DATA ACQUISITION ASPECTS OF A FUTURE SPACE ASTROMETRY MISSION: SUMMARY OF THE PARALLEL DISCUSSION SESSION

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1. INTRODUCTION

This parallel session dealt with the *Data Acquisition and Data processing* in an astrometric interferometric mission. About 15 attendants took part in this session which was mainly a free discussion of three hours around the following three main items: (a) data acquisition; (b) data management; (c) data processing. The following report of this session follows closely this structure and attempts to summarize the important questions raised during the discussion. Obviously no definite conclusion can be drawn from such a preliminary discussion with no formal presentations.

2. DATA ACQUISITION

2.1. Data Flow

In the hypothesis of an observing programme of 50 millions stars, and with the typical instrument parameters of GAIA as they are foreseen today, we have on the average: 500 stars at a time in the fields of view; a sampling of 5 kHz to code the information of the fringes; a basic coding of each CCD counter on 8 bits.

This yields about 20 Mb/s of raw scientific data, that is to say a flow 2000 times larger than the data rate of Hipparcos. Such a sustained rate is much too large to achieve with present technology and the other design constraints of the spacecraft. So an on-board data compression (packing the bits in a reversible way) or a pre-processing (in principle with some loss of information) seems inescapable. It is known that savings of 20–50% are typical for a text file, whereas 50–90% might be achieved for binary files when the information content is low and the data have much redundancy. Little more can be said at the moment without knowing the actual coding of the raw information and the technology to be used for the detector. In any case, an optimized data compression will require large on-board computer resources both in terms of computation and data storage, and is more risky than the immediate downlink of the CCD content.

A pre-processing might be more efficient with savings up to 99%, but at the expense of the amount of information downlinked. A specific model will be needed based on sufficient statistics for the parameters one wishes to retrieve. A more detail consideration of this problem by Høg (1995) yields a data rate after an on-board preprocessing between 250–500 kbits/s, which will be achievable today. It was pointed out the information not included in the model of the data pre-processing will be definitely lost.

Table 1: Number of stars per square degree

V	Galactic Latitude (deg) 0	30	60	Aver. 0–90
<12	150	50	25	60
12–13	250	70	30	90
13–14	650	150	60	210
14–15	1600	330	130	500
15–16	3400	630	230	1100

2.2. Programme Stars

Another way to limit the amount of data is to work on a list of stars to be observed, known beforehand with sufficient accuracy to restrict the CCD readout to the active subfields. This would also ease the subsequent operations as no star identification would be needed. The table below gives an indication of the number of stars in the field of view as a function of the galactic latitude. The number of objects at low galactic latitude is so large that one will have to select the area of interest in the focal plane to make the operations feasible. It was suggested that an on-board programme could be defined on real time by using the observations in the incoherent mode. In any case, the on-board processing must be able to recognize and transmit data with sufficient modulation even though the star is not in the observation list.

This is clearly an open question that need not to be settled now, but which should be investigated in connection with the work in progress in the digitized surveys of both hemispheres.

3. DATA MANAGEMENT

The discussion on the management of the reduction focused on whether to stick to the strategy of the two independent consortia running the reduction in parallel. This method proved so successful in the case of Hipparcos, and the conditions that had led to this choice being the same for GAIA, there are good reasons to do something similar.

The possibility to set up one or two dedicated institutes, somewhat akin to the Space Telescope Science Institute, was considered and quickly ruled out. A more modest venture, with the two reduction consortia being each in a single place, was also considered as very difficult to implement in Europe. We however converged on the need for each consortium to make most of the involved computations and data storage on a centralized computing centre, with a dedicated computer. With the modern communication networks it should not be a problem for each participant to have a remote access to the computing centre and to the data base.

4. DATA PROCESSING

The discussion on this topic was necessarily limited to few generalities as the definition of the project is not sufficiently advanced to allow serious investigations. Some points were identified nevertheless: to carry out the aberration correction with an accuracy of 1 μas the velocity of the satellite with respect to the barycentre of the solar system must be known to 1 mm/s. For a spacecraft at a few thousand kilometers this can be achieved already today with a tracking using either GPS or the Doris system. If the rapid progress observed during the last decade persists, one may expect that the capability of the tracking will be ten times better than the requirement for GAIA in 2010 for a low Earth orbit satellite. At the Earth–Moon L_4 or at the Sun–Earth L_2 this is probably not so obvious, and no member of the panel was able to be more specific.

Now for the ephemeris of the Earth with respect to the barycentre of the solar system, the requirement corresponds to a relative accuracy of 3×10^{-08}, that is to say to better than 0.001 arcsec in angular position and 5 km in distance, which is well within the reach of current ephemerides. Experts of the Bureau des Longitudes in Paris have confirmed this view.

The radial velocity for all the nearby stars with large proper motion is required to allow for the perspective effect in the data analysis. This will be easily achieved for the bright stars but much more difficult for the faint brown dwarfs lying at less than 100 pc. A specific ground-based programme will have to be set up on time.

5. CONCLUSION

No significant aspects that could hinder a GAIA-like mission were identified during the discussion on the data acquisition and analysis. Several points were noted as requiring in-depth analysis while for others, such as the orbit-tracking requirements, we were not in position to conclude because of the lack of knowledge of the state of the art in that field.

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REFERENCES

Høg, E., 1995, Some designs of the GAIA detector system, ESA SP–379, this volume