1. INTRODUCTION

The Hipparcos data reductions were the responsibility of two scientific consortia, FAST and NDAC, supervised by the ESA-appointed Hipparcos Science Team. Two other consortia, TDAC and INCA, were responsible for the Tycho data reductions and the preparation of the Hipparcos Input Catalogue respectively. In this chapter the motivation for presenting descriptions of the various processes employed in the data reduction by FAST and NDAC is outlined. A general overview of the data reductions is provided, with references to specific chapters where more details can be found, and a summary of various other aspects is presented, such as the preparation of the Hipparcos Input Catalogue and the role of comparison activities.

1.1. The Purpose of this Volume

In addition to the tasks of production and description of the final Hipparcos and Tycho Catalogues, the Hipparcos Science Team placed considerable importance on the full documentation of the Hipparcos satellite operations (Volume 2), and in a detailed description of the procedures used to reduce, calibrate and verify the data contained in the final Hipparcos and Tycho Catalogues.

Several reasons motivated the preparation of this documentation. In the first instance, the scientific method demands a careful and thorough explanation of the steps involved in any scientific experiment, and in this respect the Hipparcos mission is no exception. For many catalogue users, the precise methods adopted for the data analysis will be of little interest, but for certain applications, a careful understanding of the data reduction steps, the instrument calibration, the reduction algorithms, and the associated assumptions and numerical constants, will be relevant in assessing the limitations of the astrometric, photometric, and associated data presented in the catalogues. Similarly, the steps that have been undertaken to place the resulting catalogues on an extragalactic reference system, and to verify the quality of the resulting data, is important information that must be preserved for future catalogue users.

Second, the compilation of the adopted methods, assumptions, and complications of the data analysis was considered as an important contribution to a future astrometric space mission, where target accuracies of microarcseconds have already been proposed. This volume should provide many pointers to the difficulties, and possible solutions, to be faced by such a mission in the future.

At the same time, the documentation should serve to illustrate the intricate complexities of achieving milliarcsec astrometry, and may therefore more easily illustrate the profound and dedicated commitment and considerable scientific involvement which has been invested in the Hipparcos project, and the challenges faced in bringing the largest data analysis problem ever undertaken in astronomy to a rapid and successful conclusion.

1.2. Pre-Launch Preparations

As described in the Prologue to Volume 2, the first ideas for carrying out astrometric measurements from space were presented in 1966. Lengthy and careful studies resulted in an ESA Phase A study report, on which selection of the Hipparcos mission as a programme within ESA's scientific programme was finally based. Following this selection in 1980, organisation of the scientific aspects was discussed in detail, and in 1981 ESA, in consultation with the interested scientific community, issued two 'Announcements of Opportunity': the first for a scientific consortium willing to undertake the compilation of the Hipparcos Input Catalogue; the second, for one or more groups willing to undertake the main mission data analysis, leading to the construction of the final Hipparcos Catalogue. As reflected in the interest shown by the scientific community during the Phase A studies, one consortium (subsequently called the INCA Consortium, and led by Dr Catherine Turon of the Observatoire de Paris, Meudon) duly responded to the first announcement; two teams (the NDAC Consortium and the FAST Consortium) responded to the second. The FAST Consortium was led by Professor Jean Kovalevsky of the Observatoire de la Côte d'Azur, CERGA, Grasse, France. The NDAC Consortium was initially led by Professor Erik Høg of the Copenhagen University Observatory, Denmark. It was subsequently led by Dr Lennart Lindegren of the Lund Observatory, Sweden, following the inclusion of the Tycho experiment within the Hipparcos programme, and the consequent formation of the Tycho Data Analysis Consortium, led by Professor Høg.

From 1981 ESA organised a Hipparcos Science Team, under the chairmanship of the ESA Hipparcos Project Scientist, Dr Michael Perryman. The four scientific consortia (INCA, NDAC, FAST, and TDAC) thereafter worked autonomously under their respective consortia leaders, with the coordination of all of the scientific tasks being undertaken by the Hipparcos Science Team. The Science Team included representatives from each of the Consortia (including the leaders); its terms of reference were to supervise and take responsibility for all of the scientific aspects of the mission, including the definition of the entire satellite observing programme, monitoring and approval of the satellite's scientific performance, the preparation and testing of the data analysis software, the eventual creation of the final mission products including the production of a single agreed-upon final catalogue, and the overall policy for preliminary and final data distribution.

Preparations leading up to the satellite launch were described in the three volume ESA SP-1111 (1989) 'The Hipparcos Mission': Volume 1 dealing with the Hipparcos satellite, Volume 2 dealing with the preparation of the Hipparcos Input Catalogue, and Volume 3 dealing with the preparations for the data analysis.

Following termination of the satellite observations in August 1993, after the satellite had been in orbit for just four years, and with the completion of the final Hipparcos and Tycho Catalogues announced by the Hipparcos Science Team on 8 August 1996, all of the original scientific goals of the Hipparcos mission had been met, and indeed in all cases, significantly exceeded. More target stars, a higher astrometric accuracy, and a substantial photometric data base have been realised. The original cost envelope for the mission was exceeded by less than 15 per cent, a cost over-run largely attributable to the one-year launch delay imposed by the Ariane launcher programme. The complex data analysis system—the global treatment of 1000 Gigabits of data was considered as the largest single data reduction problem undertaken in astronomy to date—was completed according to the originally foreseen time schedule announced before launch for the main Hipparcos Catalogue, and one year in advance of the pre-launch expectations for the Tycho Catalogue.

These achievements may be attributed to a variety of factors and important organisational aspects:

(a) a clear set of scientific goals was established by the scientific community, and endorsed by the ESA advisory bodies at the time of the project's selection by ESA in 1980. These were considered as inflexible by the ESA Project Team and, in turn, by industry. Specifications were established at the highest level—thus, a mean sky accuracy in the five astrometric parameters at 9 mag of 2 mas was demanded—as well as at all intermediate levels. With the scientific importance of the mission critically dependent on the final accuracy, the spirit prevalent within the entire project was that 2 mas was the requirement, anything worse was unacceptable;

(b) many of the intermediate specifications were formulated based upon extensive simulations and studies already carried out during the Phase A study of the mission, many of them relying critically on the studies carried out by the scientists who would eventually take responsibility for the satellite data analysis;

(c) responsibility for all of the scientific aspects was taken by a single committee, the Hipparcos Science Team, a non-political group committed to the mission goals and hence its scientific success. All other bodies involved in the scientific aspects—the scientific proposal selection committee, the four scientific consortia, and a variety of working groups, all reported directly to this Science Team. This organisation is shown schematically in Figure 1.1. The Hipparcos Science Team was in turn, responsible for all scientific decisions during the satellite development phase, for overseeing the timely preparation of the observing programme catalogue and the data analysis software, and for controlling all other interfaces with ESA and ESOC having a potential impact on the scientific conduct. The majority of the members of the Science Team were involved with the Hipparcos project as their primary research effort during a period of about 16 years since formal approval of the project by ESA;

(d) members of the Hipparcos Science Team were closely involved in project decisions which affected any aspect of the scientific performances, in formal project reviews, and also as direct consultants to industry during the satellite's detailed definition phase, assisting the prime contractor in its interpretation and implementation of the ESA project specifications;

(e) all of the scientific aspects of the Hipparcos mission, apart from the overall scientific coordination of the project led by the ESA Project Scientist, were entrusted to the scientific community, under their responsibility and financial authority, although with the Hipparcos Science Team coordinating their activities and schedule at the highest level;

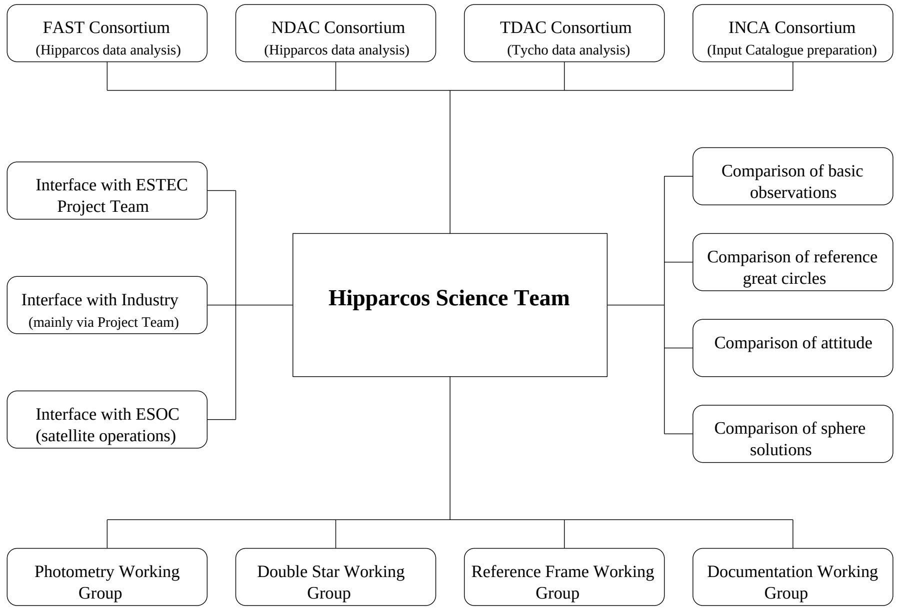

Figure 1.1. *The organisation of the scientific aspects of the Hipparcos mission. The Hipparcos Science Team was responsible for the scientific aspects of the ESA/ESOC and industrial development efforts (left-hand boxes), the overall coordination and synchronisation of the scientific consortia activities (top boxes), the comparison activities between the parallel reduction of the main mission data (right-hand boxes), and the coordination of the working group activities devoted to the unification of specific results generated as part of the data analysis (bottom boxes).*

(f) in turn, ESA took financial responsibility for the entire satellite (spacecraft and payload), and entrusted its development, manufacture, testing and calibration (on-ground and in-orbit) to the industrial prime contractor. The overall system approach to the satellite as a single entity, adopted by ESA and the prime contractor (Matra, France, subsequently Matra Marconi Space)—including error analysis and allocation, and procurement, integration, verification and calibration of the payload—was a substantial and crucial factor contributing to the eventual success of the mission;

(g) the parallel development of the satellite, the observing programme, and the software and management system for the on-ground data analysis, was crucial. Thus, the deadline for observing proposals terminated in 1982 (at a time when launch was scheduled for 1988) despite various suggestions to keep it undefined for longer. Careful optimisation of the observing programme, and its optimisation with respect to the satellite's operational and observational capabilities, occupied a team of 30 or so people—some working full time, and some part time—for 6 years. But as a result, the Hipparcos Input Catalogue and the associated observations of nearly 120 000 programme stars worked smoothly and flawlessly. In retrospect, the early deadline imposed on the observing proposals, allowing extensive and meticulous preparations of the Input Catalogue, was without doubt a correct decision;

(h) similarly, development of the software for the data analysis tasks started in the two main data reduction teams (the FAST and NDAC Consortia) in 1981, in parallel with the development of data simulation software. Consequently, not only was the software finalised and tested pre-launch, but very significant guidance was provided by both consortia, to ESA and to industry directly, in the area of satellite design and operation.

The efficiency of the consortia's preparations were evident from their results: even in spite of the post-launch problems, the first great-circle reductions were completed within a month or so after the start of the routine acquisition of data, and the first 'sphere solution' was reported just one year later;

(i) the data distribution system established by ESOC was prepared in parallel with the data reception software being developed by the consortia. This ensured that, when data first started flowing from the satellite—at 24 kbit/s—it could be received and treated almost immediately by the consortia;

(j) an 'Agreement', or Memorandum of Understanding, was drawn up at an early stage between ESA and the four scientific consortia involved in the project, setting out deliverables and schedules for all groups, and their respective 'rights' in terms of pre-release data. This included the agreement not to circulate, release, or publish preliminary data, or scientific results based on such preliminary data; this had the very beneficial effects of not propagating incorrect or misleading data into the literature, and not distracting the work of the catalogue finalisation by motivations to publish investigations into such preliminary data.

The accuracy analysis and error allocation budget for Hipparcos during the development phase was a highly complex activity, comprising diverse but inter-related aspects such as spacecraft attitude control and jitter, optical performance and stability, detector characteristics, spacecraft and payload thermal control, data rates, spacecraft and payload shielding (electromagnetic and particle/Cerenkov), straylight, satellite spin rate, scanning law, mission duration, and so on. Global missions like Hipparcos demand that target accuracies are met and, in turn, that a minimum operational lifetime is also achieved. Hipparcos was unusual amongst ESA missions in that the development of the spacecraft and payload was entrusted to a single prime contractor (rather than separate Principal Investigator groups providing the payload instruments).

All of this can be summarised by stating that a systems approach was adopted for Hipparcos, with all of the many complex tasks encountered in a satellite project viewed as part of the same system. A unique goal—the final catalogue, of the highest possible astrometric accuracy, precision and rigour—was also established early on as the final mission product; this ensured that the ultimate objectives of the mission were apparent to all, both inside and outside the project. The simple advisory and decision-making structure was efficient and successful, with a clear identification of responsibilities.

1.3. Preparation of the Observing Programme

A very challenging problem for Hipparcos was to identify the desired subset of programme stars (about 120 000 could be accommodated) from amongst all those potentially observable (a few million down to about 12 mag). This required (a) an announcement of opportunity for observing proposals (500 000 objects were eventually proposed for study); (b) scientific assessment and priority allocation by an *ad hoc* (independent) selection committee; (c) extensive mission simulations covering scientific and operational considerations; (d) a careful compromise between scientific desires and aspirations and technical capabilities (e.g. general requirements on the uniformity of the overall sky distribution of programme stars, and the inability to observe many faint stars in a small region of the sky); (e) an extensive, laborious, and complex programme for the compilation of the requisite *a priori* astrometric and photometric data.

The details of the preparation of the Hipparcos Input Catalogue, published as ESA SP–1136 in March 1992 (and subsequently on CD-ROM) have been described in ESA SP-1111 Volume 2, and some key aspects of the observing programme are summarised in Chapter 3.

1.4. Methodology and Organisation of the Data Analysis

The data analysis problem for Hipparcos was both global and complex, and is the subject of the remainder of this volume. Both of these aspects have influenced how the data analysis was undertaken, and how the final mission products have been made available. It was not considered possible, or appropriate, for example, to circulate widely preliminary astrometric data, for which the errors, both internal, external, or systematic had been neither confirmed nor qualified. Neither was it possible to circulate subsets of the raw data to Principal Investigators: the complex inter-relationship between the data acquired by the satellite throughout the mission was itself the key to the eventual determination of the astrometric parameters. The scientific community, many members of which had been eagerly anticipating the mission results for many years, had to wait patiently, and allow the data analysis teams to complete their work.

In practice, the Hipparcos reduction problem was broken down into a series of three ‘steps’: (1) solving for one-dimensional positions on a ‘reference great circle’; (2) reconstructing the origins of these reference great circles; and (3) back-substitution of the one-dimensional coordinates within the reference great circle system in order to estimate the astrometric parameters. The overall flow of data through the data analysis chain is illustrated in Figure 1.2, and the details of this analysis are the subject of the remainder of this volume. A more detailed synopsis of the entire data reduction procedure is given in Chapter 4, which itself gives reference to details covered in subsequent chapters.

It may be noted that the sequential approach to the data analysis problem introduces approximations in the projections onto the reference great circles, and to an extent decouples the solution of the astrometric parameters from the problem of the satellite attitude determination. Truly global reduction algorithms for the Hipparcos data were studied; they could possibly lead to small improvements in the overall astrometric accuracies and the suppression of certain potential systematic errors, but were not adopted due to time, schedule and computer resource constraints. On the other hand the sequential approach also had one major advantage: that a comparison between the two parallel reduction schemes could be undertaken at numerous well-defined points, permitting errors to be identified and rectified before subjecting the results of that step of the processing to the next.

The treatment of error sources such as chromatic terms, timing errors, relativistic (metric) effects, orbit corrections and Earth ephemeris, secular acceleration, effects of double and multiple stars (including astrometric binaries), computational rounding errors, and so on, resulted in a complex analysis problem which required careful evaluation, and iteration, before the results could be considered final and free from systematic errors at the level of a few tenths of milliarcsec.

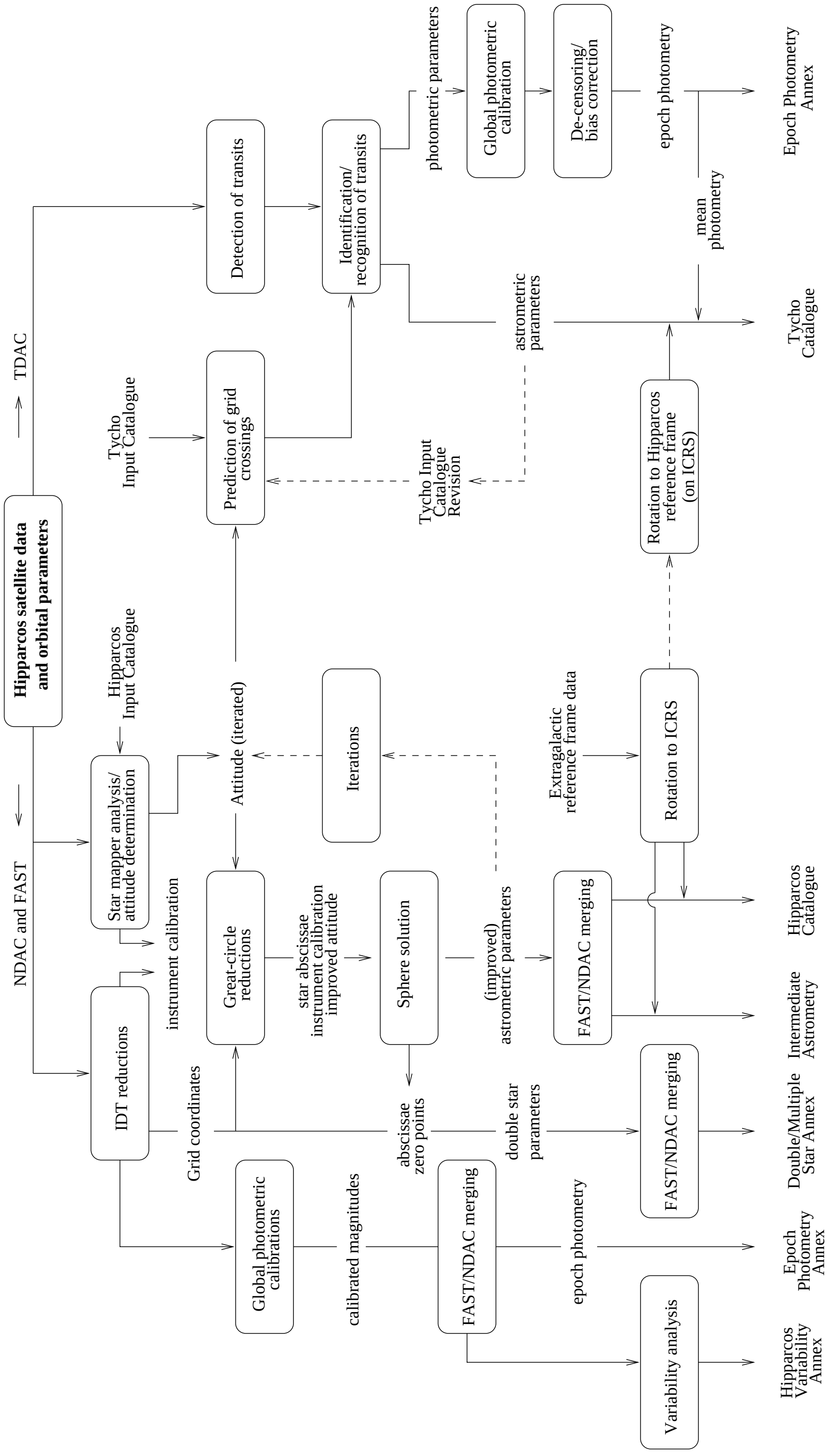

Figure 1.2. *The organisation of the data processing. The main mission data (left-hand part) were analysed in parallel by the FAST and NDAC Consortia, with comparison activities leading to the establishment of a single agreed-upon Hipparcos Catalogue. The main mission data processing is the subject of this volume. The Tycho data processing (right-hand part) are the subject of Volume 4.*

This considerable complexity in the data analysis motivated the original selection of two data analysis groups who would undertake the entire analysis tasks in parallel. This was a highly unusual feature of the mission. However, in brief, this approach proved to be a remarkably powerful solution to the problem of cross-verification, identification of software coding errors or incorrect comprehension of interface specifications, etc., as well as providing important information on the final data quality, and the possible contribution of modelling terms to the final accuracy estimations. Many errors or imperfections were rapidly identified in this way. It is difficult to overemphasize how important and successful this has been for Hipparcos. The power of this approach has been repeatedly stressed by the Hipparcos scientific consortia, and at the time of writing a similar approach has been proposed in the scientific management plan of the COBRAS/SAMBA (microwave background) mission.

The necessity of the two independent reductions may be qualified further. Aside from the fact that complex problems generally benefit from an independent approach to their solution, the nature of the Hipparcos data means that any future re-analysis of the raw satellite data seems highly unlikely. Confidence by the scientific community in the results of the processing is very important. Unlike many other types of astronomical observations, astrometric data have a crucial historical relevance: a new experiment with a more modern instrument cannot simply be expected to reproduce or confirm measurements that were made previously. One specific example may suffice: as of the time of writing, FK5 and Hipparcos proper motions have not been fully reconciled: one very likely explanation seems to be that the existence of (astrometric) binaries and the corresponding photocentric motion due to orbital effects means that proper motions measured at one epoch will not necessarily agree with, or will not necessarily be superficially consistent with, proper motions at another. All efforts to eliminate artificially induced random or systematic errors within the Hipparcos data have been made, and independent reductions of the satellite data, along with appropriate cross-verifications, offered powerful possibilities of controlling such errors.

As evident from the introduction to Volume 1, the complexities of the data analysis demanded the formation of data analysis consortia comprising members and institutes throughout Europe contributing a range of knowledge, interest, and expertise. The geographical distribution of participating scientists involved its own complexities of management and coordination. Regular meetings took place between the members of each consortium, of the Hipparcos Science Team, and latterly between working groups involved in the preparation of the final mission products (see Figure 1.1). In the early 1980's, additional communication between participating scientists took place by normal mail or, in urgent cases, by telex. From the mid-1980's the widespread availability and efficiency of electronic mail revolutionised daily working practices. It is not possible to imagine the final mission products having been finalised so efficiently in the absence of electronic mail communications.

Nevertheless, the geographical distribution of participants posed problems for information flow. A centralised data processing institute would certainly have overcome some of these problems, advantages including (i) centralisation of expertise and improved possibilities for the exchange of ideas; (ii) ease of communications (even in the age of fast computer networks meetings are necessary, and the problem of defining and controlling interfaces of different tasks is complicated by geographical separation); (iii) centralisation of documentation and the consequent improvement in the exchange of information (the problem of keeping large numbers of individuals in many different institutes up to date with a large, rapidly moving project was a formidable one, and was absolutely crucial at all stages of the project); (iv) exchange of data (in the multi-step, sequential processing of the Hipparcos and Tycho data, large quantities of data had to be moved from institute to institute). In this approach the need for two independent reduction groups might have been relaxed, with critical steps perhaps being undertaken by two or more separate individuals or groups within the central institute.

On the other hand the disadvantages of a centralised institute would have been numerous, including: (i) the difficulties of attracting and retaining the necessary individuals to work away from their home institutes for prolonged periods of time; (ii) making this approach attractive to participating countries or institutes, both financially and intellectually. Although the European-wide distribution of the Hipparcos data analysis effort had its complications, the advantages of the large-scale collaboration of individuals and institutes with various competences at various stages of the project was indispensable.

1.5. Comparisons

As mentioned above, the sequential approach for the data reductions allowed the identification of a number of key steps at which rigorous comparisons of the intermediate data could be undertaken. These comparison activities had not been carefully specified in advance of launch, but grew up naturally as the processing advanced, with the comparison activities being undertaken by the individual(s) or institute(s) possessing the capabilities or resources necessary to carry out the work. A simplified diagram illustrating the main aspects of the comparison activities is shown in Figure 1.3.

All intermediate data were not compared. Rather, various data subsets, including 'difficult' great circles, were identified, and evaluation and analysis of these cases pursued until all features had been explained. It should also be noted that the eventual outcome of each comparison task was never complete agreement on the numerical values derived at each step: the independence of the parallel reduction groups was paramount, and so many different assumptions, numerical algorithms, approximations, divisions of data sets, etc., occurred such that this was not a realistic (or desirable) product of the comparison exercises. The main objective was to ensure that the outcomes of each step were consistent with their predicted errors, and with the models adopted for the data analysis.

The entire comparison exercise identified numerous errors, shortcomings, imperfections, and incorrect assumptions. Like the parallel data reductions themselves, it is difficult to overemphasise the importance of these tasks in achieving the final, agreed-upon catalogue.

1.6. The Final Results Data Base and the Final Mission Products

Although the data analysis activities were undertaken within each consortium, the final mission results are a combination of data derived at numerous separate institutes. Thus the astrometric data, independently generated within the FAST and NDAC Consortia (at CNES/CERGA and Lund respectively) were combined into a single final catalogue

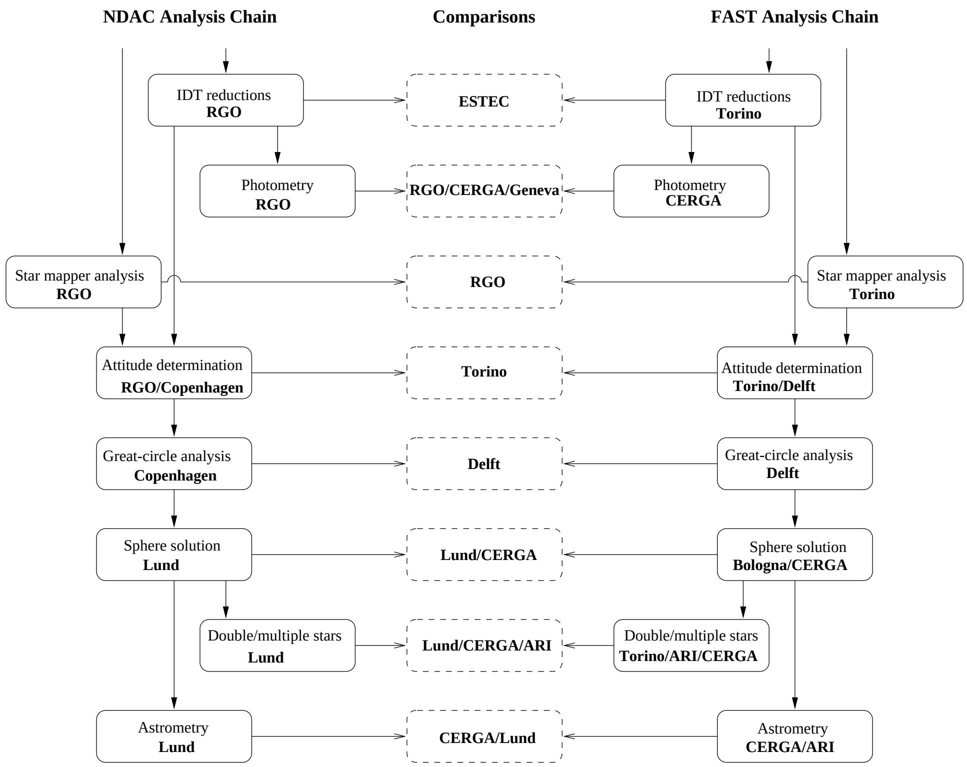

Figure 1.3. *The organisation of the comparisons. Only the principle features of the main mission comparisons are indicated. The left and right columns indicate schematically the flow of data through the NDAC and FAST Consortia respectively, and the institute at which the corresponding software was developed (in the FAST Consortium, the main chain of the data analysis was entirely implemented at CNES, Toulouse). The central column indicates the location at which the corresponding comparison activities were carried out (ARI = Astronomisches Rechen-Institut, Heidelberg; Bologna = Università di Bologna; CERGA = Observatoire de la Côte d'Azur, CERGA; Copenhagen = Copenhagen University Observatory; Delft = Delft Geodetic Institute; Geneva = Observatoire de Genève; Lund = Lund Observatory; RGO = Royal Greenwich Observatory, Cambridge; Torino = Centro di Studi Sui Sistemi.)*

at the Observatoire de Paris-Meudon. Photometric data were unified into a single photometric catalogue at the RGO, while corresponding light curves were produced at the Observatoire de Genève using periods determined there and at the Royal Greenwich Observatory. Double and multiple star parameters were derived within institutes in Italy, at CERGA, and at ARI (Heidelberg) for the FAST Consortium, and at Lund Observatory for the NDAC Consortium. The final Hipparcos Catalogue includes Tycho photometry generated at Tübingen and Strasbourg, and transformed photometric colour indices produced at the Observatoire de Genève. Each catalogue iteration produced intermediate astrometric catalogues which evolved in parameters and precision. The final astrometric data resulted from a rotation of the Hipparcos internal reference system to the ICRS, using a final prescription based on a substantial coordinated effort within the Hipparcos 'Reference Frame Working Group'. Details of the final stages of the Hipparcos Catalogue production are given in Chapters 16–18.

To keep track of these large data sets, and their updates, a central 'Hipparcos Results Data Base' was set up, during the mission operations, at SRON Utrecht, under the responsibility of Dr Hans Schrijver. Using the SYBASE data base system, intermediate and final astrometric and photometric data were compiled into this centralised data base, and critically examined for quality and consistency with all other available astrometric and photometric data, including ground-based results. The comprehensive centralised system maintained an account of the various updates, drawing together the various elements into a final single data base system.

Generation of the final mission products was based on this final results data base. Definition of the form, content, format, and inter-relationship of the final mission products was a task handled by the Documentation Working Group. Starting with the early results of the first iterations of the catalogues, the concept for these final mission products drew together the parallel evolution of the Hipparcos and Tycho results, resulting in a comprehensive series of mission products which aims to be fully interconsistent and properly documented. Converging to this series of final mission products, in an agreed format, was a substantial effort which occupied the members of the Documentation Working Group for several years.

In parallel with the final catalogue production, considerable effort was devoted to the task of catalogue and data verification based, for example, on comparisons with the best-available catalogues of ground-based positions, proper motions, and parallaxes. The results of these verification activities are presented in Chapters 19–22.

1.7. Astrophysical Exploitation

With the Hipparcos programme of 120 000 stars, many of the target objects were known, in advance, as objects of astrophysical or astrometric 'interest'. In many cases their spectral types and/or multi-colour photometry, and details of their multiplicity or (coarse) photometric variability, were known. Metallicities, luminosity types, and many radial velocities were known or are in the process of being acquired as part of dedicated support programmes. Nevertheless, it must be pointed out that much of this 'auxiliary' material is of very inhomogeneous quality: when the final Hipparcos Catalogue is published, two-dimensional MK spectral types will be available for some 60 000 of the 120 000 programme stars; while radial velocities will only be available for some 20 000 of the programme stars (although many others have meanwhile been acquired by associated principal investigators).

The absence of radial velocities for the majority of the Hipparcos objects (let alone for the one million Tycho objects) is considered unfortunate—radial velocities provide the third space velocity component of the star, and high velocity accuracy can be achieved. The radial velocity is a very important supplementary piece of information for any kinematical or dynamical interpretation of the proper motion data. At the same time, repeated radial velocity measurements provide a powerful method of inferring and characterising double or multiple systems (and consequently, for mass determinations). And finally, radial velocities will be of significance in the assessment of secular (perspective) acceleration, the contribution to the apparent photocentric motion due to the (apparent) time-dependent proper motion, an effect which will attain increasing significance with improved astrometric measurements in the future.

Efforts were made by the Hipparcos Science Team to coordinate the acquisition and inclusion of the radial velocities within the final Hipparcos Catalogue. Unfortunately, this (ground-based) aspect was never incorporated within ESA's scientific mandate for the mission. Formal and less formal attempts to acquire, compile, or support independent national efforts to acquire these data were also largely unsuccessful; it proved difficult for the Hipparcos project to present a convincing case to relevant funding authorities. Nevertheless, it must be concluded that for any future astrometric mission, a parallel effort directed at the acquisition of complementary photometric, spectroscopic, or radial velocity data should be considered very carefully, in order to provide the homogeneous observational data necessary for a complete astrophysical exploitation of the resulting astrometric data.

1.8. Data 'Rights' and Related Issues

The question of data rights, publication policies, and early release of data, are complex issues which face the conduct of any space mission and, of course, all scientific experiments conducted as large collaborations. Much energy is devoted to these issues, for which there is rarely a clear-cut right or wrong answer.

The Hipparcos Science Team debated this question at an early stage. The earliest thoughts were directed at the release of preliminary astrometric data two or three years into the mission. As the complexities of the real data analysis became apparent, and the huge effort that had to be devoted to the preparation and documentation of the results became evident, the Hipparcos Science Team realised the dangers of this approach. Preparing the data for release, even in preliminary form, would have taken critical effort away from the principal task at hand—that of completing the final catalogue as carefully and rapidly as possible. More importantly, it was considered that it would undoubtedly have led to great confusion (and criticism) of the results from users unfamiliar with the details of the Hipparcos project. Before the final iterations the errors were poorly categorised, and the coupling of errors between parallaxes, proper motions, and double/multiple stars would have created many problems at the level of the scientific interpretation; furthermore the positions and proper motions would not have been on any well-defined reference system. For an experiment aiming at high-precision astrometry, these shortcomings would have been unacceptable. The Hipparcos Science Team considered that the benefits of releasing only final results convincingly outweighed the prospects of distributing preliminary data. It is to be hoped that any such perception of 'delays' will be considered appropriately in an historical context.

M.A.C. Perryman