

Actuator test Dellner - TTL

Test report

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Abbreviations & Acronyms

Abbreviation / Acronym	Description
DAC	Digital automatic coupler
DBST	DB Systemtechnik GmbH
HVLE	Havelländische Eisenbahn
TTL	Train Test Lab
ERJU	Europe's Rail Joint Undertaking
VT	Voith
KB	Knorr-Bremse
DL	Dellner
HBK	Hottinger Brüel & Kjaer

1 Description of test case

Aim of the project is to test the Actuator and Electronics from Dellner. The purpose of this test is to verify that the test object withstands the specified proof load without significant permanent deformation or functional degradation.

1.1 Test schedule summary

Date	Location	Action	From Test-Nr.
Prev. to 27.01.2025	HVLE Berlin-Spandau	Installation of coupler heads and TTL measurement equipment	-
28.01.2025	HVLE Berlin-Spandau	Test part 1	001-019
29.01.2025	HVLE Berlin-Spandau	Test part 2	020-044

2 Introduction and description of systems under test

The purpose of this chapter is to introduce the coupler and the systems to be tested.

2.1 Introduction Dellner coupler

The description of the initial state of the Dellner coupler will not be part of this report. The position of the actuators and electronics will be added in chapter 2.2.

2.2 Description of test objects

In the following, information on the tested couplers are given. In summary two couplers from Dellner were used in the Train Test Lab.

The couplers are mounted on the following wagons:

- DL_DAC4.5_009 is mounted on Sgnss_6849
- DL_DAC4.5_010 is mounted on Shimmns_6025

2.2.1 DL_DAC4.5_009

Description: Digital Automatic Coupler

Manufacturer: Dellner

Type: DAC 4.5

Configurations:

Part	Config.	Date	Change
DL_DAC4.5_009	#001	21.01.2025	Installation on Wagon Sg_6849 Side B
DL_DAC4.5_009	#002	28.01.2025	Installation of Actuator and Electronics

In comparison to the initial state, the following components were installed for the tests:

- An actuator was installed on the outside of the coupler.



Figure 1: Actuator on D09.

- Two boxes with push buttons and one DACCU were installed on the front side of the wagon.



Figure 2: Overall view of Wagon Sg_6849 with coupler D09.



Figure 3: DACCU-Box.



Figure 4: Push button boxes.

- A coupler status indicator was mounted at the top of the coupler.



Figure 5: Side view (left) and top view (right) of Coupler status indicator.

2.2.2 DL_DAC4.5_010

Description: Digital Automatic Coupler

Manufacturer: Dellner

Type: DAC 4.5

Configurations:

Part	Config.	Date	Change
DL_DAC4.5_010	#001	21.01.2025	Installation on Wagon Shimmns_6025 Side B
DL_DAC4.5_010	#002	28.01.2025	Installation of Actuator and Electronics

In comparison to the initial state, the following components were installed for the tests:

- An actuator was installed on the outside of the coupler.

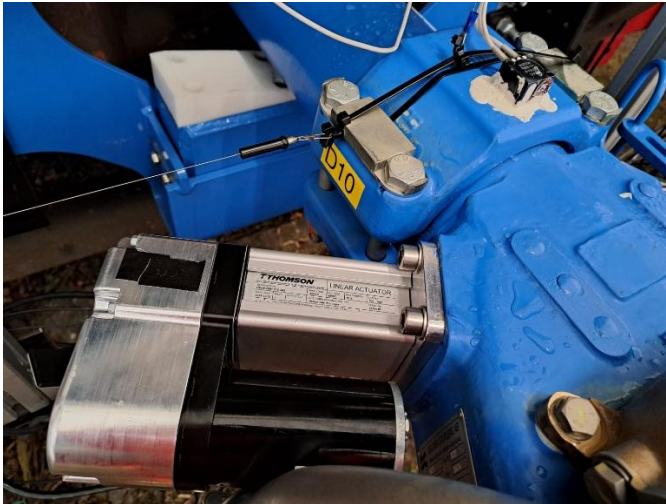


Figure 6: Actuator on D10.

- Two boxes with push buttons and one DACCU were installed on the front side of the wagon.



Figure 7: Overall view of Wagon Shimmns_6025 with coupler D10.



Figure 8: DACCU-Box (left) and push button boxes (middle and right).



Figure 9: Push button boxes.

- A coupler status indicator was mounted at the bottom of the coupler.

3 Test description and results

3.1 Description of execution

In general, the Actuator tests were performed as impact tests. The two DACs were coupled with a defined speed by a push-off operation. Therefore one standing wagon is positioned on a defined location on the track. A moving wagon is accelerated and pushed-off. The moving wagon impacts on the standing wagon and the couplers impact on each other. The coupling result depends on the initial positions of the couplers.

When both couplers are in ready to couple position, they should couple. If one coupler is in ready to couple position and the other coupler in prevent coupling position, the couplers should not couple and the ready to couple coupler should go in coupled position. The other coupler should stay in prevent coupling position. When both couplers are in prevent coupling position, they should not couple and stay in this position.

In advance to every test, the following steps need to be done:

1. Both wagons are coupled and stand on a defined coupling position.
2. Wagons are uncoupled.
3. Both wagons need to be set up with the following:
 - Coupler centered
 - Coupler in status "ready to couple" or „prevent coupling" by pushing the correct button
 - Brakes deactivated
4. Moving wagon and loco move to start position. To brake the wagons after impact, brake shoes are used for both wagons.
5. The moving wagon is uncoupled from the loco.
6. The moving wagon is accelerated. As the moving wagon is slowed due to different influences after push-off, the speeds during the push-off operation are not defined and up to the loco driver. Only the impact speed is defined.
7. The moving wagon impacts on the standing wagon. Both wagons couple or not.
8. Both wagons move further and are braked by brake shoes.
9. After braking, the wagons are coupled and pulled back to the couple position.

3.2 Infrastructure

3.2.1 Wagons

The couplers were installed on two different wagons, a Shimmns-ttu wagon ("Shimmns_6025", type 722, coil transport wagon) and a Sgnns wagon ("Sg_6849", flat wagon).

The wagon Shimmns_6025 was equipped with a measurement system by DBST (see chapter 3.3).

3.2.1.1 Shimmns_6025

Model: Shimmns-ttu

Type: 722

Description: Coil transport wagon

Number: 31 80 4675 602-5

Config:

Wagon	Config.	Date	Change
Shimmns_6025	#005	21.01.2025	Initial status before tests: Coupler A: Screw coupler Coupler B: D10 Load state: full

Loading:

Load state	Weight	Source / description / remark
full	86.400 kg	Sources: - Wagon-inscription. - Coil-inscriptions (Coil 1: 31 t and Coil 2: 31,8 t) Remarks: - Measurement system not included. - Screw coupler exchanged with DAC.

Photo documentation:



Figure 10: Shimmns_6025.

3.2.1.2 Sg_6849

Model: Sgnss

Description: Flat wagon

Number: 33 83 4575 684-9

Config:

Wagon	Config.	Date	Change
Sg_6849	#002	28.01.2025	Status: Coupler A: D09 Coupler B: Screw coupler Load state: empty

Loading:

Wagon	Weight	Source / description / remark
Sg_6849	18.000 kg	Sources: - Wagon-inscription Remarks: - Measurement system not included - Screw coupler exchanged with DAC

Photo documentation:



Figure 11: Sgnss_6849.

3.2.1 Test location

All tests were executed on track 4 and 10 at the HVLE premises in Berlin-Spandau (Schönwalder Allee 51, GER-13587 Berlin).

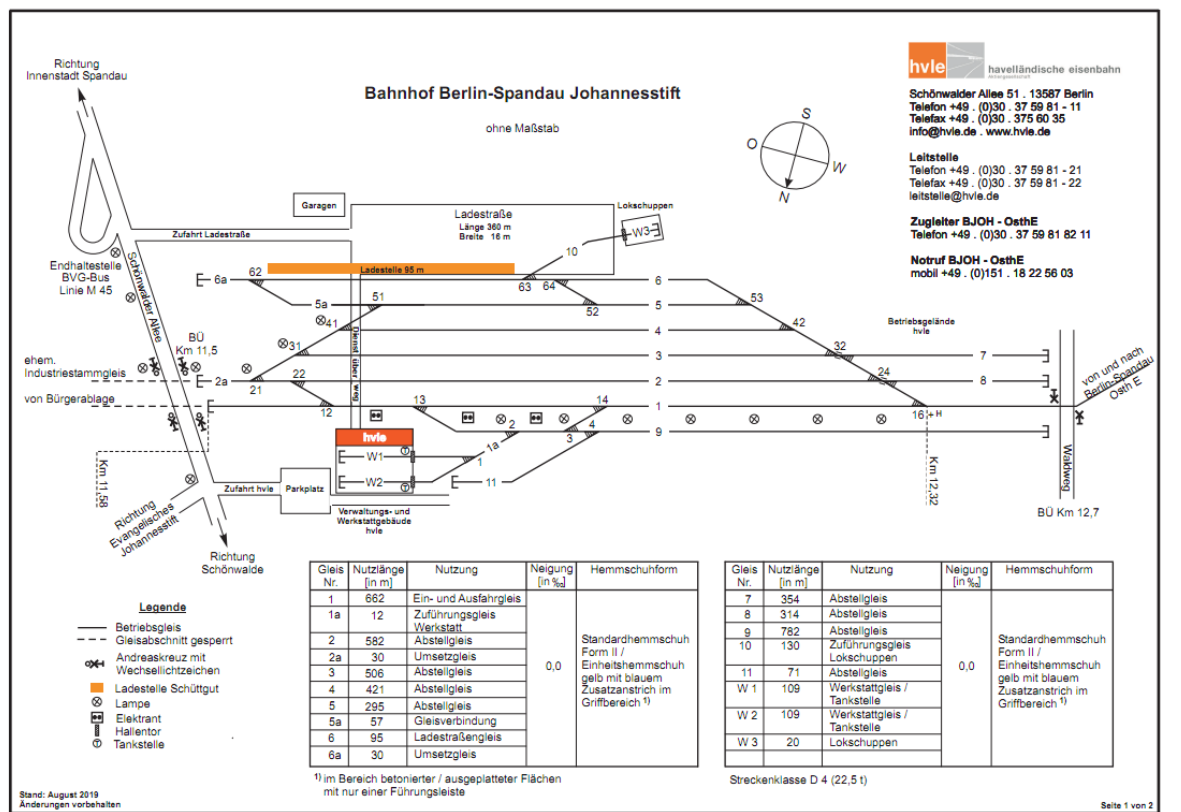


Figure 12: Track layout of the HVLE, location Berlin-Spandau [HVLE_TL].

3.3 Measured and documented data

The following data were documented or measured:

Documented in the protocol:

- Environmental inputs
- Initial status of couplers, wagons and track
- Moving / Standing wagon and coupler
- Type of actuation of coupler and actuated coupler
- Abnormalities and deviations from procedure

Documentation by photo:

- Photo documentation of the coupler

Measured by measurement systems:

- Impact Speed
- Displacement of coupler
- Acceleration on coupler
- Acceleration on wagon

Every test was recorded by the DBST on-wagon system on the moving wagon, the Shimmns_6025 (see chapter 3.3.1).

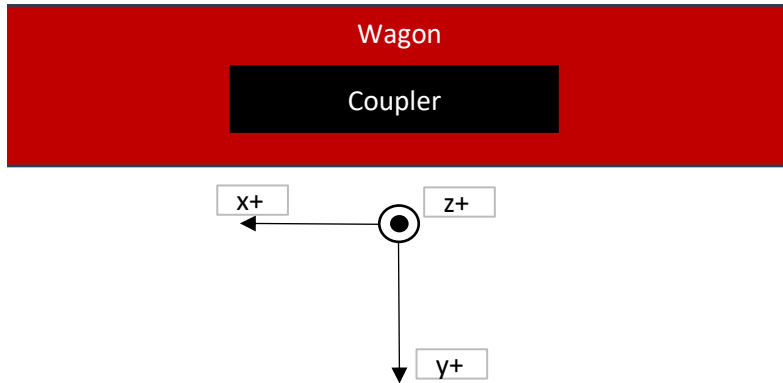
3.3.1 Measurement equipment on Shimmns_6025

The on-wagon measurement system was installed on the Shimmns_6025 wagon. It consisted of a Datalogger and two measuring amplifiers. Calibrated measurement chains were used to record the data of the on-board system. The location of installation of the sensors, signal names, identifiers and descriptions are shown in the following table:

Name	New unit	A = analogue D = digital	Description	Source / Installation	Connection	Range
Time		A	Time	Data-logger		
S_x		A	Displacement (x-axis -> Sideways)	Wire sensor	On rack -> rights side of coupler	0 to 1.000 mm
S_y		A	Displacement (y-axis -> Up/Down)	Wire sensor	On rack -> above coupler	0 to 1.000 mm
S_z		A	Displacement (z-axis -> Forward/Backward)	Wire sensor	On rack -> behind coupler	0 to 1.000 mm
Imp		A	Impulses (Distance)	Incremental Encoder	Pushed on left wheel	0-70.000.000
ax_Coup		A	Acceleration Coupler (x-axis - Sideways)	Acceleration Sensor (3ax) - M240TT	Glued onto coupler	1000g
ay_Coup		A	Acceleration Coupler (y-axis - Up/Dpwn)	Acceleration Sensor (3ax) - M240TT	Glued onto coupler	1000g
az_Coup		A	Acceleration Coupler (z-axis - Forward/Backward)	Acceleration Sensor (3ax) - M240TT	Glued onto coupler	1000g
ax_Wag		A	Acceleration Wagon (x-axis - Sideways)	Acceleration Sensor (3ax) - M241EK	Screwed into middle of wagon	10g
ay_Wag		A	Acceleration Wagon (y-axis - Up/Dpwn)	Acceleration Sensor (3ax) - M241EK	Screwed into middle of wagon	10g
az_Wag		A	Acceleration Wagon (z-axis - Forward/Backward)	Acceleration Sensor (3ax) - M241EK	Screwed into middle of wagon	10g
pBP		A	Brake Pipe Pressure	Pressure Sensor	Stäubli-socket screwed into Distributor valve	0-10 bar
s	m	A	Distance	- calculated		
v	m/s	A	Speed	- calculated		

The following coordinate system was defined:

Front view on the coupler:



3.3.1.1 Displacement of the coupler

To measure the displacement of the coupler wire sensors were used in x-, y- and z-axis. Wire sensors with a high mechanical resistance were used to prevent vibrations. The sensors were aligned with the axis of movement to prevent high elongation during off-axis movement of the coupler. The zero position of the wire sensors is the straight aligned uncoupled position.



Figure 13: Wire sensor for horizontal movement S_x .

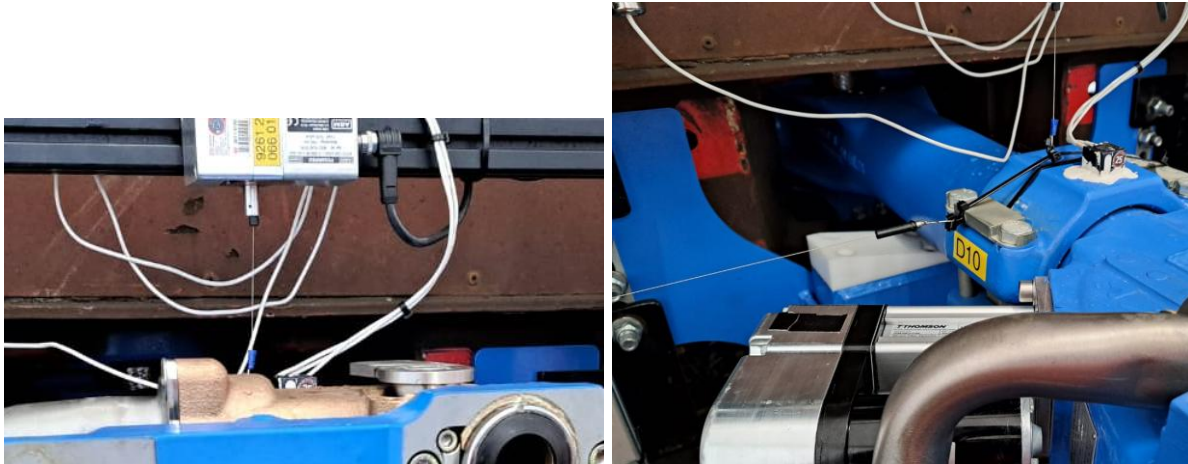


Figure 14: Wire sensor for vertical movement S_y .



Figure 15: Wire sensor for forward/backward movement S_z .

3.3.1.2 Impact-speed

The speed of the moving wagon was measured with an incremental encoder. It measured the rotation of a wheel, pushed to the outer side of the wagon-wheel. The impulses of the encoder were transformed into a distance and then differentiated by the time. A mean-filter of 0.1 s was applied for the speed.

To calculate the distance from the given impulses, a calibration was done over a distance of 50 m.



Figure 16: Incremental encoder with wheel, attached to the wagon wheel.

3.3.1.3 Brake pipe pressure and brake cylinder pressure

The brake pipe and brake cylinder pressure were measured with a pressure sensor, which was attached to the test-points of the distributor valves.

Due to testing without air, the sensors had no function.



Figure 17: Pressure sensors attached to the distributor valve on test-points of brake pipe and brake cylinder.

3.3.1.4 Acceleration of coupler and wagon

Acceleration-sensors (3ax) were installed on the coupler and on the wagon. The sensor on the coupler was glued onto the coupler. The sensor on the wagon was screwed onto the wagon, positioned in the middle of the wagon.



Figure 18: Left: 1000g-acceleration sensor glued onto the coupler. Right: 10g-acceleration sensor screwed onto the middle of the wagon.

3.3.1.5 Data acquisition

For Data acquisition a system by HBK was used, consisting of:

- Data logger: SomatXR CX22B-R-W (HBK) [HBK_CX22]
- Measuring amplifiers: SomatXR MX480B-R (HBK) [HBK_MX480]
SomatXR MX1601B-R (HBK) [HBK_MX1601]
- Data acquisition software: CatMan-Easy, Version 5.6.2 (HBK) [HBK_CM]

For power-supply a battery pack with four 12 V batteries (12 V, 24 V and 48 V output possible) was designed and installed by HVLE.

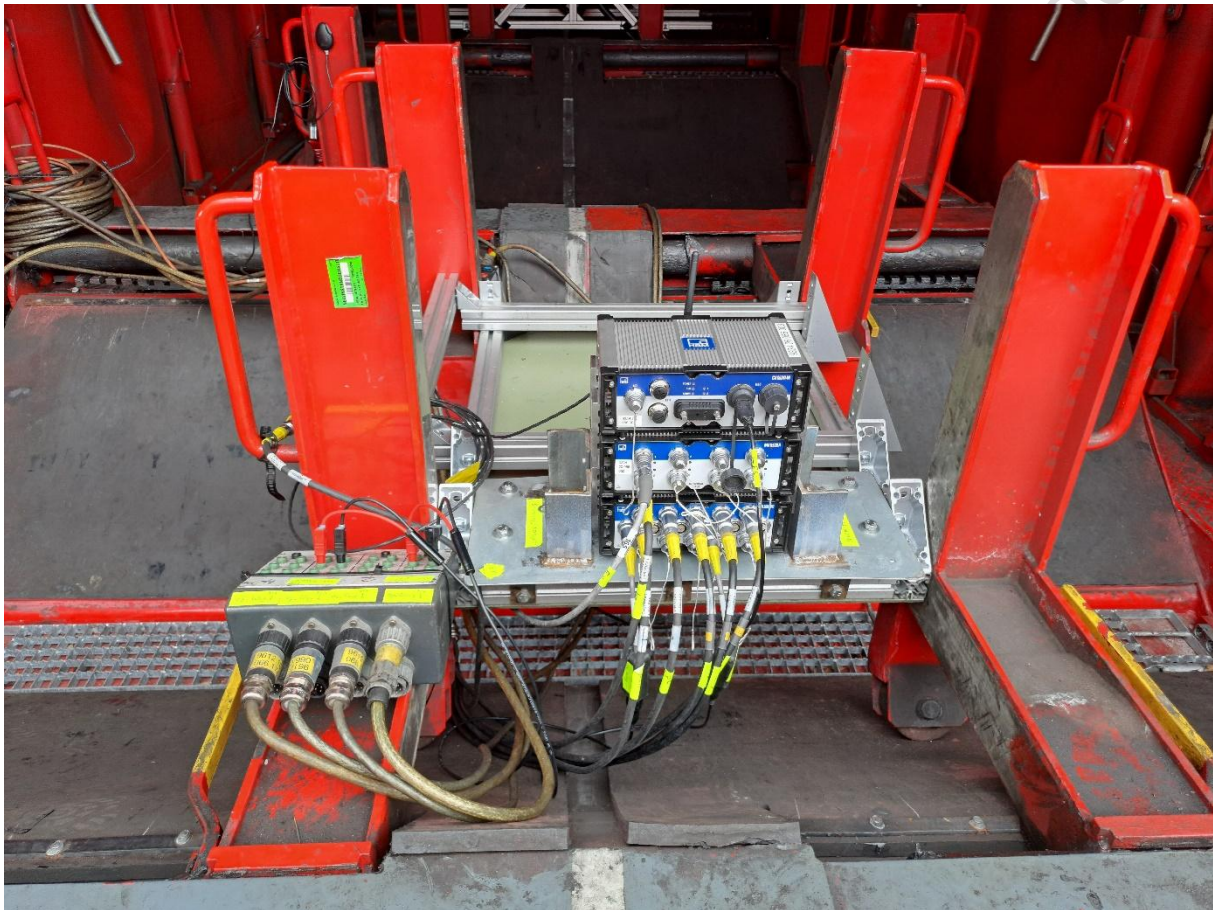


Figure 19: DBST on-wagon measurement system: Data-logger and measuring amplifiers.



Figure 20: DBST on-wagon measurement system: Battery pack with different voltage outputs.

3.3.1.6 Data processing

Python-Scripts for editing and graphical presentation of the data were developed by the TTL.

3.3.1.7 Measurement of coupler heights

For evaluation of the vertical displacement during coupling, the heights of the couplers were measured.

The measurement of the height of the coupler consisted of two measured distances:

- Distance between top of rail and the bottom of the coupling link
- Height of coupling link

The distance between the top of rail and the bottom of the coupling link was measured with a laser-distance-sensor (Milwaukee LDM 30 [Milwaukee_LDM30]) fixed inside a rack of aluminium-profiles (see Figure 21 and Figure 22).

The heights of the coupling links were measured with a calliper gauge (see Figure 23).

The coupler height – the distance between the middle of the coupling link (CL) and the top of rail (TOR) – is calculated as:

$$\text{Coupler height} = \text{Distance}_{\text{TOR to bottom of CL}} + \frac{1}{2} \text{Height}_{\text{CL}}$$



Figure 21: Left: Laser distance sensor for coupler height measurement [Milwaukee_LDM30]. Right: Laser point on the coupler link.

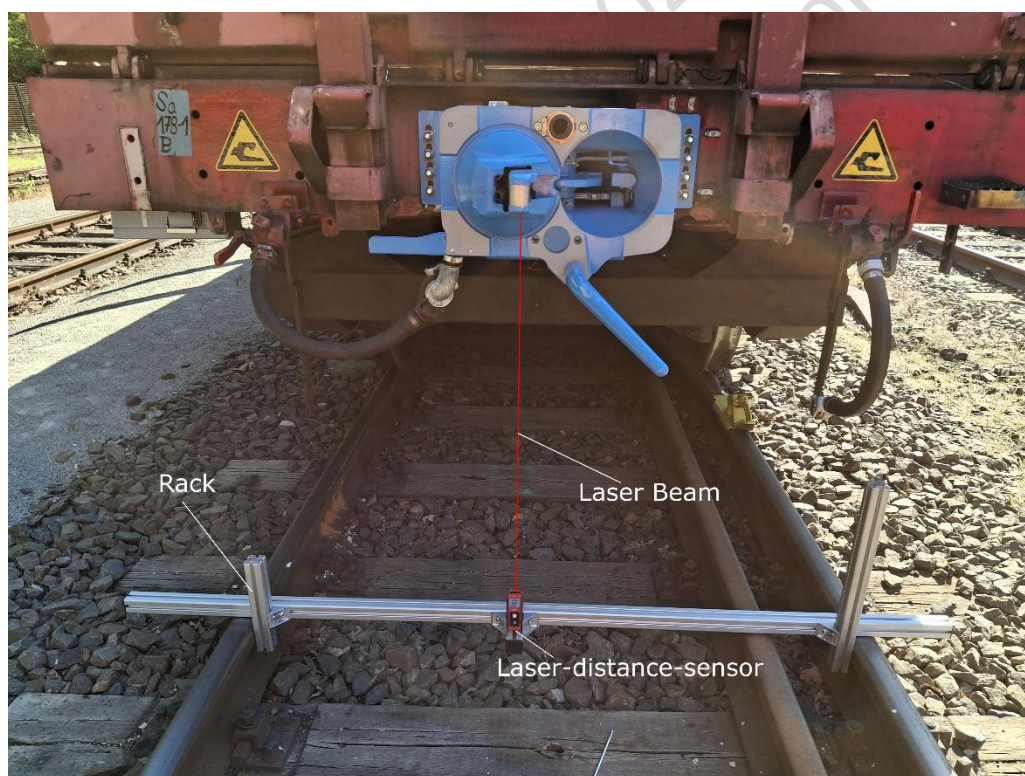


Figure 22: Aluminium rack with laser sensor for height measurement of the couplers.