OBSERVATOIRE ROYAL DE BELGIQUE

BUNDESAMT FÜR KARTOGRAPHIE UND GEODÄSIE

Comparison of the absolute gravimeters FG5-202 & FG5-101 at station Membach (Belgium) and Bad Homburg (Germany)

Michel Van Camp[1] and Reinhard Falk[2]

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[1] Observatoire Royal de Belgique, Avenue Circulaire, 3, B-1180 Bruxelles, Belgium. mvc@oma.be
[2] BKG, Richard-Strauss-Allee 11, D-60598 Frankfurt am Main, Germany. falk@ifag.de

Comparison of the absolute gravimeters FG5-202 & FG5-101

1. Parameters

This report presents the results of the comparison measurements made with the absolute gravimeters FG5-101 and FG5-202. The measurements were made at the Membach Station, Belgium, from April 15 to April 18, 2002 and at the Bad Homburg Station, from May 23 to May 26, 2002.

The used parameters in this report are :

04/2002 (Membach) :

- Datum height : The height measured for the FG5-202 is referenced to the ground. The height measured for the FG5-101 is referenced to the top of the nail, which is 0.75cm higher. In order to compare measurements, Datum Height [202] = 0 cm; Datum height [101]= -0.75cm
- Gradient Me : -2.265µGal/cm
- Gradient Mf : -2.188µGal/cm
- Nominal air pressure : 983.60 hPa
- Lat : 50.6092° ; Long : 6.0067° ; Elev : 250m
- Fringe start : 34 (FG5-202)**;** 30 (FG5-101)
- Processed fringes : 640 (FG5-202)**;** 600 (FG5-101)
- Factory height (FG5-202) : 80.71cm
- Factory height (FG5-101) : 116.38cm
- Drops/sets : 100 (FG5-202) ; 150 (FG5-101)
- 1 set / 60 minutes, 1 drop/10s

05/2002 (Bad Homburg) :

- Datum height : The heights measured for the FG5-101 and the FG5-202 are referenced to the ground.
- Gradient AA : -3.03 µGal/cm
- Gradient BA : -2.97 µGal/cm
- Nominal air pressure : 990.87 hPa
- Lat : 50.2286° ; Long : 8.611° ; Elev : 188 m
- Fringe start : 34 (FG5-202)**;** 30 (FG5-101)
- Processed fringes : 640 (FG5-202)**;** 600 (FG5-101)
- Factory height (FG5-202) : 80.71cm
- Factory height (FG5-101) : 116.38cm
- Drops/sets : 150 (FG5-101 & FG5-202)
- 1 set / 60 minutes, 1drop/20s

2. Barometers, clocks

Clock :

Frequency of FG5[202] = 10 000 000,0034Hz (Determined with METAS Cs standard on May, 2002 (Switzerland))
Frequency of FG5[101] = 10 000 000,0105Hz (April 2002) / 10 000 000,0108 Hz (May 2002)

(Determined periodically at the Wettzel station (Germany), the clock has a drift of approximately + 2,5 mHz/year).

(A frequency correction of +1mHz yields a gravity increase of +0.2µGal).
Tests performed in Membach, at the BIPM and at METAS agree with these values.

Membach:

- Test with the scope : clock [101] = clock[202] + 6 mHz.
- Test by exchanging the clocks on the running gravimeters:

FG5-202: File MF02107. First 75 drops: clock[202]: g=981 046 691.26±6.88
Last 75 drops: clock[101]: g=981 046 690.13±6.83

$\Delta(202-101) = 1.13$ µGal $\Rightarrow$ clock[101] = clock[202] + 5.6 mHz

FG5-101: File MEM_Me_101_170402_rub_comp001
First 75 sets: clock[101]: g=981 046 719.95±5.61
Last 75 sets: clock[202]: g=981 046 720.61±6.15

$\Delta(101-202) = -0.66$ µGal $\Rightarrow$ clock[101] = clock[202] + 3.3 mHz

BIPM and METAS:

BIPM, ref. = BIPM Cesium: clock[101] = clock[202]+5.9mHz (July 2001)
clock [209] = clock[202] + 4.3mHz

Switzerland, ref. = METAS Cesium: clock [209] = clock[202] + 4.3mHz

Barometers :

- April 2002 : P[101] = P[202] - 0.2 hPa. This correction on 202 would induce a positive offset of 0.06 µGal.

This correction is negligible and has not been taken into account.

3. Tidal correction

For Bad Homburg and Membach :
Potential ETGTAB
Tidal parameters from "OceanLoad"
Ocean loading (Schwiderski) from "OceanLoad"

4. Horizontal gradients

Membach : Me-Mf	**FG5-202**	**FG5-206**	**FG5-101**
Janurary 1997	33.34±2.08	n.a.	n.a.
May 1999	36.15±1.11	n.a.	n.a.
March 2002	33.72±2.40	36.81±2.39	n.a.
April 2002	36.2±1.5	n.a.	39.59±2.08

Table 1a: Differences [µGal] between the Me and Mf points (Membach), observed with the absolute gravimeters FG5-101, FG5-202 and FG5-206.

Bad Homburg : BA-AA	FG5-202	FG5-101
May 2002	35.42±1.23	33.47±2.02

Table 1b: Differences [µGal] between the AA and BA points (Bad Homburg), observed with the absolute gravimeters FG5-101 and FG5-202.

5. Instrumental differences [202 – 101]

BIPM	**Difference at point A**	**Difference at point B**
July 2001	-2.10	-5.6
Membach	**Difference at point Me**	**Difference at point Mf**
April 2002	+1.86	+5.26
Bad Homburg	**Difference at point AA**	**Difference at point BA**
May 2002	+4.51	+6.46

Table 2: Differences [µGal] between the FG5-202 and FG5-101. For BIPM, results from Leonid Vitushkin 's preliminary report. Used data in April 2002 (cf. Table 3): A1, A3, [A11-A13], A12, [A17-A20], A18

Used software:

	g Acquisition Version	g Processing Version
FG5-101	1.0302	2.0128
FG5-202	olivia (version ???)	2.0128

comment: using the g-version 2.0128 for the measurement (as for FG5-101) get the information g Acquisition version: 1.0302 in the project.txt file

3 sigma criteria used for rejection of drops within one set

5. Results

Date	Day # Hour	Number of sets	Point	Gravimeter #	File name Identification number	g [µGal]	Polar coordinates	Comments
April 2002					***Membach***			
15-04-2002	105 18:38	5	ME	202	Me02105 A1	***981046726.27±0.850***	x: 0.01295 y: 0.55245 (value 15)	
16-04-2002	106 05:48	17	ME	202	Me105b A2	***981046726.76±0.630***	x: 0.0143 y: 0.5527 (average 15-16)	Sets 105 and 105b merged: g = **981046726.65±0.69**
16-04-2002	*106* *02:52*	*11*	*MF*	*101*	*MEM_Mf_101_150402_a* *A3*	*34/640:* *981046685.77±1.24* ***30/600:*** ***981046684.44±1.50***	*x: 0.0143* *y: 0.5527* *(average 15-16)*	
16-04-2002	*106* *10:07*	*1*	*MF*	*101*	*MEM_Mf_101_160402_a* *A4*	*34/640:* ***30/600:*** ***981046680.15±6.350***	*x: 0.01574* *y: 0.5530* *(value 16)*	*Test: …*
16-04-2002	*106* *10:56*	*1*	*MF*	*101*	*MEM_Mf_101_160402_b* *A5*	*34/640:* *981046692.39±9.54* ***30/600:*** ***981046691.86±9.13***	*x: 0.01574* *y: 0.5530* *(value 16)*	*Test: (34/640) After drop 75 (?) SS Sphere grounded* *After drop 129 (?) ground disconnected.* *g (1-65) = 981046685.78±6.66* *g (75-115)= 981046700.62±6.43*
16-04-2002	*106* *11:29*	*1*	*MF*	*101*	*MEM_Mf_101_160402_c* *A6*	*34/640:* *981046693.31±10.47* ***30/600:*** ***981046691.17±9.70***	*x: 0.01574* *y: 0.5530* *(value 16)*	*Tests: …*
16-04-2002	*106* *12:39*	*1*	*MF*	*101*	*MEM_Mf_101_160402_d* *A7*	*34/640:* *981046687.11±5.02* ***30/600:***	*x: 0.01574* *y: 0.5530* *(value 16)*	*Test: ….*

						981046685.79±4.74		
16-04-2002	*106* *12:39*	*1*	*MF*	*101*	*MEM_Mf_101_160402_e* *A8*	*34/640:* *981046686.32±25.02* ***30/600:*** ***981046686.50±25.28***	*x: 0.01574* *y: 0.5530* *(value 16)*	*Test: ….*
16-04-2002	*106* *13:26*	*1*	*MF*	*101*	*MEM_Mf_101_160402template* *A9*	*34/640:* *981046697.14±13.85* ***30/600:*** ***981046695.03±13.24***	*x: 0.01574* *y: 0.5530* *(value 16)*	*Test: After drop 47 SS Sphere grounded* *After drop 113 different groundings tested.* *No UPS* *g (1-44) =* ***981046685.49±5.53*** *g (75-115)=* ***981046701.20±7.16***
16-04-2002	*106* *15:24*	*1*	*MF*	*202*	*Mf02106* *A10*	***981046693.31±10.47***	*x: 0.01574* *y: 0.5530* *(value 16)*	*Test ground Superspring :* *50 first drops:* ***981046688.76±7.3*** *50 last drops (SS sphere grounded):* ***981046694.33±24.0***
16-04-2002	106 23:17	14	ME	101	MEM_Me_101_160402_a A11	*34/640:* 981046727.19±0.91 ***30/600:*** ***981046724.27±0.76***	x: 0.0173 y: 0.5533 (average 16-17)	Acquisition 101 crashed after set 14
17-04-2002	*107* *02:13*	*20*	*MF*	*202*	*Mf02106b* *A12*	***981046690.42±1.000***	*x: 0.0173* *y: 0.5533* *(average 16-17)*	
17-04-02	107 10:47	3	ME	101	MEM_Me_101_160402_b A13	*34/640:* 981046725.48±1.71 ***30/600:*** ***981046723.13±2.14***	x: 0.01880 y: 0.5536 (value 17)	Acquisition 101 launched by M. Van Camp. No manipulation on the interferometer. Sets MEM_Me_101_160402_a and MEM_Me_101_160402_b merged: g = **981046724.48±1.032**
17-04-2002	*107* *12:29*	*1*	*MF*	*202*	*Mf02107* *A14*	***981046689.59±6.860***	*x: 0.0* *y: 0.0* *(test file)*	*Test clock.* *75 first drops: clock 202* *g =* ***981046690.20±6.86*** *74 last drops: clock 101* *g =* ***981046688.98±6.81*** *(Rem.: drop 127 removed)*
17-04-2002	107	1	ME	101	MEM_Me_101_170402_rub	***30/600:***	x: 0.0	Test clock.

	12:29				_comp A15	***981046720.28±5.87***	y: 0.0 (test file)	74 first drops: clock 202 g = **981046719.95±5.61** 73 last drops: clock 101 g = **981046720.61±6.15** (Rem.: drops 76, 90 removed)
17-04-2002	107 13:56	1	ME	101	MEM_Me_101_170402_ test_ground A16	34/640: 981046726.72±8.84 **30/600:** **981046724.67**	x: 0.01880 y: 0.5536 (value 17)	Test ground superspring. Before drop 35 normal Drops 36-76: tilts cables disconnected Drops 77-107: SS Sphere grounded Drops 108-126 SS Sphere normal Drops after 126: ground tests on the rear of the PC
17-04-2002	107 23:22	14	ME	202	Me02107 A17	**981046726.50±0.920**	x: 0.0205 y: 0.5539 (average 17-18)	
17-04-02	*107* *23:56*	*13*	*MF*	*101*	*MEM_Mf_101_170402_a* *A18*	*34/640:* *981046686.03±0.69* ***30/600:*** ***981046684.55±0.92***	*x: 0.0205* *y: 0.5539* *(average 17-18)*	*First 4 sets supressed (jumps during control)*
18-04-2002	*108* *07:02*	*1*	*MF*	*101*	*MEM_Mf_101_180402_* *final_test* *A19*	*34/640:* *981046683.81±6.87* ***30/600:*** ***981046683.40***	*x: 0.0205* *y: 0.5539* *(average 17-18)*	*Verticality checked : OK.* *No manipulations (neither fringes nor verticality) on the interferometer.*
18-04-2002	108 07:18	1	ME	202	Me02108 A20	**981046727.71±5.981**	x: 0.0205 y: 0.5539 (average 17-18)	Sets 107 and 108 merged: g = **981046726.58±0.930**
May 2002					***Bad Homburg***			
23-05-2002	143 18:42	2	BA	202	Ba02143 M1	**981055084.85±0.41**	x: 0.1336 y: 0.5380	
23-05-2002	*143* *19:24*	*3*	*AA*	*101*	*BGH_101_AA_230502_a*	***981055044.84±0.12***	*x: 0.1336* *y: 0.5380*	
24-05-2002	144	20	BA	202	Ba02143a	**981055084.81±0.91**	x: 0.1347 y: 0.5375	Sets Ba02143 & Ba02143a merged: 981 055 084.40+/-0.95

	05:54				M2			
24-05-2002	144 07:28	5	AA	101	BGH_101_AA_240502_a	**981055043.41±0.64**	x: 0.1347 y: 0.5375	
24-05-2002	144 14:27	3	AA	101	BGH_101_AA_240502_b	**981055045.87±0.31**	x: 0.1347 y: 0.5375	*BGH_101_AA_230502_a &* BGH_101_AA_240502_a & BGH_101_AA_240502_b merged: 981 055 044.47+/-1.176
25-05-2002	*145* *0:34*	*12*	*BA*	*101*	*BGH_101_BA_240502_a*	***981055077.35±1.40***	*x: 0.1370* *y: 0.5365*	
25-05-2002	145 05:34	22	AA	202	Aa02144	**981055048.98±0.78**	x: 0.1370 y: 0.5365	
25-05-2002	*145* *10:40*	*10*	*BA*	*101*	*BHG_101_BA_250502_a*	***981055078.82±1.68***	*x: 0.1370* *y: 0.5365*	*sets BGH_101_BA_240502_a &* *BHG_101_BA_250502_a merged: 981 055 077.94 +/-1.65*
26-05-2002	146 03:17	17	AA	202	Aa02145	**981055049.58±1.47**	x: 0.1393 y: 0.5355	FG5#202 with dropping chamber of FG5#101
26-05-2002	*146* *03:47*	*16*	*BA*	*101*	*BHG_101_BA_droppingch202_250502_a*	***981055079.25±1.28***	*x: 0.1393* *y: 0.5355*	*FG5#101 with dropping chamber of FG5#202*

Table 3: Results of the FG5#101 and FG5#202 measurements performed at the Membach and Bad Homburg stations