THE GLOBAL STANDARD
FOR LIVESTOCK DATA

ICAR RE-CERTIFICATION

Company name: FOSS Analytical A/S

Instrument name: MilkoScan™ 7 RM

Milk species: Cow Milk

Author: Silvia Orlandini

Approved and revised by Milk Analyses Sub Committee

Version March 2025

Network. Guidelines. Certification.

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1. Preface

MilkoScan™ 7 RM was fully certified by ICAR in April 2020 with the organization of a interlaboratory study.

The purpose of this report is to evaluate if the instrument, introduced on the market at the end of 2016 is still meeting the requirements of the previous granted certification after five years.

MilkoScan™ 7 RM is provided with Diamond or CaF2 cuvette identified by a red or green interferometer box. The instrument speed is up to 600 samples/h. The instrument is applied in central milk testing laboratories and dairy laboratories for milk recording analysis and milk payment testing.

The instrument can be provided with calibrations for several milk parameters. In this re-certification, for ICAR DHI purposes, its performance has been for fat, protein, lactose and urea.

The data obtained in the ICAR proficiency test and from the interviewed laboratories have been used for the evaluation.

The limits reported in reference documents reported below and the above results obtained, will be considered in the evaluation.

The performances will be evaluated against criteria listed in:

- ICAR protocol “Procedure 1 of Section 12 of ICAR Guidelines – Protocols for Evaluation of Milk Analyses for ICAR Approval”,

  which in turn is aligned with

  - ISO 8196-3|IDF 128-3– Milk — Definition and evaluation of the overall accuracy of alternative methods of milk analysis — Part 3: Protocol for the evaluation and validation of alternative quantitative methods of milk analysis and
  - ISO 9622|IDF 141 – Milk — Milk and liquid milk products — Guidelines for the application of mid-infrared spectrometry

2. Principle

MilkoScan™ 7 RM is an automatic, high resolution spectrophotometer, based on Fourier Transform Infrared (FTIR). The instrument is provided with a diamond or CaF2 cuvette and works at a speed of up to 600 samples/h.

3. Scope

The scope of the re-certification was raw cow milk.

4. Data evaluated

- Nine rounds of ICAR Proficiency test from March 2021 to March 2025 (the participants PT do not specify the cuvette type and the analyses speed, samples/h set.
- Raw data and report from Milchprüfring-Bayern (DE) 2024 on 11 MilkoScan™ 7 RM

(diamond cuvette with a speed of 600 samples/h)

5. ICAR proficiency tests

The ICAR proficiency test data from March 2021 to March 2025 have been evaluated. For the purpose of re-certification, these data were used to calculate and assess the repeatability of the MilkoScan™ 7 RM.

The reproducibility has been not evaluated because is influenced by the calibration settings specific to each laboratory.

For the parameters fat, protein, and lactose, the repeatability of the MilkoScan™ 7 RM was found to be:

Fat: r = 0.02

Protein: r = 0.02

Lactose: r = 0.01

These values are all below the FT-IR instrument limit defined by ISO 8196-3 | IDF 128-3, which is r ≤ = 0.02 g/100g.

For urea, the limits were calculated using ICAR proficiency test data collected from 2016 to 2025. The MilkoScan™ 7 RM showed a repeatability of r = 0.186 mg/dl, which is well below the defined limit of r ≤ = 2.63 mg/dl.

Table 1.,2.,3. And 4. Report the results of each proficiency test for MilkoScan™ 7 and its overall performance. Figures 1.,2.,3. and 4 show the results and limits.

Table 1. ICAR PT Fat - Summary Table

	rt0321	rt0921	rt0322	rt0922	rt0323	rt0923	rt0324	rt0924	rt0325	Overall
count	21	15	21	18	24	14	21	16	23	
n samples	210	150	210	180	240	140	210	160	230	1730
n.outliers Cochran	8	1	2	1	0	1	1	1	2	
n outliers Grubbs	2	3	0	7	2	6	3	4	6	
average	3,26	3,21	3,27	3,23	3,25	3,26	4,02	3,99	3,89	
s_r^2	3,22E-05	3,55E-05	2,83E-05	2,72E-05	2,33E-05	4,63E-05	5,44E-05	6,72E-05	4,23E-05	3,96E-05
s_r	0,006	0,006	0,005	0,005	0,005	0,007	0,007	0,008	0,007	0,006
s_L^2	0,002452	0,001513	0,00108	0,00183	0,000759	0,011666	0,022331	0,003721	0,00313	
s_R^2	0,002485	0,001549	0,001109	0,001857	0,000783	0,011712	0,022385	0,003788	0,003172	0,005427
s_R	0,050	0,039	0,033	0,043	0,028	0,108	0,150	0,062	0,056	0,074
s_r_relative	0,2	0,2	0,2	0,2	0,1	0,2	0,2	0,2	0,2	
sR_relative	1,5	1,2	1,0	1,3	0,9	3,3	3,7	1,5	1,4	
repeatability	0,02	0,02	0,01	0,01	0,01	0,02	0,02	0,02	0,02	0,02
Reproducibility	0,14	0,11	0,09	0,12	0,08	0,30	0,42	0,17	0,16	0,21
repeatability_relative	0,49	0,52	0,46	0,45	0,42	0,58	0,51	0,58	0,47	0,5
Reproducibility_relative	4,28	3,43	2,85	3,74	2,41	9,31	10,42	4,32	4,06	5,0

Figure 1. ICAR PT Fat

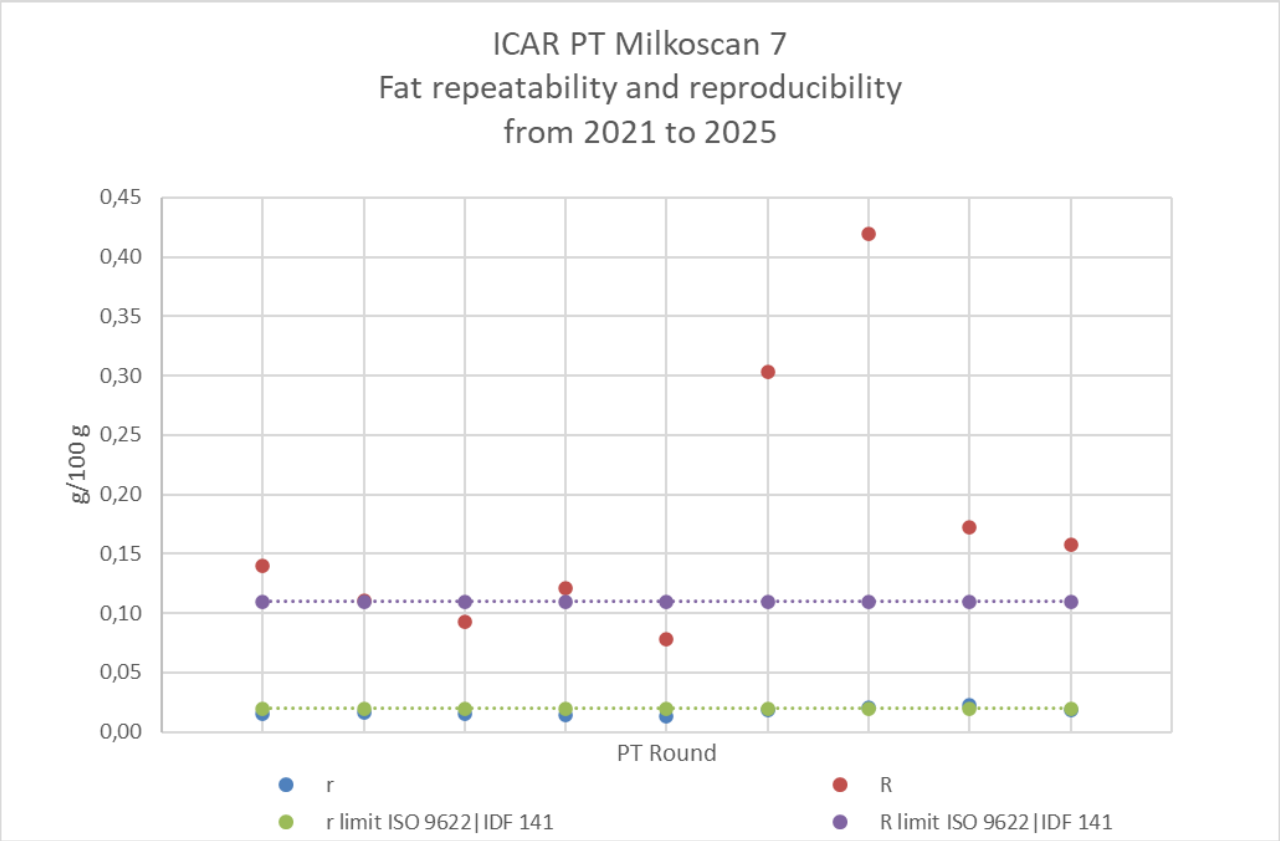


Table 2. ICAR PT protein - Summary Table

	rt0321	rt0921	rt0322	rt0922	rt0323	rt0923	rt0324	rt0924	rt0325	overall
count	21	9	14	13	19	9	16	11	19	
n samples	210	90	140	130	190	90	160	110	190	1310
n.outliers Cochran	0	0	0	7	0	0	3	1	1	
n outliers Grubbs	0	0	5	5	0	0	2	0	0	
average	3,21	3,26	3,23	3,28	3,24	3,22	3,23	3,21	3,23	
s_r^2	2,95E-05	2,39E-05	1,85E-05	2,28E-05	2,47E-05	3,78E-05	4,44E-05	5,7E-05	2,62E-05	3,16E-05
s_r	0,005	0,005	0,004	0,005	0,005	0,006	0,007	0,008	0,005	0,006
s_L^2	0,002032	0,002668	0,000704	0,002584	0,011533	0,002573	0,00395	0,002366	0,002446	
s_R^2	0,002061	0,002692	0,000723	0,002607	0,011558	0,002611	0,003995	0,002423	0,002473	0,00346
s_R	0,045	0,052	0,027	0,051	0,108	0,051	0,063	0,049	0,050	0,059
s_r_relative	0,2	0,2	0,1	0,1	0,2	0,2	0,2	0,2	0,2	
sR_relative	1,4	1,6	0,8	1,6	3,3	1,6	2,0	1,5	1,5	
repeatability	0,02	0,01	0,01	0,01	0,01	0,02	0,02	0,02	0,01	0,02
Reproducibility	0,13	0,15	0,08	0,14	0,30	0,14	0,18	0,14	0,14	0,16
repeatability_relative	0,47	0,42	0,37	0,41	0,43	0,53	0,58	0,66	0,44	0,5
Reproducibility_relative	3,96	4,46	2,33	4,35	9,28	4,44	5,47	4,29	4,31	4,8

Figure 2. ICAR PT protein

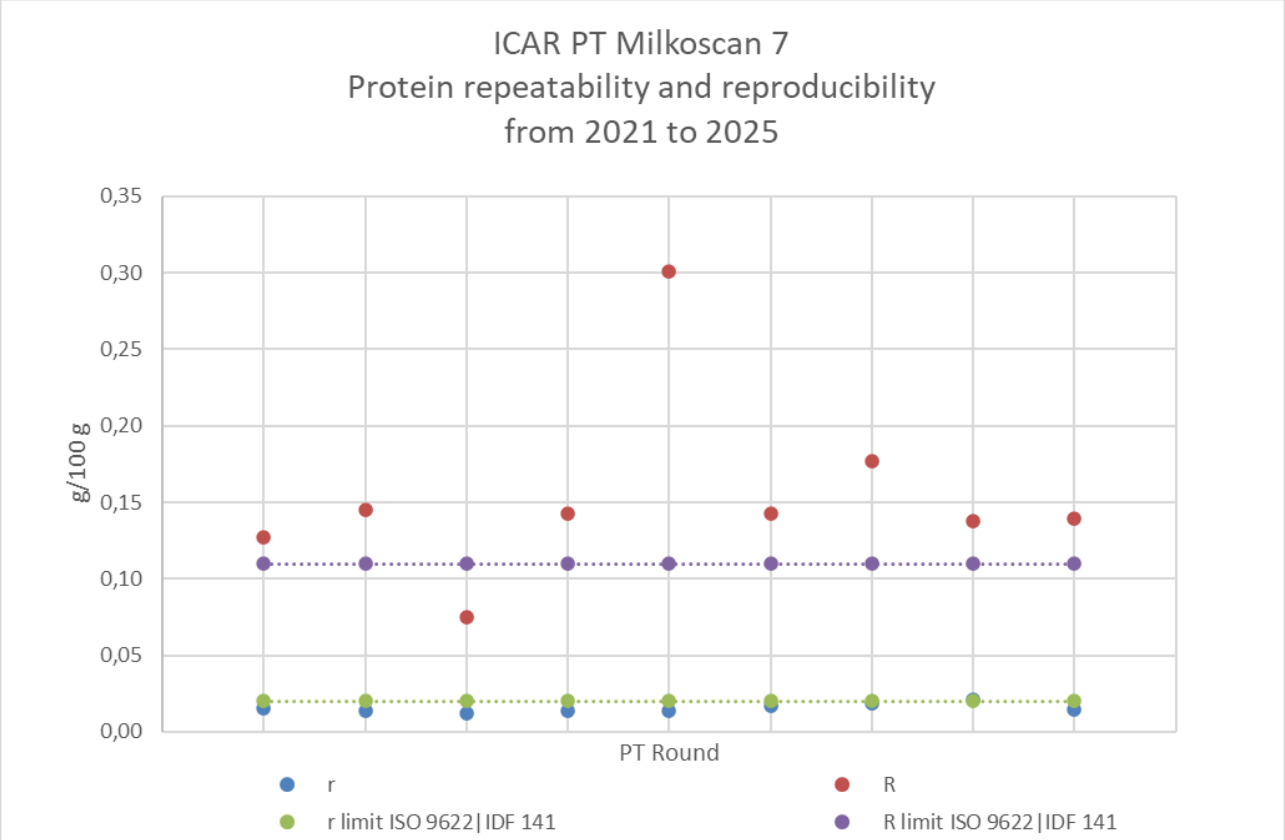


Table 3. ICAR PT lactose - Summary Table

	rt0321	rt0921	rt0322	rt0922	rt0323	rt0923	rt0324	rt0924	rt0325	Overall
count	20	13	19	18	22	12	18	16	23	
n samples	200	130	190	180	220	120	180	160	230	1610
n.outliers Cochran	1	3	9	2	0	5	3	2	2	
n outliers Grubbs	2	0	0	8	2	0	7	0	7	
average	4,86	4,93	4,77	4,72	4,80	4,79	4,93	4,80	4,85	
s_r^2	1,58E-05	2,36E-05	1,28E-05	1,27E-05	1,52E-05	1,32E-05	1,41E-05	3,47E-05	1,64E-05	1,76E-05
s_r	0,004	0,005	0,004	0,004	0,004	0,004	0,004	0,006	0,004	0,004
s_L^2	0,001117	0,00375	0,006994	0,009489	0,003662	0,001282	0,000949	0,003952	0,001695	
s_R^2	0,001133	0,003774	0,007007	0,009502	0,003677	0,001295	0,000963	0,003987	0,001711	0,003672
s_R	0,034	0,061	0,084	0,097	0,061	0,036	0,031	0,063	0,041	0,061
s_r_relative	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	
sR_relative	0,7	1,2	1,8	2,1	1,3	0,8	0,6	1,3	0,9	
repeatability	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,02	0,01	0,01
Reproducibility	0,09	0,17	0,23	0,27	0,17	0,10	0,09	0,18	0,12	0,17
repeatability_relative	0,23	0,28	0,21	0,21	0,23	0,21	0,21	0,34	0,23	0,2
Reproducibility_relative	1,94	3,49	4,92	5,78	3,53	2,10	1,76	3,68	2,39	3,3

Figure 3. ICAR PT lactose

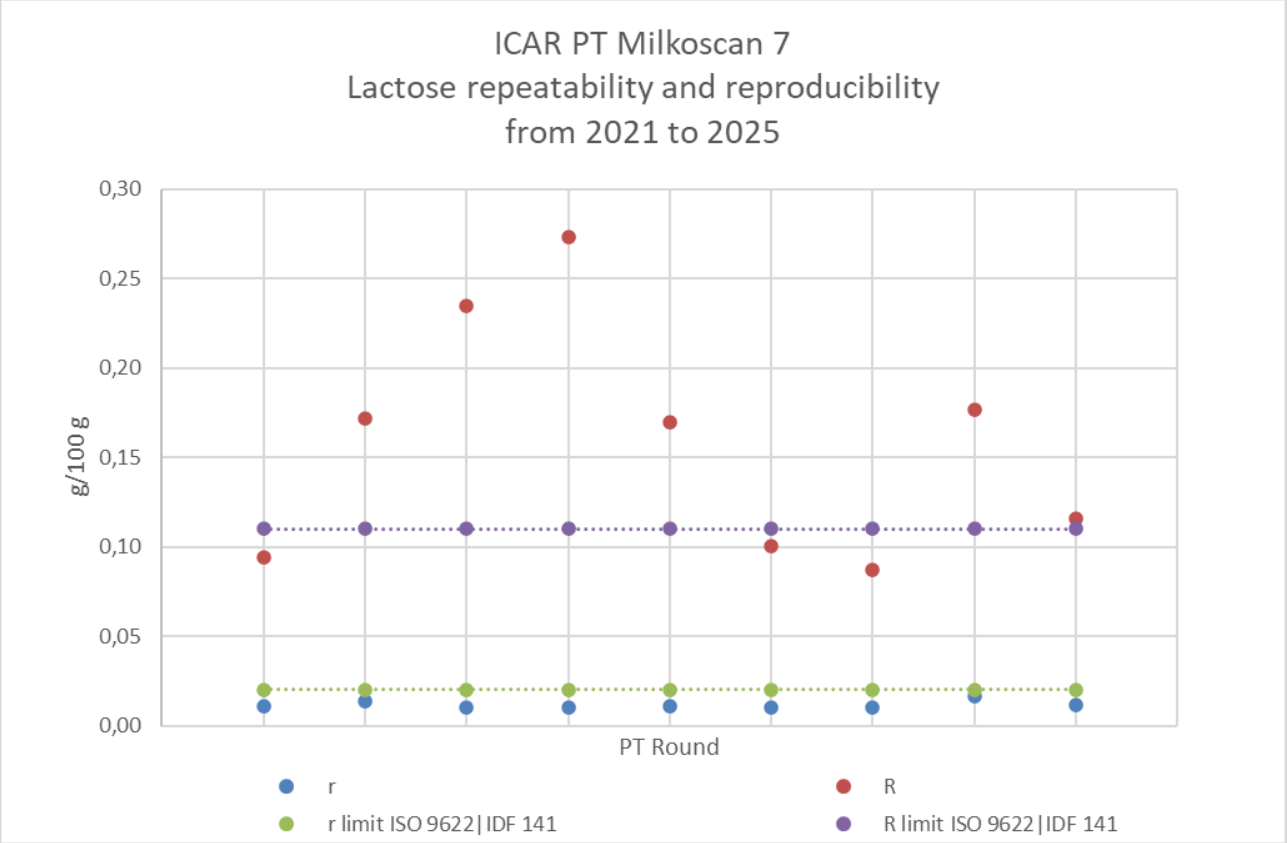
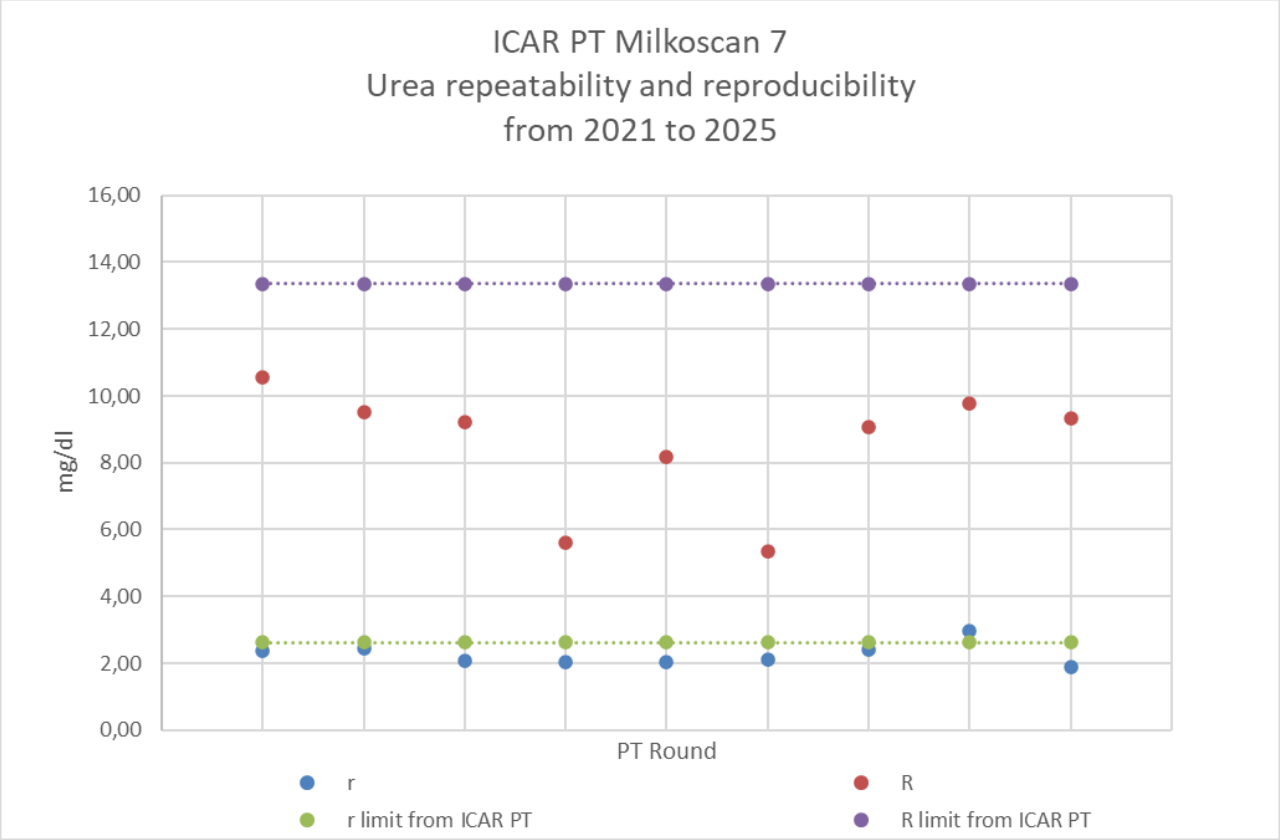


Table 4. ICAR PT urea - Summary Table

	rt0321	rt0921	rt0322	rt0922	rt0323	rt0923	rt0324	rt0924	rt0325	Overall
count	21	12	20	16	22	13	20	15	23	
n samples	210	120	200	160	220	130	200	150	230	1620
n.outliers Cochran	1	0	2	1	1	0	0	0	0	
n outliers Grubbs	0	0	0	0	0	0	2	0	0	
average	39,98	39,72	39,10	43,84	41,62	40,66	40,39	42,92	39,70	
s_r^2	0,706655	0,757165	0,553514	0,532082	0,529841	0,574201	0,738685	1,136441	0,460678	0,665474
s_r	0,841	0,870	0,744	0,729	0,728	0,758	0,859	1,066	0,679	0,816
s_L^2	13,5444	10,77106	10,29749	3,45458	7,9883	3,053266	9,742131	11,0848	10,60777	
s_R^2	14,25105	11,52822	10,851	3,986662	8,518141	3,627467	10,48082	12,22124	11,06845	9,614783
s_R	3,775	3,395	3,294	1,997	2,919	1,905	3,237	3,496	3,327	3,101
s_r_relative	2,1	2,2	1,9	1,7	1,7	1,9	2,1	2,5	1,7	
sR_relative	9,4	8,5	8,4	4,6	7,0	4,7	8,0	8,1	8,4	
repeatability	2,35	2,44	2,08	2,04	2,04	2,12	2,41	2,98	1,90	2,28
Reproducibility	10,57	9,51	9,22	5,59	8,17	5,33	9,06	9,79	9,32	8,68
repeatability_relative	5,89	6,13	5,33	4,66	4,90	5,22	5,96	6,95	4,79	5,5
Reproducibility_relative	26,44	23,93	23,59	12,75	19,64	13,12	22,44	22,81	23,46	20,9

Figure 4. ICAR PT urea



6. Stability

In 2024, Milchprüfring Bayern (DE) provided statistics on pilot sample analysis. A total of 410.093 pilot samples were examined, of which 7.501 were found to be outside the specified tolerance limits for fat, protein, lactose, or urea—resulting in a deviation rate of 1.83%.

Pilot samples are analyzed systematically: two are measured at the beginning and end of each batch, and also after every 45 DHI samples. The acceptance range is defined as ±0.05% for fat, protein, and lactose, and ±40 mg/l for urea. Both pilot samples must fall within these limits. The maximum permissible deviation for a single pilot sample is ±0.09% for fat, protein, and lactose, and ±60 mg/l for urea.

If any of the measured values fall outside the acceptance range, the analysis is automatically halted. The device operator is then required to identify and correct the source of the deviation. After corrective action, two new pilot samples must be analyzed at system start-up, and the last 45 samples must be reanalyzed to ensure instrument stability.

To calculate the intralaboratory reproducibility, Milchprüfring Bayern (DE) provided raw data results of a pilot sample analyzed using 11 MilkoScan™ 7 RM instruments over eight different working days, from 2023 through January 2025.
Each daily session had an average working time of about 14 hours.

A total of 7966 pilot data were received for fat, protein, and urea, and 4488 for lactose. These results were subjected to statistical analysis.

The standard deviation of intralaboratory reproducibility (sRintra) was calculated considering the pilot repeatability (sr) and the pilot standard deviation between instruments (sL) of eight working routine day.

Table 5. shows that the intra laboratory reproducibility is calculated for each working session on the 11 instrument. Only for working session 30.01 2023 the results were slightly above the limits

The overall Intra-laboratory reproducibility is:

R_{intra_Fat} MS7=0,035 g/100g is in the limit of $R_{intra\_Fat\_limit}$ ≤ 0,04 g/100g

$R_{intra\_Protein}$ MS7=0,027 g/100g is in the limit of $R_{intra\_Protein\_limit}$ ≤ 0,04 g/100g

$R_{intra\_Lactose}$ MS7=0,028 g/100g is in the limit of $R_{intra\_Lactose\_limit}$ ≤ 0,04 g/100g

R_{intra_Urea} MS7=4,05 mg/dl is in the limit of $R_{intra\_Urea\_limit}$ ≤ 5,60 mg/dl

Table 5. Results of pilot sample on 11 MilkoScanTM 7 RM

		30.01.2023	13.03.2023	21.04.2023	21.05.2023	13.06.23	16/12/2024	17/12/2024	15/01/2025	Overall	Limit ISO 8196-3 |IDF 128-3
Fat [%]	Mean	4,37	4,20	4,31	4,12	4,09	4,41	4,49	4,36	4,29	
	s	0,015	0,010	0,010	0,012	0,011	0,011	0,012	0,012	0,012	
	s%	0,35	0,25	0,24	0,28	0,27	0,24	0,27	0,26	0,27	
	sr	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	
	SL_{intra}	0,015	0,010	0,009	0,011	0,010	0,010	0,011	0,011	0,011	
	SR_{intra}	0,016	0,011	0,011	0,012	0,012	0,012	0,013	0,012	0,013	0,014
	R_{intra}	0,045	0,032	0,031	0,035	0,034	0,032	0,036	0,034	0,035	0,04
	n	706	772	931	887	1192	1204	1204	1030	7926	
Protein [%]	Mean	3,65	3,62	3,53	3,58	3,49	3,71	3,73	3,71	3,63	
	s	0,008	0,009	0,007	0,008	0,009	0,010	0,009	0,008	0,009	
	s%	0,23	0,24	0,21	0,23	0,27	0,26	0,25	0,22	0,24	
	sr	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	0,006	
	SL_{intra}	0,007	0,008	0,006	0,007	0,008	0,009	0,008	0,007	0,008	
	SR_{intra}	0,009	0,010	0,009	0,009	0,010	0,010	0,010	0,009	0,010	0,014
	R_{intra}	0,026	0,027	0,024	0,026	0,029	0,029	0,029	0,026	0,027	0,040
	n	706	772	931	887	1192	1204	1244	1030	7966	
Lactose %	Mean	4,80	4,81	4,78	4,80	4,81				4,80	
	s	0,010	0,011	0,008	0,008	0,009				0,009	
	s%	0,21	0,23	0,18	0,17	0,19				0,20	
	sr	0,004	0,004	0,004	0,004	0,004				0,004	
	SL_{intra}	0,010	0,011	0,008	0,007	0,009				0,009	
	SR_{intra}	0,011	0,012	0,009	0,008	0,010				0,010	0,014
	R_{intra}	0,030	0,032	0,025	0,024	0,027				0,028	0,040
	n	706	772	931	887	1192				4488	
Urea [mg/dL]	Mean	24	24	23	25	29	25	21	22	24,09	
	s	1,34	1,28	1,44	1,37	1,32	1,28	1,25	1,31	1,33	
	s%	5,57	5,29	6,36	5,42	4,62	5,20	5,91	5,96	5,51	
	sr	0,82	0,82	0,82	0,82	0,82	0,82	0,82	0,82	0,82	
	SL_{intra}	1,213	1,145	1,324	1,248	1,189	1,142	1,108	1,177	1,19	
	SR_{intra}	1,462	1,406	1,555	1,491	1,442	1,403	1,376	1,433	1,45	2,00
	R_{intra}	4,093	3,937	4,355	4,175	4,037	3,929	3,854	4,011	4,05	5,60
	n	706	772	931	887	1192	1204	1244	1030	7966	

MilkoScan™ 7 RM showed a very stable performance in between periodic maintenance each 3 months (appr. 450-500 $*10^3$ samples).

7. Robustness

Milchprüfring Bayern provided information on their collaboration with the manufacturer and the technical support arrangements, summarized as follows:

"In addition to the scheduled maintenance performed every three months, Foss Germany organizes two meetings per year to discuss potential technical issues and future improvements with customers.

Thanks to the pay-per-sample contract, nearly all spare parts are kept in stock at the MPR laboratory. We receive excellent technical support: if a problem arises that we cannot resolve internally, a Foss technician is available upon request.

While the system is generally robust, a few technical issues have been observed:

- *The MS H-pump components (piston, cylinder, motor, gear) tend to wear out more quickly than expected.*
- *The MS H-30 unit may fail and cause carry-over; in such cases, it is sent to Foss Hamburg for repair.*
- *MS Accumulator assembly requires more frequent readjustment."*

Members of the ICAR Milk Analysis Subcommittee reported that instruments configured for slower output speeds (fewer than 600 samples per hour) exhibited lower repeatability.

8. Foss report on the software change log

The following information are about new or changed functionality compared to earlier versions of the Foss Integrator Software.

8.1 Version 3.6.2. Release July 2024

1. In some rare scenarios the H-pump would report pressure stroke power incorrectly. "H-pump min. vs. max. current" was changed to the new, reliable "H-pump mean current".
2. A customer lost several samples as the software did not react properly to an internal crash, instead it kept running. Fault handling was improved to prevent such situations going forward.

8.2 Version 3.6.1. Release July 2023

3. Support for SQL 2014 and Win 7 ended.
4. Spectra were missing on LIMS export to SQL.
5. Zero settings hang in state change from Measure to Standby when Zero container get empty. The error means that Foss Integrator must be restarted, however there is no loss of results. Now it is possible to make a new Zero liquid, do a Purge and continue measurements.

8.3 Version 3.6.0. Release October 2022

6. After running the rinse job, Foss Integrator asks to put a cup under the pipette and do the job a second time. In one of the places there were errors after the job was done. This has been fixed.

8.4 Version 3.5.0. Release November 2021

The mirror movement limit on MilkoScan™ 7 RM

7. has been changed, affecting the measurement postponed error.

9. Conclusion

The results show that the MilkoScan™ 7 RM repeatability for fat protein lactose and urea are equal or lower than the ISO 8196-3|IDF 128-3 for FT-IR instruments.

The overall intra laboratory reproducibility obtained at mpr on 11 instrument, with diamond cuvette a setting of 600 samples/h speed, are equal or lower than the ISO 8196-3|IDF 128-3 for FT IR instruments.

The data provided by Milchprüfring Bayern, provided robust evidence of the instrument's stability with the setting reported above.