A generational change in vibration sensing and motion tracking

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Agenda

Sensor requirements in industrial applications

Enabling leadership in Industry 5.0 through MEMS

Industry 4.0

Motion, vibration, Angle Measurement		Motion sensors Inclinometers
Temperature monitoring & calibration		Temperature sensors
Pressure monitoring		Pressure sensors
Humidity monitoring		Humidity sensors
Acoustic monitoring		MEMS microphones

Industry 5.0

Advanced interface	
Artificial intelligence in the edge	
Automation	
Visual aid Laser beam scanning	
Infrared sensor	

Human centric
Helping individuals while working

Resilient
Based on versatile technology

Sustainable
Conceived to optimize processes

Condition monitoring
Predictive maintenance

Industrial
automation

Smart
installations

Asset
tracking

Vibration sensors – Condition monitoring

Machine conditions

Conditions start to change

Ultrasound

Vibration

Power / current

Magnetic field

Air pressure

Noise

Temperature

Smoke

Failure

minutes

days

weeks

months

Time

Imbalance

Looseness

Output shaft

Gear Mesh
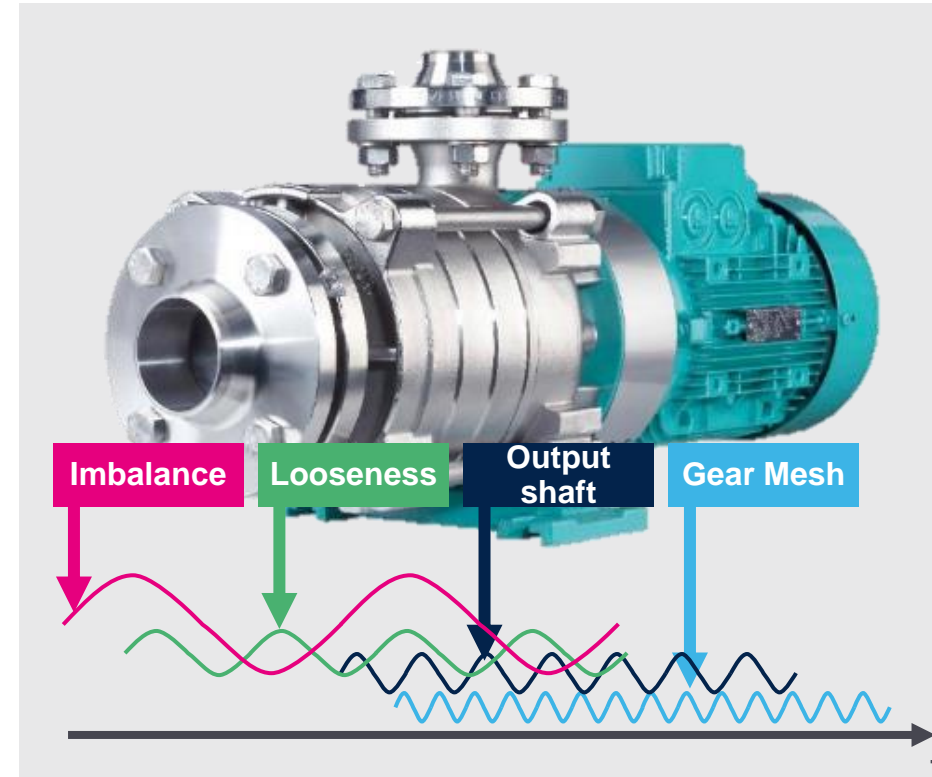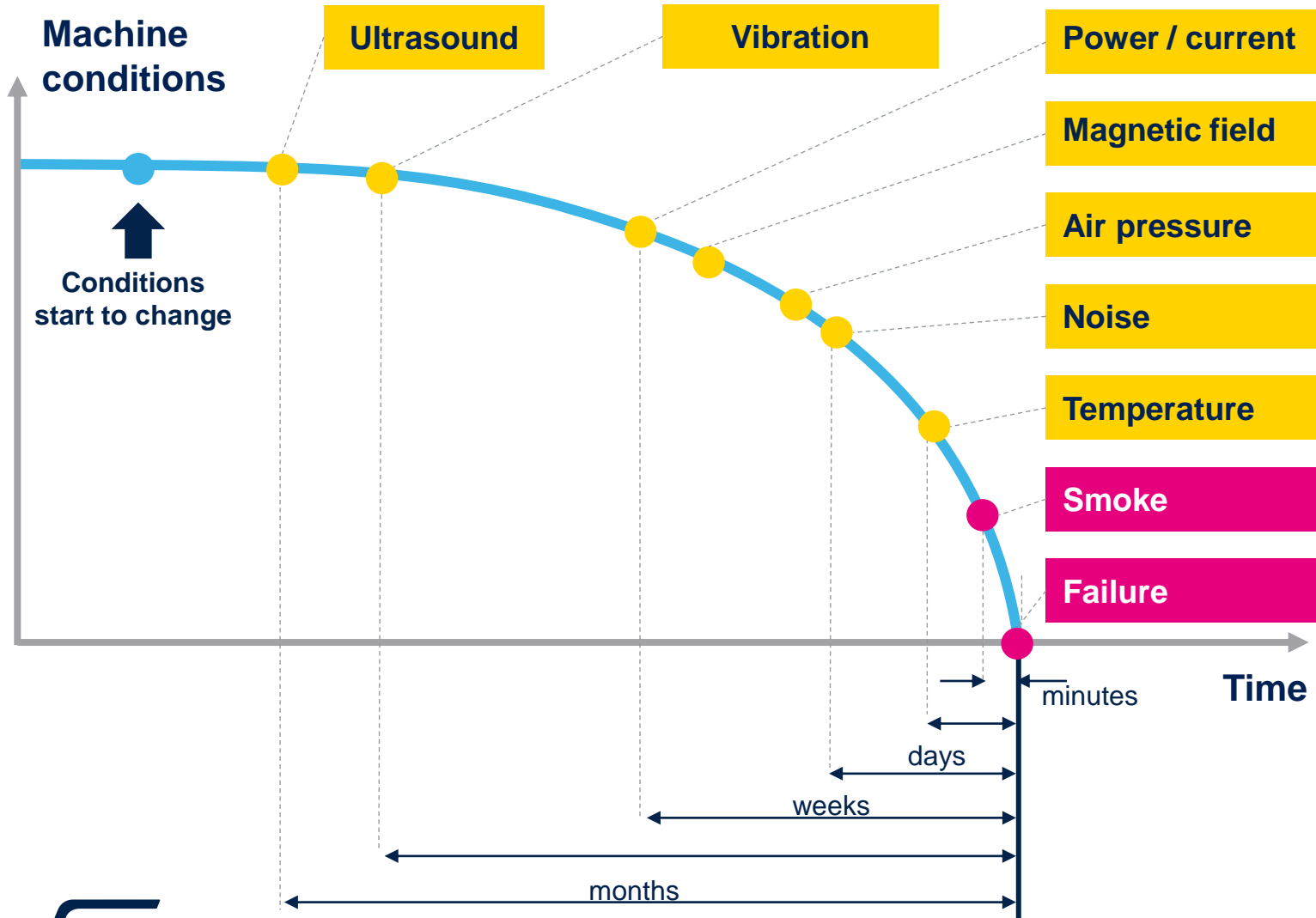
Mechanical vibration

- Displacement
- Speed
- Acceleration
- Angular speed
- Torque
- Acoustic noise

ISM330BX: the new smart industrial IMU

ISM330BX for condition monitoring

Machine conditions

Ultrasound

Vibration

ISM330BX

Conditions start to change

Power / current

Magnetic field

Noise

Temperature

Smoke

Failure

The curve slope depends on the life cycle of the equipment

min

days

weeks

months

Time

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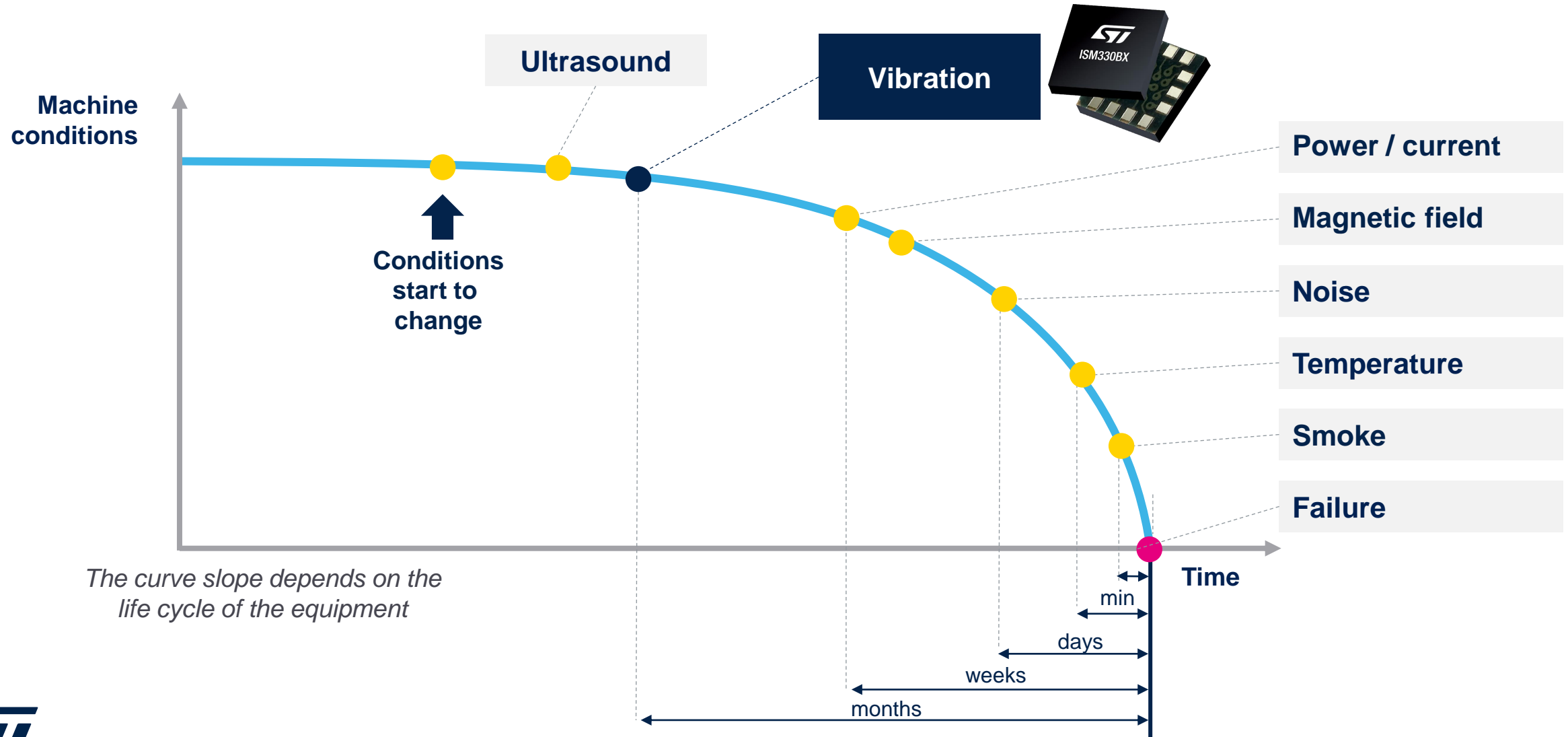
An intelligent & versatile IMU that does all by itself

ISM330BX

Condition monitoring	Robotics	Safety helmets	Appliances
Unique 3-axis accelerometer with low noise and wide bandwidth	3D orientation tracking with sensor fusion low power (SFLP) + vibration sensing	Proper helmet wearing, 3D orientation, shock events, free fall, man down	Vibration measurements and compensation, water leak detection, anomaly detection, tilt measurement

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ISM330BX
for condition monitoring

Machine learning

Data analysis

Local processing + connectivity

Set parameters, triggers, and trends

Attach sensors + collect data

Predictive maintenance

Condition monitoring

ISM330BX for robots
The self-sufficient IMU!

3D orientation tracking with embedded sensor fusion low power (SFLP)

Condition monitoring through vibration sensing

Touch sense with Qvar
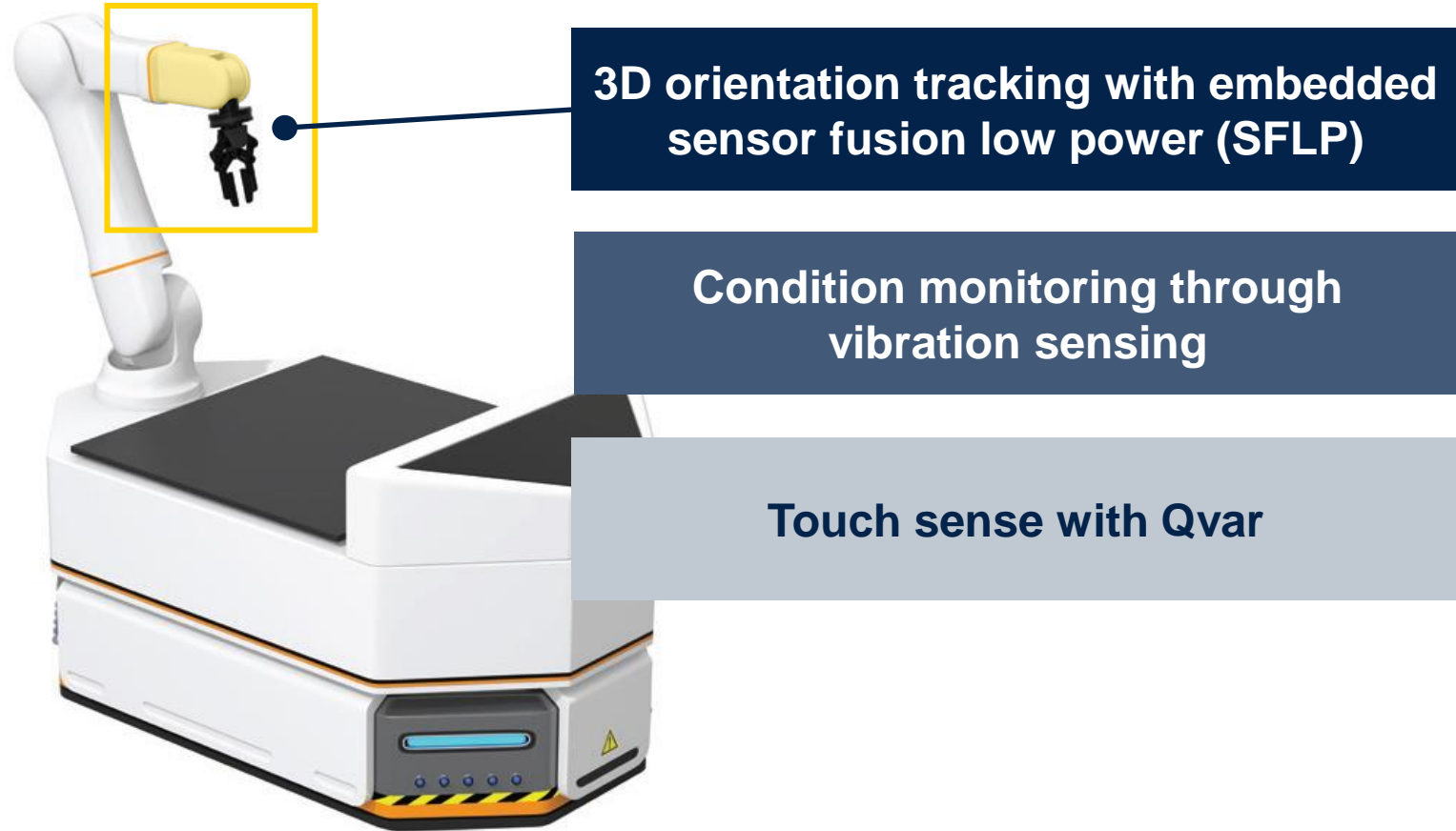
ISM330BX for appliances you just need it!

Drum balancing / vibration compensation
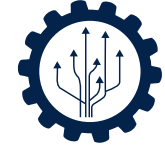
Anomaly detection / failure detection

Water leak detection with Qvar

ISM330BX

3rd generation 6-axis IMU with a wide bandwidth, low-noise 3-axis accelerometer

Multiple interfaces: SPI, I^{3}C v1.1, TDM (for accelerometer only)

FS: Gyroscope 4000 dps, accelerometer 8 g

Intelligent sensor: MLC & FSM 2.0, ASC, sensor fusion low power (SFLP)

Embedded FIFO: 1.5 Kbyte (4.5 Kbyte with compression)

Accelerometer: up to 2 kHz bandwidth on 3 axis with flat frequency response

Low noise accelerometer: 70 µg/√Hz SPI – 30 µg/√Hz TDM

Low noise gyroscope: 4.5 mdps/√Hz

Low power consumption: 0.19 mA axel HP; 0.6 mA combo HP

Package: LGA 2.5 x 3 x 0.71 14L

Key applications: condition monitoring, robotics, motion tracking, white goods, hearing aids, helmets for workers
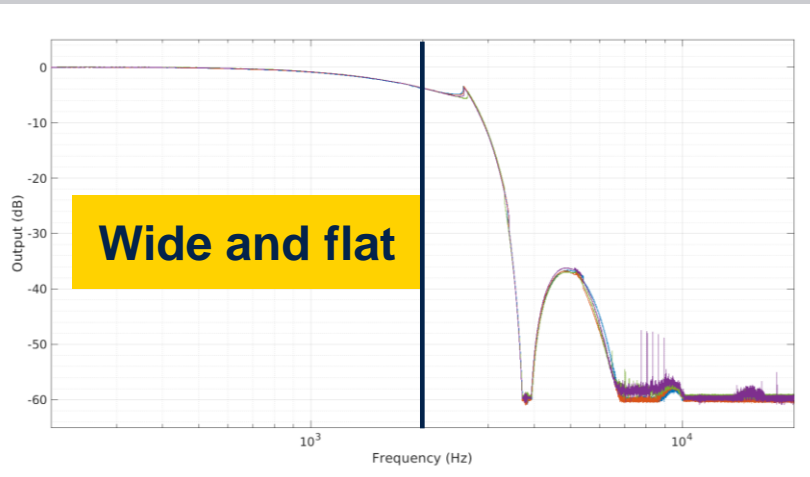
LONGEVITY 10 YEARS COMMITMENT

iNEMO

Qvar

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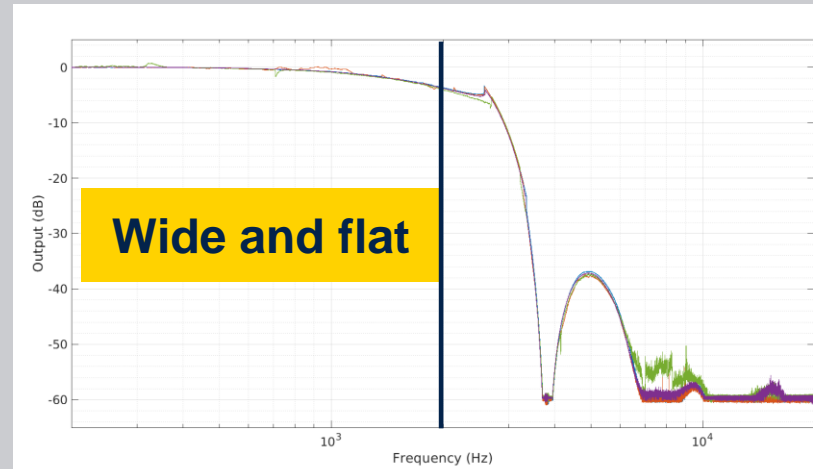
ISM330BX offers a unique accelerometer Wide, flat, repeatable frequency response

ISM330BX accelerometer: frequency response

Wide and flat — X

Wide and flat — Y
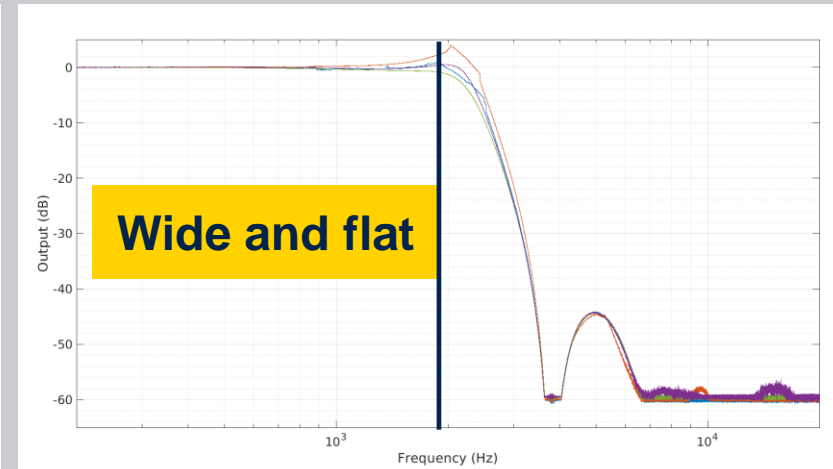
Wide and flat — Z

Perfect to fulfill ISO10816 vibration severity standards

Vibration sensing for condition monitoring ST Offer

Use cases

Unbalance Looseness Misalignment	Roller Bearings Gearing Cavitation	Bearings Gear boxes Lubrication	Fan bearings Venting occlusion Cooling failure

Vibration Sensors

- IIS3DWB
- ISM330DHCX / ISM330BX
- AIS25BA
- ISM330IS

NANOEDGE AI

1 2 3 6 10 80 kHz
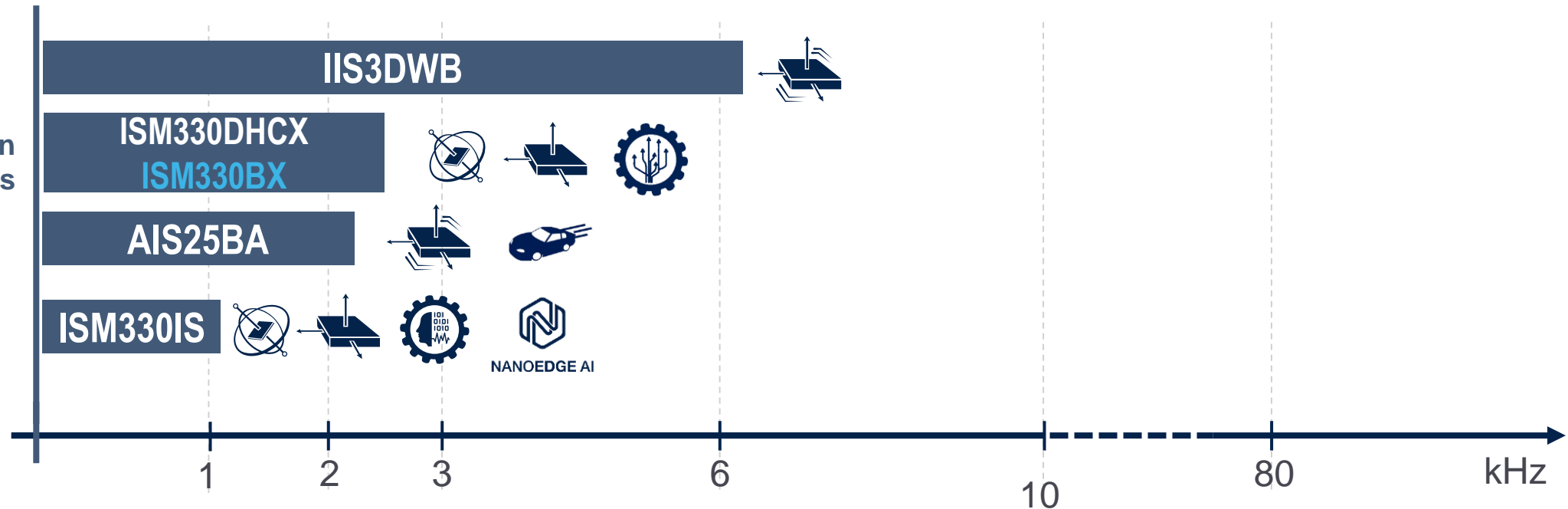
Comparing ISM330BX with other IMUs in the same family

	Bandwidth [kHz]	In-sensor AI	Sensor fusion low power	Embedded Qvar (electrostatic sensor)	Package size [mm]
ISM330BX	2	MLC and FSM	Yes	Yes	2.5 x 3.0 x 0.71 LGA-14L
IIS3DWB	6	-	-	No	2.5 x 3.0 x 0.86 LGA-14L
ISM330DHCX	2	MLC and FSM	-	No	2.5 x 3.0 x 0.86 LGA-14L
AIS25BA	2	-	-	No	2.5 x 3.0 x 0.86 LGA-14L
ISM330IS	1	ISPU	Yes (with library)	No	2.5 x 3.0 x 0.86 LGA-14L

ISM330BX is part of longevity program

10 years longevity commitment

ISM330BX

ST focuses on markets requiring long life cycles
Protecting the investments of our customers that need state-of-the-art sensors but have long development, certification or field life cycles

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LONGEVITY 10 YEARS COMMITMENT

| 10-year longevity from product introduction date | Design and manufacturing for higher robustness | Calibration & testing for higher accuracy & quality | Higher endurance to shock and vibration | Industrial temperature range |

ST's longevity program

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ISM330BX moves the intelligence at the edge

MCU computing | In-sensor AI computing

Sensor + MCU

Intelligence in the MCU

MCU standalone or hosted in the sensor package

Standard
MCU runs the algorithms

Runs any kind of software
provided it matches the MCU specs

Sensor with MLC / FSM

Machine Learning Core
Finite State Machine

MLC: reconfigurable processing unit
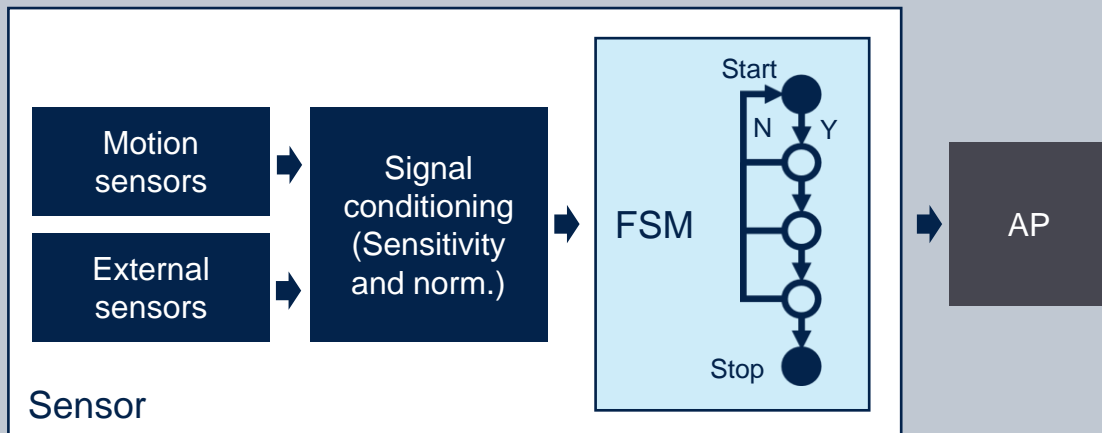integrated in the sensor ASIC

Optimized
Reconfigured through register setting

Constrained
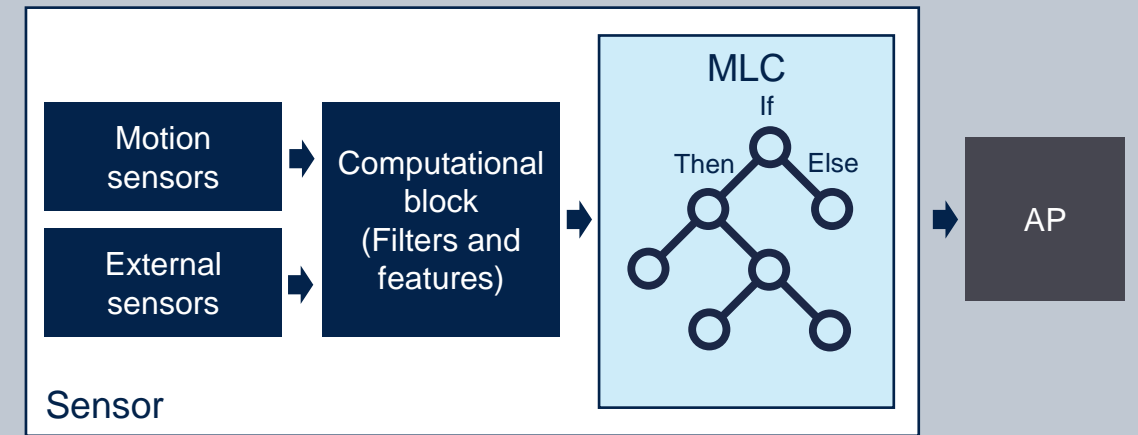Runs the same model / mapping (MLC, FSM)

Edge processing with MLC and FSM

Finite state machine

- FSM is composed of a finite number of user-defined states and transitions between them
- FSM can be in just one of the states and move to another one only if the transition condition is met
- Each state can be composed of command or a next/reset condition

Machine learning core

- The MLC runs predictive models based on a decision-tree logic: a series of configurable nodes characterized by an "if-then-else" condition
- Decision tree is "built" offline through analysis of data sets
- It uses sensor data to compute a set of statistical parameters to identify patterns matching with user-defined classes

# Adaptive self configuration (ASC)

Always perfectly fits the context

ISM330BX

Sensor

Processor	

- Full scale, ODR, BW → Axl
- Power modes → Gyro
- FIFO
- Core with ASC and MLC / FSM

The device automatically **reconfigures itself**, based on the actual context, maximizing the **system efficiency**.

MLC and FSM detect the context without the need of additional data processing

ASC allows to independently configure gyroscope and accelerometer channels.

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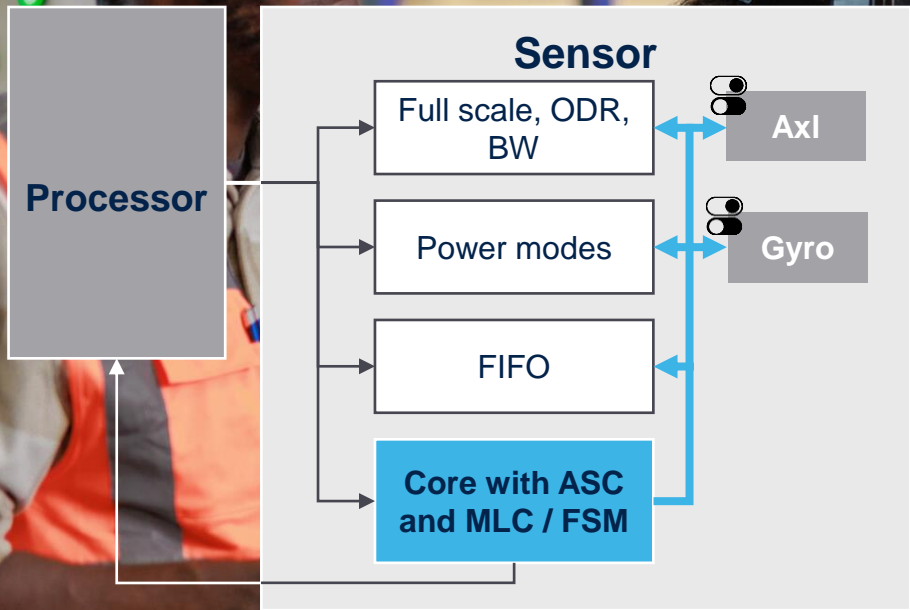
Track and monitor orientation in 3D space

ISM330BX

Detect and track device orientation with the **embedded low power sensor fusion** algorithm with **30 µA**

Plug-and-play solution that provides **6x game rotation vector** (accelerometer + gyroscope) & **gyroscope-bias calibration**

The rotation vector is available in **quaternion format**, and it can be stored in the **embedded FIFO**

Static accuracy[1]: 0.5, 1.5, 1.5 deg
Low dynamic accuracy[1]: 0.7, 0.5, 0.5 deg
Calibration time[2]: 0.8 s
Orientation stabilization time: 0.7 s
Extra power: 30 µA @ 120 MHz

(1) Heading (5 min), pitch and roll
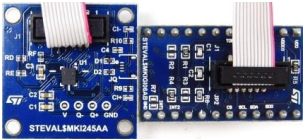(2) Time required to reach steady state

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Create your application with the ISM330BX ecosystem
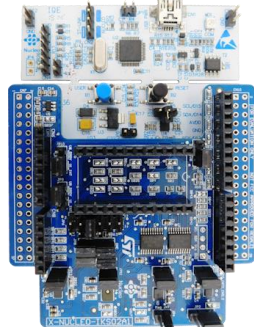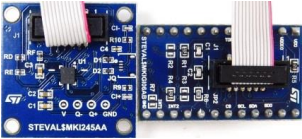
MEMS ecosystem for ISM330BX

Hardware

Evaluate

STEVAL-MKI245KA

STEVAL-MKI109V3

Develop

STEVAL-MKI245KA
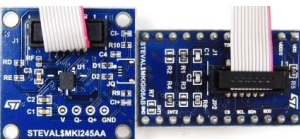

X-NUCLEO-IKS02A1

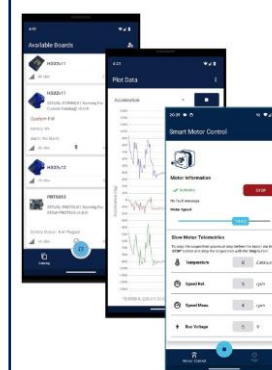### Prototype

STEVAL-MKI245KA

STEVAL-STWINBX1
STEVAL-MKBOXPRO

Software

Desktop software solution

MEMS Studio

Mobile application

STBLESensor

Ready-to-go application examples

GitHub

X-CUBE-MEMS1
FP-SNS-STBOX1
FP-SNS-DATALOG2

Easy, affordable and rapid prototyping tools

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Conclusions and takeaways

Pain points? Not anymore

ISM330BX makes your industrial and robotic applications smarter

The key **features** of **ISM330BX** are **embedded AI, sensor fusion** and **an accelerometer** with **wide bandwidth and ultra low-noise**

ST MEMS ecosystem makes any **design fast** and help you to **reduce the time-to-market**

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A complete ecosystem to create your next solution

Future-proof your industrial design with ISM330BX

Getting started with ISM330BX adapter board

Application examples (FSM & MLC) for ISM330BX

Getting started with MEMS-Studio and FP-SNS-DATALOG2

ST MEMS & Sensors community

Our technology starts with You

Find out more at www.st.com/mems

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