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Response to the INAF Announcement of Opportunity:

BANDO PER LA COSTITUZIONE DEL "CENTRO PER GLI ARCHIVI ASTRONOMICI"

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Response to the INAF Announcement of Opportunity (Decreto n. 14/2003)

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Executive summary

The proposed project is submitted as a response to the INAF announcement of Opportunity (Bando n. 14/2003, dated 8th October 2003).

This document contains the detailed proposal for the creation of a "Centro Nazionale per gli Archivi Astronomici – National Center for Astronomical Archives" (CAA), whose aim is to develop and support a national infrastructure of electronic archives, both existing and to be implemented in the future, containing data of astrophysical interest. The name chosen for the center is "Italian center for Astronomical Archives" (acronym IA²).

The long-term goal of this project is to implement a new strategy for preserving and providing access to the Astrophysical data heritage. IA² is an ambitious Italian Astrophysical research infrastructure project that aims at co-ordinating different national initiatives to improve the quality of astrophysical data services. It aims at co-ordinating these developments and facilitating access to this data for research purposes.

It is to be noted that in the context of this document the word "Center" is to be interpreted in a <u>logical</u> rather than physical sense. In other words, the national archives infrastructure is thought to be distributed geographically, although a strong technological coordination is foreseen, so as to allow seamless inclusion of the data stored in the various sites within the International Virtual Observatory Alliance (IVOA) framework and to avoid expensive and useless duplications of efforts. The proposing group intends to provide such coordination.

The first working target, which constitutes the core of this proposal, is the implementation of the TNG Long-Term Archive (LTA). Its feasibility was demonstrated by the LTA pilot project prototype, funded by CNAA in 2001 and completed successfully in July 2002. The implementation of the TNG archive implies:

- interfacing with the Centro "Galileo Galilei" (CGG) for the acquisition of TNG data;
- long-term storage of scientific, technical and auxiliary data from the TNG;
- providing accessibility by the CGG staff and by the scientific community to original and derived data;
- providing tools to support the life cycle of observing proposals.

The second target of the proposal aims at ensuring harmonization with other projects related to archiving of data of astrophysical interest, with particular reference to projects involving the Italian astronomical community (LBT, VST, GSC-II, DPOSS, ...), to the Italian Solar and Solar System Physics community (SOLAR, SOLRA, ARTHEMIS which form SOLARNET – a future node of EGSO) and to the national and international coordination efforts fostering the idea of a multi-wavelength Virtual Astronomical Observatory, and the use of the archived data through the Italian Astronomical Grid. Moreover a particular effort will be made to ensure a close interaction with a number of existing national and international projects aimed at developing and implementing advanced data mining and visualization tools.



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This center is proposed by a collaboration comprising a number of Italian Institutes. A Steering Group will be formed with the participation of scientists belonging to national and international Institutions and well known in the field of data archiving. The members of the collaboration, both at individual and Institute level, have the know-how necessary to carry out the project. Furthermore, participation of young astronomers with a good computer science background in the development of the project is considered to be essential, therefore the assignment of contracts and/or grants (in the form of *contratti di collaborazione* or *assegni di ricerca*, respectively) is foreseen.



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1. Introduction and Generalities

The Italian National Institute for Astrophysics (INAF) has recognized the need to implement and support archives containing observational data acquired by instruments built by the Italian astrophysical community directly or through its participation in international enterprises. In particular, there is an urgent need to store and provide access to data from the National "Galileo" Telescope (TNG), which has been operating since 1998. Furthermore, in 2004 the Large Binocular Telescope (LBT) will see first light and the Large Binocular Camera (LBC), built by an Italian Consortium, will be the first instrument in operation. Provided a proper agreement is found with the LBT Corporation, archiving at least the data acquired at the LBT during the Italian observing time is considered to be high in priority. Furthermore, additional data from other sources are or will soon be available to the astrophysical community.

1.1 TNG archives - status

Anticipating a need which has been widely recognized by the international community only in recent years, the implementation of an archive for the National "Galileo" Telescope (TNG) accessible by the user community at large has been felt as important long before the telescope itself was actually built and inaugurated. In late 1992 the usefulness of such a tool was discussed; a feasibility study was performed and delivered to the Italian Committee for Research in Astronomy (CRA) in early 1993 [1]. The CRA subsequently nominated a "task force" with the purpose of setting the framework for the design of the TNG archives, and defining the related requirements and implications on the observation strategy. This group worked most of 1993 and delivered a quite detailed document [2], which was endorsed by CRA. Based on the results contained in [2], a subset of the "task force" formed a "TNG Archives Working Group" which, active throughout 1994, defined detailed user requirements for the TNG archives, the system requirements and basic architecture for the Archives at the TNG and the General Archive, identified the interfaces among the various systems, and suggested to base TNG operations upon a cyclic data flow scheme. The documentation package produced [3-7] was delivered to CRA, which endorsed the work done.

At this stage, the practical work concerning the Archives at the Telescope (AaT) started at the Astronomical Observatory of Trieste (OATs). Between 1995 and 1999 the system, which includes not only the data storage itself but complete systems for the handling and archiving of telemetry and scientific data and their retrieval as well, was designed, implemented, integrated and debugged at the telescope, and has supported telescope operations continuously since July 1999. Details on the design, evolution and operations of the system can be found in [8-12]. The AaT system was officially delivered to the "Galileo Galilei Center" (CGG) in July 1999, and has been officially accepted in September 1999 after tests had been carried out. Since, the system was maintained by



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OATs until mid-January 2000 (to support possible occurrence of the "millennium bug"). As defined in the AaT maintenance plan [11], support is however still provided by the OATs group through telephone contacts and remote connections to La Palma whenever needed (and with decreasing frequency). An upgrade to the AaT database management system was performed in November 2000 as a joint OATs-CGG activity.

In June 2001, a pilot project to define a Long-Term Archive (LTA) for the TNG was initialized at OATs. Purpose of the project was to demonstrate the feasibility of a TNG LTA (to be implemented separately and later) through the construction of a prototype LTA located at INAF-OATs and satisfying requirements and constraints defined at earlier stages. In particular, the information stored in the LTA was planned to be accessed for different purposes by different classes of users (TNG observatory staff, instrument developers/maintainers, Time Allocation Committee members, scientists), and their viewpoint on the archive can be quite different. Therefore, the logic of keeping technical and scientific data separate in a Technical Archive and a Scientific Archive, respectively, has been maintained. Information necessary to understand completely the Telescope+Instruments (T&I) system and auxiliary data are for practical purposes considered to be part of the Technical Archive. The project ended in July 2002 with the production of a final report, recommendations and a set of technical documents [13-23].

1.2 LBT archive - status

One of the most important facilities that the Italian astronomical community is developing is the Large Binocular Telescope (LBT), an 8-m class binocular telescope that is under construction at Mt Graham (Arizona).

Its first light instrument will be the Large Binocular Camera (LBC), a wide-field, high-throughput imaging camera that is currently being completed from a Consortium of the Rome (P.I. Institute), Trieste, Padova and Firenze Observatories (hereafter named LBC Consortium).

At the moment of writing, an archive for the whole LBT is not planned within the LBT Corporation. Despite this, the large dataflow expected from LBC and the expectations of the Italian community to execute large surveys with this instrument suggest that an archiving facility for the raw LBC data and for their scientific exploitation should be foreseen, and we propose its implementation as part of the IA².

In this context, we propose a structure to be distributed over two centers: i) a general data archive and ii) a scientific data processing and archiving facility (2nd-level archive). The former facility will archive all raw, calibration and housekeeping data obtained within the Italian time, initially with LBC but eventually including all the LBT instruments. The scientific data processing and archiving facility will provide support to the surveys that are planned for the instruments. The general data archive can be obtained from a properly rescaled version of the TNG-LTA archive. A prototype of the scientific data processing and archiving facility is being developed at OARm.



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1.3 Other archives at INAF Institutes – status and/or perspectives

1.3.1 VST survey

The VLT Survey Telescope (VST) project started in 1997 at the Astronomical Observatory of Capodimonte (OAC) with the aim of promoting the design and construction of a 2.6 m aperture, wide-field (1°x1°), UV to I facility, to be installed and operated at the ESO Observatory on Cerro Paranal Chile. A MoU between ESO and OAC, signed in June 1998, assigned to OAC the procurement of the telescope, and to ESO the realization of the dome and the operation of the telescope for a minimum of 10 years. In exchange for the procurement of the telescope, OAC is entitled to receive a fraction of the VST observing time (around 20%), and some VLT nights.

VST will be equipped with the OmegaCAM camera built by a Dutch, German & Italian consortium + ESO. OmegaCAM is a 16K x 16K CCD mosaic camera which will produce a data flow of the order of 100 - 150 GB/night. The raw data will be stored at the Paranal and at the ESO Garching headquarter archives. This circumstance will relax the reliability requirement on the VST GoT archive at the Capodimonte Observatory. However an on-line archive, growing at approximately 7 TB/year, will be required to store raw and processed data, as well as to deliver, with high transfer rate, data to a processing Beowulf cluster.

Presently the SW/HW archive infrastructure is developed in the context of Astro-Wise consortium (see http://www.astro-wise.org). For what concern the HW, several tests at INAF-OAC have been carried out to find a good solution in terms of performance-price ratio [Cascone et.al]. The solution adopted will be based on a 4U rack mount servers populated with 2.75 TB of EIDE disks in RAID5 configuration attached to a 3Ware RAID controller. An aggregate storage capacity of 3 TB is already available at INAF-OAC.

A first prototype of the archive/dataserver has been implemented. It is based on the NAPSTER/KAAZA type of peer to peer communication protocol. This means that an ensemble of dataservers may be instantiated to serve data to the processing pipeline.

Astro-Wise has been earmarked by Oracle as "Oracle reference programme", which consists of "innovative and leading projects worldwide". For this reason, the DBMS used is Oracle.

1.3.2 LBC survey

To exploit the LBC scientific capabilities, "core programs" are being organized within the LBC Consortium, with the involvement of the whole Italian Community. They are



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designed to execute wide area, deep multicolor surveys using a significant fraction of the LBC observing time during the first two-three years of telescope operations.

The data flow expected from LBC is indeed impressive. Each observing night is expected to produce fro 60 to 120Gb of raw data, in a full binocular configuration. Medium size programs will therefore collect about 1Tb of raw data. Because of the extreme speed of the focal station, and of the need of long total integration time, each target field will be the co-addition of hundreds or even thousands of individual exposures. To reach the high level of photometric accuracy ultimately required (from 5% to 1%), the data processing must be appropriately corrected for the expected instrumental effects, like sky concentration and geometric distortion, at a high level of accuracy.

To cope with these stringent requirements, the LBC Consortium is developing a dedicated software system to reduce and analyze the LBC data. This software system, based as much as possible on public astronomical software and embedded in a DBMS, will integrate in a coordinated system both the data reduction and catalog extraction tools. The goal is to allow the execution of different data reduction pipelines, specified according to the different scientific requirements, within a single integrated system that ensures a consistent level of data quality and traceability. We remark that funding of both the software development and the required hardware are not the subject of the present proposal.

1.3.3 Tirgo

The Tirgo Data Archive comprises all data taken by the Arcetri infrared panoramic instruments developed for the TIRGO (Telescopio InfraRosso del GOrnergrat), ARNICA (Arcetri Near Infrared Camera) and LongSp (Long slit Spectrograph). The archives contains over 350.000 frames acquired from fall 1992 to present day, by ARNICA at Tirgo telescope as well as at other (VATT, the Vatican Telescope, NOT, Nordic Optical Telescope and TNG, Telescopio Nazionale Galileo).

A Web interface let the user access data and related informations, gives full searching capability for exploration and data mining. The interface is implemented as a program written in a Web-specialized database access scripting language specific to the database (HughesSql). The database is SQL compliant so it will be relatively easy to implement a standard VO interface.

In the near future the archive will be integrated wit SNAP program, to perform on line reduction on the files selected by the user. SNAP is an automatic pipeline for the reduction of near-IR images. A full reduction, comprising a double-pass sky subtraction with object masking, offset computation, bad-pixel masking and final combination is performed with one single command and in a few seconds time. The program works



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both for observations of a single region of the sky (dithering) and for the construction of large mosaics.

1.3.4 IRA

The Istituto di Radioastronomia (IRA) in Bologna has a twenty-year experience in the management of catalogs and of archives of astronomical images. The product DIRA2, supported by Astronet in the 80's, and the AVO project financed by the CNR has been the most meaningful experiences of the past.

Currently the IRA manages, in collaboration with JIVE (the center for data correlation of the European VLBI network), the archive of the European radio astronomical network. The logs of the observations have been filed for years to Bologna while the final images, produced by a standard pipeline, will be available at JIVE starting from this year.

At the IRA computer center the best surveys of radio images (NVSS, FIRST, WENSS), and the DSS optical survey are available on line and tools were developed to select many fields from different data sets. Moreover the Institute works to the IRA-PArc product, an internal archive to safeguard and organize the personal images of the researchers of the institute. Together with CINECA and other astronomical Institutes in Italy and Europe, IRA has participated in Cosmolab, a project to develop tools for the visualization of data obtained from astronomical catalogues using 3D techniques.

The Istituto di Radioastronomia wishes to share its resources and competences with the "Centro per gli Archivi Astronomici"; the resources and competences are mainly in the management of archive of radio astronomical data. In the philosophy of a geographically distributed center for astronomical archives, IRA plans to explore "GRID technologies" that seem to provide innovative tools and concepts for the management of big data archives.

1.3.5 Archives of High-Energy Data

Two INAF Institutes, the Osservatorio Astronomico di Brera-Milan (OAB) and the Osservatorio Astronomico di Palermo (OAPa) have a multi-decennial tradition in the fields of handling, processing and archiving high-energy data. OAB is the selected site for ISAC, the Italian Archive Center of the SWIFT mission. OAPa, after the historical experience with the data from the Einstein mission, is now deeply involved in the handling and processing of data from Chandra.

Jointly, and in collaboration both with the ASI Science Data Center (ASDC) and with the high-energy group of the Osservatorio Astronomico di Roma, they have developed DIANA (Distributed Italian Astronomy Network Archive), a multi-mission interactive archive and catalog browser.



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These efforts are expected to be coordinated with the IA² through the ASDC (see section 1.4.1).

1.3.6 SolarNet

The three Italian solar archives, SOLAR (INAF-OATo) storing the space data of the 12 SOHO instruments, SOLRA (INAF-OATs) storing the radio data obtained by the Trieste Radio System and ARTHEMIS (INAF-OAC) storing both the data of the French-Italian telescope THEMIS and those obtained at the ground-based solar observatories of Catania, Rome and Naples, form SOLARNET (SOLar ARchives NETwork), the project aimed to federate the Italian solar data archives as the first step towards the EGSO framework implementation and integration.

1.3.7 Archives GSCII-DB and GSPCII

The Guide Star Catalogue II (GSC-II) is an all-sky catalog realized as a joint project of the Space Telescope Science Institute (STScI, Baltimore) and of the Osservatorio Astronomico di Torino (OATo). The version 2.2.01 (July 2001) contains positions, classifications, and magnitudes (photographic BR) for 455,851,237 objects down to B=19.5 and R=18.5, and is now available to the community via the WWW from the CDS or directly from the STScI. The next version, GSC-II 2.3, will contain all the objects (> 1 billion) down to plate limits (B=22, R=20.5, I=19.5) including proper motions and new photometry from infrared plates. The catalogs have been extracted from a global DB (3 TB) which includes about 6 billion multi-epoch (1950-2000) and multi-band observations derived from about 7000 digitized plates provided by the Palomar and UK Schmidt surveys.

The Guide Star Photometric Catalog II (GSPC-II) is a catalogue of very accurate (<5%) stellar BVRc magnitudes for about 500,000 stars distributed over the entire sky down to V=19, which has been used to calibrate the GSC-II plates. The sequences can be downloaded from the OATo and STScI WEB pages.

In the context of this proposal, OATo will provide the access, via s/w interfaces defined by the CAA requirements, to (1) the GSC-II 2.3 export catalog, (2) GSPC-II and (3) the Data maintenance, including data quality checks, will be also GSC-II database. provided by OATo.

1.4 Other archives at non-INAF Institutes – status and perspectives

1.4.1 ASDC

The ASI Science Data Center (ASDC) is a facility of the Italian Space Agency (ASI) established in November 2000 to support all ASI scientific missions in the management



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and preservation of scientific space data and to provide high quality services to the scientific community.

The ASDC manages the data archive and supports the scientific operations of several space astronomy satellites with various degrees of involvement. At this time it provides full support (including prime responsibility for the data archives, pipeline data reduction, contribution to software development and data distribution) to the recently completed *BeppoSAX* project and to the upcoming AGILE gamma-ray observatory. Another major activity of the ASDC is the close cooperation with the Swift project within which it leads the development of the data reduction software of the X-ray telescope and is one of the main archive and data distribution sites.

In addition, the ASDC hosts a copy of the scientific data archive of several other past and present space astronomy missions (including EXOSAT, *Einstein*, ROSAT, ASCA, XMM-*Newton*, *Chandra* and INTEGRAL) and integrates them into a locally developed Multi-Mission, Multi-Wavelength Interactive Archive.

The ASDC is based at the ESA establishment of ESRIN in Frascati which provides an excellent local infrastructure and is conveniently located with respect of several scientific institutions in the Rome area. Its many software and communication systems are based on reliable, state of the art, hardware infrastructure directly managed by ASI staff in cooperation with industrial contractors.

The ASDC actively collaborates at scientific and technical level with several Italian and international astronomy institutes.

1.4.2 Mirror archives (DPOSS, SDSS)

The Department of Physical Sciences of the University of Napoli "Federico II" is currently implementing a mirror of the Digitised Palomar Sky Survey (DPOSS) obtained in the framework of an international collaboration. The archive contains both the pixels (ca. 2 TB of raw data) and the catalogues (ca. 250 GB) and can be queried via an internet interface. The DPOSS archive has been calibrated to the Gunn-Thuan photometric system and uses the astrometric calibration of the USNO. Beginning with year 2004 it is also planned to mirror the Sloan Digital Sky Survey (SDSS) and a MoU with the SDSS team is at the moment being evaluated by the two institutions.



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1.5 Virtual Observatory and Data Grid

1.5.1 The International Virtual Observatory Alliance

The International Virtual Observatory Alliance (IVOA) was created in June 2002 to facilitate the international coordination and collaboration necessary for the development and deployment of the tools, systems and organizational structures necessary to enable the international utilization of astronomical archives as an integrated and interoperating virtual observatory.

To fulfill the scope of its mission, IVOA has organized a set of working groups defining standards and mechanisms to allow archives to be interoperable. Active groups are: Data Access Layer WG, Data Modelling WG, Grid and Web Services WG, Resource Metadata and Registry WG, Standardization Process WG, Unified Contents Descriptors WG, VO Query Language WG and VOTable WG. The mechanism to allow the proposals coming from the WGs to become effective and operational involves the approval of a board (the IVOA Executive Committee) which acts as a coordinating body.

Countries having specific VO activities include US, Canada, UK, France, Germany, Italy, Hungary, Russia, India, Japan, Korea, China, Australia, plus a European coordination effort which is building a phase-A Euro-VO prototype under the auspices and with the funding of the EU 5th Framework Program. The Italian participation to IVOA is guaranteed by INAF through the DRACO project (see section 1.5.3).

1.5.2 Grid.it

A project called "Enabling platforms for high-performance computational Grids oriented towards scalable virtual organizations" which has been approved and funded by the Italian Fund for Basic Research (FIRB). The astrophysical section of the project (work-package 10, coordinated by L.Benacchio/OAPd) is the implementation of three demonstrators which are to prove the feasibility of porting astrophysical applications within the framework of a national Grid structure.

The demonstrators chosen, for scientific and technological interests, are the following: i) access and browsing of astronomical databases; ii) a facility for the retrieval and processing of VST images; iii) distributed monitoring of observations on remote telescopes and quasi-real-time observation of targets of opportunity.

GRID related research is also ongoing at the Department of Physical Sciences at the University of Naples in strict collaboration with the INFN-GRID team. The main goal of this collaboration is to implement data mining and data analysis tools capable to work in a distributed environment. Other GRID activities are being carried out at the Observatory of Catania jointly with the INFN team.



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1.5.3 DRACO

The Italian Data Grid for Astrophysical Research (DRACO: Datagrid for italian Research in Astrophysics and Coordination with the virtual Observatory) is a concept having the aim of providing the scientific community with a distributed multi-functional environment allowing the use of specialized (observational, computing, storage) Grid nodes.

DRACO has been generated from a section of Grid.it (described above) and expects now to expand the number of nodes and applications of the Italian astronomical data grid, after a proposal in this direction has been funded under the Italian Cofin programme for 2003. The project involves the Observatories of Capodimonte, Catania, Padova, Rome and Trieste, and the University of Salerno.

DRACO provides the framework through which the Italian astrophysical community can participate in the international Virtual Observatory (VO) effort, through the participation in the development of the Euro-VO project and the setup of a structure of interoperability among national archives.

1.5.4 EGSO

EGSO, the "European Grid of Solar Observations", is a Grid test-bed that will lay the foundations of a "Virtual Solar Observatory".

EGSO addresses the problem of combining heterogeneous data from scattered archives of space and ground-based observations into a single "virtual" dataset. The project will also create catalogues of solar features and observation data to enable innovative searching, and provide visualization tools for user-friendly data browsing. EGSO will be a unique resource for the solar physics community, while also serving as an interface to solar data for the Space Weather, Climate Physics and Astrophysics communities.

The main technical objectives for EGSO include: the federation of solar data archives, the creation of tools to select, process and retrieve distributed and heterogeneous solar data, the creation of tools to compile standardized catalogues for space and ground-based observations, and the creation of tools for the automatic generation of solar feature catalogues. The project will carry out extensive consultation with various stakeholder groups to determine the community and scientific requirements for the EGSO system. The results will be used to develop an architecture for EGSO, designed to meet the technical objectives of the project.

EGSO is funded under the Information Society Technologies (IST) thematic programme of the European Commission's Fifth Framework Programme. The project is one of many partners from across Europe that co-operate through the EU GRIDSTART initiative. EGSO is also working closely with the US Virtual Solar Observatory (VSO) project, funded by NASA.



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INAF is participating in EGSO through development activities carried out by working groups operating at INAF-OATo, INAF-OATs, INAF-OAC and INAF-OAA.

1.6 Other activities

1.6.1 Cosmo Lab Project

The Cosmo.Lab project is financed by the EC in the framework of the FP5 (IST-2000-28481). It is to build software which can handle efficiently large datasets allowing both their graphical representation and analysis, responding to the requirements proposed by several research fields. The main investigated fields are: i) data coming from cosmological simulations; ii) data coming from observational catalogues (VIRMOS); iii) observational data of extragalactic radio sources

Although these fields do not cover all the requirements of astronomy, they pose many typical problems that we have solved with AstroMD and therefore represent a significant test-case. The solution to these problems have been implemented following the suggestions and the indications of the research groups involved in the project, and this gives immediate benefit of the possibility of using AstroMD for the related studies.

The project has also an educational goal, based on the 3D capabilities of AstroMD. This feature has been exploited on different platforms, from a very sophisticated virtual theatre which is effective way of presenting astrophysical problems to students, giving the possibility of observing objects and structures from a privileged and personalised point of view

AstroMD will represent the first experience of a tool of immersive visualisation and data analysis in astrophysics. It was developed using low cost software, running on the most common platforms, using the Visualization Toolkit (VTK) by Kitware. VTK supports a wide variety of visualization algorithms including scalar, vector, tensor, texture, and volumetric methods and advanced modelling techniques. It supports stereographic rendering and can be used for virtual realty visualization. Furthermore, being easily extensible, the system allows ad hoc implementation of specific modules.

However AstroMD is a continuously evolving project. It takes advantage of being an open-source software to allow the inclusion of the contributions from the astronomical community. AstroMD must be also modified in order to interact with the data repository retrieving data and information and allowing the upload of lessons and user-produced material. Database access and interaction capabilities are already integrated in AstroMD, however this feature must be developed to integrate the visualization features and the analysis tools of AstroMD, with the database of this project.



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1.6.2 Soft Computing

The AstroMining software (Longo et al. 2001) is a package written in the MatLab © environment to perform a large number of data mining and knowledge discovery tasks, both supervised and unsupervised, in large multiparametric astronomical datasets. The package relies also on the Matlab © "Neural Network", the "SOM" (Vesanto 1997) and the "Netlab" (Nabney and Bishop 1998) toolboxes. AstroMining accepts as input any ASCII table containing a header describing the contents of each column and then a set of parameters.

Via interactive interfaces, it is possible to perform a large number of operations: i) manipulation of the input data sets; ii) selection of relevant parameters; iii) selection of the type of neural architecture; iv) selection of the training validation and test sets construction procedure; v) etc. The package is completed by a large set of visualization and statistical tools which allow to estimate the reliability of the results and the performances of the network. The user friendliness and the generality of the package allow both a wide range of applications and the easy execution of experiments (more details on other aspects of the AstroMining tool which are not relevant to the present work may be found in Tagliaferri et al. 2002).

1.7 Acronyms

AaT Archives at the (TNG) Telescope

ANN Artificial Neural Network
ARNICA Arcetri Near Infrared Camera

ARTHEMIS ARchive of THEMIS
ASDC ASI Science Data Center
ASI Agenzia Spaziale Italiana

AVO Astronomical Virtual Observatory

BeppoSAX Satellite per Astronomia X, "Beppo" in honor of <u>Giuseppe Occhialini</u>
CAA Centro Nazionale per gli Archivi Astronomici (Center for Astronomical

Archives)

CADC Canadian Astronomica Data Center

CD-R Compact Disc - Recordable CDS Centre Données Strasbourg CGG Centro "Galileo Galilei"

CINECA Consorzio Interuniversitario del Nord-Est per il Calcolo Automatico

CNAA Consorzio Nazionale Astronomia e Astrofisica

CNR Consiglio Nazionale delle Ricerche
COSPAR Committee on Space Research
COTS Commercial Off-The-Shelf



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CPU Central Processing Unit

CRA Comitato per le Ricerche in Astrofisica

CVS Concurrent Versioning System

DB DataBase

DBMS DataBase Management System

DIANA Distributed Italian Astronomy Network Archive

DIRA Distributed Information Retrieval from Astronomical catalogs

DM Data Model

DPC Data Processing Center
DPOSS Digitised Palomar Sky Survey

DQ Data Quality

DRACO Datagrid for Research in Astrophysics and Coordination with the virtual

Observatory (aka IDGAR)

DVD Digital Video Disc

EGSO European Grid of Solar Observations

EMMI ESO Multi-Mode Instrument ESA European Space Agency

ESIS European Space Information System ESO European Southern Observatory

EU European Union

EXOSAT The European Space Agency's X-ray Observatory

FIRB Fondo Italiano per la Ricerca di Base FITS Flexible Image Transport System FP5 Framework Programme no.5 (EU)

GB GigaByte

GriPho Italian Grid for Photometric Data (aka IGPD)

GSC Guide Star Catalog

HDF Hierarchical Data Format HST Hubble Space Telescope HTML HyperText Markup Language

IA² Italian Center for Astronomical Archives

IAU International Astronomical Union ICD Interface Control Document

IDGAR Italian Data Grid for Astrophysical Research (new name: DRACO)

IGPD Italian Grid for Photometric Data (new name: GriPho)

INAF Istituto Nazionale di Astrofisica INFN Istituto Nazionale di Fisica Nucleare

INTEGRAL The International Gamma-Ray Astrophysics Laboratory

IRA Istituto di RadioAstronomia ISAC Italian SWIFT Archive Center

IVOA International Virtual Observatory Alliance



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JOSO Joint Organization for Solar Observations

K€ Thousands of Euro

LBC Large Binocular Camera at the LBT

LBT Large Binocular Telescope

LongSp Long slit Spectrograph (at TIRGO)
LTA Long-Term Archive (of the TNG)
MoU Memorandum of Understanding

NASA National Aeronautical and Space Administration
OAA Osservatorio Astrofisico di Arcetri – Firenze
OAB Osservatorio Astronomico di Brera – Milano

OABo Osservatorio Astronomico di Bologna

OAC Osservatorio Astronomico di Capodimonte – Napoli

OACt Osservatorio Astrofisico di Catania OAPa Osservatorio Astronomico di Palermo OAPd Osservatorio Astronomico di Padova

OARm Osservatorio Astronomico di Roma – Monte Porzio

OATo Osservatorio Astronomico di Torino OATs Osservatorio Astronomico di Trieste

OO Object-Oriented

OODBMS Object-Oriented DataBase Management System

PC Personal Computer PI Principal Investigator

PP Pilot Project RAID redundancy disk

RDBMS Relational DataBase Management System

SCSP Simple Cone Search Protocol SIAP Simple Image Access Protocol

SIMBAD Set of Informations, Measurements, Bibliography And Data

SOHO SOlar and Heliospheric Observatory

SOLAR SOHO Long-term Archive

SOLARNET Network of the Italian Solar Archives

SOLRA SOLar Radio Archive of the Trieste Solar Radio System

SSAP Simple Spectra Access Protocol SUV Spectrum Ultra-Violet mission SDSS Sloan Digital Sky Survey

SWG Science Working Group (of the AVO project)

TAC Time Allocation Committee

TB TeraByte

TBC To Be Confirmed
TBD To Be Defined
TBN To Be Nominated



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THEMIS Télescope Héliographique pour l'Étude du Magnétisme et des Instabilités

Solaires

TIRGO Telescopio InfraRosso del GOrnergrat

TNG Telescopio Nazionale "Galileo"
T&I Telescope and Instruments

UIF User Interface

USNO US Naval Observatory

VIRMOS Visible and InfraRed Multi Object Spectrograph

VLT Very Large Telescope VO Virtual Observatory VST VLT Survey Telescope

VTK Visualization Toolkit by Kitware WBS Workpackage Breakdown Structure

WG Working Group WP Work Package

XML eXtended Markup Language



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2. Statement of Work

The work is planned to be carried out through the implementation of three different layers, in order of priority:

- 1. the implementation of the TNG archive at OATs;
- 2. provision for LBC data at OATs, and integration of other archives, whenever available, in different locations;
- 3. integration of application software (visualization, data mining) on the IA² distributed structure.

These tasks will be performed in a continuous fashion, covering development and operational duties, throughout the lifetime of the center. It is however to be noted that during the first year, the three phases will be implemented sequentially. In any case, a close eye will be kept on the standards being defined and implemented within the IVOA collaboration, so as to allow seamless integration of the IA²-supported archives in the Virtual Observatory.

2.1 Scope of the IA²

This proposal considers the reports of the "Data-Base and Data Reduction Committee" [24], the "Announcement of Opportunity" with the attached list of services to be provided by the IA², and the "LTA Pilot Project" documentations, and in particular the "Final Report and Recommendations" [13], as the basis to develop any further work.

The main task of the IA² will be the development of a "distributed" Center that saves the data acquired from the telescopes built by Italy, or with Italian participation, and to make them available to the whole national and international astronomic community. This may happen through the classical web interface, and/or through the interface with two crucial and strategic realities currently in rapid evolution and to whom the IA² can give an effective contribution: the Virtual Observatory and the Grid.

The strategic tasks of the IA² will be:

Service to the users;

The public data of the Italian telescopes shall be retrievable by the whole community to the best of their quality and following the IVOA standards. To achieve this goal different types of interfaces need to be developed or acquired. This implies that the same data can be used (or seen or acquired) through:

- the classical web interface
- the IVOA framework



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the Grid

These three methods, even if at a first sight can appear to be different, should lead toward the definition of a unique interface.

Interface to data providers;

The center cannot loose contact with the various data providers (the telescopes), and therefore one of its tasks will be the definition and the maintenance of Interface-Control Documents (ICDs) with the telescope managers. The concept of "data" in this context embraces both scientific and technical data. To allow a smooth integration of data acquired by the observing facilities in the archives and within the standard structure of the Virtual Observatory, the detailed definition of proper interfaces between pairs of IA² subsystems is needed. Such interfaces will be defined and maintained by means of ICDs, to be signed and maintained jointly by IA² and data providers. The interfaces can be changed only when a mutual agreement has been reached. In this case the corresponding ICD must be revised consequently.

Coordination with other Italian data repositories:

In Italy a large but spread and not organized expertise exists on the management, visualization and use of astronomical data, so this implies that the IA² must be physically distributed, but must also be a single logical entity. This is essential to allow the efforts to be assembled toward a common objective and the synergies, both human and "material" (computer and data), to be exploited to the best. This is a key point for a profitable life of the IA²: a coordinated development of the whole structure can bring to a fast and efficient growth of the Center and to an optimization of the resources.

2.2 Work Plan

In the following, the work needed to implement the "Centro nazionale per gli Archivi Astronomici" (Italian Center for Astronomical Archives) (IA²) is described.

2.2.1 IA² conceptual design

The IA² is a center aimed at supplying services (as defined in 2.2.1.1) to the end-user relatively to the public data of the Italian telescopes or with an Italian share. These data can be "raw scientific data", "calibrated scientific data", "processed scientific data", "housekeeping data" and "auxiliary data".

Public scientific data (those no longer subject to a proprietary period), will be looked up without restrictions, while for housekeeping (technical) data (with the exception of meteo data or other data of public interest) access policies will be applied based on a simple identification of the user; in fact, if we consider the massive structure of data



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present in the DBs and the potential complexity of queries, an indiscriminate access could bring a significant loss of performance of the system involved.

As previously stated, the IA² will be a distributed center, as the necessary competence in acquiring, managing, understanding, visualizing and using data is spread over the national and international institutions. In order to optimally exploit these competences the IA² will need to invest resources in a coordination activity. To support this activity a hardware/software infrastructure has to be developed and/or integrated.

The IA² will use the TNG-LTA experiences to develop a whole series of services (see 2.2.1.1) that will allow the user to make the best use of the scientific observations, independently from their source. The coordination with national and international structures (DRACO, GriPho and IVOA) will be one of the main points of its presence on the national territory as an INAF official supplier of astronomical data. To do this, the IA² will supply a common layer that connects the user to whole set of data providers, in univocal way and in the IVOA's spirit, keeping in mind the evolutions of the Grid phenomenon.

2.2.1.1 Location of the coordination site

The site where the technical coordination, the definition of the project standards and the custodianship of the interface documents will reside is the Observatory of Trieste (OATs). The coordination site will play a major role in the design and in the joint implementation of the system, and in the enforcement of standards.

OATs will host the TNG Long-Term Archive and the LBC/LBT general data archive. The Observatory will provide appropriate logistic arrangements for this purpose. As for personnel, the participation of the staff included in this project is foreseen, plus some support by the OATs administration for the management of the funds.

2.2.1.2 Services

The services that the IA² will supply (by maintaining existing software or by implementing new tools) are:

- Filling the database with the observational logs;
- Filling the archive with housekeeping data in FITS format;
- Filling the archive with scientific data in FITS format;
- Maintaining the interfaces (Interface Control Documents ICDs) with the data providers (telescopes and instruments);
- Providing standard quality control on the data, through procedures arranged with the data providers;



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- Providing quality control of long period (trend analysis) on the data, through procedures arranged with the data providers;
- Providing a "Name Server" to convert the name of an object in coordinates and vice versa:
- Providing a "Data Organizer" to associate to any scientific exposure its "best" calibration files, through procedures arranged with the data providers and/or with the national grid for the photometric data (GriPho);
- Providing a conversion service among different systems of coordinates (through Web Services);
- Providing tools to search the information in the DB through defined keys, on the base of parameters corresponding to the keywords of the headers FITS;
- Allowing data retrieval according to international standards (VOTables);
- Providing a Web based user interface;
- Providing a graphic utility for the visualization of the data extracted by the database;
- Providing an utility for the visualization of the observed data;
- Providing a management tool of the user's requests to define the duration of each request, to define its priorities, to manage a queue of requests, and to notify the conclusion of the request to the user;
- Providing a pre-reduction of the data (if needed) using procedures provided by the GriPho collaboration;
- Distributing data to the users via the network;
- Distributing data to the users on optical support (CD or DVD);
- Maintaining the interfaces with the International Virtual Observatory;
- Coordinating with the Italian grid for the astronomical research (DRACO);
- Coordinating with the Italian grid for the photometric data (GriPho).

2.2.1.3 Development

To provide the above services, the IA² will carry out the tasks listed below. To do that both commercial and public software (COTS) will be adopted and collaborations with providers of data and already existent services will be established. Tasks to be carried out are:

 Development of repositories of housekeeping telemetry and scientific exposures in FITS format, handled by means of a database management system (DBMS);



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- Development of data quality control and trend analysis software, through procedures set up jointly with the data provider;
- Installation (or provision through Web Services) of a "Name Server" to convert the name of an object in its coordinates and vice versa;
- Development of a "Data Organizer", to associate to any scientific exposure the "best" calibration file, through procedures arranged with the data providers and/or with the national grid for the photometric data (GriPho);
- Development of database search tools based on the keywords of the FITS headers;
- Development of data retrieval tools based on international standard (VOTables);
- Development of a Web user interface;
- Development of a graphic utility for visualizing the data extracted by the database;
- Development of a management tool for user applications able to notify to the user the duration of the various requests, to define its priorities, to manage a queue of requests, and to notify the conclusion of the request;
- Development of pre-reduction tools in collaboration with data providers and/or with the national grid for the photometric data (GriPho)
- Design and development of interfaces with the International Virtual Observatory
- IA² co-ordination with the Italian grid for the astronomical research (DRACO)
- IA² co-ordination with the Italian grid for the photometric data (GriPho)
- Installation of a CVS server to maintain trace of all mantained and developed software;
- Investigate the suitability of installing a TWiki Web Based Collaboration Platform to share document and software.

2.2.1.4 Infrastructure of the coordination site

The Hardware infrastructure of the IA² at its coordination site will be initially constituted of:

- An observational database server, the target being the management of both the information on the observed files and the files themselves through a DBMS;
- A housekeeping database server, the target being the management of information on the housekeeping data through a DBMS;
- A web server; it will be the interface between the DBMSs and the users;



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- A processing server, being it a multi-CPU machine or a Beowulf system devoted to the pre-reduction (systematic or "on-the-fly") of the observed data and the data quality tools;
- A storage system capable to store on-line all the technical and scientific data;
- A Juke Box unit (CD or DVD)
- Backup units (Tape, CD and DVD)

The basic software infrastructure of the IA² will include at least:

- A database management system (DBMS), preferably compatible with the data provider;
- Software for the standard calibration of the data (defined by GriPho);
- A archive management software;
- A network management software;
- A system backup management software;
- Standard software for the connection to the Italian grid of research
- Standard software used by the International Virtual Observatory
- Utility software

2.2.1.5 Data Policy

The scientific exposures are assumed to be publicly available after a proprietary period (in other archives world-wide, this is generally between 6 and 24 months). In any case, there will be a period in which they will exclusively available to the reference scientists of the relevant proposal approved by the TAC. The project will propose a set of data policies, one for each Data Provider, to the INAF management for approval.

2.2.1.6 Personnel and management

The management of the CAA will be as follows: the PI of the center will manage the project and will be assisted by a Steering Group and a Data Providers' Group. The PI will also coordinate a Development and Operations Team, distributed across the participating Institutes.

In the following, the professional profiles of the personnel participating in the CAA are described.

Personnel at the coordination site:

Staff Astronomer - PI (management and coordination)



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- Staff Astronomer responsible for the management of policies and ICDs
- Staff Astronomer responsible for the infrastructure
- Staff Astronomer responsible for the procedures
- Contractor software development
- Fellow ("assegno di Ricerca") development of operational procedures
- Contractor(s) future CAA development and support (if applicable)

Personnel at other sites:

- Local Responsabile coordination
- Collaborator(s) system development (if applicable)
- Collaborator(s) data management and provision (if applicable)
- Contractor(s) future CAA development and support (if applicable)

Steering Group:

A Steering Group for the CAA will be formed, with the task of advising the CAA development and operations group in the fulfilment of their task and of suggesting directions for the further extension of CAA services. The Steering Group members will have a three-year mandate, and can be renewed for additional three years. Number of members and terms of reference of the group are TBD.

If the project is approved, the following scientists have accepted to serve in the CAA Steering Group: Leopoldo Benacchio (INAF/OAPd), Daniel Durand (CADC), Paolo Giommi (ASI/ASDC), Giuseppe Longo (Univ. Naples), Alberto Micol (ESO), François Ochsenbein (CDS), Fabio Pasian (OATs).

Data Providers' Group:

An additional group (the Data Providers' Group) will be formed, composed of representatives from the various sites providing data to the CAA. Members of this group are staff both from observatories providing data and from sites having stabilized scientifically-usable datasets (i.e. mirrors of surveys, etc.).

The membership of this group is currently TBD, although it is logically going to increase whenever a new data providing site joins the CAA.



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2.2.2 TNG archive

The goal of the first task of the IA² is to make possible the use of the TNG public data by exploiting the experience acquired through the construction of the TNG-LTA prototype archive. The conclusions reached at the end of this project are still basically valid, as are the recommendations done to the data provider (the CGG).

The TNG-LTA pilot project has made possible to study and to define an optimal structure as regards scientific raw data and housekeeping telemetry, together with their processing; futhermore, a big evolution concerned the interoperability concept. This means that during this project the greatest effort will be devoted to the harmonization of the LTA according to current IVOA standards so that not only we will be able to make available the LTA to the end user in the most efficient way and with the up-to-date standards, but also the TNG data will be seamlessly included in those transparently accessible by the Virtual Observatory.

2.2.2.1 Archive conceptual design

An overall architecture for the LTA system, as defined in the TNG-LTA Architectural Design Document [23], is depicted in Figure 1. The TNG-LTA-PP was successfully tested in real conditions, so no main changes are planned in the internal structure of the archive, except for some interface to best adapt to the IVOA and Grid systems.



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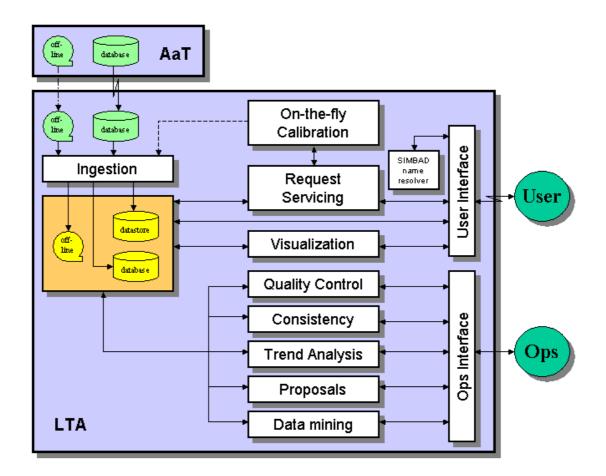


Figure 1 - Overall architecture for the TNG LTA system. See explanations in the text for an overview description.

2.2.2.2 Interface Control Document

A draft ICD related to TNG data has been prepared for the CGG-LTA interface [22], during the TNG LTA pilot project. That document contains the definitions of the data interfaces between the TNG AaT and LTA. The format of data structures needed for a proper exchange was described. The contents of the data structures to be exchanged were described: telemetry data, instrument exposures, auxiliary information. In particular, the contents of FITS headers were defined, and divided in groups to reflect the responsibilities of the different data providers.

This will be the first ICD to become operational, after proper updating and agreement with the CGG staff. The other ICDs will be prepared and signed whenever needed.



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2.2.2.3 Ingestion of TNG data

2.2.2.3.1 Ingestion of TNG scientific data

Files containing scientific exposures are sent by CGG to LTA via mail or courier [22]. The ingestion procedure reads all CD-Rs loaded on the juke-box and dumps their content on magnetic disk to allow on-line access.

2.2.2.3.2 Ingestion of TNG housekeeping data

Technical data (telemetry) information is updated at LTA via network [22]. For their ingestion, a pipeline is defined composed of processes running automatically, both at the TNG and at the LTA.

2.2.2.3.3 Ingestion of TNG auxiliary data

Other important information must be stored in the IA². Auxiliary data like documents, filters information, etc., are essential for understanding the scientific data. It is necessary to define and implement how store then, and how then can be made available to the user.

2.2.2.4 Proposals Archive

All the information on submitted observing proposals shall be store in the IA². Some of this information will be public and some will be reserved to the Time Allocation Committee (TAC). The definition of the public and reserved data is a matter of the policies.

2.2.2.5 User Interface

The definition of user interface must be broader than that of a classical Web interface. As previous described, the same data must be accessible through:

- the classical web interface
- the IVOA interface
- the Grid

Independently on the access method the user will be able to:

- browse the contents of the Database;
- specify constraints for database searches;
- allows to display information retrieved from the database in alphanumeric form;
- allows to select files to be extracted from the Data Store;
- allows to select exposures to be retrieved as FITS files;



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• allows to choose if exposures to be retrieved are to be calibrated on-the-fly.

2.2.2.6 Data Organizer

A "data organizer" tool is expected to be available: for any given scientific exposure, the existence of the corresponding calibration exposures will be verified, thus verifying the possibility to perform calibration (at least at a "standard" level) of the scientific exposures; for each acquired exposure, the "best possible" corresponding files needed to perform data calibration and reduction will be selected, following some pre-determined rule defined within the GriPho collaboration or with the CGG for TNG data.

2.2.2.7 Data Quality

Some tools and procedures to evaluate Data Quality (DQ) for ground-based optical data, and specifically for the TNG, will be implemented and tested. The IA² will collaborate with the observing facilities for the definition of data calibration plans and of observational procedures to be implemented operationally.

Additional DQ tools will be built at the IA². Initially they will be tuned upon data stored in the TNG Long-Term Archive (LTA); however, the tools will be designed to be independent as much as possible from specific telescopes and instruments, so as to be easily exportable and thus usable for data related to other observatories.

2.2.2.8 Optimization of TNG data handling

The optimization and harmonization of the TNG data handling system is actually recognized, being based upon the experience of its use.

In collaboration with the CGG and using the experience of the TNG-LTA-PP and TNG-AaT, the IA^2 will upgrade the data handling system (Telescope - Observer to the TNG - IA^2) and harmonize the UIFs by introducing at the TNG those that will be developed at the IA^2 using the international standards.

2.2.3 LBC/LBT extension

As stated above, we feel that an archive for LBC/LBT is a top priority for its scientific exploitation, and we strongly recommend its prompt implementation. In this context, we propose a scenario where the whole LBC raw data are stored in a "LBC general data archive", and their scientific processing is made possible by a "LBC Survey Science Archive", that we detail below. Such a system can provide access to the raw and reduced LBC data to the whole Italian community, and become one of the first working examples of the Data Grid concept. We remark that funding of both the software development and the required hardware for the Grid are not the subject of the present



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proposal, since their early development has already been funded by Cofin dedicated proposals.

2.2.3.1 LBC General Data Archive

The LBC General Data archive is expected to archive the raw science and calibration exposures, and the telemetry data of the LBC instrument, at least those acquired during the observing time assigned to Italian users. This archive can be obtained from a properly rescaled version of the TNG-LTA archive proposed here, adopting a dedicated storage and computing hardware but using the TNG-LTA archive concept. We note that, since the LBC Data Handling System has already been designed by the participants of this proposal, it will be extremely simple to implement the LBC data in a TNG-LTA-like archive.

2.2.3.2 LBC Survey Science Archive

The LBC Survey Science Archive is designed to mirror a relevant part of the general LBC data archive and to provide support to the surveys that are planned for the instruments and possibly to its ordinary users, to obtain the best scientific results from this instrument. This system, based as much as possible on public astronomical software and embedded in a DBMS, will integrate in a coordinated system both the data reduction and catalog extraction tools. It will provide in a IVOA standard format about the multiwavelength catalogs that will result from the LBC surveys. A prototype of the scientific data processing and archiving facility is being developed at OARm, as well as its implementation in the Prototype for Italian Astronomical Data Grid.

2.2.3.3 Extension to all LBT Data

Such an extension can be foreseen when all the LBT first-light instruments will be operational. We remark that this will imply a significant amount of coordination with the LBT partners that build the other LBT instruments to define the operational details.

2.2.4 IA² extension and harmonization with current and future archives

As mentioned earlier in this document, the Italian institutes hold currently, or will hold in the near future, a remarkable amount of data which may well be of use for the scientific community at large. These data are, or will be, available through Web sites which use HTML-based interfaces differing from case to case.

It has also been previously said that the basic idea behind the IA² is the implementation of a distributed set of archives which logically constitute a single center. The key issue



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in the implementation of such a structure is the coordination of all involved local data providers to strictly enforce the standards to be used to homogenize the data access.

The plan for subsequent phases of the project, after the TNG LTA has been established and given public accessibility, is to integrate in a VO-like fashion a number of different archives within the common IA² framework, based on the IVOA standards already used for the TNG.

The integration of the following distributed archives in the IA² will be studied and, if possible, implemented:

- 1. the TIRGO archive, located at OAA;
- 2. the surveys of radio images located at IRA;
- 3. the GSCII-DB mirror archive, to be located at OATo;
- 4. the DPOSS and SDSS mirror archives, to be located at University of Naples.

It is to be noted that it is already foreseen to harmonize within a VO-based framework (DRACO) the IA² with the high-energy archives jointly managed by ASDC and some INAF institutes (OAB, OAPa, OARm). This concept could be practically implemented in the framework of a (distributed) center for space data, for which a feasibility study proposal has been submitted recently to ASI for funding. INAF leads this proposal managerially, while ASDC has the technical leadership.

The IA² will also analyze periodically the feasibility of including within its umbrella mirrors of archives implemented with the involvement of Italian scientists. As an example, the possibility of acquiring a mirror of the GALEX archive will be explored.

A key part of the project will be to analyze if and how the archives of solar data can be included in the center. This item is of particular importance, given the cornerstone position the solar community has among INAF and ASI (for SOHO) on one side, EGSO, DRACO and IVOA on the other.

Possibly, also the archives of telescopes located on the Italian territory (Loiano, Ekar, Toppo) could be integrated, together with the archive of digitized photographic plates built as a collaboration of various Institutes and led by the University of Padova. Once again, the feasibility of performing such an integration within the IA² must be verified.

2.2.5 Co-ordination

In order to avoid the IA² to become a simple but practically useless repository of data it is crucial for the IA² to be coordinated with a number of selected national and international activities which will give to the center, and to the stored data, an essential added value for their fruition and for the very survival of the center. In this target the



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data available within the IA^2 will therefore be compatible with the IVOA approach and usable directly inside the DRACO structure.

2.2.5.1 Virtual Observatory activity

Adherence to the standards defined within the IVOA collaboration is an absolute must for any archiving facility, since such standards are rapidly becoming the FITS of the new millennium. In particular, the IA² project needs to adopt the standards defined in the IVOA Working Groups: Data Access Layer, Data Modelling, Grid and Web Services, Resource Metadata and Registry, Standardization Process, Unified Contents Descriptors, VO Query Language and VOTable. Furthermore, to ensure that such standards are useful for the data the IA² is expected to provide in the short-term and long-term future, participation in the above WGs and in the IVOA Executive Committee is necessary.

As a first step, within the IA² software development, it is foreseen to implement the current standard search and access protocols like SCSP (Simple Cone Search Protocol), SIAP (Simple Image Access Protocol), SSAP (Simple Spectra Access Protocol) defined by the Data Access Layer WG, and the VOTable, an XML-based standard used to represent tabular data handling any extension and attachment. The development of the VO Query Language standard will be followed closely, and adopted whenever agreed. The implementation of the Resource Metadata and Registry standards is necessary to publish to the VO environment the data made available by the IA², and so is the Unified Contents Descriptors, needed to allow interoperability with other archives worldwide. The IA² archives will be matched to the Data Model prepared within the IVOA auspices.

To allow the IA² software system to flexibly support the changes that will inevitably occur within the dynamic IVOA environment, a "translation layer" between the IA² archive systems and the VO standards will be built. This mechanism should have the effect of minimizing the effort of software patching whenever a change in the IVOA environment occurs. The "translation layer" solution has been successfully tested by the ESA ISO archive.

2.2.5.2 DRACO - GRID activity

The IA² will coordinate its activity with the DRACO and Grid.it projects. This comes in smoothly and logically, since the IA² plans are to harmonize within a single coordinated framework a number of different data archives geographically distributed. In a sense, it is a sort of strictly coordinated "Italian VO".

The natural extension of this coordination activity within DRACO is the connection to the non-INAF archives, namely to the ASDC archives of high-energy data (including the Observatories of Brera, Palermo and Roma) and in general to the DIANA system. The plan is to be able to work together tightly in order not to duplicate work in interfacing towards the VO.



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At all levels, the VO activity is seen as a set of applications superimposed to a lower level middleware capable of handling geographically-distributed resources. Thus, the extension of the VO to the Grid world has universally been understood to be the way to go. At the Italian level, the integration of applications of astronomical interest within a grid environment has been given attention, and is handled within the FIRB-funded Grid.it (WP 10) project and the proposal recently approved in the Cofin03 framework. This project plans to integrate the TNG archive within the grid (by naturally extending what planned within Grid.it); if this step is successful, the integration of the other archives (sharing the same VO interface) should come in smoothly.

2.2.5.2 GriPho/IGPD activity

In early 2003, a Committee nominated by the 3rd Department of INAF has examined the issues related to the archiving and processing of photometric data. Besides recommending the establishment of a center for astronomical archives (which is taken care of by the INAF Announcement of Opportunity and this proposal), the Committee suggested the creation of an Italian Grid for Photometric Data (GriPho was chosen as the acronym). The main task of the GriPho collaboration is to define a set of processing tools to calibrate photometric data, tailored to the specific instruments built by the Italian community and to the specific scientific applications.

As a result, GriPho shall provide the IA² with tools to perform for data obtained from the supported photometric instruments the basic calibration of observations (i.e. "precalibration"). In other words, the software capable of removing instrumental signatures will be provided, so to allow the IA² to be able of supporting a "standard" level of calibration.

2.2.5.3 ASDC and high energy data

Another important coordination activity will occur with the archives of high-energy data located at the ASDC and including the Observatories of Brera, Palermo and Roma partners in the DIANA system. This coordination effort will be performed within the DRACO project and the Virtual Observatory framework, to optimize the integration and avoid duplication of work.

2.2.5.4 Solar data

Solar observations, covering a broad range of wavelengths, atmospheric heights, and observational techniques are by their nature quite heterogeneous. The EGSO combines groups from across Europe involved in science and information technologies with the objective of creating an accessible federated solar data archive. The effort to federate the European resources in solar physics have to go towards the European VO/Grid framework with a links to the USA counterpart to the EGSO, the Virtual Solar



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Observatory (VSO) , in order to explore and create new and powerful applications for researchers from Europe and around the world.

2.2.5.5 Data mining activities

A large number of data mining and knowledge discovery tasks can be performed in the IA² archives. To do so, a proper software system shall be available for use within the "distributed center" IA² will support.

The AstroMining software (Longo et al. 2001) is a package written in the MatLab © environment to perform a large number of data mining and knowledge discovery tasks, both supervised and unsupervised, in large multiparametric astronomical datasets. The package relies also on the Matlab © "Neural Network", the "SOM" (Vesanto 1997) and the "Netlab" (Nabney and Bishop 1998) toolboxes.

AstroMining accepts as input any ASCII table containing a header describing the contents of each column and then a set of parameters. Via interactive interfaces, it is possible to perform a large number of operations:

- i) manipulation of the input data sets;
- ii) selection of relevant parameters;
- iii) selection of the type of neural architecture;
- iv) selection of the training validation and test sets construction procedure;
- v) etc.

The package is completed by a large set of visualization and statistical tools which allow to estimate the reliability of the results and the performances of the network. The user friendliness and the generality of the package allow both a wide range of applications and the easy execution of experiments (more details on other aspects of the AstroMining tool which are not relevant to the present work may be found in Tagliaferri et al. 2002).

It is to be noted that this system is planned to be ported on a grid environment in the framework of the project financed by Cofin03. Its inclusion in the IA² is planned.

Data mining is essential to most if not all the activities described above. The IA² will therefore provide the community with all those tools which are needed to monitor the quality of the raw and calibration data and of the extracted catalogues

2.2.5.6 Astrophysical visualization tools

The focus will be the development of an "interface" to interact with huge, distributed dataset. The important and "new" elements are both "huge", since both observations and simulations are producing an unprecedented amount of data, and "distributed", which



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means find out and collect data and information spread all over the world in a way completely transparent to the user. In this sense, the tool would represent the interface to a Virtual Observatory framework.

The starting point will be AstroMD. AstroMD is a software of visualization and analysis of astrophysical data developed in the EU funded Cosmo.Lab project (5th framework, ends on november 2003).

AstroMD is particularly suitable to this purpose because it is designed for astrophysics; it supports standard data formats (FITS, HDF, Tipsy) and visualization techniques specific for astrophysical data; it allows already to interact with standard DBMS (mySql) but can be easily integrated with ORACLE; it is completely open source; it works both on Linux and MS Windows platforms; its kernel is written in standard, high-performance language (C++); it allows also to present data and results for educational purposes.

AstroMD will be Grid enabled such that it can interact with distributed dataset in a way completely transparent to the user, exploiting the up-to-date technology (based on Globus, Unicore). This will be done in several steps until the end of the project.

The working program could be:

- Web-enable AstroMD via Java or C++ implementation of the GUI
- Integrate AstroMD with standard DBMS systems
- Integrate AstroMD with the Grid environment
- Support of the basic VO standards (VOTable, SIAP, etc, and link with IVOA)
- Develop all the visualization and analysis functionalities which are priority for the project (any tool)
- improve the performance and the efficiency of the software in order to handle large dataset (any tool)
- Test the software

2.2.5.7 Public Outreach

Coordination with the INAF project "Stelle di Carta" is strongly suggested due the importance that the Public Outreach has on the scientific environment. Unfortunately no contact person or responsible is now present within the IA² project, but the IA² intends to find a contact person during its initial phase.



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2.3 Priorities and Planning

To realize the IA² and make use of the experience present in the proponent group, whose principal part has already realized the TNG-LTA pilot project, and some hardware used for that project are already present on the site and usable, the first year of life of the IA² can be divided in three principal portions:

- 1. Study phase where the TNG-LTA prototype system will be study and updated the new international standards:
- 2. Implementation phase of the international standards and tools that allows the interface with both VO and Grid system;
- 3. Operation phase.

2.4 Documentation

2.4.1 Documents

Initially, the basic documents issued at previous stages (User Requirements [x], Architectural Design Document [x], Data Model [x] and Interface Control Document [x]) will be considered valid for the TNG LTA. DM and ICD will be revised with the CGG and co-signed. During the project a User Manual will be written, and after the testing phase a Test Report will be produced as well.

After the first release of the TNG LTA is made available and tested, a cycle of evaluation and revision of the requirements will be performed analyzing the inputs of the testers with the help of the Steering Group. New IA² User Requirements will be produced, followed by a IA² Architectural Design Document and User Manual.

Whenever a new data provider is added to the system, the Data Model document will be revised and a dedicated ICD will be issued.

2.4.2 Documentation policies

Documents identifiers will have the following labelling: IA²-XXX-DDD-NNN, where:

- XXX is the institute producing the document, extracted from table 1;
- DD is the type of document, extracted from table 2;
- NNN is a three-digit number.

Code	Institute
ASDC	ASI Science Data Centre
CGG	Centro Galileo Galilei
IRA	INAF - Istituto di Radioastronomia



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OAA	INAF - Osservatorio Astrofisico di Arcetri
OAB	INAF - Osservatorio Astronomico di Brera
OABo	INAF - Osservatorio Astronomico di Bologna
OAC	INAF - Osservatorio Astronomico di Capodimonte
OACt	INAF - Osservatorio Astrofisico di Catania
OAPa	INAF - Osservatorio Astronomico di Palermo
OAPd	INAF - Osservatorio Astronomico di Padova
OARm	INAF - Osservatorio Astronomico di Roma
OATo	INAF - Osservatorio Astronomico di Torino
OATs	INAF - Osservatorio Astronomico di Trieste
UniNa	Università di Napoli "Federico II"

Table 1 - List of Institutes and corresponding codes.

Code	Type of document
AD	Architectural Design Document
ME	Memo
MM	Minutes of Meeting
PL	Plan
RF	Request for funding
RP	Report
SR	Software Requirements Document
TN	Technical Note
UR	Users Requirements Document

Table 2 - Types of documents and corresponding codes.

To be valid, documents need to be signed by the document producer and by the project PI. Documents (in PDF format) will be digitally signed using the Adobe Acrobat facility.

Documents will be issued and kept under configuration by the coordination Institute.



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3. Work Packages

3.1 Workpackage Breakdown Structure

In the figure below, the workpackage breakdown structure (WBS) is shown in graphical form. Only higher-level workpackages (WPs) are shown; a further level of detail can be defined by WP responsibles. WPs are described in detail in the following section.

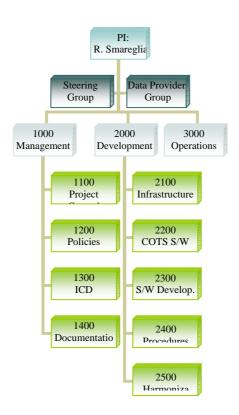


Figure 2 - IA² project workpackage breakdown structure (Ist Part).



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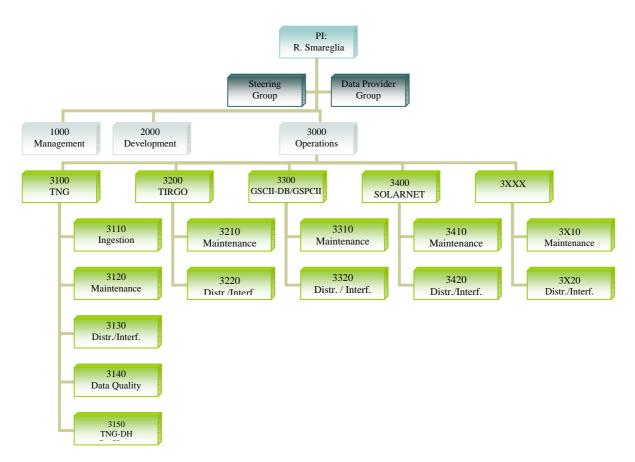


Figure 3 - IA² project workpackage breakdown structure(2th Part).

3.2 Workpackage Description

In the following, the workpackages shown in graphical form in figure 2 are described in detail. For every WP, the following information is given: WP title and reference number, starting and ending events and dates, responsible, inputs, outputs and tasks to be carried out. Only higher-level WPs are described; a further level of detail can be defined by WP responsibles.



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Programme:	"Ce	"Center for Astronomical Archives"			date:	2003-11-10	
WP Title:	Proj	Project control and management		WP Re	ef.:	<i>ef.:</i> 11	
Start Event:	Kicl	c-off meeting	Sched	uled D	ate:		t_0
End Event:	End	of project	Sched	uled D	ate:		
WP Responsi	ble:	R .Smareglia - INAF/OATs	•		Shee	t:	1 of 1
Inputs: Tasks:	•	Authorization Contract Organization and scheduling Definition of detailed objectives Resources organization Organization of meetings Control of activity progress					
Outputs:	•	Verification of open issues Management documentation Memos Progress reports Minutes of meetings					



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Programme:	"Ce	"Center for Astronomical Archives"			Issue date:		3-11-10	
WP Title:	P Title: Definition and implementation of archive policies		WP Ref		WP Ref.:			
Start Event:	Kic	Kick-off meeting Schedul					t_0	
End Event:	End	of project	Sched	uled De	ate:			
WP Responsi	Responsible: F. Pasian - INAF/OATs St		Shee	et:	1 of 1			
Inputs:	•	 Data providers' policies INAF policies on data access Coordination meetings IA² Response (LBC?LBT archive suggestions) 						
Tasks:	•	Prepare IA ² policies for data ingestion Prepare IA ² policies for data access Coordination with INAF and LBT Consideration and maintain IA ² policies		ion				
Outputs:	•	IA ² policies for data ingestion IA ² policies for data access Agreement about LBC and/or LBT at	rchive					



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Programme:	Programme: "Center for Astronomical Archives"		Issue date:		2003-11-1		
WP Title:	ttle: Interfaces with Data Provider - ICDs		WP Ref.:			1300	
Start Event:	Kicl	x-off meeting	Sched	luled Date:		t_0	
End Event:	End	End of project Schedu		uled Date:			
WP Responsi	sponsible: F. Pasian - INAF/OATs		Shee	et:	1 of 1		
Inputs:	 IA² policies Coordination meetings 						
Tasks:	 Development of ICDs Co-ordination with external IA² activities 						
Outputs:	•	IA ² ICD documents IA ² agreement with Data Provider					



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Programme:	ogramme: "Center for Astronomical Archives"		Issue d	date:	200	3-11-10	
WP Title:	e: Project documentation			WP Ref.:		1400	
Start Event:	Kicl	Kick-off meeting		luled Date:		t_0	
End Event:	End	End of project Scheduled Date:		ate:	te:		
WP Responsible:		$TBN - IA^2$	She		Shee	et:	1 of 1
Inputs:	•	Management Documentation			•	,	
Tasks:	•	Define Standard Documentation Twiki Installation					
Outputs:	•	Standard Documentation Format Documentation Policies					



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Programme:	"Ce	'Center for Astronomical Archives"				3-11-10	
WP Title:	Har	Iardware and network infrastructure WP Ref.:			2100		
Start Event:	Kicl	x-off meeting	Sched	uled Do	ate:		t_0
End Event:	End	End of project Schedul			ate:		
WP Responsible: C. Vuerli - INAF/OATs					Shee	et:	1 of 1
Inputs:	•	 IA² Response document INAF Services List 					
Tasks:	 Hardware evaluation Hardware acquisition Contact with GARR services 						
Outputs:	Hardware maintenance Network maintenance						



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Programme:	"Ce	"Center for Astronomical Archives"				3-11-10	
WP Title:	CO	COTS and public domain software WP Ref.			ef.:		2200
Start Event:	Kicl	x-off meeting	Sched	uled Do	ate:		t_0
End Event:	End	End of project Scheduled D			ate:		
WP Responsible: TBN - INAF				Shee	rt:	1 of 1	
Inputs:	•	 IA² Response document Kick-off meeting 					
Tasks:	•	Software evaluationTesting software					
Outputs:	Software maintenanceCOTS Licence acquisition and maintenance						



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Programme:	"Ce	"Center for Astronomical Archives"					3-11-10
WP Title:	Soft	oftware development and integration WP Ref.:					2300
Start Event:	Kic	k-off meeting	Sched	uled D	ate:		t_0
End Event:	End	of project	Sched	uled D	ate:		
WP Responsi	ble:	R. Smareglia - INAF/OATs			Shee	et:	1 of 1
Inputs:	•	 Astronomical Community Requirements IVOA and GRID frameworks Interoperability of distributed archives IA² Response document IA² COTS suggestion 					
Tasks:	•	 Development and implementation of Web User Interface Development and Implementation of services for the IVOA and Grid frameworks Testing Documentation and user tutorial 					
Outputs:	•	 Web User interfaces Applications and Services for IVOA and Grid complaints Documentation 					



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Programme:	"Ce	"Center for Astronomical Archives"					3-11-10
WP Title:	Proc	cedures		WP Re			2400
Start Event:	Kicl	x-off meeting	Sched	uled Do	ate:		t_0
End Event:	End	End of project Scheduled			ate:		
WP Responsible: A. Zacchei - INAF/OATs					Shee	et:	1 of 1
Inputs:	•	 Data Providers' policies Astronomical Community Requirements IVOA and GRID frameworks GriPho frameworks 					
Tasks:	•	S/W Procedures for on-the-fly calibration					
Outputs:	•	Documentation					



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Programme:	"Ce	"Center for Astronomical Archives"				'Center for Astronomical Archives" Issue de		date:	200	3-11-10
WP Title:	Har	Harmonization WP Ref.:			2500					
Start Event:	Kicl	x-off meeting	Sched	uled Do	ate:		t_0			
End Event:	End	of project	Sched	luled Do	ate:					
WP Responsi	ble:	le: R. Smareglia - INAF			Shee	t:	1 of 1			
Inputs:	•	 Astronomical Community Requirements IVOA and GRID frameworks 								
Tasks:	 Harmonization of different Web User Interface Harmonization of services for the IVOA and Grid frameworks Testing Documentation and user tutorial 									
Outputs:	•	Applications and Services for IVOA a Documentation	nd Gri	d comp	laints	}				



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Programme:	"Ce	'Center for Astronomical Archives" Issue date: 2003					3-11-10
WP Title:	TNO	TNG (management) WP Ref.:			3100		
Start Event:	Kic	k-off meeting	Sched	uled Do	ate:		t_0
End Event:	End	of project	Sched	uled Do	ate:		
WP Responsi	ble: R.Smareglia - INAF/OATs				Shee	t:	1 of 1
Inputs: Tasks:	•	S/W development					
Tasks:	 Distribution and Interface Maintenance Data Quality 						
Outputs:	•	Documentation Data distribution					



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Programme:	"Cen	"Center for Astronomical Archives"			date:	200	3-11-10
WP Title:	TNC	G: Data Ingestion		WP Re	ef.:		3110
Start Event:	Kick	Kick-off meeting		luled Date:		t_0	
End Event:	End	End of project Schedu			ate:		
WP Responsible: TBN – INAF/IA ²					Shee	t:	1 of 1
Inputs:	•	IA ² Requirement ICD Requirement S/W development					
Tasks:	 Scientific Data Ingestion Housekeeping Data Ingestion 						
Outputs:	•	Documentation	•				



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WP Title:	TNG	: Maintenance		WP Ref.:			3120
Start Event:	Kick-	-off meeting	Sched	uled Do	ate:		t_0
End Event:	End o	End of project Sch			ate:		
WP Responsible: TBN – INAF/IA ²					Shee	et:	1 of 1
Inputs: Tasks:	 IA² Requirement ICD Requirement H/W development S/W development H/W installation and upgrade 						
Outputs:		S/W installation and upgrade Documentation					



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Programme:	"Center for Astronomical Archives"			Issue date:		: 2003-11-			
WP Title:	TNG: Distribution and Interface WP R			WP Re	WP Ref.:		3130		
Start Event:	Kic	k-off meeting	Schea	luled D	ate:		t_0		
End Event:	End	of project	Schea	luled D	ate:				
WP Responsi	ble: TBN – INAF/IA ²				Shee	et:	1 of 1		
Inputs:	•	 Astronomical Community Requirements IVOA and GRID frameworks IA² Requirements 							
Tasks:	•	Development and implementation of Development and Implementation of frameworks				OA a	and Grid		
Outputs:	•	Web User interfaces Applications and Services for IVOA Documentation and user tutorial Data distribution	and Gri	id comp	olaints	3			



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WP Title:	TNO	TNG: Data Quality			ef.:	3140	
Start Event:	Kicl	x-off meeting	Scheduled Date:		t_0		
End Event:	End	of project	Sched	duled Date:			
WP Responsible:		A. Zacchei – INAF/OATs			Shee	et:	1 of 1
Inputs:	•	TNG expertise Data Mining Expertise					
Tasks: Outputs:	•	S/W development Documentation Request to IA ²					



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WP Title:	Opt	imization and Harmonization of TNG	- DH	WP R	ef.:		3150	
Start Event:	Kic	k-off meeting	Sched	uled D	ate:		t_0	
End Event:	End	of project	Sched	uled D	ate:			
WP Responsi	P Responsible: T. Oliva – INAF/CGG				Shee	eet: 1 of		
Inputs: Tasks:	•	Data Providers' policies TNG-AaT expertise TNG-LTA expertise Prepare New TNG-AaT ADD						
Tasks:	•	Implement and Install New TNG-Aa	Γ					
Outputs:	•	Documentation						
Note	pu	least 3 mm of the IA ² staffs will be we rpose. All the transfer costs to/from Tay G bugget	_					



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Programme:	: "Center for Astronomical Archives"			Issue date:		2003-11-10	
WP Title:	VP Title: Tirgo (Management)			WP Ref.:		320	
Start Event:	Kic	Kick-off meeting Schedu			ate:	t_0	
End Event:	End of project Scheduled Date			led Date:			
WP Responsible: C. Baffa – INAF/OAA				Shee		et:	1 of 1
Inputs:	•	Management Interface S/W development Interface development definition					
Tasks:	7						
Outputs:	•	Documentation					



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Programme:	mme: "Center for Astronomical Archives"			Issue date:		200	3-11-10		
WP Title:	GSO	CII – DB / GSPCII (Management)		WP Ref.:		ef.: 3			
Start Event:	Kicl	x-off meeting	Sched	uled D	ate:	t			
End Event:	End	of project	Sched	Scheduled Date:			duled Date:		
WP Responsi	WP Responsible: Alessandro Spagna – INAF/OATo		Shee		et:	1 of 1			
Inputs:	•	Management Interface S/W development Interface development definition							
Tasks:	71 11 1 17 0 7 1								
Outputs:	•	Documentation Data distribution (user oriented)							



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Programme:	c: "Center for Astronomical Archives"			Issue date:		2003-11-10	
WP Title:	GSC	CII – DB / GSPCII (Maintenance)		WP Ref.:		3310	
Start Event:	Kicl	x-off meeting	Sched	uled Do	ate:		t_0
End Event:	End	of project	Sched	Scheduled Date:			
WP Responsib	WP Responsible: R. Morbidelli – INAF/OATo				Shee	et: 1 of	
Inputs:	•	Request from scientific community o Investigation about anomalous data re Scientific Images archive		•	SCII e	expo	rt like)
Tasks:		122	list of	obio etc			
Outputs:	•	Generation of particular astronomical Quality Assurance and Quality check Retrieve particular scientific images		3	B inco	onsis	stencies



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Programme:	"Center for Astronomical Archives"			Issue date:		2003-11-10	
WP Title:		DB / GSPCII (Distribution and Implementation)		WP Ref.:		3320	
Start Event:	Kick-off	meeting	Sched	uled D	ate:		t_0
End Event:	End of pr	roject	Sched	luled Do	ate:		
WP Responsi	ble: Cos	imo Antonio Volpicelli - INAF/0	ОАТо		Shee	et:	1 of 1
Inputs: Tasks:	 IVO. Inter IA² I Deve Deve fram Testi 	conomical Community Requirement A and GRID frameworks operability of distributed archive Requirements elopment and implementation of elopment and Implementation of eworks ing	es Web U			OA a	and Grid
Outputs:	WebApplDocu	User interfaces lications and Services for IVOA amentation distribution	and Gri	d comp	laints	3	



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Programme:	"Center for Astronomical Archives"			date:	: 2003-11-1			
WP Title:	SOLARNET (Management)		WP Re	ef.:		3400		
Start Event:	Kick-off meeting	Kick-off meeting Scheduled Date:				t_0		
End Event:	End of project	Sched	uled Do	ate:				
WP Responsib	ble: Mauro Messerotti – INAF/OATs	•		Shee	t:	1 of 1		
Inputs:	S/W developmentInterface development definition	Interface development definition Interoperability of distributed archives (SOLAR(1), SOLRA(2),						
Tasks:	 Organization of Meetings Control of activity progress Distribution and Interface Implementa Maintenance 	tion						
Outputs:	DocumentationApplications and Services for VO/EG	SO(4)						
Note	(1) Responsible : E. Antonucci (2) Responsible : M. Messerotti (3) Responsible : G. Severino (4) Coordinator : E. Antonucci, Dep		I. Mess	erotti				



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Programme:	"Center for Astronomical Archives"		Issue d	date:	ate: 2003-11					
WP Title:	SOLARNET (Maintenance)		LARNET (Maintenance) WP		ef.:		3410			
Start Event:	Kicl	Kick-off meeting Sched			ick-off meeting Schedule		uled Do	ate:		t_0
End Event:	End	of project	Sched	Scheduled Date:						
WP Responsi	onsible: A.Cora - INAF/OATo Sheet:		t:	: 1 of 1						
Inputs:	 Requirements by community IA² policy requirements 									
Tasks:	•	Hardware/Software maintenance and DBs administration and Data Integrit DB performances and optimizations Backup/Restore Web Users support Data Analysis software maintenance	ty checl							
Outputs:	•	Documentation Backup/Restore procedure and police								



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Programme:	"Center for Astronomical Archives"		Issue date:		2003-11-10	
WP Title:	SOLARNET (Distribution and Interface WP Ref.: Implementation)		n and Interface WP Ref.:		3420	
Start Event:	Kick-off meeting	Sched	eduled Date:		t_0	
End Event:	End of project		duled Date:			
WP Responsi	ble: Cosimo Antonio Volpicelli - INAF/O	ATo	S	Shee	t:	1 of 1
 Inputs: Astronomical Community Requirements IVOA and GRID frameworks (VSO/EGSO) Interoperability of distributed archives IA² Requirements Tasks: Development and implementation of Web User Interface Development and Implementation of services for the IVOA and Grid (EGSO) frameworks Testing 						
Outputs:	 Documentation and user tutorial Web User interfaces Applications and Services IVOA at Documentation Data distribution 	nd Grid	l (EGSO)) co	mplair	nts



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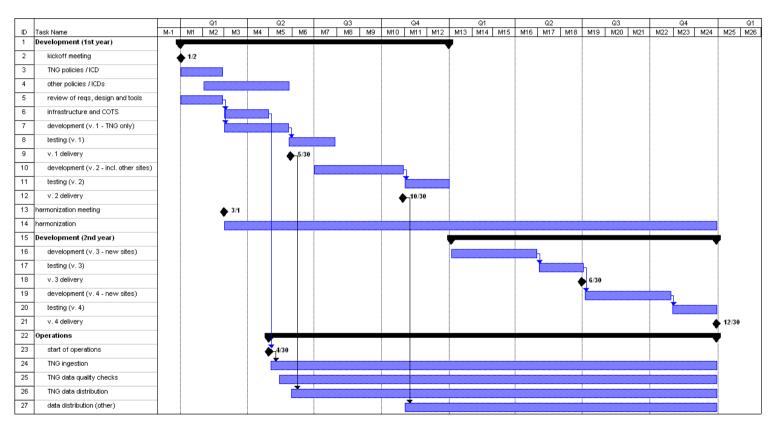
3.3 Schedule (first year)

In figure 4, the schedule of the project is shown in the form of a Gantt diagram. Only WPs related to development have a precise ending date; operations WPs are assumed to continue after the end of the project's first year. For the subsequent years, development of further versions of the system are foreseen. For the second year, in version 3 the development of visualization and data mining applications is foreseen, in version 4 the building up of new applications using the grid paradigm, besides for each version the integration of new Data Providers. New versions of the system will be built in the following years.

The funding cap respected by this proposal (140 K \oplus) is assumed to cover the first year of development and operations of the center.



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*Figure 4 - IA*² *project schedule (first year).*



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4. Institutions and Staff

4.1 Manpower and Work Breakdown

Institute	Team	Position	Responsibility	mm
INAF - OATs	Riccardo Smareglia	Astr. researcher	PI	6
	Mauro Messerotti	Astr. researcher	Coord. SolarNet	2
	Fabio Pasian	Full Astr.	Policies and ICDs	2
	Claudio Vuerli	Astr. researcher	Infrastructure	2
	Andrea Zacchei	Astr. researcher	Procedures	2
	Maurizio Comari	Labs. Responsible	Sw. Development	1
	Igor Coretti	Technician	Sw. Procedures	1
	TBN1	Contractor	Sw. Development	11
	TBN2	Contractor	Procedures Dev.	11
INAF – OAA	Carlo Baffa	Astr. Researcher	Loc. Contact point	2
	Filippo Mannucci	Astr. researcher	Data Processing	1
	Kevin Reardon	Archive Scientist	Arch. Design	1
INAF – OAB	Stefano Andreon	Astr. Researcher	Requirements	1
INAF – OAC	Aniello Grado	Astr. Researcher	Loc. Contact point	2
	Giulio Capasso	Technician		2
	Juan Alcalà	Astr. researcher		2
INAF – OACt	Ugo Becciani	Astr. Researcher	Loc. Contact point	2
INAF – OARm	Adriano Fontana	Astr. Researcher	Loc. Contact point	2
INAF – CGG	Ernesto Oliva	Assoc. Astr.	Loc. Contact point	1
	Marcello Lodi	Contractor		1
INAF - OATo	Alessandro Spagna	Astr. Researcher	Loc.Contact GSC2	2
	Mario Gilberto Lattanzi	Assoc Astr.	Data Quality	2
	Beatrice Bucciarelli	Astr. Researcher	Data Quality	2



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	Renato Pannunzio	Astr. Researcher	Data Quality	2
	Roberto Morbidelli	Senior Scientist	DB Maintenance	3
	Richard Smart	Senior Scientist	Data Quality	2
	Alberto Vecchiato	Post Doc.	S/W development	1
	Cosimo A Volpicelli	Computer Scientist	Interf. Dev., DBs, VO/Grid/Objectivit	11
	Ester Antonucci	Full Astronomer	Loc.Contact	
	Silvio Giordano	Astr. Researcher		
	Alberto Cora			
	Carlo Benna	Senior Scientist		
INAF – IRA	Mauro Nanni	I Researcher	Loc. Contact point	2
UniNa	Giuseppe Longo	Ass. Professor	Loc. Contact point	3
	Ciro Donalek	Ph. D. student		3
	Mauro Sereno	Fellow		3



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4.2 Experiences and competence in the group

In the following short CVs are included, referring to the scientists involved in the project. They contain the essential information aiming at defining the expertise each person will bring to the project through his/her participation.

Riccardo Smareglia – In 1990 contract with ESA/VILSPA for the porting of the user interface of the ULDA/*IUE* archive under Unix and TCP/IP. From 1994 to 2000 he has developed the Archives at the *TNG* telescope, and was responsible for their integration. He was the Proget Manager of the TNG-LTA prototype project. He is also the Responsible for the design and implementation of the data handling and archiving system for the Large Binocular Camera at the *LBT*, and is involved in the development of the Data Processing Centre for the Low Frequency Instrument of the ESA *Planck* mission. He is involved in the some of the interoperability working groups of the IVOA.

Ester Antonucci – She has been Professore Incaricato from 1976 to 1983 and Professore Associato from 1983 to 1995 at the University of Torino.In 1995 she became Astronomo Straordinario at the Observatory of Torino. She visited for extended periods Stanford University (US), the Rutherford Laboratory (UK) and the Goddard Space Flight Center, NASA (US).Her main fields of research are cosmic rays, solar physics and space solar physics. She has been Deputy Principal Investigator of the Soft X-ray Polychromator of Ultraviolet Coronagraph Spectrometer onboard SOHO (ESA/NASA) and Principal Investigator of SPECTRE, an instrument of the Solar Dynamics Observatory, NASA. She has been a member of the Solar System Working Group of the European Space Agency. She has been part of the Editorial Borad of Solar Physics, and Topical Editor of Annales of Geophysicae. She is vice-chairman of the Commission on Astrophysics of the Committee on Space Research (COSPAR) and member of the International Academy of Astronautics. She is author of more than 150 publications and editor of three volumes of Advances in Space Research. Coordinator of the INAF working groups participating in EGSO.

Carlo Baffa - is the coordinator of the Tirgo Data Archive team.

Ugo Becciani – From 1988 to 1999 Head of the OACt Computer Center. From 1990 to 1996 he was responsible of the working group for the Phase A study of the On Board scientific computer for the Spectrum Ultra Violet mission (*SUV*). Since 1993 he has been involved in the development of codes using massively parallel systems. Since 2000 he is the PI for a project of data analysis, visualization and educational aspects using Virtual Reality techniques, recently funded by the CNAA.

Carlo Benna Since 1997 permanent research position at the Astronomical Observatory of Torino (OATo). Since 1992 involved in the Ultraviolet Coronagraph Spectrometer (UVCS) for the Solar and Heliospheric Observatory at the Harvard-Smithsonian (SOHO) project. In 1993-1994 External ESA fellow Astrophysical Observatory (SAO), in 1993-1994, 1996, 1997 Smithsonian



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Institution `Visiting Scientist' at SAO, in 1996-1997 Consorzio Interuniversitario Fisica Spaziale (CIFS) fellow at University of Torino. the The main research activity of the fellowship was related to the UVCS/SOHO project with the design and development of the UVCS 'Data Analysis and processing Basic Software (DAS)' and to the NASA Spartan 201-1/Spartan 201-2 satellites flight scientific data analysis. The main research fields at the software testing and OATo have concerned the study of the profiles and intensities of UV, EUV and lines in physics, with particular interest in solar dynamical properties of the solar corona and chromosphere and and coronal flare plasma, space-based solar observations, data reduction and data analysis.

Beatrice Bucciarelli – B. Bucciarelli is currently Research Astronomer at the Osservatorio Astronomico di Torino. She is an expert in large field astrometry with Schmidt telescopes; for the past several years she has been coordinating the realization of the an all-sky catalogue of CCD photometric sequences used in the calibration of GSC-II. In the field of space astrometry, she is involved in the study of the relativistc, numerical and statistical properties of an astro – geodetic network at the micro-arcsecond level accuracy, as will be realized by the ESA satellite GAIA. She is responsible for the Torino Observatory of a 2-year project dealing with the digitization and scientific exploitation of the plate archives of the Italian Astronomical Observatories.

Maurizio Comari - Head of the laboratories of OATs. Project and construction of radioreceivers and electronic equipments for the Trieste Solar Radio System (*TSRS*); interfacing of these instumentations to microprocessor control systems with design and development of the controlling software. Design and development of systems for realtime data acquisition, compression and storage of solar radio events detected by the *TSRS*. Design and development of programs for data reduction, visualization, selection and archiving of solar radio events recorded by the data acquisition system.

Alberto Cora - He worked in Aeritalia (now Alenia) from 1985 to 1989 at the integrated logistic support of the weapon system AMX and Eurofighter. He has been working since 1989 at the Astronomical Observatory of Torino (OATo). He was involved to support and maintenance of the UBVRI Photo-polarimeter; from 1996 he is in the local Solar Physics Group participating to the measurement campaigns with the UltraViolet Coronagraph Spectrometer on board of the SOHO. From 1999 to 2001, in collaboration with GSFC and MEDOC Institut d'Astrophysique Spatiale IAS, has implemented the SOho Long-term Archive (SOLAR) and the related WEB site at the OATo. Since 2001 he is the Technician Responsible and Data Base Administrator of SOLAR. He collaborates to the development of the SOLAR Network (SOLARNET) and he is a member of the EGSO Team.

Igor Coretti – Staff technician of the OATs Electronic Lab, he has been participating in the development of the SOLar Radio Archive (SOLRA) since 2001. In particular, he has been involved in the design and specification of the database structure, in the development of the procedures for data transformation and ingestion under MicrosoftSQL. Recently he carried out the development of the archiving automation procedures for real-time data ingestion and indexing. He is also responsible for the setup and maintenance of the machines involved in data



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archiving and publishing. Previous working experiences include embedded systems programming and network planning / addministration in the telecom industry branch.

Adriano Fontana – Researcher at OAR, working in the field of observational cosmology. A distinctive feature of his activity in these years is the development of original software, aimed at coping with the large flow of data coming from the surveys in which he is involved. In 1995 he develops a pipeline for the reduction of *NTT*-EMMI echelle data coming from an ESO key project. In 1996 contract for *ESO* for developing FITLYMAN, a Midas package for the analysis of echelle spectra. In 1998-2000 at OAR, develops an automated pipeline for the reduction of deep imaging data within the SUSI2 project. Since 1997 he is a member of the Project Office of *LBT* Large Binocular Camera project, of which he is also responsible for the Data Reduction Systems and Calibration Procedures.

Silvio Giordano – Researcher at OATo, he is working in the field of solar physics, with particular interest in solar observation from space-based instruments, data reduction and data analysis. Since 1993 he has been involved in the Ultraviolet Coronagraph Spectrometer (*UVCS*) for the Solar and Heliospheric Observatory (*SOHO*), working in the design and implementation of the Data Processing and Analysis Software for UVCS. He developed the procedures to reconstruct the 2D images of solar corona from spectral data obtained by UVCS. He is involved in the development of the *SOLAR* archive (SOHO Long Term ARchive) and he is in the team of the European Grid of Solar Observations (*EGSO*), funded by the European Commission, in particular in the EGSO project he is working on the science requirements and in the definition of the solar data model to created a generalized catalogue of solar observations.

Aniello Grado - From 1999 to 2000 Visiting Astronomer at ESO to start the **BEOWFI** projects to develop a photometric pipeline for WFI images running on a beowulf cluster. In 2001 he became task leader of WP4 (processing) and WP5 (archiving) of the **AstroWise** consortium. His main activity is focused on design and implementation of pipeline running on distributed platform to process CCD mosaic images.

Mario G. Lattanzi. ESA Associate Astronomer at ST ScI, 1989-1995; Senior Research Astronomer at the Osservatorio Astronomico di Torino, 1990-2002; Associate Astronomer at the same Observatory since 2003, and Lecturer in Fundamental Astronomy for the University of Turin since the academic year 2002-2003. Member of the HIPPARCOS FAST team, responsible for developing and implementing the software for the FAST Sphere Adjustment, and member of the HIPPARCOS FAST Committee for the early evaluation of the results of the Hipparcos mission (1985-1996). Instrument Scientist at the ST ScI, responsible for the design and implementation, in collaboration with B. Bucciarelli and L.G. Taff, of the complete pipeline (from the telemetry stream to the derivation of calibrated astrophysical measurements) for the scientific exploitation of interferometric data from the Astrometer FGS aboard the HST (1989-1995). ST ScI consultant for the scientific exploitation of the interferometric mode of the astrometer Fine Guidance Sensor on HST (1995-1997). Italian Project Scientist for the Italian CRA of the Guide-Star-Catalog-II project, the largest all-sky data base at optical wavelengths to date (1995-2002). Member of the ESA Science Advisory Group for the study of the GAIA mission (since 1997). His main research interests are: structure and evolution of open clusters



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and star-formation regions; structure, kinematics, and age of the thin and thick discs, and of the halo of the Milky Way; methods and strategies for the construction of large science-quality Data Bases in astronomy, with emphasis on data generation, including calibrations and QA, and DB operations for production.

Giuseppe Longo – Associate Professor at the University of Napoli Federico II. Research Associate to the INFN for the GRID project. Italian detegate in the COST-Action 283 "Computational Infrastructures in the Astronomical Data GRID". Co-PI of the *CRoNaRio* (Caltech Rome Naples and Rio) project aimed at the production of the Palomar Norris Sky Catalogue (DPOSS); local PI of the MURST COFIN'2000 on "New Tools for *Data Mining*". Long-lasting involvement in projects aimed at the development and implementation of artificial intelligence tools for astronomical data reduction.

Filippo Mannucci - is the supervisor of the TIRGO telescope and the author of the SNAP program.

Mauro Messerotti – Scientific manager of the Trieste Solar Radio System (*TSRS*). Chairman of Working Group 3 (Software Development and Data Handling) of the Joint Organization for Solar Observations (*JOSO*). Scientific responsible for the development of the Trieste SOLar Radio Archive (*SOLRA*), part of a national project co-financed by MURST for the development of the SOLAR NETwork (*SOLARNET*), a system of interoperating solar data archives in Italy (SOLAR, SOLRA, ARTHEMIS). Deputy Coordinator of the INAF working groups participating in EGSO.

Roberto Morbidelli – From 1981 with the Astronomical Observatory of Torino. Integration and design of astronomical database. From 1983 to 1991 involved in Catalogue management and data processing pipeline for the double stars task in the Hipparcos Space Mission. From 1987 to 1992 member of the Astronet DIRA s/w team for the access to astrometric catalogs set available at OATo. From 1990 to 1994 Ingestion of GSCI in DIRA and data distribution to the Italian Astronomical community. From 1994 to 2002 Work on the Quality Assurance task for the GSCII Project and collaboration with Commissioning TNG team for production of a catalog for telescope operations. From 2001 responsible for the Scientific GSCII Data Archive in OATo and Associate member of GAIA Space mission (double stars and exstrasolar planets WGs).

Mauro Nanni – Coordinator of the *Astronet* Databases Working Group since 1987, he has developed the DIRA (Distributed Information Retrieval from Astronomical files), a database system to manage Astronomical Catalogues. He has specific responsibilities for the Astronomical Virtual Observatory (*AVO*), a project supported by Comitato Nazionale per la Scienza e le Tecnologie dell'informazione of the National Council of Research (C.N.R.) in Italy.

Renato Pannunzio – has started his activity in OATo since 1973 working for about 10 years in the field of the photographic observations of visual double stars. Successively has been engaged in the Data Analysis of the signal coming from the Double Stars observed by the Hipparcos satellite and in the realization of the Catalog of these double/multiple objects. In these last ten years has been occupied in the realization of the GSC2 Catalog from the point of view of the



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Quality Assurance of the Catalog, while at present is occupied in the simulation of the signal of the possible extrasolar planets that will be observed by the next astrometric mission GAIA.

Fabio Pasian – In 1987-88 involved in the development of the ULDA archive for the *IUE* space mission; from 1989 to 1992, at the ST-ECF/ESO as Senior Archive Scientist, leader of the team responsible for the design, development, maintenance and management of the European Archive for the *HST* mission; from 1990 to 1993 chairman of a WG in charge of evaluating ESA's European Space Information System (*ESIS*); from 1994 to 2000 PI for the Archives at the *TNG* telescope, with responsibility for their design and implementation. Currently, Planck/LFI co-I and Data Processing Manager, with the responsibility for the design and development of the distributed Data Processing Centre for the Low Frequency Instrument of the ESA *Planck* mission. INAF contact point for Virtual Observatory activities. Member of the European FITS Committee (since 1986), of the Task Group on Virtual Observatories, Data Centres and Networks of IAU Commission no. 5, and of the International Virtual Observatory Alliance Executive Committee.

Alessandro Spagna – In 1989-1997: member of the FAST consortium and the data reduction of the astrometric satellite Hipparcos (alghorithms for double/multiple star processing). Since 1992: partecipant to the definition and realization of the GSC-II project (object matching algorithm, photometric calibration, DB Q.A.).In 1998-2000: STScI consultant, in charge for the studies of the guide star availability for NGST. In 2000-2001: P.I. of a CNAA project on galactic structure studies via the data mining of GSC-II database. Since 1997: involved in the studies of the GAIA mission (ESA), as member of the Extrasolar planetary system working group and collaborator to the ESA experiment for the simulation of the database system and pipeline for the GAIA data ingestion and processing. Since December 1999, researcher at the Torino Observatory (astrometric group).

Richard Smart – Richard Smart: After obtaining a PhD in 1993 from the University of Florida undertook one year as a Research Scientist at the Space Telescope and Science Institute followed by a Royal Society Fellowship and a Torino University fellowship at the Astronomical Observatory of Torino. Permanent staff at the Observatory since 2000. Projects include early development of the Galax proposal (1993-1994), pre-release scientific usage of the Hipparcos and Tycho databases (1994-1996), research scientist involved with the astrometry, classification and quality assurance of GSCII (1995-1998), and project scientist for the Torino Observatory Parallax Program a long term project that has produced over 20000 images for the determination of parallaxes for nearby stars (1994-2003). Member of the GAIA working group on Accuracy and Object Detection.

Alessandro Spagna – In 1989-1997: member of the FAST consortium and the data reduction of the astrometric satellite Hipparcos (algorithms for double/multiple star processing). Since 1992: participant to the definition and realization of the GSC-II project (object matching algorithm, photometric calibration, DB Q.A.). In 1998-2000: STScI consultant, in charge for the studies of the guide star availability for NGST. In 2000-2001: P.I. of a CNAA project on



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galactic structure studies via the data mining of GSC-II database. Since 1997: involved in the studies of the GAIA mission (ESA), as member of the Extrasolar planetary system working group and collaborator to the ESA experiment for the simulation of the database system and pipeline for the GAIA data ingestion and processing. Since December 1999, researcher at the Torino Observatory (astrometric group).

Alberto Vecchiato – In 1997-2001 independent software developer in VB-Access. In 1998-2001 collaboration contracts with Comune di Abano Terme and Library Consortium of Abano Terme for the development of a orders database in MySQL/Oracle and its web interface in PHP. Ph. D. in Space Science and Technologies in 2001. In 2001-2003 post-doc fellow at the Physics Department of University of Padova. From May 2003 Research Associate at the Osservatorio Astronomico di Torino. Core member of the Gaia Relativity and Reference Frame Working Group (simulation task) and Simulation Working Group.

Antonio Volpicelli – From 1996 to the end of 2001 Head of the Computer and Network Center and Astronomical Archives at OATo. Since 1996, in collaboration with STScI, he designed and developed the Object Model for GSC2 database (COMPASS) using Objectivity OODBMS and C++ interface code for Object Matching and Quality Assurance tasks. From 1999 to 2001, in collaboration with GSFC, he implemented the SOLAR archive (SOHO Long Term Archive), a mirror of SOHO archive at OATo using ORACLE DBMS. From October 2001 to October 2003, he worked at MAST (Multi-mission Archive at Space Telescope) in Baltimore on the GALEX archive project, as Senior Database Engineer, with the responsibility for the design, develop and implementation of the database and the user interface and its integration in the NVO framework. He was involved on the develop of one NVO demo project (Galaxy Morphology Analysis Demo) writing a structured C# VOTables parser library.

Claudio Vuerli – In 1989-90 contract with ST-ECF/ESO for the development of an operator interface to the European Archive for the *HST* mission. Later he has participated in the design of the maintenance software for the *UVES* instrument for the VLT. From 1992 to 2000 he was involved in building the high-level control system (WSS) for the *TNG*, being responsible for its integration and maintenance. Currently, he is involved in the Data Processing Centre for the Low Frequency Instrument of the ESA *Planck* mission, with responsibility for the integration of the data processing pipeline from scientists' contributions, and for the definition of the Planck data model. After working for the Data Processing Centre for the Low Frequency Instrument of the ESA *Planck* mission, with responsibility for the definition of the Planck data model he is currently in charge of the OATs participation in the Grid.it project.

Andrea Zacchei – In 1993-95 under contract with Simulmondo. From June 1995 to October 1997 under contract with the Osservatorio Astronomico di Torino and the Space Telescope Science Institute in Baltimore in the framework of the *GSC2* project – in charge of developing algorithms for the data processing pipeline and tools for the production of the catalog. From October 1997 to October 2001, at the CGG under contract with the CNAA – responsible for the *TNG* control software, for the Archives at the Telescope, and for the *DOLORES* low-resolution



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spectrograph. From October 2001 astronomer researcher at OAT involved in – the Data Processing Centre (DPC) for the Low Frequency Instrument of the ESA *Planck* mission, with responsability for the integration of the data processing pipeline from scientists contributions and act as Level 1 Manager.



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4.3 Main related publications of the proposing group

- [1] TNG Long-Term Archive pilot project, A pilot project for the implementation of the Italian "Telescopio Nazionale Galileo" Long-Term Archive, TNG-LTA-OATs-001, 16 February 2001
- [2] Benacchio L., Bonoli C., Brocato E., Cutispoto G., Ferraro I., Pasian F., Pucillo M., di Serego S., Stirpe G., 1993, *Analisi e proposte sugli archivi TNG e sui metodi di gestione di osservazione e calibrazione ad essi connessi*, Oss. Astr. Padova-Asiago
- [3] Benacchio L., Bonoli C., di Serego S., Pasian F., 1994, TNG Archives User Requirements Document, Oss. Astr. Padova-Asiago
- [4] Pasian F., Benacchio L., Bonoli C., di Serego S., 1994, TNG Archives Data Interface Document, Version 1.0, Oss. Astr. Padova-Asiago
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5. Financial Request

In the following, the funds needed for carrying out the IA² are specified.

5.1 First Year (requested funds)

No.	Hardware infrastructure	KEuro
1	Observational Database Server	3
2	Housekeeping Database Server	3
3	UI Server	3
6	Storage Server: 4 Tb in Raid 5	21
5	Storage server: 1 Tb in Raid 5 Hot Swap	(20)
6	Processing Server	(30)
7	CD Juke Box	(15)
8	DVD Writer	(1)
9	DLT 8000 backup system	(4)

No.	Manpower	KEuro
1	Research fellowship	20
2	Contractor	25

No.	Consumables	KEuro
1	DBMS (Oracle TBC)	10
2	Parallel Compiler (Portland)	5
3	Travel	30
4	Consumables	10
5	Network traffic	10

Total:	<u>140</u>	

During the first year, all hardware and software infrastructure at the Coordination Site is to be purchased (or recovered from existing material). In the points 5 to 9 of the first (Hardware Infrastructure) table, the values are within brackets because that hardware are



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already present at the OATs, since it constituted the TNG-LTA prototype project hardware; such values are not accounted for in the total of 140 K€

There are to make some statements about the last (Consumables) table:

• DBMS:

currently the TNG-AaT archive works using Oracle 8i Enterprise Edition version, this was used for the production of the TNG-LTA pilot project too. In a first analysis it seems that the costs for the use of Oracle EE (9i or grid version are now present) are now considerably increased, therefore during the operational sketch of the IA² a coordinated action of the INAF toward the Oracle Corporation is suggested to test a possible agreement to reduce the costs. If this cannot be accomplished, the use of different DBMS will be evaluated.

• Travel:

the estimated cost for the travel is justified due both to the high number of project's participants distributed in the national territory and to the necessity to maintain narrow contacts with the international VO activity

Network. traffic:

Since the TNG archive and the coordination center of the IA² will be located at the OATs, this will bring to saturation the current network connection. To avoid problems to the local community, an increase in bandwidth will be necessary between the Garr and the OATs; such an increase must be estimated to allow the IA² to become an useful tool for the community.

5.2 Estimation for following years

During the operation phase, the basic hardware will be already present, but some hardware maintenance or upgrade must be scheduled. In this phase the IA² will be supporting the services, but must keep up contacts with VO and Grid.

The prices are per year and they are related to the period 2005-2006.

No.	Hardware Infrastructure	KEuro
1	Hardware upgrade	20
2	Storage upgrade 2Tb/year	10

No.	Manpower	KEuro
1	Research Fellowship	20
2	Contract	25



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No.	Consumable	KEuro
1	Software licences	10
2	Travel	30
3	Consumable	10
3	Network Traffic	10

Total:	<u>135</u>

The justification as it regards the estimated cost of the consumable are the same for the start up of the center.



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5.3 LBT Additional Cost

Additional costs for 2004 in the event of LBT extension:

No.	Item	KEuro
1	DVD Juke Box	20
2	4 Tb disk storage raid 5	20
3	Observational/Housekeeping DB Server	5

No.	Manpower	KEuro
1	Research Fellowship	20

No.	Consumables	KEuro
1	Software licences	5
2	Travel	15
3	Consumables	5

Total:	<u>90</u>	

5.4 Harmonization Additional Cost

The huge work about harmonization of the existent archives or catalogs with the IA² and IVOA standards imply Additional Cost for the 2004 or 2005 year/s related Contractors or Research Fellowships and travel. A minimal cost can be estimated to be a Research Fellowship for every participant Institution and a minimal travel cost (about 20+5 KEuro each).



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6. Logo



In the IA² logo, within the letter A two images are included: the first is the Horse Head Nebula from the Anglo-Australian Telescope, the second is a spectrum of a type-2 QSO taken with DOLORES at the TNG by R. Dominguez, J. Licandro, M. Pedani, G. Tessicini, A. Zacchei (CGG), A. Marconi and N. Nagar (OAA).



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7. Responsibility Statement

By undersigning this request we jointly take responsibility for the realization of the proposed project, for providing the competence and infrastructures described in this proposal (beyond those requested to INAF), and for managing the project on behalf of all other participating Institutions.

Dr. Riccardo Smareglia Principal Investigator Dr. Paolo Molaro INAF - Osservatorio Astronomico di Trieste Director

Trieste, 10 November 2003