



Doosan L136T Diesel Engine Vibrometry

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 **MMATIDIA**
A NEW LOOK AT LIDAR



Laser Radar

Doosan L136T engine

Experimental Configuration

Laser Radar System for 3D Doppler vibrometry (65 parallel beams) + **BCB Informática** IR camera for simultaneous thermography.

Doosan L136T diesel engine tested at ~800 rpm, 1300 rpm and 1900 rpm; installed at the School of Naval Engineering (UPM) test bench.

3D point cloud acquisition and synchronous recording of time/spectral signals at 65 positions; sub- μm resolution of vibrational velocity.

Collaborative configuration UPM Navales (structural tests) + **BCB** (thermography) + characterization equipment (**Ommatidia**)

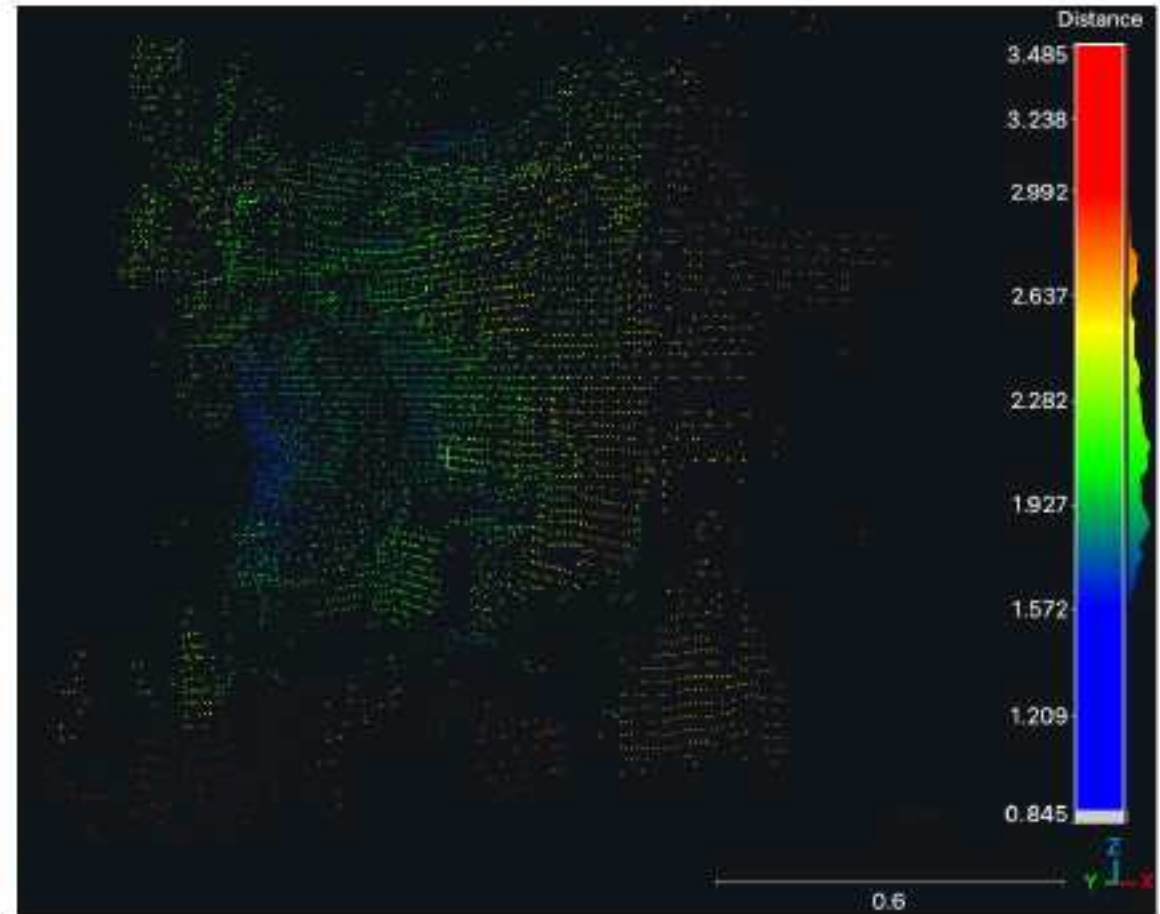


3D point cloud

Multibeam laser capture (65 beams) → full block reconstruction; ~10 mm average spacing with precision < 0.1 mm over 11k+ recorded points.

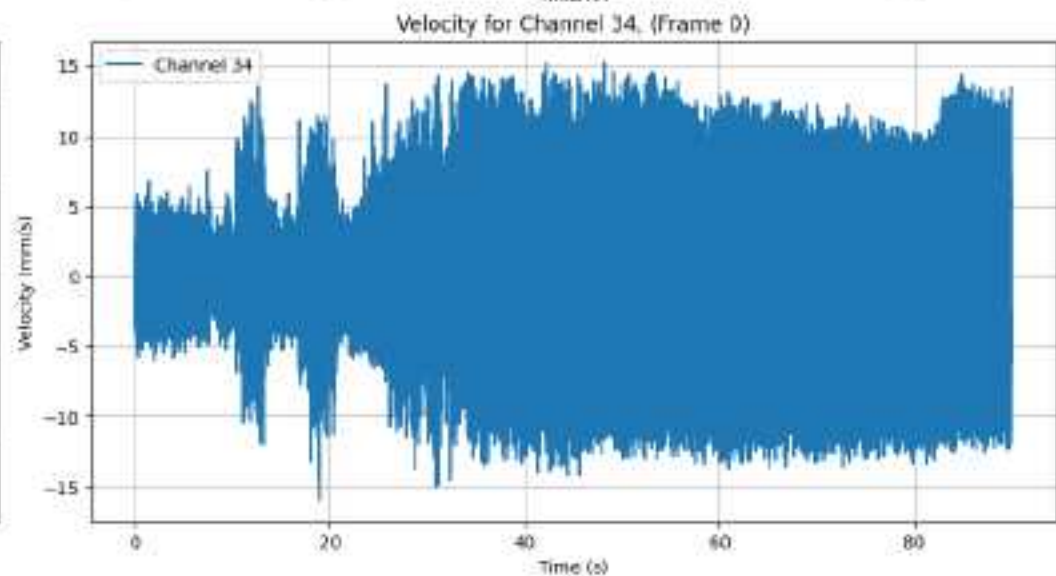
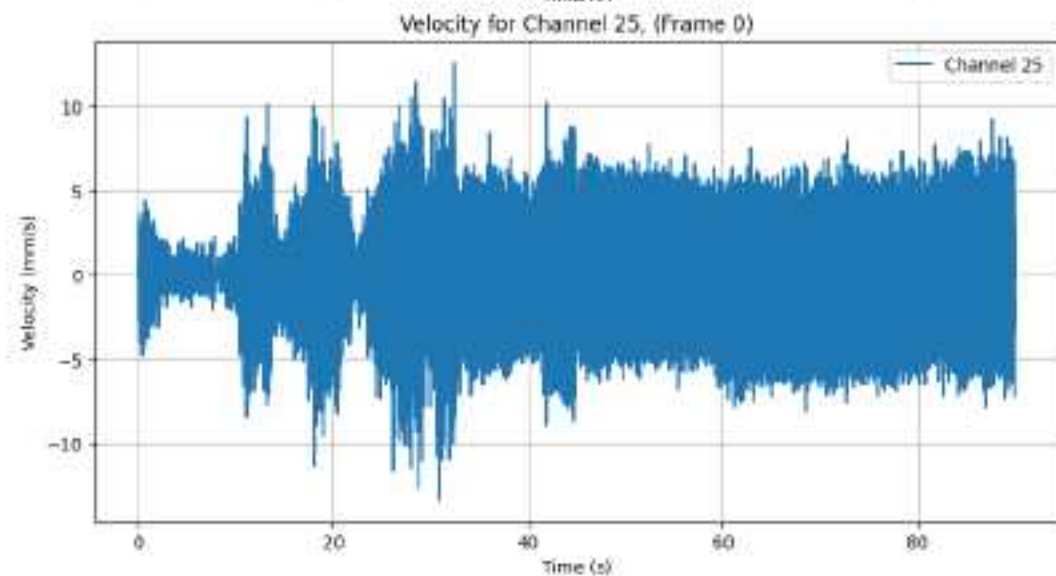
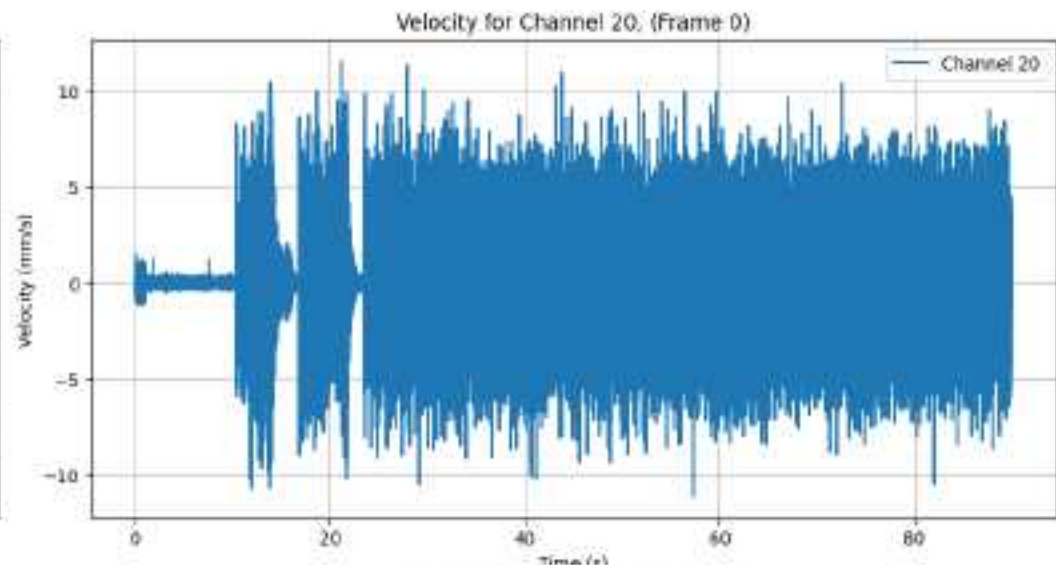
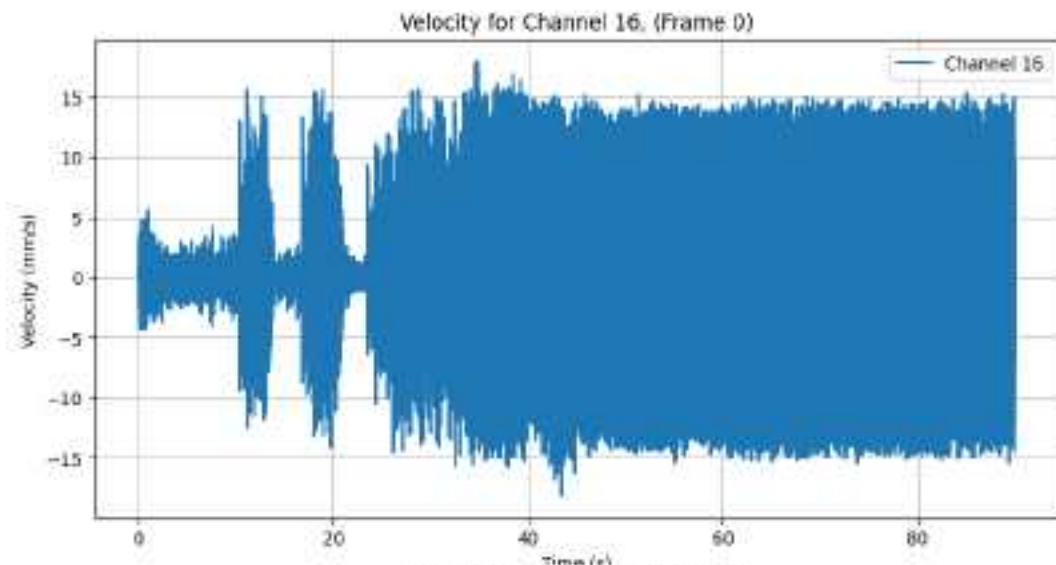
Color coding by peak-peak velocity amplitude (0-10 mm/s) allows locating critical vibration zones and superimposing the modes calculated by FEM.

Exportable data (PLY / STL) + global reference by optical targets for modal animations, thermomechanical comparison with IR thermography and future predictive maintenance documentation.

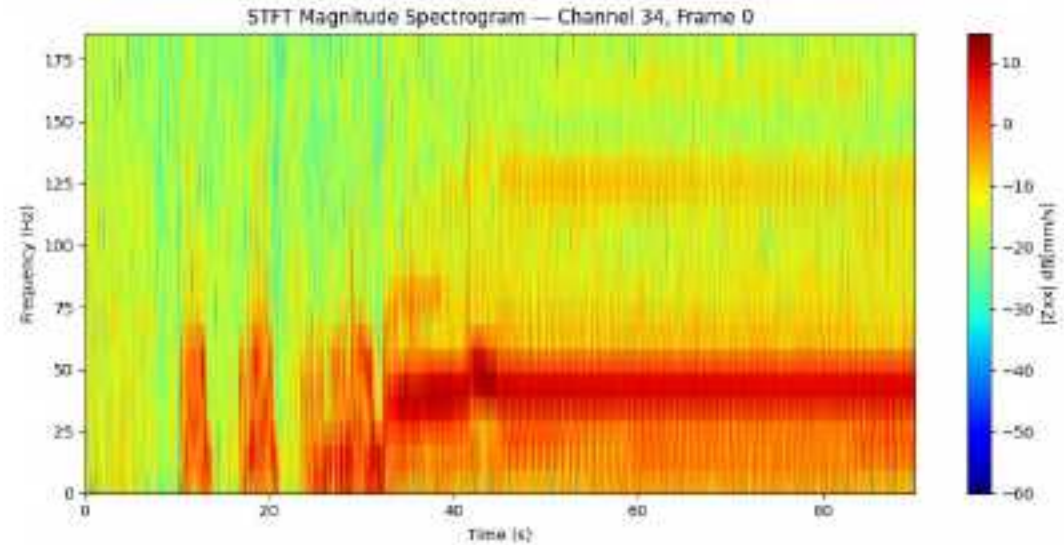
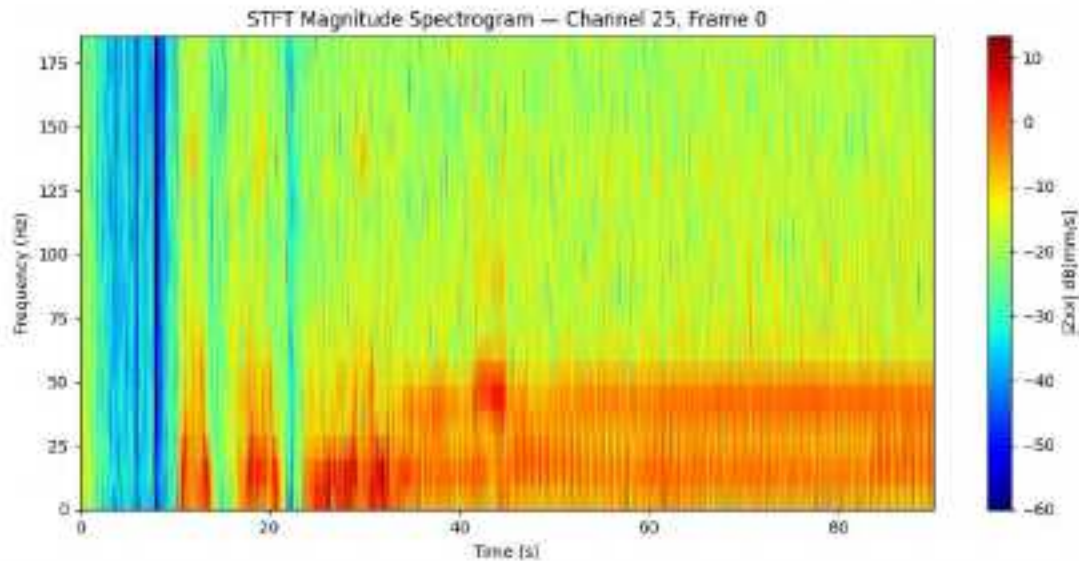
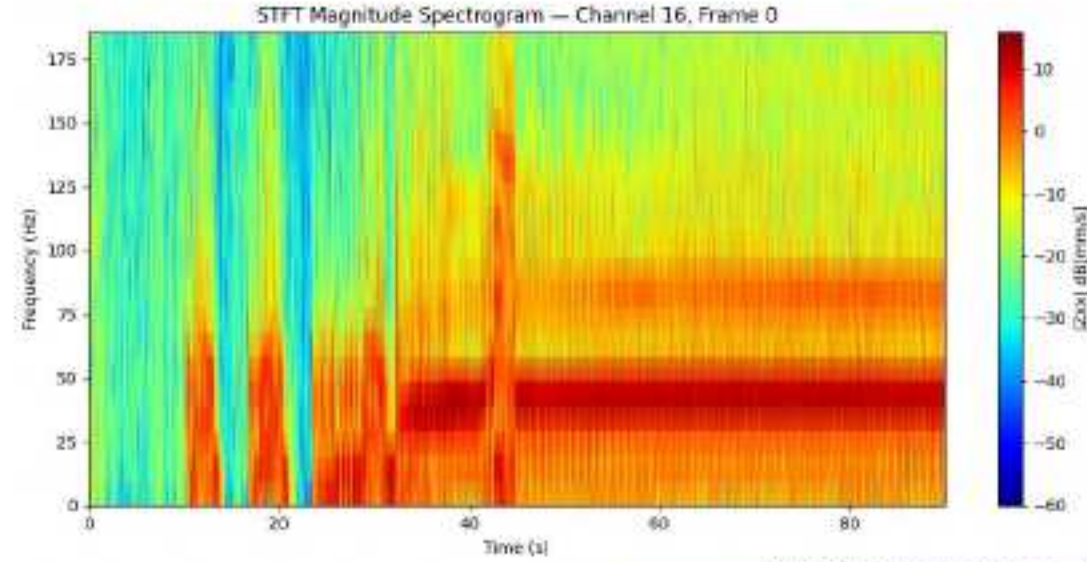


3D Point cloud

Vibration at start-up (4 positions)

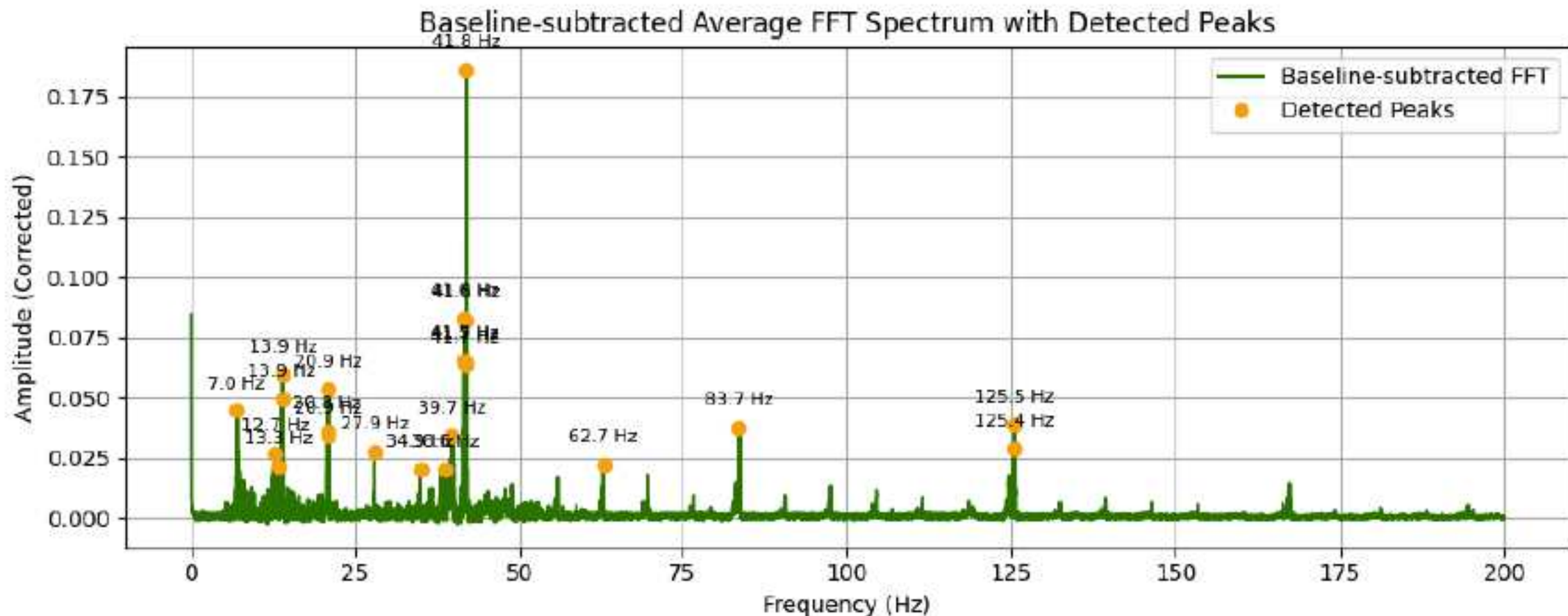


Start-up: Time-frequency behavior



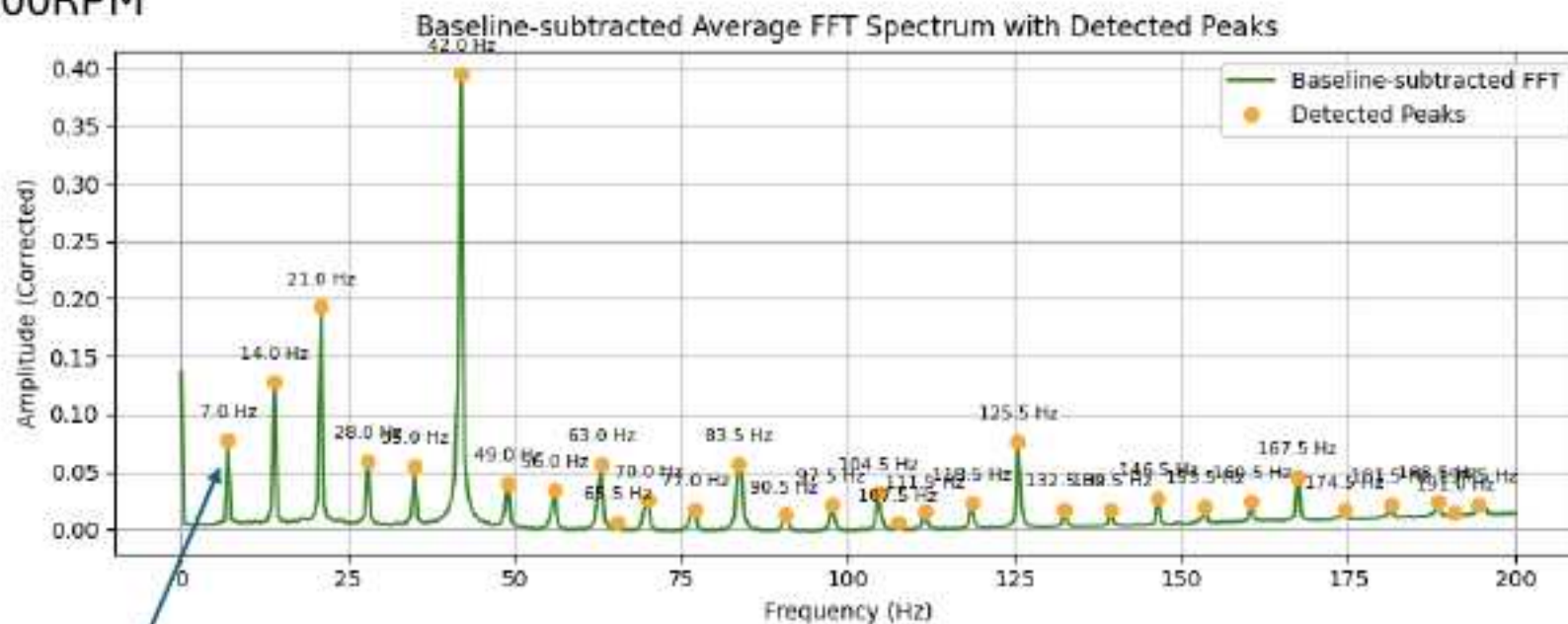
Start-up: Integrated Spectrum

Main peak at 41.8Hz
First Harmonic at 13.9Hz (800 rpm)
Subharmonic 1:2 at 7.0Hz

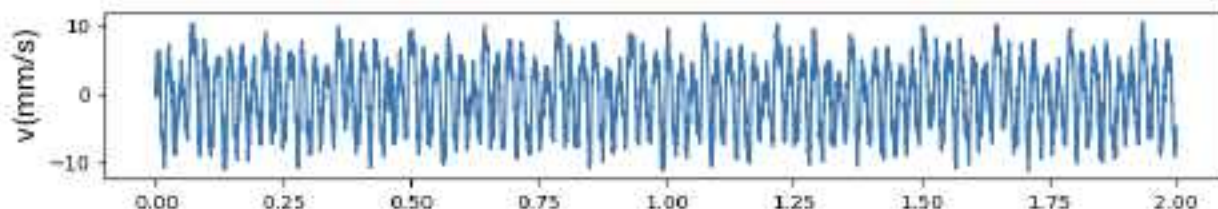


Spectral analysis and time signals

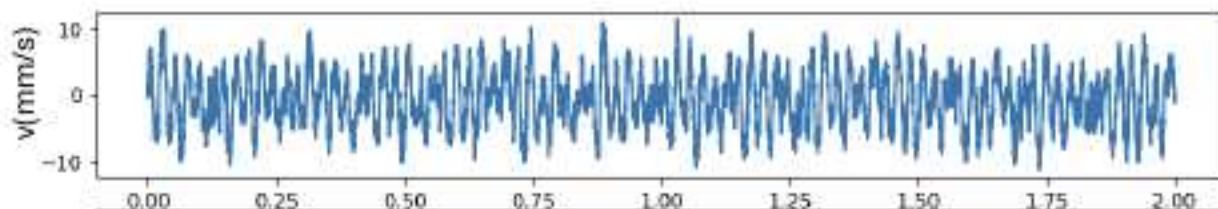
Motor ~800RPM



Subharmonic 1:2
1 explosion every 2
revolutions

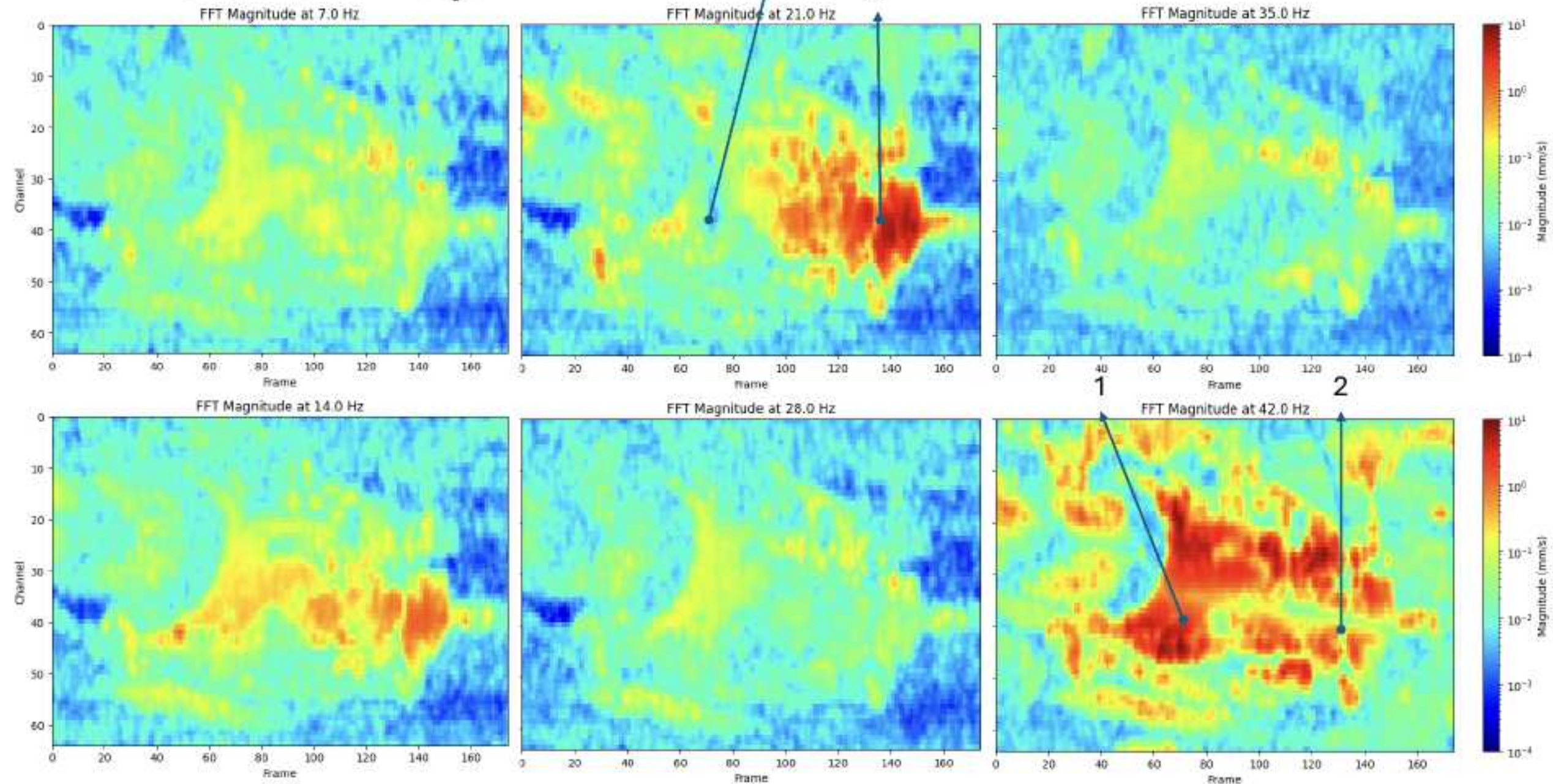


Point 1

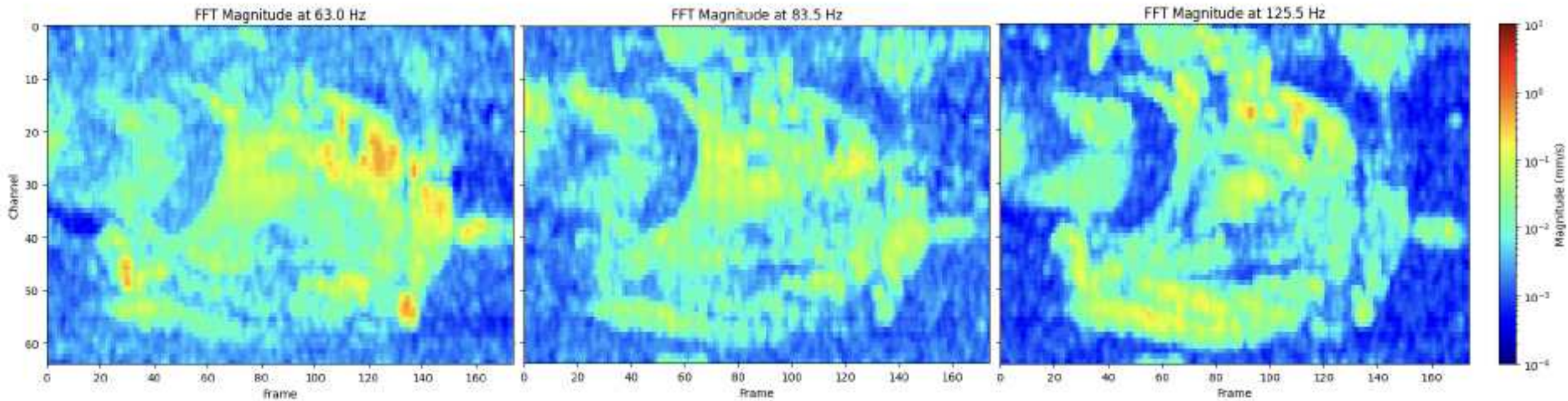


Point 2

Vibration Map

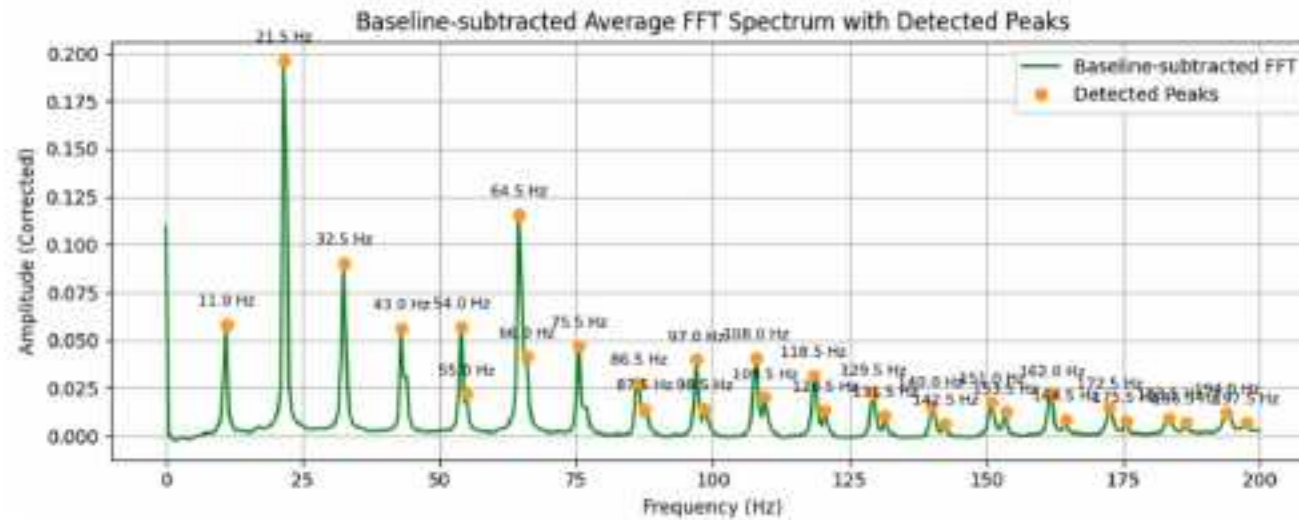


Vibration Map: Overtones



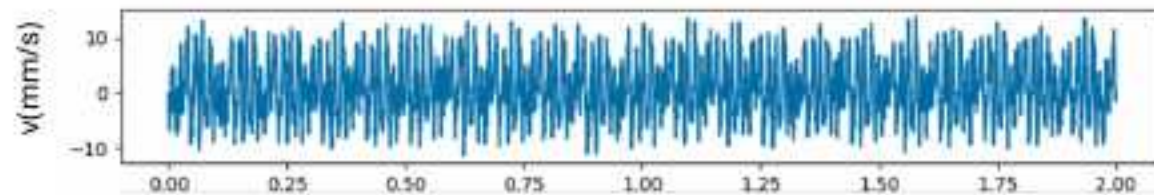
Spectral analysis and time signals

Engine ~1300rpm

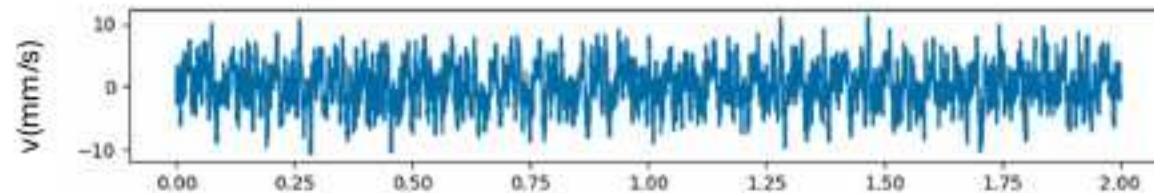


There is a separation of the harmonics split into two series.

The separation seems proportional to the frequency

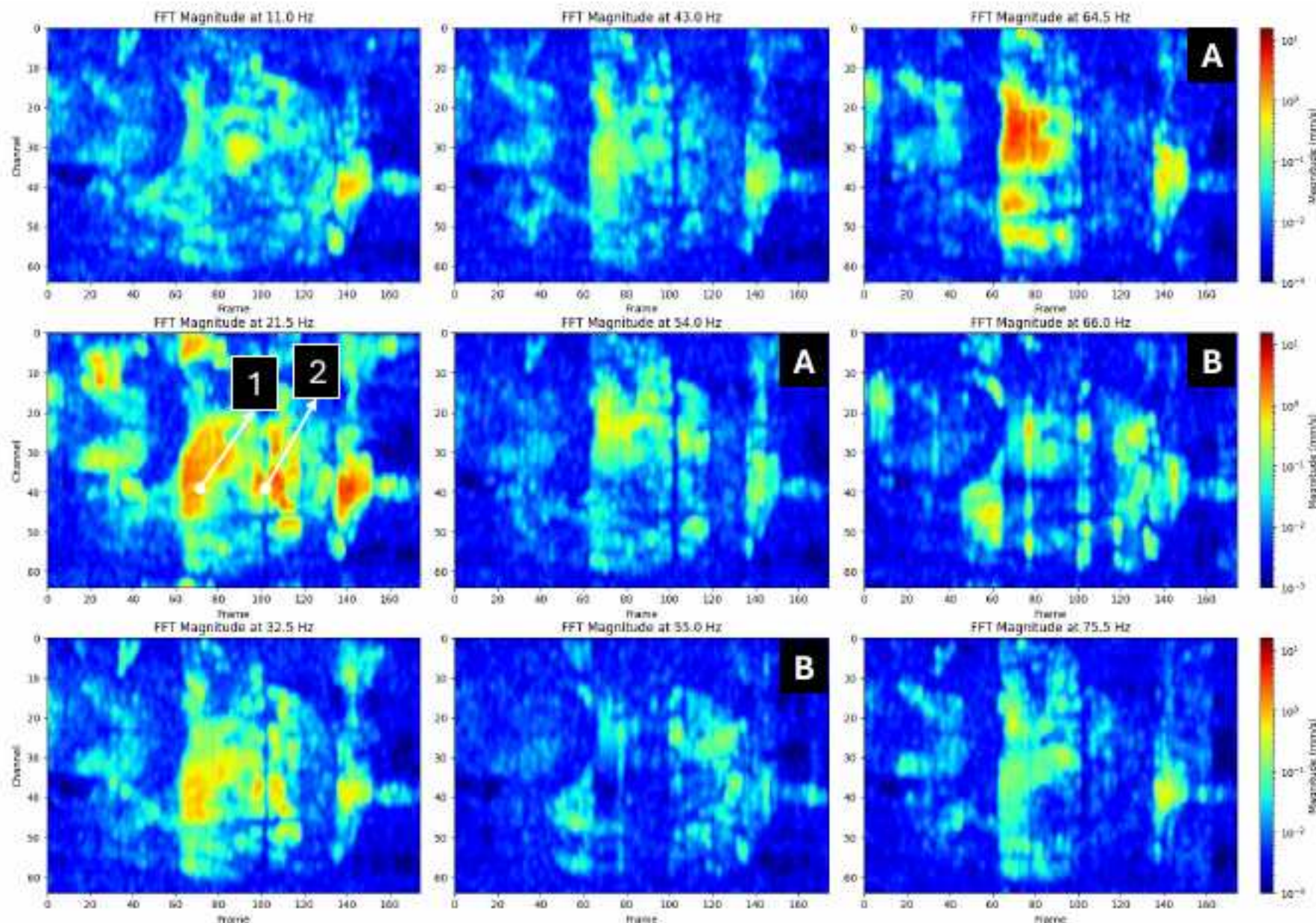


Point 1



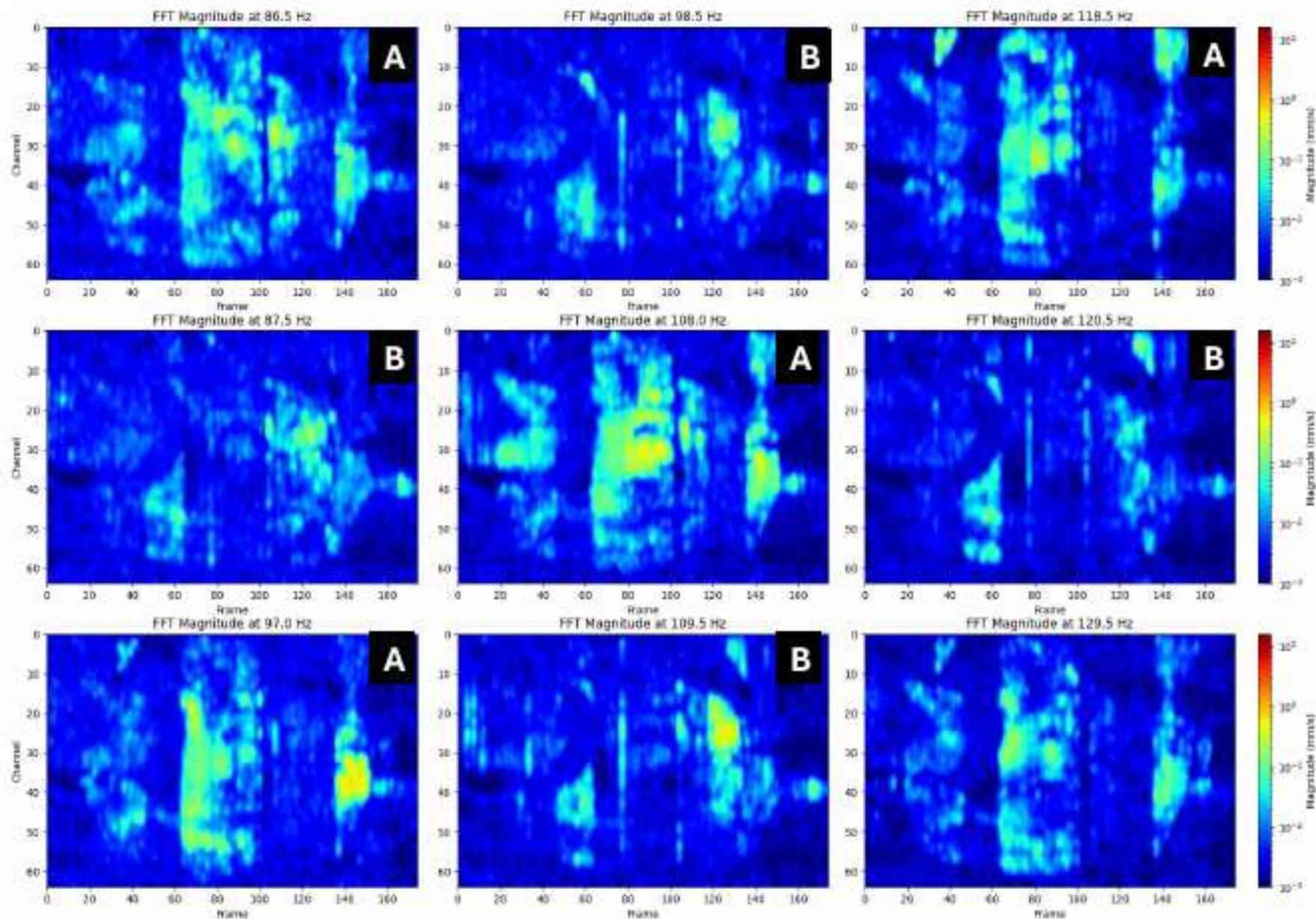
Point 2

Vibration Map (1300rpm)



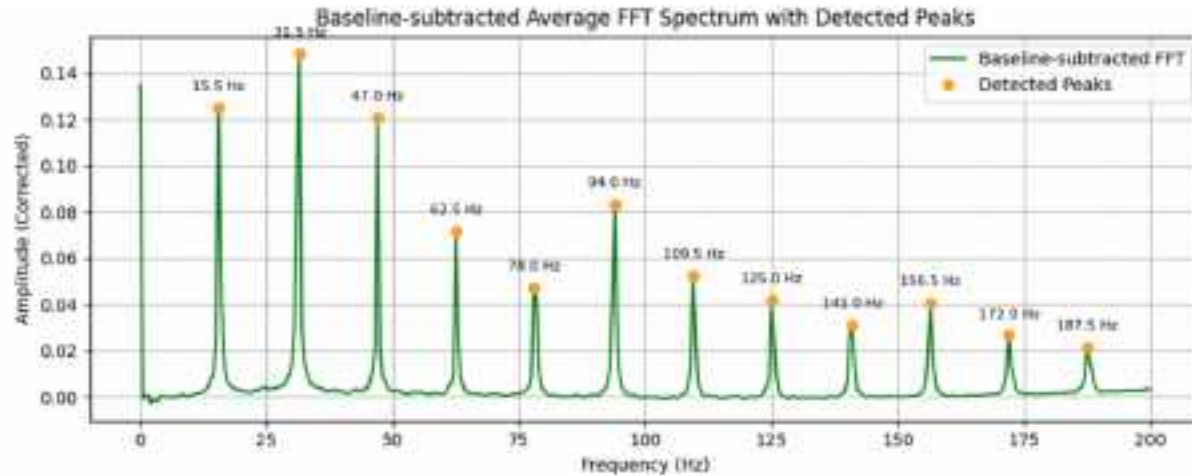
Location of the series of frequencies A, B in pairs does not coincide spatially.

Vibration Map (1300rpm)

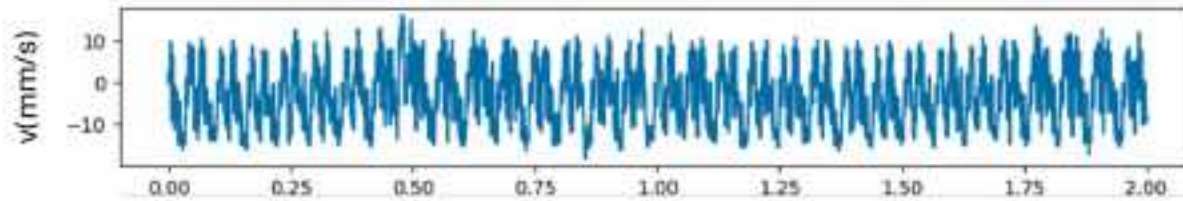


Spectral analysis and time signals

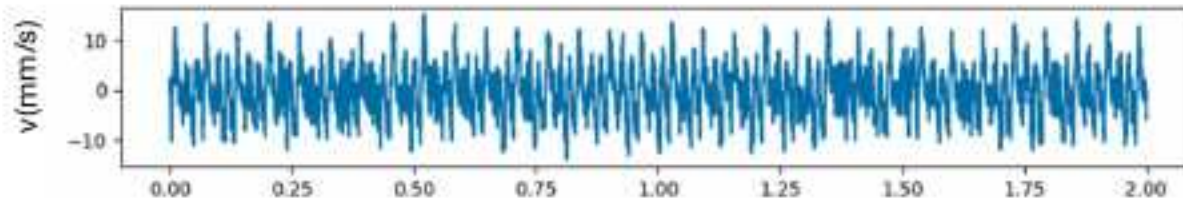
Engine ~1900rpm



The splitting observed at 1300 rpm disappears at 1900 rpm.

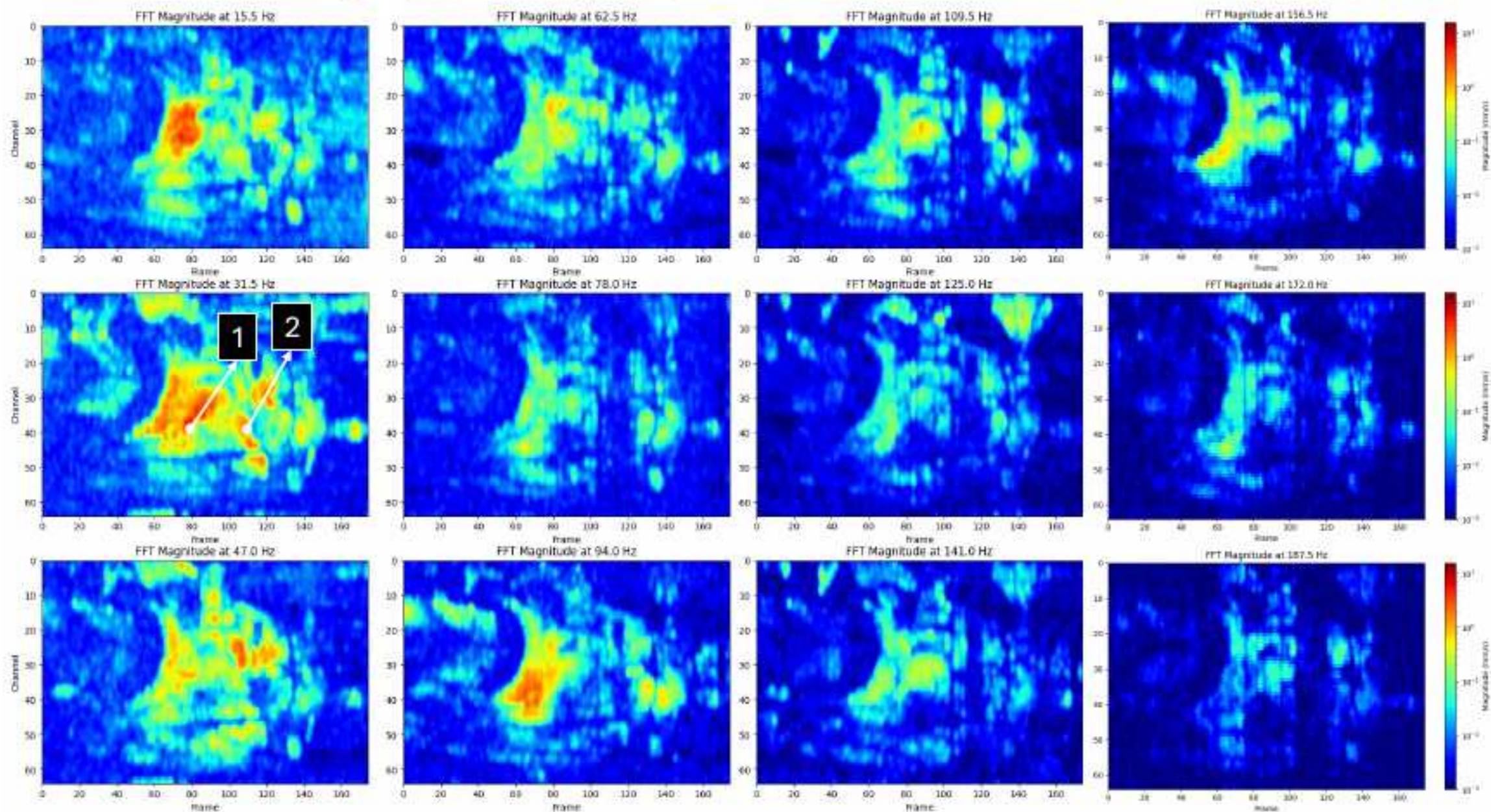


Point 1



Point 2

Vibration Map (1900rpm)



Conclusions

In each case, the rotation frequency, the upper harmonics and the **1:2 subharmonic** (one burst every two turns) are detected and located, consistent with the kinematics of a 4-stroke engine.

At 1300 rpm all harmonics (whole and $\frac{1}{2}$ -orders) **split into two peaks**; the separation grows with frequency and each family has a **different spatial pattern**.

The splitting **disappears at 1900 rpm**, suggesting that the cause is associated with a torsional mode/coupling that goes out of resonance at higher speed.

The 3D vibrometry allowed mapping modes and locating the A/B families, validating the metrological capability of the system for engine diagnostics.



Perspectives and possible next steps.

Correlate harmonic separation with torque and RPM measurements on both shafts (motor-generator / balancer shaft) to confirm the dual-source hypothesis.

Repeat tests under **different loads and governor settings** to evaluate the influence of hunting and torsional stiffness.

Fully integrate **thermography**: relate hot spots to areas of high vibration and validate thermomechanical models.

Extend the **3D cloud** to all accessories (pump, alternator, piping) and generate ODS animations for training and predictive maintenance.

Develop an **automatic diagnostic algorithm** that combines spectra, 3D maps and thermography for early warnings in naval fleets.

