2020 embedded VISION summit®

Designing Cameras to Detect the "Invisible": Handling Edge Cases Without Supervision

Dr. Felix Heide
CTO & Co-Founder
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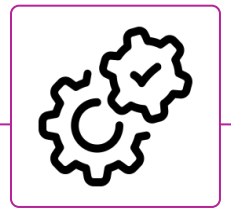
Algolux – Robust Perception for All Conditions

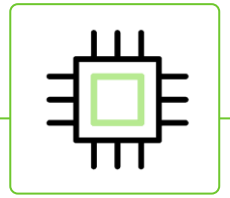
- AI software company based in in Montreal, with offices in Palo Alto and Munich
- 75+ employees primarily in Montreal with over 85% in R&D
- Significant industry and academic recognition



Atlas Camera Optimization Suite

Optimize accuracy for existing vision systems

Up to **15%** improvement



Eos Embedded Perception

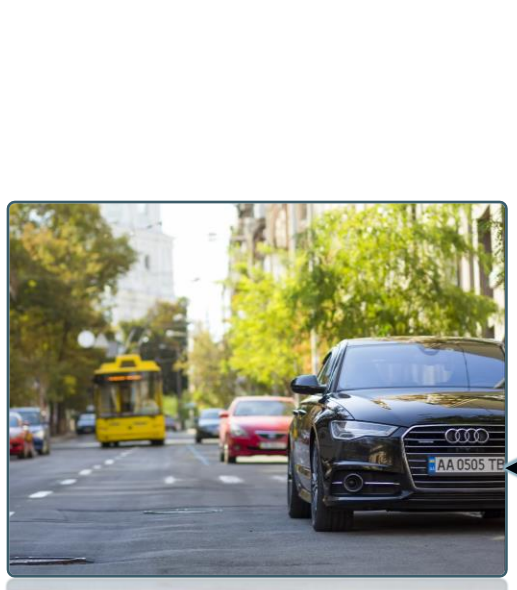
Optimize accuracy for new vision systems

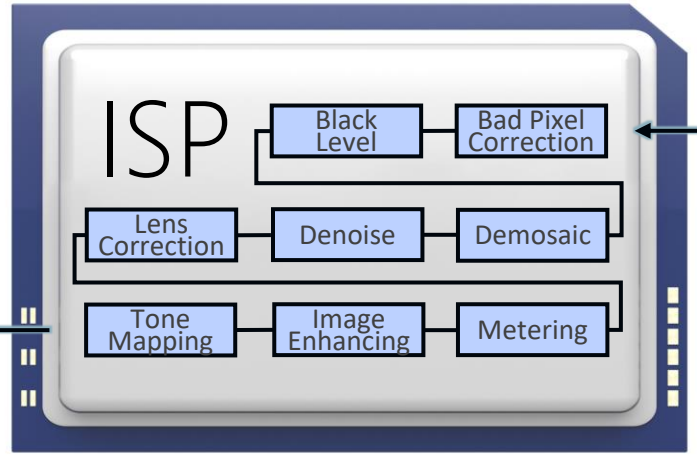
Up to **3x** improvement

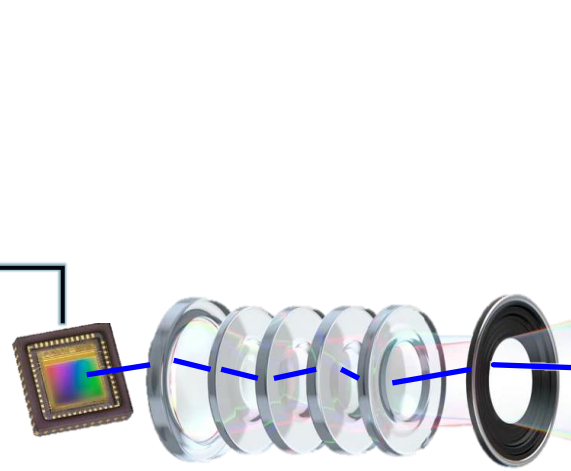
Today's Vision Systems Fail in Edge Cases

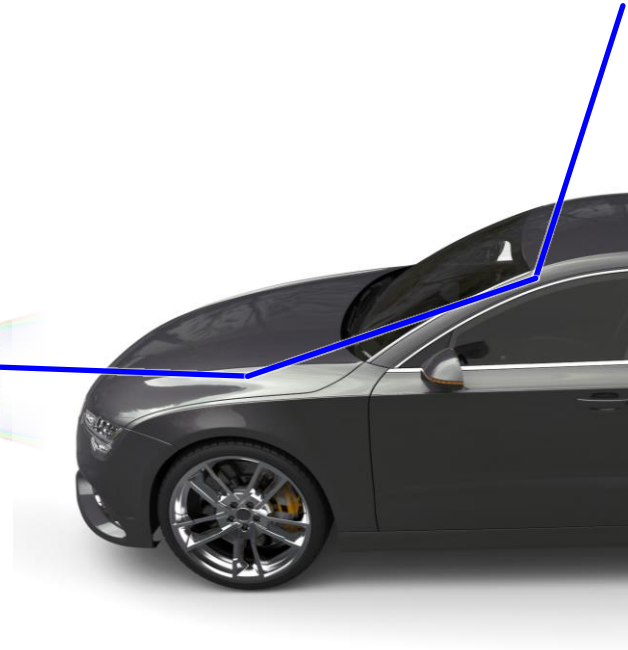
FRCNN Resnet 50

Typical Imaging Stack

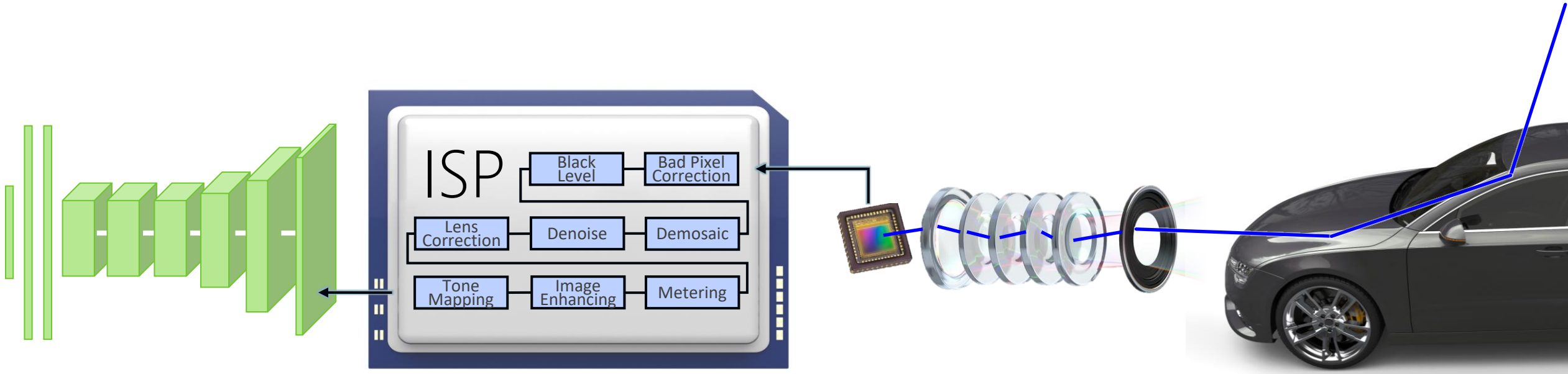






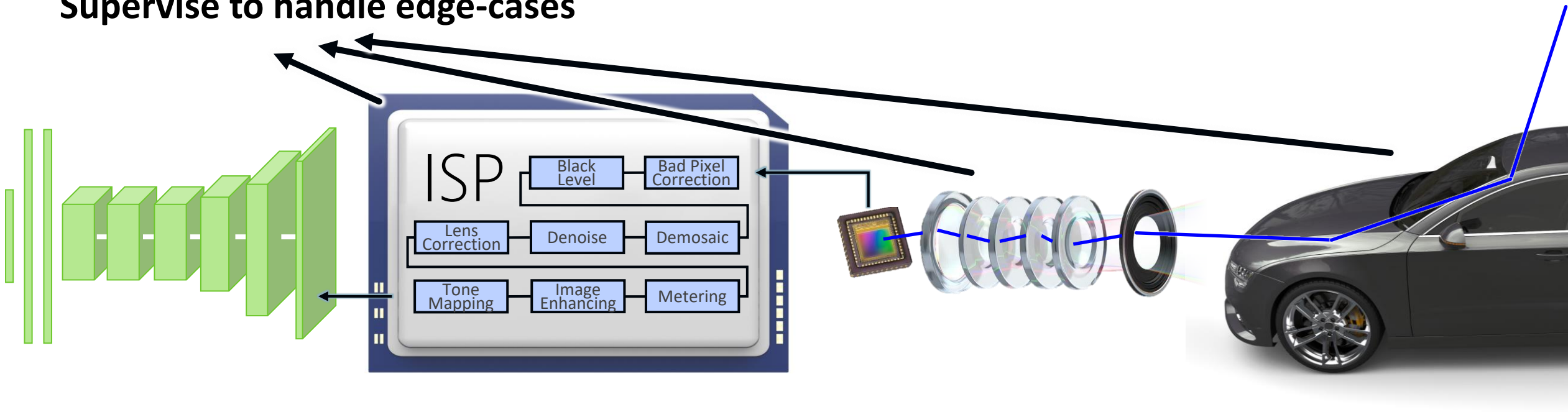


Typical Imaging Stack



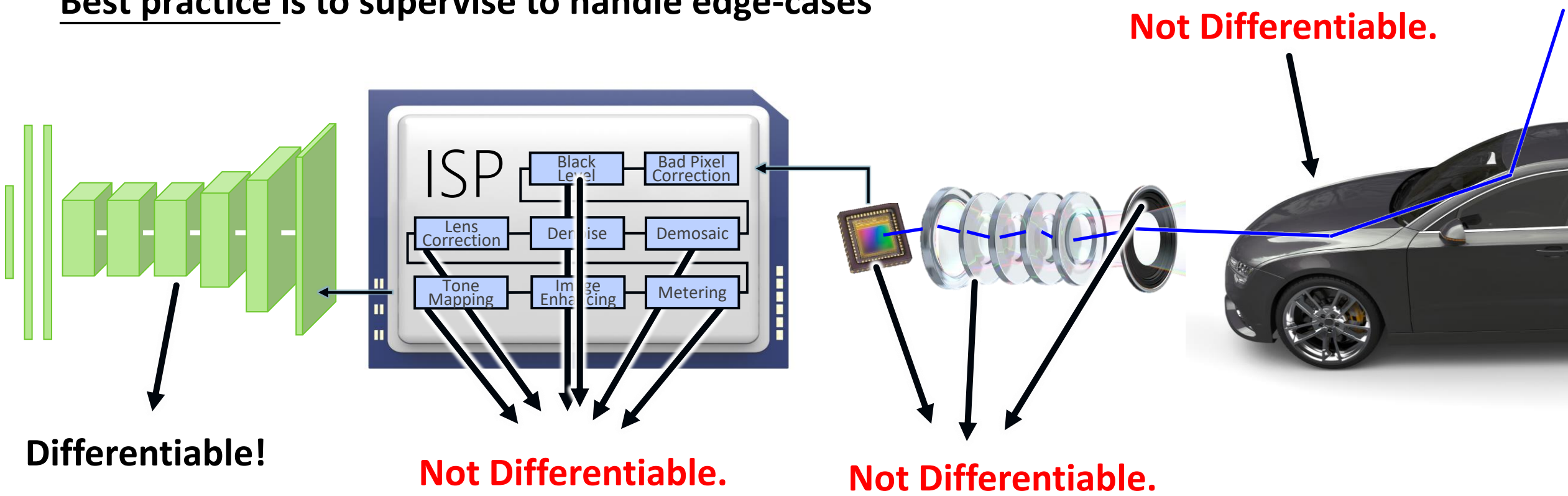
Typical Imaging Stack

Supervise to handle edge-cases

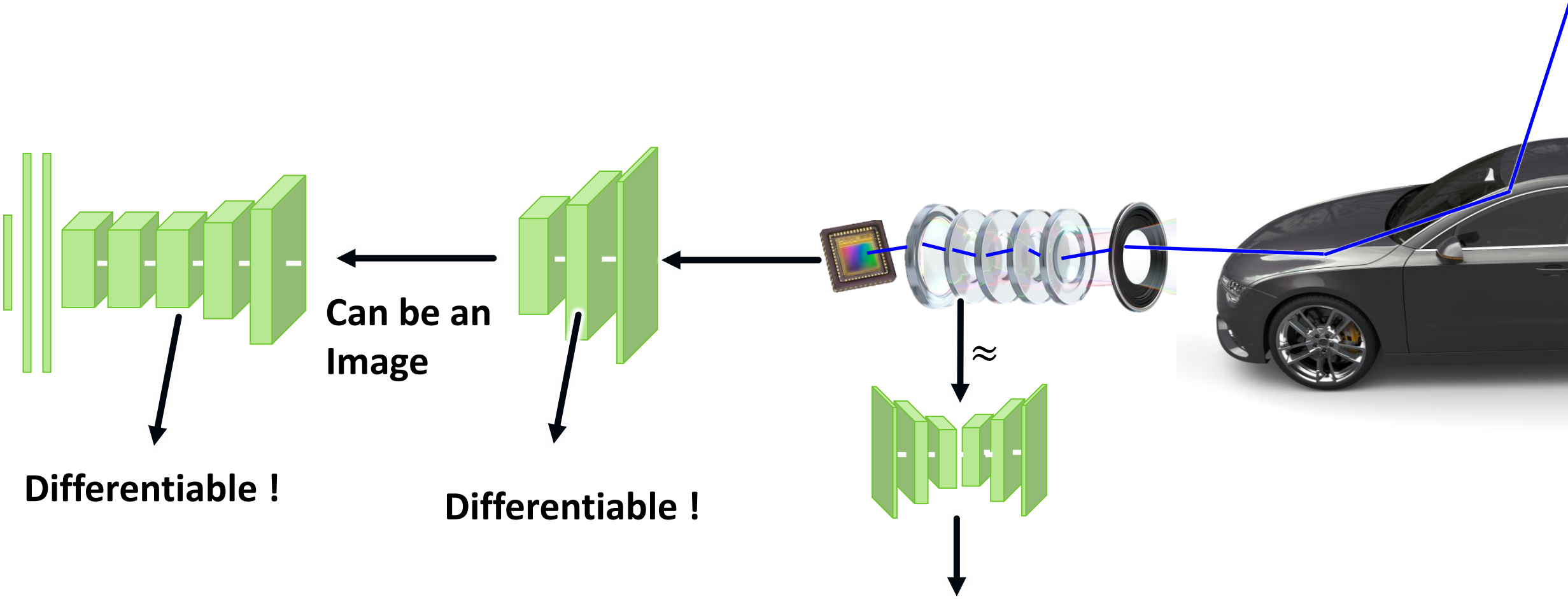


Today's Best Practices

Best practice is to supervise to handle edge-cases



Jointly Learn Perception, Image Processing and Sensing



Algolux Eos
Embedded Perception Software

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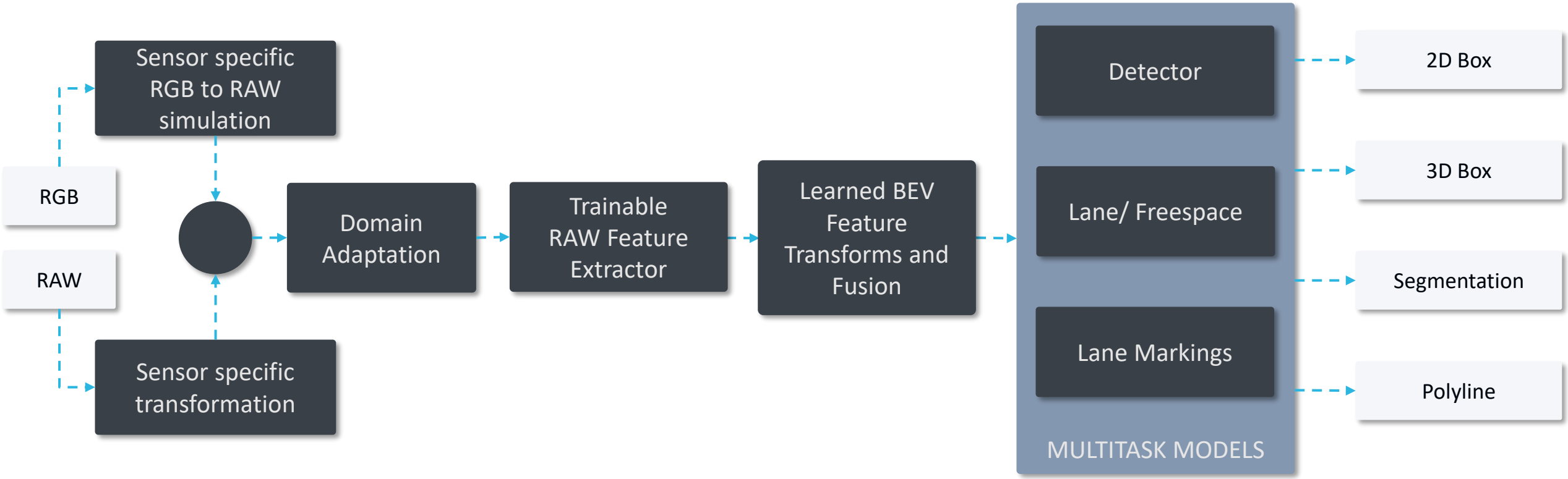
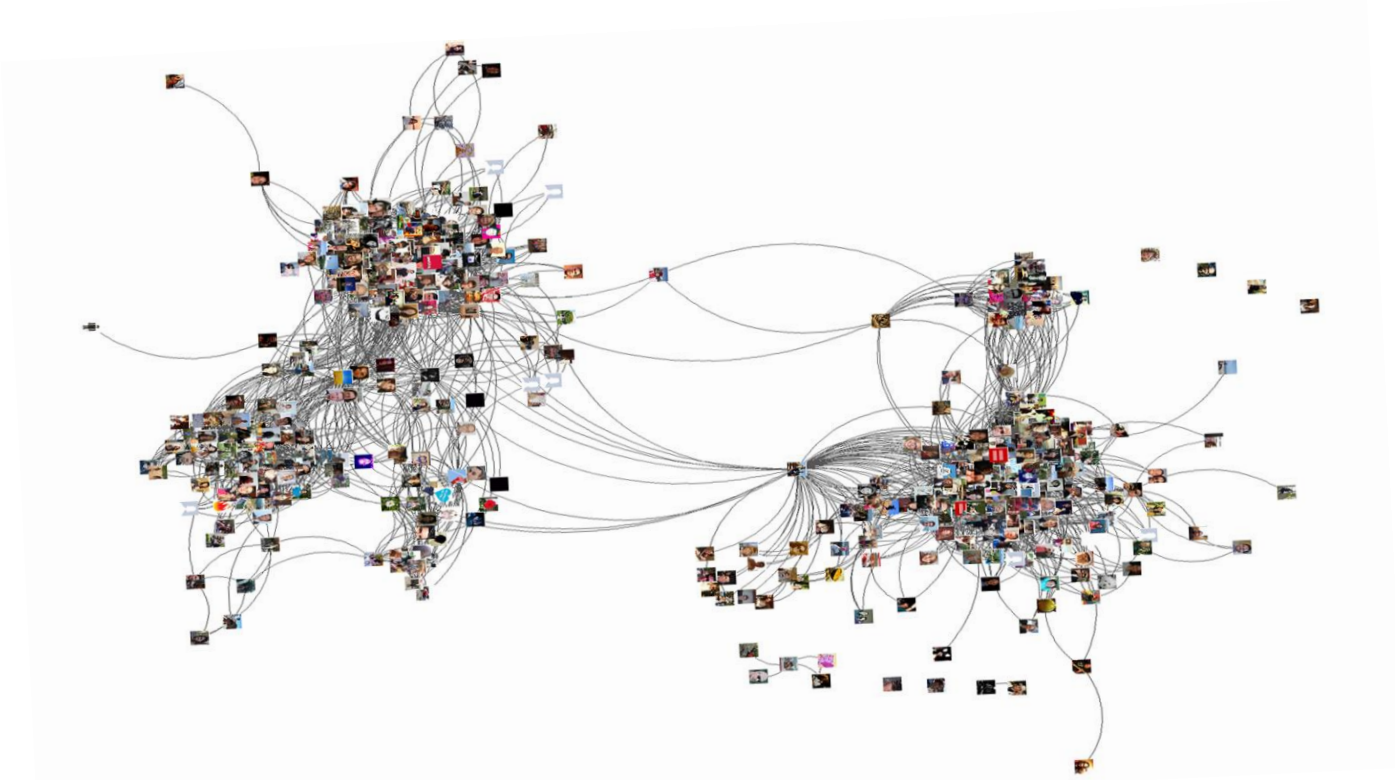
Eos
Training Directly **from RAW**



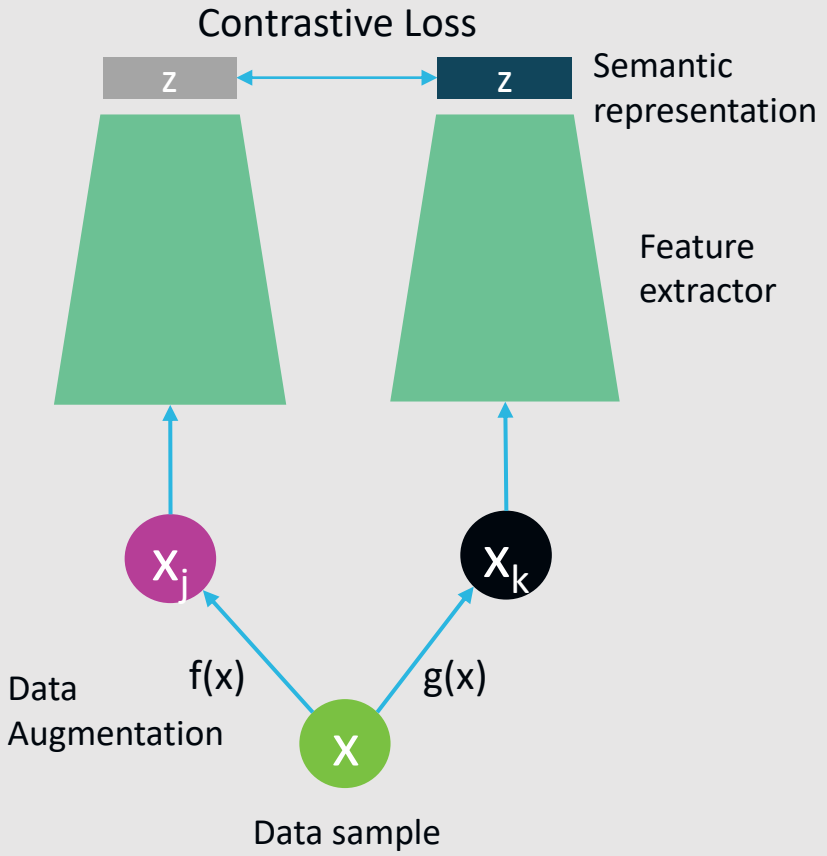
- Simulates RGB to RAW for generic data
- Transforms arbitrary sensor raw to target raw
- Domain adaptation for clear well-illuminated images to suboptimal images

Eos
Unsupervised Learning **in RAW**

We leverage vast amounts of **unlabeled data** by intensive **contrastive learning in the RAW domain.**



Unsupervised Contrastive Learning



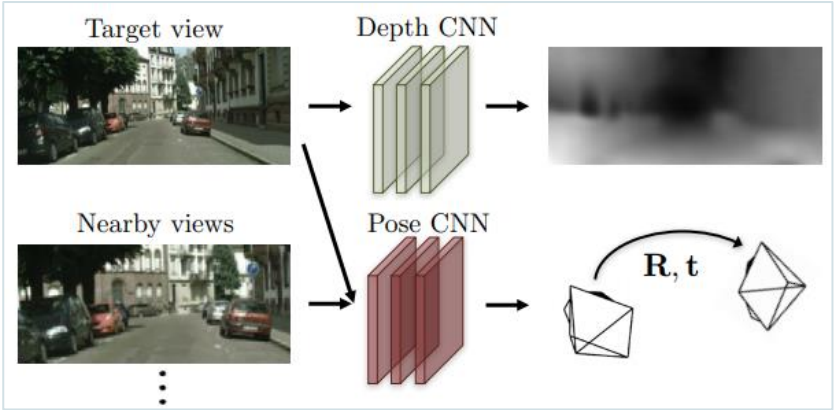
Eos
Self-Supervised Learning **in RAW**

We jointly train Monocular Depth Estimation
and motion models from **unlabeled videos in RAW**

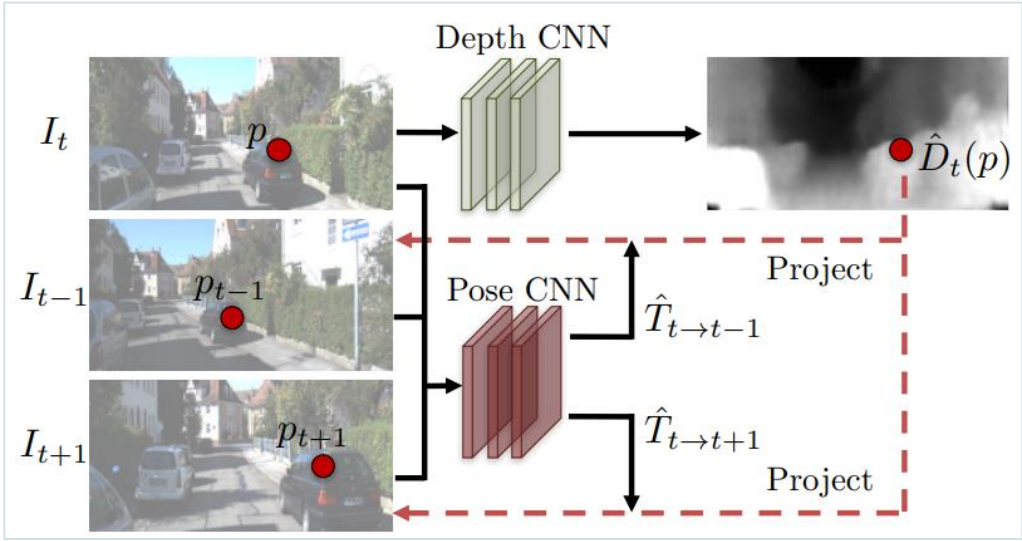
Unlabeled Video Frames

- Given an input frame I_t and nearby frames I_{t-1}, I_{t+1}, a convolutional network produces a depth map from I_t, a second network estimates camera poses relative to I_{t-1} and I_{t+1}
- All losses defined in the RAW domain instead for post-ISP.

Depth and Camera Pose Estimation Networks



Training using consistency between Depth Map and Camera Pose Estimations



Perception Stack

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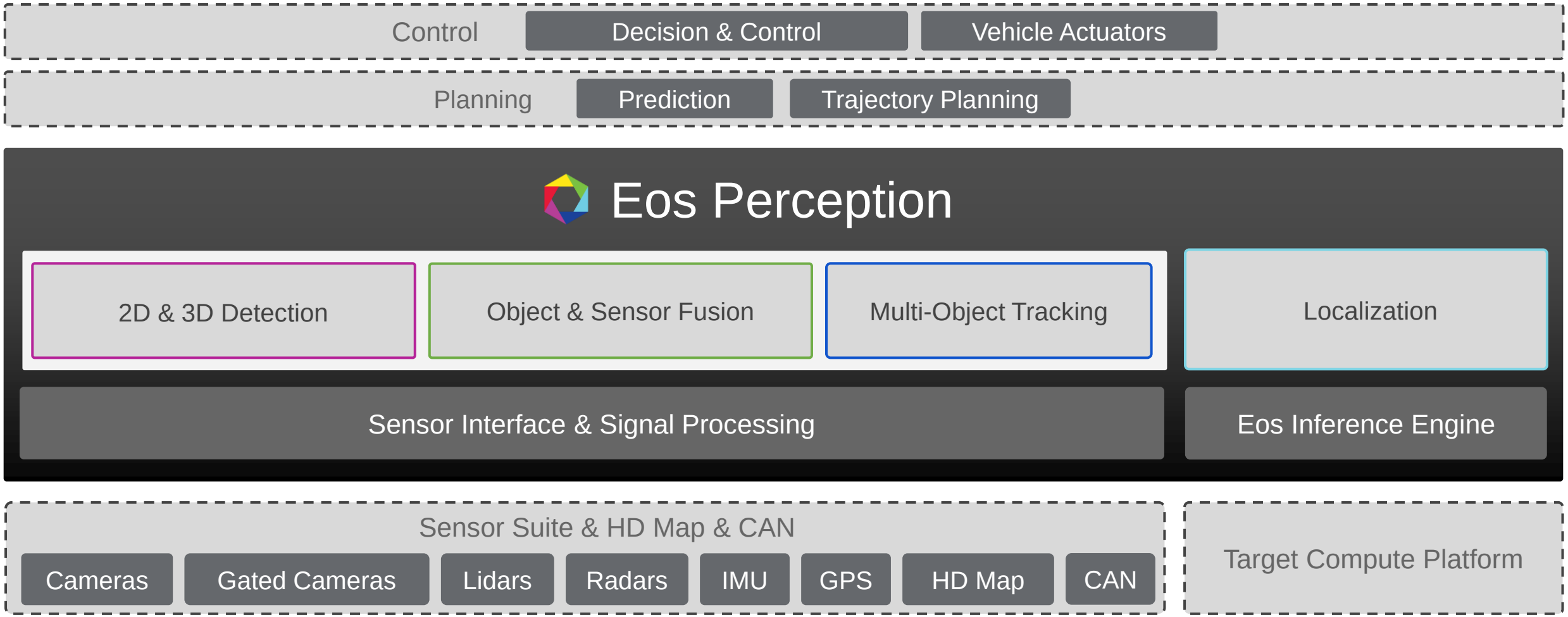
Eos Perception Portfolio



Eos Perception Baseline Features

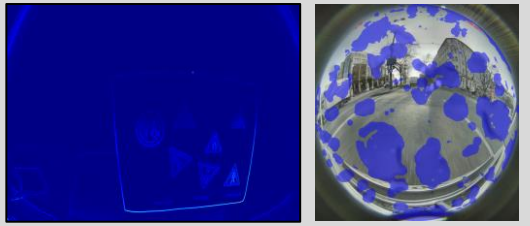
Object Detection & Tracking

Traffic Light Detection

Lane Detection

Freespace Detection (with Ego-Lane Extension)

Reflection Removal & Obstruction Detection

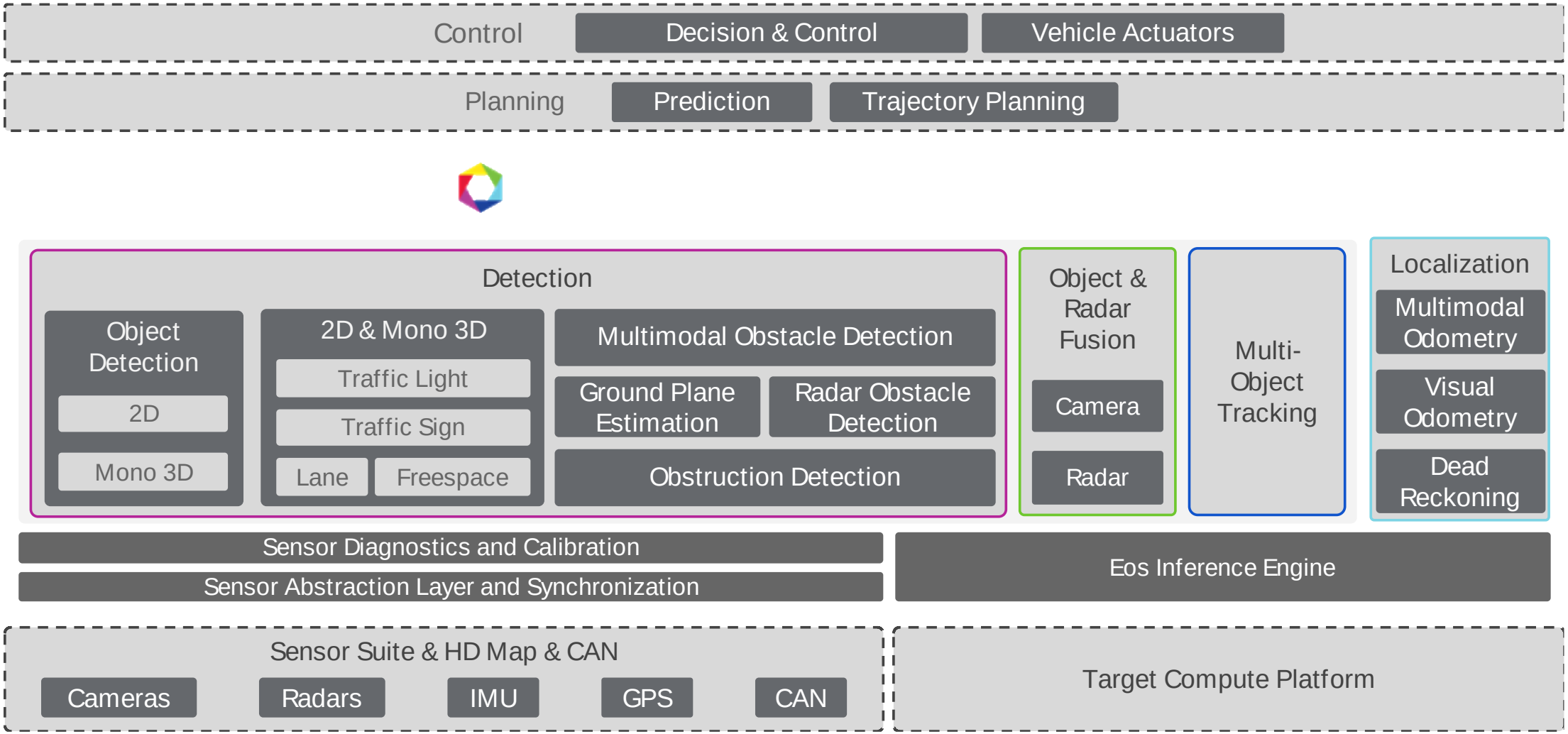


Online Calibration

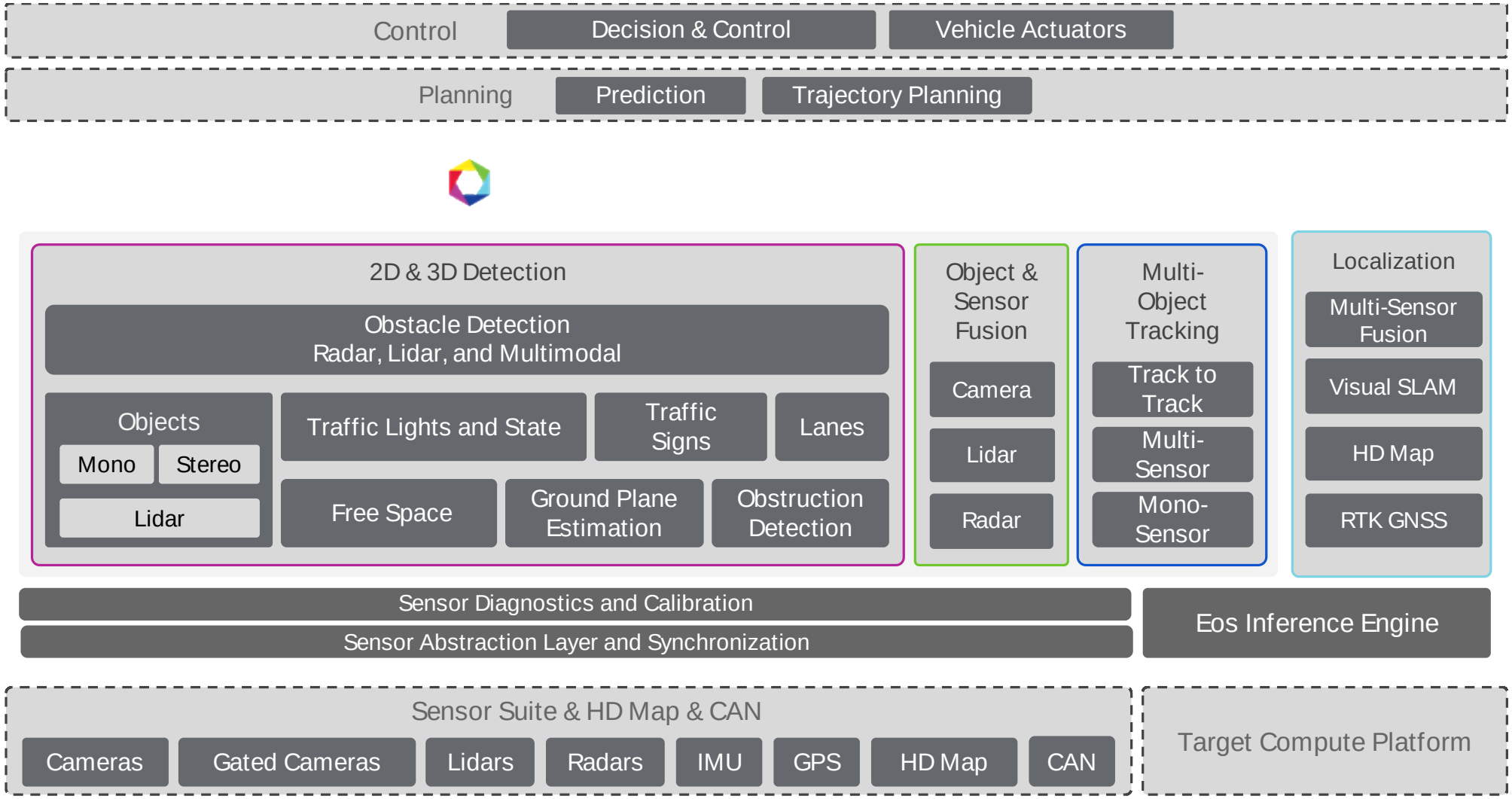
Sensor Interface & Signal Processing

Eos Inference Engine

Eos L2+ Stack for Camera and Radar Perception



Eos L4 Stack for Multi-Sensor Fusion



Evaluations

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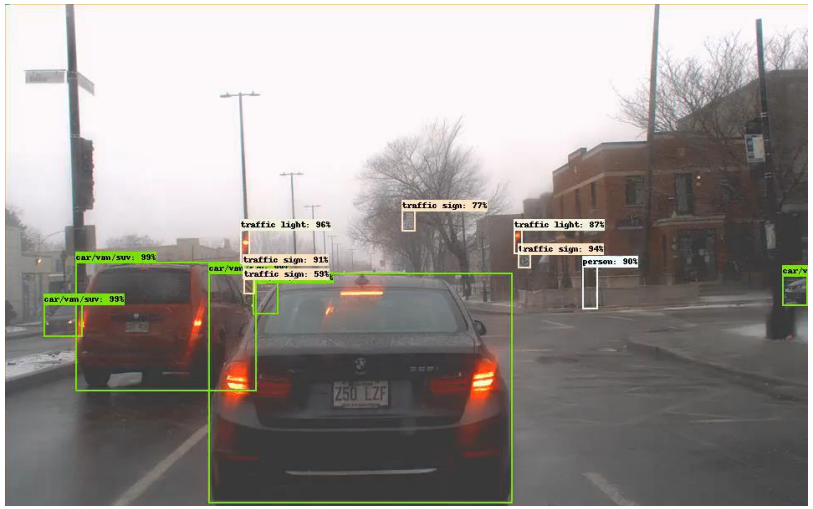
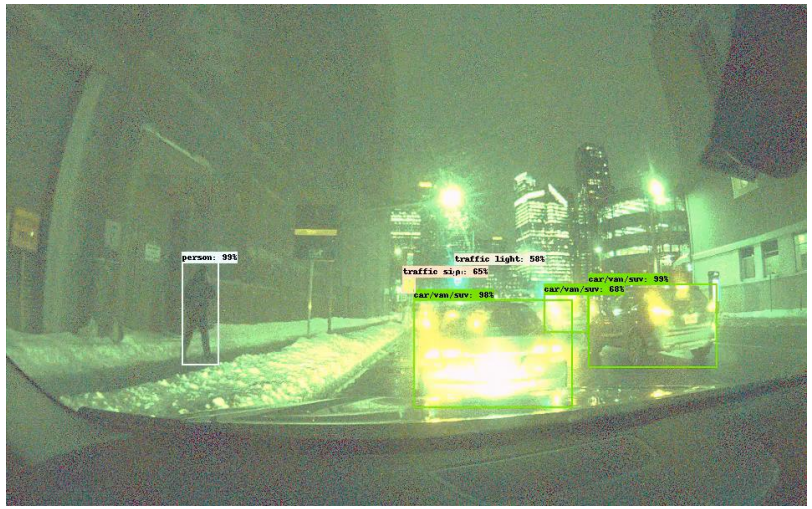
Qualitative Object Detection Examples

Dark Night



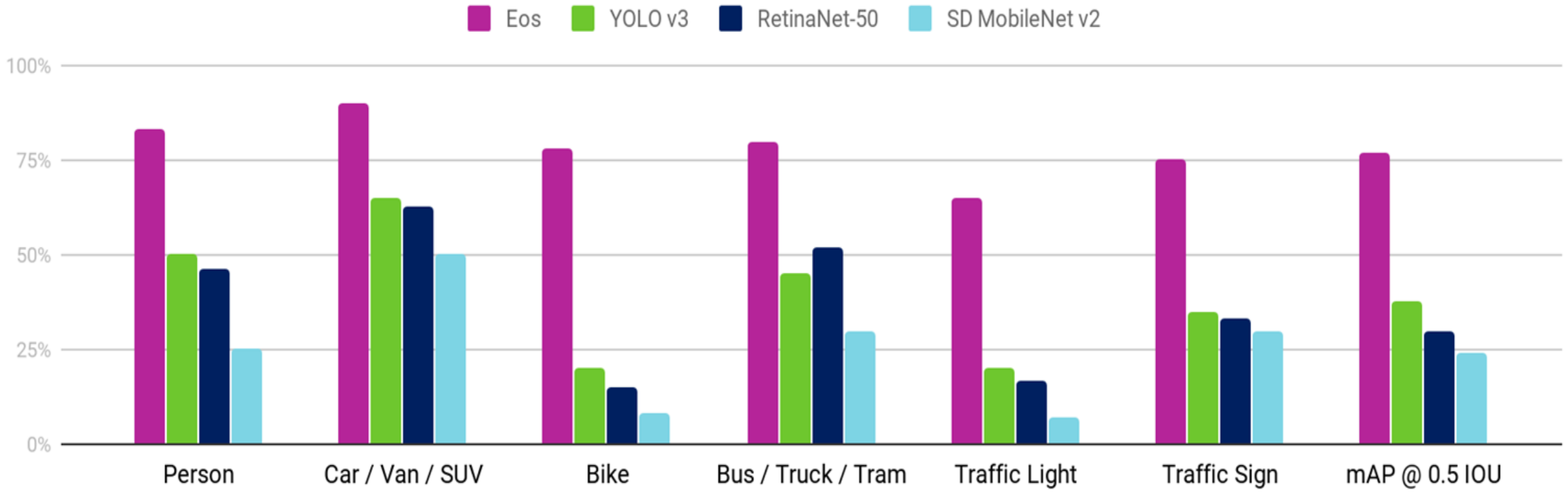
Snow Fall

Low Light & Glare from Dirty Windshield



Foggy Night

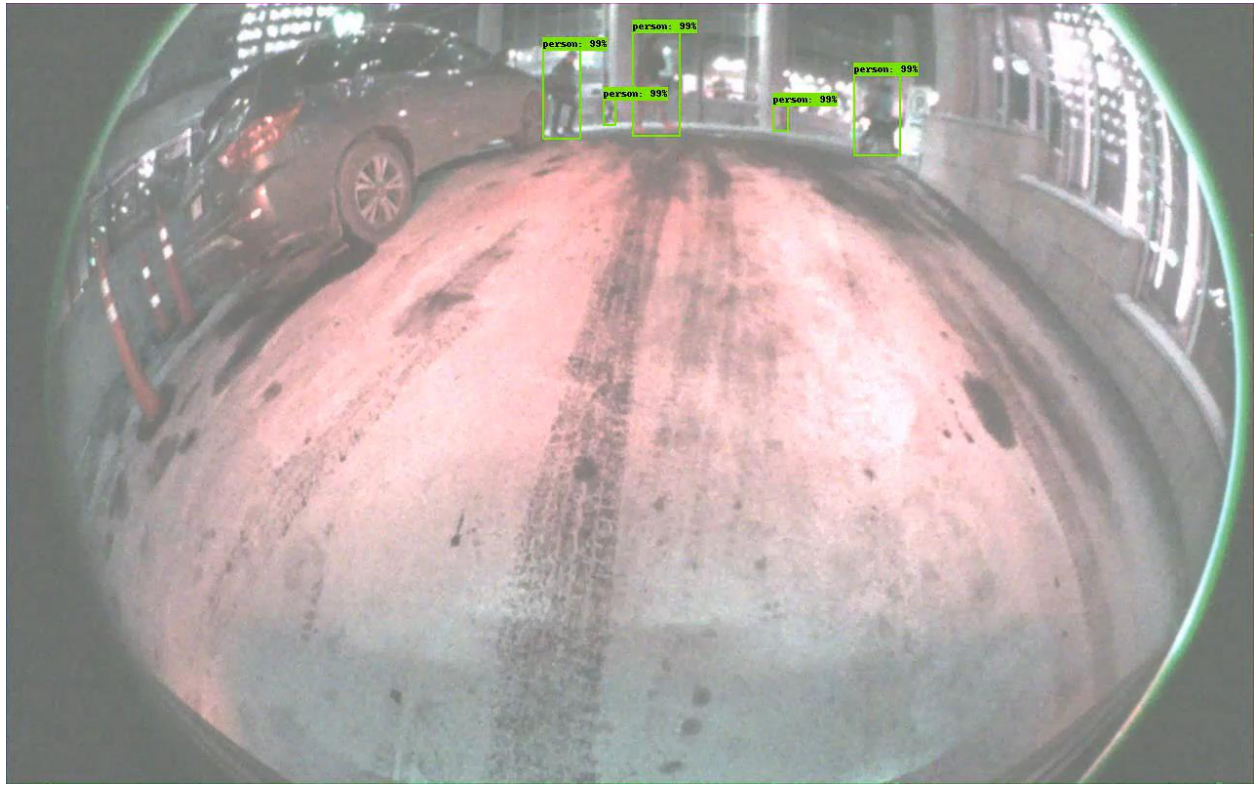
Best Performance in Harsh Conditions



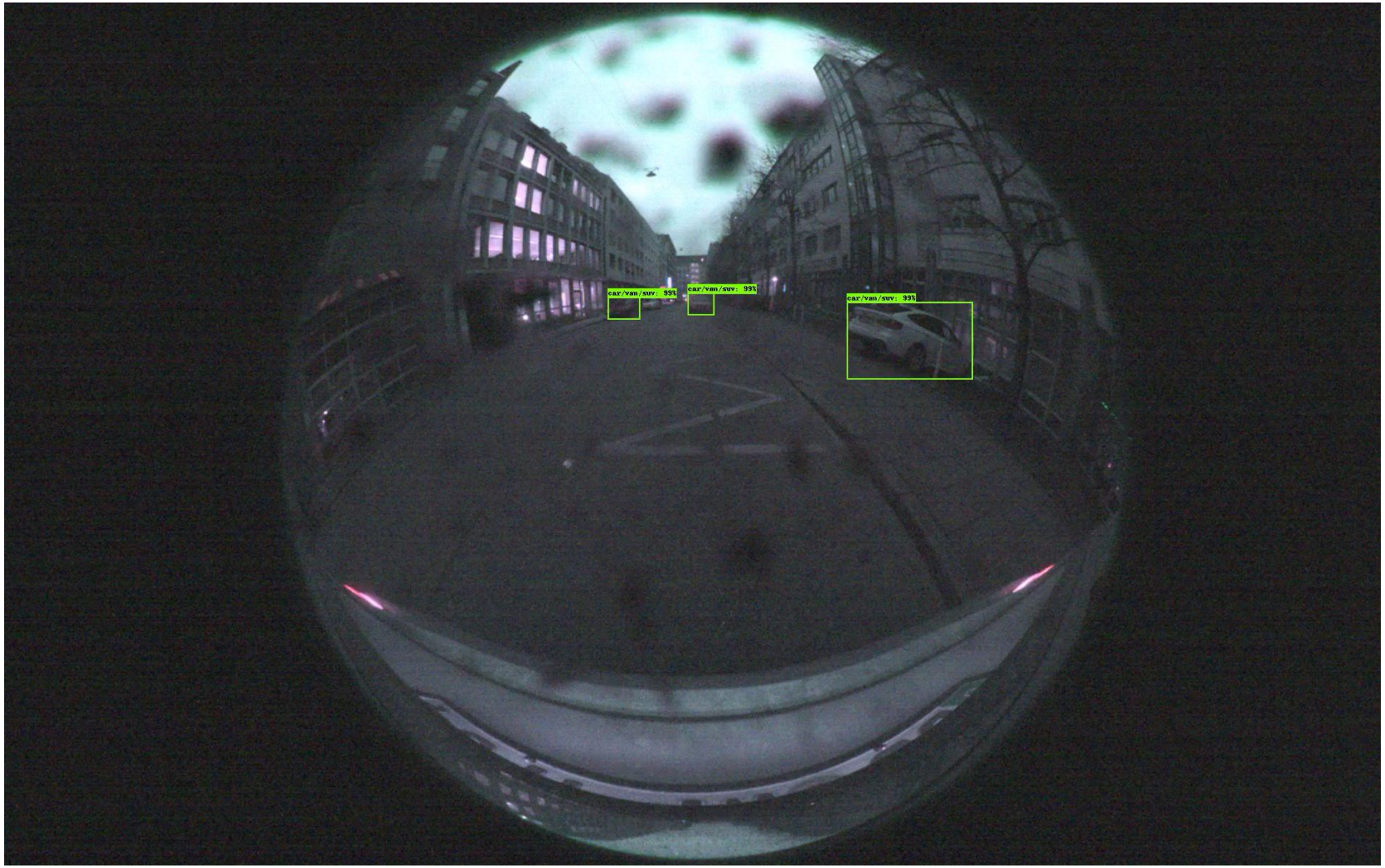
Training Data
Algolux dataset with a mix of easy and challenging lighting and weather scenarios

Validation/Test Data
See Dataset specs later in the slides.

Eos Pedestrian Detection
Wide-Angle Low-Light

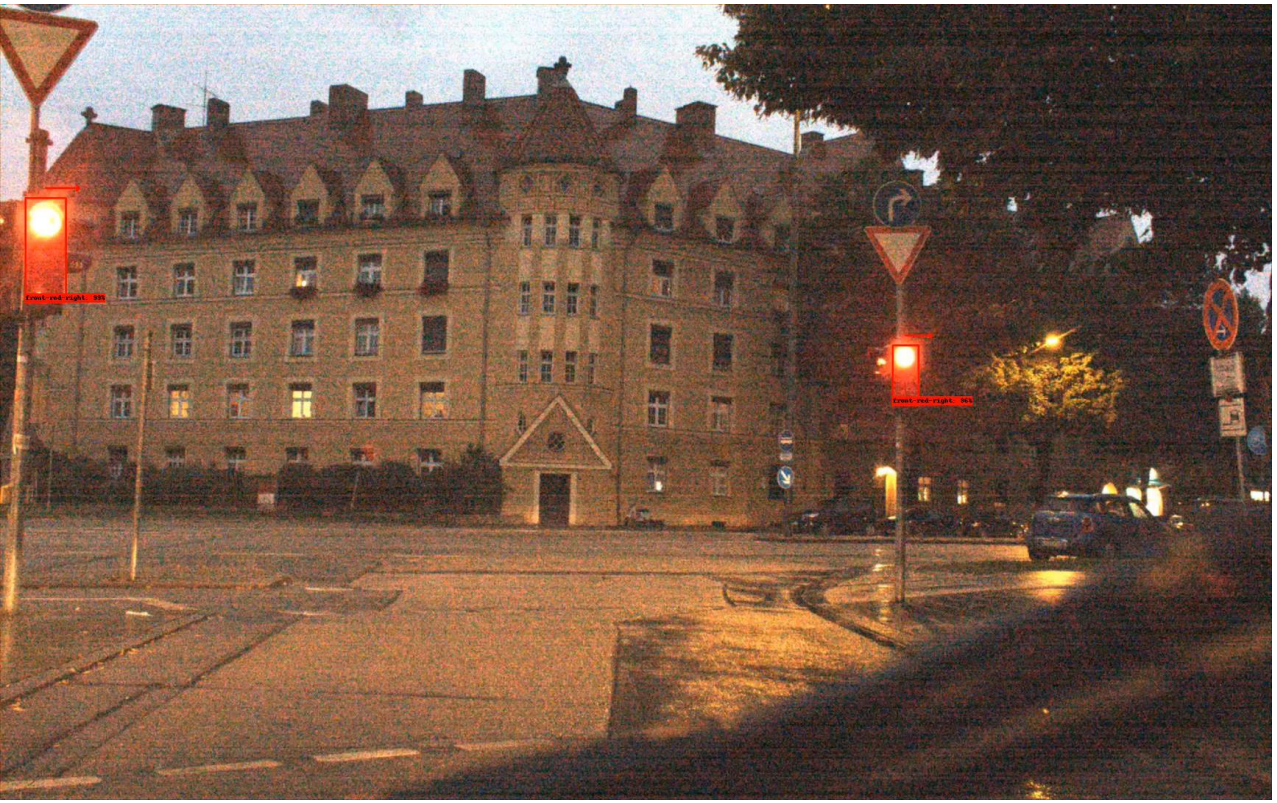


Eos Surround View
Wide-angle Rearview – Dusk / Mud

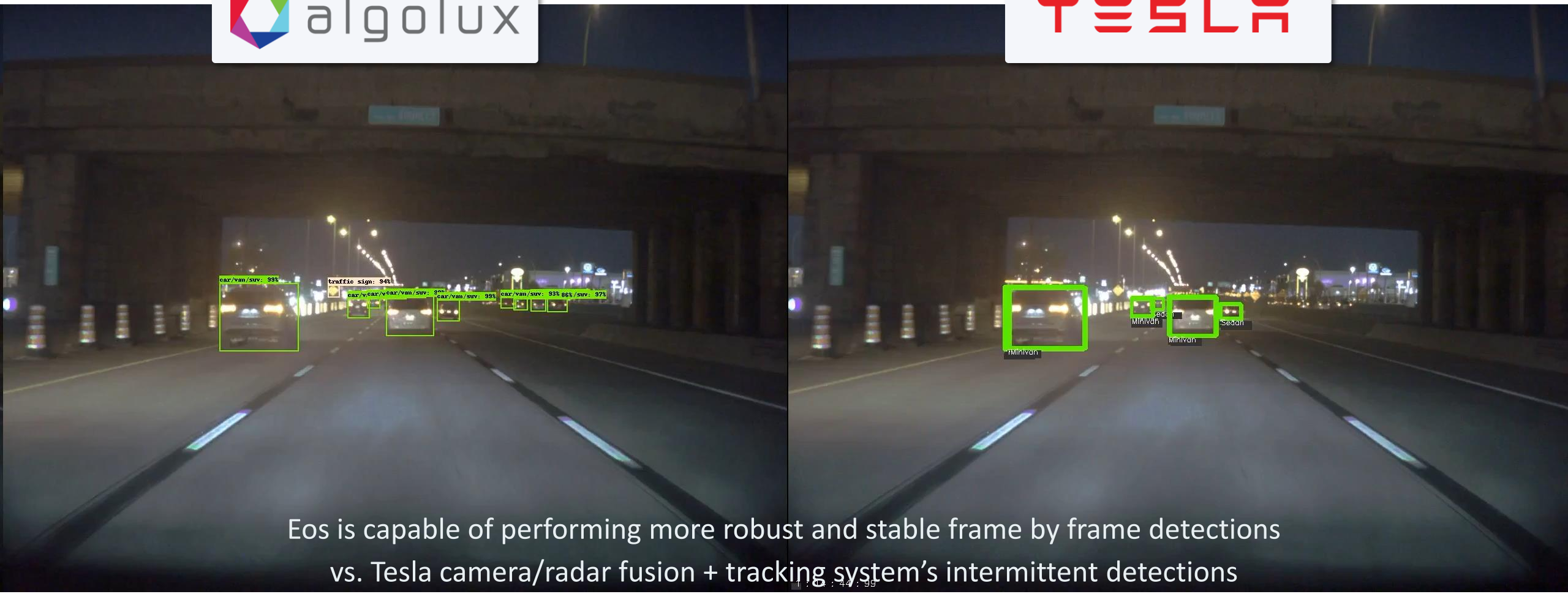


Eos Free Space Detection
Harsh Conditions

Eos Traffic Light State Detection
Evening Rainy Conditions

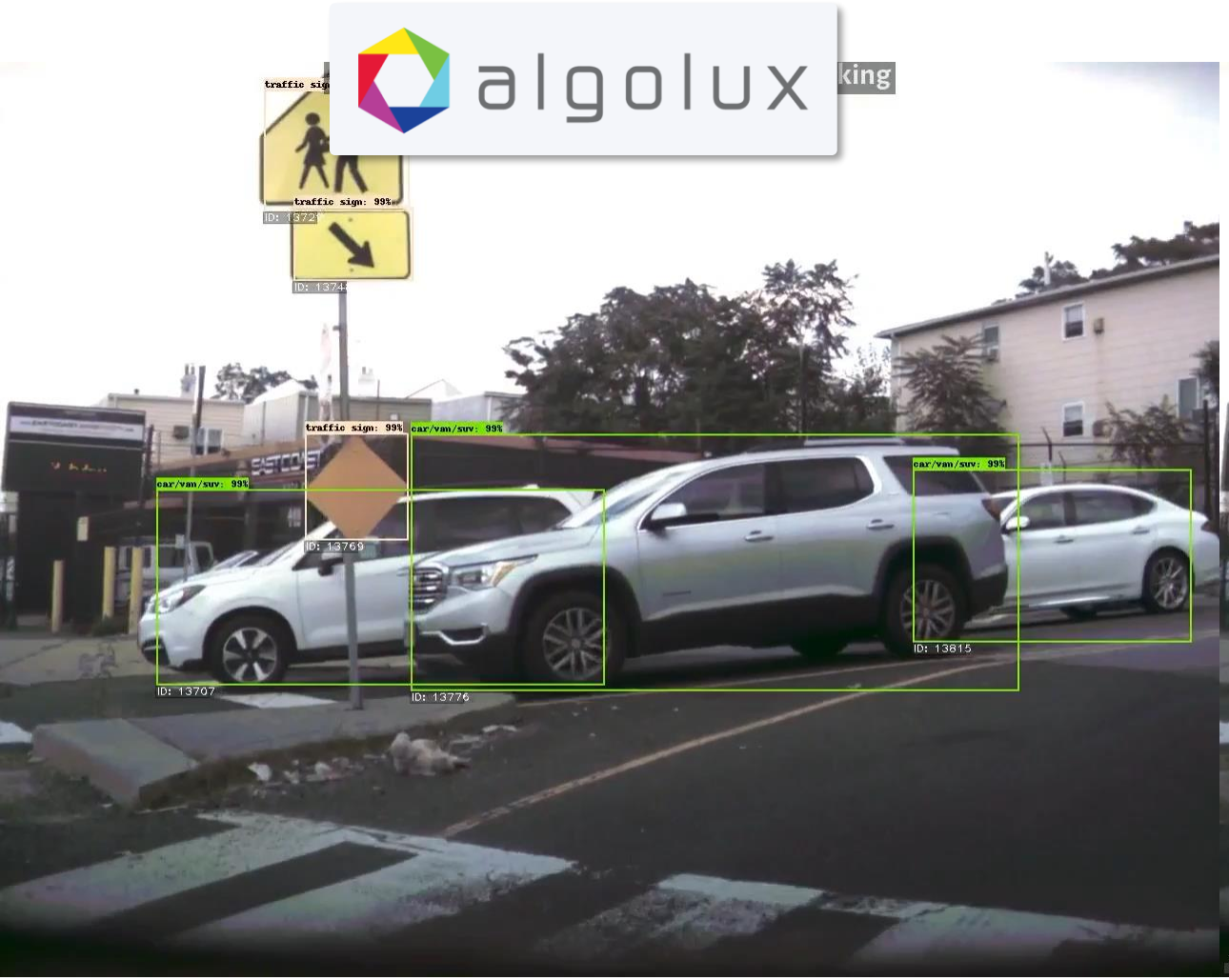


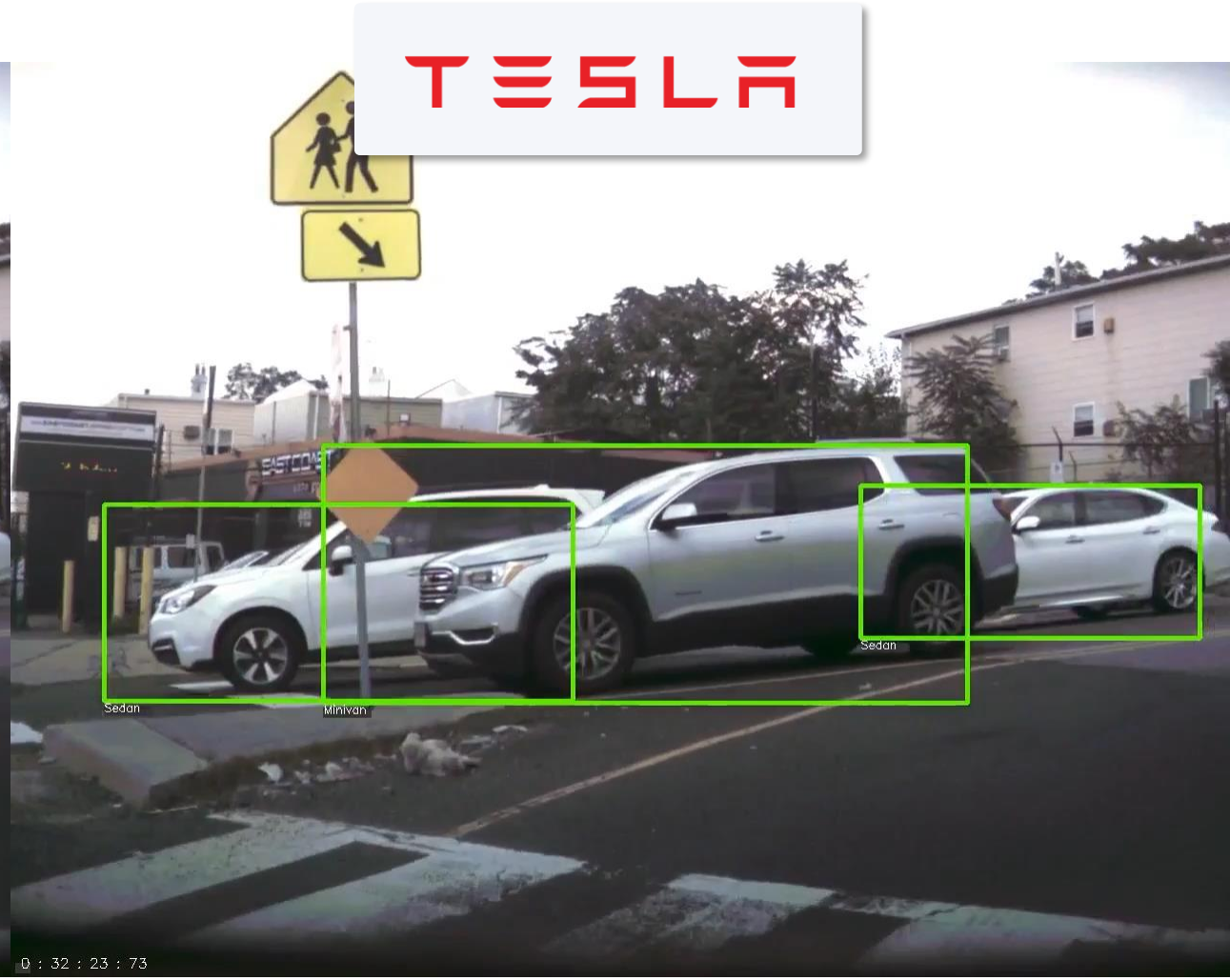
Eos vs. Tesla Autopilot



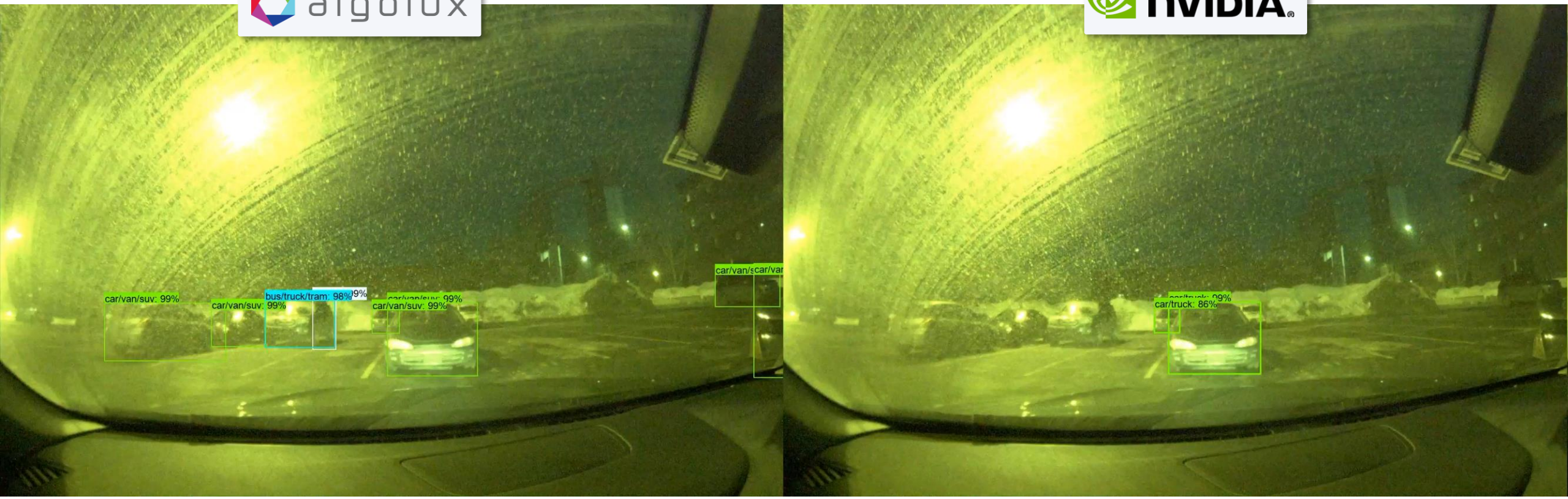
Eos is capable of performing more robust and stable frame by frame detections vs. Tesla camera/radar fusion + tracking system's intermittent detections

Eos vs. Tesla Autopilot



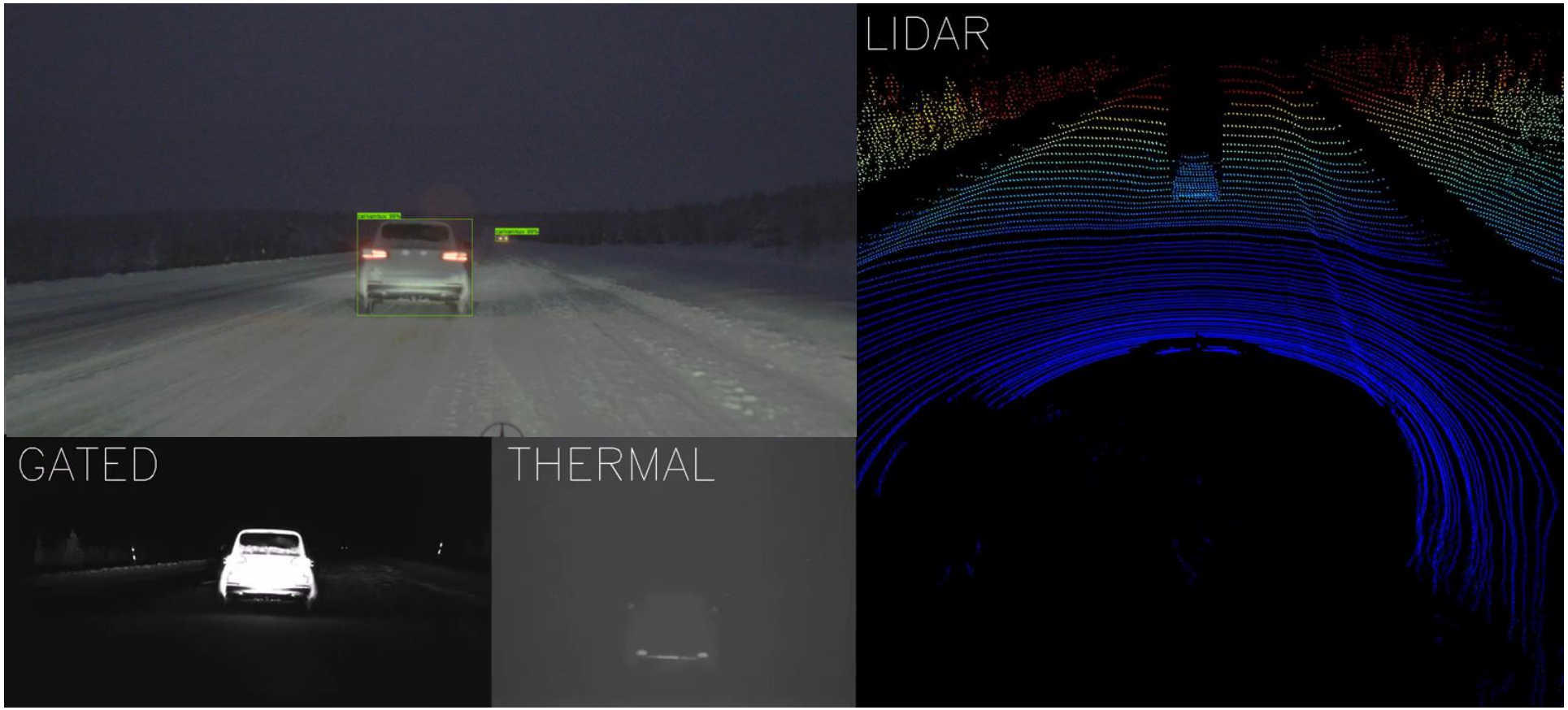


Eos vs. Nvidia Driveworks Object Detection – AR 0231



Object Detection – Next-Gen Sensors AT820

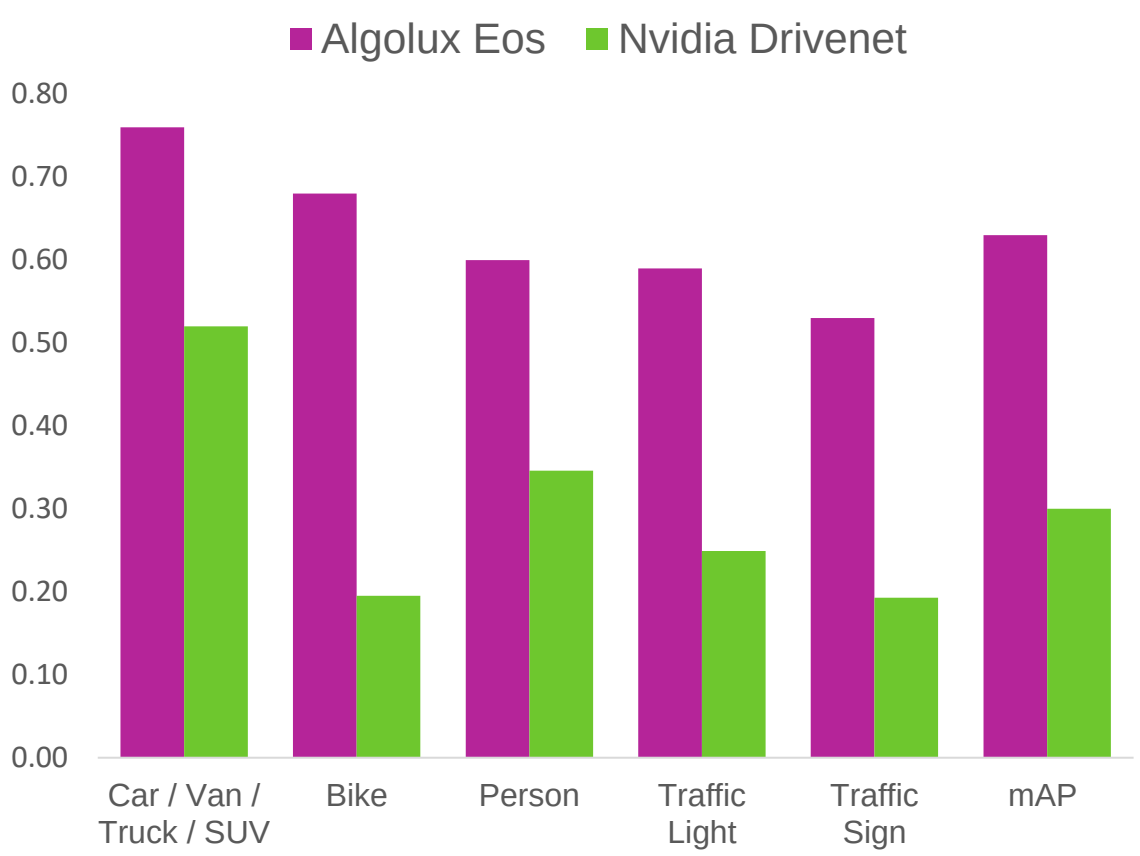
Low-Contrast Measurements in Bad Weather



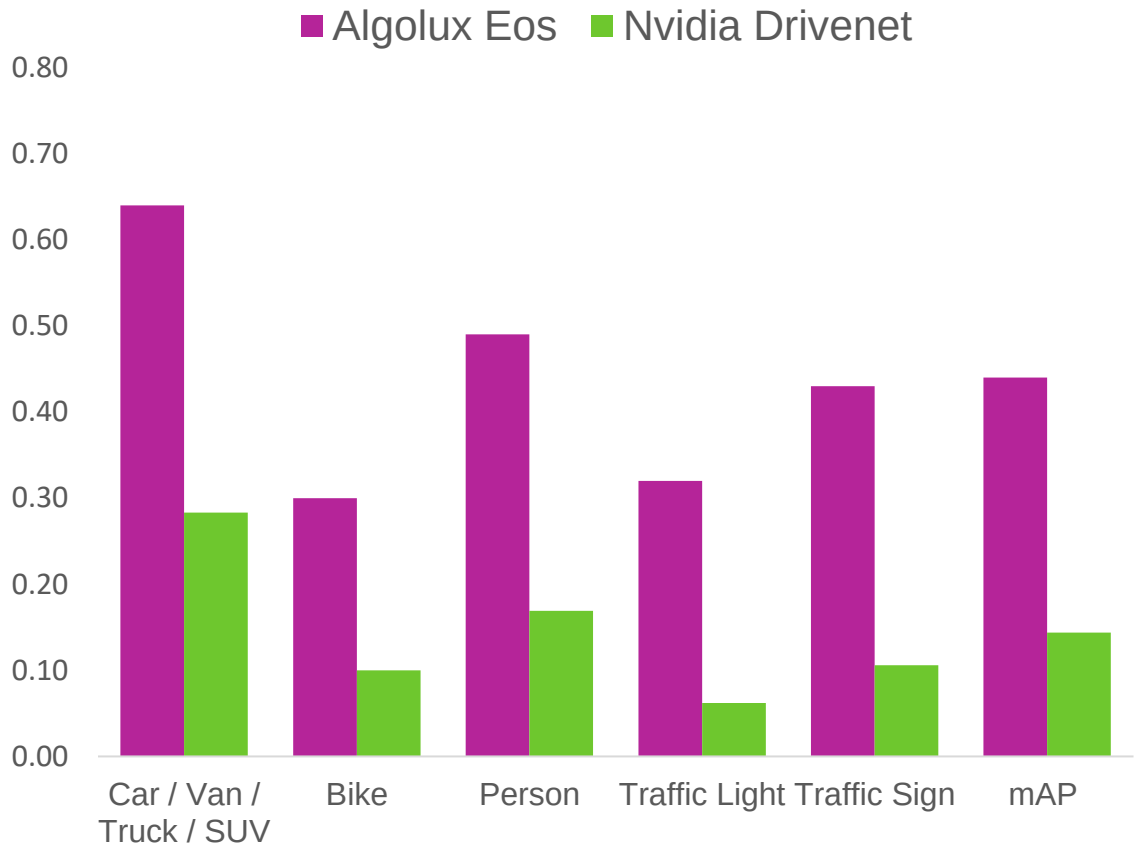
Eos vs. Nvidia Drivenet 2.2
Object Detection – Night and Snow

Eos vs. Nvidia Drivenet – Object Detection
Small Objects down to 10pix width

Clear Day



Night Conditions



Key Takeaways

- Current vision systems are *designed* to fail in edge cases
- Domain adaptation and unsupervised end-to-end learning from RAW to detections is required to address robustness issues
- Significantly outperforms the industry for perception robustness and scalability

Resources

To learn more about Eos, visit https://algolux.com/solutions/eos-embedded-perception/

To learn more about the research behind the technology, visit https://algolux.com/research/

Visit us at the Algolux and Intel Virtual Booths and www.algolux.com

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