Participant data

Details of the participant must be provided in advance to the actual measurements by sending the completed Table A to the pilot lab's contact (michael.matus@bev.gv.at). An agreement with the node laboratory is a matter of course. The actual date of measurement might be updated in the final report at a later stage.

A.1 Participant data	
Laboratory (Country code)	SMU (SK)
RMO	EURAMET
Contact person, Operator	Roman Fira
Address	Karloveská 63, 842 55 Bratislava, Slovak Republic
Phone, Fax, Email	Tel. +421 2 602 94 232 E-mail: fira@smu.gov.sk
Artefact's designation	SMU-1
CMC	*U* = 20 kHz @ 633 nm (iodine stabilized He-Ne laser)
Date of measurements	27.09.2022 – 30.09.2022

A.2 Host/node data	
Laboratory (Country code)	BEV (AT)
Contact person, Operator	Michael Matus
Address	Bundesamt für Eich- und Vermessungswesen Arltgasse 35, 1160 Wien Austria
Phone, Fax, Email	Tel. +43 1 21110 826540 E-Mail: michael.matus@bev.gv.at

Description of artefact

Details of the standard relevant to the comparison are collated in the following tables. The participant had to decide in advance of the actual measurements to what extent they wish to correct for deviations of working parameters. The parenthesis notation for stating standard uncertainties is used in table B.3.

B.1 Description of artefact (mandatory)	
Designation	SMU-1
Manufacturer Model / Type Serial Number	Winters Electro Optics Model 100 204
Wavelength (approx.)	633 nm
Operation principle	MEP 2003
Last compared	June 2010 (CCL-K11)
Comments	—

B.2 Detail information of artefact (mutable)	
Laser type	Iodine stabilised HeNe Laser
Stabilisation technique	Saturation spectroscopy on iodine vapour, 3*f* frequency modulation
Dither frequency	8.333 kHz
Modulation width	6.0 MHz
Iodine cell	BIPM #426, 10 cm, Brewster windows
Laser cavity length	26.5 cm
Cavity mirrors (curvature, transmission, location)	M1: 30 cm, 0.7 % , front, output mirror M2: ∞, 0.25 %, rear

B.3 Reference conditions and sensitivity coefficients of artefact (optional)			
Parameter	**Nominal value**	**Sensitivity coefficient (standard uncertainty)**	**Comment**
Output power	52 µW	−0.0082 (0.0066) kHz/µW	Measured 2010 at SMU
Modulation width	6.0 MHz	−6.71 (0.50) kHz/MHz	Measured 2010 at SMU
Iodine cell cold finger temperature	12.9 °C	−12.51 (3.20) kHz/°C	Measured 2010 at SMU
Cell wall temperature	—	—	—

Participant Results Report Form

The measurement result (C.1) of the comparison has to be determined by the participant in advance, before measurements are performed by the node/host lab. The remainder of the table has to be filled by the node laboratory. The parenthesis notation for stating standard uncertainties is used here.

The laser is intentionally working far off the CIPM recommended working parameters. The iodine cell cold finger temperature is reduced in order to reach a useable output power. The participant corrects for this temperature deviation from the recommended value (15 °C) using the stated sensitivity coefficients (Table B3). For this comparison the participant states the corrected frequency value (as he does for calibration work). Consequently, the host lab does not correct for the deviation of the working parameters.

C.1 “Measurement result” of participant (stated before C.2!)	
Expected frequency f_e	473 612 353 638 (10) kHz

C.2 Frequency measurement of host laboratory (to be performed after C.1!)	
Measured frequency f_0 (uncorrected)	473 612 353 638.681 (0.075) kHz

C.3 Correction due to working parameters (optional)		
Parameter	**Measured value**	**Frequency correction**
Output power	46 (5) µW	—
Modulation width	5.998 (0.100) MHz	—
Iodine cell cold finger temperature	12.9 (0.1) °C	—
Cell wall temperature	—	—
Overall frequency correction f_p	—	

C.4 Measurement of host laboratory (KCRV)	
Measured frequency $f_m = (f_0 + f_p)$	473 612 353 638.681 (0.075) kHz

C.5 Comparison Result	
Frequency difference $\Delta f = f_e - f_m$	−0.681 (10.000) kHz
Fractional frequency difference $\Delta f / f_e$	$-1.4\ (21.1) \cdot 10^{-12}$
Degree of equivalence stated as E_n value	−0.03

Description of Measurements

Here a short summary of the actual measurement technique shall be given by the node lab.

- Method: A femtosecond fiber laser comb generator (BEV) is used to measure the absolute frequency of the 633 nm standard. The output beam of the standard is transferred to the comb via free space, avoiding optical feedback using a double stage Faraday isolator. All counters and synthesizers are referenced to an active hydrogen maser. This maser is part of the BEV clock assemble which takes part in the CCTF-K001.UTC key comparison thus providing a link to the SI.
- Conditions: The measurements are made in accordance with the BEV quality system (respective working document A_0118). The laser was put into operation one day before the actual measurements (manually locked). A measurement of 6900 s was made with a sample time of 1 s (raw data filename SMU_2022_02.dat). This data was used to determine the KCRV. Immediately before and after this section the working parameters have been determined. Possible cycle slips and outliers are automatically detected and removed using a schema described in the references of the technical protocol and the working document A_0118.
- Special observation: The laser model tested in this comparison comes with an automatic line detection. The operator decided to lock the laser manually, since he has doubt on the reliability of this system.
- Allan variance stability: A long run absolute frequency measurement of the laser was used to determine the relative overlapping Allan standard deviation (raw data filename SMU_2022_03.dat, 80 000 s).