VSM-4000LL-3D-SCAN-TRACK-EXT

3D SCANNING LASER VIBROMETER with ROTATION-TRACKING

- **SCANNING VIBROMETER FOR FULL-FIELD 3D VIBRATION MEASUREMENT ON LARGE OBJECTS**
- **CLASS 2 LASER**
- **FAST AUTOFOCUS**
- **ROTATION-TRACKING OPTION UP TO 20000RPM**
- **SELF-MIXING INTERFEROMETRIC CONFIGURATION**
- **3X LASER TELEMETERS FOR 3D GEOMETRY MEASUREMENT**
- **FREQUENCY RANGE FROM DC TO 100 KHZ (EXTENDED TO 3 MHZ)**
- **EASY AND AUTOMATIC ALIGNMENT OF THE THREE OPTICAL HEADS**

3D SCANNING LASER VIBROMETER

The Julight Laser Vibrometer VSM-4000LL-3D-SCAN-TRACK-EXT **combines three individual 2D scanning laser vibrometer heads**, each equipped with a state-of-the-art two-axis galvanometer mirror system for deflection and scanning of the laser beam. The VSM-4000LL-3D-SCAN-TRACK-EXT allows to perform the full-field 3D vibration and modal analysis of a large object without contact. Operating distance is up to 1.2m (or 11m for -L option). For distance larger than 2m, the use of retroreflective tape is recommended.

The system is managed by a proprietary PC software that simultaneously controls the three scanning heads, so that the three laser beams hit the same point of the target.

A dedicated, high-precision fully-analog electronic circuit board calculates in real time the exact vibration components along the X, Y, and Z directions, starting from the raw vibration signals A, B, and C measured by the three lasers. Thus, the electrical output signals are a replica of the target displacement or velocity components along the X, Y, and Z axes, in a frequency range from DC to 100 kHz (or from DC to 3 MHz with "-EXT, extended frequency" option).

APPLICATIONS

- Full-field 3D non-contact vibrations measurement
- Automotive, aerospace, and mechanical industry
- Modal analysis

PRINCIPLE OF OPERATION

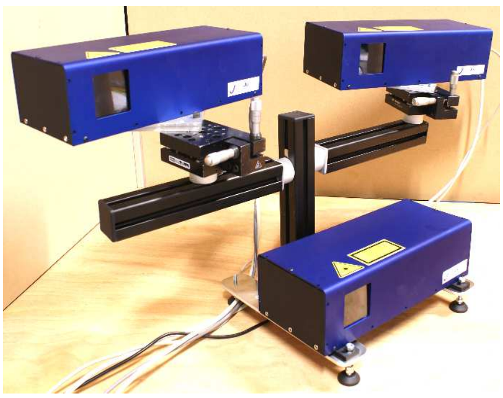
Julight Laser Vibrometers use state-of-the-art diode semiconductor lasers, and are based on the novel self–mixing interferometric scheme, that exploits the coherent interference of the backscattered light directly into the laser, allowing for greatly simplified optical design and the smallest, most lightweight, optical heads on the market.

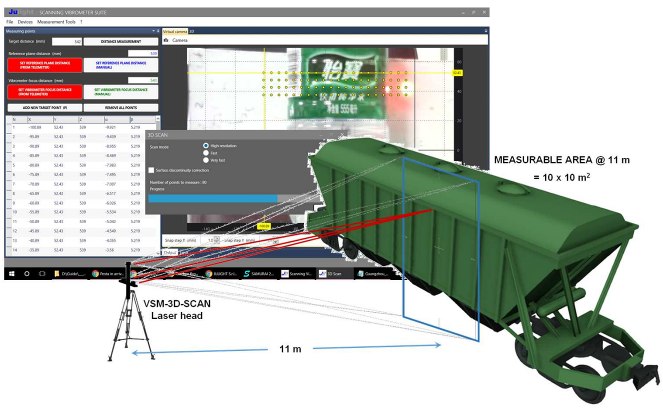
FEATURES FOR 2D/3D SCAN SYSTEM

- **HD Video Camera** – The object under test can be viewed on the PC through a HD color camera integrated into the optical head, with 96X zoom. The user can select the measuring points on the image of the object.
- **Geometry 3D Scan** – A scanning laser telemeter is integrated in each optical head, to acquire the 3D profile of the object under test with high accuracy. This feature greatly simplifies the alignment of the three laser beams for 3D vibration measurements, for which the user must not do any manual alignment.

Each of the three scanning vibrometer units can also be used independently as a 2D scanning system.

An external data acquisition system is required to store and analyse vibration time series.





VSM-4000LL-3D-SCAN-TRACK-EXT optical heads (left). PC software and measurable area (right)

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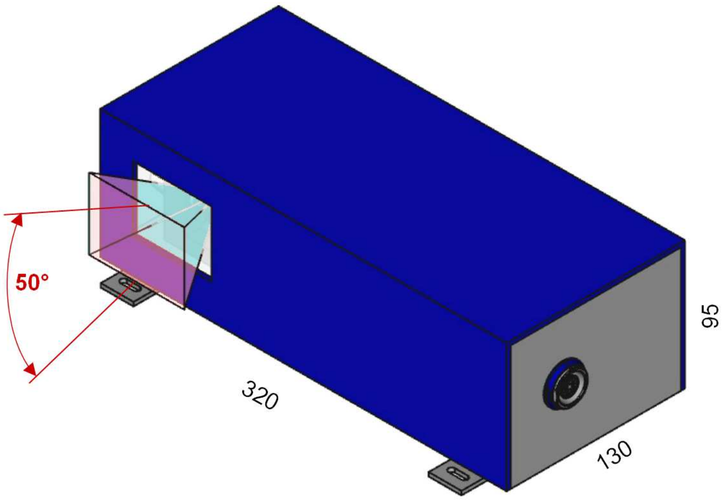
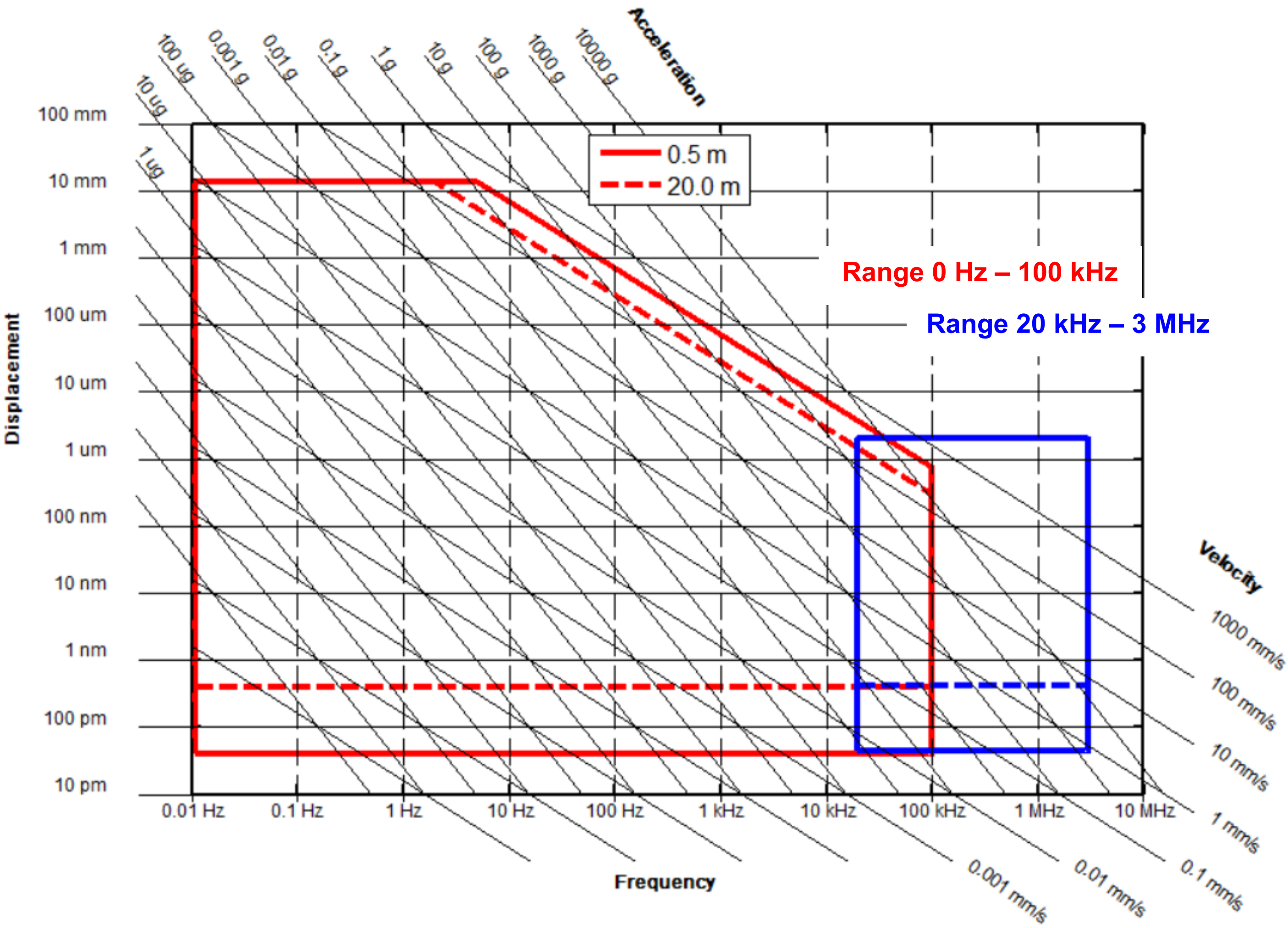
VISIBLE AND INVISIBLE
LASER RADIATION
DO NOT STARE INTO THE BEAM
CLASS 2 LASER PRODUCT
λ = 650 ± 10 nm ; P max. < 1 mW
λ = 1310 ± 10 nm ; P max. < 15 mW
(according to IEC 60825-1:2007)

SINGLE LASER HEAD DIMENSIONS
(in mm)



MEASURABLE VIBRATIONS



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FULL MODAL ANALYSIS CAPABILITY

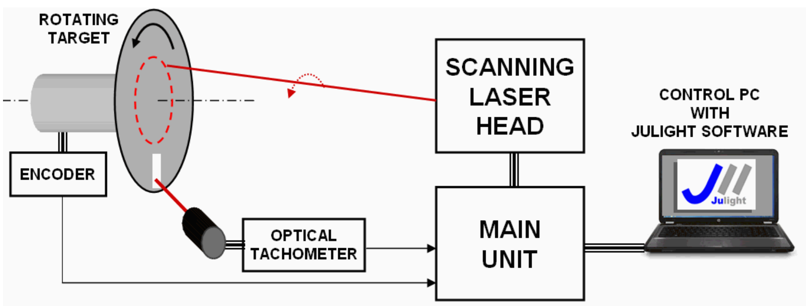
Julight Laser Vibrometer VSM-4000LL-3D-SCAN-TRACK-EXT allows complete Modal Analysis tests, yielding as output the 3D ODS (Operational Deflection Shapes).
For laboratory experiments where the vibration of the object under test is forced by the user, the three lasers of the VSM-3D-SCAN allow to obtain the 3D EMA (Experimental Modal Analysis).
Instead, for in-the-field experiments, where the vibration of the object under test is not forced and is intrinsic or naturally generated, an additional single-point Laser Vibrometer head (OH-1000-L) can be used as reference channel for the three lasers of the VSM-3D-SCAN. In this way the OMA (Operational Modal Analysis) can be obtained.

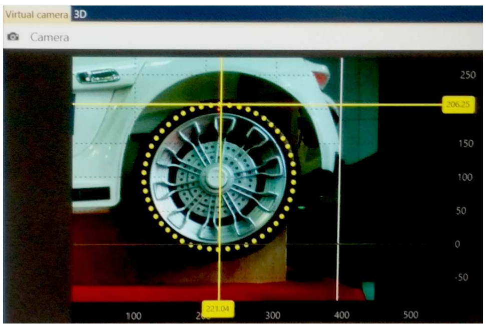
OPTIONAL 2D/3D ROTATION TRACKING

Julight Scanning Laser Vibrometers (both 2D and 3D) 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 driving the mirrors of the two-axis galvanometer scanner in real-time, in such a way that the laser beam(s) always aim at the same identical point on the rotating surface.
The rotation-tracking does not require a complex and expensive rotating prism (optical de-rotator), hence it can be efficiently done also for 3D vibration measurements, with the three lasers aiming at the same point of the rotating surface, from three different angles of incidence.

PRINCIPLE OF ROTATION-TRACKING

Rotation-Tracking is obtained through a combination of the Julight PC control software and a dedicated electronic hardware/sensor (Julight non-contact optical tachometer SNS-1000-TACHO, or third-party tachometer, or third-party encoder). The system receives as input a signal from the encoder or tachometer, and it accurately synchronizes the movement of the laser beams along a circulr trajectory, in-phase with the rotating object. The user can choose the position of the point to be tracked along two directions, i.e. radial direction and tangential direction. The latter is achieved by changing the value of the tracking phase from 0° to 360°. Different points can be tested in sequence within a single mesurement session, thus fully exploiting the 3D scanning capability of the system also for the case of rotating targets. The obtained result from the rotation-and-scanning vibration measurement is similar to the case when the rotating object is at rest. The different points to be measured during the rotation-tracking scanning session are identified from the image at rest of the object, provided by the camera integrated within each optical head.
The principle of the rotation-tracking is based on a circular trajectory for the scanned laser beams, that is implemented automatically by the software according to the rotational speed of the object under test (deducted from the encoder or tachometer input signal), and the circle drawn by the user in the camera window of the Julight control software. A pre-run test function allows the user to check that the projected beam(s) is(are) correctly positioned onto the object under test. As for all rotation-tracking laser systems, the Julight 3D scanning vibrometer requires a mechanical alignment procedure to be carried out by the user. During this operation, the user is guided by the on-line and real-time instructions from the software.
For cases where the instantaneous rotational speed of the rotating object is not constant (ramp-up and coast-down regimes), the Julight system can track rotational speed variations within a single turn, by accurate synchronization in real-time to the angle signal from the encoder. This feature (that cannot be obtained by an optical de-rotator system due to its large inertial mass) can be obtained by the Julight system, thanks to the use of high-speed state-of-the-art galvanometer mirrors.
The Rotation-Tracking option can equip one of the three 2D scanning optical heads, or all the three of them. In the latter case, the system acts as a full 3D-scanning rotation-tracking laser vibrometer.
For rotating experiments where there is not an external, user-defined excitation, i.e. OMA (Operational Modal Analysis), an optional additional laser vibrometer head can be added to the system to provide a reference vibration signal for the subsequent 2D or 3D scanning vibration measurements. Two options are available: i) aim the reference laser to a fixed position at the center of the rotating object; ii) use a 2D scanning head with rotation-tracking option that tracks the same identical rotating point, while the scanning laser(s) perform the measurement on different points of the rotating object.
An optional DSLR (Digital, Single-Lens Reflex) camera with speedlight, by Nikon™ or Canon™, can be included in the system, with the goal of taking an ultra-fast snapshot at the rotating object, thus enabling the user to check that the beam(s) of the laser(s) head(s) is(are) exactly aiming at the desired points onto the rotating target. The camera takes snapshots with 1/8000 s exposure time or shorter, synchronized with the tacho signal from the rotating object, thus allowing to identify the angular and radial position of the laser beam(s), with a angular phase accuracy of <0.5° @1000 rpm, and 2° @10000 rpm.





Rotation-tracking. Left: scheme of rotation-tracking system. Right: Detail of the definition of the circular trajectory

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Performance	0-100 kHz	20 kHz - 3 MHz
Maximum measurable vibration (peak-to-peak)	43 mm (theoretical) 15 mm (practical)	4 µm
Maximum measurable velocity	0.5 m/s @ 0.5 m 0.2 m/s @ 10.0 m	40 m/s
Output signals	• Raw (A, B, C) and X, Y, Z Displacement and Velocity (analog) • Scan Sync (digital) • 3x Monitor (3.5mm jack): - Optical Signal Level (analog) - Speckle-Tracking active (digital)	
Output signal responsivity	• Displ.: 0.5, 50, 5000 V/mm • Vel.: 5, 500, 50000 V/(m/s)	5 V/µm
High-Pass filter	None (DC response) , 0.1 Hz, 5 Hz, 100 Hz	20 kHz
Low-Pass filter	100kHz, 10kHz, 3kHz, 1kHz, 0.3kHz	3 MHz
Resolution	Noise-limited	
Noise Equivalent Displacement	0.04 nm/√Hz @ 0.5 m 0.4 nm/√Hz @ 5.0 m	
Output signal accuracy	1 % (@0.5m)	<5 %
Spatial transverse resolution	100 µm @ 0.5 m 500 µm @ 5.0 m	
Target surface	Diffusive or retro-reflective.	
Working distance	from 0.1 m to 11.0 m (-L version)	
Autofocus	Fast, assisted by laser telemeter	
Telemeter resolution	±0.5 mm	
Scan angle	50° × 50° (2D scanning, single head) 40° × 40° (3D scanning, 3x heads)	
Scanned area	from 10cm x 10cm, to 10m x 10m	
Maximum scan rate	up to 400 pts/s	
Angular resolution	0.05°	
Angular stability	<0.01°/h	

Rotation-Tracking option	
Input signals	Tachometer (TTL) Encoder pulse angle (TTL) Sync polarity positive or negative
Maximum rotational speed	20000 rpm
Maximum rotational speed change	1000 rpm/s
Allowed scanning angle	50° x 50° (full field)
Phase tracking error	<0.5° (with tachometer signal) <0.2° (with encoder signal)

Physical and Interface	
Laser radiation	• pointer / telemeter: Pout < 1 mW @ 650 nm (visible) • vibrometer: Pout < 15 mW @ 1310 nm (invisible)
Laser safety class	• Class 2 @ 650 nm (visible) • Class 1M @ 1310 nm (invisible)
Camera (for each head)	HD 5MP (2592 x 1944 pixels), autofocus, variable exposure, 96X zoom (24X optical zoom + 4X digital zoom)
Optical head dimensions (single)	95 mm × 130 mm × 320 mm
Electronic unit dimensions (single)	24.6 cm × 15.5 cm × 32.0 cm
Optical head cable length	3 m
I/O	USB 2.0
Control PC (included)	• Processor: Intel Core i7 • RAM: 8 GB • OS: Windows 10
Software functionality	Alignment; Distance setting; Autofocus; Laser control; Camera pan and zoom; Measuring point selection (mouse-click, automatic array, import); 3D profile measurement (3D view, data export); Vibration measurement; Rotation-Tracking
Power supply	• 110-120 VAC / 60 Hz • 220-240 VAC / 50 Hz
Power consumption	< 120 W
Weight	• main units: 3x 4 kg • optical heads: 3x 4 kg • mechanical mount: 5 kg
Temperature (operating)	Optical head: -10 °C to +60 °C Main unit: +10 °C to +50 °C

One main unit and optical scanning head

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