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Frequency Evaluation of UTC(NIST) and Maser 412015 by NIST-Yb1 for the period MJD 58054 to 58084

I. Results

Period (MJD)	y(UTC(NIST) - Yb1) (10^{-16})	y(Maser 412015 - Yb1) (10^{-16})	total u_A (10^{-16})	total u_B (10^{-16})	total $u_{l/Lab}$ (10^{-16})	u_{SecRep} (10^{-16})
58054-58084	4.0	-22276.4	<0.1	0.31	2.88	5

u_A, Type A uncertainty (10^{-16})	
Yb stability	<0.1
Total	<0.1

$u_{l/Lab}$, Type A uncertainty (10^{-16})	
Dead time	2.7
Yb-Maser comparison	1.0
Time scale measurement	<0.1
Total	2.88

Type B Uncertainty (10^{-16})	
Frequency comb + counting	0.3
Yb + gravitational redshift	0.062
Total	0.31

II. Yb1 operation

During the indicated period, Yb1 and an optical frequency comb were operated intermittently with an uptime of 6.47%. The measured frequency difference, y(Maser-Yb1), assumes the Yb absolute frequency equal to the most recently recommended BIPM value: 518,295,836,590,863.6 Hz [1]. y(UTC(NIST) – Yb1) is obtained from the NIST time scale measurement system where y(UTC(NIST) – Maser) is measured. The frequency shift and uncertainty budget of Yb1 over this period is given in the table below. More details on the Yb1 clock operation and uncertainty budget can be found in Ref. 2 and 3.

Systematic biases and uncertainties

Effect	Shift (10^{-18})	Uncertainty(10^{-18})
Background gas collisions	-5.5	0.5
Spin polarization	0	<0.3
Cold collisions	-0.21	0.07
Doppler	0	<0.02
Blackbody radiation	-2,361.2	0.9
Lattice light (model)	0	0.3

Travelling wave contamination	0	<0.1
Lattice light (experimental)	-1.5	0.8
Second-order Zeeman	-118.1	0.2
DC Stark	0	<0.07
Probe Stark	0.02	0.01
Line pulling	0	<0.1
Tunnelling	0	<0.001
Servo error	0.03	0.05
Optical frequency synthesis	0	<0.1
Yb1 Total	**-2,486.5**	**1.4**
Grav. redshift from geoid [4]	180,819	6
Yb + gravitational redshift	**178,333**	**6**

III. Frequency measurement

The frequency measurement was carried out with an optical frequency comb that was phase-locked to Yb1, and the resulting comb frequencies were subsequently counted relative to a hydrogen maser, 412015. For this analysis, one- and ten- second gated counting data were binned into twelve minute intervals, and related to internal NIST timescales. A final average value was calculated over the month-long indicated period [3]. For this measurement period, uncertainty from Yb1 and the comb system were essentially negligible. The most significant source of uncertainty stemmed from dead time, due to the small fraction of measurement uptime from Yb1 and the optical frequency comb [3]. A post-processed NIST time scale was used as the flywheel for the purposes of calculating dead time uncertainty [3]. A breakdown of the Type A and Type B uncertainties for this measurement are listed in the results section. Also listed is u_{SecRep}, which is the recommended uncertainty of the standard frequency of the ^{171}Yb secondary representation [1]. Finally, the reported frequency offsets, y(UTC(NIST)-Yb1) and y(Maser 412015-Yb1), are computed with Yb frequency corrections from the geoid.

[1] "Recommended values of standard frequencies for applications including the practical realization of the metre and secondary representations of the definition of the second," BIPM publication, approved by CCTF June 2017, https://www.bipm.org/utils/common/pdf/mep/171Yb_518THz_2018.pdf.

[2] W. McGrew, et al., "Atomic clock performance enabling geodesy below the centimetre level," Nature **564** 87–90 (2018).

[3] W. McGrew, et al., "Towards Adoption of an Optical Second: Verifying Optical Clocks at the SI Limit," arXiv:1811.05885 (2018).

[4] N. K. Pavlis and M. A. Weiss, "A re-evaluation of the relativistic redshift on frequency standards at NIST, Boulder, Colorado, USA," Metrologia **54**, 535-548 (2017).

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Frequency Evaluation of UTC(NIST) and Maser 412015 by NIST-Yb1 for the period MJD 58084 to 58114

I. Results

Period (MJD)	y(UTC(NIST) - Yb1) (10^{-16})	y(Maser 412015 - Yb1) (10^{-16})	total u_A (10^{-16})	total u_B (10^{-16})	total $u_{l/Lab}$ (10^{-16})	u_{SecRep} (10^{-16})
58084-58114	-0.5	-22727.4	<0.1	0.31	3.49	5

u_A, Type A uncertainty (10^{-16})	
Yb stability	<0.1
Total	<0.1

$u_{l/Lab}$, Type A uncertainty (10^{-16})	
Dead time	3.1
Yb-Maser comparison	1.6
Time scale measurement	<0.1
Total	3.49

Type B Uncertainty (10^{-16})	
Frequency comb + counting	0.3
Yb + gravitational redshift	0.062
Total	0.31

II. Yb1 operation

During the indicated period, Yb1 and an optical frequency comb were operated intermittently with an uptime of 2.78%. The measured frequency difference, y(Maser-Yb1), assumes the Yb absolute frequency equal to the most recently recommended BIPM value: 518,295,836,590,863.6 Hz [1]. y(UTC(NIST) – Yb1) is obtained from the NIST time scale measurement system where y(UTC(NIST) – Maser) is measured. The frequency shift and uncertainty budget of Yb1 over this period is given in the table below. More details on the Yb1 clock operation and uncertainty budget can be found in Ref. 2 and 3.

Systematic biases and uncertainties

Effect	Shift (10^{-18})	Uncertainty(10^{-18})
Background gas collisions	-5.5	0.5
Spin polarization	0	<0.3
Cold collisions	-0.21	0.07
Doppler	0	<0.02
Blackbody radiation	-2,361.2	0.9
Lattice light (model)	0	0.3

Travelling wave contamination	0	<0.1
Lattice light (experimental)	-1.5	0.8
Second-order Zeeman	-118.1	0.2
DC Stark	0	<0.07
Probe Stark	0.02	0.01
Line pulling	0	<0.1
Tunnelling	0	<0.001
Servo error	0.03	0.05
Optical frequency synthesis	0	<0.1
Yb1 Total	**-2,486.5**	**1.4**
Grav. redshift from geoid [4]	180,819	6
Yb + gravitational redshift	**178,333**	**6**

III. Frequency measurement

The frequency measurement was carried out with an optical frequency comb that was phase-locked to Yb1, and the resulting comb frequencies were subsequently counted relative to a hydrogen maser, 412015. For this analysis, one- and ten- second gated counting data were binned into twelve minute intervals, and related to internal NIST timescales. A final average value was calculated over the month-long indicated period [3]. For this measurement period, uncertainty from Yb1 and the comb system were essentially negligible. The most significant source of uncertainty stemmed from dead time, due to the small fraction of measurement uptime from Yb1 and the optical frequency comb [3]. A post-processed NIST time scale was used as the flywheel for the purposes of calculating dead time uncertainty [3]. A breakdown of the Type A and Type B uncertainties for this measurement are listed in the results section. Also listed is u_{SecRep}, which is the recommended uncertainty of the standard frequency of the ^{171}Yb secondary representation [1]. Finally, the reported frequency offsets, y(UTC(NIST)-Yb1) and y(Maser 412015-Yb1), are computed with Yb frequency corrections from the geoid.

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Frequency Evaluation of UTC(NIST) and Maser 412015 by NIST-Yb1 for the period MJD 58114 to 58149

I. Results

Period (MJD)	y(UTC(NIST) - Yb1) (10^{-16})	y(Maser 412015 - Yb1) (10^{-16})	total u_A (10^{-16})	total u_B (10^{-16})	total $u_{l/Lab}$ (10^{-16})	u_{SecRep} (10^{-16})
58114-58149	3.0	-23290.4	<0.1	0.31	2.55	5

u_A, Type A uncertainty (10^{-16})	
Yb stability	<0.1
Total	<0.1

$u_{l/Lab}$, Type A uncertainty (10^{-16})	
Dead time	2.3
Yb-Maser comparison	1.1
Time scale measurement	<0.1
Total	2.55

Type B Uncertainty (10^{-16})	
Frequency comb + counting	0.3
Yb + gravitational redshift	0.062
Total	0.31

II. Yb1 operation

During the indicated period, Yb1 and an optical frequency comb were operated intermittently with an uptime of 4.93%. The measured frequency difference, y(Maser-Yb1), assumes the Yb absolute frequency equal to the most recently recommended BIPM value: 518,295,836,590,863.6 Hz [1]. y(UTC(NIST) – Yb1) is obtained from the NIST time scale measurement system where y(UTC(NIST) – Maser) is measured. The frequency shift and uncertainty budget of Yb1 over this period is given in the table below. More details on the Yb1 clock operation and uncertainty budget can be found in Ref. 2 and 3.

Systematic biases and uncertainties

Effect	Shift (10^{-18})	Uncertainty(10^{-18})
Background gas collisions	-5.5	0.5
Spin polarization	0	<0.3
Cold collisions	-0.21	0.07
Doppler	0	<0.02
Blackbody radiation	-2,361.2	0.9
Lattice light (model)	0	0.3

Travelling wave contamination	0	<0.1
Lattice light (experimental)	-1.5	0.8
Second-order Zeeman	-118.1	0.2
DC Stark	0	<0.07
Probe Stark	0.02	0.01
Line pulling	0	<0.1
Tunnelling	0	<0.001
Servo error	0.03	0.05
Optical frequency synthesis	0	<0.1
Yb1 Total	**-2,486.5**	**1.4**
Grav. redshift from geoid [4]	180,819	6
Yb + gravitational redshift	**178,333**	**6**

III. Frequency measurement

The frequency measurement was carried out with an optical frequency comb that was phase-locked to Yb1, and the resulting comb frequencies were subsequently counted relative to a hydrogen maser, 412015. For this analysis, one- and ten- second gated counting data were binned into twelve minute intervals, and related to internal NIST timescales. A final average value was calculated over the month-long indicated period [3]. For this measurement period, uncertainty from Yb1 and the comb system were essentially negligible. The most significant source of uncertainty stemmed from dead time, due to the small fraction of measurement uptime from Yb1 and the optical frequency comb [3]. A post-processed NIST time scale was used as the flywheel for the purposes of calculating dead time uncertainty [3]. A breakdown of the Type A and Type B uncertainties for this measurement are listed in the results section. Also listed is u_{SecRep}, which is the recommended uncertainty of the standard frequency of the ^{171}Yb secondary representation [1]. Finally, the reported frequency offsets, y(UTC(NIST)-Yb1) and y(Maser 412015-Yb1), are computed with Yb frequency corrections from the geoid.

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Frequency Evaluation of UTC(NIST) and Maser 412015 by NIST-Yb1 for the period MJD 58149 to 58174

I. Results

Period (MJD)	y(UTC(NIST) - Yb1) (10^{-16})	y(Maser 412015 - Yb1) (10^{-16})	total u_A (10^{-16})	total u_B (10^{-16})	total $u_{l/Lab}$ (10^{-16})	u_{SecRep} (10^{-16})
58149-58174	0.2	-23877.4	<0.1	0.31	3.22	5

u_A, Type A uncertainty (10^{-16})	
Yb stability	<0.1
Total	<0.1

$u_{l/Lab}$, Type A uncertainty (10^{-16})	
Dead time	2.9
Yb-Maser comparison	1.4
Time scale measurement	<0.1
Total	3.22

Type B Uncertainty (10^{-16})	
Frequency comb + counting	0.3
Yb + gravitational redshift	0.062
Total	0.31

II. Yb1 operation

During the indicated period, Yb1 and an optical frequency comb were operated intermittently with an uptime of 4.23%. The measured frequency difference, y(Maser-Yb1), assumes the Yb absolute frequency equal to the most recently recommended BIPM value: 518,295,836,590,863.6 Hz [1]. y(UTC(NIST) – Yb1) is obtained from the NIST time scale measurement system where y(UTC(NIST) – Maser) is measured. The frequency shift and uncertainty budget of Yb1 over this period is given in the table below. More details on the Yb1 clock operation and uncertainty budget can be found in Ref. 2 and 3.

Systematic biases and uncertainties

Effect	Shift (10^{-18})	Uncertainty(10^{-18})
Background gas collisions	-5.5	0.5
Spin polarization	0	<0.3
Cold collisions	-0.21	0.07
Doppler	0	<0.02
Blackbody radiation	-2,361.2	0.9
Lattice light (model)	0	0.3

Travelling wave contamination	0	<0.1
Lattice light (experimental)	-1.5	0.8
Second-order Zeeman	-118.1	0.2
DC Stark	0	<0.07
Probe Stark	0.02	0.01
Line pulling	0	<0.1
Tunnelling	0	<0.001
Servo error	0.03	0.05
Optical frequency synthesis	0	<0.1
Yb1 Total	**-2,486.5**	**1.4**
Grav. redshift from geoid [4]	180,819	6
Yb + gravitational redshift	**178,333**	**6**

III. Frequency measurement

The frequency measurement was carried out with an optical frequency comb that was phase-locked to Yb1, and the resulting comb frequencies were subsequently counted relative to a hydrogen maser, 412015. For this analysis, one- and ten- second gated counting data were binned into twelve minute intervals, and related to internal NIST timescales. A final average value was calculated over the month-long indicated period [3]. For this measurement period, uncertainty from Yb1 and the comb system were essentially negligible. The most significant source of uncertainty stemmed from dead time, due to the small fraction of measurement uptime from Yb1 and the optical frequency comb [3]. A post-processed NIST time scale was used as the flywheel for the purposes of calculating dead time uncertainty [3]. A breakdown of the Type A and Type B uncertainties for this measurement are listed in the results section. Also listed is u_{SecRep}, which is the recommended uncertainty of the standard frequency of the ^{171}Yb secondary representation [1]. Finally, the reported frequency offsets, y(UTC(NIST)-Yb1) and y(Maser 412015-Yb1), are computed with Yb frequency corrections from the geoid.

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Frequency Evaluation of UTC(NIST) and Maser 412015 by NIST-Yb1 for the period MJD 58174 to 58204

I. Results

Period (MJD)	y(UTC(NIST) - Yb1) (10^{-16})	y(Maser 412015 - Yb1) (10^{-16})	total u_A (10^{-16})	total u_B (10^{-16})	total $u_{l/Lab}$ (10^{-16})	u_{SecRep} (10^{-16})
58174-58204	-11.2	-24376.0	<0.1	0.31	2.63	5

u_A, Type A uncertainty (10^{-16})	
Yb stability	<0.1
Total	<0.1

$u_{l/Lab}$, Type A uncertainty (10^{-16})	
Dead time	2.5
Yb-Maser comparison	0.8
Time scale measurement	<0.1
Total	2.63

Type B Uncertainty (10^{-16})	
Frequency comb + counting	0.3
Yb + gravitational redshift	0.062
Total	0.31

II. Yb1 operation

During the indicated period, Yb1 and an optical frequency comb were operated intermittently with an uptime of 8.66%. The measured frequency difference, y(Maser-Yb1), assumes the Yb absolute frequency equal to the most recently recommended BIPM value: 518,295,836,590,863.6 Hz [1]. y(UTC(NIST) – Yb1) is obtained from the NIST time scale measurement system where y(UTC(NIST) – Maser) is measured. The frequency shift and uncertainty budget of Yb1 over this period is given in the table below. More details on the Yb1 clock operation and uncertainty budget can be found in Ref. 2 and 3.

Systematic biases and uncertainties

Effect	Shift (10^{-18})	Uncertainty(10^{-18})
Background gas collisions	-5.5	0.5
Spin polarization	0	<0.3
Cold collisions	-0.21	0.07
Doppler	0	<0.02
Blackbody radiation	-2,361.2	0.9
Lattice light (model)	0	0.3

Travelling wave contamination	0	<0.1
Lattice light (experimental)	-1.5	0.8
Second-order Zeeman	-118.1	0.2
DC Stark	0	<0.07
Probe Stark	0.02	0.01
Line pulling	0	<0.1
Tunnelling	0	<0.001
Servo error	0.03	0.05
Optical frequency synthesis	0	<0.1
Yb1 Total	**-2,486.5**	**1.4**
Grav. redshift from geoid [4]	180,819	6
Yb + gravitational redshift	**178,333**	**6**

III. Frequency measurement

The frequency measurement was carried out with an optical frequency comb that was phase-locked to Yb1, and the resulting comb frequencies were subsequently counted relative to a hydrogen maser, 412015. For this analysis, one- and ten- second gated counting data were binned into twelve minute intervals, and related to internal NIST timescales. A final average value was calculated over the month-long indicated period [3]. For this measurement period, uncertainty from Yb1 and the comb system were essentially negligible. The most significant source of uncertainty stemmed from dead time, due to the small fraction of measurement uptime from Yb1 and the optical frequency comb [3]. A post-processed NIST time scale was used as the flywheel for the purposes of calculating dead time uncertainty [3]. A breakdown of the Type A and Type B uncertainties for this measurement are listed in the results section. Also listed is u_{SecRep}, which is the recommended uncertainty of the standard frequency of the ^{171}Yb secondary representation [1]. Finally, the reported frequency offsets, y(UTC(NIST)-Yb1) and y(Maser 412015-Yb1), are computed with Yb frequency corrections from the geoid.

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Frequency Evaluation of UTC(NIST) and Maser 412015 by NIST-Yb1 for the period MJD 58204 to 58234

I. Results

Period (MJD)	y(UTC(NIST) - Yb1) (10^{-16})	y(Maser 412015 - Yb1) (10^{-16})	total u_A (10^{-16})	total u_B (10^{-16})	total $u_{l/Lab}$ (10^{-16})	u_{SecRep} (10^{-16})
58204-58234	6.8	-24890.7	<0.1	0.31	4.81	5

u_A, Type A uncertainty (10^{-16})	
Yb stability	<0.1
Total	<0.1

$u_{l/Lab}$, Type A uncertainty (10^{-16})	
Dead time	4.6
Yb-Maser comparison	1.4
Time scale measurement	<0.1
Total	4.81

Type B Uncertainty (10^{-16})	
Frequency comb + counting	0.3
Yb + gravitational redshift	0.062
Total	0.31

II. Yb1 operation

During the indicated period, Yb1 and an optical frequency comb were operated intermittently with an uptime of 3.23%. The measured frequency difference, y(Maser-Yb1), assumes the Yb absolute frequency equal to the most recently recommended BIPM value: 518,295,836,590,863.6 Hz [1]. y(UTC(NIST) – Yb1) is obtained from the NIST time scale measurement system where y(UTC(NIST) – Maser) is measured. The frequency shift and uncertainty budget of Yb1 over this period is given in the table below. More details on the Yb1 clock operation and uncertainty budget can be found in Ref. 2 and 3.

Systematic biases and uncertainties

Effect	Shift (10^{-18})	Uncertainty(10^{-18})
Background gas collisions	-5.5	0.5
Spin polarization	0	<0.3
Cold collisions	-0.21	0.07
Doppler	0	<0.02
Blackbody radiation	-2,361.2	0.9
Lattice light (model)	0	0.3

Travelling wave contamination	0	<0.1
Lattice light (experimental)	-1.5	0.8
Second-order Zeeman	-118.1	0.2
DC Stark	0	<0.07
Probe Stark	0.02	0.01
Line pulling	0	<0.1
Tunnelling	0	<0.001
Servo error	0.03	0.05
Optical frequency synthesis	0	<0.1
Yb1 Total	**-2,486.5**	**1.4**
Grav. redshift from geoid [4]	180,819	6
Yb + gravitational redshift	**178,333**	**6**

III. Frequency measurement

The frequency measurement was carried out with an optical frequency comb that was phase-locked to Yb1, and the resulting comb frequencies were subsequently counted relative to a hydrogen maser, 412015. For this analysis, one- and ten- second gated counting data were binned into twelve minute intervals, and related to internal NIST timescales. A final average value was calculated over the month-long indicated period [3]. For this measurement period, uncertainty from Yb1 and the comb system were essentially negligible. The most significant source of uncertainty stemmed from dead time, due to the small fraction of measurement uptime from Yb1 and the optical frequency comb [3]. A post-processed NIST time scale was used as the flywheel for the purposes of calculating dead time uncertainty [3]. A breakdown of the Type A and Type B uncertainties for this measurement are listed in the results section. Also listed is u_{SecRep}, which is the recommended uncertainty of the standard frequency of the ^{171}Yb secondary representation [1]. Finally, the reported frequency offsets, y(UTC(NIST)-Yb1) and y(Maser 412015-Yb1), are computed with Yb frequency corrections from the geoid.

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Frequency Evaluation of UTC(NIST) and Maser 412015 by NIST-Yb1 for the period MJD 58234 to 58269

I. Results

Period (MJD)	y(UTC(NIST) - Yb1) (10^{-16})	y(Maser 412015 - Yb1) (10^{-16})	total u_A (10^{-16})	total u_B (10^{-16})	total $u_{l/Lab}$ (10^{-16})	u_{SecRep} (10^{-16})
58234-58269	-17.6	-25418.2	<0.1	0.31	4.83	5

u_A, Type A uncertainty (10^{-16})	
Yb stability	<0.1
Total	<0.1

$u_{l/Lab}$, Type A uncertainty (10^{-16})	
Dead time	4.4
Yb-Maser comparison	2.0
Time scale measurement	<0.1
Total	4.83

Type B Uncertainty (10^{-16})	
Frequency comb + counting	0.3
Yb + gravitational redshift	0.062
Total	0.31

II. Yb1 operation

During the indicated period, Yb1 and an optical frequency comb were operated intermittently with an uptime of 1.61%. The measured frequency difference, y(Maser-Yb1), assumes the Yb absolute frequency equal to the most recently recommended BIPM value: 518,295,836,590,863.6 Hz [1]. y(UTC(NIST) – Yb1) is obtained from the NIST time scale measurement system where y(UTC(NIST) – Maser) is measured. The frequency shift and uncertainty budget of Yb1 over this period is given in the table below. More details on the Yb1 clock operation and uncertainty budget can be found in Ref. 2 and 3.

Systematic biases and uncertainties

Effect	Shift (10^{-18})	Uncertainty(10^{-18})
Background gas collisions	-5.5	0.5
Spin polarization	0	<0.3
Cold collisions	-0.21	0.07
Doppler	0	<0.02
Blackbody radiation	-2,361.2	0.9
Lattice light (model)	0	0.3

Travelling wave contamination	0	<0.1
Lattice light (experimental)	-1.5	0.8
Second-order Zeeman	-118.1	0.2
DC Stark	0	<0.07
Probe Stark	0.02	0.01
Line pulling	0	<0.1
Tunnelling	0	<0.001
Servo error	0.03	0.05
Optical frequency synthesis	0	<0.1
Yb1 Total	**-2,486.5**	**1.4**
Grav. redshift from geoid [4]	180,819	6
Yb + gravitational redshift	**178,333**	**6**

III. Frequency measurement

The frequency measurement was carried out with an optical frequency comb that was phase-locked to Yb1, and the resulting comb frequencies were subsequently counted relative to a hydrogen maser, 412015. For this analysis, one- and ten- second gated counting data were binned into twelve minute intervals, and related to internal NIST timescales. A final average value was calculated over the month-long indicated period [3]. For this measurement period, uncertainty from Yb1 and the comb system were essentially negligible. The most significant source of uncertainty stemmed from dead time, due to the small fraction of measurement uptime from Yb1 and the optical frequency comb [3]. A post-processed NIST time scale was used as the flywheel for the purposes of calculating dead time uncertainty [3]. A breakdown of the Type A and Type B uncertainties for this measurement are listed in the results section. Also listed is u_{SecRep}, which is the recommended uncertainty of the standard frequency of the ^{171}Yb secondary representation [1]. Finally, the reported frequency offsets, y(UTC(NIST)-Yb1) and y(Maser 412015-Yb1), are computed with Yb frequency corrections from the geoid.

[1] "Recommended values of standard frequencies for applications including the practical realization of the metre and secondary representations of the definition of the second," BIPM publication, approved by CCTF June 2017, https://www.bipm.org/utils/common/pdf/mep/171Yb_518THz_2018.pdf.

[2] W. McGrew, et al., "Atomic clock performance enabling geodesy below the centimetre level," Nature **564** 87–90 (2018).

[3] W. McGrew, et al., "Towards Adoption of an Optical Second: Verifying Optical Clocks at the SI Limit," arXiv:1811.05885 (2018).

[4] N. K. Pavlis and M. A. Weiss, "A re-evaluation of the relativistic redshift on frequency standards at NIST, Boulder, Colorado, USA," Metrologia **54**, 535-548 (2017).

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Frequency Evaluation of UTC(NIST) and Maser 412015 by NIST-Yb1 for the period MJD 58269 to 58299

I. Results

Period (MJD)	y(UTC(NIST) - Yb1) (10^{-16})	y(Maser 412015 - Yb1) (10^{-16})	total u_A (10^{-16})	total u_B (10^{-16})	total $u_{l/Lab}$ (10^{-16})	u_{SecRep} (10^{-16})
58269-56299	-3.1	-25992.3	<0.1	0.31	2.20	5

u_A, Type A uncertainty (10^{-16})	
Yb stability	<0.1
Total	<0.1

$u_{l/Lab}$, Type A uncertainty (10^{-16})	
Dead time	2.0
Yb-Maser comparison	0.9
Time scale measurement	<0.1
Total	2.20

Type B Uncertainty (10^{-16})	
Frequency comb + counting	0.3
Yb + gravitational redshift	0.062
Total	0.31

II. Yb1 operation

During the indicated period, Yb1 and an optical frequency comb were operated intermittently with an uptime of 7.87%. The measured frequency difference, y(Maser-Yb1), assumes the Yb absolute frequency equal to the most recently recommended BIPM value: 518,295,836,590,863.6 Hz [1]. y(UTC(NIST) – Yb1) is obtained from the NIST time scale measurement system where y(UTC(NIST) – Maser) is measured. The frequency shift and uncertainty budget of Yb1 over this period is given in the table below. More details on the Yb1 clock operation and uncertainty budget can be found in Ref. 2 and 3.

Systematic biases and uncertainties

Effect	Shift (10^{-18})	Uncertainty(10^{-18})
Background gas collisions	-5.5	0.5
Spin polarization	0	<0.3
Cold collisions	-0.21	0.07
Doppler	0	<0.02
Blackbody radiation	-2,361.2	0.9
Lattice light (model)	0	0.3

Travelling wave contamination	0	<0.1
Lattice light (experimental)	-1.5	0.8
Second-order Zeeman	-118.1	0.2
DC Stark	0	<0.07
Probe Stark	0.02	0.01
Line pulling	0	<0.1
Tunnelling	0	<0.001
Servo error	0.03	0.05
Optical frequency synthesis	0	<0.1
Yb1 Total	**-2,486.5**	**1.4**
Grav. redshift from geoid [4]	180,819	6
Yb + gravitational redshift	**178,333**	**6**

III. Frequency measurement

The frequency measurement was carried out with an optical frequency comb that was phase-locked to Yb1, and the resulting comb frequencies were subsequently counted relative to a hydrogen maser, 412015. For this analysis, one- and ten- second gated counting data were binned into twelve minute intervals, and related to internal NIST timescales. A final average value was calculated over the month-long indicated period [3]. For this measurement period, uncertainty from Yb1 and the comb system were essentially negligible. The most significant source of uncertainty stemmed from dead time, due to the small fraction of measurement uptime from Yb1 and the optical frequency comb [3]. A post-processed NIST time scale was used as the flywheel for the purposes of calculating dead time uncertainty [3]. A breakdown of the Type A and Type B uncertainties for this measurement are listed in the results section. Also listed is u_{SecRep}, which is the recommended uncertainty of the standard frequency of the ^{171}Yb secondary representation [1]. Finally, the reported frequency offsets, y(UTC(NIST)-Yb1) and y(Maser 412015-Yb1), are computed with Yb frequency corrections from the geoid.

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