BARC

N E W S L E T T E R

VISUAL ENVIRONMENT WITH HIGH RESOLUTION TILED DISPLAY AND PC RENDERING CLUSTER

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Introduction

Today we can have huge datasets resulting from computer simulations (CFD, physics, chemistry, etc) and sensor measurements (medical, seismic and satellite). There is an exponential growth in computational requirements in scientific research. Modern parallel computers are providing the required computational power for the simulation runs and efficient visualization is essential in interpreting the large, dynamic data generated from these simulation runs. The visualization process maps these data sets on to graphical representations and then generates the pixel representation. The large number of pixels show the picture in greater detail and interaction with it enables greater insight on the part of user in understanding the data and picking out small anomalies that could turn out to be critical. However, the memory constraints, lack of the rendering power and the display resolution offered by even the most powerful graphics workstation make the visualization of this magnitude difficult or impossible. All over the world, tightly coupled multi processor multi pipe graphics supercomputers are used for large-scale data visualization. The number of graphics accelerator cards that can fit in the system and the high cost involved are the limitations of this approach.

While the cost-performance ratio for the component based on semiconductor technology doubles in every 18 months, or beyond that for graphics accelerator cards, the display resolution is lagging far behind. The resolutions of the displays have been increasing at an annual rate of 5% for the last two decades. The ability to scale the components of computing CPU, memory, graphics accelerator and displays by combining them is the most cost-effective way to meet the ever-increasing demand for computational power, rendering rate and high resolution. The high resolution tiled display and rendering cluster initiative at Computer Division, BARC, explore means to build and use a scalable display system by tiling multiple LCD displays driven by the Linux-based PC graphics-rendering cluster. Off-the-shelf components such as PCs, PC graphics accelerators, network components and LCD displays are used. This article focuses on building such a system that can render and drive over 20 million pixels, using the open source software framework that allows running existing graphics (OpenGL) as well as non-graphics (X11) applications at interactive speed. Tiled display-aware applications requiring higher intrinsic display resolution and more display space have been developed.

System Architecture

In our architecture, a display is constructed by tiling the LCD displays. A single workstation drives a single display; software environment controls the rendering of the portion of the graphics apportioned to that display. A separate workstation of the cluster is used to control the entire tiled display.

In March 2003, we designed the first 4-tile LCD display system that provides a display resolution of 2048 x 1536 (3.1 million) pixels. Each tile is 15″ ViewSonic display with maximum resolution of 1024x768. A PC Linux cluster of five workstations running Red Hat 7.2 is used to drive the display system. The workstations are Intel P-IV 1.7 Ghz processor, 256 MB RDRAM and

3Dlabs GVX1 pro AGP graphics accelerator cards. Communication between them is handled over the Fast Ethernet. The display is constructed from 2 x 2 LCD displays. A picture of the cluster and display system is shown in Fig. 1.

Fig.1: 2x2 Tiled display system

In September 2003, we scaled the display by constructing 16-tiles from 4 x 4 17″ ViewSonic LCD display and cluster of 17 (16+1) workstations running Red Hat 7.2. Fig. 2 shows the current high-resolution display system. The resolution of our new system is 5120x4096 (20 million) pixels. In our scaling efforts, we used two commodity interconnects: Gigabit Ethernet for graphics related communication and Fast Ethernet for file sharing etc.

Fig. 2: 4x4 Tiled display system

The commodity projectors can also be used for seamless tiled display. The projectors are costly as compared to LCD monitors and they are hard

to align. The brightness, color coordination, balance and edge blending also need to be addressed. Because of these issues, we decided to use LCD monitors for tiled display. However, the borders of the LCD displays (seams) provide a grid-like pattern etched through the logical display, in which nothing can be displayed. The seams introduce issues while visualizing the data. Our software environment treats the borders as if represented by hidden pixels, thereby creating the "panned window" effect.

Software Environment for Tiled Display

Moving the visualization applications to PC rendering cluster and tiled display makes software environment much more complex than the traditional shared memory multi-processor multi-pipe systems. In these systems the application data uses the shared memory, enabling the graphics and computations to easily access data and process it. In the PC rendering cluster, since there is no single place to share the data, the programmer must know the cluster configuration and provide ways to effectively share data through interconnecting network

Finally, the tiled display environment must fulfill three functional requirements: *genlock*, *swaplock* and *datalock*. *Genlock* synchronizes the video frames from each node of the cluster so that final image presented is coherent image. It is critical for active stereo on tiled display. Each graphics card in a cluster renders different number of polygons resulting in different rendering times for each frame. *Swaplock* ensures that the frame buffers swaps are synchronized. *Datalock* further ensures the synchronization of the views to maintain consistency across the tiles. We have not used any explicit *genlock* for tiled display whereas *swaplock* and *datalock* have been implemented in the software.

The basic two approaches for software architecture for PC rendering cluster and tiled display are: *Client/Server* and *Synchronized program execution*. In the *Client/Server*, single

instance of the application (client) serves data to the graphics rendering servers. This is usually transparent because the program can be implemented as if it runs on a single node. The software system will handle the necessary changes for running the program on PC cluster. The disadvantage is higher consumption of network bandwidth. With the *Synchronized program execution* approach, multiple instances of the applications execute on the cluster nodes. The execution of the application on all nodes must be synchronized to insure consistency among all application instances. Typically, the master node handles all user interaction and synchronizes state changes between the slaves. The advantage is the less consumption of network bandwidth.

With aim to support existing applications along with available open source software for running them on the tiled display, we selected Chromium and DMX software environment. These software environment implements *Client/Server* approach. Chromium is used for running OpenGL based graphics applications while non-graphics applications (X) use DMX (Distributed Multihead X).

Distributed Rendering

The rendering pipeline consists of three conceptual stages: geometry database (graphics primitives), geometry processing (transformation, clipping, lighting etc) and rasterization (scan-conversion, shading and visibility). The graphics accelerator cards of the cluster provide multiple rendering pipelines. The decision to split up and recombine the rendering workload can happen before or after either of the geometry processing or rasterization stage. Thus we can have *sort-first*, *sort-middle*, and *sort-last* architectures for distributed rendering.

The *sort-first* architecture distributes the graphics primitives early in the rendering pipeline (geometry processing) to the rendering node that

can do the remaining work. This is achieved by dividing the display into disjoint regions and making rendering nodes responsible for all rendering calculations that affect their respective screen regions. The screen-space bounding box of the primitive determines the regions into which it falls. The primitives are then distributed over an interconnect network to the appropriate rendering nodes. In *sort-middle*, primitives are distributed arbitrarily to geometry processing units and then screen space primitives are redistributed in the middle of the rendering pipeline to the appropriate rasterizer responsible for a portion of the display screen. The *sort-last* architecture assigns arbitrary subsets of the primitives to the rendering nodes which rasterize into pixels values no matter where they fall in the screen. The rendering nodes then transmit these pixels over an interconnect network to compositing nodes which resolve the visibility of the pixels according to the alpha or Z-buffer entries of the pixels. In short, the partial images are rendered in parallel and in the end combined according to their Z-buffer values.

The main advantages of *sort-first* architecture are relatively less communication requirements; it can deal well with both large number of primitives and large number of pixels. The disadvantages are extra work for finding primitive-tile overlap for each frame, limited scalability and load imbalance. The *sort-last* approach is scalable but requires an image composition network with very high bandwidth. The desired resolution and quality of the output image also directly affects the communication bandwidth. The *sort-middle* approach is very difficult in a cluster-of-PCs system; we can not break the rendering pipeline as it is implemented in hardware. We selected the *sort-first* approach for high-resolution graphics system.

Chromium

Chromium is a flexible framework for distributed-rendering on cluster of computers, initiated at Stanford University and supported by the Lawrence Livermore, Sandia, and Los Alamos National Labs and IBM Research. It provides a generic and extensible mechanism for manipulating streams of OpenGL (industry standard graphics) API commands. Hence, existing applications can take advantage of the rendering capability of a cluster, without modifying, or even recompiling the source code.

Chromium implements sort-first, sort-last and hybrid algorithms to distribute the rendering of polygonal geometry across the cluster. It works by replacing the native OpenGL library with its own. It directly operates on the stream of the OpenGL graphics commands issued by the application. It provides Stream Processing Units (SPU). Each SPU has its input-streams of graphics commands, performs some operation on these commands and passes them on. SPUs can be chained to perform combined operations. The SPUs for tiled rendering are *tilesort, render* and *pack. Tilesort* SPU implements the sort-first algorithm. The *tilesort* SPU sorts the OpenGL commands into tiles so that they are packed and sent over a network to the nodes handling the tiles. *Render* SPU passes the stream to the node's local OpenGL implementation. *Pack* SPU packs the stream into a buffer for transmission to cluster servers.

A python script called *mothership* controls running programs through Chromium. It contains the tile layout, SPU chains and nodes used for running the application. The *mothership* runs an event loop waiting for communication from the *crappfakers* and *crservers*. The *crappfaker* will run the OpenGL program and relink it against the defined SPU libraries. The *crserver* is used for tiled rendering and any SPU that requires network access for data transmission. *Crserver* sits on a socket and waits for packed OpenGL commands. Fig. 3 shows the *sort-first* configuration used by our PC cluster.
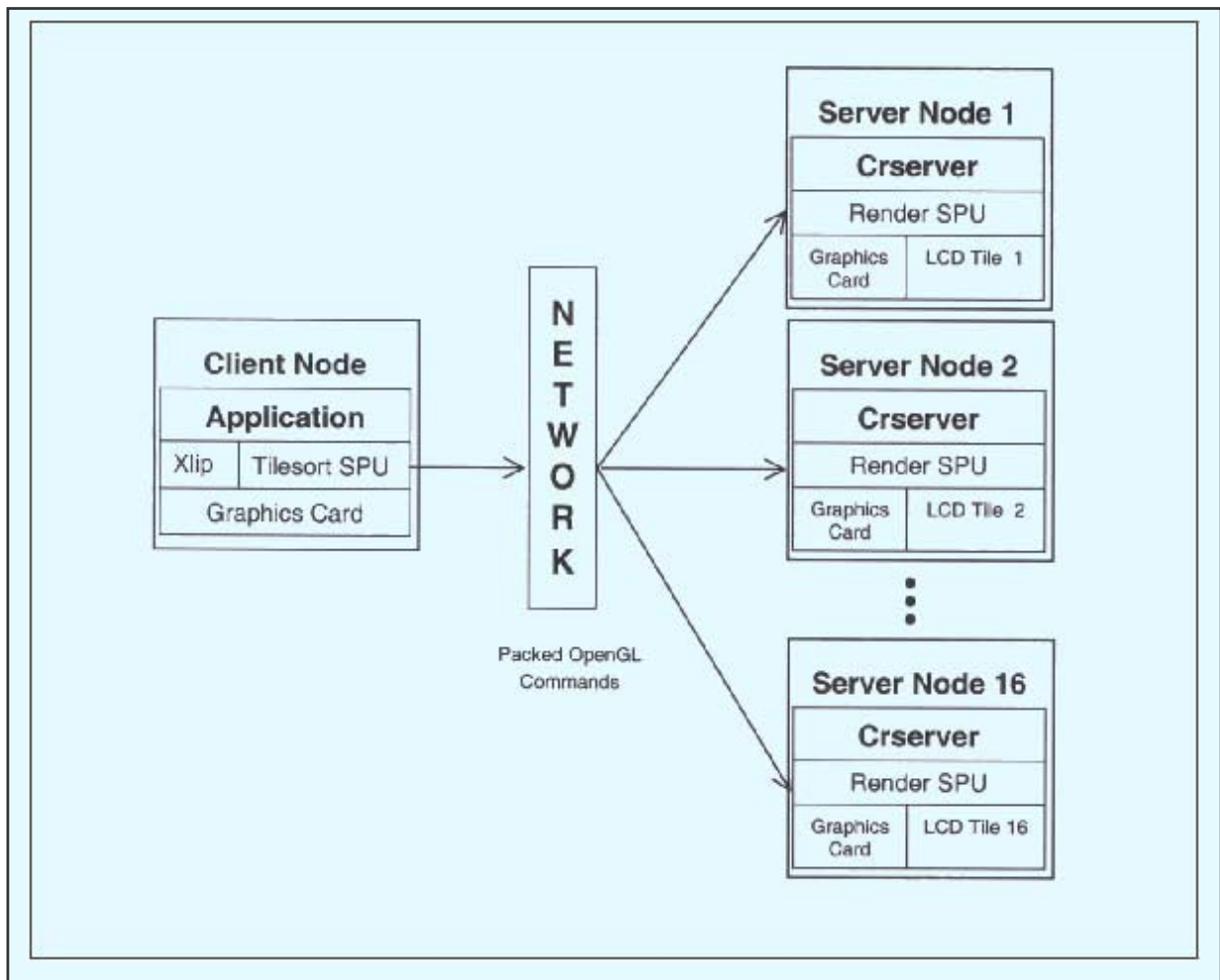
Fig. 3: Sort-first configuration

DMX (Distributed Multihead X)

DMX is an open source framework, distributing X Window sessions across the nodes of a tiled display such that the X display/desktop can span many individual tiles. It is used to run any program that runs under X Windows on the tiled display. The program can use the entire display space and resolution offered by the tiled display.

It works by providing a front-end X server acting as a proxy to a number of back-end X servers running on the nodes of the cluster driving tiled display. X clients will connect to front-end X server running on the control node of the tiled display. Rendering and input requests will be accepted by the front-end server and then will be sent appropriately to back-end servers.

Fig. 4: X session on tiled display

Applications

Many application domains would benefit from the system. The tiled display-aware applications available for visualization, display of images and animations currently include:

CollabCAD

CollabCAD is a java based distributed 2D&3D CAD/CAM and CAE software system being developed by the Computer Aided Design Group of National Informatics Centre, New Delhi.

We have augmented the display capabilities of CollabCAD with the tiled display environment setup in BARC, which is extremely useful for visualizing huge CAD models. It provides detailed view of the individual components of the model

Fig. 5: CollabCAD on tiled display

and as well as overall interrelationships often required for design reviews. Fig 5 shows one such model.

VTK (*Visualization ToolKit*)

VTK is an open source software system for 3D computer graphics and visualization. VTK supports a wide variety of visualization algorithms including scalar, vector, tensor, texture and volumetric methods. The advanced modeling techniques such as implicit modeling, polygon reduction, mesh smoothing; cutting, contouring and triangulation are also supported. We decided to use VTK for our high-end scientific applications running on the rendering cluster and presenting the high-resolution visual information on the tiled display.

We are developing visualization applications for CFD and medical data sets. The visualization of CFD datasets is a powerful tool for problem solving, engineering design and communication of results to decision-makers. CFD visualizations with high-resolution grid will enhance the quality of the visual information. In the field of medical imaging, which is moving from films to digital images, the high-resolution visualization is an absolute need. With this new display technology, it is possible to see the very fine detail of important areas, such as a tumor in the brain, while at the same time seeing the overall context of the entire head. A number of high-resolution slices can be displayed together for analysis.

Interacting with large CFD data sets in real time and providing rich and deep visual feedback is achieved only with rendering cluster and tiled display. This system also provides the cost

Fig. 6: High-resolution visualization of multiple data sets

Fig.7: Postprocessor for CFD applications (scalar plot)

effective and scalable solution in visualizing the complex data sets generated by medical scanners. Interactive visualization in real time

with these datasets provides a wealth of information about internal structures, which lacks in static images.

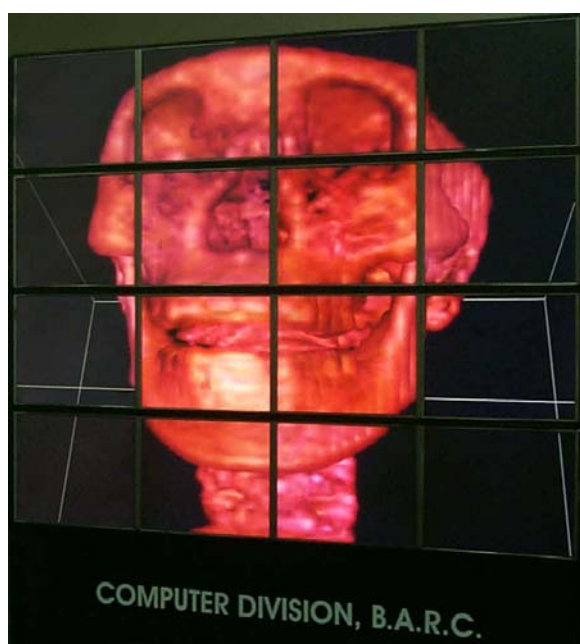
Fig. 8: Volume rendering (isosurfaces)

Fig.9: Volume rendering (ray casting)

Open source softwares like ParaView and VisIt based on VTK, specifically developed for parallel interactive visualization of large data sets, are also available.

VMD

VMD is an open source molecular visualization program for displaying, animating, and analyzing large biomolecular systems.

It is used with our tiled display for high-resolution visualization of complex molecule structures.
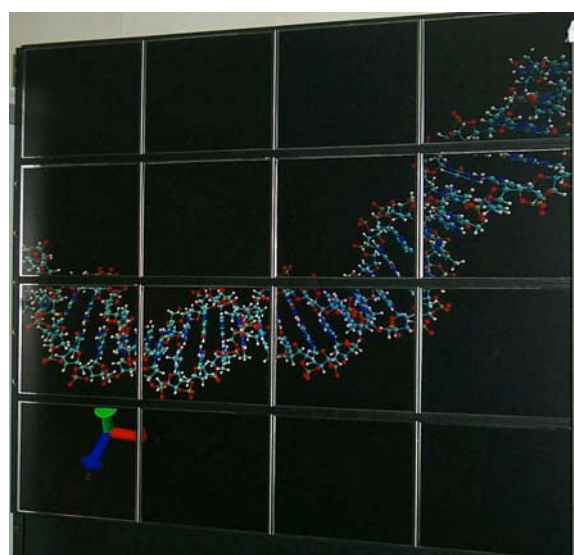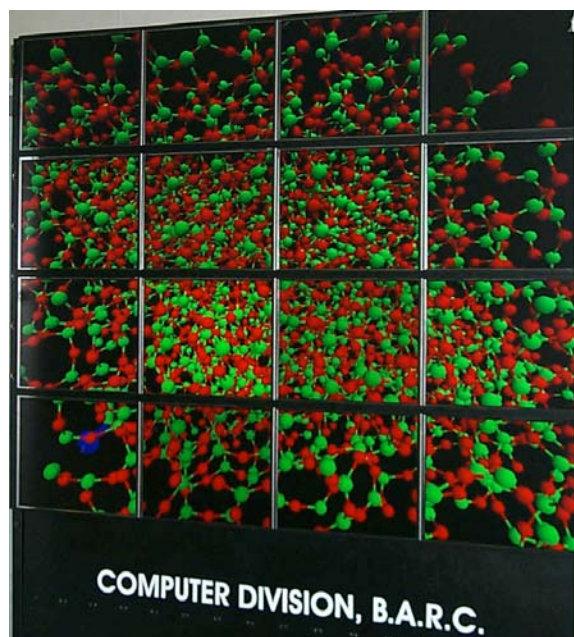

Fig.10: Complex molecule visualization with VMD on tiled display

Tiled MPEG/AVI movie player

The MPEG/AVI movie is a powerful way of visualizing complex data. The tiled movie player developed by Computer Division, BARC, plays the MPEG/AVI movie at the native resolution of the tiled display. It is an MPI (Message Passing Interface) application where the master reads the MPEG/AVI file, decodes it and divides the frame into tiles. Tiles are sent to the slave running on nodes of the tiled display, which uses interpolation for mapping it to the entire display resolution. The frames of the movie are rendered using OpenGL texture functionality.
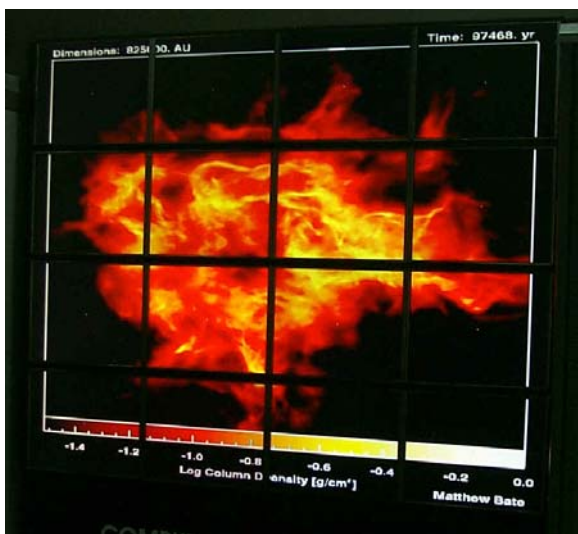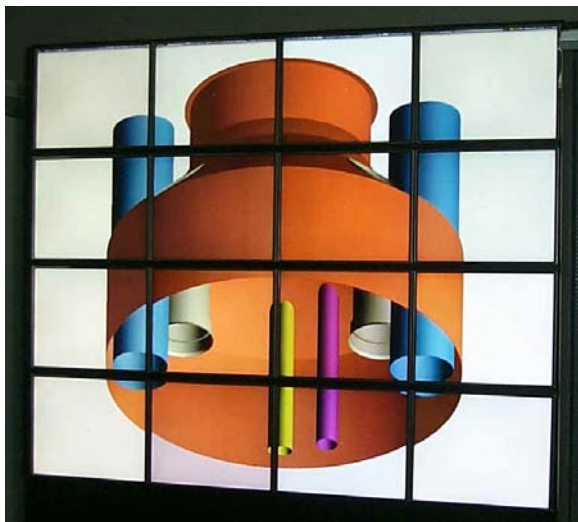
Fig.11: Movie player on Tiled Display

Tiled Image Viewer

It is useful for viewing high-resolution images. The typical display does not have sufficient resolution, requiring scrolling or image shrinking which results in loss of context and lack of details.
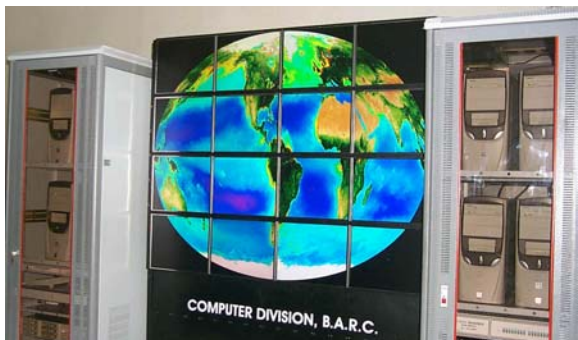

Fig 12: Image viewer on tiled display

Fig. 13: High resolution map on tiled display

Conclusion

The PC rendering cluster and high-resolution tiled display is a reasonable alternative to high-end multiprocessor, multipipe systems. The advantages are low cost and technology tracking: commodity components have better price/performance ratio and improve at faster rate than proprietary hardware. The large field of view (FOV) coupled with 20 times more pixels than the standard display provides the deep and rich visual experience. We found that the approach is scalable, works well with various computing and display configurations. Many visual-intensive applications would benefit from it. The visualization power that is available now also compliments the computational power of BARC's ANUPAM supercomputer.

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DEVELOPMENT OF ADVANCED ALARM ANNUNCIATION SYSTEM FOR NUCLEAR REACTORS

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Introduction

In any plant, when a process parameter goes to abnormal limit, the operator is to be alerted immediately, so that he can take corrective actions to bring the parameter back to normal. Also, when the parameter returns to normal, the operator should know it. This task of calling the operator attention in such conditions is accomplished by alarm annunciation system. This function has a very important role in the safety of nuclear reactors and hence alarm annunciation system is classified as category-IB system as per AERB guidelines.

Alarm annunciation systems have been available around in the industry for quite some time. But systems available in the industry generally do not provide enough self-diagnostic and fault tolerant capabilities required for the purpose of a nuclear reactor. Moreover, it is extremely difficult to qualify these commercially available systems. Hence, Reactor Control Division took up the task of developing an advanced alarm annunciation system.

The requirements were finalised after studying the existing systems, inputs from plant personnel, latest industry trends and methodologies to qualify for category-IB

requirements. It was decided to adopt a microcontroller based distributed architecture with hot standby redundancy.

Though knowledge and experience of designing microcontroller/ microprocessor-based systems was already available with Reactor Control Division, certain new design methodologies were successfully established for the first time during this development.
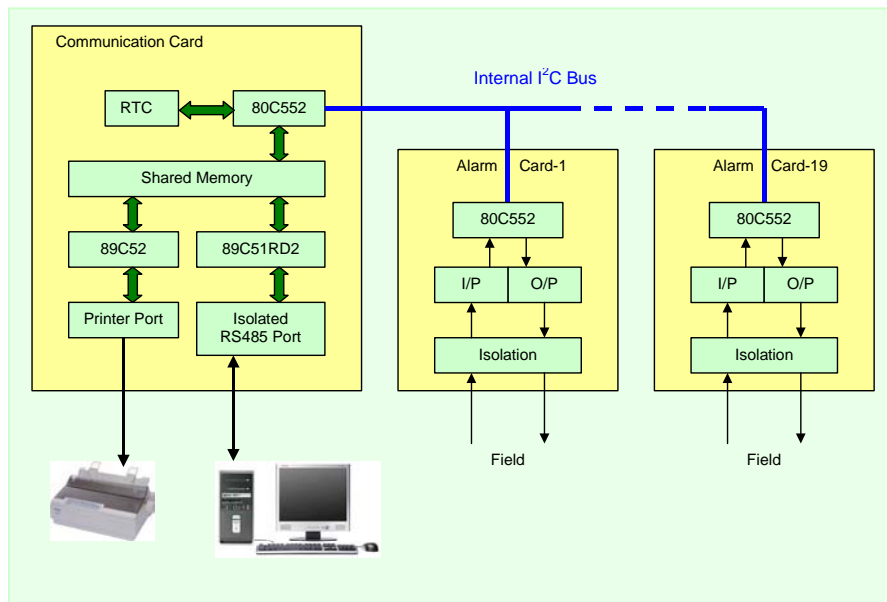

Simplified Architecture

System Basics

The alarm annunciation system acquires the alarm inputs as potential free contacts, processes them as per ring-back sequence and controls the display windows and hooters.

Generally, the display windows and the hooters are located in the main control room on the control panels and the system electronics, referred here as alarm annunciation system, is located in the control equipment room. In other words, they are physically different and can be located at different or at the same location. In control room, operator is provided with a set of push button switches to 'Acknowledge' the incoming alarm by muting the hooters, 'Reset' a returning to normal alarm and carry out a manual 'Test'.
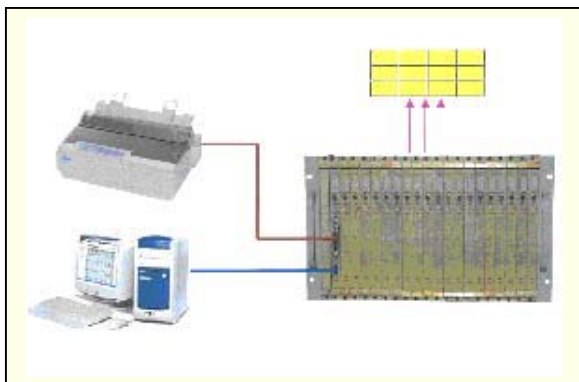
System Description

The advanced alarm annunciation system is designed around industry standard 8051-family of microcontrollers. The system consists of two type of cards, viz. alarm card and communication card. In one 19″ module, there can be one communication card and up to 19 alarm cards.

An alarm card itself is a complete annunciator for 8 alarm points. It also carries out self-diagnostics and sends alarm and diagnostic data to communication card via I^2C bus. It has a dedicated 80C552 microcontroller. Alarm card does not depend upon communication card for its function.
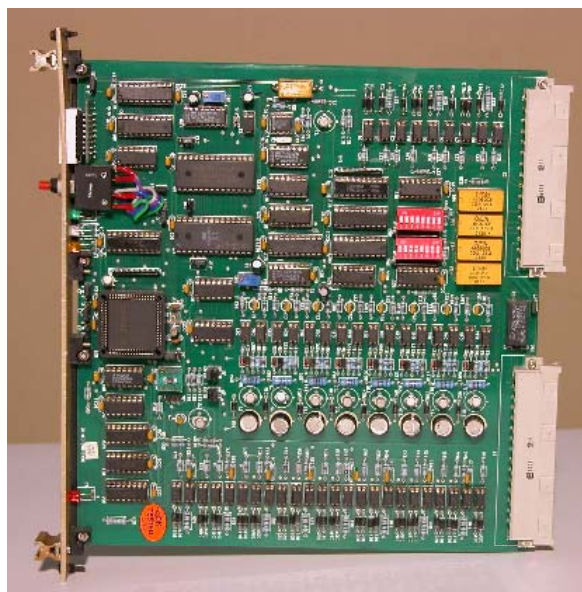
Alarm Card

Communication card employs three microcontrollers on board for various functionalities. Three microcontrollers communicate to each other via a shared RAM. First microcontroller is an 80C552, which acts as a master on I²C bus and collects alarm and diagnostic data from 19 alarm cards of this module. It then timestamps this data using an on-board Real Time Clock (RTC). The second microcontroller is a communication slave on RS-485 external communication. The third controller (89C52) is for on-line printing.

Communication Card

System Features

General

- Micro-controller based modular design.
- Each card can independently handle up to 8 alarms.
- As the microcontrollers are distributed on each card, the failure of one controller does not affect the entire system.
- Each card is a complete annunciator for 8 points.
- Ring-back sequence as per ISA S18.1-R.
- Both single and redundant architecture possible.

- The system is fault tolerant.
- Time stamping in real time format.
- Battery backed memory.
- Cards are Hot-Pluggable.
- Synchronisation with station master clock.
- Self-diagnostic: On board self-diagnostic can detect failures in input, output or microcontroller

Card Level Redundancy

Two alarm cards form a redundant pair. One card is active and the other is standby. When active card fails, the standby card takes over automatically without any bump. This allows multiple card failures in a system as long as they are in different redundant card pairs. The redundant card can sit either in the same bin or in the separate bins. Card level redundancy gives freedom of having some cards in redundant mode and rest of them in single mode. This facilitates optimisation of cost and space.

Online Logging and Printing

Communication card of the system provides a printer port and a serial port. A dot matrix printer can be connected directly to the printer port of the system for online printing of alarms with time stamp. An isolated RS-485 serial port is provided with MODBUS protocol for communication with PC. The PC side software logs the alarm and diagnostic data periodically from the system. The data is stored in database for later analysis. The information is provided to the operator via a tabular graphic user interface.

Manual System Test

Operator can at any time invoke a manual system test by pressing a pushbutton momentarily. This forces the system to enter into 'Test mode'. In this mode, all inputs are simulated by the software and full alarm sequence and system electronics are verified.

Alarm Annunciation System - Front View
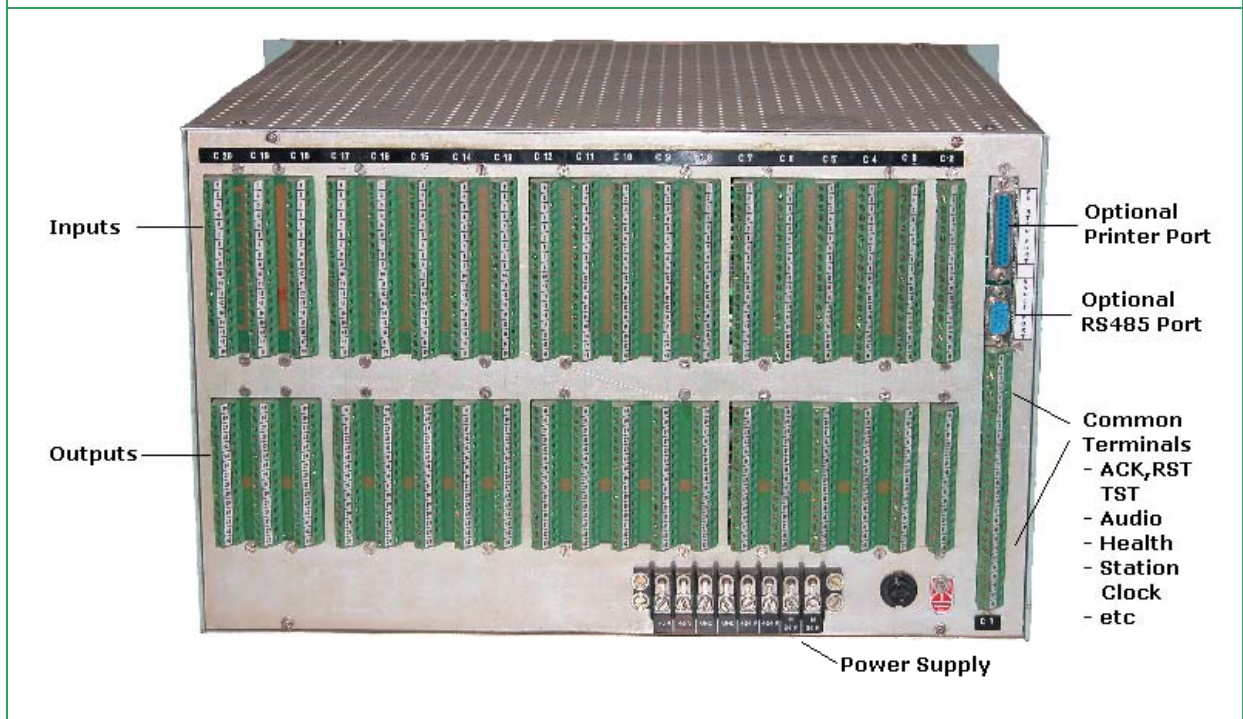
Alarm Annunciation System - Rear View

When system enters the test mode, present state is preserved and the same is restored as soon as the test mode is exited. If there is a change in the actual system inputs during the test mode, the same is registered and presented after the test mode is exited.

Assistance to the Maintenance Personnel

Alphanumeric display and LEDs are provided on each card. By looking at the system, one can easily make out faulty card and type of fault.

Beyond this, one can identify from PC connected to the system the faulty card, faulty channel in the card and type of fault in that channel.

System Engineering

Various aspects were considered for engineering the system module like robustness, ease of operation, wiring, maintenance and aesthetics.

The system module has terminal blocks directly mounted on the backside for input, output and power supply connections. For ease of wiring/maintenance, input and output terminals are separated. One column of the terminals is dedicated for one card. Common signals are provided through a distinct terminal column. Printer port and RS-485 port are available on both front and rear side. Either of the front or rear can be used.

The system is designed to meet seismic requirements. All the components and internal wirings are properly tied and supported. The card guides are provided with springs. Staggered Euro connectors are used and cards are screwed to the bin. System bin has ventilated top and bottom.

One standard 19″ module (approx. 267 mm height, 480mm width, and 420mm depth) can accommodate 19 alarm annunciation cards (152

alarm points). More such modules can be used for larger systems.

The system requires two types of power supplies, viz. 24VDC and 5VDC.

Category-IB compliance

AERB guide SG-D25 defines the criterion for development and qualification of computer based systems. After drawing system requirements, the system architecture design was evolved, collimating hardware and software requirements. After detailed design of hardware and software, system integration, testing and validation was carried out.

Conclusion

A microcontroller based advanced alarm annunciation system with modular distributed architecture and card level active redundancy has been successfully developed. The hardware has been qualified to meet the environmental conditions for a nuclear reactor. The system software has been developed according to category-IB as per AERB guidelines. This system shall be employed in three nuclear reactors at BARC. The technology of the system is being transferred to ECIL, Hyderabad.

OPTICAL TECHNIQUE FOR HIGH SPEED MEASUREMENT

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Optical techniques are most suitable for speed measurement of fast moving projectile, particularly when the projectile is of small size and speed is to be measured in the vicinity of the projectile. Other techniques used are based on

either pin/foil contact technique or microwave signal, the first one being destructive in nature and the second requiring a large size object. Optical techniques have distinct advantage of being non-contact, non-destructive in nature and

are suitable for practically all sizes of objects. It could be based on Doppler's principle or on time of flight principle. An optical technique based on time of flight principle has been developed and used to make an instrument for speed measurement of fast moving projectile fired from a gas gun upto the speed of 4000 m/sec with object size as small as 4 mm in diameter. In this technique, a horizontally moving projectile interrupts two vertical optical screens generated using collimated Laser lines and separated horizontally by a fixed known distance, the time between two interruptions is measured electronically to calculate the speed. The instrument has been supplied to DMRL, Hyderabad, and has been successfully tested upto the projectile speed of 2600 m/sec.

System Description

The system consists of two units:

1) Sensor unit
2) Monitor unit

The Sensor unit and Monitor unit are connected through a single Fiber Optic cable of 50 meters length. The monitor unit is housed inside the control room. This isolates them electrically and eliminates any EMI during the signal travel from sensor unit to monitor unit.

Description of Sensor Unit

The sensor unit consists of a transmitting part and a receiving part. The transmitting part carries two diode laser modules with line generating optics and the line collimating optics to generate two similar and parallel Optical Screens.

An optical screen is created using the collimated Laser line coming out of transmitting part as shown in Fig 1. It is 85mm in height and 1mm width which is obtained from a Diode Laser (635 nm, 15 mW) with uniform intensity line generating optics (SLH501L series of Stocker Yale, Canada), and a spherical lens of diameter 85mm for collimation. The laser line between collimating and focusing optics form the rectangular optical screen. Since the line is collimated, the separation between two units, i.e. transmitting and receiving parts, can be increased to any convenient distance. The collimated line is then focussed at the receiving part using focusing optics on a photodiode (PIN 6D). The output of the photodiode represents the total intensity of the collimated line. There are two such parallel optical screens and distance between two screens is kept at 20 cm. When any projectile passes perpendicular to the optical screen, it reduces the intensity of the Laser line falling on the photodiode by the amount
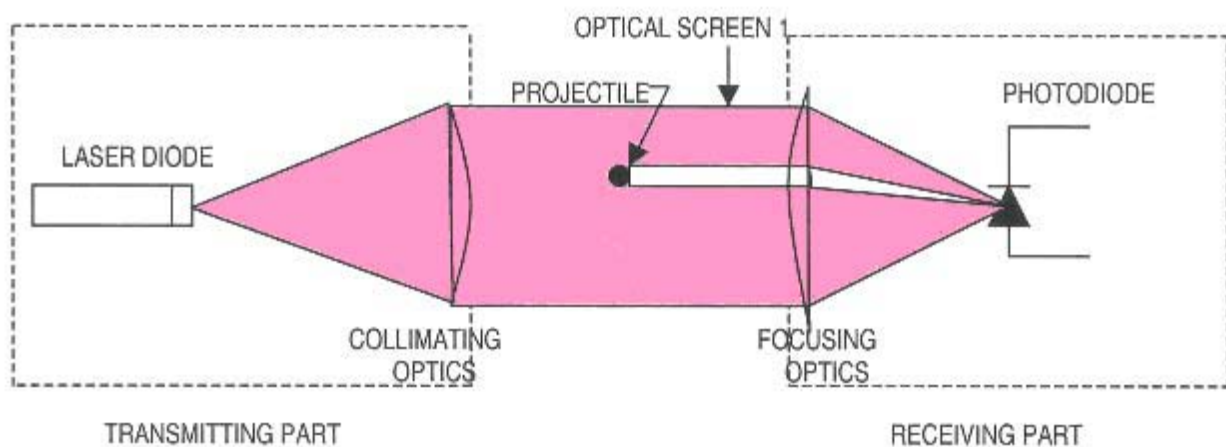

Fig.1: Optical Screen (OS) 1 Generation (projectile is moving perpendicular to the plane of the paper)

proportional to its dimension. This change in the intensity level is amplified by the electronic circuit to generate shadow pulse. The electronic circuit is sensitive enough to detect even 1 % change in intensity. The 4 mm diameter projectile passing through 85 mm line results in about 5 % change in intensity. The electronic circuit consists of amplifier, comparator and pulse generating circuit. The final output signal of electronic circuit is a TTL pulse of 2.5 microsecond duration whenever a projectile passes through any of the optical screen. Shadow pulse generated at optical screen-1 is the start pulse and at optical screen-2 is the stop pulse. These output electrical pulses are consecutively converted into optical pulses by passing it through a fiber optic link transmitter HFBR 1526. One end of the single fiber cable is connected to HFBR 1526.

Description of Monitor Unit

The fiber optic cable used is a multi-mode plastic fiber of core diameter about 1 mm. The other end of the fiber optic cable, carrying pulse signal, is connected at a distance of 50 meters to the fiber optic receiver (HFBR 2526) in the Monitor unit. This unit carries ac amplifier, logic circuit, counter and micro controller (87C51) to process the input pulses and calculate the speed. The programmable counter 8254-2 measures the duration between two pulses. Counter is operated at the clock frequency of 10 MHz. The count value is read by micro-controller, which calculates the speed using the formula,

$$S = D/(C*T) \qquad\qquad --(1)$$

where

S = Speed, D = Distance between two optical screens, C = No. of counts, and T = Counter clock period.
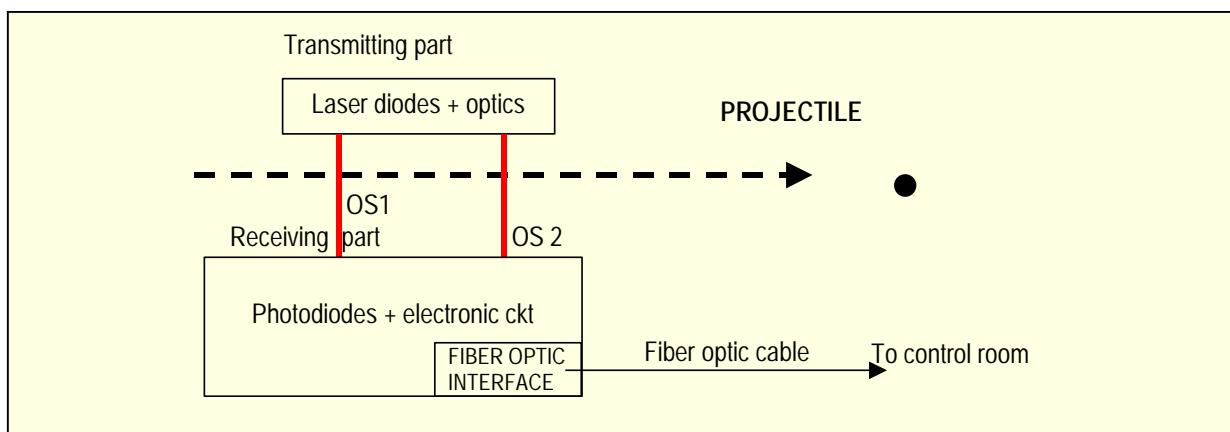

Fig. 2 Block Diagram of the top view of Sensor Unit
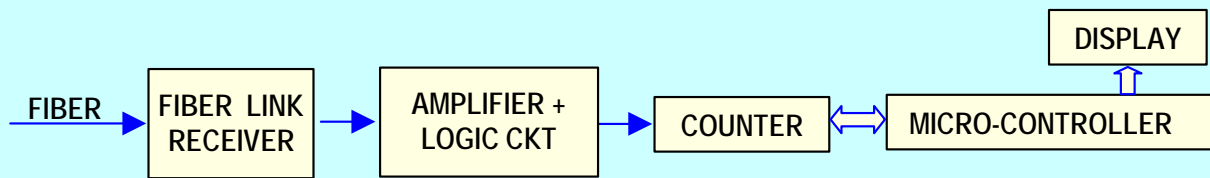

Fig. 3: Sensor Unit

Fig. 4: Block diagram of the Monitor unit

The calculated speed is then displayed on the LCD and simultaneously transmitted through RS 232 interface. There are two switches, viz 1) Test, and 2) Reset, on the unit for user interface.

The Test button is for testing the digital circuit of Monitor unit and if the circuit is working fine then pressing it results in the display of reading 250 m/sec.

The Reset button is to initialize the circuit so that it then becomes ready for new measurement. This Reset button should be pressed after each reading to make the unit ready for next measurement.

Performance

An air gun has been used for testing the system in our laboratory. The pellet of the air gun was of 0.22″ size and the range was 50 meters. The air gun was placed perpendicular to the optical screen on one side of the system. The target, properly aligned, was kept on the other side of the system. The air gun was fixed on a heavy mount, which restricted its movement during and after firing. During testing, the gunpoint was kept very near to the first screen of the set-up and the target near to the second screen. The speed readings for different shots varied from 140 m/sec to 145 m/sec. The reasons for variation in speed value could be due to piece-to-piece difference in mass and shape of projectiles. Although the air gun and the set-up were placed on the same table the reading was not affected due to vibration caused by the gun during firing. The ruggedness in its design is mainly due to the use of Laser line as compared to multiple reflection technique[1] for optical screen generation and tolerance in size of the focusing optics as compared to the size of the Laser line. Due to these design features, a little vibration of the instrument does not deviate the line out of the focusing optics area and thus focused spot remains on photodiode.

An instrument, "Laser Velocity Meter", consisting of a Sensor unit and a Monitor unit, connected by an optical fiber link, has been designed and developed for DMRL, DRDO, Hyderabad. This is required for the high speed projectile measurement in their experiments and testing facility.

It has been tested at DMRL lab using table-top gas gun as shown in Fig 5, and the speed of the projectile fired from the gas-gun was measured upto 400 meters/sec. This reading was compared with a proven system and found in close agreement.

Fig. 5: Testing of Laser Velocity Meter with table-top gas gun

It has been successfully tested with high speed gas gun using cylindrical projectiles of diameter 25 mm upto a speed of 2600 meters/sec.

Discussion

a) It has been found that Laser Velocity Meter is very suitable for measuring speed of fast moving projectiles of different sizes either from the gas gun or ballistic firing range and can be adopted for such different applications.

b) It is observed that due to use of Laser line for generating optical screen, the system is capable of absorbing some vibration caused during firing of gas gun without giving erroneous reading.

c) As the separation between Sensor unit and Monitor unit is about 50 meters, the use of Optical fiber cable has eliminated the formation of ground loops and any EMI in the signal transmitted between the two units.

d) For higher speed measurement, either the separation between optical screens should be increased or counter clock has to be faster. However, increasing the separation reduces the accuracy because it will then be measuring the average speed of the projectile between the far apart screens. Thus increasing the counter clock frequency would be better for accurate high-speed measurement.

e) The use of visible Laser makes the alignment easier.

Conclusion

Because of collimated Laser line that generates optical screen, the separation between the transmitting and receiving units and their separation from projectile path can be adjusted suitably. This technique of high-speed measurement is very simple, instant and is of low cost. Modifications in the optical design can be done to increase the height of the optical screen to cover a larger area. The Laser velocity meter has a local LCD display as well as PC connectivity using RS-232 interface for data logging.

Reference

1. Kawade Nitin O., Bhartiya U.C., Rawat Aseem Singh, Makker S.L., "Optical Technique for Projectile Speed Monitor", *Proceedings of the National Laser Symposium-2000*, New Delhi, India, 74-75

BARC TRANSFERS TECHNOLOGY OF "LASCAN DIA GAUGE"

BARC has transferred the technology on Lascan Dia Gauge developed by Laser & Plasma technology Division, BARC, to M/s. Aditya Engineering Company, Pune. The technology transfer agreement was signed on April 13, 2004 at BARC.

Lascan Dia Gauge is a laser based non-contact diameter measuring instrument ideally suitable for high temperature, toxic radioactive or soft materials. It can be used for on-line measurement, process monitoring and control.

It is based on the principle of beam scanning. A fine beam of visible light from a laser diode is reflected by a high speed-rotating mirror on to a lens to produce parallel scanning beams. These parallel beams after interacting with the object are focused by receiver optics on to a photodiode. Any object kept in the measuring plane will obstruct the scanning beam for a period proportional to its dimension. The parallel beams are then focused by optical means on to a photodiode to generate a shadow pulse of the object, which is electronically processed to give the dimension of the object.

Photograph after signing the agreement with M/s. Aditya Engineering Company, Pune. Seen from left to right are Mr A. S. Bagadi, TT&CD, Mr A. M. Patankar, Head, TT&CD, Mr P. B. Sumant, General Manager, M/s. Aditya Engineering Company, Pune, Mr Aditya Salunkhe, Partner, M/s. Aditya Engineering Company, Pune, Dr N. Venkatramani, Director, Beam Technology Development Group, BARC, Dr A. K. Ray, Head, L&PTD, Mr S. L. Makker, Head, Laser Application Section, L&PTD, Mr A. S. Rawat, L&PTD, and Ms S. Mule, TT&CD.

Technology Transfer and Collaboration Division, BARC, coordinated all activities related to the transfer of this technology, such as preparation of Technical Brochure, Technology Transfer Document, Advertisement of the technology, Technology Transfer Agreement preparation and the signing of Agreement in collaboration with L&PTD and respective parties.

NATIONAL WORKSHOP ON RADIOCHEMISTRY AND APPLICATIONS OF RADIOISOTOPES

The 53rd BRNS-IANCAS National Workshop on Radiochemistry and Applications of Radioisotopes was organised by IANCAS at the National Defence Academy (NDA), Pune, during June 11-17, 2004. Forty-five staff members from NDA and nearby institutions participated in the workshop. Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary to Government of India, Department of Atomic Energy (DAE), inaugurated the workshop. In his inaugural address, Dr Kakodkar stressed upon the applications of various radioactive isotopes in industrial, biological and medical fields. He also focused on the facilities being set up by DAE such as fast breeder reactors and hybrid reactors. The NDA commandant, Vice-Admiral S.C.S. Bangara, in his presidential address, exhorted the participants to update and enhance their professional competence. Dr V. Venugopal, Associate Director, Radiochemistry & Isotope Group, BARC and President, IANCAS, emphasised the importance of the workshop and said that it would be useful in updating the syllabus in academic institutions. Dr M.L. Jayanth Kumar, Convener of the workshop, briefed the participants about the theme of the

workshop. Air Vice-Marshal P.P. Rajkumar, Dy. Commandant, NDA, proposed a vote of thanks.

During the Inauguration of the IANCAS Workshop, Dr Anil Kakodkar, Chairman, DAE receiving a memento from NDA Commandant, Vice-Admiral S.C.S. Bangara. Others from left are Air Vice-Marshal P.P. Rajkumar, Dy. Commandant, NDA, and Dr. S.C. Joshi, Principal, NDA

As the theme of the workshop was to refresh the fundamentals of Nuclear Chemistry and provide an insight into various applications of isotopes,

Valedictory function of the IANCAS Workshop. Sitting from left to right are Dr D.N. Sharma, Head, RSSD, BARC, Dr S.C. Joshi, Principal, NDA, Air Vice-Marshal P.P. Rajkumar, Dy. Commandant, NDA, Dr V.K. Manchanda, Head, Radiochemistry Division, BARC, and Dr M.K. Nagpal, Head,Physics Department, NDA

lectures were delivered in the morning followed by laboratory experiments. In the span of 6 days, 10 lectures were delivered and 4 experiments were conducted. The lectures were highly interactive and led to useful discussions between the participants and the team members of the workshop. In the laboratory work, the participants got hands-on experience in dealing with radioisotopes and radiation instruments. The experiments conducted were simple, elegant and highly illustrative, which brought a lot of appreciation from the participants.

On the last day of the workshop, a feed-back session was conducted where the participants were full of appreciation for the lectures and practicals. It was followed by a valedictory function in which Dr V.K. Manchanda, Head, Radiochemistry Division BARC, and Vice-President, IANCAS, was the Chief Guest who delivered a lecture on fuel reprocessing and waste management. A GM counter and a NaI(Tl) detector were donated to NDA for use in academic and/or research activities. All the 45 participants were awarded certificates by the Dy. Commandant, Air Vice-Marshall P.P. Rajkumar. Dr M.K. Nagpal, Head of the Physics Department, NDA, proposed the vote of thanks.

SAFETY TRAINING PROGRAMME AT BARC FACILITIES AT KALPAKKAM

Faculty and participants of Safety Training programme

A three-day training programme on "Industrial Safety, Radiological Safety & Waste Management Practices" was conducted by Waste Management Division, BARC, during May 26 to 28, 2004 at Centralised Waste Management Facilities (CWMF), BARC, Kalpakkam, for the benefit of 41 tradesmen of the BARC Facilities at Kalpakkam drawn from CWMF, Kalpakkam Reprocessing Plant (KARP) and Waste Immobilisation Project (WIP). The contents of the course covered topics on industrial safety, radiological safety, waste management practices for treatment and handling of solid, liquid and gaseous radioactive waste. Topics on general awareness regarding safety were also covered. An exhibition displaying personal protective equipment for fire safety, radiological safety, and industrial safety was also organised on this occasion for the benefit of the participants.

NATIONAL SYMPOSIUM ON ENVIRONMENT (NSE-13)

The thirteenth National Symposium on Environment was held at the North Eastern Hill University (NEHU), Shillong, Meghalaya, during June 5-7, 2004. The symposium was organised by the Health, Safety & Environment (HS&E) Group, BARC, in collaboration with Atomic Minerals Directorate of Exploration & Research (AMD), Shillong and the Uranium Corporation of India Ltd, (UCIL). It was sponsored by the Board of Research in Nuclear Sciences (BRNS), DAE. The focal theme of NSE-13 was "Mining of Energy Resources – Environmental Management".

The symposium was inaugurated on June 5, 2004, coinciding with the World Environment Day. It was presided over by Dr A. Kakodkar, Chairman, AEC. Prof D.T. Khathing, Registrar, NEHU, welcomed the dignitaries and the delegates. Dr H.S. Kushwaha, Director, HS&E Group, BARC, gave details about the previous and the current NSE symposia and the underlying aims and objectives of the symposia. He also spoke about the BRNS. Dr D.D. Lapang, the Chief Minister of Meghalaya, was the Chief Guest. In his presiding address, Dr Kakodkar reiterated the continuing efforts of DAE in maintaining utmost standards of safety in uranium mining in India. He allayed the fears and apprehensions of some NGOs and the people of Meghalaya, who were opposing the mining project at Domiasiat, Meghalaya. Mr V.D. Puranik, Head, Environment Assessment Division, BARC, thanked the local organizers, dignitaries and delegates, who graced the occasion.

Assessment, etc. Every session began with one or two invited talks by guest speakers, followed by 3-5 oral presentations. Apart from the invited talks, 35 contributory papers and 45 posters were presented at the symposium, by participants form BARC and other institutions and universities. Dr A.N. Shaikh, EAD, BARC, who was also a member of the poster papers committee, presented the summary of all poster papers. The committee also announced three prizes (one each from BARC, NEHU and other universities) in this category.

The symposium was divided into ten sessions. Each session dealt with specific topics like Monitoring, Modeling, Environmental Impact

Dr H.S. Kushwaha spoke about energy resources with particular reference to mining. Dr R. Gupta, CMD, UCIL, discussed the role of UCIL in mining and described the existing and proposed mining and milling facilities in India and their environmental monitoring programmes. Prof Khathing described the impact of ionizing radiation on humans. Dr V. Venkat Raj, former Director, HS&E Group, gave a comparative account of the environmental impact of different sources of energy, used for power generation. Mr Puranik described the various sources of natural radiation to which human beings are exposed in the environment.

Dr S. Ramakrishnan, NPCIL, discussed the current perspectives and future prospects in using nuclear energy. Dr C.F. Lyndgdoh, UCIL, Shillong, described the social impact of coal mining at Cherrapunji, Jaintia Hills, Khasi Hills and Garo Hills in Meghalaya. Dr S.Q. Hoda, Regional Director, AMD, Shillong, talked about Uranium exploration in Meghalaya and the assessment of its impact on the environment. Dr (Ms) Malti Goel, DST, spoke about DST programmes in the management of environmental resources.

NUCLEAR AND RADIOCHEMISTRY SYMPOSIUM (NUCAR 2005)

In association with the Guru Nanak Dev University, Amritsar, the Board of Research in Nuclear Sciences (BRNS), DAE, is organising a symposium on Nuclear and Radiochemistry at Amritsar, during March 15-18, 2005. The objective of the symposium is to provide a forum for effective interaction among the scientists in the areas of Nuclear and Radiochemistry and application of Radioisotopes for the advancement of these disciplines.

The scope of the symposium covers the areas of
- Nuclear chemistry
- Chemistry of actinides and reactor materials
- Spectroscopy of actinides
- Chemistry of fission and activation products
- Radioanalytical chemistry
- Radioisotope applications
- Radioactivity in environment
- Nuclear instrumentation

The programme will include invited talks by eminent scientists as well as contributed papers. These papers would be either oral presentations or posters. A special half-day seminar on

"Application of Radioisotopes in Health Care, Agriculture, Industry & Chemical Research" is also being scheduled as part of the programme.

Interested persons may contact or write to:

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WORKSHOP ON MINIMISATION OF RADIOACTIVE SOLID WASTE

A workshop on "Minimisation of Radioactive Solid Waste" was organised by Waste Management Division, BARC, on August 23-24, 2004 at BARC, Trombay.

Mr Kanwar Raj, Head, Waste Management Division, BARC, in his welcome address, brought out the significance of segregation, categorisation and packaging to achieve minimization of radioactive solid waste.

Mr N.K. Bansal, Associate Director (Operations), Nuclear Recycle Group, BARC, in his opening

remarks, emphasised the need for minimisation of the volumes of radioactive solid waste, which has shown a rising trend in the last few years resulting in utilization of large area for disposal.

Mr D.S. Shukla, Director, Chemical Engineering and Technology Group, BARC, inaugurated the workshop. Mr Shukla pointed out that even though the processes like compaction and incineration are being employed to achieve volume reduction of generated solid wastes, generation at source itself needs to be minimised.

During the workshop, lectures were arranged on various topics like methods of volume reduction,

(L to R) Mr P.D. Ozarde, Plant Supdt., Waste Management Facilities, BARC, Trombay, Mr N.K. Bansal, Associate Director (Operations), Nuclear Recycle Group, BARC, Mr Kanwar Raj, Head, Waste Management Division, BARC, Mr D.S. Shukla, Director, Chemical Engineering & Technology Group, BARC

monitoring of waste, good practices followed at various radio-chemical plants and laboratories, management of waste arising from decommissioning and site remediation, trends in waste generation, as well as on design, construction, operation and radiological safety aspects in near surface disposal facility. Visits to RSMS and CDCFT provided an opportunity to all the participants to have a first hand experience on various aspects of waste management, treatment processes adopted for volume reduction, waste assaying and imaging facilities and also an insight into operation of near surface disposal facility.

The interactive workshop ended with a lively feed back session, where every participant shared his experiences on minimisation of radioactive solid waste and promised to put the lessons learnt during the workshop into practice to achieve the goals of the workshop.

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

भाभा परमाणु अनुसंधान केंद्र के वैज्ञानिकों को दिसंबर ४, २००३, की नैशनल वेल्डिंग गोष्ठी के दौरान दि इन्डियन इंस्टिट्यूट ऑफ वेल्डिंग के द्वारा दो प्रकार के पुरस्कारों से सम्मानित किया गया।

अ) "बेस्ट प्रज़नटेशन इन फेब्रिकेशन " के लिए "केसीपी पुरस्कार " निम्न वैज्ञानिकों को प्रदान किया गया:-

१.   श्री जी. एल. गोस्वामी, अध्यक्ष, एलपी एवं एडब्ल्यूएस

२.   श्री ए. चेटर्जी, एलपी एवं एडब्ल्यूएस

३.   श्री के. जयाराजन, अध्यक्ष, टेलि मेनिपुलेटर सेक्शन, डीआरएचआर

४.   श्री एस. गंगोत्रा, पीआईईडी

५.   श्री मनीश चन्द्रा, एनआरजी

६.   डॉ. साइलेश कुमार, एल एवं पीटीडी

७.   श्री जे.के मिश्रा, डीआरएचआर

८.   श्री एच.बी. कुलकर्णी, चीफ डिज़ाइन इंजीनियर (मेकेनिक्ल), एनआरजी

९.   श्री के. के. प्रसाद, अध्यक्ष, बीईटी एवं डीडी

१०. श्री के. सी साहू , अध्यक्ष, पीआईईडी तथा

११. श्री टी.पी.एस. नाथन, अध्यक्ष, ठोस अवस्था लेज़र प्रभाग, सीएटी, इन्दौर

यह पुरस्कार इन्हें "डेवलोप्मेंट ऑफ रिमोटली आपरेबल लेसर कटिंग सिस्टम फॉर डिसअसेम्बली ऑफ पी एच डबल्यू आर स्पेंट फ्यूअल बंडल्ज़" शोध-पत्र की प्रस्तुति के लिए प्रदान किया गया था।

ब) "लेज़र क्लेडिंग ऑफ निखेल बेसड हार्डफेसिंग मेटीरियल्स एज़ एन आलटरनेटिव ऑफ सेटलाइट" शोध-पत्र की "बेस्ट प्रजनटेशन ऑन नॉन फेरस वेल्डिंग" के लिए श्री जी. एल. गोस्वामी, अध्यक्ष, एलपी एवं एडबल्यूएस, तथा श्री संतोष कुमार, एलपी एवं एडबल्यूएस को "पंथकी पुरस्कार" से सम्मानित किया गया. यह पुरस्कार इन्हे टेक्निकल यूनिवर्सिटी ऑफ क्लौस्थाल, जर्मनी के इन्सटिट्यूट प्युर वेर्कटॉफटेक्नीक उप्ट वेर्कटॉफस्कुंड के डॉ. आर. गलुन तथा प्रोफेसर बी.एल. मोडिक के साथ मिला।

A) The Indian Institute of Welding, during its National Welding Seminar (NWS-2003) held on December 4, 2003, honoured scientists from BARC with two types of awards for their papers presented during January 23-25, 2002 at NWS-2002

The "KCP Award" for "best presentation in fabrication" was given to

1. Mr G. L. Goswami, Head, LP&AWS
2. Mr A. Chatterjee, LP&AWS
3. Mr K. Jayarajan, Head, Tele-Manipulator Section, DRHR
4. Mr. S. Gangotra, PIED
5. Mr Munish Chandra, NRG
6. Dr Shailesh Kumar, L&PTD
7. Mr J.K. Mishra, DRHR
8. Mr H.B. Kulkarni, Chief Design Engineer (Mech.), NRG
9. Mr K.K. Prasad, Head, BETDD
10. Mr K.C. Sahoo, Head, PIED, and
11. Mr T.P.S. Nathan, Head, Solid State Laser Division, CAT, Indore

The award was presented to them for their paper " Development of remotely operable laser cutting system for disassembly of PHWR spent fuel bundles".

B) The "Panthaki Award" for "best presentation on non-ferrous welding" was given to the paper "Laser cladding of Nickel based hardfacing materials as an alternative of stellite". Mr G. L. Goswami, Head, LP&AWS, and Mr Santosh Kumar, LP&AWS jointly shared this award with Dr R. Galun and Prof B.L. Mordike of Institut fur Werktofftechnik and Workstoffkunde, Technical University of Clausthal, Germany.

डॉ. रघुनाथ आचार्या रेडियो रसाइनिकी प्रभाग को "न्यूक्लियर अनालिटिक्ल केमिस्ट्री " के क्षेत्र में विशिष्ट योगदान के लिए इन्डियन एसोसियेशन ऑफ न्युक्लियर केमिस्टस् एन्ड एलाइड सांइटिस्टस् (IANCAS) के द्वारा वर्ष २००३ का डॉ. तरुण दत्ता मेमोरियल यंग सांइटिस्ट अवार्ड प्रदान किया गया। एक प्रशस्ति-पत्र, पदक एवं नकद राशि का यह पुरस्कार उन्हें आइएएनसीएस (IANCAS) के AGM में भाभा परमाणु अनुसंधान केंद्र के पूर्व निदेशक श्री बी.भट्टाचार्जी के द्वारा प्रदान किया गया।

डॉ. आचार्या विभिन्न नमूनों एवं संदर्भ सामग्री के बहु-तत्व निर्धारण के लिए कन्वेन्शनल प्रॉम्प्ट गामा रे की k_o पद्धति एवं भीतरी मोनो-स्टंडार्ड न्यूट्रान एक्टिवेशन एनालिसस् (NAA) के विकास तथा अनुसंधान पर काम करते रहे हैं।

Dr. Raghunath Acharya of Radiochemistry Division, BARC, has been awarded Dr Tarun Datta Memorial Young Scientist Award for the year 2003 by the Indian Association of Nuclear Chemists and Allied Scientists (IANCAS) for his outstanding contributions in the field of "Nuclear Analytical Chemistry". This award comprising a citation, a medal and a cash prize was conferred on him in the AGM of IANCAS by Mr B. Bhattacharjee, former Director, BARC. Dr Acharya has been carrying out research and development work on the k_0-methodologies (single comparator method) in conventional, prompt gamma ray and internal mono-standard neutron activation analysis (NAA) for the multi-element determination in a variety of samples and reference materials.