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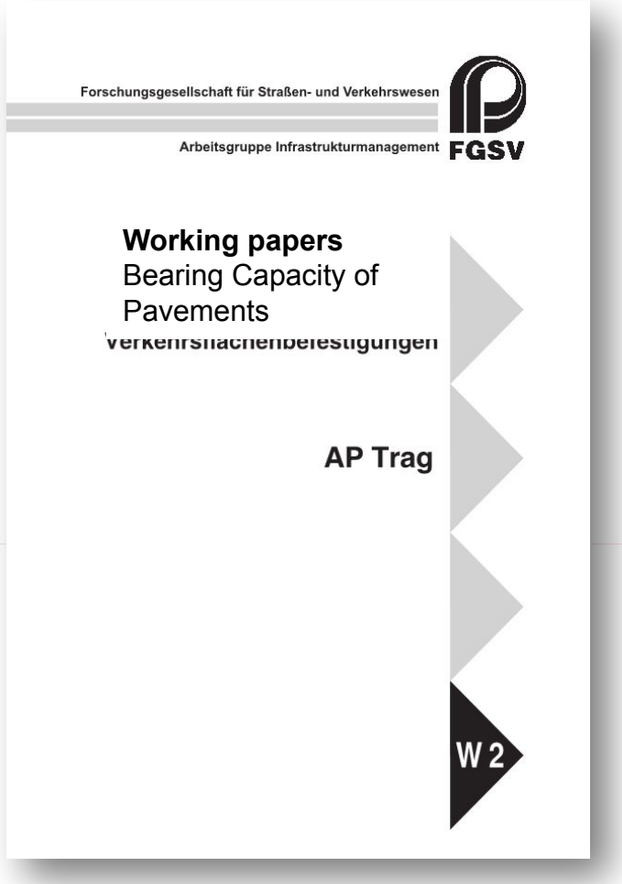
Status of the introduction of traffic-speed bearing capacity measurements in Germany

11th International Conference
Silesian Road Forum, Wisla
21.04.2026 | Dr. Dirk Jansen | BASt

Bearing Capacity Measurements in Germany

No obligations for bearing capacity measurements but a set of standardisation papers available



Structure

Part A Measuring systems

Part B Device description, measuring procedure

- B 1 **Benkelman Beam**
- B 2.1 **Falling Weight Deflectometer (FWD)** - asphalt construction
- B 2.2 **Falling Weight Deflectometer (FWD)** - concrete construction
- B 3 **Deflectograph Lacroix**
- B 4 **Curviameter**
- B 5 **Traffic Speed Deflectometer Devices (TSDD)**

Part C Evaluation and assessment of the measurement results

- C 1 **Benkelman Beam**
- C 2.1 **Falling Weight Deflectometer (FWD)** - asphalt construction
- C 2.2 **Falling Weight Deflectometer (FWD)** - concrete construction
- C 3 **Deflectograph Lacroix**
- C 5 **Traffic Speed Deflectometer Devices (TSDD)**

Part D Standardisation of bearing capacity measurement data

TSD history in Germany

First trials

1st generation TSD

- 2006: Measurements on BASt indoor test road
- 2008: Measurements on different in situ pavements

New interest

2nd generation TSD

- 2012: 300 km of measurements on different pavements
- 2014: 50 km comparative measurements on highway section
- 2015: Start of R&D project – focus: repeatability

Commitment

BASt TSD - MESAS

- 2016: funding application
- 2017: contract signings
- 2018: delivery

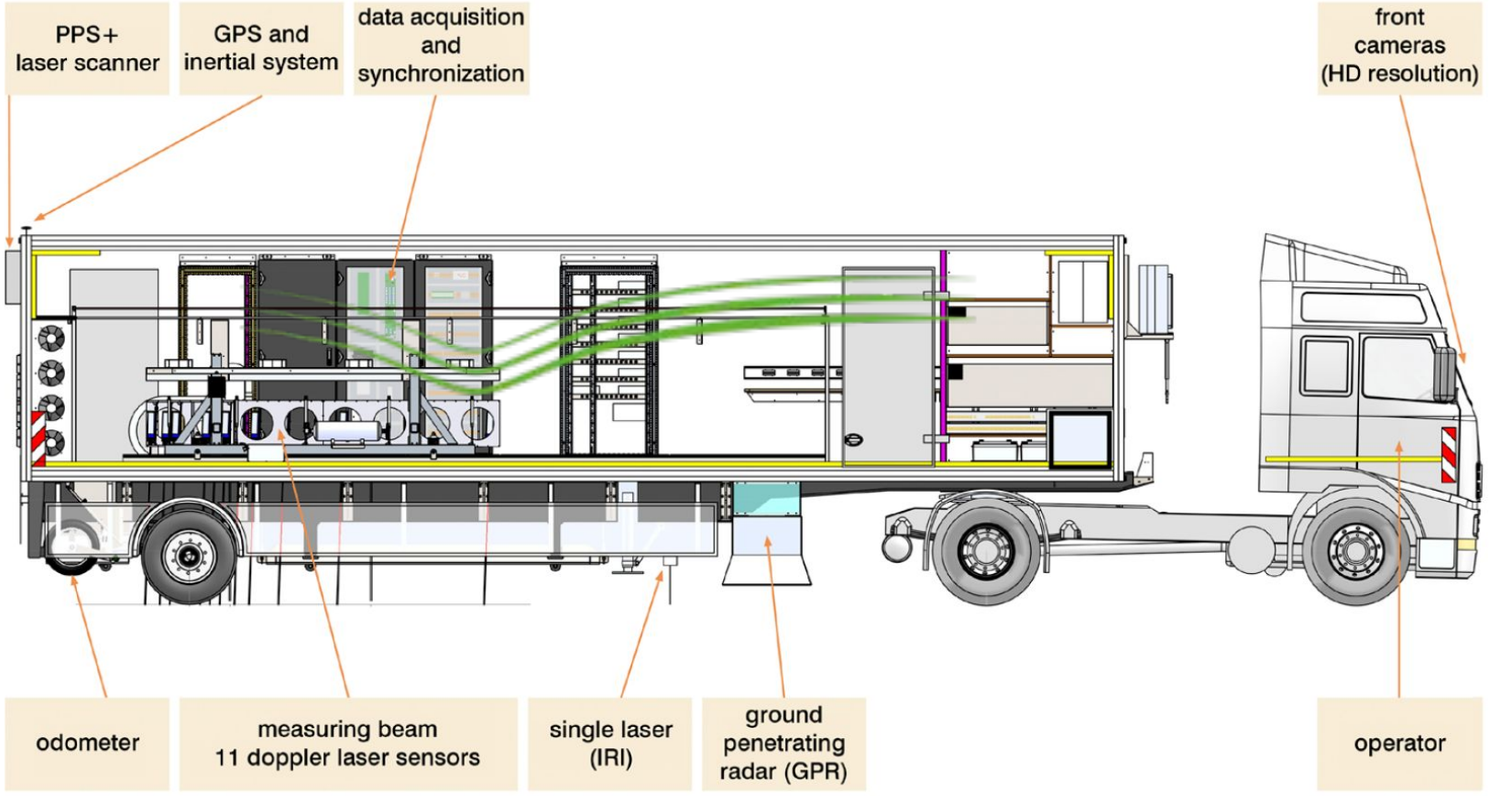
Our device

MESAS

TSD with additional components

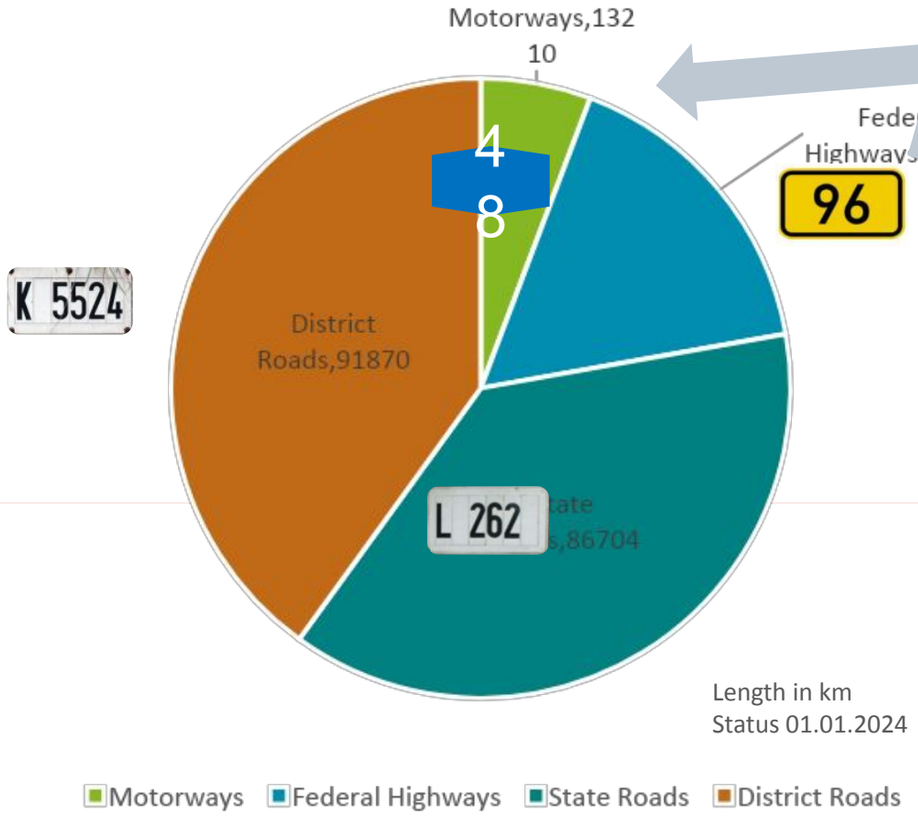
In operation since 2018.

> 30,000 km measured in Germany, Austria, Netherlands, France, Belgium, Denmark



Our role

Preparation for the implementation of TSDD
(quality standards, normalization, assessment, etc.).



BASt

Research Institute – not a road operator!

On behalf of the Federal Ministry of Transport – but also with a sense of responsibility for all types of road networks

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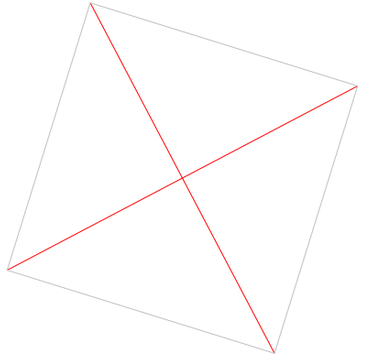
Introduction of the TSDD technology

What is needed for the introduction of a new technology?



- Operational issues

  Security concepts, infrastructure, human resources, etc.

- Clarification of influencing factors

  Speed, Load, Temperature

- Assessment procedure

  Asphalt pavements, Concrete pavements

- Quality assurance

  Self-monitoring, external monitoring, comparative measurements

Speed normalisation

Objective

- TSD claims to provide valid data at speeds greater than 40 km/h – Reason: Viscoelastic effects of asphalt
- High traffic density and narrow roads often forces the TSD to slow down!
- Investigation programme: Parameter study & Field tests

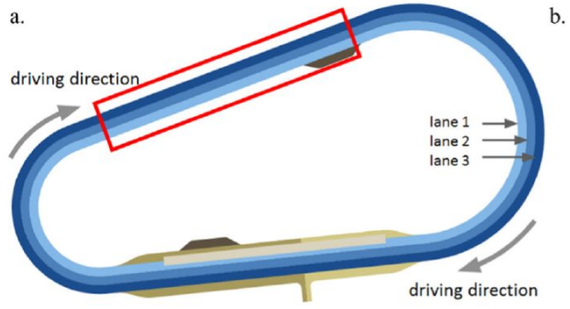
Eleventh International Conference on the Bearing Capacity of Roads, Railways and Airfields, Volume 3 – Hoff, Mork & Saba (eds)

Influence of driving speed on Traffic Speed Deflectometer data – Field test and parameter study

C. Podolski
Bundesanstalt für Straßenwesen (BASt), Bergisch Gladbach, Germany
M. Čičković
HELLER Ingenieurgesellschaft mbH, Darmstadt, Germany

Result

- no significant impact at real world conditions
- **TSD operation between 20 and 80 km/h works fine!**



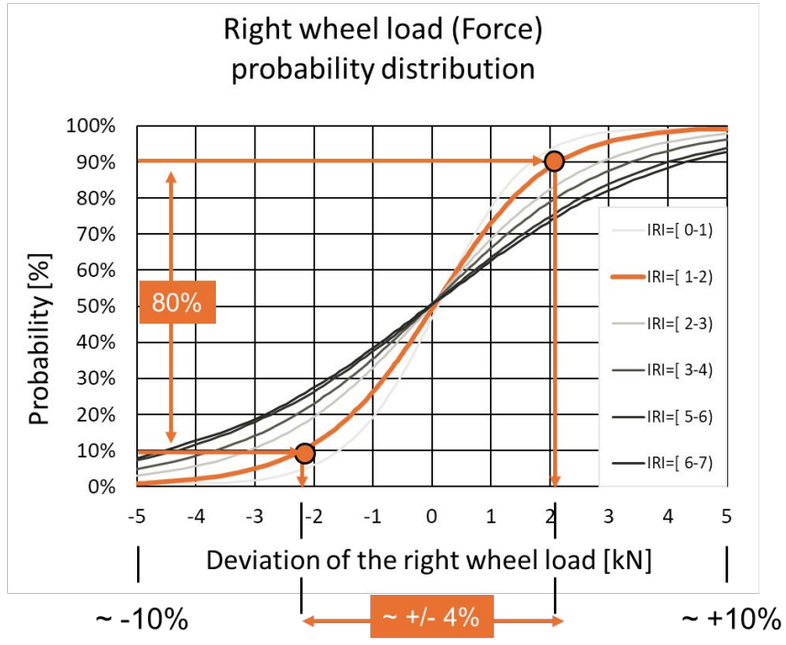
https://www.atc-aldenhoven.de/de/strecken.html

[1] C. Podolski & Čičković, M., 2022. Influence of driving speed on Traffic Speed Deflectometer data – Field test and parameter study, Trondheim: Taylor & Francis.

Load normalisation

Objective

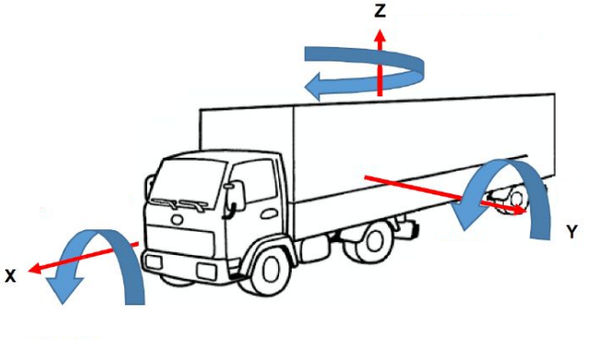
- Impact of dynamic loading?
- Load normalization approach?



Results

- Due to characteristic of road and TSD (geometry, chassis damping) no significant impact on motorways and federal highways (+/- 4%)
- **In case load normalization is needed anyways, simple algorithms can be used**

$$D_{onorm} = D_{0orig} - (p_1 * (\text{load} - \text{reference}))$$

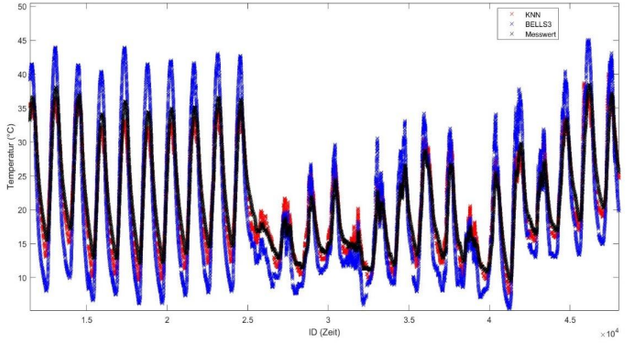


Temperature normalisation

Calculation of internal road temperatures

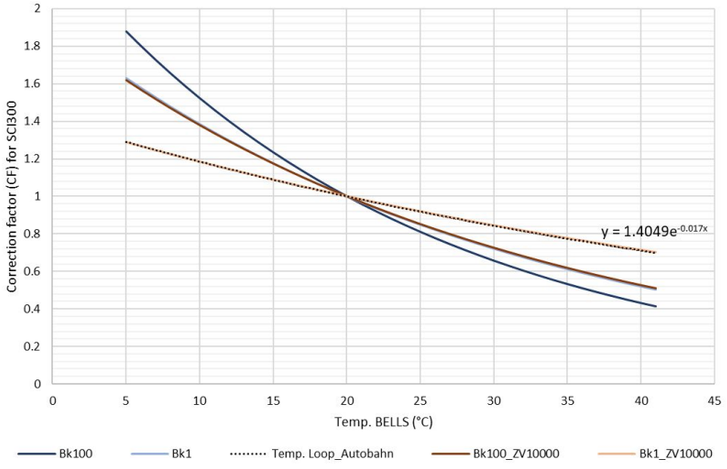
- ANN Model

  Input: Surface temperature (TSD), Time (TSD), mid air temperature previous da
  (weather station)



Empirical temperature normalisation approach *(version 1)*

- 70 measurements taken at various temperatures along round circuit (~270,000 data points) were analysed



Physical-mechanical approach *(version 2)*

- taking into account asphalt thickness, base course type, condition and age

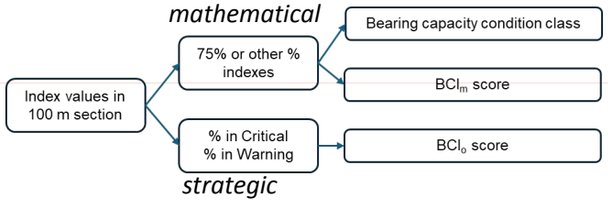
References:
- Rahimi Nahoujy, M., Jansen, D. (2025). Ermittlung von Asphaltkörpertemperaturen mittels KI. in Straße und Autobahn, Heft 10.2025. Kirschbaum Verlag. https://doi.org/10.53184/STA10-2025-4
- Kalantari, M. & Jansen, D, 2024. Temperature Normalisation of TSD measurements, Washington: TRB Annual Meeting.
- Kalantari, M., Rahimi, M. & Jansen, D., 2024. Update on Temperature Normalization of TSD Measurements, Presentation, Bergisch Gladbach, DaRTS21 Meeting.

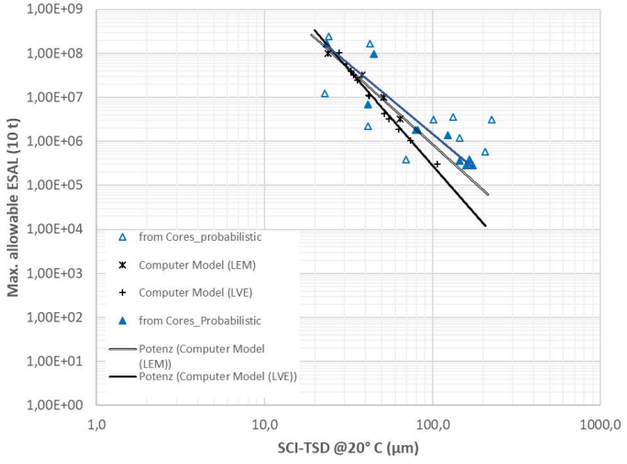
Assessment | Asphalt

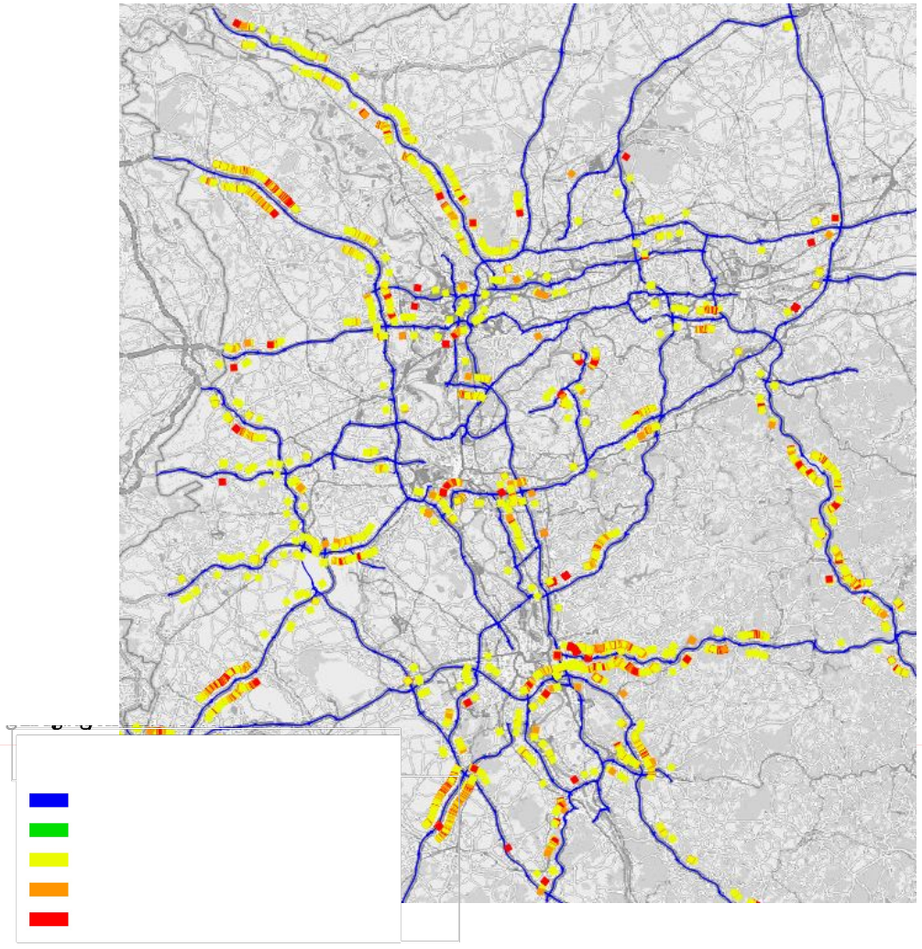
- Assessment model has been developed based on mechanistic pavement models.

example for German motorways:

SCI300 or SCI-TSD value	Condition Class
≤ 24	01. good
> 24 and ≤ 38	02. acceptable
> 38 and ≤ 51	03. suspicious
> 51 and ≤ 64	04. warning
> 64	05. critical







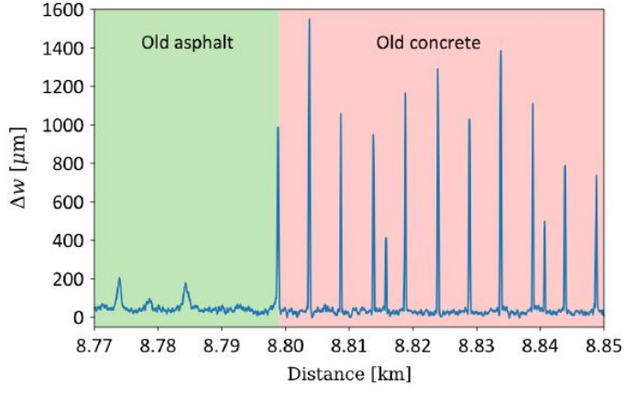
References:
- Pettinari, M., Baltzer, S., Kalantari, M. & Jansen, D., 2021. Development of simplified models to assess pavement structural condition on network level, Trondheim: Taylor & Francis
- *currently under development within the BEPROACT project https://beproact.nweurope.eu*

Assessment | Concrete

Under development

- more than 30% of motorways in Germany are concrete roads
- Initial tests have shown that joint movements can be detected and evaluated with the TSD
- Details will be clarified in R&D project

(data has [illegible] oject has started 2025)



Literature: Nielsen, C., Jansen, D.:"Measuring Joint Movement on Rigid Pavements using the Traffic Speed Deflectometer", Journal of Transportation Engineering, pat B. Pavements, ISSN 2573-5438, 2023

Quality assurance

Self-monitoring

- Approach under development:
  Evaluation and monitoring of the device's own status using machine operating parameters

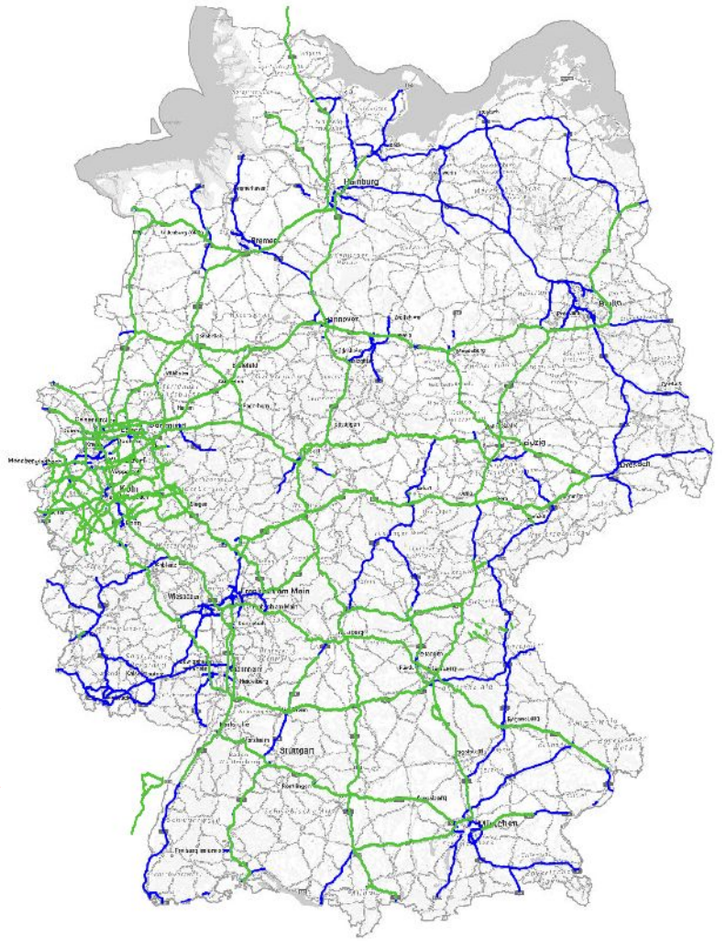
External monitoring

- Approach under development (joint effort):
  Comparative measurement design

Conclusions on research activities

- Operating conditions
  - Temperature
  - Axle load
  - Speed
- QC/QA
- Assessment and Data usage

The picture is getting clearer day by day!



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Thank you!

I look forward to the joint discussion.

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