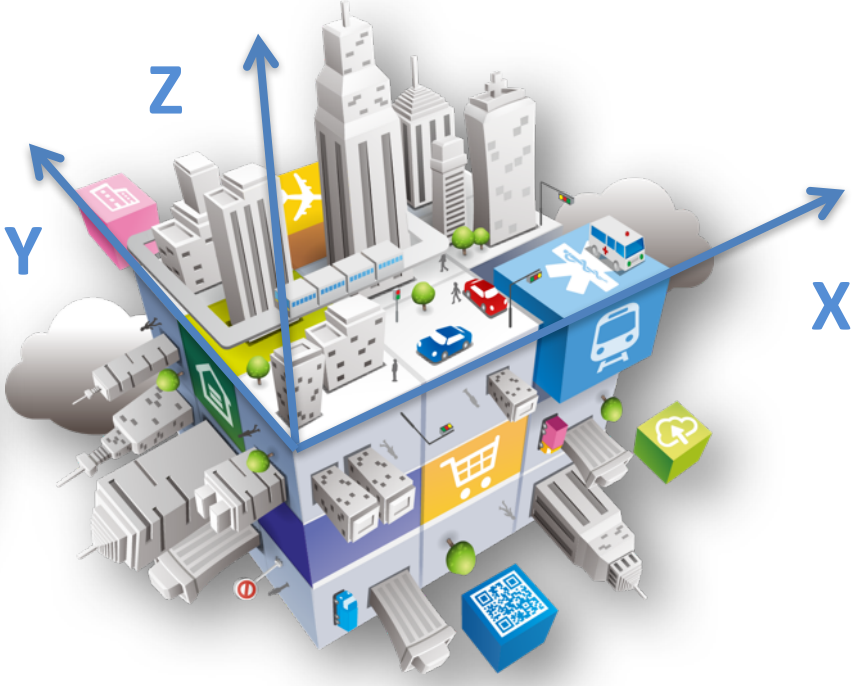

Les Géomètres Experts en … GNSS

Joël van Cranenbroeck, Managing Director

CREATIVE GEOSENSING SPRL-S CGEOS

Why Surveyors are GNSS Experts

Chris Rizos
Professor, Geodesy & Navigation, Surveying & Geospatial Engineering, School of Civil & Environmental Engineering, UNSW Australia (The University of New South Wales), Sydney Australia

Its been a claim whose veracity can now be confirmed. Over the past decade or so I have noticed that the GNSS experts, commentators, advocates and decision-makers with whom I deal with in a variety of academic, research, government and commercial circles, have something of a similar background. They have gained their GNSS knowledge and expertise by virtue of receiving a Surveying or Geomatics education. From the highest international scientific bodies, through international policy and professional (FIG), a number of national Institutes of Navigation, and many other boards, committees and organisations. We all were attracted to GPS in the 1980s, and have maintained our passion and commitment to GNSS ever since. How is this so?

The first civilian applications of GPS were in the fields of Geodesy and Surveying. GPS in the early 1980s offered a rev
for coordina
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to the devel
phase-based
technologie
spirit of inn
accuracy GN

Real world GNSS performance is boosted by innovations that address the limitations of standard GNSS solutions. Surveyors have been in the past, are currently, and should remain the "GNSS experts"

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE
CNIG
Conseil national de l'information géographique

LEXIQUE GNSS
pour le positionnement
Version 4 provisoire

Ce lexique est élaboré dans le cadre du groupe de travail GNSS de la commission GEOPOS du CNIG. L'objectif est de concevoir un lexique couvrant le domaine du positionnement par GNSS, en langue Française. Il devrait permettre de se repérer dans le jargon des GNSS mais pas d'acquérir une connaissance approfondie des GNSS. Pour cela le Groupe de travail conseille au lecteur de se réferrer entre autre à navipedia.net mis en ligne par l'ESA.

La coordination a été assurée par Françoise Duquenne (AFT/CNFGG)

Ont contribué au travail de rédaction :

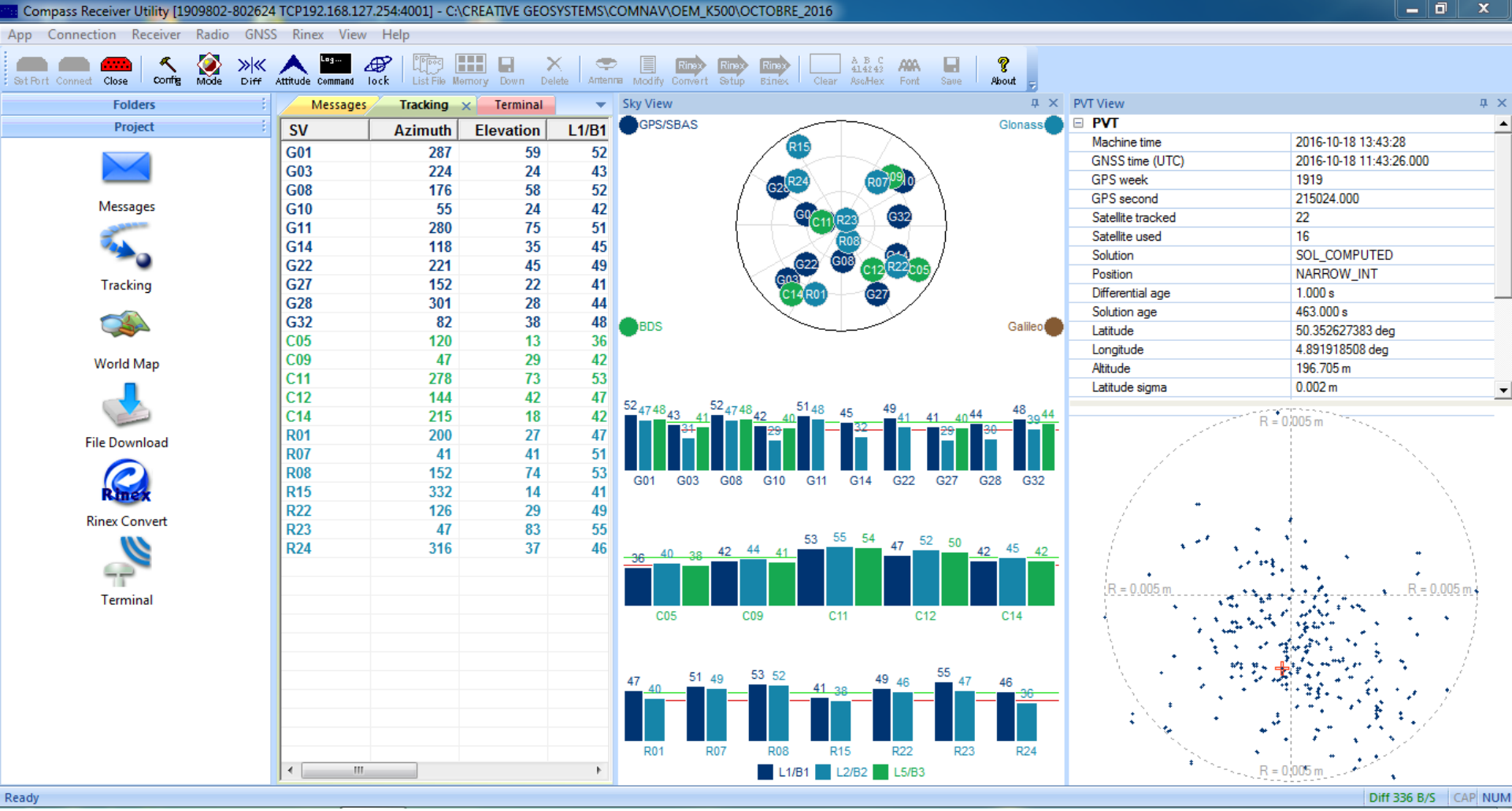
Jacques BEILIN (ENSG)
Florian BIROT (SNCF)
Bernard BONHOURE (CNES)
Philippe BONNIFAIT (UTC)
Paul CHAMBON (TERIA)
Jonathan CHENAL (IGN, CNFGG)
Françoise DUQUENNE (AFT, CNFGG)
Denis LAURICHESSE (CNES)
Elise-Rachel MATHIS (IGN)
Laurent MOREL (ESGT)
Norbert SUARD (CNES)
Joël VAN CRANENBROECK (CREATIVE GEOSYSTEM)

- GPS
- GNSS
- DGNSS
- QZSS
- ITRF
- NTRIP
- RTCM
- NMEA
- VRS
- FKP
- PRS
- SSR
- BDS
- PPP
- IGS
- EGNOS
- RINEX
- CORS
- ARP

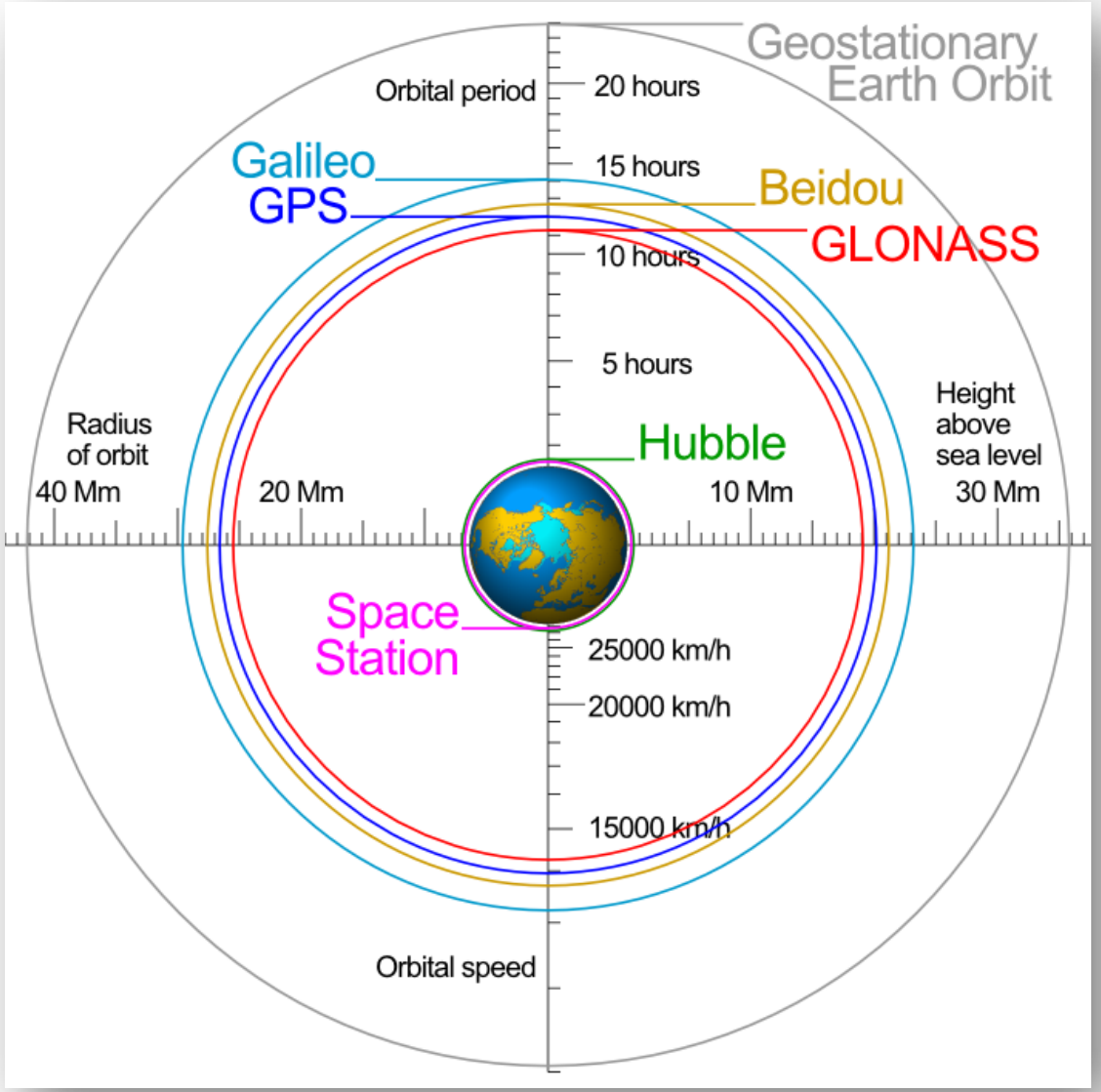
Sommaire

- Rappel des fondements du positionnement par GNSS.
- Traitement des observations issues du GNSS
- Les réseaux GNSS RTK, PPP et autres ...
- Applications topographiques du GNSS
- Le futur du GNSS ...

Rappel des fondements du positionnement par GNSS

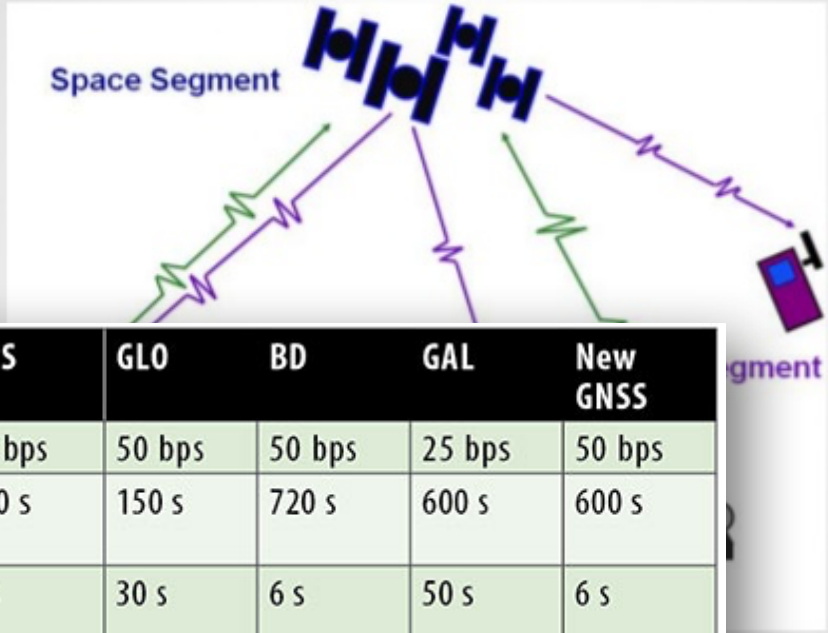


Mont, NAMUR – CGEOS – Le 18 Octobre 2016 – 22 satellites GNSS en vue



25.000 km de la surface terrestre, vitesse 5 km/sec. révolution en 12 heures, même configuration géométrique en 23h56 (temps sidéral), horloges synchronisées sur le GNSS time

The three segments of GNSS



	GPS	GLO	BD	GAL	New GNSS
Data rate	50 bps	50 bps	50 bps	25 bps	50 bps
Length of frame	750 s	150 s	720 s	600 s	600 s
Length of subframe	6 s	30 s	6 s	50 s	6 s
Length of ephemeris	18 s	10 s	18 s	about 30 s	12 s
Repeat of ephemeris	30 s	30 s	30 s	50 s	24 s
Update of ephemeris	2 hr	0.5 hr	1 hr	3 hr	24 hr
Life span of ephemeris	4 hr	0.5 hr	2 hr	4 hr	>24 hr

X, Y, Z + GPS Time synchronisation for all GPS Satellites ... IONO coefficients

```
     2              NAVIGATION DATA                         RINEX VERSION / TYPE
EPHTORNX            Version 1.07        11-NOV-93 18:46     PGM / RUN BY / DATE
                                                            END OF HEADER
27 93 11 11 18  0  0.0 0.841403380036D-05 0.909494701773D-12 0.000000000000D+00
    0.108000000000D+03 0.965000000000D+02 0.485520201821D-08-0.375803540903D+00
    0.493600964546D-05 0.105678813998D-01 0.371783971786D-05 0.515362939453D+04
    0.410400000000D+06-0.115483999252D-06-0.244025773192D+01-0.169500708580D-06
    0.951057845137D+00 0.304062500000D+03 0.229817330711D+01-0.864000249123D-08
    0.248224635291D-09 0.100000000000D+01 0.722000000000D+03 0.000000000000D+00
    0.700000000000D+01 0.000000000000D+00 0.139698386192D-08 0.108000000000D+03
    0.000000000000D+00
19 93 11 11 18  0  0.0 0.126533210278D-03 0.216004991671D-11 0.000000000000D+00
    0.159000000000D+03 0.105281250000D+03 0.511664177694D-08 0.288984102701D+01
    0.537186861038D-05 0.545520102605D-03 0.352039933205D-05 0.515369178200D+04
    0.410400000000D+06 0.130385160446D-07-0.245018043754D+01-0.558793544769D-08
    0.937608797433D+00 0.300843750000D+03-0.515589087966D+00-0.863178772903D-08
    0.186079179842D-09 0.100000000000D+01 0.722000000000D+03 0.000000000000D+00
    0.700000000000D+01 0.000000000000D+00 0.419095158577D-08 0.415000000000D+03
    0.000000000000D+00
 2 93 11 11 18  0  0.0-0.544767826796D-04-0.193267624127D-11 0.00000
    0.260000000000D+02-0.102625000000D+03 0.460983473616D-08-0.28528
   -0.532902777195D-05 0.124366548844D-01 0.390782952309D-05 0.51536
    0.410400000000D+06-0.134110450745D-06-0.141089253574D+01-0.16577
    0.955430596514D+00 0.303000000000D+03-0.271411579302D+01-0.82674
   -0.259296528693D-09 0.100000000000D+01 0.722000000000D+03 0.00000
    0.700000000000D+01 0.000000000000D+00 0.931322574615D-09 0.26000
    0.000000000000D+00
18 93 11 11 18  0  0.0-0.325078144670D-05-0.227373675443D-12 0.00000
    0.111000000000D+03 0.540937500000D+02 0.457376181373D-08 0.22256
    0.262632966042D-05 0.551540812012D-02 0.128746032715D-04 0.51536
    0.410400000000D+06 0.000000000000D+00 0.277872765026D+01-0.11175
    0.944246377137D+00 0.118000000000D+03 0.124343432788D+01-0.79431
   -0.283226081477D-09 0.100000000000D+01 0.722000000000D+03 0.00000
    0.700000000000D+01 0.000000000000D+00-0.186264514923D-08 0.36700
    0.000000000000D+00
 3 93 11 11 18  0  0.0 0.587664544582D-06-0.136424205266D-10 0.00000
    0.220000000000D+02-0.113125000000D+02 0.940753475120D-09 0.56333
   -0.581145286560D-06 0.133475030307D-01 0.130217522383D-04 0.51536
    0.410400000000D+06 0.108033418655D-06 0.648861938790D-01-0.10989
    0.112772727133D+01 0.209937500000D+03 0.246090165797D+01-0.60141
    0.722887250060D-09 0.100000000000D+01 0.722000000000D+03 0.00000
    0.200000000000D+01 0.000000000000D+00-0.419095158577D-08 0.53400
    0.000000000000D+00
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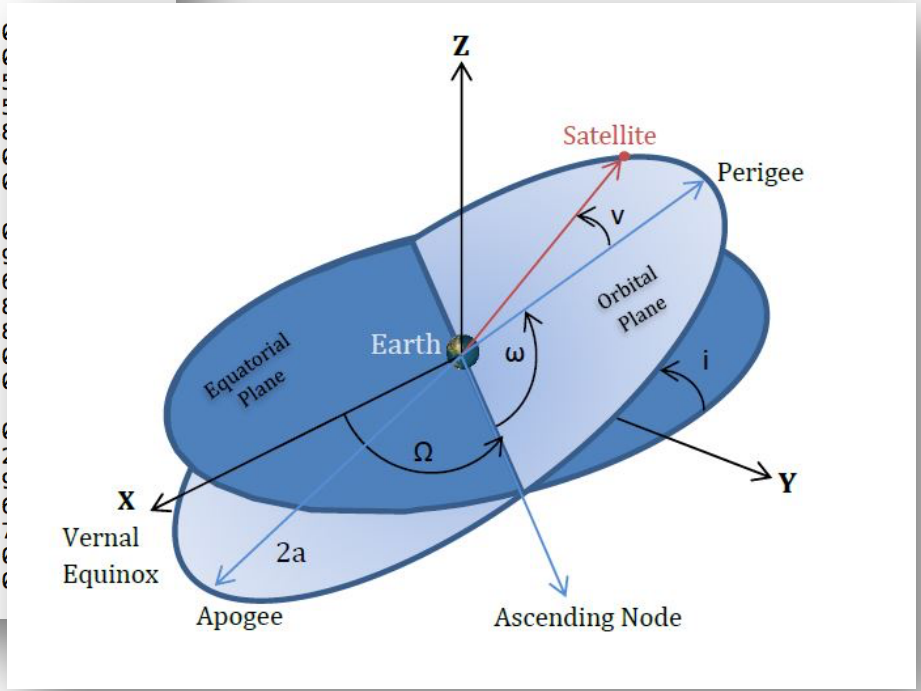
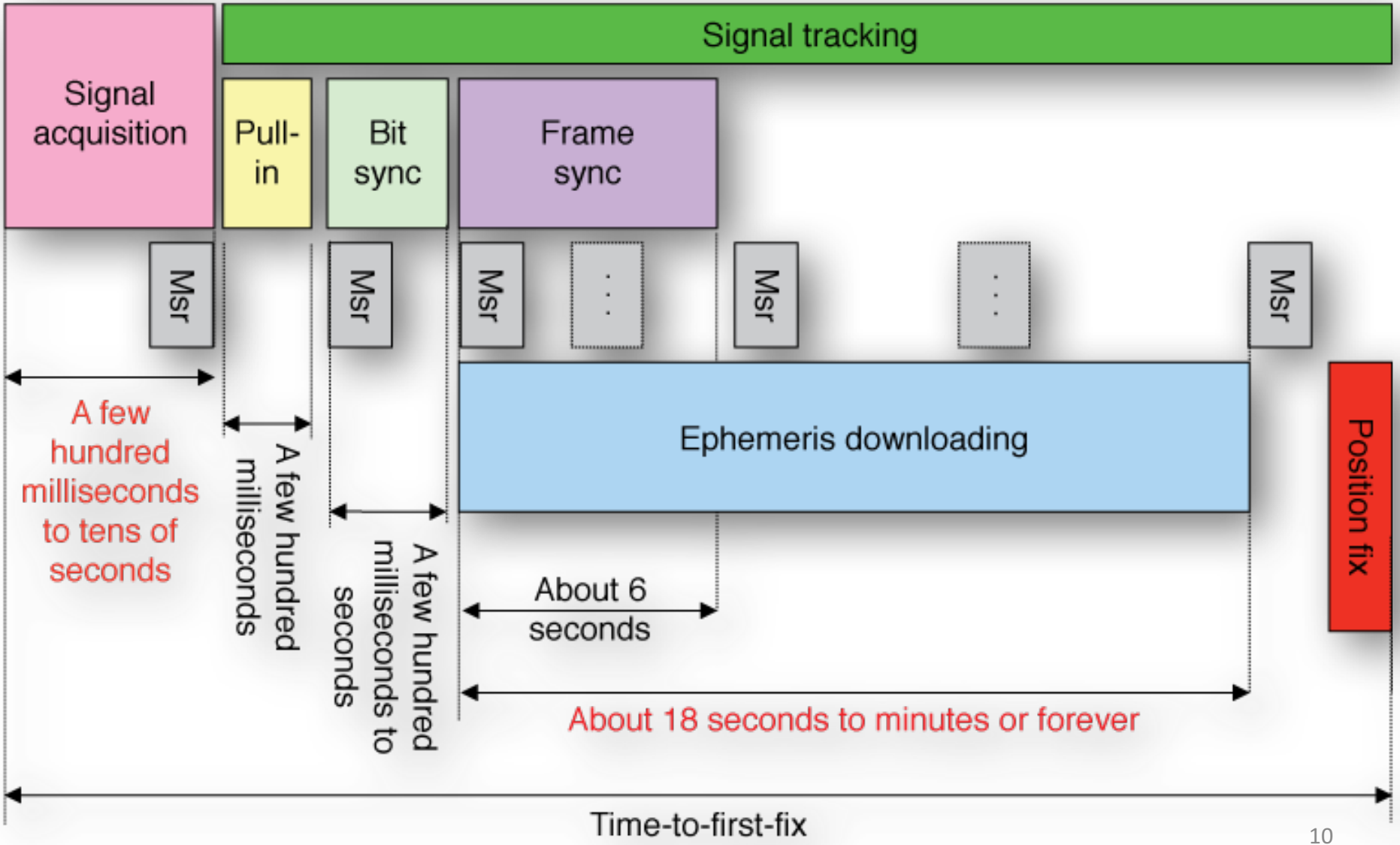
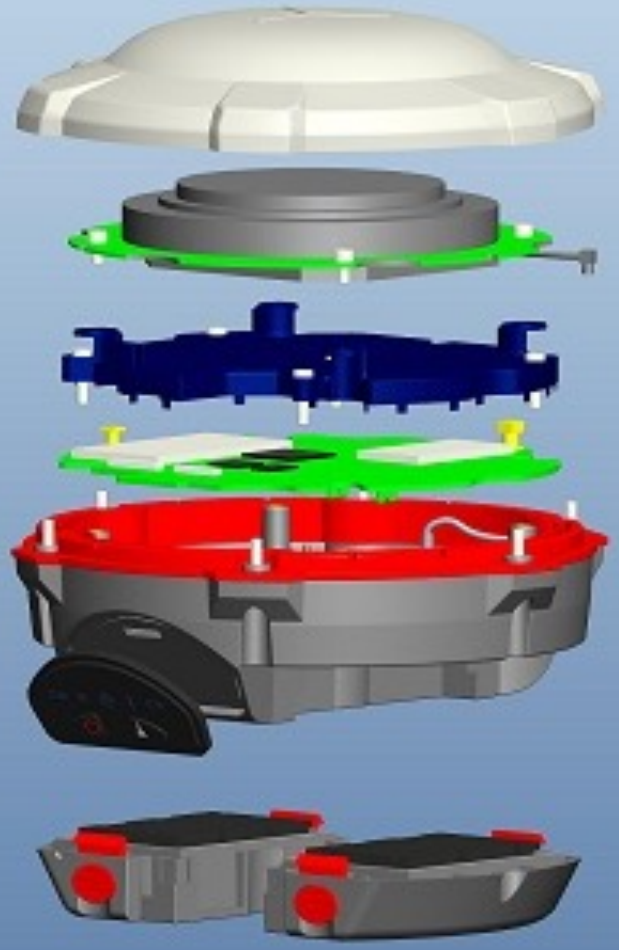



Signal tracking
Signal acquisition
Pull-in
Bit sync
Frame sync
Msr
Msr
Msr
Msr
Msr
Ephemeris downloading
Position fix
A few hundred milliseconds to tens of seconds
A few hundred milliseconds
A few hundred milliseconds to seconds
About 6 seconds
About 18 seconds to minutes or forever
Time-to-first-fix



housing top

GNSS Antenna

interface shield AD stage

GNSS ME + processing board

LED’s + interface shield, memory and 3G Modem

ON NE CALIBRE PAS UN RECEPTEUR GNSS

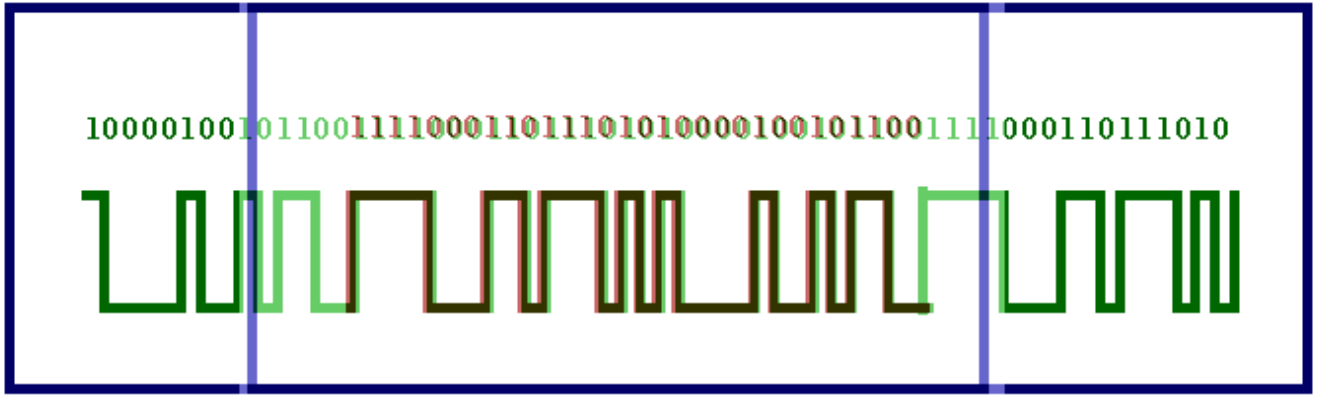
battery slots covers

Récepteur GNSS permettant de suivre les constellations opérationnelles en vue : GPS, GLONASS et BEIDOU. Modem 3,5 G, batteries, BT ...

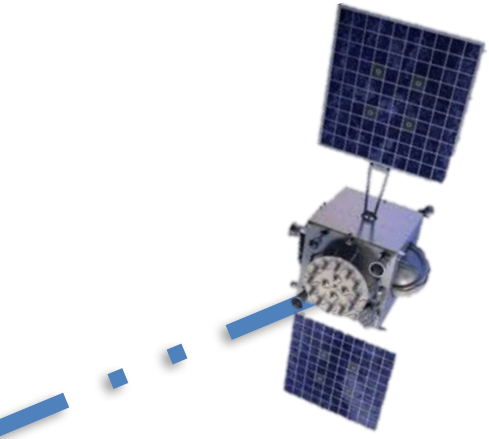
Opérateur GNSS RTK

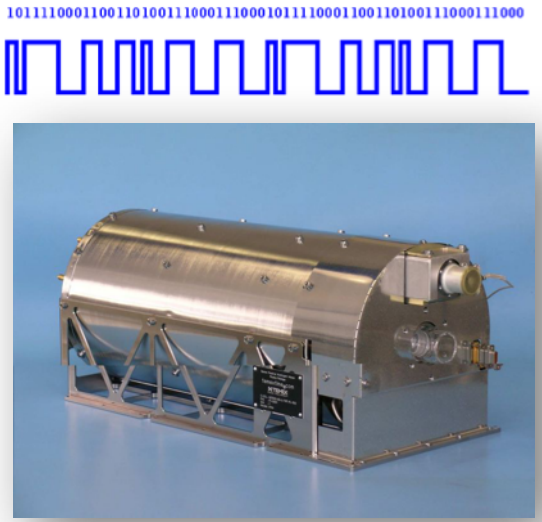
Canne de lever de 2 mètres en fibre de carbone pour fixer le récepteur GNSS et le carnet de terrain électronique ou un Smartphone.

Smartphone durcit disposant d'une application connectée au récepteur via BT et disposant de Internet Mobile. Les résultats sont envoyés par e-mail.

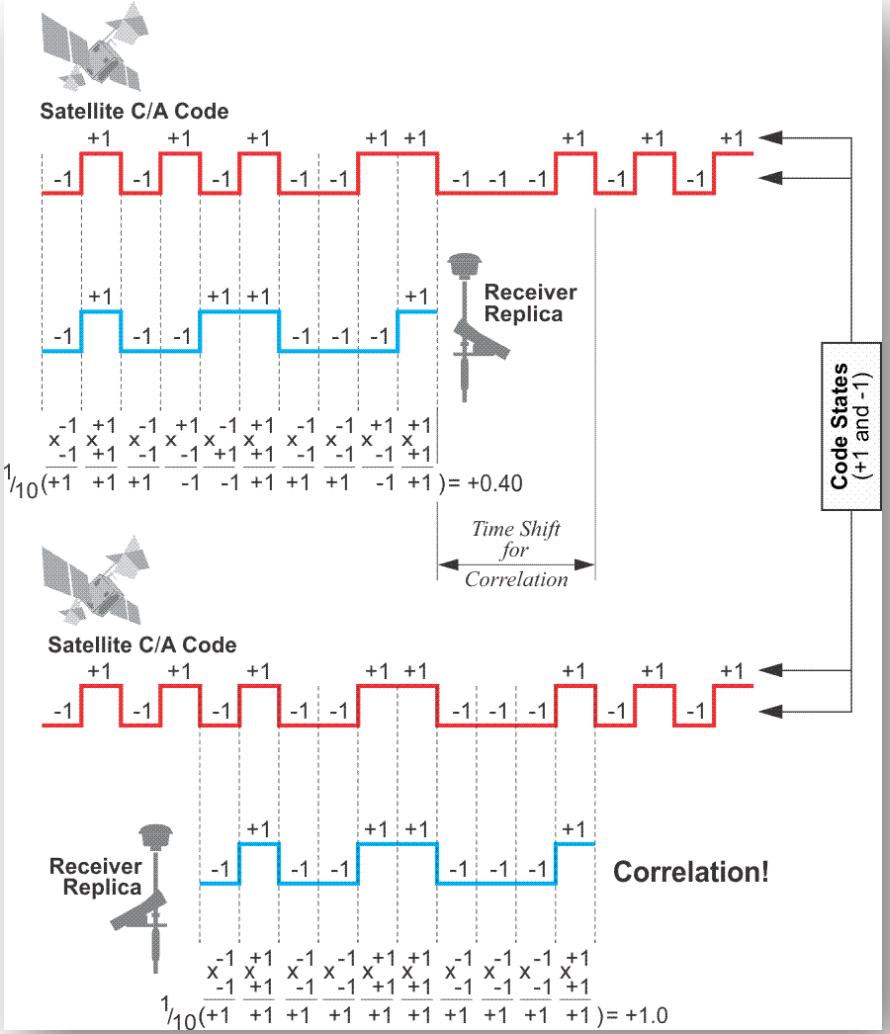


Full Correlation (Code-Phase Lock) of Receiver and Satellite PRN Codes

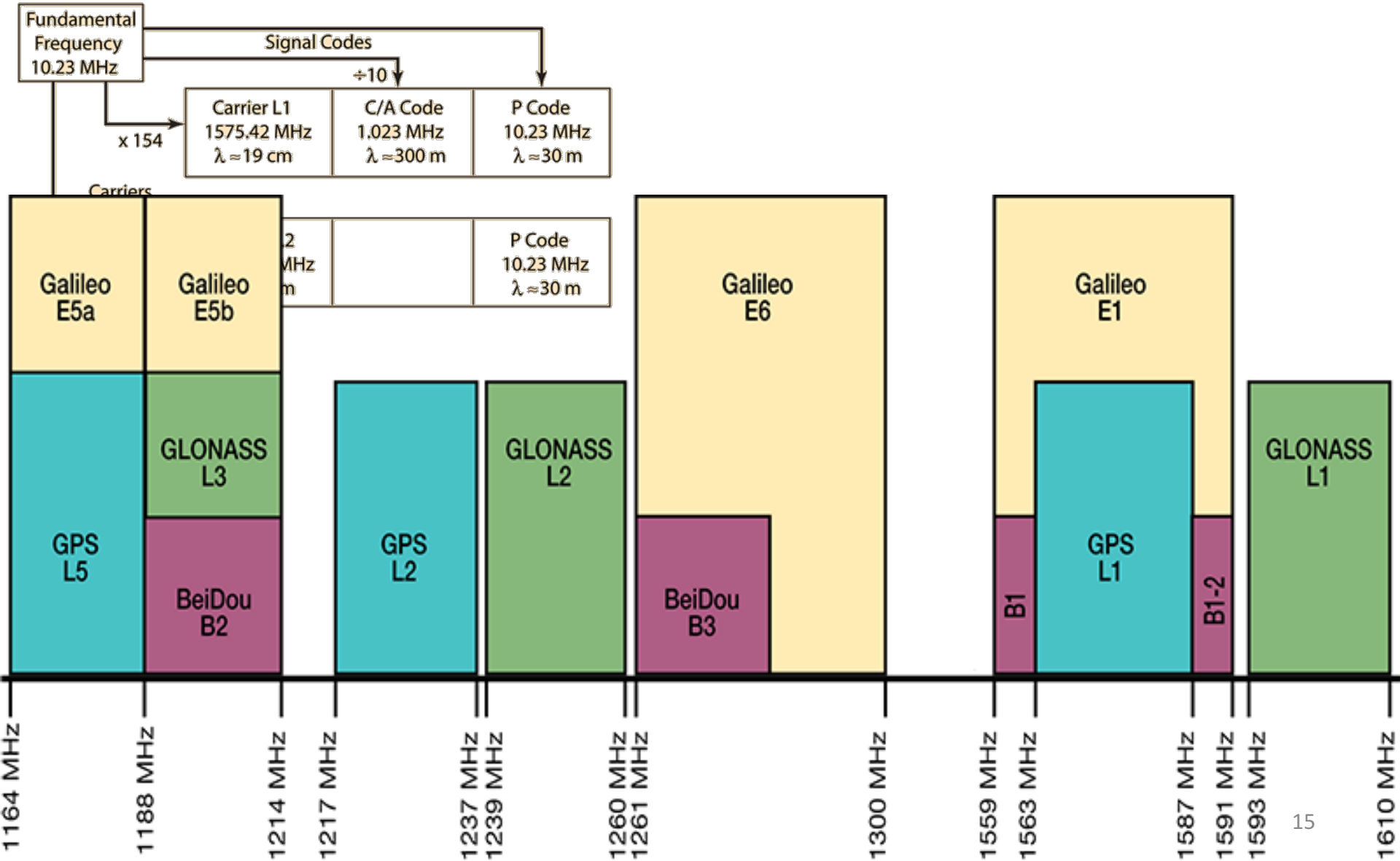


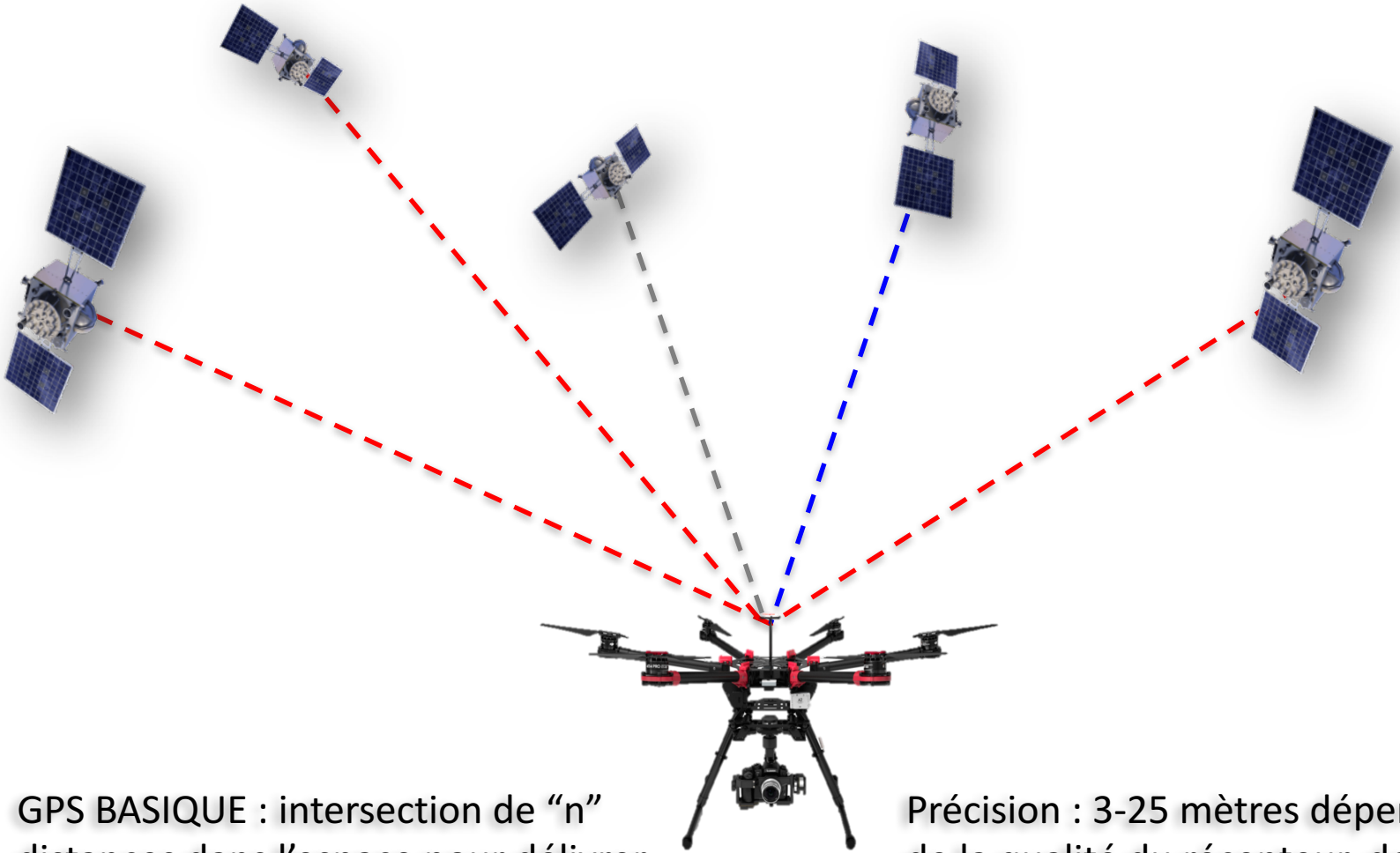


Chaque récepteur GNSS dispose de l'entièreté des codes PRN de toutes les constellations. Un récepteur « réplique » !



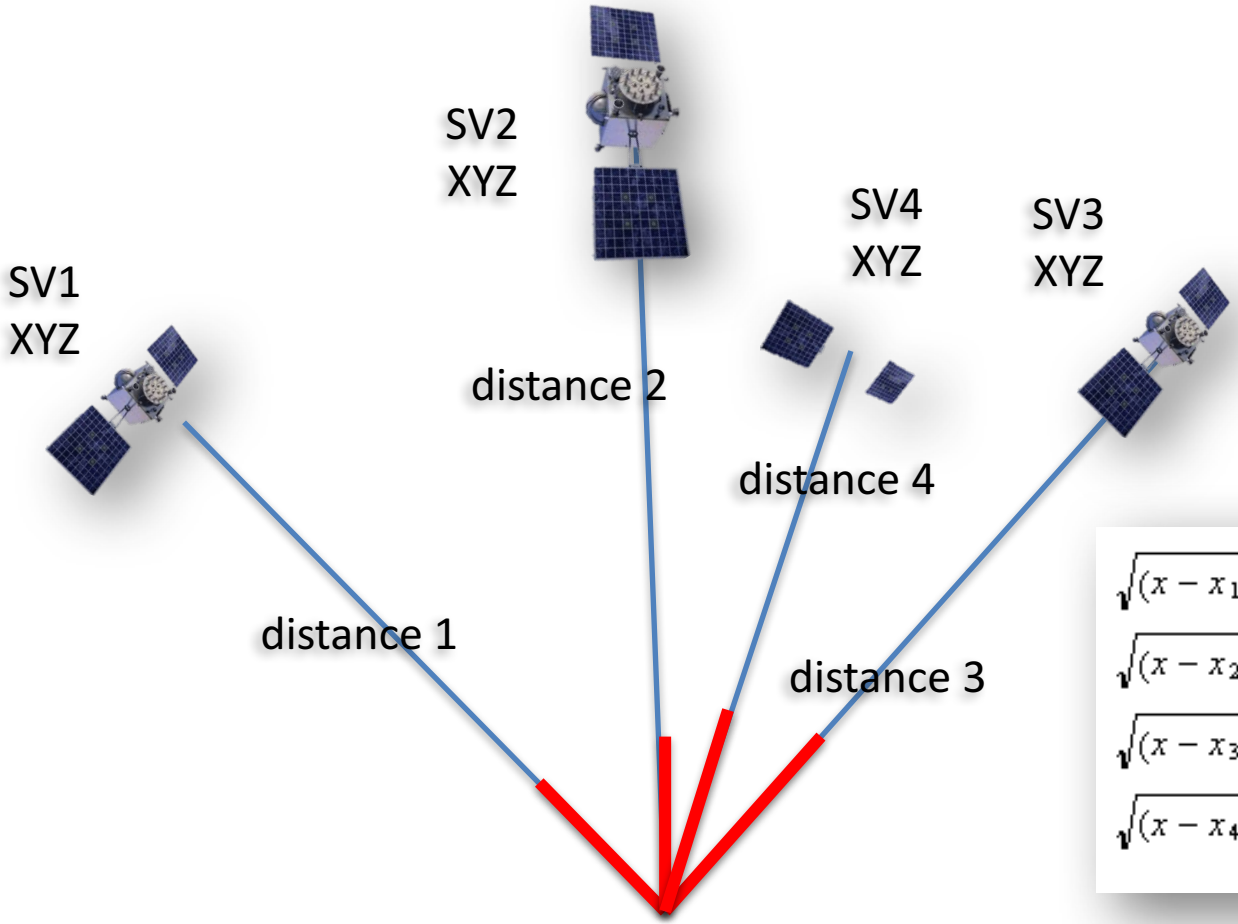
« corrélateur » = canal ! Aujourd'hui les récepteurs GNSS sont pourvus de centaines de canaux ... (GPS, GLONASS, BEIDOU, GALILEO) pour tracker 20 à 25 satellites en vue.


Fundamental Frequency 10.23 MHz
Signal Codes
÷10
x 154
Carrier L1 1575.42 MHz λ≈19 cm
C/A Code 1.023 MHz λ≈300 m
P Code 10.23 MHz λ≈30 m
Carriers
P Code 10.23 MHz λ≈30 m
Galileo E5a
Galileo E5b
Galileo E6
Galileo E1
GLONASS L3
GLONASS L2
GLONASS L1
GPS L5
GPS L2
GPS L1
BeiDou B2
BeiDou B3
B1
B1-2
1164 MHz
1188 MHz
1214 MHz
1217 MHz
1237 MHz
1239 MHz
1260 MHz
1261 MHz
1300 MHz
1559 MHz
1563 MHz
1587 MHz
1591 MHz
1593 MHz
1610 MHz



GPS BASIQUE : intersection de “n” distances dans l’espace pour délivrer une position 3D et le temps

Précision : 3-25 mètres dépendant de la qualité du récepteur, de la configuration géométrique et des erreurs induites par l’atmosphère ...



$$\sqrt{(x-x_1)^2+(y-y_1)^2+(z-z_1)^2}+ct_B=d_1$$

$$\sqrt{(x-x_2)^2+(y-y_2)^2+(z-z_2)^2}+ct_B=d_2$$

$$\sqrt{(x-x_3)^2+(y-y_3)^2+(z-z_3)^2}+ct_B=d_3$$

$$\sqrt{(x-x_4)^2+(y-y_4)^2+(z-z_4)^2}+ct_B=d_4$$

Distance = Δt x c mais le **Δt** est composé du temps de propagation des ondes électromagnétiques (Signal reçu – Signal émis) **et l'horloge du récepteur n'est pas synchronisée** avec le temps GPS (les satellites sont tous synchronisés en temps)

En partant de l'équation exprimant la distance entre un satellite GNSS et le centre de phase de l'antenne GNSS d'un récepteur :

$$D_i^2 = (x - x_i)^2 + (y - y_i)^2 + (z - z_i)^2 + c.\Delta_t$$

Nous devons linéariser cette équation en utilisant un développement de TAYLOR limité aux termes linéaires et donc disposer d'une position approchée du point.

$$D_i^{mes} = D_i^{calculé} + \left(\frac{\partial D_i}{\partial x}\right)_0 dx + \left(\frac{\partial D_i}{\partial y}\right)_0 dy + \left(\frac{\partial D_i}{\partial z}\right)_0 dz$$

Avec les coefficients suivants qui sont en fait les cosinus directeurs du vecteur « Satellite – Récepteur »

$$\left(\frac{\partial D_i}{\partial x}\right)_0 = \frac{(x_0 - x_i)}{D_i^{calculée}} \qquad \left(\frac{\partial D_i}{\partial y}\right)_0 = \frac{(y_0 - y_i)}{D_i^{calculée}} \qquad \left(\frac{\partial D_i}{\partial z}\right)_0 = \frac{(z_0 - z_i)}{D_i^{calculée}}$$

$$D_i^{calculée} = \sqrt{(x_0 - x_i)^2 + (y_0 - y_i)^2 + (z_0 - z_i)^2}$$

$$D_i^{mesurée} - D_i^{calculée} = \frac{(x_0 - x_i)}{D_i^{calculée}} \cdot dx + \frac{(y_0 - y_i)}{D_i^{calculée}} \cdot dy + \frac{(z_0 - z_i)}{D_i^{calculée}} \cdot dz + c.\Delta_t$$

$$\begin{bmatrix} \frac{x_0 - x_1}{D_1^c} & \frac{y_0 - y_1}{D_1^c} & \frac{z_0 - z_1}{D_1^c} & 1 \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots \\ \frac{x_0 - x_n}{D_n^c} & \frac{y_0 - y_n}{D_n^c} & \frac{z_0 - z_n}{D_n^c} & 1 \end{bmatrix} \begin{bmatrix} dx \\ dy \\ dz \\ \Delta t_r \end{bmatrix} = \begin{bmatrix} D_1^m - D_1^c \\ \dots \\ D_n^m - D_n^c \end{bmatrix} = \begin{bmatrix} v_1 \\ \dots \\ v_2 \end{bmatrix}$$

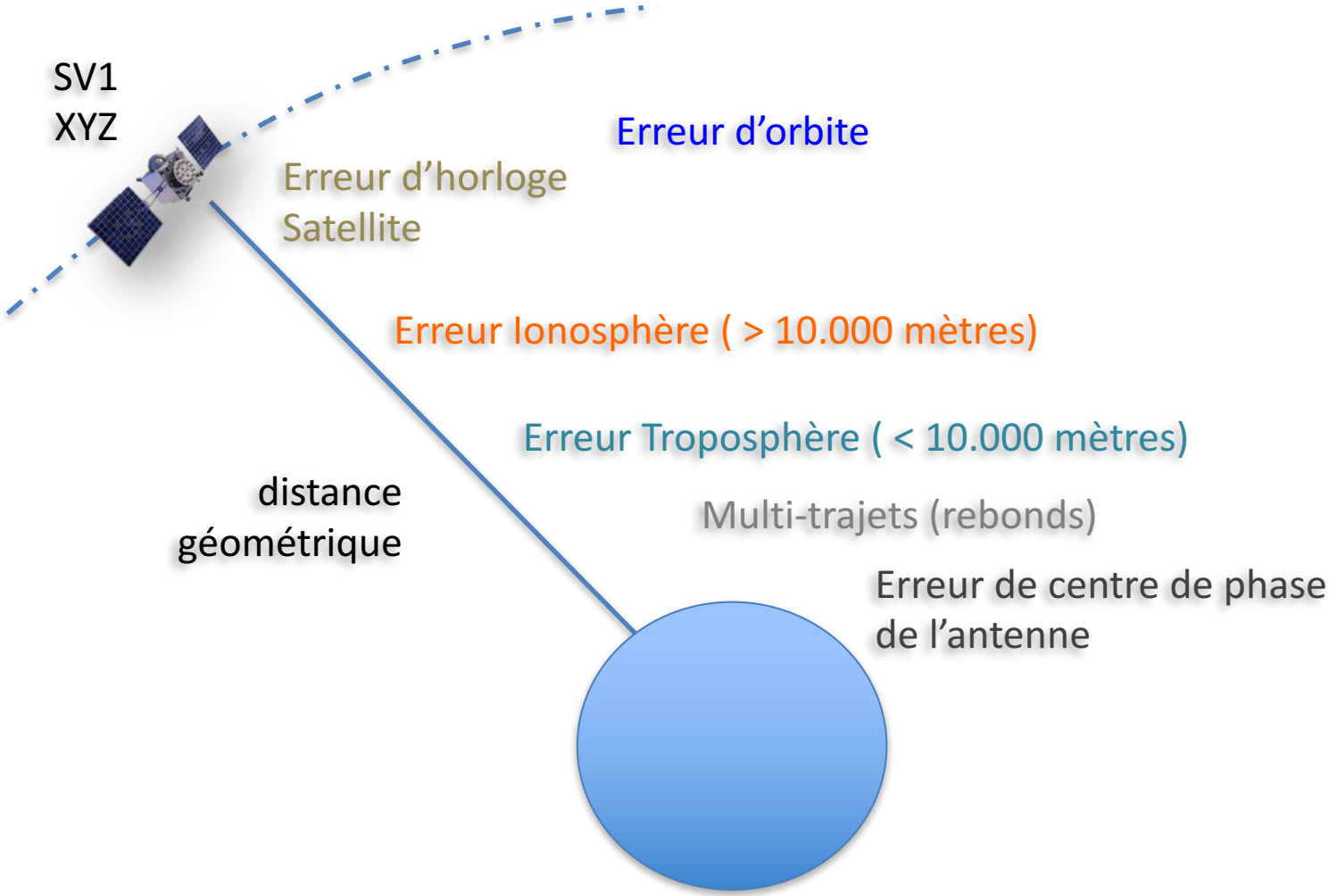
Les distance obtenues sur 15 satellites GNSS fourniront donc un système de 15 équations et 4 inconnues. Il faut utiliser la méthode des Moindres Carrés pour résoudre un tel système d'équation !

$$\hat{x} = (A^t \cdot A)^{-1} \cdot (A^t.l)$$

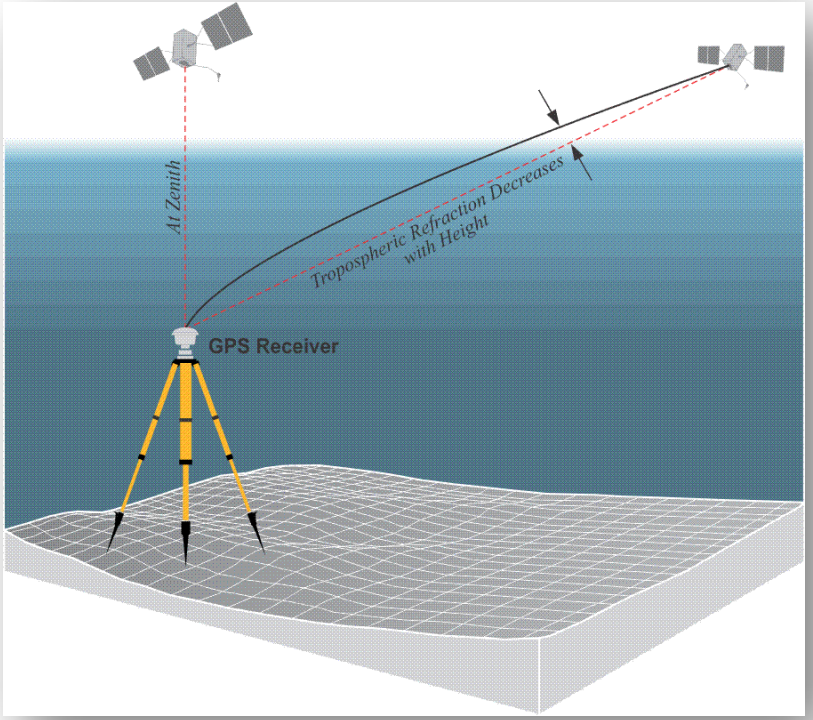
$$C_{xx} = (A^t \cdot A)^{-1} = \begin{bmatrix} q_{xx} & q_{xy} & q_{xz} & q_{xt} \\ \cdots & q_{yy} & q_{yz} & q_{yt} \\ \cdots & \cdots & q_{zz} & q_{zt} \\ \cdots & \cdots & \cdots & q_{\Delta t.c} \end{bmatrix}$$

$$PDOP = \sqrt{Tr(A^t \cdot A)^{-1}}$$

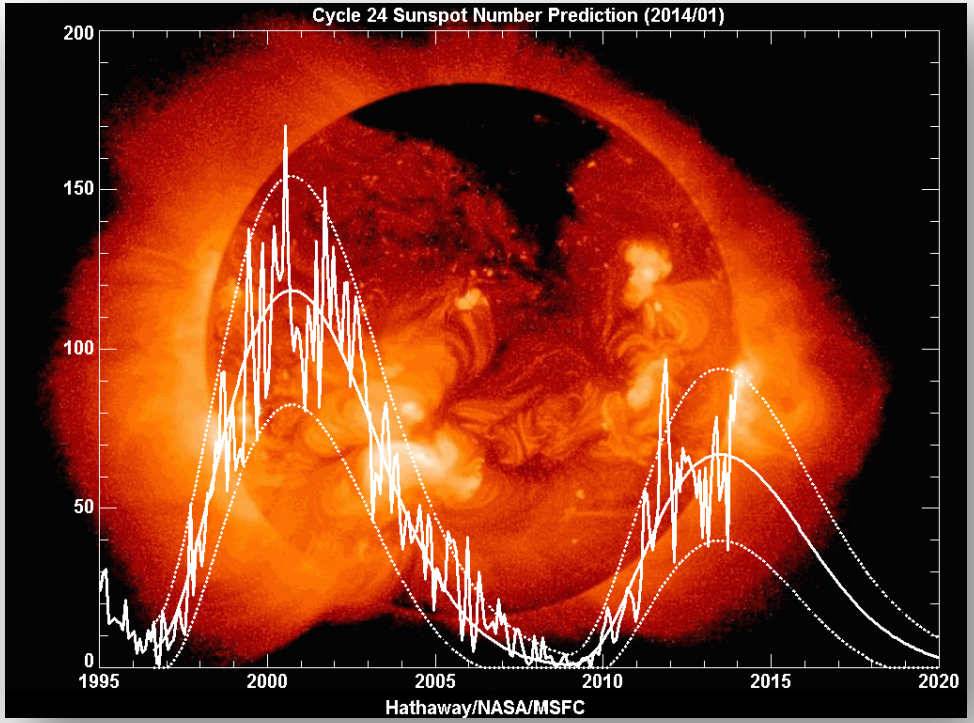
La compréhension des paramètres GDOP, PDOP, HDOP, VDOP, TDOP repose donc sur la méthode des Moindres Carrés. La matrice de variance-covariance contient la signature « géométrique » récepteur – constellation !


SV1
XYZ
Erreur d'orbite
Erreur d'horloge
Satellite
Erreur Ionosphère (> 10.000 mètres)
Erreur Troposphère (< 10.000 mètres)
distance
géométrique
Multi-trajets (rebonds)
Erreur de centre de phase
de l'antenne

La réfraction atmosphérique



Troposphère



Ionosphère

Produced by JVC at 10/06/00 23:11:27

AT : 9.023

PRN	WN	GPS Time	X sat	Y sat	Z sat	ClockBias	PseudoRange
3	1065	32550	13990304.251	-8323190.561	20944262.868	2796.180	20772776.045
15	1065	32550	23169627.625	-11764842.825	5169535.994	246065.101	22382570.861
17	1065	32550	4001242.152	14557817.177	21715884.18	-77350.959	22098103.857
19	1065	32550	2878203.791	-20110633.835	17079420.799	58826.452	23789799.15
21	1065	32550	24955272.191	10079352.237	-5235.477	3019.308	23558094.378
22	1065	32550	23277667.552	-2202387.506	12845555.826	84267.606	20870627.311
23	1065	32550	16126267.877	17016391.450	13140505.33	3308.231	22162417.262
31	1065	32550	7568408.737	-20134934.095	15144809.787	256.131	23177977.059

Xapp = 4061150.018 Yapp = 352974.928 Zapp = 4889382.161

3	Az. = 288.1	Ele. = 61.	Trop. = 2.736	Ion. = 5.380
15	Az. = 225.1	Ele. = 31.1	Trop. = 4.608	Ion. = 8.332
17	Az. = 55.3	Ele. = 38.2	Trop. = 3.852	Ion. = 7.426
19	Az. = 296.1	Ele. = 18.2	Trop. = 7.579	Ion. = 10.49
21	Az. = 158.2	Ele. = 25.2	Trop. = 5.560	Ion. = 9.613
22	Az. = 203.5	Ele. = 60.3	Trop. = 2.753	Ion. = 5.454
23	Az. = 108.2	Ele. = 42.3	Trop. = 3.546	Ion. = 6.976
31	Az. = 284.0	Ele. = 22.5	Trop. = 6.151	Ion. = 9.631

Le récepteur itinérant applique les corrections provenant de la station de base à ses propres coordonnées de navigation Xn, Yn, Zn

Une station de base transmet les différences entre la position de navigation Xn, Yn, Zn et les coordonnées du point de station Xs, Ys, Zs.

Récepteur Itinérant

Station de base locale

```
*****************************************************************************
*                                                                           *
*                    Dxyz - a dGPS Post Processing Software                 *
*           Development & Design by Joël Van Cranenbroeck - 07 1999         *
*                                                                           *
*****************************************************************************

Computed at   10/06/00      23:12:00
Observations File at the Base  : D:\TFE_Gembloux\Test2000\Rinex\mont1560.00o
Observations File at the Rover : D:\TFE_Gembloux\Test2000\Rinex\mail1560.00o
Ephemeride File                : D:\TFE_Gembloux\Test2000\Rinex\mont1560.00n

============================================================================
                      SINGLE DIFFERENCE PROCESSING EPOCH N∞ 1

============================================================================
Epoch of Observation   :     4 / 6 / 2000  at 9.0230
GPS Week Number        :     1065

Observation Time Base  :     32550
X Base position        :    4063022.408
Y                      :    347738.726
Z                      :    4888075.205

Observation Time Rover :     32550
X Rover position app.  :    4061150.018
Y                      :    352974.928
Z                      :    4889382.161

============================================================================


Number of Satellite    :     8
Number of Unknowns     :     4
Number of Equations    :     8
Degree of Freedom      :     4
Epochs definition      :     15  sec.

============================================================================
CORRECTIONS ON PSEUDO-RANGES :
============================================================================

PRN#         Azimuth      Elevation      CorrDiff.      Base.Diff.   Range.Diff.

 3            288.24        61.08          -.003          43.793       -2136.808
 15           225.11        31.23          -.015          47.123       -4430.614
 17           55.42         38.38           .014          38.606        4325.923
 19           296.23        18.26          -.021          32.801       -3772.746
 21           158.28        25.41           .000          36.056         166.159
 22           203.82        60.45          -.003          22.130       -1932.208
 23           108.29        42.44           .009          35.287        3338.083
 31           284.02        22.79          -.019          31.548       -4379.558
```

```
============================================================================
DESIGN MATRIX A AND OBSERVATIONS VECTOR L :
============================================================================

 3            .478          -.418          .773          1            -65.898
 15           .844          -.536          .012          1            -61.93
 17          -.003           .645          .764          1            -55.84
 19          -.05           -.858          .511          1            -41.059
 21           .887           .413         -.208          1            -64.161
 22           .917          -.122          .38           1            -73.533
 23           .544           .752          .372          1            -66.134
 31           .151          -.884          .442          1            -46.359

============================================================================
VECTOR OF CORRECTIONS AFTER ADJUSTEMENT :
============================================================================

PRN#           Corr.       Standardized

 3            -.17          -.7
 15           -.001          0
 17           -.054         -.28
 19            .194          .79
 21           -.121         -.63
 22            .171          .59
 23            .112          .3
 31           -.132         -.36

============================================================================
FINAL ADJUSTED COORDINATES :
============================================================================

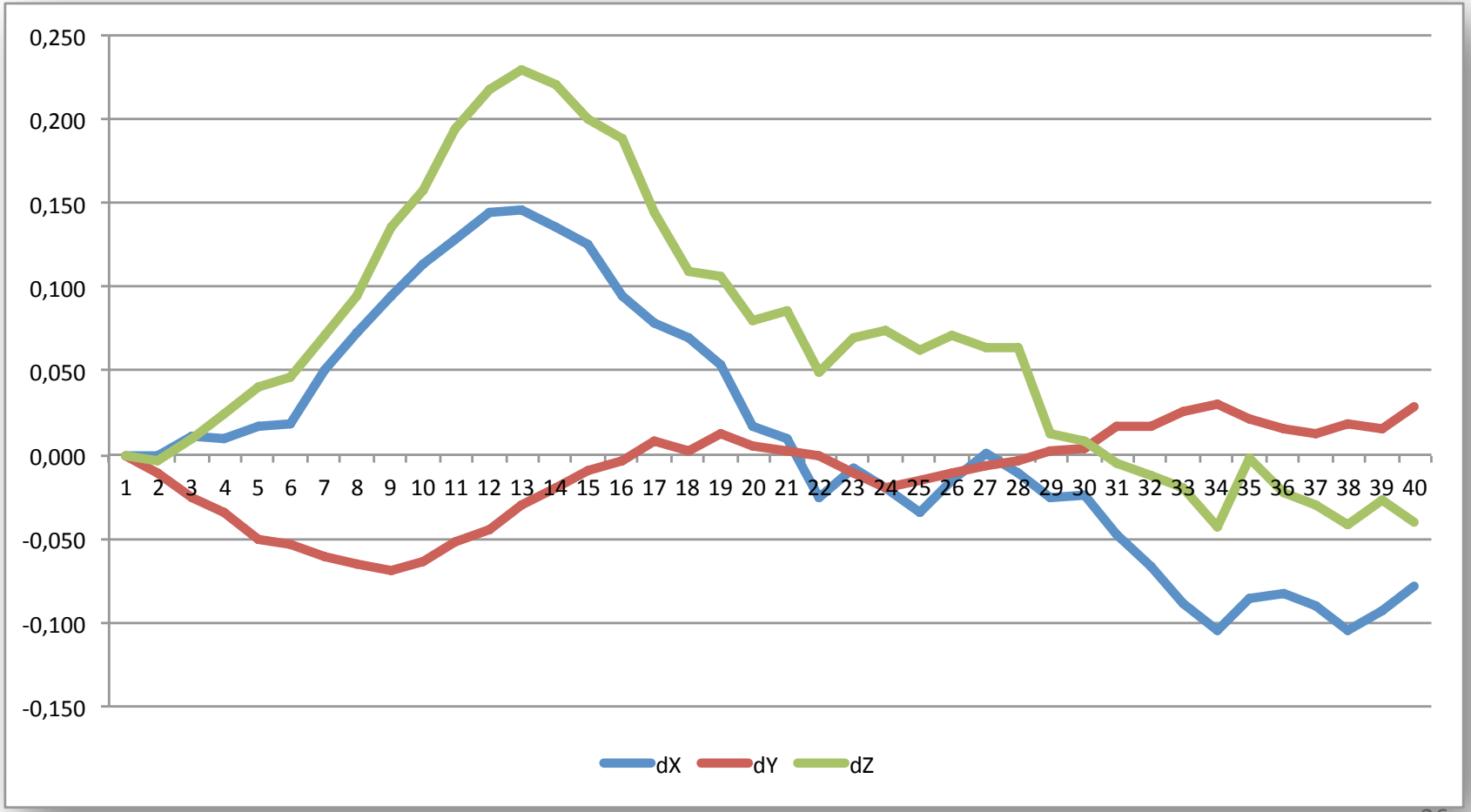
 dXo      : -32.169 m.
 dYo      : -5.354 m.
 dZo      : -19.671 m.
 RClockBs : -.000000125 secondes

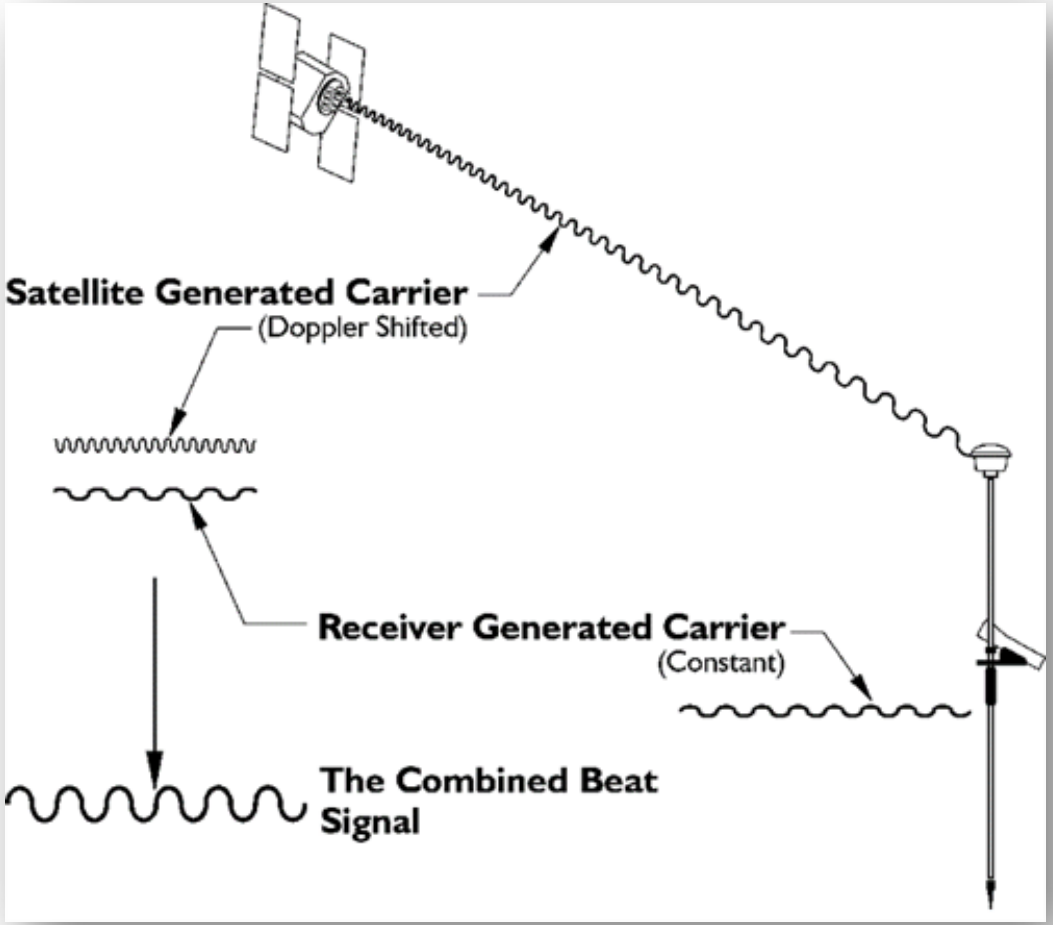
 X WGS 84 : 4061117.848 m.
 Y WGS 84 : 352969.574 m.
 Z WGS 84 : 4889362.490 m.

 GDOP     : 2.4
 PDOP     : 1.1
 HDOP     : .8
 VDOP     : .8
 TDOP     : 2.1

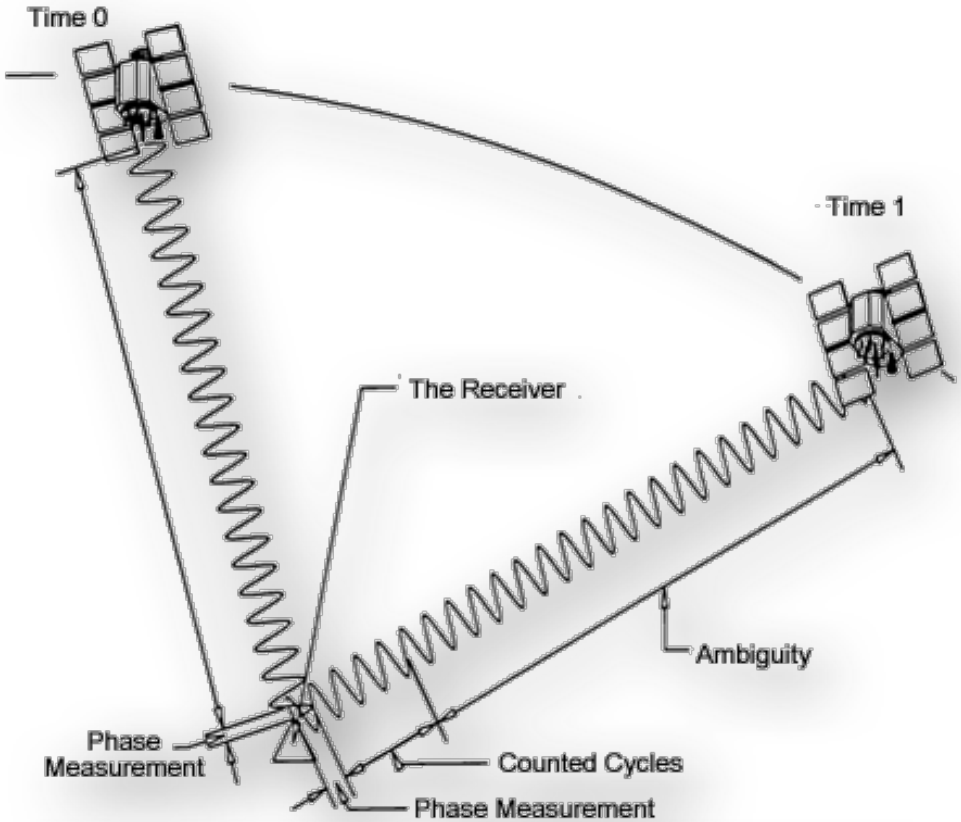
 RMS      : .189m.
 RMSxGDop : .460m.
 RMSxPDop : .217m.
 RMSxHDop : .154m.
 RMSxVDop : .153m.
 RMSxTDop : .405m.
```

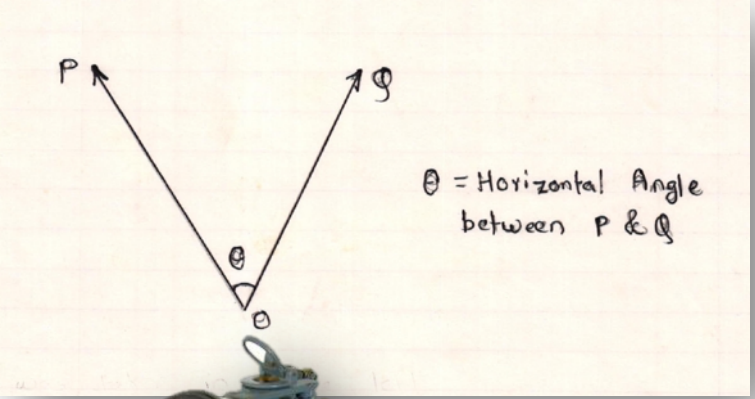
Résultats en DGPS (2010)

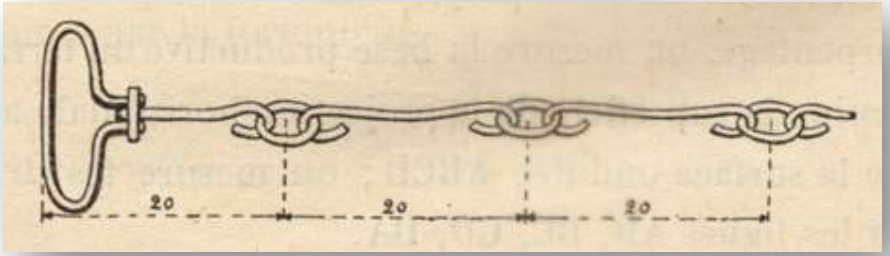


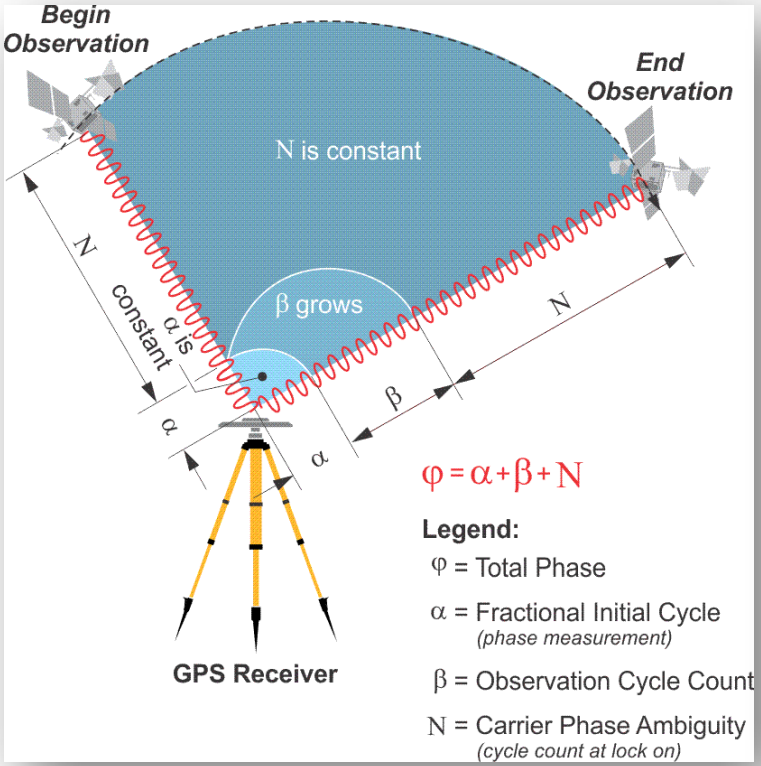


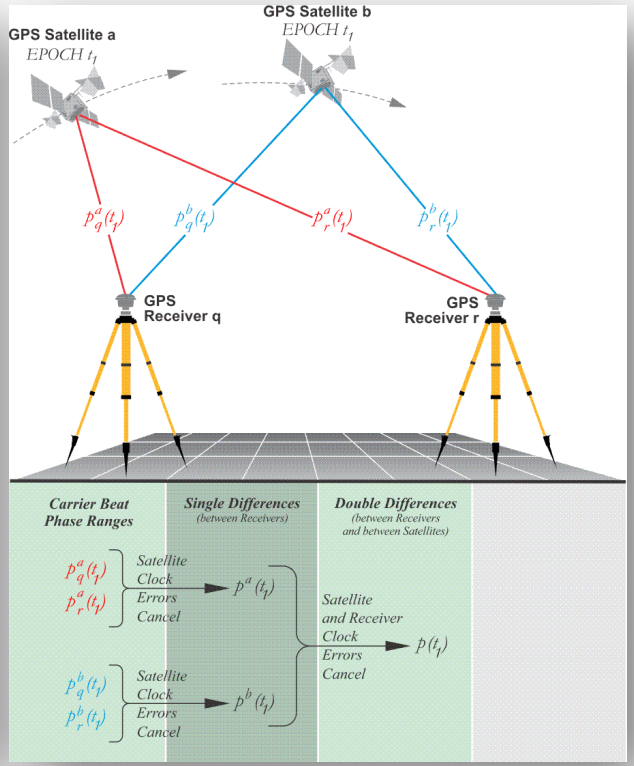
La mesure de phase (battement) est extrêmement précise : Ecart Type +/- 0,2 mm mais le challenge est de déterminer le nombre de longueur d'onde séparant le satellite de l'antenne de réception !

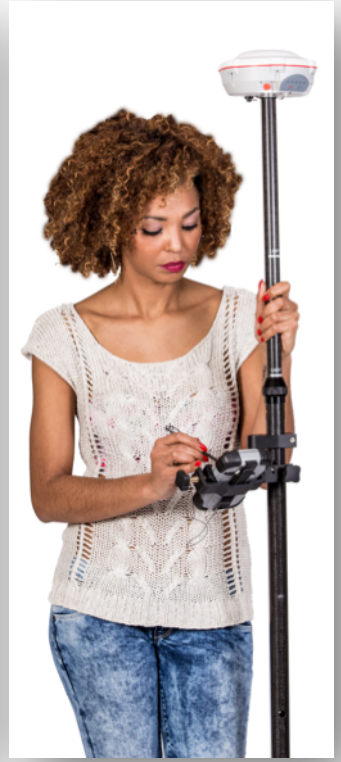

Time 0
Time 1
The Receiver
Ambiguity
Phase Measurement
Counted Cycles
Phase Measurement


P
Q
θ
θ = Horizontal Angle between P & Q


20
20
20







les différences doubles sauvegardent le caractère « integer » des Δ ambiguities

INT(29,908) = 29 ou 30 ?

float integer

Traitement des Observations GNSS

Décharger les données du récepteur (binaire) de REFERENCE

Décharger les données du récepteur (binaire) du MOBILE

Observations et éphémérides en format RINEX

Observations et éphémérides en format RINEX

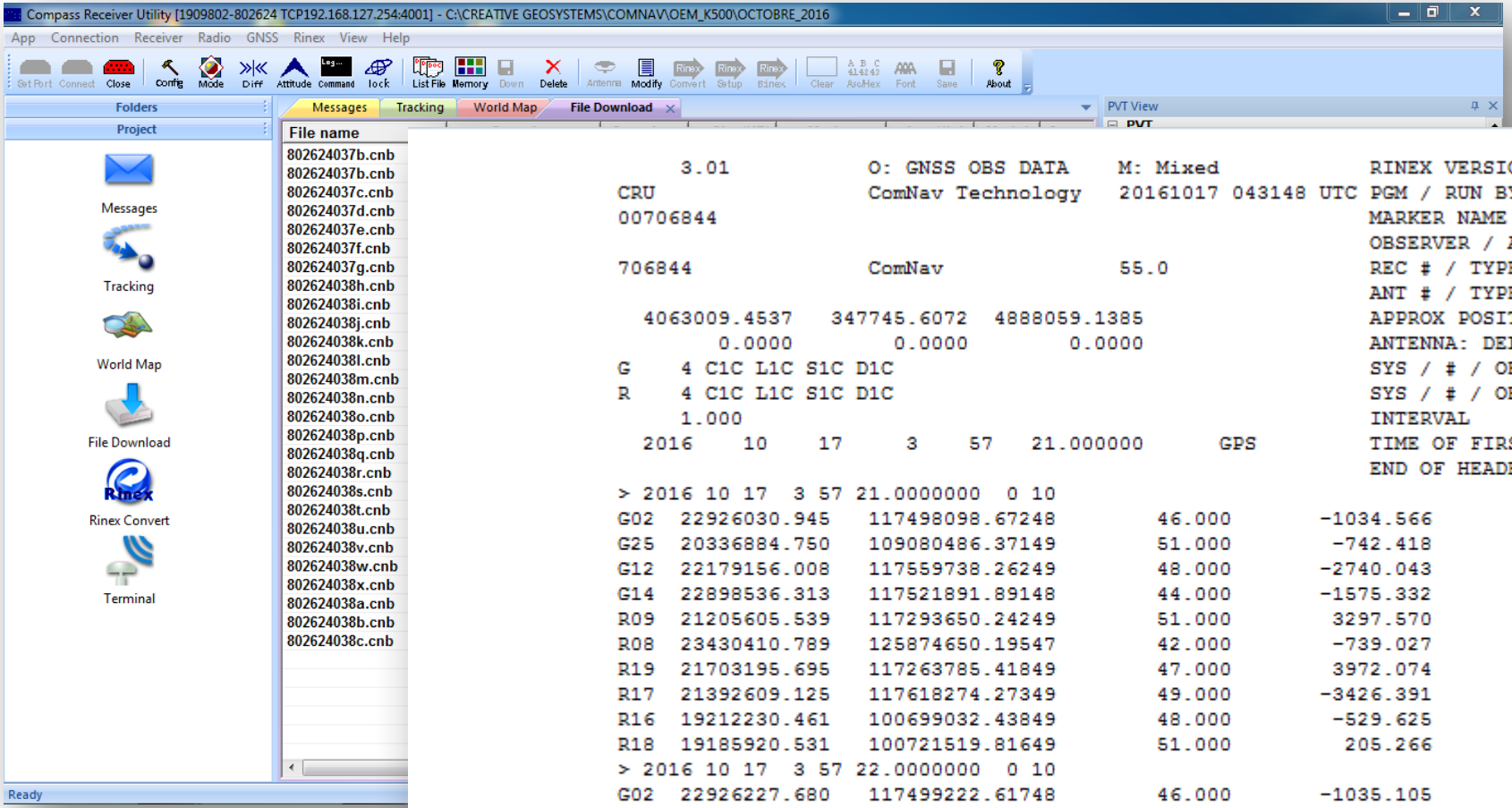
Logiciel de Traitement des observations GNSS
Open Source RTK-LIB développé par Mr. TAKUZA Japan

Le format RINEX (Receiver INdependent Exchange Format) est un format « texte » développé par les universités pour échanger des observations GNSS indépendamment des formats propriétaires.

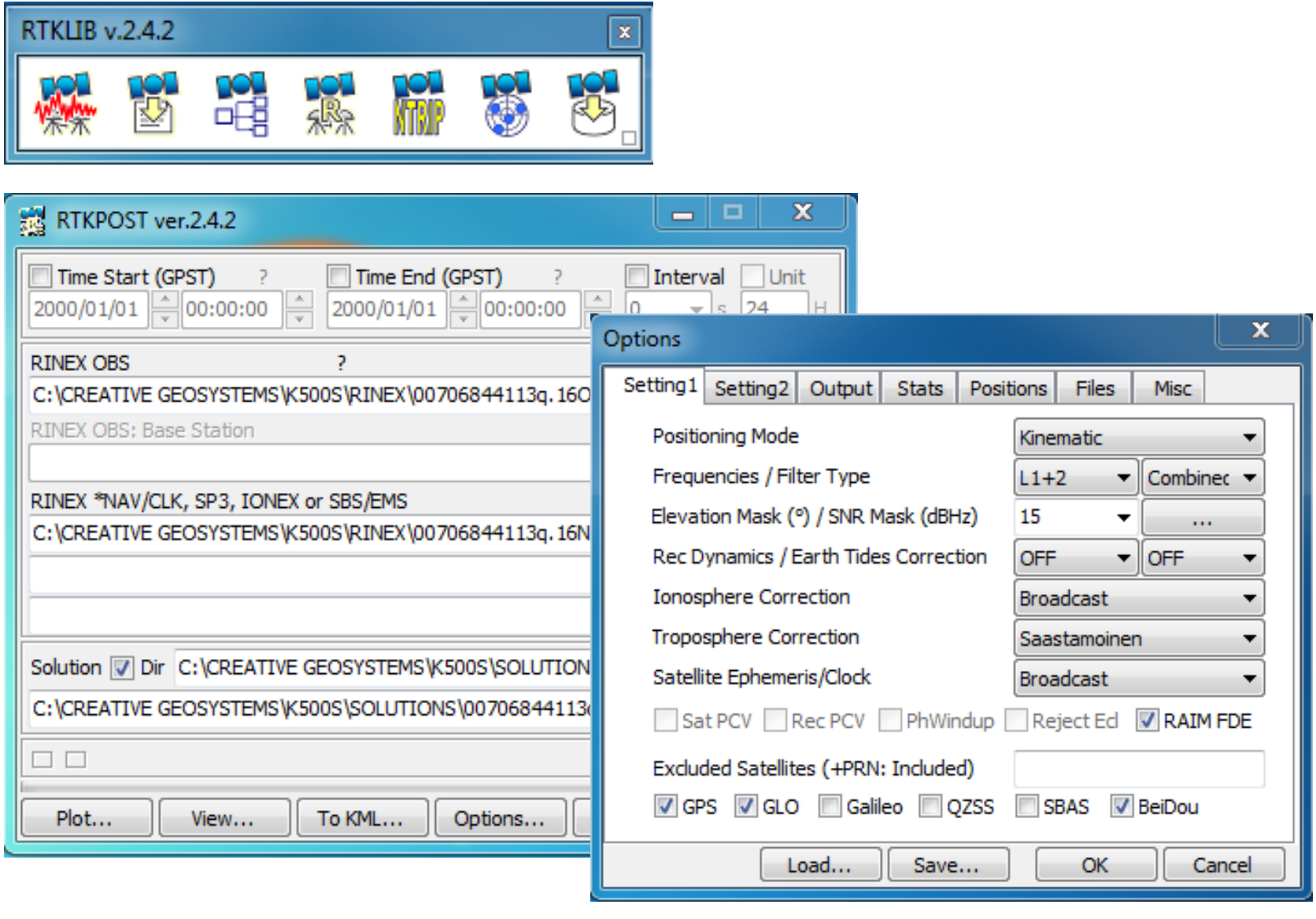
Fichier résultat MOBILE en X,Y,Z WGS-84

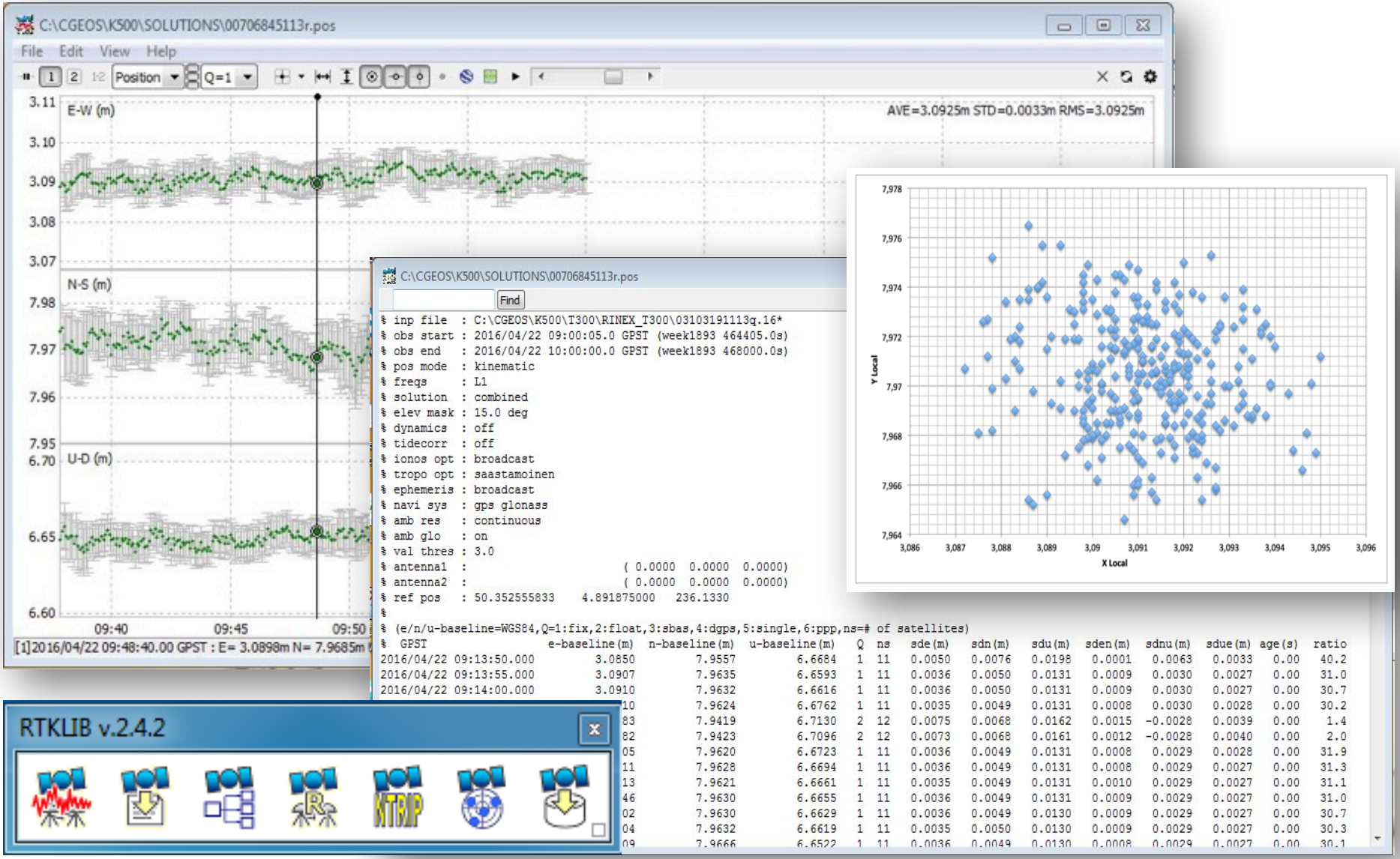
Logiciel GTRANS IGNb

Résultats dans les systèmes de coordonnées LAMBERT 72 et LAMBERT 2008



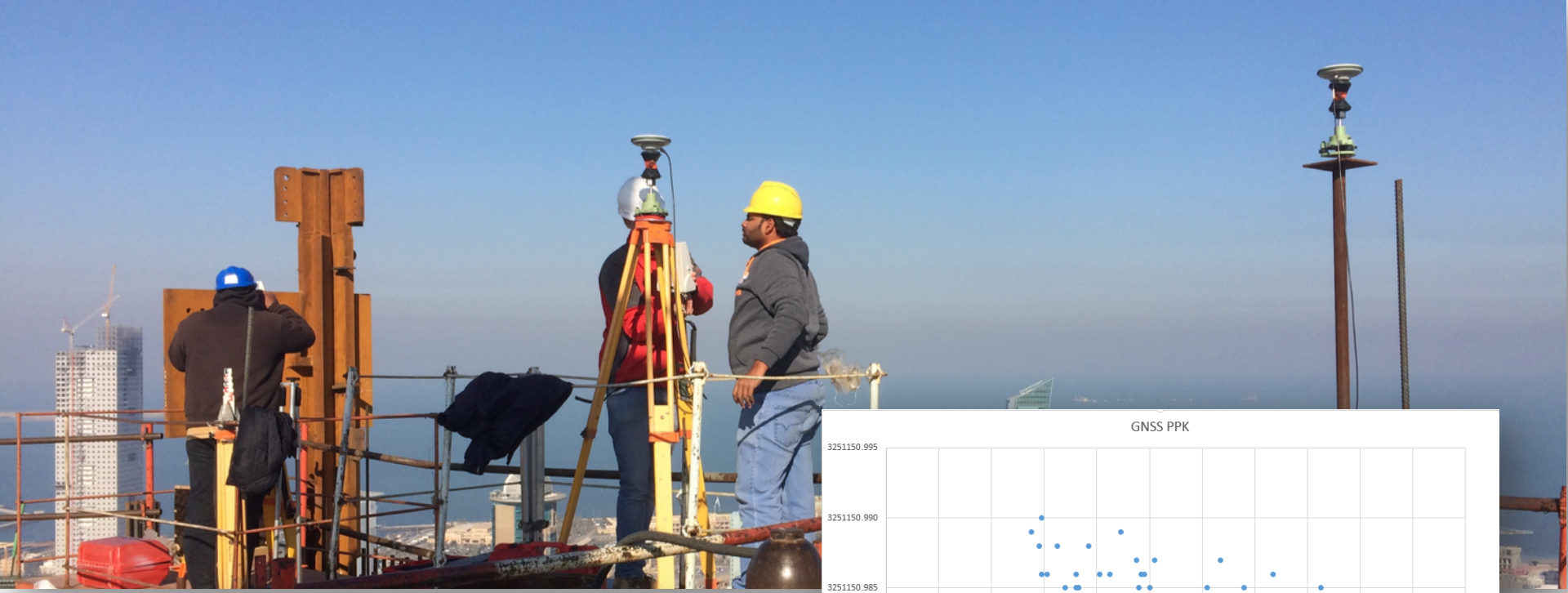

```
     3.01           O: GNSS OBS DATA    M: Mixed            RINEX VERSION / TYPE
CRU                 ComNav Technology   20161017 043148 UTC PGM / RUN BY / DATE
00706844                                                    MARKER NAME
                                                            OBSERVER / AGENCY
706844              ComNav              55.0                REC # / TYPE / VERS
                                                            ANT # / TYPE
  4063009.4537   347745.6072  4888059.1385                  APPROX POSITION XYZ
        0.0000        0.0000        0.0000                  ANTENNA: DELTA H/E/N
G    4 C1C L1C S1C D1C                                      SYS / # / OBS TYPES
R    4 C1C L1C S1C D1C                                      SYS / # / OBS TYPES
     1.000                                                  INTERVAL
  2016    10    17     3    57   21.000000      GPS        TIME OF FIRST OBS
                                                            END OF HEADER
> 2016 10 17  3 57 21.0000000  0 10
G02  22926030.945   117498098.67248        46.000       -1034.566
G25  20336884.750   109080486.37149        51.000        -742.418
G12  22179156.008   117559738.26249        48.000       -2740.043
G14  22898536.313   117521891.89148        44.000       -1575.332
R09  21205605.539   117293650.24249        51.000        3297.570
R08  23430410.789   125874650.19547        42.000        -739.027
R19  21703195.695   117263785.41849        47.000        3972.074
R17  21392609.125   117618274.27349        49.000       -3426.391
R16  19212230.461   100699032.43849        48.000        -529.625
R18  19185920.531   100721519.81649        51.000         205.266
> 2016 10 17  3 57 22.0000000  0 10
G02  22926227.680   117499222.61748        46.000       -1035.105
G25  20337025.523   109081318.30149        51.000        -742.930
G12  22179676.891   117562567.71549        48.000       -2740.180
G14  22898835.719   117523556.63748        44.000       -1575.855
R09  21204986.813   117290443.64549        51.000        3297.211
R08  23430548.773   125875480.59047        42.000        -739.746
R19  21702452.914   117259904.68049        47.000        3971.523
R17  21393249.063   117621791.70749        50.000       -3426.875
R16  19212329.195   100699653.18449        48.000        -530.254
R18  19185881.633   100721405.67249        51.000         204.457
```


RTKLIB v.2.4.2
NTRIP
RTKPOST ver.2.4.2
Time Start (GPST)
Time End (GPST)
Interval
Unit
2000/01/01
00:00:00
2000/01/01
00:00:00
RINEX OBS
C:\CREATIVE GEOSYSTEMS\K500S\RINEX\00706844113q.16O
RINEX OBS: Base Station
RINEX *NAV/CLK, SP3, IONEX or SBS/EMS
C:\CREATIVE GEOSYSTEMS\K500S\RINEX\00706844113q.16N
Solution
Dir
C:\CREATIVE GEOSYSTEMS\K500S\SOLUTION
C:\CREATIVE GEOSYSTEMS\K500S\SOLUTIONS\00706844113
Plot...
View...
To KML...
Options...
Options
Setting1
Setting2
Output
Stats
Positions
Files
Misc
Positioning Mode
Kinematic
Frequencies / Filter Type
L1+2
Combinec
Elevation Mask (°) / SNR Mask (dBHz)
15
...
Rec Dynamics / Earth Tides Correction
OFF
OFF
Ionosphere Correction
Broadcast
Troposphere Correction
Saastamoinen
Satellite Ephemeris/Clock
Broadcast
Sat PCV
Rec PCV
PhWindup
Reject Ed
RAIM FDE
Excluded Satellites (+PRN: Included)
GPS
GLO
Galileo
QZSS
SBAS
BeiDou
Load...
Save...
OK
Cancel


C:\CGEOS\K500\SOLUTIONS\00706845113r.pos
File Edit View Help
Position
Q=1
E-W (m)
AVE=3.0925m STD=0.0033m RMS=3.0925m
N-S (m)
U-D (m)
09:40
09:45
[1]2016/04/22 09:48:40.00 GPST : E= 3.0898m N= 7.9685m
Find
% inp file : C:\CGEOS\K500\T300\RINEX_T300\03103191113q.16*
% obs start : 2016/04/22 09:00:05.0 GPST (week1893 464405.0s)
% obs end : 2016/04/22 10:00:00.0 GPST (week1893 468000.0s)
% pos mode : kinematic
% freqs : L1
% solution : combined
% elev mask : 15.0 deg
% dynamics : off
% tidecorr : off
% ionos opt : broadcast
% tropo opt : saastamoinen
% ephemeris : broadcast
% navi sys : gps glonass
% amb res : continuous
% amb glo : on
% val thres : 3.0
% antenna1 : (0.0000 0.0000 0.0000)
% antenna2 : (0.0000 0.0000 0.0000)
% ref pos : 50.352555833 4.891875000 236.1330
%
% (e/n/u-baseline=WGS84,Q=1:fix,2:float,3:sbas,4:dgps,5:single,6:ppp,ns=# of satellites)
% GPST e-baseline(m) n-baseline(m) u-baseline(m) Q ns sde(m) sdn(m) sdu(m) sden(m) sdnu(m) sdue(m) age(s) ratio
2016/04/22 09:13:50.000 3.0850 7.9557 6.6684 1 11 0.0050 0.0076 0.0198 0.0001 0.0063 0.0033 0.00 40.2
2016/04/22 09:13:55.000 3.0907 7.9635 6.6593 1 11 0.0036 0.0050 0.0131 0.0009 0.0030 0.0027 0.00 31.0
2016/04/22 09:14:00.000 3.0910 7.9632 6.6616 1 11 0.0036 0.0050 0.0131 0.0009 0.0030 0.0027 0.00 30.7
10 7.9624 6.6762 1 11 0.0035 0.0049 0.0131 0.0008 0.0030 0.0028 0.00 30.2
83 7.9419 6.7130 2 12 0.0075 0.0068 0.0162 0.0015 -0.0028 0.0039 0.00 1.4
82 7.9423 6.7096 2 12 0.0073 0.0068 0.0161 0.0012 -0.0028 0.0040 0.00 2.0
05 7.9620 6.6723 1 11 0.0036 0.0049 0.0131 0.0008 0.0029 0.0028 0.00 31.9
11 7.9628 6.6694 1 11 0.0036 0.0049 0.0131 0.0008 0.0029 0.0027 0.00 31.3
13 7.9621 6.6661 1 11 0.0035 0.0049 0.0131 0.0010 0.0029 0.0027 0.00 31.1
46 7.9630 6.6655 1 11 0.0036 0.0049 0.0131 0.0009 0.0029 0.0027 0.00 31.0
02 7.9630 6.6629 1 11 0.0036 0.0049 0.0130 0.0009 0.0029 0.0027 0.00 30.7
04 7.9632 6.6619 1 11 0.0035 0.0050 0.0130 0.0009 0.0029 0.0027 0.00 30.3
09 7.9666 6.6522 1 11 0.0036 0.0049 0.0130 0.0008 0.0029 0.0027 0.00 30.1
Y Local
X Local
RTKLIB v.2.4.2
NTRIP

% (x/y/z-ecef	Q=1:fix	2:float	3:sbas	4:dgps	5:single	6:ppp	ns=# of satellites)								X LGO	Y LGO	Z LGO
%	GPST	x-ecef(m)	y-ecef(m)	z-ecef(m)	Q	ns	sdx(m)	sdy(m)	sdz(m)	sdxy(m)	sdyz(m)	sdzx(m)	age(s)	ratio	3722563,5730	4133201,4020	3110406,6660
25/08/15	23:18,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	5,3	0,0007	0,0013	-0,0004
25/08/15	23:19,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	5,6	0,0007	0,0013	-0,0004
25/08/15	23:20,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	6,2	0,0007	0,0013	-0,0004
25/08/15	23:21,0	3722563,573	4133201,398	3110406,668	1	12	0,0034	0,0038	0,0031	0,003	0,0026	0,0026	0	6,4	0,0001	-0,0045	0,0024
25/08/15	23:22,0	3722563,574	4133201,404	3110406,666	2	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	2,4	0,0010	0,0015	0,0002
25/08/15	23:23,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	5,8	0,0007	0,0012	-0,0004
25/08/15	23:24,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	6,1	0,0007	0,0012	-0,0004
25/08/15	23:25,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	6,3	0,0007	0,0012	-0,0004
25/08/15	23:26,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	6,5	0,0007	0,0012	-0,0004
25/08/15	23:27,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	6,6	0,0007	0,0012	-0,0004
25/08/15	23:28,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	9,5	0,0007	0,0012	-0,0004
25/08/15	23:29,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	7,8	0,0007	0,0012	-0,0004
25/08/15	23:30,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	7,7	0,0007	0,0012	-0,0004
25/08/15	23:31,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	6,6	0,0007	0,0012	-0,0004
25/08/15	23:32,0	3722563,575	4133201,399	3110406,669	1	12	0,0018	0,002	0,0016	0,0016	0,0013	0,0013	0	5	0,0016	-0,0031	0,0031
25/08/15	23:33,0	3722563,575	4133201,398	3110406,669	1	12	0,0017	0,0019	0,0016	0,0015	0,0013	0,0013	0	8,3	0,0020	-0,0036	0,0033
25/08/15	23:34,0	3722563,575	4133201,398	3110406,669	1	12	0,0017	0,0019	0,0015	0,0015	0,0013	0,0012	0	10,7	0,0024	-0,0044	0,0033
25/08/15	23:35,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	43	0,0006	0,0012	-0,0004
25/08/15	23:36,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	5,1	0,0006	0,0011	-0,0004
25/08/15	23:37,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	14,4	0,0006	0,0011	-0,0004
25/08/15	23:38,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	20,8	0,0006	0,0011	-0,0004
25/08/15	23:39,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	24,7	0,0006	0,0011	-0,0004
25/08/15	23:40,0	3722563,574	4133201,403	3110406,666	1	12	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	29,5	0,0006	0,0011	-0,0004
25/08/15	23:41,0	3722563,575	4133201,398	3110406,669	1	12	0,0014	0,0016	0,0013	0,0013	0,0011	0,001	0	31,7	0,0018	-0,0040	0,0032
25/08/15	23:42,0	3722563,575	4133201,398	3110406,669	1	12	0,0014	0,0015	0,0012	0,0012	0,001	0,001	0	37,1	0,0019	-0,0043	0,0031
25/08/15	23:43,0	3722563,575	4133201,397	3110406,669	1	12	0,0014	0,0015	0,0012	0,0012	0,001	0,001	0	39,5	0,0020	-0,0048	0,0031
25/08/15	23:44,0	3722563,575	4133201,397	3110406,669	1	12	0,0013	0,0015	0,0012	0,0012	0,001	0,001	0	39,1	0,0022	-0,0055	0,0030
25/08/15	23:45,0	3722563,574	4133201,403	3110406,666	1	11	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	180,1	0,0006	0,0012	-0,0004
25/08/15	23:46,0	3722563,574	4133201,403	3110406,666	1	11	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	200,5	0,0006	0,0012	-0,0004
25/08/15	23:47,0	3722563,574	4133201,403	3110406,666	1	11	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	222,5	0,0006	0,0012	-0,0005
25/08/15	23:48,0	3722563,574	4133201,403	3110406,666	1	11	0,0002	0,0002	0,0002	0,0002	0,0002	0,0002	0	245,2	0,0006	0,0011	-0,0005

Pas de différence notable ($\Delta < 0.1$ mm) entre RTK-LIB POST-Processing et Leica LGO par exemple. Ici ce sont les résultats d'une ligne de base « zéro » ...

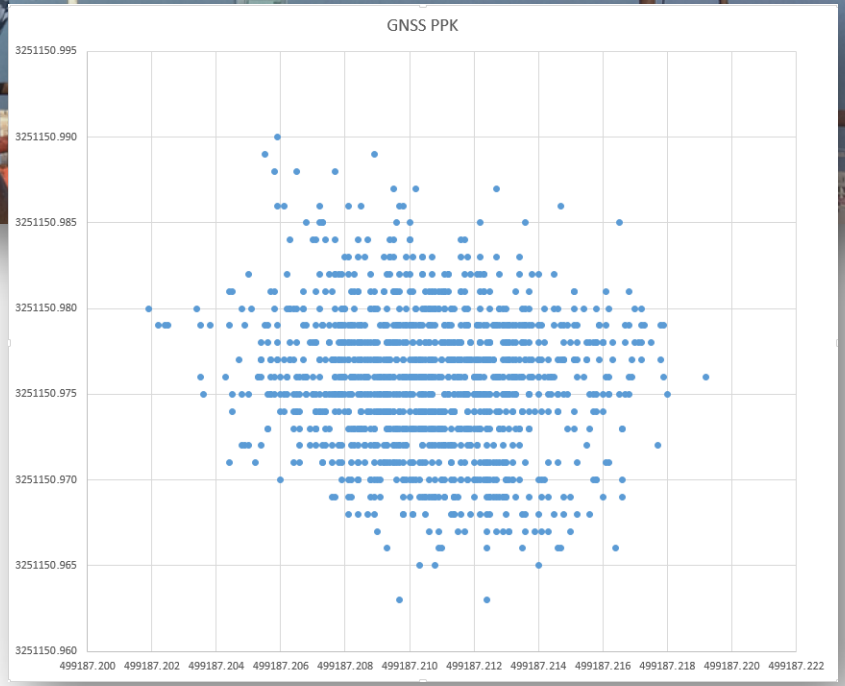


Target Residuals

Point ID	dHz	dDist	dE	dN	dH	Use
B	0° 00' 02.9"	-0.0059 m	0.0045 m	-0.0049 m	-	2D
H	-0° 00' 04.0"	0.0003 m	-0.0027 m	0.0029 m	-	2D
3	0° 00' 55.0"	-0.0015 m	-0.0030 m	0.0015 m	-	2D
2	0° 00' 46.2"	0.0011 m	-0.0030 m	-0.0023 m	-	2D
1	-0° 00' 57.4"	0.0048 m	0.0042 m	0.0028 m	-	2D

Setup Results

Station ID:	25		
Easting:	499181.6600 m	Sd. E:	0.0030 m
Northing:	3251149.4152 m	Sd. N:	0.0026 m
Height:	4.7620 m	Sd. Hgt:	0.0000 m
Use scale:	No		
Calculated scale:	-		
Orientation:	344° 52' 52.2"		
Apply scale to survey obs:	No		



Une mesure “Zero baseline” consiste à connecter 2 x récepteurs GNSS sur la même antenne en utilisant un “splitter”.

Normalement les résultats de la ligne de base doivent être “zéro” (dX, dY, dZ). Ce qu’il en reste ce sont les “bruits de fond”...

LGO Processing

STATION	Mode	Data	X WGS-84	Y WGS-84	Z WGS-84	Precision
REFERENCE	Reference	08/25/2015 13:32:04	499201,2884	3251064,9791	21,9383	2,2287
M300Pro	Measured	08/25/2015 15:16:00	499224,4270	3251077,9130	18,9155	0,0003
GRX1200	Measured	08/25/2015 15:23:01	499224,4272	3251077,9129	18,9182	0,0003
			-0,0002	**0,0001**	**-0,0027**	

Il n'y a aucune différence significative entre la ligne de base "REFERENCE – LEICA" et la ligne de base "REFERENCE – M300 Pro".

Ce test a démontré au consultant que nous pouvions valablement établir une station de référence SinoGNSS M300 PRO et supporter toutes les opérations réalisées avec les récepteurs Leica GNSS GRX1200.

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MERCI POUR VOTRE ATTENTION !