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FODITS: A Time Series Analysis Tool

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L. Ostini (1), R. Dach (1), M. Meindl (1), U. Hugentobler (2), S. Schaer (3), G.Beutler (1)

(1) University of Bern, Astronomical Institute, Bern, Switzerland
(2) Technische Universität München, IAPG, Munich, Germany
(3) Federal Office of Topography, swisstopo, Wabern, Switzerland

INTRODUCTION

Today many reprocessing efforts of GNSS data are initialized for global, regional, or even local networks. Such homogeneously processed time series are the basis for many geophysical and geodetic applications.

Nevertheless they may contain discontinuities and outliers (e.g., due to equipment changes or environmental effects). Because of the big number of stations and the length of the time series over many years an automated tool is necessary to detect such events.

Recently the Bernese GPS Software (BSW, Dach et al. 2007) has been extended by the program FODITS (Find Outliers and Discontinuities in Time Series, Ostini et al. 2009). Basically, the program provides the following functionality:

- Test for significance known predefined equipment changes (e.g., antanna change) and known geophysical signals (e.g., earthquakes) in time series.
- Identify epochs of unknown discontinuities, velocity changes, and outliers, and, identify periods of unknown periodic functions in time series.
- Feedback of time series analysis results to the program ADDNEQ2 of BSW for a more consistent solution of station coordinates and velocities.

Moreover, FODITS has the following features:

- Combined analysis up to three components.
- The variance information may be considered.

The algorithm implemented in FODITS is intended to analyze GNSS coordinate time series but can also be applied to other GNSS derived time series (e.g., DCB, RPR, etc).

ALGORITHM OF FODITS

The Nassi-Schneidemann diagram of the algorithm implemented in FODITS is given in **Figure 1**. The input and output files are in internal formats of the BSW for station coordinates (CRD), velocities (VEL), residual time series (PLT), and station information (STA). A detailed description is given in Ostini et al. (2009).

The three main parts of the algorithm are

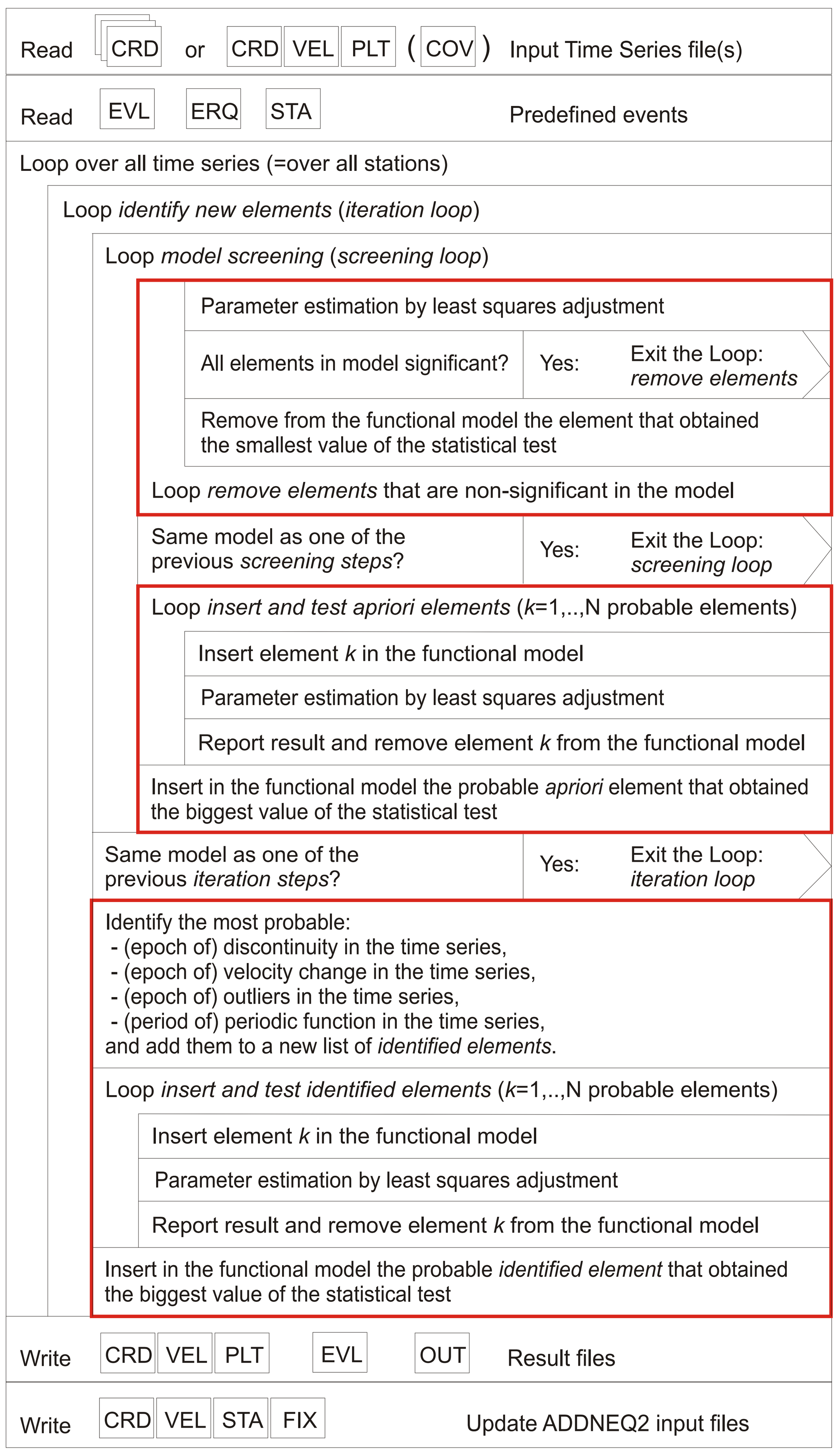

Fig: 1: Nassi-Schneidemann diagram of the algorithm.

highlighted in **Figure 1** by three red blocks and a graphical example of the functionality is given in **Figure 2.**

The first two red blocks in the diagram describe how a screening procedure works: step-by-step a priori predefined elements (e.g., equipment changes or geophysical events) are inserted in the functional model. At the same time non-significant elements are removed step-by-step. The remaining functional model only contains significant elements.

The third red block describes how the most probable element is sought to reduce the discrepancy between the residual time series and the functional model. The identification of new elements is illustrated in **Figure 2** by D-TST (for discontinuities), O-TST (for outliers), V-TST (for velocity changes), and P-TST (for periodic functions).

The algorithm stops as soon as no more additional elements significantly improve the functional model with respect to the time series.

EXAMPLES FOR FODITS ANALYSIS RESULTS

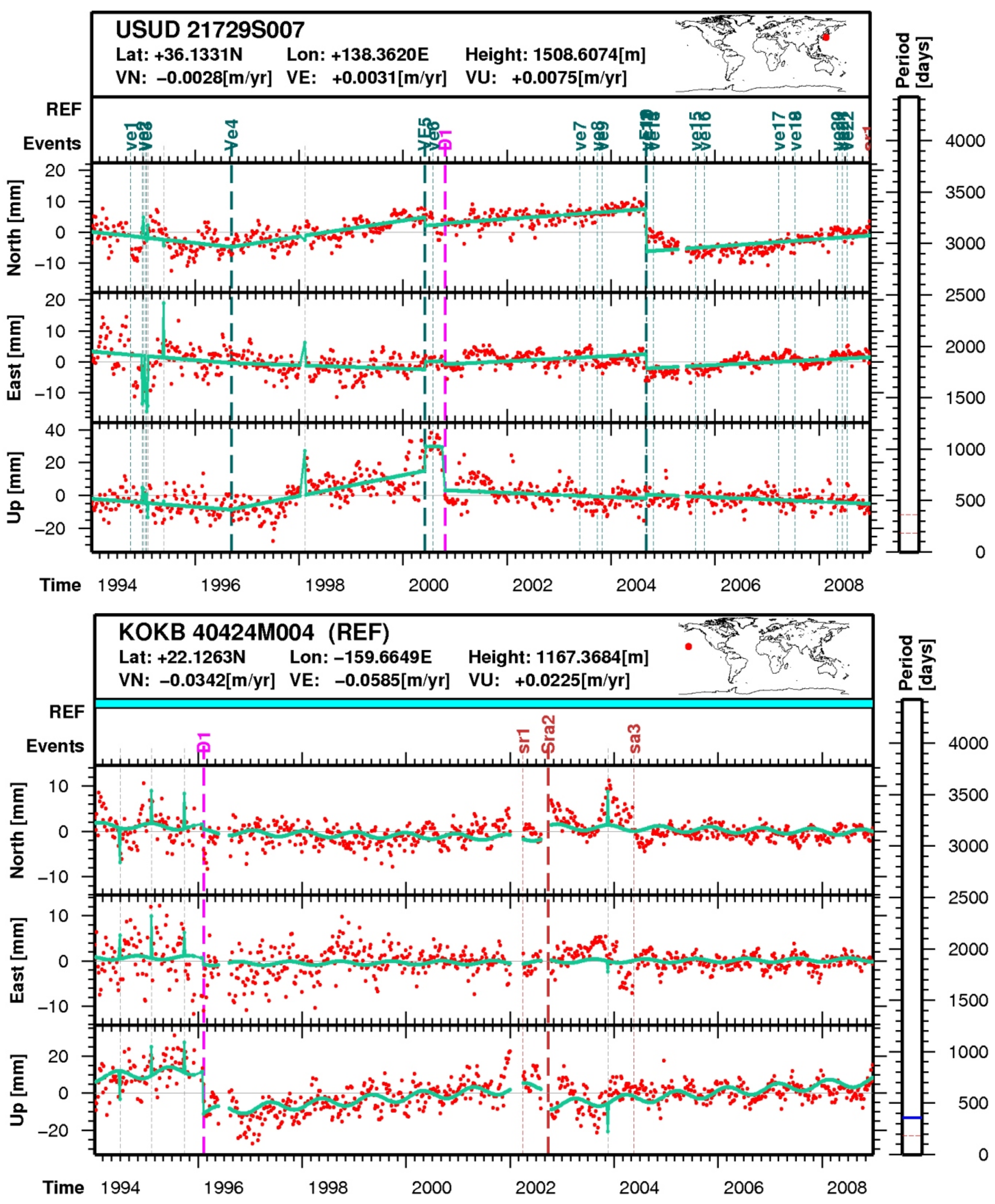

Fig: 3: FODITS analysis of CODE reprocessed weekly time series for the contribution to the IGS REPRO1 effort (Steigenberger, 2009).

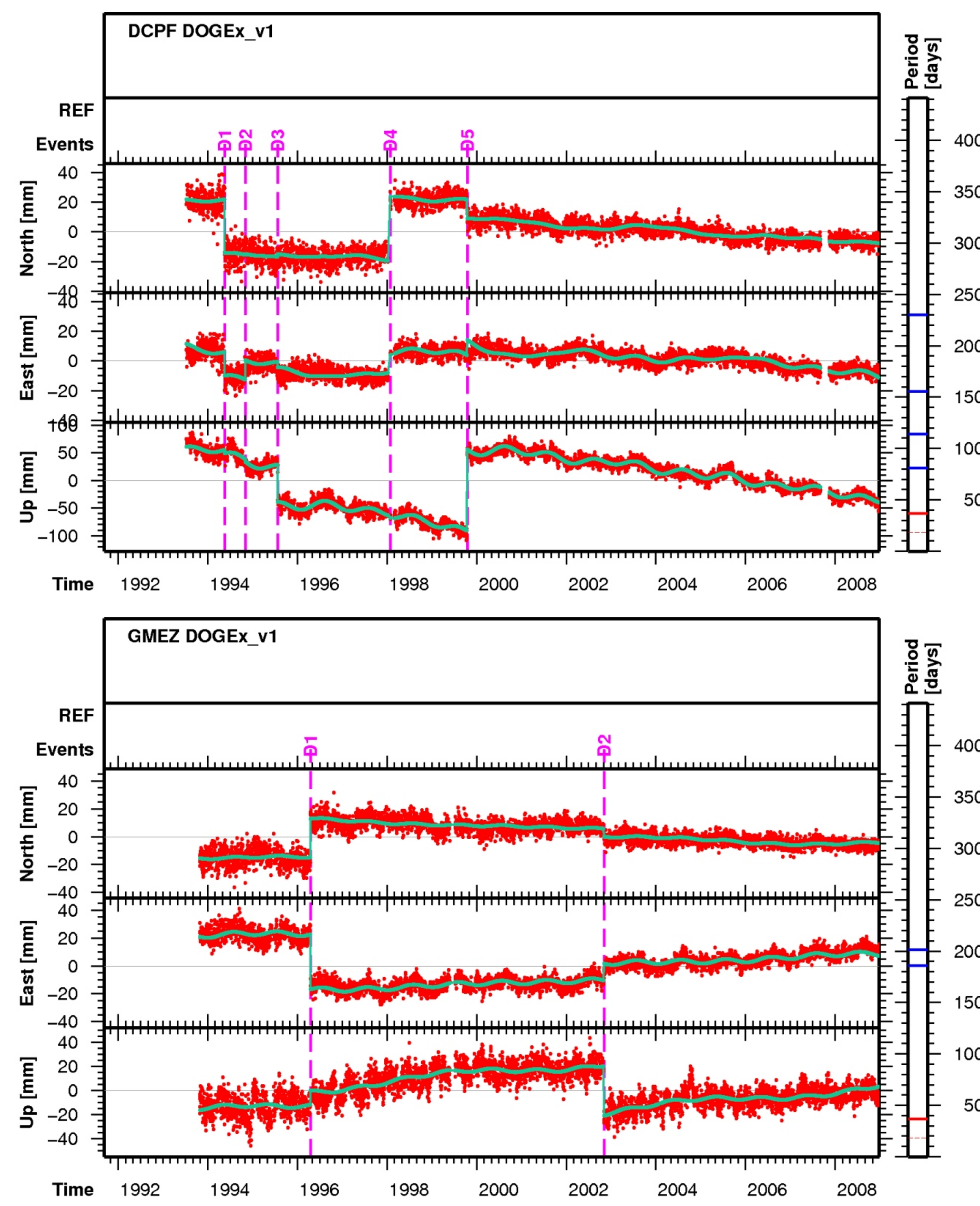

Fig: 4: FODITS analyzed time series for the community experiment DOGEx to test automated offset detection algorithms (King and Williams, 2010). For this experiment time series were declared to be without outliers and have one rate per component.

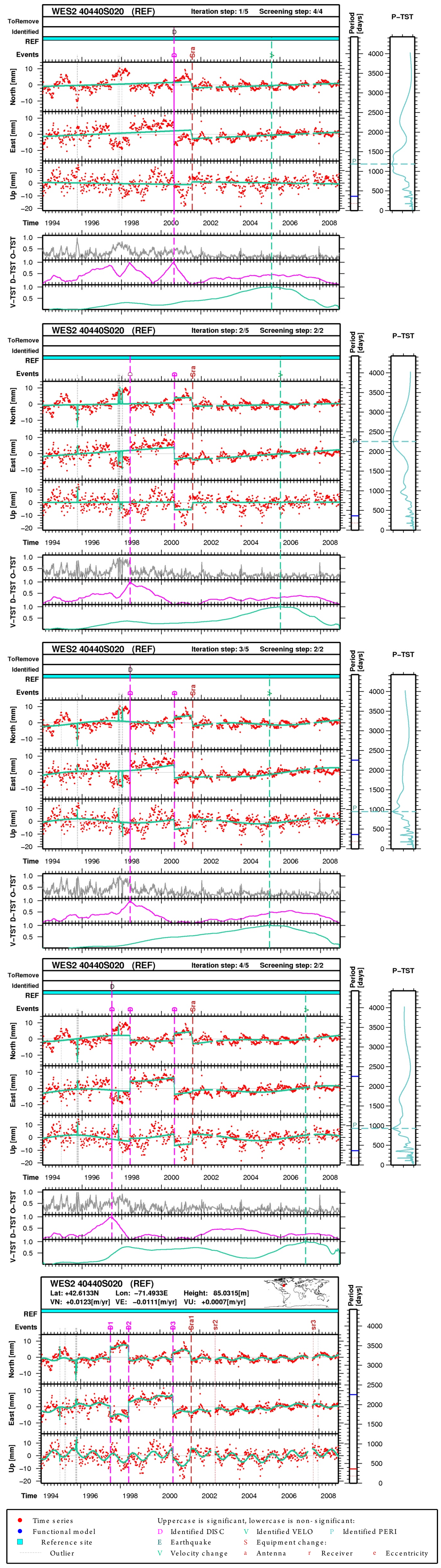

Fig: 2: Steps of the analysis for WES2 using FODITS.

References

Dach, R., U. Hugentobler, P. Fridez, M. Meindl, eds. (2007): *Bernese GPS Software*, version *5.0*. Astronomical Institute, University of Bern, February 2007.

Ostini, L., R. Dach, M. Meindl, S. Schaer, U. Hugentobler; (2009): FODITS: A New Tool of the Bernese GPS Software to Analyze Time Series. In Proceedings of EUREF 2008 Symposium, Brussels, Belgium, June 18-21, 2008.

Steigenberger, P., S. Schaer, S. Lutz, R. Dach, L. Ostini, U. Hugentobler, H. Bock, A. Jäggi, M. Meindl, D. Thaller: CODE Contribution to IGS Reprocessing: Status and Perspectives; European Geosciences Union General Assembly 2009, Wien, 21.04.2009.

King, M. and Williams S. (2010), DOGEx community experiment, http://www.cost-es0701.gcparks.com/working-groups/wg.

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Astronomical Institute, University of Bern
luca.ostini@aiub.unibe.ch

UNIVERSITÄT BERN