# ACCURACY UNIFORMITY OF HIPPARCOS PARALLAXES AND PROPER MOTIONS : STRATEGY AND CURRENT STATUS

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ABSTRACT. Even before the launch difficulties, it was planned to monitor the trend of the accuracy acquisition resulting from the adopted observing process and eventually to modulate the initial values of the observing strategy parameters whenever it may help correcting distorsions in the final uniforme accuracy. Of course this monitoring of accuracy acquisition became more important when, as a result of the revised orbit, large departures from the nominal observations take place. The observing strategy and the associated modulation process behave according to expectation and may smooth out on the long range inhomogeneities. However important effects due to the complete lack of long sequences of observations in the early period in some regions will not be compensated unless the real mission extends substantially beyond the end of 92.

## 1. Introduction

The final accuracy of Hipparcos data on individual stars result from the combination of observations made at different epochs whenever the path of the scanning law comes close to the star's position. Depending on how long the image dissector dwells on each star during each field crossing, the final accuracy may to some extent accumulate on a few privilegiate stars or on the contrary be evenly shared between all candidates. The image dissector is steered by an algorithm installed on the on-board computer (OBC) the so-called observing strategy. Observing strategy decisions are based on a small set of parameters assigned to stars on ground and transmitted to the OBC via the Program Star File (see for instance Perrryman and Vaghi 1989). The main parameters relevant to observing decisions are the *target observing time* and the *minimum observing time*. Both parameters have been computed a priori for each star on the basis of the stars magnitude and position and the nominal scanning law. Even before the launch difficulties, it was planned to monitor the trend of the accuracy acquisition resulting from this process and eventually to modulate the initial values of the observing strategy parameters whenever it may help correcting distorsions in the final uniforme accuracy. Of course this monitoring of accuracy acquisition became more important when, as a result of the revised orbit, large departures from the nominal observations were expected to take place.



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## 2. Monitoring and modulating the accuracy acquisition for individual stars

Knowing from the nominal scanning law the expected observation dates for each star, the target observing time per field transit being assigned, one can derive the expected number of photons at each date, the expected accuracy of the along scan position and finaly, recombining observations at different epochs and different great circle orientations, build a set of nominal observation equations for the final positions, proper motions and parallaxes. Thus nominal standard errors for the final astrometric parameters can be obtained. Then, whenever a star should be seen in one of the fields of view, the relevant nominal observation equation can be replaced by the one resulting from the actual observations. This is made by substituting the actual observing time instead of the nominal one (Crézé, Nicolet, Chareton, 1989).

Figure 1 illustrates this process for one of the stars which are currently monitored. The three parameters displayed are standard error ratios for the parallaxe, and the two components of the proper motion.

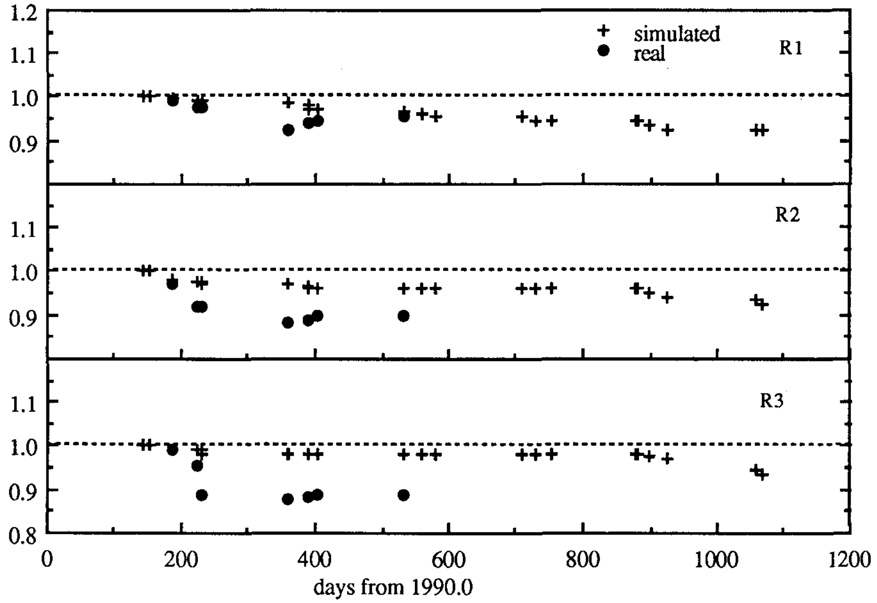


Figure 1. Evolution of the standard errors of the parallaxe, proper motion in longitude and proper motion in latitude (from top to bottom) with respect to nominal. Crosses are from simulations based on the nominal scanning law, dots from real observations.

R1= O.85 for instance at date T means that actual observations prior to date T have been such that, combined with nominal observations till the end of the mission (assumed here to be end 1992), they would result in a final standard error of the parallaxe 1/0.85 times larger than nominal.

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Crosses are standard error ratios obtained in a simulation of the observing strategy based ont the nominal scanning law. So crosses indicate in principle the best we can do taking into account the conflicting observing time requirements of stars present in the field at the same moment. Dots are the actual results from the real mission.

Obviously something happened during august 1990, resulting in a dramatic drop of the accuracy . Actually there has been a four-day loss of attitude control during this period. This loss turns out to be more effective on the proper motion components since in this early period of the mission, the time baseline for the proper motion determination is larger.
Once this underobservation has been detected, the observing parameters (target time and minimum time) uplinked to the satellite are artificially forced to higher values, hence Hipparcos will spend more time on underobserved stars. This process is currently called the modulated strategy. As a result the situation improves gradually at later dates, although proper motions do not improve that much because observations in the central part of the mission do not contribute efficiently in the proper motion accuracy. Conversely there may be (and there actually are) overobserved stars which can be down modulated.

## 3. Mapping the status of accuracy acquisition on May 1991.

On May 1991, a mapping of standard error ratios R1, R2 and R3 has been made for all Hipparcos stars, thus giving a global picture of the status of accuracy acquisition. The result is shown on Figure 2.

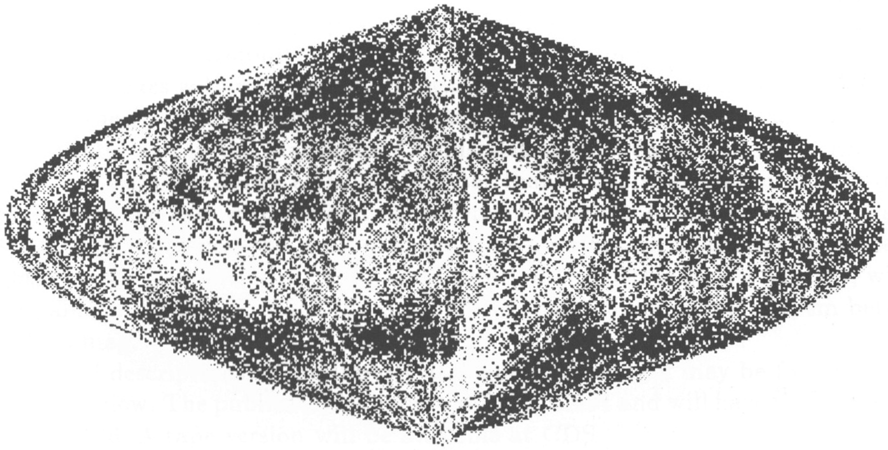

Figure 2. Sky distribution of under (clear gray) and over (dark gray)-observed proper motions in ecliptic longitude. Map in ecliptic coordinates, origine of longitudes at left.

This map displays on three gray levels the status of the standard errors of proper motions in ecliptic longitude. Clear gray indicates underobserved stars, medium gray nominally observed (i.e. R2 close to 1) and dark gray overobserved. Underobservation turns out to accumulate in two regions : one lane joining the ecliptic poles : it is the trace of the four days failure in August 1991. The other is the shadow of the earth limb as seen from the apogee of the orbit where most observations occur. The first underobservation cause is unlikely to reiterate at least at the same place, the second will affect other regions thanks to the slow precession of the orbit. Both are clearly visible in the proper motion picture since both hazards appear in the early period of the mission; no such structure can be found in the similar map based on parallaxe standard errors, although there are also underobserved parallaxes which deserve positive modulation in the future.

The degraded orbital conditions turn out to create far larger inhomogeneities in the accuracy acquisition than expected in the nominal mission. The observing strategy and the associated modulation process behave according to expectation and may smooth out on the long range inhomogeneities. However some important effects like the proper motion degradation due to the complete lack of long sequences of observations in the early period in some regions will not be compensated unless the real mission extends substantially beyond the end of 92.

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