SIXTH FRAMEWORK PROGRAMME

Structuring the European Research Area Specific Programme

RESEARCH INFRASTRUCTURES ACTION

Contract for a

DESIGN STUDY

implemented as

SPECIFIC SUPPORT ACTION

Annex I – "Description of Work"

Project Acronym: **KM3NeT**

Project full title: **Design Study for a Deep Sea Facility in the Mediterranean for Neutrino Astronomy and Associated Sciences**

List of Contents

List of Acronyms

AC	Additional Cost
ApPEC	Astroparticle Physics European Coordination
ASPERA	AStroParticle European Research Area
AUV	Autonomous Underwater Vehicle
CDR	Conceptual Design Report
D-B	Delta-Berenike
EC	European Commission
EIB	European Investment Bank
EMSO	European Multidisciplinary Seafloor Observatory
EOC	Electro Optical Cable
ESONET	European Seafloor Observatory Network
ERA-NET	European Research Area Network
ERI	European Research Infrastructure
ESFRI	European Strategy Forum on Research Infrastructure
EU	European Union
FC	Full Cost
FCF	Full Cost Flat rate
FMECA	Failure Modes Effects and Criticality Analysis
FP	Framework Programme
GA	General Assembly
PCC	Project Coordination Committee
PMT	Photo-Multiplier-Tube
PO	Project Office
QA/QC	Quality Assurance / Quality Control
QAP	Quality Assurance Programme
R&D	Research and Development
RA	Risk Assessment
ROV	Remotely Operated Vehicle
SC	Steering Committee
TDR	Technical Design Report
WP	Work Package
w.r.t.	with respect to

1 Project Summary

In the framework of the three-year KM3NeT Design Study the scientific and technical design issues related to a future cubic-kilometre sized deep-sea infrastructure housing a next-generation neutrino telescope and providing long-term access for deep-sea research is assessed. The major deliverable of the Design Study is a technical design report (TDR) for the envisaged infrastructure. Legal, governance and political aspects are addressed in parallel with the scientific and technical work.

The consortium performing the Design Study consists of 24 participants from Cyprus, France, Germany, Greece, Italy, The Netherlands, Spain and the United Kingdom, amongst them all institutes involved in the existing pilot projects in the Mediterranean Sea (ANTARES, NEMO, NESTOR) and several institutes specialised in deep-sea technology and science.

The work to be performed in the Design Study is structured in the following nine work packages (WPs): WP1 is devoted to the management of the Design Study and its overall coordination. WP2 is concerned with evaluating the physics sensitivity of the neutrino telescope depending on its geometry, the site parameters and the component characteristics and will provide input for sensitivity optimisation with respect to cost. WP3 addresses the design of the photo sensor modules, the mechanical structures and the calibration system, whereas WP4 covers data acquisition, transport and online processing. In WP5 the site characteristics, the sea-bottom infrastructure, the deep-sea and deployment operations and the shore facilities are studied. Possibilities to use floating platforms for deployment and calibration purposes are investigated in WP6. In WP7, an appropriate quality assurance programme for the future construction of the infrastructure is developed and risk assessment studies are performed. The funding, legal, governance and political aspects are pursued in WP8. Finally, in WP9 the deep-sea research aspects are covered.

2 Project Objectives

Major objective:
The primary objectives of the KM3NeT Design Study are the development of a cost-effective design for a cubic-kilometre sized deep-sea infrastructure[1] housing a neutrino telescope with unprecedented physics sensitivity and providing long-term access for deep-sea research, the evaluation of procedures for the assembly and construction of the infrastructure and the preparation of models for its operation and maintenance.

General conditions:
The combination of the relatively low flux of high energy cosmic neutrinos and their weak interaction with matter implies the need for a very massive detector (10^{12} kg, i.e. a cubic kilometre of water). The solution pursued is to instrument a large volume of deep-sea water with a three-dimensional array of photo-sensors (photomultiplier tubes, PMTs) detecting the Čerenkov light produced by charged particles emerging from neutrino interactions in the water or sea bed. In order to suppress daylight and background from muons produced in cosmic ray interactions in the Earth's atmosphere, the telescope must be operated at depths of several kilometres. In seawater, irreducible background light is emitted by decays of ^{40}K nuclei and by bio-activity, and environmental processes such as sedimentation or bio-fouling affect the long-term performance of the KM3NeT infrastructure.

Design goals:
The technical design targets at an overall cost below 200 M€ per cubic kilometre of instrumented sea water; a figure which represents an improvement of cost per unit volume of more than two from the present generation of underwater neutrino detectors. The goal of the Design Study is to prepare the framework allowing for the construction of the KM3NeT neutrino telescope in time to take data concurrently with the IceCube neutrino telescope in the Southern Hemisphere. The KM3NeT infrastructure is foreseen to have an operational lifetime of at least 10 years without significant reduction in sensitivity due to environmental processes. A further major

[1] In the following denoted by "KM3NeT infrastructure".

goal is to provide the associated sciences communities with well-defined access to the infrastructure from day one of operation.

In order to reach these goals, the Design Study will comprise the following major tasks:

- The mechanical structure of the KM3NeT infrastructure and the geometry of the PMT array are designed and optimised for low cost, high physics sensitivity, reliability and easy assembly and deployment. Software simulations play a central role in this process, in which also the overall cost and reliability of deep-sea connectors and other expensive marine components are considered.
- The choice of the PMTs and the design of the front-end electronics and the pressure housings (all together forming the optical modules) are optimised w.r.t. low cost, high physics sensitivity and stable operation. In this, the quantum efficiency, the overall surface area of the PMTs and the number of connectors in the detector array are taken into account as important parameters.
- The readout and data processing system is designed such that it can efficiently extract the rare neutrino signals from the backgrounds. The distance between the telescope and the coast is taken into account as a parameter in the design of the data transmission and off-shore data processing.
- Design of the sea-floor network (cables, connectors, junction boxes, power distribution).
- Appropriate production and assembly models for the KM3NeT infrastructure are set up, and the deployment and maintenance procedures and tools are developed.
- The use of sea-surface platforms for deployment operations and for auxiliary detectors is investigated.
- A quality assessment of the telescope parts and assembly procedures and a risk analysis of the technical design and the operation model of the KM3NeT infrastructure are performed to assure stable operation with minimal maintenance.
- Cooperation models between the associated science and the neutrino telescope communities are developed and suitable interfaces for the corresponding sensors as well as for data transfer defined.
- Political developments are monitored closely and, where possible, appropriate action will be taken by interacting with regional, national and EU authorities and research agencies in order to prepare the ground for the construction and operation of the KM3NeT infrastructure.

Site considerations:
Three possible sites in the Mediterranean Sea for the KM3NeT infrastructure have been identified in the past. During the Design Study, these sites are further investigated, and the optimal combinations of site and detector design are identified. Designs of the local infrastructures required for the construction and operation of the KM3NeT infrastructure are assessed.

Data distribution:
In order to integrate the KM3NeT neutrino telescope into the world-wide net of astrophysics observatories, data distribution and analysis models are developed during the Design Study that do not only allow for easy access to reconstructed data but also for appropriate and swift reaction to rare events triggered by observations at other facilities, including satellites and terrestrial telescopes.

3 List of Participants

See table Table 1 (parts 1–5) on the following pages.

Table 1: List of participants of the Design Study, part 1/5

Participant number	Organisation	Short name	Short description (i.e. fields of excellence) and specific roles in the consortium
1	University of Erlangen, Germany	U-Erlangen	The physics institute of U-Erlangen has experience and is active in particle/astroparticle detector development and in data analysis/simulation for neutrino telescopes. The contributions to the Design Study are: • Management of the Design Study (WP1); • Development of simulation and reconstruction software (WP2); • Photomultiplier studies, R&D for acoustic calibration (WP3); • Development of online filter software (WP4); • Contributions to and close cooperation with WP8 (Resource exploration).
2	University of Kiel, Germany	U-Kiel	As a branch of U-Kiel, the Forschungs- und Technologiezentrum Westküste (FTZ) (Research and Technology Center West Coast), located in Büsum at the North Sea coast, has experience and is active in the fields of applied marine physics and marine technology. Design Study contributions: • Development of specific sea operations for KM3NeT telescope modules (WP6); • Demonstration of deployment and recovery procedures of task adapted scientific payloads (anchor systems and/or mechanical structures for positioning of optical modules) (WP6).
3	University of Cyprus, Nikosia, Cyprus	U-Cyprus	The physics department of the U-Cyprus hosts all research activities in particle physics and astrophysics in the Republic of Cyprus. Design Study contribution: • Simulation of astroparticle physics processes.
4	Institut Français de Recherche pour l'Exploitation de la Mer, France	IFREMER	IFREMER is the French Research Institute for the Exploitation of the Sea. It deals with most disciplines of sea research in marine technology, oceanology (studies on climate, sea environment, bio-diversity, marine geology, etc.) and associated data management. Design Study contributions: • Design and assessment of mechanical structures (WP3); • Assessment and measurement of deep-sea site characteristics and deployment procedures (WP5); • Development of interfaces for marine sciences (WP9).
5	Centre National de la Recherche Scientifique/ Institut National de Physique Nucléaire et de Physique des Particules (CNRS/IN2P3), France	IN2P3	IN2P3 is a division of CNRS charged with research in particle, astroparticle and nuclear physics. Under the umbrella of IN2P3 the Centre de Physique des Particules de Marseille (CPPM), the Institut de Recherches Subatomique (IReS) in Strasbourg and the Laboratoire Astroparticule et Cosmologie (APC) participate in the Design Study. The contributions to the Design Study are: • Coordination of and major contributions to WP2 (Physics analysis and simulation); • Contributions to studies of mechanical structures and calibration devices (WP3); • Information technology (WP4); • Studies of deep-sea infrastructure (WP5); • Risk assessment and quality assurance (WP7); • Associated science (WP9).

Table 1: List of participants of the Design Study, part 2/5

Participant number	Organisation	Short name	Short description (i.e. fields of excellence) and specific roles in the consortium
6	Commissariat à l'Energie Atomique (CEA) / Laboratoire de recherche sur les lois fondamentales de l'Univers (DAPNIA), France	Saclay	The field of excellence of Saclay includes construction and operation of detectors for ground based and space experiments. It will contribute in the Design Study on: • Physics analysis and simulation (WP2); • Coordination of and major contributions to WP3 (System and product engineering); • Studies of signal detection and digitisation (in collaboration with APC/IN2P3) and of online data processing (WP4); • Shore and deep-sea infrastructures (WP5); • Risk assessment and quality assurance (WP7).
7	Hellenic Centre for Marine Research (Institute of Oceanography), Anavissos, Greece	HCMR	HCMR groups the majority of sea related research activities in Greece. It owns and operates several surface and underwater research vessels and large scale facilities to be used in the project like the multi-beam bathymetry, sediment traps, a remotely operated submersible, etc. Contributions to the Design Study: • Studies of deep-sea sites (WP5); • Associated science (WP9).
8	Hellenic Open University, Patras, Greece	HOU	The Astroparticle Physics Group of the School of Natural Science and Technology of the HOU has experience and is active in developing data acquisition, monitoring and quality checking systems, calibration strategies and filtering and reconstruction algorithms. Contributions to the Design Study: • Development of filtering and reconstruction algorithms, simulation of physics signatures and the response of the detectors (WP2); • Photodetector studies (WP3); • Development of data acquisition electronics (WP4).
9	National Centre for Scientific Research "Demokritos", Athens, Greece	NCSR "D"	Two institutes of NCSR "D" will participate in the Design Study: 1. *Institute* of Nuclear Technology and Radiation Protection; Fields of excellence: Nuclear reactor technology and radiation protection. Contributions to the Design Study: • Probabilistic risk assessment of KM3NeT (WP7). 2. *Institute* of Nuclear Physics; Fields of excellence: Particle physics, nuclear astrophysics, EU science policy, management of large projects. Contributions to the Design Study: • Determination of the physics sensitivity for different detector configurations and sites; development of calibration models and determination of calibration accuracies (WP2); • Coordination of and major contributions to WP8 (Resource Exploration): legal, funding and governance issues.

Table 1: List of participants of the Design Study, part 3/5

Participant number	Organisation	Short name	Short description (i.e. fields of excellence) and specific roles in the consortium
10	National Observatory of Athens (NOA)/Nestor Institute of Astroparticle Physics, Athens, Greece	NOA/Nestor	The Nestor institute participating in the Design Study is one of five institutes hosted by NOA. It has experience and is active in building, deploying and operating underwater structures, in constructing and operating sea-surface infrastructures, and in simulation and reconstruction of neutrino telescope data. Contributions to the Design Study: • Contributions to reconstruction and simulation (WP2); • Photomultiplier studies (WP3); • Information technology (WP4); • Shore and deep-see infrastructure (WP5); • Coordination of and major contributions to WP6 (Sea-surface infrastructures).
11	University of Athens, Greece	U-Athens	The physics department of U-Athens has experience and is active in particle physics and neutrino telescope experiments and in sea-surface operations. Contributions to the Design Study: • Shore and deep-see infrastructure (WP5); • Studies of a general-purpose sea surface infrastructure (WP6).
12	Consiglio Nazionale delle Ricerche (CNR) / Istituto di Scienze Marine (ISMAR), La Spezia, Italy	CNR	ISMAR is a multidisciplinary institute of the Consiglio Nazionale delle Ricerche (CNR), covering a large part of marine disciplines: from physics to geology, chemistry, biology and fishery. The ISMAR sections of La Spezia and Genova will contribute to the Design Study with • Oceanographic characterisation of the deep sea, measurements of fouling and corrosion (WP5); • Development of a model for long-term measurements of climate changes or trends (WP9).
13	Istituto Nazionale Fisica Nucleare, Rome, Italy	INFN	INFN supports all theoretical and experimental research activities in sub-nuclear, nuclear and astroparticle physics in Italy. The INFN groups participating in this Design Study (Universities of Bari, Bologna, Catania, Genova, Napoli, Pisa, Roma-1 and the laboratories LNS Catania and LNF Frascati) have expertise in various aspects of neutrino telescope experiments. Contributions to the Design Study: • Development of simulation and reconstruction software (WP2); • System and product engineering (WP3); • Information technology (WP4); • Coordination of and major contributions to WP5 (Shore and deep-sea infrastructure); • Coordination of and major contributions to WP7 (Risk assessment and quality assurance); • Associated science (WP9).

Table 1: List of participants of the Design Study, part 4/5

Participant number	Organisation	Short name	Short description (i.e. fields of excellence) and specific roles in the consortium
14	Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy	INGV	INGV is the most important research institute for Earth Sciences in Italy. INGV is involved through its RIDGE Marine Unit in geophysical and environmental monitoring at sea participating to the development of multidisciplinary seafloor observatories. In the Design Study, INGV is appointed to • perform marine geophysical and environmental studies, deep-sea monitoring and operation of benthic observatories (WP5); • study the opportunities offered by a deep-sea platform for long-term multidisciplinary monitoring tasks (WP9).
15	Tecnomare SpA, Venice, Italy	Tecnomare	Tecnomare S.p.A. (ENI group) is specialised in providing a complete range of off-shore design and engineering services for international oil and gas companies. Tecnomare is presently involved in the development and demonstration of innovative technologies for long-term deep sea monitoring and observations. Its tasks in the Design Study will be • the tooling for the deployment and recovery of deep-sea instruments.
16	Stichting voor Fundamenteel Onderzoek der Materie, Utrecht, The Netherlands	FOM	NIKHEF, an institute of FOM, will participate in the KM3NeT Design Study. NIKHEF is the national institute for experimental and theoretical subatomic physics in the Netherlands. It has expertise in designing and building detectors for subatomic experiments, development of simulation, reconstruction and physics analysis software and GRID technologies. Contributions to the Design Study: • Simulation software; event selection and reconstruction software; physics sensitivity of detector configurations; calibration models (WP2); • Specifications of optical modules, calibration modules and mechanical structures; procedures and tooling for detector assembly and transport (WP3); • Coordination of and major contributions to WP4 (Information technology).
17	Consejo Superior de Investigaciones Científicas, Valencia, Spain	CSIC	CSIC has hands-on experience on time calibration of neutrino telescopes. CSIC and the University of Valencia (see participant 18) work together through IFIC (*Instituto de Física Corpuscular*). The contributions to the Design Study are: • Develop calibration software, study influence of calibration on physics performance (WP2); • Design and test the time calibration unit (WP3).
18	Universitat de Valencia Estudi General, Spain	U-Valencia	U-Valencia has hands-on experience on time calibration of neutrino telescopes. The University of Valencia and CSIC (see participant 17) work together through IFIC (*Instituto de Física Corpuscular*). The contributions to the Design Study are: • Develop calibration software, study influence of calibration on physics performance (WP2); • Design and test the time calibration unit (WP3).

Table 1: List of participants of the Design Study, part 5/5

Participant number	Organisation	Short name	Short description (i.e. fields of excellence) and specific roles in the consortium
19	Universidad Politécnica de Valencia, Spain	UP-Valencia	The UP-Valencia group takes part in the Acoustic and Optic Devices and Systems R&D program (DISAO), investigating dynamic and piezoelectric transducers, ultrasounds, materials, acoustic positioning in the sea, etc. The contributions to the Design Study are: • Design and test of the positioning system, development of the calibration units and their test and assembling procedures/tooling, especially w.r.t. to acoustic positioning (WP3).
20	University of Aberdeen, UK	UNIABDN	UNIABDN Oceanlab specialises in deep-sea biological research and underwater vehicles capable of working to 6000 m depth. Contributions to the Design Study: • Sites surveys and evaluation; contributions to measurements of environmental and biological properties including bioluminescence using profiler instruments (WP5); • Coordination of and major contributions to WP9 (Associated science).
21	University of Leeds, UK	U-Leeds	The School of Physics and Astronomy at U-Leeds has expertise in photodetector development, electronics systems design and physics analysis. Contributions to the Design Study: • Simulations and design optimisation w.r.t. the astrophysics potential (WP2); • Calibration systems and requirements (WP3).
23	University of Liverpool, UK	U-Liverpool	U-Liverpool has one of the largest particle physics groups in the UK with expertise in detector development, simulation and data analysis using GRID and eScience technologies. Contributions to the Design Study: • Contributions to detector modelling and optimisation activities; studies of the physics reach of KM3NeT (WP2); • Prototyping of calibration devices (WP3).
24	University of Sheffield, UK	U-Sheffield	The Particle Astrophysics group at U-Sheffield is specialised in dark matter searches via direct and indirect methods and in calibration systems for neutrino telescopes. Contributions to the Design Study: • Simulation and optimisation of the KM3NeT detector (WP2); • Design of calibration sub-systems (WP3).
25	Université de Haute Alsace, Groupe de Recherches en Physique des Hautes Energies (GRPHE)	UHA-GRPHE	GRPHE is a laboratory of the University of Haute Alsace in Mulhouse and is involved in particle and astroparticle physics experiments. The GRPHE group is experienced in database design, in physics simulation and analysis and in detector construction. UHA-GRPHE will contribute to • Detector simulation and physics studies (WP2); • Information Technology (WP4).

4 Implementation plan for the full duration

4.1 List of Tasks

See Table 2, parts 1 and 2 on the next pages.

4.2 Implementation Plan

Figures 1–4 show the multi-annual implementation plan that covers the various tasks for the whole duration of the project. Tasks and sub-tasks are based on the work packages WP1–WP9 outlined in Table 2 and described in detail in Section 4.3.

The first 18 months of the Design Study are devoted to the study of different detector concepts and their performance. The results of these studies are reported in a Conceptual Design Report (CDR). The final results of the Design Study are collected in a Technical Design Report (TDR), containing the necessary information both for the construction and the operation of the KM3NeT infrastructure.

4.3 Description of Tasks

See pages 18–38.

Table 2: List of tasks for the Design Study, part 1/2

Task	Descriptive title	Leading participant	Short description and specific objectives of the task
WP1	Management of the Design Study	U-Erlangen	WP1 is devoted to the management of the Design Study and its overall coordination. • Management of the administrative, financial, legal, contractual and social aspects of the KM3NeT Design Study, including reporting activities and organisation of meetings; • Overall scientific and technical coordination of the Design Study, including risk management, knowledge and information management and organisation of meetings; • Organisation of public outreach activities.
WP2	Physics analysis and simulation	IN2P3	WP2 is concerned with evaluating the physics sensitivity of the neutrino telescope depending on its geometry, the site parameters and the component characteristics and will provide input for sensitivity optimisation with respect to cost. • Assessment and optimisation of different detector options w.r.t. the physics sensitivity per PMT area and per total cost for different benchmark neutrino fluxes, and taking into account the conditions at the different candidate sites. • Specification of precision and density of calibration modules required for the target physics performance.
WP3	System and product engineering	Saclay	WP3 addresses the design of the photo sensor modules, the mechanical structures and the calibration system. • Design optical modules • Design calibration modules • Design mechanical structures • Develop procedures and design tooling for detector assembly and transport
WP4	Information technology	FOM	WP4 covers data acquisition, transport and online processing. • Design of the readout and data acquisition system. • Design of the on-shore data processing system.
WP5	Shore and deep-sea infrastructure	INFN	In WP5 the site characteristics, the sea-bottom infrastructure, the deep-sea and deployment operations and the shore facilities are studied. • Site studies • Design procedures and tooling for detector deployment and recovery • Design specifications for deep-sea power and data network • Design shore infrastructure

Table 2: List of tasks for the Design Study, part 2/2

Task	Descriptive title	Leading participant	Short description and specific objectives of the task
WP6	Sea surface infrastructure	NOA/Nestor	In WP6, possibilities to use floating platforms for deployment and calibration purposes are investigated. • Improvement of the dynamic position holding ability of the platform Delta-Berenike (D-B); • Improvement of the heave compensation mechanism of D-B; • Evaluation and operational optimisation of the sea bottom delivery accuracy of scientific payloads deployed by D-B; • Development and demonstration of deployment and recovery techniques of scientific payloads down to depths of 4000 m using D-B; • Development of a concept for absolute angular calibration of a neutrino telescope using D-B.
WP7	Risk assessment and quality assurance	INFN	In WP7, an appropriate quality assurance programme for the future construction of the infrastructure is developed and risk assessment studies are performed. • Quality assurance for the KM3NeT infrastructure (parts, assembly, transport, deployment and recovery); • Risk assessment of the design and operation of the KM3NeT infrastructure
WP8	Resource exploration	NCSR “D”	In WP8, the funding, legal, governance and political aspects are pursued. • Monitoring and interfacing with processes that run concurrently with the Design Study • Exploration of funding sources • Investigate legal aspects related to the KM3NeT infrastructure • Establish governance model
WP9	Associated science	UNIABDN	In WP9 the deep-sea research aspects are covered • Define the Co-operation Model between KM3NeT and the Marine Science Community. • Design of the Associated Sciences Node.

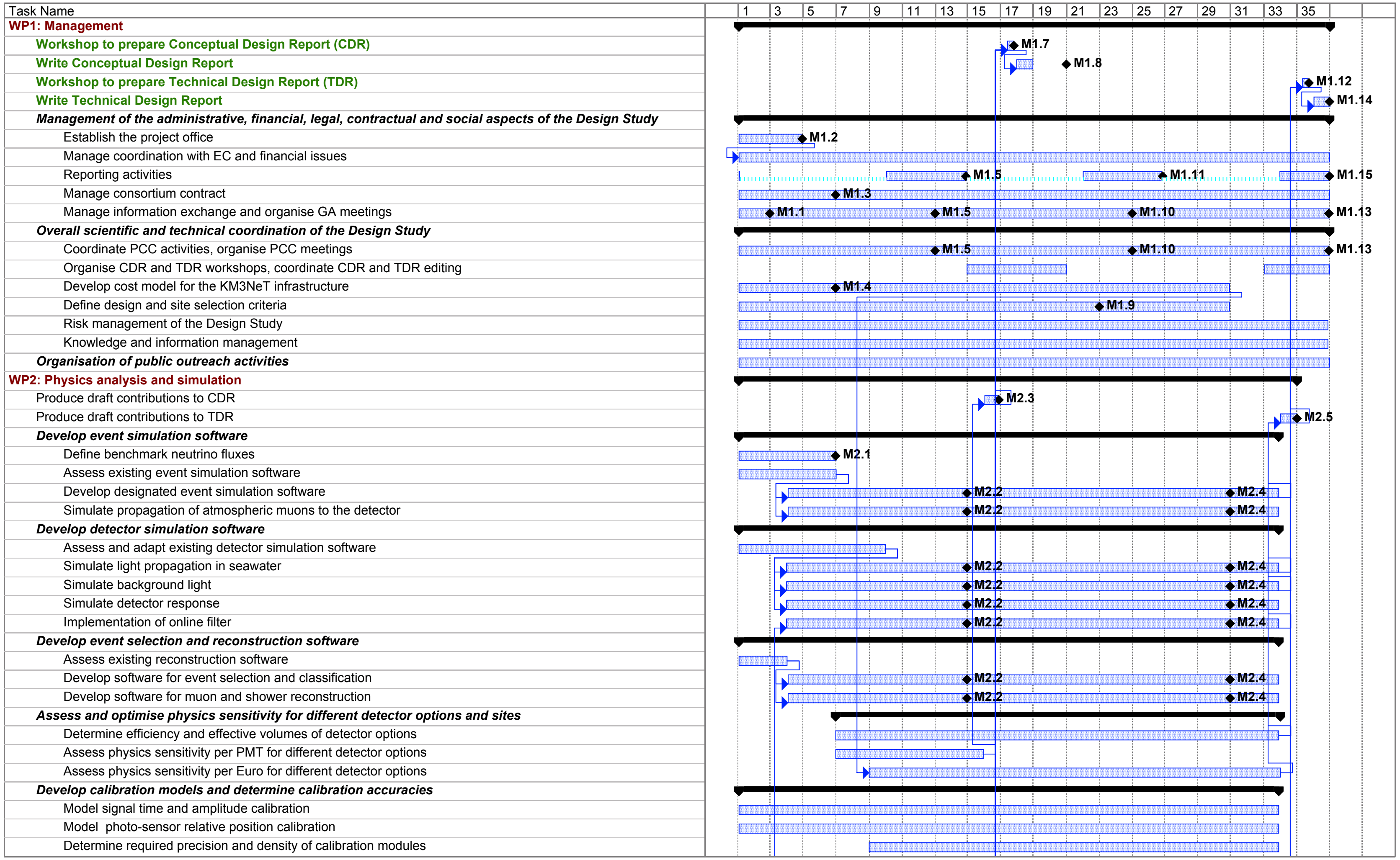

Figure 1: *Gantt chart of the multi-year implementation plan for work packages WP1 and WP2. The numbers in the top line indicate the months starting at the vertical lines left to the numbers. The overall project duration is 36 months.*

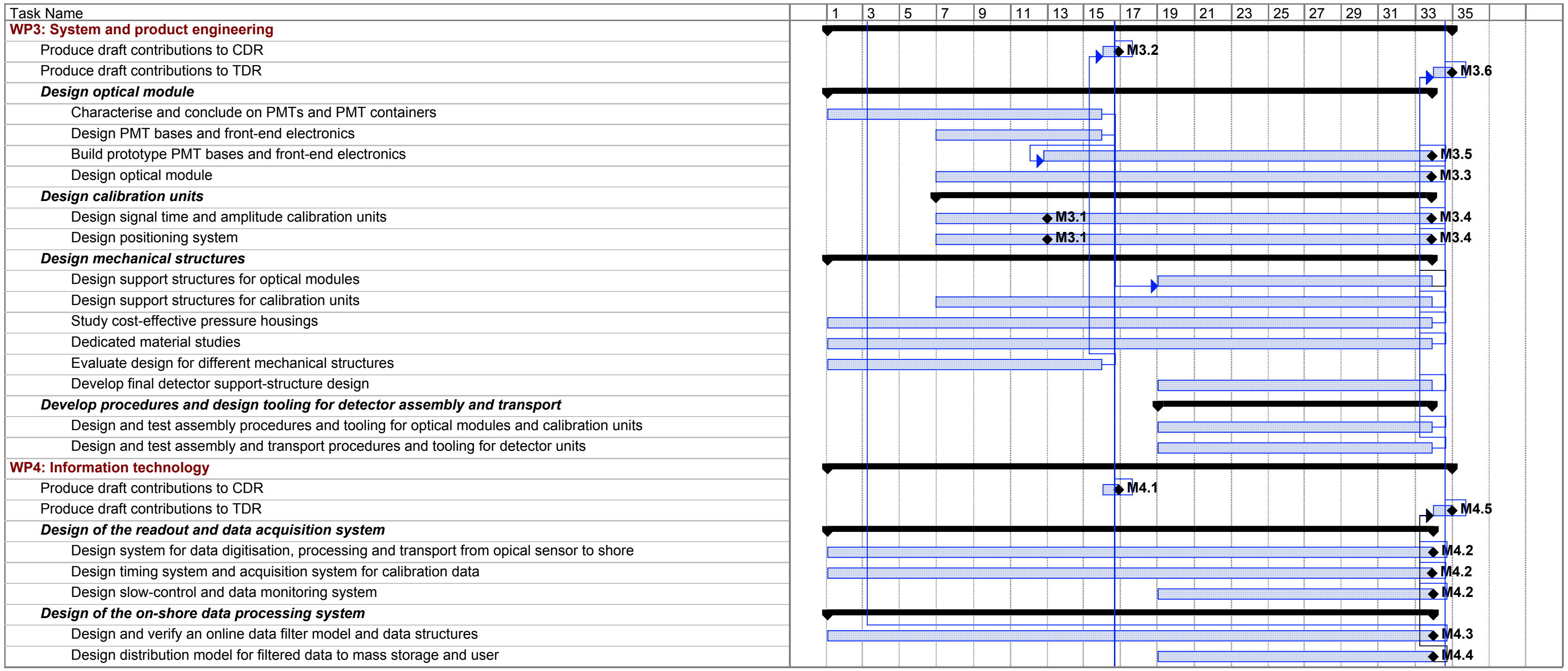

Figure 2: *Gantt chart of the multi-year implementation plan for work packages WP3 and WP4. The numbers in the top line indicate the months starting at the vertical lines left to the numbers. The overall project duration is 36 months.*

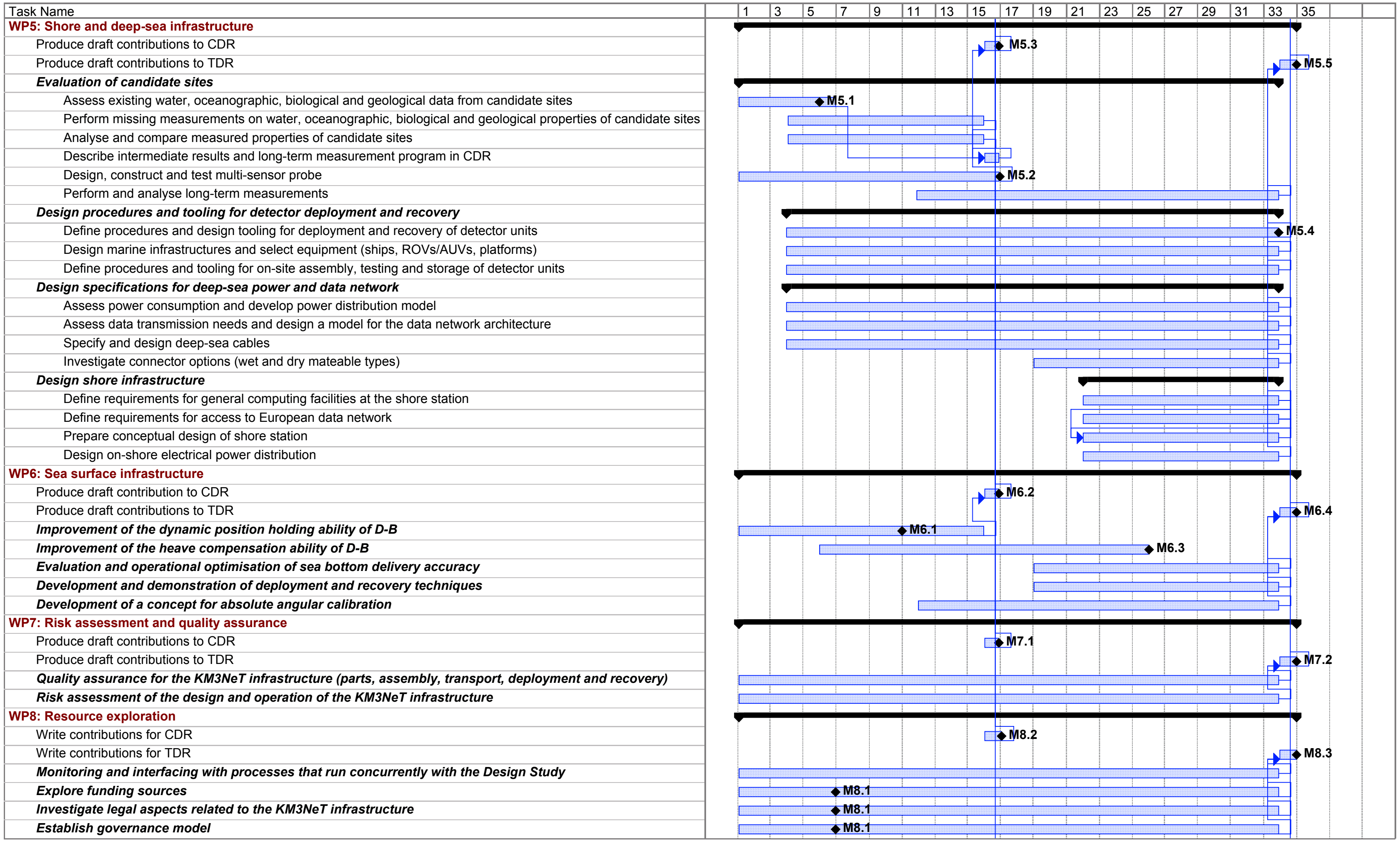

Figure 3: *Gantt chart of the multi-year implementation plan for work packages WP5 to WP8. The numbers in the top line indicate the months starting at the vertical lines left to the numbers. The overall project duration is 36 months.*

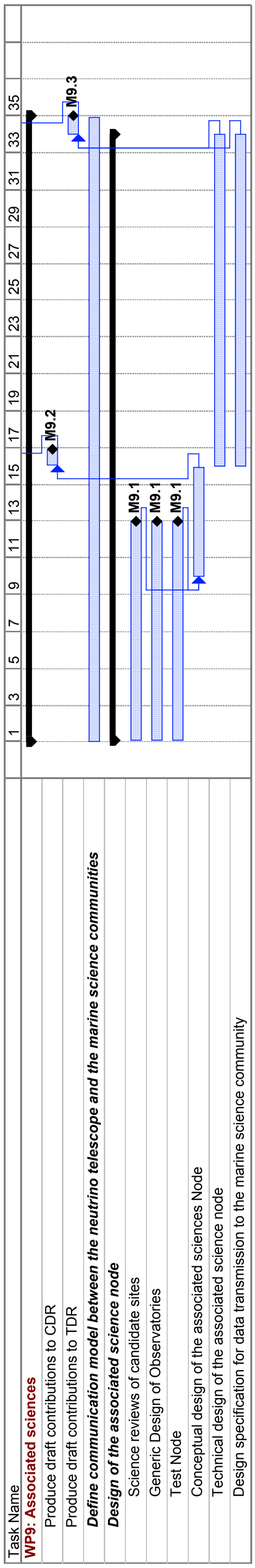

Figure 4: *Gantt chart of the multi-year implementation plan for work package WP9. The numbers in the top line indicate the months starting at the vertical lines left to the numbers. The overall project duration is 36 months.*

Task number	WP1	Task title	**Management of the Design Study**
Start month: **1**		End month: **36**	

		Person-months (*)	
Participant number	Participant short name	total	additional
1	U-Erlangen	90	78
total		90	78

(*) for AC contractors, the column "additional" shows the human effort for additional staff.

Objectives:

The management of the Design Study is performed by U-Erlangen, being the only participant in WP1. It comprises all aspects relating to the organisation of the consortium and the work to be performed, and the representation of the project vis-a-vis the European Commission (EC). The major tasks are

- Management of the administrative, financial, legal, contractual and social aspects of the KM3NeT Design Study, including reporting activities and organisation of meetings;
- Overall scientific and technical coordination of the Design Study, including risk management, knowledge and information management and organisation of meetings;
- Organisation of public outreach activities.

Description of work:

- **Management of the administrative, financial, legal, contractual and social aspects of the Design Study**
  - Establish the Project Office (PO)
    The PO (see Sect. 5.1) is the central office for all managerial aspects of the Design Study. It is manned with administrative staff and equipped with all necessary tools, such as computers and communication devices. The PO is instrumental in all managerial aspects of the Design Study. It covers services related to administrative work, communication with external entities, etc.
  - Manage coordination with EC and financial issues
    The coordinator establishes the single point of contact between the KM3NeT consortium and the EC. With support by the PO the coordinator represents the consortium vis-a-vis the EC, receives the EU financial contributions and distributes them to the participants.
  - Reporting activities
    This subtask comprises the organisation of the preparation of the scientific and financial reports to the EC as well as the coordination of auditing activities.
  - Manage Consortium Agreement
    The consortium will conclude a *Consortium Agreement* establishing the management scheme, voting rights, regulations for new or defaulting participants etc. The set-up of the initial agreement and its maintenance is the task of the coordinator.
  - Manage information exchange and organise GA meetings
    Through the PO, a web-based platform for information exchange inside the consortium as well as appropriate mailing lists are set up. Furthermore, the kick-off meeting at the beginning of the project and the meetings of the General Assembly (GA), foreseen once a year, are organised by the coordinator. This task includes the preparation of the agendas and the minutes of the GA meetings.
- **Overall scientific and technical coordination of the Design Study**
  - Coordinate PCC activities, organise PCC meetings
    The Project Coordination Committee (PCC) is the major scientific/technical steering body of the consortium (cf. Section 5.1). It is chaired by the coordinator[2], who also organises, through the PO, the PCC meetings that are foreseen twice a year. This task includes the preparation of the agendas and the minutes of the PCC meetings and the reporting of PCC decisions to the GA.

[2] The term *Coordinator* here denotes the person representing the coordinating partner.

  - Organise CDR and TDR workshops, coordinate CDR and TDR editing
    Two workshops (after about 16 and after about 34 months) are foreseen to prepare the CDR and the TDR. These workshops are organised by the coordinator, who also coordinates the editing of the CDR and the TDR.
  - Develop cost model for the KM3NeT infrastructure
    A cost model for the KM3NeT infrastructure is developed, taking also into account distinctions between different sites. This cost model is used by WP2 to relate physics sensitivity and total cost.
  - Define design and site selection criteria
    Criteria to decide between different design options are developed by the coordinator. Also, in cooperation with WP8, criteria for the site decision are developed, taking into account scientific/technological, infrastructural, funding, legal/governance and political issues.
  - Risk management of the Design Study
    The coordinator organises the risk analysis along the description in Sect. 5.2.
  - Knowledge and information management
    The coordinator organises the knowledge and information management (see Section 5.3).

- **Organisation of public outreach activities**
  This task includes organising and coordinating the public outreach activities during the Design Study and to acquire corresponding material. Setting up and maintaining the public web representation of the KM3NeT Design Study is included in this task.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M1.1	Kick-off meeting held	2 months
M1.2	Project office established	4 months
M1.3	Draft Consortium Agreement presented to GA	6 months
M1.4	Draft cost model for detector presented to PCC and GA	6 months
M1.5	First-year GA and PCC meetings held	12 months
M1.6	1st Annual Report delivered to EC	13.5 months
M1.7	CDR Workshop held	17 months
M1.8	Conceptual Design Report (CDR) presented to public	20 months
M1.9	Draft set of site selection criteria for CDR presented to PCC and GA	22 months
M1.10	Second-year GA and PCC meetings held	24 months
M1.11	2nd Annual Report delivered to EC	25.5 months
M1.12	TDR Workshop held	35 months
M1.13	Third-year GA and PCC meetings held	36 months
M1.14	Technical Design Report (TDR) presented to public	36 months
M1.15	3rd Annual Report and Final Report delivered to EC	37.5 months

Deliverable number	Deliverables	Dissemination level (*)
D1.1	1st Annual Report to EC	CO
D1.2	2nd Annual Report to EC	CO
D1.3	3rd Annual Report to EC	CO
D1.4	Final Report to EC	CO
D1.5	Draft Consortium Agreement	CO
D1.6	Report: Draft cost model for detector	PU
D1.7	Report: Draft set of site selection criteria for CDR	PU
D1.8	Conceptual Design Report (CDR)	PU
D1.9	Technical Design Report (TDR)	PU

(*) CO = confidential, PU = public

Task number	WP2	Task title	Physics analysis and simulation
Start month: 1		End month: 36	

Participant number	Participant short name	Person-months (*) total	additional
5	IN2P3	174	—
1	U-Erlangen	173	108
3	U-Cyprus	36	18
6	Saclay	83	—
8	HOU	144	60
9	NCSR "D"	72	—
10	NOA/Nestor	18	—
13	INFN	252	108
16	FOM	108	—
17	CSIC	30	—
18	U-Valencia	20	16
21	U-Leeds	15.6	12
23	U-Liverpool	60	18
24	U-Sheffield	60	18
25	UHA-GRPHE	28	12
total		1273.6	370

(*) for AC contractors, the column "additional" shows the human effort for additional staff.

Objectives:

- Assessment and optimisation of different detector options w.r.t. the physics sensitivity per PMT area and per total cost for different benchmark neutrino fluxes, and taking into account the conditions at the different candidate sites.
- Specification of precision and density of calibration modules required for the target physics performance.

Description of work:

In order to achieve the objectives, intense software development is necessary, summarised in the first three main tasks below.

- **Develop event simulation software**
  Event simulation software is required to model neutrino interactions in water or rock, including all secondary particles emerging from the reaction, their secondary interactions and the production of Čerenkov light.
  - Define benchmark neutrino fluxes
    In order to quantify and compare the absolute physics performances of different detector designs benchmark neutrino fluxes are defined which exemplarily represent the physics objectives pursued with the neutrino telescope.
  - Assess existing event simulation software
    Existing event simulation software for neutrino telescopes is investigated to identify parts that can be used for the Design Study. These parts are combined into a primary software set-up.
  - Develop designated event simulation software
    Parts of the required event simulation software that do not become available from the previous subtask or need modifications are developed.
  - Simulate propagation of atmospheric muons to the detector
    Software for muon propagation is required to simulate the background from atmospheric muons (see section 2). This software is taken from existing program packages and adapted to the needs of the KM3NeT Design Study.

- **Develop detector simulation software**
  Detector simulation software is required to model the propagation of Čerenkov light through the sea water, its registration in the photo sensors and the production of the output signals. Further this task includes the simulation of background light and the emulation of the online filter software (developed in WP4) in the offline program environment.
  - Assess and adapt existing detector simulation software
    Existing detector simulation software for neutrino telescopes is investigated to identify parts that can be used for the Design Study. These parts are combined into a primary software set-up and are adapted to allow for simulations of different possible detector geometries and parameters.
  - Simulate light propagation in seawater
    A software environment is set up allowing for the detailed simulation of light propagation in sea water, including absorption and scattering effects.
  - Simulate background light
    A software environment is set up allowing for simulation of the background light from potassium decay and bioluminescence depending on parameters such as water transparency or bioluminescence activity.
  - Simulate detector response
    A software environment is set up allowing for simulation of the photon detection process, taking into account as parameters the properties of the PMTs, of the front-end electronics and the data acquisition process.
  - Implementation of online filter
    The online filter algorithm developed in WP4 is emulated in the simulation software environment to assess filter efficiency and purity and to allow for realistic physics sensitivity estimates.
- **Develop event selection and reconstruction software**
  Event selection and reconstruction software is required to infer the properties of the primary neutrinos (direction, energy, arrival time) from the measured or simulated data.
  - Assess existing reconstruction software
    Existing event selection and reconstruction software for neutrino telescopes is investigated to identify parts that can be used for the Design Study. These parts are combined into a primary software set-up.
  - Develop software for event selection and classification
    Building on existing software, a program environment is produced for identifying neutrino events in the background signals and to classify them w.r.t. the event type (such as neutrino events with outgoing muon or particle cascade, or atmospheric muon events).
  - Develop software for muon and shower reconstruction
    Building on existing software, a program environment is set up for the reconstruction of the properties of the primary neutrinos (or muons) from the signals assigned to identified events of different types.
- **Assess and optimise physics sensitivity for different detector options and sites**
  - Determine efficiencies and effective volumes of detector options
    For the different detector options under study (geometry, choice of components, site-dependent parameters) the physics sensitivity is investigated in terms of the effective volume assigned to the various options. The results are evaluated and optimised as functions of parameters like water depth, water transparency, level of background light etc.
  - Assess physics sensitivity per PMT for different detector options
    The results of the previous subtask are evaluated relative to the overall photocathode area of the PMTs.
  - Assess physics sensitivity per Euro for different detector options
    The results of the penultimate subtask are evaluated relative to the overall cost of the detector. This is done using the cost model developed in WP1.
- **Develop calibration models and determine calibration accuracies**
  - Model signal time and amplitude calibration
    A software environment is set up allowing for the simulation of the calibration procedure for signal time and amplitude, using as input the design of calibration devices and methods developed in WP3.
  - Model photo-sensor relative position calibration
    A software environment is set up allowing for the simulation of the calibration procedure for the relative

position calibration of the photo-sensors, using as input the design of position calibration devices and methods developed in WP3.

– Determine required precision and density of calibration modules
Using the software developed in the previous two subtasks, the calibration accuracy is investigated, and the number of calibration modules is determined that is sufficient to reach the required precision.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M2.1	Benchmark neutrino fluxes defined	6 months
M2.2	First version of simulation software packages released	14 months
M2.3	Draft contributions to the CDR written	16 months
M2.4	Final version of simulation software packages released	30 months
M2.5	Draft contributions to the TDR written	34 months

Deliverable number	Deliverables	Dissemination level (*)
D2.1	Report: Definition of benchmark neutrino fluxes	PU
D2.2	Software package for event simulation, detector and background light simulation, event selection and reconstruction, online filter emulation and calibration simulation	PU
D2.3	CDR contribution describing first version of simulation methods and software	PU
D2.4	CDR contribution describing first-version simulation results, presenting at least one viable solution for detector geometry and calibration procedures, and comparing the physics potential of the candidate sites	PU
D2.5	TDR contribution describing final version simulation methods and software	PU
D2.6	TDR contribution describing final version simulation results, presenting the optimisation results w.r.t. detector geometry and component choices, comparing the physics potential of the candidate sites, and the result of the optimisation of calibration methods and systems	PU

(*) PU = public

Task number	WP3	Task title	System and product engineering
Start month: 1		End month: 36	

Participant number	Participant short name	Person-months (*) total	additional
6	Saclay	77	—
1	U-Erlangen	54	36
4	IFREMER	33	—
5	IN2P3	63	—
8	HOU	36	0
10	NOA/Nestor	72	—
13	INFN	144	72
16	FOM	108	—
17	CSIC	15	—
18	U-Valencia	10	8
19	UP-Valencia	77	—
21	U-Leeds	15.6	12
23	U-Liverpool	58	16
24	U-Sheffield	58	16
total		820.6	160

(*) for AC contractors, the column "additional" shows the human effort for additional staff.

Objectives:

- Design optical modules
- Design calibration modules
- Design mechanical structures
- Develop procedures and design tooling for detector assembly and transport

Description of work:

- **Design optical modules**
  - Characterise and conclude on PMTs and PMT containers
    A market survey of existing PMTs and PMT containers satisfying a minimal set of specifications is performed and suitable models are selected based on laboratory measurements and simulation results;
  - Design PMT bases and front-end electronics
    The existing bases and front-end electronics are evaluated. New versions are designed to satisfy the specific needs, where special attention is given to the power consumption;
  - Build prototype PMT bases
    Prototypes of the PMT bases are built to validate the design;
  - Design optical module
    Constituent elements of the optical module are chosen. The optical module is designed and prototyped.
- **Design calibration modules**
  - Design signal time and amplitude calibration units
    Using the simulation results from WP2, the signal time and amplitude calibration units are designed and prototyped;
  - Design positioning system
    Using the simulation results from WP2, the positioning system is designed and prototyped.
- **Design mechanical structures**
  - Design support structures for optical modules
    The support structures adapted to the optical module design are developed;

- Design support structures for calibration units
  The support structures adapted to the different calibration modules are designed;
- Study cost-effective pressure housings
  Specific studies are performed to optimise the ratio cost/safety of pressure housings;
- Dedicated material studies
  The reliability of materials foreseen to be used for the KM3NeT infrastructure is evaluated under realistic conditions;
- Evaluate design for different mechanical structures
  Several models of mechanical structures exist for the whole detector. They are evaluated and optimised in terms of cost, reliability, operability, hydrodynamic behaviour and maintenance. The optimisation procedure includes deployment tests with instrumented elements to perform hydrodynamic and sea operation studies.
- Develop final detector support-structure design
  Based on the previous studies, the final design of the detector units and support structures is produced.

- **Develop procedures and design tooling for detector assembly and transport**
  - Design and test assembly procedures and tooling for optical modules and calibration units
    The tools needed for the mass production of the modules are designed. The assembly procedures are set up;
  - Design and test assembly and transport procedures and tooling for detector units
    A set of procedures is written to specify the production methods and validation tests, taking into account that it is foreseen to assemble the detector units at different sites. Special care, including a conceptual design of appropriate packaging, is taken for the transport of detector units from the production sites to the on-shore station.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M3.1	Calibration systems defined	12 months
M3.2	Draft of CDR contribution ready	16 months
M3.3	Prototype of the optical module ready	33 months
M3.4	Prototypes of the calibration systems ready	33 months
M3.5	Prototype of PMT basis and front-end electronics ready	33 months
M3.6	Draft of TDR contribution ready	34 months

Deliverable number	Deliverables	Dissemination level (*)
D3.1	Report describing definition of calibration systems	PU
D3.2	CDR contribution describing the choice of PMTs and PMT housings, the design of the PMT bases and front-end electronics, and the result of the support structure evaluation	PU
D3.3	Prototype of the optical module, including PMT base	PU
D3.4	Prototypes of the calibration systems	PU
D3.5	A working prototype of the front-end electronics satisfying the main specifications	PU
D3.6	TDR contribution describing the design of the optical modules including bases, front-end electronics and support structure, the design of the calibration system, the design of the mechanical support structures and the assembly and transport procedures and tooling.	PU

(*) PU = public

Task number	WP4	Task title	Information technology
Start month: 1		End month: 36	

Participant number	Participant short name	Person-months (*) total	additional
16	FOM	216	—
1	U-Erlangen	59	36
5	IN2P3	90	—
6	Saclay	110	—
8	HOU	144	36
10	NOA/Nestor	18	—
13	INFN	72	36
25	UHA-GRPHE	10	0
total		719	108

(*) for AC contractors, the column “additional” shows the human effort for additional staff.

Objectives:

- Design of the readout and data acquisition system.
- Design of the on-shore data processing system.

Description of work:

This work package covers the translation of the required angular resolution of the telescope, its energy threshold and detector volume and the distribution of photo-sensors in the detector volume into requirements for a data readout system and data handling system. It includes the development and design of a readout and data handling system, i.e. signal detection, transmission and digitisation as well as data processing and data distribution to mass storage and users.

- **Design of the readout and data acquisition system**
  - Design system for data digitisation, processing and transport from optical sensors to shore
    The readout design, the optimal photo-sensor hierarchy and the number of readout channels per optical module are investigated and defined. For the components needed for the digitisation of the signals from the photo-sensors and the transfer of the digitised signals to shore a market survey for possible hardware solutions is performed.
  - Design timing system and acquisition system for calibration data
    The signals from the photo-sensors must be calibrated and accurately time-stamped. The timing system and the acquisition system for calibration data are designed. A survey of the market for possible hardware solutions is performed.
  - Design slow-control and data monitoring system
    A slow-control system is developed to start and stop data taking and to survey the functionality and operation parameters of the hardware. A monitoring system is designed to continuously monitor the quality of the recorded data.
- **Design of the on-shore data processing system**
  - Design and verify an online data filter model and data structures
    The data arriving at the shore station must be filtered and reduced online. Models and algorithms for fast and efficient filtering are studied and verified. The structure of filtered data is defined.
  - Design distribution model for filtered data to mass storage and user
    Filtered data must be distributed from the shore station to mass storage facilities for further analysis by the users. The distribution model is designed and the use of GRID technologies and the required connectivity of the shore station to mass storage facilities is studied.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M4.1	Draft of CDR contribution ready	16 months
M4.2	Design of the readout and data acquisition system ready.	33 months
M4.3	Design of the on-shore data processing model ready	33 months
M4.4	Design of the data distribution model ready.	33 months
M4.5	Draft TDR contribution ready	34 months

Deliverable number	Deliverables	Dissemination level (*)
D4.1	Contribution to the CDR describing the specifications for a readout and data acquisition system, and for off-shore data processing including the data distribution system.	PU
D4.2	Report: Proof of concept for the readout and data acquisition system	PU
D4.3	Report: Proof of concept for the on-shore data processing system	PU
D4.4	Report: Proof of concept for the data distribution system	PU
D4.5	Contribution to the TDR describing the readout and data acquisition system, the off-shore data processing system, the data distribution system and a protocol for accessing scientific data.	PU

(*) PU = public

Task number	WP5	Task title	Shore and deep-sea infrastructure
Start month: 1		End month: 36	

Participant number	Participant short name	Person-months (*) total	additional
13	INFN	255	108
4	IFREMER	19	—
5	IN2P3	27	—
6	Saclay	45	—
7	HCMR	66	—
10	NOA/Nestor	18	—
11	U-Athens	46	28
12	CNR	72	—
14	INGV	65	36
15	Tecnomare	9	—
20	UNIABDN	36	24
total		658	196

(*) for AC contractors, the column “additional” shows the human effort for additional staff.

Objectives:

- Evaluation of candidate sites.
- Design procedures and tooling for detector deployment and recovery.
- Design deep-sea power and data network.
- Design shore infrastructure.

Description of work:

- **Evaluation of candidate sites**
  - Assess existing water, oceanographic, biological and geological data from candidate sites
    All information available about optical and biological water properties, sea bottom surveys, environmental properties and geo-hazards at the three sites (Capo Passero, Toulon, Pylos) is collected and categorised. As a result of this preliminary study the experimental activities needed to complete the set of measurements are identified.
  - Perform missing measurements on water, oceanographic, biological and geological properties of candidate sites
    The missing measurements defined in the previous subtask are performed.
  - Analyse and compare measured properties of candidate sites
    All collected data are analysed in a common analysis framework and format. Detailed one-to-one comparisons of the three candidate sites are performed.
  - Describe intermediate results and long-term measurement program in CDR
    The results of the site comparison, on the basis of the collected data, are reported in the CDR. A recommendation is made for the program for long-term measurements to be performed during the second Design Study phase.
  - Design, construct and test multi-sensor probe
    In order to acquire long-term time series of data on the evolution of optical, oceanographic and environmental parameters of seawater close to the seafloor, an autonomous multi-sensor deep-sea probe is designed, constructed and tested using sensors commercially available and/or new detectors to be custom-designed.
  - Perform and analyse long-term measurements
    Long-term measurements, using the autonomous probe, are performed according to the program spec-

ified in the CDR (see penultimate subtask) to refine the knowledge of optical, oceanographic and environmental parameters of the sea water at the sites. Geo-hazard characterisation is performed by means of the autonomous device and/or the already developed benthic observatory SN-1. The space and time variability of the current field is measured by means of four current-meter moorings covering a depth range of about 1000 m. One selected mooring is equipped with multi-sensor probes for a continuous monitoring of hydrographic parameters. High-resolution imaging of the sea-bottom and analysis of samples are also performed.

- **Design procedures and tooling for detector deployment and recovery**
  This work is based on input from other WPs. According to functional specifications defined in WP2, the general architecture of the detector is designed in close collaboraton of WP3 with WP4 and WP5. After early design, concept verification and optimisation, structural verification and deployment simulation is provided as input for WP5. In collaboration with WP3 and WP7 the following subtasks will be performed in WP5:
  - Define procedures and design tooling for deployment and recovery of detector units
    Detailed studies of the operational procedures needed for the assembly, deployment and recovery of the underwater detector subsystems are performed and the required tools are designed. Once the CDR of the KM3NeT infrastructure is ready, the resulting technologies are verified by building and operating prototypes of the most critical parts of the system.
  - Design marine infrastructures and select equipment (ships, ROVs/AUVs, platforms)
    An infrastructure is designed for
    - detector modules deployment;
    - detector modules (junction boxes, instrumented parts) handling;
    - connection, disconnection and maintenance of the deep-sea structures;
    - visual inspection of deep sea floor and of detector parts.

    Studies are performed to demonstrate that the foreseen technologies and tools exist for all essential construction and repair requirements, and are reliable and affordable.

    For deep-sea operations, studies are carried out by assuming the use of existing equipment, where possible (vessels, non highly specialised surface ships, underwater vehicles like ROVs), and/or of a system of stationary docking stations, connected to the shore by means of the main electro-optical cable and located around the KM3NeT infrastructure. One solution is a docking system capable to host and operate an hybrid system made by Autonomous Underwater Vehicle (AUV) and ROV units, allowing for visual inspections of the deep-sea bottom, of the mechanical structure, of the various detector parts and of critical aspects of the different operations. The number of docking stations is defined such that the ROV umbilical cable length is minimised. A "conceptual test" of the solution(s) finally identified is performed to define the required deep-underwater tools and infrastructures. Alternative solutions may also be considered.
  - Define procedures and tooling for on-site assembly, testing and storage of detector units
    The procedures are developed that are needed for the assembly at the deployment site of the subsystems produced in external laboratories. The on-shore logistic structures needed for equipment storage, for workshops and for tests are defined.

- **Design specifications for deep-sea power and data network**
  The electro-optical cable (EOC) network for the KM3NeT infrastructure is designed building on the functional specifications defined in WP2. In WP5, the following subtasks are performed in close collaboration with WP3, WP4, WP6 and WP7:
  - Assess power consumption and develop power distribution model
    The power consumption of each detector unit and of the overall km3 infrastructure is evaluated. A model is developed and verified for the distribution of the electrical power from the on-shore laboratory to each single detector element. The characteristics of the associated power real-time control system are defined.
  - Assess data transmission needs and design a model for the data network architecture
    The data rate of each detector unit and of the overall km3 infrastructure is evaluated and the architecture of an optical data network is developed and verified. The EOC network layout is defined taking into

account results achieved by WP3, WP4, WP7 and by the subtasks of WP5 dedicated to the deep-sea infrastructures.

- Specify and design deep-sea cables
  Using the results of the previous two subtasks, the cables for interconnections between detector units and the cable(s) to shore are defined in terms of the materials used, the geometrical arrangement and the manufacturing process. The EOC fibres and related optical connections must guarantee the total optical power budget defined by WP4. The mechanical properties of the cables must match the requirements of the transport and deployment/recovery procedures. It is foreseen to produce prototypes and to test them under pressure.
- Investigate connector options (wet- and dry-mateable types)
  Commercial options for the connectors between cables and detector units and junction boxes are studied for different power distribution options and for different deployment procedures. Both wet- and dry-mateable connector types are investigated. Solutions are identified respecting the requirements imposed by the previous subtasks.

- **Design shore infrastructure**
  - Define requirements for the shore station computing facilities
    Using the specifications for the on-shore computing capabilities defined by WP4, the requirements for the shore station computing facilities are investigated.
  - Define requirements for access to European data network
    The options to connect the shore station to the high-speed European data network are investigated and the necessary infrastructure is defined.
  - Prepare conceptual design of shore station
    The specifications for the shore station (space, power supply, logistic requirements etc.) are defined and a conceptual design of the shore station is produced.
  - Design on-shore electrical power distribution
    The on-shore system feeding the power distribution to the KM3NeT infrastructure and interfacing it to (public) power providers is designed and verified.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M5.1	Report on evaluation of existing water, oceanographic, biological and geological data from candidate sites ready	6 months
M5.2	Autonomous multi-sensor deep-sea probe ready	16 months
M5.3	Draft contribution to CDR ready	16 months
M5.4	Prototypes of the most critical parts of the deployment/recovery system ready	33 months
M5.5	Draft contribution to TDR ready	34 months

Deliverable number	Deliverables	Dissemination level (*)
D5.1	Report on evaluation of existing water, oceanographic, biological and geological data from candidate sites	PU
D5.2	Autonomous deep-sea multi-sensor probe for deep-sea measurements	PU
D5.3	CDR contribution containing • the final report on the first phase of site studies including a recommendation of a long-term measurement program; • an intermediate report on design procedures and tooling for detector deployment and recovery; • an intermediate report on deep-sea infrastructures required for deployment, connection and recovery of deep-sea detector units • an intermediate report on the design of the deep-sea power and data network.	PU
D5.4	Prototypes of the most critical parts of the deployment/recovery system	PU
D5.5	TDR contribution containing • the final results of the site studies; • a description of the procedures and tooling for detector on-shore assembly, deployment and recovery; • a description of the deep-sea infrastructures required for deployment, connection and recovery of deep-sea detector units • the final results of the design of the deep-sea power and data network; • a description of the design of the shore infrastructure.	PU

(*) PU = public

Task number	WP6	Task title	**Sea surface infrastructure**
Start month: **1**		End month: **36**	

Participant number	Participant short name	Person-months (*) total	additional
10	NOA/Nestor	288	—
2	U-Kiel	120	90
11	U-Athens	54	36
total		462	126

(*) for AC contractors, the column "additional" shows the human effort for additional staff.

Objectives:

The deployment of scientific instruments at sea is complicated by the unavoidable motion of the ship, which can cause catastrophic events by exciting oscillations of the scientific payload during deployment operations. For these reasons, NOA/Nestor has already constructed a special-purpose deployment platform named Delta-Berenike (D-B). D-B is an isosceles triangular steel construction (side length about 50 m) floating on three 6 m-diameter cylinders containing water jet propulsion units that can maneuver D-B and hold its position without anchoring.

The objectives of WP6 are to improve and test D-B for a potential employment in the construction and operation of the KM3NeT infrastructure, which poses constraints on the positioning accuracy and also the heave compensation that are more stringent than those for the NESTOR experiment, for which D-B has originally been designed. Therefore, the following goals are pursued in the Design Study:

- Improvement of the dynamic position holding ability of D-B;
- Improvement of the heave compensating mechanism of D-B;
- Evaluation and operational optimisation of the sea bottom delivery accuracy of scientific payloads deployed by D-B;
- Development and demonstration of deployment and recovery techniques of scientific payloads down to depths of 4000 m using D-B;
- Development of a concept for absolute angular calibration of a neutrino telescope using D-B.

Description of work:

- **Improvement of the dynamic positioning ability of D-B**
  The hydrodynamic conditions of the platform behaviour up to 4 Beaufort are investigated and field tests with manual controls are performed. Based on the results, the specifications of a GPS-controlled positioning control system including the associated software are defined. This system is developed or, if commercially available, adapted to the specific use for D-B. It is installed, tested, commissioned and evaluated under varying static and dynamic loads of various geometric complexities and different sea states.
- **Improvement of the heave compensation ability of D-B**
  The existing heave compensation system is evaluated in field tests under different sea conditions, dynamic and static loads. Based on the results, the specifications of the required heave-compensation mechanism including the associated software are defined. This system is developed, installed, tested, commissioned and evaluated for varying sea conditions and payloads.
- **Evaluation and operational optimisation of sea bottom delivery accuracy**
  A suspended, transponder-assisted locating system is specified, purchased, installed and commissioned. Procedures using this system for positioning scientific payload with D-B on the sea floor at depths up to at least 4000 m are designed, tested and optimised with respect to the absolute accuracy of the payload positioning on the sea floor.

- **Development and demonstration of deployment and recovery techniques**
  Procedures for the deployment and recovery of scientific payload with D-B are designed, tested and optimised.
- **Development of a concept for absolute angular calibration**
  The use of D-B as a carrier of temporarily operated surface detectors serving for calibration purposes (in particular for the absolute pointing determination of the neutrino telescope) is investigated. Different options for the realisation of surface detectors are studied and the conceptual design of an optimised array is worked out. The achievable calibration precision is evaluated.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M6.1	Definition of software and controls required for positioning system	10 months
M6.2	Draft report to the CDR written	16 months
M6.3	Report on final results of heave compensation written	25 months
M6.4	Draft contribution to TDR written	34 months

Deliverable number	Deliverables	Dissemination level (*)
D6.1	Report: D-B behaviour using manual controls	PU
D6.2	CDR contribution including final results on positioning system and conceptual design of heave compensation system	PU/CO
D6.3	Report: Final results of heave compensation	PU/CO
D6.4	TDR contribution, including final results on deployment/recovery capabilities of D-B and the conceptual design of a surface array on D-B.	PU

(*) CO = confidential, PU = public, PU/CO = public unless confidentiality is requested to secure license or patent rights

Task number	WP7	Task title	Risk assessment and quality assurance
Start month: 1		End month: 36	

Participant number	Participant short name	Person-months (*) total	additional
13	INFN	219	72
5	IN2P3	9	—
6	Saclay	11	—
9	NCSR “D”	13	—
total		252	72

(*) for AC contractors, the column “additional” shows the human effort for additional staff.

Objectives:

- Quality assurance for the KM3NeT infrastructure (parts, assembly, transport, deployment and recovery);
- Risk assessment of the design and operation of the KM3NeT infrastructure

Description of work:

Risk Assessment (RA) and a Quality Assurance Program (QAP) are important tools in many hi-tech and research areas as well as in the industrial applications to obtain high reliability and an efficient resource management. In order to ensure maximal coherence of the R&D work in the KM3NeT Design Study and the QAP/RA activities, the latter will be pursued in close cooperation with the other WPs.

- **Quality assurance for the KM3NeT infrastructure (parts, assembly, transport, deployment and recovery)**
  During the first phase of the Design Study the standards and the quality evaluation method for all the Design Study procedures are defined: conceptual design, study, document writing, data base implementation, and anything else that will be needed for the correct management and control of the project.
  After this phase, documents will be produced describing:
  - the Quality Assurance / Quality Control (QA/QC) procedures for the production, for validation tests and for final detector components;
  - the QA/QC procedures for the storage of the components before and during the assembly operations and the QA/QC procedures for their assembly and integration. In setting up these procedures we will also define the QA/QC-relevant requirements on the laboratories where the assembly and the integrations will be performed;
  - the QA/QC procedures for the operations related to deployment, installation in the deep sea, connection of the underwater detector parts and recovery of detector modules.
- **Risk assessment of the design and operation of the KM3NeT infrastructure**
  FMECA risk analysis is applied to the project during the initial definition of the entire detector and of its sub-systems. This allows to verify the reliability of each choice, of each crucial component, of the integration procedure, of the deployment, connection and operation procedures. The final aim of this task is to identify and mitigate the weak points of the system (in terms of reliability). During the last phase of the Design Study RA methods are applied to characterise the full project and to validate the results that will be achieved by comparing them to the initial specifications.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M7.1	Draft CDR contribution written	16 months
M7.2	Draft TDR contribution written	34 months

Deliverable number	Deliverables	Dissemination level (*)
D7.1	CDR contribution describing the standards and the quality evaluation method for all the Design Study procedures and initial results of the FMECA RA studies	PU
D7.2	TDR contribution with the results of the QA/QC assessment and the FMECA risk analysis of the KM3NeT infrastructure and its construction and operation	PU

(*) PU = public

Task number	WP8	Task title	Resource exploration
Start month: 1		End month: 36	

Participant number	Participant short name	Person-months (*) total	additional
9	NCSR "D"	36	—
1	U-Erlangen	3	0
5	IN2P3	9	—
13	INFN	12	0
total		60	0

(*) for AC contractors, the column "additional" shows the human effort for additional staff.

Objectives:

The aim of WP8 is to explore the resources that need to be mobilised in preparation for the steps immediately following the conclusion of the Design Study in order to move towards the construction of the KM3NeT infrastructure. This requires to pursue the following objectives:

- Monitoring and interfacing with processes that run concurrently with the KM3NeT Design Study
- Exploration of funding sources
- Investigate legal aspects related to the KM3NeT infrastructure
- Establish governance model

Description of work:

WP8 addresses four subjects that constitute four distinct tasks for which the deliverables are corresponding reports:

- **Monitoring and interfacing with processes that run concurrently with the Design Study**
  These processes involve a number of European and international initiatives that are either in progress or are likely to start soon:
  ESFRI: Following the presentation of the *List of Opportunities* for future European Research Infrastructures (ERI), the ESFRI (European Strategy Forum on Research Infrastructures) has appointed thematic expert panels whose task is to provide recommendations to the corresponding panels and through them to the ESFRI concerning the road map for the landscape of research infrastructures in Europe. KM3NeT is on the ESFRI *List of Opportunities* and is subject to further evaluation in the *Astrophysics and Astroparticle* panel. In WP8 the ESFRI developments are monitored, and if necessary input to the expert panel is provided.
  ASPERA: This is a planned ERA-NET network for AstroParticle Physics. A first proposal to this effect, submitted by a large number of EU funding agencies to the EC, has been rejected. A new proposal is being prepared that takes into account the referee comments. Through WP8 contributions to the ASPERA operations are made.
  ApPEC: The Astroparticle Physics European Coordination group consists of representatives of European funding agencies whose tasks involve the coordination of activities across the whole spectrum of astroparticle physics in Europe. ApPEC played a key role in bringing together the KM3NeT partners, and the Design Study proposal was assessed by ApPEC before submission. Through WP8 consultation with ApPEC is maintained throughout the Design Study, exploiting the fact that the coordinator of WP8 is also a member of the ApPEC Steering Committee.
- **Exploration of funding sources**
  As outlined in the Design Study Proposal, in addition to possible unilateral or multilateral funding by one or more EU funding agencies, the following funding models for the KM3NeT infrastructure will be explored in WP8:
  Article 169: This is potentially a very powerful instrument to integrate national programs. Through WP8 the option of co-funding the construction of KM3NeT through this instrument is explored.

Structural Funds (regional development): The possibility of using EU structural funds for the construction of the KM3NeT infrastructure depends on the eligibility of the region that will host the infrastructure. Exploring this possibility will have to start well before the end of the Design Study in order to make appropriate provisions in the Community support frameworks of the candidate host regions. This planning takes place through WP8.

European Investment Bank: The mode of partly financing the construction of the KM3NeT infrastructure through an EIB loan is actively explored in the course of the Design Study. It might allow funding agencies to spread the initial construction costs over a long period thus making the initial capital expenditure less disrupting to their ongoing programs.

The above funding models do not take into account the funding options through FP7. Therefore developments concerning FP7 and the EU budget are monitored and any new possibilities are explored and responded to. This is especially necessary since it is expected that there will be a funding gap between the final stage of the Design Study and the eventual start of the construction phase. It is explored whether, depending on the final provisions of FP7, this gap can be filled by a *Preparatory Study* action or something similar.

- **Investigate legal aspects related to the KM3NeT infrastructure**

  Most probably the construction and operation of the KM3NeT infrastructure will involve a new legal entity that will be empowered to execute contracts for the construction and subsequent operation of the infrastructure facility. It will also be necessary to establish independent supervisory mechanisms to assure proper management of funds. Finally a legal title will have to be assigned to the site chosen and its enforcement established; this addresses questions such as protection against damages by cable laying or trawling vessels, responsibilities in case of damages to third parties etc. These issues are explored in WP8 and reported upon.

- **Establish governance model**

  A separate governance structure (the KM3NeT Governing Council), in which the funding agencies are represented, will be necessary in order to set financial policies and develop sustainable funding plans for the KM3NeT infrastructure.

  Furthermore the scientific program of the infrastructure will have to be decided in consultation with the funding agencies. The scientific programs performed by users of the new facility will have to be reviewed and evaluated. These tasks will be assigned to a Scientific Council.

  The details concerning the operation of these two councils and all associated issues of governance are studied in WP8 and reported upon.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M8.1	Report on methodology for exploring funding options and investigating legal aspects and governance models written	6 months
M8.2	Draft of CDR contribution ready	16 months
M8.3	Draft of TDR contribution ready	34 months

Deliverable number	Deliverables	Dissemination level (*)
D8.1	Report on methodology for exploring funding options and investigating legal aspects and governance models	PU
D8.2	CDR contribution summarising status and results of the ongoing WP8 activities	PU
D8.3	TDR contribution with the final reports on concurrent processes, funding options, legal aspects and governance models	PU

(*) PU = public

Task number	WP9	Task title	Associated science
Start month: 1		End month: 36	

Participant number	Participant short name	Person-months (*) total	additional
20	UNIABDN	24	12
4	IFREMER	13	—
5	IN2P3	12	—
7	HCMR	66	—
12	CNR	17	—
14	INGV	14	0
total		146	12

(*) for AC contractors, the column “additional” shows the human effort for additional staff.

Objectives:

- Define communication model between the neutrino telescope and the marine science communities;
- Design of the associated sciences node.

Description of work:

- **Define communication model between the marine science and neutrino telescope communities**
  A cooperation model between the neutrino telescope and the marine science communities is defined, with the goal to identify clients for the data and their specific needs and to integrate KM3NeT into the global cabled observatory community. The three KM3NeT candidate sites are recognised as regional networks within the proposed ESONET (European Seas Observatory Network) framework. KM3NeT is to be represented at regional, European and Global forums on sub sea-cabled observatories. The final outcome is to be a model for operation of the KM3NeT observatories within the context of the general marine observatory capacity using all three candidate sites. The model includes use of the sites as test platforms for observatory technology.
- **Design of the associated sciences node**
  Equipped with additional sensors in a so-called “associated sciences node” the KM3NeT infrastructure will contribute to global sub-sea monitoring programmes providing continuous vigilance in relation to geophysical, biogeochemical, oceanographic and biological environmental processes with alarms in the event of hazards such as earthquakes and tsunamis as well as archiving of information related to global change. In preparation of these goals, the following tasks will be performed:
  - Science reviews of candidate sites
    The first step in the second objective is to prepare reports for each of the three candidate sites describing: Bathymetry, underlying geology, sedimentation regime, the sediment interface, water circulation, wave propagation, biological productivity regime, biodiversity, human impacts, resource issues and hazards. The reports conclude with an assessment of the main science issues to be addressed, e.g. seismicity, slope stability, tsunamis, flow, temperature, biological productivity and sedimentation. Clients, ultimate users and destination archives of data are to be identified.
  - Generic design of observatories
    For economy of manufacture the associated sciences node is to use standardised components of generic design that are largely site independent. All aspects of architecture are considered for sea floor platforms, attachment to the sea floor, penetration of the sea floor, and observatories with strings of sensors extended upwards to the surface layer. Cable terminations, and junction boxes are critically examined. Information is to be collated into a technical reference library.
  - Test node
    The associated sciences node will provide a site for observatories or submodules of observatories to be connected into a deep water location for test purposes. A general specification is to be defined for a

special junction-box for such “non operational” applications.

- Conceptual design of the associated sciences node
  Based on the results of the previous subtasks, a full specification of the associated sciences node and its data management is produced, where additional information on the sites from WP5 is considered.
- Technical design of the associated sciences node
  The conceptual design is transformed into a detailed specification and design of all aspects of the associated sciences node concerning sensors, connectors and their configuration into observatory structures. Special attention is directed to appropriate materials for survival in the high-salinity, high-temperature environment of the Mediterranean Sea. The overall layout on the sea floor at each of the three sites is considered together with cable routes, junction boxes and relationship with the overall KM3NeT infrastructure. Some prototyping work may be required.
- Design specification for data transmission to the marine science community
  Protocols are developed for:
  - real time transmission of hazard warning data (seismic, pressure/tsunami) without delay;
  - real or near-real time interrogation or acquisition of data from identified sensors;
  - transfer of data to long-term archives with appropriate meta-data.

Milestones and expected result of this task:

Milestone number	Milestones	Date
M9.1	Report 1 (deliverable D9.1) submitted to the PCC	12 months
M9.2	Draft contribution to CDR ready	16 months
M9.3	Draft contribution to TDR ready	34 months

Deliverable number	Deliverables	Dissemination level (*)
D9.1	Report on the science review of the candidate sites, on the generic design of the observatories and on the test node (Report 1)	PU
D9.2	CDR contribution including the conceptual design of the associated sciences node and intermediate results on the definition of a communication model between the marine science and the neutrino telescope communities	PU
D9.3	TDR contribution including the technical design of the associated sciences node, the design specifications for data transmission to the marine science community and the definition of a communication model between the marine science and the neutrino telescope communities	PU

(*) PU = public

5 Consortium Management Activities

5.1 Organisational Structure and Overall Project Management

The KM3NeT Design Study project is performed under the regulations of the *Contract* between the EC and the KM3NeT consortium. Issues not covered by this contract are regulated in a *Consortium Agreement*, governing in particular details of the management structure of the Design Study project and the decision-making processes.

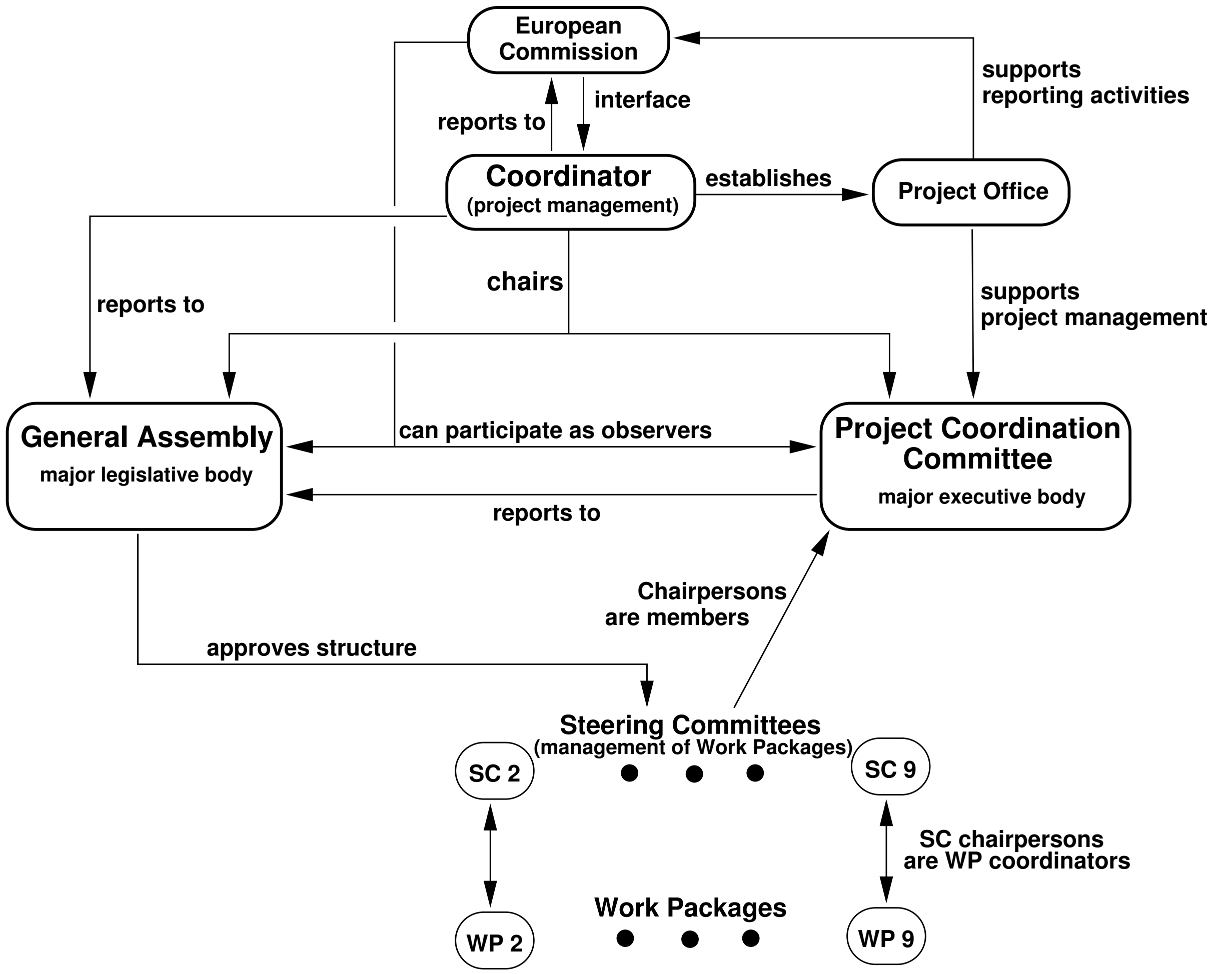

Figure 5: *Schematic representation of the foreseen management structure of the KM3NeT Design Study project. Note that, for simplicity, "coordinator" here represents a person acting on behalf of the coordinating legal entity.*

The foreseen management structure, as shown in Fig. 5, will contain the following entities:

- **The Coordinator:**
  The Coordinator[3] establishes the single point of contact between the *European Commission (EC)* and the consortium. The Coordinator is responsible for the overall management of the project as detailed in the description of WP1 (see Section 4.3).
- **The Project Office (PO):**
  The PO will be established for the duration of the project and led by administrative staff specialised in

[3] In the following this term partly refers to the legal entity as defined in the *Contract*, partly to the person performing the coordination tasks on behalf of this legal entity.

EU administrative and legal affairs and generally in the management of large scientific/technical R&D projects. They will provide support for the day-to-day project management tasks, for the reporting activities towards the EC, and for the maintenance of the project accounts. The PO also oversees the maintenance of the web site that serves as central instrument for communication inside the project and for dissemination of results (see below).

- **The General Assembly (GA):**
  The GA is the major decision-taking body of the project. It consists of one representative per participant or, in the case of participants representing several institutions, one representative per institution. The GA is convened and chaired by the Coordinator. GA meetings are foreseen once per year; in addition an initial meeting is foreseen in the framework of the kick-off meeting shortly after the official start of the project. The GA approves administrative and financial decisions related to the progress of the project and reaches decisions amongst others on the acceptance of new participants and exclusion of participants, the structure and restructuring of the Work Packages (including the replacement of leading participants), and the conclusion and maintenance of the Consortium Agreement.

- **The Work Packages (WPs) and their Steering Committees (SCs):**
  To facilitate the organisation and management, the project is structured in WPs. In the initial GA meeting, the partition and leading participants of the work packages are confirmed by the GA. Representatives of the institutions involved in each work package form its Steering Committee (SC), whose chairperson shall be a representative of the leading institute. The SC chairperson is entitled to nominate additional members of the SC who are to be endorsed by the SC. The chairperson represents the work package in the Project Coordination Committee (see below). The SCs shall be responsible for their own organisational arrangements, work procedures and time schedules, provided they are in accordance with requests made by the Coordinator, the PCC or the EC.

- **The Project Coordination Committee (PCC):**
  The PCC is the supervisory body for the project execution which shall report to the GA. It comprises the chairpersons of the WP SCs; additional members of the PCC can be nominated by the Coordinator and must be confirmed by the GA. The PCC assumes overall responsibility towards the GA for liaison between the participants for analysing and approving the results generated under SCs and/or participants. It will be chaired and convened by the Coordinator; PCC meetings are foreseen twice a year. The tasks of the PCC include: support of the Coordinator in fulfilling his obligations towards the EC; monitoring and reporting the progress of the work packages; steering the work sharing between participants; reviewing budgetary issues; agreeing on press releases and joint publications.

The communication between partners and management bodies will be facilitated by installing a central computer server providing a web platform which is used both for the distribution of password-protected internal information and for the dissemination of results to the public. The URL `http://www.km3net.org` has already been reserved for this purpose. In pursuing the project, video and telephone conferences will be instrumental to maintain a high level of information exchange.

5.2 Potential Impact and Risks Assessment

The objective of the Design Study is to arrive at a complete technical design of the KM3NeT infrastructure, including an optimised Northern Hemisphere neutrino telescope operational complementary to and simultaneously with the Southern Hemisphere IceCube project.

The risks of failure to achieve this will be formally analysed and monitored through a risk management system. Risks to the project will be identified by analysis of the project plan. Each risk will be catalogued with reference number, title, date of opening, responsible entity and an initial description. A probability (on a scale from 1 [low] to 5 [high]) will be assigned to each risk, and the impact on the project be classified as low, medium or high. During the time the risk is open, a description of mitigation measures and finally a date of closure will be added.

The Coordinator will keep a register of all the risks, and a graphical presentation of the number of open risks month by month will be presented at each PCC meeting. The top ten risks current at the time of each meeting will be tabled and considered for action on mitigation. The highest ranked risks are those with high probability and/or highest potential impact on the project. The chairpersons of the WP SCs will contribute to this process and notify the Coordinator of any new risks. The WP chairperson or the individual or group directly working on a task will normally be the responsible owner of the risk. Closure of risks, through successful mitigation measures or completion of tasks will be notified to the coordinator and ratified by the PCC. A successful project should show a steady decline in the number of open risks.

The full range of risks will be defined as part of the project management process. At the outset, the major risks in this project are managed through parallel redundancy with alternative solutions considered in each aspect of the design. As design choices are refined so the nature of the risk will change to potential for failure, or delay in realisation of the optimal design. There is a cost in sustaining parallel work on alternative approaches so the risk management will be done in conjunction with resource management within the project.

Major risks within the project are e.g.:

1. Failure to develop a successful readout concept
   Mitigation measures: The project is carefully designed with adequate resources in this area, so that readout concepts can be thoroughly tested and parallel redundancy with alternative approaches investigated by different groups.

2. Failure to develop a practical marine architecture
   Mitigation measures: The project builds on experience from three groups who have built successful undersea detector arrays. Sufficient resources are available to sustain examination of alternative approaches.

3. Failure to find a suitable site for construction
   Mitigation measures: The project has access to three candidate sites in the Mediterranean Sea which is considered an optimal environment for the KM3NeT infrastructure. Site surveys will allow further optimisation within these locations which have all been subject to previous studies that identified them as candidate sites.

The major risks will be subdivided into component risks with probability and impact scores for the purposes of management. The scores will be subjective but the catalogue of risks will provide a quantifiable means of reducing and finally eliminating risk in the project.

5.3 Plan for Use and Dissemination of Knowledge

The scientific/technical results of the Design Study (except those classified as *restricted*, see below), will be made public on the KM3NeT web site, in workshops, conferences, publications and presentations of consortium members in seminars, colloquia etc.

The output of this project will be the technical design of the KM3NeT infrastructure, so the main exploitation of the output will occur after the end of the Design Study. A knowledge exploitation and dissemination plan according to the scheme shown in Fig. 6 will be implemented for use of information in three domains: *Restricted*, *Professional/Academic*, and *Public Outreach*, where the latter two are subsumed under *Public*. Information subject to *restricted dissemination* will be made available within the partnership through workshops and internal working documentations, but not outside the KM3NeT consortium. This regulation applies if at least one of the partners contributing to a development requests it.

Wider exploitation of engineering hardware and software innovations through patenting and licensing will be explored according to the rules of the inventors' home institutes and the Consortium Agreement. Innovations arising from the project will be promoted through workshops, participation in exhibitions and publications.

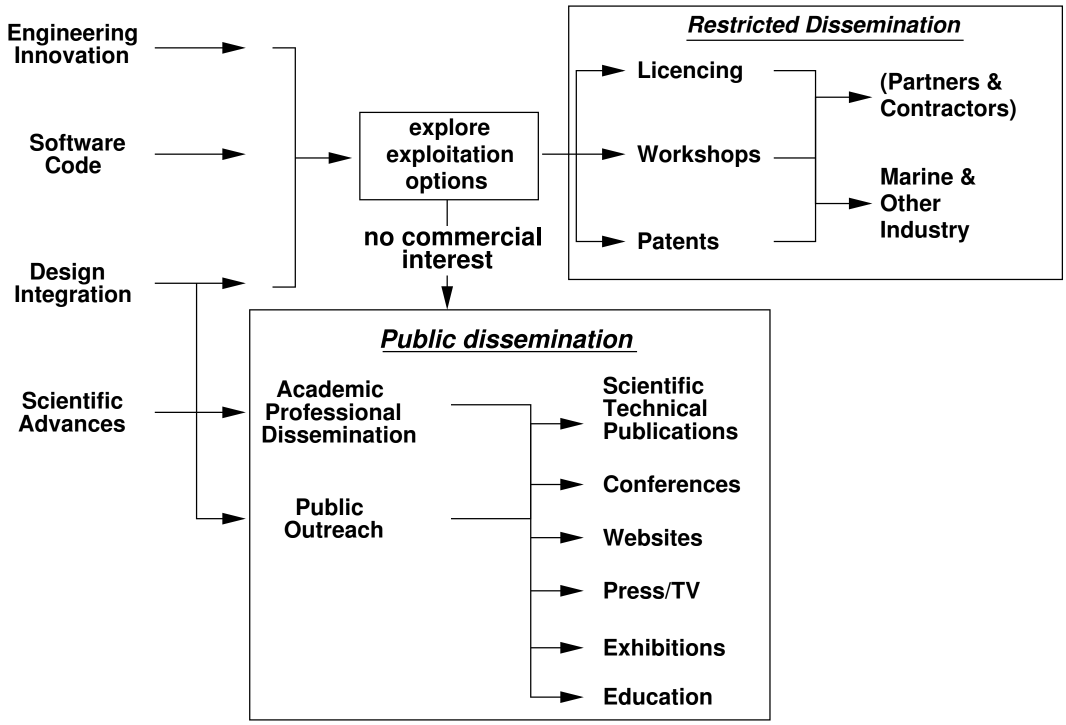

Figure 6: *Foreseen knowledge exploitation and dissemination plan.*

A publication committee will oversee the academic/professional and public outputs from the project. The task of the committee will be to ensure coordination across the partnership, adherence to academic etiquette in authorship of publications and quality standards to output. A central resource of artwork and presentations will be maintained to ensure a unified image of the project. Forward-planning will ensure representation of the project at all major conferences and exhibitions. Postdocs, PhD students, scientists and engineers will be encouraged to publish their findings in relevant professional journals.

6 Project Resources and Budget Overview

6.1 Personnel Effort for the Full Duration of the Project

The personnel effort for the full duration of the project is summarised in Table 3.

6.2 Description of Other Resources Needed

In addition to personnel cost, the total budget for the KM3NeT Design Study contains costs for

- travel and subsistence;
- consumables, in particular for use in sea operations and for the production of prototypes;
- equipment for computing and for use in sea operations (altogether about 200 k€);
- subcontracting: for audit certificates of several participants (together about 13 k€) and for the provision of services and technical consultancy advice (together about 230 k€); further subcontracting costs for the provision of services and technical consultancy advice may occur during the Design Study.
- other issues, such as ship time for sea operations and public outreach material.

6.3 Overall Budget for the Full Duration of the Project

The overall budget for the full duration of the project can be inferred from Figs. 7 to 11 and from Fig. 12 on the following pages.

Table 3: Total effort in person-months needed for the full duration of the project (*)

participant	WP1		WP2		WP3		WP4		WP5		WP6		WP7		WP8		WP9		total	
	t	a	t	a	t	a	t	a	t	a	t	a	t	a	t	a	t	a	t	a
U-Erlangen	90	78	173	108	54	36	59	36	—	—	—	—	—	—	3	0	—	—	379	258
U-Kiel	—	—	—	—	—	—	—	—	—	—	120	90	—	—	—	—	—	—	120	90
U-Cyprus	—	—	36	18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36	18
IFREMER	—	—	—	—	33	—	—	—	19	—	—	—	—	—	—	—	13	—	65	—
IN2P3	—	—	174	—	63	—	90	—	27	—	—	—	9	—	9	—	12	—	384	—
Saclay	—	—	83	—	77	—	110	—	45	—	—	—	11	—	—	—	—	—	326	—
HCMR	—	—	—	—	—	—	—	—	66	—	—	—	—	—	—	—	66	—	132	—
HOU	—	—	144	60	36	0	144	36	—	—	—	—	—	—	—	—	—	—	324	96
NCSR “D”	—	—	72	—	—	—	—	—	—	—	—	—	13	—	36	—	—	—	121	—
NOA/Nestor	—	—	18	—	72	—	18	—	18	—	288	—	—	—	—	—	—	—	414	—
U-Athens	—	—	—	—	—	—	—	—	46	28	54	36	—	—	—	—	—	—	100	64
CNR	—	—	—	—	—	—	—	—	72	—	—	—	—	—	—	—	17	—	89	—
INFN	—	—	252	108	144	72	72	36	255	108	—	—	219	72	12	0	—	—	954	396
INGV	—	—	—	—	—	—	—	—	65	36	—	—	—	—	—	—	14	0	79	36
Tecnomare	—	—	—	—	—	—	—	—	9	—	—	—	—	—	—	—	—	—	9	—
FOM	—	—	108	—	108	—	216	—	—	—	—	—	—	—	—	—	—	—	432	—
CSIC	—	—	30	—	15	—	—	—	—	—	—	—	—	—	—	—	—	—	45	—
U-Valencia	—	—	20	16	10	8	—	—	—	—	—	—	—	—	—	—	—	—	30	24
UP-Valencia	—	—	—	—	77	—	—	—	—	—	—	—	—	—	—	—	—	—	77	—
UNIABDN	—	—	—	—	—	—	—	—	36	24	—	—	—	—	—	—	24	12	60	36
U-Leeds	—	—	15.6	12	15.6	12	—	—	—	—	—	—	—	—	—	—	—	—	31.2	24
U-Liverpool	—	—	60	18	58	16	—	—	—	—	—	—	—	—	—	—	—	—	118	34
U-Sheffield	—	—	60	18	58	16	—	—	—	—	—	—	—	—	—	—	—	—	118	34
UHA-GRPHE	—	—	28	12	—	—	10	0	—	—	—	—	—	—	—	—	—	—	38	12
total	90	78	1273.6	370	820.6	160	719	108	658	196	462	126	252	72	60	0	146	12	4481.2	1122

(*) the columns “t” give the estimated total human effort (including permanent staff), the columns “a” are for additional staff (AC contractors only)

Financial information - whole duration of the project								
Participant n	Organisation short name	Cost model used	Estimated eligible costs and requested EC contribution (whole duration of the project)		Costs and EC contribution per type of activities: Specific activities (1)	Costs and EC contribution per type of activities: Consortium Management activities (2)	Total (3)=(1)+(2)	Total receipts
1	U-Erlangen	AC	Eligible costs	*Direct Costs (a)*	517.916,67	348.530,33	866.447,00	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	103.583,33	69.706,07	173.289,40	
				Total eligible costs (a)+(b)	621.500,00	418.236,40	1.039.736,40	
			Requested EC contribution		621.500,00	418.236,40	1.039.736,40	
2	U-Kiel	AC	Eligible costs	*Direct Costs (a)*	235.000,00	2.000,00	237.000,00	,00
				of which subcontracting	,00	2.000,00	2.000,00	
				Indirect costs (b)	47.000,00	,00	47.000,00	
				Total eligible costs (a)+(b)	282.000,00	2.000,00	284.000,00	
			Requested EC contribution		282.000,00	2.000,00	284.000,00	
3	U-Cyprus	AC	Eligible costs	*Direct Costs (a)*	50.000,00	1.000,00	51.000,00	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	10.000,00	200,00	10.200,00	
				Total eligible costs (a)+(b)	60.000,00	1.200,00	61.200,00	
			Requested EC contribution		60.000,00	1.200,00	61.200,00	
4	IFREMER	FC	Eligible costs	*Direct Costs (a)*	791.666,67	,00	791.666,67	,00
				of which subcontracting	50.000,00	,00	50.000,00	
				Indirect costs (b)	148.333,33	,00	148.333,33	
				Total eligible costs (a)+(b)	940.000,00	,00	940.000,00	
			Requested EC contribution		406.000,00	,00	406.000,00	
5	IN2P3	FCF	Eligible costs	*Direct Costs (a)*	1.852.583,33	5.833,33	1.858.416,66	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	370.516,67	1.166,67	371.683,34	
				Total eligible costs (a)+(b)	2.223.100,00	7.000,00	2.230.100,00	
			Requested EC contribution		654.000,00	7.000,00	661.000,00	

Figure 7: *Budget for the full duration of the project for participants 1–5.*

Financial information - whole duration of the project								
Participant n	Organisation short name	Cost model used	Estimated eligible costs and requested EC contribution (whole duration of the project)		Costs and EC contribution per type of activities: Specific activities (1)	Costs and EC contribution per type of activities: Consortium Management activities (2)	Total (3)=(1)+(2)	Total receipts
6	Saclay	FC	Eligible costs	*Direct Costs (a)*	1.951.661,68	5.833,33	1.957.495,01	,00
				of which subcontracting	150.000,00	,00	150.000,00	
				Indirect costs (b)	360.332,34	1.166,67	361.499,01	
				Total eligible costs (a)+(b)	2.311.994,02	7.000,00	2.318.994,02	
			Requested EC contribution		656.650,00	7.000,00	663.650,00	
7	HCMR	FCF	Eligible costs	*Direct Costs (a)*	666.666,67	2.000,00	668.666,67	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	133.333,33	400,00	133.733,33	
				Total eligible costs (a)+(b)	800.000,00	2.400,00	802.400,00	
			Requested EC contribution		400.000,00	2.400,00	402.400,00	
8	HOU	AC	Eligible costs	*Direct Costs (a)*	200.000,00	2.000,00	202.000,00	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	40.000,00	400,00	40.400,00	
				Total eligible costs (a)+(b)	240.000,00	2.400,00	242.400,00	
			Requested EC contribution		240.000,00	2.400,00	242.400,00	
9	NCSR"D"	FC	Eligible costs	*Direct Costs (a)*	441.666,67	7.833,33	449.500,00	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	88.333,33	1.566,67	89.900,00	
				Total eligible costs (a)+(b)	530.000,00	9.400,00	539.400,00	
			Requested EC contribution		265.000,00	9.400,00	274.400,00	
10	NOA/Nestor	FC	Eligible costs	*Direct Costs (a)*	1.345.000,00	7.833,33	1.352.833,33	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	269.000,00	1.566,67	270.566,67	
				Total eligible costs (a)+(b)	1.614.000,00	9.400,00	1.623.400,00	
			Requested EC contribution		753.000,00	9.400,00	762.400,00	

Figure 8: *Budget for the full duration of the project for participants 6–10.*

Financial information - whole duration of the project								
Participant n	Organisation short name	Cost model used	Estimated eligible costs and requested EC contribution (whole duration of the project)		Costs and EC contribution per type of activities: Specific activities (1)	Costs and EC contribution per type of activities: Consortium Management activities (2)	Total (3)=(1)+(2)	Total receipts
11	U-Athens	AC	Eligible costs	*Direct Costs (a)*	200.000,00	2.000,00	202.000,00	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	40.000,00	400,00	40.400,00	
				Total eligible costs (a)+(b)	240.000,00	2.400,00	242.400,00	
			Requested EC contribution		240.000,00	2.400,00	242.400,00	
12	CNR	FC	Eligible costs	*Direct Costs (a)*	461.666,67	2.000,00	463.666,67	,00
				of which subcontracting	,00	2.000,00	2.000,00	
				Indirect costs (b)	92.333,33	,00	92.333,33	
				Total eligible costs (a)+(b)	554.000,00	2.000,00	556.000,00	
			Requested EC contribution		277.000,00	2.000,00	279.000,00	
13	INFN	AC	Eligible costs	*Direct Costs (a)*	1.137.500,00	13.666,67	1.151.166,67	,00
				of which subcontracting	,00	2.000,00	2.000,00	
				Indirect costs (b)	227.500,00	2.333,33	229.833,33	
				Total eligible costs (a)+(b)	1.365.000,00	16.000,00	1.381.000,00	
			Requested EC contribution		1.365.000,00	16.000,00	1.381.000,00	
14	INGV	AC	Eligible costs	*Direct Costs (a)*	346.666,67	4.000,00	350.666,67	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	69.333,33	800,00	70.133,33	
				Total eligible costs (a)+(b)	416.000,00	4.800,00	420.800,00	
			Requested EC contribution		416.000,00	4.800,00	420.800,00	
15	Tecnomare	FC	Eligible costs	*Direct Costs (a)*	68.333,33	1.000,00	69.333,33	,00
				of which subcontracting	,00	1.000,00	1.000,00	
				Indirect costs (b)	13.666,67	,00	13.666,67	
				Total eligible costs (a)+(b)	82.000,00	1.000,00	83.000,00	
			Requested EC contribution		41.000,00	1.000,00	42.000,00	

Figure 9: *Budget for the full duration of the project for participants 11–15.*

Financial information - whole duration of the project								
Participant n	Organisation short name	Cost model used	Estimated eligible costs and requested EC contribution (whole duration of the project)		Costs and EC contribution per type of activities: Specific activities (1)	Costs and EC contribution per type of activities: Consortium Management activities (2)	Total (3)=(1)+(2)	Total receipts
16	FOM	FC	Eligible costs	*Direct Costs (a)*	2.788.800,00	5.833,33	2.794.633,33	,00
				of which subcontracting	30.000,00	,00	30.000,00	
				Indirect costs (b)	551.760,00	1.166,67	552.926,67	
				Total eligible costs (a)+(b)	3.340.560,00	7.000,00	3.347.560,00	
			Requested EC contribution		650.000,00	7.000,00	657.000,00	
17	CSIC	FC	Eligible costs	*Direct Costs (a)*	182.333,33	1.068,00	183.401,33	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	36.466,67	213,60	36.680,27	
				Total eligible costs (a)+(b)	218.800,00	1.281,60	220.081,60	
			Requested EC contribution		109.000,00	1.281,60	110.281,60	
18	U-Valencia	AC	Eligible costs	*Direct Costs (a)*	90.833,33	1.200,00	92.033,33	,00
				of which subcontracting	,00	1.200,00	1.200,00	
				Indirect costs (b)	18.166,67	,00	18.166,67	
				Total eligible costs (a)+(b)	109.000,00	1.200,00	110.200,00	
			Requested EC contribution		109.000,00	1.200,00	110.200,00	
19	UP-Valencia	FC	Eligible costs	*Direct Costs (a)*	206.666,67	1.000,00	207.666,67	,00
				of which subcontracting	,00	1.000,00	1.000,00	
				Indirect costs (b)	41.333,33	,00	41.333,33	
				Total eligible costs (a)+(b)	248.000,00	1.000,00	249.000,00	
			Requested EC contribution		86.000,00	1.000,00	87.000,00	
20	UNIABDN	AC	Eligible costs	*Direct Costs (a)*	250.000,00	7.679,33	257.679,33	,00
				of which subcontracting	,00	1.846,00	1.846,00	
				Indirect costs (b)	50.000,00	1.166,67	51.166,67	
				Total eligible costs (a)+(b)	300.000,00	8.846,00	308.846,00	
			Requested EC contribution		300.000,00	8.846,00	308.846,00	

Figure 10: *Budget for the full duration of the project for participants 16–20.*

Financial information - whole duration of the project									
Partici pant n	Organisation short name	Cost model used	Estimated eligible costs and requested EC contribution (whole duration of the project)		Costs and EC contribution per type of activities		Total (3)=(1)+(2)	Total receipts
					Specific activities (1)	Consortium Management activities (2)		
21	U-Leeds	AC	Eligible costs	*Direct Costs (a)*	141.671,67	1.000,00	142.671,67	,00
				of which subcontracting	,00	1.000,00	1.000,00	
				Indirect costs (b)	28.334,33	,00	28.334,33	
				Total eligible costs (a)+(b)	170.006,00	1.000,00	171.006,00	
			Requested EC contribution		170.006,00	1.000,00	171.006,00	
23	U-Liverpool	AC	Eligible costs	*Direct Costs (a)*	141.700,00	1.000,00	142.700,00	,00
				of which subcontracting	,00	1.000,00	1.000,00	
				Indirect costs (b)	28.340,00	,00	28.340,00	
				Total eligible costs (a)+(b)	170.040,00	1.000,00	171.040,00	
			Requested EC contribution		170.040,00	1.000,00	171.040,00	
24	U-Sheffield	AC	Eligible costs	*Direct Costs (a)*	141.700,00	1.000,00	142.700,00	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	28.340,00	200,00	28.540,00	
				Total eligible costs (a)+(b)	170.040,00	1.200,00	171.240,00	
			Requested EC contribution		170.040,00	1.200,00	171.240,00	
25	UHA-GRPHE	AC	Eligible costs	*Direct Costs (a)*	41.666,67	833,33	42.500,00	,00
				of which subcontracting	,00	,00	,00	
				Indirect costs (b)	8.333,33	166,67	8.500,00	
				Total eligible costs (a)+(b)	50.000,00	1.000,00	51.000,00	
			Requested EC contribution		50.000,00	1.000,00	51.000,00	
TOTAL			Eligible costs		**17.056.040,02**	**508.764,00**	**17.564.804,02**	**,00**
			Requested EC contribution		**8.491.236,00**	**508.764,00**	**9.000.000,00**	

Figure 11: *Budget for the full duration of the project for participants 21–25.*

Estimated breakdown of the EC contribution per reporting period				
Reporting Periods	Start month	End month	Estimated Grant to the Budget	
			Total	In which first six months
Reporting Period 1	1	12	2.944.055,00	,00
Reporting Period 2	13	24	3.301.967,00	1.742.501,00
Reporting Period 3	25	36	2.753.978,00	1.412.454,00
Reporting Period 4	37	48	,00	,00
Reporting Period 5	49	60	,00	,00
Reporting Period 6	61	72	,00	,00
Reporting Period 7	73	84	,00	,00

Figure 12: *Estimated budget breakdown by half-years for the full duration of the project.*