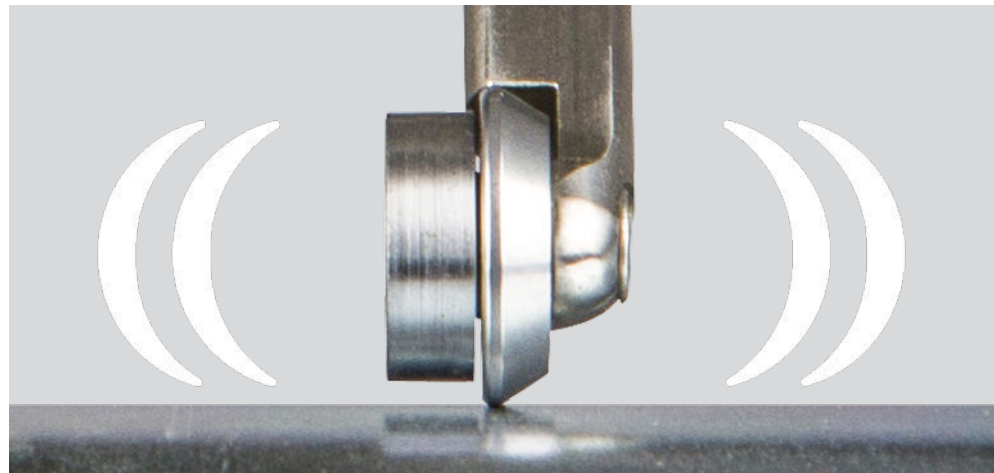
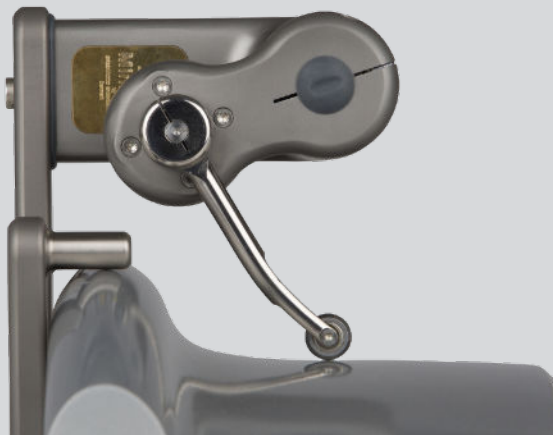


MUCH MORE THAN  
A MEASUREMENT!

# MiniProf<sup>BT</sup>

DIGITAL PROFILE MEASURING

by  
GREENWOOD ENGINEERING A/S



*Full contact - Your way to valid and reliable data*

**Safety**

**Capacity**

**Quality**

**Punctuality**

**Travelling Comfort**

Stay in **full control** of your assets  
Choose **full contact** measurements

**Costs**

**Frequency**



# Area of use

The MiniProf<sup>BT</sup> system is an excellent full contact measurement system with Bluetooth connection for fast, reliable and extremely high quality profile measurements. Combined with a user-friendly and flexible software package which can easily be configured from basic use to in-depth post measurement analysis, MiniProf<sup>BT</sup> can be used for numerous purposes on all types of wheel, rail and brake profiles. It enables the user to make critical decisions in purchase, maintenance, quality and safety departments etc. and represents a great platform for research and development all over the world.



### Research & universities

- WRI studies, verification of research and principles
- Reduce noise and wear-rates to extend asset lifetime
- Improve safety, speed, load and travel comfort



### Safety regulation

- Inspection check if assets are within regulation
- Accident and derailment investigation
- Analysis and documentation of work



### Quality control

- Verify accuracy of on-site/build-in laser-based gauges
- Verify accuracy of wheel lathes and rail grinding machines
- Verify accuracy of handheld laser-based gauges



### Product design & development

- Material and life cycle test
- Lubrication/friction effect
- Design of wheel, rail, brake disk, boogie



### Manufacturing

- Production quality control
- Factory acceptance inspection before shipment
- Verification of production equipment



### Procurement

- On-site field/workshop incoming inspection
- Lifetime/performance monitoring – forecast planning
- Compare quality from different suppliers



### Maintenance

- On-site field/workshop conformity, limit inspection and documentation
- Rail grinding, profile check before/after
- Wheel re-profiling, profile check before/after milling



### Management

- Life cycle wear monitoring
- Trend forecast, planning of on-time maintenance intervals
- Life expectancy / improvements / replacements

# MiniProf<sup>BT</sup>

MUCH MORE THAN A MEASUREMENT!



# Measuring principles

MiniProf<sup>BT</sup> is based on secure full-contact measurements and has a knife-shaped full contact point directly to the surface of a given profile. The magnetic full contact point minimizes influences from oil, lubrication, dirt and other substances on the profile as it “cuts” through the layers. It ensures constant contact to the actual profile during the complete measuring process and minimizes operator influence.

The accuracy of a MiniProf<sup>BT</sup> system is very consistent due to the unique measuring principle with a small magnetic measuring wheel and two rotating optical high resolution encoders which ensure that the measurement is performed perpendicular to the surface of the entire profile.

Due to the unique combination of full contact measurements, consistency and outstanding high-resolution optical encoders, MiniProf<sup>BT</sup> provides the highest accuracy available on the world market today. 20-30.000 collected individual points in one single profile measurement generate outstanding raw material resulting in excellent profile measurements with extremely high accuracies.





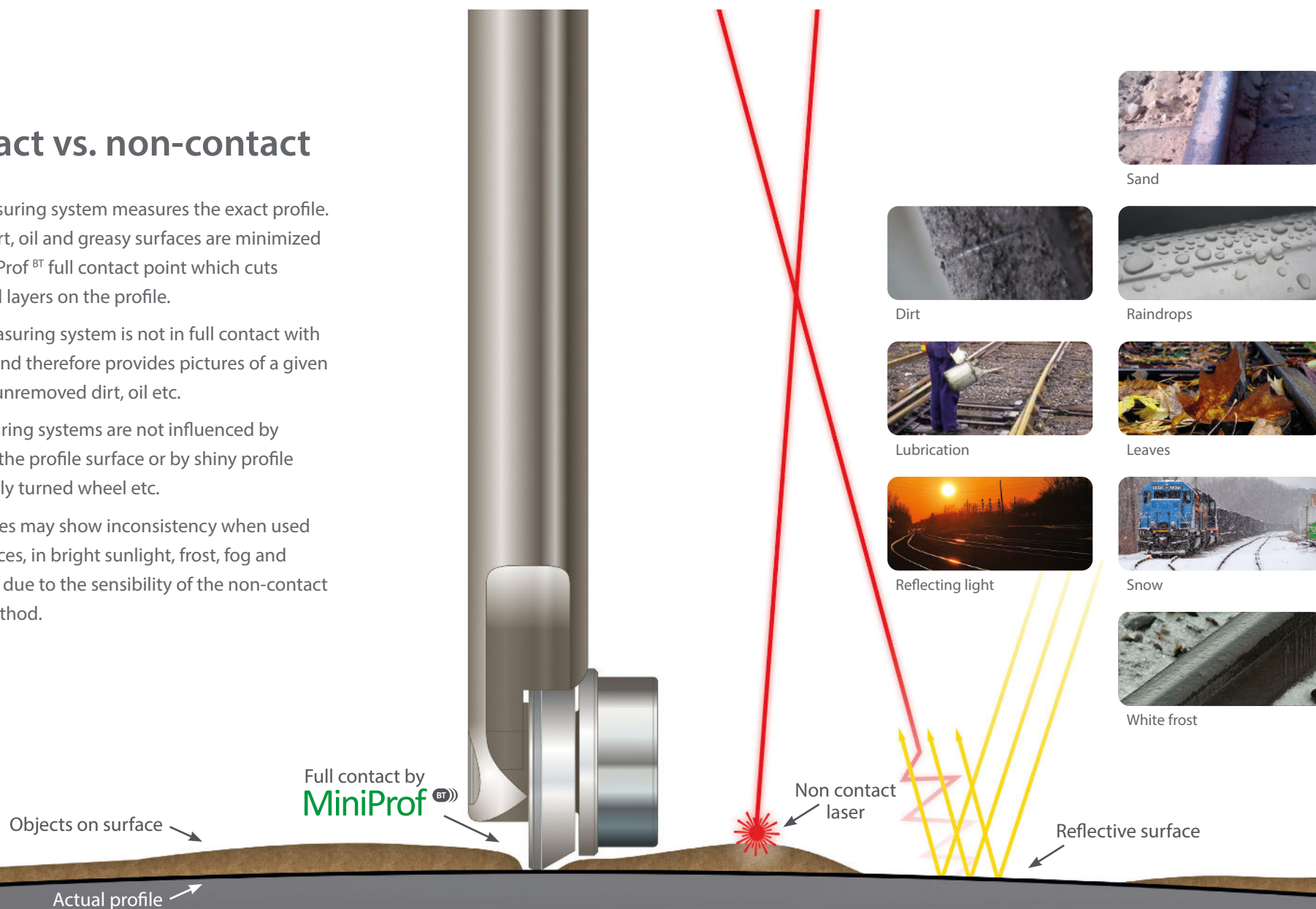
## Full contact vs. non-contact

A full contact measuring system measures the exact profile. Concerns about dirt, oil and greasy surfaces are minimized thanks to the MiniProf<sup>BT</sup> full contact point which cuts through unwanted layers on the profile.

A non-contact measuring system is not in full contact with the actual profile and therefore provides pictures of a given surface including unremoved dirt, oil etc.

Full contact measuring systems are not influenced by reflecting light on the profile surface or by shiny profile surfaces like a newly turned wheel etc.

Non-contact devices may show inconsistency when used on reflecting surfaces, in bright sunlight, frost, fog and moist climates etc. due to the sensibility of the non-contact data collecting method.



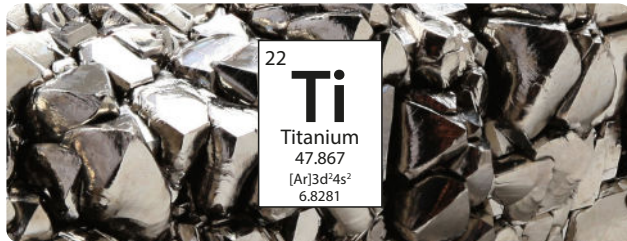


# Features



## Bluetooth

MiniProf<sup>BT</sup> has a strong Bluetooth connection with a standard operating range from minimum 5-10 m. The user is able to perform fast and wireless measurements making the measuring process even more flexible and efficient. Option for USB cable connection is included.



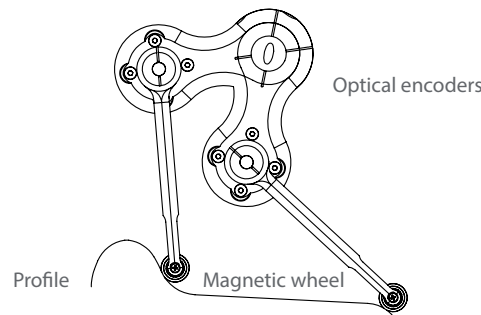
## Top quality components

MiniProf<sup>BT</sup> is made of titanium which makes it very temperature and shock resistant and ensures accuracy, stability and a very long lifetime.



## Highest accuracy

A MiniProf<sup>BT</sup> instrument provides the highest accuracy available on the market today. The profile accuracy lies between 9 and 11 μm depending on the MiniProf system configuration.



## Consistent accuracy

The accuracy of a MiniProf<sup>BT</sup> system is very consistent due to the measuring principle with a small magnetic measuring wheel and two rotating optical high resolution encoders which ensure that the measurement is performed perpendicular to the surface of the entire profile.



## Lightweight and handheld unit

A MiniProf<sup>BT</sup> instrument is a compact and wireless handheld unit, which can enter very narrow places. It weighs from only 0,7 kg and is delivered in a ready-to-go transport case for safe storage and transportation.



## Fast and easy to use

The MiniProf<sup>BT</sup> is a fast and easy to use measuring system which enables the user to carry out a single profile measurement in less than 5 seconds.



Long battery life

MiniProf<sup>BT</sup> is the perfect tool for field work. A new fully charged battery contains approximately 1000 Bluetooth measurements or 10 hours of work, which can be even further extended when using the cable connection option.



Easy-to-clean design

The MiniProf<sup>BT</sup> instrument has an easy-to-clean design, which reduces the accumulation of oil and dirt. The cleaning of the instrument is easily done just by using a mild solvent and a cloth after use of the instrument.



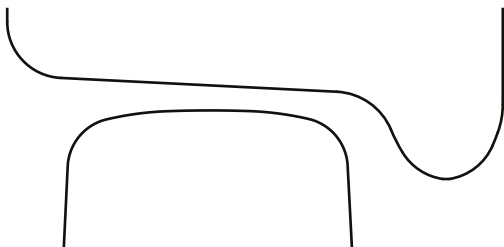
Warranty - 5 years

The MiniProf<sup>BT</sup> systems are founded on 25 years of solid experience. We are therefore proud and confident to offer up to 5 years warranty on all new MiniProf<sup>BT</sup> instruments as well as discounted loyalty calibration prices.



Operation temperature

The MiniProf<sup>BT</sup> instrument can be used for measuring in various types of environments and measures perfectly in temperatures from at least -15°C to +50°C.



Full digital profile

MiniProf<sup>BT</sup> uses high resolution optical encoders when measuring a profile. An extreme high amount of data for the total profile is collected and an average of approximately 600 points of the profile is saved digitally for further analysis.



MiniProf<sup>BT</sup> is supplied with the MiniProf Envision software for standard computers and tablets, which allows for data collection and contains powerful modules for advanced data handling, analyzing and reporting. MiniProf<sup>BT</sup> also includes the MiniProf Criterion app for Android phones which is designed for easy data collection in the field.



# MiniProf<sup>BT</sup> Rail

MiniProf<sup>BT</sup> Rail is a high precision, lightweight and portable tool for performing cross-sectional rail profile measurements in order to monitor and analyze the wear of rails. It is equipped with Bluetooth as well as cable connection option and is supplied in few variations for all types of rails, including grooved rails.

- MP-260: Incl. perpendicular device
- MP-261: Incl. gauge determination, grade, super elevation, also suitable for grooved rails
- MP-262: incl. gauge determination, grade, super elevation, perpendicular device

Magnetically attached to the top of the railhead using the opposite rail as reference, the rail profile is measured in less than 5 seconds reducing exposure on the track.

**Profile accuracy**

Better than:  $\pm 11 \mu\text{m}$

Repeatability:  $\pm 2.5 \mu\text{m}$

**IP rating**

IPX4

**Measuring speed**

Speed: < 5 seconds

**Weight**

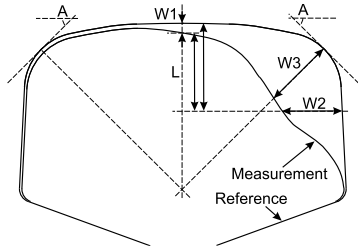
MP-260: 0,8 kg

MP-261: 0,7 kg

MP-262: 1,2 kg

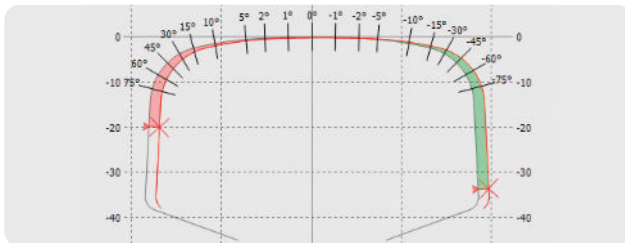
Telescopic rod: 0,6 kg





## Rail wear calculations

Vertical, horizontal and angled wear is calculated instantly. Numerous additional calculations and alignments for rails are available in the versatile and flexible Envision software package and can easily be added for optimum and customized configuration.



## Rail analysis & grinding

The MiniProf Envision software can visualize and calculate residuals and areas automatically and provides a functionality which is often used for rail grinding analysis. Measurements can be compared in multiple ways and easily exported to various formats. MiniProf Envision offers you a powerful rail analysis tool as well as user friendly measuring software.



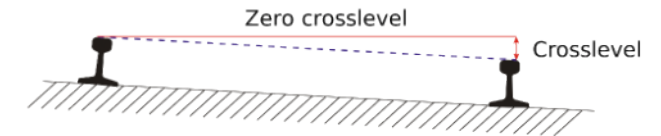
## Gauge measuring

MiniProf<sup>BT</sup> Rail is equipped with a telescopic rod using the opposite rail as reference. This ensures a correct and stable position and prevents the instrument from tilting. Depending on system configuration, the track gauge is measured simultaneously.



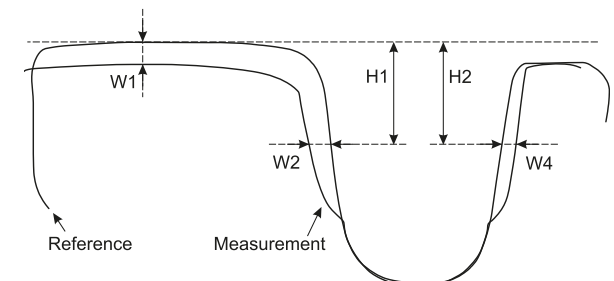
## Perpendicular device

Depending on system configuration, MiniProf<sup>BT</sup> Rail is equipped with a small built-in perpendicular device which ensures correct alignment to the rail and prevents faulty diagonal measurements.



## Super-elevation / Grade

Super elevation and grade are measured automatically depending on system configuration. The values are stored with the measurement and can be displayed at any time. The range of the measured inclination is  $\pm 30$  deg.



## Suitable for grooved rail

MiniProf<sup>BT</sup> Rail, type MP-261, can be used on grooved rails. The full contact magnetic measuring wheel ensures that the measurement is taken all the way down to the groove. Based on a reference, both the horizontal wear and the side wear are calculated.



# MiniProf<sup>BT</sup> Wheel

MiniProf<sup>BT</sup> Wheel is a high precision, lightweight and portable tool for performing cross-sectional wheel profile measurements in order to monitor and analyze the wear of wheels. It is equipped with Bluetooth as well as cable connection option and can be used on various types of wheels.

Magnetically attached to the backside of the wheel, the wheel profile is measured in less than 5 seconds. A complete railroad car can be measured in less than 5 minutes.

Various calculations and alignments for wheel are available in the versatile and flexible Envision software package and can easily be added for optimum and customized configuration of the MiniProf<sup>BT</sup> Wheel system.

**Profile accuracy**

Better than:  $\pm 9 \mu\text{m}$

Repeatability:  $\pm 2.5 \mu\text{m}$

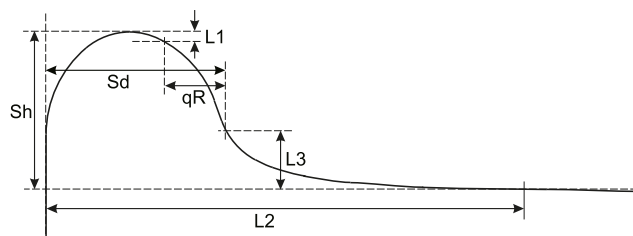
**Measuring speed**

Speed: < 5 seconds

**Weight**

Unit: 1,1 kg





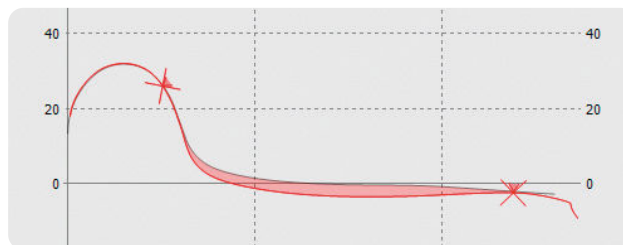
### Wheel wear calculations

The Sd, Sh and qR values are calculated instantly and numerous additional calculations and alignments for wheels are available in the versatile and flexible Envision software package.



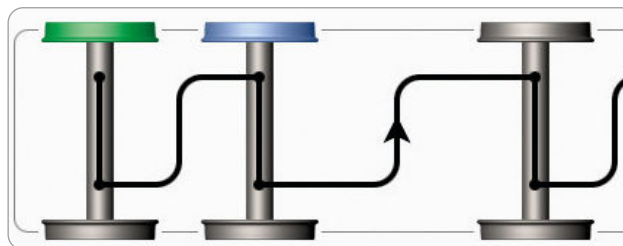
### Reprofiling

The MiniProf<sup>BT</sup> Wheel system is ideal to use before and after reprofiling of the wheels to determine when to reprofile and how much material to take off during the reprofiling process. This leads to precise reprofiling and improved lifetime of the rolling stock due to the unmatched high accuracy of the MiniProf system.



### Wheel analysis

The MiniProf Envision software can visualize and calculate residuals and areas automatically. Measurements can be compared in multiple ways and easily exported to various formats. MiniProf Envision offers you a powerful wheel analysis tool as well as user friendly measuring software.



### Measuring scheme

When measuring multiple profiles, the MiniProf<sup>BT</sup> measuring scheme is a very strong tool for clear identification of each profile in advance and for simplifying and reducing the measuring process even further.

# MiniProf Wheel *Mini*

MiniProf Wheel Mini is a small instrument, with an only 100 mm backplate, specially designed for use on tramway vehicles. This small and compact instrument can be mounted where only limited space is available and fits all tram wheels.

#### Profile accuracy

Better than:  $\pm 9 \mu\text{m}$

Repeatability:  $\pm 2.5 \mu\text{m}$

#### Measuring speed

Speed: < 5 seconds

#### Weight

Unit: 0,7 kg



# MiniProf

## Wheel 400

MiniProf<sup>BT</sup> Wheel 400 is equipped with a wide 400 mm backplate instead of the standard 250 mm backplate. The extremely high profile accuracy remains unchanged. Due to the increased width of the backplate, the diameter reading is improved significantly and is three times less sensitive to the state of the wheel and the measuring process.

### Profile accuracy

Better than:  $\pm 9 \mu\text{m}$   
Repeatability:  $\pm 2.5 \mu\text{m}$

### Diameter accuracy

800 mm: 30  $\mu\text{m}$   
1000 mm: 50  $\mu\text{m}$   
1200 mm: 80  $\mu\text{m}$

### Measuring speed

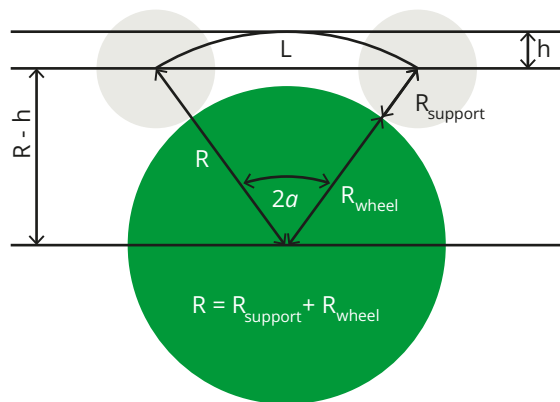
Speed: < 5 seconds

### Weight

Unit: 1,4 kg

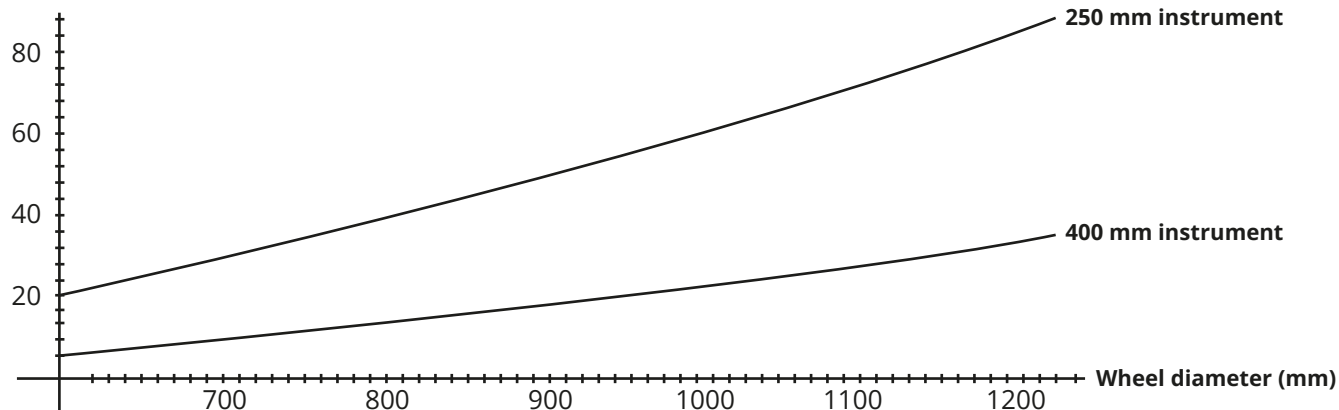


## The versine measuring principle



$$R_{\text{wheel}} = \frac{(\frac{1}{2}L)^2 + h^2}{2h} - R_{\text{support}}$$

**Error amplification (times)**







# MiniProf<sup>BT</sup> Brake

MiniProf<sup>BT</sup> Brake is an excellent tool for measuring the important wear parameters of brake discs and for calculating the brake hollowing and brake thickness.

MiniProf<sup>BT</sup> Brake provides instant calculations of the brake hollowing and brake thickness. The MiniProf Envision software can visualize and calculate residuals and areas automatically. Measurements can be compared in multiple ways and easily exported to various formats. MiniProf Envision offers you a powerful brake analysis tool as well as user friendly measuring software.

#### Profile accuracy

Better than:  $\pm 11 \mu\text{m}$   
Repeatability:  $\pm 2.5 \mu\text{m}$

#### Weight

Wheel mounted: 0,9 kg  
Axle mounted: 1,2 kg

#### Measuring speed

Speed: < 5 seconds

### Wheel mounted

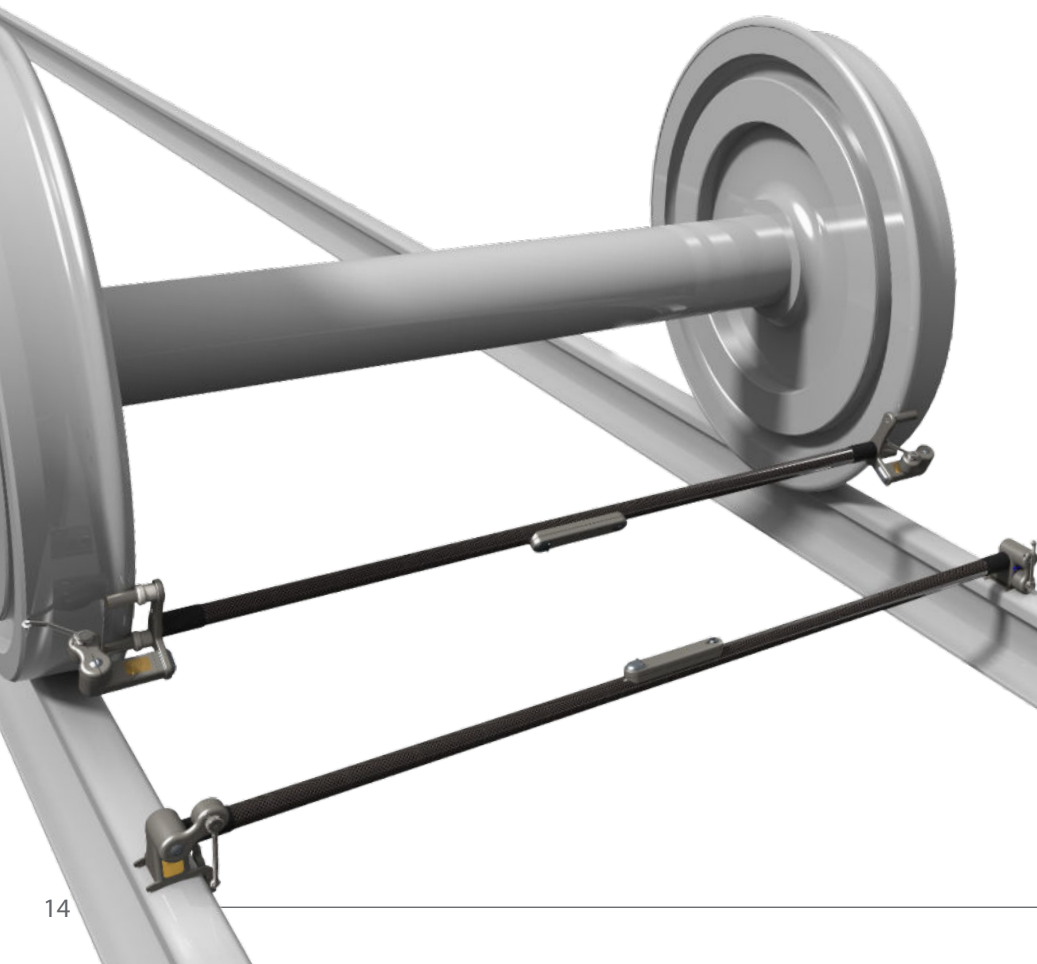
The wheel mounted MiniProf<sup>BT</sup> Brake instrument is attached magnetically to the vertical part of the wheel, either on the backside of the flange or on the outer side of the rim. This part of the wheel is used as a reference for the measurement.

### Axle mounted

The axle mounted MiniProf<sup>BT</sup> Brake instrument is mounted on the outer diameter of the brake disc and is attached using magnetic rollers. These also align with the wear marker on the disc which act as reference points for the measurement.



# MiniProf<sup>BT</sup> TwinHead



With the full contact MiniProfTwinHead instruments for wheels and rails, the left and right profiles are measured consecutively one by one obtaining an extremely accurate relationship between the two profiles, including a precise knowledge of the rotation of the profiles relative to each other. This is a crucial part of any wheel/rail interaction study and is especially important when analyzing running characteristics for rolling stock using e.g. equivalent conicity studies.

### Profile accuracy

Better than:  $\pm 11 \mu\text{m}$   
Repeatability:  $\pm 2.5 \mu\text{m}$   
Gauge:  $\leq 100 \mu\text{m}$

### Measuring speed

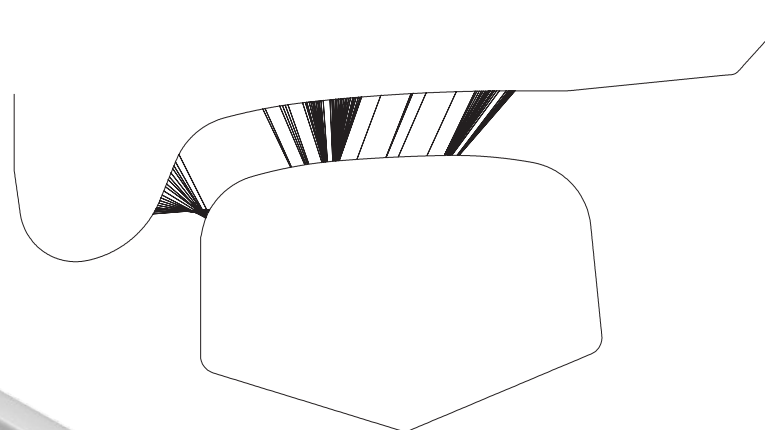
Speed:  $< 5$  seconds per profile

### Weight

TwinHead Rail: 1,9 kg  
TwinHead Wheel: 2,7 kg

## Equivalent conicity

The dynamic interaction between railway vehicle and the track is fundamental to ensure a safe and efficient operation and maintenance of the railway and can be described by using equivalent conicity. A high equivalent conicity increases instability/hunting, infrastructural damages and the risk of derailment and it is therefore a vital parameter when analyzing the wheel/rail interface.





## Contact studies

When you know the exact profiles and geometric interaction between the wheels and rails you can:

- Optimize your reprofiling maintenance schedule
- Identify critical speed limits
- Reduce the risk of derailment
- Improve vehicle stability & driving comfort
- Reduce maintenance costs

## TwinHead calculations

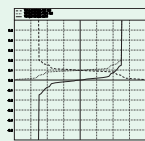
### Contact points

The contact points is a graph showing where all the contact between the wheel and rail profiles were found.



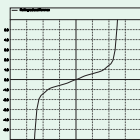
### Contact angles

The contact angles shows a graph of the left and right contact angle and the difference between the left and right angle relative to the wheelset displacement.



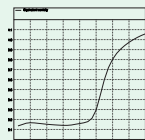
### Rolling radius difference

The rolling radius difference shows a graph of the difference rolling radius relative to the wheelset displacement.



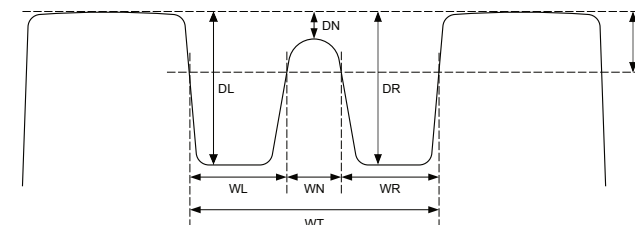
### Equivalent Conicity

The equivalent conicity shows a graph with the conicity plotted relative to the wheelset displacement.



# MiniProf<sup>BT</sup> Switch & Crossings

The MiniProf Switch & Crossings system is a portable wireless instrument designed to measure multiple profiles on switches and crossings. The instrument extends to the opposite rail through a fixed rod, offering stability, gauge and track relative measurements. These give precise information on the physical placement of multiple rails, both useful for maintenance, investigation of problems and for quality control of new installations.



### Profile accuracy

Better than:  $\pm 11 \mu\text{m}$   
Repeatability:  $\pm 2.5 \mu\text{m}$   
Gauge:  $\leq 200 \mu\text{m}$

### Measuring speed

Speed: < 5 seconds per profile

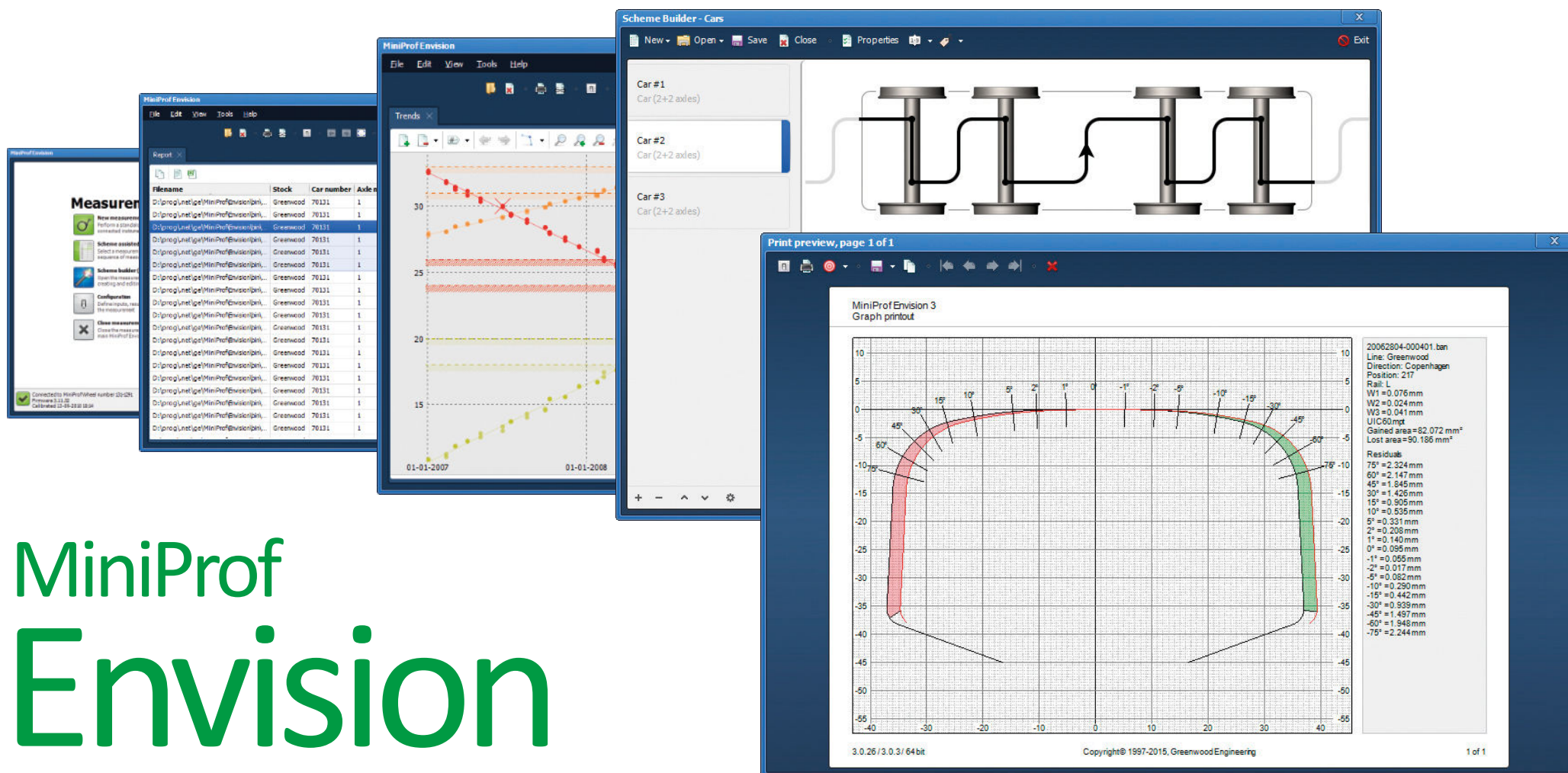
### Weight

Unit: 5,5 kg

### Horizontal movement

Range: 300 mm  
• 100 mm towards gaugeside  
• 200 mm towards fieldside  
Displacement:  $\leq 100 \mu\text{m}$





# MiniProf Envision

Complete data analysis toolbox

MiniProf<sup>BT</sup> is supplied with an extensive software package usable for all variations of our MiniProf<sup>BT</sup> instruments. It is highly flexible and customizable to the individual customer requirements and can be used to perform measurements as well as in-depth post measurement analysis. The software package includes measurement schemes, trending and a lot of other analysing possibilities.





## Measurement



**New measurement (F3)**  
Perform a standalone measurement with the connected instrument



**Scheme assisted measurement (F4)**  
Select a measurement scheme for performing a sequence of measurements



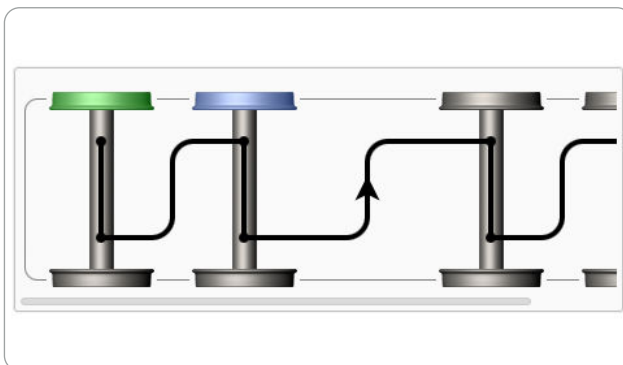
**Scheme builder (F9)**  
Open the measurement scheme builder for creating and editing measurement schemes



**Configuration**  
Define inputs, results and configure settings for the measurement

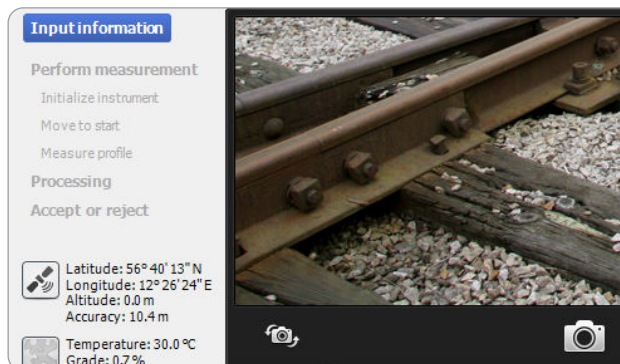
## User-friendly design

A MiniProf<sup>BT</sup> system is supplied with modern and user-friendly software package MiniProf Envision. Its smart configuration wizard makes setup process easy and provides a simplified user learning curve.



## Measuring scheme

MiniProf Envision features a measuring scheme system to perform large sequences of wheel, rail and brake profiles efficiently. An intelligent scheme wizard, enables the user to make customized scheme solutions.



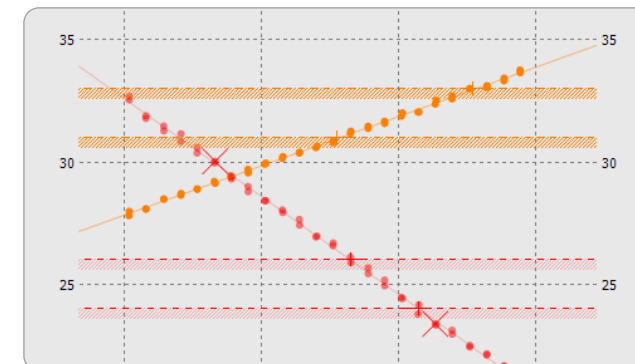
## More than a profile

MiniProf Envision has features such as logging of GPS locations and attachment of photographs to measurements. It can also measure temperature, super-elevation and grade with relevant MiniProf instrument.

Stock	Car number	Axle n...	Wheel ID	Sd [mm]	Sh [mm]	qR [mm]
Greenwood	70131	1	1	32.718	27.837	10.913
Greenwood	70131	1	2	32.575	28.012	10.828
Greenwood	70131	1	1	31.923	28.107	11.286
Greenwood	70131	1	2	31.816	28.114	11.064
Greenwood	70131	1	1	31.502	28.516	11.849
Greenwood	70131	1	2	31.306	28.513	11.926
Greenwood	70131	1	1	30.878	28.673	12.293
Greenwood	70131	1	2	31.186	28.742	12.250
Greenwood	70131	1	1	30.397	28.927	12.857
Greenwood	70131	1	2	30.626	28.921	12.561
Greenwood	70131	1	1	30.061	29.157	13.049
Greenwood	70131	1	2	29.997	29.237	13.366
Greenwood	70131	1	1	29.341	29.421	13.781

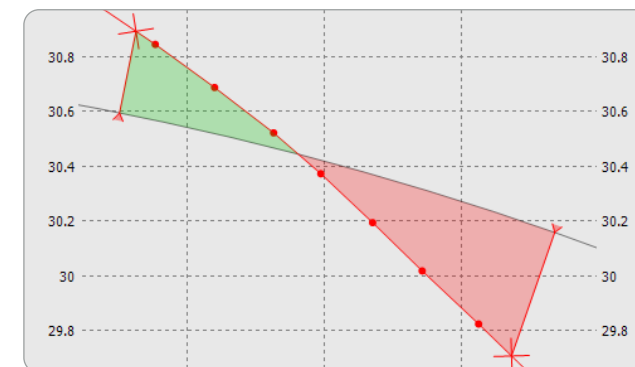
## Presentation and portability

Data and results can be extracted and easily used in third-party applications. Customizable templates allow attention to details when creating reports, which can be saved as PDF, Windows Metafile or printed.



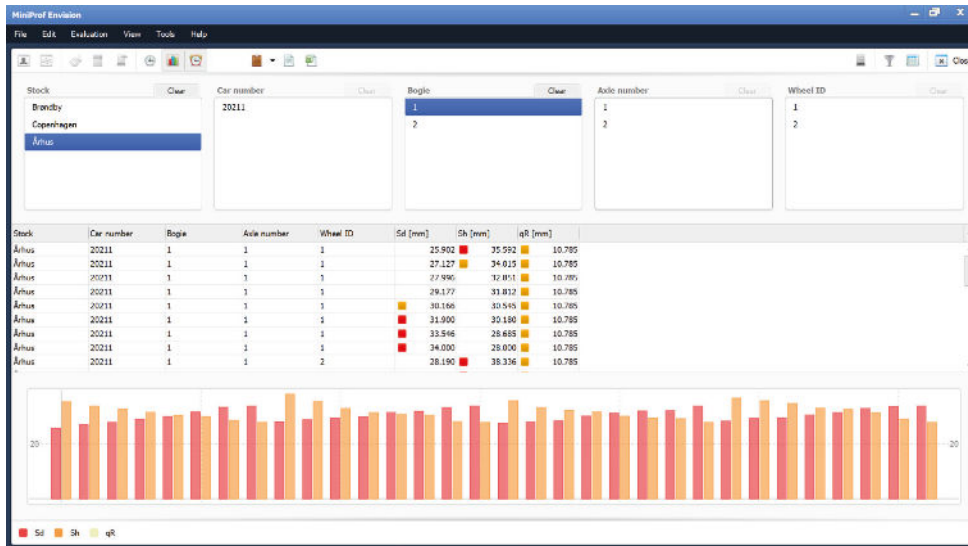
## Examine trends

You can perform trend analysis on your data which can show alarm and failure warning levels and estimates. These are imperative for safety requirements and decision making for your company.



## Intelligent cursors

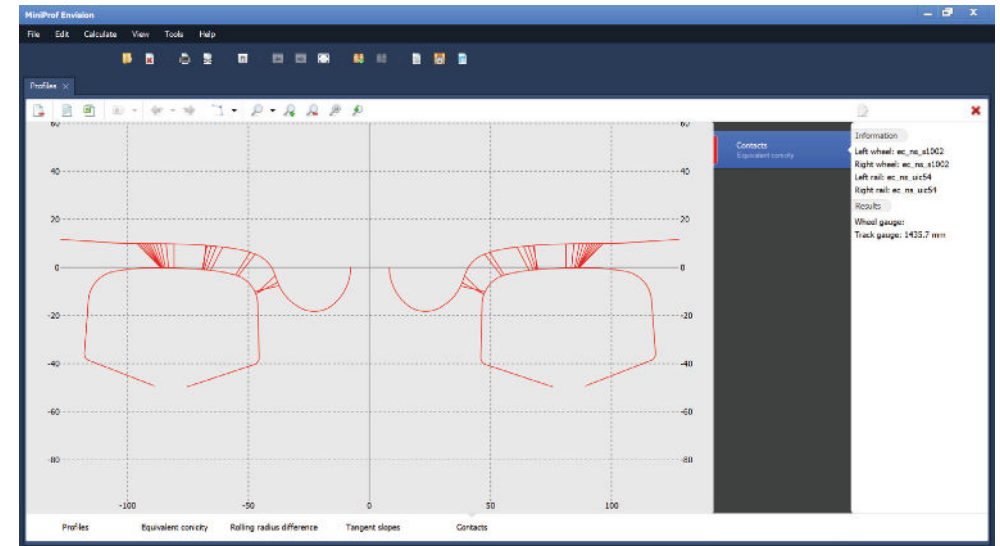
Profile cursor runs smoothly through the data points which allow readings between the points. The advanced functionality also gives instant residuals and area results to the user by highlighting the area between the profiles.



## Evaluation Module

The Evaluation module is probably the most powerful tool in the MiniProf Envision software package, as it brings all major functionalities together to transform your data into valuable information.

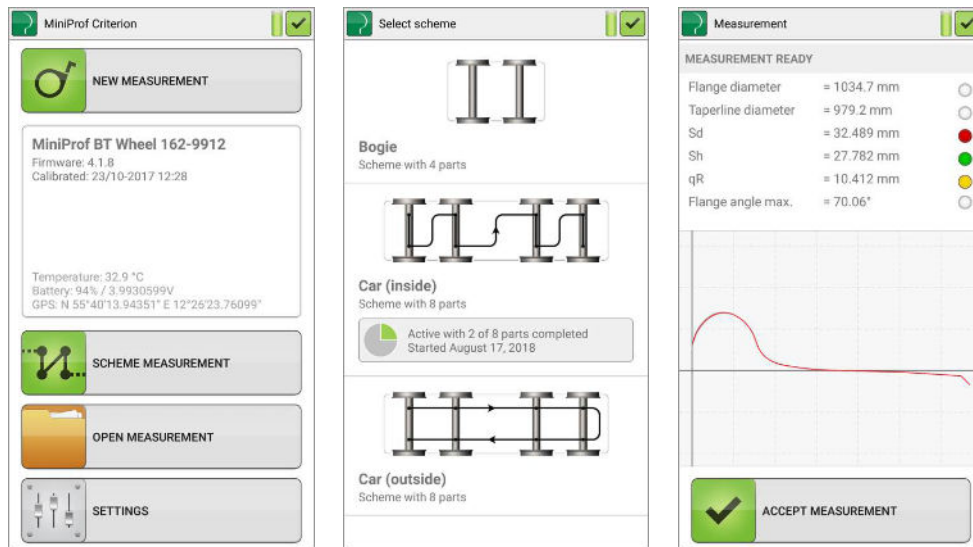
- Import measurements from all MiniProf instruments
- Backwards compatible with all MiniProf generations
- Filter measurements based on any recorded information
- Overview of wear parameters with live alarm information
- Graphical overview of results to highlight areas of special interest
- Open data to view details on the original profiles and perform trending
- Edit meta data to correct mistakes and unify displayed information
- Recalculate results in case of changes to settings
- Extract data and results for third-party applications



## Contacts Module

Wheel/rail interaction is vital for railway safety and comfort. The Contacts module adds functions for calculating equivalent conicity on MiniProf TwinHead measurements.

- Implemented in accordance with international standards
- Shows graphs for equivalent conicity, contacts points, tangent angles and rolling-radius difference.
- Comes with an integrated construct function which allows creation of sophisticated TwinHead reference profiles.
- Includes automated batch processing of TwinHead data sets



## MiniProf Criterion

MiniProf Criterion is an application designed to run on modern Android based phones and similar devices. The software provides easy installation and setup to carry out data collection in the field and workshops.

### Highlights of MiniProf Criterion:

- Compatible with various types of mainstream Android phones and similar devices
- Fully compatible with MiniProf<sup>BT</sup> line of instruments
- Easy data collection
- GPS location recording
- Attach pictures to your measurements
- Integrates directly with MiniProf Envision



## MiniProf Envision Coach

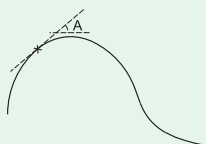
MiniProf Envision Coach is a self-training video tutorial software package supplied with all new MiniProf<sup>BT</sup> instruments and available for MiniProf Envision users for download on request. The software includes tutorials for:

- Software and license installation
- Instrument setup & measurement configuration • Measuring with different instruments
- Measuring & functionality on handheld devices • Analysis functions of the software
- Batch processing and reporting
- Additional modules and tools
- And much more...

## Common

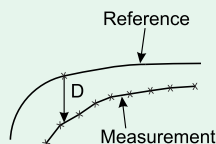
### Angles

Calculates the tangent angle, measured in degrees, at each point of the selected profile. The angles for a reference profile are calculated and displayed along with the angles of the measured profile if a reference is selected.



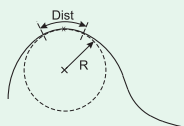
### Vertical residuals

Calculates the vertical distance (D) to a measured profile at each point of the reference profile. The calculation assumes that the points in the measured profile can be connected with straight lines.



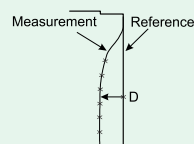
### Curvature

Calculates the curvature in every point of a profile by fitting a 2nd degree polynomial to a small part around each point. If a reference profile is available, the curvature will also be calculated for this and the result displayed as a reference for the curvature of the measurement.



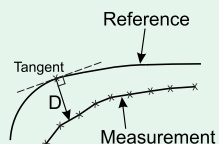
### Horizontal residuals

Calculates the horizontal distance (D) to a measured profile at each point of the reference profile. The calculation assumes that the points in the measured profile can be connected with straight lines.



### Residuals

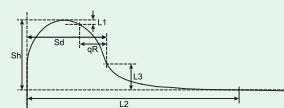
Calculates the distance (D) to a measured profile perpendicular to a reference profile at each point of the reference profile. The calculation assumes that the points in the measured profile can be connected with straight lines.



## Wheel

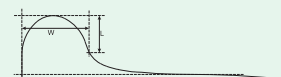
### Wheel wear

Calculates the flange thickness (Sd), flange height (Sh) and the flange gradient (qR) for a wheel profile.



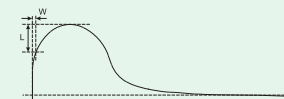
### Wheel flange width

Calculates the width of the flange (W) for a wheel profile at a specific distance (L) from the top of the flange.



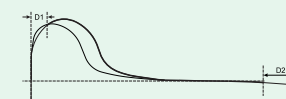
### Wheel flange back wear

Calculates the flange back wear (W) for the selected profile.



### Maximum residuals

Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.



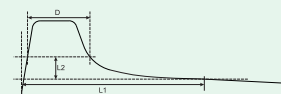
### Wheel flange radius

Calculates the radius of the wheel flange (R) for a wheel profile.



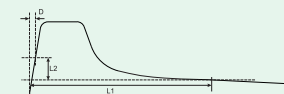
### Wheel flange width (Tram)

Calculates the width of the flange (D) for a wheel profile.



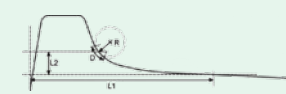
### Wheel flange back wear (Tram)

Calculates the flange back wear (D) for the selected profile.



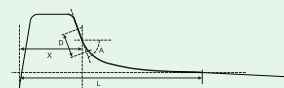
### Wheel flange root radius

Calculates the wheel flange root radius (R) at a given point defined from the taperline (L1). The radius is determined from the curvature of a 2nd order polynomial fitted to a specified area (D).



### Wheel flange angle maximum

Calculates the maximum flange angle (A) and the position (X) for a wheel profile.



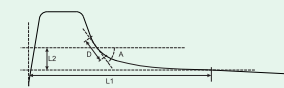
### Wheel flange crown thickness

Calculates the thickness of the flange crown (D) for the selected profile.



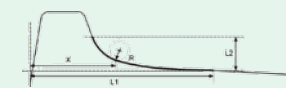
### Wheel flange angle

Calculates the angle of the flange (A) for a wheel profile.



### Wheel flange root radius minimum

Calculates the minimum flange root radius (R) and position (X) for the selected profile. The calculation determines the radius using the precalculated curvature values.



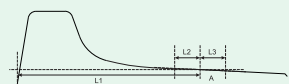




# Calculations & alignments

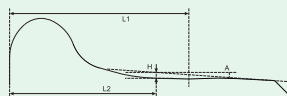
## Wheel taperline angle

Calculates the taperline angle (A) using the average for a distance (L2, L3) around the taperline (L1) for a wheel profile.



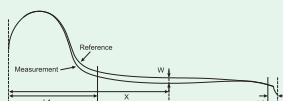
## Wheel hollowing

Calculates the maximum wheel hollowing (H) and position (X) for a wheel profile.



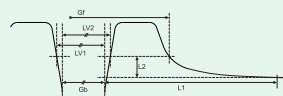
## Wheel thread wear maximum

Calculates the maximum thread wear (W) and position (X) between the measurement and the reference in an area set from the flange backside (L1) to the outer thread (L2).



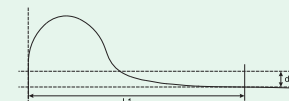
## Wheel gauge flange

Calculates a number of wheel dimensions and gauge values given two measured wheel profiles.



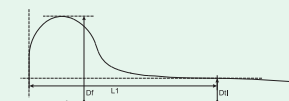
## Align wheel on taperline

Aligns a measured wheel profile on a given taperline. This alignment only moves the profile in the vertical direction (dy). No rotation is performed.



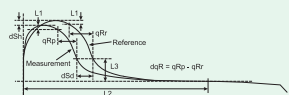
## Align wheel on diameter

Aligns a measured wheel profile using the diameter information stored with the profile.



## Wheel wear difference

Calculates the difference between the wheel wear on a measured profile and a reference profile.



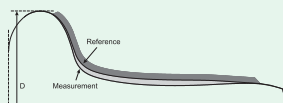
## Wheel hollowing maximum

Calculates the highest wheel hollowing (H) and position (X) for the selected profile.



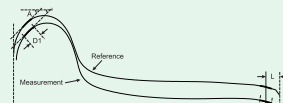
## Wheel volume loss

Calculates the volume between the measurement and a reference. This is done using either the measured diameter (if available) or the diameter entered as a parameter for the calculation.



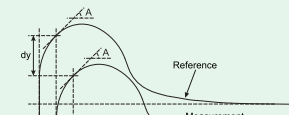
## Align wheel

Aligns a measured wheel profile to the reference profile at the top of the flange. This alignment only moves the profile in the vertical direction (dy). No rotation is performed.



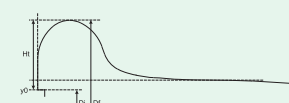
## Align wheel on flange back

Aligns a measured wheel profile to the reference profile at the flange back. No rotation is performed.



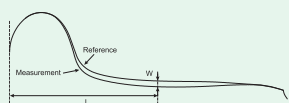
## Align wheel on tyre

Aligns a measured wheel profile using the tyre height information if present.



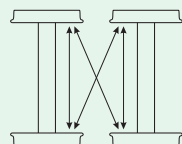
## Wheel thread wear

Calculates the thread wear (w) as the distance between the measurement and the reference at a given point (L) defined from the backside of the flange.



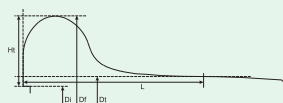
## Wheel diameter difference

Calculates the difference between the diameters on wheels in a bogie.



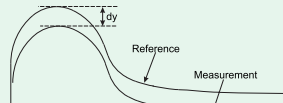
## Wheel diameter from tyre

Determines the wheel diameter using the inner diameter and a field containing the tyre height, measured separately.



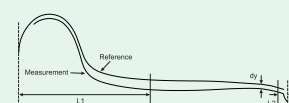
## Align wheel on flange top

Aligns a measured wheel profile to the reference profile at the top of the flange. This alignment only moves the profile in the vertical direction. No rotation is performed.



## Align wheel on outer thread

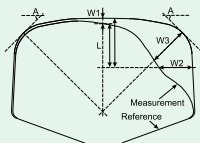
Aligns a measured wheel profile to the reference profile on the outer thread. This alignment only moves the profile. No rotation is performed.



## Rail

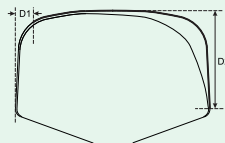
### Rail wear

This function will calculate the vertical (W1), horizontal (W2) and 45° (W3) wear. The wear is calculated as the difference between a measured profile and a reference profile.



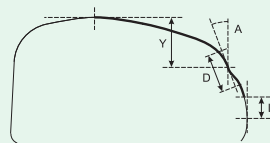
### Maximum residuals

Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.



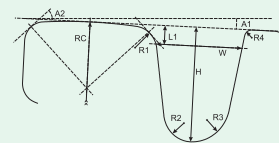
### Rail gauge angle maximum

Calculates the maximum gauge angle (A) and position (Y) for the selected profile. The calculation determines the angles either as the tangent angle in each point, as the angle between two points on each side or as the average of the tangent angles in a certain area (D).



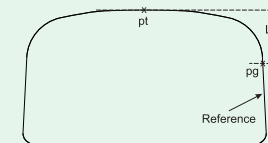
### Grooved rail geometry

This function calculates a number of geometrical features for a grooved rail profile: Groove width (W), groove height (H), crown radius (RC) and radii for the different parts of the groove (R1, R2, R3 and R4).



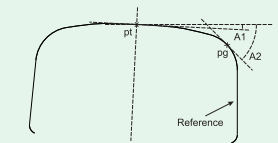
### Align rail (CEN)

Aligns a measured rail profile against a reference by moving the measurement so it intersects the reference at the top and in a point on the gauge side. No rotation is performed on the measured profile.



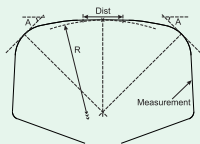
### Align rail for grinding (High)

Aligns a measured rail profile against a reference according to the CEN grinding standard for the high rail in curves. No rotation is performed on the measured profile.



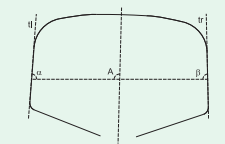
### Rail crown radius

The rail crown radius (R) is calculated as the radius of the circle that gives the best fit at the top of the rail head in an area determined by the distance parameter (Dist).



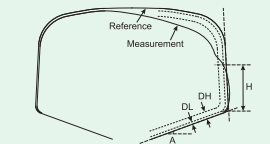
### Railhead angle

Calculates the angle of the rail head (A) for the selected profile.



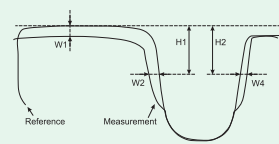
### Rail height

Calculates the remaining height of the rail head (H) for the selected profile.



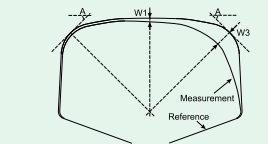
### Grooved rail wear

This function will calculate the vertical (W1) and horizontal (W2, W4) wear for a grooved rail. The wear is found as the distance between the measurement and the reference.



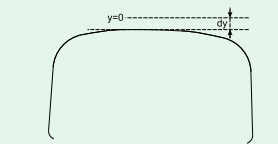
### Align rail on wear

Aligns a measured rail profile against a reference by minimizing the wear parameters W1 and W3. No rotation is performed on the measured profile.



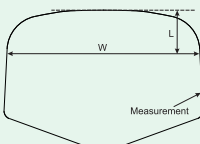
### Align rail on top

Aligns a measured rail profile so the profile intersects the horizontal axis at the top point. This alignment only moves the profile in the vertical direction. No rotation is performed.



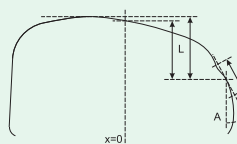
### Rail head width

The rail head width (W) is the distance from the field side of the rail head to the gauge side measured at L millimeters from the highest point of the rail profile. Setting the L parameter to 0 makes the calculation return the largest width.



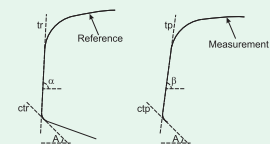
### Rail gauge angle

Calculates the gauge angle (A) at a given point defined from the top of the railhead (L). The angle is determined either from the tangent in the point, the angle between two points on each side or as the average of the tangent angles in a certain area (D).



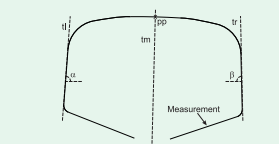
### Align rail

Aligns a measured rail profile against a reference by using the field side face and the lower corner. The alignment can optionally use the gauge side face if desired.



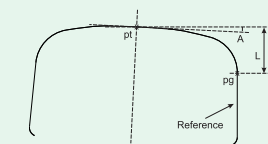
### Align rail centered

Aligns a measured rail profile against a reference by using both sides of the profiles and the top point. This alignment is particularly useful for aligning measurements of new rails for quality control.



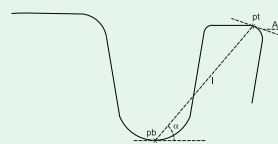
### Align rail for grinding (Low)

Aligns a measured rail profile against a reference according to the CEN grinding standard for tangent track and the low rail in curves. No rotation is performed on the measured profile.



### Align grooved rail

Aligns a measured grooved rail profile against a reference using a point on the inner side of the check part and the bottom of the groove.





# Calculations & alignments

## Brake

### Align grooved rail (Flat)

Aligns a grooved rail measurement using the bottom parts of the groove, either gauge part or check part.



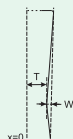
### Brake wear

Calculates the brake-disc hollowing (W) and the remaining thickness (T).



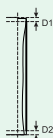
### Brake wear (No reference)

Calculates the brake-disc wear (W) and the remaining thickness (T).



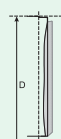
### Maximum residuals

Calculates the maximum, minimum and average residual between the reference profile and the measured profile in a given area. This area is defined independently for wheel, rail and brake profiles as illustrated below.



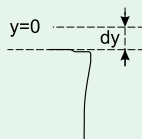
### Brake volume loss

Calculates the volume between the measurement and a reference. This is done using either the measured diameter (if available) or the diameter entered as a parameter for the calculation.



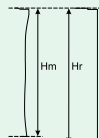
### Align brake on top edge

Aligns a measured brake profile on the top edge so this edge overlays the horizontal axis.



### Align brake on scale

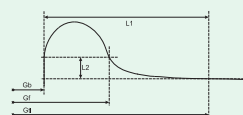
Aligns a measured brake profile against the reference by stretching the measured profile vertically so the height of the measurement (Hm) matches the height of the reference (Hr).



## TwinHead

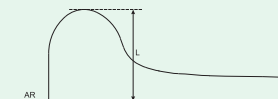
### TwinHead wheel gauge

Calculates the wheel gauge values (Gb, Gtl and Gf) for a set of TwinHead wheel profiles. Gb is the gauge found at the backside of the wheels, Gtl is the gauge found at the taperline on the wheels and Gf is the gauge found on the flange.



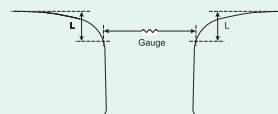
### TwinHead wheel gauge (AR)

Calculates the wheel gauge value (AR) for a set of TwinHead wheel profiles. AR is the gauge found at the backside of the wheels at a point relative to the flange top.



### TwinHead rail gauge

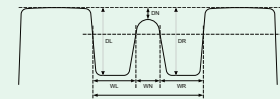
Calculates the gauge between two rail profiles made with a TwinHead rail unit. The two profiles must be linked together for the calculation to succeed.



## Switch & Crossing

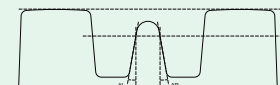
### Switch frog clearance

Calculates width values of total width (WT), left width (WL), nose width (WN) and right width (WR). Depth values of left depth (DL) and right depth (DR). Nose depth values of nose depth left (DNL) and nose depth right (DNR).



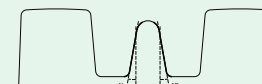
### Switch nose angles

Calculates nose angle values of left angle (AL) and right angle (AR) at a given point defined by the parameter (L). The angles are determined either from the tangent in the point, the angle between two points on each side or as the average of the tangent angles in a certain area (D).


















### Switch nose angles maximum

Calculates the maximum nose angle values of left angle max (AL) and right angle max (AR) for the selected profiles. The angles are determined either from the tangent in the point, the angle between two points on each side or as the average of the tangent angles in a certain area (D).



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QCM Resco Engineering Siemens Toronto Transit Commission – TTC TTC Ashbridges</p> <p> <b>Chile</b> Alstom Chile EFE Icila-icafal S.A Ingenieria Reyes Metro SA</p> <p> <b>China</b> 2.7 Track Manufacture Antong Borui Company Baodin track depot Baoqiao Branch, China Railway</p>	<p>Beijing CRM-Vossloh Track Beijing EMU Depot Beijing High Speed Train Track Beijing Large Machinery Beijing Metro Beijing Metro Airport Line Beijing Metro Line 1 Beijing Metro Line 13 Beijing Metro Line 16 Beijing Metro Line 4 Beijing Metro Line 5 Beijing Metro Line 7 Beijing Metro Line 8 Beijing Metro Line 9 Beijing Nankou Division Beijing Railway Beijing Railway Bureau Beijing Tram Line Xijiao Beijing University of civil eng. an Bombardier Transportation China Bombardier Transportation Qingdao C Bombardier Transportation Qingdao C Changchun Highspeed Track Department Changchun Light Rail Changchun Metro Changchun Railway Vehicles Co. Changsha EMU Depot Changsha Metro Line 4 Changzhou Metro Line 1 Chengdu Large Machinery Chengdu metro Chengdu Metro Line 1 Chengdu Metro Line 2 Chengdu Metro Line 3 Chengdu Metro Line 5 Chengdu Railway Bureau Chengdu Track Depot China Academy of Railway Science China National Elec. Chongqing Metro Chongqing Metro Line 5 Chongqing Vehicle Depot Chongqingbeifu Line Depot CRCC-Switch branch CRMSC CRMSC-Beijing CRMSC-Chengdu CRMSC-Wuhan CRRC – Changzhou CRRC Zhuzhou Shidai Dianzi CSR Meishan Co. Ltd. Dalian Metro Line 1 Dalian Metro Line 2 Detieguidao</p>	<p>Fengtai track department of Beijing Four Oceans Limited Fushiluo Company Fuzhou EMU Depot Fuzhou Metro Line 1 Fuzhou Track Depot Gansu Wuwei Track Depot GE Transportation Systems Goldschmidt-thermit in China Guangxi Nanning Subway Line 1 Guangxi Railway Bureau Guangzhou EMU Depot Guangzhou Railway Bureau Guangzhou Subway Line 1 Guangzhou Yuehai Railway Hainan Tra Guanke Depot Guilin Highspeed train track Guilin North EMU Operational Depot Guiyang High Speed Train Track Divi Guiyang Metro Line 1 Guiyang North Vehicle Depot Hai Lar Track Depot Hainan Hami Track Depot Hanggang Metro Hangzhou Metro Hangzhou Metro Line 5 Harbin EMU depot Harbin Railway Bureau Harbin Track Depot Harsco Company China Hefei EMU Depot Heilongjiang Rail Bureau Hengshui Track Depot Houma Locomotive Depot Huahua Track Depot Huohot Huohot Track Depot Huizhou EMU Depot Jasontech Jiayuguan track depot Jinan Large machinery &amp; equipment Jinan Mechanical Depot Jinan Railway Bureau Jinan Track Depot Jinan Vehicle Depot Jinanzi Track Depot Jinying Heavy Industry Kashi Track Depot Kuerle Track Depot Kuitun Track Depot Kunming EMU Depot Kunming Metro Line 3 Kunming South EMU Operational Depot Lanzhou</p>	<p>Lanzhou Railway Bureau Lanzhou Vehicle Depot Lanzhou West Track Depot Liaocheng Track Depot Linfenxi High Speed Train Linyi Track Depot Liupanshui Track Depot Liuzhou Track Depot Longyan Track Depot Luoyang Track Depot Manzhouli Track Depot Mechanic Track Depot of Xi'an Mianyang Track Depot MTR Beijing Mudanjiang Track Depot Maanshan Steel Nanchang Railway Bureau Nanjing EMU Depot Nanjing Metro Nanjing Metro Line 2 Nanjing Metro Line 3 Nanjing Metro Line 4 Nanning EMU Operational Depot Ningbo Metro Line 1 Panzhuhua Steel Pingxiang Track Depot Qingdao EMU Depot Qingdao Metro Line 13 Qingdao Metro Line 13 Qingdao Metro Line 13 Qiqihaer Locomotive Depot Sanya EMU Operational Depot Shanghai EMU Depot Shanghai metro repairing factory Shanghai Railway Bureau Shangqiu high speed train Shanhaiguan Shenyang EMU depot Shenyang High Speed train track dep Shenyang Metro Line 1 Shenyang Metro Line 10 Shenyang Railway Bureau Shenyang Track Depot Shijiazhuang Subway Line 1 Shijiazhuang Subway Line 2 Shijiazhuang Subway Line 3 Sichuang Tangyuan Sifang Railway Vehicle Co. Ltd. Southwest Jiaotong University Suining Track Depot Suzhou Metro Line 3 Taiyuan Taiyuan EMU Depot Tanshan Railway Vehicle Co. Ltd Tianjin Tianjin EMU Depot</p>	<p>Tianjin Metro Tianjing-Baoding Line, Baoding Tianjing-Baoding Line, Tianjing Transportation University Urumqi Railway Bureau Urumqi Track Depot Urumqi EMU Operational Depot Wuhan Depot Wuhan EMU Operational Depot Wuhan High Speed Rail Wuhan Railway Bureau Wuhan Steel Wulumuqi Track Division Wuwei High Speed Train Wuxi Metro Line 1 Wuxi Metro Line 2 Xi'an Railway Bureau Xi'an Jiaotong University Xiamen track depot Nancha Xian Metro Line 4 Xian Vehicle Depot Xiangyang Jinying Company Xining Xining EMU Operational Depot Xining Track Depot Xinjiang Hami Track Depot Xuzhou Metro 2 Yinchuan EMU Operational Depot Yingtan Track Department Yongzhou Track Depot Yunchengbei High speed train Zhangjiakou Track Depot Zhengzhou Bridge Engineering Depot Zhengzhou EMU Depot Zhengzhou EMU Depot Zhengzhou Railway Bureau Zibo Track Depot</p>	<p> <b>Denmark</b> Ansaldo Danmark Banestyrelsen DSB Lokalgot Region H Metro Service A/S</p> <p> <b>Estonia</b> TTK University of Applied Sciences</p> <p> <b>Finland</b> Bombardier Transportation Finland HKL-Metrolikenne Tampere University of Technology</p> <p> <b>France</b> France Alstom ARTELIA Bombardier Transportation France Camrail CEF (Centre Dessais Ferroviaires) Centre Opérationnel du Tramway Chemins de fer de la Corse Cogifer TF Colas Rail Corus Rail EGIS RAIL EUROTUNNEL Faiveley Keolis Bordeaux Keolis Lyon Logitrade (Amay) Nancy Tram RATP RTM MR/TW ATELIER TRAMWAY Sculfort Semitan Setram Centre de Maintenance Tramwa SNCF TAM Transpole Valdunes SAS</p> <p> <b>Germany</b> Adranz Alstom Germany Bayerische Oberlandbahn BEC Brazil Export Company Becorit Berliner Verkehrsbetriebe Bochumer Verein Verkehrstechnik Gm Bogestra Bombardier Transportation Germany Chemnitz Verkehr AG DB DB Systemtechnik GmbH</p>
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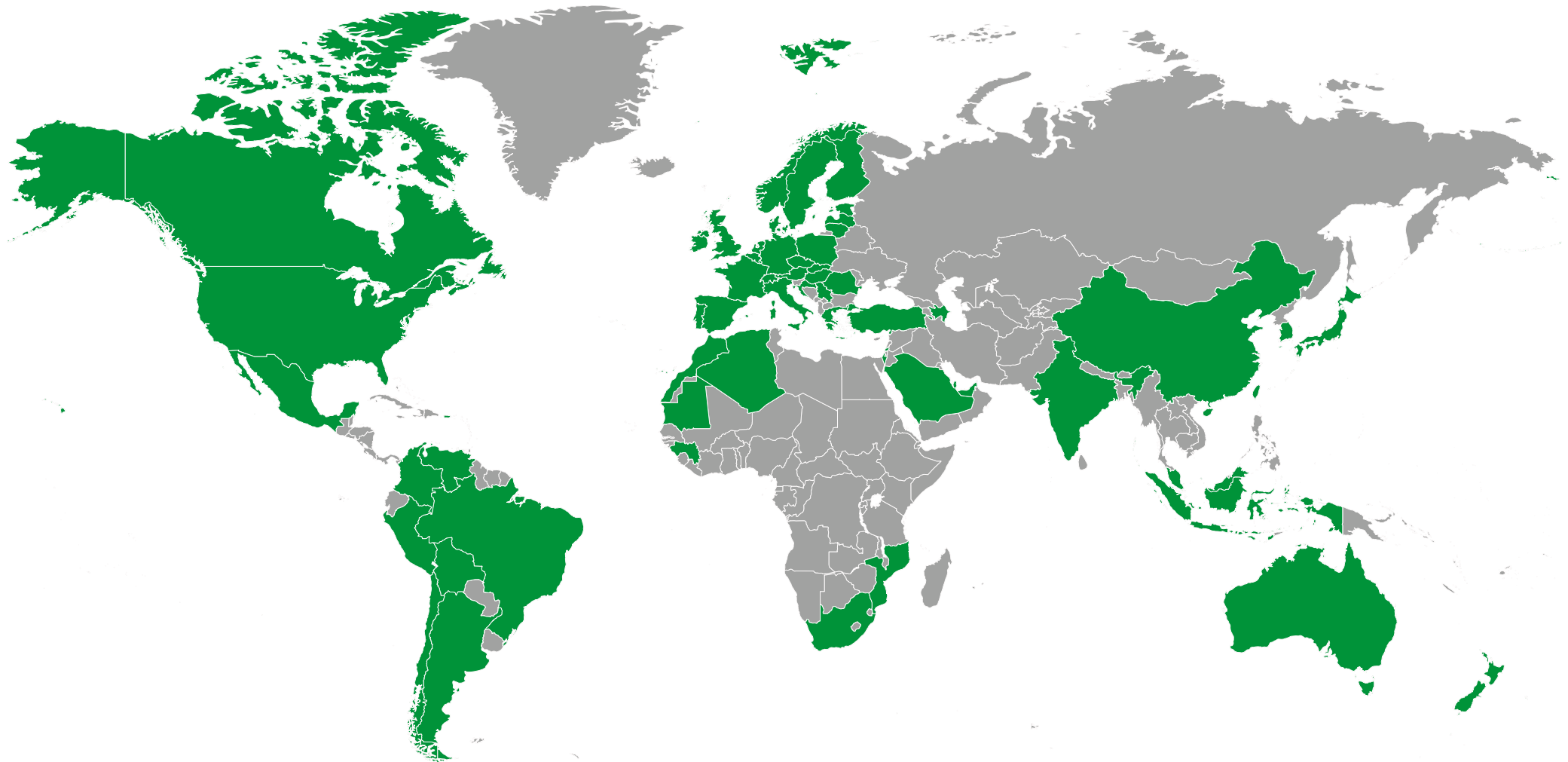
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