The GRAND Project



Project Management Plan

V0.1

Revision History

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# Project Description

## Introduction

This document describes the organization of the GRAND project. It details the tasks and duties of the GRAND officers and bodies, as well as the methodology for quality assurance and cost control.

## The GRAND Project

The GRAND project consists of several stages, separated in time and scope, ultimately leading to the creation of the GRAND observatory. The GRAND observatory will be a distributed experiment consisting of several arrays of detectors, each with an area of approximately 10,000 km2, summing up to a combined size of 200,000 km2. The stages of the GRAND project will be used to optimize the technical layout of the observatory as well as to jump-start the scientific output of the project.

## Scientific Objectives (copied from white paper)

The Giant Radio Array for Neutrino Detection (GRAND) aims to answer one of the most pressing open questions in astrophysics: what is the origin of ultra-high-energy cosmic rays?

Ultra-high-energy cosmic rays (UHECRs) — extraterrestrial charged particles with the highest energies detected — have been observed for more than fifty years, yet their origin is unknown. They are purportedly made in powerful cosmic accelerators, though none has been identified. Thus, discovering the sources of UHECRs is fundamental to understanding the high-energy Universe. However, the interaction of UHECRs with the cosmic microwave background prevents the majority of the most energetic UHECRs — those with energies above 4 · 1010 GeV — from reaching us. And, because of scattering off cosmological magnetic fields, the lower-energy UHECRs that reach us do not point back to their sources. As a result, discovering the sources of UHECRs by direct observation of cosmic rays is challenging.

Fortunately, there is a way to discover the sources indirectly: UHECRs make secondary UHE neutrinos which encode information about the properties of UHECRs and their sources. These neutrinos carry ∼5% of the energy of the parent cosmic ray, i.e., they have energies in excess of 109 GeV. Because neutrinos are not severely affected during propagation, the information they carry is preserved until they are detected.

However, because neutrinos are notoriously difficult to detect, UHE neutrinos have escaped detection so far. How low the flux of UHE neutrinos is is an important open question and is related to UHECR unknowns. There is no guarantee that the flux lies within reach of existing neutrino detectors and their planned upgrades. Without a suitable detection strategy, UHE neutrinos might remain undiscovered, or, if discovered, their energy spectrum might remain unmapped — and the origin of UHECRs might remain a mystery.

GRAND is a next-generation detector designed to discover UHE neutrinos even under pessimistic predictions of their flux. Its strategy is to detect the radio emission from large particle showers in the terrestrial atmosphere, of energies above 108 GeV, that are triggered by the interaction of high-energy primary particles: neutrinos, cosmic rays, and gamma rays. Charge asymmetries inside the showers produce radio emission in the 50–200 MHz range, which leaves a footprint on the ground that is detectable up to 100 km from the point of emission. To detect the footprint, GRAND will use 200,000 radio antennas covering an area of 200,000 km2, making it the largest air-shower detector ever built.

Building upon decades of research in antenna design and radio detection, GRAND plans to reach a sensitivity to neutrino fluxes of ∼10−10 GeV cm−2 s−1 sr−1 around 109 GeV. This is an order of magnitude better than what is envisioned for planned upgrades of existing detectors. With this sensitivity, GRAND will discover cosmogenic neutrinos — made by UHECR interactions with cosmic photon fields — in 3 years of operation, even in disfavorable scenarios. Because of its sub-degree angular resolution, GRAND will also search for point sources of UHE neutrinos, both steady and transient.

GRAND will also be the largest UHECR detector. After decades of data-taking, experiments have collected a few hundreds of UHECR events above 4 · 1010 GeV. GRAND could improve event statistics ten-fold within a few years. With these statistics, the spatial clustering of events could reveal the approximate position of UHECR sources, constrain the source number density, and precisely measure the mass composition of UHECRs. Further, GRAND will also be sensitive to UHE gamma rays, which carry complementary information on nearby sources and cosmological photon backgrounds.

Moreover, GRAND will be a valuable instrument for astronomy and cosmology, allowing for the discovery and follow-up of large numbers of radio transients — fast radio bursts, giant radio pulses — and studies of the epoch of reionization.

## Principal Documents

A series of documents forms the basis for designing, constructing and operating the GRAND observatory.

### Performance requirements and Technical specifications

A full set of performance requirements and technical specifications will be maintained for each stage of the project. Together with the Engineering drawings these form the configuration of the GRAND project.

### Technical Design Report (TDR)

The TDR is the technical definition of the project. It will contain the technical design of each of the stages of the GRAND project after the technical design of that stage has matured.

### Engineering Drawings

A complete series of engineering drawings of all elements of the GRAND project will be maintained. Together with the Performance requirements and technical specifications they form the configuration of the GRAND project.

### Quality Assurance Plan

The GRAND project establishes a quality assurance plan to assure the performance and reliability of the detector. Quality assurance is part of the design, procurement, assembly and test processes of the project.

### Project Management Plan

The Project management plan describes the organization, management responsibilities and procedures used in construction and operation of all stages of the GRAND project.

### Cost Estimate

Labour and materials required for the successful completion of each stage of the GRAND project are contained in a work breakdown structure (WBS). The WBS contains a complete definition of the scope of the project and forms the basis of planning, costing, scheduling and control of each of the stages of the GRAND project.

### Operations Plan

An operations plan for the data taking phase of each of the stages of the GRAND project will be created to ensure accurate and efficient data taking and analysis.

### Agreement for Organization Management and Funding

The purpose of the International Agreement is to define the framework for the organization, management, and funding required for the construction, commissioning and operation of the GRAND project.

# Project Organization

## Global Organization



### Finance Board

The Finance Board is the governing body for oversight of the financial aspects of the Collaboration and works by the consensus of its members. The Finance Board provides the mechanism whereby the Parties to the International Agreement exercise oversight of the GRAND Project. The Parties to the International Agreement are the institutions funding the construction and operation of each of the stages of GRAND.

The Finance Board determines by unanimous agreement its own rules of procedure, which shall be reported to the Parties.

The Finance Board consists of members appointed by each Party that is a signatory to the International Agreement.

Each Party to the International Agreement is entitled to designate a member of the Finance Board. The Parties should avoid potential conflicts of interest in the designation of the Finance Board members.

The Collaboration will provide reports through the Spokespersons and Project Manager to the Finance Board on the status and proposed plans, including financial plans, of the observatory.

The Finance Board will review and approve yearly budget requests and financial reports. It will also examine the reports from the Project Manager and Spokespersons to ensure that schedule and budgetary goals are being met.

The Finance Board Chairperson is elected from the members of the Finance Board by the members of the Finance Board to serve for a term of two years.

The Finance Board is to meet at least on an annual basis in a place chosen by its members.

The Finance Board meeting will have as an item on its agenda the approval of the Annual Financial Report and Budget.

#### Executive Financial Institution

The Finance Board identifies the Executive Financial Institution that collects, holds and disburses funds at the request of the Project Manager for use in the operation of each of the stages of GRAND.

### Collaboration Board

The Collaboration Board is the oversight body concerned with scientific and technical aspects of the Collaboration and the GRAND project. It deals with issues including governance of the Collaboration, scientific policy, new members and institutions, publication policy and monitoring the operation of each of the stages of GRAND to ensure that the scientific objectives are being met.

The members of the Collaboration Board are appointed by their home institutions among the scientists participating in GRAND.

The Chairpersons of the Collaboration Board are elected from the membership to a renewable two- year term.

### Executive Committee

Executive Committee will assist the spokesperson and project manager in the decision-making process and in defining the actions to be taken to implement the decisions made by the Collaboration Board. It will meet regularly at each Collaboration meeting and in between meetings by video/teleconference. It will report to CB regularly.

The Executive Committee is composed of:

• The spokesperson (chair)

• The co-spokesperson

• The chair of the Collaboration Board

• The co-chair of the Collaboration Board

• The Project manager

Agenda and minutes of the meetings will be made available to the Collaboration.

## Project Offices and Responsibilities

### Spokespersons

The GRAND Spokespersons are elected by the Collaboration Board and are the representatives of the Collaboration in scientific, technical, and management concerns, and speak and negotiate on behalf of the Collaboration. The Spokespersons are responsible for establishing the scientific goals and the means for the Collaboration to pursue these goals successfully. They are also expected to pursue the identification of resources needed by the project and to seek the commitment of such resources toward the construction and operation of each of the stages of the GRAND project. These resources come from the scientific groups and institutions that collaborate in GRAND, as well as their various sources of funding for that purpose. The Spokespersons serve renewable three-year terms.

The Finance Board confirms the selection of the spokespersons.

### Site spokespersons

The Observatory has designated Site Spokespersons, one for each host country, who are members of the Collaboration. They will serve as liaison between the Project Spokesperson and the host countries.

### Collaboration Board

The Collaboration Board, whose membership consists of one representative selected by each collaborating institution, deals with issues which concern the Collaboration as a whole. These include the governance of the Collaboration, the policy on admission of new members and institutions, and publication policy.

Before the signing of the International Agreement, the GRAND Core Team prepares the collaboration forming process and serves as the Collaboration Board.

### Project Manager

The Project Manager is responsible for the overall design, construction and operation of all stages of the GRAND project. The Project Manager's duties and responsibilities include the following:

1. Write and implement the GRAND Project Management Plan for the construction and operation of each of the stages of GRAND.
2. Organize, direct and control the day to day activities necessary to build, commission and operate GRAND so that Project technical cost and schedule objectives are met.
3. Prepare and maintain system configuration documents including the Performance Requirements and Technical Specifications, the Technical Design Report and engineering drawings.
4. Manage and coordinate interfaces among Project Task Groups.
5. Develop and maintain a complete description of components material and labor for the construction of the Project in the form of the Work Breakdown Structure (WBS).
6. Develop and maintain an integrated resource loaded project schedule for Observatory construction.
7. Track the progress of the project cost and schedule using the WBS and Schedule and established milestones and check points.
8. Prepare progress cost and schedule reports for the Spokesperson Collaboration Board, Finance Board, and funding agencies as required.
9. Develop and implement a Project Quality Assurance Plan.
10. Develop and implement a Project Environment, Safety and Health Plan.
11. Serve as chair of the Auger Technical Board.
12. Prepare with the Spokespersons the Memorandum of Understanding with collaborating institutions contributing to the construction and operation of the Observatory.
13. Hold and allocate contingency funds.

The Project Manager is appointed by the Spokesperson, approved by the Collaboration Board and confirmed by the Finance Board. The Project Manager serves an indefinite term. The Project Manager reports to the Project Spokesperson.

### Deputy Project Manager

The Deputy Project Manager works with the Project in carrying out Project Manager responsibilities. The Deputy Project Manager acts as the Project Manager in his/her absence. The Deputy Project Manager is appointed by the Spokesperson in consultation with the Project Manager, and is approved by the Collaboration Board.

### Technical Board

The Technical Board consists of scientists and engineers involved in leadership roles in the various technical areas of the Project. The members of the Technical Board are the Spokesperson, Task Leaders and others appointed by the Spokespersons and the Project Manager. The Technical Board is chaired by the Project Manager. The Technical Board advises the Project Manager and Spokespersons on technical issues pertaining to the design, fabrication and testing of the Auger detectors, assignment of tasks and other issues as required.

### Site Managers

The Site Managers for the GRAND Project are key individuals in the construction and operation of each of the arrays of the GRAND project. The Site Manager is responsible for activities at a site both during construction and later during data taking operations. The responsibilities of the Project Site Managers are as follows. He/she shall:

1. Assume responsibility for all day to day operations at the site.
2. Hire and supervise the site staff in consultation with the Project Manager.
3. Have the primary responsibility for writing and administering contracts related to construction and maintenance at the site. All contracts will be written in consultation with the sponsoring agency and the Project Manager and approved by both.
4. Oversee the civil construction including roads, power, buildings, communication equipment, detector foundations and other site improvements.
5. Assist Task Groups in the receiving, inspection and storage of detector related equipment.
6. Oversee the deployment of the detector stations, and communications equipment. This work may be done with a combination of contractors, collaborating institutions and site staff.
7. Be the point of contact with land owners, local and state officials regarding the site.
8. Assume the responsibility for protecting the environment in accordance with the local, state or provincial and national laws.
9. Assume responsibility for safety for all project related individuals and equipment on site according to the Site Safety Manual. The Site Manager will conduct safety reviews of all incoming equipment as well as ongoing activities. The Site Manager will provide safety training to collaborators, contractors and visitors as required.

The Site Manager has the authority to exclude any individual from the site who does not follow safe work practices. The Site Manager has the authority to refuse equipment delivered to the site that he deems to be a hazard to safety, health or the environment.

### Task Leaders

The Task Leaders play a fundamental role in the construction and operation of all stages of the GRAND project. The Task Leader is responsible for coordinating all aspects of the Task from development of requirements through data taking operations. This responsibility includes administrative duties such as cost accounting, scheduling and progress reporting. In particular:

1. The Task Leaders are responsible to the GRAND Project and will report to the Project Manager.
2. Their appointment must be ratified by the Collaboration Board.
3. All contracts and purchases with Project funds above a certain amount must be approved and signed by the Project Manager according to the Project Management Plan.
4. All contracts related to activities at the site must be negotiated with and approved by the corresponding Site Manager in consultation with the Project Manager.
5. All Site labor, other than from collaborating institutions for the specific assignment of the Task Leader area of responsibility, shall be requested through the corresponding Site Manager.

Tasks can be broken down into a number of subtasks, each with its own leader. These Subtask Leaders will support the Task Leader in carrying out their duties. The task Leader reports to the Project Manager.

The responsibilities of a GRAND Task Leader are as follows:

1. Define the requirements and specifications for the components (or software) of the Task. The information shall be entered and maintained in the Performance Requirements and Technical Specifications document.
2. Distribute subtask assignments among the collaborating institutions in coordination with the Spokesperson and Project Manager. Assist them in writing a Memorandum of Understanding with each participating institution defining the responsibilities and commitments of that institution related to the particular task involved.
3. Organize and coordinate the research and development effort within the Task. The Task Leader is responsible that the results of work in the R&D phase are summarized in frequent progress reports and written up in detail and distributed to the collaboration in a timely way.
4. Coordinate the design, coding, fabrication, assembly, testing, commissioning or other activities contained in the Task description. The design of the components is to be based on the Requirements and Specification document.
5. Determine a detailed list of jobs and related resources necessary for the manufacturing, delivery and installation of components for both sites. This information is to be entered and maintained current in the Project Cost Estimate (WBS) in accordance with the GRAND Cost Estimation Procedures.
6. Develop a resource loaded schedule for activities within the Task.
7. Track cost and schedule including updates to work descriptions, cost estimates and work accomplished as the Project proceeds and provide progress reports to the Project Manager.
8. Implement a Quality Assurance and Inspection plan for the testing and acceptance of the Task components and/or software.
9. Oversee the production and delivery of the Task components to both sites.
10. Develop with the corresponding Site Manager a plan for the deployment, integration and commissioning of the Task components.
11. Develop with the corresponding Site Managers a plan for the operation and maintenance of the Task components.
12. Circulate to the whole collaboration quarterly progress reports indicating the activities of the Task group for that month.
13. Organize Task presentations for internal and Project level reviews.
14. Assume responsibility for environmental, safety and health requirements, policies and procedures for the Task.

### Subtask leaders

Each task can be divided into a number of subtasks that constitute primary components or jobs to be delivered. Subtasks leaders are chosen by the task leaders and are subject to the approval of the Project Manager.

## Commitments

### Memoranda of Understanding

Project tasks and contributions from each of the collaborating institutions are negotiated by the Spokesperson and the Project Manager. A Memorandum of Understanding (MOU) among the GRAND Project, each collaborating institution and its associated funding agency will detail the scope of work, deliverables, the level of contribution to the common fund, the work schedule, and funding arrangements. In like manner a Memorandum of Understanding for Operations is negotiated with each collaborating institution which describes specific continuing commitments to operations and maintenance of the Observatory and data analysis structure.

### Construction Funds

Construction funds for each stage of GRAND comes by way of contribution of components and equipment from the participating countries and from the common fund. The common fund is a mechanism by which countries contribute to the common procurement of hardware for the antenna array.

### Common Fund

The Common Fund is intended to cover costs of common procurement of hardware as well as some restricted operating costs during construction.

### Operating Fund

An operating fund will be established and is controlled in the same manner as the Common Fund. The use of the operating fund is highly restricted so that such funds are not to be used for expenditures properly, which are the responsibility of the Task Groups. Features of the proposed Operating Fund:

1. All participating countries would contribute to the Operating Fund.
2. The Operating Fund use is restricted to those costs necessary for the routine operation of the observatory. Operating expenses associated with the assembly, deployment and maintenance of detectors remain the responsibility of the Task Group until the Observatory has transitioned to data taking.
3. The Project Manager will submit the operating budget in September for the coming year to the Spokesperson and the Finance Board.
4. Collaborating countries contribute to the Operating Fund in proportion to the number of authors who sign publications. These authors include engineers and PhD physicists who have made a major contribution to the Project. The numbers will be submitted to the Spokesperson and Project Manager in November preceding the year for which Operating Fund allocations will be made.
5. Countries unable to contribute their share of operating funds may petition the Spokesperson for special consideration.

# Membership

## Membership definitions

### Full Member Countries

A country is a full member of the Collaboration if it has signed the International Agreement and therefore is a member of the Finance Board.

### Associate Countries

The status of “associate country” is created so as to give the possibility to developing countries to participate in the activities of the Collaboration without having strong obligations (financial or otherwise). Such a status has to be approved by the Collaboration Board. Country B may ask for association with the Collaboration through its cooperation with a full member country A. For all practical purposes, groups from country B have the same status as the associate groups (see below), particularly in what concerns the contribution to the operating costs which are the responsibility of country A. Associate countries do not have to report either to the Project Management or to the Finance Board.

### Full Member Groups

Full member groups are those having signed a Memorandum of Understanding with the Project Management. They have to be approved by the Collaboration Board. They have the duty of contributing (in kind or fund) to the detector and of operating it once built. They have direct access to raw data and are entitled to sign GRAND papers and to present GRAND results in conferences on behalf of the Collaboration in agreement with the authorship rules. Only groups from a full member country can have the status of a full member group.

### Associate Groups

Under special circumstances groups may associate with full member groups. They have to be approved by the Collaboration Board. Members of the associate groups have the same responsibilities, duties and rights as members of full member groups.

### Rules of Membership

* Each institution having at least three participating physicists and/or engineers will have one representative on the CB.
* Full members of GRAND are those institutions that have signed a MOU with the Collaboration as specified in the Project Management Plan, and approved by the CB with a simple majority.
* Physicists or engineers, supported by their home institutions, who devote a reasonable amount of their time to the progress of the project and/or the running of the experiment, are considered as participating persons. The CB will be regularly informed (by oral or written reports) on the desired or actual activities of the persons participating in the project.
* If institutions from one country do not qualify to have one representative, a group of two or three such institutions is allowed to have one representative.
* Each participating country shall have at least one representative, even if they have less than three physicists or engineers.
* Any project or experiment not directly involved with the GRAND project but which uses or intends to use GRAND as a facility may have one representative as non-voting members of the CB.
* The responsibility for selecting a representative lies with the institution or institutions involved.
* The project spokesperson and co-spokesperson, the site spokespersons, the project manager and the task managers are, ex-officio, non-voting members of the CB.
* Exceptions to the membership rules are to be agreed by the CB after a vote.

### Organization and Duties

* The CB will vote on admission of new member institutions to the collaboration.
* Each institutional or country representative will have one vote on the CB. If a CB member is unable to attend a meeting, a substitute may replace him/her.
* The chairperson and the secretary of the CB are elected by the CB to a renewable two-year term.
* The GRAND spokespersons and project manager are elected by the Collaboration Board.
* The Task Leaders are proposed by the project spokespersons and project manager and their nomination approved by the CB.
* The site spokespersons and site managers will be proposed by the host countries. Their appointment will be ratified by the CB.

### Meetings

The CB will meet at least twice a year.

A special meeting can be convened at any time on the instigation of at least one third of the CB members or of the spokesperson and co-spokesperson of the collaboration.

### Country Representatives

Each participating country nominates a country representative. With respect to the collaboration, the country representatives are in charge of the transmission of information in both directions. They have also the task of collecting the votes for their countries whenever a vote is submitted to the collaboration as a whole.

### Elections

# Project Task Descriptions

The following are the descriptions of the responsibilities of each task group.

## Radio Detector

* Mechanics
* LNA
* Electronics
* Power harvesting

## Communication

* Layout
* Protocol
* Antennas
* Electronics

## Central DAQ

* Trigger formation
* Run Control
* Event Building

## Monitoring

* Monitoring hardware
* Sensors
* Slow Control
* Alarm system

## Outreach

Basic scientific research such as what we propose with GRAND depends on public support. Informing the public of our project, it's objectives and results is therefore an important obligation. Sharing the excitement of scientific inquiry and discovery particularly with young people will help insure the vitality of scientific research in the future.

## Data Processing and Analysis

* Software standards definition -

This is the coordination of the intra tasks group responsible for the definitions of software standards.

* Data format definition -

This is the definition of interfaces between the different data analysis stages.

It tells the simulation people what they must handle to the analysis programs.

* Data processing (reconstruction) -

Coordination of work of people doing the reconstruction of events and insuring that the best algorithms get into the central reconstruction software (on which papers should be based). Fast reconstruction for use in the analysis of the quality of data collected.

* Data storage, distribution and bookkeeping -

Where and how the data should be kept, making copies available to people doing analysis, keeping track of different stages and versions of the data reconstruction.

* Database management -

This is a hybrid task, once the database should be defined by the central DAQ, but this task is the main client of it. How it is made available to people analyzing the data, keeping track of versions and all that would be the responsibility of this task.

* Data and simulation coherence -

Interface with the simulation (of detectors and showers) groups to insure that real data feed the quality of the simulation.

* Software environment -

Maintenance of a software library and a homogeneous environment for people doing analysis.

* Analysis tools -

Collecting and making available to the whole collaboration the tools developed for analysis.

## Data Management

* Data access
* Data storage and preservation
* Public Data
* FAIR policy (Findability, Accessibility, Interoperability, and Reusability)

# Cost Estimation, Tracking and Control

# Schedule Tracking and Control

# Project Reviews

# Operations

# Quality Assurance

# Data Management

# Publications and Authorship