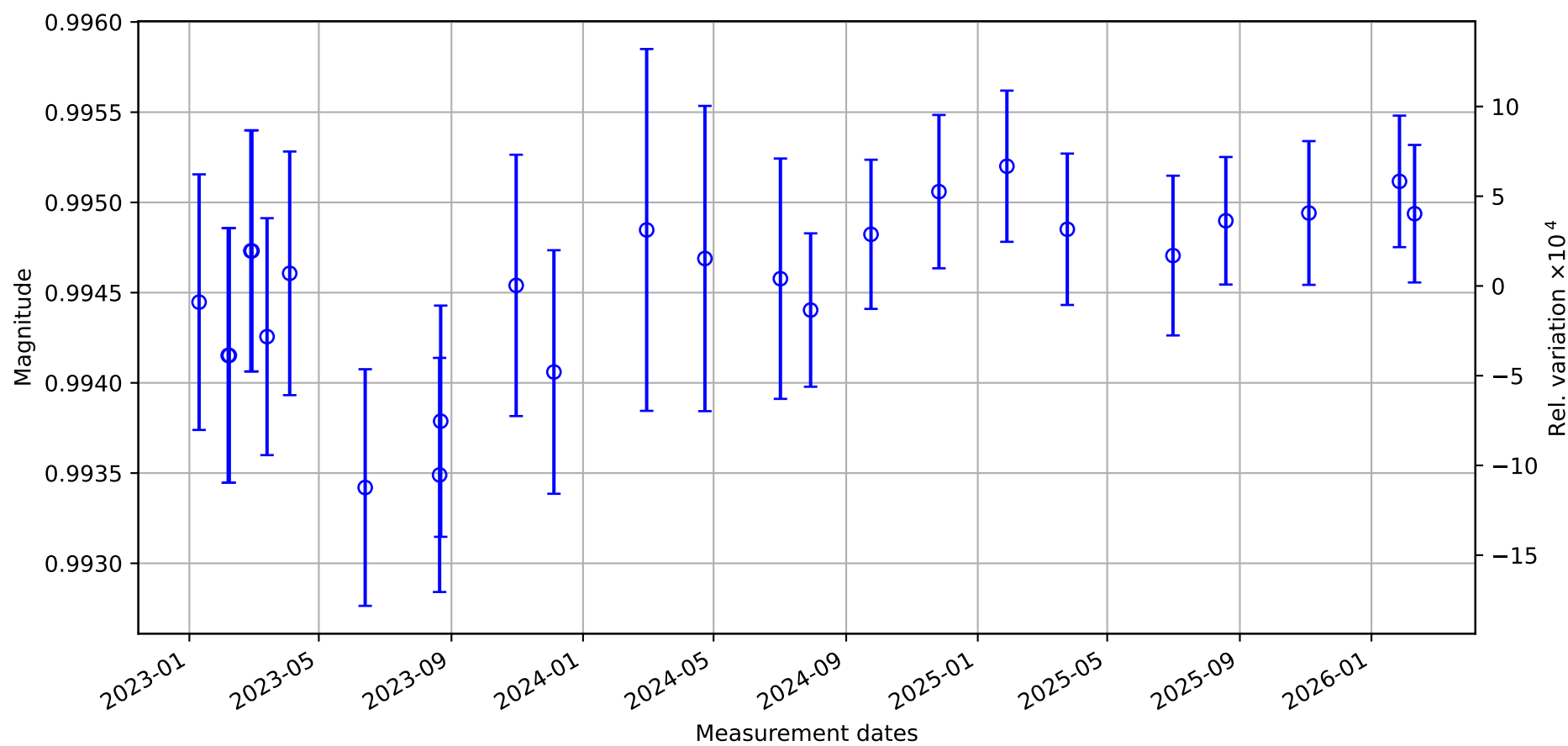
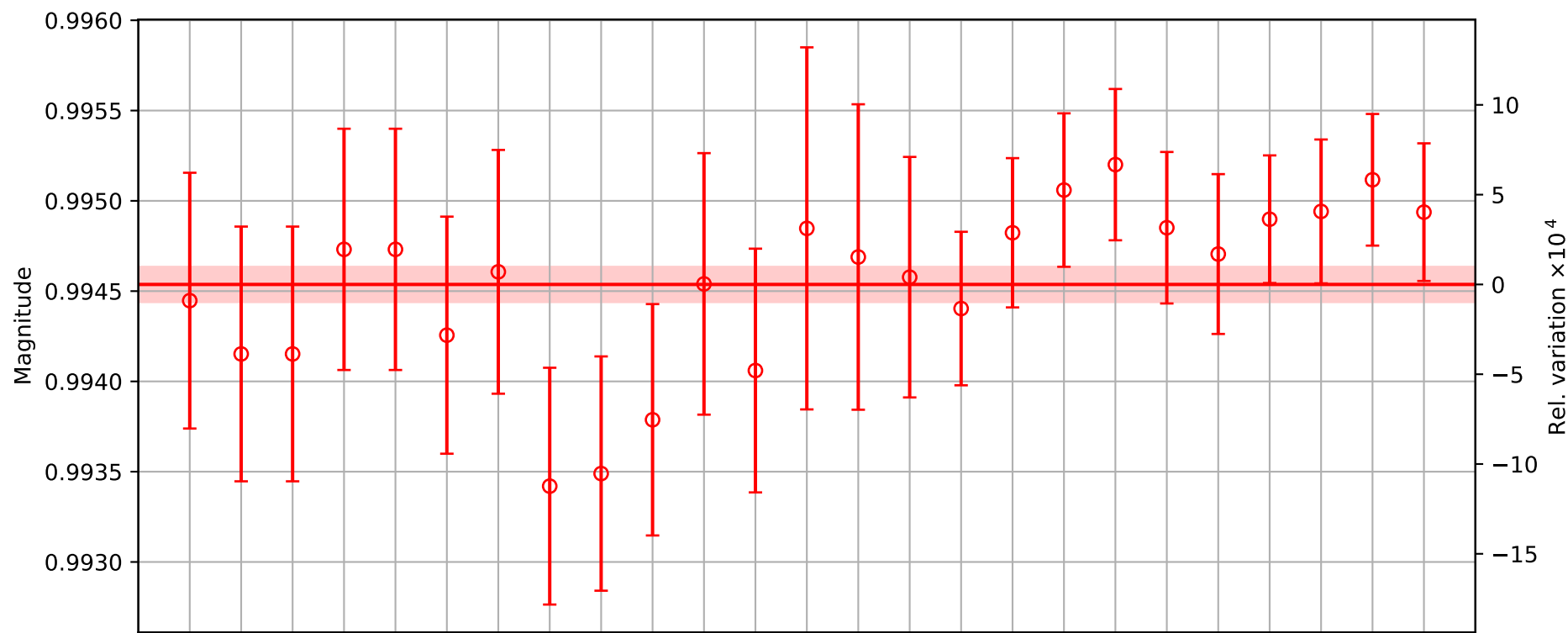
Relative Standard error: 0.000098

Description:

Rx side Optical Efficiency Correction Factor: $E_R = \sqrt{e/\beta}$

This parameter is used to apportion the optical loss inside the vacuum chamber to before the ETM and after the ETM, and uses the Optical Efficiency (e) along with the last in-chamber measurements (DCC- T1800107). The in-chamber measurements yield a ratio of optical efficiencies between the Tx side and Rx side, referred to as β , which we assume have not changed. Applying this correction factor corrects for the optical loss on the Rx side, providing the Rx and Tx responsivities at the ETM.

Output Side Optical Efficiency correction factor



	PowerImbalance
Date	None $\pm$ SD_None
D20230110	0.9850 $\pm$ 0.0005
D20230206	0.9832 $\pm$ 0.0005
D20230207	0.9832 $\pm$ 0.0005
D20230227	0.9813 $\pm$ 0.0004
D20230228	0.9813 $\pm$ 0.0004
D20230314	0.9834 $\pm$ 0.0004
D20230404	0.9843 $\pm$ 0.0005
D20230613	0.9935 $\pm$ 0.0004
D20230821	0.9922 $\pm$ 0.0004
D20230822	0.9940 $\pm$ 0.0004
D20231031	0.9853 $\pm$ 0.0005
D20231205	0.9884 $\pm$ 0.0004
D20240229	0.9870 $\pm$ 0.0006
D20240423	0.9816 $\pm$ 0.0005
D20240702	0.9924 $\pm$ 0.0009
D20240730	0.9927 $\pm$ 0.0006
D20240924	0.9925 $\pm$ 0.0012
D20241126	0.9899 $\pm$ 0.0012
D20250128	0.9786 $\pm$ 0.0012
D20250325	0.9898 $\pm$ 0.0012
D20250701	0.9912 $\pm$ 0.0013
D20250819	0.9896 $\pm$ 0.0011
D20251104	0.9887 $\pm$ 0.0012
D20260127	0.9789 $\pm$ 0.0010
D20260210	0.9866 $\pm$ 0.0012

Description:

Power Imbalance:
 The Power imbalance is a measurement of Inner Beam Power divided by Outer Beam Power, as measured by the Working Standard inside the TX module. M1/M2.

	PowerImbalance
Summary of Power Imbalance	
Mean value:	0.986988
Standard deviation:	0.004746
Standard error:	0.000969
Relative Standard error:	0.000981

Power Imbalance

