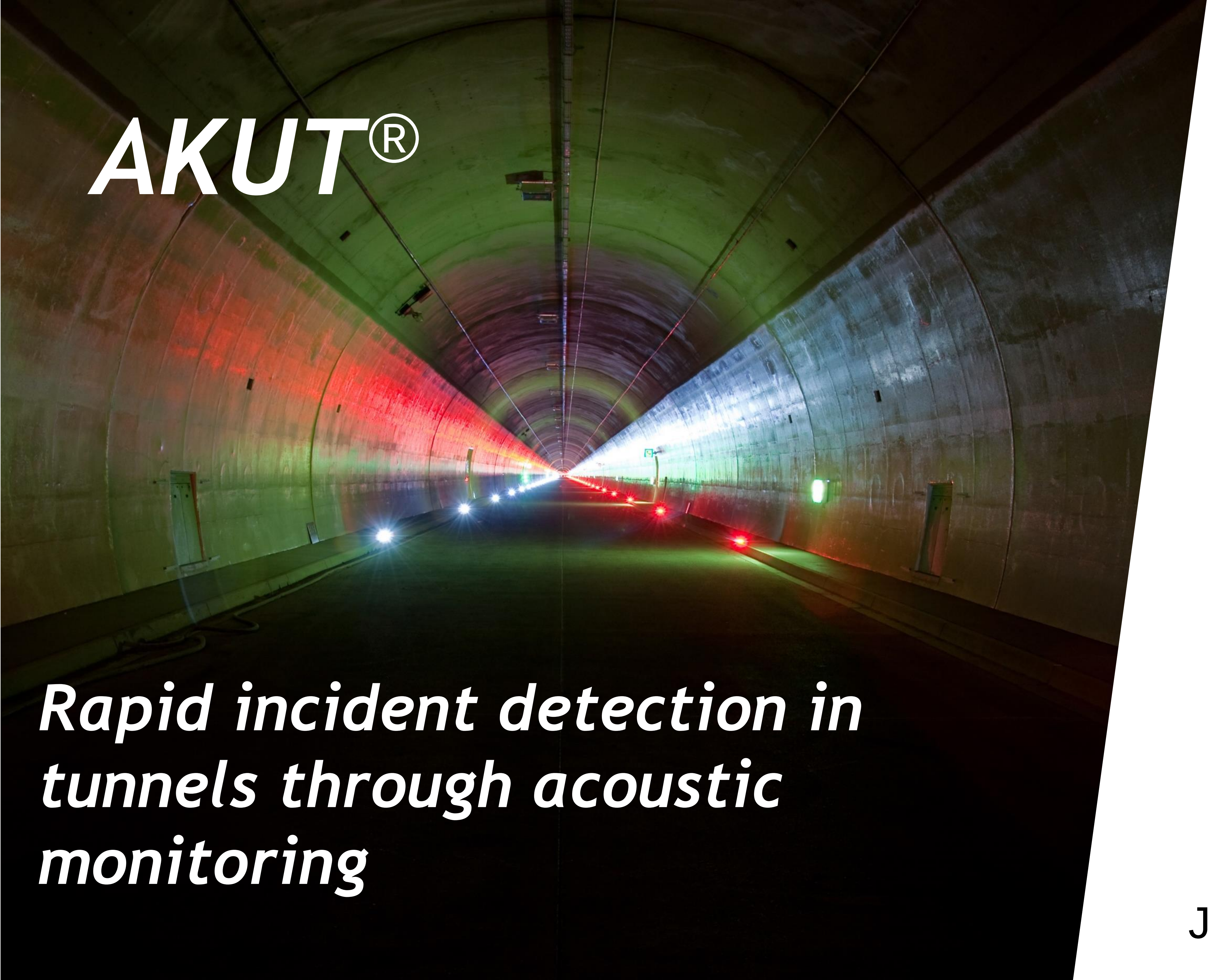


AKUT®

Rapid incident detection in tunnels through acoustic monitoring

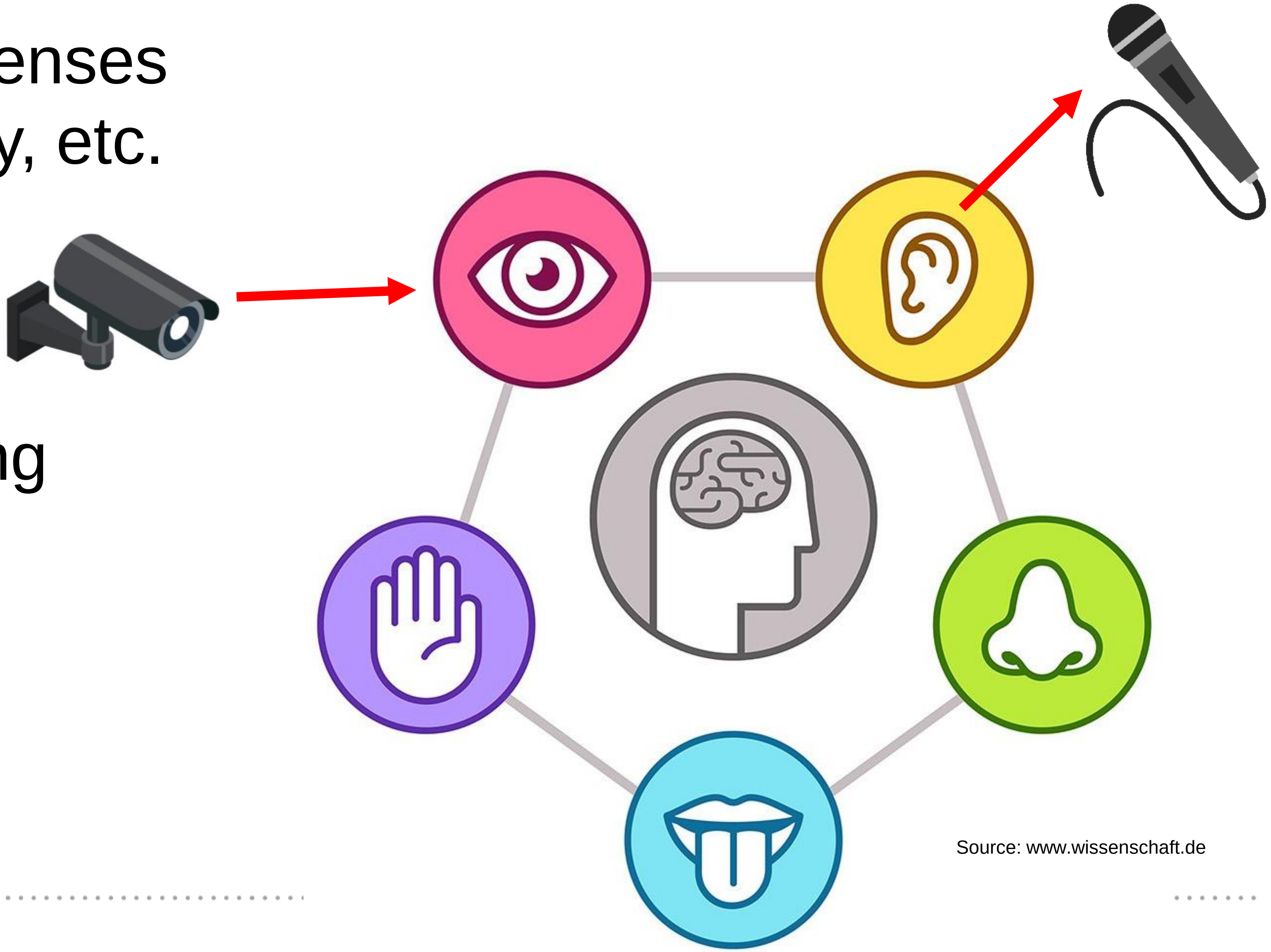
AKUT
ACOUSTIC TUNNEL MONITORING

JOANNEUM RESEARCH DIGITAL

Franz Graf
JOANNEUM RESEARCH

The big aim

- Replication of human senses in industry, traffic, safety, etc.

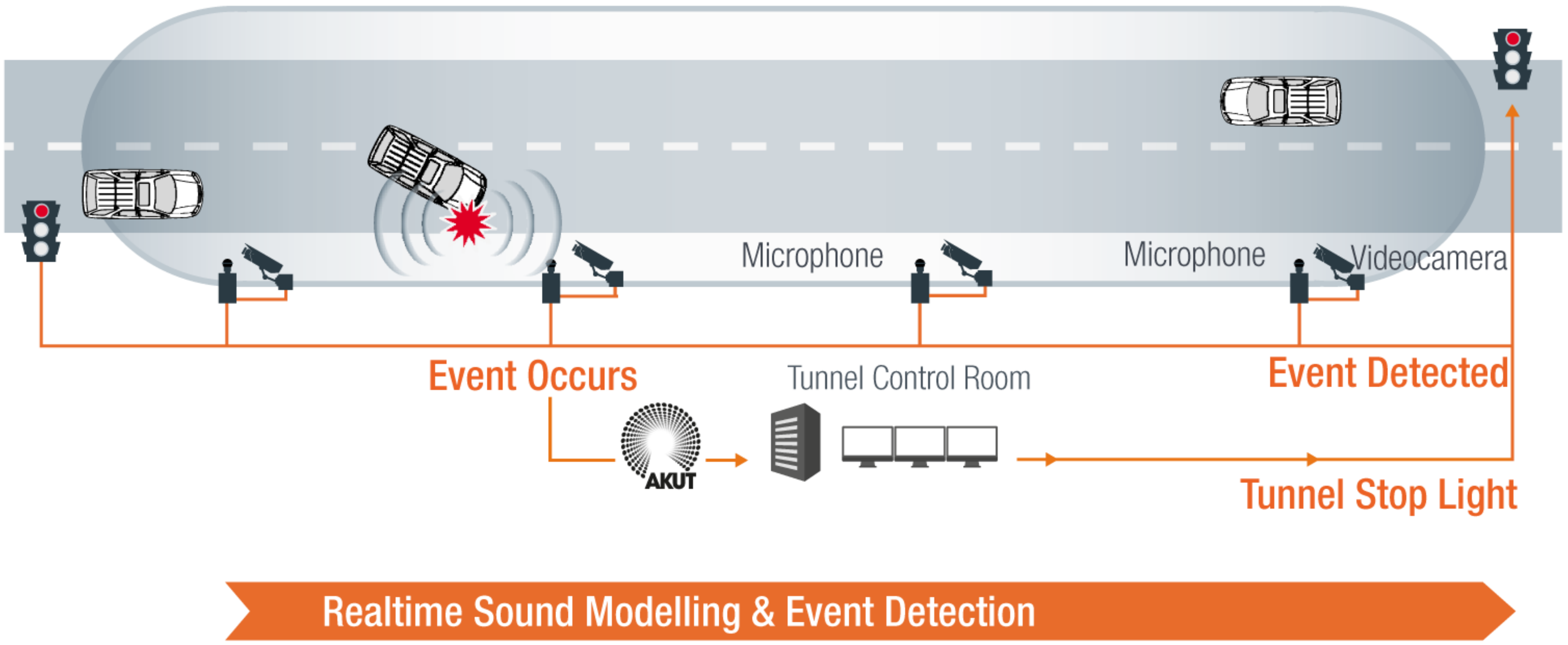


- → Multimodal Monitoring

Source: www.wissenschaft.de

Acoustic Tunnel Monitoring - Principle

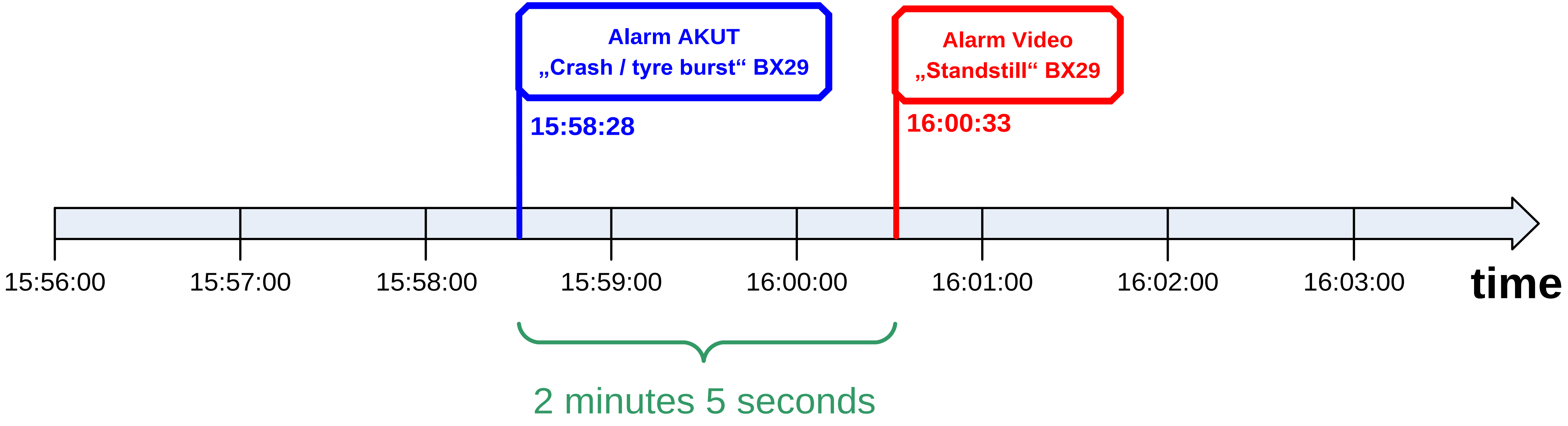
- Detection of abnormal sounds in in tunnels



- Incident detection in **less than 1 second**!

The big advantage

Time line traffic accident



Benefits

- Very fast incident detection
- Tunnel **stop lights** can be **immediately activated**
- **Fewer** tunnel occupants require **evacuation**
- Even with **poor visibility** due to smoke the operator can **hear people in the tunnel** – and is able to locate them

Features

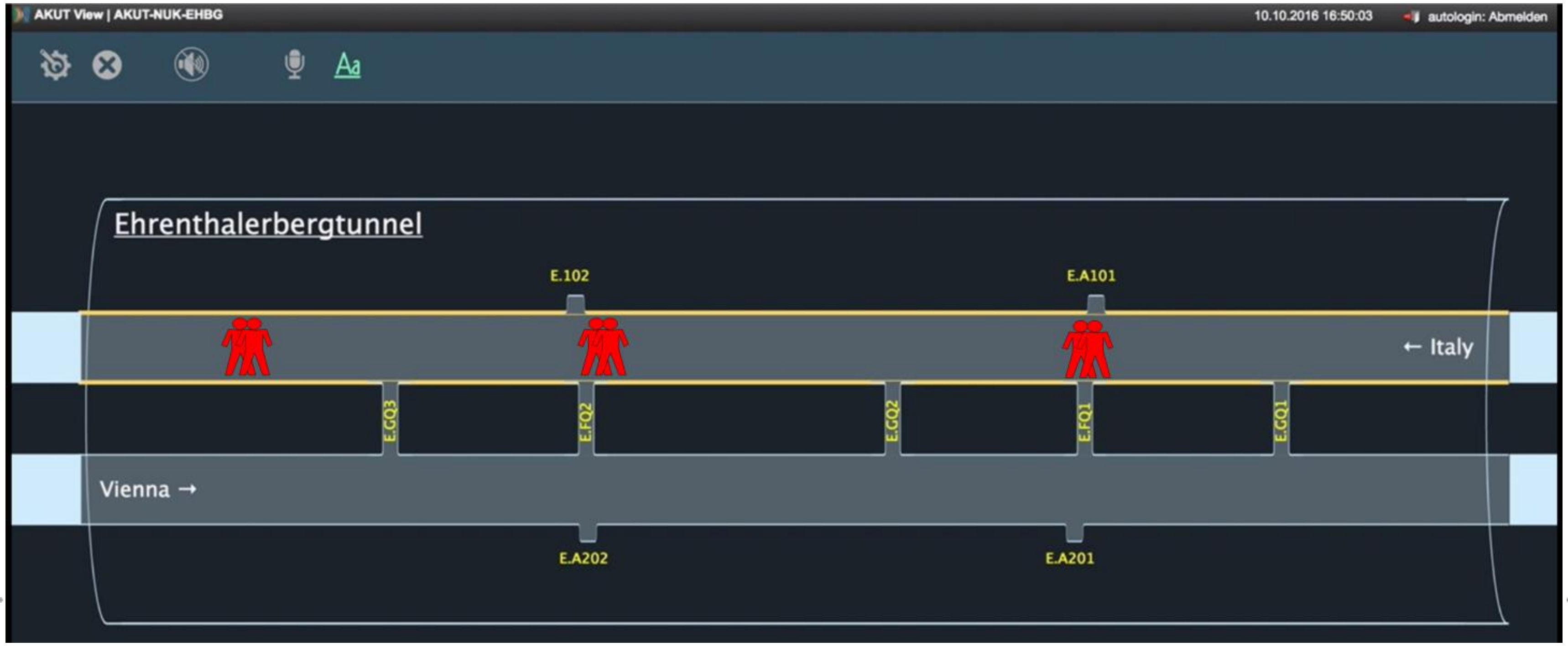
- Detection of anomalies within the noise of the tunnel
- Discrimination of different danger categories
- Localization of the incident
- Switch on correct cameras

Incidents currently detected

- Crash / tyre burst
- Tyre squeal
- Door slam
- Honking
- Voices/shouting (Voice Scan)

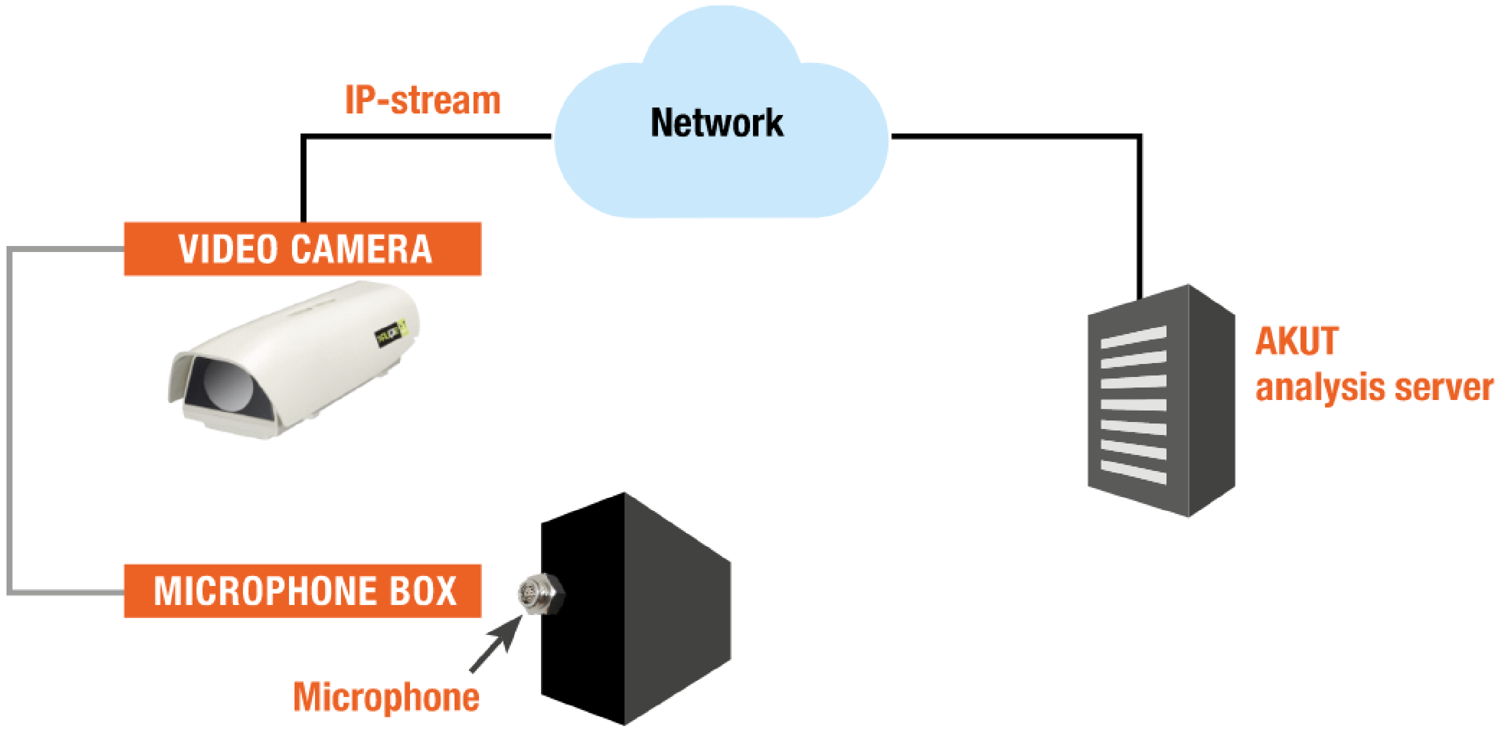
Voice Scan

- Detection
  - persons in tunnel with poor visibility (e.g. smoke)
  - Speech, voices, screams, etc.
- Clear display of positions of persons



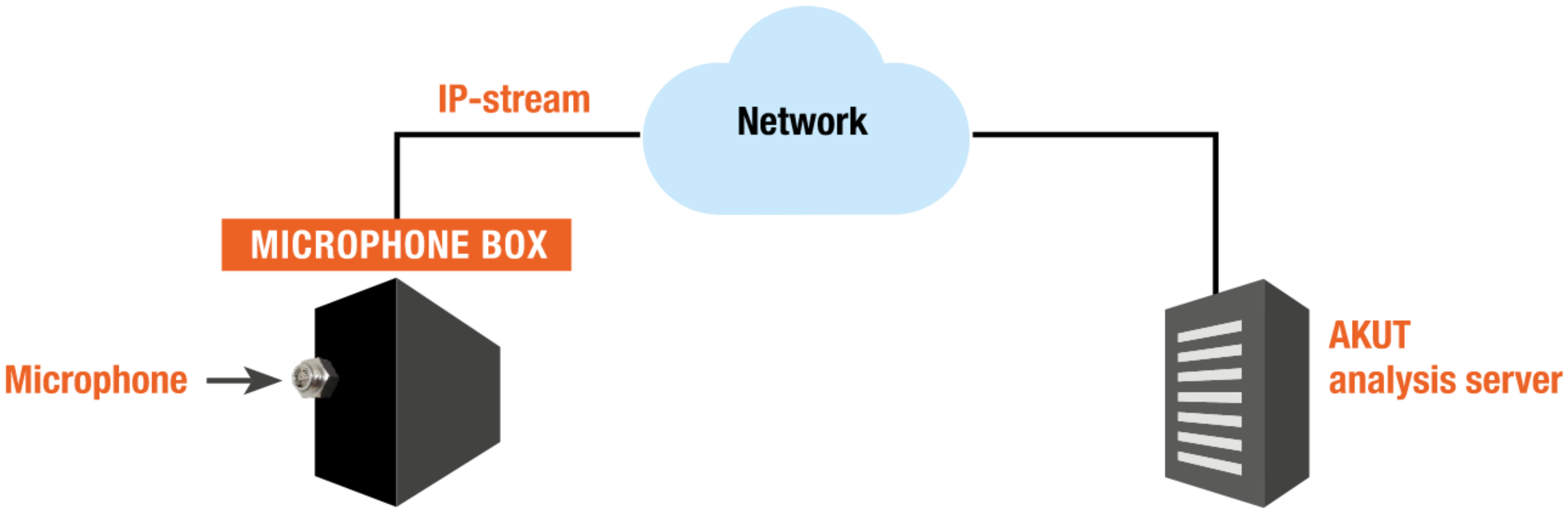
Installation & Data Transmission
Option 1 - Video camera with Audio Encoder

- Installation together with video camera (cost-efficient!)
- Microphone can be plugged in at video camera

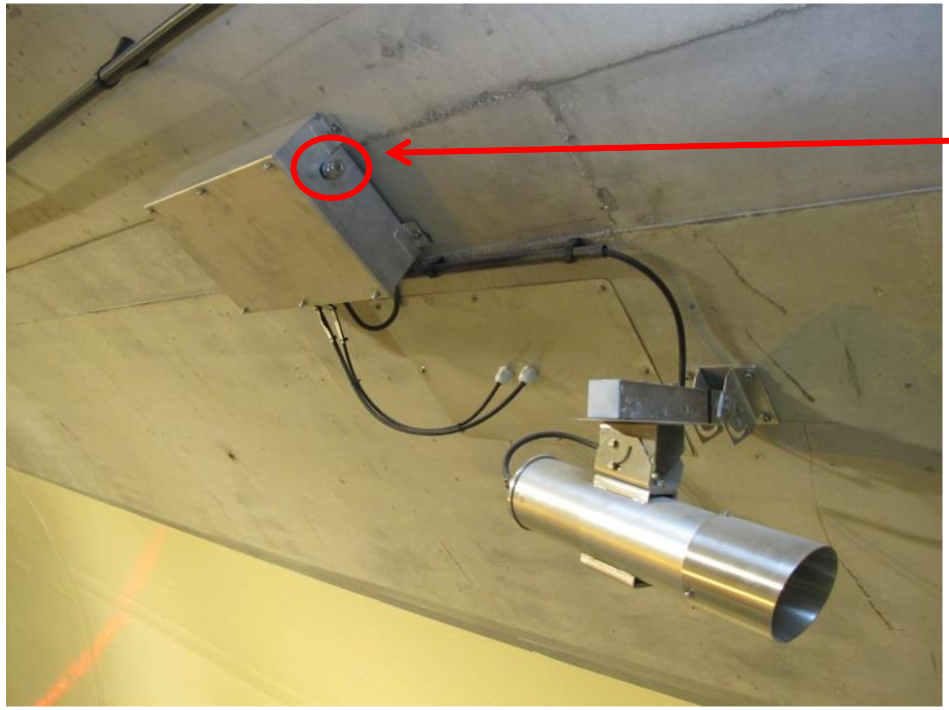


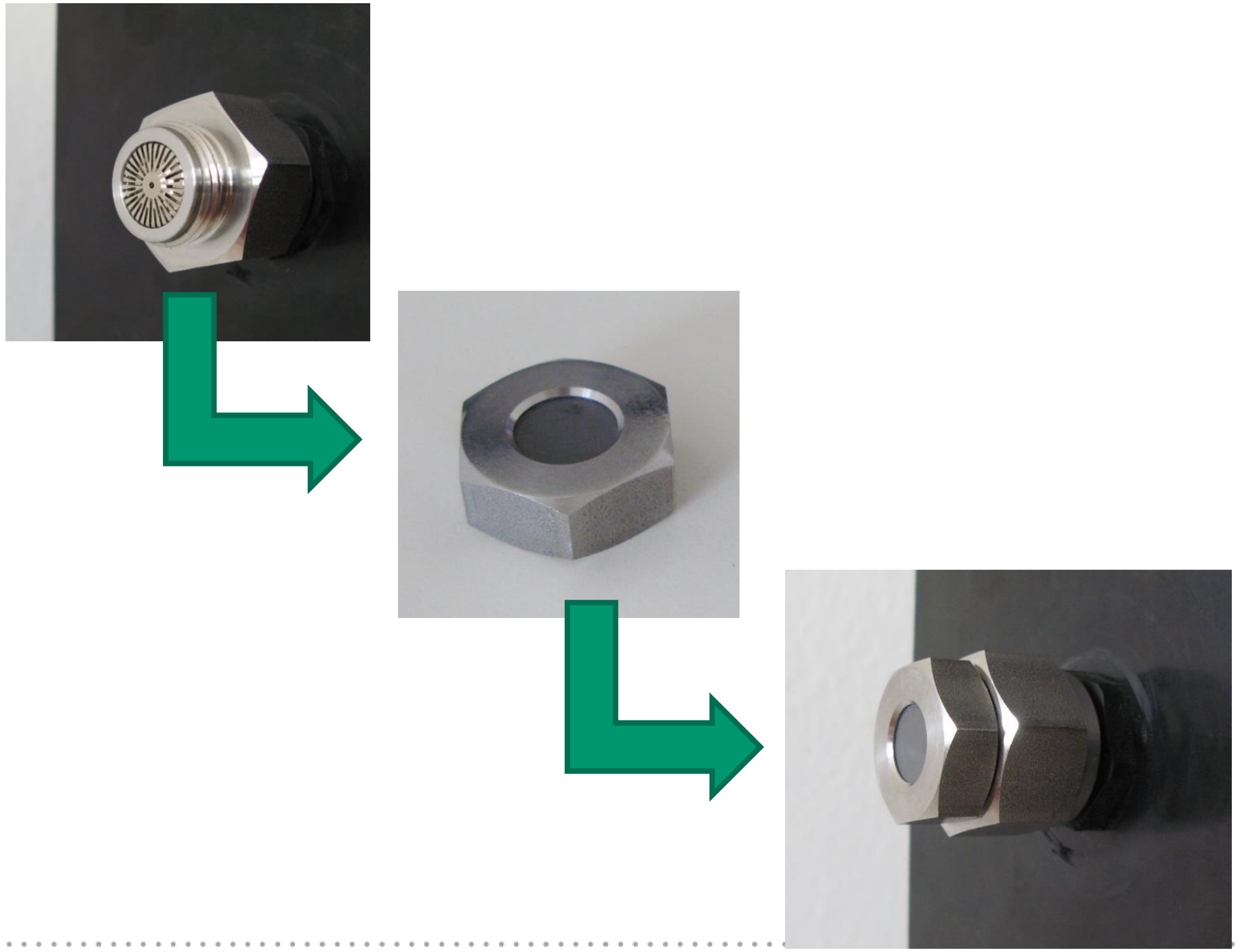
Installation & Data Transmission
Option 2 - AKUT as Standalone System

- Separate audio encoder in microphone box
- Audio signal (IP-stream) is transmitted on own optical fibre



Tunnel microphone





Operational experience
Analysed tunnels

Systems analysed using the ASFINAG incident database

Tunnel	Length in m	Number of bores	Number of microphones	Average Daily Traffic Volume
Bosruck, A9	5,505	2	122	17,470
Ehrentalerberg, A2	3,345	2	75	30,623
Falkenberg, A2	1,090	2	26	30,623
Lendorf, A2	800	2	20	30,623
Trettnig, A2	450	2	12	30,623
Götschka, S10	4,435	2	86	37,298
Neumarkt, S10	1,970	2	38	37,298
Pernau, S10	245	2	4	37,298
Lest, S10	545	2	12	37,298
∑ 9 Tunnel	**∑ 36.77 km bore length**		**∑ 395**	

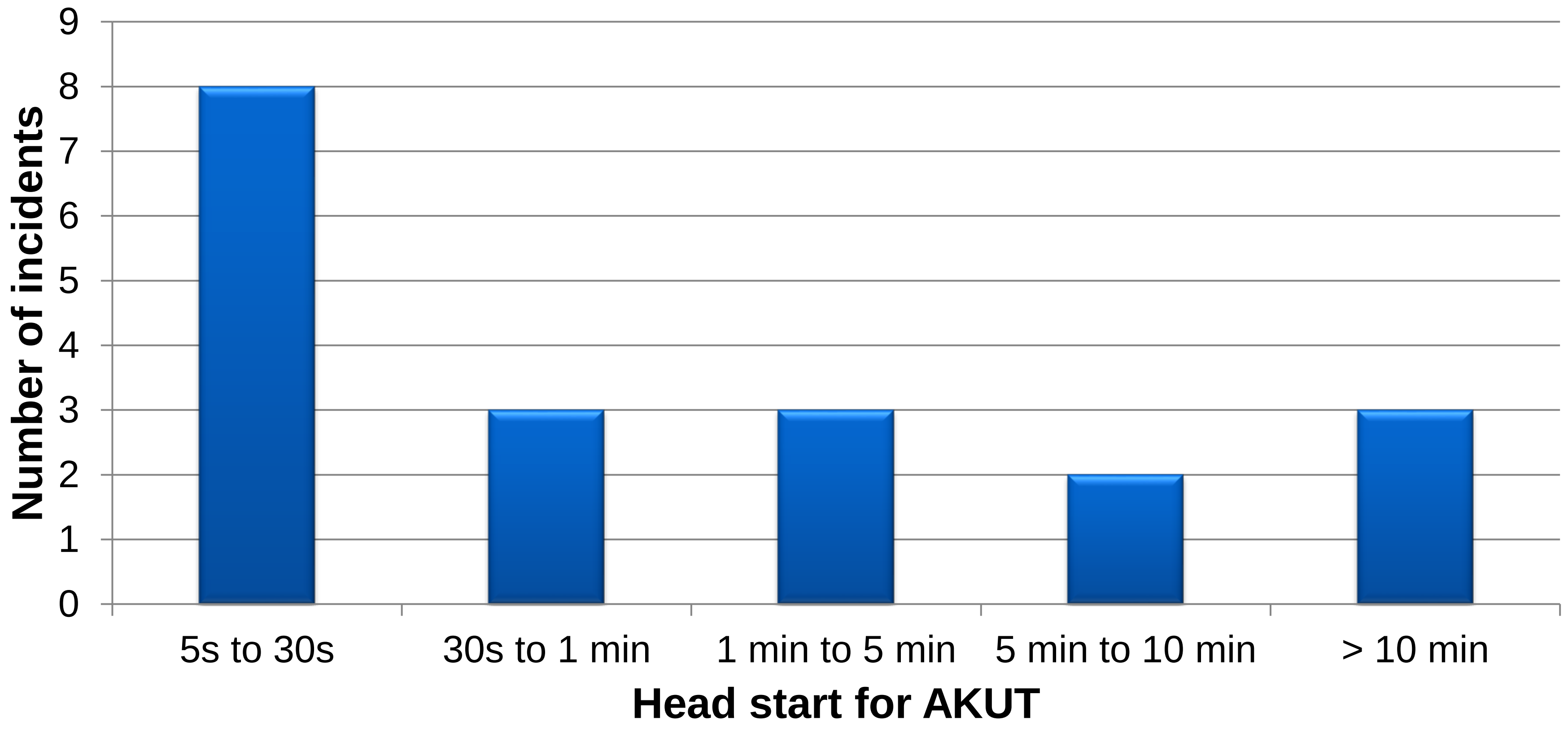
Longterm analysis of incidents

- Analysed period of time: **July 2016 – February 2018**
- ASFINAG incident database contained **19 relevant incidents** in the analysed tunnels

Incident type	
Rear-end collision	5
Collision of 2 vehicles	4
Collision of a vehicle with the infrastructure	10
Total	**19**

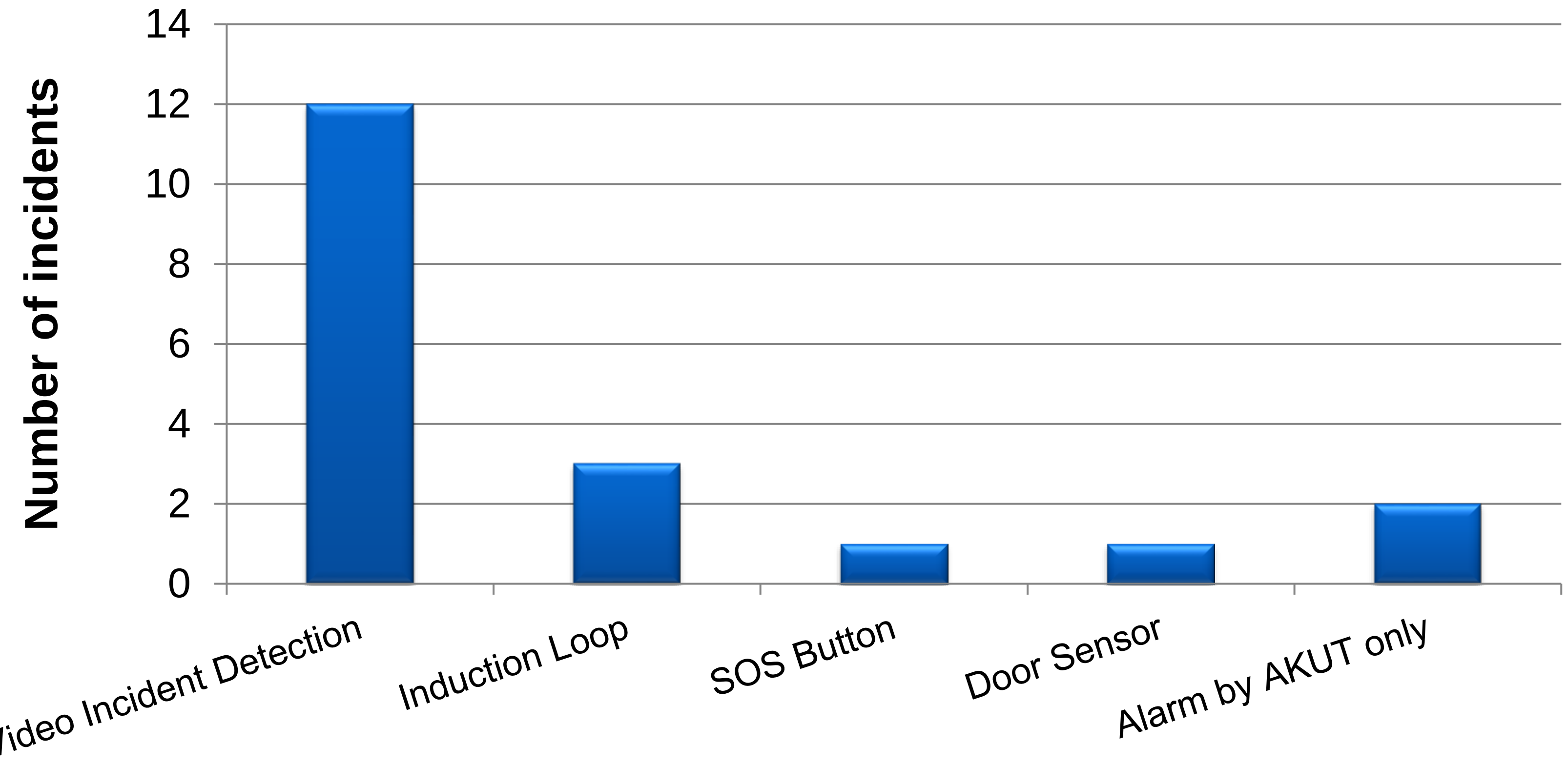
Result of longterm analysis

- Result: **all 19 incidents were detected quickest by AKUT!!!**
- No missed incident!



Result of longterm analysis

- Safety systems that reported alarms in **second place** after AKUT



False alarms

- Main task is the detection of real incidents
- Each detection system has false alarms
- Number of false alarms is essential for operators
- **No acceptance** if number of false alarms to high

False alarms

- Examples of tunnels (Data from November 2019)

Tunnel	Total bore length in meters	Number of microphones	Average Daily Traffic Volume	Number of false alarms per 24h and per km bore length
Kaisermuehlen	4,268	97	109,000	0.21
Goetschka	8,870	82	37,298	0.11
Spering	5,740	62	19,819	0.02
Arlberg	15,516	175	13,033	0.29

Avarage False Alarm Rate

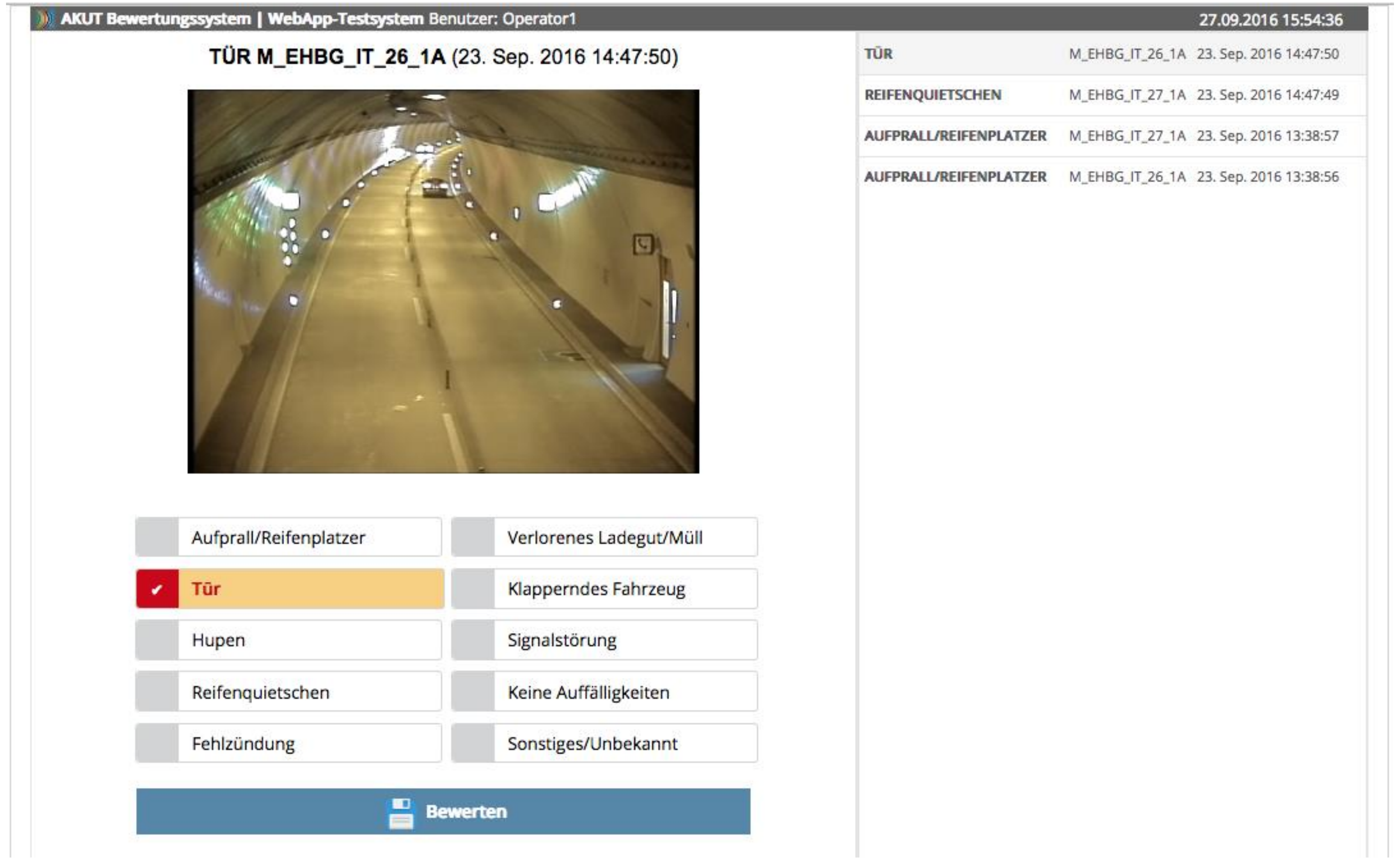
- False alarm rate averaged over
  - 26 tunnels
  - 1679 microphones
  - 130 km bore length

- **Result: 0.16 false alarms per 24h and per km bore length!**

- → e.g. 10 km long tunnel: 1.6 false alarms per 24h

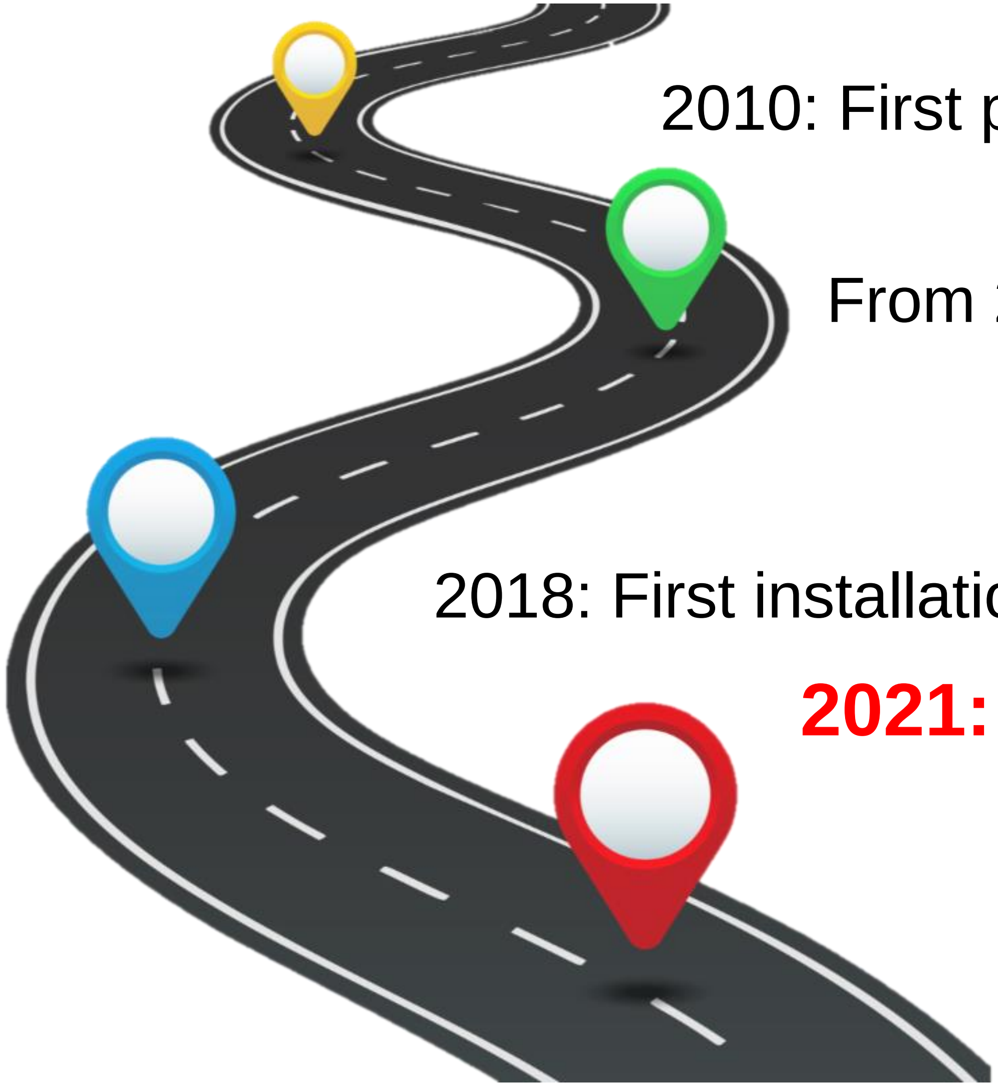
Why do we know the exact number of false alarms?

- **Each individual alarm is evaluated manually!**
- → Continuous 100% quality control of all AKUT systems in Austria



Software tool for rating

References



2010: First pilot system in Austria (Kirchdorf tunnel)

From 2014 : Roll out of AKUT in Austria

2018: First installation in UK

2021: 30 tunnels installed so far
1,800 microphones
144 km bore length
Contracts for further
26 tunnels signed

Reference Highlights

- **Longest tunnel** equipped with AKUT
  - Arlberg tunnel → 15,516 m
- **Shortest tunnel** equipped with AKUT
  - Pernau tunnel → 268 m
- Tunnel with the **largest number of microphones**
  - Plabutsch tunnel → 282 microphones
- Tunnel with **highest DTV**
  - Kaisermuehlen tunnel → DTV: 110,000

Video

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