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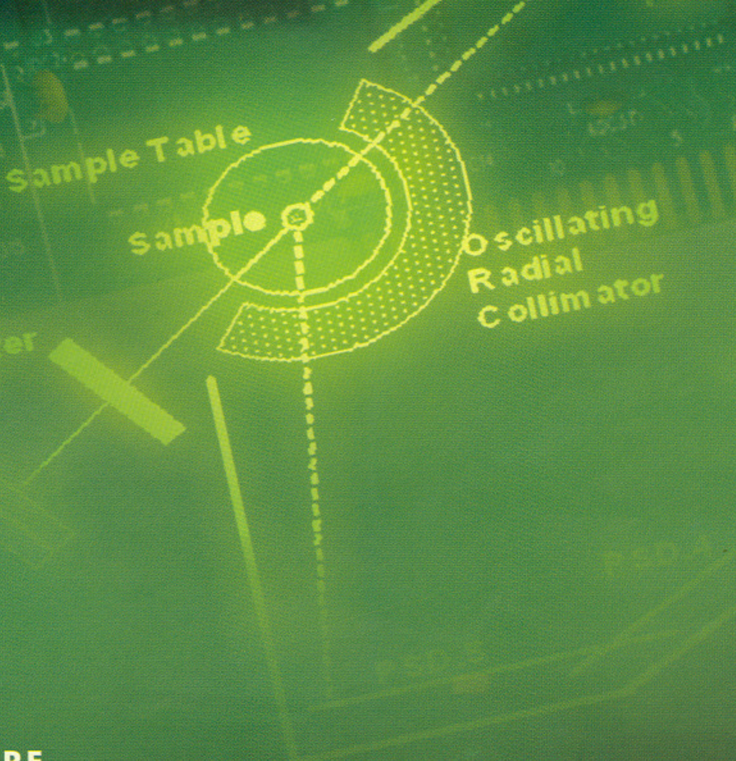
बीएआरसी न्यूज़लैटर

BARC NEWSLETTER



IN THIS ISSUE

INSTRUMENTATION FOR PSD BASED NEUTRON DIFFRACTOMETERS AT DHRUVA REACTOR

A HI-TECH MULTIMEDIA CENTRE

भाभा परमाणु अनुसंधान केंद्र
Bhabha Atomic Research Centre

पंडित जवाहरलाल नेहरू द्वारा परमाणु ऊर्जा संस्थान, ट्रॉम्बे (जिसका बाद में श्रीमती इंदिरा गांधी द्वारा दिनांक 12 जनवरी 1967 को भाभा परमाणु अनुसंधान केंद्र के रूप में पुनर्नामन किया गया) का दिनांक 20 जनवरी 1957 को औपचारिक उद्घाटन किया गया था.

Atomic Energy Establishment Trombay (later renamed as Bhabha Atomic Research Centre on 12 January 1967 by Smt. Indira Gandhi) was formally inaugurated by Pandit Jawaharlal Nehru on 20 January 1957.

बीएआरसी न्यूज़लैटर
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CONTENTS

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INSTRUMENTATION FOR PSD-BASED NEUTRON DIFFRACTOMETERS AT DHRUVA REACTOR

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Introduction

Neutron diffraction is a widely used technique, to probe the structure of both crystalline and non-crystalline substances. The atomic structure of a material acts like a diffraction grating, when a monochromatic neutron beam is incident on a given sample. Linear Position Sensitive Detectors (PSDs) are often used to detect the diffracted neutrons and their angular distribution is recorded as counts, over an angular region. The angular distribution data consists of sharp peaks over and above the background in the case of crystals, whereas it shows very broad diffuse peaks, in the case of liquids and glasses. This data is analyzed using different techniques, to study the crystallographic and magnetic properties of the sample. During the IXth plan, the Solid State Physics Division had planned to install two multi-PSD diffractometers in the Dhruva reactor. The UGC-DAE Consortium for Scientific Research, Mumbai Centre, had also planned for a multi-PSD diffractometer. The Electronics Division developed and provided the instrumentation required for these new (PSD- based – systems) and modernized the instrumentation for five single PSD diffractometers.

The instrumentation is organised such that it is scalable and configurable for each of the instruments, thus minimizing development efforts. Broadly, the instrumentation consists of pulse shaping front-end electronics for individual PSDs and a data acquisition system, that can handle sixteen PSDs. For front-end NIM modules like Pre-amplifiers (PA), High Voltage Bias Supply (HV) and Shaping Amplifiers (SA), the technology was transferred to ECIL and the modules were then supplied by ECIL. The addressable Ratio ADCs (RDCs) were developed especially for use in multi-PSD set-ups. The data acquisition system includes a PC add-on card and application software, that can handle total data rates up to 15 kcps without any loss of counts. Some diffractometers use commercially available hardware like temperature controller and stepper motor controller. Such hardware is also integrated into the data acquisition system. This instrumentation is now an integral part of all the linear PSD-based diffractometers in the Dhruva reactor.

Diffractometers

Most of the diffractometers at Dhruva use PSDs to detect the position of scattered neutrons. The most

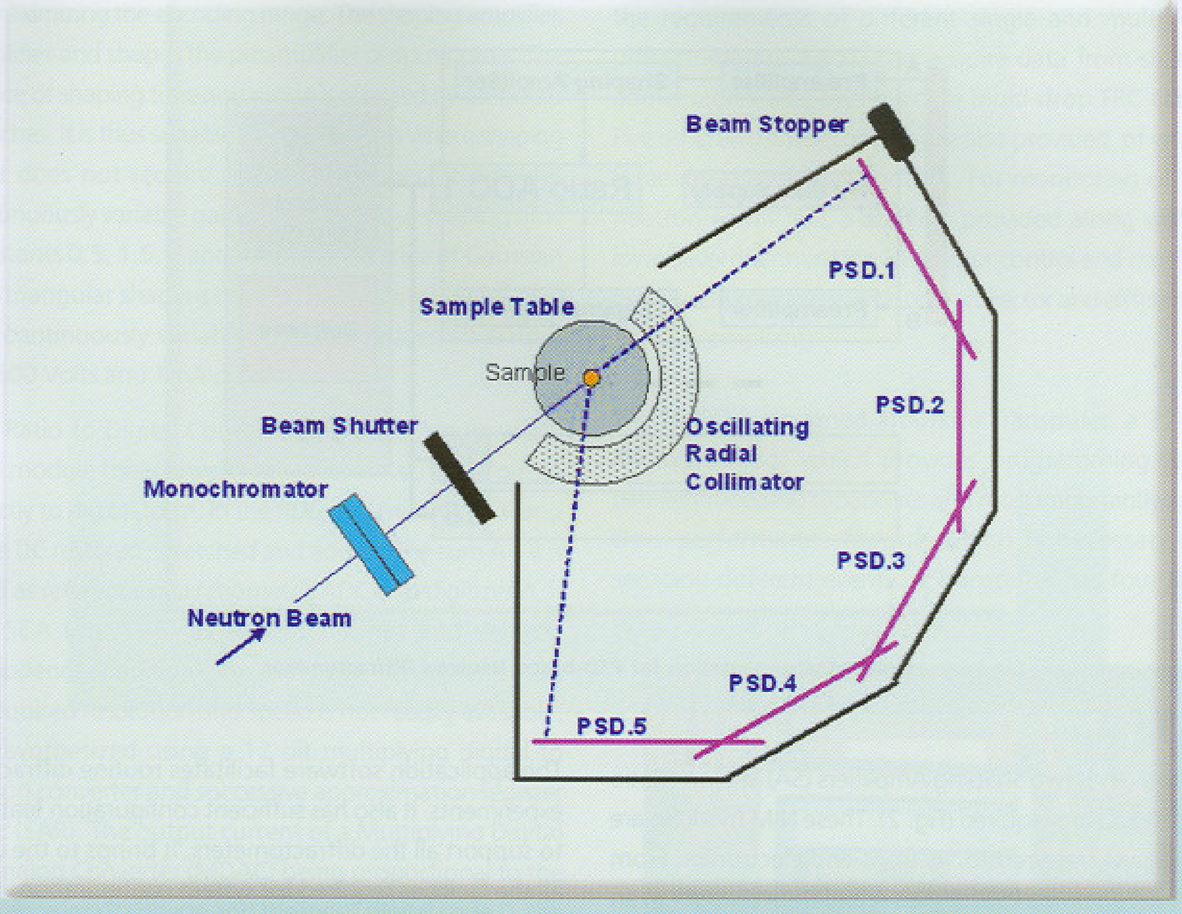

Fig.1 : A multi-PSD neutron diffractometer

common method of position sensing in a PSD, is the position localisation in proportional counters, using the charge division method. The anode wire of a PSD is fabricated to provide significant resistance per unit length. When a neutron induces ionisation in a gas, the charge collected, is divided between the two amplifiers placed at either end of the wire, in a proportion that is simply related to the position of the interaction. In a single PSD system, the PSD is positioned using a motor to cover large angle of scattering. In order to reduce the experiment time, multiple PSDs or PSD banks are fixed at different angular positions and the data is acquired simultaneously through all the PSDs. Fig.1 shows the typical layout of a multi-PSD diffractometer.

The monochromatic neutron beam required for diffraction, is obtained with the help of a monochromator crystal. By rotating or positioning the monochromator, a neutron beam of given wavelength is obtained. Some diffractometers use elaborate setups like a focusing monochromator (FMC). Usually, diffraction experiments are carried out under various sample environments like low/high temperatures or external magnetic fields. For this purpose, commercially available controllers with standard interfaces like GPIB or RS232 are used.

Instrumentation

The use of PSDs is common to all diffractometers. For each PSD, two Pre-amplifiers (PA), one High Voltage Bias

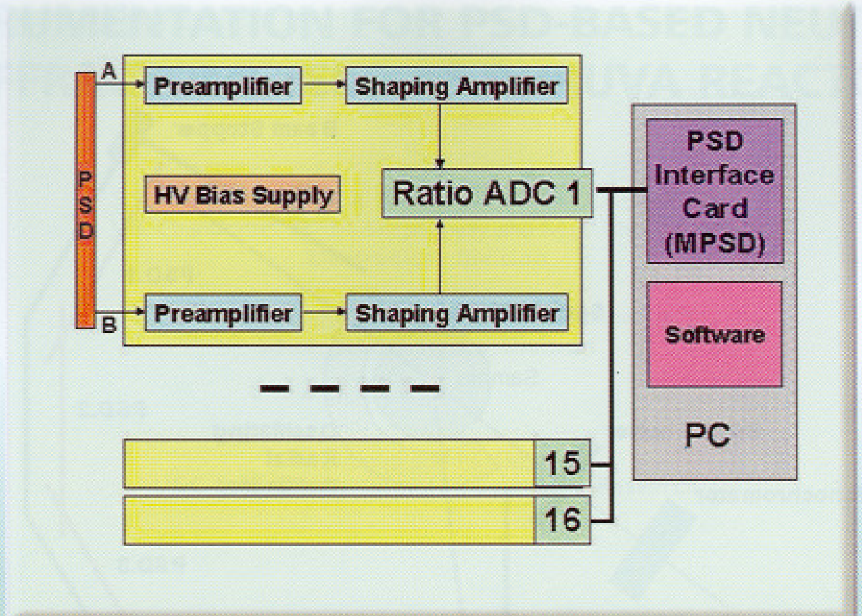

Fig. 2 : Instrumentation for PSD-based Neutron Diffractometer

Supply (HV), two Shaping Amplifiers (SA) and one Ratio ADC (RDC) are required (Fig. 2). These NIM modules are collectively referred to, as front-end electronics. From the two ends of a PSD, signals A and B are brought to an RDC through the preamplifiers and then the shaping amplifiers. The signals are converted by the RDC to the digital equivalent of A/(A+B), which indicates the position of a neutron.

The PC add-on card called Multiple PSD (MPSD) was developed, to handle the superset of data acquisition and control requirements of the diffractometers. With MPSD, sixteen RDCs can be connected over a multi-drop FRC cable. It has a Transputer as an onboard processor. Through a computer program, the Transputer carries out various control activities and also generates spectra. The raw spectrum data from all the PSDs is periodically transferred from the Transputer to a PC for further processing. Windows application on the PC, performs data reduction routines on the raw data, which is then merged before display as a composite spectrum.

The application software facilitates routine diffraction experiments. It also has sufficient configuration features to support all the diffractometers. It brings to the user, all the facilities required for system configuration, data acquisition, processing and display.

The interface card has other features like motor controls, monitor control and the signal discriminator. Three closed-loop motor controls are provided, out of which, one is used to position the PSD of a single PSD diffractometer and the other two are used to position the focusing monochromator (FMC). Two ON/OFF controls are provided to operate simple features like beam stopper. Other systems such as a temperature controller with a GPIB interface and stepper motor controllers with serial interface are also included in the data acquisition system.

Front-end Electronics

The Preamplifier is a charge-sensitive preamplifier with a low dynamic input impedance, designed for use with linear PSDs. The low impedance is important in minimizing position-encoding errors and also in maximizing the encoding range. The shaping amplifier, amplifies and shapes the preamplifier output pulses. The choice of shaping time and mode is effected by on-board switches. It is thus suitable for applications where shaping time does not require frequent changes. It provides continuously variable gain up to 1.5K, four shaping time constants 0.5, 1.5, 3 and 4 ms and a choice of Gaussian and triangular shaping modes. The high voltage supply is a continuously variable supply, designed to output ±2500 Volts and 1 mA current.

The Ratio to Digital Converter (RDC) is a single width NIM module that converts the ratio of two input pulses directly to digital form. In the RDC, the two inputs A and B are DC restored, stretched and added. The sum A+B is used as reference of a ratiometric ADC that digitizes A, if the SCA (on A+B) as well as prompt and delayed coincidence conditions are valid. Since a ratiometric ADC of required resolution and speed is not readily available, it is synthesized using a 12 bit multiplying digital to analog converter and successive approximation register logic (SAR). The output current of a Multiplying Digital to Analog Converter (MDAC) being proportional to the reference input voltage and the input digital code D, the final digital code generated by the SAR satisfies the condition

$$(A+B) * D = A$$

The differential non-linearity (DNL) is improved by the sliding technique, whereby a variable analog offset is added to the signal input of the radiometric ADC and the corresponding digital number is subtracted from the SAR output. For consistency, the analog offset is also required to be proportional to the A+B in the current conversion cycle. Hence it is generated by another MDAC. The RDC can also be operated as a conventional fast nuclear ADC.

PSD Interface Card

As shown in Fig.4, the Multiple PSD (MPSD) interface card is an ISA-based PC add-on card, designed to support the requirements of different single and multi-PSD diffractometers. MPSD can acquire data from sixteen addressable RDCs over a single multi-drop FRC cable. Five different motor controls are also provided, of which three are closed-loop controls. For monitoring of the neutron beam flux, a scaler is provided along with a lower level discriminator. The motor control and monitor signals are provided as both open collector and differential (RS422 compliant).

The MPSD is designed around a Transputer, a 32-bit Microprocessor which provides programming and parallel processing capabilities and most importantly, real-time performance feature which is necessary for servicing different events. A Transputer has four links

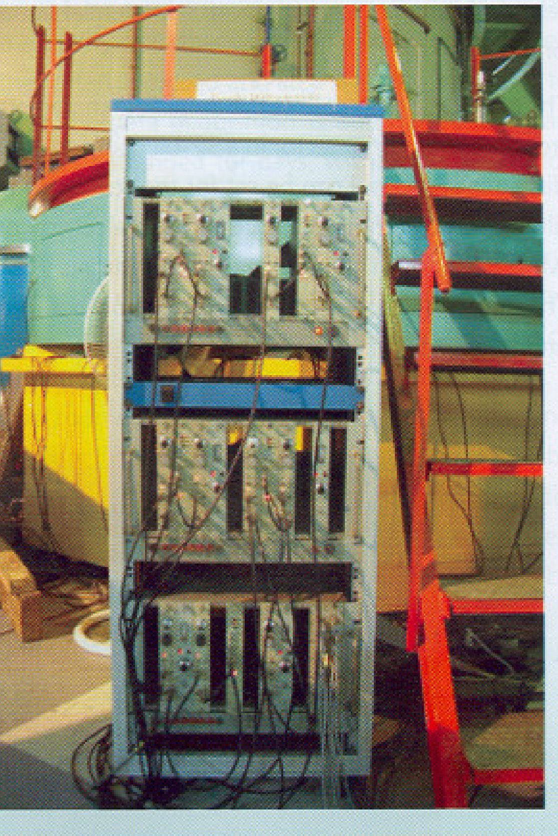

Fig.3 : The instrumentation rack containing front-end electronics

for communication, one of which is used to communicate with the PC. The link interface of the Transputer is mapped in the IO space of the PC. Peak speed of communication between Transputer and PC could be adjusted to either 10 or 20 MBits/Sec as required. It is also provided with a 512KB local RAM for program download and execution. All the hardware control required for data acquisition, monitoring, detector positioning, FMC positioning etc. is implemented by various control registers mapped in the IO space of the Transputer. Except for the bus buffers, all the digital logic including counters etc. is executed through three CPLDs (Complex Programmable Logic Devices).

MPSD incorporates a specially designed parallel bus for data acquisition up to sixteen RDCs, spread over 90 meters of cable. The interface defines a hardware protocol for reliable data collection with RS 485 differential signaling on the bus.

The onboard scalar counts the amplified analog pulses from the monitor detector in a 32-bit counter. A lower discrimination level can be set for the scalar, so as to filter out the gamma background and electrical noise while counting. The peak rate of counting is 10MHz. The discriminator level is derived from on-board DAC and an 8-bit programmable register.

A typical closed loop motor control in MPSD, is implemented using a Forward and a Reverse control signal for motor movement. Either Forward or Reverse signal is asserted to start turning the motor in the required direction. Motor movement is measured with the help of an optical encoder mounted on the shaft of the motor. Pulses output by the encoder are counted in MPSD using a 16-bit down counter. An Event is raised in the Transputer, once the preset number of counts is over. In response to the Event, the previously asserted signal is de-asserted to stop the motor. Similar closed-loop control is implemented for the detector motor, FMC motor and the Oscillating Radial Collimator (ORC). For the FMC motor, there is one more set of Forward and Reverse signals, which drive the motor in either coarse or fine mode.

The neutron beam shutter is opened and closed with the help of a motor. MPSD uses a Forward and a Reverse control signal to operate the motor. No feedback is necessary as the motor is stopped by a limit switch mechanism. The Sample Table is also rotated with the help of a motor. The motor can be turned ON or OFF by a control signal from the MPSD.

Software for Diffractometers

Data acquisition and the GUI are the main features of the software. The raw data acquired from a linear PSD

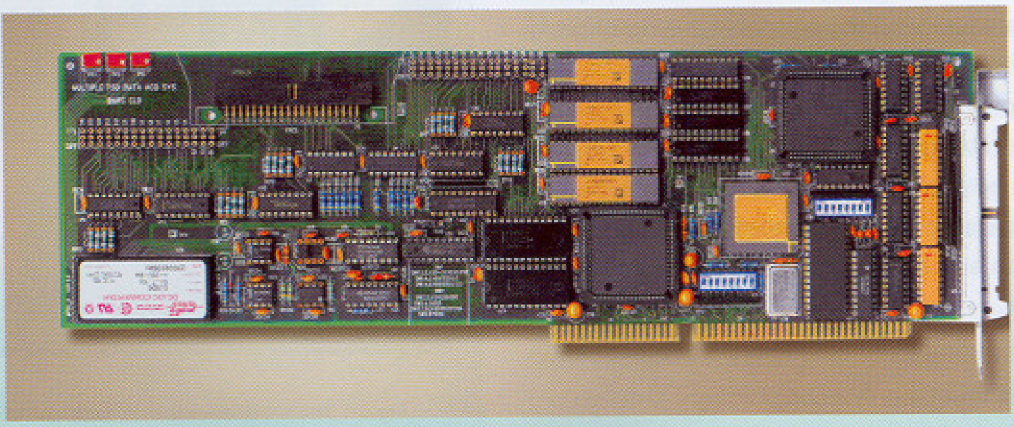

Fig. 4 : The PSD interface card

is converted into equiangular data, using simple geometrical considerations and data interpolation routines. The equiangular data from different PSDs is combined and presented for use in further analysis. A user can specify in advance, a data acquisition sequence in the software, so that experiments can continue unattended. This has resulted in better utilization of the available beam time. Software also plays a key role in configuring the data acquisition systems from different diffractometers, thus achieving the design goal of minimizing development efforts.

The software is a Windows application, developed to support all the linear PSD-based diffractometer configurations. It performs data acquisition, processing, display and storage of data in an easy-to-use Windows GUI environment. It has a front-end Windows98 application on PC, to provide the user interface and a Transputer program on the MPSD card to acquire data and perform control operations. The Transputer program also processes various requests of the front-end program. A Windows98 device driver (VTRANSPD) supports the communication between Transputer and PC. VTRANSPD also supports bootstrapping of the Transputer and is compatible with any Transputer-based hardware.

A number of additional features have been incorporated, as a result of continuous user interaction, during the development and user evaluation of a prototype system. Some of the more important features are described below.

Data Acquisition and Processing

The data from the RDCs is acquired and the spectra are generated in the Transputer on MPSD. Periodically the spectra are transferred from the Transputer to the PC for processing and presentation. The online spectra are also periodically saved to a file, so that, it is not lost due to power failure or any other unexpected event.

PSD being a linear detector, the RDC channels represent equal length and not equal angle. The raw spectra coming from the Transputer are equidistant spectra. By applying Spline fitting to these spectra, they are transformed into equiangular spectra. The angular resolution can be adjusted by setting the step size of the Spline fitting. For multiple PSDs within a bank, their equiangular data is averaged. The equiangular data is joined together on specified joining points between PSDs. Thus the equiangular distribution of neutrons over a large angular region is obtained.

In any experiment, data acquisition may be repeated so that, data affected by transients during reactor operation can be detected and ignored. In a single PSD diffractometer, the acquisition is performed in different detector positions. Elsewhere, data acquisition is performed at different temperatures of the sample. To define such a sequence of operations, a number of steps can be specified. The steps, preset values and other acquisition parameters can be modified on the fly, during data acquisition. Further operational flexibility is provided by the restart, proceed and step-over facilities. Due to this facility, data acquisition is automated and can continue unattended for days, without any operator intervention.

Different display modes are provided to view the raw data (Fig. 5) or equiangular data in graphical or text formats. The graphical display represents channels or angles on horizontal axis and counts on vertical axis. It can be zoomed in and out, scrolled horizontally and vertically or fitted in the window. Different colors can be used to identify the RDCs easily. In numerical mode, data is displayed in multiple columns of numerical values. In equiangular display mode, joining points can be selected graphically.

Diffractometer Configuration

All the single and multi-PSD configurations can be specified, using five Banks and sixteen PSDs, predefined in the software. A Bank is a group of PSDs occupying the same angular region. Each PSD is identified by the address of its RDC. The RDCs, LSB, MSB and the calibration constants together define the span of a PSD. The span of

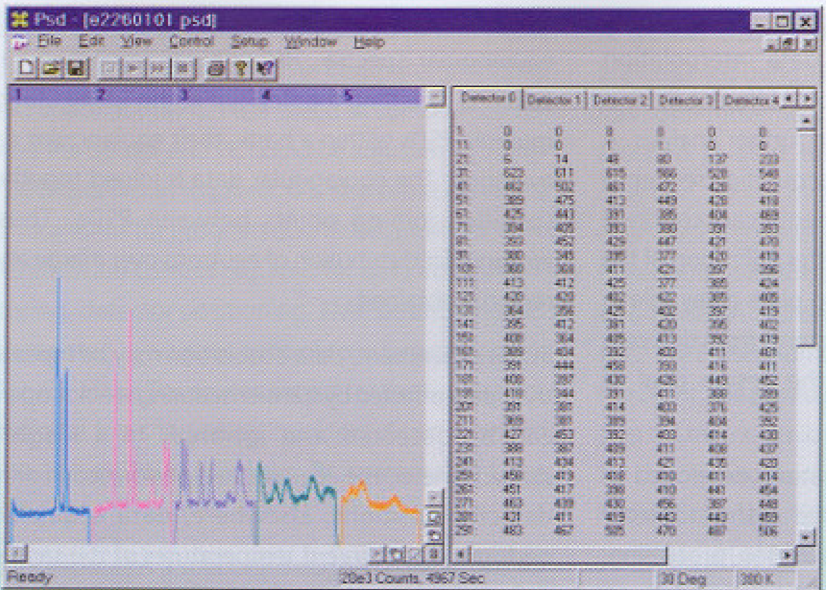

Fig. 5 : The raw data display

a Bank is the union of spans of all the PSDs in that Bank. Different colors can be assigned to individual PSDs so that their data can be easily identified in the cluttered display of multiple PSDs. Calibration constants are necessary to calculate the angular position of RDC channels. These constants depend on the position of the PSD and the RDC resolution. The raw data of a standard sample with known d-spacing values, is used to get the RDC channel to angle calibration, using the Levenberg-Marquardt method of nonlinear least square fitting.

Diffractometer Subsystems

The MPSD card provides a few closed-loop motor controls and on/off controls. The motors are operated from the PC by sending commands to the Transputer program. For the closed-loop motor controls like a detector motor, scaling factors can be set, so that the number of input pulses for respective encoders or similar hardware, is converted into meaningful physical units. These motors can be conveniently operated by appropriately setting their current position and destination. Detector motor control and FMC motor control are the important closed-loop controls available on the MPSD.

The Monochromator Goniometer is a setup for mounting the monochromator crystal. It consists of multiple movement stages designed to position and align the crystal accurately. The crystal is rocked in small steps with the help of a rotation stage, to scan an angular region and the number of neutrons reflected at each step, for a given time is counted and the position where maximum counts are recorded in a given time, is noted. The scanning may be performed in coarse or fine steps. The counts are displayed both graphically and in a tabular format. The monochromator crystal is finally positioned where maximum counts are recorded.

For other multi-PSD diffractometers, the crystal is mounted on a four-stage motorized goniometer set up. Position of the monochromator crystal is adjusted with the help of four stepper motors, each motor controlled by a dedicated controller module. The modules are connected to an RS232 serial port over a single cable. The entire set of commands of the motor control unit is controlled through the software.

A temperature controller is used in one of the diffractometers to set the sample temperature. It is interfaced with the PC through GPIB interface and is addressed by its GPIB device name. The temperature of the sample is read from two sensors. Before data acquisition can begin, the sample temperature is preset to a given value. If the observed sample temperature is within a given tolerance range for sufficient settling time, then data acquisition is continued.

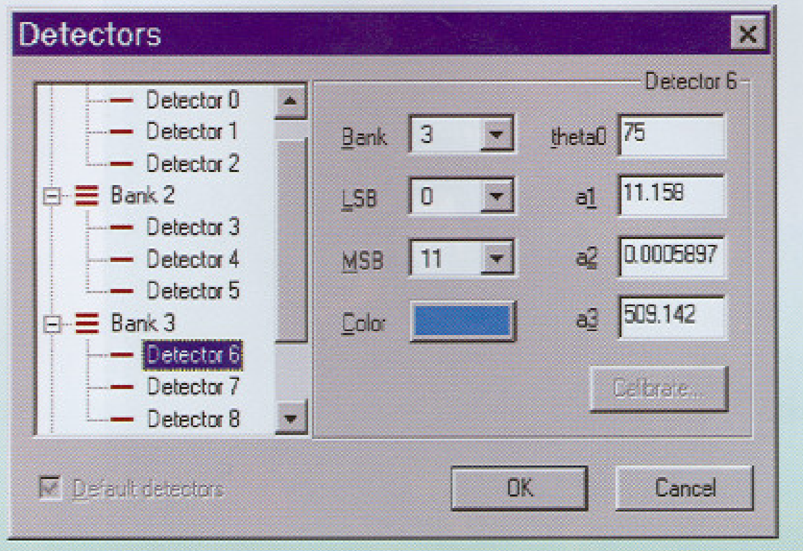

Fig. 6 : Detectors setup

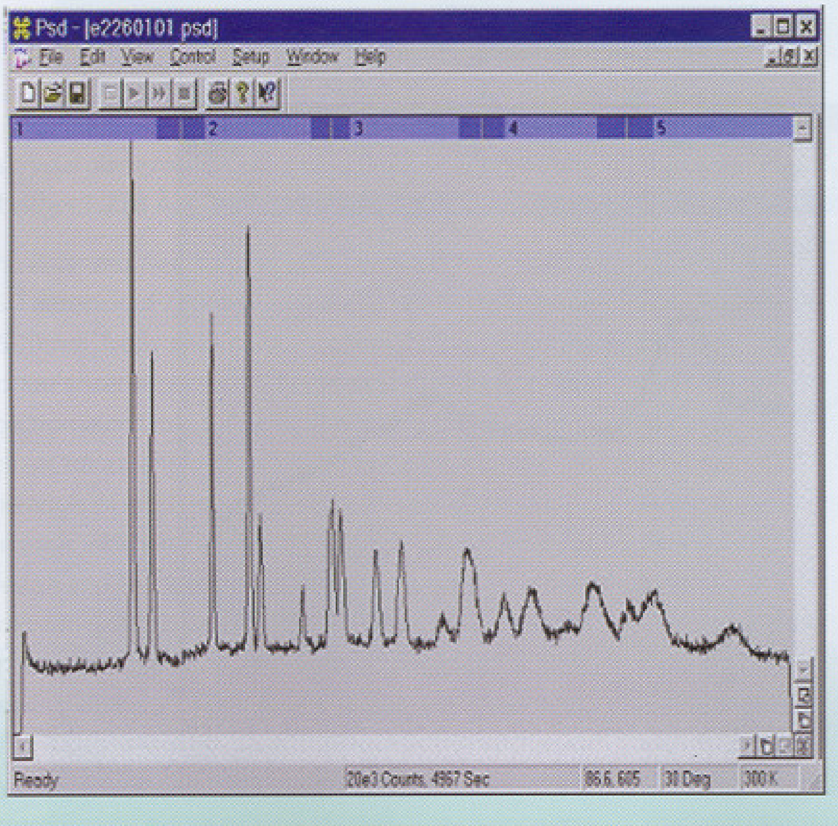

Fig. 7 : Diffraction spectrum of crystalline materials (Nickel powder)

Applications

Three multi-PSD and five single PSD diffractometers are being used for various applications in the Dhruva reactor. A brief description of some of these applications follows.

A Powder diffractometer for Poly-crystals is built at the beam port T-1013 in the Dhruva Reactor Hall. The total angular range for this diffractometer is 140°. Five PSDs of one-meter length each, are housed inside a detector shield. Each PSD has an active length of 88 cm and a diameter of 4 cm. The PSDs are filled with 4.0 Bar of He^3 and 2 Bar of Kr. The anode wire is made of thin Nicrome wire and its specific resistance is uniform to 1% along its length, with a total resistance of about 11 KOhm. A Germanium monochromator is used to produce a neutron beam of 1.249 Å wavelength. The neutron flux at the sample position is about 8.5×10^5 neutrons/cm²/sec.

The High-Q Diffractometer for Liquids, Glasses and Polycrystals is built at the beam port HS-1019 (Fig.8). Except for the monochromator, its configuration is the same as that of the Powder Diffractometer. A Copper monochromator is used here.

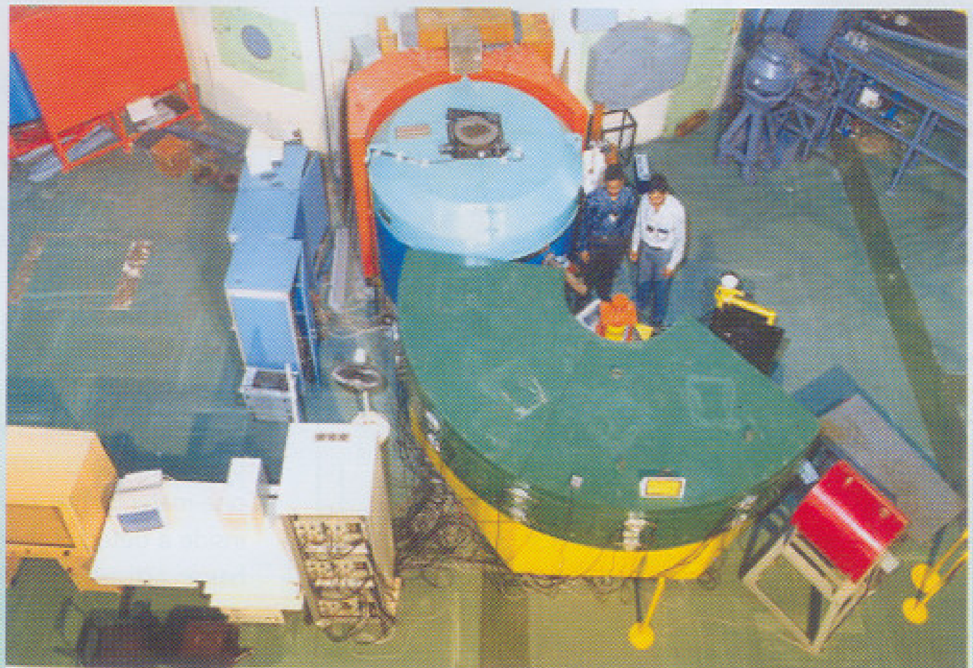

Fig. 8 : The High-Q diffractometer system at Dhruva

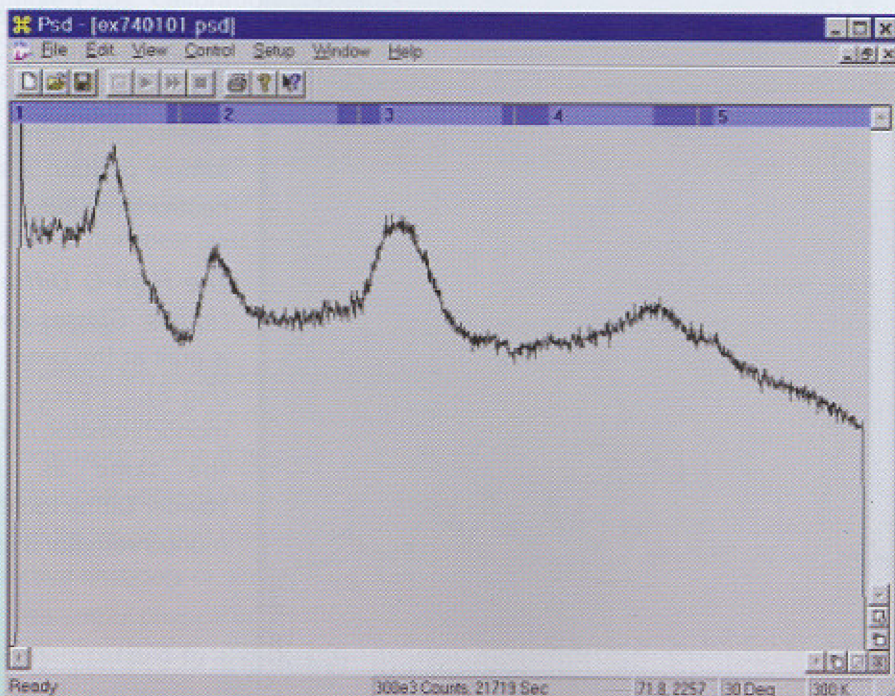

Fig. 9 : Diffraction spectrum of liquids and glasses (Silica rod)

Fig. 10 : Focusing crystal-based diffractometer

Its crystal plane may be selected to produce wavelengths of either 1.278 Å or 0.783 Å.

The Polarized Neutron Reflectometer has a He^3-based PSD detector of 200mm length, placed at a distance of 3500mm from the monochromator. The polarizer/nonpolarizer supermirror assembly is mounted on the spectrometer table following the collimator. The mirrors are set for an angle of incidence of 15 arc minutes. At this angle of incidence, the polarization efficiency of the mirror is 98% with a reflectivity of 85%. The Centre for Design and Manufacture, BARC, has fabricated a high precision rotation stage for the Reflectometer, which has an angular resolution of 3.6 arc seconds and a load-bearing capacity of 400 Kg. Its accuracy is in the range of ± 40 arc seconds. This accuracy has been achieved by using a high precision ball bearing and a worm gear assembly with reduction ratio of 1:360. The components of the table were fabricated with very close tolerance. The control panel for stepper motor movements, (supplied by a local company), can control nine stepper motors used in the spectrometer.

The Quasi-elastic Neutron Scattering Spectrometer is a powerful experimental tool for studying the various dynamic motions in solids and liquids. It is particularly suited for studying the dynamics of protons, because of its large scattering cross-section. Inelastic neutron scattering experiments are used, either for studying the periodic motions like vibrations or for studying the thermally activated single particle motions, which show up as Doppler broadened elastic lines. The latter are studied by using the quasi-elastic neutron scattering technique. The time scale of the dynamic motion, its geometry as well as the nature of the hindering potential, can all be obtained through these neutron scattering experiments, which are carried out using either a triple axis spectrometer or a time-of-flight spectrometer.

The Focusing Crystal-Based Diffractometer (FCD) (Fig.10) has been installed by the scientists of the UGC-DAE Consortium for Scientific Research, on the TT1015 beamline. It will cater to the growing needs of a large number of university scientists, interested in using neutron diffraction as a probe. The diffractometer uses a novel design of open beam geometry (no Soller collimators) and a toroidally bent monochromator, for focusing the beam on the sample. This has been done to achieve a better resolution over a wide range of scattering angles with improved intensities. The design of this diffractometer was optimized by carrying out Monte Carlo calculations, which proves, that the use of a focusing monochromator results in a better resolution as compared to plane crystal, in the same geometry.

FCD employs twelve PSDs arranged in four banks of three detectors each. This will result in a higher data throughput, thus significantly lowering data acquisition time. The bent monochromator crystal can be oriented with the help of a goniometer, to reflect several neutron wavelengths. A lot of attention has been paid to sample environment facilities. There is an Oscillating Radial Collimator to cut off extraneous radiation, scattered from the CCR, furnace, etc. The diffractometer will also have sample environment facilities like low-temperature closed-cycle refrigeration (CCR) down to 5K and high temperature image furnace up to 1500K.

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A HI-TECH MULTIMEDIA CENTRE

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Introduction

The Central Complex (CC) Auditorium of BARC is the place, where several important events such as seminars, colloquia, Founders Day function, lectures and addresses are organised. Communication media used during such events have evolved over the years; from simple delivery of speeches to electronic multimedia presentations with special effects and computer-based presentations thanks to the technological advances made during the last two decades. Communication technologies have added a new dimension to these developments, providing global connectivity to remote sites, for interactive sessions as well as for broadcasts and webcasts of events, expanding the geographical outreach of the participants and the audience, beyond the confines of the auditorium. Some of the events may also include remote control (from the auditorium) of real or symbolic actions for commissioning, inauguration or demonstration of new plants. Such multifunctional live sessions relayed from the auditorium to remote sites include videoconferencing and remote control and also enable e-visits to remote sites. In order to accomplish various tasks involving multi-media communication and presentation during such events, a highly equipped multimedia centre has been set up at the Central Complex auditorium of BARC.

The Multimedia Centre consists of a number of component systems, which can be assembled and integrated in a flexible manner so as to cater to the requirements of a particular event. In generalized terms, such requirements can be summarized as follows.

1. The presentations in the auditorium are required to support a variety of media contents including local speeches, point-to-point or multiparty multimedia interactive videoconference sessions with remote sites, computer-based presentations, prerecorded video clips and movies, live and recorded animations etc.
2. Sequences of live communication sessions with several remote sites in interactive mode, have to be integrated with the presentations.
3. Sets of sequences have to be transmitted to remote sites with adaptability to alter contents for each site.
4. Sets of sequences have to be broadcast and webcast to remote audiences.
5 Flexibility of switching various combinations of audio and video contents within the sequences, is a standard requirement.
6. Remote control of actual or symbolic events at the remote sites may have to be carried out from the auditorium.

This article gives a brief technical description of the audio-video equipment, set up at the Multimedia Centre and at the remote sites, for fulfilling the above requirements; the kind of networks used for communication, different characteristics of the contents and orchestration of actual events. The present Multimedia Centre has a permanent equipment set-up, while additional equipment could be mobilized as and when needed.

Components of the Multimedia Centre

Videoconferencing (VC) Systems

The VC systems used at the Multimedia Centre are point-to-point or multi-party systems, enabling live multimedia communication sessions with remote sites.

Basic VC Set-up : The videoconference units at the control room of the Multimedia Centre, receive local audio-video signals from the cameras and the audio amplifiers, used for the audio-video coverage of events in the auditorium. The remote site has a similar videoconferencing unit, to decode the remote audio-video signals and is in constant communication with the central unit via IP-based connection or ISDN-dial-up connection.

1. IP-based connection: For the IP (Internet protocol) connectivity, the DAE-Wide network "ANUNET" is used, for establishing communication links. For a good quality jitter-free session, the satellite resources over the ANUNET are reserved on point-to-point basis, during the session.
2. ISDN dial-up connection: ISDN lines hired from MTNL/ BSNL, provide good quality communication channel and have lower overheads and delay problems as compared to IP-based networks. There is, however, a higher probability of call disconnection. These lines are used either as back-up to IP-based connections or as main lines where ANUNET is not available.

The VC systems at both ends and the interconnecting network, form the basic VC set-up, required for live interactive sessions.

Multi-Party Conference : The multi-party conference set up involves two or more remote sites and one central site, usually at BARC. A Multi-party Conference Unit (MCU) is used for this purpose, which receives signals from all the sites. Figure 1 shows the set-up in a simplified form. The signal displayed at the auditorium can be either a single selected remote signal or a mixed signal using split screen. The audio-video signal multicast back to remote sites, is required to be composed separately and may contain signals from the auditorium and/or selected/ mixed remote signals. When the audio-video formats on different links follow different standards, owing to bandwidth or equipment differences, the MCU is required to perform the compute-intensive job of transcoding, format conversion.

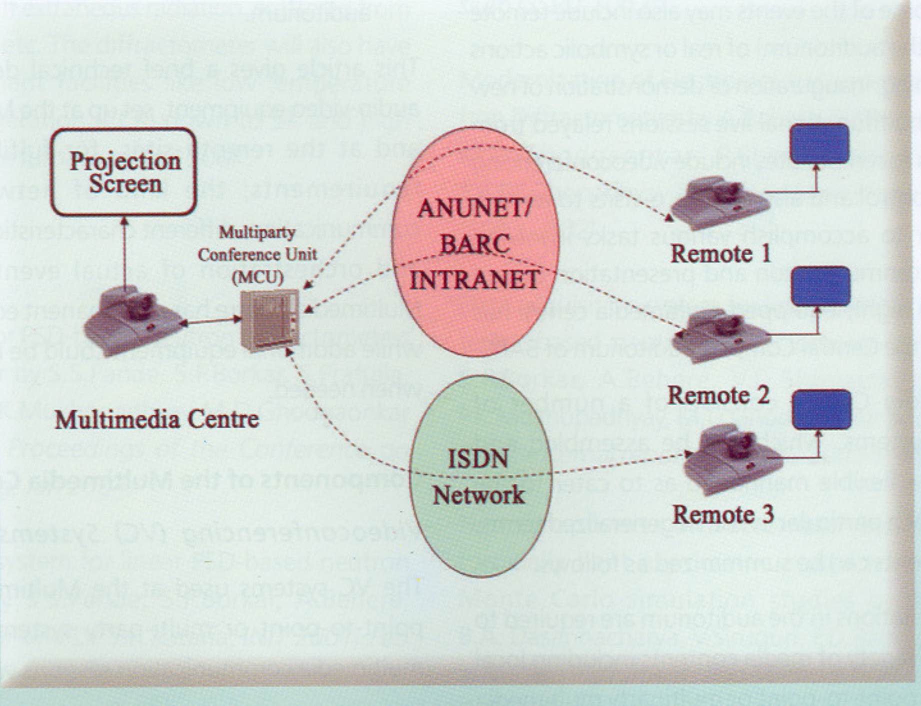

Fig. 1 : Multi-party conference using multi-party conference unit (mcu)

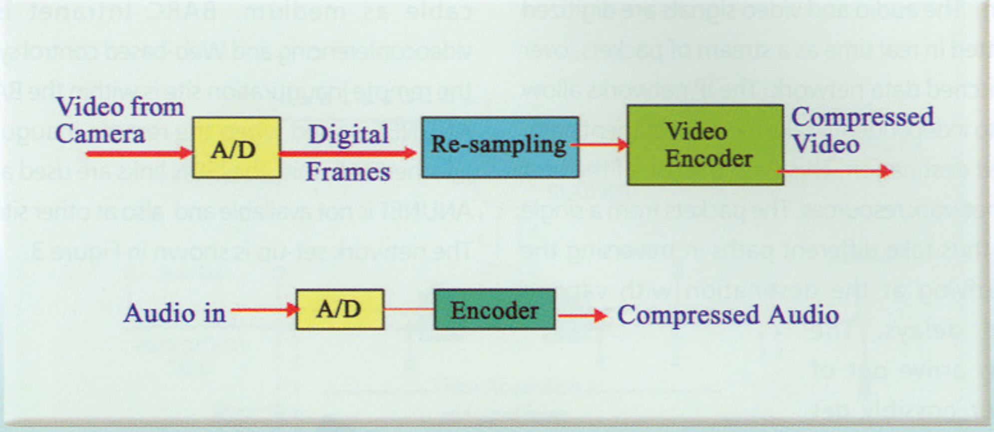

Fig.2 : Video and audio processing in videoconference systems

Parameters affecting the audio-video quality : Figure 2 shows the basic blocks of audio-video processing unit of a VC system. Both the signals are transmitted in the compressed format, which is selected on the basis of the required audio and video quality and available bandwidth. Depending upon the selected compression algorithm, the output audio rate is set at 8 Kbps, 16 Kbps or 32 Kbps. The main problem encountered in audio is acoustic and electronic echoes, which need to be rectified by critically setting the systems for each event, especially if satellite links are in use. The video signal available as a sequence of video frames after digitization, needs to be resampled digitally for resizing and is to be encoded in one of the standard VC formats, such as H.261 or H.263. The picture resolution used, typically follows CIF (Common Intermediate Format), which is 352 x 288 for luminance and 176 x 144 for chrominance or a multiple or a fraction of the CIF. Fractions or multiples of the basic CIF resolutions are used, depending on the bandwidth available.

The various parameters that need to be set carefully, to achieve optimum video and audio quality are as under :

1. **Network Bandwidth :** This sets the optimum bandwidth, which will be used by the application. A low bandwidth setting offers poorer video-audio quality, while a higher setting may cause instability, if the desired bandwidth is not actually available on the network continuously. The actual bandwidth settings can be selected separately for each site.

2. **Picture resolution versus smoother picture :** The videoconferencing system uses a video compression algorithm, which is adjusted to the bandwidth setting. It involves a compromise between two parameters, namely, picture resolution that affects the picture sharpness and frame rate that affects the smoothness of movements.

3. **Audio bandwidth :** Audio bandwidth required, depends upon the audio compression algorithm used. Audio bandwidth needs to be given priority over video as it is less tolerant to impairments.

4. **Precedence levels :** This sets the priority in the IP packets, carrying different types of information, such as video, audio, network control and inter-network control.

5. **Lip synchronization :** This parameter provides an option of audio synchronization with lip movements which, however, may result in audio clipping.

Networks used by the Multimedia Control Centre

IP and ISDN Networks : The IP-based packet-switched networks are the primary networks used by the Multimedia Centre, for videoconferencing and remote

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BARC NEWSLETTER

inauguration. The audio and video signals are digitized and transmitted in real time as a stream of packets, over a packet-switched data network. The IP networks allow each packet to independently take the most efficient path, to the desired destination. This results in use of the best of available network resources. The packets from a single source may thus take different paths in traversing the network, arriving at the destination with varying end-to-end delays. The packets may arrive out of sequence, or possibly get dropped on the way. At the destination, the packets are re-assembled and converted back into the original audio and video signal. On ISDN networks, a dedicated channel (or bandwidth) is allotted for each call, whereas in IP network, it shares traffic with many sources, leading to low audio & video quality due to delay and delay jitter. The delay causes echo and talker overlap. To get good audio and video quality, the network has to be configured to support Quality of Service (QoS), using standard techniques such as IP Precedence and DiffServ.

For videoconferencing and remote inauguration, various networks, namely, BARC Intranet, ANUNET and LAN at respective remote sites, are used. BARC Intranet and ANUNET have been extended to the Control Room using Ethernet switches and fiber cable as medium. BARC Intranet is used for videoconferencing and Web-based control systems, when the remote inauguration site is within the BARC campus. ANUNET is used when the remote inauguration site is another DAE unit. The ISDN links are used at sites where ANUNET is not available and also at other sites as backup. The network set-up is shown in Figure 3.

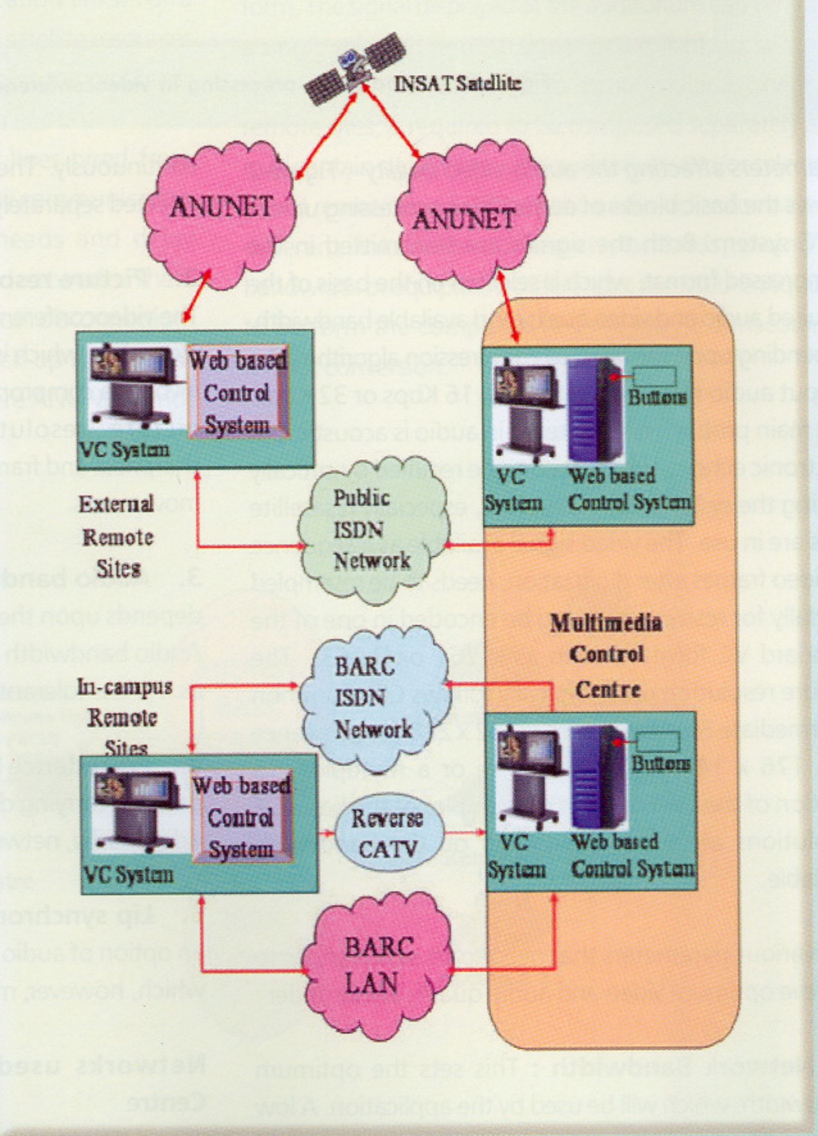


Fig. 3 : Network connectivity

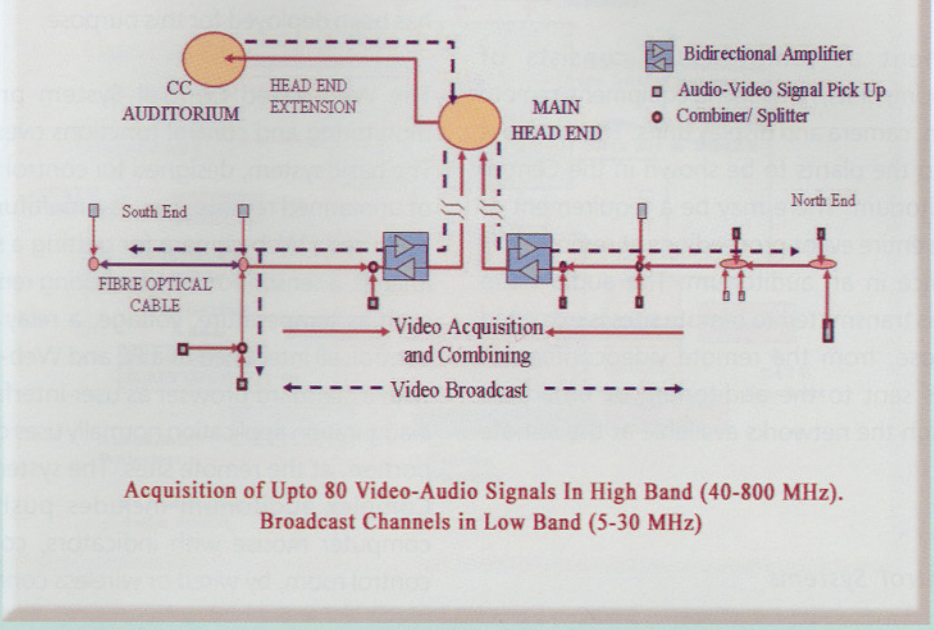


Fig. 4 : Reverse CATV Network

CATV network : The CATV network has been set up using innovative 'Reverse CATV' technique. A conventional CATV network has all the TV signals, consisting of upto 100 Radio Frequency TV channels, sourced at the Head End and is distributed over the physical area using tree topology. A few channels in the reverse direction may also be provided, in case services such as Internet through cable modems are offered, which need bi-directional signal flow. The CATV network in BARC has the reversed signal flow i.e. large number of channels sourced at scattered locations are combined and brought to the Head End using Inverted Tree topology and are used for collection of audio-video signals, to be made available at a central location. The channels in direction from the head end to remotes, which occupy unused frequency band below 40MHz, are taken up for broadcast of daily information displays and for event-based video broadcasts. Figure 4 illustrates the concept of the Reverse CATV network. The Multimedia Centre makes use of this network in both the directions, i.e for making videos from the remote sites within the campus available at a central location and for broadcasting the auditorium proceedings over the entire campus.

The Remote Sites

The remote sites involved in the events are often new sites, where civil construction work is still in progress, and hence, they lack infrastructure facilities such as availability of convenient power outlets, network connections and clean environment. This calls for careful site coordination with the concerned agencies, for setting up minimum required infrastructure in terms of electrical power, telephone and LAN cabling, setting up of ANUNET nodes and ISDN lines and even equipment platforms. It is also required to provide necessary redundancy in the equipment and network connections, which are subject to failure, due to an unconditioned environment and to the temporary nature of electrical and network connections.

The equipment at remote sites consists of videoconferencing units, networking equipment, remote control system, camera and display units. The system is set up close to the plants to be shown in the Central Complex auditorium. There may be a requirement of displaying the entire event proceedings at remote sites to the audience in an auditorium. The audio-video signal, which is transmitted to remote sites is extracted for this purpose, from the remote videoconference system and is sent to the auditorium or broadcast system, through the networks available at the remote site.

Remote Control Systems

The event often includes inauguration or commissioning of a remote plant from the Central Complex auditorium. The Web-based Remote Monitoring and Control System designed and developed by Computer Division, BARC has been deployed for this purpose.

The Web-based Control System provides remote monitoring and control functions over an IP network. The basic system, designed for control and monitoring of unmanned remote sites, is a multifunctional system, that uses a Web-camera for getting a sequence of still images, a sensor box for monitoring remote parameters such as temperature, voltage, a relay box for remote control; all interfaced to a PC and Web-based software, with a standard browser as user interface. The remote inauguration application normally uses only the relay box portion, at the remote sites. The system at the Central Complex auditorium includes push buttons or a computer mouse with indicators, connected to the control room, by wired or wireless connection.

The operation of remote inauguration at the sites is carried out as follows. At the start of an inauguration

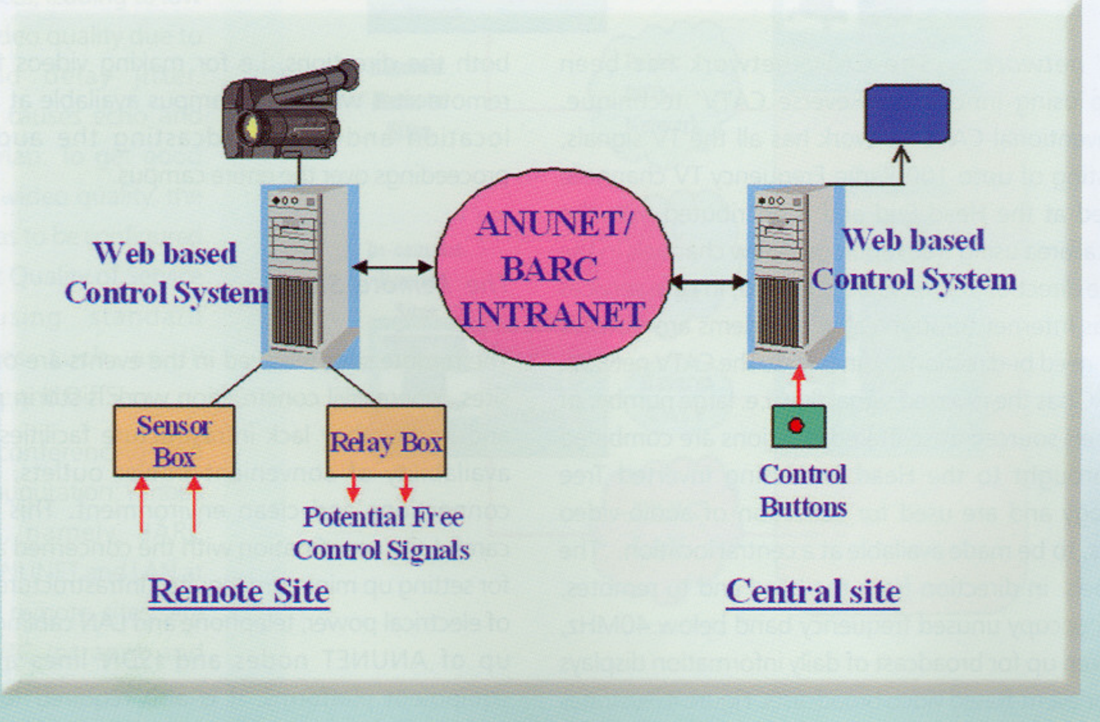


Fig.5 : Web-based remote control

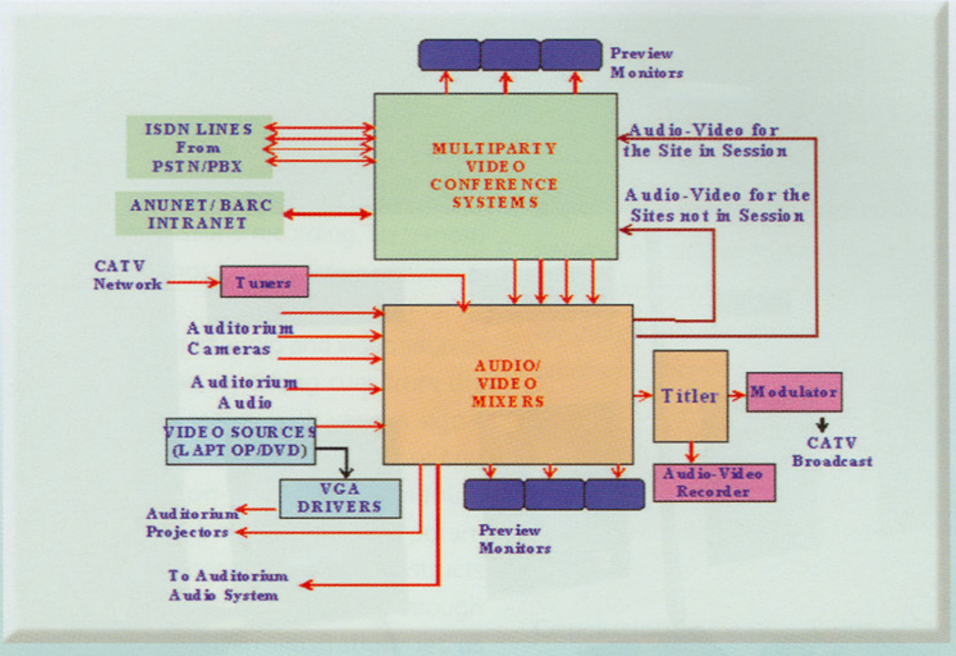


Fig. 6 : Multimedia Control Centre; simplified schematic

session, the particular driver software is invoked, resulting in the blinking of the corresponding indicator on the dais. Upon pressing of the button, the control signal is then sent to the remote site using IP protocol. The remote site, upon receiving the control signal, switches on the desired relay in the relay box, that provides potential free contacts, which can be used to activate certain function of a remote plant or to switch on a servomotor. This puts into motion certain predetermined operations in the remote plant to be inaugurated, or a symbolic operation such as the opening of a plaque. Audio-visual coverage of this sequence is sent to the central auditorium through the video conferencing system. A demonstrative animation display may also be initiated at the central auditorium. The remote inauguration set up is shown in Figure 5.

Audio-Video Systems

The audio video systems in the centre include mixers, switchers and distributors for selecting and mixing a number of audio video streams coming from remote sites, local cameras and other sources such as DVD players, laptops etc. The number of such streams may reach a maximum of 12, with a provision of selecting, mixing and composing video and audio in several ways independently. Separate sequences of compositions may be required, for scenes to be displayed in the auditorium, to be sent to a remote site currently in live session, remote sites currently not in live session and to the event broadcast system and the event recording system.

The transitions between the scenes of a sequence can be programmed as audio only, video only or both, with video transitions featuring selected special effects. A video titler is added to the sequences to display titles, names etc. to the picture. The system involves a cascade of audio and video mixers and monitors. Figure 6 shows the complete set-up at the Multimedia Centre in the form of a simplified block diagram and depicts videoconferencing and audio-video systems.

Auditorium Systems

Cameras and Audio : Three or four CCTV cameras, cover the event in the auditorium, each camera being operated

Fig. 7

manually. The operators are given headphones for instructions to be followed regarding picture contents, zooming, panning etc., by the program director from the control room, who is monitoring all the cameras. The audio source may be dais microphones, audience microphones or DVD player/laptop. Speaker volumes and microphone positions are set critically so as to completely eliminate the acoustic feedback. The signals from these sources are fed to audio-video system as depicted in Figure 6.

Projection System : The auditorium has upto three projectors, two in the front on either sides and one at the rear, the contents being usually identical. The video signal from the video mixers in the Multimedia Control Room is relayed to all the projectors. During the slide presentations by the speakers, the VGA signal from the podium laptop computers, is fed directly to the projectors through VGA long-cable drivers. This signal is also made available to the control room for onward transmission to remote sites and to the broadcast network.

Broadcast and recording

The Multimedia Centre uses various audiovisual sources, available in the centre and mixes them to compose audio-video coverage of the event, for broadcasting over the CATV network and for making audio-video recording of the entire event, in analog or digital formats. The contents for these two applications are usually identical although they could be composed separately. The recording acts as an archive and can be replayed anytime later.

Program Orchestration

The event to be covered consists of sequences of scenes, with each scene consisting of different combinations of selected and mixed audio-video signals. The signals in each scene, may have to be differently composed for local projection, for broadcast and recording, for remote sites in active session and those not in active sessions.

This needs precise switching of audio and video sources on-line, from scene to scene, by taking cues from the proceedings. A number of scenes with various signal combinations are preconfigured for this purpose and sequences are executed on-line. Such a manual orchestration is done in live mode by the program director who follows the program script and instructs the equipment operators to switch progressively through the sequences of scenes. As an illustration, let us consider a remote inauguration sequence of a remote site 'A', consisting of the following scenes.

1. Scene: Speech from the auditorium: Video and Audio: From the auditorium dais to everyone.

2. Scene: Presentation from the auditorium: Video: From laptop to everyone. Audio: From the auditorium dais to everyone.

3. Scene: A Video clip on site 'A': Video and Audio: From media player to everyone.

4. Scene: Video Conference with site 'A': Video: Site 'A' projected in the auditorium, Auditorium Video to Site 'A' and a mix of the two to other sites and to broadcast. Audio: Mix of the auditorium dais and remote site 'A' to everyone.

5. Scene: Remote Inauguration: Video: Auditorium Video to Site 'A' and mix of the auditorium and Site 'A' Videos to the auditorium, to other sites and to broadcast. Audio: Mix of the auditorium dais and remote site 'A' to everyone.

6. Go to next sequence.

A typical event consists of several such sequences followed in quick succession. The Multimedia Centre, set up for this application, has a multiplicity of heterogeneous equipment, forming various components of the centre, which can be physically connected to suit various configurations and to enable the execution of a set of sequences of scenes, in a flexible manner. There is further scope to implement the audio video signal processing, which is partly in analog domain at present, using fully digital technology and also to automate the sequence configuration and execution.

Conclusion

A hi-tech Multimedia Centre consisting of component systems which include : videoconference systems, audio-video and projection system, remote control and monitoring system, broadcast system and different types of network connections has been set up at the Central Complex auditorium of BARC, for enhancing participation and the audience outreach in the auditorium. The total system includes equipment which is flexible, configurable at the control room, compatible with several types of interconnection networks including IP, ISDN and CATV networks at remote sites. Actual events are scripted as sequences of scenes and implemented on-line for live participation and coverage during the events. The system has been successfully used on several occasions in the past, during important events and has added a new dimension to the coverage of such events.

BARC SIGNS TWO MOUs WITH ECIL FOR DEVELOPMENT AND TECHNOLOGY TRANSFER OF MACHINERY PROTECTION SYSTEM AND EC BUS BASED MICROCOMPUTER BOARD TEST FACILITY

Bhabha Atomic Research Centre and Electronics Corporation of India Limited, Hyderabad signed two Memoranda of Understanding (MOUs) for development and technology transfer of Machinery Protection System and EC Bus-based Microcomputer Board Test Facility on December 16, 2005. These two systems are being designed and developed in Computer Control Design Section (CCDS) of Reactor Control Division (RCnD), BARC. After completion, the technology will be transferred to ECIL, for manufacture and supply of systems, to various Nuclear Power Plants and other industries.

The Machinery Protection System is a DSP-based embedded system, which will be useful for vibration monitoring and protecting heavy rotating machineries from possible catastrophic failures due to excessive vibration. ECIL agreed to pay Rs. 300,000/- to BARC, towards the development cost of the Machinery Protection System.

RCnD developed a family of microcomputer boards for control and monitoring applications in nuclear power plants. The technology of these boards was transferred to ECIL. These boards are manufactured by the Control and Automation Group of ECIL, under the brand name of EC bus-based boards. The microcomputer board test facility will be useful for automated functional testing and troubleshooting of various types of EC bus-based microcomputer boards. ECIL agreed to pay Rs. 100,000/- to BARC, towards the development cost of EC Bus-based Board Test Facility.

Mr G.P. Shrivastava, Chairman and Managing Director, ECIL, Hyderabad and Mr G. Govindarajan, Director, E&I and A&M Groups, BARC signing the two MOUs. Also present are Mr B.B. Biswas, Head, RCnD, BARC and Mr C.K. Pithawa, Head, CCDS, RCnD, BARC

REPORT ON INDO-FRENCH BILATERAL SEMINAR "NUCLEAR WASTE MANAGEMENT"

An Indo-French bilateral seminar on "Nuclear Waste Management" was held at BARC during December 14-18, 2005, with the objective of exhanging information and pursuing collaborative work in R&D activities of common interest.

The seminar began with a keynote address by Dr S. Banerjee, Director, BARC, followed by presentations covering overviews of radioactive waste management in India and France. Mr B. Bhattacharya, Special Advisor to Chairman, AEC covered the overview from the Indian side and Dr Denis Aker, Director, DSNL, CEA from the French side. Mr P.K. Wattal, Head, Back-End Technology Development Division, BARC and Indian co-ordinator for bilateral programme on waste management, covered the current status of R&D activities in India.

The presentations made by Indian participants included topics covering R&D strategies for waste management, waste management practices in nuclear power plants, management of low and intermediate level aqueous and organic wastes, oxidative destruction of organic wastes, supercritical extraction studies and magnetically assisted chemical separation, vitrification of high level waste including remote handling, melter technology including development work on waste and achievements of 15 years of research on HLW, cement encapsulation of low level radioactive slurries of complex chemistry, decontamination processes using foam and gel, supercritical CO_2 and pulsed power processes, ceramics for separated radionuclides regulatory aspects on waste management AREVA's experience in vitrification, cold crucible melter development, radiological inventory and hot spots localization and dose uptake optimisation dose simulation and remote operation.

Based on discussions, the areas of cooperation pertaining to long term behaviour of vitrified waste, decontamination processes using foams and gels, supercritical studies for decontamination, nuclear waste package characterisation and assisted membrane separation techniques were identified.

Seen in the photograph at the Indo-French bilateral seminar from left to right are : Dr S. Banerjee, Director, BARC, Dr Denis Acker, Director, DSNL,CEA, France, Mr B. Bhattacharjee, Special Advisor to Chairman, AEC and Mr P.K. Wattal, Head, BETDD, BARC

TRAINING PROGRAMME ON ANALYTICAL PROTOCOL FOR TRACE ANALYSIS OF FORENSIC SAMPLES : A REPORT

A three-day training programme on "Analytical Protocol for Trace Analysis of Forensic Samples" was organised jointly by the Neutron Activation Analysis (NAA), Unit of Central Forensic Science Laboratory (CFSL), Hyderabad and Analytical Chemistry Division, BARC, Mumbai from November 23 - 25, 2005. The course was designed with the objective to expose the forensic scientists/ document examiners to recent trends in analytical procedures as an aid to crime detection and to counter organised crimes. The course covered lectures emphasizing analytical protocol aspects of samples, sampling, analytical methodologies, computation, evaluation of uncertainties, interpretation of data etc. A lecture on NDT methods was also included. Exposure to equipment facilities at ACD, BARC on various nuclear and non-nuclear analytical techniques and a visit to the APSARA nuclear reactor at BARC was also arranged.

The programme was inaugurated by Dr S. Banerjee, Director, BARC, on November 23, 2005 in the 'C' Block Auditorium, Modular Laboratories, BARC. Delivering the inaugural address, he stressed on the potential of nuclear and other technologies in helping to solve crime cases. He appreciated the sustained team efforts and competence of the scientists, right from simple visual inspection to versatile techniques, in taking up challenges and opportunities. Dr Banerjee also elaborated on the possibility of analysing a single molecule with modern development of science and technology. Compiled lecture notes in the form of a book was released by the Director, BARC, before the inaugural address. These were prepared to enhance the information content and for the benefit of the participants. Dr M. Sudersanan, Head, ACD, BARC, formally welcomed the participants who had come from different places to attend the course. He reiterated the importance of analysis to forensic studies, touching upon the dire need to develop fool-proof analytical procedures in helping to solve forensic science problems. Dr T. Mukherjee, Director, Chemistry Group, BARC, in his introductory remarks, put forward the key words in forensic science to be given priority in the forensic science profession. He stressed the need for updating knowledge in the pursuit of truth. In this context, reflection on present day scenario through Internet and its usefulness were also cited by him. Dr S.K. Kulshreshtha, Associate Director, Chemistry Group, BARC, Mumbai spoke about the importance of this unique collaborative work programme between BARC

Dr S. Banerjee, Director, BARC releasing compiled lecture notes in the form of a book during inaugural function. Seen on the dais from left to right are Dr. S. K. Kulshreshtha, Associate Director, Chemistry Group, BARC, Dr T. Mukherjee, Director, Chemistry Group, BARC, Dr. S. Banerjee, Director, BARC, Dr.(Mrs.) R. Krishnamurthy, Director, Forensic Science Laboratory, Maharashtra State, Mumbai, Dr. M. Sudersanan, Head, Analytical Chemistry Division, BARC.

Dr T. Mukherjee, Director, Chemistry Group and Dr. S. K. Kulshreshtha, Associate Director, Chemistry Group, BARC, with participants, organisers and some of the faculty members of the training programme on "Analytical Protocol for Trace Analysis of Forensic Samples", organized by the NAA Unit of CFSL (H), ACD, BARC, Mumbai.

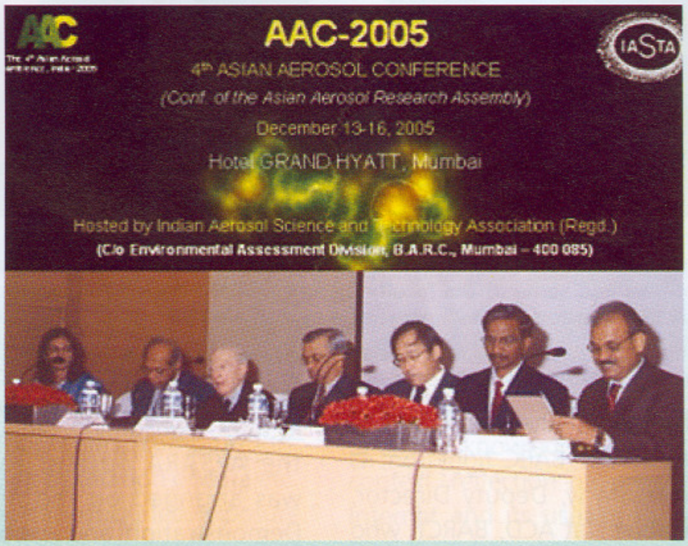
and CFSL. He gave a brief account of the type of exercise carried out in the NAA Unit at ACD, BARC, right from its inception. Dr N. Chattopadhyay, Deputy Director, NAA Unit of CFSL, Hyderabad (at ACD, BARC) who was the Course Director, gave an introduction on the design of the training course. Dr (Mrs) R. Krishnamurthy, Director, Forensic Science Laboratory, Mumbai elaborated on the importance of forensic science in the service to the society, touching upon preventive forensics and mental alertness, to avoid untoward incidents. Dr. A. K. Basu, Asstt. Director, NAA Unit of CFSL, Hyderabad (at ACD, BARC) proposed a vote of thanks.

Dr M. S. Rao , Director-cum-Chief Forensic Scientist, DFS, MHA, New Delhi conveyed through a messaage that the focal theme of the course i.e., "analytical protocol" was the need of the day. He said that mutual exchange of views during the training programme would certainly strengthen the scope of the programme. Director, CFSL, Hyderabad rendered full administrative and financial support to the course.

A total of 24 participants from different FSL(s), CFSL(s), GEQD(s) and BARC attended the course. In all, 14 technical lectures on different aspects covering the syllabi of the course were arranged. Senior scientists with rich experience in various analytical techniques for trace inorganic/organic analysis and forensic science, delivered lectures, highlighting various protocol aspects. A visit to the APSARA nuclear research reactor of BARC was arranged on the first day in the afternoon. Demonstration and exposure to various analytical equipment in ACD, BARC was also arranged.

Valedictory function was held in the 'D' block lecture hall, Modular Laboratories, BARC, on the final day i.e., November 25, 2005 at the end of the technical sessions. The function was chaired by Dr T. Mukherjee, Director, Chemistry Group, BARC. Dr. A. K. Basu, Asstt. Director (NAA) summed up the programme. Some of the participants expressed their views on the usefulness of the course. Dr. N. Chattopadhyay, Course Director expressed his observations. Dr. B. Venkataramani, Head PCMS, ACD, BARC, gave his remarks about the course. Dr Mukherjee in his valedictory address mentioned that the impact of interactive deliberations would be fruitful for the participants, in gathering awareness about the potentialities of analytical methods in forensic studies. The mutually interactive course received a healthy and lively feedback from the participants and was reviewed by Dr T. Mukherjee, Director, Chemistry Group, BARC. The peers and the participants regarded the programme as scientifically stimulating and rewarding for the organisers too. Dr. A.B.R.Tripathi, JSO, NAA Unit extended the vote of thanks. Dr. A.B.R.Tripathi, JSO and Mr C.A. Bhadkambekar, SSA, NAA Unit were also associated with the training course.

ASIAN AEROSOL CONFERENCE (AAC-2005) : A REPORT



Inaugural session: (L-R) Dr. B.K. Sapra, Dr. S. Banerjee, Prof. S.K. Friedlander, Dr. A. Kakodkar, Prof. Y. Iwasaka, Dr. P.C.S. Devara and Dr.Y.S. Mayya

Indian Aerosol Science and Technology Association (IASTA) organized the 4th Asian Aerosol Conference (AAC-2005) at Hotel Grand Hyatt, Mumbai, during December 13-16, 2005, under the aegis of the Asian Aerosol Research Assembly (AARA). The AACs are held once in two years and the previous three were held in Japan, Korea and Hong Kong. AAC-2005 was sponsored by various national bodies such as BRNS, ISRO, CPCB, DST, AERB, MPCB and INSA and international organizations such as NASA (USA), HEI (USA) & TSI Inc. (USA). The conference was also supported by several industries by way of participation in the exhibition and sponsorship. The convenor of the conference was Mr H.S. Kushwaha, Director, Health, Safety and Environment Group, BARC.

About 200 Indian delegates and 158 delegates from abroad participated in the conference. The high spirited tone of the deliberations to follow, was set in the inaugural session itself. Delegates were welcomed by Dr. P.C.S. Devara, Vice-president IASTA and by Prof. Iwasaka, President AARA. Dr. S. Banerjee, Director BARC, in his presidential address, spoke about the role that aerosol science has played in making fundamental contributions to the development of physical sciences. In his inaugural speech, Dr. Anil Kakodkar, Chairman AEC & Secretary, DAE emphasized the importance of aerosols, over a wide range of topics of societal relevance and pointed out the need to have international collaborations, for tackling issues of global importance. He expressed his happiness at the overwhelming response to the conference from almost all corners of the world and appreciated the efforts of IASTA in organizing this event. Dr. B.K. Sapra, Secretary, IASTA proposed the vote of thanks.

Prof. Sheldon Friedlander, Parson's professor of Chemical Engineering, UCLA, who is a leading figure in the field of aerosol science, delivered the keynote address on "Aerosol Science and Technology- an enabling discipline". The talk touched upon various domains of aerosol science and technology right from nano-particles, fractal structures, collision-coalescence reactors and laser ablation techniques for fabrication of nano-particles. He gave deeper insights into the latest applications of aerosol science, associated instrumentation, technological applications and future dimensions. As a memento, Dr. Kakodkar presented Dr. Friedlander with a portrait of the latter, sketched by Mr. K. Gharat of BARC.

The technical programme consisted of about 170 platform presentations, deliberated upon in 3 parallel sessions over four days. An equal number of poster presentations were also made. The topics covered dozens of areas of current interest in aerosol science. Chief among them were: nano-particles and material synthesis, atmospheric aerosols and remote sensing, climate models, health effects, nuclear aerosols and aerosol physics. The proceedings were brought out in the form of a CD as well as published in the form of extended abstracts, covering an 800-page volume of IASTA bulletin. Four tutorials were held by acknowledged experts on basic aspects of aerosols and the participants were given lecture handouts.

The plenary lectures were delivered by Dr. G. Kasper, University of Karlsruhe (Germany), Dr. Mansoo Choi, Seoul National University (Korea) and Dr. A. Jayaraman, Physical Research Laboratory (India). These provided the overview on the current status of aerosol research in areas pertaining to material synthesis and novel materials and air pollution and climate effects. In addition to this, six special lectures were delivered on the thrust areas of aerosol research dealing with air pollution effects in Asia, climate models, indoor aerosols and vehicular emissions. The plenary lectures, special lectures and various technical sessions were intensely deliberated by packed audiences.

The conference was marked by "The young Asian aerosol scientist award" function instituted jointly by AARA and TSI Inc., USA. This year's award was conferred upon Dr. Chak K. Chan of Hong Kong University of Science and Technology for his work on the thermodynamics of atmospheric aerosols. In the AARA meeting held during the conference period, the responsibility of hosting the 5th AAC in August 2007, was entrusted to the Chinese Association of Aerosol Research and Technology (CAART), Taiwan, through a majority vote among the members of AARA. Also, Dr Y.S. Mayya, BARC, was chosen as the President of AARA for the next two years.

The Mumbai AAC is considered to be the largest congregation of aerosol scientists in Asia to date and has set a technical hallmark for future aerosol conferences. It is a tribute to the great leap in the magnitude and quality of aerosol research, in recent years in Asia, in general and in India, in particular. It provided an occasion for direct exposure of Indian aerosol expertise to the outside world as well as an invaluable opportunity for young Indian researchers to interact with their counterparts from various countries. The conference ended on a hopeful note of provision of a forum for increased international collaboration, among the scientists working in Asian countries.

Dr Anil Kakodkar, Chairman, AEC & Seretary, DAE, being welcomed at the inaugural function

Dr. S. Banerjee, Director, BARC delivering the presidential address

BRNS THEME MEETING ON CLADDING CORROSION, EMBRITTLEMENT AND PELLET-CLAD INTERACTION

Dr S. Banerjee, Director, BARC releasing the Proceedings of the 1st Theme Meeting. Mr D. N. Sah, Convener, HBINF-2005 looks on.

A series of theme meetings are planned to be organised on High Burnup issues in Nuclear Fuels (HBINF-2005) by Nuclear Fuels Group, BARC and Directorate of Engineering, NPCIL. The first theme meeting was organised earlier in March 2005 on Fission Gas Release. The second theme meeting was organised on "Cladding Corrosion, Embrittlement and Pellet-Clad Interaction (PCI)" on October 17, 2005 at Multipurpose Hall of BARC Training School Hostel, Anushaktinagar, Mumbai. The response to the theme meeting was overwhelming. More than 150 delegates participated in this theme meeting. The presentations in the meeting included seven theme talks by experts, five short invited presentations and 22 poster papers.

Mr K.B. Dixit, ED(Engg.), NPCIL, welcomed the delegates. The meeting was inaugurated by Dr S. Banerjee, Director, BARC. In his inaugural address, Dr Banerjee brought out important aspects of irradiation behaviour of Zr-alloys as cladding material for water reactor fuel pins. Dr. Banerjee emphasised the urgent need to undertake experimental studies on corrosion behaviour of Zircaloy cladding under partial boiling condition, since partial boiling of coolant is envisaged in PHWR units in the near future. He also released the Proceedings of the Ist Theme Meeting of HBINF-2005, on this occasion. Mr D. N. Sah, Convener, HBINF-2005 proposed a vote of thanks.

The theme meeting was organised in 4 technical sessions as follows:

Technical Session I	:	Fast Reactor Fuel-Cladding Behaviour
Technical Session II	:	Corrosion and Hydriding of Cladding in Water Reactor Fuel Pins
Technical Session III	:	Fuel Pin Performance in Reactor
Technical Session IV	:	Mechanical Properties and Hydriding

Mr B. K. Shah of Atomic Fuels Division, BARC, delivered a theme talk on corrosion of Zr alloys. Dr. S. L. Mannan of IGCAR, Kalpakkam delivered a talk on issues in the performance of core structural materials for FBRs. Dr A. K. Sengupta of BARC and Dr P. R. Vasudeva Rao of IGCAR, Kalpakkam delivered talks on Fuel-Clad interaction and Fuel-Cladding compatibility in fast reactor fuel pins. Mr K.P. Dwivedi of NPCIL delivered a theme talk on performance of Zircaloy cladding in PHWR fuel assemblies. Mr K.C. Sahoo and Mr S. Chatterjee of BARC delivered talks on PCI/SCC failure and irradiation effect on the mechanical properties of cladding respectively. Twenty-two contributed papers were presented as posters. These papers covered various aspects of cladding corrosion, embrittlement and PCI in fuel pins. Dr H.S. Ubhi of Qinetic, U.K., delivered an invited talk on texture determination using XRD and EBSD.

A panel discussion was held at the end of the presentations. The panel was chaired by Mr H. S. Kamath, Director, Nuclear Fuels Group, BARC. The following important points emerged from the panel discussion:

1. There are two approaches to developing cladding material with better corrosion resistance suitable for higher burnup. The first approach is to optimize the existing alloys in terms of chemical composition and microstructure. This has resulted in the development of optimized Zircaloy-4 (low Sn, Low C and controlled Si). The second approach is to develop new alloys namely, Zr-Sn-Nb-Fe series of alloys. Important alloys in this series are ZIRLO and Alloy 635.

2. Effect of dissolved oxygen in the coolant water on the cladding oxidation is important while using Zircaloy-4 as fuel cladding in PHWR and AHWR fuel pins. There is a need to generate our own data on corrosion behaviour in partial boiling conditions.

3. Quantification of chemical composition of cladding materials is essential. Suitable corrosion test methods are needed to study the detrimental effect of high impurity content.

4. Trial irradiation of new alloys in test reactor/ power reactor may be considered to generate corrosion data for actual operating conditions.

The panel recommended the formation of a task force with members drawn from NFC, BARC and NPCIL to take up a joint program on the above issues.

ONE YEAR HEALTH PHYSICS STIPENDIARY TRAINING COURSE – XII BATCH

Dignitaries on the dais: (from left to right) Mr M.L. Joshi, Head, Health Physics Division, BARC, Mr S.K. Chande, Vice Chairman, AERB, Mr S.K. Jain, Chairman & Managing Director, NPCIL, Mr S.S. Bajaj, Sr. ED (Safety), NPCIL, Mr P.S. Nair, Head, Power Projects Safety Section, HPD, BARC

Health Physics Division has been conducting One Year Health Physics Stipendiary Training Course for science graduates since 1989, to augment the requirements of trained professionals in Health Physics discipline for various DAE facilities. Formal training programme for the XII Batch of this training comprising 28 science graduates recruited by NPCIL, was inaugurated by Shri S.K. Jain, Chairman & Managing Director, NPCIL on Monday, February 6, 2006 at Health Physics Division Auditorium, CT&CRS Building, Anushaktinagar. Mr S.K. Chande, Vice Chairman, AERB was the guest of honor. Mr S.A. Bohra, Sr. ED (T), Mr S.S. Bajaj, Sr. ED (Safety) and Head of Divisions of HS&EG, BARC were the other dignitaries present. The function was also attended by senior officers from BARC, NPCIL and AERB in addition to the course coordinators and faculty members. In his welcome address, Mr M.L. Joshi expressed happiness that the very presence of CMD, NPCIL at the function indicated the importance given to radiation safety and health physics profession in our department. Also, he briefly touched upon the present status of nuclear power generation in India and the role of health physicists in operating units and in the future expansion plans of NPCIL. He reiterated the close coordination between Health Physics Division and Atomic Energy Regulatory Board in ensuring radiological safety and appreciated the encouragement received from AERB through the awards instituted by AERB, for the merit holders of each batch of health physics trainees. Mr M.L. Joshi also mentioned his close association with Shri S.S. Bajaj, Sr. ED (Safety), NPCIL in finding solutions to problems related to radiological safety, at different nuclear power plants. He also gave a brief description of the objectives, syllabus, training methodologies and structure of the training programme. He went on record to say that so far 400 scientific assistants had been trained through the previous batches and presently are holding responsible positions in different DAE facilities including NPCIL units. In his address, Mr S.S. Bajaj, Sr. ED (Safety), NPCIL stressed the important role of an operational health physicist in a nuclear power station. He also reminded that the health physics professionals are required to interact with a variety of personnel – employees and the public and hence they should develop good communication skills in addition to the expertise in the discipline of the radiological safety. He called upon the health physicists to act as "mouth piece of DAE" on matters related to radiological safety.

Mr S.K. Jain, Chairman & Managing Director, NPCIL formally inaugurating the Training Course by lighting the traditional lamp

Mr S.K. Chande, Vice Chairman, AERB congratulated the new entrants for making the right choice in selecting a career in the Department of Atomic Energy. He also stressed on the importance of nuclear power as a benign source of power; for, unlike thermal power stations, nuclear power plants do not pollute the environment. Hence, the world over, nuclear power generation is seen as a clean source of energy for the future. At the same time, Mr S.K. Chande remarked that the department has a responsibility to build public acceptance and confidence in our nuclear power programme. In this context, the health physics professionals have a vital role in ensuring safety of the radiation workers, the general public and the environment. The primary control on radiation exposure begins at the power station itself where the health physicist has to play a major role in limiting the individual exposures, within the limits stipulated by the AERB, controlling the collective dose and ensuring the environmental discharges to a small fraction of the authorised limits. He also remarked that the subject of health physics is still in an evolving stage and the professionals should keep abreast of the latest developments and pursue R&D activities in the relevant fields.

The training course was formally inaugurated by Mr S.K. Jain, Chairman & Managing Director, NPCIL by lighting the traditional oil lamp in the presence of the other dignitaries. In his inaugural address, Mr S.K. Jain welcomed the trainees to the NPCIL family and reminded them of their responsibilities in the light of the massive expansion programmes in the field of nuclear power generation in the country. He reminded them that the responsibility of a health physicist begins from the very first stage of siting a nuclear facility. In this context, it is a matter of pride to all that the radiation levels in the vicinities of Nuclear Power Plants are comparable to the natural radiation background elsewhere and that NPCIL was able to produce power at rates cheaper than or comparable to the conventional sources. Mr S.K. Jain also shared the information that the performance of NPCIL on the financial front was also impressive and that the Corporation is considered as one of the best performing Public Sector Undertakings in the country. It was also a matter of pride that NPCIL has entered the second stage of power generation through BHAVINI using the fast breeder technology for which the construction work is already in progress. He also remarked that a major achievement for NPCIL was the reduction of the gestation period of a Nuclear Power Plant to less than 5 years as compared to the 10 years taken for the first generation of the Indian PHWRs. In conclusion, he advised the young entrants to maintain professional integrity and commitment to improve the standards of safety.

The function concluded with a vote of thanks proposed by Mr P.S. Nair, Head, Power Projects Safety Section, HPD, BARC.

FORTHCOMING CONFERENCE OPENUPP-2006, NOVEMBER 15, 2006

Three national symposia on 'Operating Experience of Nuclear Reactors and Power Plants' have been conducted under the auspices of Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy (DAE), in the past. The primary objective of conducting such series of symposia on this topic has been to discuss the rich operating experiences of nuclear and conventional power plants, on a common platform. Such exchange of information on a variety of engineering and scientific aspects, provides the necessary feedback for improvements in design and choice of new materials apart from improving plant performance.

Subsequent to the last symposium held in the year 1989, installed power capacity in the country has almost doubled. Significant experience has also been gained in various areas of our nuclear power programme. In order to share the experience, the Reactor Group of BARC along wih the Directorate of Operations, NPCIL, is organising a National conference on 'Operating Experience of Nuclear Reactors and Power Plants' under the auspices of BRNS.

Authors and presenters are invited to participate in this conference by disseminating the actual experience gained during various stages of nuclear reactor and power plant commissioning, operation, maintenance, engineering changes and in providing various plant related services. Dissemination of knowledge by presenting the experience, new developments and novel concepts in the above areas would be beneficial in improvement of plant safety, reliability and availability. It is expected that the experience gathered over the years, would recognize the requirements for new developmental activities and the conference presentations can be a tool for prioritizing R&D activities in these areas, apart from providing the necessary feedback to O&M community, designers, fabricators and regulators. The conference would address the following topics :

- Overview of Power Plants and Power System Management
- Experience with Nuclear and Conventional Equipment
- Experience with Computerized Control System, Operator Information Systems and Simulators
- Training, Licensing, Qualification of Personnel and Human Performance
- Experience in Commissioning and Testing of Nuclear and Process Systems
- Operational Safety, Significant Events, Low Level Events and Lessons Learnt
- Operational Feedback on Plant Documentation
- Equipment Maintenance Management, Surveillance practices and ISI
- Experience with Electrical Systems in Plants
- Experience with Steam Generators and Turbo-Generators
- Fuel performance and Core Physics Management
- Fuel Handling Experience
- Effluent Management and Pollution Control
- Controlling Chemistry parameters in Reactors and Power Plants
- Material behaviour and Corrosion Control
- Analysis for Safety Improvements
- Radiation and Industrial Safety

Important Dates :

Submission of Abstract	:	May 31, 2006
Acceptance of Abstract	:	June 30, 2006
Submission of Manuscript	:	August 31, 2006
Registration	:	October 10, 2006

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भा.प.अ. केंद्र के वैज्ञानिकों को सम्मान
BARC SCIENTISTS HONOURED


M. Pandey


Dr D. Datta


M. D. Deshpande

श्री मृदुलेंदु पांडे, श्री डी.दत्ता, श्री एम.डी.देशपांडे, स्वास्थ्य भौतिकी प्रभाग, भाभा परमाणु अनुसंधान केंद्र को जनवरी 18 - 20, 2006 के दौरान मीनाक्षी कॉलेज फॉर-वोमेन, चिन्नई, में आयोजित राष्ट्रीय परिचर्चा के दौरान विकिरण भौतिकी (एन एस आर पी -16) पर डेवलोपमेंट ऑफ ए कंप्यूटेशनल मेथडोलोजी फॉर एस्टिमेशन ऑफ पोटेन्शल इन्टरनल एक्सपोजर इन दि फ्युअल रिप्रोसेसिंग प्लांट नामक शोधपत्र के लिए सर्वश्रेष्ठ (पोस्टर) पुरस्कार से सम्मानित किया गया। इस शोध का संपूर्ण स्तलिखित रूप विकिरण भौतिकी की 16 वीं राष्ट्रीय परिचर्चा के कार्य विवरण में प्रकाशित किया गया है।

A paper titled : Development of a Computational Methodology for Estimation of Potential Internal Exposure in the Fuel Reprocessing Plant" authored by Mr Mridulendu Pandey, Mr D. Datta and Mr M.D. Deshpande of Health Physics Division, BARC. was given the Best Paper (Poster) award during the National Symposium on Radiation Physics (NSRP-16) held at Meenakshi College for Women, Chennai, during January 18-20, 2006. The complete manuscript of the paper is published in the Proceedings of Sixteenth National Symposium on Radiation Physics.


T.S.R. Ch. Murthy

श्री टी.एस.आर.चि.मूर्थी, पदार्थ उच्च ताप प्रक्रिया वर्ग, भाभा परमाणु अनुसंधान केंद्र को डेवलोप्मेंट एन्ड करेक्टरैजेशन ऑफ टीआइबी (TiB_2)बेस्ड मेटीरियलस फॉर हाई टेंपरेचर एप्लिकेशनस नामक शोध पत्र के लिए इन्डियन नेशनल अकादमी ऑफ इन्जीनियर्स (आइ एन ऐ ई) द्वारा एम.टेक. के शोध के लिये वर्ष 2005 (मास्टर्स लेवल) का इन्नोवेटिव स्टूडन्ट प्रोजेक्ट पुरस्कार से सम्मानित किया गया। यह शोध इन्डियन इन्सटिट्यूट ऑफ टेक्नालोजी, कानपुर के पदार्थ एवं धातुकी इन्जीनियरिंग प्रभाग को डीएई स्नातक स्कीम-2002 (डीजीएफएस - 02) के योगदान के रूप में प्रस्तुत किया गया। श्री मूर्थी ने यह पुरस्कार दिसंबर 10, 2005 को इन्डियन इनस्टिट्यूट ऑफ साइन्स, बेंगलोर में आयोजित अकादमी के वार्षिक सम्मेलन में आइएनएई के अध्यक्ष एवं आईएसआरओ के पूर्व सभापति डॉ.सी.कस्तूरीरंगन के द्वारा प्राप्त किया।

Mr T.S.R. Ch. Murthy, High Temperature Processing Section, Materials Processing Division, BARC, has been awarded the Innovative student project award (Master's Level) for the year 2005 by the Indian National Academy of Engineers (INAE) for his M.Tech. thesis titled "Development and Characterization of TiB2 based Materials for High Temperature Applications". This thesis was submitted to Department of Materials and Metallurgical Engineering, Indian Institute of Technology, Kanpur, as part of his M.Tech. under DAE Graduate Fellowship Scheme – 2002. Mr Murthy received the award from Dr C. Kasturirangan, President, INAE and ex-Chairman, ISRO on December 10, 2005 at the annual convention of the academy held at the Indian Institute of Science, Bangalore.

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