RxPD and TxPD Calibration Trends

GENERATED FOR LHO_EndY

Report Generated on May 18, 2023

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1 About

This document contains the Pcal Calibration trends. It includes the ratios measured at the end-station labeled as m1, m2 .....m6 as well as the quantities derived from these six ratio measurements, namely α_{TW}, α_{RW}, optical efficiency and power imbalance. This document also includes the trend of the ADC conversion factor. The sections 17 to 20 shows the trend of the parameters calculated from the derived quantities, which include Input/Output optical efficiency correction factors and Tx/Rx PD calibration factors.

Understanding Each Section

Each section contains a list of measurements with the mean value (m1), standard deviation on the mean (SD_m1) and a ratio of thestandard deviation of the quantity and error bars for each measurement (frac). The list is followed by two plot figures with Magnitude on the Y axis and Index on the X axis for the first plot and the Magnitude on the Y axis and time on the X axis for the second. The error bars of each data point is the standard deviation SD_m1. Each section ends with a summary that contains the mean (the red line on the plot) along with their Standard Deviation, Std Err and Rel Err (the pink band on the plot) where each of these terms are defined as:

```
Mean = sum(x(i))/n

Std_Dev = sqrt(sum((x(i)-x_mean)^2)/(n-1))

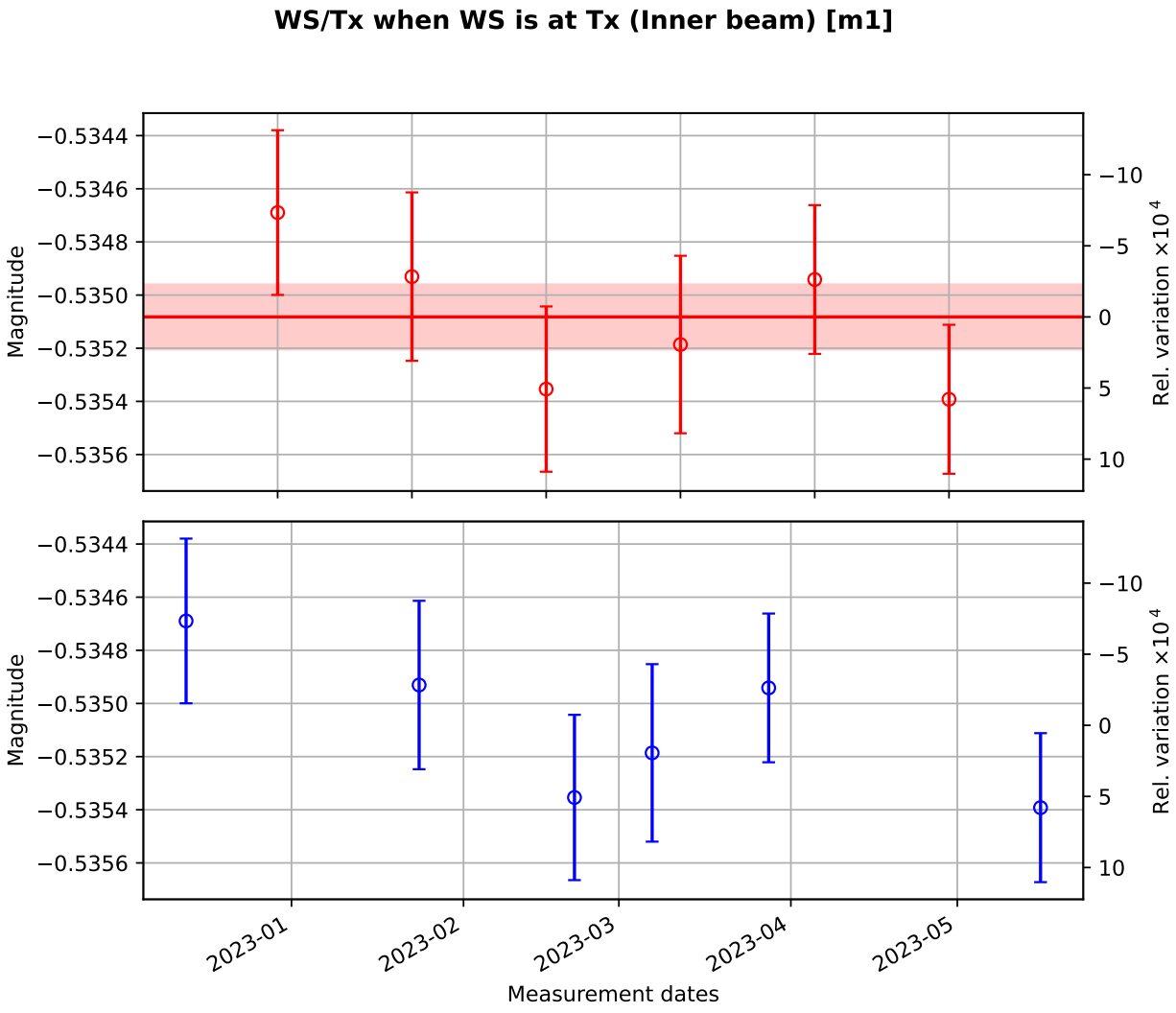
Std_Err = Std_Dev*Student's_t_correction/sqrt(n)

Rel_Err = Std_Err/Mean
```

2 WS/Tx Ratio when WS is at Tx (Inner Beam)

List of Measurements

Date	m1 ± SD_m1
D20221213	-0.5347 ± 0.0003
D20230124	-0.5349 ± 0.0003
D20230221	-0.5354 ± 0.0003
D20230307	-0.5352 ± 0.0003
D20230328	-0.5349 ± 0.0003
D20230516	-0.5354 ± 0.0003

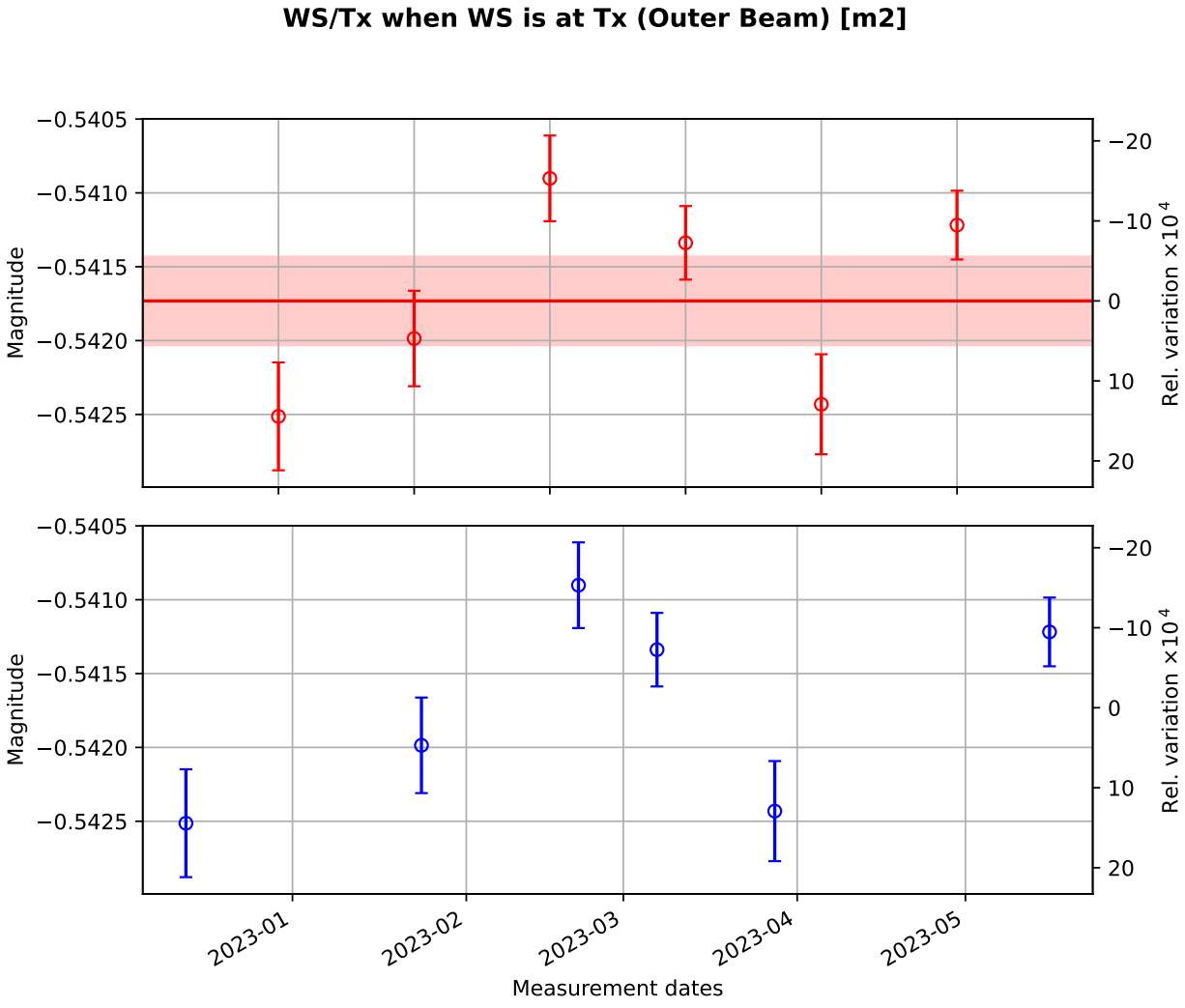


Summary of WS/Tx when WS is at Tx (Inner beam) [m1]	
Mean value:	-0.535082
Standard deviation:	0.000275
Standard error:	0.000122
Relative Standard error:	-0.000229

3 WS/Tx Ratio when WS is at Tx (Outer Beam)

List of Measurements

Date	m2 ± SD_m2
D20221213	-0.5425 ± 0.0004
D20230124	-0.5420 ± 0.0003
D20230221	-0.5409 ± 0.0003
D20230307	-0.5413 ± 0.0002
D20230328	-0.5424 ± 0.0003
D20230516	-0.5412 ± 0.0002

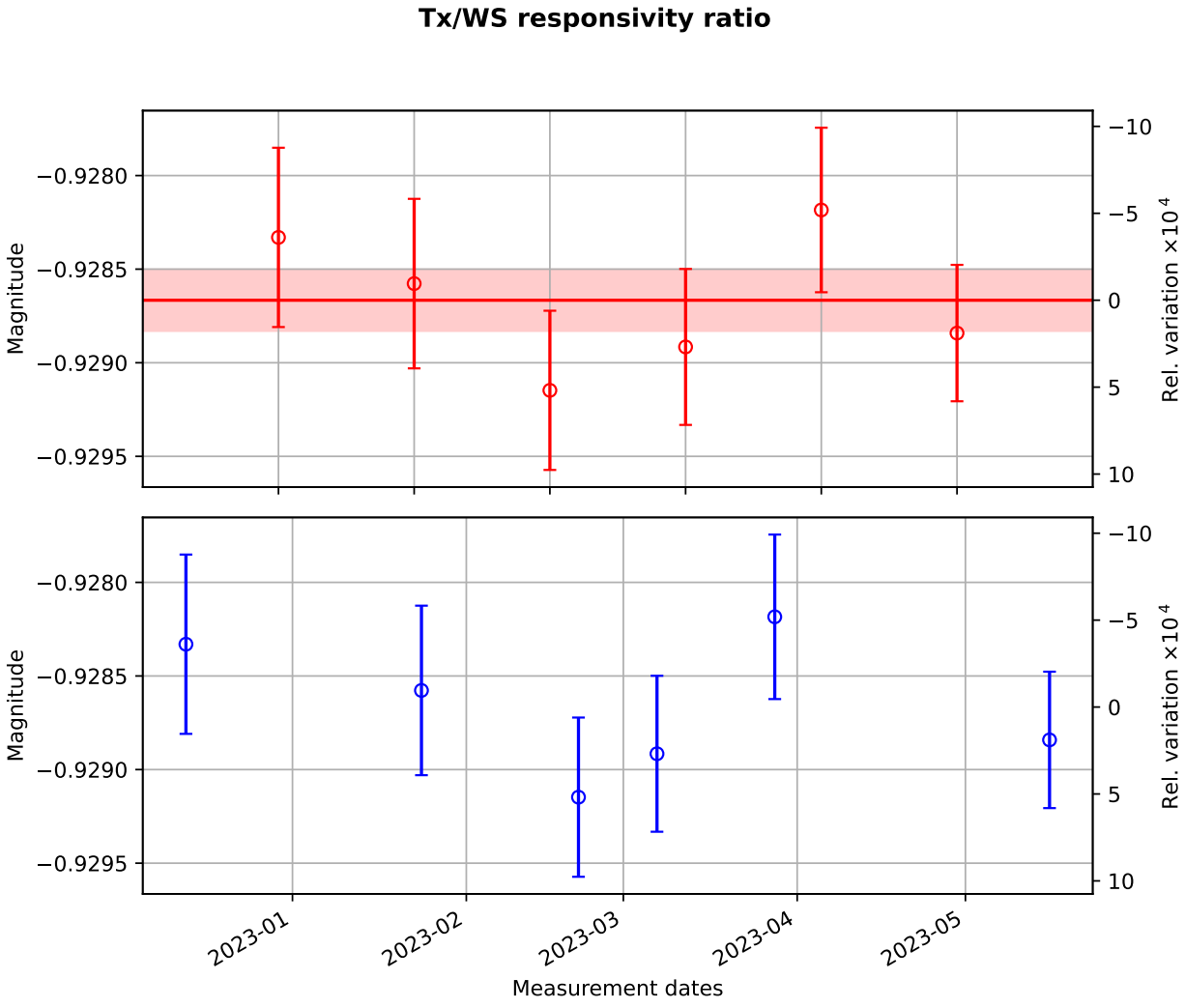


Summary of WS/Tx when WS is at Tx (Outer Beam) [m2]	
Mean value:	-0.541731
Standard deviation:	0.000674
Standard error:	0.000300
Relative Standard error:	-0.000554

4 Tx/WS responsivity ratio $\alpha_{\mathbf{TW}} = \mathbf{1}/[\mathbf{m1} + \mathbf{m2}]$

List of Measurements

Date	TXWS ± SD_TXWS
D20221213	-0.9283 ± 0.0005
D20230124	-0.9286 ± 0.0005
D20230221	-0.9291 ± 0.0004
D20230307	-0.9289 ± 0.0004
D20230328	-0.9282 ± 0.0004
D20230516	-0.9288 ± 0.0004



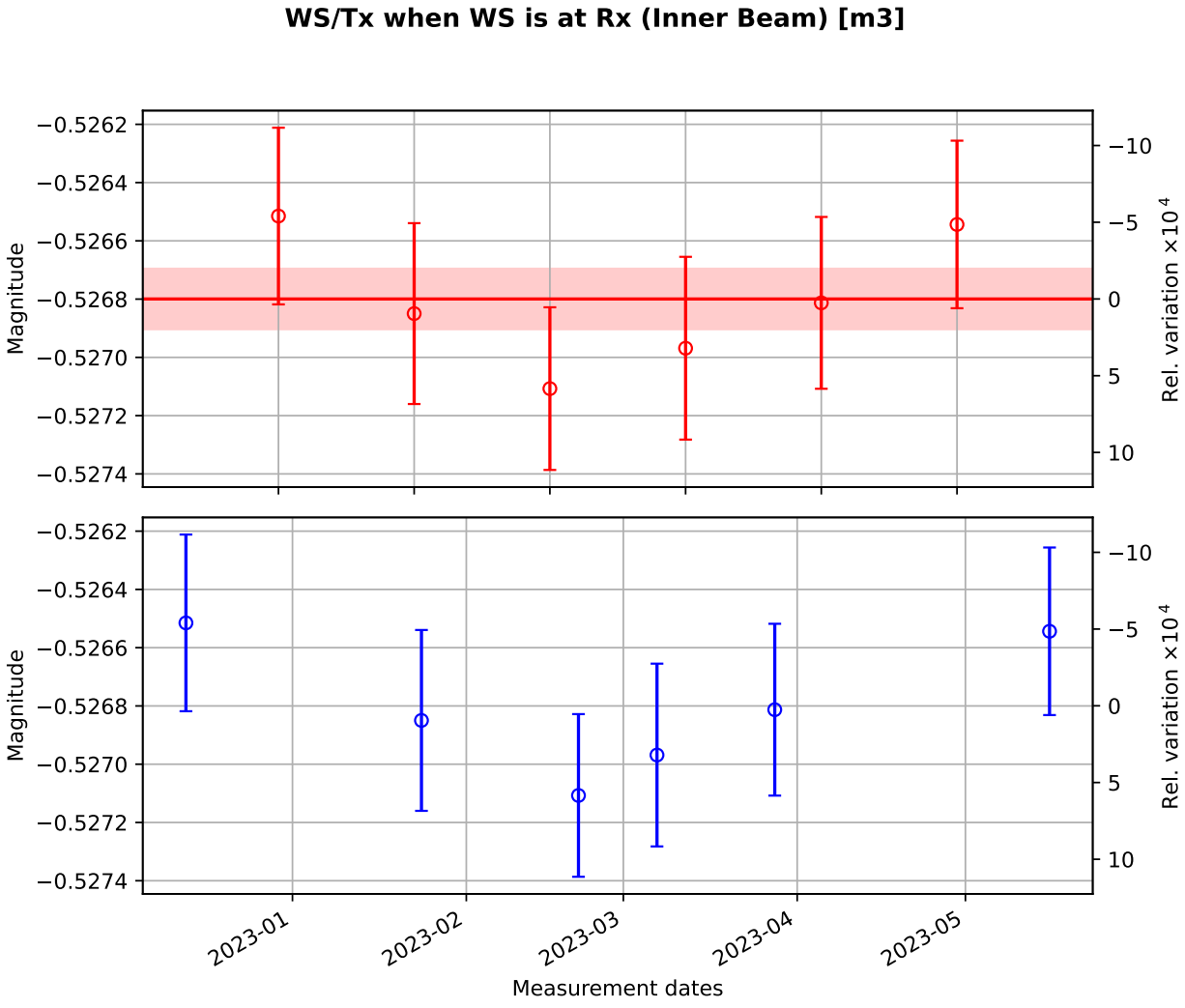
Summary of Tx/WS responsivity ratio

Mean value:	-0.928666
Standard deviation:	0.000368
Standard error:	0.000164
Relative Standard error:	-0.000177

5 WS/Tx Ratio when WS is at Rx (Inner Beam)

List of Measurements

Date	m3 ± SD_m3
D20221213	-0.5265 ± 0.0003
D20230124	-0.5268 ± 0.0003
D20230221	-0.5271 ± 0.0003
D20230307	-0.5270 ± 0.0003
D20230328	-0.5268 ± 0.0003
D20230516	-0.5265 ± 0.0003

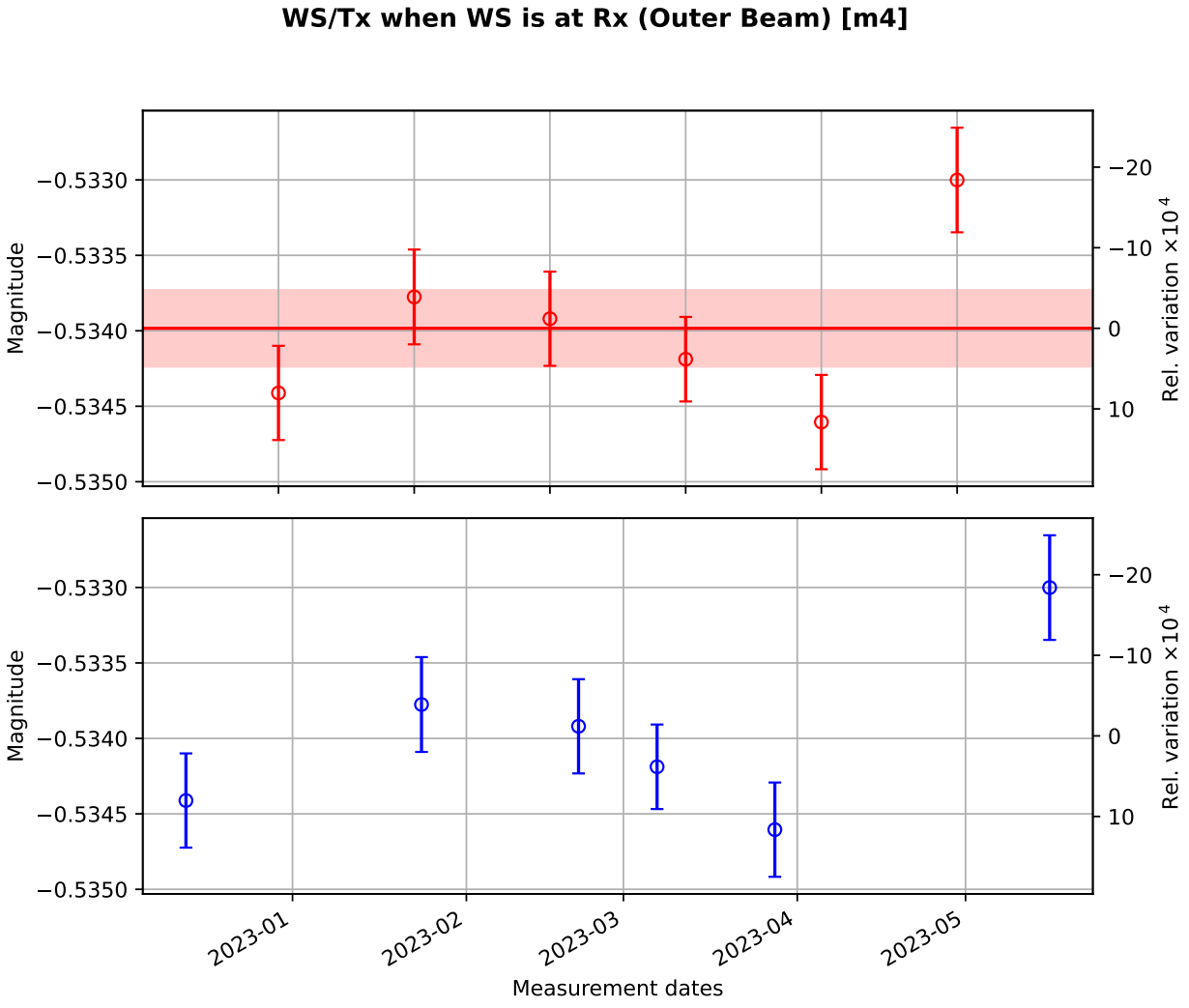


Summary of WS/Tx when WS is at Rx (Inner Beam) [m3]	
Mean value:	-0.526799
Standard deviation:	0.000233
Standard error:	0.000104
Relative Standard error:	-0.000197

6 WS/Tx Ratio when WS is at Rx (Outer Beam)

List of Measurements

Date	m4 ± SD_m4
D20221213	-0.5344 ± 0.0003
D20230124	-0.5338 ± 0.0003
D20230221	-0.5339 ± 0.0003
D20230307	-0.5342 ± 0.0003
D20230328	-0.5346 ± 0.0003
D20230516	-0.5330 ± 0.0003

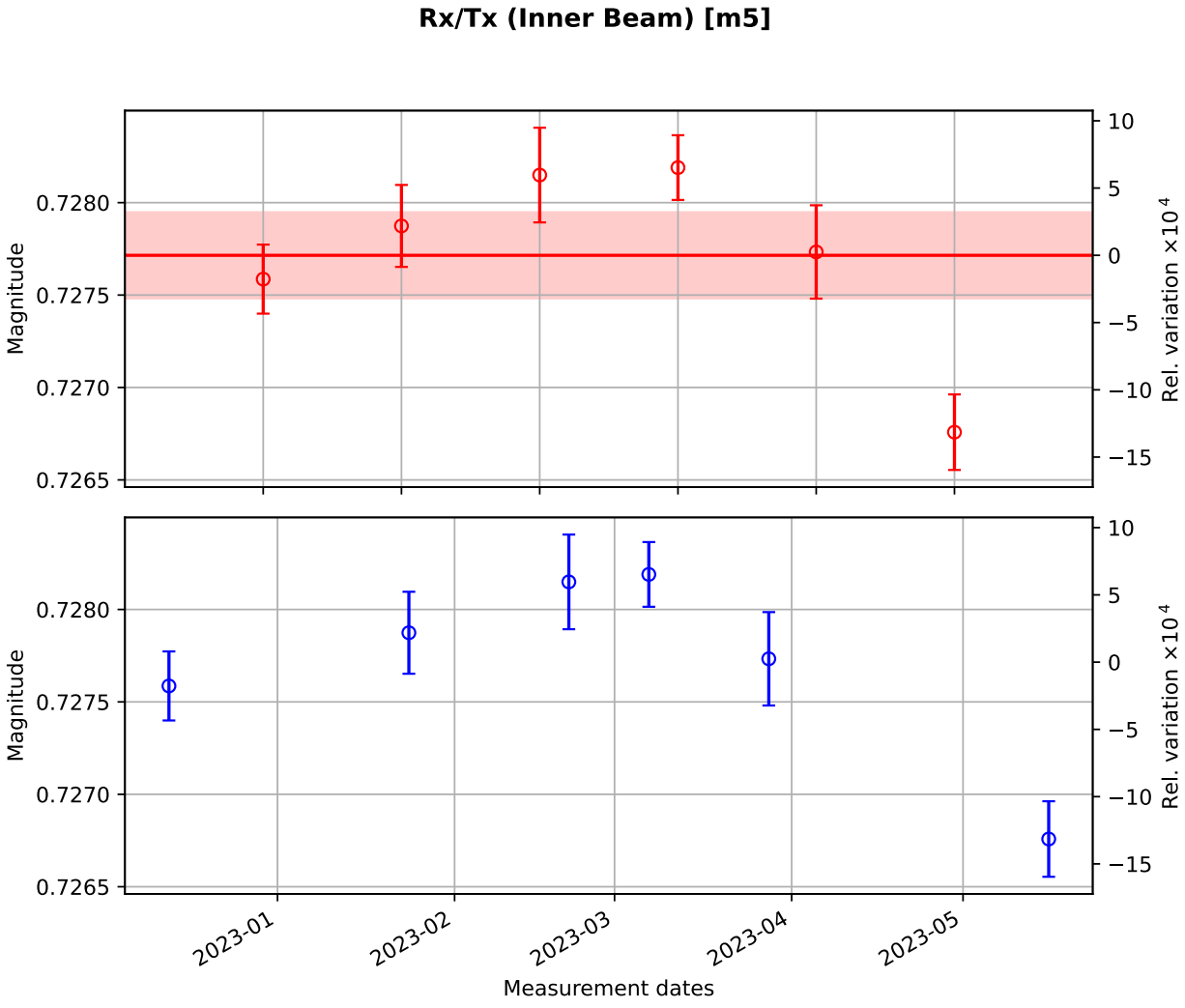


Summary of WS/Tx when WS is at Rx (Outer Beam) [m4]	
Mean value:	-0.533983
Standard deviation:	0.000570
Standard error:	0.000254
Relative Standard error:	-0.000475

7 RX/TX Ratio (Inner Beam)

List of Measurements

Date	m5 ± SD_m5
D20221213	0.7276 ± 0.0002
D20230124	0.7279 ± 0.0002
D20230221	0.7281 ± 0.0003
D20230307	0.7282 ± 0.0002
D20230328	0.7277 ± 0.0003
D20230516	0.7268 ± 0.0002

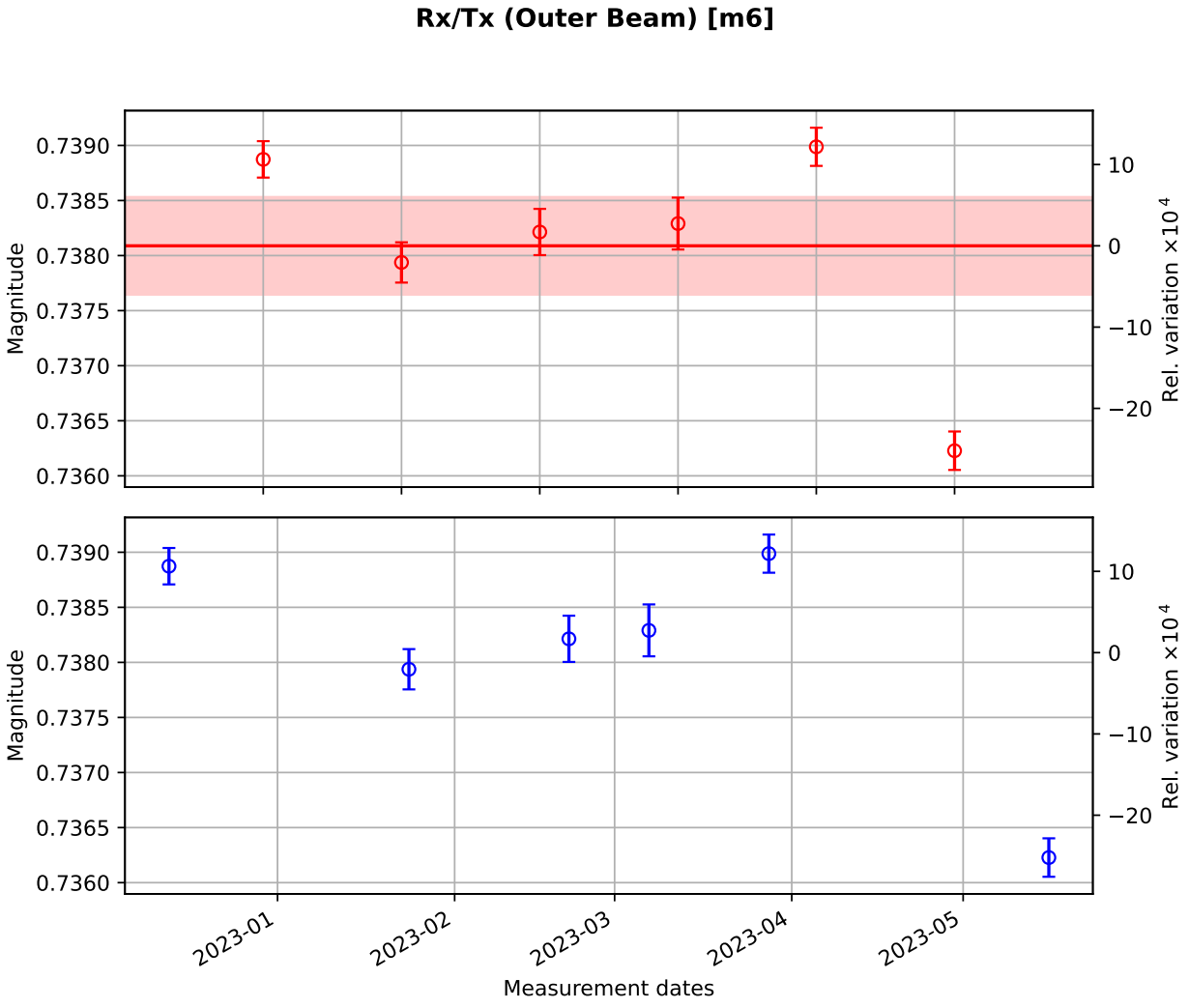


Summary of Rx/Tx (Inner Beam) [m5]	
Mean value:	0.727715
Standard deviation:	0.000524
Standard error:	0.000233
Relative Standard error:	0.000320

8 Rx/Tx Ratio (Outer Beam)

List of Measurements

Date	m6 ± SD_m6
D20221213	0.7389 ± 0.0002
D20230124	0.7379 ± 0.0002
D20230221	0.7382 ± 0.0002
D20230307	0.7383 ± 0.0002
D20230328	0.7390 ± 0.0002
D20230516	0.7362 ± 0.0002

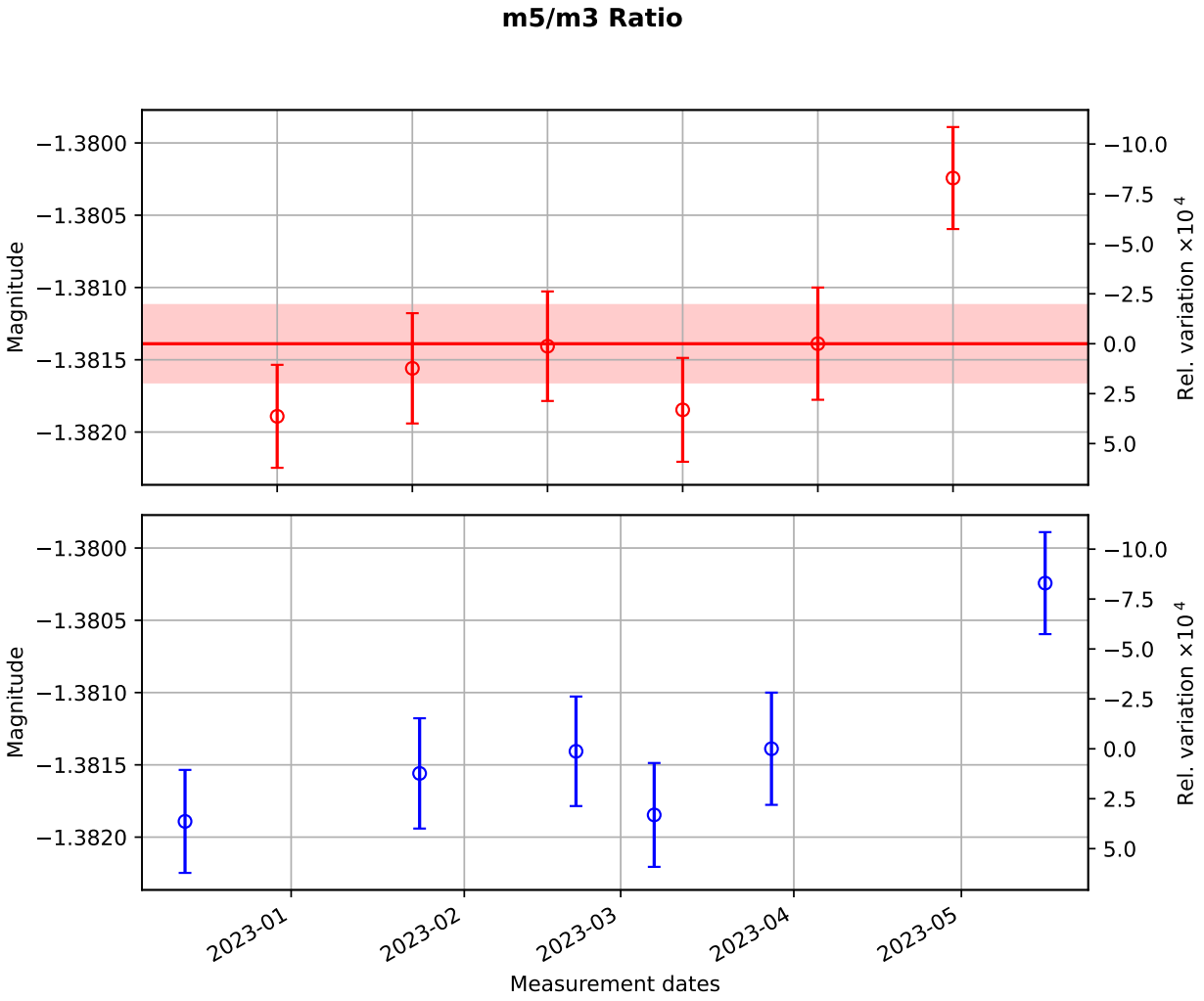


Summary of Rx/Tx (Outer Beam) [m6]	
Mean value:	0.738088
Standard deviation:	0.000997
Standard error:	0.000444
Relative Standard error:	0.000601

9 m5/m3 Ratio

List of Measurements

Date	RiTWriT ± SD_RiTWriT
D20221213	-1.3819 ± 0.0004
D20230124	-1.3816 ± 0.0004
D20230221	-1.3814 ± 0.0004
D20230307	-1.3818 ± 0.0004
D20230328	-1.3814 ± 0.0004
D20230516	-1.3802 ± 0.0004



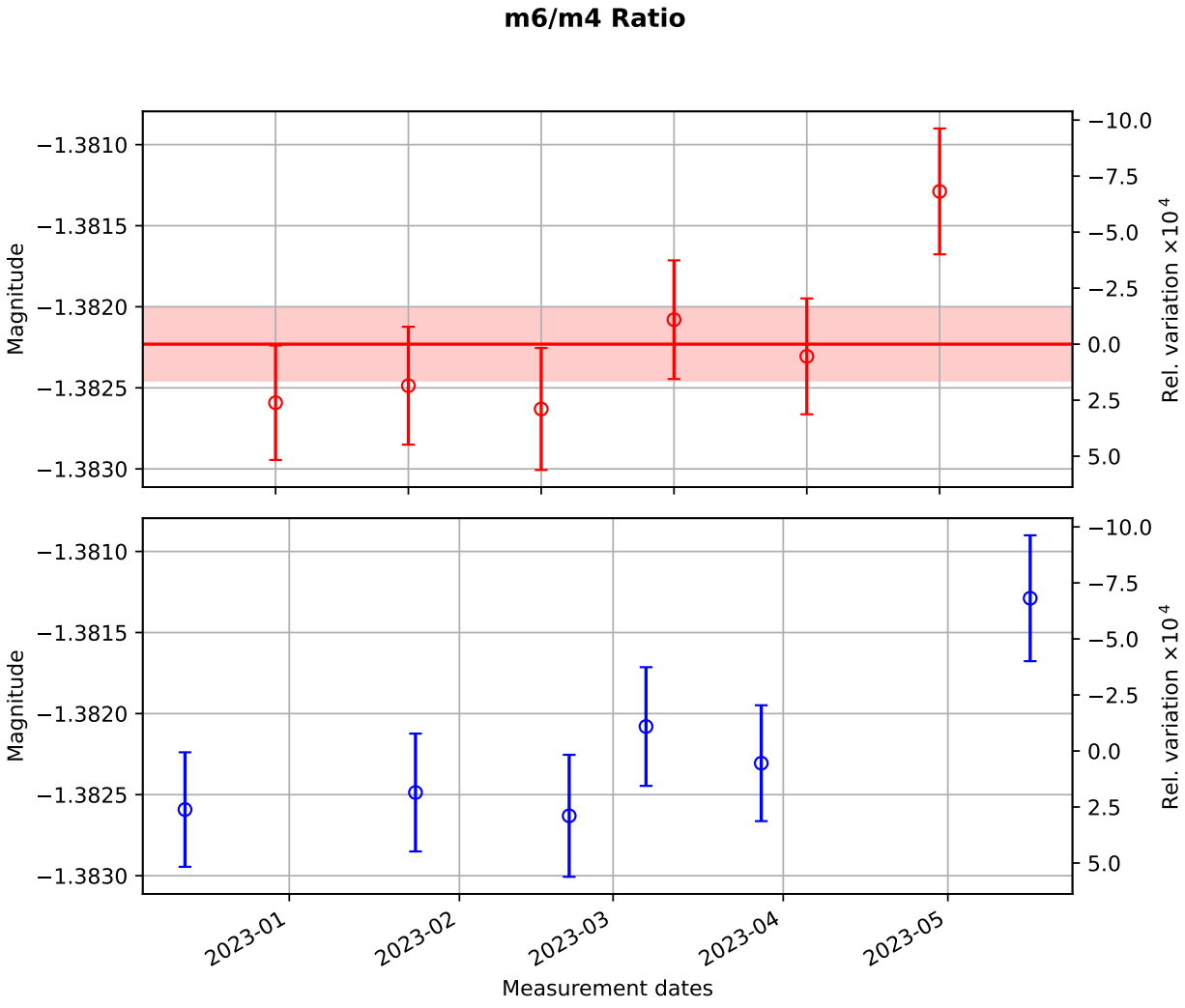
Summary of m5/m3 Ratio

Mean value:	-1.381389
Standard deviation:	0.000601
Standard error:	0.000267
Relative Standard error:	-0.000194

10 m6/m4 Ratio

List of Measurements

Date	RoTWroT ± SD_RoTWroT
D20221213	-1.3826 ± 0.0004
D20230124	-1.3825 ± 0.0004
D20230221	-1.3826 ± 0.0004
D20230307	-1.3821 ± 0.0004
D20230328	-1.3823 ± 0.0004
D20230516	-1.3813 ± 0.0004



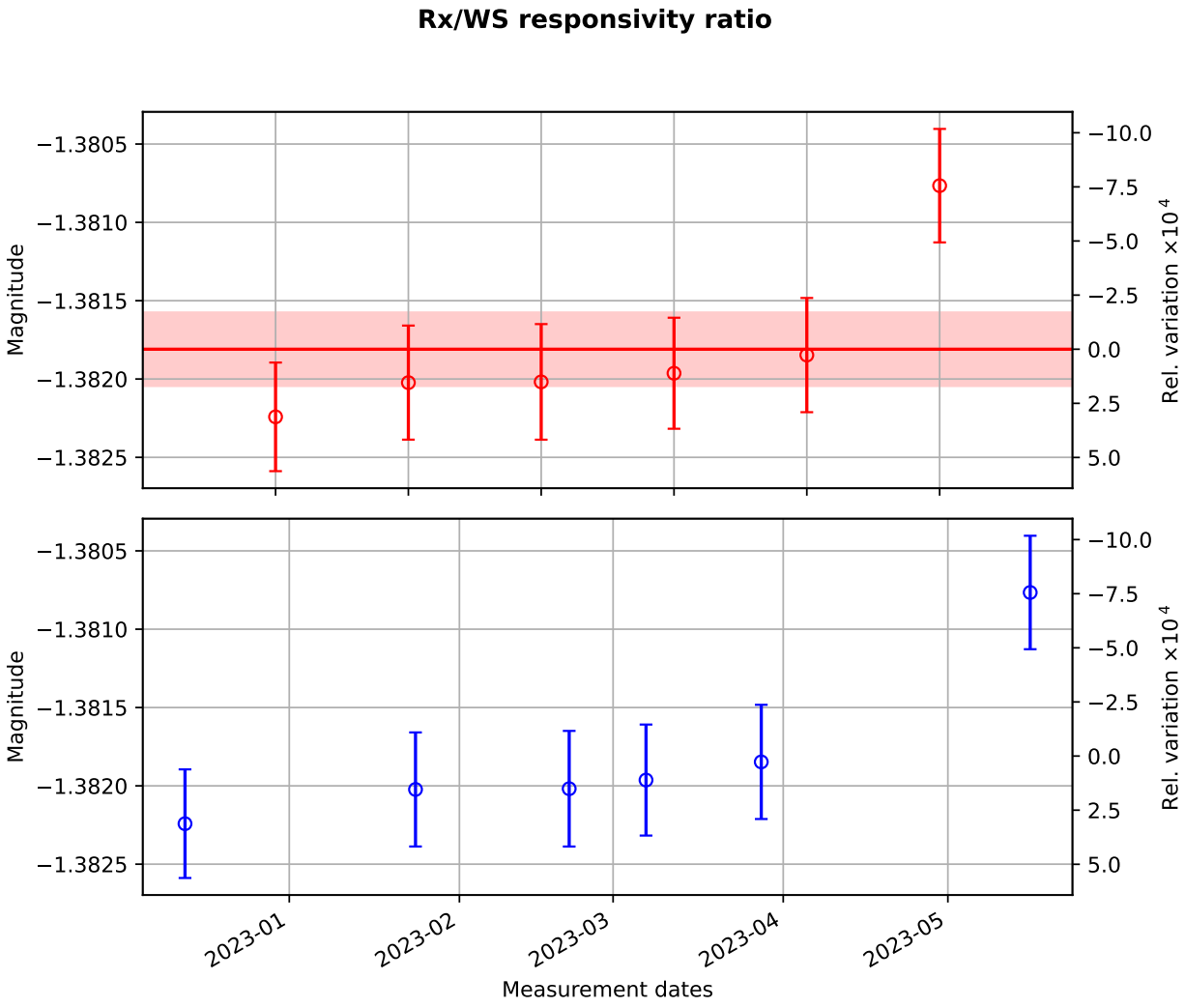
Summary of m6/m4 Ratio

Mean value:	-1.382231
Standard deviation:	0.000504
Standard error:	0.000225
Relative Standard error:	-0.000162

11 Rx/WS responsivity ratio $\alpha_{\mathbf{RW}} = \frac{1}{2}\,[\mathbf{m5/m3 + m6/m4}]$

List of Measurements

Date	RXWS ± SD_RXWS
D20221213	-1.3822 ± 0.0003
D20230124	-1.3820 ± 0.0004
D20230221	-1.3820 ± 0.0004
D20230307	-1.3820 ± 0.0004
D20230328	-1.3818 ± 0.0004
D20230516	-1.3808 ± 0.0004



Summary of Rx/WS responsivity ratio

Mean value:	-1.381810
Standard deviation:	0.000527
Standard error:	0.000235
Relative Standard error:	-0.000170

12 ADC conversion factor (ζ)

List of Measurements

```
Date            zeta ± SD_zeta
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
D20230516       1.6379e+03 ± 1.0000e-09
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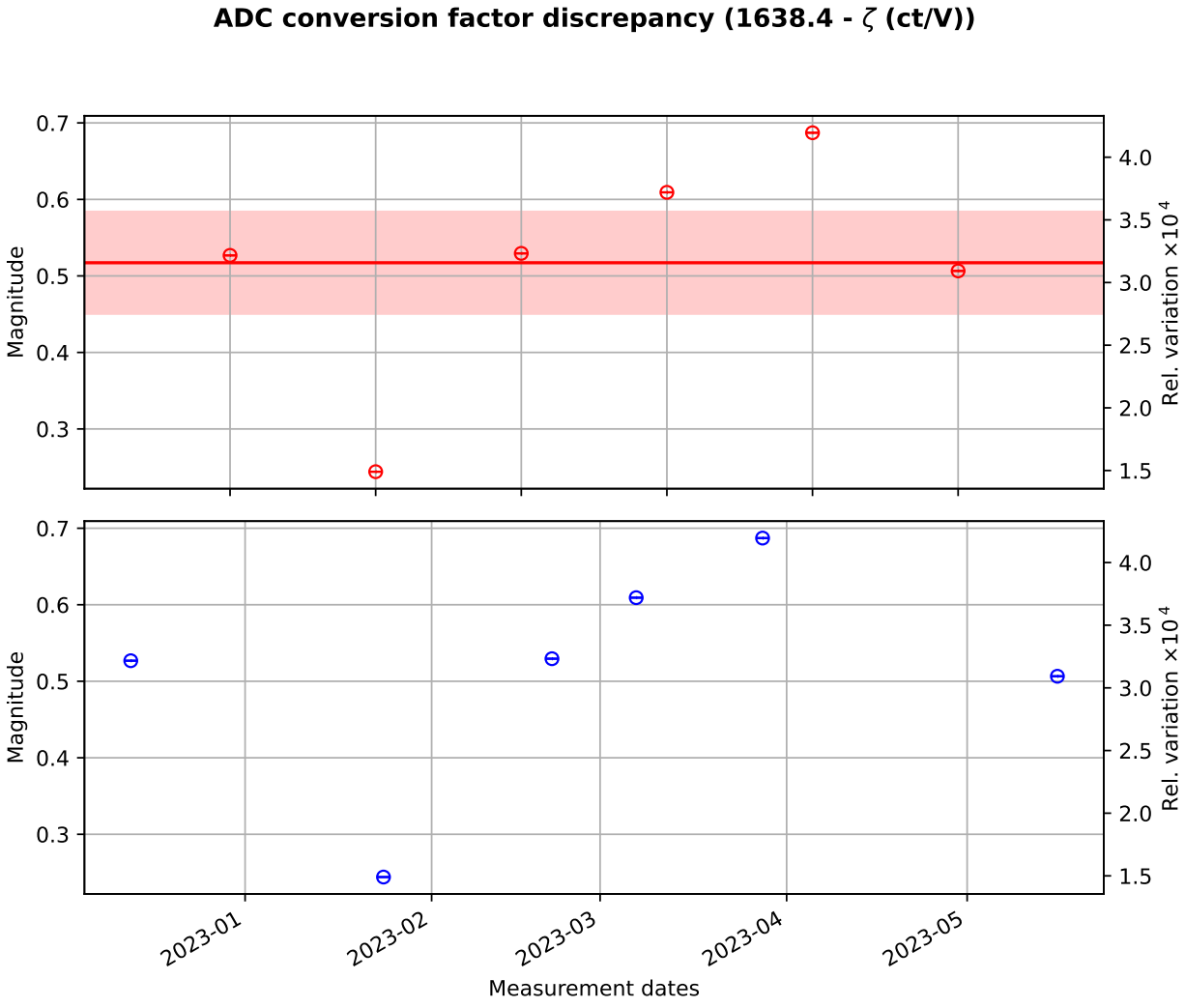
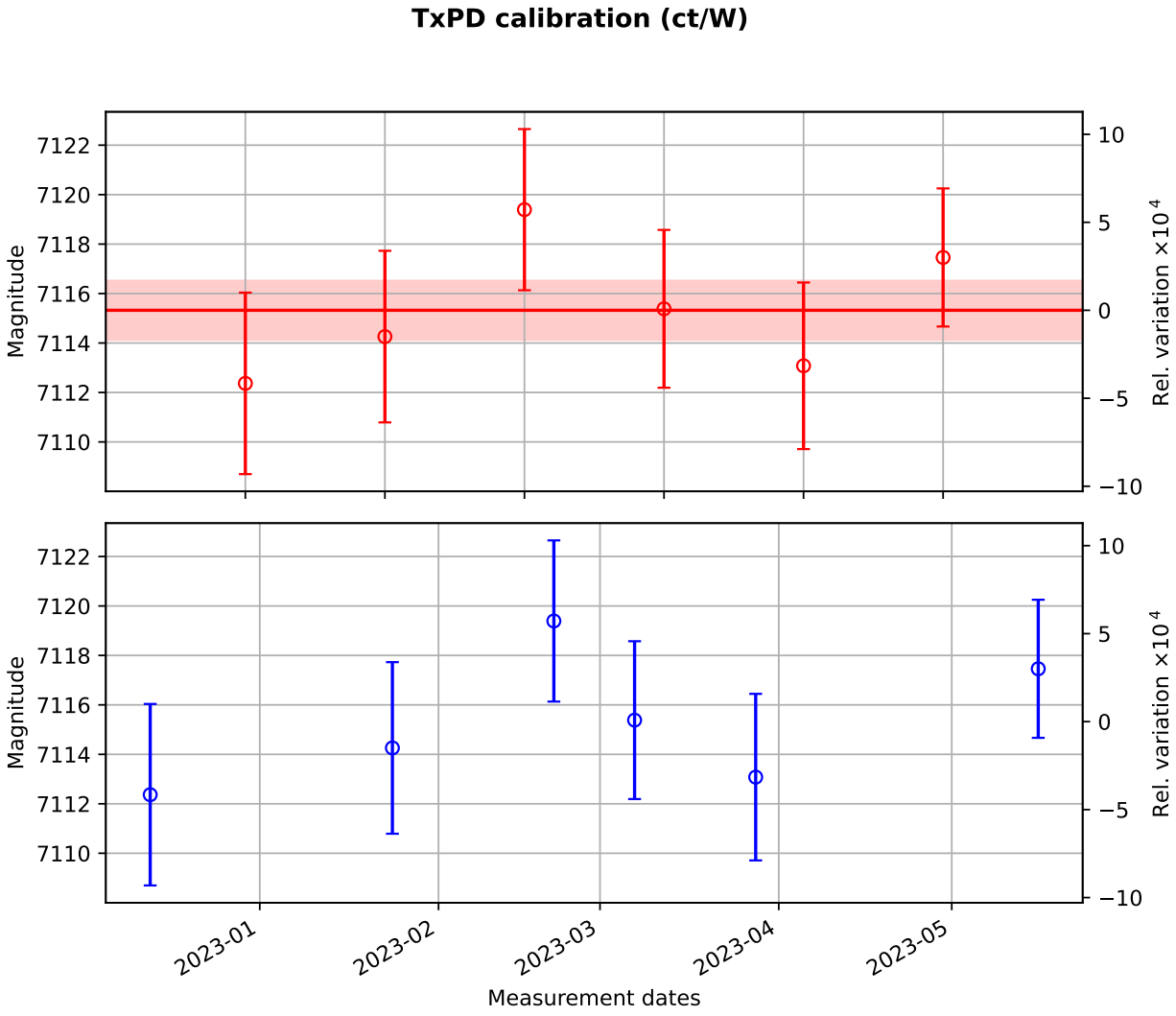



```
Summary of ADC conversion factor discrepancy
```

13 TxPD calibration ($\rho_{Tx} = \rho_G.\alpha_{WG}.\alpha_{TW}.\zeta$)

List of Measurements

Date	rhoTx ± SD_rhoTx
D20221213	7112.3680 ± 3.6694
D20230124	7114.2592 ± 3.4691
D20230221	7119.3923 ± 3.2588
D20230307	7115.3830 ± 3.1908
D20230328	7113.0787 ± 3.3677
D20230516	7117.4595 ± 2.7919



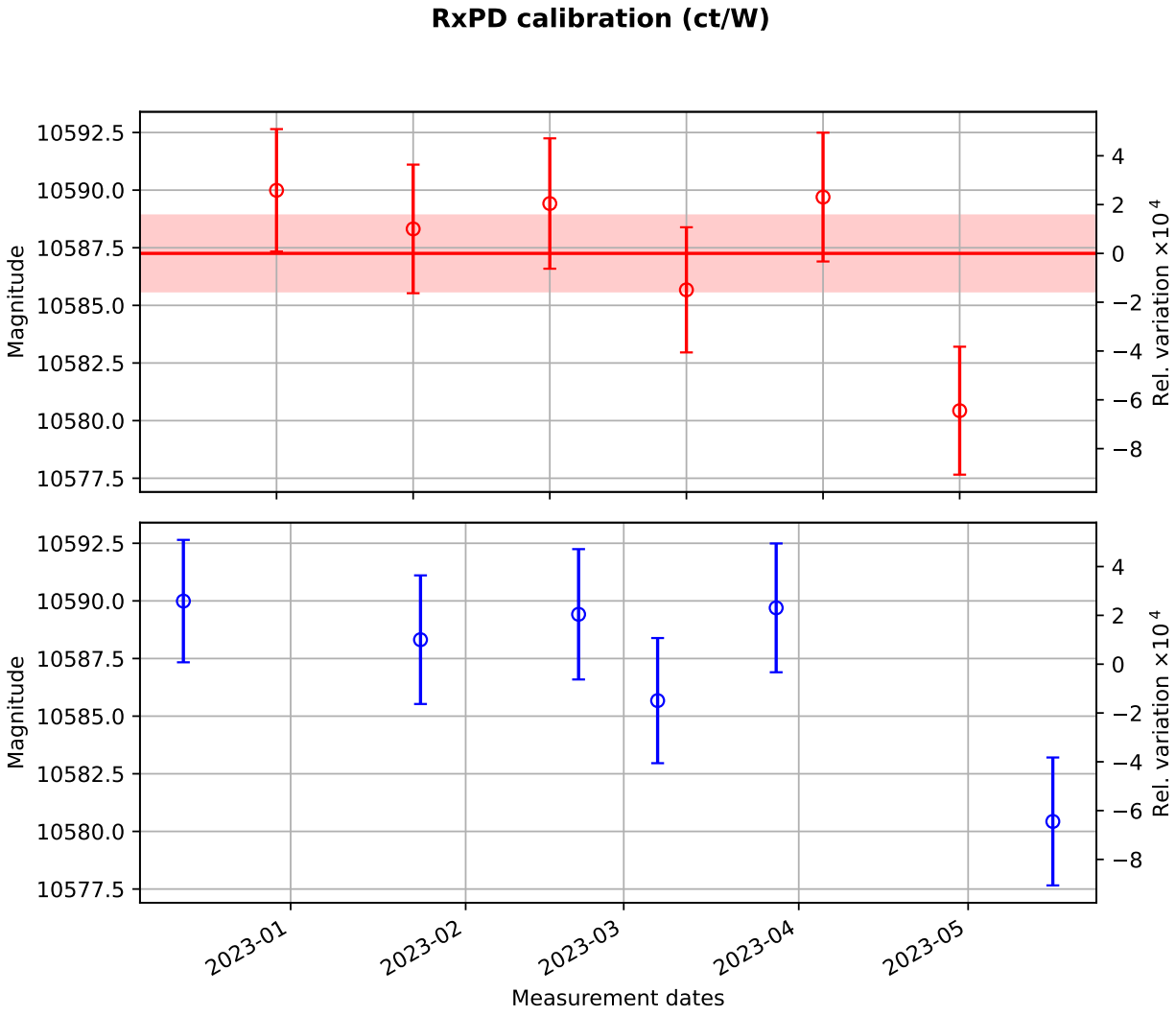
Summary of TxPD calibration (ct/W)

Mean value:	7115.323434
Standard deviation:	2.684319
Standard error:	1.195120
Relative Standard error:	0.000168

14 RxPD calibration ($\rho_{Rx} = \rho_G.\alpha_{WG}.\alpha_{RW}.\zeta$)

List of Measurements

Date	rhoRx ± SD_rhoRx
D20221213	10589.9915 ± 2.6559
D20230124	10588.3168 ± 2.7896
D20230221	10589.4183 ± 2.8272
D20230307	10585.6737 ± 2.7144
D20230328	10589.6979 ± 2.7939
D20230516	10580.4314 ± 2.7750



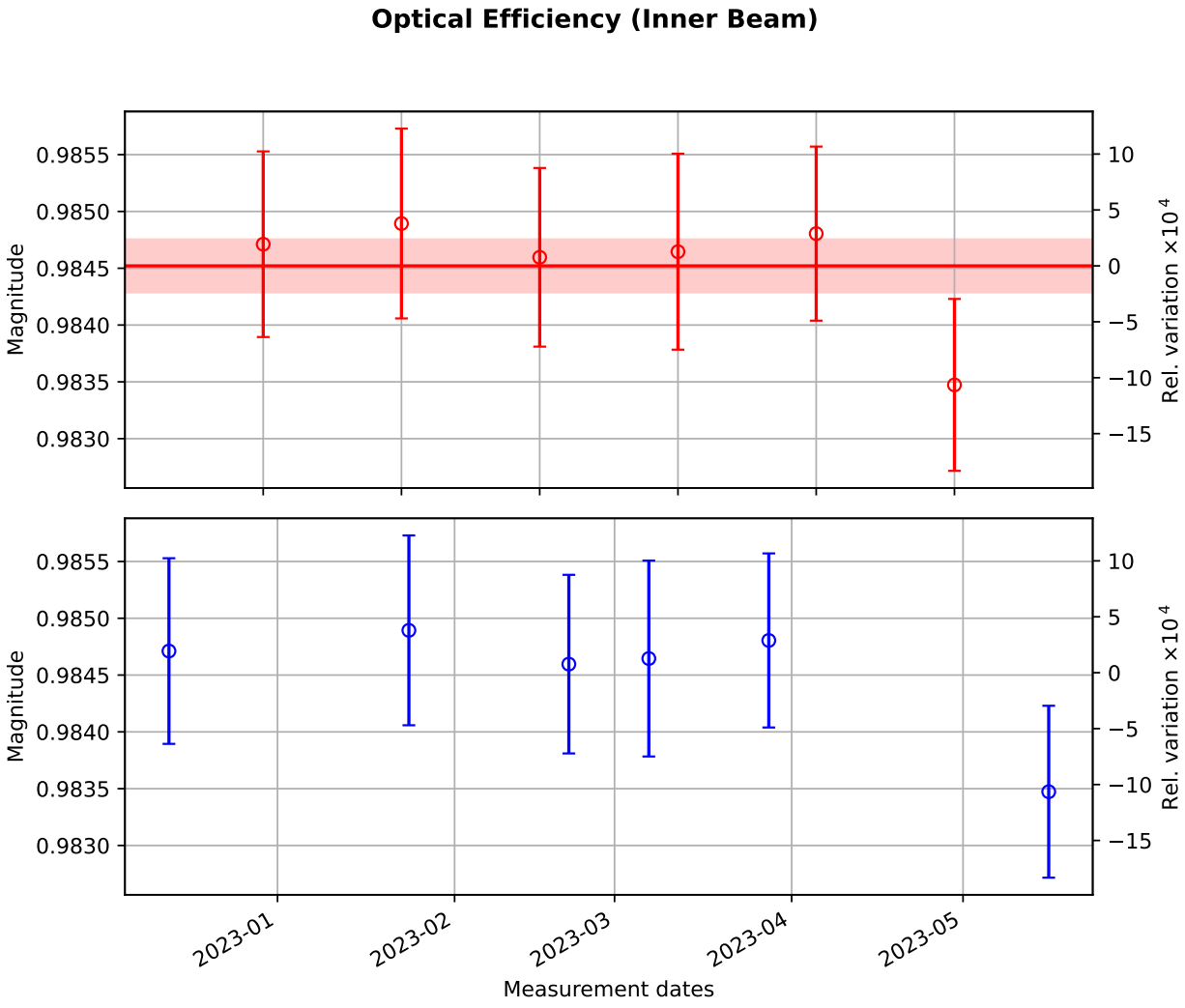
Summary of RxPD calibration (ct/W)

Mean value:	10587.254938
Standard deviation:	3.696622
Standard error:	1.645821
Relative Standard error:	0.000155

15 Optical Efficiency of Inner Beam $e^i = m3/m1$

List of Measurements

Date	e_i ± SD_e_i
D20221213	0.9847 ± 0.0008
D20230124	0.9849 ± 0.0008
D20230221	0.9846 ± 0.0008
D20230307	0.9846 ± 0.0009
D20230328	0.9848 ± 0.0008
D20230516	0.9835 ± 0.0008



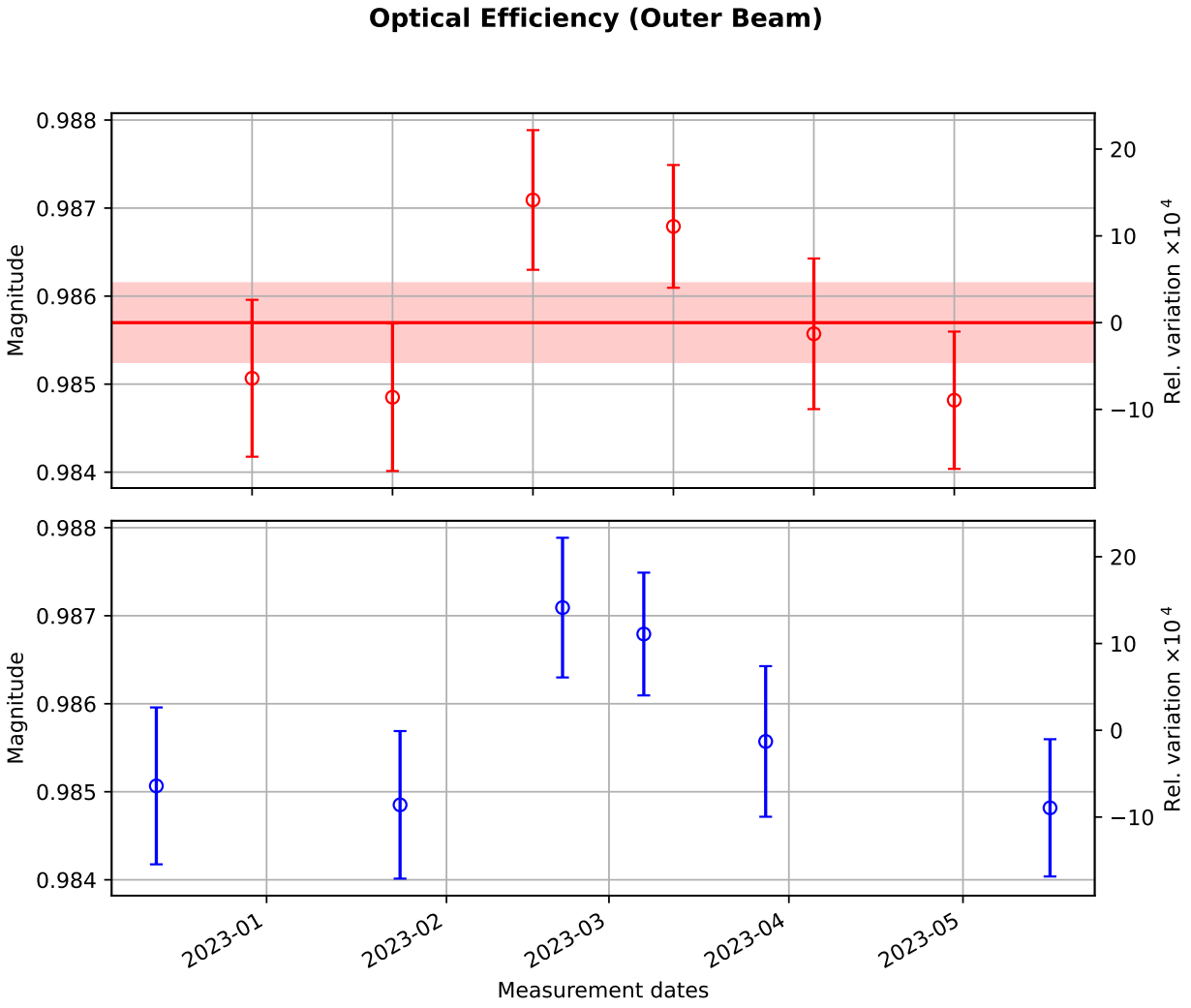
Summary of Optical Efficiency (Inner Beam)

Mean value:	0.984521
Standard deviation:	0.000524
Standard error:	0.000233
Relative Standard error:	0.000237

16 Optical Efficiency of Outer Beam $e^o = m4/m2$

List of Measurements

Date	e_o ± SD_e_o
D20221213	0.9851 ± 0.0009
D20230124	0.9849 ± 0.0008
D20230221	0.9871 ± 0.0008
D20230307	0.9868 ± 0.0007
D20230328	0.9856 ± 0.0009
D20230516	0.9848 ± 0.0008

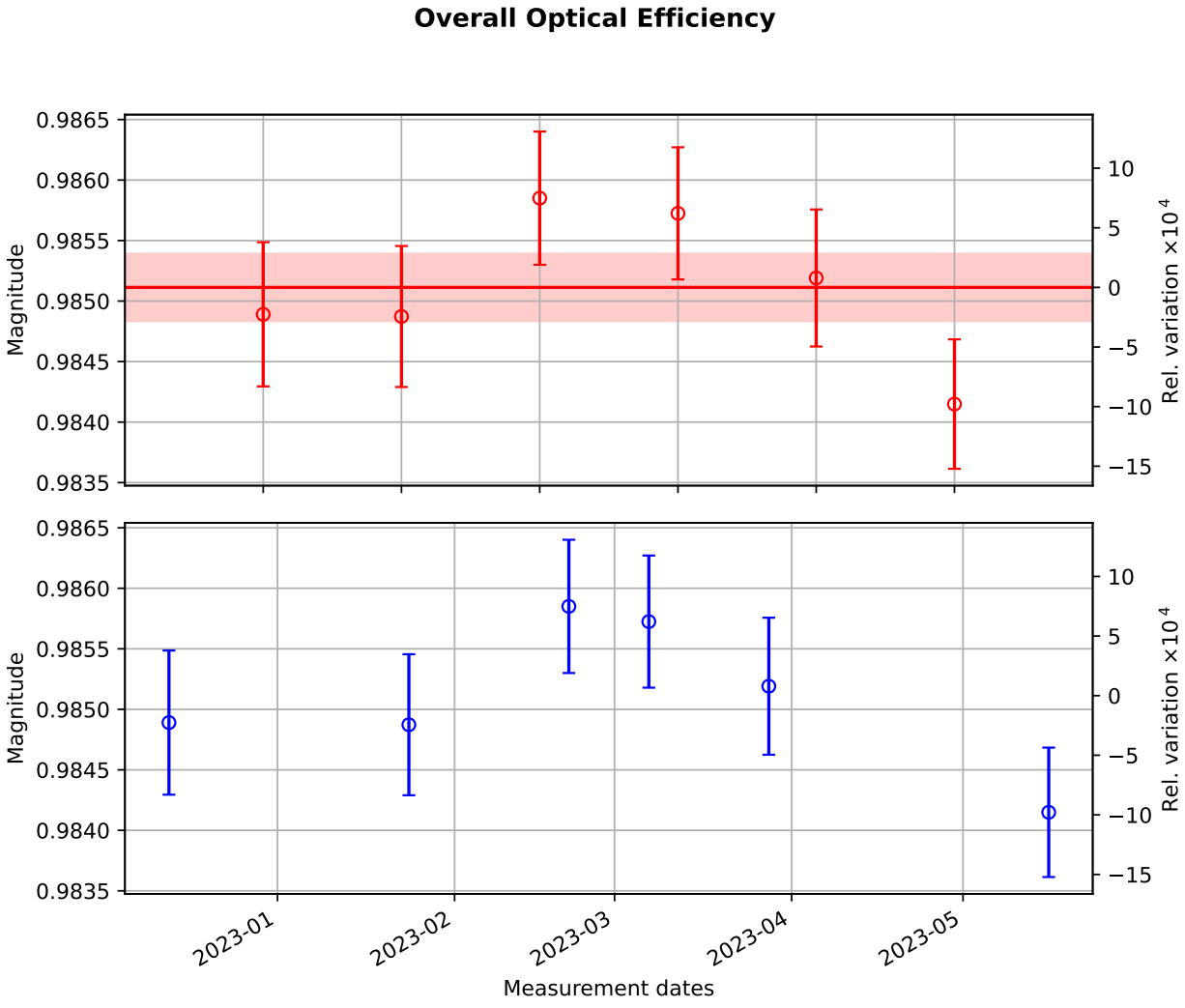


Summary of Optical Efficiency (Outer Beam)	
Mean value:	0.985699
Standard deviation:	0.001005
Standard error:	0.000447
Relative Standard error:	0.000454

17 Total Optical Efficiency $\mathbf{e = (m3 + m4)/(m1 + m2)}$

List of Measurements

Date	e ± SD_e
D20221213	0.9849 ± 0.0006
D20230124	0.9849 ± 0.0006
D20230221	0.9859 ± 0.0006
D20230307	0.9857 ± 0.0005
D20230328	0.9852 ± 0.0006
D20230516	0.9841 ± 0.0005

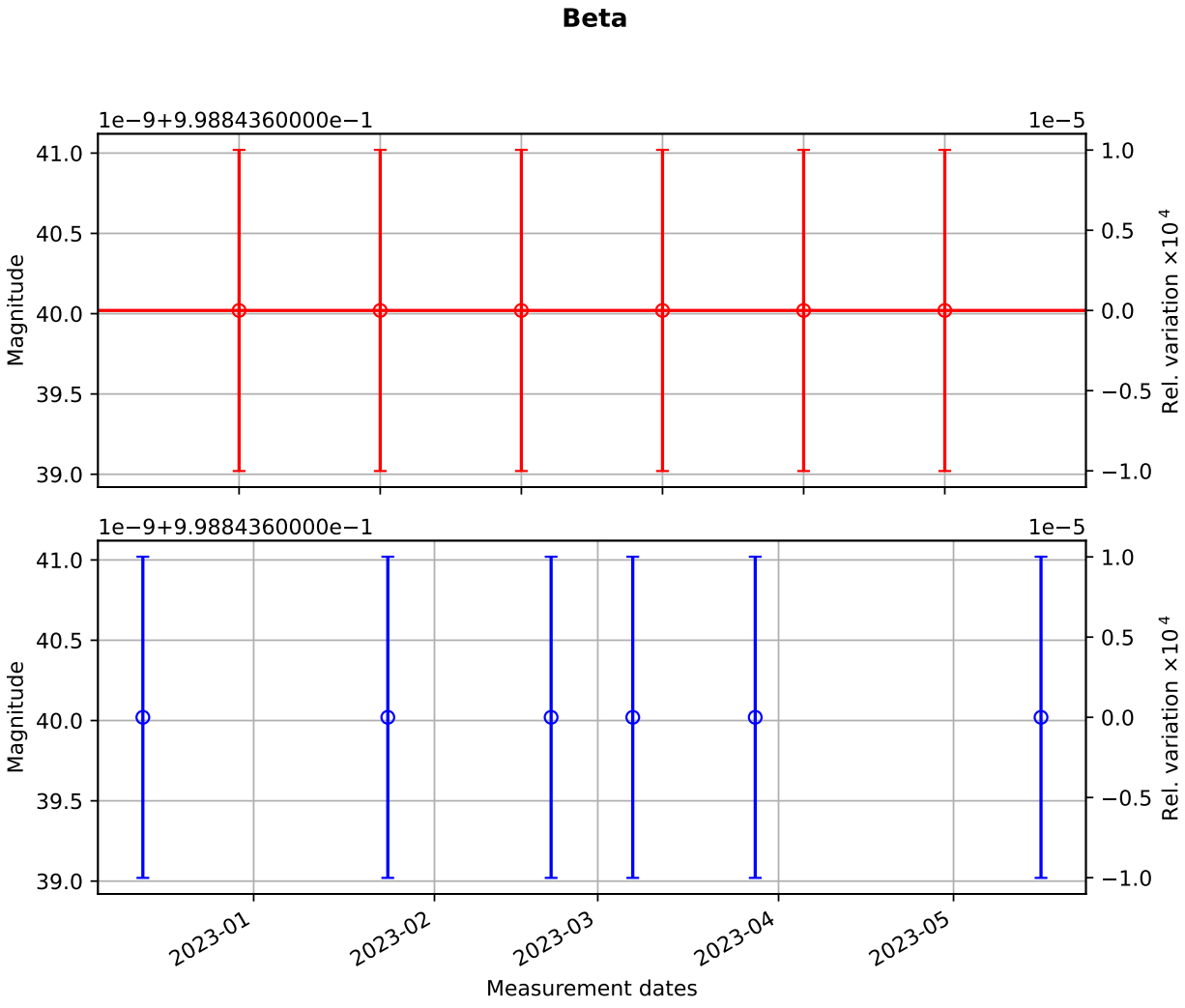


Summary of Overall Optical Efficiency	
Mean value:	0.985113
Standard deviation:	0.000626
Standard error:	0.000279
Relative Standard error:	0.000283

18 Input/Output optical efficiency ratio (β)

List of Measurements

Date	beta ± SD_beta
D20221213	9.9884e-01 ± 1.0000e-09
D20230124	9.9884e-01 ± 1.0000e-09
D20230221	9.9884e-01 ± 1.0000e-09
D20230307	9.9884e-01 ± 1.0000e-09
D20230328	9.9884e-01 ± 1.0000e-09
D20230516	9.9884e-01 ± 1.0000e-09



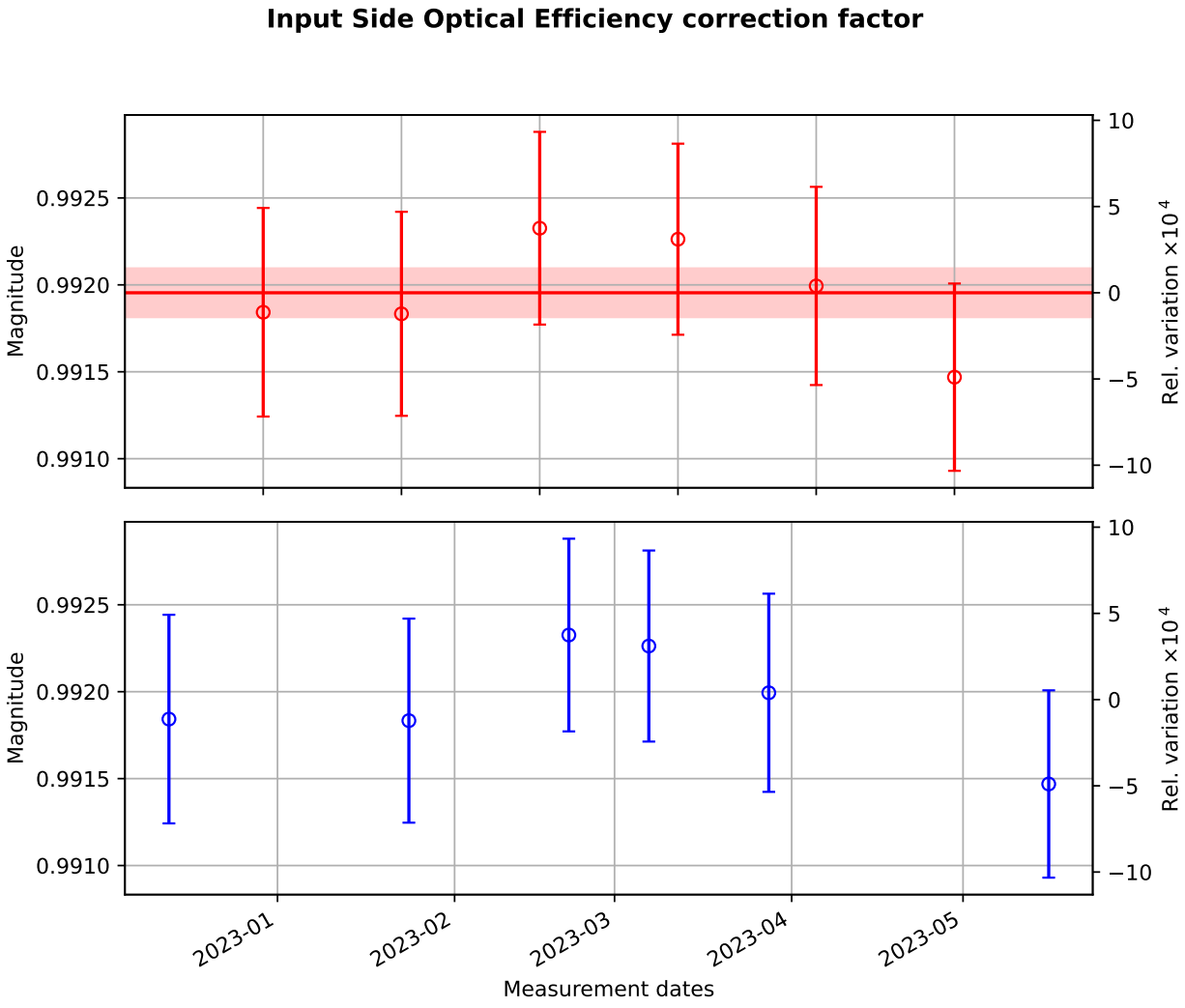
Summary of Beta

Mean value:	0.998844
Standard deviation:	0.000000
Standard error:	0.000000
Relative Standard error:	0.000000

19 Input Optical efficiency correction factor ($\eta_T = \sqrt{e.\beta}$)

List of Measurements

Date	E_T ± SD_E_T
D20221213	0.9918 ± 0.0006
D20230124	0.9918 ± 0.0006
D20230221	0.9923 ± 0.0006
D20230307	0.9923 ± 0.0005
D20230328	0.9920 ± 0.0006
D20230516	0.9915 ± 0.0005

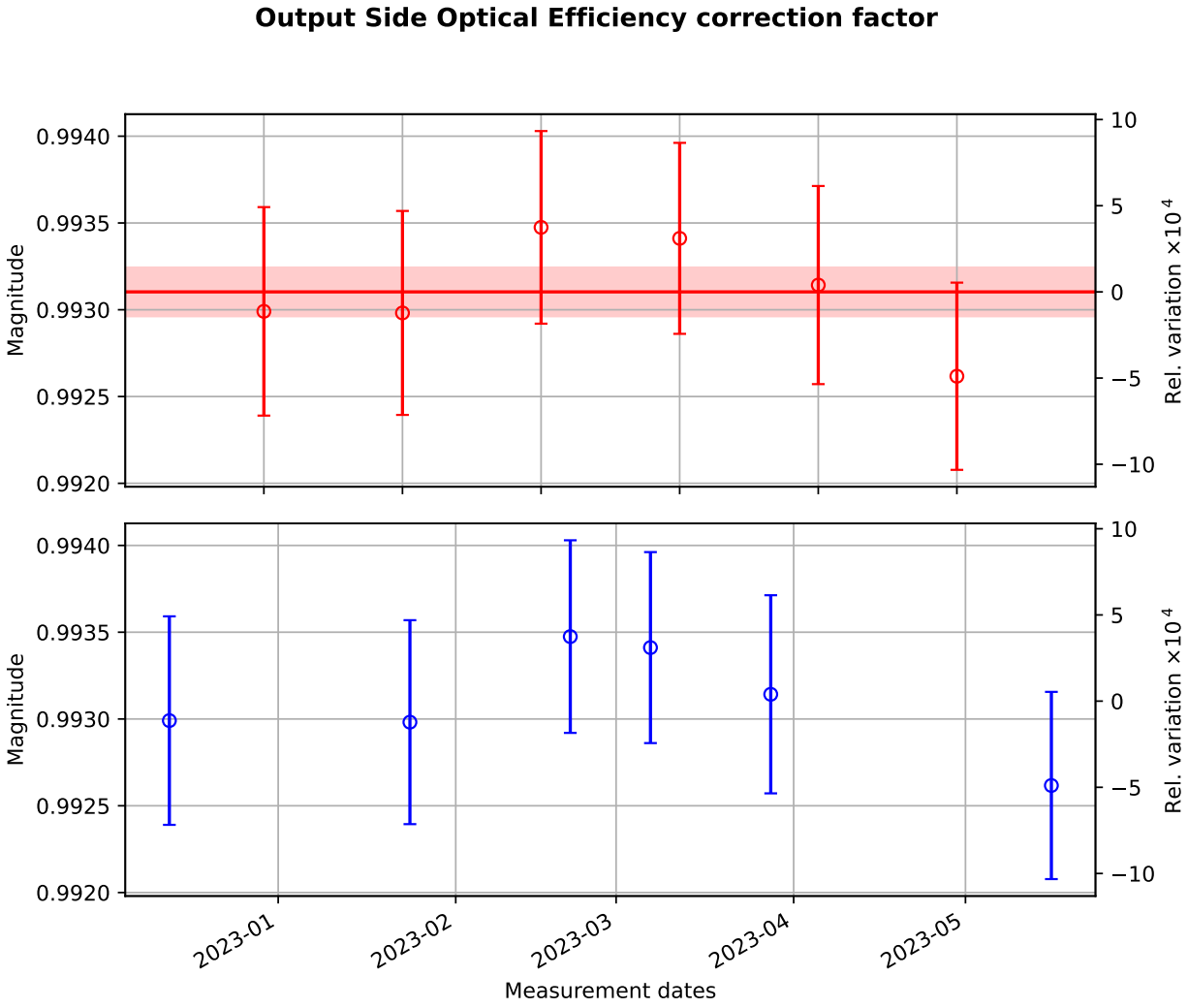


Summary of Input Side Optical Efficiency correction factor	
Mean value:	0.991955
Standard deviation:	0.000315
Standard error:	0.000140
Relative Standard error:	0.000142

20 Output Optical efficiency correction factor ($\eta_R = \sqrt{e/\beta}$)

List of Measurements

Date	E_R ± SD_E_R
D20221213	0.9930 ± 0.0006
D20230124	0.9930 ± 0.0006
D20230221	0.9935 ± 0.0006
D20230307	0.9934 ± 0.0006
D20230328	0.9931 ± 0.0006
D20230516	0.9926 ± 0.0005



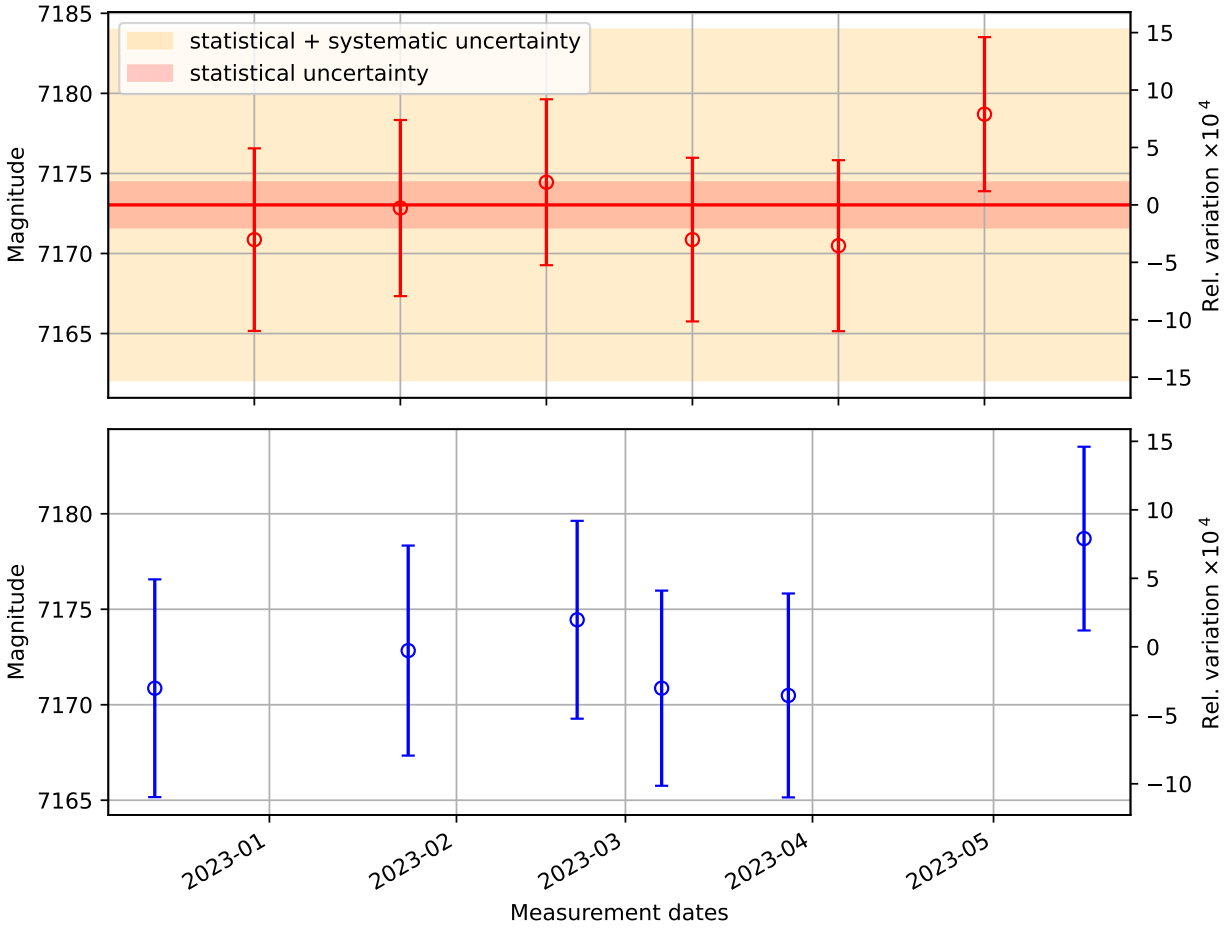
Summary of Output Side Optical Efficiency correction factor	
Mean value:	0.993103
Standard deviation:	0.000316
Standard error:	0.000141
Relative Standard error:	0.000142

21 TxPD calibration at ETM ($\rho\prime_{Tx} = \rho_T.\eta_T.\zeta$)

List of Measurements

Date	rhoT_prime ± SD_rhoT_prime
D20221213	7170.8645 ± 5.7012
D20230124	7172.8367 ± 5.4999
D20230221	7174.4498 ± 5.1810
D20230307	7170.8667 ± 5.1102
D20230328	7170.4871 ± 5.3391
D20230516	7178.7008 ± 4.8110

TxPD calibration corrected for optical efficiency (ct/W)



Summary of TxPD calibration corrected for optical efficiency (ct/W)

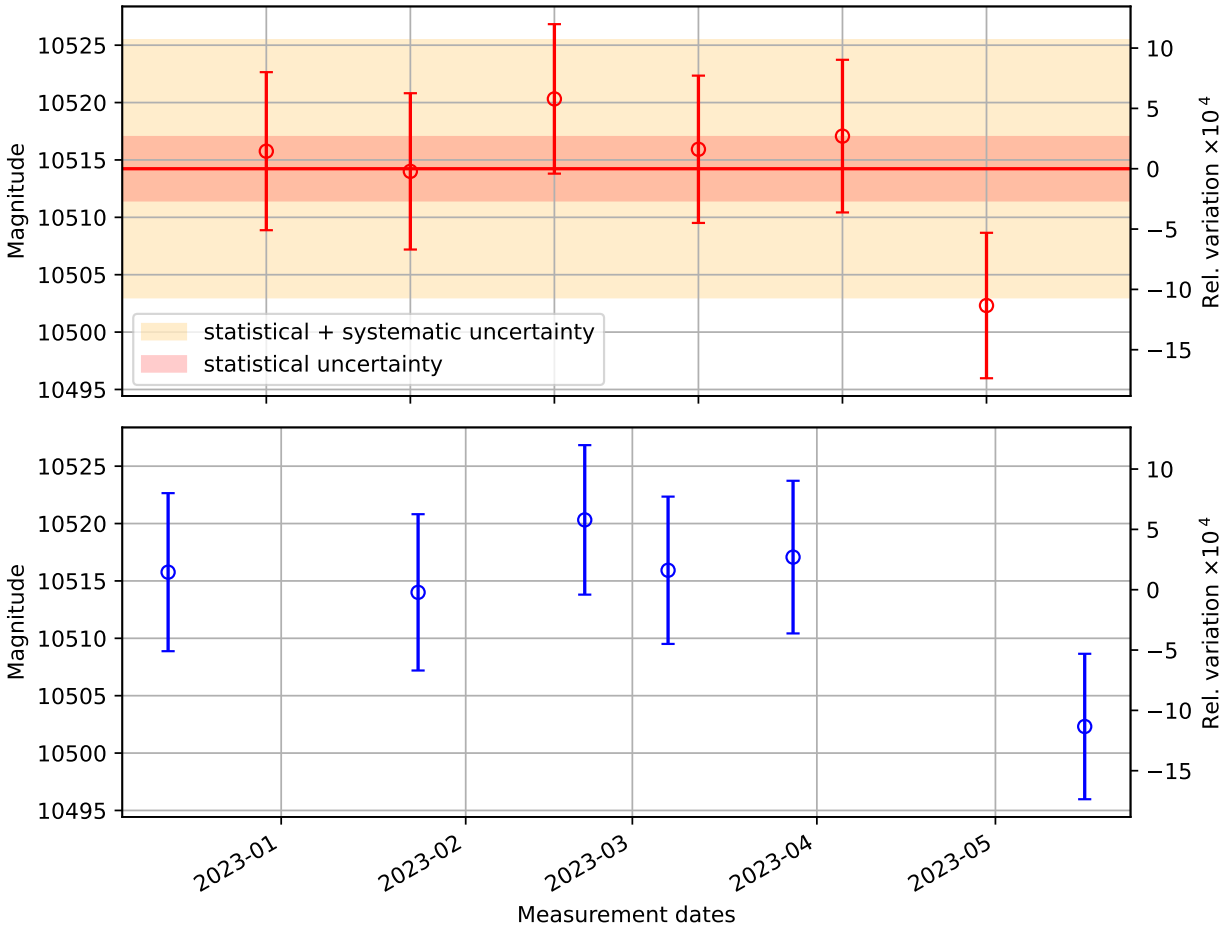
Mean value:	7173.034255
Standard deviation:	3.163753
Standard error:	1.408576
Relative Standard error:	0.000196

22 RxPD calibration at ETM ($\rho\prime_{Rx} = \rho_R.\eta_R.\zeta$)

List of Measurements

Date	rhoR_prime ± SD_rhoR_prime
D20221213	10515.7634 ± 6.8862
D20230124	10514.0046 ± 6.8103
D20230221	10520.3192 ± 6.5129
D20230307	10515.9286 ± 6.4182
D20230328	10517.0760 ± 6.6505
D20230516	10502.3145 ± 6.3367

RxPD calibration corrected for optical efficiency (ct/W)



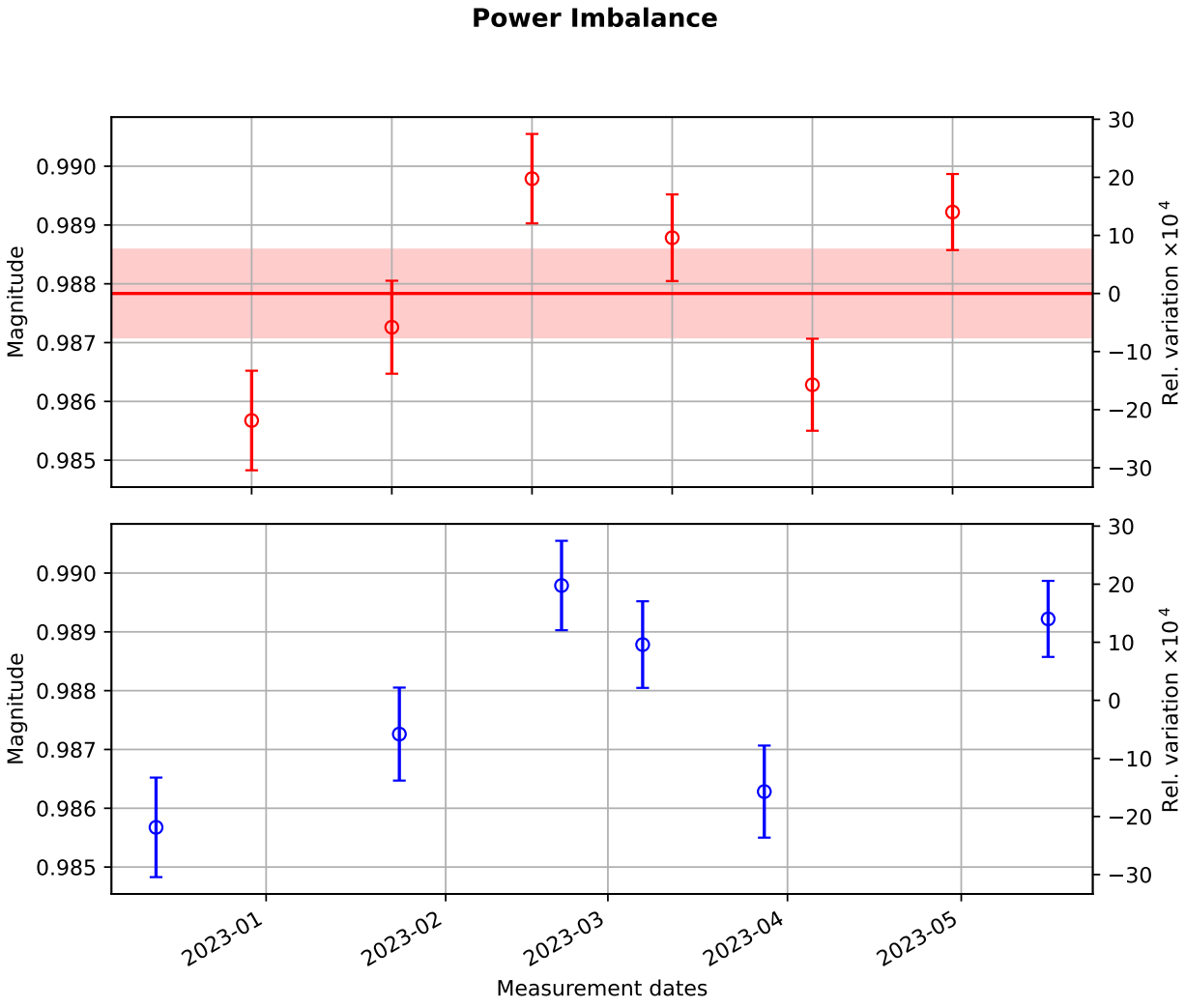
Summary of RxPD calibration corrected for optical efficiency (ct/W)

Mean value:	10514.234381
Standard deviation:	6.203930
Standard error:	2.762132
Relative Standard error:	0.000263

23 Power Imbalance

List of Measurements

Date	PI ± SD_PI
D20221213	0.9857 ± 0.0008
D20230124	0.9873 ± 0.0008
D20230221	0.9898 ± 0.0008
D20230307	0.9888 ± 0.0007
D20230328	0.9863 ± 0.0008
D20230516	0.9892 ± 0.0006



Summary of Power Imbalance

Mean value:	0.987835
Standard deviation:	0.001676
Standard error:	0.000746
Relative Standard error:	0.000755