# Scalable ADAS hardware solutions

Presentation

# ADAS sensors

## Radar, video, ultrasonic and localization solutions

Advanced driver assistance systems

Multi-purpose camera

Ultrasonic

Front/corner radar

Camera heads

Micro mechanics
unit performance

Front radar premium

Entry

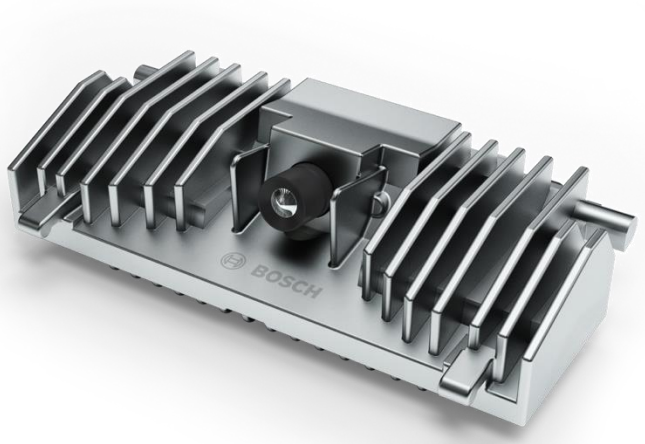
Mid

High

# ADAS sensors

## Why choose Bosch multi purpose camera?






**Powerful SoC inside**

CPU 28 K DMIPs
AI 18 TOPs

**In-house Bosch Video Perception**

Bosch scalable perception stack uses CNN and transformer technologies in the most efficient way for best performance

**Mature advanced driver assistance features**

Video-based features or fusion with radar is available at MPC4

**8 MP resolution imager**

120° HFOV
Increased detection range and accuracy

**Worldwide engineering and customer presence**

Based on worldwide road, vehicle and traffic sign data, provide outstanding ADAS performance globally

# ADAS sensors

## Building the next generation front camera

Advanced driver assistance systems

**The next generation mutli purpose camera would be a hardware combination of camera heads and SoC**

Realizing Bosch tech stack with video perception and fusion e.g. with radar and including safety and driving functions based on video capabilities

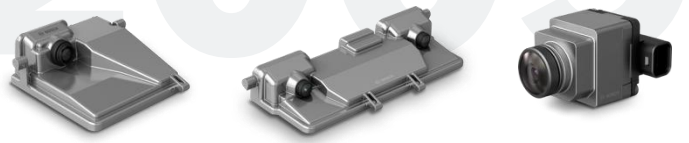
**Camera head** (8MP, 120°) + **Performance SoC** + **Video perception software** + **Advanced driver assistance functions** =

# ADAS sensors

## Multi purpose camera gen. 4: Over 15 years of experience

Advanced driver assistance systems

2009



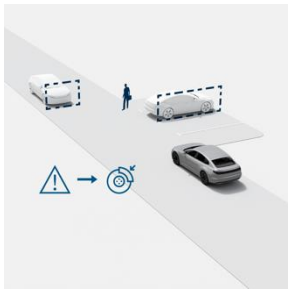
2029

**Local**
development, sales organizations and production locations in major regions

**> 69**
million cameras produced and integrated by end of 2023

**> 300**
vehicle model platforms

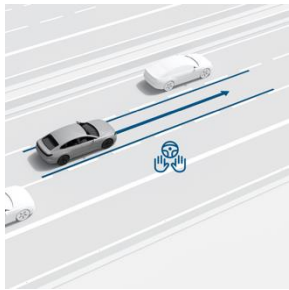
**> 50**
vehicle brands

Bosch multi purpose camera generation 3 is a **key component** of attainment of ADAS legal requirements around the world

**Multi purpose camera**
Generation 4

In addition to **legal** and **NCAP** requirements we enable functions up to **SAE Level 2** with single sensor



# ADAS sensors

## Why choose Bosch camera heads?

Advanced driver assistance systems

**Worldwide footprint**

International high-quality production network with special and plant engineering

**Technology + manufacturing**

**High quality over lifetime**

thanks to 15 years of experience in automotive camera design and production

**Future oriented**

Scalable performance and system integration level

**Optimized manufacturing concept**

“Flexible line concept with common mechanical design”
→ flexible production

**Technology building blocks**

supporting latest components and assembly process innovations

**Fit for perception**

Designed for open market from Bosch system expertise, fulfilling ISO and legislation requirements

**High flexibility**

for customer-specific design adaptations

# ADAS sensors

## Camera heads: Benefit of lifetime stability



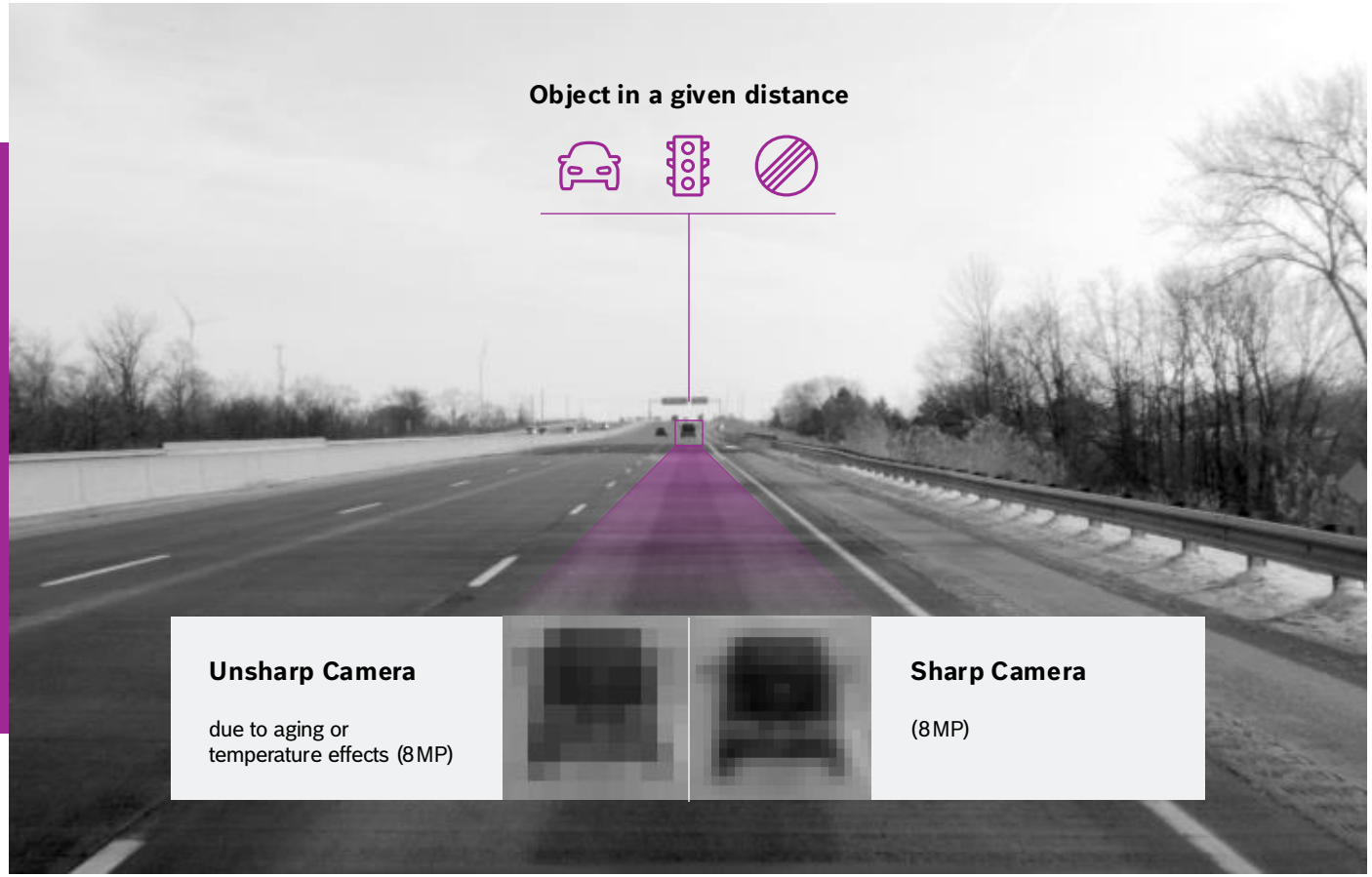
Bosch camera design is best in class for high and stable sharpness over temperature and lifetime, keeping end user experience on same level from day 1 to end-of-life.

**ACC Comfort**

- In ACC use case on standing object or high-speed approach, an unsharp camera will affect target object estimation and will lead to non-comfortable braking profile.

**Traffic sign/light**

- In speed adaptation or reaction on traffic light use case, an unsharp camera could lead to late detections of signs/lights resulting in change of vehicle reaction.



# ADAS sensors

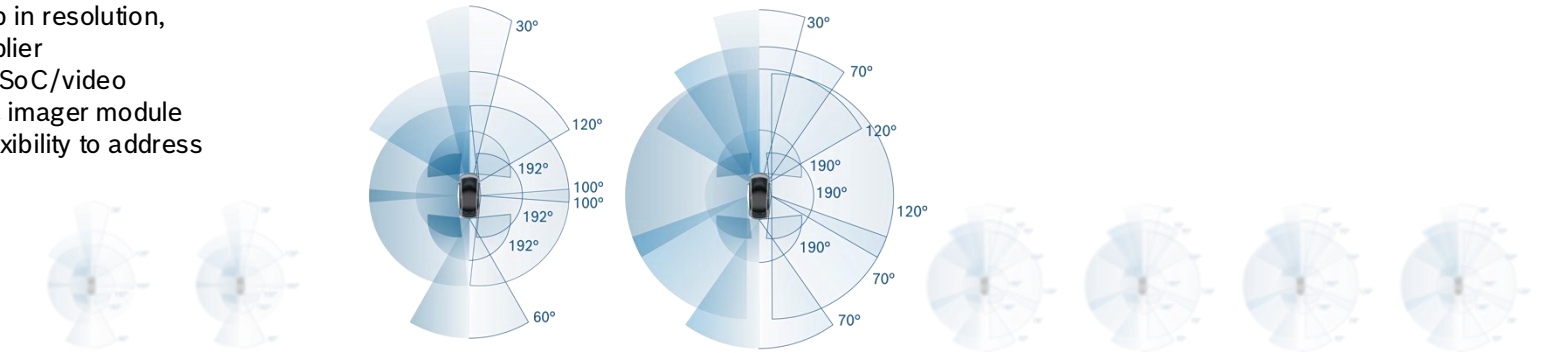
## Camera heads: System configuration examples

Advanced driver assistance systems

### System overview

- High diversity in camera belt set-up in resolution, field of view, CFA and imager supplier
- Every single combination System/SoC/video perception requires a specific optic imager module (OIM) platform concept enables flexibility to address these diverse OIM requirements

Modular platform concept enables a variety of camera options



# ADAS sensors

## Why choose Bosch ultrasonic sensors?

Advanced driver assistance systems

**Worldwide footprint**

International high-quality production network with special and plant engineering

**Future oriented**

Scalable performance and system integration level

**Optimized manufacturing concept**

“Flexible line concept with common mechanical design”
→ flexible production

**Technology building blocks**

supporting latest components and assembly process innovations

**Fit for perception**

Designed for open market from Bosch system expertise, fulfilling ISO and legislation requirements

**High quality over lifetime**

thanks to > 30 years of experience in automotive ultrasonic development and production

**High flexibility**

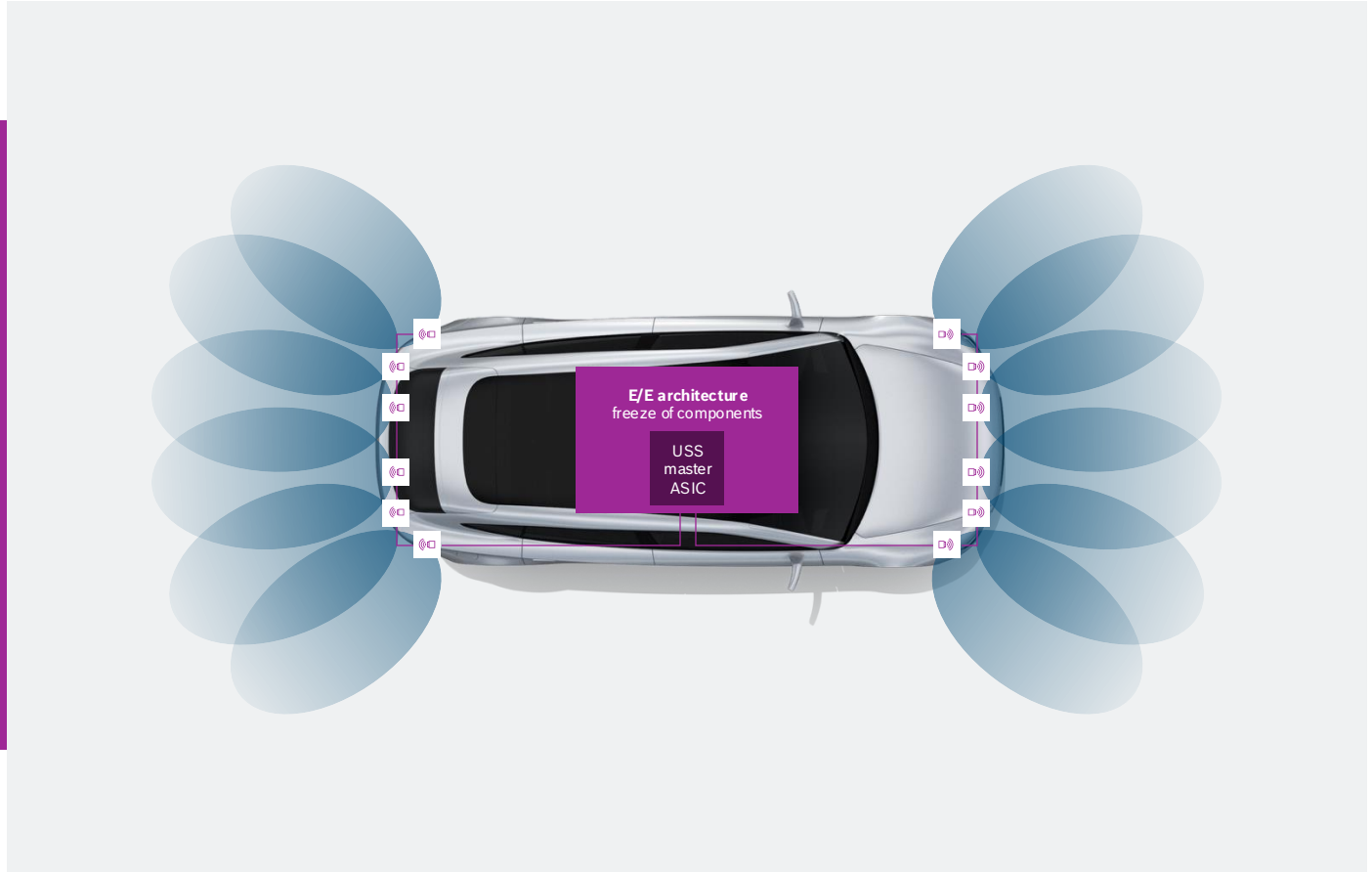
for customer-specific design adaptations

# ADAS sensors
## Ultrasonic



### Gen 7

- AI-driven development with high data quality: Data is collected once, allowing for easy adjustments without re-collection or software changes.
- Machine learning for object classification: Utilizes AI and machine learning to enhance efficiency and accuracy in object classification.
- Data adaptability for various bumper variants: Collected data can be easily adapted, saving time and costs.
- USS sensors for performance and cost efficiency: Incorporates USS sensors to improve performance and support a cost-effective bus topology.



# ADAS sensors

## Why choose Bosch Micro mechanics unit performance?

Advanced driver assistance systems

**IMU**
High-performance IMU for enabling a wide range of advanced applications in ADAS (from L2+ up to L5), vehicle dynamics and safety


**High scalability**

Flexible deployment of a wide range of in-house sensor modules covering full segment from low-cost up to high-end performance and safety-levels from ASIL-B up to ASIL-D

**Turnkey solution**

Bosch offering all-in-one solution by ensuring customer specified calibration, validation and release

**Highly scalable concept**

with broad range of safety and performance levels for an optimal customer fit

**Market leader**

in high-performance inertial sensors for ADAS and vehicle motion applications

**Stand-alone 6DoF**

Inertial Measurement Unit – micro mechanics performance specifically designed for ADAS

**End-to-end development**

with in-house MEMS technology, design, production and testing and > 30 years experience in IMU-development

# ADAS sensors

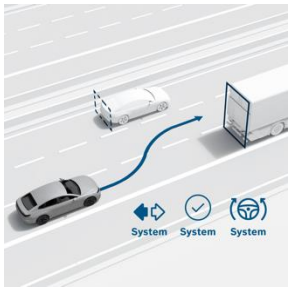
## Bosch history for inertial measurement units

Advanced driver assistance systems

1995

**> 30 years**
experience in
IMU development

2026




**Key enabling product for accurate relative positioning**

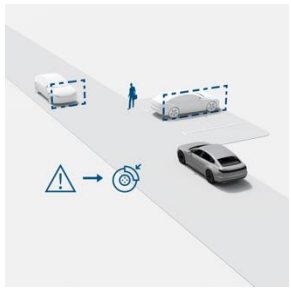
- Strong enhancement of availability and reliability of ADAS features
- High redundancy and integrity, scalable from ASIL B to ASIL D

**ADAS**

**Vehicle motion**

**Additionally supporting vehicle motion applications**

Input signal for vehicle motion control (e.g. ESP, suspension, ...)



# ADAS sensors

## MMP for both worlds: ADAS & vehicle motion

Advanced driver assistance systems

### ADAS

**Ego motion compensation**
Bridging in case of sensor outages

Enhanced **ADAS driving and parking** performance, enabler for new features

Covering **L2+ up to L5**
(Passenger cars and commercial vehicles/trucks)

**Functional benefits**
Availability, robustness, accuracy, safety and redundancy

### Vehicle motion

**Stabilized trailering**

Increased **offroad capabilities**

Detection of **light collisions**

**Intelligent suspension control** for more driving comfort and sportiveness

**Advanced ABS + ESP** for shortened braking distances, enhanced stability and vehicle dynamics

**“One fits all”**
IMU-MMP is a key element for enabling a wide range of advanced applications in ADAS & vehicle motion

# ADAS sensors

## Why choose Bosch radar sensors?

Advanced driver assistance systems

**Cost optimized**

Highly integrated Bosch inhouse 22 nm SoC


**Flexible**

radar software output with raw signal, locations, objects and functions on sensor

**Vertical integration**

Maximum supply chain robustness: proprietary design of key components (SoC, power supply, waveguide antenna)

**AI-based**

Enhanced compute to host deep learning-based perception & bridge the gap to future central AI-fusion

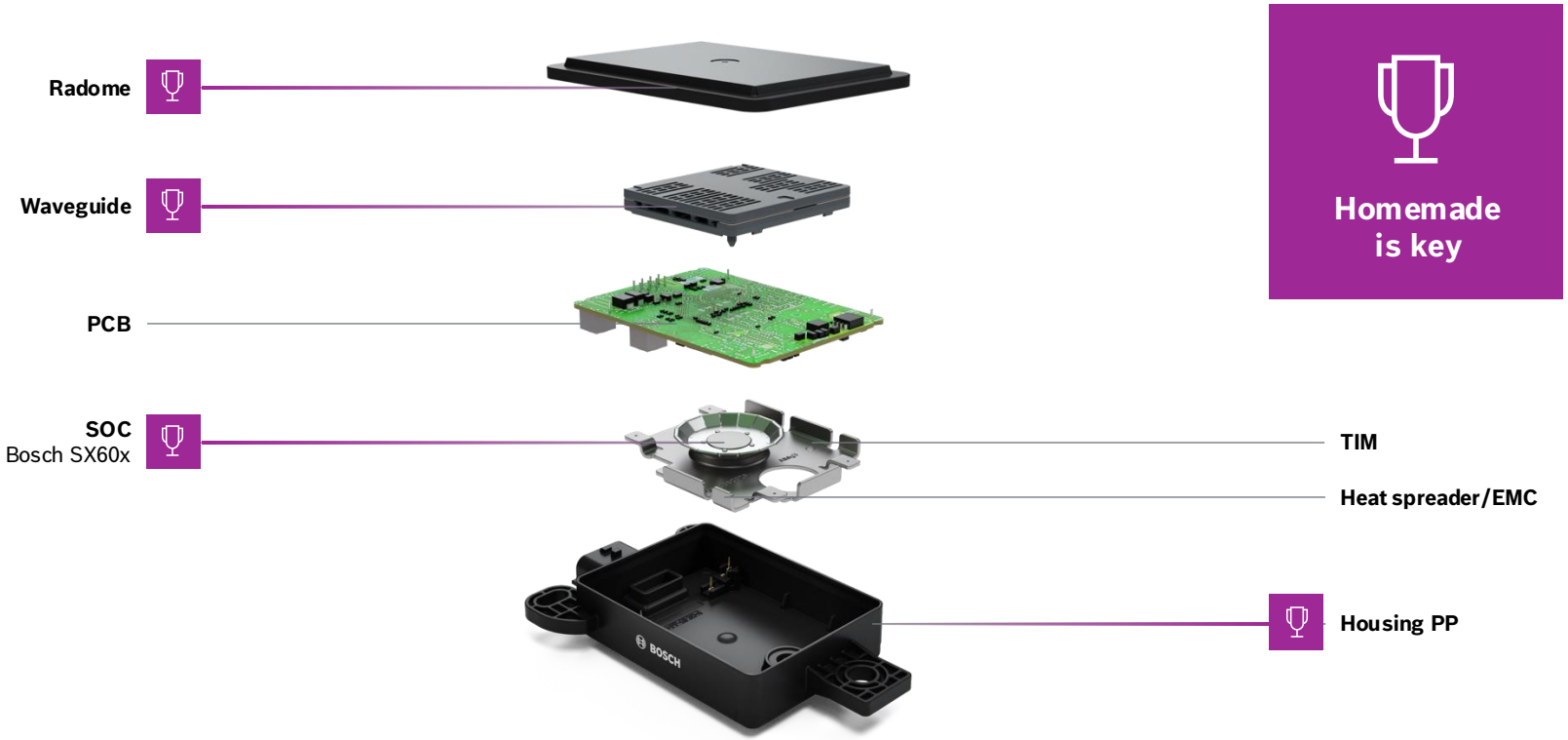
**Best-in-class**

Best-in-class Radar performance in real world (small objects, temperature robustness, etc.), & benchmark interference robustness

# ADAS sensors

## Front/corner radar gen. 7: Exploded view





# ADAS sensors
## Bosch radar gen. 7 SoC

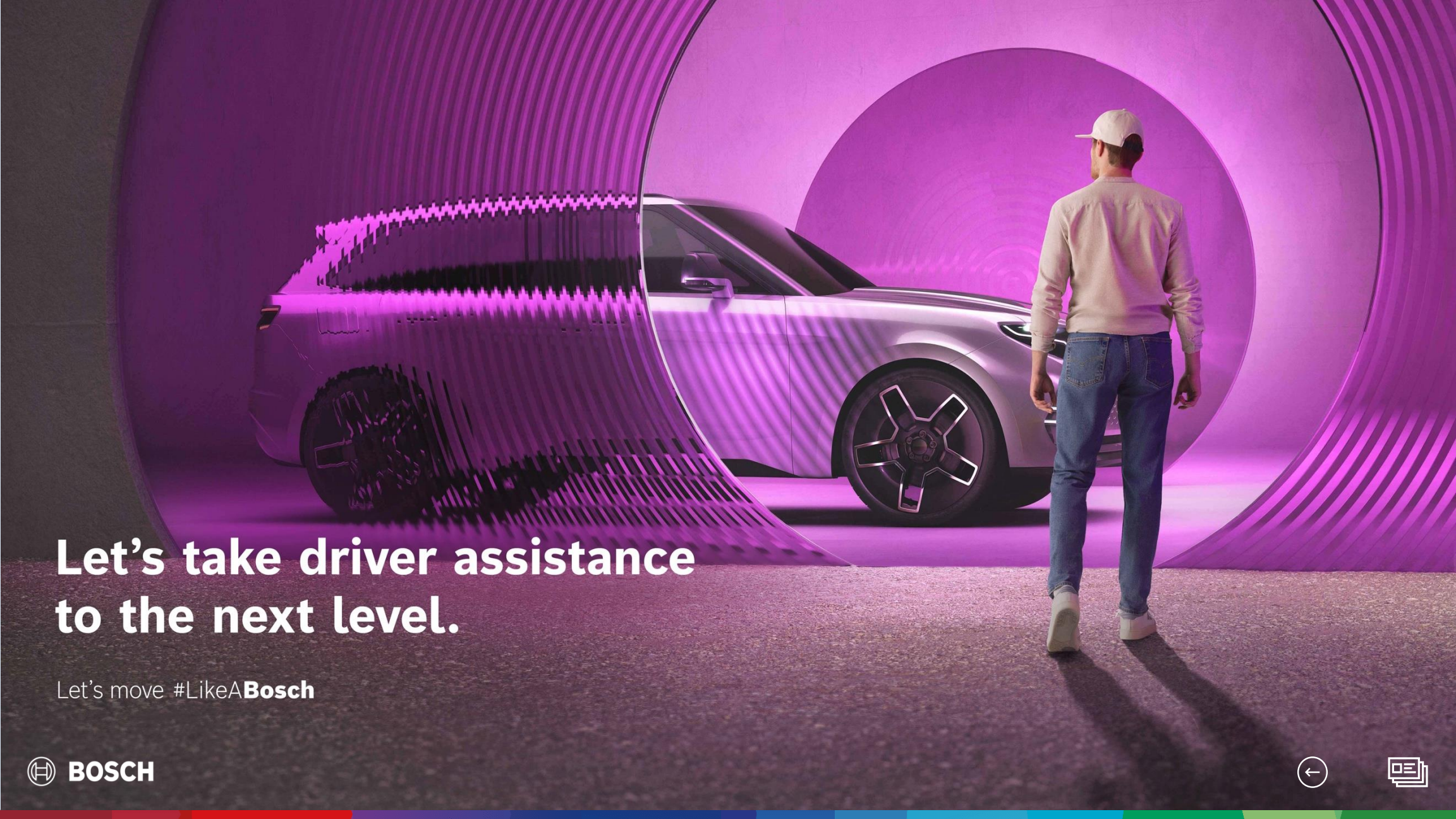


**76 – 81 GHz frequency range with best-in-class RF**
- 4 transmit channels with doppler division multiplexing
- 4 receive channels with high interference robustness
- FMCW modulation with high performance PLL

**Hardware**
- AI-ready digital signal processor
- Multiple µC cores with large memory
- HSM hardware security module incl. crypto accelerators

**Interface**
- Fast interconnects:
  1000 BASE T1 ETHERNET, CAN-XL, PCIe
- ISO26262 ASIL B qualification


**Unprecedented monolithic sensing and processing provides superior mmW performance and best-in-class computational capabilities**


Let’s take driver assistance
to the next level.
Let’s move #LikeABosch
BOSCH