RxPD and TxPD Calibration Trends

GENERATED FOR LHO_EndY

Report Generated on July 25, 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

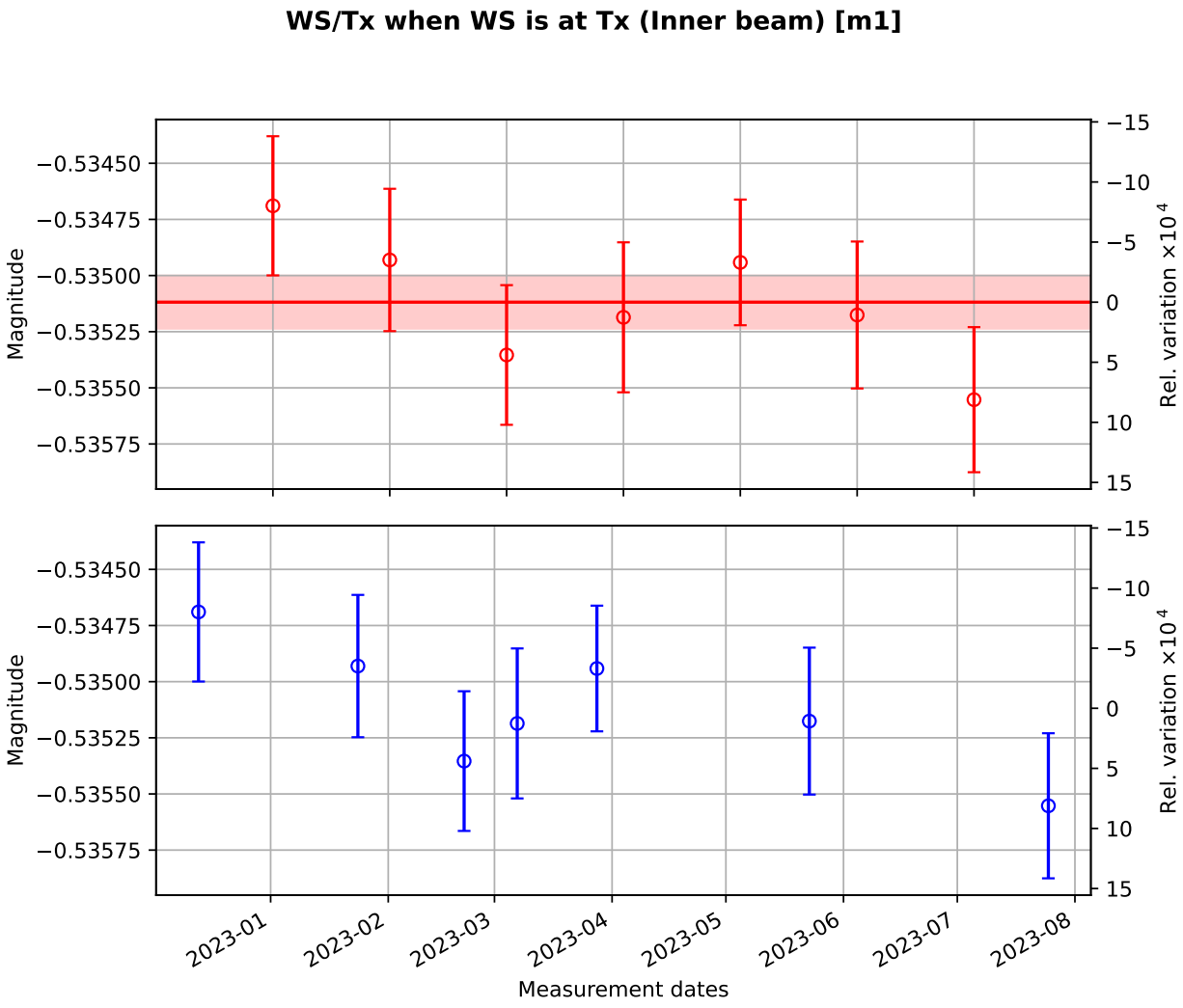
Each section contains a list of measurements with the mean value (m1), standard deviation on the mean (SD_m1) and a ratio of thestandard deviation of the quantity and error bars for each measurement (frac). The list is followed by two plot figures with Magnitude on the Y axis and Index on the X axis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

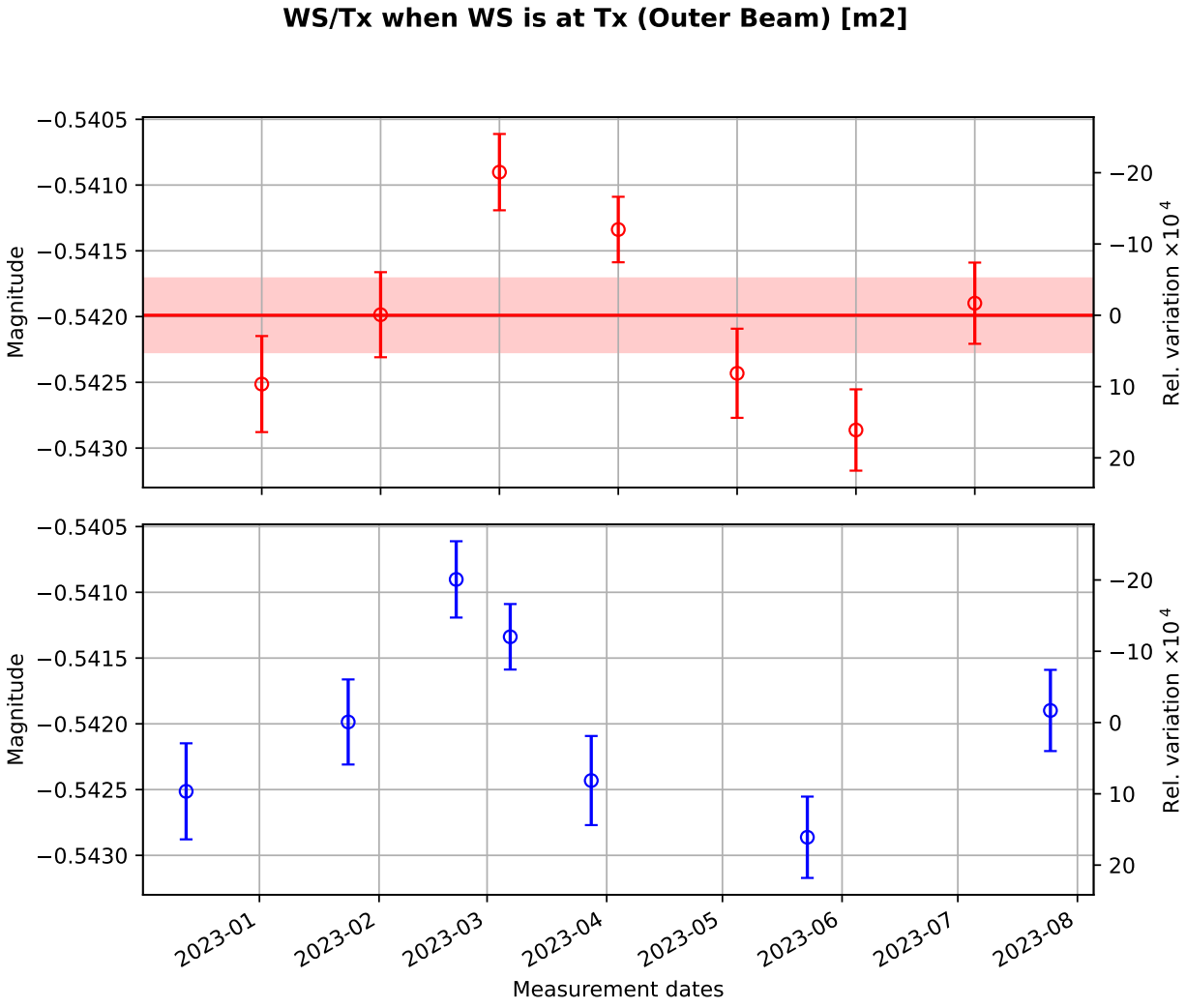


Summary of WS/Tx when WS is at Tx (Inner beam) [m1]	
Mean value:	-0.535119
Standard deviation:	0.000289
Standard error:	0.000118
Relative Standard error:	-0.000220

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

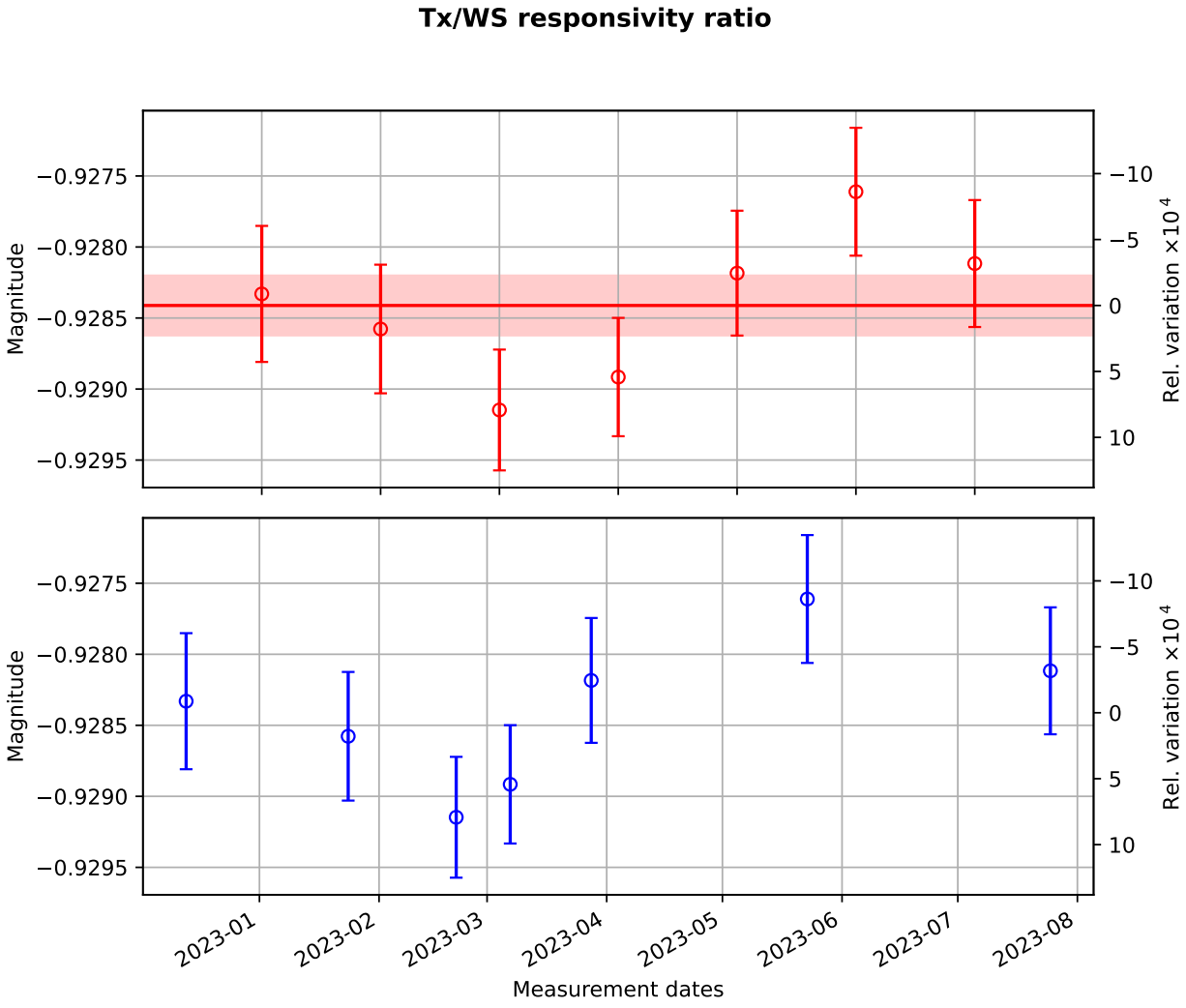


Summary of WS/Tx when WS is at Tx (Outer Beam) [m2]	
Mean value:	-0.541990
Standard deviation:	0.000689
Standard error:	0.000280
Relative Standard error:	-0.000517

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



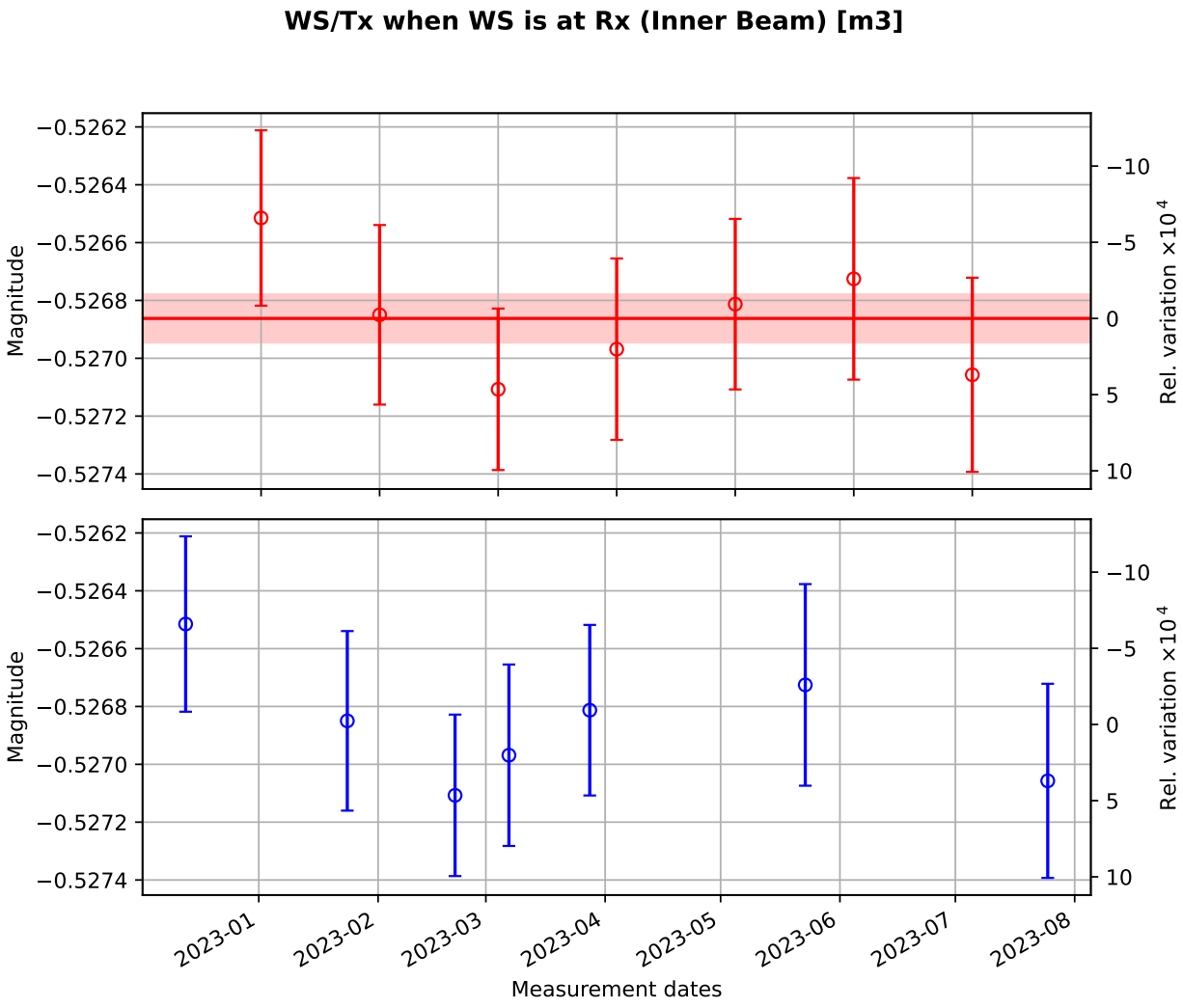
Summary of Tx/WS responsivity ratio

Mean value:	-0.928412
Standard deviation:	0.000518
Standard error:	0.000211
Relative Standard error:	-0.000227

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

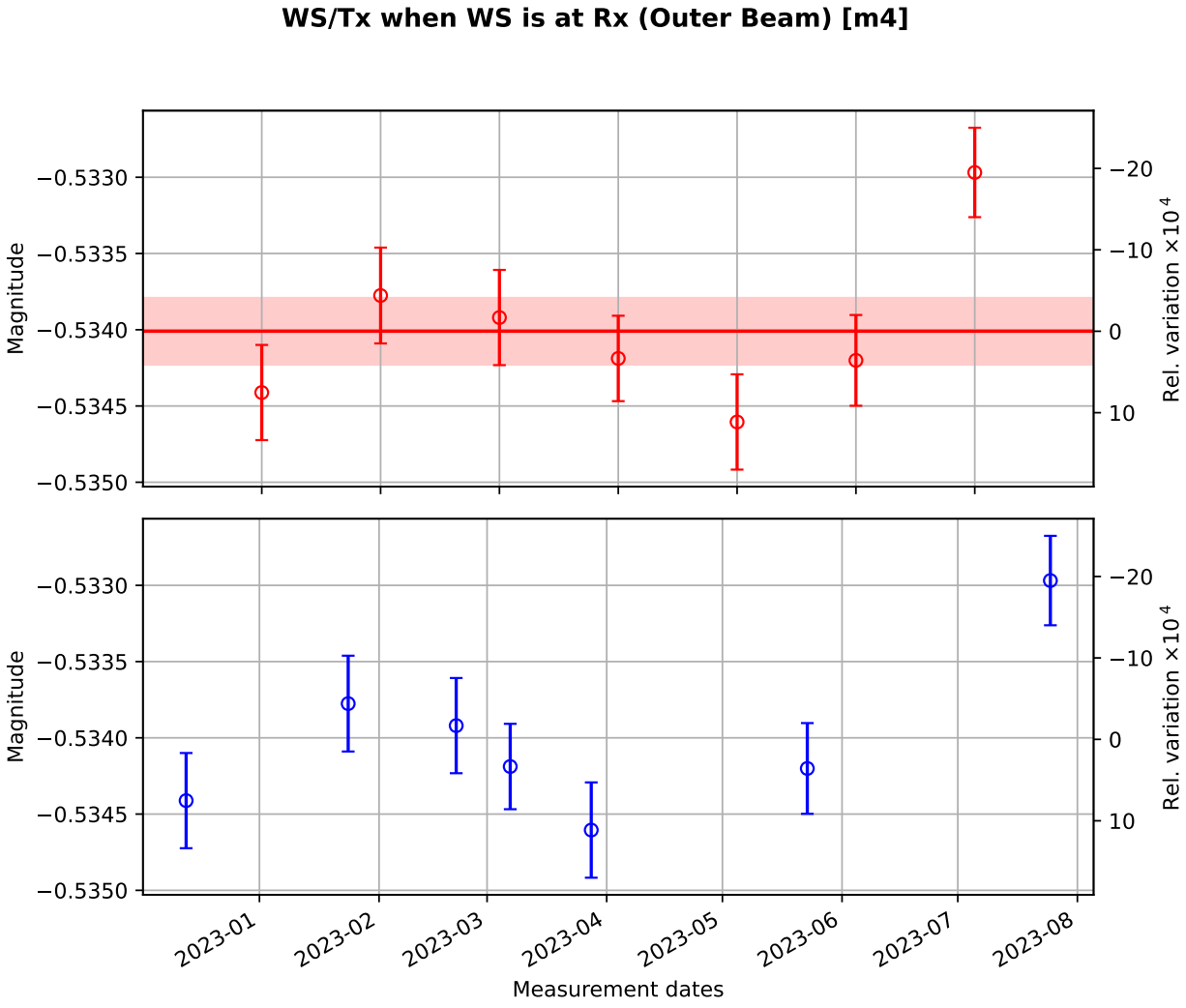


Summary of WS/Tx when WS is at Rx (Inner Beam) [m3]	
Mean value:	-0.526862
Standard deviation:	0.000205
Standard error:	0.000083
Relative Standard error:	-0.000158

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



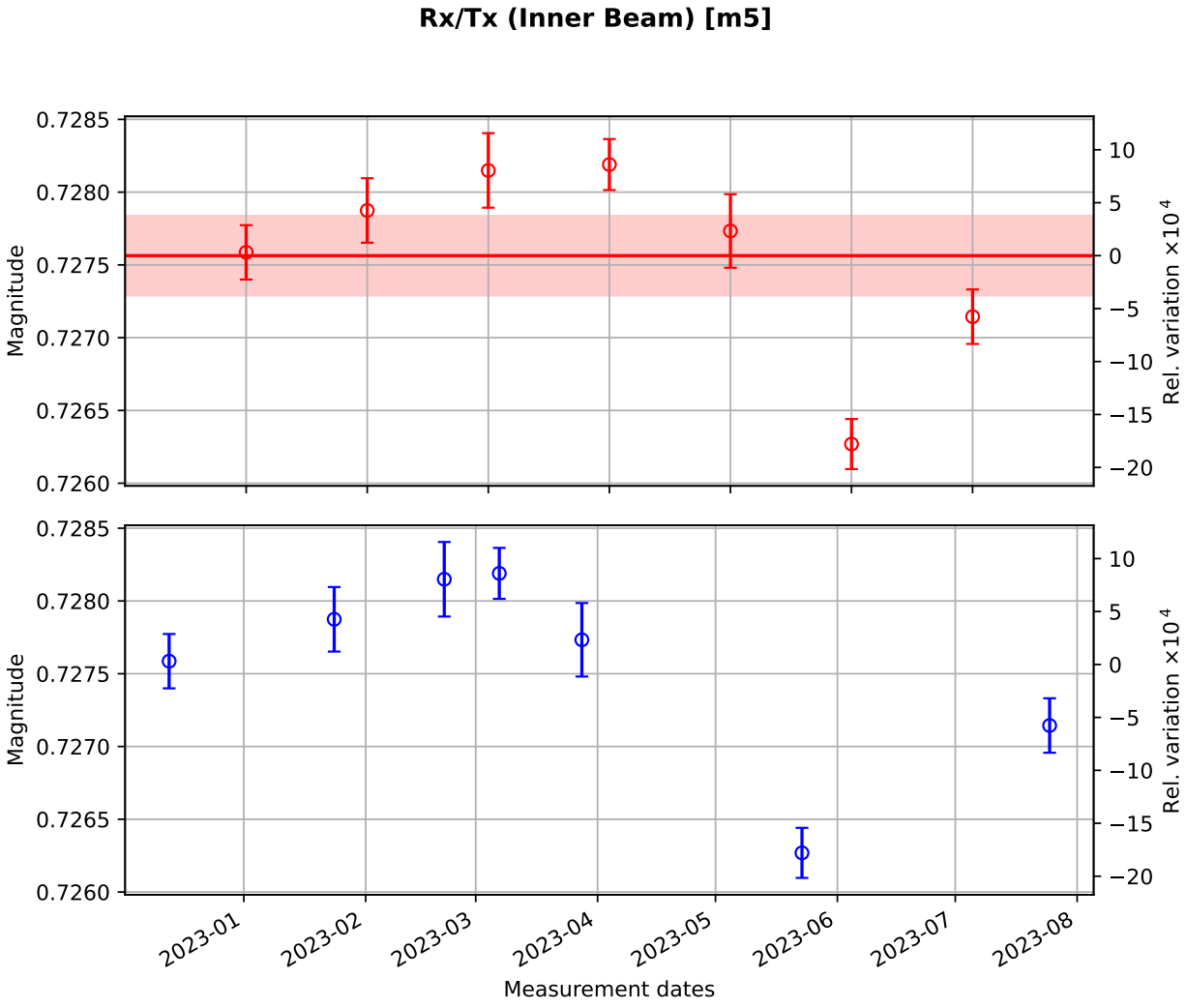
Summary of WS/Tx when WS is at Rx (Outer Beam) [m4]

Mean value:	-0.534010
Standard deviation:	0.000537
Standard error:	0.000219
Relative Standard error:	-0.000409

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



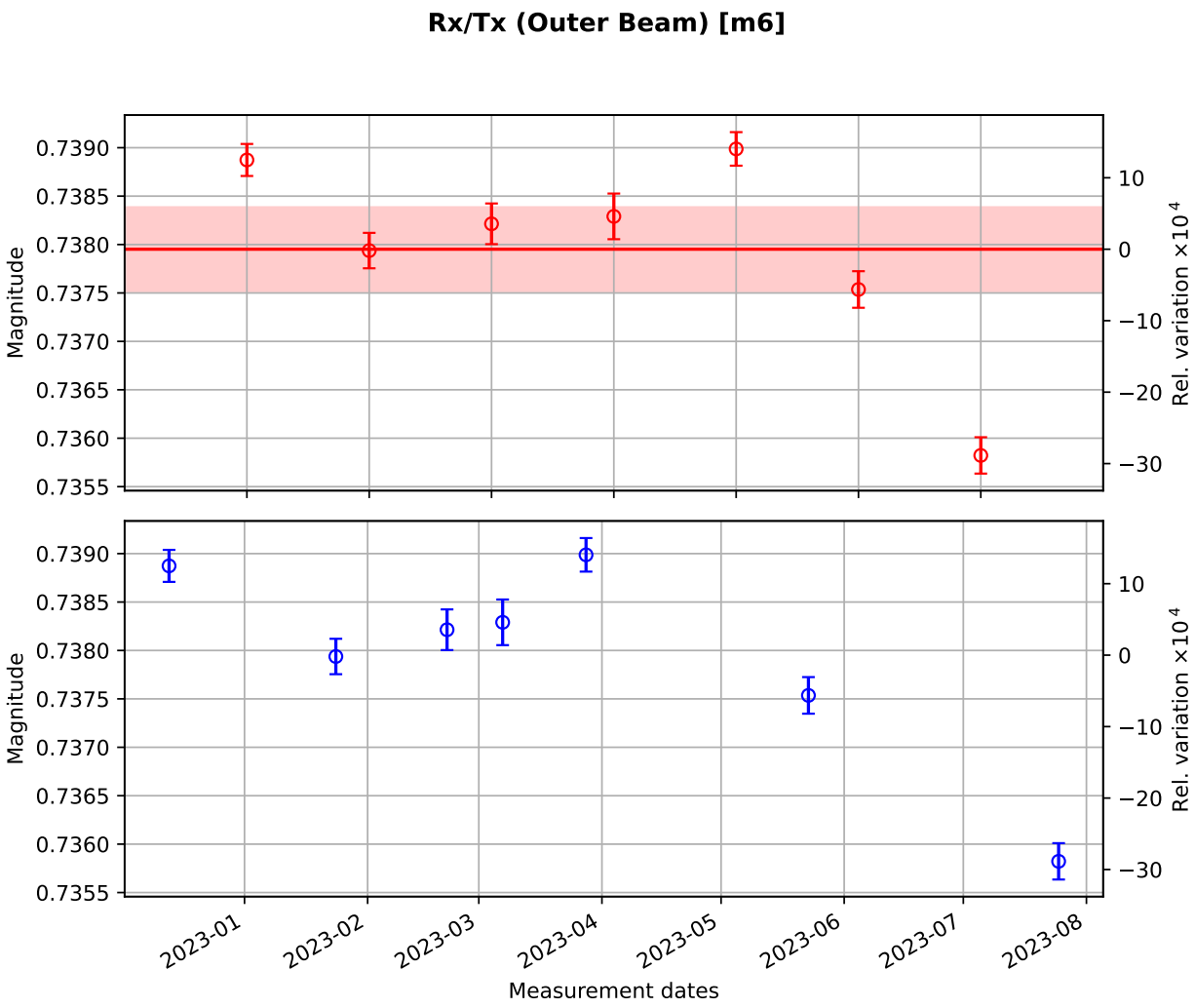
Summary of Rx/Tx (Inner Beam) [m5]

Mean value:	0.727564
Standard deviation:	0.000672
Standard error:	0.000274
Relative Standard error:	0.000376

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

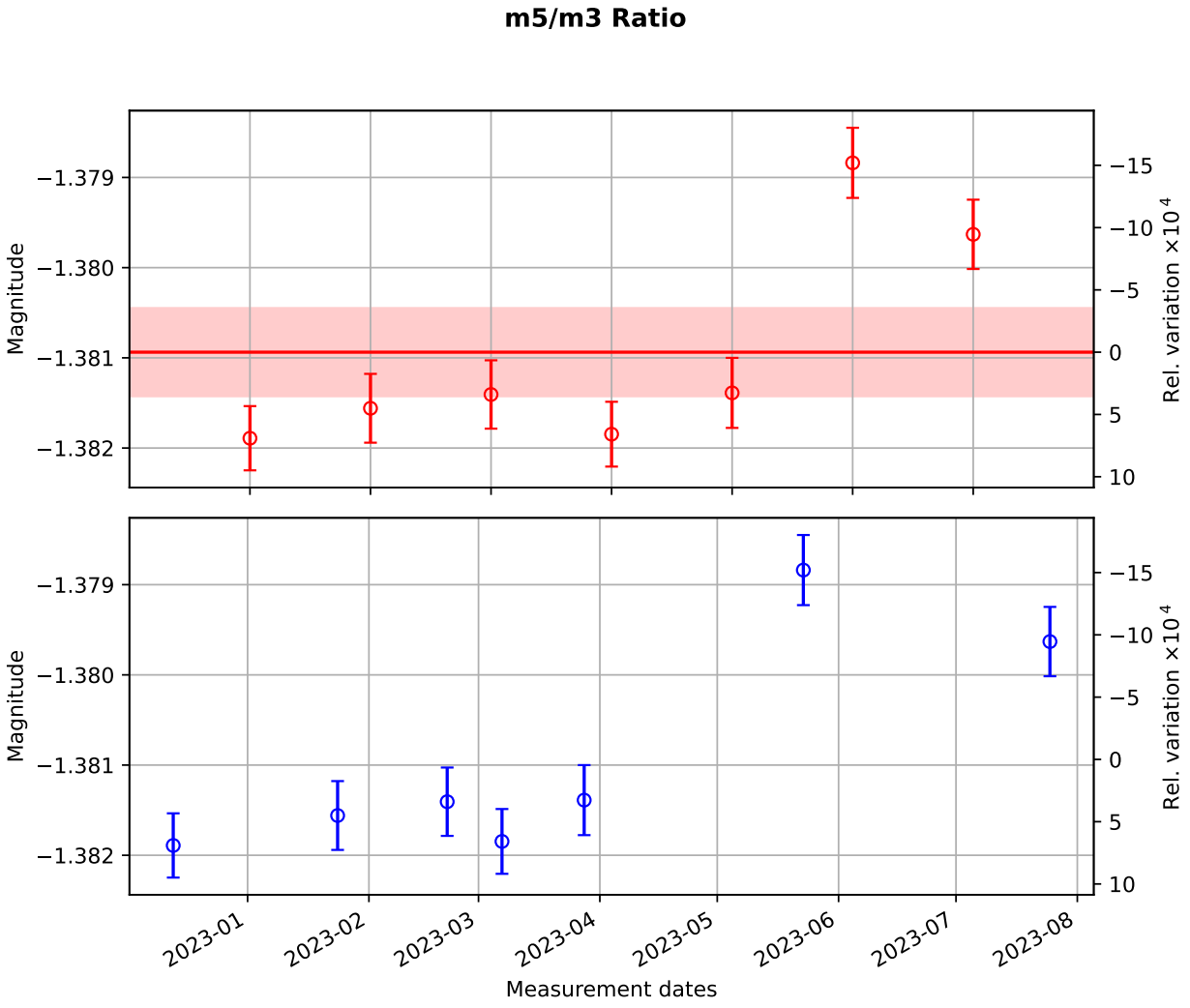


Summary of Rx/Tx (Outer Beam) [m6]	
Mean value:	0.737952
Standard deviation:	0.001066
Standard error:	0.000434
Relative Standard error:	0.000588

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



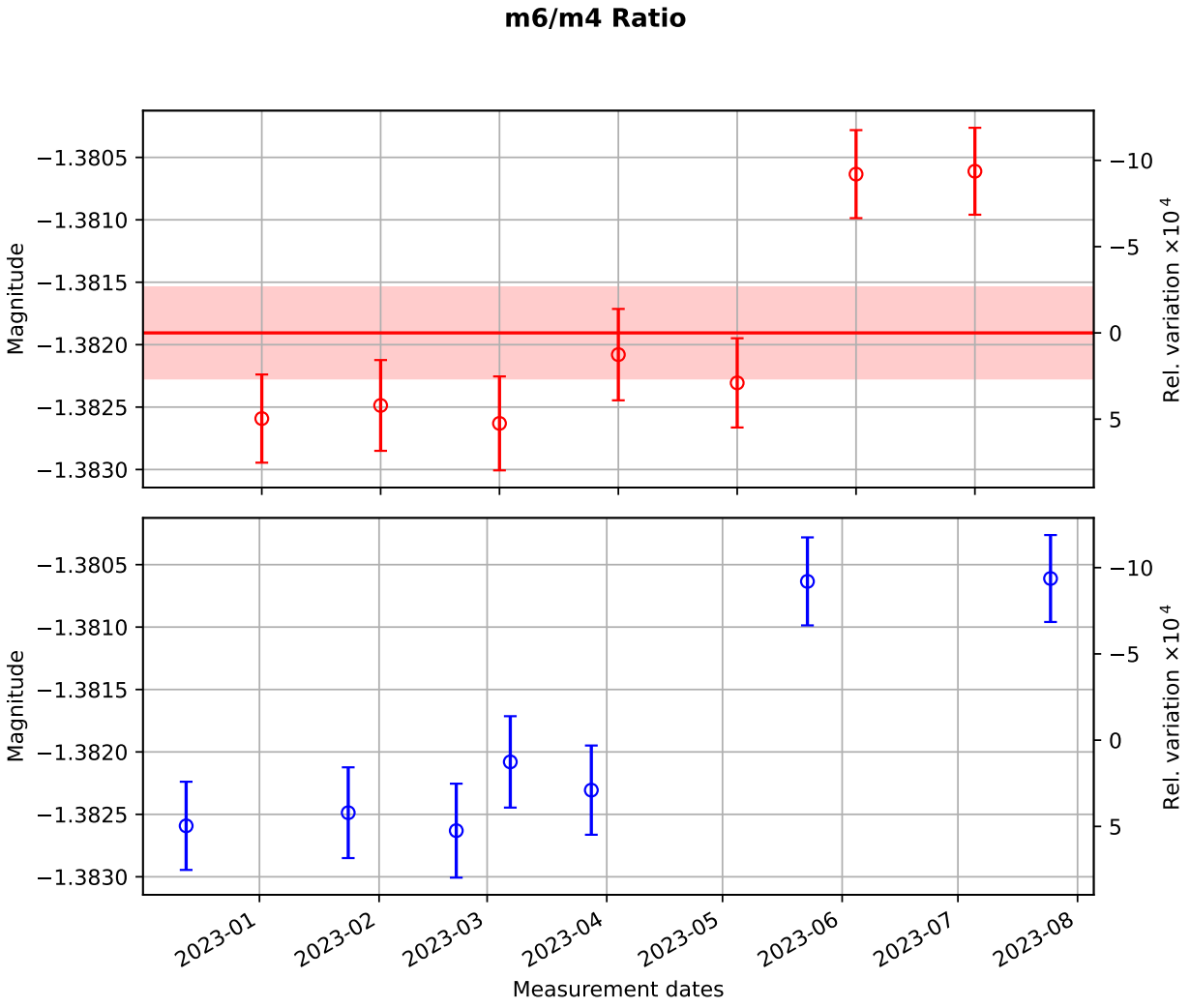
Summary of m5/m3 Ratio

Mean value:	-1.380937
Standard deviation:	0.001201
Standard error:	0.000489
Relative Standard error:	-0.000354

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



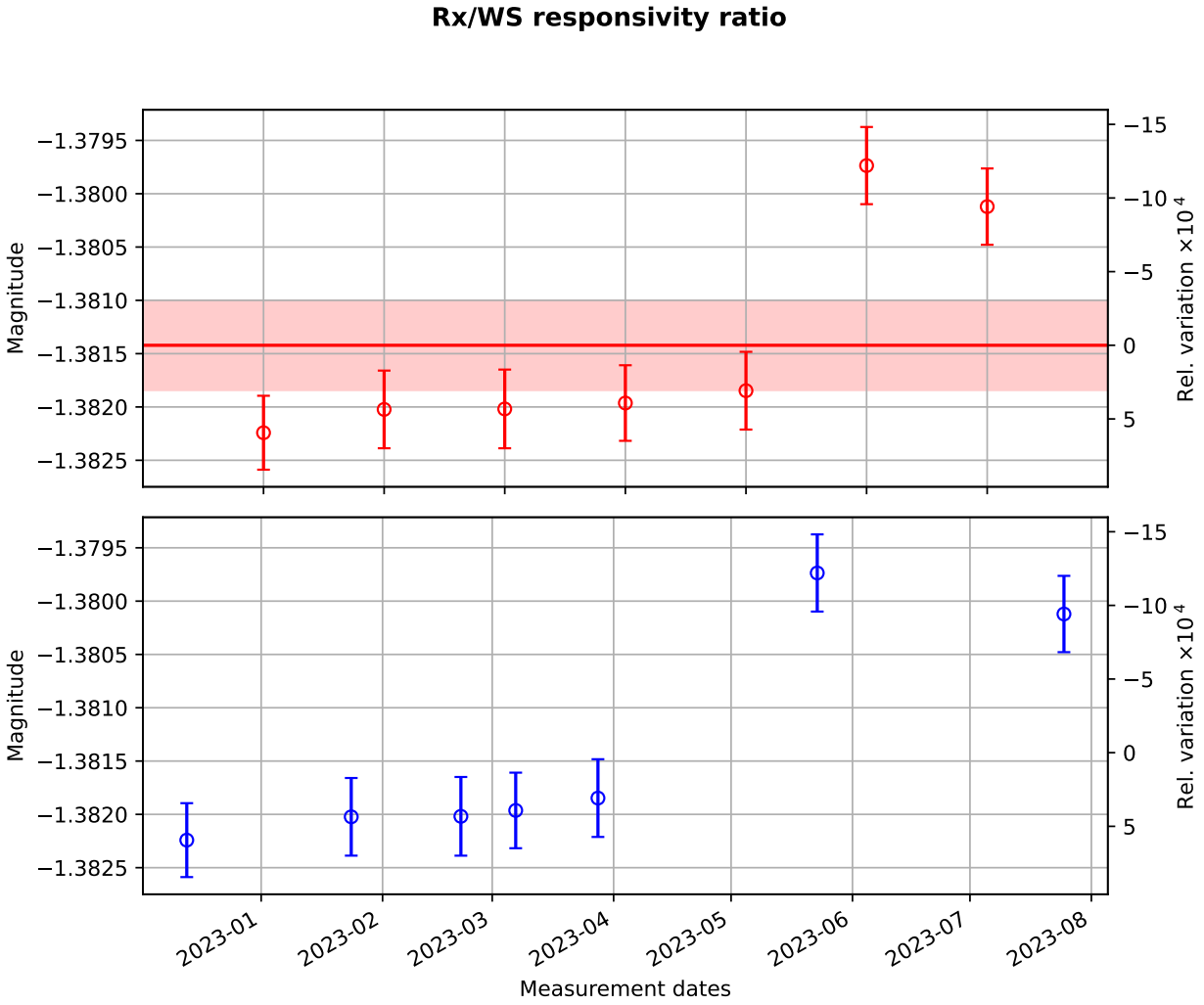
Summary of m6/m4 Ratio

Mean value:	-1.381906
Standard deviation:	0.000896
Standard error:	0.000365
Relative Standard error:	-0.000264

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

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
D20230523	-1.3797 ± 0.0004
D20230725	-1.3801 ± 0.0004



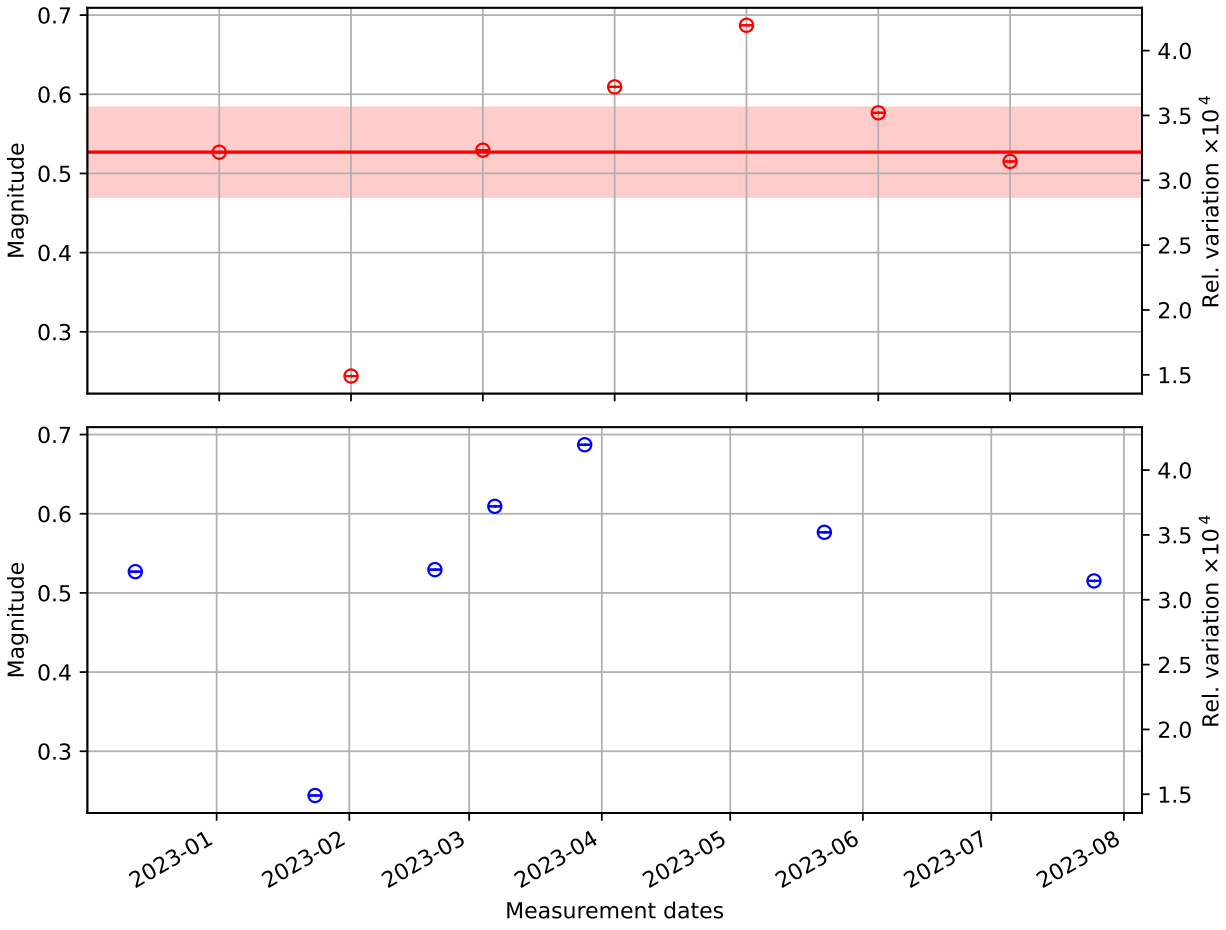
Summary of Rx/WS responsivity ratio	
Mean value:	-1.381421
Standard deviation:	0.001033
Standard error:	0.000420
Relative Standard error:	-0.000304

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

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

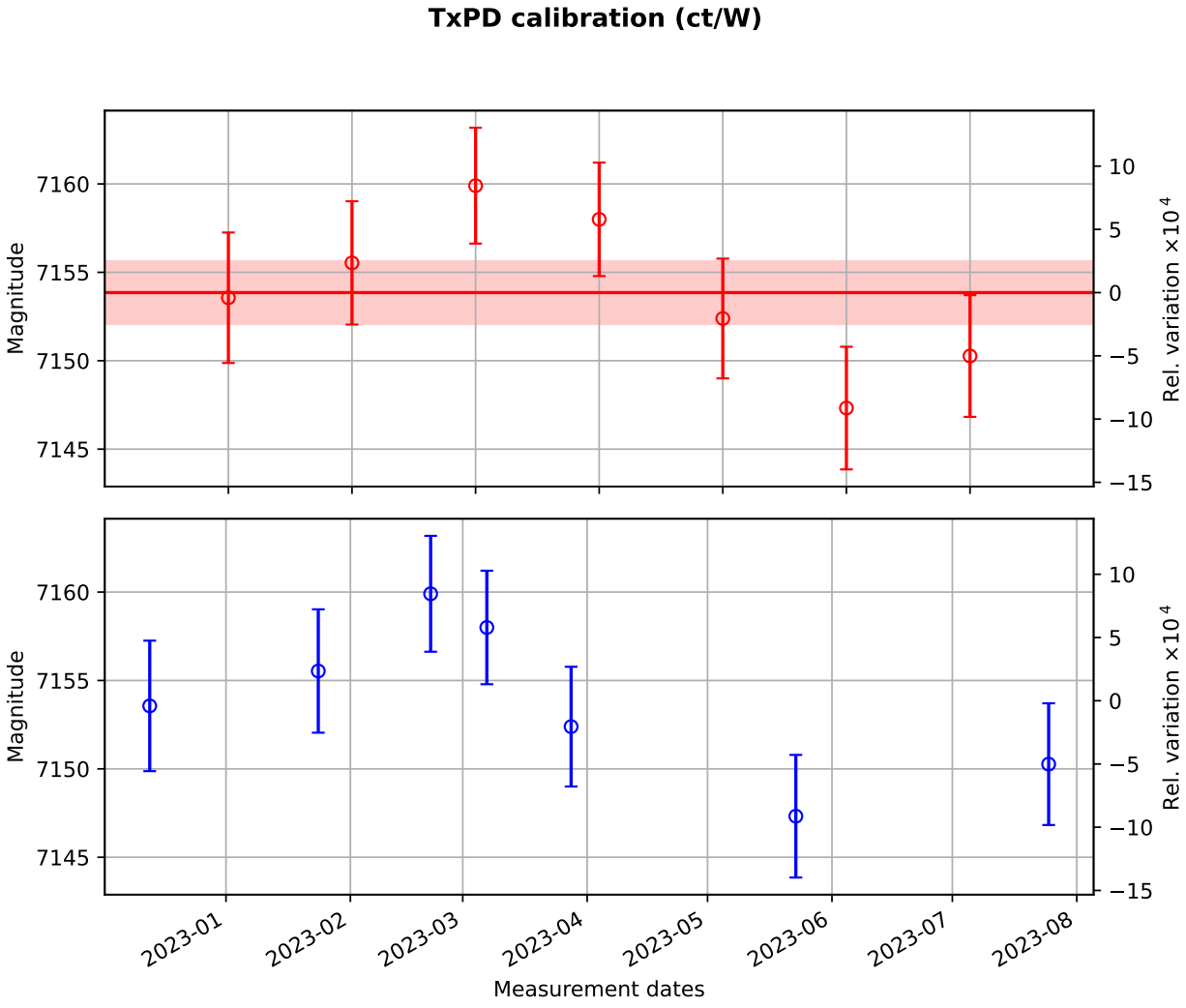


Summary of ADC conversion factor discrepancy

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

List of Measurements

Date	rhoTx ± SD_rhoTx
D20221213	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



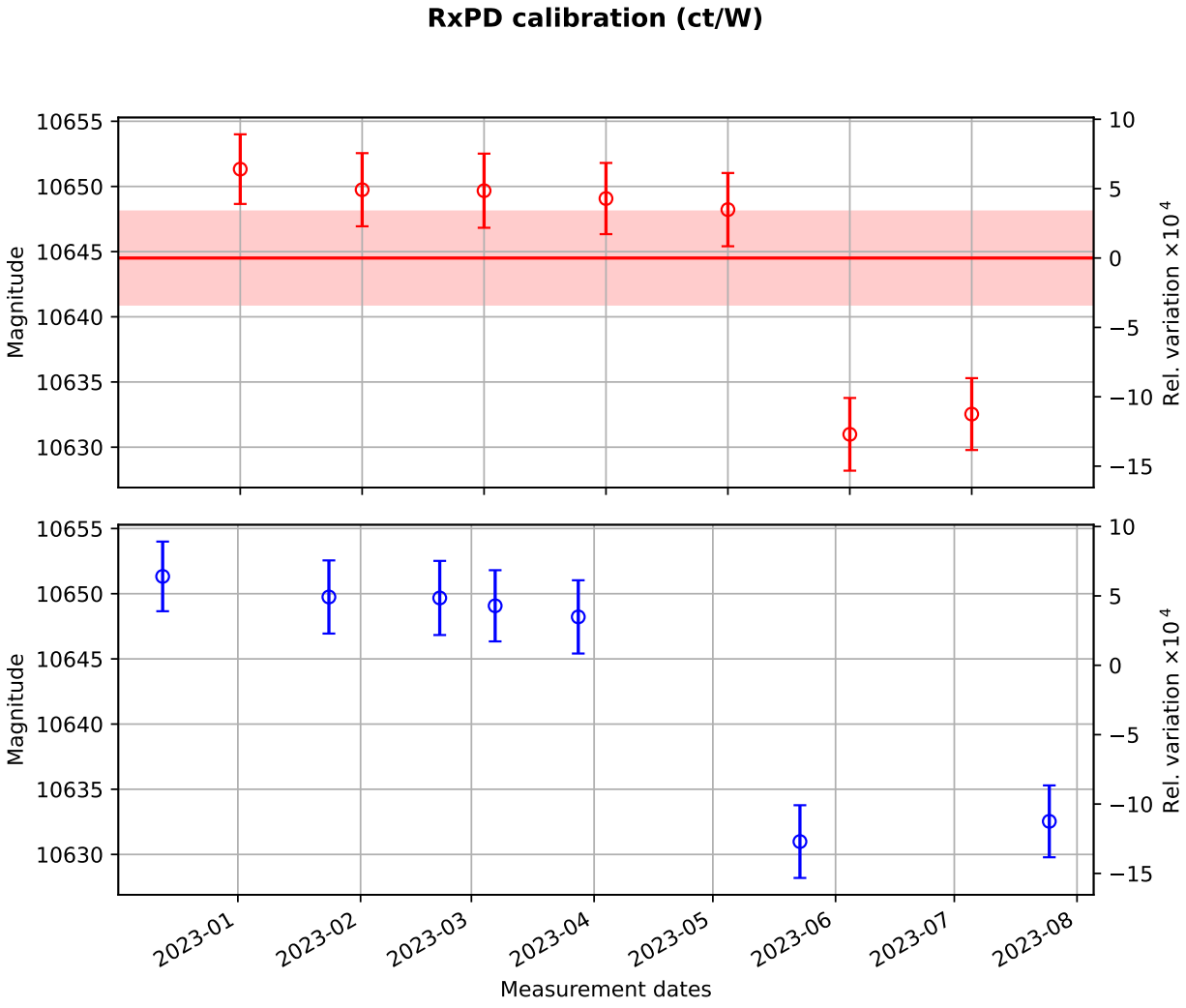
Summary of TxPD calibration (ct/W)

Mean value:	7153.853803
Standard deviation:	4.365457
Standard error:	1.776564
Relative Standard error:	0.000248

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



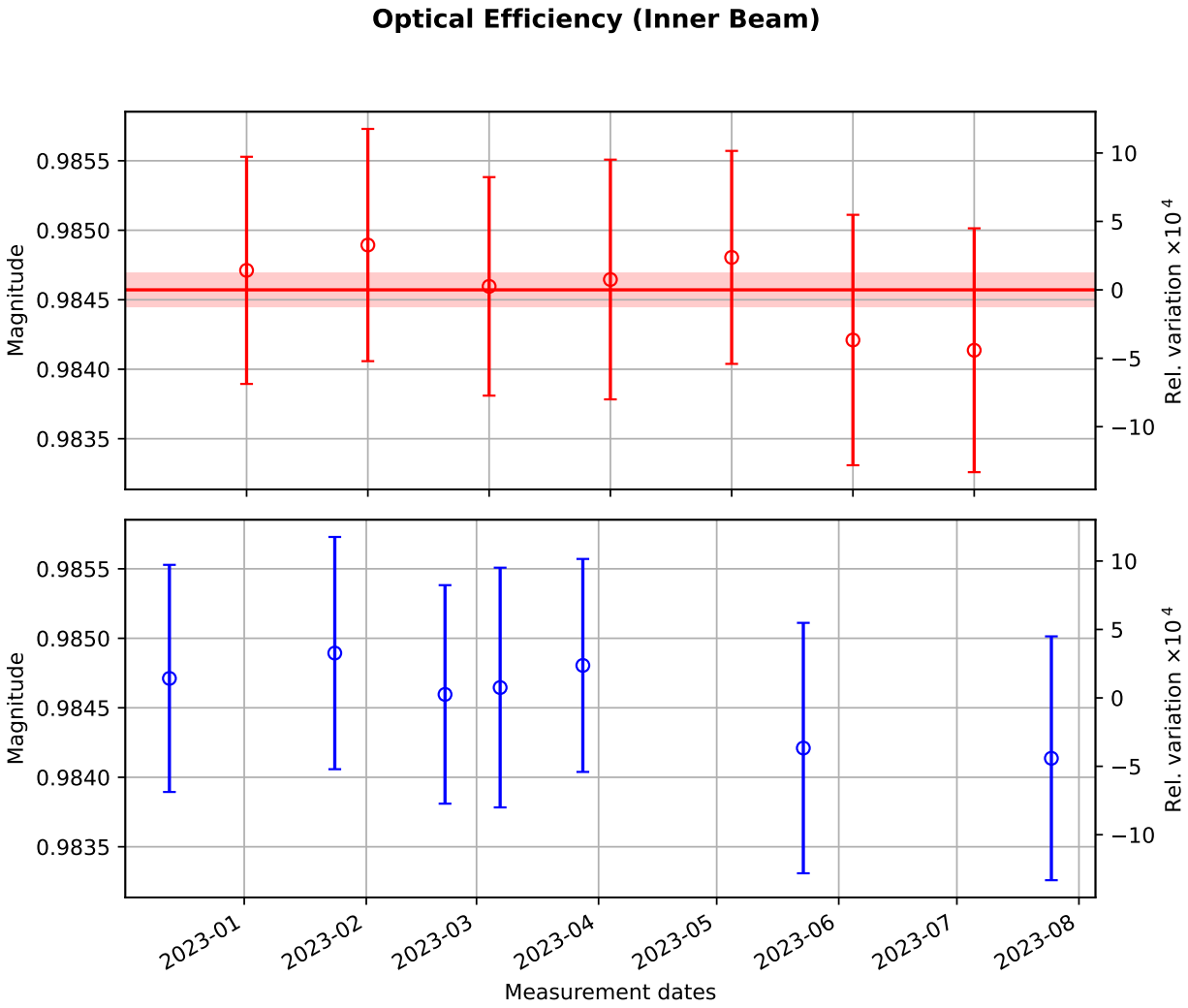
Summary of RxPD calibration (ct/W)

Mean value:	10644.509753
Standard deviation:	8.769452
Standard error:	3.568811
Relative Standard error:	0.000335

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



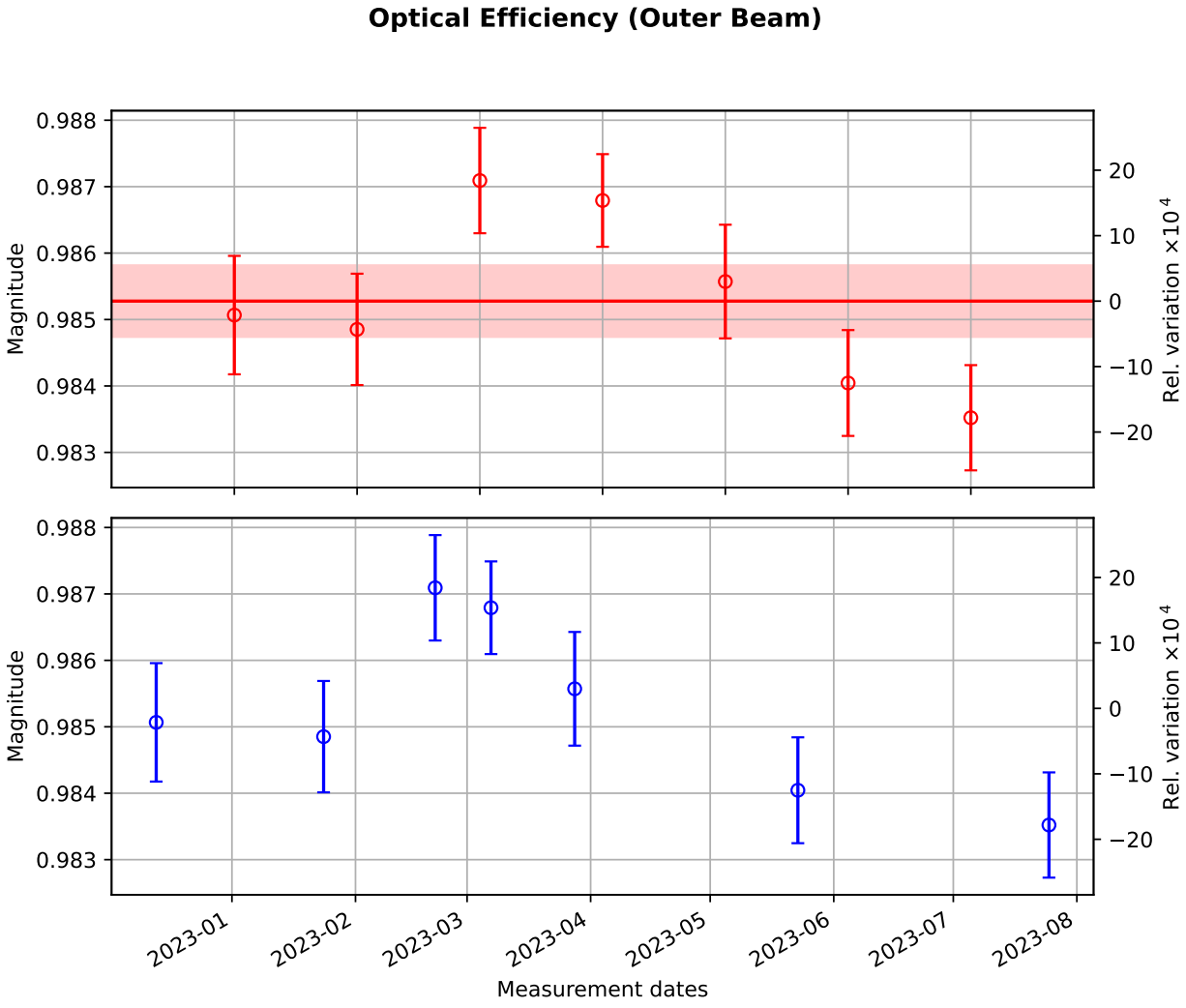
Summary of Optical Efficiency (Inner Beam)

Mean value:	0.984571
Standard deviation:	0.000290
Standard error:	0.000118
Relative Standard error:	0.000120

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



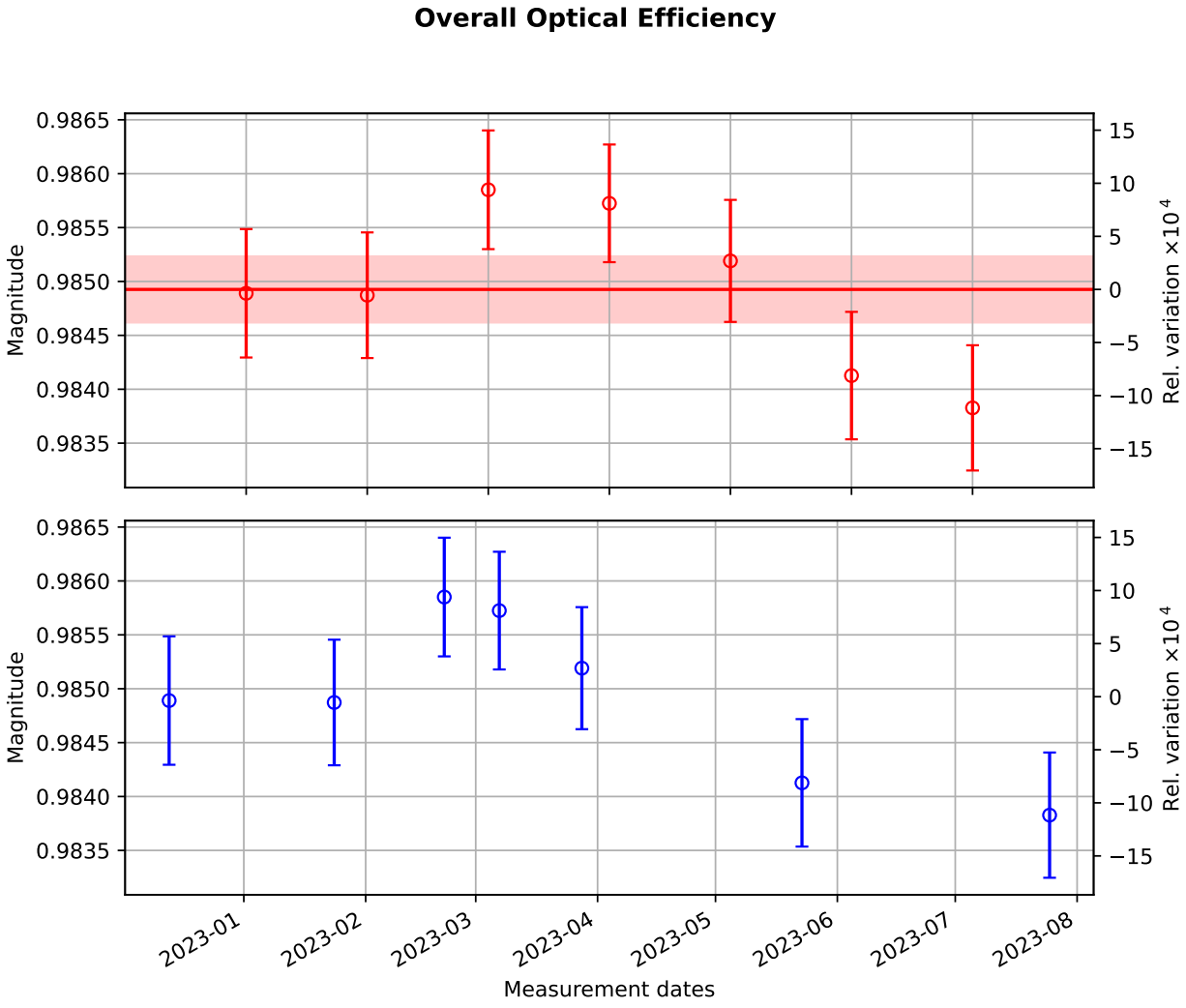
Summary of Optical Efficiency (Outer Beam)

Mean value:	0.985277
Standard deviation:	0.001323
Standard error:	0.000538
Relative Standard error:	0.000546

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



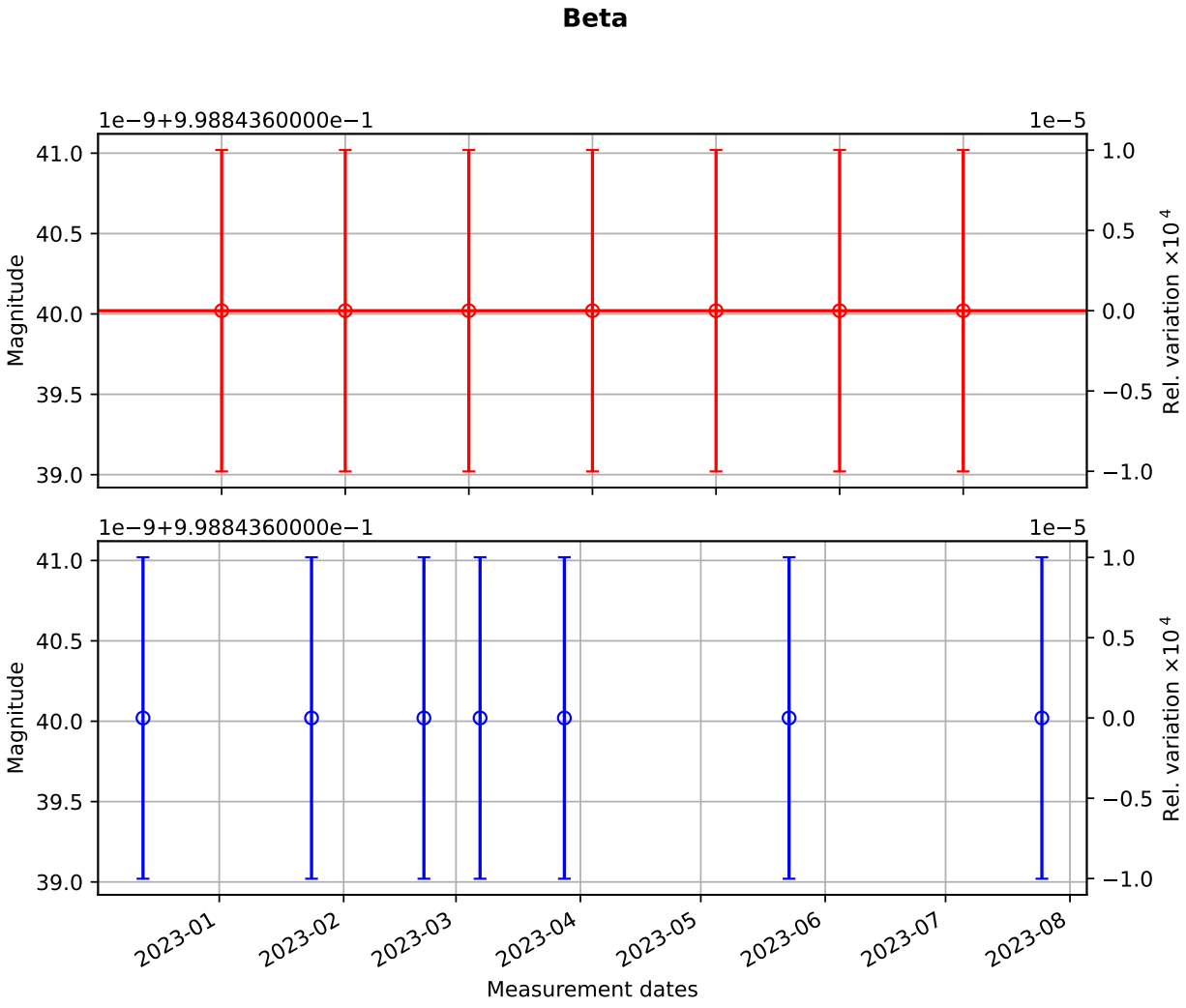
Summary of Overall Optical Efficiency

Mean value:	0.984926
Standard deviation:	0.000754
Standard error:	0.000307
Relative Standard error:	0.000312

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



Summary of Beta

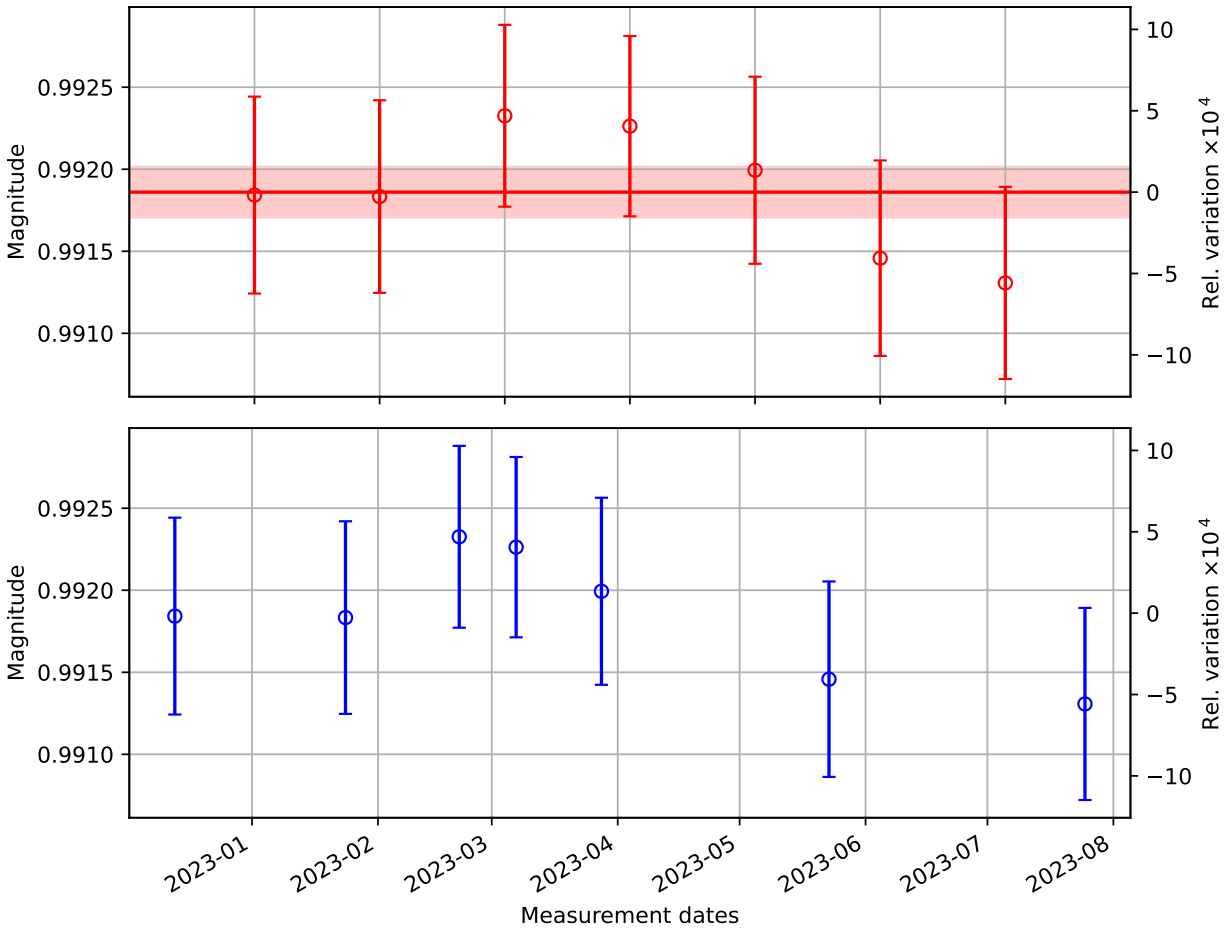
Mean value:	0.998844
Standard deviation:	0.000000
Standard error:	0.000000
Relative Standard error:	0.000000

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

Input Side Optical Efficiency correction factor



Summary of Input Side Optical Efficiency correction factor

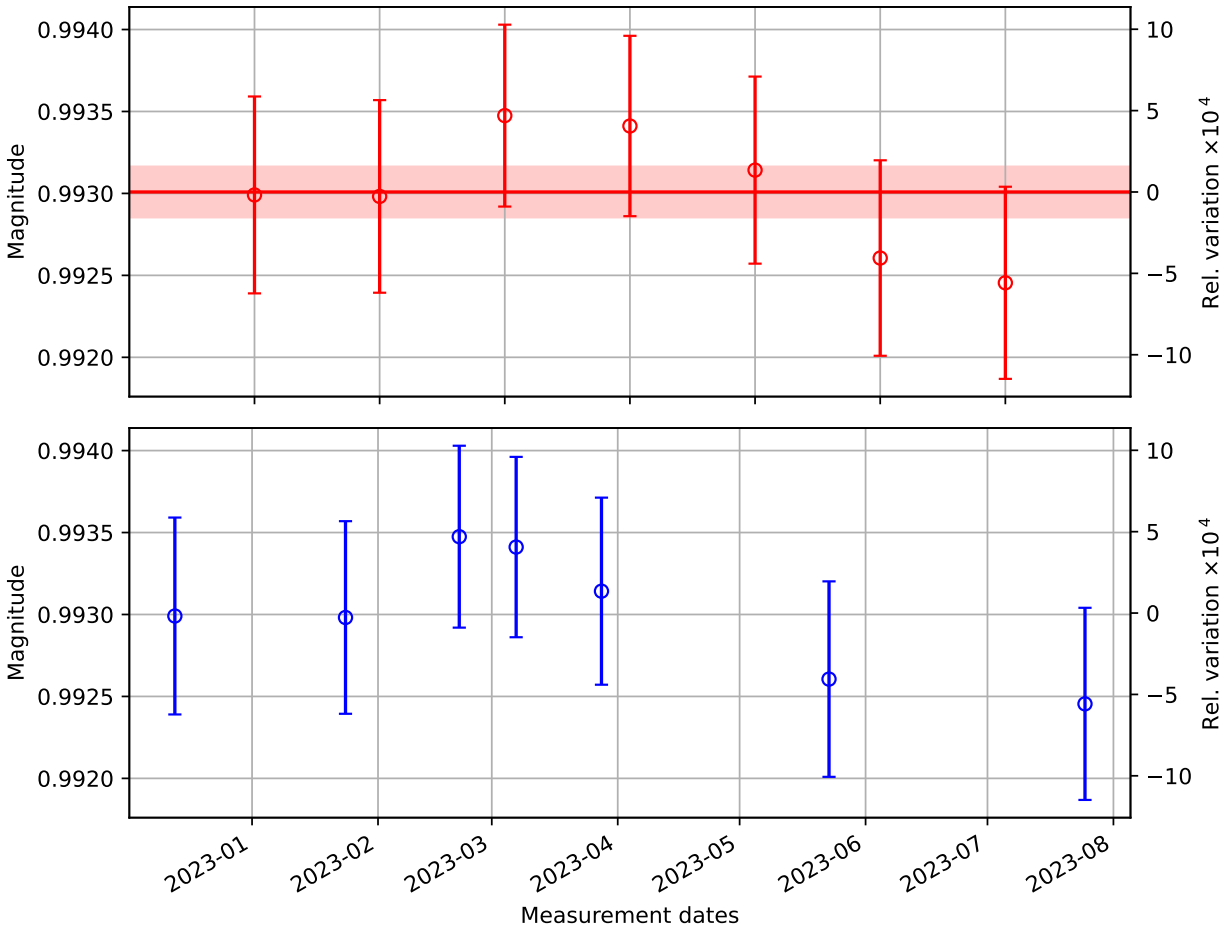
Mean value:	0.991860
Standard deviation:	0.000380
Standard error:	0.000155
Relative Standard error:	0.000156

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

Output Side Optical Efficiency correction factor



Summary of Output Side Optical Efficiency correction factor

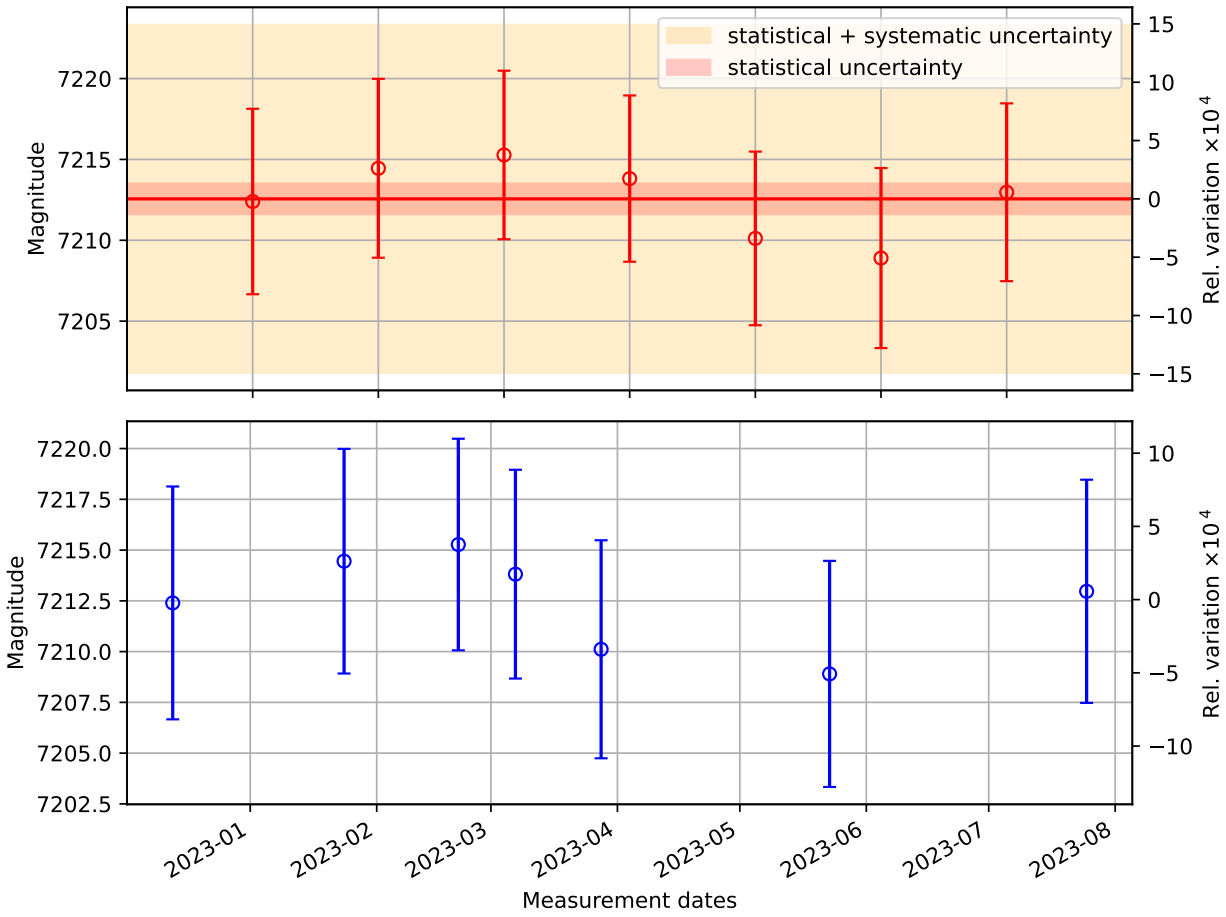
Mean value:	0.993009
Standard deviation:	0.000380
Standard error:	0.000155
Relative Standard error:	0.000156

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

TxPD calibration corrected for optical efficiency (ct/W)



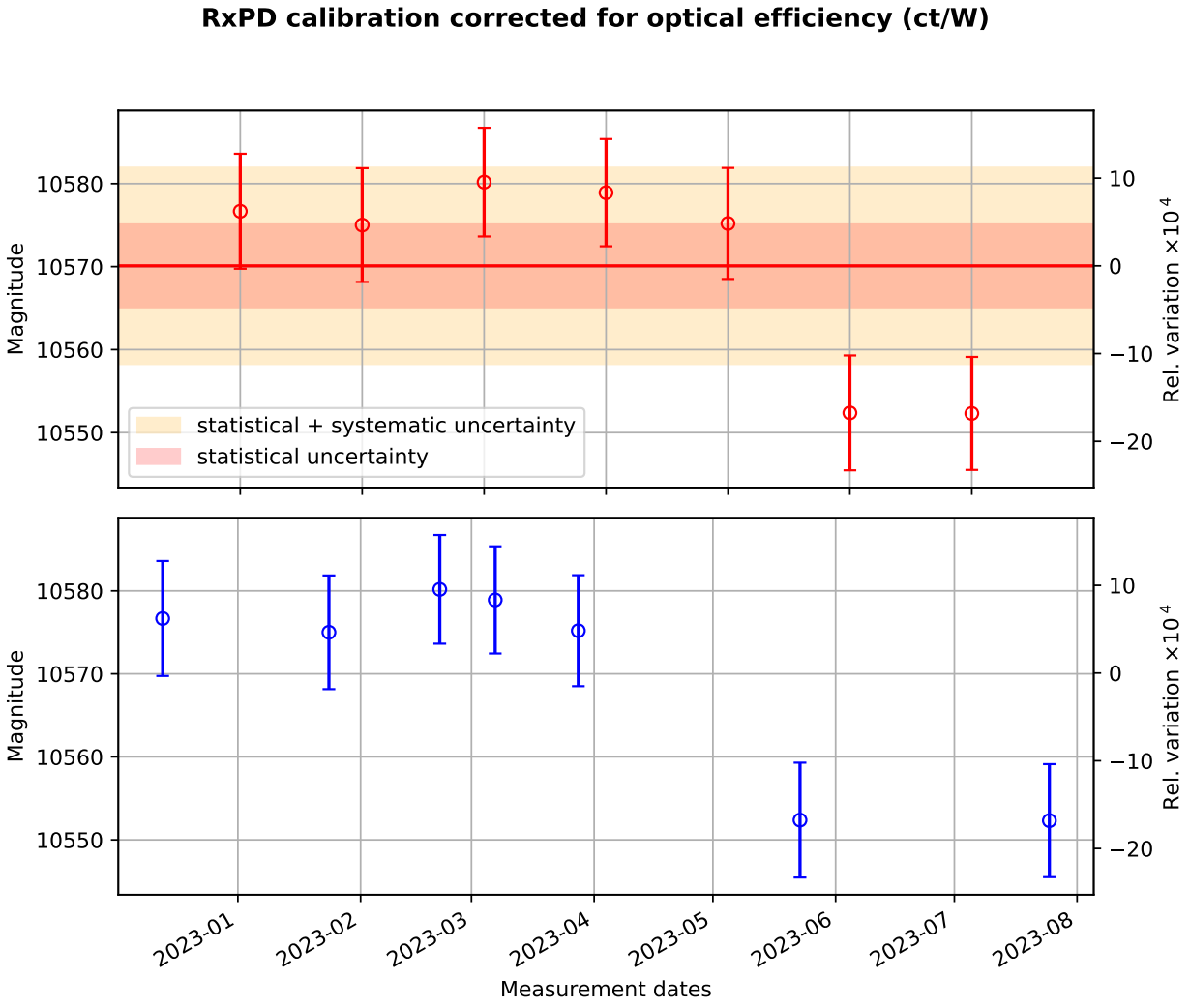
Summary of TxPD calibration corrected for optical efficiency (ct/W)

Mean value:	7212.560441
Standard deviation:	2.312129
Standard error:	0.940943
Relative Standard error:	0.000130

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

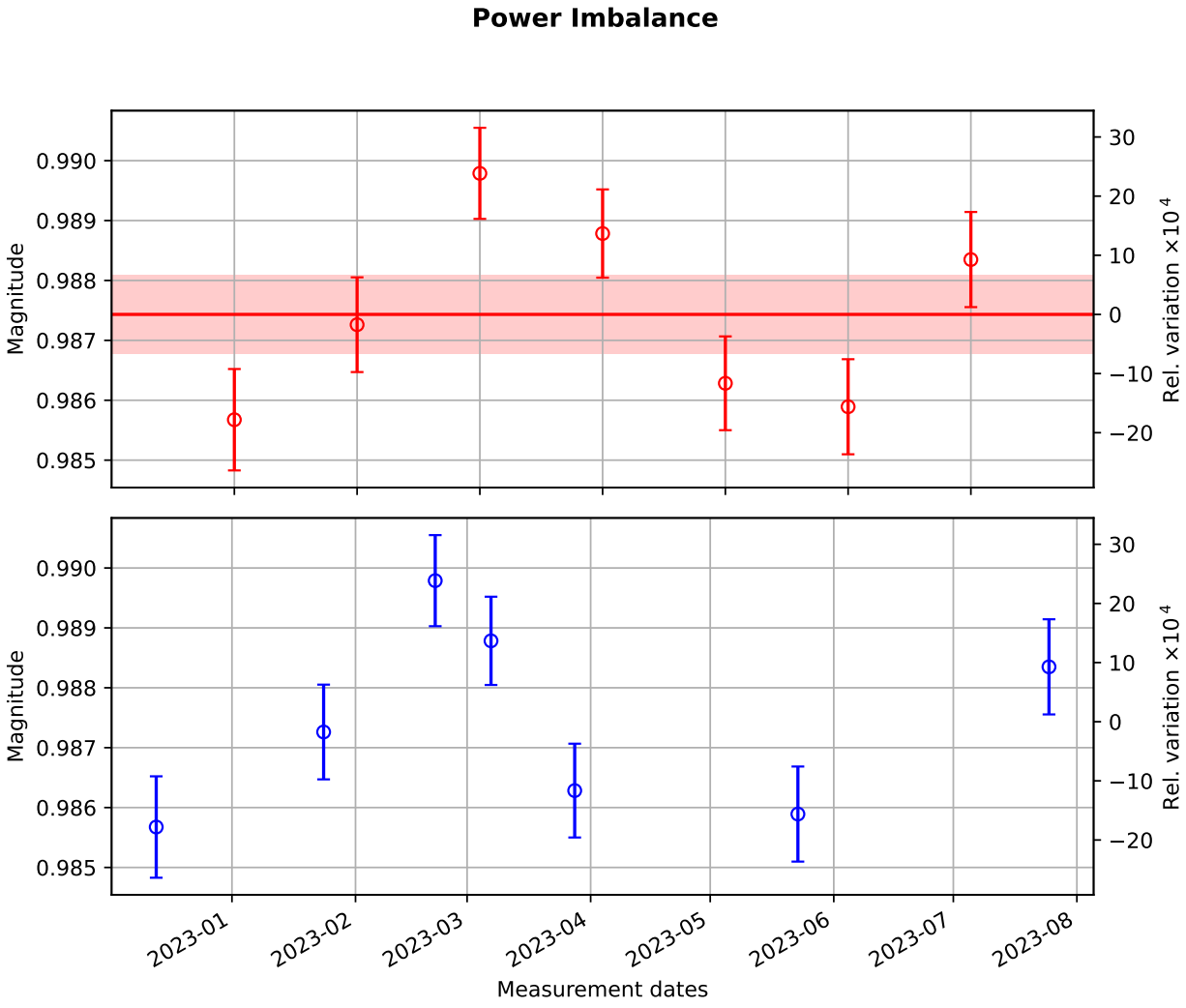


Summary of RxPD calibration corrected for optical efficiency (ct/W)	
Mean value:	10570.093401
Standard deviation:	12.267731
Standard error:	4.992468
Relative Standard error:	0.000472

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



Summary of Power Imbalance

Mean value:	0.987433
Standard deviation:	0.001583
Standard error:	0.000644
Relative Standard error:	0.000652