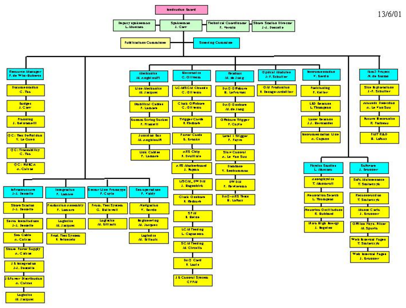
Chapter 10 : Management and Quality assurance

The elements that are implemented are described in the following sections:

Collaboration Organisation

Organisational structure of the 0.1 km^2 ANTARES project.



Click here or on the icon to read it

Institution Board

The governing body of the collaboration is the Institution Board consisting of one representative from each collaborating institute. All Collaboration decisions are formally made by this body according to the Collaboration Regulations. In practice, the majority of technical decisions for the detector construction are made by the management structure described below and ratified by the Institution Board.

Executive Management

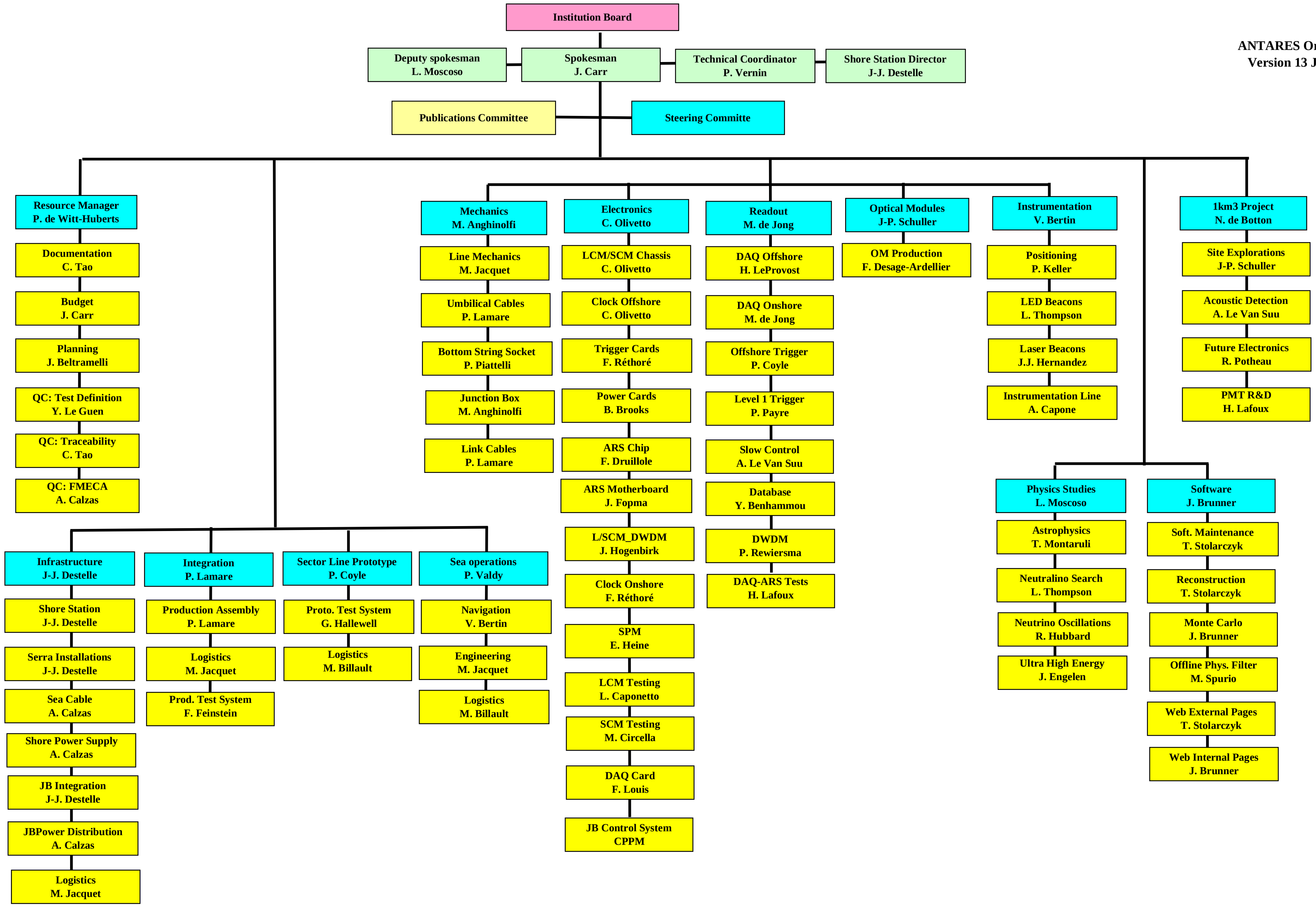
The project is managed by a Spokesman assisted by a Deputy Spokesman (DS), a Technical Coordinator (TC) and Shore Station Director (SSD). The Spokesman has overall responsibility for all aspects of the collaboration programme. The Technical Coordinator has the role of assessing in detail all technical aspects of the project. Internal reviews are used to aid in these assessments. The TC has executive responsibility (i.e. control responsibility when appropriate) for the Mechanics, Electronics, Readout, Optical Module and Instrumentation sub-project. The TC also has executive responsibility for the ResourceManagement sub-project including quality control. The Shore Station Director has the role of managing the construction and operation of the ANTARES Shore Station at La Seyne-sur-Mer. The SDD also has responsibility for the ANTARES installations in La Seyne-sur-Mer. The SDD has executive responsibility for the Infrastructure, Integration and Sea Operations sub-projects.

The Deputy Spokesman has a special role concerning the scientific programme of the Collaboration. The DS chairs the Publication Board and has executive responsibility for the Physics Studies and Software sub-projects.

Sub-project Coordinators

The full scope of the programme is divided into sub-projects each having a coordinator. The sub-project coordinators take responsibility for all significant decisions in their area. They are responsible for following the sub-project schedule and tracking milestones. The budgets of the various sub-project tasks are controlled by these coordinators. The sub-project coordinators report at

ANTARES Organigram
Version 13 June 2001



regular intervals to the spokesman, steering committee and collaboration.

Resource Manager

A group of organisational tasks are linked under the responsibility of the Resource Manager (RM), a post analogous to that of sub-project coordinator. Among these tasks are the documentation, budget and planning aspects of the project. The RM will handle the Memoranda of Understanding between the Institutes and the ANTARES Finance Review Committee. Quality Control falls under the responsibility of the RM.

Steering Committee

The sub-project leaders plus the executive management form the project Steering Committee that meets, typically, once per month to follow the project progress in all aspects. The Steering Committee helps the Spokesman manage the project budget and maintain the schedule.

Technical Decisions

In general, technical decisions will be presented to and discussed by the full collaboration during the regular meetings. Only major aspects will be considered by the Steering Committee and Institution Board. Most decisions will be made by the sub-project coordinators and members of their teams. The Technical Coordinator has a control responsibility for all technical decisions of the project.

Publication Committee

The publication committee is chaired by the Deputy Spokesman and is described in a set of regulations.

Operational Reliability

This chapter establishes the provisions for the programme regarding product- and quality assurance of the ANTARES 0.1 km^2 detector. The product assurance programme described herein will apply to design, procurement, system integration and testing of sub systems.

Objectives

A key issue for the ANTARES detector is the level of reliability required to ensure optimal availability for physics data taking and affordable maintenance cost. The latter condition is imposed because of the relatively large cost and effort involved in off-shore recovery and repair operations. The objective set for operational reliability of the entire instrument is the following:

The planned operational lifetime of the detector is ten years. After three years of operation, with neither corrective nor preventive maintenance applied, on average not less than 85% of the Optical Modules will be operational. The systems that could be subject to single-point-failure (the Junction Box and the Electro Optical Cable) should have a probability of failure smaller than 10% in ten years.

Note that the probability of failure of an OM equals the combined probability of failure at all relevant functional levels in the chain from OM, LCM, SCM/SPM, JB, MEOC to the shore station.

Product- and Quality Assurance

Quality-assurance tools will be applied in the three phases of implementation of the instrument: design, procurement, testing and system integration.

Quality-assurance tools applied are the following

- Failure Modes, Effects and Criticality Analysis (FMECA).
- Minimisation of Single Point Failures (SPF)
- Logbooks, test reports and status documentation that will accompany all objects and subsystems of the instrument with the objective to ensure traceability. Test reports are formally approved by the signature of the person responsible for the test.

The objective of FMECA is to identify the effects of assumed failures and in particular to identify critical failure effects, specifically all single point failures (SPF).

A single point failure is a failure of a non-redundant item, component or part caused by a single failure mechanism, resulting in an irreversible failure of maximal criticality or having catastrophic or critically hazardous consequences.

FMECA will initially start with assumed failure modes, proceed on assembly level and finalise on component level, if necessary. The goal of FMECA is also to give the involved parties insight into the analysis of any failure propagation over the interface. The following failure modes will be considered in the FMECA:

- Severity of effect of a failure mode
- Likelihood of a failure mode

- Error detection modality

The following criticality categories will be used in the FMECA:

Severity

Three types of severity are distinguished:

- *Loss of functionality* - from marginal (one OM lost), to one string lost, to total detector lost; scale from 1-8.
- *Loss of material* (e.g. a string is released and wrecks) - from one OM lost to full detector lost;
  scale from 3-9.
- P*ersonnel hazard* -from harmless to casualty;
  scale from 1-10.
  There should be no compromise on safety issues (cf. section on Safety Assurance)

The overall figure on the scale of severity is constructed by taking the maximum of the three separate figures.

Likelihood

Less frequent than once every 100 years to once every hour;
scale from 1-10.

Error detection modality

From detectable before immersion to not detectable;
scale from 1-8.

For several major sub-systems described in this Technical Design Report, a FMECA has been carried out and the results of the analysis was used to improve the robustness of the design wherever achievable.

Design level

The design principles have emphasized the need to find the most reliable configuration/architecture feasible under the constraints of the available budget and human resources. For example, the applied concept of sectorisation in a detector string - resulting in a partial star network- enhances its graceful-degradation characteristics.

On the other hand, the quantity of complex electronics located in the sea is appreciable: Data acquisition comprising a complex ASIC, the analog ring sampler ARS1, the DAQ processor board, opto-electronics including Dense Wavelength Division Multiplexing and Giga bit/s ethernet connections.

The design will be such that Single Point Failures (SPF) will be avoided as far as feasible; otherwise a rationale for their retention will be provided. Single point failures in the sea-borne parts of the ANTARES detector are essentially limited to the Electro Optical Cable and the Junction Box, in particular where the electric-power function of the latter is concerned. Concerning the Junction Box, a design of similar complexity and subject to similar reliability requirements is currently operational for ocean surveillance purposes. Design concepts applied to the JB have been in part derived from this example.

In the chapter on the Electrical Power System (EPS), an account of the applicable FMECA is given. In addition the Mean Time Between Failure (MTBF) is calculated, within specific model constraints.

Design Review

Evaluation of the design will be implemented with a technical design review by experts that are not associated with the ANTARES project. The TDR will form the basis of the evaluation.

Procurement and manufacturing

Components and materials will be selected for best possible MTBF compatible with availability and acceptable price. Component lists and the rationale for their selection are included in the TDR.

The present engineering design is based on extensive know-how obtained in previous deep-sea experiments and prototype tests. In particular the recent Demonstrator Line experiment has shown that:

- Launching of a set of interconnected storeys equipped with Optical modules is well mastered, **i.e. OM-integrity OK, connectors and connecting cables intact.**
- Connection on deck of the vessel to an EOC is under control.
- Short term (several months) corrosion is not an issue.
- The acoustic positioning system satisfies specifications.
- Adequate time reserved for quality assurance, system integration and strict respect for procedures is indispensable.

For the interfaces of mechanical, metallic parts, material combinations will be selected to minimise contact potentials and galvanic corrosion. An example is given in the chapter on Mechanics, where the Junction Box configuration is described. In the production process of the JB, a quality assurance programme will be implemented by the industrial manufacturer. In this case, where a single-point-failure risk is involved, control of the QA-programme implementation will be ensured by an independent expert firm.

In order to prevent major delays during fabrication, integration and testing, a spare part policy of 5-10 % of the baseline amount of components will be applied.

The procurement of a spare Junction Box is not considered feasible in the current phase of the project.

System integration and testing

Testing of sub-systems comprises two major phases:

1. Functional tests of electronics boards, which will be subjected to a sequence of environmental conditions that exceed operational end-use specification in an Accelerated Stress Testing (AST) procedure. The purpose of applying AST is to eliminate most of the faulty items associated with the "infant mortality" phase of the standard reliability-versus-time curve.

The scenario of AST for the LCM electronics has been established as follows:

- Temperature cycling from 10-40 °C with four cycles of 2 hours
- Vibration with 3g acceleration at 50 Hz for 30 minutes

Compliance with functional specifications after AST will be assessed and documented. Similar AST scenarios apply to other objects - see the relevant chapters in this TDR. Once product quality has been assured with AST on item level, the prototype of a set of objects assembled into a sub-system (e.g. the LCM electronics) is subjected to a qualification test to anticipate upcoming environmental conditions.

2. In order to ensure product quality at the moment of arrival at the site where system assembly takes place and in the subsequent phase of launching the detector string, the life profile of products from the moment of shipment from the forwarding laboratory has been established.

The life profile includes the following phases and related environmental conditions, as applicable to the Local Control Module equipped with its electronics cards - see also the Chapter on Electronics.

- Thermal shock at immersion - 50-15 ºC
- Vibrations and shocks- sinusoidal 5-55 Hz, simulates transport; shocks of 15g during 20 ms
- Atmospheric conditions - storage with container open: damp heat 50 ºC at 93% Relative humidity ; salt fog - container closed on quay for one month with 50 ºC
- Free fall from 70 cm on concrete floor - test whether object functionality is OK or not after non-standard handling event.

The methodology applied conforms to the IFREMER recommended standard XPX 10-812. In general, all container-like items will be subjected at prototype level to hyperbaric tests performed with the test facilities of IFREMER-Brest in accordance with the standards applicable to oceanographic instruments.

Post Test Review

After completion of each major test sequence a Post Test Review Board will be organised to determine that the test results conform to its specifications. The Board may consist of the following people:

- Spokesman
- Technical Coordinator
- Resource manager
- Other specialists (on request)

The aim of the review is to verify that:

- the test was properly executed,
- test procedure deviations are properly documented,
- required test data are complete and adequate,
- non-conformances have been recorded.

Historical Records (Logbooks)

Logbooks will be established for all operations and tests to record the history of operations. They will include historical record sheets with data of operation/test/transport, applicable procedures, responsible organisation and person. The logbooks will accompany the hardware. Further details of the documentation system setup for ANTARES are given in the next section.

Safety Assurance

A preliminary description of the scope of the safety assurance programme to be implemented for the ANTARES project is given. The basic elements of the safety programme are:

- establishment of safety requirements;
- identification of hazards;
- hazard reduction;
- safety assurance.

The main areas of safety concern for the ANTARES programme fall into two categories are:

- ground operations, comprising integration and test, transportation and handling and pre-launch operations;
- sea operations.

The practical implementation of safety assurance and the assignment of safety responsibility will be set up as soon as possible.

The ANTARES Documentation

Existing ANTARES documents

There are different types of ANTARES documents,stored on via the ANTARES WEB site in CPPN Lyon, http://antares.in2p3.fr/. Some documents are accessible to everyone (Public), others are accessible to everyone in the collaboration with a common password (Internal) and some are on private areas (Privileged) with privileged access.

Internal notes: Internal technical and physics notes from ANTARES are entered and accessed via the Web. Copies of transparencies shown in ANTARES meetings are also accessible.

Scientific communication: publications, conference presentations,...

Public Communication tools: photo library, videos, posters, plaquettes, maquettes, animation tools, ...

Software for simulations, reconstruction, physics analysis, test software, bibliographies, ..

Additional Documents needed for 0.1 km^2 detector

The development of the ANTARES project requires the establishment of additional documentation, such as a general database, and logbooks. These will include information relevant to the different stages of the ANTARES experiment, from the construction time, assembly, testing, to the online control of the detector, monitoring, the exploitation of the data, and the maintenance of the detector.
People involved in producing these documents are primarily the subproject coordinators, but most technical members of the collaboration will have to enter data at some point.

For the database to be used in tests and for future online and offline purpose, a technical interface has been set up with the users via the WEB, and ***ORACLE8i*** has been selected for the management of this database.

It is the responsiblity of each subproject leader to:

- define the preliminary content of the database file. For each individual object, the minimal contents are:

  - the object name, PBS number, serial number
  - person entering the data and time of entry
  - data needed for traceability of the object: location in detector or in storage,
  - status (assembled, labelled, mounted, tested OK, returned for failure,...), date of change of status

  Additional information will often be necessary concerning items such as: assembly, sector test, line test, deployment, detector maintenance, online control, readout, online monitoring, online reconstruction, offline analysis.
- ensure that this draft database entry has been checked by all relevant persons;

- liaise with the database manager to set up the appropriate file format and data entry tools;
- manage the file contents (ensure the information is accessible and up to date). The management of the actual files(backup, structure,etc...) is the responsibility of database manager.

Logbooks are a necessity at every level of the ANTARES project. Examples can be found under the Site Evaluation and Demonstrator ("Line 5") Web pages. For the 0.1 km^2 detector, a record of all stages in the assembly and testing of each component should be stored, in any readable format (ASCII, HTML, PDF, PS), on the Lyon computer system for easy Web access by ANTARES Collaboration members. A tool analogous to that used for the publication of ANTARES notes will be provided for that purpose. These logbooks are the principal means of ensuring traceability in the project.

Online logbooks from data acquisition during the running of the experiment are automatically recorded by the online computers. They should be immediately accessible to the ANTARES collaboration to allow remote monitoring of the experiment and provide diagnostic information in the event of problems.

Rules of acceptation, approval and evolution of documents

Documents should be circulated to the appropriate subproject or physics working group and approved before their being entered on the system. Entry is performed using an automatic tool offering several options:

- Enter a new document (a new number is automatically released)
- Enter a new version of an existing document (the version number is increased)
- Delete an existing document.

Documents may be entered in the repository in any WEB readable format (PS, PDF, HTML, Word). In the case of PS or PDF documents, authors are encouraged to provide separate files containing figures and tables (in source format, e.g., Tex, Word, jpeg, gif, ...) for use in presentations, papers, etc...

It is the responsibility of each author to inform the collaboration of the existence of a new document or a new version.

Up Next Previous Contents

Role of the database

The database is used for:

- **detector assembly and integration** : at each step of the construction, different parameters have to be recorded at different sites. A World Wide Web interface will be used to record all these data in a central database in CCIN2P3 in Lyon;
- centralising the **running conditions** of the detector and the **data taking** actions. It is also used to store and retrieve the calibration information for hardware devices.

Database as a tool for detector assembly

Data entry

Measurements for ANTARES take place in various sites. Due to the large number of detector parts to characterise, test and store, it is necessary to record all these data and the history of each part in a central database to be able to find exactly what happened and where for each component.

Assembly stage

Once subsets are in the final site, operators can construct lines and use the web interface to know which component is available, tested, qualified.
For example, to construct a sector, the operators will have a list of OM, cables, LCM, MLCM.

Accessing web pages

There are two kinds of users : ``readers'' and ``writers''. Every member of the collaboration has reading privilege of the database. ``Writers'' have an account which allows them to read and write data, via the web interface, into tables of the database.

Example of a database

For the construction of Optical Modules realised in Saclay, 14 tables have been created, which can be found on the WEB:

- cages : cage_stock, cage_history
- LED : LED_stock, LED_history
- PMT Bases : PMT_Base_stock, PMT_Base_history
- spheres : sphere_stock, sphere_history
- PMT : PMT_stock, PMT_charac, PMT_history
- OM : OM_general, OM_test, OM_history

Only Saclay operators can fill these tables whereas the whole ANTARES collaboration can read them.

Database for Slow Control use: cf Chapter 4 in Readout, Trigger and DAQ

Standard tools used for the database

ORACLE8*i* has been chosen for the database management system. User interfaces for construction tools are built using **WEBDB** (another ORACLE product) and the slow control database system is based on JAVA and C^{++} code.

Product Breakdown Structure (PBS)

A **line (or string)** is made of 6 **sectors** and each sector is a system formed by 5 subsystems, called **storeys** (or **floors**), each with different objects:

Components : elements that form an object
Objects : LCM, SCM, OM, laser, LED optical beacon, ...
Subsystems : Storey, BSS, JB, cables
Systems : sector, line (or string)

Each component is given a PBS name and number to ease retrieval of information, ensuring a unique definition, and helping identifying missing objects.

A schematic view of the distribution of main objects in ANTARES can be viewed here.

PBS 1.- Mechanics

- **PBS 1. 1 Junction Box: Mechanics part**

PBS1.1.1	JB Frame	
PBS1.1.2	JB_Container	
PBS1.1.2.1	*JB Vessel*	*2 Ti hemispheres and a cylind. spacer*
PBS1.1.2.2	*JB Diaphragm*	*Separates the transformer to the electronic volumes*
PBS1.1.2.3	*Feed-throughs*	*Transmit power and diagnostic (7)*
PBS1.1.2.4	*PRE-JB*	*Holds penetrator for connection to Main EO cable*
PBS1.1.2.5	*JB O-ring*	
PBS1.1.2.6	*Balancing device*	
PBS1.1.3	JB Transponder support	

- **PBS1.2 Bottom String Socket**

PBS1.2.1	BSS Structure	Recoverable part of the BSS
PBS1.2.2	BSS Dead Weight	Unrecoverable part of the BSS
PBS1.2.3	BSS RX_Hydrophone Support	
PBS1.2.4	BSS Pressure Sensor Support	
PBS1.2.5	BSS Sound velocimeter Support	

PBS1.2.6	SPM/SCM Container	Hosts the Power components and String Control electronics
PBS1.2.6.1	SCM tube	
PBS1.2.6.2	SCM End Cap	
PBS1.2.6.3	Central Junction Part	
PBS1.2.6.4	SPM tube	
PBS1.2.6.5	SPM end cap	
PBS1.2.7	SPM/SCM Support	

- **PBS1.3 Storey**

PBS1.3.1	OMF	Structure of the Storey
PBS1.3.2	LCM Container	Houses electronics for the storey
PBS1.3.3	LCM support	Support of LCM
PBS1.3.4	OM support	Support of OMs
PBS1.3.5	Hydrophone support	Support of hydrophone
PBS1.3.6	OMF interface with EMC	Interface device carrying cables
PBS1.3.7	LED Optical beacon support	Support of Optical Beacon

- **PBS1.4 Cables**

PBS1.4.1	Interconnecting link IL	Link between the line and the Junction Box
PBS1.4.2	Electromechanical cable EMC	Section of cable in the line between storeys or BSS and bottom storey
PBS1.4.2.1	*Cable*	*Electro-mechanical cable*
PBS1.4.2.2	*Mechanical termination*	*Interface between cable and OMF*
PBS1.4.2.3	*Penetrator*	*Electro-optical interface between cable and LCM*
PBS1.4.3	SPM – SCM link	Link between the SPM and the SCM

- **PBS1.5 Buoy**

PBS 2.- Electronics

- **PBS2.1 LCM Local Control Module**

PBS2.1.1	LCM_CRATE	Support of boards and backplane
PBS2.1.2	LCM_BACK	Distributes signals between boards in LCM crate
PBS2.1.3	COMPASS_MB	Motherboard for the tiltmeter-compass sensor
PBS2.1.4	ARS_MB	Analog pipeline with ADC conversion from PMT signal
PBS2.1.4.1	*ARS*	*ARS Chip on ARS_MB*
PBS2.1.5	LCM_BIDICON	Concentrates 4 optical transceivers from each LCM slave DAQ channel
PBS2.1.6	LCM_TRIG	Receives trigger from ARS boards and constructs trigger function
PBS2.1.7	LCM_CLOCK	Receives optical clock distribution signal and distributes inside LCM crate
PBS2.1.8	ACOUST_RX_PREAMP	Acoustic positioning system preampli board
PBS2.1.9	ACOUST_RX_DSP	Acoustic positioning system DSP board
PBS2.1.10	ACOUS_RX_CPU	Acoustic positioning system CPU board
PBS2.1.11	POWER_BOX	Converts 400V to needed voltages
PBS2.1.12	LCM_OPTCON	Optical and electrical connections between main cable and LCM crate
PBS2.1.13	UNIV1	Daughter board plugged on other board for Slow Control MODBUS interface
PBS2.1.14	BIDIANT2	Daughter optical transceiver board for Ethernet and Clock signals
PBS2.1.15	BIDITRIG1	Daughter optical transceiver board for trigger signals
PBS2.1.16	MLCM_DWDM	DWDM transceiver board with laser, receiver and DWDM filter or circulator

PBS2.1.17	LCM_DAQ/SC	Data and Slow Control board which sends and receives Ethernet Protocol
PBS2.1.18	MLCM_ Switch	

- **PBS2. 2 SCM String Control Module**

PBS2.2.1	SCM_CRATE	Support of boards and backplane
PBS2.2.2	SCM_BACK1	Distributes signals between boards in SCM crate
PBS2.2.3	SCM_WDM1	Optical transceiver WDM with clock distribution
PBS2.2.4	SCM_REP	Optical transceiver to regenerate clock signal
PBS2.2.5	SCM_CLOCK	Clock Distribution for SCM
PBS2.2.6	SCM_DWDM	Optical transceiver for DWDM function with laser and receiver part
PBS2.2.7	ACOUST_RXTX_EM	Acoustic positioning system emitter board
PBS2.2.8	ACOUST_RXTX_PREAMP	Acoustic positioning system preampli board
PBS2.2.9	ACOUST_RXTX_DSP2	Acoustic positioning system DSP board
PBS2.2.10	ACOUST_RXTX_DSP1	Acoustic positioning system DSP board
PBS2.2.11	ACOUST_RXTX_CPU	Acoustic positioning system CPU board
PBS2.2.12	ACOUST_RXTX_POW	Acoustic positioning system power board
PBS2.2.13	SCM_OPTCON	Optical connections between main cable and SCM crate
PBS2.2.14	SCM_DWDM_ MUX/DEMUX	Optical mux and demux to separate or mix wavelengths from shore or Master LCM

- **PBS2.3 SPM String Power Module**

PBS2.3.1	SPM_CRATE	Support of boards and backplane
PBS2.3.2	SPM_BACK1	Distributes signals between boards in SPM crate
PBS2.3.3	SPM_CONNECT1	Connections inside SPM
PBS2.3.4	SPM_CONNECT2	Connections inside SPM

PBS2.3.5	SPM_CONT1	Controls power distribution
PBS2.3.6	SPM_CONT2	Controls power distribution
PBS2.3.7	SPM_CONT3	Controls power distribution
PBS2.3.8	SPM_CONT4	Controls power distribution
PBS2.3.9	SPM_LV	Produces low voltage
PBS2.3.10	SPM_TRANS1	Transformer for HV AC
PBS2.3.11	SPM_FILT1	Electrical filter for power conversion
PBS2.3.12	SPM_REGUL	Voltage regulator
PBS2.3.13	SPM_DC/DC	DC/DC conversion
PBS2.3.14	SPM_FILT2	Electrical filter on output
PBS2.3.15	SPM_HEAT1	Heat dissipator

- **PBS 2.4 Junction Box: Clock distribution and trigger construction**

PBS2.4.1	JB_ELECBOX	Contains electronics boards
PBS2.4.2	JB_SPLIT1	Passive splitters for clock distribution
PBS2.4.3	JB_TRIG1	RoR signal construction

- **PBS2.5 ONSHORE Clock Master Clock onshore**

PBS2.5.1	ON_CRATE1	Electronics crate
PBS2.5.2	ON-GPS	GPS receiver producing reference signal for clock distribution
PBS2.5.3	ON_CLOCK	Coding /decoding orders for clock distribution
PBS2.5.4	ON_WDM	Optical transceiver for clock distribution
PBS2.5.5	ON_SYNCPC1	PC board
PBS2.5.6	ON_PCIO	Digital interface for ON_CLOCK board

PBS 3.- Readout, Trigger and DAQ Hardware PBS defined in other chapters

PBS 4.- OM Optical Module

PBS4.1	Photo-multiplier	Light sensitive detector
PBS4.2	OM-LCM link	Interconnecting cable between OM and LCM
PBS4.3	Glass sphere	External envelope of the Optical Module
PBS4.4	Magnetic shield	μ-metal cage
PBS4.5	Gel	Glue and optical contact
PBS4.6	Base	Power supply and output signals access
PBS4.7	LED system	Internal calibration system
PBS4.8	Tools	Tools for integration and tests

PBS 5.- Instrumentation

- **PBS5.1 ACOUSTIC Acoustic positioning system**

PBS5.1.1	ACOUSTIC _RX	Acoustic receiver module
PBS5.1.1.1	*RX_CARDS*	*Acoustic receiver electronic boards*
PBS5.1.1.2	*RX_HYDROPHONE*	*Acoustic receiver hydrophone & cable*
PBS5.1.1.3	*RX_HYDRO_BULKHEAD*	*Acoustic hydrophone cable bulkhead*
PBS5.1.2	ACOUSTIC _RXTX	Acoustic emitter-receiver module
PBS5.1.2.1	*RXTX_CARDS*	*Acoustic emitter-receiver electronic boards*
PBS5.1.2.2	*RXTX_HYDROPHONE*	*Acoustic emitter-receiver transducer & cable*
PBS5.1.2.3	*RXTX_HYDRO_BULKHEAD*	*Acoustic transducer cable bulkhead*
PBS5.1.3	ACOUSTIC _CONTROL	Dedicated computer and software to control the acoustic system
PBS5.1.4	ACOUSTIC _PRESS	Pressure sensor
PBS5.1.4.1	*PRESS_SENSOR*	*Pressure sensor container & probe*
PBS5.1.4.2	*PRESS_CABLE*	*Pressure sensor cable*

PBS5.1.4.3	*PRESS_BULKHEAD*	*Pressure sensor cable bulkhead*
PBS5.1.5	ACOUSTIC _SVEL	Measure the sound velocity
	SVEL_SENSOR	*Sound velocimeter container & probe*
PBS5.1.5.2	*SVEL_CABLE*	*Sound velocimeter cable*
PBS5.1.5.3	*SVEL_BULKHEAD*	*Sound velocimeter cable bulkhead*
PBS5.1.6	ACOUSTIC _SVEL-CTD	Measure the sound velocity and Conductivity, Temperature, Depth
PBS5.1.6.1	*SVEL-CTD_SENSOR*	*Sound velocimeter-CTD container & probe*
PBS5.1.6.2	*SVEL-CTD_CABLE*	*Sound velocimeter-CTD cable*
PBS5.1.6.3	*SVEL-CTD_BULKHEAD*	*Sound velocimeter-CTD cable bulkhead*
PBS5.1.7	ACOUSTIC _TRANSP	Autonomous acoustic transponder
PBS5.1.7.1	*TRANSP_CONTAINER*	*Transponder electronic container*
PBS5.1.7.2	*TRANSP_HYDROPHONE*	*Transponder transducer*
PBS5.1.7.3	*TRANSP_CABLE*	*Transponder transducer cable*
PBS5.1.7.4	*TRANSP_FRAME*	*Transponder mechanical frame*
PBS5.1.7.5	*TRANSP_BASE*	*Transponder supporting base*
PBS5.1.8	ACOUSTIC _PRESS-ABS	Measure the absolute atmospheric pressure

- **PBS5.2 TILT_COMPASS Sensor board measuring tilt angles and heading**
- **PBS5.3 LED_OB LED Optical Beacon**

PBS5.3.1	BEACON_CABLE	Umbilical link between LCM and Optical Beacon
PBS5.3.2	BEACON_CYLINDER	High pressure containment vessel
PBS5.3.3	BEACON_FACE	PCB with 5 pulser-LEDs and accompanying logic
PBS5.3.4	BEACON_ MOTHERBOARD	Power and Logic Interface between LCM and Optical Beacon
PBS5.3.5	BEACON_MOUNTING	Mechanical structure onto which Optical Beacon faces are mounted

PBS5.3.6	BEACON_PMT	Low voltage PMT

- **PBS5.4 LASER_OB Laser Optical Beacon**

PBS5.4.1	LB_CONTAINER	Titanium container equipped with a glass rod and a electrical connector
PBS5.4.2	LB_CABLE	Electrical cable with connectors
PBS5.4.3	LB_BULKHEAD	Bulkhead of Laser Beacon cable
PBS5.4.4	LB_LASER	Green laser source
PBS5.4.5	LB_DIFFUSER	Lambertian diffuser
PBS5.4.6	LB_FRAME	Inner mechanical frame
PBS5.4.7	LB_ELEC	Electronics boards

- **PBS5.5 INST_LINE Instrumentation line**
- **PBS5.6 HUMIDITY Humidity sensor**

PBS 6.- Infrastructure:

- **PBS6.1 Power Hut**

PBS6.1.1	55kVA Power Supply
PBS6.1.1.1	*Tri/mono converter*
PBS6.1.1.2	*Variable voltage transformer*
PBS6.1.2	20 kVA self
PBS6.1.3	Hut (building)
PBS6.1.4	Cable and optical platine
PBS6.1.5	Electrodes
PBS6.1.6	Shore power cupboard
PBS6.1.7	Remote control cupboard
PBS6.1.8	Slow Control node

- **PBS6.2 Shore station**
- **PBS6.3 Link from shore to sea**

PBS6.3.1	Main ElectroOptical Cable (MEOC)
PBS6.3.2	Terminations
PBS6.3.2.1	*Shore termination*
PBS6.3.2.2	*Sea termination*
PBS6.3.2.3	*Stress relief device*
PBS6.3.2.4	*Link for tests (50m with plug)*

- **PBS6.4: Junction Box (Power part)**

PBS6.4.1	Penetrators and bulkhead receptacles
PBS6.4.2	Power components
PBS6.4.3	Power Remote diagnostic
PBS6.4.4	Very Low Voltage Power Supply
PBS6.4.5	Cabling and Connections
PBS6.4.6	Sensors
PBS6.4.7	Remote Control

- **PBS6.5 Sea electrode**

PBS6.5.1	Electrode and its cable
PBS6.5.2	Electrode support

- **PBS6.6 Maintenance equipment and procedures**

PBS 8.- Sea operations

- **PBS8.1 LFLBL Low Frequency Acoustic Long Baseline Navigation System**

PBS8.1.1	LF_REF _TRANSP	LFLBL acoustic reference transponder
PBS8.1.2	BSS_RELEASE _TRANSP	Releasable acoustic transponder for BSS
PBS8.1.3	CABLE_RELEASE _TRANSP	Releasable acoustic transponder for winch cable used for deployments
PBS8.1.4	SUBMARINE _TRANSP	Acoustic transponder for submarine vehicle
PBS8.1.5	JB _TRANSP	Acoustic transponder for Junction Box
PBS8.1.6	LF_TRANSP_ TELECOMMAND	Autonomous telecommand for LF transponders
PBS8.1.7	LF _RANGEMETER	LBL multi-channel rangemeter for LF transponders
PBS8.1.8	LF_RANGEM _TRANSD	Remote tranducer for the LF rangemeter
PBS8.1.9	LF_TRANSD_EM _CABLE	Electro-mechanical cable for the remote tranducer of the rangemeter

PBS8.1.10	LF_TRANSD_LF _CABLE	Electrical cable for the remote tranducer of the rangemeter
PBS8.1.11	LF_LBL _COMPUTER	Control computer of the LFLBL system
PBS8.1.12	LF_LBL _SOFTW	Software for the LFLBL system
PBS8.1.13	DGPS _RECEIVER	DGPS receiver and its antenna
PBS8.1.14	GYROCOMPASS	Gyrocompass

- **PBS8.2 Ship equipment**

PBS8.2.1	Workshop container
PBS8.2.2	Navigation Container
PBS8.2.3	ORE fishes
PBS8.2.4	Booms

- **PBS8.3 Tools for sea operations**

PBS8.3.1	Hooks (Launching and Recovery)
PBS8.3.2	Deck Support
PBS8.3.3	OMF Supports
PBS8.3.4	Interconnecting Cable Reel

ANTARES Milestone Planning

The major- milestone planning of the complete project is presented hereafter. The current, detailed sub-project planning information can be accessed on the ANTARES internal WEB page: http://antares.in2p3.fr/internal/planning/pdf.

Jun	2000	Order Acoustic Positioning System
Sep	2000	Order Sea Electro-Optical Cable
Jan	2001	Order Optical Module Components (10 lines)
Jan	2001	Order mechanics parts for sector prototype
Jan	2001	Order optical transmitters and receivers proto+2 lines
Mar	2001	Site **Survey** with Cyana
Apr	2001	Order Link Cables and Sockets
Apr	2001	Order Navigation System
Apr	2001	**Deploy** Sea Electro-Optical Cable
Jul	2001	**TDR version 1 finished**
Jul	2001	Mechanical Prototype (5 storeys) Deployment Test
Jul	2001	Junction Box Deployment Test in shallow water
Sep	2001	**Integrate** electronics complete 1 MLCM, 1 SCM, 1 SPM
Sep	2001	Pre-assemble mechanics complete prototype sector line
Nov	2001	Lab electronics tests finished 1 MLCM, 1 SCM, 1 SPM
Dec	2001	**Deploy** Junction Box
Jan	2002	**Integrate** complete PSL: 1 MLCM, 4 SLCM, 1 SCM, 1 SPM
Mar	2002	Electrical tests finished PSL: 1 MLCM, 4 SLCM, 1 SCM, 1 SPM
Apr	2002	Calibration finished PSL: 1 MLCM, 4 SLCM, 1 SCM, 1 SPM
Apr	2002	**Integrate** Instrumentation Line
May	2002	Prototype Sector Line **Deployment**
May	2002	Instrumentation Line **Deployment**
Jun	2002	**Connect** Prototype Sector and Instrumentation lines
Jun	2002	Order Line Umbilical Cables (10 lines)
Jun	2002	Order Mechanical Parts (2 lines)
Jun	2002	Order Electrical Parts (2 lines)
Aug	2002	**Sea Tests** Complete Prototype Sector Line
Oct	2002	Order Electrical Components (+8 lines)
Jan	2003	**Deploy 1st** line
Feb	2003	Order All Remaining Mechanical Components (+8 lines)
Mar	2003	**Deploy 2nd** line
Jun	2003	Connect 1st and 2nd lines
Jul 2003 until Jan 2004		**Deploy 3rd – 6th** Lines
Feb	2004	Connect 3rd – 6th Lines
Jan-Oct	2004	**Deploy 7th-10th** Lines
Oct	2004	Connect 7th-10th Lines

Annexes

List of acronyms

AC Alternative Current (also ac)

ADC Analog to Digital Converter

ADCP Acoustic Doppler Current Profiler

ARS Analog Ring Sampler

ASIC Application Specific Integrated Circuit

AST Accelerated Stress Testing

BIDI Bi-Directional

BSS Bottom String Socket

CDR Conceptual Design Report

CRM Counting Rate Monitor

CTD Conductivity Temperature Depth

DAQ Data Acquisition

DC Direct Current (also dc)

DGPS Differential Global Positioning System

DP Dynamic Positioning

DSP Digital Signal Processor

DWDM Dense Wavelength Division Multiplexing

DWFI Dense Wavelength Filter

EM Electromagnetic

EMC Electro-Mechanical Cable

EO Electro-Optical

EOC Electro-Optical Cable

EPLD Electrically Programmable Logic Device

FEA Finite Element Analysis

FMECA Failure mode and effects critical analysis

FIFO First-In First-Out

FPGA Field Programmable Gate Array

FWHM Full Width Half Maximum

GPS Global Positioning System

GUI Graphic User Interface

HBW High Bandwidth

HFLBL High Frequency Long BaseLine

HV High Voltage

IP Internet Protocol

IL Interconnecting Link Cable from Junction Box to String

JB Junction Box

LAN Local Array Network

LBL Long BaseLine

LBLPS Long BaseLine Positioning System

LCM Local Control Module

LED Light Emitting Device

LFLBL Low Frequency Long BaseLine

LSB Least Significant Bit

LVDS Low Voltage Differential Signal

MEOC Main Electro-Optical Cable

MIL Mini Instrumentation Line

MLCM Master Local Control Module

MTBF Mean time between failure

MTBSF Mean time between system failure

OB Optical Beacon

OC Open Collector

O/E/O Optic/Electric/Optic

OM Optical Module

OMF Optical Module Frame

OF Operating life

OS Operating system

PBS Product Breakdown Structure

PE Polyethylene

pe photoelectron

PIC Microcontroller from MICROCHIP company

PIFC Polarisation-Insensitive Fibre optic Circulator

PLL Phase Lock Loop

PMT PhotoMultiplier Tube

PSD Pulse Shape Discriminator

PSL Prototype Sector Line

PU Polyurethane

RMS Root Mean Square (also rms)

RoR Read out Request

ROV Remote Operated Vehicle

RTS Reset Time Stamp

RTOS Real Time Operating System

SC Slow Control

SCC Serial Communication Controller

SCM String Control Module

SDRAM Synchronous Dynamic Random Access Memory

SPE Single Photo Electron

SPI Serial Peripheral Interface

SPM String Power Module

TDR Technical Design Report

TCP/IP Transmission Control Protocol/Internet Protocol

TT Time Transit

TTS Time Transit Spread

TVC Time to Voltage Converter

UV Ultra-Violet

WDM Wavelength Division Multiplexing

WF Waveform

List of units used in the TDR

Throughout the TDR, we have used standard SI units. Please refer to the WEB for the precise definitions. One example is http://www.ex.ac.uk/cimt/dictunit/dictunit.htm#SI.

Some commonly used non standard units have been accepted. Here are the definitions:

- **bar**: unit of static pressure inside a fluid (absolute or differential) $=10^5$ Pa
- **barg**: "bar-gauge", gauge pressure scale derived from "bar" unit: P[barg]=Pabsolute[bar] - 1. (Subtract atmospheric pressure)
- **inch: (or ")** the use is restricted to the 8" or 10" photomultipliers.
- **PSU**: Practical Salinity Unit" = S/1000, where S is the "Practical Salinity" of sea water. For the (revised 1978) definition of S, see: http://www.start.or.th/got/data/techsupp/pss78.htm
- **(Sea water) Buoyancy**: vertical force acting on a solid, which results from the balance between gravity and the buoyant force in sea water; the specific mass =1 033. kg/m^3 by convention. The buoyancy is positive if upwards, negative if downwards: $B = g\,(\rho_{water}.V - M)$ for a rigid body of mass M and volume V, where g is the acceleration due to gravity and ρ_{water} is the water density.

Note 1: 1.033 10^3 kg/m^3 is the "typical" sea water density seen during an ANTARES deployment/recovery at a depth of 1000 m, with a temperature of 13°C and a salinity of 38 PSU.

Note 2: for the (effective) acceleration of gravity in the Provence coast area, take g=9.805 m/s^2 (sea-level value at Marseille).

Members of the ANTARES Collaboration

as of June 30, 2001

CPPM (CNRS/IN2P3, Marseille)

E. Aslanides, J-J. Aubert, S. Basa, F. Bernard, V. Bertin, M. Billault, J. Brunner, A. Calzas, J. Carr, P. Coyle, J-J. Destelle, F. Feinstein, M. Jaquet, G. Hallewell, P. Lagier, A. Le Van Suu, F. Montanet, E. Nezri, C. Olivetto, A. Oppelt-Pohl, P. Payre, F. Réthoré, R. Potheau, J-S Ricol, C. Tao.

DAPNIA (CEA/DSM, Saclay)

S. Anvar, F.E. Ardellier-Desages, R. Azoulay, J. Beltramelli, N. de Botton, G. Dispau, F. Druillole, P. Goret, L. Gosset, J-F. Gournay, R. Hubbard, M. Karolak, H. Lafoux, P. Lamare, J-C. Languillat, H. Le Provost, S. Loucatos, F. Louis, P. Magnier, B. Mazeau, L. Moscoso, N. Palanque-Delabrouille, J. Poinsignon, Y. Queinec, Y. Sacquin, J-P. Schuller, I. Sokalski, T. Stolarczyk, P. Vernin.

GRPHE (Université de Haute Alsace, Mulhouse)

Y. Benhammou, R. Blaes, C. Ferdi, D. Stubert, O. Suvorova.

IReS (CNRS/IN2P3, Strasbourg, France)

F. Devillez, J-M. Gallone, C. Racca.

Centre de Physique Théorique (CPT) (CNRS Marseille)

R. Triay, P. Taxil, J-M. Virey.

IFREMER (Toulon/La Seyne sur Mer and Brest)

C. Compère, J. Croquette, J.F. Drougou, D. Festy, G. Herrouin, Y. Le Guen, L. Lemoine, A. Massol, F. Mazéas, J.L. Michel, J.P. Morel, J.F. Rolin, P. Valdy.

Laboratoire d'Astronomie Marseille (LAM) (CNRS/INSU Marseille)

A. Mazure, P. Amram, J. Boulesteix, M. Marcelin.

Centre d'Océanologie de Marseille (COM) (CNRS/INSU Marseille)

L. Laubier, C. Millot.

IFIC, CSCI – UVEG, (Valencia, Spain)

E. Carmona, J. J. Hernandez, V. Roca-Blay, G. Vaudaine, J.de D. Zornoza, J. Zuniga.

ITEP (Moscow, Russia)

M. Danilov, V. Lyashuk, A. Rostovtsev, A. Usik, I. Varlamov, E. Vladimirsky, M. Vorobiev, V. Zakharov.

INFN - Sezione di Bari (Bari)

R. Bellotti, F. Cafagna, F. Ciacio, M. Circella, C. De Marzo, T. Montaruli.

INFN - Sezione di Bologna (Bologna)

S. Cecchini, G. Giacomelli, A. Margiotta, V. Popa, M. Spurio.

INFN - Sezione di Catania (Catania)

L. Caponetto, L. Lo Nigro, D. Lo Presti, C. Petta, N. Randazzo, G.V. Russo.

INFN - Sezione di Genova (Genova)

M. Anghinolfi, M. Battaglieri, R. DeVita, P. Prati, M. Ripani, M. Taiuti, S. Zavatarelli.

INFN - Laboratori Nazionali del Sud (Catania)

E. Migneco, P. Piattelli, G. Raia, G. Riccobene.

INFN - Sezione di Roma (Roma)

A. Capone, R. Masullo, M. Petruccetti, E. Salusti, V. Valente.

NIKHEF (Amsterdam, Netherlands)

M.Bouwhuis, C. Carloganu, R. van Dantzig, R. Donders, J. Engelen, A. Heijboer, E. Heine, J. Hogenbirk, M. de Jong, E. Kok, P. Kooijman, G.J. Nooren, H. Peek, P. Rewiersma, G. Venekamp, R. van Wijk, G. de Vries, P. de Witt Huberts, E . de Wolf .

University of Oxford, Sub Department of Particle Physics, Oxford

D. Bailey, C.B. Brooks, S. Cooper, J. Fopma, W. Schuster, S. Tilav.

University of Sheffield, Department of Physics and Astronomy

R. Brook, S. Cartwright, V. Kudryavtsev, J. McMillan, J. Roberts, N. Spooner, L. Thompson.