Notice of market consultation to confirm the conditions for the use of a negotiated procedure without prior publication of a call for tenders for the acquisition of a system of scanning laser vibrometers for three-dimensional measurements as part of the project "Large Scientific Equipments- Large Equipment" Fiscal Year 2018 (CUP B88D19000020005)

1. INTRODUCTION

This Notice pursues the aims set forth in art. 66, paragraph 1, of the legislative decree n. 50/2016 (Procurement Code) and is aimed - on the basis of the indications provided by the National Anti-Corruption Authority (ANAC) - to confirm the existence of the conditions that allow, pursuant to art. 63 of the Procurement Code, the use of the negotiated procedure in question, or to identify the existence of solutions for the acquisition of a laser scanning vibrometer system for three-dimensional measurements.

2. OBJECT OF THE SUPPLY

The Department of Structural and Geotechnical Engineering of the University of Rome "La Sapienza" intends to purchase a laser scanning vibrometer system for three-dimensional measurements, as part of the project "Large Scientific Equipment - Large Equipment" year 2018 (CUP B88D19000020005), titled “Wide-Range Laser Scanning Station for 3D Shape Reconstruction and Dynamic Measurements”.

The Laser Doppler vibrometry is, at the moment, the method that offers the best resolution in speed and displacement and is used in countless fields of theoretical and applied research as well as in research and development. It allows to obtain resolution in displacement of the femtometer order (10^{-15} meters) and to investigate frequency ranges up to 1 GHz. The properties of Laser Doppler vibrometry are independent of the measurement distance for which this technology is used both in applications with microscope, both at great distances. Light, as a sensor, has no influence on the object under test and is not invasive. It is therefore possible to perform measurements on extremely small or light structures.

Doppler effect

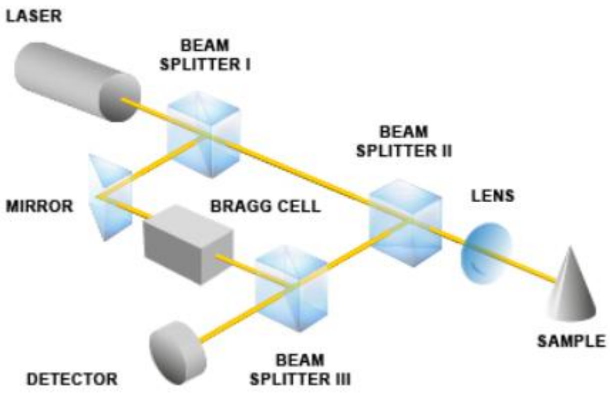
If a wave is reflected by a moving object and detected by an instrument (in this case with a Laser Doppler or LDV Vibrometer), the variation in the wave frequency can be described by the law: $f_D = 2 \times v/\lambda$ where v is the speed of the object and λ is the emitted wavelength. To be able to determine the speed of the object, the frequency variation (Doppler effect) must be measured with respect to the known wavelength of the probe beam. This operation is performed by the laser Doppler vibrometer using an interferometer which constitutes an integral part of the system.

Interferometry

The Doppler laser vibrometer works on the basis of optical interference, so that, two coherent light beams, with the respective intensities I_1 and I_2, must overlap. The total intensity of the two rays is not simply the sum of the individual intensities, but is modulated by the so-called "interference" term:

$$I_{tot} = I_1 + I_2 + 2 \times \sqrt{(I_1 \times I_2) \times \cos[2\pi \times (r_1 - r_2)/\lambda]}$$

The term interference is associated with the difference in optical path between the two rays. If this difference is an integer multiple of the wavelength of light, and the intensities I_1 and I_2 are equal to each other, the total intensity is four times the single intensity.



Optical set up

The image above shows how this physical law is technically exploited in a laser Doppler vibrometer.

The laser beam is divided into a measurement beam and a reference beam from the beam splitter (BS I). After passing through a second beam splitter (BS II), the measurement beam is focused on the object that reflects it. This reflected ray is now divided again by BS II and is then joined with the reference radius on the detector.

Since the optical path of the reference radius (r_2) is constant in time (except for the negligible thermal effects in the interferometer), a movement of the object ($r_1 = r(t)$) generates a light/dark pattern, typical of the interferometry, on the detector. A complete light/dark cycle on the detector corresponds to a displacement of the object by exactly half the wavelength of the light used. In the case of the He-Ne laser often used for vibrometers, this corresponds to a displacement of 316 nm.

The change of optical path per unit of time is manifested as the Doppler variation of the frequency of the measurement beam. In metrological terms, this means that the frequency modulation on the detector is directly proportional to the speed of the object. Since an object that moves away causes the same modulation as an approaching one, this setup alone cannot determine the direction of the object's motion. For this reason, an optical-acoustic modulator (Cradle of Bragg) is used to shift the frequency of the reference radius by 40 MHz (for comparison, the laser light frequency is

4.74x1014 Hz). This generates an interference pattern at the modulation frequency of 40 MHz when the object is stopped. If the object moves towards the interferometer, the modulation frequency increases, if it moves away, the detector receives a frequency lower than 40 MHz. In this way it is possible to detect not only the optical path, but also the direction of movement.

Displacement and speed

With laser Doppler vibrometry it is possible to directly measure not only speed but also displacements. Instead of transforming the Doppler frequency into a voltage proportional to the speed, the light/dark fringes on the detector are counted. Using appropriate interpolation techniques, the vibrometers can reach a resolution of 2 nm and, thanks to digital demodulation techniques, this precision can be extended to the range of pm. Displacement demodulation is more suited to reduced frequency measurements, while speed demodulation is better for higher frequencies since the maximum amplitudes of harmonic vibrations can be expressed as follows:

$$v = 2\pi \times f \times s$$

When its frequency increases, a vibration generates a relatively high speed at very low displacement amplitudes.

3D scanning vibrometry

The possibility of combining contactless laser Doppler technology with the ability to move the laser beam sequentially on a mapping of measurement points allows the complex vibrational behavior of entire three-dimensional surfaces to be analyzed. This method reduces development times by providing precise information on the dynamic behavior of structures, parts, objects in motion. As a result it is possible to obtain the visualization of the vibration modes and of the operational deflection shapes with a data quality that allows the validation, for example, of the finite element models.

The 3D scanning laser technology allows the simultaneous measurement of in-plane and out-of-plane vibrations and can be applied to many fields including the analysis of surface wave propagation in non-destructive tests, the structural analysis of any mechanical component and the mapping of stresses and deformation fields in structures of any kind.

3. MINIMUM MANDATORY REQUIREMENTS

The equipment supplied must comply with the following **minimum mandatory requirements**:

Hardware

- Standard front that includes 3 14-range speed decoders which can operate in two frequency bandwidths (Mode I and Mode II) and has the following technical features:

1) **Mode I (high frequency)**

- **Minimum Frequency bandwidth**: **100 kHz** 24 bit
- Speed range (full scale): 2.5 mm/s ÷ 30 m/s
- Resolution: 0.01-0.15 $\mu m/s/(Hz)^{1/2}$
- Tracking filter

2) **Mode II (ultra high frequency)**

- **Minimum Frequency bandwidth** for 1D measurements: **25 Mhz**
- **Minimum frequency bandwidth** for 3D measurements: **5 MHz**
- Speed range (full scale): 2.5mm/s ÷ 30 m/s
- Resolution: 0.01-48 $\mu m/s/(Hz)^{1/2}$
- Integrated acquisition card for 8 extra channels and Mode II generator (max 25 MHz)

The same front should include the listed components with the following minimum requirements:

- Data management system that includes an industrial PC and 24 "TFT monitor
- Scanning sensor with high sensitivity laser for long distance measurements with the following features:
    - Measurement laser: infrared 1550 nm; output power <10, class 2
    - Pointing laser: visible coaxial to the measurement laser
    - Scan angle (Horizontal x Vertical): 50° x 40°
    - Minimum operating distance: 125 mm
    - Integrated HD video camera
- 2 scanning sensors similar to the previous measurement laser sensor but without video camera
- System cabinet to store the system and all accessories
- Distance sensor for coordinate measurements
- 3 tripods for positioning and pointing the laser sensors
- Rigid (isolated) support for stable positioning of the 3 scanning heads for out-of-plane acquisitions with small parts
- Extension of spectral lines minimum 204.800

Software

- Software for the control, acquisition and analysis of data with the following characteristics:
    - Remote control of all scanning sensor functions
    - Data acquisition in the frequency domain with different types of triggers and media and peak hold functions (number of spectral lines 12800)
    - AC, DC and ICP coupling
    - Digital filters, signal enhancement and speckle tracking functions
    - Calculation of FRF, APS, CPS, PSD and coherence and calculation of operational deflections in the frequency domain with profile calculation
    - Display of amplitude, phase, real part and imaginary part
    - Possibility of exporting data in various formats

- Software for acquiring and storing scan data over time. The software must allow acquisition of time-domain scans.
- Software for comprehensive analysis of time-domain and frequency-domain vibration test data and visualization enabling easy reporting of experimental output.
- Software for easy sharing of scanning vibrometer measurements data with other parties.
- Software for the post-processing of 3D in-plane measurements. Stress calculation and dynamic strains calculations starting from the measured in-plane components.

Services

- Training

- Assistance consisting of telephone and on-site support

- Permanent software maintenance that provides the right to obtain new versions of the software at the time of their release, for the entire life of the system.

Hardware accessories available for future expansion

- Interfacing with industrial robots for 3D scanning of large structures, vehicles and machines
- Automatic hammers
- Variety of tripods (compact, motorized and independent)
- Set of mirrors
- Telescopic or foldable and compact tripod
- Protective window to protect the scanning mechanism against dust, wind and acoustic excitation at high dB levels.

4. AMOUNT

The initially estimated value for the supply is € 500,000.00 + VAT.

5. ADMISSIBLE SUPPLIERS

Any supplier referred to in art. 45 of Legislative Decree 50/2016 is admitted to participate in this expression of interest.

6. GENERAL REQUIREMENTS AND PROFESSIONAL ELIGIBILITY

a) Absence of the grounds for exclusion pursuant to art. 80 of Legislative Decree 50/2016
b) Requirements of professional suitability pursuant to art. 83, paragraph 1 letter a) of Legislative Decree 50/2016: Entry in the register of companies of C.C.I.A.A. or in the appropriate register if cooperative, which shows that the company carries out activities in the field of this expression of interest.
These requirements must be filled in the DGUE.

7. SELECTIVE CRITERIA OF PROFESSIONAL TECHNICAL CAPACITY

Documented and matured experience of at least 3 supply contracts, by the manufacturer or its authorized resellers, of a laser scanning vibrometer for three-dimensional measurements with requirements equal to or greater than those established in item 3 of this notice, to European universities or research institutes.

The references of the customers who acquired the mentioned machines must be indicated.

8. APPLICATION PROCEDURE

Entities able to meet the minimum mandatory requirements and that possess the technical and professional skills as outlined in the contract text can submit their candidature by presenting:

1. DGUE

2. ILLUSTRATIVE DOCUMENTATION

3. DOCUMENTATION PROVIDING THE REQUIREMENTS OF ITEM 7.

The documentation must be provided exclusively in electronic format and can be sent by certified electronic mail to the email address

disgpec@cert.uniroma1.it

The message must have as its object: "**Application for acquisition of a laser scanning vibrometer for three-dimensional measurements**"

Please note that the PEC service has legal validity only if both e-mails, the one from which you send and the one in which you receive the message, are certified e-mail. Any messages sent from non-certified email accounts or with objects other than those indicated above will NOT be taken into consideration.

Interested entities must submit an application and must attach the documentation and the DGUE.

The documentation must be received by 12:00 on the day 10.01.2020.

Any documentation received after this deadline will not be taken into consideration.

9. OTHER INFORMATION

This consultation is aimed at exploring the wide market offer, the potential competitors, the suppliers concerned, the associated characteristics, the available technical solutions, the economic conditions practiced, the generally accepted contractual clauses, in order to verify their correspondence to the actual requirements of the contracting station.

The suppliers that will present their candidature can be contacted by the RUP (Designated Procurement Officer) in order to deepen the technical solutions available for the realization of the equipment in question and the relative conditions.

This Notice does not constitute a contractual proposal and does not bind this Entity in any way.

This Entity reserves the right to interrupt the proceedings initiated at any time, for reasons beyond its exclusive competence, without the requesting parties having any claim.

The Entity, following the applications received and the related documentation analyzed, reserves the right to invite to the subsequent negotiated procedure, all suppliers meeting the deadlines and in possession of the requisites and criteria required respectively in items 5, 6 and 7 and declared in the application.

Any requests for technical clarification can be sent to the Execution Director, Prof. Walter Lacarbonara, email: walter.lacarbonara@uniroma1.it.

Any requests for clarification of an administrative nature can be addressed to the Chief Administrative Officer of the Department of Structural and Geotechnical Engineering, Mrs. Elena Alessia De Roberto(until 31.12.2019, email: elenaalessia.deroberto@uniroma1.it) Mrs. Stefania Pontecorvo (from 1.1.2020 stefania.pontecorvo@uniroma1.it) Tel +39 06 44585757.

Please note that the offices of the Department of Structural and Geotechnical Engineering will be closed from December 23rd to 27th, any requests for clarification sent in this period will be processed subsequently.

Notice of pre-consultation was sent to the GUCE.

The RUP

Ing. Roberta Marzellotta