



# TRAFFIC SOLUTIONS

## VHD - VEHICLE HOT SPOT DETECTOR

NORWEGIAN TUNNEL SAFETY CONFERENCE 2017

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**SICK**  
Sensor Intelligence.

### 1999: Montblanc Tunnel (F-I)

- Killed: 41 people
- Tunnel closure: 3 months
- Repair costs: 28 millions

### 1999: Tauern Tunnel (AT)

- Killed / injured: 12 / 42 people
- Tunnel closure: 3 months
- Repair costs: 28 millions

### 2001: Gotthard Tunnel (CH)

- Killed: 9 people
- Tunnel closure: 2 months
- Repair costs: 14 millions (+ 30 millions economic loss)



Source: sueddeutsche.de

- Injured or killed people
- Tunnel closure
- Huge damages on infrastructure
- Traffic jams on alternative routes
- Longer travelling times
- High economic loss
- ...



Source: swissinfo.ch

According to **Jean Claude MARTIN**, honorary professor of Université de Lausanne (CH), expert for fires and explosions:

- A heavy vehicle fire represents the worst danger potential inside a road tunnel
- The consequences are mainly depending on:
  - ☐ Tunnel related infrastructure, organisation and staff
    - Automated detection systems
    - Infrastructure and training level of emergency staff
  - ☐ Unpredictable factors:
    - Behaviour of defective vehicle and other travellers
- Following cases excerpt of an analysis for the organisation “Round Table of monotube and bidirectional tunnels” are illustrating the **four main causes** of heavy vehicle fires:

- Fire cause A: **Fuel leak**
- Inflammation mechanism:
  - ❑ Leaked fuel over engine or exhaust parts
  - ❑ Fuel vaporization due to contact with hot engine or exhaust components
  - ❑ Spontaneous inflammation of air + fuel vapour mix
- Combustion kinetics:
  - ❑ Fast spreading of fire into the engine compartment
  - ❑ Spreading of combustion gas and flames within minutes into the passenger compartment
- **Massive fuel spillage**
- Inflammation mechanism:
  - ❑ Rupture of fuel tank caused by a collision
  - ❑ Fuel vaporization due to contact with hot engine or exhaust components
  - ❑ Spontaneous inflammation of air + fuel vapour mix
- Combustion kinetics:
  - ❑ Fast spreading of flames producing big quantities of dense, hot and toxic smoke
  - ❑ Fire spreads over the roadway onto other vehicles



# VHD – VEHICLE HOT SPOT DETECTOR

## MAIN CAUSES OF HEAVY VEHICLE FIRES

- Bus fire due to fuel leakage at Piumogna Road Tunnel, south ramp of Gotthard tunnel



# VHD – VEHICLE HOT SPOT DETECTOR

## MAIN CAUSES OF HEAVY VEHICLE FIRES

- Big 2001 fire in Gotthard road tunnel caused by frontal collision with massive fuel spillage.
- 9 people killed by intoxication



- Fire cause B: **oil vaporization**
  
- Rupture of turbo loader leads to lubricant oil to get in contact with hot exhaust components. The rupture is unforeseeable.
- Inflammation mechanism:
  - ☐ Oil gets vaporized and mixes to the air
  - ☐ Spontaneous inflammation of air + oil vapour mix
- Combustion kinetics:
  - ☐ The combustion kinetics of oil is fast and similar to fuel
  - ☐ Fast spreading of fire into the engine compartment
  - ☐ Slower spreading of flames to the rest of the vehicle due to confined engine compartment



# VHD – VEHICLE HOT SPOT DETECTOR

## MAIN CAUSES OF HEAVY VEHICLE FIRES

- Rupture of turbo loader in Gotthard road tunnel without vehicle fire



- Fire cause C: **electrical defect**
  
- Inflammation mechanism:
  - ☐ Electrical defect on a power line leading to a short circuit of the battery
- Combustion kinetics:
  - ☐ The heat source is powerful and persistent
  - ☐ Fast spreading of fire into the engine compartment and the rest of the vehicle
  
- The defect can be detected by infrared sensors before the vehicle starts to burn

# VHD – VEHICLE HOT SPOT DETECTOR

## MAIN CAUSES OF HEAVY VEHICLE FIRES

- Battery short circuit in Gotthard road tunnel
- Fire under control thanks to the fast intervention of fire fighters





- Fire cause D: **friction**
- Inflammation mechanism:
  - ❑ Friction in the braking system, bearings, clutch disc, or tires produces heat and when transmitted to a combustible component that enflames spontaneously.
- Combustion kinetics:
  - ❑ Heating due to friction can be quasi instantly
  - ❑ Fire spreads slowly to the entire vehicle
- The defect can be detected by infrared sensors before the vehicle starts to burn





# VHD – VEHICLE HOT SPOT DETECTOR

## SYSTEM DESCRIPTION

VHD = Vehicle Hot Spot Detector

The objective of a VHD is to **detect overheated vehicles** automatically which

- could **catch fire**
- are in a **bad operating condition** (safety hazard)



Source: swissinfo.ch



Source: swissinfo.ch

# VHD – VEHICLE HOT SPOT DETECTOR

## SYSTEM DESCRIPTION



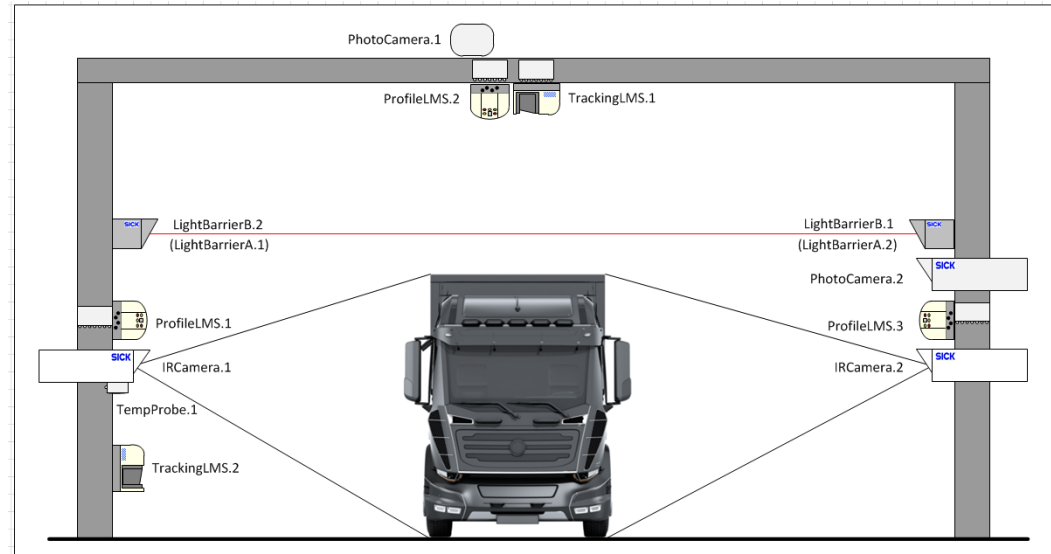
<https://www.youtube.com/watch?v=Polavg5hU5o>

# VHD – VEHICLE HOT SPOT DETECTOR

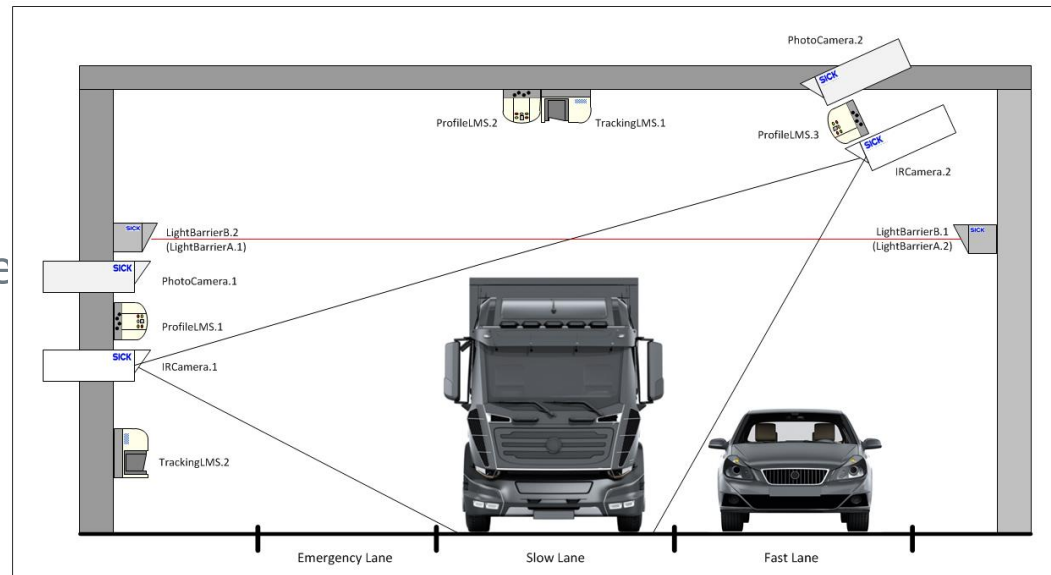
## SYSTEM DESCRIPTION

### Layout flexibility

### Single lane free flow



### One lane in a multi-lane free-flow environment





# VHD – VEHICLE HOT SPOT DETECTOR

## SYSTEM DESCRIPTION

### System overview (example)





# VHD – VEHICLE HOT SPOT DETECTOR

## SYSTEM DESCRIPTION

### Sensors:

side of the gantry



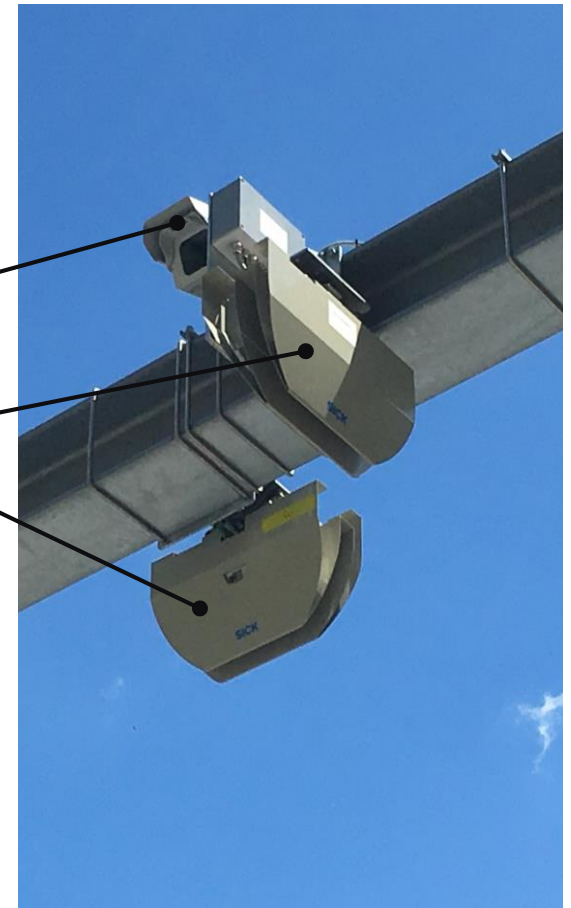
Light Barrier

Photo Camera

Laser Scanners

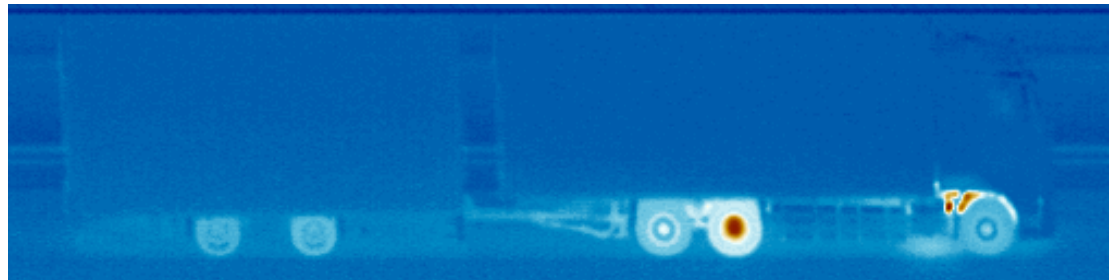
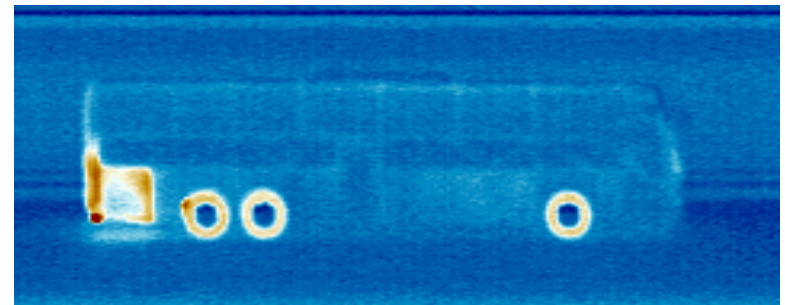
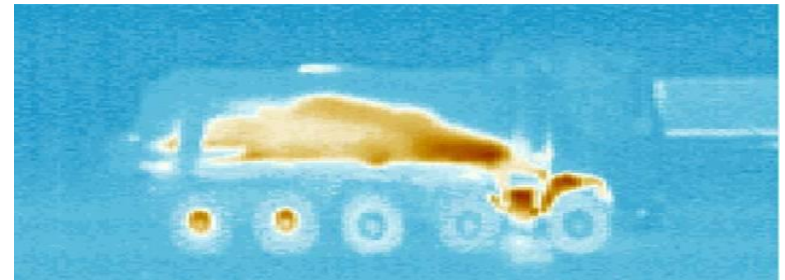
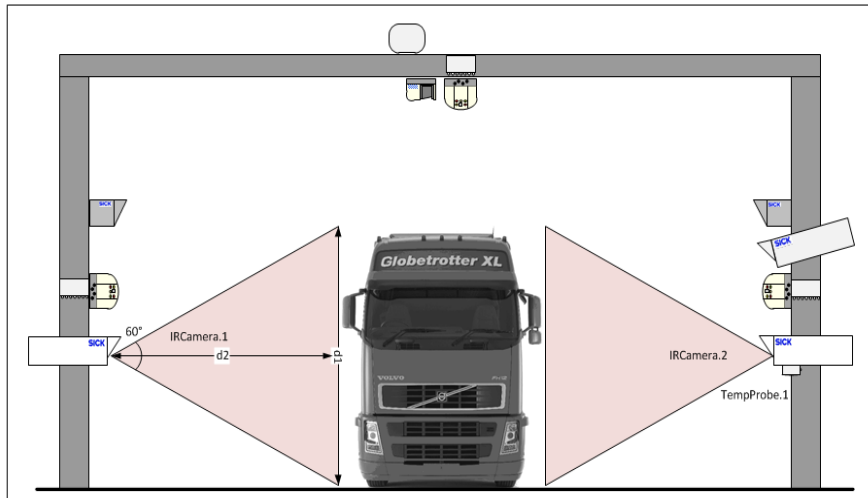
IR-Camera

top of the gantry



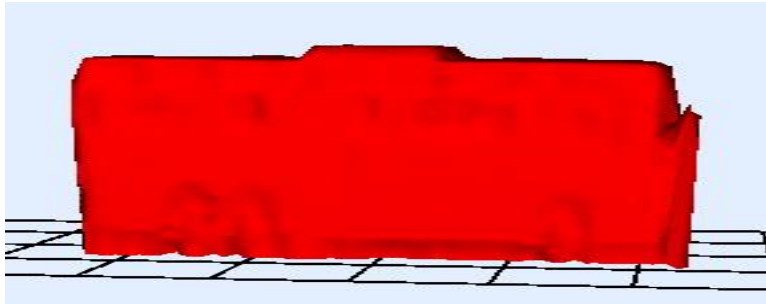
### Measurement of vehicle surface temperature with infrared (IR) cameras

- Temperature range IR camera: 0 ... 600 °C (32 ... 1112 °F)



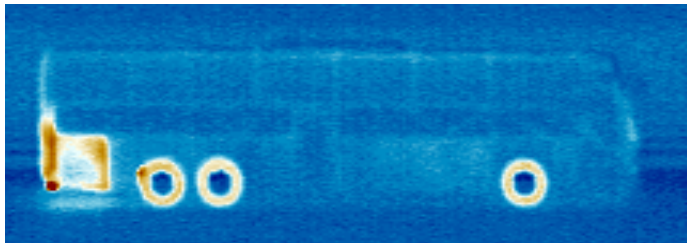
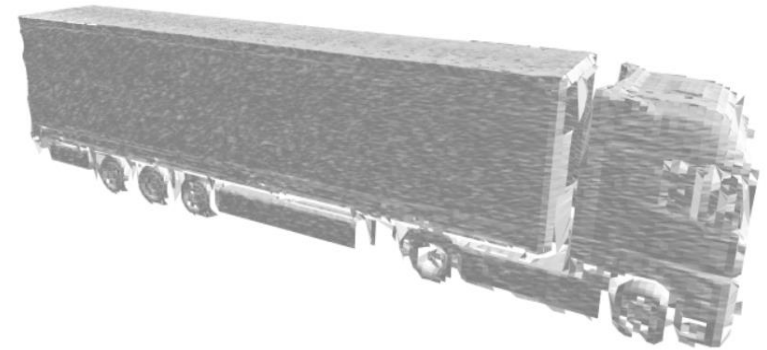
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## SYSTEM DESCRIPTION

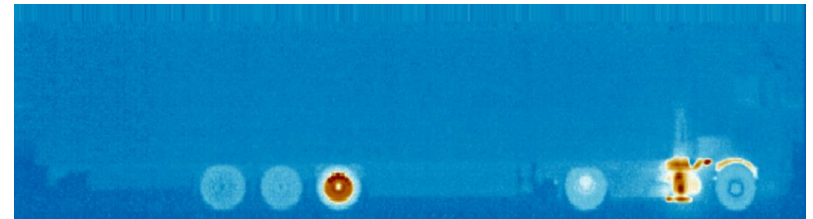


3D  
Model

+

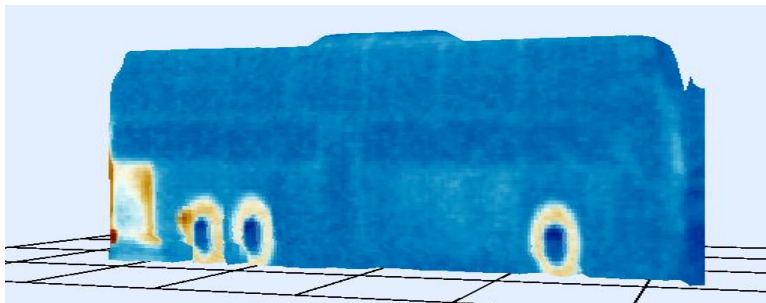


2D  
Thermo-  
Image



=

3D  
Thermo-  
Model



### Segmentation of vehicle parts based on:

- Vehicle classification
- Information in 3D Thermo-Model

Individual alarm temperature thresholds according to vehicle class and vehicle part

- ✓ Fully automated alarming
- ✓ Maximized alarming sensitivity
- ✓ Minimized false alarm ration





- Configurable temperature threshold

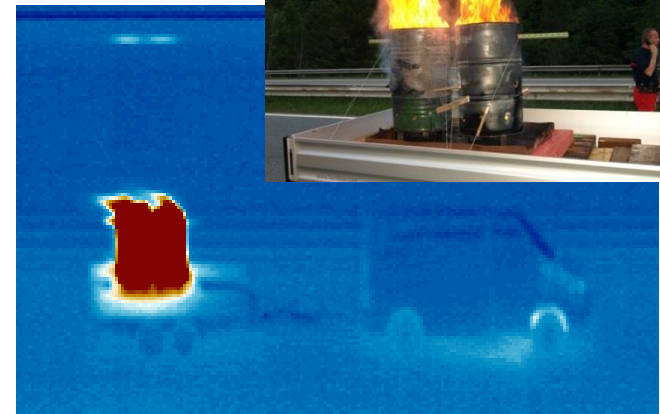
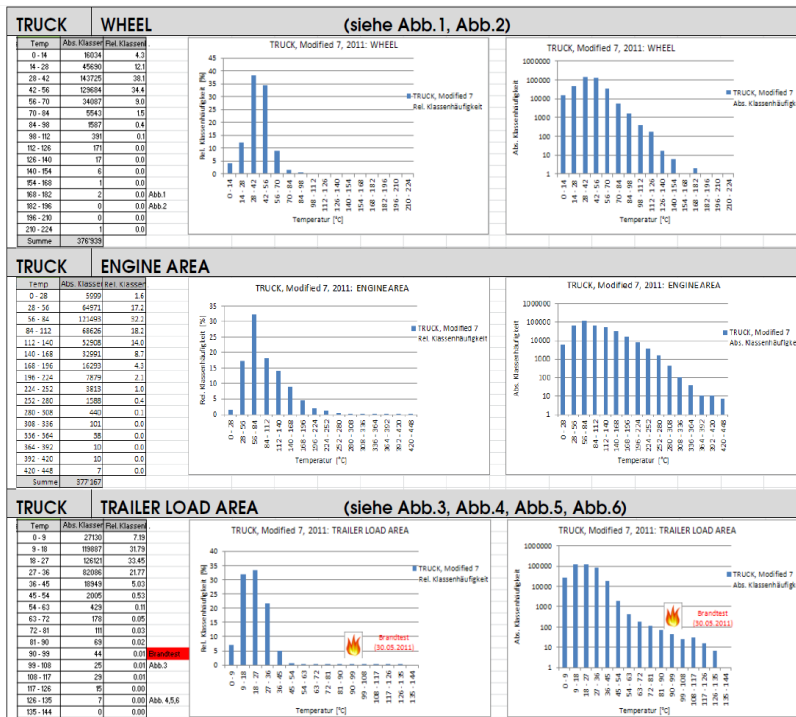
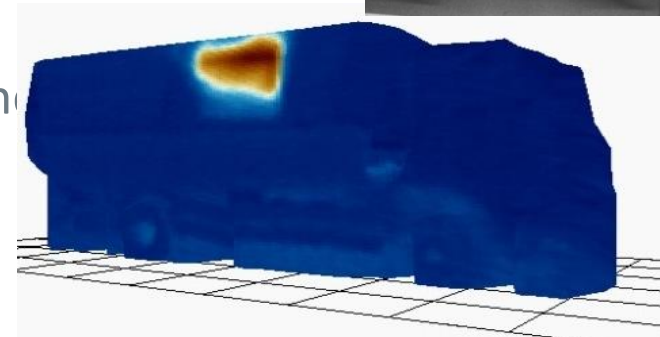
	truck	bus	car/van	motorbike
wheels	120°C	70°C	150°C	-
engine + exhaust	500°C	350°C	350°C	-
passenger zone	80°C	80°C	80°C	-
loading zone	120°C	80°C	80°C	-
contour	500°C	450°C	450°C	450°C

# VHD – VEHICLE HOT SPOT DETECTOR

## TEMPERATURE THRESHOLDS

### Expertise based on

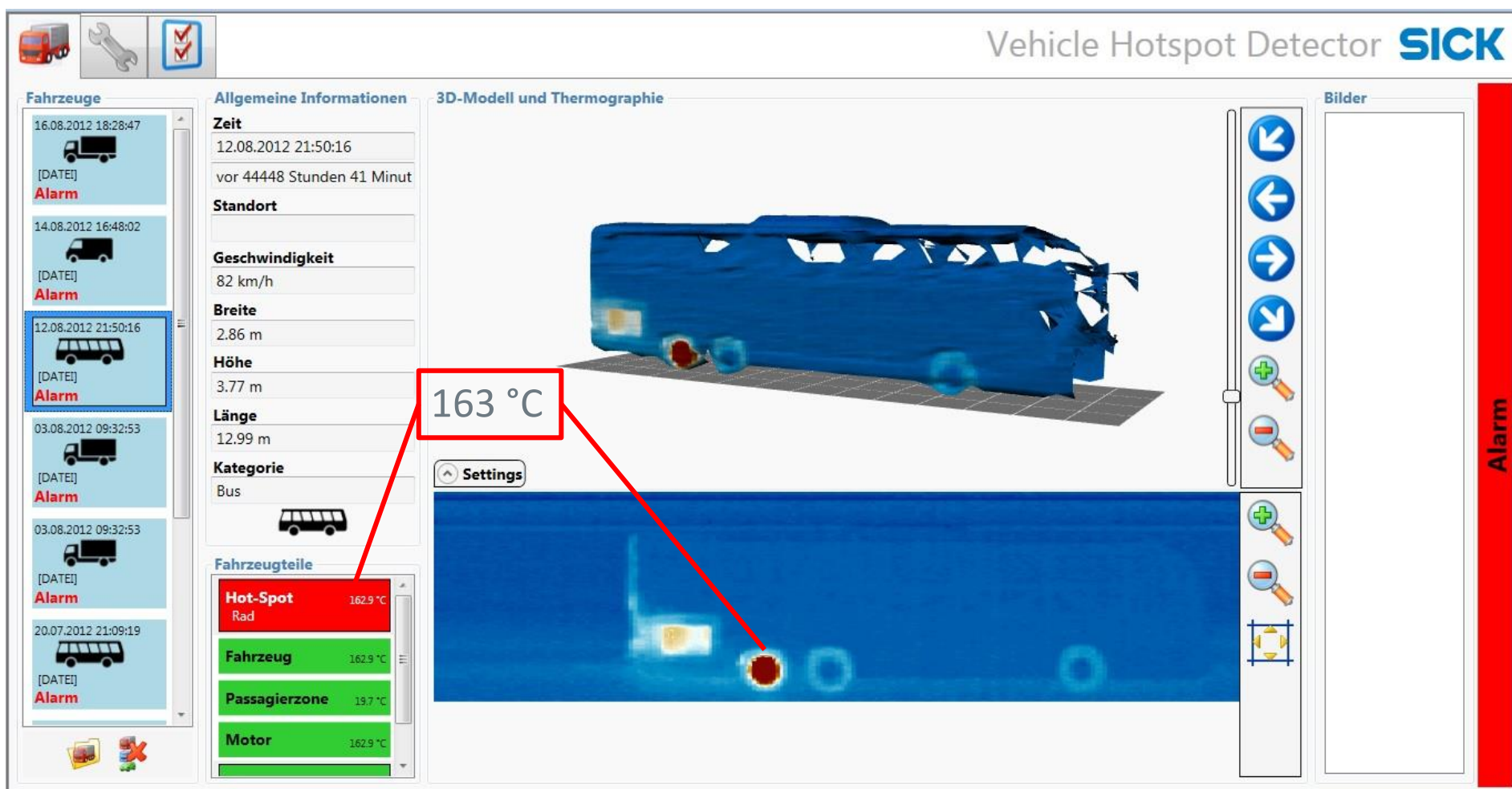
- ✓ Collaboration with experts
- ✓ Real fire tests
- ✓ 1.7 million recorded vehicles in database
- ➔ We know what temperatures are driving around



# VHD – VEHICLE HOT SPOT DETECTOR

## OVERHEATED VEHICLES

- What temperatures are driving around?

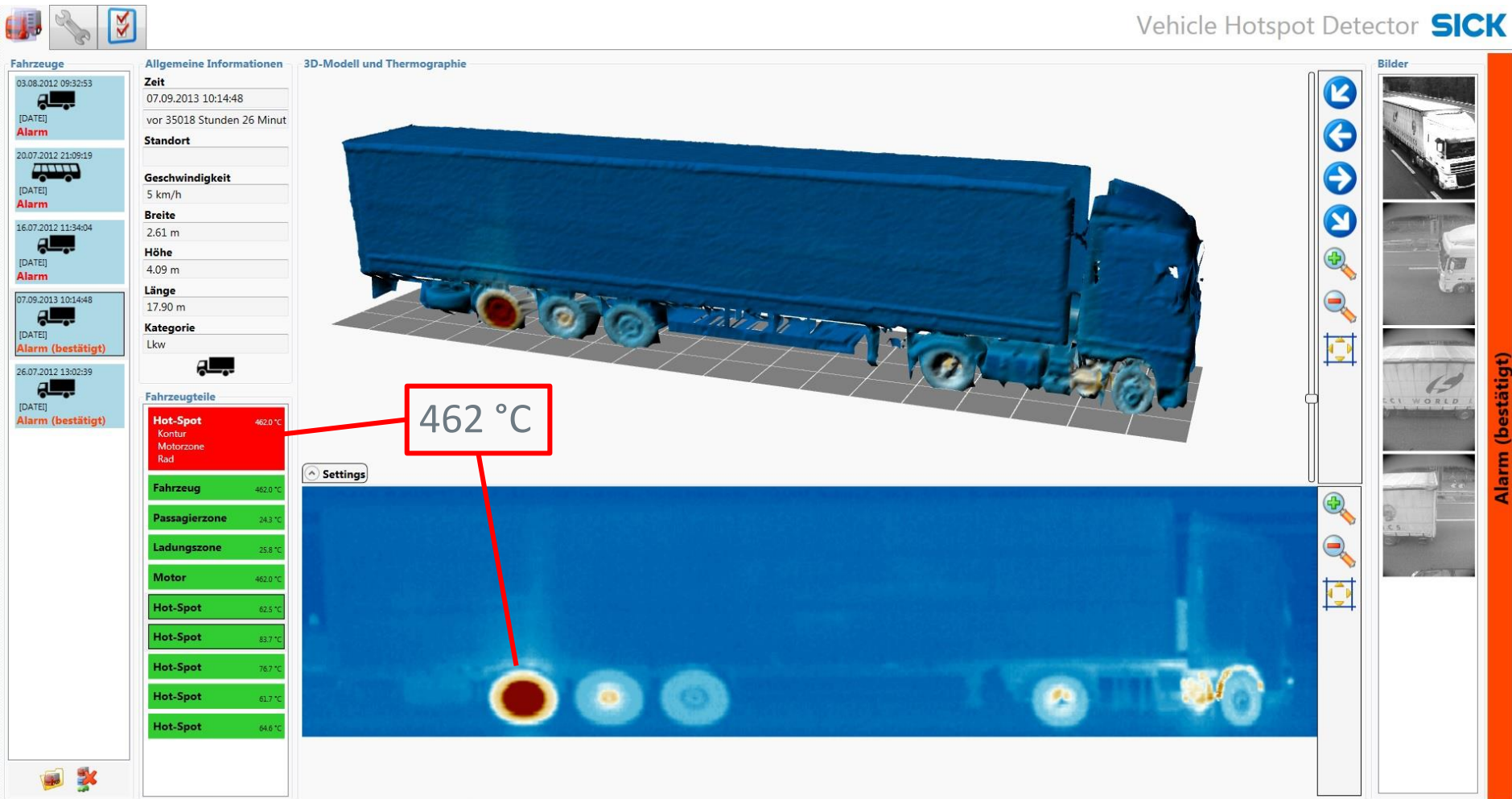


# VHD – VEHICLE HOT SPOT DETECTOR

## OVERHEATED VEHICLES

- What temperatures are driving around?

Vehicle Hotspot Detector **SICK**





# VHD – VEHICLE HOT SPOT DETECTOR

## OVERHEATED VEHICLES



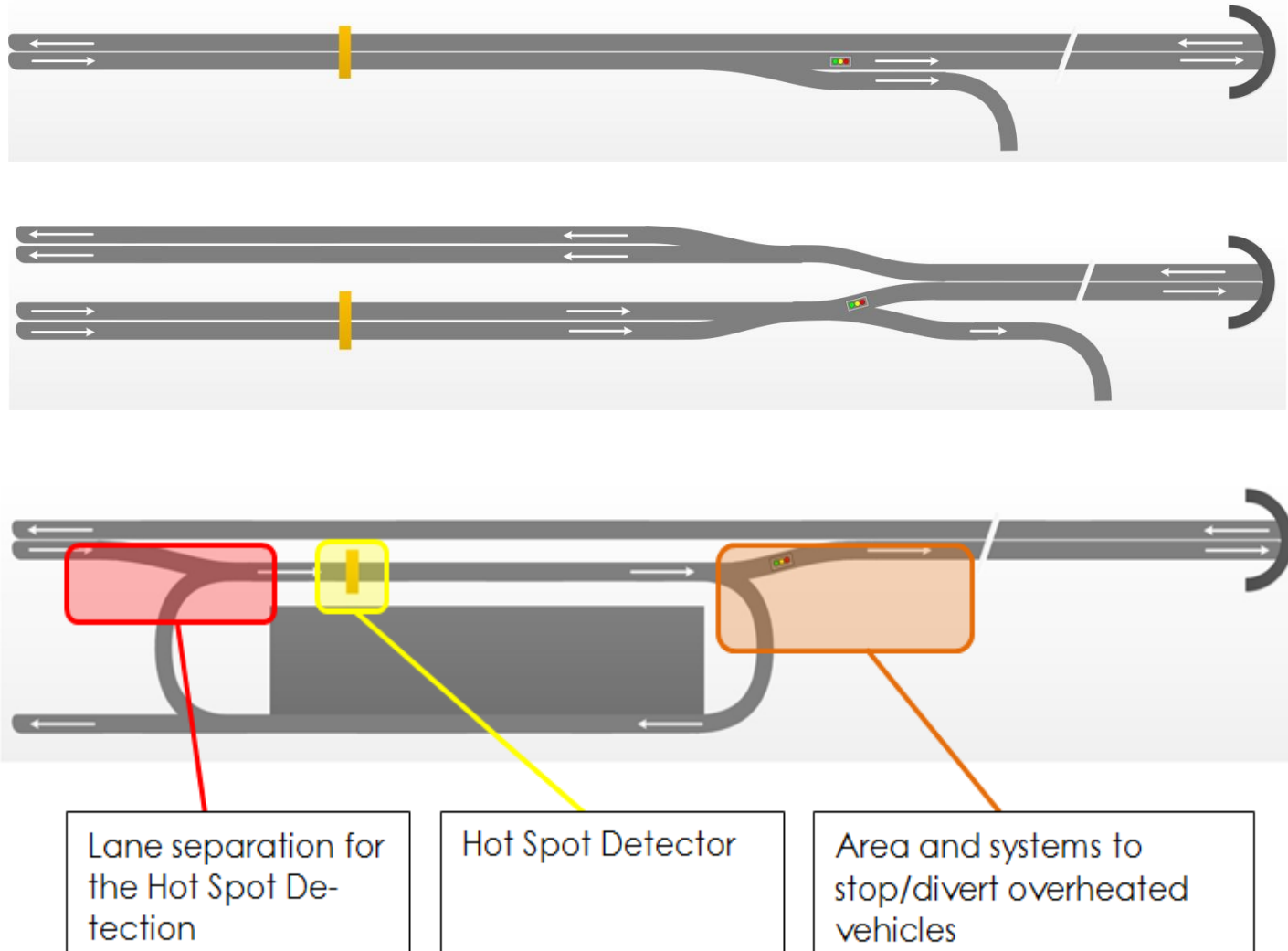
# VHD – VEHICLE HOT SPOT DETECTOR

## OVERHEATED VEHICLES



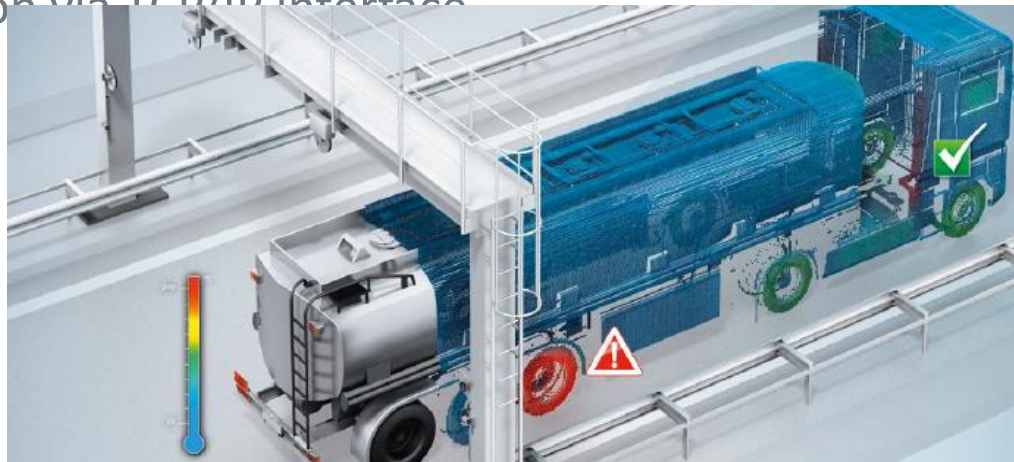
# VHD – VEHICLE HOT SPOT DETECTOR

## TAKE OUT PROCEDURE





- ✓ Fully automated free flow measurement
- ✓ Individual alarm thresholds for different vehicle parts (wheels, exhaust, load, ...)
- ✓ GUI with 3D representation of the hotspot location on the vehicle
- ✓ Temperature measurement up to 600°C
- ✓ Upgradable with e.g. detection of hazardous goods plates or over-height
- ✓ Vehicle classification with up to 28 classes
- ✓ Reliable operation in all weather conditions
- ✓ Communication via TCP/IP interface





Improving of safety and availability of traffic infrastructure such as:

**Road &  
Railway  
Tunnels**



**Terminals for  
rolling  
highway**



**Ferry  
Terminals**



...and other strategically important traffic infrastructures

## REFERENCES

### Gotthard, Switzerland Road Tunnel (2 systems)



#### Solution

Detection of overheated vehicle parts in free-flow with:

- 5x LMS511 for vehicle profiling
- 2x IR camera for temperature measurement
- 2x Photo camera for vehicle identification
- Software with 3D GUI for vehicle analysis

#### Results

- ✓ Detection of 2 vehicles which pose a real safety risk every month! (24 vehicles in the year 2014)
- ✓ 2<sup>nd</sup> system was approved after test phase of 1<sup>st</sup> system due to the positive impact on the safety

<b>Customer</b>	ASTRA, Switzerland
<b>Handover</b>	1 <sup>st</sup> system 2015, 2 <sup>nd</sup> system 2016

## REFERENCES

### Arlberg, Austria

#### Road Tunnel (2 systems)



### Solution

Detection of overheated vehicle parts at slow-speed with:

- 5x LMS511 for vehicle profiling
- 2x IR camera for temperature measurement
- 2x Photo camera for vehicle identification
- 1x HISIC for over-height detection
- Software with 3D GUI for vehicle analysis

### Results

- ✓ Positive impact on the safety and efficiency

Customer	ASFINAG, Austria
Handover	2016



## REFERENCES

### Vereina, Switzerland

Terminal for rolling highway (2 systems)



### Solution

Detection of overheated vehicle parts in free-flow with:

- 5x LMS511 for vehicle profiling
- 2x IR camera for temperature measurement
- 2x Photo camera for vehicle identification
- 1x HISIC for over-height detection
- Software with 3D GUI for vehicle analysis

### Results

- ✓ Vehicle profile check before loading on car-transfer train
- ✓ Positive impact on the safety after risk analysis
- ✓ Supportive system for operating personnel

Customer	Rhätische Bahn (RhB), Switzerland
Handover	2017



MANY THANKS FOR YOUR ATTENTION



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