RxPD and TxPD Calibration Trends

GENERATED FOR LHO_EndY

Report Generated on September 26, 2023

Contents

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

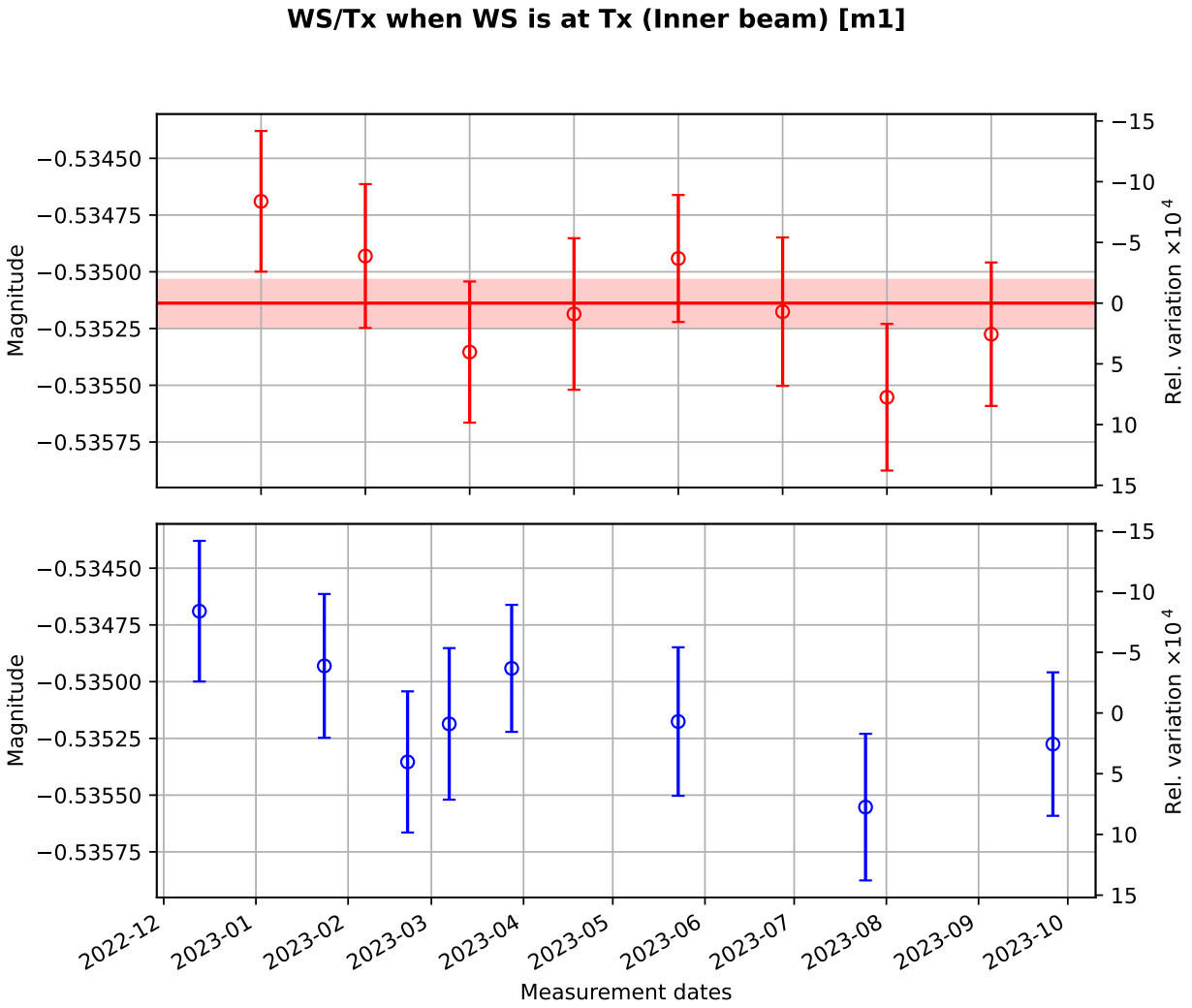
Each section contains a list of measurements with the mean value (m1), standard deviation on the mean (SD_m1) and a ratio of thestandard deviation of the quantity and error bars for each measurement (frac). The list is followed by two plot figures with Magnitude on the Y axis and Index on the X axis 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
D20230523	-0.5352 ± 0.0003
D20230725	-0.5356 ± 0.0003
D20230926	-0.5353 ± 0.0003

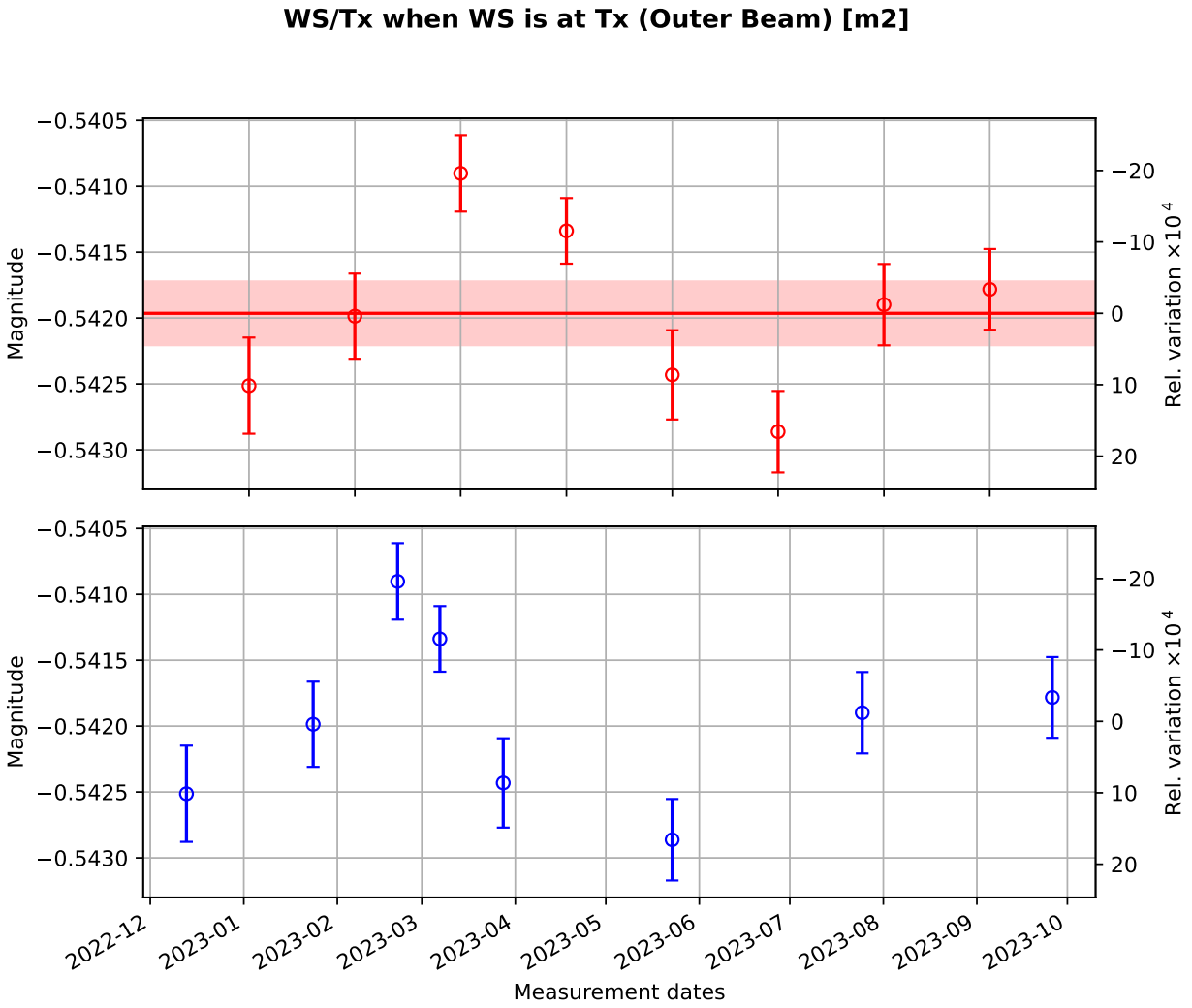


Summary of WS/Tx when WS is at Tx (Inner beam) [m1]	
Mean value:	-0.535138
Standard deviation:	0.000274
Standard error:	0.000103
Relative Standard error:	-0.000193

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
D20230523	-0.5429 ± 0.0003
D20230725	-0.5419 ± 0.0003
D20230926	-0.5418 ± 0.0003

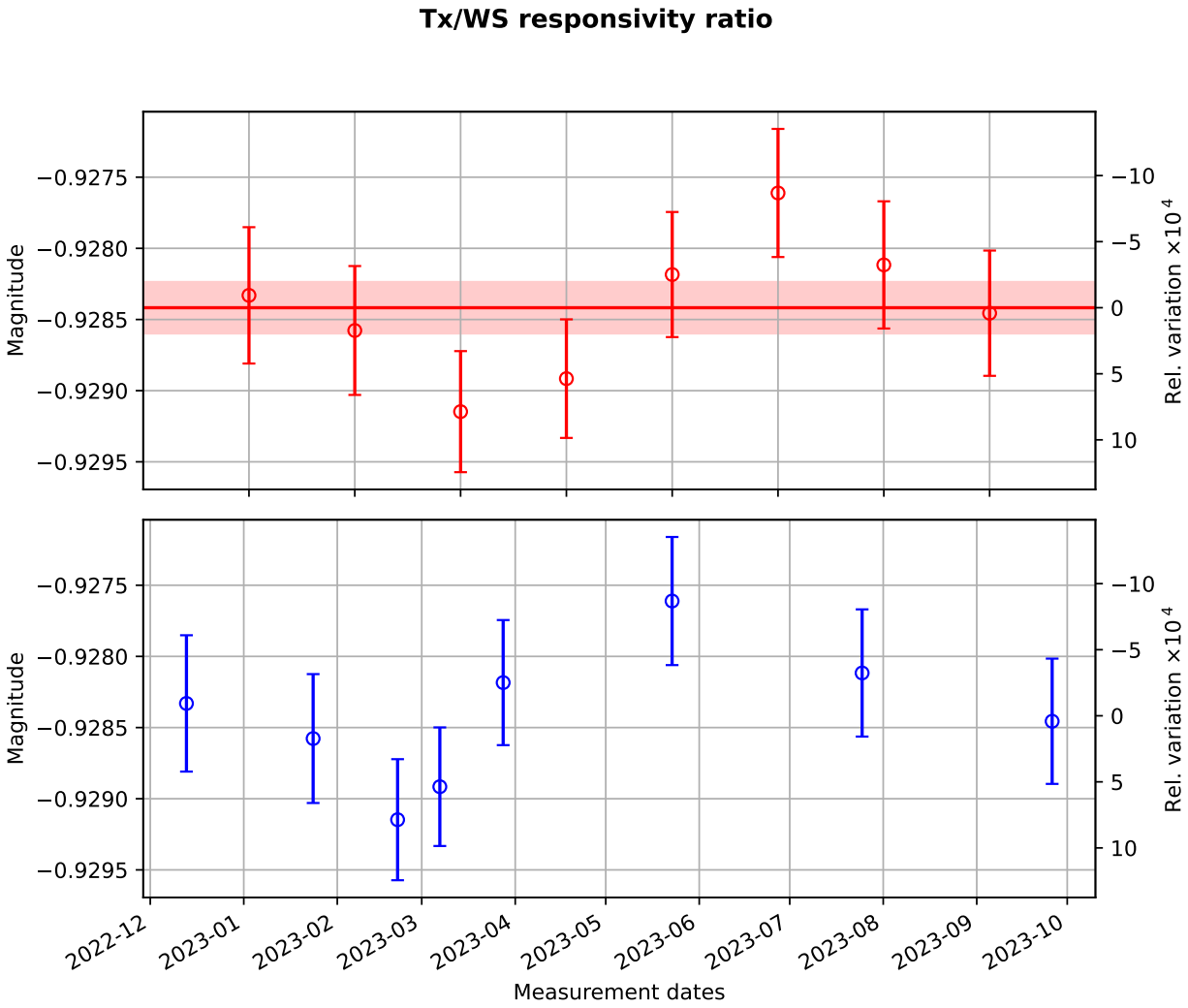


Summary of WS/Tx when WS is at Tx (Outer Beam) [m2]	
Mean value:	-0.541964
Standard deviation:	0.000642
Standard error:	0.000242
Relative Standard error:	-0.000447

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
D20230523	-0.9276 ± 0.0005
D20230725	-0.9281 ± 0.0004
D20230926	-0.9285 ± 0.0004



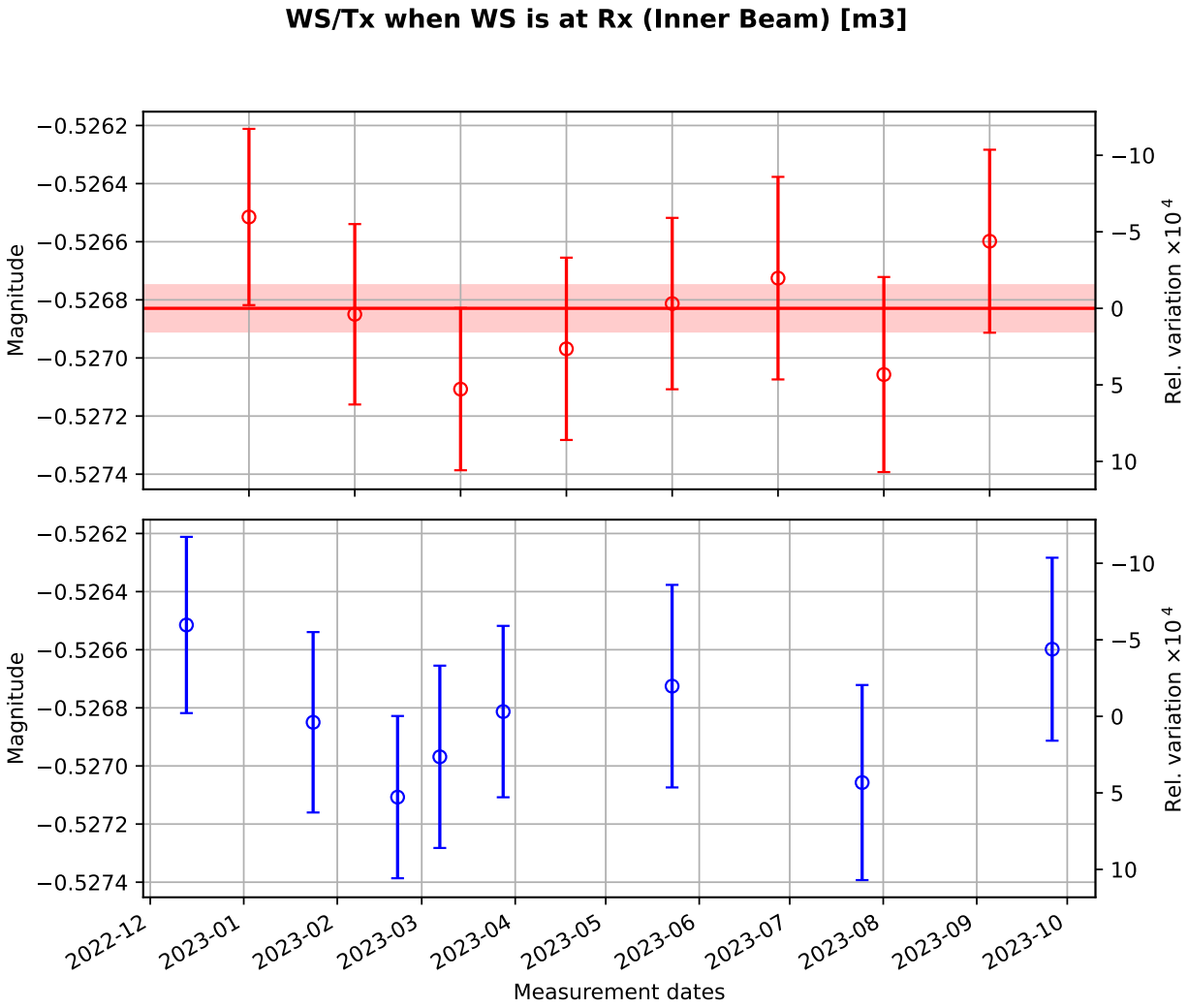
Summary of Tx/WS responsivity ratio

Mean value:	-0.928417
Standard deviation:	0.000480
Standard error:	0.000181
Relative Standard error:	-0.000195

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
D20230523	-0.5267 ± 0.0003
D20230725	-0.5271 ± 0.0003
D20230926	-0.5266 ± 0.0003



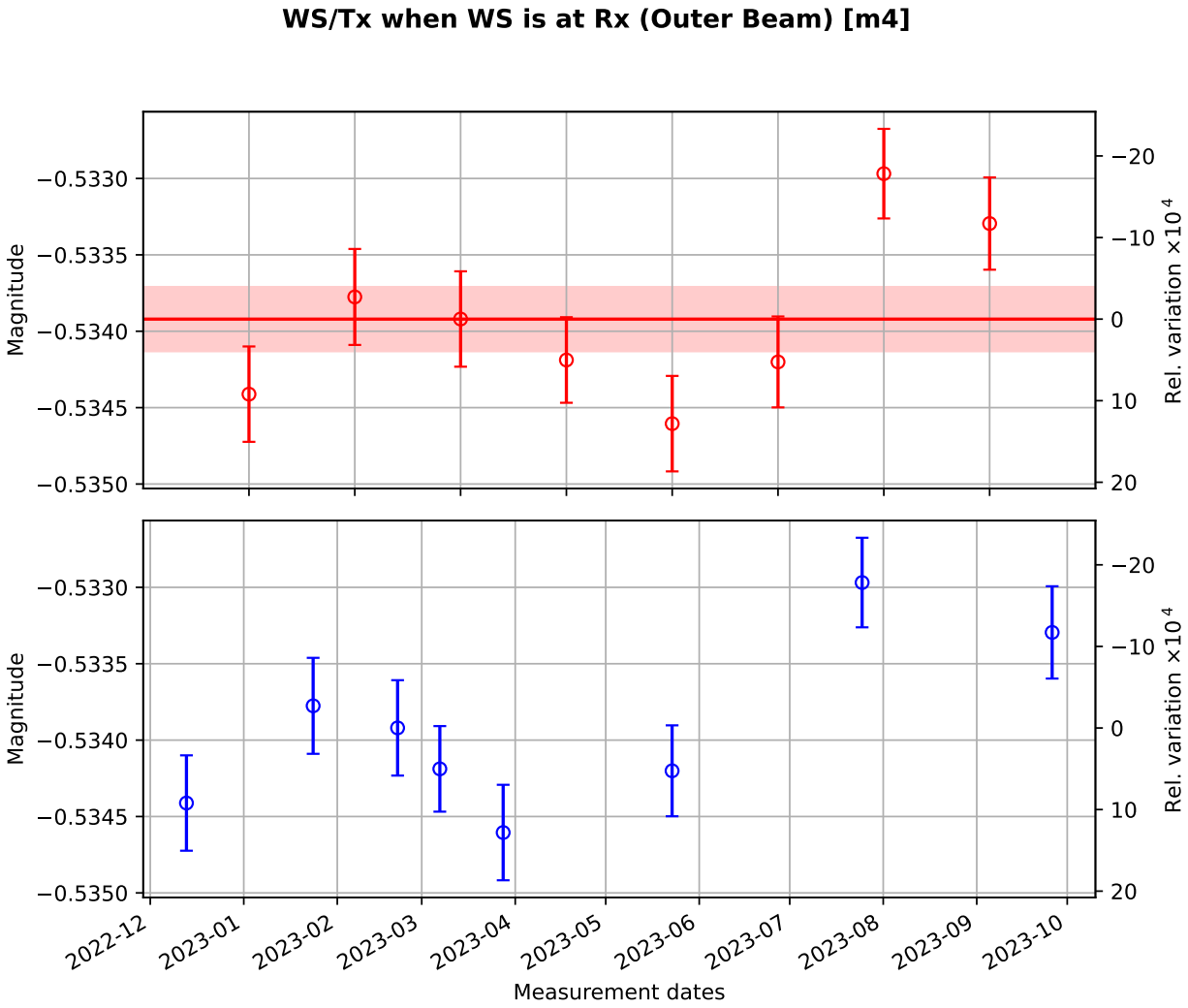
Summary of WS/Tx when WS is at Rx (Inner Beam) [m3]

Mean value:	-0.526829
Standard deviation:	0.000211
Standard error:	0.000080
Relative Standard error:	-0.000151

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
D20230523	-0.5342 ± 0.0003
D20230725	-0.5330 ± 0.0003
D20230926	-0.5333 ± 0.0003



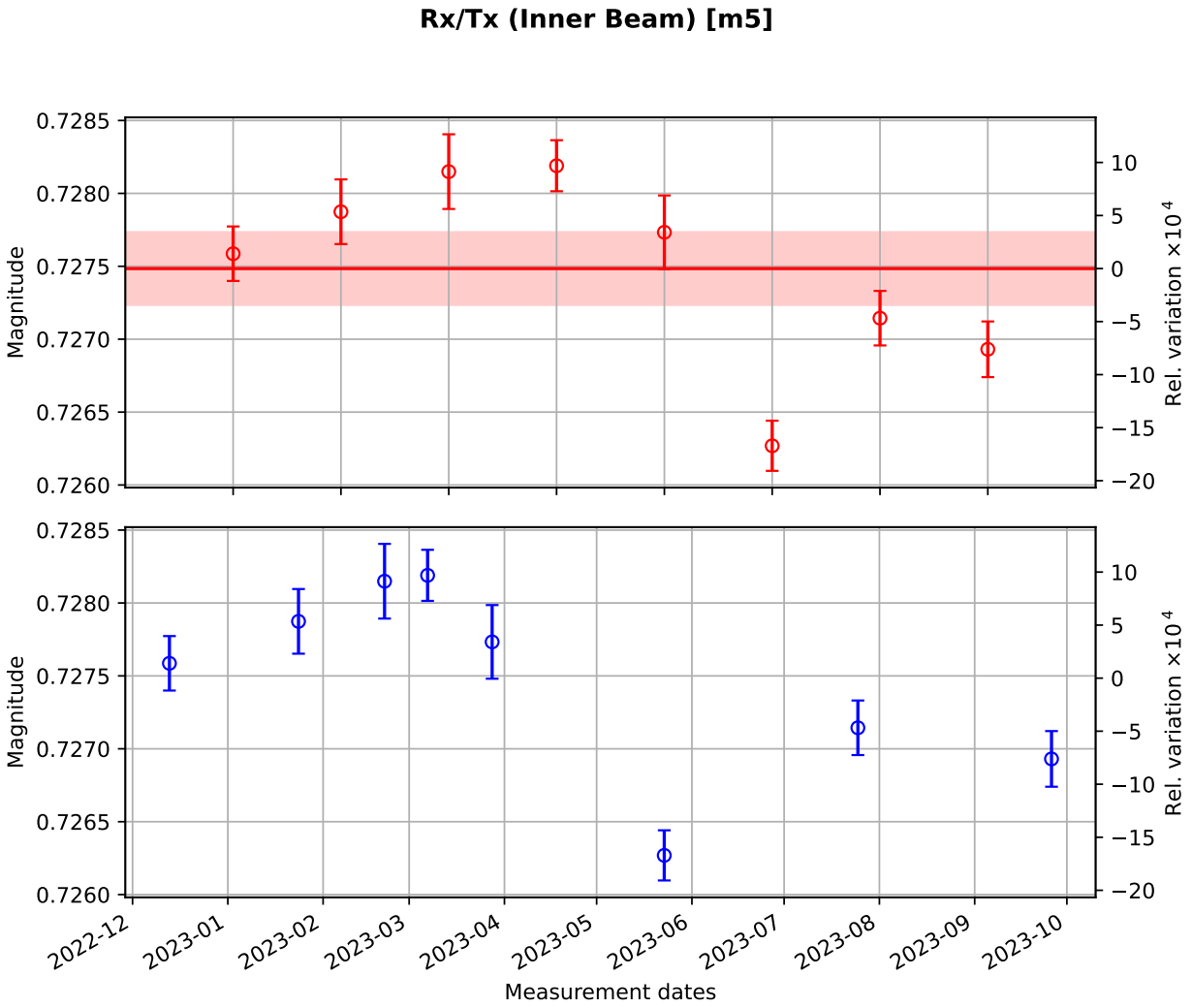
Summary of WS/Tx when WS is at Rx (Outer Beam) [m4]

Mean value:	-0.533921
Standard deviation:	0.000558
Standard error:	0.000210
Relative Standard error:	-0.000394

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
D20230523	0.7263 ± 0.0002
D20230725	0.7271 ± 0.0002
D20230926	0.7269 ± 0.0002



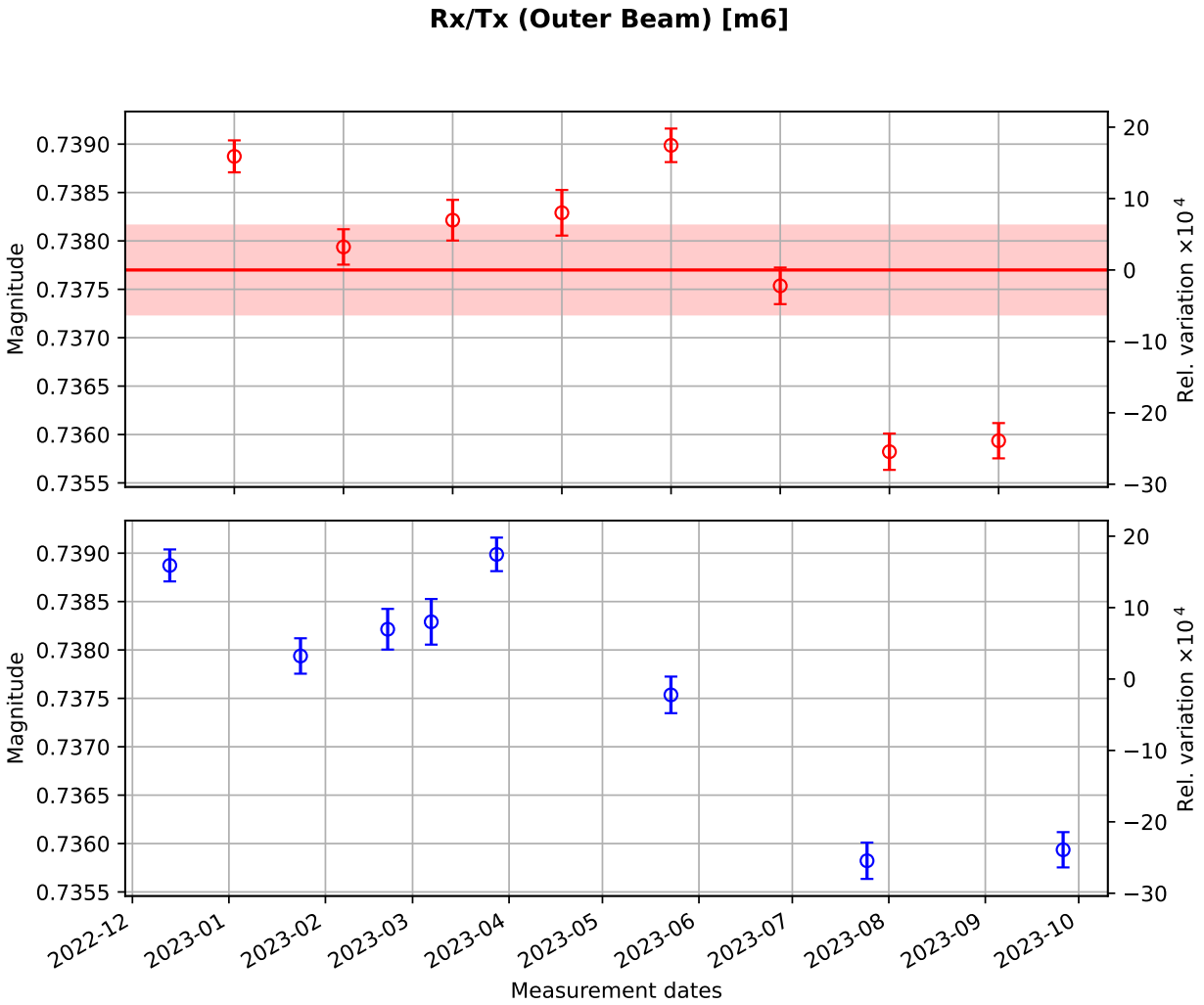
Summary of Rx/Tx (Inner Beam) [m5]

Mean value:	0.727485
Standard deviation:	0.000661
Standard error:	0.000249
Relative Standard error:	0.000343

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
D20230523	0.7375 ± 0.0002
D20230725	0.7358 ± 0.0002
D20230926	0.7359 ± 0.0002



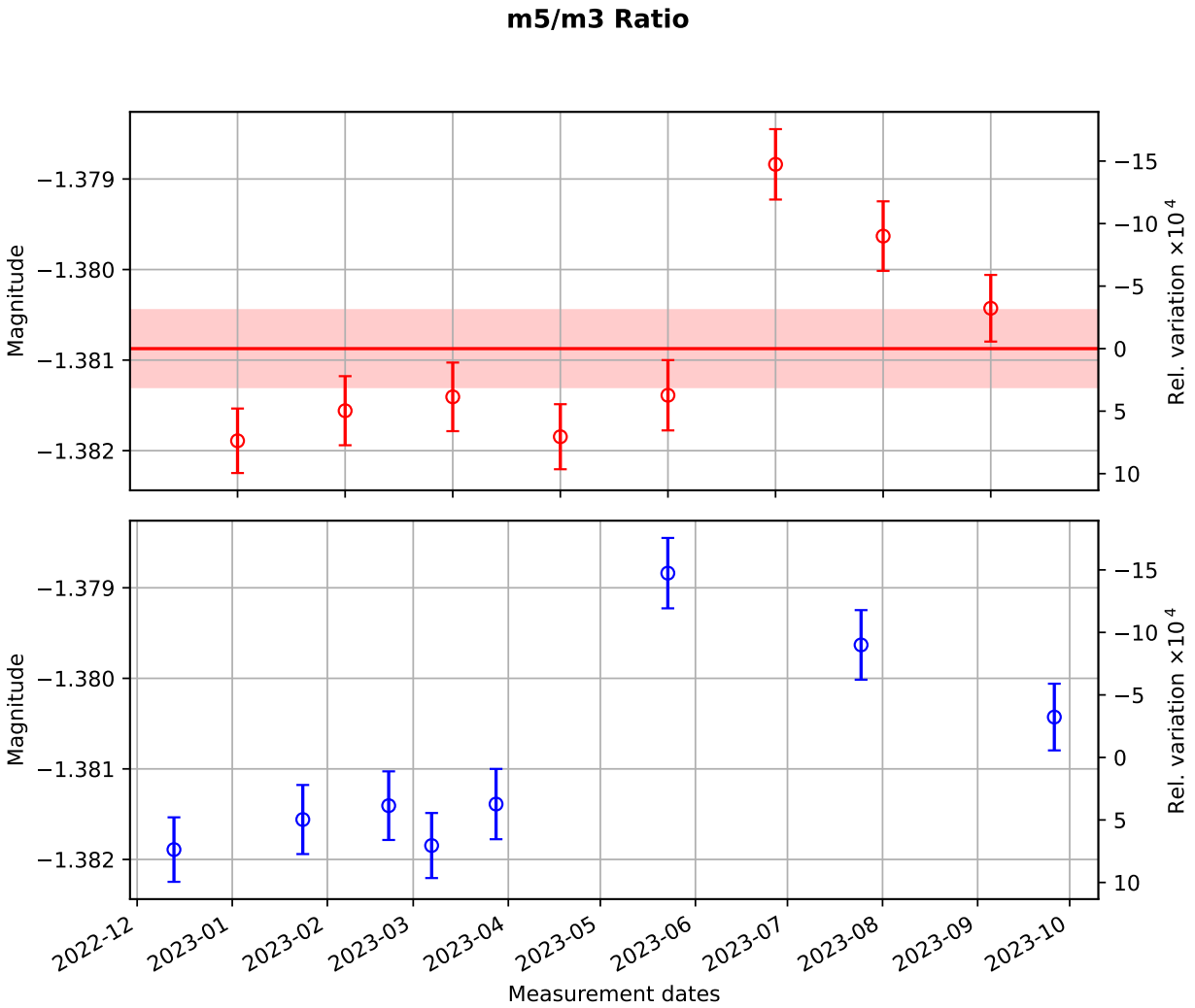
Summary of Rx/Tx (Outer Beam) [m6]

Mean value:	0.737700
Standard deviation:	0.001217
Standard error:	0.000459
Relative Standard error:	0.000622

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
D20230523	-1.3788 ± 0.0004
D20230725	-1.3796 ± 0.0004
D20230926	-1.3804 ± 0.0004



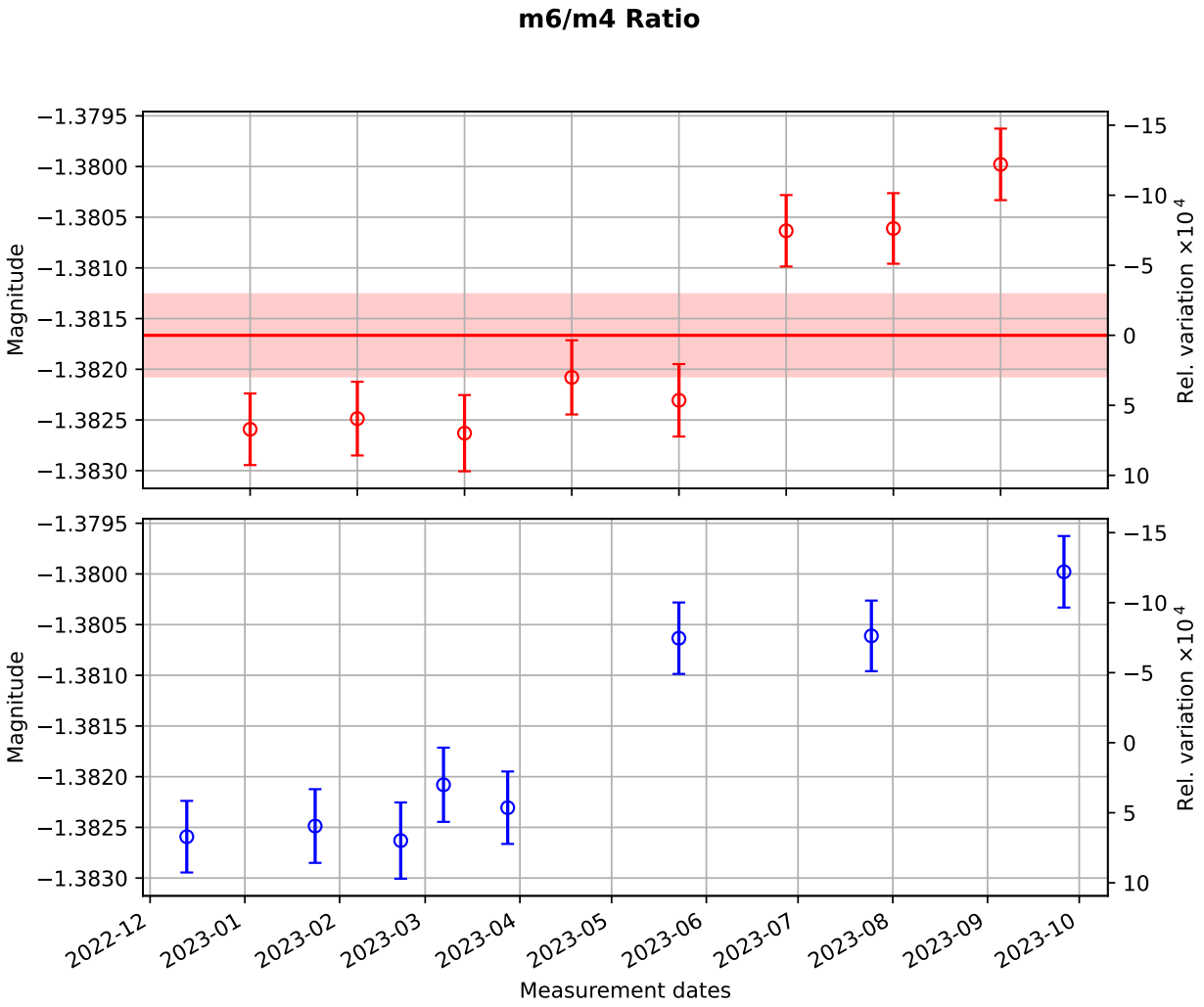
Summary of m5/m3 Ratio

Mean value:	-1.380873
Standard deviation:	0.001127
Standard error:	0.000425
Relative Standard error:	-0.000308

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
D20230523	-1.3806 ± 0.0004
D20230725	-1.3806 ± 0.0003
D20230926	-1.3800 ± 0.0004



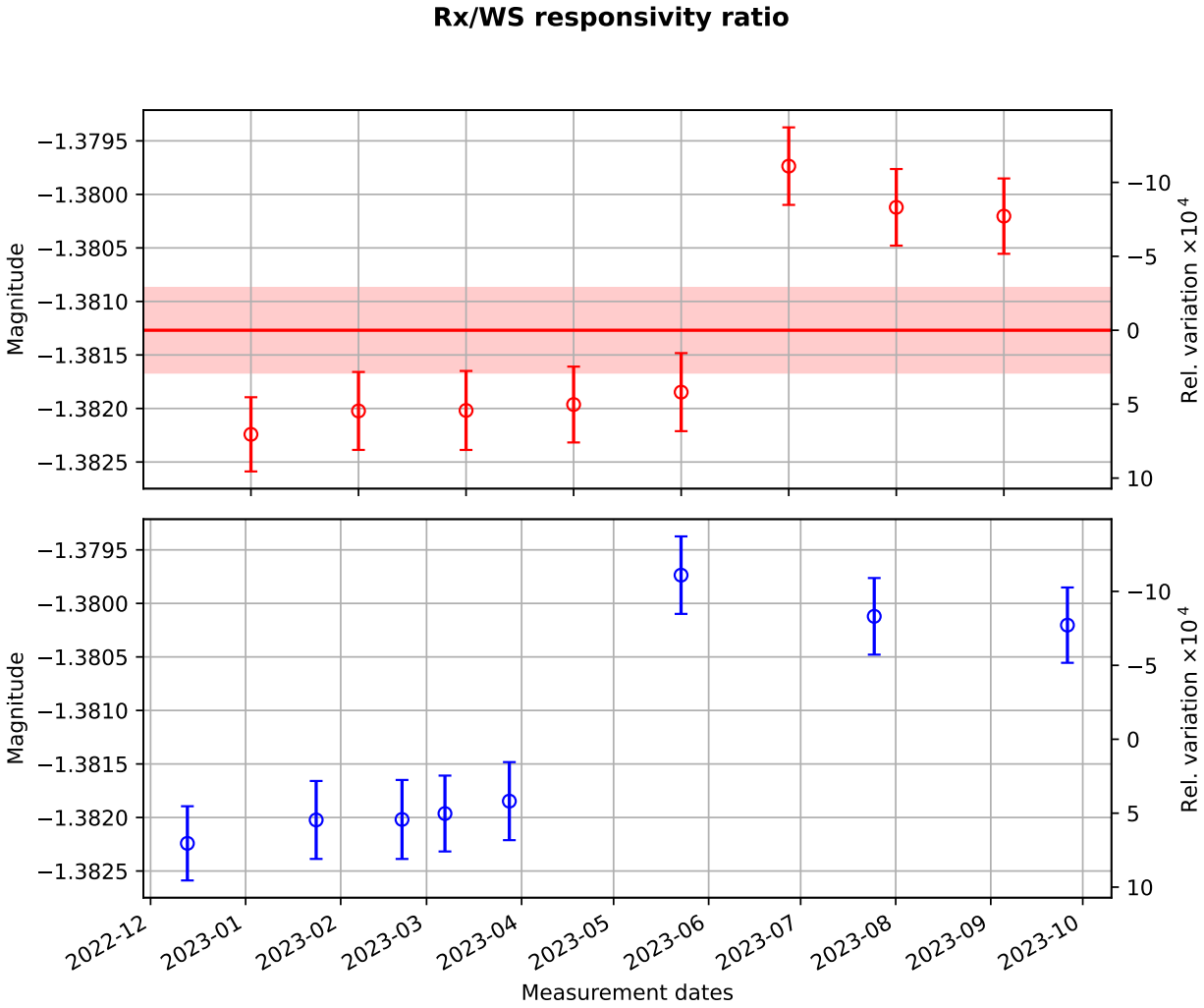
Summary of m6/m4 Ratio

Mean value:	-1.381665
Standard deviation:	0.001074
Standard error:	0.000405
Relative Standard error:	-0.000293

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

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
D20230523	-1.3797 ± 0.0004
D20230725	-1.3801 ± 0.0004
D20230926	-1.3802 ± 0.0004



Summary of Rx/WS responsivity ratio

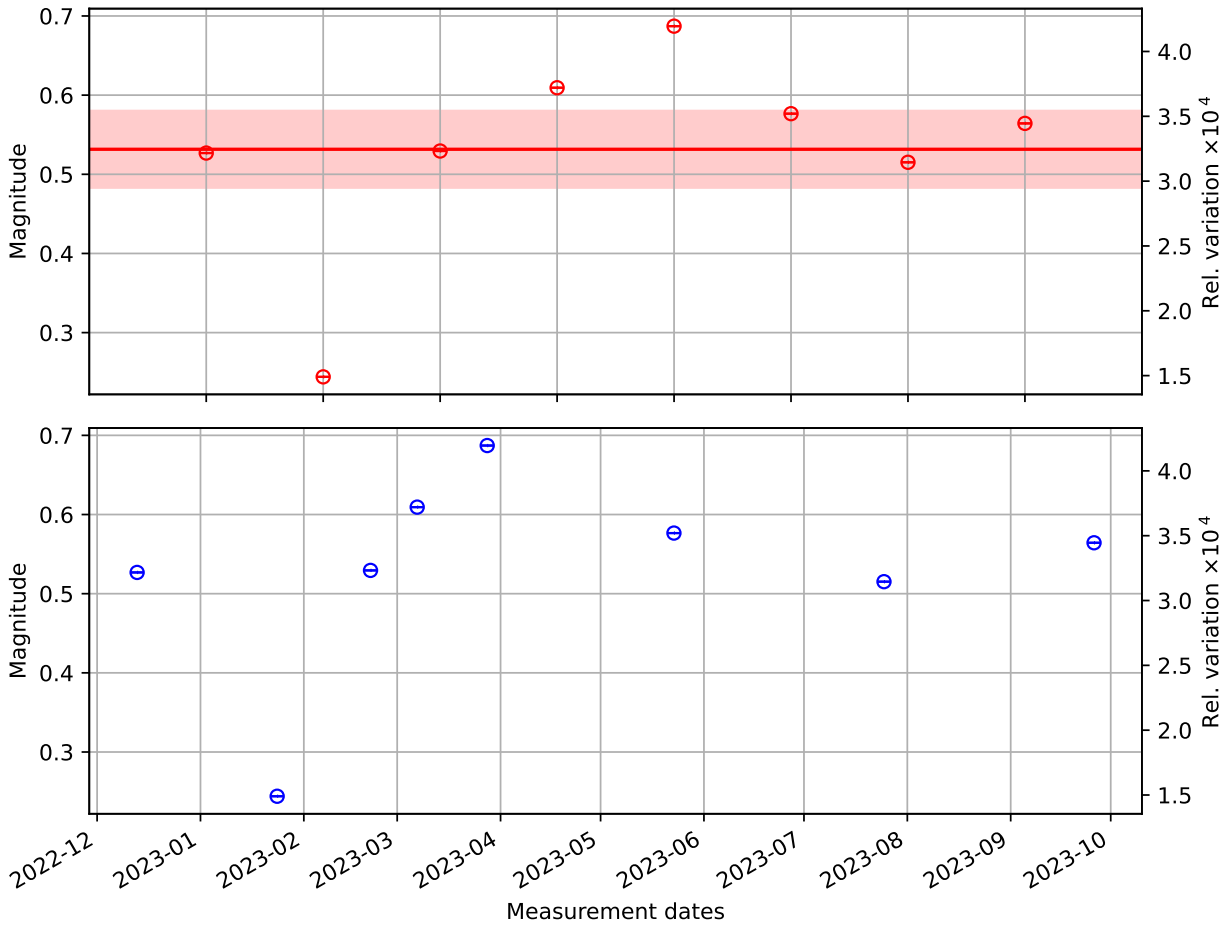
Mean value:	-1.381269
Standard deviation:	0.001049
Standard error:	0.000395
Relative Standard error:	-0.000286

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
D20230523       1.6378e+03 ± 1.0000e-09
D20230725       1.6379e+03 ± 1.0000e-09
D20230926       1.6378e+03 ± 1.0000e-09
```

ADC conversion factor discrepancy (1638.4 - ζ (ct/V))

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Summary of ADC conversion factor discrepancy
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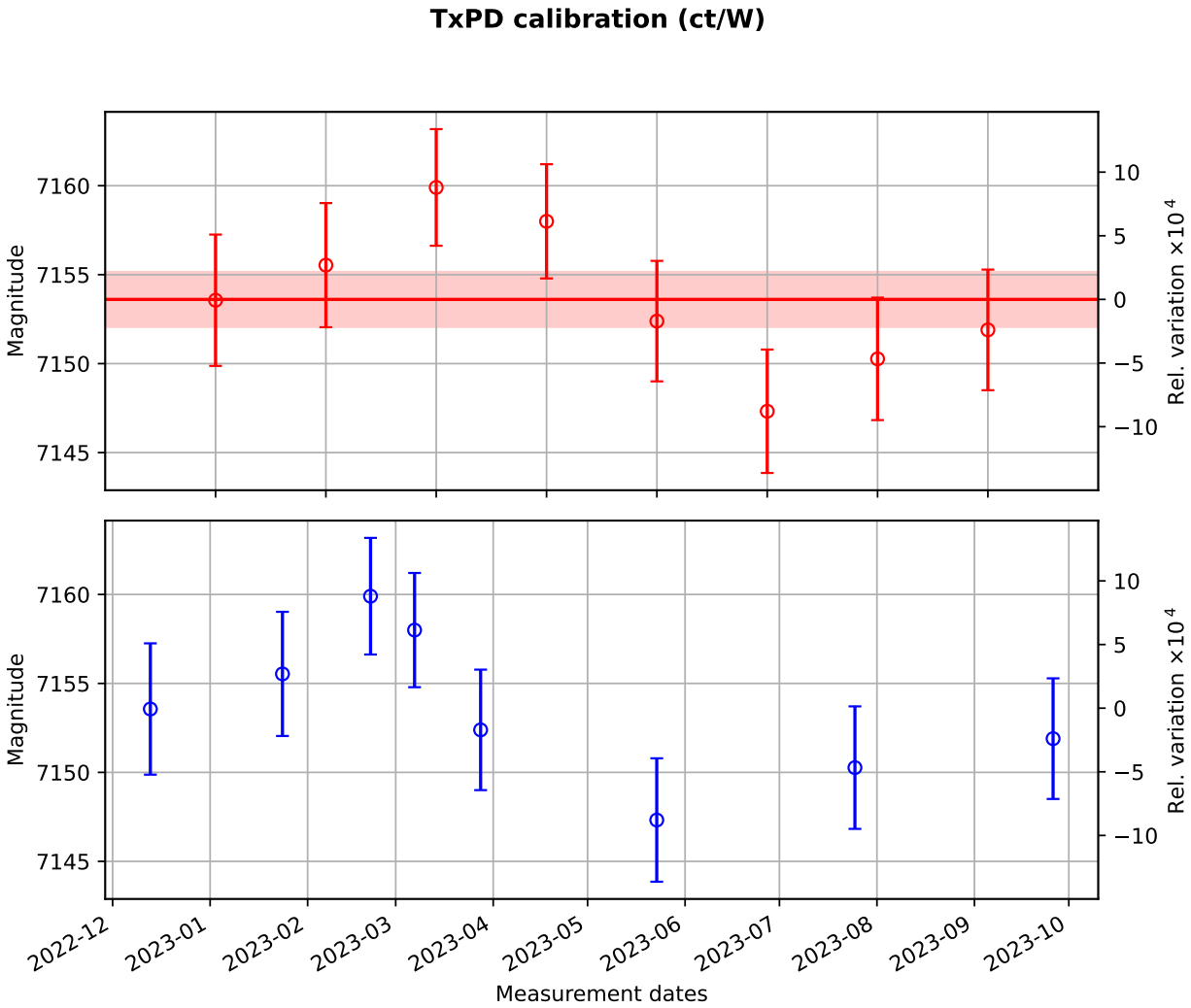
13 TxPD calibration ($\rho_{Tx} = \rho_G.\alpha_{WG}.\alpha_{TW}.\zeta$)

List of Measurements

Date	rhoTx ± SD_rhoTx
D20221213	7153.5622 ± 3.6907
D20230124	7155.5352 ± 3.4892
D20230221	7159.9027 ± 3.2774
D20230307	7157.9979 ± 3.2099
D20230328	7152.3889 ± 3.3863
D20230523	7147.3224 ± 3.4684
D20230725	7150.2673 ± 3.4427
D20230926	7151.8956 ± 3.3903

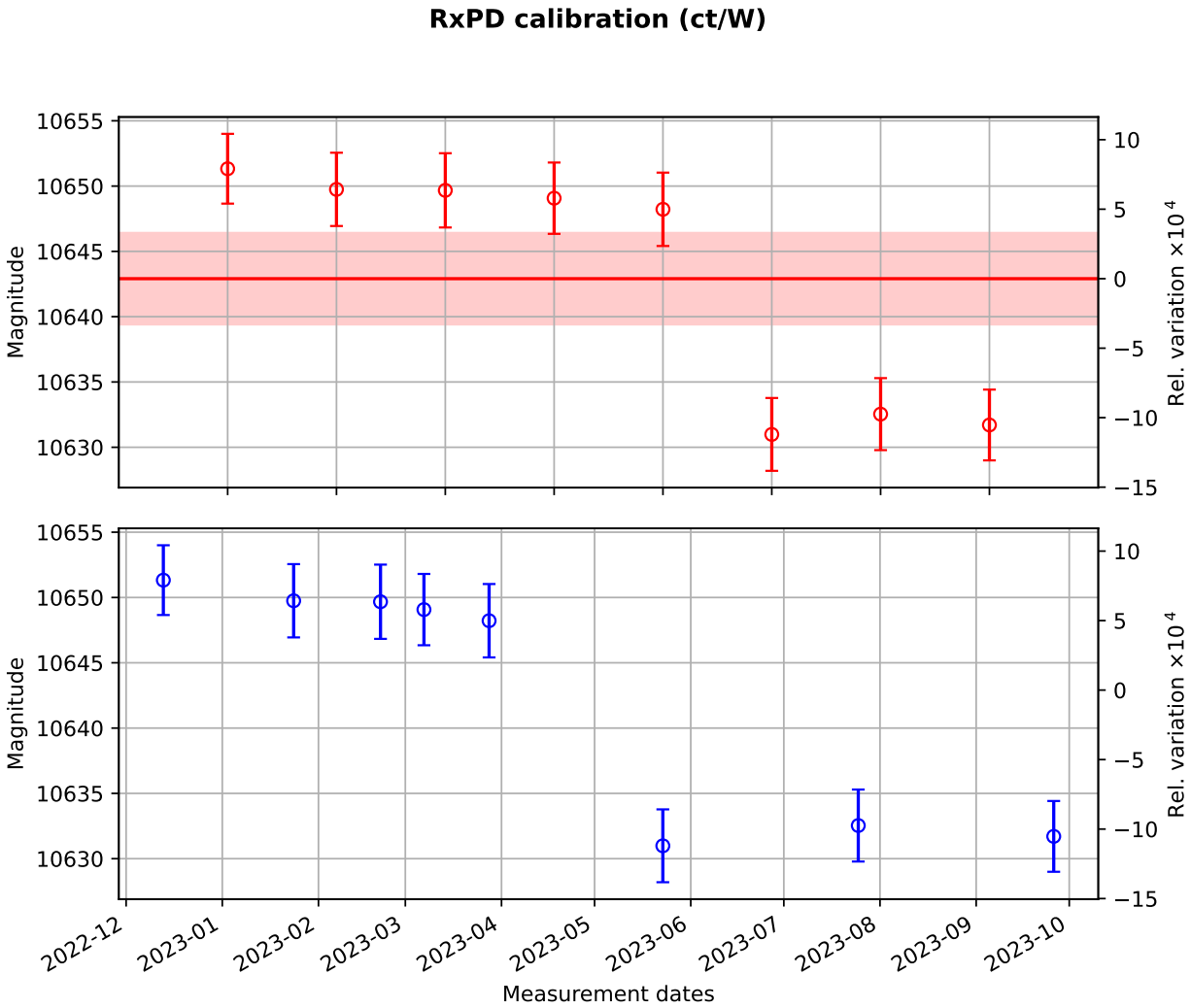


Summary of TxPD calibration (ct/W)	
Mean value:	7153.609024
Standard deviation:	4.100498
Standard error:	1.546194
Relative Standard error:	0.000216

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

List of Measurements

Date	rhoRx ± SD_rhoRx
D20221213	10651.3278 ± 2.6712
D20230124	10649.7487 ± 2.8058
D20230221	10649.6738 ± 2.8433
D20230307	10649.0726 ± 2.7307
D20230328	10648.2216 ± 2.8093
D20230523	10630.9855 ± 2.7890
D20230725	10632.5382 ± 2.7567
D20230926	10631.7067 ± 2.7108



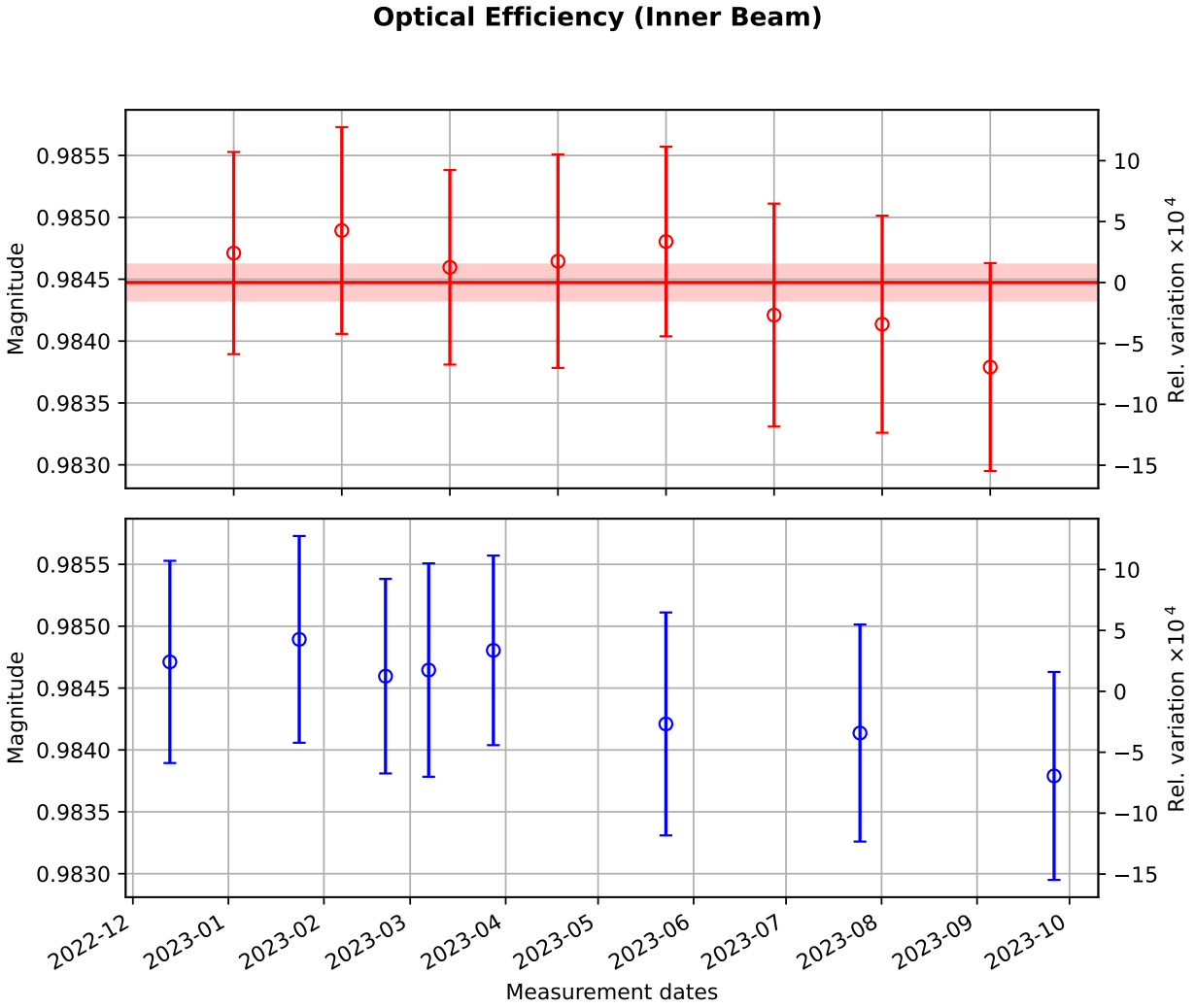
Summary of RxPD calibration (ct/W)

Mean value:	10642.909377
Standard deviation:	9.295522
Standard error:	3.505107
Relative Standard error:	0.000329

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
D20230523	0.9842 ± 0.0009
D20230725	0.9841 ± 0.0009
D20230926	0.9838 ± 0.0008



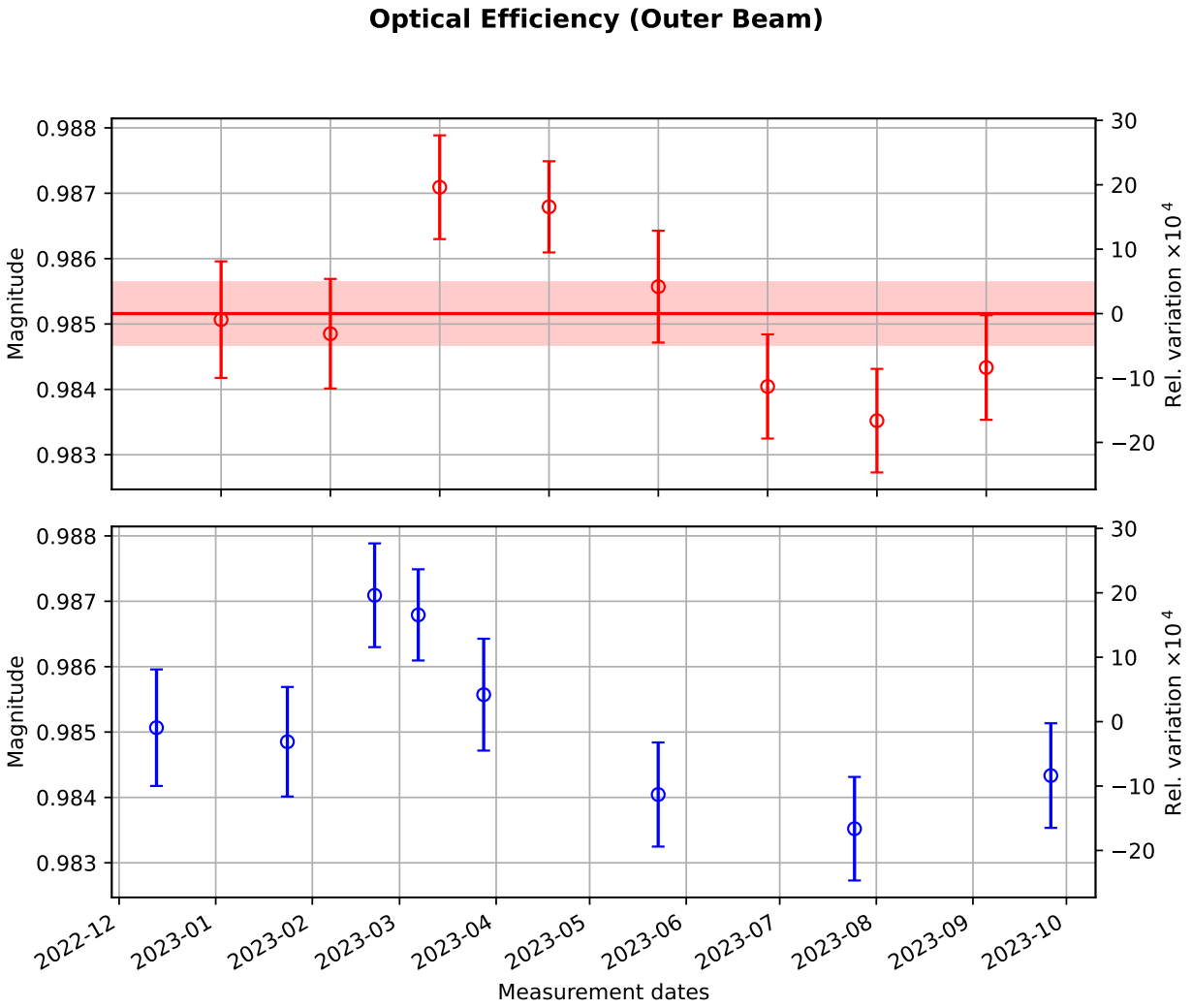
Summary of Optical Efficiency (Inner Beam)

Mean value:	0.984474
Standard deviation:	0.000385
Standard error:	0.000145
Relative Standard error:	0.000147

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
D20230523	0.9840 ± 0.0008
D20230725	0.9835 ± 0.0008
D20230926	0.9843 ± 0.0008

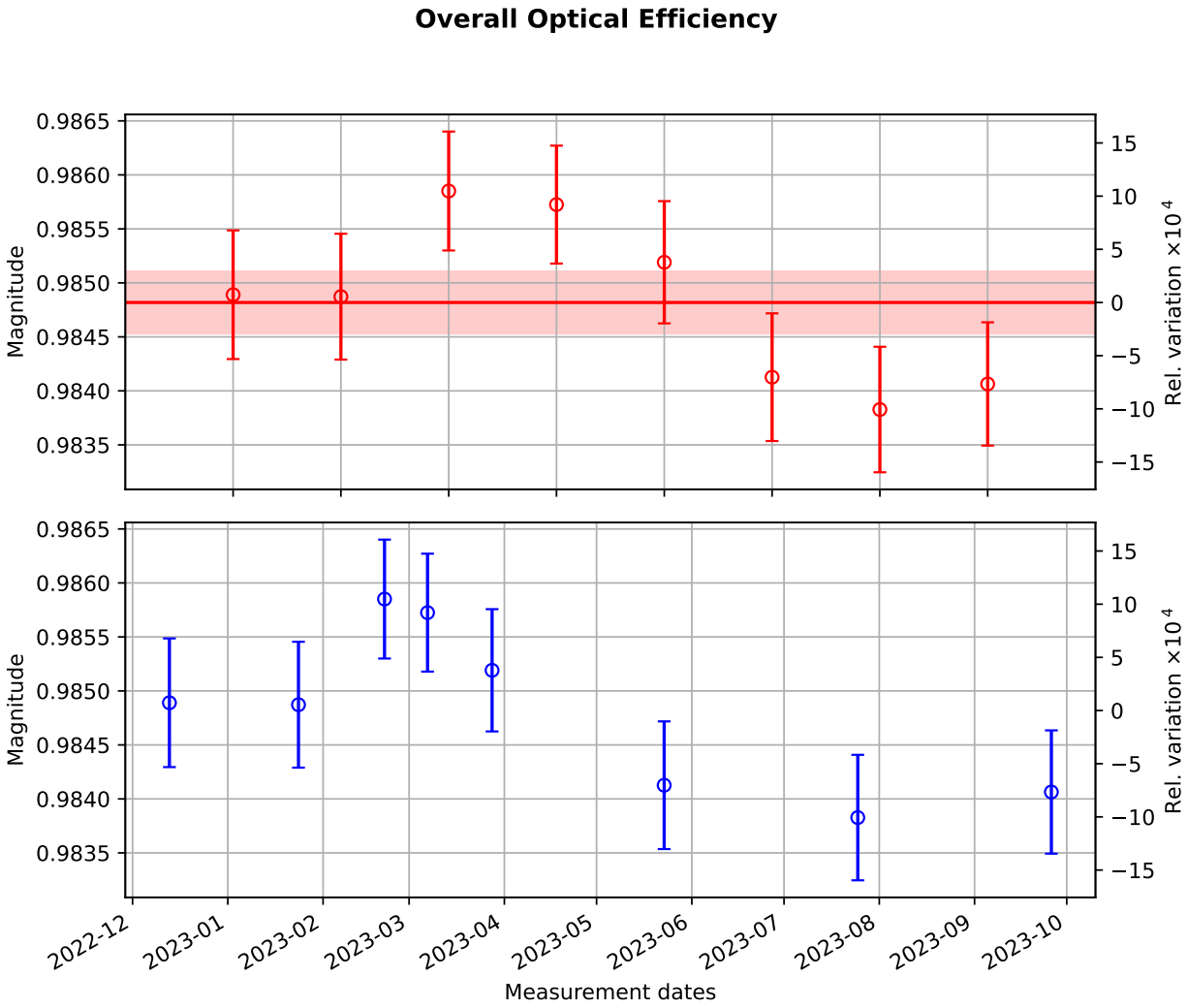


Summary of Optical Efficiency (Outer Beam)	
Mean value:	0.985159
Standard deviation:	0.001269
Standard error:	0.000479
Relative Standard error:	0.000486

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
D20230523	0.9841 ± 0.0006
D20230725	0.9838 ± 0.0006
D20230926	0.9841 ± 0.0006

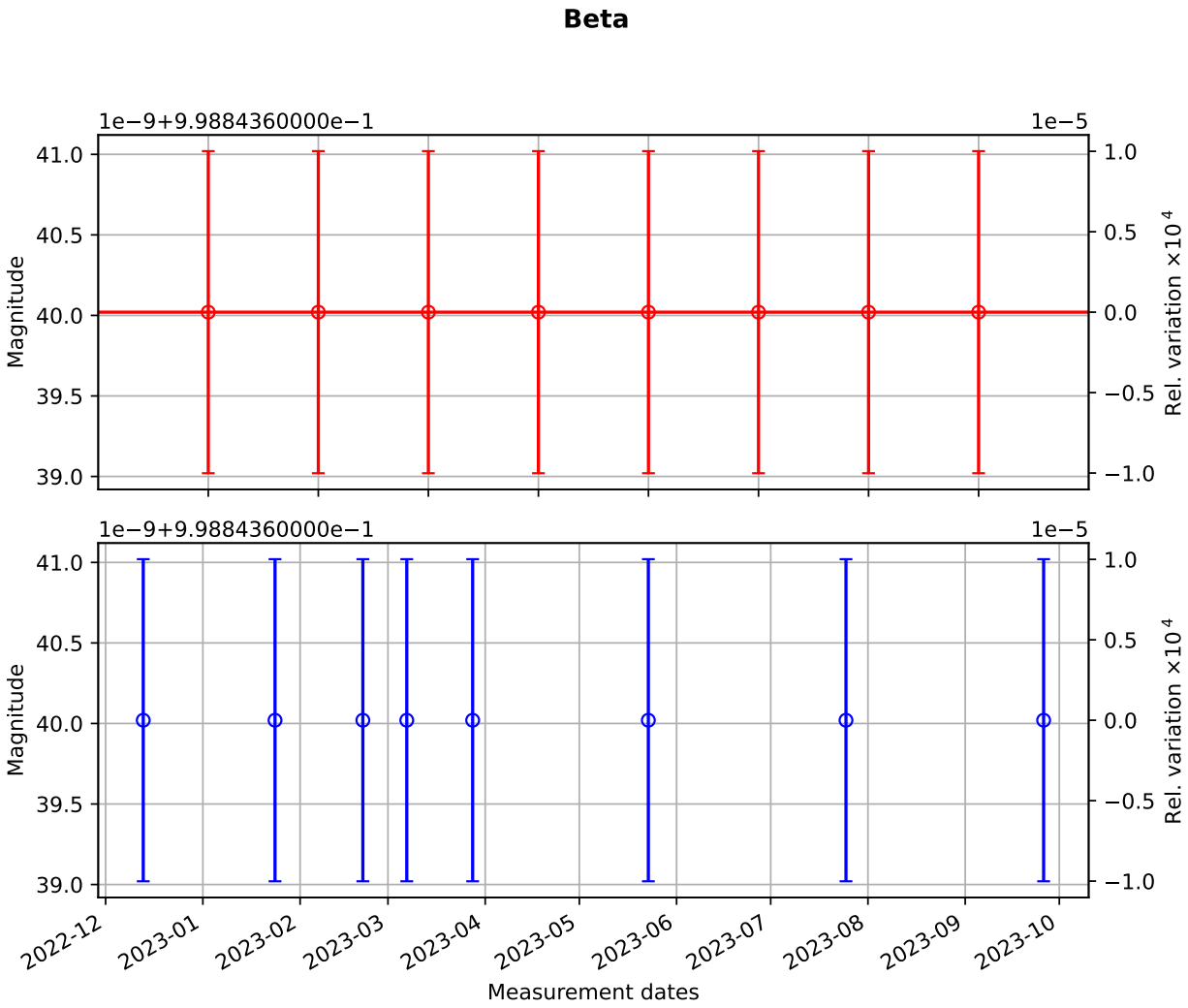


Summary of Overall Optical Efficiency	
Mean value:	0.984818
Standard deviation:	0.000762
Standard error:	0.000287
Relative Standard error:	0.000292

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
D20230523	9.9884e-01 ± 1.0000e-09
D20230725	9.9884e-01 ± 1.0000e-09
D20230926	9.9884e-01 ± 1.0000e-09



Summary of Beta

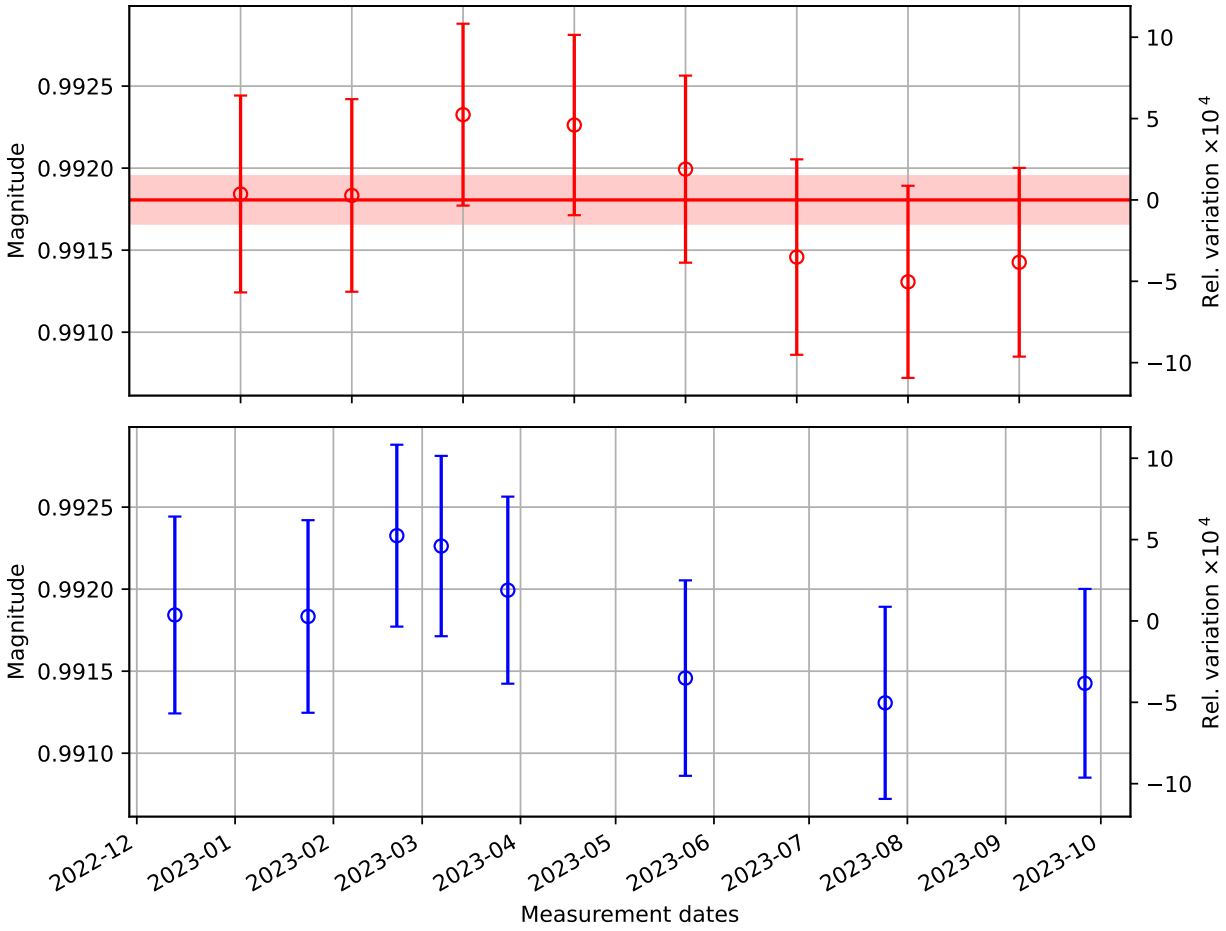
Mean value:	0.998844
Standard deviation:	0.000000
Standard error:	0.000000
Relative Standard error:	0.000000

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
D20230523	0.9915 ± 0.0006
D20230725	0.9913 ± 0.0006
D20230926	0.9914 ± 0.0006

Input Side Optical Efficiency correction factor



Summary of Input Side Optical Efficiency correction factor

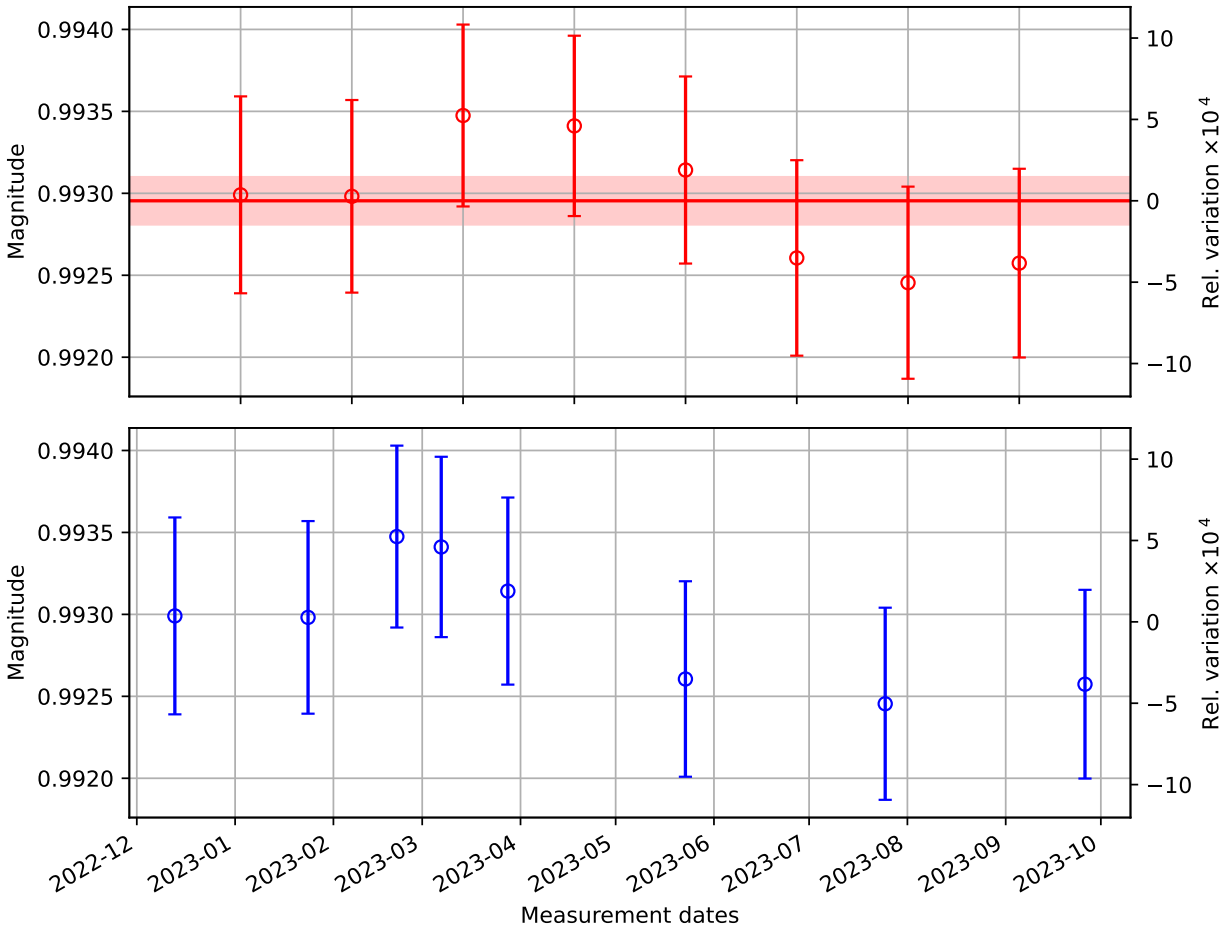
Mean value:	0.991806
Standard deviation:	0.000384
Standard error:	0.000145
Relative Standard error:	0.000146

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
D20230523	0.9926 ± 0.0006
D20230725	0.9925 ± 0.0006
D20230926	0.9926 ± 0.0006

Output Side Optical Efficiency correction factor



Summary of Output Side Optical Efficiency correction factor

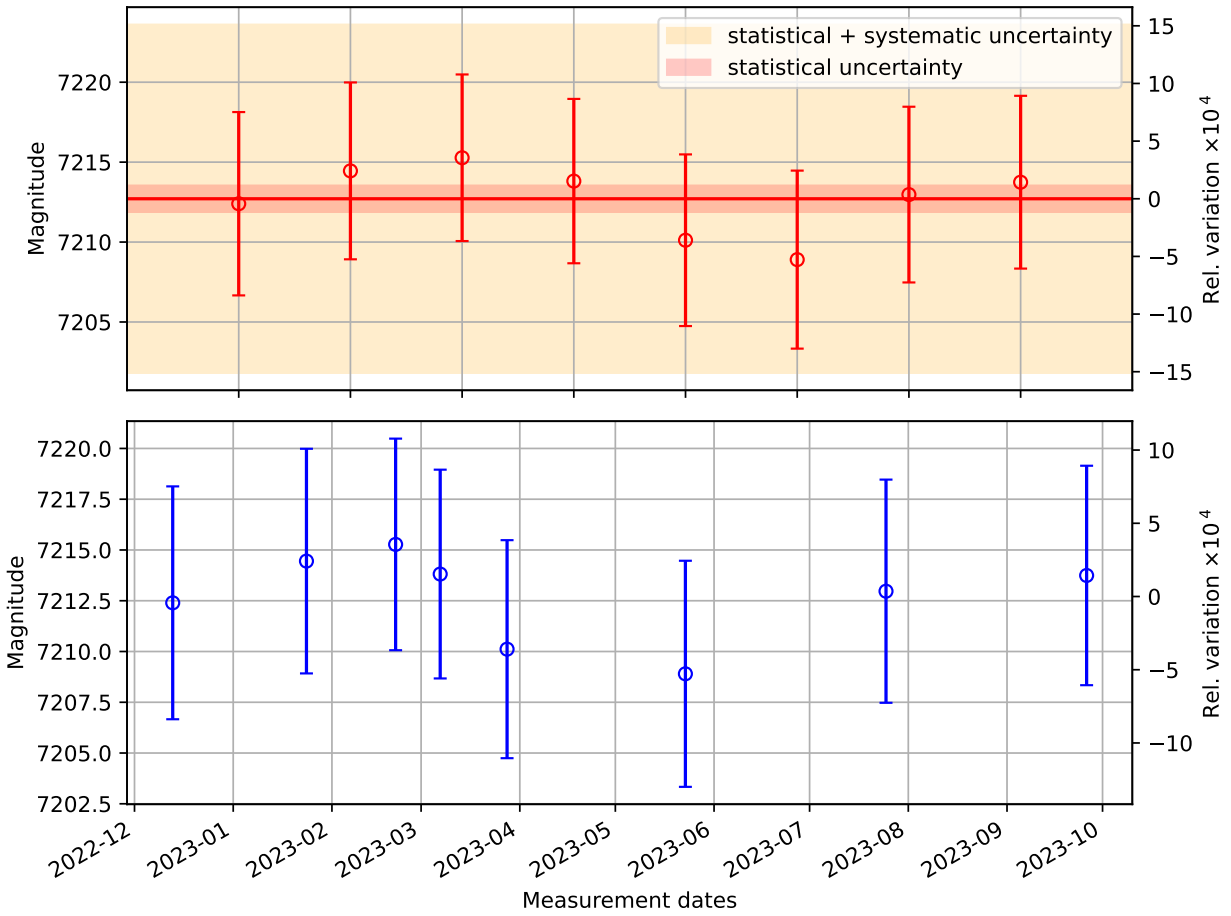
Mean value:	0.992954
Standard deviation:	0.000384
Standard error:	0.000145
Relative Standard error:	0.000146

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

List of Measurements

Date	rhoT_prime ± SD_rhoT_prime
D20221213	7212.3975 ± 5.7342
D20230124	7214.4524 ± 5.5318
D20230221	7215.2736 ± 5.2105
D20230307	7213.8139 ± 5.1408
D20230328	7210.1146 ± 5.3686
D20230523	7208.9015 ± 5.5675
D20230725	7212.9695 ± 5.4961
D20230926	7213.7446 ± 5.4039

TxPD calibration corrected for optical efficiency (ct/W)



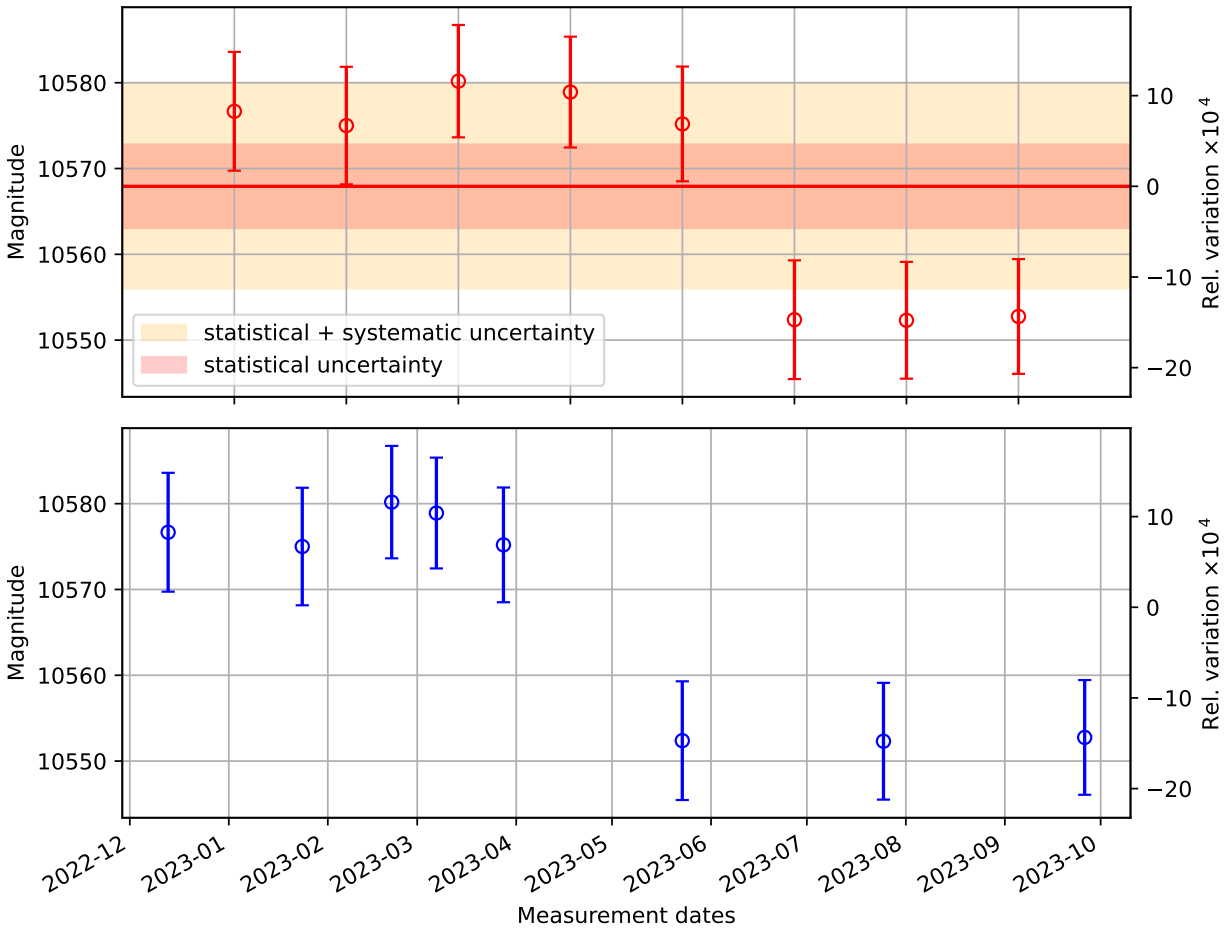
Summary of TxPD calibration corrected for optical efficiency (ct/W)	
Mean value:	7212.708456
Standard deviation:	2.181170
Standard error:	0.822464
Relative Standard error:	0.000114

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

List of Measurements

Date	rhoR_prime ± SD_rhoR_prime
D20221213	10576.6698 ± 6.9261
D20230124	10575.0054 ± 6.8499
D20230221	10580.1815 ± 6.5500
D20230307	10578.9098 ± 6.4566
D20230328	10575.1983 ± 6.6872
D20230523	10552.3770 ± 6.9180
D20230725	10552.3120 ± 6.8061
D20230926	10552.7557 ± 6.6864

RxPD calibration corrected for optical efficiency (ct/W)



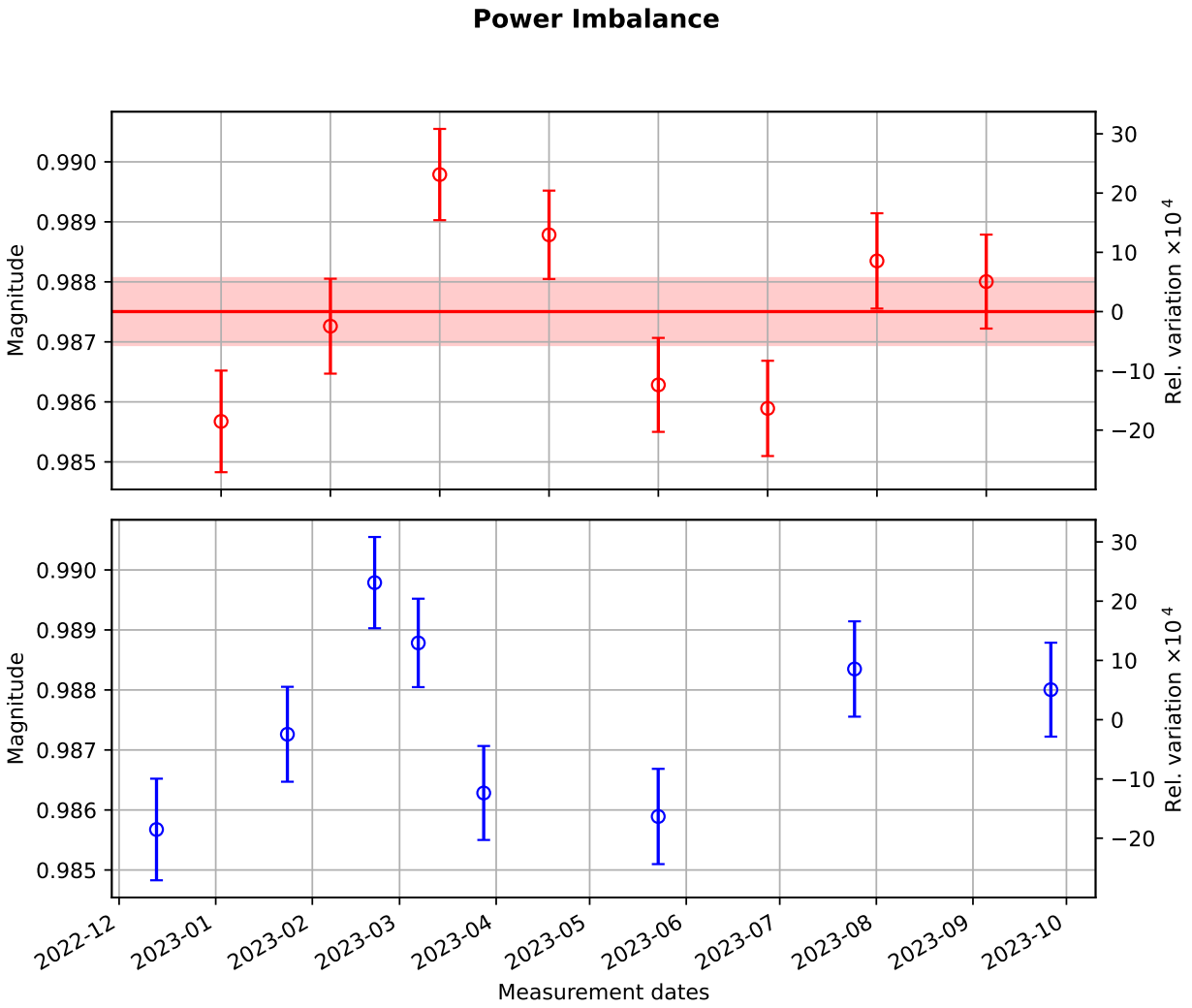
Summary of RxPD calibration corrected for optical efficiency (ct/W)

Mean value:	10567.926190
Standard deviation:	12.906279
Standard error:	4.866632
Relative Standard error:	0.000461

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
D20230523	0.9859 ± 0.0008
D20230725	0.9883 ± 0.0008
D20230926	0.9880 ± 0.0008



Summary of Power Imbalance

Mean value:	0.987505
Standard deviation:	0.001479
Standard error:	0.000558
Relative Standard error:	0.000565