ITRF Co-location Survey
Observatoire de la Côte d'Azur
Plateau de Calern – Caussols, France

March, 20th to 24th 2017

PPMD16

Teachers : Jacques Beilin et Damien Pesce

Ecole Nationale des Sciences Géographiques

6 & 8 avenue Blaise Pascal – Cité Descartes – 77455 Marne la Vallée – CEDEX 2

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1 Introduction

ITRF is the result of a combination of the different terrestrial reference frames provided by the four space geodetic techniques : GNSS, VLBI, SLR and DORIS. To perform this combination between independent reference frames, it is necessary to have some co-location sites where the various techniques are observing and whose ties have been surveyed in three dimensions.

In this frame of work, it has been decided to survey the Grasse co-location site (Calern, France) as often as possible. Indeed, this site contain three space geodetic techniques (GNSS, SLR, Doris) and a VLBI campaign reference.

— the GNSS antenna GRAS (used for French GNSS permanent network)
— the GNSS antenna GRAC (used for French GNSS permanent network)
— the Lunar Laser Ranging MeO (GRSM)
— the experimental DORIS station (GR4B)
— the former VLBI point
— the former SLR point (GRSF)

In order to ease the survey, this site has been equiped with geodetic pillar well distributed over the plot of land. This survey was done to reach the best accuracy as possible with the objective to follow the ITRF accuracy requirements.

2 Acknowledgements

We would like to express our thanks to OCA team in Calern, with a special thanks to all the team working on the Laser. Their very nice welcome, their cooperative work on technical and administrative aspects contributed for a great part to the success of this work.

3 Co-location site description

Although this co-location site is located at Caussols on the "Plateau de Calern", it is also often called Grasse. However, this site hosted by "Observatoire de la Côte d'Azur" (OCA) is about 10 km north of Grasse and 30 km west of Nice (see below an extract of the Geoportail website http ://www.geoportail.gouv.fr/accueil).

On a geodetic point of view, this observatory site is of a great interest ; indeed there are :

- A Laser ranging station contributing to the ILRS called "GRSM", a 154 cm aperture telescope.
- Two IGS and RGP permanently operating Global Navigation Satellite System stations : these are GRAS (GPS) and GRAC (GPS/GLONASS) which are about 32 m apart.

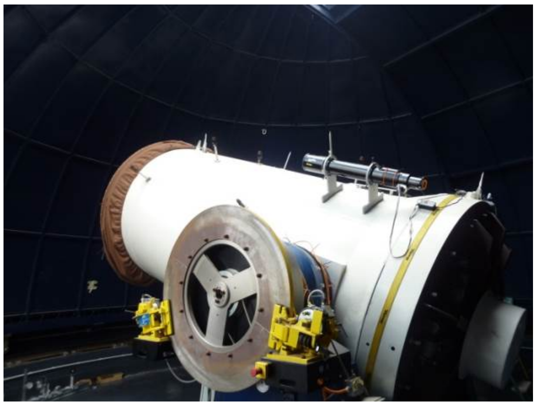
Furthermore, the importance of the site is complemented by :

- One DORIS station, taking part in the T2L2 project.
- One former VLBI station marker.

Several surveys had been conducted at Grasse over the last decades, particularly in 1994 ,1999, 2009 and 2013, but restoring the local tie, after the big changes on the mechanics of the telescope MeO (Laser Moon), was crucial. Since 2013, surveys are operated every year by the PPMD students. The purpose of those surveys is to compare with 2013 survey.

4 ITRF space geodesy techniques

4.1 Grasse LLR station



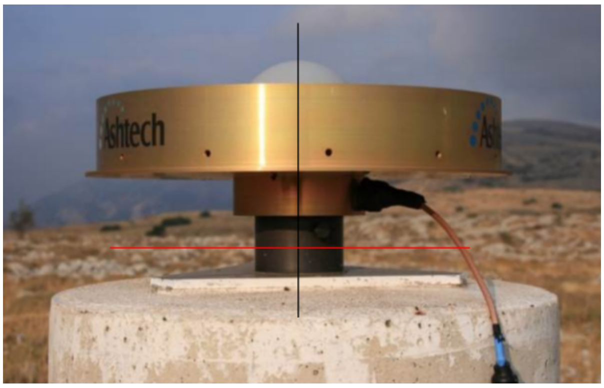
— Name : GRSM
— DOMES number : 10002S002 - CDP 7845
— Description : intersection of the Azimuth and Elevation rotation axes

The LLR measurements refer to a point in the telescope where the two rotation axes intersect. Of course, the Ranging System Reference Point (SRP) can't be materialized. This telescope formerly called "Laser Lune" is now called "Laser MeO" because not only implicated as Laser Moon station but also in research and development in Optical Metrology activities.

4.2 Former mobile Laser station

— Name : GRSF
— DOMES number : 10002M004 - CDP 7846
— Description : benchmark fixed on concrete slab.

4.3 Permanent GNSS stations



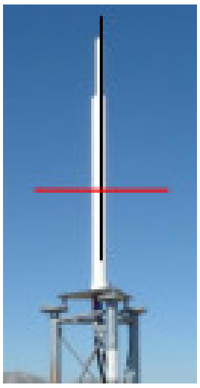
- Name : GRAS
- DOMES number : 10002M006
- Description : the bass mark reference point is 0.0350 m under the Antenna Reference Point (ARP).

GRAS is part of "Réseau GNSS Permanent" (RGP) and "International GNSS Service" (IGS) networks since 1996.

- Name : GRAC
- DOMES number : 10002M010
- Description : the bass mark reference point is 0.050 m under the Antenna Reference Point (ARP).

GRAC is part of thr RGP since 2001, and IGS since 2013.

4.4 Doris station

- Name : GR4B
- DOMES number : 10002S019
- Description : DORIS Antenna reference point. (ARP).

4.5 Former mobile VLBI station

Main point

Auxiliary point

- Name : VLBI
- DOMES number : 0002M003 – CDP 7605
- Description : 1989 mobile VLBI campaign main reference mark.

4.6 Other points of interest

4.6.1 Local tie survey piers

To make the yearly survey easier, four concrete piers were building around the site. Centring plates were embedding on the top of each pier and four leveling benchmark were placed on each concrete base.

Centering plate

Pier

4.6.2 Tripod station

To complete the network, we used a station centred on a bolt. It is embedding on a concrete plate fixed on the roof of the telescope building.
Nevertheless the plate seems to be wobbly. The mesures must be done carefully on the plate.

Concrete plate on the roof

Bronze benchmark

However, to complete the survey, a total station was centered on the old Doris mast thank a special adaptor.

4.6.3 Distant references

To align the network to the ITRF frame, two points far away were setup. One is centred on air vent axis of the Calern's water reservoir (about 672 m from MeO). For the survey, it is called 10000. (See description sheet).

Water reservoir

Target point

- Name : 10000
- Description : top of air vent (point engraved)

The second one is a centering marker fixed on an old concrete pier near Tarot buildings (about 294 m from Meo). For the survey, it is called 20000.

Pier

Target point

Target used to aim at the point 20000

- Name : 20000
- Description : Top of pillar centering marker

5 Survey description

5.1 Organization

The local tie survey of GRASSE co-location site has been carried out by Jacques Beilin, Damien Pesce, Gauthier Duponchel, Kevin Gobron, Vladimir Schott Guilmault, Maylis Teyssendier de La Serve and Charlotte Wolff with the useful help of the observatory team. They work at the National Institute of Geographic and Forest Information (IGN) and mainly deal with metrology and micro-geodesy. The survey took place from March, 20^{th} to March, 24^{th} 2017. The weather conditions were bad :

- 21^{st} : very foggy weather.
- 22^{th} : sunny weather
- 23^{th} : very foggy weather with rain.

All the topometric survey instruments and equipments belong to IGN and were brought with us to realize the survey.

5.2 Instruments

The used instruments are described in the following table.

Observations type	Instruments used
Topometry	2 tacheometers : TS30 and TM30
Altimetry	Leica electronic level (DNA03) linked
	with invar bar code levelling rods
GNSS antenna	2 Leica GX1230 receivers
	and 2 Trimble Zephyr antennas

The tacheometers which are regularly calibrated by IGN's metrology unit, were associated with six Leica accurate prisms. Their standard deviation is 0.15 mgon for horizontal and vertical angles and 1 mm + 1 ppm for distances. The altimetric instruments are also regularly calibrated and have a resolution of 0.01 mm.

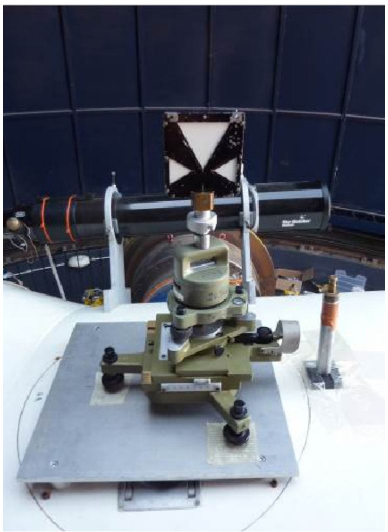
All these instruments allowed the observations to be digitally recorded on memory cards and were then downloaded on a laptop PC for processing.

5.3 Equipments and accessories

Several very useful accessories have also been brought for this kind of field work :

- Tripods to ensure centering on marks

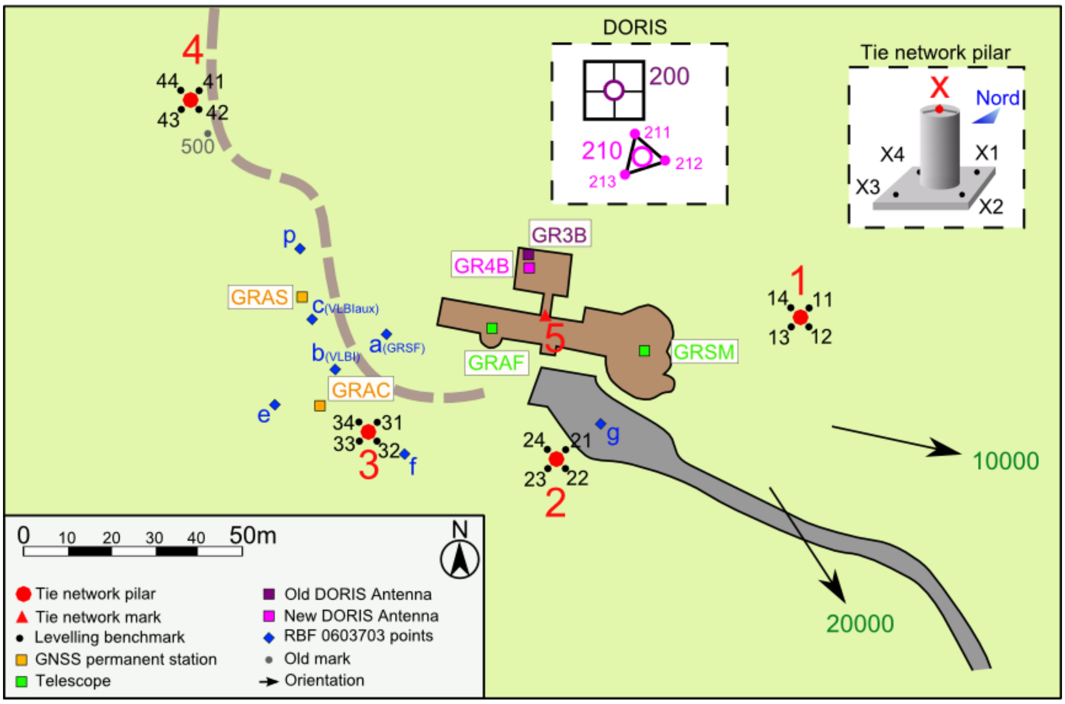
— Three levelling rods of 0.5 m, 1.8 m and 3.0 m which are calibrated with each other
— Calibrated trefoil targets and prisms
— A translation stage to center a target on the vertical telescope rotation axis (see picture below)
— Half brass balls to set the levelling rods
— Walkie talkies



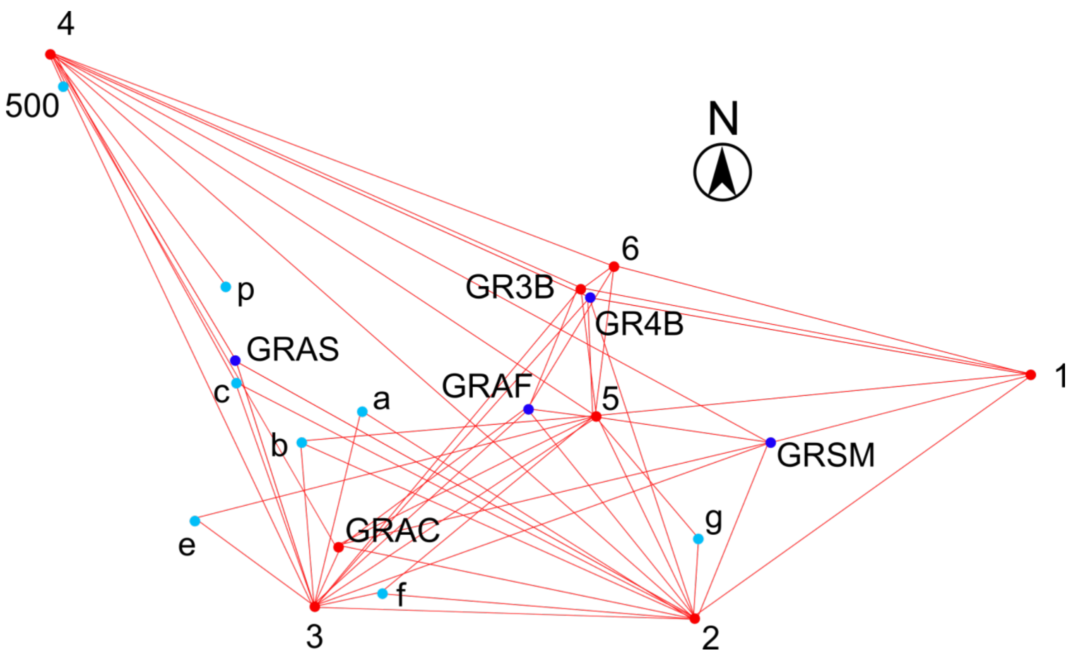
Translation stage

5.4 Observations polygon

All the survey was conducted in order to provide the highest accuracy in the determination of the 3D vector between the observing instruments.



Site map and station location



Calern observation sketch

The network does not exactly match the site map :

— The GRAF station does not exist anymore.

— The GRAS station code is 300.

— The GRAC station code is 310.

— The VLBI (b) former mark code is 510.

— The SLR/GRSF (a) former mark code is 520.

— The rotation centre of the telescope (GRSM) has the code 100.

The following table is an intervisibility matrix.

Points\Stations	1	2	3	4	5	200
1		x		x	x	x
2	x		x		x	
3		x		x	x	
4	x	x	x		x	x
5	x	x	x	x		
200	x			x		
211	x	x		x	x	
212	x	x			x	
213	x			x	x	
218	x	x	x	x	x	
300		x	x	x		x
310		x	x	x	x	
510		x	x	x		
520		x	x	x		
10000		x		x		
20000	x	x	x		x	x
105	x	x	x	x	x	x

5.5 Survey method

All the lines of sight have been observed with the total stations. Horizontal directions and zenith angles were observed in data sets, each set consisting in one reading in both direct and reverse theodolite positions. Any observed angle was rejected if the difference between the two measurements was too high. Distance measurements were observed over each line once in both direct and reverse positions. Meteorological data (atmospheric pressure and temperature) used to correct the distances, were recorded at the beginning of each station occupation. As far as direct levelling is concerned, forward and backward runs were observed between each benchmark. At the beginning of the spirit levelling, the instrument collimation was checked. The electronic level instrument was set to perform two readings on a bar code staff, and measurements were repeated if the difference between the two readings was inconsistent (i.e. greater than 0.1 mm). In the same way, we checked the difference between two runs, and a third run was completed if the difference between two runs was greater than $\sqrt{nb_{measures}} * 0.1mm$.

5.6 Laser MeO reference point

The reference point of the Laser MeO is its rotation center, called 100. It has been determined in two successive steps :
- 1) The vertical axis determination
- 2) The horizontal axis determination

5.6.1 Vertical axis

To measure its position from one theodolite set up on a tripod, a target on the two axes translation stage was seen with the theodolite and the position of the target read on the micrometre. It is worth mentionning that MeO was at its minimum elevation of 3.5° in order to set the stage horizontally.

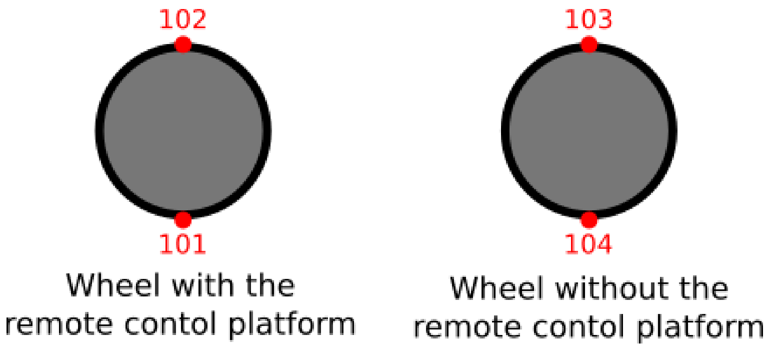
MeO was then rotated 180° around the vertical axis, and the target rotated towards the theodolite. The target was then shifted using the translation stage, until it was aimed from the same theodolite direction. The new target position was read on the micrometre. Then the translation stage was adjusted by half the difference of the two readings. This protocole is repeated until the theodolite could see the prism without moving for the two directions.

The same thing was done with the telescope oriented at 90° from the original position. At last, we checked that the target didn't move when aimed with the theodolite, as the telescope rotated around its vertical axis.

For this operation, the telescope is supposed perfectly vertical, it was checked with the accurate level of the target (leveling then telescope was rotated of 90° and 180°).

5.6.2 Horizontal axis

To determine the horizontal axis, we practiced a levelling work. From a bolt at the entrance of the dome (see figure below) named 100c, we levelled to two points on each wheel of the telescope. These four points are 101 and 102 for the first wheel, 103 and 104 for the second one.



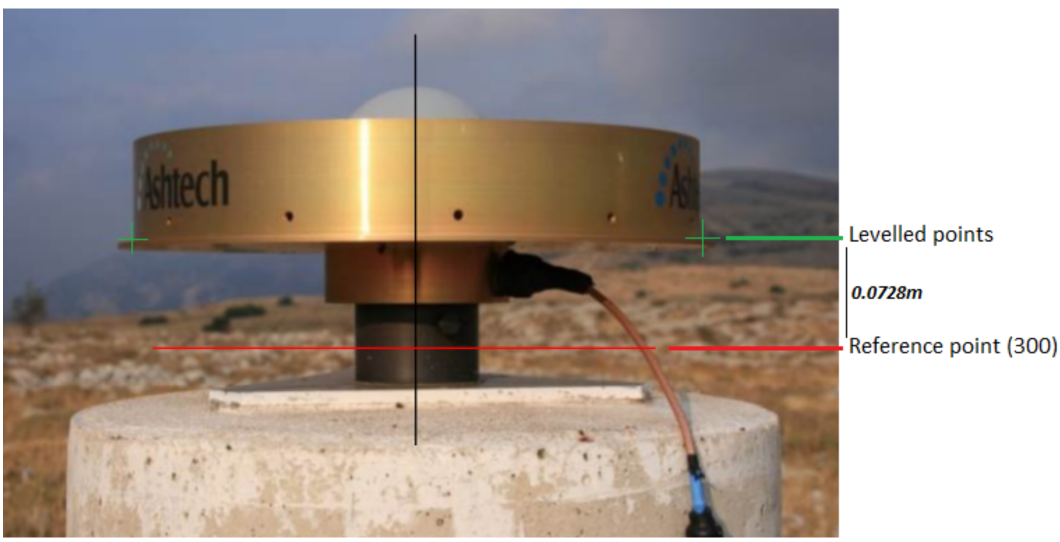
Leveled points on the telescope

Then we calculated the mean for each couple to obtain the height of the wheel center. We assume that these two points, 101102 and 103104, determine the horizontal axis. In a second step, we calculated the mean of the center height of each wheel. We obtain the telescope center height.

It is worth mentionning that 101102 and 103104 have a height difference of 0.8mm. They do not not exactly determine the horizontal axis. Such a difference was also observed the previous years.

5.7 GRAS GNSS station

To determine the vertical axis of the antenna, we measured from each station the average of the horizontal angles of the left and right sides of the antenna. We also levelled both sides of the antenna to obtain its reference point height. (See picture below)



Vizualisation of GRAS points

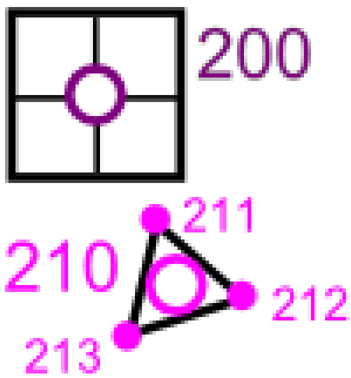
5.8 GRAC GNSS station

For the vertical axis, we used the same method as for the GRAS station. However, the levelling of the antenna was not as easy. The antenna is not rigid, indeed. We installed the level at the same height as the antenna ARP. At the same distance from the level tripod, we installed another one with a half blass ball and a ruler to read the height difference between the ARP and this temporary point. Then we continued the levelling until the point 31 of the pier 3.

To ease the manipulation, the next survey could be done with a *'crémaillère'* tripod.

5.9 Doris antennas

There is no more antenna on the spot of the old antenna (GR3B) so we used it as a pier. We named it 200.
For the new antenna, we intersected the center of the red line from each station. This red line corresponds to one of the two antenna phase centers. It is named 218. We also set three mini-prisms at the base of the antenna.



Vizualisation of DORIS points

We also levelled the antenna stage and thanks to the online documentation, we know the height difference between this stage and the two antenna phase centers.

5.10 GNSS observations

Points 10000 and 20000 were observed day 80 and 81. These observations have been carried out for more than 12 hours, in order to align the survey to the ITRF, with a 30 sec sampling.

All antenna heights are related to the antenna reference point (ARP).

The following specifications have been used to convert the coordinates from RGF93 to the local frame in Circe :

- PRC number : 0141
- Mode : 2
- Elg : 037
- X_0 : 200
- Y_0 : 200
- Lgo : 01
- Angular unit : 02
- L_0 : 6.920575430555556
- J_0 : 43.75473903611111
- Delta : 1.0000
- J_1 : 43
- J_2 : 44
- c : 1
- Type : 1
- Name : LAMBERT-Calern

Type	Points	Description	Specifications
Piers	1	Center of the top of the piers 1	
	2	Center of the top of the piers 2	
	3	Center of the top of the piers 3	
	4	Center of the top of the piers 4	
	T1.1	Tacheometer of the piers 1 of the first day before occupation	Centered on 1
		Base change	
	T1.2	Tacheometer of the piers 1 for the rest of the stay	Centered on 1
	T2	Tacheometer of the piers 2	Centered on 2
	T3	Tacheometer of the piers 3	Centered on 3
	T4	Tacheometer of the piers 4	Centered on 4
	11	North-East point of the piliar 1 base for levelling	
	12	South-East point of the piliar 1 base for levelling	
	13	South-West point of the piliar 1 base for levelling	
	14	North-West point of the piliar 1 base for levelling	
	21	North-East point of the piliar 2 base for levelling	
	22	South-East point of the piliar 2 base for levelling	
	23	South-West point of the piliar 2 base for levelling	
	24	North-West point of the piliar 2 base for levelling	
	31	North-East point of the piliar 3 base for levelling	
	32	South-East point of the piliar 3 base for levelling	
	33	South-West point of the piliar 3 base for levelling	
	34	North-West point of the piliar 3 base for levelling	
	41	North-East point of the piliar 4 base for levelling	
	42	South-East point of the piliar 4 base for levelling	
	43	South-West point of the piliar 4 base for levelling	
	44	North-West point of the piliar 4 base for levelling	
Tripod	5	Bronze benchmark on a plate on the roof	
	T5	Tacheometer above the point 5	Centered on 5

Type	Points	Description	Specifications
DORIS stations	200	Plate of the former GR3B station	
	T200	Tacheometer on the plate of former GR3B	Centered on 200
	210	Plate of the GR4B D0RIS antenna	
	210b	Levelled point on the plate	2cm higher than 200
	211	North mini-prism on the GR4B plate	
	212	South-East mini-prism on the GR4B plate	
	213	South-West mini-prism on the GR4B plate	
	218	Phase center of GR4B 40 MHZ, red line	39.1cm higher than 210
	219	Phase center of GR4B 2 GHZ	87.7cm higher than 210
GNSS stations	300	GRAS reference point	
	301	GRAS levelled point	7.28cm higher than 300
	310	GRAC reference point	
	311	GRAC ARP	5cm higher than 310
	1001	Levelled point used to determine 311 height	
Ground points	510	GRSF, former SLR station	
	520	VLBI former station	
	520b	Half blass ball used to levelled 520	2cm higher than 520
References	10000	Water reservoir	
	20000	Pier near Tarot	
Telescope	100	Intersection of GRSM telescope rotation axis	
	105	Prism to determine the vertical rotation axis	Centered on 100
	100c	Bolt at the entrance of the dome	
	101	Point on the wheel	
	102	Point on the wheel	
	103	Point on the wheel	
	104	Point on the wheel	

6 Computation

6.1 On-site validation

The survey network has been processed on site in order to point out any problem in the observations. The observations have been checked in a local coordinate system. The outliers have been detected and the precision has been estimated in order to check if the requirements of such a survey could be met.

6.2 GPS network

The GPS baselines have been first processed on site with the online computation service of the RGP.
!!!!! Then, at the office, there was processed with the scientific software Bernese version 5.0 of the University of Berne. This software incorporates the movements of the poles, information on satellites, the ocean overload FES2004 model, as well as specific changes in the position of the phase centres and reference points of antennas and satellite receivers. !!!!!

6.3 ITRF2008

The international reference system for the whole Earth is undoubtedly the International Terrestrial Reference System (ITRS) as defined by the International Earth rotation and Reference systems Service (IERS). ITRS is an ideal reference system defined through theoretical prescriptions and conventions.

The ITRS needs to be realized on the basis of coordinates and velocities of a set of physical earth-related points. Such a realization is the so-called ITRFyyyy (International Terrestrial Reference Frame) where yyyy stands for the last year of observations taken into account.

ITRF2008 is the new realization of the ITRS released in May 2010. Following the procedure already used for the ITRF2005 formation, the ITRF2008 uses as input data time series of station positions and Earth Orientation Parameters (EOPs) provided by the Technique Centres of the four space geodetic techniques (GPS, VLBI, SLR, DORIS). Based on completely reprocessed solutions of the four techniques, the ITRF2008 is expected to be an improved solution compared to ITF2005.

A full description of ITRF2008 is available at http://itrf.ensg.ign.fr/ITRF_solutions/2008.

ITRS is stated to meet the "no net rotation" condition, i.e. the mean displacement due to tectonic plate motion for the whole Earth is zero. Hence, any realization has to provide coordinates and velocities of the involved stations. Therefore a specific epoch must be fixed to express coordinates in an operational geodetic reference set.

6.4 IGS08 ??

The International GNSS Service (IGS) is currently maintaining the ITRF related to GNSS stations through a weekly solution. As far as the ITRF alignment is ensured, the main goal is to improve coordinates and velocities as well as to detect possible discontinuities.

The new IGS reference frame, IGS08, was released on April 17th 2011. IGS08 was initially intended to be a direct subset of well performing, stable GNSS stations from ITRF2008 rather than a separate GNSS-only frame solution. But, while the IGS contribution to ITRF2008 was computed using the original set of "absolute" GNSS antenna calibrations (igs05.atx), IGS08 had to be consistent with the latest set of calibrations (igs08.atx) that includes new determinations for some existing antennas. Coordinate corrections due to the antenna calibration updates were thus estimated and applied when possible to the ITRF2008 coordinates of 64 affected stations (out of a total of 232 stations in IGS08).

More details are available in the reference publication : Rebischung, P. ; Garayt, B. ; Schmid, R. ; Ray, J. ; Collilieux, X. : IGS08 : Elaboration, consequences and maintenance of the IGS realization of ITRF2008 ; European Geosciences Union General Assembly 2011, Wien, 07.04.2011 [EGU2011-6850.pdf and igs08_egu11.pdf].

6.5 Global Adjustment

6.5.1 Terrestrial adjustment

Back at the office, the computation has been carried out by 3D Least Squares Adjustment with IGN software COMP3D v.5. At a first step, a computation was done only with total station and level observations in local coordinates system. The input files were created from all the terrestrial observations : horizontal and vertical angles, spirit levelling, distances, planimetric and altimetric centrings.

The a priori standard deviations used for the different observations are on precision prism and target :

- 0.8 mgon for horizontal angles
- 1.2 mgon for vertical angles
- 0.1 mm on the target definition (centering)

— 1 mm for distances
— 0.1 mm for each levelling observation
— 5 mm for the levelling on the GRAC GNSS station

This adjustment gives us local coordinates and a covariance matrix of all points of the CALERN tie network.

6.5.2 GNSS orientation

Comp3D software is a micro-geodesy computation software which works in a local coordinates system with Z axis along the vertical. Georeferenced points can also be constrained in compensation, and will be automatically transformed into Comp3D local coordinates system.

All the computations will be done in this frame, using constrains on GNSS stations coordinates to orientate the network. GRAS coordinates will have an accuracy of 0.5 mm in planimetry and 1 mm in altimetry. 10000 and 20000 planimetric coordinates are constrained at 5 mm, in order to express the orientation uncertainty. This process gives covariance matrix useful to create the SINEX file. The resulting coordinates can be changed into geocentric, simply by inverting the transformation.

Those constraints are the same as those used in 2013 (IGS08, epoch 2013.56, converted in the local frame presented above) in order to compare the results with the previous sessions. The coordinate values did not change significantly within 4 years, indeed.

Year	Point	East (Lambert93)	North (Lambert93)	Elevation (IGN69)
2013	10000	1016428.991 m	6302829.760 m	1288.013 m
	20000	1015899.394 m	6302646.473 m	1269.989 m
2016	10000	1016428.999 m	6302829.759 m	1287.994 m
	20000	1015899.400 m	6302646.463 m	1269.958 m
2017	10000	1016428.998 m	6302829.767 m	1288.003 m
	20000	1015899.398 m	6302646.468 m	1269.960 m

7 Results

7.1 Station name translation table

The following list sums up the most interesting points used in the process input file.

GNSS permanent station GRAS IGS ARP	GRAS	301
GNSS permanent station GRAC RGP ARP	GRAC	311
LASER MeO station SRP Prism on the translation stage	GRSM	105
LASER MeO station rotation center	GRSM	100
Former Mobile LASER station Reference Point	GRSF	510
Former mobile VLBI station RP	VLBI	520
DORIS station ARP support plate	GR4B	210
Former DORIS station ARP support plate	GR3B	200

Adjusted coordinates and confidence regions The results of the adjustment are the coordinates of all points as well as their confidence ellipsoids in the IGS08 frame at the mean epoch of the observations (i.e. epoch 2013.56). Hereafter is a table with the 3D coordinates relative accuracy and confidence region at 1 sigma of the main points of interest.

8 Results comp3D

Comp3D

Calern17

Version : Comp3D v5.01 alpha

Summary

Project configuration↑

Name
    Calern17
Description
Configuration file
    /home/dpts/Chantiers/Calern2017/Calern2017/calculs/calern17.comp
Root COR file
    Coord_2017.cor
Root OBS file
    appel.obs
Unit
    grad
Computation nature
    Compensation
Center latitude
    43.5000
Module linéaire
    1.0000
Local coordinates center
    0.0000 0.0000
Number of digits
    4
Maxium iterations
    100
Forced iterations
    2
Refraction coefficient
    0.1200

Computation information↑

σ0 ini
    1837.5887
Compensation done
    Yes
Final σ0
    1.0927
Iterations

5

Computation interruption
No

Computation start
2017-Mar-27 15:25:42.359315

Computation duration
00:00:00.031933

Sphere radius
6377226.0662

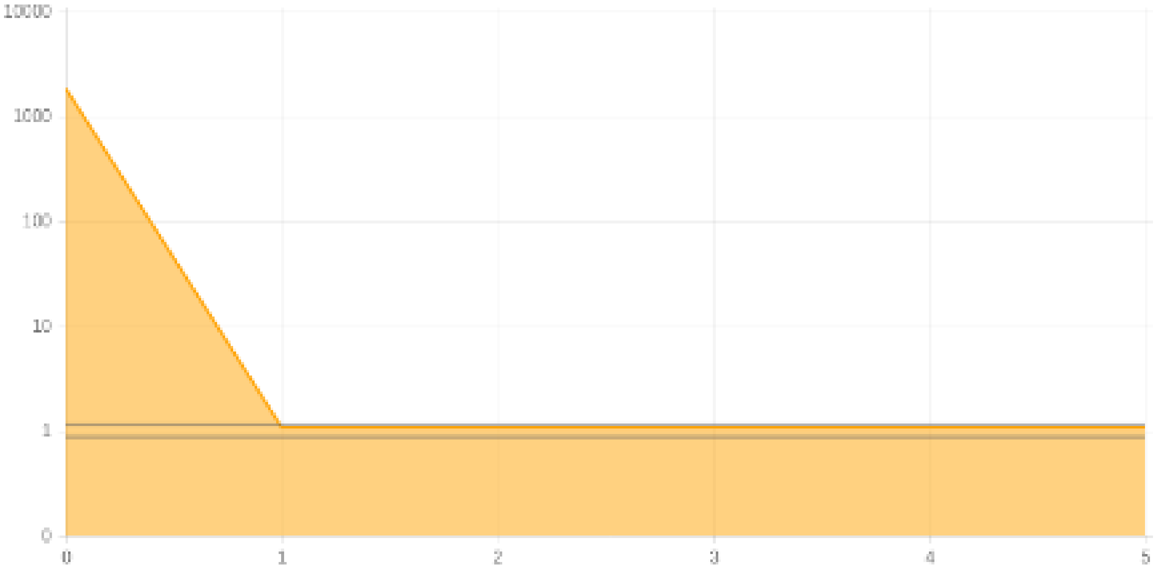
Observations
351

Parameters
162

Matrix inversion
Yes

Contraintes internes
No

σ0 evolution↑



X² test: 😄↑

Confidance: 99%

Degrees of freedom: 189

Test: 0.8822 < 1.0927 < 1.1509 ?

Test passed : Yes !

Initial coordinates↑

Name	X init	Y init	Z init	σX init	σY init	σZ init
10000	946.1439	74.9282	1288.0140	0.0050	0.0050	0.0001
20000	408.2063	-81.8156	1269.9890	0.0050	0.0050	0.0001
1	319.9363	198.2064	1270.2306			
2	269.4038	161.7484	1269.5724			
3	212.2061	163.2655	1268.8727			
4	171.8941	246.0986	1267.3551			
5	257.4053	194.6912	1271.7584			
T1.1	319.9363	198.2064	1270.5206			
T1.2	319.9363	198.2064	1270.5206			
T2	269.4038	161.7484	1269.8624			
T3	212.2061	163.2655	1269.1627			
T4	171.8941	246.0986	1267.6451			
T5	257.4053	194.6912	1273.2844			
11	319.4744	197.7506	1268.9395	0.0001	0.0001	0
12	319.4740	197.7512	1268.9335	0.0001	0.0001	0
13	319.4738	197.7513	1268.9361	0.0001	0.0001	0
14	319.4740	197.7512	1268.9332	0.0001	0.0001	0
21	268.9422	161.2918	1268.2781	0.0001	0.0001	0
22	268.9419	161.2919	1268.2806	0.0001	0.0001	0
23	268.9422	161.2918	1268.2774	0.0001	0.0001	0
24	268.9424	161.2925	1268.2757	0.0001	0.0001	0

31	211.7417	162.8092	1267.5748	0.0001	0.0001	0
32	211.7415	162.8092	1267.5767	0.0001	0.0001	0
33	211.7415	162.8092	1267.5761	0.0001	0.0001	0
34	211.7418	162.8098	1267.5744	0.0001	0.0001	0
41	171.4255	245.6434	1266.0611	0.0001	0.0001	0
42	171.4254	245.6429	1266.0728	0.0001	0.0001	0
43	171.4256	245.6433	1266.0595	0.0001	0.0001	0
44	171.4256	245.6433	1266.0599	0.0001	0.0001	0
105	280.5941	188.3593	1274.0523			
100	280.5941	188.3593	1274.0523			
100c	280.5941	188.3593	1274.0523	0.0050	0.0050	0
T200	252.3301	210.6012	1272.7256			
200	252.3301	210.6012	1272.7256			
210	252.6736	209.6180	1272.8407			
210b	252.6736	209.6180	1272.8407	0.0050	0.0050	0
211	252.5570	209.8124	1272.8747			
212	252.8973	209.6230	1272.8791			
213	252.5634	209.4196	1272.8856			
218	252.6735	209.6173	1273.2317			
219	252.6733	209.6176	1273.7178			
300	200.0000	200.0000	1268.7250	0.0001	0.0001	0.0001
301	200.0000	200.0000	1268.7250	0.0050	0.0050	0
310	215.5674	172.4433	1269.3374			
311	215.5677	172.4438	1269.2874	0.0050	0.0050	0
1001	215.5674	172.4433	1269.3374	0.0001	0.0001	0
510	219.4221	192.3516	1268.0833			
520	210.1982	187.8497	1268.0632			
520b	210.1982	187.8497	1268.0632	0.0010	0.0010	0

Observations↑

code	from	to	measure	total sigma	residual mm	normalized residual
c_X	**10000**	**10000**	946.1439 m	0.0050 m	-0.9 mm	-0.2 σ
c_Y	**10000**	**10000**	74.9282 m	0.0050 m	-2.4 mm	-0.5 σ
c_Z	**10000**	**10000**	1288.0140 m	0.0001 m	-0.0 mm	-0.0 σ
c_X	**20000**	**20000**	408.2063 m	0.0050 m	4.9 mm	1.0 σ
c_Y	**20000**	**20000**	-81.8156 m	0.0050 m	2.6 mm	0.5 σ
c_Z	**20000**	**20000**	1269.9890 m	0.0001 m	0.0 mm	0.0 σ
c_X	**11**	**11**	319.4744 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**11**	**11**	197.7506 m	0.0001 m	0.0 mm	0.0 σ
c_X	**12**	**12**	319.4740 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**12**	**12**	197.7512 m	0.0001 m	0.0 mm	0.0 σ
c_X	**13**	**13**	319.4738 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**13**	**13**	197.7513 m	0.0001 m	0.0 mm	0.0 σ
c_X	**14**	**14**	319.4740 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**14**	**14**	197.7512 m	0.0001 m	0.0 mm	0.0 σ
c_X	**21**	**21**	268.9422 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**21**	**21**	161.2918 m	0.0001 m	0.0 mm	0.0 σ
c_X	**22**	**22**	268.9419 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**22**	**22**	161.2919 m	0.0001 m	0.0 mm	0.0 σ
c_X	**23**	**23**	268.9422 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**23**	**23**	161.2918 m	0.0001 m	0.0 mm	0.0 σ
c_X	**24**	**24**	268.9424 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**24**	**24**	161.2925 m	0.0001 m	0.0 mm	0.0 σ
c_X	**31**	**31**	211.7417 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**31**	**31**	162.8092 m	0.0001 m	0.0 mm	0.0 σ
c_X	**32**	**32**	211.7415 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**32**	**32**	162.8092 m	0.0001 m	0.0 mm	0.0 σ
c_X	**33**	**33**	211.7415 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**33**	**33**	162.8092 m	0.0001 m	0.0 mm	0.0 σ
c_X	**34**	**34**	211.7418 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**34**	**34**	162.8098 m	0.0001 m	0.0 mm	0.0 σ
c_X	**41**	**41**	171.4255 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**41**	**41**	245.6434 m	0.0001 m	0.0 mm	0.0 σ
c_X	**42**	**42**	171.4254 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**42**	**42**	245.6429 m	0.0001 m	0.0 mm	0.0 σ
c_X	**43**	**43**	171.4256 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**43**	**43**	245.6433 m	0.0001 m	0.0 mm	0.0 σ
c_X	**44**	**44**	171.4256 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**44**	**44**	245.6433 m	0.0001 m	0.0 mm	0.0 σ
c_X	**100c**	**100c**	280.5941 m	0.0050 m	0.0 mm	0.0 σ
c_Y	**100c**	**100c**	188.3593 m	0.0050 m	0.0 mm	0.0 σ
c_X	**210b**	**210b**	252.6736 m	0.0050 m	0.0 mm	0.0 σ

c_Y	**210b**	**210b**	209.6180 m	0.0050 m	0.0 mm	0.0 σ
c_X	**300**	**300**	200.0000 m	0.0001 m	-0.0 mm	-0.0 σ
c_Y	**300**	**300**	200.0000 m	0.0001 m	-0.0 mm	-0.0 σ
c_Z	**300**	**300**	1268.7250 m	0.0001 m	-0.0 mm	-0.0 σ
c_X	**301**	**301**	200.0000 m	0.0050 m	0.0 mm	0.0 σ
c_Y	**301**	**301**	200.0000 m	0.0050 m	0.0 mm	0.0 σ
c_X	**311**	**311**	215.5677 m	0.0050 m	0.0 mm	0.0 σ
c_Y	**311**	**311**	172.4438 m	0.0050 m	0.0 mm	0.0 σ
c_X	**1001**	**1001**	215.5674 m	0.0001 m	0.0 mm	0.0 σ
c_Y	**1001**	**1001**	172.4433 m	0.0001 m	0.0 mm	0.0 σ
c_X	**520b**	**520b**	210.1982 m	0.0010 m	0.0 mm	0.0 σ
c_Y	**520b**	**520b**	187.8497 m	0.0010 m	0.0 mm	0.0 σ
tour	**T5**	**T4**	0.0000 g	0.0008 g	0.7 mm	0.6 σ
hz	**T5**	**213**	45.2661 g	0.0008 g	0.0 mm	0.1 σ
hz	**T5**	**211**	45.7309 g	0.0008 g	0.1 mm	0.7 σ
hz	**T5**	**218**	45.9405 g	0.0008 g	0.0 mm	0.1 σ
hz	**T5**	**212**	46.8249 g	0.0008 g	-0.1 mm	-0.3 σ
hz	**T5**	**T1.1**	161.9648 g	0.0008 g	-0.2 mm	-0.2 σ
hz	**T5**	**T3**	326.8806 g	0.0008 g	-0.8 mm	-1.1 σ
hz	**T5**	**310**	334.4443 g	0.0008 g	0.1 mm	0.2 σ
zen	**T5**	**T4**	103.6033 g	0.0012 g	-1.9 mm	-1.0 σ
zen	**T5**	**213**	101.6975 g	0.0012 g	0.0 mm	0.0 σ
zen	**T5**	**211**	101.6938 g	0.0012 g	0.0 mm	0.0 σ
zen	**T5**	**212**	101.7126 g	0.0012 g	-0.1 mm	-0.2 σ
zen	**T5**	**T1.1**	102.8230 g	0.0012 g	0.2 mm	0.1 σ
zen	**T5**	**T3**	104.7705 g	0.0012 g	-0.6 mm	-0.5 σ
dist	**T5**	**T4**	99.9752 m	0.0010 m	-0.8 mm	-0.8 σ
dist	**T5**	**213**	15.5201 m	0.0010 m	0.7 mm	0.7 σ
dist	**T5**	**211**	15.8962 m	0.0010 m	-0.4 mm	-0.4 σ
dist	**T5**	**212**	15.6136 m	0.0010 m	0.4 mm	0.4 σ
dist	**T5**	**T1.1**	62.6936 m	0.0010 m	-0.3 mm	-0.3 σ
dist	**T5**	**T3**	55.2293 m	0.0010 m	-0.4 mm	-0.4 σ
tour	**T5**	**T4**	0.0000 g	0.0008 g	1.6 mm	1.3 σ
hz	**T5**	**20000**	233.7607 g	0.0008 g	-2.1 mm	-0.5 σ
hz	**T5**	**T2**	243.3305 g	0.0008 g	-0.1 mm	-0.2 σ
hz	**T5**	**T3**	326.8807 g	0.0008 g	-0.4 mm	-0.5 σ
zen	**T5**	**T4**	103.6029 g	0.0012 g	-1.2 mm	-0.7 σ
zen	**T5**	**T2**	106.2218 g	0.0012 g	0.8 mm	1.2 σ
zen	**T5**	**T3**	104.7696 g	0.0012 g	0.2 mm	0.2 σ
dist	**T5**	**T4**	99.9744 m	0.0010 m	0.0 mm	0.0 σ
dist	**T5**	**T2**	35.2285 m	0.0010 m	-0.3 mm	-0.3 σ
dist	**T5**	**T3**	55.2293 m	0.0010 m	-0.4 mm	-0.4 σ
tour	**T200**	**T4**	0.0000 g	0.0008 g	-1.4 mm	-1.3 σ
hz	**T200**	**20000**	242.3586 g	0.0008 g	11.7 mm	2.8 σ
hz	**T200**	**T5**	253.8374 g	0.0008 g	-0.2 mm	-1.1 σ
hz	**T200**	**300**	360.8174 g	0.0008 g	-0.3 mm	-0.4 σ
hz	**T200**	**T1.1**	185.0816 g	0.0008 g	-0.1 mm	-0.1 σ
zen	**T200**	**T4**	103.8470 g	0.0012 g	-3.0 mm	-1.8 σ
zen	**T200**	**T5**	98.7213 g	0.0012 g	0.0 mm	0.1 σ
zen	**T200**	**T1.1**	102.2617 g	0.0012 g	0.3 mm	0.2 σ
dist	**T200**	**T4**	88.1061 m	0.0010 m	0.4 mm	0.4 σ
dist	**T200**	**T5**	16.7142 m	0.0010 m	-1.4 mm	-1.4 σ
dist	**T200**	**T1.1**	68.7918 m	0.0010 m	0.4 mm	0.4 σ
tour	**T1.2**	**T4**	0.0000 g	0.0008 g	0.6 mm	0.3 σ
hz	**T1.2**	**T200**	391.6235 g	0.0008 g	-0.2 mm	-0.2 σ
hz	**T1.2**	**T2**	340.2935 g	0.0008 g	-0.1 mm	-0.1 σ
zen	**T1.2**	**T4**	101.1761 g	0.0012 g	-3.3 mm	-1.1 σ
zen	**T1.2**	**T200**	97.7356 g	0.0012 g	-0.1 mm	-0.1 σ
zen	**T1.2**	**T2**	100.6730 g	0.0012 g	-3.0 mm	-2.5 σ
dist	**T1.2**	**T4**	155.6624 m	0.0010 m	0.1 mm	0.1 σ
dist	**T1.2**	**T200**	68.7917 m	0.0010 m	0.2 mm	0.2 σ
dist	**T1.2**	**T2**	62.3310 m	0.0010 m	-0.3 mm	-0.3 σ
tour	**T2**	**T4**	0.0000 g	0.0008 g	0.7 mm	0.4 σ
hz	**T2**	**T5**	32.3846 g	0.0008 g	0.2 mm	0.5 σ
hz	**T2**	**T1.1**	114.8121 g	0.0008 g	-0.7 mm	-0.9 σ
zen	**T2**	**T4**	101.0965 g	0.0012 g	-5.4 mm	-2.2 σ
zen	**T2**	**T5**	93.7795 g	0.0012 g	-1.3 mm	-2.0 σ
zen	**T2**	**T1.1**	99.3288 g	0.0012 g	-1.7 mm	-1.4 σ
dist	**T2**	**T4**	128.9826 m	0.0010 m	0.1 mm	0.1 σ
dist	**T2**	**T5**	35.2285 m	0.0010 m	-0.3 mm	-0.3 σ
dist	**T2**	**T1.1**	62.3306 m	0.0010 m	0.1 mm	0.1 σ
tour	**T2**	**T3**	0.0000 g	0.0008 g	0.3 mm	0.4 σ
hz	**T2**	**310**	10.7973 g	0.0008 g	-0.3 mm	-0.4 σ

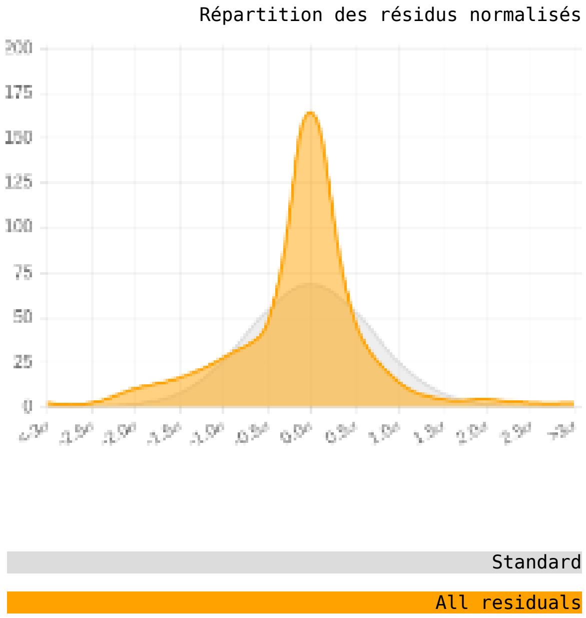
hz	**T2**	**300**	30.3793 g	0.0008 g	0.6 mm	0.7 σ
hz	**T2**	**510**	33.2890 g	0.0008 g	-0.1 mm	-0.2 σ
hz	**T2**	**520**	24.7464 g	0.0008 g	0.4 mm	0.5 σ
hz	**T2**	**T4**	43.7138 g	0.0008 g	-0.6 mm	-0.4 σ
hz	**T2**	**218**	76.9055 g	0.0008 g	-0.9 mm	-1.3 σ
hz	**T2**	**211**	76.8467 g	0.0008 g	0.3 mm	0.5 σ
hz	**T2**	**212**	77.1736 g	0.0008 g	0.8 mm	1.2 σ
hz	**T2**	**T1.1**	158.5253 g	0.0008 g	-0.8 mm	-1.0 σ
zen	**T2**	**T3**	100.7736 g	0.0012 g	0.5 mm	0.5 σ
zen	**T2**	**510**	101.7131 g	0.0012 g	0.5 mm	0.5 σ
zen	**T2**	**520**	101.5687 g	0.0012 g	3.5 mm	2.9 σ
zen	**T2**	**T4**	101.0940 g	0.0012 g	-0.4 mm	-0.1 σ
zen	**T2**	**211**	96.2360 g	0.0012 g	0.4 mm	0.4 σ
zen	**T2**	**212**	96.2101 g	0.0012 g	0.9 mm	0.9 σ
zen	**T2**	**T1.1**	99.3258 g	0.0012 g	1.2 mm	1.1 σ
dist	**T2**	**T3**	57.2364 m	0.0010 m	0.1 mm	0.1 σ
dist	**T2**	**510**	58.6439 m	0.0010 m	-1.0 mm	-1.0 σ
dist	**T2**	**520**	64.7407 m	0.0010 m	-1.1 mm	-1.1 σ
dist	**T2**	**T4**	128.9823 m	0.0010 m	0.4 mm	0.4 σ
dist	**T2**	**211**	51.0321 m	0.0010 m	-0.5 mm	-0.5 σ
dist	**T2**	**212**	50.7421 m	0.0010 m	-0.2 mm	-0.2 σ
dist	**T2**	**T1.1**	62.3306 m	0.0010 m	0.1 mm	0.1 σ
tour	**T3**	**T2**	0.0000 g	0.0008 g	-0.3 mm	-0.5 σ
hz	**T3**	**T5**	359.6480 g	0.0008 g	-0.6 mm	-0.8 σ
hz	**T3**	**218**	344.0035 g	0.0008 g	1.0 mm	1.3 σ
hz	**T3**	**510**	313.7924 g	0.0008 g	0.0 mm	0.1 σ
hz	**T3**	**520**	293.1244 g	0.0008 g	0.1 mm	0.4 σ
hz	**T3**	**310**	320.6604 g	0.0008 g	-0.0 mm	-0.0 σ
hz	**T3**	**300**	277.8895 g	0.0008 g	-0.1 mm	-0.3 σ
hz	**T3**	**T4**	269.4774 g	0.0008 g	-0.2 mm	-0.2 σ
zen	**T3**	**T2**	99.2265 g	0.0012 g	-0.1 mm	-0.1 σ
zen	**T3**	**T5**	95.2301 g	0.0012 g	0.5 mm	0.5 σ
zen	**T3**	**218**	95.7988 g	0.0012 g	3.1 mm	2.7 σ
zen	**T3**	**510**	101.8739 g	0.0012 g	-0.2 mm	-0.3 σ
zen	**T3**	**520**	102.3284 g	0.0012 g	-0.2 mm	-0.5 σ
zen	**T3**	**T4**	101.0545 g	0.0012 g	-6.7 mm	-3.9 σ
dist	**T3**	**T2**	57.2363 m	0.0010 m	0.2 mm	0.2 σ
dist	**T3**	**T5**	55.2282 m	0.0010 m	0.7 mm	0.7 σ
dist	**T3**	**510**	29.9902 m	0.0010 m	-1.3 mm	-1.3 σ
dist	**T3**	**520**	24.6895 m	0.0010 m	-0.4 mm	-0.4 σ
dist	**T3**	**T4**	92.1582 m	0.0010 m	-0.5 mm	-0.5 σ
tour	**T1.2**	**20000**	0.0000 g	0.0008 g	1.1 mm	0.3 σ
hz	**T1.2**	**T2**	79.6519 g	0.0008 g	0.1 mm	0.1 σ
hz	**T1.2**	**T5**	115.8615 g	0.0008 g	-1.0 mm	-1.3 σ
hz	**T1.2**	**T4**	139.3577 g	0.0008 g	2.7 mm	1.4 σ
hz	**T1.2**	**T200**	130.9826 g	0.0008 g	-0.8 mm	-0.9 σ
hz	**T1.2**	**218**	130.1339 g	0.0008 g	1.7 mm	2.0 σ
hz	**T1.2**	**211**	130.2981 g	0.0008 g	-0.9 mm	-1.0 σ
hz	**T1.2**	**212**	130.1782 g	0.0008 g	-0.4 mm	-0.4 σ
hz	**T1.2**	**213**	129.9385 g	0.0008 g	-0.1 mm	-0.1 σ
zen	**T1.2**	**T2**	100.6705 g	0.0012 g	-0.5 mm	-0.4 σ
zen	**T1.2**	**T5**	97.1737 g	0.0012 g	0.2 mm	0.2 σ
zen	**T1.2**	**T4**	101.1761 g	0.0012 g	-3.3 mm	-1.1 σ
zen	**T1.2**	**T200**	97.7355 g	0.0012 g	-0.0 mm	-0.0 σ
zen	**T1.2**	**211**	97.8047 g	0.0012 g	0.0 mm	0.0 σ
zen	**T1.2**	**212**	97.7904 g	0.0012 g	-0.4 mm	-0.3 σ
zen	**T1.2**	**213**	97.7928 g	0.0012 g	1.2 mm	1.0 σ
dist	**T1.2**	**T2**	62.3314 m	0.0010 m	-0.7 mm	-0.7 σ
dist	**T1.2**	**T5**	62.6934 m	0.0010 m	-0.3 mm	-0.3 σ
dist	**T1.2**	**T4**	155.6619 m	0.0010 m	0.6 mm	0.6 σ
dist	**T1.2**	**T200**	68.7916 m	0.0010 m	0.3 mm	0.3 σ
dist	**T1.2**	**211**	68.4306 m	0.0010 m	0.3 mm	0.3 σ
dist	**T1.2**	**212**	68.0621 m	0.0010 m	0.1 mm	0.1 σ
dist	**T1.2**	**213**	68.3581 m	0.0010 m	0.9 mm	0.9 σ
tour	**T1.2**	**20000**	0.0000 g	0.0008 g	-2.1 mm	-0.6 σ
hz	**T1.2**	**T2**	79.6514 g	0.0008 g	-0.1 mm	-0.1 σ
hz	**T1.2**	**105**	103.8242 g	0.0008 g	0.7 mm	1.3 σ
hz	**T1.2**	**T4**	139.3586 g	0.0008 g	-1.2 mm	-0.6 σ
zen	**T1.2**	**T2**	100.6695 g	0.0012 g	0.5 mm	0.4 σ
zen	**T1.2**	**105**	94.4596 g	0.0012 g	0.1 mm	0.2 σ
zen	**T1.2**	**T4**	101.1759 g	0.0012 g	-2.8 mm	-1.0 σ
dist	**T1.2**	**T2**	62.3309 m	0.0010 m	-0.2 mm	-0.2 σ

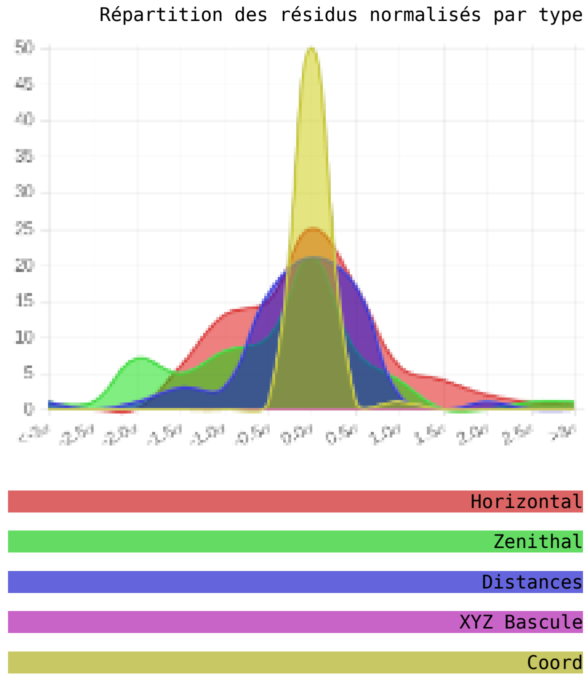
dist	**T1.2**	**105**	40.7206 m	0.0010 m	-0.5 mm	-0.5 σ
dist	**T1.2**	**T4**	155.6619 m	0.0010 m	0.6 mm	0.6 σ
tour	**T2**	**10000**	0.0000 g	0.0008 g	4.5 mm	0.5 σ
hz	**T2**	**20000**	58.9018 g	0.0008 g	-3.6 mm	-1.0 σ
hz	**T2**	**T1.2**	352.0890 g	0.0008 g	-0.0 mm	-0.1 σ
hz	**T2**	**105**	317.2196 g	0.0008 g	0.2 mm	0.6 σ
hz	**T2**	**T3**	193.5655 g	0.0008 g	-0.0 mm	-0.0 σ
zen	**T2**	**T1.2**	99.3311 g	0.0012 g	-0.5 mm	-0.4 σ
zen	**T2**	**105**	90.8158 g	0.0012 g	-0.2 mm	-0.3 σ
zen	**T2**	**T3**	100.7741 g	0.0012 g	0.0 mm	0.0 σ
dist	**T2**	**T1.2**	62.3309 m	0.0010 m	-0.2 mm	-0.2 σ
dist	**T2**	**105**	29.1781 m	0.0010 m	-0.1 mm	-0.1 σ
dist	**T2**	**T3**	57.2362 m	0.0010 m	0.3 mm	0.3 σ
tour	**T3**	**10000**	0.0000 g	0.0008 g	8.0 mm	0.9 σ
hz	**T3**	**20000**	49.4286 g	0.0008 g	-0.5 mm	-0.1 σ
hz	**T3**	**T2**	394.0625 g	0.0008 g	0.5 mm	0.6 σ
hz	**T3**	**105**	369.9876 g	0.0008 g	-0.9 mm	-0.9 σ
hz	**T3**	**T4**	263.5410 g	0.0008 g	-0.5 mm	-0.4 σ
zen	**T3**	**T2**	99.2256 g	0.0012 g	0.7 mm	0.6 σ
zen	**T3**	**105**	95.7333 g	0.0012 g	0.4 mm	0.3 σ
zen	**T3**	**T4**	101.0522 g	0.0012 g	-3.4 mm	-2.0 σ
dist	**T3**	**T2**	57.2363 m	0.0010 m	0.2 mm	0.2 σ
dist	**T3**	**105**	73.0284 m	0.0010 m	0.6 mm	0.6 σ
dist	**T3**	**T4**	92.1576 m	0.0010 m	0.1 mm	0.1 σ
tour	**T4**	**10000**	0.0000 g	0.0008 g	-9.8 mm	-1.0 σ
hz	**T4**	**T1.2**	6.0657 g	0.0008 g	0.0 mm	0.0 σ
hz	**T4**	**T5**	20.6032 g	0.0008 g	1.0 mm	0.8 σ
hz	**T4**	**T200**	12.6069 g	0.0008 g	-0.3 mm	-0.3 σ
hz	**T4**	**218**	13.1541 g	0.0008 g	1.1 mm	1.0 σ
hz	**T4**	**211**	13.0602 g	0.0008 g	1.0 mm	0.9 σ
hz	**T4**	**213**	13.3151 g	0.0008 g	0.7 mm	0.6 σ
hz	**T4**	**T2**	31.5496 g	0.0008 g	-2.1 mm	-1.3 σ
hz	**T4**	**T3**	57.3140 g	0.0008 g	-1.4 mm	-1.2 σ
hz	**T4**	**300**	51.2910 g	0.0008 g	-0.1 mm	-0.2 σ
hz	**T4**	**310**	52.0744 g	0.0008 g	-0.4 mm	-0.4 σ
hz	**T4**	**510**	40.0519 g	0.0008 g	-0.8 mm	-0.9 σ
hz	**T4**	**520**	49.1131 g	0.0008 g	1.6 mm	1.9 σ
zen	**T4**	**T1.2**	98.8288 g	0.0012 g	-5.3 mm	-1.8 σ
zen	**T4**	**T5**	96.4001 g	0.0012 g	-2.1 mm	-1.1 σ
zen	**T4**	**T200**	96.1573 g	0.0012 g	-1.9 mm	-1.1 σ
zen	**T4**	**218**	95.9962 g	0.0012 g	0.2 mm	0.1 σ
zen	**T4**	**211**	96.2425 g	0.0012 g	-1.8 mm	-1.1 σ
zen	**T4**	**213**	96.2434 g	0.0012 g	-2.2 mm	-1.3 σ
zen	**T4**	**T2**	98.9092 g	0.0012 g	-3.8 mm	-1.6 σ
zen	**T4**	**T3**	98.9532 g	0.0012 g	-3.2 mm	-1.9 σ
zen	**T4**	**510**	99.4365 g	0.0012 g	-1.1 mm	-0.8 σ
zen	**T4**	**520**	99.4391 g	0.0012 g	-1.8 mm	-1.4 σ
dist	**T4**	**T1.2**	155.6624 m	0.0010 m	0.1 mm	0.1 σ
dist	**T4**	**T5**	99.9741 m	0.0010 m	0.3 mm	0.3 σ
dist	**T4**	**T200**	88.1046 m	0.0010 m	1.9 mm	1.9 σ
dist	**T4**	**211**	88.6291 m	0.0010 m	-3.6 mm	-3.6 σ
dist	**T4**	**213**	88.7927 m	0.0010 m	0.9 mm	0.9 σ
dist	**T4**	**T2**	128.9823 m	0.0010 m	0.4 mm	0.4 σ
dist	**T4**	**T3**	92.1578 m	0.0010 m	-0.1 mm	-0.1 σ
dist	**T4**	**510**	71.7700 m	0.0010 m	-1.9 mm	-1.9 σ
dist	**T4**	**520**	69.7369 m	0.0010 m	-1.5 mm	-1.5 σ
tour	**T4**	**10000**	0.0000 g	0.0008 g	-15.6 mm	-1.6 σ
hz	**T4**	**105**	17.2300 g	0.0008 g	3.6 mm	2.3 σ
hz	**T4**	**T1.2**	6.0661 g	0.0008 g	-2.1 mm	-1.1 σ
hz	**T4**	**T2**	31.5485 g	0.0008 g	-0.8 mm	-0.5 σ
hz	**T4**	**T3**	57.3119 g	0.0008 g	1.0 mm	0.8 σ
zen	**T4**	**105**	96.6890 g	0.0012 g	0.0 mm	0.0 σ
zen	**T4**	**T1.2**	98.8267 g	0.0012 g	-0.2 mm	-0.1 σ
zen	**T4**	**T2**	98.9072 g	0.0012 g	0.2 mm	0.1 σ
zen	**T4**	**T3**	98.9532 g	0.0012 g	-3.2 mm	-1.9 σ
dist	**T4**	**105**	123.2818 m	0.0010 m	0.5 mm	0.5 σ
dist	**T4**	**T1.2**	155.6621 m	0.0010 m	0.4 mm	0.4 σ
dist	**T4**	**T2**	128.9820 m	0.0010 m	0.7 mm	0.7 σ
dist	**T4**	**T3**	92.1576 m	0.0010 m	0.1 mm	0.1 σ
tour	**T5**	**20000**	0.0000 g	0.0008 g	0.4 mm	0.1 σ
hz	**T5**	**105**	348.7553 g	0.0008 g	0.0 mm	0.1 σ
hz	**T5**	**T3**	93.1202 g	0.0008 g	-0.1 mm	-0.2 σ
hz	**T5**	**T1.2**	328.2044 g	0.0008 g	-0.0 mm	-0.1 σ

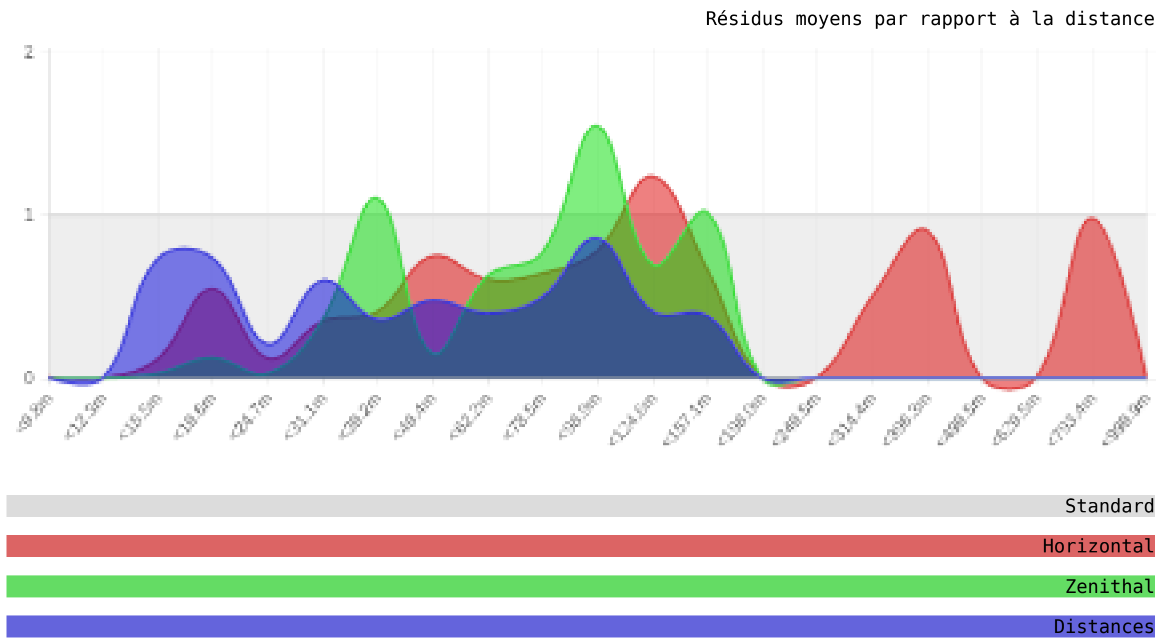
zen	**T5**	**105**	97.9955 g	0.0012 g	0.0 mm	0.0 σ
zen	**T5**	**T3**	104.7692 g	0.0012 g	0.6 mm	0.5 σ
zen	**T5**	**T1.2**	102.8282 g	0.0012 g	-1.5 mm	-1.3 σ
dist	**T5**	**105**	24.0409 m	0.0010 m	0.2 mm	0.2 σ
dist	**T5**	**T3**	55.2292 m	0.0010 m	-0.3 mm	-0.3 σ
dist	**T5**	**T1.2**	62.6935 m	0.0010 m	-0.4 mm	-0.4 σ
tour	**T200**	**20000**	0.0000 g	0.0008 g	0.7 mm	0.2 σ
hz	**T200**	**105**	373.6222 g	0.0008 g	0.3 mm	0.7 σ
hz	**T200**	**T1.2**	342.7198 g	0.0008 g	0.6 mm	0.7 σ
hz	**T200**	**T4**	157.6395 g	0.0008 g	-1.7 mm	-1.5 σ
zen	**T200**	**105**	98.0672 g	0.0012 g	0.1 mm	0.1 σ
zen	**T200**	**T1.2**	102.2657 g	0.0012 g	-0.6 mm	-0.5 σ
zen	**T200**	**T4**	103.8454 g	0.0012 g	-0.8 mm	-0.5 σ
dist	**T200**	**105**	35.9899 m	0.0010 m	-0.4 mm	-0.4 σ
dist	**T200**	**T1.2**	68.7921 m	0.0010 m	-0.2 mm	-0.2 σ
dist	**T200**	**T4**	88.1063 m	0.0010 m	0.2 mm	0.2 σ
den	**21**	**22**	0.0025 m	0.0001 m	-0.0 mm	-0.1 σ
den	**22**	**23**	-0.0032 m	0.0001 m	-0.0 mm	-0.0 σ
den	**23**	**24**	-0.0015 m	0.0001 m	-0.0 mm	-0.0 σ
den	**24**	**21**	0.0023 m	0.0001 m	-0.0 mm	-0.1 σ
den	**11**	**12**	-0.0060 m	0.0001 m	0.0 mm	0.1 σ
den	**12**	**13**	0.0027 m	0.0001 m	0.0 mm	0.1 σ
den	**13**	**14**	-0.0030 m	0.0001 m	0.0 mm	0.1 σ
den	**14**	**11**	0.0063 m	0.0001 m	0.0 mm	0.1 σ
den	**41**	**42**	0.0116 m	0.0001 m	0.0 mm	0.1 σ
den	**42**	**43**	-0.0132 m	0.0001 m	0.0 mm	0.1 σ
den	**43**	**44**	0.0004 m	0.0001 m	0.0 mm	0.1 σ
den	**44**	**41**	0.0012 m	0.0001 m	0.0 mm	0.1 σ
den	**31**	**32**	0.0018 m	0.0001 m	0.0 mm	0.3 σ
den	**32**	**33**	-0.0007 m	0.0001 m	0.0 mm	0.2 σ
den	**33**	**34**	-0.0016 m	0.0001 m	0.0 mm	0.3 σ
den	**34**	**31**	0.0003 m	0.0001 m	0.0 mm	0.2 σ
den	**301**	**510**	-0.7144 m	0.0001 m	-0.0 mm	-0.0 σ
den	**510**	**301**	0.7144 m	0.0001 m	-0.0 mm	-0.1 σ
den	**510**	**520b**	-0.0001 m	0.0001 m	-0.0 mm	-0.1 σ
den	**520b**	**510**	0.0002 m	0.0001 m	-0.0 mm	-0.1 σ
den	**520b**	**520**	-0.0200 m	0.0001 m	0.0 mm	0.0 σ
den	**21**	**11**	0.6613 m	0.0001 m	-0.0 mm	-0.0 σ
den	**11**	**21**	-0.6611 m	0.0001 m	-0.1 mm	-1.5 σ
den	**21**	**31**	-0.7031 m	0.0001 m	-0.3 mm	-2.0 σ
den	**31**	**21**	0.7034 m	0.0001 m	0.0 mm	0.1 σ
den	**31**	**41**	-1.5132 m	0.0001 m	-0.1 mm	-0.9 σ
den	**41**	**31**	1.5131 m	0.0001 m	0.2 mm	1.2 σ
den	**41**	**11**	2.8782 m	0.0002 m	-0.2 mm	-0.9 σ
den	**41**	**11**	2.8783 m	0.0002 m	-0.3 mm	-1.7 σ
den	**31**	**510**	0.5086 m	0.0001 m	0.0 mm	0.3 σ
den	**510**	**31**	-0.5086 m	0.0001 m	0.0 mm	0.3 σ
den	**21**	**5**	3.4795 m	0.0001 m	-0.1 mm	-0.6 σ
den	**5**	**21**	-3.4794 m	0.0001 m	-0.1 mm	-0.6 σ
den	**5**	**210b**	1.1014 m	0.0001 m	0.0 mm	0.2 σ
den	**210**	**210b**	0.0200 m	0.0001 m	-0.0 mm	-0.1 σ
den	**210**	**5**	-1.0814 m	0.0001 m	-0.1 mm	-0.5 σ
den	**5**	**210**	1.0815 m	0.0001 m	-0.1 mm	-0.4 σ
den	**100c**	**5**	-0.0135 m	0.0001 m	-0.0 mm	-0.1 σ
den	**100c**	**5**	-0.0136 m	0.0001 m	0.0 mm	0.1 σ
den	**100c**	**100**	0.9885 m	0.0001 m	0.0 mm	0.0 σ
den	**100**	**100c**	-0.9886 m	0.0001 m	0.0 mm	0.0 σ
den	**1001**	**31**	-1.6228 m	0.0001 m	-0.0 mm	-0.1 σ
den	**31**	**1001**	1.6228 m	0.0001 m	-0.0 mm	-0.1 σ
den	**1001**	**311**	0.1378 m	0.0005 m	1.1 mm	2.2 σ
den	**1001**	**311**	0.1400 m	0.0005 m	-1.1 mm	-2.3 σ
ctr_plani	**1**	**T1.1**	0.0000 m	0.0005 m	-0.6 mm	-1.2 σ
den	**1**	**T1.1**	0.2895 m	0.0010 m	-0.0 mm	-0.0 σ
ctr_plani	**1**	**T1.2**	0.0000 m	0.0001 m	0.0 mm	0.2 σ
den	**1**	**T1.2**	0.2860 m	0.0010 m	0.0 mm	0.0 σ
ctr_plani	**2**	**T2**	0.0000 m	0.0001 m	0.0 mm	0.0 σ
den	**2**	**T2**	0.2880 m	0.0010 m	-0.0 mm	-0.0 σ
ctr_plani	**3**	**T3**	0.0000 m	0.0001 m	0.0 mm	0.0 σ
den	**3**	**T3**	0.2930 m	0.0010 m	0.0 mm	0.0 σ
ctr_plani	**4**	**T4**	0.0000 m	0.0001 m	0.0 mm	0.0 σ
den	**4**	**T4**	0.2905 m	0.0010 m	0.0 mm	0.0 σ
ctr_plani	**5**	**T5**	0.0000 m	0.0005 m	0.0 mm	0.0 σ

den	5	T5	1.5440 m	0.0010 m	-2.0 mm	-2.0 σ
ctr_plani	200	T200	0.0000 m	0.0001 m	0.0 mm	0.0 σ
den	200	T200	0.2420 m	0.0010 m	-0.0 mm	-0.0 σ
den	301	300	-0.0728 m	0.0001 m	-0.0 mm	-0.0 σ
den	311	310	-0.0500 m	0.0001 m	0.0 mm	0.0 σ
den	210	218	0.3910 m	0.0002 m	0.1 mm	0.5 σ
den	210	219	0.8770 m	0.0002 m	-0.0 mm	-0.0 σ
ctr_plani	210	218	0.0000 m	0.0001 m	0.0 mm	0.0 σ
ctr_plani	210	219	0.0000 m	0.0001 m	0.0 mm	0.0 σ
ctr_plani	105	100	0.0000 m	0.0001 m	0.0 mm	0.0 σ

Residual repartition↑







Biggest residuals↑

code	from	to	normalized residual
zen	T3	T4	-3.9 σ
dist	T4	211	-3.6 σ
zen	T2	520	2.9 σ
hz	T200	20000	2.8 σ
zen	T3	218	2.7 σ
zen	T1.2	T2	-2.5 σ
hz	T4	105	2.3 σ

den	1001	311	-2.3 σ
den	1001	311	2.2 σ
zen	T2	T4	-2.2 σ
den	21	31	-2.0 σ
zen	T2	T5	-2.0 σ
hz	T1.2	218	2.0 σ
den	5	T5	-2.0 σ
zen	T3	T4	-2.0 σ
dist	T4	510	-1.9 σ
hz	T4	520	1.9 σ
zen	T4	T3	-1.9 σ
zen	T4	T3	-1.9 σ
dist	T4	T200	1.9 σ

Bascules↑

Nom fichier	Point origine	Verticale

Compensated coordinates↑

Name	X comp	Y comp	Z comp	ΔX	ΔY	ΔZ	σX init	σY init	σZ init
10000	946.1430	74.9258	1288.0140	-0.0009	-0.0024	-0.0000	0.0050	0.0050	0.0001
20000	408.2112	-81.8130	1269.9890	0.0049	0.0026	-0.0000	0.0050	0.0050	0.0001
1	319.9421	198.2071	1270.2312	0.0058	0.0007	0.0006			
2	269.4069	161.7472	1269.5735	0.0031	-0.0012	0.0011			
3	212.2061	163.2643	1268.8727	-0.0000	-0.0012	0.0000			
4	171.8914	246.1021	1267.3561	-0.0027	0.0035	0.0010			
5	257.4222	194.6878	1271.7576	0.0169	-0.0034	-0.0008			
T1.1	319.9424	198.2065	1270.5206	0.0061	0.0001	0.0000			
T1.2	319.9421	198.2071	1270.5172	0.0058	0.0007	-0.0034			
T2	269.4069	161.7472	1269.8615	0.0031	-0.0012	-0.0009			
T3	212.2061	163.2643	1269.1657	-0.0000	-0.0012	0.0030			
T4	171.8914	246.1021	1267.6466	-0.0027	0.0035	0.0015			
T5	257.4222	194.6878	1273.2997	0.0169	-0.0034	0.0153			
11	319.4744	197.7506	1268.9394	0.0000	0.0000	-0.0001	0.0001	0.0001	
12	319.4740	197.7512	1268.9334	0.0000	0.0000	-0.0001	0.0001	0.0001	
13	319.4738	197.7513	1268.9361	0.0000	0.0000	0.0000	0.0001	0.0001	
14	319.4740	197.7512	1268.9332	0.0000	0.0000	-0.0000	0.0001	0.0001	
21	268.9422	161.2918	1268.2782	0.0000	0.0000	0.0001	0.0001	0.0001	
22	268.9419	161.2919	1268.2807	0.0000	0.0000	0.0001	0.0001	0.0001	
23	268.9422	161.2918	1268.2774	0.0000	0.0000	0.0000	0.0001	0.0001	
24	268.9424	161.2925	1268.2759	0.0000	0.0000	0.0002	0.0001	0.0001	
31	211.7417	162.8092	1267.5748	0.0000	0.0000	-0.0000	0.0001	0.0001	
32	211.7415	162.8092	1267.5766	0.0000	0.0000	-0.0001	0.0001	0.0001	
33	211.7415	162.8092	1267.5760	0.0000	0.0000	-0.0001	0.0001	0.0001	
34	211.7418	162.8098	1267.5744	0.0000	0.0000	0.0000	0.0001	0.0001	
41	171.4255	245.6434	1266.0615	0.0000	0.0000	0.0004	0.0001	0.0001	
42	171.4254	245.6429	1266.0731	0.0000	0.0000	0.0003	0.0001	0.0001	
43	171.4256	245.6433	1266.0598	0.0000	0.0000	0.0003	0.0001	0.0001	
44	171.4256	245.6433	1266.0603	0.0000	0.0000	0.0004	0.0001	0.0001	
105	280.5980	188.3589	1274.0565	0.0039	-0.0004	0.0042			
100	280.5980	188.3589	1272.7597	0.0039	-0.0004	-1.2926			
100c	280.5941	188.3593	1271.7712	0.0000	0.0000	-2.2811	0.0050	0.0050	
T200	252.3340	210.6001	1272.9640	0.0039	-0.0011	0.2384			
200	252.3340	210.6001	1272.7220	0.0039	-0.0011	-0.0036			
210	252.6746	209.6155	1272.8391	0.0010	-0.0025	-0.0016			
210b	252.6736	209.6180	1272.8591	-0.0000	0.0000	0.0184	0.0050	0.0050	
211	252.5574	209.8116	1272.8768	0.0004	-0.0008	0.0021			
212	252.8995	209.6232	1272.8798	0.0022	0.0002	0.0007			
213	252.5644	209.4197	1272.8859	0.0010	0.0001	0.0003			
218	252.6746	209.6155	1273.2302	0.0011	-0.0018	-0.0015			
219	252.6746	209.6155	1273.7161	0.0013	-0.0021	-0.0017			
300	200.0000	200.0000	1268.7250	-0.0000	-0.0000	-0.0000	0.0001	0.0001	0.0001
301	200.0000	200.0000	1268.7978	0.0000	0.0000	0.0728	0.0050	0.0050	
310	215.5676	172.4431	1269.2864	0.0002	-0.0002	-0.0510			
311	215.5677	172.4438	1269.3364	0.0000	0.0000	0.0490	0.0050	0.0050	
1001	215.5674	172.4433	1269.1975	0.0000	0.0000	-0.1399	0.0001	0.0001	
510	219.4224	192.3525	1268.0834	0.0003	0.0009	0.0001			
520	210.1985	187.8503	1268.0632	0.0003	0.0006	0.0000			
520b	210.1982	187.8497	1268.0832	0.0000	0.0000	0.0200	0.0010	0.0010	

Ellipsoïdes de confiance↑

Name	1/2 Axe (mm)	Azimut (gr)	Site (gr)
10000	6.0	110.38	0.00
	5.5	10.38	0.00
	0.1	0.00	100.00
20000	5.6	169.03	0.00
	3.5	-130.97	0.00
	0.1	0.00	100.00
1	1.4	-10.70	-0.02
	1.0	-92.80	99.93
	0.7	-110.70	-0.06
2	1.3	-29.02	99.89
	1.1	-7.37	-0.10
	0.8	-107.37	-0.04
3	1.3	173.36	99.88
	1.0	-40.71	0.11
	0.6	-140.71	-0.03
4	1.3	-42.31	99.78
	1.0	-31.48	-0.22
	0.8	-131.48	-0.04
5	1.2	-25.66	-0.00
	0.9	-125.66	-0.01
	0.3	-92.54	99.99
T1.1	1.5	-10.74	-0.03
	0.8	86.48	99.34
	0.8	-110.74	0.66
T1.2	1.4	-10.69	-0.01
	0.7	-110.69	0.32
	0.6	87.66	99.68
T2	1.1	-7.37	0.06
	0.8	-107.37	0.09
	0.5	130.60	99.89
T3	1.0	159.29	0.07
	0.6	-140.71	0.14
	0.4	28.48	99.84
T4	1.0	-31.48	0.30
	0.8	-131.48	0.15
	0.6	138.90	99.67
T5	1.1	-25.66	-0.03
	0.6	-125.66	0.34
	0.5	68.43	99.66
11	0.2	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
12	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
13	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
14	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
21	0.2	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
22	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
23	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
24	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
31	0.2	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
32	0.2	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
33	0.2	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
34	0.2	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00

41	0.2	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
42	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
43	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
44	0.3	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
105	1.1	-17.20	0.05
	0.8	-117.20	-0.35
	0.6	-126.99	99.64
100	1.2	-17.20	-0.00
	0.8	-117.20	-0.01
	0.3	-92.56	99.99
100c	6.0	100.00	0.00
	6.0	0.00	0.00
	0.3	0.00	100.00
T200	1.0	-37.16	-0.01
	0.6	62.84	-1.78
	0.6	62.54	98.22
200	1.3	-149.24	99.96
	1.0	-37.16	0.01
	0.6	-137.16	-0.04
210	1.3	-25.60	0.00
	0.6	-125.60	-0.04
	0.3	-129.19	99.96
210b	6.0	100.00	0.00
	6.0	0.00	0.00
	0.3	0.00	100.00
211	1.2	-29.02	-0.37
	0.6	71.00	-4.16
	0.6	65.35	95.83
212	1.2	-27.70	-0.52
	0.6	72.34	-4.13
	0.6	64.38	95.84
213	1.2	-28.03	-0.51
	0.6	72.01	-5.14
	0.6	65.70	94.84
218	1.3	-25.60	0.01
	0.6	-125.60	-0.12
	0.4	-129.02	99.88
219	1.3	-25.60	0.00
	0.6	-125.60	-0.04
	0.4	-128.80	99.96
300	0.1	187.33	100.00
	0.1	-194.53	-0.00
	0.1	105.47	-0.00
301	6.0	100.00	0.00
	6.0	0.00	0.00
	0.2	0.00	100.00
310	1.1	-18.77	-0.00
	0.7	-118.77	-0.00
	0.5	-103.62	100.00
311	6.0	100.00	0.00
	6.0	0.00	0.00
	0.5	0.00	100.00
1001	0.2	0.00	100.00
	0.1	100.00	0.00
	0.1	0.00	0.00
510	1.1	175.03	-0.00
	0.7	75.03	-0.00
	0.2	98.59	100.00
520	1.1	-26.87	-0.02
	0.6	-126.87	0.02
	0.2	33.91	99.97
520b	1.2	100.00	0.00
	1.2	0.00	0.00
	0.2	0.00	100.00

Confidence intervals↑

Name	σX	σY	σZ

10000	5.4 mm	5.1 mm	0.1 mm
20000	3.7 mm	4.8 mm	0.1 mm
1	0.7 mm	1.3 mm	1.0 mm
2	0.8 mm	1.0 mm	1.2 mm
3	0.7 mm	0.8 mm	1.2 mm
4	0.8 mm	0.9 mm	1.2 mm
5	0.8 mm	1.1 mm	0.2 mm
T1.1	0.7 mm	1.3 mm	0.7 mm
T1.2	0.7 mm	1.3 mm	0.6 mm
T2	0.7 mm	1.0 mm	0.5 mm
T3	0.7 mm	0.8 mm	0.4 mm
T4	0.8 mm	0.9 mm	0.5 mm
T5	0.6 mm	0.9 mm	0.5 mm
11	0.1 mm	0.1 mm	0.2 mm
12	0.1 mm	0.1 mm	0.2 mm
13	0.1 mm	0.1 mm	0.2 mm
14	0.1 mm	0.1 mm	0.2 mm
21	0.1 mm	0.1 mm	0.2 mm
22	0.1 mm	0.1 mm	0.2 mm
23	0.1 mm	0.1 mm	0.2 mm
24	0.1 mm	0.1 mm	0.2 mm
31	0.1 mm	0.1 mm	0.2 mm
32	0.1 mm	0.1 mm	0.2 mm
33	0.1 mm	0.1 mm	0.2 mm
34	0.1 mm	0.1 mm	0.2 mm
41	0.1 mm	0.1 mm	0.2 mm
42	0.1 mm	0.1 mm	0.2 mm
43	0.1 mm	0.1 mm	0.2 mm
44	0.1 mm	0.1 mm	0.2 mm
105	0.7 mm	1.0 mm	0.5 mm
100	0.7 mm	1.0 mm	0.3 mm
100c	5.5 mm	5.5 mm	0.3 mm
T200	0.7 mm	0.8 mm	0.5 mm
200	0.7 mm	0.8 mm	1.2 mm
210	0.7 mm	1.1 mm	0.3 mm
210b	5.5 mm	5.5 mm	0.3 mm
211	0.7 mm	1.0 mm	0.5 mm
212	0.7 mm	1.0 mm	0.5 mm
213	0.7 mm	1.1 mm	0.5 mm
218	0.7 mm	1.1 mm	0.3 mm
219	0.7 mm	1.1 mm	0.3 mm
300	0.1 mm	0.1 mm	0.1 mm
301	5.5 mm	5.5 mm	0.2 mm
310	0.7 mm	0.9 mm	0.5 mm
311	5.5 mm	5.5 mm	0.4 mm
1001	0.1 mm	0.1 mm	0.2 mm
510	0.7 mm	0.9 mm	0.2 mm
520	0.7 mm	1.0 mm	0.2 mm
520b	1.1 mm	1.1 mm	0.2 mm

9 Results and comparisons

9.1 Altimetry

Piers Stability Control				
Point	Height (m)			
	2013	2015	2016	2017
11	1268,9395	1268,9391	1268,9392	1268,9394
12	1268,9335	1268,9331	1268,9333	1268,9334
13	1268,9361	1268,9357	1268,9359	1268,9361
14	1268,9332	1268,9327	1268,9329	1268,9332
21	1268,2781	1268,2778	1268,2779	1268,2782
22	1268,2806	1268,2803	1268,2804	1268,2807
23	1268,2774	1268,277	1268,2772	1268,2774
24	1268,2757	1268,2754	1268,2755	1268,2759
31	1267,5748	1267,5746	1267,5745	1267,5748
32	1267,5767	1267,5765	1267,5763	1267,5766
33	1267,5761	1267,5758	1267,5756	1267,576
34	1267,5744	1267,5742	1267,5742	1267,5744
41	1266,0611	1266,0617	1266,0615	1266,0615
42	1266,0728	1266,0734	1266,0731	1266,0731
43	1266,0595	1266,0601	1266,0599	1266,0598
44	1266,0599	1266,0605	1266,0602	1266,0603

Point	Difference of height (mm)					
	13-15	13-16	13-17	15-16	15-17	16-17
11	0,4	0,3	0,1	-0,1	-0,3	-0,2
12	0,4	0,2	0,1	-0,2	-0,3	-0,1
13	0,4	0,2	0	-0,2	-0,4	-0,2
14	0,5	0,3	0	-0,2	-0,5	-0,3
21	0,3	0,2	-0,1	-0,1	-0,4	-0,3
22	0,3	0,2	-0,1	-0,1	-0,4	-0,3
23	0,4	0,2	0	-0,2	-0,4	-0,2
24	0,3	0,2	-0,2	-0,1	-0,5	-0,4
31	0,2	0,3	0	0,1	-0,2	-0,3
32	0,2	0,4	0,1	0,2	-0,1	-0,3
33	0,3	0,5	0,1	0,2	-0,2	-0,4
34	0,2	0,2	0	0	-0,2	-0,2
41	-0,6	-0,4	-0,4	0,2	0,2	0
42	-0,6	-0,3	-0,3	0,3	0,3	0
43	-0,6	-0,4	-0,3	0,2	0,3	0,1
44	-0,6	-0,3	-0,4	0,3	0,2	-0,1

Instruments (levelling)				
Point	Height (m)			
	2013	2015	2016	2017
GRAS	1268,7251	1268,725	1268,725	1268,725
GRAC	1269,2873	1269,2866	1269,2866	1269,2864
GRAF	1271,5951			
GRSM	1272,76	1272,7596	1272,76	1272,7597
GRSF	1268,0833	1268,0832	1268,0832	1268,0834
GR4B	1273,2317	1273,2297	1273,2295	1273,2302
GR3B	1273,1167			
VLBI	1268,0631	1268,063	1268,062	1268,0632
201	1272,7256	1272,7254	1272,718	1272,722
211	1272,875	1272,8762	1272,8757	1272,8768
212	1272,879	1272,8784	1272,8785	1272,8798
213	1272,886	1272,8844	1272,8847	1272,8859

Points	Difference of height (mm)					
	13-15	13-16	13-17	15-16	15-17	16-17
GRAS	0,1	0,1	0,1	0	0	0
GRAC	0,7	0,7	0,9	0	0,2	0,2
GRSM	0,4	0	0,3	-0,4	-0,1	0,3
GRSF	0,1	0,1	-0,1	0	-0,2	-0,2
GR4B	2	2,2	1,5	0,2	-0,5	-0,7
VLBI	0,1	1,1	-0,1	1,0	-0,2	-1,2
201	0,2	7,6	3,6	7,4	3,4	-4
211	-1,2	-0,7	-1,8	0,5	-0,6	-1,1
212	0,6	0,5	-0,8	-0,1	-1,4	-1,3
213	1,6	1,3	0,1	-0,3	-1,5	-1,2

9.2 Coordinates

Final coordinates (Lambet MEO – Height) (m)						
Point	2013			2015		
	E	N	H	E	N	H
GRAS	200	199,9999	1268,7251	200	200,0003	1268,725
GRAC	215,5674	172,4436	1269,2873	215,5672	172,4429	1269,2866
GRAF	244,1093	192,9869	1271,5951			
GRSM	280,5939	188,3608	1272,76	280,5975	188,3583	1272,7596
GRSF	219,4217	192,3517	1268,0833	219,4236	192,3531	1268,0832
GR4B	252,6731	209,6175	1273,2317	252,6746	209,6171	1273,2297
GR3B	252,3306	210,6012	1273,1167			
VLBI	210,1987	187,8494	1268,0631	210,1997	187,8499	1268,063
1	319,9362	198,2062	1270,2306	319,9415	198,2071	1270,2299
2	269,4045	161,7489	1269,5723	269,408	161,7478	1269,5715
3	212,2062	163,2653	1268,8726	212,2059	163,2655	1268,8723
4	171,8939	246,0989	1267,355	171,8918	246,1016	1267,3552
5	257,4054	194,6909	1271,7584	257,4137	194,6898	1271,7575
201	252,3306	210,6012	1272,7256	252,3341	210,6008	1272,7254
10000	946,1428	74,9267	1288,0084	946,1438	74,9278	1288,014
20000	408,2063	-81,8104	1269,9843	408,2094	-81,8178	1269,989
211	252,5572	209,8122	1272,875	252,5594	209,8108	1272,8762
212	252,8977	209,6237	1272,879	252,8975	209,6228	1272,8784
213	252,5634	209,42	1272,886	252,5659	209,4198	1272,8844

Point	2016			2017		
	E	N	H	E	N	H
GRAS	200	200,0003	1268,725	200	200	1268,725
GRAC	215,5672	172,4436	1269,2866	215,5676	172,4431	1269,2864
GRAF						
GRSM	280,5988	188,3602	1272,76	280,598	188,3589	1272,7597
GRSF	219,4218	192,349	1268,0832	219,4224	192,3525	1268,0834
GR4B	252,6758	209,6179	1273,2295	252,6746	209,6155	1273,2302
GR3B						
VLBI	210,1993	187,8464	1268,062	210,1985	187,8503	1268,0632
1	319,9407	198,2088	1270,2302	319,9421	198,2071	1270,2312
2	269,4046	161,7479	1269,5718	269,4069	161,7472	1269,5735
3	212,2065	163,265	1268,8722	212,206	163,2643	1268,8727
4	171,8927	246,1008	1267,3551	171,8914	246,1021	1267,3561
5	257,4201	194,6912	1271,7577	257,4222	194,688	1271,7576
201	252,332	210,6	1272,718	252,334	210,6001	1272,722
10000	946,144	74,9281	1288,014			
20000	408,207	-81,8164	1269,989			
211	252,5582	209,8131	1272,8757	252,5574	209,8116	1272,8768
212	252,9001	209,6241	1272,8785	252,8995	209,6232	1272,8798
213	252,5653	209,4209	1272,8847	252,5644	209,4197	1272,8859

Difference of coordinates (mm)									
Point	2013 – 2017			2015 – 2017			2016 – 2017		
	dE	dN	dH	dE	dN	dH	dE	dN	dH
GRAS	0	-0,1	0,1	0	0,3	0	0	0,3	0
GRAC	-0,2	0,5	0,9	-0,4	-0,2	0,2	-0,4	0,5	0,2
GRSM	-4,1	1,9	0,3	-0,5	-0,6	-0,1	0,8	1,3	0,3
GRSF	-0,7	-0,8	-0,1	1,2	0,6	-0,2	-0,6	-3,5	-0,2
GR4B	-1,5	2	1,5	0	1,6	-0,5	1,2	2,4	-0,7
VLBI	0,2	-0,9	-0,1	1,2	-0,4	-0,2	0,8	-3,9	-1,2
1	-5,9	-0,9	-0,6	-0,6	0	-1,3	-1,4	1,7	-1
2	-2,4	1,7	-1,2	1,1	0,6	-2	-2,3	0,7	-1,7
3	0,2	1	-0,1	-0,1	1,2	-0,4	0,5	0,7	-0,5
4	2,5	-3,2	-1,1	0,4	-0,5	-0,9	1,3	-1,3	-1
5	-16,8	2,9	0,8	-8,5	1,8	-0,1	-2,1	3,2	0,1
201	-3,4	1,1	3,6	0,1	0,7	3,4	-2	-0,1	-4
211	-0,2	0,6	-1,8	2	-0,8	-0,6	0,8	1,5	-1,1
212	-1,8	0,5	-0,8	-2	-0,4	-1,4	0,6	0,9	-1,3
213	-1	0,3	0,1	1,5	0,1	-1,5	0,9	1,2	-1,2