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The GPS Receivers Antenna Phase Center Determination on the Temporary Base

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Abstract

Project of observation on the temporary space base assuming movement of the antenna centre around the antenna reference point. Elaboration of measurements data by means of mathematical effective estimation model of parameters antenna centre.

1. Introduction

Every GPS instrument has its antenna, on which a antenna reference point (ARP) is designated or described. Usually, this point is exploited for the centering of antenna above a control point. Therefore it is usually assumed that ARP is projected over the gravity line to a control point. There is spread a conception conveying that it is sufficient to measure the height difference between the control point and ARP. GPS system works on the principle of phase measurements of the distances between a satellite and an antenna. Therefore measured values referring both to the satellite and the antenna are related to the antenna phase centre (APC). Precise measurements show that the APC position is not always identical with ARP. This paper aims at presenting a mathematical model, the measurement and processing procedure of GPS device group APC parameters determination on temporary base which does not require a special care, necessary for similar normal standards.

2. Motivation and definition of a problem

At present in the Geodetic and Cartographic Institute (GCI) Bratislava two groups of two-frequency GPS receivers Trimble and Zeiss GePoS are used to build the new national spatial network (NSN) [1], [2], [10], [14], [15]. In final processing of all repeated precise campaigns it was revealed that in measuring by Zeiss devices, whose APC position was not known, occurred systematic errors of a random character to the extent of up to 2 cm. The APC position of these devices was determined in 1999 and 2000 at the Department of Geodetic Control of the Faculty of Civil Engineering of Slovak Technical University (STU) using the methods [4], [5]. Our motivation (early in 2000) was to estimate and verify the APC of GPS devices in alternative way. We suppose that it is not necessary to build permanent base with a precise knowledge of the points position . By precise direct measuring of spatial relations between the points of temporary base and by appropriate organisation of measuring method we not only can determine a precise position of APC compared with ARP, but at the same time we can verify whether multipath way of signal transmission or other influences have not worked. Thanks to any discrepancies with our assumptions we are motivated to look for a deeper understanding of the limit possibilities of GPS technology in building and developing modern monitoring systems for positioning objects and phenomena to monitor their changes in time.

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3. Definition of Basic Concepts and Relations

Let us start from the Fig. 1.

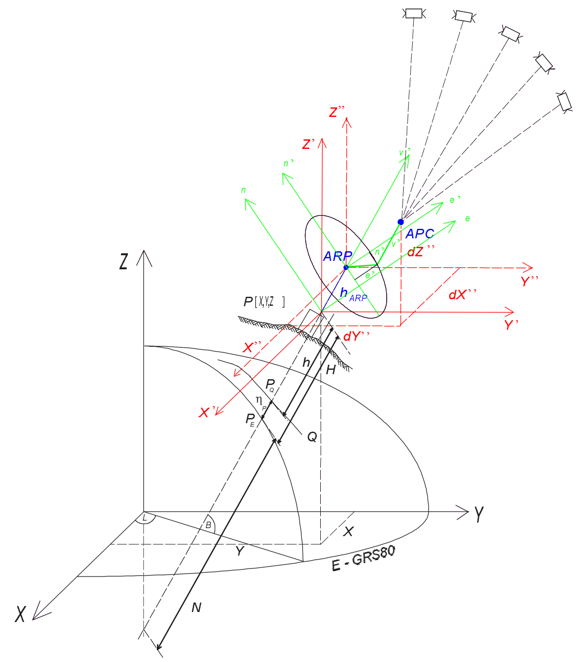


Fig. 1

Where is : [XYZ] - carthesian coordinate 3D system, represented by the terrestric reference system xTRSyy, where x=I (International) , E(European), resp. C(Central), yy is the epoch of a reference framework, *X,Y,Z* - coordinates of the point P in the system [XYZ], *B,L,H*-position of the point P above the reference ellipsoid E, e.g. E = GRS 80, where *B*, *L* are ellipsoidal coordinates and *H* is the ellipsoidal height, *h* - height of the point P in a system of normal heights, η_P - height of a quasi-geoid at the point P_E above the reference ellipsoid E, ARP - an antenna reference point, h_{ARP} - height of ARP above the point P, [nev] - local horizontal topocentric coordinate system with the origin at the control point P, where *n* is a coordinate oriented to the north , *e* is a coordinate oriented to the east and *v* is a coordinate in a vertical (gravity line) direction, ARP[*n, e, v*] - coordinates of ARP in a local horizontal topocentric coordinate system with the origin at a point P, APC[*n′, e′, v′*] – coordinates of APC in local horizontal topocentric coordinate system with the origin at ARP, [X″Y″Z″] - local topocentric rectangular coordinate system with the origin at ARP, d*X″*, d*Y″*, d*Z″* - coordinates of APC in the system [X″Y″Z″], [X′Y′Z′] - local topocentric rectangular coordinate system with the origin at a point P, d*X′*, d*Y′*, d*Z′* - coordinates of ARP in the system [X′Y′Z′], E - designation of an ellipsoid, Q - designation of the surface of a quasi-geoid.

Position of APC in the rectangular coordinate system [XYZ] related to the control point and ARP is

$$\mathrm{APC}[X,Y,Z] = \mathrm{P}[X,Y,Z] + \mathrm{ARP}[\mathrm{d}X', \mathrm{d}Y', \mathrm{d}Z'] + \mathrm{APC}[\mathrm{d}X'', \mathrm{d}Y'', \mathrm{d}Z''].\qquad (1)$$

Position of APC expressed in ellipsoid coordinates is

$$\mathrm{APC}[B,L,H] = \mathrm{P}[B,L,H] + \mathrm{ARP}[n, e, v] + \mathrm{APC}[n', e', v'], \qquad (2)$$

where $n = 0,\ e = 0,\ v = h_{ARP}$, $n' \neq 0,\ e' \neq 0,\ v' \neq 0$.

For individual components of ellipsoid coordinates of APC it means :

$$B_{APC} = B_P + n'_{APC},\ L_{APC} = L_P + e'_{APC},\ H_{APC} = H_P + h_{ARP} + v'_{APC}\ . \qquad (3)$$

<u>Transformation of ellipsoidal coordinates to cartesian ones BLH → XYZ will be carried out according to known relations</u> :

$$\begin{aligned} X &= (N+H)\cos B\cos L, \\ Y &= (N+H)\cos B\sin L, \\ Z &= (b^2/a^2)(N+H)\sin B, \end{aligned} \qquad (4)$$

where $N = a^2/(a^2\cos^2 B + b^2\sin^2 B)$ is a transversal radius of curvature, a, b are great and small semi-axis of the reference ellipsoid E-GRS 80.

By putting equations (3) to fundamental equations (4) we obtain for cartesian coordinates gradually:

$$\begin{aligned} X &= (N + H_P + h_{ARP} + v'_{APC})\cos(B_P + n'_{APC})\cos(L_P + e'_{APC}), \\ Y &= (N + H_P + h_{ARP} + v'_{APC})\cos(B_P + n'_{APC})\sin(L_P + e'_{APC}), \\ Z &= (b^2/a^2)(N + H_P + h_{ARP} + v'_{APC})\sin(B_P + n'_{APC}), \end{aligned} \qquad (5)$$

where n' a e' for equation (5) is necessary to be expressed in radian measure.

<u>Transfer of coordinates from a rectangular topocentric coordinate system [X′Y′Z′] with the origin at a control point to a local horizontal topocentric coordinate system [nev]</u>

It is valid [3] :

$$\begin{pmatrix} n \\ e \\ v \end{pmatrix} = \mathbf{R}(B,L)\begin{pmatrix} dX \\ dY \\ dZ \end{pmatrix}, \text{ where } \begin{pmatrix} dX \\ dY \\ dZ \end{pmatrix} = \begin{pmatrix} dX' \\ dY' \\ dZ' \end{pmatrix} + \begin{pmatrix} dX'' \\ dY'' \\ dZ'' \end{pmatrix} \qquad (6), (7)$$

Equations (6), (7) expresses in other way the difference of the coordinates of two points APC[X,Y,Z] a P[X,Y,Z]. We will write it in the following way:

$$d[X,Y,Z] = FCA[X,Y,Z] - P[X,Y,Z]. \qquad (8)$$

For the rotation matrix $\mathbf{R}(B,L)$ with the rotation centre at the point P[B,L,H] it is valid [3], [13]. The transformation of the coordinate difference d[X,Y,Z] to local horizontal topocentric system [nev] has, in view of the equations (6), (7), the form as follows :

$$\begin{pmatrix} n \\ e \\ v \end{pmatrix}_{APC} = \mathbf{R}(B,L)\begin{pmatrix} dX' \\ dY' \\ dZ' \end{pmatrix} + \mathbf{R}(B,L)\begin{pmatrix} dX'' \\ dY'' \\ dZ'' \end{pmatrix} = \begin{pmatrix} n \\ e \\ v \end{pmatrix}_{ARP} + \begin{pmatrix} n' \\ e' \\ v' \end{pmatrix}_{APC} . \qquad (9)$$

In general, APC related to ARP has an arbitrary position, despite the fact that the producers try to achieve their identity. The aim of this contribution is, apart form other things, effective estimation of the APC parameters n', e', v'. While the vertical (gravity line) led through the point P passes also through the point ARP, its pass through the APC point is need not. Therefore, if we turn the antenna round its vertical axis, the APC position is changing, whereas positions of the P and ARP points are not changing. If the position of the antenna (its slewing to the fundamental orientation $\alpha = 0$) is expressed by the angle α, then n', e' a v' are the function of this angle.

$$n' = n'(\alpha), \quad e' = e'(\alpha), \quad v' = v'(\alpha). \qquad (10)$$

In the coordinate v' we start from the assumption that the vertical component of the APC position does not change its value by rotating the antenna. It is constant , however, it is necessary to mention that there exists the APC height variation caused by the change of the satellite zenith height. The same assumption on constant values is valid for local horizontal topocentric coordinates ARP[n, e, v]. Their values are determined by direct measurement by GPS observation. In addition, it is supposed that APC after its projection to horizontal plane

$n'e'$ rotates over the circle with the radius of r. For expression of the r radius value the known equation is valid

$$n'^2(\alpha_i) + e'^2(\alpha_i) = r^2 \text{, where i= 1, 2, ... ; } \alpha_i = <0, 2\pi>. \quad (11)$$

The height of APC above the plane $n'e'$ is supposed not to change in the rotation of antenna. Therefore it is valid: :

$$v'(\alpha_i) = v'(\alpha_j) \text{, where i,j = 1, 2, ... ; } \alpha_i, \alpha_j = <0, 2\pi>. \quad (12)$$

Let the coordinates of APC in the basic position of the antenna α° = 0 are unknown parameters x,y,z. See in more detail Fig. **2**.

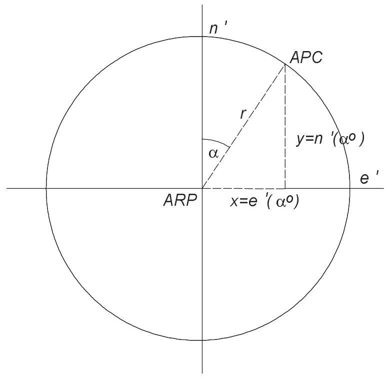


Fig. 2

For the position of APC[$n'(\alpha_i), e'(\alpha_i), v'(\alpha_i)$] in slewing the antenna at the angle α_i the following equation is valid::

$$\begin{pmatrix} n'(\alpha_i) \\ e'(\alpha_i) \\ v'(\alpha_i) \end{pmatrix} = \mathbf{P}(\alpha_i) \begin{pmatrix} x \\ y \\ z \end{pmatrix} \text{, where } \mathbf{P}(\alpha_i) = \begin{pmatrix} \cos(\alpha_i) & -\sin(\alpha_i) & 0 \\ \sin(\alpha_i) & \cos(\alpha_i) & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad (13)$$

Condition expressed by the equations (11) and (12) is implicitly included in the model (13). The measurements on the temporary base aim at estimating unknown parameters of the position of APC[x,y,z], which are the coordinates of APC compared with ARP in a fundamental orientation of the antenna.

Since the cartesian coordinates X, Y, Z are determined using the GPS survey, and, consequently, dX, dY, dZ, then for the equations (6) and (9) we have to apply the inverse relation :

$$\begin{pmatrix} dX'' \\ dY'' \\ dZ'' \end{pmatrix}_{FCA} = \mathbf{R}^-(\mathrm{B,L}) \begin{pmatrix} n' \\ e' \\ v' \end{pmatrix}_{FCA} , \quad (14)$$

where for g-inversion of the matrix **R**(B,L), defined by the expression (9), in view of its orthogonal characteristics, it is valid:

$$\mathbf{R}^-(B,L) = \mathbf{R}'(B,L). \quad (15)$$

In view of the Figure 1, from the equations (1), (6), (7) a (8) for the observation-determined position APC[$\widetilde{X}_i, \widetilde{Y}_i, \widetilde{Z}_i$] in the cartesian coordinate system [XYZ] we will obtain the equation (16), where $\widetilde{X}_i, \widetilde{Y}_i, \widetilde{Z}_i$ are the coordinates at the i-position of the antenna determined by GPS observation and Bern GPS software package version 4.2 (BSW42) [6], $\Theta_X, \Theta_Y, \Theta_Z$ are unknown parameters of the point P of the temporary base, which are also the subject of estimation, dX', dY', dZ' are usually the known additions of the coordinates defining the excentric position of ARP compared with the control point P, which are unchangeable in the rotation of the antenna together with the parameters $\Theta_X, \Theta_Y, \Theta_Z$, and therefore we can eliminate them as soon as during the BSW42 processing. Values $dX''(\alpha_i), dY''(\alpha_i), dZ''(\alpha_i)$ are functionally dependent on the unknown parameters of APC[x,y,z] and the angle of antenna slewing α_i. Vector $(\varepsilon_X, \ \varepsilon_Y, \ \varepsilon_Z)'$ is a real errors vector of measurement.

$$\begin{pmatrix} \tilde{X}_i \\ \tilde{Y}_i \\ \tilde{Z}_i \end{pmatrix}_{APC} = \begin{pmatrix} \Theta_X \\ \Theta_Y \\ \Theta_Z \end{pmatrix}_P + \begin{pmatrix} dX' \\ dY' \\ dZ' \end{pmatrix}_{ARP} + \begin{pmatrix} dX''(\alpha_i) \\ dY''(\alpha_i) \\ dZ''(\alpha_i) \end{pmatrix}_{APC} + \begin{pmatrix} \varepsilon_X \\ \varepsilon_Y \\ \varepsilon_Z \end{pmatrix}_i , \qquad (16)$$

By observation in t different positions of the antenna on the point P we obtain the measured values $(dX''(\alpha_i), dY''(\alpha_i), dZ''(\alpha_i))'$, i= 1, 2, ... ,$t$; α_i = <0, 2π>. Considering equations for unknown parameters APC (13) and (14) we obtain the equation (17) :

$$\begin{pmatrix} dX''(\alpha_i) \\ dY''(\alpha_i) \\ dZ''(\alpha_i) \end{pmatrix} = \mathbf{R}'(\mathrm{B},\mathrm{L})\mathbf{P}(\alpha_i)\begin{pmatrix} x \\ y \\ z \end{pmatrix} + \begin{pmatrix} \varepsilon_{X_i} \\ \varepsilon_{Y_i} \\ \varepsilon_{Z_i} \end{pmatrix}. \qquad (17)$$

By its substitution to the equation (16) we obtain a fundamental relation for the point P in i-position of the antenna :

$$\begin{pmatrix} \tilde{X}(\alpha_i) \\ \tilde{Y}(\alpha_i) \\ \tilde{Z}(\alpha_i) \end{pmatrix}_{APC} = \begin{pmatrix} \Theta_X \\ \Theta_Y \\ \Theta_Z \end{pmatrix}_P + \begin{pmatrix} dX' \\ dY' \\ dZ' \end{pmatrix}_{ARP} + \mathbf{R}'(B_P, L_P)\mathbf{P}(\alpha_i)\begin{pmatrix} x \\ y \\ z \end{pmatrix}_P + \begin{pmatrix} \varepsilon_X \\ \varepsilon_Y \\ \varepsilon_Z \end{pmatrix}_i . \qquad (18)$$

By additional modification of the equation (18) and after its formal transcription for the j-point P_j of temporary base we obtain the following expression:

$$\boldsymbol{\xi}_{ij} = \mathbf{X}\Theta_j + \mathbf{R}'(B_j, L_j)\mathbf{P}(\alpha_{ij})\boldsymbol{\vartheta}_j + \boldsymbol{\varepsilon}_{ij}, \qquad (19)$$

where

$\xi'_{ij} = (\tilde{X}(\alpha_i), \tilde{Y}(\alpha_i), \tilde{Y}(\alpha_i))'_j - (dX', dY', dZ')'_j$ is a random vector, by the realization of which we obtain vector of measured values on the j-point of temporary base at the i-position of the antenna, $\mathbf{\Theta}_j = (\Theta_X, \Theta_Y, \Theta_Z)'_j$ is the estimated mean position parameters vector of the P_j-point (if we suppose dX' = dY' = dZ' = 0 than $P_j \equiv ARP_j$), $\boldsymbol{\vartheta}_j = (x_j, y_j, z_j)'$ is the estimated APC position parameters vector in local horizontal topocentric system with the centre in ARP, $\boldsymbol{\varepsilon}_{ij} = (\varepsilon_{X_i}, \varepsilon_{Y_i}, \varepsilon_{Z_i})'_j$ is an error vector on the j-point in the antenna i-position , $\mathbf{X}_j$ is the design matrix which creates a link between measured values and the parameters of the j-point Θ_j.

Let us imagine that the antennas of GPS receivers will be lay out on the temporary base according to the Fig. 3. On the temporary base we will do a precise measurement of spatial distances $b_{i,j}$ and height differences $\Delta h_{i,j} = h_i - h_j$ between the ARP points, where $i,j = 1, 2, ..., k$ are the indexes of base points. By precise measuring of baseline parameters we will know precise numerical expression of the functional relations between unknown parameters Θ_i .

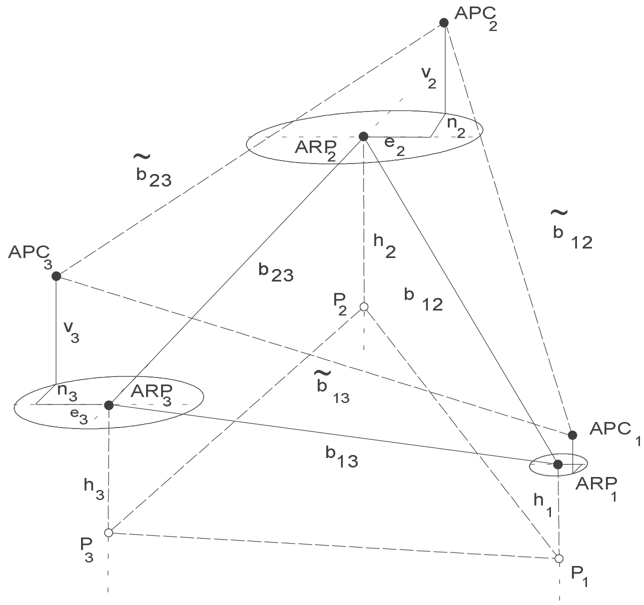


Fig. 3

Functional expression for spatial distance $b_{i,j} = f(\Theta_i, \Theta_j)$:

$$b_{i,j} = f(\boldsymbol{\Theta}_i, \boldsymbol{\Theta}_j) = \sqrt{(\Delta X^2_{i,j} + \Delta Y^2_{i,j} + \Delta Z^2_{i,j})}, \tag{20}$$

where $\Delta X_{ij} = (\Theta_{X_j} - \Theta_{X_i})$ $\Delta Y_{ij} = (\Theta_{Y_j} - \Theta_{Y_i})$ $\Delta Z_{ij} = (\Theta_{Z_j} - \Theta_{Z_i})$. By a formal transcription of the equation for all spatial length normal standards we obtain its simplified notation :

$$\boldsymbol{b} = \boldsymbol{b_0} + \mathbf{S}\boldsymbol{\Theta} + \boldsymbol{\varepsilon}_{\mathbf{b}}, \quad \boldsymbol{\Sigma}_b = \sigma^2_{\mathbf{b}} \mathbf{V}_{\mathbf{b}}, \tag{21}$$

where $\boldsymbol{b}_0$ is the vector of approximate lengths calculated from approximate coordinates of the temporary baseline points, $\mathbf{V}_{\boldsymbol{b}}$ is mainly a diagonal cofactor matrix.

Functional expression for the height difference of normal heights is based on the principle of the exploitation of vertical stochastic normal standard that is based on the properties of stage building of a geodetic integrated network [8] and [9] . Let us describe the relation of two points of the temporary baseline in the direction of normal heights using equation (22)

$$\Delta \mathrm{h}_{i,j} = h(\boldsymbol{\Theta}_i) - h(\boldsymbol{\Theta}_j), \tag{22}$$

where

$$h(\Theta_i) = \frac{p}{\cos(B_i)} - N(B_i) - \eta(B_i, L_i), \quad p = \sqrt{\Theta^2_X + \Theta^2_Y}\ . \tag{23}$$

By formal transcription of the equation a simplified notation of the height normal standard expressed by the height difference between the points of the baseline :

$$\boldsymbol{h} = \boldsymbol{h_0} + \mathbf{D}\boldsymbol{\Theta} + \varepsilon_h, \quad \mathbf{\Sigma}_h = \sigma^2_h \mathbf{V}_h, \tag{24}$$

where $\boldsymbol{h}_0$ is the vector of the approximate values of height differences Δh, calculated from the approximate coordinates of baseline points, $\mathbf{V}_{\boldsymbol{h}}$ is mainly a diagonal cofactor matrix of vector $\boldsymbol{h}$.

4. Complete stochastic model of the base points and APC parameters estimation

Complete stochastic model of the temporary baseline points coordinates estimate determination and of the APC parameters simultaneous estimate while respecting a stochastic normal standard defined by equations (21), (24) and a fundamental equation (19) has the expression as follows :

$$\boldsymbol{\eta} = \mathbf{B}\boldsymbol{\Theta} + \mathbf{T}\boldsymbol{\vartheta} + \boldsymbol{\varepsilon} \ , \quad \boldsymbol{\Sigma}_{\eta} = \sigma_0^2 \mathbf{V}_{\eta} \ , \qquad (25)$$

where $\boldsymbol{\eta}' = \left(\boldsymbol{\xi}', (\boldsymbol{b} - \boldsymbol{b}_0)', (\boldsymbol{h} - \boldsymbol{h}_0)' \right)$, $\mathbf{B}' = [\mathbf{X}', \mathbf{S}', \mathbf{D}']$, $\mathbf{T}' = \left[(\mathbf{R}'(B,L)\mathbf{P}(\alpha))', \ \mathbf{0}, \ \mathbf{0} \right]$, $\boldsymbol{\varepsilon}' = (\boldsymbol{\varepsilon}'_{XYZ}, \ \boldsymbol{\varepsilon}'_b, \ \boldsymbol{\varepsilon}'_h)$, $\mathbf{V}_{\eta} = Diag(q_{XYZ}\mathbf{V}_{XYZ}, \ q_b\mathbf{V}_b, \ q_h\mathbf{V}_h)$, $q_i = \sigma^2_i / \sigma^2_0$, i = {XYZ, b, h}. It is necessary to point out that the mathematical model (25) is sensitive to 2nd order parameters. Choosing the characteristics of normal standards $\sigma^2_b\mathbf{V}_b$ and $\sigma^2_h\mathbf{V}_h$ precision compared with $\sigma^2_{XYZ}\mathbf{V}_{XYZ}$ we can significantly influence the extent of the unbiasedness of point positions parameters estimates and the parameters of APC position [11], [12]. Precision $\sigma^2_{XYZ}\mathbf{V}_{XYZ}$ we obtain by processing GPS campaign using BSW42, which depends on the length of observation and processing strategy, other covariance submatrixes depend on the way the normal standards are determined. It depends only on the subjective evaluation of a person who carries out the processing, what proportion of the different measuring techniques precision characteristics q_i is used.

Further significant moment of the model (25) solution is elimination of the high degree of mutual mathematical correlation of the temporary baseline points geocentric coordinates. The elimination is carried out by the relativization of a local network on the dominant point [9], to which during the processing by BSW42 for coordinates XYZ stochastic condition of a-priori precision 0.1 mm is attributed. It is mainly the reference point of a baseline.

5. Experimental measurements

Experimental measurements were carried out on the temporary base which consists of three points on the roof of the GKÚ building (Fig.3). Points P_1 and P_2 are permanently monumented with the modules of dependent centering into the construction of the building and point P_3 is monumented with the same modul into a concrete mobile block. On principle they may be established according to the need. On the point P_1 there was reference antenna installed as a permanent one, on points P_2 and P_3 the tested antennas were placed. The reference antenna was constantly directed to the north, after 24 hours of continuous observation, the tested antennas were gradually turned at 45° angle. The start of measurement, as well as the change of tested antennas position were always at 12^{00} UT. In measuring there were set elevation mask 5°, record interval 30s, ARP height of all antennas 0,0 m.

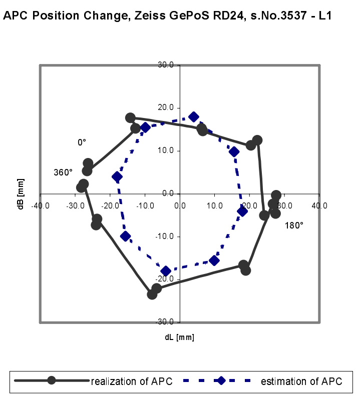
The spatial position of ARP was determined in a terrestric way. Spatial distances b_{ij} by compared steel tape with 0,2 mm accuracy, height differences Δh_{ij} by high-precision levelling with 0,05 mm accuracy. Measured values of spatial relations between the points of temporary baseline served as normal standards during the processing of experiment.

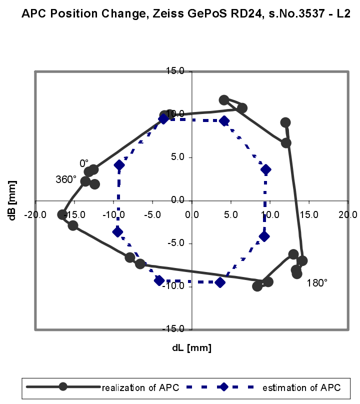
6. Processing strategy

Succession of the processing of individual steps is made up of the combination of solutions using BSW42 and our own solutions in the following way:

a) to processing, by means of BSW42, measured data without introducing tested antennas eccentricity, with the aim to obtain estimates of $\tilde{X}, \tilde{Y}, \tilde{Z}$ coordinates realizations of APC for each position of antenna and their presicion characteristics,
b) our own estimate of APC parameters according model (32) using the EOAPC procedure of WIGS software package [7], (example of the APC realization and effective estimation are on the following graphs),

c) the processing of measured data using APC parameters estimates determined in the step b), using BSW42 with simultaneous estimate of base points and parameters of APC spatial position in [nev] and using the estimate of APC height variation parameters depending on zenith distance of oncoming signal,
d) calculating mean values of spatial relations from the estimates of base points coordinates and to compare the values with a normal standard
e) repeating steps c) and d), using APC parameters estimates published in [5]
f) comparing results from d) and e).





7. Conclusion

By the elaboration of calibration campaigns realized hitherto by GCI method were confirmed following starting assumptions:

- universal and convenient space layout of base points is more suitable than points layout at straight line,
- on calibration of APC position it is not necessary to know precise coordinates of base points,
- also temporary calibration base establishment is sufficient on unbiased estimate of APC position parameters,
- the number of together calibrated antennas depends only on number portable concrete blocks, which are not problem layout into suitable configuration according to requirement,
- it is possible to interrupt a calibration campaign and to finish it in a few days later.

If at the same time appear following limitations, they can be eliminated by:

- using the best reference antenna (choke ring) which eccentricity of APC is precise known,
- directional exact antennas setup or exact determination of antenna orientation angle,
- removing the influences effecting of portable points displacement (water ice-up, strong wind) and measuring of the space relations at the beginning and in the end of every calibration campaign.

New knowledge :

- at precise measurement with “unknown“ antenna it is necessary to turn it in half of measurement by 180°, herewith is eliminated uncertainty in APC position, it obtains unbiased estimation of position of points,
- for vertical variations of APC position is necessary to use the IGS model (if it exists),
- if it incoming to marked influences, which can evoke the change of base portable points position, it is necessary to interrupt the measurement, to measure the space parameters

once again, to continue in observation and base points to declare by change their identification onto not identical,

- here described measurement way we can apply on investigation of influence antennas cover protection placed at permanent stations.

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