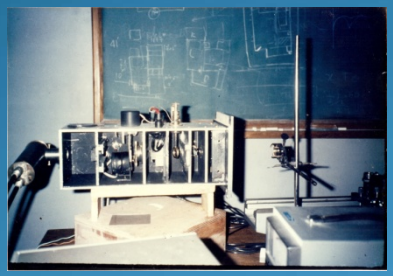
Overview of the Instrument & Technology development at IIA (Past,Present,Future)

Coating Plant

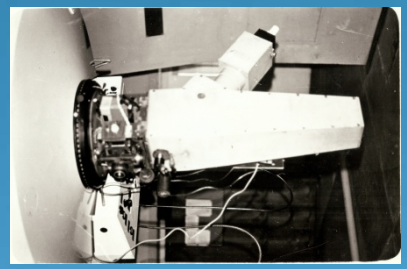
2.34M Primary Mirror Inspection

Kodaikanal Solar Telescope

High Resolution Spectroheliograph

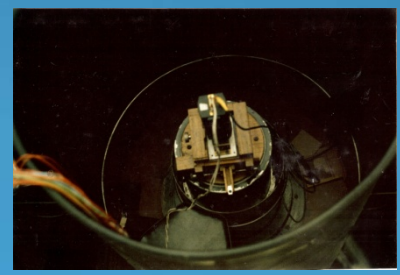


Photometer



Eschell Spectrograph 1 Meter Telescope

1 Meter Telescope Photometer Scanner Spectrograph



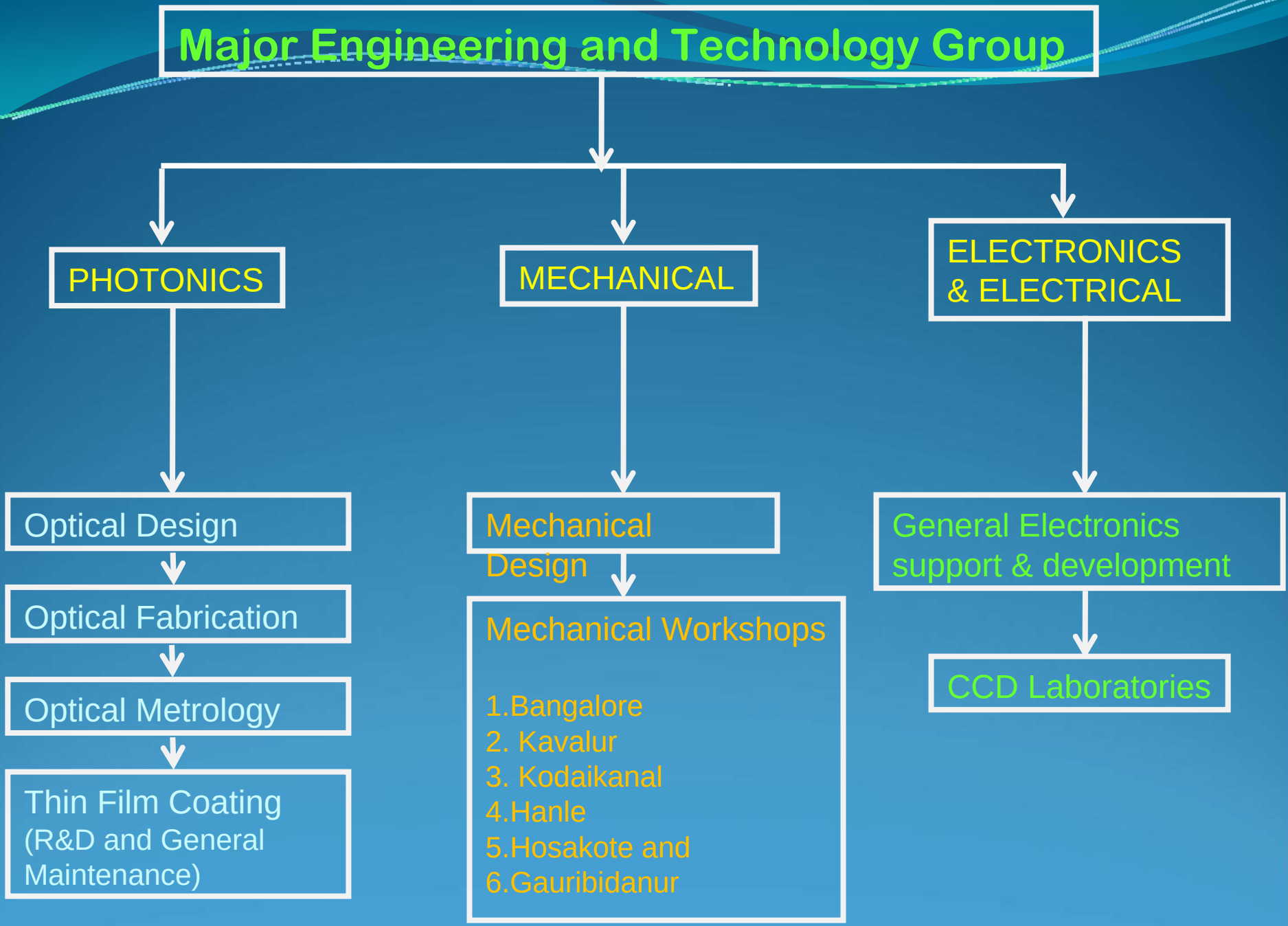
90'' Telescope Prime focus cage

Optical Tower for testing

Dr.A.K.Saxena,
Dean, Faculty of Sciences(Engg.)

The success of an Astronomical research Institute of this kind depends on the availability of the technical knowhow and the efficiency with which it supports the research activity.

Major Engineering and Technology Group



Electronics & Electrical

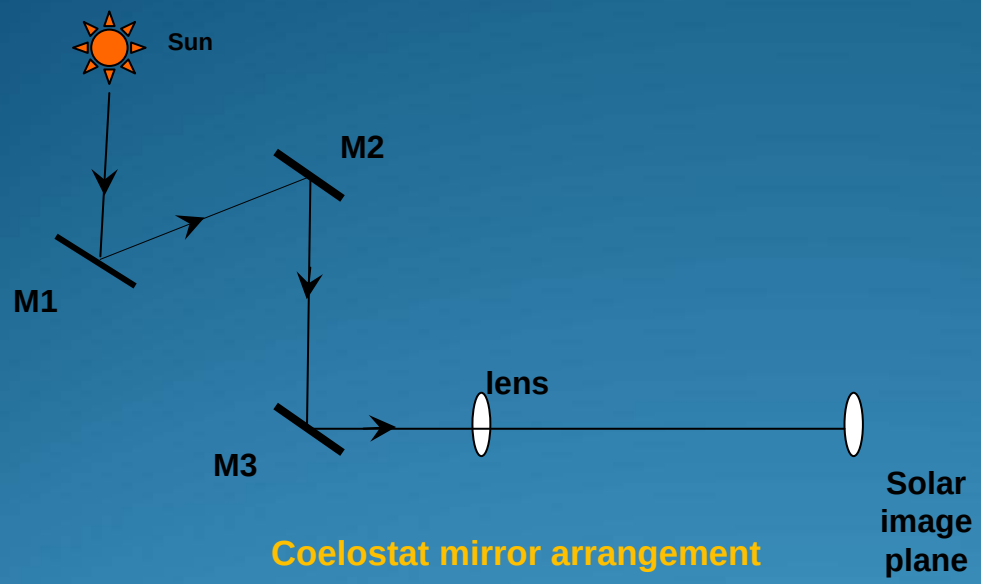
Activities and Current Projects

“4KX4K Mosaic Camera system for 1.3M DFM Telescope” at VBO, Kavalur

- Includes two buttable 2KX4K CCD sensors (each 15 X15 micron pixels) and a CCD controller.
- Consists of a mosaic CCD Dewar and CCD controller to control the mosaic configuration
- Mount the two CCDs (each 2KX4K, EEV 44-82 matrix of 2048 columns and 4096 rows).

Lab setup for acquiring an image using CCD DEWAR.

WARM Telescope at KODAIKANAL



Coelostat mirror arrangement

The first mirror M1 tracks the sun and second mirror guides the image in the image plane. There are three axes to be controlled one track axis and two Guide axes RA and DEC. Motor speed for track axis at 7.5 arc sec/sec = 0.9 RPM, Guide axis motor speed at 0.25 degrees/sec = 1000 rpm

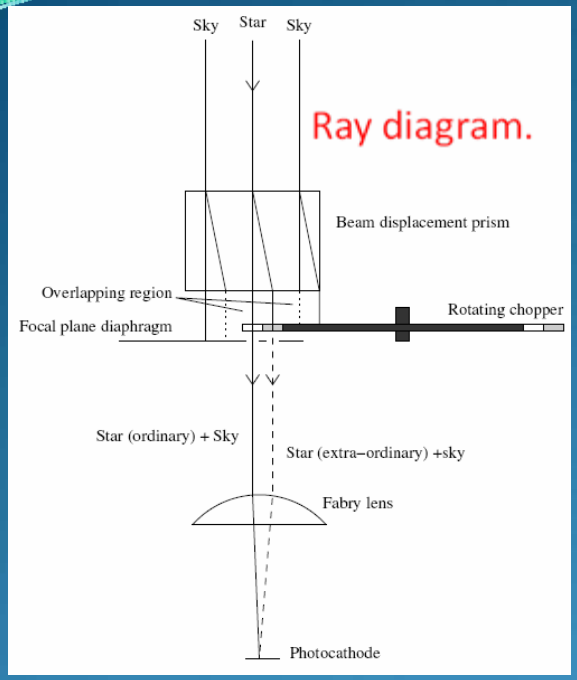
Radio Heliograph of the Nobeyama Radio Observatory

The correlator system will be built using chips designed for the Nobeyama Radio Heliograph of the Nobeyama Radio Observatory. It is custom built double side band (DSB) chips using CMOS gate array technology. Chips can work at clock speeds up to a maximum of 40 MHZ. Each chip is made up of 4 complex correlator units. The digital backend system will consist of 128 samplers, 128 Delay lines, 4096 correlators (32 PCB's and each PCB containing 128 correlators)

Status :

- ✓ Antenna erection work going on
- ✓ Most of RF cabling work done
- ✓ Design of Front End Electronics & back end electronics completed.
- ✓ Fabrication of electronics given under item ' C ' remaining.

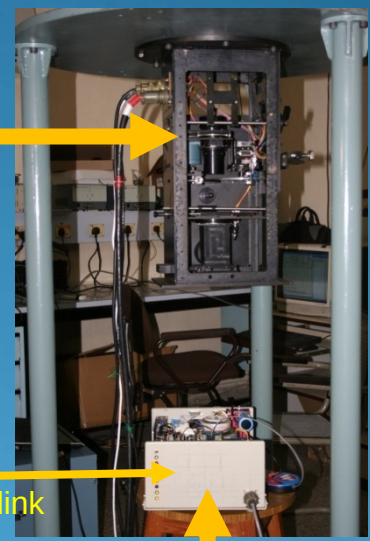
MULTI-CHANNEL STELLAR PHOTO-POLARIMETER.



Features.

- Simultaneous measurements in 3 wavelength bands.
- Accuracy: photon-limited.
- Variable chopping frequency (5-300Hz).
- On line data analysis.
- Unaffected by sky polarization.

System Outline



Polarimeter instrument

Host computer

Initiates data acquisition by issuing a sequence of commands.

RS485 communication link

Instrument controller

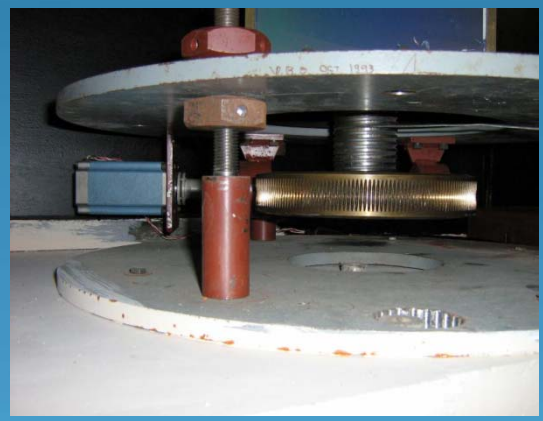
Present Status

- Instrument fabrication is completed.
- electro-mechanical and optical components are loaded.
- Instrument controller is designed and developed in the electronics laboratory.
- Data acquisition software is written on the host computer.
- Instrument control code for embedded system is completed.
- On line data analysis packages are written and tested.
- System integration is going on.

Micro Stepping Drive for high precision Tracking & Positioning

- High precision drive system consisting of a micro step module (MD 808)
- Micro stepping drive system with stepper motor for the Coelostat. The system was successfully used during the total solar eclipse expedition during July 2009 at China.
- The high precision micro stepping drive has been introduced into the grating drive of the tunnel telescope at Kodaikanal, enabling the grating to be moved line by line with micro step resolution.

KML 063 & MD 808 being used in the Coelostat for tracking Solar image, during Total Solar Eclipse expedition.



Stepper Motor KML 063 being used for positioning the Grating at 24" Solar Tower Tunnel Telescope, Kodaikanal

Rotation Stages for Grating Automation

Cryo-cooled CCD camera

Efforts are on to develop a CCD cooled camera using CRYO-COOLING technology for a 2k*4k CCD sensor. This is to replace the liquid nitrogen cooled systems.

Earlier the cryo-cooled camera was initially tested on 2k*2k sensor. This was found to be working satisfactorily but the sensor was not suited for our application. Hence the need for the new system.

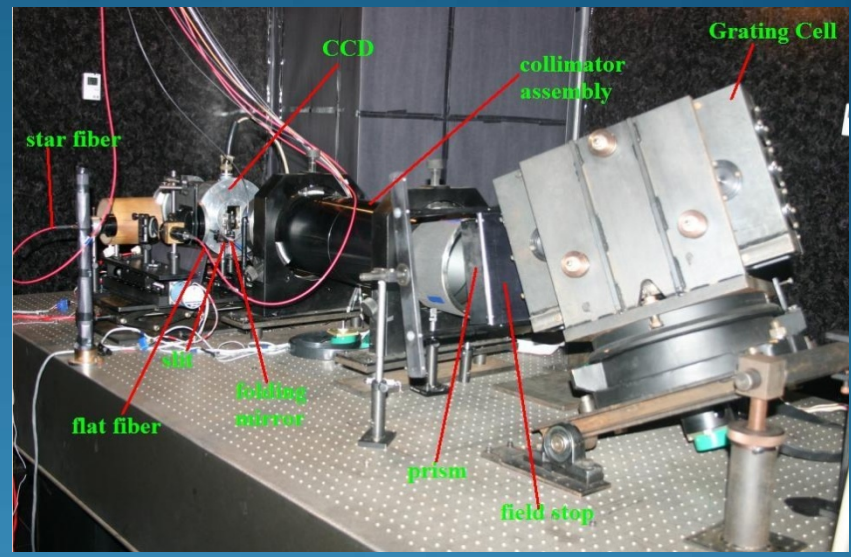
MECHANICAL ENGINEERING

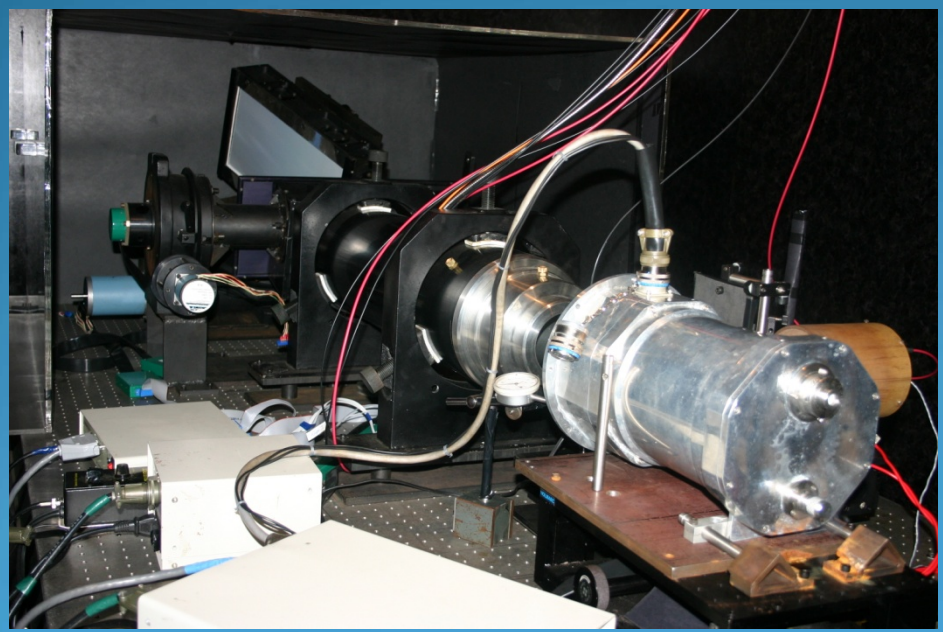
High Altitude GAmma Ray telescope (HAGAR).

- An array of gamma ray telescopes at Hanle, in collaboration with TIFR
- HAGAR would be the highest operating gamma ray telescope studying the Cerenkov radiation produced by celestial gamma ray sources, through their interaction with earth's atmosphere.
- There are seven telescopes in the array,. Each telescope consists of seven mirrors of 900mm diameter and f-ratio 1. The HAGAR telescope employs an altitude over azimuth (alt-azimuth) mount. .

VBT Fiber fed Echelle Spectrometer

Fiber fed Echelle Spectrometer works in High (72,000) and low (30,000) resolution mode. It is housed in a thermally controlled, mechanically stable space in VBT observing floor called Coude laboratory.





This instrument was commissioned in 2003 and since then it has been used for optical astronomy. This instrument works in Litrow configuration and single collimator unit is used and same is used as camera for focusing spectra.

75 cm Telescope

The Telescope dome, mechanical mount ,electronics and control systems including optics has been fully built at IIA

DIMM TELESCOPE

- Manufactured by DFM Engineering, USA
- Diameter of 40cm, F/9 Cassegrain focus
- Image scale of 56 arc sec/mm.
- 1600x1200 pixel CCD detector and
- Five standard broad-band filters.
- Remote control operations via the internet.

A view of the DIMM telescope in its dome

A Differential Image Motion Monitor telescope at VBO for monitoring the "astronomical seeing" of the site .

OPTICS / PHOTONICS

Optical Design, Optical Fabrication, Optical Metrology, Thin Film Coating (R&D and General Maintenance)

This facility in the institute is an unique and one of its kind in the Country

The Optical Fabrication at IIA dates back to the year 1964 with hand working of optical components in one of the rooms attached to the solar tower in Kodaikanal. At the initiative of Late Prof.M.K.V.Bappu, the then Director,

Mr..A.P.Jayarajan had set up the optical workshop.

Has additional component of technology development for other sister institutions.

Large optics Fabrication & Technology….early years

The picture shows 30 inch & 18 inch polishing machines. The primary mirror of the 30 inch telescope optics were fabricated using these machines during 1980s.

The 50 inch polishing machine which was indigenously built at IIA and used for fabricating 50 inch f/1.45 Hindle's sphere which was used as Hindle sphere for 2.34 M Telescope secondary mirror testingf - can be seen at the Photonics lab.

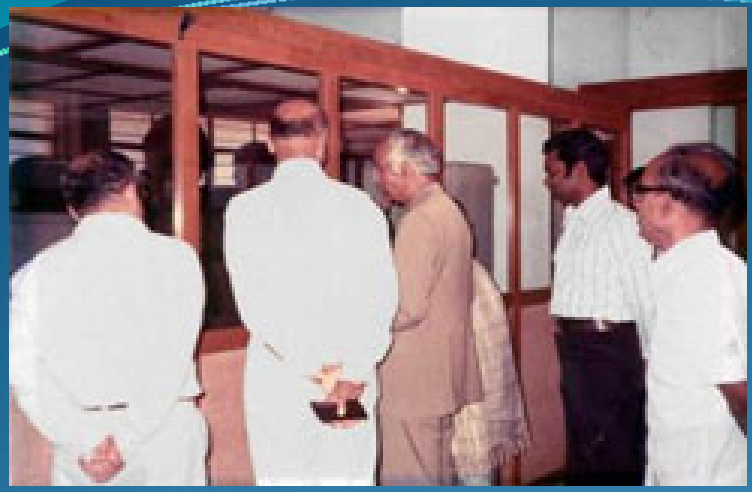
Some of the Fabrication Activities…

Champhering of schlierean window

40" Zerodur primary mirror side Pocketing

Spheroidal Mirror Polishing

Some of the pictures related to the fabrication of 2.34M primary mirror of the Vainu Bappu Telescope.



Nobel Laurate Prof. S. Chandrasekar visiting Photonics Lab and Prof. M. K. V. Bappu explaining.

Prof. M. G. K. Menon and Prof. Radhakrishnan visiting Photonics Lab. In discussion with Prof. M. K. V. Bappu and Dr. A. K. Saxena.

Some of the Completed Optics fabricated in the optical fabrication shop

Samples of small optics

Two sets of Synchrotron Radiation Beam Line Optics (SRBL) for Bhaba Atomic Research Center funded by BRNS was fabricated and delivered. The optics consists of spheroidal and plane mirrors.

Optics for LIDAR telescope for VSSC, Trivandrum

EUV Telescope Optics

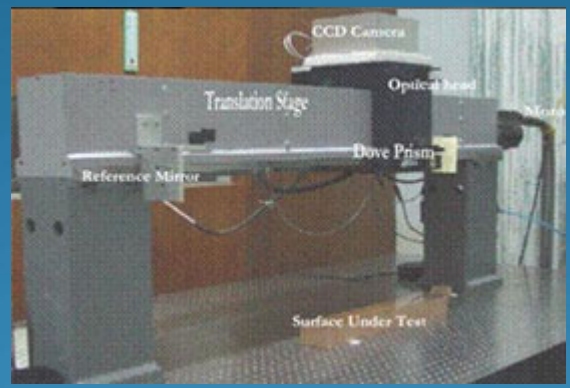
Rotational Shearing Interferometer

Optical Metrology

Optical Metrology instruments

An optics cannot be fabricated with better accuracy than with which it could be tested. A full fledged Optical Metrology Laboratory facilitates the testing of high precision optics.

Fiber Optic Spectrometer



Long Trace Profilometer

Digital Spherometer

WYCO Profilometer

Scanning Electron Microscope EVO 40, Carl Zeiss

ZYGO Interferometer

Thin Film Coating

1.5 M Vacuum Coating Plant,VBO
Used for coating of Mirrors upto the size of 1.2M

2.8M Vacuum Coating Plant, VBO being used for coating 2.34M primary mirror of the VBT

A completely automated 2M Vacuum Coating Plant, at IAO Hanle, to be used for coating 2M HCT Telescope at Hanle.

12'' Vacuum coating plant at Bangalore for Thin Film Research

Major contributions from Photonics

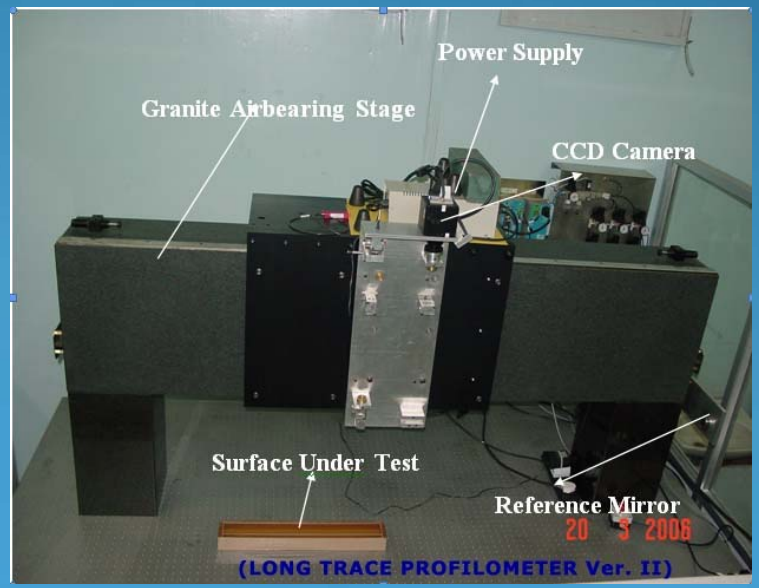
- ✓2.34 M Telescope Optics
- ✓Prime focus three element wynne corrector design & fabrication
- ✓ Prime focus photometer
- ✓1.2M Infra red Telescope Optics for PRL
- ✓24 Inch Schmidt Telescope Optics
- ✓LIDAR Telescope Optics
- ✓Rotational Shearing Interferometer (RSI) (IIA,RRI)
- ✓40 Inch Telescope Optics (replacement)
- ✓SRBL Optics
- ✓Metal Optics (VHRR specularly reflecting sunshields)
- ✓SDIMM Telescope for NLST Site survey, IIA

Spin off from technology development at IIA

Sunshields for VHRR passive cooler

(micro roughness better than 18 A^0)

Long Trace Profilometer, BARC



Solar Differential Image Motion Monitor (SDIMM)

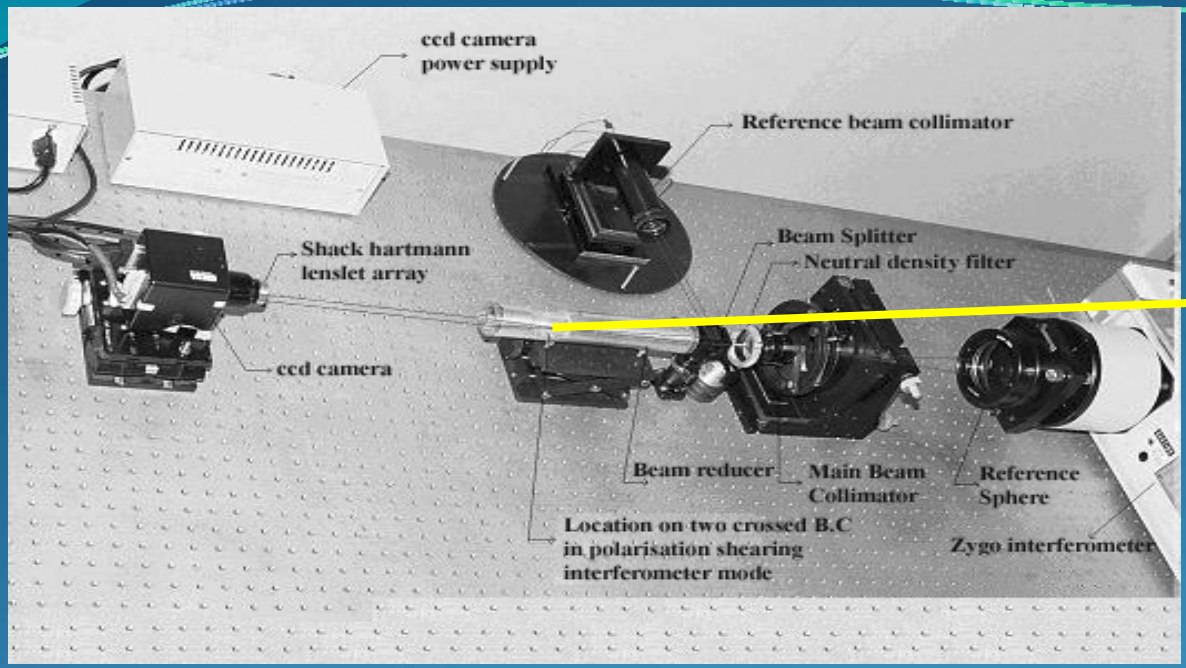
Three SDIMMs were designed and built at IIA and installed at three sites namely Hanle & Merak (at Pangong lake) in Ladakh, and Devasthal in Uttarakhand for the site survey work.

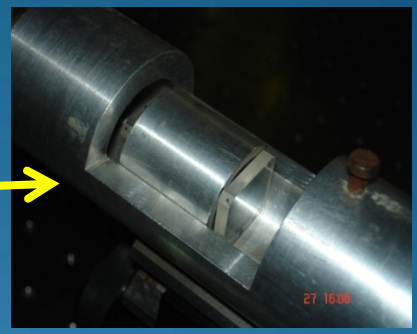
Current Projects

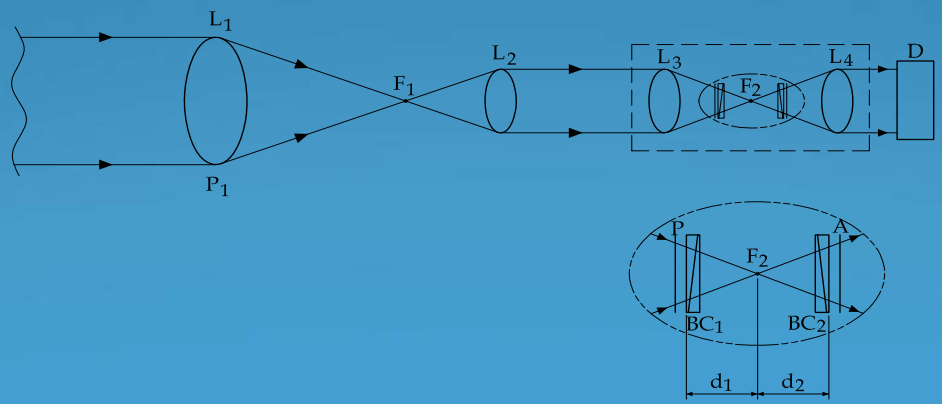
Adaptive Optics:

We are actively pursuing research work on the development of adaptive optics system for the NLST project. Laboratory experiments with the closed loop control of the tip tilt mirror and deformable mirror along with the 70 x 70 lenslet array, 300μ diameter and 40mm focal length Shack Hartmann sensor are in progress. Real time operating system working on industrial PC bus such as PXI bus is chosen for this configuration. A new wave front sensor is being developed using polarization shearing interferometric technique. The technique has already been established for large optics testing and evaluation for use during fabrication. The algorithm for the reconstruction of the wavefront from a single interferometric record has already been developed. Two candidates have received their Ph.D degree from the above program.

Polarization Shearing Interferometer Wavefront Sensor development

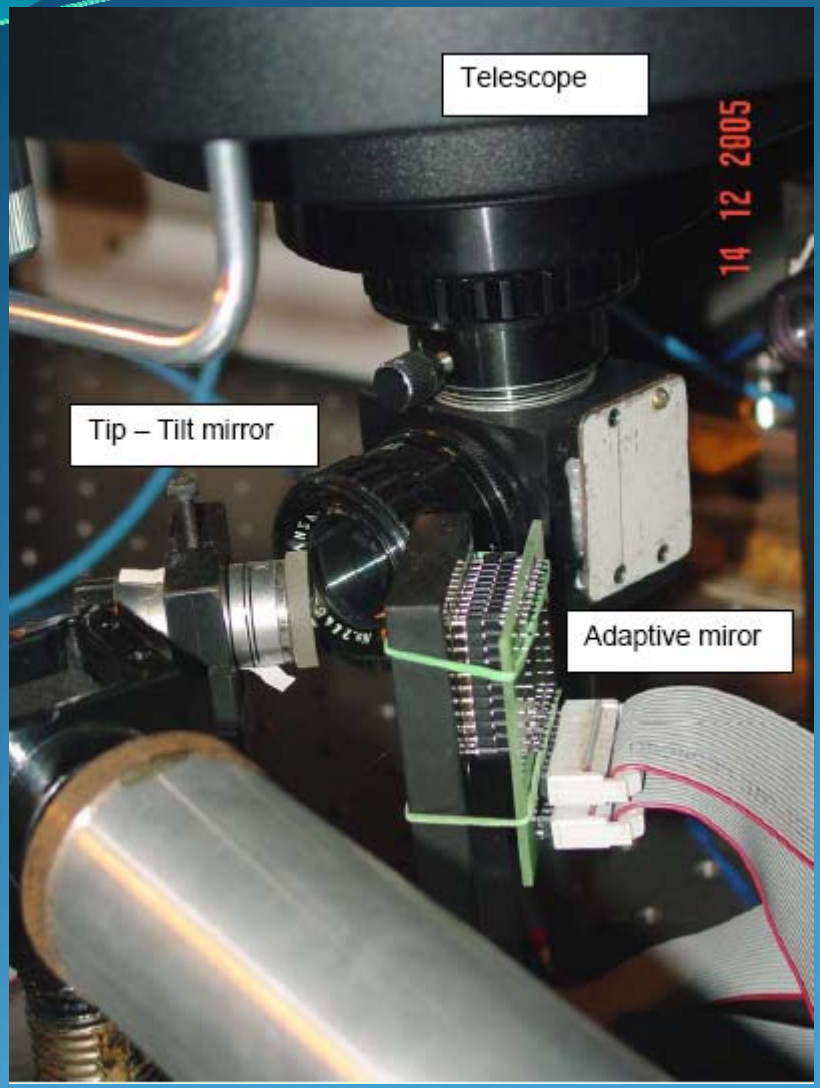




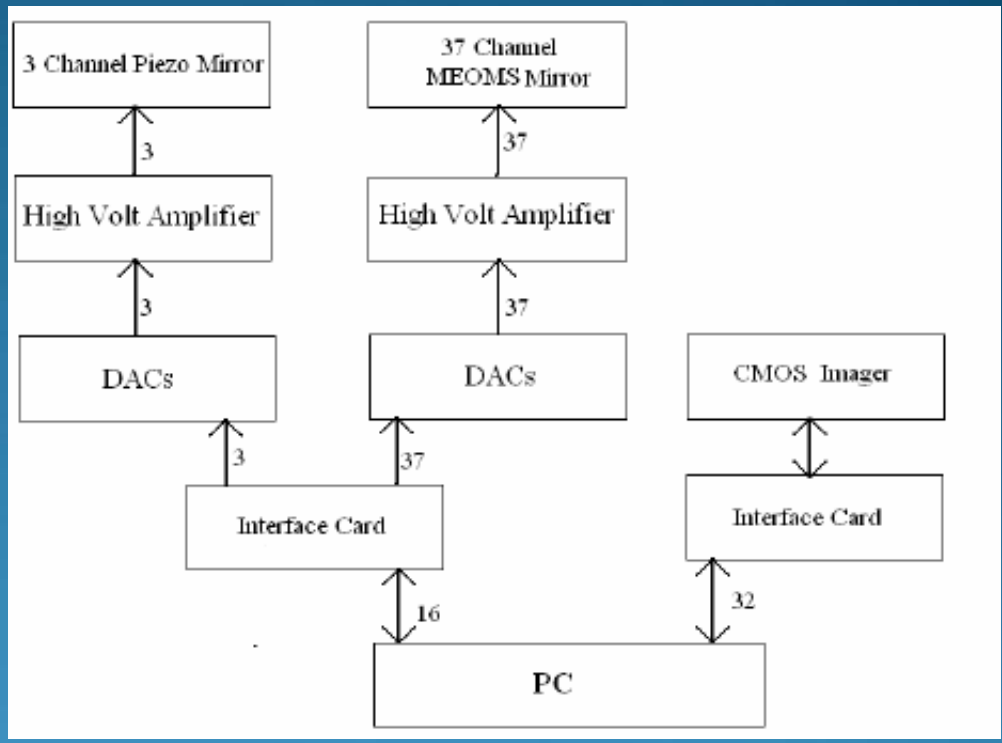


Optical layout for Polarization Shearing Interferometer wavefront sensor.

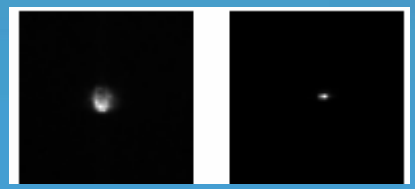
Laboratory experiment for Adaptive Optics



A view of the experimental setup showing tip-tilt mirror and adaptive mirror



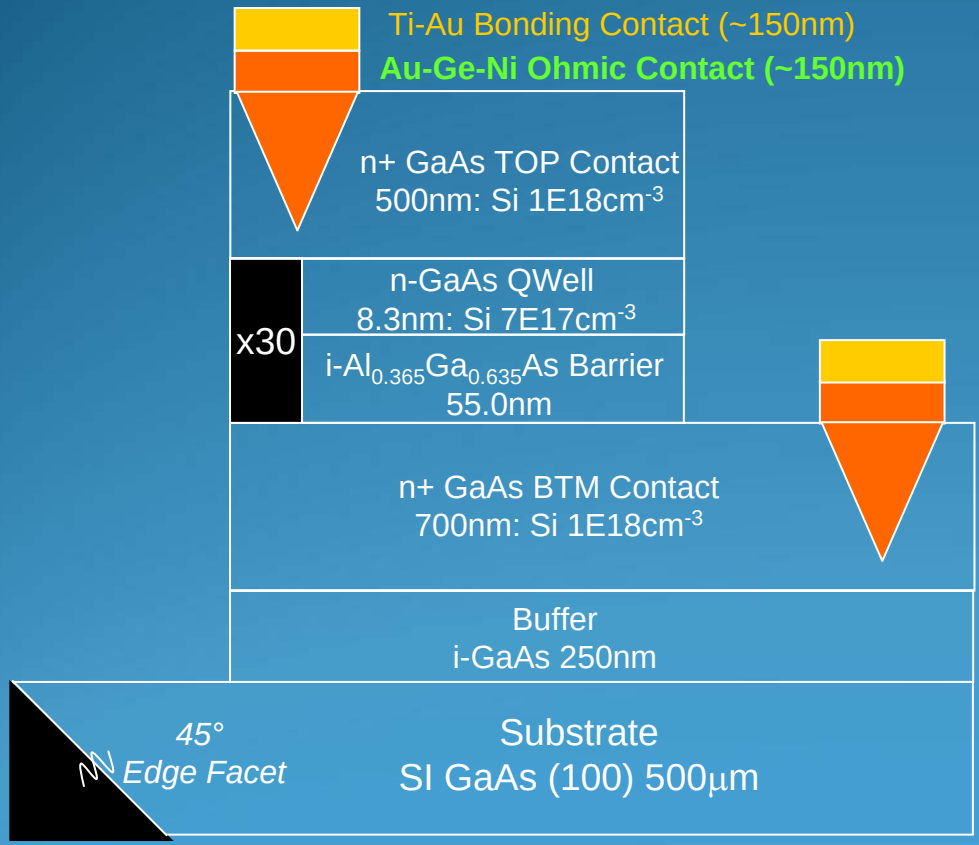
Schematic of electronic control of tip-tilt mirror, deformable mirror and wave-front sensor camera



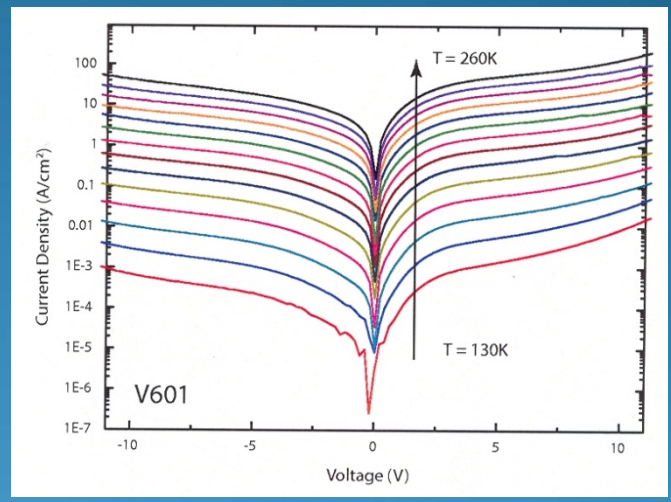
uncorrected image & Corrected image

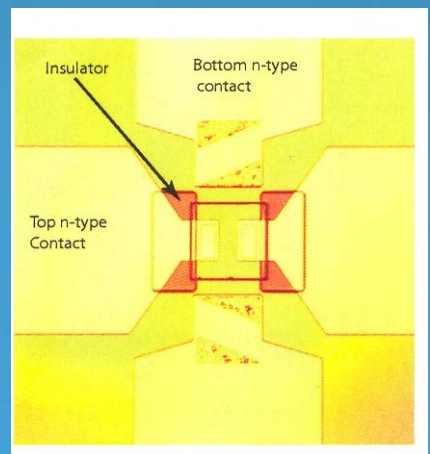
Development of 10.5µm Quantum Well Infrared Photo detector

A high responsivity cum better efficiency photo detector has been designed at IIA. The important optical and electrical performance parameters were theoretically studied and optimized. The sample wafer was grown using Molecular Beam Epitaxy (MBE) method at the **Cavendish laboratory, Cambridge, UK**, as per our specifications. The device was made ready for VI studies. Measurement on the dark current, current density and activation energy were carried out at the Cavendish laboratory. Work on Electro optical characterization is in progress.



Schematic of Processed Device Structure: Cross section and plan views





Device for measurement of VI characteristics.

Major future instrument program

- 1.3 M Telescope commissioning & installation
- Backend instruments for 1.3 M telescope
- Larger format Mosaic CCD camera development
- Automated dome / telescope control
- NLST - related technology and instrument development
    1. SHABAR instrument for NLST site characterization
    2. Dual Fabry – Perot based imaging spectrometer for NLST
    3. Adaptive optics for solar telescope
- GSMT – related technology and instrument development

THANKS