The TYCHO Survey of Stars Brighter than Eleventh

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1. Introduction

The real-time attitude of the HIPPARCOS satellite (see Turon, *this symposium*) is monitored by a star mapper viewing a 40 arcmin. wide band of the sky, ahead of the main field of view, through a system of four vertical and four inclined slits (fig. 1). The resulting on-board precision will be 1 arcsec. rms and on-ground attitude reconstitution will later improve this value to 0.1 arcsec. rms.

The TYCHO project (approved by ESA in 1981) consisted in introducing dichroic beam splitters and a pair of redundant photomultipliers (with a bandpass close to Johnson B and V) into the science payload. This configuration will give a complete survey of the sky down to 11th magnitude in B, during the two and a half years of the mission. The data reduction is prepared by a scientific consortium (TDAC) which will be described in more details in section 4. The work related to the TYCHO Input Catalogue is described in section 2. An overview of the data reduction process is given as section 3, and aspects of the TYCHO outputs are discussed in section 5.

2. The TYCHO Input Catalogue

The reason of using a *TYCHO Input Catalogue* (TIC)—and not reducing the TYCHO records on a pure survey mode—is discussed in previous papers (see Høg, 1986). The main advantages are the savings in data processing and the possibility to work to a fainter limiting magnitude. In addition to searching for data from all of the Input Catalogue stars in the data stream, an optional serendipity mode will allow one to detect additional transits with a higher signal-to-noise-ratio, in large maps around TIC stars.

The primary source for elaborating an input catalogue of two million stars complete up to B=12.5, is the *Guide Star Catalogue* (GSC) presently being compiled at the Space Telescope Science Institute (see Lasker, Jenkner and Russell, *this symposium*). The GSC is expected to be complete up to 15th mag. in the direction of the galactic poles and up to 13th in the plane. The SIMBAD database of the CDS will be cross-matched with the GSC, in order to improve the positions and magnitudes for the brightest stars; this will make also possible to identify the variable and high proper-motion stars, as well as lists of astrophysical interest (standard stars, HIPPARCOS stars, etc.). More details about the matching procedure are to be found in Didelon and Egret (1987).

The TIC is to be ready before HIPPARCOS launch.

S. Débarbat et al. (eds.), Mapping the Sky, 265–268.

3. Overview of TYCHO data reduction

An overview of the TYCHO data reduction can be illustrated by Figure 2, in which the main (weekly) data stream during mission is described by bold face lines. Bold face terms, in the following, refer to the different tasks of the consortium.

The **Prediction** process derives the predicted transit times for each star of the TYCHO Input Catalogue, from the known satellite attitude and the known geometry of the slit groups.

Detection of statistically significant transits (having a signal to noise ratio larger than 1.5) is then made on the raw Star Mapper counts (B+V) around each predicted transit time: this gives "Raw Transits" which include an **Estimation** of the background, transit time and signal amplitude in B and V. Every detection is identified with the close-by TIC star(s). An optional serendipity mode searches for transits detected more than 6 arcsec. away from a TIC position.

Photometry and **Astrometry** of standard stars give the first calibration of the instrument, while a number of signature stars are used to test the way more difficult cases are treated.

This main process leaves out the problem of **Identification**, which is not completely solved by the use of an Input Catalogue: this is an additional task which is to be applied *off-line*, to the observational material accumulated during the first year of the mission (and then iterated on the other semesters). The output of this process is a revised input catalogue (TIC3) containing new entries, and giving improved positions for those stars really detected by the telescope (center of Fig. 2).

The final photometry and astrometry tasks will benefit of the prediction improvement (lower left of Fig. 2) based on the on-ground **Attitude** reconstitution and the revised TIC: they will, then, produce a TYCHO Photometric and a TYCHO Astrometric Catalogue, respectively, which are expected to appear three years after the end of the mission.

4. Organization of the consortium

Here is the present organization of the consortium (May 87):

- Chairman: E. Høg (Copenhagen University Observatory)
- Deputy chairman: M. Grewing (Astronomisches Institut Tübingen)
- Consultants: F. Donati (Torino), P. Wesselius (SRL, Groningen)

Task leaders	Consultants
Input Catalogue: D. Egret (CDS)	J. Russell, B. McLean (STScI)
Attitude: P.L. Bernacca (Asiago)	F. van Leeuwen (RGO)
Prediction: U. Bastian (ARI, Heidelberg)	
Photometry: M. Grewing (AIT)	U. Bastian, M. Grenon (Genève)
Astrometry: E. Høg (CUO)	L. Lindegren (Lund)
Detection: G. Bässgen (AIT)	G.K. Andreasen (CUO)
Identification: J.L. Halbwachs (CDS, Strasbourg)	
Calibration: J. Kovalevsky (CERGA, Grasse)	

5. The TYCHO outputs

The expected photometric precision of the TYCHO output catalogue for a 10th magnitude star is 0.03 mag. in B and V. This value is obtained by averaging approximately one hundred crossings of the star mapper, irregularly distributed throughout the mission. The typical value of the positional error would be 0.03 arcsec.

A discussion of the expected number of variable stars to be discovered by TYCHO can be found in a recent paper by Mauder and Høg (1987). Even if it is not at all a commitment of the consortium, it is presently contemplated to produce a TYCHO catalogue of variable stars, based on the individual measurements.

A TYCHO catalogue of proper motions could be valuably produced, using previous comprehensive catalogues (such as the Astrographic Catalogue, AGK3 or Cape) as a first epoch.

The final number of stars in the TYCHO catalogue will probably be between 500 000 and one million (among the two million candidates from the TYCHO input catalogue). This will give the largest accurate photometric survey of the sky ever made.

6. References

Didelon, P., and Egret, D.: 1987, Bull. Inf. CDS **32**, p. 27
Høg, E.: 1986, IAU Symp. **109**, p. 413
Lasker, B., Jenkner, H. and Russell, J.L.: *this symposium*, p.
Mauder, H. and Høg, E.: 1987 (submitted for publication to Astron. Astrophys.)
Turon, C.: *this symposium*, p.

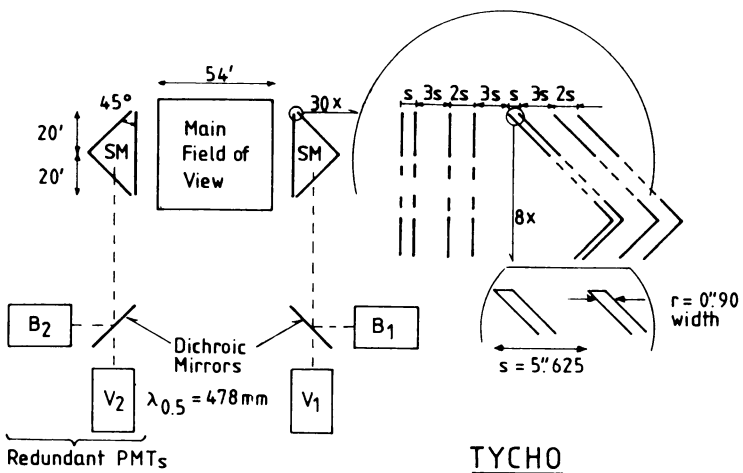

Fig. 1: TYCHO slit system

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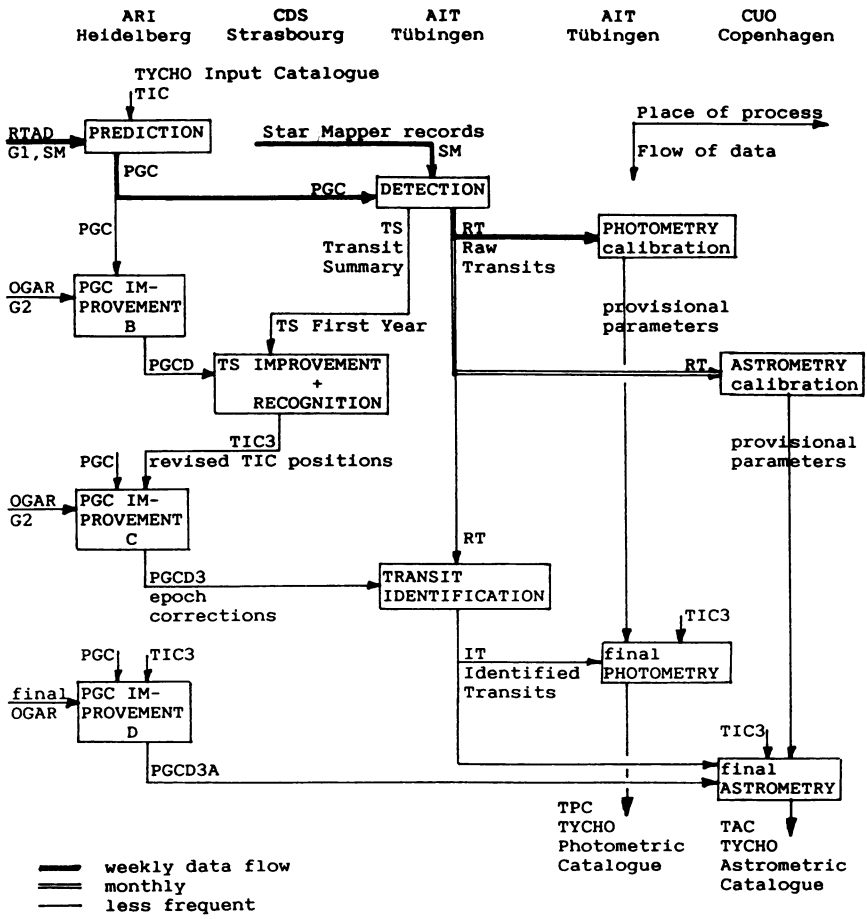

Legend: TIC = TYCHO Input Catalogue
RTAD = Real Time Attitude
OGAR = On-Ground Attitude
PGC = Predicted Group Crossing epoch
PGCD = PGC Difference = epoch corrections
TS = Transit Summary
G1,G2 = Geometric calibration parameters

Fig. 2. TDAC Data Flow

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