

Pioneer in hybrid MEMS technologies

PowerMEMS: Electrostatic stepper micromotors
ChronoMEMS: Energyless detectors and counters
MyMEMS: Innovative engineering in micromechanics

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OUR TECHNOLOGIES

AREAS OF APPLICATION

MANUFACTURING PROCESS

Based in Besançon, SilMach is an SME at the confluence of watchmaking heritage and the ultra-precision of microtechnologies

A pioneering deeptech in the field of hybrid MEMS



20 years
FOUNDATION

19 December 2003



HEAD OFFICE

Besançon, France



TEAM

28 engineers and technicians



KNOW-HOW

Hybrid MEMS* Solutions
(*Micro-Electro-Mechanical Systems)



ISO 9001/2015 CERTIFIED

Quality Management Systems

Silicon

- Tetravalent metalloid and semiconductor -> raw material for microelectronics and MEMS (Micro-Electro-Mechanical Systems)
- Purely brittle elastic behavior, high yield strength
- Wide operating temperature range, from very low T° to several hundred $^\circ\text{C}$
- Insensitive to corrosion and magnetic fields



Silicon

Main properties



Silicon wafer: form of use

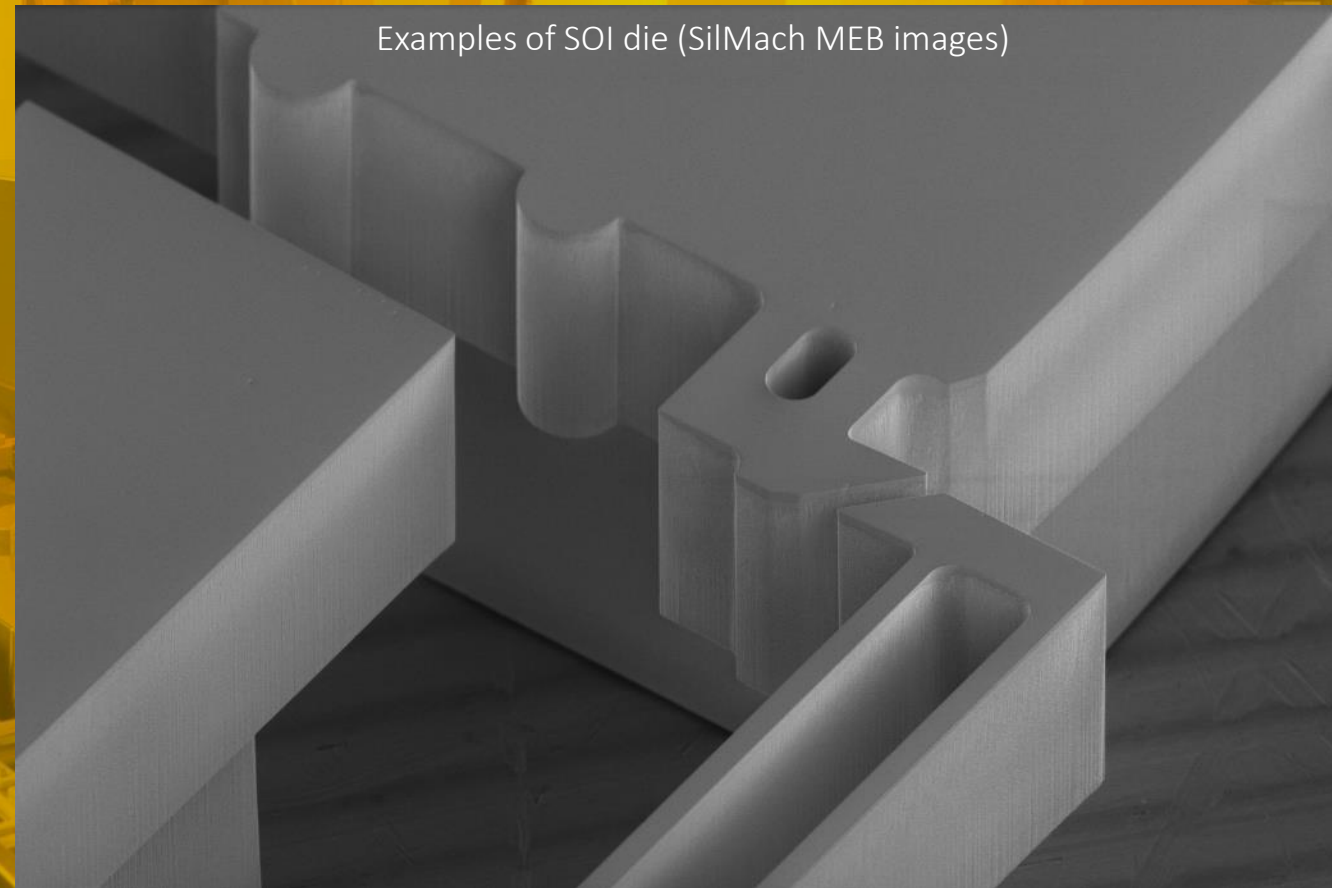


- Wafer engraving methods are manufacturing techniques for mass production
- They make it possible to duplicate chips in large quantities as soon as the production process is stabilized.

MEMS chips are designed and manufactured by SilMach in the MIMENTO FEMTO-ST clean room at Besançon

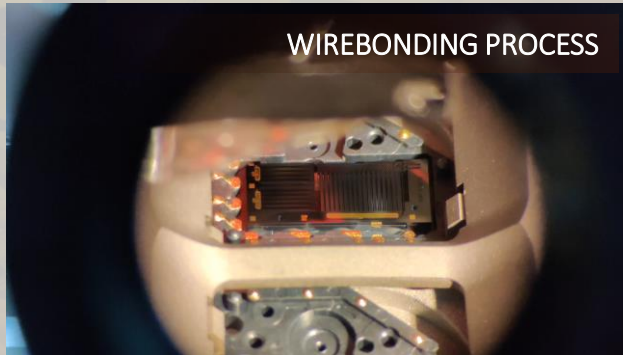
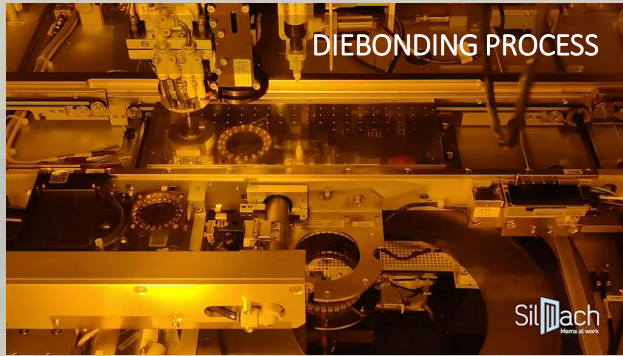
Silicon etching: manufacturing MEMS chips

- Creation of very precise engraving patterns from mask techniques over great depths (up to several 100 μm)
- Manufacture of parts for purely mechanical (passive component) or electromechanical (active component) functionalities



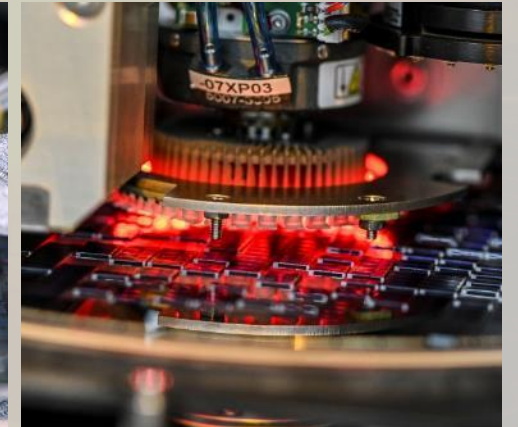
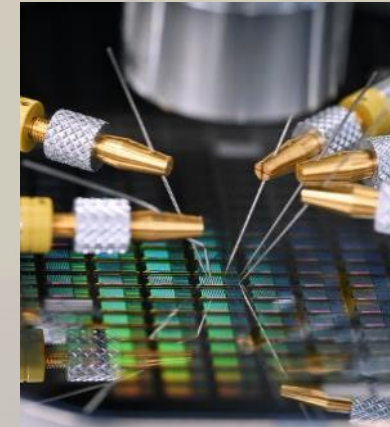
ASSEMBLY OF MEMS DIES BY HYBRIDIZATION: a SilMach technology

MANUFACTURING AND ASSEMBLY



Clean room at SilMach

TESTS

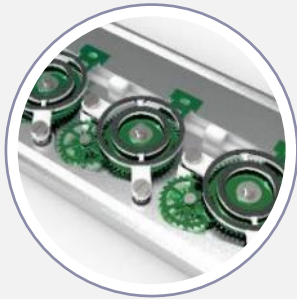


Testing facilities at SilMach

SilMach

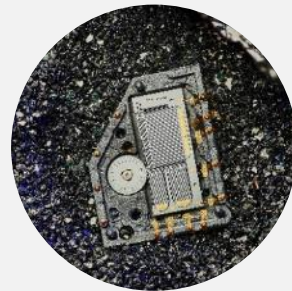
Mems at work

ChronoMems



SHM SENSORS
ENERGY FREE

PowerMems



MICROMOTORS AND MICROMACHINES
Hybrid MEMS

MyMems



MANUFACTURE & ASSEMBLY OF
MEMS SYSTEMS
On demand



+60 patents



+40 clients

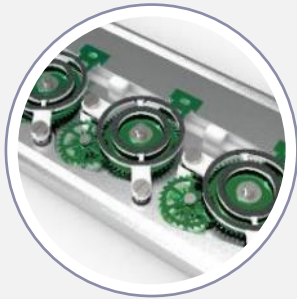


Made in France

SilMach

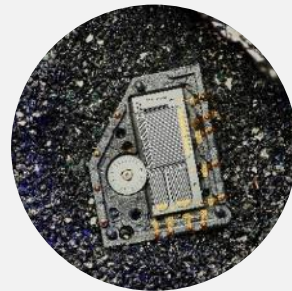
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Made in France

The first ever hybrid MEMS micromotor for electronics

A stepper micromotor, direct drive, CW/CCW directly integrable on your PCB



Ultracompact

Ultra low consumption

Amagnetic

SMT compatible

No lubricant

Customizable

Exists in different version (one output, two output) and could be adapted to specific requirements

MOTOR BOX 011

Moving 1 single
output (hand)



MOTOR BOX 022

Setting in motion of
2 outputs (hands)

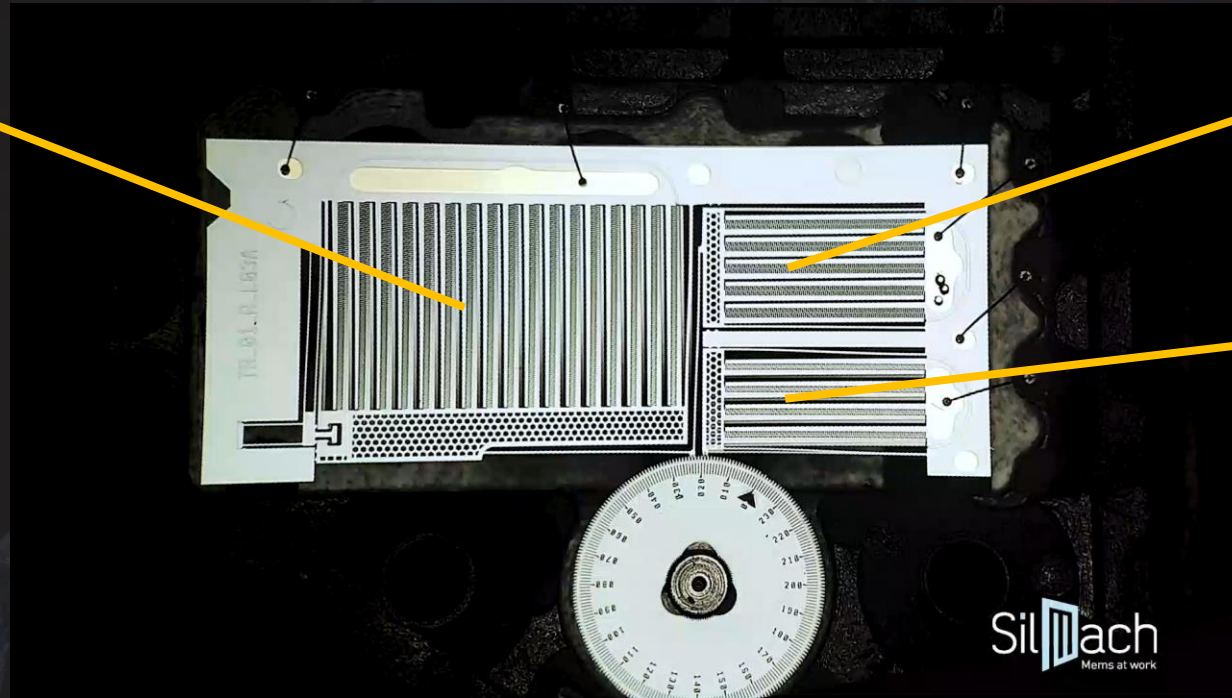
Concentric axis



2 versions of motors: for 1 or 2 outputs, step-by-step motions, CW/CCW, variable speed up to 100 Hz

MICROMOTORS & MICROMACHINES FOR ELECTRONICS

ACTUATOR



CLUTCH

INDEXER

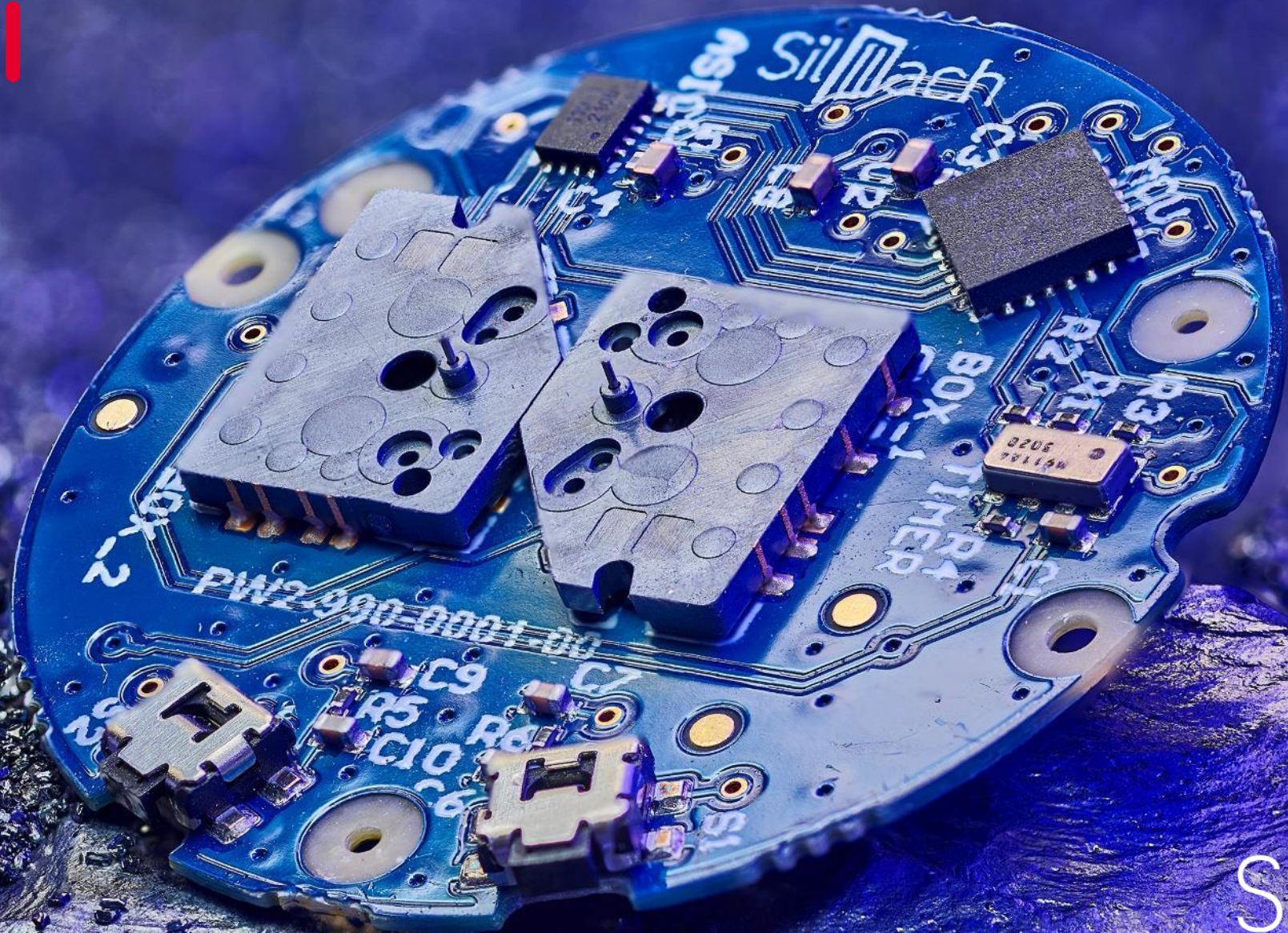
DIRECT DRIVE

ULTRA THIN & REDUCED SIZE

SMT COMPATIBLE

The first ever hybrid MEMS micromotor for electronics

POWERED BY
SILICIUM
MACHINERY



SilMach
Mems at work

SilMach
Mems at work



THE TIME
CHANGER

POWERED BY
SILICIUM
MACHINERY

SilMach
Mems at work



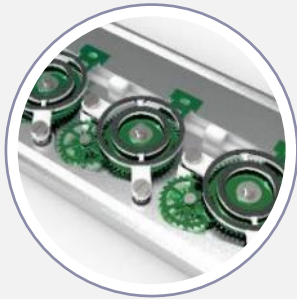
Biomimetics Nanodrones
Integration & miniaturization

4th generation of flying insects

SilMach

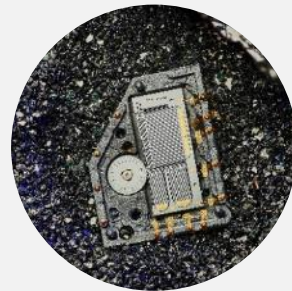
Mems at work

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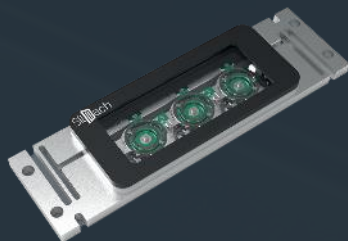


+40 clients



Made in France

EVENT COUNTING



Quasi-static

Strain, deformation, pressure, temperature

MECHANICAL LOADS
& THERMAL IN QUASISTATIC



Dynamic

Accelerations, falls, repeated brutal movements, shooting...

TRANSIENT DYNAMICS

THRESHOLD EXCEEDANCE (ONESHOT)



Quasi-static

Threshold of strain, pressure, critical T° exceeded

MECHANICAL LOADS
& THERMAL IN QUASISTATIC



Dynamic

Detection of fall, shock, acceleration..

TRANSIENT DYNAMICS

MICROMECHANICAL SENSOR



Without energy



Compatible Atex

XXS Micro Size

MICRODONNÉES



Accurate & targeted



Reliable and secure



Energy frugality
Minimal carbon impact

The ChronoMEMS system is available on 3 levels to offer a monitoring service adapted as accurately as possible to the use case

100% PASSIVE SOLUTIONS

1

ChronoMEMS
Optical

READING ON THE SENSOR

Optical :

Eye or smartphone snapshot

Digital :

Smartphone snapshot & image analysis Apps

2

ChronoMEMS
Energyless RFID

NEAR REMOTE READING

Reading through a
RFID terminal

3

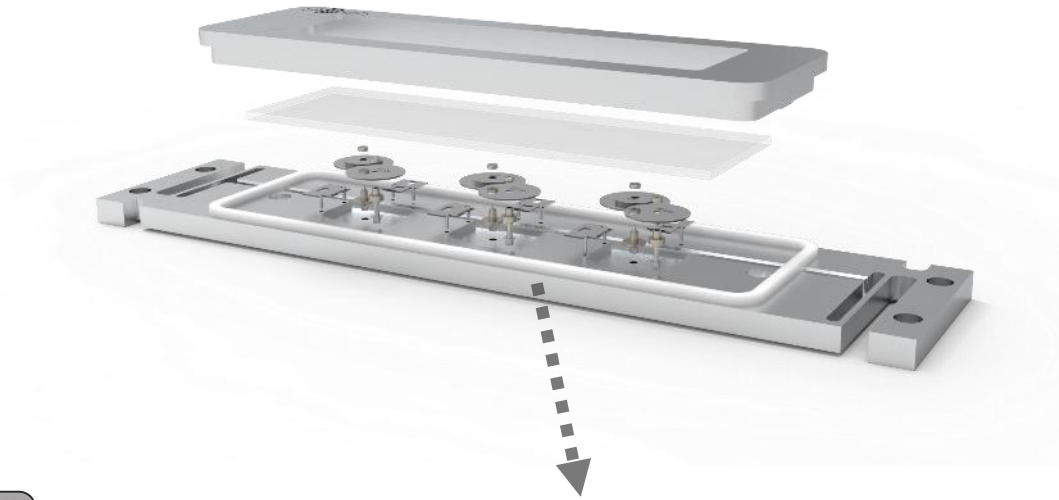
ChronoMEMS
Connected

REMOTE MONITORING, SENSOR FLEET MANAGEMENT

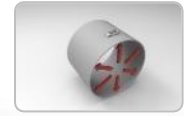
Data transfer by RF,
Communication network

HYBRID SOLUTION

Passive sensor / Active transmission



Strain



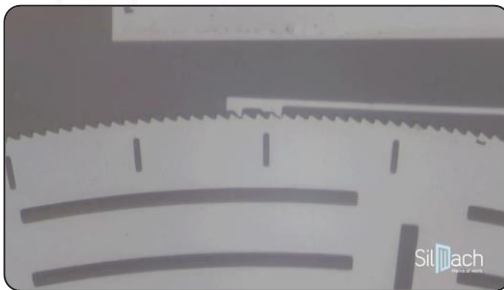
Pressure

SEUILS DE COMPTAGE

D'une dizaine à plusieurs centaines de micromètres
D'une dizaine de MPa à plus de mille Mpa

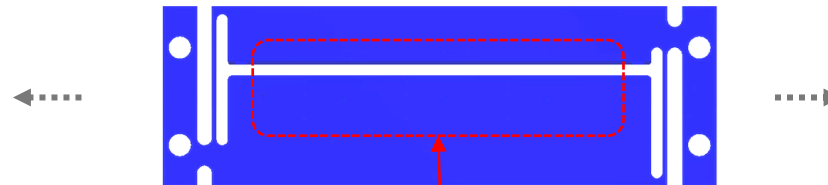


EVENT COUNTING



Counting wheel principle
Increments = exceeding preset threshold
Several side-by-side sensors possible
Optical or remote reading

Straining body



Relative motion



FUSE-LIKE SYSTEM



« one-shot » fuse-like principle
Breakage = exceeding preset threshold
Several side-by-side one-shot sensors possible
Optical or remote reading

Chronoems

SPRAT FATIGUE MONITORING (IN SERVICE)

Military Engineering SHM



- Operational monitoring of the equipment
- Detection and counting of vehicles passage (3 classes)
- Computation of the damage rate
- Determining residual useful life

In service since 2012



Airliner applications

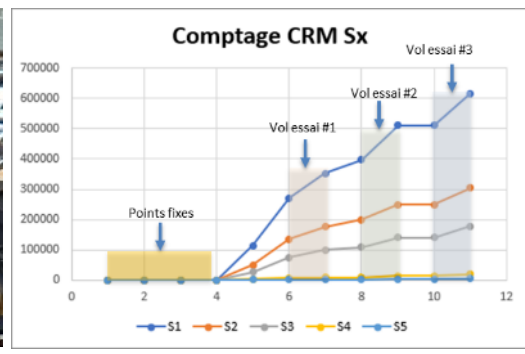


Detection of abnormal events on landing gear (hard landing, runway excursion, trolley incident)

One-shot technology (GO/NOGO indicator)

Evaluation on test aircraft for 2 years

TRL6 aero version with optical display and TRL5 with RFID



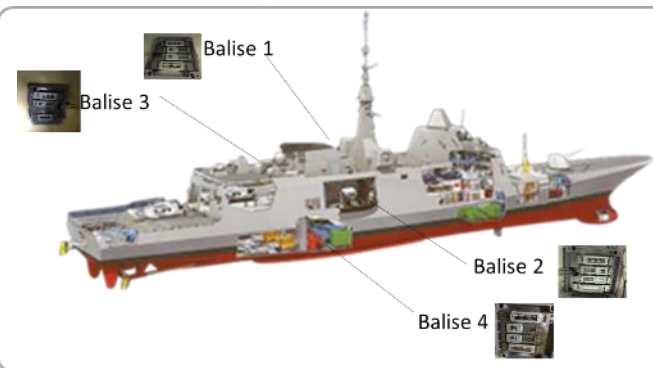
Helicopter applications



Overload detection on rear rotor elements Structure monitoring & Fatigue monitoring of rotating parts

Evaluation on helicopters

TRL6 helicopter version with optical display



Monitoring boat hulls



Fatigue monitoring of ship hulls

In-service evaluation over 44 months

Experimentation with RFID interrogation technology

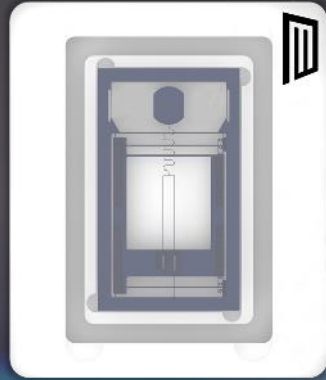
TRL6 naval version with optical display

ENERGY-FREE SHOCK & T° SENSORS

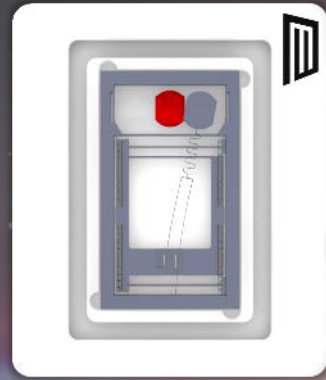
Initially designed for space, these new generation sensors completely overcome energy and time constraints. Accurate, robust and reliable, they provide H24/7 monitoring over unlimited service lives.

G₀os

Shock detection



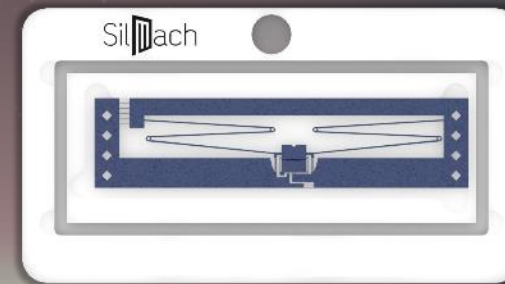
OK



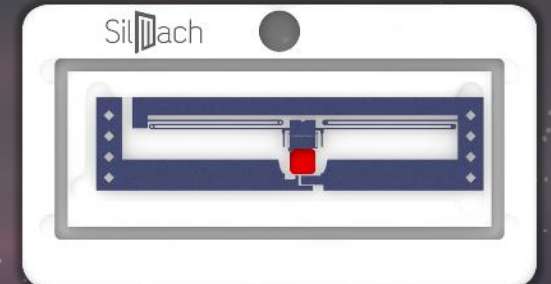
KO

Ther₀os

Excessive T° detection



OK

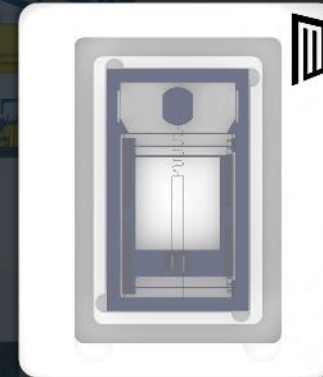


KO

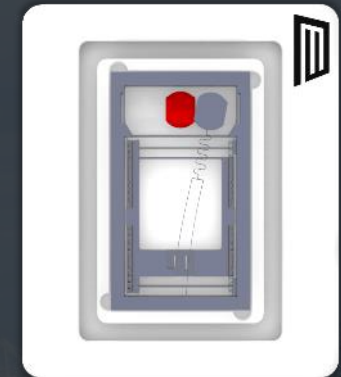
SHOCK DETECTION (LOGISTICAL INCIDENT)



Shock detection



OK



KO

Special event : One-Shot technology

DIVERSIFICATION

MONITORING OF CONTAINERS & SHELTERS, OR ANY MONITORING OF FRAGIL/HIGH-VALUE/SAFETY COMPONENTS

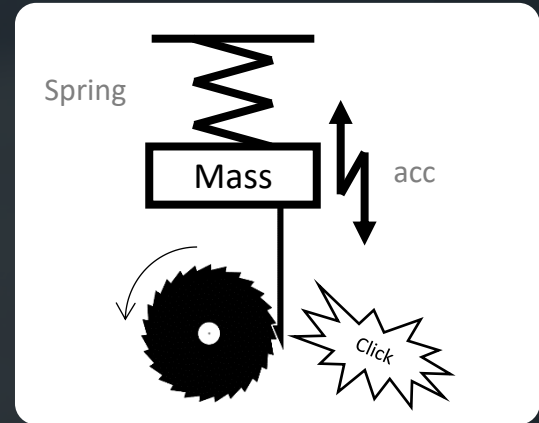


COUNTING ACCELERATIONS WITHOUT ENERGIE

Counter to record the passing of acceleration thresholds from a few G to 2000 G

Inertial system (mass\spring), 100% passive

Developped for rifle application for the French Army



Merci pour votre attention