Final Report – 1/12/2001 – 30/11/2006[1]

for

Research Infrastructure RTD Project

ASTRO-WISE
HPRI-CT-2001-50029

Groningen, 21 Februari 2007

NOVA/ OmegaCEN
Kapteyn Instituut
Rijksuniversiteit Groningen

This document can be found on the INTERNET at the following address:

http://www.astro-wise.org/Public/Awefinal-2006.pdf

The Final Report covers the five years of the project.

IHP-ARI RESEARCH INFRASTRUCTURE RTD PROJECT

Final Report – 1/12/2001 – 30/11/2006

Contract N°	**HPRI-CT-2001-50029**
Project Title	Astronomical Wide-Field imaging system for Europe ASTRO-WISE
Start date of contract	1/12/2001
End date of contract	1/12/2006
Contract value (EURO)	1.500.000 Euro
Internet homepage	http://www.astro-wise.org
Contract Manager/Co-ordinator	Prof Dr E.A. Valentijn
Telephone N°	+31-50-3634011 +31-6-48276416 mobile
Fax N°	+31 –50-3632003
E-Mail address	valentyn@astro.rug.nl

Partnership Summary

Participant number (Co-ordinating partner as participant N°1)	Name of Participating Organisation	Name of Responsible Person	Role in Project*
001	Nederlandse Onderzoekschool voor Astronomie – NOVA	Prof. dr.E.A. Valentijn	LSF-IHP
002	European Southern Observatory - ESO	Dr F. Cameron	LSF-IHP
003	Osservatorio Astronomico di Capodimonte – OAC	Prof. M. Capaccioli	LSF-IHP
004	Centre National de la Recherche Scientifique- TERAPIX	Dr Y. Mellier	LSF-IHP
005	Ludwig-Maximilians-Universität - USM	Prof. R. Bender	LSF-IHP

* LSF-IHP: a research infrastructure funded for access under the IHP programme
LSF-TMR: a research infrastructure funded for access under the TMR programme
LSF-OTH: a research infrastructure outside the IHP or TMR programmes
IND: an industrial or commercial enterprise
OTHER: other types of participant

1. EXECUTIVE SUMMARY

This summary should be as comprehensive and clear as possible. It should contain, in about 200 words a description:

- of the main objectives and characteristics of the RTD project, emphasising its innovative aspects and its potential impact on the quality and quantity of access provided by Europe's research infrastructures, and
- of the work performed and achievements.

-

Objectives

The ASTRO-WISE programme co-ordinates the development work to deal with and access astronomical wide field imaging data. It provides an operational environment for researchers to analyse and access the huge data volumes of observational data produced by a new generation of Europe's wide field imaging telescopes.

The programme pools the expertise of a number of European groups with experience or commitment to optical wide-field survey work. All partner sites will function as (linked) national data centres. The code and expertise to run additional satellite centres is a deliverable of the project.

ASTRO-WISE develops and disseminates in the community software tools needed to access the wide-field image data, to perform individual research programmes. The huge data volumes require an innovative dynamical approach, in which results can be re-derived, customized to the users specific needs. To this end, the various calibration data and other input files are distributed over a network, which connects the data centres. The geographical distribution of the key information (both methods and data) is provided by the system, allowing the various National Data centres to work cooperatively in an efficient manner and optimally profit from the work done at each of the centres. This enhancement, consolidation and dissemination through National data centres, is going to build up the Astronomical Wide-field Imaging System for Europe.

Results

The project plan as outlined in the contract has been successfully completed. A detailed architectural design was made. Accordingly, the system has been built, implemented, extensively tested and qualified on test data. The entire information system has been distributed over the involved nodes. Many upcoming European wide-field imaging surveys have decided to use the system.

National AstroWise data center nodes were put into operation at Groningen, Munich, Napoli and Paris, while AstroWise satellite nodes have been put into place at Leiden and Bonn, also serving research groups in Nijmegen, Bochum and Heidelberg. The system i.e. code base, documentation and data is ready for delivery to other nodes on request. The system is ready for deriving, hosting, and warehousing the data of new generations of massive data accumulators and is scalable up to the Petabyte data regime.

The system has been qualified using ~20Tb of astronomical wide field imaging data, ingested into the system, from the ESO Wide Field imager, Chile, the ING Wide Field Camera , La Palma (Canary Islands), test data of OmegaCAM, the MDM telescope (US) and the Suprime Camera at the 8m Subaru telescope (Hawaii). Extensive web services have been put into operations.

The AstroWise information system has been presented at several important conferences like the "International Virtual Observatory (Garching 2002), the EURO-VO workshop (Garching 2005), the IAU General Assembly in Praha and the ADASS XVI in Tucson (USA).

Several papers describing the system have been published (e.g. Valentijn et al. 2006, Valentijn & Verdoes Kleijn 2006). In particular the novel concept of "entire backward chaining", i.e the linking of data products to the input raw data draws attention and provides a unique backbone for the infrastructure for advanced distributed e-science.

Advanced courses were held yearly to introduce and involve the user community in the system, which includes in the fifth year a centralized course at the Lorentz center in Leiden (40 persons) and local courses at the partner sites München, Bonn and Napoli, typically attended by 15-25 persons.

Subset of papers describing and/or using the Astro-WISE Information System (see Annex I for full listing and see http://www.astro-wise.org/publications.shtml for full articles):

-Valentijn & Verdoes Kleijn 2006 , "The Astro-WISE system: a federated information accumulator for astronomy", ERCIM News, 65, 20

-Valentijn et al., 2006, "Astro-WISE: Chaining to the Universe", ADASS XVI, ASP Conference Series, 2006, Shaw, Hill, Bell, eds, in press

-Sikkema et al, 2006, "Globular cluster systems of six shell galaxies", Astronomy & Astrophysics, 458, 53

-Valentijn & Begeman, 2006, "Creating and analysing multi-dimensional data in Astro-WISE environment: a test case", white paper

-Verdoes Kleijn et al., 2006, "The secondary standards programme for OmegaCAM at the VST", Standardization workshop, ASP Conference series, Sterken editor, in press

-Kovac, 2006, "Searching for the lowest mass galaxies: an HI perspective", PhD thesis

-Pavlov et al, 2006, "The VST data processing within the GRID", Computational GRIDs for astrophysics in Italy, in press

On 14 November 2005 AstroWise has publicly announced its web portal www.astro-wise.org/portal which contains various web services, including code base viewers, database viewers, a calibration file monitor and updater, collected documentation, a menu with "HOW TOs" for users and an test version of a very innovative distributed processor facility, which includes a viewer to all data items, their dependencies and their actual status (OK or outdated) in the system. During the fifth year these services were significantly optimized and qualified according to the needs of the users.

Hardware for WP5 (disk storage) and WP4 (computers) have been installed, maintained and upgraded at the various nodes. A consortium wide compute Grid and storage grid has been achieved.

Project Manager contact information- Valentijn see previous page

2. COMPARISON WITH THE PROJECT PROGRAMME

Scientific and Technical Performance

This section should be an overview covering all the aspects of the work undertaken by the partners to date.

2.1 Summary of the specific project objectives

The programme will establish a number of data centres where the voluminous wide-field imaging data can be processed to the specifications of the user, who can select on the basis of atmospheric conditions, quality of calibration data, etc which data to process and how. The linking of the data centres means that the user will always have access to the most up-to-date data.

highlights, if any, of important research results from the project (please, attach abstract of corresponding publication to Annex 1);

2.2.1 Highlights

The official starting date of the project is 1/12/2001; so this report highlights the five years of the project.

The programme executed all phases and successfully completed the last phase: "Phase III: qualify, operate and populate the mass production system", highlights include:

- The full AstroWise e-science information system, its code base, web services and documentation has been installed and delivered.
- The information system is connected to fileservers and compute servers in a European wide grid, together forming an extensive and unique e-science infrastructure.
- A public portal bundling an extensive set of GRID and web services has been operated and improved. It was opened on 14 November 2005 (www.astro-wise.org/portal). Some services can be reached by the "world", while others are restricted to registered users.
- Yearly tutorial/training weeks were organized at the Lorentz center, typically attended by 40 persons of the consortium (Leiden, November, each year); additional training courses involving scientists were held in Napoli, Garching bei München and Bonn.
- The system was populated and qualified on very large datasets of 20 Terabyte of wide field imaging data of the ESO Wide Field imager, Chile, the ING Wide Field Camera, La Palma (Canary Islands), test data of OmegaCAM, the MDM telescope (US) and the Suprime Camera at the 8m Subaru telescope (Hawaii), which:
    - was partly processed on the parallel computing clusters provided by WP4,
    - by pipeline software delivered by WP1,
    - was viewed by users via AstroWise provided user interfaces (WP2) connected to the database (WP3)
    - was archived using the databases (WP3) connected to fileservers and storage (WP5).

- A prototype image pipeline (WP1), written in the Astro-Wise paradigm, was extensively tested, improved and qualified using the aforementioned data sets.
- Extensive web services- including extensive on-line documentation such as "How-Tos"- were developed and improved after extensive user interactions, also at the courses.
- The Astro-Wise novel approach, named "Target processing", characterized by "backward chaining" through advanced integration of database technology in pipelines, was implemented, published and presented at various conferences.
- A European wide federation of databases has been implemented.
- Advanced research on facilitating European wide distributed database servers took place, leading to the implementation of a truly unique architecture of federated scientific databases which are kept in synchronisation when different user communities at different nodes work simultaneously.
- Surface photometry packages have been implemented (GALPHOT, GALFIT)
- Photometric Redshift Tool (PhotRed) and Light Variability Tools (VODIA, MDia) were built and fully integrated into the system.
- A image cutout server for fast web viewing and input to surface photometry was built and integrated in various services.
- The upgrading of the Panorapix viewer (WP2 Terapix) was not successful, due to unexpected complications with updating the software libraries used by graphic boards and instead the AstroWise system has been connected to the EuroVO Aladin viewer.
- Additional data sources of the radio telescope WSRT were ingested.
- A pioneer project involving Artificial Intelligence, for pattern recognition of digital scans of handwritten text using super computers has been integrated and tested in the system.
- Meetings of complementary programmes were attended: SISCO, EURO-VO, DataGRID and the "Euro-VO DCA board" for coordination (WP6)
- The AstroWise information system has been presented at several important conferences, like the "International Virtual Observatory (Garching 2002), the EURO-VO workshop (Garching 2005), the IAU General Assembly in Praha and the ADASS XVI in Tucson (USA).
- Papers describing the system have been delivered (Valentijn et al 2006, Valentijn & Verdoes Kleijn 2006). In particular the novel concepts of "entire backward chaining", i.e the linking of data products to the input raw data draws attention and provides a unique backbone for the infrastructure for advanced distributed e-science.
- Many European future wide-field imaging surveys plan to use the Astro-WISE system. A subset of examples: Kilo Degree Survey (KIDS), VIKING survey, OmegaTranS survey, OmegaWhite survey, Vesuvio survey, UltraVista survey and LOFAR surveys (see project pages at http://www.astro-wise.org/projectpages_index.shtml for descriptions)

The organization of the project, as outlined in the contract, was maintained:

- A PI meeting was held annually (minutes are listed on www.astro-wise.org/minutes).
- Per year 1-2 large meetings/workshops were held to review with developers and the user community together the functionalities of the system, leading to elaborate context domains (i.e projects and research groups, equivalent to Virtual Organizations) in the system

- The project web site www.astro-wise.org was built and maintained, listing descriptions of the WPs, documentation pages, tutorials, agenda, minutes etc, etc. The project website is upgraded for general use by the astronomical community.
- A project news group news@astro-wise.org and issues mailinglist (issues@astro-wise.org) is frequently used by all partners.
- teleconferences between local contacts were held monthly, and in addition weekly internet meetings between Data base administrators were held.

The project organizational scheme with short communication lines both in between developers and with users/researchers was extremely useful during the qualifications and for achieving the user-friendliness of the system. The other AstroWise typical organizational aspect, the central role of databases (WP3) in the whole system and connecting all the work packages has proven to be extremely useful, and was perhaps one of the keys for achieving exactly the goals and even more than those which were originally set out.

Work packages (1-5) outline the developments for the project:

- WP1: Design, data model and development rules for the data reduction pipeline to be built.
- WP2: Description of visualization tools and particularly in the case of the new to be developed visualization tool *detailed* design specifications are included. Development of database access tools.
- WP3: Design of Federated Database to distribute administrative and calibration data as well as documentation and software over the participating sites in support of WP1 and WP2. In addition the database will deliver or point to data items such as raw and processed image data and will contain astronomical source lists. WP3 provides the glue for the whole project.
- WP4-5: Lists the hardware currently operated or expected in the future by the partners. Enables the pooling of expertise for the setting up of the edge of technology hardware configurations (parallel processors – WP4 and dozens of Terabyte disk storage - WP5).

The Architectural Design Document (ADD) Version 1.0 (www.astro-wise.org/Public.cdr.pdf) forms the basis for the actual implementations, and constitutes the blueprint of the project. The implementation of the system was successfully finalized in the fifth year according to the specifications in the ADD. Special attention was given to building web and GRID services for the system enhancing its e-science aspects and qualifying the system with test projects

2.2.2 Technical Progress on a task by task basis

A detailed account of the step by step design, implementations and qualifications by each of the partners is listed in the five annual reports and is not repeated here.
The main progress for each of the tasks WP1-5 is the implementation of the design as worded in the ADD. Here, we briefly summarize activities on the implementation and qualification of the Astro-Wise Information system and GRID (hereafter Awe).

- **WP1 NOVA**: The prototype **image pipeline** has been qualified with large amounts of data and was delivered. The Awe pipeline converts raw image data from the telescope into astrometrically and photometrically calibrated images. The database keeps track of all operations done to the data and eventually facilitates on-the-fly- re-processing of the data, user customized. NOVA/OmegaCEN extensively tested and upgraded the prototype pipelines in an operational environment using actual data from the WFI@2.2m instrument as test data. The web-based innovative "target processing" facility was extensively tested, upgraded and delivered.

- **WP1 OAC**: Awe is fully operational at OAC. OAC delivered and tested an extensive set of quality control software integrated in the pipeline . For example, tests using the OAC Deep Field demonstrated that global astrometry is obtained with final accuracy of the order of 0.05 arcsec.
- **WP1: USM/MPE** installed and maintained the distributed version of the Awe pipelines, running a number of tests using in-house WFI data. In 2006 the Awe system is installed and maintained on a 16+1 node Beowulf cluster at MPE, that will act as the main German parallel host in the Awe compute Grid for the reduction of OmegaCam data at the USM/MPE (**WP4**).

  WP1 MPE/USM and OAC: Training courses were organized at both MPE.and OAC
- **WP2 MPE/USM:** The MPE/USM group finished the development and delivered two pieces of software to AstroWise, the photometric redshift code (photoz) together with a Python interface, and the Munich Difference Imaging Analysis tool (MDIA) which also allows to perform PSF convolution. Corresponding sections to the AstroWise User's Manual and HowTo web pages were also made available
- **WP1: Terapix** The performance of the QualityFITS package, developed by Terapix, has been compared with the AstroWise system.
- **WP1 Terapix:** Scamp is an astrometric and photometric field to field rescaling and calibration tool, developed by Terapix. Scamp has been validated by calibrating the astrometry/photometry of more than one million Megacam images over the past two years (it uses catalogues extracted from images, not pixels). The Scamp performance has been compared with the performance of the AstroWise astrometric package.
- **WP2 Terapix:** The upgrading of the Panorapix viewer was not successful, due to unexpected complications with updating the software libraries used by graphic boards and instead the AstroWise system has been connected to the EuroVO Aladin viewer.
- **WP2: OAC** delivered the **VODIA** software (VST OmegaCAM Difference Image Analysis) to the project:
- **WP2: NOVA** developed fast computer algorithms to associate (**Associate tools)** on the basis of positional coordinates to very large tables, with at least 100.000 entries. It was applied in application programmes to compute "global astrometric solutions", i.e. astrometric solutions which make use of information provided by overlapping images. The Global astrometric solutions were further refined and qualified on real data, leading to a low failure rate, less than a few percent, which for most cases was due to the presence of very bright stars.
- **WP2: NOVA/OmegaCEN** built and delivered the **dbViewer** (Graphical User Interface) to view the contents of the database via the internet. This web service has been bundled with other Awe web services in the Awe portal, a deliverable of the project allowing users to access the database throughout Europe (and beyond) without requiring software licenses. Publishing data into Euro-VO has been prepared.
- **WP2 NOVA: Image cutout server** was built, qualified and delivered. This tool can make customized thumbnails of astronomical sources to be used for inspection or input to source analysis applications
- **WP2 NOVA:** a web-based calibration management system (CALts) was built, qualified and delivered. This allows the calibration scientists to review and validate the calibration files via time stamping.

- **WP3**: The federated repositories for documents and source code, CVS, has been successfully used at the various partner institutes, providing the basic computer network infrastructure. The repository populated with source code, documentation and also internet web site data was built and maintained. This system successfully provides the backbone for a common partner wide development network. The web services for this federated repository have been bundled on internet in the Awe-portal pages.
- **WP3 NOVA**: The Oracle database server for astronomical data has been implemented, maintained and upgraded at NOVA/OmegaCEN. Also fileservers were installed and maintained. The layout of the data in the Oracle database was changed to accommodate Advanced Replication which is needed for the federated database. The federated fileserver was upgraded to support authorized deletion of federated files. The federation of database servers at the disposal of the users and connected in real time through Advanced replication was delivered to the project.
- **WP3** Oracle Advanced Replication was used to implement the federated database and a federation between Astro-Wise nodes was established and tested. The federated database is set up at the Astro-Wise nodes and integrated in the production environment..
- **WP3:** The federated fileservers have been connected and are in daily use.
- **WP3: MPE/USM** participated in the efforts to implement and test the federation of the AstroWise databases. A test database was federated with Groningen and queries running over tables in both databases and timing tests were carried out. In addition tests of the automatic replication of newly created data were run.
- **WP3 OAC**: Implemented the Oracle database on linux (first) and Solaris (last). Tests on federated DB with Oracle streams were performed. A new DB server was bought and is running Oracle 10g. Thanks to this new facility the computing time to calculate the global astrometric solution was reduced by a factor >100
- **WP4 - 5: NOVA/OmegaCEN**: Astro-Wise's central CVS repositories, Oracle db and servers with ~20 Tbyte of disk space were installed and maintained. The AstroWise servers are connected via a 24-port GB ethernet switch to the parallel cluster of the University computing centre. The parallel cluster, a 200 node dual core Opteron Linux cluster, was frequently used to bench mark , qualify and operate the AstroWise system. Research oriented data reduction was done on the new cluster using the Awe system and its "distributed processing environment". The "distributed processing environment" was adapted to allow for synchronized jobs on parallel clusters. This is useful for doing global astrometry and processes such as regridding combined with coaddition. This compute grid and storage grid was delivered to the project.
- **WP4 MPE/USM**: After the hardware for the first remote computing cluster (with 16 double CPUs and 16 TByte of disk) had been delivered by the end of 2005, the cluster was put into operation in the first months of 2006. The AstroWise software with the underlying tools was installed. In May 2006 the definition of a second computing cluster was started with benchmark testings and performance simulations. The system was purchased in November 2006. This second cluster has 124 4-CPU SUN nodes and 100 TByte IBM disk space attached to a PByte robotic storing device. The new system will be operated by the Max-Planck Computing Center in Garching and will soon run AstroWise.
- **WP4 and WP5 (OAC**): The operation system, scientific linux, was installed on the OAC beowulf cluster.
- **WP4 (OAC)** The data storage system was bought and is now available. The system is a NS704 from EMC, equipped with four NAS heads, two storage controllers populated with 12.5 TB (raw) of fibre channel disks. Storage capacity can be scaled up to 130 TB

with a very high performance in data delivery (the storage is connected to the Beowulf cluster through 24 Gigabit Ethernet connections divided in four channels).

- **WP5 MPE-USM**: The storage system was installed. Benchmark tests and performance simulations for the storing device of the latest cluster were performed to qualify the system.
- **WP5: Terapix** focussed on installing using the hardware and testing it performances with new Dual-core processors integrated in the heterogeneous Terapix cluster.
- **WP6:** One PI meeting was organized annually, regular quarterly telecons were held and several bi-lateral visits were organized.
- **WP6:** The Astro-Wise consortium collaborated with the “satellite” node Sternwarte University of Bonn. Representative visited various workshops and brainstorms..
- **WP6:** Meetings with EU-EURO-VO, the EU-EURO-VO-DCA (Data Center Alliance) board and EU-RTN-SISCO were attended by Valentijn for coordination with the virtual observatory projects and the Survey design network.

2.3 Comparison

The contract reads:

```
The programme is split into three phases, each ending with  a deliverable
and milestone.  Phase I is characterised by design reviews and creating
class definitions as soon as possible to receive wide-field imaging data,
in order to avoid possible later backwards compatibility problems. During
Phase II the system will be developed to prepare for mass production,
while during Phase III the system will be fully qualified, populated, and
delivered.
Phase I: be ready to receive first data without later re-definitions or
re-shuffling
```

Table 4.1 Milestones and deliverables

Mile-stone	Months after kick-off	Description of milestones, actions and deliverables
Phase I: be ready to receive first data without later re-definitions or re-shuffling		
1	0	milestone: kick-off WP6
2	0	milestone: kick-off- prepare design review for all WP1, 2, 3, 4 and 5
3	3	milestone: design review WP1, 2 and 3; procurement WP4 and 5
4	6	action: import pipeline
5	6	action: procure WP4, WP5 start sub-component installation
6	9	deliverable: WP1 fully operational with first version of WP4 and 5 i.e. operational pipelines at participant centres/WP1
Phase II: evaluate and prepare for mass production		
7	15	milestone: WP2 Evaluation - given experience with operational WP1
8	21	milestone:WP1/WP3 1 year operations and population of database review deliverable: set of tools to users and populated calibration database deliverable: export Beta version to satellite sites
9	27	action: upgrade of mass storage WP4- ready for bulk operations
10	30	milestone: system full mass production proof (i.e. 100 Tbyte data volume) deliverable: operational pipeline, tools, data, results in Tbyte regime
Phase III: qualify, operate and populate the mass production system		
11	33	milestone: review and set goals and schedule for final system
12	48	milestone: end of implementation/development work of the project deliverable: key objective of the project - a qualified survey system to be used for the derivation of survey and research results; including pipeline, software tools and databases.

During the five years, the programme followed the plan as outlined in Annex II - see table above.
However, already during year three it became clear that ESO will delay its commissioning of the VST telescope and its camera (OmegaCAM). Since this is one of the most important infrastructures the AstroWise system will support this implied that the foreseen qualification, operation and mass production had to be delayed to the period December 2005 – November 2006.
Accordingly, the PIs decided to re-schedule the last part of Phase II and the Phase III in a 5 year Programme that can be completed in November 2006, without requiring additional funding. An Amendment to the Contract has been set up and was signed by all partners and countersigned by the Commission. In effect the Phase III has started on 18 November 2005, when the portal was launched and the general workshop and tutorial started.

Unfortunately during the fifth year VST was not delivered by ESO, but the system was extensively tested and populated for mass production using OmegaCAM laboratory test data, next to several other data sources such as the WFI@2.2m and the SuprimeCAM@8m Subaru telescope totalling over 20 TByte of raw + processed observational data

2.4 Planned activities in the next period

The EU contract came to an end, but partners decided to continue support both for operations and maintenance of the system and will bid for funding for support for existing e-science infrastructures for massive data take up and deployment over other communities in the FP7 programme. The AstroWise partners are glad to announce that many European future wide-field imaging surveys plan to use the Astro-WISE system. A subset of examples: Kilo Degree Survey (KIDS), VIKING survey, OmegaTranS survey, OmegaWhite survey, Vesuvio survey, UltraVista survey and LOFAR surveys (see project pages at http://www.astro-wise.org/projectpages_index.shtml for descriptions)

3 Deliverables

This section should contain the list of contractual deliverables (reports, software codes, experimenta l results, prototype products, etc.) of any tasks completed to date and a comparison with Annex 1 to the contract.

The following deliverables were built, maintained and delivered:

- AstroWise Environment: a fully operational information system for wide field imaging for Europe, ready for lookup or research.
- User and developer manual – last update November 2006 (246 pages)
- CVS distributed project documentation
- CVS distributed source code
- Operating image pipeline
- Operating Calibration Pipelines
- Operating web services, including the novel TARGET processor, and the calibration file time stamp manager (CALts).
- Dedicated application packages MDIA, VODIA, GALFIT, GALPHOT and Photo-z.
- Extensive web portal www,astro-wise.org/portal including web services and documentation (docs + HowTos), including dedicated webpages and services for science projects using AstroWise.
- Hardware, parallel computers installed at NOVA/OmegaCEN, OAC, USM and Terapix-, together forming a compute GRID
- Hardware, central fileserver and database installed at NOVA/OmegaCEN together forming a data GRID
- A federated and real time synchronized distributed database system
- ASTRO-WISE web site with internal reports on various WP evaluations
- Test benches for database scalability- WP3
- Benchmarks Beowulf clusters WP4
- Hard disk towers for Terabyte storage – WP5
- Over 20 Tbyte of Wide field imaging data ingested into the AstroWise system .

The software deliverables listed above were also delivered to the Sternwarte Bonn, who as a ‘satellite node‘ installed the Astro-Wise system.

State whether the research objectives, as set down in Annex I to the contract, are still relevant and achievable. If not explain, why.

Has the methodological approach changed from that described in the contract. If so, how?

Any significant deviations from the planned schedule as described in Annex I to the contract should be clearly highlighted and discussed, stating the recommended actions to correct such deviations.

All objectives have been achieved- the e-science aspects of the project were more strengthened than originally outlined.

The programme has been implemented remarkably close to what has been outlined in the Contract Annex I.

4.0 Exploitation and Dissemination of Results

This section should describe all project aspects that are pertinent to exploitation and dissemination of results, such as:

- publications and conference presentations resulting from the project;
- patentable results, including a list of patents applied for; contacts with potential users and an indication of customer requirements.

List in Annex 1 the most significant publications/conference presentations/patents.

See Annex 1 and http://www.astro-wise.org and www.astro-wise.org/portal

See list of publications presentations at conferences.

Figure: July 2006 Visit of mayor of Groningen Dr J. Wallage, rector of University Groningen Prof F. Zwarts and dean of Faculty Prof Wiersma at Kapteyn institute
Coordinator Prof. Valentijn and Dr G. Verdoes Kleijn give a demo of the ASTRO-Wise system

5 Management and Coordination

5.0 Meetings

Meetings attended by AstroWise Staff during the 5th year. For year 1-4 see annual reports.

1. Astro-Wise Workshop: “Astro-Wise Preparing for Surveys” at the Lorentz Center in Leiden (see Agenda at at www.astro-wise.org). 20-23 November 2006 , E.A.Valentijn, K.Kuijken, R.Silvotti (I), , Y. Mellier (F), E. Bertin (F), J.Snigula (D), D. Wilman (D), O-M. Cordes (D), E.Deul, K. Begeman, D.Boxhoorn, W-J Vriend, E.Helmich, R.Vermeij, Ph. Heraudeau, M. Tempelaar, T.Schneider, G.Sikkema, G. Verdoes Kleijn, F.Getman (I), S.Leccia (I), and ,
2. PI meeting 22 Nov 2006 at Leiden minuted at www.astro-wise.org , E.A. Valentijn, K. Kuijken, G. Verdoes-Klein, O.Cordez (Bonn), R. Silvotti (for Cappacioli), D.Wilman (for Bender), Y. Mellier
3. ADASS XVI, 15-18October 2006, Tucson, Arizona, USA
4. IAU XXXVIth General Assembly, 14-25 August, Praha, Czech Republic
5. AstroWise Milestone Meeting Groningen, NL, 19-20 April 2006
6. visit mayor Groningen Wallage & Dean Rector University Groningen at OmegaCEN – AstroWise demo
7. 2 Nov 2006: GigoPart VO presentation Valentijn Utrecht, NL
8. Photometric Standardization workshop, Blankenberge, Belgium, 8-11 May, 2006
9. SISCO network cosmology confrence Durham, UK, July 31- August 4, 2006

5.1 Coordination activities

The contract reads:

```
The PM team meets at least two times a year, and is in monthly
contact  with the local contacts. The project management organisation
includes the  following ingredients to support the communication between
partners spread over different sites:
- weekly teleconferencing on fixed days and times between local contact
persons and other team members
- two-monthly meetings reviewing work-packages progress and
      setting priorities for the next quarter
- 6-monthly project review with PM team and external scientists

There will be an extensive infrastructure channelling, procedurising and
defining fixed formats (classes) of all digital information exchanged
```

between partners. Most of this is handled by work-package 3, which also provides an important management tool. To sum up, the exchange of digital information is supported by the following infrastructure:

- project internet web-site, with pages for all official documentation, manuals, arrangements, names of associated persons.
  pass word protected informal pages for intra consortium communications
- federated database for text files, such as source code, manuals etc (eg. CVS)
- federated database for all relevant wide-field imaging data, like calibration files

We have been operating closely along the lines set out in the contract.

5.2 Tasks per partner

Detailed up-to-date tables of persons actually working on the various work packages are posted on our webpages. Partners have contributed to the various workpackages in agreement to what was outlined in the contract and the Amendment. The latter involved some shift of work planned at ESO to NOVA.

ASTRO-WISE funded personnel include:

Total
OAC: 6 person year scientific programmer
Terapix: 4 person year scientific programmer
NOVA: 8 person year scientific programmer + junior programmer + 3 person year qualification scientist
NOVA: coordination: 2 person year coordination plus DBA
USM: 3 person year scientific programmer
ESO: 4 person year scientific programmer

The coordinator maintains detailed sheets (Excel) recording the actual spend human resources for each of the work packages for the various partners, both for EU funded staff and matching staff (eligible costs).

Table 4.2 presents a copy of this Table from the Contract, in which we added in the last three columns, after the /, the totals of the actually spend human resources of each partner during the reporting period.
Due to the three different cost models operated by the various partners any tabulated column has the potential to give a false impression.
To avoid misunderstandings we have added in the last column the cost model employed by the particular partner.

The last three columns of Table 4.2 are defined as follows:
Column (8):
Number of man month funded by the project for the whole contract period, as copied from the Contract. After the / we have indicated how much approximately of these ***contract units*** have been spend by the partners during the contract period.
Column (9):
Number of manmonth contributing to the eligible costs (matching costs, having different definitions in the various costmodels) as copied from table 4.2 from the contract, with after the / the total amount of manmonth during the reporting period assigned by partners to the

project, but for which no direct EU funding is given, but which are accounted in the Full cost models.
Column (10):
In the last column we list the actual human resources funded by the project expressed in person hours. Note that in AC models these are the additional costs, while in the full cost models these are the total costs to be multiplied by the fractional EU contribution for deriving the actual EU funding.

The last column is the only column which really matters in the actual financial transactions, while the previous two columns serve to trace the actual costs of the last column to the tables in the contract and partners agreement (Annex II 4.3).

Table 4.2 Human resources by participant and work package with totals for the project

Human resource breakdown (person-month)										
	(1) WP1 Proc .	**(2)** WP2 tools	**(3)** WP3 db	**(4)** WP4 Beo	**(5)** WP5 sto	**(6)** WP6 coor	**(7)** Total	**(8)** Funded by project /yr1- 5 [month]	**(9)** Not funded by project /yr1- 5 [month]	**(10)** Funded by project in year1- 5 [hours]
NOVA	41	74	52	16	9	50	242	66/75	176/198	16.311 AC
NOVA/co-or			12			12	24	24/36	0/16	4.580 AC
ESO	30	72	18	6	6	8	140	36/10	104/55	7.710 FC
OAC	33	34	18	7	14	12	118	30/30	88/96	9.720 AC
TERAPIX	10	28	27			14	79	48/45	31/31	9.790 FF
USM	20	24	3	7	6	8	68	18/22	50/64	4.511 AC
Total	134	232	130	36	35	104	671	222/218	449/460 39 prs yr	52.622 32 pers yr

Note the tabulated values in the columns WP1-WP6 correspond to the original contract, while in the Amendment some some 'ESO resources' were re-distributed.

5.3 Budget

Integrated cost statement has been submitted in the Cost Statements in Form E2, which summarizes for each partner the costs for the various budget posts.
The consumed money matches well to the budget.

Cost-Statement form E3 lists the transferred sums from Coordinator to partners.

6. SUPPLEMENTARY INFORMATION

Annex 1 – List of Publications/Patents

(see http://www.astro-wise.org/publications.shtml and http://www.astro-wise.org/documents.shtml for full articles)

(1) ASTRO-WISE: " Architectural Design Document" Version 1.0 – Internal Report
78 pages

(2) ASTRO-WISE:"Users and Programmers Manual, version Nov 2006" 246 pages

(3) Heraudeau, Ph and Valentijn E. A., ``An optical survey of the ELAIS-S2 field, data reduction with Astro-WISE'' SF2A-2005: Semaine de l'Astrophysique Francaise, meeting held in Strasbourg, France, June 27 - July 1, 2005, Edited by F. Casoli, T. Contini, J.M. Hameury and L. Pagani. Published by EdP-Sciences, Conference Series, 2005, p. 717

(4) Heraudeau, Ph and Valentijn E. A., 2005, in Proc. The fabulous destiny of galaxies. Bridging past and present, Marseille, 2005, in press.
``An optical survey of the ELAIS-S2 field, data reduction with Astro-WISE'

(5) Alcala' J.M.,, Marconi M., Ripepi V., de Martino D., Musella I., et al., 2006, "The stellar VST-GTO surveys at the INAF-OA~Capodimonte", in proc. of the XLIX meeting of the Italian Astronomical Society, Mem. Soc. Astron. Ital. Suppl., 9, 204

(6) Baruffolo A., Alcala' J.M., Benacchio L., et al., 2005, "WP10: Astrophysics in GRID.it", in proc. of "Computational GRIDs for astrophysics in Italy", in press (http://wwwas.oat.ts.astro.it/twiki/bin/view/GridWshop/GridWorkshopPapers)

(7) Pavlov, M., Alcala' J.M., and Valentijn. E.A., 2005, "VST processing within the GRID" in proc. of "Computational GRIDs for astrophysics in Italy", in press (http://wwwas.oat.ts.astro.it/twiki/bin/view/GridWshop/GridWorkshopPapers)

(8) Valentijn & Verdoes Kleijn 2006 , "The Astro-WISE system: a federated information accumulator for astronomy", ERCIM News, 65, 20

(9) Valentijn et al., 2006, "Astro-WISE: Chaining to the Universe", ADASS XVI, ASP Conference Series, 2006, Shaw, Hill, Bell, eds, in press 2007astro.ph..2189V

(10) Sikkema et al, 2006, "Globular cluster systems of six shell galaxies", Astronomy & Astrophysics, 458, 53

(11) Valentijn & Begeman, 2006, "Creating and analysing multi-dimensional data in Astro-WISE environment: a test case", white paper

(12) Verdoes Kleijn et al., 2006, "The secondary standards programme for OmegaCAM at the VST", Standardization workshop, ASP Conference series, Sterken editor, in press, 2006astro.ph.12469V

(13) Valentijn, Verdoes Kleijn, The Virtual Observatory in Action: New Science, New Technology, and Next Generation Facilities, 26th meeting of the IAU, Special Session 3, 17-18, 21-22 August, 2006 in Prague, Czech Republic, SPS3, #39

(14) Kovac, 2007, “Searching for the lowest mass galaxies: an HI perspective”, PhD thesis, Ch 5, University Groningen