

## Absolute gravity measurements in the town hall (“Rathaus”) of Bad Frankenhausen with the Hannover gravity meter FG5X-220 in August 2018

(Extension to the first report about gravity determination at that site in 2015, and the second report about the 2016 measurements)

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In the period from 08<sup>th</sup> to 09<sup>th</sup> of August 2018, absolute gravity measurements were carried out in three 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 (or 100) free-fall experiments (drops) were started automatically with a 10 s interval between each drop.

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 second setup consists of two runs because the operator was to some extent unsure about the adjustment due to the increasing air humidity (97% at the end). The arithmetic mean of the two g-results from the setups is the final g-value of this gravity determination.

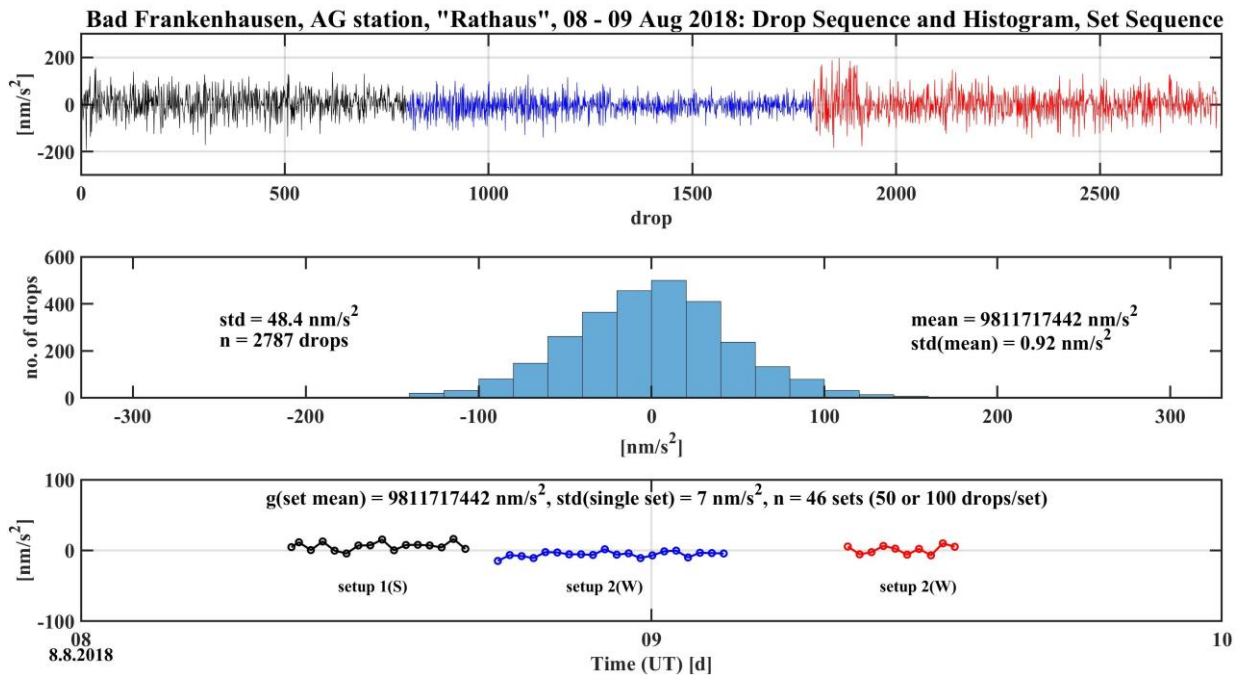
The results from 2015, 2016 and 2018 are comprised in Tab. 3. They agree within the instrumental error estimate of the FG5X-220 gravimeter with respect to long-term repeatability (no significant change since 2015). This overall estimate of the repeatability has been derived empirically as an average 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 15<sup>th</sup> 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  $0.01 \mu\text{m/s}^2$ .

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

| Station at<br>“Rathaus” | $\varphi$ [deg] | $\lambda$ [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<br><b>Rathaus</b> | Measurement run<br>(orientation) | Date in 2016   | Drops | $\delta g/\delta h$<br>[ $\mu\text{m/s}^2$ /<br>m] | $g_{h=1.250}$<br>[ $\mu\text{m/s}^2$ ] | $g_{h=0.000}$<br>[ $\mu\text{m/s}^2$ ] |
|------------------------|----------------------------------|----------------|-------|--|--|--|
| Run 1/setup1           | 20180808a (S)                    | 08. August     | 798   | -2.678   | 9811717.449                            |  |
| Run 2/setup2           | 20180808b (W)                    | 08. August     | 996   | -2.678   | 9811717.437                            |  |
| Run 3/setup2           | 20180809a (W)                    | 09. August     | 993   | -2.678   | 9811717.443                            |  |
| <b>Average</b>         |                                  | 08. – 09. Aug. | 2787  | -2.678   | <b>9811717.444</b>                     | <b>9811720.792</b>                     |



**Figure 1:** Statistical compilation of the station determination with the Hannover FG5X absolute gravimeter at the “Rathaus” site in Bad Frankenhausen in August 2018

**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 | $\delta g/\delta h$<br>[ $\mu\text{m}/\text{s}^2 / \text{m}$ ] | $g_{h=1..250}$<br>[ $\mu\text{m}/\text{s}^2$ ] | s(drop)<br>[ $\mu\text{m}/\text{s}^2$ ] | s(mean)<br>[ $\mu\text{m}/\text{s}^2$ ] |
|---------|-----------------|-------|--|--|---|---|
| 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                                   |
|         | 08-09 Aug. 2018 | 2787  | -2.678   | 9811717.444                                    | 0.048                                   | 0.001                                   |



**Figure 2:** The situation for the absolute gravimeter FG5X-220 in the town hall (cellar vault), August 2018. The point is officially marked and documented by the “Landesamt für Vermessungswesen und Geoinformation” of Thuringia. To avoid dirt falling down from the ceiling, a cover tent was deployed.