Modern Engineering Trends in Astronomy – 2019

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INDIAN INSTITUTE OF ASTROPHYSICS Bengaluru

Book of Abstracts(Posters)

Table of contents

Study of Alignment Sensitivity of TMT Primary Mirror Segments on Image Quality

Abstract :

TMT is a ground-based optical/infrared telescope. The telescope utilizes a Ritchey-Chrétien optical design with 30-meter hyperboloid f/1 primary mirror. As it is difficult to make a monolithic mirror of such dimension the primary mirror is subdivided into 492 hexagonal segments each having a diameter of 1.44 meter from edge to edge. The primary mirror is having 6-fold symmetry and hence they are divided into 6 sectors. Each mirror segment is supported by segment support assembly consisting of 3 actuator and 12 capacitive edge sensor which controls the relative segment position. Any misalignment of these segments from their mean position causes a deviation from near diffraction limited performance. The algorithms for aligning and phasing these segments is similar to that of Keck primary mirror algorithms with few modifications. Keck is a 10- meter class telescopes with 36 hexagonal segments with 492 segments TMT algorithm has to process large amounts of data. An attempt was done in the present work to simulate the sample of TMT model using Python and thereby determining the PSSN (Normalized Point Source Sensitivity) for different segment perturbation, further clustering these values for creating a database for better error analysis using neural network algorithm.

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Non-spherical representation of optical surfaces - an advanced study

Abstract :

In general a majority of optical system used conventional spherical surfaces as it is easy to make and characterize. Though advantages of using non-conventional surfaces such as aspheric, freeform are being well known since primitive era of geometric optics. The recent progress in high precision engineering technology continuously demanding these surfaces in order to meet stringent optical design requirements. However the right choice of representation of these surfaces is not easy and sometimes may lead to fabrication and metrology criticality which directly push the cost of the optics. In this document different type of non-conventional surface representation with their advantages and disadvantages is being covered

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Closed-loop control of Filter Wheel for 70 cm GROWTH telescope

Abstract:

The GROWTH (Global Relay of Observatories Watching Transients Happen) – India telescope at Hanle in Ladakh is India's first effort towards a fully robotic telescope. It is also the first one dedicated for a rapid follow-up of transient events in the universe. Mounted in between the CCD camera and the output port of the GROWTH telescope is a filter wheel which houses 6 filters whose centers are located on the same pitch circle. These filters are rotated into position in a specified sequence by a stepper motor coupled to the filter wheel shaft. A closed-loop control system has been designed to rotate the filter wheel and ensure that the correct filter is positioned before the camera in the required sequence, in line with stringent performance requirements. This system is realized with a 16-bit dsPIC33F microcontroller. TheQuadrature Encoder Interface module is used to interface with an optical encoder attached to the filter wheel shaft. The Output compare module on the microcontroller has been used to generate the pulses to the stepper motor driver which will be used to move the stepper motor. The stepper motor rotation is ramped by varying the frequency of the pulses from pre-defined maximum to minimum frequencies to reduce the inertial effects of the filter wheel. An algorithm has been designed to calculate the shortest distance between any two filters and rotate the motor accordingly in either direction. As a marked improvement from the previous system, an interrupt system has been designed to ensure that the encoder values and desired position match with a very high accuracy. The electronic components have been carefully chosen keeping in mind the low temperatures of the observation floor of the telescope at Hanle. A GUI has been designed to allow the user to select the required filter, after which, the filter wheel is rotated to the position within 6 arcseconds of the position in a maximum of 25 seconds.

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Concept Design of retractable dome for the proposed 2m class National Large Solar Telescope

Abstract:

The National Large Solar Telescope (NLST) is a proposed 2 m class telescope dedicated for making high resolution solar observations. A suitable site has been identified at Merak village, near Pangong Tso Lake in Jammu & Kashmir state, India.

It has been observed that installing a telescope near the lake produce good images during the day time observations. At the same time the open dome conditions help to reduce the “dome seeing effect”. The absence of dome around the telescope also ensures that no temperature gradient is created around the telescope and the cool breeze without any obstruction, helps to cool the telescope structure and mirror. In this paper, we present a number of design concepts of retractable dome for NLST, their functionality, time taken to open and close the dome, power requirement, weights etc. Keywords: Dome Concept Design, Retractable dome, National large Solar Telescope

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Recent and Future development of Far Infra-Red (FIR) Balloon borne experiment

Abstract :

T100 is a TIFR 100 cm balloon borne telescope which is used for the FIR observation with the Japanese Fabry Perot Spectrometer (FPS) as a focal plane instrument. FPS is tuned to the [CII] line at ~158 micron to study Galactic star forming regions. T100 along with FPS is being flown regularly from TIFR Balloon Facility, Hyderabad. The FPS consists of two Fabry Perot Interferometer, one with movable plates to scan the wavelength and the other with fixed plates which acts as an order sorter. FPS is operated in two primary modes as chopped and unchopped modes. In the chopped mode, secondary mirror of the T100 telescope wobbles at the 10 Hz in two different positions such that in one position, telescope is focused on the region of interest and in the other position, telescope is pointed to the blank sky. This helps us to subtract the background emission and to get meaningful results. In the unchopped mode, background subtraction is done separately without wobbling the secondary mirror. Telemetry and Tele-command systems are currently in the process of upgradation, as the existing hardware is quite old and needs modifications. We designed and developed a micro-controller based encoders which can be interfaced with the windows OS. We developed a software in LabVIEW to receive the telemetry data over the Ethernet (as UDP packets) and plot them as per our requirements. We have also developed an onboard telemetry data storage module using the single board computer which is under test. We have also developed an offline telemetry data analysis software in the LabVIEW which operates in the file I/O mode. This helps us to understand the telemetry data using a standalone computer or laptop, without using the bulky data playback system at the balloon facility at Hyderabad. The present single pixel FPS focal plane instrument is planned to be upgraded to 5x5 FPS array, which would improve resolution of image from 90” to 40“. This would need change in the Telemetry data rate, frame formats, command rate and command format, data analysis software etc. These changes will be done on both the onboard and ground based systems.

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RASCAL (Reflector Antenna Sensitivity Calculator) Software

Abstract :

G/Tsys defines the sensitivity of a radio telescope and is an important figure of merit. It is important to know the overall antenna efficiency and system noise temperature of the telescope in order to calculate the G/Tsys. In order to calculate the G/Tsys for uGMRT bands, a Software was developed in-house at GMRT-NCRA, named as RASCAL (Reflective Antenna Sensitivity CALculator).

This paper presents the G/Tsys calculation of any single-dish radio telescope (Prime Focus feed/ Cassegrain Feed) using it is a software and can be used for any other Reflector antenna. Some basic inputs like primary Dish dimensions (F/D, Dish diameters, angle of quadruped, feed house area, etc), Radiation pattern of the feed, LNA noise temperature and receiver losses are required to compute antenna overall efficiency, system noise temperature and finally G/Tsys and secondary Radiation pattern of single dish. The program was also used to calculate the G/Tsys of other radio telescopes in order to cross verify the results and the results were found to match closely

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Power and Heat Management of New Era Electronic Systems (GMRT)

Abstract:

Heat and Power Management of new era Electronic Systems” With the developments in Electronics device technology and software based modern design tools, signal processing systems are becoming compact and powerful. These developments alongwith the advent of high speed computers and software based signal processing, the per cubic feet power consumption and heat generation in modern signal processing systems has thrown up new challenges to designers. Dissipating the generated heat, needs special efforts and planning to continue to use the systems with their maximum capacity. Accomodating multiple systems in a small room makes it necessary to use the specially designed electronic cabinets with suitable arrangements for signal, power distribution while allowing free flow of cold air to take away the generated heat within the units. During the development of the upgraded GMRT Backend systems, we also faced the task of supporting continued observations using the legacy backend systems and develop and install the new systems without affecting the old receivers. It is also

challenging to meet the electric power requirements of these systems in safe, secure and disciplined way. In the GMRT receivers sytem, the legacy 32MHz bandwidth digital backend and the new 400 Mhz digital backend consume about 15 KWatts of power each generating a heat of 4,30,000 calories/minute. We have modified the standard 19” racks to make them suitable for handling this heat generated within the racks. We have developed a cost effective solution to provide a cool air supply through the circuits and maintain the temperature.
Here we present the details of the system developed, analysis and test results. As part of this activity an automatic calculator is also developed to calculate the heat genetated in calories/minute and the amount of cooling needed to maintain the temperature.

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Filter integrated Low Noise Amplifier to suppress out of band Radio Frequency Inference

Abstract:

Radio Telescope Operating at Low Frequency suffer from various commercial transmission outside the observing ban. Low Noise Amplifier being the first device to receive the Radio signals easily get saturated due to the out of band transmission and become impossible to carry out useful Radio Astronomical observation. In addition to saturation the out of band Interfering signals produce in band Intermodulation product. Placing a band pass filter after the LNA do not reduce these products and prevent from saturation of LNA. Similarly placing the band pass filter before the LNA will degrade the Receiver performance. The paper present a LNA design with Low Pass Filter integrated between the amplification stages of the LNA without degrading the Noise Figure of LNA. The LPF cuts off the out of band RFI and prevent early saturation of the LNA and reduce the intermodulation product in the band. The designed LNA for frequency 120-245 MHz have a gain of 35 dB and Noise temperature of 40 K with a 80 dB rejection for the Interfering mobile signal.

Reference: 1. Swarup, G. et al., The Giant Metrewave Radio Telescope. Curr. Sci., 1991, 60, 95–105. 2. Yashwant Gupta, et al., The upgraded GMRT: Opening new windows on the radio Universe. Curr. Sci., 113(4):707-714 • January 2017.

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Reducing effects of cross talk in a Radio Telescope using Walsh modulation

Abstract :

The signal flow chain of a typical radio telescope receiver consists of various sub-systems viz. feeds, front-end electronics, signal conditioning circuits, signal transportation to central station, baseband conversion circuits, and digital back-end receivers. There are strong possibilities of spurious coupling of signals from one to the other signal chains at various locations. Since a radio telescope is a very sensitive instrument, such cross talk can seriously affect its usefulness and capabilities. A suitable method for reducing the effect of such cross talk is Walsh modulation and demodulation scheme. The suggested scheme utilizes phase modulation of the received signals using ortho-normal patterns at the front-end receiver of the antenna, and demodulating them just before combining the signals from antennas in the digital back-end. It is very important to match and align the modulating and demodulating patterns, else this can lead to loss of coherence of the desired signal. This poster describes the scheme proposed for the upgraded GMRT receivers that are currently under installation. We also present the tests carried out and the results obtained.

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Single Antenna Receiver Design for Radio Astronomy

Abstract :

The single dish telescope is a basic building element of radio astronomy that can be used for trying new concepts like FPA (Focal Plane Array), Pulsar & VLBI experiments and by enthusiastic students to get hands on experience. The single dish telescope receiver chain consists of various sub-systems viz. feeds, frontend electronics, signal transportation system, analog back-end system (signal conditioning circuits, down conversion circuits) and digital back-end. The front-end system may differ in frequency of operation viz. Lband, X-band, S-band. The back-end system consists of analog back-end and digital back-end. The analog backend is a dual polarization system with frequency down conversion, bandwidth selection and gain adjustment features. The digital back-end system is used as a spectrometer and for pulsar & VLBI observations. Remote radio quiet zone is chosen for antenna site and unlike in array of telescopes operation of all antennas can simultaneously controlled & monitored from center station, single dish telescope control is at antenna site. Hence reliability is important due to remote location and manpower availability.

The single dish receiver system can be used on full time basis in existing antennas viz. 15m NCRA campus and possibly with unused/experimental communication dish in various organizations. The system can be a piggy back on partially used antennas. We are in search of and in talk with some

organizations to revamp their telescope back-end. The receiver setup can be used by any universities in their campus all over country and will be in public domain for encouraging it's use.

The receiver systems for 15m dish at NCRA operates at L-band and going with other telescopes will give access to extended frequency range and will be useful to get experience to build back-ends for them. The 15m dish receiver system has real time spectrometer and 10Gbe raw voltage recording facility for offline analysis. Various features and modes of back-end system and test results will be illustrated in the poster presentation.

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Characterization of Upgraded Frequency Standard for the GMRT Observatory

Abstract:

An Active Hydrogen Maser (AHM) unit was recently installed and upgraded the frequency standard of the Giant Metrewave Radio Telescope (GMRT) observatory. The ultra-low phase noise and stability characteristics of this AHM have facilitated the observatory to carry out Very Long Baseline Interferometry (VLBI) observations. The outputs from the AHM are used as a precision frequency reference for the GMRT signal processing receiver chain particularly for synchronizing sampling clocks for the digitizers and as a reference to the computing cluster.

The AHM is housed in a room, specifically designed considering the environmental parameters such as ambient temperature, mechanical shock and vibrations, magnetic and RFI shielding. Continuous monitoring and remote logging of ambient room temperature, current requirement as well as other vital AHM parameters are being carried out using tools developed in-house. The software tools are also developed to record the phase data between the GPS disciplined Rubidium oscillator and AHM to compare and understand the stability parameters.

To understand the long term characteristics and behavior of the AHM, collaborative effort is initiated with ISTRAC-ISRO. Through this collaboration, the GMRT timescale system is built with the help of ISRO timescale instrumentation setup. GMRT timescale system had the AHM unit, GPS disciplined Rudium oscillator and two free-running rubidium oscillators and common view GPS systems.

This presentation will explain the characteristic understood of the Maser Unit with the help of GMRT Timescale system giving the brief of present Phase noise, stability, drift characteristics of the AHM system. Also, the presentation will walk-through the future plan and collaboration with other Institutes within India for the performance evaluation of AHM.

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Advanced technology used in LIGO

Abstract :

LIGO (Laser Interferometer for Gravitational-Wave Observatory) is one of the technological marvel involving world's advanced technology. It has overcome many difficulties to achieve one of the finest scientific measurements ever taken precisely. Its extreme engineering can be divided into different domains including mechanical structures, optics, civil engineering, physics, geology, electronics, high performance computation,analysis, testing, etc. Some of the following are the advances in LIGO experiment: Vacuum tubes: The vacuum tubes are world's third largest vacuum tubes having one trillionth of pressure as that of the atmospheric pressure carried by very thin walls for 20 years now. Its a blind L shaped 4 km long tubes and it took 40 days to achieve this vacuum. Also it is second in the world for having Ultra-High vacuum in the tubes.

Sensitivity: It is able to measure motion 10000 times smaller than the atomic nucleus. It has some of the best seismic isolation and dampening systems e.g. HAM AUX. Its accuracy of measuring the distance of the nearest star (4.2 light years) is smaller than the human hair.

Civil Construction: The length of the tubes is 4 Km long. While construction care had to be taken to overcome the Earth's curvature of about one meter by pouring concrete. Also CFD models were taken into account while constructing the structure to cancel the wind load effect on the tubes giving rise to vibrations. Optics: LIGO's main mirror absorb only one photon out of 3.3 million photos. The test masses each weigh 40 Kg giving acting as large inertial masses to resist vibrations upto certain level. The test masses are coated with many optical coatings and polished to a nanometer smoothness. There are 280 reflections before reaching the photo detector.

Laser: It uses electricity to generate 4 watt near-IR laser. It is 800 times more powerfull than off-the-shelf laser pointers. The control and use of this laser is a very complex game of optics and electronics.

These are very few engineering marvels involved. It has many important and complex electronics and computers involved in its complete operation which can be studied and discussed in detail.

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GMRT back-end system monitoring system

Abstract:

Giant Meterwave Radio Telescope (G.M.R.T) back-end system is installed in three different locations correlator room, new receiver room and Active Hydrogen Maser (A.H.M.) room there are many critical electronics components whose electronics circuits are susceptible to variations in environmental parameters such as temperature, humidity and supply voltage etc. Hence a real time 24/7 monitoring of these parameters along with warning alarm is essential the monitoring system developed also provides recording and plotting of the data on a web based interface.

A.H.M. and the related time and frequency circuits are extremely critical in ensuring proper operation of G.M.R.T. system. The proper working of these circuits depends on stable environmental parameters. We have installed comprehensive monitoring scheme for the A.H.M. which can monitor temperature, relative room humidity, and mains supply voltage along with monitoring of proper operations of air conditioners installed. For safety and security we have also included CCTV based monitoring for the room. The temperature is monitored at different locations of the room.

We have also developed web based application to monitor various internal parameters of A.H.M. and give warning, plotting program is also developed to see the performance over time. An integrated health monitoring scheme of the back-end receiver is developed which monitors the parameters of the back-end electronics and power level of received signals at different locations.

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Prototype for raw voltage recording in the backend system of the upgraded GMRT

Abstract :

The GMRT Wideband Backend (GWB) combines the Baseband signals of all antennas and gives out the visibilities in each of the baselines. The Baseband signals are digitized and coarse correction of geometric and astronomical delays is performed before converting the time domain continuous samples into frequency domain. In the frequency domain, the fine delays are compensated by proportionate phase rotation and the signals in each baseline are multiplied and then accumulated. The resulting visibility spectrum is stored for offline processing. The hardware of the GWB consists of FPGAs, CPUs and GPUs. This hardware has been frozen as per the observatory requirements. Due to hardware limitations the digitized data needs to be accumulated before storing them on the Hard Disk Drives and cannot be processed directly in real time. The raw voltages if recorded will give astronomers the

flexibility to analyze the data using their own algorithm/software. This will also lead to the development of new observatory modes which require raw voltages for data analysis

The final aim of this project is to record the raw voltages from the antenna which is sampled at Nyquist rate on the Hard drives installed on a computer. The writing speed of the disks is the major bottleneck in the data recording. Hence as a precursor to the raw voltage recording project it is essential to find the maximum speed at which the data can be written on the Hard drives of a computer and enhance the data recording speed if needed. In addition to the writing speed of the Hard drives a huge volume of the data has to be recorded on the drives.

As a prototype of the raw voltage system a RAID0 of the hard drives is done on a server to overcome the problems of speed and volume limitations of Hard Disk Drives. RAID0 is a technology that is used to increase the performance and/or quantity of data storage. The abbreviation stands for Redundant Array of Inexpensive Disks. A RAID system consists of two or more drives working in parallel.

Upcoming technologies such as the NVMe SSDs are also being explored which increase the writing speed upto 35 times as that of the standard Hard drives.

The poster presentation explains the setup of the prototype system and shows the test results of the system. It explains the methodology used to show that all the packets coming from the network to the node is written on the hard disk drive without any data loss. Upcoming technologies in the field of data storage are also discussed in the poster.

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Towards an Optimal Real-time Broadband RFI Filter for the Upgraded GMRT

Abstract:
Broadband Radio Frequency Interference (RFI) is one of the main reasons for corruption of astronomical data observed using the Upgraded GMRT (uGMRT) at frequencies below 700 MHz. A real-time RFI excision system, operating on Nyquist-sampled digital time-series per antenna and polarization, has been implemented as part of the GMRT Wideband Backend (GWB). The system, implemented on FPGA, computes robust standard deviation and detection threshold using Median-of-MAD (MoM) estimator. The RFI samples are replaced by digital noise samples. We describe the techniques for simultaneous acquisition of data with and without the filter for the interferometer and beamformer modes of uGMRT and present results from the tests. We show the effect of filtering on the signal-to-noise ratio, cross-correlation function and closure phase for the interferometric data. The system-level aspects and the tests carried out to fine-tune the filtering parameters would be described.

To understand the filtering performance on imaging, we carried out test observations on calibrator radio sources and extended sources from June 2018 to August 2019. Typically 1 − 5% of the samples (at 2.5ns time resolution) are found to be affected by broadband RFI filter during monsoon when the broadband RFI is stronger. Our offline data processing pipeline used for imaging utilizes the Common Astronomy Software Applications (CASA) software tasks customized for use with the uGMRT data. The spatial cross-correlation spectrum (visibilities) at short baselines show significant improvement in the form of the reduced standard deviation on the visibilities by factors of two or more and consequently improved image fidelity. We have also quantified the decorrelation introduced in the data due to the digital noise replacement. We are currently testing a strategy for optimizing the filter based on the engineering and imaging test results. The online RFI filtering system is planned to be released for the users of the uGMRT.

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Opto-mechanical design and analysis of Cubesat based NUV Spectrograph

Abstract:

A NUV (1800-3000 Å) spectrograph has been designed to investigate the diffuse nebulae and other extended sources. The spectrograph has been designed to fit into a 6U form factor (350 × 240 × 150 mm) Cubesat and will be launched into a low-earth orbit (LEO). Optical design, optimization, and tolerancing have been completed. Designs of mounting elements are in progress; stringent volume considerations restrict the optomechanical design of various subsystems. In this work, we present some of the work we have done in modeling the subassemblies and system-level assembly of the Cubesat. We have adopted an analysis methodology in such a way that we design each component and model by applying Finite Element Analysis using Ansys® software. Find the resulting deformations, validate the model and incorporate the corrections and improve it. The cycle will continue until we have a model with optimal performance. Once the subsystem level analysis is completed we will re-initiate the same model for complete system-level assemblies to improve and validate the design. Our aim is to arrive at an optomechanical model of the system such that it is reasonably lightweight and does not affect the optical performance of the spectrograph both in terms of mechanical integrity and thermal performance.

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Reliability Study of GMRT Analog Backend Receiver System

Abstract:

Reliability means the probability of the system to perform a required function without failure under stated conditions for a stated period of time. Reliability study is essential for electronic systems. Hence, this study is applicable to a radio telescope receiver. Giant Metrewave Radio Telescope's (GMRT) receiver system consists front end (FE), antenna base receiver (ABR), baseband (BB) and Digital. Also, systems peripheral to the receiver systems are servo, feed positioning, telemetry systems. All these systems are design-wise identical across 30 antennas. ABR and BB systems include local as well as master oscillator systems. These systems have control and monitoring electronics as well. Several types of units i.e. amplifier, oscillator, filter, mixer, switch, attenuation, power supplies form an interconnection. Such multiple active-passive devices and components are connected through RF cables and connectors. Hence the receiver system assembly becomes diverse and complex and hence understanding its reliability becomes crucial.

GMRT, as part of its day-to-day operation, is keeping a record of functional performance of all systems through a callsheet database. Using the data from the same, reliability performance is studied of old (32MHz) and new (400 MHz) Analog back end systems. Studying mean time between failures over a certain duration and plotting performance with respect to time, prediction of quality performance is done for GMRT Analog back end receiver systems.

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Telescope Automation And Control

Abstract:

1.04M aperture optical telescope named as Sampurnanand has been installed as the one of the main observing facility in optical domain at, Aryabhatta Research Institute of Observational Sciences Manora Peak, Nainital. The 104-cm, f/13 telescope produce a field of around 45 arcmin with corrector at the cassegrain end. the total research output of the 104cm Sampurnanand Telescope reaches nearly 364 scientific publications in different refereed journals and 45 PhD Thesis. The telescope is covered by a spherical dome with a slit opening for observation. The dome and the telescope are rotated and moved accordingly in order to take observations. This paper presents the work on the control system and movement control of the telescope using PIC18F4431 microcontroller of 8051 family along with Gurley Models A19 Absolute Rotary Encoder which had resolution up to 18 bit and gave an SSI output.The code was compiled and run using ICD-3 debugger and MPLABX IDE v 5.25 and xc8 compiler.A pair of SPDT relay's was used to change the direction of a DC motor.The raw data as acquired from the data acquisition software is transfered to the another PC meant for archiving the 40-

inch data. Transfer is done through ftp or windows PC sharing facility. It’s faster and more accurate than any resolver-based system. This paper presents the use of mentioned electronic components to control Sampurnanand Optical Telescope, ARIES, Nainital.

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Monopole antenna for detecting the signal during Cosmic Dawn to Epoch of Reionization – Current status

Abstract:

Cosmic Dawn to Epoch of reioniztion is a period which began in the history of universe, with the formation of stars for the first time and ended in transforming completely the neutral state of hydrogen to ionized state. Thermal history of the universe during this era is currently poorly understood. The 21cm line of neutral hydrogen is considered as a power tool to probe this era to gain better understanding of it. Its intensity variation as a function of time is predicted to carry information about various physical processes responsible for either heating or ionizing the intergalactic medium. This signal could be detected by measuring the spectral distortion imprinted by the signal in the spectrum of the cosmic microwave background radiation over the frequency range of 50-200 MHz. The magnitude of these distortions is orders of magnitude weaker than the Galactic and Extragalactic foregrounds and hence measuring them in the presence of foregrounds is challenging.

Several factors of an antenna used for the detection often mask the desired signal. They either make the antenna insensitive to the signal or produce undesired features in its spectral response which would mimic the signal under detection. Reflection efficiency, radiation efficiency and spectral smoothness in impedance characteristics and radiation patterns are the three primary factors which predominantly govern the detection process. It is desired to have reflection efficiency better than 10%, radiation efficiency more than 50% and spectral smoothness at a few parts in a million over 1:4 band of 50-200 MHz. It is difficult to achieve these simultaneously over a large bandwidth because of their complex dependencies on i) physical dimensions of the antenna and ii) media around it. In this talk, I present the recent progress made by us in the antenna design, experiences in simulation and prototyping and the measurement results. Our work continues towards constructing a broadband antenna with all the desired features at metre wavelengths.

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Radio telescope observation planning using machine learning techniques

Abstract:

Low frequency radio telescope observations suffer from time varying interference from the neighborhood. We plan to extract radio spectrum features through a statistical analysis and develop machine learning techniques to make predictions about available good-band regions for an observation schedule. We consider routine monitoring of signals across a broadband and use noise characteristic analysis to classify and rank the frequency bands. The results will be stored in a database and once a sufficient data set is available, we will explore possibilities of feeding the data through a layers of dimensional analysis and clustering algorithms to classify and predict the probability of a selected band being a good choice for a radio astronomy observation that is scheduled in a near future. This is an on going work, and we will present the details and current status of this work in a poster.

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An overview of Analog Receiver System for Detection of Global EoR Signal

Abstract:

SARAS is an ongoing experiment aiming to detect the redshifted global 21-cm signal expected from Cosmic Dawn (CD) and the Epoch of Reionization (EoR). Standard cosmological models predict the signal to be present in the redshift range z ~6-30 corresponding to a frequency range of 40-200 MHz, and as a spectral distortion of amplitude 20-200 mK to the cosmic microwave background. Design of a radiometer for detection of this weak signal is a challenging task, owing to the fact that this frequency range is dominated by astrophysical foregrounds of Galactic and Extragalactic origin, with several orders of magnitude greater brightness temperature and strong terrestrial Radio Frequency Interference (RFI). It is critical that the instrumental systematics do not preclude the measurement of the weak 21-cm signal via additive or multiplicative confusing structures in the measured sky spectrum.

Here, we present the system design of the SARAS 3 version of the receiver, emphasising on the receiver configuration and the signal flow from the antenna to the digital backend. We touch upon the aspects on the system design and laboratory measurements. New features in the evolved design include Dicke switching, double differencing and implementation of optical isolation and optical switching for improved accuracy in calibration and rejection of additive systematics leave no confusing systematic

structures at a level of a few mK. We review the design and engineering challenges involved in the deployment of the system in field for sky observations with future plan of action.

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Configuration Design for a Prototype Segmented Mirror Telescope

Abstract:

To cater the need of growing astronomical community of India, there is a proposal to realize a 10-12m size optical-NIR telescope, equipped with state of the art back-end instruments. With the current technology, it is not possible to realize a monolithic primary mirror required for such a large telescope. This necessitates use of smaller mirror segments aligned to act like a single mirror. Since the Segmented Mirror Telescope (SMT) is yet to be realized in India, it is essential to realize a Prototype Segmented Mirror Telescope (PSMT) of smaller size to understand the complexities of design, fabrication, assembly and testing of a SMT. This will help to reduce the cost, time and risk for realizing the full size (10-12 m) SMT.

With this in mind, design of a 7 Segment PSMT having hexagonal mirror segments of size 500mm each and overall aperture of about 1.5 m, is initiated at IIA. After considering various aspects of a PSMT, a configuration is designed which is now undergoing fabrication. Some of the mechanical aspects of the design of this PSMT are presented in this paper.

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21 cm Horn Receiver

Abstract :

We have developed a 21 cm receiver based on a horn antenna and RTL SDR, and successfully detected the 21 cm line emission from different directions. The design details and results will be presented in this poster.

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