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LATVIAN DIGITAL ZENITH CAMERA IN TEST APPLICATIONS

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Introduction

Development of a digital zenith telescope prototype, improved zenith camera construction and analysis of experimental vertical deflection measurements for applications in Latvian geodetic network has been performed at the Institute of Geodesy and Geoinformation (GGI), University of Latvia.

At first, the prototype camera has been constructed and tested. Original optical system, zenith camera construction design and control and data processing software was developed and hardware components were integrated.

A number of observation sessions were performed in Riga and outside Riga and a huge amount of observation data have been processed in order to evaluate prototype zenith camera properties, such as influence of fundament vibrations, convection, background lights, to find optimal structure of observation sessions.

Design of improved zenith camera construction, based on acquired experience, has been completed. Expected accuracy of vertical deflection measurements is about 0.1".

The task now is to acquire a representative set of real observations as a proof of digital zenith camera's qualities and capacity and to promote it's commercial use.

Prototype camera design

Astrometric and gravimetric subsystems of the prototype camera:

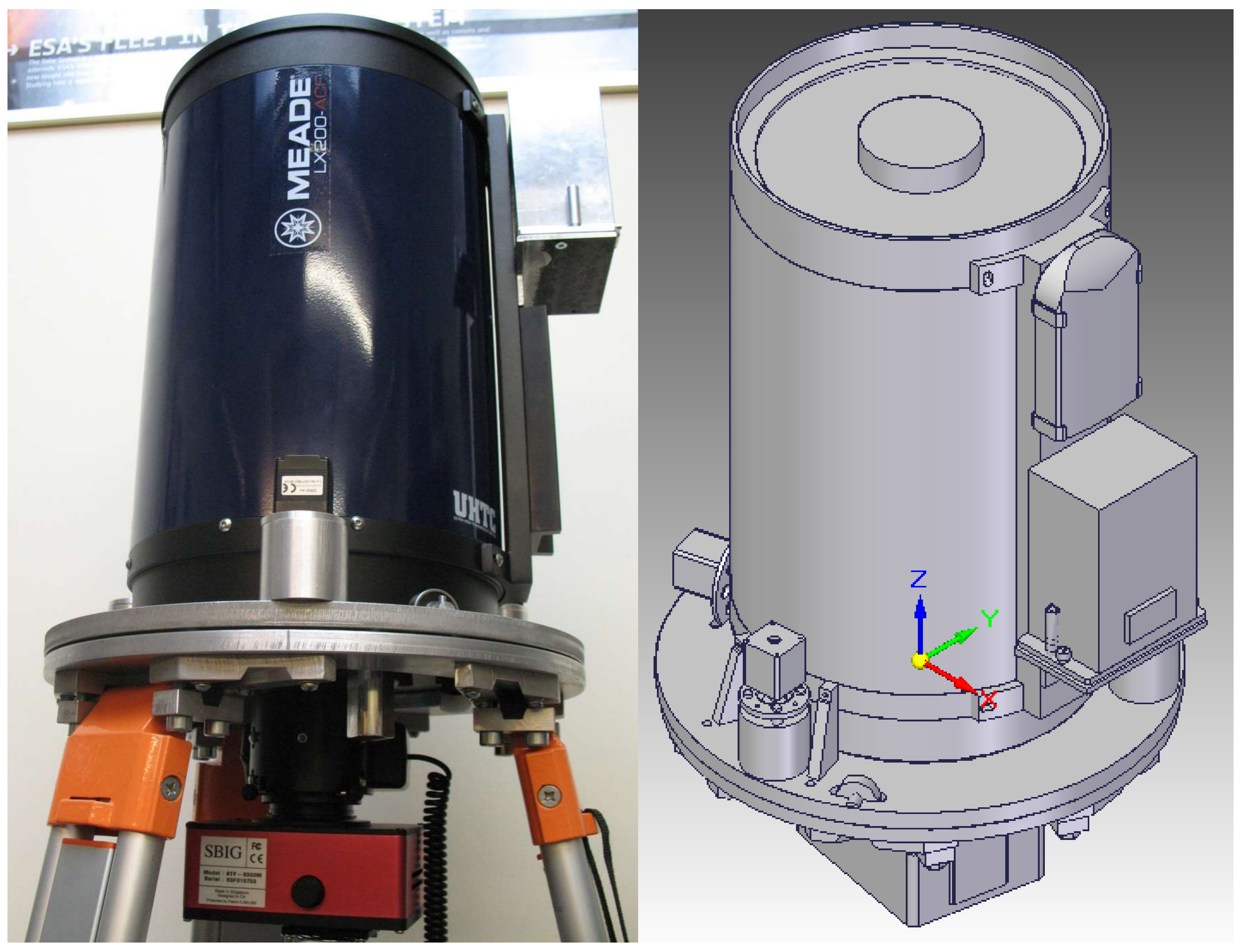
- 20 cm catadioptric telescope, F=1373 mm
- CCD field of view 0.35 x 0.27 dg, 1360 x 1024 pixels (CCD resolution ~1" per pixel)
- Reference star catalogue: subset of NOMAD *(Naval Observatory Merged Astrometric Dataset)* up to 15^m
- Reference stars per frame: 4 .. 23, average 12
- Star magnitude: 6^m ..13^m with 0.1-0.3 sec. expousure
- Source of apparent places: NOVAS (*Naval Observatory Vector Astrometry Software*)
- RMS of star image position: 0.3" .. 1.5", average 0.5"
- Zenith position accuracy for frame: 0.1" .. 0.2"
- Precision tiltmeter HRTM with 50 prad (~1e-5") resolution in +-2' range
- Time scale resolution: 0.1 mks

Digital zenith camera

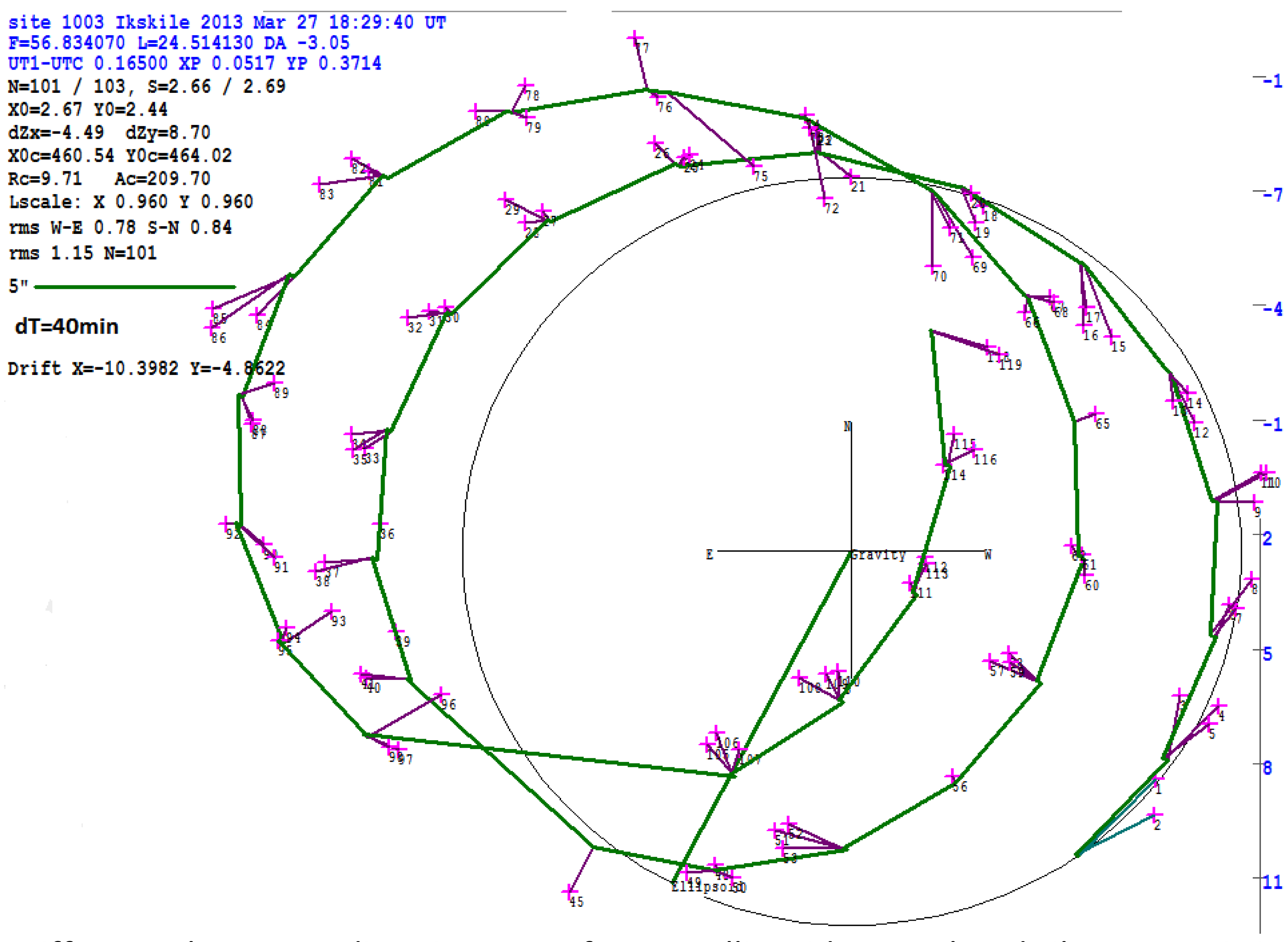
Continuing digital zenith camera project, a prototype camera has been built and an extensive test research carried out, looking for solutions and design elements which might present problems and should be improved [1]. In general, camera properties were found close to expected. The most problematic aspect of prototype camera was mechanical stability of camera assembly. Effects of thermal deformations during observation sessions were found to be a serious disturbing factor. Also, necessity to improve extent of automation was obvious. As a result, an improved camera design was made. It uses different approach to observation process – motorized leveling will be performed in each camera position before measurements, ensuring, that tiltmeter readings are always small and minimizing problems rising from tiltmeter scale and orientation uncertainty.

Subsystem improvements of the new camera:

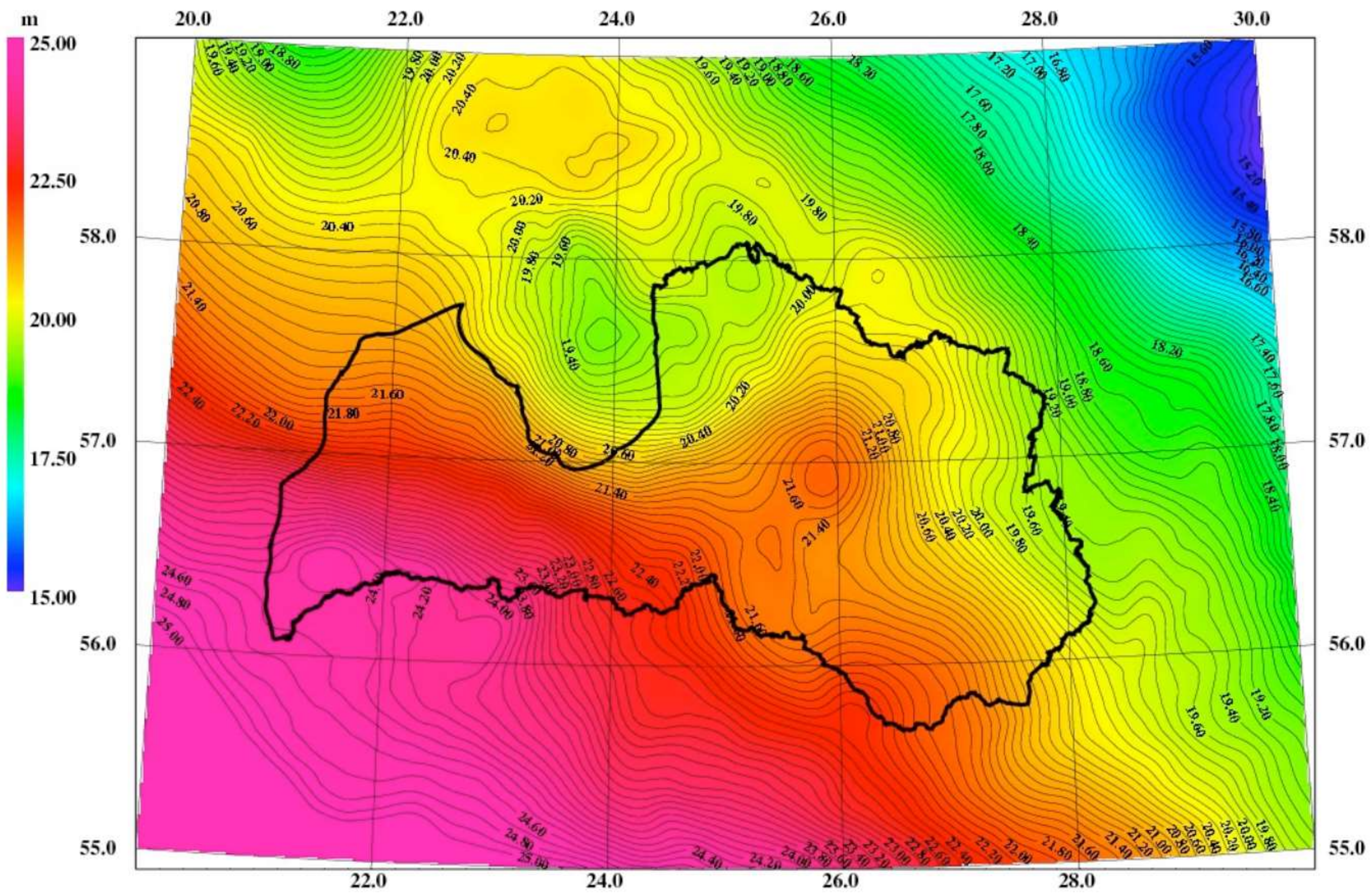
- 8 inch catadioptric telescope, F=2000 mm
- CCD field of view 0.5 x 0.39 dg, 3300 x 2500 pixels
- Star magnitude: up to 14^m
- Computer controlled levelling
- Wireless data transmission



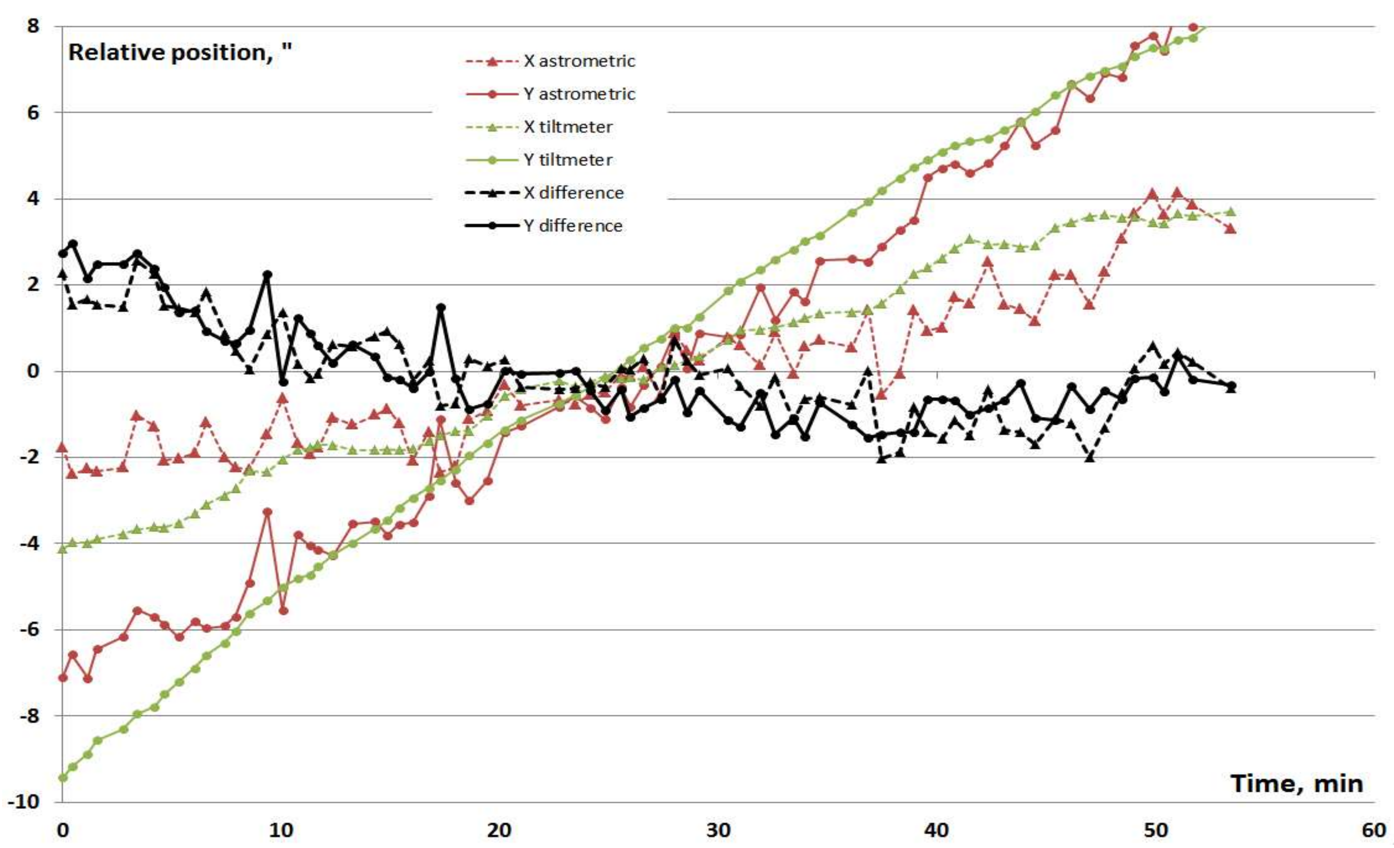
New camera design



Difference between directions to reference ellipsoid normal and tiltmeter axis in rotating coordinate system. In ideal circumstances it should make circle with radius of plumb line deflection value (shown by thin black line). In reality, thermal deformations changes tiltmeter axis direction relative to optical system, resulting in spiraling trajectory.



LV'98 – Latvian geoid model from gravimetric and ERS-1 data [2]



Drift of plumb line and ellipsoidal zenith positions and difference of them in instrument coordinate system. Some bending of instrument assembly has occurred besides tilting of support surface, resulting in decidedly non-linear drift of tiltmeter and imager relative orientation. Observation sessions must be short (a few minutes) to avoid most of effects of this bending or include them in linear drift model.

References

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2. Kaminskis J. Latvijas ģeoīda modelis un tā attīstība. Promocijas darbs. Rīga: RTU, 2010. - 150 lpp (ISBN 978-9934-507-27-4).

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