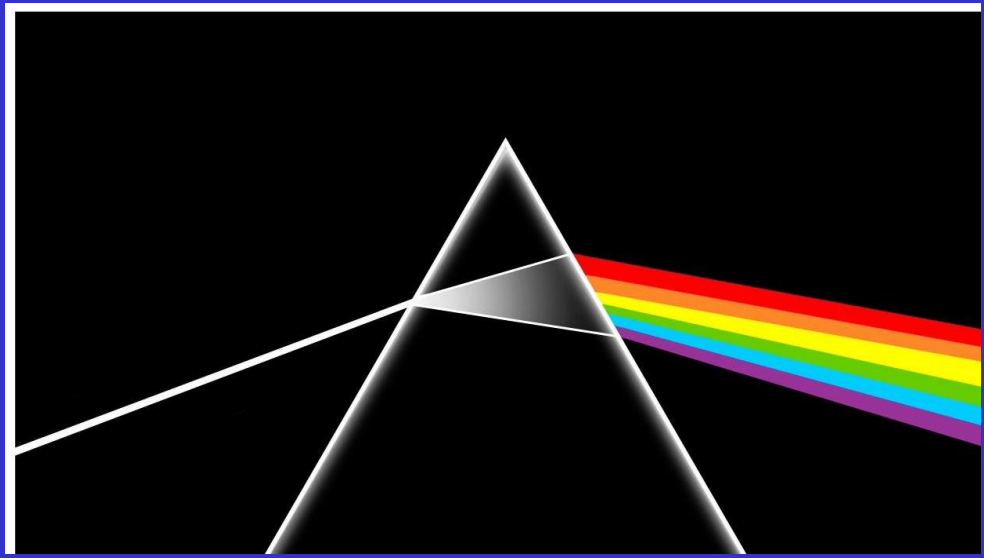
Ώριμες Καινοτόμες Τεχνολογίες Έγκαιρης Διάγνωσης Βλαβών στην Ναυτιλία: Βαθειά Μηχανική Εκμάθηση από Στοχευμένα Μεγάλα Δεδομένα Δυναμικής Συμπεριφοράς

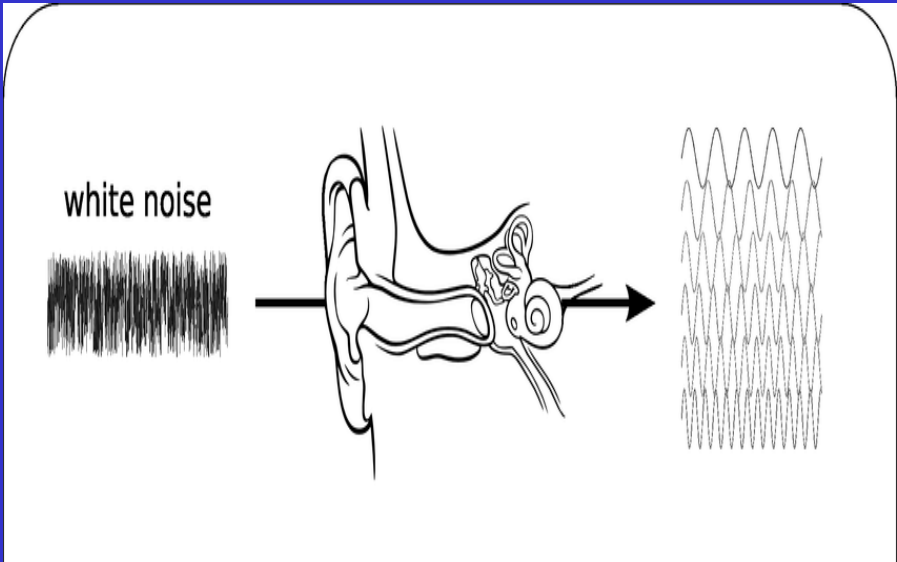
Ioannis T. Georgiou [*]
Faculty, School of Naval Architecture & Marine Engineering
National Technical University of Athens
Athens, Greece
&
Adjunct Faculty Member, School of Mechanical Engineering
Purdue University, West Lafayette, Indiana

[*] Aerospace & Aeronautical-Astronautical Engineer

21ST INFOCOM WORLD 2019, ATHENS,GREECE

Big Data Sets of Dynamics of Complex Systems in Marine & Aerospace Engineering are and shall be encountered Naturally as Light and Sound are Natural to us and thus we had to understand their Nature and use this knowledge to develop Useful Technologies for Mankind



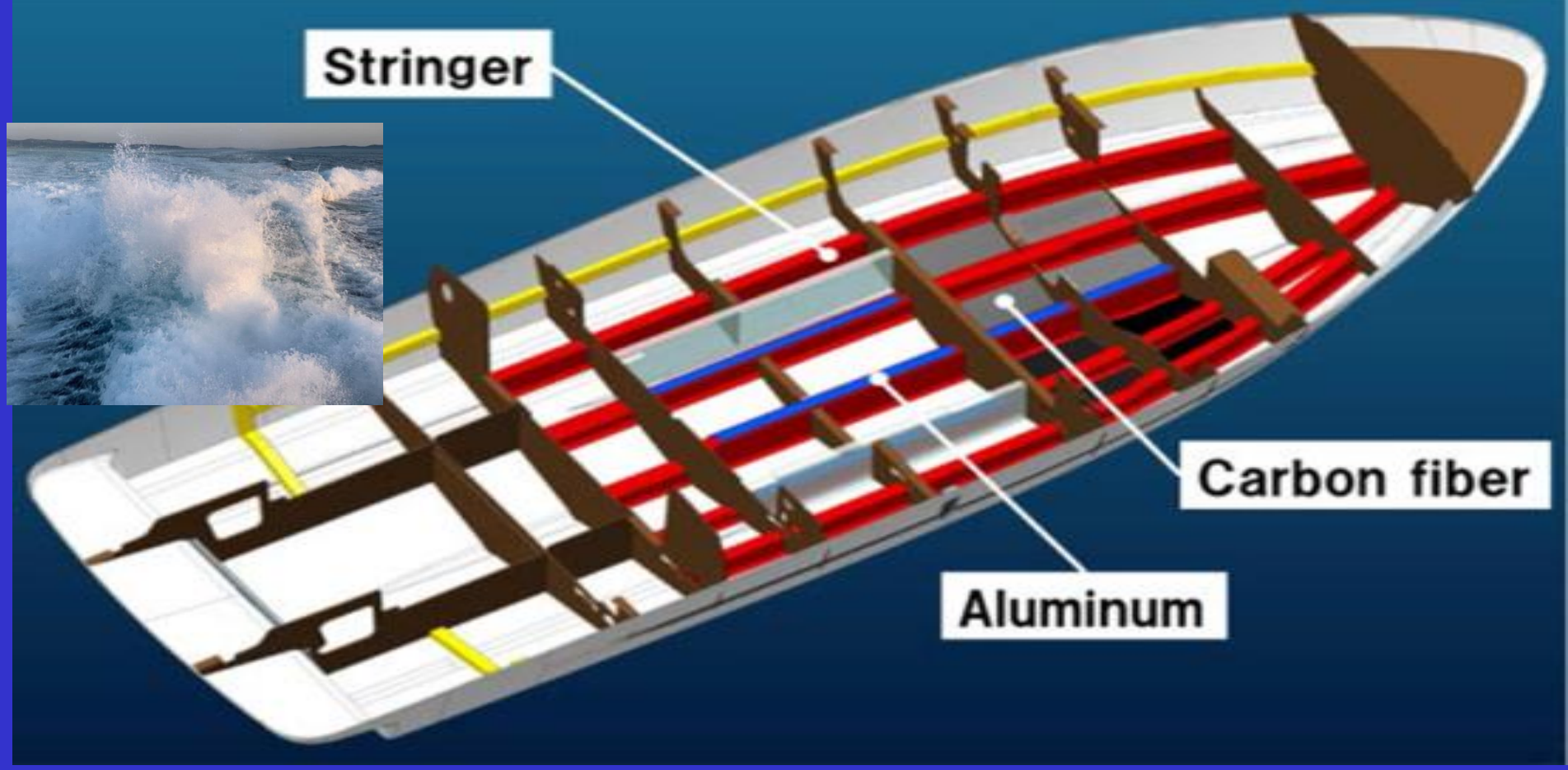


Discovery of Natural decomposition of Light and Sound Led to Deep Knowledge and sparked Science & Technology

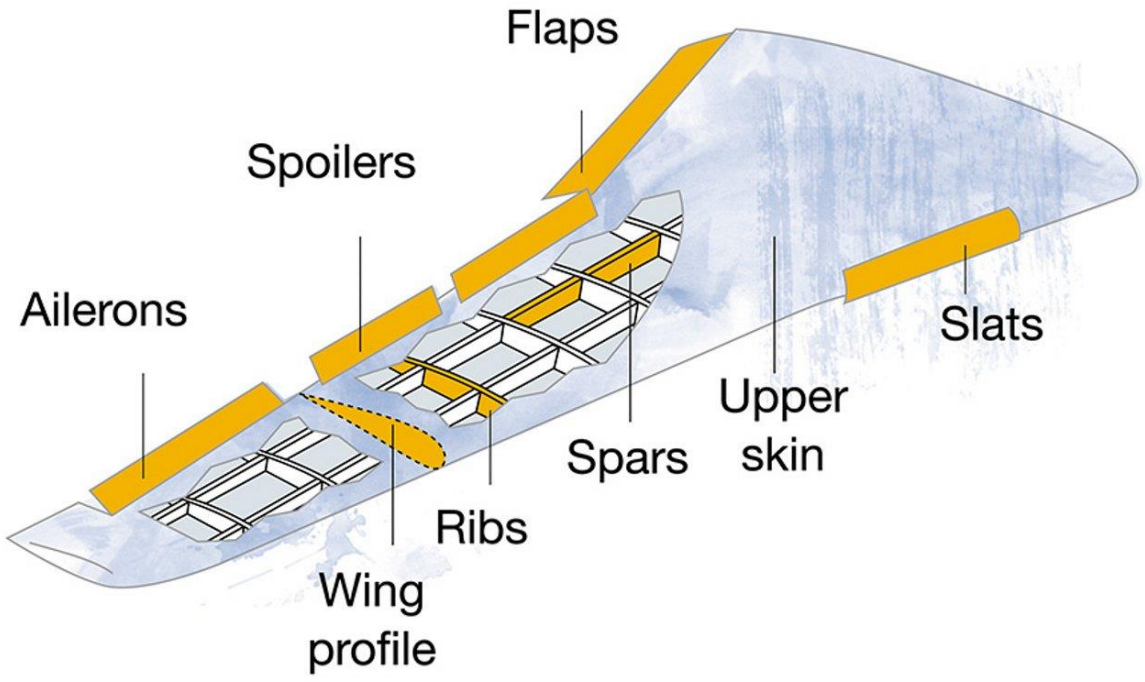
Dig Data Surpasses many Science Barriers due to the Established Classical Approaches.

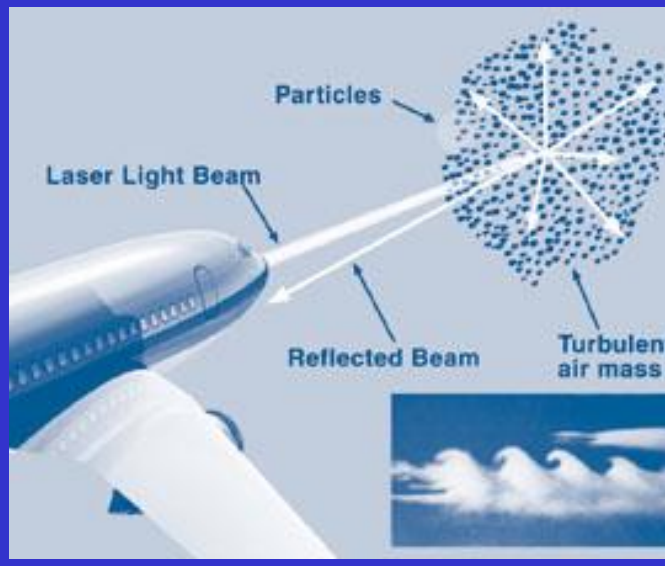
Classical approach I: Extract information Form single isolated Sensors

Classical approach II: Ideas developed using Simple structures and thus no need to use many sensors.



Synchronous Distributed Measurements of Dynamics leads to Big Datasets but it covers the Domain (or subdomain) of the Complex Structure and thus it contains Critical Information (such as damage, or interaction with the environment)



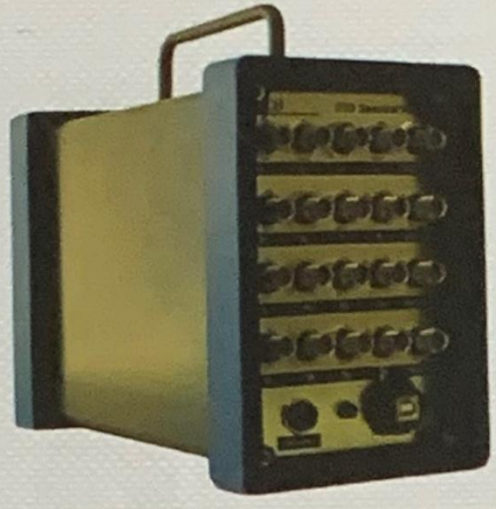


Synchronous Distributed Measurements of Dynamics leads to Big Datasets but it covers the Domain (or subdomain) of the Complex Structure and thus it contains Critical Information (such as damage, or interaction with the environment)

Big data : data acquisition and sensor technologies

8 or 16-Channel Portable USB (VQ-USB8/VQ-USB16)

- 8 or 16 analog input simultaneous sampling channels
- 2 (8-chan) or 4 (16-chan) Tachometer input channel
- 24 bits ADC, 102 dB dynamic range
- 102.4 K samples/sec
- Rugged design for easy handling and field application where more channel count is needed
- USB 3.0/2.0-compliant connectivity to PC.
- IEPE sensor power
- Built-in anti-aliasing filter
- AC/DC coupling
- ± 10 Volts input range
- VibraQuest data acquisition and analysis software.



Παρουσιάζουμε ενδιαφέροντα αποτελέσματα της **Δράσης Ποσειδώνας**, μια πρωτοβουλία μεταφοράς και πιλοτικής δοκιμής επιστημονικά ώριμης τεχνογνωσίας από τον Ακαδημαϊκό χώρο στην Ναυτιλία-με την στοχευμένη υποστήριξη της τελευταίας μέσω διαφόρων σχημάτων, όπως πρόσβασης σε πραγματικά συστήματα, και ανάθεσης Λύσης Παγματικών Προβλημάτων Λειτουργίας Ναυτικών Συστημάτων.

Pure Data-driven Structural & Machinery Health Monitoring for the Typical Marine Platform: The unparalleled leverage of distributed sensory information-based mechanics-dynamics

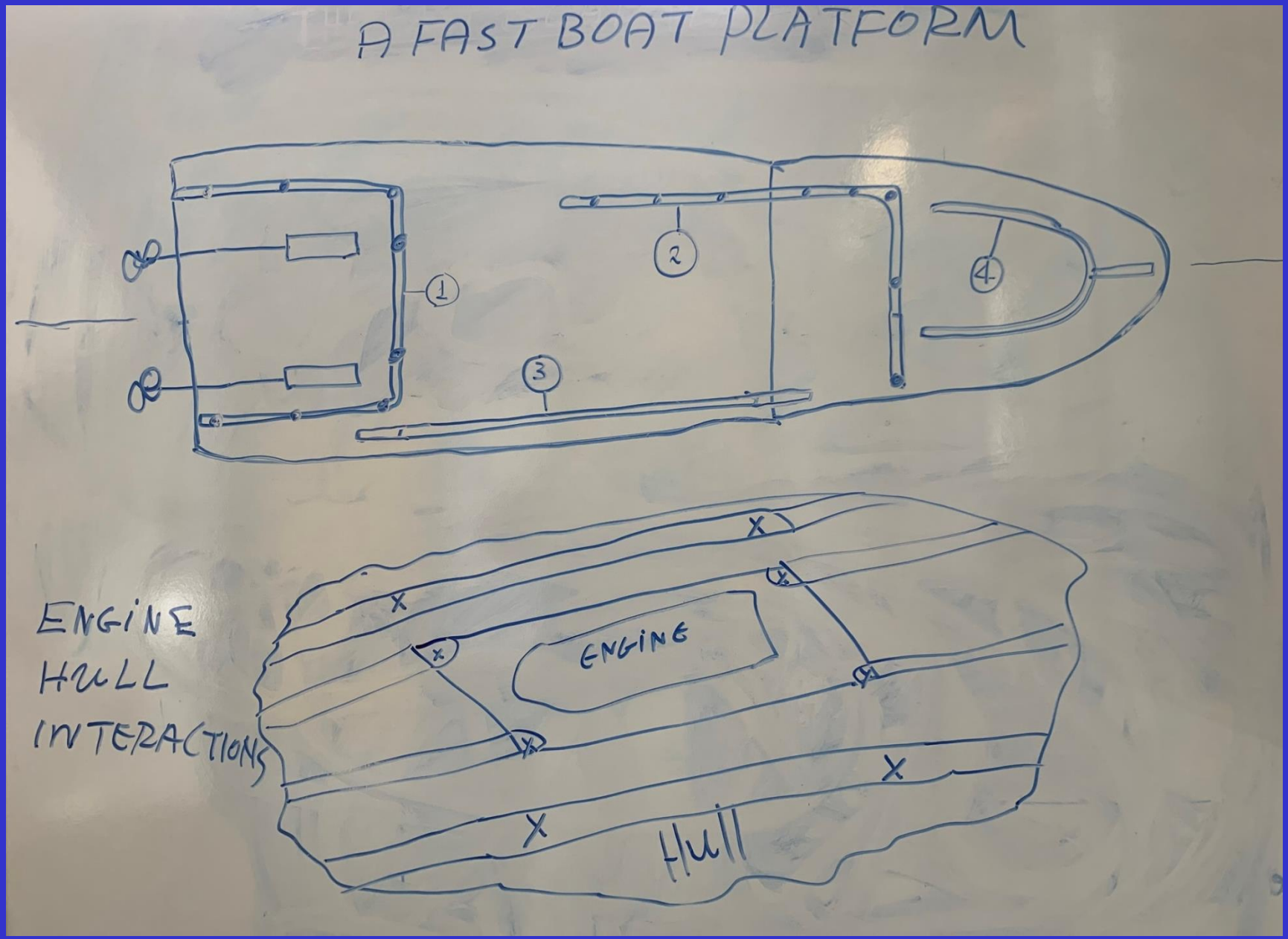
Shipping Industry Applications of the Project-Aristeia II IMS-PB DIAGNOSIS "Intrinsic Multi-scale Pulse-based Damage Diagnosis in Complex Structures with Applications to Integrity Monitoring of Machinery and Structures in Marine and Aero Engineering"

Posidonia 2018, June 4-8, Athens, Greece
The International Shipping Exhibition

Με γνώμονα ανεπτυγμένα μαθηματικά εργαλεία αξιοποίησης, ως προς την Εξαγωγή Δεικτών Άνωμαλίας, Μεγάλων Δεδομένων (BIG DATA), μελετήσαμε και λύσαμε

- Α. προβλήματα που προξενούνται από ανεπιθύμητα επίπεδα κραδασμών και θορύβων σε δυο κατηγορίες γρήγορων σκαφών,
- Β. προβλήματα λειτουργίας μεγάλων ναυτικών κινητήρων λόγω βλαβών στους κυλίνδρους, μεταξύ άλλων.

A. VIBRATIONS AND NOISE PROBLEMS IN FAST CRAFTS BIG VIBRATION DATASETS APPROACH



1. ALUMINUM ALLOY SUPER YAGHT

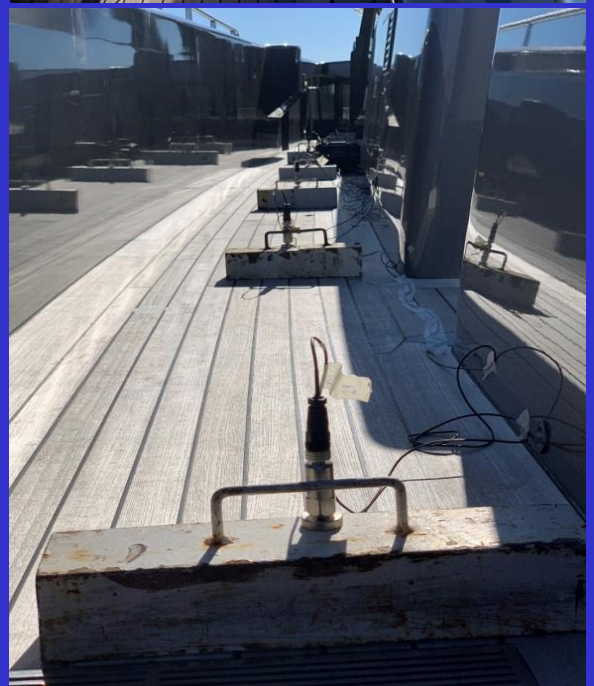
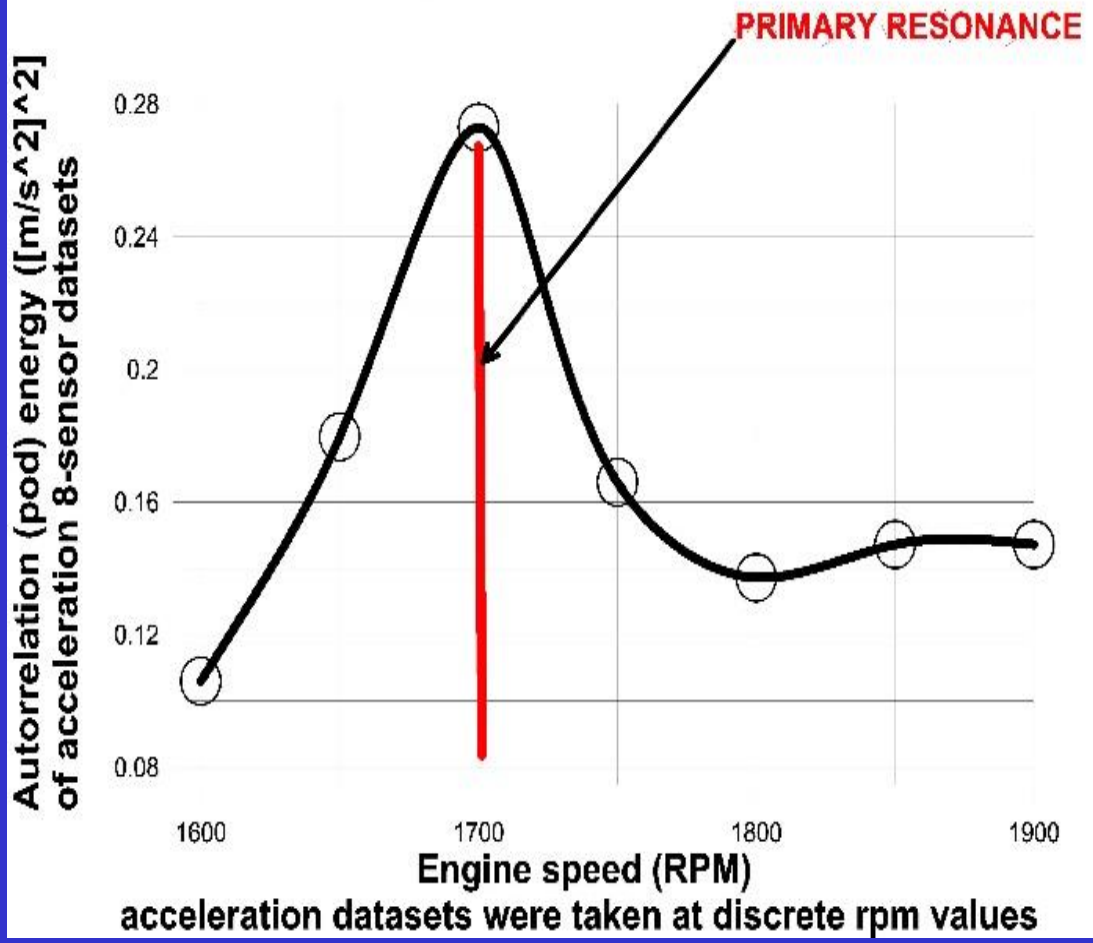
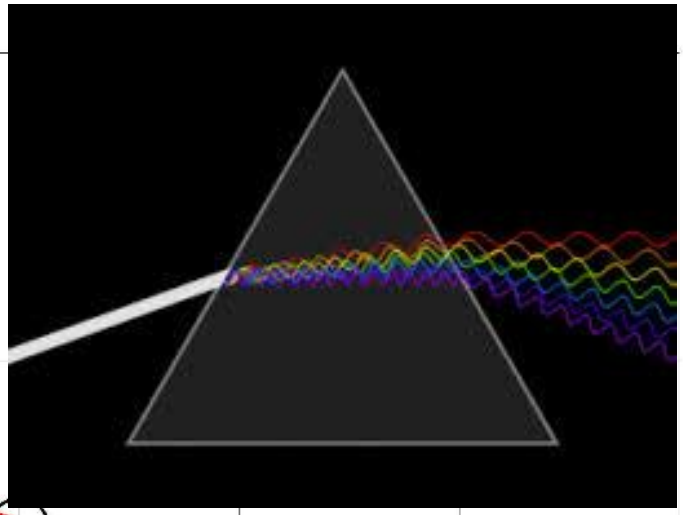


Figure1: Distribition of hull vibration energetics in bridge region covered by L-shaped acceleration monitoring curve. Diagnosis: machinery-induced coupled structural resonance near 1700 rpm, synchro=on

Scientrific Method: Extraction-characterization of reduced dynamics (vibrations) of complicated systems by Advanced Proper Orthogonal Decomposition Tools (Prof. Dr. I. Georgiou)



SPACE-TIME SPECTRUM DECOMPOSITION OF VIBRATION BIG DATABASE



POD modal energy

1

0.1

0.01

0.001

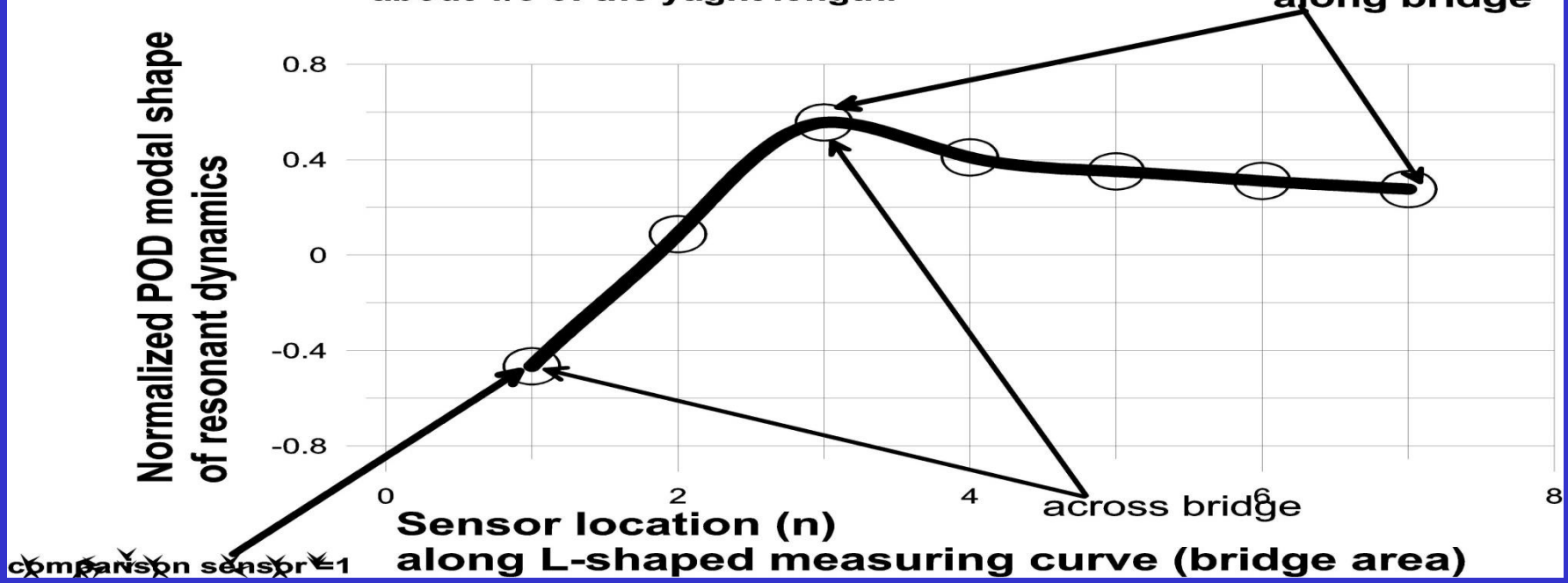
2

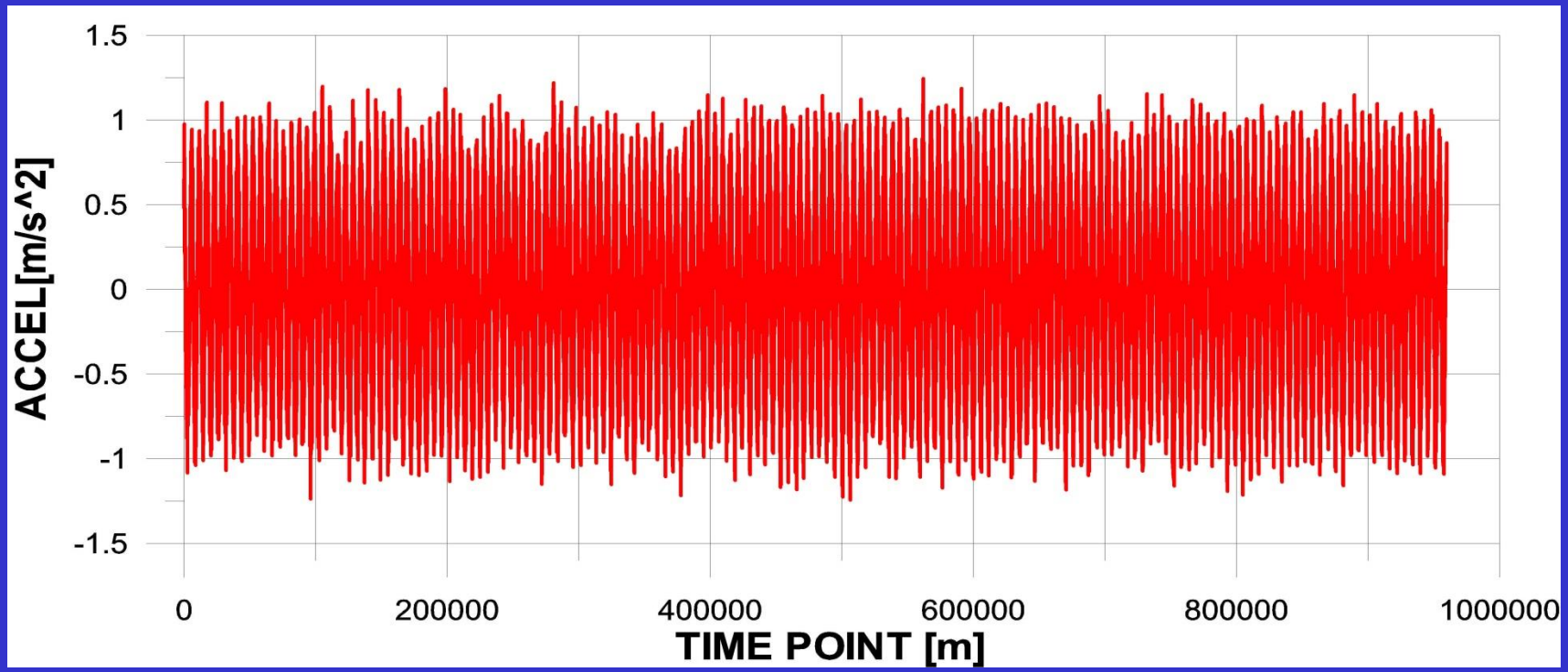
4

6

8

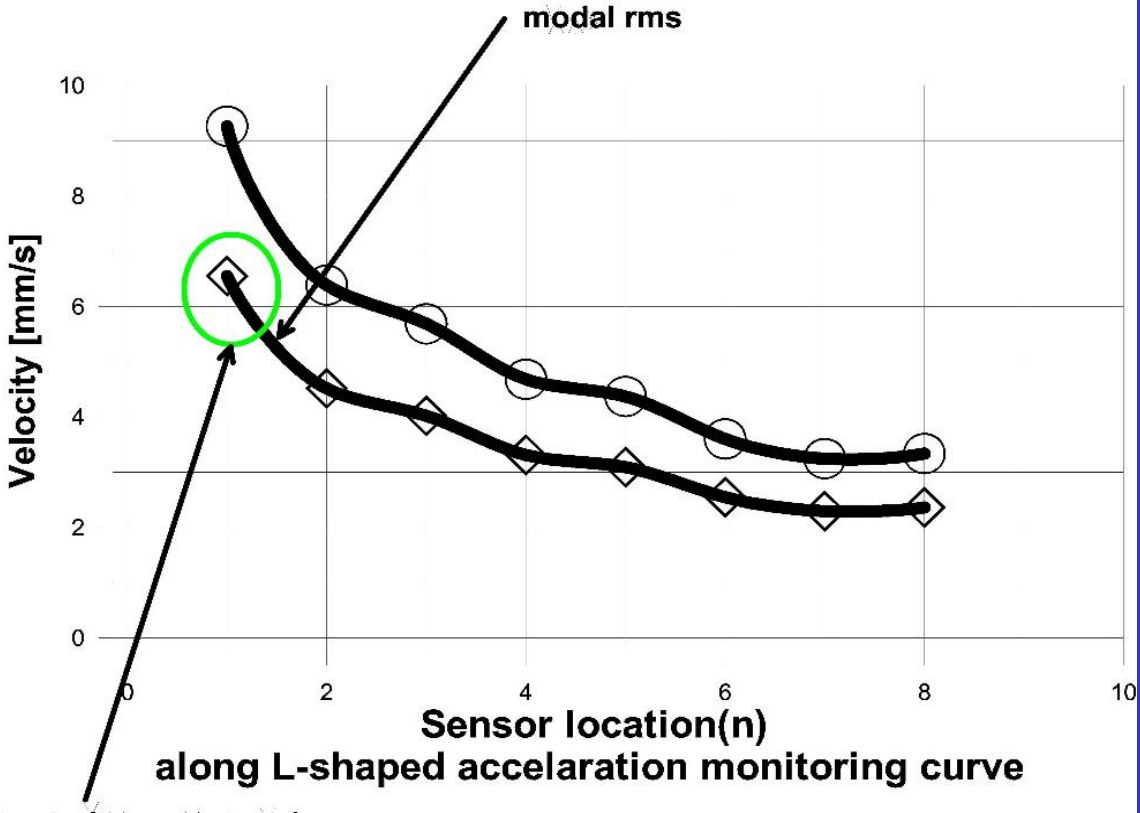
POD modal number (k)


along bridge
Normalized POD modal shape
of resonant dynamics
0.8
0.4
0
-0.4
-0.8
0
2
4
6
8
across bridge
Sensor location (n)
along L-shaped measuring curve (bridge area)
comparison sensor =1


1.5
1
0.5
0
-0.5
-1
-1.5
ACCEL[m/s^2]
0
200000
400000
600000
800000
1000000
TIME POINT [m]

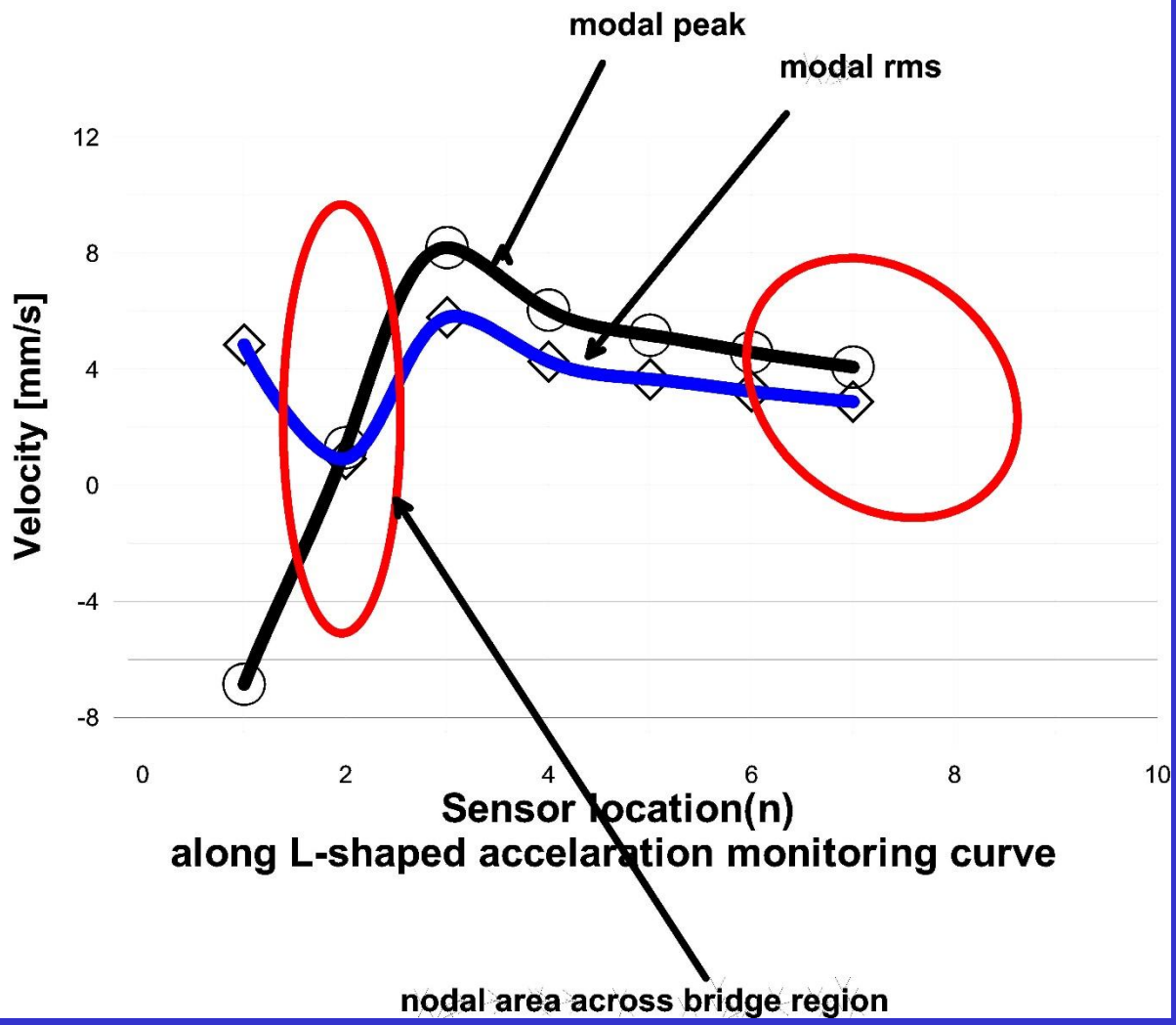
CRITICAL DISTRIBUTED VIBRATION INDEX TRANSVERSE

Figure5: Spatial distributrion of modal velocity (rms,peak) of diagnosed machinery-induced coupled structure resonant vibrations @ about 1700 rpm, synchro=on
Analytic Velocity Estimation (conservative): 90% of the max value of the reduced modal dynamics.
Transverse direction

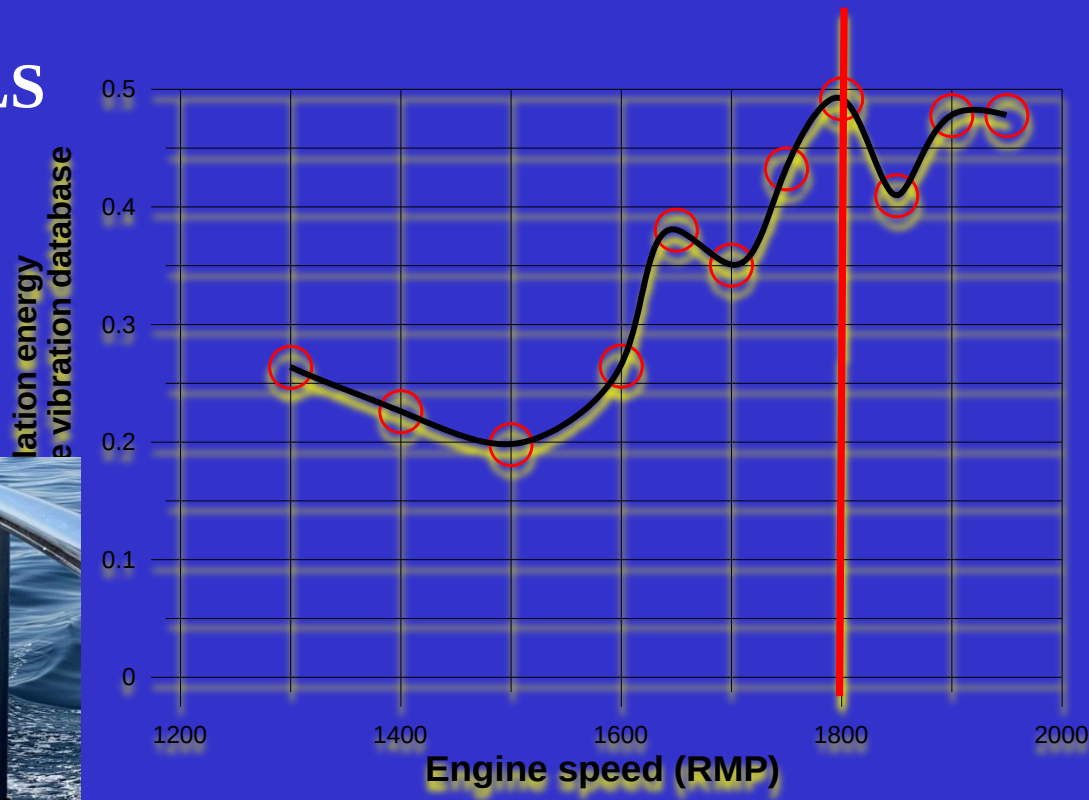


CRITICAL DISTRIBUTED VIBRATION INDEX VERTICAL

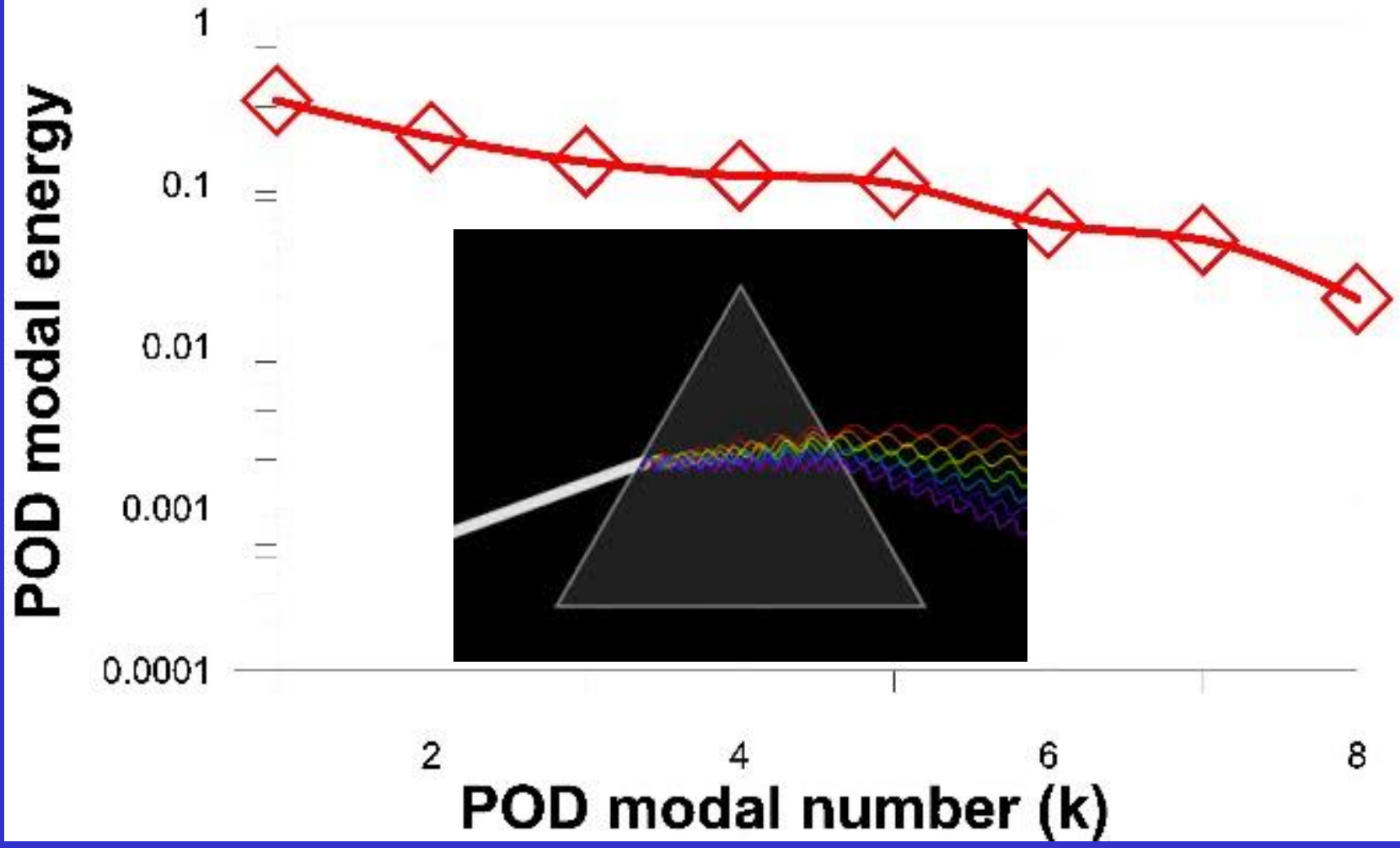
Spatial distributrion of modal velocity (rms,peak)
of diagnosed machinery-induced
coupled structure resonant vibrations
@ about 1700 rpm, synchro=on
VERTICAL VIBRATION



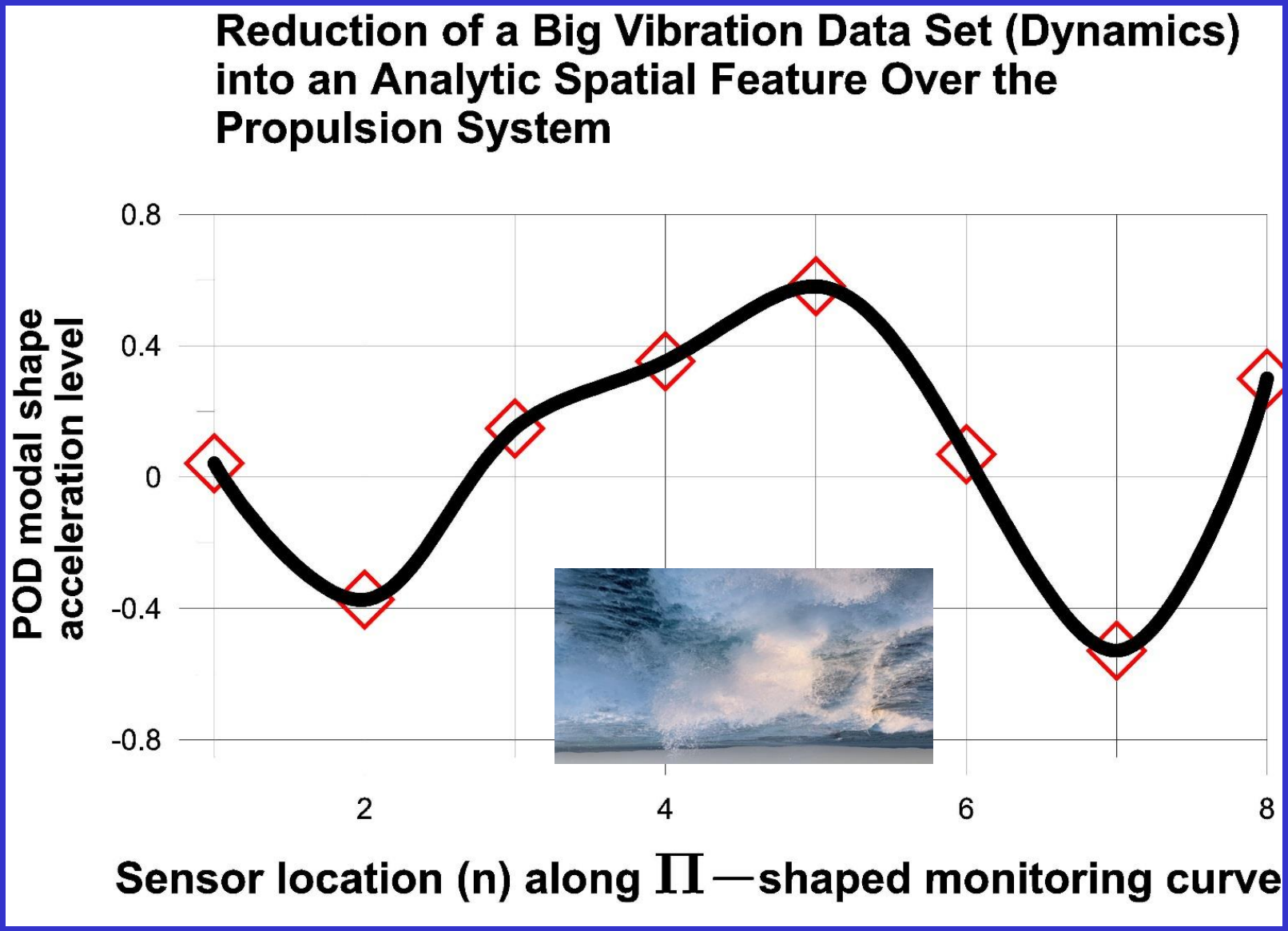
2. COMPOSITE MATERIALS SUPER YAGHT



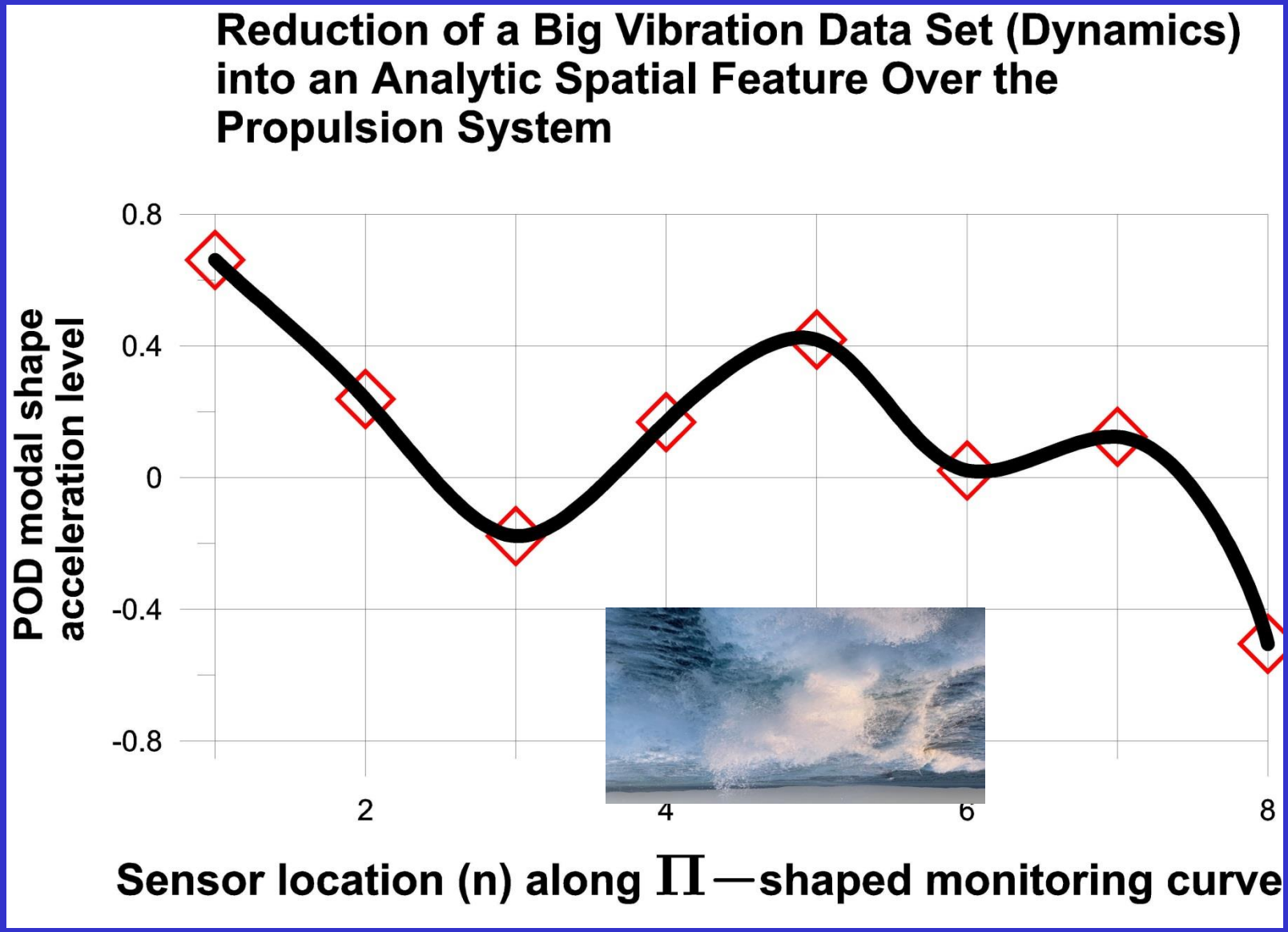
SPACE-TIME SPECTRUM OF DECOMPOSITION OF A BIG VIBRATION DATA SET OVER THE PROPELLER+AXES AREA



CRITICAL VIBRATION SHAPE I

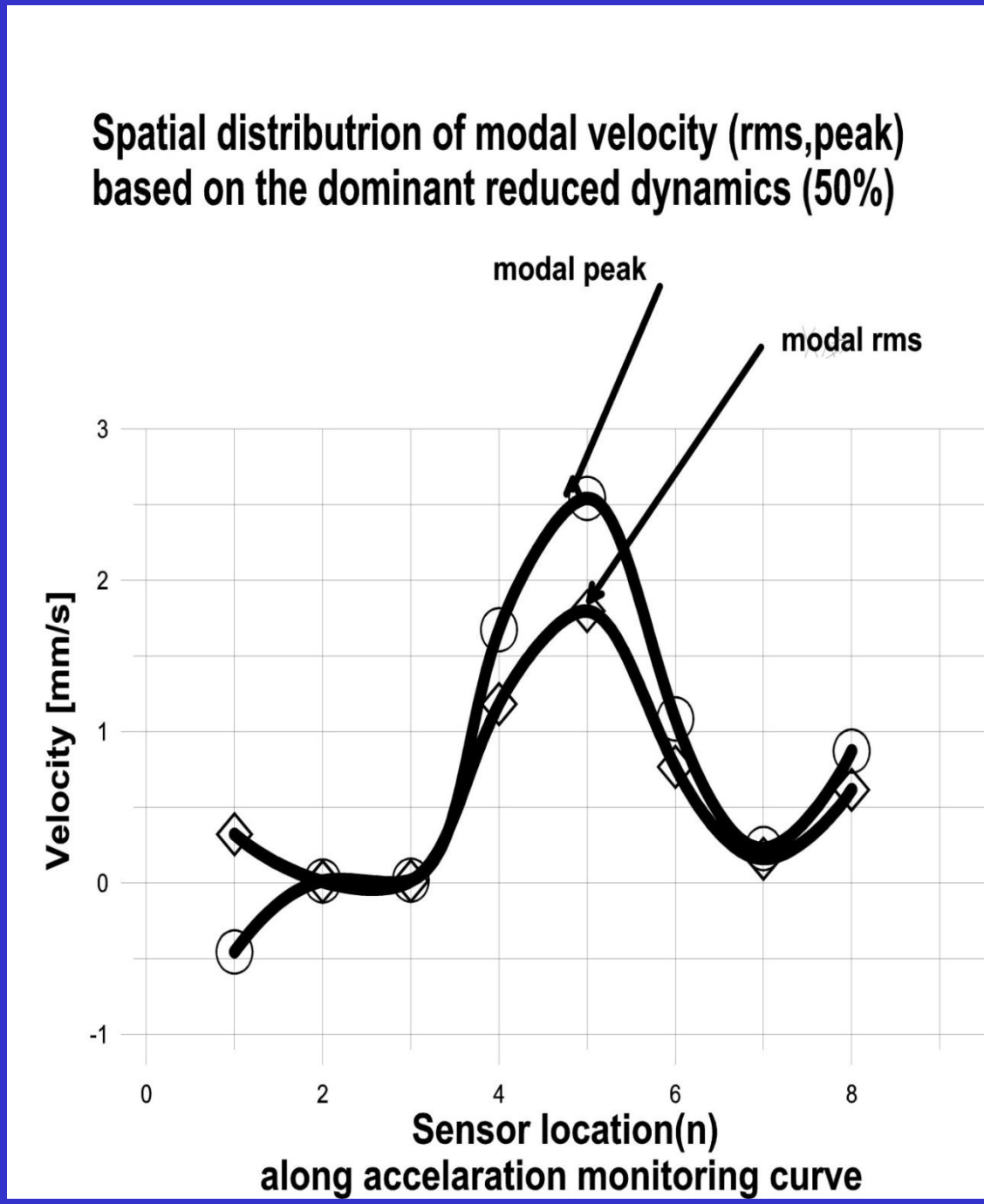


CRITICAL VIBRATION SHAPE II

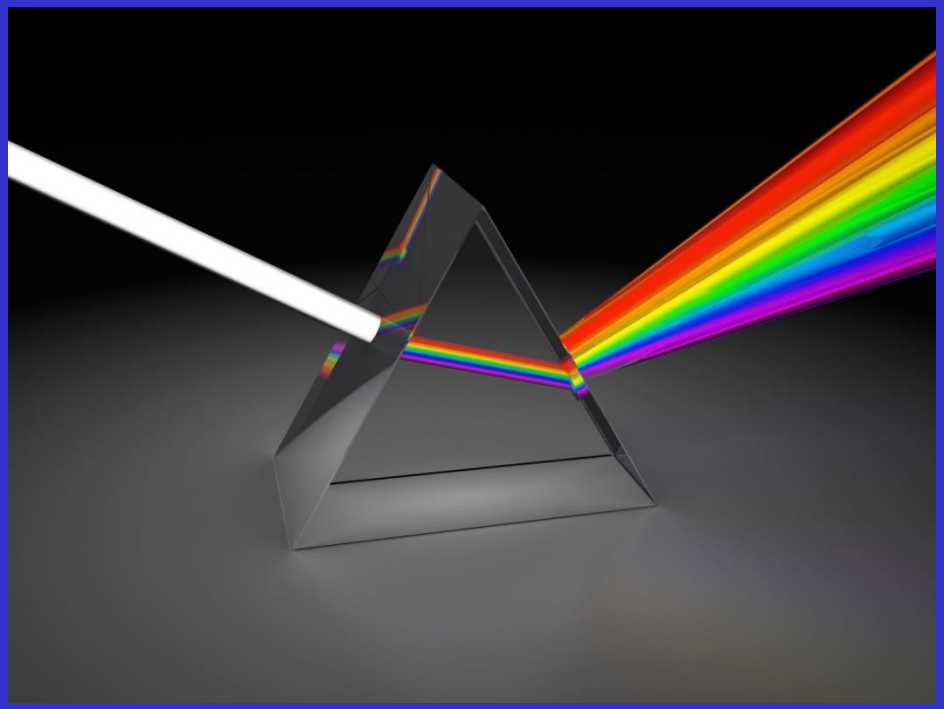


DIANGOSIS: PROPELLER DISK INCLINATION AND UNBALANCE

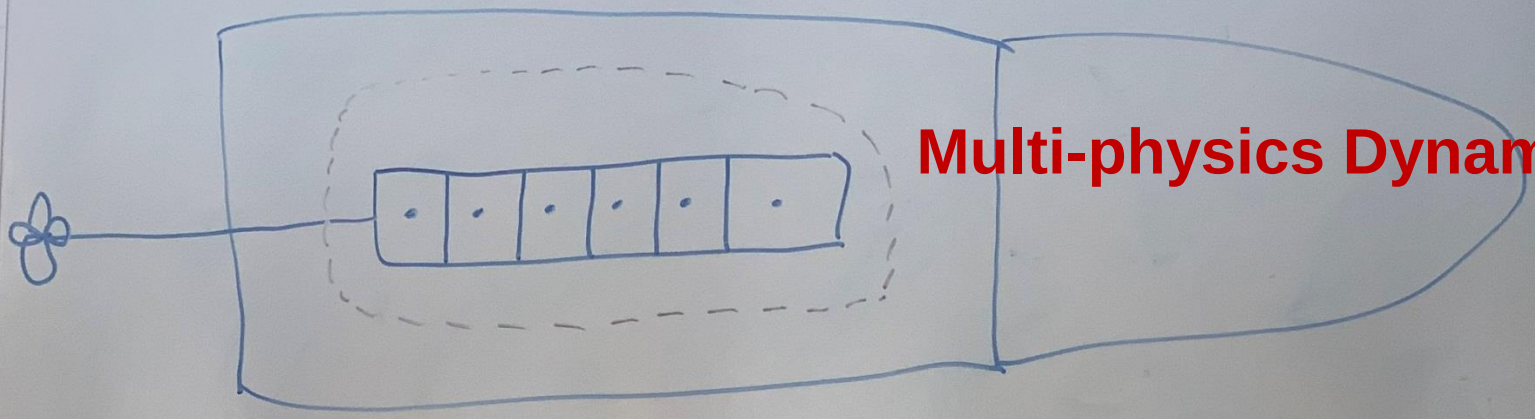
CRITICAL DISTRIBUTED VIBRATION INDEX VERTICAL



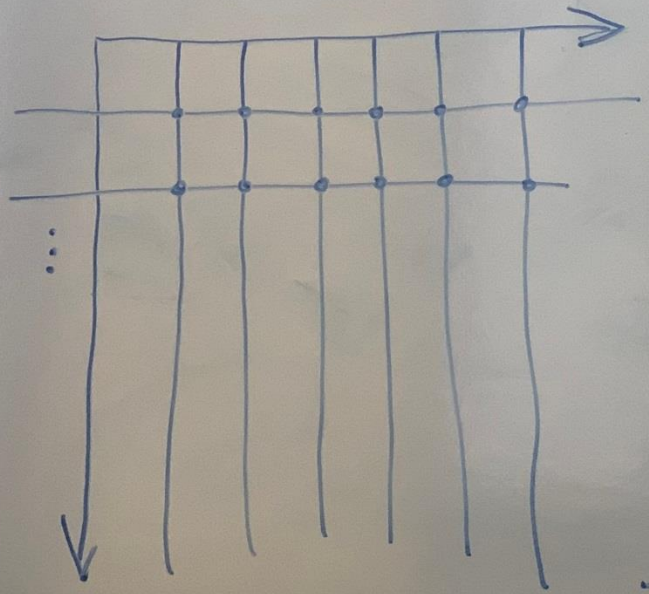
Β.Έγκαιρη Δίαγνωση Δεικτών Ανωμαλίας Προβλήματα λειτουργίας μεγάλων ναυτικών κινητήρων λόγω βλαβών στους κυλίνδρους, μεταξύ άλλων.
Multi-physics Dynamics



The Ship platform



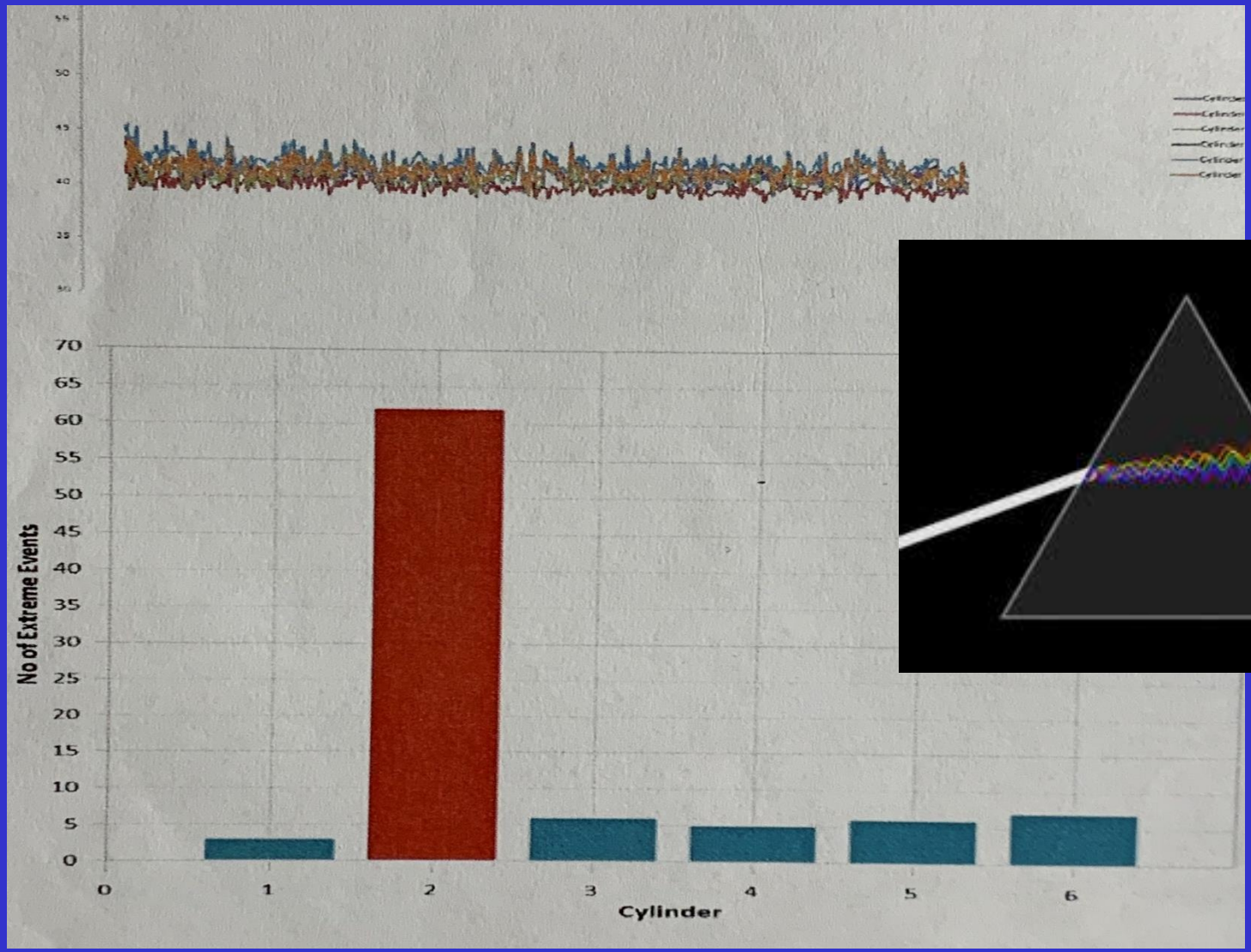
Multi-physics Dynamics



Whole Engine
Cylinders pressure
data set

Complex Dynamical
System

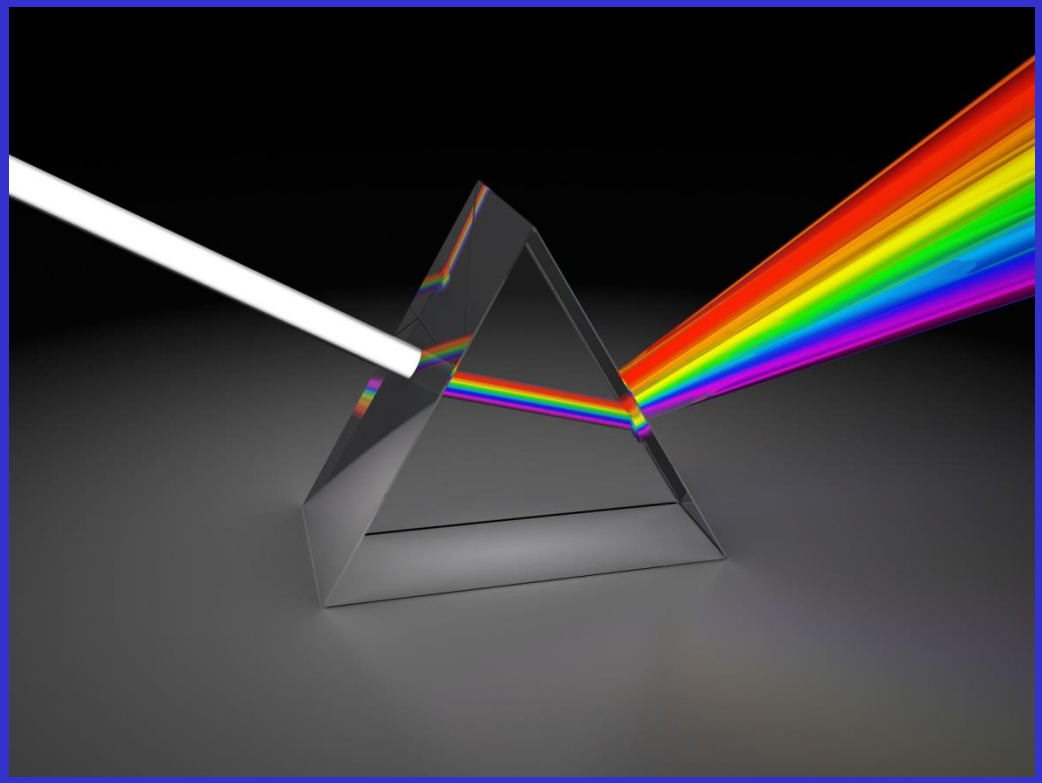
INDEX OF EXTREME EVENTS



CYLINDER NUMBER (SPACE VARIABLE)

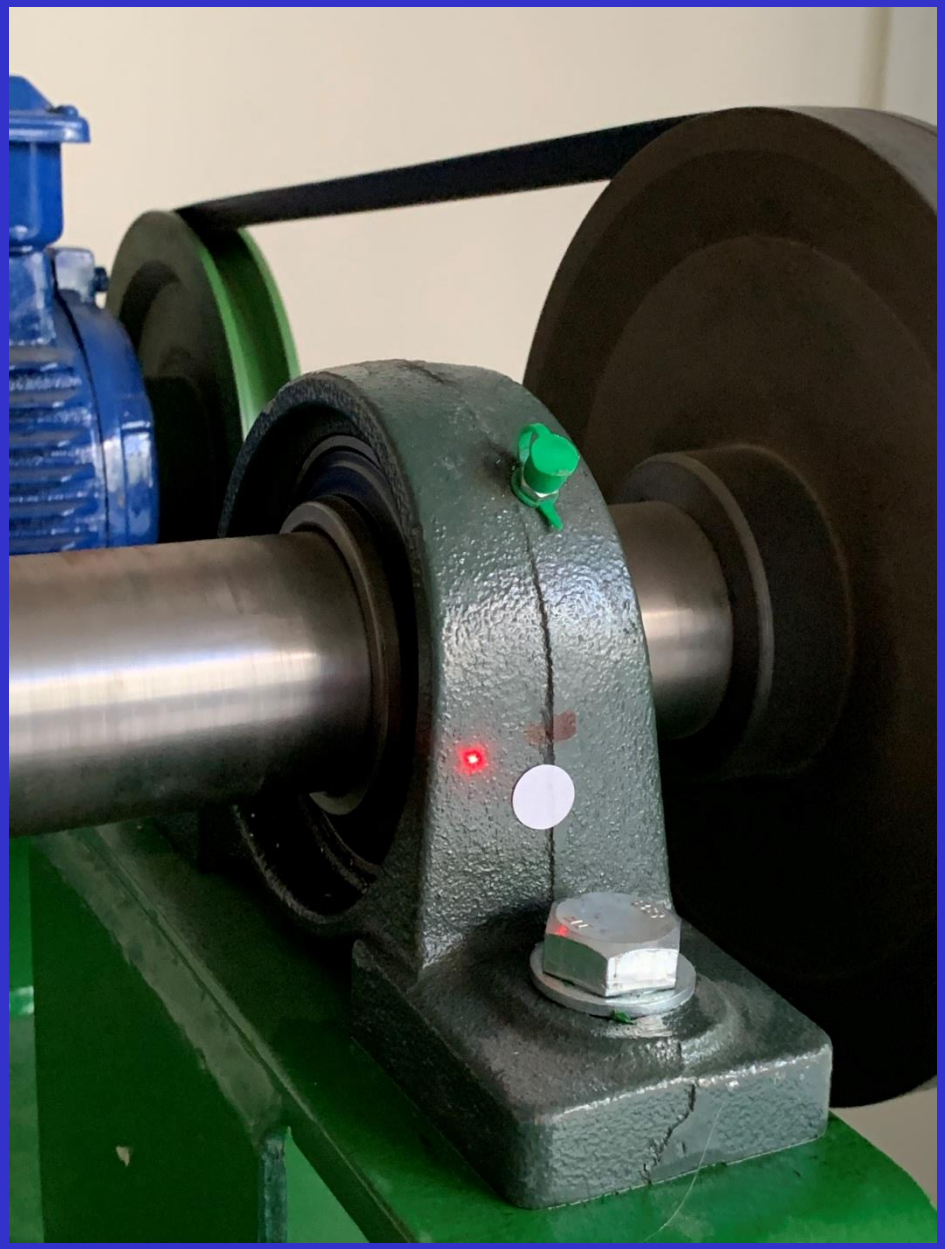
Αποτέλεσμα της εμπειρίας Ποσειδώνας είναι η ΕΚΚΟΛΑΨΗ τεχνολογιων Προχωρημένης Διαγνωστικής όχι μόνο για τις δυο κατηγορίες, αλλά και για πόλλες άλλες στη Ναυτιλία, προβλημάτων που λύσαμε και τα οποία αποτέλεσαν την αρένα εξαγωγής γνώσης από δεδομένα δυναμικής από πραγματικά υπάρχοντα πολύπλοκα συστήματα.

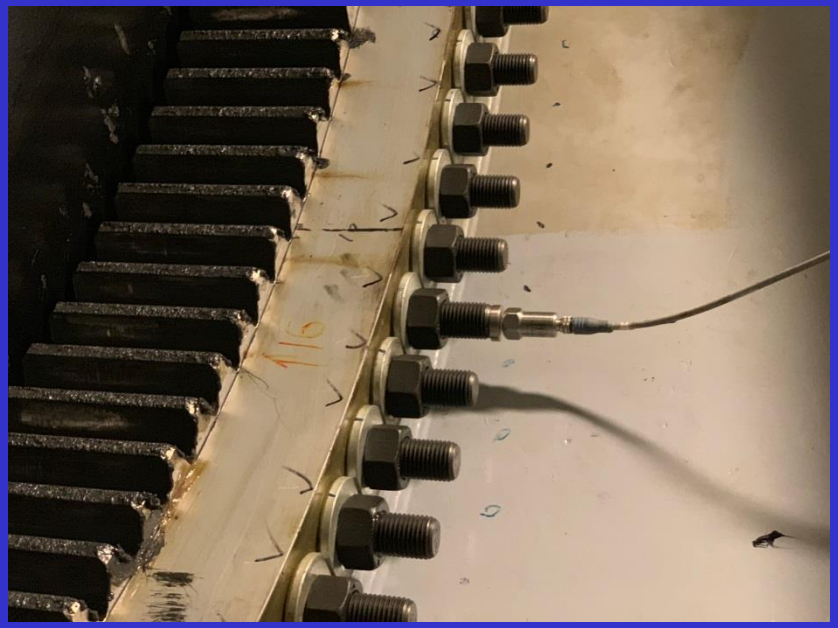
Η επεξεργασία μεγάλων όγκων δεδομένων με την μέθοδο των Προχωρημένων Ορθοκανονικών Προβολών (Advanced Proper Orthogonal Decompositions & Projections) τοποθετεί μια βάση για μια άνευ προηγούμενου Βαθεία Μηχανική Εκμάθηση, και η ποια μπορεί να αποτελέσει μία βάση για προχωρημένη διαγνωστική και προγνωστικη με τεχνητή νοημοσύνη.



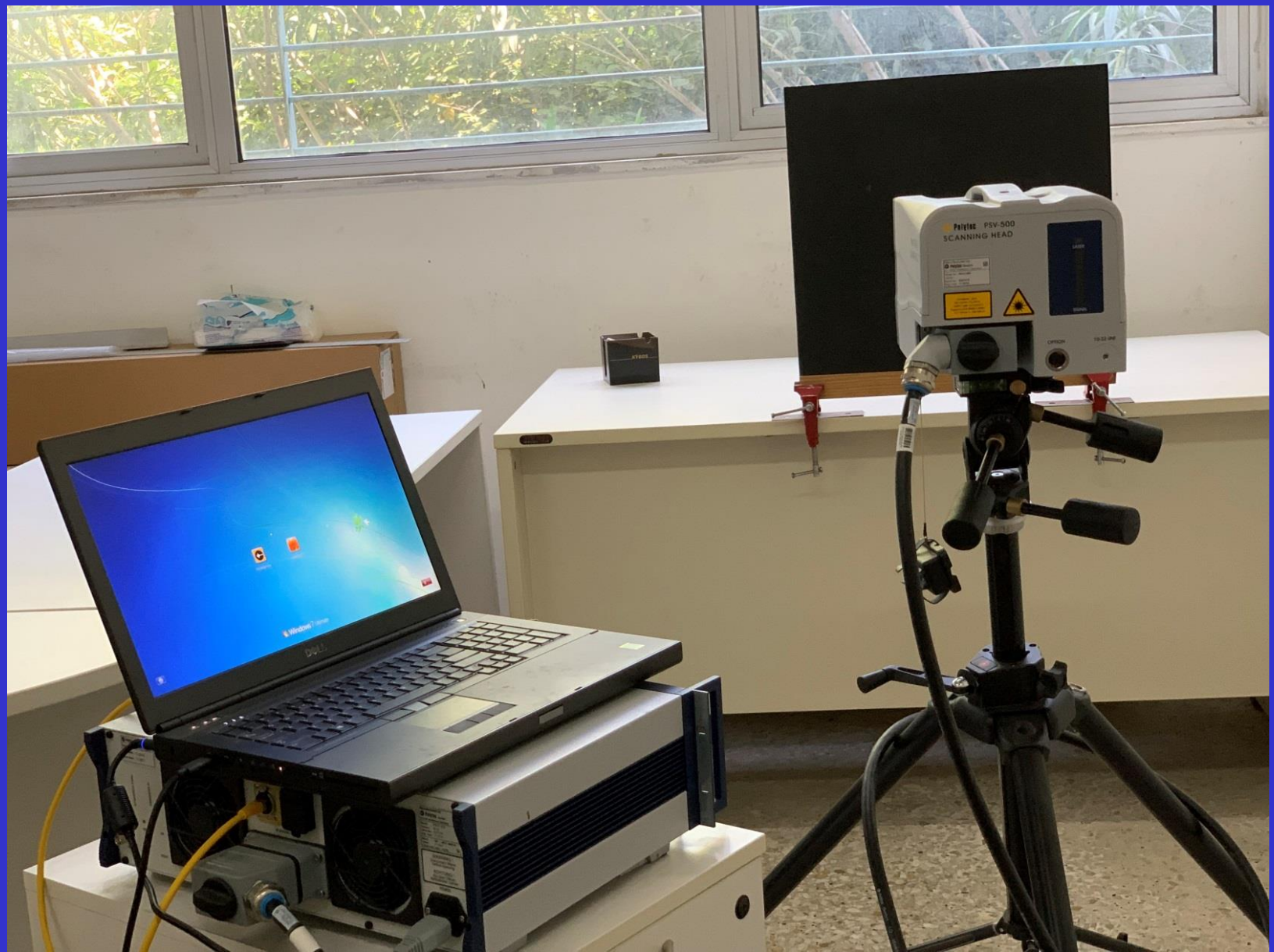
Πέρα από την επιτυχή λύση, η Δράση προσεφερε το έδαφος για Βαθειά Μηχανική Εκμάθηση απο την πλέον αποτελεσματική επεξεργασία Στοχευμένων Μεγάλων Δεδομένων που δημιουργήσαμε με τον σχεδιασμό και κατασκευή συσκεύης συλλογής πολυκάναλων δεδομένων, αλλά και απο ήδη υπάρχοντα μεγάλα δεδομένα ναυτικών κινητήρων που συλλέγονται από τους κατασκευαστές των τελευταίων και τα οποία ήταν ανεκμετάλλευτα ως προς της εξαγωγή Δεικτών Διάγνωσης Άνωμαλιων Λειτουργίας.

Incubation of Innovative Technologies for Early Fault Diagnostics in Shipping: Deep Machine Learning by Targeted Big Data Sets of Dynamics





Dynamics-Acoustics & Diagnostics of Complex Structures Laboratory Unit, NTUA



2020 | OriginalPaper | Chapter

10. Energy Flow Considerations in Nonlinear Systems on the Basis of Interesting Experiments with Three Paradigmatic Physical Systems in Engineering

Author: Ioannis T. Georgiou

Publisher: Springer International Publishing

Published in: IUTAM Symposium on Exploiting Nonlinear Dynamics for Engineering Systems

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Abstract

Nonlinear dynamical systems host types of centra
dynamics-phenomena whose phase space dynam
structure allows potentially the appearance of

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Enabling Intelligent Life-cycle Health Management for Industry Internet of Things (IIOT)

Proceedings of the Twelfth International Workshop on Structural Health Monitoring, September 10–12, 2019

Edited by: Fu-Kuo Chang, *Department of Aeronautics and Astronautics, Stanford University, USA,* Alfredo Güemes, E.T.S.I. Aeronauticos, Universidad Politecnica de Madrid, Madrid, Spain and Fotis Kopsaftopoulos, *Department of Mechanical, Aerospace and Nuclear Engineering, Rensselaer Polytechnic Institute*

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Description

Table of Contents

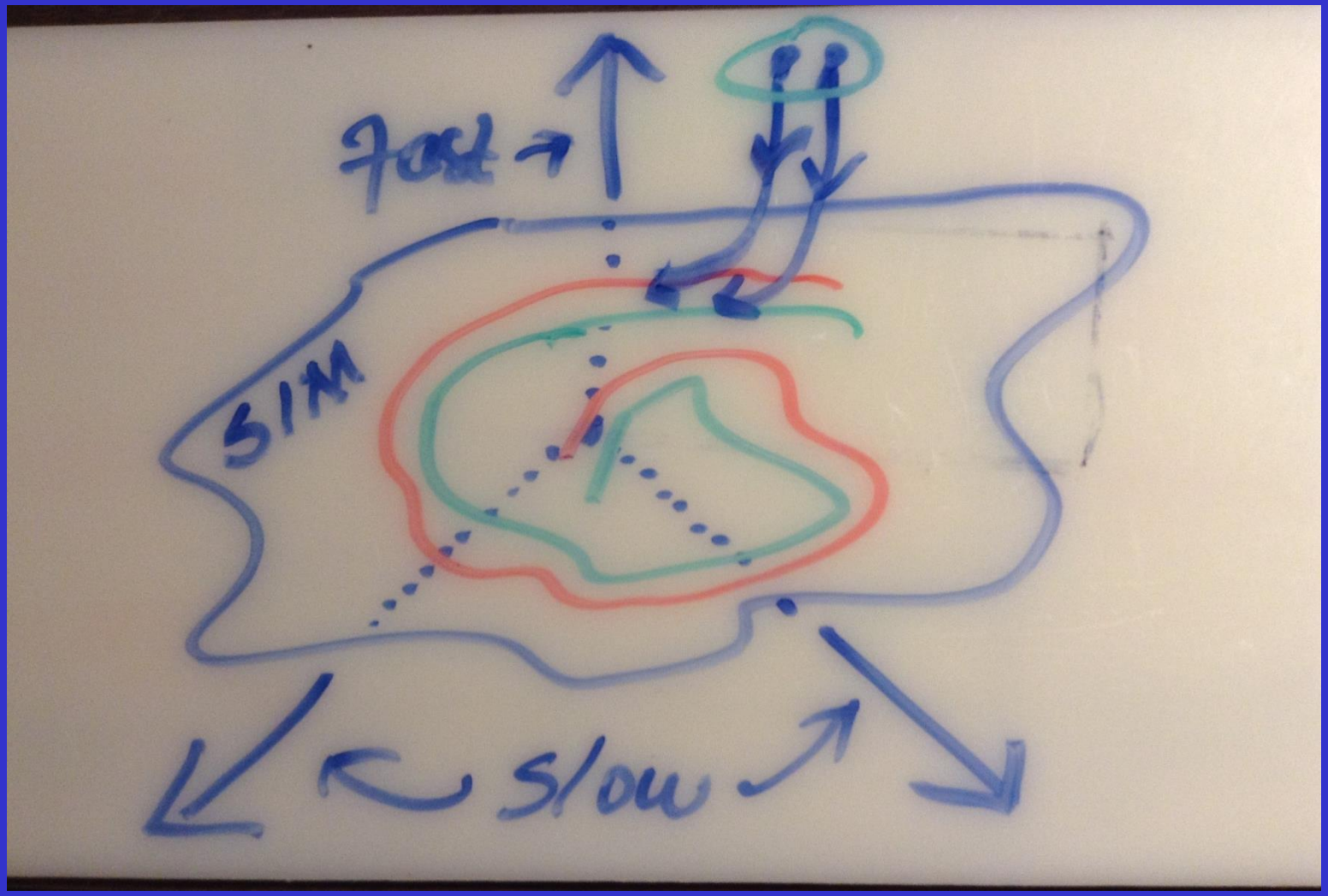
Ensemble II

"signals of same physics fixed spatial point"

Steps:

Interrogation pulse at a fixed point on the soft substructure (blade). Small energy level. Measure velocity response at a fixed point on stiff substructure (aluminum alloy beam)

Compute POD transform (ensemble II)
+Physics of POD modes
Example: 20-signals ensemble
signals are of small energy level


SLOW