TEMPO 2D

Multi-component Measurement

One Laser Probe

LASER ULTRASONICS FOR NON-DESTRUCTIVE TESTING

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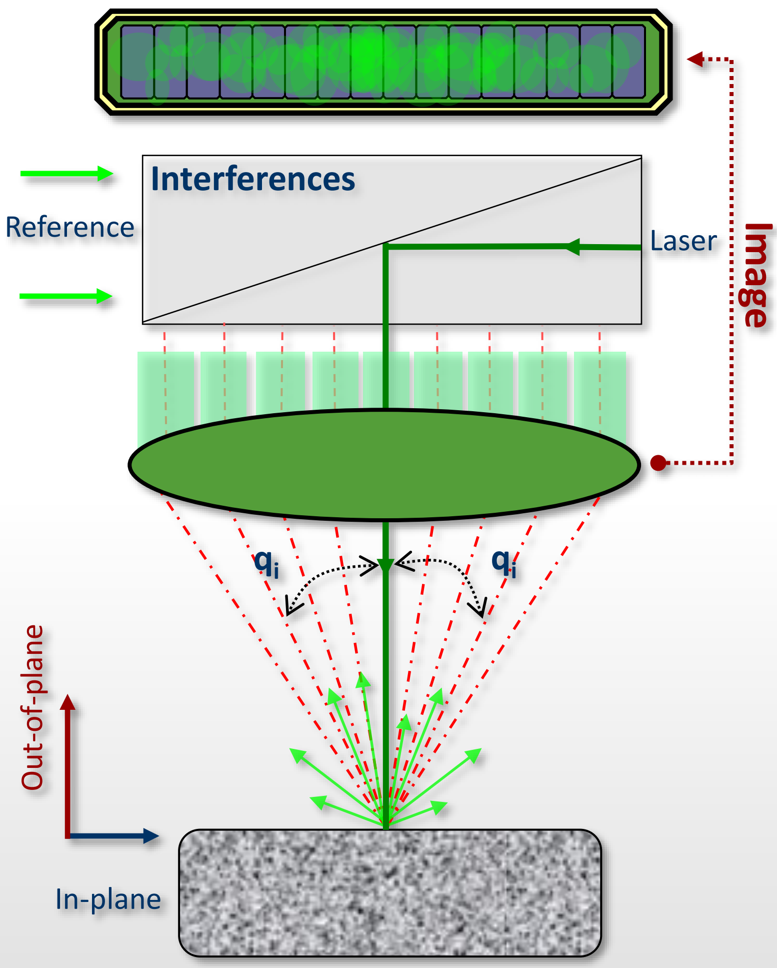
Technology

2D Interferometry

Traditionally, interferometers have focused on measuring the out-of-plane component of vibration. Systems designed to perform simultaneous multi-dimensional measurements require multiple laser sources, demand meticulous alignment, and are contingent upon surface reflectivity. The Tempo 2D unlocks a new dimension of laser ultrasound testing by taking advantage of two-wave mixing and combining it with a photodetector array to capture both out-of-plane and in-plane components of surface displacement using a single probe beam, offering unparalleled insights into material behavior and wave dynamics. Optimized for scattering surfaces, this multicomponent technology enables efficient detection of shear waves, particularly when propagation is normal to the surface of inspection.



Optical Design

The optical design of the Tempo 1D is modified to accommodate a linear detector array, which replaces the single-element detector. The front collection optic is imaged on the detector, and each element of the detector array corresponds to a small area of the back-scattered light entering through the front collecting optic. This design enables the simultaneous detection of multiple speckles corresponding to different viewing angles.

Signal Processing

The interference signals are processed as a function of the backscattered angle, yielding both in-plane and out-of-plane displacements. The signals are normalized and then processed in pairs having the same incidence angles. The normalized signals are added to generate the elementary out-of-plane component, and their subtraction yields the elementary in-plane component. The final in-plane signal is weighted depending on the angular contribution of the in-plane component.

Application Examples

This technology has been applied in various fields, including (https://doi.org/10.1016/j.pacs.2022.100440):

- Measurement of in-plane and out-of-plane components of Rayleigh waves in an aluminum block.
- Estimation of alpha-phase volume fraction in titanium alloy based on Rayleigh wave velocity, amplitude, and peak frequency.
- Detection of subsurface defects using the evolution of the wave phase.
- Measurement of in-plane and out-of-plane displacement components in multiferroic composite structures subjected to sinusoidal electric AC field.
- Measurement of acoustic emission from cracks occurring during laser cladding of Stellite alloy layers onto steel substrate.

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Specifications

NESD (Noise Equivalent Surface Displacement)	Out-of-plane: 2. 10^{-7} nm/$Hz^{1/2}$ In-plane: 10. 10^{-7} nm/$Hz^{1/2}$
Detection Bandwidth Upper limit	20 MHz
Detection Bandwidth Lower limit	20 kHz
Suitable CW Laser power	500mW / 1000mW internal laser
Laser wavelength	532nm (Visible)
Focusing	Motorized and controllable via USB
Spot diameter on sample	20µm to 1.5mm (depend on stand-off)
Optical stand-off	30mm, 100mm and 200mm
Diameter of collecting aperture	2" (50mm)
Depth of focus	Out-of-plane: 2mm In-plane: 0.7mm
Analog Outputs	Calibrated out-of-plane – 100mV/nm Calibrated in-plane – 100mV/nm Direct output, Calibration level and DC level
Options	2D scanning set-up including PC, software, digitalization card and X-Y translations
Electrical Requirements	110V / 220V - 50Hz / 60Hz
Dimensions	492 x 302 x 114 mm
Weight	16kg

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