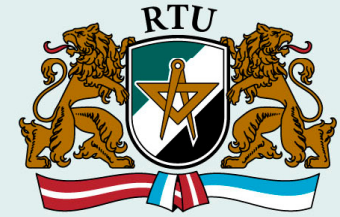


LKS92 and ETRS89 coordinates of LATPOS and EUPOS[®]-Riga RTK networks

J.Balodis (1), I.Janpaule (1,2), I.Jumare (1), K.Morozova (1), M.Normand (1,2),
A.Zarinsjh (1), J.Zvirgzds (2,3)

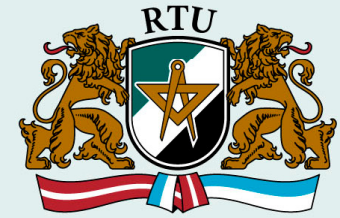
(1) - University of Latvia, (2) - Riga Technical University,
(3)- Latvian Geospatial Information Agency



OVERVIEW

- **2 sets: Reference stations and “Rover” stations**
 - EPN Reference Stations
 - Stations of LATPOS and EUPOS[®]-Riga RTK networks
- **Trends in station coordinate time series of LATPOS and EUPOS[®]-Riga RTK networks**
- **Helmert transformation**
- **New instrumentation**
- **Conclusions**

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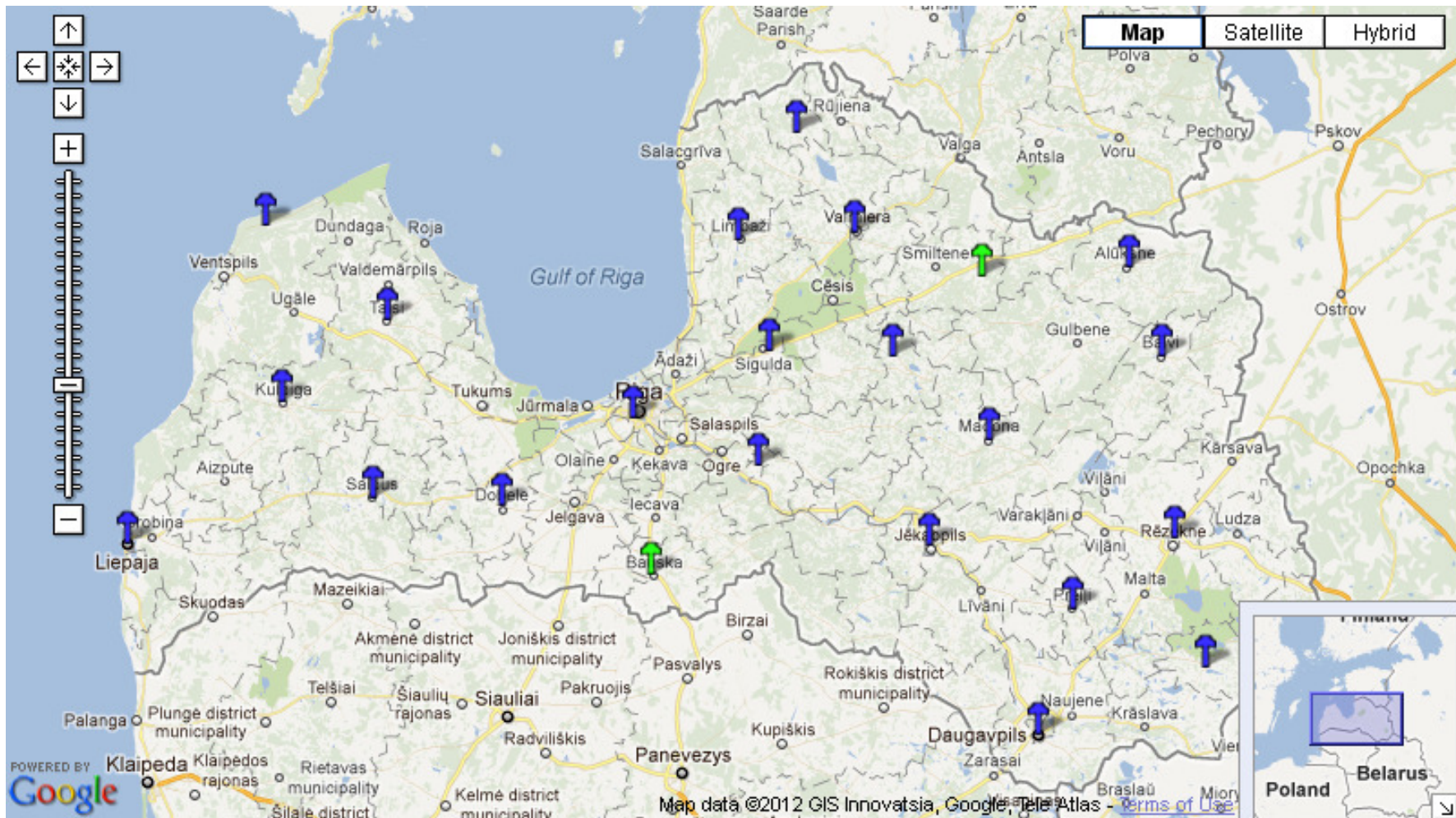
LATPOS

23 stations

Distance
between
stations

~70 km;

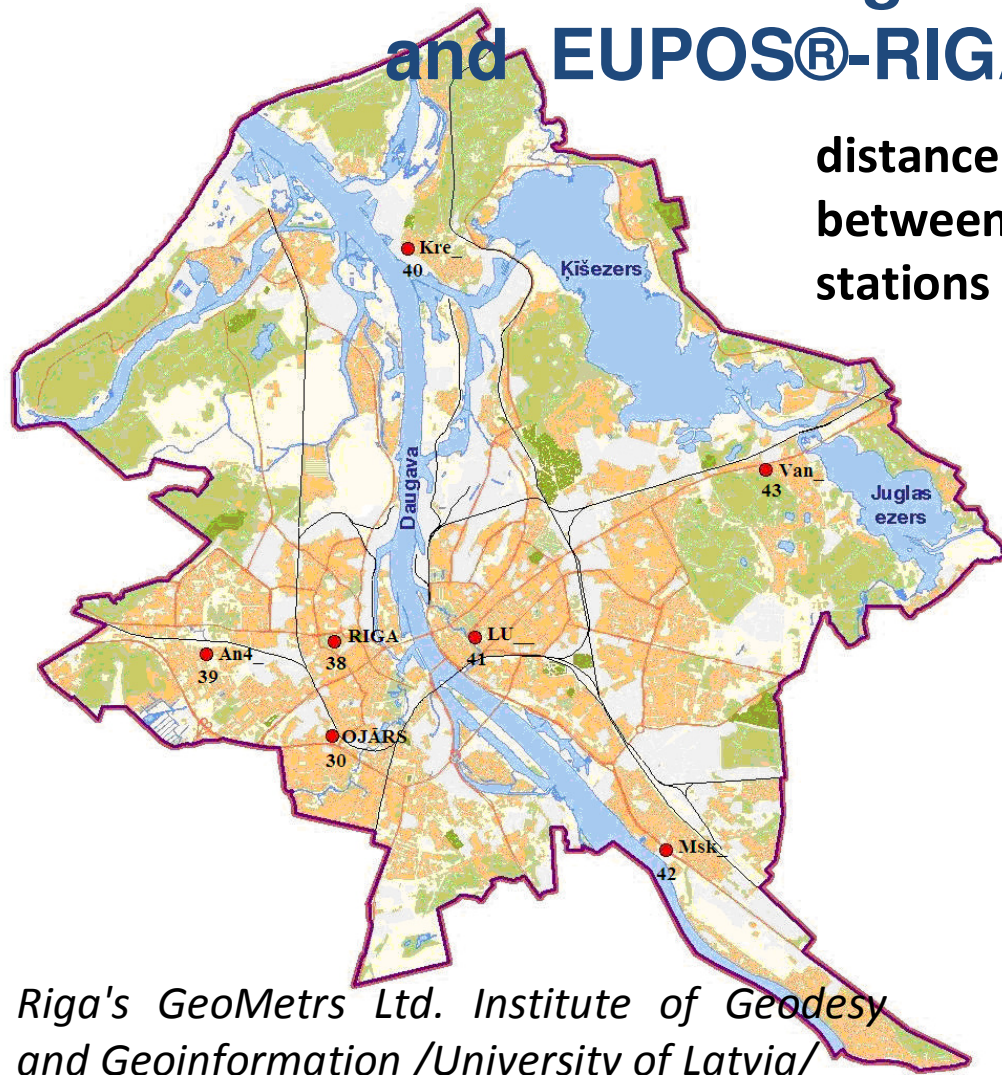
*Latvian
Geospatial
Information
Agency*



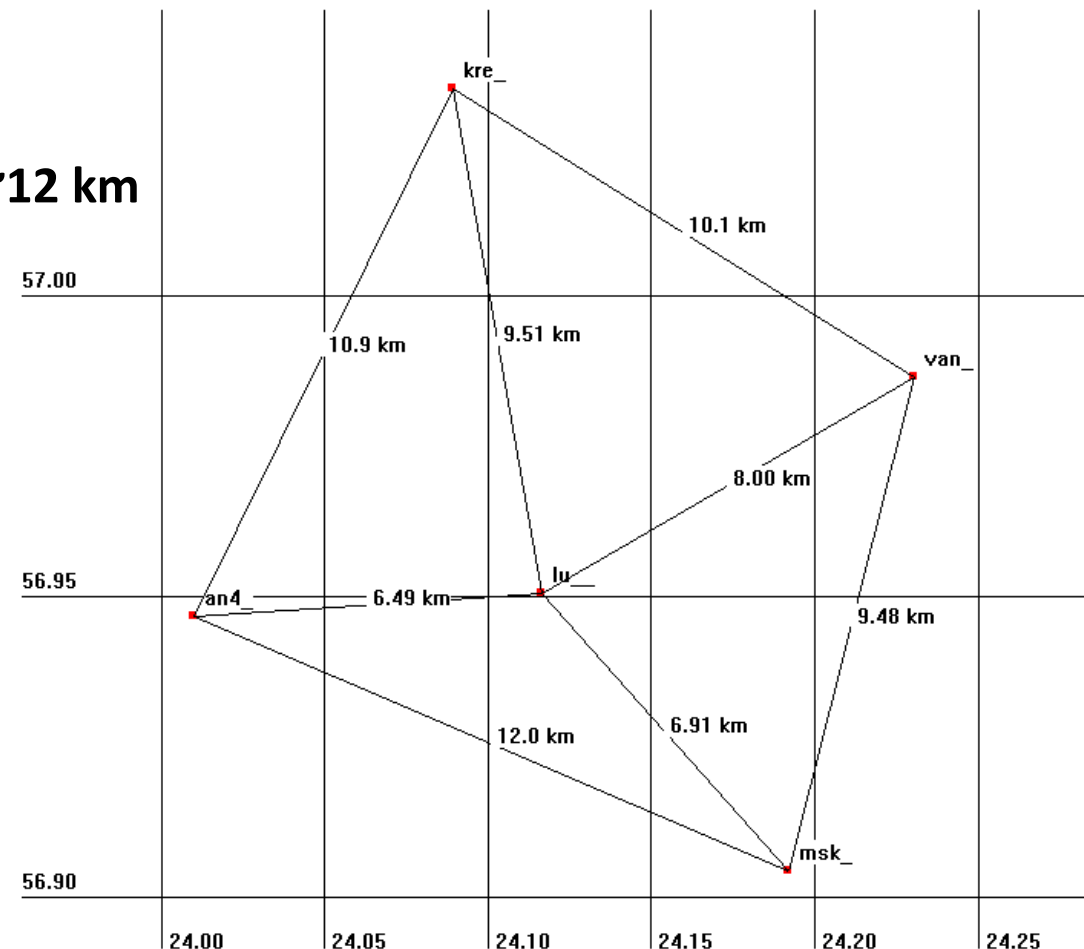
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J.Balodis, I.Janpaule, I.Jumare, K.Morozova, M.Normand, A.Zarinsjh, J.Zvirgzds

GNSS stations in Riga: RIGA1884, OJAR (LATPOS) and EUPOS®-RIGA network (5 base stations)



distance
between
stations ~12 km

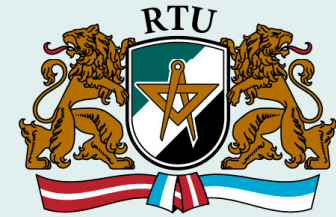


Riga's GeoMetr's Ltd. Institute of Geodesy
and Geoinformation /University of Latvia/

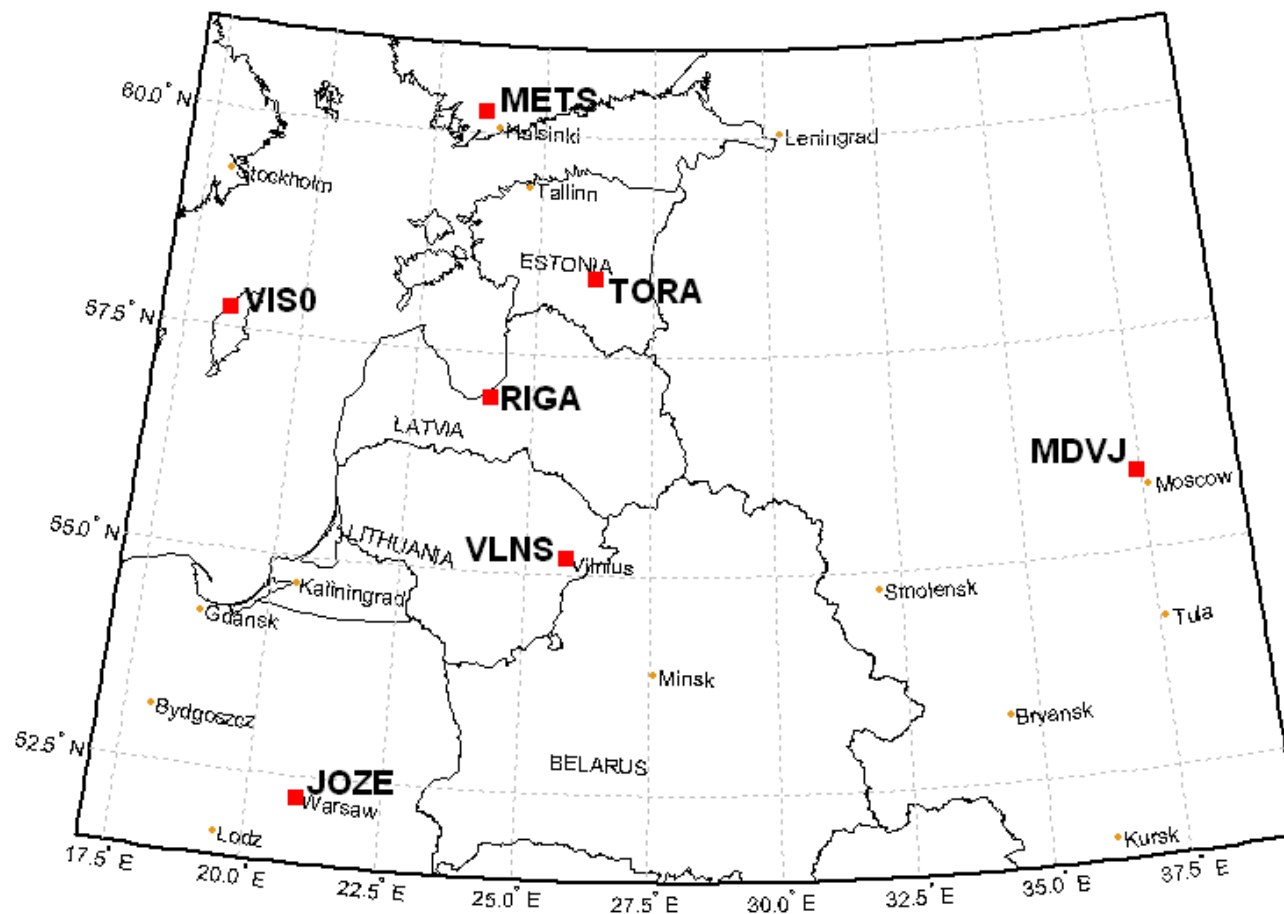
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EPN Reference Stations

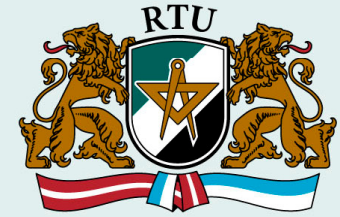


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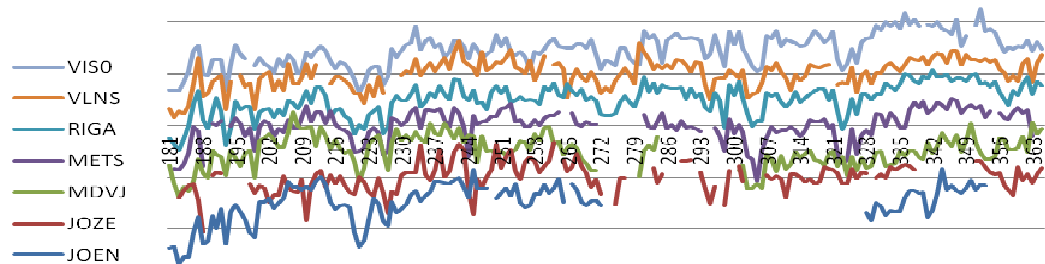
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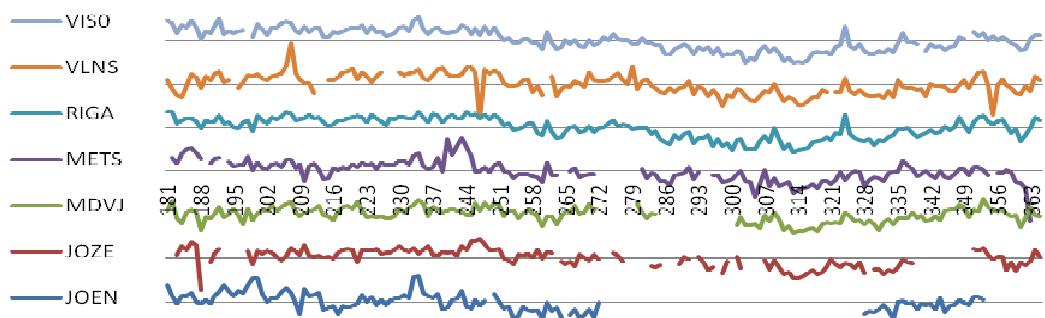
Reference station coordinate time series

(time series shifted in order to place in single figure)

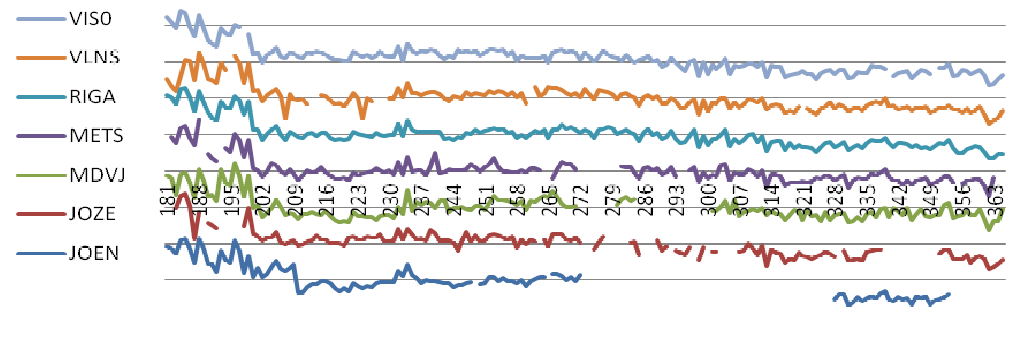
Height changes 2008 (jul-dec)



Easting changes 2008 (jul-dec)



Northing changes 2008 (jul-dec)

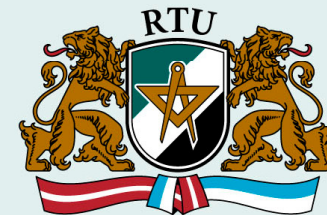


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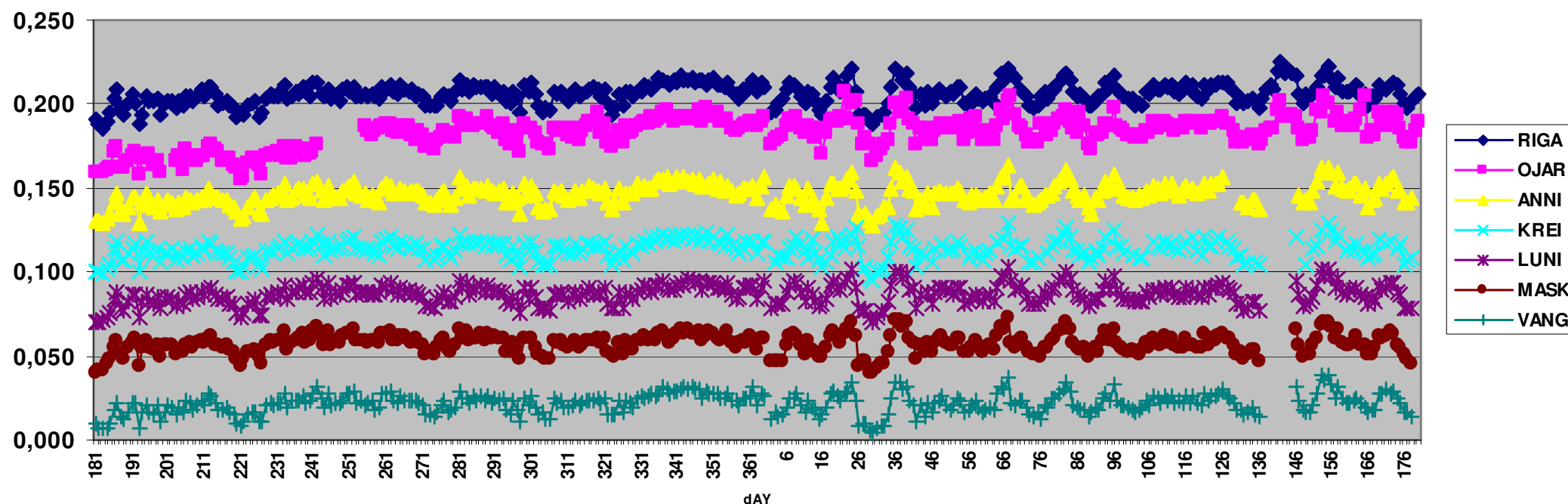
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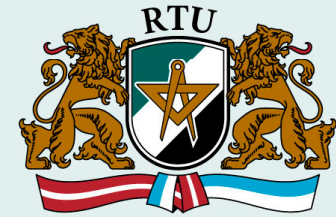
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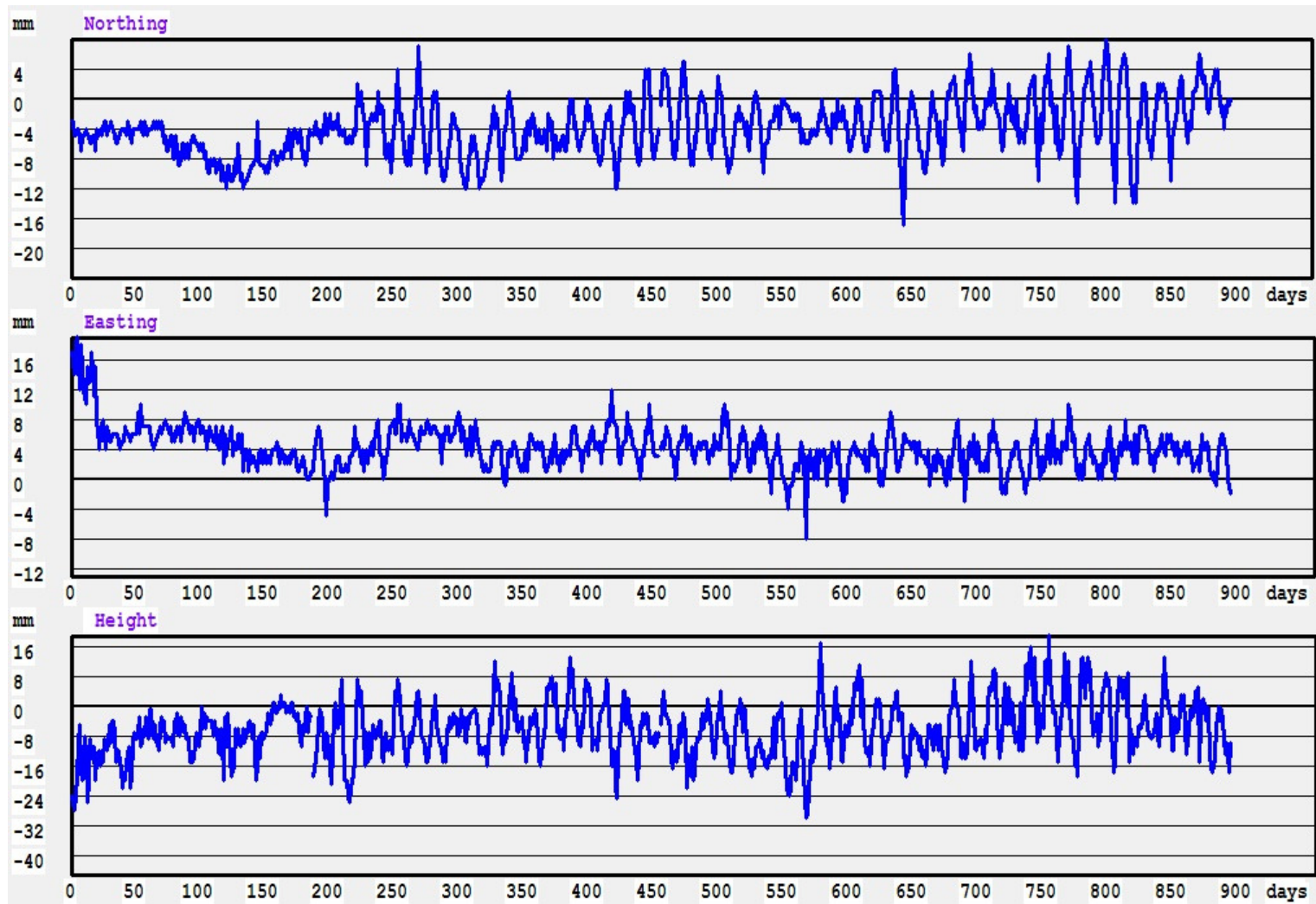
hHEIGHTS D181(2008) - D180(2009)



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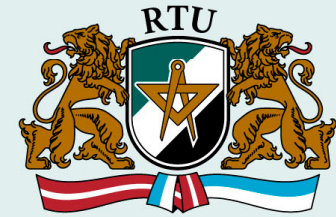
EPN/IGS STATION RIGA



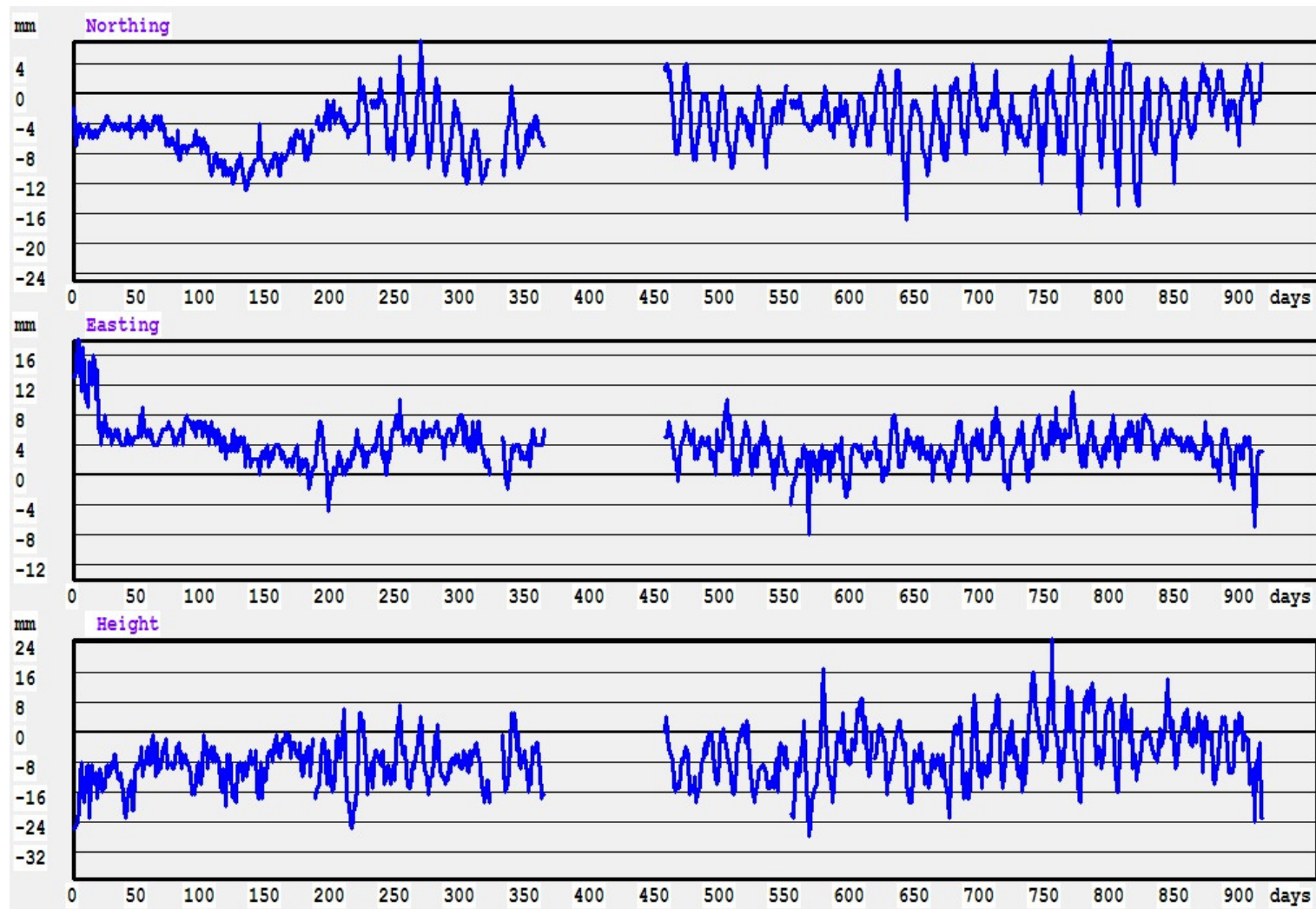
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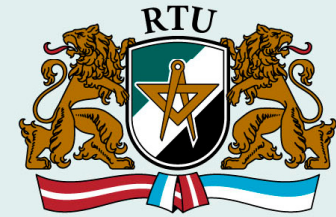
EUPOS-RIGA STATION LUNI



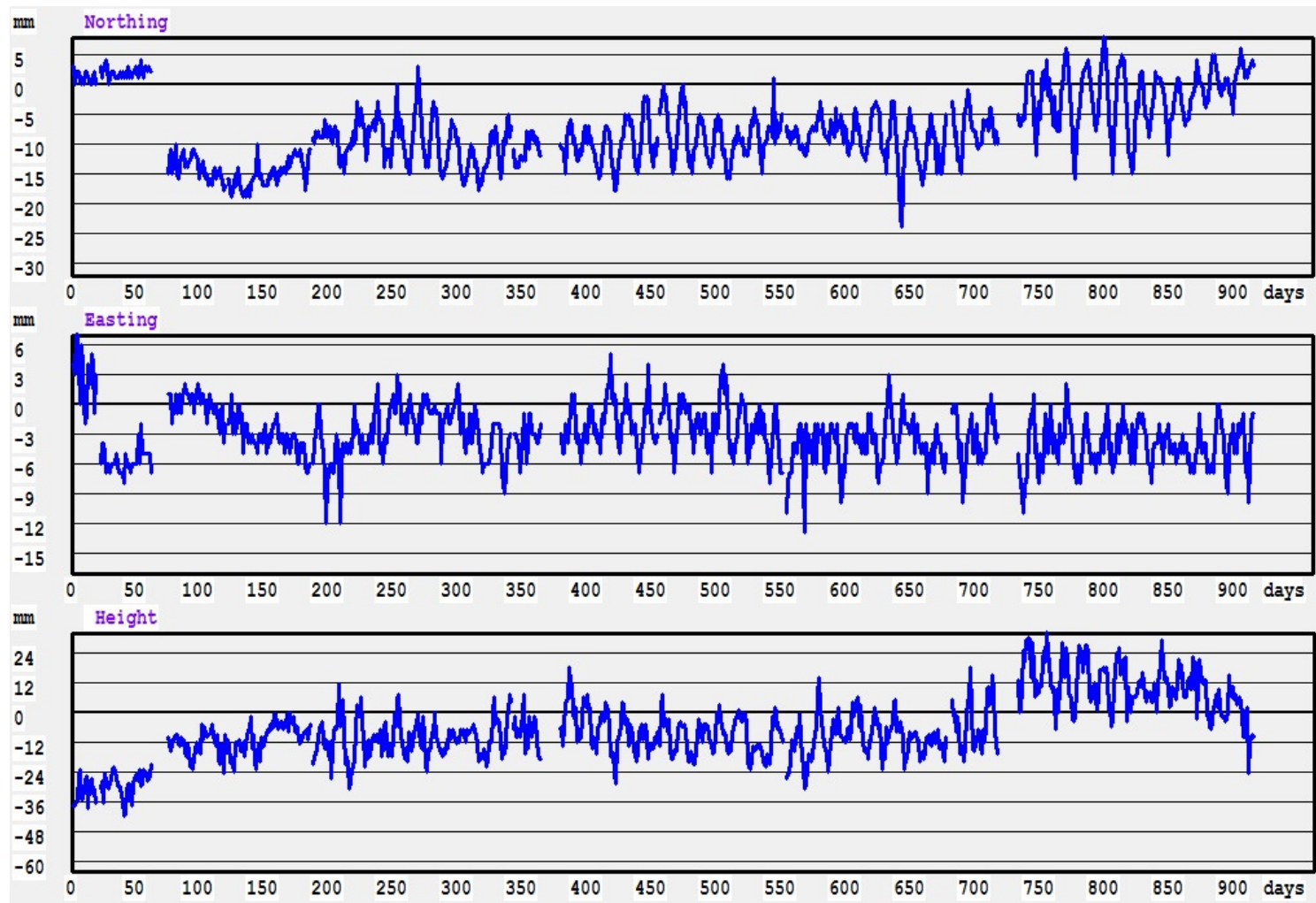
LKS92 and ETRS89 coordinates of LATPOS and EUPOS®-Riga RTK networks

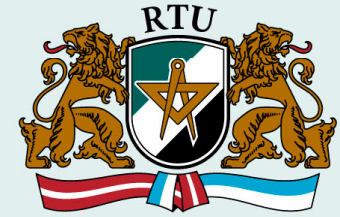
J.Balodis, I.Janpaule, I.Jumare, K.Morozova, M.Normand, A.Zarinsjh, J.Zvirgzds

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LATPOS STATION OJAR





Helmert transformation

$$\begin{pmatrix} \tilde{X}_i \\ \tilde{Y}_i \\ \tilde{Z}_i \end{pmatrix} = (1 + \mu) \begin{pmatrix} 1 & \gamma & -\beta \\ -\gamma & 1 & \alpha \\ \beta & -\alpha & 1 \end{pmatrix} \begin{pmatrix} X_i \\ Y_i \\ Z_i \end{pmatrix} + \begin{pmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{pmatrix}$$

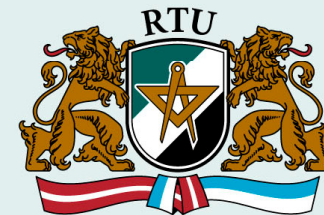
, kur

- $\tilde{X}_i$ - transformācijas vektors
- X_i - sākotnējais vektors

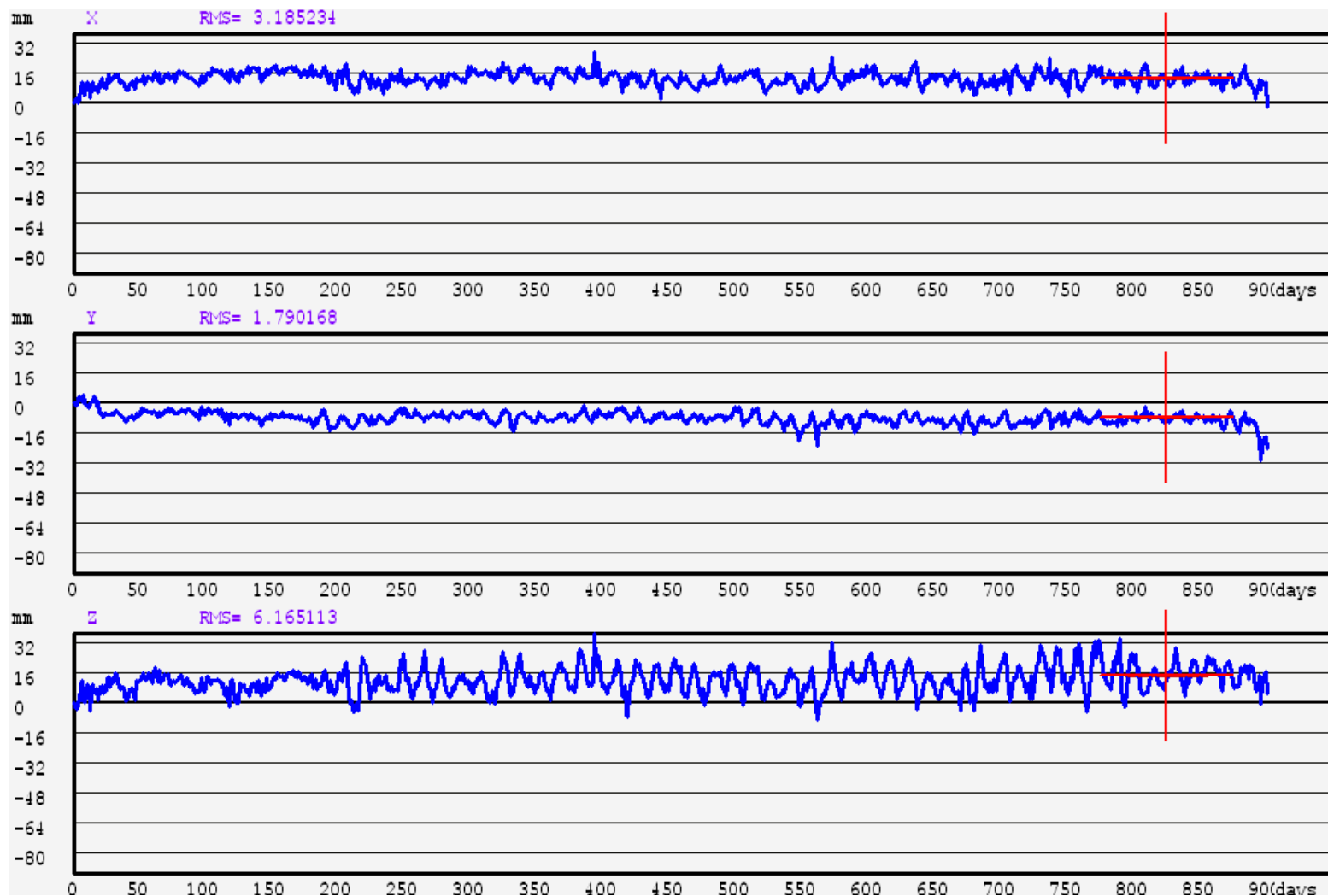
Parametri:

- ΔX - novirzes parametri
- μ - mēroga koeficients
- α, β, γ - rotācijas parametri

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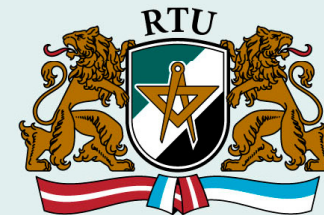
BAUS 2010



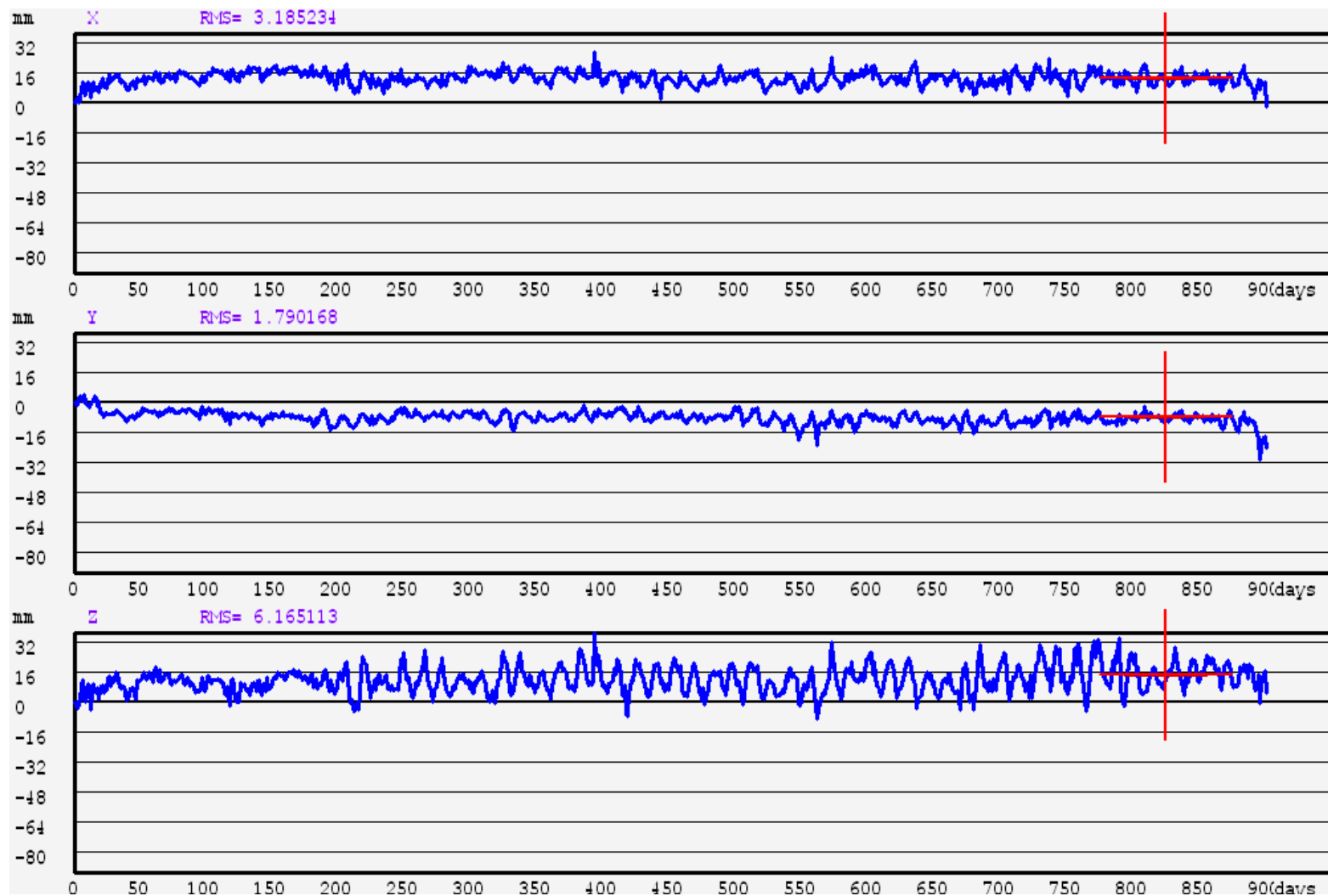
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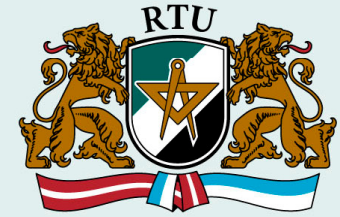


OJAR 2010



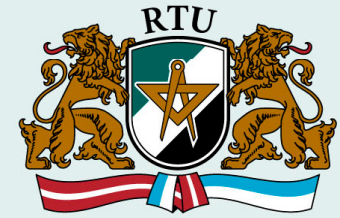
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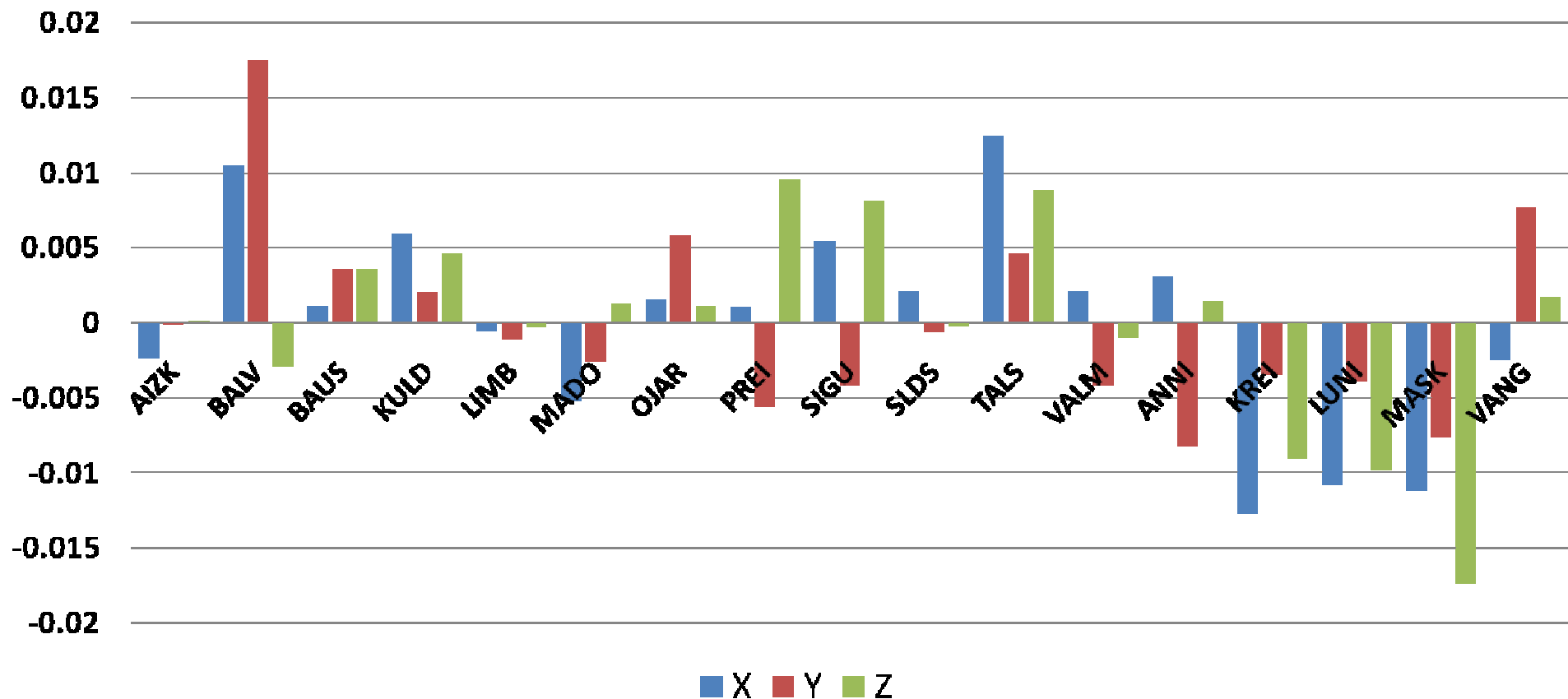


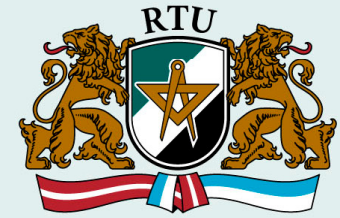
Helmert transformation 2010 LKS92→ETRS89

	PARAMETERS
ΔX (m)	0.711283931
ΔY (m)	1.051246726
ΔZ (m)	-0.506971373
μ (ppb)	-2.22178E-08
α (arc sec)	1.73464E-07
β (arc sec)	-1.33545E-07
γ (arc sec)	-4.83105E-08

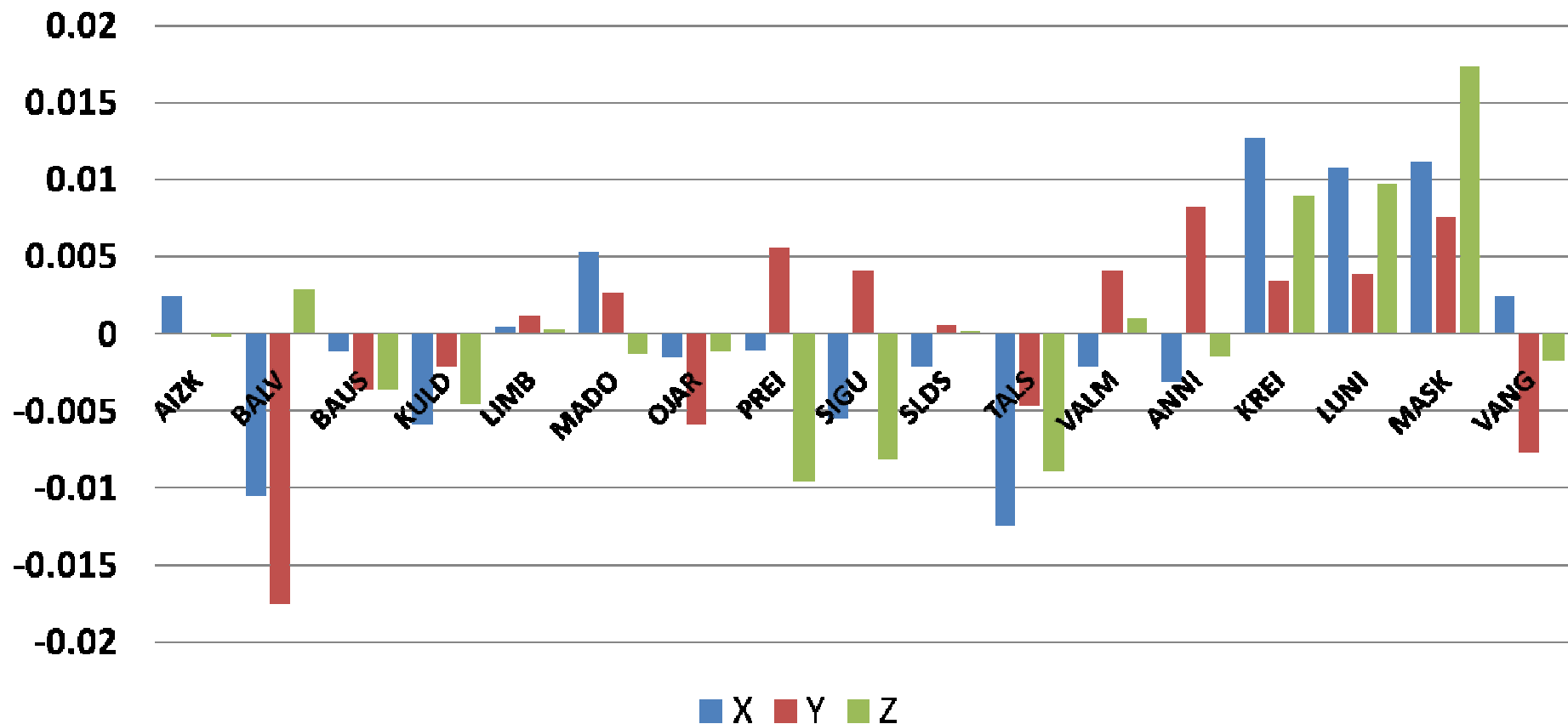


Helmert Transformation LKS92->ETRS89 Residuals 1 October 2010

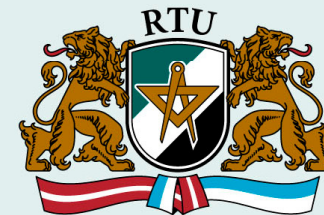




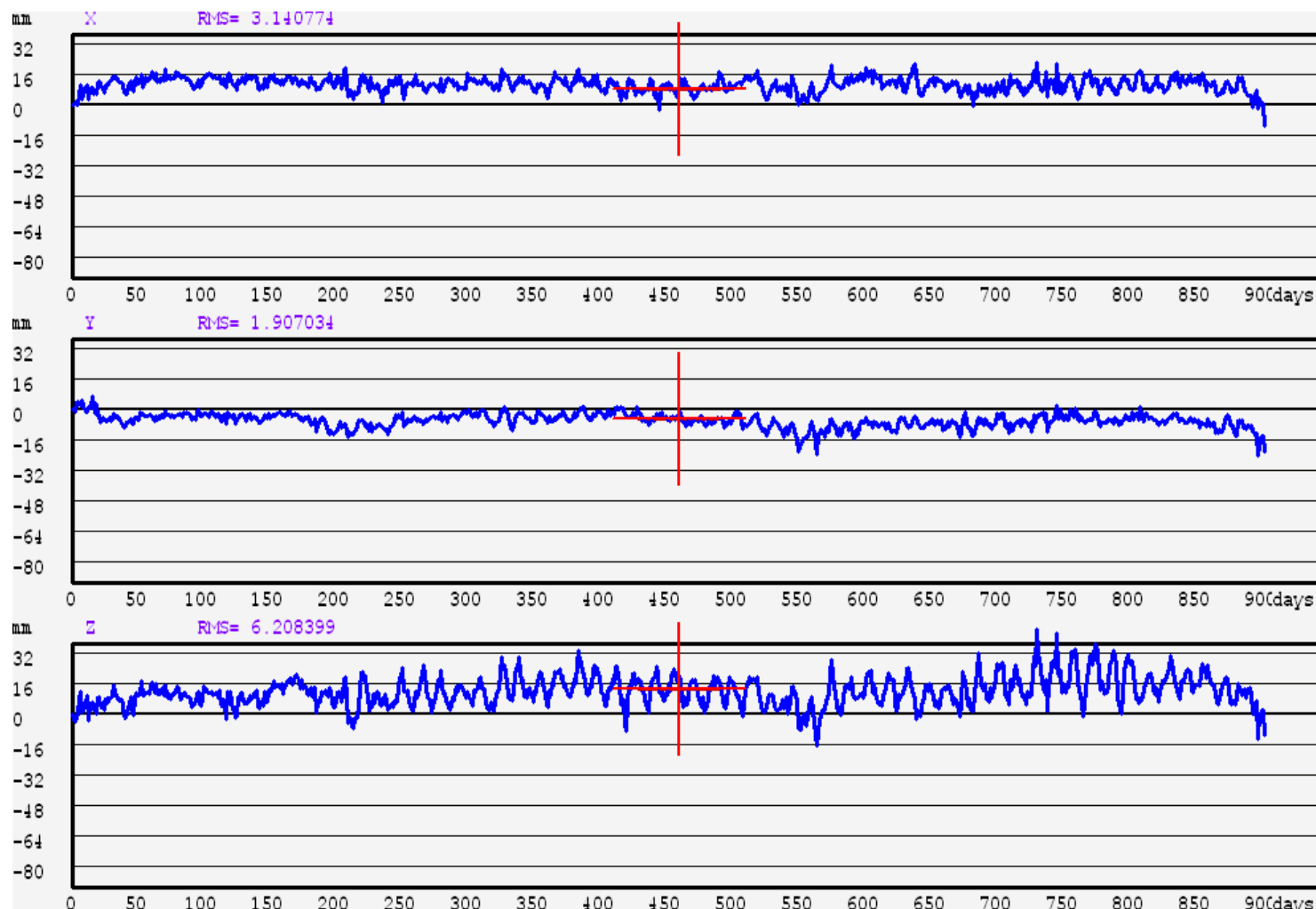
Helmert Transformation ETRS89->LKS9 Residuals 1 October 2010



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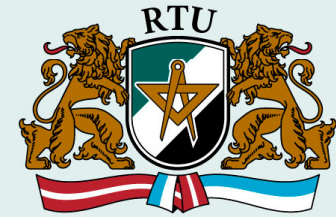
AIZK 2009



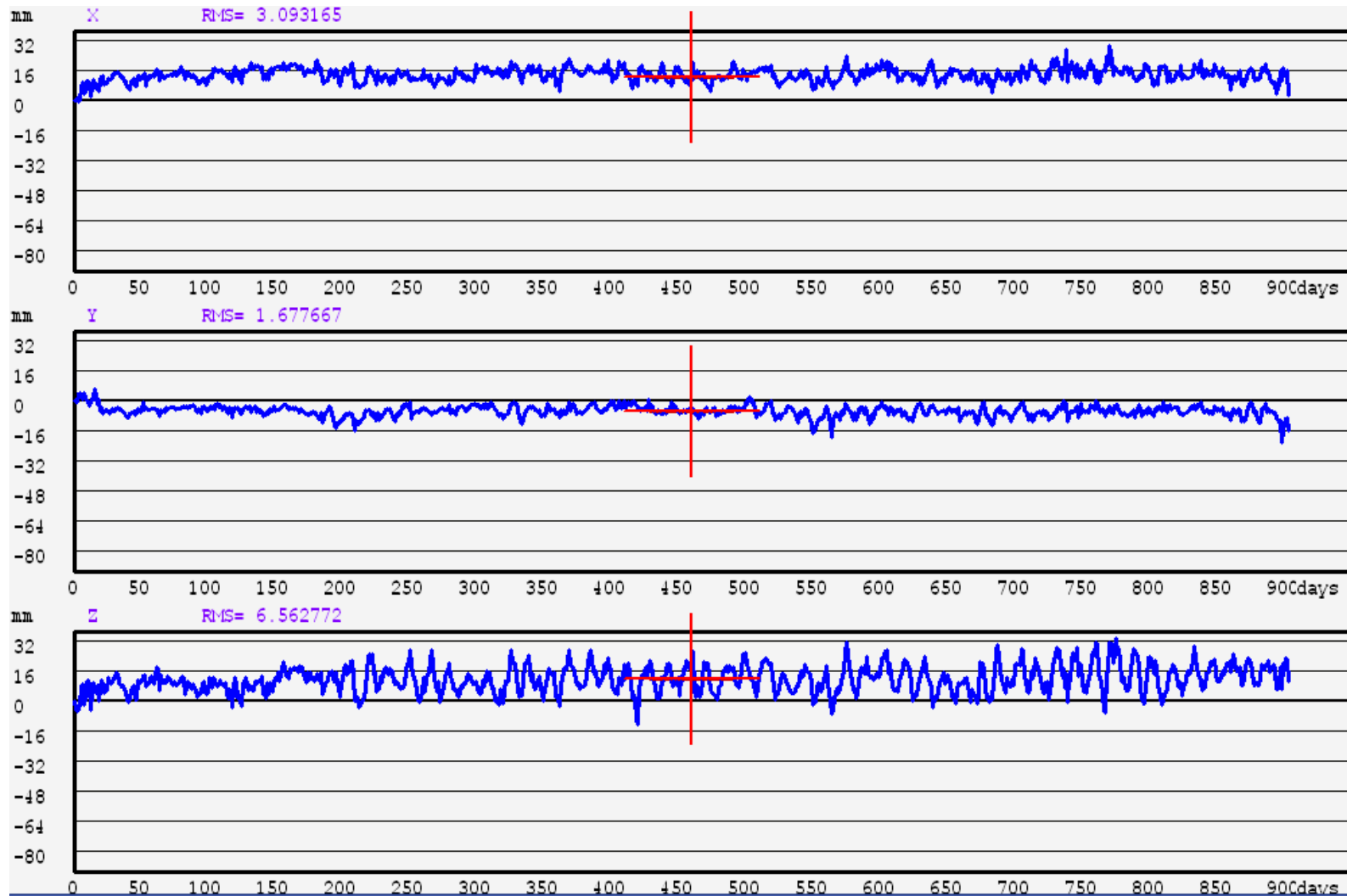
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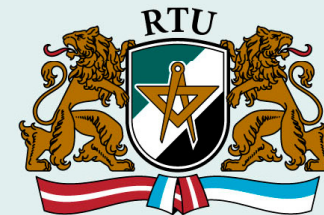


LIMB 2009

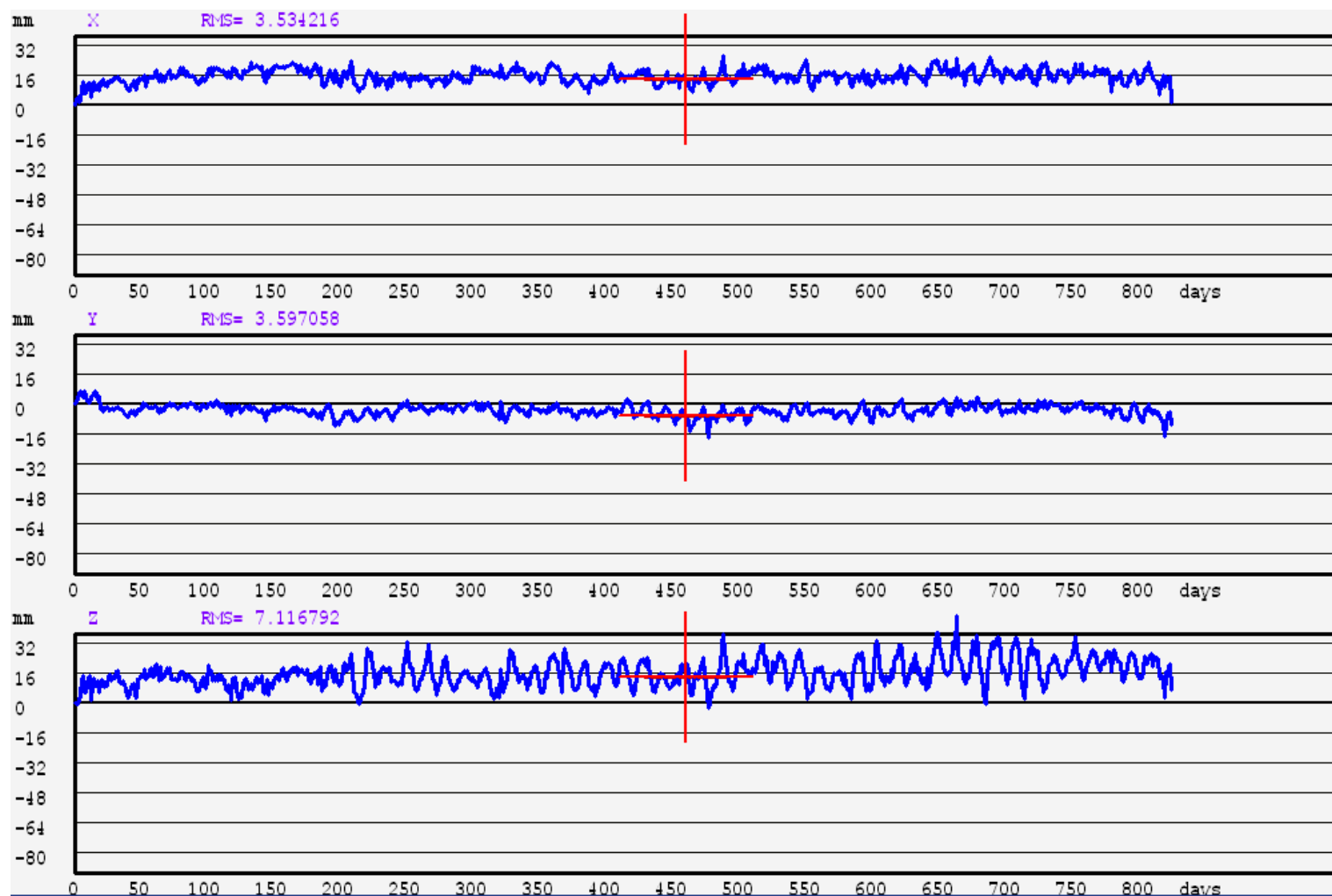


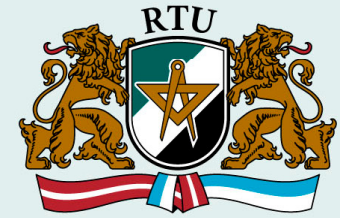
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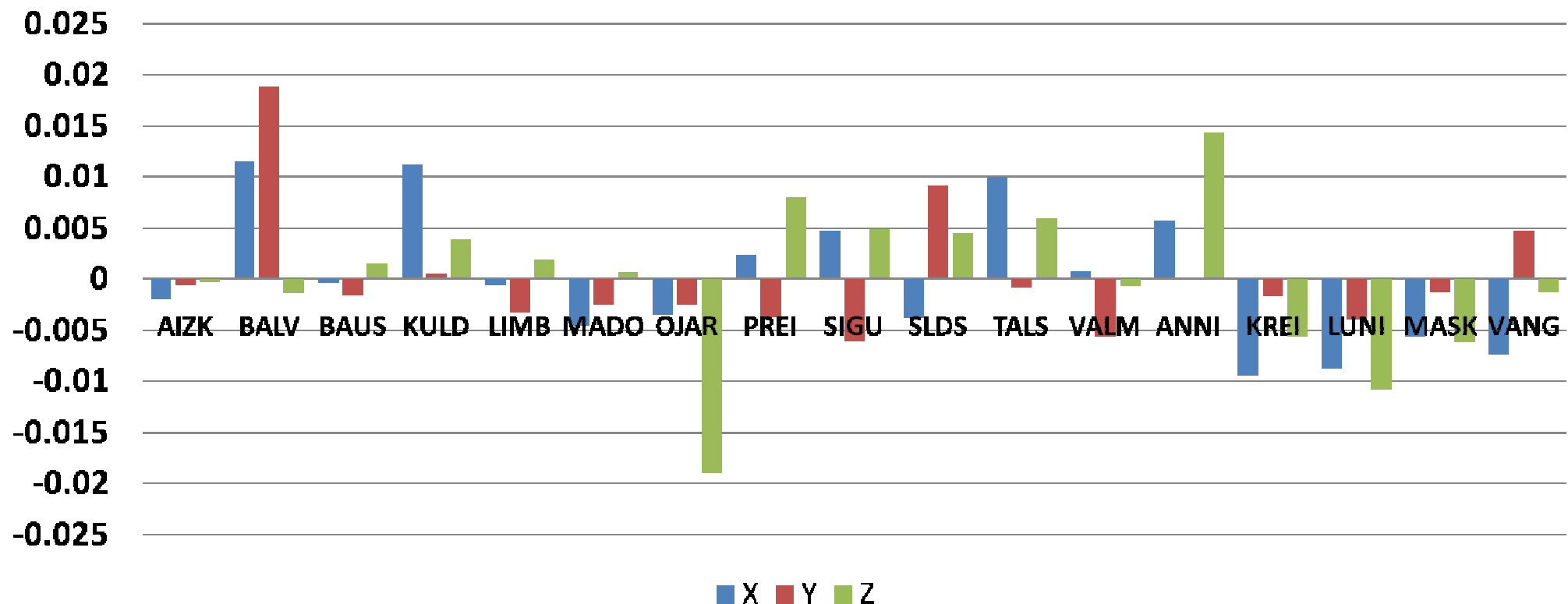


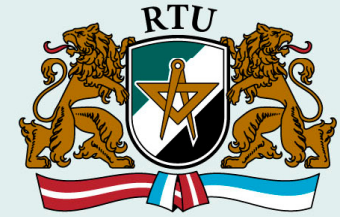
LUNI 2009





Helmert Transformation LKS92->ETRS89 Residuals 1 October 2009

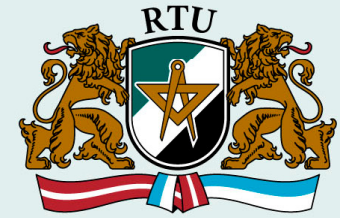




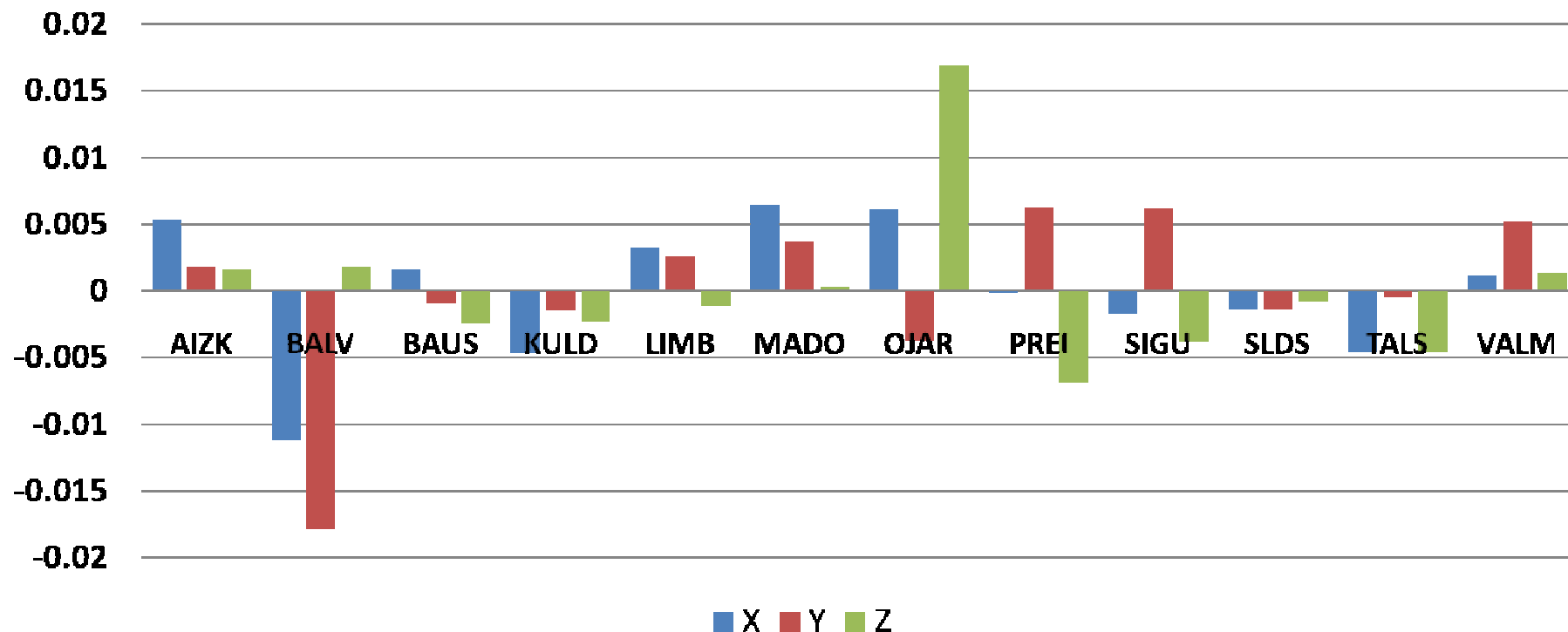
Helmert transformation 2009

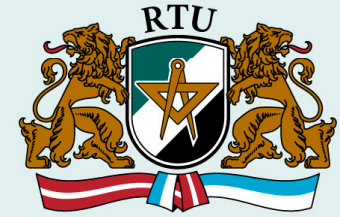
LKS92→ETRS89

	PARAMETERS
ΔX (m)	0.762171251
ΔY (m)	0.969984516
ΔZ (m)	-0.377102031
μ (ppb)	-4.09054E-08
α (arc sec)	1.59902E-07
β (arc sec)	-1.29312E-07
γ (arc sec)	-3.64685E-08



Helmert Transformation ETRS89-->LKS92 LATPOS only Residuals

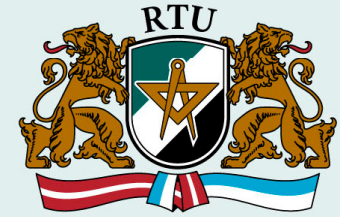




Helmert transformation ETRS89→LKS92 LATPOS

	PARAMETERS
ΔX (m)	-0.82358903
ΔY (m)	-0.923248141
ΔZ (m)	0.503609567
μ (ppb)	2.6965E-08
α (arc sec)	-1.63299E-07
β (arc sec)	1.44616E-07
γ (arc sec)	2.23018E-08

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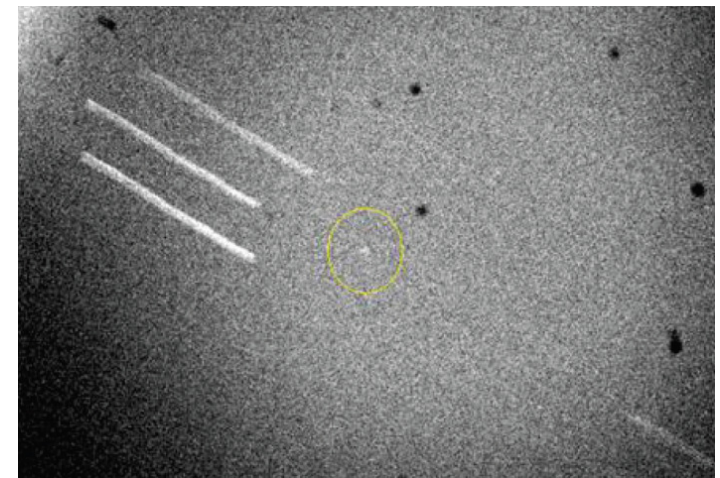
Satellite Laser Ranging system for LEO satellites



SLR for LEO ranging

Date	Satellite	Points	RMS (cm)	NP	RMS (cm)
[Noisy data visualization]					

SLR test results

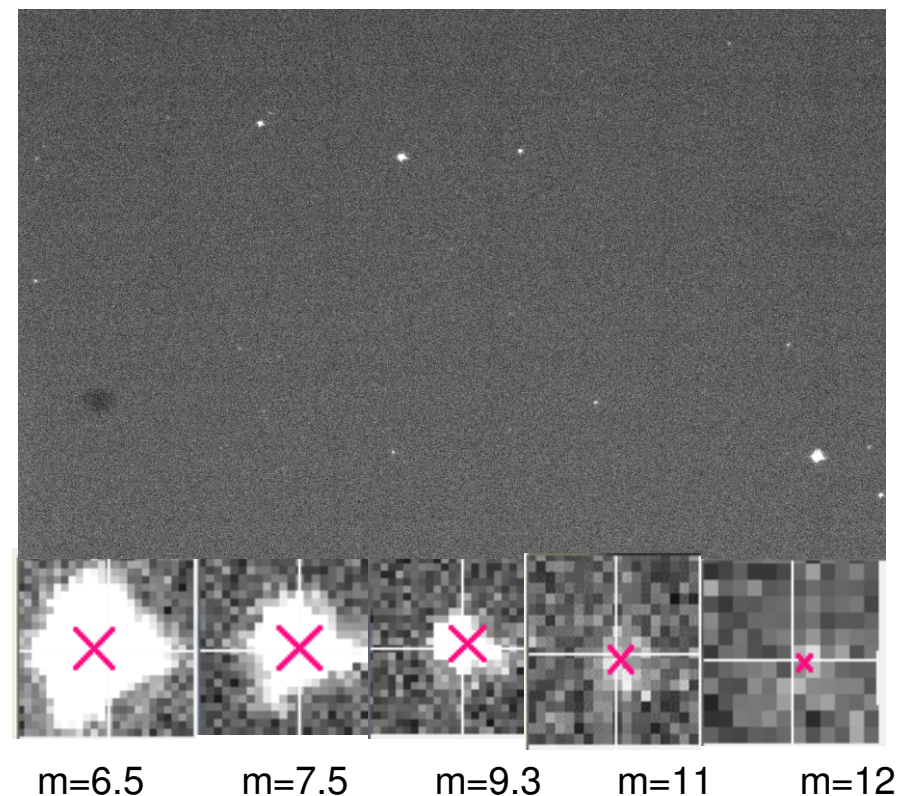


LAGEOS satellite observation using SLR

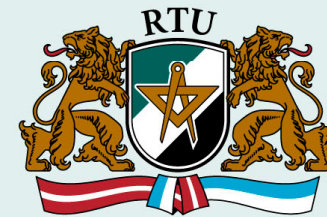
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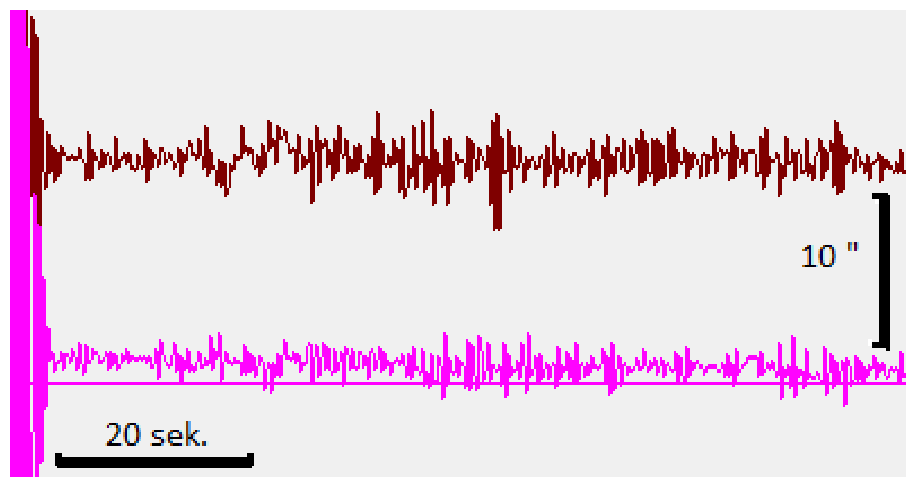
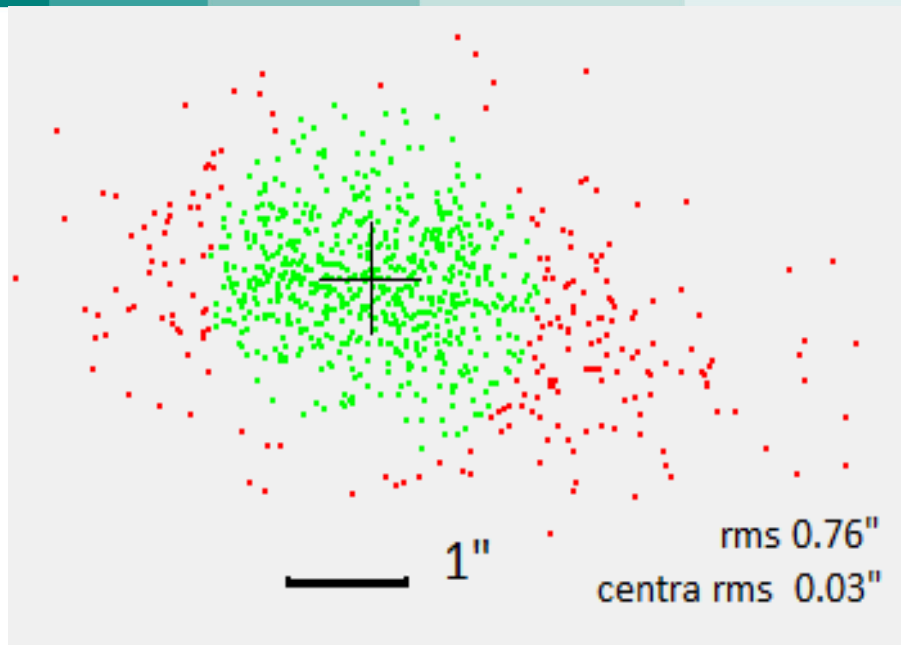
Digital zenith camera for studies of vertical deflection

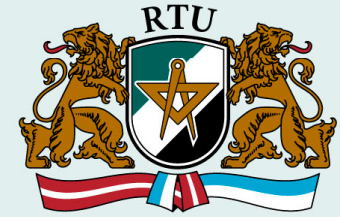


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Līmeņrāža nolasījumi

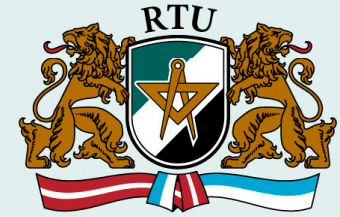




Conclusions

- LKS92 framework is an ETRS89 realization in Latvia. It has been applied during 20 years for cadastre and mapping.
- Time series of LATPOS and EUPOS-RIGA networks calculated in ETRS89 framework.
- Helmert transformation parameters are calculated to convert LKS92 coordinates in ETRS89 and otherwise.
- The antenna calibration effect is one of the reasons for LATPOS and EUPOS-RIGA transformation parameters.

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Thank You!

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