

Lighting Up the Dark

How new PAEB safety requirements can be met
in the most economical way by combining next
generation thermal Imaging optics and sensors

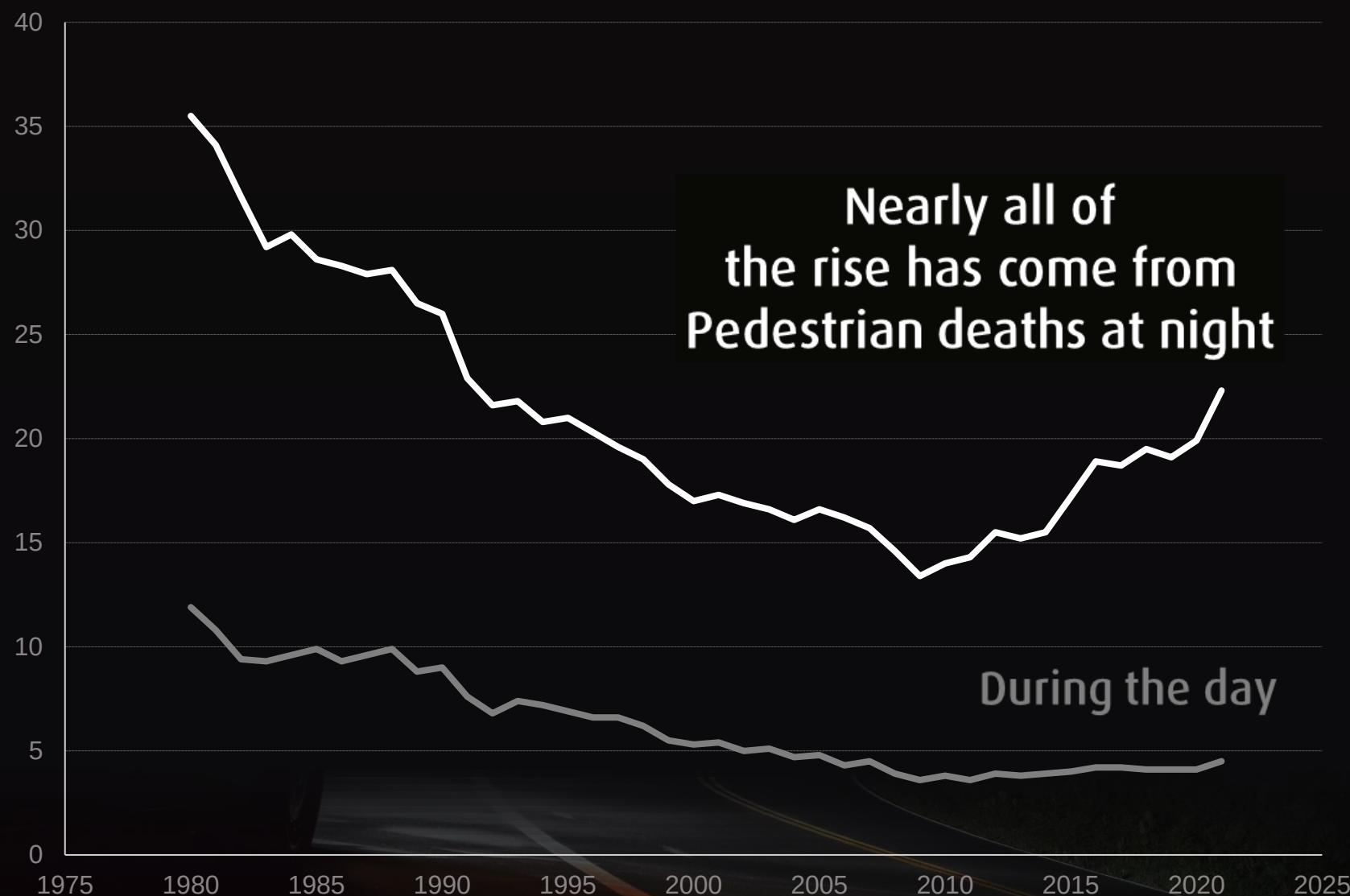
Bendix De Meulemeester

What
?
Is happening

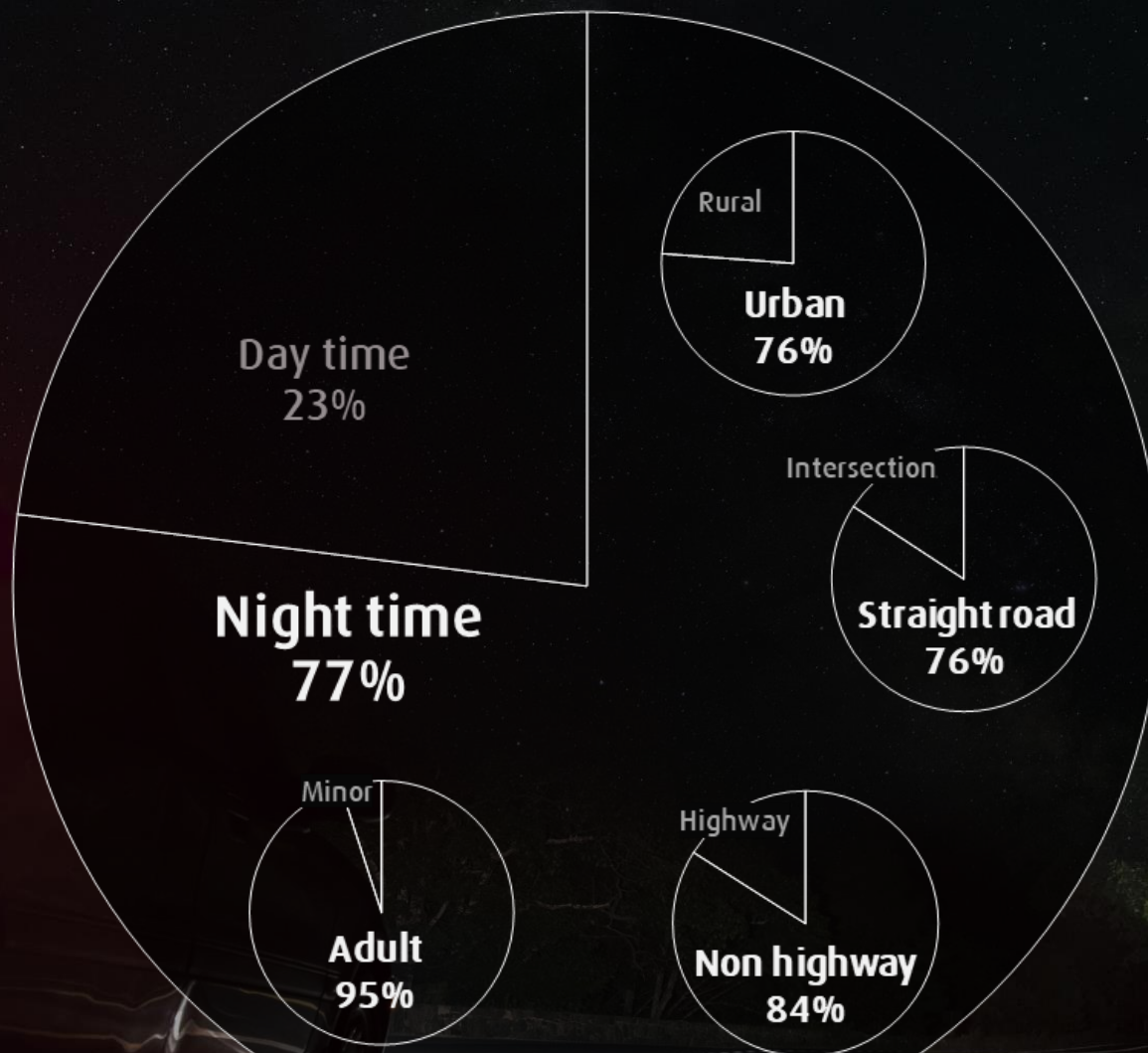
After decades of decline,
pedestrian fatalities in the US
started to rise again in 2010



What
?
Is happening



Where
?
Is it happening



Most fatalities in the US happen during the night on a straight urban road and involve mostly adults

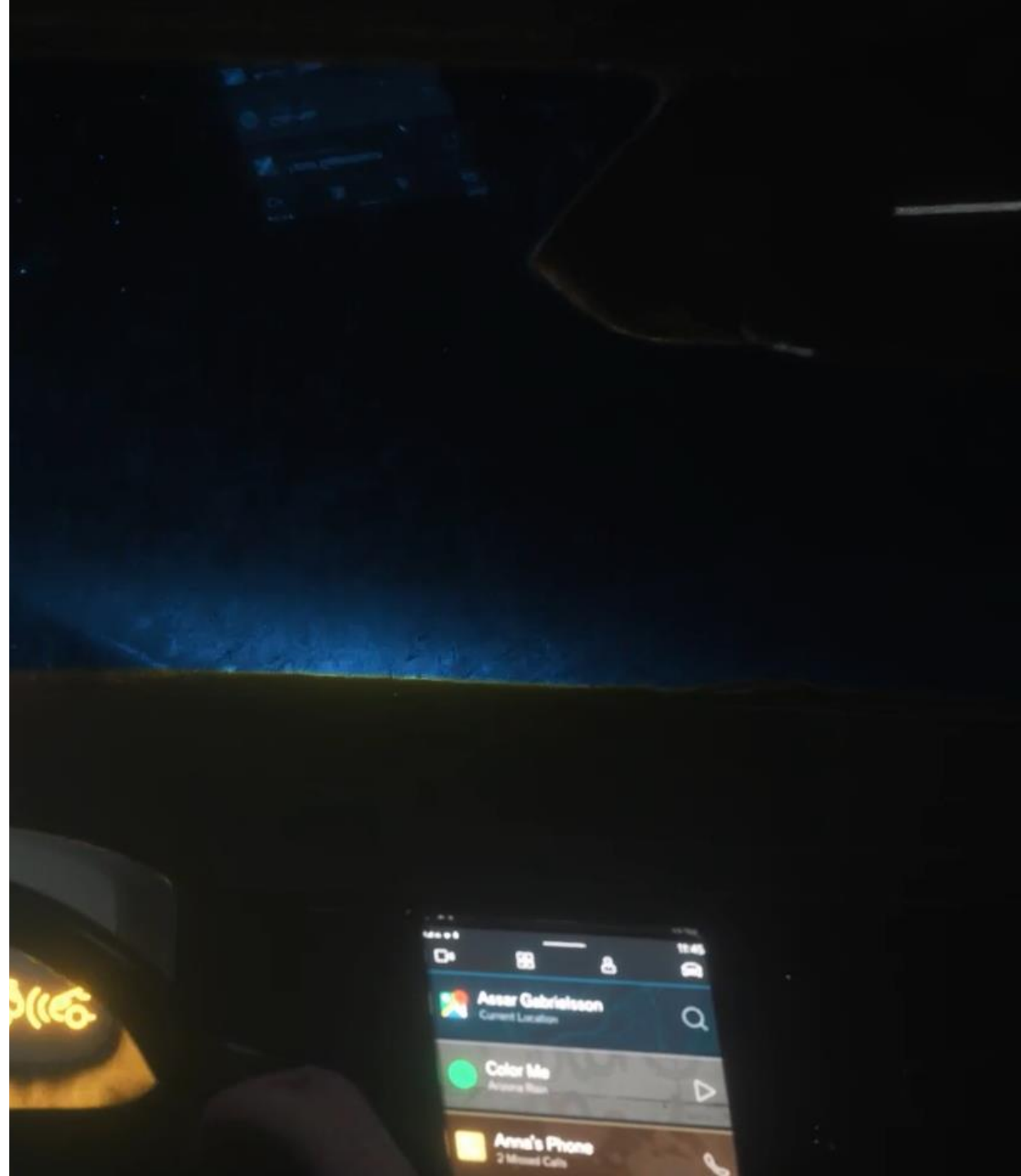


Saving lives comes first,
convenience of self-driving is next

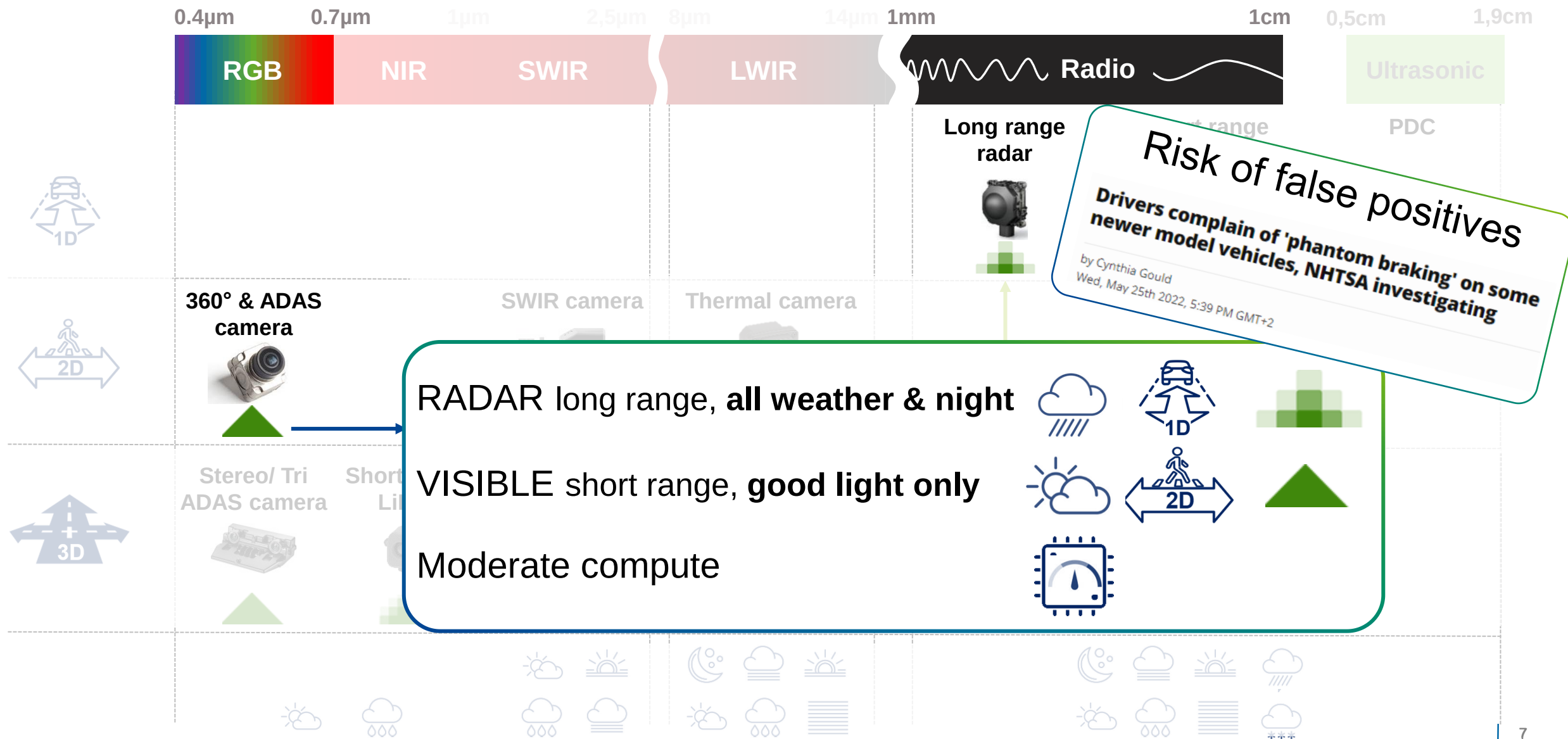


NHTSA

Will PAEB standard require Thermal?



RGB and Radar are already widely implemented!



For robust detection at night, thermal will be inevitable!



Thermal emittance
of a pedestrian
(50W/m²)



≈

Visible emittance of
pedestrian @ 15m
from high beam



Thermal sensing is the default
technology to detect humans

Thermal
camera



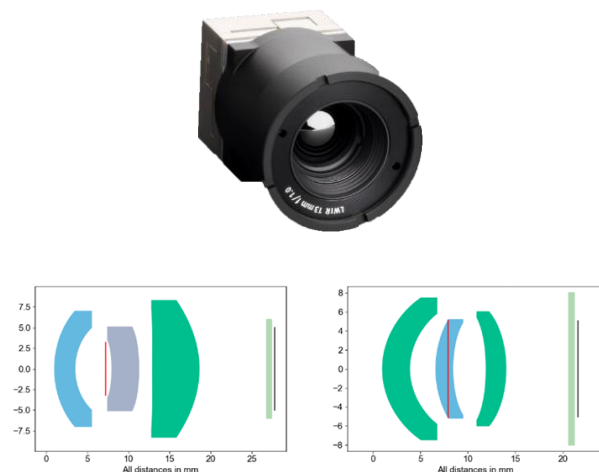
Thermal

- 2D, long range
- medium/high resolution
- most weather conditions
- **no light source needed**
- Machine learning: easy



European Commission JRC assessment

Thermal camera assessment in collaboration with Lynred and Umicore



QVGA

36° FoV

12μm pixels

VGA

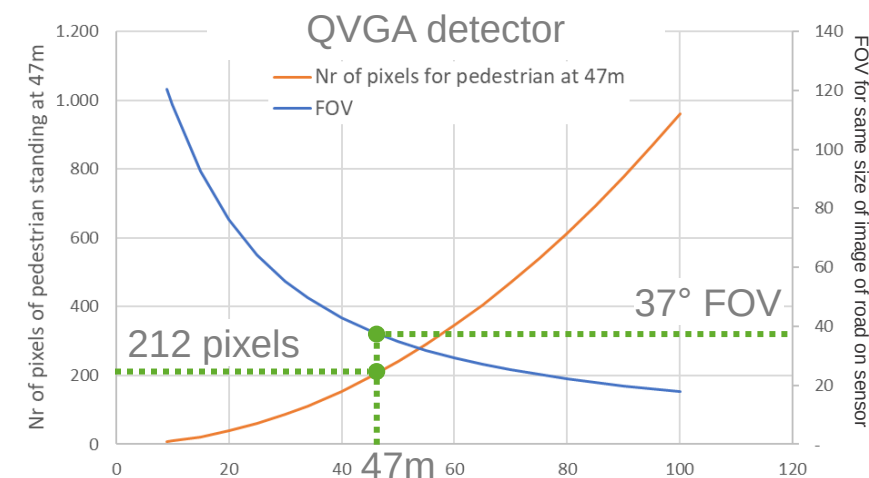
31° FoV

12μm pixels



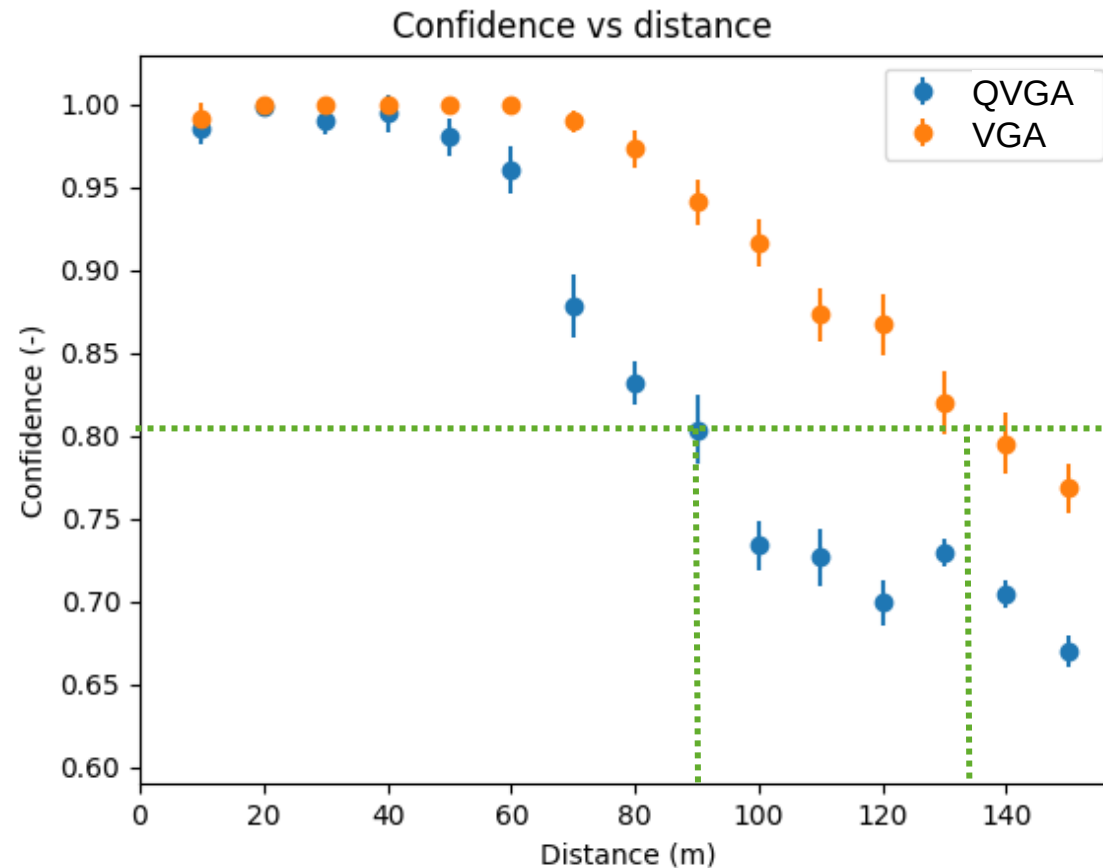
Inference with Resnet50 Neural Network

Fine-tuned with 5000 thermal images



European Commission JRC assessment

Sufficient range for both QVGA and VGA



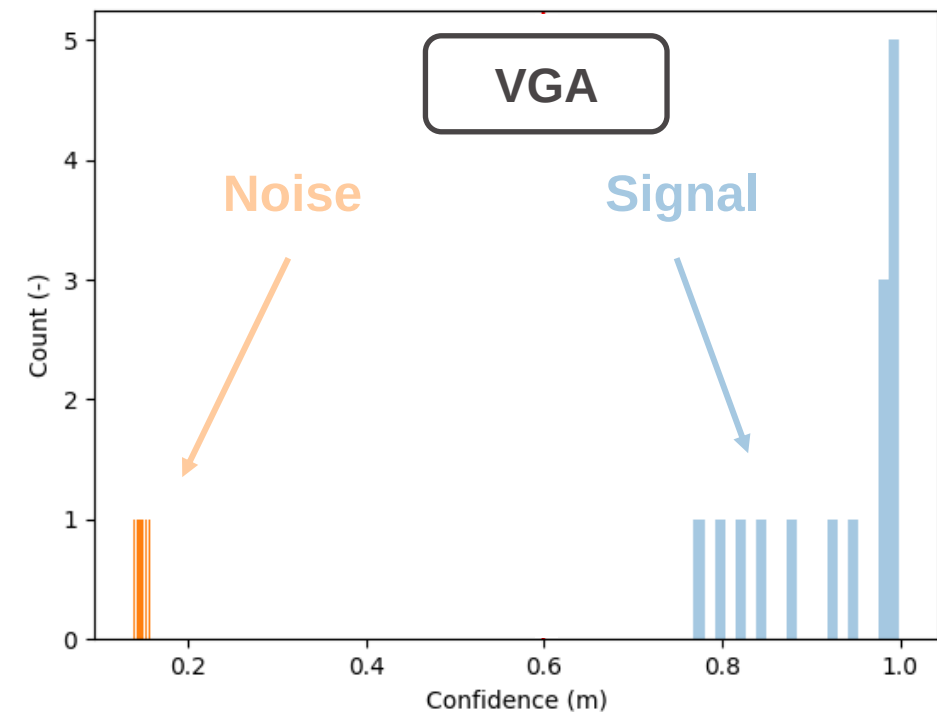
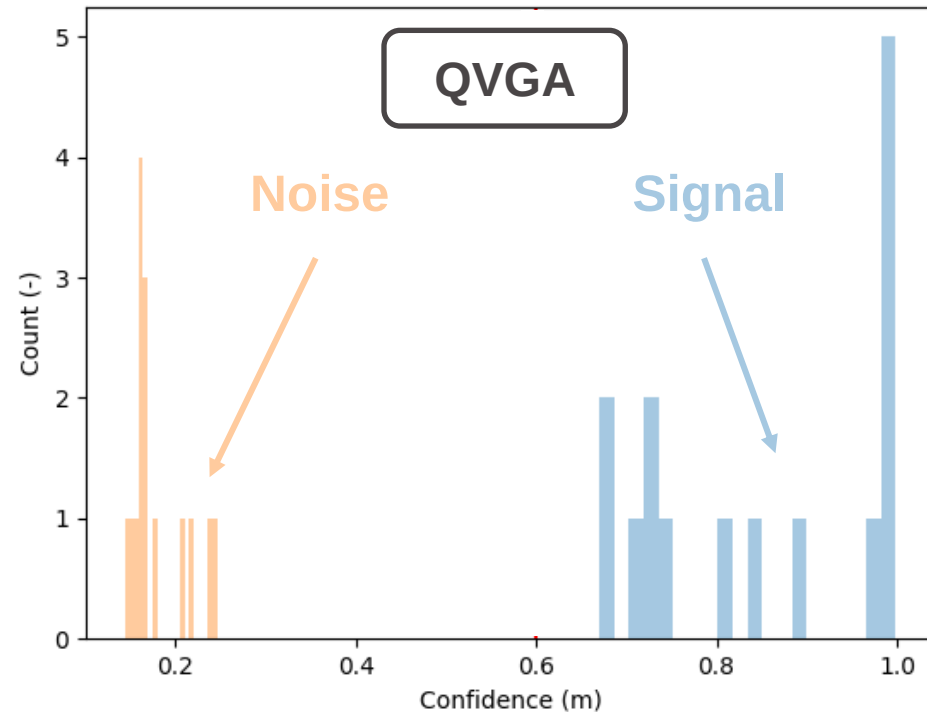
Pedestrian detection range
with >80% confidence

> **90m** for QVGA sensor

> **120m** for VGA sensor

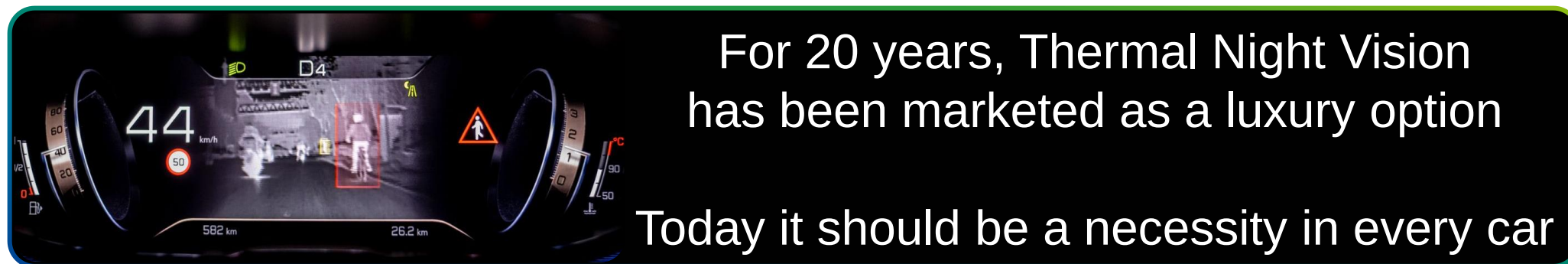
European Commission JRC assessment

True positives versus noise floor

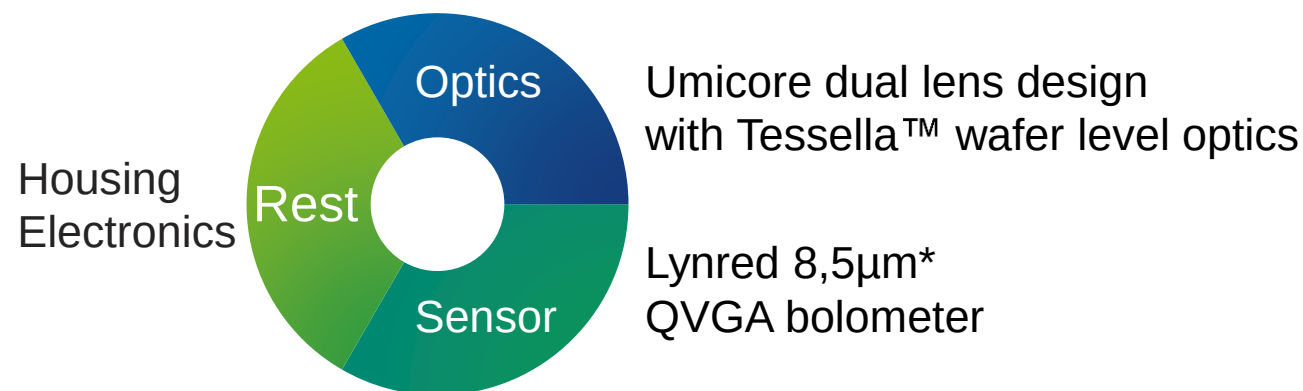


Low risk of false positives for robust detection

Thermal for PAEB has <\$100 cost roadmap

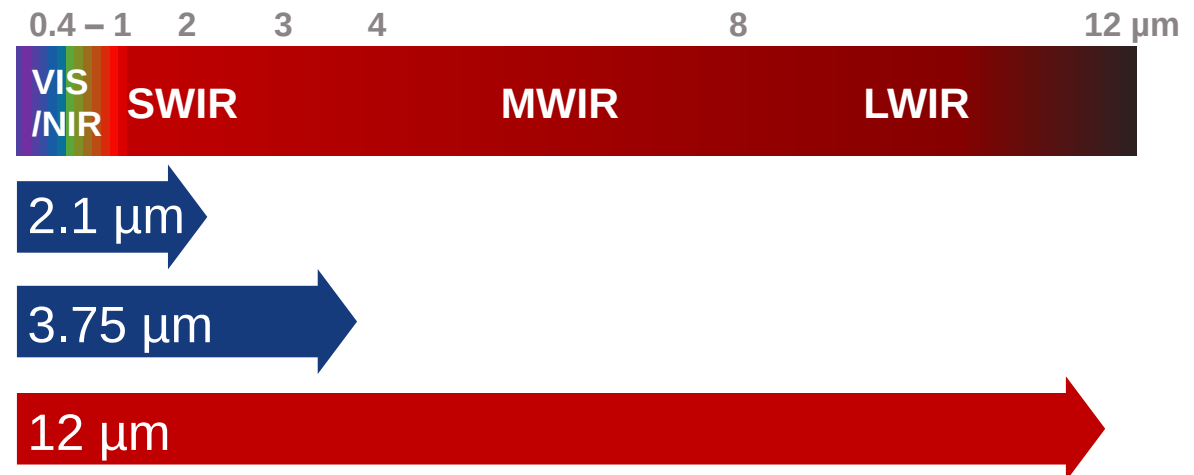
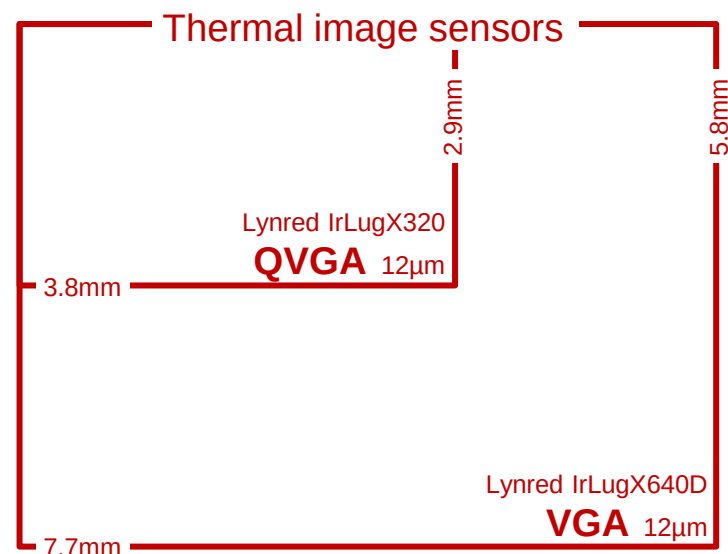
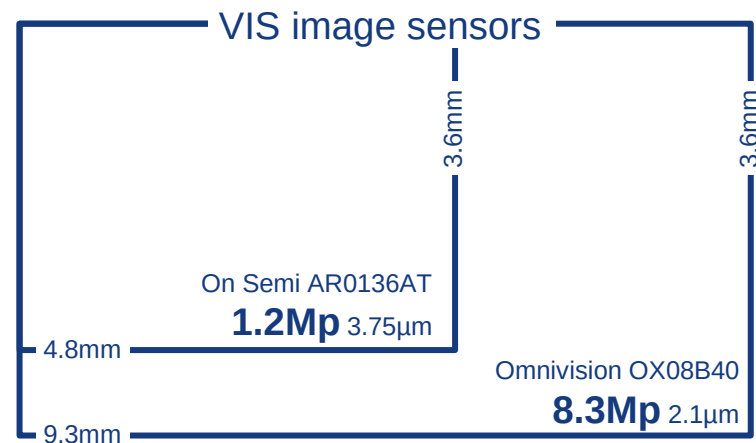


Bill Of Materials



Thermal for PAEB has <\$100 cost roadmap

Make it affordable: choose the right sensor size



Pixel size $\geq$ Wavelength

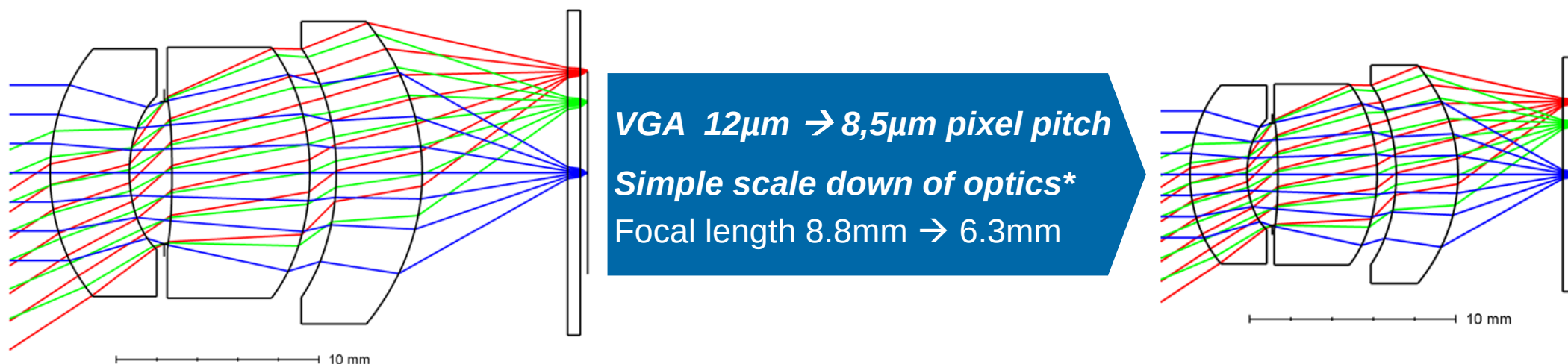
Thermal imager resolution is **significantly lower** for same die size

Thermal for PAEB has <\$100 cost roadmap

Smaller sensor = smaller optics

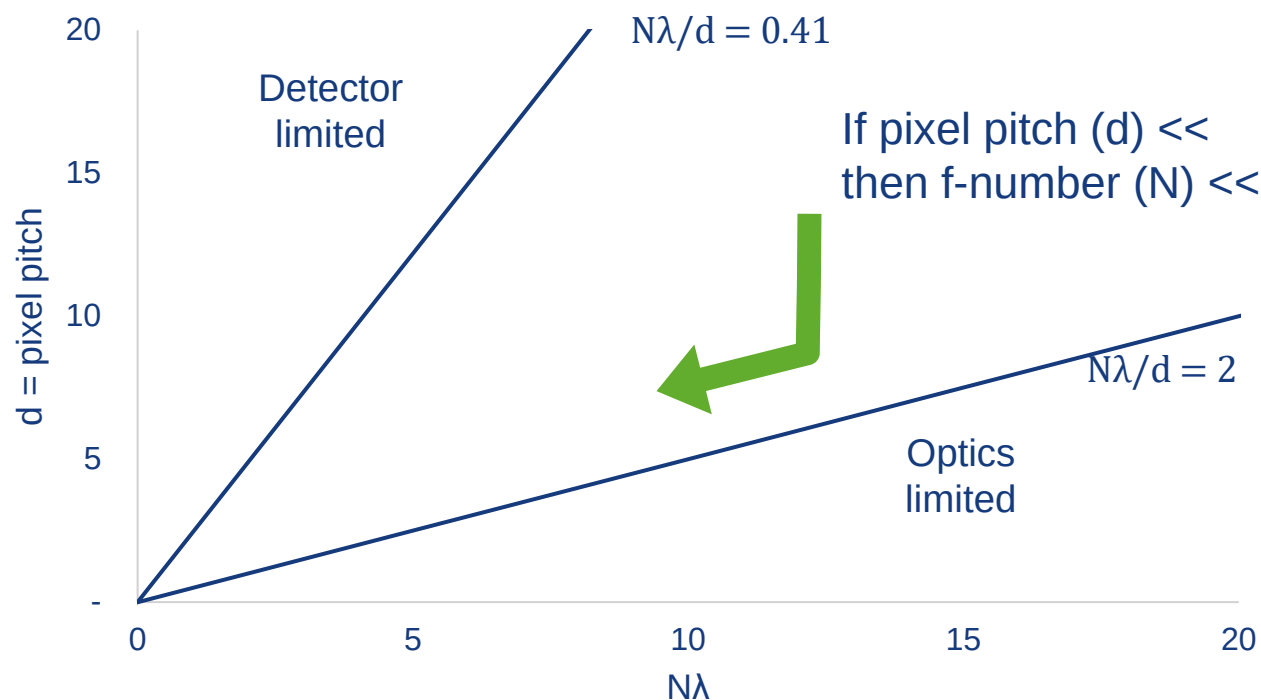
As the focal length is proportional to the sensor size, a smaller sensor implies a shorter focal length → **smaller optics**

$$\text{Field of View} \approx \frac{\text{Sensor width}}{\text{Focal length}}$$

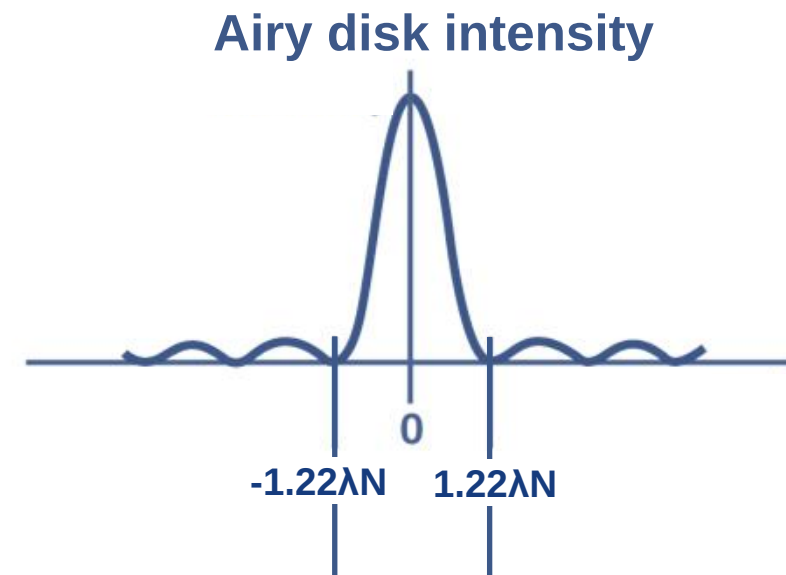


Thermal for PAEB has <\$100 cost roadmap

Thermal Imaging Optics size is limited by diffraction



A balanced design of sensor and optics makes an affordable thermal camera possible as part of a PAEB sensor system.



Rayleigh criterion

$$\lambda = 10\mu\text{m} \quad N = f/1.0$$

$$R_{\text{Airy Disk}} \approx 1.22 \times \lambda \times N \\ \approx 12 \mu\text{m}$$

NHTSA new PAEB test parameters

Affordable thermal camera for new NHTSA standard

	Low speed (10km/h) HFOV max		High speed (65km/h) range max (½ g deceleration)	
Test	HFOV	Range	HFOV	Range
Crossing path Adult – AEB		5.6 m		46.8 m
Stationary Adult-AEB	Wide	3.4 m	Narrow	40.7 m
Longitudinal Adult-AEB		3.4 m		31.8 m
	Low beam + Visible camera		Thermal camera Detector: QVGA 8,5µm Optics: 37°FOV 4,1mm f/1.0	



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Featuring  **MAGNA**
Thermal Sensing demo



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Umicore Lynred Sekurit
Social Event @ the Waterview Loft
tonight at 8pm

Lighting Up the Dark
Visit us at booth #226
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