

Absolute gravity measurements in the town hall (“Rathaus”) of Bad Frankenhausen with the Hannover gravity meter FG5X-220 in August 2016

(Extension to the first report about gravity determination at that site in 2015)

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In the period from 16th to 17th of August 2016, absolute gravity measurements were carried out in four runs. A run is an automatically performed sequence of free-fall experiments. Each run was organized in that way that every half an hour a set with 50 free-fall experiments (drops) were started automatically with a 10 s interval between each drop. Within the first run, only 3 sets could be accepted during the post-processing because the instrument became mis-adjusted after about 2 hours due to problems with temperature adaptation (automatic working mode, too early started with measurements).

The gravimeter was installed two times (2 setups). The first one was orientated in south direction which means that the tripod foot of the super spring with the spirit level showed southwards. The second setup was west orientated. The reason is that slightly different systematic errors are inherent in the observations from different instrumental setups. The arithmetic mean of the two g-results from the setups is the final g-value of this gravity determination.

The results from 2015 and 2016 are comprised in Tab. 3. They agree within the instrumental error estimate of the FG5X-220 gravimeter with respect to long-term repeatability. This overall estimate of the repeatability has been derived empirically as an average root mean square (r.m.s.) discrepancy from comparisons with other absolute gravimeter over the whole lifetime of the Hannover instrument, cf. first report dated 15th October, 2015. Nevertheless, the discrepancies between the single epoch results are not only caused by instrumental errors but also by real gravity variations. E.g., local hydrological variations (groundwater change) may induce several $0.01 \mu\text{m/s}^2$ (up to more than $0.1 \mu\text{m/s}^2$ in the North German basin).

Table 1: Coordinates of the absolute gravity site occupied by the Hannover meter at town hall Bad Frankenhausen in 2015 and 2016

Station at “Rathaus”	φ [deg]	λ [deg]	H [m]	Description
Cellar vault	51.3557	11.1005	130	Old “historical” basement of town hall; high air humidity; heating in small tent necessary for temperature stabilization; a permanent ground mark was installed after the observations in 2015

Table 2: Absolute gravity values of the FG5X-220 measurements on “Rathaus” point (cellar vault). The gradient insensitive sensor height (“dead-gradient-point”) depends on the gravimeter setup and is about 1.25 m above floor level. Thus, the reference height $h=1.250$ m (above floor point) is chosen for comparison reasons. For relative gravimetry, the derived g -value at $h=0.000$ m is also given.

Site Rathaus	Measurement run (orientation)	Date in 2016	Drops	$\delta g/\delta h$ [$\mu\text{m}/\text{s}^2 / \text{m}$]	$g_{h=1.250}$ [$\mu\text{m}/\text{s}^2$]	$g_{h=0.000}$ [$\mu\text{m}/\text{s}^2$]
Run 1	20160816a (S)	16. August	148	-2.678	9811717.461 s=0.001	
Run 2	20160816b (S)	16. August	548	-2.678	9811717.457 s=0.001	
Run 3	20160816c (W)	16./17. Aug.	948	-2.678	9811717.446 s=0.001	
Run 4	20160817a (W)	17. August	298	-2.678	9811717.451 s=0.001	
Average		16. – 17. Aug.	1942	-2.678	9811717.452	9811720.800

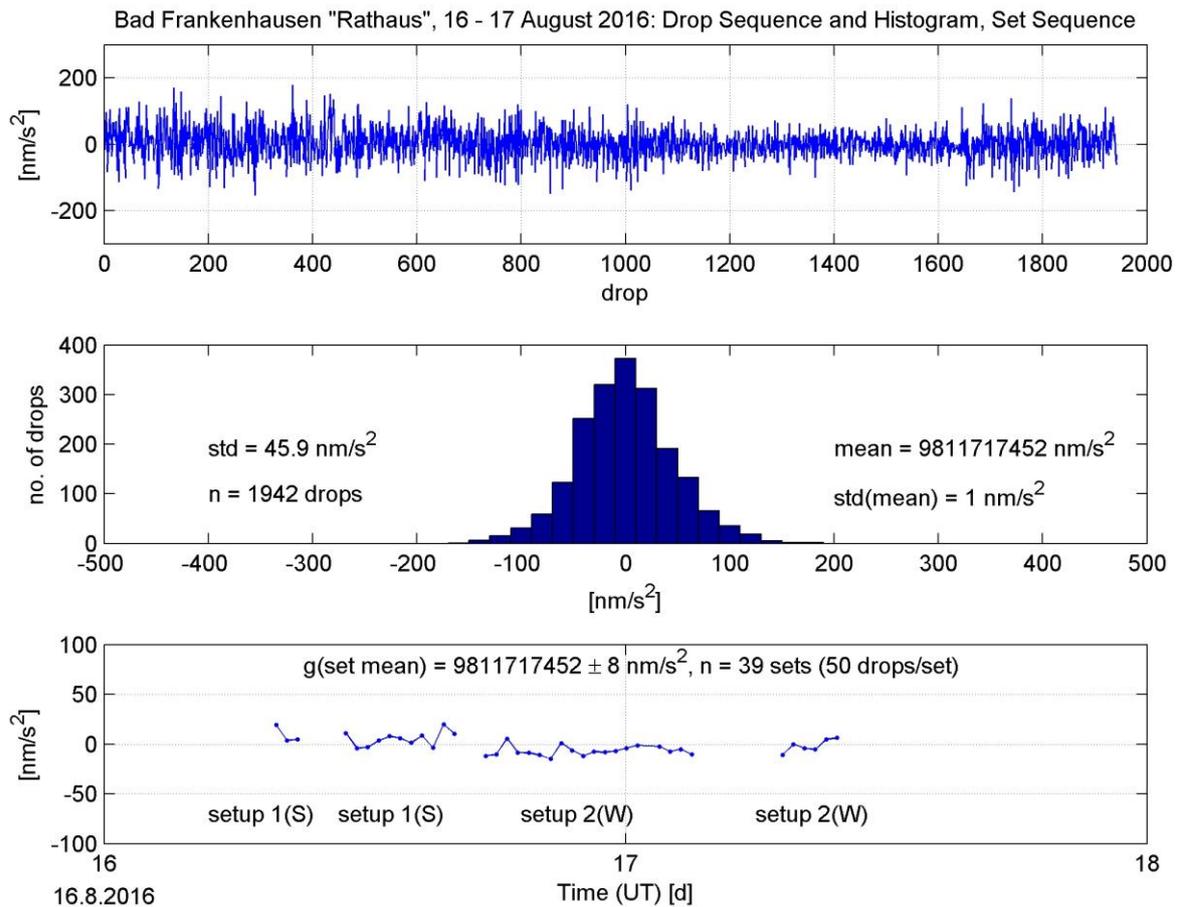


Figure 1: Statistical compilation of the station determination with the Hannover FG5X absolute gravimeter at the “Rathaus” site in Bad Frankenhausen in August 2016

Table 3: Absolute gravity results of FG5X-220 measurements since 2015
 (s(drop): std. dev. of a single drop (\equiv scatter); s(mean): std.dev. of mean result)

Station	Date	Drops	$\delta g/\delta h$ [$\mu\text{m/s}^2 / \text{m}$]	$g_{h=1..250}$ [$\mu\text{m/s}^2$]	s(drop) [$\mu\text{m/s}^2$]	s(mean) [$\mu\text{m/s}^2$]
Rathaus	22-24 June 2015	1796	-2.678	9811717.473	0.051	0.001
	16-17 Aug. 2016	1942	-2.678	9811717.452	0.046	0.001



Figure 2: The situation for the absolute gravimeter FG5X-220 in the town hall (cellar vault), August 2016. The point is officially marked and documented by the “Landesamt für Vermessungswesen und Geoinformation” of Thuringia. To avoid dirt falling down from the ceiling and to solve the humidity issue with a small heater, a cover tent was deployed.