Questionnaire
previous to the 2007 meeting of the
CCL-CCTF Frequency Standards Working Group

Note: Results will be considered only if there is a publication or at least acceptance for publication at the date of the meeting.

1. Have you made absolute frequency measurements of radiations included in the CCL list of recommended radiations (Mise en Pratique 2005)?

   Yes [x] No [ ]

   If yes, please list the values and uncertainties obtained and the methods used and refer to the publication(s) in which they may be found. Please be sure to include measurements made in other laboratories in your country.

Absolute frequency measurements were performed of reference ro-vibrational transitions for various Acetylene isotopes in the 1.5 μm region. The work was performed using an NRC diode laser based, cavity enhanced saturated absorption spectrometer in conjunction with frequency combs. The following tabulations give the determined values and uncertainties (1σ) for the transitions:

1. $\nu_1+\nu_3$ band of $^{13}C_2H_2$:

Absolute Frequency Measurements were performed of the P(16) reference line under the conditions as specified by the *mise-en-pratique*: The radiation at 194 THz was frequency doubled and measured with a self-referenced Ti:sapphire-based frequency comb. The results obtained were:

ν_1 **(P(16)) = 194 369 569 384 036 ± 500 Hz (1σ)**: Reference [1]

ν_2 **(P(16))** = **194 369 569 385 950 ± 1200 Hz (1σ)**: Reference [2]

ν_1**(P(16))** = **194 369 569 386 316 ± 1000 Hz (1σ)** : Reference [3]

References:

[1] : A.A. Madej, J.E. Bernard, A.J. Alcock, A. Czajkowski, and S. Chepurov, "Accurate Absolute Frequencies of the $\nu_1+\nu_3$ Band of $^{13}C_2H_2$ Determined using an Infrared Mode-locked Cr:YAG Laser Frequency Comb", Journ. Opt. Soc. Am. B 23 , 741-749 (2006).

[2] A.A. Madej, A.J. Alcock, A. Czajkowski, J.E. Bernard, and S. Chepurov, "Accurate Absolute Reference Frequencies from 1511 nm to 1545 nm of the $\nu_1+\nu_3$ Band of $^{12}C_2H_2$ Determined using Laser Frequency Comb Interval Measurements", Journ. Opt. Soc. Am. B 23 (no.10), 2200-2208 (2006).

[3] J.E. Bernard and A.A. Madej, Yearly absolute frequency Calibration of Acetylene

Standard, Unpublished result, Feb. 2007.

An infrared frequency comb was used to measure the frequency difference between other lines in the $\nu_1+\nu_3$ band of $^{13}C_2H_2$ and the P(16) line. The measurements were performed for the conditions specified by the *mise en pratique.*

Line	**Offset from P(16) [kHz]**	**U_c [kHz]**	**Frequency [kHz]**	**U_c [kHz]**	**Vacuum Wavelength [nm]**	**U_c [nm]**
P30	-1149564560.27	5.00	193220004822.2	5.2	1551.560141383	4.2e-8
P29	-1063105005.79	5.00	193306464376.7	5.2	1550.866180118	4.2e-8
P28	-977244287.20	5.00	193392325095.3	5.2	1550.177639429	4.2e-8
P27	-892105377.05	2.00	193477464005.5	2.4	1549.495490553	1.9e-8
P26	-807638067.23	1.09	193561931315.3	1.7	1548.819315673	1.4e-8
P25	-723847081.75	1.09	193645722300.7	1.7	1548.149137704	1.4e-8
P24	-640721965.92	1.09	193728847416.6	1.7	1547.484858336	1.4e-8
P23	-558275718.82	1.09	193811293663.7	1.7	1546.826566878	1.4e-8
P22	-476502654.07	1.09	193893066728.4	1.7	1546.174203433	1.4e-8
P21	-395402885.42	1.09	193974166497.1	1.7	1545.527754617	1.4e-8
P20	-314976289.88	1.09	194054593092.6	1.7	1544.887205308	1.4e-8
P19	-235222731.31	1.09	194134346651.2	1.7	1544.252540426	1.4e-8
P18	-156142105.29	1.09	194213427277.2	1.7	1543.623745294	1.4e-8
P17	-77734397.64	1.09	194291834984.9	1.7	1543.000806099	1.4e-8
P16	---------	------	194369569384.0	0.5	1542.383712379	0.4e-8
P15	77063007.04	1.09	194446632389.5	1.7	1541.772435531	1.4e-8
P14	153451225.34	1.09	194523020607.8	1.7	1541.166989199	1.4e-8
P13	229165962.30	1.09	194598735344.8	1.7	1540.567349879	1.4e-8
P12	304206524.31	2.20	194673775906.8	2.6	1539.973510061	2.0e-8
P11	378572272.53	2.10	194748141655.0	2.5	1539.385461922	2.0e-8
P10	452257032.74	1.09	194821826415.2	1.7	1538.803241486	1.4e-8
P9	525279211.56	1.09	194894848594.1	1.7	1538.226690765	1.4e-8
P8	597619762.18	2.00	194967189144.7	2.4	1537.655947727	1.9e-8
P7	669287337.36	1.09	195038856719.9	1.7	1537.090931735	1.4e-8
P6	740285117.16	1.09	195109854499.7	1.7	1536.531605586	1.4e-8
P5	810618381.02	1.09	195180187763.5	1.7	1535.977915767	1.4e-8
P4	880294498.51	1.09	195249863881.0	1.7	1535.429792580	1.4e-8
P3	949322305.39	1.09	195318891687.9	1.7	1534.887155099	1.4e-8
P2	1017710759.51	1.09	195387280142.0	1.7	1534.349921766	1.4e-8
P1	1085467075.61	1.09	195455036458.1	1.7	1533.818025018	1.4e-8
R0	1219093123.73	1.09	195588662506.2	1.7	1532.770121532	1.4e-8
R1	1284956012.80	2.00	195654525395.3	2.4	1532.254147428	1.9e-8
R2	1350174197.98	1.09	195719743580.5	1.7	1531.743566161	1.4e-8
R3	1414736584.66	1.09	195784305967.2	1.7	1531.238454068	1.4e-8
R4	1478632192.59	2.20	195848201575.1	2.6	1530.738886489	2.0e-8
R5	1541851517.42	1.09	195911420899.9	1.7	1530.244927136	1.4e-8
R6	1604387137.56	1.09	195973956520.1	1.7	1529.756623398	1.4e-8
R7	1666233738.04	1.09	196035803120.5	1.7	1529.274006216	1.4e-8
R8	1727380520.09	1.09	196096949902.6	1.7	1528.797149313	1.4e-8
R9	1787844397.64	1.09	196157413780.1	1.7	1528.325910414	1.4e-8
R10	1847604827.86	1.09	196217174210.4	1.7	1527.860439365	1.4e-8
R11	1906665848.39	1.09	196276235230.9	1.7	1527.400694472	1.4e-8
R12	1965025956.75	1.09	196334595339.2	1.7	1526.946677339	1.3e-8
R13	2022683715.30	1.09	196392253097.8	1.7	1526.498389174	1.3e-8
R14	2079635682.00	1.09	196449205064.5	1.7	1526.055846862	1.3e-8
R15	2135883116.68	1.09	196505452499.2	1.7	1525.619030857	1.3e-8
R16	2191421971.34	1.09	196560991353.8	1.7	1525.187962958	1.3e-8

R17	2246250503.66	1.09	196615819886.2	1.7	1524.762647144	1.3e-8
R18	2300366567.71	1.09	196669935950.2	1.7	1524.343090628	1.3e-8
R19	2353767929.03	1.09	196723337311.5	1.7	1523.929301409	1.3e-8
R20	2406452322.42	1.09	196776021704.9	1.7	1523.521287820	1.3e-8
R21	2458417494.25	1.09	196827986876.7	1.7	1523.119058205	1.3e-8
R22	2509661432.99	1.09	196879230815.5	1.7	1522.722619132	1.3e-8
R23	2560176325.51	1.09	196929745708.0	1.7	1522.332022124	1.3e-8
R24	2609973045.35	1.09	196979542427.8	1.7	1521.947174336	1.3e-8
R25	2659039017.02	1.09	197028608399.5	1.7	1521.568164315	1.3e-8
R26	2707376845.93	1.09	197076946228.4	1.7	1521.194963375	1.3e-8
R27	2754934188.73	1.09	197124503571.2	1.7	1520.827966939	1.3e-8
R28	2801831910.29	1.09	197171401292.8	1.7	1520.466234121	1.3e-8
R29	2847963520.84	1.09	197217532903.3	1.7	1520.110578338	1.3e-8

Operating parameters and characteristics of the $^{13}C_2H_2$ stabilized laser system

$^{13}C_2H_2$ pressure (Pa)	3.3 ± 0.7
One –way Intracavity Saturation power (mW)	200 ± 100
Peak-to-peak Modulation amplitude (MHz)	1.8 MHz ± 0.1 MHz
Cavity Coupling efficiency	60%
Empty Cavity Finesse (calculated from the mirror reflectivities)	380
Cavity waist (mm) on input mirror	0.47
Modulation frequency used in lock to cavity	10 MHz
Modulation Frequency used in lock to absorber line	1.01 kHz

References:

[1] A.A. Madej, J.E. Bernard, A.J. Alcock, A. Czajkowski, and S. Chepurov, "Accurate Absolute Frequencies of the $\nu_1+\nu_3$ Band of $^{13}C_2H_2$ Determined using an Infrared Mode-locked Cr:YAG Laser Frequency Comb", Journ. Opt. Soc. Am. B 23 , 741-749 (2006).

[2] A.J. Alcock, S. Chepurov, J.E. Bernard, A. Czajkowski, J.M. Fraser, P. Ma, A.A. Madej, I.V. Mitchell, P.J. Poole, I.T. Sorokina and E. Sorokin, "Ultrashort Pulse, Cr^{4+}:YAG Laser for High Precision, Infrared Frequency Interval Measurements", Optics Express 13, 8837-8844 (2005).

2. $\nu_1+\nu_3$ band of $^{12}C_2H_2$:

An infrared frequency comb was used to measure the frequency difference between lines in the $\nu_1+\nu_3$ band of $^{12}C_2H_2$ and the P(16) line of $^{13}C_2H_2$. The measurements were performed for the conditions specified by the *mise en pratique* and were found to be:

Line	Offset from P(16) [kHz]	U_c [kHz]	Frequency [kHz]	U_c [kHz]	Vacuum Wavelength [nm]	Uc [nm]
12P31	-351195291.6	4.0	194018374094.3	4.1	1545.1756020504	3.3e-8
12P30	-258109650.9	1.5	194111459735.0	1.9	1544.4346171487	1.5e-8
12P29	-165753448.2	1.2	194203815937.8	1.8	1543.7001407635	1.4e-8
12P28	-74128756.4	1.5	194295440629.5	2.0	1542.9721718055	1.6e-8
12P27	16762897.6	1.5	194386332283.6	2.0	1542.2507049653	1.6e-8
12P26	106919478.4	2.0	194476488864.4	2.4	1541.5357391043	1.9e-8
12P25	196340804.5	1.3	194565910190.5	1.8	1540.8272585186	1.4e-8
12P24	285023746.4	2.0	194654593132.4	2.4	1540.1252710029	1.9e-8
12P23	372967336.9	1.2	194742536722.9	1.8	1539.4297673475	1.4e-8
12P22	460170032.2	1.5	194829739418.2	1.9	1538.7407430469	1.5e-8
12P21	546630314.5	1.6	194916199700.5	2.0	1538.0581935244	1.6e-8
12P20	632346688.8	1.3	195001916074.7	1.8	1537.3821141591	1.4e-8
12P19	717317679.1	1.3	195086887065.0	1.8	1536.7125003133	1.4e-8
12P18	801541820.8	1.3	195171111206.7	1.8	1536.0493473980	1.4e-8
12P17	885017681.1	2.2	195254587067.1	2.6	1535.3926507088	2.0e-8
12P16	967743824.0	1.4	195337313210.0	1.9	1534.7424057057	1.5e-8
12P15	1049718850.4	1.5	195419288236.3	2.0	1534.0986076947	1.6e-8
12P14	1130941360.2	2.8	195500510746.2	3.0	1533.4612521253	2.4e-8
12P13	1211409984.4	3.5	195580979370.4	3.7	1532.8303343458	2.9e-8
12P12	1291123355.4	2.9	195660692741.4	3.1		2.5e-8
12P11	1370080137.4	3.1	195739649523.4	3.3	1532.2058498292	2.6e-8
12P10	1448278992.7	3.6	195817848378.7	3.8	1531.5877939393	3.0e-8
12P9	1525718615.7	2.4	195895288001.6	2.7	1530.9761621945	2.1e-8
12P8	1602397698.5	1.9	195971967084.5	2.3	1530.3709500024	1.8e-8
12P7	1678314964.8	2.7	196047884350.7	3.0	1529.7721529260	2.3e-8
12P6	1753469134.1	1.3	196123038520.1	1.8	1529.1797664275	1.4e-8
12P5	1827858961.3	3.4	196197428347.2	3.6	1528.5937861363	2.8e-8
12P4	1901483194.4	1.2	196271052580.4	1.8	1528.0142075536	1.4e-8
12P3	1974340616.0	2.6	196343910002.0	2.9	1527.4410263694	2.2e-8
12P2	2046430009.0	1.3	196415999394.9	1.8	1526.8742381515	1.4e-8
12P1	2117750175.7	1.3	196487319561.7	1.8	1526.3138386057	1.4e-8
12R0	2258078098.8	1.2	196627647484.7	1.7	1525.7598234265	1.4e-8
12R1	2327083532.0	1.7	196696652917.9	2.1	1524.6709292157	1.6e-8
12R2	2395315080.4	3.1	196764884466.3	3.3	1524.1360417309	2.6e-8
12R3	2462771621.3	1.3	196832341007.2	1.8		1.4e-8
12R4	2529452039.9	2.2	196899021425.9	2.6	1523.6075218053	2.0e-8
12R5	2595355239.0	1.2	196964924625.0	1.8	1523.0853652705	1.4e-8
12R6	2660480130.6	1.5	197030049516.5	1.9	1522.5695680403	1.5e-8
12R7	2724825646.8	1.3	197094395032.7	1.8	1522.0601260391	1.4e-8
12R8	2788390730.7	1.2	197157960116.6	1.7	1521.5570352628	1.3e-8
12R9	2851174350.5	1.3	197220743736.5	1.8	1521.0602916956	1.4e-8
12R10	2913175471.7	1.2	197282744857.7	1.7	1520.5698913841	1.3e-8
12R11	2974393096.1	1.3	197343962482.1	1.8	1520.0858303249	1.4e-8
12R12	3034826223.5	2.7	197404395609.4	3.0	1519.6081046837	2.3e-8
12R13	3094473893.8	2.0	197464043279.7	2.3	1519.1367104894	1.8e-8
12R14	3153335123.6	1.2	197522904509.6	1.7	1518.6716439344	1.3e-8

12R15	3211408993.5	1.3	197580978379.4	1.8	1518.2129010463	1.4e-8
12R16	3268694565.8	2.1	197638263951.8	2.5	1517.7604781800	1.9e-8
12R17	3325190939.9	1.3	197694760325.9	1.8	1517.3143713477	1.4e-8
12R18	3380897227.8	1.3	197750466613.7	1.8	1516.8745768436	1.4e-8
12R19	3435812557.1	1.2	197805381943.0	1.7	1516.4410908301	1.3e-8
12R20	3489936076.3	1.4	197859505462.2	1.8	1516.0139095178	1.4e-8
12R21	3543266956.9	1.4	197912836342.9	1.9	1515.5930291441	1.5e-8
12R22	3595804386.5	1.6	197965373772.4	2.0	1515.1784459366	1.5e-8
12R23	3647547589.4	1.3	198017116975.3	1.8	1514.7701560933	1.4e-8
12R24	3698495209.9	1.7	198068064595.9	2.1	1514.3681558406	1.6e-8
12R25	3748648054.0	1.2	198118217439.9	1.8	1513.9724412683	1.3e-8
12R26	3798003983.5	1.3	198167573369.4	1.8	1513.5830130498	1.4e-8
12R27	3846562721.7	1.6	198216132107.7	2.0	1513.1998554900	1.5e-8
12R28	3894323473.2	5.5	198263892859.1	5.6	1512.8229755388	4.3e-8
12R29	3941286000.1	2.1	198310855386.0	2.4	1512.4523660723	1.9e-8
12R30	3987450177.5	9.1	198357019563.5	9.1	1512.0880240814	7.0e-8
12R31	4032805511.4	4.4	198402374897.3	4.6	1511.7299424506	3.5e-8
					1511.3781133620	
					1511.0326081287	

Operating parameters and characteristics of the $^{12}C_2H_2$ stabilized laser system

$^{12}C_2H_2$ pressure (Pa)	2.7 ± 0.6
One –way Intracavity Saturation power (mW)	200 ± 100
Peak-to-peak Modulation amplitude (MHz)	1.8 MHz ± 0.1 MHz
Cavity Coupling efficiency	60%
Empty Cavity Finesse (calculated from the mirror reflectivities)	380
Cavity waist (mm) on input mirror	0.47
Modulation frequency used in lock to cavity	10 MHz
Modulation Frequency used in lock to absorber line	1.01 kHz

Reference : A.A. Madej, A.J. Alcock, A. Czajkowski, J.E. Bernard, and S. Chepurov, "Accurate Absolute Reference Frequencies from 1511 nm to 1545 nm of the $\nu_1 + \nu_3$ Band of $^{12}C_2H_2$ Determined using Laser Frequency Comb Interval Measurements", Journ. Opt. Soc. Am. B 23 (no.10), 2200-2208 (2006).

3. $2\nu_1$ band of $^{12}C_2HD$:

Using a self-referenced fibre-laser-based infrared frequency comb, the frequencies of lines in the $2\nu_1$ band of $^{12}C_2HD$ were measured under the conditions specified by the *mise en pratique* and were found to be:

Line	Frequency (kHz)	U_c (kHz)	Vacuum Wavelength (nm)	U_c (nm)
P27	195 083 584 556.3	1.7	1536.738 514 836	1.3e-8
P26	195 161 449 714.5	1.3	1536.125 389 715	9.9e-9
P25	195 238 655 952.4	1.2	1535.517 935 921	9.0e-9
P24	195 315 202 226.7	1.3	1534.916 148 780	9.7e-9
P23	195 391 087 966.7	1.2	1534.320 020 016	9.0e-9
P22	195 466 309 716.0	1.2	1533.729 564 116	9.1e-9
P21	195 540 867 837.3	1.1	1533.144 765 674	8.6e-9
P20	195 614 760 668.5	1.2	1532.565 625 291	9.0e-9
P19	195 687 985 368.1	1.1	1531.992 152 896	8.5e-9
P18	195 760 540 273.7*	1.7	1531.424 349 263	1.3e-8
P17	195 832 422 907.6	1.1	1530.862 221 633	8.5e-9
P16	195 903 630 363.6	1.1	1530.305 780 672	8.6e-9
P15	195 974 159 502.3	1.5	1529.755 038 936	1.2e-8
P14	196 044 006 223.8	1.1	1529.210 016 540	8.5e-9
P13	196 113 166 245.0	1.1	1528.670 735 067	8.5e-9
P12	196 181 634 239.2	1.4	1528.137 224 275	1.1e-8
P11	196 249 404 477.3	1.1	1527.609 517 076	8.5e-9
P10	196 316 469 424.0	1.2	1527.087 660 447	8.9e-9
P9	196 382 821 147.6	1.4	1526.571 704 429	1.1e-8
P8	196 448 450 320.2	1.2	1526.061 709 886	9.5e-9
P7	196 513 346 479.1	1.1	1525.557 746 440	8.5e-9
P6	196 577 498 143.4	1.3	1525.059 891 551	1.0e-8
P5	196 640 893 107.2	1.4	1524.568 228 220	1.1e-8
P4	196 703 518 963.8	1.1	1524.082 840 913	8.8e-9
P3	196 765 363 847.5	2.4	1523.603 809 827	1.8e-8
P2	196 826 417 376.6	1.2	1523.131 203 604	9.1e-9
P1	196 886 671 625.8	1.5	1522.665 071 863	1.2e-8
R0	197 004 767 626.3	1.3	1521.752 298 750	9.7e-9
R1	197 062 611 544.6	1.3	1521.305 617 794	9.9e-9
R2	197 119 660 022.9	1.5	1520.865 336 138	1.1e-8
R3	197 175 921 813.3	1.3	1520.431 375 408	1.0e-8
R4	197 231 407 144.6	1.1	1520.003 646 175	8.6e-9
R5	197 286 126 795.2	1.3	1519.582 055 109	9.8e-9
R6	197 340 091 336.2	1.1	1519.166 510 819	8.6e-9
R7	197 393 310 617.9	1.1	1518.756 927 788	8.5e-9
R8	197 445 793 469.0	1.1	1518.353 228 665	8.5e-9
R9	197 497 547 587.3	1.1	1517.955 345 078	8.6e-9
R10	197 548 579 273.4	1.2	1517.563 219 653	9.3e-9
R11	197 598 894 431.8	1.3	1517.176 798 291	9.8e-9
R12	197 648 497 165.4	1.2	1516.796 040 949	9.2e-9
R13	197 697 391 167.2	1.1	1516.420 910 918	8.5e-9
R14	197 745 579 093.3	1.1	1516.051 379 629	8.5e-9
R15	197 793 063 418.1	1.2	1515.687 420 071	9.5e-9
R16	197 839 845 664.7	1.1	1515.329 012 681	8.5e-9
R17	197 885 927 073.1	1.1	1514.976 140 214	8.5e-9
R18	197 931 308 538.2	1.1	1514.628 788 210	8.7e-9
R19	197 975 990 083.8	1.1	1514.286 949 003	8.5e-9
R20	198 019 972 926.1	1.8	1513.950 605 942	1.4e-8
R21	198 063 257 107.1	1.4	1513.619 751 482	1.1e-8
R22	198 105 840 644.7	1.1	1513.294 393 666	8.5e-9
R23	198 147 725 370.0	1.1	1512.974 511 518	8.5e-9
R24	198 188 910 238.6	1.4	1512.660 106 154	1.1e-8
R25	198 229 394 674.8	1.1	1512.351 175 222	8.7e-9
R26	198 269 179 255.0	1.3	1512.047 707 699	9.8e-9
R27	198 308 261 613.7	2.0	1511.749 715 118	1.6e-8

Operating parameters and characteristics of the C_2HD stabilized laser system

C_2HD pressure (Pa)	2.0 ± 0.7
One –way Intracavity Saturation power (mW)	200 ± 100
Peak-to-peak Modulation amplitude (MHz)	1.8 MHz ± 0.2 MHz
Cavity Coupling efficiency	60%
Empty Cavity Finesse (calculated from the mirror reflectivities)	380
Cavity waist (mm) on input mirror	0.47
Modulation frequency used in lock to cavity	10 MHz
Modulation Frequency used in lock to absorber line	1.01 kHz

Reference: J. Jiang, J. E. Bernard , A. A. Madej, A. Czajkowski , S. Drissler, and D. J. Jones, “Measurement of Acetylene-*d* Absorption Lines with a Self-Referenced Fiber Laser Frequency Comb”, Journ. Opt. Soc. Am. B (accepted for publication).

1.1. If yes, indicate for each one whether you think that any of these measurements should modify the current value and uncertainty already on the list.

Yes ☒ No ☐

(add as many lines as necessary)

The present worldwide series of measurements on the P(16) reference line and associated other acetylene lines of the various isotopes have shown a remarkable reproducibility. The current assigned (1σ) relative standard uncertainty of 2.6×10^{-11} (5 kHz) appears to be in line with what can be obtained with this system for most of the measured transitions which provided good reproducibility. A review of current published results to update the mean and re-examine the assigned uncertainty of the P(16) line may be in order. In addition, there have been new results obtained for other ro-vibrational lines for a number of acetylene isotopes. These lines potentially have the same accuracy of the P(16) line and may be used to advantage at other reference frequency/wavelengths. It is thus proposed that new tabulations of these other lines be compiled and provided as part of an update of the available reference lines in the 1.5 μm region.

2. Have you made absolute frequency measurements of radiations included in the CCTF list of secondary representations of the second?

Yes ☐ No ☒

No new determinations have been made in the past year of the $^{88}Sr^+$, 5s $^2S_{1/2}$ – 4d $^2D_{5/2}$ transition. Future measurements will be performed upon completion of the NRC Cs fountain frequency standard.

2.1. If yes, please list the values and uncertainties obtained and the methods used and refer to the publication in which they may be found. Please be sure to include measurements made in other laboratories in your country.

2.2. If yes, indicate for each one whether you think that any of these measurements should be proposed as an update of existing value and uncertainty to be considered at the next CCL-CCTF Joint WG meeting just prior to the CCTF (2008/2009).

Yes ☐ No ☐

(add as many lines as necessary)

3. Have you made absolute frequency measurements of other radiations not included in these lists?

Yes ☒ No ☐

If yes, please list the values and uncertainties obtained and the methods used and refer to the publication in which they may be found. Please be sure to include measurements made in other laboratories in your country.

5s $^2S_{1/2}$ – 6p $^2P_{1/2}$ transition in Rb at 422 nm

Absolute Frequency measurements were made using a saturation absorption dip stabilized laser employing an external cell. The cell used a natural isotopic mixture of Rb and stabilization was performed on the 5s $^2S_{1/2}$ – 6p $^2P_{1/2}$ transition at 422 nm. The absolute frequency measurements were performed using a Ti: Sapphire self-referenced frequency comb system together with a frequency doubled 844-nm diode laser link to 422-nm.

The measurements were performed under the conditions of: Rb pressure of: P= 14 ± 2 mPa, saturating optical power of P = 0.30 ± 0.02 mW (ω = 0.5-0.7 mm) , and peak to peak modulation excursion of Δf = 13.6 ± 0.5 MHz.

Component Identifier	Isotope	Spectral Assignment (F”,F’)	Transition Frequency [kHz]	Final Uncertainty [kHz] (1σ)
a	87	(2,1)	710 957 977 778	20
b	87	(2,1) + (2,2) c.o.	710 958 110 355	25
c	87	(2,2)	710 958 242 899	20
d	85	(3,2)	710 959 248 217	20
e	85	(3,2) + (3,3) c.o.	710 959 306 912	20
f	85	(3,3)	710 959 365 587	20
g	85	(2,2)	710 962 283 962	60
h	85	(2,2) + (2,3) c.o.	710 962 342 621	40

i	85	(2,3)	710 962 401 328	40
j	87	(1,1)	710 964 812 509	70
k	87	(1,1) + (1,2) c.o.	710 964 944 993	40
l	87	(1,2)	710 965 077 596	40

The spectral assignment is specified for the 5s $^2S_{1/2}$ (F”) - 6p $^2P_{1/2}$ (F’) transition as (F”,F’). Cross over dip (c.o.) features are identified with the contributing direct transitions that participate in the process.

Reference: A.D. Shiner, A.A. Madej, P. Dubé, and J.E. Bernard, “Absolute Optical Frequency Measurement of Saturated Absorption Lines in Rb near 422 nm”, Appl. Phys. B (Submitted for publication).

3.1. If yes, indicate if any of these sources should be included in a updated list of “Recommended values of standard frequencies for applications including the practical realization of the metre and secondary representations of the second, and present your arguments for a positive assessment.

Recommended for the MeP:

Yes ☐ No ☒

Recommended for secondary representation of the second

Yes ☐ No ☒

(add as many lines as necessary)

Although the measured Rb transitions are considered the among the most accurate known for the violet region of the spectrum (< 430 nm) and these transitions may be of utility in precision measurments, the measured lines are not proposed to be recommended for the *mise en pratique.* The assigned uncertainties for the transitions are larger than most accepted values in the MeP and the current work is under review and has not yet been accepted for publication.

4. Are you currently developing new frequency sources or are you aware of such sources developed in your country?

Yes ☒ No ☐

If yes, please give a brief description of your experiment.

A project has begun at NRC to develop an optical atomic clock based on laser cooled neutral atoms held in an Optical Lattice potential and probed at ultra-high resolution. The current effort has chosen to study the Strontium (Sr) system reference transitions. Work has begun in the design and purchase of the necessary laser and experimental components. Work has also been devoted to the construction of an ultra-stable laser system that will be employed to probe the neutral Sr system reference transition at 429 THz and the existing Sr^+ optical frequency/time standard reference at 445 THz.

NAME: ……**Alan A. Madej** …………………………

INSTITUTE: ……**Institute for National Measurement Standards (INMS), National Research Council of Canada   [CANADA]**……………………………

Note: After the decision of the CIPM in autumn 2006

that

- the CCL-*Mise en Pratique* WG and CCL/CCTF JWG be combined into a single CCL-CCTF frequency standards working group,
- the *Mise en Pratique*-CCL list of Recommended Radiations and CCTF Secondary Representation list be combined into a single new list of “Recommended values of standard frequencies for applications including the practical realization of the metre and secondary representations of the second”,
- other frequencies may be proposed, evaluated and maintained on the frequency standards list by the CCL-CCTF frequency standards WG, not all of which are adopted as CCL-preferred radiations or CCTF-accepted representations,
- the CCTF consider and recommends those frequencies which it proposes the CIPM to accept as secondary representations of the second,
- the CCL considers and recommends those frequencies which it deems important for use in high accuracy length metrology, and
- the frequency values list is maintained on the BIPM website.

the CCL-CCTF frequency standards working group at its meeting in September 2007 will thus be required

1. to recommend to the CCL, frequency standards to be added to the list of recommended radiations,
2. to follow the development of frequency standards to be considered at the next CCTF as possible secondary representations of the second (no decision before the next CCTF),
3. to recommend other frequencies relevant for science or technology.

Additional information:

The current list of recommended frequencies as secondary representations of the second contains

- the unperturbed ground-state hyperfine quantum transition of ^{87}Rb with a frequency of $f\,(^{87}Rb) = 6\,834\,682\,610.904\,324$ Hz and an estimated relative standard uncertainty of 3×10^{-15},

- the unperturbed optical 5d^{10} 6s $^{2}S_{1/2}$ (F = 0) – 5d^{9} 6s^{2} $^{2}D_{5/2}$ (F =2) transition of the $^{199}Hg+$ ion with a frequency of $f\,(^{199}Hg+) = 1\,064\,721\,609\,899\,145$ Hz and a relative standard uncertainty of 3×10^{-15},

- the unperturbed optical 5s $^{2}S_{1/2}$ – 4d $^{2}D_{5/2}$ transition of the $^{88}Sr^{+}$ ion with a frequency of $f\,(^{88}Sr^{+}) = 444\,779\,044\,095\,484$ Hz and a relative uncertainty of 7×10^{-15},

- the unperturbed optical 6s $^{2}S_{1/2}$ (F = 0) – 5d $^{2}D_{3/2}$ (F =2) transition of the $^{171}Yb^{+}$ ion with a frequency of $f\,(^{171}Yb^{+}) = 688\,358\,979\,309\,308$ Hz and a relative standard uncertainty of 9×10^{-15},

- the unperturbed optical transition 5s^{2} $^{1}S_{0}$ – 5s5p $^{3}P_{0}$ ^{87}Sr neutral atom with a frequency of $f\,(^{87}Sr) = 429\,228\,004\,229\,877$ Hz and a relative standard uncertainty of 1.5×10^{-14}.