Ref: Global Tender Notice No.PUR/IMP/NLST/01/10-11 dated 23rd August 2010.

ANNOUNCEMENT OF OPPORTUNITY

For

Detailed Design, Manufacture & installation of a 2m class National Large Solar Telescope (NLST) including Enclosure building and Dome for the Indian Institute of Astrophysics (IIA).

August 2010

Indian Institute of Astrophysics
Block II, Koramangala
Bangalore-560034
INDIA

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Detailed Design, Manufacture & installation of a 2m class National Large Solar Telescope (NLST) including Enclosure building and Dome for the Indian Institute of Astrophysics (IIA).

The Indian Institute of Astrophysics (IIA) is an autonomous organization under the Department of Science and Technology, Government of India, with headquarter at Koramangala, Bangalore, India. The Institute is a premier institute devoted to research in astronomy, astrophysics & related physics.

The Indian Institute of Astrophysics (IIA), Bangalore has plans to set up a state of the art 2 m class solar telescope – the National Large Solar Telescope (NLST), for carrying out observations from a suitable site in the country.

Broad scientific goals:

1. To make high precision measurements of the magnetic fields and plasma motions in the solar photosphere and chromosphere of small features with a spatial resolution of 70 km (0.1 arcsec) or better.
2. Since these features are in constant motion and have short life times, both high spectral and spatial resolutions coupled with high temporal resolution are needed to study their evolution on a microscopic scale.
3. It is also envisaged that the telescope will be used for night time observations over the whole sky.

NLST shall be a multi-purpose telescope which later will be equipped with state of the art post focus instruments such as:

- A spectrograph operating in the Czerny- Turner mode for spectro-polarimetry
- A high resolution spectrograph for simultaneous multi- line spectroscopy
- A Tunable Fabry - Perot filter of pass band 40 mA.
- Narrow pass band filters for H – alpha , Ca II K , CN band , G band and 1083.0 nm

NLST will be larger than the telescopes which are now close to their finalization and can benefit from their experiences. On the other hand NLST is small enough not to run into the design problems which are related to the 4m-class projects. This makes NLST a very competitive telescope which can play an outstanding role in the international solar community.

The Institute already has an observatory at Hanle in Ladakh, about 250 km south east of Leh in the state of Jammu and Kashmir for night time observations. Site characterization for NLST is currently in progress to locate a suitable site, with large number of clear sunshine hours coupled with good day-time seeing conditions. **A suitable site has been identified at Merak village, near Pangong Lake** (Longitude 78.62 E, Latitude 33.78 N, Altitude 4300 m above MSL).

A Detailed Concept Design study has been carried out and the salient features of the report are included in Section A as Technical Specifications.

In pursuance of the above, the Director, Indian Institute of Astrophysics, through this announcement, invites organizations with proven technical expertise and experience in executing astronomical telescope projects to offer their quotes for the fabrication and execution of the NLST and its associated supporting systems, as per the Technical Specifications contained in Section A.

SUBMISSION OF PROPOSAL

Proposals are invited from well reputed organizations/ consortium with proven technical expertise, track record and experience in executing astronomical telescope projects with ample experience in the field of **Manufacture & installation of Large Telescopes and development of Adaptive Optics /** equivalent technology projects to respond to this announcement. However the design and construction of Dome and building for housing the telescope may be undertaken separately by companies who have expertise in executing large structures. Submission of proposal has to be done in two stages:

1. By sending a letter of Expression of Interest (EOI). The letter of expression should contain details as per B 1.1 of Section B. The Expression of Interest shall reach the institute **within 30 days from the date of this announcement**.

2. Based on the profile, eligibility criteria as mentioned in B2.0 of Section B and technical competence of the organization, the institute will invite the qualified organizations by providing the Detailed Concept Design Report of NLST for their detailed technical analysis and to submit their offers. The offer shall be submitted in two parts separately :

    (i) Technical Bid
    (ii) Price Bid

The interested organizations have the option of submission of their **EXPRESSION OF INTEREST (EOI)** and subsequent **Technical & Price Bids** for the complete scope of work or parts of the scope of work mentioned under Section 'A'. **The price bids may be structured according to the parts mentioned in Section A with price for each part opted by the bidder. The project may be executed by an individual firm or by a consortium. Participation of competent Indian firms in the consortium is encouraged.**

SECTION – A

SCOPE OF WORK AND TECHNICAL SPECIFICATIONS

Scope of work broadly includes various phases of the activities required for realizing the telescope which has various components for carrying out solar observations.

The complete project has the following major scope of works.

1. Optics
2. Adaptive Optics
3. Telescope Structure
4. Telescope Control System (TCS) with Control Software & Thermal control system.
5. Building and Dome design (civil construction of the enclosure building and dome will be handled separately)
6. Power supply & Solar Power.

Note

The Scope of work in detail shall include complete reconfirming the available Concept Design and analysis as necessary, fabrication, installation and testing of items specified in 1-6 above, preparation of manufacturing/fabrication drawings, supervision and inspection at various stages of works for dome and enclosure building, including civil, mechanical, electrical, and electronic works etc.

Environmental conditions:

The telescope structure shall meet both the performance and functional requirements under the environmental conditions specified below. The ‘performance’ values refer to environmental conditions up to which the criteria set forth must be fully met. For ‘functional’ values, attempt must be made to meet these criteria as close as possible. The ‘survival’ values provide the extreme environmental conditions which the telescope, within its dome, and the overall super structure, should be able to withstand effectively.

Wind velocity:	Performance	up to 15 m / s
	Functional	up to 20 m / s
	Survival	55 m / s

The survival speed refers to enclosure building including Dome. i.e the Dome should be closed so that the telescope can be protected at the above wind speed.

Temperature Range:	Performance	- 25˚ C to + 25˚ C
	Functional	- 30˚ C to + 30˚ C
	Survival	- 40˚ C to + 40˚ C
Relative humidity	Performance	5 % to 90 %
	Functional	5 % to 95 %

Survival 5 % to 100 %

Access to the Site and Infrastructure Conditions:

The Scope of the Works includes a detailed assessment of transportation of the telescope and installation at the site. A Survey shall be conducted at an appropriate stage of detailed designing in order to determine the size and weight limits for the major components that need to be transported and installed at the site as a single unit.

A1 OPTICS

Although the sun is the brightest object in the sky there are never enough photons on the detector: Even though the NLST will be equipped with a powerful AO system one always wants to keep the integration times as short as possible. This helps to

a. Freeze the seeing
b. Obtain better time resolution
c. Increase the signal to noise ratio for a given integration time

Thus there is a guiding theme in the NLST optical design: High optical efficiency

Further details about the optical system are as follows.

A1.1 Optical Design

The special properties of the proposed optical design can be summarized as follows:

The number of mirrors is minimized. The system has only 6 mirrors including AO mirrors to produce a vertical focus. The small number of mirrors is due to the following facts:

- No relay optics for the AO is needed because a field lens shifts the pupil on M6. Details of the field lens and its justification is given in A1.6.
- The azimuth axis is beside M1. No reflections are needed to bring the beam into the azimuth axis below the centre of M1.
- Image derotation will be done mechanically by means of rotating stages in the building. So no optical image derotator is needed.

The proposed optical configuration of NLST is given in fig 1.

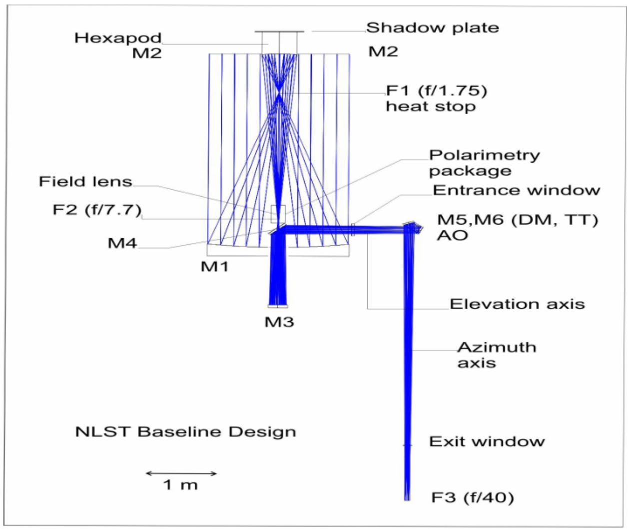

Figure 1: Schematic sketch of the optical configuration

Table1: Optical requirements and performance parameters

Aperture (primary mirror M1)	: 2 metre
Focal length of M1	: 3.5 metre
Optical configuration Total number of mirrors should not exceed 7 till the science focus	: Gregorian on – axis
Total Field of View	: 300 arc sec
Final focal ratio of the system	: f / 40
Image scale	: 2.58 arc sec mm^{-1}
Optical quality	: 80 % of energy to be within circle of 0.1 arc sec diameter or less over the field of view of 200 arc sec diameter at 5000 Å.
Wavelength of operation	: 3800 Å to 2.5 microns
Polarization accuracy Scattered light level within telescope	: better than 1 part in 10,000 : < 1 %
Active and Adaptive optics	: to realize near diffraction-limited performance; Strehl ratio >0.5 within the Isoplanatic patch
Telescope	: Alt-azimuth
Spatial resolution	: < 0.1 arcsec at 5000 Å.

The specifications of the individual components are described below:

A1.2 Mirror M1

Light weighted Zerodur as the substrate's material having the diameter of 2000mm with conic constant of -1 and f-ratio 1.75.

A1.3 Focus Unit at F1

A hole of 3.4 mm diameter limits the field of view to 200 arcsec. In principle an exchangeable set of holes allows for different field of views and also a laser illuminated fiber can be placed here which serves as a point source for alignment purposes

At NLST we have to assume a total power of about 3 kW arriving at F1 where the solar image has a diameter of about 33 mm. This yields an irradiance in the order of 2 Megawatts/(m^2). Primary mirror cooling is indicated in section 4.4.1 and a heat trap near F1 is elaborated in section 4.4.2.

A1.4 Secondary Mirror M2

M2 picks up the image in F1 and produces an enlarged image in F2. The position of M2 with respect to M1 is very critical. This is an intrinsic property of a Gregorian system. A small value of de-centre decreases the Strehl ratio significantly.

M2 should be mounted on precision hexapod stage which allows for fine adjustment. The alignment will be monitored by the wave front sensor of the AO system. M2 will be calibrated either by means of a point source in F1 or by a mathematical model.

Light weighted Zerodur as the substrate's material having the diameter of 502mm with conic constant of -0.388515.

A1.5 Intermediate Focus F2

3780 mm behind M2 a magnified image is formed at F2. Here the beam has a f-ratio of f/7.7. A FOV of 200 arcsec has a linear diameter of 15 mm.

A1.6 Field Lens

The main purpose of the field lens is to shift the pupil image out of the telescope main structure so that the tip-tilt and DM can be integrated along with the telescope. Without this field lens, integrated AO system will not be feasible with this design and hence the minimum number of reflections.

The field lens could also be used as a device to shift the pupil laterally on the deformable mirror. This "pupil guiding" might be an issue for a high order AO system. A shift range of ± 3mm would be enough to shift the pupil over two actuator pitches.

The field lens is placed 10 mm in front of F2. This defocusing causes a smearing of possible dust particles on the field lens. The PSF of an object on the field lens is about 1 mm broad in the science focus. Even though the lens is thin it introduces some chromatic effects which should be removed.

For the field lens, fused Silica may be used as the substrate material with a diameter of 25.4mm, a front radius of 500mm, and infinity back radius.

A1.7 Polarimetry Package

This device contains rotation stages in two different levels which house polarizers and retarders. Of course there are two empty positions for the use without polarimetric optics (e.g. night time applications) Polarimetry box will be of 400 mm long, 200 mm wide cylindrical structure. A polarization modulation package along with the polarizers and retarders will also be included inside this volume.

A1.8 Mirror M3

The image at F2 is transferred and magnified by M3. M3 is placed 1300 mm behind M1. It will be used to focus and to shift the focus F3 without degrading the image quality too much. There is a leverage of about a factor of 28: Shifting M3 by 10 mm shifts the focus by 280 mm and hence using this mirror, a focus shift of ± 1m is also possible.

Light weighted Zerodur as the substrate's material having the diameter of 302mm with conic constant of -0.4505.

A1.9 Mirror M4

M4 is a flat mirror which reflects the light into the elevation axis after passing M3. Since M4 is close to F2 there has to be a central hole in M4 in order to allow the light to reach M3.

The central hole has to have a projected diameter of 50 mm in order to allow a 200 arcsec field to pass. On its way back the hole would cause vignetting if only M2 would act as the central obscuration. In order to avoid this we introduce a 700 mm shadow plate in front of the telescope which stops the light which otherwise would be vignetted by the central hole.

For this mirror, Zerodur may be used as the substrate material with a diameter of 260mm, orientated at 45°, and an infinite radius of curvature. Change in wave front error is 0.07 when a surface quality of mirror is changed by 1 fringe with surface tolerance of 0.15.

A1.10 Deformable Mirror M5

The deformable mirror M5 is a central component of the Adaptive Optics system. It is placed near the pupil image which is formed by the field lens. Whereas we prefer to put the tip tilt mirror M6 in the exact pupil position we put the deformable mirror in a position 230 mm in front of the pupil. The mirror is used under an angle of incidence of 22.5°. The exact diameter of the footprint is 176.3 mm. We chose an elliptical mirror with a long diameter of 195 mm and a short diameter of 180 mm.

A1.11 Tip-tilt Mirror M6

The second optical element in the Adaptive Optics system is the tip tilt mirror M6. It is placed in the pupil plane and can be slightly smaller than the deformable mirror. M6 has to have high optical quality and at the same time has to be light weighted in order to allow for a high tip tilt bandwidth. Light weighted tip tilt mirror having the diameter of 170mm with infinite radius of curvature.

A1.12 Folding flat mirror M7

The telescope delivers a focus about 6m below the elevation axis. A removable, rotatable folding flat, M7, can be placed 250 mm behind the exit window. In the proposal this 45° mirror has a diameter of 140 mm. Change in wave front error is 0.008 when a surface quality of mirror is changed by 1 fringe with surface tolerance of 0.20.

A2 ADAPTIVE OPTICS:

It is proposed to have an in built Adaptive Optics(AO) System having 25 sub apertures and Shack Hartmann Wave front Sensor with a camera operating at 3 kHz frame rate, and a Deformable Mirror actuator stroke of 10µm. Since the proposed AO is a high order system, it is feasible to have an automatic alignment system that removes static aberrations of the system.

Following figure indicates devices controlled by the AO system. The solid line to the Deformable Mirror (DM) and Tip Tilt (TT) mirror resembles the fast (3 kHz) AO control loop frequency, whereas the other devices are driven a few times per minute or even only once per observation.

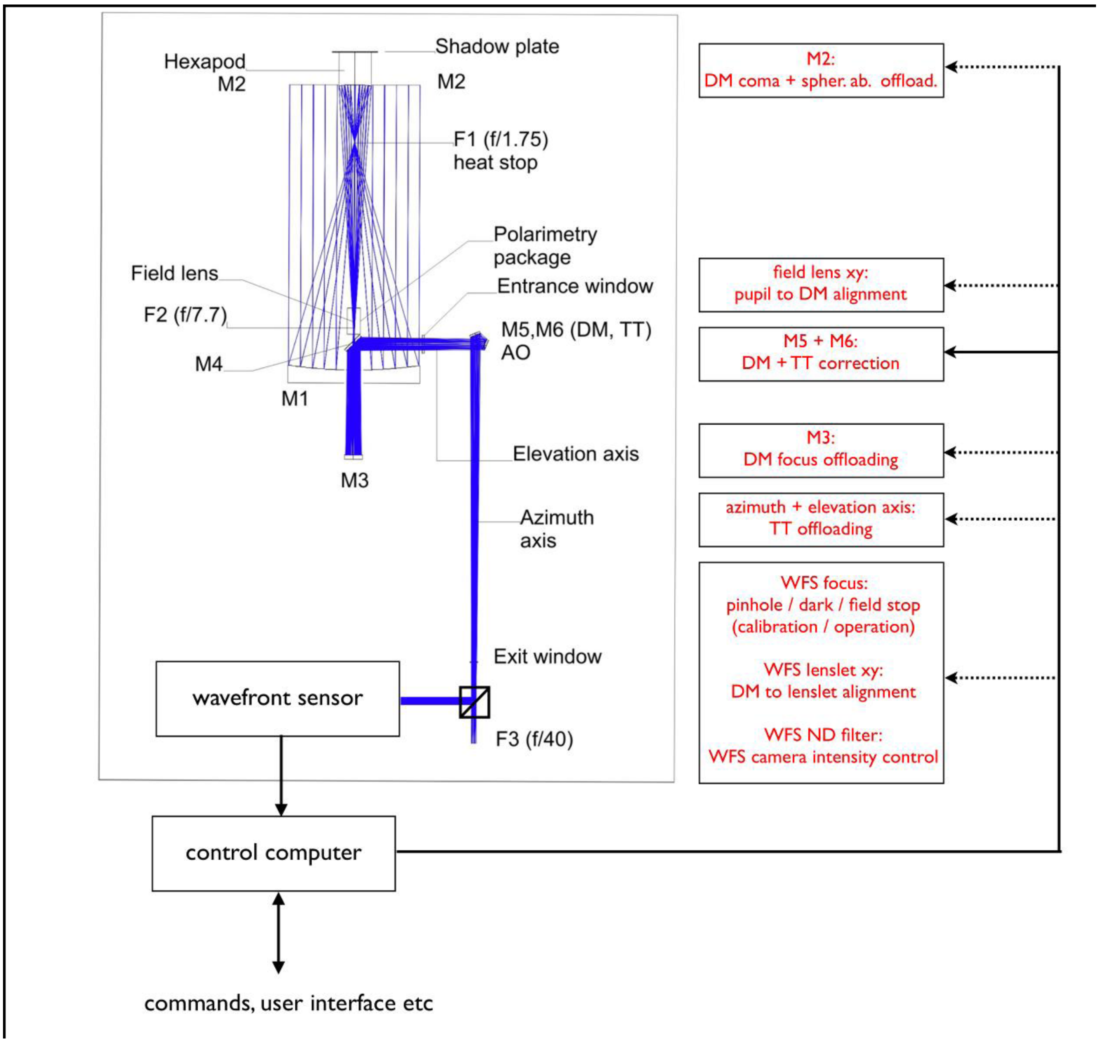

Figure 2: Adaptive and active optics control scheme

A3 TELESCOPE STRUCTURE:

The telescope structure will have a largely open truss structure carrying the telescope's optical system and all mechanical parts. The mount of the telescope is an elevation over azimuth configuration allowing the required elevation movement from -5 through +95 degree and the required azimuth movement of ± 270 degree.

The chosen asymmetric design concept for the telescope structure is driven by the layout of the optical system, particularly in regard of minimizing the number of mirrors.

Goal of the design is to minimize the structural components exposed to the outside environment during observation, particularly in regard of wind and solar exposure. Therefore it is proposed to make the elevation structure completely of carbon fiber composites (CFRP), whereas the azimuth structure and the interface ring to the tower top shall be made of steel. The CFRP makes the elevation structure very light weighted and stiff. The steel for the azimuth part and the foundation ring is mainly chosen in regard of interfaces to the mechanical subsystem as bearings and drives.

The figure below shows a full view of the telescope structure. The following components form a part of the structure.

a. Passive main mirror supports (iso-static levers)
b. Primary mirror cooling system based on off-the-shelf ventilators and chillers.
c. Structure made of conventional welded structural steel.
d. Roller bearings in both axes.
e. Geared drives with two biased units in each axis.
f. State-of-the-art servo drives.
g. one-side arrangement of the drives in elevation
h. Standard encoder in elevation
i. Strip encoder in azimuth
j. Backlash, friction, bearing misalignment compensation by sophisticated control system.

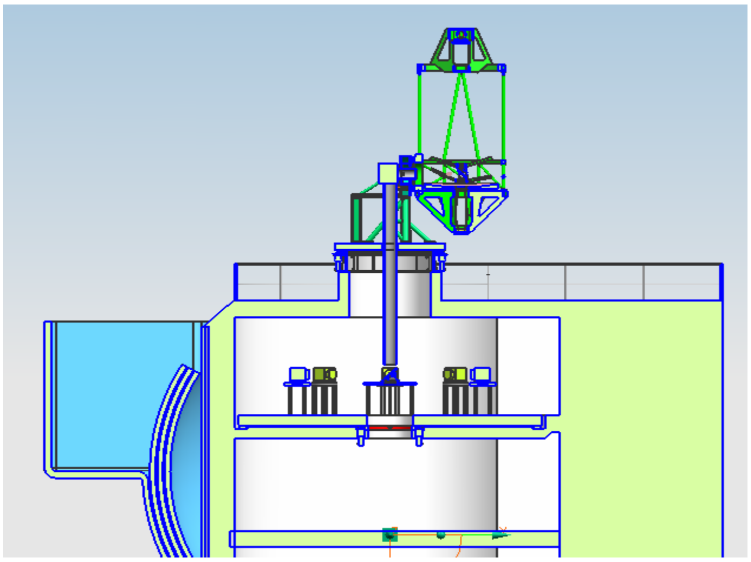

Figure 3: Cross section through telescope, instrument platform, and tower top

A4 <u>TELESCOPE CONTROL SYSTEM WITH CONTROL SOFTWARE</u>:

The design of the Telescope Control System (TCS) needs to meet stringent requirements as listed below:

- Maximum slewing velocities < 2 deg/sec in elevation and < 4 deg./sec in Azimuth
- Tracking Azimuth 1 …. 3600 arcsec / sec
- Tracking Elevation 0.05…20 arcsec / sec
- Tracking Error in 10 min time interval < 0.1 arcsec rms
- Blind Pointing Accuracy 2 arcsecs rms after compensation listed in Table 2 between 10° and 87° elevation
- Relative pointing error < 1 arcsec within 1° field on sky
- Motion range Azimuth +/- 270°. operational and functional
- Motion Range Elevation + 10° …+89.5°. operational, -5 …. +95° functional.

- The design should be based on Ethernet interface for remote control.

A 4.1 <u>OVERALL POINTING BUDGET</u>

The following table gives an overview on the resulting pointing features of the telescope. "Uncomp." refers to uncompensated by adaptive and active optics. The acronyms in the last column are explained in the next paragraph. The numbers are in arc sec.

Source and Type of Error		Uncomp.	Comp.	Comp. Technique
Environmental Influences (Steady-state)				
	Gravity	~ 15	0,2	LUT
	Wind (10 m/sec)	< 8	0,2	FBC
	Thermal	tbd	0,2	FBC
Environmental Influences (Dynamic)				
	Gusts on Structure	1,6	0,1	FBC
	Gusts on Servo	0,2	0,2	
Mechanical Alignment				
	Main Axes	~100	0,2	Alignment
	Optics	tbd	0,1	
Servo				
	Encoders	0,2	0,2	
	Drives	5	0,2	DPT
	Controllers	5	0,2	DTG
Margin			0,2	
Overall Poiting Error			**0,6**	

Table 2: Overall Pointing Error Budget (without the contributions of the Adaptive Optics)

Interpretation of the Pointing Budget:

- The elevation dependant gravity influences can be compensated by a Look-up-Table (LUT) in the main axes control system

- The steady state wind influences on the pointing should be compensated by Flexible Body Control (FBC)

- The thermal deformations have to be further analyzed. Due to the use of CFRP for the elevation structure, they are small.

- The low frequent parts of the wind gusts should be compensated by FBC (together with the steady state component as described above).

- The permanent bending of the asymmetric azimuth structure shall be compensated by adequate alignment of the elevation bearing.

- The optical alignment has influence on the pointing. Easy procedure to be developed for alignment and compensations for small misalignment to be modeled for possible correction.

- The main axes control system shall use standard compensation methods as Drive- Pre-Tension (DPT) and Dynamic Trajectory Generators (DTG)

The given values are first estimates and they need to be further modeled. Particularly the interaction with the Adaptive Optics system has to be elaborated in more detail.

A 4.2 TELESCOPE CONTROL SYSTEM (TCS) SOFTWARE DESIGN DESCRIPTION

The software residing on the control computer comprises the operating system, the real-time operating system, software tools destined for diagnosis and commissioning, parameter files, and the actual control application with a local operator console. The following diagram shows the software architecture.

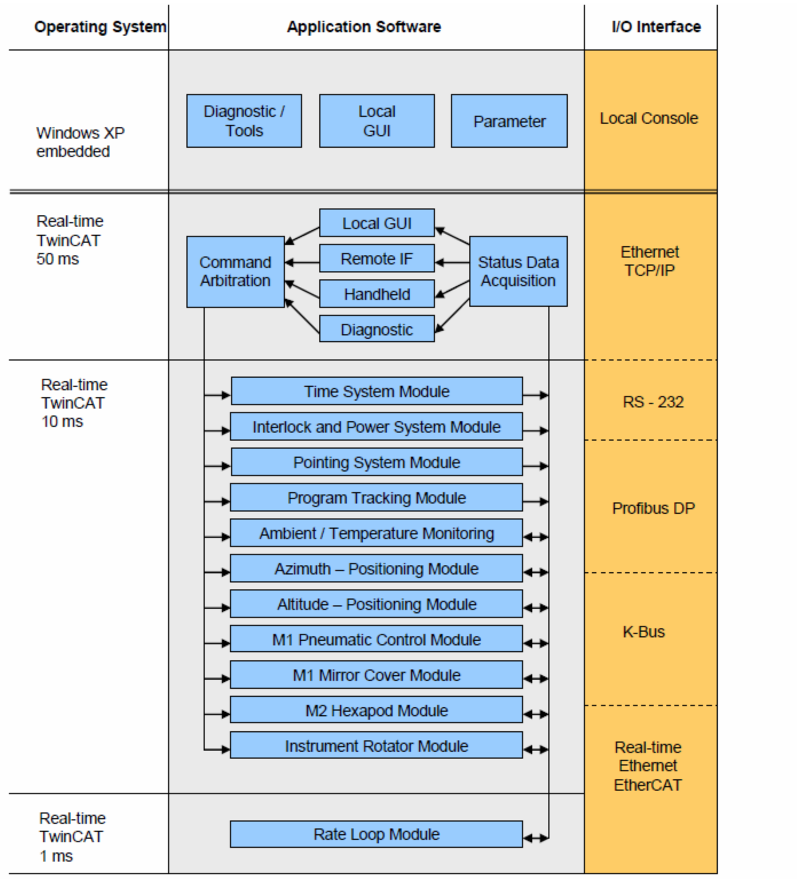

Figure 4: Overview software modules

OPERATING SYSTEM, DIAGNOSIS AND TOOLS

Suitable operating system and diagnosis tools have to be provided. The real-time operating system and the operating system preferably linux based should share the processing resources of the industrial PC.

The User Interface consists of a remote control interface, a graphical user interface and an engineering interface for diagnosis.

A 4.3 AUXILIARY TELESCOPE:

Provision for an auxiliary telescope should be made in the design. The following table summarizes the properties of the NLST auxiliary telescope.

Aperture	150 mm
Focal length	2250 mm
Image scale	91.7 arcsec/mm
Strehl at field center	0.56
Strehl 1000 arcsec away from center	0.20
Resolution	2 to 3 arcsec
Relay optics	Providing a 27 mm pupil in a collimated beam
Wavelength channels	3
Filters	Daystar
Camera	Optimized for 2k x 2k camera with 10 µm pixel size
Mechanical envelope	2500 mm x 700 mm x 200 mm

MECHANICAL MOUNTING

The auxiliary telescope including the filter devices will be mounted on an optical rail system. Filters and cameras should be put into enclosures which protects them from environmental influences.

It is used as a finder telescope in the sense that there is a cross hair on the auxiliary telescope's camera monitor and the main telescope is aiming at the cross hair's position. In that case the auxiliary telescope has to be aligned with respect to the main telescope. Because of the limited field of view in this mode the observer does not see the full disk if he moves the telescope to the solar limb.

A 4.4 THERMAL CONTROL SYSTEM

A 4.4.1 Primary Mirror M1

The mirror has to handle the impact of the solar radiation and has therefore to be active cooled. The simplest concept is to cool it from the rear by an artificial stream of cold air. For this purpose a light-weighted "honeycomb sandwich" type mirror is particularly suited. The cooling air is blown into the honeycomb cells via individual nozzles of the cooling system.

A thermal time constant of approx. 20 minutes is expected, which shall be a reasonable number, both in the dimensioning for the cooling device as well as for the environmental specification (to allow the mirror to follow sinking air temperatures in the afternoon in reasonable times, respectively with acceptable temperature differences to the air).

A 4.4.2 Heat Trap Design

Main purpose of the cooling system of the heat trap is to keep the temperature increase over the ambient at the reflecting surface as small as possible (design goal < 10 K, upper limit < 20 K). The heat has to be removed via conduction through the trap material and convection at the fluid ducts to the cooling fluid.
The design driving parameters are the thermal conductivity of the trap material and the convective heat transmission coefficient of the cooling fluid at the walls of the fluid ducts. Best heat trap material is copper with a thermal conductivity of 350 W/mK.

A 4.4.3 Improved Heat Trap Concept

Since the heat trap discussed above is limited in its performance to a remaining difference in temperature, it has been analysed to improve the concept by boosting the heat conduction from the heat stop. The proposed design makes use of a passive heat pipe element, which is in itself a small closed volume, circulation liquids and by that improving heat conduction (on the pipe level) by a factor of approx. 70 compared to the material properties of copper. The top of the heat pipe is connected to a copper plate, while the bottom would have been cooled by a common liquid (water/glycol liquid).

A 4.5 TELESCOPE DRIVE SYSTEMS

A 4.5.1 Main Drives:

Concerning the main drives in the azimuth and alt and / or elevation axes, a pre-loaded drive system will be used. Two autonomous servo motors will be electrically pre-loaded with respect to each other to eliminate the gear backlash. The positioning system operates via a high-precision encoder, which is directly installed (i.e. without any additional transmission ratio) in the main axis of rotation.
In order to achieve a maximum speed resolution, an overall transmission ratio (gear and gear rim) of approx. 3,000 is to be achieved. This corresponds to 0.0002 arcsec or 0.2 arcsec per scanning interval.

In a model configuration with six (6) reader heads and a diameter of 1,502.57 mm, the position encoder data are as follows:
Accuracy across 360°: 0.4 arcsec rms
Repeatability: 0.08 arcsec
Distance of encoder marks (signal period): 40 µm (10.98 arcsec)
Sinus interpolation (resolution): 10 bit (0.0107 arcsec)
Base distance of reference marks: 1,000 x 40 µm (183 arcmin)

Hence a larger diameter, which is very likely required for the NLST, can deliver even better resolutions as shown above.

A 4.5.2 M2 Hexapod Drive

In general the position of the M2 needs to adjust the following changes of the elevations angle as main contributor but also additional pointing model contributions like thermal effects, wind load etc. Usually the repositioning makes use of 5 degrees of freedom, only omitting the rotation along the line of sight of the mirror. Hence, a hexapod system is the standard solution. There are off the shelf products available on the market, but it needs to be carefully analyzed whether those systems can meet the requirements (especially for load and stiffness requirements) or if a custom made solution is required. Both ways are feasible and can be handled by the control system.

A 4.5.3 M1 Mirror Covering Drives

Concerning the M1 mirror cover, an industrial standard drive will be used. The drive will be switched via corresponding limit switches located at the telescope I/O system. To assure the closing after a current loss, an UPS will be used for buffering.

A 4.5.4 I/O and Safety System

With respect to the safety system, internationally certified safety bus terminals should be used. Using these terminals, it is possible to read, process, and issue safety-specific signals. By means of these safety terminals, a cascaded safety circuit will be set up. This circuit integrates emergency stop signals, emergency limit switches, watchdogs, converters and brakes to enable a safe and controlled shutdown in case of critical errors and situations.

A 4.5.5 Clock

On site accessible GPS module will be used as a clock. The clock module will be mounted in the switch cabinet. Using a BNC cable and a lightning arrester module, a mushroom-type antenna will be connected. The absolute UTC time will be read in from the control computer via a serial interface. The clock module will additionally issue a PPS (pulse per second) hardware signal enabling a fine synchronization with an accuracy of 1 millisecond, i.e. the smallest scanning period.

A 4.5.6 Telescope Hand-Held Operator Panels

The large number of tasks to be performed by means of the telescope hand-held operator panel requires a flexible hardware solution. Therefore it is proposed to use a hand-held operator panel with built-in 8.4" TFT color display (resolution: 800 x 600) and a touch screen.

A5 BUILDING AND DOME

A 5.1 Building and Dome Concept

The proposed design for the building and dome has the following design features:

- For observation, the enclosure is fully retracted below the edge of the tower roof.
- The tower roof has a maintenance platform, which can be accessed with open and closed enclosure.

- Access to the maintenance platform and the instrument laboratory via staircase or elevator
- Four additional floors for equipment, storage and living
- Circular strip type foundation

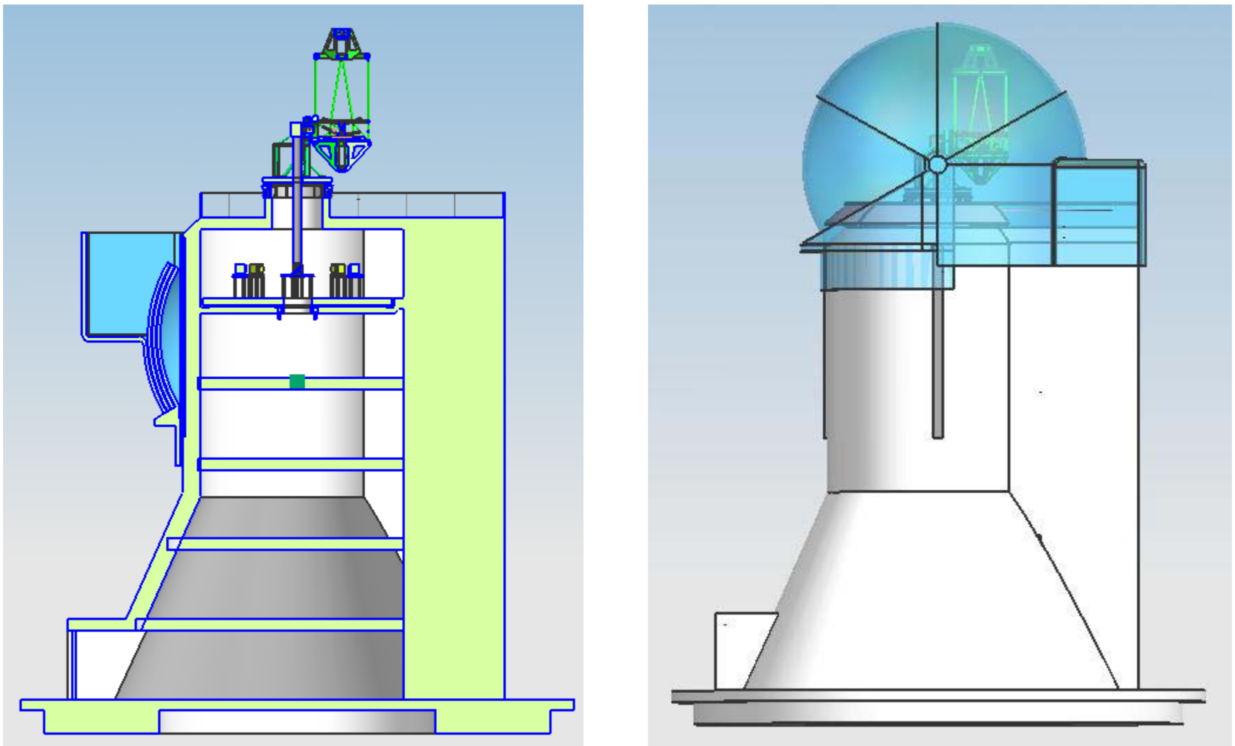

Figure 5: Tower with retractable Dome

Main design goal is the arrangement of an observation laboratory with a huge co-rotating instrument platform just below the telescope. The diameter of the instrument platform is determining the outer dimensions of the upper cylindrical part of the tower and thereby also the diameter of the retractable dome. Therefore the floor of the co-rotating platform fills completely the laboratory, it is accessible for the alignment and maintenance of the instruments, and has a diameter of 10m. The access from the outside is via the staircase or the elevator. Below the observation laboratory are four additional floors in the tower, which can be used as further equipment rooms, computer rooms, storage etc.

The tower design includes structural analysis of the tower, design of observation floor with suitable stairs, design and/or selection and specification of the industrial elevator, catwalk with stairs to reach observation floor, suitable overhead hoist for maintenance, proper ventilation system in the tower to maintain thermal stability, related electrical power distribution system, cable routing for telescope etc. Smoke alarm and lightning arrester should be included as well.

The dome consists on a semicircular base frame, which runs on three vertical tracks on the tower structure, and four retractable dome shells, which may be made of light weighted glass fibre composites. The shape of the tower platform is optimized in regard of airflow.

The tower consists on the upper part on a cylindrical concrete structure, which houses in the interior the instrument laboratories and on the outside the sliding tracks of the dome. The lower part is a concrete cone accomplishing an adequate diameter for the tower foundation. The tower has two bays for an elevator and a stair case which are attached on one side of the cylindrical part and protrude the conical part of the tower (right structure in the figures). The upper exit of the staircase and elevator is protected by a cove in the last segment of the dome shells. The entrance to the tower on ground is opposite to the staircase and elevator bay.

The height from the ground to the telescope axis is 26m. The diameter of the cylindrical part of the dome is 12m.

Civil works includes design/analysis of pier, pier foundation, foundation for enclosure structure, superstructure with necessary control room and other utilities, water supply & sanitation, conduits for electrical power cables, air ventilation system for pier, rainwater drainage and evacuation system

The foundation has to be designed in a way that its influence on the overall dynamic behavior of the telescope on the tower is minor compared with the dynamic behavior of the telescope itself. The lowest natural frequency of the telescope is assumed to be > 8 Hz. Therefore the lowest natural frequency of the tower on its foundation is claimed to be > 10 Hz.

RECOMMENDATIONS FOR THE FINAL FOUNDATION LAYOUT

The tower and foundation dimensions should be as follows:

- Outer tower diameter on ground 16m
- Wall thickness of tower 1m
- Outer diameter of circular strip foundation 22m
- Inner diameter of circular strip foundation 12m
- Young's modulus of soil > 20.000 MN/m²

The last number is the value to be achieved by the soil preparatory via piling or alternatives.

A5.2 DOME:

The Telescope will be housed in a retractable dome to provide protection from elements in the closed position and can be opened such that the telescope can point to any position on the sky during observations.

We have developed an improved dome concept, which can be completely retracted below the platform silhouette (see figure above). The dome consists of a semicircular base frame, which runs on three vertical tracks on the tower structure, and four retractable dome shells, which may be made of light weighted glass fibre composites. Every segment rests in a compact ring round the wall when the dome is retracted. The shape of the tower platform is optimized in regard of airflow.

This dome is non-rotating and can be fully automated with our failsafe control panel allowing complete remote control operation.

A 6.0 POWER SUPPLY & SOLAR POWER

A 3 x 400 V AC / 50 Hz input as assumed to be suitable for India shall be provided for the power supply, as standard. A UPS-based or redundant power supply will be used for the supply of 24 V DC, this would also be used to supply power to the primary mirror shutter drives.

In addition to the 24 V DC power packs, the power supply also comprises the current distribution (including monitoring and switching devices) in accordance with the German / US or other international standards (DIN VDE 0100). The status of the major monitoring and switching devices will be monitored within the framework of status data of the control computer. Furthermore, the power supply is equipped with appropriately dimensioned power main circuit breakers, which enable a complete disconnection of the load. Using a padlock, the power main circuit breakers can be locked during maintenance activities.

The solar power system need to be installed to cater the power requirement for the complete system by designing the solar panels required considering the site conditions and the power availability for uninterrupted observations.

SECTION ‘B’

B 1.0 INVITATION FOR EXPRESSION OF INTEREST(EOI)

B1.1 Sealed **“EXPRESSION OF INTEREST”** are invited for Detailed Design, Manufacture & installation of a 2m class National Large Solar Telescope (NLST) including Dome and building for the Indian Institute of Astrophysics (IIA).

B1.2 “EXPRESSION OF INTEREST” shall contain detailed description of the organizations including (a)Profile of the organizations (b) management structure, (c) Technical staff (d) Areas of expertise (e) List of astronomical telescope projects and adaptive optics works carried out by the organizations/partners e) The partners in the consortium (f) the above details with respect to the partners (g) Plants and equipments with the organization (h) the financial capability of the organization (i) Audited Balance sheets for the last 3 years including the partners.

B 2.0 ELIGIBILITY CRITERIA:

The organizations/ consortium should have proven technical expertise, track record and experience in executing large astronomical telescope projects with ample experience in the field of **Manufacture & installation of Telescopes and development of Adaptive Optics**. However the design and construction of Dome and building for housing the telescope may be undertaken separately by companies who have expertise in executing large structures. The organizations should have necessary infrastructure, professional manpower to carry out design, analysis and testing using modern tools/techniques. The organizations should have financial capability of handling such high value projects.

The organizations/Consortium may opt for taking up the entire project or parts of the project in which the organization is interested or having expertise.

The Bidder shall submit his Expression of Interest as per the ‘Form’ enclosed as “ANNEXURE” on his letterhead.

B 3.0 INSTITUTE INVOLVEMENT

The institute will have an option of involving in any scope of work with the organization for development of the project by mutual agreement. The acceptance of the Institute involvement shall be mentioned in the expression of interest.

Involvement of Indian Industries and/or institutes in the execution of the project may receive preference depending on the nature of work and their expertise.

B4.0 PRE TECHNICAL DISCUSSION MEETING:

The pre technical discussion meeting will be held at the Institute in October, 2010 in the presence of authorized representatives of the firms to discuss various technical/administrative issues required to submit the expression of interest and subsequent technical & price bids in complete form.

The organizations not able to attend the meeting may send their queries in writing well in advance to the Institute to discuss the issue during the pre technical discussion meeting. The minutes of the meeting with necessary clarifications/decisions will be communicated to all the organizations and also will be published in the Institute website.

Important points :

(a) The specifications of the work can be modified slightly during the design and or execution stage after consultation with the IIA.

(b) The executing organization should specify the nature of local support / help needed for installation/commissioning of the telescope at site.

(c) Detailed testing, installation, operation and maintenance manuals to be provided by the manufacturer/executing organization

(d) Size and weight of the major components of the telescope, which need to be transported in a single assembly to be determined through a detailed survey of road from the port of entry and the installation plan based on the constraints of infrastructure at the site.

(e) The organization may like to give their suggestions in order to provide the telescope as a state of art instrument.

(f) Recommended spares to be provided by the executing organization for five years after the installation and commissioning of the telescope for the materials which are covered under warranty.

(g) The components should be of such dimensions that can come in standard container of length less than 20 feet, except the primary mirror and primary mirror cell which will need special transport arrangement. This point is to be considered at the stage of design of the telescope.

(h) The supplier to provide guarantee for three years for trouble free running of the telescope. The guarantee is to be backed by an irrevocable Bank Guarantee of 5% of the project cost to be provided prior to withdrawal of final payment.

(i) Suitable procedure, tools and training to be provided by the executing organization for maintenance and alignment of the telescope optics after re-aluminization of the mirrors

B 5.0 Check List of EOI

The organizations shall need to enclose the following documents in complete with Expression of Interest.

1. Profile of the firm/firms

2. Memorandum of Understanding (MoU) of consortium/Partnership details like partnership deed etc., if applicable.

3. Documents regarding the registration of the firm with the government and also with other institutions/authorities, if any.

4. Organization chart.

5. List of Technical personnel with their qualification, specialization, total experience etc.,

6. List of similar works executed and works under progress with value of the project.

7. Photographs of the major works executed/executing by the firm.

8. Appreciation/reward letter, if any, from the clients.

9. Financial details of the firm including the audited balance sheets.

10. Any additional document/papers which the organization wishes to submit.

B6 .0 DOCUMENTS/ REPORTS.

The organization shall ensure that all the required documents/ reports as mentioned in this “EXPRESSION OF INTEREST” are attached in full & complete. All necessary catalogues / drawings / technical literature data, as may be considered essential for full and correct evaluation of the expression of interest shall invariably accompany.

B7.0 IMPORTANT DATES:

1) The pre technical discussion meeting will be held in October, 2010.

2) Organizations/consortium interested to bid for this project should first send a letter of expression of interest **within 30 days from the date of this announcement** to The Director, Indian Institute of Astrophysics, Koramangala , Bangalore – 560 034, INDIA.

B 8.0 The envelopes for EXPRESSION OF INTEREST shall bear the following.

(i) **"Detailed Design, Manufacture & installation of a 2m class National Large Solar Telescope (NLST) including Enclosure building and Dome for the Indian Institute of Astrophysics (IIA)."**

ii) The words "DO NOT OPEN BEFORE 17.00 HRS IST on 20 September, 2010

(ii) The Expression of Interest should be addressed to:

THE DIRECTOR,
INDIAN INSTITUTE OF ASTROPHYSICS (IIA),
SARJAPUR ROAD, KORAMANGALA,
BANGALORE – 560 034
KARNATAKA, INDIA

Interim enquiries may be directed to nlst@iiap.res.in.

ANNEXURE

FORMAT FOR SUBMISSION OF "EXPRESSION OF INTEREST"

Last Date for Receipt of EOI 20 September, 2010 upto 17.00 Hrs (IST).

Due Date for Opening of the EOI : 21 September, 2010 at 11.00 Hrs (IST).

Bidder's Offer No. --------------------------------

Dated --

FROM

M/s ---------------------------

To

The Director,
Indian Institute of Astrophysics (IIA),
Sarjapur Road, Koramangala,
Bangalore, Karnataka – 560 034,
India

Dear Sir,

1. We have gone through the EOI conditions pertaining to this invitation and by accepting the same: we are submitting herewith our Expression of Interest.
2. We hereby agree to supply the Stores (Telescope components/ systems) conforming to the tender specifications incorporated in Section – A of the Tender Document.

Yours faithfully,

Stamp and Signature of the Bidder

SECTION C

C 1.0 SUBMISSION OF BIDS (TECHNICAL AND PRICE BIDS):

C1.1 The qualified bidders who will receive the Detailed Concept Design Report (DCDR) shall submit their offers in TWO PARTS viz. **PART-I (Technical Bid) and PART-II (Price Bid).**

C1.2 The Bidder shall prepare original and two copies of the Bid, clearly marking each as "Original Bid" and "Copy of Bid," as appropriate. In the event of any discrepancy between them, the Original shall govern.

C1.3 Both the Original and Copies of the Bid shall be signed by the Bidder or a person or persons duly authorized by the Bidder. The latter's authorization shall be indicated by written Power of Attorney accompanying the Bid. All pages of the Bid (except for un-amended printed literature) shall be initialed by the person or persons signing the Bid.

C1.4 The Bidder's name stated on the proposal shall be the exact legal name of the firm.

C1.5 The bidder shall submit the typical work plan and the percentage of works for the similar projects executed recently.

C1.6 The Technical bids will be evaluated and the short listed organizations will be expected to make presentations of their detailed proposals to a Technical / Academic body based on the detailed design concept report to be provided by the institute. Following the evaluation of the technical bid and presentation of their proposals, the price bids of the qualified organizations will be opened to choose one of the organizations to execute the project.

C1.7 The inner and outer envelopes shall indicate the name and address of the Bidder.

C1.8 If the outer envelope is not sealed and marked as required, the IIA will not take any responsibility for Bid's misplacement or premature opening what so ever the reason may be.

C1.9 The Bidder has the option of sending the Bid by registered post or submitting the Bid in person so as to reach the IIA by the date and time indicated. The IIA will not be responsible for late, delayed Bids and loss of Bids in transit what so ever the reason may be.

C1.10 Advance copy of the Technical Bids may be submitted by E-Mail. The covering letter should be signed by an authorized person.

C 1.11 IIA reserves the right to Accept/ Reject any or All Bid without assigning any reason.

C 1.12 Any other condition or guideline for submission of the bids will be notified by IIA if necessary.

C 2.0 DEADLINE FOR SUBMISSION OF BID

C 2.1 The last date for submission of Technical and Price Bids will be notified by IIA later.

C 2.2 IIA may, at its discretion, extend this deadline for the submission of Bids by amending the Bidding Documents, in which case all rights and obligations of the IIA and Bidder previously subject to the deadline will thereafter be subject to the deadline as extended.

C3 .0 BID OPENING

C3.1 Expression of Interest shall be opened on 21 September, 2010 **at 11.00 Hrs. IST** at IIA, Bangalore. Bidders or their authorized agents can be present at their own interest when the Bids are being opened.

C3.2 Technical bid (Part I) shall be opened on the date specified by IIA. Bidders or their authorized agents can be present at their own interest when the Bids are being opened.

C3.3 To assist in the examination, evaluation of bids, the IIA may at its discretion ask the Bidder for a clarification of his Bid. The IIA may call for meetings with bidders to seek clarifications to the Expression of Interest at appropriate times at Bangalore. The request for clarification and the response shall be in writing and attend at their own cost.

C3.4 Any effort by a Bidder to influence the IIA in the Bid Evaluation, Bid Comparison or Contract Award decisions may result in the rejection of his Bid.

C4.0 CLARIFICATION OF BIDDING DOCUMENTS

C4.1 Any clarifications pertaining to this document may be obtained from IIA by the Bidders in writing at the following addresses:

The Director ,
Indian Institute of Astrophysics,
Bangalore – 560034,
Karnataka, India
Tel. +91 80 25530672-6, Fax +91 80 25534043,
Email: nlst@iiap.ernet.in

C5.0 AMENDMENT TO BIDDING DOCUMENTS

C5.1 At any time prior to the deadline for submission of Bids, the IIA may, for any reason, whether at its own initiative or in response to a clarification requested by a prospective Bidder, modify the Bidding documents by amendment.

C5.2 In order to allow reasonable time to the prospective Bidders for taking the amendment into account in preparation of their Bids, the IIA may, at its discretion, extend the deadline for the submission of CLARIFICATION OF BIDDING DOCUMENTS.

C5.3 The amendments, if any, will be notified in writing in the institute website so that all prospective Bidders who have received the Bidding documents and the amendment will be binding on them. Hence all the bidders shall view the notification in complete before submitting their bids.