SERVICE
DE GEODESIE
ET NIVELLEMENT

J-C. Poyard

Rattachement ITRF à Dionysos

Dionysos ITRF co-location survey

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Mots-clé

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Résumé

L'ITRF2008, dernière réalisation de l'International Terrestrial Reference System menée par le Laboratoire de Recherche en Géodésie (LAREG) de l'IGN, est le résultat de la combinaison des référentiels terrestres issus des quatre techniques de géodésie spatiale (c'est à dire GNSS, SLR, DORIS et VLBI). Un moyen d'améliorer les réalisations consiste à ajouter dans la combinaison les résultats de rattachement sur des sites co-localisés. Dionysos (Grece) a été un important site de mesures laser dans le passé. Il dispose actuellement d'une station DORIS et de stations GNSS permanentes. Le présent rapport décrit le rattachement de précision réalisé lors de la mission d'installation de la station GNSS du réseau REGINA.

Matériel

Système d'exploitation	**Logiciel**
Mac OS X	Word 2008 pour Mac version 12.2.3

Validation

	Fonction	**Nom**	**Visa**
Commanditaire	Chef de l'unité RSI	Bruno Garayt	03/01/2012 – signé
Rédacteur principal	Responsable de production	Jean-Claude Poyard	04/10/2011 – signé
Correcteur	Responsable SIRS DORIS	Jérôme Saunier	28/11/2011 – signé
Correcteur	Responsable opérations REGINA	Charles Velut	25/11/2011 – signé
Approbateur	Chef de service	Alain Harmel	02/04/2012 – signé
Vérificateur	Responsable qualité	Thierry Person	03/04/2012 – signé

Diffusion

Organisme, service	Nom	Numérique	Papier
IGN / DG	Alain Perret	oui	-
IGN / DPR	Philippe Gerbe	oui	-
IGN / DPR	Didier Moisset	oui	-
IGN / MODSP	François Becirspahic	oui	-
IGN / SG / SDOG / CDOC	Richard Grimm	oui	-
IGN / DT / SR / LAREG	Olivier Jamet	oui	-
IGN / ENSG / DPTS	Serge Botton	oui	-
IGN / DPR / SGN	Alain Harmel	oui	-
IGN / DPR / SGN	Responsable qualité / Thierry Person	oui	-
IGN / DPR / SGN / PMC	Responsable documentation / Xavier della Chiesa	non	3
IGN / DPR / SGN / PMT	Responsable produits / François L'Ecu	oui	-
IGN / DPR / SGN	Chefs de départements	oui	-
IGN / DPR / SGN	Bruno Garayt	non	1
IGN / DPR / SGN	Jérôme Saunier	oui	-
IGN / DPR / SGN	Charles Velut	oui	-
IGN / DPR / SGN	Jean-Claude Poyard	non	1
IGN / DT / SR / LAREG	Zuheir Altamimi	non	1
IGN / DT / SR / LAREG	Xavier Collilieux	oui	-
CNES	REGINA operation	oui	-
CNES / DCT / ME / OT	François Boldo	oui	1
CNES / DCT / ME / OT	Cédric Tourain	oui	1
NTUA	Jordan Galanis	oui	1
NTUA	Demitris Paradissis	oui	-

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INTRODUCTION

The International Terrestrial Reference Frame (ITRF) is the result of a combination of different terrestrial reference frames provided by the four space geodetic techniques (i.e. GNSS, SLR, DORIS and VLBI). To perform this combination between independent reference frames, it is necessary to have some co-location sites where the various techniques are operating, from which tie vectors between their reference points have been surveyed in three dimensions.
One way to improve the ITRS realization consists in surveying sites where ties are inconsistent or in adding some co-location sites in the combination.
Dionysos (Greece) was an important site of laser measurements in the past. Currently, a DORIS station and two permanent GNSS stations are operating for several years. With the installation of a new GNSS station part of the REGINA network, it was decided to survey reference points of these different space geodetic techniques.

This document presents the Dionysos local tie survey, which took place in May 2011, from the observations on site to the computation, with as many details as necessary.

ACKNOWLEDGEMENTS

We would like to acknowledge the National Technical University of Athens for his involvement for many years in the DORIS project and now in the REGINA one. I would also add a special thank to Jordan Galanis for his very warmly welcome, for the equipment management and his precious help during the survey work and the REGINA's GNSS station installation.

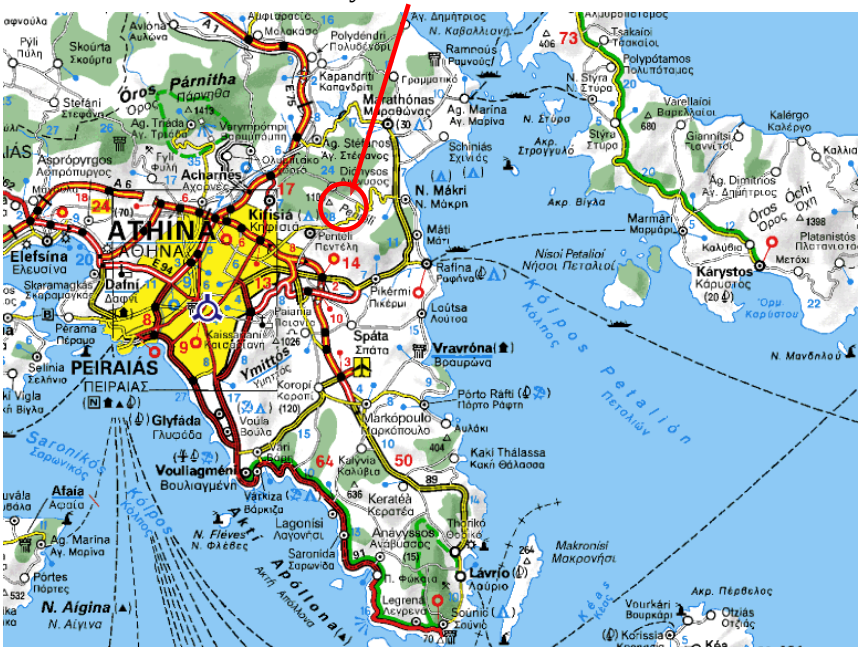
1 CO-LOCATION SITE DESCRIPTION

Dionysos Satellite Observatory is located by 38° N & 24° E, about 25 km to the north-east of Athens, not far away from the well-known Marathon site. The site in the slopes of mount Penteli is at an altitude of 480 meters (site pictures in appendix 6.1). His purpose is to serve the educational and research needs of the School of Rural and Surveying Engineering, at both pre and post graduate level, in the fields of geodesy.

On a geodetic point of view, Dionysos can be considered as a three space geodetic techniques site. Indeed there are :

- three GNSS stations
- a DORIS station
- at least two former laser ranging station reference points

Dionysos site location



(Source : ViaMichelin)

Dionysos site overview

(Photo : 2006)

2 CO-LOCATED POINTS

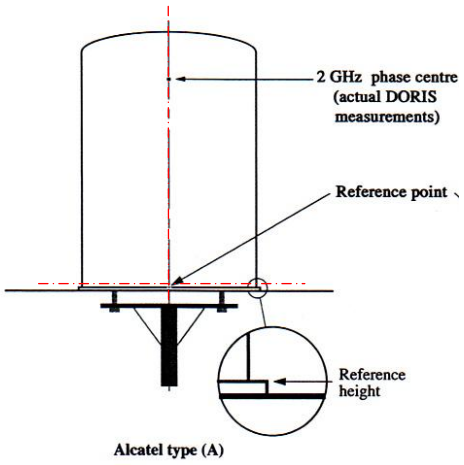
2.1 DORIS station

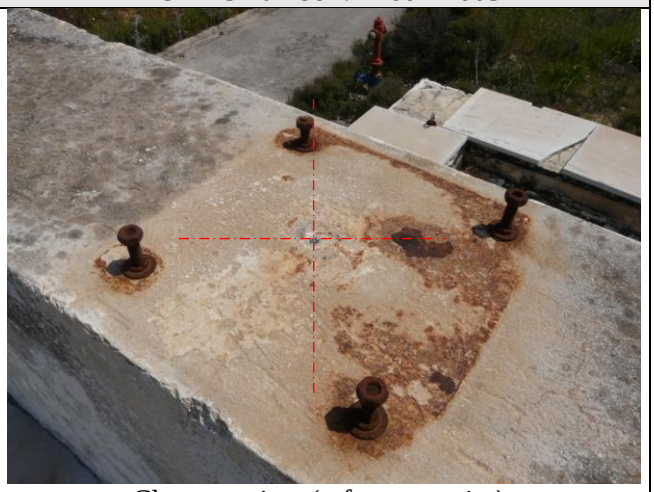
The first DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) station "DIOA" was initially set up in February 1989. The DORIS Alcatel antenna was on a guyed 2 m height tower on top of a load-bearing wall of a one-storied building. In May 2006, the station was upgraded and the new DORIS antenna moved to a 30 cm sided 1 m high very rigid metal tower. This new DORIS reference point "DIOB" is on top of a load-bearing wall of the same building (appendix 6.2).

The different DORIS reference points have been associated with distinct acronyms and DOMES numbers as summarized below :

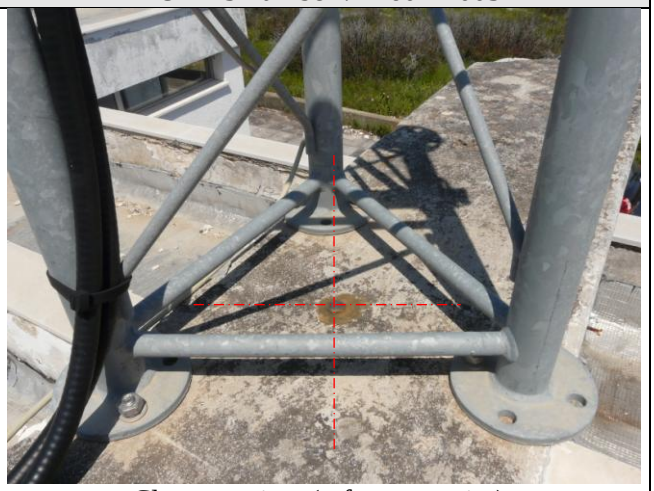
Acronym	DOMES number	Antenna / Support	Period
DIOA	12602S011	Alcatel / 2 m guyed tower	From Feb. 1989 to May. 2006
DIOB	12602S012	Starec / 1 m height very rigid tower	From May 2006 till now
DORIS mark	12602M003	Brass mark 12 mm in diameter	From Feb. 1989 till now
DORIS 2 mark	12602M005	Domed hexagonal brass mark	From May 2006 till now

NB : DIOA doesn't exist anymore but his position has been tied in the past to the DORIS mark.

Acronym : DIOA **(former point)**	DOMES number : 12602S011
 General view	 Sketch of reference point
Description : DORIS antenna reference point (Alcatel type) **(destroyed point)**.	

Acronym : DORIS mark	DOMES number : 12602M003
	
General view	Close-up view (reference point)
Description : DORIS mark.	

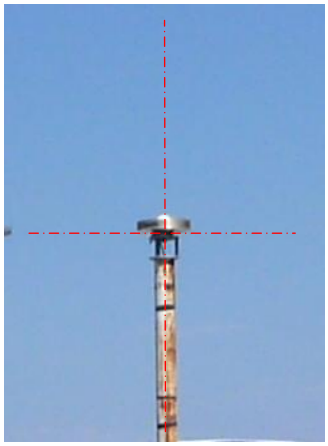
Acronym : DIOB	DOMES number : 12602S012
	
General view	Close-up view (reference point)
Description : DORIS antenna reference point (Starec type).	

Acronym : DORIS 2 mark	DOMES number : 12602M005
	
General view	Close-up view (reference point)
Description : DORIS 2 domed brass mark on concrete wall.	

2.2 GNSS stations

2.2.1 DION permanent station

This GNSS station (not part of the IGS network) is continuously operating since June 1995. It has been upgraded in October 1996 and December 2001 (appendix 6.3).

Acronym : DION	DOMES number : 12602M004
 General view	 Reference point
Description : EUVN GPS marker. Antenna height is **0.000 m**.	

The tie with the DORIS antenna has been surveyed by GPS technique in May 2006 *(cf. report CR/G 211 SGN n°28151 "Rénovation de la station DORIS de Dionysos").*

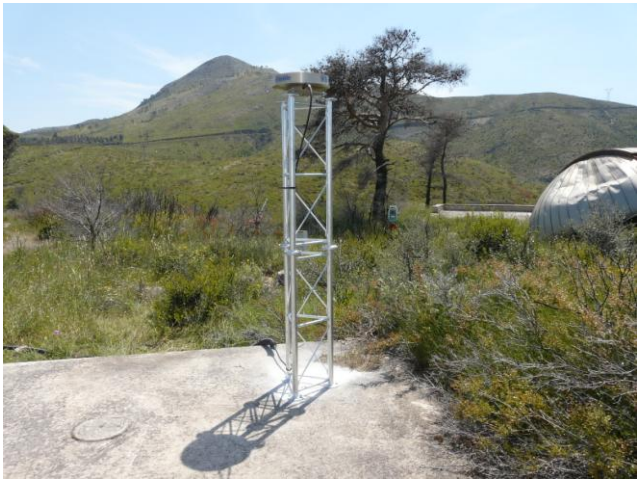
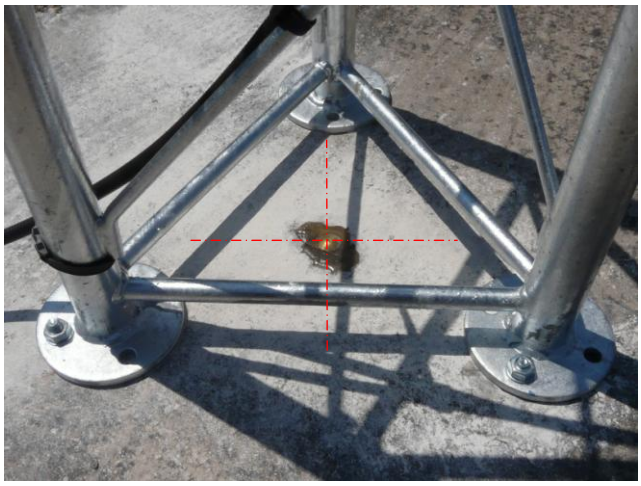
2.2.2 DIOP permanent station

This GNSS station set up in collaboration with the Oxford University is continuously operating since 2008.

Acronym : DIOP	DOMES number : 12602M001
 General view	 Close-up view (reference point)
Description : axis of device and level of the concrete surface of the pillar. Antenna height is **0.110 m** above the ITRF reference point.	

2.2.3 REGINA GNSS station DYNG

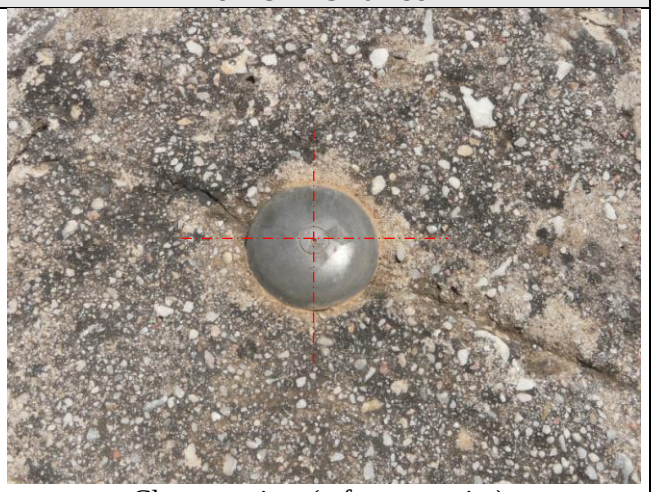
This GNSS station, part of the REGINA network, has been installed on May 10, 2011.

Acronym : DYNG	DOMES number : 12602M006
	
General view	Close-up view (reference point)
Description : marker embedded in the former concrete laser pad. The reference point is **2.018 m below the ARP**.	

2.3 Laser Ranging station

A main point and several auxiliary points have been tied to a mobile laser station in the early nineties. We surveyed during our work only the two following points.

Acronym : 7515A	DOMES number : 12602M002
	
General view	Close-up view (reference point)
Description : (mark) SLR standard WEGENER disk embedded in the concrete laser pad.	

Acronym : 7515C	no DOMES number
	
Global view	Close-up view (reference point)
Description : (mark) SLR standard WEGENER disk embedded in the concrete laser pad	

3 SURVEY DESCRIPTION

3.1 Organization

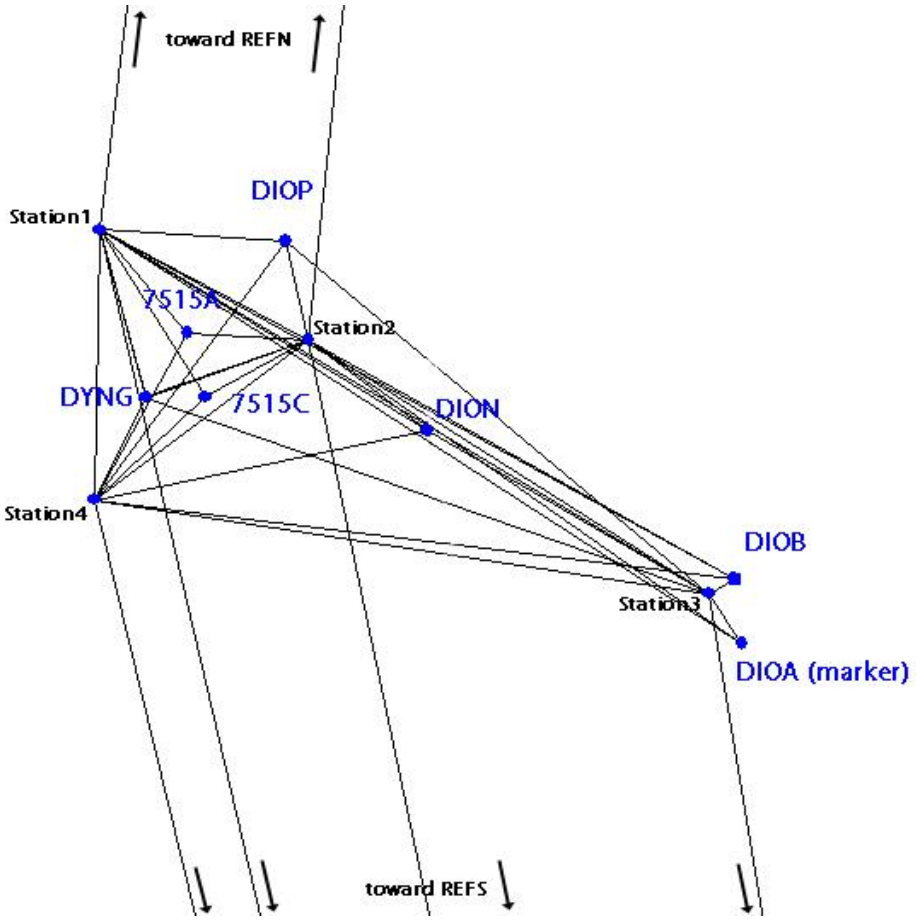
I carried out the local ties survey from the 10th to the 12th of May 2011, with the friendly cooperation of Jean-Paul Cardaliaguet (CNES) and Jordan Galanis (NTUA).
All the topometric survey instruments and equipments belong to IGN and were sent for the purpose of this survey.

3.2 Equipment (Instruments)

A Leica tacheometer (TCRA1201) was used for this work. This instrument, which is regularly calibrated by IGN's equipment control unit, was associated with two Leica accurate prisms. It has a standard deviation of 0.3 mgon for horizontal and vertical angles and 1 mm + 1 ppm for distances. The GPS observations were done with a Leica 1200 receiver and a Trimble Zephyr Geodetic antenna (without radome). Concerning the permanent GNSS station DION, the receiver is a Trimble 4000SSI and the current antenna is a Trimble Dorne Margolin (TRM29659.00) without radome.
All these instruments allowed the observations to be recorded electronically on memory cards or storage devices and were then downloaded to a laptop PC for checking.

3.3 Dionysos observations polygon

All the survey was conducted in order to provide the highest accuracy in the determination of the 3D vectors between the observing reference points. Hereafter is the Dionysos observations polygon.



3.4 Survey method

All the visible lines of sight were observed with the tacheometer. Horizontal directions and zenith angles were observed in data sets, each set consisting in one reading in both direct and reverse theodolite positions. Distance measurements were observed at least once over each line. Meteorological data (atmospheric pressure and temperature), used to correct the distances, were recorded at the beginning of each station occupation.
Two stations were determined by GPS technique and used to get the polygon bearing.

3.4.1 Antennas reference points

As our strategy was to keep in place the DORIS or GNSS antennas (i.e. DIOB, DION), their reference point had to be determined indirectly.

For the planimetric position :
From each survey station aiming at the antennas, the right and left sides of the antenna theoretically centered on the antenna reference point (ARP) were observed. This element was chosen so that it is optically well defined for the operator, and in the adjustment, horizontal angle observations were simply averaged to get its planimetric position.
For the altimetric position :
Vertical angles have been measured on a well-defined element of the antenna. Then, the resulting position has been reduced to the reference point using the manufacturer values, and some centering equations have been included in the adjustment.

3.4.2 Verticality check and centering equation

Using a theodolite the verticality of the "theoretical" antenna reference points were measured with respect to the corresponding marker. The results of this eccentricity combined with the height above the marker form the centering equations. The GNSS position DYNG is exactly above the marker. DIOP verticality has not been checked.

3.4.3 GPS observations

GPS observations have been carried out on the two reference points "REFN" and "REFS" with a Leica 1200 receiver associated with a Trimble Zephyr antenna (TRM41249.00 without radome).

The following table sums up the GPS observations.

Point	Start (UT)	End (UT)	Ant. Height (m)	Ant. Type
DION	Daily RINEX file DOY 131&132		0,000	TRM29659.00
REFS	DOY 131 06 : 30	DOY 131 12 : 05	0,000	TRM41249.00
REFN	DOY 132 07 : 20	DOY 132 12 : 40	0,000	TRM41249.00

None of the antennas was equipped with a radome. All antenna heights are related to the antenna reference point (ARP). As we're just interested in the planimetric position, antenna heights are set to nought.

4 COMPUTATIONS

4.1 On-site validation

The theodolite observations were checked on site in order to detect any problem in the observations.

4.2 GPS network

Back to the office, the GPS baselines were processed with BERNESE v5.0 Software. This software incorporates the movements of the poles, information on satellites, the FES2004 ocean overload model, the absolute antenna offset and phase variation models (igs08.atx). In addition, this software precisely models tropospheric parameters. In our case, the GPS observations of the ten nearest stations from the IGS network were used.
The result allows us to determine the bearings from DION toward the two references REFS and REFN.

4.3 Global Adjustment

The final computation is carried out by a 3D Least Squares Adjustment with the Microsearch GeoLab 2001 version 2001.9.20.0 software. The input file (see appendix 6.5) comes from :

- Theodolite observations : horizontal and zenith angles, distances.
- Centering equations : relative position between points.
- Azimuths toward references issued from the GPS baselines process.
- DIOB coordinates are constrained at 1 mm to its ITRF2008 (epoch 2011:131) values.

The a priori standard deviations used for the different observations with tacheometers are :

- 0.8 mgon for horizontal angles
- 1.2 mgon for vertical angles
- 1mm for distances on prism

These are the values used for most of the targets in our Microsearch GeoLab computation input file.
This adjustment provided coordinates and a covariance matrix of our survey work (appendix 6.6).

5 RESULTS

5.1 Station name translation table

The following list sums up the most interesting points used in the Microsearch GeoLab input file with the main points in bold (appendix 6.4).

Point Description	Used name or code	Computation name
DORIS station • **DIOB Antenna Reference Point** • DORIS 2 mark / domed brass mark • DORIS mark / 12 mm in diameter	 **12602S012** 12602M005 12602M003	 **DIOB** DIOB_m DIOA_m
GNSS permanent station • **DION / EUVN GPS Marker** • DIOP_arp / "Oxford University" GPS • **DIOP / axis&concrete surface level** • **DYNG / hexagonal domed brass mark**	 **12602M004** - **12602M001** **12602M006**	 **DION** DIOP_arp **DIOP** **DYNG**
Laser Ranging Mobile Station • **Mark SLR Standard WEGENER disk** • Mark SLR Standard WEGENER disk	 **12602M002** -	 **7515A** 7515C

5.2 Adjusted coordinates and confidence regions

The results of the adjustment are the coordinates of all points as well as their confidence ellipsoids in the ITRF2008 at the mean epoch of the observations (i.e. epoch 2011:131).
The table below provides the 3D coordinates and confidence region at 95% of the points of interest.

```
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0004
================================================================================
Adjusted XYZ Coordinates:
                          X-COORDINATE       Y-COORDINATE       Z-COORDINATE
 CODE FFF STATION              STD DEV            STD DEV            STD DEV
 ---- --- ------------ ------------------ ------------------ ------------------
 XYZ      7515A              4595216.4992       2039435.5563       3912629.3390 m       0
                                    0.0012             0.0012             0.0012
 XYZ      7515C              4595218.3920       2039437.7084       3912626.0242 m       0
                                    0.0012             0.0012             0.0012
 XYZ      DIOA_m             4595213.6903       2039474.8711       3912613.5644 m       0
                                    0.0012             0.0013             0.0012
 XYZ      DIOB               4595212.4970       2039473.7500       3912617.8460 m       0
                                    0.0011             0.0011             0.0011
 XYZ      DIOB_2GHz          4595211.1913       2039473.1696       3912616.7277 m       0
                                    0.0009             0.0022             0.0011
 XYZ      DIOB_m             4595211.4635       2039473.2934       3912616.9601 m       0
                                    0.0012             0.0012             0.0011
 XYZ      DION               4595216.4960       2039453.0835       3912626.7108 m       0
                                    0.0012             0.0013             0.0012
 XYZ      DION_bcr           4595216.5212       2039453.0947       3912626.7324 m       0
                                    0.0012             0.0013             0.0012
```

XYZ	**DIOP**	4595212.6098	2039441.0068	3912636.1130	m	0
		0.0016	0.0017	0.0016		
XYZ	DIOP_arp	4595212.6889	2039441.0420	3912636.1808	m	0
		0.0012	0.0012	0.0012		
XYZ	**DYNG**	4595220.0157	2039434.0890	3912625.9959	m	0
		0.0012	0.0012	0.0012		
XYZ	DYNG_bcr	4595221.4930	2039434.7442	3912627.2620	m	0
		0.0012	0.0012	0.0012		

```
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0019
================================================================================
```

2-D and 1-D Station Confidence Regions (95.000 and 95.000 percent):

STATION	MAJOR SEMI-AXIS	AZ	MINOR SEMI-AXIS	VERTICAL
7515A	0.0030	82	0.0029	0.0022
7515C	0.0030	75	0.0029	0.0023
DIOA_m	0.0032	132	0.0029	0.0022
DIOB	0.0028	90	0.0028	0.0022
DIOB_2GHz	0.0058	113	0.0029	0.0000
DIOB_m	0.0029	60	0.0028	0.0022
DION	0.0033	112	0.0030	0.0024
DION_bcr	0.0032	112	0.0029	0.0023
DIOP	0.0041	80	0.0040	0.0032
DIOP_arp	0.0030	80	0.0029	0.0023
DYNG	0.0030	70	0.0029	0.0022

The whole covariance matrix was computed and a submatrix with the 7 main points of interest i.e. 7515A, DIOA_m, DIOB, DIOB_m, DION, DIOP and DYNG was extracted. Finally, this covariance submatrix was converted into the SINEX format using the “geotosnx” tool provided by Z. Altamimi. The resulting SINEX file (12602_IGN_2011-131.SNX) is presented in appendix 6.7.

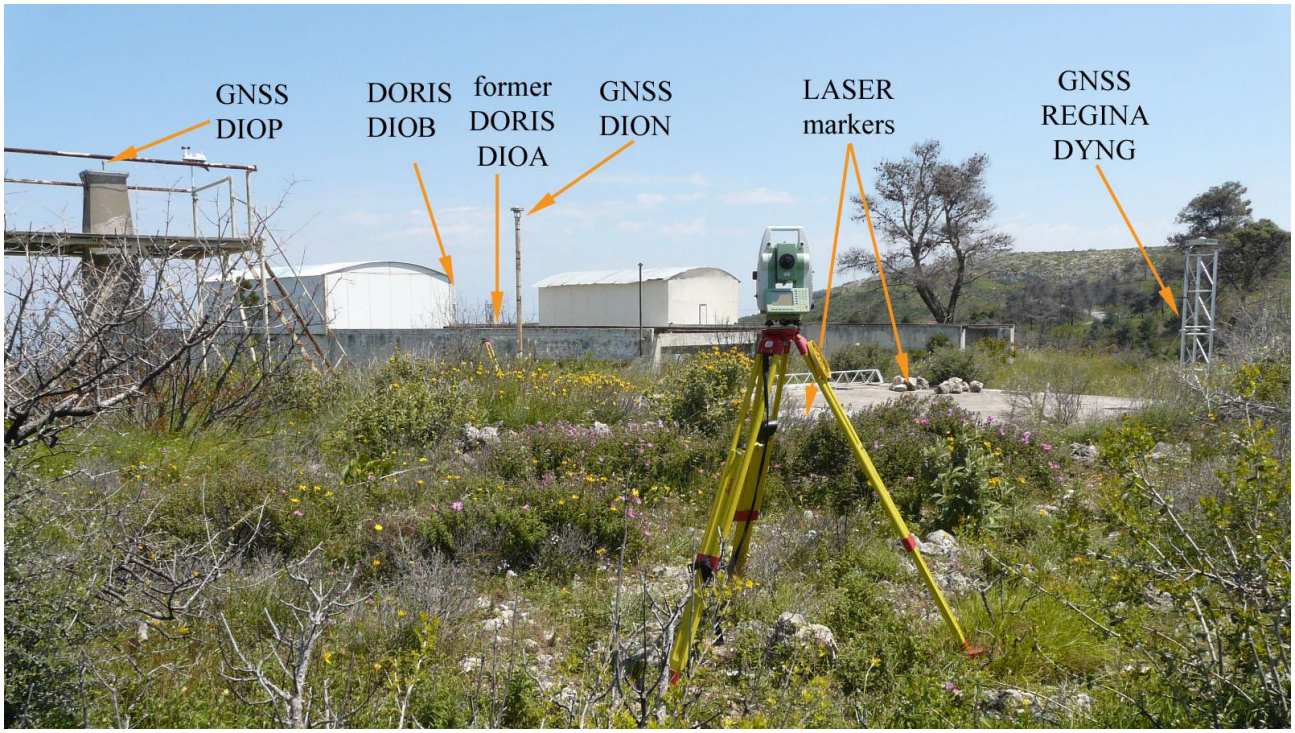
6 APPENDIXES

6.1 Appendix 1 : site pictures

Dionysos site overview

(photo: J. Galanis)

Dionysos colocated points



6.2 Appendix 2 : "DIOB" DORIS station sitelog (extract)

Note : only the most relevant points to this survey were retained in the following extract.
The complete version of this site log is available at : http://ids-doris.org/network/sitelogs.html

```
DIONYSOS DORIS site description form

0. Form

   Prepared by       : SIMB (DORIS installation and maintenance department)
   Date prepared     : 9/12/2008
   Report type       : UPDATE

1. Site location information

   Site name               : DIONYSOS
   Site DOMES number       : 12602
   Host agency             : National Technical University of Athens
   City                    : Dionysos
   State or province       :
   Country                 : GREECE
   Tectonic plate (PB2002) : Eurasia
   Geological information  :

   Geographical coordinates (ITRF) :
          North Latitude   :   38 deg  4' 42''
          East Longitude   :   23 deg 55' 58''
          Ellipsoid height :  514 m
   Approximate altitude    :

2. DORIS antenna and reference point information

2.1
   Four character ID        : DIOA
   Antenna model            : Alcatel
   Antenna serial number    : 47
   IERS DOMES number        : 12602S011
   CNES/IGN number          : 126021
   CTDP number              : 47
   Date installed (dd/mm/yy): 15/02/1989
   Date removed (dd/mm/yy)  : 16/05/2006
   Antenna support type     : Guyed 2 metre tower
   Installed on             : Top of a load-bearing wall of a 1 storied
                            : building.
   Height above ground mark : 2.195 m
   Ground mark type         : Brass mark 12 mm diameter
   Ground mark DOMES number : 12602M003
   Notes                    :

2.2
   Four character ID        : DIOB
   Antenna model            : Starec 52291 type
   Antenna serial number    : 129
   IERS DOMES number        : 12602S012
   CNES/IGN number          : 126022
   CTDP number              : 271
   Date installed (dd/mm/yy): 17/05/2006
   Date removed (dd/mm/yy)  :
   Antenna support type     : 30 cm sided very rigid metal tower, 1 m high
   Installed on             : Top of a load-bearing wall of a 1 storied
                            : building, 4 m high above the ground
   Height above ground mark : 1.434 m
   Ground mark type         : Domed brass screw
   Ground mark DOMES number : 12602M005
   Notes                    :

3. DORIS beacons information

(…)

4. ITRF coordinates and velocities of the current DORIS ref. point (DIOB)

   Solution : ITRF2005 (tie to DIOA)
   Epoch    : 2000.0
```

```
   X = 4595212.456 m     Y = 2039473.647 m     Z = 3912617.934 m
   Sig X = 0.002 m        Sig Y = 0.002 m       Sig Z = 0.002 m

   VX = 0.0053 m/y        VY = 0.0082 m/y       VZ = -0.0086 m/y
   Sig VX = .0005 m/y    Sig VY = .0006 m/y   Sig VZ = .0004 m/y

5. IERS co-location information

6. Tide gauge co-location information

7. Local site ties

7.1
   Point description      : DORIS Alcatel antenna reference point (DIOA)
   DOMES number           : 12602S011

   Differential components from the current DORIS ref. point (DIOB)
   to the above point (in the ITRS) :
                  dX (m) : 2.783
                  dY (m) : 1.776
                  dZ (m) : -2.911
   Accuracy (m)           : 0.001
   Date measured          : May 2006
   Additional information : Survey by IGN-F and NTUA

8. Meteorological Instrumentation

(…)

9. DORIS network contacts

   Primary contact:

(…)

   Secondary contact:

   Name                : Francois BOLDO
   Agency              : Institut Geographique National
   Mailing address     : CNES (DCT/ME/OT)
                       : 18 Avenue Edouard BELIN
                       : 31401 TOULOUSE Cedex    FRANCE
   Telephone           : + 33 5 61 27 40 72
   Fax                 : + 33 5 61 28 25 95
   E-mail              : Simb.Doris@cnes.fr
```

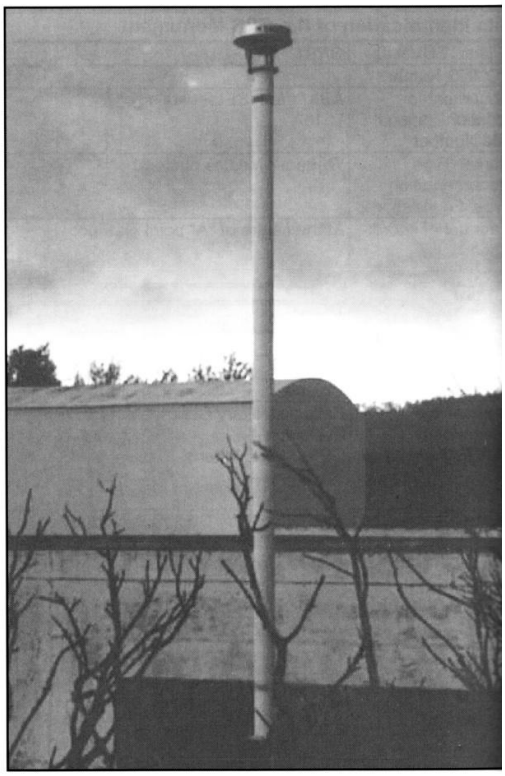
6.3 Appendix 3 : "DION" GNSS station sitelog (extract)

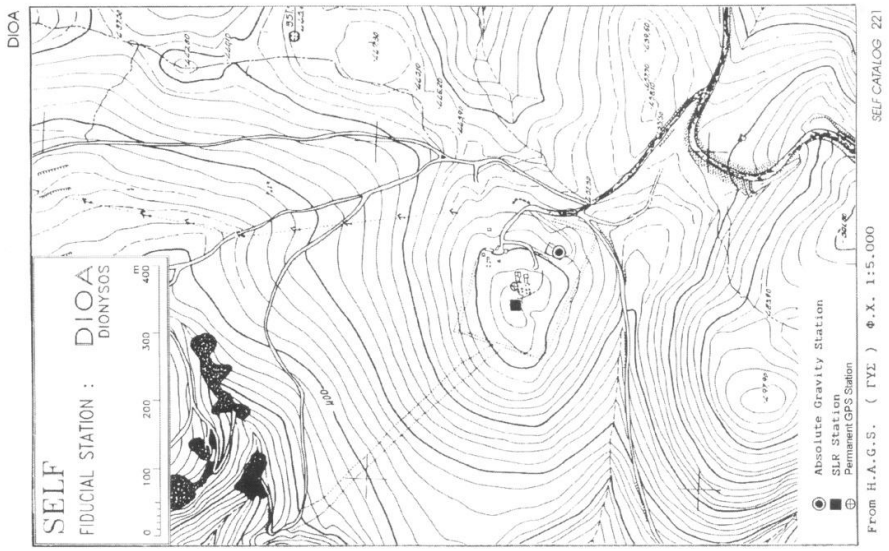
European Vertical GPS Reference Network (EUVN)

Station Dionysos

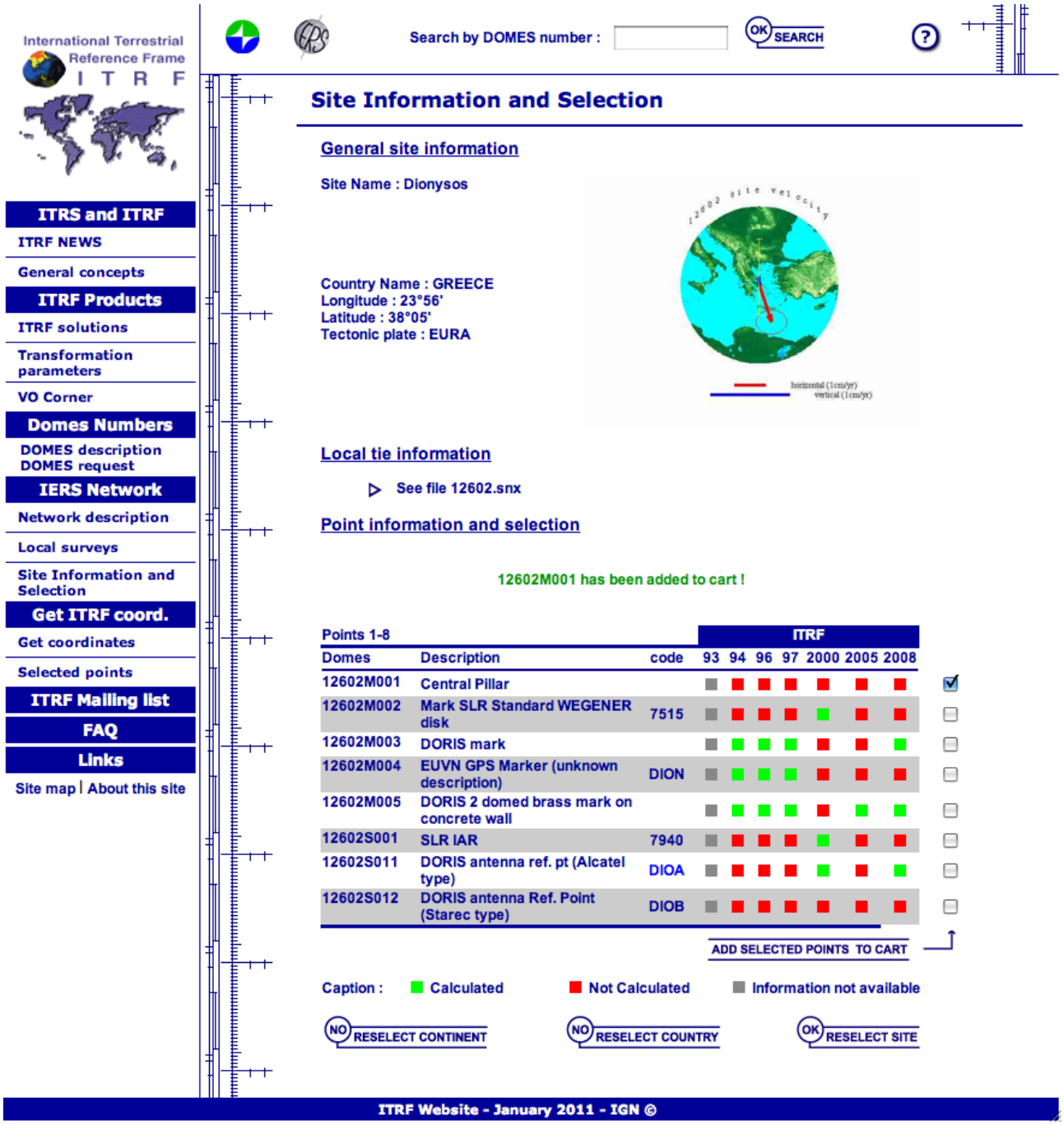
Site Identification of the GPS Monument	
4-Char. EUVN ID	DION
DOMES Number	
Monument Inscription/National Site Number	DION GPS
Marker Type, Monumentation Type, Foundation	Permanent GPS station
Mark dot of coordinates	At the top of post-pole

Site Location Information	
City or Town	Dionysos
State or Province	Athens
Country	Greece
Responsible Agency (Full Address)	National Technical University of Athens Higher Geodesy Lab H. Polytechniou 9 GR – 15780 Zographos Greece
Contact Agency Information	National Technical University of Athens Higher Geodesy Lab H. Polytechniou 9 GR – 15780 Zographos Greece
Coordinates in ETRS89, Epoch 97.4	X = 4595216.632 m Y = 2039452.852 m Z = 3912626.688 m
Height in UELN-95/98	475.593 m
Gravity in ISGN71	979 958.521 mgal





6.4 Appendix 4 : list of points (ITRF website)



6.5 Appendix 5 : adjustment input file

```
 TITL DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
 COMP ADJ
 ELIP GRS80              6378137.0000  6356752.3141      0.0      0.0      0.0
 MAXI         15
 CONF YES YES YES YES NO
 PSOL NO  YES
 PMIS NO  NO
 PRES YES NO
 PADJ NO  NO  YES NO  YES NO  NO  NO
 VARF YES YES NO
 RTST TAU MAX
 LUNT m    1.000000000000
 CONV    0.00010
 CLEV     95.000
 ANGT GRD
 LDEC 4


*****************************************************************************************************************
*                                  ITRF ACRONYMS, n° DOMES  and  POINTS DESCRIPTION                             *
*****************************************************************************************************************

*DORIS
*DIOB   : (DOMES 12602S012) = DORIS Ant. Ref. Pt. (Starec type)
*DIOA_m : (DOMES 12602M003) = DORIS mark (12mm in diameter below the former DIOA)
*DIOB_m : (DOMES 12602M005) = domed brass mark on concrete wall (hexagonal screw)

*FORMER DORIS POINTS
*(destroyed point) DIOA : (DOMES 12602S011) = DORIS Ant. Ref. Pt. (Alcatel type)

*PERMANENT GNSS STATIONS
*DION : (DOMES 12602M004) = EUVN GPS MARKER (on top of a mast)
*DION_bcr : bottom of Choke Ring (i.e. 0.035 m above ARP)
*DIOP_arp : (no DOMES number) = ARP of the Oxford University Ant. = Top of screwed device on top of CONCRETE
PILLAR
*         0,110 m above DIOP
*DIOP : (DOMES 12602M001) = Axis and level of the concrete surface of the pillar
*DYNG : (DOMES 12602M006) =  Marker 2.018 m below the GNSS REGINA antenna (axis and base)
*DYNG_bcr : bottom of Choke Ring (i.e. 0.035 m above ARP and 2.053 above marker)


*GEODETIC SLR POINT
*7515A : (DOMES 12602M002) = Mark SLR Standard WEGENER disk
*7515C : (no DOMES number) = Mark SLR Standard WEGENER disk


*****************************************************************************************************************
*                              LIST OF POINTS for the SURVEY ADJUSTMENT                                         *
*****************************************************************************************************************

*POINTS OF INTEREST
*7940  : (12602S001) = no mark = not available

*TEMPORARY MARKS or TEMPORARY STATIONS
*100 200 300 400 Temporary stations on tripod (light tripod)


*REFN  : temporary Point to the north (916m) determined by GPS and used for the bearing (ARP)
*REFS  : temporary Point to the south (540m) determined by GPS and used for the bearing (ARP)


*no spirit levelling done


**********************AZIMUT DEDUCTED FROM THE GPS DETERMINATION*****************************
 AZIM     DION         REFN                        6 14    53.0      0.002
 AZIM     DION         REFS                      187 48    13.0      0.003
***********************************POINTS COORDINATES*****************************************

*FORCED ITRF2008 EPOCH 2011:131 COORDINATES
 3DC
 XYZ  000 DIOB                4595212.497        2039473.750        3912617.846
 COV  CT DIAG                     1
 ELEM               0.000001               0.000001               0.000001


*****************************APPROXIMATE COORDINATES*****************************************
 PLH  000 100          n 38  4 43.152780 e 23 55 56.636060     511.9701
 PLH  000 200          n 38  4 42.914418 e 23 55 57.208830     511.5615
 PLH  000 300          n 38  4 42.367227 e 23 55 58.306036     511.9691
 PLH  000 400          n 38  4 42.570543 e 23 55 56.621649     511.2791
 PLH  000 DION         n 38  4 42.720067 e 23 55 57.534156     514.5430
 PLH  000 DYNG         n 38  4 42.791675 e 23 55 56.763207     512.5873
 PLH  000 REFN         n 38  5 12.237014 e 23 56  1.150375     457.9648
 PLH  000 REFS         n 38  4 25.518049 e 23 56  1.869342     543.4010


***********************************CENTRING EQUATIONS*****************************************

 3DD
 PLH  000 DION_bcr     n 38  4 42.720000 e 23 55 57.534000     514.5350
 PLH  000 DION         n 38  4 42.720000 e 23 55 57.534000     514.5000
 COV  LG DIAG
```

```
 ELEM              0.00000009              0.00000009              0.00000009

*DYNG_bcr is 2.018 + 0.0350 = 2.053 m above the marker DYNG
 3DD
 PLH  000 DYNG_bcr      n 38  4 42.791700 e 23 55 56.763200     512.0530
 PLH  000 DYNG          n 38  4 42.791700 e 23 55 56.763200     510.0000
 COV  LG DIAG
 ELEM              0.00000009              0.00000009              0.00000009

 3DD
 PLH  000 DIOB          n 38  4 42.399400 e 23 55 58.375158     512.4340
 PLH  000 DIOB_m        n 38  4 42.399400 e 23 55 58.375200     511.0000
 COV  LG DIAG
 ELEM              0.00000025              0.00000025              0.00000025

 3DD
 PLH  000 DIOP_arp      n 38  4 43.129400 e 23 55 57.145500     514.1100 m       0
 PLH  000 DIOP          n 38  4 43.129400 e 23 55 57.145500     514.0000 m       0
 COV  LG DIAG
 ELEM               0.000001                0.000001                0.000001


*Tours d'horizon
 SIGM AH       8.0
 HIST NEW
 DSET AH
 DIR      400          REFS                      0  0     0.0
 DIR      400          100                     216 46    52.1
 DIR      400          DYNG_bcr                245 00    38.0
 DIR      400          DYNG                    245  0    88.8
 DIR      400          7515A                   247 78     0.9
 DIR      400          7515C                   267 71    71.0
 DIR      400          DIOP_arp                255 81    83.0
 DIR      400          200                     274 60     1.6
 DIR      400          DION_bcr                302 17    18.6
 DIR      400          DIOB_2GHz               323  1    60.1
 DIR      400          DIOB                    323 01    68.9
 DIR      400          300                     324 83    77.1
 DIR      400          DIOB_m                  323  1    83.7
 DSET AH
*DIR      400          2000                      0  0     0.0
 DIR      400          REFS                     14 24    73.6
 DIR      400          DIOB                    337 26    66.8
 DSET AH
*DIR      100          2000                      0  0     0.0
 DIR      100          REFS                     14 28    90.8
 DIR      100          400                      30 23    15.3
 DIR      100          DYNG_bcr                 11 72    58.3
 DIR      100          DYNG                     11 72    40.5
 DIR      100          7515A                   384  9    42.4
 DIR      100          7515C                   392 91    39.4
 DIR      100          300                     363 13    68.4
 DIR      100          DION_bcr                363 81    62.5
 DIR      100          200                     359 82    75.1
 DIR      100          DIOP_arp                332 68    22.4
 DIR      100          DIOB_2GHz               360 87    54.0
 DIR      100          DIOB                    360 87    60.4
 DIR      100          DIOB_m                  360 87    60.7
 DIR      100          DIOA_m                  365 28    44.2          6
 DSET AH
*DIR      100          2000                      0  0     0.0
 DIR      100          REFS                     14 28    97.3
 DIR      100          REFN                    236 72    79.4
 DIR      100          DIOB                    360 87    69.7
 DSET AH
*DIR      200          2000                      0  0     0.0
 DIR      200          REFS                     15 12    64.9
 DIR      200          400                      87 82    11.3
 DIR      200          DYNG_bcr                107  6    87.6
 DIR      200          DYNG                    107  7     8.9
 DIR      200          7515C                    96 68    65.2
 DIR      200          7515A                   132  4    44.2
 DIR      200          DIOP_arp                213 91    38.7
 DIR      200          100                     159 28     3.3
 DIR      200          DION_bcr                369 60    88.9
 DIR      200          DIOB_m                  360 83    83.2
 DIR      200          DIOA_m                  367 17    75.8
 DIR      200          300                     364 24    19.4
 DIR      200          DIOB_2GHz               360 83    99.5
 DIR      200          DIOB                    360 84    11.6
 DSET AH
*DIR      200          2000                      0  0     0.0
 DIR      200          REFS                     15 12    58.8
 DIR      200          REFN                    235 15     5.3
 DIR      200          DIOB                    360 84    04.0
 DSET AH
*DIR      300          2000                      0  0     0.0
 DIR      300          REFS                     16 85    52.1
 DIR      300          400                     137  4    64.2
 DIR      300          DYNG_bcr                148 71    88.4
 DIR      300          100                     161 57    84.0
 DIR      300          200                     163 22    84.9
 DIR      300          DION_bcr                160 78    04.5
 DIR      300          DIOP_arp                171 53    27.7
 DIR      300          DIOB_m                  293 86    65.8
 DIR      300          DIOB                    293 81    88.1
 DIR      300          DIOB                    293 82    12.8
 DIR      300          DIOA_m                  389 81     0.0
```

```
HIST GEN Tours d'horizon

Zenithales

SIGM ZA        12.0
HIST NEW

HT       7515A              0.20
HT       7515C              0.20
HT       DIOA_m             0.20
HT       DIOB_m             0.20
HT       DYNG               0.20

ZANG ZA  400          100                       97 54    46.6
ZANG ZA  400          DYNG_bcr                  88 87    64.9
ZANG ZA  400          DYNG                     104 19    64.3
ZANG ZA  400          7515A                    102 52    64.0
ZANG ZA  400          7515C                    103 14    73.3
ZANG ZA  400          DIOP_arp                  92 53    76.4
ZANG ZA  400          200                       98 98    30.5
ZANG ZA  400          DION_bcr                  90 80    23.1
ZANG ZA  400          DIOB                      97 74    97.6
ZANG ZA  400          300                       98 93    86.7
ZANG ZA  400          DIOB_m                    99 57    50.7
ZANG ZA  400          DIOB                      97 74    80.9
ZANG ZA  100          400                      102 45    46.4
ZANG ZA  100          DYNG_bcr                  96 39    15.9
ZANG ZA  100          DYNG                     106 57     6.9
ZANG ZA  100          7515A                    108 37    64.0
ZANG ZA  100          7515C                    105 75    32.5
ZANG ZA  100          300                       99 99    99.5
ZANG ZA  100          DION_bcr                  93 53    55.6
ZANG ZA  100          200                      101 64    41.2
ZANG ZA  100          DIOP_arp                  90 68    68.9
ZANG ZA  100          DIOB                      98 90    68.9
ZANG ZA  100          DIOB_m                   100 53    51.0
ZANG ZA  100          DIOA_m                   100 49    10.3
ZANG ZA  100          DIOB                      98 90    60.7
ZANG ZA  200          400                      101  1    83.0
ZANG ZA  200          DYNG_bcr                  94 13    18.4
ZANG ZA  200          DYNG                     104 36    25.4
ZANG ZA  200          7515C                    106 33    98.9
ZANG ZA  200          7515A                    106 17    72.9
ZANG ZA  200          DIOP_arp                  79 73    10.1
ZANG ZA  200          100                       98 35    48.7
ZANG ZA  200          DION_bcr                  81 21    52.3
ZANG ZA  200          DIOB_m                    99 99    27.4
ZANG ZA  200          DIOA_m                    99 97    12.8
ZANG ZA  200          300                       99 17    66.2
ZANG ZA  200          DIOB                      97 57    91.7
ZANG ZA  200          DIOB                      97 57    80.1
ZANG ZA  300          400                      101  6    37.1
ZANG ZA  300          DYNG_bcr                  98 95    46.4
ZANG ZA  300          100                      100  0    16.5
ZANG ZA  300          200                      100 82    44.6
ZANG ZA  300          DION_bcr                  92 39    15.8
ZANG ZA  300          DIOP_arp                  96 83     8.9
ZANG ZA  300          DIOB_m                   112 95    51.8
ZANG ZA  300          DIOB                      74 50    38.6
ZANG ZA  300          DIOA_m                   106 21    73.2

HIST GEN Zénithales

Distances

SIGM DP   0.0010
HIST NEW

DIST DP  400          100                     17.97082
DIST DP  400          DYNG                     7.65764
DIST DP  400          7515A                   12.70123
DIST DP  400          7515C                   10.10718
DIST DP  400          200                     17.81332
DIST DP  400          300                     41.53574
DIST DP  400          DIOB_m                  43.07777
DIST DP  100          400                     17.97033
DIST DP  100          DYNG                    11.61771
DIST DP  100          7515A                    9.12217
DIST DP  100          7515C                   13.21124
DIST DP  100          300                     47.35836
DIST DP  100          200                     15.77629
DIST DP  100          DIOB_m                  48.34638
DIST DP  100          DIOA_m                  51.01743
DIST DP  200          400                     17.81383
DIST DP  200          DYNG                    11.53022
DIST DP  200          7515C                    7.89015
DIST DP  200          7515A                    8.14615
DIST DP  200          100                     15.77629
DIST DP  200          DIOB_m                  32.57561
DIST DP  200          DIOA_m                  35.32966
DIST DP  200          300                     31.62309
DIST DP  300          400                     41.53679
DIST DP  300          100                     47.35891
DIST DP  300          200                     31.62310
DIST DP  300          DIOB_m                   2.00454
DIST DP  300          DIOA_m                   4.03608
```

```
HIST GEN Distances
HIST ALL Toutes les observations
END
```

6.6 Appendix 6 : adjustment output file

```
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0001
================================================================================
Mon Oct 3 14:49:31 2011
Input file:  X:\Dionysos\DIO_tt_light.iob
Output file: X:\Dionysos\DIO_tt_light.lst
Options file: C:\Program Files\Microsearch\GeoLab\default.gpj
--------------------------------------------------------------------------------
|             PARAMETERS               |             OBSERVATIONS              |
|--------------------------------------------------------------------------------|
|   Description    |      Number       |   Description     |      Number       |
|--------------------------------------------------------------------------------|
| No. of Stations  |          18       | Directions        |          60       |
| Coord Parameters |          51       | Distances         |          28       |
| Free Latitudes   |          18       | Azimuths          |           2       |
| Free Longitudes  |          18       | Vertical Angles   |           0       |
| Free Heights     |          15       | Zenithal Angles   |          47       |
| Fixed Coordinates|           3       | Angles            |           0       |
| Astro. Latitudes |           0       | Heights           |           0       |
| Astro. Longitudes|           0       | Height Differences|           0       |
| Geoid Records    |           0       | Auxiliary Params. |           0       |
| All Aux. Pars.   |           7       | 2-D Coords.       |           0       |
| Direction Pars.  |           7       | 2-D Coord. Diffs. |           0       |
| Scale Parameters |           0       | 3-D Coords.       |           3       |
| Constant Pars.   |           0       | 3-D Coord. Diffs. |          12       |
| Rotation Pars.   |           0       |                   |                   |
| Translation Pars.|           0       |                   |                   |
|                  |                   |                   |                   |
|                  |    --------       |                   |    --------       |
| Total Parameters |          58       | Total Observations|         152       |
|--------------------------------------------------------------------------------|
|                      Degrees of Freedom =        94                          |
 --------------------------------------------------------------------------------
--------------------------------------------------------------------------------
                        SUMMARY OF SELECTED OPTIONS
--------------------------------------------------------------------------------
    OPTION                                |   SELECTION
--------------------------------------------------------------------------------
    Computation Mode                      |   Adjustment
    Maximum Iterations                    |   15
    Convergence Criterion                 |   0.00010
    Residual Rejection Criterion          |   Tau Max
    Confidence Region Types               |   1D 2D 3D Station
    Variance Factor (VF) Known            |   Yes
    Scale Covariance Matrix With VF       |   Yes
    Scale Residual Variances With VF      |   No
    Force Convergence in Max Iters        |   No
    Distances Contribute To Heights       |   No
    Compute Full Inverse                  |   Yes
    Optimize Band Width                   |   Yes
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0002
================================================================================
    Generate Initial Coordinates          |   Yes
    Re-Transform Obs After 1st Pass       |   Yes
    Geoid Interpolation Method            |   Bi-Quadratic
--------------------------------------------------------------------------------
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0003
================================================================================
Adjusted PLH Coordinates:
                                LATITUDE          LONGITUDE  ELIP-HEIGHT
 CODE FFF STATION                 STD DEV            STD DEV      STD DEV
 ---- --- ------------ ------------------ ------------------ ------------
 PLH  000 100          N 38  4 43.152944 E 23 55 56.636011     511.9667 m       0
                            0.0012             0.0012       0.0011
 PLH  000 200          N 38  4 42.914556 E 23 55 57.208455     511.5589 m       0
                            0.0012             0.0012       0.0011
 PLH  000 300          N 38  4 42.367401 E 23 55 58.305672     511.9676 m       0
                            0.0011             0.0012       0.0011
 PLH  000 400          N 38  4 42.570713 E 23 55 56.621282     511.2739 m       0
                            0.0012             0.0012       0.0011
 PLH  000 7515A        N 38  4 42.929548 E 23 55 56.876341     510.5698 m       0
                            0.0012             0.0012       0.0011
 PLH  000 7515C        N 38  4 42.792862 E 23 55 56.925544     510.5744 m       0
                            0.0012             0.0012       0.0011
 PLH  000 DIOA_m       N 38  4 42.259212 E 23 55 58.397403     511.3742 m       0
                            0.0012             0.0013       0.0011
```

```
 PLH  000 DIOB         N 38  4 42.399426 E 23 55 58.375224     512.7982 m       0
                                   0.0011             0.0011      0.0011
 PLH  001 DIOB_2GHz    N 38  4 42.399457 E 23 55 58.375191     510.9837 m       0
                                   0.0014             0.0022      0.0000
 PLH  000 DIOB_m       N 38  4 42.399409 E 23 55 58.375302     511.3625 m       0
                                   0.0011             0.0012      0.0011
 PLH  000 DION         N 38  4 42.720304 E 23 55 57.533670     514.5434 m       0
                                   0.0012             0.0013      0.0012
 PLH  000 DION_bcr     N 38  4 42.720304 E 23 55 57.533670     514.5784 m       0
                                   0.0012             0.0013      0.0012
 PLH  000 DIOP         N 38  4 43.129355 E 23 55 57.145473     513.6897 m       0
                                   0.0016             0.0017      0.0016
 PLH  000 DIOP_arp     N 38  4 43.129355 E 23 55 57.145473     513.7997 m       0
                                   0.0012             0.0012      0.0011
 PLH  000 DYNG         N 38  4 42.791825 E 23 55 56.762795     510.5695 m       0
                                   0.0012             0.0012      0.0011
 PLH  000 DYNG_bcr     N 38  4 42.791819 E 23 55 56.762775     512.6225 m       0
                                   0.0012             0.0012      0.0011
 PLH  001 REFN         N 38  5 12.242646 E 23 56  1.150587     457.9648 m       0
                                   0.6593             0.0638      0.0000
 PLH  001 REFS         N 38  4 25.524398 E 23 56  1.867262     543.4010 m       0
                                   0.1386             0.0278      0.0000
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0            GRS80       UNITS: m,GRAD Page 0004
================================================================================
Adjusted XYZ Coordinates:
                              X-COORDINATE       Y-COORDINATE       Z-COORDINATE
 CODE FFF STATION                  STD DEV            STD DEV            STD DEV
 ---- --- ------------ ------------------ ------------------ ------------------
 XYZ      100                4595215.9973       2039428.9248       3912635.6229 m       0
                                    0.0012             0.0012             0.0012
 XYZ      200                4595214.1877       2039443.3867       3912629.5851 m       0
                                    0.0012             0.0012             0.0012
 XYZ      300                4595213.1438       2039472.1823       3912616.5564 m       0
                                    0.0012             0.0012             0.0011
 XYZ      400                4595225.7651       2039432.8671       3912621.0634 m       0
                                    0.0012             0.0012             0.0012
 XYZ      7515A              4595216.4992       2039435.5563       3912629.3390 m       0
                                    0.0012             0.0012             0.0012
 XYZ      7515C              4595218.3920       2039437.7084       3912626.0242 m       0
                                    0.0012             0.0012             0.0012
 XYZ      DIOA_m             4595213.6903       2039474.8711       3912613.5644 m       0
                                    0.0012             0.0013             0.0012
 XYZ      DIOB               4595212.4970       2039473.7500       3912617.8460 m       0
                                    0.0011             0.0011             0.0011
 XYZ      DIOB_2GHz          4595211.1913       2039473.1696       3912616.7277 m       0
                                    0.0009             0.0022             0.0011
 XYZ      DIOB_m             4595211.4635       2039473.2934       3912616.9601 m       0
                                    0.0012             0.0012             0.0011
 XYZ      DION               4595216.4960       2039453.0835       3912626.7108 m       0
                                    0.0012             0.0013             0.0012
 XYZ      DION_bcr           4595216.5212       2039453.0947       3912626.7324 m       0
                                    0.0012             0.0013             0.0012
 XYZ      DIOP               4595212.6098       2039441.0068       3912636.1130 m       0
                                    0.0016             0.0017             0.0016
 XYZ      DIOP_arp           4595212.6889       2039441.0420       3912636.1808 m       0
                                    0.0012             0.0012             0.0012
 XYZ      DYNG               4595220.0157       2039434.0890       3912625.9959 m       0
                                    0.0012             0.0012             0.0012
 XYZ      DYNG_bcr           4595221.4930       2039434.7442       3912627.2620 m       0
                                    0.0012             0.0012             0.0012
 XYZ      REFN               4594626.8203       2039287.8121       3913308.3507 m       0
                                    0.3976             0.1067             0.5189
 XYZ      REFS               4595493.2960       2039691.5031       3912227.1059 m       0
                                    0.0669             0.0600             0.1091
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0            GRS80       UNITS: m,GRAD Page 0005
================================================================================
Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                  OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                       STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ------------------ -------- --------
AZIM               DION         REFN              6 14     53.0      0.0      0.0
                                                          0.0      0.0        *
AZIM               DION         REFS            187 48     13.0     -0.0     -0.0
                                                          0.0      0.0        *
XCT  DIOB                                       4595212.49700  -0.0000  -0.0000
                                                     0.0010   0.0000        *
YCT  DIOB                                       2039473.75000   0.0000   0.0000
                                                     0.0010   0.0000        *
ZCT  DIOB                                       3912617.84600  -0.0000  -0.0000
                                                     0.0010   0.0000        *
ELAT               DION_bcr     DION             0 00  0.000000   0.0000   0.0000
```

```
                                                        0.0003   0.0000    12.78*
ELON            DION_bcr    DION          0 00  0.000000   0.0000   0.0000
                                                        0.0003   0.0000   144.88*
EHGT            DION_bcr    DION                   -0.03500   0.0000   0.0000
                                                        0.0003   0.0000     0.00*
ELAT            DYNG_bcr    DYNG          0 00  0.000000   0.0002   0.6583
                                                        0.0003   0.0003    81.68
ELON            DYNG_bcr    DYNG          0 00  0.000000   0.0005   1.7449
                                                        0.0003   0.0003   233.25
EHGT            DYNG_bcr    DYNG                   -2.05300   0.0000   0.1466
                                                        0.0003   0.0003    19.16
ELAT            DIOB        DIOB_m        0 00  0.000000  -0.0005  -1.1524
                                                        0.0005   0.0005   377.60
ELON            DIOB        DIOB_m        0 00  0.000042   0.0009   2.1818
                                                        0.0005   0.0004   619.45
EHGT            DIOB        DIOB_m                 -1.43400  -0.0017  -3.4674
                                                        0.0005   0.0005  1199.18
ELAT            DIOP_arp    DIOP          0 00  0.000000  -0.0000  -0.0000
                                                        0.0010   0.0000     0.00*
ELON            DIOP_arp    DIOP          0 00  0.000000  -0.0000  -0.0000
                                                        0.0010   0.0000     0.00*
EHGT            DIOP_arp    DIOP                   -0.11000  -0.0000  -0.0000
                                                        0.0010   0.0000     0.00*
DIR             400         REFS           0  0       0.0     -5.8     -1.0
                                                        8.0      5.8
DIR             400         100          216 46      52.1     -5.0     -0.8
                                                        8.0      6.1
DIR             400         DYNG_bcr     245  0      38.0     13.9      3.2
                                                        8.0      4.4
DIR             400         DYNG         245  0      88.8     -7.6     -1.7
                                                        8.0      4.4
DIR             400         7515A        247 78       0.9      1.1      0.2
                                                        8.0      4.7
DIR             400         7515C        267 71      71.0     -8.7     -1.7
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0006
================================================================================
Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                  OBSERVATION RESIDUAL  STD RES
TYPE AT          FROM        TO                      STD DEV  STD DEV      PPM
---- ----------- ----------- ----------- ----------------- -------- --------
                                                        8.0      5.2
DIR             400         DIOP_arp     255 81      83.0      7.2      1.2
                                                        8.0      6.2
DIR             400         200          274 60       1.6      3.9      0.6
                                                        8.0      6.9
DIR             400         DION_bcr     302 17      18.6     -2.2     -1.7
                                                        8.0      1.3
DIR             400         DIOB_2GHz    323  1      60.1     -0.1     -1.2
                                                        8.0      0.1
DIR             400         DIOB         323  1      68.9      3.4      0.5
                                                        8.0      6.9
DIR             400         300          324 83      77.1      6.9      1.0
                                                        8.0      6.7
DIR             400         DIOB_m       323  1      83.7     -6.9     -1.0
                                                        8.0      6.8
DIR             400         REFS          14 24      73.6      7.6      1.5
                                                        8.0      5.0
DIR             400         DIOB         337 26      66.8     -7.6     -1.5
                                                        8.0      5.0
DIR             100         REFS          14 28      90.8     -2.8     -0.4
                                                        8.0      6.3
DIR             100         400           30 23      15.3    -11.0     -1.7
                                                        8.0      6.4
DIR             100         DYNG_bcr      11 72      58.3      9.0      1.8
                                                        8.0      5.0
DIR             100         DYNG          11 72      40.5     -1.1     -0.2
                                                        8.0      5.0
DIR             100         7515A        384  9      42.4      0.1      0.0
                                                        8.0      4.1
DIR             100         7515C        392 91      39.4     -1.2     -0.5
                                                        8.0      2.4
DIR             100         300          363 13      68.4     -3.1     -0.4
                                                        8.0      7.1
DIR             100         DION_bcr     363 81      62.5     -9.8     -1.4
                                                        8.0      7.1
DIR             100         200          359 82      75.1    -12.1     -1.8
                                                        8.0      6.9
DIR             100         DIOP_arp     332 68      22.4     -0.3     -0.1
                                                        8.0      3.2
DIR             100         DIOB_2GHz    360 87      54.0      7.4      1.2
                                                        8.0      6.3
DIR             100         DIOB         360 87      60.4      6.7      1.0
                                                        8.0      7.0
```

```
DIR               100          DIOB_m          360 87     60.7      0.6      0.1
                                                            8.0      6.9
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0007
================================================================================
Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                  OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                     STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
DIR               100          DIOA_m          365 28     44.2     27.7      3.1
                                                           10.0      9.1
DIR               100          REFS             14 28     97.3     -3.9     -0.7
                                                            8.0      5.2
DIR               100          REFN            236 72     79.4      1.1      0.5
                                                            8.0      2.2
DIR               100          DIOB            360 87     69.7      2.8      0.5
                                                            8.0      5.3
DIR               200          REFS             15 12     64.9      2.0      0.3
                                                            8.0      6.7
DIR               200          400              87 82     11.3      1.8      0.3
                                                            8.0      6.5
DIR               200          DYNG_bcr        107  6     87.6     13.4      2.7
                                                            8.0      5.0
DIR               200          DYNG            107  7      8.9     -7.9     -1.6
                                                            8.0      4.9
DIR               200          7515C            96 68     65.2     -7.7     -1.9
                                                            8.0      4.0
DIR               200          7515A           132  4     44.2     -0.5     -0.1
                                                            8.0      3.8
DIR               200          DIOP_arp        213 91     38.7     -3.6     -1.9
                                                            8.0      1.9
DIR               200          100             159 28      3.3     10.2      1.7
                                                            8.0      5.9
DIR               200          DION_bcr        369 60     88.9     -4.9     -1.5
                                                            8.0      3.3
DIR               200          DIOB_m          360 83     83.2     10.8      1.8
                                                            8.0      6.1
DIR               200          DIOA_m          367 17     75.8     -0.5     -0.1
                                                            8.0      6.2
DIR               200          300             364 24     19.4      0.4      0.1
                                                            8.0      6.6
DIR               200          DIOB_2GHz       360 83     99.5     -4.9     -1.2
                                                            8.0      4.1
DIR               200          DIOB            360 84     11.6     -8.6     -1.4
                                                            8.0      6.2
DIR               200          REFS             15 12     58.8      6.1      1.0
                                                            8.0      6.1
DIR               200          REFN            235 15      5.3     -3.1     -0.5
                                                            8.0      6.0
DIR               200          DIOB            360 84      4.0     -3.0     -0.5
                                                            8.0      5.6
DIR               300          REFS             16 85     52.1     -1.4     -0.5
                                                            8.0      2.9
DIR               300          400             137  4     64.2     -2.6     -0.4
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0008
================================================================================
Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                  OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                     STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
                                                            8.0      6.6
DIR               300          DYNG_bcr        148 71     88.4      5.0      0.7
                                                            8.0      6.9
DIR               300          100             161 57     84.0      1.7      0.2
                                                            8.0      7.1
DIR               300          200             163 22     84.9      4.8      0.7
                                                            8.0      7.2
DIR               300          DION_bcr        160 78      4.5    -20.6     -3.2
                                                            8.0      6.5
DIR               300          DIOP_arp        171 53     27.7     14.1      2.1
                                                            8.0      6.8
DIR               300          DIOB_m          293 86     65.8     -0.7     -1.3
                                                            8.0      0.5
DIR               300          DIOB            293 81     88.1     12.9      2.3
                                                            8.0      5.7
DIR               300          DIOB            293 82     12.8    -11.8     -2.1
                                                            8.0      5.7
DIR               300          DIOA_m          389 81      0.0     -1.3     -1.7
                                                            8.0      0.8
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
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Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0010
================================================================================
Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                  OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                     STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
ZANG              400          100             97 54     46.6     -6.2     -0.5
                                                         12.0     11.4
ZANG              400          DYNG_bcr        88 87     64.9    -15.1     -1.9
                                                         12.0      8.1
ZANG              400          DYNG           105 85     23.3      0.8      0.1
                                                         12.0      7.9
ZANG              400          7515A          103 52     73.2     -7.6     -0.8
                                                         12.0     10.2
ZANG              400          7515C          104 40     40.5      3.3      0.4
                                                         12.0      9.2
ZANG              400          DIOP_arp        92 53     76.4      5.4      0.5
                                                         12.0     11.3
ZANG              400          200             98 98     30.5     14.1      1.2
                                                         12.0     11.5
ZANG              400          DION_bcr        90 80     23.1      3.1      0.3
                                                         12.0     11.0
ZANG              400          DIOB            97 74     97.6     14.5      1.2
                                                         12.0     11.7
ZANG              400          300             98 93     86.7     17.8      1.5
                                                         12.0     11.7
ZANG              400          DIOB_m          99 87      6.3     13.8      1.2
                                                         12.0     11.7
ZANG              400          DIOB            97 74     80.9     -2.2     -0.2
                                                         12.0     11.7
ZANG              100          400            102 45     46.4     -2.6     -0.2
                                                         12.0     11.4
ZANG              100          DYNG_bcr        96 39     15.9      5.5      0.6
                                                         12.0      9.9
ZANG              100          DYNG           107 65     87.5     -9.5     -1.0
                                                         12.0     10.0
ZANG              100          7515A          109 75     60.6    -11.1     -1.3
                                                         12.0      8.8
ZANG              100          7515C          106 71     17.8     -1.8     -0.2
                                                         12.0     10.3
ZANG              100          300             99 99     99.5     10.3      0.9
                                                         12.0     11.8
ZANG              100          DION_bcr        93 53     55.6     14.6      1.3
                                                         12.0     11.2
ZANG              100          200            101 64     41.2    -17.8     -1.6
                                                         12.0     11.3
ZANG              100          DIOP_arp        90 68     68.9     12.1      1.2
                                                         12.0      9.9
ZANG              100          DIOB            98 90     68.9     16.7      1.4
                                                         12.0     11.8
ZANG              100          DIOB_m         100 79     84.5     26.6      2.3
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0             GRS80       UNITS: m,GRAD Page 0011
================================================================================
Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                  OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                     STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
                                                         12.0     11.8
ZANG              100          DIOA_m         100 74      5.8     10.2      0.9
                                                         12.0     11.8
ZANG              100          DIOB            98 90     60.7      8.5      0.7
                                                         12.0     11.8
ZANG              200          400            101  1     83.0     -2.4     -0.2
                                                         12.0     11.5
ZANG              200          DYNG_bcr        94 13     18.4     14.0      1.4
                                                         12.0     10.1
ZANG              200          DYNG           105 46     28.3      7.1      0.7
                                                         12.0     10.0
ZANG              200          7515C          107 94     13.4     -1.5     -0.2
                                                         12.0      7.8
ZANG              200          7515A          107 72     89.0     14.8      1.8
                                                         12.0      8.1
ZANG              200          DIOP_arp        79 73     10.1     -9.9     -1.5
                                                         12.0      6.6
ZANG              200          100             98 35     48.7      6.1      0.5
                                                         12.0     11.3
ZANG              200          DION_bcr        81 21     52.3    -14.4     -2.0
                                                         12.0      7.2
ZANG              200          DIOB_m         100 38     35.9     -2.9     -0.2
                                                         12.0     11.5
ZANG              200          DIOA_m         100 33     16.7    -12.8     -1.1
                                                         12.0     11.6
```

ZANG	200	300	99	17	66.2	-5.9	-0.5
					12.0	11.5	
ZANG	200	DIOB	97	57	91.7	0.5	0.0
					12.0	11.5	
ZANG	200	DIOB	97	57	80.1	-11.1	-1.0
					12.0	11.5	
ZANG	300	400	101	6	37.1	1.8	0.2
					12.0	11.7	
ZANG	300	DYNG_bcr	98	95	46.4	13.1	1.1
					12.0	11.6	
ZANG	300	100	100	0	16.5	1.0	0.1
					12.0	11.8	
ZANG	300	200	100	82	44.6	13.5	1.2
					12.0	11.5	
ZANG	300	DION_bcr	92	39	15.8	13.9	1.3
					12.0	10.3	
ZANG	300	DIOP_arp	96	83	8.9	4.0	0.3
					12.0	11.5	
ZANG	300	DIOB_m	119	3	41.2	1.7	1.2
					12.0	1.4	

DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
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Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.

TYPE	AT	FROM	TO	OBSERVATION STD DEV	RESIDUAL STD DEV	STD RES PPM
ZANG	300	DIOB	74 50	38.6	-4.7	-2.7
				12.0	1.8	
ZANG	300	DIOA_m	109 34	0.0	0.7	0.4
				12.0	1.6	

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Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.

TYPE	AT	FROM	TO	OBSERVATION STD DEV	RESIDUAL STD DEV	STD RES PPM
DIST	400	100		17.97080	-0.0006	-0.6445
				0.0010	0.0010	34.48
DIST	400	DYNG		7.67337	-0.0001	-0.1113
				0.0010	0.0010	14.14
DIST	400	7515A		12.71071	0.0004	0.4522
				0.0010	0.0010	34.71
DIST	400	7515C		10.11895	0.0008	0.8267
				0.0010	0.0010	79.34
DIST	400	200		17.81330	0.0001	0.0914
				0.0010	0.0010	4.97
DIST	400	300		41.53570	0.0010	1.1092
				0.0010	0.0009	25.28
DIST	400	DIOB_m		43.07682	0.0006	0.6083
				0.0010	0.0009	13.05
DIST	100	400		17.97030	-0.0001	-0.1244
				0.0010	0.0010	6.65
DIST	100	DYNG		11.64001	0.0002	0.1800
				0.0010	0.0010	15.06
DIST	100	7515A		9.15049	-0.0009	-0.9112
				0.0010	0.0010	97.52
DIST	100	7515C		13.23075	-0.0012	-1.2396
				0.0010	0.0010	91.41
DIST	100	300		47.35830	0.0008	0.9031
				0.0010	0.0009	17.89
DIST	100	200		15.77620	-0.0004	-0.4264
				0.0010	0.0010	26.16
DIST	100	DIOB_m		48.34838	-0.0014	-1.5278
				0.0010	0.0009	29.20
DIST	100	DIOA_m		51.01933	-0.0001	-0.1201
				0.0010	0.0008	1.96
DIST	200	400		17.81380	-0.0004	-0.4249
				0.0010	0.0010	23.10
DIST	200	DYNG		11.54562	-0.0004	-0.3702
				0.0010	0.0010	31.33
DIST	200	7515C		7.91249	-0.0005	-0.5157
				0.0010	0.0010	63.65
DIST	200	7515A		8.16790	0.0003	0.2630
				0.0010	0.0010	31.57
DIST	200	100		15.77620	-0.0004	-0.4264
				0.0010	0.0010	26.16
DIST	200	DIOB_m		32.57619	0.0003	0.2826
				0.0010	0.0009	8.13
DIST	200	DIOA_m		35.33008	-0.0005	-0.5884
				0.0010	0.0008	13.94

```
DIST              200          300                    31.62300   0.0002   0.2224
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0            GRS80       UNITS: m,GRAD Page 0015
================================================================================
Residuals (critical value = 3.657):
NOTE: Observation values shown are reduced to mark-to-mark.
                                                    OBSERVATION RESIDUAL  STD RES
TYPE AT           FROM         TO                       STD DEV  STD DEV      PPM
---- ------------ ------------ ------------ ----------------- -------- --------
                                                        0.0010   0.0010     6.69
DIST              300          400                   41.53670   0.0000   0.0527
                                                        0.0010   0.0009     1.20
DIST              300          100                   47.35890   0.0002   0.2635
                                                        0.0010   0.0009     5.22
DIST              300          200                   31.62310   0.0001   0.1173
                                                        0.0010   0.0010     3.53
DIST              300          DIOB_m                 2.05428   0.0001   0.1403
                                                        0.0010   0.0009    64.23
DIST              300          DIOA_m                 4.06038  -0.0008  -0.9524
                                                        0.0010   0.0008   193.79
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
Microsearch GeoLab, V2001.9.20.0            GRS80       UNITS: m,GRAD Page 0017
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```

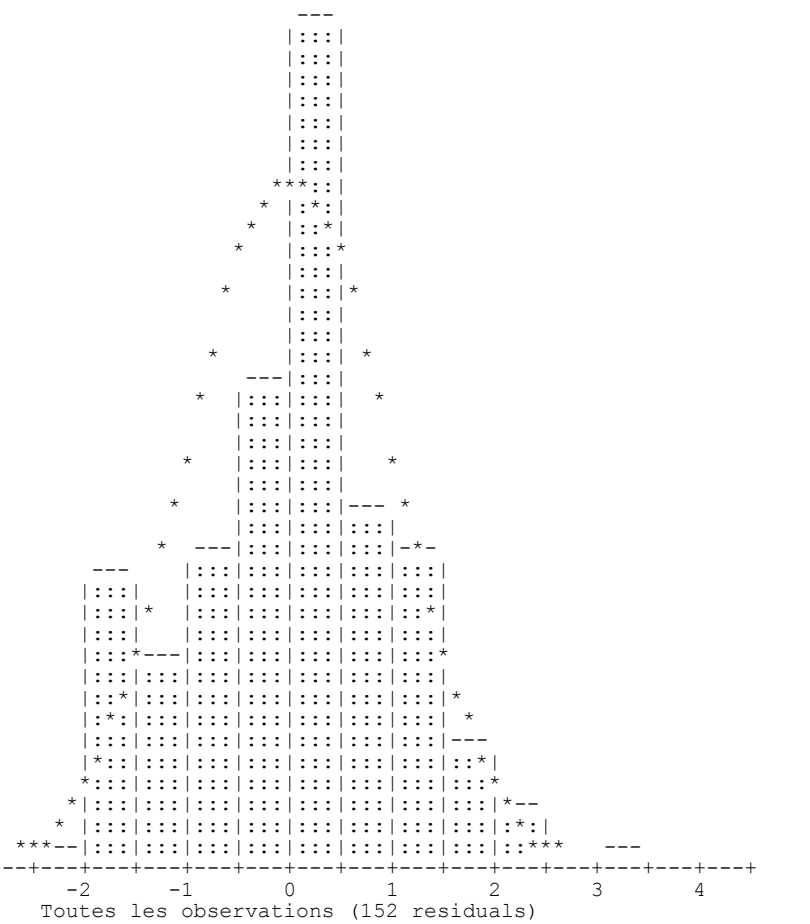


```
================================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
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================================================================================

 ------------------------------------------------------------------------------
|                                                                              |
|                  S T A T I S T I C S     S U M M A R Y                       |
|                                                                              |
 ------------------------------------------------------------------------------
|                                  |                                           |
|     Residual Critical Value Type |                Tau Max                    |
|     Residual Critical Value      |                 3.6572                    |
|     Number of Flagged Residuals  |                      0                    |
|     Convergence Criterion        |                 0.0001                    |
|     Final Iteration Counter Value|                      6                    |
|     Confidence Level Used        |                95.0000                    |
|     Estimated Variance Factor    |                 1.2700                    |
```

```
|     Number of Degrees of Freedom    |                    94                |
|                                     |                                      |
 --------------------------------------------------------------------------
|                                                                          |
|                  Chi-Square Test on the Variance Factor:                 |
|                                                                          |
|                   9.7283e-01  <  1.0000  <  1.7285e+00  ?                |
|                                                                          |
|                             THE TEST PASSES                              |
|                                                                          |
 --------------------------------------------------------------------------

 --------------------------------------------------------------------------
|                                                                          |
| NOTE:  All confidence regions were computed using the following factors: |
|        ---------------------------------------------------------------   |
|        Variance factor used      =          1.2700                       |
|        1-D expansion factor      =          1.9600                       |
|        2-D expansion factor      =          2.4477                       |
|        3-D expansion factor      =          2.7955                       |
|                                                                          |
|        Note that, for relative confidence regions, precisions are        |
|        computed from the ratio of the major semi-axis and the spatial    |
|        distance between the two stations.                                |
|                                                                          |
 --------------------------------------------------------------------------
==============================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
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==============================================================================
2-D and 1-D Station Confidence Regions (95.000 and 95.000 percent):
STATION            MAJOR SEMI-AXIS  AZ     MINOR SEMI-AXIS             VERTICAL
------------ ---------------------- --- ------------------- --------------------
100                         0.0030  74              0.0029               0.0022
200                         0.0030  88              0.0029               0.0022
300                         0.0029  61              0.0028               0.0022
400                         0.0030  63              0.0029               0.0022
7515A                       0.0030  82              0.0029               0.0022
7515C                       0.0030  75              0.0029               0.0023
DIOA_m                      0.0032 132              0.0029               0.0022
DIOB                        0.0028  90              0.0028               0.0022
DIOB_2GHz                   0.0058 113              0.0029               0.0000
DIOB_m                      0.0029  60              0.0028               0.0022
DION                        0.0033 112              0.0030               0.0024
DION_bcr                    0.0032 112              0.0029               0.0023
DIOP                        0.0041  80              0.0040               0.0032
DIOP_arp                    0.0030  80              0.0029               0.0023
DYNG                        0.0030  70              0.0029               0.0022
DYNG_bcr                    0.0030  71              0.0029               0.0022
REFN                        1.6214   6              0.0032               0.0000
REFS                        0.3461 169              0.0032               0.0000
==============================================================================
    DIONYSOS (GREECE - NTUA) GNSS&DORIS&SLR TOPOGRAPHIC LOCAL TIE - MAY 2011
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==============================================================================
3D Station Confidence Regions (95.000 percent):
STATION         MAJ-SEMI (AZ,VANG)    MED-SEMI (AZ,VANG)    MIN-SEMI (AZ,VANG)
------------ --------------------- --------------------- ---------------------
100              0.0034 (254,  0)      0.0033 (344,  0)      0.0032 ( 79, 90)
200              0.0034 (268,  0)      0.0033 (178,  0)      0.0032 ( 48, 90)
300              0.0033 (241,  0)      0.0032 (133, 90)      0.0032 (331,  0)
400              0.0034 (243,  0)      0.0034 (333,  0)      0.0032 ( 78, 90)
7515A            0.0034 (262,  0)      0.0033 (172,  0)      0.0032 ( 65, 90)
7515C            0.0034 (255,  0)      0.0033 (165,  0)      0.0032 ( 72, 90)
DIOA_m           0.0037 (312,  0)      0.0033 (222,  0)      0.0032 ( 51, 90)
DIOB             0.0032 (294,  0)      0.0032 (204, 90)      0.0032 ( 24,  0)
DIOB_2GHz        0.0066 (113,  0)      0.0034 ( 23,  0)      0.0000 (  0, 90)
DIOB_m           0.0033 (240,  0)      0.0032 (106, 90)      0.0032 (330,  0)
DION             0.0037 (292,  0)      0.0034 (202,  0)      0.0034 ( 29, 90)
DION_bcr         0.0036 (292,  0)      0.0033 (202,  0)      0.0032 ( 29, 90)
DIOP             0.0046 (260,  0)      0.0046 (170,  0)      0.0045 ( 65, 90)
DIOP_arp         0.0034 (260,  0)      0.0033 (170,  0)      0.0032 ( 65, 90)
DYNG             0.0034 (250,  0)      0.0033 (340,  0)      0.0032 ( 70, 90)
DYNG_bcr         0.0034 (251,  0)      0.0033 (341,  0)      0.0032 ( 86, 90)
REFN             1.8518 (  6,  0)      0.0037 ( 96,  0)      0.0000 (  0, 90)
REFS             0.3952 (349,  0)      0.0036 ( 79,  0)      0.0000 (  0, 90)
Mon Oct 3 14:49:35 2011
```

6.7 Appendix 7 : Dionysos SINEX File

```
%=SNX 1.00 IGN 11:277:00000 IGN 11:131:00000 11:131:00000 C 00021
*-------------------------------------------------------------------------------
+FILE/COMMENT
* File created by geotosnx software (Z.Altamimi)
* Original input file: ratt.cov
* Matrix Scalling Factor used:         1.0000000000
-FILE/COMMENT
*-------------------------------------------------------------------------------
+SITE/ID
*CODE PT __DOMES__ T _STATION DESCRIPTION__ APPROX_LON_ APPROX_LAT_ _APP_H_
 DION  A 12602M004   12602M004               23 55 57.5  38 04 42.7   514.5
 DIOB  A 12602S012   12602S012               23 55 58.3  38 04 42.3   512.8
 DYNG  A 12602M006   12602M006               23 55 56.7  38 04 42.7   510.6
       A 12602M005   12602M005               23 55 58.3  38 04 42.3   511.4
 DIOP  A 12602M001   12602M001               23 55 57.1  38 04 43.1   513.7
 7515  A 12602M002   12602M002               23 55 56.8  38 04 42.9   510.6
       A 12602M003   12602M003               23 55 58.3  38 04 42.2   511.4
-SITE/ID
*-------------------------------------------------------------------------------
+SOLUTION/EPOCHS
*Code PT SOLN T Data_start__ Data_end____ Mean_epoch__
-SOLUTION/EPOCHS
*-------------------------------------------------------------------------------
+SOLUTION/ESTIMATE
*INDEX TYPE__ CODE PT SOLN _REF_EPOCH__ UNIT S __ESTIMATED VALUE____ _STD_DEV___
     1 STAX   DION  A    1 11:131:00000 m    2 0.459521649600000E+07 0.12062E-02
     2 STAY   DION  A    1 11:131:00000 m    2 0.203945308350000E+07 0.13316E-02
     3 STAZ   DION  A    1 11:131:00000 m    2 0.391262671080000E+07 0.12095E-02
     4 STAX   DIOB  A    1 11:131:00000 m    2 0.459521249700000E+07 0.11270E-02
     5 STAY   DIOB  A    1 11:131:00000 m    2 0.203947375000000E+07 0.11270E-02
     6 STAZ   DIOB  A    1 11:131:00000 m    2 0.391261784600000E+07 0.11270E-02
     7 STAX   DYNG  A    1 11:131:00000 m    2 0.459522001570000E+07 0.11694E-02
     8 STAY   DYNG  A    1 11:131:00000 m    2 0.203943408900000E+07 0.12047E-02
     9 STAZ   DYNG  A    1 11:131:00000 m    2 0.391262599590000E+07 0.11829E-02
    10 STAX         A    1 11:131:00000 m    2 0.459521146350000E+07 0.11437E-02
    11 STAY         A    1 11:131:00000 m    2 0.203947329340000E+07 0.11488E-02
    12 STAZ         A    1 11:131:00000 m    2 0.391261696010000E+07 0.11530E-02
    13 STAX   DIOP  A    1 11:131:00000 m    2 0.459521260980000E+07 0.16215E-02
    14 STAY   DIOP  A    1 11:131:00000 m    2 0.203944100680000E+07 0.16532E-02
    15 STAZ   DIOP  A    1 11:131:00000 m    2 0.391263611300000E+07 0.16293E-02
    16 STAX   7515  A    1 11:131:00000 m    2 0.459521649920000E+07 0.11646E-02
    17 STAY   7515  A    1 11:131:00000 m    2 0.203943555630000E+07 0.12096E-02
    18 STAZ   7515  A    1 11:131:00000 m    2 0.391262933900000E+07 0.11750E-02
    19 STAX         A    1 11:131:00000 m    2 0.459521369030000E+07 0.11611E-02
    20 STAY         A    1 11:131:00000 m    2 0.203947487110000E+07 0.12961E-02
    21 STAZ         A    1 11:131:00000 m    2 0.391261356440000E+07 0.11794E-02
-SOLUTION/ESTIMATE
*-------------------------------------------------------------------------------
+SOLUTION/MATRIX_ESTIMATE L COVA
*PARA1 PARA2      PARA2+0_____________ ____PARA2+1_____________ ____PARA2+2_____________
     1     1 0.145480482976117E-05
     2     1 -.482227397181912E-08 0.177325140284753E-05
     3     1 -.166195131571162E-07 0.615482518082611E-08 0.146299555212822E-05
     4     1 0.127001690578530E-05 -.197441213795671E-11 0.172024496477258E-12
     4     4 0.127001668282291E-05
     5     1 0.195983172275738E-11 0.127001665999618E-05 -.250147118390926E-11
     5     4 -.657462537902753E-19 0.127001668285939E-05
     6     1 0.171981607231928E-12 0.252001242950209E-11 0.127001682097381E-05
     6     4 0.156300822543631E-17 0.837481864548817E-19 0.127001668282213E-05
     7     1 0.132533350549936E-05 -.938639529834476E-08 -.321488989017842E-07
     7     4 0.127001642674881E-05 -.378639160501194E-11 -.182715101841847E-12
     7     7 0.136757498892539E-05
     8     1 -.217334505092069E-07 0.141512341392278E-05 0.277391102874947E-07
     8     4 0.378170761334679E-11 0.127001666463962E-05 -.482680390075956E-11
     8     7 -.225500076448836E-07 0.145137404701135E-05
     9     1 -.321488989173135E-07 0.119801618162607E-07 0.133937769444557E-05
     9     4 -.182772608138602E-12 0.483271131344754E-11 0.127001651676830E-05
     9     7 -.642195773142890E-07 0.287813087532130E-07 0.139922481688930E-05
    10     1 0.128598185531346E-05 -.171399289412259E-07 -.177780233529183E-07
    10     4 0.127001650641066E-05 0.447204760803155E-14 -.134503722557101E-12
    10     7 0.128464470136291E-05 -.156370430927685E-07 -.161420437332992E-07
    10    10 0.130815410600905E-05
    11     1 -.257280034509651E-07 0.130086194620719E-05 0.328374882567218E-07
    11     4 0.189242105300703E-14 0.127001667768238E-05 -.253373322378575E-14
    11     7 -.280504194493652E-07 0.130363419651037E-05 0.358016633833225E-07
    11    10 -.412368254220808E-07 0.131977040027775E-05
    12     1 -.177780232964272E-07 0.218762491474202E-07 0.129474353509479E-05
    12     4 -.134603165792099E-12 -.569907196140492E-14 0.127001657262281E-05
    12     7 -.161420436918610E-07 0.199580670269430E-07 0.129260010873230E-05
    12    10 -.430901069718710E-07 0.526319025492890E-07 0.132939053453089E-05
    13     1 0.132151138136679E-05 -.228186047749062E-07 -.297090260927670E-07
    13     4 0.127001681753359E-05 -.287374213141819E-11 0.879711432455500E-13
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    13     7 0.133521330033590E-05 -.363923721222851E-07 -.423635531627270E-07
    13    10 0.128421076817192E-05 -.150953648400868E-07 -.155726809103051E-07
    13    13 0.262923879306770E-05
    14     1 -.309740564885425E-07 0.142072025518193E-05 0.395331965202927E-07
    14     4 0.287918921470901E-11 0.127001666998243E-05 -.367487638719515E-11
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    14    13 -.279958434068282E-07 0.273318397396819E-05
    15     1 -.297090260869890E-07 0.291241280132714E-07 0.133615310903805E-05
    15     4 0.879339571514815E-13 0.366785510483991E-11 0.127001677415025E-05
    15     7 -.423635531841152E-07 0.464487691571690E-07 0.135609165588473E-05
    15    10 -.155726808480685E-07 0.192667054273999E-07 0.129188557208461E-05
    15    13 -.513620812069164E-07 0.357320062133627E-07 0.265455196237983E-05
    16     1 0.132348426383041E-05 -.248390074236800E-07 -.316580872424136E-07
    16     4 0.127001640893586E-05 0.351442535638281E-11 -.212154292825951E-12
    16     7 0.134603871206490E-05 -.292822811259332E-07 -.543561138233679E-07
    16    10 0.128444489285416E-05 -.274224045349772E-07 -.158861057918739E-07
    16    13 0.133830625901367E-05 -.211502029317457E-07 -.455277149976207E-07
    16    16 0.135631064536241E-05
    17     1 -.152317023404763E-07 0.141457316610306E-05 0.194407174615634E-07
    17     4 -.351461291725300E-11 0.127001665757946E-05 0.448581935863470E-11
    17     7 -.190184371439561E-07 0.144240471889151E-05 0.242738503465687E-07
    17    10 -.153941394916898E-07 0.130290196604729E-05 0.196480412411912E-07
    17    13 -.358857631387333E-07 0.143298087220451E-05 0.458021676059145E-07
    17    16 -.268903741374264E-07 0.146304923549999E-05
    18     1 -.316580872471088E-07 0.317028336815628E-07 0.133908656229520E-05
    18     4 -.212116032155146E-12 -.448565337294782E-11 0.127001651344598E-05
    18     7 -.543561138438790E-07 0.373739285609804E-07 0.137282745348956E-05
    18    10 -.158861058530340E-07 0.350001075139613E-07 0.129227416439038E-05
    18    13 -.455277149965436E-07 0.269946924260698E-07 0.136074403276715E-05
    18    16 -.495122797182449E-07 0.343210597943414E-07 0.138071216278226E-05
    19     1 0.129457208423452E-05 -.322449522198368E-07 -.283473961277463E-07
    19     4 0.127001650749534E-05 -.663203181108744E-13 -.135616794285825E-12
    19     7 0.129185217704890E-05 -.357508183256197E-07 -.249057761682104E-07
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    20     4 0.258518090937023E-13 0.127001662765580E-05 -.329908376969016E-13
    20     7 -.227622767718669E-07 0.139454784049415E-05 0.290522347362809E-07
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-SOLUTION/MATRIX_ESTIMATE L COVA
%ENDSNX
```