AKUT® Acoustic Tunnel Monitoring

**The tunnel of the future has ears:
recognize an incident in less than 1 second!**

AKUT®

www.akut-tunnel.com

THE INNOVATION COMPANY

Acoustic Tunnel Monitoring

AKUT recognizes events faster – even 2 minutes faster than any other current technology.

Foto: ASFINAG

In a tunnel with 50.000 vehicles JDTV this means in 2 minutes, 70 vehicles will be prevented from entering the tunnel. This is the equivalent of 70 to 200 people being out of the danger zone and not requiring evacuation. This way AKUT minimizes the risk for people and infrastructure.

Benefits

- Even with **poor visibility** due to smoke the operator can **hear people** in the tunnel – and is able to locate them.

- The operator is able to **direct tunnel occupants** to safe areas even if the cameras are blind.

- Emergency services can be guided around dangerous areas to rescue people via safe escape routes.

- Automatic display of the **relevant camera**

- Event recognition in **less than 1 second.**

- The **tunnel stop lights** can be immediately **activated.**

- In comparison to other safety systems, several minutes worth of traffic **flow are prevented from entering the tunnel.**

- **Fewer** tunnel occupants require **evacuation.**

Acoustic Tunnel Monitoring

A word from a customer

„Thanks to this innovative system we can offer all vehicle drivers the highest possible levels of traffic safety on the basis of latest technology. For this reason we will be equipping all 32 tunnels of danger class 3 and 4 with AKUT by 2019. "
DI Alois Schedl, Board Director ASFINAG

ASFiNAG

„Experience so far has shown that accidents were always recognized first by the acoustic tunnel monitoring system. The time gained was between just under one more than two minutes. In the event of an accident this time difference could save lives. "
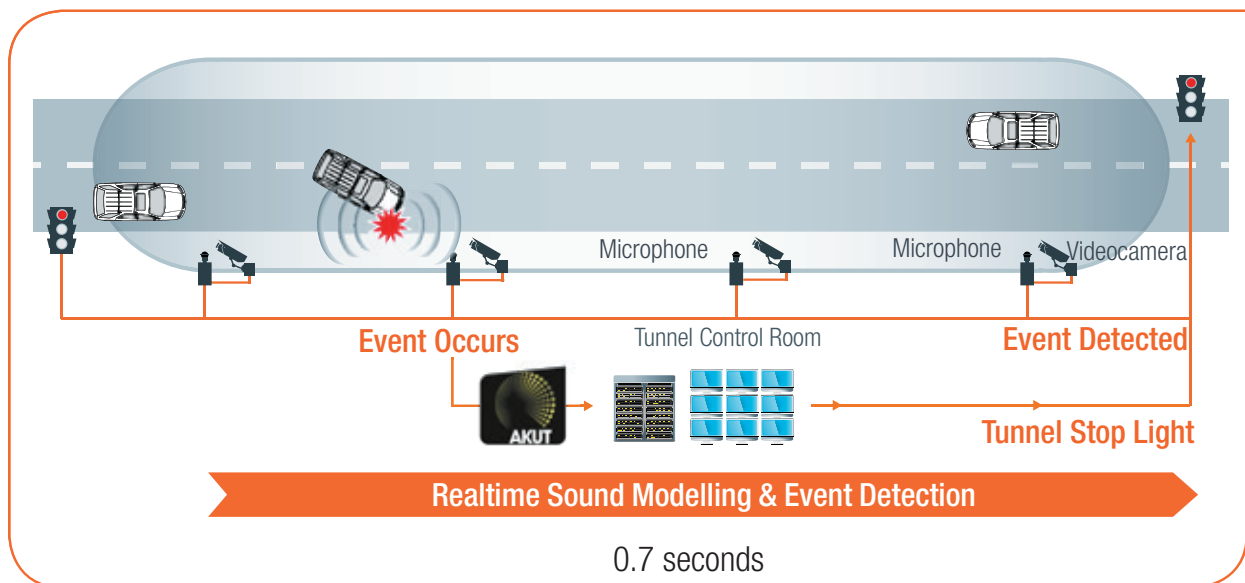**DI Gerhard Ruhdorfer, Project Manager ASFINAG**

Foto: ASFINAG

Portal of the tunnel Kirchdorf/Austria where the first pilot system was installed

How it works

**The tunnel never stops listening and reacts immediately:
Events are detected and localized within 0.7 seconds**

Microphone   Microphone   Videocamera

Event Occurs   Tunnel Control Room   **Event Detected**

AKUT

Tunnel Stop Light

Realtime Sound Modelling & Event Detection

0.7 seconds

Events are detected acoustically via the microphones installed in the tunnel.
Abnormal sounds are recognized and an alarm is transmitted to the control room within 0.7 seconds.
The operator can then decide whether to activate the tunnel traffic lights and other emergency measures.

Alert classes

- Crash and tyre burst

- Tyre squealing

- Door banging

- Car horn

- Voices and shouts

System Components

- Dust, corrosion and jet-wash resistant
  microphones & connection boxes with easy
  maintenance

- Data transmission via optical fibres or copper cables
  alternatively

- Realtime sound modelling & incident detection
  including ring buffer and alert storage

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Principle of acoustic tunnel monitoring

The operating noise inside a tunnel is characterised by a specific mix of engine, rolling and airflow noise produced by vehicles passing through. Microphones installed in the tunnel detect acoustic anomalies such as a vehicle-wall and vehicle-vehicle collisions, tyre bursts, voices and shouts, etc.

Special detection algorithms make it possible to automatically identify these sounds and assign them to specific alarm classes. One big advantage of acoustic detection methods is that accidents or critical incidents in tunnels are virtually always accompanied by a characteristic sound. These sounds occur concurrently with the incident and can thus be immediately detected. The detection of an incident allows measures to be immediately and automatically activated. For example, the system may, depending on the alert class, trigger an acoustic alarm in the tunnel control room and display the

video camera image of the affected section on a central screen giving the tunnel operator a real-time overview of the situation. This saves valuable time in providing first aid to people involved and in alerting drivers approaching the scene of the accident.

Features

- Live streaming of sounds and voices
- Sound localisation by assignment to nearest microphones (100 – 150m apart, depending on camera positions)
- Alarm in the tunnel control room with incident category and camera image
- Tunnel operator obtains information even when visibility is poor
- Ring buffer for all microphone signals

System setup
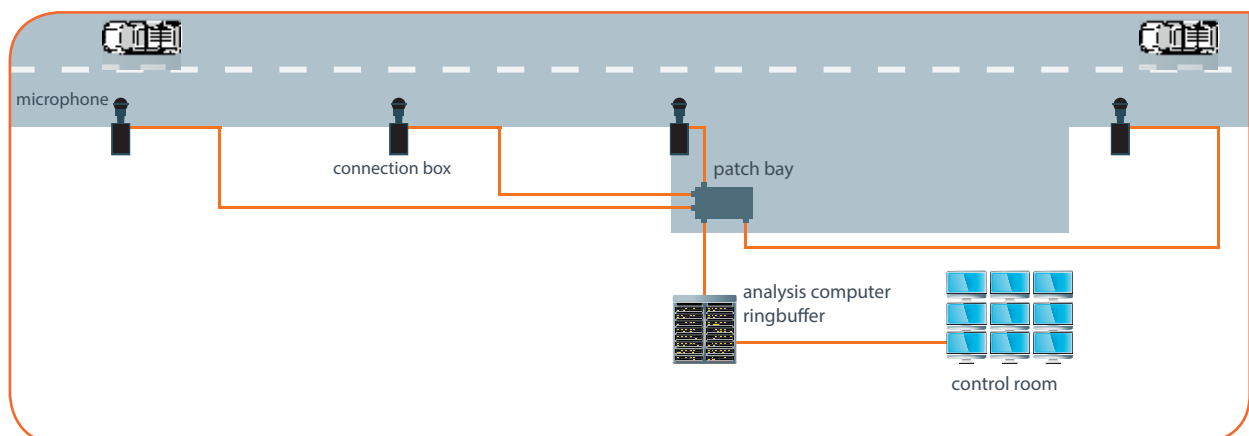
The acoustic tunnel monitoring system consists of the following main components:
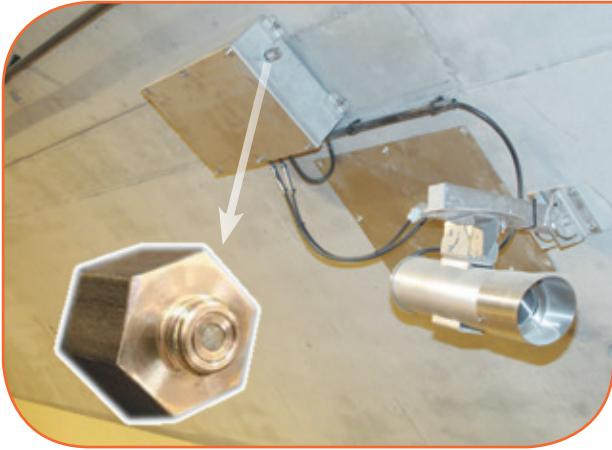
- Microphone
- Connection box
- signal transmitters (optical or copper)
- Analysis computers with ring buffer and alert log

The microphones withstand the prevailing climatic conditions in tunnels and provide high quality signals. The higher the quality, the more robust the analysis algorithms. The microphones can be mounted on a separate fixture on the sidewall of the tunnel or directly on the connection box. The connection boxes provide the power supply to the

microphones and are responsible for the amplification and A/D conversion of signals into digital audio signals, which are then transmitted as digital signals via optical fibre or copper cables. The analysis computer analyses and classifies the microphone signals in realtime. The first step is to reliably differentiate the acoustic signals into "normal" and "alarm" classes. The second step is to then automatically classify in more detail and assign individual alert classes such as crash, tyre burst, door banging, etc. The analysis computer is also connected to a ring buffer, which stores the data from all microphones for defined period of time (e.g. 48 hours). The alert log also stores all incidents detected, including the start and end time, the classification, the microphone channels involved, the detection parameters and the audio data.

Special microphones were developed which are able to withstand the rough conditions in tunnels. The microphones were subjected to comprehensive splashing water and ageing tests, the results of which were validated by acoustic measurements.

Features of the tunnel microphones
- Linear frequency response
- Resistance to temperature, dirt and corrosion
- Protection against splashing water and water jets
- Simple mounting, maintenance and cleaning

Hydrophobic dust-proof membranes provide additional protection against ingress of water and dust. Despite these protective characteristics, the membrane is acoustically transparent across the entire frequency range. The membranes are fitted in protective caps and can be easily replaced during periodic maintenance.

Incident detection involves several steps. Abnormal sounds are first distinguished from normal tunnel sounds for each microphone channel. The machine learning method used models normal conditions and detects any deviation from them. This enables the system to detect abnormal and unknown sounds.

Alert classes currently detected:
- Crash and tyre burst
- Door banging
- Car horn
- Tyre squealing
- Voices and shouts

The AKUT system can be connected to each tunnel control centre and traffic management system both using a standardized or proprietary interface. All of the monitored information is transmitted to the control centre, which is also responsible for system control.
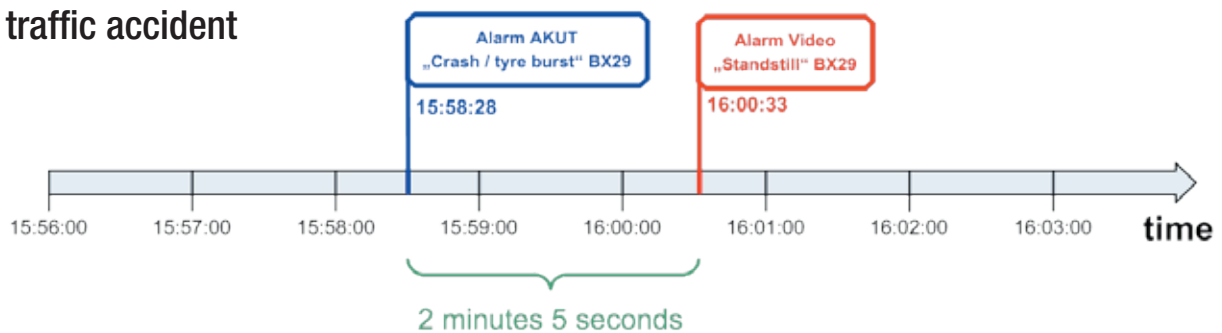
During maintenance, individual microphones or tunnel tubes or even the entire system can be set to maintenance mode.
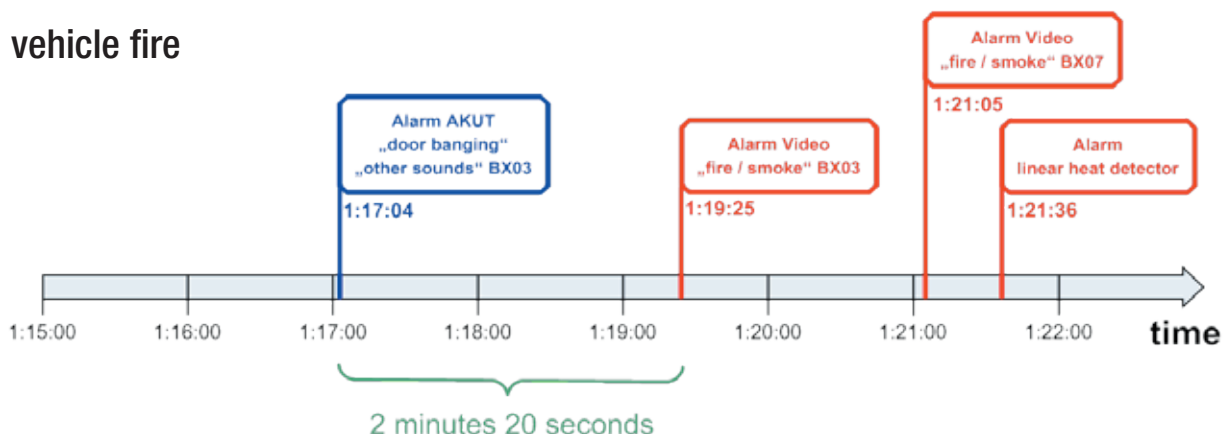
The respective audio signal is retrieved from the alert log and played back over the loudspeaker in the control centre. The dialog box also allows the user to start live audio streams from a specific microphone to provide the tunnel operator with a real-time overview of the current situation in the tunnel.

Examples for incidents & alarms

traffic accident

Alarm AKUT
„Crash / tyre burst" BX29
15:58:28

Alarm Video
„Standstill" BX29
16:00:33

2 minutes 5 seconds

vehicle fire

Alarm AKUT
„door banging"
„other sounds" BX03
1:17:04

Alarm Video
„fire / smoke" BX03
1:19:25

Alarm Video
„fire / smoke" BX07
1:21:05

Alarm
linear heat detector
1:21:36

2 minutes 20 seconds

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