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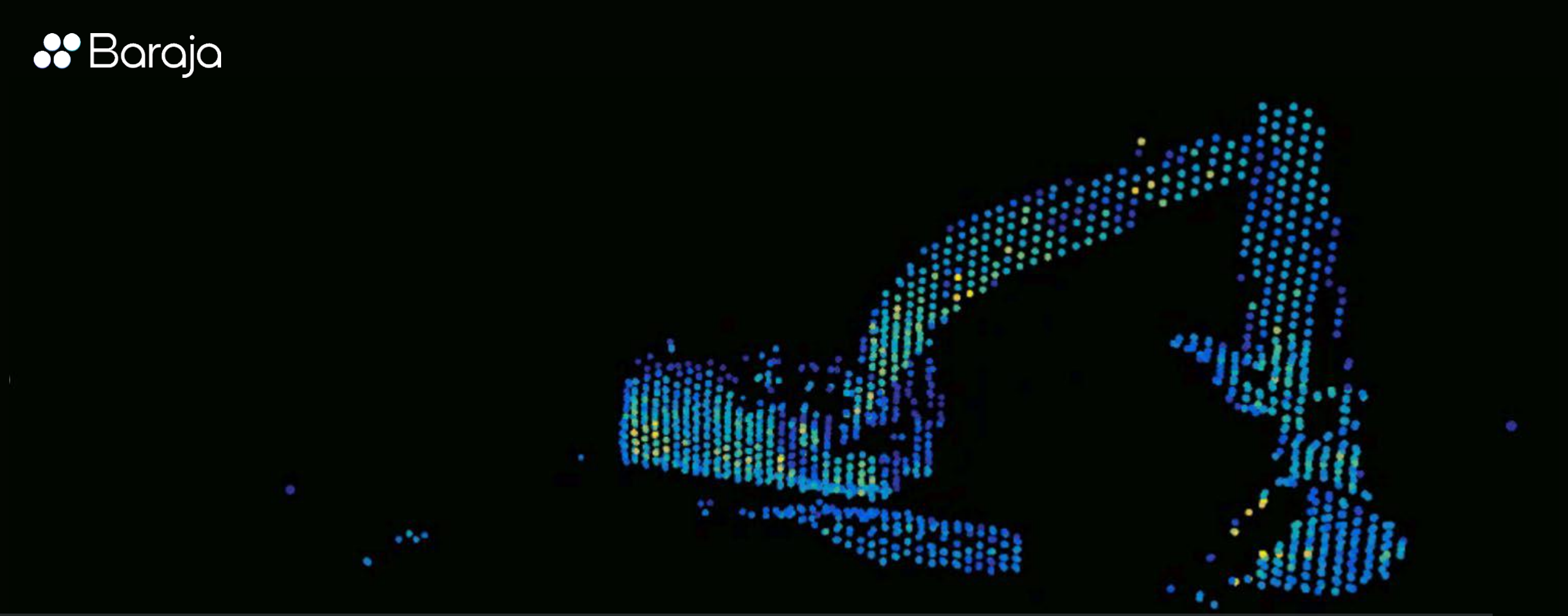

The future of Automotive LiDAR is here – what we have learned from the harshest environments

Joseph Notaro - Chief Commercial Officer

6 December 2022

Company at a glance

What we do

- Offer an innovative approach to LiDAR with our patented platform called Spectrum-Scan™
- Enabling a global shift towards autonomous vehicle mass deployment

Where are we

- HQ: Sydney (Australia)
- R&D Design Center: Palo Alto (USA)
- Offices: China, Germany, Sweden, USA

Where we operate

Automotive	Heavy industry
MaaS / Robotaxi	Trucking

Key facts

>100 patents awarded or pending	>5 strategic partnerships
3+ years of use in customer fleets	150+ full-time employees

Key public partnerships

veoneer, HITACHI, MACNICA, Tier IV

Leading investors

BLACKBIRD, SEQUOIA, REGAL FUNDS MANAGEMENT, HESTA, InterValley VENTURES, PRISMA, PERENNIAL, main sequence ventures

Agenda

The harshest environments reveal next-gen capabilities

1. *Testing and Developing LiDAR in the Harshest Environments*
   - LiDAR challenges in the field

2. *Built for Reliability, Robustness, High volume*
   - Unique solid-state scanning: *Spectrum-Scan™*
   - Unique ranging: Random Modulated Continuous Wave (*RMCW*)
   - Unique information: Per-point *Doppler* from Homodyne RMCW + Spectrum-Scan™

3. Mass Deployment
   - From off-road durability to on-road autonomy

From off-road durability to on-road autonomy

- Extremes are the norm
- Reliability is money
- Immunity to interference is a must

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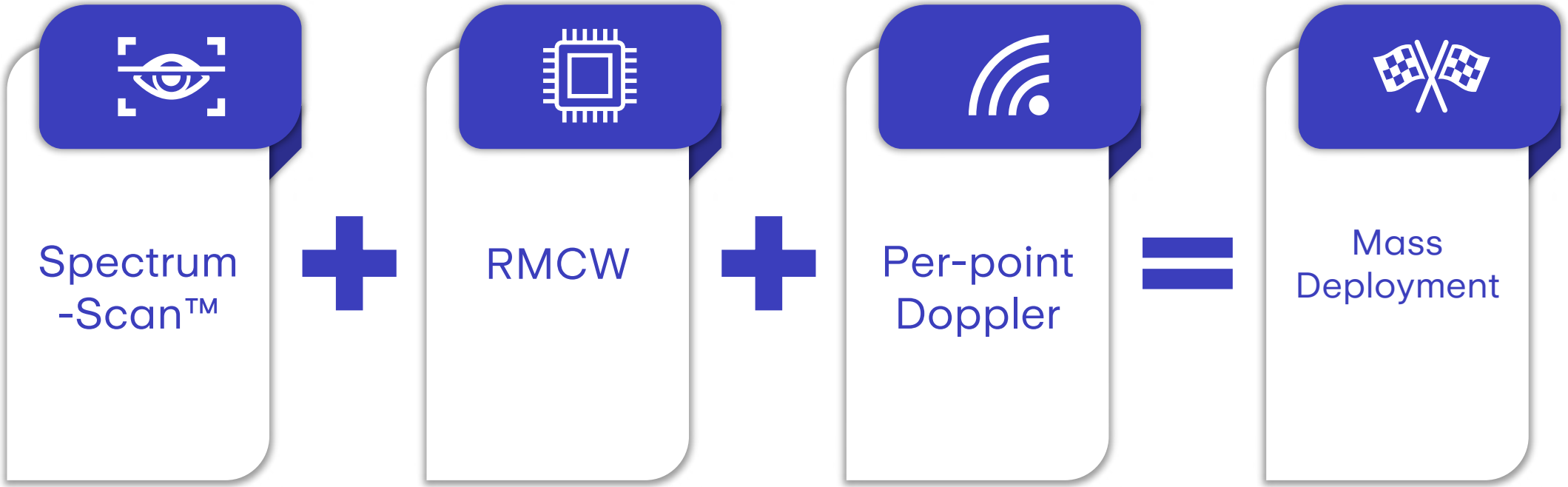
1 Accurate object detection at long range

2 Data you can trust

3 Seamless automotive integration



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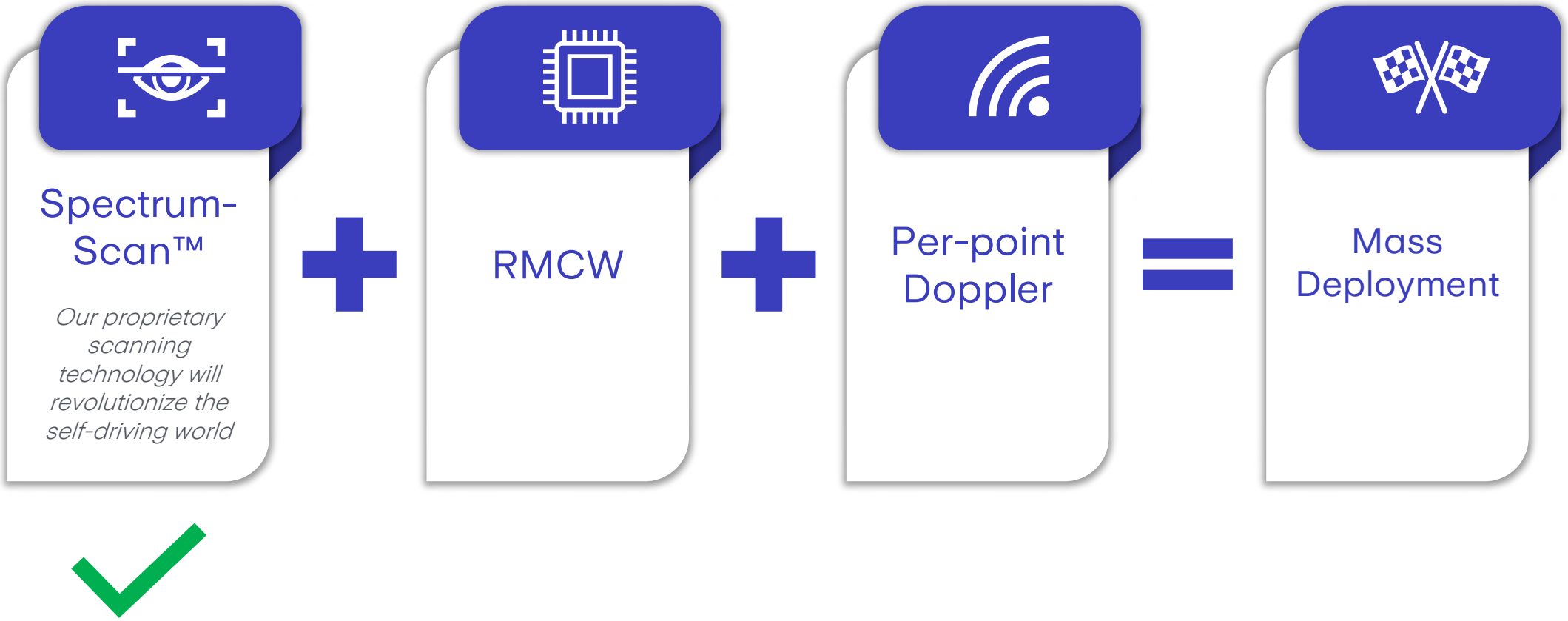
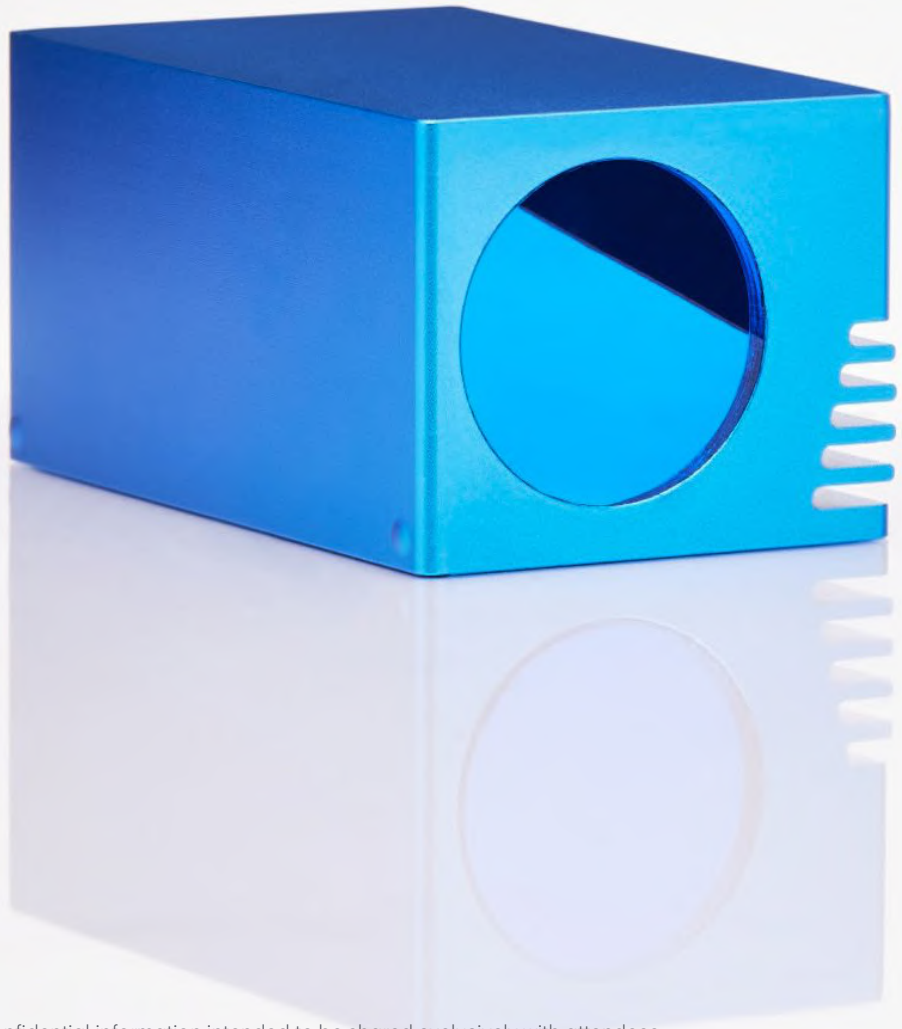


Spectrum-Scan™

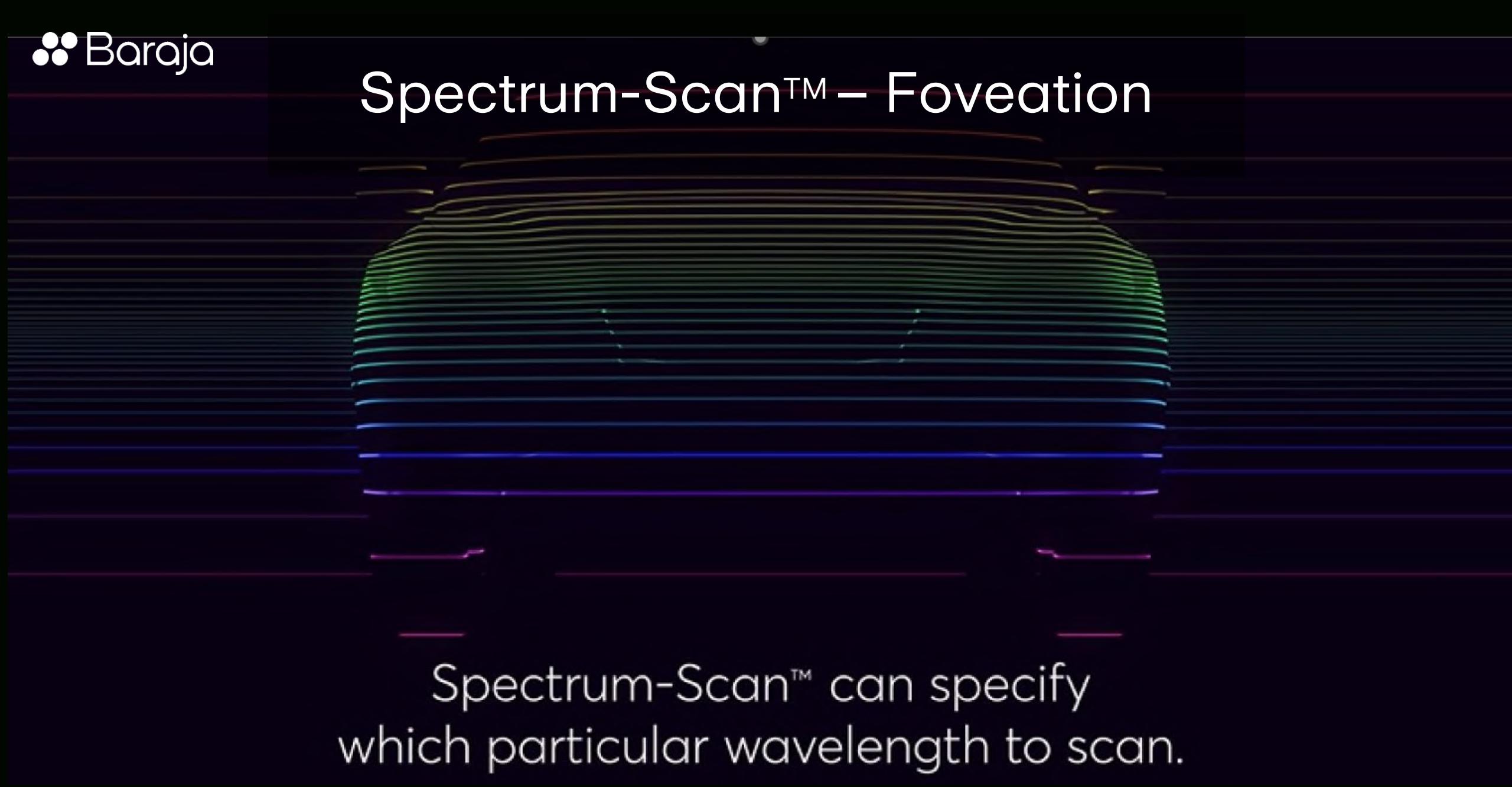
Spectrum-Scan™ - built for reliability

Image: Spectrum HD25 LiDAR

- Eliminated the most expensive, bulky and failure prone components of a LiDAR system - mechanical scanning in the fast axis
- No large spinning lasers / other cumbersome, rapidly moving parts means a **more reliable, high performing system**
  - Unique fast axis solid-state design means increased **durability and longevity**
- Creates a substantial increase in resolution, only made possible by moving away from mechanical scanning



Spectrum-Scan™ – Foveation



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Achieved only through an unique combination of: *Range*, *Resolution*, *Angular Accuracy*, *Beam collimation*

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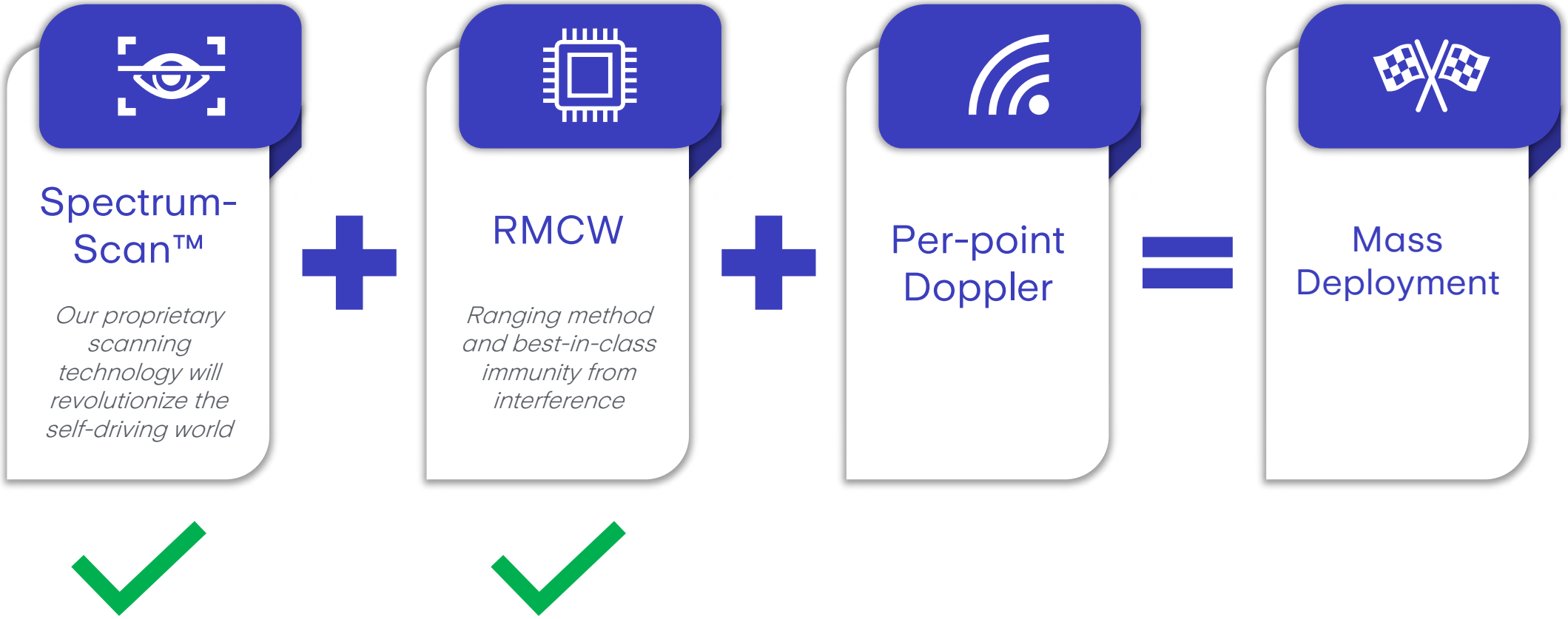

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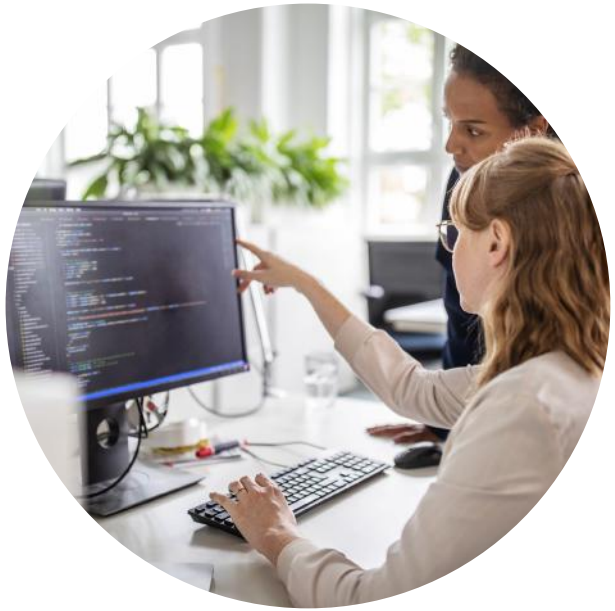
Why use RMCW in LiDAR?

Multi-layered Protection

2x More Robust Against Interference

Scalability

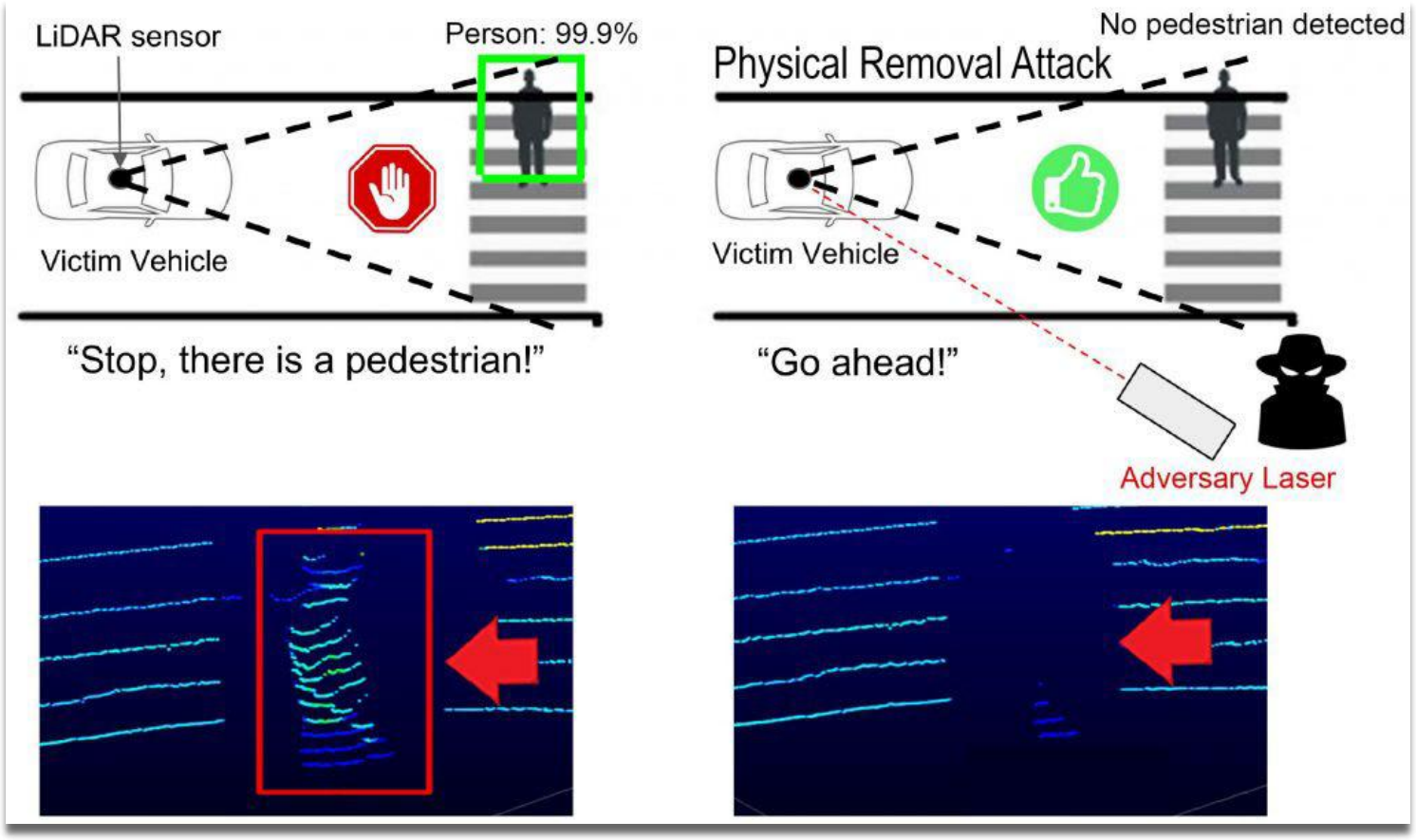
Enabling high volumes



Requirements

Not requiring high performance electronics and lasers

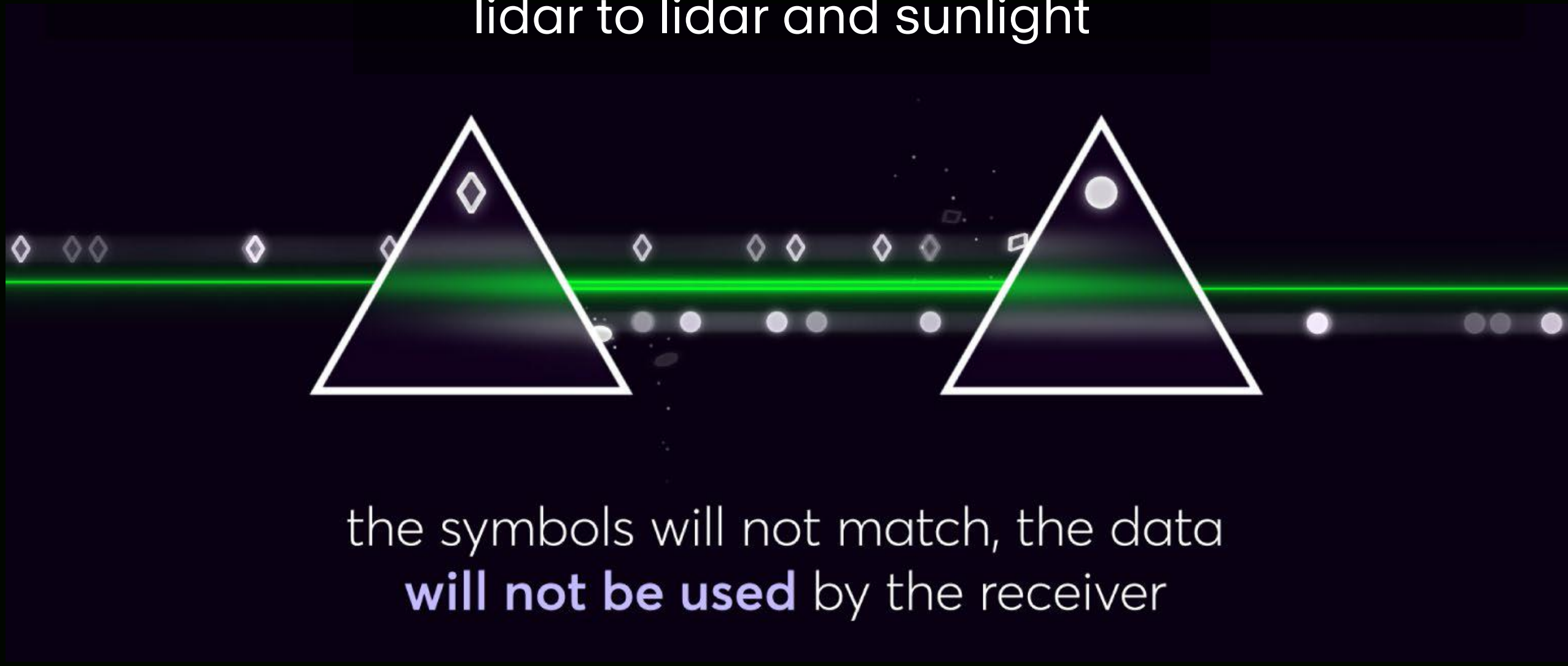
What happens without immunity to interference?



A study conducted by the University of Florida, University of Michigan and University of Electro-Communications in Japan demonstrated that **AVs fitted with LiDAR sensors were at risk of being blinded from lasers emitted by other LiDAR sensors.**

Ref: Yulong Cao et al, You Can't See Me: Physical Removal Attacks on LiDAR-based Autonomous Vehicles Driving Frameworks, *arXiv* (2022). DOI: 10.48550/arxiv.2210.09482. arxiv.org/abs/2210.09482

Built-in immunity to interference: lidar to lidar and sunlight



Built-In Immunity to Interference

RMCW is 2x more robust against interference than competing ranging technologies.

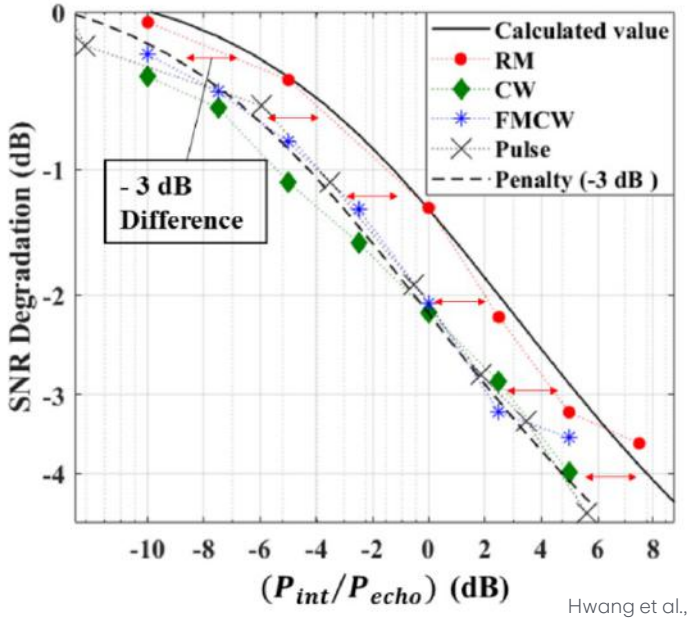
Dependable sensor data which is immune to interference from both the environment and other LiDAR sensors.

Problem

Traditional LiDAR systems are vulnerable to interference from external light sources, in particular other LiDAR sensors – a major obstacle to safely putting autonomous vehicles on the road.

Solution

The Spectrum-Scan™ platform is the first LiDAR with a unique built-in immunity to interference. A signal needs to match the exact timing, angle, wavelength and encoding to interfere with our sensor. This multi-layered protection means no more blind spots in perception and enhanced safety that's ready for tomorrow's sensor-filled world.

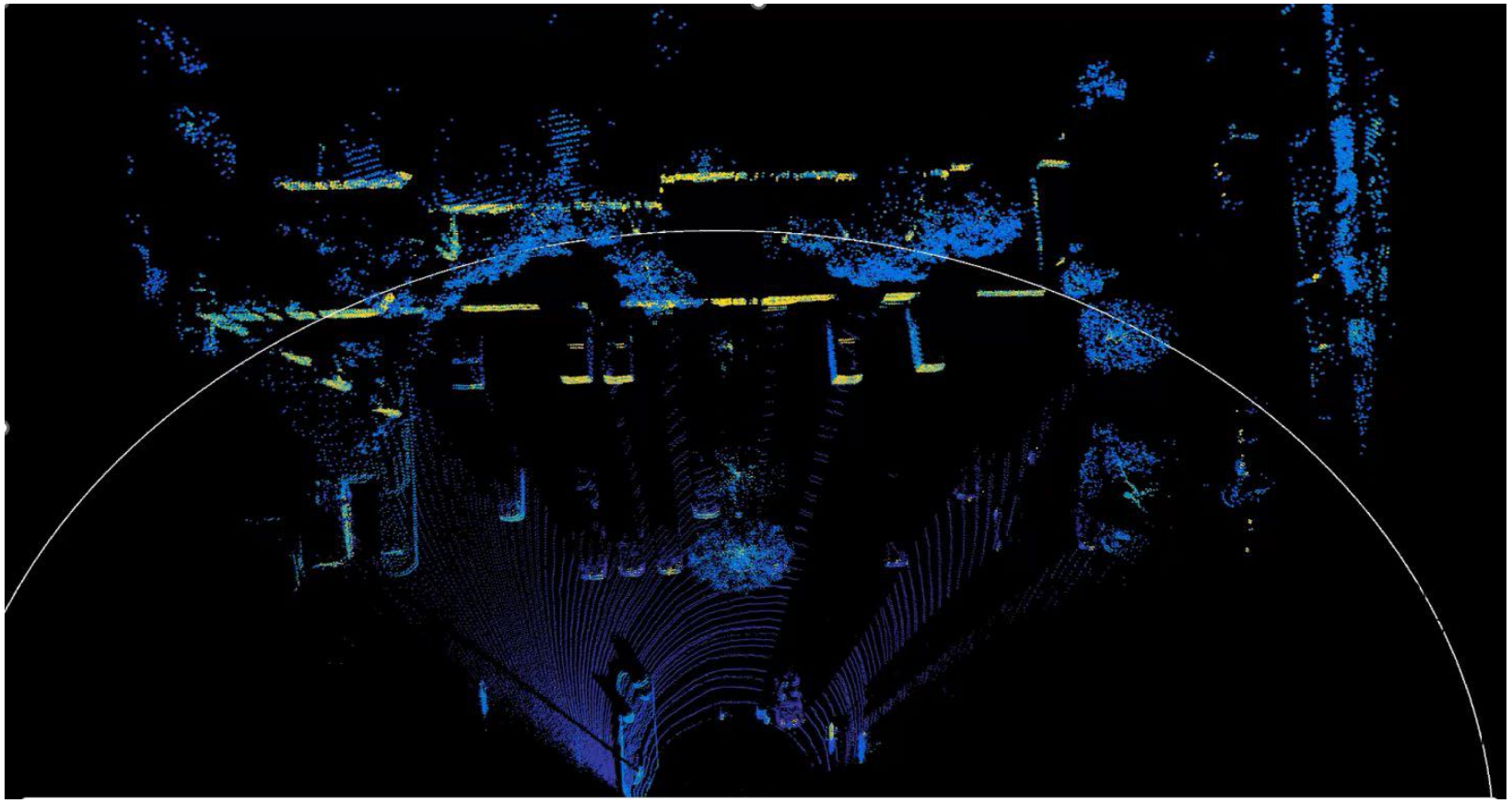


Hwang et al., IEEE Access, 2020.

"[...] FMCW LiDAR's have mutual interference problems... [that] degrades the [SNR] and ...generates ghost images."

Interference Performance

2x SPHD'23 aimed at each other – Van mounted system rolls out and back 1-40m



Aggressor system mounted on a tripod in centre FOV.

DUT mounted on van, moving from 1-40m

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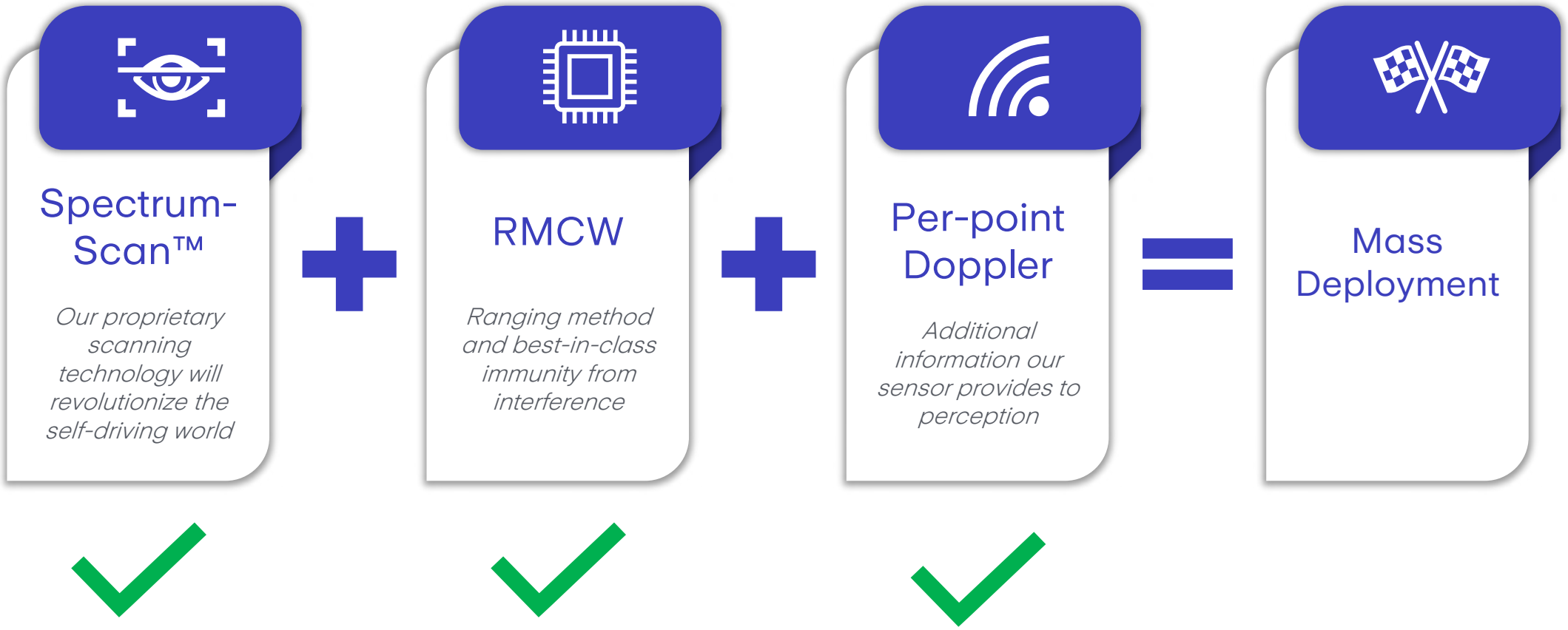

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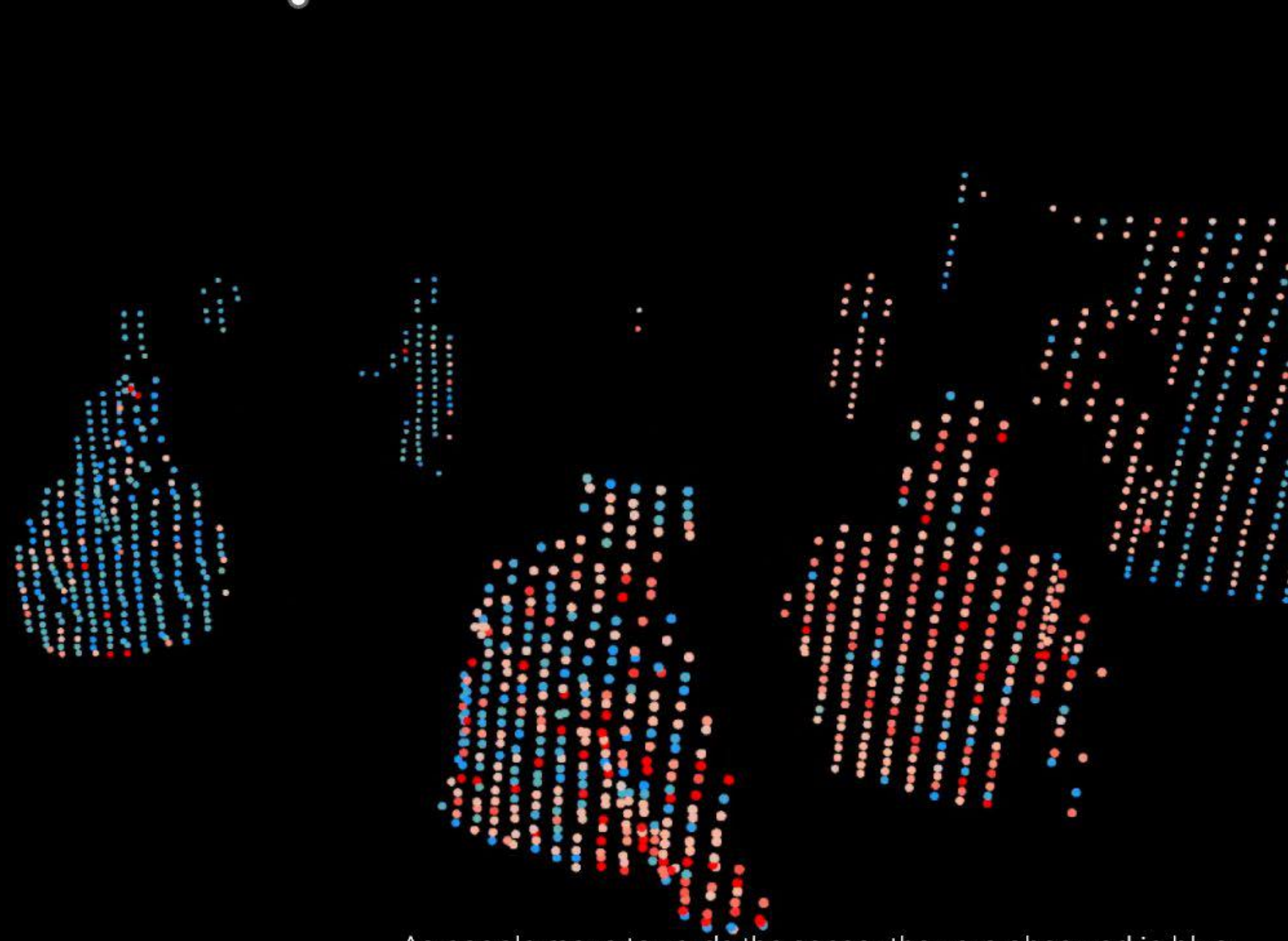

As people move towards the sensor they are observed in blue and then change to red as they begin to move away

Advantage of Per-point Doppler capability

- Per-point Doppler velocity is instantaneous, precise and requires no additional computation power
- Grouping by velocity helps segment and predict trajectory of objects, leading to better perception outcomes
  - Example: The data can be used to detect movement at a distance, such as a pedestrian stepping out of a stationary crowd into the road

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Spectrum-Scan™

Our proprietary scanning technology will revolutionize the self-driving world

+

RMCW

Ranging method and best-in-class immunity from interference

+

Per-point Doppler

Additional information our sensor provides to perception

=

Mass Deployment

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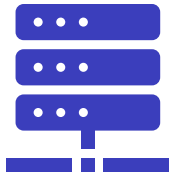
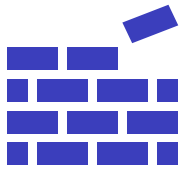
Automotive LiDAR sensors need …



Reliable Data

High quality,
Durable



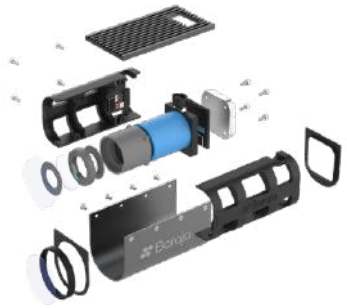
High Volume
Manufacturable

Scalable
Low cost

but also ….

Invisible Integration

Function, Performance meets Cost, Size, Aesthetics



< 200cm^3 *Keep Out Zone*

- Lowest in market for mid to long range LiDAR

< 300 cm^3 *Product Volume*

- Coaxial design driving smallest available package size

Optimized *power consumption* based flexible options

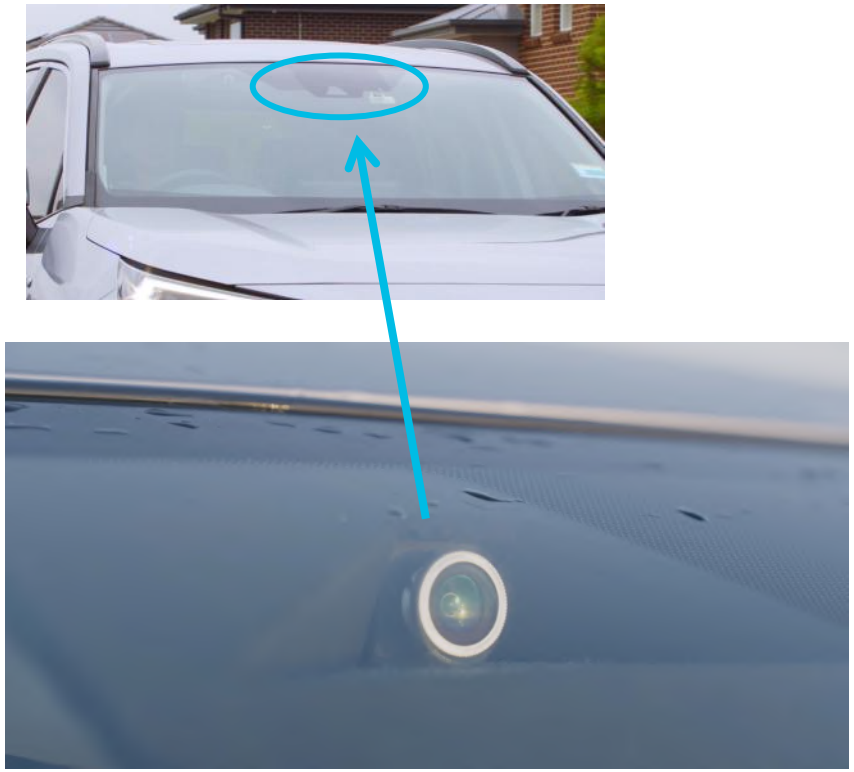
- Providing efficient high resolution doppler LiDAR

>80% 2-way *efficiency glass transmission* (rake angle of 60°)

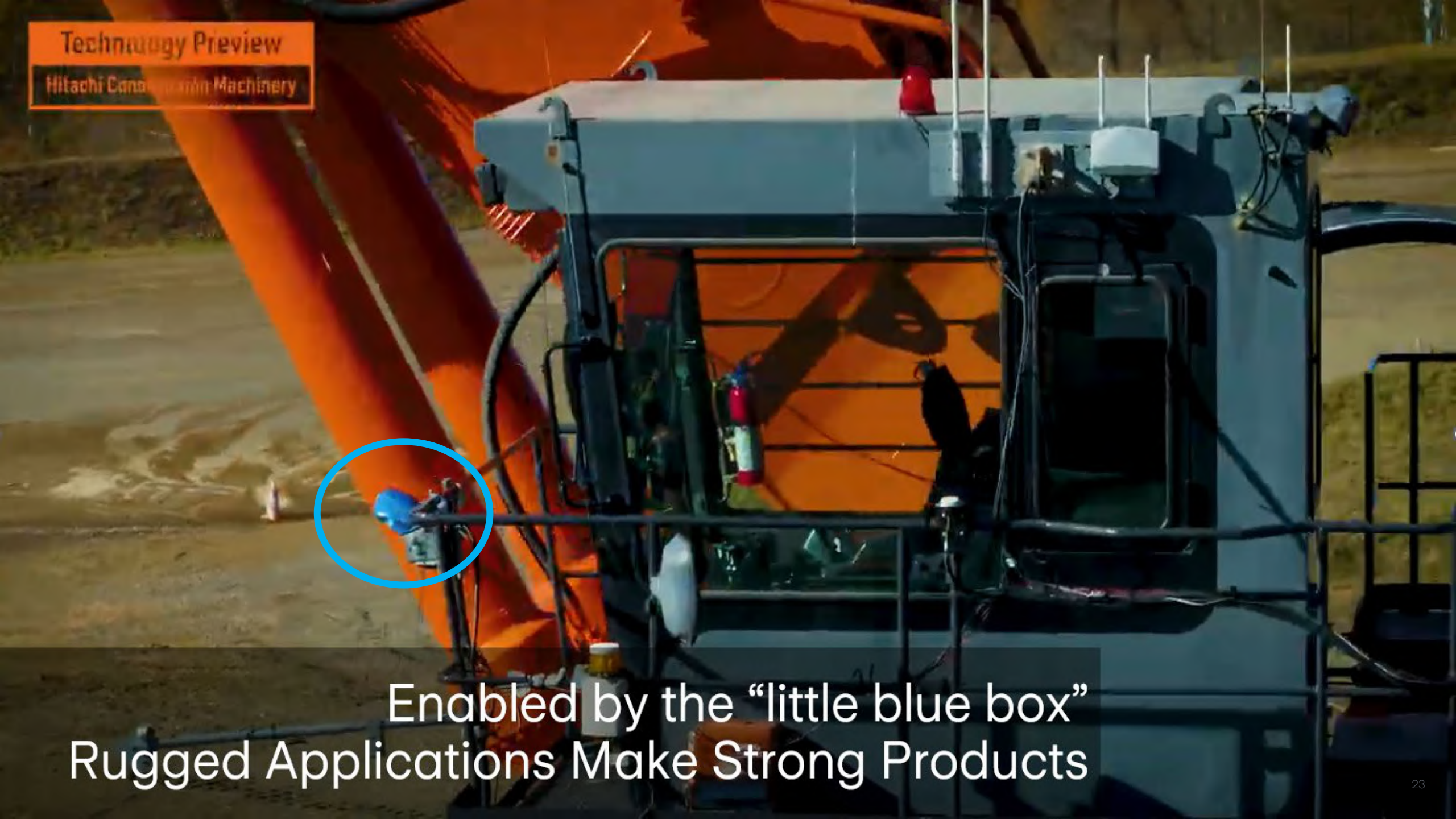
- Enabled through polarization control

Low *audible noise*

- No highspeed spinning motors



Seamless vehicle integration: behind the windshield, in the headlamp besides the grill or roof



Enabled by the “little blue box”
Rugged Applications Make Strong Products

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