

Absolute gravity measurements in Hamburg (Groß Flottbek) at DESY (Deutsches Elektronen-Synchrotron) with the Hannover gravity meter FG5X-220 in July 2018

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

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In the period from 10th to 12th of July 2018, 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.

The gravimeter was installed three times (3 setups). The first one was orientated in north direction which means that the tripod foot of the super spring with the spirit level showed northwards. The second setup was south orientated, and the last one again northwards. During setup 2, a re-adjustment of the horizontal position of the superspring part (lower part) with respect to the dropping chamber part was performed. The reason is that slightly different systematic errors are inherent in the observations from different instrumental setups and adjustments. The arithmetic mean of the two g-results from the two setups orientations is the final g-value of this gravity determination.

The results from 2015, 2016 and 2018 are comprised in Tab. 3. They agree not within the instrumental error estimate of the FG5X-220 gravimeter with respect to long-term repeatability which is about 0.02 $\mu\text{m/s}^2$. 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 December, 2015. 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: Used coordinates of the absolute gravity site occupied by the Hannover meter FG5X-220 in Groß Flottbeck in 2015, 2016 and 2018

Station "DESY/DORIS"	φ [deg]	λ [deg]	H [m]	Description
Building 30a (Lager 048)	53.5776	9.8815	30	Perfect room conditions for abs. gravity measurements (temp. stability, low humidity, no windows, stable foundation); no permanent ground mark; coordinates from Google Earth (internet).

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	$\delta g/\delta h$ [$\mu\text{m/s}^2$ / m]	$g_{h=1..250}$ [$\mu\text{m/s}^2$]	s(drop) [$\mu\text{m/s}^2$]	s(mean) [$\mu\text{m/s}^2$]
DESY/DORIS	12-14 Oct. 2015	1994	-2.826	9813689.771	0.103	0.002
	01-04 Aug. 2016	3742	-2.826	9813689.825	0.125	0.002
	10-12 July 2018	3290	-2.826	9813689.848	0.119	0.002

Table 2: Absolute gravity values of the FG5X-220 measurements on the “DESY/DORIS” point. 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	Measurement run (orientation)	Date in 2018	Drops	$\delta g/\delta h$ [$\mu\text{m/s}^2 / \text{m}$]	$g_{h=1.250}$ [$\mu\text{m/s}^2$]	$g_{h=0.000}$ [$\mu\text{m/s}^2$]
DESY/DORIS						
Run 1	20180710a (N)	10./11. July	997	-2.826	9813689.874	
Run 2	20180711a (S)	11. July	449	-2.826	9813689.827	
Run 3	20180711b (S)	11./12. July	1199	-2.826	9813689.826	
Run 4	20180712a (N)	12. July	645	-2.826	9813689.864	
Average		10. – 12. July	3290	-2.826	9813689.848	9813693.380

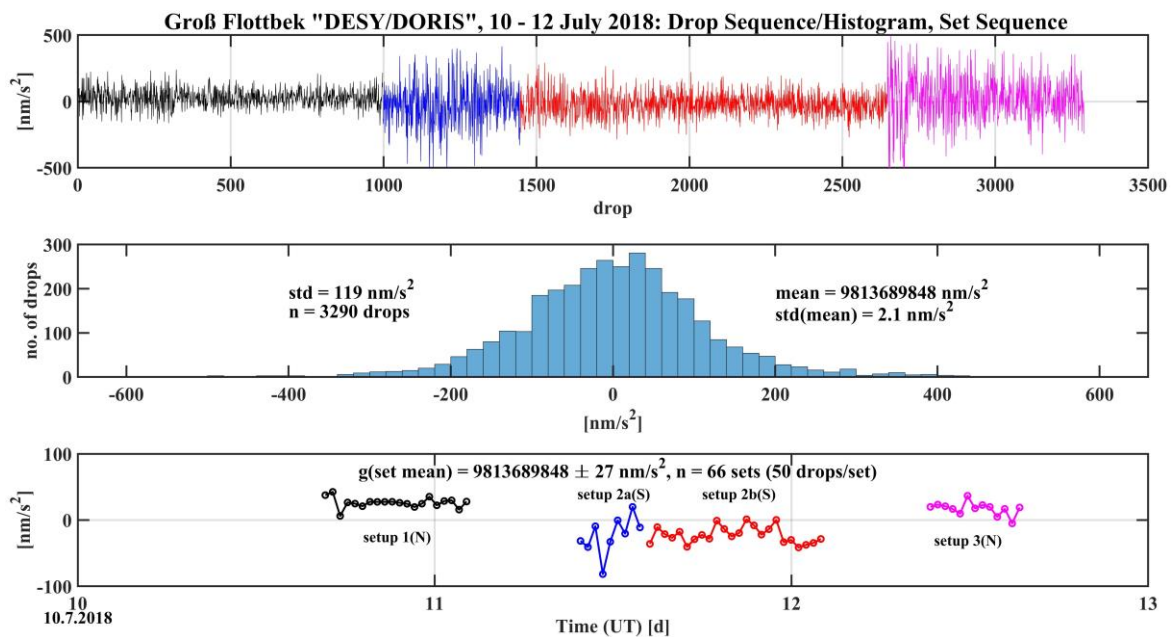


Figure 1: Statistical compilation of the station determination with the Hannover FG5X-220 absolute gravimeter at “DESY/DORIS” in Hamburg/Groß Flottbek, July 2018



Figure 2: The point mark at floor level provided by BKG in 2017