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VLBI real-time analysis by Kalman Filtering

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Geodetic Very Long Baseline Interferometry (VLBI) is one of the primary space geodetic techniques. It provides the full set of Earth Orientation Parameter (EOP) and is unique for observing long term Universal Time (UT1) and precession/nutation. Currently the VLBI products are delivered with a delay of about two weeks from the moment of the observation. However, the need for near-real time estimates of the parameters is increasing, e.g. for satellite based navigation and positioning or for enabling precise tracking of interplanetary spacecraft. The goal is thus to reduce the time span between observation and the final result to less than one day. This can be archived by replacing the classical least squares method with an adaptive Kalman filter.

We have developed a Kalman filter for VLBI data analysis. This method has the advantage that it is simultaneously possible to estimate stationary parameters, e.g. station positions, and to model the highly variable stochastic behavior of non-stationary parameters like clocks or atmospheric parameters. The filter is able to perform without any human interaction, making it a completely autonomous tool.

In this work we describe the filter and discuss its application for EOP determination and prediction. We discuss the implementation of the stochastic models to statistically account for unpredictable changes in EOP. Furthermore, additional data like results from other techniques can be included to improve the performance. For example, atmospheric angular momentum calculated from numerical weather models can be introduced to supplement the short-term prediction of UT1 and polar motion.

This Kalman filter will be extended and embedded in the newly developed Vienna VLBI Software (VieVS) as a completely autonomous tool enabling the VLBI analysis in near real-time and providing all the parameters of interest with the highest possible accuracy.