

✚ **A Low Cost, Far Infrared module for Pedestrian Detection and other Safety Applications**

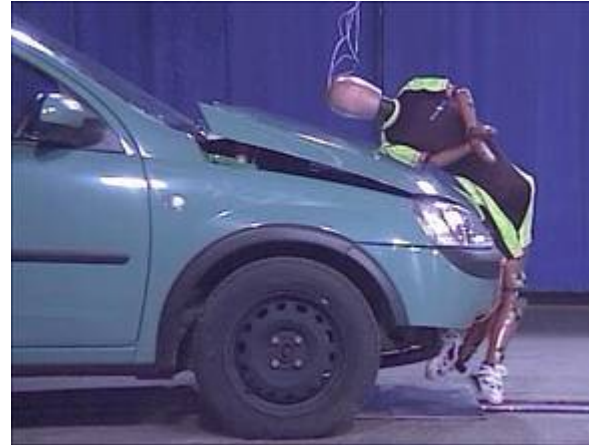
✚ **Enhancement of Brake Assist functionality**

Collision speed reduced from 50 to 31 km/h

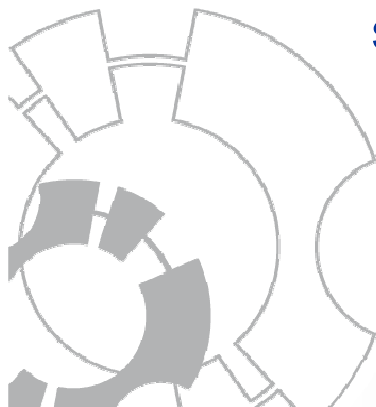
=> fatality risk reduced from ~33% to 5%

Assuming braking force 0.6 g 10 m before impact

Source: ACEA Proposal and justification to EU Enterprise Directorate-General consultation on EU Directive 2003/102/EC Phase 2



Detection range 10m provide >500ms activation time enable simple reversible solutions:



## EU Pedestrian Protection Regulation proposal Oct 2007

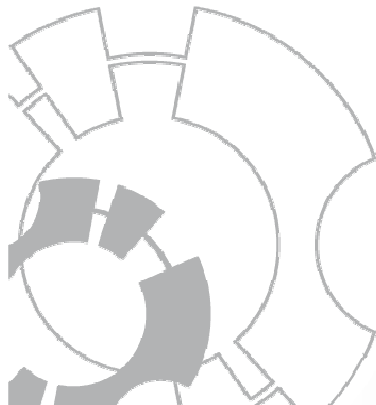
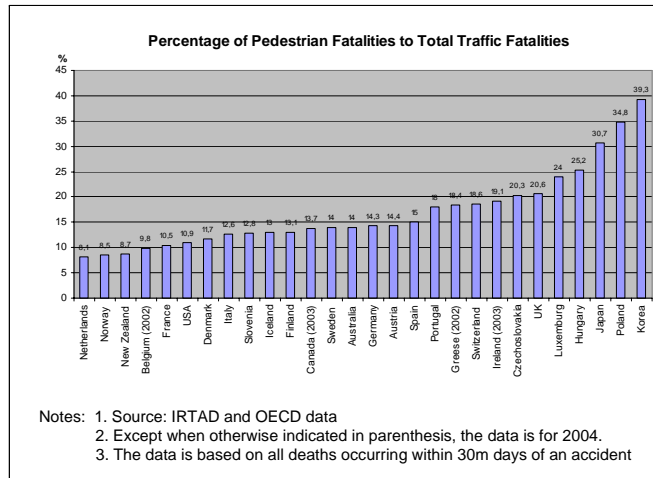
Article 11

### Collision Avoidance Systems

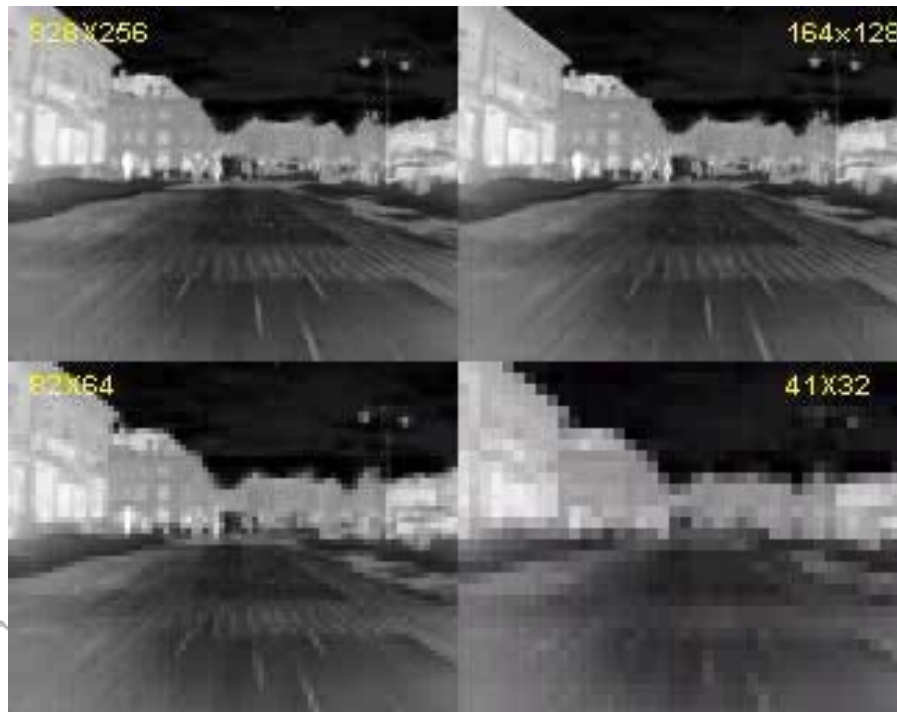
1. Vehicles equipped with collision avoidance systems shall not have to fulfil the test requirements laid down in Sections 2 and 3 of Annex I in order to be granted an EC type-approval or a national type-approval for a type of a vehicle with regard to pedestrian protection, or to be sold, registered or to enter into service.
2. The Commission may adopt implementing measures laying down performance requirements necessary for the application of paragraph 1.

Those measures, designed to amend non-essential elements of this Regulation, inter alia, by supplementing it shall be adopted in accordance with the procedure referred to in Article 40(2) of Directive [...]/.../EC.

The requirements shall ensure levels of protection which are at least equivalent, in terms of actual effectiveness, to those provided by Sections 2 and 3 of Annex I to this Regulation.



## Low resolution enough at short range

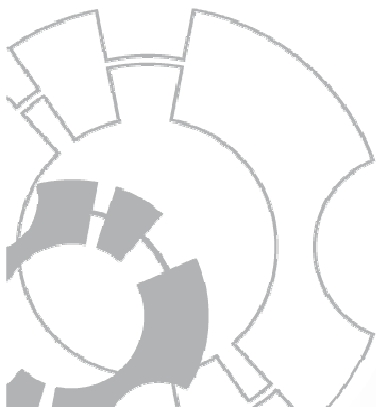
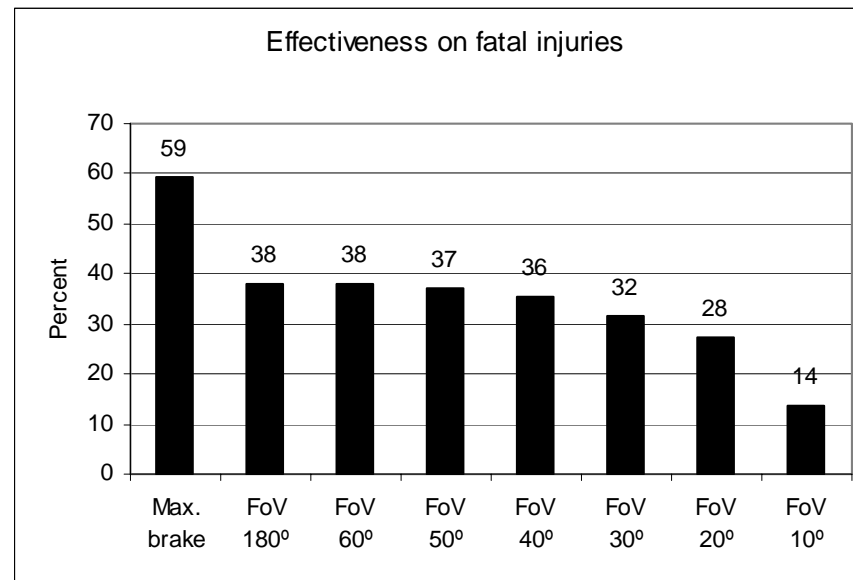


Low resolution simulated from a high resolution camera is used to evaluate algorithms and the needed resolution.

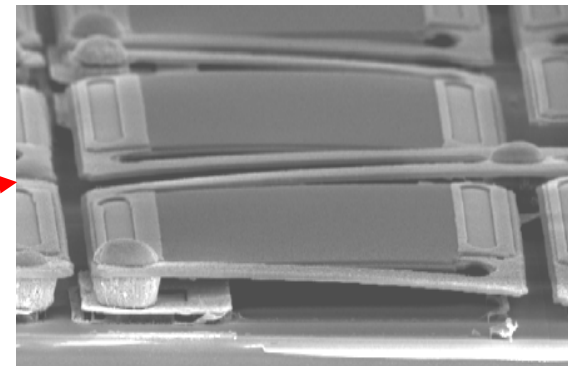
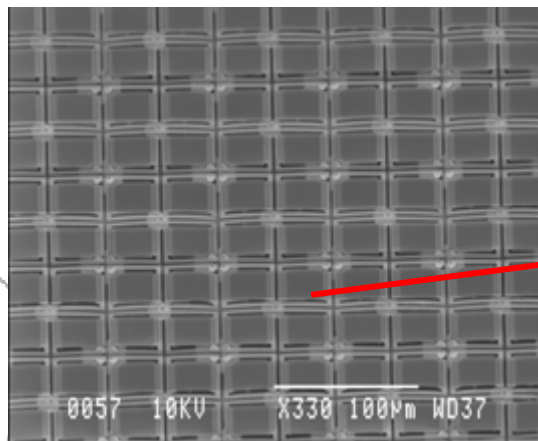


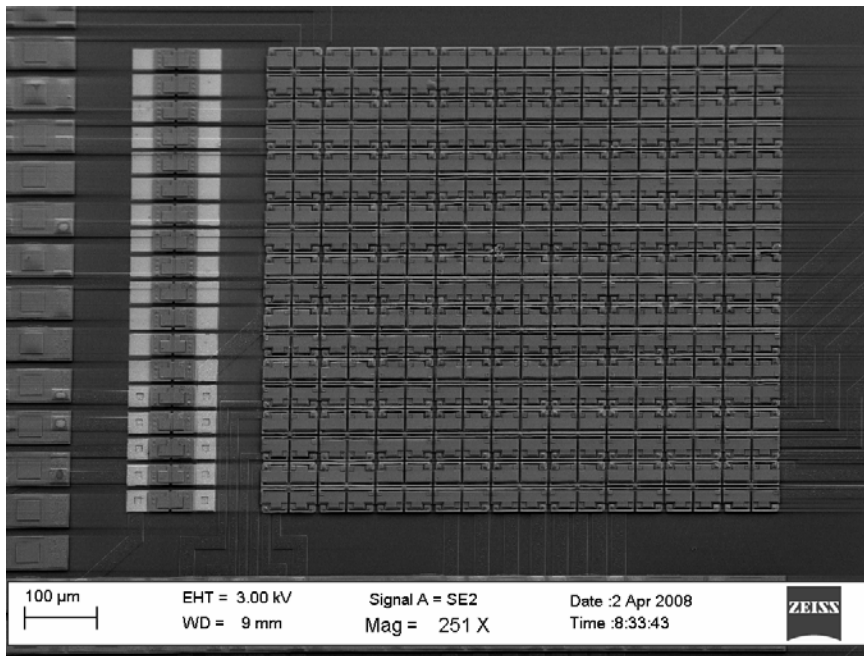
From a dataset with pedestrian accidents from GIDAS  
(German In Depth Accident Study)

The effectiveness of an autonomous collisions speed  
reduction was calculated

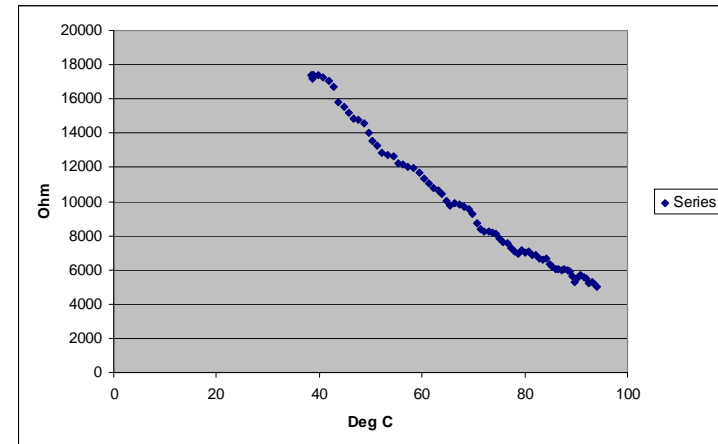


- **Allows use of standard, high-performance semiconductors (SiGe) for the bolometers (crystalline materials with low  $1/f$  noise, high TCR and uniform material properties).**
- **Improved sensor uniformity and sensitivity allows cheaper package with lower vacuum requirements.**
- **Existing MEMS foundries can be used for manufacturing.**



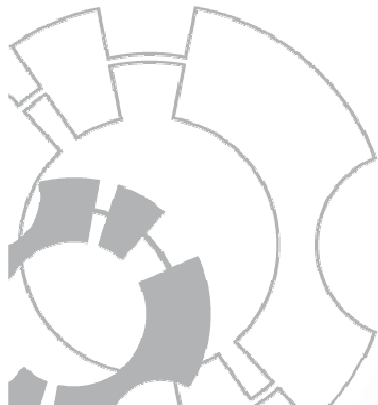


16x16 Si/SiGe bolometer array on fan-out wafer

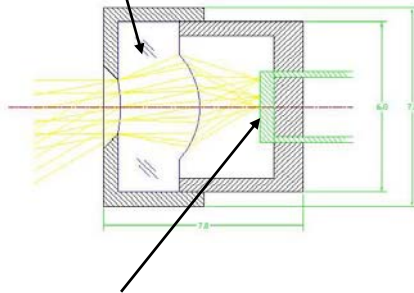


Bolometer TCR measurement  $\sim 2\%/K$

**Bolometers are currently being integrated on top of read-out integrated circuit (ROIC) wafers.**



Low Cost, single element lens

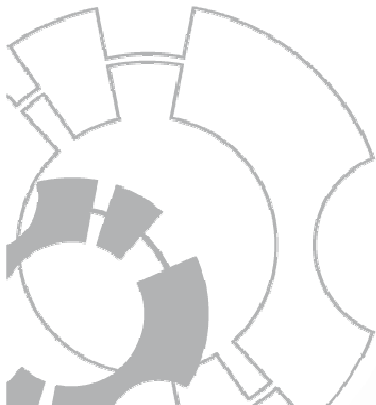


Bolometer chip  
Wafer level package

## First evaluation version According to PIMS Spec.



## Investigation of alternative technologies: Ge casting



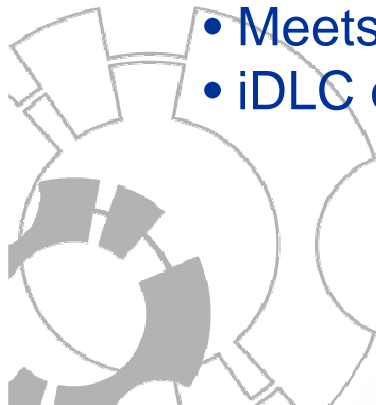
## iDLC development on GASIR®



Test	GASIR Standard HDAR	iDLC
<b>Adhesion</b>	<b>PASS</b>	<b>PASS</b>
<b>Humidity</b>	<b>72 hrs +</b>	<b>72hrs +</b>
<b>Severe Abrasion</b>	<b>20 strokes test</b>	<b>20 strokes test</b>
<b>Salt Spray</b>	<b>24hrs ( tested)</b>	<b>&gt;168hrs (7 days)</b>
<b>Wiper</b>	<b>upto 5000</b>	<b>upto 80000</b>
<b>Transmission</b>	<b>96%</b>	<b>92%</b>

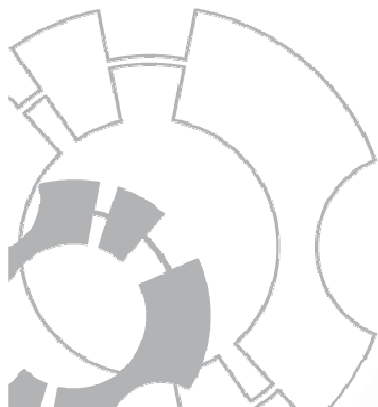
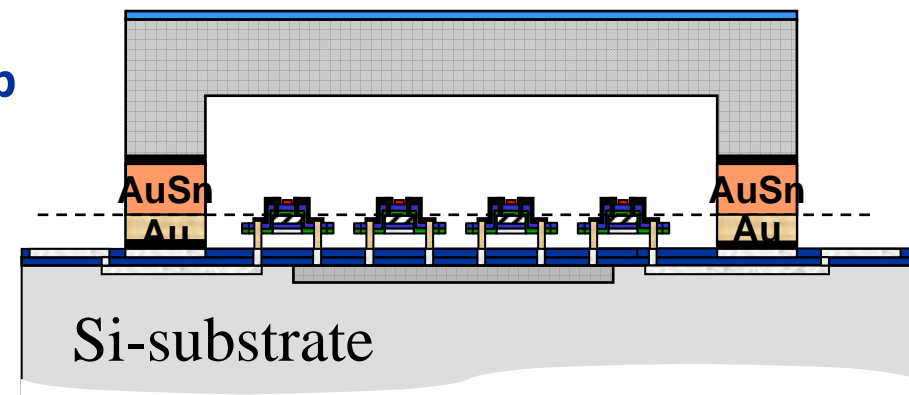
**Best performing coating on GASIR® available: similar as DLC on Ge**

- Meets the DLC on Germanium specs according to DLC data sheet
- iDLC on GASIR® commercially available



## ✚ Encapsulation of bolometer sensors

- ➔ Low temperature bonding
- ➔ Hermetic cavities (~1 mbar)
- ➔ High bond strength
- ➔ Minimizing IR absorption in cap
- ➔ Anti-reflective (AR) coating

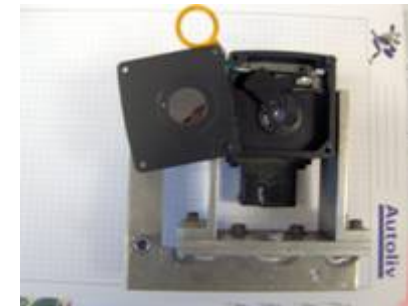


## Camera demonstrator

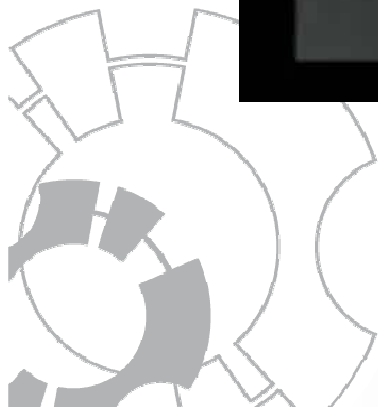
100 pixels (software adjustable)



Camera with micro lens from SP4



Demonstrator vehicle

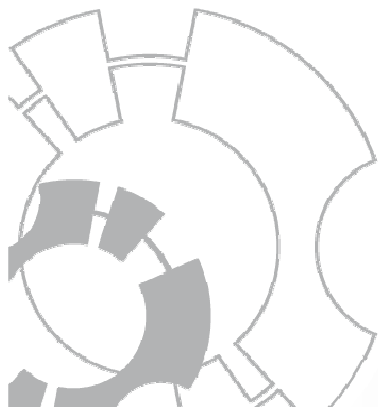


**Deployable systems and automatic braking systems can become an effective alternative solutions of fulfilling EU pedestrian protection directive proposal**

**Proposed Long Wave Infrared sensor is enabling technology**

**Cost competitiveness allow high market penetration.**

**European Automotive market alone 17 million vehicles p.a  
=> potential market many million units annually.**



## Acknowledgement

**Concept analysis** project phase finished, funded by Intelligent Vehicle Safety System (IVSS) initiative

**Proof of concept, PIMS** project currently running under Eurimus network of EUREKA, funded by National Authorities

**FNIR Fusing Far and Near InfraRed imaging for pedestrian injury mitigation**  
Sponsored by Seventh Framework Programme. Intelligent vehicles and mobility services  
Grant Agreement no. 216384

**ICU Infrared Imaging Components for Use in Automotive Safety Applications**  
Sponsored by Seventh Framework Programme. ICT-2007.3.5 - Photonic Components and Subsystems  
Grant Agreement No. 223989



Thank You for Your Attention

