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FAX MESSAGE

Date: May 31, 2006

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Dear Dr. Petit,

Attached is the report of our evaluation of NICT-O1 performed over the 30 days period of MJD 53839 to 53869. The detail of the evaluation is discussed in this report.

Sincerely,

Mizuhiko Hosokawa

M. Hosokawa.

4 pages

1. SUMMARY

April-May 2006 Evaluation of NICT-O1

The evaluation of NICT-O1 is reported. The number

$$Y_{(\text{NICT-O1-UTC(NICT)})} = +5.4 \times 10^{-15}$$

is the average frequency difference between NICT-O1 and the UTC(NICT) over the 30 days interval MJD 53839 to 53869.

The type A uncertainty (statistical confidence on the frequency measurement) for this evaluation is 4.0×10^{-15} (1σ). The type B uncertainty is less than 5.5×10^{-15} (1σ). The combined uncertainty (type A and type B) is 6.8×10^{-15} (1σ). A more detailed description of the various biases and uncertainties is given in the following sections of this report.

2. DETAILS OF EVALUATION

2.1 Second-Order Doppler Bias

The second-order Doppler bias was determined from measurements of the atomic velocity distribution for each beam direction. The resulting biases are shown below.

Beam Direction	Bias	Type B Uncertainty
East-to-West	-264.7	2
West-to-East	-269.9	2

2.2 Quadratic Zeeman Bias

The quadratic Zeeman bias was determined by measuring the linear Zeeman splitting of the microwave spectrum. A typical value for this bias is shown below.

Bias	Type B Uncertainty
152,470.1	0.2

2.3 Cavity Pulling Bias

The microwave cavity pulling bias was determined by measuring the displacement of the Ramsey fringe from the Rabi pedestal. It is the same for both beam directions. The resulting bias is shown below.

Bias	Type B Uncertainty
1.0	0.6

2.4 Cavity Phase Bias

The microwave cavity phase bias was measured by using the 2 beam directions. The resulting bias is shown below.

Beam Direction	Bias	Type B Uncertainty
East-to-West	132.1	3.6
West-to-East	133.7	3.6

Table 1: Frequency Biases and Their Type B Uncertainty.
(Units are fractional frequency $\times 10^{-15}$)

Physical Effect	Bias	Type B Uncertainty
Second-order Doppler East-to-West West-to-East	 -264.7 -269.9	2
Second-order Zeeman	152,470.1	0.2
Cavity pulling	1.0	0.6
Cavity phase (end-to-end) East-to-West West-to-East	 132.1 133.7	3.6
Blackbody	-19.4	0.5
Gravitation	8.2	0.1
Uncorrected biases	0	3.6
Total type B uncertainty		≤5.5

3. EVALUATION RESULTS

The measured frequency between NICT-O1 and H maser was

$$Y_{(\text{NICT-O1-H maser})} = -3\times10^{-15}$$

After the correction of blackbody and gravitational shift, we obtained the value of

$$Y_{(\text{NICT-O1-H maser})} = +8.2\times10^{-15}$$

The frequency difference between UTC(NICT) and H maser which we used for evaluation was

$$Y_{(\text{UTC(NICT)-H maser})} = +2.8\times10^{-15}.$$

The final value of the frequency between the NICT-O1 and the UTC(NICT) was

$$\mathbf{Y_{(\text{NICT-O1-UTC(NICT)})} = +5.4\times10^{-15}}$$

This value is shown below. The type A uncertainty is also shown. Units are fractional frequency $\times10^{-15}$.

Corrected Value	Type A Uncertainty
+5.4	4.0

Type A uncertainty of link between NICT-O1 and UTC(NICT) : 0.8

Table 2: Final Results

Evaluation interval	~~MJD 53769 to 53789~~ 53839 - 53869
UTC(NICT) frequency	$\mathbf{Y_{(\text{NICT-O1-UTC(NICT)})} = +5.4\times10^{-15}}$
Type A uncertainty (including the link uncertainty)	$\mathbf{4.0\times10^{-15}\ (1\sigma)}$
Type B uncertainty	$\mathbf{\leq 5.5\times10^{-15}\ (1\sigma)}$
Combined Uncertainty	$\mathbf{6.8\times10^{-15}\ (1\sigma).}$

References

1. A. Hasegawa, K. Fukuda, M. Kajita, H. Ito, M. Kumagai, M. Hosokawa, N. Kotake and T. Morikawa, "Accuracy evaluation of optically pumped primary frequency standard CRL-O1", Metrologia, Vol.41, pp.257-263 (2004).