



Viewing the railway through digital eyes

Maintenance planning at the Matterhorn Gotthard Bahn

Presentation overview

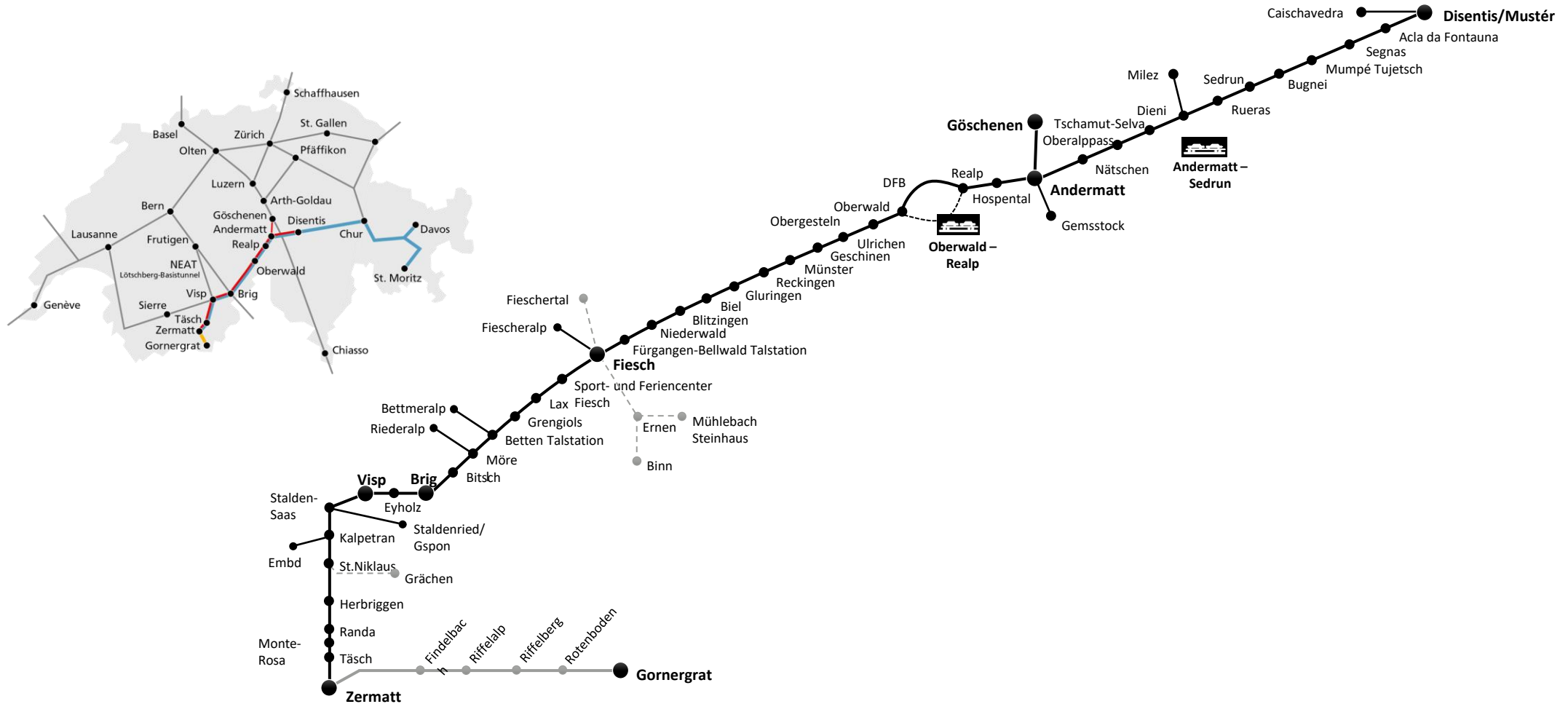
- Railway Overview
- Mainline
 - Geometry
 - Roadbed stiffness
 - Rail wear
 - Next steps
- Switches
 - Malfunction detection
 - Next steps

Railway Overview





MGB «Network»





Infrastructure

Quick facts

- 181 km track
- 246 Switches
- 47 Tunnels
- 35 Avalanche Sheds
- 170 Bridges
- 3'000 gross daily tons –
22'000 gross daily tons
- 3 Cantons (Wallis, Uri,
Graubünden)





Infrastructure

More Quick Facts

- Track
 - Meter gauge (3' 3³/₈"')
 - 179‰ Ruling Grade
 - Adhesion & rack railway
 - Tightest curves: ~80 m radius (21° of curvature)
- Top speed: 90 kmh (55 mph)
- Maximum axle weight: 16 t (15.7 t (US))







**Mainline
Track Geometry,
Roadbed Subsidence &
Rail Wear**

Mainline

Measurement Car

- External Consortium: «ARGE Fahrwegdiagnose»
- Two measurement campaigns per year (entire line)
 - Track Geometry
 - Rail Wear
- Subsidence Measurements every 5 years



Mainline

Track Geometry

- Measurements
 - Superelevation
 - Alignment (horizontal & vertical)
 - Gauge
 - Warp
- Algorithms
 - «Quality points»
 - «TUG TQI»

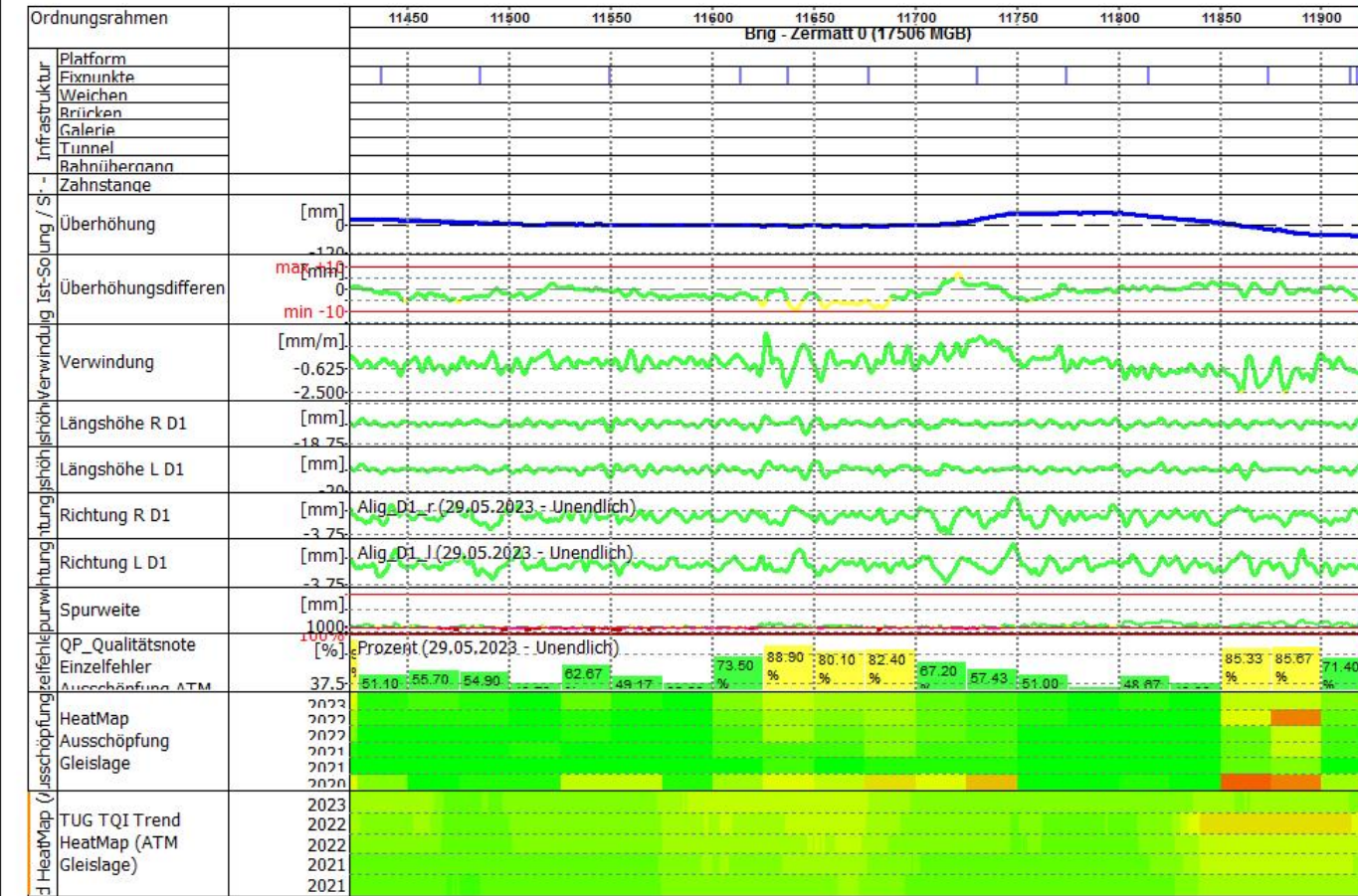


- Uses
 - Diagnosis of track «health»
 - Planning of tamping & lining

Mainline: Track Geometry

Analyse Gleislage ATM

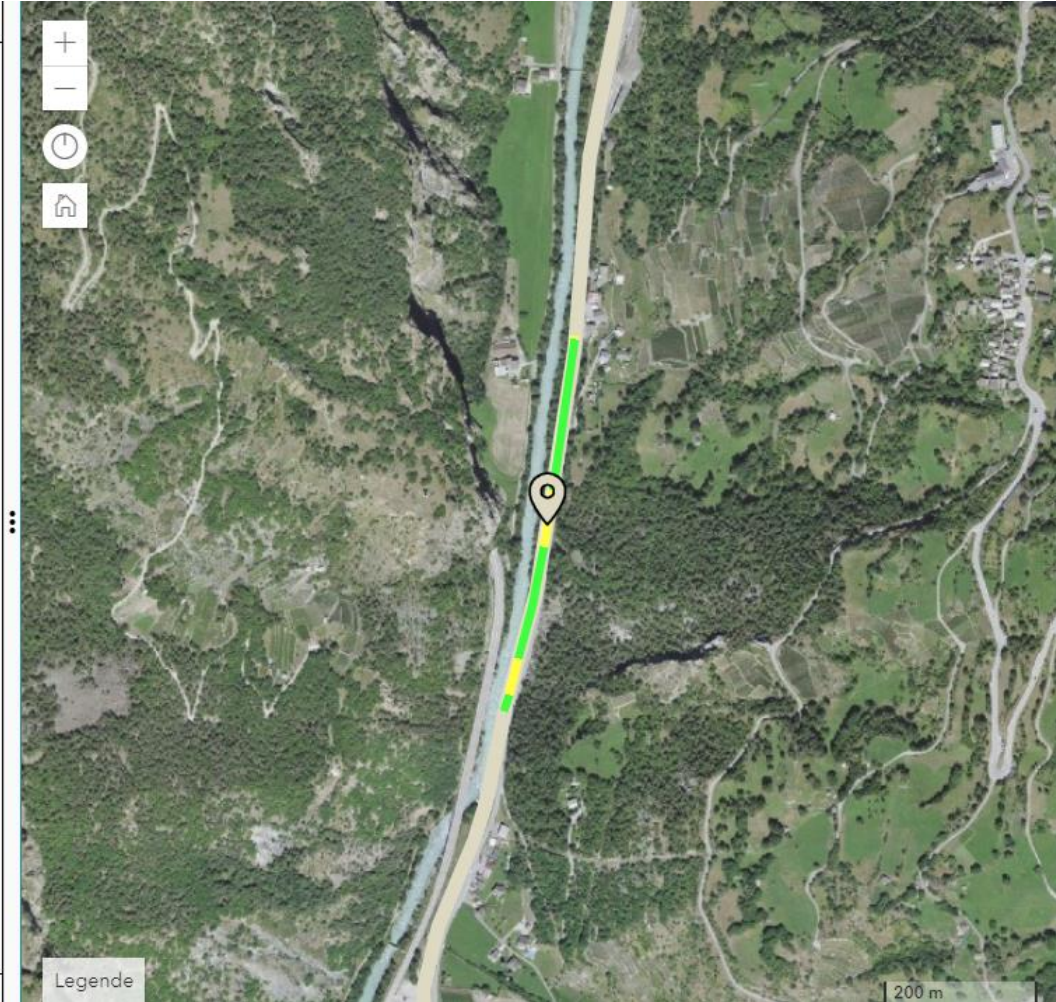
29.08.2023



Length 500.000 m

Offset: 2213.016 m

5 / 70



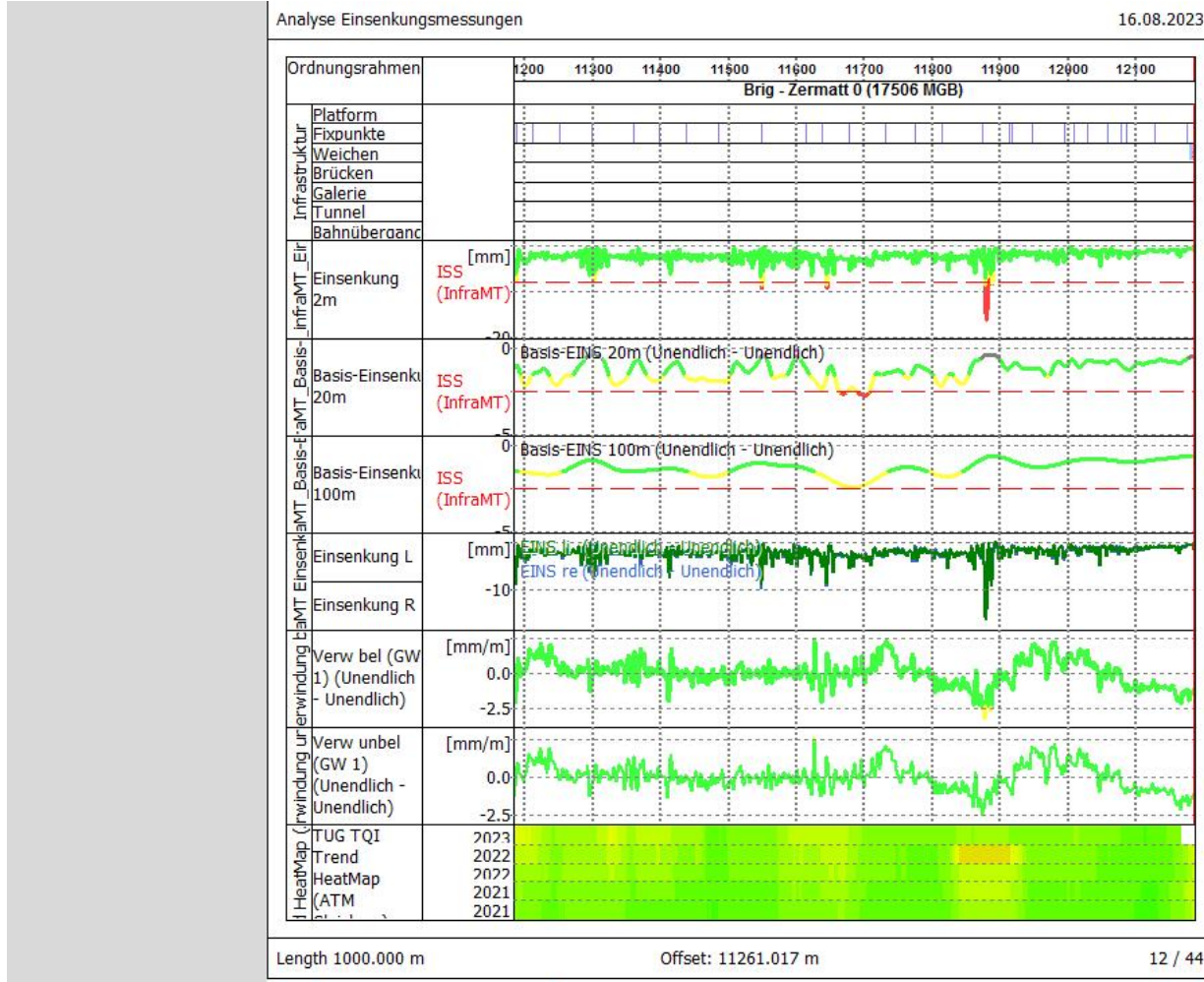
Mainline

Roadbed Subsidence

- Measurements
 - Deflection filtered over
 - 2 m,
 - 20 m &
 - 100 m
- Uses
 - Identification of mud pumping
 - Identification of excessive stiffness



Mainline: Roadbed Subsidence



Mainline: Roadbed Subsidence



Mainline Rail Wear

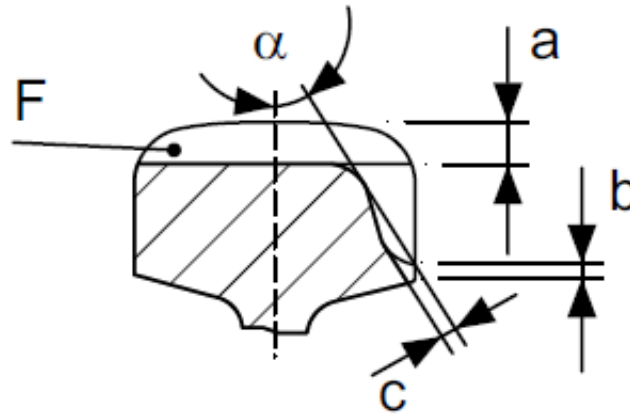
Measurements

- Rail Profile
 - Nominal
 - In-situ
- 5 parameters for wear from D RTE 22540 (see diagram)
- Longitudinal surface roughness

Uses

- Rail grinding / milling
- Rail replacement

Senkrechte und seitliche Abnützung

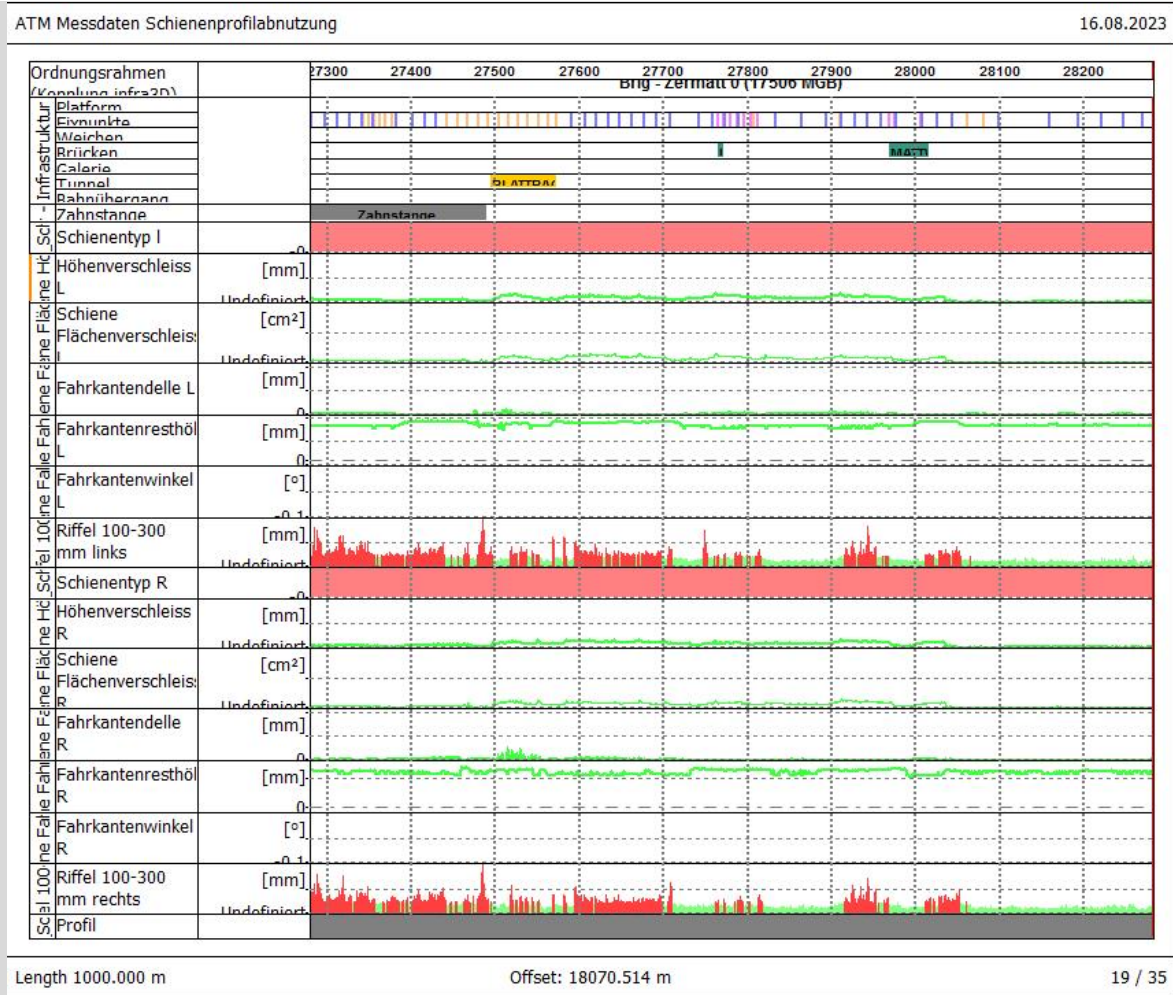


- Bemerkungen:
- Beidseitige Abnützung ist nicht zugelassen.
 - Bei gleicher Reduktion des Wx wie beim 46 E1 lässt das Profil 36 E3 infolge der tieferen Schwerachslage eine grössere senkrechte Abnützung zu.

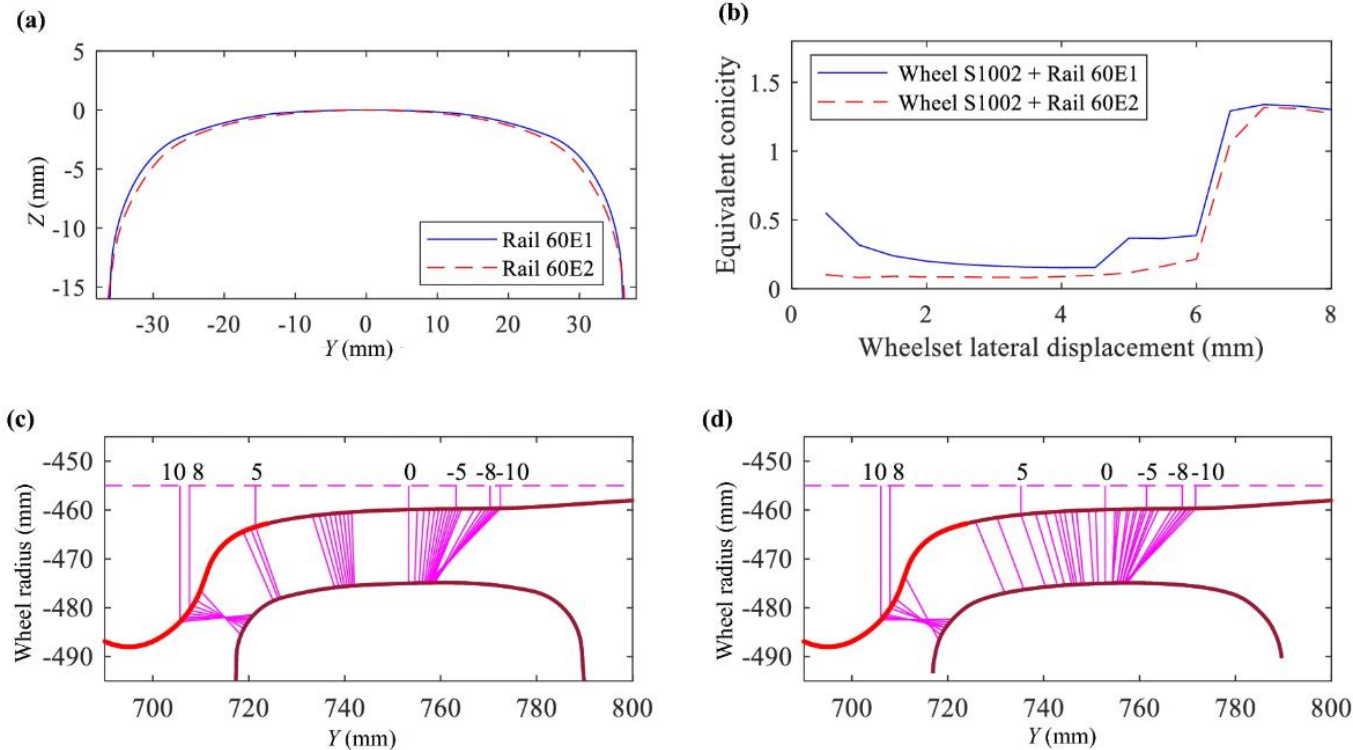
Abnützung	Mass	Profil 36 E3		Profil 46 E1		Profil 54 E2	
		HG	NG	HG	NG	HG	NG
Höhenverschleiss	a [mm]	6	13	5	13	6	15
Flächenverschleiss	F [cm ²]	5.0	8.0	5.5	9.0	6.0	10.5
Fahrkantenwinkel	α [°]	30					
Fahrkantendelle	c [mm]	2		2		2	
Fahrkantenresthöhe	b [mm]	1					

Verband öffentlicher Verkehr (VöV). 2011. Bern. D-RTE 22540: *Fahrbahnpraxis Meterspur und Spezialspur.*

Mainline: Rail Wear



Mainline: Next steps



Next Steps

- «Prioritised defect report»
- Improvements in the Rail cross-section detection
- Combination of rail profiles with wheel profiles

Yunguang, Y. et al. (2021). 'Railway wheel profile fine-tuning system for profile recommendation', *Railway Engineering Science*, 29, pp. 74-93.



Switches

Malfunction Detection

Switches



Switches

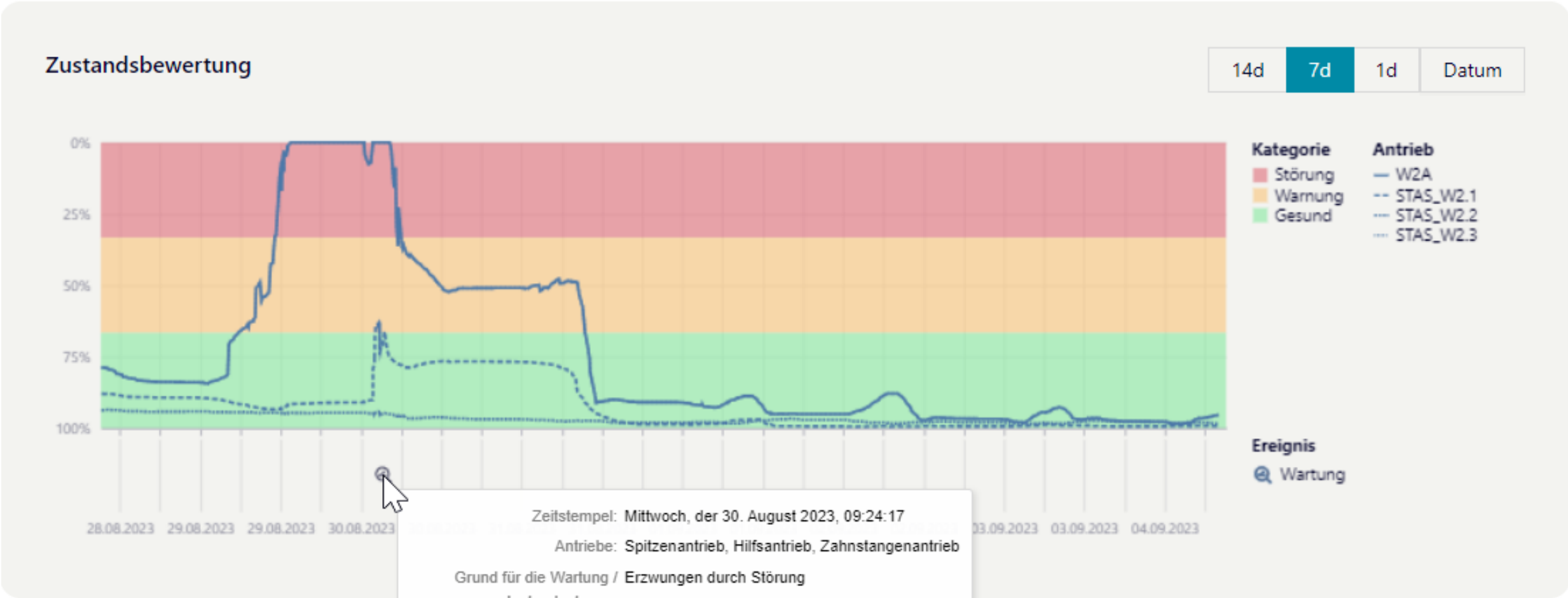
«Switch health»

- Colaboration with Siemens: SIDIS-W
- Sensors
 - Air temperature
 - Rail temperature
 - Switch heaters
 - Switch motor
 - Power drawn
 - Duration of throw
 - Precipitation
- Result: «Health score»

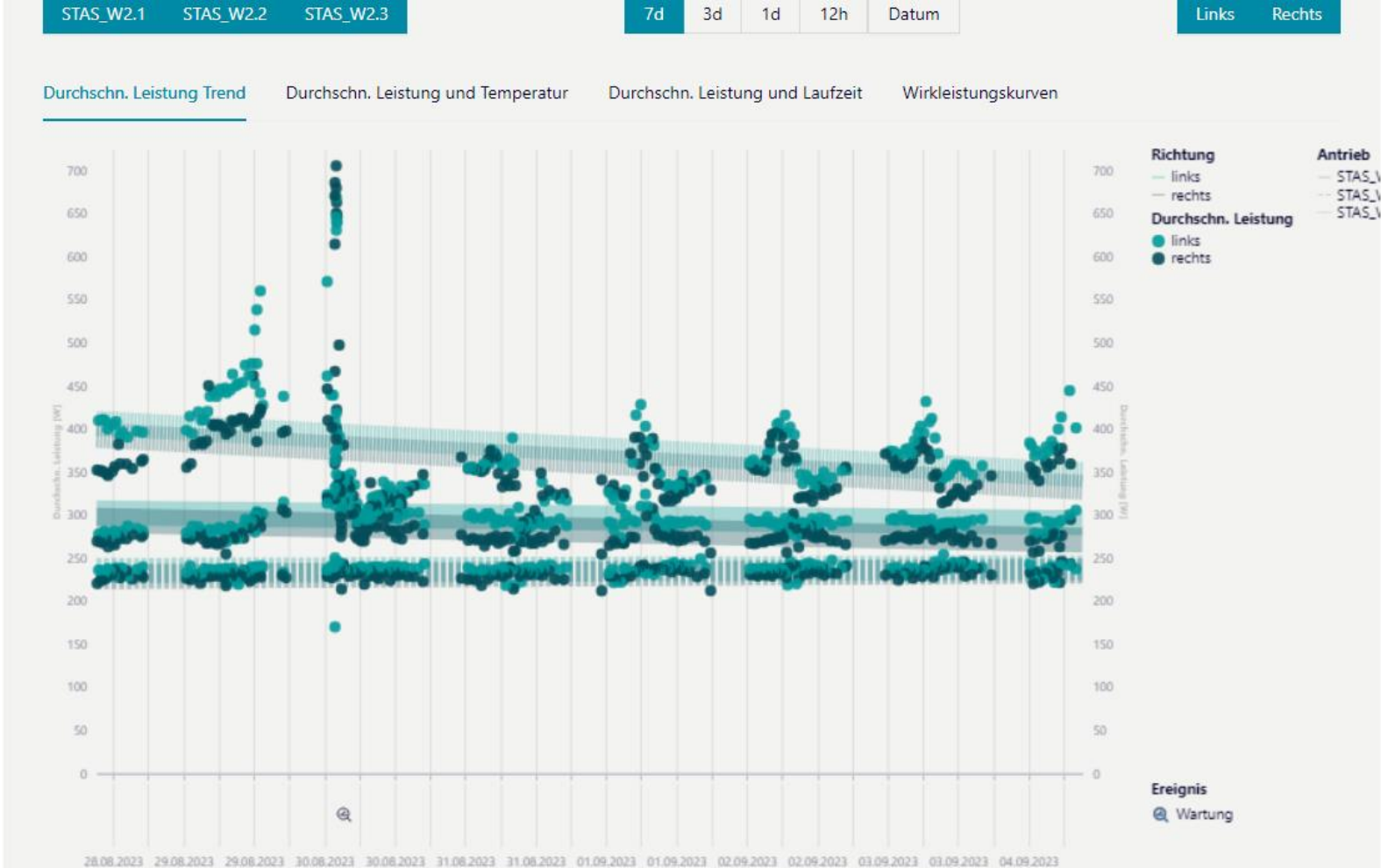


XKCD «Machine Learning», xkcd.com/1838/

Switches: Health Dashboard



Switches: Health Dashboard



Switches



Next Steps

- Health trend prediction
- Instalation on the entire network
- Gornergrat Bahn



Thank you for your attention!