Automatic Incident Detection

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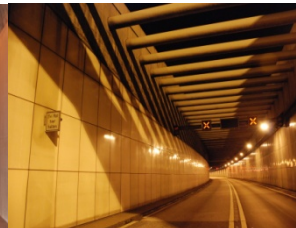
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Content

Motivation

Frame conditions at the Elbtunnel

Field Test - Involved Systems

Field Test - Results

Actual Project Status

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Motivation

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One Requirement of the RABT 2006 for the safety upgrade of the Elbtunnel

**was to equip the four Tubes
with a Traffic Monitoring System
for a quick and reliable Incident Detection every 300 m ...**

**Scource: RABT 2006 page 29, chapter 5.3.2 Basic Equipment
(German Guidelines for Equipment and Operation of Tunnels)**

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But which system ??

RABT gives no specifications or detailed requirements

To do:

$\Rightarrow$ **Market Analysis**

$\Rightarrow$ **System Analysis**

$\Rightarrow$ **Field Tests**

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Frame conditions at the „Elbtunnel"

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4 tubes in operation

- Surveillance 24 hours / 7 days
- Technical staff, Police and Fire Brigade
- Manual
  incident detection by
  video monitoring
  with 72 Monitors

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Geometrical conditions

Old tubes 1st to 3rd

- Length ca.   2,800 m
- Clear height   4.5 m
- Lane width   3.50 m
- Bright walls
  out of white ceramic tiles

Newer 4th Tube

- Length ca.   3,100 m
- Clear height   4.85 m
- Lane width   3.75 m
- Hard shoulder width 2.00 m
- Grey walls
  out of facing concrete

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Traffic Volumes (during tests in the first tube 2007)

Weekly Time Variation Curve with a peak of
48,000 veh./day on 2 lanes – Thursday

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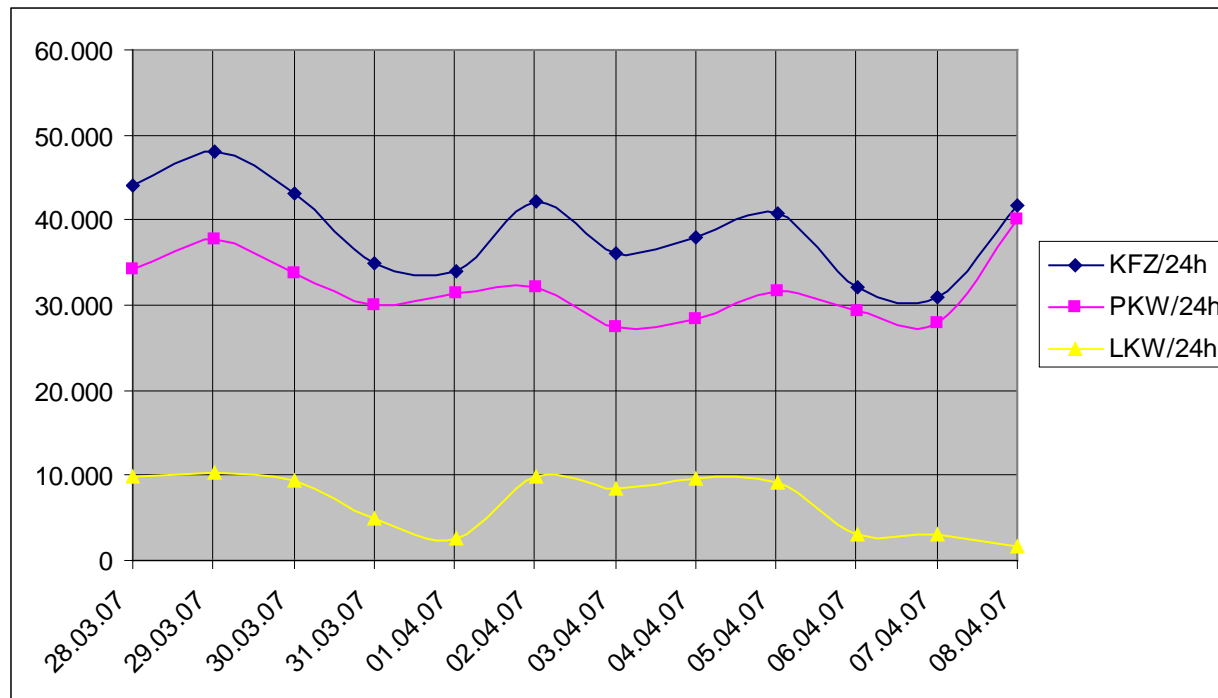
What traffic incidents should be detected?

- **Traffic disturbance or congestion**

- **Stopped vehicles**

- **Standstill traffic as an indicator for an accident**

And nice to have

- **Short-term prediction of congestion to react proactive**

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Field Test
Involved Systems
(in 2007)

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After an inquiry on the market two system suppliers were willing to support a field test

- **Video technology system:**
  Traficon VIP/SYS System with VIP-T Modules (Belgium)

- **Induction loop technology system**
  ave Aachener Verkehrs- und Informationstechnik GmbH with the product MAVE®-tun

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Traficon VIP/SYS System with VIP-T

Edge-based picture analytics with promised detection of:

Traffic events
- Stopped vehicle
- Speed drop
- Levels of service
- Wrong-way drivers
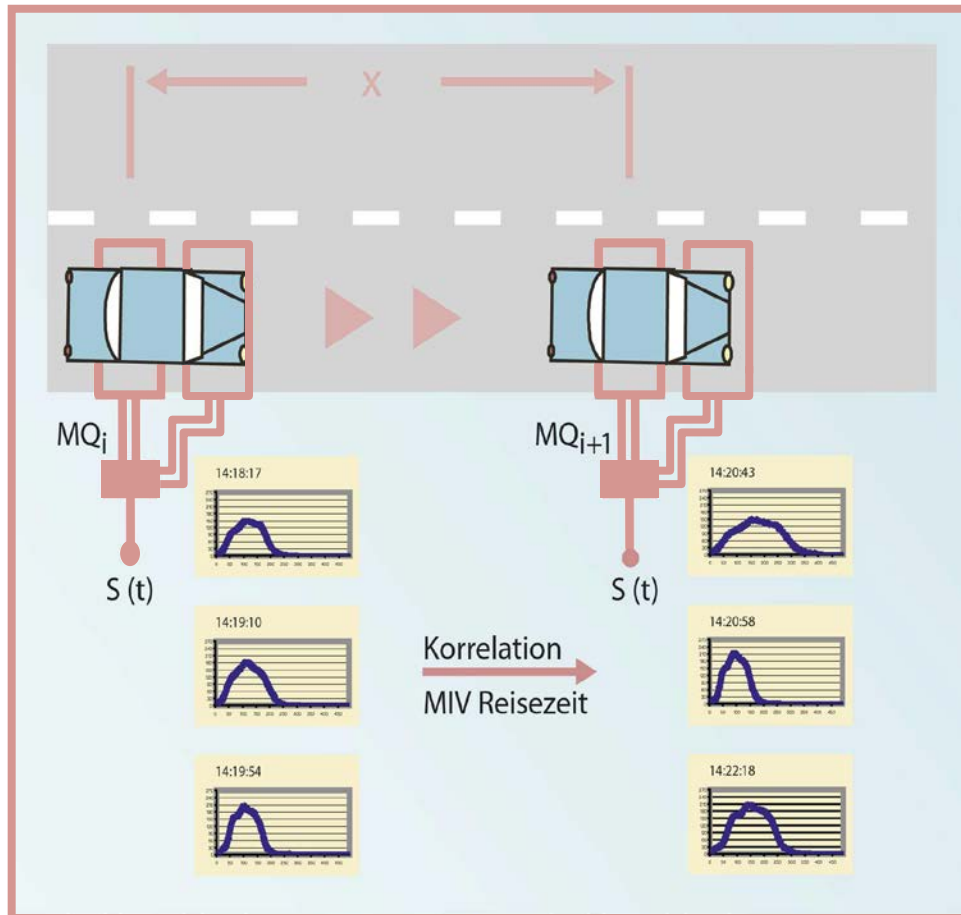- Traffic congestion
- Under speed

Non-traffic events
- Smoke in tunnel
- Pedestrian
- Fallen object

Technical alarms
- Camera tampering
- Image quality

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MAVE®-tun Induction Loop Technology

The inductive Loops create detuning curves of each passing over vehicle.
With correlation analyses the single vehicle can be identified at the next detection module with its own characteristic detuning curve

Advantage according to normal loops is the possibility of section analyses not only local analyses on a cross section

(MAVE®-tun) from ave Verkehrs- und Informationstechnik GmbH

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Dynamic Fundamental-Diagrams
Analysing the level of service (LOS) and
the disturbance in the traffic flow on a section

Fundamentaldiagramm am 31.03.2007 (lokal MQ-1)
(08:31 - 08:35)
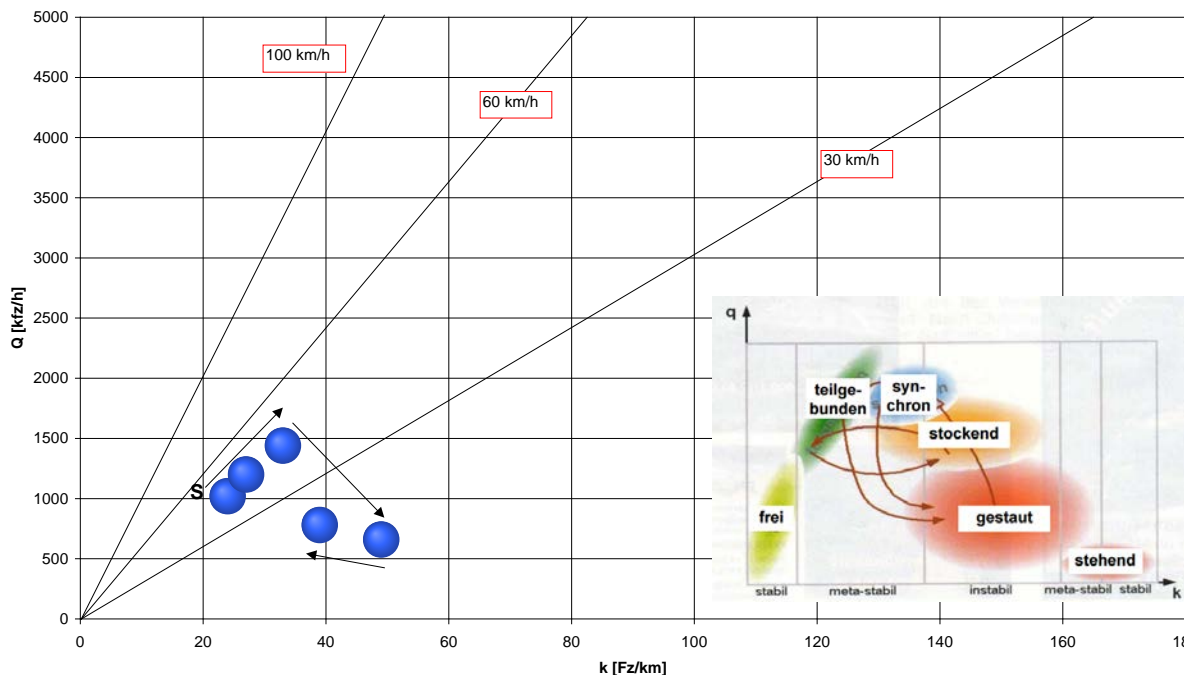
Fundamentaldiagramm M1, 31.03.2007, 8:31 – 8:35 Uhr

Continuously monitoring the traffic status (every 5 to 15 seconds) with analysing the trend of

- Traffic Volume
- Traffic Density
- Speed

Traffic quality areas of FD

- Free flow
- Bounded traffic
- Synchronized flow
- Slow moving traffic
- Congestion
- Standstill

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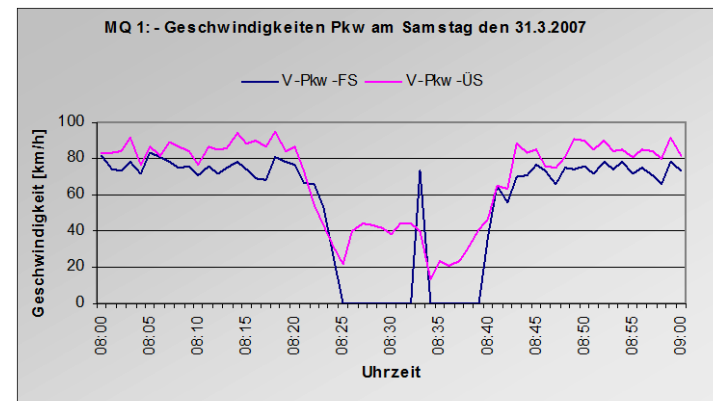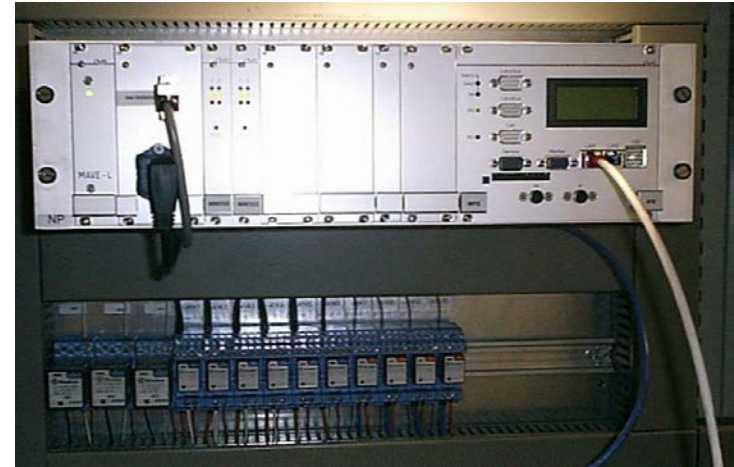Brücken und Gewässer
Hamburg

MAVE®-tun Induction Loop Technology

Used modules

– Traffic data,

– Traffic flow analysis,

– Incident detection

Promised detection of traffic events:

– **Local traffic data at the loop**

  – Over- / under speed vehicles

  – Wrong-way drivers

– **Section traffic flow by analyses of traffic volumes and driving time**

  – Level of service / traffic quality

  – Speed drop / congestion

  – Disturbance in traffic flow

  – Break-down / stopped vehicle

  – Traffic at a standstill

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Test Track

- East tube in north direction with one-way traffic on two lanes
- Inclining section (3,5%)
- Section with frequent congestion

Messpunkte im Feldversuch

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Monitored Sections (distance 200-300m)

Four Inductive Loop cross sections

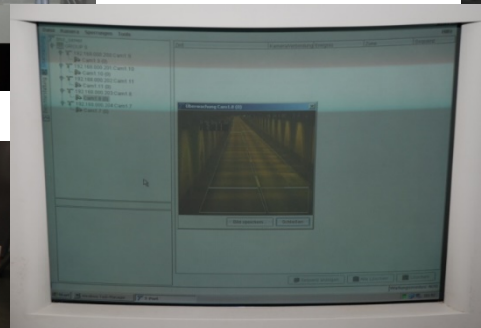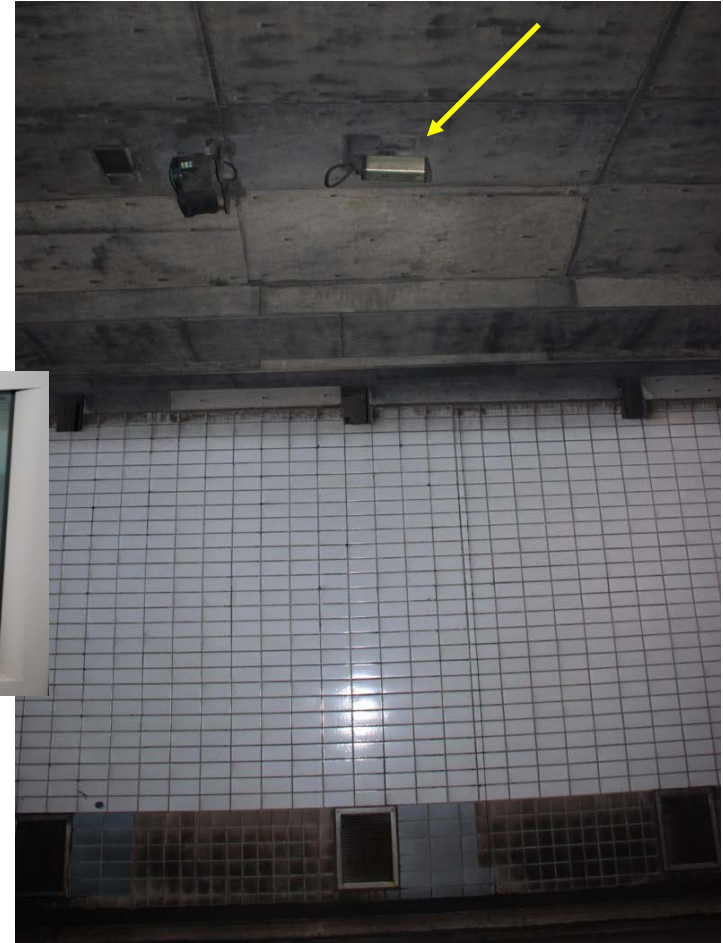| Detektion	Streckenkilometer BAB A7	Abstand
Induktionsschleife 1.6	157.433.250	0
Induktionsschleife 1.7	157.091.000	342.250
Induktionsschleife 1.8	156.878.900	212.100
Induktionsschleife 1.9	156.563.580	315.320

Five Cameras

Detektion	Streckenkilometer BAB A7	Abstand
Kamera 07	157.739.600	0
Kamera 08	157.437.950	301.650
Kamera 09	157.133.500	304.450
Kamera 10	156.837.200	296.300
Kamera 11	156.616.700	220.500

Loop 1.7 was not considered cause of bad values
(reason: adverse position of reinforcement)

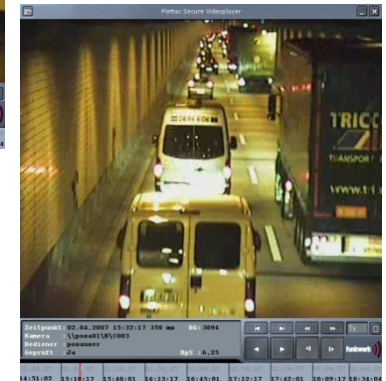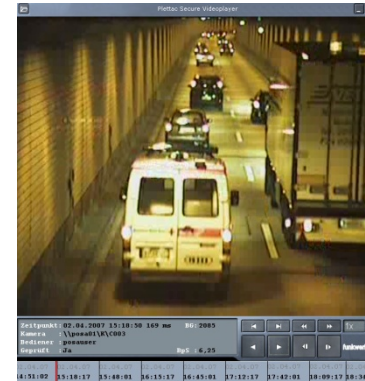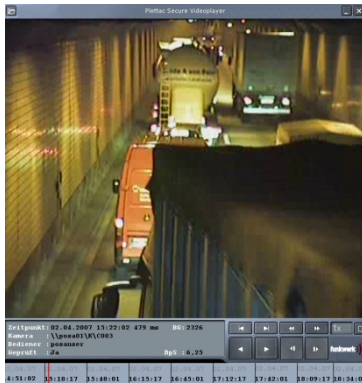**Süden**   **Norden**

157.740   302m   157.438   304m   157.134   296m   156.837   221m   156.617

Kamera 7   Kamera 8   Kamera 9   Kamera 10   Kamera 11

Fahrtrichtung
=>

=>

Schleife 1.6   Schleife 1.7   Schleife 1.8   Schleife 1.9

157.433   342m   157.091   212m   156.879   315m   156.564

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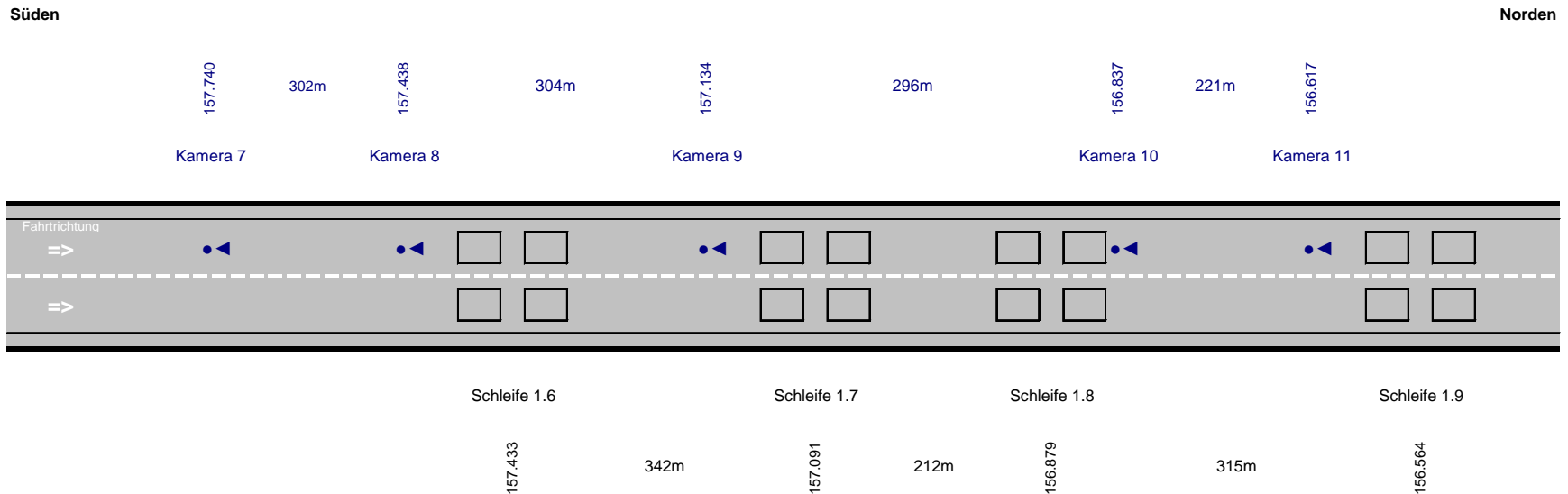
Video Installation

- Device to convert analogue to digital Signals / Camera Height 4.5m

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Problems with Video Installation
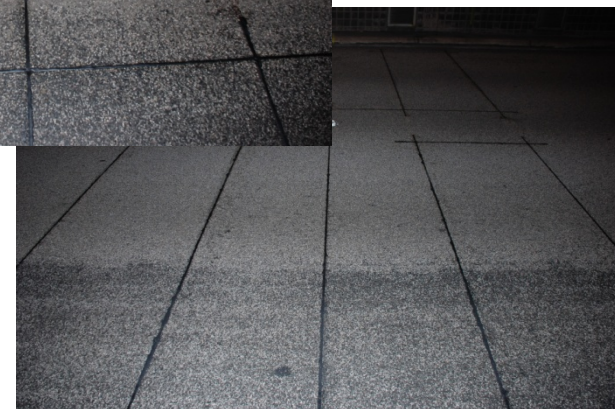
Hidden Object Areas (occlusion of trucks)

Soiled Lens in the near of the front portals

Problems with Loop Installation

- Adverse position of reinforcement
- Pavement deck with steel girder to fix the joints

= > Pre-Measurements to find the best installation place had to be done

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Field Test - Results

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Summery (2007)

	Automatic Detection with Video Technology (System VIP-T "Traficon")		Automatic Detection with Inductive Loops and Correlation Analysis (System Mave-TUN von "ave")	
Investment Costs	o	1.950.000 €	o	1.800.000 €
Maintenance Costs	-	Costs for maintenance, cleaning and energy	+	Costs for maintenance, cleaning and energy
Traffic Flow Analysis with Trend Forecast	-	Installation height causes hided areas	+	Detailed traffic flow analyses with dynamic fundamental diagrams
Stopped Vehicle	+	**Quick reliable detection except in hidden areas**	+	**light delayed reliable detection , trend analysis possible**
Wrong Driver	+	**Quick reliable detection**	+	**Quick reliable detection**
Fallen Objects	+	Objects have to be bigger than 50cm	-	Only if traffic flow reacts clearly
Pedestrian	+	Quick reliable detection except in hidden areas	-	Only if traffic flow reacts clearly
Smoke	+	Quick reliable detection	-	Only if traffic flow reacts clearly
Truck on overtaking Lane	-	Not reliable detection of vehicle type	+	reliable detection of vehicle type
Slow Driving	o	Imprecise detection of speed	+	**Precise detection of speed**
Too fast driving car	o	Imprecise detection of speed	+	Precise detection of speed
Fire load density	-	**No Detection in smoked area**	+	**Traffic detection is possible in fire area**
Number of Persons in Smoke area	-	No Detection in smoked area	+	Traffic detection is possible in fire area

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Current Project Status

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Elbtunnel System Requirements

- **Important Interfaces to:**
  - **Traffic Control System**
  - **Operation Control System**
  - **Video Control System**
  - **Traffic Management System**
  - **Statistic Database Application**

- **The Algorithms have to consider:**
  - **Traffic Operational Status (One-Way or Contraflow Traffic)**
  - **Regulations as Speed Limits, No Passing allowed**
  - **Closed Lanes, End of Closed Lanes,**
  - **Emergency Stops and Height Control**
  - **Detected Fires, Maintenance situations, ...**

- **Traffic Flow Analysis should be able to detect trends for proactive Traffic Control Measurements to avoid potential Accident Situations**

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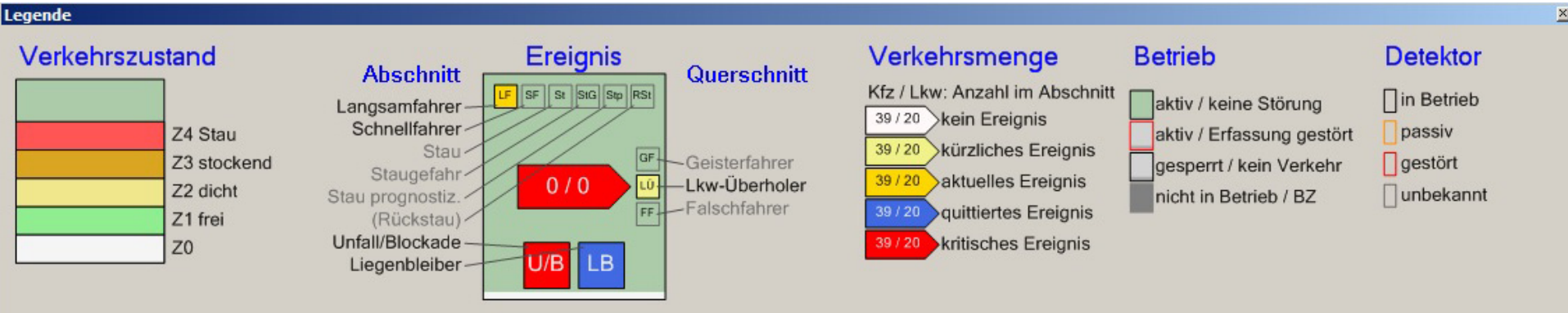## A7, Elbtunnel – Tunnel operation and traffic telematics

Current Graphic User Interface
under Construction

Filling Level Indication,
Driving Direction Arrows with Number of Cars / HGV
Traffic quality based on dynamic Fundamental Diagrams
Incident (Local / Section)

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Legend of the Graphic User Interface (GUI)

Legende

Verkehrszustand
- Z4 Stau
- Z3 stockend
- Z2 dicht
- Z1 frei
- Z0

Abschnitt — Ereignis — Querschnitt
- Langsamfahrer (LF)
- Schnellfahrer (SF)
- Stau (St)
- Staugefahr (StG)
- Stau prognostiz. (Stp) (Rückstau) (RSt)
- Unfall/Blockade (U/B)
- Liegenbleiber (LB)
- 0 / 0
- GF — Geisterfahrer
- LÜ — Lkw-Überholer
- FF — Falschfahrer

Verkehrsmenge — Kfz / Lkw: Anzahl im Abschnitt
- 39 / 20 kein Ereignis
- 39 / 20 kürzliches Ereignis
- 39 / 20 aktuelles Ereignis
- 39 / 20 quittiertes Ereignis
- 39 / 20 kritisches Ereignis

Betrieb
- aktiv / keine Störung
- aktiv / Erfassung gestört
- gesperrt / kein Verkehr
- nicht in Betrieb / BZ

Detektor
- in Betrieb
- passiv
- gestört
- unbekannt

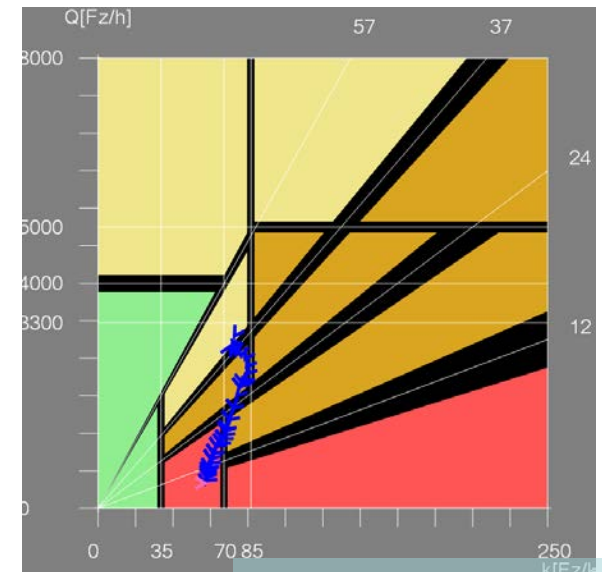| Filling Level Indication and LOS	Incident in the Section	Incident Local at inductive loop	Traffic Volumes	Operational Status and Technical Faults
- Congestion - Slow Traffic - Bounded - Free Traffic - No Traffic	- Slow Driving Car - Too Fast Driving Car - Congestion - Disturbance in Traffic Flow - Predicted Congestion - Congestion back into tunnel - **Blockade / Accident red** - **Stopped Vehicle red**	- Ghost Driver - Truck is overtaking - Driver on closed Lanes	- Total Vehicles - No. of Trucks **Colour of Incident Status** - No Incident - Recently Inc. - Actual Inc. - Quitted Inc. - Critical Inc.	- Operating active - Non Operating passive - Disturbed - No traffic - Others

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Dynamic Fundamental-Diagrams to detect the traffic quality (LOS)

Thresholds have to be calibrated

Bounded or Synchronized Flow

Slow Down Traffic

Free Flow

Congestion

Volume /h

Speed

Hysteresis Area

Density /km
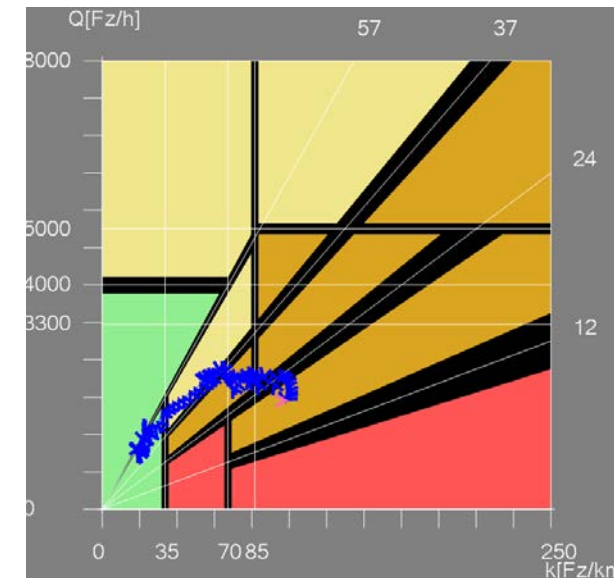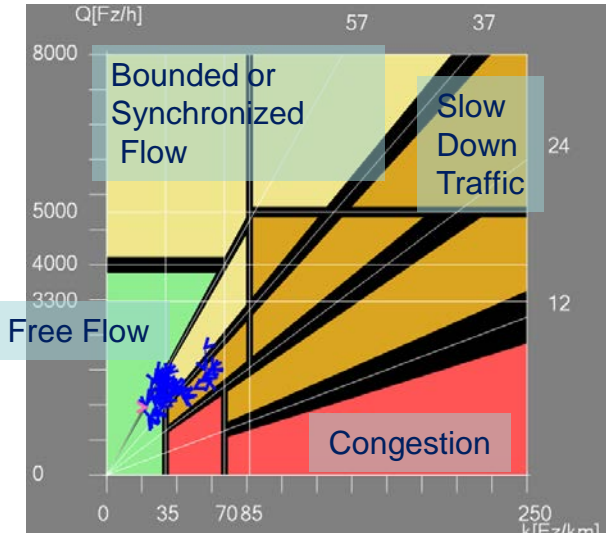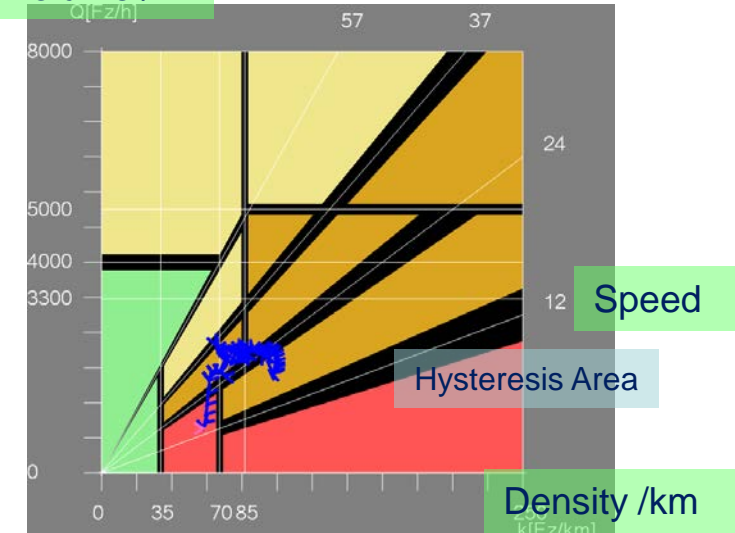
Traffic Break Down

At the moment we are working on

- **the implementation of the interfaces to the video monitoring system and to the tunnel control system**
- **optimizing the Graphic User Interface (GUI)**
- **optimizing of the detection parameters**

So next year we will be able to present more …

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Thank you for attention