



# Empowering IoT: ST MEMS Sensors Driving Connected Device Innovation

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# Extending humans senses

MEMS and sensors are a natural extension of our five senses

Enhance our ability to understand and interact with the world around us

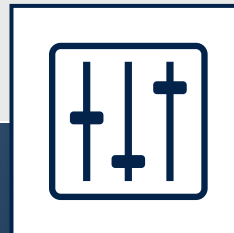
Lead to improved safety, health, and overall quality of life

# The key attributes of future sensors



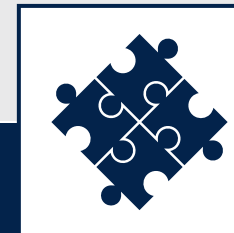
## Differentiating features

Advanced **technologies**, unique **architectures**, and innovative **features** bringing unparalleled **performance** and **efficiency**.



## Seamless ecosystem

A comprehensive and **integrated** set of **tools** to **simplify** development, accelerate **innovation** and foster collaboration.

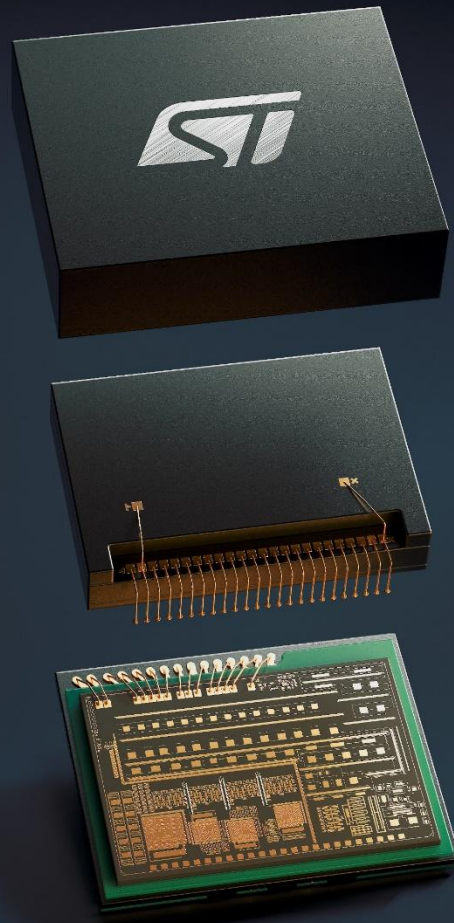


## Endless possibilities

A **portfolio** of products and solutions addressing a broad range of **applications**, unlocking **creativity**, and transforming industries.



# Differentiating features

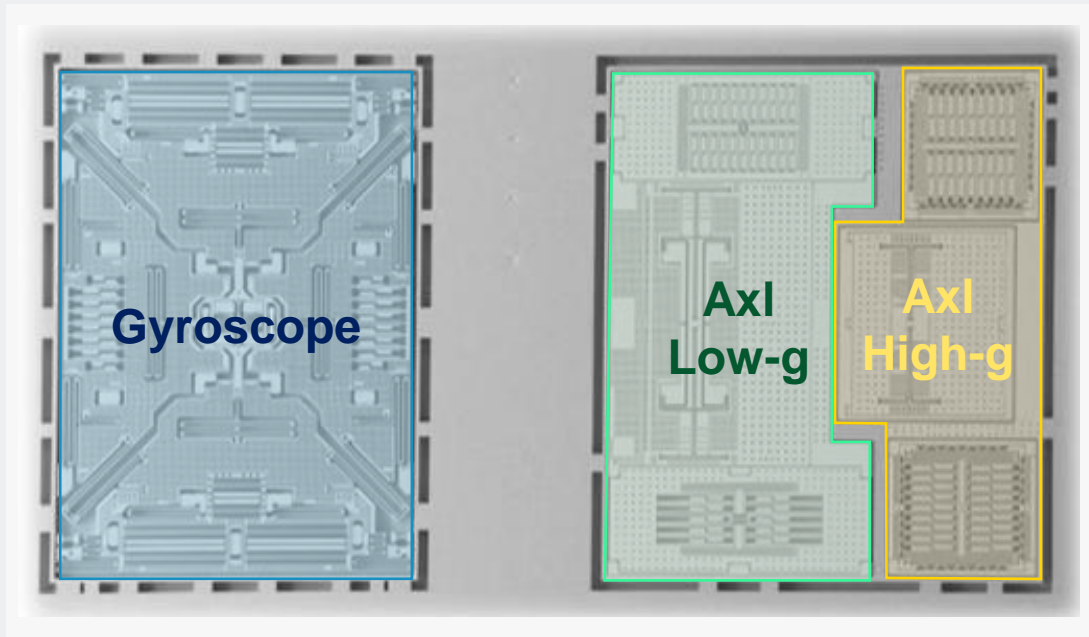


Technologies, architectures, and features to bring unparalleled performance and efficiency

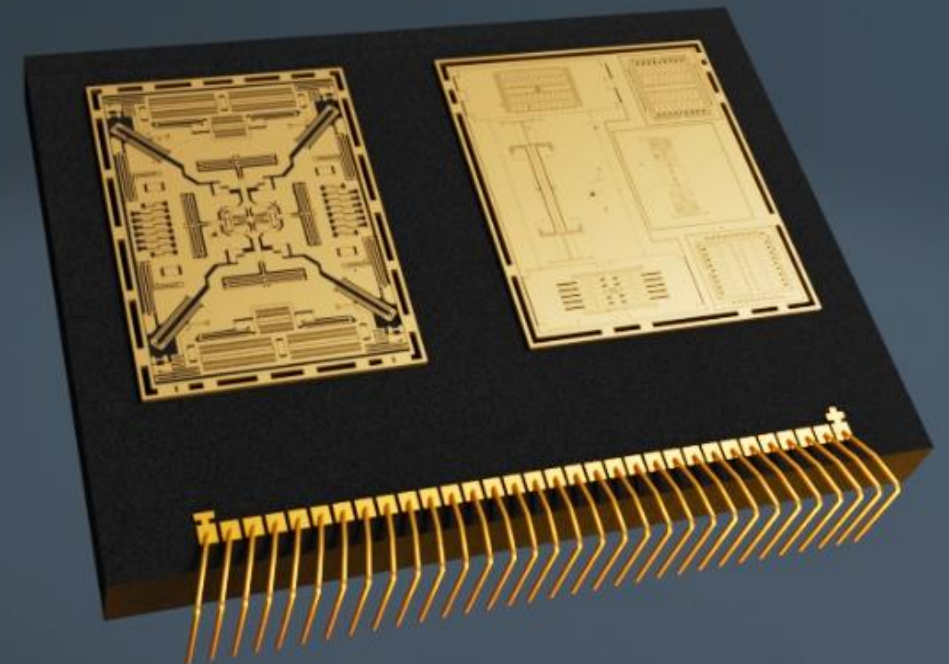
- **High-g IMU** with dual-accelerometers
- A new **super symmetric gyroscope** architecture
- Biosensor for **biosignal tracking**
- **In-sensor AI** features
- **Sensor fusion** low power
- Adaptive **self-configuration**
- **Advanced packaging**

## Track all the events and never miss a moment

Industry-first high performance 6-axis IMU with a **dedicated high-g accelerometer** for intensity impact and shock detection

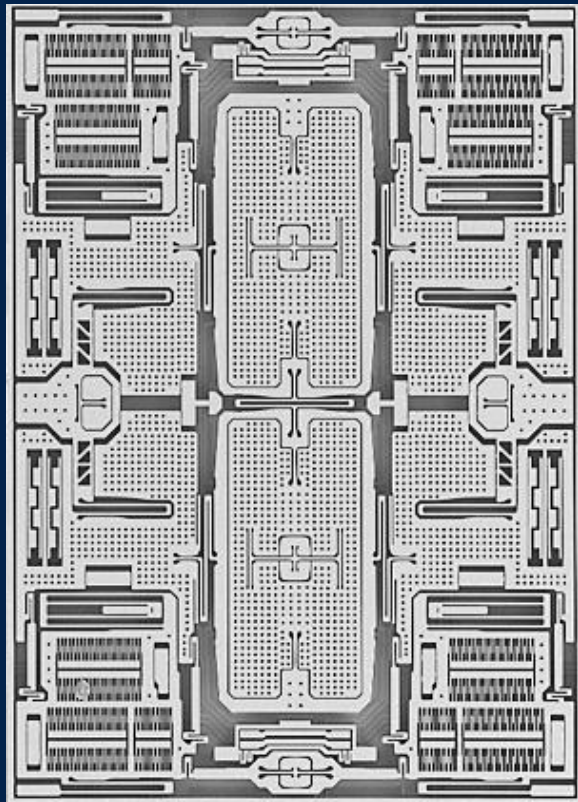


Top view of MEMS unit of LSM6DSV320X



# New IMU immune to vibration and resilient to shocks

**New super symmetric gyroscope architecture for a strong rejection to vibrations**



## **Fully differential signal reading chain**

Dual rotor per axis oscillate in counterphase and are mechanically coupled for a differential mechanical and electrical design

## **Compensated effect of manufacturing process asymmetries**

The impact of process non idealities is reduced by the mechanical coupling of the rotors

## **Scalable design to cope with single/dual accelerometer architecture**

Thanks to the compact design this solution can fit in the tighter spaces

# Biosignal tracking with biosensor

## Vital sign monitoring

Check the heart status, the mind focus level, the gaze direction or detect movements just through the electrical signals flowing in the body

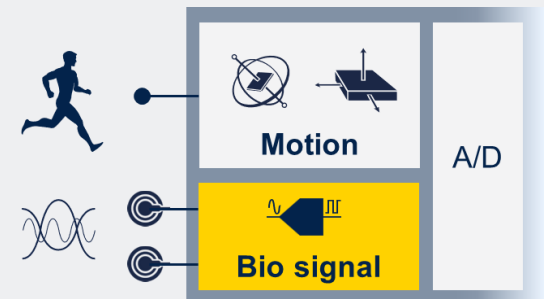
## Motion sensing

Detect the user activity or understand the context with the inertial data of the onboard accelerometer and gyroscope

## Blended and in one unique device

The two data streams are acquired synchronously.

More sensing capabilities in the same package.



# MEMS solutions for Pb free, BPA and PFAS applications

## MEMS and sustainability

MEMS at ST anticipates the most severe environmental regulations. We make you ready for the transition. Just ask us!



The logo features the European Union flag (a blue rectangle with twelve yellow stars) at the top. Below it, the text "PFAS FREE" is written in green, with a green leaf icon to the right. At the bottom, the text "PFAS compliant" is written in bold black letters, with a green leaf icon to the left.



The logo consists of a green circle with a diagonal slash through it, and the letters "Pb" in the center. A green leaf icon is positioned at the bottom right of the circle.



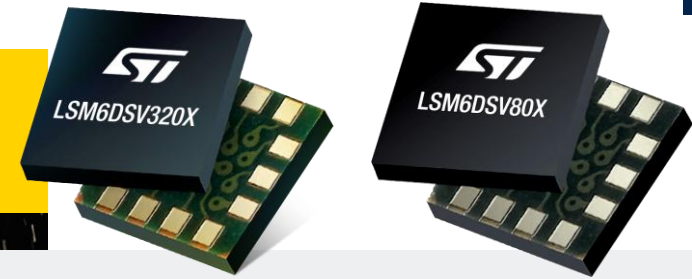
The logo features a green leaf icon on the left. To its right, the text "BPA" is written in white on a green background, and "100% FREE" is written in green on a white background below it.

**The latest and the greatest**



# High-g IMU, designed with activity tracking in mind

Extended full scale to detect any activity dynamic



## High performance for everyday life and intense sport training

- Multiple full scales from 2g up to 80g or 320g
- ODR up to 7.68 kHz with HAODR<sup>(1)</sup>
- Low noise and low power

## At-the-edge processing

- Adaptive self-configuration (ASC)
- MLC<sup>(2)</sup>, FSM<sup>(3)</sup>
- Embedded SFLP<sup>(4)</sup>
- Automatic FS switch based on the context
- 1.5 KB FIFO (up to 4.5 KB with compression)

## No overhead in the package size

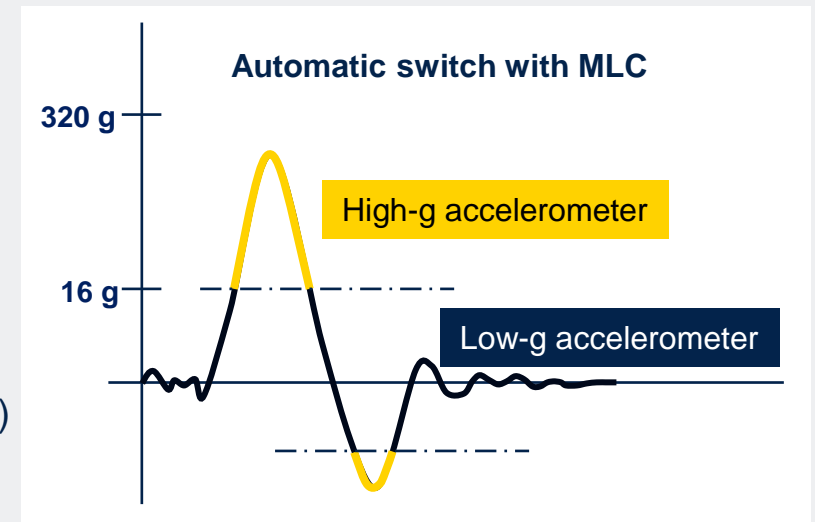
- Standard IMU footprint: 2.5 x 3.0 x 0.83 mm

(1) HAODR: High Accuracy ODR

(3) FSM: Finite state machine

(2) MLC: Machine learning core

(4) SFLP: Sensor fusion low power

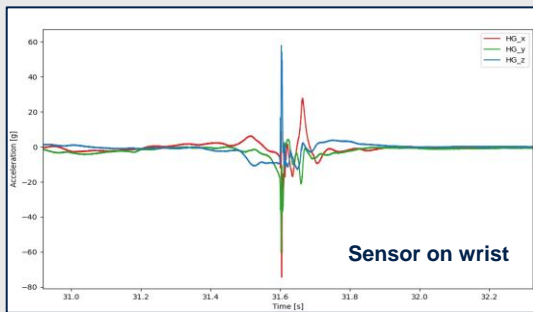


# Intense impacts tracking in sports

## Volleyball



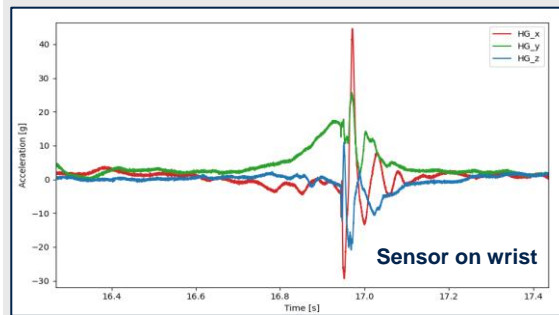
**Training:** Measure spike force progress  
**Performance:** Collect ball-hand contact time and acceleration profile for guide athletic improvement



## Padel / tennis



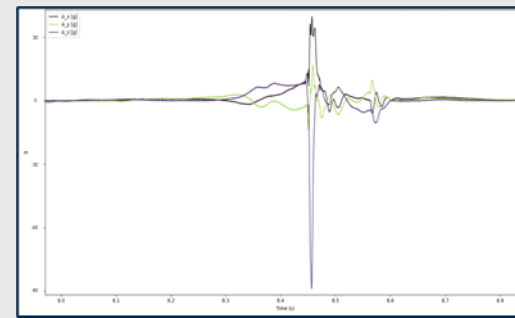
**Training:** Wrist rotation speed and acceleration tracking  
**Performance:** ball hitting metrics



## Boxing



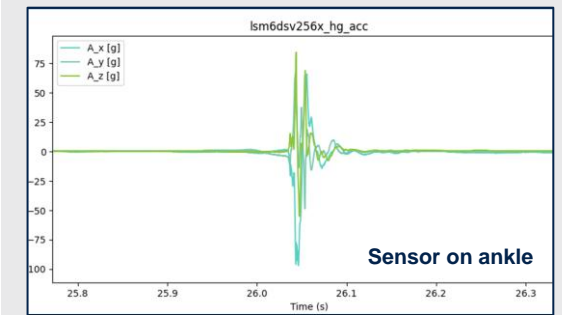
**Training:** performance and motion monitoring  
**Performance:** punch metrics, concussion detection on helmet



## Plyometrics / Explosive jumps



**Training:** stress of joints  
**Performance:** metrics (impulse intensity, impulse width, fall time)



# LSM6DSV80X / LSM6DSV320X High-g IMUs

## Track all the events and never miss a moment

### Fall and drop reconstruction



Full reconstruction of every fall and drop with the new symmetric gyroscope architecture

### Concussion detection



Exploit the independent low-g and high-g sensing channels to monitor the user activity and be ready to unexpected events

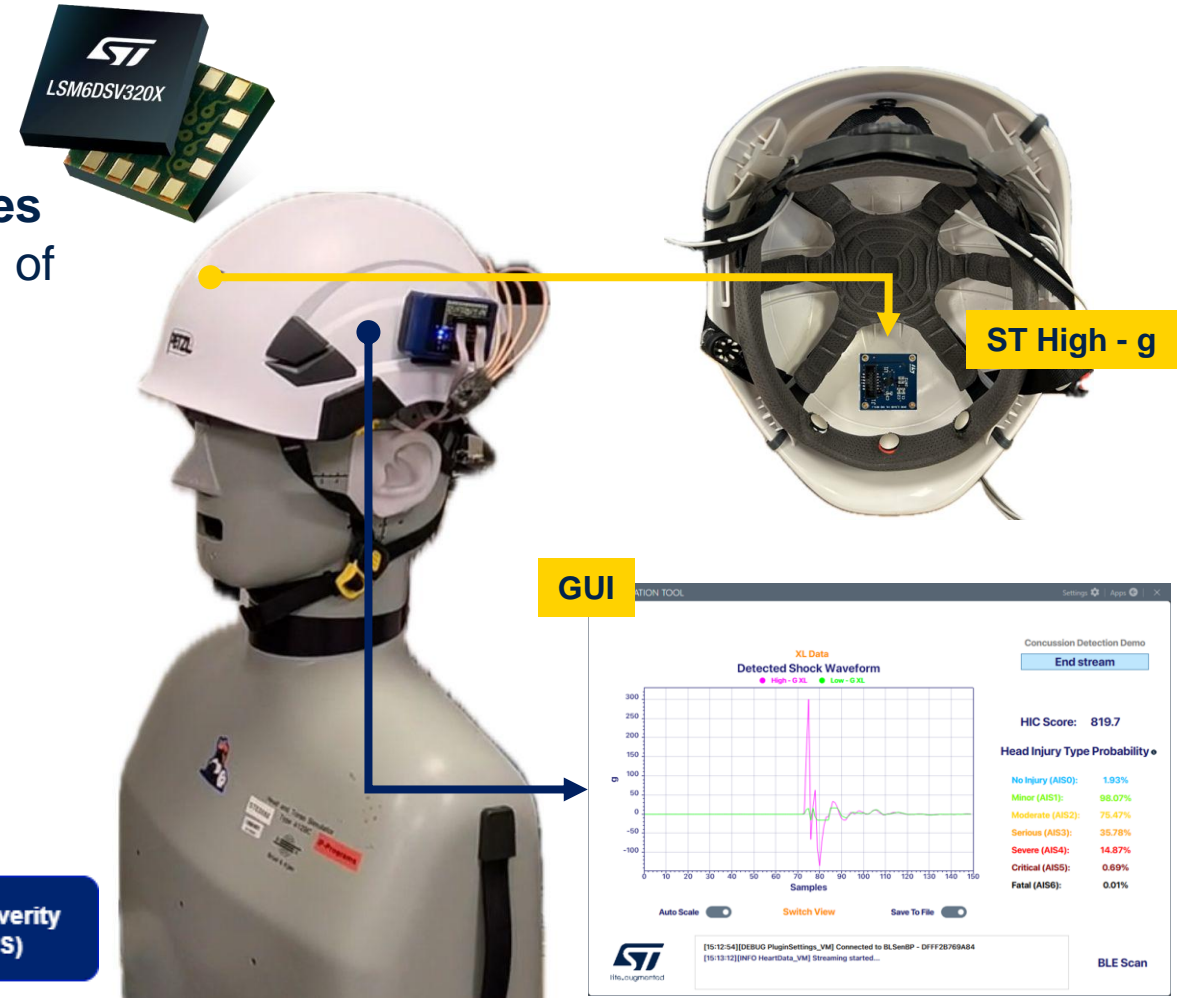
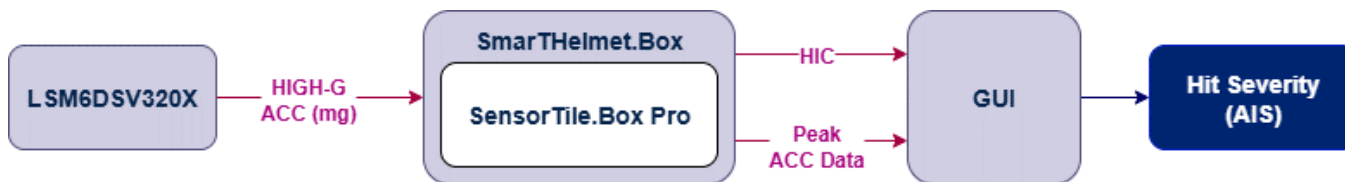
### Car crash detection



Detect even the high intensity events with the high-g full scale up to 320g

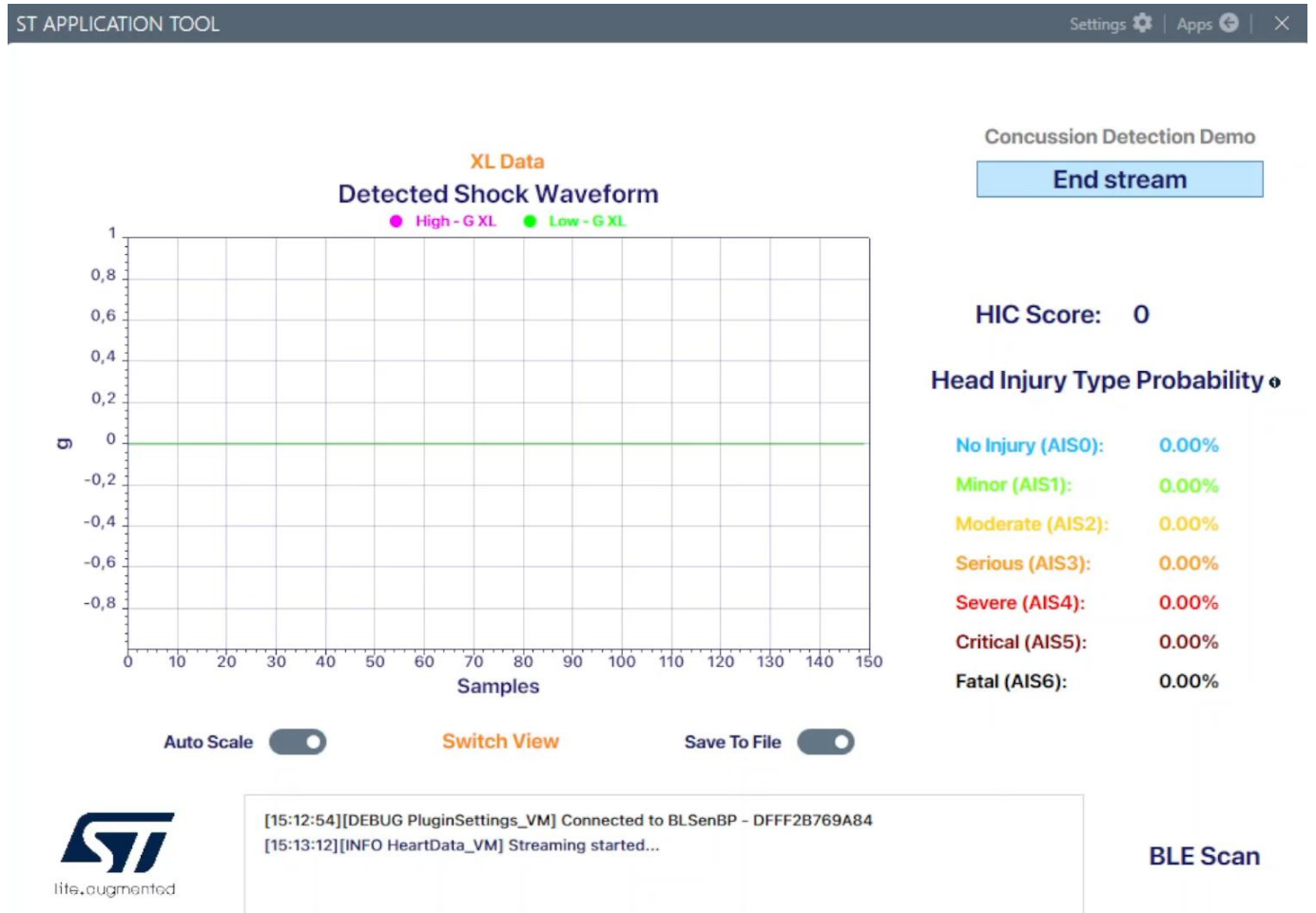
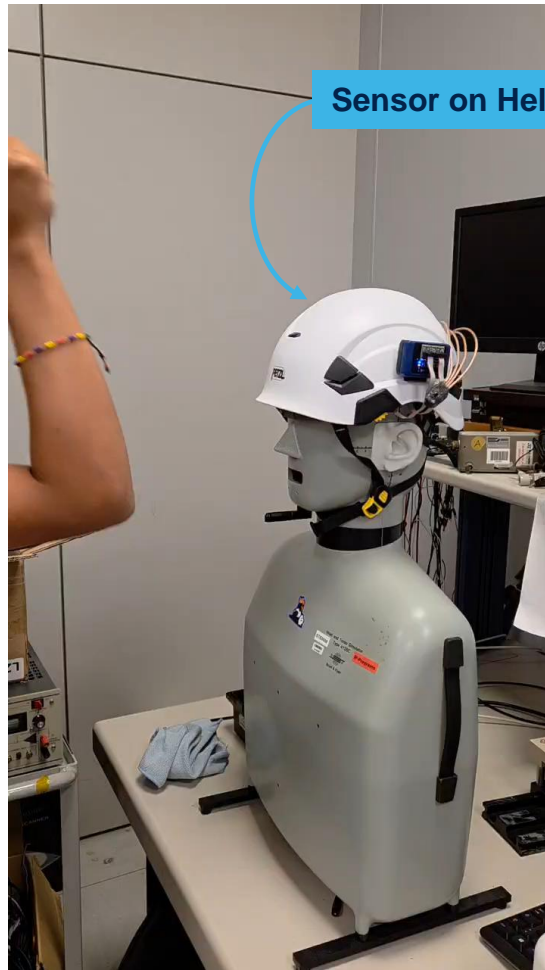
# Head impact demo

- The demo integrates a **High-g IMU on the SmartHelmet.Box** worn by a mannequin, which **captures head acceleration (by direct impact)**; a first evaluation of the impact is processed by MLC and the SensorTile.Box Pro processes this data to calculate an HIC score and transmits it to a PC via BLE.
- The **GUI** receives and plots the acceleration waveform, compares low-g and high-g XL data, shows **the HIC<sup>(1)</sup> score**, and **displays AIS<sup>(2)</sup> classification** based on the HIC score, indicating hit severity from minor to fatal by probability percentage.



(1)Head injury criterion`  
(2)Abbreviated injury scale

# Head impact on dummy head

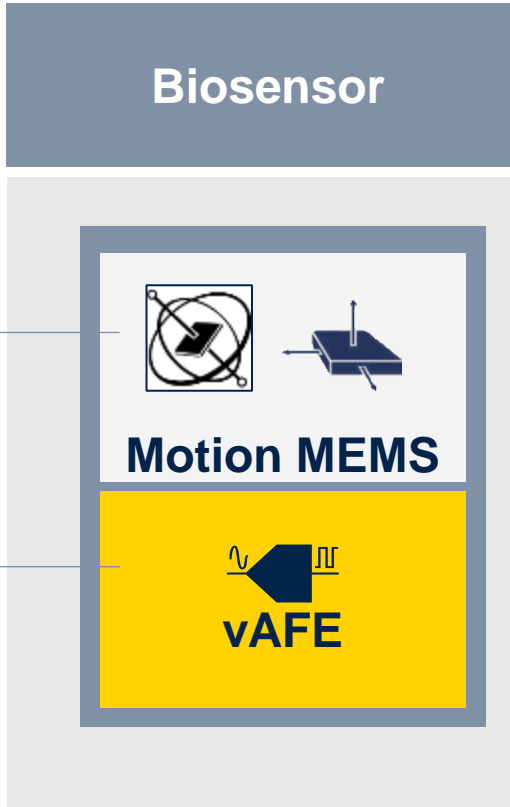
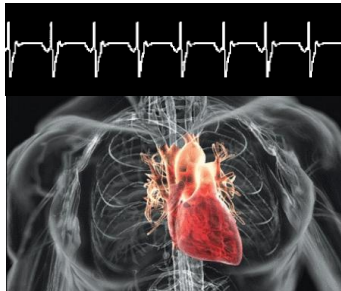




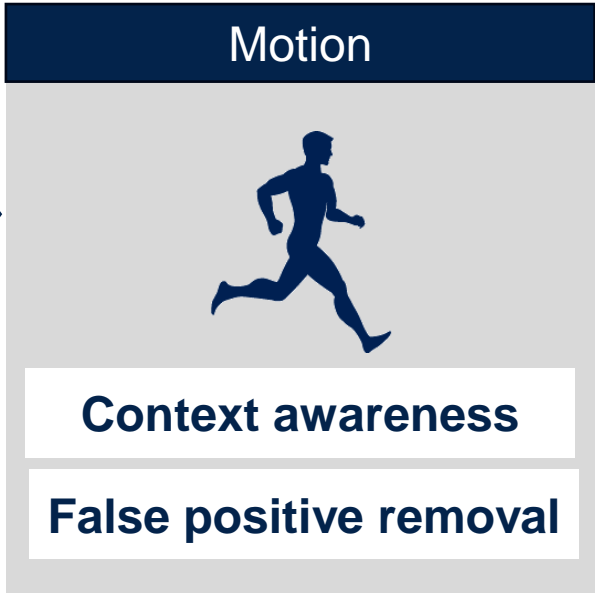
# Biosensors



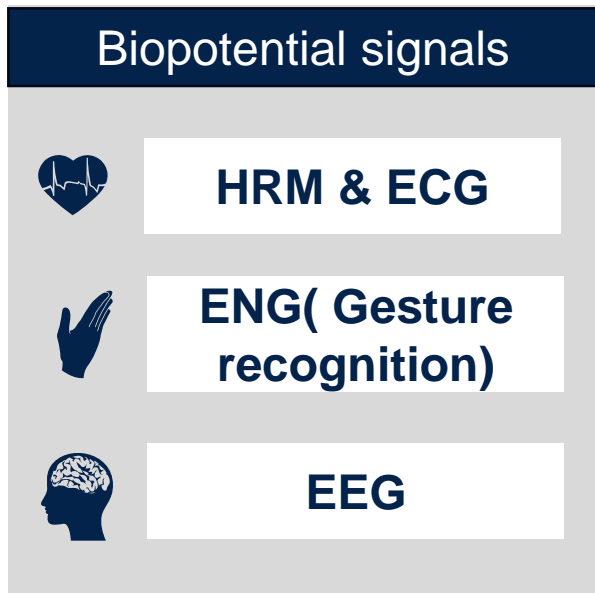
A new sensor technology for Digital Healthcare and biopotential signals monitoring



vAFE and motion signals are intrinsically **synchronous**, so the result is a unique **context aware analysis** done at the edge, leveraging on embedded **MLC / FSM**



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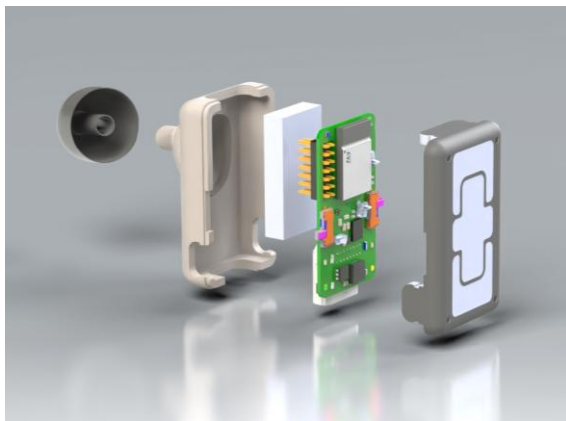


# ECG through TWS

It is possible to collect a good ECG using a TWS integrating ST's biosensor



TWS mock-up detecting biopotential signals from the ear



Analysis confirms that it is possible to collect a good ECG using a TWS worn on the ear with a finger placed on the same TWS





# Which attributes for biosensors?

## Synchronization

**Biopotential** and **motion** signals are intrinsically **synchronous**.

Unique **context-aware analysis and artifact removal** with **in-sensor AI**.

## Miniaturization

Integrates biopotential & motion information measurement system in a **compact form factor**.

Vital signs monitoring, healthcare, and gesture detection **in any wearable device**.

## Efficiency

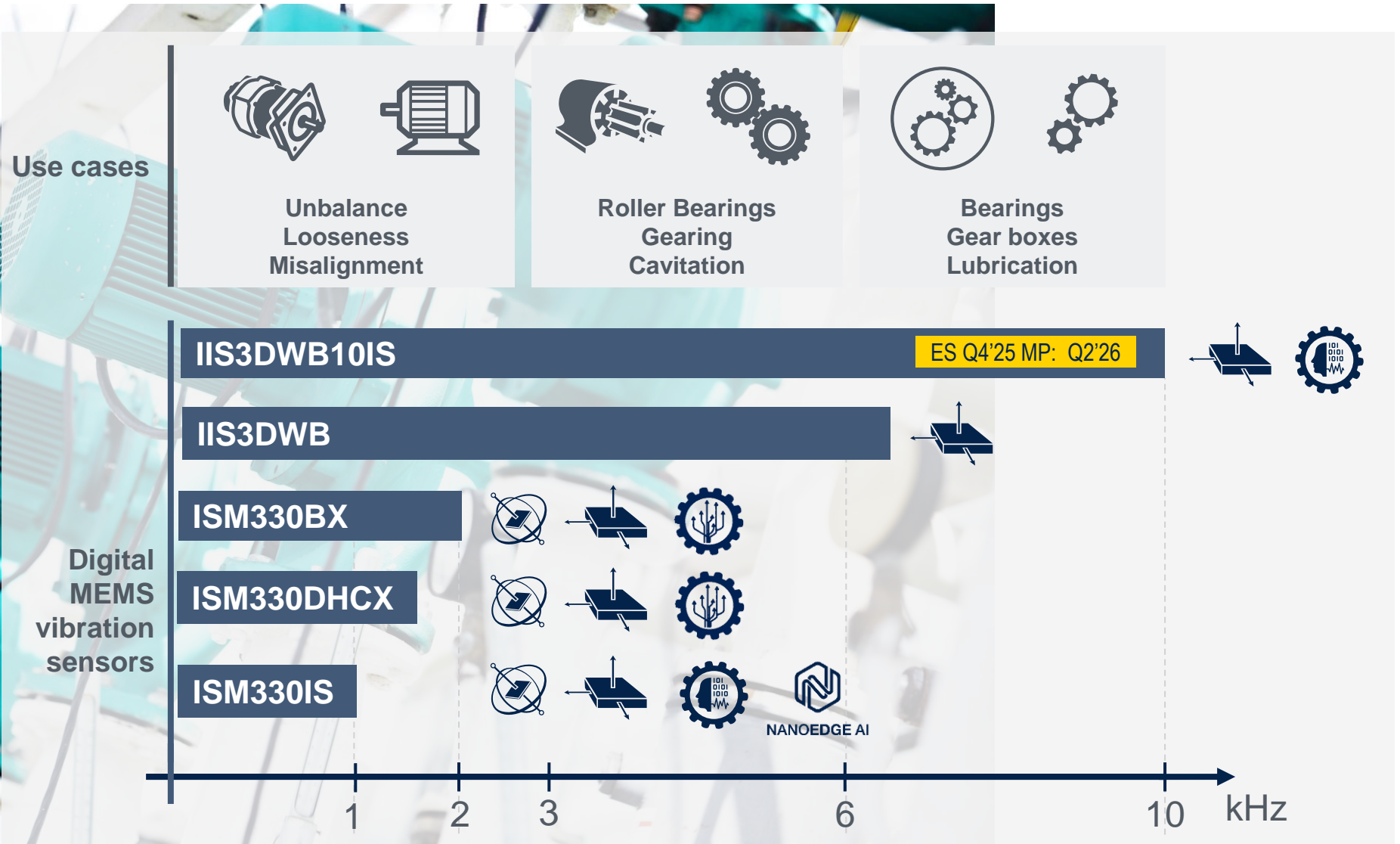
**Ultralow power consumption:** few  $\mu\text{A}$  to record and process information.

Analysis **at the edge**, leveraging in-sensor AI features, **offloading the microcontroller**

Enhance **efficiency** with ST dual-function biosensor that **monitors movement and bio signals**, paving the way for **predictive healthcare of the human body**

# Condition monitoring

# MEMS vibration sensors



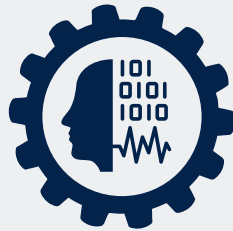
# IIS3DWB10IS: cutting-edge advancement in vibration sensors

## Unprecedented vibration sensing capabilities



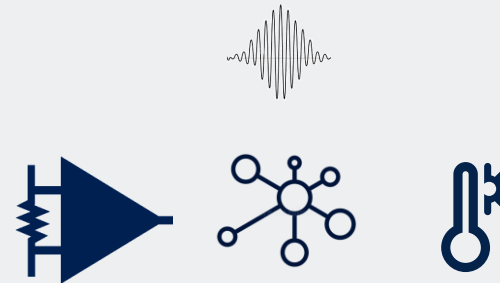
**3-axis digital, ultra wide bandwidth (10kHz) and dynamic range (FS up to 200g) make the sensing of any vibration for condition monitoring possible**

## Decision making at the edge



ISPU with HW accelerators to process **at the edge, in real time** vibration data with any customer defined algorithms

## Hub for condition monitoring



**Analog hub for external analog sensor or current sensing, integrated temperature sensor** make it a smart hub for condition monitoring

## Suitable for harsh environments and with Long-term availability

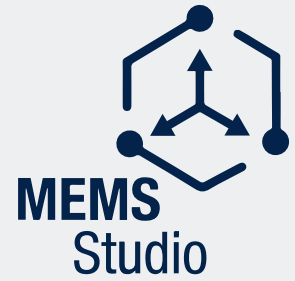


**Operate up to 125°C and guaranteed for Long-term availability**, in line with the industrial environment and product life cycle

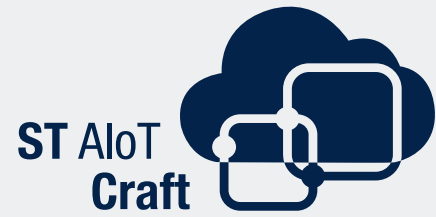
# MEMS sensors ecosystem

# Large sensor portfolio with a supportive ecosystem

Software tools to develop sensors' features



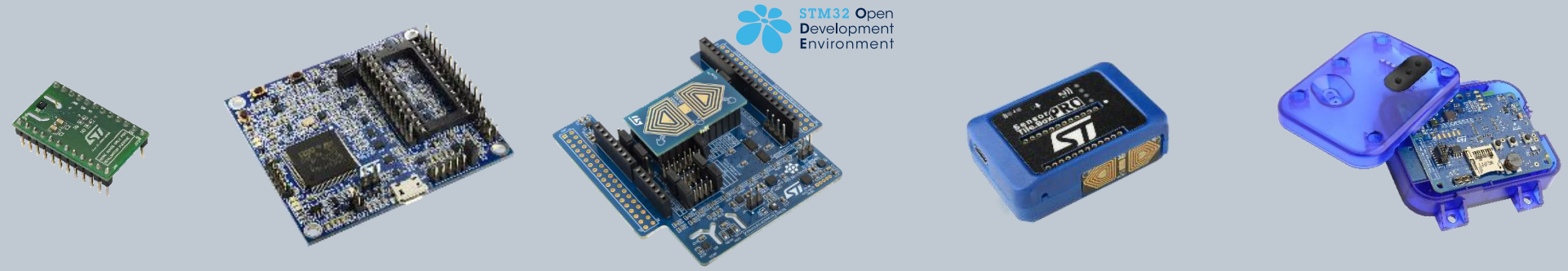
- Sensor configuration
- Sensor data analysis
- Develop embedded AI features
- Application development



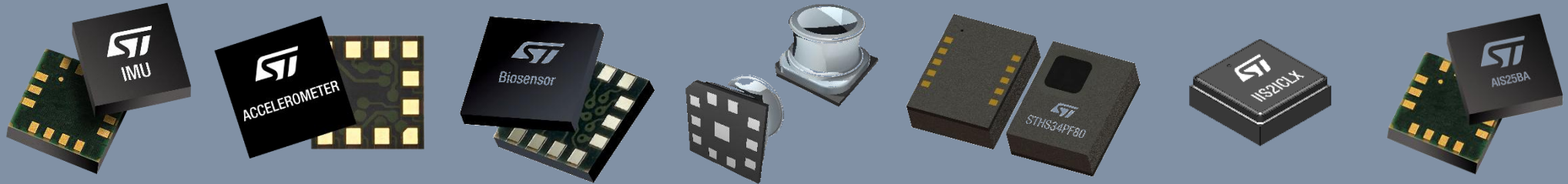
Create end-to-end sensor-to-cloud solutions



A broad range of evaluation & prototyping tools



100+ MEMS sensors released



6-axis IMUs      Accelerometers      Biosensors      Pressure      IR sensors      Inclinometers      Audio

# Our technology starts with You



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