LASER VIBROMETERS VSM SERIES

All-models Datasheet

Self-Mixing Interferometry (SMI) configuration
Non-contact vibrations measurement on diffusive surfaces
Working distance: 0.1 m ÷ 5.0 m (up to 100.0 m) with autofocus systems

Standard frequency range: from DC to 100 kHz and from 20 kHz up to 25 MHz
PC software for remote control
Fixed-point, 2D and 3D Scanning, Underwater versions
Customized solutions on request

Julight VSM series Laser Vibrometers are based on the smart Self-Mixing Interferometry (SMI) technology, that allows easy and accurate non–contact vibration measurements on all rough and diffusive surfaces, with the smallest-sized optical heads on the market.

The output signal is an analogue replica of the target displacement or velocity, in a frequency range from DC to 100 kHz, or up to 10 MHz or 25 MHz with extended frequency (-MHZ, and -MHZPLUS) options. Vibration with amplitudes from picometers (10^{-12} m) to a few mm can be measured, over a working distance from 0.1 m to 5 m, with optional maximum distance up to 50 m. Proprietary speckle-tracking technology avoids signal fading due to speckle effects from diffusive surfaces, and autofocus function allows quick setting of the laser focus. All the functions can be controlled remotely from a PC, through Ethernet connection.

Several models are available, including single fixed-point heads, multiple fixed-point optical heads integrated into one single instrument, scanning version for automated measurements of multiple points onto extended objects, 3D vibration measurement using three optical heads (also in scanning version), a microscope-coupled model for the measurement of tiny objects. Underwater and through-water target measurements are made possible, and the unique IP68 optical head can even be submerged, for full-underwater measurements.

Julight Laser Vibrometers offer top performance with great versatility, and the best value for money on the market.

Julight, a laser measurement Company

Julight is a privately held Company founded in 2011 and based in Italy. Julight owns a sound expertise in the development of sensors and measuring instruments based on laser and photonic technologies. The solid know-how of Julight's scientists and engineers in laser sources, photodetectors, electronic design, software, and opto-mechanical design has brought to the market innovative and unique Laser Vibrometers and Laser Triangulation Sensors for the measurement without contact of physical quantities such as: vibration, distance, velocity.

Julight represents the “Italian Excellence for Vibrations”.

Self-Mixing Interferometry technology

The innovative Self-Mixing Interferometry (SMI) technology has been pioneered by Julight co-founders, and Julight owns the world’s most advanced knowledge and expertise in this field.

In SMI, the traditional concept of laser vibrometry and laser interferometry is revolutionized, in favor of an ultra- simplified optical configuration where the beamsplitter and reference arm of classical interferometers are removed, leaving one single measurement path that goes straight from the laser source to the target. Light back-reflected or back-diffused by the target re-enters into the laser cavity, where interferometric mixing occurs, and the laser simultaneously operates as light source and ultra-sensitive coherent detector.

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The use of semiconductor laser sources with small dimensions, and the reduced number of optical elements ensure high-efficiency and compact size of the measuring head, with largely reduced manufacturing cost with respect to the schemes employed by traditional Laser Doppler Vibrometers (LDVs). The basic working principle of SMI is still the interferometric coherent Doppler effect; the sensitivity and performance are the same; the smart simplified configuration of SMI technology brings an added value in terms of optical head size and production cost.

Use

The optical head is connected to the main electronic unit using a shieled cable of 3 m length (optional: 5 m and 10 m).
The laser beam shall be simply aimed onto the target surface, and the vibration signal is readily available from the output BNC connector, providing an analogue replica of the target displacement or velocity.
Operation on natural, untreated diffusive rough surfaces (e.g.: unfinished metal, plastic, rubber, paper, fabric, leather, human skin, etc.), is possible up to a typical distance of 2-3 m (depending on the surface type). For longer distance, the use of retroreflective paint or adhesive tape is recommended. The small optical head of the standard model also allows hand-held operation.
The quality/strength of the back-reflected optical signal is measured by the instrument, and displayed by a LED bar on the front panel, and in the remote control software. An automatic, proprietary Speckle-Tracking system finds the point on the target surface that gives the best signal quality, by changing the transverse position of the laser beam by a few microns. The measurement of the signal quality/strength can be performed even on perfectly static targets with no vibration.
For proper operation on untreated, diffusive surfaces, the measuring laser beam must be focused. This can be achieved by either manually setting the working distance, or by the autofocus function. In the -EXTRA and -SCAN models, the autofocus is faster and assisted by an integrated laser telemeter that exactly measures the target distance.
Julight Laser Vibrometer do not include an internal DAQ (Data Acquisition System). They can be considered as advanced optical vibration transducers, that leave users total freedom to choose the DAQ of their choice. The output signal can be supplied to a high resolution 24-bit DAQ, or to an oscilloscope, or to a data logger. Signal analysis can be performed in the time-domain or in the frequency-domain through Fast-Fourier Transform.
Four sensitivity levels can be selected (from 0.5 V/mm to 80 V/mm), as well as high-pass and low-pass filters.
The measurable vibration frequency range goes from DC to 100 kHz. With the -MHZ/-MHZPLUS option, an additional BNC output is made available on the rear panel, providing an extended vibration frequency range from 20 kHz to 10 or 25 MHz, with increased sensitivity.
The resolution is noise-limited, and the noise is white (e.g.: constant spectral density vs. frequency) for the displacement output. A Noise Equivalent Displacement (NED) as low as <10 pm/√Hz can be achieved for shorter working distances.
A unique feature of Julight Laser Vibrometers is that the signal processing (e.g., that takes the raw Doppler signal and produces the vibration output signal) is mostly analogue. A positive consequence is that the electrical output vibration signal is generated in **real-time with zero-delay**, thus greatly simplifying the signal interpretation by the user, and enabling the use of Julight Laser Vibrometers in real-time control systems.

Software for remote control

A dedicated software running on a PC (OS: Windows® 7, 8, 10, 11) allows remote full control of the instrument via Ethernet connection, through an intuitive graphical interface, that is replicated for the case of instruments with multiple measuring channels.

Advanced lasers, for high performance and extended temperature range

Julight Laser Vibrometers are based on the innovative SMI technology, where the accurate coherent detection of the phase change of the light back-reflected by the moving target is performed by the semiconductor laser source itself. Thus, the choice of the laser plays a crucial role for the whole system performance. Thanks to their deep expertise and knowledge in advanced semiconductor lasers, Julight designers choose reliable distributed feedback semiconductor lasers (DFB), that are the same devices used for long-distance fiber-optic telecommunications.
In models with working distance from 0.1 m to 5 m, the measuring laser has a wavelength of 1310 nm. This is an invisible infra-red wavelength, and the laser belongs to laser safety class 1, that is totally eye-safe. Aiming onto the target is made easier by a visible red laser pointer (of laser safety class 2), superposed to the invisible infra-red laser. In models that are equipped with an integrated laser telemeter, the latter also acts as visible pointer.
In models with longer maximum operation distance (from 10 m to 50 m) the laser must have a long coherence length, to keep its coherence properties even after propagation over such long distances. For this, Julight uses state-of-the-art DFB lasers emitting at 780 nm, that are designed for spectroscopy applications, and belong to laser safety class 3B.
All semiconductor laser used in Julight products are individually selected and quality tested.
As the semiconductor laser is the only optically active element contained in the optical head, Julight Laser Vibrometers can operate over a wide temperature range (0 °C .. +70 °C), unlike traditional Laser Doppler Vibrometers that have a very limited temperature range. With the -HEAT option, an electrical heater is integrated in the optical head, thus extending the operating temperature range to -20 °C .. +70 °C. The heater has the role of avoiding ice formation and water condensation onto the output optical window.

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Models and options

The VSM series is based on the entry-level model VSM-1000 (VSM = Vibrometer Self-Mixing).

• The **extended frequency options (-MHZ and MHZPLUS)** adds a BNC connector on the rear panel, providing vibrations signals with frequency from 20 kHz to 10 MHz or 25 MHz, with increased sensitivity (by a factor 1000x).

• The **-EXTRA option** integrates into a larger optical head the following elements

□ A laser telemeter that acts as visible laser pointer and allows fast and precise measurement of the target distance (with 0.2 mm accuracy), enabling faster autofocus. It also allows the user to perform a profile measurement of the target surface (provided the laser beam is scanned by some means over the target surface).

□ A HD color camera (1MP, 13MP) that allows the user to view the exact position of the laser beam onto the target surface.

• The **Underwater option (-UW)** that makes use of a laser wavelength (660 nm, or 780 nm) that is much less attenuated by water with respect to the standard wavelength of 1310 nm, and thus is suitable for applications where the laser beam travels through water, or where the target is submerged in water.

• The **-IP868 option** is unique in the Laser Vibrometers market, as it allows the optical head to be submerged in water, down to 3 m depth.

Models with largely modified characteristics are described in the "Special models" section:

• VSM-1000-MICRO, where the optical head is coupled to a microscope, and allows measurements of tiny objects

• VSM-1000-3D, for fixed-point vibration measurement in 3 dimensions

• VSM-1000-SCAN, a Scanning Laser Vibrometer

• VSM-3D-SCAN, a Scanning Laser Vibrometer that performs vibration measurement in 3 dimensions

FOR SPECIAL NEEDS, ON REQUEST, ALL MODELS CAN BE CUSTOMIZED, FROM THE SHAPE AND SIZE OF THE OPTICAL HEADS, TO THE IMPROVEMENT OF PERFORMANCE.

Applications

• Non-contact measurement of vibrations

• Vibration measurement without mass-loading on small, soft and delicate structures

• Loudspeaker, piezoceramic, MEMS-MOEMS testing

• Material analysis

• Modal analysis

• Automotive, Aerospace, and Mechanical Industry

• On–line process & quality control in industrial plants

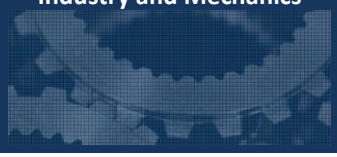
□ In view of the small size of the optical head, the VSM-1000 is particularly recommended for end-of-line testing of products (electrical motors, compressors, dish-washing machines, home apparels, smartphones, etc…)

• Non-destructive testing (NDT) on metal and composite materials

□ In the typical application, the -MHZ/-MHZPLUS option is recommended for measuring ultrasound waves generated either by pulsed laser excitation or ultrasonic transducers, allowing to detect flaws and defects (cracks, delamination, etc…) of materials and products.

Application sectors

Industry and Mechanics



Process and product quality,vibration control, condition monitoring and predictive maintenance

Automotive

Mechanical and electrical components testing, valve motion analysis

Aerospace

Structural analysis, turbine blades vibrations

Acoustics

Musical instruments, loudspeakers, ultrasound tools

Building, Infrastuctures, Monuments

structural health monitoring, non-destructive testing, conservation and restoration

Electronics

Welding and process quality control, MEMS/MOEMS characterization

Biomedical

Biological vibrations, non-invasive screening, heart-rate monitoring, cardiovascular

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Laser Vibrometer and Laser Triangulation technologies, integrated

Julight is the only Company in the world that masters the two leading technologies for vibration and distance measurement: laser interferometry/vibrometry and laser triangulation.
With the VSM-4000 series (large main electronic unit that can host up to four measuring channels) Julight offers the unique possibility of integrating laser vibrometers and laser triangulation sensors into the same instrument.
Please contact our sales team for options and pricing.

Special models

Microscope Laser Vibrometer

The **VSM-1000-MICRO** features a Laser Vibrometer optical head coupled to a digital microscope with a monochrome 1.6MP camera. The Mitutoyo-type long working-distance microscope objective tightly focused the laser beam, allowing to measure the vibration of very small objects, like MEMS, MOEMS, micro-membranes, biological samples and insects.
The lightweight Julight optical head allows for a smart design that features a movable microscope column, that can be translated along X and Y using a manual or motorized micropositioner, instead of the usual configuration where the object under test is mounted onto a translation stage. In this way, it is possible to easily test objects that are naturally attached/mounted onto larger structures, allowing for high flexibility of use and operation. The vertical focusing can be manual or motorized.
The tight focusing of the microscope objective (standard magnification: 10X, optional magnifications: 5X, 20X, 50X) also allows vibration measurements on highly reflective surfaces, even if inclined ad at angle (up to 60° and more is tolerated).

• The **VSM-1000-MICRO-A** model only operates as microscope vibrometer.
• In the **VSM-1000-MICRO-B** model, the optical head can be detached and used as a standard vibrometer with fixed working distance (that can be selected by the customer at the time of order, the standard fixed working distance is 400mm)
• In the **VSM-1000-MICRO-PLUS** model, the optical head can be detached and used as a standard vibrometer with full working distance from 0.1 m to 5 m.

3D Laser Vibrometer

The **VSM-3D** Laser Vibrometer solves the problem encountered when the vibration of a point of the target needs to be measured in its three orthogonal components (X, Y and Z). In fact, the principle of laser vibrometry allows to measure only the vibration component projected along the propagation direction of the laser beam. Thus, for a measurement of the X, Y and Z vibration components, the vibration must be measured simultaneously using three Laser Vibrometers, aiming at the same point from three different directions.

The **VSM-3D** Laser Vibrometer features three compact laser vibrometer heads mounted onto a mechanical structure, equipped with manual tip-tilt micropositioners, that allow an easy alignment of the three laser beams onto the same point. The vibration signals measured by the three vibrometers are internally input to an analogue electronic board that, based on the geometry of the system, generates the **X, Y and Z output vibration signals in real-time and zero-delay**.
Two pre-set, fixed working distance for the XYZ mode are allowed, to be chosen by the customer at the time of order in the range between 0.25 m and 1.0 m.
The three heads of the **VSM-3D** can also be used as **three independent laser vibrometers** with working distance from 0.1 m to 5 m, thus adding great versatility of use, and increasing the value for money for the customer.

Scanning Laser Vibrometer

The **VSM-1000-SCAN** Laser Vibrometer uses a **state-of-the-art two-axis galvanometer** deflection scanning system for the laser beam, that allows to perform the full-field vibration analysis of a large object. It has the smallest (in terms of volume and weight) optical head available on the market for scanning vibrometers.
The scanning vibrometer is remotely controlled by a PC through a dedicated software with a graphical interface showing the picture of the object under test captured by a **HD color camera** (13MP). The user can select the points to be measured directly on the camera picture, or they can be imported from a pre-saved file.

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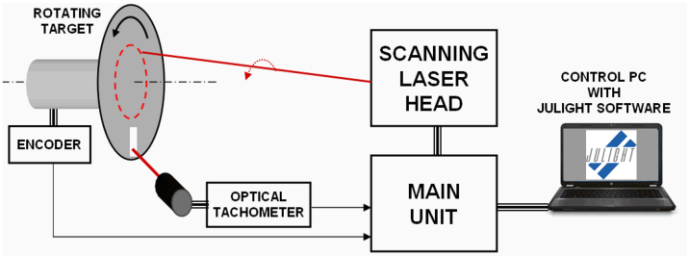
A laser telemeter, integrated into the optical head, performs precise distance measurement, and to implements the **Geometry 3D Scan** mode, that acquires the 3D shape of the object under test (distance resolution: 0.2 mm).
Automatic or manual scanning of the selected points can be performed, and a synchronization digital electrical output signal is available to sync with an external DAQ for vibration signal acquisition.
These options are available:
• extended frequency range (-MHZ, -MHZPLUS) from 20 kHz up to 25 MHz
• maximum measurable distance up to 50 m
Typical applications include:
• Full-field non-contact measurement of vibrations
• Modal analysis - ODS (Operational Deflection Shapes), EMA (Experimental Modal Analysis), OMA (Operational Modal Analysis)
The modal analysis data visualization can be obtained using a third-party software, that takes as input the time-domain or FFT data saved by the DAQ during the scan.

Rotation-Tracking option

The **VSM-1000-SCAN** Laser Vibrometer can be equipped with the **Rotation-Tracking option** (-TRACK) for the measurement of the vibration of rotating targets, such as: discs, wheels, fans, turbines. The tracking of a point of the rotating object is obtained by fast-driving the mirrors of the two-axis galvanometer scanner in real-time, so that the laser beam always aims at the same identical point on the rotating surface. This configuration can be implemented thanks to the small size and fast response of the galvanometers, and it does not require a complex and expensive rotating Dove prism (optical de-rotator).



Accurate tracking of the rotating point is obtained through a combination of Julight control software and a dedicated electronic hardware that takes as input the signals (A,B,Z) from an encoder or from a tachometer (a versatile **optical tachometer VSM-1000-TACHO** manufactured by Julight is also available). The system accurately synchronizes the movement of the laser beams along a circular trajectory, in-phase with the rotating object.
A tripod with precision micropositioners (X-Y + angular) is supplied to achieve the alignment between the axis of rotation and the central optical axis of the scanning laser head. The alignment procedure is easy and assisted by the software.
The maximum rotating speed is 10,000 rpm, and rotational speed variations within a single turn can be tracked thanks to the accurate real-time synchronization

3D Scanning Laser Vibrometer

The **VSM-3D-SCAN** Laser Vibrometer performs 3D vibration measurements with scanning capability. It combines three scanning Laser Vibrometer heads, each connected to its corresponding main electronic unit. The dedicated PC software allows full and easy control of the three heads, allowing the three laser beams to be directed automatically onto the measuring point of the target surface chosen by the user from the graphical interface, that includes a live image of the working area.

The vibration signals measured by the three heads are internally combined by a programmable analogue electronic board that produces in **real-time with zero delay the X, Y, and Z vibration signals**. Aiming of the three lasers onto a single point, and the automatic calculation of the X, Y, and Z vibration are based on proprietary algorithms developed by Julight engineers, that are based on the smart use of the distance measurements performed by the three laser telemeters integrated in the optical heads, from which the real geometric parameters are calculated.
The system requires a few, simple steps for the geometry calibration, fully assisted by the software guidance.
The three vibrometer units can also be used independently as **three separate VSM-1000-SCAN scanning vibrometers**, thus providing great versatility to the system.

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SINGLE FIXED-POINT LASER VIBROMETERS

MODEL	VSM-1000 VSM-1000-LL10m -LL20m, -LL30m, -LL50m -LL100m	VSM-1000-LL20m -EXTRA-LARGE	VSM-1000-UW1 VSM-1000-UW2
Short description	fixed-point standard and long-distance	Long-distance, working on untreated surfaces up to 20 m, fast autofocus	For through-water and underwater application
Working distance	0.1 ÷ 5 m | 0.1 ÷ 10 m (**-LL10m**) 0.1 ÷ 20 m (**-LL20m**) | 0.1 ÷ 30 m (**-LL30m**) 0.1 ÷ 50 m (**-LL50m**) | 0.1 ÷ 100 m (**-LL100m**)	0.4 ÷ 20 m	0.1 ÷ 5 m
Laser safety class	Visible pointer (red/green): Cl. 2 Measuring laser (IR): Cl. 1		Visible pointer (red): Cl. 2 Measuring laser (IR): Cl. 3B
Laser radiation	Vis. pointer (collimated): < 1 mW @ 650 nm (green laser, < 1mW @ 530nm available upon request) Measuring laser (focused): < 10 mW @ 1550 nm		Pointer (collimated):< 1 mW @ 650 nm (green laser, < 1mW @ 530nm available upon request) Measuring laser (focused): **UW1** < 15 mW @ 785 nm **UW2** < 15 mW @ 650 nm
Maximum travel length in water[1)]	0.0 m[2)]		0.5 m (UW1) 2.0 m (UW2)
Maximum distance for operation on untreated surface[3),4)]	3.5 m (typ.)	20.0 m (typ.)	1.5 m (typ.)
Measurable vibration frequencies | Max. vibration amplitude | Max. measurable velocity	from DC to 100 kHz|20 mm p-p|2 m/s	from DC to 100 kHz | 20 mm p-p | 1.75 m/s	
	with -MHZ/-MHZPLUS option (rear panel BNC connector output): from 20 kHz to 10/25 MHz | 4 µm p-p | 40 m/s **-VELDECODER option:** - velocity decoder for SMI Doppler signal | - sensitivities: 0.1 V/(m/s) ; 1.0 V/(m/s) | - maximum target velocity: +/- 50 m/s **-HS option (postprocessing):** max displacement +/-1m | max velocity +/-10m/s		
Output signal sensitivity | Noise Equivalent Displacement - NED (@200 mm distance, @10 kHz) [5)]	0.5 V/mm | <100 pm/√Hz 2.0 V/mm | <100 pm/√Hz 10 V/mm | <1 pm/√Hz 40 V/mm | <1 pm/√Hz	1.0 V/mm | <100 pm/√Hz 4.0 V/mm | <100 pm/√Hz 20 V/mm | <1 pm/√Hz 80 V/mm | <1 pm/√Hz	1.0 V/mm | <100 pm/√Hz 4.0 V/mm | <100 pm/√Hz 20 V/mm | <1 pm/√Hz 80 V/mm | <1 pm/√Hz
	with -MHZ/-MHZPLUS option (rear panel BNC connector output):		
	1 V/µm | <5 pm/√Hz	2 V/µm | <2 pm/√Hz	2 V/µm | <2 pm/√Hz
	with -MULTRANGE option: Displacement: from +/- 1um to +/- 1m | Velocity: from +/- 1um/s to +/- 50m/s		
Output signal accuracy	1% for frequency range from DC to 100 kHz 5% for frequency range from 20 kHz to 10 MHz		
Spatial transverse resolution (diameter of measuring laser spot)	90 µm @ 0.1 m - 0.2 m 500 µm @ 1 m 2.5 mm @ 5 m 5 mm @ 10 m (-LL10,20,30) 10 mm @ 20 m (-LL20,30) 15 mm @ 30 m (-LL30) 25 mm @ 50 m (-LL50) 50 mm @ 100 m (-LL100)	30 µm @0.1 m - 0.2 m 100 µm @1 m 300 mm @5 m 2 mm @20 m	90 µm @0.1 m - 0.2 m 150 µm @0.4 m 500 µm @1 m 2.5 mm @ 5 m
Optical Head weight	0.5 kg	1.5 kg	0.5 kg
temperature range (optical head)	Standard: from +5° C to +65°C		
	with -COLD option [6)] **:** from -20° C to +65°C		
	FOR SPECIAL NEEDS, ON REQUEST, ALL MODELS CAN BE CUSTOMIZED, FROM THE SHAPE AND SIZE OF THE OPTICAL HEADS, TO THE IMPROVEMENT OF PERFORMANCE		

1) The target can be submerged, or it can be in air while the laser beam travels through a water thickness. See IP68 option for submersible optical head.
2) The radiation at 1300 nm is strongly absorbed by water: travel of the laser beam through a few mm of water can disrupt the measurement.
3) Beyond this distance, the use of retroreflective target (adhesive paper, painting, etc.) is recommended.
4) Maximum distance for operation on untreated surface strongly depends on the type of surface; see operating manual for further details.
5) For longer working distance the NED is increased by the following factors: @5 m: x10; @10 m: x20; @30 m: x25; @50 m: x50; @100 m: x100
6) with -COLD option, an electric heater is included inside the optical head, to keep it at a temperature that prevents forming of ice and/or aqueous vapor on the output glass window.

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MICROSCOPE LASER VIBROMETERS

MODEL	VSM-1000-MICRO-A	VSM-1000-MICRO-B	VSM-1000-MICRO-PLUS
Short description	Microscope-coupled laser vibrometer	Microscope-coupled & fixed-distance standard laser vibrometer	Microscope-coupled & standard laser vibrometer
Working distance (microscope mode)	5x objective (**option**): 37.5 mm 10x objective (standard): 30.5 mm 20x objective (**option**): 20.0 mm 50x objective (**option**): 17.0 mm		
Working distance (standard mode) [1)]	Not available	0.4 m (or, another distance specified by the customer at the time of order)	0.1 ÷ 5 m
Laser safety class	Visible pointer (red/green): Class 2 Measuring laser (IR): Class 1		
Laser radiation	Visible pointer (collimated): < 1 mW @ 650 nm (green laser, < 1mW @ 530nm available upon request) Measuring laser (collimated/focused): < 15 mW @ 1310 nm		
Max. vibration amplitude (microscope mode)	5x objective (**option**): 1 mm 10x objective (standard):0.5 mm 20x objective (**option**): 0.35 mm 50x objective (**option**): 0.2 mm		
Measurable vibration frequencies | Max. vibration amplitude | Max. measurable velocity	from DC to 100 kHz | 2 mm p-p | 1.75 m/s **with -MHZ/-MHZPLUS option** (rear panel BNC connector output)**:** from 20 kHz to 10/25 MHz | 4 µm p-p | 40 m/s **-VELDECODER option:** velocity decoder for SMI Doppler signal | sensitivities: 0.1 V/(m/s); 1.0 V/(m/s) | maximum target velocity: +/- 50 m/s **-HS option (postprocessing):** max displacement +/-1m | max velocity +/-10m/s		
Output signal sensitivity | Noise Equivalent Displacement - NED (microscope mode)	0.5 V/mm | <100 pm/√Hz 2.0 V/mm | <100 pm/√Hz 10 V/mm | <1 pm/√Hz 40 V/mm | <1 pm/√Hz **with -MHZ/-MHZPLUS option** (rear panel BNC connector output)**:** 1 V/µm | <5 pm/√Hz		
Output signal accuracy	1% for frequency range from DC to 100 kHz 5% for frequency range from 20 kHz to 25 MHz		
Spatial transverse resolution (diameter of measuring laser spot, microscope mode)	5x objective (**option**): 10 µm 10x objective (standard):6 µm 20x objective (**option**): 4 µm 50x objective (**option**): <3 µm		
Camera resolution	1440 (H) x 1080 (V) (~1.6 MP)		
Camera field of view | pixel resolution	**5x objective (option):** 3.3 mm x 2.6 mm | 2.6 µm 10x objective (standard): 1.6 mm x 1.3 mm | 1.4 µm **20x objective (option):** 0.82 mm x 0.65 mm | 0.8 µm **50x objective (option):** 0.33 mm x 0.26 mm | 0.4 µm		
Optical Head Weight	0.5 kg		
Microscope Module Weight	2 kg		
temperature range (optical head)	Standard: from +5° C to +65°C		
	FOR SPECIAL NEEDS, ON REQUEST, ALL MODELS CAN BE CUSTOMIZED, *FROM THE SHAPE AND SIZE OF THE OPTICAL HEADS, TO THE IMPROVEMENT OF PERFORMANCE*		

1) For models VSM-MICRO-B and VSM-MICRO-PLUS the laser optical head can be detached from the microscope structure, and it can be used as a standard laser vibrometer. For specification related to standard laser vibrometer mode, please refer to the model VSM-1000.

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SINGLE-POINT 3D LASER VIBROMETERS

MODEL	VSM-3D
Short description	System composed of THREE single-point vibrometer heads aimed at the same point on the target surface, for simultaneous 3-axis vibration measurements [1]
Working distance [2]	to be chosen by customer from 0.25 m to 1 m upon order (Standard: 250 and 500 mm)
Laser safety class	Visible pointer (red/green): Class 2 Measuring laser (IR): Class 1
Laser radiation (for each optical head)	Visible pointer (collimated): < 1 mW @ 530 or 650 nm (green laser, < 1mW @ 530nm available upon request) Measuring laser (focused): < 15 mW @ 1310 nm or < 10 mW @ 1550 nm
Measurable vibration frequencies | Max. vibration amplitude | Max. measurable velocity	from DC to 100 kHz | 20 mm p-p | 2 m/s **with -MHZ/-MHZPLUS option** (rear panel BNC connector output)**:** from 20 kHz to 25 MHz|4 µm p-p|40 m/s **-VELDECODER option:** - velocity decoder for SMI Doppler signal - sensitivities: 0.1 V/(m/s) ; 1.0 V/(m/s) - maximum target velocity: +/- 50 m/s
Output signal sensitivity | Noise Equivalent Displacement - NED (@250 mm working distance, @10 kHz)	0.5 V/mm | <100 pm/√Hz 2.0 V/mm | <100 pm/√Hz 10 V/mm | <1 pm/√Hz 40 V/mm | <1 pm/√Hz **with -MHZ/-MHZPLUS option** (rear panel BNC connector output)**:** 1 V/µm | <25 pm/√Hz
X, Y and Z Output signal accuracy	1% for frequency range from DC to 100 kHz 5% for frequency range from 20 kHz to 25 MHz
Spatial transverse resolution (diameter of measuring laser spot)	90 µm @ 0.1 m - 0.2 m 500 µm @ 1 m 2.5 mm @ 5 m
transverse superposition error of the three lasers	< 5 mm
temperature range (optical head)	Standard: from +5° C to +65°C **with -COLD option [3] :** from -20° C to +65°C
	FOR SPECIAL NEEDS, ON REQUEST, ALL MODELS CAN BE CUSTOMIZED, FROM THE SHAPE AND SIZE OF THE OPTICAL HEADS, TO THE IMPROVEMENT OF PERFORMANCE

1) The measurement is performed simultaneously by three laser heads that are aimed at the same point on the target surface from different angles. Each laser vibrometer measures the target vibration component along its laser beam direction, while the real-time calculation of the vibration along the X, Y, and Z orthogonal axes is done by a specifically designed analog electronic module.

2) The optical heads are mounted on a suitable 3D structure, with precision angular tip-tilt micro-positioners for manual alignment of the laser beams (that must be aligned for working at the defined distance). A central reference aiming visible laser beam helps in the superposition of the three laser spots. The three laser optical heads can be detached from the 3D structure and used as separate and independent standard single-point laser vibrometers. For specification related to standard laser vibrometer mode, please refer to the VSM-1000 model.

3) with -COLD option, an electric heater is included inside the optical head, to keep it at a temperature that prevents forming of ice and/or aqueous vapor on the output glass window.

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SCANNING LASER VIBROMETERS

MODEL	VSM-1000-SCAN VSM-1000-SCAN-LL10m -LL20m, -LL30m, -LL50m, -LL100m
Short description	Scanning laser vibrometer, standard working distance
Working distance	0.1 ÷ 5 m | 0.1 ÷ 10 m (**-LL10m**) 0.1 ÷ 20 m (**-LL20m**) | | 0.1 ÷ 30 m (**-LL30m**) 0.1 ÷ 50 m (**-LL50m**) |0.1 ÷ 100 m (**-LL100m**)
Laser safety class	Visible pointer (red/green): Class 2 Measuring laser (IR): Class 1
Laser radiation	Visible pointer (collimated): < 1 mW @ 650 nm (green laser, < 1mW @ 530nm available upon request) Measuring laser (focused): < 10 mW @ 1550 nm
Maximum travel length in water[1)]	0.0 m[1).2)]
Maximum distance for operation on untreated surface[3),4)]	2.0 m (typ.)
Measurable vibration frequencies | Max. vibration amplitude | Max. measurable velocity	from DC to 100 kHz | 20 mm p-p | 2 m/s (Class 1), 1.75 m/s (Class 3B) **with -MHZ/-MHZPLUS option** (rear panel BNC connector output)**:** from 20 kHz to 10/25 MHz | 4 µm p-p | 40 m/s **-VELDECODER option:** - velocity decoder for SMI Doppler signal - sensitivities: 0.1 V/(m/s) ; 1.0 V/(m/s) | maximum target velocity: +/- 50 m/s -**HS option (postprocessing):** max displacement +/-1m | max velocity +/-10m/s
Output signal sensitivity | Noise Equivalent Displacement - NED (@200 mm distance, @10 kHz) [5)]	0.5 V/mm | <100 pm/√Hz 2.0 V/mm | <100 pm/√Hz 10 V/mm | <1 pm/√Hz 40 V/mm | <1 pm/√Hz
	with -MHZ/-MHZPLUS option (rear panel BNC connector output): 1 V/µm | <5 pm/√Hz
	with -MULTRANGE option: Displacement: from +/- 1um to +/- 1m | Velocity: from +/- 1um/s to +/- 50m/s
Output signal accuracy	1% for frequency range from DC to 100 kHz 5% for frequency range from 20 kHz to 25 MHz
Spatial transverse resolution (diameter of measuring laser spot)	90 µm @0.1 m - 0.2 m , 150 µm @0.4 m 500 µm @1 m, 2500 µm @5 m 5 mm @ 10 m (-LL10,20,30,50,100), 10 mm @ 20 m (-LL20,30,50,100) 15 mm @ 30 m (-LL30,50,100), 25 mm @ 50 m (-LL50,100) 50 mm @ 100 m (-LL100)
Autofocus	Fast, assisted by laser telemeter
Laser telemeter resolution (1σ)	<0.1 mm @ <1 m distance | <0.3 mm @ <5 m distance
Camera	13 MPixels CMOS camera with autofocus, digital zoom: up to 50x **With -ZOOMCAM option (central camera only):** 2 MPixels CMOS camera with Optical zoom x10, digital zoom: up to 50x
Max. Scanning Points	1024x1024
Scan angle	50° x 50°
Maximum scan rate	up to 10 pts/s (with Windows SW control) up to 150 pts/s (with direct Galvanometer programming)
Angular resolution | stability	0.001° | <0.001 /h
temperature range (optical head)	Standard: from +5° C to +65°C
	FOR SPECIAL NEEDS, ON REQUEST, ALL MODELS CAN BE CUSTOMIZED, *FROM THE SHAPE AND SIZE OF THE OPTICAL HEADS, TO THE IMPROVEMENT OF PERFORMANCE*

1) All the models can be supplied with laser wavelength 765-785 nm (barely visible by the naked eye, well visible with a camera), Class 3B laser source. The target can be submerged, or it can be in air while the laser beam travels through a water thickness.
2) The radiation at 1550 nm is strongly absorbed by water: travel of the laser beam through a few mm of water can disrupt the measurement.
3) Beyond this distance, the use of retroreflective target (adhesive paper, painting, etc.) is recommended.
4) Maximum distance for operation on untreated surface strongly depends on the type of surface; see operating manual for further details.
5) For longer working distance the NED is increased by the following factors: @0.4 m: x1.5; @1 m: x3; @2 m: x4; @5 m: x10; @10 m: x20; @30 m: x25; @50 m: x50

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SCANNING 3D LASER VIBROMETER

MODEL	VSM-3D-SCAN VSM-3D-SCAN-LL10M
Short description	Scanning laser vibrometer for 3D full-field vibration measurement, composed of THREE single-point scanning laser vibrometer heads aimed at the same points on the target [1)]
Working distance	0.2 0.1 - 5 m | 0.1 ÷ 10 m (**-LL10m**)
Laser safety class (each scanning laser head)	Visible pointer (red/green): Class 2 Measuring laser (IR): Class 1
Laser radiation	Visible pointer (collimated): < 1mW@ 650nm (green laser, < 1mW @ 530nm available upon request) Measuring laser (focused): < 10mW@1550nm
Maximum distance for operation on untreated surface [2), 3)]	2.0 m (typ.)
Measurable vibration frequencies | Max. vibration amplitude | Max. measurable velocity	from DC to 100 kHz | 20 mm p-p | 2 m/s **with -MHZ/-MHZPLUS option (rear panel BNC connector output):** from 20 kHz to 10/25 MHz | 4 µm p-p | 40 m/s
	-VELDECODER option: - velocity decoder for SMI Doppler signal - sensitivities: 0.1 V/(m/s) ; 1.0 V/(m/s) - maximum target velocity: +/- 50 m/s
	-HS option (postprocessing): max displacement +/-1m | max velocity +/-10m/s
Displacement resolution	Better than 1 pm
Velocity Resolution	Better than 0.008 µm/s/√Hz
Output signal sensitivity | Noise Equivalent Displacement - NED (@200 mm distance, @10 kHz) [4)]	0.5 V/mm | <100 pm/√Hz 2.0 V/mm | <100 pm/√Hz 10 V/mm | <1 pm/√Hz 40 V/mm | <1 pm/√Hz
	with -MHZ/-MHZPLUS option (rear panel BNC connector output): 1 V/µm | <5 pm/√Hz
	with -MULTRANGE option: Displacement: from +/- 1um to +/- 1m | Velocity: from +/- 1um/s to +/- 50m/s
Output signal accuracy	1% for frequency range from DC to 100 kHz 5% for frequency range from 20 kHz to 10 MHz
Spatial transverse resolution (diameter of measuring laser spot)	90 µm @ 0.1 m - 0.2 m | 150 µm @ 0.4 m 500 µm @ 1 m | 2500 µm @ 5 m
transverse superposition error of the three lasers	< 5mm @ working distance < 1m < 10mm - @ working distance < 5m
Autofocus	Fast, assisted by laser telemeter
Laser telemeter resolution (1σ)	< 0.1 mm @ < 1 m distance < 0.3 mm @ < 5 m distance
Camera	13 MPixels CMOS camera with autofocus, digital zoom: up to 50x **With -ZOOMCAM option (central camera only):** 2 MPixels CMOS camera with Optical zoom x10, digital zoom: up to 50x
Max. Scanning Points	1024x1024
Scan angle	50° x 50°
Maximum scan rate	up to 10 pts/s (with Windows SW control) up to 150 pts/s (with direct Galvanometer programming)
Angular resolution | stability	0.001° | <0.001 /h
temperature range (optical heads)	Standard: from -25°C to +65°C(storage) Standard: from 0°C to +40°C(operation)
	FOR SPECIAL NEEDS, ON REQUEST, ALL MODELS CAN BE CUSTOMIZED, FROM THE SHAPE AND SIZE OF THE OPTICAL HEADS, TO THE IMPROVEMENT OF PERFORMANCE

1) The measurement is performed simultaneously by three laser heads that are aimed at the same point on the target surface. Each laser vibrometer measures the target vibration component along its laser beam direction, while the real-time calculation of the vibration along the X, Y, and Z orthogonal axes is done by a specifically designed analog electronic module. The three scanning laser optical heads can be detached from the 3D structure and used as separate and independent standard single-point laser vibrometers. For specification related to standard laser vibrometer mode, please refer to the VSM-1000-SCAN model.
2) Beyond this distance, the use of retroreflective target (adhesive paper, painting, etc.) is recommended.
3) Maximum distance for operation on untreated surface strongly depends on the type of surface; see operating manual for further details.
4) For longer working distance the NED is increased by the following factors: 1.5 @ 0.4 m, 3 @ 1 m, 4 @ 2 m, 10 @ 5 m, 20 @ 10 m, 25 @30 m, and 50 @50 m.

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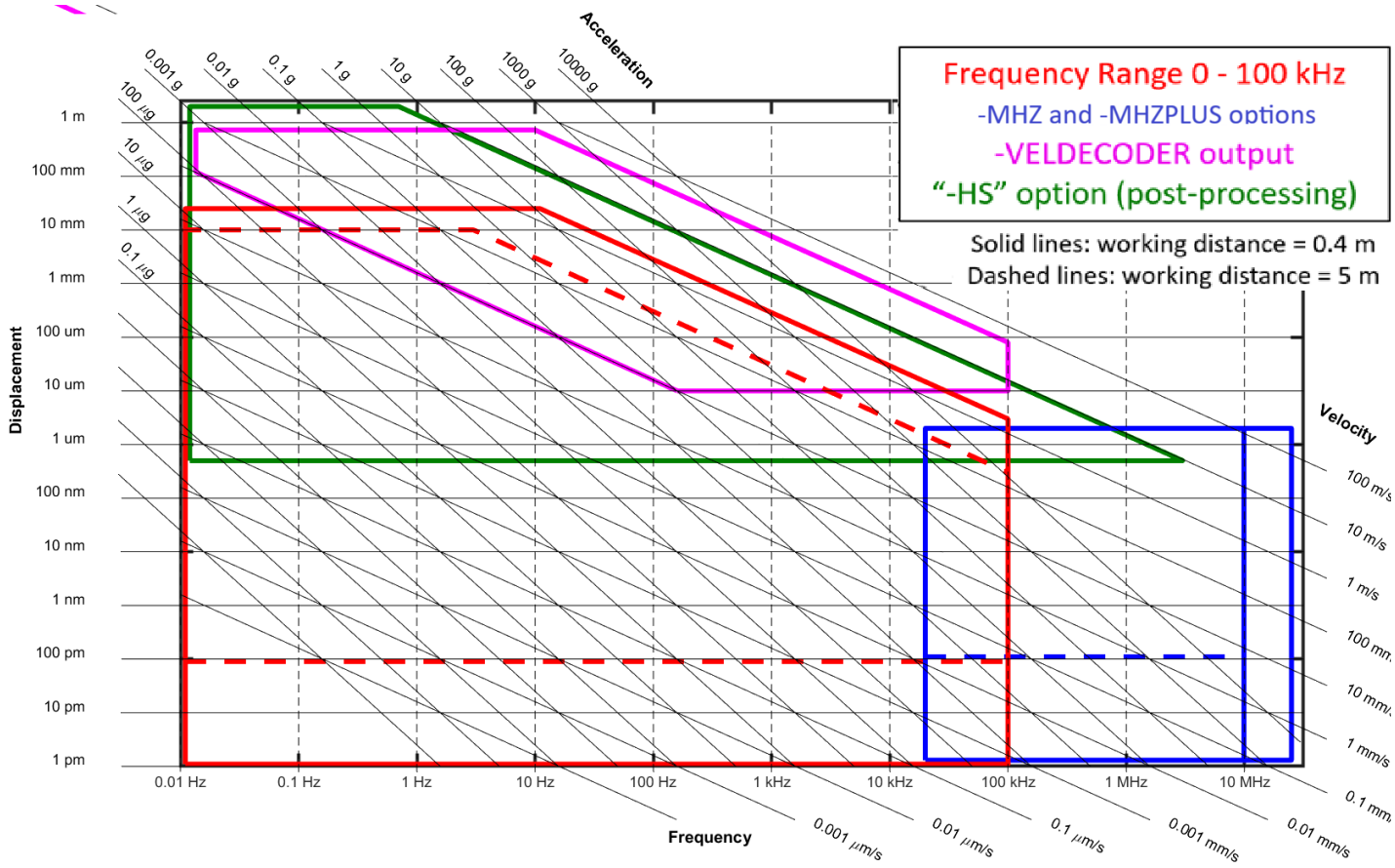
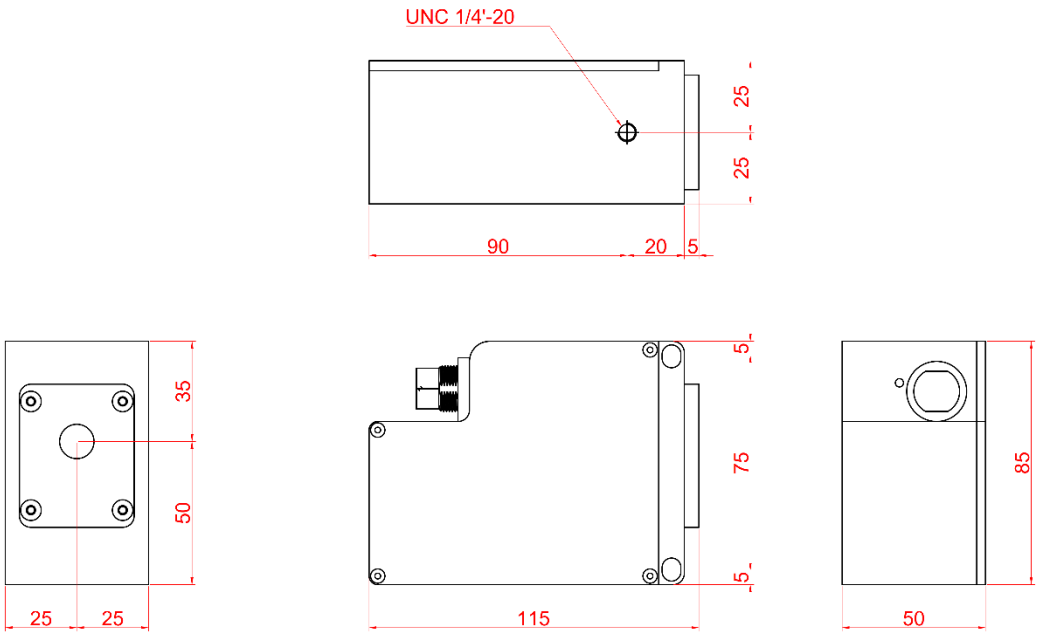
MEASURABLE VIBRATIONS





VSM-1000 laser head

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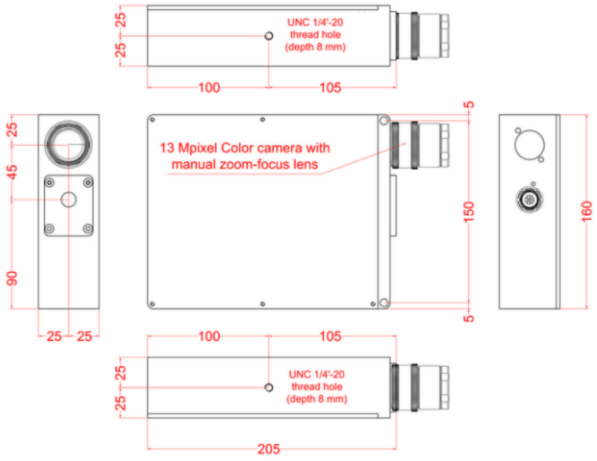

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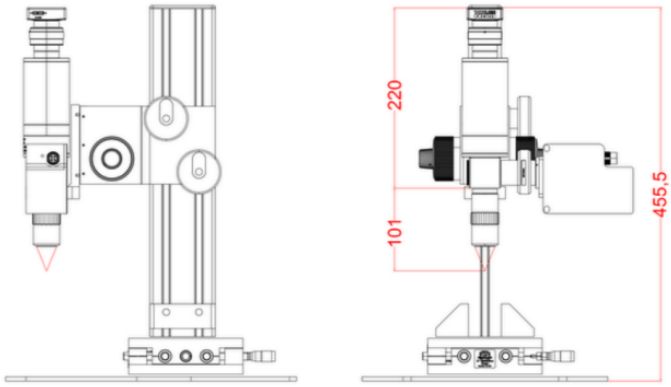
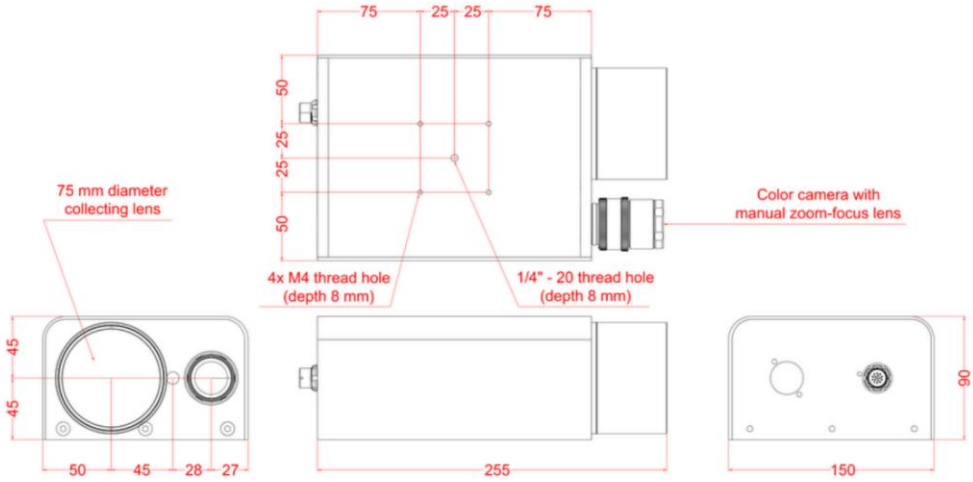
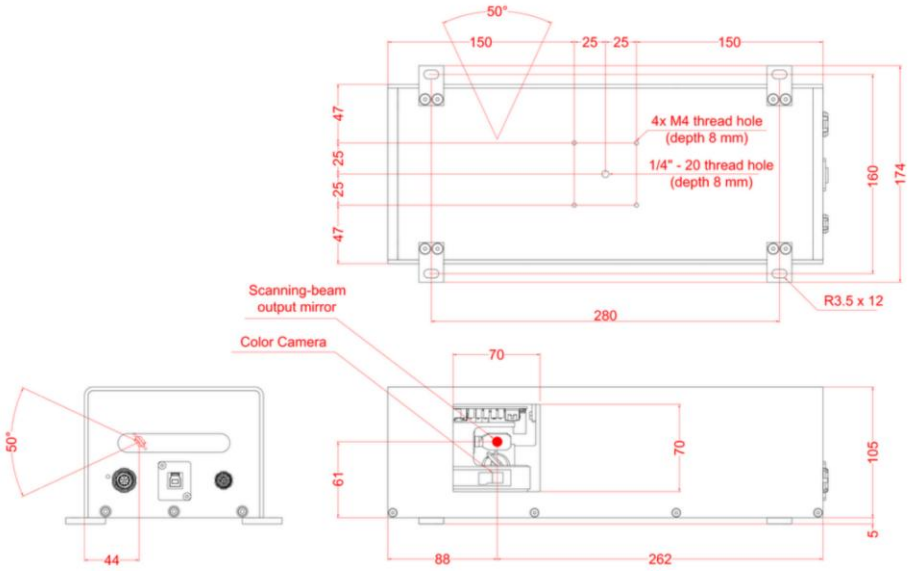


VSM-1000-MICRO
Microscope module and laser head



VSM-1000-EXTRA-LARGE laser head



VSM-1000-SCAN laser head

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