

BROCHURE OF NATIONAL PHYSICAL LABORATORY (Research Programmes & Experimental Facilities)

CSIR-National Physical Laboratory, New Delhi (CSIR-NPL)

The National Physical Laboratory was conceptualized in 1943 by the Governing Body of Council of Scientific and Industrial Research (CSIR), with a view to pave way for using science and technology as a means for industrial growth and development, as well as to give fillip to the fledgling Indian industry. Pandit Jawaharlal Nehru, the then Prime Minister of India, laid the foundation stone for the laboratory on January 4, 1947 and it was one of the first National Laboratory to be set-up under the CSIR. On January 21, 1950, Sardar Vallabhbhai Patel, the then Deputy Prime Minister of India, inaugurated the NPL building. Over the years, the Laboratory has more than realized its primary mandate as the keeper of Measurement Standards for the nation while also substantially expanding its research activities to emerge as a leading national institution for research in a whole gamut of areas in the Physical Sciences.

Charter of CSIR-NPL

The main aim of the Laboratory is to strengthen and advance physics-based research and development for the overall development of science and technology in the country. In particular, its objectives are:

- To establish, maintain and improve continuously by research, for the benefit of the nation, the National Standards of Measurements and to realize the Units, based on the International System
- To identify and conduct, after due consideration, research in areas of physics which are most appropriate to the needs of the nation and for advancement of the field
- To assist industries, national and other agencies in their development tasks by precision measurements, calibration, development of devices, processes and other allied problems related to physics

Outline of Research Activities at CSIR-NPL

In order to realize these objectives, the Laboratory's research & development programme is currently divided into three main research centres :

- (i) Centre of Materials
- (ii) Centre of Radio and Atmospheric Sciences &
- (iii) Centre of Metrology

The R & D activities of these research centres are carried out under different research divisions of the Laboratory, namely :

- Physics of Energy Harvesting
- Materials Physics & Engineering

- Radio & Atmospheric Sciences
- Time Frequency & Electrical Standards
- Apex Level Standards & Industrial Metrology
- Quantum Phenomena & Applications
- Sophisticated and Analytical Instruments

(i) Centre of Materials

Over the years, the CSIR-NPL has grown into a national centre of materials pursuing R & D work on a wide range of materials, products and devices. Its materials characterization facilities, required for studying and analyzing materials for purity, composition, structure and perfection, are comparable to the best in the world. It commands state-of-the-art instruments and experimental facilities as well as excellent physical, technical and computing infrastructure for the purpose. The Laboratory has earned a reputation for developing novel materials with exotic properties that have strategic, economic and societal impact. This core strength has also enabled it to establish linkages with the country's industry and top academic institutions and laboratories for collaborative programmes, sponsored research and consultancy. The Centre of Materials of the Laboratory also has several international linkages in terms of collaborative research and consultancy projects with several countries.

Currently the Laboratory has several on-going research and development programmes in diversified areas of materials research to develop high performance materials for strategic, societal and industrial applications. Materials research activities at the NPL are focused on new and advanced materials, such as, materials for energy harvesting, polymeric materials including conducting polymers, carbon-based materials & their composites, light weight metallic materials, nanomaterials & their composites, advanced ceramics, optical thin films, luminescent materials and superconducting materials as well as their related components & devices. Currently, the core strength lies in materials processing and characterization of these advanced & strategic materials, and technology development for components, devices and systems based on these.

(ii) Centre of Radio and Atmospheric Sciences

An important area of research at the CSIR-NPL is the study of the physics, the chemistry and the dynamics of the earth's atmosphere for increasing our knowledge and understanding of atmospheric changes and their causes, as well as their impact on the propagation of radio-waves and on the earth's environment. The Laboratory has been able to establish state-of-the-art instrumentation and experimental facilities for supporting a series of atmospheric studies, such as, investigations on Greenhouse Gases (GHGs), atmospheric ozone, UV-B radiation, fog formation, transport and evolution of aerosols, radio propagation in various regions of the earth's ionosphere, aeronomy and antarctic atmosphere. For research in these areas, it has developed ground based and *in-situ* techniques for satellite, rocket and balloon borne instruments. As a result of these activities, the Laboratory is today recognized as an important centre for research in radio and atmospheric sciences in the country.

Currently, the Laboratory is participating in many national and international programmes. It is the national node for assimilation and dissemination of information on space weather alerts and for Indian Ocean Experiment (INDOEX) research data for various users. It is also the host for the START (System for Analysis, Research and Training) Regional Research Centre under the aegis of the International Council for Science (ICSU) for capacity building in global change research in South Asia.

(iii) Centre of Metrology

The Laboratory has been playing significant role to ensure that the country's economic and development activities are based on accurate and reliable measurements as mandated by the Government of India under *the Standards of Weights and Measures Act* of 1956 and 1976 and under the Rules of 1988. Under this Act, the Laboratory is the custodian of national standards of measurement. Accordingly, the NPL carries out all metrological work for establishing, maintaining and improving the national standards of measurement for all the basic units and also undertakes the necessary work for constantly keeping them "traceable", through an unbroken chain of calibrations, to the international standards. These include all the base units under the *Système International d'Unités* (the SI system of units). Besides, it provides apex level calibration services to the nation in physico-mechanical, electrical and electronic standards so that physical measurements in the country remain traceable to the national measurement standards. CSIR-NPL has been maintaining six SI base units namely, *metre* (for length), *kilogram* (for mass), *second* (for time), *kelvin* (for temperature), *ampere* (for current) and *candela* (for luminous intensity). It also realizes and maintains several derived units in the area of physico-mechanical and electrical and electronic parameters.

India is a signatory to CIPM's global Mutual Recognition Arrangement (MRA) related to national measurement standards and calibration and measurement certificates issued by the NMIs of the participating countries. The MRA is in response to the growing need for an open, transparent and comprehensive system to give users reliable and quantitative information on the compatibility of national metrology services and to provide technical basis for wider agreement for international trade. The Laboratory has implemented a quality system as per ISO/IEC 17025 for physico-mechanical, electrical and electronic standards. The calibration activities in these areas are periodically peer-reviewed to fulfill the requirements of the MRA.

MAJOR RESEARCH AREAS

Centre of Materials

Innovative research and development of advanced materials and technologies for energy harvesting related to improved solar cells, efficient lighting, variety of engineering materials including nanomaterials & their nanocomposites,

superconducting materials, quantum phenomena at low temperatures and development of their related devices. The main thrust areas include, Physics of Energy Harvesting, Materials Physics & Engineering and Quantum Phenomenon & their Applications. The research areas of materials research include silicon solar cells, a-Si:H and microcrystalline solar cells, organic & hybrid solar cells, thermoelectric materials and devices, organic & inorganic LEDs, polymer & soft materials, carbon-based materials, CNT & their composites, polymer & soft materials, conducting polymers, bio and gas-sensors, luminescent materials, multiferroics and magnetic materials, optical thin films, advanced ceramics, metal, alloys, composites and nanocomposites, Josephson junction & single electron tunneling, quantum transport in thin film heterostructures and superconductivity & cryogenics.

Centre of Radio & Atmospheric Sciences

Radio Physics and Applications : Characterization of the ionized and non-ionized atmospheric media over the Indian region and studies of various geophysical processes therein, in relation to ionospheric/tropospheric radio propagation for the purpose of betterment of various types of radio communication, navigation and other applications. This involves monitoring of ionospheric/tropospheric related parameters using satellites, ground and space based monitoring systems, Radars, LOS communication and mobile links etc., for generation of required data base, understanding various geophysical processes involved therein to estimate necessary corrections, improvements and development of applicable reference models/data bases, etc.

Atmospheric Environment and Global Change : Characterization of the changing atmospheric environment, processes and impacts in respect of atmospheric trace constituents, green house gases and precursors, aerosols and solar radiation involving temporal and spatial (including Antarctica and Arctic) measurements, modeling, instrumentation, setting up of referral lab and creation of various data bases.

Centre of Metrology

This centre is responsible to establish, maintain and continually upgrade the National Standards of Measurements and disseminates the standards by providing the apex level calibration services to the industry and institutions of the country and thus ensures the traceability to measurements made by these. NPL, India is the signatory of the Mutual Recognition Arrangement (MRA) of BIPM (*Bureau International des Poids et Mesures*). The standards work encompasses a range of physico-mechanical, electrical and electronic and chemical measurements, such as, Physico-Mechanical Standards : mass, volume, density & viscosity, length & dimension, temperature & humidity, optical radiation force, torque & hardness, vacuum and pressure, acoustics, fluid flow and ultrasonics.

Electrical and Electronic Standards : time and frequency, Josephson voltage, DC voltage, resistance and current, DC high voltage, quantum hall resistance, AC power and energy, AC high current and high voltage, LF & HF impedance, LF & HF

voltage, current and RF power, RF attenuation and impedance, magnetic standards, bio-medical measurements.

Chemical Metrology : certified reference materials.

New measurement facilities are continuously created and existing ones upgraded to disseminate improved measurement uncertainty to the user industries by establishing these primary/reference standards.

CURRENT RESEARCH ACTIVITIES

Materials Physics & Engineering

- Silicon solar cells
- Si, a-Si:H and microcrystalline solar cells
- Organic and hybrid solar cells
- Thermoelectric materials and devices
- Organic and Inorganic LEDs for solid state lighting
- Polymeric and soft materials
- Conducting polymers
- Advanced carbon products
- Hybrid organic/inorganic nanocomposites
- Luminescent materials - phosphors/nanophosphors
- Multiferroics and magnetics
- Biomedical instrumentation – bio & gas sensors
- Optical thin films
- Advanced ceramics
- Light weight & high strength metallic materials
- Metal & ceramic matrix nanocomposites
- Bulk nanostructured materials
- Josephson junctions and single electron tunneling
- Quantum transport in thin film heterostructures
- Quantum optics, photonics and plasmonics
- Superconducting materials and devices

Radio & Atmospheric Sciences

- Atmospheric composition, budgets and radiation impact related work
- Physical and chemical transformations in ambient and tropospheric aerosols, ozone, pollutant precursors and radiation
- Aerosol radiative forcing in the atmosphere.
- Modelling work related to atmospheric composition
- Atmospheric research programme at Antarctica and Arctic
- Mega-city ambient air pollutant precursor processes
- Trace gases and aerosols effects on climate change, health, agriculture etc.
- Trace gases inventory and emission factor determination
- Ionospheric dynamics
- Space physics

- International facility for nowcasting & forecasting of space-weather parameters through Regional Warning Centre
- Ionospheric modeling
- Space borne payload development
- Radio environment related to non ionized media
- Fixed and mobile radio communication

Standards

- Mass, volume, density and viscosity standards
- Length and dimension standards
- Temperature and humidity standards
- Optical radiation standards (visible, infrared and ultraviolet regions)
- Force, torque and hardness standards
- Pressure and vacuum standards
- Acoustic and ultrasonic standards
- Fluid flow standards
- Shock and vibration sensors
- Bio-medical measurements
- Time and frequency standards
- AC power & energy standards
- AC high current & high voltage standards
- LF & HF voltage, current & RF power standards
- Josephson voltage standard and DC current, voltage & resistance standards
- Instrument development and electronics
- RF attenuation and impedance standards
- LF and HF impedance standards
- DC high voltage standards

MAJOR R & D PROJECTS AT CSIR-NPL

Supra-Institutional Project

- *R&D on photovoltaic & other energy applications*

Network Projects

- *Fabrication of LED devices and systems for solid state lighting applications*
- *Advancement in metrology*
- *Conducting polymer paints and coating for corrosion protection and shielding of concrete structures in strategic areas*
- *Nanostructured advanced materials*
- *Development of advanced light weight metallic materials for engineering applications*
- *Environmental constraints: New screening technologies and effect on human health*
- *Design and fabrication capability for very high power microwave tubes*
- *Surface analysis of dispenser cathodes for high power microwave tubes*

- *Technology for assessment and refurbishment of engineering materials and components*

Empower projects

- *Residue analysis on spent ammunition castings using bismuth ion gun of IONTOF-SIMS V for identification of their source of origin*
- *Role of ambient ammonia in formation of aerosol over Indo-Gangetic Plain (IGP) of India; Implication on its chemical and biological properties*
- *Fabrication of intelligent and smart issue paper based sensor for management of infectious diseases*
- *Fabrication of pump-less microfluidic channel on circular mounts*

Sponsored/Supported R&D Projects

NATIONAL

- *Setting up of facilities for dissemination of Indian Standard Time in north-eastern states*
- *Investigation study on microwave sintering of beta alumina tubes*
- *Study of the mechanisms involved in enhancement of electroluminescent properties of inorganic nanophosphors*
- *High rate deposition of the microcrystalline silicon films using high density microwave plasma and its application to efficient to large area thin film solar cells*
- *Study on the effects of atmospheric dynamical activity in the tropical tropopause region: Implications on the stratosphere-troposphere exchange of the minor constituents*
- *Development of carbon-ceramic composites and the influence of oxidation at elevated temperatures on their properties*
- *Studies on rare earth substituted magnesium ferrite thin films and the effect of humidity on its performance*
- *Development of nanostructured metal oxide gas sensor array for detecting chemical warfare agents*
- *Formation of alkali metal nanostructures on reconstructed low and high index silicon surfaces*
- *Ionospheres of Venus and Mars: chemistry, dynamic thermal structure and solar wind interaction*
- *Assessment of impacts of heat stress on human health and adaptation studies*
- *Proficiency Testing (PT) among national accreditation board for testing and calibration laboratories (NABL) accredited laboratories in chemical discipline*
- *Development of carbo-graphite material for aeronautical application*
- *Feasibility study for the use of infrasoni sensors to predict Tsunami*
- *Bio-sequestration & bio-impregnation of heavy metals leading to nanomaterials synthesis and decontamination of industrial effluent*
- *Development of rubidium atomic clock by NPL & SAC*
- *Infrared spectroscopic study for tumor diagnosis*

- *To conduct inter-laboratory proficiency testing amongst the NABL accredited calibration laboratories in India*
- *QA/QC support for GHG (CO₂, CH₄ and N₂O) emission measurements undertaken by different national teams under the aegis of NATCOM-SNC*
- *Determination of country specific emission factor for methane from land-fills and estimation of its emission inventory under the aegis of the NATCOM-SNC*
- *Amorphous carbon thin film having nanoparticle inclusions deposited by the modified vacuum plasma arc techniques*
- *Development of TiO₂ nanocatalyst for environmental purification*
- *Development of white organic light emitting diodes (WOLEDs) for general lighting applications*
- *Evaluation of emission factors and budgets of gases and particulate matter of relevance to climate change emitted by fuels particularly biomass used in India by the rural sector & small scale industries*
- *Physico-chemical studies of metal and metal oxide nanoparticles*
- *Coherent Radio Beacon Experiment (CRABEX) for tomographic studies of the ionosphere on board GSAT-II satellite*
- *Integrated campaign for aerosols, gases & radiation budget*
- *High pressure Raman studies of rare earth sesquioxides*
- *Dispersion and alignment of CNTs and development of CNT reinforced composites*
- *Development of DNA biosensor*
- *Development of DNA biosensor for detection of neisseria gonorrhoea in clinical samples*
- *Nano-metrology: surface roughness*
- *Dynamics of memory effect in layered perovskite ferroelectric ceramics and ferroelectric liquid crystal materials*
- *Development of conducting polymer-graphite nanoferrites composites for absorption dominated EMI Shielding - a material of strategic importance*
- *Centre on bio-molecular electronics*
- *Carbon nanotube-polymer composites for electromagnetic interference shielding and structural applications*
- *Studies on double perovskite CMR thin films for magnetic sensor applications*
- *A study of adaptive spherical lens using nematic liquid crystal for defence applications*
- *Recommended standard practices in the field of static force, pressure & torque metrology*
- *Development of biosensors for detection of pathogens*
- *Development of acoustic equipment for object detection for divers*
- *Study of distribution and sources of ambient ammonia over national capital region*
- *Investigation of pure and substituted rutheno-cuprate magneto superconductors in bulk and thin film at low temperature and high magnetic field*
- *Validation of OCM-II geo-physical products (optical instrument calibration)*
- *Generic development of nanometrology for nanotechnology*
- *Morphological study of polar region ionosphere with special emphasis on space weather events*
- *Development of hybrid electroluminescent materials and low power driven lamps*

- Preparation of energy sector GHG emission inventory and assessment of heat stress vulnerability under future climate change scenarios in India
- Innovative product development centre
- Multicentric collaborative study on the impact of global warming and ultra violet radiation (UVR) exposure on ocular health in India

INTERNATIONAL

- Low cost technology for high efficiency silicon solar cell
- Strengthening the quality infrastructure in environmental analytics
- Growth and structural characterization of nearly perfect single crystals of oxide materials for scintillation applications
- Operation of the South Asian Regional Research Centre (SAS-RRC) for study of global change
- Study of defect centres in nano-piezoelectric materials for application in sensors
- HPHT synthesis and characterization of new novel physical property materials
- Technically important high TCR (temperature coefficient of resistance) manganite nanometal devices for infrared/bolometric detector applications
- Assessment of effects of high particulate on pulmonary pollutants - health status in selected mega cities of south asia
- Application of new functional conducting polymers in Nio-sensor and Nano electronic

Consultancy Projects

- Metrological characterization of dual range piston gauge
- Noise and vibration impact study for proposed Taj Hotel in Dwarka, New Delhi
- Reduction of QI from high QI coal tar pitch
- Measurement of minority carrier Life Time in multicrystalline silicon wafers
- Investigation of induced vibration due to acoustic excitation from sound show at Brihadisvara Temple, Thanjavur
- Investigation on effect of light show at Brihadisvara Temple, Thanjavur
- Investigation of induced vibration due to acoustic excitation from sound show at Talatal Ghar at Shiv Sagar, Assam
- Investigation on effect of light show at Talatal Ghar at Shiv Sagar, Assam
- Evaluation of metrological characteristics of a pressure balance
- Guidance in implementing of quality system dimensional parameters as per ISO 17025
- Recrystallization and grain refinement mechanism during extrusion of magnesium alloys
- Strain gauge measurement to determine stress in tension and bending moment on metallic bolts used in wind mill energy upto 450N
- Design development & fabricate secondary force standard upto 50 kN
- Acoustics of multipurpose hall at Bhagdari, Bhawan, Gomati, Lucknow

RESEARCH FACILITIES AT CSIR-NPL

Material processing, characterization & testing

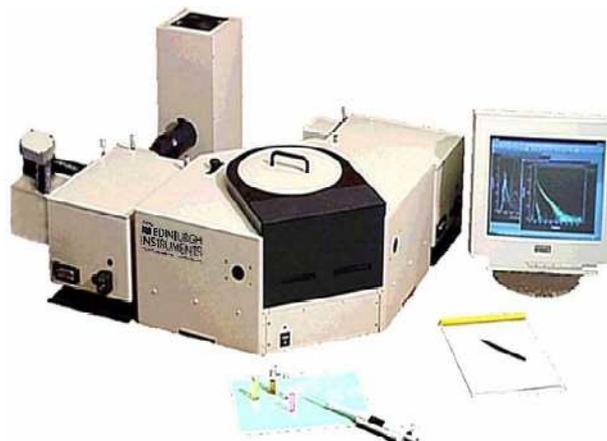
- Multitechnique surface analysis system (OMICRON)
- Molecular beam epitaxy (RIBER)
- Physical Property Measuring System (14 Tesla PPMS) (Quantum Design, USA)
- UHV Scanning Tunneling Microscope (Omicron)
- Variable Angle Spectroscopic Ellipsometer (J. A. Woollam, USA, Model: VASE)
- Nano-indentation measurement system (Fisher Cripps, Australia)
- Focused Ion Beam FE-SEM (Zeiss)
- Cryomill (Union Process, USA)
- 500 Ton Vertical Hydraulic Press (Wellman Enefco, UK)
- Spray atomization and Deposition unit
- Spark plasma sintering unit – 25 tons (SPS Syntex, Japan)
- High Energy Planetary Ball Mill (Pulverisette IV, FRITSCH Germany)
- Vacuum Sintering Furnace
- 5-ton capacity UTM with high temperature test facility (Instron, USA)
- Microhardness Tester (Future Tech Corporation, Japan)
- Wear & Friction Monitor (Ducom, India)
- Inverted Metallurgical Microscope with Image Analyzer (Nikon, Japan)
- Deep level transient spectroscopy
- Laser cutting facility
- Impedance Analyzer (M/s Nova Controls, Germany)
- Luminescence Spectrofluorometer (M/s Edinburgh Instruments, UK, Model: F900)
- FTIR (M/s Perkin Elmer, UK, Model: Spectrum BX)
- Zetasizer-Dynamic Light Scattering (M/s Malvern Instruments, UK)
- Surface Area and Pore Size Analyzer (M/s Quantachrome, Model: Nova 2000e)
- Stylus based Surface Profiler (M/s Ambios, USA, Model: XP-200)
- X-ray Photoelectron Spectroscopy (M/s Perkin Elmer, Model: 1257)
- Auger/LEED/EELS System (VT 112)
- Micro PCD based Minority Carrier Lifetime Measurement System (M/s Semilab, Hungary, Model: WT2000PV)
- Spectral Response Evaluation System (Model: CEP-25 HS-50, Japan)
- Rapid Thermal Processing (Model: Annealsys AS-One-150, France)
- 4 point Probe System for electrical conductivity (M/s Lucas Labs. Model: Quadprom-302-8, USA)
- E-beam Evaporation system (M/s Hind Hi-vac, Model: EBG-PS-6k, 15F6)
- UV-VIS-NIR spectrophotometer (Shimadzu UV-3101)
- Stress Measurement system (Frontier Semiconductor, USA)
- I-V/C-V Measurement system (Keithley/Agilent, USA)
- Thermal conductivity measurement system
- Seebeck coefficient measurement system
- Microprocessor based high temperature and microwave furnaces
- Sputtering systems for thin films
- TGA, DTA and DSC system
- Heavy hydraulic and cold isostatic presses



***Multi-technique Surface Analysis System
(XPS, UPS, ISS, AES, SAM, SEM, LT-STM, LT-AFM, LEED)***



Field Ion Beam & Field Emission SEM



***Time Resolved Spectrophotometer
equipped with Integrating Sphere
attachment***



Variable Angle Spectroscopic Ellipsometer



***Physical Property
Measurement System
(14 Tesla)***



Spark Plasma Sintering Unit



IBIS nanoindenter

Structural, Microstructural & Chemical Characterization

- Scanning Electron Microscope (SEM)
- Analytical High-Resolution TEM with STEM and EDAX
- Time-of-Flight Secondary Ion Mass Spectrometry
- Electron Paramagnetic Resonance Spectroscopy
- FTIR Spectrophotometer
- Photoluminescence spectrometer
- Scanning Probe Microscopy
- Raman Spectrometer
- Powder X-Ray diffractometers
- High-Resolution X-ray diffractometry and X-ray reflectometry
- X-ray Fluorescence spectrometer
- Gas Chromatography with FID and ECD detectors
- Flame Atomic Absorption Spectrometer
- Atomic Absorption Spectrometer
- Ion Chromatograph
- Inductively Coupled Plasma – Atomic Emission Spectroscopy
- High Resolution - Inductively Coupled Plasma Mass Spectroscopy



**Scanning Electron Microscope
(LEO 440 with Oxford ISIS 300 EDS)**



**Scanning Electron
Microscope (EVO MA10)**



Analytical High-Resolution TEM (Tecnai G² F30 STWIN) with STEM and EDAX



Time-of-Flight Secondary Ion Mass Spectrometry



FTIR Spectrophotometer (Spectrum M GX PE model 2000)



Electron Paramagnetic Resonance Spectroscopy (Bruker Biospin A 300)



Photoluminescence spectrometer (Perkin-Elmer LS-55)



Scanning Probe Microscopy (Multimode Nanoscope V, Veeco Instruments, USA)



***Powder X-Ray diffractometer
(Bruker X-ray diffractometer
D-8 Advance)***



***High-Resolution X-ray
diffractometry and X-ray
reflectometry***



***Flame Atomic Absorption
Spectrometer (AAS Vario 6)***



***Gas Chromatography with FID
and ECD detectors (Agilent 6890)***



***Josephson Series Array
Standard at 1 Volt Level***



***Quantum Hall Resistance (Primary
Standard of Resistance)***



***Calculable Cross Capacitor
Traceable to Length Standard***



Vibrating Sample Magnetometer



***Set up of the Black Body for optical
radiation standard***



***Optical Profiler (surface finish and
step height)***



Iodine frequency Stabilized He-Ne Laser, to realise SI unit Metre

Radio Science & Atmospheric Sciences

- NO_x, CO, SO₂, O₃, VOC, CH₄, NMHC, NH₃, and NO_y monitoring facility along with the measurements of surface ozone
- Lidar for optical properties of aerosols
- Optical Aerosol Spectrometer
- Solar radiation measurements in UV, VIS and IR region
- Particulate matter and Black carbon measurements
- Fourier Transform Infrared Spectrometer
- Air volume samplers
- Ion Chromatograph
- Network of ionosonde, GPS and CRABEX receivers.
- Atmospheric research programme at Antarctica and Arctic using ionosonde, GPS receiver, VLF receiver and trace gases analyzers
- Ozone Standard (Standard Reference Photometer) facility for ozone traceability
- Meteorological tower for met parameters
- Data base on rain and cloud related work
- Satellite met data
- Microwave communication field strength data
- Development of space borne Payload

AMENITIES ON THE CAMPUS

Hostels

Separate hostel accommodation for male and female students will be made available very close to the laboratory premises. The students are required to abide by the rules and regulations of the hostel in force.

Recreation

The staff club of laboratory has a recreational room with facilities for indoor and a few outdoor games. The staff club of the laboratory also organizes various sports and games related activities for its members. It also organizes various sports events in coordination with the CSIR Sports Promotion Board.

Canteen/Cafeteria

The laboratory canteen facility in the campus is available for breakfast and lunch at nominal rates. Apart from the regular canteen, the laboratory also has a tea/coffee/snacks cafe, which is open till late, beyond office hours.

Medical Facilities

There are medical facilities available within the laboratory premises. A full-time nurse and part-time doctors are available for medical consultation during office hours.

Auditorium/Seminar Hall/Lecture Hall/Conference Room

The laboratory campus houses a auditorium, seminar halls, conference & meeting rooms, lecture halls with projection systems and audio-visual facilities.

IT Infrastructure

A campus LAN (Local Area Network) has been setup which connects approximately 850 computers spread over the NPL campus. The network utilizes a mixture of optical fibre, UTP cables and switches.

Internet Connectivity

The internet access is provided through a gateway to the external world via a 2 Mbps ERNET radio link, 2 Mbps ERNET leased line and 8 Mbps Airtel leased line. Redundancy against failures is provided using three separate links based on different technologies such as Fiber Optics based leased line, Copper based leased line and Radio link based last mile connectivity. Email and Internet services are thus brought to the user's desktops.

Intranet

NPL intranet website provides one single stop location for various laboratory-related information, such as, circulars, soft copy of essential forms; telephone directory; essential pointers/links to webmail, various online journals etc; web based interface to online stores, online complaint system etc.

E-mail Facility

An in-house mailing facility with web based interface is provided to the staff of the Laboratory.

Information Security

Internal network has been divided in various zones, which are protected by Unified Threat Machine (UTM). Enterprise Antivirus with centralized control is installed on the computers in the laboratory.

Video Conferencing Facility

State-of-the-art video conferencing has been setup for video based interaction between remote locations, especially the CSIR labs.

Web-Server

A Linux based web server hosting the various websites related to NPL functionalities, including its main website, is deployed in-house. Open-source Database backend solutions viz. PostgreSQL and MySQL are deployed.

Electronic Attendance Facility

Electronic card based attendance system has been established to facilitate marking of attendance of staff using units at various locations in the campus. A central attendance server stores data using LAN and generates various reports.

Knowledge Resource Centre (Library)

NPL Knowledge Resource Center (KRC) provides library and information support for laboratory's R & D pursuits. Over the years, it has developed a rich collection of scholarly books and journals for this purpose, especially in the field of physics and related sciences.

During the current year, KRC subscribed to 87 scholarly journals (*65 foreign journals and 22 Indian journals*) having an approximate collection of 44,381 S & T books 1,336 Hindi books and 73,369 back volumes of journals (*as on March 2010*). KRC also serves the NPL community with services like Reprographic service, Electronic Document Delivery service, Inter Library Loan service, Reference service, Literature Search service etc.

NPL KRC offers online access to more than 6000+ full text journals under the e-consortium project of CSIR. The project facilitates access to electronic content from various publishers such as Elsevier, Springer, AIP (American Institute of Physics), APS (American Physical Society), Wiley - Blackwell, Oxford University Press, Royal Society of Chemistry, American Chemical Society etc as well as the archives of few publishers on concession rates.

KRC also provides access to intranet edition of Indian Standards. It also offers wi-fi connectivity within the KRC thereby offering freedom to the users to use their personal laptops in the KRC premise and thus helps in optimizing the use of e-resources. KRC maintains its site on the NPL intranet to provide latest information on its activities such as additions to its collection, current subscribed journals, new journals received during the week, links to electronic libraries, publishing houses, papers published by NPL scientists and latest news related to CSIR. NPL KRC also maintains NPKL website (<http://www.nplindia.org>) on Internet providing information about various activities of NPL, such as, its role towards the society; thrust area of research, facilities, services and achievements.