LÄRM FORSCHUNG EISEN BAHN
FAHRBAHNLABOR

MÜLLER-BBM
RAIL TECHNOLOGIES

Monthly report

Railway Field Laboratory

August 2023

Client:	Swiss confederation; Federal Offices for the Environment (FOEN) and Transport (FOT), CH-3003 Bern The FOEN and the FOT are offices of the Federal Department of the Environment, Transport, Energy and Communications (DETEC).
Consultant:	Müller-BBM Rail Technologies GmbH Helmut-A.-Müller-Straße 1 - 5 82152 Planegg www.MuellerBBM-Rail.com
Author:	Natan Isert, Stefan Lutzenberger
Supervision BAFU / BAV:	Fredy Fischer Franz Kuster, Christoph Dürig
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Version:	V2 Data basis: Database V3
Date:	26.2.2024

1. Status railway field laboratory

Construction work on the tracks:

- none

Downtimes of the measurement systems:

- none

Downtimes of the sensors:

- MQ 2_2: v-mq22 (Destruction during mowing work) Di 8.8.-Fr 18.8.
- MQ 1_2: a-mq12-4-rf (due to defect) 25.7. – 9.8.

Maintenance and sensor exchange:

- MQ 2_2: v-mq22 am 18.8. (Installation of a new vibration sensor)
- MQ 1_2: a-mq12-4-rf 9.8.

Modifications to the data, database, or analysis:

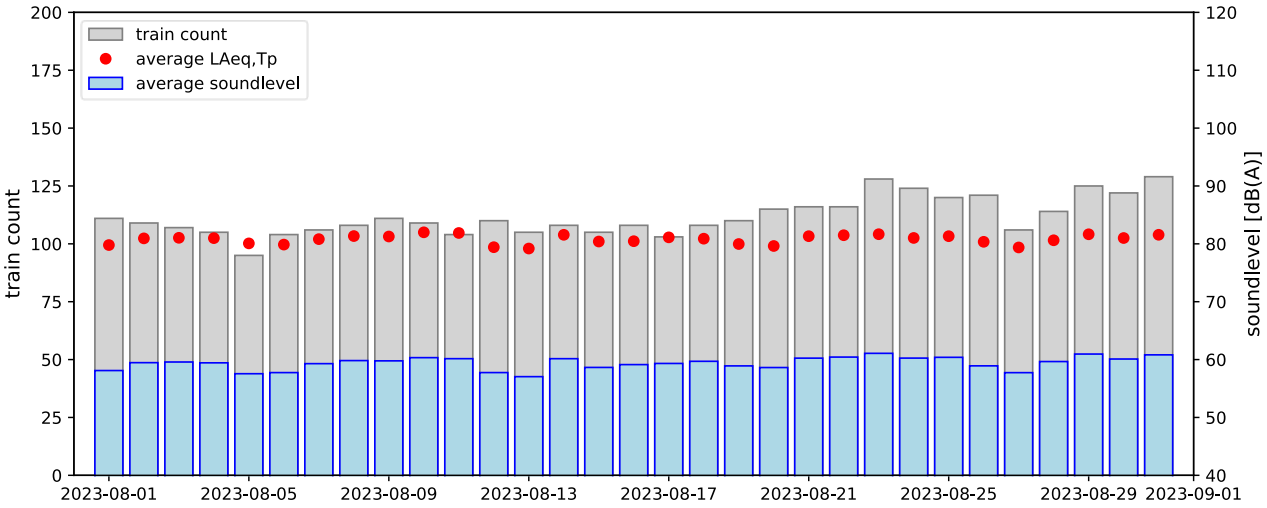
- none

Monthly data volume collected:

- 508 GB

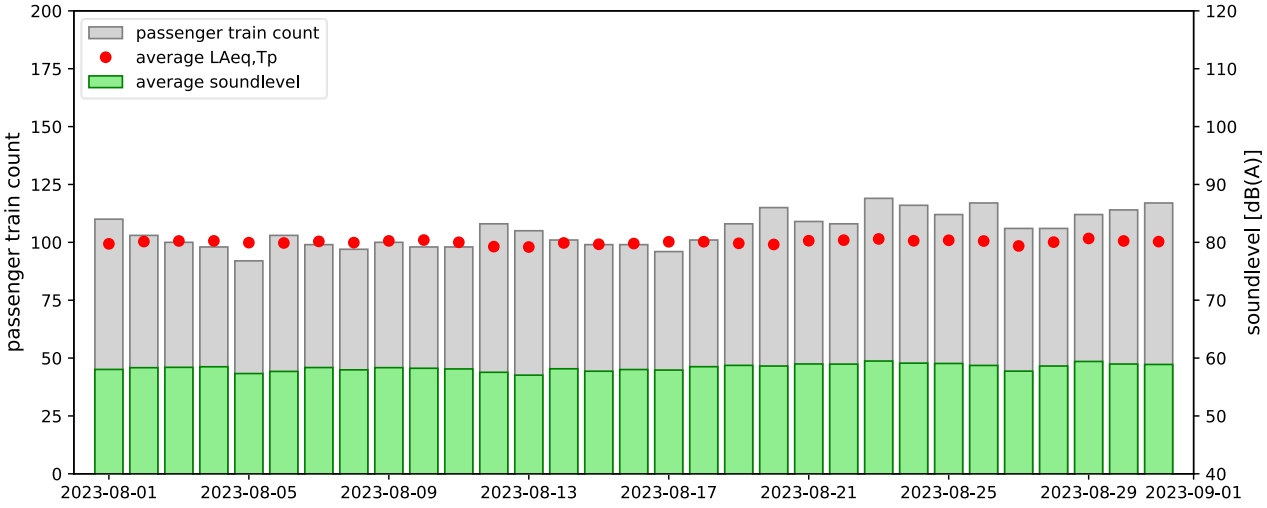
2. Measurement data

Daytime averages (24h) for all train passages at reference section (REF)



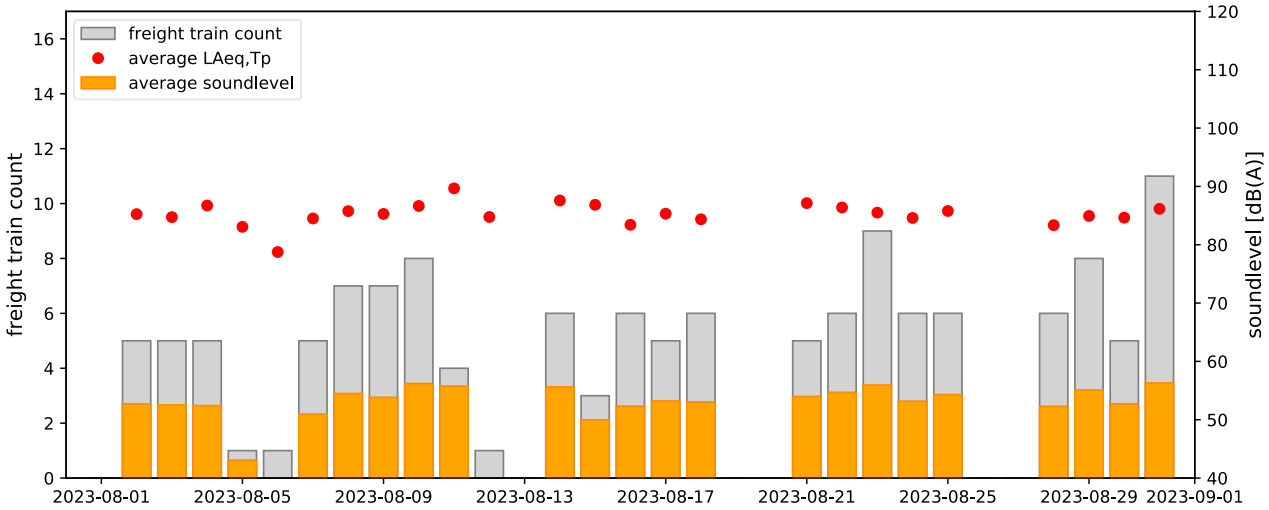
date	location	train count	passenger train count	freight train count	service train count	average LAeqTp	average soundlevel
01.08.2023	REF	111	110	0	1	79,8	58,1
02.08.2023	REF	109	103	5	1	80,9	59,5
03.08.2023	REF	107	100	5	2	81	59,6
04.08.2023	REF	105	98	5	2	81	59,4
05.08.2023	REF	95	92	1	2	80,1	57,6
06.08.2023	REF	104	103	1	0	79,9	57,8
07.08.2023	REF	106	99	5	2	80,8	59,3
08.08.2023	REF	108	97	7	4	81,3	59,8
09.08.2023	REF	111	100	7	4	81,3	59,8
10.08.2023	REF	109	98	8	3	82	60,3
11.08.2023	REF	104	98	4	2	81,9	60,2
12.08.2023	REF	110	108	1	1	79,4	57,8
13.08.2023	REF	105	105	0	0	79,2	57
14.08.2023	REF	108	101	6	1	81,6	60,2
15.08.2023	REF	105	99	3	3	80,4	58,6
16.08.2023	REF	108	99	6	3	80,5	59,1
17.08.2023	REF	103	96	5	2	81,1	59,3
18.08.2023	REF	108	101	6	1	80,9	59,7
19.08.2023	REF	110	108	0	2	80	58,9
20.08.2023	REF	115	115	0	0	79,6	58,6
21.08.2023	REF	116	109	5	2	81,3	60,2
22.08.2023	REF	116	108	6	2	81,5	60,4
23.08.2023	REF	128	119	9	0	81,7	61,1
24.08.2023	REF	124	116	6	2	81	60,3
25.08.2023	REF	120	112	6	2	81,3	60,4
26.08.2023	REF	121	117	0	4	80,4	58,9
27.08.2023	REF	106	106	0	0	79,4	57,7
28.08.2023	REF	114	106	6	2	80,6	59,7
29.08.2023	REF	125	112	8	5	81,7	61
30.08.2023	REF	122	114	5	3	81	60,1
31.08.2023	REF	129	117	11	1	81,6	60,8
month	**REF**	**3462**	**3266**	**137**	**59**	**80,9**	**59,5**

Daytime averages (24h) for all passenger train passages at reference section (REF)



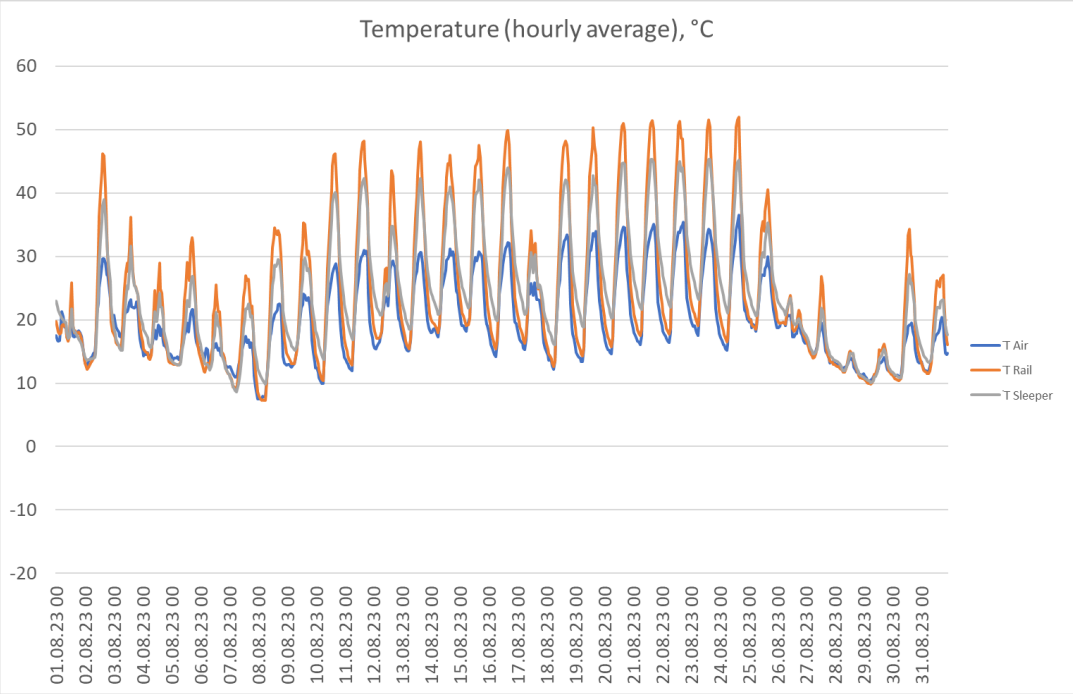
date	location	passenger train count	average speed	average length	average axlecount	average LAeqTp	average soundlevel
01.08.2023	REF	110	112,3	148,4	21,6	79,7	58
02.08.2023	REF	103	111,3	151,1	21,6	80,1	58,3
03.08.2023	REF	100	109,9	153,5	22	80,2	58,4
04.08.2023	REF	98	111,7	161,4	23	80,2	58,5
05.08.2023	REF	92	112	141,2	20,1	79,9	57,3
06.08.2023	REF	103	112,1	137,2	19,8	79,9	57,7
07.08.2023	REF	99	110,7	153,8	22,1	80,2	58,4
08.08.2023	REF	97	111,2	152,5	21,9	79,9	58
09.08.2023	REF	100	111,9	151,7	21,8	80,2	58,3
10.08.2023	REF	98	110,9	148,8	21,4	80,4	58,2
11.08.2023	REF	98	112,8	160,6	22,6	80	58,1
12.08.2023	REF	108	111	144,4	20,3	79,3	57,5
13.08.2023	REF	105	111,7	139	19,5	79,2	57
14.08.2023	REF	101	112,3	163,2	23	79,9	58,1
15.08.2023	REF	99	112,4	157,5	22,3	79,7	57,7
16.08.2023	REF	99	111,8	161,9	23	79,8	58
17.08.2023	REF	96	113,8	155,2	22,1	80,1	57,9
18.08.2023	REF	101	110,7	162,4	22,9	80,1	58,5
19.08.2023	REF	108	110,9	171,3	24,2	79,8	58,7
20.08.2023	REF	115	111,6	163,4	23,5	79,6	58,6
21.08.2023	REF	109	112,4	164	23,8	80,3	59
22.08.2023	REF	108	110,7	161,3	23,4	80,4	59
23.08.2023	REF	119	111,6	158	22,9	80,6	59,5
24.08.2023	REF	116	113	160,5	23,2	80,3	59,1
25.08.2023	REF	112	113,3	165,3	23,8	80,4	59,1
26.08.2023	REF	117	112,5	144,4	20,6	80,2	58,7
27.08.2023	REF	106	110,3	145	20,8	79,4	57,7
28.08.2023	REF	106	110,6	162,6	23,4	80	58,6
29.08.2023	REF	112	113,3	162,1	23,5	80,7	59,4
30.08.2023	REF	114	113,2	159,8	23,2	80,2	59
31.08.2023	REF	117	112,9	157	22,7	80,1	58,9
month	**REF**	**3266**	**111,8**	**155,5**	**22,3**	**80,1**	**58,4**

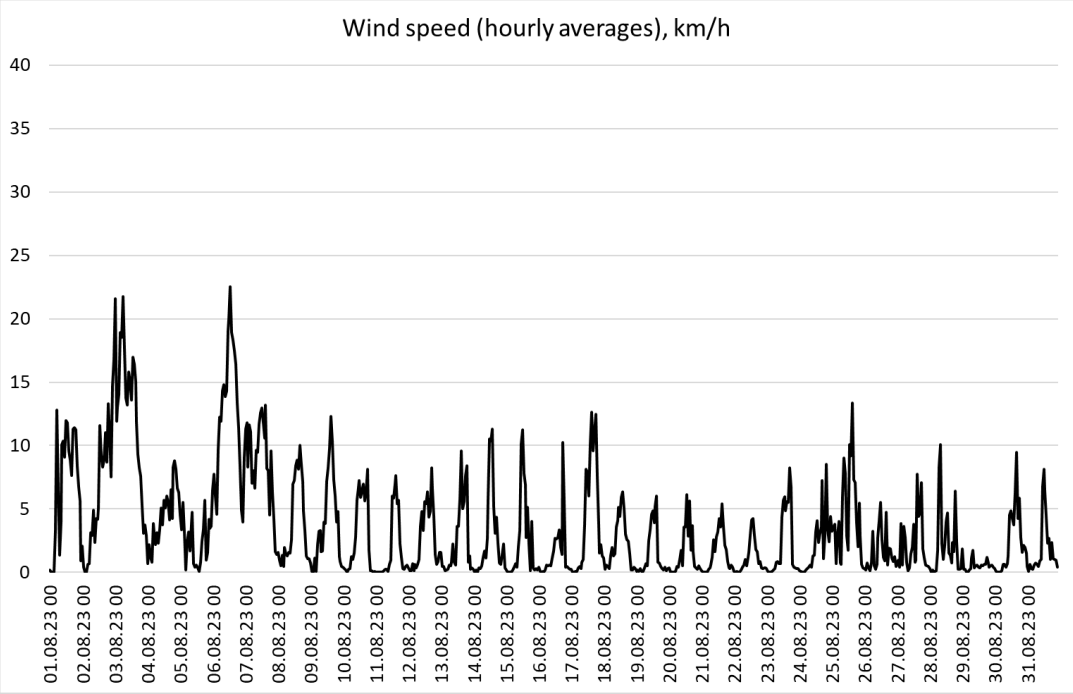
Daytime averages (24h) for all freight train passages at reference section (REF)



date	location	freight train count	average speed	average length	average axle count	average LAeqTp	average soundlevel
01.08.2023	REF	0					0
02.08.2023	REF	5	78,3	199,4	48,4	85,2	52,7
03.08.2023	REF	5	88,1	243	54	84,7	52,5
04.08.2023	REF	5	93,9	159,3	38	86,7	52,4
05.08.2023	REF	1	88,9	200,7	42	83,1	43,1
06.08.2023	REF	1	62,8	131,9	26	78,8	38,8
07.08.2023	REF	5	89,3	176,1	35,6	84,5	51
08.08.2023	REF	7	89,4	220,2	50,9	85,8	54,5
09.08.2023	REF	7	92,1	220,5	50,6	85,3	53,8
10.08.2023	REF	8	91,4	222,8	52	86,6	56,2
11.08.2023	REF	4	99,2	230,3	55,5	89,7	55,8
12.08.2023	REF	1	99,8	57,9	14	84,8	38,9
13.08.2023	REF	0					0
14.08.2023	REF	6	90,6	213,8	47,7	87,6	55,6
15.08.2023	REF	3	97	151,1	24,7	86,8	50
16.08.2023	REF	6	74,6	218,5	48	83,4	52,3
17.08.2023	REF	5	79,1	218,2	49,2	85,3	53,2
18.08.2023	REF	6	79,3	210,1	45,7	84,4	53,1
19.08.2023	REF	0					0
20.08.2023	REF	0					0
21.08.2023	REF	5	91,6	203,6	40	87,1	54
22.08.2023	REF	6	87,6	224,7	54,7	86,4	54,7
23.08.2023	REF	9	86,7	242,4	54,2	85,5	55,9
24.08.2023	REF	6	83,6	218	49,7	84,6	53,2
25.08.2023	REF	6	84,3	216,7	48,7	85,8	54,3
26.08.2023	REF	0					0
27.08.2023	REF	0					0
28.08.2023	REF	6	75,1	199,6	43	83,4	52,3
29.08.2023	REF	8	85,8	252,4	59	84,9	55,1
30.08.2023	REF	5	85	248,3	51,2	84,6	52,7
31.08.2023	REF	11	90,6	193,4	40,6	86,2	56,3
month	**REF**	**137**	**86,7**	**213,5**	**47,6**	**85,7**	**52,6**

3. Weather data





Appendix: measurement quantities

Transit Exposure Level *TEL*

A-weighted sound pressure level of a single train pass-by as energetic average over the entire exposure duration *T* and averaged over the pass-by duration T_p.

$$TEL = 10\,log\left(\frac{1}{T_p}\int_0^T \frac{p_A^2(t)}{p_0^2}dt\right) \quad (1)$$

Where

$p_A(t)$ = the A-weighted sound pressure, [Pa]

$p0 = 20\,\mu Pa$ (reference pressure), [Pa]

$Tp = T_2 - T_1$ = pass-by duration of the train, time interval during which a train is within the measurement cross-section and which starts with the entry time T_1into the measurement cross-section and ends with the exit time T_2, [s]

$T =$ time interval which starts when the smoothed sound pressure level (sound pressure level smoothed as a function of time with the frequency weighting A and a time weighting F („fast“) or averaging over a duration period of time, e.g. 100 ms) is for the last time 10 dB below that prevailing at the time of entering the measurement cross-section and which ends when the smoothed sound pressure level is for the first time 10 dB below the one at the time of leaving the measurement cross-section. [s]

A-weighted equivalent sound pressure level of the train pass-by $L_{Aeq,Tp}$

The A-weighted equivalent sound pressure level equals the (energetic) average of the sound pressure level over the train pass-by time T_p according to the following equation:

$$L_{Aeq,Tp} = 10\,log\left(\frac{1}{T_p}\int_{T_1}^{T_2} \frac{p_A^2(t)}{p_0^2}dt\right) \quad (2)$$

where

$p_A(t)$ = the A-weighted sound pressure, [Pa]

$p0 = 20\,\mu Pa$ (reference sound pressure), [Pa]

$Tp = T_2 - T_1$ = pass-by duration of the train, [s]

Sound Exposure Level *SEL*

The sound exposure level *SEL* references the acoustic energy of the entire pass-by event to one second. The SEL is used in calculating average sound level contributions from trains over longer periods of time (i.e. days/months/year). The SEL is related to the transit exposure level TEL through:

$$SEL = \mathrm{TEL} - 10 \log (T_0 / T_p) \quad (3)$$

where

T_0 = 1 [s]

Tp = pass-by duration of the train, [s]

Average sound level (period)

Average (energetic) A-weighted sound pressure level measured over a given period of time.

For the average sound level contributions from train pass-byes this equals the sum (energetic) of all sound exposure levels during the period for a given measurement position:

$$average\ soundlevel = 10 \cdot log10 \left(\sum 10^{\frac{SEL}{10}} \right) - A1 \quad (4)$$

where

A1 = $10 \cdot log10(n \cdot 24 \cdot 3600)$ for a 24-hour period

SEL (see equation 3) taken from measurement data

n = number of days being averaged over

Average $L_{Aeq,Tp}$

Average (energetic) sound level of all the A-weighted sound pressure levels from the individual equivalent sound level of all train pass-byes in a given period of time (day/month/year).

Calculated per train category and per period day/night, month, year, etc. and per measurement location:

$$average\ L_{Aeq,Tp} = 10 \cdot log10 \left(\sum T_p \cdot 10^{\frac{L_{Aeq,Tp}}{10}} \right) + 10 \cdot log10 \left(\frac{1}{\sum T_p} \right) \quad (5)$$

where

Tp = pass-by duration of the train [s]

$L_{Aeq,Tp}$ (see equation 2) is calculated directly from the measurement data