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Award

Optical Frequency Comb

National Physical Laboratory

F15: Voluntary ex ante transparency notice
Notice identifier: 2024/S 000-001905
Procurement identifier (OCID): ocds-h6vhtk-042e73
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Section I: Contracting authority/entity

I.1) Name and addresses

National Physical Laboratory

Hampton Road

Teddington

TW11 0LW

Email

nina.heath@npl.co.uk

Country

United Kingdom

Region code

UK - United Kingdom

Internet address(es)

Main address

www.npl.co.uk

I.4) Type of the contracting authority

Body governed by public law

I.5) Main activity

Other activity

Research

Section II: Object

II.1) Scope of the procurement

II.1.1) Title

Optical Frequency Comb

II.1.2) Main CPV code

- 38000000 - Laboratory, optical and precision equipments (excl. glasses)

II.1.3) Type of contract

Supplies

II.1.4) Short description

Comparison of optical frequency standards is essential for verifying that the clocks both locally and remotely at other national metrological institutes all agree to within their quoted uncertainties. These quoted uncertainties can be as low as ~1e-18, and so agreement between multiple clocks all operating at this level is required to verify that uncertainty. Remote clock comparisons at NPL, or between NPL and other European NMIs, are only possible at this uncertainty using optical frequency combs and telecoms optical fibre links to compare and transmit frequencies over long distances.

By using an optical frequency comb with the full flexibility to cover the 500 nm to 2000 nm wavelength range, the infrastructure will be in place to enable any of the likely candidates for an optical representation of the SI second to be compared over a short cross-site fibre link. The optical frequency comb will also require dedicated branches to link with the optical clocks and oscillators already available at NPL, these include the Sr+ at 674 nm,

the Sr lattice at 698 nm, the Yb+ clocks at both 871 nm and 934 nm, and an ultrastable laser at 1064 nm.

II.1.6) Information about lots

This contract is divided into lots: No

II.1.7) Total value of the procurement (excluding VAT)

Value excluding VAT: 588,100 EUR

II.2) Description

II.2.3) Place of performance

NUTS codes

- UK - United Kingdom

Main site or place of performance

NPL Management Ltd

Hampton Road

Teddington

TW11 0LW

II.2.4) Description of the procurement

Description of the procurement / requirements:

Mandatory Requirements:

1. The system must fulfil all regulatory requirement for operation in the UK and in the European Union. It must be CE marked or conform to equivalent international standards for electrical safety and a declaration of conformity or certificate of compliance must be provided.

2. The Frequency Comb must be based on femtosecond fibre laser technology, with the output from the fundamental oscillator covering a wavelength range that includes 1542 nm.

3. The nominal value of the repetition rate (comb mode spacing) must be equal to or

greater than 200 MHz.

4. The frequency comb must have outputs optimised for simultaneous high precision measurement of lasers at the following nominal wavelengths: 674 nm, 698 nm, 871 nm, 934 nm, 1064 nm, and two outputs at 1542 nm.

5. It must have outputs that enable high precision measurement of the frequency of any laser with wavelength in the range from 500 nm to 2000 nm, as well as the optical frequency ratio between any two such lasers. These outputs must be useable simultaneously with those outlined in 4.

6. At least one additional output must be provided from the fundamental oscillator, to be used for monitoring of the comb spectrum and for high resolution measurement of the repetition rate. This output must be useable simultaneously with those outlined in 4 and 5.

7. The spatial mode of all output beams must be the fundamental TEM00 mode.

8. All equipment required for full stabilisation of the comb degrees of freedom must be provided. This equipment must be suitable for stabilising the comb either to an ultrastable optical reference (at 1064 nm) or to an external 10 MHz reference frequency.

9. The power of the comb outputs at 674 nm, 698 nm, 871 nm, 934 nm, 1064 nm, the two outputs at 1542 nm, as well as the outputs covering the range from 500 nm to 2000 nm, must be sufficient to achieve a signal to noise ratio > 30 dB (at 100 kHz resolution bandwidth) on the optical beat note with a CW laser with 1 mW average power. At 1542 nm the power must be sufficient to achieve this for beat notes with two separate CW lasers. This specification must be achievable by all outputs outlined in 4 simultaneously. - All beat detection units required to achieve this must be included with the system.

10. When used for spectral purity transfer from a 1064 nm ultra-stable laser to a laser at any of the outputs outlined in 4, or for optical frequency ratio measurements, the excess instability introduced by the frequency comb must be no more than 5E-17 at 1 s (measured using a Lambda-type counter).

11. When used for optical frequency ratio measurements, the comb must be able to reach an accuracy of 1E-18 or better. - Accuracy here is defined by measuring an optical frequency ratio with this comb and another independent comb and comparing the results.

12. The supplier must provide a means of tuning the repetition rate of the comb, with a tuning range of at least 500 kHz.

13. The frequency comb must be provided with automatic mode-locking capabilities.

14. A control PC must be provided with suitable software for controlling the comb

included. This must be compatible with other hardware running the Windows operating systems.

15. The capability to network the control PC via Ethernet must be provided.

16. The system must include suitable equipment for monitoring all lock error signals and beat notes.

17. All control and monitoring electronics must be mountable in a 19" rack.

18. A user manual in English must be made available.

19. The supplier must provide an additional ultrastable microwave reference output of the frequency comb. The frequency of this output must be at 8 GHz and be optimised for the lowest achievable phase noise. All required components must be included.

Specifications: Required:

1. The power of the comb outputs at those outlined in the mandatory requirement 4 above, as well as the outputs covering the range from 500 nm to 2000 nm, should be sufficient to achieve a signal to noise ratio > 35 dB (at 100 kHz resolution bandwidth) on the optical beat note with a CW laser with 1 mW average power. At 1542 nm the power should be sufficient to achieve this for beat notes with two separate CW lasers. This specification should be achievable for the outputs outlined in 4 above, and any two wavelengths in the range 500 nm - 2000 nm simultaneously. Higher signal to noise ratios would be beneficial. - Please advise how this requirement can be met.

2. When used for spectral purity transfer from a 1064 nm ultra-stable laser to a laser at any of the outputs outlined in the mandatory requirement 4 above or for any optical frequency ratio measurements, the excess instability introduced by the frequency comb should be no more than 1E-17 at 1 s (measured using a Lambda-type counter). A better stability would be beneficial. - Please provide details of how this stability is achieved, including the beat detection setup and any proposed noise cancellation schemes. In addition, a retroreflector should be included in all beat detection setups to enable fibre link noise to be cancelled.

3. When used for optical frequency ratio measurements, the comb should be able to reach an accuracy of 1E-18 or better for sufficiently long averaging times. The minimum time required to reach this accuracy should be specified. Better achievable accuracy would be beneficial, as would being able to achieve this accuracy with a shorter averaging time. – Please advise how this requirement can be met.

4. The linewidth of all comb modes should be